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MODELING TROPICAL CYCLONE GRIDDED WIND FIELD FORECASTS

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1. INTRODUCTION

The National Weather Service (NWS) is embarking on one of its biggest changes in many years with the transition to producing a National Digital Forecast Database (NDFD) using the Interactive Forecast Preparation System (IFPS) beginning in 2003. This database consists of gridded surface forecast information such as temperature, dew point, and wind, at moderately high spatial resolution (1 to 5 km) and high temporal resolution (1 to 6 hours, out to 7 days). The NDFD will be extended across portions of the Pacific in 2004 as the NWS Pacific Region begins producing grids for the Mariana Islands in the west Pacific and the Hawaiian Islands in the central Pacific.

A major concern with implementation of the NDFD in the Pacific Region is how to deal with the forecast problem of producing grids of winds during periods of tropical cyclone activity. Tropical cyclone warnings in the Pacific include only position locations, maximum wind intensity, and limited wind radii information. This paper will address one possible method for creating a wind grid of sufficient temporal and spatial resolution for NDFD and based on the limited information found in the official tropical cyclone warnings.

2. INPUT DATA

The NWS Central Pacific Hurricane Center (CPHC) and the Department of Defense Joint Typhoon Warning Center (JTWC) are the source for the NWS for tropical cyclone warnings in the central Pacific and west Pacific, respectively. Data extracted from these warnings for the purpose of this study included: latitude, longitude, sustained maximum wind speed and direction, and wind radii for defined thresholds (approximately 18, 26, and 51 m s^{-1}). These data values are only available for a few forecast hours based on the initial warning time plus 6, 12, 24, 36, 48, and 72 hours. Warnings in the central Pacific also include 96 and 120 hour forecast positions but without wind radii information.

3. ALGORITHM

The technique used is to apply the common empirical function (Anthes, 1982):

$$v(r) = v(R_0)\left(\frac{R_0}{r}\right)^x, \; R_0 \le r \le r_0$$

where v(r) is the tangential wind speed, $v(R_0)$ is the maximum sustained wind, R_0 is the radius of maximum wind, and r_0 is the maximum radial extent of the wind influence from the storm center. This formula works well with exponential values of *x* between 0.5 and 0.7.

For grid points between the center of the storm and the maximum radius of winds a different function is used:

$$v(r) = v(R_0)\left(\frac{R_0}{r}\right), \; 0 \le r \le R_0$$

thus accounting for the rapid decrease of wind experienced in the eye of the tropical cyclone.

Hourly positions of the tropical cyclone from 0 to 72 hours were then computed using linear interpolation for both location and sustained wind speeds.

The next step was to construct a high-resolution fixed rectangular grid at 11 km resolution. Wind speed was computed using the above formulae for each grid point based on some initial values for *x* and R_0. The grid points were further modified to reflect the influence of the movement of the storm by increasing the right semi-circle relative to the storm's movement and decreasing the left side, with the influence weighted most for grid points near the radius of maximum winds.

The final resultant hourly grids will be converted into the netCDF format that is used in IFPS for forecasters use in producing wind grids for NDFD.

4. RESULTS

Results for some storms for the 2004 storm season should be available at:

http://www.prh.noaa.gov/hq/regsci/presentations/Miami-2004/supplemental.html

5. FUTURE GOALS

Future enhancements are planned for this technique. Among these include the ingest of model output grids to initialize the environmental flow. This could be useful in the common occurrences where the tropical cyclone is embedded in a monsoonal flow.

Another planned enhancement will be modify the radius of maximum winds and the exponential factor based on both observational and forecast model output factors for better description of the wind field.

6. REFERENCES

Anthes, R., 1982, Tropical Cyclones – Their Evolution, Structure and Effects.

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