Introduction

Radiometric Uncertainty (RU) characterization of a sensor dataset describes the various sources of calibration uncertainty and their relevant dependencies. For infrared spectrometers, common examples include the uncertainty in the knowledge of the calibration blackbody temperature and resulting radiance uncertainty as a function of scene temperature, or, the uncertainties in the degree of polarization of a scan mirror and resulting radiance uncertainties as a function of wavelength, scan angle, and scene temperature. RU characterization is required for various applications and is particularly important for climate and intercalibration studies, for sensors being intercalibrated as well as sensors serving as a reference. For high spectral resolution infrared sounders, RU estimates have been provided recently for the Atmospheric Infrared Sounder (AIRS) (Pagano, 2013) and for the Cross-track Infrared Sounder (CrIS) on Suomi-NPP (Tobin, 2013). Here, the CrIS RU results are summarized, and post-launch cal/val efforts to validate the CrIS radiances and RU estimates are presented.


Summary and Conclusions

- On-orbit Radiometric Uncertainty (RU) characterized
  - Based on careful estimation of the various sources of the primary calibration parameters and associated uncertainties.
- RU characterization provides information on the performance of the entire system.
- RU uncertainty correction algorithm and coefficients refined
- Provides improved modeling of sensor uncertainties in the TES (Temperate Earth Observation Satellite) target.
- Reforms radiance model in the CrIS and NPP bands.
- RU characterization provides insight into the performance of the CrIS.
- CrIS/VIIRS comparisons: very excellent stability of both sensors, and scene IFU dependence further explored.

Areas of further refinement have been identified and are under investigation.

Other Terms

- Sensing footprint
- Polarization
- Possible non-linear band non-linearity

CrIS/VIIRS comparisons

- Example Daily Comparisons:
  - MHS band differences
  - Descending track

CrIS/VIIRS Daily Mean Differences

- Each day includes 100,000 observations which pass a spatial uniformity test.

CrIS/VIIRS Daily Mean Differences

- Vertical extent provides the full extent of the sensor footprint.
- Differences of less than 0.2 mK are consistent with the sensor specifications.
- Larger VIIRS footprints are observed due to the scan mirror orientation and other factors.

CrIS/VIIRS Northern SN0s

SNO Datasets

- AIRS/AMS-1 2D “Big Circle” SNOs collected to date (March 2012 to Nov 2013): 20 minute windows, 16 LS (low sun angle), 16 HS (high sun angle) 4 IFU.
- AIRS/AMS-1 3D-CO2/OP/SHIP_S10_L1B LS, 16 LS.

C1-C4: AIRS LS “Big Circle” SNOs collected to date (March 2012 to Nov 2013): 20 minute windows, nadir - 50 day of data coincidences, 50 day gaps.

Summary of SNO results for 4-nanometer spectral windows, and AIRS/AMS-1 comparisons

Clear Sky Obs-Calcs Analyses

- Behavior of three cases and calculated differences are presented for each SNO dataset.
- For each, the analysis includes the evaluation of inter-calibration differences for each SNO.
- Good radiometric performance for CrIS.

Radiometric Uncertainty Estimates

Simplified On-Orbit Radiometric Calibration Equation:

\[ R_{\text{rad}} = R(T_{\text{bb}})C_L + C_PC_P + C_MC_M + C_BC_B + C_WC_W + C_P' + C_B' + C_W' + C_P'' + C_B'' + C_W'' \]

- With

Parameter Uncertainties:

- Input parameters: 
  - Temperature: N.B. 1.2 mK
  - Pressure: 2.0 mK
  - Humidity: 2.0 mK
  - Sea Level: 1.0 mK
  - Effect: 2.0 mK

- Uncertainties in the RU estimates are greater due to the effects of the TES data and on-orbit F2-3 FDOV analysis. The new, SNO-based uncertainties are greatly reduced due to the high accuracy of the TAR and high CH4 concentrations.

Error from Scene Mirror Induced Polarization

- CrIS: uses a 45° gold mirror that provides low sensitivity to polarization, no correction is included in the CrIS algorithms.
- However, it seems almost certain that CrIS should have polarization effects at 1°-2° for mostly cloudy and clear conditions in some spectral regions.
- Polarization effects are not expected to be constant and the effects to be invariant measurements of some mirror diameter, orientation, and interferometric measurement vectors.
- Radiance error dependence ±240nW (N; H; L)

SNO Datasets

Table: AIRS/AMS-1 2D “Big Circle” SNOs collected to date (March 2012 to Nov 2013): 20 minute windows, 16 LS (low sun angle), 16 HS (high sun angle) 4 IFU.

Example 3-sigma RU estimates

- For a typical warm, clear sky spectrum.
- For a cold high cloud spectrum.

SNO Datasets