# TOWARD DEVELOPMENT OF A “RAPID-RESPONSE” LOCAL WAVE MODEL FOR THE NWS MELBOURNE, FLORIDA FORECAST OFFICE

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## 1. Project Summary

The marine forecast region for the NWS Melbourne Weather Forecast Office (WFO MLB) covers approximately 250 km along the east coast of central Florida (including Port Canaveral) and is heavily used by both large and small craft. Census data reveals that the population along the east-central Florida coast continues to steadily grow, suggesting an even greater demand for accurate and timely marine forecasts in the future. This increasing demand also comes at a time of greater NWS emphasis on closer partnerships with government agencies for incident support (e.g. hazardous material spills, homeland security assistance at coastal ports).

The region's wave environment is affected by waves generated by large-scale systems such as low pressure systems/cold fronts (primarily in the “cool season”, November-April) and tropical cyclones (June-November), but also by meso-scale systems such as coastal lows/troughs, the diurnal sea breeze circulation (strongest May-October) and cool season squall lines. Many of these systems can produce a rapid onset of dangerous and varied wind and wave conditions that endanger small (and even large) craft and present a challenge for WFO MLB marine forecasters.

This proposal seeks funding to configure and test prototype elements of an in-house high resolution “rapid response” wave forecast system for WFO MLB. One key purpose of such a system would be to assist forecasters in assessing and forecasting the effects of rapidly evolving, meso-scale weather systems on local wave conditions. The envisioned final system would use wind data output from the WFO MLB 2.5-km resolution Weather Research and Forecast (WRF) model and lateral wave boundary data available from operational NCEP wave models. Such a system would thus complement the information available from existing NCEP models.

The funding requested for this proposal would be used a) for development of a prototype implementation for the Wavewatch III (WWIII) wave model covering the WFO MLB forecast region and b) to perform a proof-of-concept demonstration simulation for a past case of strong local winds using archived output from the WFO MLB 2.5-km WRF model (see example in Figure 1). Major elements of the prototype system would serve as a foundation toward leveraging an eventual operational in-house system.

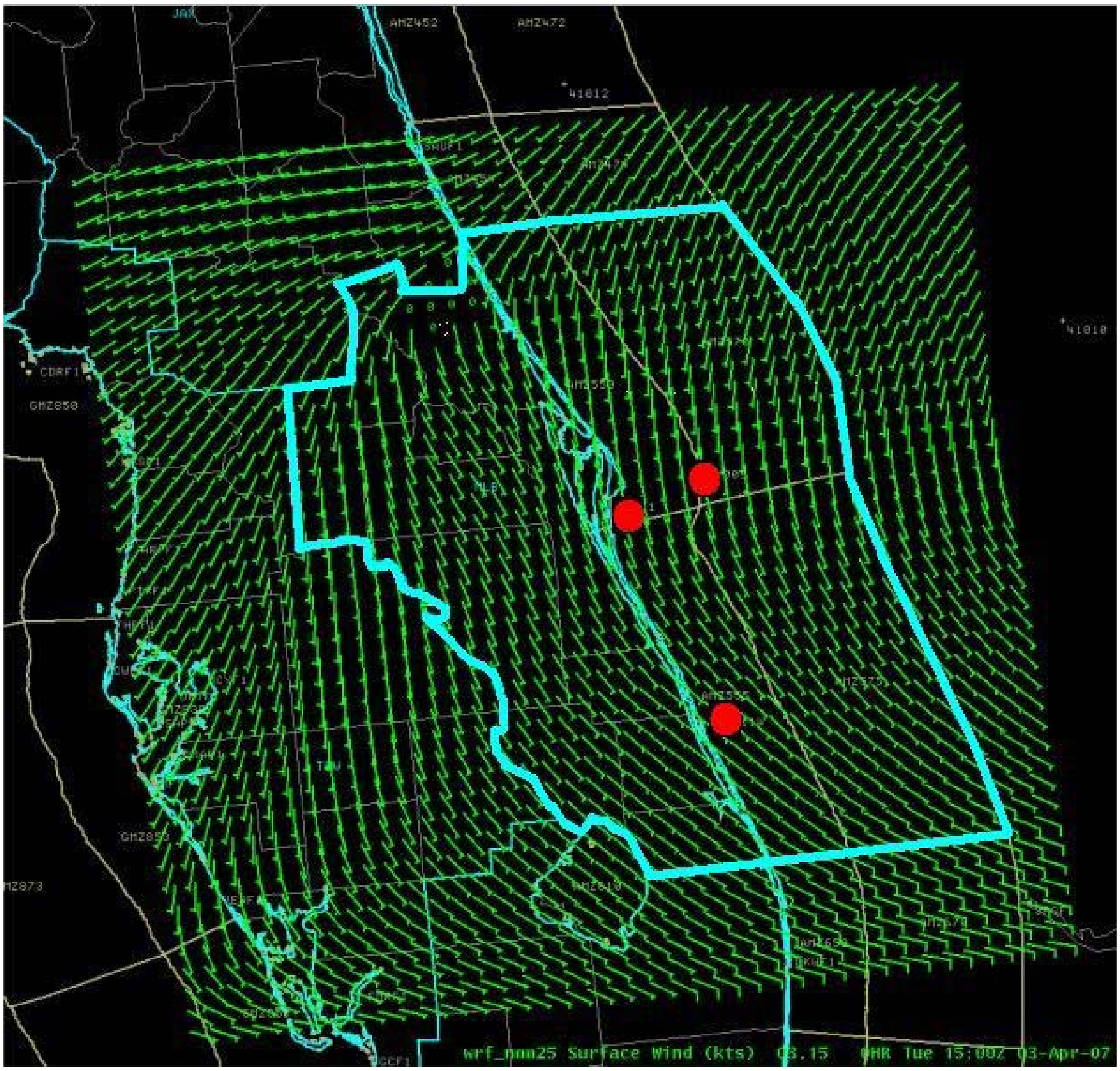


Figure 1. Sample of WFO MLB 2.5-km WRF domain with a wind forecast (note displayed resolution is lower than 2.5-km for clarity). WFO MLB county and marine warning area is shown within the thick cyan contour. The buoy locations for wave height verification are shown by the red circles.

## 2. Objectives

The objectives of the proposed work are the following:

- Configure a prototype high-resolution (2.5-km) “rapid response” local wave model covering WFO MLB marine forecast area. This prototype would contain elements (software, data) of an envisioned in-house operational nowcast/ forecast system.

- Perform a proof-of-concept simulation with the prototype system using winds from the WFO MLB in-house 2.5-km resolution WRF model for one or two past episodes of strong local winds and high waves that were of particular concern to WFO MLB forecasters and small craft operators.

The proposed work will result in development of foundation data sets (bathymetry) and software (WWIII implementation, WRF data handling code, graphical software) necessary for an operational system. By including a proof-of-concept simulation, the work will encourage WFO MLB marine forecasters to envision how they would operate and interact with such a system. HRC staff and WFO MLB forecasters will discuss these issues and include the most important points in a brief summary report.

## 3. Tasks

### *a. Hydrologic Research Center*

The Hydrologic Research Center (HRC) will contribute the computer resources necessary for development and testing of the prototype system. The main tasks to be conducted are listed below:

- Create a 2.5 km resolution bathymetric data set covering, and extending slightly beyond, the WFO MLB marine forecast region.

- Configure the Wavewatch III (WWIII, Tolman 1999) wave model at 2.5-km resolution over the selected domain. [The use of Wavewatch III, rather than the SWAN wave model, for this implementation is guided by the relatively large (250 km) north-south dimension of the domain (per discussions with NOAA NCEP MMAB wave model expert Dr. Hendrik Tolman).

- Develop computer code to process the WFO MLB WRF wind data into a format suitable for ingestion into WWIII.

- Perform the demonstration simulation with WWIII.

- Obtain the buoy wave measurements from the three wave buoys in the region. These buoys include the i) NOAA Buoy 41009 (28.5N 80.17W, 41.5 m depth), ii) Scripps Institution of Oceanography Coastal Data Information Project (CDIP) Fort Pierce Buoy (27.55N 80.23W, 16 m depth) and iii) CDIP Cape Canaveral Buoy (28.4N 80.53W 9.9 m depth). See buoy locations in Fig. 1.

- Prepare a brief summary report concerning project results.

### *b. National Weather Service (WFO MLB)*

WFO MLB co-PI's will identify one (or two) archived case study (studies), provide high-resolution atmospheric winds fields as input for the selected case, and provide an analysis of the potential operational benefits of such forecast wave data. The specific tasks are outlined below.

- Identify one or two important local wave events for proof-of-concept simulations. The selected event(s) will be cases in which i) waves entering the domain from outside had little effect on the wave environment (there will be no lateral wave boundary conditions for this simulation), ii) local winds were strong, iii) winds are available from the 2.5-km in-house version of the WRF model and iv) occurs after mid-November 2006 so that data from all three wave buoys presently operating in the region can be used for verification (see Fig. 1 and section 3a, bullet 5) coincident with the availability of archived 2.5-km WRF wind field grids.

- Provide (to HRC) archived wind grids from the WFO MLB 2.5-km resolution WRF model for the local event(s) identified above (see section 3b, bullet 1) to be used as wave model initial conditions.

- Compare the available buoy wave measurements with the model results and contribute to the HRC summary report (section 3a, bullet 6) by analyzing the model verification and discussing potential operational forecast benefits of using such data sets in real-time. For example, the potential for development of new forecast products for specific marine user groups will be explored (i.e. highly detailed, site-specific "spot" forecasts, short-range marine text forecasts, etc.).

## 4. Time Schedule

The prototype work described above will require approximately six months for completion. An estimated schedule with key task milestones is as follows:

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| August-September 2007 | Acquire archived WRF data. |
| | Complete bathymetric data set. |

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| October-November 2007 | Configure WWIII.<br><br>Develop computer code to process WRF data.<br><br>Run forecasts. |
| December 2007-January 2008 | Provide proof-of-concept results to WFO MLB for evaluation.<br><br>Verify proto-type forecast and evaluation.<br><br>Finalize summary report. |

## 5. Envisioned Operational System (follow-on initiative)

This system would be configured upon a workstation at WFO MLB as a possible follow-on project and would result in a fully operational system. Model output would be ingested into the Advanced Weather Interactive Processing System (AWIPS) to utilize display and overlay capabilities and to populate official National Digital Forecast Database graphics and subsequent textual forecasts, if desired. The model domain could be expanded to encompass the coastal waters of surrounding WFOs (i.e. regional wave model including MIA and/or JAX forecast waters) or could be run independently at adjacent WFOs. The operational “rapid-response” high-resolution wave modeling system would be composed of five components:

- The Wavewatch III (WWIII; Tolman 1999) model configured at 2.5 km resolution.

- Winds from a high-resolution implementation of the WRF Environmental Modeling System (EMS) model run in-house at WFO MLB out to lead times of 12 hours. Flexibility will allow for model initialization using WRF data with differing resolutions (i.e. 2.5-km and higher) and initial conditions. The capability to use manually synthesized gridded wind forecasts from the AWIPS Graphical Forecast Editor (GFE) should also be incorporated (in the event the GFE wind forecast varies significantly from the WRF and is preferred by the forecaster).

- Lateral (wave) boundary conditions for the modeling system would come from either the currently operational NCEP North Atlantic Hurricane (NAH) Wavewatch III implementation (Chao et al., 2003) or follow-on versions of Wavewatch likely to become operational during late 2007 or early 2008. In rapid-response mode, the WFO MLB system would use the most recently available NAH forecast boundary condition products (ire., it would not wait for new analysis/forecast products to become available).

- A set of software that would sequence operations, process and store necessary data, and provide graphical products in NetCDF for ingest into AWIPS Display 2-Dimension (D2D) and GFE.

- An objective verification and calibration activity in which wave model results would be compared to in situ buoy measurements and appropriate adjustments made to wave model parameters.

- It is envisioned that this system would be run every 6-hours (or on an as needed basis) out to a lead time of approximately 24 hours. Output would be available on an hourly basis and would consist of a) gridded fields of significant wave height, dominant wave period and dominant wave direction, and b) directional wave spectra at locations selected by WFO MLB forecasters.

## 6. Budget

See attached Budget Page.

## 7. Principal Investigator - Hydrologic Research Center

Dr. Nicholas Graham, a Senior Research Scientist at the Hydrologic Research Center, has extensive experience with ocean wave climate, ocean wave forecasting, and both large-scale and regional ocean wave modeling (e.g., Graham and Diaz, 2001; Caires et al., 2004, and Graham, 2005). Recent operational work includes development of a regional modeling system using NCEP boundary conditions for the Bermuda Weather Service and a broadly similar system under development for the southern half of California for CDIP.

The Hydrologic Research Center was established in 1993 as a nonprofit research, technology transfer, and training organization. HRC was created to help bridge the large gap existing between scientific research in hydrology and applications for the solution of important societal problems that involve water. The Hydrologic Research Center is a public benefit nonprofit organization with 501(c) (3) status in the United States.

## 8. References

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