Linking GRUAN to the Satellite Community

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Major Themes

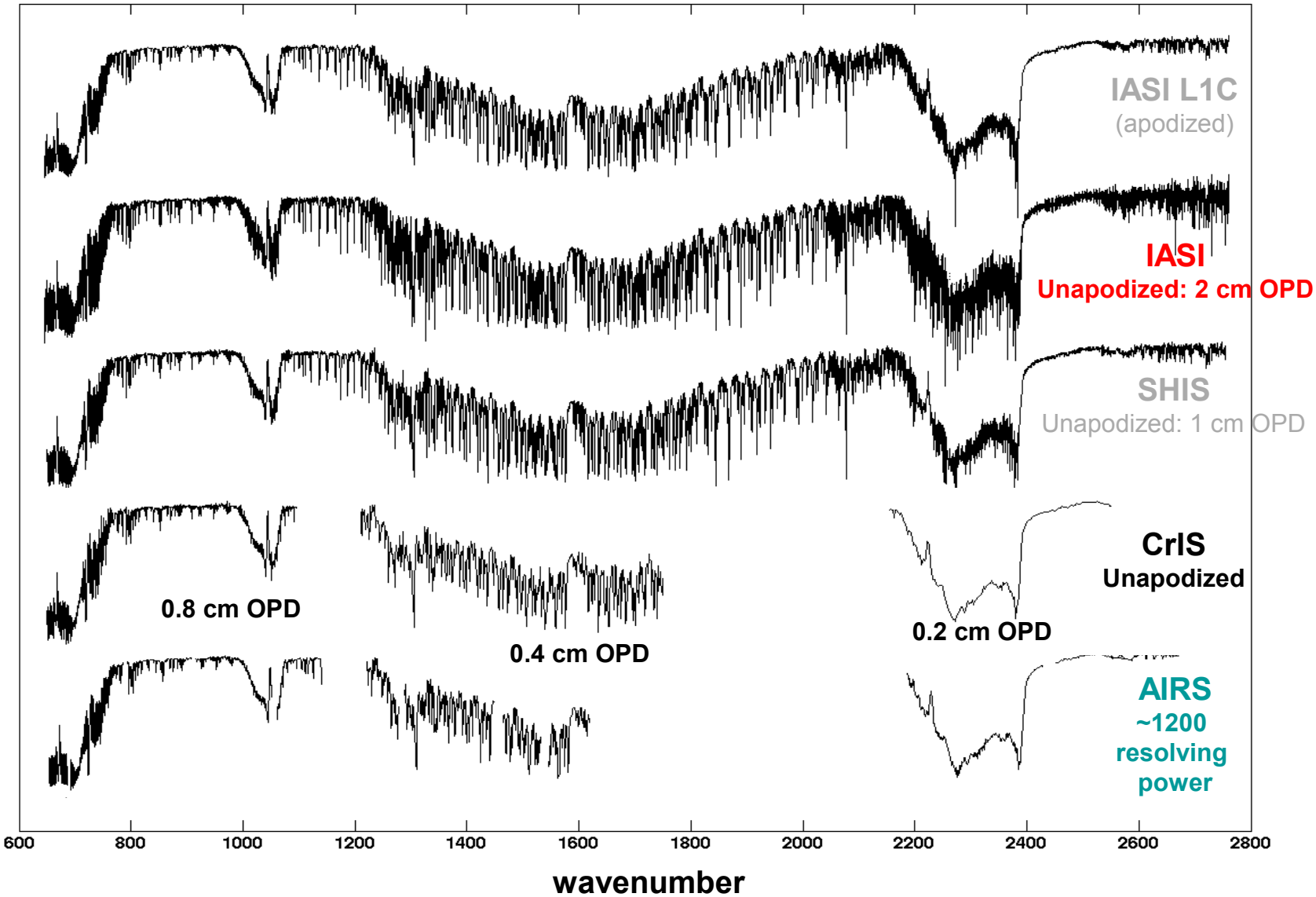
- Fundamental satellite calibration will come through satellite-satellite methods: GSICS
- Predominant interests of satellite community in GRUAN-like measurements are:
  - Product (retrieval) validation
  - Radiative transfer improvement
- Multiple high-quality measurements to estimate atmospheric state at satellite overpass
- Site Atmospheric State Best Estimate (SASBE)

AIRS
Atmospheric InfraRed Sounder
Grating spectrometer
166 kg, 256 W
13.5 km FOV at nadir, contiguous
Launched on Aqua in 2002

IASI
Infrared Atmospheric Sounding Interferometer
Michelson interferometer
236 kg, 210 W
2x2 12 km FOVs at nadir, non-contiguous
Launched on Metop-A in 2006

CrIS
Cross-track Infrared Sounder
Michelson interferometer
146 kg, 110 W
3x3 14 km FOVs at nadir, contiguous
To be launched on NPP on 25 October 2011

Spectral Coverage and Resolution



Summary of products from AIRS & IASI

gas	Range (cm^{-1})	Precision	d.o.f.		AIRS	IASI
T	650-800 2375-2395	1K/km	6-10	H2O,O3,N2O emissivity	NASA DAAC	NGDC/CLASS
H_2O	1200-1600	15%	4-6		NASA DAAC	NGDC/CLASS

CriMSS Performance Specification

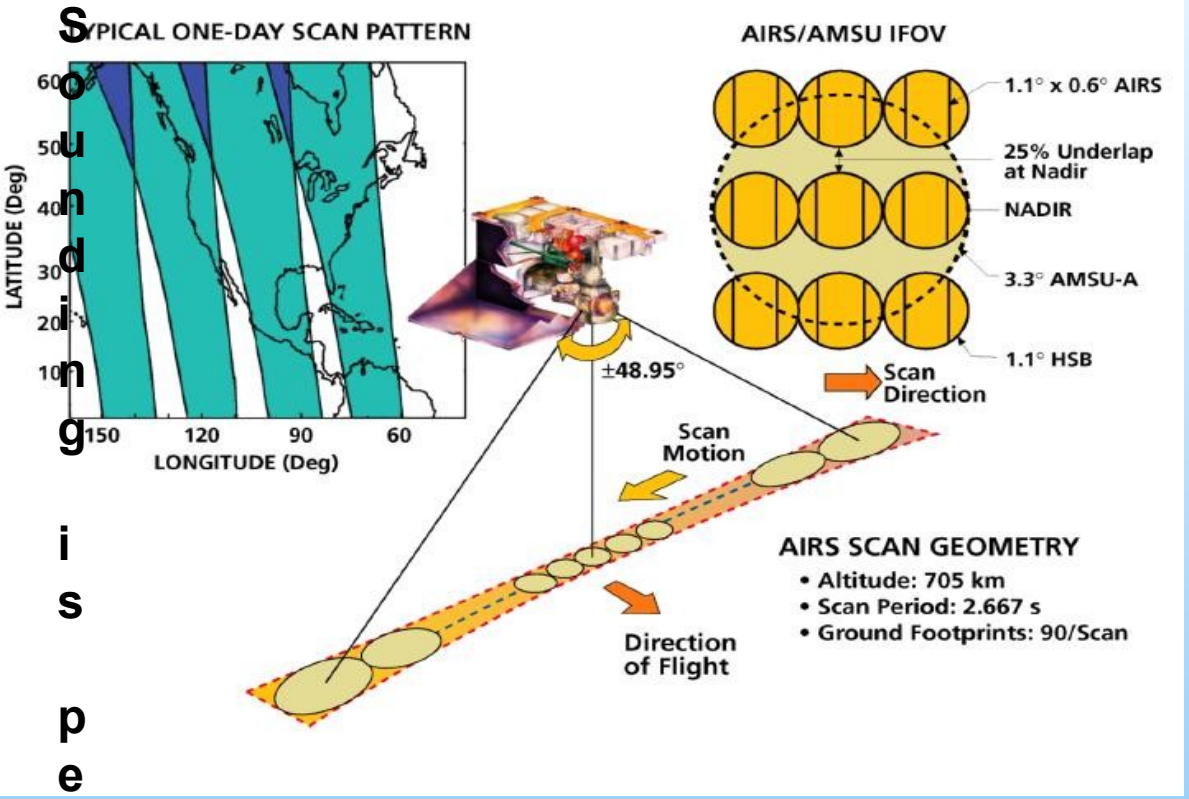
Atmospheric Vertical Temperature Profile (AVTP) Measurement Uncertainty – Layer Average Temperature Error	
PARAMETER	**THRESHOLD**
AVTP Clear, surface to 300 mb	**1.6 K / 1-km layer**
AVTP Clear, 300 to 30 mb	1.5 K / 3-km layer
AVTP Clear, 30 mb to 1 mb	1.5 K / 5-km layer
AVTP Clear, 1 mb to 0.5 mb	3.5 K / 5-km layer
AVTP Cloudy , surface to 700 mb	**2.5 K / 1-km layer**
AVTP Cloudy, 700 mb to 300 mb	1.5 K / 1-km layer
AVTP Cloudy, 300 mb to 30 mb	1.5 K / 3-km layer
AVTP Cloudy, 30 mb to 1 mb	1.5 K / 5-km layer
AVTP Cloudy, 1 mb to 0.5 mb	3.5 K/ 5-km layer

Atmospheric Vertical Moisture Profile (AVMP) Measurement Uncertainty – 2-km Layer Average Mixing Ratio % Error	
PARAMETER	**THRESHOLD**
AVMP Clear, surface to 600 mb	**Greater of 20% or 0.2 g/kg / 2-km layer**
AVMP Clear, 600 to 300 mb	Greater of 35% or 0.1 g/kg / 2-km layer
AVMP Clear, 300 to 100 mb	Greater of 35% or 0.1 g/kg / 2-km layer
AVMP Cloudy, surface to 600 mb	**Greater of 20% of 0.2 g/kg / 2-km layer**
AVMP Cloudy, 600 mb to 400 mb	Greater of 40% or 0.1 g/kg / 2-km layer
AVMP Cloudy, 400 mb to 100 mb	Greater of 40% or 0.1 g/kg / 2-km layer

(courtesy Nick Nalli)

Sounding Strategy in Cloudy Scenes: Co-located Thermal & Microwave

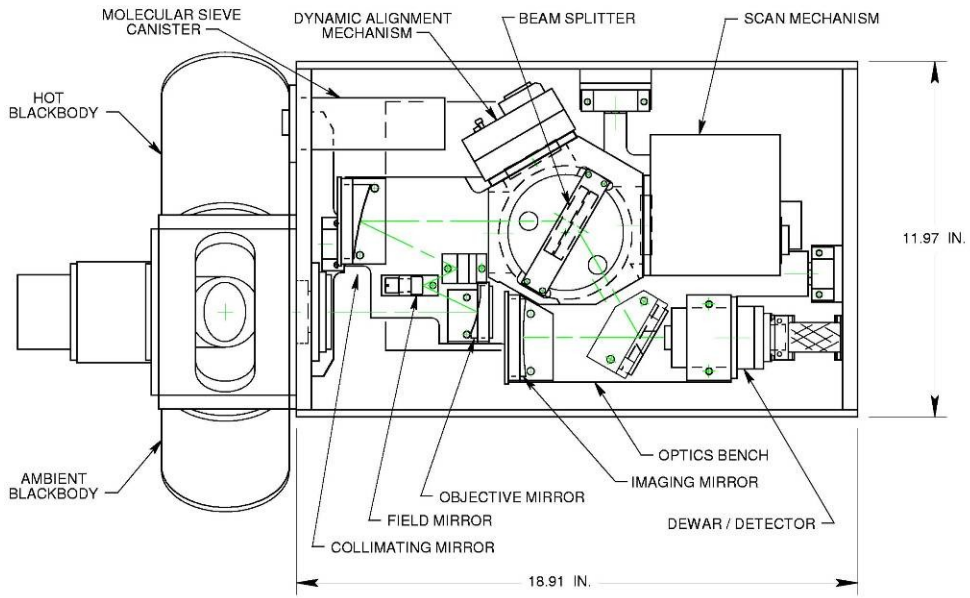
- Sounding is performe

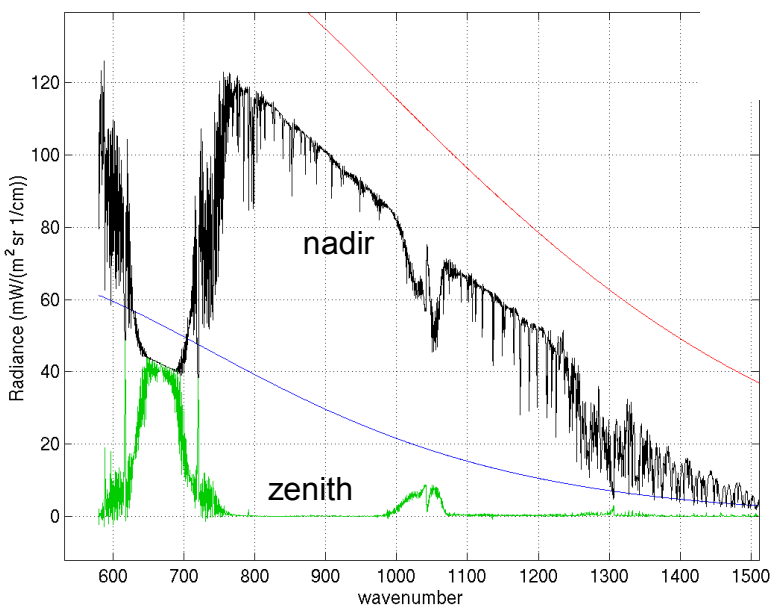


AIRS, IASI, and CrIS all acquire 324,000 FOR's per day

Scanning-High resolution Interferometer Sounder (S-HIS)

- HIS and AERI heritage
- 0.5 cm^{-1} resolution
- 580-3000 cm^{-1} coverage with three spectral bands
- 100 mrad FOV (~2 km diameter from 20 km)
- programmable cross track downward and zenith viewing
- 1998 to present on NASA ER-2, Proteus, and NASA WB-57
- In-field calibrated spectra

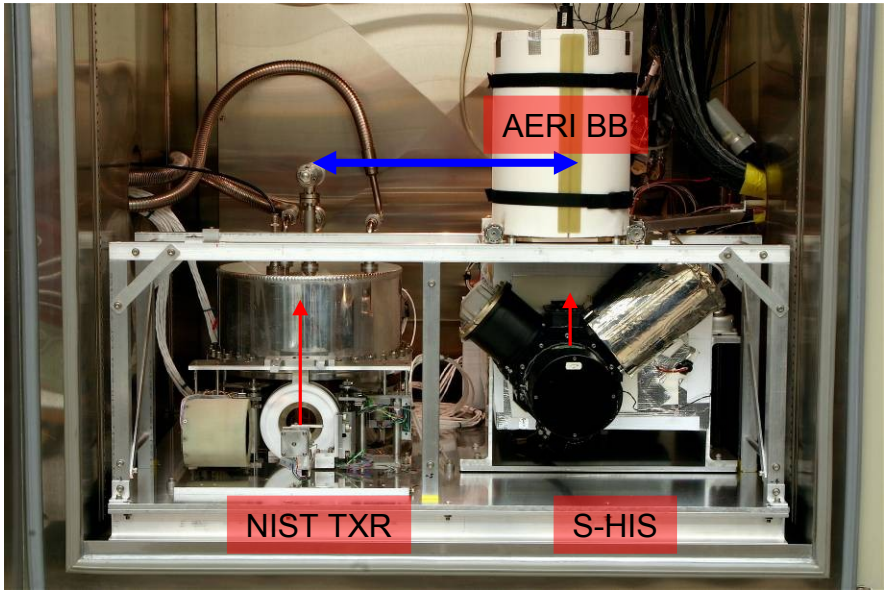




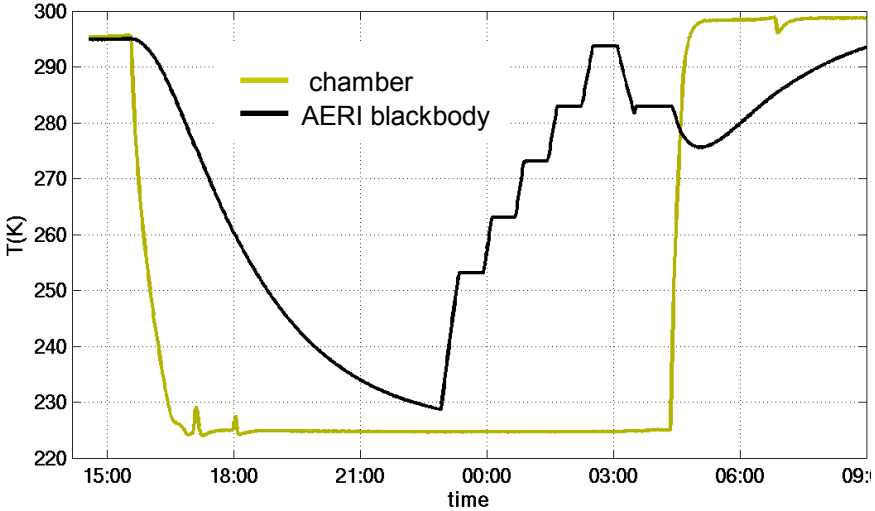
S-HIS on WB-57 wing pod

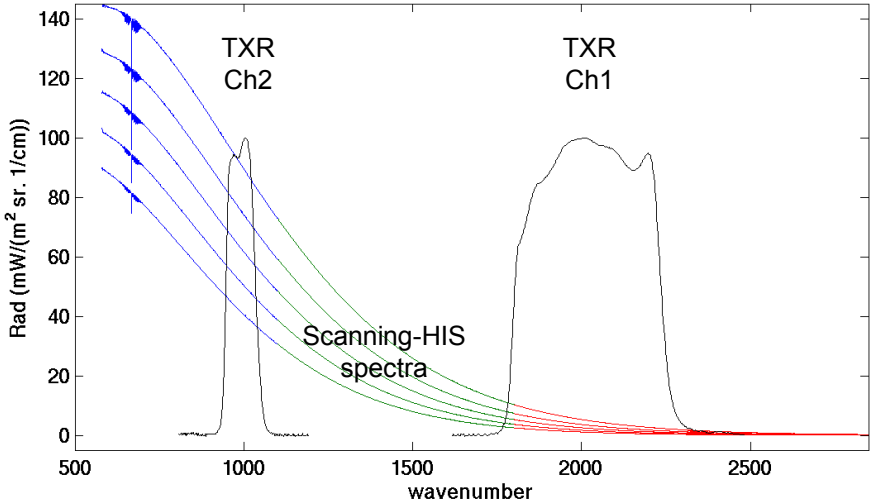
Traceability

Perform **periodic end-to-end radiance evaluations** under flight-like conditions with NIST transfer sensors such that satellite validation analyses are traceable to the NIST radiance scale

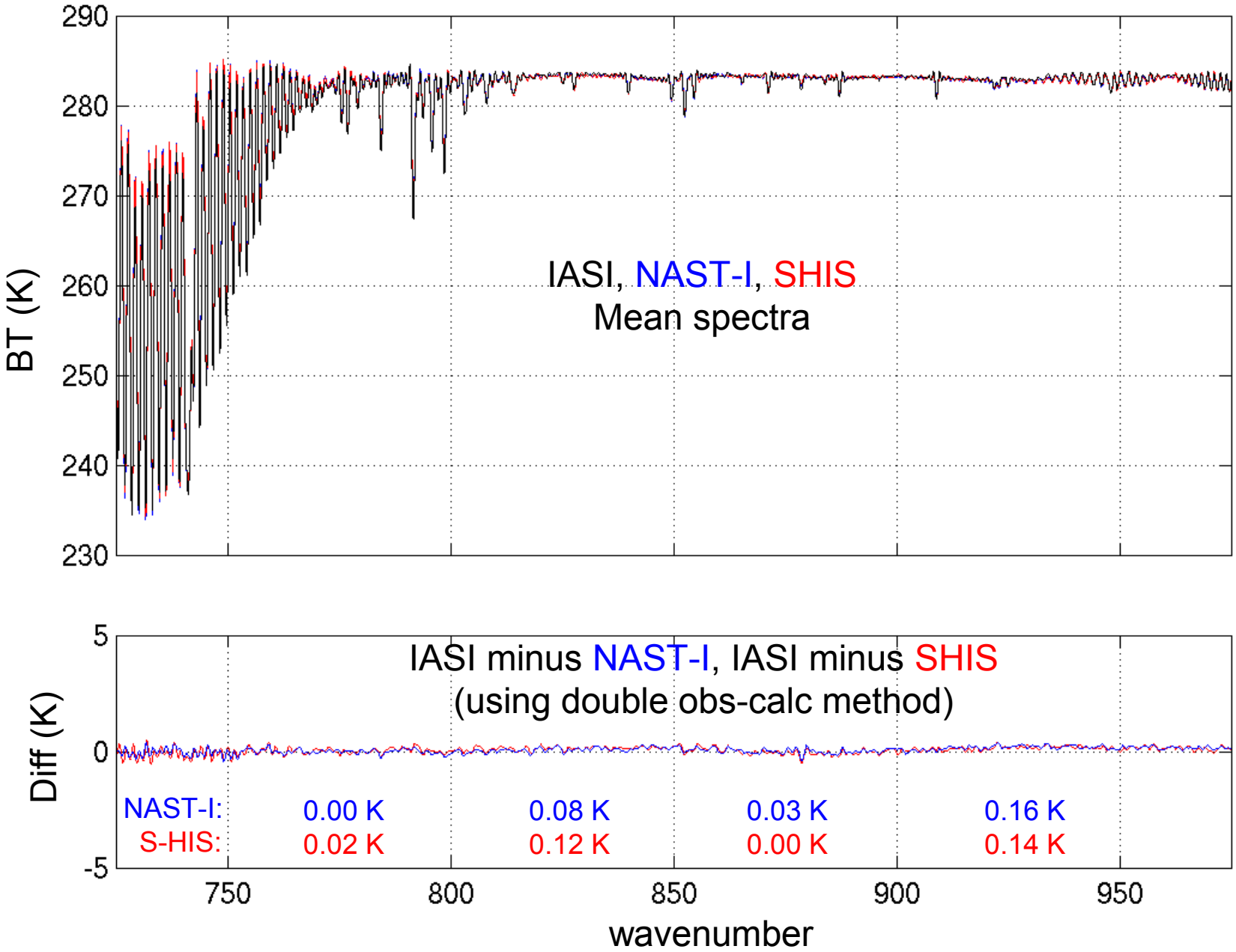


January 2007, testing at UW/SSEC

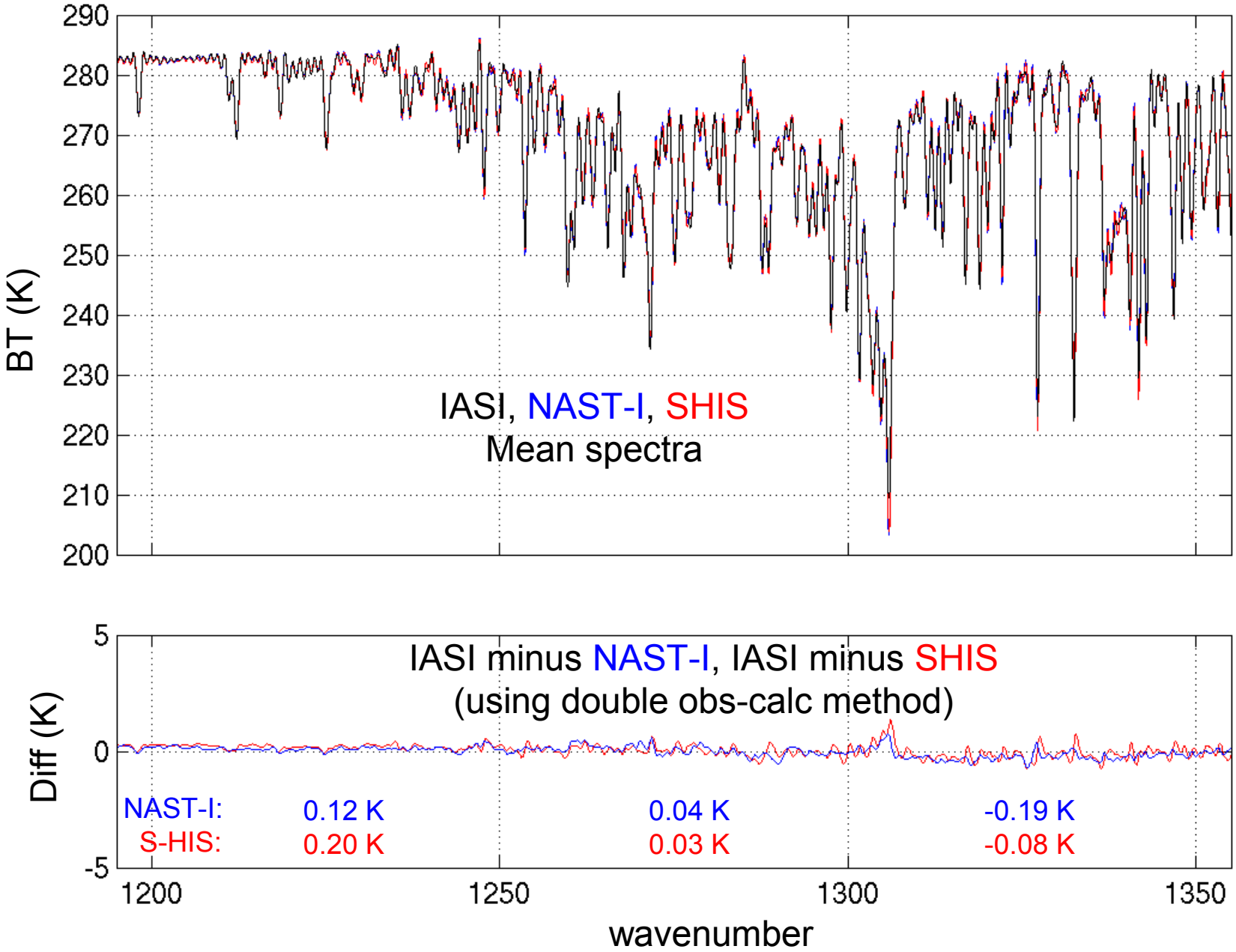




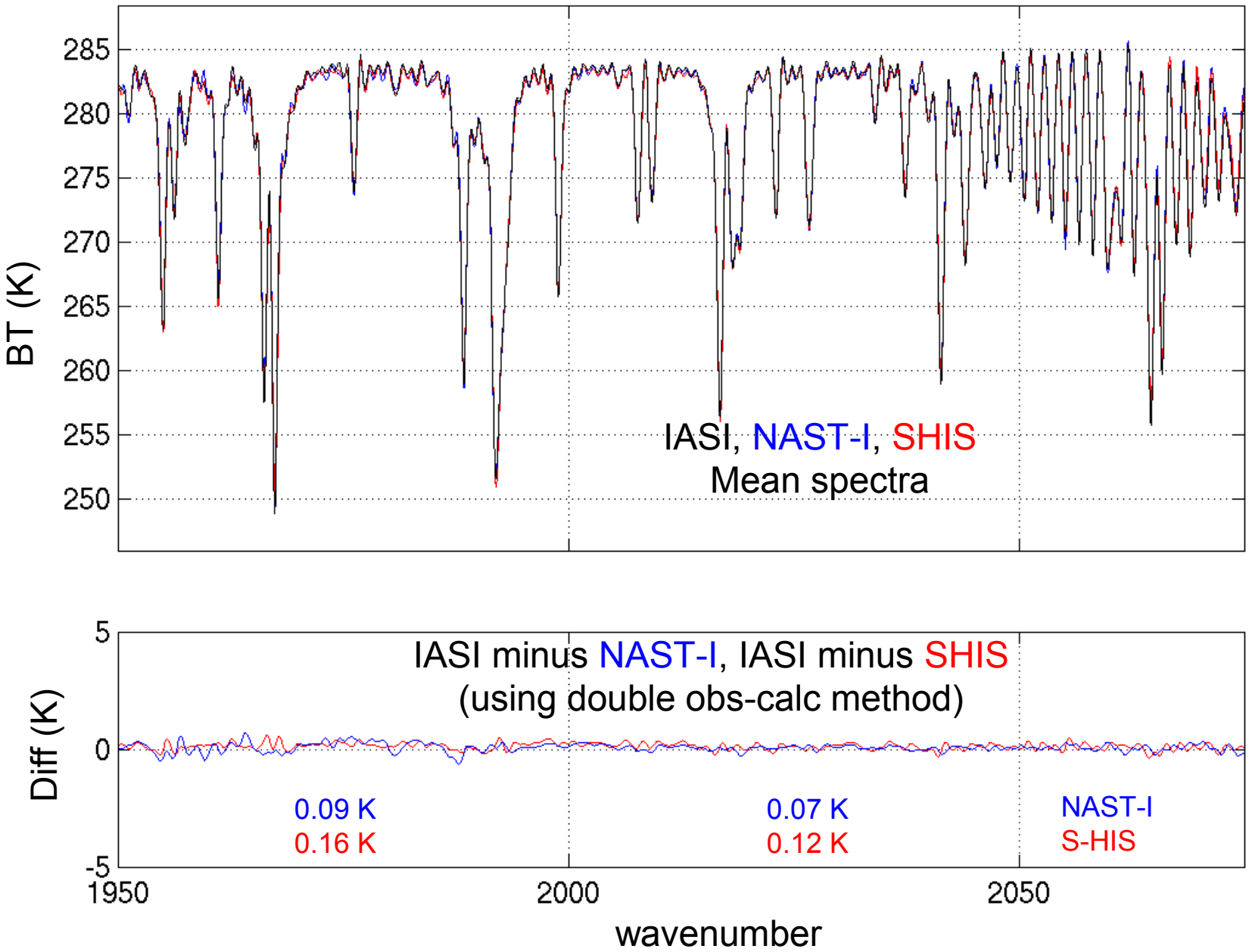
IASI Longwave Validation, JAIVEX



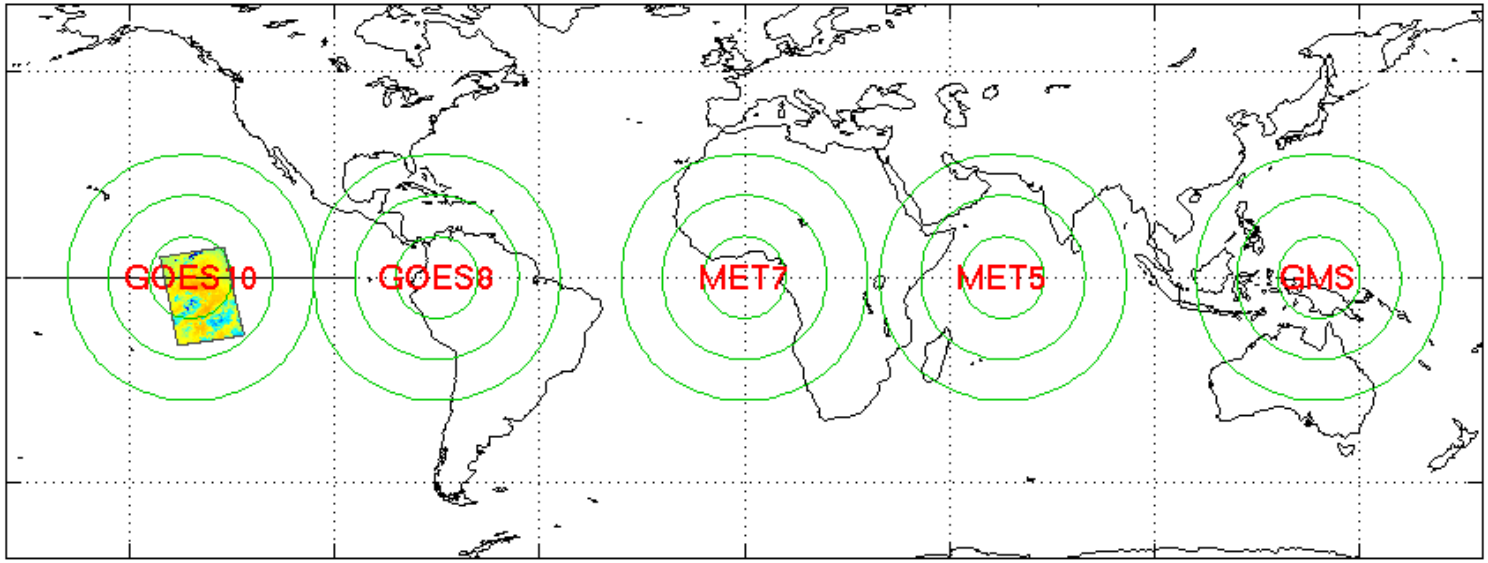
IASI Midwave Validation, JAIVEX

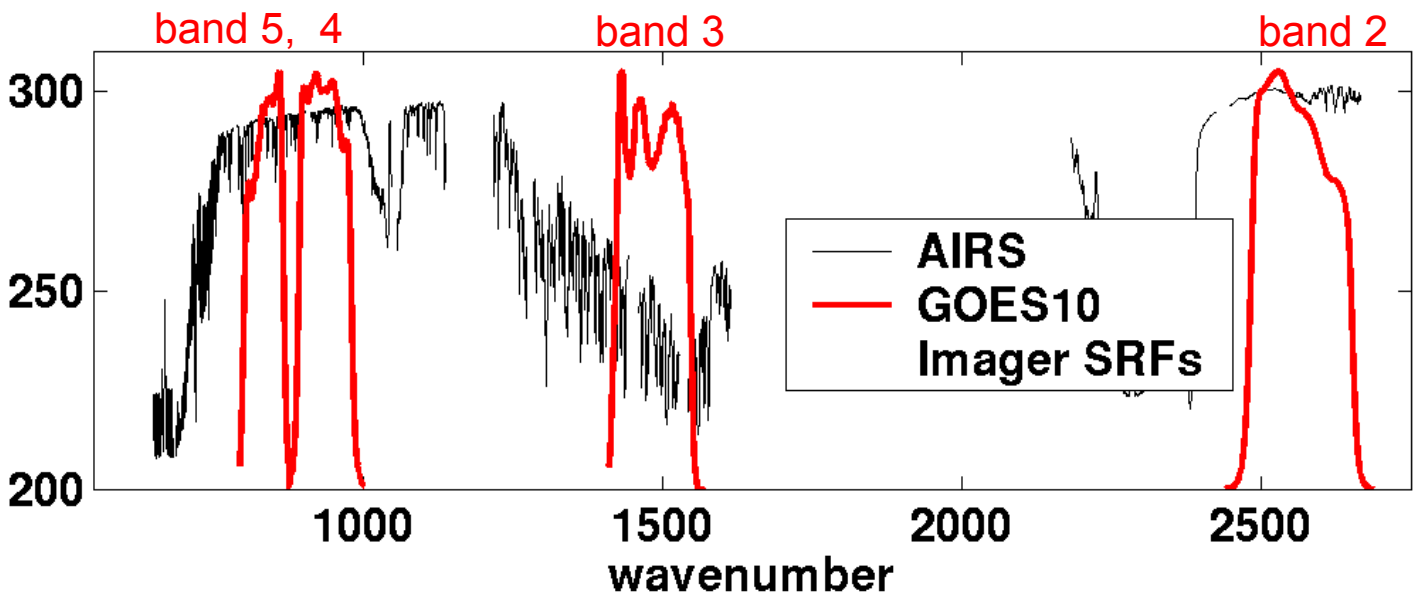


IASI Shortwave Validation, JAIVEX

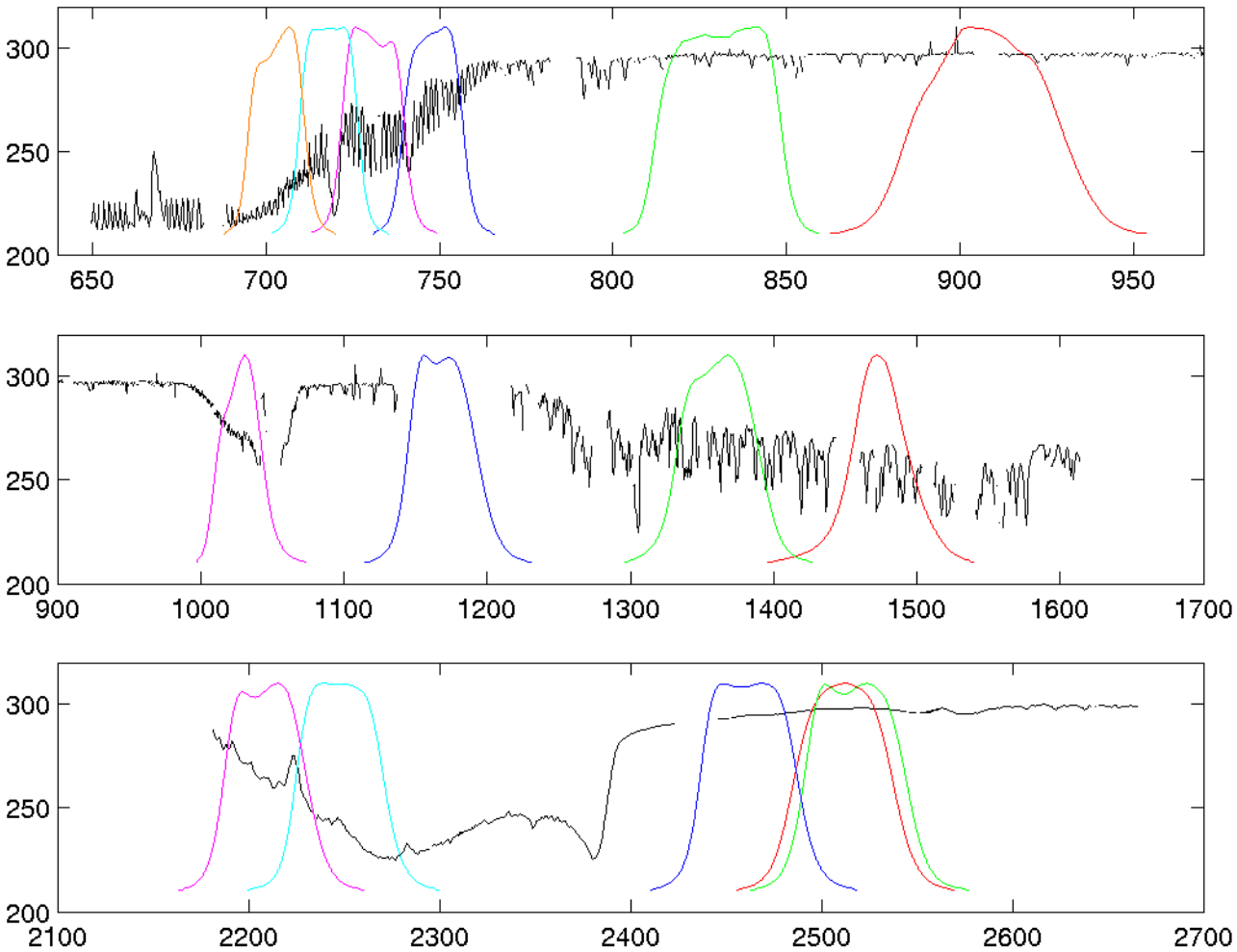


GEO Intercalibration based on AIRS and IASI





Sample AIRS spectrum and Aqua MODIS SRFs



MODIS Band / wavelength(μm)

36 / 14.2
35 / 13.9
34 / 13.7
33 / 13.4
32 / 12.0
31 / 11.0

30 / 11.0
29 / 9.7
28 / 7.3
27 / 6.8

25 / 4.5
24 / 4.4
23 / 4.1
22 / 4.0
21 / 4.0

wavenumber

Site Atmospheric State Best Estimate

- Radiosondes drift in time and space
- Radiosondes ascent time much greater than satellite measurement length
- Solution: use ancillary measurements to interpolate in space and time
- One approach: Tobin et al., “Atmospheric Radiation Measurement site atmospheric state best estimates for Atmospheric Infrared Sounder temperature and water vapor retrieval validation,” JGR 2006
- See also Calbet et al., AMT, 2011

Tobin 2006 Approach to SASBE

- Two sondes were launched near overpass time
- Interpolate sonde profiles in time with IR-based atmospheric profiling
- Interpolate sonde profiles in space with geostationary measurements
- Perform weighted average of interpolated profiles to get best estimate of atmospheric column

Current Research

- How does SASBE compared for standard sonde launch times versus special overpass times?
- What is the quantitative improvement from each ancillary measurement?
- How do uncertainties of ancillary measurements propagate into state estimate?
- Answering these questions supports a demonstration project

SCOPE-CM

- AVHRR based data set of cloud and aerosol properties
- SSM/I: total column water vapour, precipitation, liquid water path
- Surface albedo, clouds and aerosols from geostationary satellites
- Atmospheric Motion Vectors (AMV) and clear sky radiance
- Upper tropospheric humidity