

## Climate change impact on precipitations associated with Typhoons Nancy and Jebi over Western Japan

○Sridhara NAYAK , Tetsuya TAKEMI

### Introduction:

The Typhoons are one of the major life-threatening weather-related disasters that cause various socio-economic damages over landfall region (e.g., Takemi et al., 2016; Chen et al., 2018). Recent studies suggest that the typhoons in future climate may become more intense and carry heavy precipitations (e.g., Nayak and Takemi, 2019). In September of 1961 and 2018, two very strong Typhoons known as “Typhoon Nancy” and “Typhoon Jebi” respectively made landfall over Western Japan with strong winds and extensive precipitation amounts and caused significant damages over target regions. Interestingly, both typhoons made landfall around same region of Western Japan with a difference of 57 years. However, it is uncertain that whether the precipitation amounts associated with Typhoon Jebi is a future projection of that of with Typhoon Nancy under warmer environment? If so, then what will be the future projection of precipitation amounts linked to Typhoon Jebi? This study intends to explore this issue by examining the climate change impact on Typhoon Nancy and Typhoon Jebi by using Advanced Research dynamic solver of Weather Research and Forecasting (WRF) model.

### Experimental Design:

The WRF model is configured with 4 nested domains with 45km, 15km, 5km and 1km resolution. The initial and boundary conditions are forced from Japanese Reanalysis (JRA55). A total of 4 numerical simulations are conducted (two simulations for

present climate and two simulations for future climate). For future climate simulations, we used MRI-AGCM3.2 climate simulations and computed the warming increments by taking 25-year mean difference between the present-day simulation (1979-2003) and the future projection (2075-2099). The warming increments are added to present JRA55 fields before performing future climate simulations. This is hereafter referred as Pseudo Global Warming (PGW) experiments. We compared the results of typhoon track and intensities with the Regional Specialized Meteorological Center (RSMC) best track datasets.

### Preliminary Results:

Figure 1 shows the typhoon tracks as obtained from the model simulations and RSMC best track datasets. It indicates that Typhoon Nancy and Typhoon Jebi made landfall over same region (highlighted as red colored circle) and well reproduced by WRF model.

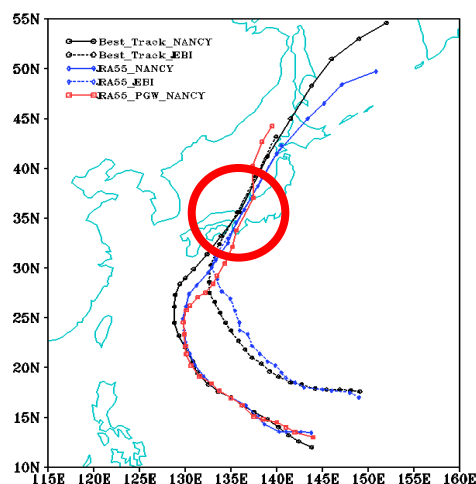


Fig 1: Typhoon track

We also find similar typhoon tracks in future climate (shown in red color lines). This implies that Typhoon Jebi is a possible projection of Typhoon Nancy although it was formed over different location.

Figure 2 shows the 24-hours accumulated precipitation induced by Typhoon Nancy in present climate simulation (left side of Fig. 2) and that of in future climate (middle of Fig. 2) and the precipitation amount induced by Typhoon Jebi in present climate (right side of Fig. 2). We find that Precipitation associated with the Typhoon Nancy under PGW is higher than the amount in Typhoon Jebi. However, the precipitation amount associated with Typhoon Jebi in present climate has an overall good agreement with that of with Typhoon Nancy in future climate, especially over landfall region (highlighted in red color circle).

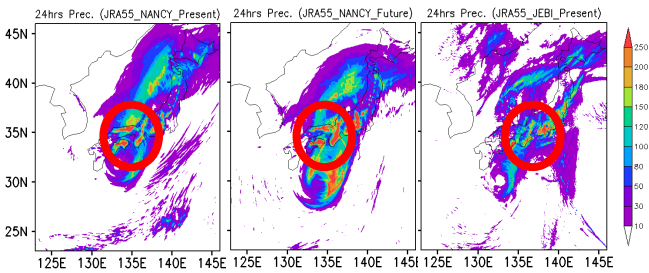


Fig 2: 24-hours accumulated rainfall

The higher amount of precipitation in the simulation with Typhoon Nancy may be associated with the dynamics. We analyzed vertical cross-section of vorticity (Fig. 3) and potential vorticity (Fig. 4) of both typhoons in two climate periods and found higher vorticity in the simulations with Typhoon Nancy in future climate, indicating highly unstable atmosphere compared to that of in the simulation with Typhoon Jebi in present climate.

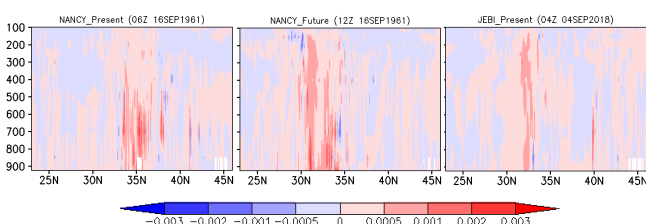


Fig 3: Vertical cross section of vorticity with lon=135

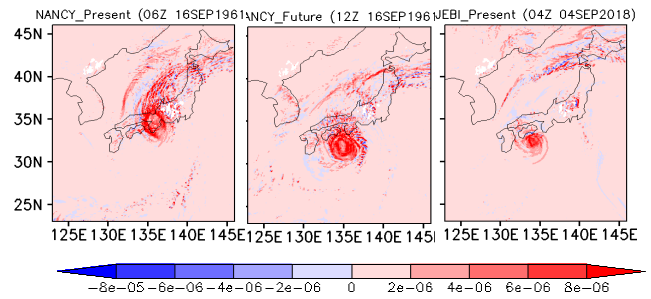


Fig 4: Potential vorticity with 850 hPa and 500 hPa

**Summary:**

In this study, the climate change impact of precipitation amounts associated with two typhoons (Typhoon Nancy and Typhoon Jebi) are analyzed over Western Japan. We find that Typhoon Nancy and Typhoon Jebi made landfall over same region and well reproduced by WRF model. The precipitation associated with the Typhoon Nancy under PGW is higher than the amount induced by Typhoon Jebi. This study is preliminary and we will discuss more on this issue with PGW experiments on Typhoon Jebi.

**Acknowledgments:**

This study is supported by the TOUGOU Program, funded by the Ministry of Education, Culture, Sports, Science, and Technology, Government of Japan.

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