Evaluation of the Genesis of Typhoon JANGMI for Modified Convection and Cloud Schemes in JMA-GSM: Comparison with T-PARC Special Observations

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1. INTRODUCTION

For numerical weather prediction models, accurate forecasting of typhoon genesis is a crucial function. However, verification of vertical profiles for simulated typhoons over ocean areas is usually problematic due to a lack of observational data.

In 2008, observation using supplemental dropsondes deployed by manned aircraft was conducted as part of T-PARC (THe Observing system Research and Predictability EXperiment (THORPEX) Pacific Asian Regional Campaign) over the western North Pacific Ocean to investigate TC genesis, structural change, targeted observation and extratropical transition. Based on the dropsonde and satellite data obtained, this study was performed to evaluate the forecast performances of the operational Global Spectral Model (GSM) with revised parameterization schemes for TC genesis over the tropical western North Pacific Ocean.

2. EXPERIMENTAL DESIGN

Two experiments (CNTL and TEST) were conducted to compare 36-hour forecast performance levels. The CNTL experiment was run using the operational GSM (TL959L60: 20-km horizontal resolution, 60 layers) in which a convection scheme (the prognostic Arakawa-Schubert scheme with a spectral cloud ensemble) and a large-scale cloud scheme (cloud fraction is diagnosed following an assumed probability density function (PDF)) were implemented. In the TEST experiment, the convection and cloud schemes were modified (see Komori and Yoshimoto 2012).

3. VERTICAL CROSS-SECTION EVALUATION

Figure 1 (a) shows the locations of the T-PARC special observations for Typhoon JANGMI (the 15th typhoon of 2008; T0815) overlaid onto MTSAT satellite images, and Fig. 1 (b) shows a satellite image of the area around JANGMI during the development stage. The vertical cross section of dropsonde observations along the black line in Fig. 1 (b) reveals high relative humidity (RH) at the center of JANGMI and strong wind peaks around it (Fig. 2 (a)).

Figures 2 (b) and (c) show the results of the CNTL and TEST experiments, respectively, corresponding to the observations shown in Fig. 2 (a). In the CNTL data, RH is lower around the center of JANGMI and above the 900-hPa level in contrast to the observation results, which suggests weak transport of water vapor from the convective boundary layers to the free atmosphere by moist convection. Conversely, the TEST data show that the higher RH seen at the TC center in the observation data is reproduced successfully. In the modified convection scheme introduced in TEST, the upward mass flux varies depending on RH, which may be a significant contributory factor to this improvement.

Concerning wind speed, TEST forecasted strong wind peaks around the center of JANGMI corresponding to large low-level vorticity causing organized precipitation, whereas CNTL did not forecast such peaks (not shown).

4. PRECIPITATION EVALUATION

Figure 3 shows the distributions of 24-hour cumulative precipitation for CNTL and TEST in comparison to Tropical Rainfall Measuring Mission (TRMM) satellite and Global Precipitation Climatology Project (GPCP) data. The other typhoon seen in the figure is HAGUPIT (T0814), which made landfall around the same time as JANGMI was generated.

For CNTL, spurious precipitation was caused by a large-scale cloud scheme (not shown) in addition to the weak convection and higher RH in the lower atmosphere. In the TEST experiment, distribution around JANGMI was reproduced better than in the CNTL experiment, and spurious precipitation in other areas was suppressed. The organized precipitation seen in TEST suggested large vorticity, which is consistent with the results for wind speed and RH shown in Fig. 2.

Regarding precipitation around Hagupit, little difference was seen between the results of CNTL and TEST, although both experiments simulated more precipitation than TRMM and GPCP data. Accordingly, further research should be performed with a separate focus over ocean and land areas.

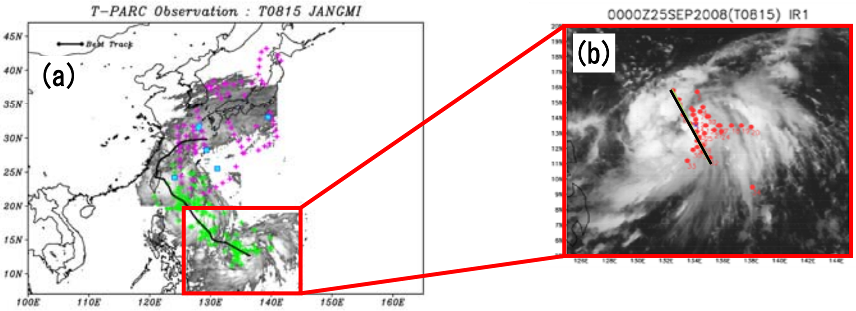

Figure 1. Locations of T-PARC special observations for Typhoon JANGMI (T0815) overlaid onto satellite images: (a) all dropsonde observations from manned aircraft (pink and green dots) and upper-air soundings (blue dots), and (b) dropsonde observations from manned aircraft (red points) around 00 UTC on 25 September, 2008. The black lines in (a) and (b) show the best track and the location of the vertical cross section shown in Fig. 2, respectively.

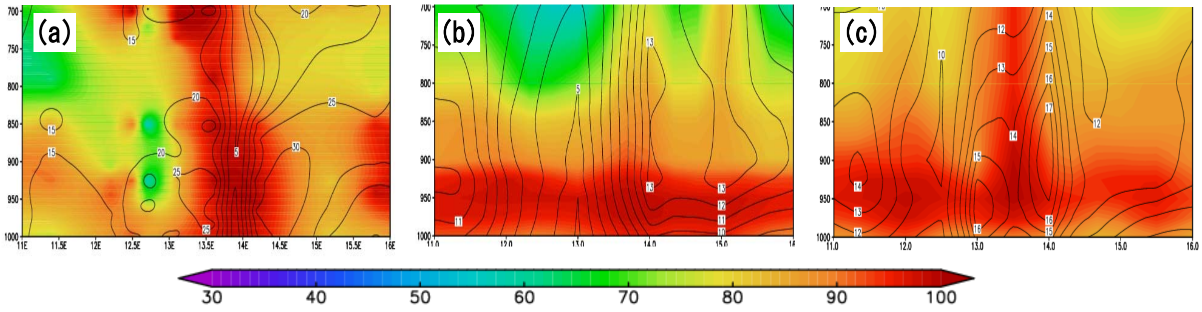

Figure 2. Vertical cross sections for relative humidity (shading) and wind speed (contours) around Typhoon JANGMI (T0815) estimated from (a) dropsonde observations, (b) CNTL and (c) TEST. (b) and (c) show 36-hour forecasts with an initial time of 12 UTC on 23 September, 2008.

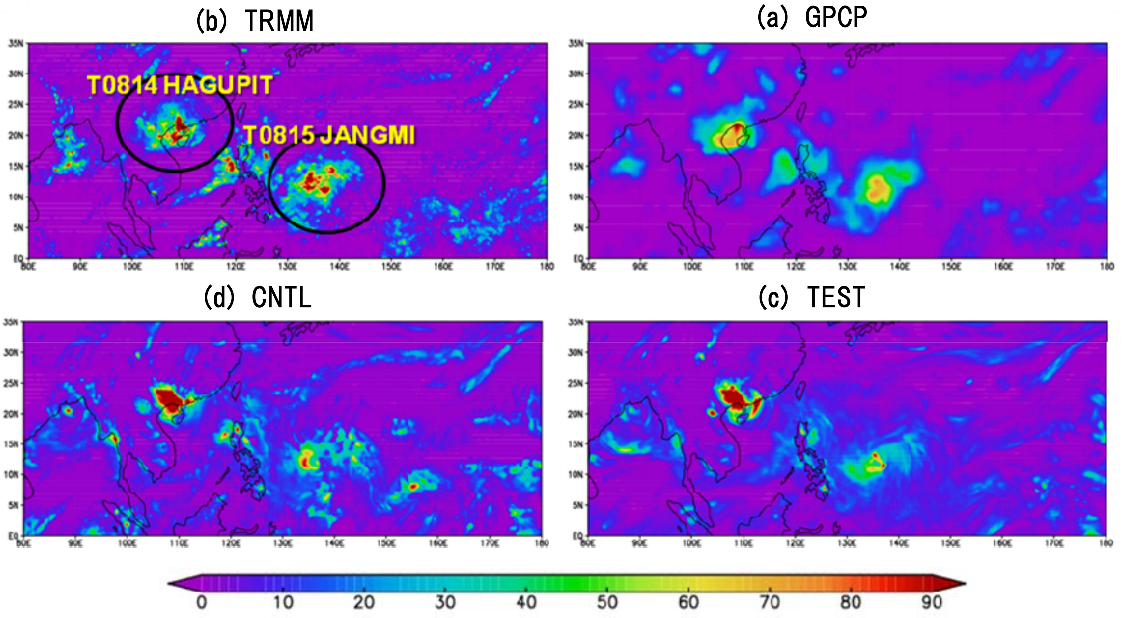

Figure 3. 24-hour accumulated precipitation [mm/day] during the landfall period of Typhoon HAGUPIT (T0814) and the genesis of Typhoon JANGMI (T0815) estimated from (a) TRMM satellite observations, (b) GPCP analysis, (c) CNTL and (d) TEST. (c) and (d) show 36-hour forecasts with an initial time of 12 UTC on 23 September, 2008.

REFERENCES

Komori, T. and K. Yoshimoto, 2012: Evaluation from a Perspective of Spin-down Problem: Moistening Effect of Convective Parameterization. *CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modeling*, **44**, in press.