Introduction

The Environmental Modeling Center’s Hurricane Weather Research and Forecasting (HWRF) model is designed to study rapid intensification, a process by which tropical cyclones grow rapidly in intensity. This study focuses on evaluating the HWRF model’s performance in predicting rapid intensification through a series of idealized experiments and real-time forecasts in the northwestern Pacific basin.

Objectives

- Conduct idealized experiments to understand the behavior of rapid intensification (RI) in the HWRF model, defined as a 30-knot wind increase in 24 hours.
- Identify sensitivity of the model’s RI to specification of various parameters such as vortex size, intensity and structure, and boundary condition.
- Examine model performance in real-time, focusing on the model’s RI prediction capability.
- Stress the importance of continued model research and development based on the model’s performance.

Methods

- Use an HWRF idealized configuration in moist (Jordan 1965 tropical profile) environment.
- Implement GFS PBL scheme; no SAS cumulus convection scheme, GFDL radiation for short/long wave; constant boundary condition.
- Change initial vortex due to friction.
- Use an HWRF idealized configuration in moist (Jordan 1965 tropical profile) environment.
- Model physics include Ferrier microphysics scheme, GFDN radiation for short/long wave; GFS PBL scheme; no SAS cumulus convection for 3km domain.
- Model physics modified by Chanh Kieu at EMC to include capability for changing the radius of maximum wind and maximum tangential wind for the initial vortex.

Results

- Sensitivity to specification of RMAX (radius of maximum wind): R30 (30 km), R60 (60 km), R90 (90 km), R120 (120 km), R150 (150 km).
- Sensitivity to specification of VMAX (maximum tangential wind): V40 (40 kts), V50 (50 kts), V60 (60 kts), V70 (70 kts), V80 (80 kts).
- Smaller storms have the largest intensification rate, however they level off faster than larger storms.
- Given the same VM, if the storm is too small, HWRF fails to forecast intensification (as seen with red line in all experiments).

Case Study: Super Typhoon Haiyan (2013)

- Although HWRF did not fully capture RI, it captured Haiyan’s raw intensity better than other models with considerably less spin-down.

Conclusions

Through the idealized experiments, this analysis found that smaller storms tend to have the largest intensification rate, however they also tend to level off faster than R120 and R150 storms. As the initial VM increases in value, HWRF becomes more consistent in its runs at later lead-times. Given any value of VM, if storm is too small (R30), HWRF fails to intensify in all experiments (further investigation is currently being conducted on this issue).

There is an upward VM and downward RM trend for MPI. For a larger initial storm with initially stronger VM, RI rate is larger, and there appears to be an overall downward trend for RM and RI rate, however there must be more analysis to make this statement conclusively.

In the northwestern Pacific, HWRF was superior to regional models and close to GFS in track forecasts for FY2013. HWRF was superior to all other models in forecasting storm intensity for FY2013. This was consistent for its performance for the specific case study of Super Typhoon Haiyan (2013), where HWRF came close to GFS in best track forecasts. HWRF did fail to capture Haiyan’s raw intensity, however HWRF did comparatively better than all other models with significantly less model spin-down effect.

References


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