Operational use of surface-sensitive clear-sky radiance data in JMA's mesoscale NWP system

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1. Introduction

The Japan Meteorological Agency (JMA) began to use Himawari-8 surface-sensitive band 9 and 10 (6.9 and 7.3 μm) clear-sky radiance (CSR) data in its mesoscale NWP system on March 26 2019 in addition to band 8 (6.2 μm) CSR data (Kazumori 2018). Experiments indicated that this assimilation with a new radiative transfer (RT) calculation method for JMA's global NWP system also had positive impacts on water vapor (WV) field first-guess (FG) and precipitation forecasting scores in the mesoscale NWP system. The results are reported here.

2. Methodology

The new RT calculation method is the same as that of the global NWP system (Okabe 2019). The land surface emissivity atlas of Wisconsin University (Borbas and Ruston 2010) and retrieved land surface temperatures from window channel (10.8 μm; band 13) CSR observation data are used in the calculation.

3. Assimilation experiment

The control experiment performed (referred to here as CNTL) had the same configuration as the operational JMA mesoscale NWP system as of October 2018. The test experiment (TEST) was as per CNTL, but surface-sensitive CSRs from Himawari-8 (band 9 and 10) were additionally assimilated. The experiment periods were from June 22 to July 31 2017 (referred to as summer) and from December 6 2017 to January 15 2018 (referred to as winter).

4. Impacts on the NWP system

Figure 1 shows normalized changes in the standard deviation (STD) of the FG departure for microwave humidity sounder (MHS) and microwave imager data, which contain information on WV in the troposphere. The decreases indicate the improvement of fittings between FG and other observations. Figures 2 (a) and (b) show the data counts of Himawari-8 band 9 CSR used in the TEST experiment. Figures 2 (c) and (d) show differences in the FG departure STD for MHS between TEST and CNTL. The decreases observed (plotted in blue) were seen in particular over areas where counts of newly assimilated data were relatively large (as indicated by red circles). These results imply that assimilation of surface-sensitive CSRs contributes to reducing WV field errors in mesoscale model (MSM) FG data.

Figure 3 shows threat scores and bias scores for three-hour cumulative precipitation forecasts. Reductions of precipitation forecasting underestimation in the summer experiment and overestimation in the winter experiment are observed, and slight improvements are seen in threat scores.

5. Summary

JMA began to assimilate surface-sensitive CSRs from Himawari-8 (bands 9 and 10) in the mesoscale NWP system on March 26 2019, and the new RT calculation method used in JMA's global NWP system was applied. Positive impacts from these CSRs on WV field accuracy of the first guess in the MSM were shown in an assimilation experiment, which also revealed improved precipitation forecasting scores.

References

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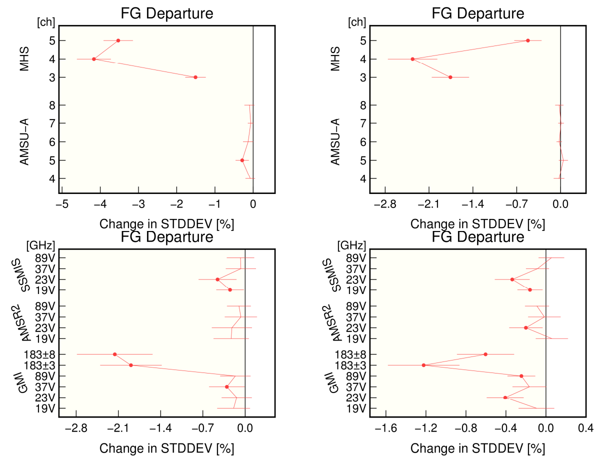

Figure 1. Normalized changes in the standard deviation (STDDEV) of first-guess departures for microwave sounding data for each channel number [ch] (top) and microwave imager data for each channel's frequency [GHz] (bottom). "V" means the polarization as vertical. The validation periods are from June 27 to July 31 2017 (right) and from December 11 2017 to January 15 2018 (left).

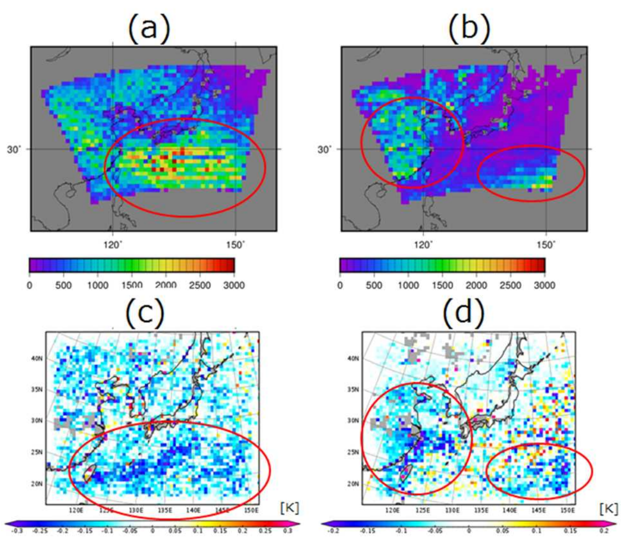

Figure 2. Counts of Himawari-8 band 9 CSR data used in the TEST experiment of the summer period (a) and the winter period (b), and normalized changes in the standard deviation of first-guess departures for MHS (channel 4) between the TEST and CNTL experiments for the summer period (c) and the winter period (d)

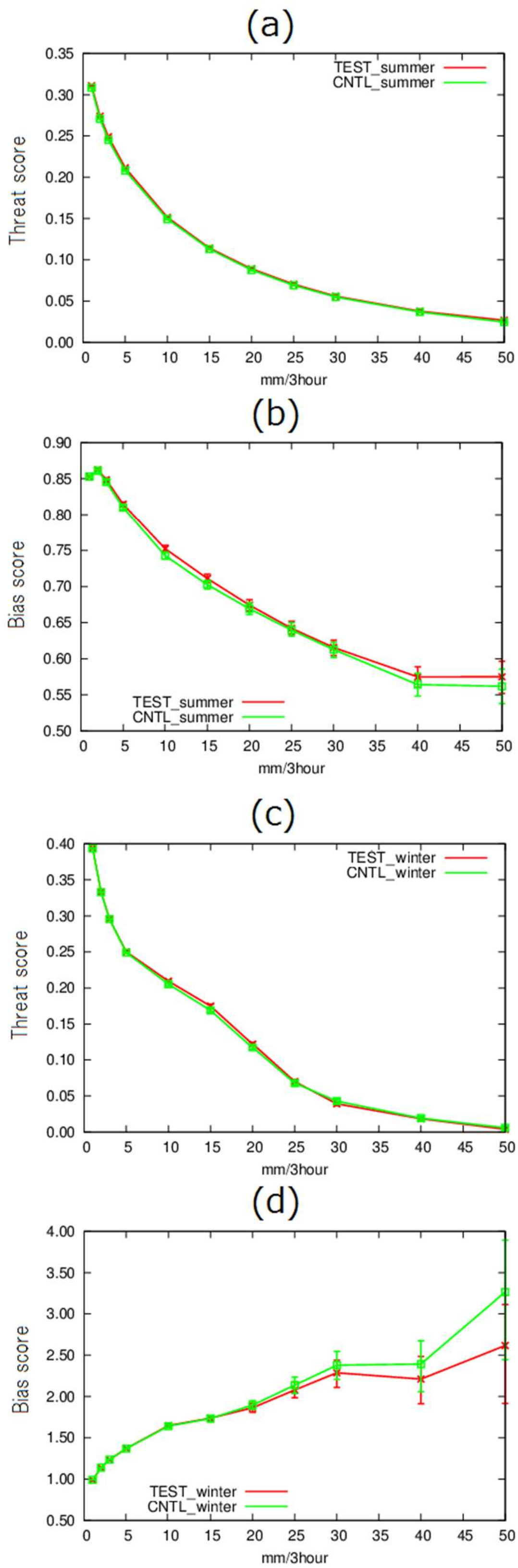

Figure 3. Threat scores (a), (c) and bias scores (b), (d) for three-hour cumulative precipitation forecasts against Radar/Raingauge-Analyzed Precipitation data during the summer experiment period (a), (b) and the winter experiment period (c), (d). Green lines are for CNTL and red lines are for TEST. Error bars represent 95% confidence intervals.