The Defense Meteorological Satellite Program (DMSP) launched the first (F-16) in a series of five spacecraft carrying Special Sensor Microwave Imager Sounders (SSMIS) on October 18, 2003. The SSMIS is a 24 channel conically scanning microwave radiometer, with frequencies ranging from 19 to 183 GHz. During the comprehensive SSMIS Calibration and Validation (Cal/Val) efforts, unexpected calibration anomalies were discovered in the radiometric data [1]. Two principal anomalies were detected: an intermittent solar intrusion to the warm load calibration target; and reflector emission due to solar heating of the reflector face itself. Data assimilation systems for numerical weather predictions typically demand less than 0.4 K uncertainty in the 50-60 GHz oxygen absorption channels, and require that such observed biases be removed prior to assimilation.

**SSMIS Warm Load Solar Intrusion**

The orbit of the DMSP F-16 and the design of the SSMIS warm load and reflective canister top result in 4 distinct geometric scenarios where solar radiation can impinge upon the surfaces of the warm load tines. Two direct impingements and two reflections off of the canister top can occur per orbit. This in turn causes rapid heating of the tines that is not sensed by the 3 hemispheres embedded on the deep inside the substrate of the warm load resulting in anomalous radiometer gains and subsequent calibration errors.

**Mitigation Strategy**

The solar intrusion anomaly is readily evident in the time series of the individual channel radiometer gains and match the cool anomalies in the Scan Averaged OB-BK time series.

**SSMIS Reflector Emission**

The SSMIS reflector was designed to be non-emissive at microwave frequencies, and was specifically coated with SiOx to minimize such effects. Pre-launch tests of the main reflector showed a reflectivity of 0.9999. The F-16 SSMIS is equipped with a thermometer placed upon the rim of the reflector that observes an incident solar thermal cycle ranging from 230-300 K.

On orbit the F-16 SSMIS reflector appears to show a frequency dependent emissive behavior in the 50-60 GHz channels and ~5 K in the high frequency channels are observed. The maximum reflector emission anomaly occurs just after the spacecraft emerges from earth and/or spacecraft shadow, and the reflector face is directly illuminated by the sun. A simple physical model governs the reflector emission and resulting scene temperature bias.

\[ \Delta T_{\text{refl rim}} = T_{\text{refl rim}} - T_{\text{form rim}} = e_{\nu}(\nu)T_{\text{F}} \]

The goal of applying the SSMIS Reflector Emission Correction is to remove the effect of the reflector emissions from the observed brightness temperature and produce an improved scene temperature.

\[ T_{\text{scene int}} = T_{\text{scene int}} - \Delta T_{\text{refl rim}} = e_{\nu}(\nu)T_{\text{F}} \]

However, this requires accurate knowledge of three parameters:

1. The True Reflector Temperature
2. The Frequency Dependent Reflector Emissivity
3. The best estimate of the True Scene Brightness Temperature

**Mitigation Strategy**

It is assumed that an estimate of the true reflector face temperature can be made from a lag filtered time rate of change of the observed SSMIS reflector rim temperature, as follows [3]:

\[ T_{\text{obs}} = T_{\text{refl rim}} - e_{\nu}(\nu)T_{\text{F}} \]

However, this requires accurate knowledge of three parameters:

1. The True Reflector Temperature
2. The Frequency Dependent Reflector Emissivity
3. The best estimate of the True Scene Brightness Temperature

The SSMIS Fourier filtered Gain corrections have been applied to the TDR files and an estimate of the reflector face temperature have been made available for NRL radiance assimilation. Results of the SSMIS Reflector emission corrections indicate:

1. Scene temperatures immediately upon emergence from shadow are still not adequately emission corrected, but can be QC’ed with magnitude of \( \Delta T_{\text{refl rim}} \)
2. Channels 10 and 11 show that the mean monthly OLR values match the effect of the sun as apparent in the scene temperatures, i.e. the double hump feature in near the middle in the optical channels.
3. Channel 5 OB-BK characteristics and to a lesser degree Channel 6, seem to point to an OLR absorption RTM error, i.e. the Gamma correction as the bias appears to be airmass dependent with negative biases in the tropics

**Results**

The SSMIS Fourier filtered Gain corrections have been applied to the TDR files and an estimate of the reflector face temperature have been made available for NRL radiance assimilation. Results of using these files in radiance assimilation trials are being presented in a companion paper. The following observations have been made regarding the SSMIS reflector emission corrections:

1. The estimated reflector face temperature is channel dependent as the feedhorns view different warm load tines. The duration and shape of the intrusion period is channel dependent as the feedhorns view different warm load tines. A Fourier based filtering mitigation strategy has been implemented to perform the gain filtering in the SSMIS processing software for the sensor data records (SDRs). NRL has applied a Gain Ratio correction to TDR files used for radiance assimilation as follows: The Original Gain, \( G_0 \), to Filtered Gain, \( G \), Ratio should be equal to 1.0 and have values greater than 0.90 only where the intrusions occur. The corrected TDR file is calculated using a linear calibration equation:

\[ T_{\text{unfiltered}} = G_0(C - C_0) + T_C \]

\[ T_{\text{filtered}} = G(C - C_0) + T_C \]

where:

- \( T_{\text{unfiltered}} \) is the uncorrected antenna temperature
- \( T_{\text{filtered}} \) is the corrected antenna temperature
- \( G_0 \) is the original gain
- \( G \) is the filtered gain
- \( C \) is the cold space count
- \( C_0 \) is the mean cold space count
- \( T_C \) is the mean cold space reflector count

**References**


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