Impacts of high-resolution Himawari-8 AMVs assimilation on TC forecast in HWRF

Masahiro Sawada[1], Ryo Oyama[2], Kazuki Shimoji[1], Zaizhong Ma[3,4], Avichal Mehra[4], Vijay Tallapraga[4]

1. Numerical Prediction Division, Japan Meteorological Agency, Japan

2. Meteorological Research Institute, Japan Meteorological Agency, Japan

3. I.M. Systems Group, Inc., USA

4. Environmental Modeling Center, National Center for Environmental Prediction, USA

Email: msawada@mri-jma.go.jp

1. Introduction

Accurately estimating the tropical cyclone (TC) intensity and structure is essential to improve TC forecasts and to diagnose numerical model characteristics. Several previous studies show the data assimilation (DA) of atmospheric motion vectors (AMVs) derived from consecutive satellite images benefits TC forecasts using HWRF (Velden et al. 2017, Zhang et al. 2018). Himawari-8 provides high spatiotemporal resolution AMVs and these have a potential to better capture the TC structure and initial conditions of the surrounding environment, leading to more skillful forecasts. Therefore, purposes of this study are to assess the capability of DA for the Western Pacific TCs, to investigate what impacts of assimilating the high resolution Himawari-8 AMVs have on the TC forecasts, and to understand how the impacts arise.

2. Model description and experimental design

NCEP Operational hurricane model, Hurricane Weather Research and Forecasting Model (HWRF), is used in this study. The configuration of the model is the same as the 2017 operational version, except for the ocean model. Initial condition for outermost domain comes from global forecast system (GFS) analysis with vortex initialization. Forecast length for each experiments is 126 hours. The total number of cycles is 26. Target case is typhoon Meranti (2016), which experienced extreme rapid intensification (RI). Its maximum intensification rate reached 70 kt / day.

Control experiment and four sensitivity experiments are conducted. CTL is control experiment which does not use DA for initialization. Two ensemble-variational hybrid DA configurations, based on the Grid-point Statistical Interpolation (GSI), are used for the sensitivity experiments. One is using background error covariance generated from global ensemble forecast system (GEFS), gDA experiment. The other is

generated from HWRF ensembles, hDA experiment. The assimilated observation data are the same as those in the GFS analysis. Two additional sensitivity experiments (gDA-AMV and hDA-AMV experiments) with high-resolution Himawari-8 AMVs (H8AMV) are conducted. In the gDA-AMV and hDA-AMV experiments, H8AMV are added to the gDA and hDA experiment, respectively.

3. Results

A track verification shows hDA-AMV experiment provided the best track forecast for longer forecast lead time (Fig. 1a). Track error was smaller in the hDA-AMV than that in the gDA-AMV experiments. It implies that the assimilation of high-resolution Himawari-8 AMVs (H8AMV) with the covariance generated from HWRF ensembles can benefit the track forecast skill. On the other hand, track error was larger in the gDA than in the CTL experiment for almost all forecast lead time, indicating DA in high resolution grid space cannot improve track forecast in this case and in this configuration at least. A intensity verification shows gDA and gDA-AMV had larger intensity errors than that CTL, gDA, and gDA-AMV for shorter-range lead time. The assimilation with the covariance generated from GEFS could not improve the intensity forecast, even if H8AMV was assimilated. The intensity forecast biases in the all experiments were negative partly because the extreme RI could not captured (not shown). We will discuss what processes account for these impacts in the presentation.

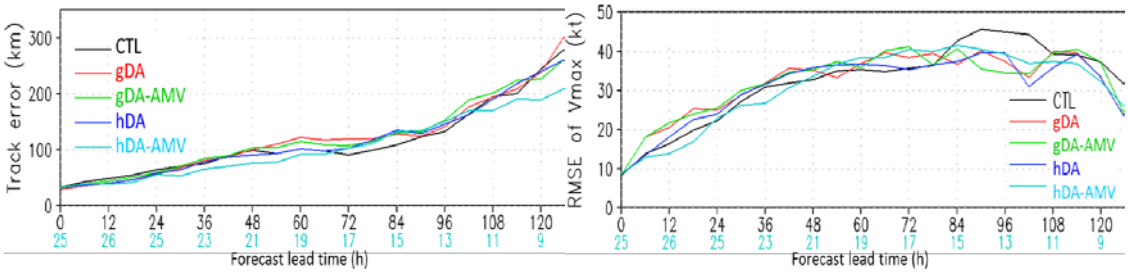

Fig. 1 (a) Statistics of (a) track error, and (b) RMSE of maximum wind speed with reference to the best-track data of JTWC. Figures at bottom show number of sample.

References:

Velden, C., W. E. Lewis, W. Bresky, D. Stettner, J. Daniels, and S. Wanzong, 2017: Assimilation of High-Resolution Satellite-Derived Atmospheric Motion Vectors: Impact on HWRF Forecasts of Tropical Cyclone Track and Intensity. Mon. Wea. Rev., 145, 1107–1125.

Zhang, S., Z. Pu, and C. Velden, 2018: Impact of Enhanced Atmospheric Motion Vectors on HWRF Hurricane Analyses and Forecasts with Different Data Assimilation Configurations. Mon. Wea. Rev., 146, 1549–1569.