UNIVERSITY OF THE PHILIPPINES

Master of Science in Meteorology

Kate Ann R. Esguerra

Numerical Simulation of Tropical Cyclones in the Philippines using the Weather Research and Forecasting (WRF) and Cloud-Resolving Storm Simulator (CReSS) model.

Thesis Adviser:

Gerry Bagtasa, Ph.D.

Institute of Environmental Science and Meteorology

University of the Philippines, Diliman

Date of Submission:

Thesis Classification:

P

Institute of Environmental Science and Meteorology
College of Science

NUMERICAL SIMULATION OF TWO TROPICAL CYCLONE CASES IN THE PHILIPPINES USING THE WEATHER RESEARCH AND FORECASTING (WRF) AND THE CLOUD-RESOLVING STORM SIMULATOR (CReSS) MODELS.

Kate Ann R. Esguerra
University of the Philippines

Adviser:
Gerry Bagtasa, Ph.D.

ABSTRACT

The Philippines is situated between the western part of the Pacific Ocean and the South China Sea which subjects it to numerous tropical cyclones (TCs). The associated hazards of these TCs that occur near the Philippine archipelago have impacted numerous socio-economic aspects of the country. One way to mitigate these hazards is to properly forecast the TC's characteristics, particularly its intense wind and rainfall. In this study, two numerical prediction models namely the Cloud Resolving Storm Simulator (CReSS) and Weather Research and Forecasting (WRF) were assessed by simulating two TCs that occurred in 2018; Typhoon Mangkhut on September 13-15, 2018, and Tropical Depression Usman on December 28-29, 2018.

The results show that both models were able to capture the track of an intense TC well but performed poorly when capturing the track of a weak TC at tropical depression intensity. Moreover, the CReSS model was able to better estimate the TC minimum central pressure bias of 24.17 hPa than 29.74 hPa for WRF while WRF was better at simulating the maximum wind speed for the intense TC case of 9.61 m/s wind speed bias 110.53 m/s for CReSS. Moreover, in a weak intensity TC, CReSS showed a better pressure and wind bias estimation with 1.14 hPa and 6.03 m/s, respectively than WRF's pressure and wind estimation of 3.24 hPa and 30.93m.s. In terms of rainfall, WRF had a better-simulated rainfall distribution than the CReSS model, however, CReSS did a better domain-wide (total rainfall volume) rainfall value estimation than

WRF. In addition, the CReSS showed a prominent wet bias while WRF showed the opposite in both TC cases. The WRF model showed it is marginally better in getting the correct forecasts than the CReSS model in both TC cases.

Relative humidity and wind field gradient are also investigated to identify the possible causes of the models' misrepresentation of simulated rainfall. Upon comparing the RH with the NCEP Reanalysis II, the CReSS has an overall high RH in the domain while low RH is observed around the center of the TCs. Suggesting that the CReSS model converted environmental moisture into rainfall near the TC center but unable to do the same for the rest of the domain. The WRF model, on the other hand, was able to capture the overall RH distribution better which suggests that the model hydrometeor conversion was better simulated. In terms of the wind field gradient, the better hydrometeor budgeting in the WRF microphysics scheme likely resulted in better latent heat release in the TC core, leading to higher simulated TC maximum wind speed for TY Mangkhut. In the case of TD Usman, its weak nature meant that the simulated wind did not play much role in determining the spatial distribution of rainfall.

Keywords: the Philippines, Tropical cyclones, WRF, CReSS, numerical simulation