S-NPP CrIS Sensor Data Record (SDR): Validated Maturity Level Product

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AMS Annual Meeting
February 2-6, 2014
Atlanta, GA
(4:15 Room C111, 2/04/14)

Outline

- CrIS SDR Science Team and Cal/Val process
- CrIS measurement and data processing
- CrIS SDR product
- CrIS SDR uncertainties
- CrIS SDR product documentation
- Summary

JPSS CrIS SDR Science Team member & Cal/Val Process

CrIS SDR calibration and validation (Cal/Val) team members (Subject Matter Experts):

Organization	PI
NOAA Center for Satellite Applications & Research (NOAA/STAR)	Yong Han
University of Wisconsin (UW)	Hank Revercomb
University of Maryland Baltimore County (UMBC)	Larrabee Strow
Space Dynamics Laboratory/Utah State University (SDL)	Deron Scott
Massachusetts Institute of Technology/Lincoln Labs (MIT/LL)	Dan Mooney
Northrop Grumman Aerospace Systems	Degui Gu
Exelis-ITT	Mike Cromp
NASA	Dave Johnson
Raytheon	Wael Ibrahim

CrIS SDR Validation phases:

- Early Orbit Checkout (EOC), 18 January – 23 February 2012
- Intensive Calibration and Validation (ICV), 23 February 2012 – 20 December 2013
- Long-term Monitoring (LTM), remaining NPP mission

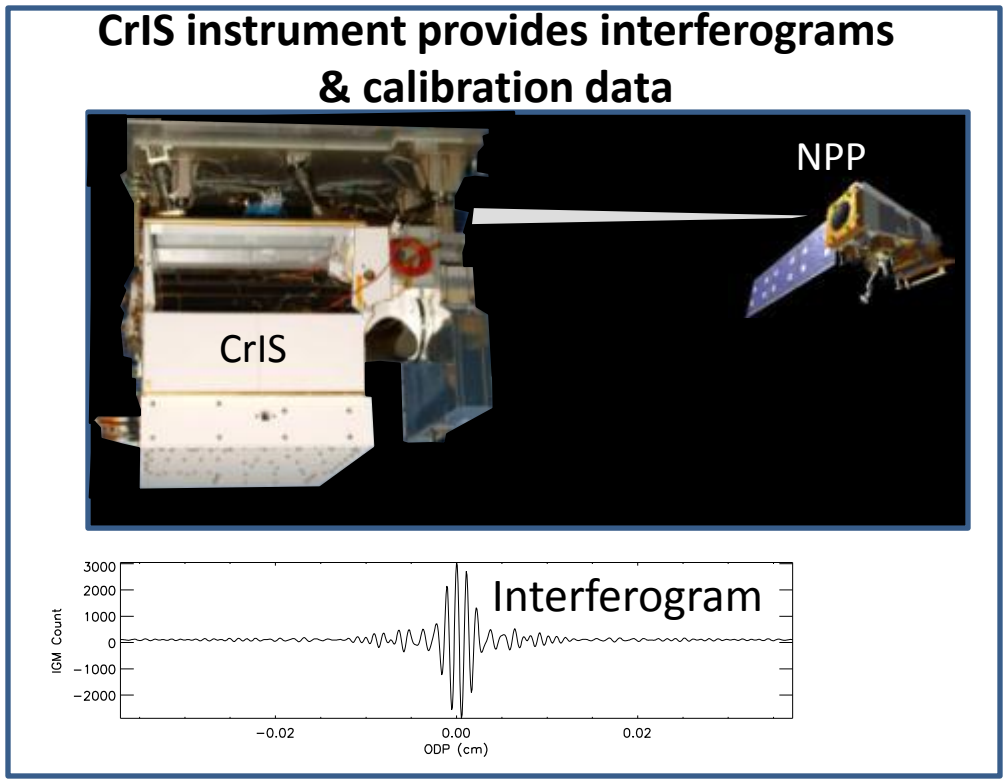
CrIS SDR Product Maturity Status Timeline

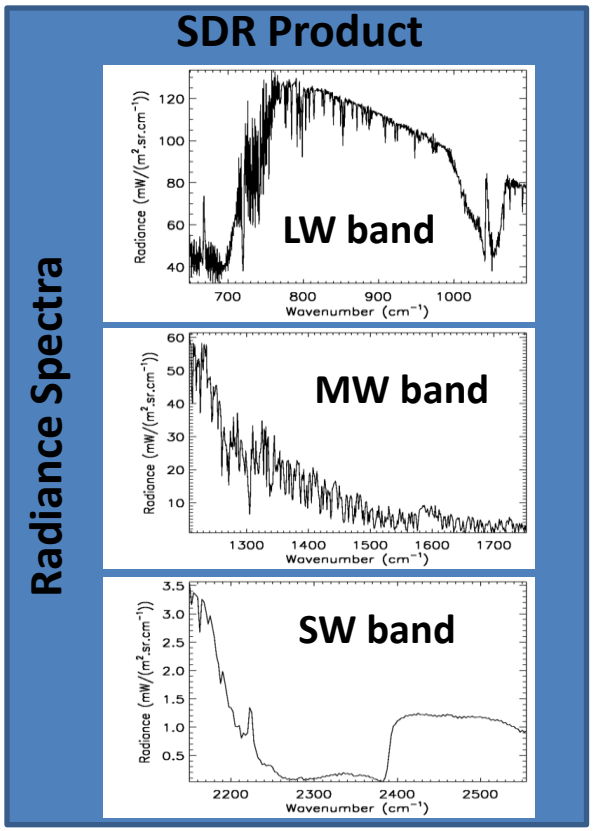
- First operational SDR product, April 2, 2012
- Beta maturity status, review meeting on April 4, 2012
- Provisional maturity status, review meeting on October 23, 2012
- Validated maturity status, review meeting on December 18, 2013

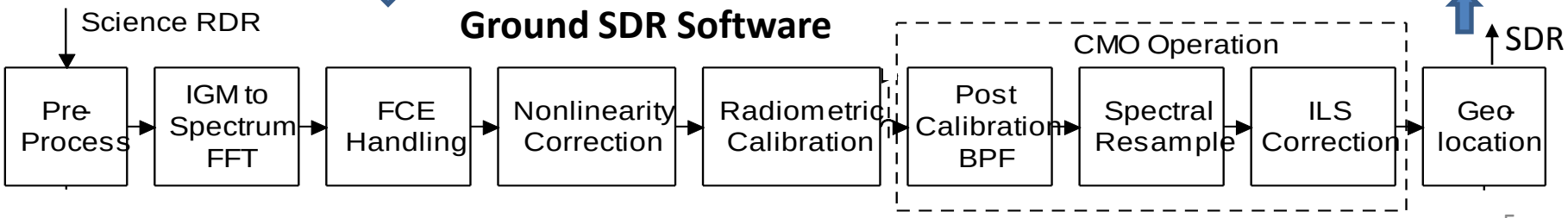
The next calibration algorithm/coefficient updates scheduled on Feb. 20, 2014

- Updates of instrument line shape and detector nonlinearity correction algorithms and corresponding coefficients
- Up to 0.1 K radiance impact

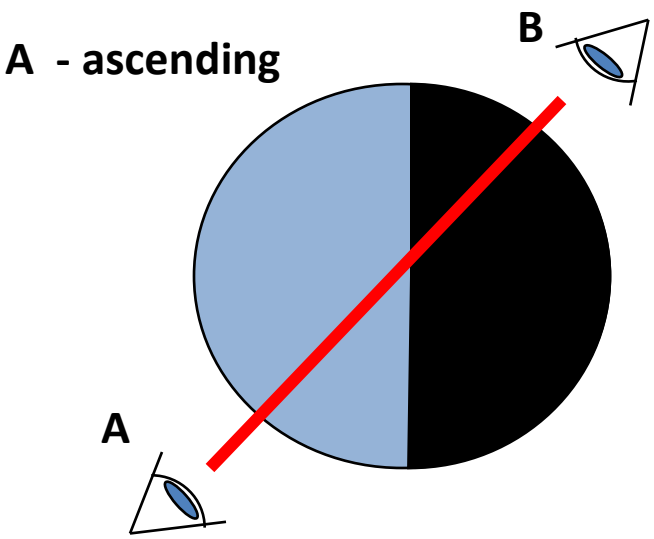
CrIS System

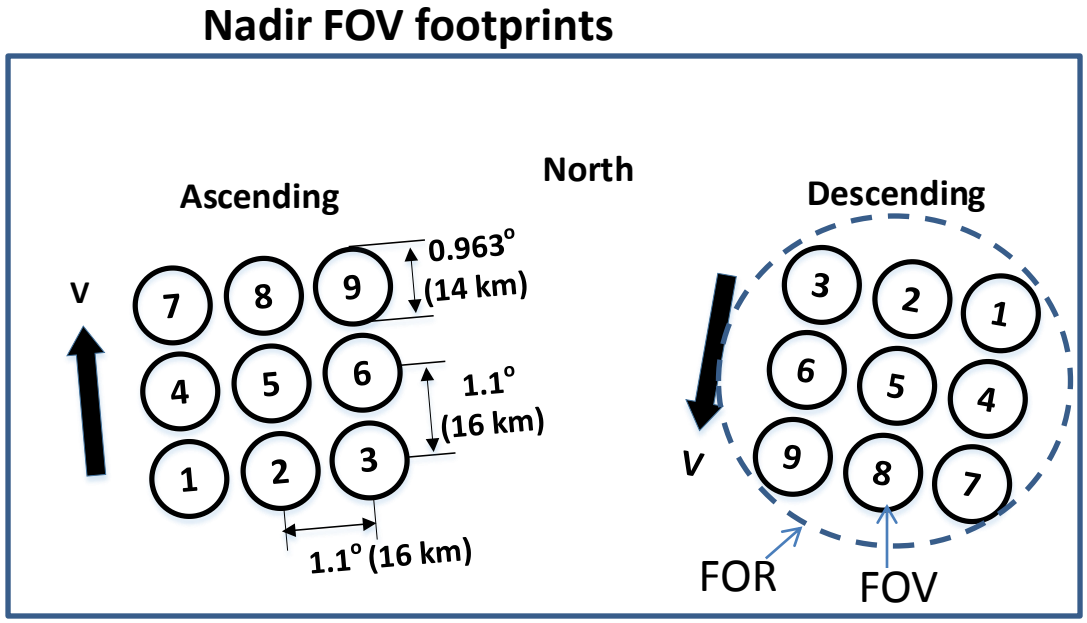

CrIS instrument provides interferograms & calibration data
NPP
CrIS
Interferogram
IGM Count
ODP (cm)

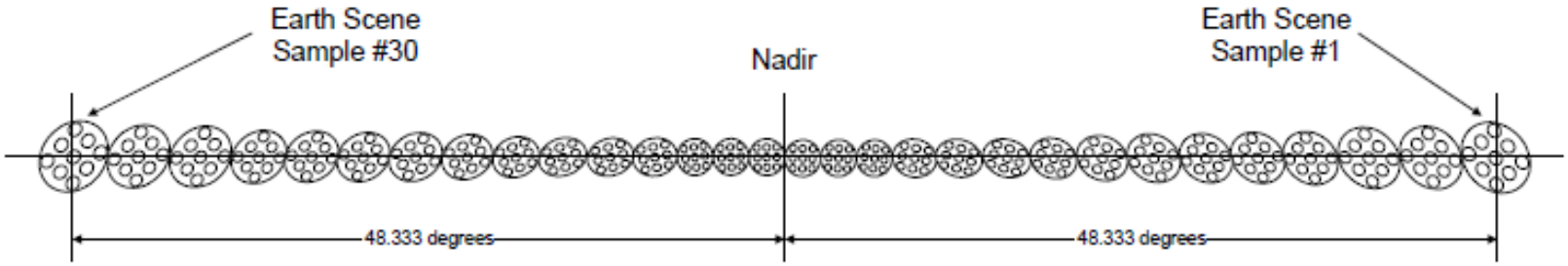

SDR Product
Radiance Spectra
LW band
MW band
SW band
Radiance (mW/(m².sr.cm⁻¹))
Wavenumber (cm⁻¹)


Science RDR
Ground SDR Software
CMO Operation
SDR
Pre-Process
IGM to Spectrum FFT
FCE Handling
Nonlinearity Correction
Radiometric Calibration
Post Calibration BPF
Spectral Resample
ILS Correction
Geo-location

CrIS FOV, FOR and Scan







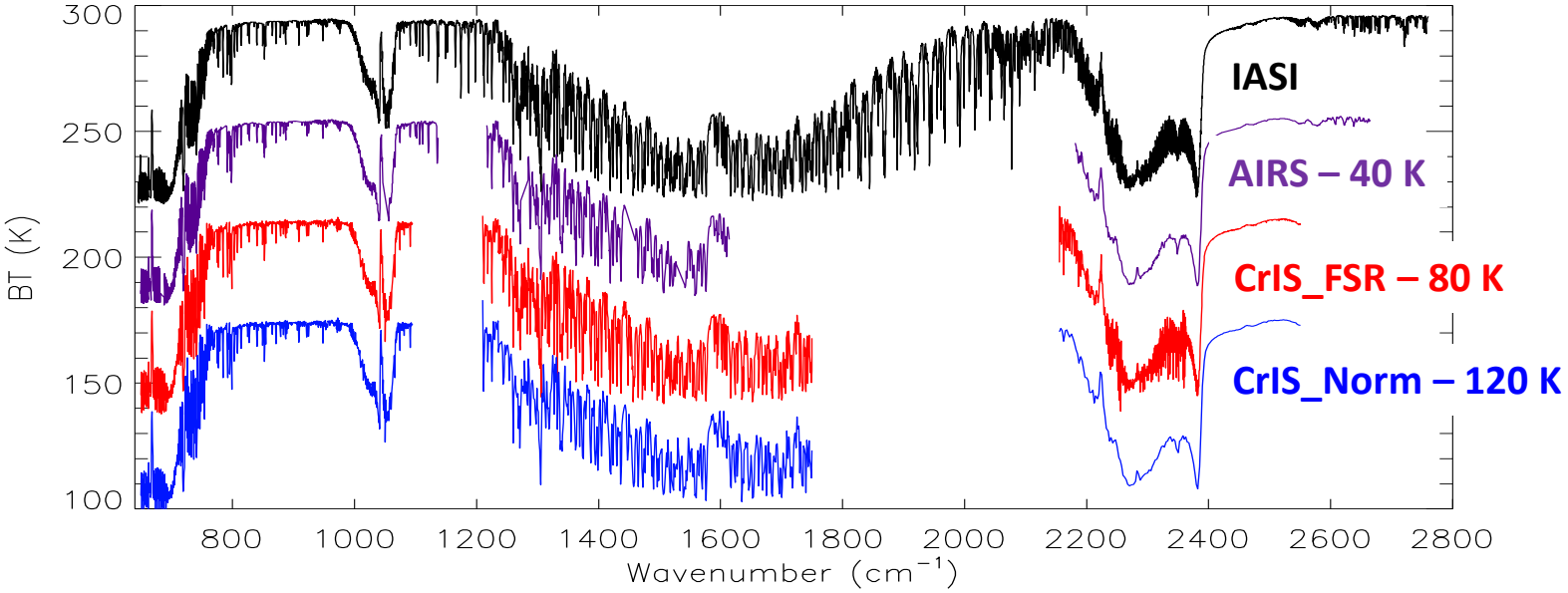
- Each scan has 30 Earth view Field of Regards (FORs)
- Each FOR has 9 Field of Views (FOVs)

CrIS Spectral Parameters

Band	Spectral Range (cm^{-1})	Normal Mode		Full Resolution Mode*	
		Resolution (cm^{-1})	MPD (cm)	Resolution (cm^{-1})	MPD (cm)
LW	650-1095	0.625	0.8	0.625	0.8
MW	1210-1750	1.25	0.4	0.625	0.8
SW	2155-2550	2.5	0.2	0.625	0.8

* NOAA intends to operate CrIS in full spectral resolution (FSR) mode in near future

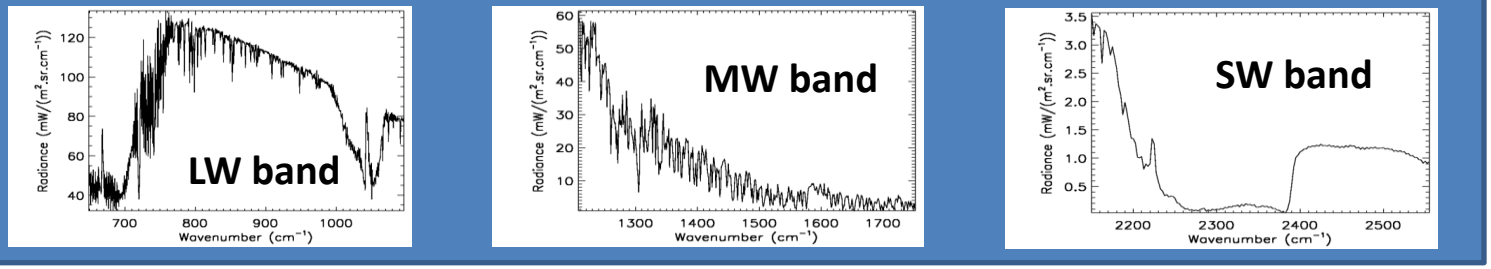
Simulated CrIS (unapodized), IASI and AIRS spectra



CrIS SDR Product (1/2)

Radiance spectra

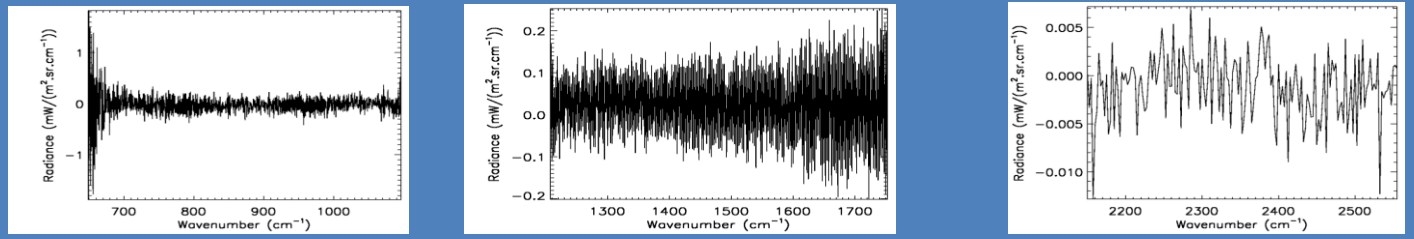
Details in CrIS SDR User's Guide



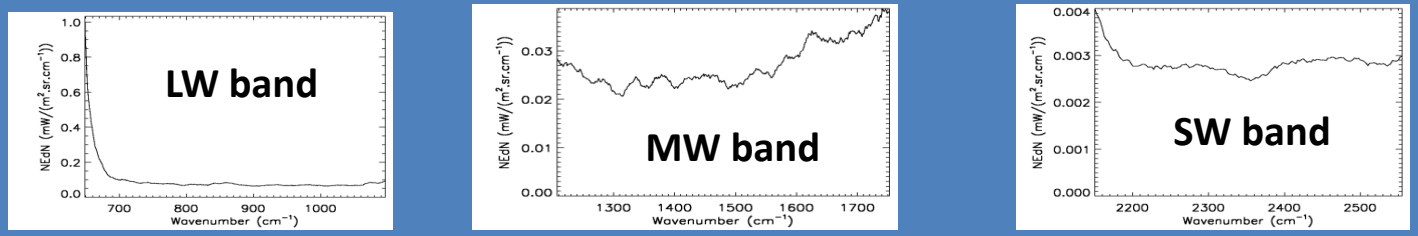
16 Data quality indicators (DQIs - integer or floating variables)

Examples of DQI:

Imaginary radiance spectra



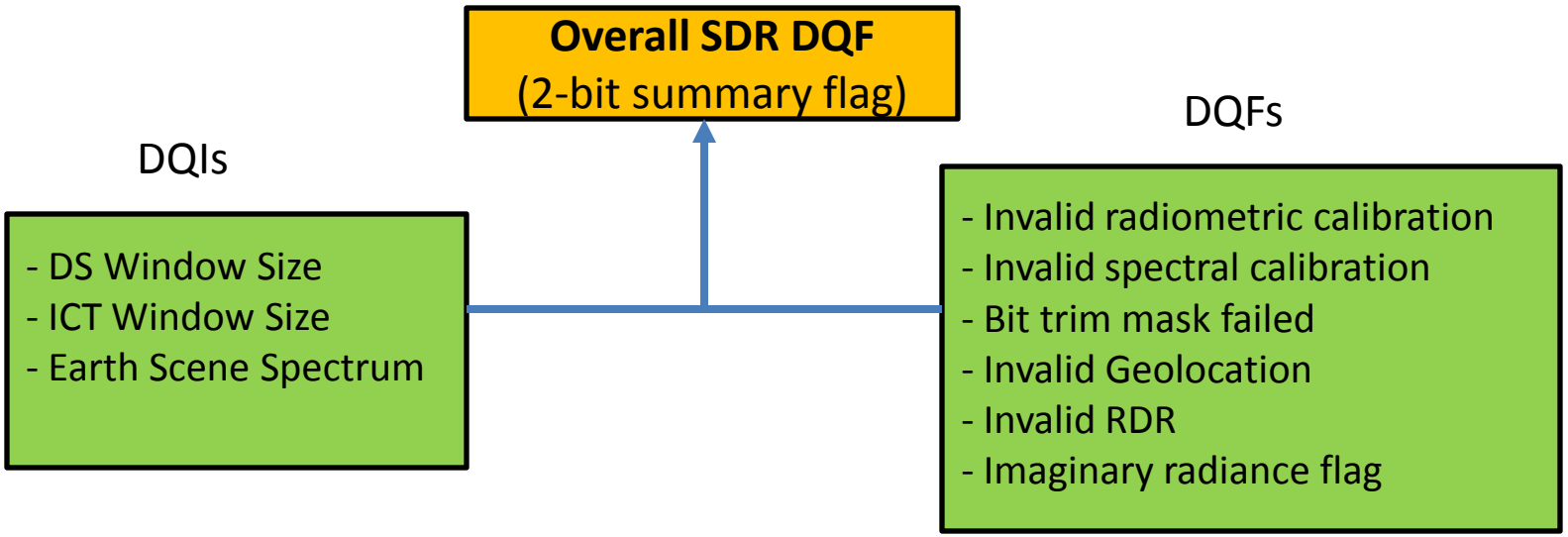
NEdN spectra



CrIS SDR Product (2/2)

18 Data quality flags (DQFs - 1 or 2 bits)

Relations of SDR Overall Quality Flag with DQIs and DQFs

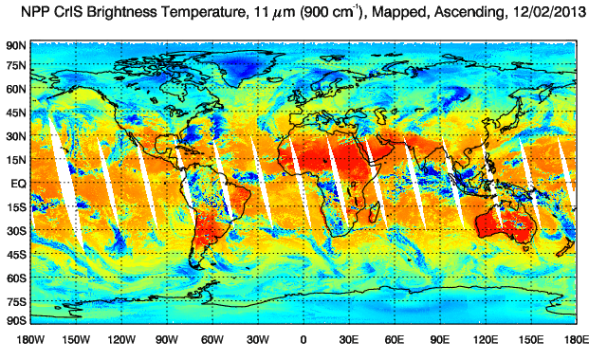


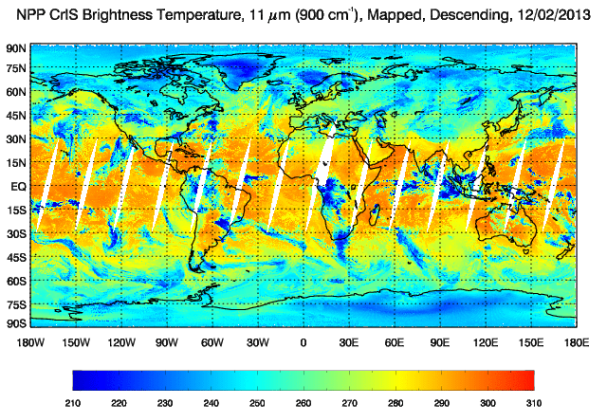
Details in CrIS SDR User's Guide

CrIS SDR/RDR Monitoring System

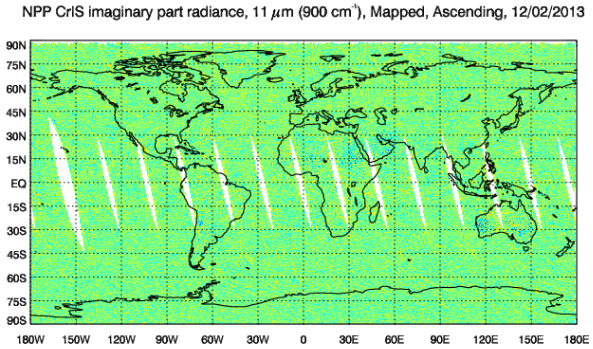
Over 120 SDR as well as Raw Data Record (RDR) parameters are monitored with the Web-based monitoring system open to Public

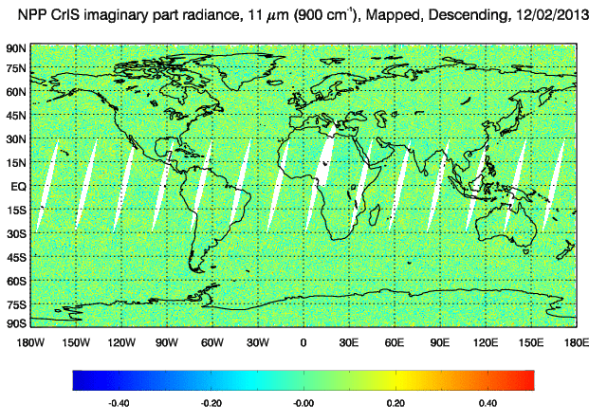
Real radiance



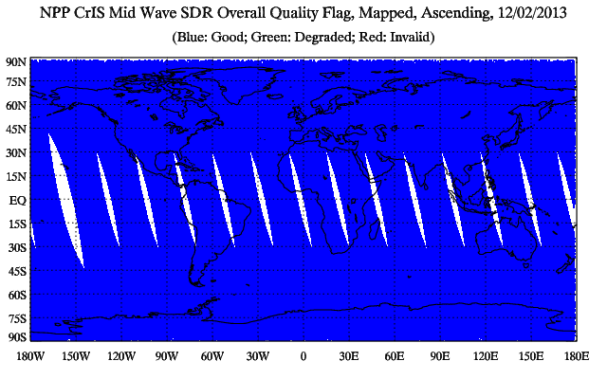


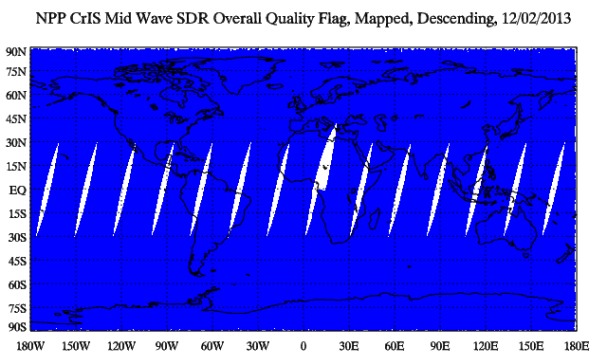
Near zero Imaginary radiance indicates good real radiance





Overall SDR quality flag Blue - good





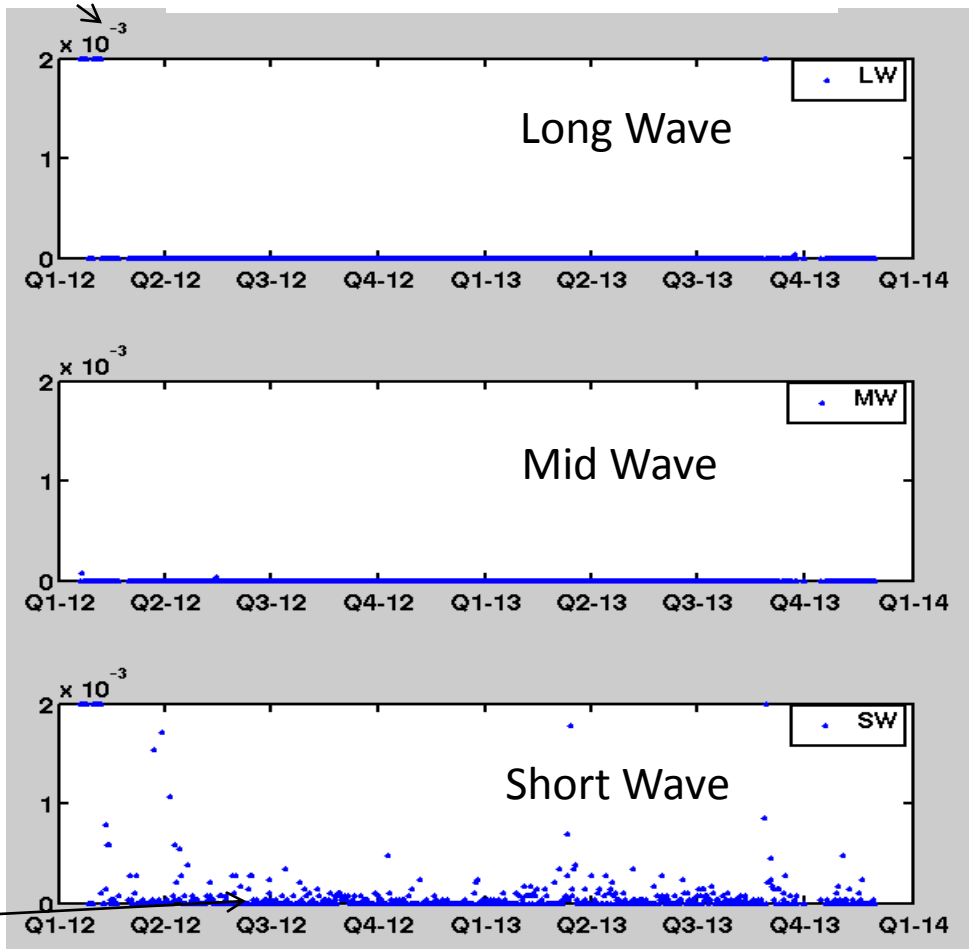
CrIS Data Quality

Daily occurrence of Good SDR spectra from 2013-07-11 to 2013-11-24

LW	99.9817%
MW	99.9817%
SW	99.9816%

- No ice contamination on detector so far
- No significant South Atlantic Anomaly (SAA) impact
- No Fringe Count Error (FCE)

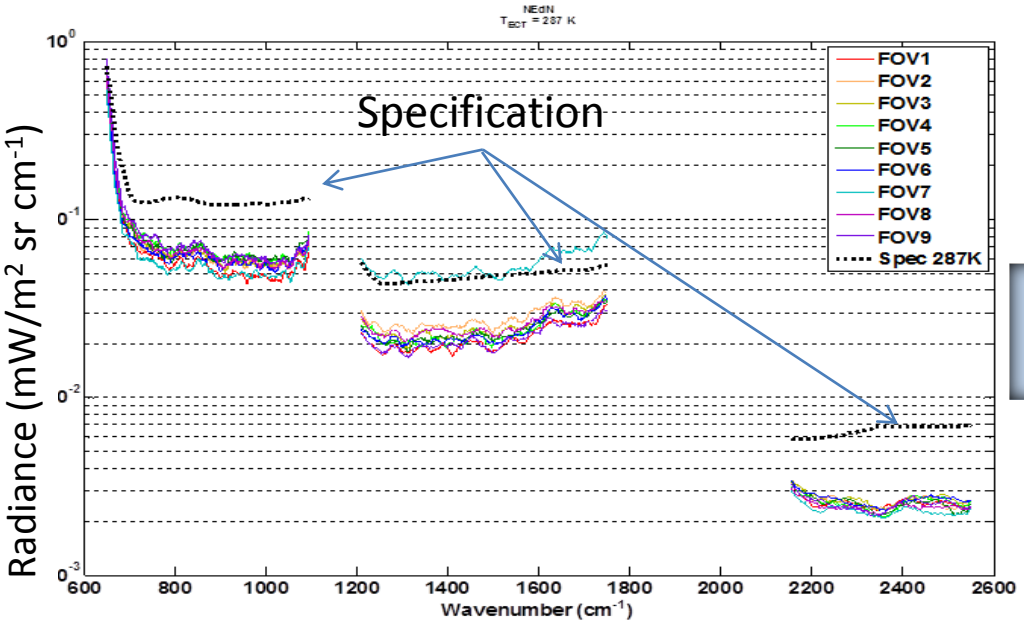
Daily Percentage of Invalid interferogram measurements



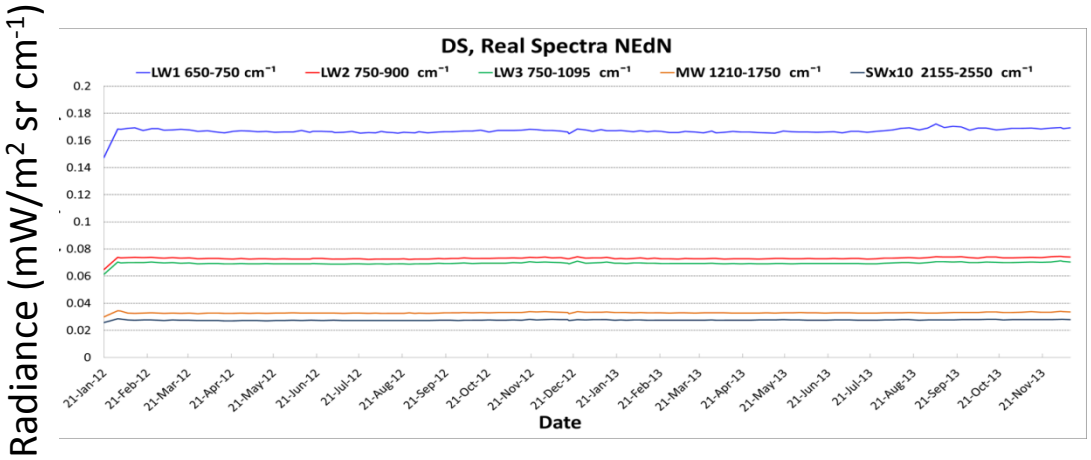
Mainly due to sun-glint saturation

Han et al. 2013, JGR

CrIS Noise (NEdN)



The noise levels substantially better than specification



Stable NEdN
Jan 2012 to Jan 2014

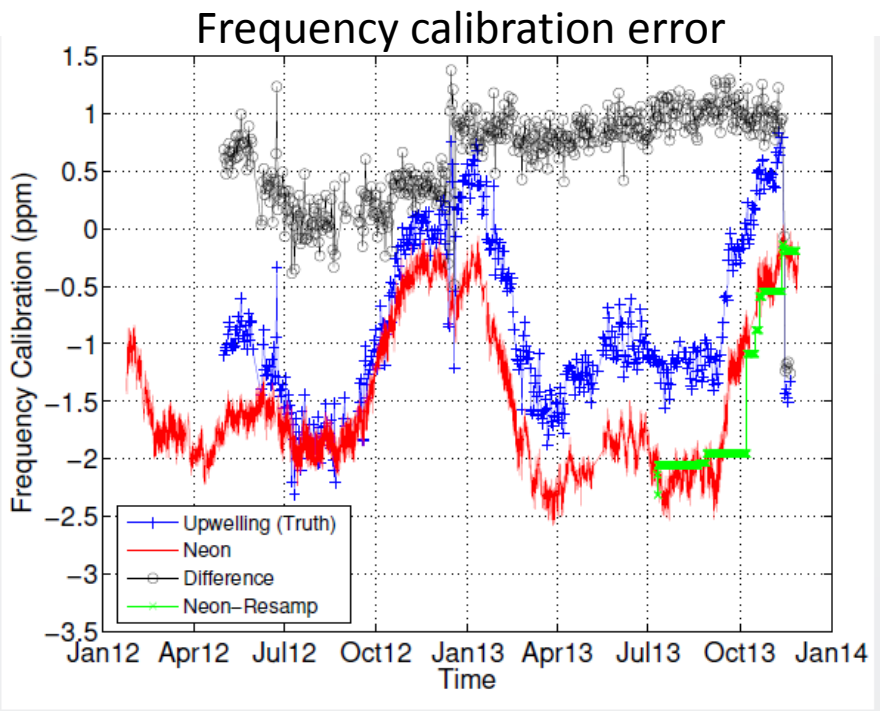
Zavyalov et al. 2013, JGR

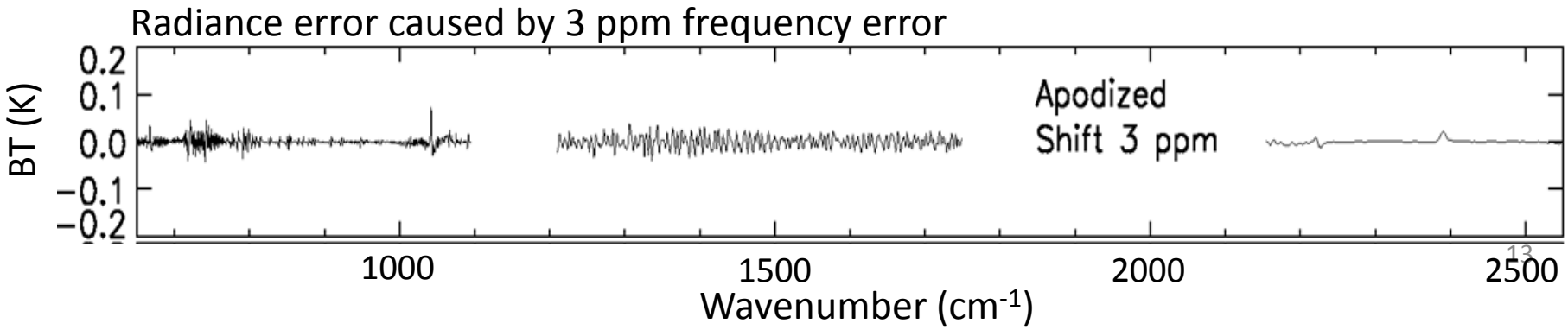
Spectral Calibration Accuracy

Spectral calibration accuracy (all FOVs & all bands):

< 3 ppm

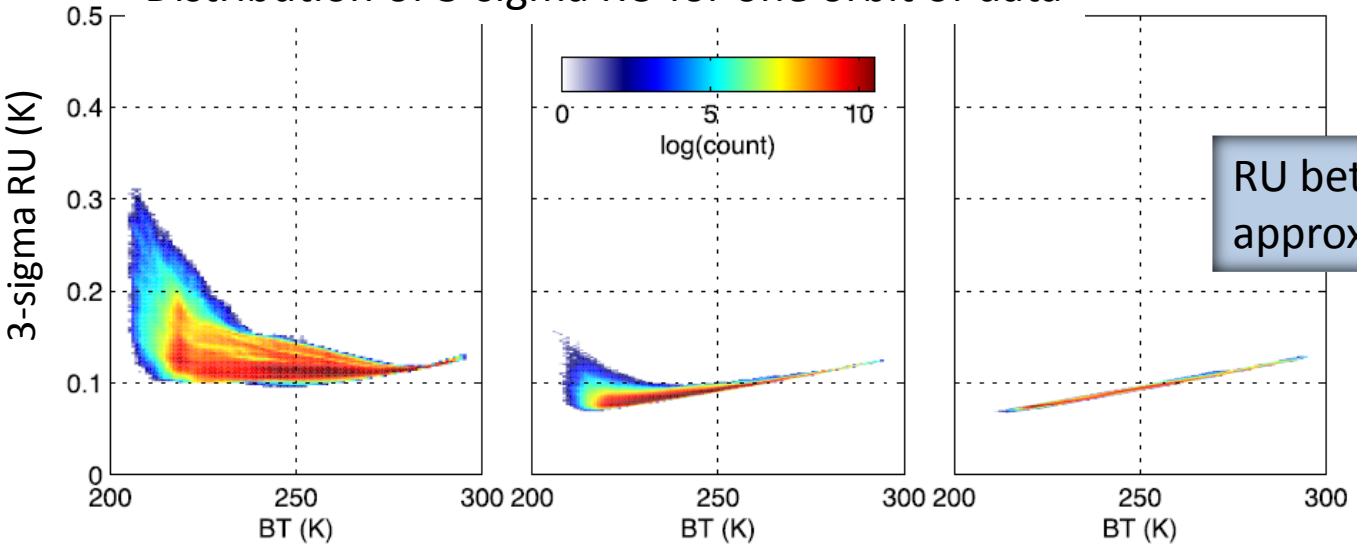
Strow et al. 2013, JGR



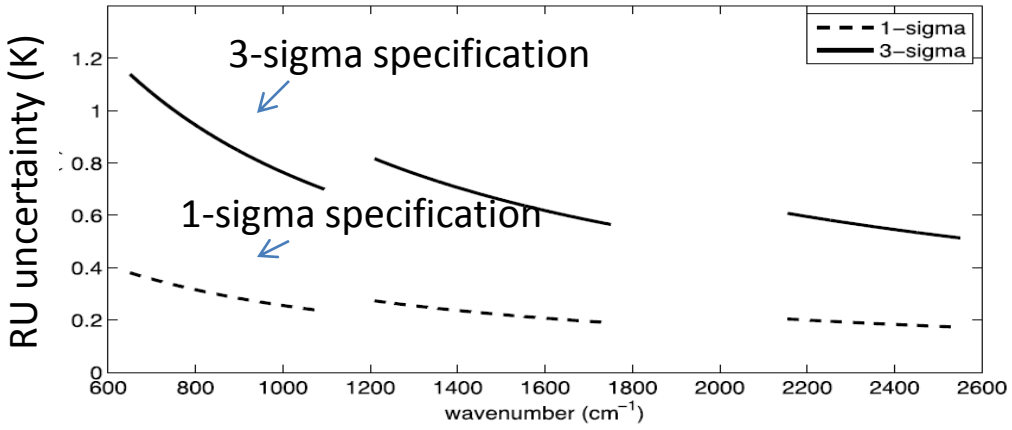


Radiometric Uncertainty (RU)

Distribution of 3-sigma RU for one orbit of data



RU better than spec by approximately a factor 4

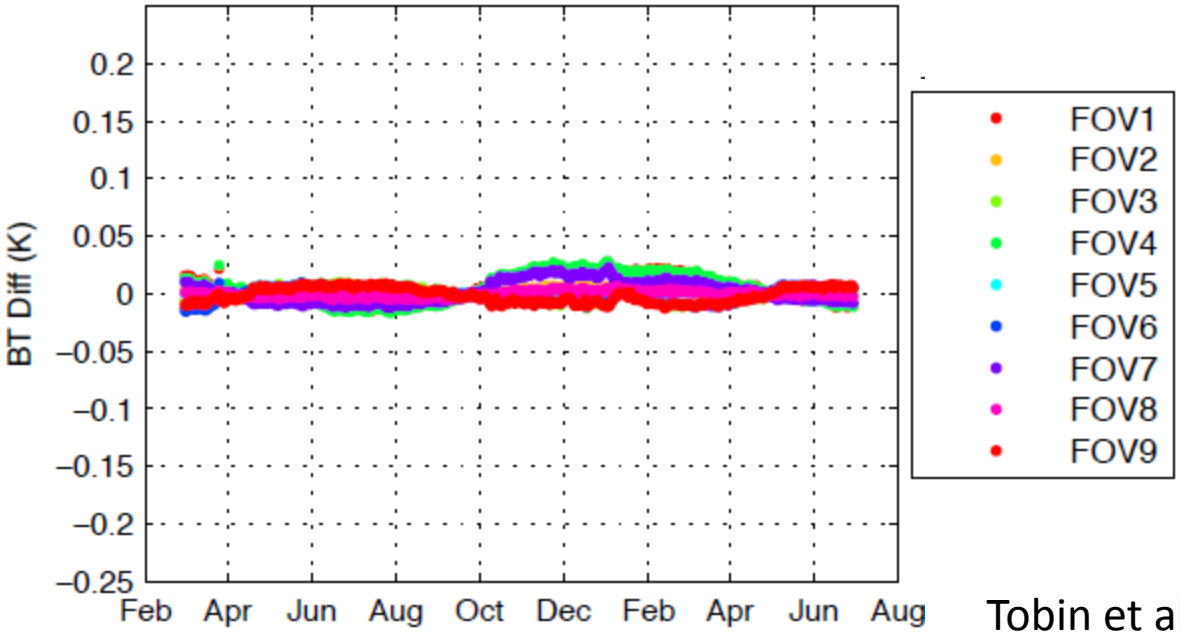


Uncertainty specification @287K blackbody

Tobin et al. 2013, JGR

FOV-2-FOV Radiometric Performance Difference

1-year LW (672-682 cm^{-1}) BT difference with respect to FOV5



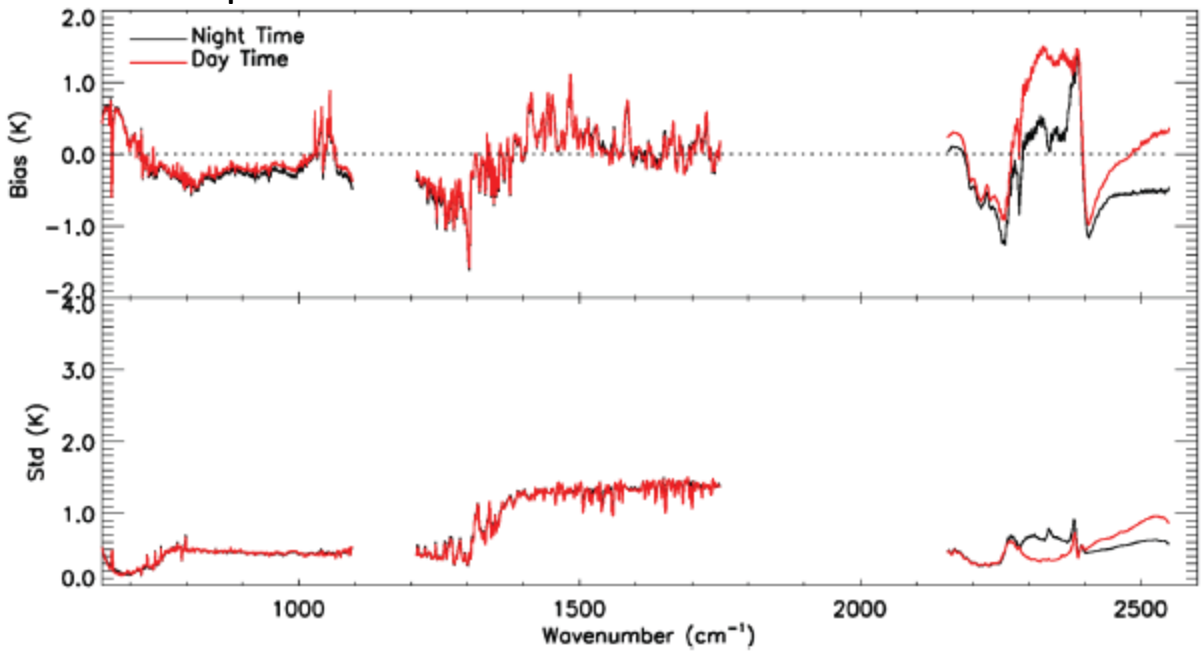
Tobin et al. (UW)

FOV to FOV radiometric differences are well below 0.1 K

Clear-sky Observation-Calculation Analysis

Behavior of mean biases and standard deviation of obs-calcs are consistent with forward model and atmospheric state uncertainties, implying very good radiometric performance for CrIS

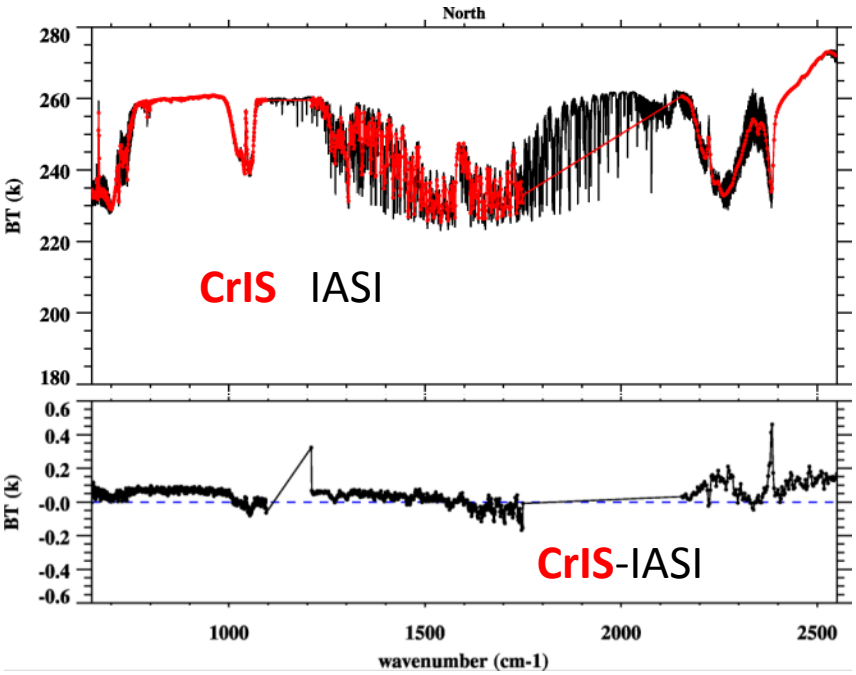
Example of obs-calc bias and std



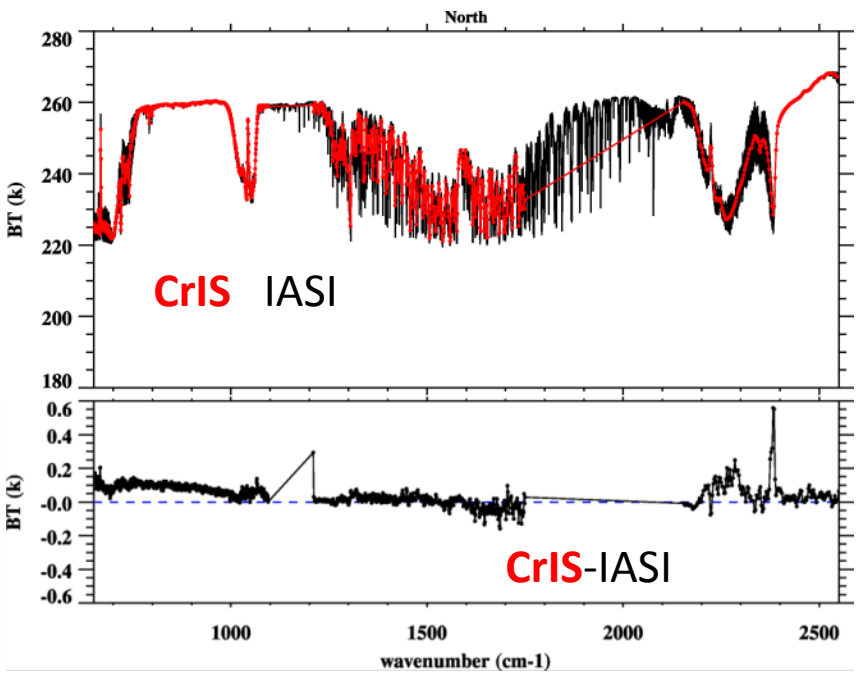
Chen et al. (NOAA/STAR)

CrIS/IASI Simultaneous Nadir Overpass (SNO)

Metop-A



Metop-B



Wang et al. (NOAA/STAR)

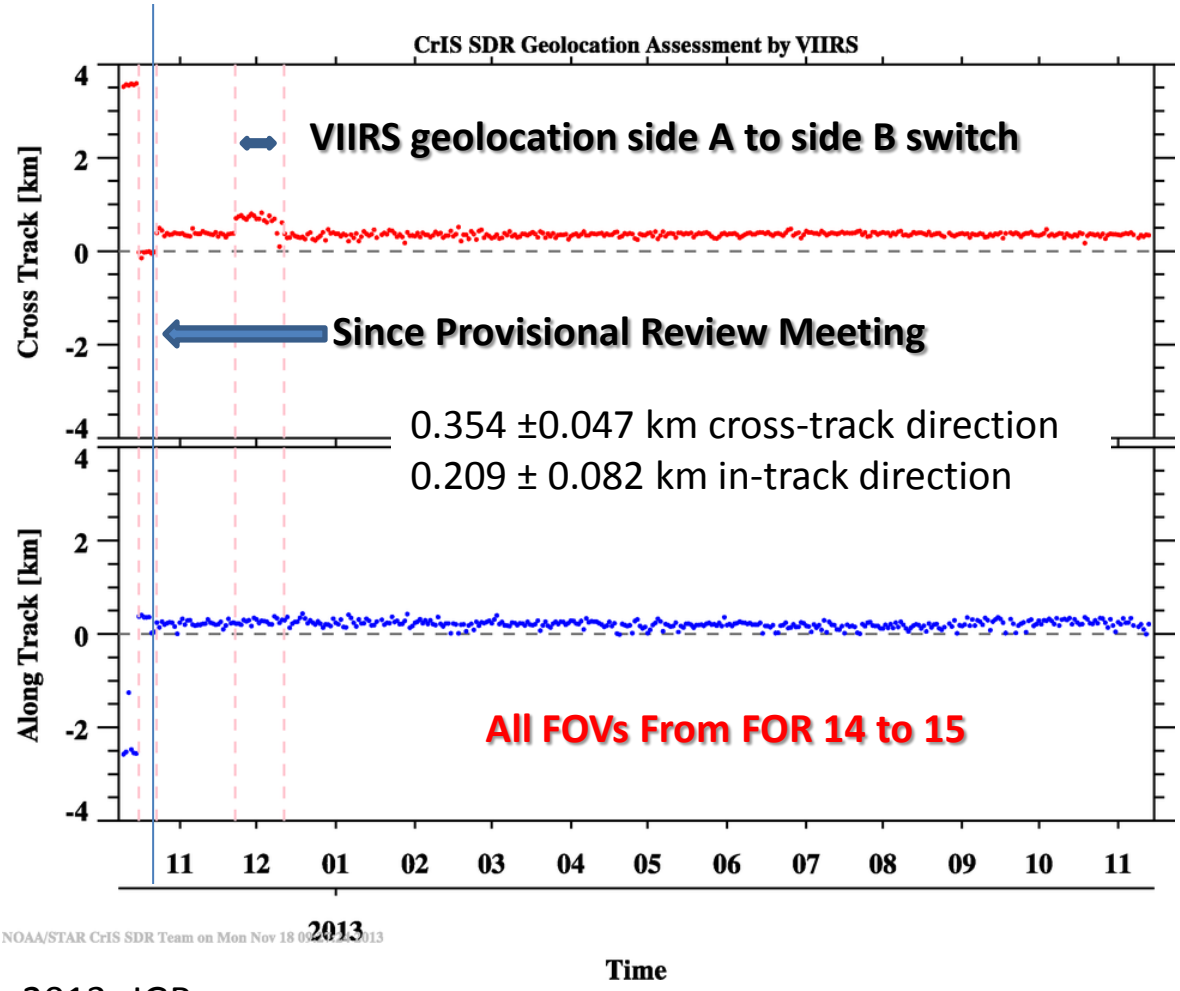
Geolocation Accuracy Assessed with VIIRS

VIIRS I5 band data (350m spatial resolution) are used to assess CrIS geolocation accuracy

Pixel geolocation accuracy:
< 1.3 km
(Zenith angle < 30°)

Due to VIIRS "bowtie deletion", this method does not apply to pixels with zenith angle larger than 30°

Nadir geolocation accuracy time series



Wang et al. 2013, JGR

Summary of CrIS SDR Uncertainty

CrIS SDR uncertainties (**blue**) vs. specifications (black)

Band	NEdN @287K BB mW/m^2/sr/cm^{-1}	Radiometric Uncertainty @287K BB (%)	Frequency Uncertainty (ppm)	Geolocation Uncertainty (km) *
LW	**0.098** (0.14)	**0.12** (0.45)	**3** (10)	**1.3** (1.5)
MW	**0.036** (0.06)	**0.15**(0.58)	**3** (10)	**1.3** (1.5)
SW	**0.003** (0.007)	**0.2** (0.77)	**3** (10)	**1.3** (1.5)

* Within 30^o scan angles

CrIS SDR meets all the requirements with the exception of the NEdN for MWIR FOV7.

Documentation and Data Download

- ATBD, User's guide, and more science documentation are available at

  http://www.star.nesdis.noaa.gov/jpss/ATBD.php

- CrIS monitoring system located at

  http://www.star.nesdis.noaa.gov/icvs/status_NPP_CrIS.php

- CrIS SDR Data available at CLASS http://www.nsof.class.noaa.gov/saa/products/welcome

References
(JGR Special Issue)

- Han, Y., *et al. (*2013*),* Suomi NPP CrIS measurements, sensor data record algorithm, calibration and validation activities, and record data quality, J. Geophys. Res. Atmos., 118, *doi:*10.1002/2013JD020344
- Tobin, D., *et al. (*2013*),* Suomi-NPP CrIS radiometric calibration uncertainty, J. Geophys. Res. Atmos., 118, 10,589–10,600, *doi:*10.1002/jgrd.50809
- Strow, L. L., H. Motteler, D. Tobin, H. Revercomb, S. Hannon, H. Buijs, J. Predina, L. Suwinski, *and* R. Glumb *(*2013*),* Spectral calibration and validation of the Cross–track Infrared Sounder (CrIS) on the Suomi NPP satellite, J. Geophys. Res. Atmos., 118, *doi:*10.1002/2013JD020480.
- Zavyalov, V., M. Esplin, D. Scott, B. Esplin, G. Bingham, E. Hoffman, C. Lietzke, J. Predina, R. Frain, L. Suwinski, Y. Han, C. Major, B. Graham, L. Phillips (2013), Noise performance of the CrIS instrument, J. Geophys. Res., doi: 10.1002/2013JD020457
- Wang, L., D. A. Tremblay, Y. Han, M. Esplin, D. E. Hagan, J. Predina, L. Suwinski, X. Jin, *and* Y. Chen *(*2013*),* Geolocation assessment for CrIS sensor data records, J. Geophys. Res. Atmos., 118, *doi:*10.1002/2013JD020376.

Summary

- The CrIS instrument has been working very well since the beginning of the NPP mission
- CrIS SDR product has been validated, which meets the requirements with large margin
- A complete set of documentation on SDR product, SDR theoretical basis, and SDR calibration/validation results are available publicly