2012 Yeosu Workshop on "Climate Change Projections"

by Enrique Curchitser and Icarus Allen

A 2-day workshop on "*Climate change projections for marine ecosystems: Best practices, limitations and interpretations*" was held on May 13–14, 2012, preceding the 2nd International Symposium on "*Effects of Climate Change on the World's Ocean*" convened in Yeosu, Korea. The goal of the workshop was to explore different approaches to modeling the impacts of climate change and variability on marine ecosystems and to highlight their strengths and limitations. A significant motivation was to bring together both global and regional modelers whose communities often work separately. A particular interest of the convenors (co-authors of this article) was to insure that the definition of an ecosystem included higher trophic levels and both direct and indirect anthropogenic influences. The tone for the workshop was set by the opening remarks of Icarus Allen (Plymouth Marine Laboratory, UK) who discussed the scientific interest in understanding how ecosystems respond to climate change, the propagation of the climate signal through an ecosystem, difficulties in making future projections, issues with downscaling, whole ecosystem approaches, and anthropogenic effects questions of how to deal with uncertainty. The need to take risks in our approaches to these problems was indicated.

Over the two days, about 40 scientists participated in the workshop. Invited talks by Villy Christiansen and William Cheung (University of British Columbia, Canada), Jason Holt (National Oceanographic Centre, UK), Charles Stock (NOAA's Geophysical Fluid Dynamics Laboratory, USA dealt with research using both global and regional climate models coupled with marine ecosystem models. Together with submitted contributions, a range of models was presented which included global and regional coupled physics, fish and fishers.

Dr. Christiansen started the workshop with a talk about the NEREUS project led by the University of British Columbia. The work is motivated by the question of "Will there be fish for coming generations?" and the realization that many fisheries have collapsed across the globe. The project takes a global approach and models the ecosystem from biogeochemistry to the market. It includes on the order of 1000 fish species and nearly 250 fishing fleets (Fig. 1). NEREUS is also a leader in outreach activities, producing visualizations of model data for the public at large.

Dr. Holt tackled the topic of climate drivers on coastal marine ecosystems. His emphasis was on downscaling global climate models to the broad continental shelves of northern Europe and exploring the physical mechanisms (the

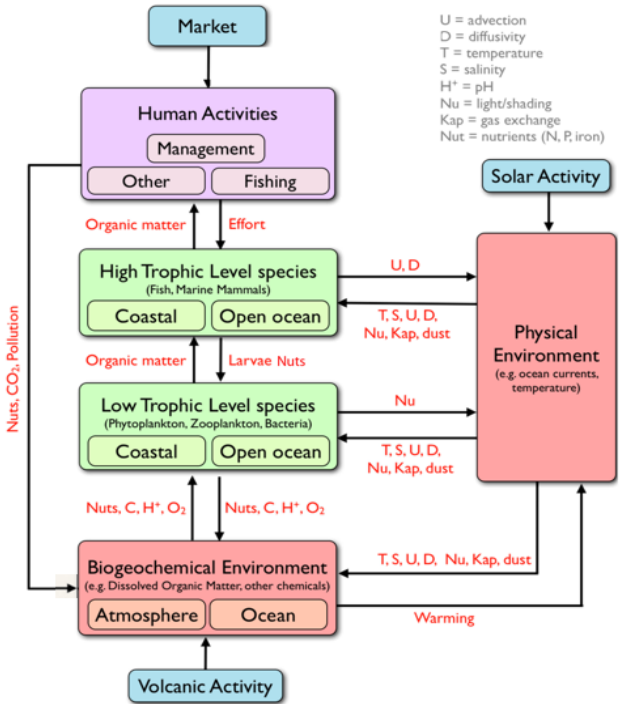

Fig. 1 Schematic diagram of the Nereus modeling framework. The model is being used to concurrently study the effects of climate change and human activity (such as fishing) on global fish stocks. Nereus takes a global approach to the problem simultaneously modeling 1000 species of fish and over 250 different fishing fleets (see http://www.nereusprogram.org/ for details).

interplay of turbulence, mixing and nutrient supply) that exert controls over phytoplankton growth. He presented several considerations for the treatment of uncertainty in complex coupled bio-physical models.

Dr. Stock described his work on using IPCC-class models to assess the impact of climate change on living marine resources. He described some of the challenges of using global models: resolution, separating variability and trends and the fact that these models were not designed to address marine ecosystems, in particular on regional scales (Fig. 2). However, an understanding of the functioning of coupled global climate models and the careful design of ecosystem models can yield insight into ecosystem functioning under projected climate change scenarios.

Dr. Cheung focused on the modeling of large-scale effects of global change on marine ecosystems and fisheries. The motivating issues were ocean warming, de-oxygenation, acidification and overfishing. His presentation dealt with the question of the combined effect of these issues on fisheries

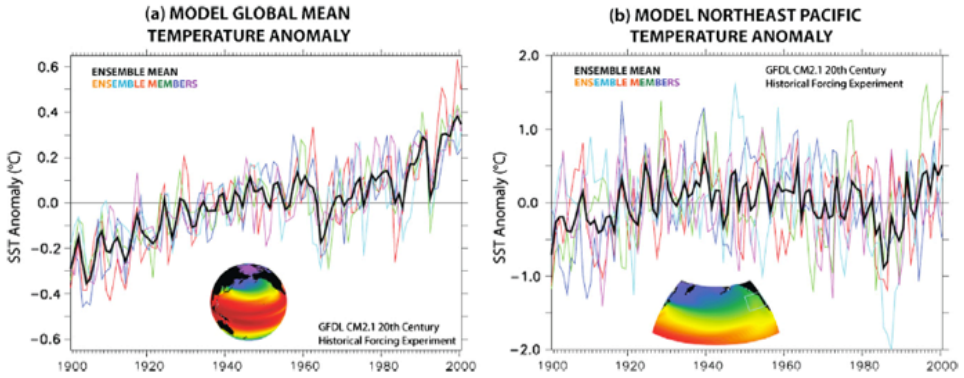

Fig. 2 Temperature anomalies from an ensemble of future projections using the GFDL CM2.1 model. Left: Global mean, Right: Northeast Pacific. This figure illustrates the difference in global and regional variability in the climate model suggesting needed caveats when evaluating global models on a regional basis and interpreting regional ecosystem responses to a global climate signal. Stock et al., 2011. Prog. Oceanog. 88, 1–27.

and explored the sensitivity of model results to projected climate scenarios. His model results suggest that by 2050 warming may cause regions in the tropics to lose catch potential, while high-latitude regions may gain. However, global catch potential is predicted to decrease.

Further presentations at the workshop discussed various approaches to linking climate and ecosystem models, and several threads emerged from these presentations:

- How useful these models are for management, planning and policy purposes,
- The need, advantage and issues of downscaled climate solutions, and
- The validity of regional interpretations of global climate model results.

The topic of model resolution and the multi-scale nature of the problem (both in physics and biology) permeated throughout the presentations and the ensuing discussions. In particular, the participants articulated the needs of coastal ecosystem research that are not necessarily well served by global climate models. A significant amount of time was devoted to a discussion on the communication of model results and model uncertainty to a variety of constituents. The challenge of taking research models and developing them to be useful tools for operational oceanography or management strategy evaluation was also discussed (Fig. 3).

It was recognized at the workshop that as we move forward in trying to make projections of future ecosystem health under likely climate change, it is important for the regional ecosystem and global climate communities to continue working together. Current modeling capacities are inadequate for some of the questions that are being posed. In particular, the challenge of making policy-relevant predictions over the next 2 or 3 decades in the face of a modeled climate signal, which is indistinguishable from the natural variability of the system, was noted. The participants agreed that at present, the community is not ready to describe "best practices", but enough different approaches exist that we can contrast "current" practices. A review manuscript on state-of-the-art approaches highlighting their strengths and weaknesses for making projections of particular ecosystems is expected as the outcome from the workshop.

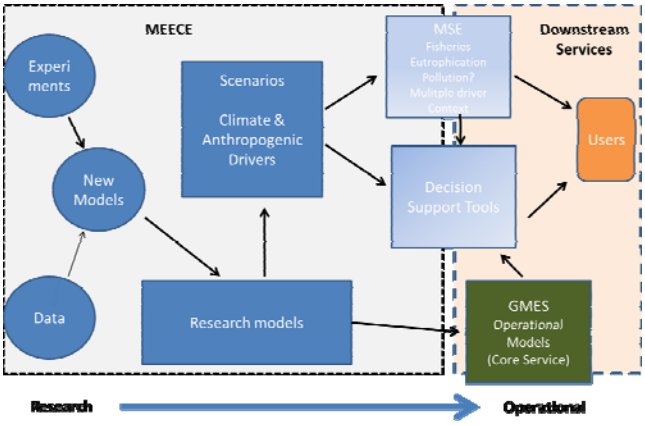

Fig. 3 Schematic of the model development process illustrating the challenge of building research models and pulling them through to operational and decision support tools.

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Dr. J. Icarus Allen (jia@pml.ac.uk) is Head of Science for marine ecosystem modelling at the Plymouth Marine Laboratory (UK). His main research interests are the response of marine ecosystem to combinations of climatic and anthropogenic change, ecosystem model skill assessment and operational oceanography. He is a member of the ICES Working Group on Integrative Physical-Biological and Ecosystem Modelling (WGIPEM) and leads the EC FP7 Marine Ecosystem Evolution in a Changing Environment (MEECE) project.