LONG-TERM GOALS

The long term goal of this effort is to develop a robust assimilation capability for the use of remote sensing data for estimation of wave conditions and for ocean bottom characterization.

OBJECTIVES

The objectives of this effort are to refine and validate a variational approach developed for assimilation of SAR imagery into the SWAN model for estimation of waves and bottom friction, improve the performance of the algorithm through parallel implementation, and to extend the approach to the assimilation of optical sensor data.

APPROACH

This program makes use of a variational data assimilation capability described in Walker (2006). The assimilation algorithm uses the SWAN wave spectrum model of Booij et al. (1999) and the nonlinear Hasselmann & Hasselmann (1991) model for the SAR image spectrum (with extensions proposed by Krogstad 1992), along with adjoint forms of both models. The algorithm can be used to determine the incident wave spectrum and bottom friction coefficient distribution which minimizes the error between the estimated and observed SAR-image spectrum.

WORK COMPLETED

The work completed during the two months since the inception of the program includes beginning transition of the assimilation algorithm to the latest, parallel version of the SWAN model, and starting the procurement process for parallel computing hardware.

RESULTS

A SAR assimilation methodology based on the SWAN near-shore wave-spectrum model has been developed which can be used to estimate the wave spectrum over a large (100 km square) region. This methodology has recently been extended to the estimation of the bottom friction coefficient. To date, the approach has only been applied at a single location, near the USACE FRF site at Duck, NC (this is based on the availability of both SAR data and contemporaneous ground-truth wave data). An example of an estimated wave field determined using the algorithm is shown in figure 1. While some of the wave information is lost due to SAR imaging effects, resulting in underestimation of the significant wave height, the peak frequency and wave direction are well captured.
Figure 1. Sample results from assimilation of an ERS SAR data set for the region around the USACE FRF at Duck, NC: a) SAR image intensity overlaid on bathymetry contours; b) Iteration history of cost function $J$, showing rapid convergence; c) Estimated significant wave height with $x$'s indicating the location SAR spectrum observations; d) Estimated directional spectrum at FRF 8m array; e) Observed spectrum at FRF 8m array. The estimated spectrum lacks some of the high-frequency content and has a narrower angular distribution due to the SAR imaging effects (resulting in lower significant wave height), but the dominant wave frequency and direction are well-estimated.

IMPACT/APPLICATIONS

This approach will allow regional estimates of current wave conditions from available remote sensing data, along with estimation of bottom conditions. Information on current wave conditions is important for situational awareness. Knowledge of bottom conditions is critical to obtaining accurate predictions estimates of near-shore waves, important for both awareness and the planning of operations.
REFERENCES


