Suomi NPP/JPSS Cross-track Infrared Sounder (CrIS): Calibration Validation With The Aircraft Based Scanning High-resolution Interferometer Sounder (S-HIS)

Joe K. Taylor[1], D. C. Tobin[1], H.E. Revercomb[1], F.A. Best[1], R. K. Garcia[1], A. Merrelli[1], and M. Goldberg[2]

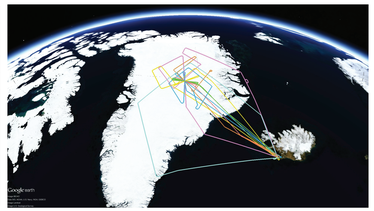
1. Space Science and Engineering Center, University of Wisconsin-Madison, 1225 West Dayton St., Madison, WI, 53706

2. Joint Polar Satellite Systems Office, National Oceanic and Atmospheric Administration, Lanham, Maryland, USA

JPSS Science Team Meeting 2015

Summary

2015-02-23	Engineering test flight; SNPP
2015-03-07	Transit flight
2015-03-15	SNPP, METOP-B, SNPP
2015-03-19	Multiple passes over Greenland Summit Station
2015-03-23	METOP-A, SNPP, Aqua
2015-03-24	SNPP • poor scene conditions for SNPP radiance comparison
2015-03-25	METOP-A, SNPP, METOP-B, Aqua • poor scene conditions for SNPP radiance comparison
2015-03-28	SNPP, SNPP
2015-03-29	Aqua, METOP-A, METOP-B, SNPP
2015-03-31	Transit flight

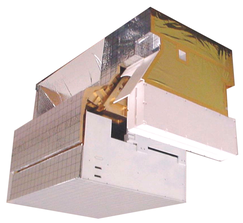


Considering the wide range of existing satellite calibration validation approaches, the high accuracy of aircraft sensors combined with the ability to perform pre- and post-campaign calibration tests to confirm the radiometric performance make satellite under-flight comparisons like those presented here uniquely capable of assessing infrared satellite observations with sufficient accuracy and traceability. **The S-HIS has proven to be an extremely dependable and accurately calibrated airborne reference instrument with a well defined radiometric uncertainty and traceability path.**

The second Suomi NPP dedicated airborne calibration validation campaign was conducted in March 2015. The primary goals of the campaign are to assess the radiometric calibration and environmental product retrieval for polar conditions. The campaign was conducted out of Keflavik, Iceland with high altitude under-flights of the Suomi-NPP, METOP-A, METOP-B, and NASA Aqua satellites on the NASA ER-2 over the Greenland ice sheet. During this calibration validation campaign, the NASA ER-2 payload consisted of the **Scanning-High resolution Interferometer Sounder (S-HIS)**, the NPOESS Atmospheric Sounder Testbed-Interferometer (NAST-I), the NPOESS Atmospheric Sounder Testbed-Microwave Spectrometer (NAST-M), and the NASA MODIS/ASTER airborne simulator (MASTER).

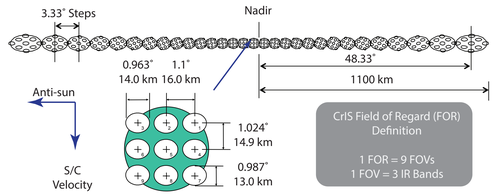
CrIS

- Infrared **Fourier transform spectrometer** with **1305 spectral channels**; **produces high-resolution, three-dimensional temperature, pressure, and moisture profiles**. Designed to give scientists more refined information about Earth's atmosphere and improve weather forecasts and our understanding of climate.



CrIS Sensor Features

- 8 cm clear aperture
- 3 spectral bands
- 3x3 FOVs, 14 km diameter at nadir
- PV MCT detectors
- 4-stage passive cooler
- Plane mirror interferometer with DA
- Internal spectral calibration
- Deep-cavity calibration target

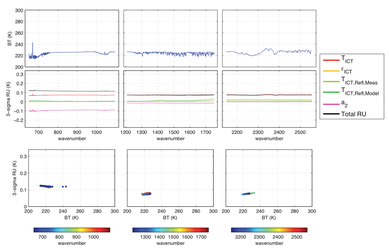


CrIS Field of Regard (FOR) Definition

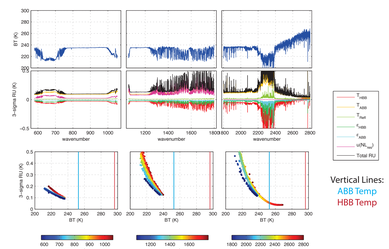
1 FOR = 9 FOVs
1 FOV = 3 IR Bands

Example of Preliminary Calibration Verification Results

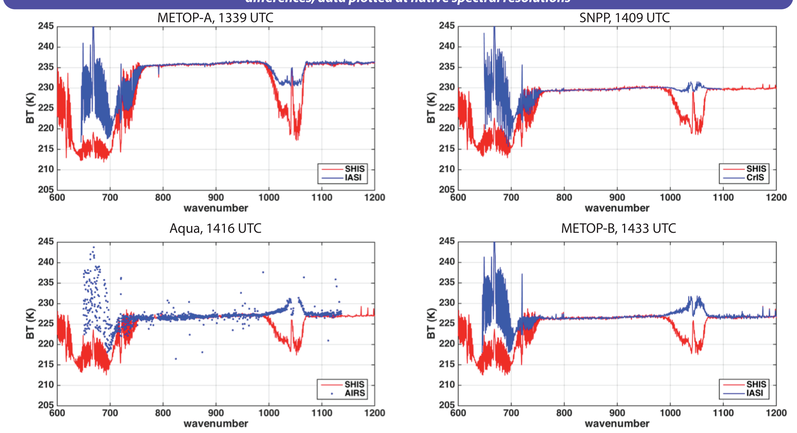
CrIS Brightness Temperature Spectra and RU
(typical cold high cloud spectrum)



S-HIS Brightness Temperature Spectra and RU
(for flight conditions encountered near the SNPP overpass on 2015-03-29)



Preliminary LW Comparisons for 2015-03-29 Flight; No double obs minus calc, does not account for view angle or altitude differences, data plotted at native spectral resolutions

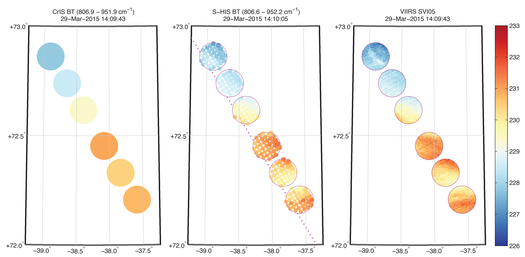


FOV Selection for CrIS 2015-03-29

CrIS FOVs
Mean BT: 806.9 – 951.9 cm^{-1}

S-HIS FOVs
Mean BT: 806.6 – 952.2 cm^{-1}

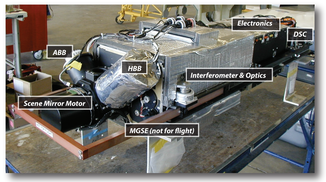
VIIRS SVI05 BT within selected CrIS FOVs



S-HIS

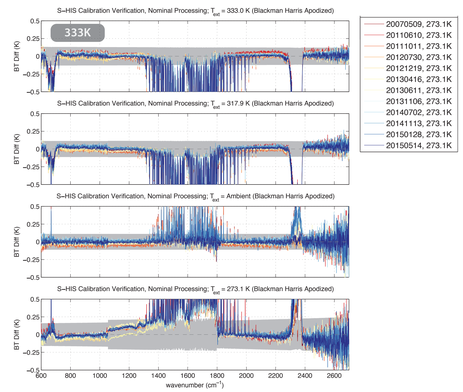
Calibration, Calibration Verification, and Traceability

- Pre-integration **calibration of on-board blackbody references** at subsystem level
- **Pre and post deployment end-to-end calibration verification**
- Periodic **end-to-end radiance evaluations under flight like conditions with NIST transfer sensors.**
- Instrument calibration during flight using **two on-board calibration blackbodies**



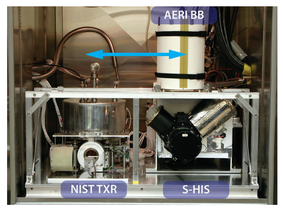
IFOV: 100 mrad (2km @ 20km, nadir)
FOR: Programmable 45° scene mirror nadir ± 40° typical
Spectral Coverage: 580 - 3000 cm^{-1}
Spectral Resolution: 0.5 cm^{-1}

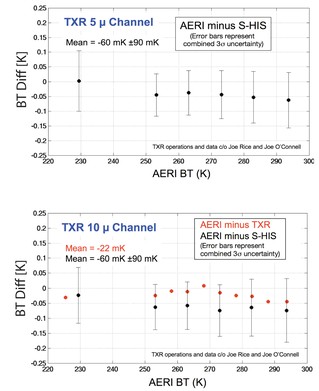
Pre and post deployment End-to-end Cal Verification 2007 - present

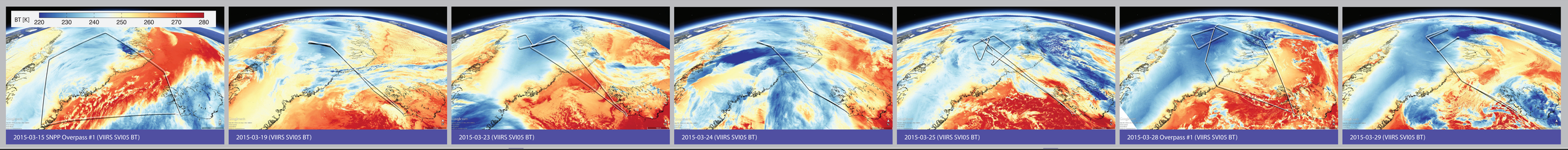


- Data acquired for external blackbody temperatures of ambient, 318K, 333K, and Ice Bath Blackbody
- Atmospheric emission/absorption not included in predicted BT (i.e. no LBLRTM)
- S-HIS NLC is optimized for 'flight' detector and instrument temperatures, not for laboratory temperatures
- 2013-04-16: Stirling cooler failing during testing and etector temperature increased to ~85K during calibration verification; primary impact is on MW nonlinearity (note the outlier spectra for Ice Bath blackbody.

NIST TXR Comparison







joe.taylor@ssec.wisc.edu, Space Science and Engineering Center, University of Wisconsin-Madison, 1225 West Dayton Street, Madison WI 53706 USA