SNPP VIIRS Emissive Bands Calibration Assessed via a CrIS-VIIRS Data Comparison

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Abstract

The calibration of the Suomi NPP VIIRS thermal emissive bands (TEB) M13 (4.05 μm), M15 (10.76 μm), and M16 (12.03 μm) is assessed by a comparison between CrIS and VIIRS SDR Earth radiance data, obtained at the same time and with the same view geometry. A correction to the VIIRS calibration coefficients, based on the CrIS calibration, is derived. The motive to attempt an alternative approach to the VIIRS TEB calibration, independent from the VIIRS on-board Black Body (BB) data, is that while in general agreement, the BB WUCR results and pre-launch estimates of the calibration coefficients show some systematic differences, especially for the zeroth order coefficients. The discrepancy could arise from BB view radiative model inadequacies, or from real differences in the offsets on-orbit compared to pre-launch. The VIIRS TEB calibration coefficients derived from comparison with CrIS are band-average (over all detectors and HAM-sides), derived under the assumption of a linear relationship between CrIS and VIIRS radiance, at three different scan angles (nadir and ±49 deg) to explore the possibility of uncorrected VIIRS background path differences (function of the scan-angle) affecting the calibration. Data from over 10 orbits was used, including orbits during a BB WUCR – when the VIIRS calibration was affected by the BB temperature change – as well as nominal operational data. The results are consistent between WUCR and nominal operations, and between the three scan angles used. The derived offset for M13 is close (slightly lower) to the pre-launch value, while for M15 and M16 the offset is higher than the pre-launch and consistent with WUCR results.

Data Selection

Scan Angle Selection and CrIS - VIIRS Matching

Using c0, as we define a new set of "corrected" VIIRS calibration coefficients c' by substituting c0 in Eq. (2) with Eq. (3) and comparing the results to Eq.(4).

\[
\begin{align*}
\text{c}_0' &= \frac{\text{c}_0}{1 + \text{c}_0 \
\text{c}_1' &= \frac{\text{c}_1}{1 + \text{c}_0} 
\end{align*}
\]

VIIRS TEB calibration coefficients derived from comparison with CrIS are real differences in the offsets on-orbit compared to pre-launch.

The coefficients derived at the three scan angles are consistent within the uncertainty, supporting the scenario that the change in c0 we see at WUCR is due to background radiance mismatch.

The derived calibration coefficients are in very good agreement between the different data sets, and as expected, are not dependent on the BB temperature.

The coefficients derived at the three scan angles are consistent within the uncertainty.

For M15 and M16 the CrIS-based coefficients agree better with the average WUCR values (excluding c2).

For M13 the CrIS-based coefficients are closer to the LUT table.

Conclusions

• The coefficients derived at the three scan angles are consistent within the uncertainty, supporting the scenario that the change in c0 we see at WUCR is due to background radiance mismatch.

• For M15 and M16 the CrIS-based coefficients agree better with the average WUCR values (excluding c2). On orbit offset change can explain the CrIS-VIIRS temperature dependent difference.

• For M13 the CrIS-based coefficients are closer to the LUT table. The CrIS – VIIRS discrepancy might be due to a different mechanism.

• A correction to the CrIS radiance, using scenes at the VIIRS BB temperature as reference, yields better agreement between the M13 data sets.

• Further improvements are possible: expanding the CrIS data set with data taken during the last WUCR cycles; separating HAM-sides.

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References: