REPORT OF PHYSICAL OCEANOGRAPHY AND CLIMATE COMMITTEE

The meeting of POC was held in two sessions. An aggregate list of participants and observers is to be found in Endnote 1.

The meeting began at 11:15 on Oct 19. The Chairman, Dr. Paul H. LeBlond (Canada) welcomed participants and observers.

WG 10 (Japan/East Sea Circulation)

Co-Chairman Dr. Christopher N.K. Mooers described progress of the final report. A draft has already been circulated and comments received. More work is needed to complete the report, which will be submitted to the Secretariat by Dec. 1, 1998. It will then be posted on the PICES web site or otherwise made available to POC members for review. Comments on the report are to be made to the Chairman of POC, with copy to the Secretariat, by Jan. 13, 1999. Final approval for publication will be made by the Chairman of POC by Jan 31, 1999. In addition, Dr. Mooers reported on the creation of a modern bibliography on the Japan/East Sea. This document will be available on the PICES web site and will be kept up to date under POC supervision with the assistance of the Secretariat. POC members thanked Dr. Mooers and Dr. Sang-Kyung Byun, Co-Chairmen of WG 10, as well as other members of the working group, for their work. It was agreed that WG 10 should be disbanded after completion of its report.

WG 13 (CO_2 in North Pacific)

Dr. Yukihiro Nojiri, Co-Chairman of WG 13, reported on progress. The WG, under the co-chairmanship of Dr. Nojiri and Dr. Richard A. Feely, held a meeting and technical discussions in Fairbanks on Oct 14-15, 1998 (see Endnote 2). POC recommended support for a technical workshop to discuss results of intercomparisons of measurement techniques and to initiate a detailed technical exchange on measurement technique and data quality among scientists studying CO_2 in the North Pacific. This workhop is to be held in Japan, in April 1999. Travel assistance was also requested for Dr. Feely to attend the JGOFS North Pacific Workshop in March 1999. POC also expressed support for other initiatives of the WG. The idea of a data workshop in the year 2000 received support in principle, but will have to receive detailed justification and further discussion at PICES VIII. POC members agreed with the desirability of sampling the WOCE P1 line within a single year. Canadian participation in some of this work may be available.

The meeting adjourned at 12:15 and resumed at 13:30 on Oct 22.

Election of new Chairman

Dr. Vyacheslav B. Lobanov was elected by acclamation as the new Chairman of POC. Members thanked the outgoing chairman and welcomed Dr. Lobanov.

Strategic plan

The structure of the draft circulated by the Chairman was deemed generally acceptable. A lively discussion about the future role of POC led to a number of suggestions, which were incorporated in the strategic plan attached as Endnote 3.

POC-CREAMS relations

Drs. Stephen C. Riser and Kuh Kim reported on the recent CREAMS Workshop (Oct. 18, 1998). Besides the original physical core of CREAMS, results of a number of ecosystem studies were reported at the workshop. Consequently, POC members suggested that the Japan/East Sea might be a suitable area to start a REX pilot

project. CREAMS appreciates the support of PICES, especially in obtaining clearances to work in national waters. The resolution approved by PICES last year (1997 PICES Annual Report, p. 96) is re-affirmed.

GODAE and ARGO

Dr. Riser presented an overview of the Global Ocean Data Assimilation Experiment (GODAE) and its informational support, the Array for Real-time Geostrophic Oceanography (ARGO). U.S., European and Japanese groups are currently developing these programs. Assimilated data are to be available freely on the web. The ARGO system is to consist of 3,000 PALACE floats deployed globally from ships of opportunity at a 300 km x 300 km resolution by the year 2003. GODAE and ARGO are eventually to be components of GOOS. POC recommends that PICES encourage member countries to create national committees to plan for participation in GODAE and ARGO and that ARGO data and assimilation results from GODAE remain freely available to all users. An informational article on GODAE and ARGO in PICES Press would be desirable.

Okhotsk Sea Multilingual Nomenclature

Drs. Lobanov and Yutaka Nagata reported that the Nomenclature has been completed and published as PICES Scientific Report No. 8. POC members applauded their successful efforts.

Japan/East Sea Historical Bibliography

POC discussed a proposal to publish an annotated bibliography of the Japan/East Sea oceanography, prepared by Dr. Mikhail A. Danchenkov (FERHRI, Russia). The bibliography is very extensive, containing more than 1,100 references. Publication has the support of WG 10; it would be suitable as a PICES Scientific Report. In view of the limited distribution expected, the Secretariat should consider appropriate publication options.

PICES web page

Following a request from the Secretariat for more scientific information on the PICES web page, Dr. Howard J. Freeland volunteered to help in this respect. He will liaise with the Secretariat to provide information and links to science programs for the web page.

TCODE

Mr. Robin M. Brown briefly presented the proposal for a one-day data visualization workshop to be held before PICES VIII. POC enthusiastically supports this proposal.

Second Okhotsk Sea Workshop, Nemuro

This workshop will be held Nov 9-12, 1998. To date, 23 participants from Japan, 13 from Russia and 2 from the U.S.A. are expected. Organisers expect a report including about 25 papers (at 10 pp each). Manuscript submission is expected by Feb. 1, 1999, review and completion by May 1, 1999. POC members expressed their thanks to the organizers: V. Lobanov, Y. Nagata and S. Riser, and supported publication of the proceedings as a PICES Scientific Report.

Iron fertilization experiment

POC was apprised of the plans for the formation of an Advisory Group on an iron fertilization experiment in the Subarctic Pacific and expressed general support for this endeavour.

Future symposia

POC proposes to hold a symposium at PICES VIII entitled: "Modeling and prediction: the state of the art". Convenors will be Drs. Nobuo Suginohara (Japan) and David L. Musgrave (U.S.A.). They are to invite prominent modelers and address a broad range of problems.

Best Presentation Award

17 nominations for the Best Presentation Award were received. The nominee receiving most votes was Dr. Hisashi Nakamura for his

presentation of the paper of H. Nakamura and T. Yamagata: "Observed association between SST and atmospheric anomalies in the North Pacific decadal climate variability".

Scientific Program

The following scientific papers were presented from the POC Committee sponsored part of the program.

Decadal Variability of the North Pacific climate. (POC) Convenor: James E. Overland (U.S.A.)

Shoshiro Minobe. Bidecadal and pentadecadal climatic oscillations over the North Pacific

David W.J. Thompson & J.M. Wallace. The arctic oscillation

Koji Yamazaki & Y. Ohhashi. Variability of the eurasian pattern and its interpretation by wave activity flux

J. King, R.J. Beamish, G.A. McFarlane, D. Noakes & R. Sweeting. Synoptic wind flow patterns off the west coast of North America in relation to recent changes in Pacific salmon catches

Ming-Yu Zhou & Y. Liu. Decadal variability of aerosol characteristics and deposition of crustal substances and pollutants in ocean areas near China

Sergey M. Varlamov & N.A. Dashko. Stable local wind patterns over the Sea of Japan and Okhotsk Sea, derived from the high resolution ECMWF operational analysis and forecasting system

Sub-session on Atmosphere - SST/Ice Coupling

Hisashi Nakamura & T. Yamagata. Observed association between SST and atmospheric anomalies in the North Pacific decadal climate variability

Andrei S. Krovnin & N.V. Klovach. Changes in abundance of salmon stocks in the context of climatic variations in the North Pacific region

Mark Johnson & A. Proshuntisky. Decadal variability of the Arctic Ocean and the Gulf of Alaska

Seiji Yukimoto, M. Endoh, Y. Kitamura, A. Kitoh, T. Motoi & A. Noda. Two distinct interdecadal modes of the Pacific in a coupled GCM

Jia Wang & M. Ikeda. Seasonal and interannual variability of sea-ice cover in the arctic and subpolar regions, 1900-1997: Signatures of AO, NAO and ENSO?

Meiji Honda & H. Nakamura. Influence of Okhotsk sea-ice extent anomalies upon the atmospheric circulation over the North Pacific: implications to the decadal climate variability

Kiyotaka Ohtani. Interannual change in residence time of the sea ice in the eastern Bering Sea

Sub-session on Ocean Response

Kimio Hanawa. Decadal/interdecadal scale variations found in the North Pacific

Yoshihiko Sekine. On the teleconnection processes around the North Pacific with reference to the decadal variations in atmosphere and ocean

V.A. Luchin, A.V. Saveliyev & V.I. Radchenko. Long-periodical climatic waves in the western Bering Sea and their effect on biological productivity

Lynne D. Talley. Simple coupled models of the PNA, circumpolar wave and NAO

David L. Musgrave. A temperature minimum in the Gulf of Alaska

Stephen C. Riser. Interannual variations in North Pacific intermediate water in the N. Pacific subtropical gyre

Carbon cycle in the North Pacific Ocean. (POC/BIO Joint Session) Co-Convenores: Shizuo Tsunogai (Japan) & C.S. Wong (Canada)

Robert M. Key. Radiocarbon in the North Pacific: What we have learned since GEOSECS

C.S. Wong, F.A. Whitney, W.K. Johnson, D. Crawford & E. Wong. Carbon flux in the subarctic northeast Pacific

Paulette P. Murphy, D.E. Harrison, R.A. Feely, T. Takahashi, R.F. Weiss & R.H. Gammon. Variability of pCO_2 in the subarctic North Pacific: a comparison of results from four expeditions

Yukihiro Nojiri. Seasonal and spactial characteristics of fCO_2 in the northern North Pacific monitored by a ship-of-opportunity

Hyung-Hoon Shin, S. Noriki, M. Itou & S. Tsunogai. Carbon cycle studied with settling biogenic particle in the western North Pacific

Noriko Nakayama, S. Watanabe & S. Tsunogai. Directly obtained CO_2 exchange rate at the sea surface from carbon and its isotopes

Shizuo Tsunogai & S. Watanabe. Role of the northwest Pacific in the absorption of atmospheric CO_2 specifically "continental shelf pump" working in the East China Sea

Shu-Lun Wang, C.T. Chen, G.H. Hong & C.S. Chung. Carbon dioxide and related parameters in the East China Sea

Paval Ya. Tishchenko, G.Yu. Pavlova, A.N. Salyuk & A.S. Bychkov. Carbon dioxide and dissolved oxygen in the Japan Sea: estimation of biological and thermal effects

Akihisa Otsuki, S. Watanabe & S. Tsunogai. Carbonate system of the Sea of Okhotsk controlled by sea ice formation

Igor P. Semiletov, P.Ya. Tishchenko, J.P. Christensen, I.I. Pipko & S.V. Pugach. On carbonate system of the Chukchi Sea and Bering Strait

Takashi Midorikawa, N. Hiraishi, K. Nemoto, K. Ogawa, T. Umeda, H. Hagai, N. Kubo & M. Ishii. Effects of biological production and air-sea interaction on seasonal variations of carbon dioxide in the subarctic North Pacific

Akihiko Murata, M. Honda, Y. Kumamoto, M. Kusakabe, K. Nemoto, T. Hiraishi, T. Midorikawa & H.Y. Inoue. Surface seawater pCO_2 distributions in subarctic water of the western North Pacific

Endnote 1

Participants and observers

Canada
- Howard J. Freeland
- Paul H. LeBlond (Chairman)
- C.S. Wong

China
- Ming-Yu Zhou

Japan
- Takeshi Uji

Korea
- Sang-Kyung Byun
- Kuh Kim
- Jae Yul Yun

Russia
- Gennady V. Khen
- Vyacheslav B. Lobanov

U.S.A.
- David L. Musgrave
- James E. Overland
- Stephen C. Riser

Observers
- Robin M. Brown (TCODE Chairman)
- Alexander S. Bychkov (Asst. Executive Secretary, PICES)
- Yong-Jean Choi (Korea)
- Michael G. Foreman (Canada)
- Victor I. Kuzin (Russia)
- Toshio Nagai (TCODE representative)
- Yutaka Nagata (CCCC IP Co-Chairman)
- Yukihiro Nojiri (WG 13 Co-Chairman)
- Seelye Martin (U.S.A.)
- Christopher N.K. Mooers (WG 10 Co-Chairman)
- Thomas C. Royer (TCODE representative)
- Alex Smirnov (Canada)

Endnote 2

Report of Working Group 13
CO_2 in the North Pacific

The Working Group was attended by representatives from Canada, Japan, China, Russia, and the United States of America. After a brief welcome by the Chairmen (Dr. Richard A. Feely, U.S.A., and Dr. Yukihiro Nojiri, Japan) and by Dr. Alexander S. Bychkov of the PICES Secretariat, the first day of the meeting was devoted to a series of technical presentations (see last section of report).

The North Pacific is an important sink for atmospheric carbon dioxide in the oceans and, consequently, plays an significant role in controlling long-term climate changes on the Earth. Some biogeochemical processes relating to the oceanic CO_2 system are peculiar to the North Pacific. This occurs because (i) the North Pacific is the final destination of circulation of the deep water that contains a high level of preformed nutrients and (ii) the North Pacific Intermediate Water stores dissolved CO_2 for more than a few tens of years. There is a considerable contrast in the ecosystems producing organic carbon and $CaCO_3$ particles, one of factors determining the CO_2 sink strength in the ocean, between the eastern and western North Pacific. The contrast is likely due to the difference in the nutrient composition in water supplied from the subsurface to the surface euphotic layer (i.e. physical forcing which affects mixed layer depth) and in the atmospheric input of iron and other substances. Continental shelf water is now receiving significant attention as a CO_2 sink. The extent of CO_2 exchange under heavy winter storms in high-latitude oceans is also not well known.

The presentations addressed a number of issues concerning the oceanic carbon dioxide system in the North Pacific. Collaborative research conducted by Japanese and Canadian scientists onboard the *M/S Skaugran* have identified the major source and sink regions for carbon dioxide north of 35°N. This region of the North Pacific is a large net sink for CO_2 (~0.3 PgC/yr) with large wintertime sources in the convective overturn regions of the western North Pacific and large spring and summertime sinks in the northwestern Pacific and Bering Sea regions due to high nutrient concentrations and primary production. Studies of anthropogenic CO_2 invasion into the central North Pacific, based on CO_2, hydrographic, and carbon isotope data, indicate downward mixing of anthropogenic CO_2 to depths of about 800–1200m. Time-series plots of anthropogenic CO_2 and chlorofluorocarbons at Ocean Station Papa show significant increases in the penetration of both anthropogenic CO_2 and chlorofluorocarbons over the last decade. Recent studies by U.S., Canadian and Japanese investigators have shown large interannual variations of pCO_2 in surface water along the west coast of North America due to the effects of the 1997-98 El Niño. The interannual pCO_2 variations are large enough to have a significant impact on the growth rate of CO_2 in the atmosphere during this period.

There were also descriptions of field programs being conducted by Canada, Japan, Russia, and the U.S.A. together with some preliminary interpretations based on the data from these programs. In addition, there were presentations on the technical issues involved in ensuring high-quality oceanic CO_2 measurements. The intercomparison of CO_2 measurement is the essential matter to have coherent data set over the global ocean. For the pCO_2 measurements, some intercomparison programs were completed in the United States and Japan. The recent Japanese intercomparison study showed reasonable agreement among various types of pCO_2 systems. It was understood the next intercomparison of DIC, alkalinity and carbon isotope is now necessary within PICES countries to understand the accurate CO_2 budget in the Pacific.

Dr. Andrew Dickson briefly outlined the planning for quality control for oceanic carbon data that was undertaken for the US Global CO_2

Survey and for other US JGOFS activities. The goal of quality control is to ensure that data generated are of known accuracy to some stated, quantitative degree of probability. This was achieved by a three-pronged approach that (a) encouraged participants to use well understood and documented analytical methods, (b) provided appropriate reference materials (developed specifically for the JGOFS program), and (c) held frequent technical discussions between the participating groups aimed at resolving issues that affected data quality. He recommended that the PICES WG 13 consider implementing such a plan for measurements in the North Pacific.

The second day was devoted to discussions and formulation of recommendations that the WG felt were important to achieve their overall objective of improving the degree of collaboration and communication between the various PICES nations making oceanic CO_2 measurements in the North Pacific.

These discussions were very valuable and resulted in the following plans and recommendations:

1. The WG would plan to carry out a series of between laboratory comparisons of measurement techniques for the parameters: total dissolved inorganic carbon, total alkalinity, and the $^{13}C/^{12}C$ ratio of the inorganic carbon in seawater. We recommend that PICES help to sponsor a technical workshop in April 1999, to discuss the results of these studies, and to initiate detailed technical exchange regarding measurement techniques and data quality between the scientists involved in studying CO_2 in the North Pacific.

2. The WG would conduct a pilot study (using samples collected on cruises to the Japanese KNOT time series station and other cruises that seem appropriate) to develop a protocol for collection and exchange of oceanic CO_2 samples for on shore analysis in multiple laboratories.

3. The WG should ask the JGOFS North Pacific Task Team to co-sponsor a data workshop in the year 2000 which is aimed at achieving a detailed comparison of existing data sets for CO_2 in the North Pacific. The goal of this workshop is to identify what needs to be done to provide effective data exchange, i.e. including a full understanding of data quality and limitations.

4. The WG requests funds from PICES to send the Co-Chairman to participate in the JGOFS-sponsored synthesis SEATS workshop in Taipei in March 1999. The Co-Chairman will coordinate PICES WG 13 activities with JGOFS.

5. The WG expressed its appreciation of Japanese plans to complete the WOCE Hydrographic Program P1 line, including high-quality CO_2 measurements and wished to encourage this activity as being important for a full understanding of the North Pacific CO_2 system.

The following presentations and discussions were made at the WG 13 meeting:

Yukihiro Nojiri - Results of NIES/IOS ship-of-opportunity monitoring and preliminary results from KNOT time series program

Akihiko Murata - Distributions of carbonate species in the western North Pacific: results from the *R/V Mirai*'s cruises in 1997-1998

Igor P. Semiletov - The Pacific Water Plume in the Arctic Ocean: an influence on carbon cycling

Richard Feely - Interannual variability of pCO_2 in the equatorial Pacific

Andrew Dickson - The quality control of oceanic carbon dioxide measurements

Vyacheslav B. Lobanov - Physical processes affecting CO_2 distributions

Yukihiro Nojiri - pCO_2 intercalibration results and ideal seawater pool facility of Fishery Engineering Institute

C.S. Wong - The ocean carbon cycle in subarctic North Pacific: interannual variability

Paul Quay - $^{13}C/^{12}C$ ratios of dissolved inorganic carbon in the N. Pacific: A tracer of anthropogenic CO_2 uptake

Discussion of Reference Materials and Intercomparison Studies - Dickson and Nojiri (Discussion Leaders)

Discussion of planned national and international CO_2 research programs in the North Pacific - Nojiri and Wong (Discussion Leaders)

Suitable sets on the CO_2 system in the North Pacific and discussion of mechanisms for data and information exchange - Dickson and Quay (Discussion Leaders)

Endnote 3

POC Review and Strategic Plan

1. Review of Activities

In its first year (PICES I - 1992), POC identified scientific issues of greatest interest and relevance which could be addressed by Working Groups: Ocean circulation and climate variability in the subarctic North Pacific; the Okhotsk Sea and the Oyashio region; new technologies and observing strategies; data collection and quality control. WG 1 on the Okhotsk Sea and Oyashio Region was created.

At PICES II (1993), POC received the report of WG 1 and endorsed its recommendations, especially on holding a workshop on the Okhotsk Sea in Vladivostok. WG 7 on Modelling of the Subarctic North Pacific Circulation was created. The theme session was on "Ocean circulation and climate variability in the subarctic Pacific".

At PICES III (1994), POC held a session on "Physical processes and modelling of the subarctic North Pacific and its marginal seas" and received an interim report from WG 7. Later in the year, POC took a leading role in holding the workshop on "Okhotsk Sea and adjacent areas" (Vladivostok, June 1995).

At PICES IV (1995), POC held a session on "Circulation in the subarctic North-Pacific and its marginal seas, and its impact on climate". It received the final report of WG 7 and moved the creation of WG 10 on "Circulation and Ventilation of the Japan/East Sea".

At PICES V (1996), POC held a session on "Exchanges of waters, organisms, and sediment between continental shelf waters and the nearby ocean" and received an interim report from WG 10. Work started on a Okhostk Sea Russian-Japanese English oceanographic nomenclature lexicon. POC also supported the plans of REX and BASS Task Teams of CCCC to hold a MODEL workshop.

At PICES VI (1997), POC and WG 10 held a session on "Circulation and ventilation of North Pacific marginal and semi-enclosed seas". WG 10 task was to be completed during the year. A second Okhotsk Sea workshop, to be held in Nemuro, was recommended. WG 13 on CO_2 in the North Pacific was created. POC also recommended that closer links be established between PICES and CREAMS.

At PICES VII (1998), POC discussed a draft of the final report of WG 10. It heard about a workshop held concurrently with the Annual Meeting by WG 13 as well as future plans of that Working Group. The published Okhotsk Sea Nomenclature was received. The Second Nemuro workshop on the Okhotsk Sea was to be held in November 1998. The POC topic session

was on “Decadal variability in the North Pacific”. POC and BIO joined forces to hold a session on “Carbon cycle in the North Pacific Ocean”.

In summary, over the past years, the Physical Oceanography and Climate Committee of PICES has provided a focus for scientific interest in the circulation of the subarctic North Pacific and its marginal seas; it has forged closer links between ocean and climate scientists of member countries; it has enhanced participation of physical oceanographers and climate scientists in interdisciplinary ocean ecology program of PICES (the CCCC Program).

2. The future

POC is one of the main instruments of PICES in working towards its purpose of advancing "scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities". To be an effective agency for its member-states, PICES must provide a forum for exchange of information and knowledge on these issues, especially on those aspects, which are of direct benefit to their citizens, and the interests of their state. Given the increasing role that the ocean will play in global human ecology, it is important to develop mechanisms favouring close collaboration between scientists, research and educational institutions, and even the general public on ocean-related issues.

POC should continue to work towards creating new opportunities for international interactions. Enhanced participation by younger scientists in PICES activities, by participating in meetings and joint research programs, is particularly important. It is also important to broaden interest in POC within PICES countries and through the scientific disciplines (more chemists, paleo-oceanographers...) by bringing new people to PICES meetings and inviting prominent scientists from all over the world.

As a forum of international experts, POC should identify priorities for physical oceanography and climate studies in the PICES area, helping to develop the scientific and technical bases for a better understanding of the ocean and its interactions with the atmosphere, and for the development of forecasting methods in ocean sciences.