Consistent Tropical Cyclone Wind and Wave Forecasts for the U. S. Navy

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BACKGROUND:

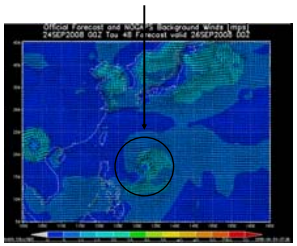
• Wave heights are important for Navy operations such as ship routing and evacuating the ships from port (sortie). The Navy uses 12-ft seas (significant wave height) contour as the important threshold for navigating around severe weather. Sorties (ships evacuating a port) are timed to avoid high winds and seas
• Current guidance is wave models run with various NWP model input
• Significant wave heights from NWP model-driven wave models are not consistent with forecasts from operational centers

GOAL:

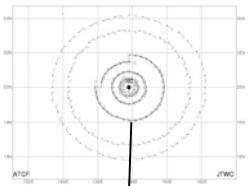
Develop an algorithm to produce significant wave heights consistent with forecasts from the operational centers. Use the forecast and bogus as stored on the Automated Tropical Cyclone Forecasting System (ATCF; Sampson and Schrader 2000). The Joint Typhoon Warning Center version of the algorithm is called JTWC/WW3.

JTWC/WW3 METHOD:

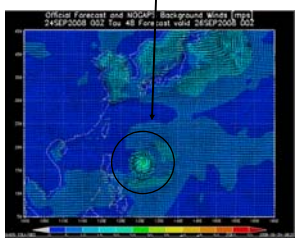
1. Obtain model surface wind field for each forecast period
2. Remove NWP model TC circulation from surface wind field



3. Generate TC wind field based on official forecast



4. Insert into wind field



5. Run WAVEWATCH III® (Tolman et al. 2005) on these modified wind fields

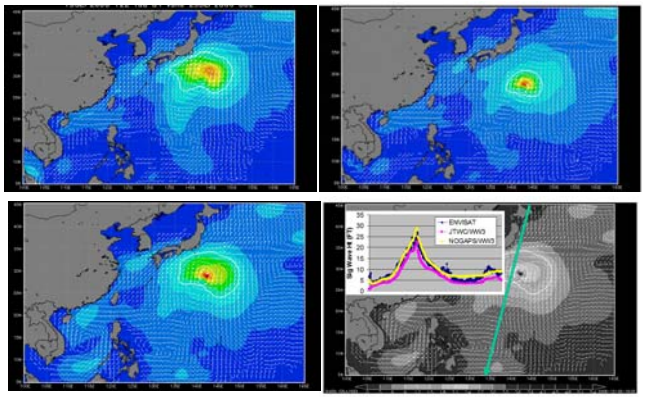
YAGI 2006:

Navy decision to sortie ships from Yokosuka based on impact of high seas along the Japanese coast forecast by NOGAPS/WW3 within 84 h (upper left panel). The lead time is needed because ships need to prepare to get underway and need enough time to steam south to avoid the forecasted high seas.

In contrast , the JTWC/WW3 forecast (upper right panel) had a small area of greater than 12-ft seas still far off the coast of Japan. This guidance indicates that the sortie decision can be delayed at least 12 h because 12-ft seas are still far off the coast.

The hindcast JTWC/WW3 (bottom left panel) indicates the high winds and seas did not impact Yokosuka, yet the NOGAPS/WW3 84-h forecast appears to have a better overall representation of the 12-ft seas area.

A timely altimeter pass (bottom right panel) indicates that the JTWC/WW3 hindcast is well correlated with the observations.



Caption: NOGAPS/WW3 (upper left) and JTWC/WW3 (upper right) 84-h forecasts for Yagi (2006) from 12 UTC 19 September and JTWC/WW3 analysis from a hindcast run valid 00 UTC 23 September (lower left). Shaded areas are significant wave height (ft). Wind barbs are surface winds used in WAVEWATCH III. The 12-ft seas area important for Navy ship navigation is indicated as a white line. JTWC/WW3 (purple) and NOGAPS/WW3 (yellow) hindcasts significant wave height (ft) verified against ENVISAT passes (blue) for a) 00 UTC 23 September (lower right).

CONCLUSIONS AND FUTURE WORK:

JTWC/WW3 produces wave field forecasts consistent with JTWC forecasts. Although the wave fields are consistent, they are not necessarily better. The JTWC errors in tracks, intensity and wind radii are statistically superior to those of NOGAPS, so the JTWC/WW3 should produce accurate significant wave heights.

The authors intend to perform more rigorous evaluation this season to investigate biases in the JTWC/WW3 product. The authors will also experiment with a JTWC/WW3 ensemble consistent with the operational wind speed probability product (DeMaria et al. 2009), which should produce significant wave height probabilities consistent with JTWC forecasts. Joint probabilities could then be used for both ship routing and sortie decisions.

NARGIS 2008:

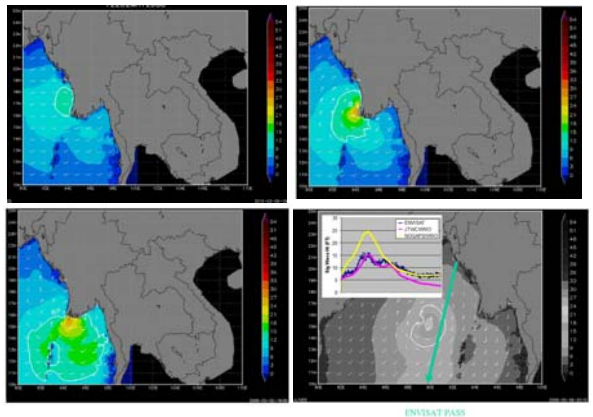
Nargis devastated southern Myanmar in early May 2008, and according to Wikipedia was responsible for an estimated 138,000 casualties.

The 72-h NOGAPS/WW3 forecast valid 12 UTC 02 May indicates that the high seas should impact an are in northern Myanmar, only the southernmost remnants of the highest seas remain in the forecast.

In contrast, the JTWC/WW3 for the same time (upper right panel) indicates that the highest seas (and the tropical cyclone) should impact southern Myanmar and near Yangon (Rangoon).

The hindcast JTWC/WW3 (bottom left panel) indicates the high winds and seas in southern Myanmar, consistent with the 72-h JTWC forecast in the upper right panel.

An altimeter pass (bottom right panel) indicates that the JTWC/WW3 hindcast is well correlated with the observations.



Caption: 72-h forecast of Nargis (2008) significant wave height from (a)NOGAPS/WW3 valid 12 UTC 02 May, (b) JTWC/WW3 valid 12 UTC 02 May, and (c) verifying JTWC/WW3 analysis 12 UTC 02 May. The 12-ft seas area important for Navy ship navigation is indicated as a white line. JTWC/WW3 (purple) and NOGAPS/WW3 (yellow) hindcasts of Nargis (2008) significant wave height (ft) verified against ENVISAT (blue) for 04 UTC 1 May (lower right).

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