Nov 17th, 11:15 AM - 11:45 AM

Session 2 Presentation: WAVEWATCH III: Transition to Naval Operations

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Session II ─ Development of wave modeling framework to protect life and save property.

Operational wave modeling frameworks include various numerical and physical approaches such as data assimilation. The mechanisms for data assimilation to improve wave forecasting are still an area of basic research, especially since wave buoy observations are sparse. This session discussed new wave models and modeling suites that are presently being used to forecast ocean waves and to support technologies such as wave gliders and autonomous underwater vehicles (AUVs). Participants describe how wave models assimilate measurements from wave buoys and procedures used to make consistent use of ocean observations and models. The following presentation, paper, and extended abstracts relate to the use of wave models to support optimal ship tracking, glider operations, marine spill response, and numerous other applications..

Session Presentation by Mr. James Dykes

WAVEWATCH III Transition

- Background
- Multi-grid model
- Irregular-grid model
- Operational Implementation
- Preliminary validation results

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Background

- NAVO runs WAM to apply BCs for smaller domain wave models, WAM and SWAN.
- Along with FNMOC used WAM since 1995.
- In 2000 FNMOC went to multi-processor mode requiring switch over to WAVEWATCH III.
- At NAVO we were able to adapt the code to multi-processor machines (C90).
- Also, applied relocatability to the code.
- Purpose of transition
  - Upgrade NAVO (and FNMOC) with latest technology.
  - Replace NAVO WAM to be in sync with FNMOC.

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Multi-Grid Model

- Known as "Mosaic Grid" feature.
- Same physics and most numerics as before.
- Implemented in code in 2006 (Tolman Tech. Note 2007; OM 2008).
- Available in the last public release (v3.14).
- Exchange of wave data between domains nested in other domains.
- All domains are run at once.
- Curvilinear grids will be added later in ver 4.

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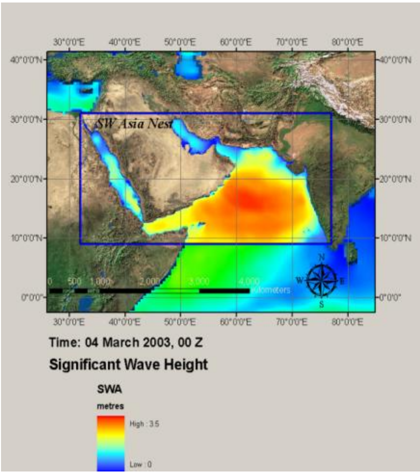
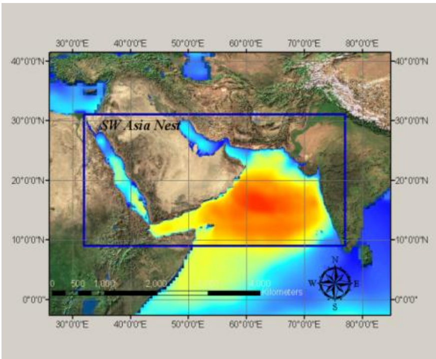
Multi-Grid Model





In the above panel additional energy is observed exiting the smaller domain as indicated by the image of modelled values of significant wave height.

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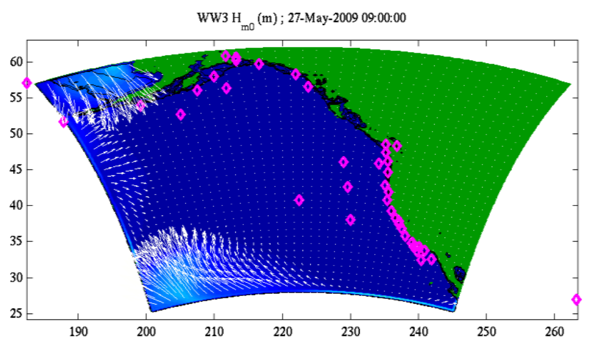
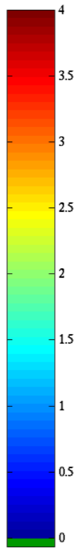
Irregular-Grid Model

Irregular-grid feature in WAVEWATCH III

- Implemented in code in 2008 (Rogers and Campbell, NRL report 2009).
- Not included in the last public release (v3.14)
- Exists in NCEP WW3 development code **added in v4.01**
- **To be implemented at FNMOC**

Irregular-Grid Model

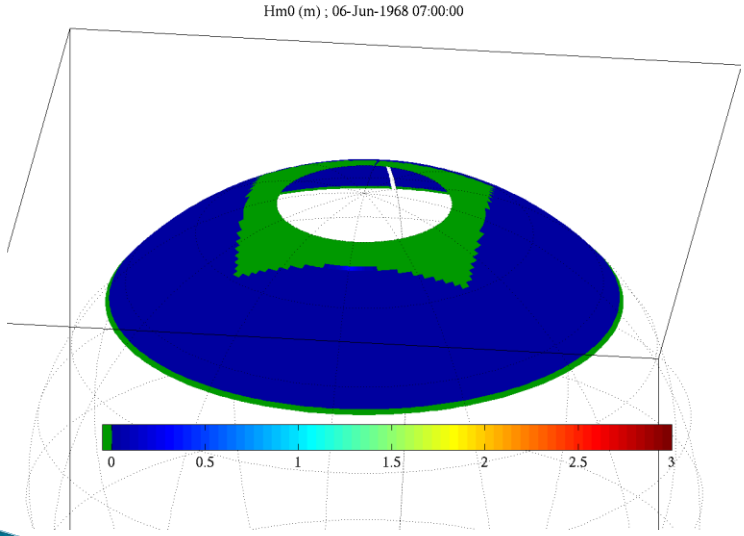




WAVEWATCH III propagation (boundary forcing only) on Lambert Conformal grid, one way nesting.

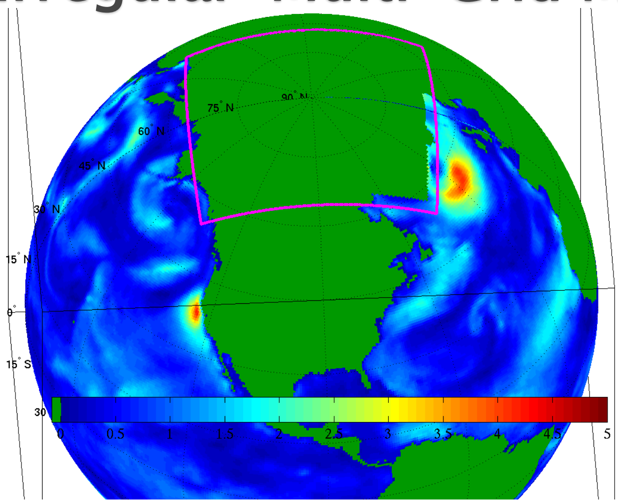
Resolution ~ 0.2°

Irregular-Multi-Grid Model



WAVEWATCH III two-way nesting test (propagation only) with COAMPS Arctic curvilinear grid (~16 km grid spacing) and a simplified global grid. Waveheight in meters.

Irregular-Multi-Grid Model



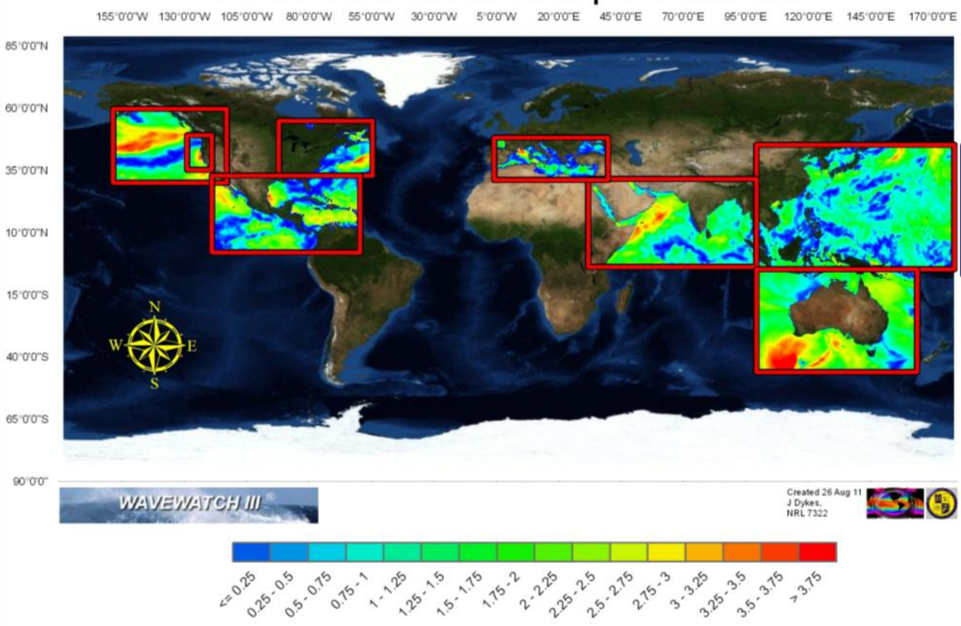
WAVEWATCH III two-way nesting test (propagation + wind + ice) with COAMPS Arctic grid (~16 km resolution) and full (0.5°) global grid. Wave height in meters. The regular (global) grid is plotted. Masked areas are shown in green and include: land, ice, and areas covered by the curvilinear grid. Thus, the global model is not computing in areas covered by the Arctic grid (read: increased efficiency).

Results for May 25 2009 12Z, after a 12 hour simulation (from cold start). The boundary of the Arctic grid is shown with a magenta line. Ice is from PIPS and winds are from NOGAPS. Setup is very similar to what it would be for an operational model.

Operational Implementation

- Forced by wind fields supplied by FNMOC from COAMPS and NOGAPS
- Ice concentrations may be applied where appropriate, but this is obviated with the curvilinear domain covering the Arctic.
- Restarts keep the continuity from one forecast to the next with the occasional need to cold start.
- Additional domains can be added on the fly, but not taken away.
- Individual domains go through their own pre- and post-processing.
- Fitting into the run stream at NAVO.

WAVEWATCH III Multiple Domains



Operational Implementation

- Global domain 0.5 degrees grid spacing
- Smaller domains start at 0.2 degrees grid spacing laid out to mostly follow the domains of the COAMPS domains whence the winds come.
- Later curvilinear Arctic grid will be added.
- More domains at 0.2 will be added around the rest of the uncovered coasts. Most of these will have to use NOGAPS winds.
- Run cycles are normally every 12 hours with forecasts at least to 48 and as far as 96 hours.
- Clock time for the current system turns around in about an hour using 256 processors IBM Power6.

Validation Results

- Comparisons from both existing WAM and this WAVEWATCH III run were made with buoys and altimeter.
- Here we show NOAA Data Buoy
  - 41048 in Western Bermuda
  - 42036 off coast by Tampa
- Promoting on-going validation (sanity check)

Validation Results

W Bermuda 41048

Owned and maintained by National Data Buoy Center
12-meter discus buoy
ARES 4.4 payload
31.978 N 69.649 W (31°58'42" N 69°38'56" W)

Site elevation: sea level
Air temp height: 10 m above site elevation
Anemometer height: 10 m above site elevation
Barometer elevation: sea level
Sea temp depth: 1 m below site elevation
Water depth: 5261 m
Watch circle radius: 4235 yards

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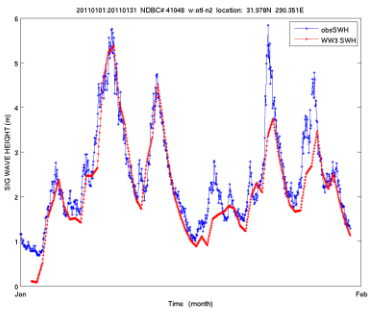
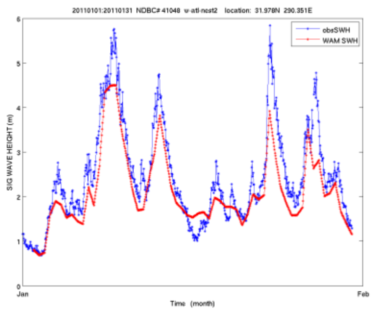
Validation Results

Wave height – 2011 January – 00 Hour
model vs. buoy 41048





WAVEWATCH III WAM

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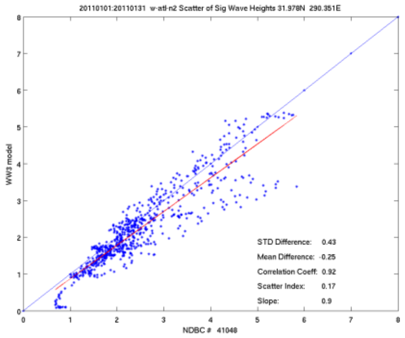
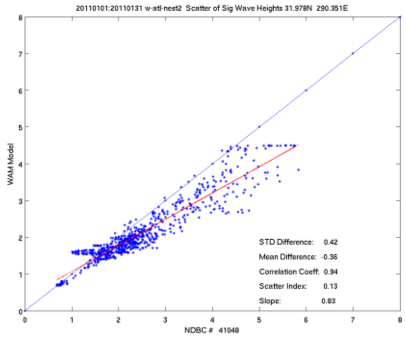
Validation Results

Wave height – 2011 January – 00 Hour
model vs. buoy 41048





WAVEWATCH III WAM

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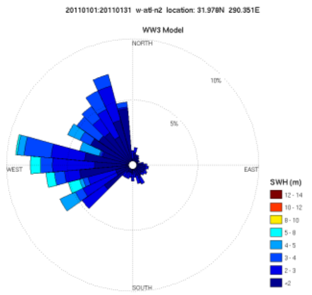
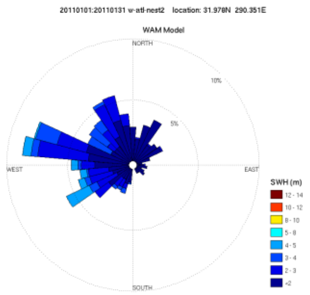
Validation Results

Wave roses – 2011 January – 00 Hour
Modelled values at buoy 42036





WAVEWATCH III WAM

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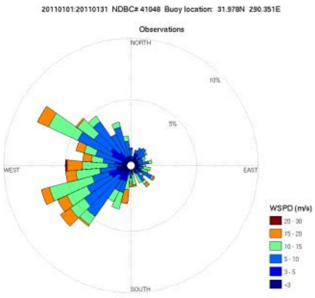
Validation Results



Wind rose
2011 January
00 Hour
Observed values at buoy 42036

Validation Results

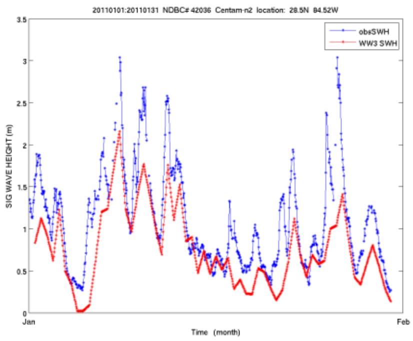
W. TAMPA 42036

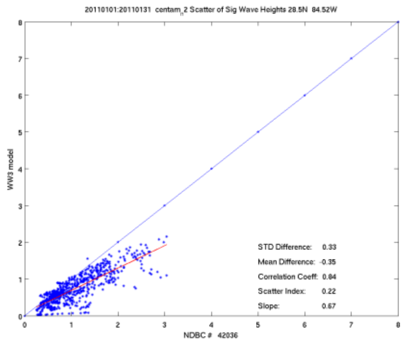
Owned and maintained by National Data Buoy Center
3-meter discus buoy
ARES 4.4 payload
28.500 N 84.517 W (28°30'0" N 84°31'0" W)

Site elevation: sea level
Air temp height: 4 m above site elevation
Anemometer height: 5 m above site elevation
Barometer elevation: sea level
Sea temp depth: 0.6 m below site elevation
Water depth: 54.5 m
Watch circle radius: 129 yards

Validation Results

Wave height – 2011 January – 00 Hour
model vs. buoy 42036



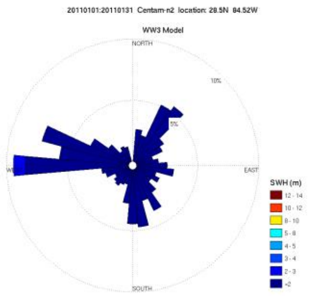


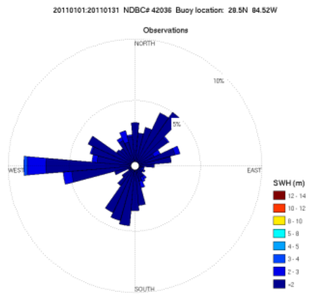
Time series

Scatter plot

Validation Results

Wave roses – 2011 January – 00 Hour





WAVEWATCH III Gulf of Mexico Domain

NDBC Buoy 42036

Summary

- Multi-grid WW3 working (v3.14), in transition to NAVOCEANO
  - Replacing all the WAMs
  - More efficiency
  - BCs for SWAN (one-way nesting)
- Irregular grid WW3 working (v4.01), transitioned to FNMOC
- On-going validation should be a part of operations not only a part of the initial validation

- Acknowledgement: Gretchen Dawson completed the statistics and graphics.

The End