A PROTOTYPE STORM RESPONSE MONITORING AND FORECAST SYSTEM
FOR THE WESTERN GULF OF MAINE

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Wave Modeling: Earth Sciences MS student, Robert Rogers has developed a scheme for determining the near real-time surface gravity wave field throughout the Gulf. This involves obtaining the Navy's Fleet Numerical Meteorological and Oceanography Center (FNMOOC) global Wave Analysis Model (WAM; WAMDI Group, 1988)) wave time series data in 1° x 1° regions offshore of the 100m isobath in the Gulf. Computer routines have been developed to interpolate the 1° x 1° WAM data to any specified grid within the domain. Then the SWAN (Simulating Waves Nearshore) model - developed at Delft University, Netherlands (http://swan.ct.tudelft.nl/) - is being used to simulate the evolution of the WAM-produced waves as they propagate toward the coast. A prototype scheme for delivering real-time waves to QUODDY, consisting of coupled WAM and SWAN wave models, has been tested for storm wave radiation stress forcing on a trio of New Hampshire beaches.

Circulation Modeling: The M. Holboke (1998) version of the Dartmouth 3-D finite element prognostic model QUODDY4 (Lynch and Werner, 1992) has been used to simulate the constant density (i.e. barotropic) circulation of the Gulf of Maine under wind stress forcing. The Styles (1998) combined current/wave bottom boundary layer model (BBLM) has been used to specify the space/time-dependent bottom stress for QUODDY4 for a trio of increasing more complex coastal ocean models. The BBLM is forced by circulation model currents and gravity wave velocities determined by applying potential wave theory to the SWAN wave model simulated waves for the region of interest.

A first set of experiments compared simulations with a coupled one dimensional (1-D) NUBBLE/BBLM model with a constant bottom drag coefficient (C_d) of 0.005 and wave/current-induced C_d using prescribed constant amplitude, 12sec surface gravity waves. These model runs forced by a steady eastward geostrophic flow in depths ranging from 100m to 12m showed that 2m
amplitude waves produced the same average bottom stress as the widely used $C_d = 0.005$. Since winter storms in the Gulf of Maine produce 12s waves with amplitudes considerably larger than 2m, we conclude that storm-induced bottom stresses in water depths less than 80m can be twice as large as normal bottom stresses. Corresponding coastal currents are therefore expected to be less.

A second set of similar bottom friction experiments employed a coupled 2-D, nonlinear, finite difference model JZB/BBLM with tidal current forcing in an idealized coastal ocean. These model runs documented the smooth evolution of shoreward propagating tidal wave, in which sea level and currents as they encountered the progressively higher (relative to constant $C_d = 0.005$ case) wave/current-induced bottom stresses in shallower water greater than 20m. The model ocean responses shoreward of 20m, apparently become complicated by tidal wave reflection effects.

A third set of experiments employed a coupled 3-D finite-element, Gulf of Maine circulation model QUODDY4/BBLM forced by tides, local winds and "remote" winds. The inclusion of the more realistic BBLM bottom stress algorithm actually increases (relative to constant $C_d = 0.005$ case) the difference between the model and observed sea level variation during the 9-10 February 1987 storm. We are presently scrutinizing the result.

Near Real-Time Storm Response Simulation of the Gulf of Maine Sea Level and Currents:
The protocol for optimally-interpolating the near real-time National Data Center Buoy (NDBC) and National Weather Service (NWS) winds and atmospheric pressures onto the QUODDY mesh has been developed (Miller et al., 1999). The protocol for the near real-time connection of forcing and the QUODDY model has been developed (Yu & Brown, 2000). These protocols have been adapted and linked to produce a preliminary prototype real-time barotropic Quoddy model system. The Rick Luetick has provided us with his operational version of the University of North Carolina ADCIRC storm surge model which we will use to provide open ocean Quoddy model model boundary conditions. That implementation is underway. Our Gulf of Maine model system will be tested in January and February 2001 during the time that Luetick will be running ADCIRC in a real-time/forecast model for another purpose.

Theses:

Fan, Yalin, 2000. "The Role of Surface Wave/Current Induced Bottom Stress on the Response of the Coastal Ocean to Storm Forcing". M.S. Earth Sciences/Oceanography Option, Department of Earth Sciences, University of New Hampshire.


Publications: Web-Served Technical Reports

Fan, Y., 1999. Thesis Progress Reports @
http://ekman.sr.unh.edu/OPAL/OPAL student reports.html


Literature Cited:


