

Assimilation Experiments on Pre-processed DMSP-F16 SSMIS Radiance Data in the JMA Global 4D-Var Data Assimilation System

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The Special Sensor Microwave Imager Sounder (SSMIS) on board the Defense Meteorological Satellite Program (DMSP) F-16 spacecraft observes radiance from the atmosphere and the surface of the earth. The SSMIS instrument is the successor to the DMSP/Special Sensor Microwave Imager (SSM/I) series, and is scheduled to be on board from DMSP F-17 to F-20 in the transition period from the Polar Operational Environmental Satellite (POES) to the National Polar-orbiting Operational Environmental Satellite System (NPOESS). In addition to SSM/I surface-sensitive channels ranging from 19 to 37 GHz, SSMIS has atmospheric temperature sounding channels in the 50 – 60 GHz range. Atmospheric temperature information from SSMIS is expected to be useful in Numerical Weather Prediction (NWP) in the same way as AMSU-A sounding channels.

However, calibration and validation of DMSP-F16/SSMIS revealed sensor problems with SSMIS measurements after launch [1]. The main reasons for this were reflector emission/scattering and solar contamination in the warm calibration target. These issues caused systematic bias and noise at the temperature sounding channels and made it difficult for the data to be used in NWP. To address these problems, the UK Met Office developed a pre-process for the SSMIS radiance data [2], and has been distributing the pre-processed results to the NWP community since July 2006. JMA has been receiving this data since May 2007.

The quality of the pre-processed SSMIS data was examined, and assimilation experiments to investigate their impact on analysis and forecast were performed in the JMA system. Figure 1 shows an example distribution of pre-processed SSMIS temperature sounding data in a six-hour global assimilation time window. A total of 4,000 to 5,000 points data are available in 160-km grid box data thinning. After the removal of cloud-contaminated data, O-B (Observed brightness temperature minus calculated brightness temperature from the background) statistics showed that the qualities of the pre-processed SSMIS temperature sounding channels were comparable with those of Metop AMSU-A (Figure 2) and were acceptable for the data assimilation. Low-resolution (TL319L60) assimilation experiments demonstrated significant improvement of forecast accuracy in terms of anomaly correlation at 500 hPa geopotential height in the Southern Hemisphere when the data were added to the full operational observation data set in the JMA global data assimilation system (Figure 3). Based on these results, high-resolution (TL959L60) assimilation experiments are planned toward the use of the data in JMA's operational system.

References

[1] D. B. Kunkel, G. A. Poe, D. J. Boucher, S. D. Swadley, Y. Hong, J. E. Wessel, and E. Uliana, "Design and evaluation of the first Special Sensor Microwave Imager/Sounder," *IEEE Trans. Geosci. Remote Sens.*, vol. 46, no. 4, pp. 863 – 883, Apr. 2008.

[2] W. Bell, S. J. English, B. Candy, N. Atkinson, F. Hilton, N. Baker, S. D. Swadley, W. F. Campbell, N. Bormann, G. Kelly, and M. Kazumori, "The assimilation of SSMIS radiances in numerical weather prediction models," *IEEE Trans. Geosci. Remote Sens.*, vol. 46, no. 4, pp. 884 – 900, Apr. 2008.

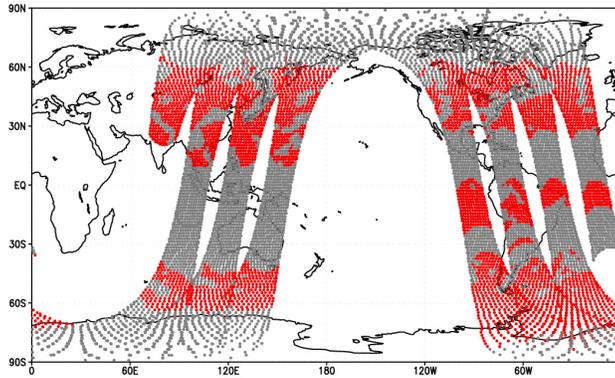


Figure 1. An example of available data distribution of SSMIS temperature sounding channels after pre-processing by the UK Met Office in a six-hour assimilation time window. The red points indicate locations where data are available.

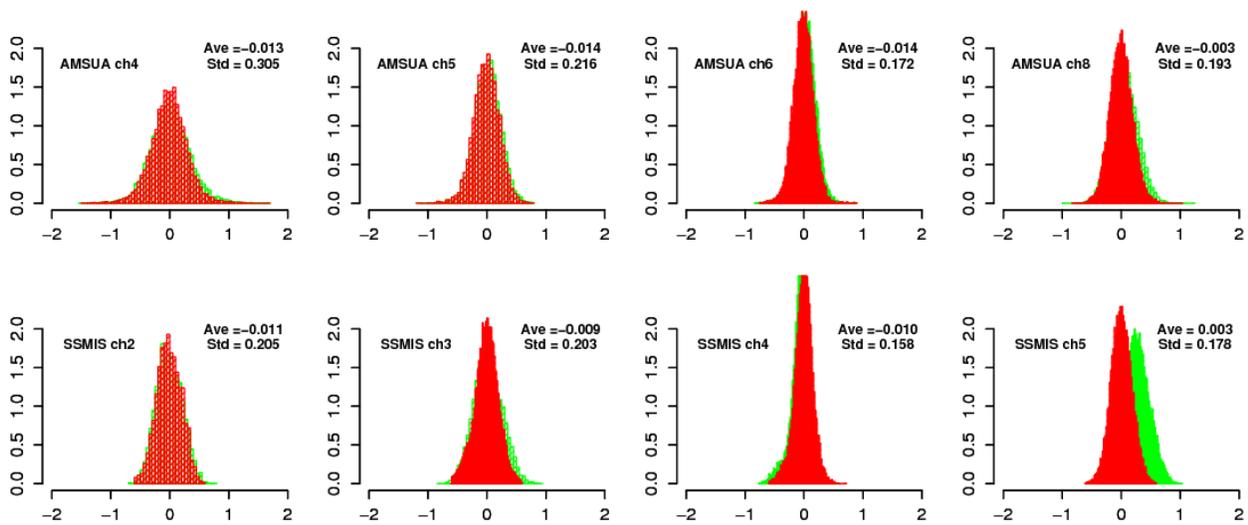


Figure 2. O-B statistics for Metop AMSU-A (ch. 4, 5, 6, 8) and SSMIS (ch. 2, 3, 4, 5). The red histograms are for after air-mass bias correction, and the light green ones are for before the bias correction.

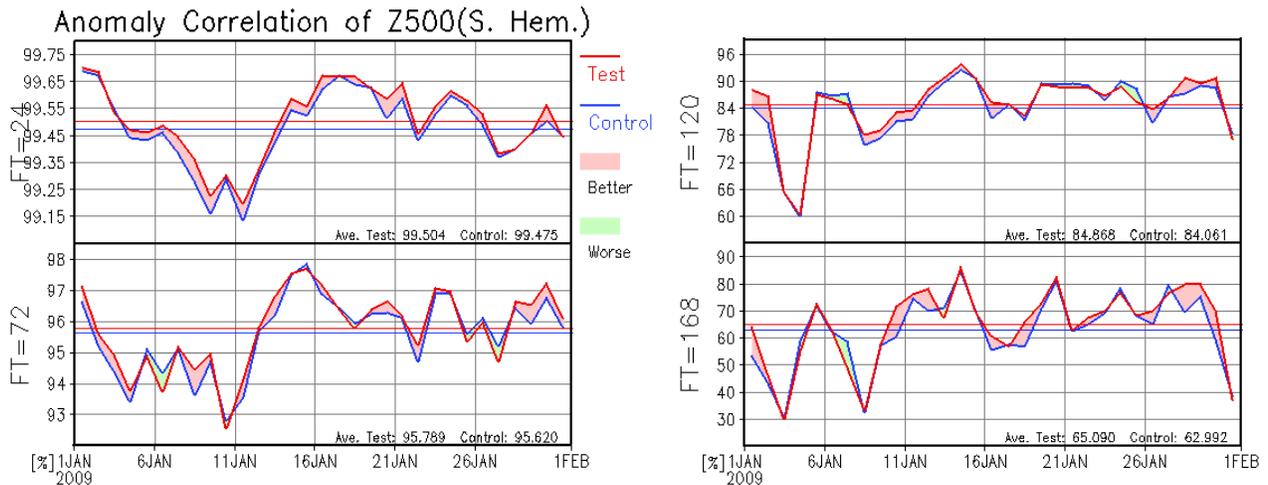


Figure 3 Time sequences of anomaly correlation at 500 hPa geopotential height in the Southern Hemisphere (FT=24, 72, 120, 168). The red lines are for the test run (with SSMIS), and the blue ones are for the control run (without SSMIS). Pink shading indicates improvement, and light green shading indicates degradation of forecast accuracy.