Development of the Nearshore Wave Prediction System

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1. Introduction

The demand for high-resolution forecasts of coastal processes, including waves, water levels and currents, has been steadily increasing over the past decade. The global operational multi-grid WAVEWATCH III® wave model (WW3, Tolman et al. 2002; Chawla et al. 2013), run by the National Weather Service's (NWS) National Centers for Environmental Prediction (NCEP), features a shelf-scale grid resolution of 4 arc-min (≈7.5 km), which is too coarse to resolve relevant coastal processes. It is furthermore desirable that forecasters at coastal Weather Forecast Offices (WFOs) be able to drive nearshore hydrodynamic models with their official forecast wind fields, in order to provide consistent marine forecasts to end users.

2. System description

The aim of the Nearshore Wave Prediction System (NWPS, Van der Westhuysen et al. 2013), which is integrated into NWS's Advanced Weather Interactive Processing System (AWIPS-II), is to provide high-resolution wave and surge model guidance, run in an on-demand manner by forecasters at coastal WFOs. The underlying wave model used is SWAN (Booij et al. 1999), and in future a nearshore version of WW3. The system is being deployed at all coastal WFOs in the United States (Figure 1). Output from various global or regional NOAA models are used as input to the downscaled NWPS domains, including: wave boundary conditions from the global multi-grid WW3 model (during tropical events wave boundary conditions are provided by a regional-scale simulation forced by official hurricane forecasts); water levels including tides and wind-driven surge, either from the ADCIRC-based Extra-tropical Surge and Tide Operational Forecast System (ESTOFS) or SLOSH-based probabilistic P-Surge system (tropical events); and surface current fields from the HYCOM-based Real-Time Ocean Forecast System (RTOFS). At present, the latter two fields are used as input only (one-way coupling) but in future a two-way coupling with a downscaled ADCIRC model will be included. The model computation occurs either on NCEP's production supercomputer (starting in 2015) or locally at WFOs, depending on resources. Output from the NWPS system includes: fields of integral wave parameters, fields of partitioned and tracked wave systems, and wave frequency spectra and partitioned output time series (Gerling-Hanson plots) at selected locations.

3. Results

Output from NWPS was validated using metocean observations from NDBC buoys at the shelf and nearshore. Since the NWPS domains overlap along the coast, each NDBC buoy was spatially collocated with output from the most representative model domain. Output for one cycle a day was extracted at 24 h, 48 h, 72 h and 96 h forecast windows, and compared to these observations. Figure 2 shows the resulting scatter plots and statistics for all coastal WFOs in NWS's Southern Region. The model displays satisfactory performance out to at least 72 h, with relative biases of around 5% and scatter indices of below 0.3. At later forecast hours (e.g., 96 h) the forecast guidance quality decreases, as the accuracy of the offshore wave boundary conditions and local forecaster wind fields deteriorates.

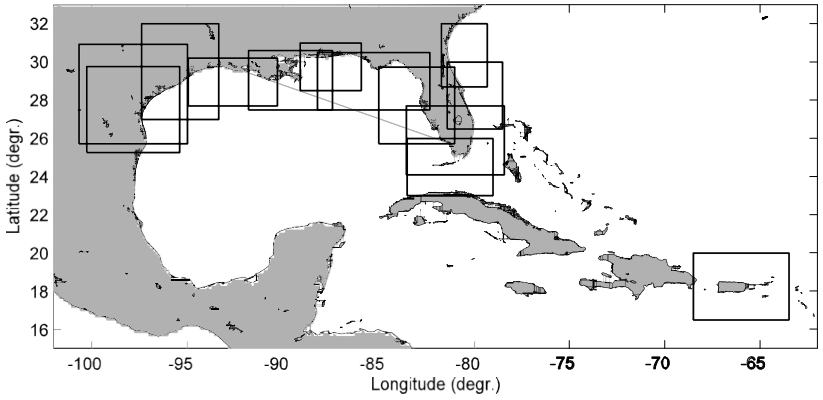

Figure 1: Example of the high-resolution NWPS wave model domains for coastal WFOs in the National Weather Service's Southern Region, including Puerto Rico and the Virgin Islands.

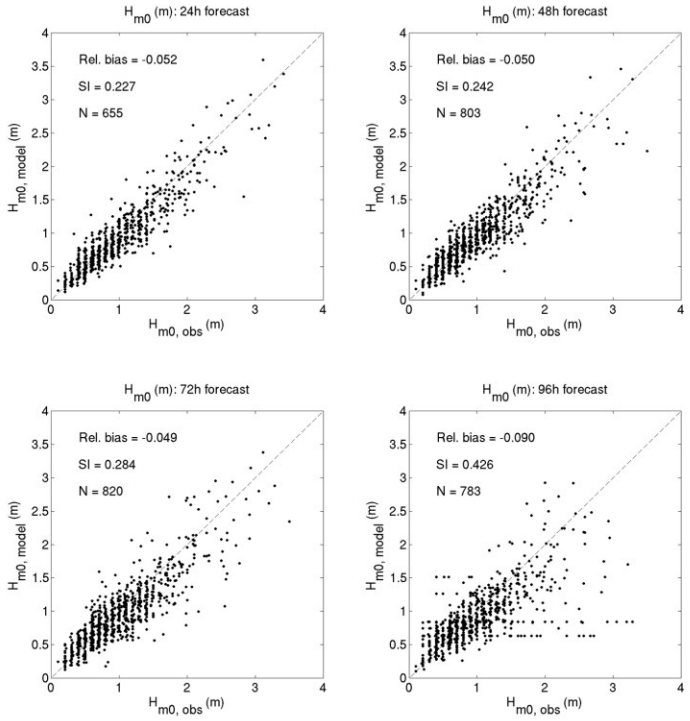

Figure 2: Forecast validation of NWPS model output at National Weather Service Southern Region WFOs during Oct 2014 to Jan 2015. Shown are model results at the 24 h, 48 h, 72 h and 96 h forecast time frames against observations at NDBC buoys.

References

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