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Numerical simulation of track and landfall of two typhoons Chanthu and Lionrock and their associated precipitation over Northern Japan by using WRF-ARW model

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Introduction:

The Typhoons are one of the major threatening weather-related disasters that cause societal damages in a number of ways; such as loss of lives, economics, health and habitats (e.g., Takemi et al., 2016; Kure et al., 2016; Chen et al., 2018). Recently, two typhoons, named as Chanthu (International number: 201607) and Lionrock (International number: 201610), have devastated the Northern Japan in August 2016 with societal and economic impacts. In our study, we conducted downscaling experiments on these two typhoons by using Advanced Research dynamic solver of Weather Research and Forecasting (WRF) model to explore the performance of the WRF model and to discuss the following two questions: (1) To what extent the WRF reproduce the track and intensity of these two typhoons? (2) To what extent the WRF represent the precipitation amount in the target region after land falling.

Experimental Design:

The model is configured with 3 nested domains at 9km, 3km, 1km resolution for outermost, inner and innermost domains respectively (see Fig.1). The initial and boundary conditions are driven at 6 hours from two different sources: European Centre for Medium-Range Weather Forecasts (ECMWF) Reanalysis (ERA-Interim) and Japanese Reanalysis (JRA55). We conducted 4 numerical simulations [two simulations with ERA-Interim and two simulations with JRA55] for two time periods: (1) 13-18 Aug, 2017 for Typhoon Chanthu; (2) 26-31 Aug, 2017 for Typhoon Lionrock. The results of typhoon track and intensities are compared with the Regional Specialized Meteorological Center (RSMC) best track datasets and the precipitation after landfall of the typhoons at targeted regions are compared with Automated Meteorological Data Acquisition System (AMeDAS) station observations.

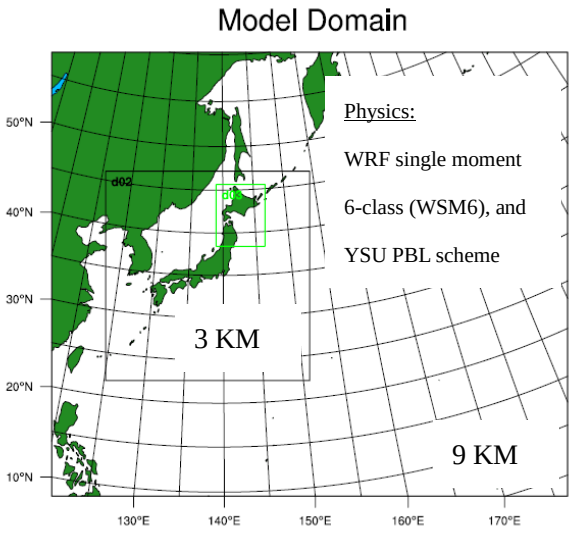

Fig 1: Model domain for the Typhoon Chanthu

Preliminary Results:

We first compared the typhoon track, central pressure and wind speed in reanalysis data with RSMC best track datasets. Our results indicate that the typhoon track is well represented in both reanalysis fields (JRA55 and ERA-Interim). However central pressure is found to be ~10hpa high and wind speed is found to be ~10knots low in both the reanalysis fields. The downscaling with WRF improved the track, central pressure and wind speed. The results for the typhoon Chanthu is shown in Fig.2.

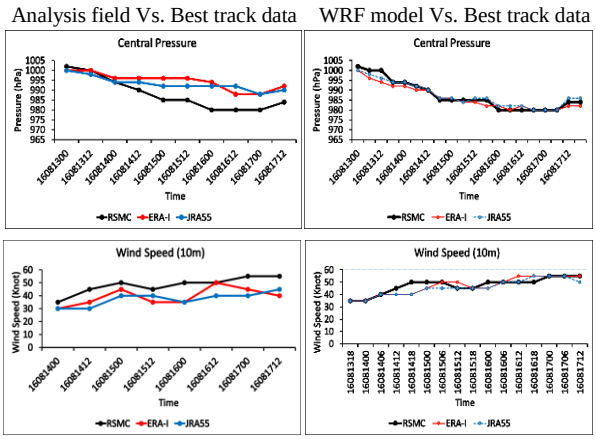

Fig 2: Central pressure and wind speed of Typhoon Chanthu in the reanalysis and WRF simulation

We find that track is not well capture by the model with ERA-Interim after landfall and diverted towards west. The 24 hours accumulated rainfall after landfall over northern Japan is significantly overestimated in the simulation driven by ERA-Interim. However, the track and accumulated rainfall after land falling is well represented by the model forced by JRA55 although slightly overestimated. The spatial distributions of the 24 hours accumulated rainfall after landfall of the typhoon Chanthu on 17th Aug 2016 is shown in Fig.3.

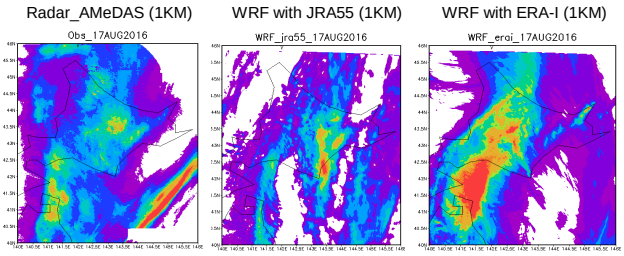

Fig 3: 24 hours accumulated rainfall on 17th Aug 2016 (the day after landfall of Typhoon Chanthu)

We also compared the rainfall amount at three AMeDAS observation stations near to landfall area. The results indicate that the model with JRA55 could better reproduce the rainfall amount (very close at the landfall area), while the model with ERA-Interim shows significant underestimation. This is shown in Fig.4.

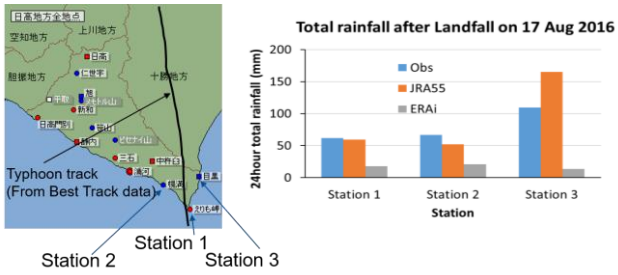

Fig 4: 24 hours accumulated rainfall on 17th Aug 2016 at three AMeDAS observation stations

Summary:

In this study, the track and intensity of the Typhoon Chanthu and the associated precipitation after landfall over Norther Japan are analyzed by using WRF model driven with two reanalysis dataset (ERA-Interim and JRA55). Results indicate that WRF with JRA55 performs better results compared to WRF with ERA-Interim. The track and intensity of the Typhoon Lionrock and the associated precipitation after landfall will also be investigated. We will also discuss more on this issue with Pseudo Global Experiments.

Acknowledgments:

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