Impact of NASA Data and Models on Decision Support Tools in Prince William Sound and Alaska Coastal Oceans
NNS06AA20G

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Our project has faced a number of unanticipated hurdles this past year and a half that have led us to postpone the proposed field experiment until spring/summer 2009. The table-top exercise has not yet occurred.

Anticipated extramural funding for charter vessels and equipment necessary for the field experiment was not forthcoming. Additionally, the Alaska Ocean Observing System (AOOS) did not receive earmark funding this year. AOOS was to serve as the primary portal for the exchange of field data and model output during the field experiment as well as provide operational funds for the Prince William Sound (PWS) HF radar during the field experiment. Lack of AOOS funding has resulted in the mothballing of the HF radar.

In spite of these setbacks, progress has been made on other fronts.

Circulation Modeling

The JPL ROMS group is in the process of refining the PWS ROMS configuration with improved coastline, air-sea fluxes and river forcing. We are also developing a particle trajectory tracking capability in order to apply it in the areas of search and rescue, oil spill response etc. The ongoing work also includes reproducing the 2004 conditions during the drifter field experiment, so as to identify the model strength and weakness for future improvement. The ultimate goal is to deliver a real-time operational model before the summer 2008 when the re-scheduled drifter field experiment is planned.

Hydrography

Temperature and salinity measurements acquired during thermosalinograph surveys conducted throughout Prince William Sound (PWS) between March 2006 and January 2008 were used to identify annual period temperature and salinity signals of surface waters. Mean states and annual period changes in oceanic conditions throughout PWS reflect proximity to glaciated watersheds. Mean temperatures are coolest in northern and western PWS and warmest in southeastern PWS. Annual period temperature amplitude is greatest in western PWS. Mean salinities are lowest in northern and western PWS and highest in central and southeastern PWS. Annual period salinity amplitude is greatest in northern and western PWS. These results represent the most spatially comprehensive descriptions to date of annual period temperature and salinity signals in PWS. The results are applicable as benchmarks for validation of numerical PWS circulation models (the hydrographic data have been given to Dr. Chao’s modeling group) and as a decision support tool for the use of dispersants in the event of an oil spill (summary results were given to John Whitney, Federal On-Scene Coordinator, NOAA Hazmat).

CTD casts conducted during the thermosalinograph surveys are currently being processed to estimate the annual cycle of freshwater content in the upper 100 m of PWS. This will be the first measurement-based estimate of freshwater content for PWS. We anticipate the submission of a manuscript describing these results in late 2008.

Wave Modeling

To provide wave forecasts for Prince William Sound (PWS) on local high-resolution domains, the approach taken is similar to that recently proposed by Rogers at al. (2007, Coastal Engineering) of interfacing several grids for the Southern California Bight. However, Rogers et al. (2007) have not examined the accuracy of the "forecasted" results. Our study expands on their effort with forecasting applications at another site (i.e. PWS), thus enabling a more general assessment of the efficacy of the scheme. Connecting to NOAA's outer ocean grids, we have constructed two grids covering the overall northern Gulf of Alaska; these are called the "intermediate" domains. A sub-domain of the intermediate domain was developed as a "fine grid" regional domain, and the simulations from the intermediate domains were used as boundary conditions for these. Considerable experimentation was needed before the appropriate grids could be identified, in keeping with the work of Rogers et al. (2007) who noted that errors can arise in areas with islands and complex bathymetry. Our first grid covered the PWS domain, with a resolution of 0.02^o resolution. This grid was connected to NOAA's outer ocean grid, and being reasonably fine, it was hoped that this would suffice for the simulations for the entire PWS nearshore region. However, it was found that the wave heights inside PWS (behind the chain of islands) at the entrance were very high. Several simulations based on this grid were made, covering a period of about one year. The wave heights inside the Sound frequently appeared to be on the high side, somewhat counter to our intuition; the islands appeared to have little influence in attenuating the significant wave heights (SWH) on the leeward side. This deficiency was confirmed by compared the simulated results with field data from four NDBC buoys: 46076, 46061, 46060 and 46081. Rogers et al. (2007) have suggested that resolution can affect the predicted results in areas with complex topography. That feature appears to be manifesting itself in our PWS grid development work also. The 2 km grid can clearly not be reliably used as our regional grid, and that a finer grid is needed. However, we decided to retain this grid as an "intermediate" grid, connecting NOAA's outer ocean grid to a new regional PWS grid. This third near-shore grid was developed to cover an area between 148.0^oW and 146.5^oW, and between 60.0^oN and 61.25^oN at a resolution of 0.01^o (approximately 1 km or less). We used the simulation results from the previous (intermediate) grid as boundary condition and still NOAA's wind simulation results as forcing function.

To examine the simulation results based on this system, we used the measurements obtained from buoy 46060. Comparisons between model-simulated SWHs and data suggest no systematic error. It appears that the fine grid works much better inside PWS than the original approach of using only one (0.02^o) grid to represent the nearshore area. Thus, in the end, we set up a three-tier system representing NOAA's Gulf of Alaska domain (at a resolution of 1^o x 0.5^o), our intermediate PWS grid covering the northern Gulf of Alaska (at a resolution of 0.02^o), and our regional PWS grid (at a resolution of 0.01^o). In spite of this improvement, in the extreme reaches of the PWS, the potential for inaccurate predictions remains. Even with a 3-tier system, the model frequently under-predicts the SWHs at the location of buoy 46081, which is deployed at Port Wells. The under-prediction may be attributed to the fact that the Port Wells region represents a relatively isolated water body, with very little connection to the rest of the Sound. Hence it is likely that locally-generated short-period waves usually dominate in this area. In fact, Londhe and Panchang (2007) have found that the daily maximum SWHs recorded by buoy 46081 are less than 2 m regardless of the size of the waves recorded by buoy 46061, which are greater than 8 m at times. As such, we do not believe that inaccuracy is a reflection on the quality of the results in the overall PWS domain. This problem will be addressed in our future research. One possible way to improve the quality of the prediction would be to increase the spectral band used by wave model to better represent the short period waves, but doing so on the entire domain would be cumbersome.

An evaluation of the forecasting skill has begun. The forecast results are compared with significant wave height measurements obtained from four buoys, located in diverse wave and bathymetric environments, to evaluate the reliability of the wave forecast system. The systems tend to provide better predictions for shorter lead times (12 hours), but overall, predictions made by the two systems are reasonably satisfactory, even for lead times as large as 48 hours. These results are based on 2 months of comparisons.

Londhe, S.N. and V. Panchang. 2007. Correlation of wave data from buoy networks. Estuarine, Coastal and Shelf Science, 74:481-492.

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Manuscripts in preparation

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