S-HIS: Scanning High-resolution Interferometer Sounder

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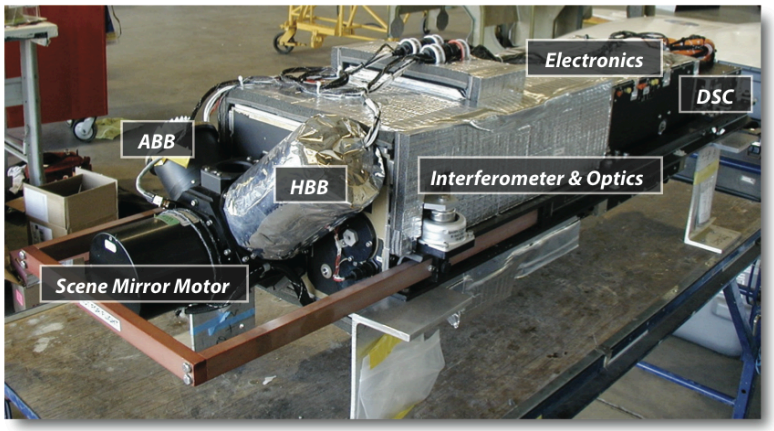
GOES-R Field Campaign Workshop
8-9 April 2015
College Park, MD

SSEC

Topics

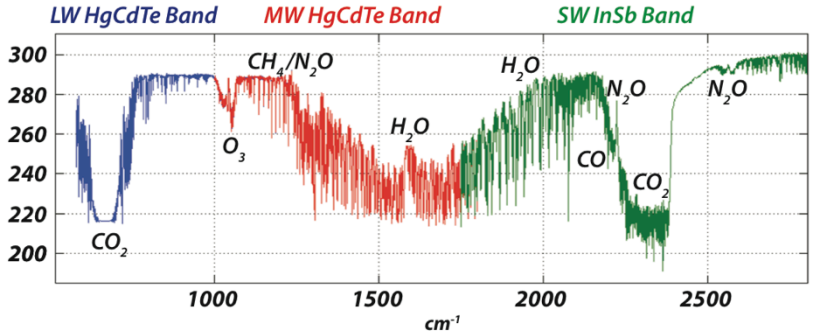
- Introduction and Instrument Overview
- Radiometric Calibration Accuracy and Traceability
- Routine data products and Example results from recent flights

S-HIS Instrument Overview



IFOV:	100 mrad (2km @ 20km, nadir)
Scene Coverage:	Programmable 45° scene mirror nadir ± 40° typical
Spectral Coverage:	LW (HgCdTe), 580 - 1180 cm^{-1} MW(HgCdTe), 1000 - 1820 cm^{-1} SW (InSb), 1750 - 3000 cm^{-1}
Spectral Resolution:	0.5 cm^{-1}

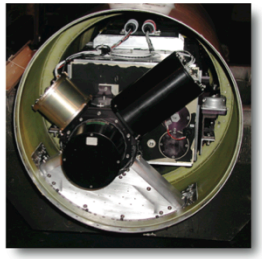
S-HIS mounted on AV-6, Zone 25



Sample upwelling S-HIS brightness temperature spectra.

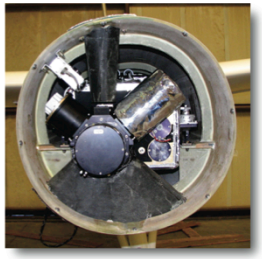
- Upwelling infrared radiances at high spectral resolution and high radiometric accuracy between 3.3 and 18 microns.
- Temperature, water vapor vertical profiles
- Trace gas retrievals
- Cloud Radiative Properties
- Surface Emissivity & Temperature
- Calibration Validation

WB-57 wingpod



ER-2 centerline pod

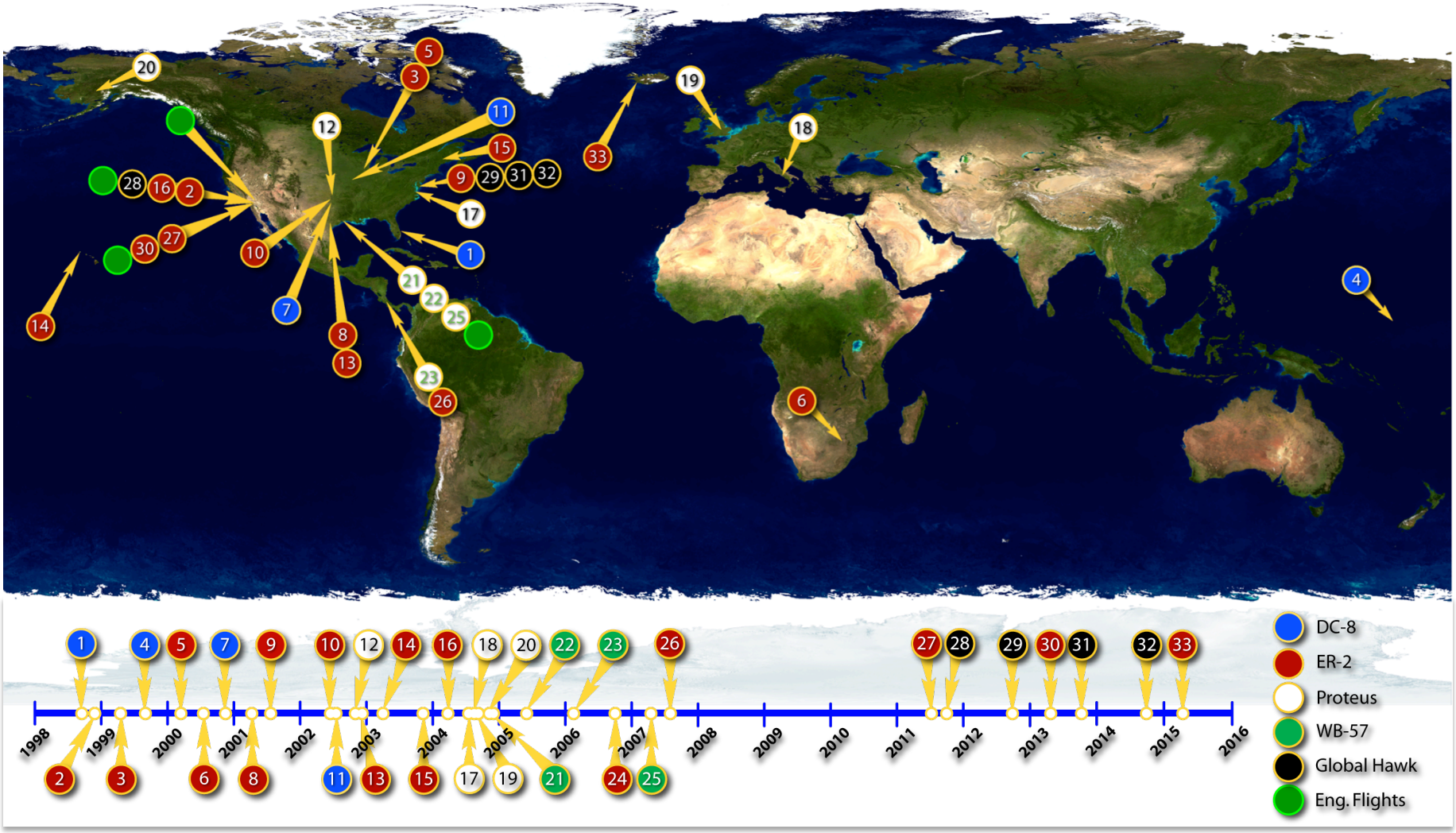
DC-8



Proteus wing boom

S-HIS Instrument Overview

- Developed 1996 - 1998 at the UW-SSEC with the combined support of the US DOE, NASA, and the NPOESS IPO.
- 33 Missions to date on 5 aircraft, typically > 99.9% up-time



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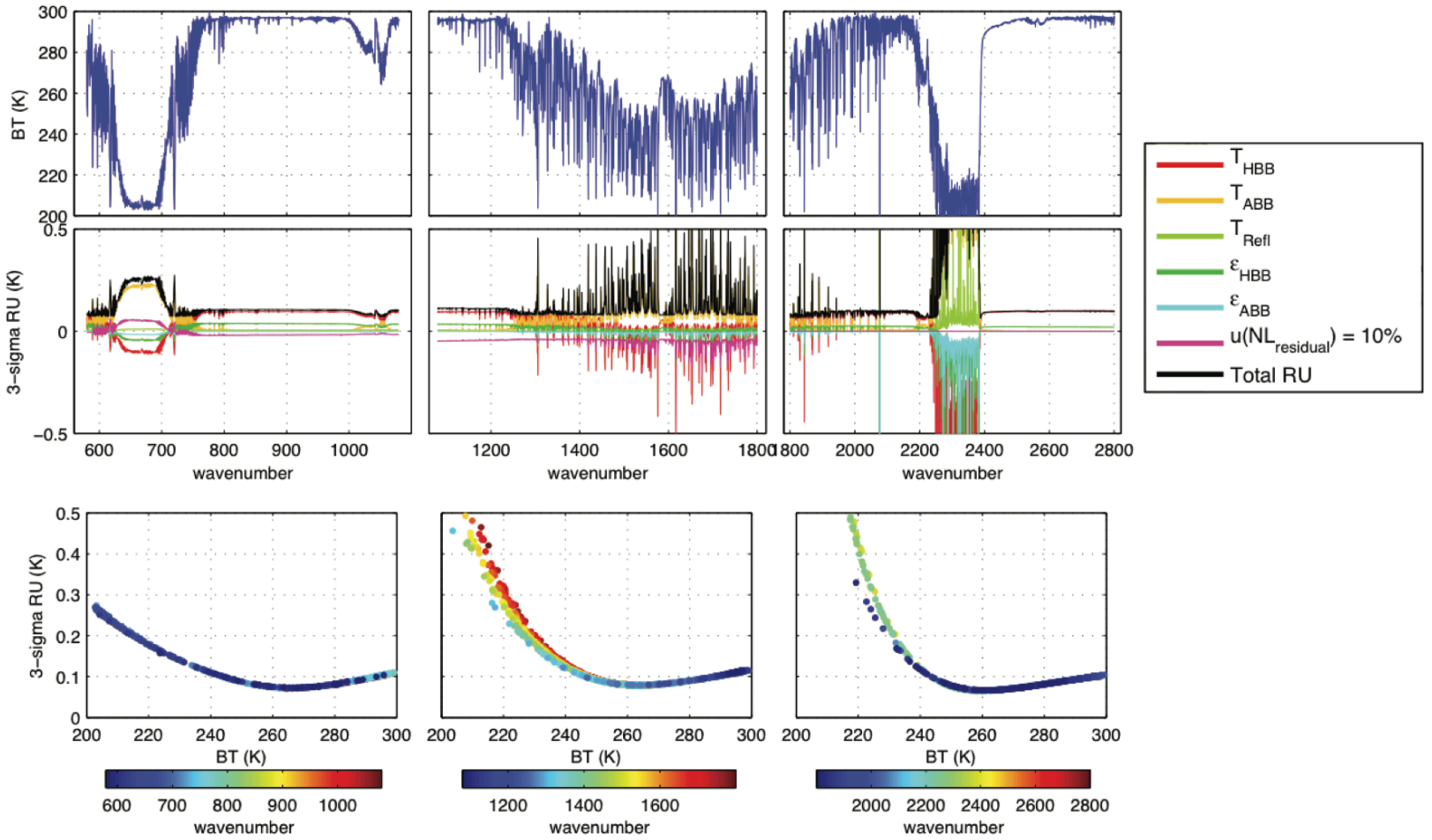
S-HIS Radiometric Uncertainty (RU)

S-HIS Brightness Temperature Spectrum and 3-sigma RU
(for clear sky conditions encountered during a S-NPP overpass on 2013-06-01)

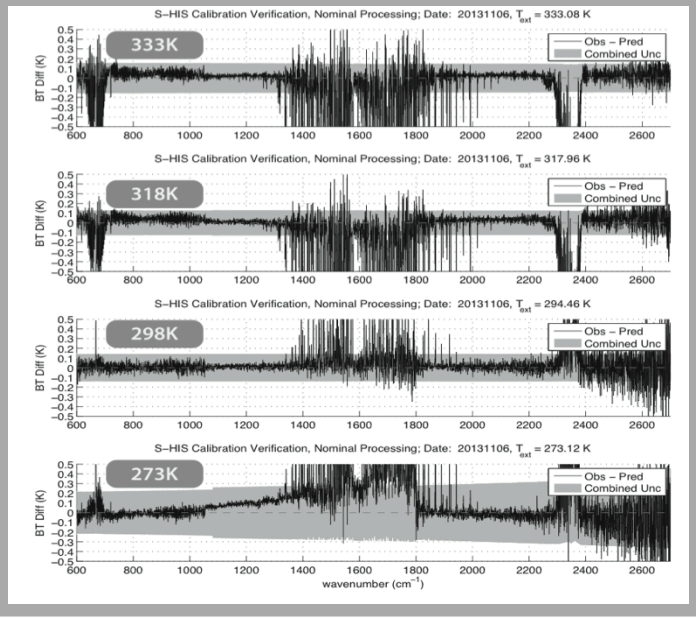


e.g. Tobin, D. C. (2007), High-Altitude Aircraft Observations Providing NIST-Traceable Benchmark Infrared Observations for GSICS, *in the October 2007 GSICS Newsletter*.

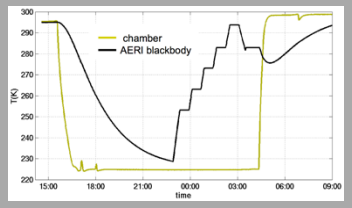
S-HIS Calibration, Calibration Verification, and Traceability

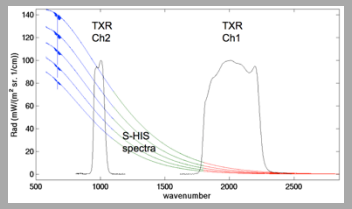
- Pre-integration calibration of on-board blackbody references at subsystem level
- Pre and post deployment end-to-end calibration verification
- Periodic end-to-end radiance evaluations under flight like conditions with NIST transfer sensors.
- Instrument calibration during flight using two on-board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

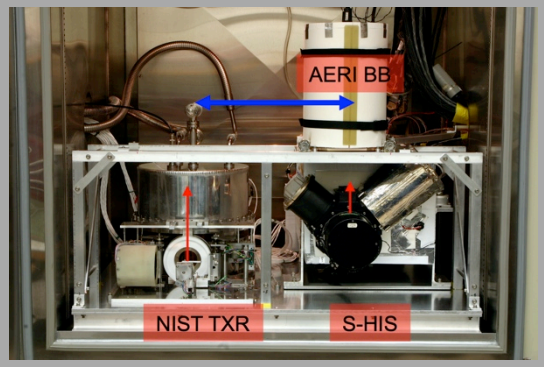
Post Mission End-to-End Calibration Verification

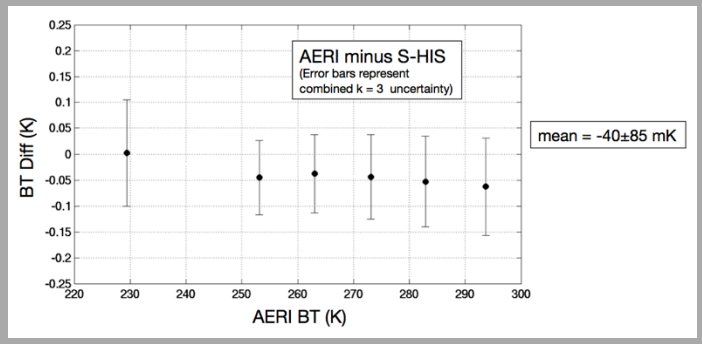


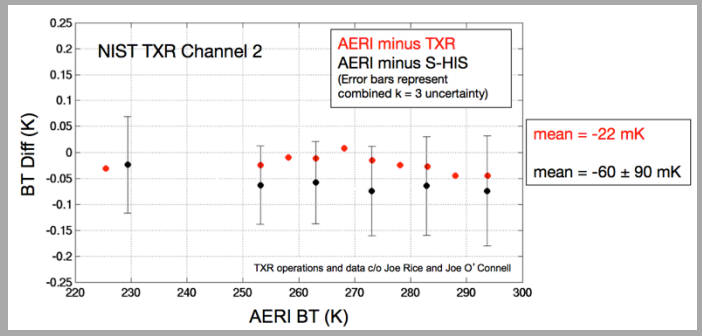
NIST TXR Validation of S-HIS Radiances











e.g. Taylor, J. K., J. Rice et al. (2007). NIST TXR Validation of S-HIS radiances and a UW-SSEC Blackbody. AGU Fall Meeting Abstracts, 1, 0311.

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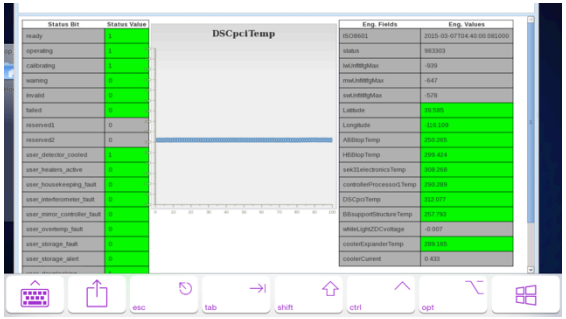
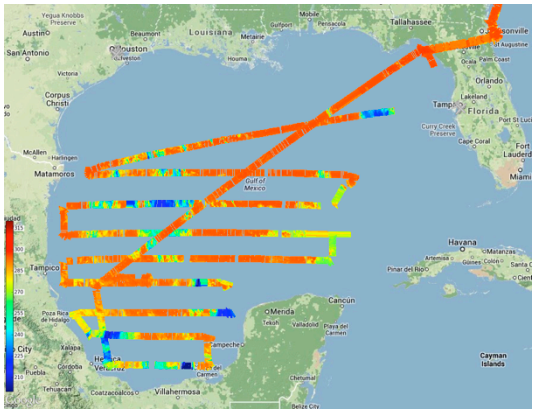
Routine Data Products, from ER-2

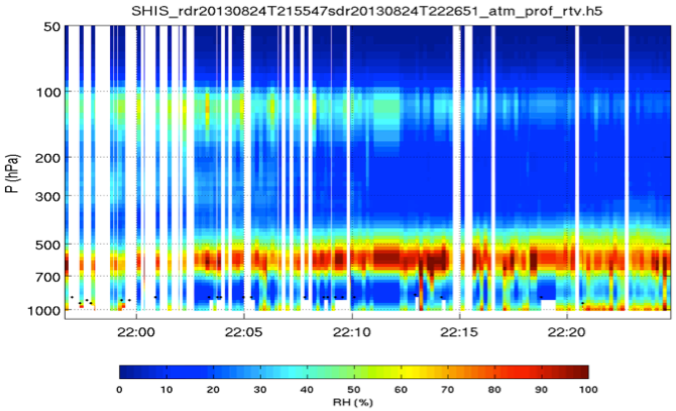
Real-Time via Iridium
- Health and Status "dashboard" monitoring of the sensor
- Trending plots of uncalibrated (ZPD) measurement data



Preliminary Products (~6 hours)
- Engineering diagnostics
- Calibrated spectral radiances
- Atmospheric profile and surface/ cloud retrievals
- And associated quicklook images

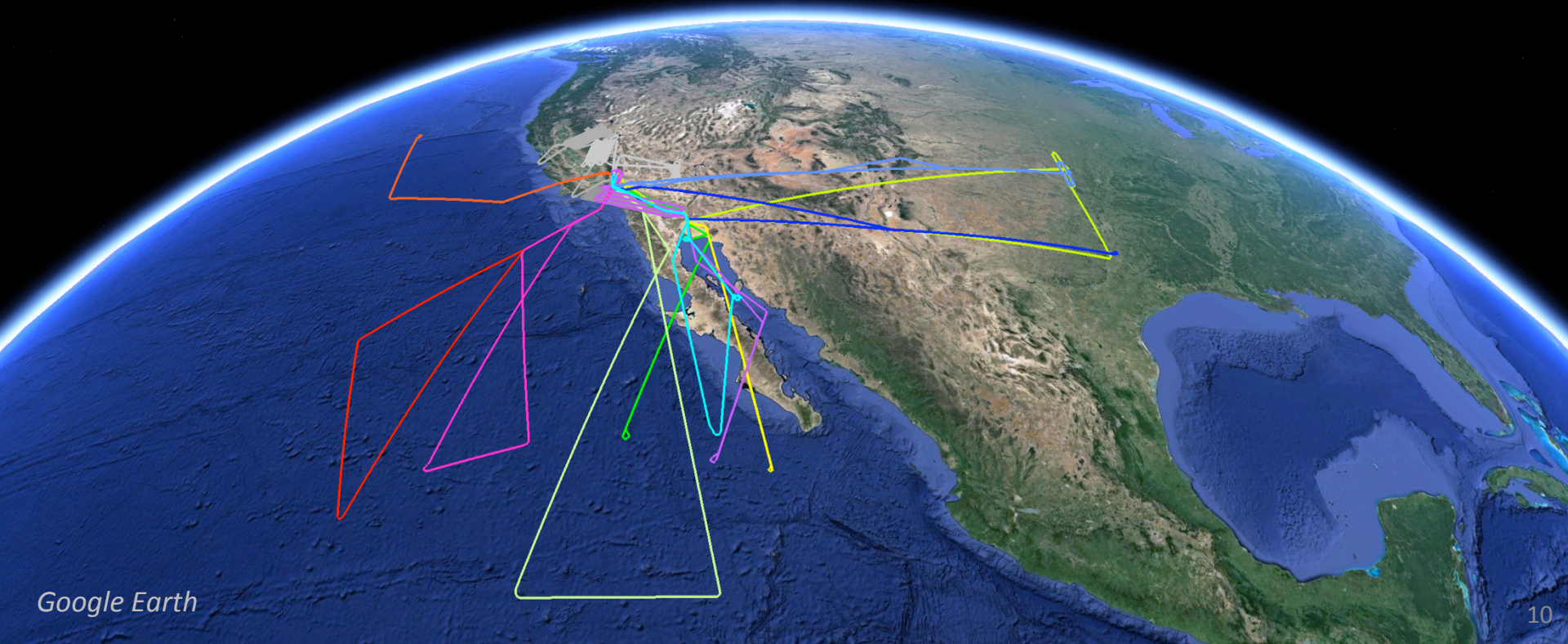


Final Products (~3 months)
- Quality controlled and verified spectral radiances
- Atmospheric sounding retrieval products



Examples of Recent Analysis and Results: SNPP Calibration Validation Campaign 2013

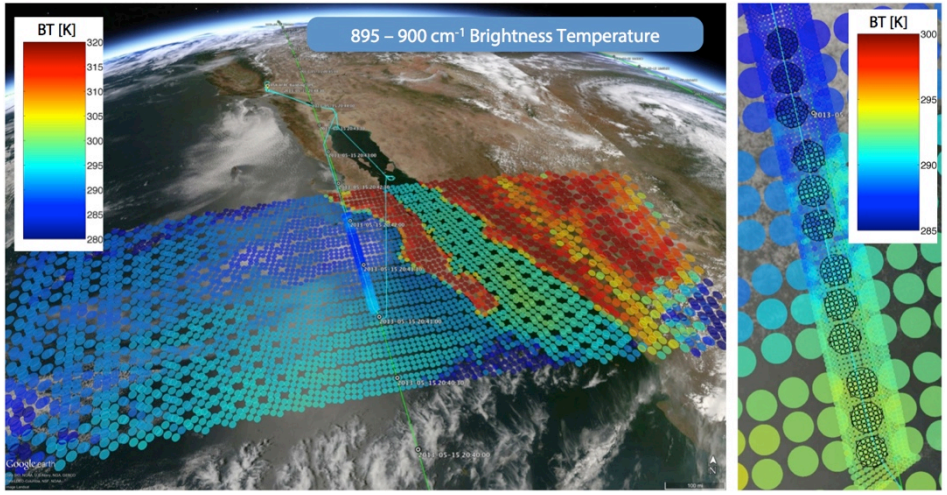
- Eleven ER-2 under-flights of the Suomi NPP satellite were conducted during the 2013 airborne calibration validation campaign. Flights were based out of the NASA Dryden Airborne Operations Facility (DAOF) in Palmdale, CA.
- Real-time status monitoring via Iridium (no KU on ER-2)
- Final data products, with QC, distributed via SSEC download site.



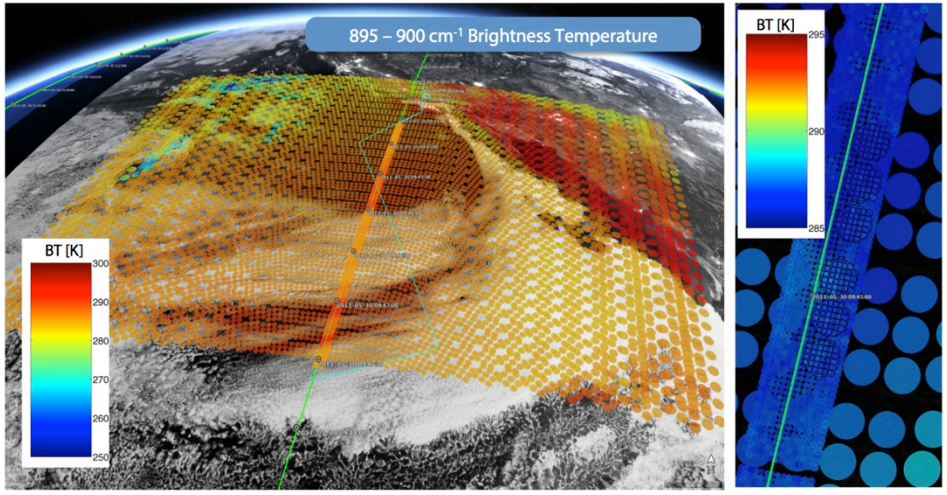
Google Earth

Examples of Recent Analysis and Results: SNPP Calibration Validation Campaign 2013

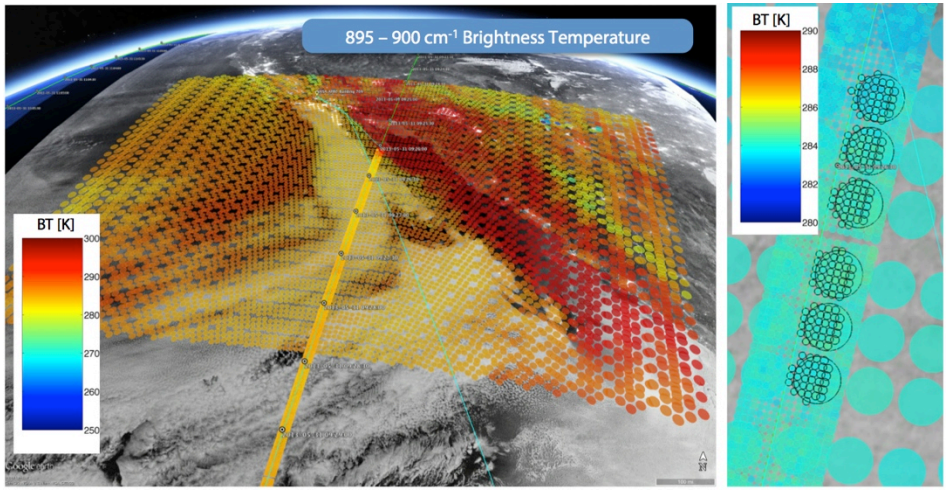
S-HIS and CrIS Footprints colored by 895 – 900 cm^{-1} Brightness Temperature



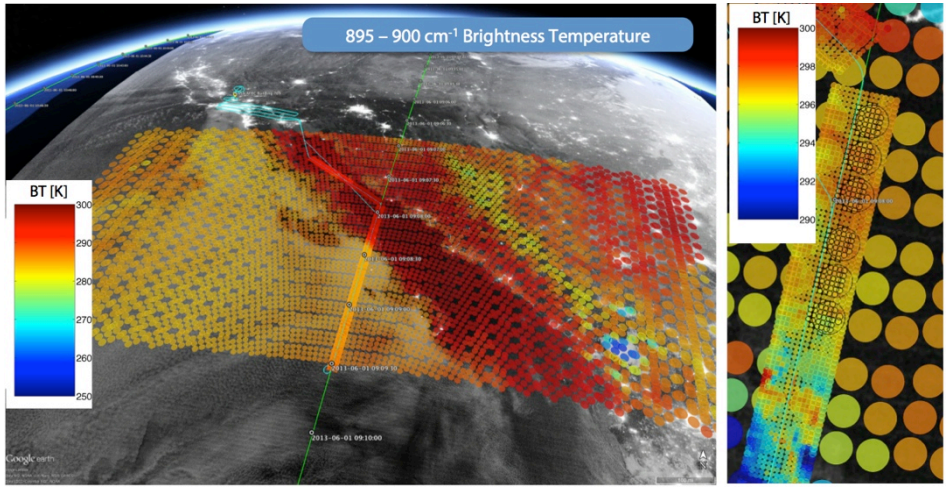
15-May-2013, overlaid on VIIRS true color image



30-May-2013, overlaid on VIIRS DNB



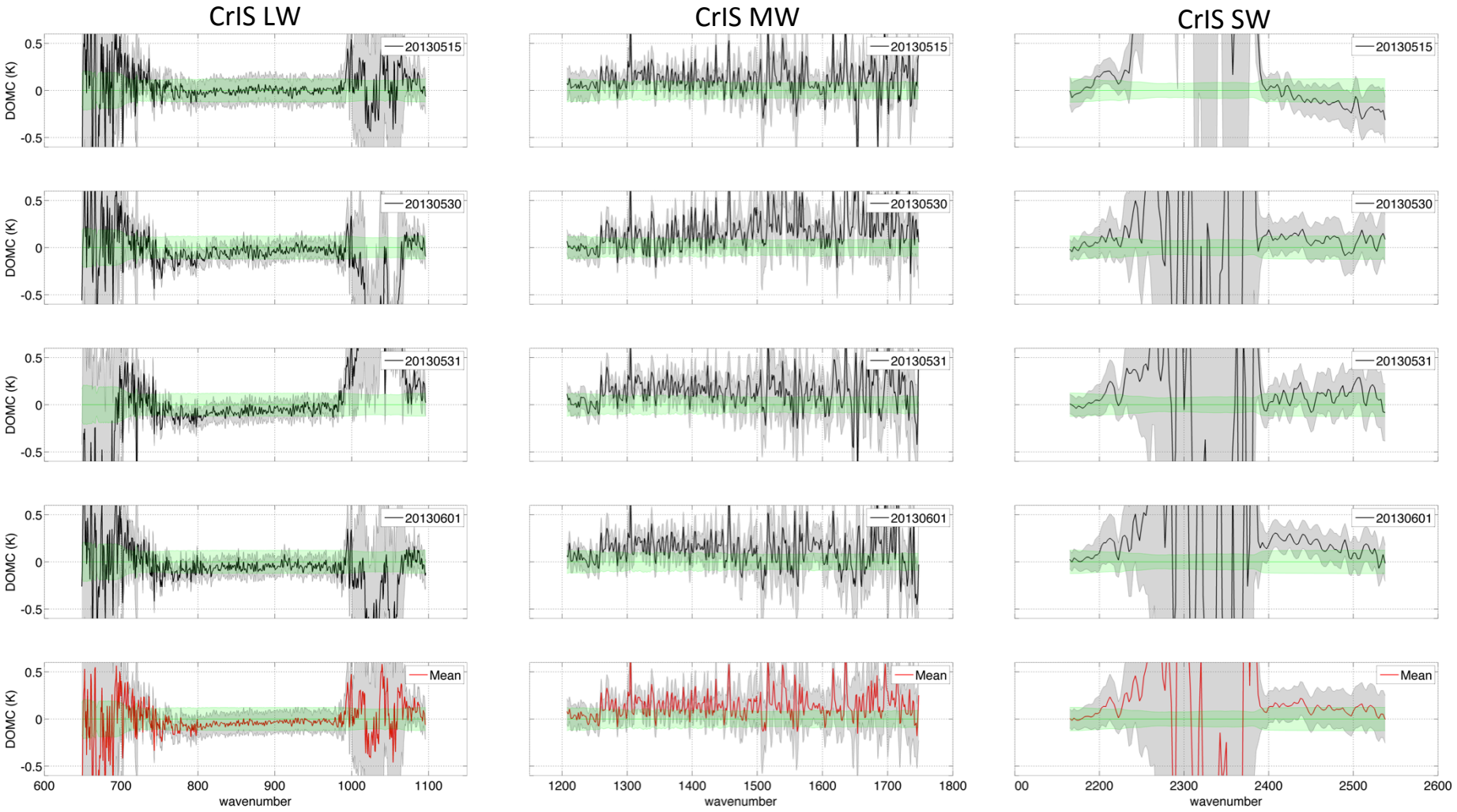
31-May-2013, overlaid on VIIRS DNB



01-June-2013, overlaid on VIIRS DNB

Examples of Recent Analysis and Results: SNPP Calibration Validation Campaign 2013

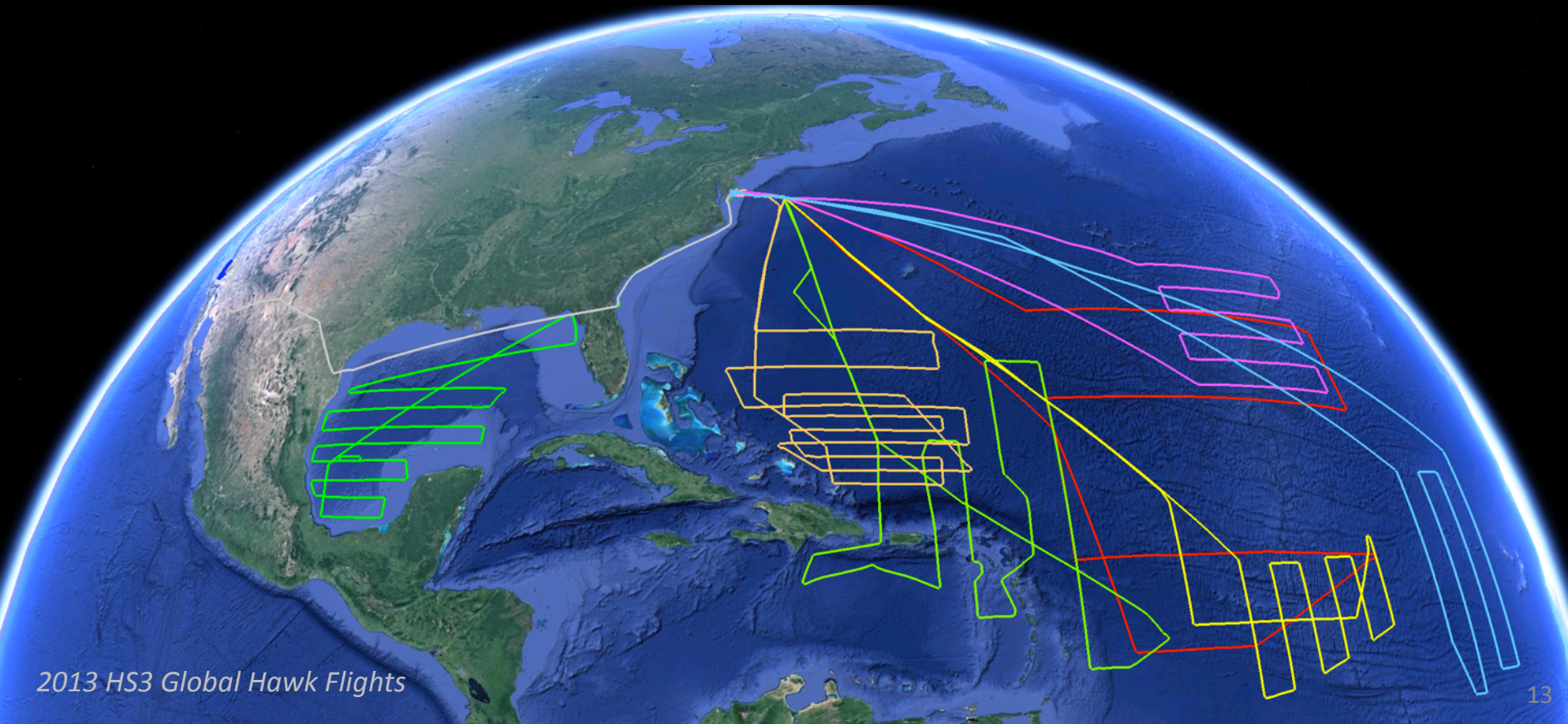
Calibration Verification Results (Double Obs – Calc Methodology, On CrIS Spectral Scale)



Taylor, Joe K.; Tobin, D. C.; Revercomb, H. E.; Best, F. A.; Knuteson, R. O.; Garcia, R. K.; Deslover, D. and Borg, L. A., **Suomi NPP/JPSS Cross-track Infrared Sounder (CrIS): Calibration validation with the aircraft based Scanning High-resolution Interferometer Sounder (S-HIS)**. Boston, MA, American Meteorological Society, 2014.

Examples of Recent Analysis and Results: Hurricane and Severe Storm Sentinel (HS3) Mission

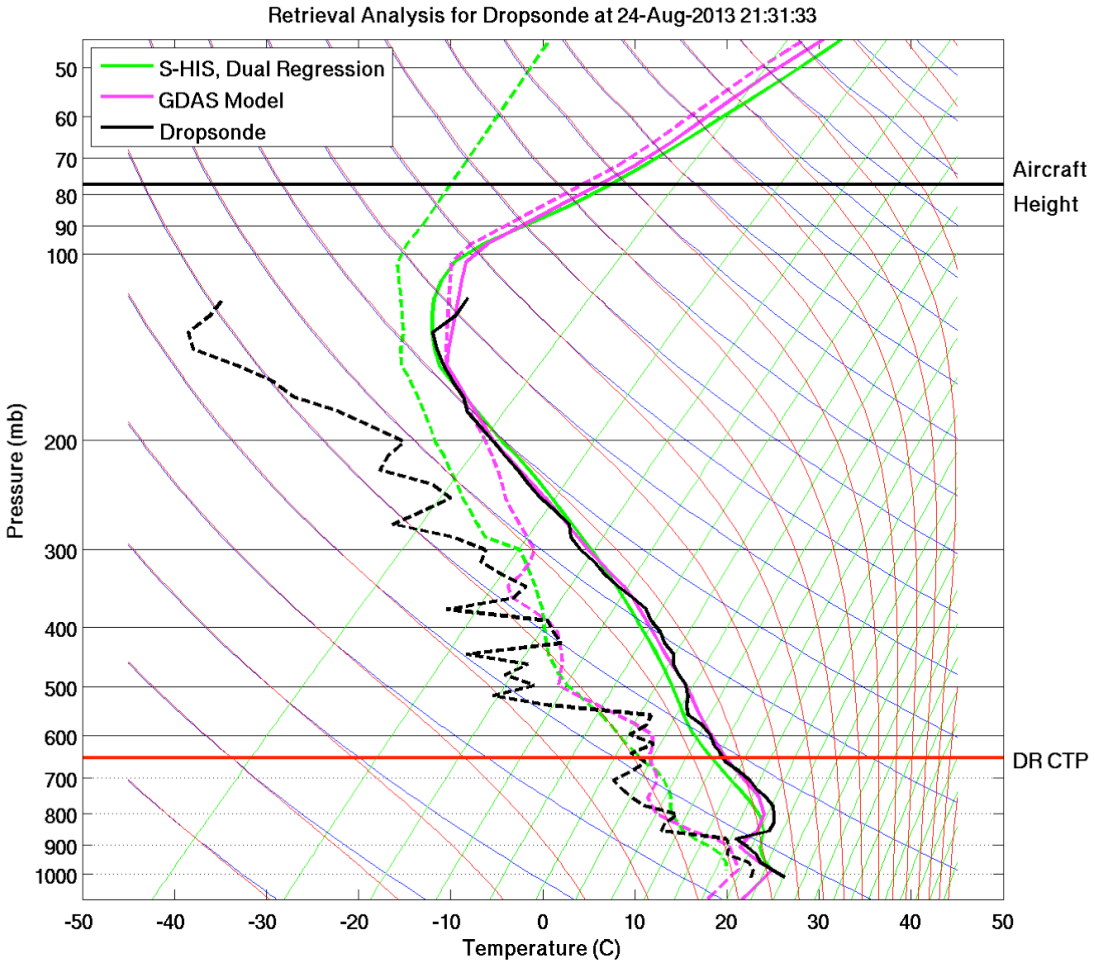
- Flights during the 2012, 2013, and 2014 hurricane seasons on the NASA Global Hawk. 605 flight hours, with > 99.8% S-HIS uptime
- Real-time data products available with < 1 minute latency
- Final radiance and retrieval data products, with QC, distributed to project

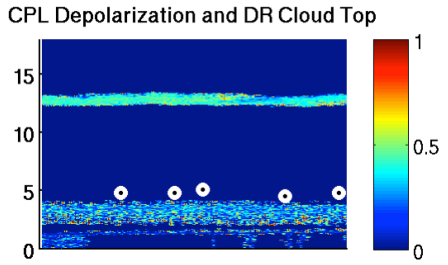


2013 HS3 Global Hawk Flights

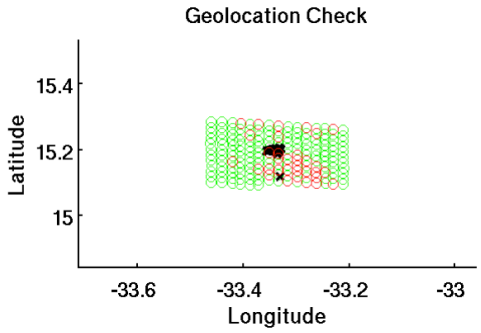
Daily HS3 S-HIS Retrieval Analysis

- S-HIS two-minute mean atmospheric state retrieval profiles are determined for each AVAPS dropsonde.
- Example for 24 Aug 2013 shows good retrieval despite upper level thin cirrus and lower level aerosol layers.





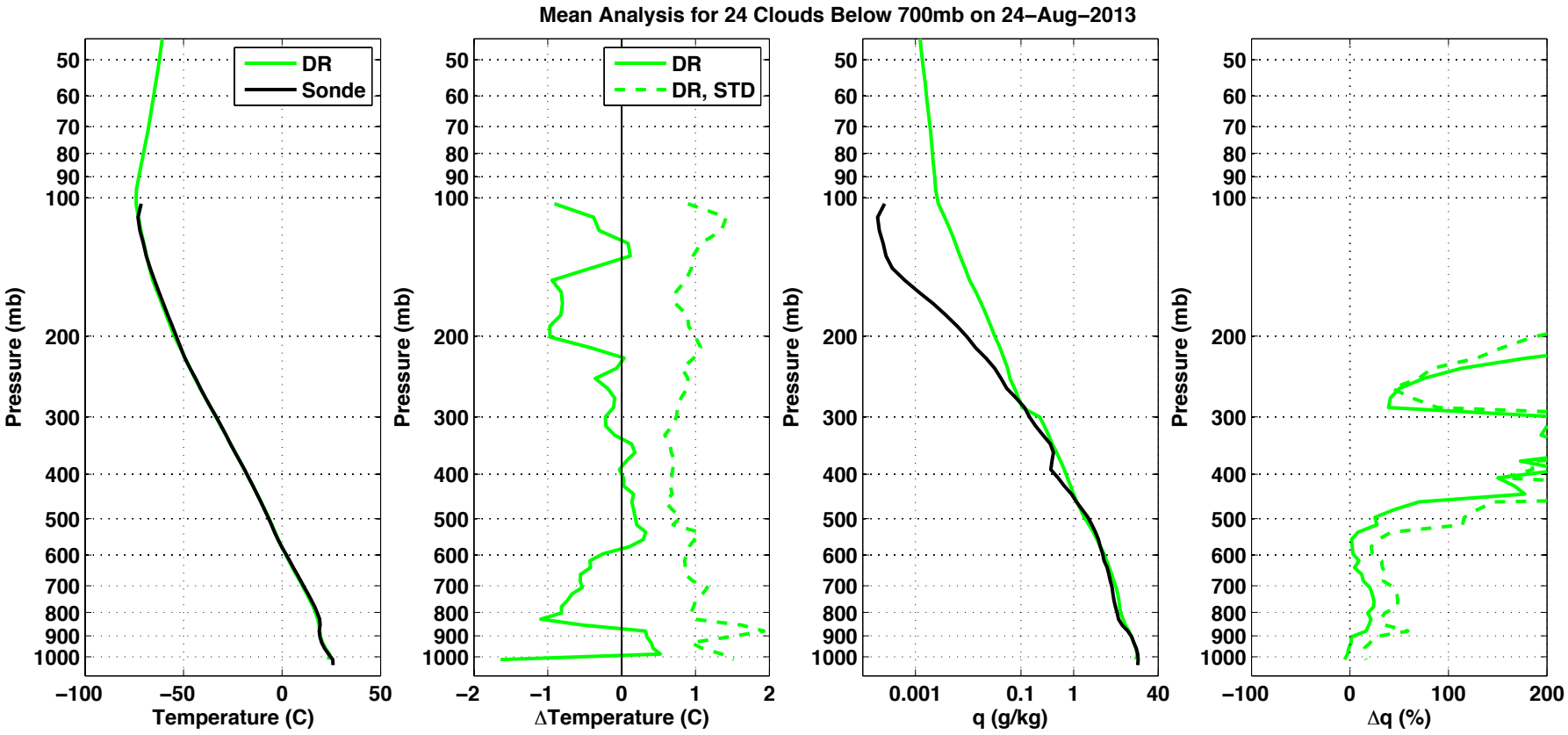
Other Details:
Dual Regression Cloud Mask: 0.22
Dual Regression Cloud Top Pressure: 651.5 mb
Dual Regression Cloud OD: 1.2
Aircraft Altitude: 18.2 km at 77.24 mb



e.g. Smith, W.L. Sr., Weisz, E., Kireev, S.V., Zhou, D.K., Li, Z., Borbas, E.E. (2011), Dual-regression retrieval algorithm for real-time processing of satellite ultraspectral radiances, Journal of Applied Meteorology and Climatology, Volume 51, Issue 8, 1455-1476.

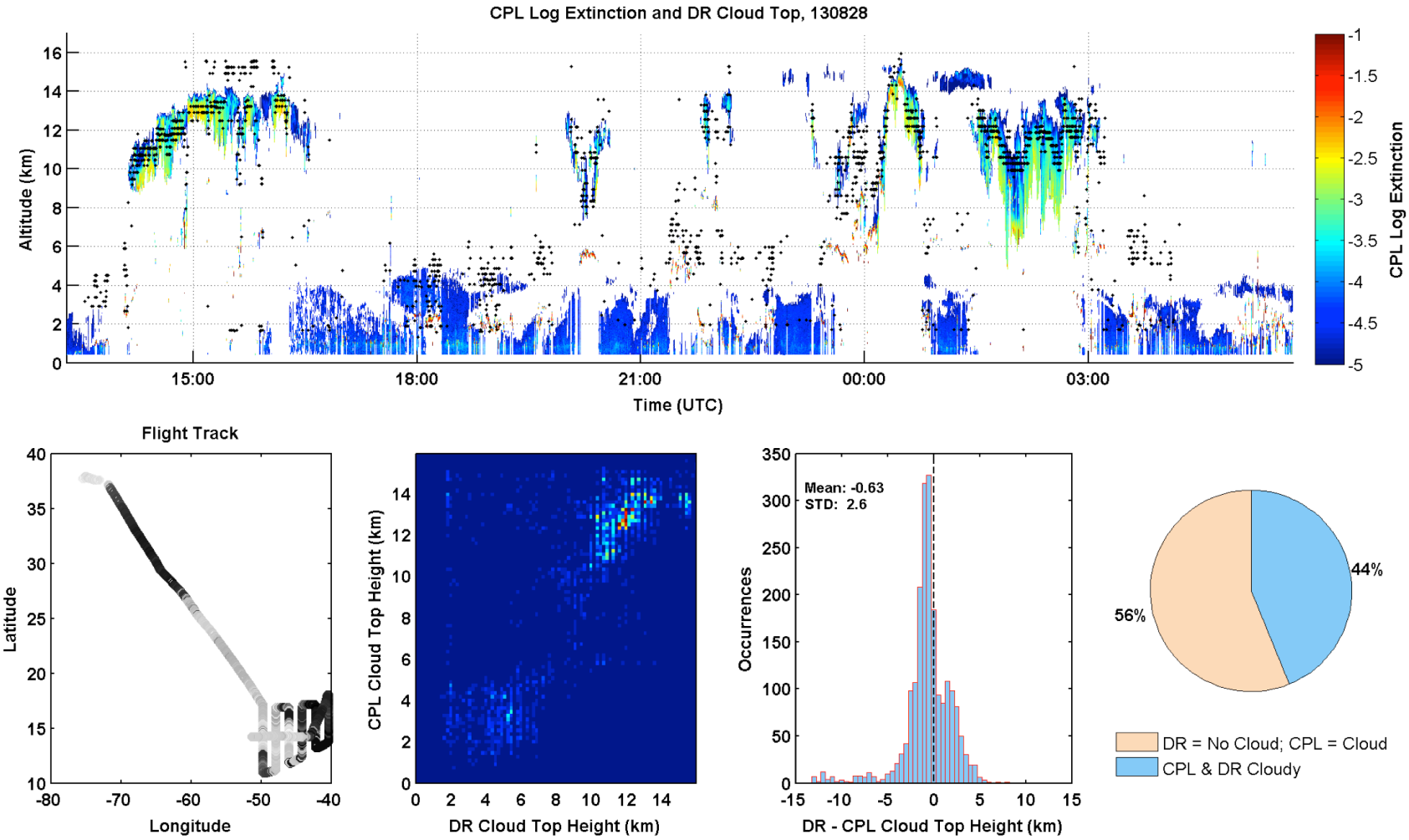
Daily HS3 S-HIS Retrieval Analysis

- Limit analysis profiles to cases where cloud top retrieval is under 700 mb.
- Compare daily mean AVAPS dropsonde profile to S-HIS profiles for these cases.
- Temperature profiles agree to within 1 K.
- Water vapor diverges sharply above 300 mb (AVAPS upper level dry bias)



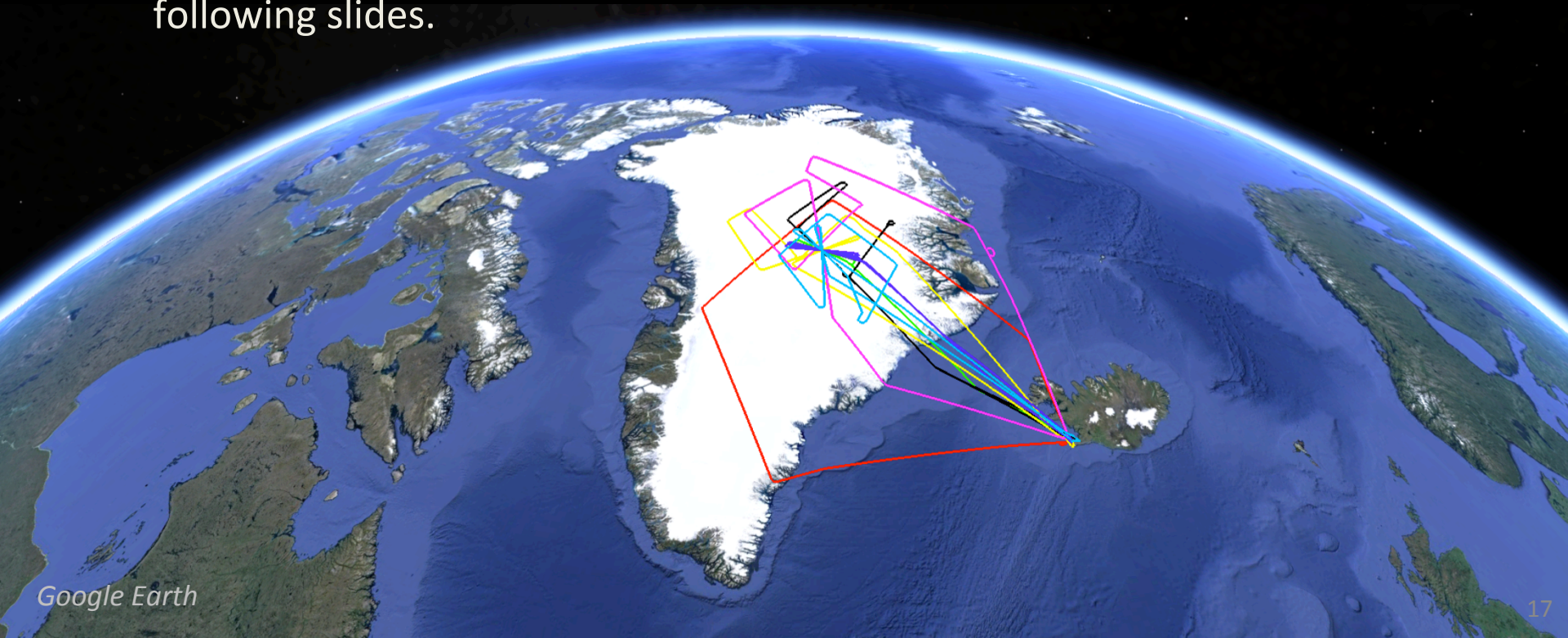
Daily HS3 S-HIS Retrieval Cloud Top Analysis

- S-HIS nadir footprints are collocated with CPL measurements.
- Mean CPL cloud top is compared to S-HIS retrieved cloud top



Examples of Recent Analysis and Results: SNPP Calibration Validation Campaign 2015

- Seven ER-2 science flights were conducted during the March 2015 airborne calibration validation campaign. Flights were based out of Keflavik Iceland with flights over the Greenland ice sheet.
- The S-HIS had 100% up-time during the campaign and many valuable satellite underflight datasets were collected.
- Some preliminary satellite radiance assessments are shown on the following slides.



Examples of Recent Analysis and Results: SNPP Calibration Validation Campaign 2015

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-
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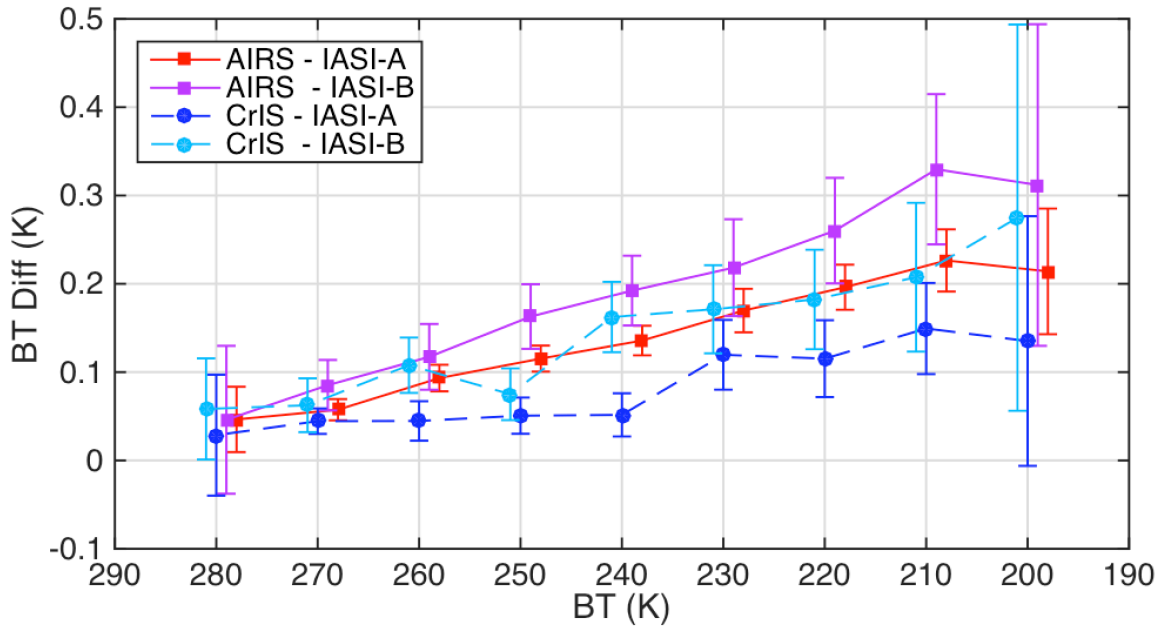
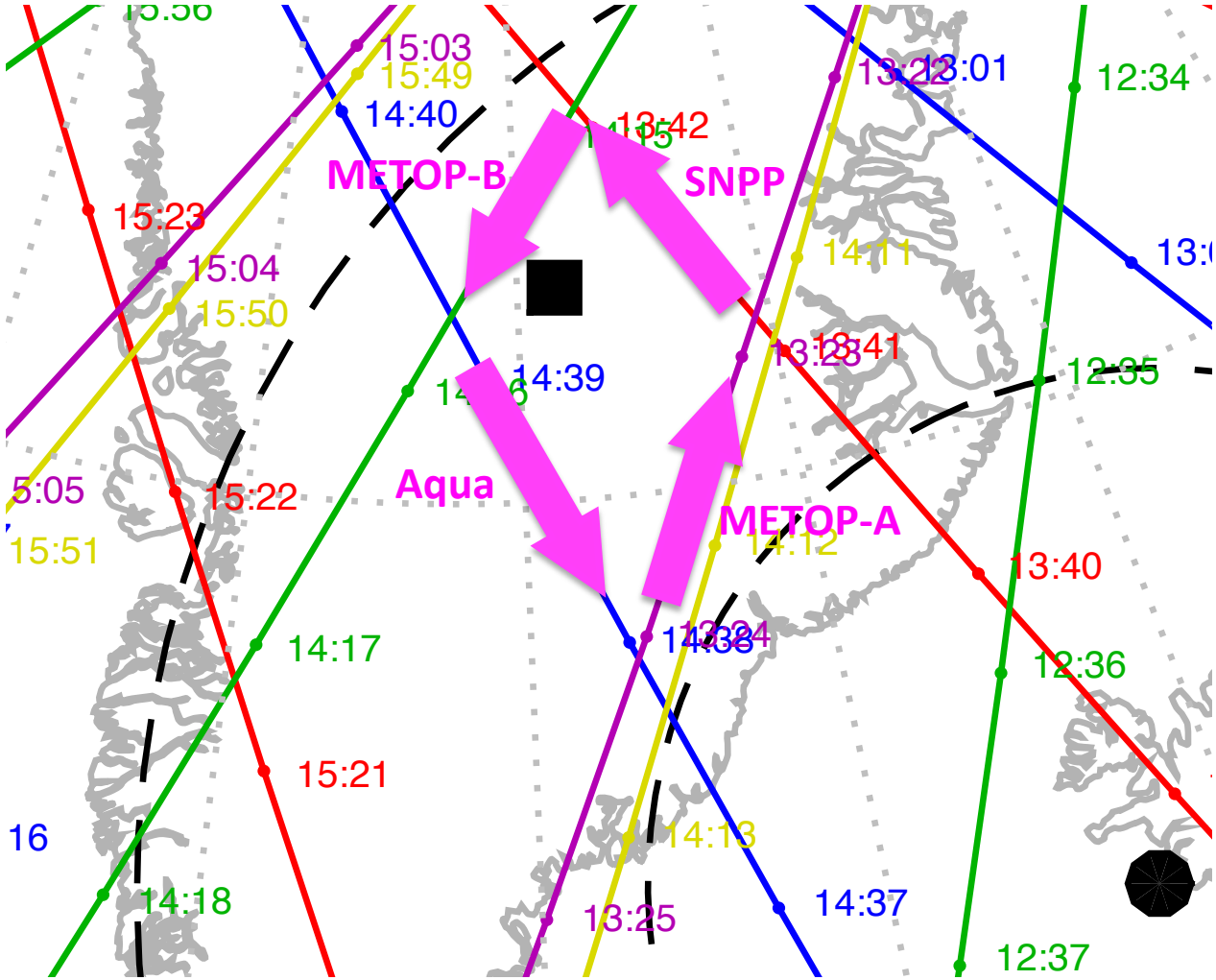
Differences between hyperspectral IR sounders as a function of scene temperature



Simultaneous Nadir Overpass (SNO) differences for the Longwave window region (910-930 cm^{-1})

Google Earth

Examples of Recent Analysis and Results:
25 March Flight: Nadir underflights of METOP-A, S-NPP, METOP-B, and Aqua



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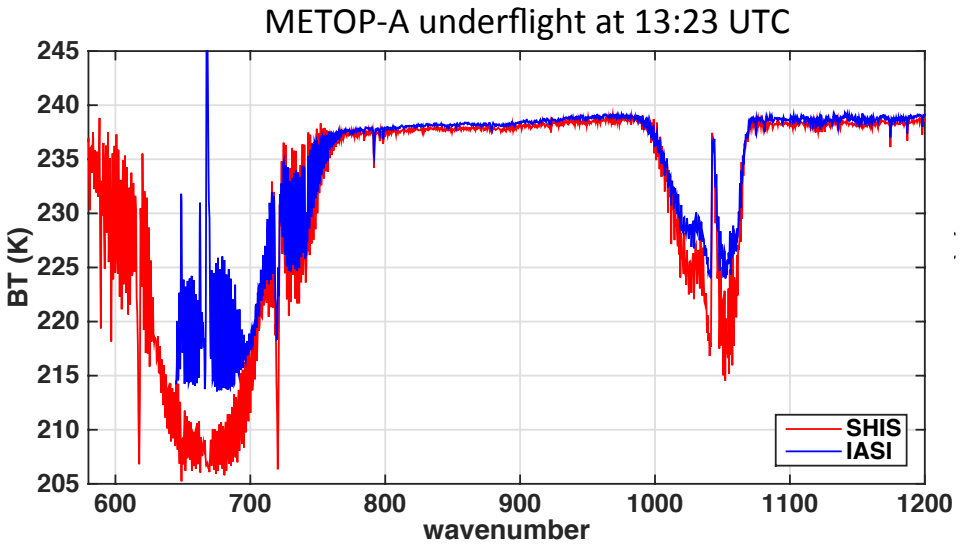

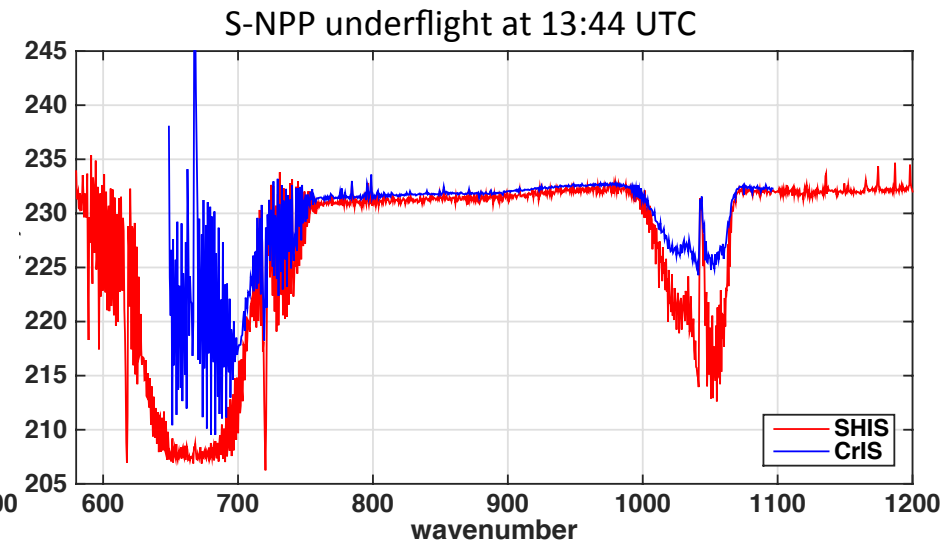

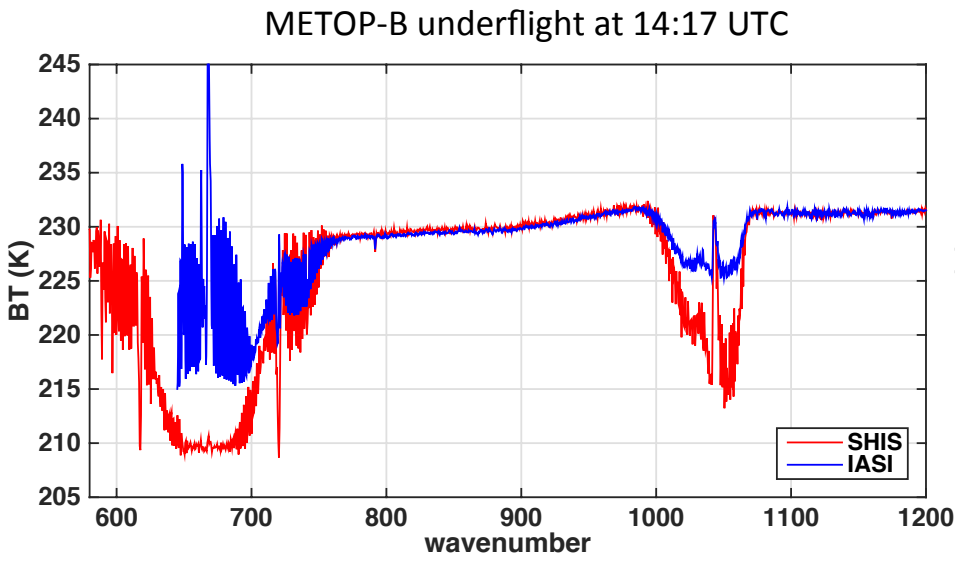

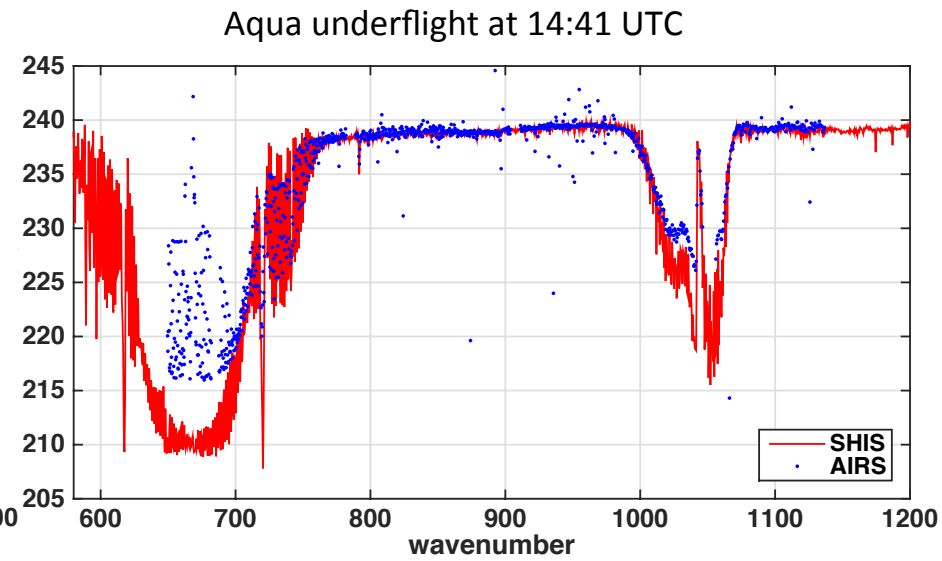

Summary

- The S-HIS has proven to be a reliable and and accurately calibrated reference instrument with a well defined radiometric uncertainty and traceability path.
- We have a well defined process/system for producing preliminary (~6 hours) and final (~3 month) radiance and retrieval products.
- There are many successful uses of S-HIS underflight data to assess and improve various satellite sensors including AIRS, MODIS, IASI, IMG, TES, CrIS, VIIRS, etc.
- We are looking forward to the opportunity to participate in the GOES-R field campaigns.

Thank You