Circulation of Marginal and Semi-Enclosed Seas
(Sea of Japan and Related Process Studies)

Christopher N.K. Mooers
Ocean Prediction Experimental Laboratory (OPEL)
Division of Applied Marine Physics
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
phone: (305) 361-4088 fax: (305) 361-4701 email: cmooers@rsmas.miami.edu

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http://www.rsmas.miami.edu/divs/amp.html

LONG-TERM GOAL

My long-term goal is to understand the circulation dynamics of marginal and semi-enclosed seas through numerical simulation. Understanding the weather-driven transient flows (especially in coastal regions), mesoscale variability, ventilation, seasonal and interannual variability, and flow interactions with the basin topography is part of this goal.

OBJECTIVES

I wish to determine the "necessary and sufficient" conditions for usefully accurate numerical simulations as a prelude to the implementation of nowcast/forecast systems, which requires attention to model evaluation using observations as well as other models. For example, we need to establish the space-time resolution and amplitude accuracy requirements for atmospheric forcing of marginal and semi-enclosed seas. Given the difficulty of determining, in particular, open (lateral) boundary conditions, it is anticipated that data assimilation will be required.

APPROACH

We are using the Princeton Ocean Model (POM) as implemented on a mesoscale-admitting grid (ca. 10 km resolution) and with 26 sigma levels (and with relatively high, logarithmic resolution in the surface and bottom boundary layers) for the Japan (East) Sea (JES). It is driven with surface wind stress, heat flux, and moisture flux, and with specified throughflow from the Korea/Tsushima Strait to Tsugaru and Soya Straits. The model output is compared to available data, including CREAMS I (1993 thru 1996) current meter data (from Prof. Masaki Takematsu, Kyushu U.) over the Japan Basin and now CREAMS II (1999 thru 2001) data. Using synoptic forcing, simulation datasets for the CREAMS II field experimental period are generated and used for model evaluations. Upon completion of the model evaluations, data will be assimilated through the CREAMS II period to form an analysis that can be used for diagnostic studies of the JES dynamics and the analysis of alternative observing system strategies.

In my research group (OPEL), Ms. (now Dr.) HeeSook Kang defended her dissertation on simulations of wintertime ventilation and subduction in the JES; Dr. Inkweon Bang is simulating the CREAMS II period with synoptic (NOGAPS) forcing, evaluating model-data comparisons, and designing data-assimilative analyses; and Dr. Francisco Sandoval conducted model-data comparisons using CREAMS II simulations from Dr. Bang and CREAMS II observations, beginning with shipborne CTD data (from Prof. Lynne Talley, SIO) and Palace Float CTD and flow data (from Prof. Steve Riser, Univ. of Washington).

WORK COMPLETED

Synoptic atmospheric (NOGAPS) and monthly throughflow (NRL) forcing drove several simulation cases covering the CREAMS II period. The parametric dependence of these cases was a factor in model-data comparisons and corresponding sensitivity studies.

Three simulation JES-POM cases and GDEMS (NRL) climatology (as a baseline case) were compared to the Lynne Talley summer and winter CTD-grids and the ca. 21/2-year Steve Riser Palace Float CTD profiles and flows.

Dr. HeeSook Kang joined the University of Southern Mississippi (SSC Campus) as a NRL post doc.

Two mss were submitted to the CREAMS II special issue of <u>Deep-Sea Research</u> and are listed under <u>PUBLICATIONS</u> below.

Dialogue continued, with several other American, Japanese, Korean, and Russian JES modelers and observationalists, for coordination of model-model and model-data comparisons with CREAMS I and II observations.

RESULTS

Substantial agreement exists between the numerical simulations with JES-POM and the shipborne and Palace Float CTD data for the upper ocean temperature and salinity fields, more so in winter than summer and for the winter/summer difference fields. The main discrepancies are associated with the strength of the seasonal thermocline and halocline. Both the simulations and Palace Float flow data at 800 m define a large cyclonic recirculation gyre over the Japan Basin; however, the simulated speeds of the mean flow were about twice those observed. The patterns of speed variance were similar in the simulations and the observations; however, the simulated variance was generally smaller than observed.

The impacts of surface atmospheric forcing of different time-space scales on the simulation of water mass formation and spreading of formed water were investigated by quantifying water mass subduction/formation/transformation rates for the JES. It was found that, without synoptic atmospheric forcing, the diagnostics using JES-POM may underestimate, by a factor of two, buoyancy loss at the surface, and, hence, water mass formation, as well as mixing and spreading of the formed water mass.

IMPACT/APPLICATIONS

The model-data comparisons presented for CREAMS I and CREAMS II timeframes demonstrate that simulations with synoptic forcing can be rationally compared with available observations; i.e., the simulations are in sensible ranges and available observations are useful for these purposes. Furthermore, the point has been reached where (1) useful feedback is being provided to the simulation efforts from the comparisons with observations, (2) the confidence in the verisimilitude of the simulations is sufficient to diagnose aspects of the wintertime ventilation and subduction, and (3) useful assessments of observing systems are in prospect.

TRANSITIONS

These results will be presented in Seoul at the mid-October 2002, NSF-sponsored, bilateral USA/Korea workshop on the JES and nowcast/forecast systems, which will form the basis for follow-on collaborative research in the topic area.

RELATED PROJECTS

OPEL is evolving a nowcast/forecast system for Prince William Sound, which is sponsored by the Oil Spill Recovery Institute (OSRI) of Cordova, Alaska, and another for the East Florida Shelf/Straits of Florida as part of the SEA-COOS Program.

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None

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PATENTS

None