Operational Use of GOES-16 Atmospheric Motion Vector (AMV) and ScatSat-1/OSCAT Data in JMA's Global NWP System

NONAKA Kenichi[1] and KOYAMATSU Shin[2]
[1]Numerical Prediction Development Center, Japan Meteorological Agency
[2]Meteorological Satellite Center, Japan Meteorological Agency
E-mail: k-nonaka@met.kishou.go.jp

1. Introduction

Atmospheric Motion Vectors (AMVs) are derived by tracking clouds and water vapor patterns from sequential satellite images, and provide information on tropospheric wind. Scatterometer wind data, such as Advanced SCATterometer (ASCAT) wind data, provide ocean surface wind vectors retrieved from microwave backscatter irradiating toward the sea surface. AMVs and scatterometer wind data are especially important for ocean areas, where in-situ observations are sparse, and are used for data assimilation in operational NWP system worldwide.

GOES-16 AMV and ScatSat-1/OSCAT data were adopted in data assimilation for JMA's global NWP system (GSM) at 00 UTC on 29 July 2020. This report outlines the results of verification experiments using these data in the GSM.

2. GOES-16 AMV

The new-generation GOES-16 geostationary meteorological satellite launched in November 2016 operates in the GOES-East role at 75.2°W, covering the area from the eastern Pacific to the western Atlantic. The satellite is equipped with the Advanced Baseline Imager (ABI) featuring upgraded observation functionality over the previous satellite GOES-13 imager, especially in terms of scanning frequency, spatial resolution and multispectral bands. GOES-16 AMVs are improved, with upgraded imagery and a new derivation algorithm developed for cutting-edge satellites (Daniels et al. 2019).

3. OSCAT Wind

ScatSat-1 equipped with OSCAT was launched in September 2016 and began providing OSCAT wind data in September 2017. Metop series ASCAT wind data are already utilized in the GSM. OSCAT involves the use of a different microwave frequency and scanning technique from ASCAT, and can scan wide regions but is more affected by raindrop attenuation. Based on research using OSCAT wind data and first-guess statistics, ASCAT preprocessing is applied to data usage in assimilation.

4. Assimilation Experiments

Observing-system experiments assimilating both GOES-16 AMV and OSCAT wind data in the GSM were performed to verify effects on analysis and forecast fields. The experiments were performed in an environment equivalent to the operational JMA system in December 2019, and were validated over periods of several months in summer (10 Jun. – 11 Oct. 2019) and winter (10 Nov. 2019 – 11 Mar. 2020). The control experiments (CNTL) had the same configuration as the operational set-up, and the test experiments (TEST) were performed using GOES-16 AMV and OSCAT wind data. Figure 1 shows AMV coverage and the scatterometer wind data utilized in the global analysis for 00 UTC on January 1, 2020. In the figures below, magenta and deep green indicate the GOES-16 AMV and OSCAT wind data used in the analysis, respectively.

5. Verification Results

Figure 2 shows normalized changes in standard deviation against the first guess in the rawinsonde u/v-component wind data applied in the summer and winter experiments. The first-guess wind field for the troposphere changes neutrally or improves slightly to match the rawinsonde observation. Figure 3 is as per Figure 2, but for microwave sounding observation. Here too, the first-guess field is modified to be more consistent with observation from the humidity sounding channels, which are sensitive to upper air (MHS Ch. 3 and ATMS Ch. 21/22), and temperature sounding channels sensitive to lower air (AMSU-A Ch. 5 and ATMS Ch. 6). The results suggest that the upper-troposphere circulation field and lower-air convergence/divergence positions in the first guess are improved by assimilation of GOES-16 AMV and OSCAT wind data.

Figure 4 shows verification of effects on tropical cyclone track prediction in summer 2019 for the Atlantic and eastern Pacific regions using best-track data provided by NOAA (B-decks) for reference. The predicted position errors are seen to be reduced within approximately 72 forecast hours based on GOES-16 AMV and OSCAT wind data assimilation.

6. Summary

The research reported here verified that analysis field consistency with microwave sounders is improved and the accuracy of tracking prediction for tropical cyclones is slightly modified by the use of GOES-16 AMV and OSCAT wind data in the global NWP system. Both data have been used operationally in GSM data assimilation since 00 UTC on 29 July 2020. OSCAT wind data are also being considered for use in JMA's meso and local scale NWP systems.

References

Daniels, J., et al., (2019). GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Derived Motion Winds, Version 3.1.

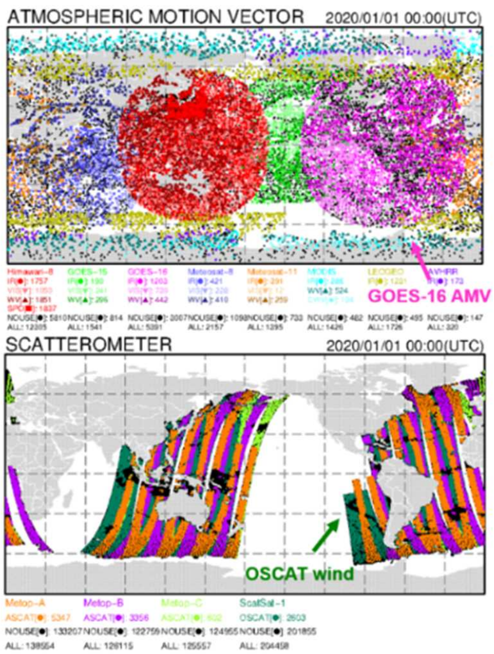

Figure 1. Data coverages of AMV (top) and scatterometer wind data (bottom) used in global analysis at 00 UTC on January 1, 2020. GOES-16 AMVs and OSCAT wind data are plotted in magenta and deep green, respectively.

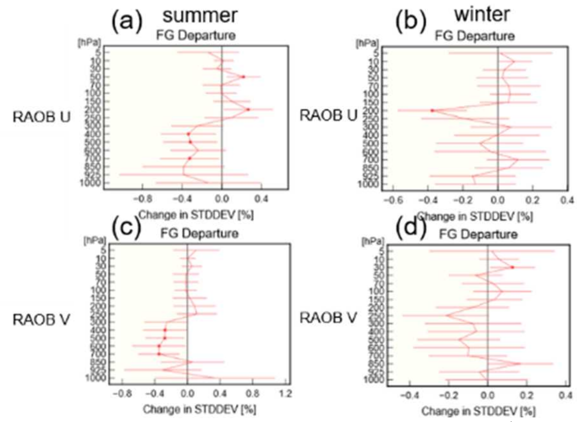

Figure 2. Normalized changes in standard deviation (STDDEV [%]) for first-guess departures in u/v components of rawinsonde (RAOB U/V). a, c and b, d are validated for summer (10 Jun. – 11 Oct. 2019) and winter (10 Nov. 2019 – 11 Mar. 2020), respectively. Error bars represent a 95% confidence interval, and dots represent statistical significance.

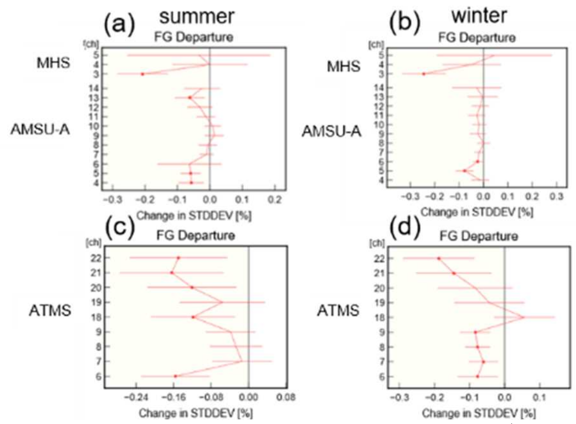

Figure 3. Normalized changes in standard deviation (STDDEV [%]) for first-guess departures in microwave sounding data for individual channels [ch]. a, c and b, d are validated for summer (10 Jun. – 11 Oct. 2019) and winter (10 Nov. 2019 – 11 Mar. 2020), respectively. Error bars represent a 95% confidence interval, and dots represent statistical significance.

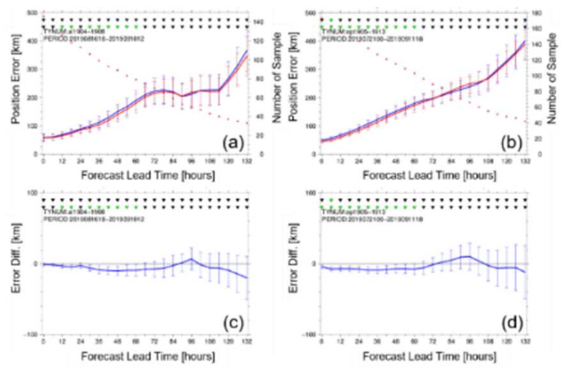

Figure 4. Average track forecast error of tropical cyclones in summer 2019 for (a) the Atlantic and (b) the eastern Pacific. Red and blue lines indicate positional errors in TEST and CNTL, respectively, and red dots indicate the number of samples. The bottom figures show position error differences between TEST and CNTL (TEST-CNTL) for (c) the Atlantic and (d) the eastern Pacific. Error bars represent a 95% confidence interval, and triangles at the top indicate statistical significance (green: significant; black: not significant).