Assimilation of Suomi NPP/CrIS radiance data into JMA's global NWP system

Norio Kamekawa, Masahiro Kazumori
Numerical Prediction Division, Forecast Department, Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku, Tokyo, 100-8122, Japan
E-mail: orion-kamekawa@met.kishou.go.jp, kazumori@met.kishou.go.jp

1. Introduction

Hyper Spectral Infrared Sounder (HSS) radiance data from the Cross-track Infrared Sounder (CrIS) on the Suomi National Polar-orbiting Partnership (NPP) spacecraft have been operationally assimilated into the global Numerical Weather Prediction (NWP) system run by the Japan Meteorological Agency (JMA) since March 2017. This report briefly describes related data quality control and the impacts of assimilation.

2. Quality control

The CrIS instrument is a Fourier transform spectrometer with a total of 1,305 infrared sounding channels covering three bands (i.e., the long-wave (655 – 1,095 cm^{-1}), mid-wave (1,210 – 1,750 cm^{-1}) and short-wave (2,155 –2,550 cm^{-1}) spectral ranges). JMA obtains the CrIS 399-channel data set from NESDIS (the National Environmental Satellite, Data, and Information Service). 27 long-wave temperature sounding channels were selected for use in assimilation. As Aqua/AIRS and Suomi NPP/CrIS are in the same 13:30 afternoon satellite orbit, data thinning is necessary for the overlap region to reduce overfitting in analysis. Normally, higher priority in data thinning is assigned to CrIS due to its wider swath coverage (CrIS: 2,230 km; AIRS: 1,650 km). Priority in such thinning depends on available channel numbers (i.e., clear-sky conditions) and the distance between the observation and the center of the thinning grid box. CrIS data for particular FOV (field of view) numbers (1, 3, 5, 7 and 9) are rejected for assimilation due to their anomalous biases. The method of cloud top estimation and cloud screening proposed by Eyre and Menzel (1989), which is already implemented in the operational system for AIRS and IASI data processing, is applied to CrIS data.

3. Assimilation experiments

Observing system experiments covering periods of a month in each of boreal summer 2015 and winter 2015 – 2016 were performed to evaluate the impacts of CrIS data assimilation into the global NWP system. The control experiment (CNTL) had the same configuration as the operational system. In the test experiment (TEST), CrIS data were added on top of the operational observation dataset.

As shown in Figure 1, changes in the normalized standard deviation of the first-guess departure (FG) in the Southern Hemisphere indicate improvement of temperature fields in the stratosphere and the upper troposphere for the combined experiment period of summer and winter. Figure 2 shows improvement of geopotential height forecasts for the stratosphere and the upper troposphere, especially in summer over the Southern Hemisphere.

4. Summary

Results from assimilation experiments conducted to evaluate CrIS radiance data assimilation into JMA's global system showed that the addition of CrIS long-wave temperature sounding channels produced clear improvement of temperature analysis for the upper troposphere and stratosphere. Significant improvement of geopotential height forecasting for the Southern Hemisphere was also confirmed. Based on these findings, CrIS radiance data have been assimilated into JMA's global NWP system since 29 March 2017.

References

Eyre, J. R. and W. P. Menzel, 1989: Retrieval of Cloud Parameters from Satellite Sounder Data: A Simulation Study. J. Appl. Meteor. Climat., 267 – 275.

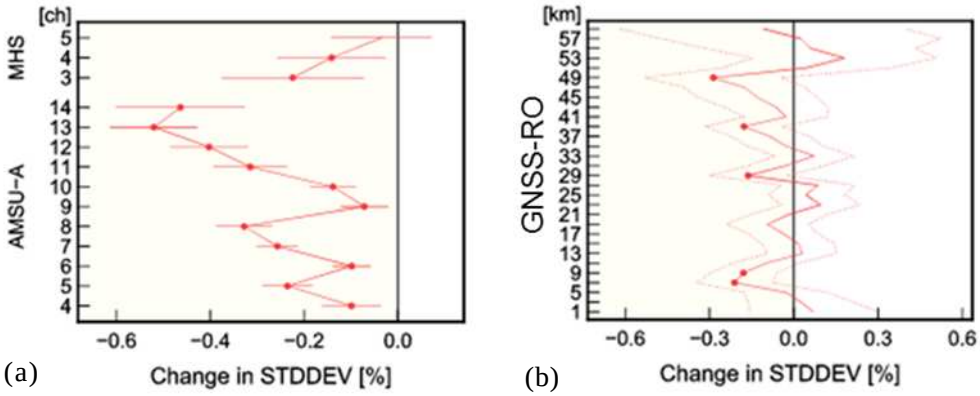

Figure 1. Normalized changes in the standard deviation of FG departures for (a) AMSU-A and MHS and (b) GNSS-RO bending angle for the combined experiment period of summer and winter. Negative values represent improvement. The horizontal axis indicates differences in normalized standard deviation. Error bars represent a 95% confidence interval, and red dots represent statistically significant changes.

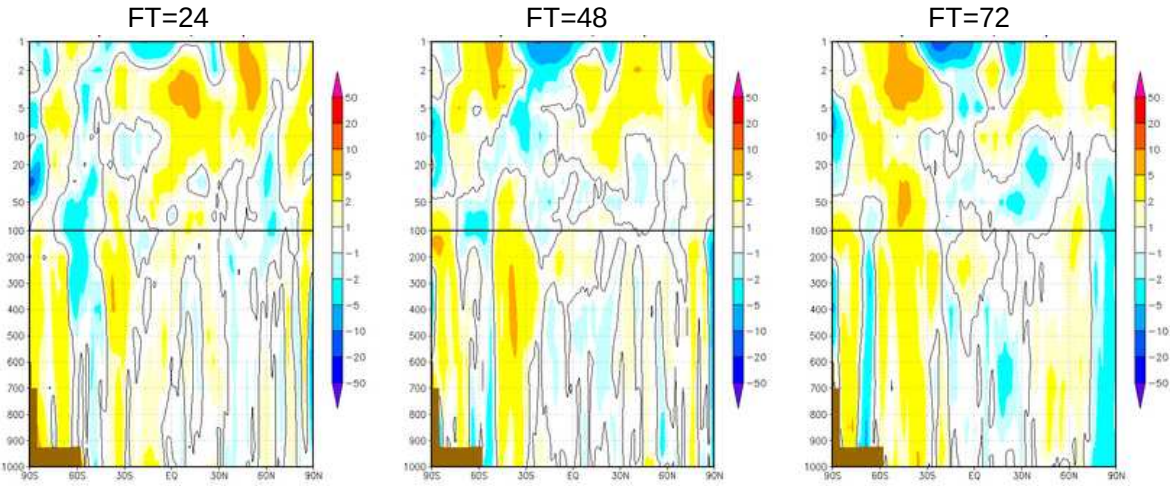

Figure 2. Improvement ratio ((CNTL – TEST) / CNTL) for zonal mean of differences in RMS error for geopotential height forecasting in August 2015. Positive values indicate forecast error reductions. Verification is against the experiment's own analysis.