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Evaluation of SSMIS Radiances for Assimilation in ACCESS NWP System

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Abstract

The Australian Bureau of Meteorology is pursuing its efforts to enhance microwave radiance data usage in its operational numerical weather prediction (NWP) system, the Australian Community Climate and Earth System Simulator (ACCESS). Microwave assimilation can be crucial in improving the initial model states over cloudy regions, where forecast skill strongly depends on the initial conditions. This study represents the first step toward assimilating direct clear radiances from Special Sensor Microwave Imager/Sounder (SSMI/S) on-board Defence Meteorological Satellite Program (DMSP) – F16 to F18 in the Bureau of Meteorology's operational global ACCESS NWP suite. ACCESS uses the 4DVAR method for assimilation. This initial assessment is based on an evaluation of SSMIS data from DMSP-F16 for a period covering from September 2012 to January 2013. SSMIS data quality was assessed by examining observation minus background brightness temperature differences (innovations), and comparing them to those for Advanced Microwave Sounding Unit (AMSU) and Microwave Humidity Sounder (MHS). The uncorrected innovations for SSMIS have similar statistical characteristics (mean and standard deviation) as AMSU / MHS. When added to the current operational global full observing system, SSMIS has a slightly positive impact on analysis and short range forecast.

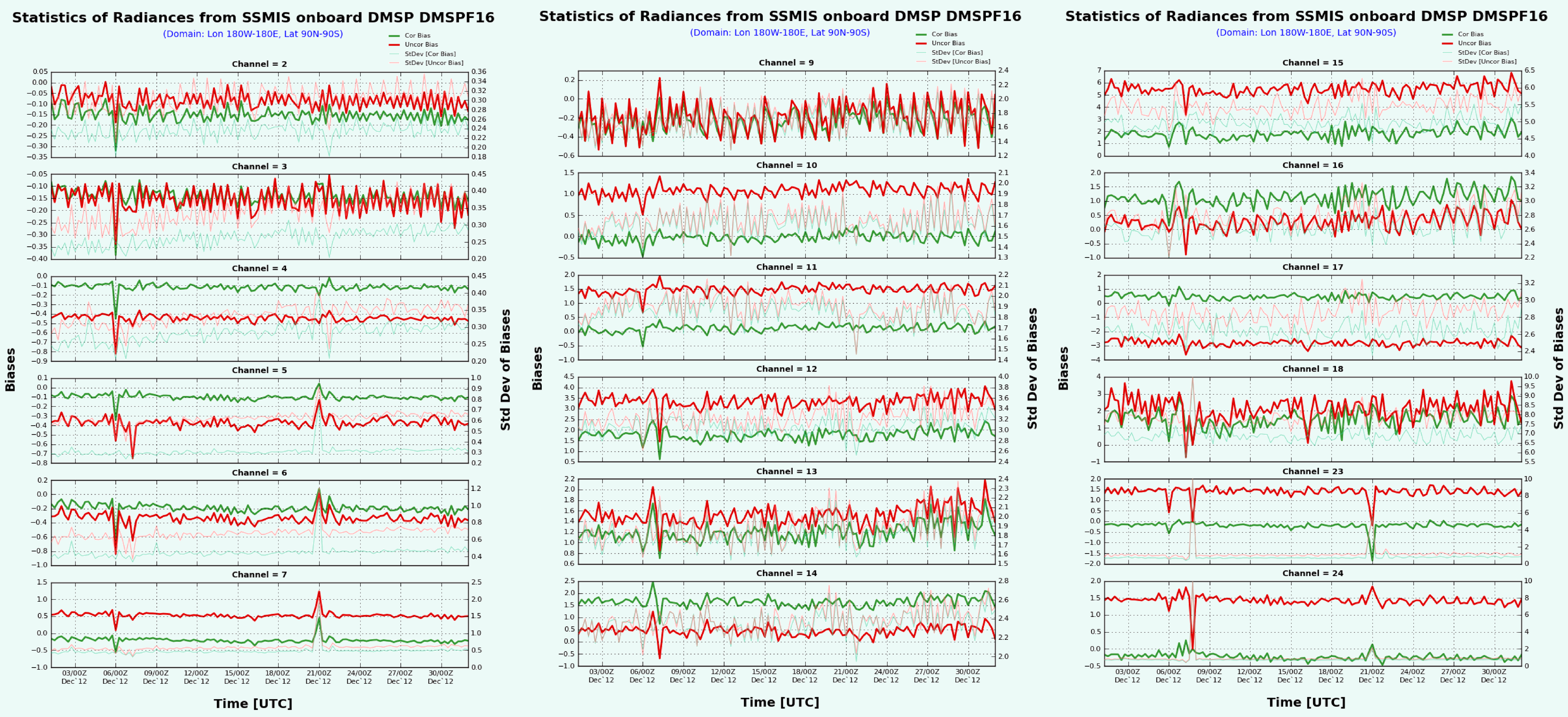


Figure 1. Time series of first guess departure (o-b) statistics for assimilated SSMIS channels.

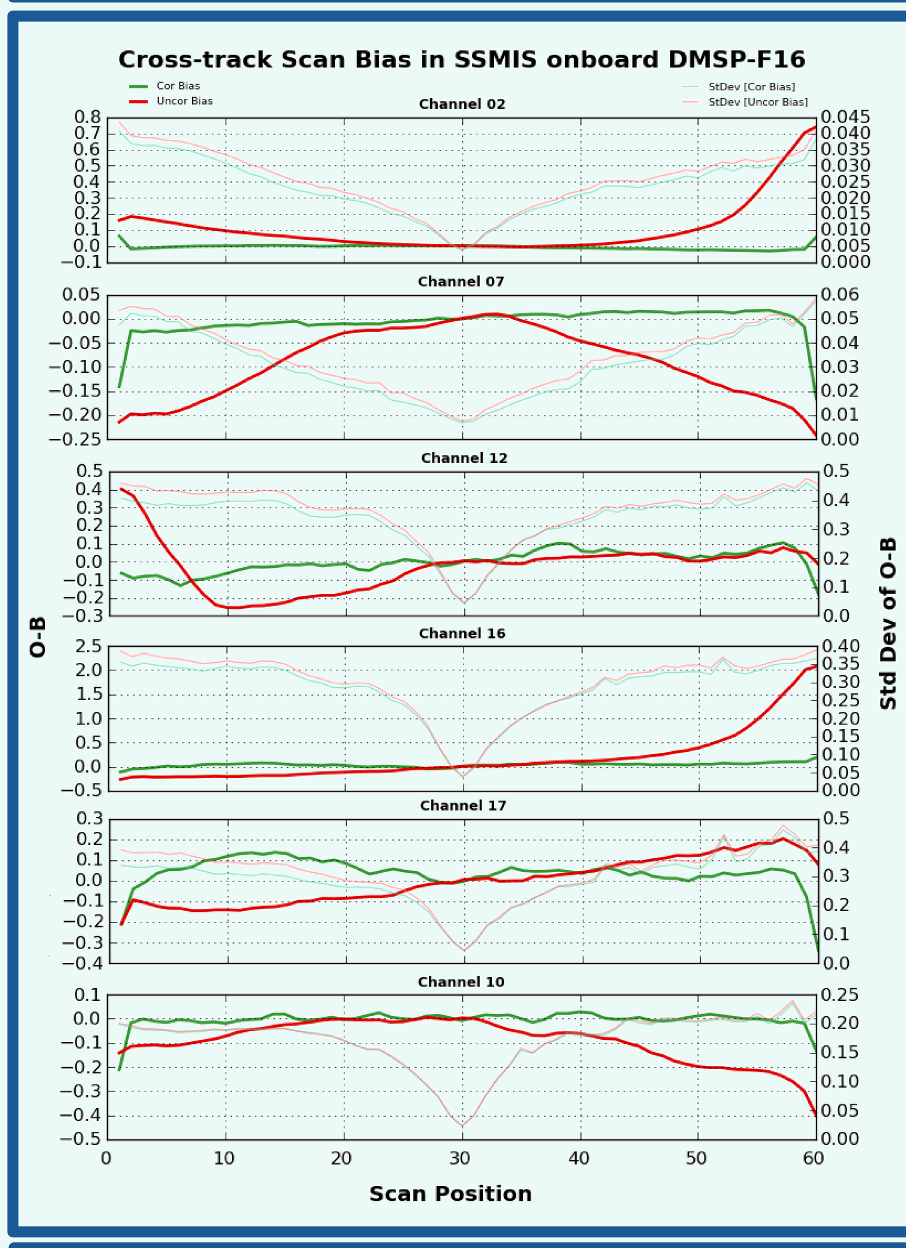


Figure 2. Scan biases for SSMIS channels 2, 7, 10, 12, 16, & 17. Each channel shown in the figure is representative of a group of channels which uses the same feed-horn. The list of channels which are fed from each feed-horn and the frequency of the associated oscillator are given below: *(a)* 19 GHz -> Ch. 12-14; *(b)* 37 GHz -> Ch. 15-16; *(c)* ~50 GHz -> Ch. 1-5; *(d)*~60 GHz -> Ch. 6-7; *(e)* 91 GHz -> Ch. 20-24; *(f)* 150 / 183 GHz -> Ch. 8-11.

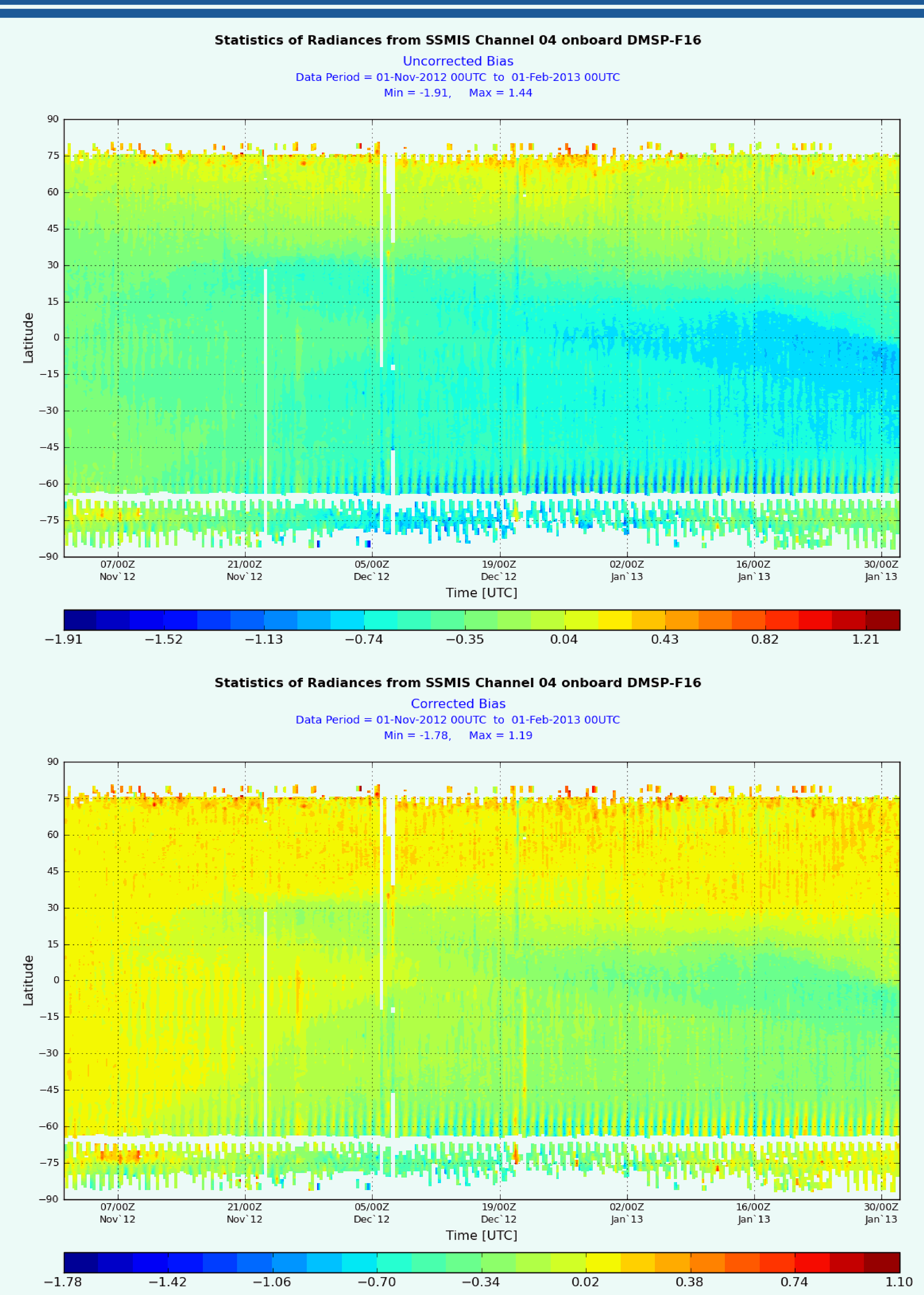


Figure3. Hovmoeller diagram of uncorrected (top panel) and corrected biases (bottom panel)for SSMIS channel 4 (54.4 GHz).

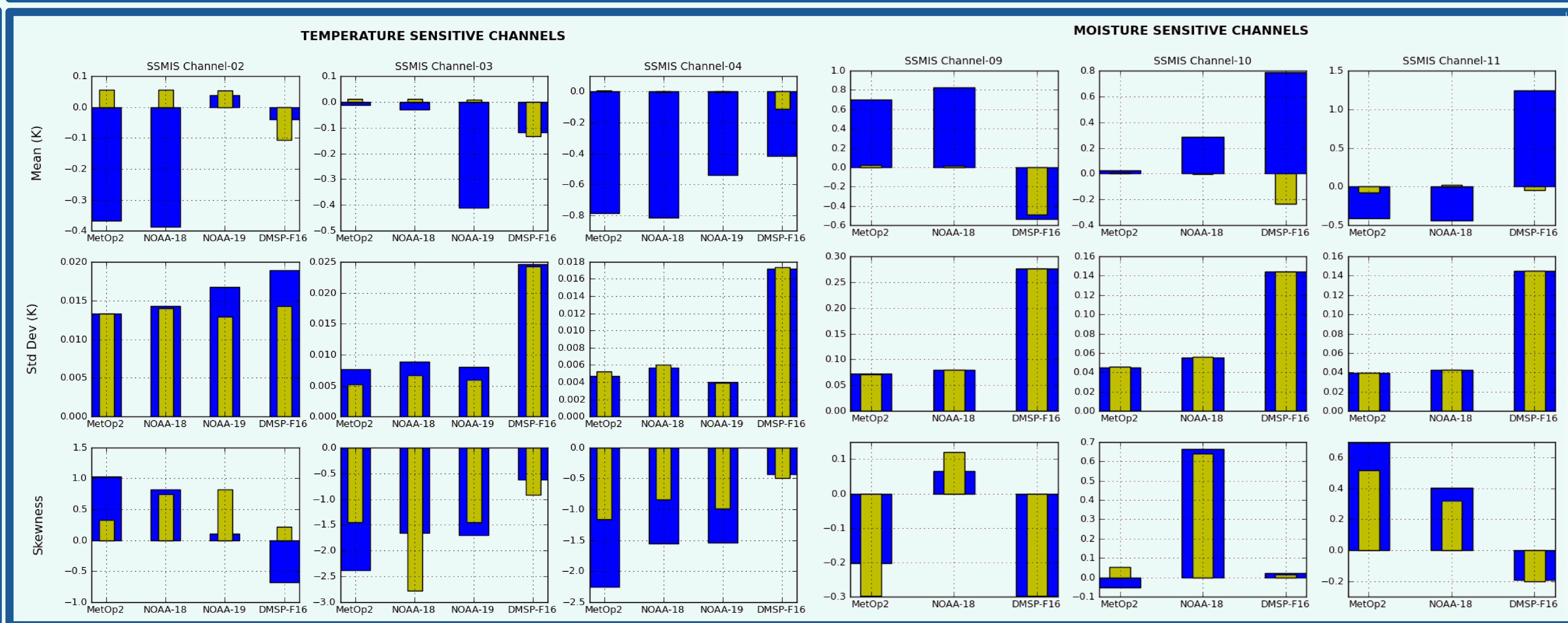


Figure 4. FG departure statistics showing mean, SD, and skewness for SSMIS from DMSP-F16 and AMSU data from NOAA-18, 19, and EUMETSAT's MetOp-A. The blue bars represent statistics for data prior to bias correction and the yellow bars represent data after bias correction.

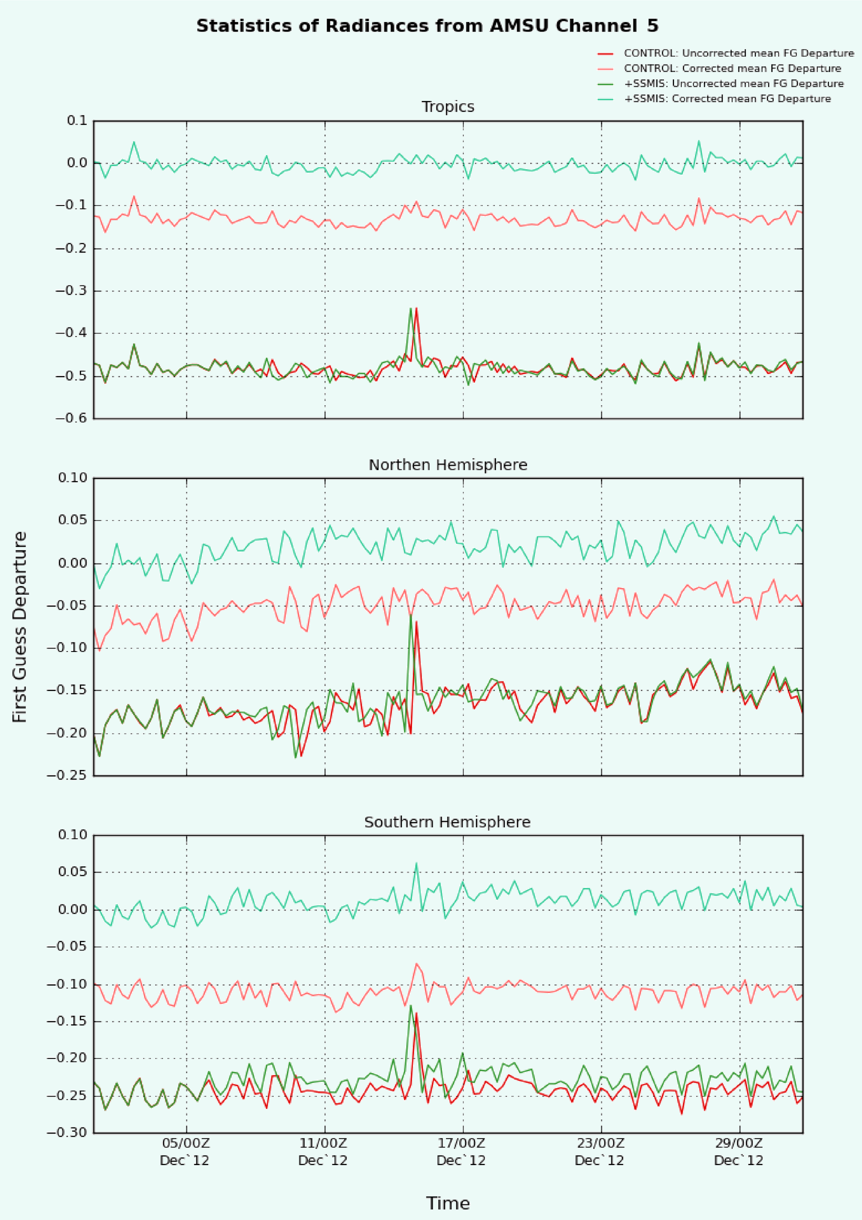


Figure 5. FG departure statistics of AMSU channel 5 (53.6 GHz) for CONTROL and SSMIS experiments.

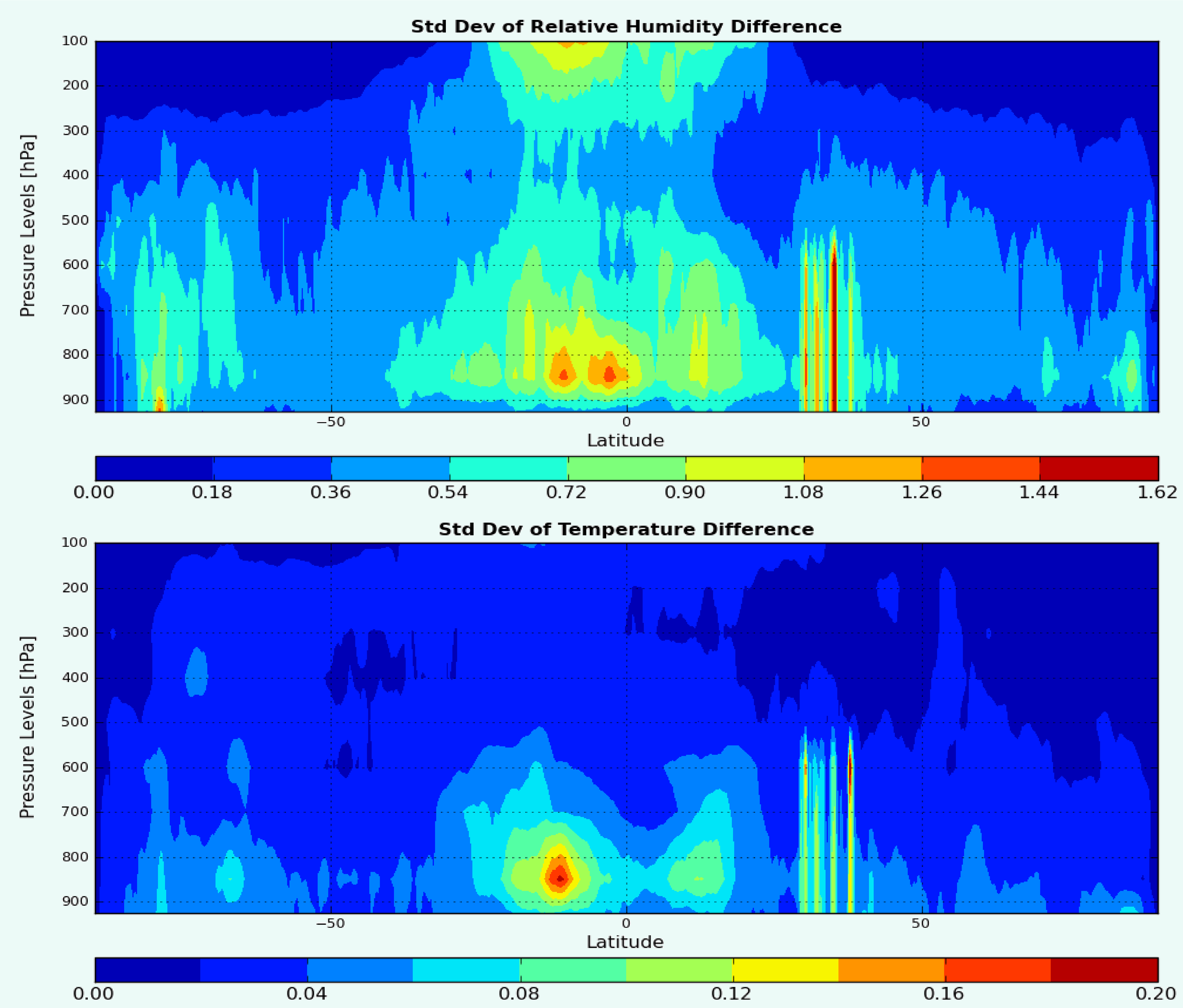
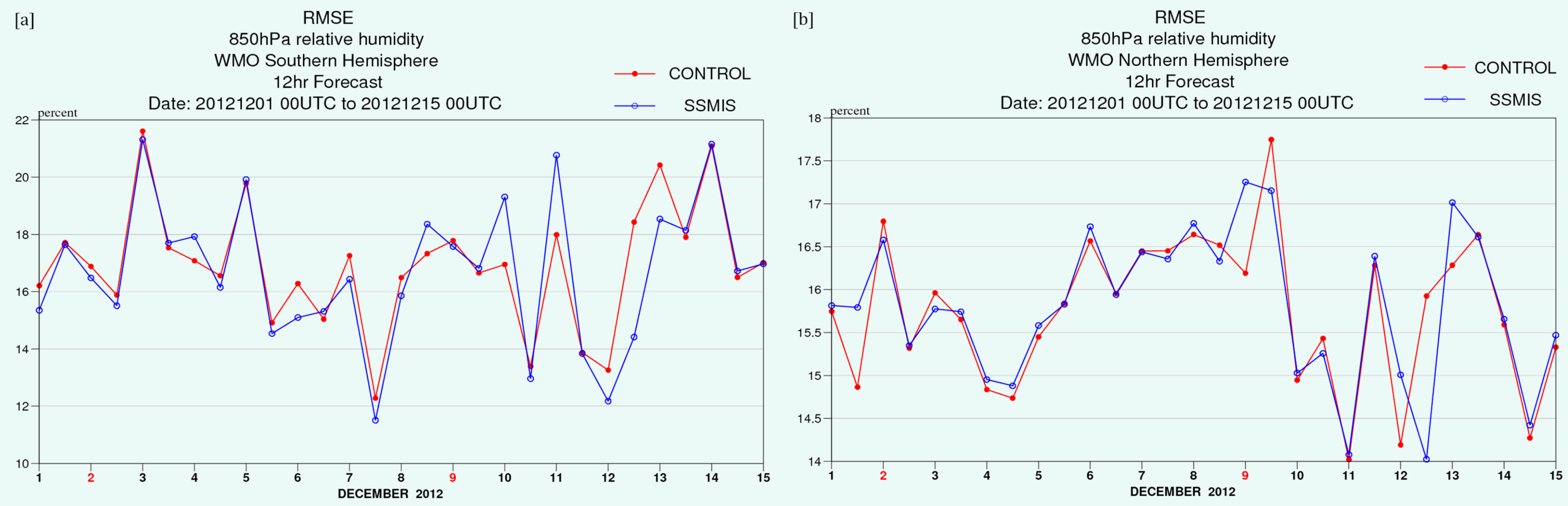


Figure 6. SD of the difference between SSMIS and CONTROL analyses in RH and Temperature.

Figure 7. RMSE scores calculated against radiosondes for 12 hour forecast fields of 850 hPa relative humidity forecast from CONTROL (red) and SSMIS (blue) experiments. **[a]** Southern hemisphere and **[b]** Northern hemisphere



Summary

The work presented here aims to assess the suitability of SSMIS for active operational assimilation in Bureau of Meteorology's ACCESS NWP system. A comparison of SSMIS with AMSU data has shown that the SSMIS data is very similar in quality to the AMSU data. Since all the satellites which currently carry AMSU are either over or are nearing their notional operational lifetime of five years, augmenting SSMIS will therefore allow Bureau to offset information loss from the current observing systems due to any unforeseen depletion. The benefit of adding SSMIS is presented through an examination of the short-range forecast (background) fit to AMSU observations. The results indicate that the inclusion of SSMIS in a full operational system improves the short range forecast accuracy. A slight positive impact on moisture analysis is also observed. Skill score verification of 12 hour forecasts against radio-sondes, however, depicts a neutral impact over both southern and northern hemisphere. It is expected that assimilating SSMIS data from additional DMSP–F17 and –F18 platforms would further improve model performance.