An Overview of S-NPP CrIS Post-launch Calibration and Sensor Data Record Product

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1. Introduction

The Cross-track Infrared Sounder (CrIS) is a Fourier transform Michelson interferometer instrument on the Suomi National Polar-orbiting Partnership Satellite (S-NPP) in the Joint Polar Satellite System (JPSS). The CrIS Sensor Data Record (SDR) science team is responsible for the calibration and validation (CalVal) of the instrument and the SDR algorithm and software. It consists of scientists and engineers from the NOAA Center for Satellite Applications and Research, NASA, the University of Wisconsin, University of Maryland Baltimore County, Space Dynamics Laboratory/Utah State University, Massachusetts Institute of Technology/Lincoln Labs, and industry partners Exelis, Northrop Grumman and Raytheon. This presentation provides an overview of the S-NPP CrIS post-launch calibration and validation work and the SDR product.

2. CrIS Raw Data Record (RDR) and SDR Algorithm

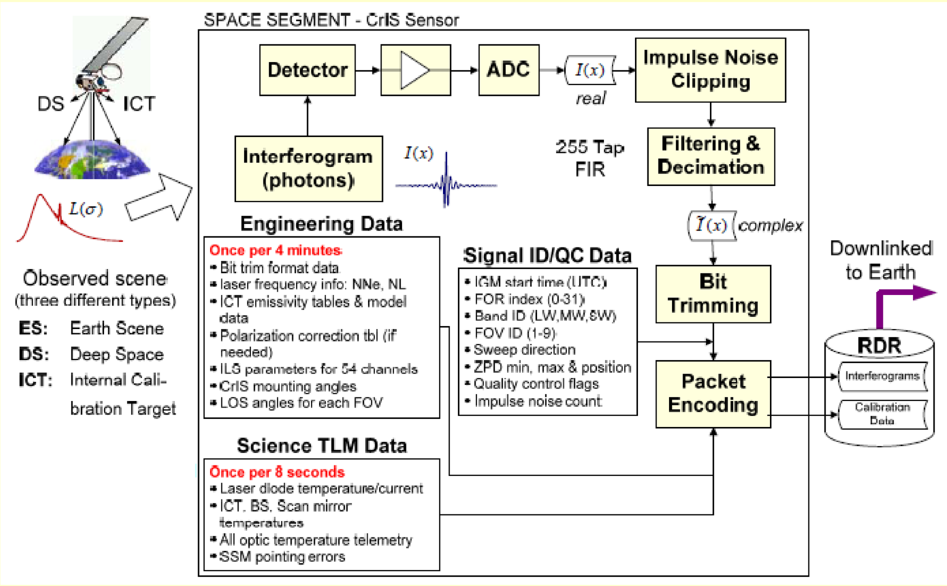


Figure 1. Space segment RDR processing

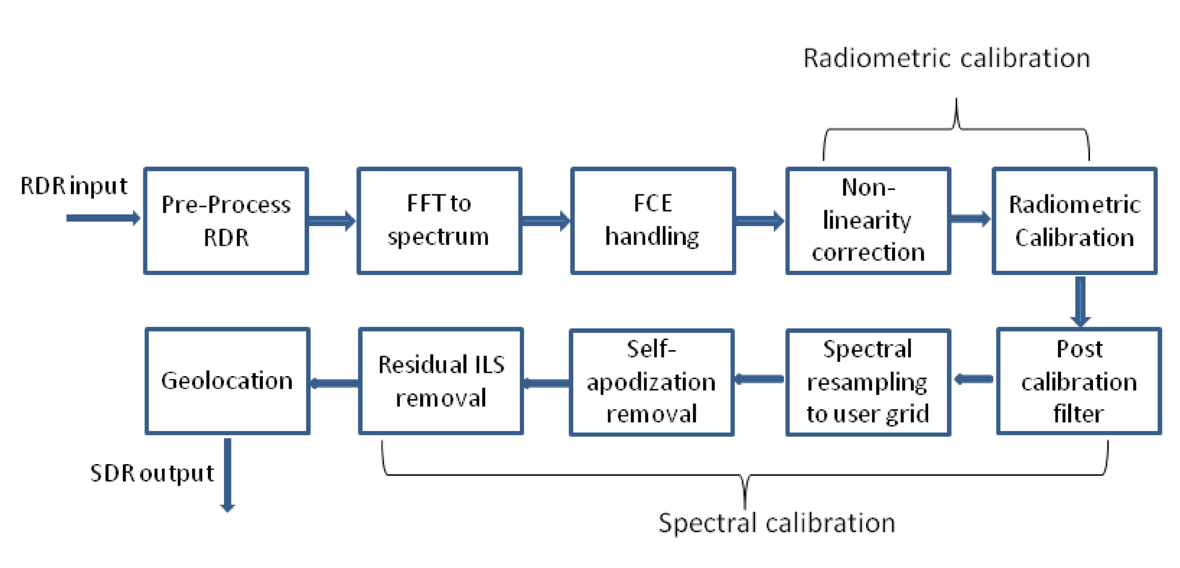


Figure 2. SDR processing algorithm

3. SDR Specification and Product Profile

Table 1. SDR specification

Band	Spectral range (cm-1)	N. of chan.	Resolution (cm-1)	FORs per Scan	FOVs per FOR	NEdN @287K BB mW/m2/sr/cm-1	Radiometric Uncertainty @287K BB (%)	Spectral (chan center) uncertainty ppm	Geolocation uncertainty km
LW	650-1095	713	0.625	30	9	0.14	0.45	10	1.5
MW	1210-1750	433	1.25	30	9	0.06	0.58	10	1.5
SW	2155-2550	159	2.5	30	9	0.007	0.77	10	1.5

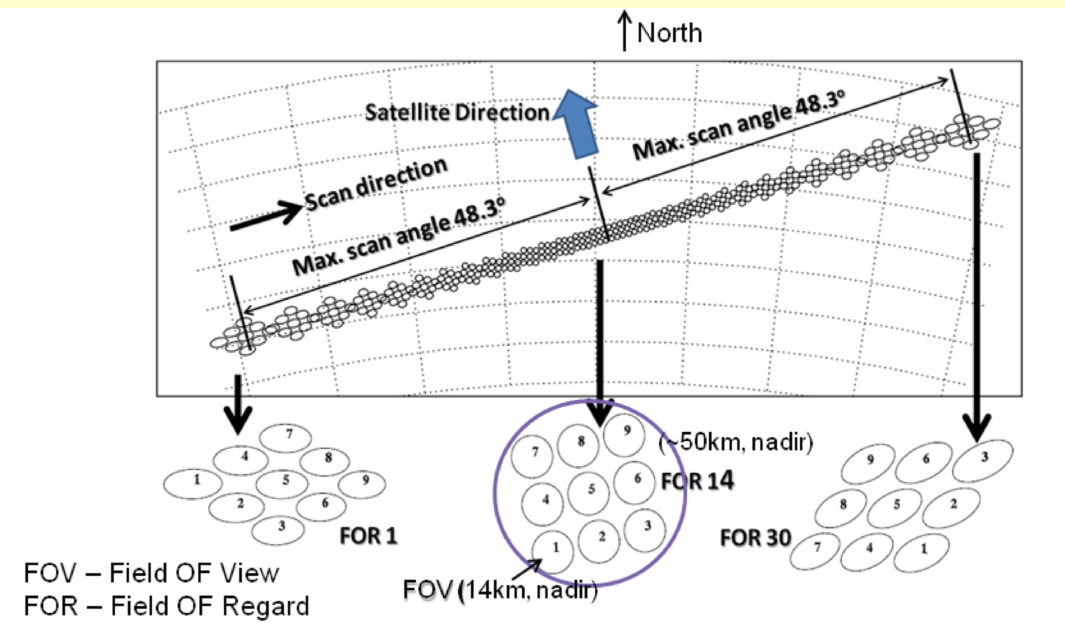


Figure 3. Scan, FOR, FOV position

Table 2.1 Selected SDR outputs

Name	Description
ESRealLW, ESRealMW, ESRealSW	LW, MW and SW band spectrally and radiometrically calibrated radiances (real part of spectra)
ESImaginaryLW, ESImaginaryMW, ESImaginarySW	LW, MW and SW band imaginary part of spectra
ESNEdNLW, ESNEdNMW, ESNEdNSW	LW, MW, SW band spectral noise estimate (NEdN)
QF1, QF2, QF3, QF4	Each QF (byte) contains bit level flags indicating the status of the data. The overall SDR quality flag is a two-bit flag contained in QF3.

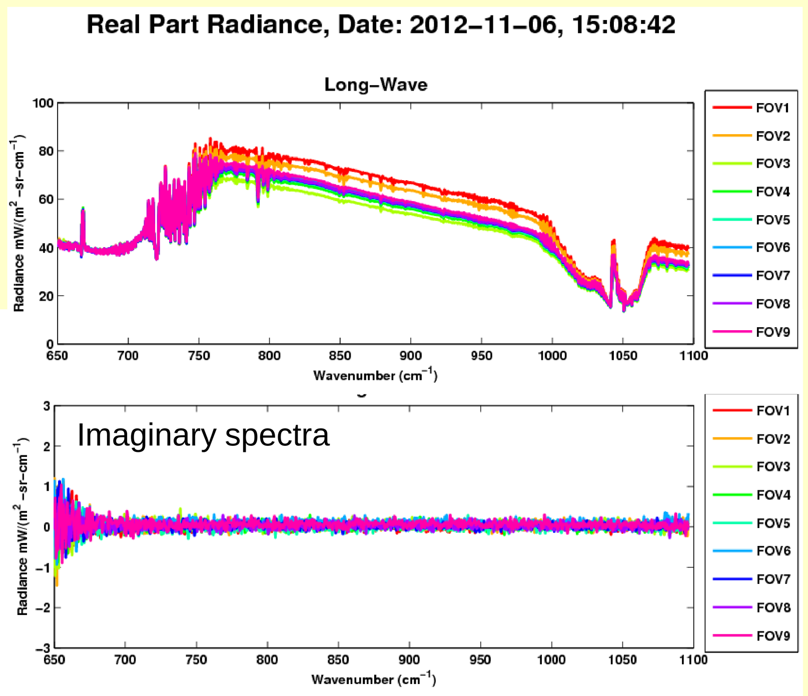


Figure 4 Sample longwave band real and imaginary spectra

Table 2.2 Selected SDR Geolocation outputs

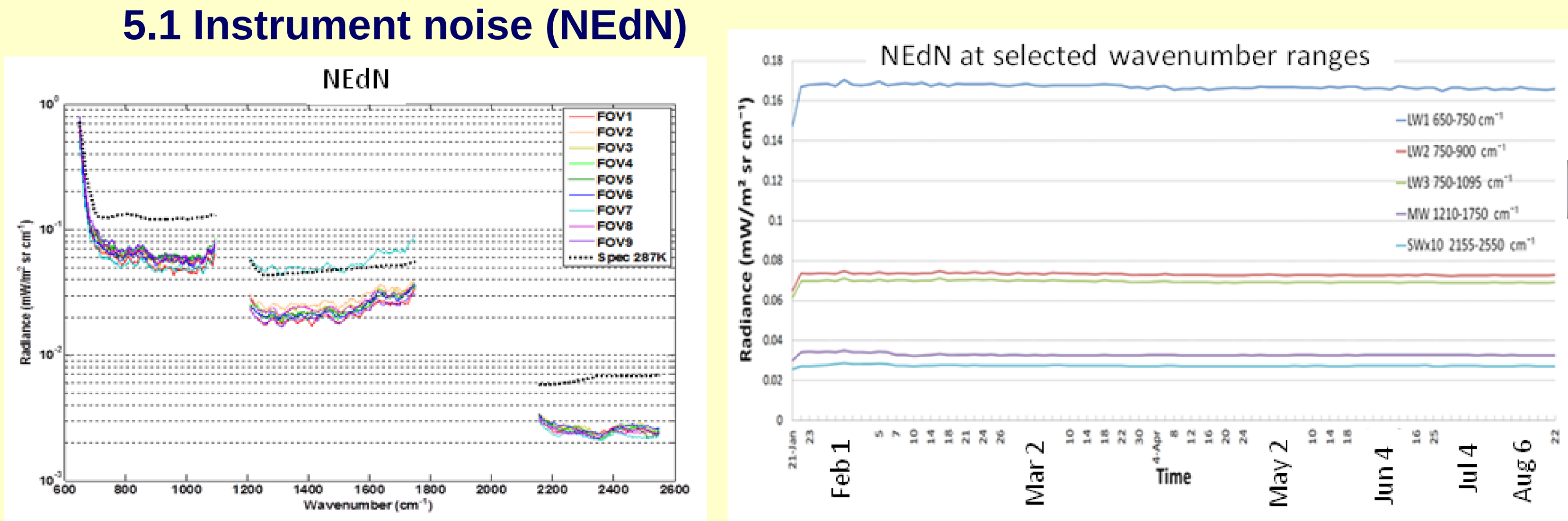
Name	Description
Lat, lon	Latitude and longitude
sunazm, sunazm	Solar zenith and azimuth angles
Satzen, satazm	Satellite zenith and azimuth angles
Height, range	Ellipsoid-geoid separation and line of sight distance form the ellipsoid intersection to the satellite
scPosition, scVelocity	Spacecraft position and velocity in ECR coordinates at the midtime of scan
scAttitude	The relative orientation of the Spacecraft with respect to the Geodetic Reference Frame at the midtime of scan
geoQualflag	Geolocation data quality flag

4. Important CalVal Events and Milestones

Date	Event Description
January 18th 2012	CrIS was powered up; team started instrument checkout and optimization
February 8th	Engineering packet v32 was uploaded (PGA setting and bit trim mask updates)
February 22nd	Full spectral resolution RDRs (0.8 cm maxOPD for all bands) were collected
April 11th	Engineering packet v33 was upload to CrIS (spectral calibration parameters, nonlinearity coefficients and ICT emissivity table updates)
April 18th	A new FIR digital filter was uploaded to CrIS to replace the corrupted one
May 15th	CrIS SDR product reached Beta maturity level (Milestone)
June 27th	Engineering packet v34 was uploaded to CrIS (temperature drift limit updates)
October 23rd	Provisional maturity status review meeting (Milestone)
2013	Validated maturity status (milestone)

5. Highlights of CrIS CalVal Results

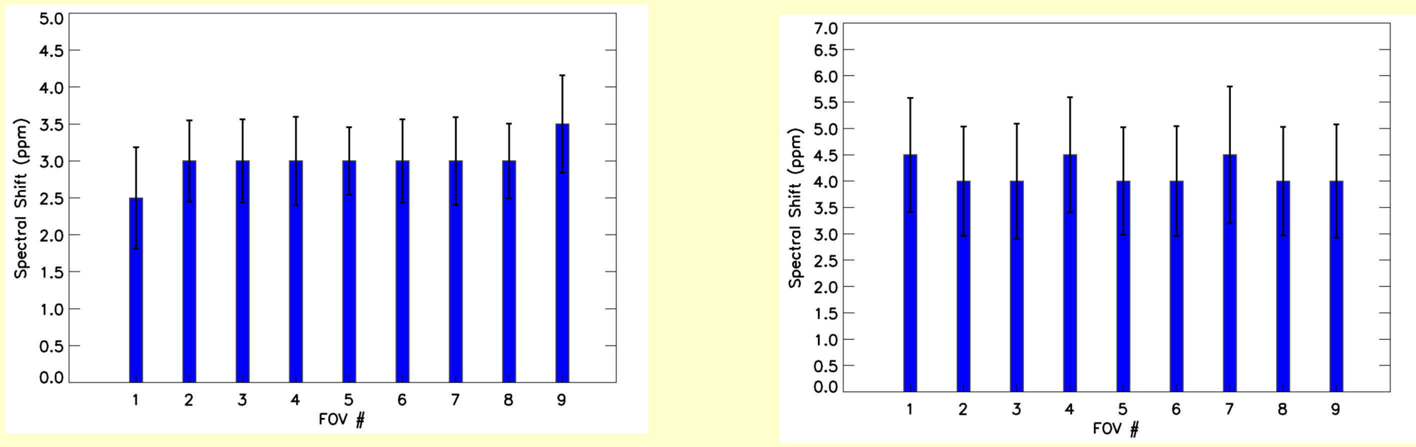
5.1 Instrument noise (NEdN)



NEdN is much better than the specification and is very stable

Figure 5. NEdN. The dotted lines in left figure are the specification (Zavyalov et al. ,2012)

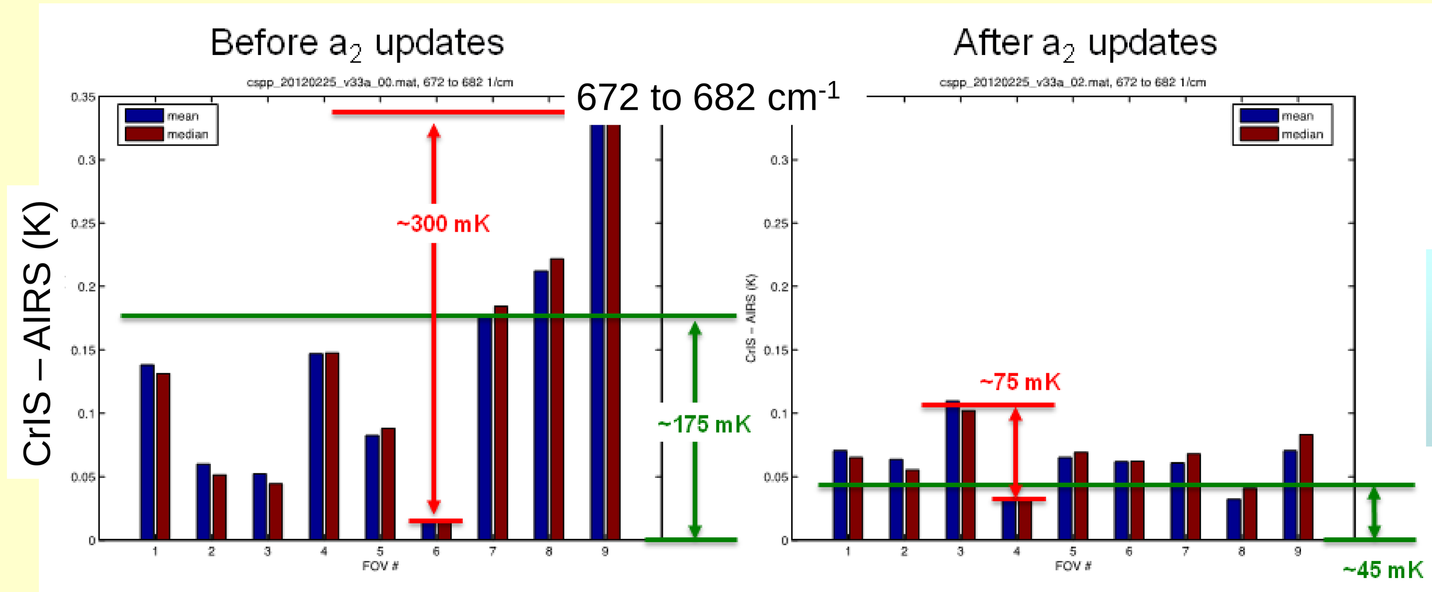
5.2 Spectral (channel center frequency) uncertainty after ILS parameter updates



The spectral uncertainty is well below the specification (10 ppm)

Figure 6. Spectral uncertainties assessed using the Community Radiative Transfer Model (CRTM) and the correlation analysis between the observations and simulations

5.3 Radiometric Uncertainty before and after Nonlinearity coefficient a2 adjustment



FOV-to-FOV difference is reduced from 300 mK to 75 mK
Radiometric uncertainty is reduced from 175 mK to 45 mK

Figure 7. CrIS/AIRS comparisons (radiance averaged over 672 to 682 cm-1) before and after adjustments of the nonlinearity a2 coefficients (Tobin et al., 2012)

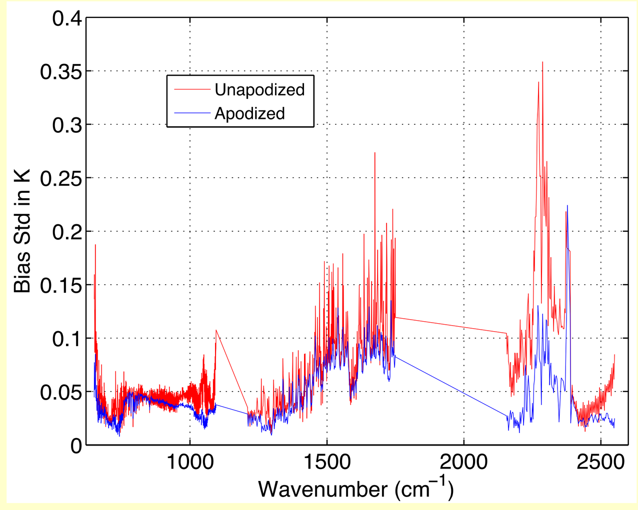


Figure 8. Standard deviation (over 9-FOVs) of Bias vs RTM simulations after a2 and ILS parameter adjustments (Strow et al., 2012)

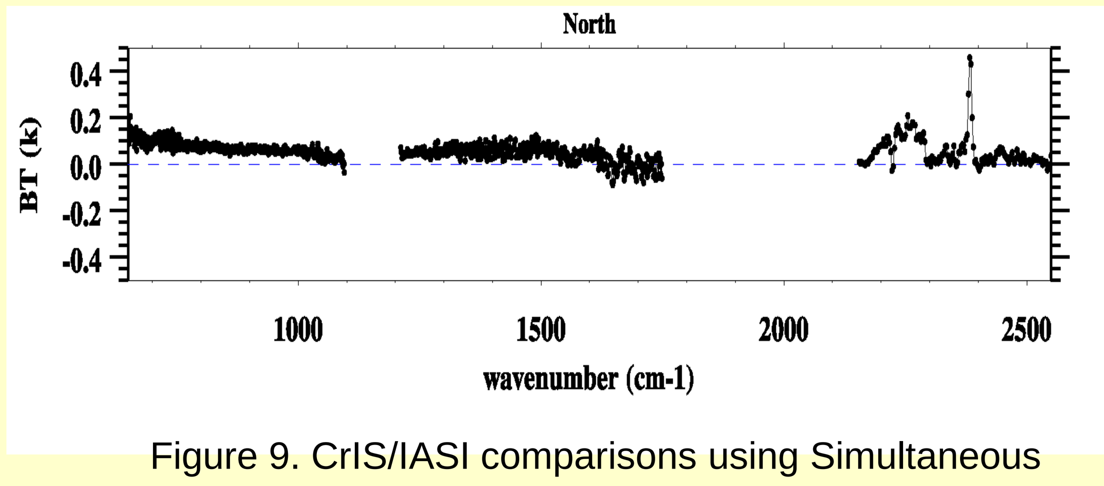


Figure 9. CrIS/IASI comparisons using Simultaneous Nadir Observation technique (SNO) after a2 and ILS parameter adjustments

The overall radiometric uncertainty is about 0.1 K

5.4 Geolocation uncertainty estimated with VIIRS radiance data

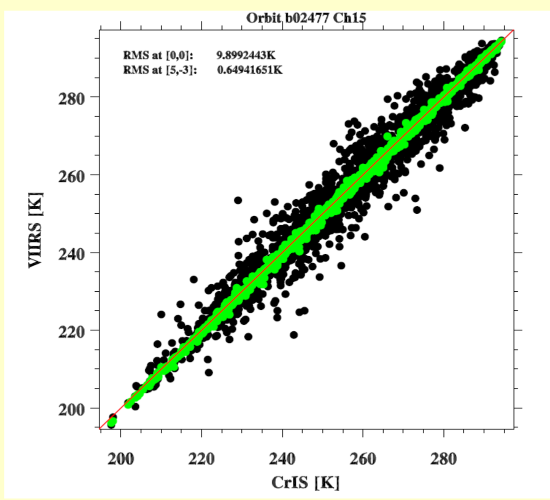


Figure 10. Collocated cloudy CrIS and VIIRS (Ch15) radiances (spectrally and spatially averaged). VIIRS pixels are shifted to find the minimum RMS difference

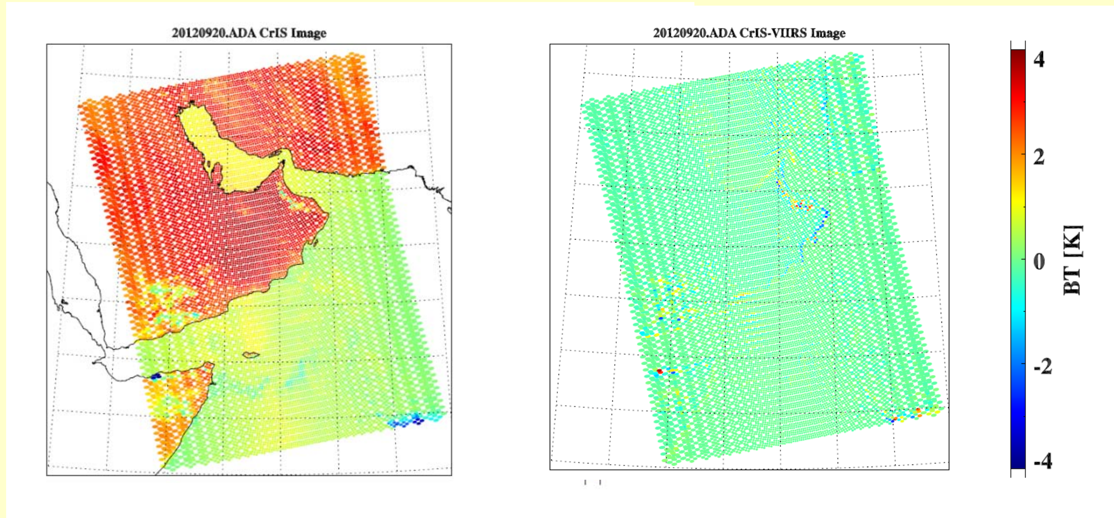


Figure 11. CrIS image cross coastlines (left) and the difference between the CrIS and VIIRS images(right), indicating the geolocation uncertainty is within 1 VIIRS pixel size (750 m).

CrIS geolocation uncertainty is better than 1 km

6. Reference

Vladimir Zavyalov et al., Cross-track Infrared Sounder (CrIS) Instrument In-flight Performance, Calcon 2012

Dave Tobin et al., Performance of CrIS on Suomi-NPP , Calcon 2012

Larrabee Strow et al., CrIS Calibration and Validation, Calcon 2012