2006 CREAMS/PICES international workshop and summer school

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The second CREAMS/PICES international workshop entitled "*Model/data inter-comparison for the Japan/East Sea*" was held August 21–22, 2006, at Pukyong National University, in Busan, Korea, and followed by the first PICES summer school on "*Ocean circulation and ecosystem modeling*" at the National Fisheries Research and Development Institute (NFRDI), also in Busan. Both events were co-sponsored by PICES, Seoul National University, and the Korean Ocean Research and Development Institute (KORDI). Pukyong National University also sponsored the workshop, and the Ministry of Maritime Affairs and Fisheries (MOMAF), the "Brain Korea 21" Program (BK21), and NFRDI also sponsored the summer school. Convenors for both events were Kyung-Il Chang (Korea), Shin-ichi Ito (Japan), Sok-Kuh Kang (Korea), Kyung-Ryul Kim (Korea), Vyacheslav Lobanov (Russia), Christopher Mooers (U.S.A.), and Jong-Hwan Yoon (Japan). All workshop and summer school materials are posted on the PICES website at http://www.pices.int/2006_CREAMS_PICES_school.aspx.

Workshop description

About 50 marine scientists participated in the workshop (**Photo 1**), which provided a forum to address: whether observational and modeling advances in the Japan/East Sea (JES) are interactive and comparable, what were the achievements and what are the remaining gaps, and how the creation of a reliable regional model should be approached. Seventeen oral talks and seven posters were presented in four sessions: *Review of up-to-date observational results* (WS1), *Ocean circulation modeling and inter-comparison with data* (WS2), *Operational nowcast/forecast system* (WS3), and *Ecosystem modeling in the North Pacific region* (WS4). A panel discussion on the future of circulation and ecosystem modeling and forecast in the JES concluded the workshop.

Up-to-date observational results on basin- and meso-scale circulation and hydrography in the northern JES (Vyacheslav Lobanov) and in the southwestern JES (Kyung-Il Chang), and a variability of sea surface temperature on decadal timescales (Sang-Wook Yeh) were presented in WS1.

Circulation model results for research and operational purposes using seven different models were presented in WS2 and WS3 (Table 1). Model results were compared with observations obtained during CREAMS I and II periods from 1993 to 2001 (Christopher Mooers, Patrick Hogan, Young-Ho Kim), or with previously known circulation and hydrographic features (Jong-Hwan Yoon, Olga Trusenkova). One presentation was on the internal tide generation using a two-layer model (Sok-Kuh Kang). To improve future modeling in the JES, it was suggested:

Photo 1 Participants of the second CREAMS/PICES international workshop.

Table 1 Various ocean circulation models presented during the second CREAMS/PICES workshop.

Model (Presenter)	Horizontal Grid	Vertical Grid	Purpose
RIAMOM (Jong-Hwan Yoon)	1/12º, 1/36º	46 levels	Research
RIAMOM (Sergey Varlamov)	1/12º	46 levels	Operational
MHI model (Olga Trusenkova)	1/8º	12 layers	Research
LOM (Patrick Hogan)	1/8º, 1/16º, 1/32º, 1/64º	4 layers	Research
HYCOM (Patrick Hogan)	1/25º	20 layers	Research
NLOM, NCOM, HYCOM (Patrick Hogan)	NLOM - 1/32º, NCOM - 1/16º, HYCOM - 1/12º	NLOM - 4 layers NCOM - 40 levels	Operational
POM (Christopher Mooers)	1/10º	21 levels	Research
JCOPE (POM) (Shin-ichi Ito)	1/12º	45 layers	Operational
Kyoto Univ. (Yoichi Ishikawa)	1/6º(EW) × 1/8º(NS)	67 levels	Research
ESROM (MOM) (Young-Ho Kim)	1/16~1/10º	42 levels	Research

- to include sea a ice module into models to better reproduce the deep water formation;
- to use a higher (>1/36°) resolution model or sophisticated parameterization to reproduce the observed magnitude of deep flow;
- to use synoptic wind forcing, preferably hourly data, for the quantitative comparison with observations;
- to nest JES models into basin or global scale models to reproduce more realistic dynamic interactions between the JES and the North Pacific and the East China Sea; and
- to use coastal hydrographic data to refine the initial condition.

WS4 introduced regional coupled physical-biological models in North Pacific to encourage such efforts in the JES. Fei Chai discussed available ocean circulation models that can be coupled to ecosystem models, and suggested how to improve future ecosystem modeling. Michio Kishi compared four ecosystem models in North Pacific regions, and showed that NEMURO gives a satisfactory reproduction of the vertical flux of particulate organic matter in the northern North Pacific, while other NPZD (Nutrients-Phytoplankton-Zooplankton-Detritus) models simulate it rather poorly. Xuehai Liu presented a 3-D ecosystem model of the southern Yellow Sea coupled to the 3-D Princeton Ocean Model, and pointed out that tides, runoff and wave mixing are important factors affecting the ecosystem in the region considered. Naoki Yoshie introduced observational results during SERIES (**S**ubarctic **E**cosystem **R**esponse to **I**ron **E**nrichment **S**tudy), and the successful modeling of high concentration of silicic acid to nitrate uptake during SERIES using NEMURO.

As it was learned from the workshop, many more sensitivity and process studies are needed to establish the adequacy of model parameters, to validate model physics, and to verify model fields. Past and future observations must be organized to facilitate this modeling analysis. Accordingly, the panel discussion held after all presentations suggested that it is necessary to design and conduct an international JES model-data comparison experiment for a specified period of time (rich in forcing, validation, and verification data) using either free-running or data assimilation models.

Summer school description

The main objective of the summer school was to teach and motivate postgraduate students, early-career scientists, and other professionals who will be the principal users of numerical models. The summer school summarized our present knowledge of ocean circulation and ecosystem modeling, and introduced numerical models that can be used and applied in various fields of oceanography. Participants also carried out computer exercises to gain modeling experience. Thirty-seven students from 8 countries (including all six PICES member countries) attended the summer school: 1 from Canada, 1 from Chile, 2 from China, 2 from Indonesia, 10 from Japan, 13 from Korea, 4 from Russia, and 4 from U.S.A. (**Photo 2**). Among those 37 participants, 25 were postgraduate students (14 Ph.D. students and 11 M.Sc. students), 7 early-career scientists, 4 undergraduate students, and 1 from a private company. The participants' major were either physical or biological oceanography.

The summer school consisted of two 1.5-day courses: *Ocean circulation modeling* (organized by Naoki Hirose from Kyushu University, Japan), and *Ecosystem modeling* (organized by Shin-ichi Ito from Tohoku National Fisheries Research Institute, Japan). Other lecturers in the *Ocean circulation modeling* course were Patrick Hogan from the Naval Research Laboratory (U.S.A.), Yoichi Ishikawa from Kyoto University (Japan), and Christopher Mooers from the University of Miami (U.S.A.). Other lecturers in the *Ecosystem modeling* course were Fei Chai from the University of Maine (U.S.A.) and Michio Kishi from Hokkaido University (Japan). Both courses involved lectures and practical exercises, and three assistants – Young-Ho Kim (Korea), Goh Onitsuka (Japan), Naoki Yoshie (Japan) – helped the lecturers and hands-on training.

Photo 2 Participants of the CREAMS/PICES summer school.

The *Ocean Circulation Modeling* course covered many aspects of numerical modeling as it was intended to present a variety of opportunities for students who are interested in, and so would like to start, ocean circulation modeling. The course introduced the overall concepts of ocean circulation modeling, basic finite differencing schemes, various models from simple 1-D/2-D models to the most sophisticated ocean general circulation models (OGCMS: RIAM Ocean Model, Princeton Ocean Model, HYbrid Code Ocean Model), and linear and non-linear data assimilation principles. Model formulation methods and issues were described with teaching hands-on model running. Sample Fortran codes on the spring-mass system, shallow water model, Kalman filter/smoother, adjoint method, *etc*. were provided, to enable the students to play the sample Fortran programs again by changing the parameters, initial, and/or boundary conditions on their home computers. The students were also expected to deepen their understanding of numerical modeling by finding the recommended references which were provided in various presentations during the class. However, nothing much was done with the implementation of models for idealistic, let alone realistic, model space–time domains and forcing. It might have been a better idea to focus on the tutorial and demonstration of a single OGCM so that the students could be fully aware of the OGCM.

The *Ecosystem Modeling* class started with the introduction of ecosystem modeling, the philosophy and rational of modeling, examples related to ecosystem modeling studies, and a brief history of ecosystem modeling dating back to the pioneering work of Gordon A. Riley. Fei Chai concluded his lecture by asking the students to "think the bigger picture with your investigation; it will bring the excitement". Introduction of the lower trophic level ecosystem model NEMURO (**N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography), and the fish growth model coupled with NEMURO − NEMURO.FISH (NEMURO **F**or **I**ncluding **S**aury and **H**erring) − followed. Basic structures, governing equations, and the characteristics of each term of the equations were explained, with emphasis on the characteristics of quadric terms for the mortality of plankton and the stability of NEMURO, and the importance of observational and experimental data in the construction of the model and determination of the parameters of NEMURO.FISH. Source codes of the box version of the two models were distributed to the students, and most of them ran the model successfully. The last lecture was on the automated parameter-tuning software PEST (Model-Independent **P**arameter **Est**imation), which is one of the data assimilation softwares that automatically finds the optimized parameters for the model. PEST calculates the error between the model outputs and observations, searches, and produces new parameter values. Source codes and PEST control files were distributed to the students, and they were asked to test several examples.

Certificates prepared by the PICES Secretariat and signed by the Chairman of the PICES Physical Oceanography and Climate Committee (Michael Foreman), organizing lecturers, and one of the convenors (Kyung-Ryul Kim) were given to all students at the end of the school day (**Photo 3**). A questionnaire for the purpose of improving the planning and implementation of a future summer school was distributed to all participants, and 29 of them were submitted. In general, students responded that the summer school was successful in that it was very well organized and executed, and provided an intense and productive learning experience. It was commented that holding the summer school in conjunction with the workshop helped them to attend the school courses. Apart from a variety of complaints ranging from accommodations, mosquitoes, air conditioning, sharing a bathroom to spicy Korean food, they also said that the contents were too diverse for the students to digest in such a tight time schedule. Apparently, the students faced a lot of new concepts and new words in the school. Some exercises could not be solved simply due to a lack of time, and some were too difficult for inexperienced students to solve even though there was enough time. The remedy for this problem in future schools would be either to select more specific topics or to have a longer schedule. Many students wanted to have a similar modeling school in the future. A recommendation from one of the school assistants, Young-Ho Kim, reflects this, "The same lectures should be repeated a couple of times in the future with a progressive revision of lecture materials to make this summer school more fruitful". Another problem was that some students were not familiar with Fortran or the command-line operation in a UNIX-like window, and the visualization software used during the course. The lecture time was too short for students to get used to the manipulation of the software, so it would be valuable to provide all tutorial materials well in advance for the students' preparation.

Photo 3 Dr. Shin-ichi Ito, lecturer for the Ecosystem Modeling course, gives a certificate to student, Arnaud Laurent (Canada).

Nevertheless, the first CREAMS/PICES summer school was successful as it provided a valuable opportunity to young students and early-career scientists to have a feel for models and modeling, and it is a touchstone for future PICES capacity-building programs. It was suggested that provision should be made for a technical follow-up to measure the impact of the summer school on the students' education and professional careers at several time horizons (they could form an "alumni group"). The preceding is associated with establishing expectations of students, instructors, and sponsors, and managing them well.

PICES Calendar

- Workshop to develop a Science Plan for the future integrative scientific program of PICES and inter-sessional Science Board/Governing Council meeting, April 16–19, 2007, Yokohama, Japan.
- 5th International Conference on "*Marine bioinvasions*", (co-sponsored by ICES, PICES and the U.S. National Sea Grant College Program), May 21–24, 2007, Cambridge, U.S.A.
- Joint meeting of ICES WGITMO, ICES/IOC/IMO WGBOSV and PICES WG on *Non-indigenous aquatic species*, May 25–26, 2007, Cambridge, U.S.A.
- 4th International Zooplankton Production Symposium on "*Human and climate forcing of zooplankton populations*" (co-sponsored by PICES, ICES and GLOBEC), May 28–June 1, 2007, Hiroshima, Japan.
- ESSAS/PICES Workshop on "*Identifying the best IPCC model or ensemble of models for subarctic regions*", and on "*Role of sea ice in marine ecosystems*", June 4–6, 2007, Hakodate, Japan.
- ICES/PICES Conference for Early Career Scientists on "*New frontiers in marine science*", June 26–29, 2007, Baltimore, U.S.A.
- Workshop on "*Forecasting climate impacts on fish production*", July 2007, Seattle, U.S.A.
- ICES/PICES theme sessions on "*Integrating observations and models to improve predictions of ecosystem response to physical variability*", "*Comparative marine ecosystem structure and function: Descriptors and characteristics*" and "*The ecosystem approach: What's the impact on marine science, science based advice and management of marine ecosystems*" at the ICES Annual Science Conference, September 17–21, 2007, Helsinki, Finland.
- PICES Sixteenth Annual Meeting, October 26–November 4, 2007, Victoria, Canada.
- International Symposium on "*Reproductive and recruitment processes in exploited marine fish stocks*" (co-sponsored by NAFO, PICES and ICES), October 1–3, 2007, Lisbon, Portugal.
- International Symposium on "*Effects of climate change on the world's oceans*" (co-sponsored by ICES, PICES, IOC, GLOBEC, SCOR and WCRP), May 19–23, 2008, Gijón, Spain.