PICES/ESSAS Workshop on "*Marine Ecosystem Model Inter-Comparisons*"

by Bernard A. Megrey, Masahiko Fujii and Shin-ichi Ito

A 1-day workshop on "*Marine ecosystem model inter-comparisons*", co-sponsored by PICES and ESSAS (a GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas), was held on October 25, 2008, in conjunction with the PICES Seventeenth Annual Meeting in Dalian, China. This was the first meeting under a new modeling project endorsed by PICES in 2007.

Comparative analysis is a valuable scientific activity because the size and complexity of marine ecosystems precludes conducting controlled *in situ* experiments. It is also a powerful technique for understanding the important similarities and differences between and among ecosystems. Modeling is a central approach to comparative analyses of ecosystem structure, function and responses. It is important to understand whether inter-relationships among physical, chemical and biological variables vary geographically, and the extent to which any particular conclusions depend on the model used to derive them.

The project is organized to promote model comparisons by applying multiple marine ecosystem models to the same location/species and using an ensemble model forecast to identify and compare predicted and observed responses of marine ecosystem types to global changes. This assessment is similar to the widely-accepted approach used by the IPCC (Intergovernmental Panel on Climate Change) to evaluate alternative climate prediction models. It is expected that this process will allow one to identify and characterize components of the major marine ecosystems which are likely to be affected at an early stage by global changes, to understand the responses to global change of each component of the ecosystem, focusing primarily on zooplankton which provide the prey base for upper trophic level fish species, and to detect which of the candidate models are the most successful at hindcasting in each of the ecosystems chosen for study. This kind of comparative approach should be one of the core activities of the new PICES science program on "**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems" (FUTURE). A 3-year duration for the project was suggested, which would be sufficient to accomplish the initial project goals, but will still allow the work to be integrated into FUTURE when that program is operational. The workshop opened with a brief introduction by Bernard Megrey. An audience of 40 to 55 people listened then to several stimulating presentations. The keynote talk was given by Fei Chai (U.S.A.). He introduced a model comparison exercise conducted under US-JGOFS in which 12 lower trophic level biogeochemical models of varying complexity were objectively assessed in two distinct regions (Equatorial Pacific and Arabian Sea) and evaluated by three methods: (a) data assimilated into the models at each station individually, (b) data assimilated into the models at two stations simultaneously, and (c) data assimilated into the models at each station individually and then the tuned model parameters were switched with each other (**Fig. 1**). Icarus Allen (UK) introduced the topic of model skill assessment (**Fig. 2**) and described several objective approaches of assessing model skill. One tool includes the Taylor diagram (**Fig. 3**), which is useful for conveying information about the similarity between model predictions and observations based on the ratio of variances, correlation and root mean squared error differences between model predictions and observed data.

William Peterson, Harold Batchelder (U.S.A.), and Toru Kobari (Japan) reviewed krill and copepod biology and ecology, as these species were chosen as the modeled indicator species.

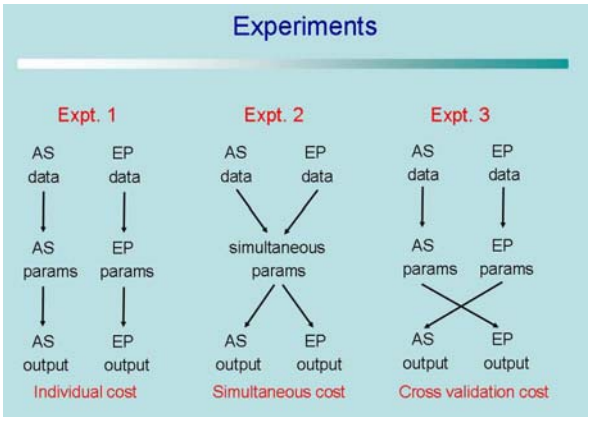

Fig. 1 Schematic of three model comparison experiments applied to two locations (Equatorial Pacific - EP and Arabian Sea - AS). From Friedricks, M.A.M. et al.*, 2007:* J. Geophys. Res.*, 112, C08001, doi: 10.1029/2006JC003852.*

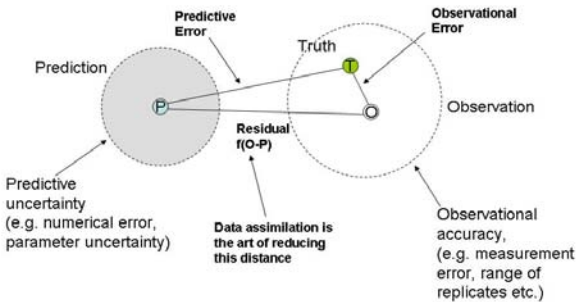

Fig. 2 Schematic depicting the relationship between the true state of nature (T), our observation of the state of nature (O), a models prediction (P) and prediction uncertainty. From Stow et al. 2009, Journal of Marine Systems 76(1-2):4-15

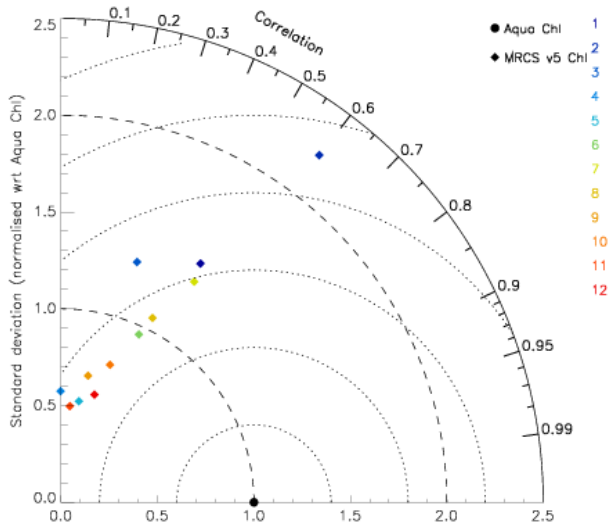

Fig. 3 Example of a Taylor diagram. A perfect model would have a correlation coefficient of 1, a RMSE (root mean squared error) of 0, and a ratio of observed to model variance ratio of 1.

After the presentations, a lengthy discussion took place on five main issues which were intended to frame the preparation of a work plan: (1) identify the objective of the models for inter-comparisons; (2) select potential models and evaluate their data needs; (3) nominate location(s) for comparisons; (4) identify protocols to compare model performance (model skill assessment), given data needs against location data availability and compatibility; and (5) name the most appropriate indicator species to be used as the "metric" for correct model behavior.

Plans are being developed to solicit active participation in the project and contribution of models. The objective of the model inter-comparison will be to apply several models to one location in order to identify important mechanisms that control secondary production abundance and variability, as well as bounding the levels of uncertainty in model predictions by calculating ensemble statistics. This approach can be applied to several places simultaneously, however discussions should be held to select suitable locations where the models can be applied.

During the workshop a schedule of activities was proposed and accepted. Participants will be contacted via e-mail to get confirmation of their willingness to stay involved and be active. A detailed work plan will be developed to prepare for a hands-on modeling workshop to be held in conjunction with the 2009 PICES Annual Meeting in Jeju, Korea. The goals of the next workshop will be to compile observational data and begin model construction, parameterization and comparison.

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Dr. Bernard A. Megrey (bern.megrey@noaa.gov) is a research fisheries biologist with NOAA's Alaska Fisheries Science Center (U.S.A.) where he has worked since 1982. His research involves studying the dynamics of exploited North Pacific fish populations, relationships of environment to recruitment variability, climate impacts on marine ecosystem production and application of computer technology to fisheries research and natural resource management. Bern is Chairman of the PICES Technical Committee on Data Exchange (TCODE) and former Co-Chairman of the PICES MODEL Task Team. He is Co-Chairman of the ESSAS (Ecosystem Studies of Sub-Arctic Seas) Working Group 3 on Modeling Ecosystem Response.

Dr. Masahiko Fujii (mfujii@ees.hokudai.ac.jp) is an associate professor at the Graduate School of Environmental Science, Hokkaido University (Japan), where he achieved his PhD in Environmental Earth Science in 2001. Masahiko worked as a postdoc at the National Institute of Environmental Studies (Japan) and at the University of Maine (U.S.A.), studying marine ecosystem modeling and helping to develop NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) for several years. His current activities are more relevant to sustainable sciences, focusing on balancing marine ecosystem and human activities such as fisheries and marine tourism. He is also Co-Chairman of the ESSAS Working Group 3.

Dr. Shin-ichi Ito (goito@affrc.go.jp) is a Chief Scientist of the Physical Oceanography Section in FRA's (Fisheries Research Agency of Japan) Tohoku National Fisheries Research Institute. Shin-ichi completed his graduate work in Theoretical Physical Oceanography at Hokkaido University and converted to an observational physical oceanographer in FRA. His research includes the development of a fish growth model coupled to a lower-trophic-level ecosystem NEMURO.FISH (North Pacific Ecosystem Model for Understanding Regional Oceanography For Including Saury and Herring) model. He is a member of the PICES Physical Oceanography and Climate Committee (POC) and former Co-Chairman of the PICES MODEL Task Team. He also co-chairs the ESSAS Working Group 3.