PICES-2015

Change and Sustainability of the North Pacific

North Pacific Marine Science Organization

October 14-25, 2015
Qingdao, China

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Abstracts for oral presentations are sorted first by session and then by presentation time. Abstracts for posters are sorted by session and then by paper ID number. Presenter name is in bold-face type and underlined. Some abstracts in this collection are not edited and are printed in the condition they were received.

For convenience all presentations (oral and posters) in the "Schedules" Section of the book include the presenter's name only. Full list of co-authors can be found in the "Abstracts" Section.

Notes for Guidance

The North Pacific Marine Science Organization (PICES) announces its 2015 Annual Meeting to be held October 14-25, 2015, at Shangri-La Hotel in Qingdao, China. The meeting is hosted by the State Oceanic Administration of China (SOA), in coordination with the PICES Secretariat. Local arrangements are made by the First Institute of Oceanography (FIO) of SOA and Qingdao City.

Presentations

In order to allow the sessions to run smoothly, and in fairness to other speakers, please note that all presentations are expected to adhere strictly to the time allocated. All authors should designate at least 5 minutes for questions. Authors can download their presentations straight to the computers where the session/workshops will be held.

Important: Please rename your files - time-name.ppt (*e.g.* 0900-Smith.ppt, 1530-Kim.ppt).

If complications occur due to incompatibilities between PCs and Macs, Macintosh owners may use their own computers to make presentations.

Posters

Posters of general interest to the PICES Scientific Committees, including those not necessarily matching the themes of the Topic Sessions and workshops, are welcome. Posters will be on display from October 21 (morning) until the end of the Evening Poster Session/Reception on October 22, when poster presenters are expected to be available to answer questions.

Internet access

Internet access via wireless LAN will be available. A few desktop computers will also be available for participants.

Social activities

1. *Monday, October 19 (18:30-21:00)*
   Ballroom 2-3, Shangri-La Hotel
   Welcome Reception
   The Welcome Reception for all participants (and registered guests).

2. *Wednesday, October 21 (18:00-21:00)*
   Sport Event
   This year the sport event is Jianzi, sort of Chinese hacky sack using heavily weighted shuttlecock.
   Please sign up for participation at the Registration Desk.

3. *Thursday , October 22 (18:00-20:30)*
   Shangri-La Hotel
   Wine & Cheese Poster Session Reception
   The wine & cheese Poster Session at the meeting venue will allow participants to roam around the poster displays and chat with presenters while sipping beer or wine and nibbling on hot and cold hors d'oeuvres.
   Poster presenters are expected to be available to answer questions.

Meeting Timetable

Wednesday, October 14

09:00 18:00	PICES/MAFF Project Science Team Meeting* (FR 31)

Thursday, October 15

	FR 26	FR 25	FR 27	FR 24	FR 31	FR 33
08:55 18:00	**W1** Day 1 Fish-Killing Flagellates	**W3** Links via Primary Producers	**W4** Marine Envir. Emergencies	**W5** Day 1 Marine Radioactivity	**WG-27** Meeting	**WG-32** Meeting Day 1

Friday, October 16

	FR 26	Chairman R.	FR 25	FR 35	FR 24	FR 33	FR 27	FR 31
08:55 12:30	**W1** Day 2 Fish-Killing Flagellates	**W2** Threats to Marine Biodiversity	**WG-28** Meeting Day 1	**WG-29** Meeting	**W5** Day 2 Marine Radioactivity and **WG-30** Meeting	**SG-NPESR3** Meeting	**AP-MBM** Meeting	**PICES/MoE PST** Meeting*
14:00 18:00	**SG-SEES** Meeting							

	FR 31	FR 33
18:00 20:00	**AP-CREAMS** Meeting	**SG-SCOOP** Meeting

Saturday, October 17

	FR 25	FR 26	FR 24	FR 31, 33	FR 27	FR 32	FR 35
08:55 18:00	**WG-28** Meeting Day 2	**WG-31** Meeting	**WG-32** Meeting Day 2	**W6** Best Practices NPCOOS and **AP-NPCOOS** Meeting	**S-CC** Meeting	**S-CCME** Meeting	**S-HAB** Meeting

18:00 20:00	FR 32 **SG-SCISC** Meeting

Sunday, October 18

09:00 12:15	FR 24-25 **FUTURE** Mini-Symposium
12:30 15:30	FR 26 **Science Board** Meeting*
15:45 17:45	FR 26 **FUTURE SSC** Meeting

	FR 26	FR 27	FR 31	FR 24	FR 25	FR 37	FR 32
18:00 20:00	**BIO** Meeting Day 1	**FIS** Meeting Day 1	**MEQ** Meeting Day 1	**MONITOR** Meeting Day 1	**POC** Meeting Day 1	**TCODE** Meeting Day 1	**S-HD** Meeting Day 1

Monday, October 19

09:00 10:00	China Hall 2-3 **Opening Session**
10:30 18:00	China Hall 2-3 **Science Board Symposium (S1)** Change and Sustainability
18:30 21:00	Room Ballroom 2-3 **Welcome Reception** for all participants and registered guests

Meeting Timetable (continued)

Tuesday, October 20

Time	FR 26	FR 31, 33	FR 24-25	FR 35, 37	FR 32
08:55 12:30	**S10** HD of HABs	**BIO-Paper** Session	**FIS-Paper** Session	**POC-Paper Session** Day 1	APC* Meeting

Time	FR 26	FR 27	FR 31	FR 24	FR 25	FR 37	FR 32
14:00 20:00	**BIO** Meeting Day 2	**FIS** Meeting Day 2	**MEQ** Meeting Day 2	**MONITOR** Meeting Day 2	**POC** Meeting Day 2	**TCODE** Meeting Day 2	**S-HD** Meeting Day 2

Wednesday, October 21

Time	FR 24-25	FR 31,33	FR 35, 37	FR 32
08:55 18:00	**S2** El Niño	**S5** West Pacific Circulation	**S8** Marine Ecosystem Services	F&A Meeting*

Time	
18:00 21:00	Sport Event****

Thursday, October 22

Time	FR 26	FR 35, 37	FR 31, 33	FR 24-25	FR 32
08:55 18:00	**S3** E-W Fisheries Approaches	**S4** Pollution Indicators	**S6** Ocean Acidification	**S7** Climate IPCC	**SG-RSP** Meeting [14:00-16:00]

Time	
18:00 20:30	**"Wine and Cheese" Poster Session****

Friday, October 23

Time	FR 26	FR 31, 33	FR 35, 37
08:55 12:20	**S9** Shared Stock Fisheries	MEQ-Paper **Session**	**POC-Paper Session** Day 2

Time	
12:30 13:30	FR 24, 25 **Closing Session*****
13:35 14:35	FR 35, 37 **Joint FUTURE SSC/SB Meeting***
14:40 18:00	FR 35, 37 **Science Board Meeting***
18:30 21:00	**Chairman's Reception*** [by invitation only]

Saturday, October 24

Time		
09:00 18:00	Chairman Room **Science Board Meeting***	FR 35, 37 **Governing Council Meeting***

Sunday, October 25

Time	
13:00 18:00	FR 35, 37 **Governing Council Meeting***

* Closed meetings
** Poster presenters are expected to be available to answer questions
*** Award-winning scientists (Best Oral/Poster presentations) will be announced during the Closing Session
**** Jianzi, sort of Chinese hacky sack using heavily weighted shuttlecock

Sessions/Workshops

S1	Change and Sustainability of the North Pacific
S2	The 2014/15 El Niño and anomalous warming of the North Pacific: What happened?
S3	Eastern-western approaches to fisheries: Resource utilization and ecosystem impacts
S4	Indicators of emerging pollution issues in the North Pacific Ocean
S5	Ocean circulation of the Western Pacific and its response to climate change
S6	Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean
S7	Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5
S8	Marine ecosystem services and economics of marine living resources
S9	Experiences and lessons learned in managing shared/transboundary stock fisheries
S10	The human dimensions of harmful algal blooms
BIO-P	BIO Contributed Paper Session
FIS-P	FIS Contributed Paper Session
MEQ-P	MEQ Contributed Paper Session
POC-P	POC Contributed Paper Session
W1	Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific — A comparative ecosystem approach
W2	Identifying major threats to marine biodiversity and ecosystems in the North Pacific
W3	Linking climate change and anthropogenic impacts to higher trophic levels via primary producers
W4	Marine environment emergencies: detection, monitoring, response and impacts
W5	Monitoring and Assessment of Environmental Radioactivity in the North Pacific
W6	Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems

Meetings

Committees

BIO	Biological Oceanography Committee
FIS	Fishery Science Committee
MEQ	Marine Environmental Quality Committee
MONITOR	Technical Committee on Monitoring
POC	Physical Oceanography and Climate Committee
TCODE	Technical Committee on Data Exchange

Advisory Panels

AP-CREAMS	Advisory Panel for a CREAMS/PICES Program in East Asian Marginal Seas (*reports to MONITOR and POC Committees*)
AP-MBM	Advisory Panel on Marine Birds and Mammals (*reports to BIO Committee*)

AP-NPCOOS	Advisory Panel on North Pacific Coastal Ocean Observing Systems (*reports to TCODE and MONITOR Committees*)

Sections

S-CC	Section on Carbon and Climate (*reports to BIO and POC Committees*)
S-CCME	Section on Climate Change Effects on Marine Ecosystems (*reports to BIO, FIS and POC Committees*)
S-HAB	Section on Ecology of Harmful Algal Blooms in the North Pacific (*reports to MEQ Committee*)
S-HD	Section on Human Dimensions of Marine Systems (*reports to Science Board*)

Study Groups

SG-NPESR3	Study Group on North Pacific Ecosystem Status Report-3 (*reports to Science Board*)
SG-RSP	Study Group on Revising the Strategic Plan (*reports to Governing Council*)
SG-SCISC	Study Group for Scientific Cooperation of ISC and PICES (*reports to Science Board*)
SG-SCOOP	Joint PICES-NOWPAP Study Group on Scientific Cooperation in the North Pacific Ocean (*reports to Science Board*)
SG-SEES	Study Group on Socio-Ecological-Environmental Systems (*reports to Science Board*)

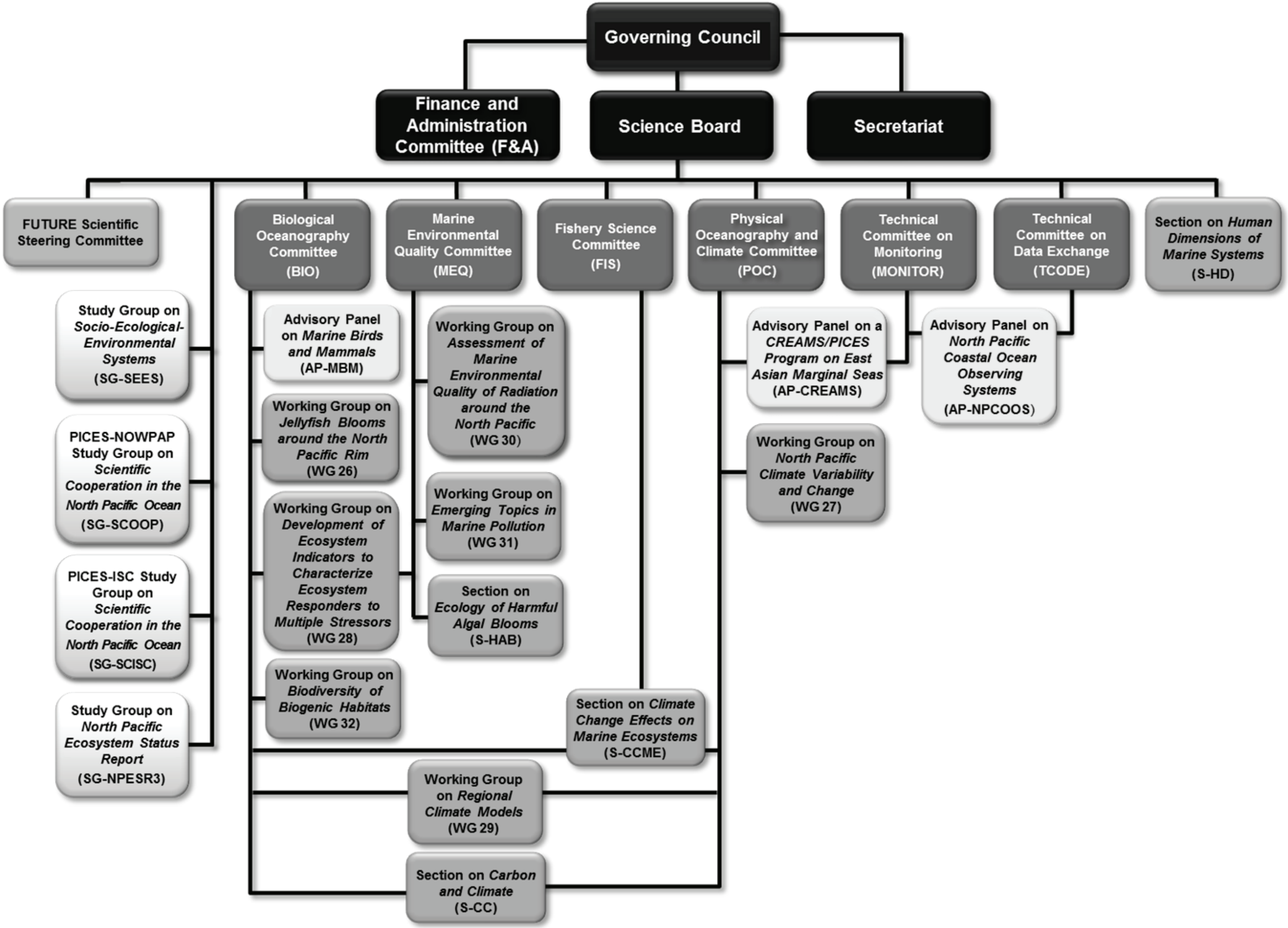
Working Groups

WG-27	Working Group on North Pacific Climate Variability and Change (*reports to POC Committee*)
WG-28	Working Group on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors (*reports to BIO and MEQ Committees*)
WG-29	Working Group on Regional Climate Modeling (*reports to BIO and POC Committees*)
WG-30	Working Group on Assessment of Marine Environmental Quality of Radiation around the North Pacific (*reports to MEQ Committee*)
WG-31	Working Group on Emerging Topics in Marine Pollution (*reports to MEQ Committee*)
WG-32	Working Group on Biodiversity of Biogenic Habitats (*reports to BIO Committee*)

Scientific Program

FUTURE-SSC	Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems Scientific Steering Committee

North Pacific Marine Science Organization (PICES) structure for 2014–2015



Sessions and Workshops Descriptions

S1: Science Board Symposium
Change and Sustainability of the North Pacific

Co-Convenors:
Thomas Therriault (SB)
Angelica Peña (BIO)
Elizabeth Logerwell (FIS)
Chuanlin Huo (MEQ)
Jennifer Boldt (MONITOR)
Kyung-Il Chang (POC)
Toru Suzuki (TCODE)
Steven Bograd (FUTURE)
Hiroaki Saito (FUTURE)
Igor Shevchenko (Russia)

Invited Speakers:
Emanuele Di Lorenzo (Earth & Atmospheric Sciences, Georgia Institute of Technology, USA)
Mike Foreman (Fisheries and Oceans Canada, Canada)
Mitsutaku Makino (Fisheries Research Agency, Japan)
Leonie Robinson (University of Liverpool, UK)
George Waldbusser (Oregon State University, USA)

Since its establishment, PICES has provided leadership in developing a better understanding of the structure, function and changes of North Pacific marine ecosystems. The integrative scientific programs of PICES, and other special activities such as periodic Ecosystem Status Reports, have advanced our knowledge of coupled physical-biogeochemical-ecological processes of the North Pacific. The *Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems* (FUTURE) program is focusing on acquiring better insight into the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services and marine dependent social systems. Climate change research remains important to ocean scientists and governments within PICES. However, the direct and indirect interactions of human activities on coastal and open ocean ecosystems and the services they provide to society are also of great concern in the North Pacific area. A sustainable North Pacific ecosystem is desired by both the public and governments. This vision seeks a balance between resource protection and resource utilization, and a balance between pressing needs at local and regional scales and climate-driven issues at basin and global ocean scales. The nature of the Science Board symposium theme allows for scientific sessions to include topics on climate change, ocean acidification, coastal eutrophication, aquaculture, fishing, pollution, coastal development and planning, sustainability, resilience, vulnerability, cumulative impacts of multiple stressors, and the tradeoffs/conflicts inherent in multiple-use ocean activities, and mechanisms to resolve these. Presentations on the above topics and the relationship and compatibility of marine resource development, eco-environment sustainability, protection and restoration are welcomed for this session.

S2: BIO/MONITOR/TCODE Topic Session
The 2014/15 El Niño and anomalous warming of the North Pacific: What happened?

Co-Convenors:
Bill Peterson (USA)
Lisa Eisner (USA)
Tony Koslow (USA)

Invited Speakers:
Nicholas Bond (University of Washington, USA)
Emanuele Di Lorenzo (Earth & Atmospheric Sciences, Georgia Institute of Technology, USA)

Major El Niño events in 1982/83 and 1997/98 had massive impacts on the ecosystems of the North Pacific Ocean. In spring 2014, computer models were predicting another major El Niño for 2014/15. However, it now appears that the event is weakening (but who knows what the future holds). Despite this, it is perhaps more noteworthy that the entire Pacific north of ~35°N is anomalously warm with SSTs in the Gulf of Alaska that are >4σ above the long-term mean. This warming event appears to be unprecedented, with strong signals in the Gulf of Alaska and Bering Sea, and across the Pacific to Japan, as well as in the Oyashio, the Sea of Okhotsk and coastal waters surrounding Russia, Japan and Korea. Anomalous warming is also seen in the Arctic Ocean, Baffin Bay, the Labrador Sea and much of the far north Atlantic. Key questions to address in this session include what are the atmospheric conditions leading to wide-spread warming, what are the consequences for local weather, and, what are the consequences to ecosystem structure and fisheries? The purpose of this session is to encourage researchers to present evidence of anomalous behaviour in the ecosystems of the North Pacific. We are interested in descriptions of anomalous behaviour in the physical environment, the chemistry of the oceans and the biological impacts of the physical anomalies. The session will be a success if investigators with related stories are brought together to write joint papers describing the evolution and impacts of both the 2014/15 El Niño event as well as anomalous warming of the North Pacific (and perhaps the North Atlantic and adjacent seas).

S3: FIS Topic Session
Eastern-western approaches to fisheries: resource utilization and ecosystem impacts

Co-sponsor: International Council for the Exploration of the Sea (ICES)

Co-Convenors:
Gordon H. Kruse (USA)
Shijie Zhou (Australia)
Xianshi Jin (China)
Jacquelynne King (Canada)
Mitsutaku Makino (Japan)
Marie-Joëlle Rochet (France)

Invited Speakers:
Xianshi Jin (China)
Marie-Joëlle Rochet (France/ICES)
Shijie Zhou (Australia)

FUTURE endeavors to develop a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems, ecosystem services and marine-dependent social systems. Although climate change has garnered much deserved attention so far, the direct and indirect interactions of human society on marine ecosystems and the services they provide are also of great concern. Fisheries are major contributors to global food security, while also posing threats to some ecosystem services. Rising demand for seafood and increasing concerns about the ecosystem effects of fishing create a fisheries management dilemma. Improved understanding about how human activities alter marine ecosystem structure and function is central to exploring options to procure food security in the future. In North America and Europe, emphasis is placed on conservative catch limits for fisheries that are highly selective for large-sizes of certain species. In Asia, a wide spectrum of fish species and sizes enter seafood markets, and less emphasis is placed on constraining catches. Both approaches affect ecosystem structure and functioning. By comparing approaches, can East and West learn from each other? Although questions about how to increase fisheries production while reducing environment impacts are not new, new ideas have entered the debate. For example, "balanced exploitation" advocates sustainable removal levels that strive to maintain natural balance among species, stocks, sexes, and sizes, thus preserving biodiversity. Yet, fisheries are commercial enterprises that must supply consumers with seafood at a profit. Also, fishing represents a diversity of lifestyles that span small-scale, artisanal fishers to large multinational corporations. This topic session provides a forum to compare and contrast alternative fishing strategies for sustainable global food security. Presentations are sought on the effects of fishing on ecosystem structure and function, cultural practices and institutional programs to manage bycatch and discards, better utilization of fishery resources, diversification of seafood products and markets, economic considerations, and many facets of human dimensions. Seafood industry representatives from Eastern and Western cultures will be invited to contribute their perspectives.

S4: MEQ Topic Session
Indicators of emerging pollution issues in the North Pacific Ocean

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors:
Peter S. Ross (Canada)
Olga Lukyanova (Russia)

Invited Speakers:
Tomohiko Isobe (National Institute for Environmental Studies, Japan)
Hyo-Bang Moon (NOWPAP, Korea)
Vladimir Shulkin (NOWPAP, Russia)
Hideshige Takada (NOWPAP, Japan)

This session led by the Working Group on *Emerging Topics in Marine Pollution* (WG-ETMP) anticipates wide-ranging interest from a number of disciplines. The session aims to attract presentations on the use of sediments, shellfish, fish, seabirds, and marine mammals as indicators of marine pollution. Novel approaches and study designs will be discussed, with the aim of providing managers, regulators and scientists with timely feedback on emerging pollution threats. Depending on the study design and sample matrix, it is expected that pollutants to be discussed will include hydrocarbons, organochlorine pesticides, flame retardant chemicals, metals, pharmaceuticals, microplastics and other contaminants. Presentations that provide insight into the identification of contaminants of emerging concern, the ranking of priority pollutants from multiple sources, and the assessment of the relative importance of pollutants among other natural and anthropogenic stressors are encouraged. Presenters will be invited to contribute to a special issue of a scientific journal.

S5: Ocean circulation of the Western Pacific and its response to climate change

Co-sponsor: Climate and Ocean - Variability, Predictability, and Change (CLIVAR)

Co-Convenors:
Zexun Wei (China)
Wang Dongxiao (China)
Dezheng Sun (USA)
R. Dwi Susanto (USA)

Invited Speakers:
Jianping Gan (Hong Kong University of Science and Technology, Hong Kong, SAR China)
Xiaopei Lin (China)
Tangdong Qu (University of Hawaii, USA)

The ocean circulation system of the Western Pacific is complex. The Mindanao Current and the Kuroshio originate from the North Equatorial Current, and the Indonesia Throughflow connects the Pacific and Indian Ocean. The region is characterized by the strongest atmospheric convection and greatest frequency of typhoons anywhere in the world. The ocean circulation of the Western Pacific carries heat from low latitude to high latitude areas where it is released to the atmosphere, adjusting the global air temperature. Meanwhile, processes in this region play a key role in the formation and evolution of the Western Pacific Warm Pool, and have an important effect on the global climate system. The ocean circulation and Warm Pool in the Western Pacific play an important role in regulating the ENSO cycle, the East Asian Monsoon and Subtropical High, and have a significant effect on the marine environment and regional climate in East Asian marginal seas. This session will focus on the North Equatorial Current bifurcation, Mindanao Current, the Indonesian Throughflow, and the Kuroshio and its interaction with the coastal circulation, and will focus on their response to climate change, feedback process and its mechanism.

S6: POC/BIO/MONITOR/TCODE Topic Session
Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean

Co-Convenors:
Li-Qi Chen (China)
Fei Chai (USA)
Kitack Lee (Korea)
Toru Suzuki (Japan)

Invited Speakers:
Richard Bellerby (SKLEC-NIVA Centre for Marine and Coastal Climate Research, East China Normal University, China)
Richard Feely (NOAA Pacific Marine Environmental Laboratory, USA)
Kunshan Gao (Xiamen University, China)
Ja-Myung Kim (Pohang University of Science and Technology, Korea)

Ocean acidification (OA) in the 21st century has reached levels not seen for 55 million years. The average surface pH of the world ocean has decreased by 0.1 since the industrial revolution and is projected to decrease 0.3 to 0.4 pH by the end of this century, an up to 2.5 times increase in ocean acidity. Due to its cold water temperature, low alkalinity and rapid loss of sea-ice, the subarctic Pacific Ocean and adjacent Arctic Ocean have absorbed large amounts of atmospheric CO_2 and have changed the $CaCO_3$ system so that aragonite unsaturated states have appeared or will appear soon on a large scale. OA in the subarctic Pacific Ocean will greatly change the marine chemical environment with far-reaching effect on marine ecosystems. This session will include a review of observations and research on OA and will consider the potential for development of an OA observation network. Main discussion issues are 1) advances in investigations and research in OA in the North Pacific and adjacent areas of the Arctic Ocean, 2) the role of the North Pacific and the Pacific Arctic regions in GOA-ON (Global Ocean Acidification Observation Networks) and AMAP-AOA (Arctic Monitoring and Assessment Program-Arctic Ocean Acidification) and 3) the exchange of data and involvement of early career scientists interested in OA.

S7: POC/BIO/TCODE Topic Session
Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5

Co-Convenors:
Chan Joo Jang (Korea)
Ho-Jeong Shin (Korea)
Zhenya Song (China)
Sukgeun Jung (Korea)
Anne Hollowed (USA)
Kyung-Il Chang (Korea)
Angelica Peña (Canada)
Shin-ichi Ito (Japan)

Invited Speakers:
Jacquelynne R. King (Pacific Biological Station, Fisheries and Oceans Canada, Canada)
Shoshiro Minobe (Hokkaido University, Japan)
Yongqiang Yu (State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, China)

Climate has been changing and is highly likely to have been influenced by human activities. These changes, which have greatly affected the Earth's environment, have been manifested in oceanic ecosystems. Social demands for information on future projections are increasing the need to adapt to and mitigate climate change. The objective of this session is to update our understanding since IPCC AR5 on the past, present and future climate for the North Pacific Ocean and its marine ecosystems, focusing particularly on climatic change in ecosystem-relevant upper ocean and atmospheric variables. Climate change and its impact have been widely investigated using global climate models, while adaptation and mitigation issues have been studied using mostly regional climate models. While this session invites papers on various topics related to both climate simulations and observations, we also encourage presentations on the development and results of regional climate models (RCMs) and Earth System Models (ESMs), and assessment of hindcast simulations and their application to the projection of future climate or marine ecosystems using coupled general circulation models (CGCMs) in the North Pacific Ocean. Future projections of the North Pacific Ocean and its ecosystems, as obtained from global climate models (including CMIP5 standard experiment data for comparison with RCM results) will also be an important contribution to this session.

S8: FIS Topic Session
Marine ecosystem services and economics of marine living resources

Co-sponsor: International Council for the Exploration of the Sea (ICES)

Co-Convenors:
Shang Chen (China)
Sebastian Villasante (Spain/ICES)
Minling Pan (USA)
Ian Perry (Canada)
Keith Criddle (USA)
Mitsutaku Makino (Japan)

Invited Speakers:
Daniel K. Lew (NOAA Fisheries, Alaska Fisheries Science Center, USA)
Sebastian Villasante (Spain/ICES)

Marine ecosystem services (MES) are benefits people obtain from the seas and oceans. Marine ecosystems provide ecological products and services, such as seafood, regulation of climate, reduction of storm disasters, waste purification, recreation and leisure, and biodiversity maintenance. Assessing the value of MES has become an emerging and somewhat challenging subject in the scientific world and is receiving increasing attention from politicians. The United Nations' Millennium Ecosystem Assessment reports published in 2005 focused on discovering changes in global ecosystem status and services. The ongoing World Ocean Assessment program has an urgent need for knowledge on MES. The United Nations Environmental Program formed the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. The IPBES aims to develop and use knowledge on ecosystem services and biodiversity to improve national, regional, and global ecosystem management. The goals of this session are: (1) to provide marine scientists, economists, and ecologists with a venue to exchange results from research on MES, on the economics of marine ecological resources, and on the contribution of the marine environment to the marine and coastal economy, and (2) to provide scientists around the North Pacific a chance to discuss collaboration on scientific projects.

S9: FIS Topic Session
Experiences and lessons learned in managing shared/transboundary stock fisheries

Co-Convenors:
Minling Pan (USA)
Shang Chen (China)
Keith Criddle (USA)
Mitsutaku Makino (Japan)

Invited Speakers:
Robert Blasiak (University of Tokyo, Japan)
Kanae Tokunaga (Ocean Alliance, University of Tokyo, Japan)

The fisheries management for a shared/transboundary stock—a stock that straddles jurisdictional boundaries—is a complex balancing act that will become even more challenging as the distribution of stocks shift in response to climate change. Some of these stocks may only involve users with different interests within a single jurisdiction. Other stocks may involve users from different jurisdictions within a nation, or users from many nations. Achieving conservation objectives for shared/transboundary stocks will require adoption of management regimes that consider biological, economic, and social criteria and elicit effective cooperation among groups. The objective of this session is to gather empirical studies involved with shared/transboundary stock management and to discuss the experiences, challenges, lessons learned, and decision-making processes that lead to successful management.

S10: SB/MEQ Topic Session
The human dimensions of harmful algal blooms

Co-Convenors:
Mark Wells (USA)
Mitsutaku Makino (Japan)

Invited Speakers:
Lorraine C. Backer (Center for Disease Control, GA, USA)
Takashi Kamiyama (Tohoku National Fisheries Research Institute, FRA, Japan)

Harmful algal blooms (HABs) comprise a spectrum of ecological, economic, and human health impacts. High biomass phytoplankton blooms in coastal and shelf waters, most often stemming from anthropogenic inputs of macronutrients, can massively shift ecosystem structure away from the support of higher trophic levels, lead to hypoxia and associated ecological impacts in deep waters, and thereby dramatically affect the human dimension. Smaller biomass blooms of toxic cells can selectively impair ecosystem components, decimate aquaculture industry success, or substantially impact human health. In some instances there are clear effects from direct human activity on HAB development; in others the oceanographic conditions regulate the success of harmful species. Despite the obvious relationship between HABs and human wellness, there has been little formalized linkage between ecological and human wellness research. This topic session is aimed at initiating this linkage by stimulating the cross-thinking needed to better assess human-HAB interactions. Presentations are invited on the distributions and character of HAB events, particularly for PICES member countries and their national interests, and the potential social-economic consequences of these societally-defined (harmful) algal bloom events. This session will provide the foundation for more coordinated efforts between the HAB and Human Dimension Sections to generate inputs useful to Ecosystem Based Management activities, and to guide goals for the FUTURE program.

BIO Contributed Paper Session

Co-Convenors:
Angelica Peña (Canada)
Atsushi Tsuda (Japan)

The Biological Oceanography Committee (BIO) has a wide range of interests spanning from molecular to global scales. BIO targets all organisms living in the marine environment including bacteria, phytoplankton, zooplankton, micronekton, benthos and marine birds and mammals. In this session, we welcome all papers on biological aspects of marine science in the PICES region. Contributions from early career scientists are especially encouraged.

FIS Contributed Paper Session

Co-Convenors:
Xianshi Jin (China)
Elizabeth Logerwell (USA)

This session invites papers addressing general topics in fishery science and fisheries oceanography in the North Pacific and its marginal seas, except those covered by Topic Sessions sponsored by the Fishery Science Committee (FIS).

MEQ Contributed Paper Session

Co-Convenors:
Chuanlin Huo (China)
Darlene Smith (Canada)

Papers are invited on all aspects of marine environmental quality research in the North Pacific and its marginal seas, except those covered by Topic Sessions sponsored by the Marine Environmental Quality Committee (MEQ).

POC Contributed Paper Session

Co-Convenors:
Kyung-Il Chang (Korea)
Michael Foreman (Canada)

Papers are invited on all aspects of physical oceanography and climate in the North Pacific and its marginal seas, except those covered by Topic Sessions sponsored by the Physical Oceanography and Climate Committee (POC).

W1: Workshop
Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific – A comparative ecosystem approach

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors:
Douding Lu (China)
Vera Trainer (USA)

Invited Speakers:
Changkyu Lee (National Fisheries Research and Development Institute, Korea)
Charles Trick (University of Western Ontario, Canada)

There is clear evidence of contrasting occurrence and impacts of fish-killing fish-kill flagellates between the western and eastern Pacific in the comprehensive dataset (2000–2012) assembled during the PICES-2012 workshop on contrasting HABs in PICES member countries. These data provide a unique opportunity for east–west Pacific comparisons to identify and rank those environmental factors that promote HAB success at different times. This workshop will focus on the fish killing species- *Heterosigma akashiwo*, *Cochlodinium* and *Chattonella* and ribotypes—organisms that historically have had massive economic impacts in western PICES member countries, as well as increasingly prevalent impacts in eastern Pacific coastal waters. The workshop foundation will be an extension of the current dataset to the 1990s and earlier where available, with PICES participants pre-submitting available data on: HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, water clarity, nutrients, wind, river flow (flooding), and upwelling indices. Workshop participants will evaluate the trends and patterns in these data to develop hypotheses for development into outlook products on day 1, and develop a detailed outline for manuscript preparation on day 2, including writing assignments and submission deadlines. The manuscript will be targeted for an appropriate peer-reviewed journal.

W2: Workshop
Identifying major threats to marine biodiversity and ecosystems in the North Pacific

Co-sponsor: Northwest Pacific Action Plan (NOWPAP)

Co-Convenors:
Takafumi Yoshida (Japan/NOWPAP)
Chris Rooper (USA)

Invited Speakers:
Malcolm Clark (National Institute of Water and Atmospheric Research, Wellington, New Zealand)
Noriaki Sakaguchi (IPBES Asia-Pacific Regional Assessment, IGES Tokyo Office, Japan/NOWPAP)

Marine ecosystems in the North Pacific are influenced by multiple emerging threats, such as rising sea temperature, harmful algal blooms, marine invasive species, hypoxia and eutrophication. These multiple threats can act synergistically, but perhaps differently, from region to region to change ecosystem structure, function and dynamics. In order to enhance conservation and sustainable use of marine ecosystems in the North Pacific region, it is essential to identify critical threats to them. This will require consultation across PICES and NOWPAP member countries to collect extensive information covering potential main threats. Recently, PICES' Working Group 21 reported on the status of non-indigenous aquatic species in the North Pacific region. That report is complemented by additional studies to identify and characterize ecosystem responses to multiple stressors through Working Group 28. CEARAC, one of the four Regional Activity Centres of NOWPAP, recently launched a project to assess the impact of major threats to marine biodiversity in the western North Pacific. A goal of this activity is to select appropriate indicators for marine biodiversity conservation and develop marine environment assessment methodology for the future. This workshop will discuss common assessment indicators to understand the status of major pressures/stressors/threats to marine biodiversity and to identify future collaborations between PICES and NOWPAP. The workshop will contribute to understanding of marine ecosystems in the North Pacific by selecting candidate indicators for investigating their status in the North Pacific. The output from the workshop will also contribute to FUTURE activities.

W3: Workshop
Linking climate change and anthropogenic impacts to higher trophic levels via primary producers

Co-Convenors:
Joji Ishizaka (Japan)
Angelica Peña (Canada)
Sinjae Yoo (Korea)

Invited Speaker:
Heather Bouman (Oxford University, UK)

The North Pacific and its marginal seas encompass diverse environments under different influences of climate change and anthropogenic impacts. As a result, these ecosystems exhibit a wide range of characteristics. For example, the primary productivity of North Pacific ecosystems ranges from an extreme oligotrophic to hyper-eutrophic state. Various nutrient limitation conditions can be found as exemplified by the subarctic region, one of the major HNLC regions in the world ocean. While ecosystem regime shifts were first identified in the North Pacific, the change in the primary producer level has not been thoroughly compared and studied in relation to regime shifts. In this workshop, we will review the current understanding of the long-term dynamics and distributional differences of primary producers in the North Pacific. We will also review the factors that determine the primary productivity in different ecosystems of the North Pacific. Differential responses by functional groups will be discussed. Finally, gaps will be identified in using primary producers as a linking element in end-to-end modeling, which is an important component of the FUTURE program.

W4: Workshop
Marine Environment Emergencies: Detection, monitoring, response, and impacts

Co-sponsor: International Council for the Exploration of the Sea (ICES), Northwest Pacific Action Plan (NOWPAP)

Co-Convenors:
Ziwei Yao (China)
Seong-Gil Kang (Korea/NOWPAP)
Peter Ross (Canada)
Olga Lukyanova (Russia)

Invited Speaker:
Seong Gil Kang (Korea/NOWPAP)
Yongge Sun (Zhejing University, China)

In recent years, the importance of marine environmental emergency issues has been illustrated by oil and chemical spills, as well as by a major nuclear power plant accident. Globalization of markets has led to rapid growth of maritime transport in the North Pacific, which has become more vulnerable to ship-source incidents, including oil and hazardous and noxious substances (HNS) spills. Oil and HNS spills may be hazardous to human health, harm living resources and marine life, and can damage amenities or interfere with other legitimate uses of the sea. In 2003, the NOWPAP Regional Oil and HNS Spill Contingency Plan (RCP) provided technical and operational guidelines for regional cooperation in responding to oil and HNS spills. Marine environmental emergency issues and their strategies become an increasingly important topic for PICES member countries. However, accepted scientific and monitoring methods to document the ecological impacts of such emergencies, and post-accident recovery of the environment, are lacking. In order to better understand the interaction between the marine ecosystem and human pressures, and to formulate sustainable marine development strategies more effectively, an applied information sharing workshop for PICES is timely. The workshop on marine environmental emergencies has three objectives. The first is to summarize important examples of North Pacific marine environmental emergencies from the perspective of different nations, and to discuss the different approaches taken by PICES member countries. The second is to develop response strategies and capacities of PICES members in light of environmental emergencies. The third is to develop joint strategies to improve responsiveness and effectiveness of current national approaches to manage and mitigate such emergencies in the PICES region. The workshop will address the following three aspects: (1) oil and chemical spills and their damage on the marine environment, (2) detection methods for oil and chemical spills and (3) spill response, monitoring and mitigation strategies at the interface of science and management. Case studies will be used to illustrate this workshop and will serve to focus efforts to design a response and monitoring framework for implementation in the event of a major environmental emergency.

W5: Workshop
Monitoring and Assessment of Environmental Radioactivity in the North Pacific

Co-sponsor: Scientific Committee on Oceanic Research (SCOR)

Co-Convenors:
Yusheng Zhang (China)
Kathryn A. Higley (USA)

Invited Speakers:
Michio Aoyama (SCOR)
Minhan Dai (SCOR)
Ronald Szymczak (Nuclear and Oceanographic Consultant, Tradewinds)

The Marine Environmental Quality Committee's area of responsibility is to promote and coordinate marine environmental quality and interdisciplinary research in the North Pacific. This workshop has three objectives: 1. To coordinate with external expert groups, 2. To review the situation and to discuss the information gaps and deficiencies in monitoring and assessment of the Environmental Quality of Radioactivity and its impact on marine ecosystems in the North Pacific, especially since the "3·11" Fukushima Nuclear Accident, and 3. To exchange information on new techniques and methodologies for monitoring and assessment of the environmental quality of radioactivity in the marine environment, and to discuss development trends and research priorities. The main topics of the workshop include: 1. the current situation of environmental quality of radioactivity and its effect on marine ecosystems in the North Pacific, 2. new techniques for the analysis of radionuclides in the marine environment and 3. assessment of the radiological risk to non-human species. The workshop will invite experts in relevant fields, and welcome reports on research and progress in the above topics with regard to the monitoring and assessment on the marine environmental quality of radioactivity in the North Pacific.

W6: Workshop
Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems

Co-Convenors:
Sung Yong Kim (Korea)
Jack Barth (USA)
Tony Koslow (USA)

Invited Speakers:
David M. Checkley, Jr. (Scripps California Cooperative Oceanic Fisheries Investigations, CalCOFI, USA)
Daji Huang (Second Institute of Oceanography, State Oceanic Administration, China)
Song Sun (Institute of Oceanology, Qingdao, China)

The collection of time series of high-quality physical, chemical and biological data from coastal ocean observatories is critical to the PICES science mission. Coastal ocean observing data are important for documenting changes in coastal ocean ecosystems and for driving numerical circulation and biogeochemical models. There is broad agreement that the 'operators' of coastal observing systems around the North Pacific would benefit from developing best practices – basically sharing experiences on what works and what does not work. At the same time, there have been significant advances in scientific understanding using coastal ocean observing systems. In recent years and in the near future, there has been a big increase in the number of permanent coastal ocean observing systems around the North Pacific. These observatories include shore-based instrumentation, very shallow installations near the coast and in semi-enclosed bays, as well as observatories that span from the coast to full ocean depth. We seek contributions that illustrate the growing number of coastal ocean observatories across the PICES member countries. Examples of topics to be considered for 'best practices' for coastal ocean observing systems include:

- Observing platforms (cabled nodes, autonomous vehicles, moorings, profilers, shore-based instruments, *etc*.),
- Sensors and sensor calibration, including physical, optical, biogeochemical, bioacoustics sensors,
- Data quality control,
- User interfaces to data and information products, with user interfaces varying, depending on their intended audience, *e.g*., observatory operators, scientists, ocean users,
- Data delivery to users, in particular, to numerical modelers
- Data archiving.

Detailed
Schedules at Glance

* Flags an Early Career Scientist

FR stands for "Function Room"

Thursday, October 15

	W1, Day 1 [FR 26]	W3 [FR 25]	W4 [FR 27]	W5, Day 1 [FR 24]
	Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific –A comparative ecosystem approach	**Linking climate change and anthropogenic impacts to higher trophic levels via primary producers**	**Marine environment emergencies: Detection, monitoring, response and impacts**	**Monitoring and assessment of environmental radioactivity in the North Pacific**
	Convenors: Douding Lu (China) Vera L. Trainer (USA)	**Convenors:** Joji Ishizaka (Japan) Angelica Peña (Canada) Sinjae Yoo (Korea)	**Convenors:** Seong-Gil Kang (Korea/NOWPAP) Olga Lukyanova (Russia) Peter Ross (Canada) Ziwei Yao (China)	**Convenors:** Kathryn A. Higley (USA) Yusheng Zhang (China)
8:55	***Introduction by Convenors***	***Introduction by Convenors***	***Introduction by Convenors***	***Introduction by Convenors***
9:00	**Changkyu Lee (Invited)** Fish-kill dinoflagellates in Korean coastal waters – A comparative ecosystem approach	**Heather A. Bouman (Invited)** Detection and distribution of phytoplankton types: A view from space, and implications for higher trophic levels	**Yongge Sun (Invited)** Geochemical and microbial community response to oil spill: A five year investigation after the Xingang oil pipeline explosion, the Dalian Bay, North China	**Ronald Szymczak (Invited)** Asia/Pacific marine ecosystem impacts from the Fukushima Daiichi nuclear power plant accident: A 2011-2015 overview
9:25		**Kirill Kivva** Seasonal nutrient dynamics in the western Bering Sea		**Michio Aoyama (Invited)** ^{134}Cs and ^{137}Cs in the North Pacific Ocean derived from the TEPCO Fukushima Dai-ichi Nuclear Power Plant accident, Japan in March 2011: Transport processes and estimation of ^{134}Cs and ^{137}Cs inventories
9:30			**Seong Gil Kang (Invited)** Marine pollution preparedness and response to oil and HNS spill incidents in the Northwest Pacific Action Plan (NOWPAP) region	
9:45	**Charles G. Trick (Invited)** Comparing physiologies and toxicities in *Heterosigma akashiwo*: An east-west perspective	**Young Baek Son** Collapse of summer biological activity in the East China Sea during 1998-2014		
9:50				**Minhan Dai (Invited)** Sources and inventory of Cesium and Plutonium in China seas
10:00			**Peter Ross** The MV *Marathassa*: Lessons learned from the 2015 spill of Bunker fuel in Vancouver Harbour	
10:05		**Xin-Ming Pu** Effects of Changjiang Diluted Water on the planktonic ecology of the Yellow Sea Cold Water Mass		
10:15				**Kyung-Tae Jung** Development of a radionuclide transport model applicable to coastal regimes with multi-fractional cohesive and non-cohesive sediments
10:20			**Chuanyuan Wang** Distribution and sources of hydrocarbons in surface sediments from tail reaches of the Yellow River Estuary	

W1, Day 1	[FR 26]	W3	[FR 25]	W4	[FR 27]	W5, Day 1	[FR 24]
10:30	***Coffee break***	10:30	***Coffee break***				
10:35						10:35	***Coffee break***
10:40				10:40	***Coffee break***		
10:50	**Svetlana Esenkulova** *Heterosigma akashiwo* bloom and associated environmental conditions in Cowichan Bay, Canada in 2014	10:50	**Shu Yang** Regional differences in decadal variations of diatom primary productivity in the southern Yellow Sea and adjacent seas over the past 100 years				
10:55						10:55	**Chang Zhao** Long-term transport and dispersion of ^{137}Cs released into ocean off Fukushima nuclear accident
11:00				11:00	**Adedayo O. Adeleye** Genotoxic effects of PCBs and heavy metals on marine mussels		
11:10	**Vera L. Trainer** Fish-kill flagellates in the Salish Sea –A comparative ecosystem approach	11:10	**Soonmi Lee** Variability of chlorophyll-a bloom timing associated with physical forcing in the East Sea/Sea of Japan (1998-2014)				
11:15						11:15	**Shin-ichi Ito** Model developments to estimate movements of radioactive cesium with ocean sediment after the Fukushima Dai-ichi nuclear power plant accident
11:20				11:20	**Zhen Wang** Distinguishing crude oils from heavy fuel oils by polycyclic aromatic hydrocarbon fingerprints		
11:30	**Ichiro Imai** Biological characteristics of the red tide causing raphidophytes *Heterosigma akashiwo* and *Chattonella* spp. in the coastal Sea of Japan	11:30	***Discussion/Summary***				
11:35						11:35	***Discussion***
11:40				11:40	**Patrick D. O'Hara** Oil dispersants impact feather function in marine birds		
11:50	**Douding Lu** Fish-killing *Heterosigma akashiwo* blooms in Chinese coastal waters						
12:00				12:00	**Un Hyuk Yim** Lessons learned from the Hebei Spirit oil spill: Environmental perspectives		
12:10	**Tatiana Yu. Orlova** Raphidophytes in the coastal waters of Far East of Russia during the latter period of the last century						
12:20				12:20	***Lunch***		
12:30	***Lunch***	12:30	***Lunch***			12:30	***Lunch***
14:00	**Yeseul Kim** Testing several hypotheses on the outbreak mechanisms of *Cochlodinium polykrikoides* blooms in the southern coastal waters of Korea	14:00	**Yuping Zhou** Effects of increasing nutrient loads on the competition and succession between two predominant red tide algae of East China Sea	14:00	**Yongliang Wei** Oil spill trajectory prediction using the GNOME model and satellite images	14:00	**John N. Smith** Transport of the Fukushima radioactivity plume to the Eastern North Pacific Ocean

W1, Day 1 [FR 26]

14:40	***Discussion***
15:00	**Nicola Haigh** USA: Presentation of spreadsheets describing *Heterosigma*, *Chattonella* and *Cochlodinium*
15:20	**Tatiana Orlova** Russia: Presentation of spreadsheets describing *Heterosigma*, *Chattonella* and *Cochlodinium*
15:40	***Coffee break***
16:00	**Ichiro Imai, Shigeru Itakura** Japan: Presentation of spreadsheets describing *Heterosigma*, *Chattonella* and *Cochlodinium*
16:20	**Chunjiang Guan, Chunlei Gao, Hao Guo** China: Presentation of spreadsheets describing *Heterosigma*, *Chattonella* and *Cochlodinium*

W3 [FR 25]

14:20	**Sinjae Yoo** Variability of the phytoplankton functional types under changing winter vertical mixing in the Ulleung Basin, East Sea: A modeling study
14:40	**Svetlana Esenkulova** Examining linkages between juvenile salmon growth and phytoplankton, zooplankton dynamics during the early marine period
15:00	**Yi Xu** Migration behavior changes of juvenile North Pacific albacore linking to environmental variability
15:20	***Coffee break***
16:00	***Discussion/Summary***

W4 [FR 27]

14:20	**Ferdenant Mkrtchyan** Features of GIMS- technology in environmental monitoring of marine ecosystems
14:40	**Yoon Young Back** The activities of Marine Environmental Emergency Preparedness and Response Regional Activity (MERRAC) for oil and HNS spills preparedness and response in the Northwest Pacific Action Plan (NOWPAP) region
15:00	***Coffee break***
15:20	***Discussion***

W5, Day 1 [FR 24]

14:20	**Hideki Kaeriyama** Monitoring activity on radioactive cesium in seawater and sediment in the North Pacific by Fisheries Research Agency after the Fukushima Dai-ichi Nuclear Power Plant Accident
14:40	**Wen Yu** Distribution and impact of radiocesium in the seawater of northwest Pacific in 2014
15:00	**Takami Morita** ***(cancelled)*** Radioactive cesium in marine biota off Fukushima
15:20	**Wu Men** The radioactive level of nekton species in the Northwest Pacific more than one year after Fukushima nuclear accident
15:40	***Coffee break***
16:00	**Hiroyuki Togashi** Temporal changes in the distribution of radiocesium contamination among ten dominant coastal fish species in Sendai bay and the coastal area off Fukushima
16:20	**Yutaka Kurita** Radiocesium contamination histories of Japanese flounder *Paralichthys olivaceus* after the 2011 Fukushima Nuclear Power Plant accident

W1, Day 1	[FR 26]	W3	[FR 25]	W4	[FR 27]	W5, Day 1	[FR 24]
16:40	**Changkyu Lee, Hae Jin Jong** Korea: Presentation of spreadsheets describing *Heterosigma*, *Chattonella* and *Cochlodinium*					16:40	***Discussion***
17:00	***Discussion*** East-West comparison and assignments for Day 2			17:00	***Workshop ends***		
17:50						17:50	***Summary***
18:00	***Workshop ends***	18:00	***Workshop ends***			18:00	***Workshop ends***

FR stands for "Function Room"

Friday, October 16

W2 [Chairman Room]		W5, Day 2 [FR 24]		W1, Day 2 [FR 26]	
Identifying major threats to marine biodiversity and ecosystems in the North Pacific		**Monitoring and assessment of environmental radioactivity in the North Pacific**		**Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific – A comparative ecosystem approach**	
Convenors: Chris Rooper (USA) Takafumi Yoshida (Japan/NOWPAP)		**Convenors:** Kathryn A. Higley (USA) Yusheng Zhang (China)		**Convenors:** Douding Lu (China) Vera L. Trainer (USA)	
8:55	***Introduction by Session Convenors***	8:55	***Introduction by Session Convenors***		
NOWPAP-related talks					
9:00	**Noriaki Sakaguchi (Invited)** IPBES Asia-Pacific regional/subregional assessment on biodiversity and ecosystem services	9:00	**Kathryn A. Higley** Challenges in calculating radiation dose to marine organisms	9:00	***Discussion and writing***
9:20		9:20	**Jinqiu Du** Assessment on marine environmental impact from artificial radionuclides in the coastal waters of Liaodong Bay		
9:25	**Takafumi Yoshida** Regional report on the impact of major threats to marine biodiversity in the NOWPAP region				
9:40		9:40	**Ken Fujimoto** Use of otoliths to estimate the concentration of radioactive strontium		
9:45	**Bei Huang** Assessment of the impacts of major threats to marine biodiversity in coastal waters of Yantai and Dalian, China				
10:00		10:00	**Jianhua He** A new device for precipitation and filtration of radiocesium in seawater		
10:05	**Young Nam Kim** Case study of identifying major threats to marine biodiversity in Korean coastal waters				
10:20		10:20	**Zhenfang Dong** Auto-system development and invention for measurement of $^{137}Cs/^{134}Cs$ *in-situ*		
10:25	**Tatiana Orlova** Potential threats to marine biodiversity and ecosystems in the Russian area of NOWPAP				
10:40		10:40	***Coffee break***	10:40	***Coffee break***
10:45	***Coffee break***				
11:00		11:00	***Discussion***	11:00	***Discussion and writing***
11:05	***Discussion/Summary***				

W2	[Chairman Room]
12:30	***Lunch***
W2 GENERAL talks	
14:00	**Malcolm Clark (Invited)** Threats to marine biodiversity in the Deep Sea: Experience from New Zealand in data-poor situations
14:25	**Fang Li** Preliminary study on the connection effects between nearshore islands and the continent in the sea area of Liaoning Province, China and its effects
14:45	**Cherisse Du Preez** Unique and vulnerable community assemblies on a shallow North Pacific seamount
15:05	**Janelle Curtis** Distribution of vulnerable marine ecosystem indicator taxa in relation to fishing effort on Cobb Seamount
15:25	**Malcolm R. Clark** Sustainable deep-sea fisheries and environmental conservation: How can we balance conflicting objectives?
15:45	***Coffee break***
16:05	***Discussion/Summary***
18:00	***Workshop ends***

W5, Day 2	[FR 24]
12:30	***Workshop ends***

W1, Day 2	[FR 26]
12:30	***Lunch***
14:00	***Discussion and writing***
15:45	***Coffee break***
16:05	***Discussion and writing***
18:00	***Workshop ends***

FR stands for "Function Room"

Saturday, October 17

S-HAB	[FR 35]	W6, AP-NPCOOS meeting	[FR 31/33]
Section on Ecology of Harmful Algal Blooms in the North Pacific meeting		**Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems**	
Convenors: Shigeru Itakura (Japan) Vera L. Trainer (USA)		**Convenors:** Jack Barth (USA) Sung Yong Kim (Korea) Tony Koslow (USA)	
8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***
9:00		9:00	**Daji Huang (Invited)** Chinese efforts in coastal ocean observation in 21st century
Country Reports (2013-15) and HAE-DAT (year 2008) reports			
9:15	**China: Douding Lu**		
9:30	**USA: Vera L. Trainer**	9:30	**David M. Checkley, Jr. (Invited)** CalCOFI: Best practices under a changing climate
9:45	**Japan: Shigeru Itakura**		
10:00	**Korea: Changkyu Lee**	10:00	**Song Sun (Invited)** Brief introduction of marine observing system in China
10:15	**Canada: Charles Trick**		
10:30	***Coffee break***	10:30	***Coffee break***
10:50		10:50	**S. Kim Juniper** Development and implementation of best practices for the Ocean Networks Canada ocean observatories
11:00	**Russia: Tatiana Morozova**		
11:10		11:10	**Matthew R. Baker** Research in the Arctic: Coordinated approaches to baseline understanding of the ecosystem and analyses of change in the Northern Bering Sea, Chirikov Basin, and Chukchi Sea
11:15	**Peng Zhao** Emergency monitoring and forecasting system of green tide in the Yellow Sea		

S-HAB [FR 35]		W6, AP-NPCOOS meeting [FR 31/33]	
11:30	**Han Gao** Prey cells and extraction trigger DSP toxin production by *Dinophysis acuminata*	11:30	**John A. Barth** Coastal ocean observing in the northeast Pacific
11:45	**Ke Sun** Modelling of the *Prorocentrum donghaiense* bloom in the coastal waters of the East China Sea		
11:50		11:50	**J. Anthony Koslow** Fishes as indicators of ecosystem change and how they can be incorporated into coastal ocean observing systems
12:00	**Anna A. Ponomareva** HAB monitoring in Paris Bay (the north-western part of the East/Japan Sea) where marine mammals are kept in captivity		
12:10		12:10	**Jiajia Liu** An overview of wireless communication technology in ocean observing system
12:15	**Yan Tian** *Karenia mikimotoi* bloom, massive fish-killing and shellfish-killing in the East China Sea		
12:30	***Lunch***	12:30	**Sung Yong Kim** A vision for the integrated coastal ocean observing system in Korea
12:50		12:50	***Lunch***
14:00	**Charles Trick and Vera L. Trainer**	14:00	***AP-NPCOOS meeting***
14:15	**Mark Wells**		
14:30	**Henrik Enevoldsen and Vera L. Trainer**		
14:45	**Shigeru Itakura and Vera L. Trainer**		
15:00	***Discussion*** Workshop proposals, part III, Contrasting conditions for success of selected harmful algal species in the western and eastern Pacific – A comparative ecosystem approach		
15:30	***Coffee break***		
15:40		15:40	***Coffee break***
16:00	***Discussion*** Proposals for the future and review of assignments		
18:00	***Meeting ends***	18:00	***Meeting ends***

Monday, October 19
[China Hall 2-3]

S1: Change and Sustainability of the North Pacific

Convenors:
Thomas Therriault (SB)
Angelica Peña (BIO)
Elizabeth Logerwell (FIS)
Chuanlin Huo (MEQ)
Jennifer Boldt (MONITOR)
Kyung-Il Chang (POC)
Toru Suzuki (TCODE)
Steven Bograd (FUTURE)
Hiroaki Saito (FUTURE)
Igor Shevchenko (Russia)

10:30-11:15

Lixin Wu (Keynote)
Multiscale processes of Pacific western boundary currents and their roles in climate

Ocean University of China and Qingdao National Laboratory of Marine Science and Technology

Pacific Ocean western boundary currents were among the first currents of these types to be explored by pioneering oceanographers. It has been recognized that these western boundary currents are highly variable with complex spatial and temporal scales. The widely accepted but poorly quantified importance of these currents—in processes such as the El Niño/Southern Oscillation, the Pacific Decadal Oscillation, winter storm genesis, and carbon uptake in mid-latitudes—has triggered renewed interest. Ongoing efforts are seeking to better understand their energy balance, multiscale air-sea interaction, potential predictability, interaction with Asian marginal seas and possible changes associated with greenhouse-gas-induced climate change. Only a concerted international effort will close the observational, theoretical and technical gaps currently limiting a robust answer to these elusive questions.

10:30	**Lixin Wu (Keynote)** Multiscale processes of Pacific western boundary currents and their roles in climate
11:15	**Emanuele Di Lorenzo (Invited)** Towards a social-ecological-environmental system approach for the coastal ocean
11:45	**Michael Foreman (Invited)** Regional climate modeling and FUTURE – An overview and possible future directions
12:15	**Mitsutaku Makino (Invited)** Toward the integrated research in fisheries science
12:45	***Lunch***
14:15	**George G. Waldbusser (Invited)** Impacts of ocean acidification on bivalve production in the Pacific Northwest
14:45	**Jeffrey Polovina** Using earth systems model output to project climate change impacts to the North Pacific Subtropical Ecosystem over the 21st Century
15:05	**Lingbo Li*** Fighting a hard battle: Effects of hypoxia and temperature on euphausiids in the North Pacific
15:25	**Andrew W. Trites** Top predators partition the Bering Sea and are unlikely to respond favourably to climate change
15:45	***Coffee break***
16:05	**Leonie A. Robinson (Invited)** A European perspective on Integrated Ecosystem Assessment
16:35	**Shin-ichi Uye** Jellyfish blooms as a threat to the sustainability of the East Asian Marginal Seas: An overview of recent jellyfish studies in China, Japan and Korea
16:55	**Vladimir I. Ponomarev** Multiple scale climate variability in the North Pacific and features of recent climatic regime
17:15	**Takamitsu Ito** Anthropogenic aerosols and climate variability control decadal variability of dissolved oxygen in the North Pacific
17:35	**Jameal F. Samhouri** Social-ecological vulnerability of forage fish and fishermen to climate change
17:55	***Session ends***

Tuesday, October 20

S10 [FR 26]		BIO-Paper [FR 31/33]		FIS-Paper [FR 24/25]		POC-P, Day1 [FR 35/37]	
The human dimensions of harmful algal blooms **Convenors:** Mitsutaku Makino (Japan) Mark Wells (USA)		**Convenors:** Angelica Peña (Canada) Atsushi Tsuda (Japan)		**Convenors:** Xianshi Jin (China) Elizabeth Logerwell (USA)		**Convenors:** Kyung-Il Chang (Korea) Michael Foreman (Canada)	
8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***
9:00	**Lorraine C. Backer (Invited)** Human dimensions of harmful algal blooms (HABs): Contributing to ecosystem-based management	9:00	**Samuel R. Laney** Using imaging flow cytometry to examine phytoplankton assemblage structure in the Bering Sea	9:00	**Hiromichi Igarashi** Relationships between ocean conditions and interannual variability of habitat suitability index (HSI) distribution for neon flying squid in central North Pacific examined using new 4D-VAR ocean reanalysis dataset	9:00	**Fangli Qiao** The development of a high resolution global ocean surface wave-tide-circulation coupled model
9:20		9:20	**Mitsuhide Sato*** Distribution of mixotrophic phytoplankton along the latitudinal transect of the central North Pacific	9:20	**Shinya Ohshima*** Annual variability in the distribution and biomass of dominant myctophid fishes off western Kyushu, Japan	9:20	**Hiromichi Ueno** Global distribution of mergers and splits of oceanic mesoscale eddies
9:25	**Takasi Kamiyama (Invited)** Changes in occurrence of paralytic shellfish poisoning and the effects on bivalve aquaculture in Tohoku region of Japan after the Great East Japan Earthquake						
9:40		9:40	**Yunyun Zhuang*** Using 454 pyrosequencing to analyze the *in situ* diet of the marine copepod *Calanus sinicus*	9:40	**Sandra Neidetcher** Image-analysis software applied to assess spatial and temporal variability of fecundity in Walleye pollock, *Gadus chalcogrammus*	9:40	**Ze-Nan Zhu** Tomographic mapping of nonlinear tidal and residual currents
9:50	**Aoi Sugimoto*** Suggestions for reducing environmental, social and economic impacts by mariculture on coastal communities based on a case study in Anda-Bolinao, northwestern Philippines						
10:00		10:00	**C. Tracy Shaw** The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA	10:00	**Shannon G. Obradovich*** The impact of fine-scale spatial behaviour of quillback rockfish (*Sebastes maliger*) on a hook-based relative abundance index from longlines	10:00	**Michael Foreman** ADCP measurements in the Discovery Islands, British Columbia, Canada
10:10	**ZhengXi Zhou*** Untangling the relationship between harmful algal blooms and environmental factors in the coastal waters adjacent to the Changjiang River estuary						

S10 [FR 26]		BIO-Paper [FR 31/33]		FIS-Paper [FR 24/25]		POC-P, Day1 [FR 35/37]	
10:20		10:20	**Yongjiu Xu*** Interannual variation of summer zooplankton size structure and its relation to physical and biological processes in the Yellow Sea and East China Sea	10:20	**Jennifer Boldt** An index of relative biomass, abundance, and condition of juvenile Pacific Herring (*Clupea pallasi*) in the Strait of Georgia, British Columbia	10:20	**Xinyuan Diao*** Structure and formation of the South Yellow Sea water mass in spring
10:30	***Coffee break***						
10:40		10:40	***Coffee break***	10:40	***Coffee break***	10:40	***Coffee break***
10:50	**Vera L. Trainer** The impacts of a massive harmful algal bloom along the US west coast in 2015						
11:00		11:00	**Hwa Hyun Lee*** Buoyancy and vertical distribution of Pacific mackerel eggs and larvae and its climate change implication for the temporal variability of recruitment	11:00	**Elizabeth Logerwell** Environmental drivers of benthic fish distribution in and around Barrow canyon in the northeastern Chukchi Sea and western Beaufort Sea	11:00	**Xiu-mei Fan*** Extracting fronts from chlorophyll and SST satellite data and analysing the relation between them
11:10	**Polina A. Kameneva*** Diarrheic shellfish poisoning in socio-economic perspective in Prymorsky region, Russia						
11:20		11:20	**Andrew Trites** Archeological data indicate that northern fur seals are likely to once again become a dominate predator in the California Current System	11:20	**Olga Novikova** Stock abundance dynamics of saffron cod on West and East Kamchatka and natural determinants of the dynamics	11:20	**Yisen Zhong*** Submesoscale eddy structures in the South China Sea
11:30	**Jinhui Wang** Do the aquaclture and ballast discharge influence the scope of Harmful Algal Bloom?						
11:40		11:40	**Kenji Konishi** Decadal scale change in the feeding habits of sei whales in the western North Pacific off Japan	11:40	**Alexey A. Khoruzhiy*** Structure of the nekton community of the upper epipelagial in the North western Pacific Ocean in February-April	11:40	**Rui Saito*** Subsurface hydrographic structures and the temporal variation of Aleutian eddies
11:50	**Baodong Wang** Does reduced sediment load contribute to increased outbreaks of harmful algal blooms off the Changjiang Estuary?						
12:00		12:00	**Elliott L. Hazen** Scales of inference: The influence of spatial and temporal resolution on habitat-based models for marine predators	12:00	**Zhongxin Wu*** Trophic flows in the marine ecosystem of an artificial reef zone in the Yellow Sea China	12:00	**Wei Hu*** An improved wave-induced mixing parameterization in the Great Lakes
12:10	**Svetlana Esenkulova*** Monitoring of harmful algal blooms in the Strait of Georgia by a Citizen Science program, Canada 2015						
12:20		12:20	***Summary***	12:20	**Tsuyoshi Wakamatsu** Development of a regional marine environment analysis system for fishery applications	12:20	***Summary***
12:30	***Session ends***	12:30	***Session ends***	12:40	***Session ends***	12:30	***Session ends***

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Wednesday, October 21

S2 [FR 24/25]		S5 [FR 31/33]		S8 [FR 35/37]	
The 2014/15 El Niño and anomalous warming of the North Pacific: What happened?		**Ocean circulation of the Western Pacific and its response to climate change**		**Marine ecosystem services and economics of marine living resources**	
Convenors: Lisa Eisner (USA) Tony Koslow (USA)		**Convenors:** Wang Dongxiao (China) Dezheng Sun (USA) R. Dwi Susanto (USA) Zexun Wei (China)		**Convenors:** Shang Chen (China) Keith Criddle (USA) Mitsutaku Makino (Japan) Minling Pan (USA) Ian Perry (Canada) Sebastian Villasante (Spain/ICES)	
8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***
9:00	**Nicholas A. Bond (Invited)** Causes and effects of the recent warming in the Northeast Pacific Ocean	9:00	**Tangdong Qu (Invited)** Sea surface salinity variability in the equatorial Pacific and ENSO	9:00	**Daniel K. Lew (Invited)** Economic values of protected marine species in the U.S.: Empirical studies and conceptual challenges for ecosystem-based management
9:25		9:25	**Jianping Gan (Invited)** Extrinsic control on the China Seas circulation from the western Pacific Ocean		
9:35	**Emanuele Di Lorenzo (Invited)** Persistent record-high temperatures in the North Pacific in 2014/2015: A climate hypothesis				
9:40				9:40	**Sebastian Villasante (Invited)*** Social transformations of marine ecosystem services: A new conceptual framework for integrated assessments
9:50		9:50	**Xiaopei Lin (Invited)** The Kuroshio decadal variability and its climate impact		
10:10	**John (Jack) A. Barth** Arrival of 2014-2015 Warm Anomaly waters off Oregon				
10:15		10:15	**Raden Dwi Susanto** Indonesian throughflow and its proxy from satellite altimeters and gravimeters		
10:25				10:25	***Coffee break***
10:35		10:35	***Coffee break***		
10:40	***Coffee break***				
10:50				10:50	**Luo-ping Zhang** Evaluation of marine ecosystem intrinsic value

S2	[FR 24/25]	S5	[FR 31/33]	S8	[FR 35/37]
10:55		10:55	**Zexun Wei** Pacific to Indian Ocean throughflow and its South China Sea branch		
11:00	**Angelica Peña** Phytoplankton responses to the anomalous warming in the NE Pacific				
11:15		11:15	**De-Zheng Sun** Response of El Niño events to higher CO_2 forcing: Role of nonlinearity	11:15	**Stephen Kasperski*** Using socio-economic and fisheries involvement indices to understand Alaska Fishing Community well-being
11:30	**Eliana Gómez-Ocampo*** Warm Blob effects on subtropical NE Pacific Ocean phytoplankton				
11:35		11:35	**Rong-Hua Zhang** ENSO modulations by Freshwater Forcing and Ocean Biology-induced Heating in the Tropical Pacific		
11:40				11:40	**Shang Chen** Valuing ecosystem diversity maintenance services of the Shandong marine protected areas: An application of the contingent valuation method
11:55		11:55	***Lunch***		
12:00	**Sonia Batten** The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling				
12:05				12:05	**Aoi Sugimoto*** Fish as “Bridge” that connects migrant fishermen and local community: Proposing a new value of marine resources from socio-cultural aspects
12:30	***Lunch***			12:30	***Lunch***
14:00	**Tony Koslow** The effects of the Blob on the zooplankton and upper trophic levels of the Northern California Current off Oregon	14:00	**Xin Wang*** The responses of the Indian Ocean Dipole and South China Sea to El Niño Modoki	14:00	**Chengcheng Shen*** Assessment and regulation of ocean health based on ecosystem services: Case study in the Laizhou Bay, China
14:20		14:20	**Shuangwen Sun*** A triggering mechanism for the Indian Ocean Dipoles independent of ENSO		
14:25				14:25	**Emmanuel A. Sweke*** Job satisfaction: Perspectives from fishers in north-eastern Hokkaido, Japan
14:30	**Akash R. Sastri** Observations of anomalously low crustacean zooplankton production rates along the west coast of Vancouver Island in the spring of 2015				
14:40		14:40	**Yan Sun*** Weak ENSO asymmetry due to weak nonlinear air-sea interaction in CMIP5 climate models		
14:50				14:50	**Pavan Kumar*** Assessment and monitoring of natural marine ecosystems: An economic perspective towards climate
15:00	**Sam McClatchie** Ichthyoplankton and corrosive waters off southern California	15:00	**Hyung-Gyu Lim*** Impact of the chlorophyll bias on tropical mean states with bio-geophysical feedback		
15:15				15:15	**Linhua Hao** Assessment of ecological damage and compensation from marine engineering construction projects in Shandong

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S2 [FR 24/25]		S5 [FR 31/33]		S8 [FR 35/37]	
15:20		15:20	**Yu Zhang*** The development of a new eddy-resolving global ocean forecasting system in NMEFC		
15:30	***Coffee break***				
15:40		15:40	***Coffee break***	15:40	***Coffee break***
15:50	**John C. Field** Anomalous patterns in California Current pelagic micronekton distribution and abundance in 2015				
16:00		16:00	**Bin Xiao*** Internal tides in the Pacific Ocean – A look into a high-resolution Wave-Tide-Circulation (WTC) coupled model	16:00	**Ohidul Alam*** A review of marine ecosystem services and economic resources of the Bay of Bengal
16:20	**Anne B. Hollowed** Preliminary observations of the impact of the BLOB on the summer distribution of marine fish in the Gulf of Alaska	16:20	**Chenghao Yang*** The annual velocity along the Slope of Northern South China Sea (SNSCS) from mooring observation		
16:25				16:25	***Summary***
16:35				16:35	***Session ends***
16:40		16:40	**Dandi Qin** Comparison between surface cyclonic and anticyclonic eddies along the Kuroshio in the northwestern Pacific Ocean		
16:50	**R. Ian Perry** Anomalous warming and its impacts in the NE Pacific from a Canadian perspective				
17:00		17:00	**Jianhong Wang** The structure analysis of typical western Pacific Ocean eddies forced by strong typhoons		
17:20	**Fei Chai** Anomalously warm conditions and their impact on marine ecosystem and seabirds during 2013-2015 off the U.S. west coast and in the Northeastern Pacific Ocean	17:20	***Discussion***		
17:50	***Discussion***	17:50	***Session ends***		
18:00	***Session ends***				

Thursday, October 22

S3	[FR 26]	S4	[FR 35/37]	S6	[FR 31/33]	S7	[FR 24/25]
	Eastern-western approaches to fisheries: Resource utilization and ecosystem impacts		**Indicators of emerging pollution issues in the North Pacific Ocean**		**Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean**		**Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5**
	Convenors: Xianshi Jin (China) Jacquelynne King (Canada) Gordon H. Kruse (USA) Mitsutaku Makino (Japan) Marie-Joëlle Rochet (France) Shijie Zhou (Australia)		**Convenors:** Olga Lukyanova (Russia) Peter S. Ross (Canada)		**Convenors:** Liqi Chen (China) Fei Chai (USA) Toru Suzuki (Japan) Kitack Lee (Korea)		**Convenors:** Kyung-Il Chang (Korea) Anne Hollowed (USA) Shin-ichi Ito (Japan) Chan Joo Jang (Korea) Sukgeun Jung (Korea) Angelica Peña (Canada) Ho-Jeong Shin (Korea) Zhenya Song (China)
8:55	*Introduction by Convenors*	8:55	*Introduction by Convenors*	8:55	*Introduction by Convenors*	8:55	*Introduction by Convenors*
							Climate change from a global perspective
9:00	**Xianshi Jin (Invited)** The marine fisheries resource utilization, ecosystem impacts and fisheries management in China	9:00	**Hideshige Takada (Invited)** Microplastic: An emerging threat to marine environment and a new tool for POP monitoring	9:00	**Richard A. Feely (Invited)** The Global Ocean Acidification Observing Network (GOA-ON): Status and initial results	9:00	**Jacquelynne King (Invited)** Report from Brazil: Effects of climate change on the world's oceans
9:25	**Zuozhi Chen** Exploitation and management of fisheries resources in northern South China Sea			9:25	**Richard Bellerby (Invited)** Arctic Ocean acidification: Present understanding, management requirements and future research strategies		
9:30		9:30	**Vladimir Shulkin (Invited)** Spatial variability of trace metal concentrations in different mussels from coastal areas of the northwestern Pacific Ocean			9:30	**Zenghong Liu** The latest progress on global Argo observations
9:45	**Gui lin Dai** New normal: The structural analysis of modern fisheries economic development in China						
9:50				9:50	**Kunshan Gao (Invited)** Effects of ocean acidification on marine primary producers	9:50	**Ho-Jeong Shin** The CMIP5 ocean heat storage and temperature
10:00		10:00	**Tomohiko Isobe (Invited)** Levels and temporal trends of legacy and emerging POPs in small cetacean species from Japan				
10:05	**Gordon H. Kruse** An ecosystem-based fishery management approach toward sustainable groundfish resource utilization in the eastern Bering Sea						

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S3	[FR 26]	S4	[FR 35/37]	S6	[FR 31/33]	S7	[FR 24/25]
10:10						10:10	**Lei Wang*** Evaluation on air-sea CO_2 fluxes in the equatorial Pacific simulated by CMIP5 models
10:15				10:15	**Ja-Myung Kim (Invited)*** Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions		
10:25	**Binduo Xu** Optimization of sampling design for a fishery-independent survey with multiple objectives						
10:30		10:30	***Coffee break***			10:30	***Coffee break***
10:40				10:40	***Coffee Break***		
10:45	***Coffee Break***					Marine ecosystem and biogeochemistry	
10:50						10:50	**Shoshiro Minobe (Invited)** SST habitat and food change projections for Pacific salmon (*Oncorhynchus* spp.) in the North Pacific and adjacent seas based on CMIP5 climate models
11:00		11:00	**Hyo-Bang Moon (Invited)** Monitoring of legacy and emerging contaminants in wildlife from Korea	11:00	**Liqi Chen** Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans		
11:05	**Guanqiong Ye*** An integrated assessment approach for natural fishery resource restoration – A case study of wild Yellow Croaker *Pseudosciaena crocea* (Riehardson) in Guanjingyang, Fujian, China						
11:20				11:20	**Di Qi*** Recent accelerated intrusion of Pacific aragonite corrosive " acidified" water into the Arctic Ocean	11:20	**Anne B. Hollowed** S-CCME's international coordinated research program to project climate change impacts on fish and fisheries by 2019
11:25	**Shengle Yin*** Selection of suitable coastal aquaculture sites with environmental and socio-economic consideration: A case study in the Menai Strait, UK						
11:30		11:30	**Iana Blinovskaia*** Microplastic is the macroproblem of the world's oceans, including the Russian Far East				
11:40				11:40	**Wei-Jun Cai** Carbon cycle and ocean acidification strongly modulated by sea-ice retreat in the Pacific sector of the Arctic Ocean over the past two decades	11:40	**Sukgeun Jung** Climate-change driven range shifts of chub mackerel (*Scomber japonicus*) projected by bio-physical coupling individual based model in the western North Pacific
11:45	**Juri Hori*** Effects of changes in marine ecosystem services on human well-being: International comparison of human well-being structure						
11:50		11:50	**Patrick D. O'Hara** At-sea distributions reveal where Cassin's Auklets are exposed to microplastics in the fall in British Columbia 2014				

S3	[FR 26]	S4	[FR 35/37]	S6	[FR 31/33]	S7	[FR 24/25]
12:00				12:00	**Zhongyong Gao** Comparison of carbon fluxes and ocean acidification between two gateways in the Arctic Ocean: The Chukchi Sea and the Nordic Sea	12:00	**Hiroomi Miyamoto** Potential effect of climate change for copepods distribution in western North Pacific Ocean
12:05	***Discussion*** The ecosystem approach: From the ecosystem to society						
12:10		12:10	**John E. Elliott** Spatial and temporal mercury trends in seabird eggs from Pacific Canada 1968-2012 are due to diet: Evidence from sulfur isotopes				
12:20				12:20	**Bofeng li** Spatiotemporal distributions of carbon species in the North Pacific subpolar region by using the parameterization technique	12:20	***Lunch***
12:30		12:30	***Lunch***				
12:35	***Lunch***						
12:40				12:40	***Lunch***		
14:00	**Shijie Zhou (Invited)** Alternative fishing strategies and their consequences	14:00	**Yanbin Li*** Mercury speciation and major factors controlling the cycling of methylmercury in the Yellow Sea and Bohai Sea, China	14:00	**Fei Chai (for Peng Xiu*)** Variability of oceanic carbon cycling and its relation to the ocean acidification in the North Pacific Ocean		
14:20		14:20	**Vasiliy Yu. Tsygankov*** Persistent organic pollutants in the food chain: Salmon, seabirds and marine mammals from the North-West Pacific (Russian Far East)	14:20	**Feng Zhou*** Hypoxia off the Yangtze River estuary: Observations and simulations	14:20	**Hyoun-Woo Kang** Near future lower-trophic ecosystem projection in the seas around Korea
14:25	**Richard Law** Exploiting the natural productivity of aquatic ecosystems						
14:40		14:40	**Olga N. Lukyanova** Bioindicators of marine pollution in impacted areas of the Sea of Okhotsk	14:40	**Naohiro Kosugi*** Autumn depression in pCO_2 in the Japan Sea and contribution of Changjiang diluted water	14:40	**Fei Chai** Future changes of nutrient dynamics and biological productivity in California Current System
14:45	**Vladimir V. Kulik*** The effects of fishing on ecosystem structure of the Northeastern part of the Okhotsk Sea					Ocean dynamics	
15:00		15:00	**Peter S. Ross** Emerging ocean pollution issues in the NE Pacific Ocean vary by matrix: Lessons from sediments, shellfish and marine mammals	15:00	**Juying Wang** Variation of sea surface pCO_2 and controlling processes in cold seasons in the northern Yellow Sea, China	15:00	**Yongqiang Yu (Invited)** Impacts of external forcing on the decadal climate variability in CMIP5 simulations

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S3	**[FR 26]**	**S4**	**[FR 35/37]**	**S6**	**[FR 31/33]**	**S7**	**[FR 24/25]**
15:05	**Km. Neha*** Appraisal of fisheries management options to mitigate climate change based on a simulation model of im-pacts in western Indian Ocean coral reefs						
15:20		15:20	***Coffee break***	15:20	**Shintaro Takao*** Diurnal variation of pH in Oshoro Bay, Hokkaido, Japan – A monitor-ing study assessing and projecting impacts of ocean acidification on a coastal ecosystem		
15:25	**Saang-Yoon Hyun** <u>Poster</u>: Assessment of Korean pollock population under data-limited situation						
15:27	**Tetsuichiro Funamoto** <u>Poster</u>: Stock assessment system in Japan						
15:29	**Yunlong Chen** <u>Poster</u>: Redistribution of anchovy (*Engraulis japonicus*) wintering stock under climate change scenarios in the Yellow Sea						
15:30	***Coffee break***					15:30	***Coffee break***
15:40		15:40	***Discussion***	15:40	***Coffee break***		
15:50	**Xinyu Guo** Modeling interannual variations of Japanese common squid (*Todarodes pacificus*) resources around Japan					15:50	**Lei Zhou** A genesis potential index for tropical cyclone using oceanic parameters
16:00				16:00	**Michiyo Yamamoto-Kawai** Calcium carbonate saturation and ocean acidification in Tokyo Bay, Japan		
16:10	**Hyun A Kim*** Management of small yellow croaker, *Larimichthys polyactis* stock in Korean waters using a length-based produc-tion value-per-recruit analysis					16:10	**Yong Sun Kim*** Seasonal characteristics of the long-term sea surface temperature vari-ability in the Yellow and East China Seas
16:20				16:20	**Tsuneo Ono** Spatio-temporal variation of pCO_2 in shore-reef waters off Arasaki district, Sagami Bay, Japan		
16:30	**Minkyoung Bang*** Changes in ecological characteristics of walleye pollock *Gadus chalcogram-mus* in accordance with the biomass fluctuation					16:30	**Dmitry V. Stepanov** Effects of atmospheric forcing on circulation variability in the northern Japan/East Sea in 1948 to 2010

S3	[FR 26]	S4	[FR 35/37]	S6	[FR 31/33]	S7	[FR 24/25]
16:40				16:40	**Julie E. Keister** Differential sensitivities of crustacean zooplankton to ocean acidification		
16:50 17:00	***Discussion*** Fishing strategies, from stocks to ecosystem					16:50	**Dongxiao Wang** Anomalous tropical cyclone activity in the northwestern Pacific in 2014
				17:00	**Liang Xue*** Is ocean acidification disturbed by climate?		
17:05 17:10 17:20	**Marie-Joëlle Rochet (Invited)** The Landing Obligation in the European Union Common Fisheries Policy: Can a regulation focused on resource utilization address broader management objectives such as limited environmental impacts, economic development, and food supply?					17:10	***Discussion***
				17:20	**Ian S.F. Jones** The expected impact of ocean nourishment on ocean acidity		
17:30 17:40	**Hee Joong Kang*** Acceptable Biological Catch in the ecosystem-based TAC management					17:30	***Session ends***
				17:40	**Kannan Gunasekaran*** Impact of ocean acidification on morphological variation in captive condition of the benthic foraminifera *Ammonia beccarii*		
17:50	**Chongliang Zhang** Poster: Efficacy of fishery closure in rebuilding depleted stocks: accounting for trophic interactions						
17:52	***Discussion*** Managing bycatch and discards						
18:00	***Session ends***	18:00	***Session ends***	18:00	***Session ends***		

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Friday, October 23

S9 [FR 26]		MEQ-Paper [FR 31/33]		POC-Paper, Day 2 [FR 35/37]	
Experiences and lessons learned in managing shared/ transboundary stock fisheries **Convenors:** Shang Chen (China) Keith Criddle (USA) Mitsutaku Makino (Japan) Minling Pan (USA)		**Convenors:** Chuanlin Huo (China) Darlene Smith (Canada)		**Convenors:** Kyung-Il Chang (Korea) Michael Foreman (Canada)	
8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***	8:55	***Introduction by Convenors***
9:00	**Robert Blasiak (Invited)*** Balloon effects in global fisheries: Shifting paradigms	9:00	**Kathryn Higley** Summary of Workshop 5 on "Monitoring and Assessment of Environmental Radioactivity in the North Pacific"	9:00	**Yuri Zuenko** The structure of regional climate variability in the Far-Eastern Seas
9:20				9:20	**Dmitry Kaplunenko** Procedures for correcting *in situ* CTD data and results obtained during the NEAR-GOOS Cross-Basin Climate Monitoring Section project
9:25	**Kanae Tokunaga (Invited)*** Cooperative management of trans-boundary fish stocks				
9:30		9:30	**Hongzhi Li*** Radioactivity estimates at North Pacific Ocean based on radiation dose rate		
9:40				9:40	**Yuping Guan** Filtering methods for detecting ocean striations
9:50	**Ekaterina Kurilova** Management of transboundary stocks of walleye pollock in the Russian Federation	9:50	**Shizuho Miki*** Strontium-90 in marine fishes		
10:00				10:00	**Vadim Navrotsky** On specifics and effects of processes in stratified bottom layers in the shelf zone of the sea
10:10	**Catarina Wor*** The use of a Lagrangian movement model and management strategy evaluation to assess management performance for transboundary stocks	10:10	***Discussion*** Radionuclides		
10:20		10:20	**Qian Zhou** Accumulation of microplastics on coastal beaches, China: Abundance, composition and sources	10:20	**Kyung-Il Chang** Seasonal variation of coastal currents in the East/Japan Sea
10:30	***Coffee break***				
10:40		10:40	***Coffee break***	10:40	***Summary***
10:45				10:45	***Session ends***

S9	[FR 26]	MEQ-Paper	[FR 31/33]
10:50	**Minling Pan** Spillover effects of marine environmental regulation for sea turtle protection		
11:00		11:00	**Sergey Kulbachnyi*** Hydrocarbon exploration on the Sea of Okhotsk shelf and its possible impact on marine ecosystems
11:10	**Mikhail A. Stepanenko** Interannual variability of Bering Sea pollock seasonal migrations and the impact of ecosystem changes		
11:20		11:20	**Yu Hao** Historical trends of terrigenous organic carbon transported by the Yangtze River (Changjiang)
11:30	**Yu Heng Lu*** The role of fishery cooperative associations on fishery management and the conservation of fishery resources: A case study of Sakuraebi (*Sergia lucens*) in Taiwan and Japan		
11:40		11:40	**Lijun Qi*** The geochemical signals in the abandoned Huanghe River Delta surface sediments
11:50	***Discussion***		
12:00		12:00	***Summary***
12:20	***Session ends***	12:20	***Session ends***

POSTER SESSION, October 22

S1. Change and Sustainability of the North Pacific

S1-P1 **Robert Blasiak**
Socio-ecological linkages enhancing the resilience of Japan's Urato Islands

S1-P2 **Yury Zuenko**
Change of the dense bottom water production on the northern Okhotsk Sea shelf and its transport to the intermediate layer of the North Pacific

S1-P3 **Yury Zuenko**
Climatic changes of temperature, salinity and nutrients in the Amur Bay of the Japan Sea

S1-P4 **Shin-ichi Ito**
Geographic variation in Pacific herring growth in response to regime shifts in the North Pacific Ocean

S1-P5 **Xiansen Ye**
A multivariate assessment of eutrophication in three typical bays of the northern Zhejiang, East China Sea

S1-P6 **Swati Katiyar**
Change dynamics analysis of the shoreline using optical sensors in coastal stretch of Bay of Bengal, India

S1-P7 **Min Zhang**
Seasonal variability of phytoplankton in the North Pacific and North Atlantic Ocean from space

S1-P8 **Meng Wei**
A quantitative definition of global warming hiatus and 50-year prediction of global mean surface temperature

S1-P9 **Yuan-yuan Wang**
Plankton distribution characteristics and its interactive relationship in southern waters of Miaodao Archipelago

S1-P10 **Hui Zhang**
Ichthyoplankton assemblage structure of spring in the Yangtze estuary revealed by biological and environmental visions

S1-P11 **Yang Liu**
The impact of winter East Asia Monsoon and ice coverage variation on Japanese scallop aquaculture in Saroma Lake, Japan

S1-P12 **Changdong Liu**
Exploring nonstationary and scale-dependent relationships between aquatic species distribution and habitat variables using geographically weighted regression

S1-P13 **John A. Barth**
Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current large marine ecosystem

S1-P14 **Umesh K. Pradhan**
Impact of typhoon on the changing particulate organic matter characteristics: Case study of Nandujiang along the tropical Hainan Island, China

S1-P15 **Yiping Ren**
Evaluating management strategies of limited data species based on hierarchical demographic approaches: An example using yellow croaker (*Larimichthys polyactis*) along north Pacific coast of China

S1-P16 **Oleg Bulatov**
Climate change and the fishery in Russia–2030

S1-P17 **Andrew R.S. Ross**
The International Group for Marine Ecological Time Series (IGMETS): Assessing global oceanic changes through joint time series analysis

S1-P18 **Zhiwei Zhang**
Island economic vulnerability to natural disasters — The case of Changdao

S3. Eastern-western approaches to fisheries: Resource utilization and ecosystem impacts

S3-P1 **Saang-Yoon Hyun**
Assessment of Korean pollock population under data-limited situation

S3-P2 **Tetsuichiro Funamoto**
Fishery stock assessment and management system in Japan

S3-P3 **Yunlong Chen**
Redistribution of anchovy (*Engraulis japonicus*) wintering stock under climate change scenarios in the Yellow Sea

S3-P4 **Chongliang Zhang**
Efficacy of fishery closure in rebuilding depleted stocks: Accounting for trophic interactions

S4. Indicators of emerging pollution issues in the North Pacific Ocean

S4-P1 **Xiaoyan Yi**
Acute effects of emamectin benzoate on the calanoid copepod *Pseudodiaptomus poplesia*

S4-P2 **Qian Zhou on behalf of Cui Zhang**
Phototransformation of oxytetracycline in saline waters under simulated sunlight irradiation: Kinetics, mechanism and products

S4-P3 **Olga Luyanova on behalf of Tatyana A. Belan**
Assessment of marine environment quality of the coastal zone of Peter the Great Bay (the Sea of Japan/ East Sea)

S4-P4 **Vasiliy Yu. Tsygankov**
Metal concentrations in pink and chum salmon (Kuril Islands, the North Western Pacific)

S4-P5 **Iana Blinoskaya on behalf of Oleg V. Losev**
Estimation of seawater pollution in Uglovoy Bay (Peter the Great Bay, Japan/East Sea)

S5. Ocean circulation of the Western Pacific and its response to climate change

S5-P1 **Jiepeng Chen**
Influences of Indian Ocean and Atlantic Ocean SST on the intensity of interannual variability in summer rainfall over southern China

S5-P2 **Yonggang Wang**
The vertical distributions of the volume transport through major exit passages of the Pacific to Indian Ocean Throughflow

S5-P3 **Zhan Lian**
A comparison of wind stress datasets for the South China Sea

S5-P4 **Junchuan Sun**
Numerical study on the bottom branch of the Yellow Sea Warm Current

S5-P5 **Feng Nan**
Rapid freshening of the upper ocean in the South China Sea since the early 1990s

S5-P6 **Wei Cui**
A statistical analysis of mesoscale eddies in the northwest Pacific Ocean from 22 years of altimetry data

S6. Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean

S6-P1 **Miming Zhang**
The surface seawater DMS distributions, sea-air fluxes and its influence to sulfur aerosols in the North Pacific Ocean

S6-P2 **Yumei Zhao**
Ocean acidification observation system at Bohai Gulf based on ocean acidification characteristic parameters

S6-P3 **Yanmin Wang**
Advances in ocean acidification of a vulnerable carbon pool in the Southern Ocean

S6-P4 **Jiexia Zhang**
Surface undersaturation and subsurface maxima of nitrous oxide in the Chukchi Sea Shelf and Chukchi Abyssal Plain

S6-P5 **Suqing Xu**
Seasonal variation of distribution of air-sea CO_2 flux in the Taiwan Strait and its controlling mechanism

S6-P6 **Naohiro Kosugi on behalf of Masao Ishii**
Trend of ocean acidification in the tropical and subtropical zones of the western North Pacific along 137°E

S6-P7 **Weimin Wang**
Effects of CO_2-driven ocean acidification on the early development of scallop *Argopecten irradias* (Lamarck, 1819)

S6-P8 **Jianfang Chen**
Monitoring of eutrophication and ocean acidification off the Changjiang Estuary

S6-P9 **Alex Kozyr**
CDIAC data management and archival support for a high-frequency atmospheric and seawater pCO_2 data set from 14 open ocean moorings

S6-P10 **Chengxuan Li**
Spatial distributions of dimethylsulfide (DMS) and dimethylsulfoniopropionate (DMSP) and influencing factors in the Norwegian and Greenland seas during summer

S7. Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5

S7-P1 **Jingli Mu**
Effects of CO_2-driven ocean acidification (OA) on early life stages of marine medaka (*Oryzias melastigma*)

S7-P2 **Dmitry V. Stepanov**
Features of the circulation structure in the Okhotsk Sea based on high-resolution numerical simulation in 1979 to 2000

S7-P3 **Guoping Zhu**
Variation and it periodicity of sea surface temperature in the eastern Yellow Sea in the recent 30 years

S7-P4 **Hee Seok Jung**
Development of a regional climate coupled model for the seas around Korea

S7-P5 **Yajuan Song**
The effects of runoff forcing on the summer monsoon onset in a climate model

S7-P6 **Lin Liu**
The Wyrtki jet simulated in CMIP5 models

S7-P7 **Yan Li**
The detecting and adjusting of the sea surface temperature data homogeneity over coastal zone of Circum Bohai Sea

S7-P8 **Lyubov Vasilevskaya**
Change of beginning and duration of the first stage of Far-Eastern summer monsoon on the southern coast of Primorye

S7-P9 **Zhi Li**
Modulation of interannual variability of tropical cyclone activity over Southeast Indian Ocean by negative IOD phase

S7-P10 **Baochao Liu**
The impact of local SST and tropical ISO on the monsoon onset over BOB in CMIP5 coupled models

S7-P11 **Kuiping Li**
Monsoon onset in the Bay of Bengal associated with the first northward-propagating intra-seasonal oscillation

S8. Marine ecosystem services and economics of marine living resources

S8-P1 **Liang Liu**
Evaluation of the Marine Ecosystem services of the Liaodong Gulf, Bohai Gulf and Laizhou Gulf, China

S8-P2 **Wei Xu**
Sea use intensity assessment and practice in China—A new methodology for ocean management

S8-P3 **Ke-liang Chen**
Marine ecosystem services value accounting and driving forces: A case study of Xiamen Bay

S10. The human dimensions of harmful algal blooms

S10-P1 **Renyan Liu**
Toxic *Protoceratium reticulatum* and yessotoxins from the Chinese Yellow Sea

S10-P2 **Ren-Cheng Yu**
Application of qPCR methods in detection of PST-producing *Alexandrium* species in the Yellow Sea and East China Sea

S10-P3 **Yang Lin**
Advances in marine algae hemolysin molecules

S10-P4 **Jingjing Zheng on behalf of Jing Yang**
Numerical study on the prediction of the Harmful Algae Blooms in the East China Sea

S10-P5 **Jingjing Zheng on behalf of Dan Wang**
Prediction, prevention and mitigation of harmful algal blooms in the China Sea

S10-P6 **Chunjiang Guan**
Study on the changes of phytoplankton composition and climate in Qingduizi Bay Chinese northern Yellow Sea

BIO Contributed Paper Session

BIO-P1 **Anders Knudby**
Distribution modeling for species and species assemblages, an exploration of spatial patterns with gradient forest

BIO-P2 **Yu Xin**
Spatial distribution of $\delta^{15}N$ of chlorophyll-*a* in surface sediment of the northern Benguela Upwelling System

BIO-P3 **Rubao Ji**
Phytoplankton phenology in the Bering Sea: Variability and drivers

BIO-P4 **Soeon Ahn**
Diet of long-beaked common dolphin (*Delphinus capensis*) in the East Sea (Japan Sea), Korea

BIO-P5 **Haifeng Zhang**
Paleoceanographic changes since 50 ka B.P. inferred from radiolarian assemblages in Gulf of Alaska, subarctic North Pacific

BIO-P6 **Feiyan Du**
Ecological characteristics of zooplankton in the northern waters of Nan'ao Island

BIO-P7 **Yan Liu**
Polyamines response to nutrient limitation stress and their physiological roles in *Skeletonema costatum*

BIO-P8 **Howon Lee**
Contribution of bacterial communities to total primary production in the Northwestern Pacific Ocean

BIO-P9 **HuiTae Joo**
Carbon and nitrogen uptake rates of phytoplankton in the East Sea (Japan Sea) in 2012

BIO-P10 **Sang Heon Lee**
Spatial and temporal patterns of primary production in the Japan/East Sea

BIO-P11 **Na-eun Jo**
Relationship between phytoplankton macromolecular compositions and zooplankton proximate compositions in the Southwestern Japan/East Sea

BIO-P12 **Jihong Zhang**
Long term change of chlorophyll-*a* concentration in Sanggou Bay, China

BIO-P13 **Chiyuki Sassa**
Comparative reproductive biology of three dominant myctophids of the genus *Diaphus* on the slope region of the East China Sea

BIO-P14 **Seung Ho Baek**
Responses of microbial communities to dosing with the algicide thiazolidinedione derivative TD49 in a mesocosm experiment

BIO-P15 **Jun Li**
The application of products from Geostationary Ocean Color Imager (GOCI) in China Sea

BIO-P16 **Ye Won Kim**
Comparison of macromolecular compositions of different size phytoplankton in Gwangyang Bay, Korea

BIO-P17 **Pan Jun**
The use of the LOPC to measure horizontal and vertical zooplankton size and abundance of 35°N section in summer

BIO-P18 **Shinji Shimode**
Three-year variability of *Eucalanus californicus* population in Sagami Bay, Japan: Relationships between population density and duration of surface occurrence

BIO-P19 **Qian Xu**
Spatial variations of phytoplankton communities in July of 2011 and 2013 in the East China Sea derived by photosynthetic pigments

BIO-P20 **Takafumi Yamaguchi**
Seasonal changes in prosome length and egg reproduction of planktonic copepod *Calanus sinicus* in Sagami Bay, Japan

BIO-P21 **Daisuke Hasegawa**
Oyashio spring bloom observed by an underwater glider

BIO-P22 **Nam-Il Won**
Marine microbiological communities in Korean coastal waters examined by NGS analysis

BIO-P23 **Nam-Il Won**
Trophic linkages among biological communities in Korean coastal waters examined by stable isotope analyses

BIO-P24 **Jingwen Liu**
Marine virus mediated sphingolipid metabolic regulation and the apoptosis-inducing in marine *Emilianian huxleyi*

BIO-P25 **Naoki Yoshie**
Phytoplankton change in the Kuroshio region of the East China Sea associated with the Kuroshio frontal eddy

BIO-P26 **Pawan K. Chaudhary**
Chlorophylls and phycoerythrins as markers of ecological forcing on phytoplankton in New Caledonia and oceanic adjacent area

BIO-P27 **Kedong Yin**
The influence of decadal typhoon events on chlorophyll and carbon fixation in the East China Sea

BIO-P28 **Kazuaki Tadokoro**
Seasonal variation of mesozooplankton community in the Oyashio and Kuroshio-Oyashio Transition waters, western North Pacific

BIO-P29 **Sachihiko Itoh**
Mixed layer depth and chlorophyll *a*: Profiling float observations in the Kuroshio-Oyashio Extension region

BIO-P30 **C. Tracy Shaw**
Hypoxia tolerance in oxygen minimum zone euphausiids

BIO-P31 **Seung Won Jung**
Effects of temperature and nutrients on changes in genetic diversity of bacterioplankton communities as revealed by 454 pyrosequencing in a semi-closed bay, South Korea

BIO-P32 **Seung Won Jung**
Microphytoplankton community structure of a *Cochlodinium polykrikoides* bloom in the Tongyeong coastal waters of South Korea using morphological and 454 pyrosequencing methods

BIO-P33 **Qinsheng Wei**
Hypoxia off the Changjiang River estuary and its relationships with plume front and upwelling in summer

BIO-P34 **Taek-Kyun Lee**
Identification of microalgae in South Sea of Korea by species-specific PCR

BIO-P35 **Qinsheng Wei**
Ecological responses to the offshore detached Changjiang diluted water in summer

BIO-P36 **Franz Mueter**
Delineating a physical and biological break point in the Gulf of Alaska

BIO-P37 **Leslie Brown**
Examination of water quality of an oligotrophic salmon lake in British Columbia, Canada using MERIS satellite imagery

BIO-P38 **Zhichuang Lu**
Analysis of finless porpoise diet using prey morphological characters and DNA barcoding

FIS Contributed Paper Session

FIS-P1 **Alexey Khoruzhiy on behalf of Alexander Zavolokin**
Shifts in hydrological regime and their implication for distribution and abundance of fish in the western Bering Sea in 21st century

FIS-P2 **Kui Zhang**
Stock assessment for the *Trichiurus japonicus* fishery in the East China Sea based on Bayesian state-space modelling

FIS-P3 **Ekaterina Kurilova on behalf of Albina Kanzeparova**
The impact of climate factors on Pacific salmon within Khabarovsk territory

FIS-P4 **Jun Zhang**
In situ target strength measurements of skipjack tuna Katsuwonus pelamis and yellowfin tuna *Thunnus albacares* in the South China Sea

FIS-P5 **Hongjun Li**
Genetic diversity and differentiation of seven geographical populations of hard clam (*Meretrix meretrix*) assessed by COI and microsatellite markers

FIS-P6 **Hitomi Oyaizu**
Modeling the migration and growth of immature Pacific saury (*Cololabis saira*) using an individual-based bioenergetics model

FIS-P7 **Su Min Kim**
Proximate composition and stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) of Japanese jack mackerel (*Trachurus japonicus*) in the Geumo Island nursery ground

FIS-P8 **Wen-Bin Huang**
Evaluation of a commercial CPUE standardization model applied to the Pacific saury fishery in the North Pacific

FIS-P9 **Xinqing Zheng**
A mass-balance ecosystem model of a subtropical bay

FIS-P10 **Elizabeth Logerwell**
Examining two macro invertebrate communities using functional traits and environmental variables in and around Barrow Canyon in the Chukchi and Beaufort seas

FIS-P11 **Jin-Koo Kim**
Restricted separation of the spawning areas of two lineages of sand lance, *Ammodytes personatus*, in the Yellow Sea and East Sea

FIS-P12 **Jung Hwa Ryu**
Diversity and community structure of marine fish species in Korean waters during 2006-2013

FIS-P13 **Se Hun Myoung**
The role of Gangjin Bay: Spawning or nursery grounds for fish?

FIS-P14 **Zhongxin Wu**
Food partitioning among three reef fish in the Lidao coastal waters of northern Yellow Sea, China

FIS-P15 **Matthew R. Baker**
Environmental thresholds and species distribution: Implications for interactions and recruitment in multispecies models

FIS-P16 **Chris Rooper**
Using species distribution models to define essential fish habitat in Alaska

FIS-P17 **Hiroshi Kuroda**
Particle tracking experiments to specify hatching areas of the Pacific stock of chub mackerel off the southeastern coast of Japan

FIS-P18 **Motomitsu Takahashi**
Interannual variations in growth trajectories of juvenile jack mackerel *Trachurus japonicus* in the Tsushima Warm Current

FIS-P19 **Zhe Li**
Behavioral responses of Pacific cod (*Gadus macrocephalus*) juveniles to food deprivation, temperature gradients and light

FIS-P20 **Tetsuichiro Funamoto**
Optimum survival temperature for walleye pollock larvae

FIS-P21 **Rintaro Koide**
Acoustic survey of dominant mesopelagic fishes off eastern Hokkaido, Japan

FIS-P22 **Jiaguang Xiao**
Complete mitochondrial genome of *Sillago* species: Insights into taxonomy and phylogeny

FIS-P23 **Zhiqiang Han**
Genetic evidence for speciation in Japanese sand lance Ammodytes personatus: Pleistocene isolation, temperature and current promoted speciation

FIS-P24 **Olga Zikunova**
The abundance of the chinook salmon *Oncorhynchus tschawytscha* (Walbaum) population in the basin of the Kamchatka River

FIS-P25 **Lu Liu**
Genetic variation and population structure of marbled rockfish (*Sebastiscus marmoratus*) in the Northwestern Pacific inferred from microsatellite analysis

FIS-P26 **Xin Yu**
Evaluating three size removal methods in otolith shape analysis, using the Japanese grenadier anchovy (*Coilia nasus*) and Osbeck's grenadier anchovy (*Coilia mystus*) in Chinese coastal waters

FIS-P27 **Alexei M. Orlov**
"Jawless Fishes of the World" – A new book dealing with various aspects of lampreys and hagfishes worldwide

MEQ Contributed Paper Session

MEQ-P1 **Shijie He**
Study of impact of moderate and heavy weathering processes on individual carbon and hydrogen isotope of n-alkanes in oils

MEQ-P2 **Hyeon Ho Shin**
The role of temporary cysts in dense blooms caused by *Cochlodinium polykrikoides* Margalef

MEQ-P3 **Ruijing Li**
The occurrence and Distribution of HBCDs in Laizhou Bay of China

MEQ-P4	**Ping Du** Responses of mesozooplankton communities to different anthropogenic activities in a subtropical eutrophic bay
MEQ-P5	**Dabin Lee** Estimation of carrying capacity by measuring coastal environmental parameters in Geoje-Hansan Bay, Korea
MEQ-P6	**Yuya Shigenobu** Radiocesium transfer from contaminated sediment to benthic organisms and demersal fish
MEQ-P7	**Daisuke Ambe** Spatio-temporal variation of radiocesium in sea sediment on benthic marine ecosystem based on five-minute resolution mapping
MEQ-P8	**Pokin Channimitsri** Distribution of major and trace elements in surface sediments of the Gulf of Thailand
MEQ-P9	**Thanakorn Jiwarungrueangkul** Clay mineralogical records of sediment provenance change during the sea level rise of last deglaciation in the southern South China Sea
MEQ-P10	**Sang Pham Nhu** Geochemical records of provenance and East Asian monsoon evolution during the Late Quaternary in the western South China Sea
MEQ-P11	**Takami Morita** Radioactive cesium in marine organisms around Japan
MEQ-P12	**Jin Huang** Research of pore water nutrients diffusion fluxes in the Yangtze River Estuary adjacent waters
MEQ-P13	**Zhun LI** Resting cysts of potentially harmful dinoflagellates in Korean coastal area
MEQ-P14	**Jun Zhao** Early diagenesis of sedimentary chloropigments in the Changjiang and Mississippi river-dominated ocean margins: Implications for source, transport and burial of organic carbon
MEQ-P15	**Sung-Suk Suh** Detection of *Cochlodinium polykrikoides* using sandwich hybridization integrated with nuclease protection assay
MEQ-P16	**Min-bo Luo** Large ocean engineering impact on distribution characteristics of epifauna community in waters around Yangshan Islands in Hangzhou Bay
MEQ-P17	**Yang-Guang Gu** Heavy metal concentrations in wild fishes captured from the South China Sea and associated health risks

POC Contributed Paper Session

POC-P1 **Andrés H. Arias**
Time-series wavelet transform exposes South Atlantic Ocean changes during the last 40 years

POC-P2 **Miaohua Mao**
Investigation of shallow and deep water wave dynamics using unstructured SWAN: An application to Lake Michigan

POC-P3 **Neil K. S. Cheong**
Paleoenvironmental reconstruction from deepwater sedimentary records in the central South China Sea since the middle Pleistocene

POC-P4 **Xiang-nan Wang**
Study on the hydrodynamic performance of a flap bottom-hinged wave energy converter

POC-P5 **He Wang**
Dynamic evaluation of Envisat ASAR derived ocean swell in North Pacific

POC-P6 **Xiaoqi Huang**
Error variation analysis and global assessment for total water vapor of HY-2 Scanning microwave radiometer

POC-P7 **Svetlana Marchenko**
Seasonal variability of water circulation in the deep Bering Sea

POC-P8 **Mingbing Li**
Application of Wave Drifter to marine environment observation

POC-P9 **Zhanming Hu**
Analysis on the formation dynamics of a typical small-scale eddy in the Bohai Sea

POC-P10 **Jianjun Kang**
Analysis of ocean surface wave spectra from a new wave buoy

POC-P11 **Ying Li**
Study of the turbulent mixing in the northwestern Pacific based on a fine-scale parameterization method

POC-P12 **Georgiy S. Moiseenko**
Upper layer phenomena monitoring of the sea using EOF analysis of remote sensing data

POC-P13 **Jianyu Ni**
Annual variation of Ba/Ca and Mn/Ca ratios in Porite coral from eastern Hainan Island and their environmental implication

POC-P14 **SvetlanaYu. Glebova**
Winter cyclonic activity in the Asia-Pacific region and its effect on surface temperature in the Sea of Okhotsk in the 2000s

POC-P15 (cancelled) **Evgeniya Maryina**
Features resulting from reconstructing vector fields of tidal currents on the shelf of eastern Sakhalin Island (Sea of Okhotsk)

POC-P16 **Tsuyoshi Wakamatsu**
Long term, high-resolution ocean reanalysis of the Northwest Pacific Ocean

POC-P17 **Ferdenant A. Mkrtchyan**
Problems in detecting and classifying sea surface anomalies by remote sensing

POC-P18 **Jianfeng Wang**
Measurements of the turbulent energy dissipation rate in the Changjiang river near-field plume

POC-P19 **Jae-Kwi So**
A preliminary study on the tidal effects on the Yellow Sea Bottom Cold Water and its ecosystem using a physics-ecosystem coupled model

POC-P20 **Hee Dong Jeong**
Variation of sea surface chlorophyll *a* in the southwestern boundary area of the East Sea

POC-P21 **Svetlana P. Shkorba**
Linkages of climatic anomalies in the North Pacific, Asia at temperate latitudes, Indo-Pacific and Arctic oceans

POC-P22 **Fei Yu**
The formation process of Southern Yellow Sea Cold Water Mass in spring

POC-P23 **Vladimir I. Ponomarev**
Simulation of mesoscale and submesoscale circulation in the northwestern Japan Sea

POC-P24 **Chuntao Chen**
Assessment of GPS buoy accuracy for altimeter sea surface height calibration

POC-P25 **Gang Wang**
Decadal variability of upper ocean heat content in the Pacific

POC-P26 **Yuanling Zhang**
Intercomparison of reanalysis datasets on ocean heat content

W2. Identifying major threats to marine biodiversity and ecosystems in the North Pacific

W2-P1 **Jianguo Du**
Assessing ecological risks of heavy metals to marine organisms by species sensitivity distributions

W2-P2 **Kwang-Sik Choi**
Macroalgal-coral phase shifts on subtidal benthic community on the northern coast of Jeju Island, Korea

W3. Linking climate change and anthropogenic impacts to higher trophic levels via primary producers

W3-P1 **Yi Xu**
How does explicit treatment of spatial variability in environmental conditions affect simulated anchovy recruitment?

W3-P2 **Jingjing Zheng**
A modeling study of the hypoxia dynamic off the Changjiang Estuary

W3-P3 **Qiang Hao**
The satellite net primary production and its control mechanisms in the Changjiang Estuary, China

W3-P4 **Yanfang Xiao**
The merged global ocean chlorophyll content product

W4. Marine Environment Emergencies: Detection, monitoring, response, and impacts

W4-P1 **Pavan Kumar**
Exploring the potential of Geospatial Technology for oil spill detection in shallow coastal areas in the Arabian Gulf

W4-P2 **Yifei Zhang**
Complex toxic impacts of heavy metals and PAHs to marine mussels cells

W4-P3 **Jiangling Xu**
Drift prediction of oil spill and its decision support for emergency response

W5. Monitoring and Assessment of Environmental Radioactivity in the North Pacific

W5-P1 **Peng Zhou**
Radioactive status of seawater and assessment in the northeast South China Sea, the Luzon Strait and its adjacent area

W5-P2 **Hongqi Shi**
Monitoring of ^{134}Cs in surface sea wate

W5-P3 **Dekun Huang**
Temporal variations of ^{7}Be and ^{210}Pb activity in aerosols at Xiamen, China

W5-P4 **Jianda Ji**
Effects of external gamma irradiation on growth of *Phaeodactylum tricornutum*

W5-P5 **Delvan Neville**
Radionuclide tracers suggest different migratory patterns in two groups of North Pacific albacore (*Thunnus alalunga*)

W5-P6 **Galina S.Borisenko**
Assessment impact of radioactive contamination on the Pacific saury after the Fukushima Dai-ichi Nuclear Power Plant accident

W6. Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems

W6-P1 **Fanglin Cheng**
A representative assessment method for the coastal marine observation environment

W6-P2 **Ryuta Murashige**
Temporal change of plankton and environmental factors during typhoons observed at the Oshima Cabled Observatory

POSTERS FROM OBSERVING ORGANIZATIONS

AOOS	**Phil Mundy** Alaska Ocean Observing System
Argo	**Jianping Xu** Observing the Oceans in Real Time
CLIVAR	**Lei Han** CLIVAR: 20 years' progress in coordinating international activities on climate and ocean research
ESSAS	**Franz Mueter** ESSAS – Ecosystem Studies of Subarctic and Arctic Seas
GESAMP	**Peter Kershaw** Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
IMBER	**Yi Xu** IMBER – Research for marine sustainability: Synthesis and the way forward
ISC	**Gerard Thomas DiNardo and Chi-Lu Sun** International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
MABIK	**Keyseok Choe** Introduction to the National Marine Biodiversity Institute of Korea
NEAR-GOOS	**Hee-Dong Jeong** North-East Asian Regional GOOS program
NPRB	**Matthew R. Baker** Integrated ecosystem research programs – North Pacific Research Board
SAHFOS	**George Graham** Integrated marine environmental sensing with the SAHFOS Continuous Plankton Recorder survey
SCOR	**Sun Song** Scientific Committee on Oceanic Research

Abstracts
Oral Presentations

S1: Science Board Symposium
Change and Sustainability of the North Pacific

October 19, 11:15 (S1-10845), Invited

Towards a social-ecological-environmental system approach for the coastal ocean

Emanuele **Di Lorenzo**[1], Keith Criddle[2] and Alida Bundy[3]

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2 School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau, AK, USA
3 Ocean Ecosystem Science Division, Bedford Institute of Oceanography, Dartmouth, Canada

The growth of human activities along the coastal ocean continues to alter the physical-biological dynamics. Predicting and understanding changes in the coastal ocean requires networks of social and natural scientists that can develop tools and scientific frameworks that support the diagnosis of the complex dynamics of coastal social-ecological-environmental systems (SEES), and explore scenarios of future change. Here we report on the recent activities of the PICES Study Group on Social-Ecological-Environmental Systems (SG-SEES).

The goals of SG-SEES activities include (1) creating the conditions to foster a *transdisciplinary* dialog between natural and social scientists in order to develop a common language for characterizing the dynamics of a SEES, (2) identifying the path for developing and implementing an integrated modeling framework for a SEES, (3) conducting a comparative analysis of two coastal hypoxia SEES.

Applying social-ecological-environmental models to test and compare scenarios of change across different coastal SEES may allow quantitative identification of key guiding principles underlying the interaction between humans and the coastal environment.

October 19, 11:45 (S1-10647), Invited

Regional climate modeling and FUTURE - An overview and possible future directions

Michael **Foreman**[1], Chan Joo Chan[2], Enrique Curchitser[3] and Angelica Peña[1]

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2 Korea Institute of Ocean Science and Technology, Ansan, R Korea
3 Rutgers University, New Brunswick, NJ, USA

Since its inception in 2011, PICES Working Group 29 on Regional Climate Modeling has encouraged, documented, and assessed activities related to the development and application of climate models for sub-regions around the North Pacific Ocean. Though the initial models were primarily physical, ongoing efforts to include biogeochemistry mean that newer models are better equipped to address the marine ecosystem and socio-economic key questions within the FUTURE Science Plan. In this presentation, we will review the state-of-the-art of regional climate modeling within PICES and suggest possible future directions to assist FUTURE in achieving its goals.

October 19, 12:15 (S1-10846), Invited

Toward the integrated research in fisheries science

Mitsutaku **Makino**

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Each fishery has its specific social and ecological backgrounds. For example, in case of the Asia-Pacific countries including Japan, a lot of small-scale fishers are catching high diversity of species for human consumption using various gears, and landing the catch at small fishing ports spread all along the coastline. Under such conditions, top-down government imposed biology-based management is difficult to implement due to the large scientific uncertainties and high monitoring costs. Rather, more effective is fisheries co-management in which local fishers' organizations determine their management measures and implement them according to the local conditions. Now, when Asia-Pacific countries occupies the 56% of total marine harvest volume and 84% of the total number of fishers (49 million fishers), co-management is one of the most realistic approach for sustainable fisheries. Under the co-management regime, the social role of fisheries science is to show the science-based and feasible management options to local stakeholders in order to facilitate their decision makings. In such management options, not only the sustainability of resources and fisheries businesses but also other factors such as local culture, equity among stake holders, food security, livelihoods, etc., should be taken into account as the equivalent importance. To be more specific, integrated research for assessing the effects to multiple objectives by various combinations of management measures is required. In this presentation, I introduce the concept of "the Fisheries System" to facilitate such integrated research, and briefly present the main results from Japanese integrated research projects based on this concept applied to several fisheries (sea cucumber, walleye pollock, chub mackerel/sardine, and hairtail). These types of research projects are becoming more important for addressing emerging issues, such as the integrated effects from globalization to the local communities or their adaptation to the climate change, which cannot be dealt with by the traditional single discipline approach. Furthermore, from the viewpoint that the fishery resource is only one of the various ecosystem services from the sea, a future task for integrated fisheries research is to discuss the appropriate balance of various ecosystem service uses in order to secure human well-being in the future. In other words, the identification of the role of fisheries science in the sustainability science as a whole is one of the most important missions for the integrated fisheries science.

October 19, 14:15 (S1-10568), Invited

Impacts of ocean acidification on bivalve production in the Pacific Northwest

George G. **Waldbusser**

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The prime cause of the US Pacific Northwest oyster seed shortage in the late 2000's has been clearly documented as increasing acidification of waters along the northeast Pacific Ocean. The implementation of strategies within oyster hatcheries in the region to mitigate the impacts of high CO_2 water have been largely effective in restoring oyster seed output for growers along the US west coast. Marine bivalves have complex life-cycle that includes stages of lesser or greater sensitivity to environmental stressors. Roughly 50% of the variation in success of Pacific oyster seed production in one hatchery for example can be predicted by the carbonate chemistry of the water they are exposed to during the first 48 hours of life. Concurrent laboratory based research has confirmed the direct sensitivity of some bivalve larvae to calcium carbonate saturation state, and the kinetic basis of this sensitivity, rapid shell formation, with limited energy, while more exposed to environmental conditions. While mitigation strategies in hatcheries may provide refuge for the early life stages of commercially important species that are amiable to culture, additional strategies will need to be implemented for the other stages of their life-history. I will discuss ongoing research across the life-history of several species of marine bivalves, what we are learning about their sensitivity (or lack thereof), and strategies for documenting thresholds and mitigating impacts to support sustainable bivalve populations for economic and ecological benefit.

October 19, 14:45 (S1-10850)

Using earth systems model output to project climate change impacts to the North Pacific Subtropical Ecosystem over the 21st Century

Jeffrey **Polovina** and Phoebe Woodworth-Jefcoats

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Physical and biological parameters from over a dozen earth systems models are available from the Climate Model Inter-comparison Project 5 (CMIP5). We explore a variety of approaches to use this output to project higher trophic level ecosystem impacts. As a first step spatial and temporal and basin-wide trends in key variables, such as temperature, phytoplankton, and zooplankton density can be displayed. Next, ecological biomes and key or new habitats can be computed and the temporal changes in their areas described. Lastly the phytoplankton output from these models can be used to drive ecosystem models to project changes in ecosystem structure and fisheries yields. We have applied these approaches to project ecosystem changes in the North Pacific subtropical ecosystem with the physical and biological output from 13 earth system models. The results indicate that over the 21st Century, 12 models project the subtropical biome to expand in area by 12 to 37% with 1 model projecting a decline by 11%. Nine models project phytoplankton density of the biome to decline from 3 to 9% while 4 models project increases from 3 to 20%. Ten models project zooplankton densities in the biome to decline by 2 to 28% while 3 models project increases from 3 to 11 %. All models project new thermal habitats will be created. A size-based and a species-based ecosystem models are forced by phytoplankton densities from one of the earth system models. Projected changes in ecosystem structure and fisheries yields between the two models show both similarities and differences.

October 19, 15:05 (S1-10635)

Fighting a hard battle: Effects of hypoxia and temperature on euphausiids in the North Pacific

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Dead zones have been increasingly reported in recent years, especially among the most productive ecosystems on the planet. Recent studies show that decreasing oxygen and increasing temperature with global warming may threaten many marine organisms. Because *Euphausia pacifica* is a key prey for fish, mammals, and seabirds, their responses to hypoxia and environmental changes play a key role in both ecosystem functioning and fisheries. We studied Hood Canal—a narrow, deep fjord in Washington State—as an example to investigate the seasonal effects of hypoxia on abundance and distribution of euphausiids. Various techniques and methods were applied including CTD, depth-stratified plankton tows, acoustics, and stable isotopes analyses at four stations during summer through fall, 2012 & 2013. Notably, we observed abundant juveniles and adult euphausiids in low dissolved oxygen waters in the Hood Canal, e.g. <2mg O_2/l. Their distributions were not significantly correlated with temperature, dissolved oxygen, salinity, or fluorescence. We then examined their stress level during hypoxic time periods by comparing their oxygen supply and demand across the environmental conditions they experienced in the field. We extend our analysis to the western North Pacific to compare spatial differences in their metabolic stress. We finally discuss the challenges of future environmental change for euphausiids and as a consequence, the food webs of the temperate coastal ecosystems.

October 19, 15:25 (S1-10604)

Top predators partition the Bering Sea and are unlikely to respond favourably to climate change

Andrew W. **Trites**[1], B. Battaile[1], K.J. Benoit-Bird[2], A. Harding[3], S. Heppell[2], B. Hoover[4], D. Irons[5], N. Jones[4], K. Kuletz[5], C. Nordstrom[1], R. Paredes[2] and D. Roby[2]

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We tracked the movements of seals and seabirds breeding on the Pribilof Islands (central Bering Sea) and Bogoslof Island (southern Bering Sea) to determine where these central place foragers feed relative to the constraints of distance from land, environmental conditions, and availability of food. A total of 115 northern fur seals, 128 thick-billed murres and 106 black-legged kittiwakes were equipped with GPS and activity tags in 2008 and 2009. At-sea locations showed no overlap in foraging areas for kittiwakes or murres breeding on the two Pribilof Islands despite the islands being within foraging distance of each other. Nor was there any overlap between the foraging areas for seabirds from Bogoslof Island compared to those from the Pribilofs. Foraging ranges of northern fur seals also showed segregation of feeding areas by breeding sites between and within islands. The distinct segregation of feeding areas by breeding colonies and the similarities in segregation between both groups of central place foragers implies a common set of selective mechanisms related to compass orientation of breeding colonies, competition within and between species, predation risk, and energetic constraints associated with distance, prey size and energy content. Our data suggest that immediate environmental conditions may have less effect on broad-scale habitat selection compared to colony orientation and the longer-term selective forces related to foraging costs and predictability of annual environmental conditions. This implies that existing breeding colonies in the Bering Sea may be poorly adapted and unable to respond favourably to global warming and environmental change.

October 19, 16:05 (S1-10860), Invited

A European perspective on Integrated Ecosystem Assessment

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An Integrated Ecosystem Assessment has been variously described, including approaches that focus on descriptions of the ecosystem (ecosystem overviews), through to policy-led and management-focused assessment methodologies that may or may not be based on complex or rather simplistic models. I will describe an approach that focuses on achievement of policy objectives and then provides a number of linked structured assessment methodologies to capture how state and change in the different elements of the ecosystem influence this (where humans and their activities are viewed as integral). The approach assesses the state of relevant policy objectives, then provides a methodology for identifying threats to these, and from this an approach to elaborate an operational process of creating, appraising and choosing management options, where full consideration of trade-offs across ecological, economic and social issues, and evaluation of the governance complexity surrounding this, are all considered. There were some key principles that framed the approach, including the need to be holistic and inclusive, even in data-poor situations, and the influence of these principles on the overall assessment methodology and thus also its potential scope and use, is discussed in light of the role for integrated ecosystem assessments going forward.

October 19, 16:35 (S1-10565)

Jellyfish blooms as a threat to the sustainability of the East Asian Marginal Seas: An overview of recent jellyfish studies in China, Japan and Korea

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The East Asian Marginal Seas (EAMS), which sustain more than 10% of the world fish catch, have seen recurrent blooms of scyphozoan jellyfish, such as *Aurelia aurita* s.l. and *Nemopilema nomurai*, in recent decades with concomitant declines in fish catch. The presumption that jellyfish blooms are a threat to fisheries sustainability has motivated scientists in China, Japan and Korea to study jellyfish intensively, especially in the last 10 years. An overview of these studies is given here. Studies on asexual reproduction in benthic polyps, a key process in determining medusa population size, have been greatly advanced, and composite results indicate that increased anthropogenic impacts to the coastal environment and ecosystem (e.g. global warming, cultural eutrophication, deoxygenation, marine construction, loss of biodiversity, overfishing) may be responsible for the rise of jellyfish. Physio-ecological properties in the planktonic medusa stage (e.g. respiration, feeding and growth rates) have been elucidated, showing that jellyfish are important predators on zooplankton including fish eggs and larvae. Hence, fisheries have to develop adaptive and management strategies, such as forecasting outbreaks prior to blooms and developing countermeasures. Monitoring of spatio-temporal distribution of medusae is routinely conducted at present, which enables us to forecast year-to-year bloom intensity of *N. nomurai* in early summer, 1-3 months before large medusae appear in the Chinse, Japanese and Korean coastal waters. Fishermen have introduced various types of jellyfish excluding devices in their fishing nets. For long-term fisheries sustainability, coastal environment and resource management strategies covering the overall EAMS are needed.

October 19, 16:55 (S1-10763)

Multiple scale climate variability in the North Pacific and features of recent climatic regime

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Interannual, decadal and multidecadal climate variability in the North Pacific, their features and linkages are studied by using statistical analyses of the observational records. EOF and clustering methods are applied for monthly mean time series of Hadley SST (1900-2014), surface net heat flux (Q), atmospheric pressure (SLP), air temperature (SAT) and wind velocity from NCEP NCAR reanalyses (1948-2014). Features of decadal oscillation and inversed multidecadal climatic regimes were shown in terms of cluster analyses of differences between Q, SLP, SAT in key tropical and extratropical regions of the Asian Pacific. The linkages between anomalies in Arctic Ocean and various Pacific regions, including certain areas of tropical-equatorial latitude band were changed with alteration of multidecadal climate regime. The climate regime changed in late 70s – early 80s of the 20th century in the Pacific Ocean is associated with a changing phase of 50–60 – years oscillation in the ocean-atmosphere system revealed by different authors in Arctic, Pacific and Atlantic Oceans. Recent climate regime is characterized by an amplification of both Arctic Oscillation signal in the North Pacific and relationship between anomalies in the Indian Ocean and South Siberia on decadal and interannual time scales. The amplitude of the decadal and interannual anomalies in the area studied is basically increased in warm multidecadal climate regimes including recent period of warming.

October 19, 17:15 (S1-10704)

Anthropogenic aerosols and climate variability control decadal variability of dissolved oxygen in the North Pacific

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The Pacific Ocean contains two of the High-Nutrient-Low-Chlorophyll (HNLC) regions, where a scarcity of iron limits biological productivity. Below these surface HNLC regions, one in the subpolar gyre and the other in the tropics, lay some of the most voluminous oxygen minimum zones of the world oceans. Dissolved oxygen concentration in these regions significantly declined in the last several decades. However, mechanisms regulating the oxygen variability in the North Pacific are not well understood. We perform a suite of computational simulations to test the hypothesis that atmospheric pollution over the Pacific Ocean as well as the regional climate variability can change the pattern of biological productivity and the distribution of oxygen in deeper waters. Climate variability modulates the upwelling and nutrient supply to the surface waters, altering the oxygen utilization below. Atmospheric pollutants increase the deposition of soluble iron and fixed nitrogen, further altering the ocean productivity and oxygen utilization. The combined effect is the increased O_2 consumption in the oxygen minimum zone of the tropical Pacific, causing the prominent trends observed over recent decades.

October 19, 17:35 (S1-10742)

Social-ecological vulnerability of forage fish and fishermen to climate change

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Marine forage species such as squid, anchovies, and sardines serve as dominant primary consumers, targets of some of the largest fisheries in the world, and essential food for higher trophic level species like marine mammals, seabirds, and larger fishes. Contemporary climate change has already changed the distribution and abundance of some of these species, and it has been challenging to predict such effects *a priori*. Using projected changes in oceanographic climate, we assessed vulnerability of marine forage species and dependent fishing vessels in the California Current. Based on expected changes in the mean and variability of temperature and chlorophyll concentrations, and species-specific sensitivity to these changes, we ranked the vulnerability of 15 forage species, all of which are fisheries targets. We used this measure of vulnerability of each stock as a proxy for the exposure of fishing vessels that target them to climate change. By coupling ecological vulnerability measure to estimates of social vulnerability—stemming from the financial dependence of fishing vessels on each stock and the potential for the vessels to adapt by targeting alternative stocks—we provide an integrated assessment of how climate change may differentially affect fishing vessels that target forage species.

S2: BIO/MONITOR/TCODE Topic Session
The 2014/15 El Niño and anomalous warming of the North Pacific: What happened?

October 21, 09:00 (S2-10788), Invited

Causes and effects of the recent warming in the Northeast Pacific Ocean

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Strongly positive sea surface temperature (SST) anomalies have prevailed in the NE Pacific Ocean since 2013. The causes and effects of these anomalies, sometimes referred to as the “blob”, are examined. Anomalous air-sea interactions associated with a strong and persistent ridge of higher than normal sea-level pressure (SLP) resulted in reduced seasonal cooling of the upper ocean during the winter of 2013-14. The ridge itself was part of a large-scale remote response to conditions in the far western tropical Pacific. Warm SSTs in the latter region, and the enhanced deep convection, forced a standing-wave pattern in the atmosphere from the tropics to higher latitudes in a manner similar to that associated with ENSO, but originating farther west. This connection is indicated both in the observations and numerical model experiments. The pattern of anomalous SST in the NE Pacific has evolved during the past year. These changes are due to the mean ocean circulation and the weather during the past year, which during the winter of 2014-15 featured lower than normal SLP over virtually the entire NE Pacific. As of early summer 2015, a wide strip of relatively warm water is present along the entire west coast of North America, in a pattern projecting on the positive phase of the Pacific Decadal Oscillation (PDO). The warm ocean temperatures have had major and wide-ranging impacts on the marine ecosystem. It will be interesting to see how the recent event plays out in terms of both the physics and biology.

October 21, 09:35 (S2-10705), Invited

Persistent record-high temperatures in the North Pacific in 2014/2015: A climate hypothesis

Emanuele **Di Lorenzo**[1] and Nathan Mantua[2]

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Record-high sea surface temperature anomalies (>3C), also referred as the warm “blob”, developed during the winter of 2013/2014 in the Gulf of Alaska and spread along the North American coast in the following winter and spring of 2014/15. These winter anomalies resembled the patterns of the North Pacific Gyre Oscillation (NPGO) in 2014 and of the Pacific Decadal Oscillation (PDO) in 2015. We suggest that the generation and interannual persistence of the warm anomalies are driven by large-scale climate teleconnections between tropics and extra-tropics that are typical of El Niño precursor dynamics. More specifically, we show that the strong atmospheric ridge that forced the warm “blob” is linked to the activity of the North Pacific Oscillation (NPO), a well-known pattern of atmospheric variability that acts as stochastic driver for El Niño. Following a strong extra-tropical NPO forcing during winter/spring, El Niño conditions typically develop in the tropics during the summer. By fall and winter of the following year the El Niño variability excites atmospheric teleconnections that carry the signal back to the North Pacific and impact the Aleutian Low (AL). This teleconnection dynamic from extra-tropics (winter year 0) to tropics to extra-tropics (winter year +1) is a source of significant interannual persistence of North Pacific SSTa as they evolve from an NPO-like SSTa (e.g. NPGO) to an AL-like SSTa pattern (e.g. PDO). Even though a strong El Niño did not develop during the fall/winter of 2015, we show that this tropical/extra-tropical coupling played an important role in the generation and persistence of the 2014/2015 warm “blob”. Given that previous studies suggest that greenhouse forcing will energize the NPO precursor dynamics, it is important to establish if the 2014/2015 temperature extreme, and its wide marine ecosystem impact, will become more frequent under climate change.

October 21, 10:10 (S2-10667)

Arrival of 2014-2015 Warm Anomaly waters off Oregon

P. Michael Kosro, Craig Risien, John A. **Barth**, Alexander Kurapov, R. Kipp Shearman and P. Ted Strub

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Moorings, gliders, remote sensing, and modeling elements of the ocean observing system off Oregon provide a view of the arrival of waters from the deep-ocean warm anomaly ("the Blob") to coastal Oregon in Fall 2014. Beginning in May 2014, sea surface temperature anomalies off the Pacific Northwest oscillated between ± 3°C for one full 2-month cycle, then varied incoherently until September 2014, when the anomalies turned positive and remained greater than 2 standard deviations warmer than average past the end of the year. The fastest transition was observed along the Newport line: a strong warming pulse from 11°C to 19°C in 31 hours, with the strongest rise of 6°C occurring over six hours on September 14. Surface encroachment of warm water is seen in successive glider transects from September 2014, with the surface layer deepening and warming over time. Downwelling of warm, fresh water is observed at the coastal end of the glider transect by September 27, properties consistent with an origin farther offshore. At mid shelf, bottom temperature reached nearly 14°C, or 3.5°C above the maximum observed the previous year. AVISO satellite altimeter products, modified nearshore to add coastal tide-gauges, indicate robust positive coastal anomalies in September 2014. Based on the PFEL upwelling index at 45°N, 125°W, winds initially turned downwelling favorable on September 14, but remained weak until September 20. The NANOOS Visualization System (nvs.nanoos.org) has a web-based Climatology App which can be used to explore climate analyses of numerous fields and anomalies for this event, and others.

October 21, 11:00 (S2-10765)

Phytoplankton responses to the anomalous warming in the NE Pacific

Angelica **Peña**, Nina Nemcek and Marie Robert

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A rapid and unexpected warming of the surface waters in the Gulf of Alaska was observed in October 2013 that persisted into 2015. In this study, we examine the effect of the anomalous warming on nutrient concentrations, phytoplankton abundance and phytoplankton assemblage composition along Line P in the northeast subarctic Pacific and in coastal waters off the west coast of Canada. Nutrient concentrations are usually high (>5 mmol m^{-3}) and chlorophyll concentrations low (<0.5 mg m^{-3}) year around in the Fe-poor prymnesiophyte dominated offshore waters, whereas high seasonal variability in phytoplankton biomass occurs in the nutrient-rich diatom dominated inshore waters. In winters 2013/14 and 2014/15, nutrient renewal from vertical transport of nutrient-rich deeper water into the surface layer was restricted due to increased stratification. Phytoplankton concentration decreased and phytoplankton assemblage composition (as determined by HPLC-derived phytoplankton pigment concentrations) was more diverse than in previous years in offshore waters. In comparison, the coastal waters off the west coast of Canada remained relatively cool until September 2014 when water temperatures rose to record levels that persisted into 2015. Despite anomalously high ocean temperatures the phytoplankton community composition and biomass on the shelf and shelf-break in May and September 2014 was similar to previous years. Possible implications for lower trophic levels and biogeochemical cycles will be discussed.

October 21, 11:30 (S2-10706)

Warm Blob effects on subtropical NE Pacific Ocean phytoplankton

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Anomalous Sea Surface Temperature (SST), Absolute Dynamic Topography (ADT), and Chlorophyll-a (CHLa) satellite data were registered off Baja California during 2014. In May, high positive SST anomalies started to be evident in the coastal zone between Vizcaino Bay and Cabo San Lucas, although the phytoplankton response was first observed in July, with high CHLa up to 12 mg m^{-3}. By August, anomalies appeared all around the coastal and oceanic zone off the peninsula, with values up to 6ºC above the mean SST registered in the coastal zone between Punta Eugenia and Magdalena Bay. In October in this area, ADT became ~ 20 cm higher than October 2013. These changes in the ADT are equivalent to ~ 50 m thermocline deepening, which in turn influenced the availability of nutrients and light for phytoplankton growth in the euphotic zone. To quantify the influence of the "warm blob" on phytoplankton production (PP), Generalized Additive Models (GAMs) were used. Our aim was to infer PP in 2013 and 2014 from a GAM built from the relationship between PP and ADT with monthly satellite data from 1998 to 2012. Preliminary conclusions show that anomalous SST during 2014 negatively affected phytoplankton biomass. The predicted PP values as a function of ADT will allow us to analyze the effects of ocean stratification on PP produced by the anomalously high SST derived from the warm Blob during the summer of 2014.

October 21, 12:00 (S2-10406)

The effects of the anomalous warming on lower trophic levels in the NE Pacific, from Continuous Plankton Recorder sampling

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Continuous Plankton Recorders (CPRs) were first deployed in the NE Pacific in 2000 so that there is now a 15 year time series of taxonomically resolved, lower trophic level abundance data. During this time the ocean has experienced periods of warmer and colder conditions, as indexed by the Pacific Decadal Oscillation, with noticeable responses in the plankton such as a higher abundance of warm water species and a more northerly distribution in warm years, or a later spring zooplankton increase in colder years. This presentation will compare 2014 data with the preceding time series for two contrasting regions that have good CPR sampling coverage; the oceanic NE Pacific and the central Alaskan Shelf. Preliminary findings suggest that some of the planktonic responses to the anomalous warming were in-line with previous warm conditions in the mid-2000s, but some were not. For example: The larger diatoms that the CPR samples were unusually low in both regions. Zooplankton biomass was very high through 2014 on the Alaskan shelf and the previously strong positive relationship between diatoms and zooplankton biomass did not hold true in 2014. Warm water copepods were more numerous in both regions than in recent cold years, but not as numerous as expected in the oceanic region. While some speculative conclusions will be drawn it is hoped that following this session, these data can contribute to a larger understanding of the impact of the unusual conditions on the marine ecosystem.

October 21, 14:00 (S2-10801)

The effects of The Blob on the zooplankton and upper trophic levels of the Northern California Current off Oregon

William T. **Peterson**[1], Jennifer Fisher[2], Jay Peterson[2] and Tracy Shaw[2]

Presented by Anthony Koslow on behalf of William T. Peterson

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The Gulf of Alaska (GOA) and the northern California current (NCC) became anomalously warm in fall/winter 2013 due to lack of deep mixing in the GOA. Waters continued to warm through summer of 2014 giving rise to a pool of anomalously warm water across the North Pacific that has now come to be called "The Blob". Anomalies exceeded 4.5°C – a historical record. In the NCC, weather conditions associated with The Blob resulted in the shortest upwelling season on record. By winter 2014, The Blob had produced a positive PDO pattern with the most positive PDO values ever recorded for winter months (+ 2.51 in December 2014 and 2.45 in January 2015). The zooplankton species sampled in the NCC indicate that The Blob water was from an offshore and southerly source, illustrated by anomalously high numbers of tropical copepod species. Eight copepod species were new records for shelf waters off Newport OR (e.g. *Acartia negligens, Clausocalanus furcatus, C. farranni* and *Subeucalanus crassus*. Other species which occur only very rarely include *Centropages bradyii, Eucalanus hyalinus* and *Rhincalanus nasutus*). An additional 9 copepod species, new to Oregon, are as yet unidentified. With respect to fishes, eggs of both sardines and anchovies occurred in our net tows off Newport in February and March 2015, a "first" for the Oregon coast (these two species usually spawn off southern California in winter). Also noteworthy are large numbers of pomfret, pompano and market squid throughout the NCC and the eastern GOA.

October 21, 14:30 (S2-10649)

Observations of anomalously low crustacean zooplankton production rates along the west coast of Vancouver Island in the spring of 2015

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The composition of the zooplankton community along the west coast of Vancouver Island (WCVI) is known to vary with warm and cold sea-surface temperatures (SST). Statistically, warm years have tended to favour small 'southern' copepod species, while cold years favour large, lipid-rich 'northern' species. Less clear is the effect that anomalous SST and compositional changes have on crustacean zooplankton production. Here we compare a unique set of measurements from the WCVI during warm/El Nino (2005, 2009, 2010) and cold/La Nina (2011) years with the highly anomalous conditions in 2015. Community-level estimates of crustacean zooplankton production rates were measured using the chitobiase method. Rates measured in 2005 and 2009-2011 ranged from 1-10 mg C m^{-3} day^{-1}, with production generally decreasing from south to north. In spring 2015, the zooplankton community was almost totally dominated by gelatinous plankton, while crustacean zooplankton biomass was the lowest ever observed. These patterns were reflected in crustacean zooplankton production rates which were typically either <1 mg C m^{-3} day^{-1} (or zero), with rates increasing from south to north. We discuss these patterns in the context of the bio-physical conditions leading up to and during our surveys and consider possible implications for higher trophic levels.

October 21, 15:00 (S2-10571)

Ichthyoplankton and corrosive waters off southern California

Sam **McClatchie**, Andrew R. Thompson and William Watson

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The influence of equatorial water in the southern California region has been increasing over the last three decades, associated with strengthening of the California Undercurrent. These waters contain lower oxygen and higher acidity, but their influence is mediated by the seasonal and inter-annual variability of currents and water masses in this complex region with strong cross-shore and latitudinal gradients. The CalCOFI program has consistently sampled the southern California region since 1951, identifying the ichthyoplankton assemblages to species. The mesopelagic fish larvae are the best represented group in these samples. We use the mesopelagic ichthyoplankton assemblages collected by CalCOFI at three locations representative of the core of the California Current, the core of the California Undercurrent and the oligotrophic central gyre waters to determine how increasing equatorial influence is reflected by the mesopelagic fish community. We discovered different temporal patterns and variability of ichthyoplankton at the three representative locations within the region. Warm and cool water associated mesopelagic ichthyoplankton assemblages also show different responses, indicating that spatial averaging over many species may fail to resolve biotic responses to complex oceanographic variability.

October 21, 15:50 (S2-10407)

Anomalous patterns in California Current pelagic micronekton distribution and abundance in 2015

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We report on the unusual distribution and abundance patterns of pelagic micronekton sampled during the late spring upwelling season in the coastal waters off of California in 2015, relative to a 33 year time series off of central California and shorter time series in northern and southern California. Data are collected from a pelagic midwater trawl survey conducted to sample the abundance of young-of-the-year (YOY) rockfish (*Sebastes spp.*) and other groundfish to develop indices of year class strength for stock assessments. Throughout the duration of these time series we have tended to see three very generalized patterns of community dominance. For example, in years of strong upwelling and/or southward transport, we see productive conditions associated with high numbers of YOY rockfish, market squid and other key elements of the food web. In contrast, in years of lower upwelling and transport (such as El Niño years), we often see greater localized abundance coastal pelagic species such as Pacific sardine (*Sardinops sagax*) and northern anchovy (*Engraulis mordax*), and an increase in the abundance of typically subtropical species, such as pelagic red crabs (*Pleuroncodes planipes*). Finally, in some years the community is dominated by gelatinous zooplankton, such as salps, pyrosomes and heteropods. The 2015 survey was unusual in that species characteristic of all three of these nominal states were encountered in high abundance throughout this region. We will discuss the results of the 2015 survey relative to past trends and oceanographic conditions and processes.

October 21, 16:20 (S2-10751)

Preliminary observations of the impact of the BLOB on the summer distribution of marine fish in the Gulf of Alaska

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In the fall of 2014, researchers projected a continuation of anomalously warm ocean conditions in the northeast Pacific Ocean using a new seasonal forecasting capability. Based on the results of these forecasts, the North Pacific Research Board funded a coordinated research project to examine the impacts of the unusual warming event in the northeast Pacific. This project will evaluate a unique dataset of acoustic and bottom trawl survey data that spans from the southern California Bight to the western Gulf of Alaska. An interdisciplinary multi-national research team has been assembled to conduct this research. The NPRB provided funds to supplement existing surveys with additional oceanographic measurements to enhance our ability to describe the mechanisms underlying observed shifts in spatial distributions. This paper will present the initial observations from the 2015 acoustic and bottom trawl surveys in the Gulf of Alaska. These results will be compared to previous years when NMFS conducted comprehensive surveys simultaneously in both the GOA and CCS (2003, 2005, 2011 and 2013).

October 21, 16:50 (S2-10670)

Anomalous warming and its impacts in the NE Pacific from a Canadian perspective

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The unusual warming in the NE Pacific in 2014 and 2015 was a widespread event but with very clear spatial and temporal footprints. We present the evolution and ecosystem impacts of this event from a Canadian perspective. While warm conditions were very intense in the Gulf of Alaska in the first half of 2014, the coastal and shelf areas of BC were cooler than normal. This changed in fall 2014 and into 2015 when the warm water reached the outer coast of BC, causing record high temperatures in some locations. These mixed conditions - cool in early 2014 but very warm in later 2014 – had a mixture of unusual biological consequences. We briefly review the physical evolution of these warm conditions and then describe how they impacted, and are impacting, the marine ecosystem and species of ecological and commercial importance in BC. Such impacts include unusual plankton species, of both southern and offshore origin, very low secondary crustacean production but very high phytoplankton biomass, oxygen, and ammonia, and impacts to salmon and seabirds. We conclude with a discussion of how Fisheries & Oceans Canada has been incorporating these unusual conditions into fisheries management planning.

October 21, 17:20 (S2-10691)

Anomalously warm conditions during 2013-2015 off the California Coast

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Anomalously warm waters during 2014 off the U.S. west coast were detected by two moorings at San Diego and Monterey Bay, three gliders along the CalCOFI Line 67/80/90, and the hydrographic survey off the coast of Newport, Oregon. The timing and strength of this 2014 warming were consistent and concurrent at all these sites. A regional model simulation demonstrated that remote forcing from offshore lateral boundary conditions was the dominant contributor to this coastal warming. Both observations and a Pacific Ocean ROMS model simulation show that this 2014 warming is correlated with the anomalously warm waters offshore in the Northeastern Pacific Ocean (nicknamed 'The Blob') with a time lag about 6-9 months. These warm waters were seen down to 100 meters and were concurrent with lower nutrient (e.g., nitrate) availability and reduction in primary production (e.g., lower phytoplankton and zooplankton). Large-scale warming off the U.S. west coast has been observed previously usually associated with major El Nino events (e.g., 1982/83, 1997/98). However, the 2014 warming is unique and unprecedented both in terms of the large geographic area covering both the ocean off the U.S. west coast and Northeastern Pacific Ocean further offshore.

S3: FIS Topic Session
Eastern-western approaches to fisheries: Resource utilization and ecosystem impacts

October 22, 09:00 (S3-10381), Invited

The marine fisheries resource utilization, ecosystem impacts and fisheries management in China

Xianshi **Jin** and Xiujuan Shan

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Chinese marine fisheries contribute greatly to meeting market demands and ensuring food security, and provide a large amount of high-quality protein. The landings of Chinese marine fisheries increased from the 1950s to the end of 1990s, and then showed a decreasing fluctuation, maintained around 12 million tons since the 2000s. The exploitation and utilization of fishery resources progressed from under-, full- to overexploitation since the 1950s. Meanwhile, mean trophic level of landings increased from the 1950s to the middle 1960s, and then decreased, particularly from the middle 1960s to the middle 1980s, and has showed a stable decreasing trend since the late 1980s. The current fisheries catch are mainly composed of small size (simple age structure), short life-span (invertebrates 1-2yr) with low trophic level species. Similar trends have also been observed in survey data, such as in the Yellow Sea, from small yellow croaker and hairtail in the 1950s and early 1960s to Pacific herring and chub mackerel in the 1970s, and then to anchovy and sandlance after the 1980s. Recently, the abundance of pelagic species such as anchovy is decreasing, while the biomass of small yellow croaker is increasing.

In order to diminish the stressors of marine fisheries, many management measures have been conducted in China, including closed season/areas, the "zero-growth" policy, the fishing license system, limits of catchable size and the proportion of juveniles in the catch, control fishing capacity, the fishing vessel scrapping program etc.. In addition, mitigation measures have also been fully considered, such as stock enhancement and sea ranching, as well as environmentally friendly aquaculture (IMTA, Integrated multi-trophic aquaculture).

October 22, 09:25 (S3-10345)

Exploitation and management of fisheries resources in northern South China Sea

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This presentation provides data and information on trends and recent status of Chinese marine fisheries in northern South China Sea, including fishing capacity, catch, fishery types and fishing grounds. The state of exploitation of fishery resources was assessed based on comparison between of recent catch and potential catch, trends in catch per unit effort, and changes in catch compositions. It was revealed that the fisheries resources have changed greatly under multiple stressors, including overexploitation, pollution, habitat destruction and climate change, and overexploitation was the main reason of fishery resource decline in this area. The fishery management and conservation in the northern South China Sea is also introduced.

October 22, 09:45 (S3-10798)

New normal: The structural analysis of modern fisheries economic development in China

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The development of a modern Chinese fisheries economy is important to the whole world. Established in the structural analysis of the global fishery value chain, we define the new normal that is dependent on the modern development of China fisheries. There are six parts of the definition. First, the mode of production is transformed from fishing of wild fish to sea farming. Second, the rise of the carbon sink fishery is responsive to changes in the ecosystem. Third, the evolution of the industrial market organization is referred to as a harmonious organization. Fourth, the mode of processing trade changed to form trade granaries. Fifth, based on the security of a traceability system of seafood products, a safety standard will be established. Last, the construction of bases for offshore, deep-water farming will be consistent with the broader pattern of transformation from land to the ocean. Therefore, based on the new circumstances, we will design the dynamic mechanism of a new normal fishing economy, and several preliminary measures adapted to our government, markets and fishing villages will be suggested.

October 22, 10:05 (S3-10511)

An ecosystem-based fishery management approach toward sustainable groundfish resource utilization in the eastern Bering Sea

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In 2013, Alaska commercial fisheries landings accounted for 2.6 million t (5.8 billion pounds) worth US$1.9 billion dollars. These landings were 58.6% of the total US landings. Such high annual yields are associated with a fishery management system that is widely regarded as among the most precautionary and successful in the world. Here, the ecosystem-based fishery management approach toward sustainable groundfish resource utilization in the eastern Bering Sea is considered as an example. I review key features of the fishery management plan and management policy, annual stock assessment and catch specification processes, ecosystem considerations including management of bycatch and discards, habitat protections, and incorporation of economics and human dimensions into management decisions. This “western style” approach to fishing has resulted in many favorable outcomes, such as relatively stable groundfish biomass and catches, stable fish community size spectrum, lower fishing effort, compliance with catch limits, reduced fishery discards, declining seabird bycatches, greater habitat protections, and increases in relative abundance of structure-forming invertebrates. However, despite these encouraging diagnostics, other undesirable trends have been difficult for fishery managers to reverse, such as declines in some populations of crabs, Pacific halibut, salmon in western Alaska, marine mammals, and seabirds. Climate regime shifts appear to explain many of these divergent patterns, but research continues to explore the potential for unknown direct or indirect effects of fishing on the Bering Sea ecosystem.

October 22, 10:25 (S3-10621)

Optimization of sampling design for a fishery-independent survey with multiple objectives

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Fishery-independent surveys are often used for collecting high quality data to support stock assessment and fisheries management. Optimization of sampling design is necessary for cost-effective sampling efforts; which, however, may not be straightforward for a survey with multiple goals. A simulation approach was developed to evaluate and optimize stratification schemes and sampling efforts for a stratified random survey with multiple goals including estimation of abundance indices of individual species and fish groups and species diversity indices. Gains in precision of survey estimates from the stratification schemes were compared to simple random sampling design for most indices. The loss of precision of survey estimates due to the reduction of sampling efforts could be compensated by improved stratification schemes. Sampling efforts in a stratified random survey could be reduced while still achieving relatively high precision and accuracy for most indices measuring abundance and biodiversity, which would reduce the cost and negative impacts of survey trawling on those species with low abundance and aggregated distribution in the coastal ecosystem. This study also showed that optimization of sampling design for a fishery-independent survey might vary with different survey objectives. A post-survey analysis, such as this study, could improve survey designs to achieve the most important survey goals.

October 22, 11:05 (S3-10540)

An integrated assessment approach for natural fishery resource restoration – A case study of wild Yellow Croaker *Pseudosciaena crocea* (Riehardson) in Guanjingyang, Fujian, China

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Coastal and marine fishery resources declined substantially in the past half century. Over 90% of the world's fisheries are fully exploited or overfished, including 29% of fish and shellfish species that have collapsed. Several fish species have already become extinct or endangered. China is the largest country for fishery production, exports and consumption. Although reported annual marine fishery catches continue to increase, a considerable amount of Chinese natural fishery resources have gone extinction or become endangered. Natural stocks of commercially important large yellow croaker (*Pseudosciaena crocea*) were nearly depleted prior to the 1980s. Despite ongoing overfishing, some studies indicate that improved management would help some natural stocks to recover. In this study, we developed an integrated assessment method in light of the ecosystem-based approach for assessing potential restoration capacity of natural marine fish species. We then applied the method to assess the restoration capacity of wild large yellow croaker in the Guanjingyang national aquatic germplasm resource protected area based on data from 2006 to 2013. Results showed that the restoration capacity of target species in Guanjingyang is moderate. Limiting factors include low survival rate of released larvae, low genetic diversity, coastal aquatic pollution, and shipping activities. The stock could be restored in the future with continuing improved ecosystem-based management efforts, such as encouraging local community involvement, monitoring of the larval release activities, better understanding of life history traits, and construction of a germplasm repository for restoration efforts.

October 22, 11:25 (S3-10516)

Selection of suitable coastal aquaculture sites with environmental and socio-economic consideration: A case study in the Menai Strait, UK

Shengle **Yin**[1], Aigo Takeshige[2], Yoichi Miyake[1] and Shingo Kimura[1]

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Due to the dramatic decline in fishery resources since the 1950s, aquaculture has flourished and brought new challenges in sustainable coastal management. Coastal areas are of diverse interests and are utilized by various users with competing demands on coastal spaces. The aquaculture activities have intensified the conflicts among coexisting users in coastal areas worldwide, including the Menai Strait. This study aims to demonstrate a local-oriented approach for selecting suitable locations for mussel cultivation in the Menai Strait by conducting Multi-Criteria Decision Analysis (MCDA), which takes environmental, and socio-economic factors into consideration. In the site selection process, six criteria consisting of these two factors were used for optimizing the effectiveness of cultivation and mitigating the conflicts among users. A hydrodynamic model was used for calculating the turbulence intensity and water submerge time, which compensated for limitation in observational data. The results of a questionnaire survey to local residents were used to rank the importance of all criteria. GIS boundary data of a statutory aquaculture area and Special Area of Conservation were converted into evaluation values for MCDA. The result indicated that 40.5% of the whole region (17.6 km^2) is suitable area, which is larger than the utilized area (about 10 km^2). The environmentally productive area was significantly different from socio-economically suitable area. Thus, these factors need to be concurrently considered to prevent conflicts among stakeholders. This selection method may contribute to the sustainable coastal development by reducing potential conflicts among users at the planning stage and maintain the sustainability of aquaculture and environment.

October 22, 11:45 (S3-10651)

Effects of changes in marine ecosystem services on human well-being: International comparison of human well-being structure

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Many people believe that they would be happier if they are richer. But many survey data on human well-being is inconsistent with this belief. In the psychological view, "human well-being" involves people's positive evaluations of their lives, such as positive emotions, engagement, satisfaction, meaning, enjoyment of social interaction and so on. In this study we developed "well-being CUBE" that measures human well-being. Based on the psychological theory and the UN Millennium Ecosystem Assessment framework, it is organized by a series of "human needs (desires)" logically and analytically. Some initial findings include the fact that all countries surveyed have similar general concepts of human well-being with regard to marine ecosystems; however, the specific understanding of how the marine ecosystem affects human well-being differs among the countries surveyed, and, therefore, what makes for a desirable relationship between people and the sea is different among countries.

October 22, 14:00 (S3-10574), Invited

Alternative fishing strategies and their consequences

Shijie **Zhou**

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Various fishing strategies result from combinations of varying intensity (catching how many fish) and selectivity (targeting only specific types or sizes of fish). Fishing intensity and selectivity directly affect ecosystems structure and the quantity and quality of fisheries production. Noticeable differences in adopting fishing intensity and selectivity exist between Western and Eastern countries: more selective in West and more intensive in East. This talk will give an overview of how alternative fishing strategies may affect ecosystem structure, biodiversity, and fisheries yields. Is it possible for fisheries to maintain ecosystem structure and functioning? What strategies may have less ecological effect while producing higher yields? What is the trade-off between conservation, food production, and economic profits? Is minimizing catch of non-target species consistent with the principles of Ecosystem Approach to Fisheries? For the purpose of EAF, what species should be harvested at an ecosystem level? How should we harvest the age and size structure of a population? We will examine some of these questions at trophic, species, size, and intra-species levels. This discussion is intended to contribute to our understanding about how human activities alter marine ecosystem structure and how they affect food security in the future.

October 22, 14:25 (S3-10851)

Exploiting the natural productivity of aquatic ecosystems

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The approximate constancy of biomass over (logarithmically scaled) body mass in aquatic ecosystems has an important consequence that productivity decreases with body size. This means that more biomass is available from exploitation of small fish than from big fish. This paper examines some consequences of this ecosystem-level property, such as whether the ecosystem-level decrease is matched by a corresponding within-species decrease, as fish grow.

We contrast major commercial fisheries, driven by markets for big fish, with small-scale artisanal fisheries, where fishing might be brought more in line with the natural productivity of aquatic ecosystems. Increasing selectivity for big fish leads to lower biomass yields, more truncation of size structure, lower resilience, and more fisheries-induced evolution (FIE). Fishing mortality, if brought closer to the underlying productivity, achieves a partial substitution for natural predation. This allows greater biomass yields, with less effect on ecosystem structure and resilience, and with less potential for FIE. It is thought to be difficult to achieve a match between fishing mortality and natural productivity (balanced harvesting). However, we show that this can emerge naturally in a small-scale fishery, when fishers are able to change gear to increase their biomass yield without minimum-size regulations. Controls on the overall fishing pressure are still needed to prevent overfishing.

October 22, 14:45 (S3-10453)

The effects of fishing on ecosystem structure of the Northeastern part of the Okhotsk Sea

Konstantin M. Gorbatenko, Vladimir V. **Kulik** and Artem E. Lazshentsev

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Walleye pollock is the main target of fisheries in the Northeastern region of the Okhotsk Sea. Its maximum catch was 1340 kiloton in 1973. In the whole Northern region of the Okhotsk Sea, a maximum catch of walleye Pollock of 1925 kiloton was achieved in 1997. The slope and shelf northward of 51° latitude and eastward of 150° longitude in the Okhotsk Sea provided decreasing catch from 889 to 706 kiloton of walleye pollock during the previous 5 years. It was still greater than 86% from the catch of walleye pollock in the Northern part of the Okhotsk Sea in 2014. The share of walleye pollock catch fell from 68 to 62% in total catch there. Meanwhile a share of the second dominant fish – pacific herring increased from 14 to 23% and the catch grew on about96 kiloton (from ~ 209 kiloton in 2010 it encreased to ~305 kiloton in 2014). Nevertheless fisheries regulation occurs via total allowable catch calculated without any consideration of indirect and direct trophic interactions between these two dominant fish. We used an EcoTroph modeling approach to simulate several fishing scenarios in the ecosystem LIM with scaled trophic positions. Trophic flows between species had *a priori* constrains from posterior probabilities of food ratios from the SIAR approach. Our results show that fisheries impacts are not straightforward.

October 22, 15:05 (S3-10648)

Appraisal of fisheries management options to mitigate climate change based on a simulation model of impacts in western Indian Ocean coral reefs

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Coral reefs are the most diverse of all marine ecosystems. They teem with life, with perhaps one quarter of all ocean species depending on reefs for food and shelter. Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures secreted by corals. Coral reefs are built by colonies of tiny animals found in marine waters that contain few nutrients. Most coral reefs are built from stony corals, which in turn consist of polyps that cluster in groups. A coral reef ecosystem simulation model, CAFFEE, developed to evaluate the effects of fisheries management measures on coral reef ecosystem services and functioning, was applied to these parameters independently and taking the effects of coral bleaching into account. We present model outputs for temporary fishing closures and the switching of fishing gears on fish biomass, fisheries yield and coral recovery after bleaching events to exemplify the types of simulations available. CAFFEE was calibrated to simulate Kenyan coral reef ecosystems and fisheries based on long-term observational data. Temporary closure simulations benefited hand line fisheries, with an increase in total annual catch over time unlike gill net fisheries. The use of spear guns or gill nets after bleaching aided coral recovery and promoted greater fisheries yields, whereas hand line fishing promoted sea urchins by reducing their predators, resulting in reduced coral recovery. Ecosystem models combined with empirical surveys can thus assist managers to evaluate the effects of fisheries management options on ecosystem services where climate change mitigation is required.

October 22, 15:50 (S3-10375)

Modeling interannual variations of Japanese common squid (*Todarodes pacificus*) resources around Japan

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Japanese common squid, *Todarodes pacificus,* is one of important fishery resources to Japan, Korea and China. It has a clear life cycle: spawns from the shelf slope of East China Sea to southwestern area of Japan Sea; makes a feeding migration from its spawning area to Japan Sea or Pacific side of Japan; makes a spawning migration back to the East China Sea after growing up in the Japan Sea and Pacific side of Japan. In the past several decades, the Japanese common squid resources around Japan have exhibited large interannual variations. Although some studies focused on the influences of environmental conditions (mainly sea surface temperature) on spawning area, there is still no quantitative argument on what the most important factor controlling interannual variations of Japanese common squid resources is. In this study, we use a particle tracking model to simulate feeding migration of Japanese common squid larvae to the water around Japan from 1992 to 2012. In our model, we consider the transport of larvae by ocean current and random walk, the survival condition of larvae by water temperature, and the influence of parent stock on larvae number. The parent stock is likely the most important factor controlling the interannual variation of Japanese common squid resources.

October 22, 16:10 (S3-10460)

Management of small yellow croaker, *Larimichthys polyactis* stock in Korean waters using a length-based production value-per-recruit analysis

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Yield-per-recruit (YPR) analysis are used to provide management guidance for efficient use of a fish cohort and to estimate biological reference points. The parameters used in the YPR models are usually taken to be age dependent. However, we often encounter difficulties in conducting stock assessment for some species since age estimation requires substantial amounts of money and time. Also, the individual fish price per unit weight of small yellow croaker in Korea increases dramatically by size. Thus, we developed an alternative method, which is called as length-based production value-per-recruit (PPR) analysis. We developed two types of thelength-based PPR analysis: a discrete function method and a continuous function method. We estimated optimum fishing mortality (F) and the length at first capture (l_c) using the two types of the length-based PPR analysis. In both case, results from management metrics derived from the length-based PPR analysis show good agreement compared to age-structured PPR analysis. And these length-based PPR estimates were much more conservative for the stock management than the traditional YPR analysis, which can prevent the fish stock from the economic overfishing. In conclusion, length-based PPR analysis could be useful to obtain important management parameters under data deficient situation when traditional stock assessment methods cannot be applied, and more proper approach for stock assessment in the case that the individual fish price per unit weight increases dramatically by size like small yellow croaker in Korea.

October 22, 16:30 (S3-10544)

Changes in ecological characteristics of walleye pollock *Gadus chalcogrammus* in accordance with the biomass fluctuation

Minkyoung **Bang**[1], Sukyung Kang[2], Suam Kim[1] and Myong Ho Shon[3]

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Walleye pollock (*Gadus chalcogrammus*, pollock hereafter) used to be the most dominant species in Korean waters, but catches decreased rapidly since the late 1980s, and the stock was collapsed completely in the early 21st century. To investigate environmental effects on the pollock stock we compared differences in biological and ecological parameters during high (1970s-1980s) and low (1990s-2000s) biomass periods. Water temperatures showed an alternating pattern of warm and cool phases off the coastal areas where the walleye pollock fishery operated. For example, at 200 m, warm phases appeared in the mid 1970s, and early 1990s with cool phases in the early to mid 1980s and since the mid 1990s. Trends in surface water temperature were similar until 1990, but thereafter surface temperature remained warm. Pollock length frequencies showed that a larger size class was dominant in the low biomass period when their condition factor was larger, as well. This indicates that growth was relatively better during the low biomass period. The gonad-somatic index also revealed that the peak spawning season was in February during the high biomass period but changed to December during the low biomass period. Population Stock Density (PSD), which is index of size structure based on length frequency, was higher during the low biomass period than during the high biomass period, indicating recruitment intensity of pollock became weaker in 1990s.

October 22, 17:05 (S3-10546), Invited

The Landing Obligation in the European Union Common Fisheries Policy: Can a regulation focused on resource utilization address broader management objectives such as limited environmental impacts, economic development, and food supply?

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The revised Common Fisheries Policy (CFP) recently launched by the European Union (EU) includes a Landing Obligation, by which all catches of the major species will gradually have to be retained and landed, for an increasing number of fisheries from 2015 to 2019. Undersized catches of these species will have to be used for purposes other than direct human consumption.

The objectives of this novel provision are to reduce the current levels of discards, which are considered a waste and an unnecessary pressure on marine resources and fleet viability. Meanwhile, the CFP aims at protecting the marine environment, supplying nutritious food to the European Union market, and fostering economic development. This presentation will examine which of these objectives are likely to be addressed by the Landing Obligation.

First, the current state of knowledge about discards in European fisheries, their causes, and consequences will be summarized. Since the EU member states have been running onboard observer programmes over the last decade, a substantial body of information has become available. Second, the difficulties met in the current process of implementing the Landing Obligation will be presented. Based on these two pillars, the expected consequences with respect to the objectives of maintaining ecosystem structure and function, providing food, and supporting fleets, will then be inferred. Focusing on resource utilization might not be a straightforward way to move towards these objectives.

October 22, 17:30 (S3-10455)

Acceptable Biological Catch in the ecosystem-based TAC management

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Acceptable biological catch (ABC) for total allowable catch (TAC) management of Korean fisheries has been estimated by a five-tier system that relies on population-based stock assessment models according to available ecological information for pelagic or demersal species. To overcome the limitation of the current ABC estimation system based on population dynamic models, this study attempted to integrate the ecosystem-based fisheries assessment (EBFA) approach into Korea's current ABC estimation system, and has developed an ABC estimation approach for ecosystem-based TAC management. To estimate an ecosystem-based ABC, the ABC estimated by the current estimation system was adjusted depending on the species risk index (SRI) that was derived from risk analysis of EBFA. During the process, the SRI-F equation which generalizes the relationship between SRI and fishing mortality (F) was devised, and was used to estimate an ecosystem-based ABC. Also, the SRI projection as a function of the F scenario was conducted to estimate the regression coefficient of the SRI-F equation. We demonstrated an ecosystem-based ABC estimation by applying it to the chub mackerel, one of the TAC species in Korea's large purse seine fishery. The SRI-F relationship showed a statistically significant level $p<0.001$. The ABC was adjusted from 180,000 mt to 170,393 mt for achieving the target species risk index, 1.0. We found that this approach can be used to allocate the TAC in an ecosystem-based context for quota-managed fisheries.

S4: MEQ Topic Session
Indicators of emerging pollution issues in the North Pacific Ocean

October 22, 09:00 (S4-10809), Invited

Microplastic: An emerging threat to marine environment and a new tool for POP monitoring

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The ubiquitous occurrence of microplastics (< 5 mm) in the marine environment has been recently recognized. International Pellet Watch (IPW) utilizes resin pellets, a sort of microplastic, as a tool to globally monitor the presence and extent of contamination by persistent organic pollutants (POPs). The target pollutants of IPW are hydrophobic compounds including polychlorinated biphenyls (PCBs), organochlorine pesticides (DDTs, HCHs), polycyclic aromatic hydrocarbons (PAHs), and the pharmaceutical triclosan, all of which are sorbed and accumulated in microplastic particles at concentration factors up to millions. Since 2005, pellets have been sent from 200 locations in 50 countries and analyzed for POPs. Spatial and temporal pattern of global POPs pollution have been revealed. Accumulation of POPs in microplastics may pose a threat to the marine environment. Furthermore, additive chemicals such as polybrominated diphenyl ethers (PBDEs) are found in microplastics, thereby increasing the potential for toxicity in biota. These chemicals can be transferred to marine food web, because it has been recently demonstrated that wide range of marine organisms ingest or intake microplastics. We collected microplastics from coastal waters (Tokyo Bay) and open ocean waters (North Pacific) and measured POPs. The analytical results indicate that PCB concentrations in microplastic in seawater were in the same orders as those in pellets stranded on corresponding beaches. This implies that chemical threat of pollutants adsorbed to microplastic can be estimated from IPW data. Deca-brominated diphenyl ether, which was compounded as additives, was detected in microplastics in coastal water. Presence of the wide range of additives in microplastics in open ocean should be examined in future study to make full assessment of risks of both adsorbed chemicals and additives in microplastics.

October 22, 09:30 (S4-10510), Invited

Spatial variability of trace metal concentrations in different mussels from coastal areas of the northwestern Pacific Ocean

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Metals continue to be ubiquitous in the environment, reflecting a combination of natural and anthropogenic sources. Assessing the ecological risks associated with metal contamination in aquatic ecosystems remains an important challenge. Biomonitoring for metal contamination has been used extensively in the last two decades, the notable example of which are the global "mussel watch" programs. However, restricted natural distributions often prevents direct comparisons among different shellfish species in different geographical/hydrographical regimes. Therefore, inter-species comparisons of trace metal concentrations in mollusks used for monitoring, as well as intra-species studies of the variability of the chemical composition, are essential background information for "mussel watch"-like programs. For the northwestern Pacific, such background information is not sufficiently developed. To overcome this, we examined spatial variation of trace metal concentrations in mussels *Mitilus trossulus* from the northwestern Pacific, and *Septifer bilocularis* from coastal waters in Vietnam, and compared results with published data on the levels of metals in other mussels (e.g. *Perna viridis*) from the western Pacific. Regardless of species and climatic zone, Cd concentration in mussels is primarily controlled by upwelling events. Factors affecting the spatial distribution of Fe, Mn, Zn, Cu and Ni concentrations in different mussels are examined. Results provide support for comparative evaluations of different mussel species to interpret environmental conditions of coastal waters of different climatic zones of western Pacific from the boreal regions to the tropics.

October 22, 10:00 (S4-10591), Invited

Levels and temporal trends of legacy and emerging POPs in small cetacean species from Japan

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Cetacean species accumulate persistent organic pollutants (POPs) in their body. Because of their persistent, bioaccumulative and toxic characteristics, environmental contamination by POPs is of public concern. Recent studies reported that POPs including the dirty dozen (‘legacy’ POPs) and emerging contaminants including brominated flame retardants (BFRs), could disrupt the endocrine and immune systems of marine mammals. Although some reports are available on the environmental behavior, bioaccumulation and ecotoxicological risk of POPs, information on the contamination status and temporal variation in cetacean species is still limited. We analyzed legacy and emerging POPs including PCBs, DDTs, CHLs, HCHs, HCB, PBDEs and HBCDs in the blubber of several toothed whale species from Japanese coastal waters. In addition, temporal trends of POP levels were also investigated by analyzing archived blubber samples in es-BANK of Ehime University. PCB and DDT levels showed decreasing trends in oceanic species, reflecting past regulations. On the other hand, PBDE and HBCD levels increased during 1990s and 2000s, reflecting extensive use of flame-retardant products in recent decades.

October 22, 11:00 (S4-10779), Invited

Monitoring of legacy and emerging contaminants in wildlife from Korea

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Persistent organic pollutants (POPs), regulated under the Stockholm Convention, are generated from anthropogenic activities and are transported to coastal environments where they bioaccumulate in fatty tissues and biomagnify in marine food web. In 2001, 12 (‘the dirty dozen’) chemicals including dioxins, PCBs and some organochlorine pesticides (OCPs) were designated as legacy POPs. During 2009-2013, 10 chemicals were added to this list of POPs by the United Nations Environment Programme (UNEP). Considering environmental persistence, bioaccumulation potentials and toxic effects of POPs to wildlife and human, studies on distribution, source and ecotoxicological effects are necessary. We determined the occurrence, accumulation profiles and ecotoxicological implications of legacy, emerged and emerging contaminants (including POPs) in wildlife (whales, dolphins, sharks and birds) from Korea. We detected all POPs and emerging contaminants including personal care products (e.g. synthetic musk compounds; HHCB and AHTN) and alternatives or replacements of regulated POPs. Significant decreasing trends for dioxins, PCBs, DDTs, HCHs and PBDEs were observed in marine mammals between 2003 and 2010. Using 10 species of birds, we found a clear shift of usage patterns of flame retardants from PBDEs to their alternatives, including DBDPE, BTBPE and Dechlorane Plus (DPs). Our findings suggest more attention should be given to emerging contaminants such as alternatives and personal care products to protect wildlife health.

October 22, 11:30 (S4-10366)

Microplastic is the macroproblem of the world's oceans, including the Russian Far East

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Preserving unique coastal ecosystems and maintaining the ecological balance of the world's oceans are top priorities for today's society. However, the consumer-orientation in many nations has led to a number of environmental issues, with marine microplastics becoming a dominant concern, especially in coastal areas. The issue of microplastics is growing into a major concern not only in heavily industrialised areas, but also in remote regions far from human sources of this pollutant. The Russian Far East is no exception. But marine litter is attracting attention in Russia. One of the first studies of microplastics in coastal areas of the Russian Far East was undertaken in the Amursky and Ussuriisky gulfs near Vladivostok City. Sampling of water were taken from 17 sites and microplastics were counted. There were 13 sites near various parts of the city, located in recreational and industrial areas differing in hydrodynamic regime. Samples taken from 5 sites revealed presence of plastic particles. While informative, results do not reveal details of microplastic sources, movement and further transformation. These microplastic studies will continue. Such monitoring will be carried out in a manner that will provide a qualitative toolkit for administrative, scientific and economic structures and will simplify the microplastic pollution mitigation in coastal areas.

October 22, 11:50 (S4-10759)

At-sea distributions reveal where Cassin's Auklets are exposed to microplastics in the fall in British Columbia 2014

Patrick D. **O'Hara**[1], Jocelyn Wood, Stephanie Avery-Gomm, Laurie Wilson, Ken H. Morgan and Peter S. Ross

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Plastic ingestion is being documented in increasing numbers of seabird species, particularly as microplastics. However, it remains unclear where and how microplastics are entering the gastrointestinal tracts of these species. Recently it has been shown that obligate planktivores such as Dovekies (*Alle alle*), found in the northwestern Atlantic, are not immune to ingesting small plastic pieces. These findings suggest that microplastics found in the stomachs of seabirds are not entirely remnants of larger plastic items that are consumed and broken down inside seabird gastrointestinal tracts. Instead microplastics may be directly targeted as food, or be ingested incidentally by ingesting planktonic prey loaded with microplastic. Cassin's Auklets (*Ptychoramphus aleuticus*) are obligate planktivore equivalents to Dovekies in the northeast Pacific. We dissected Cassin's Auklet carcasses recovered in British Columbia Canada during the fall of 2014, when unusually large numbers of dead Cassin's Auklets were beach-cast ("wrecked"). This provided us with the opportunity to test whether or not planktivorous seabirds are susceptible to microplastic ingestion. Preliminary results indicate that as much as 36% (30/83) were found containing microplastic. To understand where Cassin's Auklets were exposed to microplastic, we predicted at-sea distributions of Cassin's Auklet during the months of November and October 2014, using the machine learning regression tree algorithm "Random Forest" based on at-sea survey collected by the Canadian Wildlife Service from 1990-2010. We then compare our predicted at-sea distributions with previous studies showing distributions of microplastics, and macroplastics (as indicators of microplastic occurrence) found within the British Columbia marine Exclusive Economic Zone.

October 22, 12:10 (S4-10683)

Spatial and temporal mercury trends in seabird eggs from Pacific Canada 1968-2012 are due to diet: Evidence from sulfur isotopes

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Mercury is a ubiquitous contaminant that can be toxic to wildlife. Seabird eggs often used to monitor mercury levels in the environment because they are relatively easy to collect and yet integrate a signal from the entire food web. Spatial and temporal trends in mercury in seabird eggs, however, may represent variation in mercury abundance or in seabird diet. We measured mercury levels in six seabird species in Pacific Canada from 1968-2012. In contrast to expectation, the species feeding at the lowest trophic level, Leach's storm-petrel, had the highest mercury burden, while the species feeding at the highest trophic level, great blue heron, had the lowest mercury burden. Rather than being associated with trophic level, as assessed by $\delta^{15}N$, mercury levels across species were closely associated with sulfur isotopes $\delta^{34}S$. This association was clearest for pelagic cormorants, the only species showing a significant temporal mercury trend and where both mercury and $\delta^{34}S$ increased over time. The strong associations suggest that variation in mercury within and among bird species is associated with methylmercury binding to sulfur at the base of the food web. Variation in mercury levels in seabirds across space and time were associated with diet, specifically the origin of sulfur in the diet.

October 22, 14:00 (S4-10408)

Mercury speciation and major factors controlling the cycling of methylmercury in the Yellow Sea and Bohai Sea, China

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2 College of Chemistry and Chemical Engineering, Ocean University of China, Qingdao, China
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Two cruises were conducted in November 2013 and May 2014 to investigate the distribution of mercury species and methylation/demethylation (using isotope addition technique) in the Yellow Sea (YS) and Bohai Sea (BS). Concentrations of total mercury (THg) and methylmercury (MeHg) in BS sediments and water were higher than those in the YS. A decreasing trend from nearshore to offshore was observed for both THg and MeHg in sediments and surface water, suggesting the importance of terrestrial discharge in mercury cycling. Significant methylation and demethylation of mercury were detected in all incubated sediment and water samples. Methylation/demethylation in the water is dominated by UV-A and UV-B. By quantifying the net production/degradation of MeHg, sediment was found to be a source for MeHg while water served as a sink for MeHg in these two systems. Ratios of MeHg/THg in BS and YS water were found to be present at a much lower level in comparison with other marine systems, indicating low conversion efficiency of inorganic Hg to MeHg. This may be partly attributed to the 1) low efficiency of transporting THg from water column to sediment, 2) slow net methylation in the sediment, and/or 3) quick net photodegradation in water. These results imply that the low conversion efficiency of inorganic Hg to MeHg may explain the relatively low concentration of mercury detected in organisms in the two systems (compared to their high THg concentrations in the water).

October 22, 14:20 (S4-10733)

Persistent organic pollutants in the food chain: Salmon, seabirds and marine mammals from the North-West Pacific (Russian Far East)

Vasiliy Yu. **Tsygankov**[1], Margarita D. Boyarova[1], Peter A. Tyupeleev[2], Ilya A. Shcherbakov[1], Olga N. Lukyanova[1,2] and Nadezhda K. Khristoforova[1]

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Organochlorine pesticides (HCHs and DDT) can be toxic to some biota. HCHs and DDT are still used as pesticides in the Southern Hemisphere and can reach the North Pacific due to atmospheric transport. Maximum pesticide concentrations was found in the Pacific walrus *Odobenus rosmarus divergens* (liver; 90263 ng/g lipid) and the gray whale *Eschrichtius robustus* (liver; 13808 ng/g lipid) from the Bering Sea. Seabirds (Pacific gull *Larus schistisagus,* crested auklet *Aethia cristatella,* auklet crumb *Aethia pusilla,* northern fulmar *Fulmarus glacialis,* and grey petrel *Oceanodroma furcata*) and fishes (pink salmon *Oncorhynchus gorbuscha* and chum salmon *Oncorhynchus keta*) were sampled from the Sea of Okhotsk. Pesticide concentrations in bird tissues range from 29 ng/g lipid to 16095 ng/g lipid. Pesticide concentrations in salmon ranged from 220–330 ng/g lipid for pink to 550–790 ng/g lipids in chum. Biomagnification of organochlorine pesticides in the sub-Arctic food web is apparent.

October 22, 14:40 (S4-10694)

Bioindicators of marine pollution in impacted areas of the Sea of Okhotsk

Olga N. **Lukyanova**[1,2], Elena V. Zhuravel[2,3], Denis N. Chulchekov[1], Olga V. Podgurskaya[3] and Andrey A. Mazur[2]

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The Sea of Okhotsk is the primary fishing area for Russia. Anthropogenic impacts on this marine ecosystem are primarily due to fishing and shipping activities. However, two shelf areas are considered as impacted “hot spots” as a result of oil and gas exploration and development. Offshore oil exploration on the north-eastern Sakhalin Island started in 1996 and today oil is being extracted continuously. Significant reserves of hydrocarbons can be found on western Kamchatka shelf, and exploration in this area intensified in 2014. The embryogenesis of the sea urchin sand dollar *Scaphechinus mirabilis* was used as a bioindicator of seawater quality in the impacted areas. Fertilization membrane formation, first cleavage, blastula formation, gastrulation, 2-armed and 4-armed pluteus formation have been analyzed and a number of abnormalities were documented. A higher number of abnormalities at gastrula and pluteus stages (19-36%) were detected for the stations around oil platforms near Sakhalin Island. On the western Kamchatka shelf, the frequency of abnormalities was 7-13%, and toxic effects may be due to shipping. Such anomalies as exogastrula, incomplete development of pairs of arms, which were characterized for Sakhalin, were not observed at all; only developmental delays were observed. Eggs, embryos and larvae of sea urchins are suitable bioindicators of early disturbances caused by marine pollution in impacted ecosystems.

October 22, 15:00 (S4-10762)

Emerging ocean pollution issues in the NE Pacific Ocean vary by matrix: Lessons from sediments, shellfish and marine mammals

Peter S. **Ross**, Carmen Morales-Caselles and Marie Noel

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The NE Pacific Ocean is often perceived as relatively unspoiled by human activities, but a legacy of environmental crises has been revealed by studies of marine wildlife. Lessons learned in the past include the saga of DDT-associated eggshell thinning in aquatic birds, dioxins from pulp mills, and PCBs in killer whales. It is increasingly clear that risk assessments of new chemicals often fail to fully anticipate consequences in the environment, making it important to ensure that monitoring programs are in place to protect aquatic life and human health. The use of a blend of different matrices and/or species is important for a comprehensive monitoring program in coastal environments, as the information gleaned will be contingent upon the way in which different pollutants behave in the environment. Factors shaping the fate of contaminants include chemical hydrophobicity and persistence, as well as environmental factors including ocean currents, organic carbon cycles, sedimentation, and trophic level. Sediments in coastal British Columbia have demonstrated spatial variation in metals, PCBs, PBDEs and hydrocarbons, with high levels being associated with urban environments. Shellfish provide a complementary means to assess the quality of aquatic environments, with mussels filtering > 100L per day. Harbour seals have provided an integrated assessment of food web contamination by contaminants that possess persistent, biocaccumulative and toxic properties. We suggest that routine monitoring of sediments, shellfish, and marine mammals provides a reasonable means to assess the quality of coastal environments. However, site-specific concerns, human health, endangered species, and important habitats must be considered in the design of monitoring programs that are both routine and flexible.

S5: Ocean circulation of the Western Pacific and its response to climate change

October 21, 09:00 (S5-10567), Invited

Sea surface salinity variability in the equatorial Pacific and ENSO

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This study investigates the sea surface salinity (SSS) variability in the equatorial Pacific using Aquarius and Argo data. Both datasets nicely resolve the zonal displacement of a SSS front along the equator, which is highly correlated with the existing indices of El Niño. Analysis of these data sets also reveals a good correspondence between the SSS variability in the southeastern equatorial Pacific and the central Pacific El Niño, which together with the longitudinal location of the SSS front can be used as indices to characterize El Niño events and types. Results from an ocean general circulation model suggest that all salinity budget terms, including surface freshwater flux, horizontal advection, vertical entrainment, and small-scale processes, contribute to the SSS variability in the equatorial Pacific. The potentially important role of subsurface processes in modulating these SSS indices of El Niño is discussed.

October 21, 09:25 (S5-10557), Invited

Extrinsic control on the China Seas circulation from the western Pacific Ocean

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Oceanic circulation in the China Seas (CS) is governed intrinsically by processes induced by monsoonal wind-driven circulation and extrinsically by inflow/outflow dynamics mainly arising from water exchange between the CS and the adjacent western Pacific Ocean. The exchange is largely regulated by the path, intensity and variability of Kuroshio that is part of the circulation system formed by North Equatorial Current (NEC), Kuroshio Current (KC) and Mindanao Current (MC), or NKM, in the tropical western Pacific Ocean. The NKM is interlinked via bifurcation of the NEC off the Philippine coast. Based on a newly developed China Sea Multi-scale Ocean Modeling System (CMOMS) and field measurements, we will present new understanding about three-dimensional, time-dependent characteristics of NKM and the associated controls on Kuroshio and CS circulation. With the simulation results that are validated by the available measurements in the past, we outline the future biophysical trends in the NKM and CS.

October 21, 09:50 (S5-10405), Invited

The Kuroshio decadal variability and its climate impact

Xiaopei **Lin**[1,2], Jiayan Yang[3], Ping Chang[4] and Lixin Wu[1,2]

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The Kuroshio plays a crucial role in the North Pacific climate system due to the intense mass and heat transport and complex air-sea interaction along the sharp oceanic front of the Kuroshio. Interactions between the Kuroshio and the Pacific Decadal Oscillation (PDO) that occur on decadal timescales are still unclear and we do not fully understand the ocean response to decadal climate change, such as the fast warming before the 2000s and the following hiatus. Previous studies and observations show that the warm pool in the tropical Western Pacific Ocean is in a cold state and warm water flows eastward during the fast warming period, while the Kuroshio transport and its SST increase. In the recent warming hiatus, more warm water accumulates in the warm pool but the Kuroshio transport and its SST decrease. This anti-phase change of warm pool water and the Kuroshio variability is mainly caused by the ocean adjustment process. The long Rossby waves, which link the Kuroshio variability to the open ocean climate change, are propagating from east to west in the open ocean and from north to south near the shelf region. So the Kuroshio decadal variability is more related with higher latitude wind changes rather than its upstream forcing. Since the IPO/PDO mechanisms are still under debate and the Kuroshio should play a key role, continuous and enhanced observations are needed in the Kuroshio regions.

October 21, 10:15 (S5-10702)

Indonesian throughflow and its proxy from satellite altimeters and gravimeters

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4 Institute of Space and Earth Information Science, The Chinese University of Hong Kong Shatin, Hong Kong

The Indonesian Throughflow (ITF), the only pathway for interoceanic exchange between the Pacific to the Indian Ocean, plays an important role in global ocean circulation and climate. Yet, continuous ITF measurement is difficult and expensive. We will present an overview of the ITF measurement programs. We demonstrate a plausible approach to derive the ITF transport proxy using satellite altimetry sea surface height (SSH), gravimetry ocean bottom pressure (OBP) data, *in situ* measurements from the Makassar Strait from 1996-1998 and 2004-2011, and a theoretical formulation. The proxy time series follow the observation time series quite well, resolving the intraseasonal, monsoonal, and interannual signals with the 1993-2011 annual mean proxy transport of 11.6 ± 3.2 Sv. Long term trend shows that the ITF is increasing. Our formulation provides a continuous approach to derive the ITF proxy as long as the satellite data are available. Such a continuous record would be difficult to achieve by *in situ* measurements alone due to logistical and financial challenges. Ideally, the proxy can be used to complement or fill in the gaps of the observations for a continuous ITF proxy for better understanding the ocean climate and validating ocean circulation models.

October 21, 10:55 (S5-10373)

Pacific to Indian Ocean throughflow and its South China Sea branch

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The Indonesian Throughflow (ITF) plays an important role in determining heat, fresh water, and nutrient exchange between the Pacific and Indian Oceans. In order to estimate the ITF behavior, several international collaborative projects, such as Arlindo and INSTANT (The International Nusantara Stratification and Transport) have been carried out. Furthermore, since the South China Sea Branch (SCSB) of the ITF is considered important, a program named "The South China Sea - Indonesian Seas Transport/Exchange (SITE)" was established. The program measures the magnitude and variability of the water mass transport/exchange, temperature, salinity, and heat flux between the Indonesian Seas (IS) and the South China Sea (SCS). The data showed that the throughflow could greatly affect the circulation of both the SCS and the IS. Although many observations were obtained at ITF and SCS, the comprehensive observation on the Pacific-South China Sea-Indian Ocean water exchanges and their impacts on regional oceanography and climate (PSIE) are still expected. Specific focus is suggested: (a) Establishing an observation system for the Transport, Internal waves and Mixing in ITF region (TIMIT), (b) a long-term time-series observation is needed to further understand the SCSB, (c) the air-sea interactions over the ITF and their impacts on short-term climate anomalies should be identified, and (d) theoretic and numerical study on the PSIE should be carried out, in order to set up the integrated ocean observation and prediction systems.

October 21, 11:15 (S5-10688)

Response of El Niño events to higher CO_2 forcing: Role of nonlinearity

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El Niño corresponds to a quasi-periodic eastward extension of the western Pacific warm-pool and affects climate and weather worldwide including the North Pacific Ocean. Thus how El Niño events respond to higher CO_2 forcing is a critical question in climate change science. Giving equal weight to all CMIP5 models, IPCC AR5 suggests that the response of El Niño events to higher CO_2 forcing is likely muted if it is not uncertain. Here, we present a more careful analysis of the results from CMIP5 models and argue that once the nonlinear nature of El Nino event is taken into account, a more affirmative answer to the question emerges: El Nino events become more energetic in response to higher CO_2 forcing.

October 21, 11:35 (S5-10426)

ENSO modulations by Freshwater Forcing and Ocean Biology-induced Heating in the Tropical Pacific

Rong-Hua **Zhang**[1], Chuan Gao[1], Xianbiao Kang[1] and Hai Zhi[2]

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Recent studies have identified clear climate feedbacks associated with interannual variations in freshwater forcing (FWF) and ocean biology-induced heating (OBH) in the tropical Pacific. The interrelationships among the related anomaly fields are analyzed using hybrid coupled model (HCM) simulations to illustrate their combined roles in modulating the ENSO. The HCM-based supporting experiments are performed to isolate the related feedbacks, with interannually varying FWF and OBH being represented individually or collectively, which allows their effects to be examined in a clear way. It is demonstrated that the interannual freshwater forcing enhances ENSO variability and slightly prolongs the simulated ENSO period, while the interannual OBH reduces ENSO variability and slightly shortens the ENSO period, with their feedback effects tending to counteract each other.

October 21, 14:00 (S5-10491)

The responses of the Indian Ocean Dipole and South China Sea to El Niño Modoki

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Our early work separates El Niño Modoki events into El Niño Modoki I and II, which the warm SSTa originate in the equatorial central Pacific and subtropical northeastern Pacific. The study investigates the influence of the various groups of El Niño events on the IOD. Similar to canonical El Niño, El Niño Modoki I is associated with a weakening of the Walker circulation in the Indo-Pacific region which decreases precipitation in the eastern tropical Indian Ocean and maritime continent and thus results in the surface easterly wind anomalies off Java-Sumatra. Under the Bjerknes feedback, the easterly wind anomalies induce cold SSTa off Java- Sumatra, and thus a positive IOD tends to occur in the Indian Ocean during canonical El Niño and El Niño Modoki I. However, El Niño Modoki II has an opposite impact on the Walker circulation, resulting in more precipitation and surface westerly wind anomalies off Java-Sumatra. Thus, El Niño Modoki II is favorable for the onset and development of a negative IOD on the frame of the Bjerknes feedback.

This study also investigates variations of SSTa in the South China Sea (SCS) during the developing autumn of various El Niño events. Warm SSTa are observed in the SCS for canonical El Niño and El Niño Modoki I, whereas cool SSTa are found for El Niño Modoki II. The ocean heat budget analyses show that the change in latent heat flux is a major contributor to the SCS SST variations.

October 21, 14:20 (S5-10834)

A triggering mechanism for the Indian Ocean Dipoles independent of ENSO

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Although Indian Ocean Dipole (IOD) and ENSO are significantly correlated, there are indeed some IODs independent of ENSO. In this research, the characteristics of independent IOD are investigated and a new triggering mechanism is proposed based on case study and statistical analysis. Results show that the independent IODs peak in an earlier season and have a weaker intensity compared with the IODs associated with ENSO. The wind anomaly associated with independent IOD is very unique and shows a monsoon-like pattern, in addition to the equatorial easterly wind anomaly (EEWA) common to all the IODs. The evolution of the EEWA associated with independent IOD is well captured by the second EOF mode of the equatorial zonal wind interannual variability, suggesting that the independent IOD is an important climate mode inherent to the tropical Indian Ocean. The EEWA associated with independent IOD is tightly linked to Indian summer monsoon activities in spring, and the convection anomalies associated with early summer monsoon onset in the Bay of Bengal plays a key role in inducing the EEWA. The EEWA can persist through spring and summer, and causes a series of processes similar to those related to the IODs associated with ENSO. The correlation between independent IOD and Indian summer monsoon activities increases dramatically after 1980s, this is probably due to the mean state change in the tropical Indian Ocean climate system.

October 21, 14:40 (S5-10731)

Weak ENSO asymmetry due to weak nonlinear air-sea interaction in CMIP5 climate models

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State-of-the-art climate models have long-standing intrinsic biases that limit their simulation and projection capabilities. Significantly weak ENSO asymmetry and weakly nonlinear air-sea interaction over the tropical Pacific was found in Coupled Model Intercomparison Project Phase 5 (CMIP5) climate models compared with the observation. The results suggest that a weak nonlinear air-sea interaction may play a role in the weak ENSO asymmetry. Moreover, the results suggest that a weak nonlinearity in air-sea interaction in the models may be associated with the biases in the mean climate-the cold biases in the equatorial central Pacific. The excessive cold tongue bias pushes the deep convection far west to the western Pacific warm pool region and suppresses its development in the central equatorial Pacific. The deep convection has difficulties in further moving to the eastern equatorial Pacific especially during the extreme El Niño events, which confines the westerly wind anomaly to the western Pacific. This weakens the eastern Pacific El Niño events, especially the extreme El Niño events and leads to the weakened ENSO asymmetry in climate models. Accurate mean state structure (especially the realistic cold tongue and deep convection) is critical to reproduce the ENSO events in climate models.

Our evaluation also revealed that the ENSO statistics in CMIP5 climate models are slightly improved than in CMIP3. The weak ENSO asymmetry in CMIP5 is closer to the observation. It is more evident in CMIP5 that the strong ENSO activities are usually accompanied by the strong ENSO asymmetry and the diversity of ENSO amplitude is reduced.

October 21, 15:00 (S5-10514)

Impact of the chlorophyll bias on tropical mean states with bio-geophysical feedback

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Global coupled general circulation models (CGCM) that include a biogeochemical model can, when compared with independent satellite-derived chlorophyll data, be used to discover complicated bio-geophysical feedbacks. Generally, variability of chlorophyll concentration, an indicator of the mass of marine phytoplankton, is closely related with sea surface temperature (SST) variability due to changing thermocline depth in the tropical Pacific. However, the vertical redistribution of shortwave radiative heating by phytoplankton chlorophyll causes intensified vertical stratification, changing thermocline depth, and ultimately, changing SST. We found that the mean state and seasonal cycle of SST were impacted by chlorophyll differences between two 200 year duration CGCM experiments: a control-run of the coupled biogeochemical model, and a simulation where chlorophyll levels in the tropical Pacific were set to observed historical seasonal means. This study suggests that having the correct mean and seasonal cycle of chlorophyll concentration in a coupled CGCM-biogeochemical model simulation is necessary to obtain accurate SST mean field and seasonality.

October 21, 15:20 (S5-10463)

The development of a new eddy-resolving global ocean forecasting system in NMEFC

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This report describes the effort to develop a new eddy-resolving global ocean forecasting system in the National Marine Environmental Forecasting Center (NMEFC), and provides preliminary numerical results from the new model. This work is motivated by China's need for better numerical forecasting of the global ocean state and climate variability. The new system, which has 1/12° horizontal resolution at equator and 75 vertical levels, is based on NEMO 3.6 with LIM 3 and a new ocean data assimilation system, OceanVar.. The first results show that the higher resolution model improves the eddy simulation and forecasting skill in China Sea. The simulated strength and path of the Kuroshio in the new system is also better than that in our former forecasting system, which was based on MOM4 and had 1/4° horizontal resolution. We are continuing to improve system performance. And a new collaboration between NMEFC and Mercator is being established. Through this cooperation, we expect to enhance further the forecasting skill of high resolution global ocean modeling.

October 21, 16:00 (S5-10444)

Internal tides in the Pacific Ocean - A look into a high-resolution Wave-Tide-Circulation (WTC) coupled model

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In recent years, global tidal forcing has been solved explicitly in high-resolution ocean general circulation models (OGCM) and coupled climate models. This has provided a better understanding of tide induced phenomena (e.g. tide induced circulation, internal tides) and mixing in the ocean. Including tides into the OGCMs leads to more realistic simulations of the ocean state, which can also provide better open boundary conditions for regional circulation models. In this study, a Wave-Tide-Circulation coupled model with horizontal resolution of 0.1° is established; for sub-grid scale processes the mixing induced by surface waves is parameterized by coupling with a wave model and the global tide is explicitly resolved in the model. Global distribution of low mode internal tides can be simulated in this model. The simulated distribution of internal tide is validated by along-track satellite altimeter data. Both model results and altimeter data show that the M_2 internal tide of the Pacific Ocean is active in several specific regions.

October 21, 16:20 (S5-10747)

The annual velocity along the Slope of Northern South China Sea (SNSCS) from mooring observation

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The annual mean current along the slope of the Northern South China Sea (SNSCS) is not clear due to the shortage of long-term mooring observations. Based on results from a mooring station (April 2014 to April 2015, deployed in the SNSCS, West of SanYa, Hainan: 111.7°E, 18.4°N, water depth: 1000m), a steady southwestward current exists in all months of the year at 150m~380m with a mean annual velocity of about 15cm/s. Upwelling and northwestward flow exists only in the upper 150m from June till July (with a strong baroclinic effect). The effect of super Typhoon (RAMMASUN, 18 July 2014) reached to 300m, based on the velocity vector. The tidal effect is also analyzed from velocity and pressure data.

October 21, 16:40 (S5-10608)

Comparison between surface cyclonic and anticyclonic eddies along the Kuroshio in the northwestern Pacific Ocean

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This study investigates an 18-year dataset of sea surface geostrophic vector anomalies to detect cyclonic and anticyclonic eddies for the East China Sea and the Kuroshio in the Northwestern Pacific Ocean. More than one thousand eddies are counted by a velocity geometry-based automated eddy detection scheme, it is found that the number and lifetime of the cyclonic and anticyclonic eddies are similar in the sea area, and that there are more eddies adjacent to both sides of Kuroshio Current. East of the Ryukyu Islands cyclonic eddies are much larger and stronger than anticyclonic eddies. Along the Kuroshio, more cyclonic eddies are generated on its western side and more anticyclonic eddies on its eastern side, and most eddies propagate northeastward following the direction of the Kuroshio. Statistical analysis indicated there are more eddies having diameters between 40-50 km than any other size, and an eddy duration of 4-5 weeks is most common. The current magnitude and velocity side-shear of the Kuroshio cause flow instabilities that lead to eddy generation; thus the variation of the Kuroshio transport is one of the major mechanisms of eddy generation. Other factors, including topography and seasonal flow circulations during monsoon, also impact cyclonic and anticyclonic eddy generation, but the genesis mechanisms are complex.

October 21, 17:00 (S5-10640)

The structure analysis of typical western Pacific Ocean eddies forced by strong typhoons

Jianhong **Wang**, Chunsheng Miao, Yuyang Deng, Meiqi Li and Liu Gang

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In the western Pacific Ocean, tropic cyclone and typhoon frequently generate and impact ocean circulations during the summer monsoon season. With climate warming trends associated with higher greenhouse gas emissions, various climate modeling results show that there will be more severe typhoons. This study investigates the structures of western Pacific oceanic eddies forced by strong typhoons. The typhoon “Mawar” in June, 2012 and the super typhoon “Nuri” in November 2014 are chosen as case studies of environmental forcing. The intensities of the two typhoons are 950hPa for Mawar and 920hPa for Nuri, the intensity variance ratio is 0.7hPa/h for Mawar and 2.1hPa/h for Nuri, indicating that Nuri is stronger. The typhoon Nuri has a 270km radius and Mawar’s radius is about 350km. These two strong typhoons have similar trajectories from east of Philippines to the south of Japan, with a parabolic shape and without any land crossings during their lifetimes. So the sea eddies created by the typhoon winds mainly move around in western Pacific Ocean.. The radius of the sea eddy from each typhoon was 250km, smaller than the typhoon. The vertical cross-sections at latitude and longitude show that the sea eddies are asymmetric. The Mawar eddy has a shallow depth of 100m, but the Nuri eddy extended deeper to 200m. Furthermore, a possible influence mechanism is discussed.

S6: POC/BIO/MONITOR/TCODE Topic Session
Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean

October 22, 09:00 (S6-10802), Invited

The Global Ocean Acidification Observing Network (GOA-ON): Status and initial results

Richard A. **Feely**[1] and Elizabeth Jewett[2]

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The scientific and policy needs for a coordinated, worldwide Global Ocean Acidification Observing Network (GOA-ON) are now widely recognized by the United Nations General Assembly and many other governmental and non-governmental agencies. The design and foundation of the GOA-ON comes from two international workshops held at the University of Washington, Seattle, USA, in June 2012 and at the University of St. Andrews, UK in July 2013 involving more than a hundred participants from 30 nations. The primary goals of the GOA-ON are to: (1) improve our scientific understanding of ocean acidification conditions; (2) improve our understanding of ecosystem responses to ocean acidification; (3) to acquire and exchange the data and knowledge necessary to optimize the modeling of ocean acidification and its impacts, and (4) to provide spatially and temporally-resolved chemical and biological data fields necessary for developing socioeconomic models of societally-relevant syntheses and projections. In this presentation, I will describe the present status of the GOA-ON and some of its initial results.

October 22, 09:25 (S6-10848), Invited

Arctic Ocean acidification: Present understanding, management requirements and future research strategies

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The Arctic Monitoring Assessment Programme, following requests from the Arctic Council, has developed a synthesis of the present understanding of Arctic Ocean Acidification. A first report in 2013 provided a review of the geochemical modifications, ecological sensitivities and potential economic change under Arctic Ocean acidification. A second review is presently underway, for delivery in 2017, that is developing new approaches to meeting the future challenges and opportunities for the Arctic. This is achieved through the coupling of new climate and ocean acidification understanding with generalized models of organism and ecosystem response to develop targeted scenarios for better management of Arctic ecosystems for the benefit of Arctic and Global communities.

October 22, 09:50 (S6-10775), Invited

Effects of ocean acidification on marine primary producers

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The oceans are taking up over one million tons of CO_2 per hr and have been acidified by 30% since the industrial revolution, and will be further acidified by 150% (pH drop to 7.8, A1F1 senario) by the end of this century. Typical chemical changes associated with the ocean acidification (OA) are increased concentrations of pCO_2, H+ and HCO_3^- and decreased concentration of CO_3^{2-} and $CaCO_3$ saturation state, with different extents in different regions or waters.

The combined effects of UV radiation (UVR) and seawater acidification resulted in inhibition of calcification rates and that of photosynthesis, respectively, in calcifying algae. The results, also supported from shipboard experiments in the South China Sea, imply that calcifying algae may suffer from more damages caused by UVB when they calcify less and less with progressing ocean acidification.

When exposed to CO_2 concentrations projected for the end of this century, natural phytoplankton assemblages in the upper surface layer of the South China Sea (SCS) responded with decreased photosynthetic carbon fixation and increased non-photochemical quenching (NPQ, an indicator of light stress). The community composition of these experimental phytoplankton assemblages shifted away from diatoms, the dominant phytoplankton group encountered during our field campaigns. When respresentative diatom species were grown at different CO_2 concentrations under varying levels (5-100%) of solar radiation, above 22-36% of incident surface solar radiation, corresponding to 26-39 m depths in the SCS, growth rates in the high CO_2-grown cells were inversely related to light levels, and exhibited reduced thresholds at which PAR becomes excessive, leading to higher NPQ. In addition, photorespiration and nighttime respiratory carbon loss were also enhanced. Future ocean warming will cause a shoaling of upper mixed layer depths, exposing phytoplankton to increased mean light intensities. This, in combination with rising CO_2 levels, may cause a widespread decline in marine primary production.

Based on the data obtained from micro- and mesocosm experiments, OA has been shown to increase contents of phenolic compounds in phytoplankton and in zooplankton assemblages fed with OA-grown phytoplankton cells. The observed accumulation of the toxic phenolic compounds in primary and secondary producers can have profound consequences for marine ecosystem and seafood quality, with a possibility that fisheries industries could be influenced due to progressive ocean changes.

October 22, 10:15 (S6-10520), Invited

Shifts in biogenic carbon flow from particulate to dissolved forms under high carbon dioxide and warm ocean conditions

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Photosynthesis by phytoplankton in sunlit surface waters transforms inorganic carbon and nutrients into organic matter, a portion of which is subsequently transported vertically through the water column by the process known as the biological carbon pump (BCP). The BCP sustains the steep vertical gradient in total dissolved carbon, thereby contributing to net carbon sequestration. Any changes in the vertical transportation of the organic matter as a result of future climate variations will directly affect surface ocean carbon dioxide (CO_2) concentrations, and subsequently influence oceanic uptake of atmospheric CO_2 and climate. Here we present results of experiments designed to investigate the potential effects of ocean acidification and warming on the BCP. These perturbation experiments were carried out in enclosures (3,000 L volume) in a controlled mesocosm facility that mimicked future pCO_2 (~900 ppmv) and temperature (3°C higher than ambient) conditions. The elevated CO_2 and temperature treatments disproportionately enhanced the ratio of dissolved organic carbon (DOC) production to particulate organic carbon (POC) production, whereas the total organic carbon (TOC) production remained relatively constant under all conditions tested. A greater partitioning of organic carbon into the DOC pool indicated a shift in the organic carbon flow from the particulate to dissolved forms, which may affect the major pathways involved in organic carbon export and sequestration under future ocean conditions.

October 22, 11:00 (S6-10503)

Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans

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The ocean acidification (OA) in the 21st century has obviously speeded up in comparison to earlier periods. The averaged surface pH of the world ocean has decreased 0.1 units since the industrial revolution and is projected to decrease 0.3-0.4 pH units by the end of this century, equal to increasing 1-1.5 times in ocean acidity. Due to its cold water temperature, low alkalinity and rapid sea ice decline, the Arctic Ocean and subarctic Pacific Ocean (AOPO) have absorbed massive amounts of atmospheric CO_2 and changed the $CaCO_3$ system to an aragonite unsaturated state. In comparison of 1994's investigation with 2005, the unsaturated state of aragonite waters have been found from the continental shelf and slope to expend into the upper surface waters of the Canada Basin. By 2010, the unsaturated aragonite state region continued to expand northward and to shallower depths in the Arctic. This is the first time that aragonite undersaturation was observed at shallow depths (50 m) this far north (to 84°N) in the Canada Basin. OA in AOPO will be greatly changed in marine chemical environment to affect marine ecosystem. Therefore, it is important to develop an Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans (POA-ON). China will develop underway observations of parameters relative to AO during CHINARE (Chinese National Arctic Research Expedition) and promote POA-ON linked closely with GOA-ON, AMAP-AOA etc.

October 22, 11:20 (S6-10382)

Recent accelerated intrusion of Pacific aragonite corrosive "acidified" water into the Arctic Ocean

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The arctic is a "bellwether" for prospective impacts of ocean acidification on marine organisms due to it being a particularly sensitive area to changing climate as a result of so-called polar amplification. To better understand the extent of ocean acidification in Arctic Ocean, we present seawater CO_2-carbonate chemistry and aragonite saturation data from the 2010 Chinese Antarctic Research Expedition cruise along a transect in the Western Arctic Ocean from the Chukchi Sea towards 88°N in the Makarov Basin. We compare these data to measurements from the Arctic Ocean Section 94 (AOS94) cruise in 1994 to illustrate changes over the last two decades. We observed considerable aragonite undersaturation in the upper layer (<300 m) waters of Canada Basin in recent years with large differences between 2010 and 1994. In 1994, the zone of aragonite undersaturation was limited to the slope region of the Chukchi Sea. However, in 2010, the aragonite undersaturated waters exist in most of the upper layer waters (about 40 percent of this area) of the Canada Basin. Model simulations suggest that recent significant increases in Pacific winter water inflows via the Bering Strait have contributed to widespread "corrosive acidified" waters into the Arctic Ocean Basins. In addition, although the intrusion of winter Pacific undersaturated waters into the western Arctic Ocean is a natural phenomenon in this region, increased biological processes induced by sea-ice retreat and the ocean uptake of anthropogenic CO_2 have both significantly increased the areal extent of the affected area.

October 22, 11:40 (S6-10437)

Carbon cycle and ocean acidification strongly modulated by sea-ice retreat in the Pacific sector of the Arctic Ocean over the past two decades

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To study how carbon cycling and ocean acidification respond to sea-ice melt in the Pacific sector of the Arctic Ocean, we measured the marine inorganic carbonate parameters including underway pCO_2, discrete pH, dissolved inorganic carbon (DIC) and total alkalinity (TA), and other biogeochemical parameters in the water column over the Chukchi Abyssal Plain, Canada Basin, and Makarov Basin during the Chinese Arctic Research Expedition (CHINARE) in summer 2010. These data were compared with those collected during the Arctic Ocean Section 1994 cruise (AOS94) and other past cruises and we conclude that carbon cycling and ocean acidification are strongly modulated by sea-ice retreat. Sea-ice melt created more open water on the southern basin, which allowed more atmospheric CO_2 invasion and acidified surface water. Sea-ice melt also allowed more brine water production during later fall and winter, which was advected into the interior Arctic basin along the upper halocline layer (UHL). We observed a broadened and deepened UHL in the Chukchi Abyssal Plain and northern Canada Basin with increased nutrient and DIC inventories and acidification. In the high latitude northern Canada basin with newly open water, we found that an increase in primary production was associated with early stage of sea-ice melt. The produced organic carbon was then recycled in the subsurface, increasing DIC and nutrients and leading to more serious acidification within and above the UHL.

October 22, 12:00 (S6-10551)

Comparison of carbon fluxes and ocean acidification between two gateways in the Arctic Ocean: The Chukchi Sea and the Nordic Sea

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As two gateways of the Arctic Ocean, the Chukchi Sea and the Nordic Sea play very important roles to the Arctic Ocean, for example in freshwater balance, nutrients supply, carbon uptake, etc. The gateways are quite similar but differ in some characteristics. The Chinese National Arctic Research Expedition (CHINARE), from the Chukchi Sea to the Nordic Sea in 2012, made underway measurements of surface seawater and atmospheric partial pressure of CO_2 (pCO_2), measured carbon fluxes along the track, and sampled CO_2 system parameters from the water column. The differences of carbon cycling in the Chukchi and Nordic Seas were discussed. Moreover, based on the data from CHINARE and the CARINA database, ocean acidification (OA) in the Nordic sea and the Chukchi Sea was studied. Data were analyzed by orthogonal partial least squares discriminant analysis. The results showed that ocean acidification has been happening in the Chukchi Sea, however, OA in the Nordic sea was not obvious. Biological factors, absorption capacity of the atmospheric CO_2, temperature and salinity are the main controls on surface water ocean acidification in the two sea areas. Different controls were discussed. The Arctic sea-ice retreats as the Arctic Sea gets warm. The data of all years observed in the Arctic Ocean indicate that the extent of ocean acidification and Arctic sea-ice conditions of the same sea has a significant correlation. The Chukchi Sea suffered the worst ocean acidification in the summertime of 2008 and 2012, when Arctic sea ice retreated the most since 1980.

October 22, 12:20 (S6-10467)

Spatiotemporal distributions of carbon species in the North Pacific subpolar region by using the parameterization technique

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We provided parameterizations to speculate the seawater pH, total alkalinity (TA) and dissolved inorganic carbon (DIC) by using all available observational data of dissolved oxygen (DO, µmol kg–1), water temperature (T, ºC) and salinity (S) from previous high quality datasets of ocean hydrographic properties over the depth of 40 – 400 m during the period from 2000 to 2010 in the North Pacific subpolar region (55°N – 40°N, 145°E – 130°W). Root Mean Square Errors for the parameterizations of pH, TA and DIC with 0.02 pH, 7.3 µmol kg–1 and 7.2 µmol kg–1 were obtained with the coefficient of determination greater than 0.95. We evaluated the differences between measured pH, TA and DIC values and predicted ones using three independent datasets. The differences were almost within 0.05 pH, 10 µmol kg–1 and 10 µmol kg–1, respectively. Applying our parameterizations to the climatological dataset of DO, T and S, we reconstructed the seasonal and monthly distributions of seawater pH, TA and DIC in this region. Additionally, substituting our parameterizations into the detailed DO, T and S data provided every two weeks from Argo profiling floats, we described the spatiotemporal distributions of seawater pH, TA and DIC in this region on two-week scale. In a region where there is no time series of ocean carbon species, our parameterizations could allow us to clarify the dynamics of carbon chemistry in the North Pacific subpolar region from two-week scale to decadal scale.

October 22, 14:00 (S6-10675)

Variability of oceanic carbon cycling and its relation to the ocean acidification in the North Pacific Ocean

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The ocean plays an important role in regulating global carbon cycle by taking up and releasing carbon dioxide (CO_2) from and to the atmosphere simultaneously. The ocean has absorbed about 50% of CO_2 emitted to the atmosphere by fossil fuel burning, and this ability has been suggested to continue at a relatively stable rate of 1.4-1.8 PgC per year. The direct impact of ocean absorbing CO_2 is leading to the ocean acidification (OA) that can affect biological activities and the oceanic CO_2 system. Here, we propose a coupled three-dimensional modeling study to investigate the dynamics of the carbonate system in the North Pacific Ocean, based on the Regional Ocean Modeling System (ROMS) and the biogeochemical model, CoSiNE model, along with a carbonate system. The model results are compared and constrained with available in-situ measurements all over the Pacific Ocean. Further analysis of the model results indicates that the carbonate system in the North Pacific Ocean has strong spatial and temporal variations in terms of sea pCO_2, pH, and the aragonite saturation state. Long-term trends of these variables show conspicuous spatial variability that could be related to the local physical and biogeochemical conditions. We also analyze the impacts and feedbacks of OA to the sea pCO_2 and sea-air CO_2 flux. This modeling study allows to look into the detailed mechanisms in regulating oceanic carbonate system with high spatial and temporal resolutions that field observations normally cannot provide.

October 22, 14:20 (S6-10389)

Hypoxia off the Yangtze River estuary: Observations and simulations

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Onset and extent of hypoxia off the Yangtze River estuary and the adjacent coast changes from year to year, and the mechanism is poorly known due to varied nutrient sources and the complex circulation systems. Regional Ocean Modeling Systems (ROMS) coupled with a 11-component biogeochemical model has been applied to the East China Sea to reproduce the historically large hypoxia extent observed in 2006. The physical part of the model is driven by climatological forcing and 2006 real time forcing is verified, before the biological part is coupled. The biological model is based on the Carbon, Silicate, Nitrogen Ecosystem Model (CoSiNE). The modelled chlorophyll a, nutrients and oxygen are all in an agreement with observations. A set of sensitivity tests are designed to identify the relative contributions of riverine nutrient sources and upstream Kuroshio nutrients (nitrate, phosphate, silicate) in controlling the extent of the hypoxic water. All cases produce hypoxia extent that extends farther north of the Changjiang River mouth, indicating the significant impacts from an enhanced inward transport through the shelf break and the Taiwan Strait in 2006. The temporal variations of hypoxia and the minimum dissolved oxygen concentration off the estuary are also captured reasonably. Experiments with two types of benthic layer treatments suggest the importance of sediment oxygen consumption to the size of the hypoxic zone. Hypoxia extends tens of meters above the seabed up to the seasonal pycnocline which is shallow and thin (approximately 10 m) being suppressed upward by strong tidal mixing at lower layers. Hypoxia is very sensitive to the stratification, that is episodically relaxed at synoptic scales by strong wind stirring related with events like typhoons.

October 22, 14:40 (S6-10399)

Autumn depression in pCO_2 in the Japan Sea and contribution of Changjiang diluted water

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Carbonate chemistry in the marginal sea is variable and remains unclear. In the Japan Sea (JPS), observations of CO_2 related parameters are insufficient to understand their spatiotemporal variation. Here, we present the results of 4-years of observations of CO_2 parameters including pCO_2, dissolved inorganic carbon and total alkalinity (TA) in the autumn season in the JPS. Surface pCO_2 in the JPS during autumn sometimes was less than 300 µatm and was about 30 µatm lower on average than that in the western North Pacific off Japan between 24˚N and 43˚N in autumn. There were two types of low pCO_2 water in the autumn JPS. One was distributed mainly in the northern part of the JPS, where the low pCO_2 was attributable to the thermodynamic variation. SST in the northern JPS declined more than that in the western North Pacific because of the shallower thermocline in the northern JPS. The other low pCO2 type was seen in relatively fresh water in the southern part of the JPS. This fresher water contained Changjiang diluted water which flowed into the JPS through the Tsushima Strait. The correlation plot between salinity and TA gave a significant positive intercept of TA from 800 to 1600 µmol kg^{-1} at $S = 0$ in the low pCO_2 water. Autumn pCO_2 in the southern JPS was depressed by excess TA discharged from the Changjiang River. Yearly variation of intercept of TA was possibly determined by the mass balance among Changjiang diluted water and other fresh water such as local rivers and precipitation.

October 22, 15:00 (S6-10536)

Variation of sea surface pCO_2 and controlling processes in cold seasons in the northern Yellow Sea, China

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Marginal seas play an important role in the global carbon cycle. However, the uncertainty of the carbon budget in marginal seas is still significant due to their active physical and biogeochemical processes. Monthly variations of sea surface partial pressure of carbon dioxide (pCO_2), and other associated carbonate system parameters of the water column were observed in the northern Yellow Sea from 2009 to 2011, a region under influences of seasonal stratification and anthropogenic activities in the western North Pacific. A4HDYD station (38°40′N, 122°10′E) was established as a monthly/bimonthly observatory station in the northern Yellow Sea. Sea surface pCO_2 and other carbon system parameters demonstrated significant monthly variations. The sea surface pCO_2 was influenced by sea surface temperature and and by water mixing, air-sea exchanges and biological processes. Fluxes of CO_2 crossing the air-sea interface were estimated by underway observation and the time-series station A4HDYD. At A4HDYD station, the air-sea CO_2 flux was -3.9±1.3, -1.3±0.4, and -5.5±4.5 mmol C m^{-2}d^{-1} in September, October and November, respectively. And it converted to a net CO_2 source in December. For the underway observation, the flux was -2.3±0.9 and 6.3±3.6 mmol C m^{-2}d^{-1} in September and October. Different temporal variations were obtained between the two approaches, which may result in difficulties in the flux estimations in the northern Yellow Sea. The results of the carbon flux estimates in coastal regimes using multiple observation platforms demonstrated significant dynamic variability. An integrated framework capable of dealing with multiple temporal/spatial scales will improve our understanding of coastal carbon fluxes and biogeochemistry.

October 22, 15:20 (S6-10355)

Diurnal variation of pH in Oshoro Bay, Hokkaido, Japan – A monitoring study assessing and projecting impacts of ocean acidification on a coastal ecosystem

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Coastal marine species have already been experiencing a low pH environment (< 7.9) that is not predicted to occur until 2100 in open ocean systems. To properly assess the impacts of ocean acidification on species in coastal ecosystems experiencing wide ranges of diurnal variation of pH, we need to conduct long-term, high-frequency monitoring measurements of environmental parameters. In this study, to investigate the diurnal variation of pH in a subarctic region, we conducted monitoring measurements of pH, seawater temperature, and salinity in Oshoro Bay, Hokkaido, Japan from 2013 to 2014. Mean, maximum, and minimum pH values obtained by a pH meter were 8.02, 8.47, and 7.33, respectively. Although ranges of diurnal variation of pH were different with season, increases in pH during the day and decreases during the night were found in all periods. There are no statistically significant relationships between the variation of pH and that of seawater temperature or salinity. These results suggest that observed diurnal variations of pH may be driven by photosynthesis and/or respiration in resident organisms in Oshoro Bay.

October 22, 16:00 (S6-10401)

Calcium carbonate saturation and ocean acidification in Tokyo Bay, Japan

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From April 2011 to January 2012, seasonal variation of aragonite saturation state (Ωar) was observed for the first time in Tokyo Bay, in order to understand the current state of ocean acidification in a highly eutrophic bay in Japan. Ωar in the bay ranged between 1.55 and 5.12, much greater than observed in offshore waters. At the surface, Ωar was high during summer as a result of photosynthesis with some conflicting effect of freshwater input. At the bottom, Ωar was low during summer due to remineralization of organic matter. Based on an assumption that our observations represent current conditions in Tokyo Bay, it is estimated that the emission of anthropogenic CO_2 has already decreased Ωar by 0.6 since the preindustrial period and will further decrease by 1.0~1.6 by the end of this century if emission of CO_2 is continued at a high level (RCP8.5 scenario). With other conditions remaining the same, bottom waters of Tokyo Bay will reach seasonal aragonite undersaturation by 2060~2070. However, because coastal regions have a large interannual variability, we need further observations to evaluate our estimations and future predictions presented here. Nevertheless, it should be safe to say that the larger seasonal variation in Ωar allows Tokyo Bay to reach aragonite undersaturation earlier than offshore regions and such conditions have negative consequences for a variety of calcifying organisms living in Tokyo Bay. Ocean acidification could thus provide additional stress to the ecosystem of the bay, which is now suffering from eutrophication and hypoxia.

October 22, 16:20 (S6-10549)

Spatio-temporal variation of *p*CO_2 in shore-reef waters off Arasaki district, Sagami Bay, Japan

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Recent high-pCO_2 rearing studies show that some gastropodas such as abalone respond not to daily-averaged pCO_2 level but to its daily-maximum (e.g., Takami et al., 2015). This finding suggests that even with moderate pCO_2 elevation, some oceanic ecosystem with high diurnal pCO_2 variation may be affected by ocean acidification. We, however, have little knowledge about spatio-temporal variation of pCO_2 including diurnal variation in shore reef area, where most gastropodas inhabit in. To obtain one example of such variation of pCO_2, we have investigated pCO_2 monitoring at shore reef area in Sagami Bay. Sea waters were continuously pumped into water storage settled at shore observatory from the water intake set in rock reefs 200-m off shoreline with 3-m bottom depth. pCO_2 value in the water storage were then monitored for 36 h by NDIR with in-situ equilibrator system. Water samples were also taken repeatedly from several stations surrounding the water intake during the experiment, and pCO_2 values in these water samples were calculated from DIC and alkalinity.

pCO_2 showed 400 ppm with diurnal variation of 120-ppm amplitude, but short-time (ca. 4-h duration) elevation of pCO_2 up to 620ppm was overlaid in it. Bottle sampling data indicate that this unexpected high-pCO_2 event was caused by the intrusion of low-salinity water with significantly high DIC, which is supposed to come from a harbor near the monitoring point. Our results indicate that local eutrophication caused by human activities can bring significant acidification in near-shore waters, as well as global CO_2 emission.

October 22, 16:40 (S6-10631)

Differential sensitivities of crustacean zooplankton to ocean acidification

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Despite their critical importance in marine food webs, little is known of how ocean acidification (OA) will affect crustacean zooplankton. Most studies have focused on copepods and are finding relatively low sensitivities to OA. However, our findings suggest that some groups may be significantly impacted in the near future. The copepod *Calanus pacificus,* euphausiid *Euphausia pacifica*, and crab *Metacarcinus* (formerly *Cancer*) *magister* are trophically and economically important species throughout the eastern North Pacific and the California Current, where OA is of rapidly increasing concern. Our laboratory tests on the development of these species under high CO_2 conditions indicate large differences in sensitivities across taxa that do not match what might be expected from the conditions their populations naturally experience in the field. In particular, our experiments and the literature suggest that euphausiids are relatively sensitive compared to other crustaceans—they experience significant negative effects of high pCO_2 on growth and development at relatively low concentrations compared to other taxa. Our results indicate differential growth and survival of these taxa under current and future conditions, with profound implications for future populations.

October 22, 17:00 (S6-10558)

Is ocean acidification disturbed by climate?

Liang **Xue**, Meng Wei, Libao Gao, Yongliang Duan and Weidong Yu

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Ocean acidification (OA), mainly due to oceanic uptake of anthropogenic CO_2, can induce important influences on many marine organisms, especially those that calcify.. Reportedly the Southern Ocean was more susceptible to OA compared with other Oceans. Here we used CO_2 fugacity data collected from a transect south of Tasmania during 14 austral summer cruises from 1993 to 2011, together with estimated total alkalinity from sea surface temperature and salinity, to calculate the saturation state of aragonite (Ω_{ara}). We find that Ω_{ara} decreased from 2.48±0.11 in the north to 1.60±0.07 in the south. Trends of Ω_{ara} in the south were sensitive to climate indices, including ENSO and Southern Annular Mode (SAM). During the negative phase of ENSO and the positive phase of SAM, Ω_{ara} in the southern transect decreased faster than expected due to increasing atmospheric CO_2, indicative of enhancement of OA by climate.

October 22, 17:20 (S6-10792)

The expected impact of ocean nourishment on ocean acidity

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If the partial pressure of carbon dioxide in the atmosphere were to increase by 200 ppmv, the pH of the surface ocean would decrease by about 0.2. *Business as usual* would see this happen in 40 years. One counter to this is to fertilise a patch of ocean with nitrate in those areas where photosynthesis is limited by nitrogen. Photosynthesis in the photic zone takes inorganic carbon and exports it out of the surface ocean. The organic carbon produced may be cycled back and forth between organic and inorganic carbon but eventually almost all the carbon involved is exported to the deep ocean and its place taken by carbon fluxed from the atmosphere. The lower atmospheric concentration of carbon dioxide as a result of fertilisation reduces heat trapping (global warming). Redfield showed that ocean photosynthesis can also increase the total alkalinity. Carbon flux from the atmosphere replaces the exported carbon but it does not lower the total alkalinity. Over much of the ocean, the addition of (say) 16 micromoles of nitrate in an ocean of pH 8.1, increases the pH by .075 to a pH value of pH of 8.175. The hydrogen ions exported from the fertilised patch appear again in the deep ocean. Iron fertilisation of high nutrient low chlorophyll regions of the ocean have the same reduction of acidity but other reactive forms of nitrogen produce smaller pH changes per mole.

October 22, 17:40 (S6-10403)

Impact of Ocean acidification on morphological variation in captive condition of the benthic foraminifera *Ammonia beccarii*

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Absorbed elevated atmospheric CO_2 concentration alters seawater chemistry by decreasing in pH and carbonate ion concentration. Ocean pH has 0.1 declined 0.1 units since the pre-industrial times and world oceans pH will further drop by 0.3 to 0.4 units by 2100 due to increasing of atmosphere CO_2. Reduced pH may affect the marine calcareous organisms. The present culture experiment was performed to assess the effects of ongoing ocean acidification in the calcification of benthic foraminifera. Specimens were cultured 15 weeks at 380, 750, 1100 and 1500 ppm of atmospheric CO_2. In the present study, SEM images show that the high CO_2 level affects the shell size and causes deformation of ornamentation of *Ammonia beccarii* foraminifera. Therefore calcifying organisms are expected to be vulnerable to ocean acidification and lead to decreases in foraminiferal populations in benthic environment.

S7: POC/BIO/TCODE Topic Session
Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5

October 22, 09:00 (S7-10843), Invited

Report from Brazil: Effects of climate change on the world's oceans

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Over 280 participants assembled in Santos, Sao Paulo, Brazil (March 23-27, 2015) for the Third International Symposium on "*Effects of Climate Change on the World's Oceans*". This symposium was jointly convened by PICES (North Pacific Marine Science Organization), ICES (International Council for the Exploration of the Sea), and IOC (Intergovernmental Oceanographic Commission of UNESCO) and locally organized by the Oceanographic Institute, University of Sao Paulo (OIUSB). The symposium bridged research in physical and natural sciences to the human dimensions of climate change impacts, with a focus on coastal communities, management objectives and governance adaptation. I will highlight some of the scientific presentations, covering the latest developments in predicting changes in biodiversity, phenology, fisheries and ecosystems as well as in the physical systems that sustains these, and outlining the risks and opportunities that climate change will bring to coastal communities and to society at large.

October 22, 09:30 (S7-10690)

The latest progress on global Argo observations

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The broad-scale global array of temperature/salinity profiling floats, known as Argo, has already grown to be a major component of the ocean observing system. In recent years, the Argo is being extended from its core mission to a global mission. The mission includes the enhancement of the array at high latitudes, in marginal seas and along the equator, as well as improving observations of strong boundary currents (such as the Gulf Stream and Kuroshio), extension of observations into deep water and the addition of sensors for monitoring biological and chemical changes in the oceans. To maintain the global Argo array, each year about 1000 profiling floats are needed to deploy into the global oceans under the collaboration of about 30 nations. As of April 2015, there are more than 3800 active floats over the global oceans. The final goal is to build a "global Argo observing network" consisted of 4000 active floats, which will increase by 1000 floats than its original design (i.e. core Argo). Ranking 4th out of over 20 member states, China has contributed about 330 floats to international Argo since 2001, and 190 floats are still active now.

The Pacific Ocean is one of the basin where most Argo floats have been deployed, however, the float distribution density is quite uneven. The density in the north Pacific is prominently higher than in the south, furthermore, the present float densities in the equator, western boundary current (e.g. Kuroshio) and major marginal seas (especially in the South China Sea) are far away from their desirable design. In addition, the activities of the Pacific Argo regional centre has larger gaps compared with the other regional centers (e.g. Atlantic, Indian and Southern Ocean). For this reason, we encourage countries around the Pacific ocean to strengthen cooperation and exchanges, especially regarding to float deployment, maintenance of the regional observing network, data quality control and data application, and to make distinct contributions to successful implementation of the international Argo program and positively addressing global climate change.

October 22, 09:50 (S7-10585)

The CMIP5 ocean heat storage and temperature

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A change in ocean heat storage is one of the major contributors to a change in global mean surface temperature under a climate change. For understanding and simulating a climate change, global climate models participating Coupled Model Intercomparison Project (CMIP) have been widely used in research and became an essential tool for such purposes. Yet the analyses using the fifth phase of CMIP (CMIP5) model outputs have been usually confined to sea surface temperature or used sea surface heat fluxes to calculate the ocean's heat uptake under global warming. The purpose of this study is to analyze the temporally varying, three-dimensional global structure of ocean temperature and heat storage simulated by the models and to provide a synthetic report on the CMIP5 ocean simulations with respect to ocean heat storage change. We expect the analysis results can also provide guidance and direction for future development and improvement of global ocean models.

October 22, 10:10 (S7-10582)

Evaluation on air-sea CO_2 fluxes in the equatorial Pacific simulated by CMIP5 models

Lei **Wang**, Yong Luo and Jianbin Huang

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The simulating performance of models on the air-sea CO_2 fluxes is the basis of calculating the air CO_2 concentration when forced by the emissions, which is necessary to the air temperature simulation. As a large atmospheric CO_2 resource, the equatorial Pacific plays an important role in the air and sea carbon cycle. The air-sea CO_2 fluxes in the equatorial Pacific simulated by 13 earth system models of the fifth phase of the Coupled Model Intercomparison Project (CMIP5), which make their carbon cycle experiments outputs available, are evaluated in this research. Compared with the observation from Valsala and Maksyutov [*Valsala and Maksyutov, 2010*], most of the 13 models well capture the pattern characteristics and annual variation of air-sea CO_2 fluxes, but the amounts of the fluxes are various and with bias from the observation. Compared with other factors like sea surface wind speed, dissolved inorganic carbon, sea surface salinity and total alkalinity, the sea surface temperature (sst) is the key factor controlling the air-sea CO_2 flux in the equatorial Pacific according to the observation. CO_2 fluxes simulating biases come from the sst bias or their inaccurate response to the sst. Moreover, the various CO_2 fluxes simulated by models mainly come from the differences in sst simulation. To well simulate the air-sea CO_2 fluxes in the equatorial Pacific, the sst simulated by the ocean model and the response of CO_2 fluxes to the sst simulated by ocean carbon component need to be improved.

October 22, 10:50 (S7-10837), Invited

SST habitat and food change projections for Pacific salmon (*Oncorhynchus spp.*) in the North Pacific and adjacent seas based on CMIP5 climate models

Shoshiro **Minobe**[1], Hiromichi Ueno[2], James R. Irvine[3], Alexander V. Zavolokin[4], Katherine W. Myers[5], Mio Terada[1], Mitsuho Oe[2] and Skip McKinnell[6]

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4 Pacific Scientific Research Fisheries Centre (TINRO-Centre), Vladivostok, Russia
5 School of Aquatic & Fishery Sciences, University of Washington (Retired), Seattle, WA, USA
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Climate change is affecting Pacific salmon (*Oncorhynchus*) species in multiple ways including the abundance and distribution of thermally suitable oceanic habitat, which can be represented by sea-surface temperature (SST) change in future. Previous studies examined habitable SST changes, and suggested shrinking of SST habitat. In this presentation, we first update SST habitat estimation based on recent and previously unpublished high seas surveys, and then examine SST habitat and food changes in the habitat for salmon species during the 21st century by analyzing outputs of CMIP5, used in the IPCC Fifth Assessment Report. The results based on RCP8.5 scenario, the high end scenario in the IPCC report, are explained in this abstract. The SST habitat changes in winter are rather gradual, but those in summer are dramatic; in the end of this century most of salmon species have to utilize Arctic Sea as a refugee from too hot SSTs prevailing over the North Pacific including its marginal seas. Also in the summer season, the largest reduction of surface zooplankton amount is found among all seasons, suggesting food availability become worse especially in summer. These results suggest that, in addition to the habitat shift and shrinking, reduction of food availability in specific seasons strongly influence Pacific salmon in future.

October 22, 11:20 (S7-10750)

S-CCME's international coordinated research program to project climate change impacts on fish and fisheries by 2019

Anne B. **Hollowed**[1], Kristin Holsman[1], Shin-ichi Ito[2], Myron Peck[1], John Pinnegar[4] and Cisco Werner[5]

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The ICES/PICES Section on Climate Change Impacts on Marine Ecosystems (S-CCME) is responsible for leading and coordinating research to advance our understanding of climate change impacts on marine ecosystems throughout the northern hemisphere. In 2015 S-CCME leaders convened an inter-sessional workshop to develop a frameworks for coordinated impact assessment and projection modeling in most of the major Large Marine Ecosystems of the northern hemisphere. This paper will provide an overview of the major outcomes of the workshop and the framework proposed by the workshop participants. Key findings and guidance for how the S-CCME research effort contributes to the global Fisheries Model Intercomparison (Fish-MIP) will be discussed. Case studies based on experience in the Bering Sea LME will be presented.

October 22, 11:40 (S7-10787)

Climate-change driven range shifts of chub mackerel (*Scomber japonicus*) projected by bio-physical coupling individual based model in the western North Pacific

Sukgeun **Jung**[1], Ig-Chan Pang[1], Joon-ho Lee[1], Lee Kyunghwan[1], Tae Hoon Kim[1], Hwa Hyun Lee[2], Kyung-Su Kim[2] and Suam Kim[2]

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We explored the effects of warming ocean on the range shift of biomass of young-of-the-year (YOY) chub mackerel (*Scomber japonicas*) by developing and applying individual-based models (IBM) based on a regional ocean circulation model and the IPCC AR5 climate change scenarios. Our IBM tentatively suggested that the YOY mackerel in the Korea Strait were mostly transported from the East China Sea where they were hatched. From laboratory experiments, we observed a diurnal cycle in the buoyancy of larval mackerel, which determines their vertical position in the water column. Although our projections are uncertain, the preliminary results from the IBM projections suggest that, by the 2050s, the Tsushima warm current in the Korea Strait and the East Sea, will strengthened due to global warming, and will shift the biomass distribution of YOY mackerel from the Korea Strait to the East Sea.

October 22, 12:00 (S7-10592)

Potential effect of climate change for copepods distribution in western North Pacific Ocean

Hiroomi **Miyamoto**[1], Kazuaki Tadokoro[1], Takeshi Okunishi[1], Hiroya Sugisaki[2], Kiyotaka Hidaka[2], Yuichi Hirota[2], Tsuneo Ono[2], Kou Nishiuchi[3], Satoshi Kitajima[3], Takahiko Kameda[3], Haruyuki Morimoto[4] and Tadafumi Ichikawa[5]

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5 Fisheries Agency, Tokyo, Japan

Under the IPCC RCP8.5 scenario, the mean sea temperature upper 100 m was predicted to rise 2.0 °C in the 21st century, suggesting that the structure of ecosystem at lower-trophic level would be also changed. In the present study, the impacts of predicted environmental change on copepods species abundance were evaluated under RCP8.5 scenario. We constructed empirical models (Generalized additive modeling) of which explanatory variable was sea surface temperature, 100 m temperature, and day-night by using 4781 samples collected around Japan, and estimated the present and future (2060s) distribution. The models for dominant species around Japan (*Ctenocalanus vanus*, *Paracalanus parvus*, *Clausocalanus parapergens*, *Clausocalanus pergens*) explained the ~40% of variation for abundance, and showed the peak of abundance was found in range 5 to 15 °C on 100 m depth which indicates transition water between Oyashio and Kuroshio water in every four species. On the other hand, the response for other factors were different among the species. The predicted distribution of *Ct. vanus* and *Cl. parapergens* using the models showed that northern limit did not change except eastern Hokkaido area in future environment but the southern limit shifted to higher latitude. Also the range of *Pa. parvus* was predicted to be decreased. The results of the present study suggested the pelagic biogeography around Japan might be influenced by global warming, although temperature rise of climate change might be a few degree.

October 22, 14:20 (S7-10719)

Near future lower-trophic ecosystem projection in the seas around Korea

Hyoun-Woo **Kang**[1], Hanna Kim[1], Jae Kwi So[1], Momme Buttenschon[2], Icarus Allen[2] and Ok Hee Seo[1]

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2 Plymouth Marine Laboratory, Plymouth, UK

Near future (present to 2030s) ecosystem projections due to the environmental and climate change were carried out using a physical and biogeochemical coupled marine system model covering the East Asian marginal seas. The present state (2001 – 2010) was also simulated. Three kinds of near future (2030s) states were projected by changing atmospheric forcings as well as the open boundary conditions based on one of the warming scenario (RCP 8.5) results of global climate model. Major changes of physical and biogeochemical variables according to the change of surface and lateral boundary conditions are compared in the context of water temperature, chlorophyll-a concentration, peak bloom timing and community structure. It is shown that the surface temperature of 2030s generally goes up remarkably though the projection period is rather short. The ecosystem change, however, is not so prominent compared to the interannual variability though the responses are complicated depending on the functional groups and areas. It is worthwhile to note that the zooplankton group, the consumers, are much more affected than the primary producers in the warming states in this experiment. This study suggests that there could be the near future changes of functional groups and phenology even though the total biomass changes are not quite distinguishable. The limitations and various aspects of the marine system model improvement for the regional climate projections are discussed as well.

October 22, 14:40 (S7-10674)

Future changes of nutrient dynamics and biological productivity in California Current System

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Future climate change will impact on eastern boundary upwelling ecosystems such as the California Current System (CCS). How do the warming-induced stratification and intensification of upwelling-favorable winds will affect ocean productivity in the CCS? We used a coupled and nested physical-biogeochemical model to examine and predict changes in the physical and biogeochemical fields by the end of 2050. The large global model is an earth system model (ESM) with dynamic atmosphere-ocean general circulation and marine biogeochemistry dynamics developed at NOAA's GFDL. The nested regional model was based the ROMS coupled to a biogeochemical model CoSiNE. The full model was run from 1970 to 2050 and model outputs from two periods were analyzed (1990-2009 and 2030-2049). The model has predicted increased upwelling intensity associated with stronger alongshore winds in the coastal region, and enhanced upper stratification in the open ocean. These two changes both contribute to the increased vertical nutrient flux and biological productivity in CCS. The difference of isothermal deepening between the open ocean and the coast reflecting the basin-scale adjustment creates elevated onshore nutrient transport that increase nutrient concentrations of the upwelling source water and eventually supporting higher productivity in CCS. We found this basin-scale adjustment of nutrient plays a larger contribution than the enhanced wind-generated upwelling in terms of vertical nutrient flux increase in the coastal region. Our model also predicted increasing eddy activities in the CCS that will increase vertical nutrient transport mostly in the coastal region. This study takes advantage of high-resolution models and highlights mechanisms of future productivity enhancements in the coastal upwelling ecosystems.

October 22, 15:00 (S7-10859), Invited

Impacts of external forcing on the decadal climate variability in CMIP5 simulations

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Decadal climate variability is usually regarded as an internal variability in the climate system. However, using simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5), we have demonstrated that external radiative forcing plays an important role in modulating decadal variability of the global mean surface air temperature (SAT). In historical runs, the standard deviations of the global mean SAT exhibit robust increases relative to pre-industrial runs, indicating that external forcing acts on decadal variability of the global mean SAT through enhancing amplitude and modulating phase. By comparing model results using different external forcing agents, we find the natural-forcing agent has the strongest impact on the decadal timescale. Every type of simulation (e.g., the pre-industrial, historical, natural forcing and anthropogenic forcing runs) from almost all the CMIP5 models exhibits a high correlation between the net shortwave (SW) radiative flux at the top-of-atmosphere (TOA) and the global mean SAT with a 13 month lag. However, after taking the multi-model ensemble mean for the TOA SW and the SAT, respectively, the correlations from external-forcing runs are much higher than those from pre-industrial runs. This is because the decadal SAT anomalies from multiple models cancel each other out in the pre-industrial runs without external forcing, but generally follow decadal evolution of the external forcing with a 13 month lag. The most significant responses to external forcing are found in the tropical Indian and Pacific oceans, although with different physical mechanisms for the natural and greenhouse gas forcing agents.

October 22, 15:50 (S7-10699)

A genesis potential index for tropical cyclone using oceanic parameters

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A new tropical cyclone (TC) genesis potential index (GPI) was created by explicitly including oceanic parameters and necessary atmospheric parameters at the sea surface. Based on our general understanding of the oceanic impacts on TC genesis, many candidate factors are evaluated and discriminated, resulting in a new index named GPI_{ocean}. It includes (1) the absolute vorticity at 1000 hPa, (2) the net sea surface longwave radiation, (3) the mean ocean temperature in the upper mixed layer, and (4) the depth of the 26°C isotherm. GPI_{ocean} is comparable to the existing GPIs in representing the TC genesis over the northwestern Pacific Ocean on climatological, interannual, and seasonal scales. In the context of climate change, this new index is expected to be useful for evaluating the oceanic influences on TC genesis, using reanalysis products or climate model outputs such as the IPCC AR5 products.

October 22, 16:10 (S7-10486)

Seasonal characteristics of the long-term sea surface temperature variability in the Yellow and East China Seas

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Multi-decadal trends in sea surface temperature (SST) in the Yellow and East China Seas (YECS) are widely believed to be associated with the variation of atmospheric circulation in the North Pacific. However, AVHRR-based optimum interpolation SST anomalies after removing seasonality reveal that warming trends are quite localized with the characteristic temporal pattern of recent cooling following two peaks that occurred at the end of 1990s and middle of 2000s. To explain the localized trends and the two peaks in the SST, the spatial patterns and principal component time series of the SST anomalies were analyzed for the period of 1982–2014. Cyclostationary empirical orthogonal function analysis separates three principal modes for the SST anomalies. Among modes, the first and the third are related to the long-term SST changes, while the second captures the interannual variability. The first mode, explaining 25% of the total variability in the SST anomalies and appears to be associated with the meridional wind anomalies for winter and spring seasons observed during the first SST peak at the end of 1990s. During the warming period before the first peak, the principal component of the first mode is highly correlated with the Pacific decadal oscillation index, and then its correlation sharply drops to an insignificant level. The third mode is likely associated with the East Asian Summer Monsoon, which could influence the second SST peak at the middle of 2000s. Our findings suggest that the YECS is a complex system sensitive to the seasonal dynamics.

October 22, 16:30 (S7-10497)

Effects of atmospheric forcing on circulation variability in the northern Japan/East Sea in 1948 to 2010

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Using the Institute of Numerical Mathematic Ocean Model (INMOM) and atmospheric forcing from 1948 to 2010 extracted from CORE (Common Ocean-ice Reference Experiments) dataset we reconstruct and examine the basin-scale circulation variability in the Japan/East Sea (JES) by focusing only on the effects of atmospheric forcing such as the wind stress and heat fluxes. Numerical experiments with coarse (1/10° grid with 15 sigma levels) and high resolutions (1/12° grid with 30 sigma levels) were carried out with the nudging condition for temperature and salinity in the JES straits. We focus on the interannual to decadal circulation variability in the Japan Basin (JB). In the intermediate and abyssal layers the simulated circulation is cyclonic, which increase in spring and decrease in autumn. The reconstructed climatological circulation corresponds to that obtained by the SODA reanalysis. Analysis of the relative vorticity (RV) averaged in the JB revealed that its variability is characterized by the periods: of 2.3, 4, 5, 10 and 14.3 years. The structure of the spectrum does not vary with depth. However, a weakening the decadal variability in contrast to the interannual variability was found. Using the SVD (Singular Value Decomposition) analysis we found relationship between the monthly anomalies of the RV and wind stress curl (WSC) as well as heat fluxes (HFs) over the JES. We set that the interannual circulation variability in the JB derived by the WSC, whereas the decadal variability of the circulation results from the coupled effect of the WSC and the HFs.

October 22, 16:50 (S7-10652)

Anomalous tropical cyclone activity in the northwestern Pacific in 2014

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Northwestern Pacific experienced anomalous tropical cyclone activity in July and August 2014. It was the first time since 1949 that no tropical cyclones formed in the northwestern Pacific in August, a peak tropical cyclone month in climatology. There are only 4 tropical cyclones occurred in July of 2014, among which 3 were super typhoons. Such abhigh percentage of super typhoons is also uncommon since 1949. The anomalous tropical cyclone activity occurred in the background of decreasing eastern Asian summer monsoon (EASM) since the end of 1970s and negative Pacific Decadal Oscillation (PDO) phase since 2006 with possible phase transition from negative to positive in 2014. Intraseasonal Oscillation (ISO) also plays a significant role in inhibiting the tropical cyclone genesis in August of 2014 by preventing warm and moist air into northwestern Pacific. We were unable to confirm or reject the role of climate change in the July and August anomalous tropical cyclone activities due to the inability of CIMP5 models to accurately simulate the 850hPa wind anomaly. The CMIP5 does not show any obvious trend during 1948-2014, while reanalysis data shows significant increasing trend of low level easterly. The inability of CMIP5 in simulating 850hPa wind might be related to their limited performance in reproducing the EASM, transition of PDO and the propagation of ISO.

S8: FIS Topic Session
Marine ecosystem services and economics of marine living resources

October 21, 09:00 (S8-10778), Invited

Economic values of protected marine species in the U.S.: Empirical studies and conceptual challenges for ecosystem-based management

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Past and current research projects related to valuing the protection of threatened and endangered marine species in the U.S. using stated preference non-market valuation methods are summarized and discussed. In particular, I focus on two large national-level surveys, the Protected Species Valuation Survey and the Steller Sea Lion Economic Survey, as well as recent research related to valuing the protection of the endangered Cook Inlet beluga whale in Alaska. The key research issues, methods, and completed and planned outcomes from each of the surveys are presented. In addition, I discuss prospects and efforts undertaken to apply valuation results to inform policy decisions in an ecosystem-based management framework.

October 21, 09:40 (S8-10784), Invited

Social transformations of marine ecosystem services: A new conceptual framework for integrated assessments

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Resilience is the ability of socio-ecological systems to cope with and adapt to change. Resilient systems are adaptable, flexible, and prepared for change and uncertainty. Most of the research done on marine ecosystem services has focused on the transformation of the marine ecosystems and their ecological functions. It is impossible to address today's great challenges in global marine change and sustainability without a better understanding of how real and enduring social transformation comes about and how it can be initiated, promoted or (re)directed. Although there is general agreement that understanding that where and how humans use oceans is an essential component of marine resource planning and management, the associated social transformations are still largely unexplored. This paper presents a novel definition and conceptual framework of social-transformations to address the challenge to integrate ecological, economic and social dimensions of marine ecosystem services. Knowledge of the resilience of particular social systems will enable managers to foresee the likely consequences of external change events, such as new policies, and thus choose policy options that better balance social and economic costs with resource sustainability goal.

October 21, 10:50 (S8-10774)

Evaluation of marine ecosystem intrinsic value

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Marine ecosystem valuation can serve as a basis of scientific support for decision-making in marine and coastal areas. So far the most popular methods for ecosystem valuation are ecosystem service valuation (ESV), which is based on the utility of ecosystem to human beings rather than on the objective value of the ecosystem. After more than ten years application, we found that all losses of ESV were about 10% of the benefits of human activities. In this paper, the ecosystem intrinsic value (EIV) is defined. EIV is an objective value that emerges from the existence, structures, functions and processes of ecosystem expressed by its substance, energy and information, but independent with man, man's will and preferences. The valuating approach and methods for EIV were developed by using energy approach and Emergy and Eco-exergy analysis. The EIV calculated by emergy from the substance, energy and information of ecosystem and by eco-exergy from the structure and function of ecosystem represent the existent value and the externally working capacity of ecosystem, respectively. The approach and methods of EIV were applied to Xiamen Bay, China. The results show that the marine EIV in Xiamen Bay was RMB 222 billion including RMB 130 billion of emergy and RMB 92.4 billion of eco-exergy in 2010. The EIV in unit area of Xiamen Bay is nearly 10 times higher than the average ESV in the World estuaries calculated by Costanza et al. (1997). It implies a potential undervaluation to ecosystem value by ESV calculation which may mislead decisions-making in marine and coastal areas.

October 21, 11:15 (S8-10359)

Using socio-economic and fisheries involvement indices to understand Alaska Fishing Community well-being

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Over recent years, fisheries managers have been going through a paradigm shift to prioritize ecosystem-based management. With this comes an increasing need to better understand the impacts of fisheries management decisions on the social well-being and sustainability of fishing communities. This presentation summarizes research aimed at using secondary data to develop socio-economic and fisheries-dependence indices to measure fishing community well-being in Alaska. Data from more than 300 communities in Alaska were used to create a database of socio-economic and fisheries dependence indices of well-being and adaptability for Alaskan communities dependent on marine resources. Several applications of the indices are discussed including groundtruthing the indices, assessing their predictive accuracy, and predicting vulnerability to fishery management changes. We find that creating performance measures, such as the indices presented here, provides a useful way to track the status of important fisheries and social variables over time.

October 21, 11:40 (S8-10773)

Valuing ecosystem diversity maintenance services of the Shandong marine protected areas: An application of the contingent valuation method

Yi Xiao[1], Shang **Chen**[2], Zhiquan Cao[2], Tao Xia[2] and Linhua Hao[2]

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Eighty-eight marine protected areas (MPAs) have been established in Shandong coastal waters of the west Yellow Sea. Estimates of the value of ecosystem diversity maintenance services generated by these protected areas were derived using the contingent valuation method (CVM). Input for estimation of contingent values were obtained using a questionnaire administered in Jinan (as an example of an inland city) and Qingdao (as an example of a coastal city), in November 2014. The survey was designed to elicit local urban residents' willingness to pay (WTP) for maintaining all 88 MPAs. The total of all Shandong urban residents' WTP represents an estimate of the value of the ecosystem diversity maintenance services of all Shandong MPAs. The mean estimated WTP per inland city resident is 56.08CNY, 19.11CNY higher than the mean estimated WTP per coastal resident (36.97CNY). Based on these estimates and on estimates of inland and coastal city populations, it is estimated that in 2014, the value of ecosystem diversity maintenance service of the 88 Shandong MPAs is 1.924 billion CNY, an average value of 21.9 million CNY per MPA. Twelve natural reserves are included in the network of MPAs; the value of ecosystem diversity maintenance services they provide is estimated to be 0.714 billion CNY (an average of 59.51million CNY per MPA). The MPA network includes 30 special protected areas with an estimated value of 0.650 billion CNY, or 21.51 million CNY per MPA. The estimated value of ecosystem diversity maintenance service of the 46 aquatic germplasm resources protection areas is 0.57 billion CNY, or 12.88 million CNY per MPA. These results indicate that the value of natural reserves approved by the Environmental Protection Department is higher than the value of special protected areas approved by Marine Management Department which are, in turn, more valuable than the aquatic germplasm resources protection areas approved by the Fisheries Management Department. The results suggest that management measures pertaining to these three kinds of MPAs should be assessed and the different measures should be adopted for each.

October 21, 12:05 (S8-10521)

Fish as "Bridge" that connects migrant fishermen and local community: Proposing a new value of marine resources from socio-cultural aspects

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It is generally agreed among contributors to the Common Pool Resources management literature that the characteristics such as "unclear boundary and ownership", "ethnic diversity" or resource users' "mobility" can hinder the management of coastal-marine resources (e.g. Ostrom 1990; Berkes 2006). However, given the trend in Asia-Pacific of exacerbating displacement by a series of environmental risks (ADB 2011), we must also consider how migrant fishermen and local residents of host communities can build social relationships, and how sustainable coastal resource management can be achieved for communities that come to host migrant fishermen. This study is aimed at clarifying the dynamic process of building relationships between migrant fishermen and host communities through the connection with coastal resources. A case study of Shiraho village, Ishigaki island, Okinawa, Japan is presented. Based on in-depth interviews and participatory observations conducted during 140 days of fieldwork, we conclude that migrant fishermen and host communities can build good relationships by focusing on their shared connection with coastal resources. Based on the study, we propose a new socio-cultural value of marine fisheries that connects migrant fishermen and host communities. Our finding is expected to link with growing discussion, mainly in Europe, that focuses on better understanding and incorporation of socio-cultural aspects of fisheries into policy (e.g. Urquhart et al. 2013). Accumulation of further works about such functions or values may contribute to evaluation of the dynamic coastal-marine environment itself and its impact on the human society more properly.

October 21, 14:00 (S8-10418)

Assessment and regulation of ocean health based on ecosystem services: Case study in the Laizhou Bay, China

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The ecosystem-based management of nearshore waters requires an integrated assessment of ocean health as well as scientific guidance on the design of regulations to promote sustainable development. In this presentation, we report on the development of quantitative approaches to assess present and near-term ocean health based on ecosystem services. Results of the case study in the Laizhou Bay of China show that the index score of ocean health is 0.7856 out of 1.0 at present and is expected to range from 0.5551 to 0.8041 in the near future depending on different intensities of regulation of negative pressures such as habitat destruction, pollution, and changes in species composition. Specifically, the results indicate that cultural services and provisioning services performed essentially perfectly while supporting services and regulating services functioned less well. It can be concluded that this nearshore ecosystem will partially lose supporting and regulating services in the near future if the increasing pressures are not well-regulated but that all of these categories of ecosystem services could be slightly improved if the negative pressures are fully controlled. Based on these findings, it is recommended that publicity and education on ecosystem services, especially on cultural services and regulating services, should be further strengthened. The analytical process and resulting quantification provide flexible tools to guide future development of regulations so as to facilitate ecosystem-based management in the coastal zone.

October 21, 14:25 (S8-10601)

Job satisfaction: Perspectives from fishers in northeastern Hokkaido, Japan

Emmanuel A. **Sweke**[1,2], Yumi Kobayashi[1], Mitsutaku Makino[3] and Yasunori Sakurai[1]

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Understanding fishers' satisfaction with their occupation is important to guide future research and the adaptive management of living marine resources. We use historical data and semi–structured questionnaires to examine factors associated with satisfaction of fishers in two traditional fishing communities, Akkeshi and Erimo in the northeastern Japan. Fisheries in Akkeshi consist of capture fisheries and oyster aquaculture, whereas in Erimo fishers are specialized in capture fisheries. We found that fishers in Erimo were more satisfied (mean = 3.37, n = 71) compared with their counterparts in Akkeshi (mean = 3.08, n = 84). Satisfaction was significantly correlated to household size ($\rho = 0.417$, $n = 78$, $p<0.05$) and target species ($\rho = 0.623$, $n = 79$, $p<0.05$) in Akkeshi, and household size ($\rho = 0.259$, $n = 64$, $p<0.05$) in Erimo. Poor fisheries harvest among fishers may have also contributed to the observed difference in satisfaction levels. Specialized-capture fisheries with few but economically important species, exemplified by kelp and salmon in Erimo were found to be likely to maximize satisfaction of fishers than mixed fisheries with many species that are less economically important. Although about 60% of the respondents were proud of their occupation, over 90% of the respondents were unwilling to quit fishing due to limited alternatives, and fishing being connected to traditions. The results of our study will assist stakeholders, including fishers, policy makers, and scientists, to manage fisheries resources so as to maximize fishers' satisfaction from their occupation by addressing challenges faced by the local fishery-dependent communities.

October 21, 14:50 (S8-10625)

Assessment and monitoring of natural marine ecosystems: An economic perspective towards climate

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Ecosystem services play a crucial role in offering a wide range of benefits, and are therefore important steering forces of human wellbeing. Coastal and marine ecosystems are probably the least understood, most biologically diverse, and most undervalued of all ecosystems. Marine and coastal ecosystems are of high importance owing to mankind's dependence on the goods and services provided. This paper attempts to examine whether information from valuation studies can help the design of policies adequate to reverse and halt the generally poor state of marine and coastal ecosystems of the Mediterranean and the Black Sea. Economic implications of managing coastal and marine environments are thus discussed by assessing the results of different valuation studies implemented in the area. Lessons and policy recommendations from existing literature are inferred to guide marine resource management decisions. One of our main findings is that there are extremely few published studies within the Mediterranean and Black Sea region. This highlights the need for further research on the ability of coastal and marine ecosystems to sustain different goods and services in face of anticipated climate change and anthropogenic drivers in these regions. Nevertheless, our results indicate that the substantial positive economic values attached to marketed and non-marketed services provided by marine and coastal ecosystems in these regions justify their sustainable use and management.

October 21, 15:15 (S8-10799)

Assessment of ecological damage and compensation from marine engineering construction projects in Shandong

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Marine ecological damage (MED) consists of harmful impacts to marine ecosystem as a result of human activities that directly or indirectly change natural conditions or result in the discharge of pollutants into the sea. Marine ecological compensation (MEC) refers to payment of the costs of MED by those who caused the damage. MEC is an effective policy tools for dealing with MED. The payment of ecological compensation fees and the implementation of an ecological compensation system, not only rationally guides decision-making by enterprises that use the sea, but also pushes forward the optimization of the structure of the marine economy and promotes the development of marine industries into the deep sea and offshore, which will help contribute to China's sea power and national strategic goal of developing a maritime silk road. However, standards and methods of determining MEC have been slow to mature, which hinders their use by the marine administrative department. In view of this, we have compiled technical guidelines on the assessment of ecological damage and compensation in Shandong province, China and established a compensation standard method for addressing loss of marine biological resources and marine ecosystem services. We applied this approach to the analysis of cases involving typical marine engineering construction projects in Shandong. The purpose is to revise and perfect MED and MEC standards and methods, and to provide technical support for marine environmental protection and the construction of the national marine ecological civilization demonstration zone in Shandong.

October 21, 16:00 (S8-10676)

A review of marine ecosystem services and economic resources of the Bay of Bengal

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The Bay of Bengal (BoB) is one of the world's 64 large marine ecosystems which form in the north-eastern part of the Indian Ocean. Roughly, it is triangular in shape and is bounded by 8 countries like Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand. A number of large rivers viz. the Ganges, the Brahmaputra, and its distributaries such as Padma, Meghna, Jamuna, flow into the BoB. It has a unique and diversified ecosystem enriched with biodiversity which provides both environmental and economic services to the surrounding regions. Some parts of the BoB have already been declared as biodiversity hotspots and ecologically critical areas (ECAs) because of their great significance to keep the ecological, economic, and environmental sustainability of the coastal areas. The unique and rare species of the BoB are Hilsa, shrimp, sharks, coral reefs, mangroves, and other marine species. Additionally, the BoB has served an important role in international trade from ancient time; companies including the British East India Company and French East India Company started their business on its shorelines and contributed to the development of important ports, viz. Chennai, Chittagong, Kolkata, Mongla, and Yangon. Currently, "Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)" supports free trade internationally around the BoB. Fishermen from adjacent countries can catch between 26 and 44 species of marine fishes (avg. 2 million tons/year). Approximately (31%) of the world's coastal fishermen live and work on the BoB. Further, many people cultivate shrimp farms and salt pan in the coastal areas. Thus, it provides a great livelihood sources for a large population directly or indirectly. Moreover, it also provides valuable natural resources such as natural gas, oil, lime stone, beach sand and hydropower. Lately, there is a growing concern that the capacity of BoB to provide ecosystem services is being degraded due to accelerated economic activities and indiscriminate resources extraction. Consequently, FAO is conducting a global environment facility financed regional project "Sustainable Management of the Bay of Bengal Large Marine Ecosystem (BOBLME)" to keep sustainability of resources of the BoB as well extraction.

S9: FIS Topic Session
Experiences and lessons learned in managing shared/transboundary stock fisheries

October 23, 09:00 (S9-10341), Invited

Balloon effects in global fisheries: Shifting paradigms

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Sustainable management of straddling, transboundary and highly migratory fish stocks is a considerable challenge in a globalized and interconnected world. An uneven governance landscape and the existence of unexploited/under-exploited fisheries have generated paradigms of serial depletion (sequential exploitation) by "roving bandits", with little short-term incentive to engage in sustainable management of the stocks. Institutional responses to such shifts in fishing activities have often been slow or piecemeal. This talk will introduce evidence for an emerging paradigm of "balloon effects" caused by the virtual absence of untapped new frontiers for fisheries resources and the uneven regulatory landscape. Within this context, risk exists that new control measures or intensified enforcement activities will simply cause fishing activities to shift into areas of least statehood. Highly-migratory and straddling fish stocks, which extend into weakly regulated areas beyond national jurisdiction (ABNJ) will be particularly prone to such effects. Drawing on balloon effects research in other disciplines, recommendations are provided for a holistic framework of management interventions to reduce the risk of potentially destabilizing balloon effects and unintended consequences.

October 23, 09:25 (S9-10776), Invited

Cooperative management of trans-boundary fish stocks

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Straddling and highly migratory stocks, often referred to as trans-boundary fish stocks, move in and out of maritime boundaries. The trans-boundary migration of fish stocks creates a spatial externality, and hence, makes international cooperation beneficial. This study provides an alternative model for the management of straddling and highly migratory fish stocks and examines the relationship between fish migrations and the benefits from cooperation. Previous studies on trans-boundary fish stock management have focused on seasonal migrations of fish stocks. Instead, this study focuses on non-seasonal movements of fish. In addition, the model presented in this paper takes stock leakages from exclusive economic zones to international waters into consideration. These two model features are applicable to the tuna fisheries of the Pacific island region, where national exclusive economic zones are surrounded by international waters. The study confirms that cooperation is beneficial when fish migrate. The study finds that leakage of stocks to international waters reduces the surplus gained from cooperative management. For a given stock leakage level, the surplus gain from cooperation increases with an increase in the differential between forward and back migration rates. The study presents two surplus allocation rules. Under the Nash-bargaining rule, the surplus is gained equally between the two cooperating countries. In contrast, under the rule based on stock distribution, the country with higher outmigration rates gains more from cooperation.

October 23, 09:50 (S9-10833)

Management of transboundary stocks of walleye pollock in the Russian Federation

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Walleye pollock has a special place in Russian-Japanese and Russian-American fisheries relationships because forms a meta-population comprised of several stocks that overlap where Russian, Japanese, and American maritime boundaries abut. Accordingly, under intergovernmental agreements on mutual fishery relations between Japan and Russia and between Russia and the US, these stocks of walleye pollock are transboundary. The character of the transboundary relationship of these pollock stocks is that spawning takes place in the waters of the EEZ of one country but juveniles and adults may migrate into the EEZ of a neighboring country for feeding. Fishing for walleye pollock is largely regulated by the domestic laws of Russia, Japan, and the United States. Regulatory measures vary greatly depending on the country. In Russia there are quite modern fisheries management rules, including a strict system for determining TACs. In addition, at the legislative level there are: bans on fishing by area, season, and gear; restrictions on the length or tonnage of the vessels; and, limits on the allowable catch of juveniles and the minimum fishing length. The law also defines who can carry out fishing and sets penalties for failure to comply with the adopted law. The distribution of quotas by fishing area and determination of fishing grounds are the key aspects of the fishing regulation. Given that the stocks of walleye pollock are shared with neighboring nations, measures of conservation of transboundary stocks as well as the regulation of commercial fishing should also be shared and well-coordinated.

October 23, 10:10 (S9-10424)

The use of a Lagrangian movement model and management strategy evaluation to assess management performance for transboundary stocks

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Management of transboundary stocks commonly relies on international treaty agreements that assume that the transboundary distribution of the exploited resource will remain stable. Systematic changes in the distribution of transboundary stocks however can cause one or both signatories to become dissatisfied with such agreements. Variations in stock distribution can be caused by a number of different factors, including range contraction and changes in habitat characteristics, such as temperature or food availability. Habitat changes may be particularly important given the expected effects of climate change on ocean temperature, circulation and pH. In this study, a Lagrangian movement model was used to characterize biological and environmental processes that drive fish movement and changes in the distribution of transboundary stocks. We applied this model within a management strategy evaluation (MSE) framework to assess the performance of several management strategies for Pacific hake (*Merluccius productus*). Pacific hake is a transboundary resource shared between the U.S.A. and Canada. The northern range of Pacific hake has become more variable in the past few decades, and this has reduced the availability of the resource to the Canadian fishing fleet. The modeling approach developed was used to identify management measures that could stabilize the spatial distribution of the resource and improve the availability of it to the Canadian fleet. It is expected that this approach will be valuable for the evaluation of management strategies applied to transboundary stocks around the world.

October 23, 10:50 (S9-10465)

Spillover effects of marine environmental regulation for sea turtle protection

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The globalized/international occurrence of swordfish and sea turtles allows for "spillover effects" where conservation-minded reductions in effort and harvest in by one RFMO member may lead to increases in effort and harvests by other RFMO members that are detrimental to the very species intended for protection, and vice versa. This study examines the spillover effects in both fishery production and bycatch resulting from U.S. fishing regulation instituted to protect endangered sea turtles. An empirical model is used to estimate the increase in sea turtle bycatch that would occur if unilateral reductions in swordfish catches by the Hawaii shallow-set longline fleet were offset by increased catches of swordfish by the non-U.S. fleet that operates in the same ocean area. The model is used to demonstrate changes in the magnitude of sea turtle interactions stock-wide as Hawaii swordfish production increases or decreases.

October 23, 11:10 (S9-10338)

Interannual variability of Bering Sea pollock seasonal migrations and the impact of ecosystem changes

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The spatial distribution of the Bering Sea pollock during the summer-autumn feeding period varies annually depending on short-term and long-term variability of the environment including, for example, variation in water temperature and in the abundance and distribution of zooplankton. In 2005-2007 and 2010-2014 pollock began their seasonal migration from the northwestern Bering Sea in a southeasterly direction onto the eastern Bering Sea shelf unusually early—by the end of summer and early autumn. Temperature conditions in the Bering Sea in 2003-2006 were relatively warm and in 2007-2013 they were relatively cold and in 2014 they were again relatively warm. Thus, by itself, temperature condition does not appear to exert a significant influence for scale of pollock distribution into northwestern Bering Sea or timing of the back migration to southeastern direction. Instead, annual variation in the spatial distribution of the eastern Bering Sea pollock during the summer-autumn period could depend on the zooplankton (primarily euphausiid and copepod) abundance and distribution. In general, higher productivity and abundance of zooplankton in the northwestern Bering Sea drives pollock seasonal migrations from the eastern Bering Sea to the northwest during summer. Similarly, southeasterly back migration depends on annual variation in the real abundance of zooplankton in the northwestern Bering Sea.

The data from plankton surveys and hydroacoustic observations (120 kHz) demonstrated that zooplankton, especially euphausiid, abundance decreased in 2010-2014 both in the eastern and northwestern Bering Sea. The trend, observed since 2006, of decreasing production and total biomass of zooplankton was especially strong in the northwestern Bering Sea. Consequently, total zooplankton abundance on the eastern Bering Sea shelf by the end of summer and early autumn was potentially much higher relative to total zooplankton abundance in the northwestern Bering Sea. Limited zooplankton resources, especially euphausiids and copepods, created a deficit of food in the northwestern Bering Sea and forced unusually early pollock migration back onto the eastern Bering Sea shelf during 2012-2014. These same dynamic processes were observed during 2005-2007. Therefore, unusual early (by the end of summer and early autumn) large-scale pollock migrations from the northwestern Bering Sea onto the eastern Bering Sea shelf as result of low zooplankton abundance and deficit of food has been a common occurrence in recent years. Additional studies of zooplankton community may need to be considered in order to determine annual and seasonal zooplankton fluctuations in the Bering Sea and the relationship between eastern and northwestern Bering Sea zooplankton communities.

October 23, 11:30 (S9-10443)

The role of fishery cooperative associations on fishery management and the conservation of fishery resources: A case study of Sakuraebi (*Sergia lucens*) in Taiwan and Japan

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Sakuraebi (*Sergia lucens*) shrimp is primarily harvested in Suruga-bay in Japan and the Tong Gang areas of Taiwan. The Taiwan Sakuraebi fishery, as well as its counterpart in Japan are regarded as a well-managed fisheries. This study aims to understand the role of fishery cooperative associations on fishery management and the conservation of fishery resources. An interview survey conducted with fisheries cooperative association officials in Taiwan was used to determine that they introduced a strict catch limit per day per vessel in addition to starting local consumption promotion activities in late 2001. Analysis was conducted of the role of local consumption promotion campaigns to complement catch limitations. Sales volume and per-unit price data were collected from Taiwanese and Japanese local fisheries cooperative associations. The correlations between prices in Taiwan and Japan was examined and it was found that a positive correlation existed from 1997 through 2001; after 2001 this correlation ceased to be statistically significant. If the price of Taiwanese Sakuraebi was primarily based on domestic supply and demand conditions without being influenced by international prices (as suggested by the post-2001 correlation analysis results), it could create incentives for Taiwanese fishermen to accept reduced days of operation, because the resulting loss of production might be offset by an increase in per-unit price with no net loss of revenue to fishermen. Within this context, the study identified a positive role played by fishery cooperative associations in Taiwan for the recent successful management of the Sakuraebi fishery.

S10: SB/MEQ Topic Session
The human dimensions of harmful algal blooms

October 20, 09:00 (S10-10548), Invited

Human dimensions of harmful algal blooms (HABs): Contributing to ecosystem-based management

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Algal blooms occur naturally in all aquatic systems; however, they become harmful (harmful algal blooms [HABs]) when they adversely affect ecologic and human community health. HABs directly affect human wellness by potentially limiting access to clean drinking and recreational waters, damaging aquaculture facilities, and causing illnesses. Despite the recognized relationship, there is little formal linkage between ecologic and human wellness research. Potential ways to develop this linkage include the following: 1) Designing epidemiologic studies that include collecting the environmental data needed to carefully characterize exposures as well as the health data needed to define relevant illnesses; 2) Conducting better disease surveillance during HAB events likely to result in human and animal exposures; 3) Preparing communities for the possible consequences of HAB events; 4) Preparing to take advantage of the likely HAB events predicted by many of the ongoing operationalized forecasting systems to collect data; 5) Encouraging the human medical and veterinary communities to consider HAB-related exposures in differential diagnoses of patients presenting after exposure to waters with an ongoing HAB and to report these events to their health departments; and 6) Encouraging the design of monitoring programs to improve their use in assessing human and animal exposures. These and other efforts will create a foundation for coordinated efforts across future HABs and human wellness research.

October 20, 09:25 (S10-10710), Invited

Changes in occurrence of paralytic shellfish poisoning and the effects on bivalve aquaculture in Tohoku region of Japan after the Great East Japan Earthquake

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The tsunami by the east Japan earthquake on 3.11 in 2011 greatly influenced the coastal bottom environment on the northern Pacific coast in Japan. Results of several investigation showed drastic increases in abundance of *Alexandrium* (*A. tamarense* and *A. catenella*) cysts in coastal areas of northern Japan after the tsunami. Also, high densities of *A. tamarense* and high contents of paralytic shellfish poisoning (PSP) toxins in bivalves have occurred in spring in several bays. These facts may be due to the following scenario; increased *Alexandrium* cysts in surface bottom after the tsunami induce the increase of initial planktonic population of *Alexandrium* species, and then cause large and dense blooms of this species in each bays, and a large amount of *Alexandrium* cells promotes supply of newly produced cysts on the surface bottom, which may increase seed population for the next bloom season. High toxicities of bivalves have occurred every year in many bays since the tsunami, and caused long term halt to bivalve harvesting, which has caused economic loss of bivalve aquaculture. In particular, this problem is serious for scallop aquaculture because the shellfish toxins contaminated in scallop are not released as rapidly as in oyster. Hence, fishermen in some bays are going to change in target species for aquaculture from scallop to oyster. The tsunami probably promoted subsequent occurrence of PSP, which also influences activities of the bivalve aquaculture.

October 20, 09:50 (S10-10522)

Suggestions for reducing environmental, social and economic impacts by mariculture on coastal communities based on a case study in Anda-Bolinao, northwestern Philippines

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The mariculture industry has grown rapidly to meet food shortages in the Philippines, but has consequently raised various environmental concerns such as algal blooms, resulting in massive fish kills (e.g. McGlone et al. 2004). Even though the negative impacts by mariculture on the coastal environment and also on communities have been recognized, there has been limited empirical work on the impacts of mariculture on coastal communities and management possibilities for controlling the impacts of this industry. This study, therefore, aims at determining how the mariculture industry is affecting coastal communities, and investigates effective management systems for controlling its impacts. We conducted a comparative study on Anda and Bolinao, two major municipalities involved in production of cultured milkfish (*Chanos chanos*), where a series of massive fishkill events have occurred. We found that there are unique social and economic problems in mariculture that are unique and distinguish it from capture fisheries, such as marginalization of the municipal fisherfolk. The two municipalities have different degree of success with industry management; and the biggest difference in the management systems is the presence of active collaborators in Bolinao such as Peoples' Organizations and academics. This result indicates that a co-management scheme for mariculture should be employed, especially in tropical countries with limited governmental capacity. However, it should be emphasized that the participation of business entities such as mariculture facility owners and feed production/distribution companies should be encouraged to participate in the co-management of mariculture operations, since current co-management practices might be still insufficient for controlling powerful business interests.

October 20, 10:10 (S10-10618)

Untangling the relationship between harmful algal blooms and environmental factors in the coastal waters adjacent to the Changjiang River estuary

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Harmful-algal-bloom (HAB) events have been frequently recorded in the coastal waters adjacent to the Changjiang River estuary since 2000. Affected by the Changjiang riverine discharge and currents from the open ocean, the hydrodynamic conditions in the coastal waters adjacent to the Changjiang River estuary are notably complex. To obtain a better understanding on the mechanisms of HABs in this region, analyses based on field investigation data from the National Basic Research Priority Program (CEOHAB I) (27°14′-30°32′N, 121°00′-123°23′E, Julian Day 86-168, 2005) were performed using principle component analysis (PCA), multiple regression analysis (MRA) and path-way analysis (PA) to reveal the relationship between HABs and environmental factors, such as temperature, salinity, light intensity and nutrients. It was found that nutrients, especially phosphate, were major factors driving the succession from diatom bloom to dinoflagellate bloom in spring. The potential role of the Changjiang River and the branches of Kuroshio on the formation of HABs in the sea area adjacent to the Changjiang River estuary will be discussed, which suggested that the intrusion of upwelling supported the bloom of dinoflagellates. This research will help to elucidate the formation mechanisms of HABs in the East China Sea and to predict the occurrence of HABs in this region.

October 20, 10:50 (S10-10862)

The impacts of a massive harmful algal bloom along the US west coast in 2015

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In 2015, a massive bloom of the marine diatom *Pseudo-nitzschia*, stretching from central California to southern Alaska, resulted in significant impacts to coastal resources and marine life. This bloom was first detected in early May 2015, when Washington closed its scheduled razor clam digs on coastal beaches. It is the largest and longest-lasting bloom in at least the past 15 years, and concentrations of domoic acid in seawater, some forage fish, and crab samples have been among the highest ever reported for this region. By mid-May, domoic acid concentrations in Monterey Bay, California were 10 to 30 times the level that would be considered high for a normal *Pseudo-nitzschia* bloom. Impacts to coastal communities and marine life include shellfish and Dungeness crab closures in multiple states, impacting commercial, recreational and subsistence harvesters, anchovy and sardine fishery health advisories in some areas of California, and sea lion strandings in California and Washington. Other marine mammal and bird mortalities have been reported in multiple states, and domoic acid poisoning is a suspected cause. NOAA announced an Unusual Mortality Event for large whales in the western Gulf of Alaska, as the mortality of nearly 30 large whales has been recorded since May 2015. While the HAB is suspected of playing a role, there is no evidence yet that links these deaths to HAB toxins. While the exact causes of the bloom's severity and early onset are not yet known, unusually warm surface water in the Pacific Ocean may be a contributing factor.

October 20, 11:10 (S10-10720)

Diarrheic shellfish poisoning in socio-economic perspective in Prymorsky region, Russia

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According to the latest directive of the Russian Government, the Far-eastern region is declared as a "territory of advanced development". Among various preferences for business which this new status give there are changes that make mariculture business one of the highest interest for investment. The ecological condition of the region allow creating mussels, clams and trepan mariculture farms that would produce high quality products with low production price. However, the HABs situation in the region may threaten this initiative, due to frequent and relatively high development of potentially harmful species like *Ostreopsis* cf *ovata*, *Pseudo-nitzschia* spp., *Dinophysis* spp. Outbreaks of other harmful species also occur in the region. For example, in 2015 the unusual development of *Dinophysis acuminata* was registered in the coastal waters of Vladivostok, with cell concentrations reaching as high as 209,000 cells/L. For now, the detailed monitoring of microalgae is available by the HABs monitoring center of IMB FEB RAS, but the monitoring of toxins in shellfish is scarce. There are several reason for this situation. Firstly, HPLC method for toxin detection is approved only for ASP; only ELISA methods are approved by the government for other toxin groups. Secondly, the availability of standards and ELISA kits is low and isn't accessible for a lot of laboratories. Thus, the HABs in the Far-eastern Russia and particularly in Prymorsky region now have clear socio-economic impacts and the acceleration of its mitigation strategies is highly needed.

October 20, 11:30 (S10-10679)

Do the aquaclture and ballast discharge influence the scope of Harmful Algal Bloom?

Jinhui **Wang**[1,2,3], Zhuyou Ma[1,2], Yun Li[3] and Hongying Qian[3]

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What caused the difference of the biogeography and abundance of harmful algal bloom in different areas of China sea? The species composition of phytoplankton blooms has shifted in last decades from Skeletonema costatum and *Noctiluca scintillans* to *Karenia mikimotoi* and *Prorocentrum dentatum*, changes in the biogeography of harmful dinoflagellates and raphidophytes have been detected along the Chinese coast. One NIS, *Spartina alterniflora*, introduced intentionally for erosion control and marsh reclamation, may slow the eutrophication of certain area. As one of the most developed area in China, the coast of East China sea has experienced continuous change associated with fast urbanization and other human activities such as marine aquaculture, port development etc. Some possible effects resulting from these changes include adjustment of nutrient abundance and structure, and increases the source of algae etc. In this paper, the variability in bloom records will be analyzed with the scope of marine aquaculture, spread of Spartina alterniflora introduced intentionally for reclamation in wetland and ballast discharge.

October 20, 11:50 (S10-10814)

Does reduced sediment load contribute to increased outbreaks of harmful algal blooms off the Changjiang Estuary?

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Harmful algal blooms are increasingly frequent in coastal waters around the world over the last several decades. The accelerated coastal eutrophication, which resulted from the increasing anthropogenic loadings of nutrients, is commonly assumed to be the primary cause of this increase. However, although important, the accelerated coastal eutrophication may be not the only explanation for the increasing blooms or toxic outbreaks in estuarine waters. Changes in riverine material fluxes other than nutrients, such as sediment load, may significantly affect biological activities as well as HAB incidence in estuarine and coastal waters. A case study off the Changjiang Estuary indicated that, with the increasing riverine loadings of nutrients, sediment load from the Changjiang River has been reduced by 70% in the past four decades. A comparison of long-term data revealed that the phytoplankton biomass maximum has expanded to a much lower salinity region due to the drastic reduction in riverine sediment load and the subsequent improvement in light penetration in the Changjiang River plume. Furthermore, the number of HAB incidences off the Changjiang Estuary are positively related with the sediment load from the Changjiang River over the past four decades. Therefore, it is argued that the drastic decline in sediment load from the Changjiang River reduced turbidity in the Changjiang Estuary and thus contributed to increased frequency of HABs in buoyant discharge plumes.

October 20, 12:10 (S10-10656)

Monitoring of harmful algal blooms in the Strait of Georgia by a Citizen Science program, Canada 2015

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The Citizen Science program in British Columbia, Canada was initiated in 2015 by the Pacific Salmon Foundation, Ocean Networks Canada and Department of Fisheries and Oceans Canada as part of the Salish Sea Marine Survival Project (www.marinesurvivalproject.com). Selected members of the public took on a role as citizen scientists, collecting information in the Strait of Georgia. This program provides data at a spatial and temporal degree that has not been possible before. As of 2015, Citizen Scientist vessels are sampling in 9 areas around the Strait; sampling is done on the same day every 2-3 weeks between February and October. Properties/samples that are measured/collected are: conductivity, temperature, depth, dissolved nutrients, fluorescence, oxygen, zooplankton, phytoplankton, and turbidity. Here we present information on HAB species presence, abundance and associated water condition that were recorded in spring and summer 2015.

BIO Contributed Paper Session

October 20, 09:00 (BIO-P-10376)

Using imaging flow cytometry to examine phytoplankton assemblage structure in the Bering Sea

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The composition of phytoplankton assemblages in the Bering Sea was examined using an automated individual cell imaging approach, on numerous cruises starting in 2006. Such detailed information on nano- and microplankton assemblage composition, spanning multiple seasons and years, provides an unprecedented view into the spatiotemporal structure and scales of variability of phytoplankton communities in this Pacific shelf sea. New instrumentation designed specifically for field use in Bering Sea field programs will be described. An approach will be presented for synthesizing information about large size classes (from imaging flow cytometry) with information about smaller size classes (from standard flow cytometry). This approach provides considerable insight into how the physical and chemical oceanography of Bering Sea ecosystems control the distribution and timing of phytoplankton biomass, with ramifications to primary production and the consumption of this production by higher trophic levels.

October 20, 09:20 (BIO-P-10344)

Distribution of mixotrophic phytoplankton along the latitudinal transect of the central North Pacific

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We elucidated latitudinal distributions of mixotrophic flagellates in the central North Pacific Ocean, employing two different approaches: the traditional fluorescently-labeled bacteria (FLB) method and the acidotropic fluorescent probe LysoTracker Green method. The proportions of mixotrophs in the total nanophytoplankton as measured by the two methods were well correlated with each other, showing that LysoTracker Green is an appropriate method to assess potential phagotrophy of natural phytoplankton communities in the open ocean. The proportion of potential mixotrophic pico- and nanophytoplankton was higher in the nutrient-depleted subtropical gyre than in the other regions, suggesting that low nitrogen and phosphorus availability can provide a relative ecological advantage to mixotrophs over obligate autotrophs. This study clarified that cryptophytes, which occurred only in the subarctic waters, showed nearly 100% of potential mixotrophy. The numerical proportion of mixotrophic nanoflagellates in phagotrophic flagellates was positively correlated with nutrient concentrations, suggesting that heterotrophic flagellates have some ecological advantage over mixoptrophs in nutrient-depleted waters. In contrast to macronutrient availability, the physical stability of the water column did not apparently affect the dominance of mixotrophs. Mixotrophs significantly contributed (26-64%) to total bacterivory measured by the FLB method from the equatorial through arctic regions, which reinforces the extensive importance of mixotrophs as trophic link in the open ocean. However, no spatial trend was observed for community bacterial grazing rates by mixotrophic nanoflagellates. To clarify which environmental factors control grazing rates by heterotrophic and mixotrophic nanoflagellates will be the future work.

October 20, 09:40 (BIO-P-10614)

Using 454 pyrosequencing to analyze the *in situ* diet of the marine copepod *Calanus sinicus*

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Knowledge of in situ diet of copepods, while fundamental in understanding trophic interactions and marine food web structure, is limited due to technical challenges. 454 pyrosequencing has proven to be powerful in unraveling microbial biodiversity, but has not been exploited for dietary diversity in copepods. In this study, we developed a protocol with the combination of copepod-excluding and eukaryote-universal 18S rDNA primers embracing variable regions V7-V9 to fit the 454 GSFLX Titanium platform. We tested the feasibility of this protocol by analyzing the ambient water and natural diet of copepod *Calanus sinicus* in Jiaozhou Bay, China. DNA derived from whole-body, appendages-removed and starved copepods were analyzed. Our results showed that this protocol retrieved organisms from nearly all eukaryotic kingdoms, while depressing the amplification of 18S rDNA from most of the copepods, indicating the universality of this protocol in specifically detecting prey of copepods. Two major symbiotic ciliates *Vampyrophrya* and *Gymnodinioides* were found on *C. sinicus* by analyzing the starved copepods. Removal of the appendages significantly increased the sensitivity of detecting dietary diversity and revealed the diets mainly comprised marine fungi (35.2%), dinoflagellates (23.9%) and jellyfish (23.2%). However, in the composition of ambient water, although dinoflagellate accounted for 58.5% of the non-copepod OTUs, marine fungi and jellyfish were scarce (<1%), indicating the taxon-specific selectivity in *C. sinicus*. Our results show that this new protocol will be useful for uncovering in situ diet of copepod and removal of the appendages would maximize the dietary diversity recovery.

October 20, 10:00 (BIO-P-10753)

The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA

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Euphausiids are an important component of the food web in the northeast Pacific Ocean, serving as prey for fish (including salmon and hake), seabirds, and marine mammals. The dominant euphausiid species off the Oregon Coast are *Euphausia pacifica* and *Thysanoessa spinifera*. The ongoing time-series study off Newport, Oregon, USA, has collected environmental and biological data twice per month since 2001, a period encompassing warm and cold years (positive vs. negative PDO) and different upwelling conditions (strong, weak, late, etc.). Measurements such as abundance and biomass are often reported as seasonal or annual averages but from a predator's perspective the relevant data are when krill are abundant, which species they are, and where they are located during a particular season or year. The biomass of *E. pacifica* was similar during warm and cool years, with a consistent cross-shelf pattern of lower biomass inshore and significantly higher biomass offshore, with the highest values during cool conditions. *T. spinifera* biomass was significantly higher at inshore stations during cool conditions and similar at offshore stations regardless of whether conditions were warm or cool. Euphausiids also varied in species composition, size (length), timing of reproduction, and other parameters. The timing of when and where euphausiids are abundant has implications for the predators that rely on them. Possible effects of environmental variability on these two species of euphausiids, and how these potential changes may propagate through the food web, will be discussed.

October 20, 10:20 (BIO-P-10615)

Interannual variation of summer zooplankton size structure and its relation to physical and biological processes in the Yellow Sea and East China Sea

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Interannual variation of summer zooplankton size community and its relation to physical and biological processes in the Yellow Sea (YS) and East China Sea (ECS) were examined during 2011 to 2013. Zooplankton was size-fractionated with sieves of 2, 1, 0.5, 0.212 and 0.1 mm. The contribution of large size fraction (> 0.5 mm) to total biomass was larger than the small size fraction (<0.5 mm) in the central YS and Kuroshio Water, whereas the smaller size fraction (<0.5 mm) was dominant in the Changjiang Diluted Water (CDW) and its adjacent regions. The geographical distribution of zooplankton size community and its fraction was significantly affected by the physical and biological features of the YS and ECS. The large size fraction in all the stations in the central YS was highly related to the temperature (<10°C) under the thermocline, and these regions corresponded to the Yellow Sea Bottom Cold Water (YSCBW) region. The small size fraction in the majority of the stations in the CDW region was related to low surface salinity (<30). This indicates that the large size zooplankton in the central YS was probably related to the YSBCW, and the small size zooplankton in CDW region was related to Changjiang discharge water. The normalized size spectra of zooplankton community in each region were analyzed, and were compared with other studies to understand the characteristics of the ecosystem in YS and ECS.

October 20, 11:00 (BIO-P-10586)

Buoyancy and vertical distribution of Pacific mackerel eggs and larvae and its climate change implication for the temporal variability of recruitment

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Vertical distribution of fish eggs and larvae is a crucial component for determining advection and recruitment variability. Little has been reported about the vertical location of Pacific mackerel *Scomber japonicus* eggs and larvae in Korean waters. Therefore, we measured the specific gravity of eggs and larvae using artificially fertilized eggs, and then simulated its vertical distribution to understand the distribution patterns in the spawning area around Jeju Island, Korea. All eggs from broodfish (May-June 2013 and 2014) were spawned, in rearing tank, and the specific gravity of fertilized eggs and larvae was measured by density-gradient column (Martin In. Co. LTD). The egg specific gravity during the early stage ranged from 1.203-1.0211. In general, fertilized eggs showed a gradual decline in specified gravity until full development of the main organs, with a sudden increase just before hatching. However, specific gravity of larvae tended to increases with diel pattern from 4 to 16 days after hatching. Due to the different salinity in the spawning area, the vertical location of eggs and larvae should be different interannually, which determines the various levels of advection as well as recruitment success.

October 20, 11:20 (BIO-P-10605)

Archeological data indicate that northern fur seals are likely to once again become a dominate predator in the California Current System

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Archeologists report that ~80% of the prehistoric mammal bones (prior to 1850) contained in the middens (garbage pits) of coastal native villages from California to Alaska consist of northern fur seals (*Callorhinus ursinus*) of all ages (pups, juveniles, bulls and adult females). Based on the sizes of bones recovered, their stable isotope signatures, and knowledge of fur seal biology and migratory patterns, archeologists concluded that the remains were either from an extinct species of fur seal or from northern fur seals that once bred nearby on the North America shoreline. They ruled out the possibility that the fur seals originated from any of the four known breeding sites in Alaska and Russia. We reviewed historical documents on the early fur trade, as well as more recent data on fur seal genetics and migratory patterns of juvenile fur seals—and discovered that most of the midden remains originated in fact from a very large colony of northern fur seals that Russian sealers extirpated from the Farallon Islands (California) in 1840. Prehistorically, native hunters travelled 50 km or further offshore in open canoes during the winter and spring migration along much of North America to obtain fur seals (and other species) in their core feeding areas along the continental shelf break and waters further west. The data we compiled indicate that fur seals were once a dominate species in the California Current system, and that they are likely to again dominate this ecosystem now that they have re-established their breeding colony on the Farallon Islands.

October 20, 11:40 (BIO-P-10575)

Decadal scale change in the feeding habits of sei whales in the western North Pacific off Japan

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Sei whale *Balaenoptera borealis* is the dominant baleen whale species in the western North Pacific and preys upon a variety of species from copepods to pelagic fishes in the subarctic zone in summer. The authors have examined the stomach contents of sei whales (n=1174) from 2002 to 2014 obtained in the Japanese Whale Research Program between Japan's coast to 170°E (JARPNII) to investigate changes in prey composition. The stomach contents were removed, weighed and the prey species were identified to the lowest taxa possible. The main prey species were *Neocalanus* copepods, Euphausiids, and pelagic fishes (*Engraulis japonicus*, *Scomber japonicas* and *S. australasicus*). In the early part of the research period before 2010, *E. Japonicus* was the dominant prey species in addition to the copepods and Euphausiids, then the occurrence of anchovy decreased with later years and was finally replaced by *Scomber* spp. in the early 2010's. In 2014 Japanese sardine *Sardinops melanostictus* was, for the first time, found as one of the main prey species during the survey years. Body length distribution of *E. Japonicus* showed modes of over 100mm in the early years of survey period, with dispersed peaks in later years, suggesting the change of merged aggregation pattern in anchovy. The body length distribution in mackerels shows the opposite pattern to anchovy with a stable mode around 150-200mm after 2011. This drastic shift of fish prey species in sei whale seems highly dependent upon the change of food availability, which is the most important factor related to prey composition.

October 20, 12:00 (BIO-P-10812)

Scales of inference: The influence of spatial and temporal resolution on habitat-based models for marine predators

Kylie L. Scales, Elliott L. **Hazen**[1], Michael G. Jacox, Christopher A. Edwards, Andre M. Boustany, Matthew J. Oliver and Steven J. Bograd

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Understanding and predicting the responses of marine predators such as seabirds, cetaceans, sharks and turtles to dynamic oceanographic conditions requires habitat-based models that sufficiently capture environmental preferences. Marine systems inherently vary at finer scales than their terrestrial counterparts as habitat (fronts, eddies) move dynamically. The spatial resolution and temporal averaging of environmental data layers are key components of modeling animal distributions. The utility of surfaces contemporaneous to animal responses (e.g. daily, weekly), versus synoptic products (monthly, seasonal, climatological) is oft debated, trade-offs between high-resolution (e.g. matched scales) vs. composite products (e.g. cloud-free data) remain. Using movement simulations with built-in environmental preferences (correlated random walks, multi-state hidden Markov models) combined with modeled and remotely-sensed (ROMS & MODIS-Aqua) oceanographic datasets, we explore the effects of degrading the spatial and temporal resolution of environmental surfaces (3km – 1 degree, daily – climatological) on model inference. Results indicate that models using seasonal or climatological data fields can overfit environmental preferences in presence-availability designs, at scales greater than 1 month and 0.25 degrees. We also observed a divergence between the 'best' models selected using common metrics of model performance and those that accurately reproduced known environmental preferences. These findings have important implications for marine resource management, particularly in forecasting climate-mediated ecosystem changes.

FIS Contributed Paper Session

October 20, 09:00 (FIS-P-10609)

Relationships between ocean conditions and interannual variability of habitat suitability index (HSI) distribution for neon flying squid in central North Pacific examined using new 4D-VAR ocean reanalysis dataset

Hiromichi **Igarashi**[1,2], Yoichi Ishikawa[1], Tsuyoshi Wakamatsu[1], Yusuke Tanaka[1], Masafumi Kamachi[1,3], Norihisa Usui[3], Mitsuo Sakai[4], Sei-ichi Saitoh[2] and Yutaka Imamura[5]

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The neon flying squid (*Ommastrephes bartramii*) has a wide-spread distribution in subtropical and temperate waters in the North Pacific. It plays an important role in the pelagic ecosystem and is one of the major targets in Japanese squid fisheries. The main fishing areas for Japanese commercial vessels are located offshore of Sanriku coast in northern Japan in winter and the central North Pacific (35-45N, around the date line) in summer. Here, we focus on the interannual variability of the potential habitat area of the summer fishing area during 1999-2014, and investigate the relationship between ocean state variations in the fishing area and several kinds of habitat suitability indices (HSI) of the neon flying squid. In this study, we have used a new 4D-VAR ocean reanalysis dataset produced by JAMSTEC/CEIST and MRI-JMA. The horizontal resolution is 0.1x0.1 degree of latitude and longitude, with 54 vertical levels, which can provide realistic fields of 3-dimensional ocean circulation and environmental structures including meso-scale eddies. The data period is from 1982 to present. All the datasets were calculated using the Earth Simulator 3rd generation. Comparing the distribution of HSI fields with that of ocean phenomena scale by scale, the results show that the HSI of the neon flying squid could be strongly affected by sub-surface structure of fronts and eddies in the fishing area.

October 20, 09:20 (FIS-P-10764)

Annual variability in the distribution and biomass of dominant myctophid fishes off western Kyushu, Japan

Shinya **Ohshima**[1], Tohya Yasuda[2], Masa-aki Fukuwaka[2], Rintaro Koide[1], Koki Abe[3] and Hiroki Yasuma[1]

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Myctophid fishes are the main components of the mesopelagic sound scattering layer, and play a significant role in the marine ecosystem off western Kyushu Island, one of the important fishing grounds around Japan. Acoustic and trawl surveys were conducted in summer of 2012 and 2013 to estimate the species-specific distribution, biomass, and annual variability in these parameters. Based on swimbladder and body shape, dominant species were discriminated in echograms by differencing of target strength between two acoustic frequencies (38 and 120 kHz). Myctophid fishes (*Diaphus* spp.) occupied more than 80% (in number) of all mesopelagic fishes in each trawl. The acoustically estimated biomass of the dominant species was significantly larger than that of commercially important pelagic fishes, such as anchovy *Engraulis japonicus* and jack mackerel *Trachurus japonicus*. Species composition and biomass showed different spatial patterns between two years, and fluctuations of dominant current structures, such as Kuroshio warm current and its branches, are thought to be a potential factor influencing them.

October 20, 09:40 (FIS-P-10755)

Image-analysis software applied to assess spatial and temporal variability of fecundity in Walleye pollock, *Gadus chalcogrammus*

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Recent funding provided by FATE (Fisheries and the Environment) was used to update estimates of fecundity and to examine functional relationships between fecundity, stock conditions and environmental factors for walleye pollock. Female spawning biomass is used as a proxy for reproductive output in stock analysis of pollock. In other gadids, such as Atlantic cod, fecundity is not time-invariant per unit biomass. In such cases annual egg production would provide a better measure. Here image analysis is incorporated with histological evaluation to estimate fecundity from specimen collections from the Gulf of Alaska, the Bering Sea, and the Aleutian Islands from the early 1990's to present. These data are used to compare body condition and fecundity with pollock abundance, and to evaluate the impacts of variations in temperature and ocean productivity on fecundity rates.

October 20, 10:00 (FIS-P-10430)

The impact of fine-scale spatial behaviour of quillback rockfish (*Sebastes maliger*) on a hook-based relative abundance index from longlines

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Catches from fisheries-independent surveys provide indices of relative abundance. However, interpreting trends in these indices, such as the impact of large-scale events like climate change, depends on how they relate to true abundance. Indices from longlines can be affected by hook competition and gear saturation, particularly at high densities. The hook-based exponential model attempts to correct these issues by using instantaneous rate of bait loss as an index. The rate of bait loss is assumed to increase linearly with increasing abundance of the species caught. At low densities, both this index and catch-per-unit-effort should perform well as relative abundance indices. However, in a recent study where longline gear was observed with a remotely operated vehicle during fishing, we found that the exponential model index failed to track differences in observed density of quillback rockfish (*Sebastes maliger*) at low densities (26.8% of hooks occupied). We observed that the distribution of free-swimming quillback along the longline was patchy. Quillback often occurred in small groups around a baited hook but did not move to adjacent hooks with available bait, even though hook spacing was approximately 1.8 m. The fine-scale spatial behaviour of quillback appeared to make the exponential model index insensitive. We test whether spatial clumping by quillback causes failure of the exponential model, at what level of clumping failure occurs and whether a correction can be applied to the exponential model. Correcting failures at the gear level prevents upward propagation of errors and removes confounding from interpretation of trends at higher levels.

October 20, 10:20 (FIS-P-10709)

An index of relative biomass, abundance, and condition of juvenile Pacific Herring (*Clupea pallasi*) in the Strait of Georgia, British Columbia

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Small pelagic fish, such as Pacific Herring (*Clupea pallasi*), are an important prey species for a variety of predators and, in the case of herring, are also culturally, commercially, and recreationally important. Herring abundance can be affected by the carrying capacity of the ecosystem, and by a variety of factors affecting survival and recruitment to the adult population. To understand which factors influence herring first requires a time series of the relative abundance of herring. British Columbia's Strait of Georgia juvenile herring and nearshore pelagic ecosystem survey has collected data from ten core transects in September-October since 1992. This time-series can be used to estimate the relative abundance of age-0 herring, potentially forecast recruitment to the adult spawning population, and represent trends in prey availability to predators, such as salmon. The objectives of this report were to: 1.) update the time series and identify suitable data and statistical methods for estimating an index (and associated variance) of the relative biomass or abundance of age-0 herring, 2.) compare survey estimates of age-0 herring biomass (abundance) to stock assessment model estimates of recruitment, and 3.) examine trends in herring condition (length-weight residuals) which may have implications for herring survival and for predators of herring. To calculate unbiased estimates of the relative biomass (abundance) of age-0 herring, we applied two methods (two-stage and two-stage stratified) to a variety of data types for three scenarios (based on assumptions about nets used). Based on these results, we make several recommendations for the survey.

October 20, 11:00 (FIS-P-10370)

Environmental drivers of benthic fish distribution in and around Barrow canyon in the northeastern Chukchi Sea and western Beaufort Sea

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Barrow underwater canyon is a dominant feature of the northeastern Chukchi Sea shelf. It is oriented parallel to the shore and drops to depths around 150 m, around 20-40 km from shore. Water depths rise to around 60 m offshore of the canyon in the study area. Oceanographic processes in Barrow canyon are expected to influence the distribution, abundance and ecology of organisms in the area. Furthermore, flow through Barrow canyon and around Point Barrow is expected to influence the western Beaufort Sea. To examine these expectations, the benthic fish community in and around Barrow Canyon in the northeastern Chukchi and western Beaufort Seas was surveyed with an 83-112 eastern otter trawl. Maps of the distribution of benthic fish indicate that Barrow Canyon influences where fish are most abundant, both in the canyon and downstream of the canyon in the Beaufort Sea. To further examine the role of the environment in and around Barrow Canyon, we analyzed the distribution and abundance of benthic fish in relation to several drivers. We examined physical oceanographic drivers such as temperature, salinity, water column stratification and mixed layer depth. We also examined factors such as depth and distance from shore. Understanding the oceanographic and habitat features important for Arctic benthic fish can help predict and manage for the potential impacts on Arctic ecosystems of climate change and human activities such as shipping and oil and gas development.

October 20, 11:20 (FIS-P-10352)

Stock abundance dynamics of saffron cod on West and East Kamchatka and natural determinants of the dynamics

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Catch dynamics of saffron cod on West and East Kamchatka were analyzed for the period 1937–2014 based on the method of periodogram-analysis developed by Shuster, which revealed series of cycles within 77 years. The periods for the saffron cod catch fluctuations on West and East Kamchatka demonstrated coincidence in one case (period of 11 years), whereas in all the other cases the dynamics on West Kamchatka followed the dynamics on East Kamchatka with a lag of one year. It is most likely that the character of the difference depends on different environmental conditions and population responses to the conditions determined by general climate dynamics.

Analysis of saffron cod abundance dynamics in relation to water temperature regime demonstrated that abundant generations were in the periods of predominating warm processes or in the years with moderate hydrological regime. Years were evaluated as “warm” or “cold” on the base of the ice cover criterion.

A decrease of the ice cover in the Sea of Okhotsk and Bering Sea corresponded to a trend ofincreasing saffron cod abundance. The periods of low and high abundance were in antiphase, and that can be due to asynchronous development of the ice sheet from year to year in the Bering Sea and Sea of Okhotsk.

Thus, the dynamics of catch and abundance of saffron cod are determined by natural stock abundance waves with different length.

October 20, 11:40 (FIS-P-10343)

Structure of the nekton community of the upper epipelagial in the Northwestern Pacific Ocean in February-April

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The nekton community of the upper epipelagial in the Northwestern Pacific Ocean (NWPO) in February-April is comprised of pacific salmon, which spend the winter and feed in the area, mesopelagic species of fish and squid undergoing vertical migration in the surface layers at night, and some subtropical fish. Based on trawl survey data (2009-2011) we describe species occurrence, biomass composition and trophic relations of the nekton community. In the catches, we observed 73 species of nekton, including 54 species of fish from 32 families and 43 genera, and 19 species of cephalopods belonging to 10 families and 16 genera. Mesopelagic fish dominated the nekton community in terms of number of species (29). Mesopelagic fish (fam. *Myctophidae*; Northern lampfish *Stenobrachius leucopsarus*, Theta lanternfish *Diaphus theta,* Blue lanternfish *Tarletonbeania crenularis*, California lanternfish *Symbolophorus californiensis*) made up 29% of the nekton biomass (186,000 t). Squid (Boreopacific squid *Boreoteuthis borealis* and Firefly squid *Watasenia scintillans*)– made up 33% of the nekton biomass (211,000 t). The percentage of salmon, including dominant Pink salmon *Oncorhynchus gorbuscha*, was 21% of the nekton biomass (135,000 t). Analysis of data on the forage resources and consumption by nekton species showed that salmon consumed 41% of forage resources. Mesopelagic fish and squids consumed a lower percentange, 13 and 23%. Forage resources mainly consisted of copepods (60%) and chaetognaths (22%), while euphausiids and amphipods made up 4% and 1%, respectively. Generally nekton species diet consisted of copepods (38 %), euphausiids (28%), amphipods (11%) and micronekton (11%). But the highest predation rates were on amphipods and euphausiids, 27% and 14% of their biomass, respectively. However, total consumption of forage resources did not exceed 4% of the zooplankton and micronekton biomass.

October 20, 12:00 (FIS-P-10632)

Trophic flows in the marine ecosystem of an artificial reef zone in the Yellow Sea China

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This study represents the first attempt to evaluate the ecosystem structure and functioning of the nearshore reefs in the Lidao coastal ecosystem of northern China. This region is one where intensive aquaculture (particularly kelp culture) and fisheries enhancements, through the deployment of artificial reefs and stock enhancement programs are practiced. An Ecopath model was developed for a small area in the region and Ecosim was used to explore one scenario for alternative fishing practices. The mean trophic levels (TL) of the functional groups ranged from 1.0 to 4.1. The mean transfer efficiency was 11.7% through the whole system, and the ecosystem had a relative low maturity, stability and disturbance resistance, remaining at a developing stage. Nearly half of the total system biomass (48.9%) in the system, excluding detritus, (620.20 t km^{-2} $year^{-1}$), was comprised of benthic finfish and invertebrates. The total fishery yield from all fisheries (86.82t/km^2/year) was dominated by low TL herbivorous and detritivorous species such as the sea cucumber *Apostichopus japonicas* (TL=2.1, 46.07%), other echinoderms (TL=2.1, 34.6%) (sea urchin *Asterias amurensis; Strongylocentrotus nudus*) and abalone *Haliotis discus hannai* (TL=2.0, 18.4%), and as a consequence the mean trophic level of the catch was low (2.1). The Ecosim simulation of closing all fisheries for 20 years (keeping the original state for first 3 years) in the current ecosystem resulted in an increase of about 100% in the relative biomass of the main exploited species, sea cucumber *A. japonicas* and abalone *H. discus hannai*.

October 20, 12:20 (FIS-P-10684)

Development of a regional marine environment analysis system for fishery applications

Tsuyoshi **Wakamatsu**, Yusuke Tanaka, Shiro Nishikawa, Haruka Nishikawa, Hiromichi Igarashi and Yoichi Ishikawa

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Near-real time analyses and forecasts of marine environment variables are key factors to conduct effective and economically efficient socioeconomic activities in the ocean. For promoting and enhancing usability of the analysis products to end-users in real applications, further developments and implementations of extra features, scalability and reachability, of the analysis system are required. In order to achieve these extra features, we have newly developed a framework for a marine environment analysis and dissemination system. Its applicability and performance were tested in a pilot study launched for assisting management of neon flying squid (*Ommastrephes bartramii*) fishing in the Central North Pacific Ocean. Key components comprising the analysis/dissemination system were a four dimensional variational data assimilation system, an empirical mapping scheme of habitat suitable index at an oceanic frontal scale and a web-based visualization system for delivering the analysis products to fishing operators in quasi-operational mode. In this presentation, we discuss general performance of the data assimilation system and the effectiveness of the analysis/dissemination system during the squid fishing operation conducted in the 2015 summer season.

MEQ Contributed Paper Session

October 23, 09:30 (MEQ-P-10602)

Radioactivity estimates at North Pacific Ocean based on radiation dose rate

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In order to investigate subsequent impacts of the radioactivity release on the North Pacific Ocean, the State Oceanic Administration of China implemented online monitoring and analysis for surface water dose rate in the North Pacific Ocean during 2011–2013. The key monitored region located in the Luzon Strait and the sea areas in southern Japan. Investigation results showed that on the horizontal distribution, the mean annual dose rate of the surface water around southern Japan was higher in the east than that in the west, while there was a decrease in the dose rate at the temporal scale. On the contrary, an increasing temporal trend in the dose rate was found in the Luzon Strait, though its horizontal distribution was consistent with the sea areas in southern Japan. Nevertheless, due to the potential influence by other radioactivity sources in the monitored region and uncertainties in the dynamic mechanism of the North Pacific Ocean circulation system, further investigation and validation are required in the future based on our preliminary results.

October 23, 09:50 (MEQ-P-10593)

Strontium-90 in marine fishes

Shizuho **Miki**[1], Ken Fujimoto[1], Takami Morita[1], Yuya Shigenobu[1], Kaori Takagi[1], Tsuneo Ono[1], Tomowo Watanabe[1,2] and Hiroya Sugisaki[1]

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The high concentration of ^{90}Sr was included in radioactive wastewater released from the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) in 2011. After the wastewater was discharged into the sea, ^{90}Sr in seawater was only temporarily detected near the FDNPP harbor. Strontium-90 in seawater was spread across the ocean and diluted to undetectable level. Even though ^{90}Sr in marine fishes was not detected, citizens raised questions about the safety of the fishes because of the release of high concentrations of ^{90}Sr from the FDNPP. Therefore, in this study, we investigated the concentrations of ^{90}Sr in marine fishes collected from the coast of east Japan. A comparison was made of the the concentrations of ^{90}Sr with that of ^{137}Cs in the collected fishes. The concentration of ^{90}Sr in various fishes, e.g. *Theragra chalcogramma* and even *Paralichthys olivaceus* caught around Fukushima prefecture, was below detection limit or the same as that before the accident. Although the concentration of ^{90}Sr in *Sebastes cheni* caught near the FDNPP in Dec. 2011 was detectable that of in *S. cheni* caught off Fukushima prefecture in Jun 2012 was undetectable. Therefore we suggest that the contamination of ^{90}Sr in marine fishes may be localized to a small region near the FDNPP harbor. All the results showed the concentration of ^{90}Sr in marine fishes was notably lower than that of ^{137}Cs.

October 23, 10:20 (MEQ-P-10685)

Accumulation of microplastics on coastal beaches, China: Abundance, composition and sources

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Microplastics refers to small pieces of plastics <5mm (defined as <1 mm in some studies). Ingestion of microplastics and transfer in the trophic levels provides a potential pathway for the accumulation of pollutants, monomers and plastic additives to organisms with adverse effects. Therefore, it has been of concern worldwide as an emerging contaminant. We collected data from field investigation and published papers to address pollution of the microplastics on the shoreline, China. Several coastal types were covered, including tourism beach, aquiculture beach, estuarine flat and wetland. The data showed that microplasitcs occurred ubiquitously on the coastal beach with various types, such as foam, particle, pellet, fiber and fragments. Size of the observed microplasitcs varied from a few dozen micrometres to approximately 5mm. Abundance of the microplastics reached up to >100 pieces per square meter, and among them the foam and fibers are most abundance, which has a close relationship with coastal aquiculture. In addition, resin pellets could be found in substantial amounts in some tourism beachs, which might be result from leakage during shipment followed by transport with tide. However, more evidence is required to support this. Surface morphology of the collected microplastics from the beaches was also identified by SEM-EDX, which showed that the surface was severely eroded after weathering in the environment. The distribution of irregular porosities on the mircroplastic surface might attribute to the higher adsorption capacity for toxic pollutants. Our study provides an insight on future researches on microplastics pollution on China's coast.

October 23, 11:00 (MEQ-P-10646)

Hydrocarbon exploration on the Sea of Okhotsk shelf and its possible impact on marine ecosystems

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In recent times the question of seismic exploration (2D, 3D and 4 D) and geological development impacts on marine biota has become very acute because of the extensive scale of such surveys in the Sea of Okhotsk area. Today there exists very disputable data on an assessment of this exploration impact. Some scientists even say that such impact can't be predicted.

Special attention is paid to the seismic-acoustical impacts on plankton, birds, and marine mammals. Research on commercial fish species, such as Pacific salmon and herring are conducted to evaluate influence of this anthropogenic activity, as the seismic exploration is conducted in the area of spawning and feeding migration of these species. Data analysis of Russian and international research shows that the process of hydrocarbon exploration causes negative impacts, such as destruction of plankton, fish larvae and egg death, and some pathological deviations in fish. Deviations in fish and whale (cetacean) migration paths are also marked. Research on seismic exploration impacts in the Barents Sea have revealed a decrease of catches in the 18-mile distance from the source of impact, and their recovering when activity is ceased.

In order to mitigate the possible negative effects thathydrocarbon exploration may cause on marine biota, time and space regulation measures are applied. When seismic exploration takes place it is necessary to make models of possible effects of this activity on the basis of constant diverse monitoring and international experience.

October 23, 11:20 (MEQ-P-10576)

Historical trends of terrigenous organic carbon transported by the Yangtze River (Changjiang)

Yu **Hao** and Wu Ying

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In order to reconstruct the history of terrestrial discharge and human activities in the past 70 years, sediment core samples collected from the Yangtze River estuary were analyzed through lignin-phenols, pigments and stable isotopic ($\delta^{13}C$ and $\delta^{15}N$) analysis. The variation of concentration and degradation of lignin phenols in sediments is separated in three depths, with higher concentration and lower degradation in the first 80 cm from the surface, lower concentration and higher degradation in the middle of the core (80cm ~ 170cm) and higher concentration and lower degradation from 170cm to 270cm, which are related to different periods affected by human activities respectively. Moreover, the flooding events of the Yangtze River in 1954 and 1998 also could be recognized through the sediment core samples. After the mid-1980s, the sediment load of the Yangtze River has become an essential factor in affecting the discharge of terrigenous organic carbon, due to the building of dams. However, when compared with other research, owing to complicated sediment burial speeds and hydrodynamic conditions, as well as influences brought by vertical mixing in the Yangtze estuary, the effect of terrigenous organic carbon to the carbon cycle in this region should be further studied.

October 23, 11:40 (MEQ-P-10610)

The geochemical signals in the Abandoned Huanghe River Delta surface sediments

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The abandoned Huanghe River Delta is in an erosion period due to the lack of sediment source following the the switch in the course of Huanghe River in 1855. The erosion material from the abandoned Huanghe River Delta is transported to East China Sea by Yellow Sea Coastal Current. 16 surface (0-2cm) sediments from the abandoned Huanghe River Delta were collected in July 2013. Abundance and isotopic signatures of bulk organic carbon and biomarker of terrigenous organic matter (lignin) were used to characterize the sources of sedimentary organic material and to address their degradation and transport processes. The abundance of sedimentary organic carbon (OC) was between 0.05% - 0.48%, total nitrogen (TN) content varied from 0.01% to 0.06% and C/N atomic ratio varied from 8.7-10.2. The sediments were mainly composed of clay and silt in average grain size of 15.2 µm. The abundance of OC exponentially decreased with the increasing sedimentary grain size. The stable isotope signatures of OC ($\delta^{13}C_{OC}$) and TN ($\delta^{15}N$) ranged from -22.2‰ to -24.3‰, 4.5% to 5.8‰ respectively. The sum of vanillyl (V), syringyl (S) and cinnamyl (C) phenols normalized to organic carbon (Λ8) varied from 0.49 to 1.78 mg 100 mg OC $^{-1}$, the S/V ratio was 0.2-0.7 and C/V ratios was 0.1-0.3 throughout the study area. Terrigenous organic matter abundance was higher than that in the modern Huanghe River Delta but lower than that in the Changjiang Estuary, while interclass ratios $(Ad/Al)_V$ (acid/aldehyde ratio of vanillyl phenol) were highest among the three.

POC Contributed Paper Session

Day 1

October 20, 09:00 (POC-P-10840)

The development of a high resolution global ocean surface wave-tide-circulation coupled model

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A global surface wave-tide-circulation coupled model with horizontal resolution of 0.1°×0.1° and 54 layers in the vertical is developed. Both the breaking and non-breaking surface wave induced vertical mixing are coupled with the ocean circulation model, MOM5 and the sea ice model,SIS. Eight tidal components are coupled with MOM5. Model validation suggests that surface waves play a key role in the upper ocean, while tidal currents are important for coastal areas. The coupled model has a much better performance than models without coupled processes. This is the first time a global ocean circulation model has included surface waves and tides simultaneously.

October 20, 09:20 (POC-P-10364)

Global distribution of mergers and splits of oceanic mesoscale eddies

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The global distribution of mergers and splits of mesoscale eddies was investigated through analysis of a 20-year time series of satellite altimeter data. A neighbor enclosed area tracking algorithm capable of detecting mergers and splits of mesoscale eddies was applied to track each eddy identified using the Okubo–Weiss parameter. The frequency of eddy mergers and splits varied among areas. Both mergers and splits frequently occurred in areas of western boundary currents and their extensions, areas of subtropical counter currents, the Indian Ocean, the North Pacific southeastern subtropical region, and the Antarctic Circumpolar Current region. The ratio of the minimum distance between like-signed (or opposite-signed) eddies to the radius of the eddies may be one factor determining the distribution of mergers and splits of oceanic mesoscale eddies.

October 20, 09:40 (POC-P-10692)

Tomographic mapping of nonlinear tidal and residual currents

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Depth-averaged current data, which were measured by coastal acoustic tomography (CAT) from July 12 to 13, 2009 in Zhitouyang Bay, China, are used to estimate tidal currents of M_2, M_4 and M_6 (hereinafter, M_{2_har}, M_{4_har} and M_{6_har}). The ratio of the spatial mean amplitudes of M_{2_har}, M_{4_har} and M_{6_har} is 1.00 : 0.15 : 0.11. The shallow-water equations of M_2 are used for analyzing the generation mechanisms of M_4 and M_6. The ellipses of M_4 obtained from the advection terms have the same magnitudes of semi-major and semi-minor axis lengths as M_{4_har} (i.e. 0.15 and 0.04 m s^{-1}, respectively), indicating that advection terms are important to generate M_4. However, the vector correlation coefficient of the semi-major and semi-minor axis lengths () is 0.2 (varies between 0.0 and 2.0, and is high correlation), which means M_4 is also generated by other factors. The ellipses of M_6 obtained from the nonlinear quadratic friction terms are similar to M_{6_har}, with = 0.6, indicating that the friction mechanisms are predominant for generating M_6. In addition, a dynamical analysis of the residual current, using the tidally averaged momentum equation, shows that the spatial mean magnitudes of the averaged horizontal pressure gradient and the advection of the residual currents account for about 75% of the tidally averaged advection of the tidal currents, indicating that the residual currents are induced by the tidal currents. This is the first report on nonlinear tidal currents measured by CAT.

Keywords: Nonlinear tidal currents, residual currents, generation mechanisms of M_4 and M_6, Coastal acoustic tomography;

October 20, 10:00 (POC-P-10446)

ADCP measurements in the Discovery Islands, British Columbia, Canada

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Since 2010, nine acoustic Doppler current profiler (ADCP) moorings have been deployed throughout the Discovery Islands, British Columbia (BC). Situated between east-central Vancouver Island and the BC mainland, this area is characterized by a complex network of narrow channels and deep fjords that contain some of the strongest tidal currents in the world. Seasonally changing freshwater discharges, winds, and interactions with the Strait of Georgia to the south and Queen Charlotte Strait to the north, are also major contributors to the currents. As the region lies along the main migration route of Fraser River sockeye salmon and is home to a large Atlantic salmon farming industry, there is considerable interest in monitoring and tracking the transfer of pathogens between these fish. In this study we will present an analysis of the ADCP time series and attempt to characterize the predominant flow patterns. Results will be used to evaluate an ocean circulation model and to establish credibility for subsequent water-borne disease transmission studies.

October 20, 10:20 (POC-P-10726)

Structure and formation of the South Yellow Sea water mass in spring

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Data obtained from over 250 CTD stations in December 2006 and April 2007 were used to analyze the temperature and salinity structure of the water masses of the South Yellow Sea in spring. Six basic water masses were identified: the Southwest Yellow Sea Coastal Water Mass (SWYSCWM), Southwest Yellow Sea Local Water Mass (SWYSLWM), Qingdao Cold Water Mass (QDCWM), Yellow Sea Warm Current Water Mass (YSWCWM), Inchon Cold Water Mass (ICWM), and Subei Coastal Water Mass (SBCWM). The mechanisms of formation of these water masses are very different. The SWYSCWM is affected by continental water, whereas the SWYSLWM and SBCWM are local water masses that are less affected by other waters. The QDCWM derives from cold northern water. (The Yellow Sea Warm Current (YSWC) is also present during spring.) Because of the limited data coverage, the mechanism of formation of the ICWM remains unclear.

October 20, 11:00 (POC-P-10384)

Extracting fronts from chlorophyll and SST satellite data and analysing the relation between them

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We calculated fronts of chlorophyll and sea surface temperature (SST) in the North Pacific based on the Sobel and Canny algorithms. We then compared the results from the two algorithms to find the differences and similarities between them. The results using the Sobel algorithm reveal the real values and directions of the fronts but the results using the Canny algorithm do not show the true gradients of the fronts because standardization was used in the computational process of Canny algorithm. However, the fronts from the results of the Canny method are more accurate and more continuous so we used the fronts from Canny algorithm to make comparisons in the squid fisheries. Using four seasonal quarterly averaged MODIS data for 2013, we calculated fronts of chlorophyll and SST in the North Pacific and analyzed the features of these fronts. The fronts then were compared with the squid catches for the same period. The results reveal that the squid catches were usually abundant in places where the SST fronts were very active and plentiful. At the same time, these places are located at the edge of the area where the chlorophyll fronts were plentiful. These places were all close to 40°N and between 150°E and 160°E. In order to verify the above results, we used monthly averaged MODIS data for July, August, September, and October in 2010 and 2012 to calculate the SST and chlorophyll fronts. We then compared the fronts with the squid catches of the North Pacific in the same period and got the same results as those for 2013.

October 20, 11:20 (POC-P-10727)

Submesoscale eddy structures in the South China Sea

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Submesoscale structures play a vital role in the oceanic vertical exchanges of tracers and may be an important mechanism of the nutrient supply in the eutrophic layer. Using high-frequency sampled ADCP data and CTD profiles, the submesoscale structure of a transect across an anticyclonic eddy in the northern South China Sea (SCS) has been well investigated. The relative vorticity and the strain field are both enhanced immediately inside and outside the periphery of the eddy due to strong lateral velocity shear, where elevated buoyancy frequency is found in the mixed layer. The authors show that the submesoscale ageostrophic circulation that develops in response to the strain-induced divergence is responsible for this restratification in the mixed layer and can contribute to the vertical pump, particularly on the periphery of the eddy. This conclusion is also confirmed by an array of numerical experiments with 1 km and 5 km resolutions in the SCS and Gulf of Mexico regions, respectively. The results of this study, for the first time, provide observational evidence for the impact of the submesoscale processes on the oceanic vertical pump and mixed layer restratification associated with a mesoscale eddy as predicted by Surface Quasi-Geostrophic (SQG) theory and many previous numerical studies.

October 20, 11:40 (POC-P-10362)

Subsurface hydrographic structures and the temporal variation of Aleutian eddies

Rui **Saito**[1], Ichiro Yasuda[1], Kosei Komatsu[1], Hiromu Ishiyama[2], Hiromichi Ueno[2], Hiroji Onishi[2], Takeshi Setou[3] and Manabu Shimizu[3]

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Aleutian eddies are mesoscale anticyclonic eddies formed within the Alaskan Stream (AS) area between the 180° meridian and 170°E south of the Aleutian Islands. They propagate southwestward, isolated from the influence of AS, and pass through the Western Subarctic Gyre (WSG). We compared hydrographic structures of three Aleutian eddies observed during summer, west of 170°E (eddy A) and east of 170°E (eddies B and C). In each eddy, subsurface dichothermal (temperature minimum) water (3.0−4.0°C) was observed above subsurface (temperature maximum) mesothermal water (4.0−4.5°C). The minimum temperature in the dichothermal water at 100 m depth was lower in eddy A (2.8°C) than in eddies B and C (3.0−3.2°C). This difference could be ascribed to wintertime cooling and influence of surrounding waters during springtime warming. Wintertime cooling makes the dichothermal water cooler for a longer time for eddies isolated from the AS. Particle tracking experiments using a data-assimilative eddy resolving ocean model suggested that the dichothermal water within eddy A was cooled by entrainment of surrounding subarctic colder water even during springtime warming. The mesothermal waters at 250 m depth demonstrated similarity among the observed eddies. The maximum temperature in the mesothermal water within eddy A (4.3°C) was close to the temperature of eddies B and C (4.2°C) in the in-situ observations. These results indicated that the dichothermal water of Aleutian eddies modifies over time, whereas the mesothermal water maintains the original features as they propagate westward from the AS area to the WSG.

October 20, 12:00 (POC-P-10527)

An improved wave-induced mixing parameterization in the Great Lakes

Wei **Hu**[1], Jia Wang[2], Conghua Cao[1], Juan Huang[1], Xueming Zhu[3] and Haoguo Hu[2]

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Based on the 3/2 power law (Toba, 1972), an improved wave mixing parameter scheme is deduced for wind waves from the formula proposed by Hu et al. (2004) and Hu & Wang (2010). By fitting 63,718 measurements from nine NDBC mooring buoys in the Great Lakes from 2011 to 2013, a relationship between wave age (β) and friction velocity (u^*) is obtained to make the wave mixing coefficient a the function of u^* only. Comparing with wave age and wave steepness dependent wave mixing coefficients (Hu and Wang, 2010), the newly proposed relationship is more accurate and more convenient to use in ocean models without running a sophisticated wave model.

POC Contributed Paper Session

Day 2

October 23, 09:00 (POC-P-10725)

The structure of regional climate variability in the Far-Eastern Seas

Elena I. **Ustinova** and Yury D. Sorokin

Presented by Yuri Zuenko on behalf of Elena Ustinova

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In this study, we investigated the structure and evolution of regional climate variability in the Far-Eastern Seas using regional data sets based on historical observations. The main components of climate variability were analyzed: regimes and regime shifts, trends, quasi-periodical components (as an example, quasi-pentadecadal and decadal oscillations), extreme events and changing relationships between large-scale and regional-scale climate processes. Quasi-periodical components of regional climatic variability have a self-oscillating nature of hemispheric and basin scale, as well as a geophysical nature (for example, 18.6-year cyclicity is associated with long-term fluctuations of the “lunar tide”). The well-known 1988/89 regime shift is associated with the sharp weakening of the Siberian High and its influence on the Japan/East Sea. The nature of the recent shift of 2003/2004 in the Okhotsk Sea is not quite clear yet. As a rule, extreme events are the result of a combination of large-scale factors (for the Japan/East Sea, the large-scale factor is mainly the intensity of winter and summer monsoons) and regional specificities. The variations in intensity and shifts of cyclone trajectories in the zonal and/or meridional direction played an appreciable role in the Far-Eastern Seas, especially in the cold season (from November to March). For marine ecosystems, all of these types of the variability are important. However, we consider that the regime shifts and extreme events played a more “dramatic” role because of limited adaptive capacity of living organisms to high rates of change.

October 23, 09:20 (POC-P-10728)

Procedures for correcting *in situ* CTD data and results obtained during the NEAR-GOOS Cross-Basin Climate Monitoring Section project

Dmitry Kaplunenko[1], Aleksander Lazaryuk[1,2], Vyacheslav Lobanov[1], Sergey Sagalaev[1], Sho Hibino[3] and Toshiya Nakano[3]

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3 Japan Meteorological Agency (JMA), Japan

The Cross-Basin Climate Monitoring Section is a joint Japan-Russia pilot project implemented by the Japan Meteorological Agency (JMA) and the V.I. Il'ichev Pacific Oceanological Institute (POI) in the Japan Sea in 2011 as a part of a North East Asian Regional Global Observing System (NEAR-GOOS) activity. It consists of two coupled CTD sections covering the central part of the sea and located in Japanese (PM-line transect) and Russian (134E section) EEZs, and implemented correspondingly by the R/V *Keifu Maru and* R/V *Akademik M.A. Lavrentyev.* Because of different instruments used by each group, post-cruise data corrections were necessary before conducting the joint data analysis. Here, we discuss an approach to obtain high accuracy data on the vertical distribution of oceanographic parameters (temperature, salinity, oxygen parameters) in the water basin with stable homogeneous characteristics during CTD profiling. The high accuracy of these parameters is necessary for assessment of climate change in the Japan Sea and World Ocean. Each measured parameter can be corrected depending on the sensor type and its individual peculiarities. The considered type of sensors are SBE3plus (temperature), SBE4C (conductivity-salinity), SBE43 and RINKOIII (oxygen). We used a platinum thermometer SBE35 to check and correct temperature data. To check the accuracy of conductivity measurements, we used an Autosal salinometer. To prove the hypothesis for the existence and stability of a deep minimum salinity layer in the sea over last 15 years, it is important to correct the CTD data. The results demonstrate a slight but instrumentally significant increase in temperature in the deep bottom adiabatic layer with a corresponding decrease in oxygen due to a weakening of ventilation processes in the study area.

October 23, 09:40 (POC-P-10435)

Filtering methods for detecting ocean striations

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We present a comprehensive study on the effectiveness of different detection approaches to unveiling ocean striations. Three one-dimensional filtering methods: Gaussian smoothing, Hanning and Chebyshev high-pass filtering, are used to analyze Simple Ocean Data Assimilation (SODA) data and LICOM model outputs. The first two methods have been used in many previous studies; on the other hand, the use of the Chebyshev filter is new for this purpose. Our results show that all three methods can reveal ocean banded structures, but Chebyshev filtering is the best choice. The Gaussian smoothing is not a high-pass filter, so it merely brings regional striations, such as those in the Eastern Pacific, to light. The Hanning high-pass filter introduces a northward shifting of stripes, so it is not as good as the Chebyshev filter.

October 23, 10:00 (POC-P-10380)

On specifics and effects of processes in stratified bottom layers in the shelf zone of the sea

Vadim **Navrotsky**, Valeriy Liapidevskii, Viacheslav Lobanov, Elena Pavlova and Fedor Khrapchenkov

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Shelf zones are sites of very active physical and biological interactions between land and ocean. The most important part of these interactions is concentrated in bottom boundary layers (BBL), where the main exchange of physical and chemical properties and re-suspension of sediments take place. Our complex experiments and observations in the shelf zone of the Japanese Sea reveal several important features which need thorough modeling. In the present paper we analyze some of them: 1) Temporal intermittence of internal waves (IW) in near-bottom layers and their transformation into sequences of stratified boluses moving in a non-stratified medium; 2) Extremely high horizontal and vertical velocities in the near-bottom layer evidently caused by a surfing of IW and boluses; 3) Considerable power fluctuations caused by correlated fluctuations of near-bottom pressure and velocity; and 4) Non-monotonic vertical structure of temperature and velocity leading to the possibility of simultaneous quick energy dissipation due to IW breaking and secondary generation of high-frequency IW in quasi-homogeneous layers due to high curvature of velocity profiles. All these processes contribute to the effective vertical and horizontal exchange of nutrients and biological matter and so are important drivers of enhanced productivity in the shelf and adjacent waters.

October 23, 10:20 (POC-P-10858)

Seasonal variation of coastal currents in the East/Japan Sea

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An ocean buoy station (ESROB: East Sea Real-time Ocean Buoy) maintained for 17 years in a water of 130 m deep at 37˚32.33'N, 129˚12.87' offers an opportunity to investigate seasonal variation of boundary current off the mid-east coast of Korea. 5 CTD sensors (5, 20, 40, 60, 130 m) and surface mounted downward looking ADCP measure temperature, salinity, and current over the entire water column. The climatological monthly averaged alongshore current from 6-year long data show that the alongshore current is characterized by a summertime flow reversal (from June to September) in the upper 60 m. We investigate the reason for this flow reversal based on depth-averaged currents. The 6-year mean depth-averaged alongshore current is northwestward and its magnitude is 1.6 ± 0.6 cm/s (standard error). The depth-averaged alongshore current shows high temporal variability with its maximum (minimum) value of 40.2 (-44.2) cm/s and standard deviation 10.1 cm/s for 40-hour low-pass filtered data. The harmonic analysis shows that the amplitude of annual harmonic component of the alongshore current is 4.3 ± 2.6 cm/s (95% confidence interval) and the seasonal variation of the depth-averaged alongshore current explains 8.3% of total variance of the low-pass filtered currents. A flow reversal from the northwestward current to southeastward current occurs and low density water emerges below the seasonal thermocline in summer. The seasonal variation of alongshore sea level difference implies that the summertime reversal of the alongshore current arises from the reversal of the alongshore pressure gradient. A simple depth-averaged analytical model further shows that the reversal of the alongshore pressure gradient is due to changes in wind stress curl. We also found that the low density water which occupies the East Korea Bay (EKB) in summer is another source of the reversal of the alongshore pressure gradient. The low density water from the EKB due to warm freshwater from rivers and shelf water is carried by southeastward current along the coast, which explains the observed low density water below the seasonal thermocline at the ESROB in summer. From these results, summertime boundary current system off the mid-east coast of Korea will be suggested with its large-scale implications of the East/Japan Sea upper circulation.

HAB Section Meeting

October 17, 11:15 (HAB-S-10660)

Emergency monitoring and forecasting system of green tide in the Yellow Sea

Peng **Zhao**[1], Jingtian Guo[1], Juan Huang[1], Ruifu Wang[2] and Liang Zhao[3]

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To carry out emergency response for Green Tide disaster individualized, oceanographic satellites are used in emergency monitoring, and SAR data provides complementary monitoring for night and cloudy day. Based on the satellite data, the characters of distribution of green tide is analyzed. Besides, high-resolution meteorological and oceanic numerical models as well as Green Tide trajectory forecasting system has been developed. The models are optimized with nesting technique and zooming in area where Green Tide happens frequently. Moreover, GTS, oceanic station and buoy data are assimilated into the model with 3D-Var method to improve the forecasting accuracy. An operational Green Tide prediction and early warning platform in Yellow Sea has been established and implemented preliminary operation in North China Sea Forecasting Center of SOA (State Oceanic Administration). This platform comprises of Green Tide information collection, trajectory prediction and production publication.

October 17, 11:30 (HAB-S-10547)

Prey cells and extraction trigger DSP toxin production by *Dinophysis acuminata*

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As a causative species of diarrhetic shellfish poisoning (DSP) and/or pectenotoxins (PTXs), the physiology and toxicology of *Dinophysis acuminata* have been widely studied. However, the role of *D. acuminata* prey on this organism's toxicity and physiology has not been well studied. Therefore, we conducted a series of experiments to investigate how the prey organisms, *Mesodinium rubrum* and *Teleaulax amphioxeia,* or organic material extracted from them, influenced the growth and toxin production of *Dinophysis*. Our results showed significant growth of *D. acuminata* (0.12 /d) when fed with an *M. rubrum* extract. The highest growth rate and cell density of *Dinophysis* were observed in mixed cultures containing live *M. rubrum* cells and debris. *D. acuminata* did not grow in cultures containing either intact *T. amphioxeia* cells or its debris. Cellular okadaic acid (OA) concentrations were significantly greater in cultures containing live *M. rubrum* cells and their debris, compared to those treatments with the same amount of prey cells alone. OA, DTX1 and pectenotoxin-2 (PTX2) were released in significant amounts in the medium containing prey cells and/or debris, compared to mono-cultures of *D. acuminata*. At the end of the incubations, dissolved toxin concentrations of OA, DTX1 and PTX2 in the treatments with prey cells and/or extraction addition on average reached 1.44 (OA), 1.20 (DTX1), and 11.37 (PTX2) ng/mL, respectively, compared to 0.37, 0.24, and 3.97 ng/mL in the monoculture of *Dinophysis*. The high amount of excreted DSP toxins indicated that the addition of prey cells or organic extracts, from both ciliates and cryptophytes, trigger additional toxin production in *D. acuminata*.

October 17, 11:45 (HAB-S-10626)

Modelling *Prorocentrum donghaiense* blooms in the coastal waters of the East China Sea

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Algal blooms caused by *Prorocentrum donghaiense* have occurred frequently in the East China Sea (ECS) during the spring in recent years. A coupled biophysical model was used to hindcast a massive *P. donghaiense* bloom that occurred in this area. The model consists of the Regional Ocean Modeling System (ROMS) tailored for the ECS using a multinested configuration, and a population dynamics model for *P. donghaiense*. Comparisons are made between simulations and observations, revealing that the biological model is capable of reproducing the characteristics of *P. donghaiense* growth under different irradiances and phosphorus limitation scenarios. The variability of intracellular P and the effects of *P. donghaiense* on ambient nutrients are also reproduced. The coupled model hindcasts the hydrodynamics and the spatiotemporal distributions of *P. donghaiense* bloom reasonably well. Model hindcast solutions are further used to diagnose the factors controlling the vertical distributions, especially the subsurface presence, of the bloom. Phosphate appears to be the dominant factor controlling the evolution of the *P. donghaiense* bloom. In addition, surface wind fields play an important role in distributing *P. donghaiense* populations.

October 17, 12:00 (HAB-S-10661)

HAB monitoring in Paris Bay (the north-western part of the East/Japan Sea) where marine mammals are kept in captivity

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Paris Bay is located in the eastern part of Russky Island (43º00’27”–43º01’50”N, 131º54’20”–131º55’51”E,) in Peter the Great Bay in the northwestern part of the East/Japan Sea). Net pens with beluga whales *Delphinapterus leucas* are located in the inner part of the bay. Monitoring of HAB species started in 2013 to determine their potential effects on these marine mammals. Eleven species of potentially toxic phytoplankton belonging to 2 groups: diatoms and dinoflagellates were found from January to December. Species of the *Pseudo-nitzschia* and *Dinophysis* genera were present year round in Paris Bay. *Pseudo-nitzschia* species were one of the main phytoplankton observed in autumn; *Dinophysis* species dominated in summer. Comparison of species composition and dynamics of the phytoplankton in the bay entrance and the interior part of the bay showed no difference. Our study did not reveal any influence of nutrient inputs from the captive marine mammals on the water quality of Paris Bay, however the effect of environmental factors (including toxins from harmful algal blooms) on marine organisms is indisputable. Potentially toxic species of phytoplankton are present all year in Paris Bay. Their predominance in summer and autumn pinpoints the necessity to continue phytoplankton monitoring in order to better understand their influence on marine mammal health.

October 17, 12:15 (HAB-S-10533)

Karenia mikimotoi bloom, massive fish-killing and shellfish-killing in the East China Sea

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Large-scale *Karenia mikimotoi* blooms have occurred frequently and severely damaged aquaculture as a both fish-killing and shellfish-killing species in the East China Sea. The *K. mikimotoi* was found to have short-term lethal effect to fish due to gill impairments, and various detrimental impacts to different organisms such as copepod *Clanus sinicus* and rotifer *Brachionus plicatilis*, as well as mammalian cell lines. The *K. mikimotoi* outbreak in 2012 also caused massive mortality of abalone, *Haliotis discus hannai*, and more than 330 million dollars loss in Fujian Province in the East China Sea. Mechanisms of *K.mikimotoi* affecting the abalone *Haliotis discus hannai* were also studied under the laboratory conditions. The effects of *K. mikimotoi* on the survival of the abalone at different environmental conditions were investigated and found that the rapid mortalities of abalones were caused by the detrimental effects of *K. mikimotoi* cells, furthermore, the low oxygen condition made the toxic effects stronger. Exposure to *K. mikimotoi* also caused the shrink and deformation of afferent and efferent branchial vessel in the gill, and also induced the disruption of the gill lamella. The major protein enzyme (including Na^+-K^+-ATP, Ca^{2+}-Mg^{2+}-ATP), and antioxidant enzymes (SOD and CAT) of the abalone gill also showed inhibited activities.

W1: Workshop
Contrasting conditions for success of fish-killing flagellates in the western and eastern Pacific – A comparative ecosystem approach

October 15, 09:00 (W1-10777), Invited

Fish-kill dinoflagellates in Korean coastal waters – A comparative ecosystem approach

Changkyu **Lee**

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HAB (Harmful algal blooms) caused by flagellates have had severe impacts on fisheries along the Korean coastline since the 1980s. In particular, HAB caused by the fish-kill flagellate, *Cochlodinium polykrikoides,* have become annual and persistent occurrences since the mid 1990s. There is clear evidence of contrasting occurrences and impacts of fish-kill flagellates in Korean coasts. Data describing these fish-killing flagellates provide a unique opportunity for east-west Pacific comparisons to identify and rank those environmental factors that promote harmful algal bloom success at different times. Here, I focus on the fish-killing species, *Cochlodinium polykrikoides, Heterosigma akashiwo and Chattonella* that historically have caused fisheries damage in the eastern and/or western Pacific. I present the available dataset on these 3 genera from the 1990s to the present on the following parameters: HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, stratification, nutrients, wind, river flow, upwelling indices, and a suite of other environmental parameters associated with these problems. Together with other workshop participants, I will evaluate the trends and patterns in these data to develop hypotheses for the initiation, development, and abatement of these HABs.

October 15, 09:45 (W1-10811), Invited

Comparing physiologies and toxicities in *Heterosigma akashiwo*: An east-west perspective

Charles G. **Trick**[1,2]

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As a fish-killing flagellate, the raphidophyte, *Heterosigma akashiwo,* has a rich and somewhat negative history in many communities around the globe. When blooms occur, H. akashiwo causes significant losses in economic resources – primarily natural and farmed fish. Yet in other areas, *H. akashiwo* blooms are just aesthetically unappealing and there are no recorded toxic events. Here, we will consider the variation in environmental factors and ecophysiological potentials of *H. akashiwo* cells from east and western nations of the North Pacific to ascertain if the differences in toxicity can be correlated with differences in physiological drivers – or if the populations are fundamentally different in toxicity potentials. While based on published works, the presentation will encourage the contributions of personal research experiences to ask if there are definable difference in the stages of bloom formation: bloom development, bloom maintenance and toxicity.

October 15, 10:50 (W1-10654)

Heterosigma akashiwo bloom and associated environmental conditions in Cowichan Bay, Canada in 2014

Svetlana **Esenkulova**[1], Chrys Neville[2] and Isobel Pearsall[1]

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A *Heterosigma akashiwo* bloom was observed in June 2014 in Cowichan Bay, Canada. Here we present phytoplankton data (composition, abundance) and associated environmental parameters (i.e. sea surface temperature and salinity, cloud cover, tide type and height, dissolved oxygen, weather conditions) collected from the beginning of May to late July. On average, samples and measurements were taken 2-4 days a week at 4-8 locations in Cowichan Bay during beach and purse seining.

During the *H. akashiwo* bloom, juvenile salmon captured by beach seine did not exhibit unusual behavior; however, Chinook juveniles caught by purse seine displayed lethargic behavior as well as a dramatic (25 fold) increase in mortality of individuals after a PIT-tagging procedure.

October 15, 11:10 (W1-10771)

Fish-kill flagellates in the Salish Sea –A comparative ecosystem approach

Vera L. **Trainer**[1] and Nicola Haigh[2]

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There is clear evidence of contrasting occurrence and impacts of fish-killing fish-killing flagellates in the Salish Sea, a body of water that spans the border of the western U.S. and Canada. Data describing these fish-killing flagellates provide a unique opportunity for east–west Pacific comparisons to identify and rank those environmental factors that promote harmful algal bloom (HAB) success at different times. Here we focus on the fish killing species — *Heterosigma akashiwo* and *Cochlodinium*—organisms that historically have had economic impacts on fisheries in the U.S. and Canada. We present here the available dataset on these 2 genera from the 1990s to the present on the following parameters: HAB species presence, maximum abundance, toxicity, optimal conditions for growth, time of year, temperature range, salinity range, stratification, nutrients, wind, river flow (flooding), upwelling indices, and a suite of other environmental parameters associated with these blooms. Together with other workshop participants, we will evaluate the trends and patterns in these data to develop hypotheses for the initiation, development, and abatement of these HABs.

October 15, 11:30 (W1-10803)

Biological characteristics of the red tide causing raphidophytes *Heterosigma akashiwo* and *Chattonella* spp. in the coastal Sea of Japan

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The harmful raphidophytes *Heterosigma akashiwo* and *Chattonella* spp. (*C. antiqua*, *C. marina* and *C. ovata*) have long caused red tides in Japanese coastal waters. They have a cyst stage in their life cycle that settles to the sea bottom to overwinter and thereby ensures the persistent existence of these organisms in the same area. The germination of cysts provides the inoculum for blooms to overlying waters, leading to great regularity of blooming seasonality.

Vegetative cells of *C. antiqua* and *C. marina* originate from the germination of cysts in the bottom sediments in early summer when temperature reaches an adequate level of ca. 20°C. The cells multiply asexually during the summer (optimum temperature of 25°C). Cysts are formed when conditions are unfavourable, such as during nutrient depletion. The cysts spend a period of spontaneous dormancy at the sea bottom until the following spring. In spring, most cysts complete a period of spontaneous dormancy and acquire the ability to germinate. However, they must undergo a post dormancy period (enforced dormancy) because the temperature is too low for germination.

H. akashiwo vegetative cells can overwinter in the water column, but *H. akashiwo* also has benthic cysts. The germination of cysts was not observed at 5°C, low germination was observed at 10°C, and the optimal temperature for germination was ≥15°C. Temperature is a crucial factor for excystment and initial growth occurs just after germination. The great regularity of the spring bloom of *H. akashiwo* in Japanese coastal waters suggests that the seed populations are excysted cells that are greatly affected by bottom temperature (optimal at ≥15°C), and that population growth is affected by surface temperature (favourable at ≥18°C), allowing high growth rates. It is likely that higher growth rates at higher temperature might result in lower toxicity to aquacultured fish.

It is empirically known that raphidophyte blooms occur when diatoms are scarce in water columns. Diatoms form resting stage cells under nutrient-deficient conditions, and rapidly sink to bottom and disappear from the water columns. Raphidophyte cysts can germinate in the dark, whereas diatom resting stage cells require light for germination. Thus the predominance of raphidophytes might be attributed to the disappearance of diatoms and subsequent failure of germination of their resting stage cells under low light conditions. Thus, the selective germination of cysts at the sea bottom, with strong influences from light and temperature, is therefore a significant factor for the initiation and success of raphidophyte red tides.

October 15, 11:50 (W1-10808)

Fish-killing Heterosigma akashiwo blooms in Chinese coastal waters

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Heterosigma akashiwo blooms were first recorded in Dalian Bay in 1985. Since then, about thirty bloom events of *Heterosigma akashiwo* have been registered and bloom frequency has increased along China coastal waters. This species mainly has formed blooms in the Bohai Sea and the Yellow Sea but has expanded recently to other China coastal waters. However, *poor* records of this organism are available from the East China Sea (ECS), in part due to its fragile small cells and difficulty to identify. The bloom dynamics of this species are not well understood. During the Chinese Ecology and Oceanography of Harmful Algal Bloom (CEOHAB) cruise in 2011, two strains of flagellates were isolated, which co-occurred with *Prorocentrum donghaiense* blooms in the ECS. The bloom causing species was confirmed as *Heterosigma akashiwo* by using its morphological and molecular characteristics. The bloom patterns were related strongly with stratified water systems in the East China Sea in the spring of 2011.

October 15, 12:10 (W1-10810)

Raphidophytes in the coastal waters of Far East of Russia during the latter period of the last century

Tatiana V. Morozova and Tatiana Yu. **Orlova**

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Raphidophytes were common and abundant algae in coastal waters of Far East of Russia in the late twentieth century. In October 1987, at water temperature 13–14°C, a "red tide" of brick-red color was observed in Amur Bay (Peter the Great Bay, the Sea of Japan). It was caused by *Chattonella* sp. with a maximum density reaching 15 million cells per liter. During this bloom, fish mortalities were observed in the bay. During phytoplankton monitoring in the Peter the Great Bay in 1990 and 1991, four species of Raphidophyta were found, namely *Chattonella globosa*, *C. marina*, *Fibrocapsa japonica* and *Heterosigma akashiwo*. *C. globosa* and *C. marina* were observed from July to September at a salinity of 25-30 ‰ and a water temperature of 19–22.7°C. A maximum abundance of raphidophytes was registered in August at a temperature of 21°C during bloom of *Chaetoceros salsigeneum* - 54 x 10^3 cells per liter for *C. globosa* and 740 cells per liter for *C. marina*. *H. akashiwo* was observed from June to October, with a maximum density of 24 x 10^3 cells per liter in July at a temperature of 19.3°C. Year-round plankton monitoring in Avachinskaya Guba Inlet (Pacific coast of Kamchatka) in 1987–1988 showed that *H. akashiwo* occurred from April to October at abundance of 5 – 70 x 10^3 cells per liter in water temperature from 1 to 15°C.

October 15, 14:00 (W1-10459)

Testing several hypotheses on the outbreak mechanisms of *Cochlodinium polykrikoides* blooms in the southern coastal waters of Korea

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Harmful *Cochlodinium polykrikoides* blooms have continuously occurred and caused large damage to the fishing industry since 1995 in the southern coastal waters of Korea. Earlier studies hypothesized that the environmental factors associated with outbreaks of *C. polykrikoides* blooms include water mass stratification, nutrient input through precipitation, solar irradiance and wind. These studies, however, have limitations in that the analysis focused only on specific incidences so that require more rigorous verification. In the present study, a comparative analysis using meteorologic and oceanographic survey data (2000-2014) was conducted to see if the hypotheses could consistently explain bloom outbreaks at different locations. The analysis indicated that none of the proposed factors explained *C. polykrikoides* bloom outbreaks for the whole study period, and that critical factors differed by region. For example, precipitation showed a significant correlation with the outbreak duration in Yeosu for the period 1996-2003 but not for the whole period (1996-2014). Likewise, wind (direction and speed) and front formation explained incidences in only certain areas and in some years. These analyses suggest that the actual outbreak mechanisms are complicated and consist of multiple pathways that can alternate depending on the balance of many factors working in sequence rather than simultaneously.

W2: Workshop
Identifying major threats to marine biodiversity and ecosystems in the North Pacific

October 16, 09:00 (W2-10603), Invited

IPBES Asia-Pacific regional/subregional assessment on biodiversity and ecosystem services

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The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established in 2012 with the aim of strengthening the interface between science and policy on biodiversity and ecosystem services to promote conservation, protect biodiversity and long-term human well-being and maintain sustainable use and development. The IPBES focuses on four priorities, 1) generating new knowledge by engaging in dialogue with key scientific organizations and policymakers, 2) scientific assessments including regular regional/subregional and global assessments, 3) capacity building for strengthening the science-policy interface, 4) support policy formulation by identifying policy- relevant tools and methodologies. In order to strengthen science-policy platform, the IPBES work program in 2014-2018 sets up four objectives and 16 associated deliverables. The IPBES Technical Support Unit for Asia and the Pacific regional/subregional assessment on biodiversity and ecosystem services (TSU-IPBES-AP) was established May 2015 in the Institute for Global Environmental Strategies, Japan. The IPBES-TSU-AP provides technical and operational support to complete the assessment reports (organising authors meetings, technical support for the drafting, coordination with the secretariat and relevant organisations etc.). The first authors meeting, attended by about 130 participants, including co-chairs, coordinating lead authors, lead authors and IPBES Secretariats, was held in mid-August 2015 to discuss overall content of the Asia-Pacific assessment, the detailed scope and contents of each chapter, and to identify necessary data and knowledge to complete the draft. After reviews and revisions of the draft, the assessment report and a summary for policy makers will be completed by the first quarter of 2018.

October 16, 09:25 (W2-10664)

Regional report on the impact of major threats to marine biodiversity in the NOWPAP region

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In 2010, the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity targets were adopted at the tenth meeting of the Conference of the Parties (COP10). In the strategic plan, "Reduce the direct pressures on biodiversity and promote sustainable use" is included as one of strategic goals.

In the Northwest Pacific region, there are many pressures to marine biodiversity. Understanding the current situation and the trend of pressures on marine biodiversity is useful for member states in order to promote their measures for marine biodiversity conservation. From point of this view, NOWPAP CEARAC started a new activity "Pilot assessment on the impacts of major threats to marine biodiversity in the NOWPAP region" for the 2014-2015 biennium. This activity focusses on three pressures, eutrophication, habitat alteration and non-indigenous species, as major threats in the NOWPAP area. The current status of these pressures and its causes are assessed using available data in the selected sea area of the NOWPAP member states, China, Japan, Korea and Russia. The assessment results were summarized as national reports and regional report will be published in the end of 2015.

NOWPAP CEARAC expects this regional report will be useful information for the NOWPAP and PICES member states and also contribute to the regional assessment of biodiversity and ecosystem services planned by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

October 16, 09:45 (W2-10534)

Assessment of the impacts of major threats to marine biodiversity in coastal waters of Yantai and Dalian, China

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Biodiversity is important for the survival and development of human society, affects various aspects of our lives, and is being destroyed by the rapid expansion of modern societies and economies. Changhai County and Changdao County are important island counties in northeast China. Both are famous northern Chinese cities for fishery resources. Changhai and Changdao have established marine fishery and aquaculture as primary industries. They are rich in various biological resources, with abundant fishery yields of shrimp, globefish, flounder, and high aquaculture production of sea cucumber, abalone, scallop, and ark clam. The present study assessed the status of biodiversity and environmental protection in typical coastal zones of northern China and investigated the impacts of socio-economic development on local biodiversity. This analysis was based on long-term data on social economic development in Changhai and Changdao and related studies of the ecological environment during 2004-2013 using the PSR framework, ,. Based on the characteristics of socio-economic and ecological environment states in Changhai and Changdao, indicators were selected for the marine biodiversity assessment framework andbaseline values were set based on the national/industrial standards, statistical yearbook series, and marine environment monitoring datasets. Weight values were calculated with the Analytical Hierarchy Process approach.

The results of marine biodiversity assessment in Changhai showed that the Marine Biodiversity Index reached the maximum at 0.688 and thus matched to level Good in 2007, and declined to 0.500 and level down to Medium in 2012. During the investigated period, the state of marine biodiversity in 2004-2008 was better than that in 2009-2013. The changes of Pressure, State, and Response indices revealed that the trend of Pressure indicator scores showed an obvious decreasing trend, thus suggesting growing pressures on the local ecological environment and marine biodiversity, and raised concerns about potential impacts to biodiversity in Changhai.

The results of marine biodiversity assessment in Changdao showed that the status of marine biodiversity is good. The Marine Biodiversity Index values were above 0.6 and were graded as Good during the whole studied period, suggesting a relatively stable state of marine biodiversity with few fluctuations. The changes of Pressure, State, and Response indices revealed that the trends of Pressure indicators showed some fluctuations, suggesting growing pressures on the local ecological environment and marine biodiversity, and raising concerns about potential impacts to biodiversity in Changdao.

October 16, 10:05 (W2-10739)

Case study of identifying major threats to marine biodiversity in Korean coastal waters

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Marine biodiversity faces various anthropogenic threats including land-based pollution, eutrophication, destructive fishing, loss of physical habitats, invasion of non-indigenous species and global climate change. The objective of this study is to assess and understand the impacts of major threats (eutrophication, non-indigenous species and habitat alteration) on marine biodiversity in Korean coastal water. We are going to introduce case study results from selected sites including Saemangeum area and an overview of factors threatening biodiversity in Korean coastal waters.

October 16, 10:25 (W2-10718)

Potential threats to marine biodiversity and ecosystems in the Russian area of NOWPAP

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Based on data availability on eutrophication, non-indigenous species, and habitat alteration, Peter the Great Bay has been selected as a pilot study area for the assessment of threats to biodiversity. . The river input of contaminants dominates Peter the Great Bay as a whole, but for some parts of the Bay, the wastewater and storm water discharges are the prevailing source of phosphates, ammonia nitrogen and petroleum hydrocarbons. There has been no clearly observed increase in nutrient and COD values in Peter the Great Bay during the last decades. However, in recent years, signs of eutrophication, reflected in oxygen depletion and nutrient enrichment, were observed in the near-bottom waters of Amursky Bay during late summer. Warming of surface water of Peter the Great Bay causes a gradual increase in the number of warm-water alien species from southern areas. It favors the survival of southern migrants entering this region as a result of human-induced introduction. New invasive species may have a negative effect on the stability of local ecosystems. There are three main issues with habitat alteration in Peter the Great Bay: 1) direct elimination of habitats; 2) local changes due to aquaculture activity; 3) wider spatial changes in benthic habitats due to both natural and anthropogenic causes.

October 16, 14:00 (W2-10857), Invited

Threats to marine biodiversity in the Deep Sea: Experience from New Zealand in data-poor situations

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Major threats to biodiversity and deep-sea ecosystems in the Pacific Ocean are reasonably clear: the last three decades have seen the development of extensive commercial fisheries; the next decade is likely to see the advent of mining for seabed minerals; and ocean acidification will increase in the longer term. However, in a region as large and poorly-sampled as the Pacific Ocean, how can these threats be quantified and managed so that biodiversity, and ecosystem structure and function, are protected?

A range of research has been undertaken in New Zealand to support international conservation and management initiatives of the CBD, FAO, and the South Pacific Regional Fisheries Management Organisation. These studies have utilised global and regional environmental and biological datasets to develop a global ecological classification of seamounts, a systematic approach to selecting Ecologically or Biologically Significant Areas (EBSAs), and the identification of Vulnerable Marine Ecosystems (VMEs). Methods such as habitat suitability modelling have been applied to extrapolate from more coastal data to predict species distributions in offshore waters. Combined with information on the distribution of fisheries, mining licences, and climate change predictions, such approaches can provide a basis for ecological risk assessments and spatial management planning. However, a good knowledge of the data sources, an understanding of the limitations of models, and validation studies are needed to improve the confidence of applying such results over large regions of the Pacific.

October 16, 14:25 (W2-10579)

Preliminary study on the connection effects between nearshore islands and the continent in the sea area of Liaoning Province, China and its effects

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With the rapid development of port shipping, seashore tourism, marine aquaculture and reclamation in the coastal area of Liaoning Province, China, some nearshore islands, which play a significant role in maintaining the unique ecological environment of the islands and the ecological balance in shallow waters of Yellow Sea, were connected to continent by bridges, dams and land reclamation. This has exerted strong influences on the islands and their surrounding waters. At present, the lack of systematic information on the connection effects between nearshore islands and the continent (CENIC) impedes targeted protection of the ecosystems and rational utilization of the resources on these islands and their marine waters. In this study a classification system on the forms of connection between islands and continent has been built. Using various approaches including on-site investigation and remote sensing combined with statistical data and other cases, we analyzed the current CENIC in the marine area of Liaoning Province, China.Targeted protective measures and other suggestions have been put forward, such as enhancing surveillance and monitoring, controlling human activities, implementing regulation and restoration, etc. Related research results provide a basis for local management on islands, provide a foundation for conducting additional research on island protection, and offer important practical and theoretical directions to enhance ecosystem protection on the islands and their surrounding marine waters.

October 16, 14:45 (W2-10559)

Unique and vulnerable community assemblies on a shallow North Pacific seamount

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Despite decades of scientific interest and the attention of fisheries, a lack of comprehensive biotic and abiotic spatial data for seamounts makes it challenging to understand the impacts of fishing on ecosystem structure and function. Seamounts are known to support unique taxa and species assemblages that are potentially vulnerable to over-exploitation. In 2012, Cobb Seamount (an unusually shallow seamount, rising to 34 m depth) was studied using multiple underwater vehicles to rigorously survey above 1200 m. Imagery was annotated for biotic and abiotic data. 144 micro- and macro-taxa were recorded, seventeen of which are potential indicators of vulnerable marine ecosystems. While few unknown/endemic taxa were identified, the species assemblages support the hypothesis that seamounts have unique communities. A species distribution model was produced for each taxon and the community analysis of all SDMs demonstrates seamounts support a diversity of unique benthic communities stratified mainly by depth, slope, and rugosity. Cobb Seamount community assemblages vary from those on the deep flanks defined by sparse black corals (Antipatharia spp.) and soft corals (Alcyonacea spp.) with associated squat lobsters (Family Chirostylidae) and thornyheads (*Sebastolobus* spp.) to those that resemble a living carpet on the shallow pinnacle defined by giant rock scallops (*Crassadoma gigantea*) and strawberry anemones (*Corynactis californica*) with associated red urchins (*Mesocentrotus franciscanus*) and Rosethorn Rockfish (*Sebastes helvomaculatus*). Analyses of community structure will aid in understanding seamount ecosystems and in forecasting the response and longevity of anthropogenic impacts on seamount ecosystems and ecosystem services.

October 16, 15:05 (W2-10570)

Distribution of vulnerable marine ecosystem indicator taxa in relation to fishing effort on Cobb Seamount

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The distribution of coldwater corals, sponges, and other structure-forming species have been used in Pacific and Atlantic Oceans to indicate the potential locations of vulnerable marine ecosystems (VMEs), which are defined as areas susceptible to serious adverse impacts of bottom-contact fishing gears. Cobb Seamount, an isolated biodiversity hotspot in the Northeast Pacific Ocean, supports diverse assemblages of coldwater corals and sponges. A recent survey of Cobb Seamount mapped observed occurrences of VME indicator taxa and documented 95 incidences of fishing impacts from 19 transects ranging in depth from 34-1154 m, including entanglement of various fishing gears with corals. To evaluate the potential occurrence of VMEs on Cobb Seamount, we used the spatially-referenced data from this survey to predict the distribution of VME indicator taxa relative to the distribution of commercial sablefish fishing effort from 1996-2010. Specifically, we used a random forest technique to model the spatial distribution of 19 indicator taxa grouped at species, genus or family levels based on sablefish fishing effort and environmental variables derived from a 20 m x 20 m resolution bathymetry raster. These variables included depth, slope, aspect, rugosity, bathymetric position index, and seafloor curvature. The most important predictors of the distribution of VME indicator taxa were depth, rugosity, and slope. However, inclusion of sablefish fishing effort as an explanatory variable significantly improved most models. Sablefish fishing effort was positively correlated with the density and occurrence of VME indicator taxa. Thus, further research is warranted to determine the potential for serious adverse impacts to VMEs on Cobb Seamount.

October 16, 15:25 (W2-10573)

Sustainable deep-sea fisheries and environmental conservation: How can we balance conflicting objectives?

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Seamounts throughout the world's oceans can support diverse and abundant fish communities. Many have been subject to commercial deep-sea bottom trawl fisheries and have exhibited 'boom and bust' characteristics. There is growing concern about the effect of fishing on fragile and vulnerable benthic invertebrate species. In this paper we briefly examine why deep-sea fisheries have generally failed, and recommend that sustainable fisheries require highly precautionary feature-based catch limits, and credible and timely stock assessment advice. Management also needs to consider fishing impacts on the benthic habitat, and while reducing and spreading fishing effort on seamounts is beneficial for fish stocks, it can have a negative effect on the benthos. In order to balance exploitation and conservation, there must be close collaboration between researchers, managers, industry and conservation groups. Elements of spatial management are required, whereby in the case of seamount fisheries, some seamounts are protected before any fishing has occurred. Protected areas should include entire seamounts, and multiple seamounts in a network. A management regime should incorporate closed seamounts, seamounts open for fishing, and management of adjacent slope areas where these are important for the productivity of fish and invertebrate populations.

W3: Workshop
Linking climate change and anthropogenic impacts to higher trophic levels via primary producers

October 15, 09:00 (W3-10786), Invited

Detection and distribution of phytoplankton types: A view from space, and implications for higher trophic levels

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In recent years, new algorithms have emerged for estimating phytoplankton types or phytoplankton size classes from satellites. The algorithms may be classified as abundance-based, which relate abundance of phytoplankton empirically to community structure, or optical-trait-based, which use characteristic features in the optical signatures of particular types of phytoplankton to distinguish them from other types of phytoplankton. Algorithms have been proposed for mapping diatoms, dinoflagellates, *Trichodesmium*, and some harmful algal blooms. Many algorithms have been proposed to map fractions of pico, nano and micro-phytoplankton in the total chlorophyll concentrations derived from satellites, or even to express the size distribution as a continuous function. There is emerging evidence that phytoplankton type present may have implications for higher trophic levels: for example, Cury et al. (2008) suggested that, for the Benguela Current system, the pathway through diatoms led to anchovy and that through flagellates led to sardine. On the other hand, diatoms are said to form an important part of the diet of sardines off the south west coast of India.

October 15, 09:25 (W3-10619)

Seasonal nutrient dynamics in the western Bering Sea

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Intra- and interannual changes in the nutrient content in some regions of the Bering Sea have been shown previously to be affected by climatic state of the North Pacific, and have an impact on mean seasonal primary production rates. The objective of this study is to reconstruct the seasonal changes of dissolved inorganic nutrient content (silica, phosphorus, and nitrogen) in the western Bering Sea. To achieve broad temporal and spatial coverage, nutrient data from VNIRO, TINRO-Center, and NOAA NODC datasets were merged into a single data set. The Bering Sea area was divided into eight regions in accordance with previously documented physical environmental characteristics (e. g. presence of ice, current and frontal systems, and heat-exchange regimes). Combination of data from several earlier and recent surveys allowed us to revise the regional-scale seasonal dynamic of the nutrient field. Despite the lack of winter and spring data for the area, existing data was supported with values of the cold intermediate layer. The analysis provides new results on regional $\Delta Si/\Delta N/\Delta P$ ratios which may be used further for assessment of primary production.

October 15, 09:45 (W3-10507)

Collapse of summer biological activity in the East China Sea during 1998-2014

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The purpose of this study is to use satellite data to investigate climatological variations from the temporal and spatial surface chlorophyll concentration and to understand the physical mechanisms that affect the distribution of chlorophyll in the East China Sea (ECS) during 1998-2014. A linear trend analysis of chlorophyll data reveals that the spring bloom was enhanced in most of the ECS, while summer and fall blooms were weakened. The increased spring (Mar. - May) chlorophyll was associated with strengthened winter (Dec. - Feb.) wind that probably provided more nutrient into the upper ocean from the deep. The decreased summer (Jun. - Aug.) chlorophyll in the northern ECS were related to one or more factors such as river runoff, wind pattern, SST (stratification of the water column), and limited nutrient supply. First, although summer chlorophyll variations during the 17-year record were well correlated with the area influenced by the Changjiang River discharge, their variations were not linearly correlated with river discharge after 2003. Second, spatially different patterns of chlorophyll were better related to spatial variations of wind-direction than the amount of river discharge during the summer season. Third, the decreased summer chlorophyll seemed to be related with nutrient limitation. However, the decreased fall (Sep. - Nov.) chlorophyll was associated with weakened winds that tended to entrain less nutrient into the upper ocean from the deep. This study suggests that phytoplankton in the ECS changed differently due to seasonally and regionally dependent responses to environmental forcing.

October 15, 10:05 (W3-10736)

Effects of Changjiang Diluted Water on the planktonic ecology of the Yellow Sea Cold Water Mass

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The Yellow Sea Cold Water Mass (YSCWM) in the central part of the Yellow Sea is a relatively oligotrophic area surrounded by more eutrophic coastal and estuarine water masses. YSCWM is a relatively independent water mass with frontal structures that hinder water exchanges with adjacent water types. The YSCWM has low near-surface nutrient concentrations, and a strong thermoclines, with most phytoplankton living subsurface and dominated by small-sized (pico- and nano-) species. The dominant mesozooplankton species, *Calanus sinicus* and *Euphausia pacifica*, reside during most times in the deep cold masses of the YSCWM. Since 2009, joint research has been conducted by the First Institute of Oceanography (FIO, China) and KIOST (Korea) on the seasonal and interannual changes of the YSCWM ecosystem.. Cruises were conducted in the eastern and western parts of the southern Yellow Sea by KIOST and FIO, respectively. Changjiang Diluted Water (CDW) is the primary source of nutrients to the YSCWM. A phytoplankton bloom to the southwest of the YSCWM is a persistent phenomenon each summer during the 21st century, creating a massive low oxygen area. Diatoms of the bloom and particulate organic matter (POC) can be transported through bottom layers to the central Yellow Sea, which can serve as a food source, and affect the population dynamics of *Calanus sinicus*. The ecosystem of the YSCWM is greatly influenced by surrounding water masses; consequently, we should expand the area of active research to provide a broader view on the changes of the YSCWM.

October 15, 10:50 (W3-10442)

Regional differences in decadal variations of diatom primary productivity in the southern Yellow Sea and adjacent seas over the past 100 years

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For less known in regional differences of marine environment changes, mechanism of recent marine environment changes in Chinese shelf seas is hard to study. To further understand the regional differences, sediment cores collected in different types of sea areas in the southern Yellow Sea and adjacent seas were carefully examined. Based on sediment ages and biogenic silica analysis, the decadal variations of diatom primary productivities in different areas over the past 100 years were rebuilt and then the regional differences and possible controlling mechanisms were discussed. Results show that diatom primary productivities followed similar trends before the 1980s in all coastal seas; however, after the 1980s, diatom productivity increased most obviously in non-estuarine areas, while it was much lower in the Changjiang River estuary. Contrarily, in open waters, diatom productivities follow almost opposite trends to that found in upper non-estuarine sea. We attibute these regional differences to two possible reasons: 1) PDO could affect the diatom primary productivities in coastal sea by controlling the intensity of the East Asian summer monsoon, rainfall on land and export of terrigenous nutrients to coastal seas, while in open waters, PDO's influence is through SST and the supply of nutrients from bottom to the upper waters; 2) Since the 1980s, human activities in China have obviously affected coastal environments while the influence is much less in open seas. Moreover, among all coastal seas, the truly estuarine environments have been more influenced by upriver dam-building.

October 15, 11:10 (W3-10556)

Variability of chlorophyll-*a* bloom timing associated with physical forcing in the East Sea/Sea of Japan (1998-2014)

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The phytoplankton seasonality in the East Sea controls the recruitment success of higher trophic levels and drives the carbon export production. To quantify the variability of this seasonality, we used the long-term time series of chlorophyll-*a* concentration derived from satellite ocean color data (1998-2014). A shifted Gaussian function was used to estimate bloom initiation, peak timing, duration, termination and peak magnitude taking into account uncertainty in bloom detection. In the East Sea, the bloom initiation was inversely related to bloom duration in both spring and autumn, thus early blooms tended to last longer. This trend was more predominant in spring than autumn. Furthermore, the phytoplankton seasonality showed spatially different patterns. The variability of seasonality indicators in the southern area is much higher than that in the northern area. Unlike the southwestern area of the East Sea, in the northern area, the bloom in spring was advanced and lasted longer, whereas the bloom initiation in autumn was delayed and the bloom duration was shortened. Among the physical factors, the average wind stress during February and March is a stronger predictor for peak timing in spring. Changes in bloom termination in autumn also presented an obvious response to physical forcing, especially the date that the decreasing rate of photosynthetically available radiation (PAR) was the maximum. We discuss the implication of recent trends of the phytoplankton seasonality in light of climate change.

October 15, 14:00 (W3-10493)

Effects of increasing nutrient loads on the competition and succession between two predominant red tide algae of East China Sea

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East China Sea experiences annual succession and large-scale blooms of predominant red tide algae, *Skeletonema costatum* (*S. costatum*) and *Prorocentrum donghaiense* (*P. donghaiense*). To further understand the nutrient mechanism of these events, we evaluated the growth response and competition of *S. costatum* and *P. donghaiense* to nutrient amendments with nitrate (NO_3), phosphate (PO_4) and silicate (SiO_3). We assess effects of nutrient with field experiment, indoors experiment and outdoors experiment. Our results showed that the larger scale of red tide responded to addition of nutrients. The system with higher N/P ratio would accelerate the dominance of *P. donghaiense* and the higher Si/P and N/P led by lower PO_4-P concentration accelerate the decay of *S.costatum*. In addition, low PO_4-P concentration and the excessive DIN accelerate the red algae blooms dominated by *P.donghaiense* when *S. costatum* decayed. The results suggested that increased NO_3 loads from anthropogenic activity lead to change of nutrient structure so that the phytoplankton community changed and dinoflagellate algae begin to dominate. As best management practices are developed for P reductions in East China Sea, managers must be aware of the negative implications of not managing N loading into this system as N may significantly impact red algae bloom size and structure.

October 15, 14:20 (W3-10700)

Variability of the phytoplankton functional types under changing winter vertical mixing in the Ulleung Basin, East Sea: A modeling study

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We investigated the impacts of varying winter vertical mixing and atmospheric deposition on the lower trophic level ecosystem using a zero-dimensional European Regional Seas Ecosystem Model (ERSEM) for 2001-2012. The model results show that the changes in winter vertical mixing had varying effects on the competitive advantages of plankton functional types (PFTs) and thereby altered the succession process of PFTs in the upper mixed layer. As the winter vertical mixing increases, the annual mean of net primary production (NPP) and peak biomass of the total phytoplankton increased, and vice versa. Diatoms responded most positively to the change. Deepening winter vertical mixing would increase NPP but decrease the biomass of flagellates and picophytoplankton because of increased grazing. When winter vertical mixing deepened, the NPP and biomass of dinoflagellates decreased as their growing duration decreased. Because the PFTs showed opposite trends in biomass change, there was no significant increase in the total phytoplankton biomass. Taken together, the model suggests that the shallower mixed layer depth in the Ulleung Basin may result in a shift toward dominance of small phytoplankton such as flagellates and picophytoplankton and the increasing atmospheric deposition would amplify such changes.

October 15, 14:40 (W3-10758)

Examining linkages between juvenile salmon growth and phytoplankton, zooplankton dynamics during the early marine period

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The Strait of Georgia, an inland sea between the British Columbia mainland and Vancouver Island, is an important rearing area for juvenile Pacific salmon. Mortality that occurs during the early marine period may be important in determining overall brood year strength. The Department of Fisheries and Oceans Canada (DFO) and Pacific Salmon Foundation (PSF) are conducting research to examine the level of mortality during this early marine period and factors affecting the survival of juvenile Chinook and Coho Salmon. The study includes integrated sampling of ocean conditions, plankton production, and juvenile salmon during their first three to four months in the ocean. Here, we examine potential linkages between composition, abundance and distribution of phytoplankton and zooplankton and the distribution, growth and feeding of juvenile Chinook and Coho Salmon in Cowichan Bay in 2014 and 2015 and discuss how global warming may impact these linkages.

October 15, 15:00 (W3-10561)

Migration behavior changes of juvenile North Pacific albacore linking to environmental variability

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Distribution of tuna across the entire North Pacific Ocean is related to physical and biological conditions, like temperature, primary productivity, and presence of fronts. Here we link albacore tuna distribution and behavior in the North Pacific to environmental conditions and variability. Low albacore catch-per-unit-effort (CPUE) occurs in a low frontal intensity area (LFA, 130-145W) between two high CPUE areas in the open ocean and North American coast. This LFA has relatively low sea surface temperature and chlorophyll a gradients. We evaluated the hypothesis that the diving behavior, swimming speed, and movement pattern changes in the LFA by analyzing the electronic tagging data from albacore in the area versus the surrounding high CPUE areas. The results showed that average swimming speed is 1.5 times faster in the LFA than in the open ocean and coastal areas. Albacore spends up to 60% of the time in the surface waters (0-10m) at night in the LFA, whereas only 40% in the coastal and open ocean. The improved understanding of albacore behavior and movement pattern is likely to help in quantifying the distribution and abundance of albacore, which may help with the future management of albacore under future climate change scenarios.

W4: Workshop
Marine Environment Emergencies: Detection, monitoring, response, and impacts

October 15, 09:00 (W4-10580), Invited

Geochemical and microbial community response to oil spill: A five year investigation after the Xingang oil pipeline explosion, the Dalian Bay, North China

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The Xingang oil pipeline explosion in July 16th, 2010 resulted in a massive influx of crude oil into the Dalian Bay, North China. Despite extensive clean-up efforts were taken by the government to reduce damage, a substantial portion of oil still percolated through the superficial seawater and ultimately accumulated in a deeper layer of fine sediments, protected from hydrodynamics forces. Thereafter, the coastal area was at a high risk for long-term persistence of oil pollution induced by anthropogenic disturbance or natural resuspension of residue oil. Here, we conducted a five year investigation with molecular geochemistry and microbiology to better understand processes involved in natural attenuation of spilled oil and microbial community dynamics. Geochemical data clearly showed the oil contamination with a depth-related trend in profiles due to the sedimentation and/or oil migration into deep layer and the burial of residue oil has modified the distribution of microbial community along the oxic-redox gradients and triggered an enrichment of aromatic degradation genes. Microbiology study demonstrated remarkable succession patterns of functional and taxonomic diversity during the natural attenuation process. Principal coordinates analysis revealed that nature benthic microbial community was replaced by consortia of anaerobic hydrocarbon populations in response to oil deposition, and the relative of abundance of different specialized groups varies over time. The results provide new insights into our understanding of sediment microbial community structure and function in response to oil spill and have important implications for bioremediation strategy-making.

October 15, 09:30 (W4-10861), Invited

Marine pollution preparedness and response to oil and HNS spill incidents in the Northwest Pacific Action Plan (NOWPAP) region

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While the market has become increasingly globalized with a rapid growth of maritime transport, our ocean has become more vulnerable to ship-source incidents including oil and Hazardous and Noxious Substances (HNS) spills. Not only oil and HNS spills can cause hazards to human health, harm living resources and marine life, but can also damage amenities or interfere with other legitimate uses of the sea. As per transboundary nature of oil and HNS spills, the international society has cooperatively been seeking ways to enhance the response capabilities by introducing the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC 90) and Protocol on Preparedness, Response and Co-operation to pollution incidents by Hazardous and Noxious Substances (OPRC-HNS Protocol). In line with the concerns on oil and HNS spills, the NOWPAP member states (China, Japan, Korea and Russia) initiated development of effective measures for regional cooperation in marine pollution preparedness and response as one of priorities of NOWPAP. As a result, NOWPAP Regional Oil and HNS Spill Contingency Plan (RCP) was developed and adopted in 2003 as technical and operational guidelines for regional co-operation to address oil and HNS spill emergencies. While there have been 313 oil spill accidents and 60 HNS spill accidents occurred with spillage over 10 tons from 1990-2014 in the NOWPAP region, the NOWPAP member states have been making efforts to develop effective measures for regional cooperation in the field of marine pollution prevention and response. In this regard, current status of oil and HNS spills in the NOWPAP region as well as NOWPAP member states' national marine pollution response capabilities and regional co-operation systems for marine pollution preparedness and response in the NOWPAP region will be shared in this study.

October 15, 10:00 (W4-10766)

The *MV Marathassa*: Lessons learned from the 2015 spill of Bunker fuel in Vancouver Harbour

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A modest spill of Bunker fuel from the grain carrier MV Marathassa in English Bay on April 8, 2015 led to a vocal outcry in local and national news. Concern stemmed from the visible oiling of popular beaches within the City of Vancouver and adjacent municipalities. Actions that received scrutiny included those categorised as i) 'operational' (immediate response, notification, booming, skimming) or ii) 'monitoring' (study design, sample collection and analysis, risk assessment, recovery monitoring). The Vancouver Aquarium collection in Stanley Park found itself at immediate risk of impact as a result of the slick, with vapors, oil sheen, oil droplets and tarballs being detected in immediate vicinity of its two salt water intakes. Immediately upon hearing of the spill (08.30 on April 9) via news reports, the Aquarium established five internal teams to implement: i) emergency operational water management for the Aquarium's operations; ii) marine mammal science staff for vessel-based surveys; iii) marine mammal rescue and rehabilitation crews; iv) shoreline cleanup team (ultimately not deployed); and v) science staff from the Ocean Pollution Research Program for water influent monitoring. Science staff focussed on environmental sampling to generate insight into the nature and extent of the incident, and to characterise risks to the Aquarium's collection. The evaluation of petroleum signatures used high resolution analyses of appropriate samples, something that provided the low detection limits required to conduct risk assessments, and a more thorough evaluation of source, transport and fate in the local environment around the Vancouver Aquarium. Improvements in response are needed to protect ocean life in British Columbia in the event of future spills.

October 15, 10:20 (W4-10398)

Distribution and sources of hydrocarbons in surface sediments from tail reaches of the Yellow River Estuary

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n-Alkane and polycyclic aromatic hydrocarbons (PAHs) from surface sediments were analyzed and discussed to better understand the distributions and sources of organic matter in Yellow River and its adjacent sea. The total *n*-alkanes and total PAHs concentrations from Yellow River Estuary (YRE) (0.60 -2.44 μg/g, 0.08-0.61μg/g) were higher than those from tail reaches of the Yellow River (0.21- 0.56 μg/g, 0.06-0.08 μg/g). In addition, the *n*-alkanes and PAHs concentrations from north section of YRE were higher than the south section. All stations in tail reaches of YRE were threatened by different levels of petroleum contamination, compared to tail reaches of the Yellow River, the petroleum contamination was more serious in YRE. Organic pollutants in tail reaches of the Yellow River showed a mixed input pattern, including terrestrial plants and algae. According to ratio analysis (Ant/(Ant+Phe), BaA/(BaA+Chr), Flt/(Flt+Pyr) et al.) and the factor analysis P multiple linear regression analysis, PAHs contaminations in tail reaches of YRE showed a mixed PAHs input pattern, including oil pollution, fossil fuels burning, and wood combustion. The ecological risk assessment showed low toxicological levels of PAHs were found in tail reaches of YRE, and there was no serous ecological risk in the study area.

October 15, 11:00 (W4-10578)

Genotoxic effects of PCBs and heavy metals on marine mussels

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Marine ecosystem and environment are facing severe damage caused by pollutants from human activities. Polychlorinated biphenyls (PCBs) and heavy metals are most representative persistent pollutants, which are largely discharged into marine ecosystem. PCBs are very lipophilic and can easily bio-accumulate in fatty tissue of marine organisms. Heavy metals can also induce various biological responses in marine organisms. Marine mussel as a filter feeder are proved to be an important indicator of marine ecosystem health as they can absorb pollutants and generate serious biological responses as biomarkers. This study is aimed to apply marine mussels as a model to investigate the genotoxic effects after exposure to PCBs and heavy metals concentrations either singly or in combination. Total of seven PCBs congeners (28, 52, 101, 118, 138, 153 and 180) and two heavy metals (Cu and Zn) were selected in this study to cover the most common pollutants found in marine environment. The DNA damage was assessed in mussels haemolymph *in vitro*, using the comet assay. Significant concentration-dependent responses were discovered after exposure to series of PCBs and heavy metals concentrations either singly or in combination. The results of this experiment demonstrated that PCBs and heavy metals caused genotoxic damage, probably as a consequence of oxidative stress. This study revealed the application of comet assay and sentinel organism as a useful bio monitoring indicators and species as early warning to protect marine ecosystem and environment.

Keywords: PCBs, Heavy metals, Genotoxic effects, Marine mussel, Marine ecosystem protection

October 15, 11:20 (W4-10757)

Distinguishing crude oils from heavy fuel oils by polycyclic aromatic hydrocarbon fingerprints

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PAH biomarkers are important factors in the identification of the source of spilled oil because of the specificity and high resistance to biodegradation of such biomarkers. A novel method for distinguishing heavy fuel oils from crude oils is proposed in this study. This method comprises gas chromatography mass spectrometry analysis and principal component analysis (PCA) of the diagnostic ratios of selected polycyclic aromatic hydrocarbons (PAHs). The method was applied to 15 heavy fuel oils (B1 to B15) and 32 crude oils (C1 to C32) for distinction. Oil samples were collected from Turkmenistan, Korea, China, Vietnam, Morocco, Algeria, Sultan, Yemen, Saudi Arabia, Argentina, Russia, Indonesia, Brazil, Equatorial Guinea, Angola, and Mauritania. The discriminative power of PCA was enhanced through the selection of typical PAH diagnostic ratios, which could be used to distinguish petrogenic from pyrogenic PAHs. The heavy fuel oils have higher An/P, BaA/C, 2-m-An/total of MP, and PI, as well as lower $\Sigma N/\Sigma C$, $\Sigma P/\Sigma C$, $\Sigma D/\Sigma C$, and $\Sigma F/\Sigma C$ as compared with crude oils. PCA based on 10 PAH diagnostic ratios is a more efficient method in distinguishing heavy fuel oils and crude oils compared with the plotting of An/P and PI ratios. The method was confirmed to be highly efficient for distinguishing heavy fuel oils from crude oils, with a rapid and objective procedure under comprehensive considerations. The method provides a useful tool to apportion the spilled oil in the marine environment.

October 15, 11:40 (W4-10760)

Oil dispersants impact feather function in marine birds

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Feathers act like a natural "Gore-tex" for birds, providing a breathable barrier to water penetration, which is vitally important for the survival of water birds that forage in aquatic environments. The effectiveness of feathers as a breathable barrier depends on the maintenance of gap size between tiny feather structures called barbules, and the natural surface tension of water. Maintaining feather function is essential for buoyancy and the prevention of hypothermia; even a small drop of oil can impair feather function, often resulting in lethal consequences, especially in cold climates. Oil disrupts feather function by affecting both gap structure and water surface tension. Dispersants are surfactants added to oil spills in order to speed up dispersal /breakdown of oil with the objective of minimizing environmental impact. However, surfactant dispersants have been shown to impact feather function by decreasing surface tension of water, and increasing the penetration of water and/or oil-dispersant mixture into the protective layer formed by feathers. As well, there is some evidence that dispersants may increase the negative effect of an oil slick on marine birds. In this talk, we consider and discuss the pros and cons of dispersant use within the context of marine bird conservation in differing environments. We review recent experimental work exploring the mechanisms of disruption of feather function, and discuss what is known (published and anecdotally) about the fate and behaviour of oil and oil-dispersant mixtures and how this might interact with marine bird biology.

October 15, 12:00 (W4-10761)

Lessons learned from the *Hebei Spirit oil spill*: Environmental perspectives

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The Hebei Spirit Oil Spill (HSOS) in December 7, 2007 was one of the recent worst spill cases. HSOS spilled 10,900 tons of crude oil 10 km off the Taean coasts in South Korea, which impacted more than 375 km of western coastline of Korea. Right after the spill, an environmental impact assessment was initiated to investigate the environmental and ecological effects of the spill. The results of long-term monitoring of environmental and ecological effects of the HSOS are summarized focusing on i) pollution status for multi-media environment including seawater, sediment, and biota, ii) biological effects on the benthic ecosystem, and iii) potential toxic effects of spilled oil. Water quality recovered relatively rapidly, while sediment and biota exhibited prolonged effects of persistent oil. Oiled benthic ecosystems showed different degrees of recovery according to local oiling status and susceptibility of specific populations to oil. However, it should be noted that residual oils are still found in some pocket beaches and boulder-armored beaches, which would cause the potential toxic effects on surrounding environments. The current understandings and limitations of such effects from the HSOS are further discussed highlighting, i) long-term effects of residual oils, ii) identification of certain toxic chemicals in residual oils, iii) weathering characteristics of spilled oils, and iv) possible effects from the unknown hydrocarbons in oils.

October 15, 14:00 (W4-10419)

Oil spill trajectory prediction using the GNOME model and satellite images

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Accurate forecasting of oil spill trajectories is beneficial to fisheries, wildlife, resource management for monitoring and conserving of marine environment. Thus, oil spill monitoring is one of the most important applications for operational oceanography. Remote sensing technology plays an important role in oil spill trajectory monitoring. Among the satellite sensors, SAR (Synthetic Aperture Radar) with relatively wide coverage and day/night/all-weather imaging capabilities has been widely used to provide valuable synoptic information about the location and size of oil spills, which can be the input information for oil spill models. The GNOME (General NOAA Operational Modeling Environment) oil spill model, which is freely available from NOAA, is a well-designed model for predicticting oil trajectories using surface currents and surface winds. Two case studies were performed to validate the predictive capability of GNOME and to show the advantages of the combination of GNOME and satellite images in oil spill monitoring. One is the oil spill accident at the Deep Sea Horizon oil platform in the Gulf of Mexico and the other is the oil spill that occurred at platform B and C of Penglai 19-3 oil field in Bohai Sea. The predicted trajectories of spilled oil were compared with oil locations derived from SAR satellite images and they are in good agreement. The spatial and temporal resolution of the environmental drivers (currents, winds) can affect the prediction precision. Therefore, data from different sources was used to predict trajectories and the results verified the difference.

October 15, 14:20 (W4-10752)

Features of GIMS technology in environmental monitoring of marine ecosystems

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The most developed area of information support of environmental studies are geographic information systems (GIS). Important here is the possibility of the formation of cartographic images of elements of the environment with the geo-referenced, and with the release of specific information that is fundamentally necessary in the search and identification of emergency situations such as floods, dust storms, landslides, volcanic eruptions, etc. Standard GIS systems are not particularly dynamic, and thus not capable of indicating rapid change. We propose GIMS (GIMS = GIS + model), which combines GIS technology with dynamic modeling.

In other words, the functions of GIS are enlivened by the introduction of a new grid - time scale. The result is a forecasting tool and, therefore, may be used to carry out a dynamic integration of environmental information.

One of the important functions of geoinformation monitoring is the detection and identification of emergency situations that may occur in the environment. The rich experience of solving this problem with the use of radio-physical, optical and other methods suggests that a successful outcome requires the synthesis of a wide range of multi-channel measurements and an hierarchical structure for searching and processing information from various levels of the monitoring system, which could include satellite, airborne laboratory, ship based observations, and on ground or overwater stationary observation points. Problem detection and identification of anomalous phenomena in the environment at every level is achieved with the use of appropriate technologies, but the efficiency of its solutions is only guaranteed by all levels together. Satellite view level provides periodic elements of the environment and provides the primary indication of an abnormal formation of the next level. Signal flow through all levels (satellite to point observations) answers whether the environment really breached its parameters in a certain region, or if it was a false signal.

So, from the above it can be concluded that the problem of information support for environmental monitoring is in trying to accurately characterize a system emergency. Each level of the monitoring system requires a specific set of information structures. Thus, by carrying out a multi-step hierarchical search for anomalies identified by a certain set of criteria, the monitoring system generates an information field for environmental services and may trigger responses by other organizations in the resolution mode or regulated access through information networks.

October 15, 14:40 (W4-10732)

The activities of Marine Environmental Emergency Preparedness and Response Regional Activity (MERRAC) for oil and HNS spills preparedness and response in the Northwest Pacific Action Plan (NOWPAP) region

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The Northwest Pacific Action Plan (NOWPAP) region to which Japan, People's Republic of China, Republic of Korea and Russian Federation are the member states, have experienced a rapid increase of oil and HNS spills due to fast economic growth in the region. In response, the NOWPAP member states have established national frameworks and strategies to improve oil and HNS spill response capacity and its effectiveness. Under the framework of NOWPAP, Marine Environmental Emergency Preparedness and Response Regional Activity Centre (MERRAC) was established in 2000 and started organizing annual Focal Points Meetings as a NOWPAP arrangement to promote development of effective measures for regional co-operation in marine pollution prevention and response. In order to address oil and HNS spill emergencies, the NOWPAP Regional Oil Spill Contingency Plan (RCP) was also adopted in 2003 as technical and operational guidelines for regional cooperation and has been revised subsequently to add the HNS issues in the existing RCP in 2005. In order to build practical response capacities under the RCP, NOWPAP exercises including BRAVO (communication) and DELTA (operational) exercises have been conducted regularly under the leadership of the member states and a series of Expert Meetings have also been organized to undertake specific advisory functions relating to scientific and technical issues of the tasks with assistance from NOWPAP Regional Coordinating Unit (RCU), UNEP and IMO. Various topics within the framework of the RCP have been discussed during the Expert Meetings including HNS related issues and marine pollution incidents preparedness and response in the Sea of Okhotsk etc. The 2015 Expert Meeting is currently planned to be held in Vladivostok in October 2015 to discuss and share national frameworks of the NOWPAP member states and international experiences on oiled wildlife response. More detailed information on the MERRAC activities regarding oil and HNS spills preparedness and response in the NOWPAP region will be shared in this study.

W5: Workshop
Monitoring and Assessment of Environmental Radioactivity in the North Pacific

Day 1

October 15, 09:00 (W5-10400), Invited

Asia/Pacific marine ecosystem impacts from the Fukushima Daiichi nuclear power plant accident: A 2011-2015 overview

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Following the 2011 Fukushima Daiichi Nuclear Power Plant accident, ecological risk analyses (ERAs) of the radiological impacts of discharges were undertaken on regularly updated marine biota and seawater monitoring data from 22 Asia-Pacific countries under an International Atomic Energy Agency regional project coordinated by Australia. Radiological doses were modelled and assessed for International Commission for Radiological Protection (ICRP) reference animals and plants (RAPs), as well locally-identified 'representative biota'. Both approaches utilised the FREDERICA database on the impact of ionising radiation on non-human species (European Commission's 6th framework project on Environmental Risk from Ionising Contaminants: Assessment and Management). Initially, in 2011, maximum calculated radiological doses in Japan coastal waters, mostly due to 131-iodine, were received by macroalgae and zooplankton. Whereas, 134+137-cesium provided significant doses for higher trophic level biota (fish, crustaceans, etc). Deleterious effects were expected in macroalgae and male flatfish but doses were well below lethal (LD-50). Probabilistic ERA modelling identified impact to approximately 15% of appropriate FREDERICA data base listed species. 30km offshore Fukushima, doses were below the ICRP recommended limit of 10 microGray/hour. Apart from localized impacts in coastal Japan, monitoring until 2015 identified no significant radiological impacts to marine biota in adjacent regional seas or the greater Pacific Ocean. The presentation will also discuss the constraints of contemporary environmental measurements and marine radiological dose modelling, overview underway research activities and outline requirements for further studies.

October 15, 09:25 (W5-10394), Invited

^{134}Cs and ^{137}Cs in the North Pacific Ocean derived from the TEPCO Fukushima Dai-ichi Nuclear Power Plant accident, Japan in March 2011: Transport processes and estimation of ^{134}Cs and ^{137}Cs inventories

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We collected 2 - 10 litre surface seawater samples at 440 stations and vertical profiles at 24 stations in the North Pacific Ocean. A zonal speed of TEPCO Fukushima Dai-ichi Nuclear Power Plant, FNPP1, derived radiocaesium in surface water at mid latitude in the North Pacific Ocean was 7 km day^{-1} until March 2012, however it after March 2012 till August 2014 was ca. 3 km day^{-1}. Although FNPP1 derived radiocaesium mainly existed in the upper layers in the initial stage following the release into the North Pacific Ocean as expected, FNPP1 derived radiocaesium subducted into ocean interior in winter 2011/2012 and more than 80 % of water column inventory existed deeper than 200 m depth in June 2012. Only ca. 5 % of FNPP1 derived radicaesium was transported in surface layer crossing the North Pacific Ocean and finally reaching the west coast of American continent in 2015. Our observations indicate that CMW formation was most effective pathway to introduce FNPP1 derived radiocaesium into ocean interior about one year time scale. By comparing the observed inventories with model-simulated results, we obtained 12–15 PBq as the total atmospheric deposition of ^{134}Cs and ^{137}Cs released by the FNPP1 accident in the North Pacific Ocean. The 12-15 PBq of ^{137}Cs newly added by atmospheric deposition and the 3.6 ± 0.7 PBq added by direct discharge increased the total ^{137}Cs inventory in the North Pacific Ocean by 27% to the pre-existing ^{137}Cs derived from global fallout.

October 15, 09:50 (W5-10856), Invited

Sources and inventory of Cesium and Plutonium in China seas

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As anthropogenic radionuclides, ^{137}Cs and $^{239+240}$Pu have been intentionally and/or accidentally introduced into the marine environment since the nuclear era in the early 1940s through various human activities including above-ground nuclear tests, nuclear accidents and reprocessing of nuclear materials. This has caused major concerns both from the general public and the academic community. This presentation attempts to review the current understanding of inventory and controls of the anthropogenic radioactive isotopes in the marine environment adjacent to China. Also assessed was the impact of the Fukushima Daiichi Nuclear Power Plant accident on the China Seas. We found that the ^{137}Cs and $^{239+240}$Pu inventories in China Seas had large spatial variations, therein its distribution pattern in sediments showed decrease from the nearshore to offshore and in general followed the distribution of sedimentation rates. In addition, the total ^{137}Cs inventories in the East China Sea are lower than that expected from the global fallout, suggesting the input of ^{137}Cs has been transported away from the shelf. In contrast, the $^{239+240}$Pu inventories are higher than that expected from global fallout, indicating Pu has much higher affinity to particles and therefore can be more readily scavenged from the water column as compared to ^{137}Cs. Indeed, substantially higher $^{239+240}$Pu/^{137}Cs activity ratios than the global fallout values were observed in the China Seas.

We clarified that Pu in the China Seas was sourced from a combination of global fallout and close-in fallout from the Pacific Proving Grounds in the Marshall Islands where above-ground nuclear weapons testing was carried out during 1952-1958. The latter source dominated the Pu input in the 1950s, as evidenced by elevated ^{240}Pu/^{239}Pu atom ratios (>0.30) in a dated sediment core. Even after the 1950s, the Pacific Proving Grounds was still a dominant Pu source due to continuous transport of remobilized Pu from the Marshall Islands, about 4500 km away, along the North Equatorial Current followed by the transport of the Kuroshio current and its extension into the China Seas. Using a simple two end-member mixing model, we quantified the contribution of Pu from the Pacific Proving Grounds to the China Seas to be 36.6%±1.2%-68.0%±1.0%.

Finally, we assessed the impact of Fukushima Daiichi Nuclear Power Plant accident on the China Seas based on the input flux of ^{137}Cs in the East China Sea and the ^{240}Pu/^{239}Pu atom ratio in the South China Sea and concluded that the China Seas were little influenced by the Fukushima Daiichi Nuclear Power Plant accident.

October 15, 10:15 (W5-10422)

Development of a radionuclide transport model applicable to coastal regimes with multi-fractional cohesive and non-cohesive sediments

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2 Institute of Mathematical Machine and System Problems, Kiev, Ukraine
3 First Institute of Oceanography, Qingdao, PR China

We describe in this talk the development of a new three-dimensional radionuclide transport model applicable to coastal waters with non-uniform distribution of suspended and bed sediments of both cohesive and non-cohesive types. The model calculates the concentration of radionuclides in bed sediments and pore water as well as in dissolved and particulate phases in the water column. The transfer of activity between the water column and the pore water in the upper layer of the bottom sediment is governed by diffusion processes. The phase exchange between dissolved and particulate radionuclides is written in terms of the desorption rate and distribution coefficients for the water column and bottom deposit. The dependence of distribution coefficients is inversely proportional to the sediment particle size. For the simulation of the three-dimensional circulation and wave fields, the hydrodynamic numerical model SELFE that solves Reynolds-stress averaged Navier-Stokes (RANS) equations and the wave action transport equation on the unstructured grids has been used. In present study we have extended the original SELFE code to a model applicable to mixture of cohesive and non-cohesive sedimentary regimes by implementing a flocculation model for the determination of settling velocity of cohesive flocs. Issues related to the calibration of the sediment transport model in the Yellow Sea are described. Model of radionuclide dispersion was verified on measurements of ^{137}Cs concentration in surface water and bed sediments after the Fukushima Daiichi nuclear accident.

October 15, 10:55 (W5-10385)

Long-term transport and dispersion of ^{137}Cs released into ocean off Fukushima nuclear accident

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In the following days after the Fukushima nuclear accident which happened on 11th March 2011, significant amounts of radioactive materials (^{131}I, ^{134}Cs and ^{137}Cs) leaked into the terrestrial and marine environments. The radionuclides model was used to study the distribution of the ^{137}Cs in the Pacific and the Indian Ocean released from the Fukushima accident. The simulation on the distribution of ^{137}Cs agrees well with the observed profiles of 9th November 2011, which proved the validity of the model. In the first year of our model run, the ^{137}Cs is carried eastward by the Kuroshio and its extension, spreading southward and northward as well. Four or five years after the accident, the ^{137}Cs reaches the US coast with the surface waters of the Pacific Ocean; its concentration is no higher than 3 Bq/m^3. Ten years after the accident, all the North Pacific Ocean is labeled with the ^{137}Cs from the Fukushima. The concentration is less than 1 Bq/m^3 at that time. Thirty years after the accident, the concentration of ^{137}Cs in both the Pacific and the Indian Ocean is below 0.1 Bq/m^3. Since the spreading path of ^{137}Cs from the Fukushima nuclear accident is similar to the migration route of the Pacific tuna, a species which inhabits the western and eastern North Pacific, it may cause radioactive contamination to the fish. In the offshore seas of China, the ^{137}Cs from Fukushima nuclear accident is very low (<0.2 Bq/m^3).

October 15, 11:15 (W5-10524)

Model developments to estimate movements of radioactive cesium with ocean sediment after the Fukushima Dai-ichi nuclear power plant accident

Shin-ichi **Ito**[1,2], Kazuhiro Aoki[3], Hiroshi Kuroda[4], Takashi Setou[3], Kazuhiro Takeuchi[5], Daisuke Hasegawa[1], Hideki Kaeriyama[3], Ambe Daisuke[3], Tsuneo Ono[3], Shigeho Kakehi[1], Hiroshi Yagi[6], Kouichi Sugimatsu[6] and Akiyoshi Nakayama[6]

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6 National Research Institute of Fisheries Engineering, FRA, Kamisu, Japan

Radiocesium (Cs: Cs134+137) due to the Fukushima Dai-ichi Nuclear Power Plant accident was released into the ocean by three pathways: 1) direct release of high Cs liquid wastes to the ocean after the accident (mainly until April 2011), 2) the deposition of airborne Cs to the ocean surface, and 3) riverine Cs discharge originated by the deposition of airborne Cs on the land. The Cs concentration in seawater has been decreased rapidly, but the Cs concentration in the ocean sediment is still high in some areas of the coastal region. To investigate the movements of Cs137 in the ocean sediments, an ocean circulation-wave-sediment coupled model has been developed and Cs137 was incorporated. Both the ocean circulation and wave models were downscaled from the North Pacific model (one degree) to the coastal model (1/90 degree) through the northwestern Pacific model (1/10 degree). Observations of bottom boundary layers were also conducted to estimate model parameters and validate the model simulations. After several case studies, the horizontal distribution of median particle diameter of ocean sediment and the horizontal transport of suspended substances in the coastal region were reasonably hindcasted. Two scenarios were considered: 1) Cs absorption by ocean sediments from high Cs waters and 2) discharge of Cs absorbed particles from the Abukuma River. The simulation results revealed that the riverine effects is limited and the major distribution of Cs in the ocean sediment was determined by the high Cs water pathways after the accident and the medial particle diameter of the ocean sediment.

October 15, 14:00 (W5-10423)

Transport of the Fukushima radioactivity plume to the Eastern North Pacific Ocean

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The large discharge of radioactivity into the northwest Pacific Ocean from the 2011 Fukushima Dai-ichi nuclear reactor accident has generated considerable concern about the spread of this material across the ocean to North America and its transport to the eastern North Pacific. Time series measurements of ^{134}Cs and ^{137}Cs in seawater revealed the initial arrival of the Fukushima signal by ocean current transport at a location 1500 km west of British Columbia, Canada in June, 2012, about 1.3 years after the accident. By June, 2013, the Fukushima signal had spread onto the Canadian continental shelf and by February, 2014 had increased to a value of 2 Bq/m^3 throughout the upper 150 m of the water column resulting in an overall doubling of the fallout background from atmospheric nuclear weapons tests. Between February, 2014 and February, 2015 the Fukushima ^{137}Cs signal doubled again to levels in excess of 4 Bq/m^3 in the upper 200 m. Adjusted circulation model estimates that match our measured values indicate that future levels of Fukushima ^{137}Cs off the North American coast will likely attain maximum values of at least 5 Bq/m^3 by 2015-2016, before declining to levels closer to the fallout background of about 1 Bq/m^3 by 2021. The increase in ^{137}Cs levels in the eastern North Pacific from Fukushima inputs will likely return eastern North Pacific concentrations to the fallout levels that prevailed during the 1980s, but does not represent a significant threat to human health or the environment.

October 15, 14:20 (W5-10505)

Monitoring activity on radioactive cesium in seawater and sediment in the North Pacific by Fisheries Research Agency after the Fukushima Dai-ichi Nuclear Power Plant Accident

Hideki **Kaeriyama**[1], Daisuke Ambe[1], Tsuneo Ono[1], Shigeho Kakehi[2] and Tomowo Watanabe[2]

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Intensive monitoring of radioactive cesium (Cs-134 and Cs-137) in seawater and sea sediment near the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) had been continued from the FDNPP accident, along with monitoring on fisheries products by Fisheries Research Agency. Furthermore, seawater monitoring on radioactive Cs in a broad area covering the western-central North Pacific is also conducted by Fisheries Research Agency. In this study, we report the dispersion pattern of Cs-134 and Cs-137 in seawater in the western-central North Pacific between 2011 and 2014. The eastward dispersion as surface seawater and southward intrusion with mode water are the most important pathways of FDNPP-derived Cs-134 and Cs-137 transport. On the other hands, high concentrations of Cs-134 and C-137 in sediment were observed only near coast area off Fukushima prefecture, and the grain size may be the first component to determine the concentration of radioactive Cs in sediment. Although the spatial heterogeneity was observed, year-to-year decreasing trend of radioactive Cs in sediment was also observed during three years repeated-observation.

October 15, 14:40 (W5-10716)

Distribution and impact of radiocesium in the seawater of northwest Pacific in 2014

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To understand the distribution and impact of radiocesium (Cs-134 and Cs-137) in the seawater of northwest Pacific after Fukushima Nuclear Accident, surface and deep water (up to 2000 m) samples were collected from 14 stations in northwest Pacific. For each sample, 50 L seawater were collected, stored in polyethylene barrels with acidification to pH=2, and taken back to land-based laboratory for radiocesium analysis with AMP precipitation method followed by gamma counting. The result showed that the range of Cs-137 radioactivity levels were from not detected to 6.14 Bq/m^3, with an average value of 1.79 Bq/m^3, and the Cs-134 radioactivity levels were from not detected to 1.26 Bq/m^3, with an average value of 0.22 Bq/m^3. The profile distribution showed that the level of radiocesium peaked at the depth of 500m, where the radioactivity levels of Cs-134 and Cs-137 were 1.03 Bq/m^3 and 2.98 Bq/m^3, respectively. Comparing with the previous monitoring results, it showed that the level of radiocesium had decreased dramatically since 2011, but still higher than the background level before FNA.

Cancelled: October 15, 15:00 (W5-10597)

Radioactive cesium in marine biota off Fukushima

Takami **Morita**[1], Ken Fujimoto[1], Yuya Shigenobu[1], Daisuke Ambe[1], Hideki Kaeriyama[1], Shizuho Miki[1], Tsuneo Ono[1], Tomowo Watanabe[2] and Hiroya Sugisaki[1]

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Large amounts of radioactive cesium were released into the ocean through direct and atmospheric pathways by the Fukushima Dai-ichi Nuclear Power Plant accident. Especially, from March to April in 2011, the extremely high contaminated water leaked directly into oceans elevated the radioactive cesium levels in a variety of marine biota off Fukushima. The radioactive cesium concentration in seawater has rapidly decreased due to ocean processes, and consequently the concentrations in the pelagic fishes, invertebrates and seaweeds have been also declined because of their radioactive cesium concentrations depend strongly on that in surrounding seawater. In addition, the concentrations in the demersal fishes has been steadily decreasing over time. However, the decrease for the demersal fishes is obviously slower than those of other marine biota. Although the source for the delay of decrease of the concentration in demersal fishes is thought to be in marine sediments, the exact mechanism has been unclear yet. The monitoring research by Fukushima Prefecture showed 53 % of inspected demersal fish samples were over the Japanese regulatory limit (100 Bq/kg-wet) in the period immediately following the Fukushima Dai-ichi Nuclear Power Plant accident (April – June 2011), but the ratio has been gradually reduced over the four years after the accidents and recently has dropped to 0.20 % (January – March 2015). These results suggest that the potency of marine sediment contaminating marina biota has been also declining over time.

October 15, 15:20 (W5-10722)

The radioactive level of nekton species in the Northwest Pacific more than one year after Fukushima nuclear accident

Wu **Men**, Jianhua He, Fenfen Wang, Wen Yu, Yiliang Li and Yusheng Zhang

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Eight monitoring cruises were performed by the State Oceanic Administration of China during the period 2011-2014 (one cruise every half year) to determine the transport and the effect of radioactive pollutants in the Northwest Pacific. The third cruise, which was performed during May and June 2012, measured the amounts of total β, ^{134}Cs, ^{137}Cs, ^{90}Sr, ^{110m}Ag, ^{60}Co, ^{58}Co, ^{238}U, ^{226}Ra, ^{54}Mn and ^{40}K in the sampled nekton species. These data provided a good perspective of the radioactive effect on these species more than one year after the Fukushima nuclear accident (FNA). The sampled nekton species, including *Ommastraphes bartrami, Pteroplatytrygon violacea*. and *Gempylus serpens*, were polluted by the released radioactive pollutants in the Northwest Pacific. The pollution extended east to 151°E, south to 22.72°N, west to 137.76°E and north to 41°N. Fish can swim within this range; therefore, the area in which the nekton species were polluted should be much larger. The radioactive level of *Ommastraphes bartrami* during the third monitoring cruise decreased from the level found during the second cruise; however, the radioactive level remained higher than that found during the first cruise. Moreover, *Scolopsis vosmeri*, *Cheilopogon pinnatibarbatus* and *Takifugu retilcularis* exhibited higher ^{90}Sr activities compared with *Ommastraphes bartrami* and could be used as bioindicators of ^{90}Sr pollution. *Ommastraphes bartrami* could be used as a bioindicator of ^{110m}Ag pollution. The fish in the Taiwan Bank Fishing Ground were not polluted by the released radioactive pollutants. A radiological risk assessment showed that the total dose rates of each species were only one hundredth to one thousandth of the screening rate (10 μGy/h). Therefore, it is not necessary to consider the radiation effect of nekton species in the Northwest Pacific.

October 15, 16:00 (W5-10480)

Temporal changes in the distribution of radiocesium contamination among ten dominant coastal fish species in Sendai bay and the coastal area off Fukushima

Hiroyuki **Togashi**[1], Yukinori Nakane[2], Yuya Shigenobu[3] and Yutaka Kurita[1]

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3 National Research Institute of Fisheries Sciences, Yokohama, Japan

Temporal changes in the distribution of radiocesium-137 (^{137}Cs) contamination among ten dominant coastal fish species with difference feeding types were compared between a lightly contaminated area, Sendai Bay, and a heavily contaminated area, the southern coast off Fukushima prefecture. We revealed food web structure for these ten species by analyses of stomach contents and carbon-nitrogen stable isotope ratio. In 100-400 days after the accident, the proportion of ^{137}Cs (Bq/kg-wet) among ten species in both areas were different from that before the accident. In 400-700, and 700-1000 days after the accident, the proportion in Sendai Bay were comparable with that before the accident, while the proportion in the southern coast off Fukushima remained different. The difference in the degree of initial contamination by leaked water with extremely high ^{137}Cs concentration in April 2011 seems one of the main causes of the difference between two areas; the lighter the initial contamination is, the quicker its influence is weakened and the distribution of ^{137}Cs based on food web structure is uncovered.

October 15, 16:20 (W5-10528)

Radiocesium contamination histories of Japanese flounder *Paralichthys olivaceus* after the 2011 Fukushima Nuclear Power Plant accident

Yutaka **Kurita**[1], Hiroyuki Togashi[1], Yuya Shigenobu[2] and Shin-ichi Ito[3]

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3 Atmosphere and Ocean Research Institute, the University of Tokyo, Kashiwanoha, Kashiwa, Chiba, Japan

Radiocesium (Cs) contamination histories of Japanese flounder *Paralichthys olivaceus* after the 2011 Fukushima Nuclear Power Plant (FNPP) accident were examined by analysis of the spatiotemporal changes in observed Cs concentrations, by comparison of the dynamics of the Cs concentrations in several year classes of fish, and by simulation studies. The results revealed two contamination histories: (1) severe contamination by water that was directly released from the FNPP during March-April 2011 with extremely high Cs concentrations and that had a highly variable spatial distribution and (2) long-duration contamination at relatively low concentrations mainly due to consumption of contaminated food. These two histories were supported by three observations. First, high Cs concentrations with high variability were observed in the first year after the accident. Second, the highest values of the minimum Cs concentrations were observed in the autumn of 2011. Third, Cs concentrations were lower for fish from the 2011 year class and younger, which were not exposed to the highly contaminated directly released water, than for fish from the 2010 year class and older. Simulation studies also indicated that the Cs concentrations in some individuals that were severely exposed to the directly released water might not be in an equilibrium state even at three years after the accident.

W5: Workshop
Monitoring and Assessment of Environmental Radioactivity in the North Pacific

Day 2

October 16, 09:00 (W5-10569)

Challenges in calculating radiation dose to marine organisms

Kathryn A. **Higley**, Delvan Neville and Mario Gomez-Fernandez

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The methodological approaches and technical tools used to calculate radiation doses to humans have been under development for more than 100 years. While modifications and improvements continue to be made, there has evolved a general consensus in the radiation protection community on how to calculate dose to humans. Accordingly, a computational and regulatory architecture has been established and is widely used for the purpose of radiation protection of people. Conversely, there are several approaches being considered for calculating dose to non-human organisms, with the intent to relate radiation dose to impact and proposed regulatory standards. Unfortunately, the wide range in life histories, ecological niche, physical size, and elemental compositions and tissue densities that must be considered when evaluating dose to species in a particular marine ecosystem contribute to a dizzying array of questions that must be considered. These questions were largely ignored by all but a few academics, until the accident at Fukushima Daiichi resulted in a large release of radioactive contamination into the Pacific Ocean. This paper will examine the latest challenges in radiation dose calculation as applied to non-human biota, and discuss some of the developments and possible solutions to estimating radiation doses to marine organisms.

October 16, 09:20 (W5-10427)

Assessment on marine environmental impact from artificial radionuclides in the coastal waters of Liaodong Bay

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In view of the rapid development of nuclear power plants along the coast and effects from Fukushima nuclear accident, the potential impacts of artificial radionuclides to the marine environment is attracting more and more attention these days. Upon discharge, artificial radionuclides disperse in seawater, are absorbed by marine organisms, and are eventually buried in sediment. The level of artificial radionuclides in marine media is thus a significant indicator of marine environment quality. In this study, fifteen surface water samples, one fish sample of a dominant species, and nine surface sediment samples were collected from Liaodong Bay in May 2014. In the laboratory, artificial radionuclides including Cesium, Cobalt and Silver were measured using a HPGe gamma spectrometer. The results show that ^{134}Cs, ^{58,60}Co and ^{110m}Ag were not detected in seawater, fish nor sediment. The level of ^{137}Cs in seawater, fish and sediment was 0.69~1.53 Bq/m^3, 0.024 Bq/kg wet weight, and 0.48~2.01 Bq/kg dry weight, respectively. These ranges are consistent with background levels, and indicate a lack of detectable input of artificial radionuclides from the coastal nuclear power plants of China and Fukushima. We conclude that the coastal waters of Liaodong Bay have not been contaminated by artificial radionuclides.

October 16, 09:40 (W5-10596)

Use of otoliths to estimate the concentration of radioactive strontium

Ken **Fujimoto**[1], Shizuho Miki[1], Tomowo Watanabe[2] and Takami Morita[1]

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Environmental data for radioactive strontium are less abundant than for radioactive cesium because the measurement of radioactive strontium is time-consuming and very complex. Strontium is accumulated in bone tissues because its chemical properties is similar to that of calcium. The main material of fish otolith is calcium carbonate, such that strontium will be accumulated in otoliths. We estimated the concentration of radioactive strontium using beta-rays emitted from fish otoliths. Fish samples caught in the main port of Fukushima Dai-ichi Nuclear Power Plant (FDNPP) were kindly provided by Tokyo Electric Power Co., Inc. Beta-rays were detected in almost all otolith samples of the collected fish (*Sebastes cheni, Physiculus maximowiczi* and *Hexagrammos otakii*) caught in the FDNPP port. On the other hand, no beta-ray was detected from *P. maximowiczi* collected around or outside of the FDNPP, with samples collected using small cages by R/V SOYO Maru of the Fisheries Research Agency. These results suggest that the emission of beta-rays from otoliths are restricted to samples from fish which were exposed to high concentrations of radioactive strontium (e.g. the main port of FDNPP) immediately after the accident. The beta-ray counting rate was related to the concentration of ^{90}Sr in fish with high concentrations of radioactive strontium (more than 10 Bq/kg-wet). However, the use of otoliths to estimate the concentration of strontium was difficult to apply to samples other than those from the FDNPP port because the levels of ^{90}Sr of the sample were less than 1.0 Bq/kg-wet.

October 16, 10:00 (W5-10743)

A new device for precipitation and filtration of radiocesium in seawater

Jianhua **He**, Wu Mem, Yiliang Li, Wen Yu, Tao Yu and Yusheng Zhang

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To improve the pretreatment efficiency of radiocesium in seawater, a new device with the function of precipitation and filtering was developed. The agglomeration of AMP particles used for the precipitation of radiocesium is accelerated by heating, that is advantage to filtration. Vibration of the filter prevents the absorption of AMP on the filter membrane and further improves the filtration speed. With this device, the whole procedure for the pretreatment of radiocesium in 40 liters of seawater will take less than two hours, just one tenth of the traditional method.

October 16, 10:20 (W5-10723)

Auto-system development and invention for measurement of ^{137}Cs/^{134} Cs in-sito

Zhenfang **Dong**, Hongqi Shi and Deyi Ma

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After March 11/2011, we focused on marine radioactivity measurement in-situ, by ship, by buoy etc. With so many years of marine radioactivity measurement deposit, we select cesium as the main focus. One year later, our lab invented a selective absorptive filter element for cesium in sea water. The absorptive filter element is about 100mm of height, an about 60mm of diameter, with a cylindrical shape. The absorptive filter element can filter sea water in flow rate 7000ml/min, with >98% absorption efficiency. The filtering process must be controlled under ~pH4. The sea water acidification is controlled automatically. We developed an instrument sampling sea water and automatically pumping acid into the sea water sample, so we can get the alkalinity of sea water continuously along the whole cruise. We have used the instrument for measurements in the Western Pacific Ocean and the Chinese coastal seas.

W6: Workshop
Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems

October 17, 09:00 (W6-10581), Invited

Chinese efforts in coastal ocean observation in 21st century

Daji **Huang**

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Compared to deep ocean observations, coastal ocean observations face the challenge of a more complex environment with a wide range of parameters, and are more difficult to maintain because of heavy human activities. With the development of the national economy in the 21st century, more efforts than ever have been spent by the Chinese government in Chinese coastal waters to provide better scientific knowledge to protect the coastal ocean environment and to maintain a healthy coastal ocean ecosystem for sustainable production and service. In this talk, I will first present a general picture of the coastal ocean observing systems by reviewing Chinese efforts in the 21st century, including efforts conducted by the State Oceanic Administration, the Ministry of Science and Technology, and the National Science Foundation. Secondly, I will share some of the experiences of success and failure with these systems. Finally, I will show some of the new insights in the Chinese waters gained by these coastal ocean observing activities.

October 17, 09:30 (W6-10639), Invited

CalCOFI: Best practices under a changing climate

David M. **Checkley**, Jr.

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The California Cooperative Oceanic Fisheries Investigations (CalCOFI) has been observing the ocean off Southern California since 1949. Sensors exist for temperature, salinity, pH, inorganic carbon, oxygen, nutrients, particles, chlorophyll, active and passive acoustic scattering by plankton and fish and meteorological variables. Each sensor is calibrated to enable comparability between observations over time and space and with other observation systems. Net samples are collected for zooplankton, including fish eggs and larvae, and visual observations are made of seabirds and marine mammals. Quality control is performed by the CalCOFI technical staff prior to posting data on servers for access on the Internet. The time from observation or collection to posting varies by data type and ranges from weeks to two years; some preliminary data are posted from sea, including fish egg distributions. Data are publically available but used primarily by scientists. Data are archived redundantly by CalCOFI. A goal is to enhance their use by others, including decision-makers in management and policy, and for education. A primary use of CalCOFI data is in a range of types of models, from reanalyses to long-term earth system models. CalCOFI ship-based surveys have also come to be part of a larger observing system, including moorings, gliders and shore stations. Best practices ensure comparability over time and space and with data from other observing systems. Additional considerations include how to ensure continuity of time series given increasing costs, limited budgets, and innovations, and a change in mission to include climate change in addition to fisheries.

October 17, 10:00 (W6-10769), Invited

Brief introduction of marine observing system in China

Song **Sun**

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We need information about the status of the ocean to understand the influence of climate change, marine ecosystem dynamics, ecosystem disasters, and variations of the fishery and production of aquaculture. The most important step is to establish a multipurpose observing system. In the last 10 years, China has made great efforts in building capacity to implement such a system. The system spans from the coastal ocean to the western Pacific, and includes mooring systems, buoys and regular ship-based investigations. We focus on three main research areas: air-sea interaction, coastal environment and aquaculture areas.

October 17, 10:50 (W6-10634)

Development and implementation of best practices for the Ocean Networks Canada ocean observatories

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Ocean Networks Canada (ONC) is progressing in the development of best metadata and data practices for its ocean observatory operations and third party data hosting services. Best practices consider instrument preparations, data archival, data quality, and data distribution. Custom workflows for all deployment, maintenance and recovery operations include calibrations, configurations and testing. Data curation involves storing raw data and maintaining records of all data processing and derivations. Data Quality Assurance/Quality Control (QA/QC) procedures permit monitoring of data streams. Automated QA/QC has been implemented for most scalar observatory sensors, and soon for video imagery. Manual data QA/QC protocols are being developed for complex hydrophone and ADCP data. Automated data monitoring can be adapted to support event and instrument failure alerts. QA/QC tools increase the value of the data archive and provide information on instrument health to the observatory maintenance program. To maximize interoperability, ONC's metadata data distribution framework adheres to international standards and contributes to specialized repositories. ONC currently provides CF-compliant netCDF data products via OPeNDAP web services, and contributes seismic data to IRIS. ONC intends to support additional standards (ISO 19115 for metadata, IGSN for geological samples, and OBIS for biological samples), deliver glider data to the IOOS Glider Data Assembly Center, and provide citations and unique identifiers for datasets. Ongoing enhancements are informed by input from stakeholders. Metrics of success for this best practices program include ratios of instruments and data volume to staff, and increasing requests from third parties to host and deliver their data.

October 17, 11:10 (W6-10638)

Research in the Arctic: Coordinated approaches to baseline understanding of the ecosystem and analyses of change in the Northern Bering Sea, Chirikov Basin, and Chukchi Sea

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The Arctic marine environment encompasses a set of dynamic and rapidly changing ecological systems that have historically been under-represented in directed research. NPRB is in the process of developing an Arctic Program in the northern Bering Sea and Chukchi Sea. Research will explore how physical processes (e.g. sea ice, advection, wind, and winter reset) drive temporal and spatial patterns in productivity, influence exchange between benthic and pelagic systems, and influence distribution, recruitment, persistence, and phenology of higher order species. This program will employ models and empirical analyses on ocean-atmosphere-ice dynamics, circulation, advection and mixing, phenology of primary production and secondary consumption to investigate trends and interactions among fish, invertebrate, marine mammal and seabird populations, potential thresholds and tipping points, networks and interactions, and patterns in subsistence use. NPRB aims to inform baseline understanding of current processes at multiple scales (e.g., localized phenomena, implications of global climate models) and how systems might shift in the context of a changing climate. This Arctic program will be conducted in partnership with the Bureau of Ocean Energy Management and North Slope Borough/Shell Baseline Studies Program. To leverage resources, NPRB aims to provide a coordinating role in partnership with a wide range of additional organizations, agencies, and ongoing programs to develop common research priorities and objectives, ensure collaborative and directed research, enable data sharing, and promote integration and synthesis. NPRB is actively pursuing opportunities for partnership, including international collaborations (e.g., RUSALCA) and comparisons between the US Arctic and other regional Arctic seas (e.g., Barents Sea).

October 17, 11:30 (W6-10659)

Coastal ocean observing in the northeast Pacific

John A. **Barth**[1] and many NANOOS and OOI Colleagues

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The coastal ocean and adjacent deep waters of the Pacific Northwest are home to sustainable, productive fisheries and a thriving shellfish aquaculture industry. This northern California Current region is subject to strong interannual and decadal variability, and changing wind and freshwater forcing. Nearshore waters have experienced low oxygen (hypoxia) in recent years and are increasingly feeling the negative effects of ocean acidification. With this motivation, considerable coastal ocean observing assets are deployed in the northeast Pacific. The Northwest Association of Networked Ocean Observing Systems (NANOOS) serves the Washington, Oregon, and northern California region as part of the U.S. Integrated Ocean Observing System, a national effort funded by the U.S. National Oceanic and Atmospheric Administration. NANOOS supports measurement platforms and a variety of sensors from the coastal ocean into the estuaries. The NANOOS Visualization System delivers data and data products to a variety of ocean users. In 2014-2015, after a decade of planning, platforms and sensors were installed in the northeast Pacific as part of the Ocean Observatories Initiative (OOI), a long-term program funded by the U.S. National Science Foundation. The OOI system includes coastal moorings and gliders placed to measure on both sides of the large Columbia River outflow, and hosts a cabled seafloor observatory. These coastal ocean observing assets are used to measure and understand a variety of important processes occurring in the northern California Current including the seasonal development of near-bottom hypoxia, the far reach of anomalous Columbia River freshwater input, and the “warm blob” of 2014-2015.

October 17, 11:50 (W6-10800)

Fishes as indicators of ecosystem change and how they can be incorporated into coastal ocean observing systems

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Technological advances have considerably enhanced coastal observations of the physical and chemical ocean environment, but ecological variables – observations of ocean populations and communities – remain poorly covered. However, there is growing evidence that ocean communities are undergoing significant change related to anthropogenic stressors. Global implementation of a representative system of ecological time series is therefore critical. I demonstrate here that fish egg and larval surveys, commonly utilized for stock assessment, can also provide sensitive indices for community-scale ecological change if properly implemented and analyzed. Even limited single-transect ocean observation programs can contribute to a global network of systematic ocean ecology time series. This paper reviews the key characteristics for the successful implementation of such a global network of ocean ecological time series.

October 17, 12:10 (W6-10404)

An overview of wireless communication technology in ocean observing system

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Wireless communication plays an essential role in ocean observing systems. It is the key technology to implement the integration and interconnection between ocean observing platforms and instruments. A single communication system is unable to meet the requirements of various environments in ocean observing because of the diversity of ocean environments. This paper discusses two categories of wireless communication technology: transmission by air and by water based on the different platforms and instruments being deployed in North Pacific ocean observing systems. Features of different wireless communications which are applied in ocean observing systems are analyzed and compared, in order to understand the basis for selecting communication methods in various ocean environments.

October 17, 12:30 (W6-10566)

A vision for the integrated coastal ocean observing system in Korea

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This talk updates the current status of coastal ocean observing platforms, including tide-gauges, high-frequency radars, and hydrographic stations, on the coast of Korea. Oceanographic government agencies, institutions, and universities have contributed to the observational efforts in coastal regions with different objectives. Their integrated observational efforts and potential synergetic outcomes will also be discussed.

Abstracts
Posters

S1: Science Board Symposium
Change and Sustainability of the North Pacific

S1-P1

Socio-ecological linkages enhancing the resilience of Japan's Urato Islands

Akane Minohara and Robert **Blasiak**

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In order to sustain livelihoods and maintain human well-being, there must be conservation and sustainable use of natural resources. This poster focuses on the role that strong socio-ecological linkages have played in fostering resilience within communities on the Urato Islands, which are located off the Pacific coast of Miyagi Prefecture in northeastern Japan. The region is particularly prone to natural disasters such as earthquakes, tsunamis and typhoons. Research has been conducted to understand the role that strong human-nature bonds played in the resilience of the communities following the Great East Japan Earthquake and Tsunami of 11 March 2011. Although the magnitude of the earthquake and tsunami exceeded any other such events in recorded history, field visits conducted from 2011-2015 indicated that a confluence of strong community bonds and first-hand experience with both terrestrial and marine systems accumulated over generations contributed to the robust response of local communities. This poster illustrates a range of the formal and informal practices and activities that have sustained the communities as well as specific community-based and multi-stakeholder actions taken following the Great East Japan Earthquake and Tsunami to support the revitalization of the communities on the Urato Islands.

S1-P2

Change of the dense bottom water production on the northern Okhotsk Sea shelf and its transport to the intermediate layer of the North Pacific

Yury **Zuenko**, Alexander Figurkin, Vladimir Matveev and Elena Ustinova

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Production of water with σ_θ >26.6 in the northern Okhotsk Sea is analyzed for the last two decades. This water of high density forms in the process of freezing and accumulates at the northern shelf bottom, then sinks to the intermediate layer as intrusions having lowered temperature and heightened oxygen content, which are transported by cyclonic circulation to the southern Kuril Straits, mainly De Vris Strait, and further to the North Pacific. Its annual production is related with fluctuations of the Okhotsk Sea ice cover and both processes have negative tendencies with decreasing of the ice cover and warming, de-oxygenizing, and shallowing of the intrusions. Lag of year-to-year changes in the intrusions in the southern Okhotsk Sea corresponds to several years of this water transport between the northern and southern areas. Rate of the water properties transformation during this transport is related with the 18.6-years tidal cycle, obviously because of tidal mixing influence. The intrusions are still distinguishable in the North-West Pacific in the vicinity of the straits; further eastward they dissipate ventilating the North Pacific Intermediate Water. So, the tendency of the NPIW de-oxygenizing could be explained by reducing of the dense bottom water production associated with decreasing of the ice cover in the northern Okhotsk Sea. However, decadal changes of the ice cover and dense water production are not traceable in the water properties beyond the formation area because of distortion by tidal mixing variation.

S1-P3

Climatic changes of temperature, salinity and nutrients in the Amur Bay of the Japan Sea

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Recent climate-scale (>3 decades) changes of water temperature, salinity, and concentration of inorganic phosphorus, silicon and nitrogen (nitrite and nitrate) are considered for the Amur Bay near Vladivostok. Mean seasonal values of these parameters are determined for the 1980s and 2000s. In summer, the climatic tendencies noted are SST heightening, temperature at the sea bottom lowering, and depletion of nutrients, except nitrate, in the upper layer. In general, the bay becomes more stratified, but the primary productivity does not decline substantially because of external nitrate inputs, presumably from the atmosphere. Links of the changes with climatic conditions are analyzed. Summer monsoon weakening is defined as the main reason of the stratification strengthening in the bay. Its rate determines weather conditions over Primorye and cross-shelf exchange on its shelf. The relationship of the Amur Bay environments with the summer monsoon presents the mechanism of large-scale climate changes downscaling to mesoscale level. It is concluded that the Amur Bay is more vulnerable to marine than terrestrial processes, despite it being subjected to large river discharge.

S1-P4

Geographic variation in Pacific herring growth in response to regime shifts in the North Pacific Ocean

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Pacific herring populations at eight North Pacific Rim locations were simulated to compare basin-wide geographic variations in age-specific growth due to environmental influences on marine productivity and population-specific responses to regime shifts. Temperature and zooplankton abundance from a 3D lower-trophic level ecosystem model (NEMURO) simulation were used as inputs to a herring bioenergetics growth model. Herring at California, the west coast of Vancouver Island (WCVI), Prince William Sound (PWS), Togiak Alaska, the western Bering Sea (WBS), the Sea of Okhotsk (SO), Sakhalin, and Peter the Great Bay (PGB) were examined. The half-saturation coefficients of herring feeding were calibrated to climatological conditions at each of the eight locations to reproduce averaged size-at-age data. Using the calibrated half-saturation coefficients, the 1948 to 2002 period was then simulated. The detected shifts of herring age-5 growth showed close match (69%) to the climate regime shift years (1957/58, 1970/71, 1976/77, 1988/89, 1998/99). The first principal component of herring growth rate showed decreased growth at the SO, PWS, WCVI and California locations and increased growth at the Sakhalin, WBS and Togiak locations after 1977. The calibrated half-saturation coefficients affected the degree to which growth was sensitive to interannual variation in water temperature versus zooplankton. For sustainable use of marine resources, knowledge for the local and regional responses of the marine resources is essential. The model results demonstrate how geographic specificity of bioenergetics parameters, coupled with location-specific variation in temperature and food, can combine to determine local and regional responses of a marine resource to climate forcing.

S1-P5

A multivariate assessment of eutrophication in three typical bays of the northern Zhejiang, East China Sea

Ran Ye[1,2], Xiansen **Ye**[1], Lian Liu[1], Min Ren[1], Qiong Wang[1], Kai Wang[2], Wei Cao[1], Qinyan He[1] and Yanhong Cai[1]

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Three bays, Hangzhou Bay (HZB), Xiangshan Bay (XSB), and Sanmen Bay (SMB) in northern Zhejiang that connect to the East China Sea (ECS) are considerably influenced by a serious consequence of eutrophication. Nutrient levels and ratios have substantially increased over the past three decades due to anthropogenic activities. We quantitatively analyze the eutrophication status and driving factors in the three bays using multivariate statistics applied to data from two cruises (spring (May) and summer (August)) in 2014. Results show that HZB is characterized by high concentrations of nutrients (dissolved inorganic nitrogen, phosphate and silicate) and nitrogen/phosphorus (N/P) ratios; SMB is characterized by high silicon/nitrogen (Si/N) and silicon/phosphorus (Si/P) ratios; and the nutrient concentrations and atomic ratios in XSB are relatively low. Principal component analysis (PCA) shows that the eutrophication situation in HZB is mainly affected by urban and agricultural discharges, while mariculture activities and domestic sewage discharges are responsible for XSB and SMB eutrophications. Total score of principal components (TSPC) reveal that the eutrophic magnitudes in the three bays can be ranked as HZB > SMB > XSB on spatial scale and show a seasonal pattern, being higher in summer compared with spring. Total organic carbon (TOC), total nitrogen (TN) and dissolved inorganic nitrogen (DIN) are the major driving factors responsible for eutrophication in HZB; chlorophyll-*a* (Chl-*a*), dissolved inorganic phosphorus (DIP), and DIN for XSB; and TOC, TN, and DIN for SMB.

S1-P6

Change dynamics analysis of the shoreline using optical sensors in coastal stretch of Bay of Bengal, India

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Coast is a unique environment in which atmosphere, hydrosphere and lithosphere contact each other. Coastline is one of the most significant linear features on the earth's surface, which show a dynamic nature. Coastal zone and its environmental management need the information about coastlines and their changes. Change dynamics in this regard, is extremely helpful to assess the trend of the coastline shift depending on which future shoreline position could be ascertained or predicted under generating different scenario. Coastal zones are most vulnerable for land use changes in this rapid industrialization and urbanization epoch. It is necessary to evaluate land-use/land-cover (LU/LC) changes to develop well-organized management strategies. The main Information on LU/LC in the form of maps and statistical data is extremely vital for spatial planning, management and utilization of land. In the study, remote sensing and geographic information system (GIS) were used in order to study LU/LC changes. Change detection helps in ascertaining shoreline trend analysis and its future prediction. In this study, the coastal tract of the part of Bay of Bengal, which is sensitive to rapid shoreline change, is chosen. Applying remote sensing and GIS techniques on the multi-temporal satellite image and topo-sheets, shoreline extraction using water index and subsequent change detection analysis have been carried out to assess the erosion-accretion pattern in the region at both regional and local scale. Depending on the erosional pattern, the entire study area was divided into four erosional-cells, and independent study was carried out in different cells.

S1-P7

Seasonal variability of phytoplankton in the North Pacific and North Atlantic Ocean from space

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Taking advantage of 13-year series of remotely sensed chlorophyll a, the changes in phytoplankton seasonality (bloom timing and magnitude) are examined in the North Pacific, North Atlantic and the North Indian Ocean in the prevalence of bimodal seasonal cycles. The ensemble empirical mode decomposition and multiple linear regressions are combined to examine the impact of environmental forcing on phytoplankton seasonality. In the temperate North Atlantic Ocean and North Pacific Ocean, spring blooms are tending to earlier and lower magnitudes, while autumn blooms are tending to later and increased magnitude.. The bloom characteristics in the Arabian Sea show a complicated pattern; the region near the Persian Gulf presents delayed and increasing spring blooms with earlier and decreasing autumn blooms, while the bloom timing and magnitude in the region near the Red Sea show opposite patterns. Changes in modulated annual cycles and bloom characteristics present a clear signature of environmental factors, especially sea surface temperature. Sea surface temperature, and to a lesser extent wind stress, is closely associated with bloom characteristics in the North Pacific. Modulated annual cycle of chlorophyll-a in the North Atlantic Ocean is mainly associated with changes in photosynthetically active radiation. Wind stress appears as the most important factors in the Arabian Sea. These results illustrate the potential of different environmental factors to explain the seasonal variability of phytoplankton and its distributions.

S1-P8

A quantitative definition of global warming hiatus and 50-year prediction of global mean surface temperature

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Recent global warming hiatus has received much attention; however, a robust and quantitative definition for the hiatus is still lacking. Recent studies (Scafetta, 2010; Wu et al., 2011; Tung and Zhou, 2013) showed that multi-decadal variability (MDV) is responsible for the multi-decadal accelerated warming and hiatuses in historical global mean surface temperature (GMST) records, though MDV itself has not received sufficient attention thus far. Here, we introduce four key episodes in GMST evolution, according to different phases of the MDV extracted by the ensemble empirical mode decomposition method from the ensemble HadCRUT4 monthly GMST time series. The “warming/cooling hiatus” and “typical warming/cooling” periods are defined as the 95% confidence intervals for the locations of local MDV maxima/minima and of their derivatives, respectively. Since 1850, the warming hiatuses, cooling hiatuses and typical warming have already occurred three times, and the typical cooling, twice. At present, the MDV is in its third warming hiatus period, which started in 2012 and would last until 2017, followed by a 30-year cooling episode, while the trend will sustain the current steady growth in the next 50 years. Their superposition presents ladder-like rising since 1850. It is currently ascending a new height and will stay there until the next warming phase of the MDV carries it higher.

S1-P9

Plankton distribution characteristics and its interactive relationship in southern waters of Miaodao Archipelago

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A detailed field survey of biological resources was conducted in the southern waters of Miaodao Archipelago in 2012~2013(4 voyages). The characteristics of phytoplankton and zooplankton and the relationship between them were investigated with multivariate statistical analysis techniques. In total, 94 phytoplankton taxa were identified Diatom species were the main phytoplankton. Twenty-five species of adult zooplankton and 13 larval zooplankton were identified. Copepoda was the main zooplankton. CLUSTER analysis of phytoplankton and zooplankton showed significant seasonal differences in community structure. The phytoplankton community structure of autumn and winter were similar. And the zooplankton community structure of winter and spring were similar. The results of multidimensional scaling analysis showed that the summer phytoplankton community structure was significantly different from others. However, the largest seasonal difference for zooplankton was autumn. Pearson analysis of the characteristic species of phytoplankton and zooplankton in every season based on the SIMPER analysis showed that there was a significant preying between *Sagitta crassa* and diatom in winter and between Mysidacea larva and *Coscinodiscus* sp. in summer. There was a cooperative relationship more than preying between phytoplankton and zooplankton in spring and autumn showing that *Sagitta crassa* had a significant indirect effect on diatom in winter and Mysidacea larva had a significant indirect effect on *Coscinodiscus* sp.in summer. In spring and autumn, zooplankton had no significant effect on phytoplankton and there was a positive interaction between zooplankton and phytoplankton.

S1-P10

Ichthyoplankton assemblage structure of spring in the Yangtze estuary revealed by biological and environmental visions

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The ichthyoplankton assemblage structure in the Yangtze Estuary was analyzed based on sampling from four springs (1999, 2001, 2004 and 2007). In the present study, 42 ichthyoplankton species belonging to 23 families were collected. Engraulidae was the most abundant family, including 6 species and comprising 67.91% of the total catch. Only 4 species (*Coilia mystus*, *Engraulis japonicus*, *Trachidermis fasciatus* and *Allanetta bleekeri*) could be considered as dominant species and together they accounted for 88.70% of the total abundance. The structure of the ichthyoplankton spring community persisted on annual basis, with the dominant species reappearing consistently even though their abundance fluctuated from year to year. This interannual variation probably reflects variable environmental conditions influenced by the bloom of jellyfish, the declining river flow, and overfishing. Canonical correspondence analysis (CCA) indicated a spatial structure of the ichthyoplankton assemblage in three areas: 1) an inner assemblage that is dominated by *Coilia mystus*; 2) a central assemblage dominated by *Allanetta bleekeri* and *Trachidermis fasciatus*; and 3) a shelf assemblage featured by *Engraulis japonicus*. The pattern observed in ichthyoplankton assemblage structure appears to be strongly influenced by depth, salinity and suspended particulate matter gradients. This study was supported by National Natural Science Foundation of China (No.41406136, No.31272663, No.41176138 and U1406403).

S1-P11

The impact of winter East Asia Monsoon and ice coverage variation on Japanese scallop aquaculture in Saroma Lake, Japan

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Saroma Lake is the third largest lake (150 km^2) in Japan, which is characterized by complete ice coverage during winter. Recently, some years with incomplete ice coverage have been observed. It might be associated with climate change. Additionally, Saroma Lake is an important culture site for scallops; variations of ice coverage could possibly impact scallop aquaculture. This study integrated winter East Asia Monsoon (EAM) with atmospheric data on precipitation, temperature and wind, and in-situ observation of Chl-a, water temperature and scallop growth to explore the impact of ice coverage variation on scallop growth in Saroma Lake, Japan. The daily ice condition was detected using MODIS (Moderate Resolution Imaging Spectroradiometer) true color images and employed unsupervised classification method. The results indicated that the winter EAM significantly influenced the ice coverage variations through air temperature in Saroma Lake. When the Monsoon index (MOI) anomaly was in positive phase (2008, 2011, 2012 and 2013), Saroma Lake was completed covered by ice. Also the Chl-a concentration was significant lower in spring, and scallop growth was less than in the other years. On the contrary, in the negative MOI anomaly phase (2007 and 2009), the ice was incomplete covered during whole winter time. The concentration of Chl-a in spring was higher than in other years, and the scallops grew faster. The variation in scallop growth is perhaps due to water environment and climate change. Adaptation to these changes should be considered when developing plans and management for scallop aquaculture.

S1-P12

Exploring nonstationary and scale-dependent relationships between aquatic species distribution and habitat variables using geographically weighted regression

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Global regression techniques that assume spatial stationarity are usually used to study the interaction between aquatic species distribution and habitat variables. In this study, a local regression model named geographically weighted regression (GWR) was used to question the spatial stationarity assumption in exploring the relationships between walleye (*Stizostedion vitreum*) distribution and habitat variables in Lake Erie. The GWR model resulted in a significant improvement of model performance over the two frequently used global regression methods [an ordinary least squares model and an additive model] using the same response and explanatory variables as in the GWR model. The values of local regression coefficients from the GWR model changed significantly among spatial locations implying spatially varying and scale-dependent relationships between walleye distribution and habitat variables. The k-means cluster analyses based on the t-values of local regression coefficients of GWR model characterized special zones of species-environment relationships and had important implications on Lake Erie walleye quota allocation among jurisdictions. In conclusion, spatial stationarity needs to be questioned in studying the relationships between aquatic species distribution and habitat variables and a nonstationary approach, such as GWR, is recommended as a complementary tool.

S1-P13

Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current large marine ecosystem

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The NOAA National Marine Fisheries Service (NMFS) Northwest Fisheries Science Center (NWFSC) currently conducts groundfish research and monitoring projects in collaboration with the fishing industry. Advancements in sampling technologies have allowed new data types to be collected during traditional NMFS surveys. Environmental sensing packages are attached to trawls and record an array of parameters (e.g., depth, temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity, light). Adding a sensor package helps quantify the influence of environmental factors on the catchability for a given species, a stock assessment parameter that relates abundance from surveys to the actual stock size. The relationship between the distribution of low oxygen, an element in an Integrated Ecosystem Assessment, to fish catch and individual fish species responses is potentially important for informing fisheries management. In response to hypoxia observed on the continental shelf of the Pacific Northwest, the NWFSC added an environmental sampling program to the West Coast Groundfish Bottom Trawl Survey. Fishery and environmental sampling was conducted from chartered commercial trawlers from 55-1280 m depth from the U.S.-Canada to the U.S.-Mexico border. During the summers of 2008–2010, dissolved oxygen ranged from 0.02-4.25 mL L^{-1} with 63% of stations experiencing hypoxic conditions. Catch and species richness exhibited significant positive relationships with near-bottom oxygen. The probability of occurrence was estimated for spotted ratfish, petrale sole, greenstriped rockfish and Dover sole. Spotted ratfish and petrale sole were sensitive to near-bottom oxygen, while greenstriped rockfish and Dover sole showed no changes in probability of occurrence in relation to changes in oxygen.

S1-P14

Impact of typhoon on the changing particulate organic matter characteristics: Case study of Nandujiang along the tropical Hainan Island, China

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Studies based on the biogeochemical characteristics of organic matter along typhoon affected river-estuaries in tropical regions are limited. Our study investigated particulate organic matter (POM) characteristics along the Nandu River Estuary (NRE), the largest river on tropical Hainan Island, China. Results based on a suite of carbon isotopic ratios and biomarkers (lignin phenols) are effectively utilized to identify and quantify the differences in POM characteristics during a typhoon affected wet period (August, 2011) and a normal wet period (October, 2012). Short term heavy precipitation due to the typhoon caused large disparity in fresh water discharge as and POM composition across the NRE. These results were observed although there was no significant difference in monthly precipitation and water discharge levels during the two study periods. Results of principal component analysis suggested there are two important factors controlling the POM compositions in NRE. During the typhoon period, POM sources in the riverine region were from soil (53±13%) and freshwater plankton (39±2%). During a normal wet month (without typhoon) the source of riverine region POM was predominately from plankton (73±1%) and soil (20±9%). POM composition in the estuarine regions was predominately derived from marine sources during both study periods. The changing nature of POM composition owing to copious precipitation during typhoons and prolonged land-use change across the Hainan Island are key factors that affect the carbon cycling of the Nandu River Estuary and adjacent South China Sea. This study will serve as a model for other typhoon impacted riverine systems in tropical regions of the world.

S1-P15

Evaluating management strategies of limited data species based on hierarchical demographic approaches: An example using yellow croaker (*Larimichthys polyactis*) along north Pacific coast of China

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Over exploitation for some of the traditionally commercially important species in the north Pacific coast of China has been widely realized. Hierarchical demographic models become ideal for the assessment of data limited species in these areas because of lacking long term surveys and the relative easier availability of the demographic information. Demographic traits often come from short surveys, and vary among studies and over time because of environmental variation and selective exploitation. Hierarchical models readily incorporate this spatiotemporal variation in species' demographic traits by representing demographic parameters as multi-level hierarchies. We applied a hierarchical demographic model to yellow croaker (*Larimichthys polyactis*), a fish that was highly abundant and of high economic values along Pacific coast of China. Elasticity analyses found that fertility affected growth rate more than natural mortality, and fertility and natural mortality of age 1 fish have the most influence on growth rate. Evaluation on spawning season closure and increasing minimum catchable size/age was conducted. We suggest that multiple restoration strategies may be combined to lead to faster restoration of this traditionally important species. We also explored the influence of the changes of the life history parameters, such as earlier maturity under fishing pressure, on the population growth and reproductive contribution. Our study demonstrates the importance of considering the hierarchy of parameters in estimating population growth rate and evaluating different management strategies for species of concern using hierarchical demographic models.

S1-P16

Climate change and the fishery in Russia–2030

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The current state of commercial species in Russian EEZ is at a high level. The main target species of fisheries are walleye pollock, Pacific salmons, herring, cod, halibuts, crabs, and squids. The total national catch in 2011-2014 exceeded about 4.3 million tons, the highest level since 1999. Illegal, unreported and unregulated (IUU) fishery of walleye pollock, salmons, marine fishes, and invertebrates reaches the substantial volume of 0.3 mil t. Therefore, the use of effective measures on fishery management, including the regulation, and the illegal, unreported, unregulated fishery control will allow increasing the national catch by not less than 300 thousand tons. The stock assessment and fishery management are based on analytical approach with account of trawl surveys and statistical fishery data. As the practice has shown, the present methodology of stock assessment generally produces satisfactory results. However, the forecast of Total Allowable Catch 1-2 years in advance needs improvement. The main problems include the projected abundance of recruitment, and validity of age-specific and fishing mortality coefficients. The present studies have shown that the biomass dynamics of commercially important species was significantly impacted by climate variability. Analyzing PDO, AMO indexes, Arctic temperature and sunspot activity for last 100 years, a negative PDO trend in the Northern Hemisphere may be forecasted in the next 20 years. Therefore, a gradual decrease in the biomass of main commercial species is likely to occur in the next 10-20 years.

S1-P17

The International Group for Marine Ecological Time Series (IGMETS): Assessing global oceanic changes through joint time series analysis

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Sustained time series observations provide a wealth of data on ocean physics, biogeochemistry and ecology that can be used to examine, test and refine hypotheses about the functioning of the ocean. Such time series not only allow us to observe processes such as ocean warming, circulation, eutrophication and deoxygenation but also generate information about key ecological processes and how the marine environment is being affected by climate change at the local, regional and global levels. Maintaining these time series is critical to identifying and predicting such changes; however, existing observations are limited in use if they are not made accessible. The International Group for Marine Ecological Time Series (IGMETS) was formed under the auspices of the UNESCO Intergovernmental Oceanographic Commission (IOC) with the aim of integrating and broadening the utilization of existing time series data to help promote cost-efficiency for new and established sampling programs, increase awareness of these programs and their importance, create a platform for modeling studies, and provide a strong basis for future predictions to support sound policy decisions and advice. PICES has made enormous contributions to our understanding of the North Pacific Ocean through its programs, publications and working groups. This presentation describes how the work of PICES, and data from ocean time series maintained by its member countries, is helping IGMETS to achieve its goals, including the creation of a report based on joint time series analysis to identify and interpret temporal and spatial patterns of key ocean parameters on a global scale.

S1-P18

Island economic vulnerability to natural disasters — The case of Changdao

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The paper takes Changdao County as sample to analyze differentiated impacts of natural disasters on island counties. The result shows that under increased population densities, small islands quickly face binding size limitations and suffer diminished per-capita resources from sustained population increases. The isolated, high-risk geography of small islands exacerbate the scale of a natural disaster shock, rendering many risk-pooling local mechanisms ineffective; disaster assistance flows were also shown to be ineffective in this study. In an environment of increasing weather hazards and resources at risk, it is imperative to understand the determinants of natural disaster vulnerability towards future loss mitigation. Importantly, disaster-thwarting polices must consider perverse implications of economic development measures, such as per-capita income, and infrastructure investments interacting with increased population densities.

S3: FIS Topic Session
Eastern-western approaches to fisheries: Resource utilization and ecosystem impacts

S3-P1

Assessment of Korean pollock population under data-limited situation

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Since the late 1990s, walleye pollock (*Gadus chalcogrammus*) fisheries in Korean waters have been considered collapsed. Though many fisheries scientists suspect that such a collapse might have been triggered by overexploitation of the pollock population, or an environmental change, such conjectures have not yet been tested or investigated partially because data on the population are limited. There has been no survey of the population, fish ages in fishery catch were rarely determined, and the gear for the fishery catch was not recorded. Instead, the fishery catch data from 1975-1999 include information about two life stages (juveniles and adults), and data on fish body size (e.g., length) and sex while catch per unit effort (cpue) data from longline and gillnet fisheries are sporadically available from 1983-2007. As one of the initiatives for the investigation, we quantitatively assess the stock status first because the assessment has not yet been made. The assessment is challenging because of lack of data.

S3-P2

Fishery stock assessment and management system in Japan

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For marine fisheries resources around Japan, stock assessment is conducted for 84 stocks of 54 species based on a Japanese control rule for acceptable biological catch (ABC). This rule shows how to calculate ABC for each stock according to amount of available information. For example, when biomass is estimated, a type-I rule, which set fishing mortality (F) at an appropriate level, such as F_{med} and $F_{0.1}$, is applied to determine ABC. In addition, this type-I rule specifies the establishment of a recovery reference point called B_{limit}, and if biomass (or spawning stock biomass) falls below B_{limit}, then ABC is calculated based on reduced F. Virtual population analysis is the main stock assessment model used in Japan, and this model was applied to 28 stocks in fiscal year 2013. In recent stock assessments in Japan, vigorous efforts have been made to: (1) work with fisherman to attain consistency of stock assessment results with fishermen's observations about stock status, (2) develop ABC estimation methods that are robust under data poor situations, and (3) explore recruitment estimation methods which improve the accuracy of future stock projections. Current issues for fish stock assessment in Japan include: (1) modification of stock assessment approaches in consideration of ecosystem-based management, (2) introduction of an observer program to understand actual discards, and (3) translation of stock assessment reports into English so that stock assessment results are available to the global fisheries community.

S3-P3

Redistribution of anchovy (*Engraulis japonicus*) wintering stock under climate change scenarios in the Yellow Sea

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With the increasing effects of climate change and human activities on marine ecosystems, the dynamics of fishery resources are changing significantly. The redistribution of fish stocks under climate change scenarios is of great importance and must be considered in guidance for the rational exploitation of the fishery resources under ecosystem-based fishery management. As a key species in the food web of the Yellow Sea, anchovy *(Engraulis japonicus)* plays a critical role in the fish community, as well as in the marine ecosystem overall. The redistribution of anchovy was evaluated using a modified dynamic bio-climate envelope model under four climate change scenarios including RCP2.6, RCP4.5, RCP6 and RCP8.5, which come from Geophysical Fluid Dynamics Laboratory (GFDL) model CM2.0, and represent different emission scenarios, respectively. The resource barycenter was used to evaluate the reaction of wintering anchovy to different climate change scenarios. Results showed that the wintering anchovy stock had an obvious northward displacement, reaching as much as to 2.5-2.7^{o} in the next 30 years. The average speed of this northward shift could be 0.09^{o} per year. There were no significant differences among the four climate change scenarios. In the sensitivity analysis, the scale constant k was not sensitive to the redistribution of anchovy stock, while the intrinsic rate of population increase r was closely related to its redistribution.

S3-P4

Efficacy of fishery closure in rebuilding depleted stocks: Accounting for trophic interactions

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Fishery closures have been increasingly used for rebuilding depleted fish stocks, and the approach is drawing more attention with the emergence of ecosystem-based fisheries management. However, trophic interactions have been rarely studied in stock rebuilding especially at community levels. This simulation study used a multispecies size-spectrum model to explicitly evaluate roles of trophic interactions in the recovery of a depleted target fish stock after fishery closure. A variety of scenarios were developed to simulate the factors that might influence trophic interactions and stock recovery including the number of species within the community, predator size-preference, asymptotic body size, selectivity type, selection size and fishing effort. A fishery closure was simulated to promote the recovery rate of the depleted stock. From the fish community perspective, the targeted fish stock in a 2-species community was easily depleted and generally showed no trend of recovery. On the contrary, the target stock in the 11-species community showed resistance to fishing pressure and remarkable potential to recover to a high spawning stock biomass level. From the harvest perspective, fishing effort, selection size and selectivity type played important roles in stock depletion even though all of them showed trivial influences on stock recovery in the 2-species community. A fishery with dome-shaped selectivity showed less influence on the target stock than with sigmoid-shaped selectivity, but the recovery pattern under the two selectivity types were similar. High fishing effort and large selection size generally prolong recovery time, but the pattern tended to be nonlinear. Generally, the efficacy of fishery closure depended on the trophic structure of fish community, and a carefully designed manipulation could be more efficient in rebuilding depleted stock than “leaving the ecosystem alone”. This study contributes to a better understanding of the rationality of fishery closures and promotes the efficacy of fisheries management for a wide range degraded ecosystems.

S4: MEQ Topic Session
Indicators of emerging pollution issues in the North Pacific Ocean

S4-P1

Acute effects of emamectin benzoate on the calanoid copepod *Pseudodiaptomus poplesia*

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Emamectin benzoate (EMB) has been widely used by the salmon aquaculture industry and agriculture as an effective anti-parasitic pesticide. However, direct releases into seawater has produced potential effects on non-target organisms, such as copepods. As an important estuarine species, the calanoid copepod *Pseudodiaptomus poplesia* is widely distributed in coastal and estuarine waters in China. The aim of this study was to assess the toxicity of EMB through acute toxicity tests. Lethal concentration by 50%, effects concentration by 95%, and biochemical responses, such as respiration (R), filtering rates (F), grazing rates (G) and the activity of various oxidases were measured. Acute assays during 96h for EMB showed LC50 was 23 ng/ml (confidence interval, CI 95% 5.9–39.1), and EC95 during 24h was 20 ng/ml. In this study, significant induction in SOD and an increase in R, F, G and CAT were observed at lower concentrations (1.25-2.5 ng/mL). Respiration and CAT showed significant induction at high concentrations (20 ng/mL). Concentrations of EMB showed no significant effects on GST and protein, while the activity of GPX showed clear increases. Results suggest that the normal physiological characteristics of *Pseudodiaptomus poplesia* could be affected if the concentration of EMB exceeds 1 ng/mL, and death becomes apparent at concentrations greater than 20 ng/ml. Although the concentrations of EMB in the marine environment did not suggest adverse impacts to copepods at present, our results will inform the assessment of possible consequences of EMB in nearby areas, where intensive salmon farming is practiced.

S4-P2

Phototransformation of oxytetracycline in saline waters under simulated sunlight irradiation: Kinetics, mechanism and products

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Presented by Qian Zhou on behalf of Cui Zhang

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Pharmaceuticals and personal care products (PPCPs) are now recognized as a new class of pollutants and have been the subject of growing concern and scientific interest. Oxytetracycline (OTC) is widely administered in the form of medicated pelleted feed in marine aquaculture and modern animal husbandry due to its therapeutic value and low price. It is characterised by a low oral bio-availability. In this study, OTC photolysis in saline water was investigated with attention given to 1) the effects of major solutes in seawater on OTC photolysis; 2) the contribution of direct photolysis and reactive oxygen species (ROS, i.e. HO•, $^1O_2$, $O_2^{\bullet-}$) to OTC degradation; and 3) the products of OTC photolysis under different transformation pathways in saline water. OTC photolysis followed first order model kinetics, with about 74% of OTC phototransformation being independent of oxygen in air. The effect of initial OTC concentration, solution pH, ionic strength, divalent metal ions (Ca^{2+}, Mg^{2+}) and photoreactive species (NO_3^-, Fe^{3+} and humic acid) on photolysis of OTC were also evaluated. Additionally, the generation of photoproducts was monitored by high-performance liquid chromatography electrospray ionization mass spectrometry (LC-ESI-MS) and co-analyzed with radical quenching results. Four possible photolysis pathways (direct photolysis, HO•-induced, $^1O_2$-induced and $O_2^{\bullet-}$-induced degradation) and seven corresponding products were proposed. Our study should provide useful information for predicting the photochemical behavior of OTC in saline water.

S4-P3

Assessment of marine environment quality of the coastal zone of Peter the Great Bay (the Sea of Japan/East Sea)

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Presented by Olga Likyanova on behalf of Tatyana Belan

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To assess marine environment quality of coastal zone of Peter the Great Bay in 2013, the chemical data sets were used. Chemical data included contents of selected trace metals (TM), petroleum hydrocarbons (PHCs) and chlorinated pesticides (the sum of DDTs) in bottom sediments. According to available data, the most polluted areas were Vladivostok inner harbour (Golden Horn Inlet) and Nakhodka Inlet. The highest content of PHCs (13.02 ppt), TM: Cu (225.0 ppm), Pb (271.0 ppm), Zn (532.5 ppm) and sum of DDTs (96.1 ppb) recorded in the middle part of the Golden Horn Inlet and exceeded the threshold concentrations causing negative biological effects.

The highest concentration of PHCs and the sum of DDTs in Nakhodka Inlet was 1.85 ppt and 19.3 ppb, correspondingly. Maximum of TM content was: Cu - 63.0 ppm; Pb -61.0 ppm; Zn – 216.5 ppm.

The above mentioned pollutants in bottom sediments are capable of causing mass mortality of benthic organisms. However, this is not a complete list of all pollutants entering the water and sediments Golden Horn and Nakhodka Inlets. It should be remembered the combined impact of all kinds of chemical compounds on benthic organisms, which is definitely superior to the toxic effect of individual pollutants under consideration.

S4-P4

Metal concentrations in pink and chum salmon (Kuril Islands, the North Western Pacific)

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Concentrations of the elements zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), arsenic (As), and mercury (Hg) in chum (*Oncorhynchus keta*) and pink (*O. gorbuscha*) salmon, caught in different years, seasons and places in North Western Pacific Ocean, were determined. Among the studied microelements, copper and zinc are considered essential elements, while cadmium, lead, arsenic, mercury are non-essential elements. All can be found in the organs and tissues of organisms. In chum salmon, in which all of the samples were much larger than pink salmon, the identified elements were present at higher concentrations. None of the concentrations observed exceeded the maximum permissible concentrations under Russian guidelines. Results reflect a combination of anthropogenic and natural sources, including volcanic activities and ocean upwelling.

S4-P5

Estimation of seawater pollution in Uglovoy Bay (Peter the Great Bay, Japan/East Sea)

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Presented by I. Blinovskaya on behal of O. Losev

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In the Far Eastern seas of Russia, the greatest threat from human activities is likely to be found in Peter the Great Bay. Among the many pollutants to be found, metals can be readily detected in seawater. The main sources of pollution in this region are the settlements on the coast, notably those associated with Vladivostok and Ussuriysk. Uglovoy Bay is a bay of the third order in the Japan Sea, and is of great importance from the point of view of the source of balneological resources. Sampling was carried out in the bay in 2010-2015. Chemical analyses were performed using atomic absorption spectroscopy and atomic emission spectrometry with inductively coupled plasma. Results of the study indicate that the concentration of metals in Uglovoy Bay near the low water bridge "De Fries – Sedanka" showed an increase in the concentration of metals in 2015 compared with the previous two years. Copper concentrations attained 1.54 times the maximum permissible concentration (MPC). An increase in annual average concentrations of zinc and lead was also observed, but values did not exceed the MPC. The concentration of iron in the water continues to decline. The spatial distribution of contamination indicates the influence of erosion associated with dam and bridge.

S5: Ocean circulation of the Western Pacific and its response to climate change

S5-P1

Influences of Indian Ocean and Atlantic Ocean SST on the intensity of interannual variability in summer rainfall over southern China

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The intensity of interannual variability (IIV) in southern China (SC) summer rainfall experienced a remarkable increase in the early 1990s, concurrent with the interdecadal increase in SC summer rainfall. Two factors are proposed for this interdecadal change in precipitation. One is the interdecadal increase of IIV in tropical eastern Indian Ocean (TEIO) sea surface temperature (SST) after the early 1990s. Anomalously warmer (cooler) TEIO SST triggers anomalous ascending (descending) motion and lower-level cyclonic (anticyclone) circulation in situ, which in turn induces anomalous descent (ascent) over SC through a meridional vertical circulation. This contributes to interannual summer rainfall variability over SC. The increase in the amplitude of TEIO SST anomalies in the early 1990s led to an intensified interannual variability of summer rainfall over SC. The other factor is the strengthened influence of a coupled mode of the North Atlantic Oscillation (NAO) and North Atlantic triple SST anomaly on interannual variability in summer rainfall over SC after early 1990s. The first two EOF modes of the North Atlantic SST are characterized by a triple pattern and a stripe pattern respectively. The variability of the two modes was nearly equivalent before the early 1990s, but the intensity of the second EOF mode decayed in the early 1990s and its negative effect on NAO was weakened. Compared to the period 1979-1992, the relationship between the NAO and interannual summer rainfall over SC is enhanced during 1993-2008. The NAO exerts an impact on interannual summer rainfall over SC through Eurasian wave-like train (EUW).

S5-P2

The vertical distributions of the volume transport through major exit passages of the Pacific to Indian Ocean Throughflow

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The Indonesian Throughflow (ITF) is one important part of the Great Ocean Conveyor Belt, and is also the significant channel of water and thermohaline exchange between the tropical Pacific and Indian Ocean. It plays an important role in the oceanic heat and freshwater budgets and on the climate system. Based on analyzing the NISTANT (the International Nusantara Stratification and Transport) data, the vertical distributions of the volume transport through three major exit passages (Lombok Strait, Ombai Strait and Timor Passage) are studied. A seesaw pattern of the throughflow between the Timor Passage (below 1500 m, T_{1500}) and Ombai Strait (300~1500 m, O_{300}) was found. The correlation coefficient is -0.61, with O_{300} leading T_{1500} by 7 days. It seems that the recharge-discharge of the water mass of the Banda Sea probably causes this seesaw pattern. Our study can improve the understanding of the role of the Banda Sea in the Indian-Pacific inter-ocean heat and freshwater budgets.

S5-P3

A comparison of wind stress datasets for the South China Sea

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The wind stresses and their derived wind stress curls, and Sverdrup stream functions over the South China Sea (SCS), as well as the island rule transports in typical winter and summer months from nine datasets are compared. The datasets include CCMP, CERSAT, ASCAT, HR, QSCAT, NCEP, QSCAT-NCEP, ERA-40 and ERA-Interim. Results show that the overall patterns of the wind stresses, wind stress curls and Sverdrup streamfunctions from different datasets are similar. However, their magnitudes are remarkably different. Among them, ERA-40 is the smallest while HR is the largest. The latter is about 1/3 greater than the nine dataset ensemble mean value. The spatial resolution is important for the presentation of the wind stress features in the SCS. It can be expected that the same numerical ocean model driven by different wind stress would yield remarkably different results. The transports derived according to the island rule from the nine datasets show similar seasonal fluctuations, but have significantly different magnitudes. The transport through the Luzon Strait is into the SCS from the Pacific, and the transport through the Karimata Strait is inflow to the SCS in summer and outflow in the winter.

S5-P4

Numerical study on the bottom branch of the Yellow Sea Warm Current

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The most noticeable hydrographic feature in the Yellow Sea in winter is the presence of warm and salty water mass along the Yellow Sea Trough (YST), which suggests the existence of Yellow Sea Warm Current (YSWC). Previous studies have shown that the YSWC flows along the western side of the YST, while the circulation in the deep YST remains unknown. In this paper, the circulation in the deep YST was carefully examined by numerical simulations based on the Regional Ocean Modeling System (ROMS) together with observations. The historical observation data and model results indicate the presence of a bottom branch of the YSWC which wanders northwestward along the YST in winter. Model results demonstrate that the bottom branch of the YSWC is driven by the northerly wind and the strength of the northerly wind determines the velocity of the bottom branch of the YSWC. The bottom branch of the YSWC flows over several depressions on the seabed and its pathway is S-shaped and leaning to the west due to conservation of potential vorticity. Numerical experiments also reveal that the bottom friction has important influence on the two branches of the YSWC. The bottom branch of the YSWC becomes rather weak when the bottom friction parameter is small. With the increase of the bottom friction parameter, the west branch of YSWC becomes weaker while the bottom branch of the YSWC becomes stronger.

S5-P5

Rapid freshening of the upper ocean in the South China Sea since the early 1990s

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Ocean salinity is of dynamic, thermodynamic, and climatologic importance in physical oceanography playing an important role in modulating ocean and climate variability. Analyses of the observations reveal that the upper-ocean water in the South China Sea (SCS) had a rapid freshening trend since the early 1990s. Salinity in the SCS above 100 m (S_{SCS}) increased slightly (~0.06) in 1980-1992, while it decreased ~0.24 psu in 1993-2012, with a negative trend of -0.012 psu yr^{-1}. The maximum freshening occurred in the surface layer west of the Luzon Strait and gradually became smaller from northeast to southwest and with depth indicating the important influence of the Kuroshio intrusion. Quantitative analysis of the salinity budget above 100 m in the SCS suggested that weakening Kuroshio intrusion is the leading factor controlling the S_{SCS} freshening, while increased air-sea freshwater flux and river discharge also play a minor role. Based on GODAS (Global Ocean Data Assimilation System) model output, the Luzon Strait transport (LST) above 100 m decreased with a negative trend of -0.12 Sv yr^{-1} (1 Sv=10^{6} m^{3} s^{-1}) from 1993 to 2012, corresponding to a freshening trend of the S_{SCS} at -0.011 psu yr^{-1}. The LST and S_{SCS} changes are all closely related to the Pacific Decadal Oscillation (PDO). It is demonstrated that due to the PDO shifting from the warm phase to the cool phase since the early 1990s, the strength of the Kuroshio intrusion into the SCS weakened markedly, thereby resulting in the pronounced freshening of the SCS water.

S5-P6

A statistical analysis of mesoscale eddies in the northwest Pacific Ocean from 22 years of altimetry data

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The prevalence of oceanic eddies throughout most of the oceans are revealed by recent research analyses using satellite altimetry. The mesoscale eddies variability generally refers to ocean signals with space scale of 50-500 km and time scales of 10-100 days. In the ocean, the energy of mesoscale eddies generally exceeds that of the mean flow by an order of magnitude or more, and eddies can transport heat, salt, carbon, and nutrients as they propagate in the ocean. Mesoscale eddies play a significant role in the dynamic oceanography. The Northwest Pacific Ocean is one of the regions where eddies often-existed. Eddy properties in northwest Pacific Ocean are studied from 22 years (1993-2014) of AVISO altimeter data using a sea level anomaly-based eddy identification approach. In detail, the eddy lifetimes and propagation distances, eddy trajectories and propagation directions, geographical distribution and eddies polarity, eddy origins and terminations, eddy kinetic properties, evolution of eddy properties, and seasonal variability of eddies were analyzed in this region.

S6: POC/BIO/MONITOR/TCODE Topic Session
Ocean Acidification Observation Network for the North Pacific and adjacent areas of the Arctic Ocean

S6-P1

The surface seawater DMS distributions, sea-air fluxes and its influence to sulfur aerosols in the North Pacific Ocean

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The surface seawater DMS shipboard underway measurement was firstly constructed in the Chinese National Arctic Research Expeditions (CHINARE) from the July 2014 to September 2014. High variability of DMS concentrations were evaluated along the transect, and DMS concentration could be as high as 78.4 nM. Significant DMS concentrations and sea-air fluxes were found in the Northwest Pacific Ocean, Bering Sea in July, where DMS concentration and fluxes were 21.75 ± 9.87 nM, 12.34 ± 8.93 nM and 37.56 ± 30.59 µmol m^{-2} d^{-1}, 27.52 ± 24.51 µmol m^{-2} d^{-1}, respectively. It would be the reason that high primary productivity appeared in the ocean. While relative low DMS concentrations and fluxes were observed in September, where DMS concentration and sea-air fluxes were 4.35 ± 1.58 nM, 2.65 ± 1.20 nM and 7.19 ± 6.07 µmol m^{-2} d^{-1}, 12.75 ± 9.70 µmol m^{-2} d^{-1}, respectively. It would be attributed to the low Chlorophyll *a* occurred along the transect which near the continent. Significant MSA concentrations were found in the Subarctic Ocean, and the high atmospheric sulfur species concentrations were consistent with high DMS emissions. The main finding of this study was demonstrated that the North Pacific Ocean would be a significant DMS source to the atmospheric.

S6-P2

Ocean acidification observation system at Bohai Gulf based on ocean acidification characteristic parameters

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Ocean acidification and marine pollution are two of many stressors that our marine environments are contending with right now. The Bohai Gulf experiences concentrated human activity. It is in danger. What is at risk of being destroyed is not the gulf itself, but the conditions that have made it hospitable for human beings. We would build a real time in-situ multi-dimensional observation system based on voluntary observations, ship buoy monitor stations, and satellite remote sensing. From the system, we would get real-time data on ocean acidification and marine pollution in the Bohai Gulf. From these observations, we would explore the relationship among pollution parameters marine quality and ocean acidification in order to improve the marine environment.

S6-P3

Advances in ocean acidification of a vulnerable carbon pool in the Southern Ocean

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The uptake of anthropogenic CO_2 by the global ocean increases hydrogen ion concentration (H^+) and reduces the seawater pH in a process commonly referred to as "ocean acidification" that could have dramatic impacts on biological ecosystems in the upper ocean. Accounting for 22% of the global ocean, the Southern Ocean is a particularly important sink for anthropogenic CO_2, making it a bellwether for global ocean acidification and a natural test area of ocean acidification. The surface water pH in the Southern Ocean has reduced 0.1 unit since the preindustrial value on account of the uptake of CO_2. By the end of the century, it will become another 0.3-0.4 units lower under the IS92a scenario, which translates to a 100–150% increase in [H^+]. Ocean acidification induces fundamental changes in seawater chemistry parameters (CO_2, HCO_3^-, CO_3^{2-}) that could have passive impacts on the formation of calcareous shells by reducing the concentration of CO_3^{2-} and aragonite saturation state (Ωarg). Due to lower sea surface temperature and weak buffer capability, the Southern Ocean is characterized by naturally poor concentration of CO_3^{2-} (105μmol·kg^{-1}) in surface water relative to the tropical sea. Model studies demonstrate that [CO_2] will reach 778 ppm in the atmosphere, causing the concentration of CO_3^{2-} to drop to 55μmol·kg^{-1} in the Southern Ocean which will become undersaturated with respect to aragonite in 2100. Ocean acidification will be more serious under the driving factors, including sea-air CO_2 exchange, sea ice melt, biological processes, upwelling current *etc*.

S6-P4

Surface undersaturation and subsurface maxima of nitrous oxide in the Chukchi Sea Shelf and Chukchi Abyssal Plain

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The first observed depth profile of nitrous oxide (N_2O) from the Chukchi Sea shelf to the west of Chukchi Plateau (WCP) in the western Arctic Ocean was obtained during the 4th Chinese National Arctic Research Expedition (4th CHINARE) in September 2010. The concentration of N_2O ranged from 11.4 to 21.4 nmol L^{-1} at 13 stations. Low N_2O concentrations (11.4 - 16.7 nmol L^{-1}, saturation -8 - 0%) were observed in surface water, which was influenced by the physical diluting process induced by melting sea ice. Relatively high N_2O concentrations were found in subsurface water on the Chukchi Sea shelf and in the upper halocline layer (UHL) of the WCP at depths of 25 - 60 m and ~150 m, respectively. The excess N_2O in the Chukchi Sea shelf bottom water might be related to sediment emissions induced by the coupling of the nitrification and denitrification processes. The maximum in the UHL might be due to the spreading of shelf water, which can transport elevated N_2O levels into the basin.

S6-P5

Seasonal variation of distribution of air-sea CO_2 flux in the Taiwan Strait and its controlling mechanism

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Based on the in situ data obtained in the Taiwan Strait during Chinese Offshore Investigation and Assessment in four seasons (from year 2006 to 2007), the spatial and temporal distribution of air-sea CO_2 flux was calculated combining remote sensing data via an extrapolation method. The seasonal variation of controlling mechanism of air-sea CO_2 flux was analyzed including physical process, biological activities and wind speed. In spring, the Taiwan Strait was a weak CO_2 sink, however in the northern part it turned to be a strong sink. In summer and autumn, part of the strait was a CO_2 sink and others were a CO_2 source. In winter, due to improved primary production, Taiwan Strait was a strong CO_2 sink. In this study area, biological activities and wind speed were the dominant factors controlling the air-sea CO_2 flux.

S6-P6

Trend of ocean acidification in the tropical and subtropical zones of the western North Pacific along 137°E

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Presented by Naohiro Kosugi on behalf of Masao Ishii

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Tropical and subtropical zones of the western North Pacific accommodate many coral reef habitats and marine biodiversity hotspots. Many of the 150 million people that live in these regions depend heavily on fishing and other marine resources. From 3°N to 34°N along 137°E, Japan Meteorological Agency has been making measurements of pCO_2 in the atmosphere and in surface seawater routinely since 1983 and dissolved inorganic carbon (DIC) since 1994. These data are combined to analyze the variation of CO_2 system variables in space and time. The amplitude of seasonal variation in CO_2 system variables in surface water and SST is larger in the subtropical zone (max. ~40 µmol kg^{-1} for salinity-normalized DIC—hereafter sDIC). The seasonal variation in sDIC is ascribed to the convective mixing in winter and biological production in winter to summer. However, the net sDIC decrease from spring to summer occurs under the conditions of very low nitrate and phosphate concentrations. The rate of long-term surface sDIC increase, as evaluated from multi-parameter regression of sDIC as a function of SST and time of measurement for each 1-degree latitudinal band, is significantly different between subtropics (+1.0 – +1.2 µmol kg^{-1} yr^{-1}) and tropics (+0.7 – +0.9 µmol kg^{-1} yr^{-1}). The cause of the meridional variation in the rate of sDIC increase and thereby those of pH and Ω decreases is likely to be associated with the anthropogenic CO_2 uptake/transport pathways in the shallow overturning cell of the North Pacific, but is yet to be investigated.

S6-P7

Effects of CO_2-driven ocean acidification on the early development of scallop *Argopecten irradias* (Lamarck, 1819)

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To investigate the effects of seawater carbonate chemistry changes caused by ocean acidification (OA) on early developmental stages of marine benthic calcifying organisms, we exposed eggs and larvae of *Argopecten irradias*, an important species of bivalve in Chinese aquaculture, in seawater equilibrated with CO_2-enriched (1000 ppm) gas mixtures. We demonstrated that CO_2-driven OA significantly interfered with fertilization and larval development and resulted in a higher aberration rate. Fertilization in CO_2 treatments (pH 7.6) was 74.3±3.8 %, 9.7% lower than that in control treatments (pH 8.3) (84.0±3.0 %). Hatching success decreased by 23.7% and aberration rate increased by 30.3% under the acidified condition. Larvae in acidified seawater were still able to develop a shell during the post-embryonic phase, but shell length and height were smaller than that in control treatments. Development of embryos more than 12 h after fertilization varied significantly between the two treatments. Embryos appeared to develop slower in acidified seawater. Nearly half of the embryos in control treatments developed into D-shaped larvae at 48 h after fertilization, much higher than that in CO_2 treatments (11.7%). Our results suggest that future OA will have detrimental impacts on the early development of *Argopecten irradias*. If the present trend of increasing pCO_2 and decreasing seawater pH continues, future OA will have deleterious impacts on early development of marine benthic calcifying organisms.

S6-P8

Monitoring of eutrophication and ocean acidification off the Changjiang Estuary

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Inputs of anthropogenic nutrients and carbon dioxide-rich waters to the coastal waters can not only lead to eutrophication in the surface water and hypoxia in the bottom water, but also will enhance acidification of coastal water. To understand the detailed mechanism of concurrence of eutrophication, hypoxia and ocean acidification in the Changjiang Estuary, a real time monitoring system was established in 2010 under the support of Chinese National Key Technologies R&D Program and Chinese Marine Research Special Funds for Public Welfare Projects. The platforms of the monitoring system includes a 3-meter buoy with water column chain unit and a seabed mounted unit, the sensors include those for measuring wind speed and direction, air and water temperature, salinity, currents, PAR, DO, *p*H, nutrients, Chl-*a*, turbidity and pCO_2 etc. This presentation will report our recent results from the buoy and mooring deployed off the Changjiang Estuary.

S6-P9

CDIAC data management and archival support for a high-frequency atmospheric and seawater pCO_2 data set from 14 open ocean moorings

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One important project at CDIAC is the data management support for the Global CO_2 Time-series and Moorings Project. This poster will describe the collaboration between NOAA/PMEL Mooring group and CDIAC in the data management and archival of high-frequency atmospheric and seawater pCO_2 data from 14 open ocean sites using moored autonomous systems. Advancements in the ocean carbon observation network over the last decade, such as the development and deployment of Moored Autonomous pCO_2 (MAPCO2) systems, have dramatically improved our ability to characterize ocean climate, sea-air gas exchange, and biogeochemical processes. The MAPCO$_2$ system provides high-resolution surface seawater and atmospheric CO_2 data that can help us understand interannual, seasonal, and sub-seasonal dynamics and provide constraints on the impact of short-term biogeochemical variability on CO_2 fluxes. CDIAC NDP-092 provides a description of the data as well as the methods and data quality control involved in developing an open-ocean MAPCO$_2$ data set.

S6-P10

Spatial distributions of dimethylsulfide (DMS) and dimethylsulfoniopropionate (DMSP) and influencing factors in the Norwegian and Greenland seas during summer

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The dimethylsulfide (DMS), dissolved and particulate dimethylsulfoniopropionate (DMSPd and DMSPp) concentrations were determined in the Norwegian and Greenland Seas during summer of 2012. Surface DMS, DMSPd and DMSPp concentrations in the study area increased significantly from high latitudes to low latitudes, with the average values of 5.36, 15.63 and 96.73 nM, respectively. Moreover, the biological production and consumption rates of DMS were estimated during the cruise, with the average values of 18.19 and 15.67 $nM \cdot d^{-1}$, respectively. Our results showed that the spatial variation of chlorophyll *a* was consistent with that of DMSPd and DMSPp concentrations, suggesting that phytoplankton biomass might play an important role in controlling the distribution of DMSP in the study area. In the surface water, the biological turnover time of DMS varied from 0.03 to 1.8 days, with an average of 0.49 days, which was about 90-fold faster than the mean DMS sea–air turnover time (28.8 days). Thus, the main sink of DMS in the surface water appears to be microbial consumption.

S7: POC/BIO/TCODE Topic Session
Past, present, and future climate in the North Pacific Ocean: Updates of our understanding since IPCC AR5

S7-P1

Effects of CO_2-driven ocean acidification (OA) on early life stages of marine medaka (*Oryzias melastigma*)

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Current understanding of potential effects of high CO_2 and associated ocean acidification (OA) on marine fishes and other non-calcified organisms is limited. In this study, we investigated the responses of early life stages (ELS) of marine medaka (*Oryzias melastigma*) exposed to a series of experimental manipulation of CO_2 levels. Results showed that CO_2-driven seawater acidification (pH 7.6 and pH 7.2) had no detectable effect on hatching time, hatching rate, or heart rate of embryos. However, the deformity rate of larvae in the pH 7.2 treatment was significantly higher than that in the control treatment. There was no significant difference between the left and right otolith areas in each treatment. However, the average otolith area of larvae in the pH 7.6 treatment was significantly smaller than that in the control. Such alterations in the developmental abnormalities and otolith size of marine medaka larvae due to elevated-CO_2 levels suggest that this species will be increasingly challenged by future OA. Further studies of the impacts of OA on marine fish to assess whether or not the environmental influence in one generation can affect the later life history and the phenotype of subsequent generations are needed.

S7-P2

Features of the circulation structure in the Okhotsk Sea based on high-resolution numerical simulation in 1979 to 2000

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We reconstruct and analyze the circulation and its interannual variability in the Okhotsk Sea using the Institute of Numerical Mathematic Ocean Model (INMOM) with high-resolution (3 km on longitude and latitude and 35 sigma levels) and atmospheric forcing extracted from ERA-Interim reanalysis from 1979 to 2000. The INMOM incorporates the sea-ice model and tidal model. The tide model includes tidal forcing of 8 major components. We focus on effects of tidal forcing on basin-scale circulation in the Okhotsk Sea and carry out two numerical experiments with tides and without tidal forcing. Our results demonstrate relevance of the tidal forcing at the numerical simulations of the circulation in the Okhotsk Sea. We reveal features interannual variability circulation in the Okhotsk Sea as in the subsurface layer as in the intermediate and abyssal layers.

S7-P3

Variation and it periodicity of sea surface temperature in the eastern Yellow Sea in the recent 30 years

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Ocean warming was concerned highly worldwide and it had a significant impact on the marine living resources. In the recent 30 years, the sea surface temperature (SST) had a remarkable fluctuation in the Yellow Sea (YS) due to the global change, and this had further impacted on the resource status and abundance distribution of chub mackerel (*Scomber japonicus*). Therefore, the present study analyzed the variation of SST and SST anomaly (SSTA) in the eastern Yellow Sea (eYS) during January 1982 to December 2009, in order to reveal the potential trend of sea temperature in this region. The results can provide the help to understand the response of temperature in this region to the global warming in the context of global change. The results showed that, significantly monthly variation can be found for the mean SST in the eYS and the lowest (17.39±0.1065, mean±SE) and highest (28.45±0.0185) SSTs occurred in February and August respectively. The SST increased from February to August and decreased after that period. Remarkably variations can also be found for the mean monthly SSTs ($t=7.690$, $df=11$, $p<0.001$) and SSTAs ($t=19.408$, $df=11$, $p<0.001$) in the eYS. A significant difference can be found for the mean annual SST before and after 1996, with the SSTs were below the overall mean SST value (22.80°C) before 1996 and vice versa after 1996. Good positive correlation ($r=0.707$, $p<0.001$) can be found for the relationship between annual SST and year. The mean annual SSTA had a 4-5a periodicity before 1996, i.e., 1a positive and 3-4a negative values; the mean annual SSTAs were positive values after 1996. The wavelet analysis showed the SST had 3 significant time scales in the eYS, i.e., 1a, 3a and 4a periodicities.

S7-P4

Development of a regional climate coupled model for the seas around Korea

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The ocean in a regional climate model has been prescribed with observational data of sea surface temperature (SST) or simulated by a slab ocean model often with one-dimensional mixed layer. The prescription of SST does not allow air-sea interaction, and a slab ocean model does not simulate three-dimensional ocean circulation to depth. To overcome such limitations, we have developed a regional climate coupled model (RCCM) for the Northwest Pacific region including the seas around Korea through a two-way coupling of an atmospheric model WRF and an ocean model ROMS. In this study, we have analyzed the coupling effects separately from the downscaling effects by conducting an experiment with the ocean-only model forced with atmospheric reanalysis data and another experiment with a one-way coupling in which the ocean model is inputted with the regional atmospheric model output. The results show that the RCCM overestimates the interannual variability of SST in the East Sea and Kuroshio Extension region. Downscaling with a CMIP5 RCP simulation data, the RCCM projects a SST change in the seas around Korea larger than the ocean-only model and smaller than the one-way coupled model. These results imply that the air-sea interaction has a considerable effect on climate on a regional scale.

S7-P5

The effects of runoff forcing on the summer monsoon onset in a climate model

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The effects of freshwater from river discharge in the Bay of Bengal (BOB) on oceanic thermohaline structure and monsoon processes are investigated using a climate model. The simulated monsoon onset date is delayed in the BOB compared with observation. By restoring river runoff and sea surface salinity toward observation, the time of local summer monsoon onset is more comparable to the observed results. During spring and early summer, the freshwater transported from north to south in the BOB. The variations of sea surface temperature (SST) and ocean salinity are related to fresh water forcing. Before the monsoon onset, SST in the BOB reaches maximum, which is related to changes in atmospheric wind and precipitation. However, the climate model mean state exhibits deviation in salinity and temperature structures. The simulations with and without salinity restoring show that the large fresh water leading to more stable ocean stratification. The cold SST biases in the BOB simulated by the climate model has been alleviated. Due to a more realistic oceanic vertical and horizontal structure simulation, the atmospheric circulation and hydrologic cycle changed accordingly. The monsoon processes represent as wind and rainfall has been improved by restoring ocean salinity and freshwater flux.

S7-P6

The Wyrtki jet simulated in CMIP5 models

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Performances of simulated the Wyrtki jet from the Coupled Model Intercomparison Project Phase 5 (CMIP5) over the tropical Indian Ocean are evaluated. Results show that all of CMIP5 models are able to capture the dominant spatial distribution of the observed Wyrtki jet and reproduce the maximum current over the center part of the equatorial Indian Ocean. The seasonal evolution of the Wyrtki jet over this region is also reproduced with significant amplitude diversity among models. Most of models are able to simulate the Wyrtki jet in boreal spring and fall seasons. Further analysis also reveals that the surface wind field is responsible for the performance of the simulated Wyrtki jet. Despite the successful simulation of the Wyrtki jet in other months, simulations of the Wyrtki jet in December did not match the observations.

S7-P7

The detecting and adjusting of the sea surface temperature data homogeneity over coastal zone of Circum Bohai Sea

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Sea Surface Temperature (SST) data from 6 coastal observation stations in coastal zone of Circum Bohai Sea were chosen for experimental homogeneity studies. Due to the low density of the coastal observation stations, two analytical approaches were adopted to test the homogeneity of the SST series. First, the Penalized Maximal F Test (PMFT) method which does not rely on the reference series was taken to detect change points. Change points were then synthesized and verified with available metadata. Subsequently, a quantile-matching algorithm was used to adjust the time series to diminish discontinuities. This method was suitable to the stations with detailed metadata. However, for some stations without sufficient metadata, In these cases, the Penalized Maximal T Test (PMT) was used. The PMT method relies more heavily on the reference series. We explored options that used air surface temperature data from adjacent meteorological stations which are highly correlated with the base series to construct reference series. Results show that some inhomogeneities exist in the whole SST data series. Instrumental changes are found to be the main cause for discontinuities, followed by station relocation. The annual mean SST trend has changed obviously and homogeneity is improved after adjustment. The warming rate of SST series is larger than that before adjustment, up to 0.25°C/10a. The results could provide a more reliable data set of homogenized in a longer period for the climate studies on coast of China.

S7-P8

Change of beginning and duration of the first stage of Far-Eastern summer monsoon on the southern coast of Primorye

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The summer Far-Eastern monsoon is driven by a complex sequence of changes in airflow, which are determined by the thermal interaction of the Eastern coast of the Asian continent and coastal seas and north-western Pacific Ocean. The first stage of development depends on the thermal contrast mesoscale level (marginal seas - coast). On the southern coast of Primorye, summer monsoon is most clearly expressed. Indices of the beginning and duration of the monsoon in the first stage were derived from the temperature and wind direction at the surface of the earth in Vladivostok during the period 1966 to 2011. This start date falls on April 10 on average. The earliest start dates occurred in the mid-late March in 1985 and in 1992, and the latest start dates occurred in the first week of May in 2006 and in 2010. According to our calculations the average date of the ending of the first stage falls on 10 July, with the earliest ending date being observed on 17 June and at the latest ending date occurring on July 29. There was a reduction in the duration of the summer monsoon' first stage over the last decade. It is connected with later approach of the beginning of a summer phase of a Far- Eastern monsoon. This study also revealed some relationships between the features of the summer monsoon and the condition of atmospheric circulation, so the later approach of the summer monsoon comes amid the warm phase of ENSO. The lowered rate of zonal transfer in the middle troposphere (Blinova's index) in October – January, i.e. in 4 - 7 months also indicates later approach of the summer monsoon. With negative pressure anomalies in the basin of Amur in January and in March, the approach of the summer monsoon is expected to occur later than usual.

S7-P9

Modulation of interannual variability of tropical cyclone activity over Southeast Indian Ocean by negative IOD phase

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Tropical cyclones (TCs) over Southeast Indian Ocean (SEIO) have the notable interannual variability caused by ENSO and Indian Ocean Dipole (IOD). In the September-November of El Niño years and October-November of positive IOD (PIOD) years, the SEIO TCs are far less intense than the climatology. However, it is hard to separately understand the El Niño and PIOD's impact on SEIO TCs due to their similar occurrence time and duration. Unlike El Niño and PIOD, SEIO TCs are much more intense than the climatology in September-November of negative IOD (NIOD). Consequently, it is concluded NIOD mainly affects SEIO TCs' increase. Diagnostic results suggest that the relative humidity (RH) contributes mostly to the TCs' increase, vertical wind shear provides the secondary positive contribution, vorticity term also creates a weak positive contribution and PI term's contribution even may be negligible. The study still uncovers the process of RH change: NIOD reaches its peak period and changes atmosphere circulation to make a positive low-level vorticity anomaly over SEIO. Vorticity anomaly strengthens upward motion. The vertical velocity anomaly and climatogical specific humidity (SH) work together to make vertical advection play a dominant role in SH variation. SH's change mainly reflects in RH variation. Eventually, all of these factors associate with the NIOD, leading to more SEIO TCs in September-November and the significant difference is above 99% confidence level.

S7-P10

The impact of local SST and tropical ISO on the monsoon onset over BOB in CMIP5 coupled models

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In this study, we examined the impact of local SST and tropical ISO on the monsoon onset simulated in 23 CMIP5 coupled models. The coupled modes were skillful in the monsoon domain simulation over BOB, while the simulated monsoon onset was typically late. The evaluated models had difficulties in reproducing the central BOB SST warming and the northward propagation of tropical ISO before monsoon onset. The cold SST biases over BOB was responsible for the late monsoon onset in coupled models. The colder ocean leads to a more stable atmosphere, which will inhibit the convective activity and weakened the mid-upper tropospheric heating. The weakened heating will delay the reversal of meridional temperature gradient in the mid-upper troposphere and eventually result in the late monsoon onset in coupled models. The poor skill in the tropical ISO simulation makes it more difficult for coupled models to simulate monsoon onset accurately. The problems of simulated ISO that may affect monsoon onset simulation in evaluated models could be classified as three kinds: i. abnormal weak ISO in tropical ocean; ii. insignificant northward propagation of tropical ISO during monsoon onset; iii. unreal wavenumber-frequency spectra of equatorial OLR.

S7-P11

Monsoon onset in the Bay of Bengal associated with the first northward-propagating intra-seasonal oscillation

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The Asian summer monsoon in the Bay of Bengal (BoB) is often triggered by the first-branch northward-propagating intra-seasonal oscillation (FNISO) over the tropical Indian Ocean (IO). It is found that the FNISO convection originates from the southwestern IO and propagates eastward. After reaching the eastern IO, the major convective branch moves northward toward the northern BoB and triggers the summer monsoon. The spring warming sea surface temperature (SST) may play an important role in the northward propagation of the FNISO. The accumulated moisture induced by warming SST contributes to a greater convective instability over the northern BoB, which destabilizes Rossby waves and causes convection to shift northward. It is identified here that historical monsoon onset vortex (OV) in the form of tropical cyclone(TC) occurred during the convective phases of the FNISO. With the aid of the genesis potential index (GPI), the significant moistening of mid-level atmosphere, which is embedded in the FNISO convection-enhanced phase, is shown to be the primary factor leading to the cyclone genesis. The water vapor budget analysis further reveals that the vertical advection process, dominated by the anomalous vertical advection of the mean vertical water vapor gradient, plays the critical role.

S8: FIS Topic Session
Marine ecosystem services and economics of marine living resources

S8-P1

Evaluation of the Marine Ecosystem services of the Liaodong Gulf, Bohai Gulf and Laizhou Gulf, China

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The value of marine ecosystem services plays an important role in marine resources development and marine management. In this research, we use the classification method of Millennium Ecosystem Assessment, that is to divide the ecosystem services into food production, gene resources provision, oxygen production and climate regulation, waste disposal, biological control, leisure and recreation, scientific search and culture, primary production, biodiversity and habit provision. The result shows that the total economic values of 10 services of the marine ecosystem services of Liaodong Gulf, Bohai Gulf and Laizhou Gulf is 148.511 billion yuan. Among them, Liaodong Gulf has the largest value, followed by Laizhou Gulf and Bohai Gulf, accounting for 56.7%, 23.3% and 20%. Food production has the largest value in each ecosystem service, accounting for 71%. The high relativity among the food production, oxygen production and climate regulation and primary production. Because they depend on the same primary production phytoplankton and benthic algae. The valuation of marine ecosystem services in this study would help government officials to establish the policy of ecosystem compensation.

S8-P2

Sea use intensity assessment and practice in China – A new methodology for ocean management

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This paper presents a new methodology for ocean resources management, Sea Use Intensity Assessment (SUIA), and applies its calculation to management practice. We begin by illustrating the connotations of sea use intensity. Next, we describe the data collection process. For illustration, our data come mainly from the coastal provinces of LiaoNing, ShanDong, ZheJiang and GuangDong where there is a high level of industrial use of the marine environment. Data and drawings relevant to reclamation projects of port engineering, power industry, shipbuilding industry, petrochemical industry and other industries have been collected. The data have been statistically analyzed and summary statistics estimated. In the third part, factors affecting the sea-use area and the length of the occupied coastlines were analyzed. At the same time, we assessed the status quo of sea use of different industrial projects and established control indexes for reclamation projects of ocean industries. Next, the advantages and disadvantages of establishing indexes and determining their value are analyzed. Finally, we introduce the concept of control indexes and explore their functions in the sea area management and suggest how to popularize them in the future.

S8-P3

Marine ecosystem services value accounting and driving forces: A case study of Xiamen Bay

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The value of marine ecosystem services is estimated in Xiamen Bay from provisioning services, supporting services, regulating services and cultural services according to the *Technical Directives for Marine Ecological Capital Assessment*. The driving forces and the relationship between each marine ecosystem service and different factors including environmental, economic and social aspects are analyzed. The paper explores reasons that the marine ecosystem was degraded from human and natural aspects in Xiamen Bay. Some suggestions are put forward to ensure a future that is sustainable, prosperous and livable, taking into account the city's economy, ecology, society and culture related to the marine ecosystem.

S10: SB Topic Session
The human dimensions of harmful algal blooms

S10-P1

Toxic *Protoceratium reticulatum* and yessotoxins from the Chinese Yellow Sea

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Protoceratium reticulatum was isolated from north of the Chinese Yellow Sea and cultured in the laboratory. These *Protoceratium reticulatum* cultures were found to produce high concentrations of yessotoxins (YTX), at about 11pg/cell, and trace amounts of homo-YTX. This Chinese strain of *Protoceratium reticulatum* had the closest genetic relationship with Japanese P. *reticulatum* strain using internal transcribed spacer (ITS) analysis. Low concentrations of yessotoxin accumulated in shellfish after being fed *P. reticulatum* isolates. The distribution and accumulation of YTX produced by the *Protoceratium reticulatum* in China will be reported.

S10-P2

Application of qPCR methods in detection of PST-producing *Alexandrium* species in the Yellow Sea and East China Sea

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Saxitoxin (STX) and its analogues, commonly known as paralytic shellfish toxins (PSTs), are produced by some marine dinoflagellates in the genera *Alexandrium*, *Gymnodinium* and *Pyrodinium*. PSTs were frequently detected in shellfish cultivated in the Yellow Sea (YS), China, where both toxic and non-toxic *Alexandrium* species have been reported. Specific monitoring of PST-producing microalgae is quite difficult because they are morphologically identical to non-toxic isolates. In this study, we applied a qPCR assay targeted to *sxtA4*, a domain of the *sxt* gene cluster that encodes a unique enzyme involved in STX biosynthesis to monitor PST-producing algae in spring of 2012 in the YS. In addition, TaqMan-based qPCR assays were employed to analyze toxic *Alexandrium fundyense* and *A. pacificum* of the *Alexandrium tamarense* species complex that previously has been reported in YS. High performance liquid chromatography (HPLC) was used to analyze PSTs in parallel with qPCR assays. It was found that *Alexandrium fundyense* and *A. pacificum* were distributed in different regions in the YS and East China Sea. The distribution patterns of the *sxtA* gene coincided with those of the toxic algae *A. fundyense*/*A. pacificum* and PSTs. *SxtA*-based qPCR results correlated well with abundances of *A. fundyense*/*A. pacificum* derived from TaqMan-based qPCR assays (r^2=0.734). This study suggests that *A. fundyense*/*A. pacificum* were major PST producers during the sampling season, and *sxtA*-based qPCR is a promising method to monitor PST-producing algae in YS.

S10-P3

Advances in marine algae hemolysin molecules

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Hemolysin produced by microalgae impacted on the marine environment, it is an important cause of death of fish and shellfish, the study of the hemolysin is currently in infancy at home and abroad. This article summarizes the molecular structure of hemolysin has been reported, there are divided into five categories, Glycolipids, Amphidinolides, long-chain polyenes (Amphidinols, Colopsinols and Karlotoxins), Porphyrins and Prymnesins compound. This review provides the basis for study of hemolysin.

S10-P4

Numerical study on the prediction of the Harmful Algae Blooms in the East China Sea

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According to the demands of the HAB disaster early warning and forecasting system, ecodynamics research on the short-term prediction of HABs for the East China Sea was conducted. The parameters of the biochemical model were optimized for the East China Sea demonstration area. The HABs occurrence probability was calculated according to the threshold criteria of environmental factors acquired from a numerical model. The HABs prediction model based on statistical likelihood was used to test the operational forecast. This preliminary operational HABs forecast system can be used to forecast HABs outbreak associated with key triggering factors in the marine environment. Combined with the HABs statistical prediction method to assess likelihood, this prediction model serves to prevent and mitigate HAB disasters in the East China Sea.

S10-P5

Prediction, prevention and mitigation of harmful algal blooms in the China Sea

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Ranging from microscopic, single-celled organisms to large seaweeds, harmful algal blooms (HABs) pose a serious threat to public health, aquatic organisms, commercial fisheries, and the quality of fresh water lakes, rivers and reservoirs, as well as marine coastal environments. Over the past few decades, the world's coastal waters have experienced an increase in the number and type of HAB events. In the China Sea, every coastal province frequently experienced HAB events and suffered from more and more serious economic losses and human illness and death in the last decade. A pressing need exists to understand, monitor, and predict the outbreak of HAB events and to propose the efficient emergent management methods. In this study, the several kinds of prediction methods are introduced, including empirical prediction methods, statistical prediction methods, and numerical model prediction methods. In particular, the common prediction methods used in the national marine environmental operational forecasting systems for early warning red tide and green tide are proposed to understand the HABs occurrence mechanism and to promote HAB disaster prevention and mitigation in China. In order to improve the ability to respond to marine environmental disasters, operational HAB early warning and forecasting system and advanced emergent disaster mitigation system should be established in China as soon as possible.

S10-P6

Study on the changes of phytoplankton composition and climate in Qingduizi Bay Chinese northern Yellow Sea

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We collected the ecological data surveyed in October 1987 for Qingduizi Bay. For phytoplankton, 79 species of diatom and dinoflagellate were identified, of which diatom included 70 species, and dinoflagellate included 9 species. Dinoflagellate species accounted for 11% of the total species. The total biomass of phytoplankton was $2.0×10^7$ cell/m^3, and the ratio of N/P was 12.66:1. The average air temperature in October was 11.3°C from 1978 to 1987, whereas the mean sea surface temperature was 15.3°C from 1973 to 1982. In October 2012, the phytoplankton ecological survey for Qingduizi Bay identified 25 species. They included 21 diatom species, and 4 dinoflagellate species. Dinoflagellate species accounted for 16% of the total species. The total biomass of phytoplankton was $7.0×10^7$ cell/m^3, and the ratio of N/P was 29.48:1. The mean air temperature of October was 12.1°C and the average sea surface temperature 18.2°C by using remote sensing method from 2003 to 2012. This survey identified a new record species-*Leptocylindrus minimus*. It first appeared in Qingduizi Bay, and became the dominant species. The dominance index was 76.9%. Its abundance varied between $0.06\sim39.94×10^7$cell/m^3, with an average of $5.8×10^7$cell/m^3. From 1987 to 2012, the composition of phytoplankton community in Qingduizi Bay has changed. The proportion of dinoflagellate species in the total number rose nearly 5%. These changes might be related to N/P rising from 12.66:1 to 29.48:1, and mean air temperature in October increasing by 0.8°C between 1978-1987 and 2003-2012, and mean sea surface temperature in October rising by 2.9°C between 2003-2012 and 1973-1982.

BIO Contributed Paper Session

BIO-P1

Distribution modeling for species and species assemblages, an exploration of spatial patterns with gradient forest

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Species distribution modeling (SDM) is becoming a recognized tool to map the presence or abundance of target species in unsampled locations. The fundamental assumption in SDM is that species inhabit areas within the environmental niche they are adapted to, and are found in greater densities in more suitable environments, while they do not inhabit areas that are too cold or too hot, too fresh or too saline, too shallow or too deep. Using point observations of species presence/absence/abundance in conjunction with mapped data that describe physical and chemical characteristics of this environmental niche, the statistical relationship between a species and its environment can be formalized and predictive maps of the species presence/abundance distribution can be produced. While such maps are very useful as a first approximation, the approach ignores any biotic factors that may also influence the suitability of an area for the target species, through facilitation or competition. As an alternative, gradient forest combines predictive models for a number of species and quantifies the influence of environmental variables on the species ensemble. In the process it detects critical values of key variables, either side of which species assemblages differs dramatically. With the necessary data, gradient forest also allows a quantification of the relative influence of biotic vs. abiotic factors in determining the distribution of a target species. It thus facilitates a test of the fundamental SDM assumption, the results of which may inform how much confidence one should put in SDM results. This is especially crucial in light of the increasing use of climate-projected future species distributions, which rely not only on this assumption but also on its unchanged validity into the future.

BIO-P2

Spatial distribution of $\delta^{15}N$ of chlorophyll-*a* in surface sediment of the northern Benguela Upwelling System

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We analyzed the $\delta^{15}N$ of chlorophyll-*a* (Chl-*a*) in surface sediments of the northern Benguela Upwelling System (BUS), a coastal upwelling system with high primary productivity in surface waters and intensive denitrification in the subsurface oxygen minimum zone (OMZ). Upwelled nitrate is the major N-input to the northern BUS, and is consumed by denitrification and phytoplankton assimilation. Both processes gradually enrich the residual nitrate pool in ^{15}N that is assimilated to synthesize chlorophyll-*a* (Chl-*a*). The $\delta^{15}N_{Chl-a}$ distribution in surficial sediment should thus characterize the combined effects of denitrification and biological assimilation on the $\delta^{15}N$ of nitrate in the overlying shelf waters, and should image the spatial patterns of denitrification and nitrate assimilation, respectively, in the northern BUS.

The onshore-offshore difference (Δ) of $\delta^{15}N_{Chl-a}$ in the northern sector of the studied area (17°-19°S,11°–14°E) is created mainly by fractionation effects of progressive plankton assimilation, because here the OMZ is weak and water-column denitrification is insignificant. In the southern sector (19°-23°S, 11°–14°E) where the OMZ is prominent, additional nitrate loss through denitrification causes most of the Δ of $\delta^{15}N_{Chl-a}$. In coastal upwelling zones where OMZ intensity is coupled to the upwelling dynamics over the shelf, the $\delta^{15}N_{Chl-a}$ in surface sediment captures the spatial patterns of integrated N-loss intensity.

BIO-P3

Phytoplankton phenology in the Bering Sea: Variability and drivers

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Organisms at higher latitudes are adapted to the strong seasonality of environmental forcing. A small timing mismatch between biological processes and the environment could potentially have significant consequences for the entire food web. Climate warming is likely to induce changes in water temperature and salinity, as well as snow melt and sea ice retreat in seasonally ice-covered regions, thus causing timing variability of annually occurring biological events (phenology) such as phytoplankton blooms. This study is focused on synthesizing the available satellite observations and coupled ice-ocean-ecosystem model results to examine the spatial variability in phytoplankton phenology in the Bering Sea and surrounding areas, and to test existing conceptual models on phytoplankton blooms. The results allow us to: 1) quantify the spatial variability in bloom phenology, and 2) identify regions most susceptible to climate-related changes in mixing and light/nutrient availability. The coupled model provides insights to the mechanisms controlling the observed phenological shifts and allows us to assess the phenological responses under future climate-change scenarios. It is anticipated that the changes in phytoplankton phenology have a significant implication for organisms at higher trophic levels, such as zooplankton, fish and marine mammals.

BIO-P4

Diet of long-beaked common dolphin (*Delphinus capensis*) in the East Sea (Japan Sea), Korea

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The long-beaked common dolphin is one of the most abundant cetaceans in Korean waters, and their population has been estimated to comprise of more than 35,000 individuals. Thirty long-beaked common dolphins were collected in the East Sea from February to September in 2012 to study their diet. For stomach content analysis (SCA), the fresh prey items were identified to their lowest taxonomic level, and unidentified preys due to digestion were identified using remnants such as fish otoliths and cephalopod beaks. Fatty acid (FA) patterns of 20 dolphins from the inner layer of blubber were compared with those in the specimens of prey items. *Enoploteuthis chunii* was the dominant prey in SCA, representing 55.8% by number and 75.9% by occurrence. Common squid (*Todarodes pacificus*) and Pacific herring (*Clupea pallasii*) were the next major preys with 14.7% and 18.8% by number respectively. Even though a distinctive difference was not observed between genders, there was a significant diet variation related to maturity. Immature dolphins consumed a higher diversity of prey, and consumed more evenly than the sexually mature group, who showed a high preference for cephalopods. Furthermore, this result is consistent with FA composition of mature dolphins with a raised percentage of 20:6n–3, which is relatively abundant in *T. pacificus*.

BIO-P5

Paleoceanographic changes since 50 ka B.P. inferred from radiolarian assemblages in Gulf of Alaska, subarctic North Pacific

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The paleoceanographic record of radiolarian assemblage during past 50ka is investigated using a box core (SO202-27-6) obtained in the Gulf of Alaska, subarctic Pacific, during the R/V *Sonne* cruise SO202-INOPEX. Ten AMS^{14}C radiocarbon data are used for establishing the stratigraphic age model. Radiolarian study suggests that: (1) *Cycladophora davisiana* is the most dominant radiolarian specie in Gulf of Alaska during past 50 ka, followed by *Siphocampe arachnea* and *Acanthodesmia micropora*. (2) The Q-mode factor analysis obtains 4 maximum variance factors, which represent different radiolarian assemblages. Among them, *C. davisiana* can be used as a proxy for intermediate water of the Gulf of Alaska, which was sensitive to the rapid climate change during glacial-interglacial cycle, and their variable characteristics reveal that the evolution of intermediate water was controlled by the formation and transportation of North Pacific Intermediate Water from subarctic North Pacific. (3) Based on the indicative radiolarian species for environmental changes, such as *Ceratospyris borealis*, *Actinomma boreale/leptodermum* and *Rhizoplegma boreal*, we argue that the paleoceanographic conditions of upper ocean conditions in the Gulf of Alaska underwent periodic changes during past 50 ka. Before the last glacial maximum (LGM), relatively stable surface productivity, sea-ice expansion and retreat, and melt-water pulse (MWP) responded clearly to the interstadial to stadial cycles. During LGM, under the complex effects of ice sheets, atmospheric circulation and oceanic currents, there was rarely WMP continuous sea-ice extension and limited productivity in the Gulf of Alaska. Since LGM, rapid increase and decrease in surface productivity was caused by nutrient-rich water from MWP and by rapid cooling event, respectively.

BIO-P6

Ecological characteristics of zooplankton in the northern waters of Nan'ao Island

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Four oceanographic surveys of zooplankton were conducted in the northern waters of Nan'ao Island, in April, August, November 2011 and February 2012. The species composition, ecological groups, abundance, biomass, dominant species and diversity index of the zooplankton in the zone were investigated using the survey data, and the impact factors of the zooplankton distribution were discussed. A total of 158 zooplankton species were identified, including 46 species in spring, 104 species in summer, 96 species in autumn and 44 species in winter. The fauna of zooplankton belonged to Indo-West-Pacific-tropic-fringe Region with three main ecological groups, such as warm water neritic species, warm water oceanic species, and warm water euryhaline species. The abundance of the zooplankton was 292.31 ind m^{-3} in summer, 143.25 ind m^{-3} in winter, 116.65 ind m^{-3} in autumn and 26.48 ind m^{-3} in spring. The zooplankton biomass was 140.15 mg m^{-3} in summer, 126.75 mg m^{-3} in autum, 89.84 mg m^{-3} in winter, and 37.96 mg m^{-3} in spring. Most of the dominant species were neritic species, and *Centropages tenuiremis* was only one of the annual dominant species. The species diversity of zooplankton was the highest in summer and the lowest in winter. The zooplankton ecological characters, which were closely related to the seasonal variation of water masses, especially the runoffs, had the typical subtropical estuary ecological characteristics in the zone.

BIO-P7

Polyamines response to nutrient limitation stress and their physiological roles in *Skeletonema Costatum*

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Culture experiments were carried out about effects of nutrient limitation on the growth of the *Skeletonema costatum*, in the meanwhile, the activity of dismutase (SOD), diamine oxidase(DAO), polyamine oxidase(PAO), and the contents of malondialdehyde (MDA) and various forms of polyamines extracted from algae cells were monitored. It aimed to explore the response and physiological roles of polyamines to the nutrient limitation stress in microalgae. The results showed that nutrient limitation inhibited the growth of *Skeletonema costatum*, and the inhibiting effect of Si-limited (especially N:P:Si=16:1:4) was greatest, followed by P-limited and N-limited. With the enhancement of nutrient limitation stress, MDA content in the *Skeletonema costatum* cell increased markedly, and SOD, DAO and PAO activities enhanced respectively(particularly N:P:Si=16:1:4 and N:P:Si=64:1:64). In the algae cells increased the polyamine content to relieve nutrient limitation stress and promote growth. However, the type and form of polyamine were different. Under Si-limited stress, algae cells could enhance the free putrescine, spermine and bound spermidine, while under P-limited stress, while algae cells relies mainly on the regulation of free putrescine and conjugated spermine, and under N-limited contents of all forms of polyamine in algae cells would rise

BIO-P8

Contribution of bacterial communities to total primary production in the Northwestern Pacific Ocean

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The Northwestern Pacific Ocean has a various marine environments with latitude. We estimated carbon and nitrogen uptake rates of phytoplankton and bacterial communities in euphotic depths of the Northwestern Pacific Ocean during spring, using a ^{13}C–^{15}N dual isotope tracer technique and a metabolic inhibitor of eukaryote nitrogen metabolism. Carbon and nitrogen uptake experiments of phytoplankton communities were conducted at 9 stations, which consist of two regions, Subtropical Pacific region (SP, 30.7−32.6°N) and Tropical Pacific region (TP, 13.5−21.4°N). Metabolic inhibitor experiments for bacterial contribution to the primary production were conducted at 8 stations. The mean hourly carbon uptake rates of phytoplankton in the SP and TP regions were 20.9 mg C m^{-2} h^{-1} (S.D.= ±16.5 mg C m^{-2} h^{-1}) and 11.7 mg C m^{-2} h^{-1} (S.D.= ±4.8 mg C m^{-2} h^{-1}), respectively. The mean hourly bacterial carbon uptake rates in the SP and TP regions were 1.57 mg C m^{-2} h^{-1} and 5.31 mg C m^{-2} h^{-1} (S.D.= ±2.16 mg C m^{-2} h^{-1}), respectively. The averaged bacterial contributions to the total primary production were 4.82% and 45.5%, respectively in the SP and TP regions. In conclusion, bacterial communities accounted for a larger fraction of carbon and nitrogen uptake rates than phytoplankton in the tropical Pacific Ocean, a low latitude region.

BIO-P9

Carbon and nitrogen uptake rates of phytoplankton in the East Sea (Japan Sea) in 2012

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Carbon and nitrogen uptake rates were measured at 10 selected stations in the East Sea using ^{13}C-^{15}N dual stable isotope tracer technique during Korea-Russian joint research cruise from late October to early November, 2012. The mean carbon uptake rate was 18.04 mg C m^{-2} h^{-1} (S.D. = ± 1.50 mg C m^{-2} h^{-1}) and total nitrogen uptake rate was 9.64 mg N m^{-2} h^{-1} (S.D. = ± 0.68 mg N m^{-2} h^{-1}). Based on nitrate and ammonium uptake rates, f-ratio was 0.16 (S.D. = ± 0.15). For regional comparison, the mean carbon uptake rates were 27.26 mg C m^{-2} h^{-1} (S.D. = ± 9.45 mg C m^{-2} h^{-1}) and 14.09 mg C m^{-2} h^{-1} (S.D. = ± 5.56 mg C m^{-2} h^{-1}) whereas the mean nitrogen uptake rates were 11.01 mg N m^{-2} h^{-1} (S.D. = ± 5.94 mg N m^{-2} h^{-1}) and 9.06 mg N m^{-2} h^{-1} (S.D. = ± 7.31 mg N m^{-2} h^{-1}) in the south and north regions, respectively. Generally, carbon and nitrogen uptake rates were higher in the south than the north region. The contribution of small phytoplankton (<2 μm) was higher in the north (56.95%) than the south (35.29%) based on different size chlorophyll-a concentrations. In conclusion, the carbon and nitrogen uptake rates and f-ratio in this study were lower than those reported previously in the East Sea. Deepened surface mixed later and nitracline probably caused low nitrate availability to phytoplankton and consequently low rates of carbon and nitrogen uptake during the study period.

BIO-P10

Spatial and temporal patterns of primary production in the Japan/East Sea

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The Japan/East Sea has very dynamic environmental conditions with respect to its physical and biological characteristics, but there exists very limited knowledge for spatial and temporal patterns of primary productivity in this ecosystem. Based on a MODIS-derived primary production model, the primary production patterns were analyzed in the Japan/East Sea for the recent decade from 2003 to 2012. The mean daily and annual primary productivity was 0.68 g C m^{-2} d^{-1} (S.D. = ± 0.22 g C m^{-2} d^{-1}) and 246.7 g C m^{-2} y^{-1} (S.D. = ± 22.4 g C m^{-2} y^{-1}), respectively during the study period. The northern and southern regions divided by the sub-polar front showed different spatial and temporal patterns in primary productivity. The mean annual primary productivity in the southern and northern regions were 262.7 g C m^{-2} y^{-1} (S.D. = ± 13.9 g C m^{-2} y^{-1}) and 230 g C m^{-2} y^{-1} (S.D. = ± 13.5g C m^{-2} y^{-1}), respectively. During the observation period, remarkable decreases in the annual primary productivity were observed in the northern and southern regions in 2006, 2008 and 2011. The southern region had a positive correlation between annual primary productivity and Pacific Decadal Oscillation index, whereas the northern region had a positive correlation between productivity and El Nino Southern Oscillation index. Although no clear driving mechanisms were found in this study, the current warming sea surface temperature was suggested for the recent decrease of primary productivity in the Japan/East Sea.

BIO-P11

Relationship between phytoplankton macromolecular compositions and zooplankton proximate compositions in the Southwestern Japan/East Sea

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In the marine pelagic food web, zooplankton as secondary producers and primary consumers play an important role in the energy transfer between phytoplankton and higher trophic levels. The biochemical composition of zooplankton can affect critical physiological status, such as growth and reproduction, of higher trophic levels. Among several factors, changes in the biochemical composition of phytoplankton as major food sources can largely impact on the biochemical composition of zooplankton. Therefore, study on the relationship between compositions of zooplankton and phytoplankton is very important to understand current physiological status of zooplankton. Our study area is mainly in the southwestern Japan/East Sea which is considered as having a high productivity. Samples for proximate compositions (water, proteins, lipids and ash) of zooplankton and macromolecular compositions (proteins, lipids, and carbohydrates) of phytoplankton from April to November, 2011 were analyzed in order to determine the correlation between zooplankton and phytoplankton. As a result, zooplankton and phytoplankton presented large seasonal variations in their biochemical compositions in this study. The protein content of phytoplankton was highest (Average ± S.D.= 42.7 ± 7.4%) in August, whereas lipid was highest (Average ± S.D.= 45.7 ± 2.8%) in April and carbohydrate content was highest (Average ± S.D.= 72.3 ± 6.4%) in June. In comparison, the protein content (D.W.) of zooplankton was highest (Average ± S.D.= 62.3 ± 12.6%) in November whereas lipids (D.W.) were slightly higher in May (Average ± S.D= 6.8 ± 2.3%). We found that the lipid composition of phytoplankton had a significantly positive relationship with the lipid composition of zooplankton (r-value = 0.963, $p < 0.01$).

BIO-P12

Long term change of chlorophyll-*a* concentration in Sanggou Bay, China

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Marine phytoplankton supports the marine ecosystem, which could influence the fisheries yields and carbon absorption capacity of the ocean. chlorophyll-*a* (chla) concentration is widely used for phytoplankton biomass. Sungo Bay is used for extensive shellfish and seaweed longline cultures since 1983 and more than 70% of the water surface areas were used as longline mariculture. Chla concentration data were collected from 1983 to 2014. The relationship between chla concentrations and water temperatures or nutrients concentrations were analyzed. Results indicate an increasing trend in average chla concentration, and significant annual fluctuations. The highest value of average chla was in 2011, due to the influence of red tides in June and July. Temperature varied between 0.08 to 25.5°C. The maximum temperature value usually occurred in Aug. or Sep., the minimum value was in Jan. or Feb. Dissolved inorganic nitrogen increased significantly, whereas dissolved reactive phosphorus showed a decreasing trend. The molar ratio of N and P increased and differed significantly from the value of 16:1. Nutrients limited show specific month differ. From monthly stoichiometric ratios among N, P and Si, we could see that nutrient limitation had changed from N in 1984 to P in 2014. Comparing with the feeding impact of maricultural shellfish, seaweed cultures may have more impact on the chla concentration.

BIO-P13

Comparative reproductive biology of three dominant myctophids of the genus *Diaphus* on the slope region of the East China Sea

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We examined the reproductive biology of the three dominant pseudoceanic myctophids, *Diaphus garmani*, *D. chrysorhynchus*, and *D. watasei*, on the slope region of the East China Sea, based on specimens of 22.7–65.3, 33.1–118.2, and 34.7–172.6 mm standard length (SL), respectively. Overall, females were more abundant in *D. garmani* and *D. chrysorhynchus*, while males were abundant in *D. watasei*. In all species, most individuals in the largest size class were females. The gonadosomatic index (GSI) at 50% sexual maturity of females of *D. garmani*, *D. chrysorhynchus*, and *D. watasei* was 3.65, 3.92, and 6.27, respectively. Based on these criteria, females of each species can mature at sizes larger than 42, 71, and 120 mm SL, respectively. In all three species, GSI of females showed high values during summer, i.e. the primary spawning season. Oocytes at various sizes were found in mature ovaries, indicating that they are multiple spawners. Mean egg size at hydration and batch fecundity was respectively smallest and lowest in *D. garmani* (0.60 mm and 612–2200 eggs) and largest and highest in *D. watasei* (0.65 mm and 10356–44879 eggs). Batch fecundity increased linearly with SL in all species, with a steeper slope in *D. watasei*. *Diaphus garmani* is characterized by early maturation at a smaller size, while *D. watasei* spent energy on growth during the juvenile and later immature stages (<120 mm SL) and can use greater energy for reproduction in the larger-sized mature adults, and *D. chrysorhynchus* adopts an intermediate trait between the other two.

BIO-P14

Responses of microbial communities to dosing with the algicide thiazolidinedione derivative TD49 in a mesocosm experiment

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To clarify the effects of the algicide thiazolidinedione derivative 49 (TD49) on a microbial community, including the targeted harmful alga *Heterocapsa circularisquama*, we conducted exposure experiments (control, blank, 0.2, 0.4, 0.6, and 1.0 µM) with TD49 in mesocosm enclosures (1300 L). The algicidal effects on the target alga depended on the concentration of TD49. The algicide TD49 concentration also decreased significantly with the increase of exposure time (R^2= 0.99, P<0.001), suggesting that the toxic effect of algicide may have not occurred or may be lower because it was rapidly reduced in the natural water. Following the addition of TD49, heterotrophic bacteria (HB) and heterotrophic nano-flagellates (HNFs) grew well in all treatments. In particular, the abundance of HNFs lagged behind the increase in HB, which is occurred the 24 h time lag in 0.2-0.4 µM TD49 (r= 0.53, F= 7.03 p<0.05) and 48 h time lag in 0.6-1.0 µM TD49(r= 0.55, F= 5.99, p<0.05). This implies a primary cue for strong top-down effects on microbial communities within TD dose-dependent, suggesting that the degradation of planktonic organisms, including target algae, led to high HB concentrations, and the predator HNF had accelerated within the time lag. Total ciliates remained relatively low in abundance in TD49 treatments compared to control and blank groups, whereas aloricate ciliate abundance gradually increased at the end of the experimental period, even with high TD49 concentrations. Therefore, TD49 has a positive effect on the microbial community, particularly through its growth-promoting effects on HB and HNFs. In addition, it was able to provide a safe, environmentally-friendly approach to control HABs in an aquatic ecosystem.

BIO-P15

The application of products from Geostationary Ocean Color Imager (GOCI) in China Sea

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The first Geostationary Ocean Color Imager (GOCI) launched by South Korea in June 2010, provides coloured biogeochemical products such as remote sensing reflectance (Rrs), chlorophyll, suspended sediment and coloured dissolved organic matter (CDOM) concentrations every hour between 10:00 am and 12:00 pm local time around the Korean peninsula including the most of the China Sea. This study constitutes a contribution to the quality assessment of GOCI products such as Rrs, chlorophyll and others generated by the Korea Ocean Satellite Center (KOSC) through comparison with concurrent data from MODerate-resolution Imaging Spectroradiometer (MODIS, NASA) sensors, which were seen as "true data" in this inter-comparison, as well as in situ measurement in China Sea, such as Bo Sea, Huang Sea. These comparisons are made with spatially and temporally collocated data. We focus on the accuracy of the radiometric and bio-optics products. The radiometric GOCI products are over-estimation in the China Sea. Although GOCI compares reasonably well with MODIS, and had good performance over a turbid water body, there is a need for further improvement in the GOCI atmospheric correction algorithm.

BIO-P16

Comparison of macromolecular compositions of different size phytoplankton in Gwangyang Bay, Korea

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Photosynthetically synthesized biochemical compositions (carbohydrates, proteins, and lipids) of phytoplankton provide an important energy source to support marine ecosystems. Recently, several studies predict that ongoing climate change causes a gradual shift toward smaller primary producers in a warmer ocean. Such a transition of phytoplankton communities could affect marine ecosystems, so we investigated the difference in biochemical compositions between large and small cell size phytoplankton communities in Gwangyang Bay. Water samples for biochemical compositions were collected at 3 light depths (100%, 30%, and 1%) seasonally from 2012 to 2014. The concentrations of carbohydrates, proteins, and lipids were measured according to Dubois et al. (1956), Lowry et al. (1951), and Blighr and Dyer (1959) and Marsh and Weinstein (1966), respectively. Large phytoplankton cells (>2 µm) contributed 75% (S.D.= ±8 %), whereas small phytoplankton cells (0.7 µm - 2 µm) contributed 25% (S.D.= ±8 %) to the total chlorophyll-a concentration. The highest compositions in the large cells were carbohydrates (Mean ± S.D.= 40 ± 10%), followed by proteins (35 ± 14%) and lipids (25 ± 13%). In comparison, the highest compositions in the small cells were carbohydrates (36 ± 18%), followed by lipids (35 ± 13%) and proteins (30 ± 9%). Pearson's correlation matrix was used to test for relationships between biosynthetic patterns and chlorophyll-a concentrations. Lipids of large cells were positively correlated with large chlorophyll-a ($r = 0.6446$, $p < 0.01$, $n = 8$) whereas proteins of small cells were positively correlated with small chlorophyll-a ($r = 0.9218$, $p < 0.05$, $n = 8$).

BIO-P17

The use of the LOPC to measure horizontal and vertical zooplankton size and abundance of 35°N section in summer

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The Laser Optical Plankton Counter (LOPC) with Moving Vessel Profiler (MVP) is a kind of equipment for marine investigation with high integration and automation. The instrument uses a narrow laser beam, new geometric sampling mode, multiparameter can be observed simultaneously by it to obtain data with high spatial resolution. Based on the July 2012 Institute of Oceanology open investigation of summer cruises in 2007, the horizontal and vertical zooplankton size and abundance of 35°N section in the cold water mass of the Southern Yellow Sea were analyzed combined with the MVP, CTD hydrological simultaneous observation data. In order to further reveal the temperature, phytoplankton distribution, frontal upwelling, suspended matter, nutrients and other factors, finding the dynamic mechanism of plankton distribution.

BIO-P18

Three-year variability of *Eucalanus californicus* population in Sagami Bay, Japan: Relationships between population density and duration of surface occurrence

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A recent study demonstrated that *Eucalanus californicus* performs seasonal ontogenetic vertical migration in the middle latitude region of the northwestern Pacific Ocean (Shimode et al. 2014). Reproduction and recruitment of *E. californicus* occur in the surface layer during spring diatom bloom, which are considered as one of the most important key process regulating year-to-year changes in the population. To clarify the surface population dynamics, we analyzed monthly zooplankton samples collected at a coastal monitoring station (St. M, 120 m depth) in Sagami Bay from 2012 to 2014. Every year, *E. californicus* occurred in the surface from spring to early summer. Gonadal analysis on the adult females collected indicated that they reproduced in the surface layers during the spring diatom bloom seasons. Copepodid abundance (CI to VI) of the species reached annual maxima in every April, whereas the maxima varied among the 3 years, i.e., 3,094 inds. m^{-2} in 2012, 814 inds. m^{-2} in 2013 and 2,539 inds. m^{-2} in 2014. Durations of the surface occurrences were different among the 3 years and the longest duration was from February to August in 2013. In addition, differences in oil-sac sizes of each copepodid stage among the 3 years imply that food conditions might be not suitable for population increases in 2013. Our result suggests that the duration of surface occurrence and population density of *E. californicus* were controlled by variability of food conditions.

BIO-P19

Spatial variations of phytoplankton communities in July of 2011 and 2013 in the East China Sea derived by photosynthetic pigments

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Phytoplankton as a major primary producer in marine ecosystem can respond fast to the variations of physical and chemical properties. The East China Sea (ECS) is strongly influenced by the Changjiang Diluted Water (CDW) and Kuroshio Water (KW) in the western and southern side, respectively. Most studies in the ECS have focused in either limited areas or one year; information on interannual variations of phytoplankton community in relationship to different water masses is still limited. In this study, two cruises were conducted in July of 2011 and 2013 in the ECS. Distributions of phytoplankton community measured by HPLC in relationship to different water masses were analyzed. Three different water masses were identified by temperature and salinity as CDW, KW, and Mixed Water (MW). KW and MW were contributed by cyanobacteria, and prochlorophytes was observed only in KW in both years. Prymnesiophytes dominated in MW in 2011. Large variations in phytoplankton composition between 2011 and 2013 were found in CDW region; diatoms and dinoflagellates were major contributors to chlorophyll-a in 2013, whereas patchy distribution of different groups, including diatoms, cryptophytes, cyanobacteria, prymnesiophytes were found in 2011. This result seems to be highly related to the nutrient condition between two years, showing that compared to 2011, high phosphate ($P > 0.6$ μM, $N:P < 16$) was observed in 2013, whereas phosphate was depleted ($P < 0.1$ μM, $N:P > 100$) in 2011.

BIO-P20

Seasonal changes in prosome length and egg reproduction of planktonic copepod *Calanus sinicus* in Sagami Bay, Japan

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Calanus sinicus is known to have two life-cycles in Sagami Bay: one group reproduces in the surface layer during all seasons and the other has large size dormant C5 stages distributed in the below 500 m depth. In this study, to understand details of the two life cycles, we investigated seasonal changes in the prosome lengths and egg reproduction rates (EPR) of *C. sinicus*. Zooplankton sampling was carried out at a coastal station (St. M, 120 m depth) from March 2014 to February 2015. The annual average of the prosome length of *C. sinicus* adult females was 2.15 mm ± 0.11 mm, which varied from 2.35 ± 0.17 (February) to 1.97 ± 0.11 mm (June). The larger females (> 2.5 mm) collected from winter to spring were considered as equivalent body sizes of molted individuals from the large deep dormant C5s, implying that the dormant population might migrate into the surface during these seasons. Abundance of *C. sinicus* varied from 1361.8 (May) to 25.0 inds. m^{-2} (December). EPR varied from 44.9 ± 30.7 (March) to 9.6 ± 9.7 eggs $female^{-1}$ day^{-1} (September). Both the higher abundances and EPR were observed during the spring bloom season, whereas they were relatively lower in summer to fall. In addition, there was a significant negative relationship between the EPR and 0–100 m average temperature. Our result suggests that *C. sinicus* might migrate into the deep layer as the dormant C5 population to avoid high temperature and low reproductive unsuitable periods.

BIO-P21

Oyashio spring bloom observed by an underwater glider

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In the Oyashio region, a strong winter convective mixing brings nutrient to the euphotic zone from the deep layer. In the spring, the surface water warms up and the stratification develops with the increasing of the surface heat flux, and then an intensive phytoplankton bloom mainly consisting of diatoms occurs in the area. The production supports the rich Oyashio ecosystem and also draws down a large amount of atmospheric CO_2 by the biological pump. There are several studies explaining how the Oyashio spring bloom is extensive; however, the detailed variations of the bloom characteristics are still unclear due to a lack of observational resolutions. From March 8th through May 18th of 2015, we conducted a continuous high-resolution survey in the Oyashio region around off Hokkaido A-Line monitoring line using an underwater glider (SeaGlider). A total of 419 vertical profiles of chlorophyll, CDOM, turbidity, dissolved oxygen (DO), and temperature-salinity were observed. Phytoplankton blooms with chlorophyll concentrations of O(10 mg/m^3) were observed in two different water masses in the beginning of May. In the bloom observed in the Surface Coastal Oyashio Water (S-COW, 3~5^{o}C, S<32.8), DO was supersaturated indicating active phytoplankton production. On the other hand, in the bloom found in the Oyashio Water (OW, 4~7 ^{o}C, S~33), which was observed a few days after the above S-COW bloom, DO was not saturated, and chlorophyll and turbidity (a proxy for POC) were intermittently high below the euphotic layer; these features indicate that the observed OW bloom was ending at the time.

BIO-P22

Marine microbiological communities in Korean coastal waters examined by NGS analysis

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The global ocean has been under various environmental stressors, and ecosystem resilience became one of important and urgent topics to be well sustained. Coastal ecosystem including part of offshore ecosystem has been remarked as the most dynamic and often vulnerable environment under land-based human activities and coastal developments as well as climate forcing. In these contexts, marine microbial communities could be an important indicator to show the marine conditions affected by these complex forcing stressors. Generally, microbial life thrives throughout the marine biosphere, and microbes have adapted to all the divergent environment present. The Next Generation Sequencing (NGS) technology is a promising tool to examine the ecological traits of microorganisms. Also large scale DNA sequence-based approaches have recently been used to investigate the marine environment and these studies have revealed that the oceans harbor unprecedented microbial diversity. In this study, the seawater and soil were collected from Korean coastal areas including marine sand mining areas. DNA sequencing was conducted from the V3-V4 region of 16S rRNA amplicon. NGS analysis successfully described the composition and diversity of microorganisms using NGS. Novel gene families with representatives only within such metagenomic datasets represented a large proportion of the ocean metagenome. The presence of so many new gene families from these uncultured and highly diverse microbial populations implies high diversity of microbial community and possible enforced impacts by marine sand mining. The present study highlights both recent achievements and challenges in the biology and biochemistry of the ocean environment.

BIO-P23

Trophic linkages among biological communities in Korean coastal waters examined by stable isotope analyses

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The coastal ecosystem has been remarked as a critical part to sustain marine ecosystem resilience for human. Fisheries production is likely to largely rely on ecosystem conditions and there are increasing concerns of multiple stressors affecting the coastal resilience. Those stressors could induce cascade effects on marine ecosystems through trophic linkages. In terms of ecosystem-based management, understanding trophic linkages of a coastal ecosystem is essential to evaluate environmental status of target coastal ecosystems. Korean coastal areas typically have both many bay ecosystems closely related with land-based activities and offshore areas strongly affected by oceanic currents. The present study reports trophic structures of biological communities of Korean coastal areas including marine sand mining as a offshore environmental stressor. Fish assemblages and benthic organisms were sampled along a depth gradient from shallow coastal areas to deep offshore ones. Several size fractions of particulate organic matters were also collected as potential primary food sources. Stable isotope analyses were applied to all the samples to describe trophic structures of biological communities at each designated coastal area. Bulk particulate organic matter (POM) were isotopically different each other along the depth gradient, while surface POM fraction showed relatively strong size-dependent stable isotope values with remarkably different values of the finest POM (<20 mm). Fish compositions were also slightly different among several coastal areas, indicating that fish assemblages could be loosely connected among coastal areas. The present results imply that trophic linkages among coastal biological communities could be an important factor to understand the ecological resilience regarding possible cascade effects.

BIO-P24

Marine virus mediated sphingolipid metabolic regulation and the apoptosis-inducing in marine *Emilianian huxleyi*

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Marine viruses that infect phytoplankton are recognized as a major ecological and evolutionary driving force, shaping community structure and nutrient cycling in the marine environment. Coccolithophores, the dominant species in North Pacific, are unicellular marine eukaryotic microalgae and *Emiliania huxleyi* is the host for the coccolithovirus (EhV), which is responsible for the demise of large oceanic blooms formed by this alga. However, very little is known about the molecular mechanisms mediating *E. huxleyi* death by marine viruses.

One of the most fascinating examples of horizontal gene transfer between a eukaryotic host and its virus is a *de novo* sphingolipid biosynthesis pathway SBP found in the genomes of both *E. huxleyi* and its virus. So it will be important to identify the function of genes that encodes enzymes involved in host sphingolipid metabolism, particularly given the proposed role for this sphingolipid in apoptosis.

In this study, bioinformatics and genetic engineering technology were used to explore the cellular pathways mediating the interaction between *E. huxleyi* and its specific coccolithoviruses. A novel transformation system for the eukaryotic marine phytoplankton *E. huxleyi* BOF92 was developed and then we examined the sphingolipid biosynthetic pathway by enhancing the expression of EhV-SPT gene encoding the first and committed enzyme in de novo sphingolipid synthesis. Over-expression of EhV-SPT could trigger the accumulation of ceramide in cells and result in unnormal metabolisms and apoptosis in host cells. Phylogenetic evidence confirmed that horizontal gene transfer of SPT genes occurred between the eukaryotic microalga *E. huxleyi* and its large DNA virus. It was suggested that EhV-SPT plays an obvious role in this co-evolutionary between EhV and host. EhV plays an important role in population dynamics of phytoplankton by controlling the bloom development of *E. huxleyi*.

BIO-P25

Phytoplankton change in the Kuroshio region of the East China Sea associated with the Kuroshio frontal eddy

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The lower-trophic level ecosystem in the Kuroshio region of the East China Sea (ECS) during summer generally shows typical subtropical features, i.e., small size pico-phytoplankton such as cyanobacteria dominates in the euphotic layer under the oligotrophic condition due to the stable stratification. It is also known that such stable physical and chemical conditions are often disturbed by the Kuroshio frontal eddy. In this study, we investigated the phytoplankton dynamics associated with the passing of a Kuroshio frontal eddy. We conducted comprehensive observations around the Kuroshio region in the ECS in the mid-June, 2014. We observed a drastic change in phytoplankton community in the subsurface water where the dominant groups of phytoplankton quickly changed from pico-phytoplankton to micro-phytoplankton. We found a cyclonic frontal eddy with 25 km diameter at the 50 m depth near the drastic change of phytoplankton community. This drastic change from the oligotrophic ecosystem to the eutrophic ecosystem was caused by the upwelling of nutrient-rich subsurface water associated with the passing of the cyclonic frontal eddy. Therefore, the lower-trophic level ecosystem in the Kuroshio region of the ECS can quickly adapt to a short-term disturbance by a frontal eddy.

BIO-P26

Chlorophylls and phycoerythrins as markers of ecological forcing on phytoplankton in New Caledonia and oceanic adjacent area

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Spatio-temporal variations of chlorophylls and phycoerythrins, inferred by spectrofluorometric methods, were studied from April to June 2010 in the southwest lagoon and oceanic waters of New Caledonia. Trade winds blew 75% of the time and appeared as the main factor influencing surface Tchl (sum of monovinyl- and divinyl-chlorophyll) variations in the ocean, near the barrier reef. Lagoon and oceanic waters differed in the composition of picoplanktonic cyanobacteria, with a relative dominance of *Prochlorococcus* and high-phycourobilin *Synechococcus* in the ocean and a relative dominance of high-phycoerythrobilin *Synechococcus* in the lagoon. Phytoplankton are photosynthesizing microscopic organisms that inhabit the upper sunlit layer of almost all oceans and bodies of fresh water. They are agents for "primary production," the creation of organic compounds from carbon dioxide dissolved in the water, a process that sustains the aquatic food web. Main pigment variations in the lagoon were associated with cyclone Erica in March 2003 and showed by a 5-6 fold Tchl increase around Noumea. The cyclone stimulated mainly diatom growth as indicated by the high chlorophyll ratio and by the lowest values for the other pigment ratios. The relative importance of divinyl-chlorophyll concentration and fluorescence excitation spectra of phycoerythrins appeared as useful tools for characterizing lagoon-ocean exchanges.

BIO-P27

The influence of decadal typhoon events on chlorophyll and carbon fixation in the East China Sea

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We used data of the moderate-resolution imaging spectroradiometer (MODIS) and 35 typhoon events during 2002-2012 to analyze the influences of the typhoon events on variation in phytoplankton chlorophyll-*a* (Chl-*a*) and depth-integrated primary productivity (IPP) in East China Sea (ECS) over a decade during 2002-2011. In all 35 typhoon cases, average sea surface temperature (SST) dropped by 0.14°C in the typhoon-influenced regions, with the maximum decrease being 2.24°C. During the same period, average Chl-*a* increased by 0.09 mg m^{-3}, and the maximum increase was 0.99 mg m^{-3}. Average IPP increased by 32.90 mg C m^{-2} d^{-1}, with the largest increase being 220.95 mg C m^{-2} d^{-1}. Primary productivity was correlated with SST and Chl-*a*, and the correlation was stronger in the typhoon transit and their correlation coefficients were 0.74 and -0.48, respectively. Primary productivity responded differently to typhoons in coastal waters, continental shelf and Kuroshio Current region in the ECS. Compare to the pre-typhoon period, primary productivity in post-typhoon period increased 19.65% and 12.21% for the coastal region and continental shelf, respectively, and decreased 9.35% for Kuroshio Current region. These results indicate that typhoon events have effects on carbon fixation and the effect is stronger in the shallow coastal water column than the offshore deep water column.

BIO-P28

Seasonal variation of mesozooplankton community in the Oyashio and Kuroshio-Oyashio Transition waters, western North Pacific

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The Fisheries Research Agency has carried out monitoring on the A-line in the Oyashio and Kuroshi-Oyashio Transition (after Transition) waters since 1987. We investigated the seasonal variation of the mesozooplankton community in both waters based on 5 time cruises per year (January, March, May, July and October) from 2010 to 2013. Samples were collected by vertical haul of Norpac Net (45cm mouth diameter, 0.33 mm mesh size) from 0m to 150 m, except at a coastal station (0 m to 90 m). A total of 212 species occurred in this study. We classified observation stations into two communities of the Oyashio and Transition by using cluster analysis and investigated the seasonal variation of mesozooplankton community based on monthly mean values in both waters. In the Oyashio waters, subarctic copepods (*Neocalanus* spp. *Eucalanus bungii* and *Mertidia paicifca*) dominated from January to May. After July, subtropical copepods (*Oithona atlantica Ctenocalanus vanus* and *Mesocalanus tenuicornis*) and thaliaceas (*Doliolum nationalis*) increased. In the Transition waters, subarctic copepods dominated in the mesozooplankton community from January to March, and subtropical copepods increased in May. Although subarctic copepods decreased, subtropical copepods, Appendicularia (*Oikopleura longicauda* and *Fritillaria borealis*) increased after July. According to the change in structure of mesozooplankton community, biodiversity increased after March in both waters and it might be related to the increase in water temperature.

BIO-P29

Mixed layer depth and chlorophyll *a*: Profiling float observations in the Kuroshio-Oyashio Extension region

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Variability in the chlorophyll *a* concentration (*Chl*) in relation to fluctuations in the mixed layer (ML) was investigated together with turbidity (*Tur*) in the Kuroshio-Oyashio Extension region, using profiling floats. A particular focus was the validity of two hypotheses concerning the spring bloom: the critical depth hypothesis (CDH) and the recently proposed alternative, the disturbance- recovery hypothesis (DRH). During the period from winter to early spring, *Chl* and *Tur* integrated over the photosynthetically active layer (PL; defined as the greatest depth of the ML and the euphotic layer) increased with increasing PL depth (PLD), indicating an increase in the phytoplankton biomass. This result is partly consistent with the DRH in that the observed increase in biomass was not explained by an increase in production. Instead, it was more likely attributable to a reduction in the loss rate. However, theoretical analyses revealed that grazer dilution alone could not cause this increase in biomass because such an increase in the ML in the real ocean (as opposed to a dilution experiment within a bottle) would cause a reduction in the mean light intensity. Despite the loss-controlled fluctuation in biomass during the period of low light, a production-driven fluctuation in biomass was also revealed. This occurred when the light intensity was elevated, particularly after late spring, and was consistent with the CDH. Thus, the present study suggests that both the production-driven and loss-driven hypotheses are responsible for the dynamics of the phytoplankton dynamics from winter to spring in the Kuroshio-Oyashio Extension region.

BIO-P30

Hypoxia tolerance in oxygen minimum zone euphausiids

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The effects of variable oxygen profiles in diverse oceanic regions were assessed on the metabolism and hypoxia tolerance of dominant Pacific euphausiid species. The physiological strategies employed by these species facilitate prediction of changing vertical distributions with expanding oxygen minimum zones and inform estimates of the contribution of vertically-migrating species to biogeochemical cycles. The migrating species from the Eastern Tropical Pacific (ETP), *Euphausia eximia* and *Nematoscelis gracilis,* tolerate a PO_2 of 0.8 kPa at 10°C (~15 µM O_2) for at least 12 hours without mortality, while the California Current species, *N. difficilis*, is incapable of surviving even 3 kPa PO_2 (~40 µM O_2) for more than 2 hours at that temperature. *Euphausia diomedeae* from the Red Sea migrates into an intermediate oxygen minimum zone, but one in which the temperature at depth remains near 22°C. *E. diomedeae* survived 1.6 kPa PO_2 (~22 µM O_2) at 22°C for the duration of six hour respiration experiments. A primary mechanism facilitating low oxygen tolerance is an ability to dramatically reduce energy expenditure during daytime forays into low oxygen. The nighttime depth distribution of the species studied becomes shallower with the critical depth, providing an analogue of the likely changes in distributions with expanding oxygen minimum zones.

BIO-P31

Effects of temperature and nutrients on changes in genetic diversity of bacterioplankton communities as revealed by 454 pyrosequencing in a semi-closed bay, South Korea

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Bacterioplankton play critical roles in controlling nutrients and dissolved inorganic nitrogen, as well as facilitating interactions among other biota in marine ecosystems, and can also serve as indicators of the health of the marine environment. Bacterioplankton communities in the surface seawater of a semi-closed bay (Jangmok Bay, South Korea) were analysed using a 16S rDNA multiplex 454 pyrosequencing approach. The following conclusions were drawn: 1) Diversity and operational taxonomic units (OTUs) are highest in cold water seasons and lowest in warm water ones. 2) During cold water seasons, alpha-proteobacteria respond rapidly to pulses of the concentration of inorganic nutrients. 3) During warm water seasons, gamma-proteobacteria are the most active type of bacterioplankton present in the prevailing conditions, which include high dissolved organic carbon, rainfall, chemical oxygen demand and primary production, but low nutrient concentration. 4) Cyanobacteria, a minor group constituting 4.58% of the total bacterioplankton, are more abundant at low temperatures. 5) The Cytophagia-Flavobacteria group is more abundant in nutrient-rich conditions, including high concentrations of dissolved organic carbon and inorganic nutrients; the abundance of this group also demonstrated a delayed decline following summer phytoplankton blooms. The pronounced seasonal oscillations in phosphorus concentration and temperature exert strong selection pressure on bacterioplankton communities.

BIO-P32

Microphytoplankton community structure of a *Cochlodinium polykrikoides* bloom in the Tongyeong coastal waters of South Korea using morphological and 454 pyrosequencing methods

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Massive phytoplankton blooms such as the annual *Cochlodinium polykrikoides* proliferation in the Tongyeong coastal waters (TCW) of South Korea have a significant influence on planktonic community structure and food web dynamics. Additionally, fish farms in the TCW are severely damaged by harmful algal blooms, particularly *C. polykrikoides*. Although the ecology of the TCW is relatively complex, it has been reasonably well studied across two decades of monitoring, including morphological observations of its planktonic organisms. Our objective was to study the under-explored phytoplankton diversity using morphological and 454 pyrosequencing methods. During *C. polykrikoides* summer bloom, the phytoplankton biomass increased by threefold while its composition decreased in size. The operational taxonomic units (OTUs) in 454 pyrosequencing analysis decreased by half and corresponded with results of the morphological analysis. At the genus level, pyrosequencing revealed the diatoms *Chaetoceros*, *Skeletonema*, *Thalassiosira*, *Ditylum*, and *Leptocylindrus*, and the dinoflagellates *Akashiwo*, *Alexandrium*, and *Cochlodinium*, which were highest in abundance. Fluctuating monthly patterns of *Skeletonema*, *Leptocylindrus*, *Akashiwo*, and *Cochlodinium* in morphological and 454 pyrosequencing results correlated significantly. Although morphological data were more detailed for diatoms than for other groups, 454 pyrosequencing and morphological results still agreed regarding the relative importance of diatoms between the two data. The results between 454 pyrosequencing and morphological analyses showed similar increasing or decreasing patterns for several common species in the TCW.

BIO-P33

Hypoxia off the Changjiang River estuary and its relationships with plume front and upwelling in summer

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By depicting the plume front and upwelling off the Changjiang River estuary and the characteristics of an underlying hypoxia, the intrinsic mechanism of the hypoxia caused by the plume front and upwelling was studied. The hypoxic zone off the Changjiang River estuary was characterized by a specific physical environment. There was a certain correspondence between the location of hypoxic zone and the site of plume front and upwelling. In particular, the location of the bottom hypoxic zone to the northern area off the Changjiang River estuary agreed well with the position of the surface Changjiang diluted water plume front that mainly extended northeastward. The plume front and upwelling off the Changjiang River estuary and their coupling effects were the important driving force responsible for inducing hypoxia in summer. Under conditions in which nutrient rapidly declines because of biological depletion near the surface plume frontal area, the upwelling coupled with the front can supplement the supply of nutrient. The continuous transport of nutrients was an important mechanism for the reproduction of phytoplankton and for the bottom hypoxia off the Changjiang River estuary in summer under the interactive influence of the Changjiang diluted water plume front and the upwelling. In addition, the upwelling also played an important role in the formation of minimal oxygen concentrations in the middle layer and the hypoxic waters on the western steep slope of the underwater valley off the Changjiang River estuary.

BIO-P34

Identification of microalgae in South Sea of Korea by species-specific PCR

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Microalgae are important primary producers in the marine environment, and are also important sources of health foods and medical products. However, rapid proliferation of some species of marine microalgae can seriously harm marine ecosystems. In this study the mitochondrial cytochrome c oxidase subunit I (COI) gene was utilized as DNA barcode to identify harmful microalgae and allow the discrimination of close biogeographic subgroups within species. An unweighted pair group method with an arithmetic mean (UPGMA) phenogram based on COI sequences from 14 species of microalgae in the southern coastal region of Korea illustrated the levels of divergence within morphologically identified species, and yielded two separated clusters, the centric diatoms and dinoflagellates. In addition, species-specific primers that targeted the barcode gene, COI, were developed to evaluate the temporally heterogeneous presence and distribution of microalgae on a monthly basis. For example, some microalgae including *Chaetoceros brevis*, *Asterionellopsis glacialis* and *Stepphanopyxis turris* were present during all seasons, while *Skeletonema marinoi*, *Nitzschia improvisa*, *Ditylum brightwellii* and *Chaetoceros diadema* were only detected during winter and spring. Together, our results indicate that the COI barcode gene can be used as a biomarker to identify diverse microalgae from the South Sea of Korea.

BIO-P35

Ecological responses to the offshore detached Changjiang diluted water in summer

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The Changjiang diluted water (CDW) significantly influences the chemical, biological and sedimentary processes in the Yellow and East China Seas. Based on in-situ observations during the summers of 2006 and 2008, we show that parts of the CDW plume are detached into discrete low-salinity waters. This detached low-salinity water can reach the seabed, with its volume shrinking gradually from the surface to the seabed and with a horizontal distribution that shifts first eastward and then southward. This detachment generates certain ecological processes off the Changjiang Estuary, including weakening the conservative nutrient transport in the CDW plume, further dislodging suspended particles from the water flow, influencing the stratification and vertical transport of substances, and facilitating phytoplankton growth. The mechanisms regulating the phytoplankton dynamics in the offshore detached CDW are also analyzed in this study.

BIO-P36

Delineating a physical and biological break point in the Gulf of Alaska

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The highly complex and dynamic marine environment of the coastal Gulf of Alaska (GOA) supports a rich and diverse ecosystem which exhibits strong gradients in species composition over space and time. These regions are likely affected by top-down and bottom-up effects in dissimilar ways and forecasting tools and management approaches must account for such differences. Although there are obvious differences in the biology of the two regions, these have not been fully characterized and it remains unclear whether a previously observed faunal break is linked to a similar break in climatic or oceanographic conditions that may help elucidate reasons for the faunal break. Here we quantify the variability of key physical and biological drivers in the GOA and delineate a physical and/or faunal break between the eastern and central GOA for use in modeling and management efforts. To identify the location of the break, we examined gulf-wide patterns of variability in multiple variables, including sea surface temperature (SST), chlorophyll-a (chl-a), photosynthetically-available radiation (PAR), upwelling, and fish community structure and abundances from bottom-trawl and long-line surveys. Consistent breakpoints were identified around 148°W - 150°W across multiple variables, which coincides with the region where the Alaska coastal current transitions from an eastern to a western boundary current. Offshelf breakpoints in PAR, SST, and chl-a occurred further upstream, suggesting that the signal associated with the physical breakpoints may originate offshore before propagating onto the shelf.

BIO-P37

Examination of water quality of an oligotrophic salmon lake in British Columbia, Canada using MERIS satellite imagery

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Chilko Lake is the brood lake for one of the largest sockeye stocks (*Oncorhynchus nerka*) in the northeast Pacific. We compared annual sockeye production to lake water quality and phenology, using a chlorophyll time series created from MERIS FR. Although the lake is oligotrophic, it is subject to seasonal turbidity, so to estimate satellite chlorophyll we assessed several case II algorithms including the FUB, C2R and Boreal Lakes models and level 1 Fluorescence Line Height. The best match with *in situ* measurements ($r^2 = 0.55$) was obtained using the C2R algorithm version 1.3.2. It performed reasonably well given the low chlorophyll concentrations (0 to 1.2 mg m^{-3} chlorophyll *a*), even in water of moderately high turbidity (up to 6 mg l^{-1} suspended minerals).

For the fisheries analysis, the C2R chlorophyll product was compiled into a time series spanning June 2002 to April 2012. Data were binned from daily to 8-day and monthly temporal resolutions, and a number of metrics were derived, including the timing of bloom initiation and peak annual chlorophyll. Comparisons of chlorophyll concentration with sockeye production were in agreement with a whole lake fertilization experiment conducted the late 1980s and early 1990s: we showed that increases in lake chlorophyll, particularly at the north end of the lake, were associated with increased smolt size and increased adult returns. This project successfully demonstrated the use of satellite EO data to produce data-dense time-series for remote, sparsely-sampled locations.

BIO-P38

Analysis of finless porpoise diet using prey morphological characters and DNA barcoding

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Knowledge of the dietary choices and trophic niches of organisms is the key to understanding their roles in ecosystems. DNA-based techniques have proven useful for defining trophic links in a variety of ecosystems and recently developed sequencing technologies provide new opportunities for dietary studies. We investigated the diet of finless porpoise (*Neophocaena asiaeorientalis sunameri*) at several colonies across its range, collecting a total of 23 prey samples collected from dead finless porpoises killed by ship, bycatch or stranding. The diet was assessed using two complementary approaches for prey identification: conventional morphological analysis (using fish vertebrae, otoliths and cephalopod beaks) and DNA barcoding of COI (using for fish) and 16S (using for cephalopod) mitochondrial genes. Species assignments employed BLAST and distance-based methods. The molecular approach increased taxonomic resolution and revealed additional 9 taxa. Most of the prey species were identified for the first time. The DNA barcoding approach significantly presented the capabilities of DNA-based methods of dietary analysis. More prey samples collected by non-lethal methods are needed to shed light on diet, trophic niches and roles in ecosystems in this species. Thus more suitable protective measures will be taken for conservation of finless porpoise.

FIS Contributed Paper Session

FIS-P1

Shifts in hydrological regime and their implication for distribution and abundance of fish in the western Bering Sea in 21 century

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Shifts in hydrological regime in seas and oceans can influence significantly marine fish. In 2007, water circulation in the Bering Sea changed that resulted in weakening of Pacific waters inflow to north areas of the sea. In 2012, water circulation came back to a "normal" state. The goal was to analyze if changes in water circulation in the Bering Sea impacted on fish distribution and abundance. The study was based on the data of marine comprehensive surveys conducted by TINRO-Centre in the western Bering Sea in summer and fall 2002-2014. Change in water circulation in the Bering Sea in 2007-2011 affected the intensity of forage migrations of immature salmon to the western part of the sea. Abundance of immature chum, sockeye, and Chinook salmon decreased and their distribution changed. In 2012, when backshift in water circulation occurred, salmon abundance got back to a former state. Despite salmon, shifts in hydrological regime influenced subtropical fish. In 2007-2011, saury and pacific pomfret did not migrate to the Bering Sea while in 2002-2006 and 2012-2014 they were numerous in the south-western regions. These results testify that shifts in water circulation affected distribution and abundance of migrating fish resulting in reduction/expanding of their forage area.

FIS-P2

Stock assessment for the *Trichiurus japonicus* fishery in the East China Sea based on Bayesian state-space modelling

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Trichiurus japonicusis is one of the most important fish species in the East China Sea, and also supports one of the most valuable fisheries in China. We applied Bayesian state-space modelling to catch and CPUE data of this fishery and used a Pella-Tomlinson surplus production model for the state process. Four models were fitted with a MCMC simulation with a mix of information and non-information priors. Results show the best-fit of the four models is model 1 with information lognormal prior on intrinsic rate of increase r and carrying capacity K based on DIC. The prior distributions have a significant impact on the results of r and K which indicate the data are sensitive to the type of prior distributions of r and K. Results of biological reference points show the hair tail stock was overfished from 1995 to 2010 (catch over maximum sustainable yield); faced a serious state from 2000 to 2006 (fishing mortality coefficient over F_{MSY}); and had a good state in 2012, but this stock needs persistent management. Due to the possible distortion for the statistical catch, the results of MSY and B_{MSY} may be overrated. The estimated results from 2004 to 2012 also have uncertainties because the hair tail fishery in the East China Sea was also influenced by monsoon, precipitation and other environmental factors.

FIS-P3

The impact of climate factors on Pacific salmon within Khabarovsk territory

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During the last decade the number of Asian pink salmon increased. In this situation, we have paid more attention to studies that are able to describe the impact of climate change on Pacific salmon. Pink and chum salmon are the most abundant in the Khabarovsk Territory. Most of the pink and chum salmon production in the Khabarovsk area is caught in the Amur River. Total average catch for 107 years ranged from 2.0 (2000) to 98.9 thousand metric tons (1910). Fisheries statistics here actually reflects a change in the number of pink and chum salmon because of the stability of fishing effort. Fluctuations in catches cannot be explained by human impacts only. Dynamics of pink and chum salmon catches can be divided into three stages:

1st stage - 1900-1940s. (Rising);
2nd stage - 1950-1980. (Decline);
3rd stage - 1990-2000. (Rising).

Regarding the possible impact of climate change on pink and chum salmon stock abundance (or catches) dynamics in the Amur River, is possible to note the following facts. High pink and chum salmon catches re-occurred after about 100 years, and similar trends have been observed in other areas of Pacific Ocean. Correlation analysis showed the strongest relationship between chum salmon catch and solar activity cycles and the climate index PCI (Pacific Index of winter circulation). Pink salmon catch dynamics had the greatest linkage with trends of the PCI index and the LODindex (characterizing changes in Earth's rotation).

In conclusion, global climate events significantly affect productivity of Pacific salmon (pink and chum salmon) in the Amur River and the coast of Khabarovsk Territory. Most evident linkages of catches dynamics are with atmospheric phenomena affecting the ocean surface temperature by heat transfer within the North Pacific (index PCI), solar activity and the Earth's rotation.

FIS-P4

In situ target strength measurements of skipjack tuna *Katsuwonus pelamis* and yellowfin tuna *Thunnus albacares* in the South China Sea

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Knowledge of individual target strength (TS, dB) is essential for accurate acoustic assessment of fish abundance. The TS of skipjack tuna *Katsuwonus pelamis* and yellowfin tuna *Thunnus albacares* in the South China Sea was measured *in situ* using 70 and 120 kHz split-beam echosounders. Biological samples were collected using a light falling-net with a working depth of 50 m. Skipjack tuna (mean fork length (FL) 351 mm) had a mean TS of −50.72 dB at 70 kHz and −54.22 dB at 120 kHz. Yellowfin tuna (mean FL 412 mm) had mean TS of −36.38 dB at 70 kHz and −38.02 dB at 120 kHz. The skipjack tuna aggregation was primarily distributed in the 30–50 m layer. The yellowfin tuna aggregation was primarily distributed in the 20–30 m layer. *In situ* TS estimates for skipjack tuna and yellowfin tuna provide a reference for calculating body length distribution and abundance around fish aggregating devices. Furthermore, the TS data obtained in this study may be used to monitor schooling behaviour in skipjack tuna and yellowfin tuna.

FIS-P5

Genetic diversity and differentiation of seven geographical populations of hard clam (*Meretrix meretrix*) assessed by COI and microsatellite markers

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The hard clam (*Meretrix meretrix*) is a commercially important shellfish in China. In this study, the genetic diversity of seven geographical populationsof *M. meretrix* was assessed using the mitochondrial cytochrome c oxidase subunit I (COI) gene and microsatellite markers. We obtained a total of 142 COI sequences. Each COI sequence was 602 bp in length. These sequences contained 14 variant sites, including 12 transitions and 2 transversions. Twenty-two haplotypes were identified, with 12 haplotypes shared among populations. Population-specific haplotypes were identified in the Sinuiju, Dandong, and Qidong population, respectively. The haplotype diversity was highest in Rudong (h = 0.900) and lowest in Dongying (h = 0.600). The nucleotide diversity was highest in Dandong (π = 0.00350) and lowest in Geligang (π = 0.00115). Neutral test (Fu's *Fs*) and mismatch distribution analysis revealed that the hard clam experienced a population expansion event. Analysis of molecular variance (AMOVA) indicated that 71.64% of the genetic variance was within populations and 28.36% of the variance was among populations, demonstrating significant genetic differentiation among populations ($P < 0.05$). A total of 54 alleles were amplified from 280 individuals by using 7 microsatellite markers, with an average of 7.7 alleles per locus. The mean observed heterozygosity (H_o) and expected heterozygosity (H_e) was 0.387 and 0.7996, respectively. Compared with other populations, genetic diversity in the Jiangsu population was highest, but the difference was not significant (Kruskal-Wallis test, $P > 0.05$). Among the 49 population–locus combinations (7 populations × 7 loci), 18 cases deviated from the Hardy-Weinberg equilibrium ($P < 0.05$), indicating heterozygote deficiencies. The neighbor-joining tree showed that the haplotypes were not clustered according to geographical location, but some haplotypes from the same or neighboring locations grouped together (e.g., Rudong and Qidong showing geographical clustering). The unweighted pair group with arithmetic mean (UPGMA) phylogenetic tree showed that the Dandong population was grouped with the Jiangsu population, suggesting that the introduced Jiangsu clam seed has contaminated the genetic background of the Dandong population.

FIS-P6

Modeling the migration and growth of immature Pacific saury (*Cololabis saira*) using an individual-based bioenergetics model

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We examine effects of environmental condition on growth and migration patterns of immature Pacific saury (*Cololabis saira*), using an individual-based bioenergetics model. The model outputs are compared with results of otolith microstructure analyses for saury samples, which were collected in areas where model individuals migrate. The northward migration of winter-hatched cohorts from the Kuroshio Extension area to the Oyashio area is reproduced in the model, assuming that saury migrate in the direction that maximizes their growth. The growth rates of cohorts hatched in the northwestern Pacific are generally higher than that hatched in the northeastern Pacific, because they migrate to good feeding condition areas. In addition, our model also reproduces two peaks in growth rates of immature saury, approximately 60–80 days and 150–200 days after hatching, which were also found in the otolith microstructure analyses. The modeled second peaks are caused by the increase in prey density during the spring bloom in areas that saury migrates. Thus, it is indicated that variability in primary production has an important role in the growth of immature saury.

FIS-P7

Proximate composition and stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) of Japanese jack mackerel (*Trachurus japonicus*) in the Geumo Island nursery ground

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Proximate analysis for determining proportions of proteins, water, lipids and ash of fish tissue provides a powerful insight to obtain fitness information for the fish population being studied. In this study, the proximate composition of water, lipids, proteins, and ash for *Trachurus japonicus* were analyzed using an original proximate analysis. Fish sampling using a fyke net was executed during May to November, 2013 and 2014 at Geumo Island, Korea which is known as a nursery ground. The average composition of *T. japonicus* were 3.67 ± 2.38 % for lipids, 20.64 ± 5.11 % for proteins, 69.80 ± 4.55 % for water, and 3.55 ± 0.49 % for ash. Lipids were lowest in May and highest in September whereas water content was opposite to lipid. Based on Pearson's correlation analysis, we found that lipid content had negative correlations with water content ($r=-0.925$, $n=16$, $p < 0.01$). The ranges of muscle $\delta^{13}C$ and $\delta^{15}N$ during our study period were -19.26 to -17.76‰ and 9.80 to 12.80‰, respectively. The $\delta^{13}C$ and $\delta^{15}N$ isotope values increased with time (about 0.8‰ and 3‰ increase respectively). Overall, the low lipid content in May is consistent with a starvation period during their migration to the nursery ground in the Geumo Island since they normally use lipids during starvation. Based on the increases of $\delta^{13}C$ and $\delta^{15}N$, *T. japonicus* trophic level increased by one during the study period.

FIS-P8

Evaluation of a commercial CPUE standardization model applied to the Pacific saury fishery in the North Pacific

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The standardized catch per unit effort (CPUE) is a widely used index for assessing the abundance of exploited populations in fishery management. The commercial CPUE standardization model of relative fishing power (RFP) for individual vessels has been developed using a logbook data base from the bottom trawler fishery. In this study it is applied to the epi-pelagic fishery of Pacific saury using the Taiwanese logbook data in the North Pacific and the effects of varying model parameters are analyzed. The results indicate that more than 97.8% of the fishing effort can be standardized according to the estimated RFP with the minimum number of comparisons required being 10 in each of the 6 trial years. The RFPs from the model generally correlate with the fishing vessel's length and gross tonnage. A robust result of the model application on the Pacific saury fishery logbook data is shown when varying minimum number of comparisons required and the standard vessel. This evaluation suggests that the RFP model is appropriate for application to standardizing the commercial saury CPUE with logbook data and that it can serve as an abundance index reflecting the annual stock size of the saury fishery.

FIS-P9

A mass-balance ecosystem model of a subtropical bay

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The trophic structure of a subtropical bay in Taiwan Strait was analyzed by using mass balance modeling (Ecopath) analysis. Trophic levels of main functional groups estimated from the two methods were compared. The Ecopath model was built based on the fishery resource survey in Xiamen Bay in 2009. Specifically, data on species composition, biomass, mortality rates, diet composition and fisheries catches were obtained from the survey in and around the Bay. The model involved 26 functional groups, including plankton, benthos, fish, cephalopods, shrimps, crabs and marine mammals. The results showed that the trophic levels (TLs) of the main functional groups were between 2.89 for cephalopods and 3.94 for congers, with an average of 3.11. Anchovy, silver pomfret (*Pampus* spp.) and gobiidae were important groups in terms of the trophic structure and flow dynamics in the Xiamen Bay. Trophic transfer efficiencies of levels II to V were 12.8%, 19.2%, 19.7% and 12.1%, respectively. Catfish (*Tachysurus sinensis* and *Netuma thalassina*) and fisheries have major trophic impacts on most functional groups in the Xiamen Bay ecosystem. Total system throughput was estimated to be 411 t/km^2/year. Based on the primary production to respiration ratio (P_p/R), transfer efficiency and other ecological indexes, Xiamen Bay was characterized as an ecosystem with low maturity.

FIS-P10

Examining two macro invertebrate communities using functional traits and environmental variables in and around Barrow canyon in the Chukchi and Beaufort seas

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How an animal functions and relates to the environment can be used as a measure to characterize and compare systems beyond the extent of species diversity in a community. In this study, we examined basic functional traits of the dominant macro invertebrates (e.g. mobility, feeding) along with environmental variables (e.g. sediment, salinity) in two high Arctic systems in and around Barrow Canyon: the northwest Chukchi Sea and the western Beaufort Sea. Both communities are characterized by a large biomass of invertebrates and high species diversity. In both the northwest Chukchi Sea and western Beaufort Sea, 95% of the total biomass of invertebrates is comprised of no more than 30 species. Although these two communities are highly diverse (>175 species), the top 5 dominant species within each community are different. These results will be used as a basis to study basic underlying mechanisms that drive community structure. Finally, our conclusions will be discussed in the context of Arctic oil and gas development and climate change.

FIS-P11

Restricted separation of the spawning areas of two lineages of sand lance, *Ammodytes personatus*, in the Yellow Sea and East Sea

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We investigated the spawning areas of two lineages of sand lance, *Ammodytes personatus*, in Korean waters to indirectly elucidate their gene flow. A larval survey was conducted at 59 stations in the Yellow Sea (YS, 2006–2008, 2013), 42 stations in the Korean Strait (KS, 2009–2011), and 30 stations in the East Sea (ES, 2012–2014) using ichthyoplankton nets. In total, 8,687 inds./100 m^3 were collected in the YS and ES and identified as sand lance larvae. In contrast, no sand lance larvae were found in the KS. The number of sand lance larvae was highest in the middle ES, followed by the middle YS. We identified the lineage status of 227 larval individuals using molecular methods. Only a single lineage (south lineage; SOL) occurred in the YS, whereas two lineages (SOL and the north lineage, NOL) occurred in the ES. The larval occurrence of NOL was much higher than that of SOL (5.2:1) in the middle ES, but the two lineages occurred at similar levels (1.1:1) in the southern ES. These results suggest that there is no gene flow between the two lineages in the YS, whereas there is restricted gene flow in the ES. Therefore, our study suggests that two biogeographic barriers exist between the two lineages 1) at the thermohaline front of upwelling of the North Korean Cold Current and the Nakdong River (Busan) and 2) at the thermal front of the collision of the North Korean Cold Current and the Tsushima Warm Current (Uljin).

FIS-P12

Diversity and community structure of marine fish species in Korean waters during 2006-2013

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In order to clarify the diversity and community structure of marine fish species around the Korean peninsula, we collected fish four times a year from the Yellow Sea (2006-2008), Korean Strait (2009-2010), Jeju Island (2011), and East Sea (2012-2013), using a set net or gill net. During the survey, a total of 283 fish species was collected, of which *Engraulis japonicus* (63.8%), *Collichthys lucidus* (9.8%) and *Trachurus japonicus* (8.9%) were dominant. The number of fish species was highest in the East Sea (140 spp.), followed by the Yellow Sea (139 spp.), the Korean Strait (137 spp.), and Jeju Island (86 spp.), but the species diversity index was the highest in Jeju Island (2.9), followed by the Korean Strait (2.1), the Yellow Sea (1.8) and the East Sea (1.25). The dominant species of each sea was *C. lucidus* (37.6%) in the Yellow Sea; *E. japonicus* (41.6%) in the Korean Strait; *T. japonicus* (32.8%) in Jeju Island; *E. japonicus* (82.9%) in the East Sea. UPGMA cluster analysis using Bray-Curtis dissimilarity showed that Korean marine fish species were largely separated into four groups as follows; 1) the Yellow Sea group, 2) the western Korean Strait group, 3) the middle East Sea group, 4) Jeju Island, the eastern Korean Strait and the southern East Sea group. This grouping may be associated with the characteristics of ocean currents or water masses in this region.

FIS-P13

The role of Gangjin Bay: Spawning or nursery grounds for fish?

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Gangjin Bay is a semi-closed bay in the middle of the Korean Strait. Bays are known to be important as nursery and/or spawning grounds for fish because of the large amount of nutrients provided by rivers. In order to clarify the role of Gangjin Bay, we investigated fish species composition using shrimp beam trawls deployed inside and outside the bay between April, 2014 and January, 2015. During the same period, we also investigated fish egg composition using a RN80 net inside the bay. Using the shrimp beam trawl, inside the bay, a total of 2,831 individuals of 47 fish species were sampled, in which *Leiognathus nuchalis* and *Thryssa kammalensis* were predominant. Outside the bay, a total of 1,614 individuals of 55 fish species were sampled, in which *L. nuchalis* and *Ricuzenius pinetorum* were predominant. Similar to the number of species, diversity indices were higher outside the bay (2.95) than inside the bay (1.88). The overlap index between inside and outside the bay was 73.11. A total of 15 fish species of eggs were collected and identified by DNA barcoding marker. Of them, *Engraulis japonicus* and *L. nuchalis* were the most predominant. The comprehensive comparisons of our results indicate *Acanthopagrus schlegeli* and *Kareius bicoloratus* migrate to the bay from the open sea for spawning. Further research such as diet analysis is required to understand the whole ecosystem of bay.

FIS-P14

Food partitioning among three reef fish in the Lidao coastal waters of northern Yellow Sea, China

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Hexagrammos otakii, Sebastes schlegelii and Hexagrammos agrammus are three most abundant and co-occurring reef fish of the Lidao coastal waters. Their trophic niches and their food utilization at nearshore and offshore sites of Lidao coastal waters were compared using stable isotope ($\delta^{13}C$ and $\delta^{15}N$) and stomach contents analyses. All three fish mainly preyed on a variety of crustaceans, fish, polychaeta and seaweed segments, but in different proportions. *H. agrammus* mainly fed on polychaeta, seaweed and crustacean, while *H. otakii* switched to dominantly prey on crustacean regardless of co-occurring of polychaeta and seaweed. *S. schlegeli* exhibited a significant carnivorous diet with a domination of fish and crustacean. $\delta^{13}C$ and $\delta^{15}N$ values differed significantly ($P<0.001$) among the three reef fish and potential food sources, *H. otakii* had most enriched $\delta^{15}N$ (15.31‰), followed by *S. schlegeli* (14.98‰) and *H. agrammus* (14.47‰). Bayesian mixing model in stable isotope analysis in R (SIAR) revealed all fish were all carnivorous and the main food sources to support the three fish were primarily from fish, shrimp and crab but with different proportions. Both analysis of stable isotope and stomach contents verified the food partitioning pattern among the three reef fish.

FIS-P15

Environmental thresholds and species distribution: Implications for interactions and recruitment in multispecies models

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Projected climate change will influence the distribution of species, alter competitive and predatory interactions, and shift the relative volume and configuration of distinct marine ecoregions. Individual species will respond in distinct ways to these shifts with implications for understanding species interactions. This paper presents an approach to estimate climate impacts on the spatial distribution and volume of marine ecoregions in the Bering Sea. Our approach extends the habitat envelope approach to include multiple factors influencing the spatial distribution of selected fish species. Species distribution and abundance are driven by threshold environmental tolerances, resource preferences, and species interactions. Predicting responses to climate-driven change requires knowledge of habitat associations and environmental tolerances –determinants influencing the biogeography of marine fish. Random forest approaches were used to determine the marginal importance of environmental variables to the abundance of a select group of forage and groundfish species. A bootstrapped regression model was then applied to distinguish distinct breakpoints along variable gradients to determine threshold tolerances. Using a ROMS model we defined habitat volume within distinct temperature tolerance ranges. We then applied covariates of habitat extent, range overlap, and prey availability to multispecies model hindcasts. This was used to evaluate the extent to which inclusion of environmental correlates improve fit and explain recruitment deviates as a function of density dependent constraints and competitive and predatory interactions. Results suggest that better understanding how climate will shift habitat volume and range overlap of key species will improve stock forecasts.

FIS-P16

Using species distribution models to define essential fish habitat in Alaska

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Defining essential habitats for fishes is important for managing groundfish in Alaska. Species distribution models have been widely used in conservation biology and terrestrial systems to define the potential habitat for organisms of interest. The models themselves can take a number of forms, from relatively simple frameworks such as generalized linear or additive models to complex modeling frameworks such as boosted regression trees, maximum entropy models, two-stage models or other formulations. We used a variety of modeling methods and data sets from scientific surveys and commercial fisheries to define the habitats for over 30 fish species in three regions of Alaska. Adult, juvenile, larval and egg stages were modeled in four seasons where data were available. Depth was the dominant variable determining the distribution of most adult and juvenile life history stages. Sea surface temperature was the most important variable for egg and larval stages. Using the models, maps were developed that identified local hot spots for each species and life stage. These maps will be used for marine spatial planning and assessing impacts of anthropogenic activities in Alaska's marine environment.

FIS-P17

Particle tracking experiments to specify hatching areas of the Pacific stock of chub mackerel off the southeastern coast of Japan

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To accurately specify hatching areas of the Pacific stock of club mackerel and its relationships with the Kuroshio axis position, we conducted particle tracking experiments (PTEs) using reanalysis products from an ocean forecast system of the FRA-ROMS. The FRA-ROMS output applied in this study was based on 1/10-degree resolution, which was capable of reproducing mesoscale variations in the Kuroshio-Oyashio region around Japan. To ensure reproducibility of the PTEs, we also used otolith daily increments which were obtained from juvenile mackerel sampled at some stations in the Kuroshio-Oyashio transition region from May to June of 2012. The number of individuals was 145, and the age was in a range of 24 to 56 days. The PTEs were performed for individual juveniles. Particles were initially set at a hatch day based on otolith data to a relatively large area of the Kuroshio region including the Izu Islands, which has been known as the main spawning area of the mackerel. The particles were released and passively transported by simulated daily mean currents at the depth of 10 m and tracked during individual ages. We then examined transport pathways of particles which could successfully reach individual sampling stations. It was found that the hatching areas tended to be distributed in the nearshore side of the Kuroshio axis upstream of the Izu Islands (i.e., Enshu-nada) and near the axis downstream of the islands (i.e., Kuroshio Extension region). Namely, the hatching area around the Izu Islands appeared to be bi-modally distributed.

FIS-P18

Interannual variations in growth trajectories of juvenile jack mackerel *Trachurus japonicus* in the Tsushima Warm Current

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We examined interannual variations in growth trajectories of juvenile jack mackerel *Trachurus japonicus* in relation to environmental conditions during 2011 – 2013, in which juvenile abundance increased about 10 fold, in the Tsushima Warm Current regions. Juvenile *T. japonicus* were collected using a subsurface trawl during May – June. Body length (BL) of the juveniles ranged from 20 to 50 mm. Daily somatic growth rates were estimated for each individual fish based on otolith daily increments. Hatch dates ranged from mid February to early May with peaks in April. Mean back-calculated BLs at 50 days post hatch (dph) in 2011, 2012 and 2013 were 31.9, 34.0 and 37.5 mm, respectively. Daily somatic growth rates in 2013 were significantly faster even after the early larval stage (< 10 dph) than those in 2011 and 2012. Mean water temperature at 20 m where juvenile *T. japonicus* occurred in 2011 was 17.7°C and significantly lower than that in 2012 (19.5°C) and 2013 (19.6°C). Seasonal changes in local temperature around the spawning grounds suggested that temperature in April 2011 was lower than that in 2012 and 2013. Abundance of their primary prey item, *Paracalanus parvus*, in 2012 was significantly lower than that in 2011 and 2013. These results indicate that growth rates in 2013 were faster due to higher temperature and prey concentrations than those in 2011 with suboptimum temperature and 2012 with low food availability, and hence resulting in higher survival rates throughout the larval and early juvenile stages.

FIS-P19

Behavioral responses of Pacific cod (*Gadus macrocephalus*) juveniles to food deprivation, temperature gradients and light

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The behavioral responses of fed and unfed Pacific cod (*Gadus macrocephalus*) juveniles (57.9 ± 3.4 mm) were examined in experimental columns (diameter 100 mm, height 850 mm) under three experimental temperature conditions: pattern I, 12°C in the upper 350 mm, 8°C in the lower 400 mm; pattern II, 8°C in the upper 350 mm, 12°C in the lower 400 mm; and pattern III, 8°C throughout the column. Fed juveniles occurred higher in the water column than unfed fish in pattern I under dark conditions, and they occurred deeper in pattern II than in pattern III. Differences in depth suggested that fed juveniles may prefer warmer temperature under dark conditions. Unfed juveniles occurred deeper in both pattern I and pattern II than in pattern III. In pattern I, some might have occurred in the cooler section to conserve energy. In pattern II, some might have been prevented from entering the cooler section under dark conditions due to a sharp (4°C difference in <10 cm) thermocline. Under light conditions, both fed and unfed juveniles exhibited positive phototaxis, moving upward into the upper sections through the thermocline.

FIS-P20

Optimum survival temperature for walleye pollock larvae

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For walleye pollock (*Gadus chalcogrammus*) around Japan, strong relationship is observed between water temperature during early life stages and recruitment. However, the mechanism underlying this relationship is still unclear. In this study, to examine the effects of water temperature on growth and survival of pollock larvae under different feeding conditions, pollock larvae hatched in the laboratory were reared at two feeding levels and three temperatures. Feeding level was varied by providing low temperature-resistant rotifers (*Brachionus plicatilis* sp. complex) every day or every three days, and at each feeding level, larvae were reared at 3º, 6º, and 10ºC. Under both feeding conditions, larval body lengths (BL) at 21 days after hatching were in the order: 10ºC>6ºC>3ºC. On the other hand, larval survival rates were 6ºC>3ºC>10ºC. In addition, the mortality coefficient per 1mm increase in BL, which was calculated from BL and survival rate, increased in the order of 6º, 3º, and 10ºC. These results indicate that, under feeding and thermal conditions examined in this study, larval survival per same growth amount is best at 6ºC irrespective of feeding levels, although larval growth is faster at higher temperature. It is suggested that this optimum larval survival temperature around 6ºC is one of the main causes of the relationship between water temperature and pollock recruitment.

FIS-P21

Acoustic survey of dominant mesopelagic fishes off eastern Hokkaido, Japan

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The shelf and slope area off eastern Hokkaido is the main nursery ground for walleye pollock (*Gadus chalcogrammus*) in Japan. Recent studies have suggested that mesopelagic fishes which are the main component of the sound scattering layer in this area have a significant impact on the ecology of walleye pollock as important prey species or competing species for zooplankton. For that reason, quantitative information on mesopelagic fishes is necessary not only for a deeper understanding of the marine ecosystem but also for further development of an ecosystem based approach to walleye pollock fisheries management. Field acoustic data (38 and 200 kHz) and biological samples were obtained in the summer of 2014 to estimate species-specific distribution and biomass. Eight dominant species belonged to the Myctophidae, and they occupied more than 90% (in number) of all mesopelagic species in each trawl. Target strength of each species was estimated based on the shape of the swimbladder or body and used to allocate echo energy in the sound scattering layer. As reported by some recent studies, our observation showed that acoustically estimated biomass of mesopelagic fishes was significantly larger than previous trawling estimates. Species composition and biomass showed different spatial patterns, and it is suggested that fluctuations of dominant current structures, such as the Oyashio cold current, potentially affect them.

FIS-P22

Complete mitochondrial genome of *Sillago* species: Insights into taxonomy and phylogeny

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The genus *Sillago* species are widely distributed across the Indian and Western Pacific Oceans. The taxonomy of genus *Sillago* is chaotic due to the similarity of morphological characteristics and color patterns. More and more new species and cryptic species have been reported with rapidly advancing DNA-based techniques in recent years. However, fundamental information such as taxonomy, degree of genetic variation and phylogeny of genus *Sillago* is still lacking. Here, we described complete mitochondrial DNA sequences of 6 *Sillago* species (*S. aeolus*, *S. asiatica*, *S. sinica*, *S. japonica*, *S. sihama*, and *S. indica*) and provided insights into their taxonomy and phylogeny. The mitogenomes consisted of nucleotides ranging from 16493 bp (*S. asiatica*) to 17119 bp (*S. japonica*), including 13 protein-coding genes, 22 tRNA genes, 2 rRNA genes and a control region. Significant length variation of the control region was detected due to existence of tandem repeat sequences. A 36 bp repeat unit with 8 copies was found in the *S. sihama* control region. Gene rearrangement was detected in the *S. sinica* mitogenome, the tRNA gene cluster changed from WANCY to WNACY. The phylogenetic relationship of the 6 species was constructed based on the datasets including all the concatenated gene sequences of the mitogenomes except the 3rd codon positions and non-coding regions. Phylogenetic reconstruction and genetic distance supported the sister taxon of *S. sihama* and *S. indica*. The genetic resources reported here are available for further work in the field of taxonomy and phylogeny, in these and related species.

FIS-P23

Genetic evidence for speciation in Japanese sand lance *Ammodytes personatus*: Pleistocene isolation, temperature and current promoted speciation

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Two divergent sympatric mtDNA lineages have been described in Japanese sand lance *Ammodytes personatus*, and this high inter-lineage divergence raises questions about the taxonomic status of *A. personatus* lineages in the Northwestern Pacific. In the present study, AFLP markers were used to analyze the genetic structures of *A. personatus* and the status of the two mtDNA lineages. Two hundred and eleven individuals of *A. personatus* and 37 individuals of *Ammodytes hexapterus* were amplified by four primer combinations. The results showed a north geographic group and a south geographic group that were reciprocally monophyletic. Complete reproductive isolation may exist between the two geographic groups. These results suggest that the two groups have already reached a stage of sufficient genetic differentiation to be considered as two distinct species. The incongruence between nuclear groups and mitochondrial lineages suggests the two distinct lineages do not represent cryptic species and the presence of divergent mitochondrial lineages in the same sample is a result of secondary contact after an extended period of isolation. The Pleistocene isolation and the biological characteristics of species may be responsible for speciation in *A. personatus*.

FIS-P24

The abundance of the chinook salmon *Oncorhynchus tschawytscha* (*Walbaum*) population in the basin of the Kamchatka River

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Chinook salmon *Oncorhynchus tschawytscha* (Walbaum) is one of the highly valuable species of Pacific salmon species, normally reaching impressive body size after a typically long period at sea (up to 5 years) after the freshwater period, which can be very different. It is not highly abundant meantime, neither on Asian nor on North American coasts, although in streams of the USA and Canada the abundance of this species is 10 times higher compared to Russia, where chinook salmon plays an important commercial role only in the streams of Kamchatka. The most abundant population of chinook salmon in the peninsula is in the Kamchatka River. In recent years the spawning runs and the biological indexes demonstrated significant changes. The age structure of the Kamchatka River basin chinook salmon population changed in the direction of younger ages (5- or 4-year-old fish). While the number of 6-years-old individuals has been decreasing more and more, 1.5 individuals have been very rare currently in the catches. The percent of females in the runs is low, and younger females (1.3) have been dominating the spawning. Such unbalance in the sex ratio is even more noteworthy against the background of extremely low chinook salmon abundance which resulted in decreasing number of females in spawning runs and decreasing fecundity. The absolute individual fecundity of Kamchatka River chinook salmon dropped in the whole population and in important age groups.

It is suggested that the population process of getting younger relates in this case to increasing sea water temperature in winter, observed in recent years, which in turn can accelerate maturation rate. Analysis of linear growth of chinook salmon confirms that winter growth was significant. Expansion of the area inhabited by the species in Arctic streams (Heard et al., 2007) also confirms our suggestion.

FIS-P25

Genetic variation and population structure of marbled rockfish (*Sebastiscus marmoratus*) in the Northwestern Pacific inferred from microsatellite analysis

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Marbled rockfish (*Sebastiscus marmoratus*) is one of the most common fish species widely distributed in the western Pacific from the East China Sea to Japan. Microsatellite DNA technique was used to detect the genetic variation between twelve populations of *S. marmoratus*, eight from China and four from Japan. The total number of samples examined was 288, on average 24 individuals per population. Six microsatellite loci screened in this study showed high polymorphism, as observed in average number of allele per locus (22-35), average expected heterozygosity (0.905-0.940) and observed heterozygosity (0.861-0.956). The results demonstrated that a very high genetic diversity was present in all populations. No significant difference in average allelic richness or expected heterozygosity was observed between Chinese and Japanese populations. Pairwise F_{ST} values were generally low, no exceeding 0.0164. The result of STRUCTURE analysis showed all the populations of *S. marmoratus* shared one gene pool. No significant genealogical branches or clusters corresponding to sampling localities were detected by UPGMA tree. These results showed close genetic relationship among the locations and demonstrated that the marbled rockfish living in Chinese and Japanese offshore is a near panmixia.

Genetic homogeneity is the most remarkable feature of population genetic structure in *S. marmoratus.* Lack of physical barriers to gene exchange in China offshore and south of Japan, long planktonic phase, continuous spawning ground, and large population size could be reasons for genetic homogeneity in this species.

FIS-P26

Evaluating three size removal methods in otolith shape analysis, using the Japanese grenadier anchovy (*Coilia nasus*) and Osbeck's grenadier anchovy (*Coilia mystus*) in Chinese coastal waters

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Size is a main confounding effect in morphology analysis. We conducted a comparative study of three size removal methods (the ANCOVA, residual and allometric adjustment) in morphology analysis, using two fish species from Chinese coastal waters as an example, the Japanese grenadier anchovy (*Coilia nasus*) and Osbeck's grenadier anchovy (*Coilia mystus*). The results showed that model fitting was similar among the three methods: all the models were highly significant ($p<0.001$) and the R^2 value were sufficiently high ($R^2>0.7$). The stock discrimination results differed from each other for the two species. The allometric adjustment had the highest classification success rate (70.7%) than the ANCOVA (64.7%) and residual adjustment (58%) for *C. nasus*. While for *C. mystus*, the ANCOVA adjustment had the highest classification rate (58.9%) than the other two (residual adjustment, 50%; allometric adjustment, 55.6%). The appropriate method to remove size effects may differ, depending on different fish species.

FIS-P27

"Jawless Fishes of the World" – A new book dealing with various aspects of lampreys and hagfishes worldwide

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Living jawless fishes are elongate eel-like animals lacking paired fins, represented by hagfishes and lampreys. These animals are the only living representatives of ancient creatures that gave rise to fish and eventually humans. Hagfishes are marine animals that are widely distributed in the world's oceans and are among the most abundant demersal fishes in many areas. They represent a very diverse group of fishes whose taxonomy is poorly understood and documented. Fisheries for hagfish have developed over the last few decades off both coasts of Canada and the US, as well as off Mexico. Lampreys inhabit freshwater, brackish and marine environments and are represented by over 40 parasitic and non-parasitic species. They are widely distributed and most abundant in the Northern hemisphere but some species occur also in the southern part of the world. These animals have a specific life cycle characterized by a long larval stage (ammocete) in freshwater with subsequent radical metamorphosis. Lampreys play a significant role in freshwater and marine ecosystems as prey and parasites or predators for a variety of aquatic animals, some species are commercially important but some may damage fish in commercial catches.

The book co-edited by Drs. Alexei Orlov and Richard Beamish provides an overview of the current status of knowledge on a variety of topics related to jawless fishes including evolution, phylogeny, diversity, taxonomy, ecology, life history, demography, stock assessment, fisheries, conservation of hagfishes and lampreys worldwide and their interactions with other species. Research needs and perspectives for further advancement are also identified. The book will be published by Cambridge Scholars Publishing in late 2015.

MEQ Contributed Paper Session

MEQ-P1

Study of impact of moderate and heavy weathering processes on individual carbon and hydrogen isotope of n-alkanes in oils

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A 210-day experiment was conducted to simulate oil weathering processes to determine changes of individual carbon and hydrogen isotopes of n-alkanes in oil samples. Results show there are significant differences in the distribution of these fractions in the different initial and weathered oils. Diagnostic ratios of n-alkane displayed obvious changes after medium to long term weathering processes which suggest they are not very suitable as characteristic ratios for identification of sources of medium-sized oil spills.

MEQ-P2

The role of temporary cysts in dense blooms caused by *Cochlodinium polykrikoides* Margalef

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Although hyaline cysts (temporary cysts) of *Cochlodinium polykrikoides* Margalef have been reported in previous reports, the role of the temporary cysts has not fully understood. In 2013, when the dense bloom was observed in Tongyeong coastal area of Korea, we collected the vegetative cells of *C. polykrikoides*. The collected cells were cultured and examined to make the temporary cysts. During sexual reproduction, *C. polykrikoides* produced temporary cysts, as well as the isogametes and planozygotes. The temporary cysts were immobile and surrounded by a thin transparent membrane. The size is similar to that of the motile cells, and only faint traces of the sulcus and the cingulum are present on the surface. Interestingly, two-cell chains of *C. polykrikoides* were continuously generated from the temporary cysts, whereas individual motile cells were not observed during the generation processes. In addition, increase in hyaline cell production was higher under continuous dark conditions, and the two-cell chains were generated in light conditions within 12h. This indicates that the hyaline cells can play an important role for the survival and development of *C. polykikoides* in dense blooms.

MEQ-P3

The occurrence and Distribution of HBCDs in Laizhou Bay of China

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To investigate the occurrence and distribution characteristics of Hexabromocyclododecanes (HBCDs), surface seawater, sediment and organism samples were collected from the coastal area of Laizhou Bay which was located in the southern part of Bohai Sea of China. Three types of HBCDs isomers were analyzed by a multi-residue chemical analysis methodology, using accelerated solvent extractor coupled with liquid chromatography tandem mass spectrometry. The results showed that the concentrations of HBCDs ranged from 1.71 to 3.00 ng/L in surface seawater and from 0.88 to 10.50 ng/g (dw) in sediment samples. By contrast, relatively high concentrations of HBCDs were found in organism samples. The total HBCDs concentration in organism samples was an order of magnitude higher than that in seawater and sediment samples. Meanwhile, the same composition characteristic of HBCDs isomers were observed in three mediums with γ-HBCD>α-HBCD>β-HBCD, which was similar to that found in commercial products. This result suggested that anthropogenic activity in coastal areas was a statistically significant source of HBCDs in Laizhou Bay. The percentage of three types of isomers took a similar pattern in seawater and sediment mediums. Nevertheless, the percentage of β-HBCD was decreased to 5% in organism samples along with increased α-HBCD, which elucidated the selective bioaccumulation behavior of HBCDs in organisms. In addition, the sediment-water distribution coefficient of α-HBCD, β-HBCD and γ-HBCD was 0.92, 1.54 and 1.60, respectively. Different adsorption ability of HBCDs isomers into the sediments suggested the multimedia behavior of HBCDs.

MEQ-P4

Responses of mesozooplankton communities to different anthropogenic activities in a subtropical eutrophic bay

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To evaluate the effects of marine exploitation on a pelagic ecosystem, we conducted four seasonal cruises in a thermal discharge area (TDA) of a power plant, a kelp farm area (KFA), an oyster farm area (OFA), a fish farm area (FFA), and an artificial reef area (ARA) in the eutrophic Xiangshan Bay (China) in 2010. Results showed that different anthropogenic activities resulted in unique small-scale habitats, which exhibited mesozooplankton community patchiness. Moreover, the results indicated thermal discharge and aquaculture had influenced mesozooplankton communities in a certain range, but the influence of artificial reef was still not significant. The thermal discharge showed significantly negative impacts on biomass and abundance of mesozooplankton, but positive effects on biomass to abundance (B/A) ratio during four seasons. In addition, the dominant species in summer seemed to shift from *Acartia pacifica* to eurythermal and warmwater taxa near outfall of thermal discharge. Oyster culture reduced the biomass, abundance, and B/A ratio of mesozooplankton dramatically due to food competition, and changed community. Nevertheless, the changes in KFA and FFA were less than that in OFA. Kelp culture only slightly promoted biomass and B/A of mesozooplankton. However, compared with the historical data, the biomass and B/A of mesozooplankton in FFA declined with the increase in dissolved inorganic nitrogen and phosphate. Another notable observation in the entire study area was that *Centropage abdominalis* was the sole dominant species in winter, and revealed a rising trend in abundance and outbreak in advance.

MEQ-P5

Estimation of carrying capacity by measuring coastal environmental parameters in Geoje-Hansan Bay, Korea

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The importance of aquafarming is increasing all over the world, but most of the aquaculture grounds are concentrated in semi-enclosed bays. Consequently, coastal environmental loads are increasing. Thus, it is important to estimate the ecological carrying capacity to reduce environmental loads and maximize local productivity. Samples for various environmental parameters were collected at three light depths (100%, 30% and 1% of surface light intensity) at 8 selected stations from January to May, 2015. The chlorophyll-*a* concentrations at the 8 stations ranged from 4.3 to 108.1 μg L^{-1} and the average of chlorophyll-*a* concentrations was 37 μg L^{-1}(S.D. = ±28 μg L^{-1}). The highest concentration of chlorophyll-*a* was in January whereas the lowest concentration was in April. Large celled phytoplankton (> 20 μm) predominated at every station (51 ± 9 %). AVS (Acid volatile sulfide) concentrations of surface sediments ranged 0 to 0.946 mg S $g.dry^{-1}$ and the mean AVS concentration was 0.16 mg S $g.dry^{-1}$ (S.D. = ±0.212 mg S $g.dry^{-1}$). DIN (Dissolved inorganic nitrogen) concentrations from January to March in water columns were ranged 0.013 mg L^{-1} to 0.111 mg L^{-1} and the mean DIN concentration was 0.032 mg L^{-1} (S.D. = ±0.019 mg L^{-1}). Preliminary results showed that the concentrations of AVS and chlorophyll-*a* were relatively higher in densely culturing regions than others. These data including other parameters such as primary production, TOC (total organic carbon) and TON (total organic nitrogen) will be obtained continuously and used for estimating the carrying capacity in Geoje-Hansan Bay.

MEQ-P6

Radiocesium transfer from contaminated sediment to benthic organisms and demersal fish

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The discharged radiocesium from the Fukushima-Daiichi Nuclear Power Plant (FNPP) in April 2011 gradually associated with suspended material and settled to the sea bottom around Fukushima prefecture, Japan. Previous studies reported that the radiocesium concentrations in the surface sediment collected off the coast of Fukushima were mainly in the range of dozens to several hundred Bq/kg-dry. Therefore, it is thought that benthic organisms and demersal fish take in radiocesium from highly contaminated sediments through the benthic food web. In the present study, we estimated the radiocesium transfer from contaminated sediments to benthic organisms and demersal fish off the coast of Fukushima. We conducted experiments of a marine worm, *Perinereis aibuhitensis*, and a flatfish, *Paralichthys olivaceus*, reared on highly contaminated sediments collected off the coast of Fukushima under flow-through seawater conditions. The rearing seawater was pumped up from the coastal water of Fukushima. The rearing experiment of *P. aibuhitensis* for 84 days showed that *P. aibuhitensis*/sediment (wet/wet) concentration ratio (CR) of ^{137}Cs was less than 0.05. Moreover, the rearing experiment of *P. olivaceus* for 49 days using highly contaminated sediment (^{137}Cs concentration = about 400 Bq/kg-wet) and non-contaminated pellets showed that *P. olivaceus*/sediment (wet/wet) CR of ^{137}Cs was less than 0.006. These results indicate that the intake of radiocesium through the benthic food web is limited for benthic organisms and demersal fish, despite high contamination of the surrounding sediments.

MEQ-P7

Spatio-temporal variation of radiocesium in sea sediment on benthic marine ecosystem based on five-minute resolution mapping

Daisuke **Ambe**[1], Shigeho Kakehi[2], Toru Udagawa[3], Kazuhiro Aoki[1], Yuya Shigenobu[1], Tsuneo Ono[1], Takami Morita[1], Mikiko Tanaka[1], Ken Fujimoto[1], Hideki Kaeriyama[1] and Shizuho Miki[1]

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Spatio-temporal distributions of the radiocesium concentration in sea sediment were investigated off Miyagi, Fukushima and Ibaraki Prefectures from February 2012 to August 2014, with spatial resolution in every 5 min in latitude and longitude. The concentrations in southern area from the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) were generally higher than those in the northern area. In the southern area, especially high concentration band was observed at the region shallower than 100 m with a width about 20 km. Meanwhile in northern area, the concentrations were generally low in the central area of Sendai Bay off Miyagi. These horizontal concentration patterns were highly correlated with the distribution of grain sizes of sediment and a simulated trajectory of the dissolved radiocesium in bottom water which was discharged and transported from the FDNPP during early stage after the FDNPP accident. This result indicates that the observed horizontal distribution of the radiocesium concentrations were immediately determined after the accident by the radiocesium-contaminated water and the adsorption response of radiocesium by the sediment, and also that the distribution of those did not temporally change much during the period of this study. Nevertheless, the radiocesium concentrations in demersal fishes generally gradually decreased during the same period, suggesting that the influence of the radiocesium-contaminated sediment on marine organism were reduced such as by the process that the biologically available radiocesium (radiocesium in organic matter) would gradually translocate to the lithogenic fraction (radiocesium on minerals).

MEQ-P8

Distribution of major and trace elements in surface sediments of the Gulf of Thailand

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Elemental geochemistry of marine sediments is of significance for understanding transport and sedimentary dynamic processes and environmental conditions of their source area, especially for the continental shelf where marine sediments mostly derive from nearby drainage systems. In this study, we aim to investigate the basin-wide distribution of major and trace elements in surface sediments of the Gulf of Thailand in order to explain the behavior and source of marine sediments. A total of 45 surface sediment samples were collected using a gravity corer during March and April of 2013. The samples were analyzed by using X-ray Fluorescence (XRF) for major and trace element concentration. The data were then used for statistical analysis (hierarchical cluster analysis) to present the spatial distribution of major and trace elements. The result suggests that the distribution of major and trace elements can be classified into two provinces. The first province is the northern and southern gulf, where sediments are contributed by the river systems from middle Thailand (northern part) and coastal regions of the Malay Peninsula (southern part). The second province is the central gulf, where sediments are a mixture from multiple sources potentially including the Mekong River. The major element concentrations of two provinces are similar, but the trace element concentrations are different.

MEQ-P9

Clay mineralogical records of sediment provenance change during the sea level rise of last deglaciation in the southern South China Sea

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Sediment core MD05-2893 was investigated for clay minerals to assess the effect of sea level change on sediment provenance variation. The clay mineral results show high contents of smectite (35-55%), moderate contents of illite (16-30%), kaolinite (11-27%), and chlorite (8-17%). The smectite/illite ratio is applied to determine the sediment provenance variation. Earlier studies reported that the Indonesian Archipelago is the major smectite source, whereas the Mekong River and Boneo mainly provide illite to the southern South China Sea. The mineralogical ratio shows a stable value of 2.77 in the lower part of core, and then decreases to the value of 1.64 at around 215 cm, which is dated to the early stage of last deglaciation. Abrupt change of sediment records is usually caused by tectonic activity or sea level change rather than climate conditions (precipitation and temperature). Therefore, the rapid decrease of the ratio is expected to be the response of sediment provenance change due to the sea level rise. Our study suggests a two-stage evolution of the sediment provenance variation near the Sunda Shelf in the southern South China Sea since the last glaciation: (1) during the low sea level stand of the last glaciation, the Indonesian Archipelago provided the majority of sediments to the Sunda Shelf through the Molengraaff; (2) during the high sea level stand of Holocene, both the Mekong and Boneo provide the most sediments to the Sunda Shelf. The major sediment provenance change happened during the sea level rise of the last deglaciation.

MEQ-P10

Geochemical records of provenance and East Asian monsoon evolution during the Late Quaternary in the western South China Sea

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Terrigenous sediments in the western South China Sea are used to determine the provenance and the related East Asian monsoon evolution during the Late Quaternary. Two sediment cores of MD05-2899 (water depth 2393 m) and MD05-2901 (water depth 1454 m) were analyzed for bulk elemental geochemistry using X-ray Fluorescence (XRF). Elemental ratios of Al/Ti, Na/Al, and K/Al will be applied to determine the terrigenous sediment source. Along with the chemical index of alteration (CIA), these geochemical proxies will be incorporated to indicate the silicate weathering, which reflects the East Asian monsoon evolution. Fluvial sediments in middle Vietnam and short sediment cores in the coastal area will also be analyzed for comparison of the sediment provenance change during the Late Quaternary. These data are used to evaluate the terrigenous sediment contribution from middle Vietnam to the deep western South China Sea. The objective of this study is to answer the source of terrigenous sediments in the western South China Sea and to reconstruct the East Asian monsoon evolution during the Late Quaternary. The analysis is displayed in this presentation.

MEQ-P11

Radioactive cesium in marine organisms around Japan

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Large amounts of radioactive cesium were released into the ocean through direct and atmospheric pathways by the Fukushima Dai-ichi Nuclear Power Plant accident from March to April in 2011. Consequently, the radioactive cesium levels were elevated in many kinds of marine organisms around Japan. Because the release of large amounts of radioactive cesium was stopped in relatively short time period after the accident, marine organisms in prefectures other than Fukushima Prefecture and adjacent prefectures were less influence by the accident. Even in Fukushima Prefecture, due to the radioactive cesium concentration in seawater rapidly decreasing in ocean process, the concentrations in the pelagic fishes, invertebrates and seaweeds have also decreased because of their radioactive cesium concentrations depending strongly on that in seawater. Additionally, the concentrations in the demersal fishes has been steadily decreasing over time, though it was reported that their concentrations in 2011 had not decreased. The monitoring by the Japanese government and the Fukushima Prefecture showed that the ratio of inspected samples over the Japanese regulatory limit (100 Bq/kg-wet) off Fukushima prefecture and other prefectures were 53 % and 6.5 % in the period immediately following the Fukushima Dai-ichi Nuclear Power Plant accident (April – June 2011), respectively, but dropped to 0.3 % and 0.2 % in the recent period (January – March 2015), respectively. These results show that the pollution by the Fukushima Dai-ichi Nuclear Power Plant accident is being cleaned.

MEQ-P12

Research of pore water nutrients diffusion fluxes in the Yangtze River Estuary adjacent waters

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In November 2011, investigations were carried out in the Yangtze River Estuary Adjacent Waters to understand the nutrient composition and distribution features in overlying waters and pore water. The diagenetic models were applied to calculate benthic nutrients fluxes, to analyze main factors which affect nutrient diffusion fluxes and fluxes tendencies in future. The results showed that: according to diagenetic model, benthic nutrients diffusion fluxes were 0.0218~0.167 mmol/m2·d for NH4-N, -0.751~0.178 mmol/m2·d for NO3-N, -0.00144~0.0121 mmol/m2·d for PO4-P and 0.34~1.24 mmol/m2·d for SiO3-Si; The spatial-temporal distribution of overlying water and pore water nutrients in the Yangtze River Estuary Adjacent Waters were influenced by factors as terrigenous input, biogeochemical process, bioturbation and sedimentary type. Comparison with other regions indicated that nutrients fluxes of the Yangtze River Estuary Adjacent Waters ranked at medium level.

MEQ-P13

Resting cysts of potentially harmful dinoflagellates in Korean coastal area

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Since the 1980's the frequency of harmful algal blooms (HABs) caused by the cyst-forming dinoflagellates has increased dramatically in Korean coastal waters. Although the distribution of dinoflagellate resting cysts has been widely investigated in Korean coastal areas, the morphological characteristics of resting cysts of potentially harmful dinoflagellates are still unclear. Here we provide the descriptions of these potentially harmful dinoflagellates cysts in detail to help a better understanding of the morphological characteristics and biogeographic distribution of potentially harmful dinoflagellates. Sediment samples were collected from 51 stations in the southern coastal area, Korea. Viable resting cysts were isolated and induced to excysts, and identification was based on morphological characteristics and molecular phylogenetic positions of the germinated cells. 9 potentially harmful dinoflagellate species were identified: 7 potentially toxic species and 2 potentially bloom-forming species. The resting cysts of *Gymnodinium aureolum*, which has a smooth, thin wall and many pale lipid globules, were first observed from natural sediments. The presence of resting cysts of potentially harmful dinoflagellates suggests that further research deserves more attention and efforts in HAB monitoring and management.

MEQ-P14

Early diagenesis of sedimentary chloropigments in the Changjiang and Mississippi river-dominated ocean margins: Implications for source, transport and burial of organic carbon

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The Changjiang (CJ) and Mississippi (MS) river-dominated ocean margins (RiOMars) are major depositional pathways of organic carbon (OC). We employed sedimentary chloropigments (chlorophyll-a [Chl-a], pheophytin-a [PHtin-a], pyropheophytin-a [pPHtin-a], pheophorbide-a [PHide-a], carotenol chlorin esters [CCEs] and sterol chlorin esters [SCEs]) and TOC, TN, $\delta^{13}C$, $\delta^{15}N$ in sediment cores as proxies to determine the source, transport and burial of OC in the two RiOMars. SCEs and pPHtin-a are more stable than PHtin-a, PHide-a and CCEs based on simplified comparative decay model. The major pigment composition for the CJ RiOMar (PHide-a and SCEs) and the MS RiOMar (pPHtin-a, CCEs and SCEs) was different since Chl-a decomposed by senescence and/or grazing in the CJ RiOMar, while mainly by grazing in the MS RiOMar. Significant high chloropigment inventories in estuarine stations symptomized they were OC depocenters and burial areas. OC remineralized rapidly during the early diagenesis process, and only little part could be burial in deeper sediment. In the erosive stations, OC in surface sediment was hardly to be preserved and buried in deeper sediment, and it was transported to inner shelf stations and submarine canyon stations. In the CJ RiOMar, OC was transported and buried along-shore in the ECS inner shelf which is far way from the CJ estuary. In the MS RiOMar, OC was transported and buried off-shore in deep sea (e.g., the MS Canyon) instead of the shallow Louisiana inner shelf.

MEQ-P15

Detection of *Cochlodinium polykrikoides* using sandwich hybridization integrated with nuclease protection assay

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The frequent occurrence of harmful algal blooms (HABs) worldwide has serious impacts on the marine environment and fishery resources. *Cochlodinium polykrikoides* is an important causative agent of HABs in Korea's seas, but the presence of this organism cannot be tested in large numbers of samples by using time-consuming and expensive conventional approaches including light and electron microscopy in long-term monitoring and high-throughput sampling projects. As such, in this study, an integrated sandwich hybridization and nuclease protection assay (NPA-SH) was established for the quantitative detection of *C. polykrikoides*. The specificity of the probes was verified with individual and mixed cultures as well as field collection from Gosung Bay, Korea, and the quantity of *C. polykrikoides* determined by NPA-SH analysis showed a good correlation with that determined by cell-counting with a light microscope. In addition a standard curve for *C. polykrikoides* was established to represent the correlation between optical absorbance in the NPA-SH assay and cell density. The results show that the NPA-SH method is reliable, specific, and accurate in the detection of *C. polykrikoides*; thus, this approach provides an efficient alternative to traditional, morphology-based methods for the rapid identification and quantification of harmful algal species and could be used to monitor phytoplankton in field surveys.

MEQ-P16

Large ocean engineering impact on distribution characteristics of epifauna community in waters around Yangshan Islands in Hangzhou Bay

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As a living place of various fishes, shrimps, crabs and parrs and famous for the Zhoushan Fishing Ground, the Hangzhou Bay ecosystem has the typical flimsiness and complexities. In 2003, Yangshsan Deep Harbor started at Hangzhou Bay and was put into use in 2006.Based on 20 sites about epifauna from 2001 to 2014 in the sea around Yangshan Island of Hangzhou Bay (30°32´~30°50´N, 121°53´~122°17´E), this paper did a analysis on epifauna community succession. Compared to the data before the Yangshan Engineering, the results are shown below. The biomass and density of the epifauna ascended from the 2001 to 2014, but the species number, dominant species and the species diversity declined. *Palaemon gravieri* and *Exopalaemon annandalei* from the Crustaceans were the main dominant species. From the former state before the engineering of year 2001 to 2014, the species diversity index made a downtrend from 2.29 to 1.81.

MEQ-P17

Heavy metal concentrations in wild fishes captured from the South China Sea and associated health risks

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Heavy metal accumulation in fish can create long-term impacts on ecosphere biogeochemical cycling. Heavy metals accumulate as they move up the food chain, and may reach dangerous levels for human health. Thus, it is important to analyze the heavy metal concentrations in widely consumed fish species. However, heavy metal contents in marine wild fish species from Zhongsha (Macclesfield) Fishing Ground, Zhubi (Subi) Reef, and Meiji (Mischief) Reef of the South China Sea are unknown. Meanwhile, heavy metal contents in most of this study marine wild fish species from Wanshan Fishing Ground are scarce.

The present study conducted a large-scale investigation of heavy metals (Cd, Pb, Cr, Ni, Cu, Zn, Fe, and Mn) in 29 marine wild fish species from the South China Sea. Concentrations (wet weight) were 0.51–115.81 ng/g (Cd), 0.54–27.31 ng/g (Pb), 0.02–1.26 lg/g (Cr), 8.32–57.48 ng/g (Ni), 0.12–1.13 µg/g (Cu), 2.34–6.88 µg/g (Zn), 2.51–22.99 µg/g (Fe), and 0.04–0.81 µg/g (Mn), respectively. Iron (Fe) concentrations in all and Mn in some fish species were higher than the acceptable daily upper limit, suggesting human consumption of these wild fish species may pose a health risk. Human health risk assessment, however, indicated no significant adverse health effects with consumption.

POC Contributed Paper Session

POC-P1

Time-series wavelet transform exposes South Atlantic Ocean changes during the last 40 years

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Climate change is creating a dynamic of continuous changes in ecosystems. Generally, the expected consequences of these changes are global; however, the occurrence of extreme events and specific environmental problems are usually local or regional phenomena. One of the keys to uncover climate-driven changes is the long-term time-series of observations. While there are a number of long-term biological time-series on land, there are relatively few in marine environments. This is highlighted by the fact that the Intergovernmental Panel on Climate Change (IPCC) noted 28586 significant biological changes in terrestrial systems, but only 85 from marine and freshwater systems. The present research deals with this gap, focusing on an area which holds scarce to null long-term research on ocean observation and climate driven changes: the South Atlantic Ocean. From the results of the analysis of up to 40 years of oceanographic physicochemical variables measured at the Bahia Blanca Estuary, previously unknown underlying trends were uncovered. In order to test the variables' trends throughout several time-scales, the continuous wavelet transform (CWT) was used to divide the continuous-time function into wavelets. Moreover, the use of Cross Wavelet Correlation (CWC) allowed the relationship between the variables to be highlighted throughout different time-scales. After that, a correlation analysis which linked the ocean observations to biological documented changes was assessed. As a result, novel hypotheses were raised in the field of phytoplankton and zooplankton assemblages climate-driven control, crustaceans catches and fisheries recruitment.

POC-P2

Investigation of shallow and deep water wave dynamics using unstructured SWAN: An application to Lake Michigan

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Accurate wave simulations are vital in evaluating consequent impacts on coastal dynamics, especially when spatio-temporal wave observations are sporadically absent. Structured-grid models have demonstrated their ability of capturing wave dynamics in large-scale offshore domains, while the recent emergence of unstructured meshes provides the opportunity to better resolve the highly complex geometry near islands and coastlines. In this work, un-SWAN is configured to Lake Michigan on the basis of wave statistics comparisons (e.g., NOAA-NDBC buoy data and FVCOM-SWAVE) at both deep and shallow stations, and its performance was assessed using a hindcast of Superstorm Sandy. We found that the un-SWAN reproduced the wave height from small to moderately high ranges reasonably under wind forcing of Jansen wind (1991). Un-SWAN driven by GEM model outperformed in capturing larger wave heights in mid-lake, whereas produced shallow water waves more accurately using the wind data based on Natural Neighbor Method (NNM). During Superstorm Sandy, GEM and CFSv2 produced maximum wind speeds and significant wave heights which were along the central north-south lake axis whereas in NNM scattered lobes in the vicinity of coasts were found. Unlike the widespread influence of the wind input source term on the wave evolution, the white capping term mostly affected wave dynamics in deeper water. In shallow water, the processes of depth refraction and breaking were dominant, and were found to be highly dependent on grid resolution.

POC-P3

Paleoenvironmental reconstruction from deepwater sedimentary records in the central South China Sea since the middle Pleistocene

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The deepwater sedimentary evolution and paleoenvironmental reconstruction of the central South China Sea still remains unclear. Despite the high sedimentary rate of the fluvial drainage and sedimentary input into the sea, deepwater sedimentary processes and ocean circulation often complicate the terrigenous input of fluvial sediments into deeper basins. Here, we aim to provide detailed insights of sedimentary records of the central South China Sea over the last 900 kyr by examining an IODP Expedition 349 Hole U1433A (4379 m water depth in the Southwest Subbasin). Using clay mineralogical proxies such as smectite/(illite+chlorite), illite crystallinity, and the illite chemistry index plus carbonate geochemistry, we look at the effects of alternating glacial-interglacial periods on our marine sediment changes in provenance supply and paleoceanographic control. The clay mineral assemblage ranges from 25-60% for smectite, 20-40% for illite, 10-25% for chlorite, and 2-16% for kaolinite. Illite and chlorite contents usually appear very synchronously, whereas smectite content shows an opposing trend. We obtained an average illite crystallinity of $0.17\Delta°2\theta$. Based on comparative studies of possible provenances, we infer that the depositional conditions are highly variable with multiple provenances, including fine-grained sediments from both the Mekong and Taiwan drainage systems. The long-term clay proxy fluctuations indeed indicate paleoenvironmental changes that record glacial-interglacial cyclicity along the period similarly, and rhythms of fluctuations that could coincide with the changing of currents in the deepwater environment. We suggest that the patterns of clay mineral fluctuation are strongly related to the evolution of the East Asian monsoon which controls chemical weathering and transport processes of those clay assemblages in the region.

POC-P4

Study on the hydrodynamic performance of a flap bottom-hinged wave energy converter

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This paper first discusses wave energy resources at an ocean energy test site. Then a brief description of a bottom-hinged wave energy converter is given in which the characteristics of the device are described. Third, the hydrodynamic performance of a flap bottom-hinged wave energy converter is then investigated. A linearized frequency domain numerical model of the bottom-hinged wave energy converter is developed. The numerical model is verified and calibrated using data from wave-tank experiments. It is found that the device capture factor is affected by the device thickness and wave frequency.

POC-P5

Dynamic evaluation of Envisat ASAR derived ocean swell in North Pacific

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It is estimated that 75% of waves across the World Ocean are generated by distant storms which propagate as swell. In particular, the strongly swell-dominated North Pacific is known as a swell pool, acting as a response and/or impact factor for climate change. Nowadays, a unique swell spectra dataset on a continuous and global basis is available to the scientific community from the Advanced Synthetic Aperture Radar (ASAR) aboard the Envisat satellite that has been operating in wave mode for 10 years. In this paper, these valuable remote sensed data are validated against directional wave buoys in the North Pacific. We propose a dynamical validation approach: buoy spectra are reconstructed, partitioned, and retro-propagated to the vicinity of satellite observation along the great circle based upon the linear wave theory. Almost 40,000 ASAR-buoy swell partitions are dynamically collocated for the full mission of Envisat, making this study the first to provide detailed quality assessment for ASAR-derived ocean swell spectra. Comparison results show general statistics of 0.46 m, 0.89 s and 15.27° for swell height, peak period and direction RMSE, respectively, indicating a good agreement with in-situ buoy measurements in the North Pacific. Furthermore, a typical case is presented and discussed, describing the swell generated in the Southern Ocean propagating to the North Pacific, captured by ASAR in the middle of the Pacific and finally observed by the NDBC buoy off the California coast.

POC-P6

Error variation analysis and global assessment for total water vapor of HY-2 Scanning microwave radiometer

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The scanning microwave radiometer (RM) was launched on August 16, 2011, onboard HY-2 satellite. As the one of primary parameters retrieved from HY-2 RM, the six-month long from Jan to Jun 2012 global total water vapor column (WV) obtained from HY-2 scanning microwave radiometer were preliminarily validated using other operational space-borne radiometer observations. The gridded water vapor productions of Special Sensor Microwave Imager (SSM/I) were seen as "true data" in this inter-comparison. For the global scale, the bias and RMS difference of the dataset of these space-borne collocated WV observations was respectively -0.24 mm and 1.19 mm during this six-month period. With analysis of global map of mean difference of the collocation between HY-2 RM and SSM/I, the map of bias distribution appeared that there were a positive deviation about 1mm in the tropic ocean where the precipitation and humidity were in relative high level, a negative deviation in the coastal and near-shore regions. The results suggested that accuracy of retrieval algorithm for HY-2 WV productions obviously depends on latitude. There were potential and room for improvement of retrieval accuracy of WV, for correcting overestimation of WV in the tropic sea and underestimation in the inshore regions relative to SSM/I observations.

POC-P7

Seasonal variability of water circulation in the deep Bering Sea

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We calculated surface-to-bottom water circulation of the deep Bering Sea induced by atmospheric processes. For this purpose we used a numerical model of integral streams with uniform grid of 30' × 30', temperature and salinity (from WOA13), atmospheric pressure, and vertically averaged monthly density (from WOD13 and GEBKO-01). We used Polyakova's classification of atmospheric circulation types with regard to non-stationary over the Northern Pacific (DVGU, 1999) and selected the "northwest" type of atmospheric processes which is characterized by cyclonic trajectories from the southwest to the east-northeast or from the west-southwest to the east-northeast. Results show seasonal changes in currents produced by a variety of hydrodynamic structures having different spatial and temporal scales. In winter there is an alternation of cyclones and anticyclones. In general, there are four large hydrodynamic structures: two anti-cyclonic and two cyclonic. During the summer currents are generally dominated by cyclonic circulation. The region occupied by cyclonic and anti-cyclonic structures is reduced and velocities are smaller. The results of our calculations for winter and summer are within normal limits.

POC-P8

Application of Wave Drifter to marine environment observation

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Surface following buoys are widely used to measure wave for their excellent hydrodynamic response to wave motions. Apart from traditional wave buoys using accelerometers as the wave sensor, recently GPS device has been an alternative for its low cost, and many studies on wave measurement by GPS were carried out. A small size Wave Drifter is introduced in this study as a preferred wave observing instrument for open-sea wave-measuring applications, especially for typhoon wave. The Wave Drifter, which is based on a single GPS receiver, uses measurements of Doppler shift in GPS signals to derive wave parameters and transmits the results via BEIDOU satellites hourly. In this study, laboratory experiments were designed to simulate perfect harmonic wave motion by a dynamic simulator, in order to verify the accuracy of wave-processing algorithm. Several field tests in coastal area were carried out. Intercomparison between the derived wave parameters including direction properties and the Waverider's measurements showed good agreements. A Wave Drifter was launched around east of Taiwan in the West Pacific area from a R/V ship in late October 2013. Wave conditions during Typhoon KROSA (2013 29) were recorded and the maximum of significant wave height of 5.8 meters was detected where the buoy was located around 256km to KROSA. The Wave Drifter provides a cost-effective way to wave measurements, and many applications will benefit from this technology, such as data assimilation and validation of wave forecast models, calibration of satellite wave sensors and investigation of ocean wave climate and variability.

POC-P9

Analysis on the formation dynamics of a typical small-scale eddy in the Bohai Sea

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Small-scale eddy systems in coastal areas influence the development processes of the local ecosystems through redistributing nutrient substances. Studies on these small-scale eddies are essential for coastal management and marine ecosystem conservation areas. Until now, systematic studies on the formation dynamics of small-scale eddies were few in the Bohai Sea, and even now the existence of these eddy systems remains controversial because of the lack of qualified in-situ ocean current observational data. In this study, we first located a small-scale eddy of diameter 40km in the Qinhuangdao coastal area, which is located on the western coast of the Bohai Sea, by analyzing the high spatial and temporal resolution ocean current profile data that are measured by an ADCP in four seabed platform observation systems deployed in September 2013. Next, we conducted several numerical sensitivity experiments to discuss the formation dynamics of the small-scale eddy by considering the topography of the survey area and the meteorological conditions during the observation period. The small-scale eddy is formed mainly because of the combined effects of the summer monsoon and topography. The sea surface height (SSH) near the Qinhuangdao coastline is elevated when the summer monsoon induces a shoreward transport of the sea water. The elevated SSH then produces an ocean current which flows southward, bounded by the coastline. The coastal southward current and the northward current in the open water, which is induced by the summer monsoon, together create vorticity and eventually form a small-scale eddy. Since the hydrographical characteristics of the Qinhuangdao coastal area are typical in the Bohai Sea knowledge of the combined effects of the topography, monsoon and ocean circulation advances our understanding of the small-scale eddy dynamics in the Bohai Sea.

POC-P10

Analysis of ocean surface wave spectra from a new wave buoy

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A new wave buoy powered by solar panels, which can measure the three axes acceleration of the buoy, pitch and roll, has been developed. Non-directional wave spectra are calculated from measured acceleration time series of the buoy. A real time algorithm for estimating wave information (including wave spectra, significant wave height, mean wave direction, principle wave direction, etc.) is described in this paper. In order to evaluate data consistency, a comparison of the wave parameters from two different buoys is presented.

POC-P11

Study of the turbulent mixing in the northwestern Pacific based on a fine-scale parameterization method

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Small-scale turbulent diapycnal mixing plays an important role in heat, water mass, dissolved substances (nutrients and pollutants) transportation, as well as the global climate, the thermohaline circulation, the marine environment and ecosystems. The turbulent diapycnal mixing in the northwestern Pacific has temporal and spatial variations. The rate of turbulent mixing in the upper ocean within the 300–1800 m depth range displays a distinct seasonal cycle, bearing a statistically significant correlation to wind-induced near-inertial energy flux. Enhanced turbulent mixing is also found near the rough seafloor relative to that over smooth topography. Elevated dissipation at the surface and bottom is found to penetrate the ocean interior up to 1800 m and 3300 m, respectively, with penetration depths varying with the wind-induced near-inertial energy and topographic roughness. Here, our study provides evidence for the important role of near-inertial energy input by the wind and the influence of bottom topography in maintaining mixing in the ocean interior. Compared with the Southern Ocean, we find that the mixing rate at the neutral density surface 28 kgm^{-3} over the entire Antarctic Circumpolar Current is an order of magnitude greater than in the Northwestern Pacific, and the induced diapycnal transport is far stronger. Our study demonstrates that diapycnal mixing in the Southern Ocean is an important process to return deep ocean water to the surface, and close the meridional overturning circulation.

POC-P12

Upper layer phenomena monitoring of the sea using EOF analysis of remote sensing data

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The statistical approach based on the empirical orthogonal functions (EOF) analysis is used for analysis of MODIS Aqua data. Each measured Rrs spectrum (data vector) is represented as a point in a multidimensional space with the empirical orthogonal functions as a basis. The EOFs, derived from the set of MODIS Aqua data for the Japan Sea, the Sea of Okhotsk and the Bering Sea over the time period 2003–2014, are used. Coefficients of expansion of the remote sensing reflectance into a series with EOFs are analyzed. The spatial distribution of these coefficients can be used for identification and monitoring phenomena in the upper layer of the sea. In such processes the optical properties of the water are different from the background state and in the three-dimensional projections of four-dimensional space of the EOFs corresponding to them, figures like protuberances are seen. A typical phenomenon is a river runoff. Some examples are presented.

POC-P13

Annual variation of Ba/Ca and Mn/Ca ratios in *Porite* coral from eastern Hainan Island and their environmental implication

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The annual variations in Ba/Ca and Mn/Ca ratios of the *Porties* coral from eastern Hainan Island have been studied using inductively coupled plasma-atomic emission spectrometry (ICP-AES). The analysis results show that the skeletal Ba/Ca ratio varied from 3.120 to 10.064 μmol/mol, with an average of 5.256 μmol/mol. The maximum value occurred in 1944, and the minimum occurred in 1903. The Mn/Ca ratio changed between 0.206 and 5.708 μmol/mol, with an average of 1.234 μmol/mol, observing three Mn/Ca ratio maxima since 1932 and consistent with the strong rainfalls caused by typhoons. The results exhibit seasonal variations of the coralline Ba/Ca and Mn/Ca ratios with higher Ba/Ca and Mn/Ca ratios in the rainy season (from May to October) and lower ratios in the dry season (from November to April). Comparing the results to the instrumentally measured hydrologic data shows that in the past 100 years skeletal Ba/Ca and Mn/Ca ratios of the *Porties* coral from eastern Hainan Island mainly reflected the influence of terrigenous inputs and changes in rainfall, while the response to upwelling was limited.

POC-P14

Winter cyclonic activity in the Asia-Pacific region and its effect on surface temperature in the Sea of Okhotsk in the 2000s

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Surface cyclones play an important role in the formation of weather and climatic conditions in the various parts of the Earth, contributing to a redistribution of air masses, changing wind conditions, etc. During the past 15 years the character of winter cyclonic activity (October-March) in the Far Eastern region has changed. In the first decade of this century (2000s), the trajectories of cyclones became more meridional (relative to the long-term average). This may mean that the number of southern cyclones, coming to the Pacific Ocean in the cold part of year, has increased. During these years cyclones reached their highest strength in two areas, one of which was near the Gulf of Alaska, and the other - to the south of the Sea of Okhotsk. The cyclones in the second group brought warm oceanic air masses to the Sea of Okhotsk, promoting an increase in water temperature in most of the sea. For the years 2010-2014, the situation has changed somewhat - cyclones were often generated directly on the Sea of Okhotsk, where they reached maximum intensity. The inter-annual variability from Kunitsyn's index of cyclonicity (as indicator of the cyclonic activity over the Sea of Okhotsk) showed that since the late 1990s this parameter has steadily increased. During these years, a decrease in the intensity of the ""local"" north wind transfer (Katz's circulation index) over the Sea of Okhotsk was noted also. Both of these indicators reached extreme values from 2000 to the 2010s. As a consequence, in the early 2010s advection of warm air at the surface of the Sea of Okhotsk has increased, and this has caused an even greater warming of the surface water (distribution of positive temperature anomalies over the entire surface of the sea).

POC-P16

Long term, high-resolution ocean reanalysis of the Northwest Pacific Ocean

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New eddy-resolving ocean reanalysis of physical oceanography variables over the period from 1982 to 2014 are produced using a four-dimensional variational data assimilation system, MOVE-4DVar, on JAMSTEC's 3rd generation Earth Simulator. Reanalysis is conducted in a series of assimilation runs in cycle mode with a quasi-10 day assimilation window. The model configuration is set to the Northwest Pacific Ocean and its spatial grid coordinates are designed to resolve oceanic meso-scale eddy structures around the major western boundary currents (WBCs). A series of observational data impact studies is conducted in parallel using subsets of assimilated data and validity of this reanalysis data set before satellite altimetry and the Argo floats era are examined. Preliminary analysis shows the new data set has the capability to reproduce past events of the WBCs system with climatic and synoptic scales over the last 30 years.

POC-P17

Problems in detecting and classifying sea surface anomalies by remote sensing

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Remote sensing is the collection of information on an object or area by a satellite orbiting the earth, and classifying landforms and water bodies based on those remote measurements is one of great importance. Various algorithms are developed for image recognition, then cluster analysis is used to sort or classify the objects. Presently there are many ways to produce recognition by developing a variety of algorithms. The problem of recognition starts when we attempt to categorize some of the group of objects by class. . Information from remote sensing is fed into a processing system which produces a two-dimensional image of the investigated object. A statistical model of spottiness in the investigated area is developed from this type of image. In real conditions, the investigation of spots, their statistical characteristics and their use in detection is a complex procedure. So it is necessary to develop criteria allowing us to distinguish the spots from other phenomena. A mathematical model parametrizing the characteristics of sea surface spottiness is proposed in which the statistical characteristics for "spottiness" of brightness temperatures in microwaves can be used in detecting and classifying anomalies on the sea surface, caused by the degree of sea roughness.

The analysis of empirical histograms for spottiness of brightness temperatures in microwaves shows that in most cases characteristics will be coordinated with an exponential distribution, and amplitude characteristics will be coordinated with a normal distribution. Therefore, to detect and classify anomalies on the sea surface it is necessary to apply optimal algorithms so statistical distributions can be calculated. Numerical results of data processing from remote sensing for the Arctic and Pacific regions are given.

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POC-P18

Measurements of the turbulent energy dissipation rate in the Changjiang river near-field plume

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The discharge of the fresh Changjiang River water represents a significant source of energy, nutrients, sediments, pollutants and other terrestrially derived material to the Yellow and East China Sea(YECS). So far, the spreading mechanisms of the Changjiang River far-field plume have been well developed by modeling and observation. However, there is few study focus on turbulence mixing in the Changjiang River near-field plume. In this work, we present measurements of velocity, temperature, salinity, and turbulence collected in the Changjiang River near-field plume from October 31th to Novenber 1st 2014, using a free-falling microstructure profiler(TurboMAP-L). The turbulent kinetic energy dissipation rate (ε) were estimated, indicating semi-diurnal tidal cycle change character with highest mixing rates ε reaching $10^{-4.5}$ W/kg in the plume during ebb tide . The plume layer is the most turbulent layer in the Changjiang river plume. The distribution of ε compaired favorable with ADCP shear distribution. Stratification calculated based temperature and salinity profiles didn't match with the ε distribution. As defined by gradient Richardson number, turbulence can be defined by the competition between shear and stratifaction. Beased on our observation, shear in the Changjiang river near-field plume domains the turbulence process.

POC-P19

A preliminary study on the tidal effects on the Yellow Sea Bottom Cold Water and its ecosystem using a physics-ecosystem coupled model

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A physics-ecosystem coupled model was developed to study the marine ecosystem around the Korean Peninsula. The physical module of the model uses a finite difference grid in the horizontal coordinates (C-grid) and a hybrid σ-z grid in the vertical coordinate to describe realistically the shallow and mild slope topography along with the deep and steep slope topography. The ecosystem module, which is based on the Ecological Regional Ocean Model (ERGOM) of Neumann (2000), is composed of ten variables, that is, three nutrient types (nitrates, ammonia and phosphates), three phytoplankton functional groups (diatoms, flagellates and blue-green algae), two zooplankton group (micro- and meso-zooplankton), detritus and dissolved oxygen, and it also comprises bottom detrital sediment. Tidal effects on the behavior of the Yellow Sea Bottom Cold Water (YSBCW) were tested using the developed model. In the normal experiment including tide, YSBCW is located in the central area of the Yellow Sea. In the case of the circulation experiment excluding tide, however, YSBCW is moved to the east side of the Yellow Sea, and the stratification in the latter case is weaker than in the former. The responses of ecosystem variables in the YSBCW were also investigated and will be discussed for the two cases.

POC-P20

Variation of sea surface Chlorophyll a in the southwestern boundary area of the East Sea

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An instrumented ferry made two transects per day across two current systems which are the northward East Korean Warm Current (EKWC) and southward North Korean Cold Current (NKCC) since August 2012 from Gangneung to Ulleungdo and Dokdo in the southwestern boundary area of the East Sea. Sea surface water properties of these transects were measured with high spatial and temporal resolution for an extended period of time. Here the chlorophyll a records from the transects with the oceanographic observation data during 2005-2014 from the eastern branch of NFRDI, AVISO daily current chart and GOCI images are used to study the seasonal, bimonthly and daily variation of chlorophyll a at the surface. Sea surface Chlorophyll a concentration in the study area has remarkable seasonal variation such as high in spring season and low in winter season. This seasonal variation is caused mainly by the seasonal variation of the current systems and that of the fresh water discharge from the Yangtze River. It is also greatly influenced by physical and bio-geochemical phenomena such as wind-driven current, upwelling and HAB events.

POC-P21

Linkages of climatic anomalies in the North Pacific, Asia at temperate latitudes, Indo-Pacific and Arctic oceans

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The main goal of our study is to reveal and compare regional climate variability at various time scales in different areas of the North Pacific, Asia at temperate latitudes, the tropical Indo-Pacific and Arctic oceans. The study is based on statistical analyses of the observation records. We use time series of Hadley SST, surface heat fluxes, wind and atmospheric pressure fields (SLP), and different climatic indices. Time series of ice extent in the Japan and Okhotsk seas and ice thickness in the Baykal Lake are used as indicators of regional climate variability in the large-scale subarctic marginal area and continental South Siberia region. The decadal and interdecadal climate oscillation in the Japan and Okhotsk seas, as compared to the Northeast Pacific and South Siberia (Lake Baikal) regions, has a reversed phase. Alternating cold/warm decadal anomalies in different longitude zones of the North Asian Pacific are accompanied by alternating meridional winds and SLP anomalies at temperate latitudes. Alternating zones of inversed anomalies in temperate latitudes of the Asian Pacific are related to teleconnections with anomalies in both Arctic and Indo-Pacific oceans. Positive SSTA in the central and eastern tropical-equatorial Pacific accompanies negative anomalies of northern wind and ice extent in the Japan and Okhotsk seas in mid-winter. At both interannual and decadal time scales a significant link of winter climatic anomalies in South Siberia is found with SST, SLP and net heat flux anomalies in the Indian Ocean and certain areas of the Pacific Ocean.

POC-P22

The formation process of Southern Yellow Sea Cold Water Mass in spring

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Southern yellow sea cold water mass (SYSCWM) is the typical phenomenon in yellow sea (YS) in summer. The traditional viewpoint of its formation is it was formed by the winter residual local water. By the several survey cruise of CTD data of YS in recent years, we found that the temperature in the center of SYSCWM is lower than that of in winter and the salinity is high than that of in winter. Along with the simultaneous mooring observation of current in the area, we found that the yellow sea coastal current (YSCC) in spring make the temperature in the cold core of SYSCWM even colder than that of in winter. We also found that existence of yellow sea warm current (YSWC) in spring which make the salinity in the center of SYSCWM higher than that of in winter. So we conclude that the spring process is important for the formation of SYSCWM. The SYSCWM is not only formed by the winter residual local water but the YSWC and YSCC makes an important role in the formation of SYSCWM.

POC-P23

Simulation of mesoscale and submesoscale circulation in the northwestern Japan Sea

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Multiple scale circulation and eddy dynamics in the northwestern Japan (East) Sea are simulated by using high resolution MGI ocean circulation models developed by Naum Shapiro and Elleonora Mikhailova at the Marine Hydrophysical Institute (Sebastopol). Results show an intra-seasonal and inter-seasonal evolution of interacting mesoscale and sub-mesoscale circulation, and cyclonic and anticyclonic eddies forming, moving and degrading on the shelf, over the continental slope, and in the deep basin of the northwestern Japan Sea. On the external shelf of Peter the Great Bay submesoscale cyclone activity increases during the fall when the thickness of the upper mixed layer is increasing and the vertical density gradient in the seasonal pycnocline is weakening. The horizontal scale of the submesoscale cyclones ranges from 1 to 12 km, while the scale of mesoscale eddies ranges from 15 to 60 km. The horizontal scale of cyclonic eddies increases with depth in stratified flow, while the scale of anticyclonic eddies decreases with depth both on the shelf and in the deep sea area. The time scale of submesoscale cyclones, as a rule, does not exceed 2-3 days, while the time scale of mesoscale eddies varies from several days over the edge of the narrow shelf and steep continental slope of the Japan Basin to about several months on the wide external shelf of Peter the Great Bay, and longer in the central area of the deep Japan Basin.

POC-P24

Assessment of GPS buoy accuracy for altimeter sea surface height calibration

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There are two calibration methodologies for altimeter sea surface height: tide gauge methodology and GPS buoy methodology. GPS buoy methodology requires an accurate GPS buoy (which has been manufactured with a GPS receiver). This paper assesses of the accuracy of the GPS buoy by comparing numerical simulation results with tide gauge data. The simulation results show that the roll angles of the manufactured GPS buoy is less than 10° and the heave rate is close to 1, which meets the requirements of altimeter sea surface height calibration for sea experiment conditions. Using the results from 4 in-situ accuracy testing experiments, the accuracy of the GPS buoy to measure water level height was accessed. The results show a bias of 7.40cm with 0.55cm standard error. Through these assessments, it is concluded that the manufactured GPS buoy is suitable for altimeter sea surface height calibration.

POC-P25

Decadal variability of upper ocean heat content in the Pacific

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By examining the response of ocean heat content anomaly (OHCa) to the total solar irradiance (TSI) in each solar period, we found a decadal variation of OHCa in the upper 700 m in two areas of the Pacific: the tropical mid-Pacific and the western Pacific warm pool area. The lead-lag composite mean-difference of OHCa reveals that the plain-responding areas of OHCa to TSI may present a high response after some yearsof delay, indicating that there exists an agency for the OHCa's response to TSI. It explains why OHCa patterns, responding to solar activity, are not in-phase in different areas.

POC-P26

Intercomparison of reanalysis datasets on ocean heat content

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Irregularly distributed samples in the world ocean are usually optimally interpolated onto a regular grid to form a gridded dataset. With the help of Argo projects, recent observations are expanded both in time and space, though an unevenness still remains and leads to embedded biases during the reconstruction.

Ocean heat content (OHC) in the upper ocean plays an important role in modulating the climate system. In this study, OHC of six reanalysis datasets are analyzed, among which four are mainly based on Argo data and the other two on multi-resource data. By applying Empirical Mode Decomposition (EMD) method, the modulated annual cycle of OHC can be extracted and compared.

It is shown that OHC behavior varies between ocean regions and also along latitude. As shown in Taylor Diagrams, all datasets are plotted while color represents latitude and number represents datasets. The upper 250m OHC of the six datasets shows no significant difference along latitude except in tropical zone. The 250-700m OHC behaves similarly, though the spread is not as dense as in the upper ocean. The four Argo-based datasets show relatively similar patterns while the two multi-resource datasets show an opposite phase in the lower ocean, which is a reflection of embedded biases.

W2: Workshop
Identifying major threats to marine biodiversity and ecosystems in the North Pacific

W2-P1

Assessing ecological risks of heavy metals to marine organisms by species sensitivity distributions

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The species sensitivity distributions (SSD) method was used to assess the ecological risk of eight heavy metals (As, Cd, Cr, Cu, Hg, Mn, Pb, Zn) to marine organisms. The acute toxicity data (LC_{50} or EC_{50}) were collected from ECOTOX database and SSD curves were fitted based on BurrIII function. The acute ecological risks of the heavy metals and the sensitivity of different marine species (vertebrate and invertebrate) to these heavy metals were compared by the hazardous concentrations for 5% of the species (HC5) and the potential affected fractions (PAF). The HC5 values of the seven heavy metals were in the order: Pb>Mn>Zn>Cr>Cu>Hg>Cd>As. When exposure concentration was lower than $10 \mu g \cdot L^{-1}$, no significant differences in the ecological risks of Cr, Cu and Hg was observed. However, As, Cd, Cu and Hg exceeded the threshold of 10% (PAF) at the exposure level of $10 \mu g \cdot L^{-1}$. The ecological risks of the heavy metals increased rapidly as the exposure concentration increased. When exposure concentration was increased to $1000 \mu g \cdot L^{-1}$, 82.49 %, 87.31% and 85.90% of marine species would be affected by As, Cu and Hg, respectively. The order of sensitivity to marine species varied with different concentration of heavy metals. The ecological risk of all heavy metals to crustaceans was higher than fishes.

W2-P2

Macroalgal-coral phase shifts on subtidal benthic community on the northern coast of Jeju Island, Korea

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Jeju Island, Korea is the fastest warming region on the planet. Due to the global climatic warming, average surface water temperature in Jeju Island increased 1.3°C over the past 40 years (from 1969 to 2009). The influx and spread of subtropical species were observed around the Jeju coast due to increase of water temperatue. This led to the changes from macroalgal to coral dominated ecosystems on subtidal benthic community in the Coast of Jeju Island. In kelp-dominated ecosystem, Seongsan, major component of the benthic community included coralline algae (39.4%), *Plocamium telfairiae* (18.5%), *Ecklonia cava* (18.0%), *Sargassum macrocarpum* (6.0%), *Sargassum horneri* (2.0%) and *sponges* (1.0%). However, coralline algae and *Alveopora japonica* (hard coral) covered 55 and 35%, respectively, in Bukchon, northern Jeju. In particular, the coverage of A. japonica was more than 70% at a 15 m depth in this area. Additionally, species richness and biodiversity in Bukchon were lower than that those in Seongsan due to increase of coral. This finding contrasts with the reported trend in other coral reef ecosystems. Considering the importance of macroalgae as primary producers, this change in the dominant trophic group may affect the function and structure of subtidal benthic ecosystem.

W3: Workshop
Linking climate change and anthropogenic impacts to higher trophic levels via primary producers

W3-P1

How does explicit treatment of spatial variability in environmental conditions affect simulated anchovy recruitment?

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We used a 3-dimensional individual-based model (3-D IBM) of Peruvian anchovy to examine how spatial variation in environmental conditions affects larval and juvenile growth and survival, and recruitment. Temperature, water velocities, and phytoplankton and zooplankton concentrations generated from a coupled hydrodynamic Nutrients-Phytoplankton-Zooplankton-Detritus (NPZD) model, mapped to the three dimensional rectangular grid of the IBM, were used to simulate anchovy recruitment. The IBM simulated individuals as they progressed from eggs to recruitment at 10 cm. Eggs and yolk-sac larvae were followed hourly through the processes of development, mortality, and movement, and larvae and juveniles were followed daily through the processes of growth, mortality, and movement (advection plus behavior). A bioenergetics model was used to grow larvae and juveniles. The NPZD model provided prey fields which influence food consumption rate and behavior mediated movement, with individuals being attracted to grid cells having optimal growth conditions. We compared recruitment for monthly cohorts for 1990 through 2004 between the 3-D IBM and a point (0-D) model that used spatially-averaged environmental conditions. The 3-D and 0-D versions generated similar interannual patterns in monthly recruitment for 1991 to 2004, with the 3-D results yielding consistently higher survivorship. Both versions successfully captured the poor recruitment during the 1997-1998 El Niño event. Higher recruitment in the 3-D simulations was due to higher survival during the larval stage resulting from individuals searching for more favorable temperatures that lead to faster growth rates and higher cumulative stage survival. Our analysis demonstrated the important role played by spatial variation in environmental conditions in affecting recruitment of Peruvian anchovy.

W3-P2

A Modeling study of the hypoxia dynamic off the Changjiang Estuary

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In recent decades, with an increased anthropogenic input of nutrients into the Changjiang River, the phenomenon of hypoxia off the Changjiang Estuary has become more and more serious. In this study, a Regional Ocean Modeling System (ROMS) was coupled to a biogeochemical model (Fennel) to understand the controls on dissolved oxygen depletion off Changjiang Estuary. Validation results show that the model can reasonably capture the physical and biochemical dynamics off the Changjiang Estuary. A series of model experiments were made to understand ecosystem responses to altered loads of nitrogen. Nutrient loading experiments revealed that oxygen levels were sensitive to nitrogen and nutrient load reductions will lead to reduced hypoxic volumes. In addition, sensitivity experiments were used to examine the role that physical forcings (river discharge, wind speed, wind direction) play in controlling hypoxia in waters adjacent to the Changjiang Estuary. Variations in wind speed and direction have the greatest impact on the observed seasonal cycle of hypoxia and large impacts on the annually integrated hypoxic volume. The seasonal cycle of hypoxia was relatively insensitive to synoptic variability in river discharge, but integrated hypoxic volumes were sensitive to the overall magnitude of river discharge at annual time scales. Increases in river discharge were shown to increase hypoxic volumes.

W3-P3

The satellite net primary production and its control mechanisms in the Changjiang Estuary, China

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The primary production is an important basis of the fishery ground in the Changjiang Estuary area. In this study, the net primary production (NPP) was estimated in the Changjiang Estuary area during 1998-2010, based on an improved VGPM model and locally modified satellite datasets. The NPP had significant seasonal variation, which is highest (>1500 $mgCm^{-2}d^{-1}$) in summer and lowest (<150 $mgCm^{-2}d^{-1}$) in winter. The maximum of NPP appeared in the outer area of the Changjiang River mouth, and its location was consistent with the sea temperature fronts. A stepwise multiple linear regression was used to examine the relative importance of different factors, such as the Changjiang river discharge (CRD), total suspended matter (TSM), sea wind (SW) and coastal upwelling (CU). The results showed CRD and TSM accounted for 65% variability of NPP during the summer half year, and CRD was more important than TSM. The annual NPP level was determined by the area of phytoplankton bloom, which had obvious positive correlation (R^2=0.54) with the amount of CRD.

W3-P4

The merged global ocean chlorophyll content product

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The world's oceans cover approximately 70% of the Earth's surface, and have a large influence on global heat transport and precipitation. The ocean plays the key role in regulating the global climate. At present, the impacts of global climate change on the ocean ecological environment are becoming clear and are watched closely by ocean researchers. Ocean primary production is the key factor in ocean ecological system as it controls CO2 exchange through the air-sea interface. Ocean primary production is the important object for global climate change study. Ocean chlorophyll content is the most important indicator for ocean primary production estimate.

To provide a long time-series of ocean chlorophyll content information for global climate change research, we produced the merged global ocean chlorophyll content product of 15 years (2000~2014) with the spatial resolution of 9km. Compared with the merged product from ESA Globcolor, our product added FY-3 satellite ocean color data in addition to MODIS, SeaWiFS, MERIS and VIIRS. Also, the latest inversion algorithm of chlorophyll content was applied in our product.

W4: Workshop
Marine Environment Emergencies: Detection, monitoring, response, and impacts

W4-P1

Exploring the potential of Geospatial Technology for oil spill detection in shallow coastal areas in the Arabian Gulf

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Geospatial Technology is helpful in several modes of oil spill control, including large area surveillance, site specific monitoring and tactical assistance in emergencies. Geospatial Technology is able to provide indispensable in sequence to enhance strategic and strategic decision-making, potentially reducing incidence of spills by providing a deterrent factor, decreasing response costs by facilitating rapid oil containment and recovery and ultimately minimizing impact. Remote sensing and GIS provides an effective tool for timely oil pollution response. This research paper includes the spectral signature in the optical and infrared domains of oil slicks observed in shallow coastal waters of the Arabian Gulf were investigated with MODIS, and Landsat ETM+ data. Images estimates of sea currents from hydrodynamic models supported the multi-sensor oil tracking technique. Satellite images with and without sunglint were studied as the spectral signature of oil slicks in the optical sphere of influence depends upon the viewing geometry and the solar angle in addition to the type of oil and its thickness. Depending on the combination of those factors, oil slicks may exhibit bright contrasts with respect to oil-free waters. The oil slick with bright contrast observed by MODIS and Landsat ETM+ showed lower temperature than oil-free areas. Ocean circulation and wind data were used to track oil slicks and forecast their potential landfall. The synergistic use of satellite observations and hydrodynamic modeling is recommended for establishing an early warning and decision support system for oil pollution response.

W4-P2

Complex toxic impacts of heavy metals and PAHs to marine mussels cells

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Rapid economic development and marine exploration have placed the ocean under intensified multiple stresses. Environmental pollutants, such as heavy metals and polycyclic aromatic hydrocarbons (PAHs) are stable, difficult to break down and hazardous to marine ecosystems. It is urgent to develop a sensitive *in vitro* approach to monitor the threats of these pollutants to marine life.

In the current study, mussels (*Mytilus* spp.) were selected as model organisms to analyze the complex toxic impacts of metal and benzo(a)pyrene. Farmed mussels from Gouqi island, East China Sea, were selected in the experiments. Species identification was carried out by using molecular probes before the mussels were dissected. Haemolymph, gill cells and digestive cells were then extracted for cell viability test before the *in vitro* exposure. Cells were exposed to a range of different concentrations of heavy metals. Comet assay was applied to evaluate the DNA strand breaks induced by the exposure. A significant dose-dependent response and tissue-specific pattern were discovered in DNA strand breaks, which suggests that the *in vitro* cellular response to exposure may be a rapid approach to indicate environment stress in marine organisms and have close relationship with their biological functions.

In the future, more biomarkers, such as histopathological damage and mRNA expressions will be applied to evaluate the complex toxic effects caused by heavy metals and PAHs together. This study will build up a sensitive monitoring tool box for the evaluation of marine stresses.

W4-P3

Drift prediction of oil spill and its decision support for emergency response

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Based on the operational marine environment forecasting system implemented by the North China Sea Marine Forecasting Center (NMFC), both two- and three-dimensional oil spill models are developed based on "oil particle" model and used in operational emergency forecasting. These models can simulate the distribution, concentration, swept area and residual amount of spilled oil. Many simulation experiments at sea were implemented to evaluate and improve oil spill models. Based on that, a marine oil spill forecast system for the Bohai Sea was developed to meet the needs of emergency work. This system was awarded the second prize in the "Science and Technology Innovation Award of SOA" in 2008, for the achievement of automatic forecast and reduction time in oil spill emergency. The forecast system has been updated to an emergency decision-support system, which combines oil spill forecast, search and rescue, emergency treatment, resource management and deployment. The main functions of this system include: 3D Oil Spill forecast and dynamic presentation, search and rescue drift prediction and dynamic presentations, oil spill case analysis and planning management, emergency resource management and deployment, emergency aided decision document generation, and fire emergency at sea disposal. This new system has been adopted and is running operationally in China National Petroleum Corporation (CNPC).

W5: Workshop
Monitoring and Assessment of Environmental Radioactivity in the North Pacific

W5-P1

Radioactive status of seawater and assessment in the northeast South China Sea, the Luzon Strait and its adjacent area

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To understand the impact of Fukushima Nuclear Accident (FNA), some cruises were performed from 2011 to 2014. This paper reports the seawater radioactive monitoring results, e.g. ^{90}Sr,^{137}Cs, ^{134}Cs and gross beta radioactivity, in seawater in the northeast South China Sea, Luzon Strait and its adjacent area from March, 2011 to December, 2014. The concentrations of ^{90}Sr, ^{137}Cs and gross beta radioactivity in the surface seawater were at the same level as before FNA in the northeast South China Sea. The concentrations of ^{90}Sr ^{137}Cs and gross beta radioactivity in the Luzon Strait and its adjacent area during the two cruises in 2014 (May and October) were also consistent with in the northeast South China Sea. The ^{90}Sr activity was the highest at the depth of 0.5 m, but the ^{137}Cs was the highest at the depth of 150 m (sampling depths were 0.5, 150m and 600m). The mean values of ^{137}Cs and gross beta radioactivity in seawaters in the first cruise were higher than in the second cruise, but the mean values of ^{90}Sr activity were lower in the Luzon Strait and its adjacent area. The radioactive results were suggested that the sea waters in the northeast South China Sea, the Luzon Strait and its adjacent area were not impacted obviously by the radioactive pollutants released from the FNA.

W5-P2

Monitoring of ^{134}Cs in surface sea water

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The radioactive cesium in the ocean mainly comes from the artificial fission. The amount of ^{137}Cs and ^{134}Cs in leakage from nuclear accidents is relatively large, and so they are the focus of marine environmental monitoring of radionuclides. The half-life of ^{134}Cs (2.06 years) is shorter than that of ^{137}Cs. A large volume and efficient quantitative enrichment device was invented. The filter based on AMP material is highly selective and highly passing ability. ^{134}Cs measurement was achieved with the shipborne gamma spectrometer, which can meet the emergency monitoring requirements. The samples of 1-3m^3 were 16-50 times of the conventional seawater sampling, and the Cs core with the ^{134}Cs concentration of seawater was obtained. The Cs adsorption efficiency of 3.5dm^3·min^{-1} is more than 90%. In emergencies situation, ^{134}Cs measurement time can be reduced to 3-6h. The new source of radioactive cesium in the monitoring region was inferred by measurement of ^{134}Cs in surface water. Pollution area boundary can be determined by the specific ^{134}Cs activity. The monitoring data of ^{134}Cs can be used as the basis for determining the radioactive pollution area of the nuclear leakage and the dispersion boundary of polluted seawater.

W5-P3

Temporal variations of ^{7}Be and ^{210}Pb activity in aerosols at Xiamen, China

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The radionuclides serve as powerful tracers to identify and quantify several atmospheric processes, such as source, transport and mixing of air masses, air masses exchanging between various atmospheric layers, residence times of atmospheric gasses and pollutants. ^{7}Be and ^{210}Pb activities in aerosols were measurement from October 2013 to May 2015 at Xiamen (24°26′7.44″N, 118°5′31.30″N) in South China. The activity of ^{7}Be and ^{210}Pb in aerosols from 2013 to 2015 in Xiamen ranged from 0.48 to 9.84 (mean:5.04) mBq m^{-3} and from 0.17 to 5.40 (mean:1.49) mBq m^{-3}, respectively. The mean activity of ^{7}Be was comparable with the activities of other places in the same latitude, while the mean activity of ^{210}Pb was lower than the activity of the locations at high altitudes. The possible reason is that Xiamen is a coastal city located on southwest Pacific (the wind direction is northeast during all four seasons). The activities of ^{7}Be and ^{210}Pb had a low value in summer (July-September) and a high value in autumn (October-December). There is significant relationship between the monthly ^{210}Pb activities and the concentration of PM 2.5 and PM 10. In contrast, monthly ^{7}Be activities only show significant correlation with the concentration of PM 10, which implies that ^{7}Be and ^{210}Pb can be used to trace the different sources of the aerosols.

W5-P4

Effects of external gamma irradiation on growth of *Phaeodactylum tricornutum*

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Recently, many research projects have focused on the potential influence of radioactivity from nuclear accidents on marine environments, but little of this research was conducted on phytoplankton, some of which are food resources for many marine invertebrates. *Phaeodactylum tricornutum*, a planktonic and unicellular algae, is common in coastal waters and was investigated to determine the effect of gamma irradiation on growth and reproduction during laboratory incubation. Differences were monitored during about two week incubations and the results showed that changes were present in the development of *Phaeodactylum tricornutum* with different doses of gamma irradiation, including morphological features, reproduction, pigment content and enzymatic activity. Possible mechanisms of gamma radiotoxicity for *Phaeodactylum tricornutum* and implications for the primary producer phytoplankton were also discussed in this study.

W5-P5

Radionuclide tracers suggest different migratory patterns in two groups of North Pacific albacore (*Thunnus alalunga*)

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The Fukushima Dai-ichi power station released radionuclides into the Pacific Ocean off eastern Japan in 2011, which provided an opportunity to examine migration routes and population structure of North Pacific albacore. Albacore samples collected (2011-2013) from two regions (North and South of 40°N) in the eastern Pacific were tested for radionuclides (^{134}Cs and ^{137}Cs) released from Fukushima. Pre-disaster control samples (2008) were also tested. Measurements thus far have shown almost no ^{134}Cs in Southern region albacore and a mix of presence/absence of ^{134}Cs and elevated ^{137}Cs in Northern region albacore. Northern albacore showed a positive correlation of ^{134}Cs and elevated ^{137}Cs with length, which indicated that the smaller individuals had not recently migrated from waters with ^{134}Cs such as eastern Japan or the North Pacific Transition Zone. The spatially variable concentrations of ^{134}Cs suggest latitudinal migratory differences and limited mixing of N/S albacore in the eastern Pacific. Albacore tissue contained radionuclide levels orders of magnitude less than FDA food standards. This work, in combination with other approaches (e.g., stable isotope analysis, tagging studies) suggests that North and South albacore may have different migratory histories.

W5-P6

Assessment impact of radioactive contamination on the Pacific saury after the Fukushima Dai-ichi Nuclear Power Plant accident

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It was assumed that after radiation leakage at the nuclear power plant "Fukushima-1" the radioactive contamination of the Pacific saury would increase. Schools of the Pacific saury usually accumulate off the Kuril Islands in summer-autumn period and are fished there by Russian fleet. We investigated the effects of radioactive contamination on the population of Pacific saury migrating through Russian waters. All the materials were gathered from the 2011 – 2013 on the ships belonging to TINRO-Centre. Processing data was carried out in the laboratory using a radiochemical methods and spectrometer equipment. In 2011 Pacific saury was the basis of the Russian harvest and at the moment of leakage saury were distributed in the open ocean waters. The reproduction of this generation was in the autumn of 2009, winter and spring of 2010. The area of reproduction was situated in the open sea waters to the North of Honshu and Hokkaido islands. Our research of 2011 showed that concentration of Cs-137 in the Pacific saury samples was at the level 1.0-1.5 Bq/kg w.w. The radionuclide Cs-134 registered in the early emissions from of "Fukushima-1" was not detected in summer time. The data of 2011 did not exceed the regional background level fixed for Far-East region. The research of 2012 did not reveal the difference in radioactive contamination of fishes in the previous years. The samples of the Pacific saury during fishing in 2013 were selected according to ages and sizes of the fishes: small size (<24 cm), middle size (24-29 cm), large size (>29 cm). The level of radioactive contamination of all groups did not exceed the limits of background as in the previous years.

The research on radiation of the South Kuril area and adjacent commercial fishing areas of Russian waters did not detect any dangerous radioactive contamination of the Pacific saury during fishing seasons of 2011-2013. Thus it permits us to assess the raw material as safe in accordance with sanitary standards of safety.

W6: Workshop
Best practices for and scientific progress from North Pacific Coastal Ocean Observing Systems

W6-P1

A representative assessment method for the coastal marine observation environment

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Due to the rapid development of marine economies, the environment of coastal marine observation stations is increasingly impacted by human activities, which directly affects the accuracy and representativeness of hydrological and meteorological observation data. In order to maintain and verify the quality of the observation data, it is of great importance to investigate the environment of marine observing stations and evaluate their representativeness. Based on the characteristics of the coastal ocean observation environment, we put forward a systematic survey and assessment method for the coastal marine observation environment, which has been applied and achieved good results.

W6-P2

Temporal change of plankton and environmental factors during typhoons observed at the Oshima Cabled Observatory

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Marine studies during typhoons are hindered by storms. Especially, the studies of the response of heterotrophic plankton to the typhoons are lacking. However, a cabled observatory has a capability to reveal the change of plankton community during typhoons. We used the data of CPICS (Continuous Plankton Image Classification Sensor), and environmental sensors equipped with Oshima Cabled Observatory deployed on the sea bottom of Oshima Island from September 21 to October 30, 2014. Oshima was hit by a low-pressure system and two typhoons during the research period. We sorted 50,578 ROI (Region of interest) images into 39 categories manually, with most frequent category of marine snow (20.538) followed by mineral grain (7,795). Mineral grains appeared when significant wave height was high, suggesting resuspension of bottom sediment. Plankton species number and abundance decreased during typhoon period except *Noctiluca scintillans*. But, three days after typhoon, Chl. *a* concentration increased. And six days after typhoon, phytoplankton and zooplankton abundance increased. It suggests that vertical mixing raised nutrient concentration and phytoplankton increased by using it and then zooplankton increased. Cluster analysis showed that plankton community structure changed during the low-pressure system and second typhoon period. ANOSIM showed the plankton community differed among these events. On the other hand, daily diversity index decreased during typhoon and increased after typhoon. These results showed that plankton community was greatly affected by typhoons.

Posters from Observering Organizations

OBS-P-P1

Integrated ecosystem research programs – North Pacific Research Board

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The North Pacific Research Board (NPRB) supports integrated ecosystem research programs to further mechanistic understanding of critical processes in marine ecosystems. These programs are designed to identify and explore processes critical to ecosystem structure and function, further baseline understanding at an ecosystem level, and investigate the influence of natural variation and human impacts. In 2007 NPRB developed the Bering Sea Project in partnership with the National Science Foundation (NSF) and in 2010 launched the Gulf of Alaska Project. Both are multidisciplinary, multi-institutional, regional-scale investigations aimed at characterizing fundamental mechanisms that structure these systems to better understand the influence on the biology and natural resources supported in these regions. These programs integrate disciplines and teams in ways that allow for synthesis of results that have broaden understanding of critical ecosystem properties and processes. This poster will describe the mechanisms used to facilitate collaboration and integration of research and will detail some of the key findings related to the mechanisms that structure and govern these systems and the biology and resources associated with them.

OBS-P2

IMBER – Research for marine sustainability: Synthesis and the way forward

Eileen Hofmann, Alida Bundy, Ken Drinkwater, Alberto Piola, Bernard Avril, Carol Robinson, Eugene Murphy, Lisa Maddison, Einar Svendsen, Julie Hall and Yi **Xu**

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The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project aims at developing a comprehensive, integrated understanding of, and accurate predictive capacity for ocean responses to accelerating global change and the consequent effects on the Earth System and human society. Understanding the changing marine biogeochemistry and ecosystems and their vulnerability and resilience to multiple drivers, pressures and stressors is critical to developing responses that will help reduce the vulnerability of marine-dependent communities. A perspective is provided on the way forward for the next 10 years of IMBER research as the global environmental change research landscape is evolving and as new areas of marine research emerge. The present and next phases of IMBER science aim to foster collaborative, interdisciplinary and integrated research that addresses key ocean science issues and to synthesize and use this understanding to improve societal responses to changing marine systems. IMBER will continue to provide a platform for discussion about prevention, mitigation and adaptation to global environmental change in marine societal and ecological systems, and promote capacity development to help strengthen research, governance and management at all levels.

OBS-P3

ESSAS – Ecosystem Studies of Subarctic and Arctic Seas

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The Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) Program is a regional program of the Integration of Marine Biogeochemistry and Ecosystem Research (IMBER) project. Its objectives are to understand how climate change will affect the marine ecosystems of the subarctic and Arctic seas and their sustainability. Subarctic marine ecosystems support stocks of commercial fish that generate a major portion of the fish landings of the Nations bordering them. Both the subarctic seas and the Arctic also support subsistence fishers along their coasts, and vast numbers of marine birds and mammals. Climate-forced changes in these systems have major economic and societal impact.

ESSAS conducts research to compare, quantify, and predict the impact of climate variability and global change on the productivity and sustainability of subarctic and Arctic marine ecosystems.

OBS-P4

Integrated marine environmental sensing with the SAHFOS Continuous Plankton Recorder survey

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The Sir Alister Hardy Foundation for Ocean Science runs the Continuous Plankton Recorder (CPR) survey and provides global marine plankton observations. The spatial coverage (125,000 nm a year) and monthly tow frequency gives the survey potential as a cost effective platform for monitoring ocean health. Equipped for state-of-the-art sensing, the CPR survey could provide valuable integrated biotic and a-biotic surface property observations to the global ocean observation community for monitoring, research, and validation of remote sensing products. The monitoring capability of the survey is being enhanced, beyond traditional plankton sampling, by integrating state-of-the-art sensing technology for water temperature, salinity and chlorophyll fluorescence as well as in-situ water and micro plankton sampling systems for molecular investigations. This poster describes the on-going instrumentation activities at SAHFOS, and illustrates the validation of new sensing technologies on board the CPR. Long term, the instrumented CPR survey will be capable of documenting baseline changes to the in-situ oceanographic climatology over basin wide scales using the network of establish CPR survey lines. The resulting data sets will enable changes in species abundance and community structure to be investigated in relation to the in-situ physio-chemical environment, whilst integration of data into Global Ocean Observing Systems will help to improve calibration/verification of autonomous ocean observation networks, remote sensing and ocean modelling efforts.

OBS-P5

CLIVAR: 20 years' progress in coordinating international activities on climate and ocean research

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CLIVAR (Climate and Ocean: Variability, Predictability and Change) is one of the four core projects of the World Climate Research Programme (WCRP). The CLIVAR project was launched in 1995 building on the successes of the Tropical Ocean – Global Atmosphere Project (TOGA) and the World Ocean Circulation Experiment (WOCE) to further understanding of the oceans and climate.

CLIVAR aims at describing and understanding the dynamics of the coupled ocean-atmosphere system and to identify processes responsible for climate variability, change and predictability on seasonal, interannual, decadal, and centennial time-scales, through the collection and analysis of observations and the development and application of models of the coupled climate system, in cooperation with other relevant climate-research and observing activities.

CLIVAR has established the possibility for the community to define and implement specific Research Foci, such as Marine biophysical interactions and dynamics of upwelling systems, ENSO in a changing climate, Regional Sea Level Change and Coastal Impacts, and so on. These Research Foci will guide and focus the developments of climate research for the next 5-10 years, and will provide the CLIVAR project with the ability to remain flexible in the changing landscape of scientific research priorities, whilst the traditional CLIVAR panels maintain a focus on the core activities critical to advancing CLIVAR and WCRP goals.

OBS-P6

Introduction to the National Marine Biodiversity Institute of Korea

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The National Marine Biodiversity Institute of Korea (hereinafter, MABIK), a governmental agency, is founded in April 2015 and located at Seocheon, South Korea, aiming to respond promptly on rapidly-changing global issues in biodiversity and environment. The MABIK by nature performs a role of comprehensively responsible institute, which is also designated as the 'Competent National Authority' in the field of marine living resources under the Convention on the Biological Diversity and the Nagoya Protocol regimes, with a view to ensuring sustainable use of marine living resources as well as efficient conservation of marine living resources domestically and globally. In doing so, the MABIK has progressively made efforts on developing R&Ds in various fields, including, inter alia, ecology, taxonomy, microbiology, biochemistry, ocean/marine biodiversity policy, and international cooperation. Furthermore, MABIK's R&Ds focuses on a variety of scientific principles: these include, but not limited to, marine living resources on genetic resources, LMO management and assessment, expanding utilization of MLRs, integrated management & construction of genetic resources bank, species searching services, and marine biodiversity restoration & proliferation. The MABIK comprises 3 Divisions, 7 Offices, 1 Centre, and 24 Teams as its organizational structure; the composition of workforce is consisted of 108 people who are a mixture of renowned and young scientists. Lastly, but not the least, the MABIK proudly possesses an enormous exhibition hall where MABIK's landmark, a four-story tower 'seed-bank', is located. This hall stands for bridging the gap between our scientists and the general public because all of scientific results will be displayed here and viewed by the public. The MABIK continuously strives for out-reaching to the general public, and is dedicated to raise public awareness in marine living resources by providing various themes of marine living resources exhibitions and education.

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AOOS	Alaska Ocean Observing System www.aoos.org/
Argo	International Program for deployment of profiling floats http://www.argo.net/
CLIVAR	Climate Variability and Predictability Program http://www.clivar.org/
ESSAS	Ecosystem Studies of Sub-Arctic Seas www.imr.no/essas
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection www.gesamp.org/
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research www.imber.info/
IOCCP	International Ocean Carbon Coordination Project www.ioccp.org/
IODE	IOC International Oceanographic Data and Information Exchange www.iode.org/
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean http://isc.ac.affrc.go.jp
IWC	International Whaling Commission http://iwcoffice.org/
MABIK	The National Marine Biodiversity Institute of Korea
NEAR-GOOS	North-East Asian Regional GOOS program http://near-goos.coi.gov.cn/
NOWPAP	Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region www.nowpap.org/
NPAFC	North Pacific Anadromous Fish Commission www.npafc.org
NPFMC	North Pacific Fishery Management Council www.fakr.noaa.gov/npfmc
NPRB	North Pacific Research Board www.nprb.org/
POGO	Partnership for Observation of the Global Oceans http://ocean-partners.org
SAHFOS	Sir Alister Hardy Foundation for Ocean Science www.sahfos.ac.uk/
SCCOOS	Southern California Coastal Ocean Observing System www.sccoos.org/
SCOR	Scientific Committee on Oceanic Research http://www.scor-int.org/
SOLAS	Surface Ocean - Lower Atmosphere Study www.solas-int.org/

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