Operational Use of NOAA-20 ATMS and CrIS Radiance Data in JMA's Global NWP System

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1. Introduction

The Japan Meteorological Agency (JMA) has assimilated radiance data from the Advanced Technology Microwave Sounder (ATMS) and the Cross-track Infrared Sounder (CrIS) onboard the Suomi National Polar-orbiting Partnership (Suomi-NPP) since 29 March 2017 in its global Numerical Weather Prediction (NWP) system. In addition to Suomi-NPP data, JMA also began to assimilate data from the same instruments onboard the NOAA-20 successor satellite on 5 March 2019 into the global NWP system. This report outlines the impacts of the added data on the system.

2. Methodology

The ATMS instrument is a microwave sounder with 22 channels, including temperature and humidity sounding channels. Quality control (QC) and error handling for the assimilation of NOAA-20/ATMS radiance data, such as channel selection, thinning distance, observation errors, rain/cloud detection and bias correction (static scan bias correction and variational bias correction) follow those implemented for Suomi-NPP/ATMS data assimilation (Hirahara et al. 2017). Currently, tropospheric temperature-sounding channels (6 – 9) and humidity-sounding channels (18 – 22) are assimilated.

The CrIS instrument is a hyperspectral infrared sounder with a total of 2,211 channels in full spectral resolution (FSR) mode. QC and error handling for the assimilation of NOAA-20/CrIS radiance data also follow those for Suomi-NPP/CrIS (Kamekawa and Kazumori 2017). Currently, 27 channels for temperature-sounding are assimilated. The channels are selected from the CO_2 absorption band in the long-wave IR band (LWIR) included in the disseminated 431 channel dataset.

3. Impacts on the global NWP system

Observing system experiments covering periods in each of boreal summer 2018 and winter 2019 were performed to evaluate the impacts of NOAA-20 instruments on the NWP system. The standard deviations of the first-guess departure (i.e., the difference between observed and calculated brightness temperature), which are used as an indicator of data quality, were similar to or smaller than those of Suomi-NPP. Against baseline experiments in which the focusing radiance data of both satellites were not assimilated, the impacts of Suomi-NPP and NOAA-20 on first-guess and forecast-field data were similar.

A TEST assimilation experiment with the addition of NOAA-20/ATMS and CrIS data was performed. Experiments for individual instruments were also performed to determine their specific contributions. Figure 1 shows changes in the standard deviation of the first-guess departure of the AMSU-A and MHS microwave sounders normalized to those of the CNTL experiment (without NOAA-20). The lines show the results of assimilating NOAA-20 ATMS (red), CrIS (green) and both instruments (blue). The improvements observed with the temperature sounding channels (AMSU-A/ch4-8) and humidity sounding channels (MHS) are mainly attributable to the assimilation of ATMS data, and those observed with the stratospheric temperature sounding channels (AMSU-A/ch9-14) are attributable to the assimilation

of CrIS data.

Figure 2 shows the zonal mean of the improvement rate of geopotential height forecast data resulting from the assimilation of NOAA-20/ATMS and CrIS data in the TEST experiment relative to the CNTL experiment. Improvements in geopotential height forecast data, especially for the mid-latitudes, were observed in the TEST experiment in the boreal summer experiment, and were also seen in the boreal winter experiment (not shown).

4. Summary

JMA began to assimilate data from the ATMS and CrIS onboard NOAA-20 into its global NWP system in addition to those of Suomi-NPP on 5 March 2019. NOAA-20 data quality is similar to or better than that of Suomi-NPP, and the additional use of NOAA-20 data improved the first-guess and forecast fields.

References

Hirahara, Y., T. Egawa and M. Kazumori, 2017: Operational use of Suomi NPP ATMS radiance data in JMA's global NWP system. CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling, Rep., 47, 1 – 13.

Kamekawa, N. and M. Kazumori, 2017: Assimilation of Suomi NPP/CrIS radiance data into JMA's global NWP system. CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling, Rep., 47, 1 – 17.

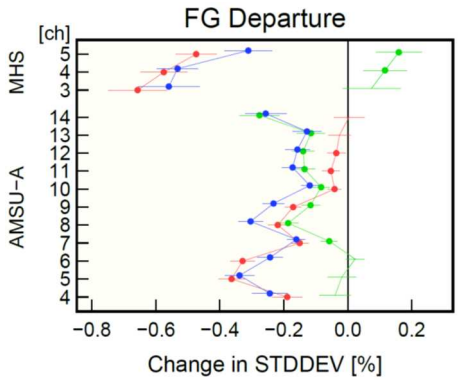

Figure 1. Normalized changes in the standard deviation (STDDEV) of the first-guess departure of microwave sounders AMSU-A and MHS resulting from assimilation of NOAA-20 ATMS (red), CrIS (green) and both (blue). Negative values indicate improvement, error bars represent a 95% confidence interval, and dots represent statistically significant changes. The validation period is from 1st August to 31st October 2018 (92 days).

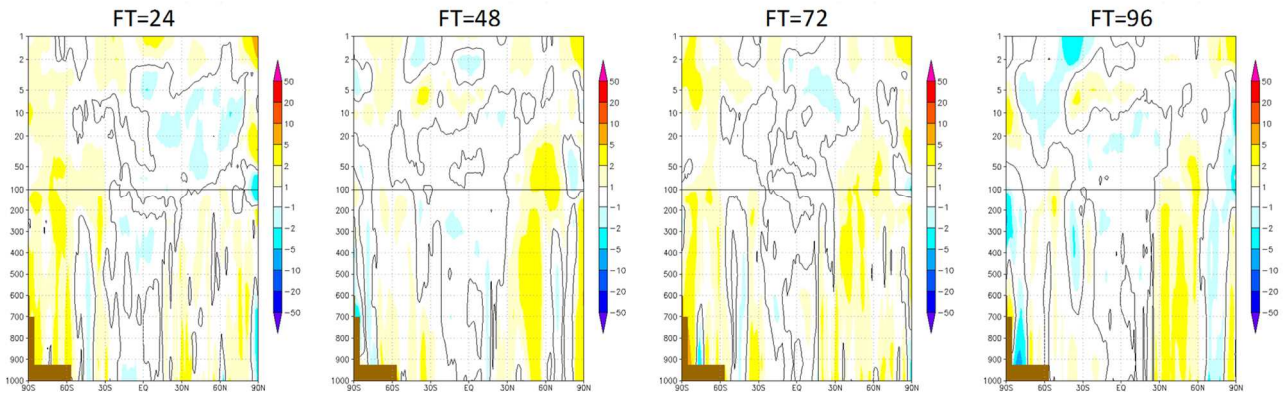

Figure 2. Zonal mean of the relative improvement rate [%] in the TEST experiment (with NOAA-20/ATMS and CrIS) relative to the CNTL experiment (without NOAA-20/ATMS and CrIS) in RMS error against own analysis of each experiment for geopotential height forecast. Warm colors indicate forecast error reduction. The validation period is from 1st August to 31st October 2018 (92 days).