Working Group 29 on *Regional Climate Modeling*

The first business meeting of Working Group (WG 29) on *Regional Climate Modeling* (RCM) was held in Hiroshima, Japan on October 13, 2012 during the PICES Annual Meeting. With 16 members and observers in attendance (*WG29 Endnote 1*), the agenda (*WG29 Endnote 2*) included an introduction to the objectives of WG29 by Co-Chairman, Dr. Enrique Curchitser. Co-Chairman, Dr. Chan Joo Jang, gave a brief overview of national activities in *Regional Climate Modeling* (RCM). After short presentations by Working Group members, discussion moved to emerging issues in RCM, plans and schedule of future activity.

AGENDA ITEM 2
Overview of national RCM activities

Dr. Curchitser described the motivation for W G29, including its terms of reference (TOR; *WG 29 Endnote 3*), future schedule and plans. Dr. Jang gave a short presentation showing each PICES member country's RCM information (model domain, grid size, *etc.*) based on responses to a questionnaire distributed to WG29 members prior to the Hiroshima meeting.

AGENDA ITEM 3
Presentations on topics relevant to terms of reference

As the main agenda item of the meeting, participating members described their research activities that are relevant to the TOR.

Michael Foreman: *An update on the IOS Regional Climate Model for the British Columbia (BC) continental shelf*

Dr. Foreman described the development and preliminary results of an RCM (ocean only) for the BC continental shelf. Future forcing and initial field anomalies were computed from the NARCCAP CRCM/CGCM fields. Runs were done with combinations of future and contemporary forcings to understand the nature of changes. Future plans include the following:

- To develop projections using other NARCCAP AR4 RCM combinations and AR5 RCM anomalies;
- To update an NPZD-type ecosystem model to include cycling of several biogeochemical elements (N, C, $Si(OH)_4$ and O_2), two types of phytoplankton and of zooplankton, multiple limiting nutrients, dynamic chlorophyll compartments, and temperature dependence of physiological rates;
- To couple the NPZD and marine geochemical ecosystem model (Angelica Peña);
- Boundary Conditions for ecosystem projections will be based on nutrients only (not plankton).

Kyung-Il Chang: *Ocean climate change: Analyses, projection, adaptation*

Prof. Chang described RCM activities focusing on future projection for seas around Korea. Better surface boundary conditions are essential for RCM projections: present climate + climate change mode. The plan is to extract climate change modes from global simulations and use these to force RCM models. Cyclostationary EOF analysis was used to identify the modes. Projections will be made for marginal seas for 2100 based on A1B and RCP4.5. The projected SST changes in marginal seas around Korea show more warming in the northern region.

Andrei Krovnin: *Introductory presentation of the INM Ocean Model (INMOM)*

Dr. Krovnin provided a short description of INMOM and numerical simulation results for the Japan/East Sea and North Pacific Ocean. INMOM uses a sigma-coordinate system with primitive governing equations. Numerical simulations of the Japan/East Sea and North Pacific Ocean circulations are performed by using INMOM and real atmospheric forcing CORE and ERA-Interim databases. The JES version had a resolution of 1/20 deg. with 40 levels. The simulation suggested that the decadal variability is likely caused by the variability of the Siberian High, whereas interannual variability is determined by the geographical features of the Japan Basin. Decadal-scale variation of total Russian salmon catches (Kotenev *et al.*, 2010) was introduced.

Hiroyuki Tsujino: *Regional ocean-climate modeling effort in JMA-MRI*

Dr. Tsujino reported on nested regional ocean-climate models in use at JMA-MRI

- Global–Western North Pacific (WNP) model,
- Global–WNP - near Japan (JPN) model,
- Global atmosphere–Global Ocean–WNP model,
- Global–Western North Pacific (WNP) model.

Purpose: long-term variability, carbon cycle and bio-geochemical processes of the western North Pacific Ocean
Global model: global tri-pole model developed for CMIP5
Western North Pacific regional model: embedded within the global model, two-way transfer
Global-WNP-near Japan model
Focus: sub-mesoscale processes around the oceanic front
1/33° × 1/50° (2 ~ 3 km horizontal resolution), integration with and without tide
Global atmosphere –Global Ocean–WNP model
Oceanic Global–WNP model is coupled with a global AGCM as a possible next generation climate model of JMA-MRI
WNP model improvement: Change southern boundary of the Subtropical gyre (12°N) – put the southern BC at 10°N

Hiroshi Kuroda: *Regional ocean modeling around Japan based on an operational ocean forecast system of the Fisheries Research Agency (FRA-ROMS)*

FRA has developed a climate modeling and downscaling subsystem around Japan (FRA-ROMS). It is used as an operational ocean forecast system with a 2 month horizon, updated weekly. The ROMS-3D VAR system is a basin-scale model with ½° horizontal resolution and nesting at one tenth of a degree. Higher resolution (1/50 deg. Horizontal) is used for a Tosa Bay, Hokkaido coastal model, while a one tenth degree horizontal resolution model coupled to a sea-ice model is used in the Okhotsk Sea.

Shin-ichi Ito: *NEMUROMS and eNEMUROMS*

The North Pacific model comes in two forms:
1) NEMUROMS: ROMS ($dx = dy$ = ½°, 48 levels) + NEMURO
2) eNEMUROMS: ROMS ($dx = dy$ = ½°, 48 levels) + eNEMURO (extended North Pacific Ecosystem Model for Understanding Regional Oceanography)

The specifications of the western North Pacific model are:
1) NEMUROMS: ROMS ($dx = dy$ = 1/10 deg., 48 levels) + NEMURO
2) eNEMUROMS: ROMS ($dx = dy$ = 1/10 deg., 48 levels) + eNEMURO

Model parameters were optimized by PEST (adjoint method software) with a box mode and observational data. Estimating the model parameters from observational data improved the simulation results. Iron is not included. A high-resolution (1/160° × 1/240° × 25 levels) version of the model was used to investigate a recent problem of megadeaths of scallops in the Mutsu Bay.

Olga Trusenkova: *Regional patterns of interannual sea level variability: Case of the Japan/East Sea*

Dr. Trusenkova described how variation in sea level trends around the basin are forced substantially by the throughflow. Eddy Kinetic Energy (EKE) indicates that mesoscale variability is caused by instability of mean currents and their interactions with bathymetry. EKE is highest from October to November and lowest in March to April, which is the same as the seasonal variation of the circulation strength. Shear instability is important. There were no interannual counterparts of the EKE Instability Mode or SLA Gradient Mode stability of the meridional density gradient despite the large variability of the transport in the Korea Strait. The main remaining questions to be answered are: Will regional climate models reproduce this variability? What should be the change of transport in the Korea Strait for destabilizing meridional density gradient and substantially changing circulation patterns and mesoscale energetics? What are mechanisms behind the relationship with PDO? Will the east–west seesaw be maintained on the 5 year or longer time scales?

Chan Joo Jang: *A regional ocean–atmosphere coupled climate model has been developing for hindcast and future projection in the seas around Korea*

Dr. Jang reported that mixed layer changes from the fifteen CMIP5 models were analyzed and the preliminary results were given. Projected changes in the mixed layer depth (MLD) in the North Pacific Ocean have similar patterns with those of CMIP3, with considerable model-to-model difference in terms of magnitude of change. An overall decrease in MLD in the Kuroshio Extension region and an increase in the Oyashio region. The relationship between the PDO and ENSO is projected to intensify in the future, possibly due to enhanced atmospheric teleconnection between equator and the mid-latitudes.

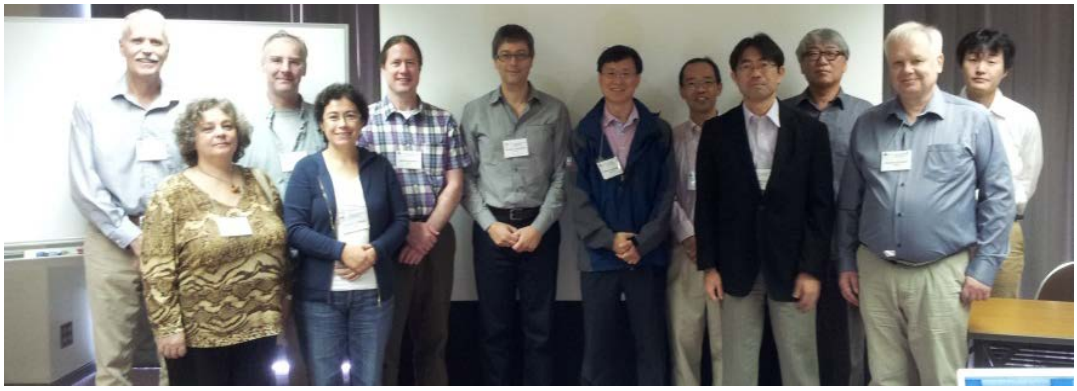
AGENDA ITEM 4

Discussion of emerging issues and schedule of upcoming activities

After the presentations, the Working Group discussed some emerging issues related with RCM development and its application to climate change studies. These included:

1. Placement and implementation of boundary conditions.
2. Downscaling of biogeochem: Worry about nutrients and less about plankton.
3. Force regional models with ensemble mean, or individual members?
4. Sea level variability issues in regional models.
5. How to estimate uncertainty in regional models.
6. How to choose which model to use for boundary conditions.
7. One- vs two-way boundary conditions.
8. Different ways to force model.
9. Overlay future anomalies on hindcast products vs. “pure” products.
10. Use (cyclo-stationary) EOF analysis to extract climate modes from global model and use that to force models.
11. Mean vs. variability: accounting for changes in variability in projections.
12. Which climate mechanisms to look for in regional models.
13. What variables (from CMIP5 models) should we provide to the rest of PICES community: T,S, MLD?
14. Where/who will analyze CMIP5 data?
15. What additional information do we need for each member’s RCM activity?

WG 29 reviewed the TORs and assigned leadership roles to each (*WG 29 Endnote 4*) before developing a plan of action for the upcoming year (*WG 29 Endnote 5*). The Co-Chairs adjourned the meeting and thanked all participants for their presentations, discussion, and commitment to conducting research directed at specific TORs.



Participants of the first meeting of WG 29 at PICES-2012. Left to right: Michael Foreman, Olga Trusenkova, Jim Christian, Angelica Peña, Seth Danielson, Enrique Curchitser, Chan Joo Jang, Shin-ichi Ito, Hiroyuki Tsujino, Kyung-Il Chang, Andrei Krovnin, and Hiroshi Kuroda

WG 29 Endnote 1

WG 29 participation list

Members

Kyung-Il Chang (Korea)
James Christian (Canada)
Enrique Curchitser (USA, Co-Chairman)
Michael Foreman (Canada)
Shin-Ichi Ito (Japan)
Chan Joo Jang (Korea, Co-Chairman)
Andrey S. Krovnin (Russia)
Hiroshi Kuroda (Japan)
Angelica Peña (Canada)
Olga Trusenkova (Russia)
Hiroyuki Tsujino (Japan)

Observers

Rongshuo Cai (China)
Seth Danielson (USA)
Skip McKinnell (PICES)
Sun Peng (China)
Elena Ustinova (Russia)

WG 29 Endnote 2

WG 29 meeting agenda

1. Welcome and self-introductions
2. Introduction to WG 29 (Curchitser) and national RCM overview (Jang)
3. Brief presentations for research topics relevant to TORs from each member
4. Discussion for some emerging issues, specific plans and schedule

WG 29 Endnote 3

WG 29 Terms of Reference

1. Assemble a comprehensive review of existing regional climate modeling efforts;
2. Assess the requirements for regional ecosystem modeling studies (*e.g*., how to downscale the biogeochemistry);
3. Continue the development of RCM implementations in the North Pacific and its marginal seas;
4. Convene special sessions and inter-sessional workshops dedicated to the RCM topic;
5. Publish report and/or review paper on best practices for regional coupled modeling;
6. Establish connections between PICES and climate organizations (*e.g*., CLIVAR) and global climate modeling centers (*e.g*., NCAR, JAMSTEC, CCCMA);
7. Collaborate with other PICES expert groups such as WG-27, SICCME and the FUTURE Advisory Panels possibly by producing “Outlooks”.
8. Publish a final report summarizing results.

WG 29 Endnote 4

Terms of reference: Members’ involvement

1. Collect and summarize the current status of each member country’s regional climate modeling efforts. (Contributing members: Jang, Curchitser)
2. Exchange information of each member country’s RCM development and related research activities, and discuss some immerging issues related with RCM development and its climate application (Contributing members: all members)
3. Discuss what variables from CMIP5 models need to be available to other PICES experts group (Contributing members: Curchitser, Jang, Foreman, and other members)
4. Collect and analyze CMIP5 data focusing on North Pacific Ocean. (Contributing members: Christian, Jang)
5. Convene workshops for exchange and summarizing RCM activity. (Contributing members: Chang, Curchitser, Jang, Peña)

WG 29 Endnote 5

Action items for 2012–2013

TOR 1, 2 and 3: Dr. Curchitser will review three requirements for RCM studies including biogeochemistry downscaling. Dr. Jang will collect and summarize information of RCM development from each member country.

TOR 4: Drs. Curchitser and Jang will contribute to a Topic Session at PICES-2013 on "*Recent trends and future projections of North Pacific climate and ecosystem*" (see below). Dr. Chang will organize the 2nd RCM workshop in September 2013, and the Co-Chairmen will also serve as Co-convenors for the workshop.

TOR 5: Both Co-Chairmen, together with other members, will publish a review paper for RCM efforts, through activities related with TOR 1–3.

TOR 6 and 7: Many members including Drs. Curchitser, Christian, and Peña will contribute to establish connections between PICES and climate organizations, and collaborate with other PICES expert groups by providing some basic data, *e.g.* mixed layer depth) for ecosystem studies.

Proposal a 1-day Topic Session on
***"Recent trends and future projections of North Pacific climate and ecosystem"* at PICES-2013**

The North Pacific Ocean experiences change on a range of timescales, and is among the most difficult regions of the world ocean in which to detect secular climate trends associated with anthropogenic forcing against the background of natural variability. Understanding impacts on ecosystems and the human communities dependent on them requires understanding of the magnitudes of climate variability and change. Sustained observations of past and present states, modeling of future states with global climate models (GCMs), and downscaling of GCM projections to the regional scale are all key components of the scientific effort to understand impacts and inform adaptation efforts. Downscaling efforts are likely to include a variety of methods, both statistical and dynamical, including high-resolution regional ocean circulation models with embedded ecosystem/biogeochemical models, statistical models relating local population statistics to climate forcing or climate indices, and multi-species models forced by temperature or oxygen anomalies from regional or global models. This session invites papers on time-series of observations of the North Pacific Ocean in the context of recent climate variability and change, and future projections of changes including statistical and dynamical downscaling.

Sponsoring Committees/Program: BIO/POC/TCODE/MONITOR/FUTURE

Convenors: James Christian (Canada), Enrique Curchitser (USA), Chan Joo Jang (Korea) and Angelica Pena (Canada), Jack Barth (USA)