VALIDATION OF UNSTRUCTURED WAVEWATCH III FOR NEARSHORE WAVES

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INTRODUCTION

Unstructured wave model grids in the nearshore coastal region provide flexibility and efficiency to resolve complex shorelines and high-gradient wave zones to drive nearshore circulation, wave setup and wave-driven sediment transport. Recent improvements to the unstructured version of WAVEWATCH III (WW3) (WW3DG 2016) to support nearshore application include an implicit solution scheme and domain decomposition for multi-scale spatial coverage over approximately three orders of magnitude. The hybrid approach to parallelization involves spectral partitioning for advection in geographical space and domain decomposition for spectral advection and the source term integration. The advection part of wave action equation is integrated fully implicitly, and a new convergent action limiter derived from Komen et al. (1994) and Hersbach and Janssen (1999) is applied. New Block-Jacobi and Block-Gauss-Seidel solvers are applied with improved convergence. The purpose of this paper is to evaluate the upgraded unstructured WW3 for nearshore application.

FIELD VALIDATION

Unstructured WW3 is evaluated for nearshore wave generation and transformation using field data from the US Army Corps of Engineers, Coastal and Hydraulics Laboratory, Field Research Facility (FRF) in Duck, North Carolina, USA. The evaluation focuses on four storms: Hurricane Irene in August of 2011 (7 m offshore waves), a November 2011 mixed sea/swell event (2.8 m offshore waves), Hurricane Sandy in October of 2012 (7 m offshore waves), and a February 2013 event with oblique 5 m offshore waves. The nearshore domain stretches from 26 m depth to the shoreline, centered on a cross-shore array of wave gauges. The model grid is 108,403 nodes with a resolution of 500 offshore to 10 m near the coast. The domain is 20 km in the cross-shore direction and 50 km in the longshore direction. Winds and water levels are varied in time, but specified as constant in space. Figure 1 shows an example comparison of modeled significant wave height, peak period and mean direction to measurements for the February 2013 event (offshore heights of 5 m). The WW3 source term packages and propagation schemes are also evaluated. RMS errors are 0.47 m with a bias of 0.29 m for wave height over all storms, and RMS error of 0.9 s and bias of -0.02 s for wave period. Figure 2 shows good parallel efficiency of WW3 up to 900 processors.

CONCLUSIONS

The unstructured grid and nesting capabilities of WW3 make it a strong candidate for combined basin wave generation and nearshore transformation for large regions (e.g., recent evaluations of storms for the northeastern US were done with WAM and multiple nested STWAVE domains). Present plans are to integrate WW3 into the Coastal STORM modeling system with linkages to Corps of Engineers circulation and sediment transport models.

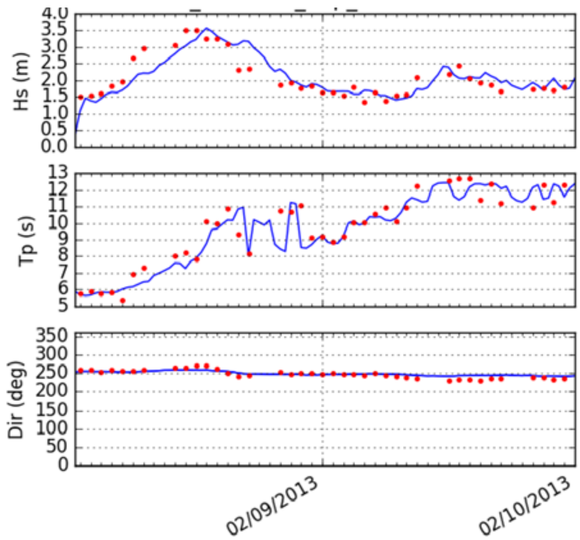

Figure 1 - February 2013 WW3 model (blue line) and data (red dot) comparison at 5 m water depth at the FRF.

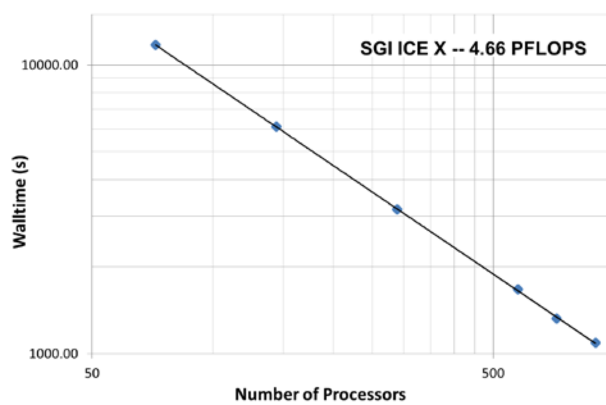

Figure 2 - WW3 parallel efficiency.

REFERENCES

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