7p.06

Quantifying the Effects of the CrIS-FSR Radiance Polarization Corrections Using the NCEP Global Data Assimilation System

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Introduction

The Cross-track Infrared Sounders (CrIS) have polarization effects due to the design of the instruments. These polarization effects may be significant to Numerical Weather Prediction (NWP), especially for the shortwave band. Scientists at the Space Science and Engineering Center (SSEC) have developed a theoretical model and correction for the polarization induced calibration errors. The polarization parameters required for the correction were determined using data acquired by the CrIS instrument during the February 2012 Suomi NPP pitch maneuver. During the pitch maneuver, all of the CrIS cross-track fields of regard that normally view the Earth, were looking to deep space. In this configuration, field of regard and detector dependent differences are dominated by the instrument polarization, making this an ideal dataset for derivation of the polarization parameters. For band 3 (shortwave), the uncorrected polarization induced calibration errors can be as much as several degrees for cold Earth scenes.

Objective

To quantify polarization effects of the 9 CrIS detectors on Suomi NPP and NOAA-20. To do this we used all three full spectral resolution bands (longwave, midwave, and shortwave) and all 2211 channels. Assimilation statistics are reviewed for each of the 9 detectors with and without the polarization corrections. We used the 2016 low resolution (T670) 4DEnsVAR version of the operational NCEP GDAS/GFS. All non-restricted operational data were used. All CrIS channels were monitored. Each detector was assimilated independently and the bias corrections were unique to each detector. These statistics are for ocean only. Shortwave channels were restricted to night only. Bias corrections had a 7 day spin up, from 2018110100 to 2018110718. The experiment was then run from 2018110100 through 2018112118.

Results

The CrIS Full Spectral Resolution (CrIS-FSR) radiances, from both Suomi NPP and NOAA-20, with and without the polarization correction are assimilated in the NCEP Global Data Assimilation System (GDAS) to quantify differences in assimilation statistics. NOAA-20 and Suomi NPP statistics for band 1-3 are shown in Figure 1-3 and 4-6 respectively. The average bias, detector difference bias, standard deviation average and detector difference standard deviation are shown in panels a, b, c, and d respectively in each figure. Detector specific differences, for both the control and polarization_corrected data, are consistent with previous work. Detector 5 in band 1 and detector 7 in band 2 on Suomi NPP and detector 9 on NOAA-20 continue to be the most “out of family”. The control-polarization corrections for NOAA-20 and Suomi NPP statistics for bands 1-3 are shown in Figures 7-9 and 10-12 respectively. The bias difference average, detector difference bias, standard deviation difference average and detector difference standard deviation are shown in panels a, b, c, and d respectively. Overall differences between the control and polarization_corrected data are small with the greatest differences in the high peaking band 3 (shortwave) channels and minimal differences in the longwave surface channels. Polarization corrections are greater for Suomi NPP than NOAA-20 and the bias correction statistics confirm this. Polarization correction differences in the standard deviation statistics are minimal, especially for NOAA-20.

An observing system experiment was also conducted to quantify the polarization correction on the analyses. The setup consisted of the 2016 low resolution 4DEnsVAR with all non-restricted operational data. The operational CrIS channel selection and observation errors were used along with all of the operational quality control procedures. Analysis differences between the control and polarization_corrected data are minimal throughout the 21 day experiment. The results show no dominant changes in the synoptic features in both the analyses and forecasts. Average temperature changes are greatest at the tropopause and are generally less than 0.1K.

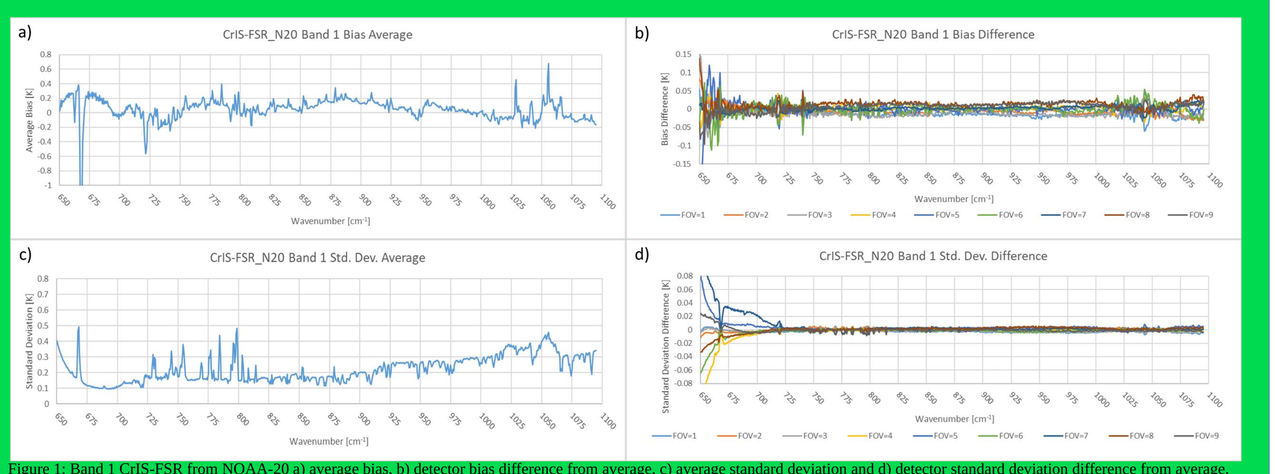

Figure 1: Band 1 CrIS-FSR from NOAA-20 a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

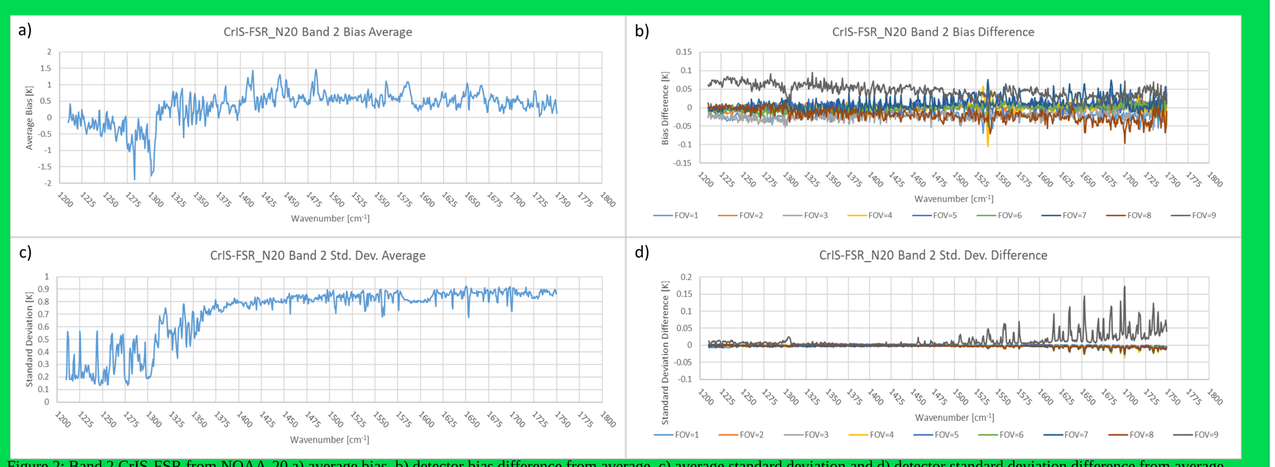

Figure 2: Band 2 CrIS-FSR from NOAA-20 a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

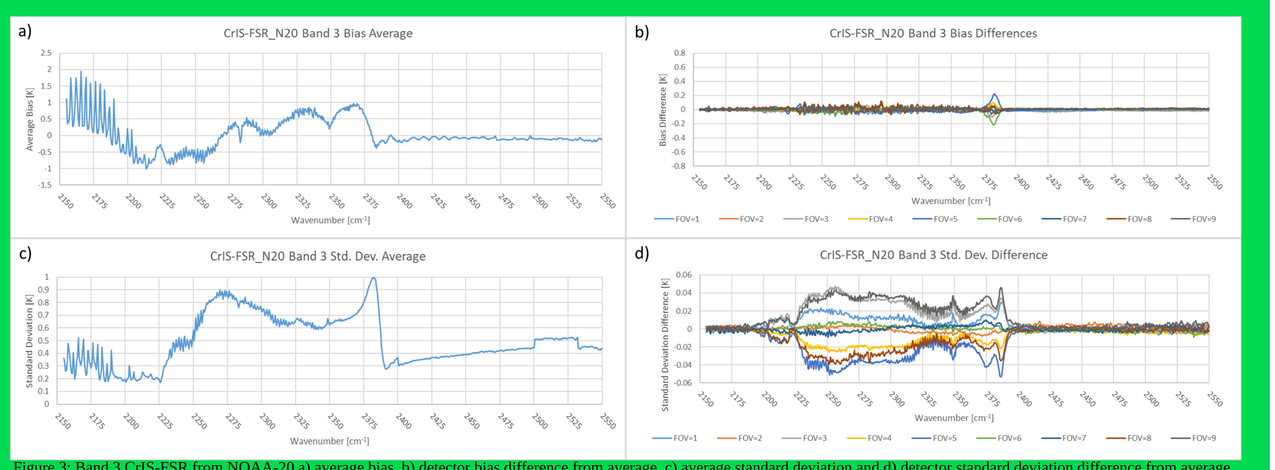

Figure 3: Band 3 CrIS-FSR from NOAA-20 a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

Figure 4: Band 1 CrIS-FSR from Suomi NPP a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

Figure 5: Band 2 CrIS-FSR from Suomi NPP a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

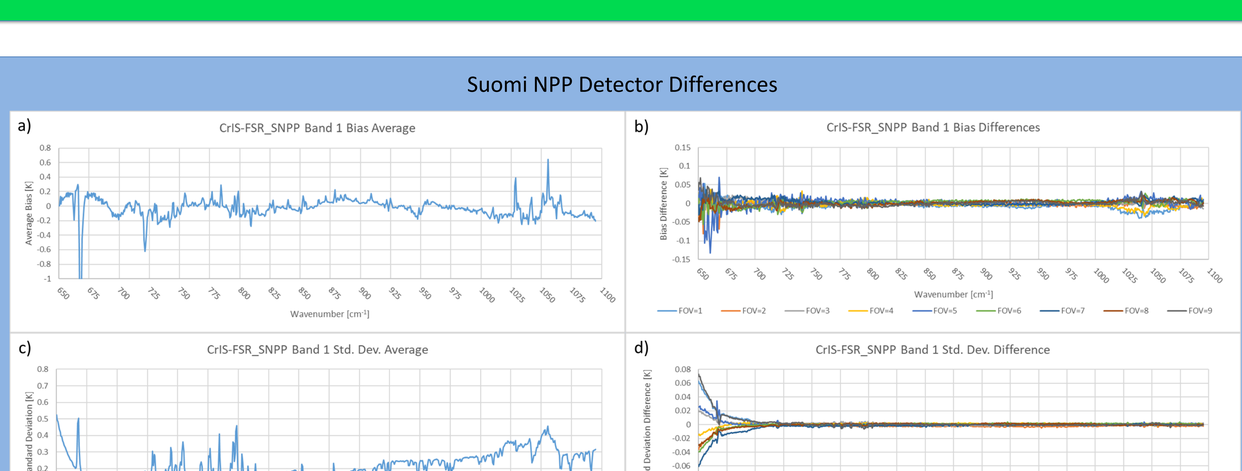

Figure 6: Band 3 CrIS-FSR from Suomi NPP a) average bias, b) detector bias difference from average, c) average standard deviation and d) detector standard deviation difference from average.

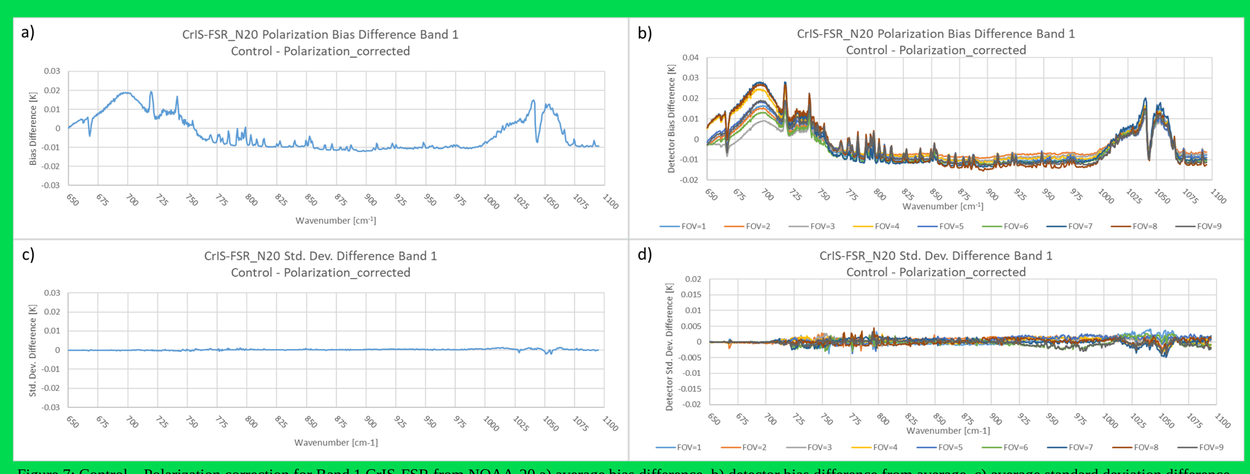

Figure 7: Control – Polarization correction for Band 1 CrIS-FSR from NOAA-20 a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

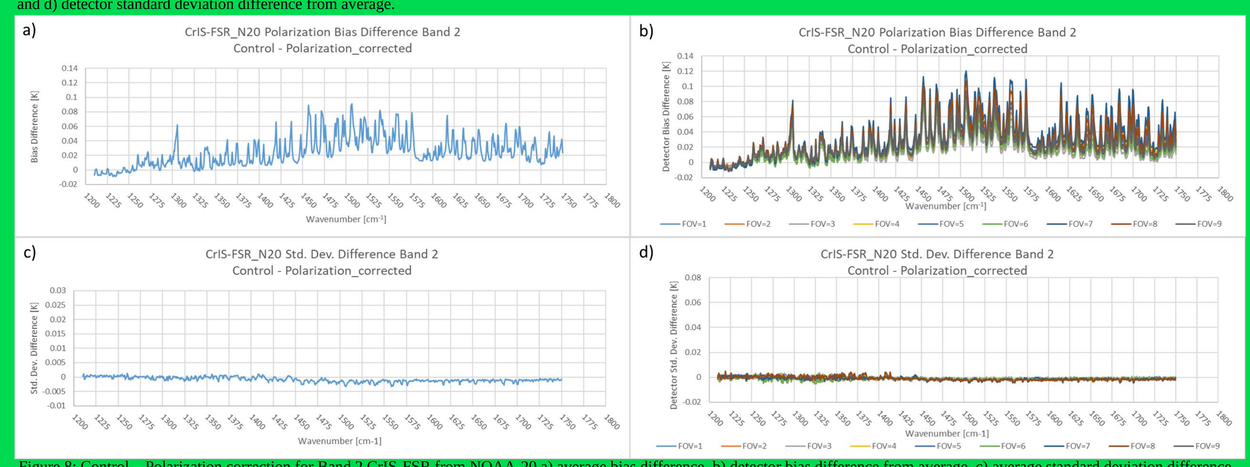

Figure 8: Control – Polarization correction for Band 2 CrIS-FSR from NOAA-20 a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

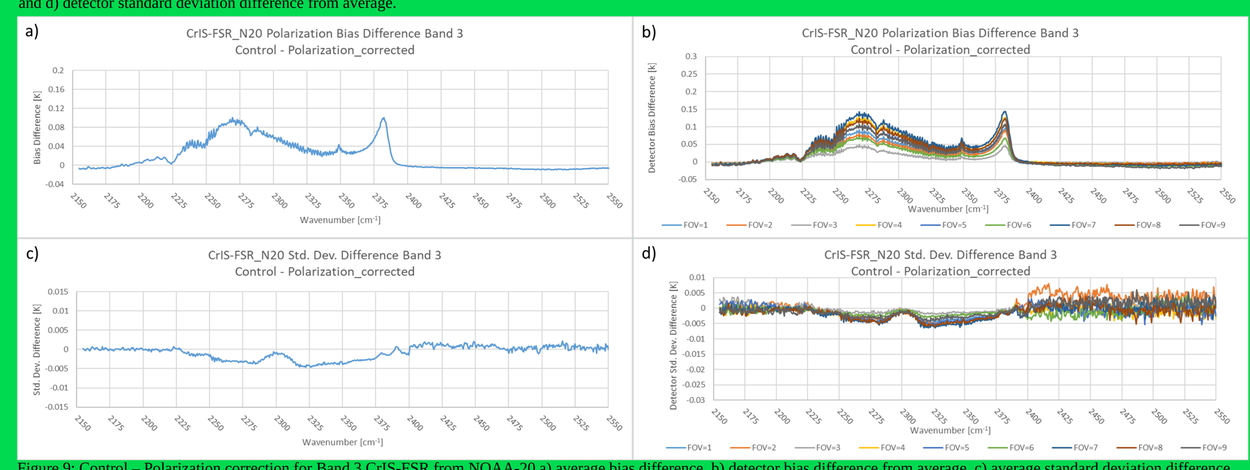

Figure 9: Control – Polarization correction for Band 3 CrIS-FSR from NOAA-20 a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

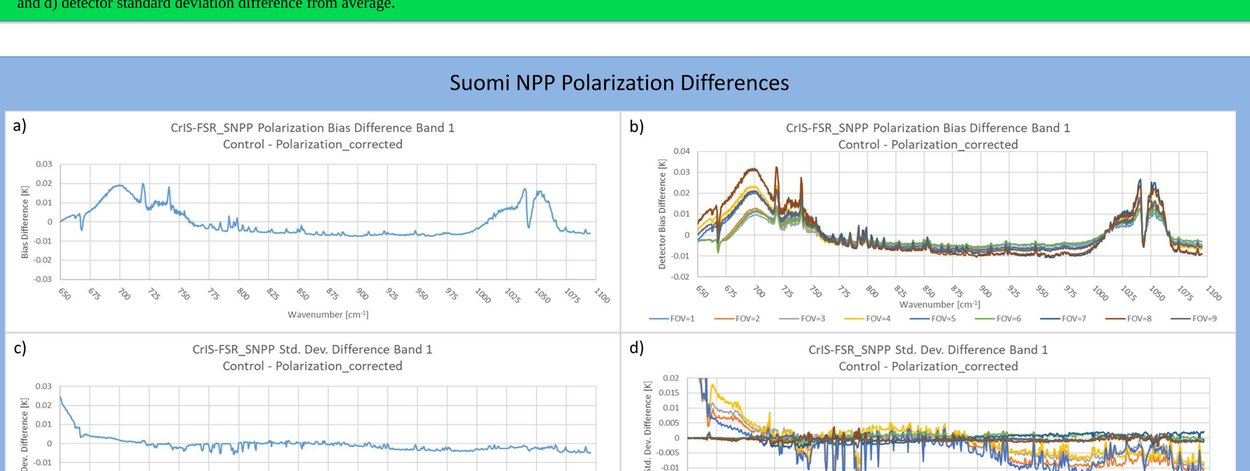

Figure 10: Control – Polarization correction for Band 1 CrIS-FSR from Suomi NPP a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

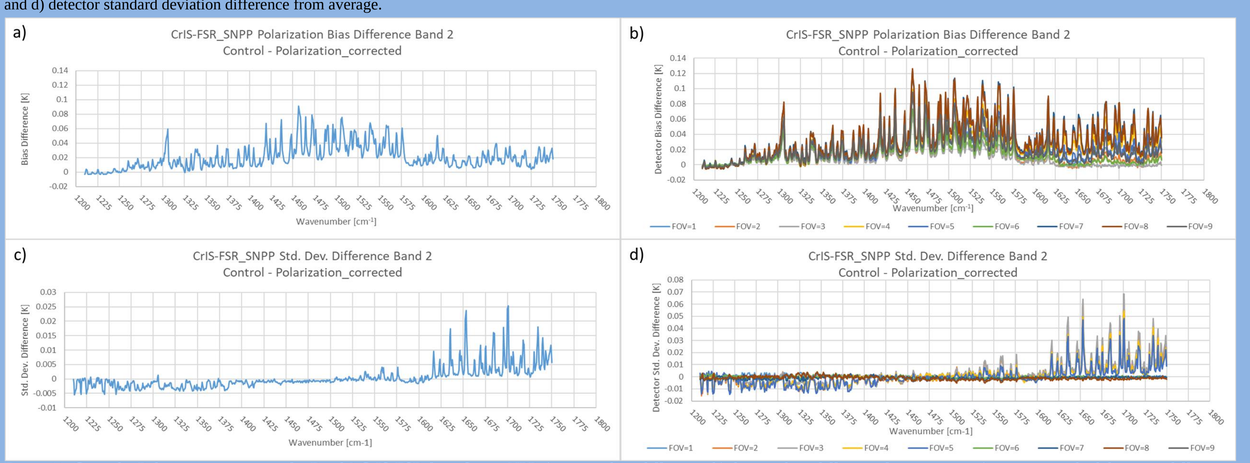

Figure 11: Control – Polarization correction for Band 2 CrIS-FSR from Suomi NPP a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

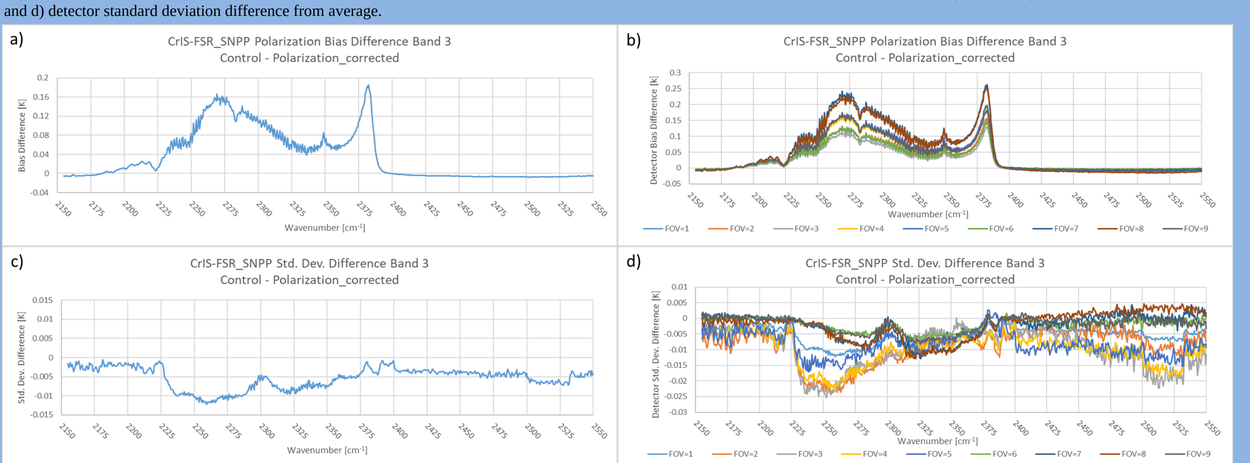

Figure 12: Control – Polarization correction for Band 3 CrIS-FSR from Suomi NPP a) average bias difference, b) detector bias difference from average, c) average standard deviation difference and d) detector standard deviation difference from average.

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