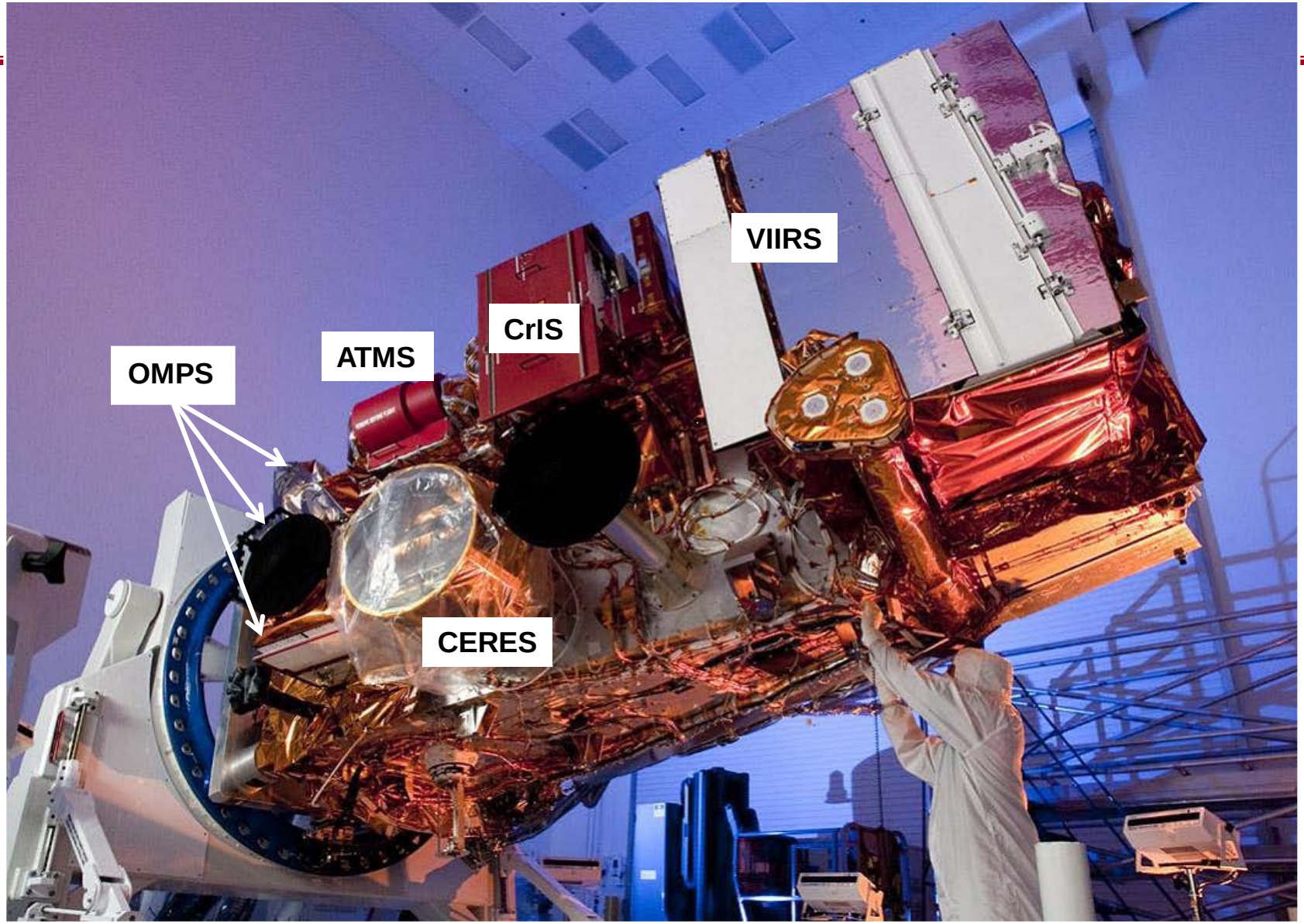
National Environmental Satellite, Data, and Information Service

NOAA Operational Calibration Support to NPP/JPSS Program

Fuzhong Weng
Satellite Meteorology and Climatology Division
Center for Satellite Applications and Research (STAR)
National Oceanic and Atmospheric Administration (NOAA)

NPP Spacecraft and Payloads



NOAA Calibration Segment for NPP/JPSS

1. **Lead all SDR teams for NPP/JPSS CalVal**
2. **Provide spacecraft/instrument telemetry trending**
3. **Provide a long-term monitoring (LTM) for all NPP/JPSS sensors**
4. **Characterize the in-orbit performance of ATMS, VIIRS, CrIS and OMPS**
5. **Update the processing coefficient files (PCT) and lookup table (LUT) in operational SDR algorithms**
6. **Lead and participate in the instrument anomaly investigations and provide the root-cause analysis**

NPP Instrument Schedule

NPP Instrument Activitities

- ATMS: Started scan on 7 Nov, completed 4 space view scan profiles
- VIIRS: Nadir Door Opened on 21 Nov with science data at visible channels
- CrIS and VIIRS: Cooler door openings for CrIS and VIIRS on January 18
- OMPS: Doors Closed Cal/Val Commanding from Command Sequence Memory
- CERES: Commanding from Spacecraft Command Sequence Memory

Planned Significant Activities

- ATMS: Perform pitch maneuvers
- OMPS and CERES door openings to follow on January 25

NPP SDR Algorithm Status

Sensor	Algorithm	Status	Date
ATMS	TDR/SDR	Provisional	February , 2012
CrIS	SDR		
OMPS	SDR		
VIIRS	SDR		
CERES	SDR		

NPP SDR Product Maturity Level Definitions
Provisional • Product quality may not be optimal • Incremental product improvements are still occurring as calibration parameters are adjusted with sensor on-orbit characterization (versions will be tracked) • General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing • Users are urged to contact NPOESS NPP Cal/Val Team representatives prior to use of the data in publications
Validated/ Calibrated • On-orbit sensor performance characterized and calibration parameters adjusted accordingly • Ready for use by the Centrals and in scientific publications • There may be later improved versions • There will be strong versioning with documentation

Search STAR websites Go

STAR Integrated Calibration/Validation System (ICVS) for NPP/JPSS

» Instrument Performance Monitoring - Telemetry >>
- NPP S/C Telemetry
- NPP ATMS >>
- NPP CrIS
- NPP VIIRS
- NPP OMPS

» Instrument Performance Monitoring - Bias

Data and images displayed on

ATMS Channel NEdT: Channel 2 — Display

ATMS Channel Gain: All Channel Snapshot — Display

ATMS Cold Calibration Count: All Channel Snapshot — Display

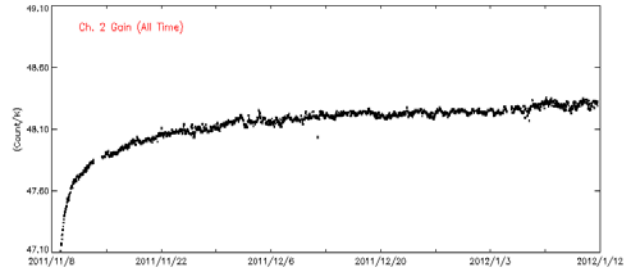
ATMS Warm Calibration Count: All Channel Snapshot — Display

ATMS 4-Wire PRTs: K,Ka,V-Band Sensor — Display

ATMS Receiver Shelf 2-Wire PRTs: K-Band — Display

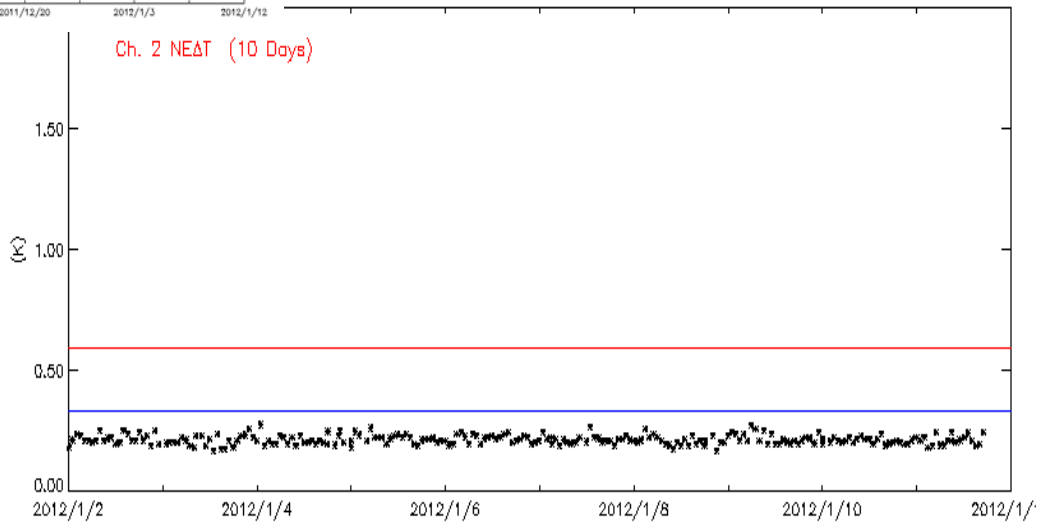
ATMS 2-Wire PRT (25 PRTs): K-Band Receiver Front End Temperature — Display

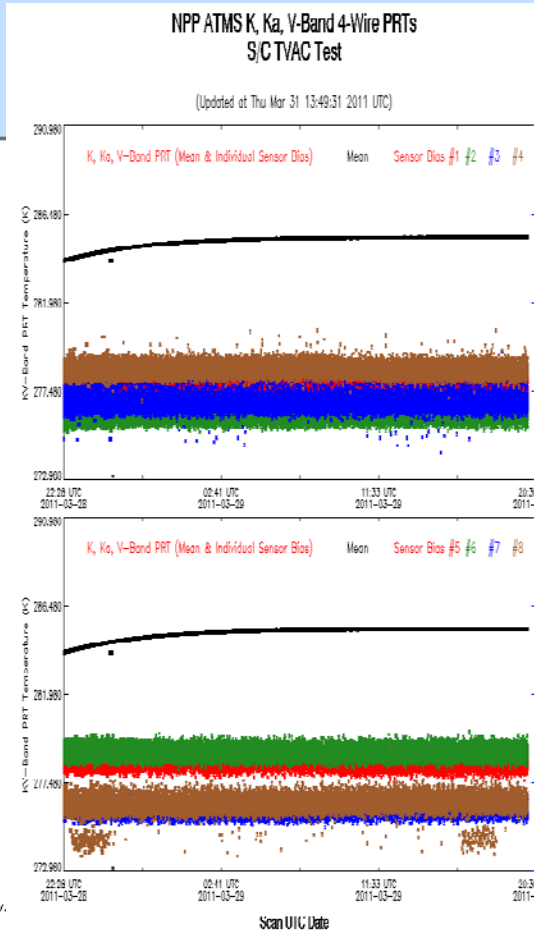
ATMS Health/Status Analog Parameters (35 Index): Signal Processing Assembly +5V Seconary Voltage — Display



NPP ATMS Ch.2 NEΔT Science RDR

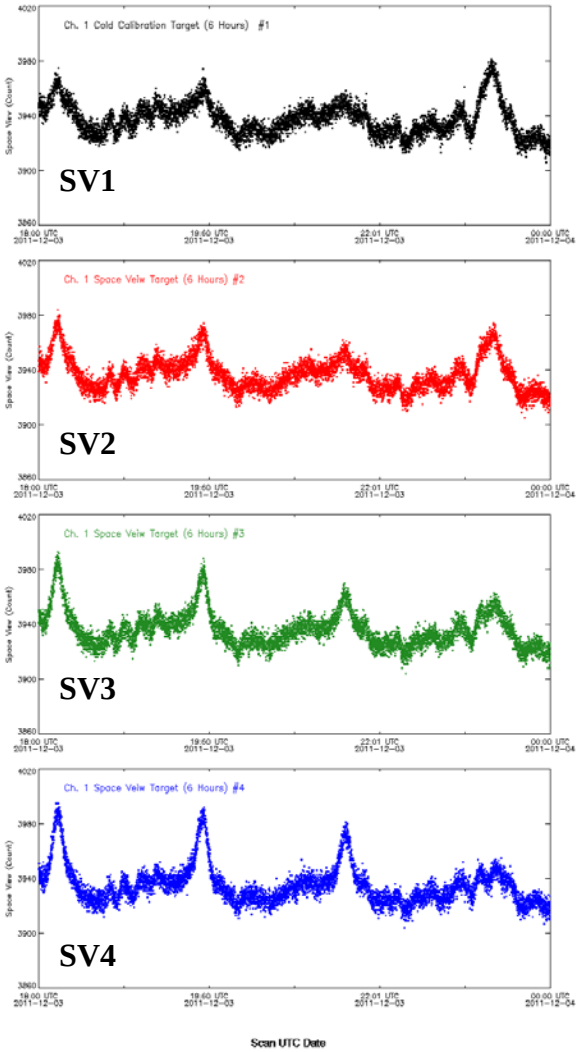
(Updated at Wed Jan 11 20:31:13 2012 UTC)



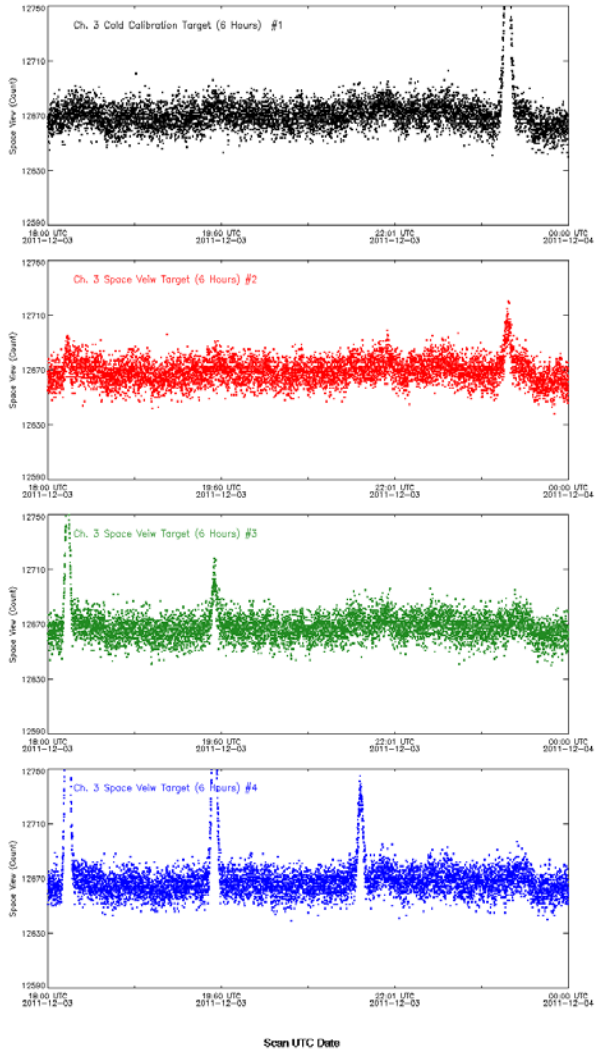


ATMS Lunar Contamination

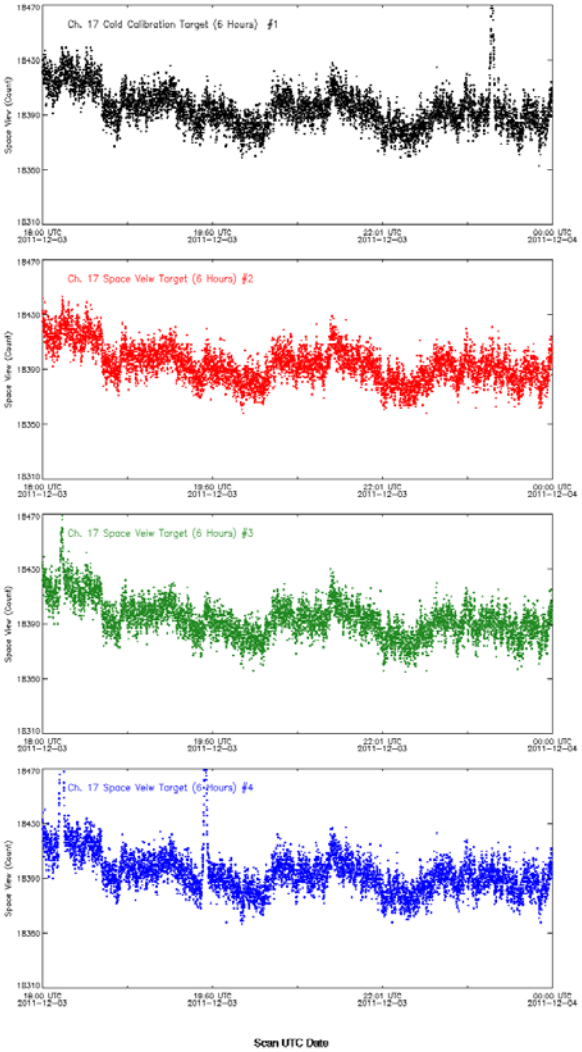
Channel 1 (FOV Size:5.2)



Channel 3 (FOV Size: 2.2)

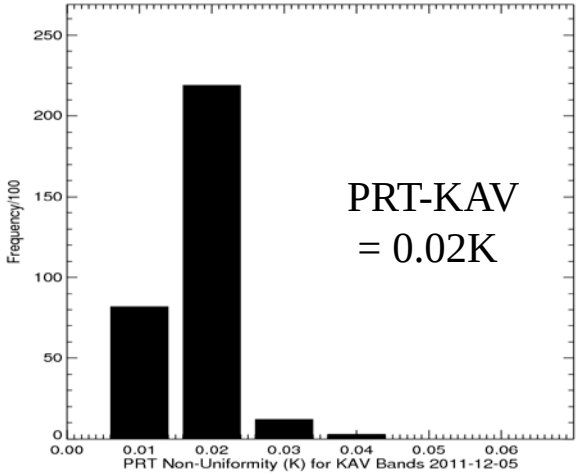


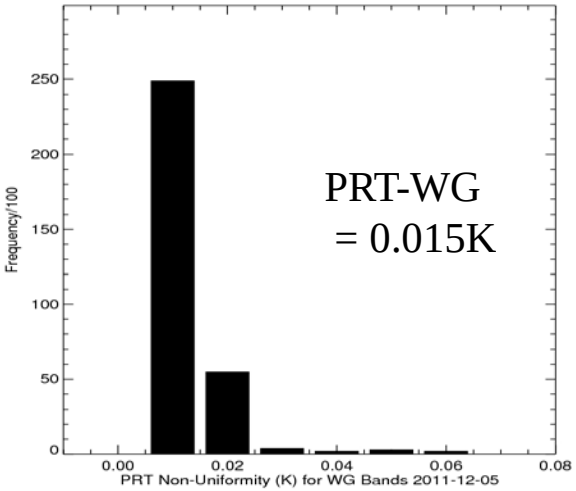
Channel 17 (FOV Size: 1.1)



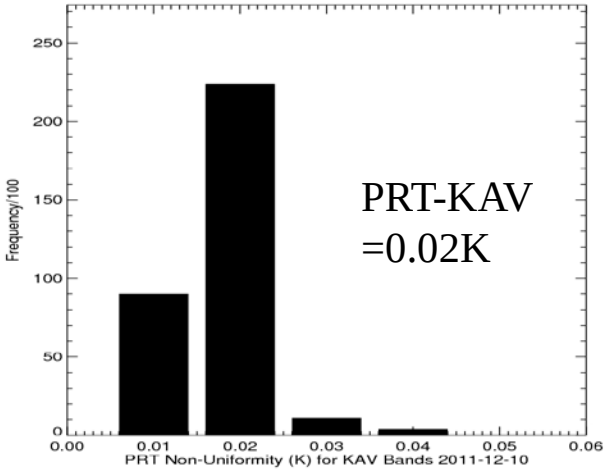
ATMS PRT Uniformity Check

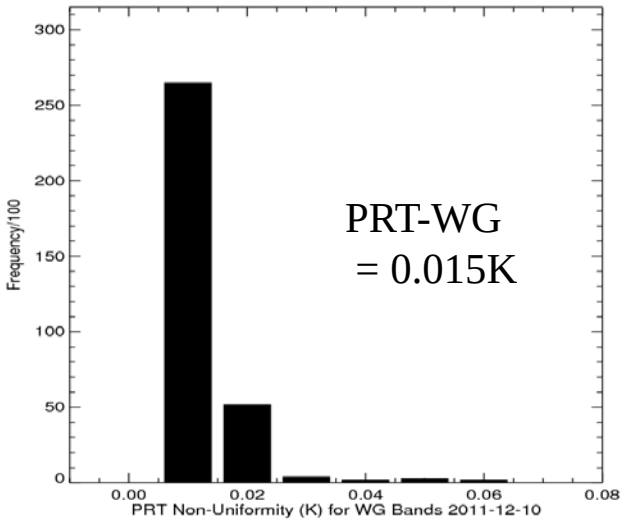
12-05-2011



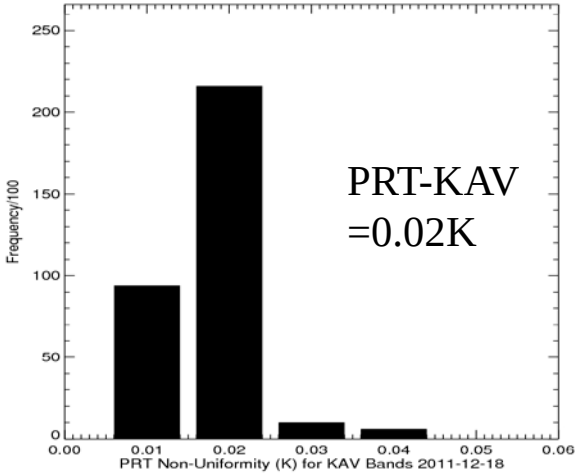


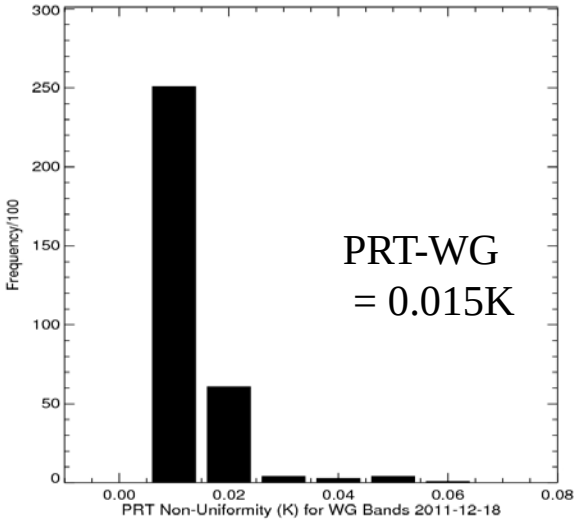
12-10-2011



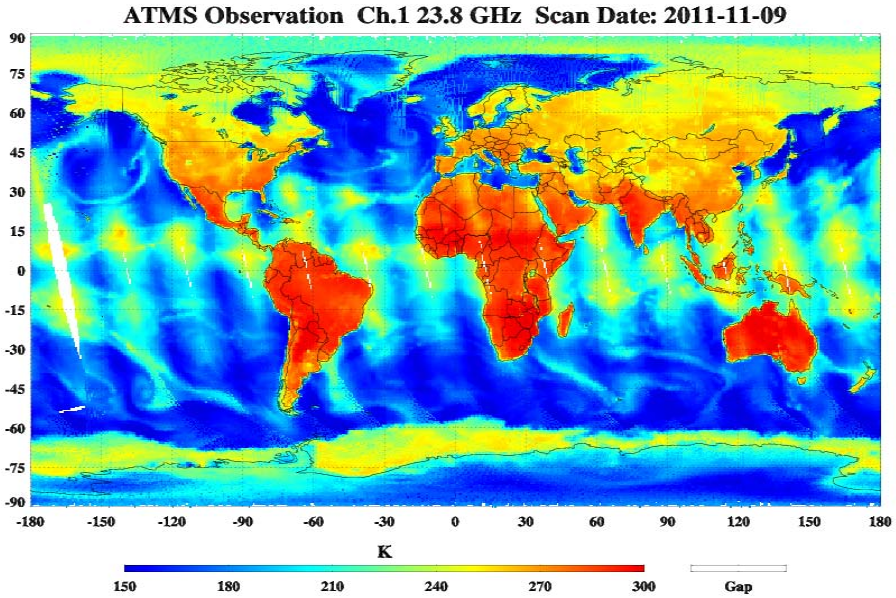


12-18-2011

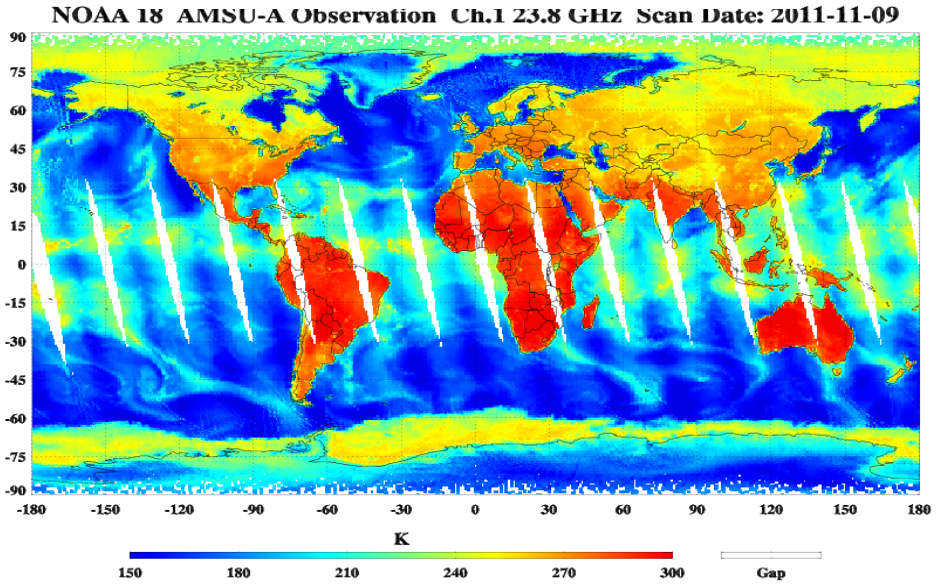




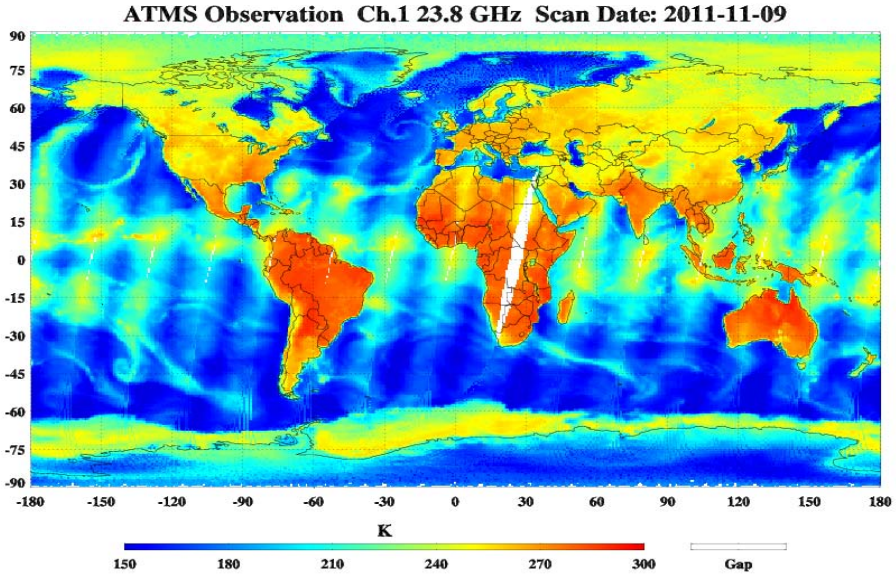
ATMS Observation Ch.1 Ascending



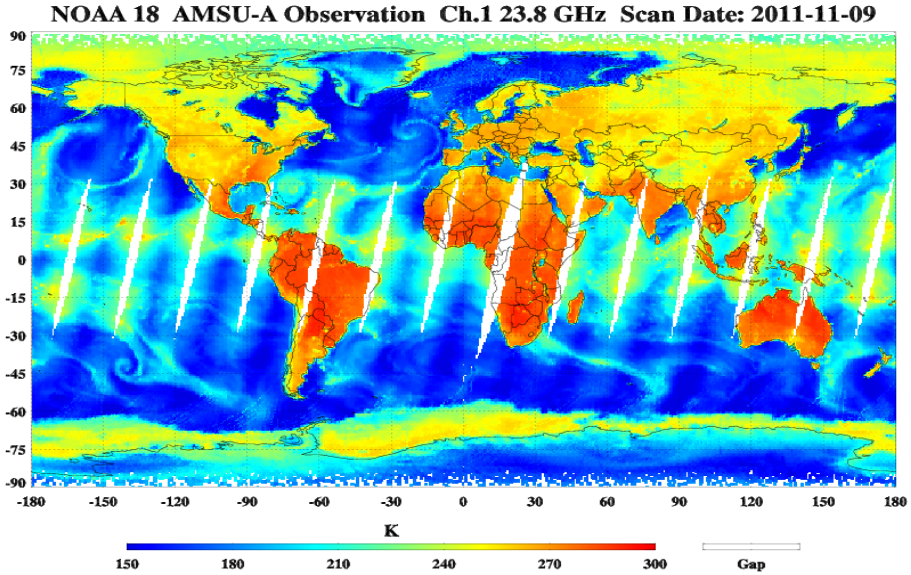
NOAA 18 AMSU-A Observation Ch.1 Ascending



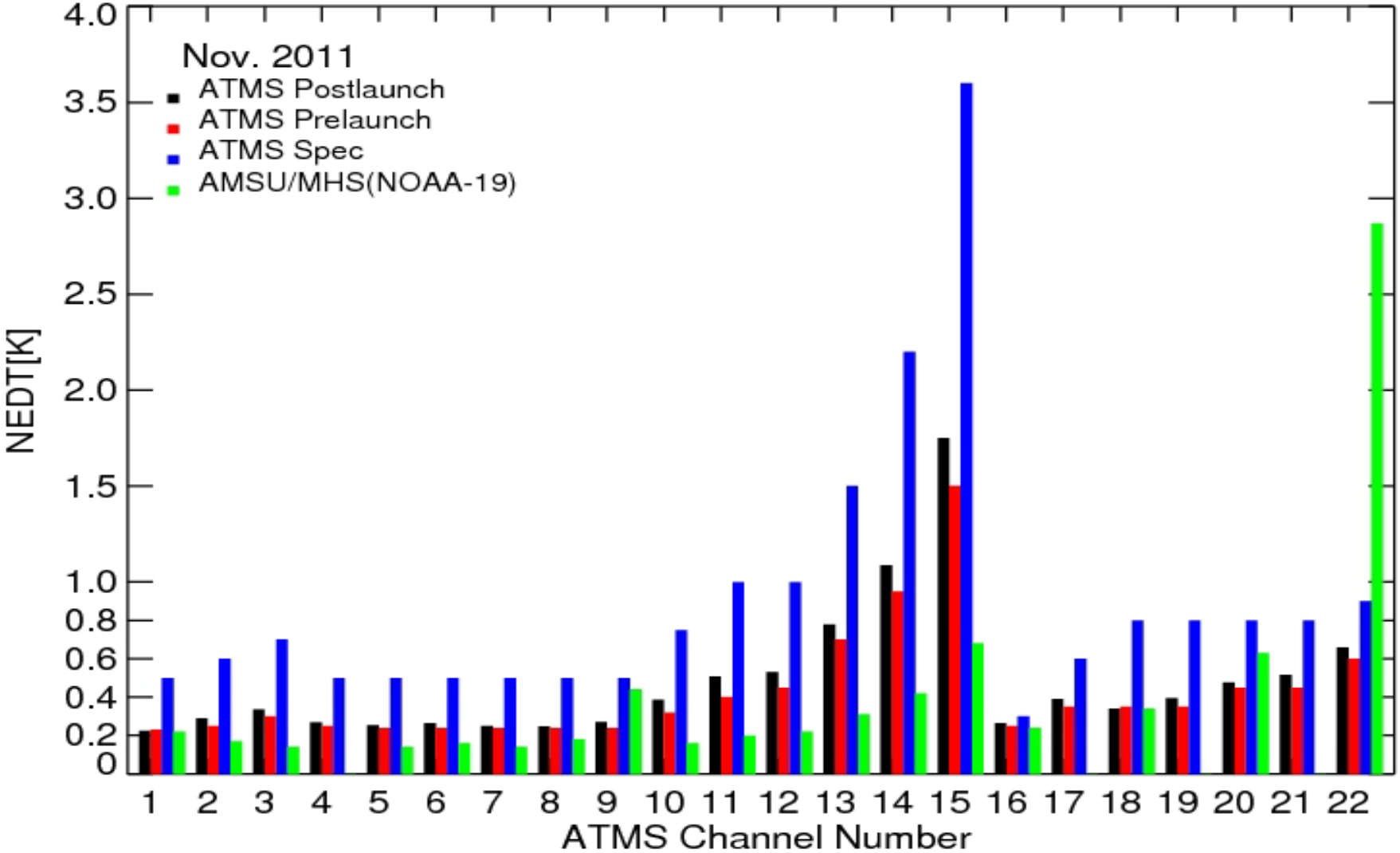
ATMS Observation Ch.1 Descending



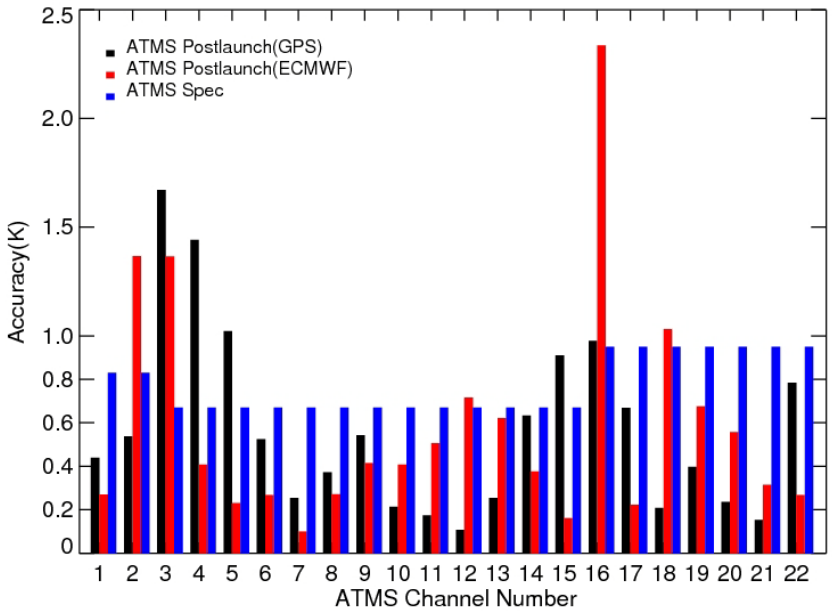
NOAA 18 AMSU-A Observation Ch.1 Descending



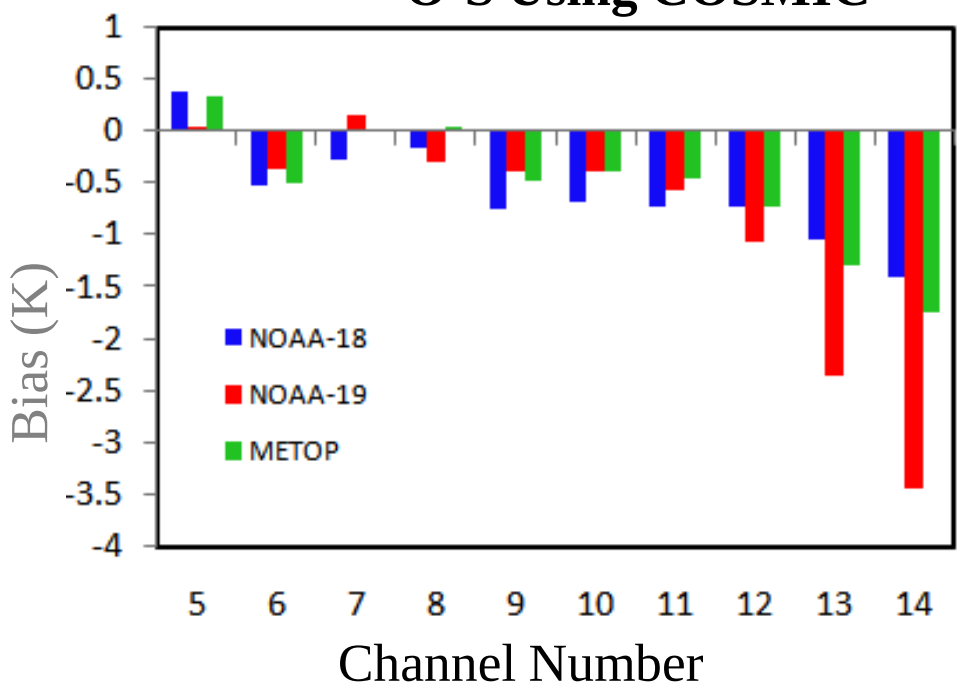
ATMS Noise Equivalent Differential Temperature (NEDT)



ATMS Accuracy Assessment Using ECMWF Analysis Fields and COSMIC Data



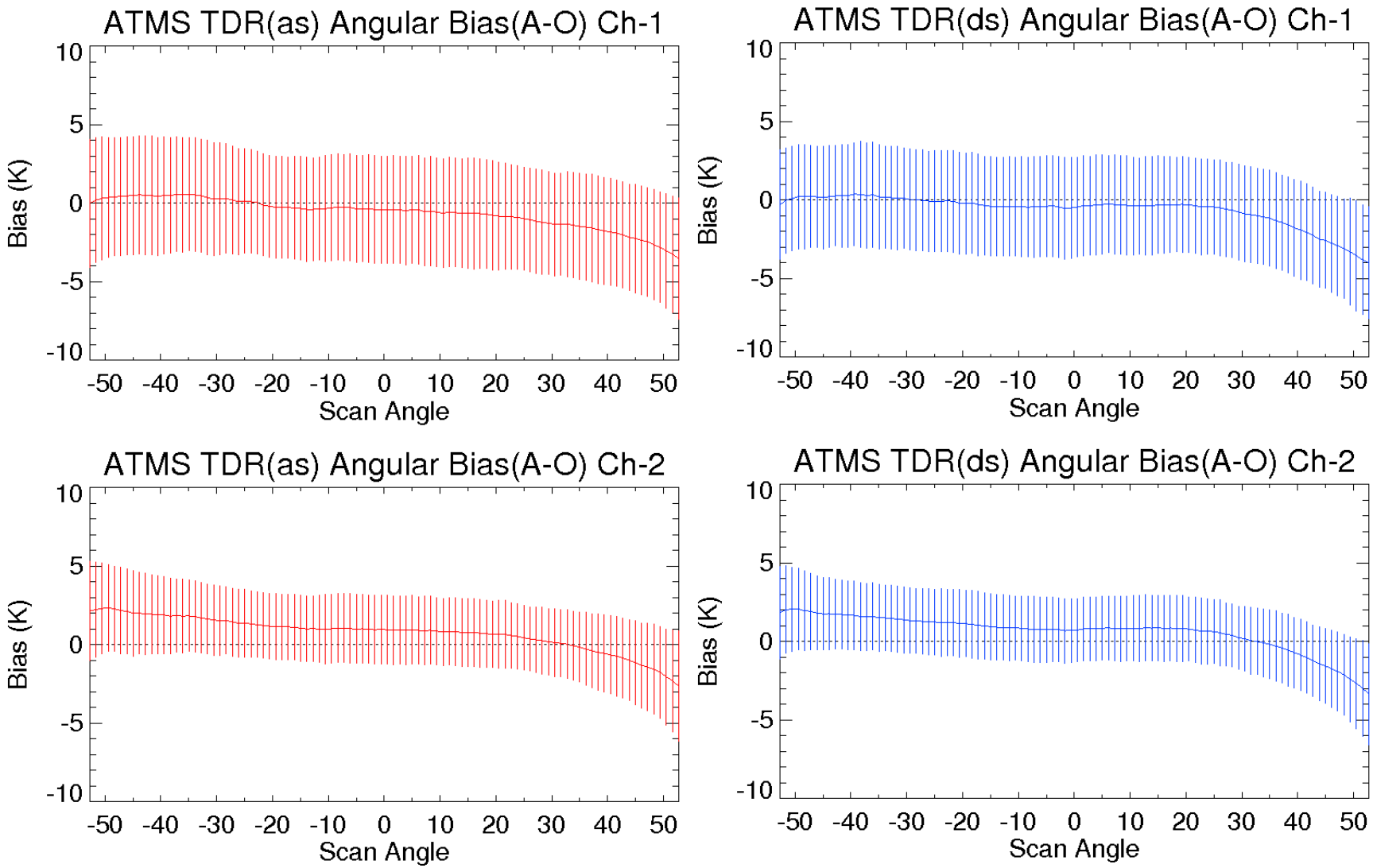
O-S Using COSMIC



ATMS TDR Along-Scan Asymmetry

Angular dependent bias (A-O) Dec, 16-22, 2011

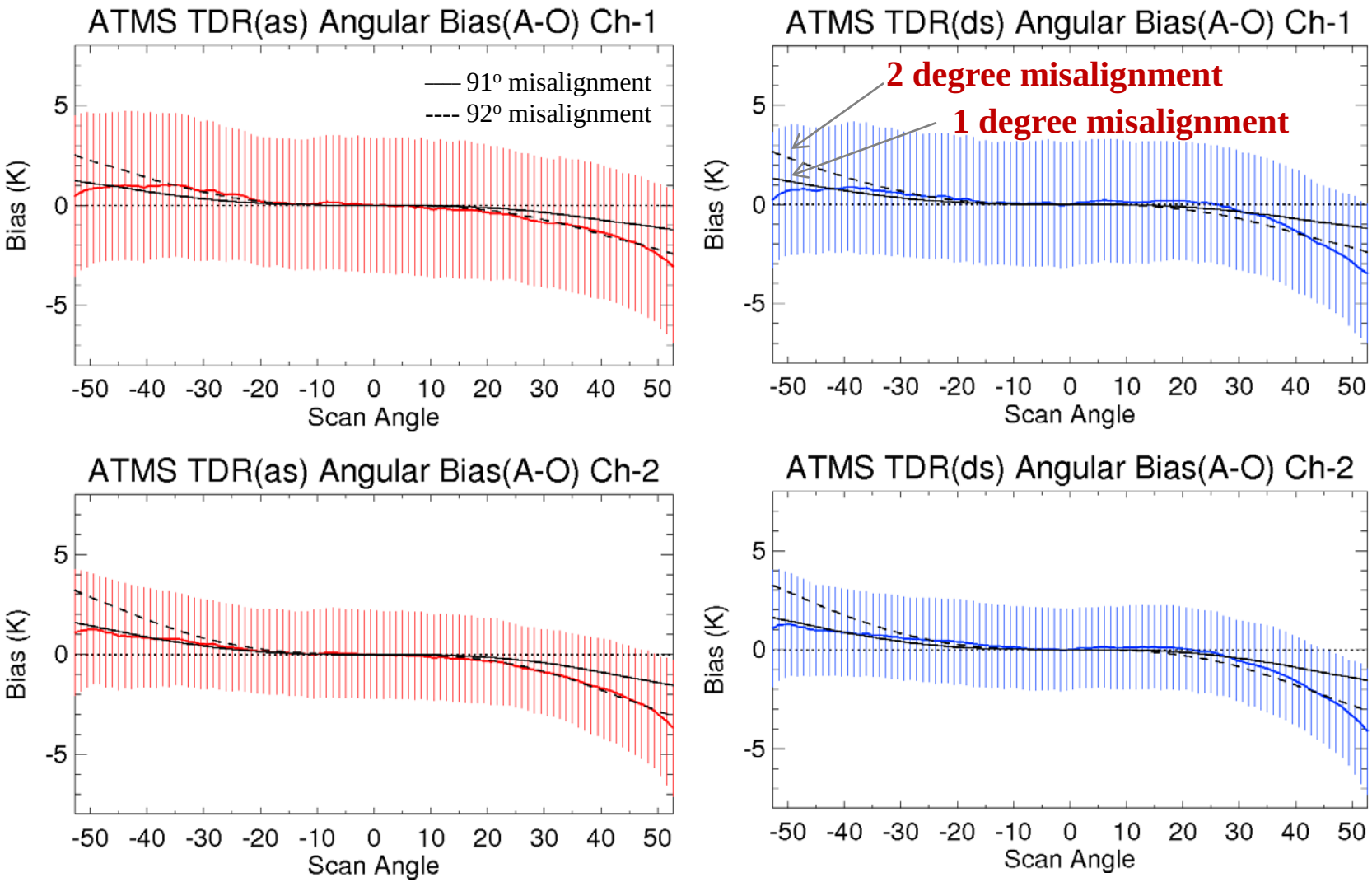
CRTM Sim: GSI analysis field ; OBS: ATMS TDR



ATMS TDR Along-Scan Asymmetry

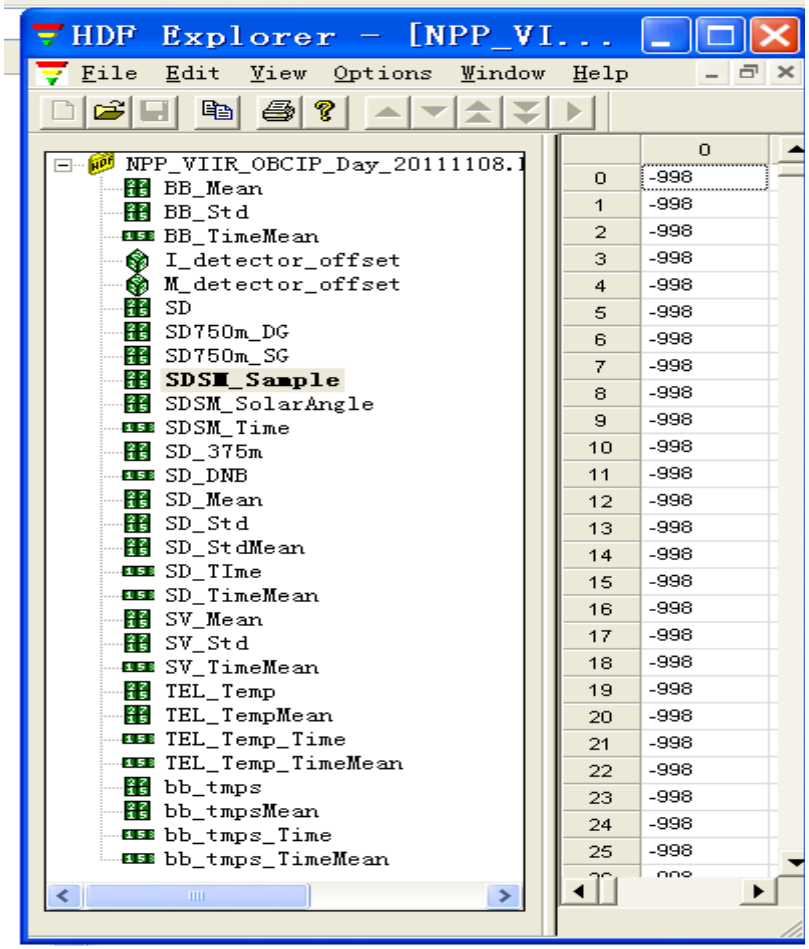
Angular dependent bias (A-O) Dec, 16-22, 2011

CRTM Sim: GSI analysis field ; OBS: ATMS TDR



VIIRS On-Board Calibration File for Monitoring and Trending

- Daily granule aggregation and processing of OBC files in HDF5 (40M in size)
- Detector average, band average and granule average for the telemetry data and OBC observation in one day.
- Effective data extraction of SD and SDSM observations
- Long term monitoring based on the daily OBC files
- Trend analysis, change mechanism analysis and anomaly report
- F- factor and H-table are generated based on the our Daily OBC aggregation file



www.star.nesdis.noaa.gov/smcd/jcsda/nsun/NPP/ipm_telemetry_npp_viirs.php

Search STAR websites Go

STAR Integrated Calibration/Validation System (ICVS) for NPP/JPSS

- Instrument Performance Monitoring - Telemetry
  - NPP S/C Telemetry
  - NPP ATMS
  - NPP CrIS
  - NPP VIIRS >>
  - NPP OMPS
- Instrument Performance Monitoring - Bias

Data and Images displayed on STAR sites are provided for experimental use only and are not official operational NOAA products. More Information>>

VIIRS Solar Diffuser (SD) Count: Band I1 Display

VIIRS SD Stability Monitor (SDSM) Count: Band I1 Display

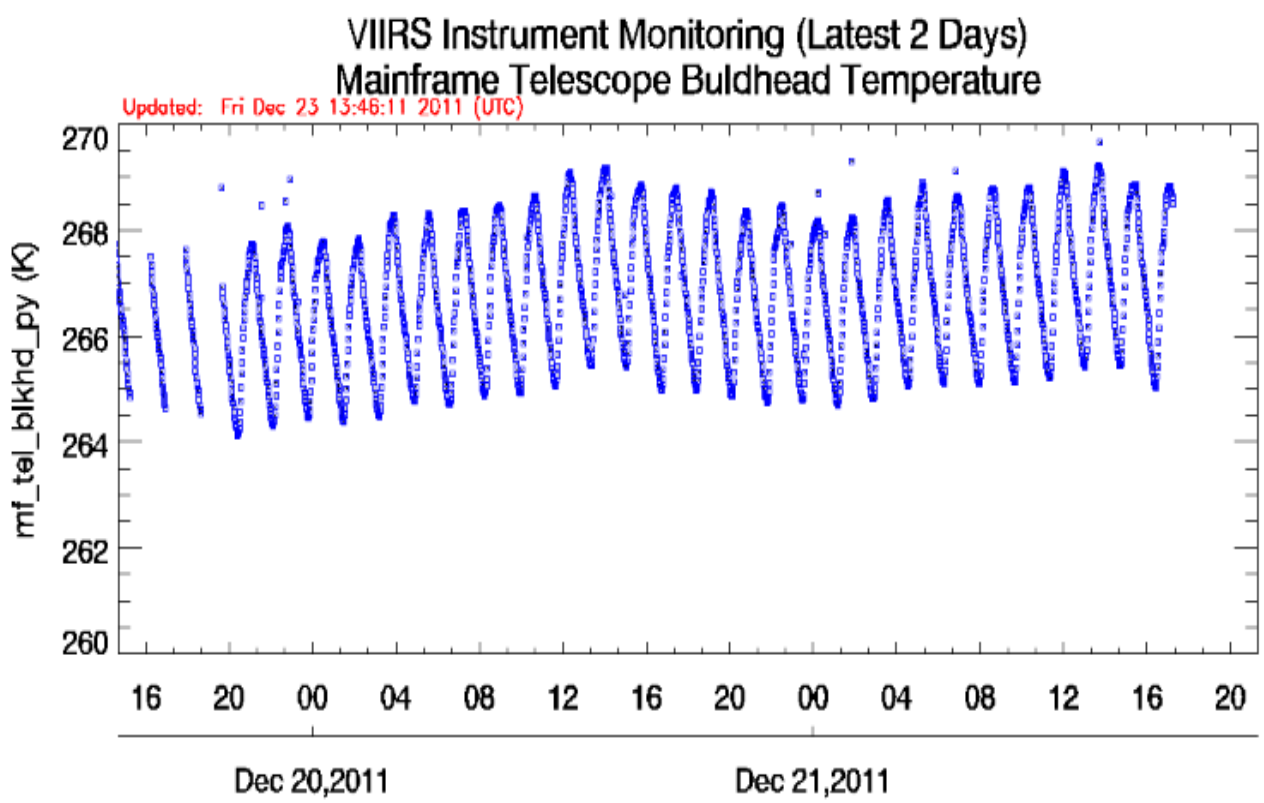
VIIRS Blackbody Count: Band M7 Display

VIIRS Blackbody Count NEΔN: Band I1 Display

VIIRS Space View Count: Band I1 Display

VIIRS Space View Count NEΔN: Band I1 Display

VIIRS Instrument Temperature: Mainframe Telescope Buldhead Temperature Display



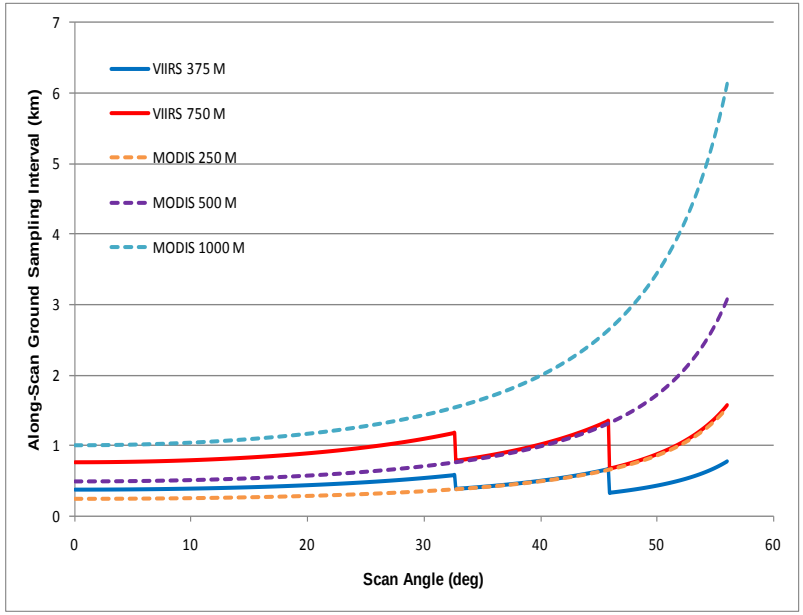
VIIRS Instrument Monitoring (LongTerm)

VIIRS vs. MODIS

VIIRS Band	Spectral Range (um)	Nadir HSR (m)	MODIS Band(s)	Range	HSR
DNB	0.500 - 0.900				
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000
M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000
M4	0.545 - 0.565	750	4 or 12	0.545 - 0.565 0.546 - 0.556	500 1000
I1	0.600 - 0.680	375	1	0.620 - 0.670	250
M5	0.662 - 0.682	750	13 or 14	0.662 - 0.672 0.673 - 0.683	1000 1000
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000
I2	0.846 - 0.885	375	2	0.841 - 0.876	250
M7	0.846 - 0.885	750	16 or 2	0.862 - 0.877 0.841 - 0.876	1000 250
M8	1.230 - 1.250	750	5	SAME	500
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000
I3	1.580 - 1.640	375	6	1.628 - 1.652	500
M10	1.580 - 1.640	750	6	1.628 - 1.652	500
M11	2.225 - 2.275	750	7	2.105 - 2.155	500
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000
M12	3.660 - 3.840	750	20	SAME	1000
M13	3.973 - 4.128	750	21 or 22	3.929 - 3.989 3.929 - 3.989	1000 1000
M14	8.400 - 8.700	750	29	SAME	1000
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000
I5	10.500 - 12.400	375	31 or 32	10.780 - 11.280 11.770 - 12.270	1000 1000
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000

Dual gain band

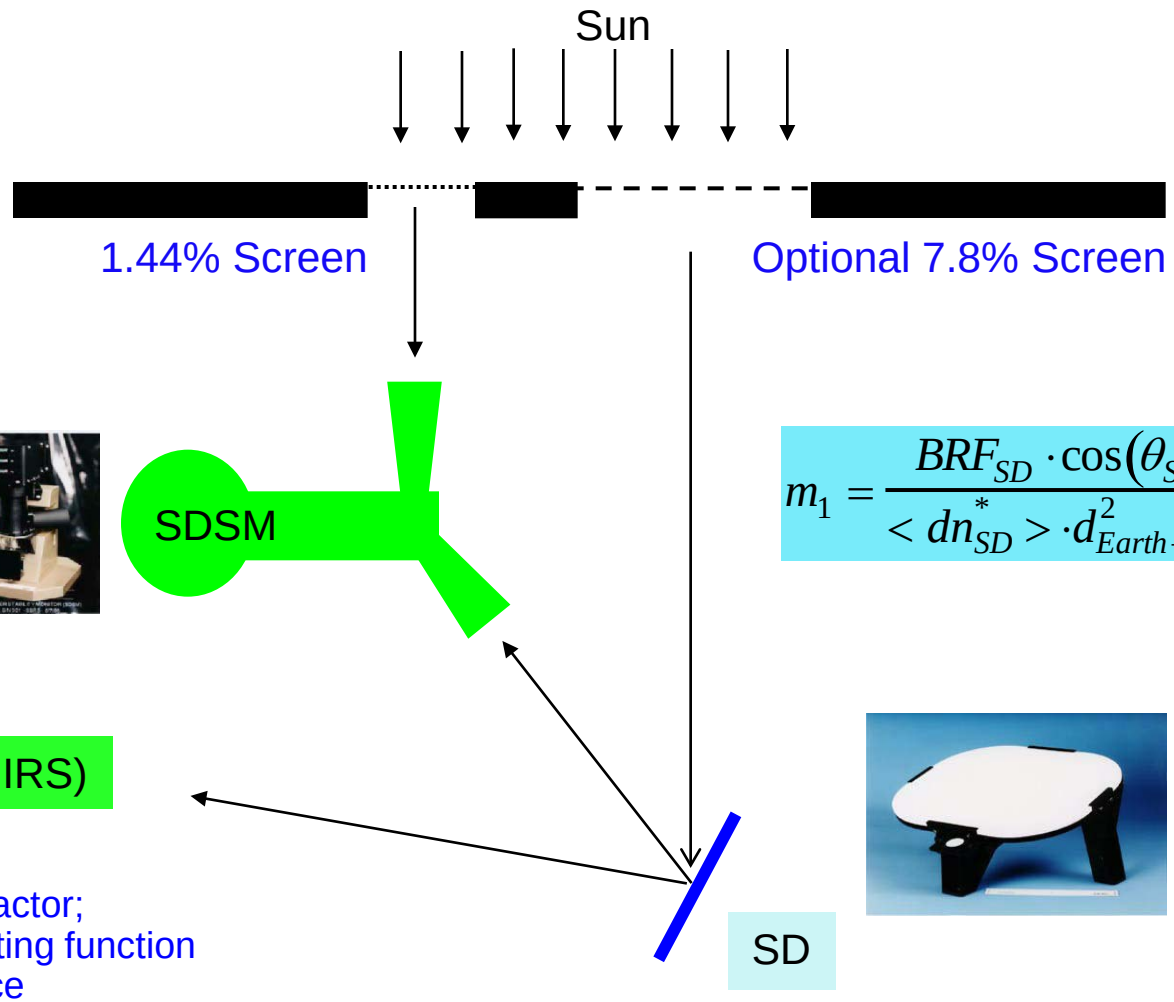
- VIIRS
  - 22 spectral bands from 0.4 to 12.5 mm, including moderate resolution and imaging bands
  - DNB, VIS/NIR, S/MWIR, and LWIR FPA
- MODIS
  - 36 spectral bands from 0.4 to 14.5 mm at three spatial resolutions
  - VIS, NIR, S/MWIR, and LWIR FPA



VIIRS RSB Calibration Using SD/SDSM

Reflectance Factor

$$\rho_{EV} \cdot \cos(\theta_{EV}) = m_1 \cdot dn^*_{EV} \cdot d^2_{Earth-Sun}$$

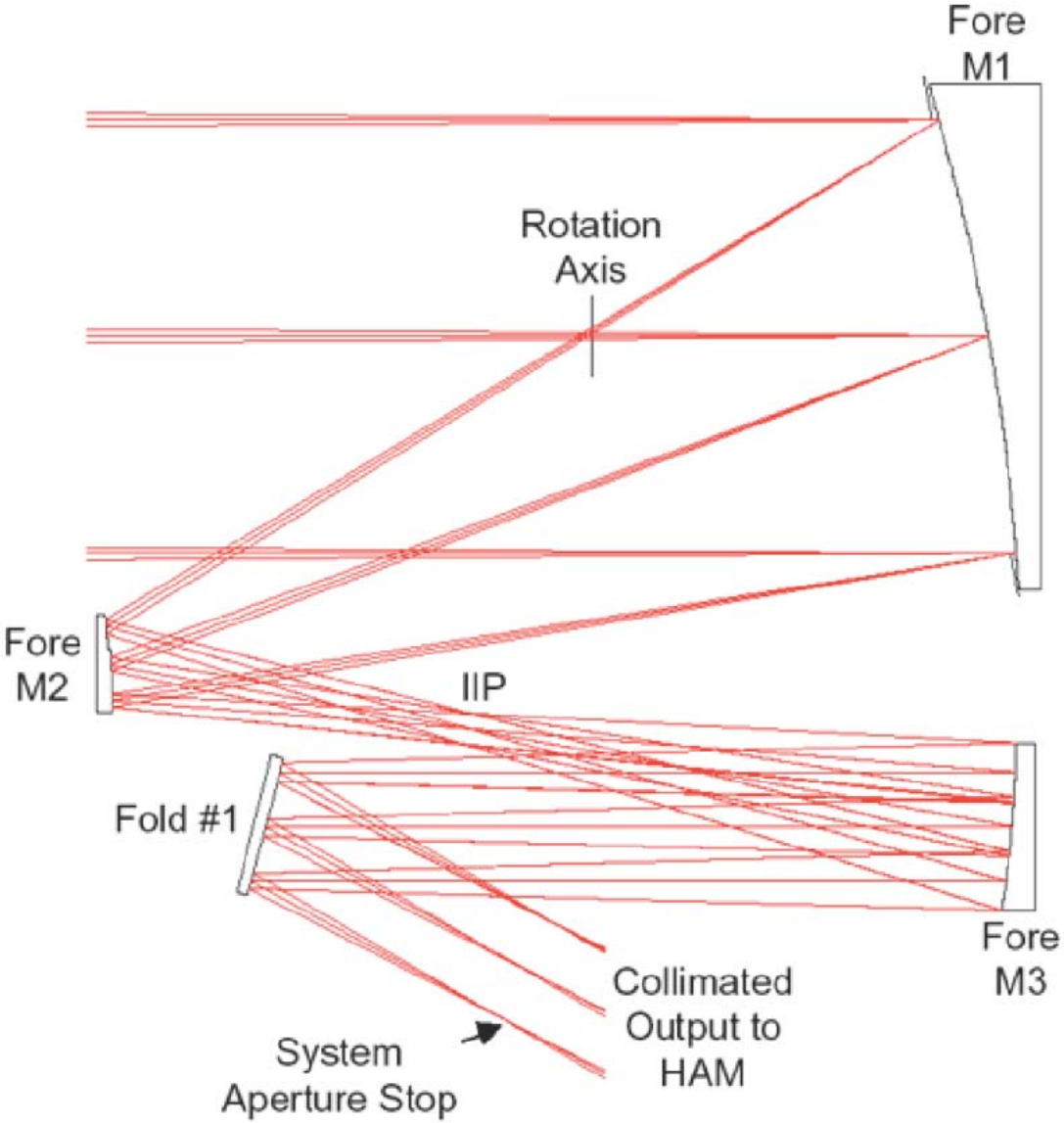


$$\Delta_{SD} = \frac{\overline{dc_{SD}}}{\overline{dc_{Sun}}}$$

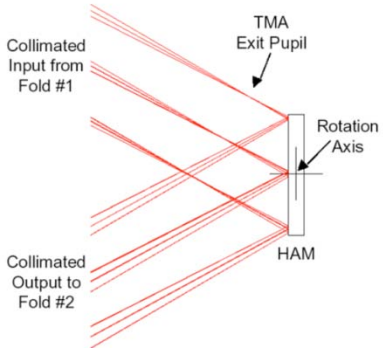
$$m_1 = \frac{BRF_{SD} \cdot \cos(\theta_{SD})}{< dn^*_{SD} > \cdot d^2_{Earth-Sun}} \cdot \Gamma_{SD} \cdot \Delta_{SD}$$

Δ_{SD}: SD degradation factor;
Γ_{SD}: SD screen vignetting function
d: Earth-Sun distance
dn*: Corrected digital number; **dc**: Digital count of SDSM

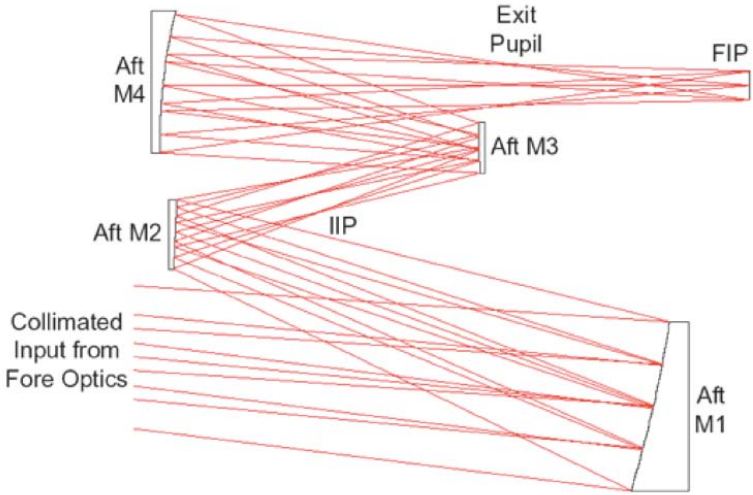
Rotation Telescope Assembly (RTA)
3 Fore Mirrors/Folder Mirror



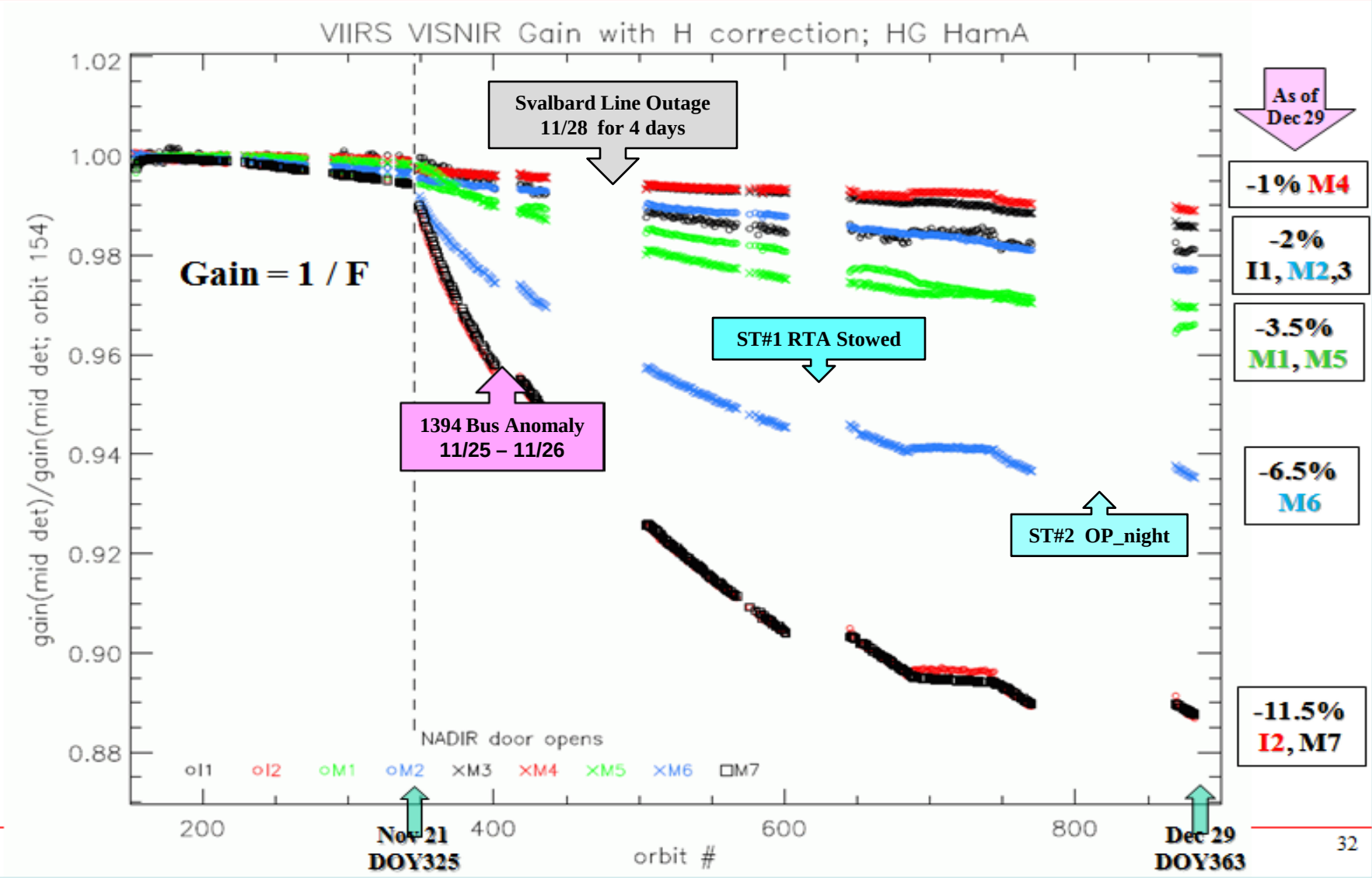
Half Angle Mirror



4 Aft Optic Mirrors

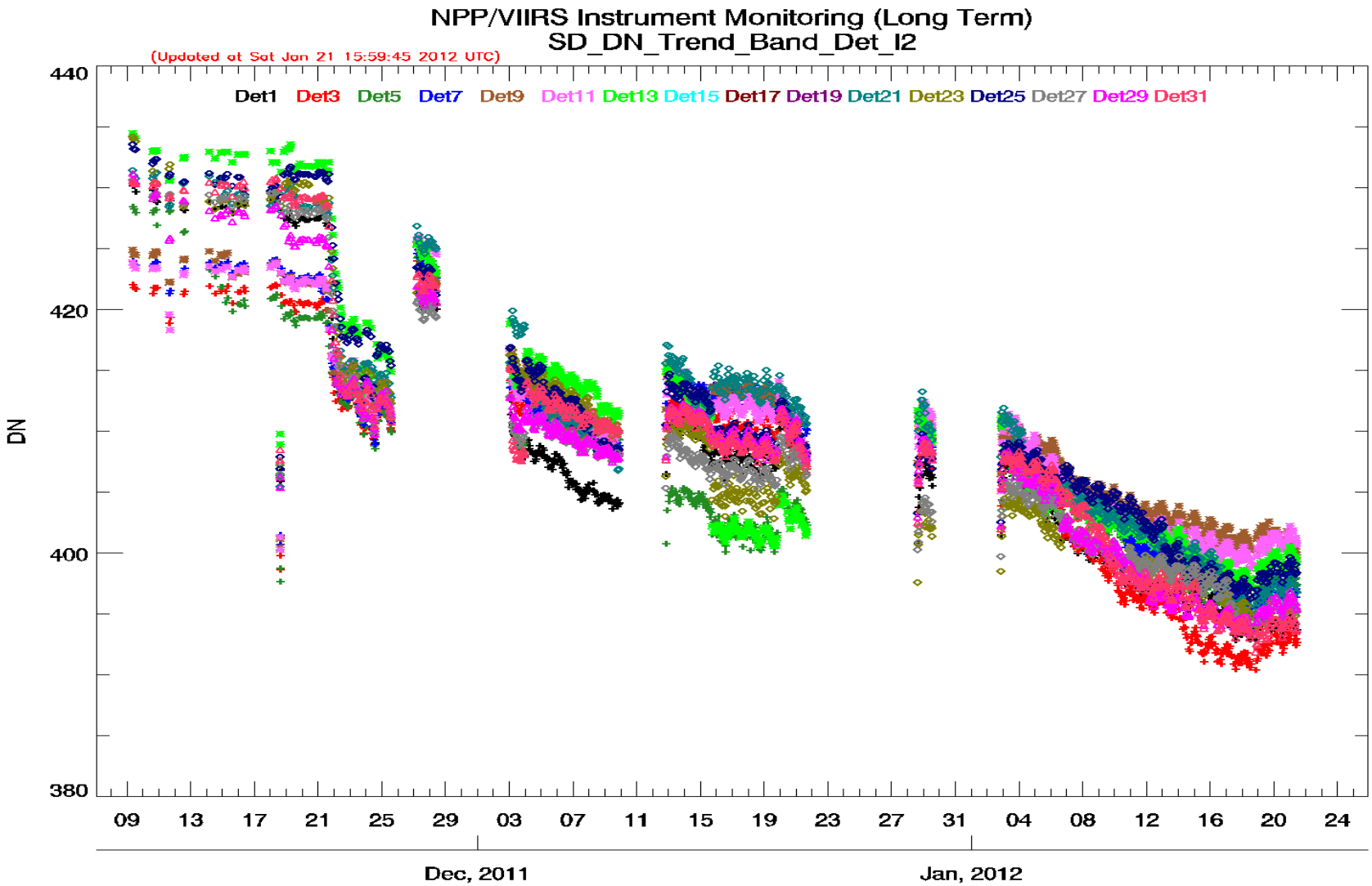


VIIRS Detectors Gain Trending
(corrected by H-factor)

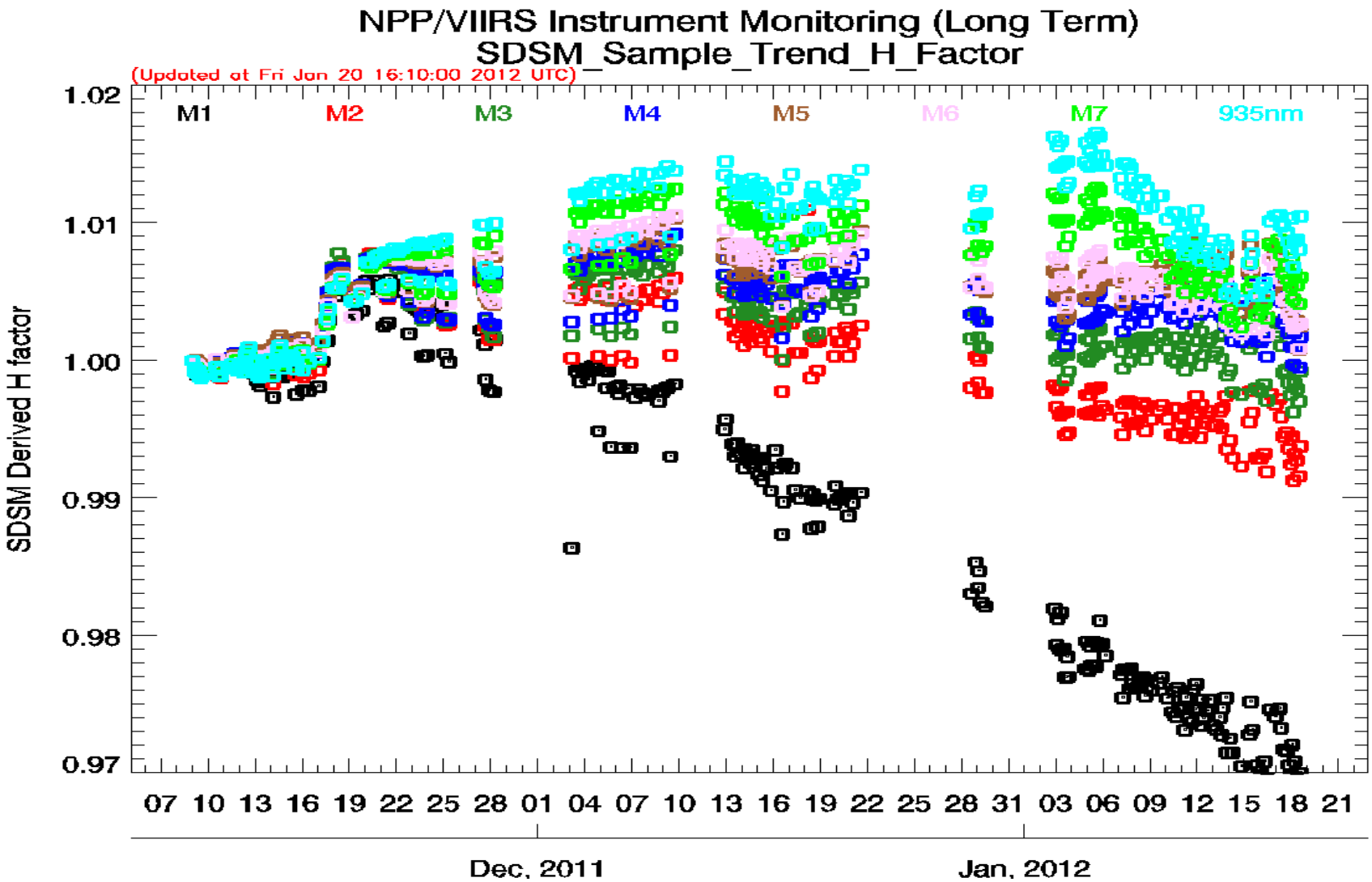


Courtesy of Ning Lei / Jon Fulbright /Chengbo Sun / Vincent Chiang NASA NPP-SDS NICSE

Trending of VIIRS I2 Band Solar Diffuser Count (RTA Degradation)



Trending of VIIRS SD Stability Monitor (Solar Diffuser Degradation)



VIIRS SDSM Degradation

The root cause of the degradation of the SDSM detector response: radiation induced displacement damage within the SDSM detectors.

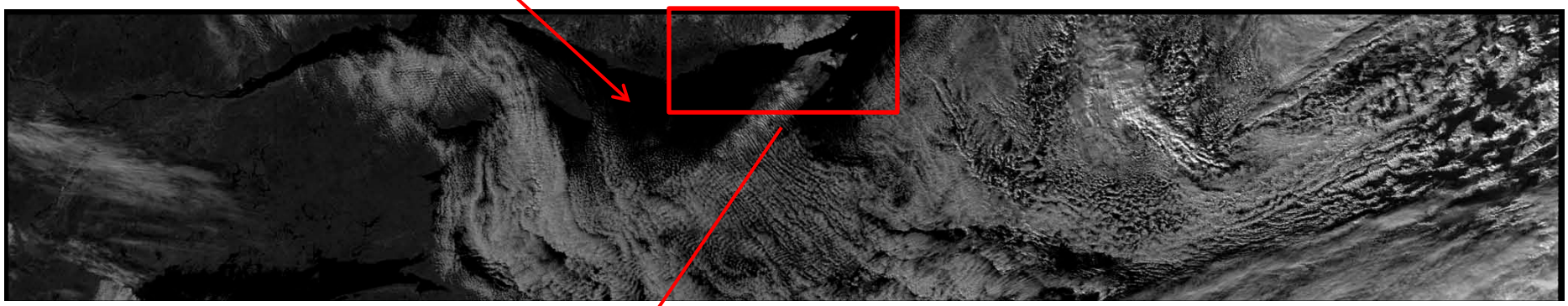
MODIS and VIIRS SDSM detectors are degrading similarly with respect to spectral signature, with the greatest degradation in the longer wavelength bands.

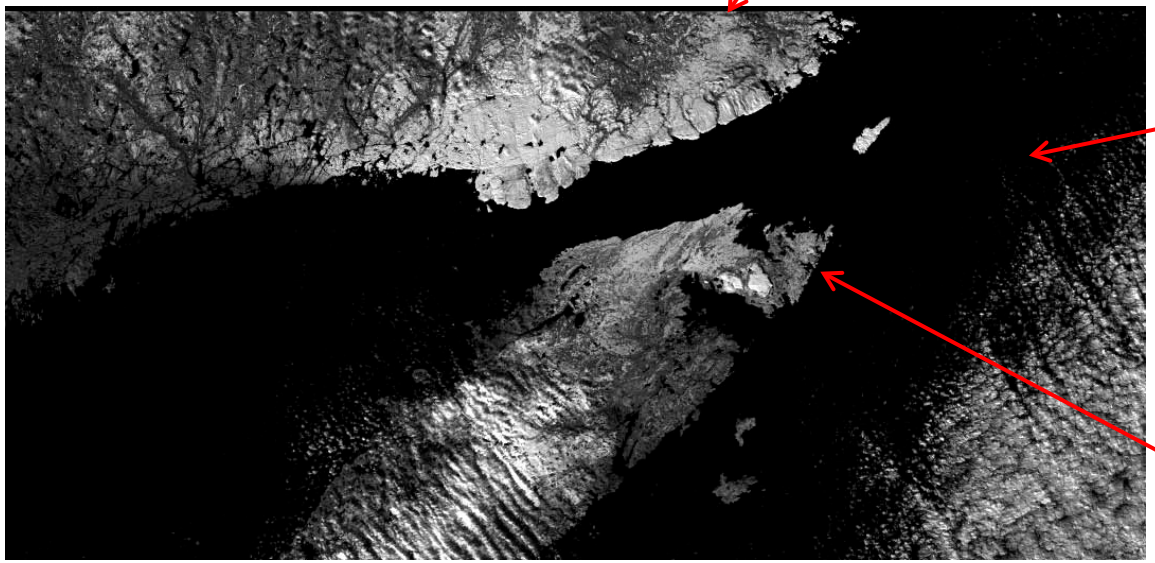
Raytheon has data from neutron exposure testing of detectors of the type used in the SDSM, and these data show degradation with the same spectral signature observed on orbit for both MODIS and VIIRS.

The neutrons and protons cause the same type of displacement damage in detectors. The natural space environment includes high energy protons and both VIIRS and MODIS are exposed to protons, albeit at different levels due to their different orbits and different amounts of shielding inherent in the designs.

VIIRS I2 Band Image

Gulf of St. Lawrence

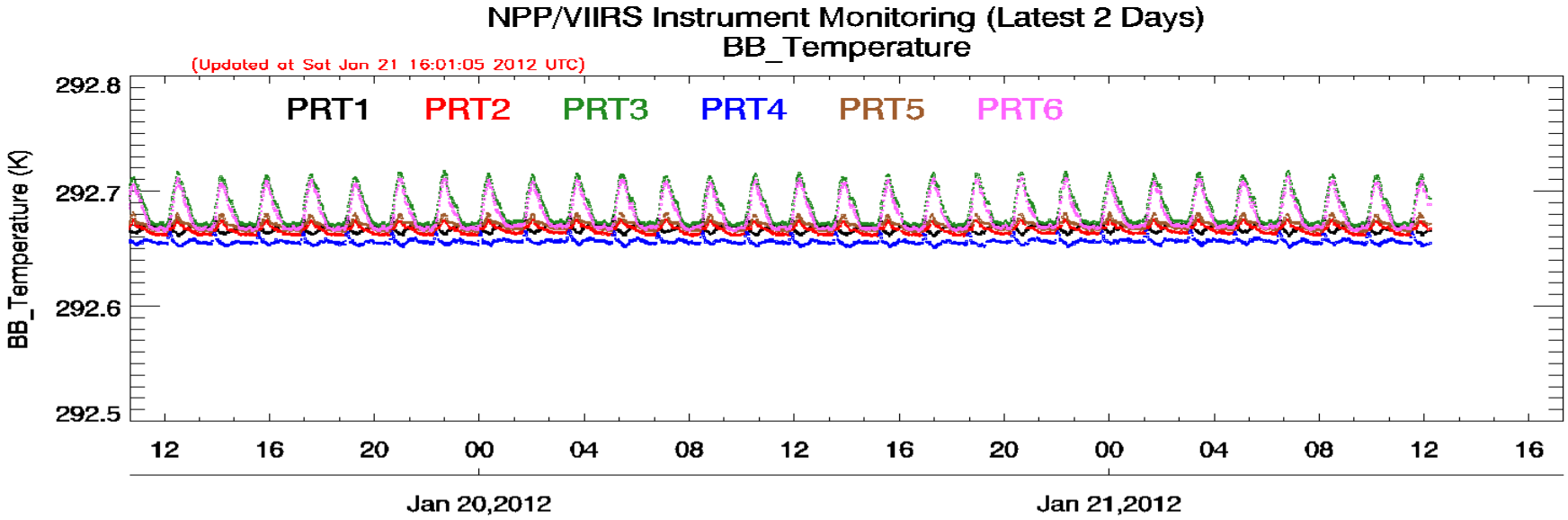


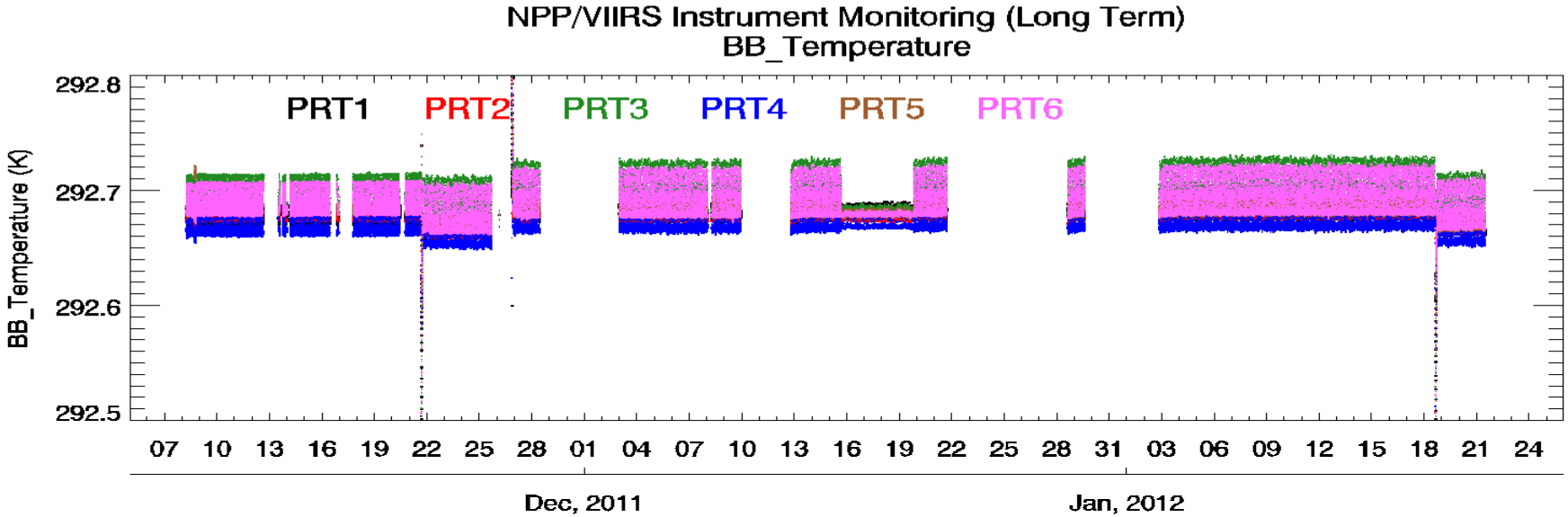


Newfoundland

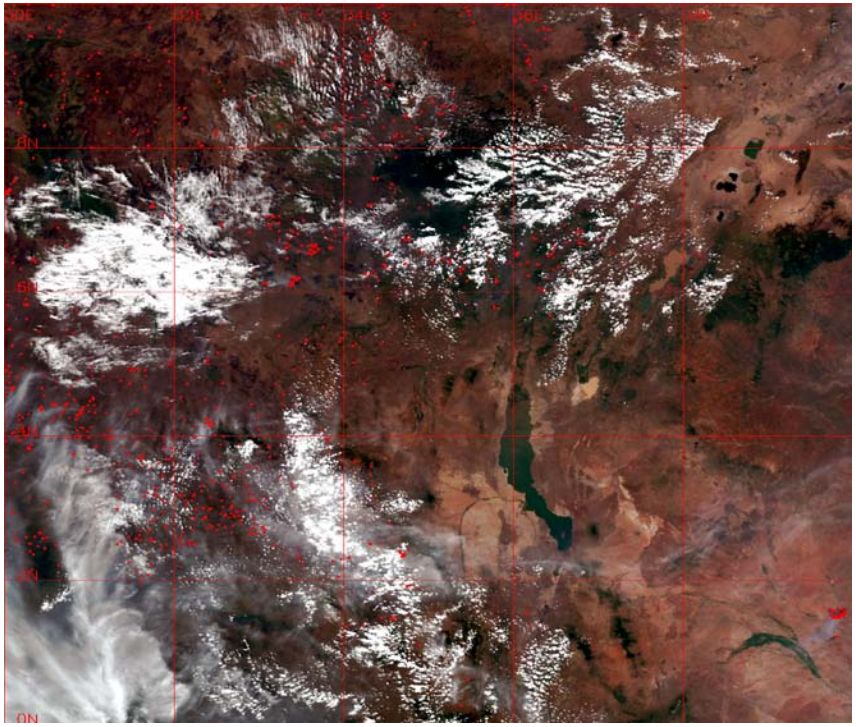
Contrast Enhanced (Robert Mahoney, NGAS)

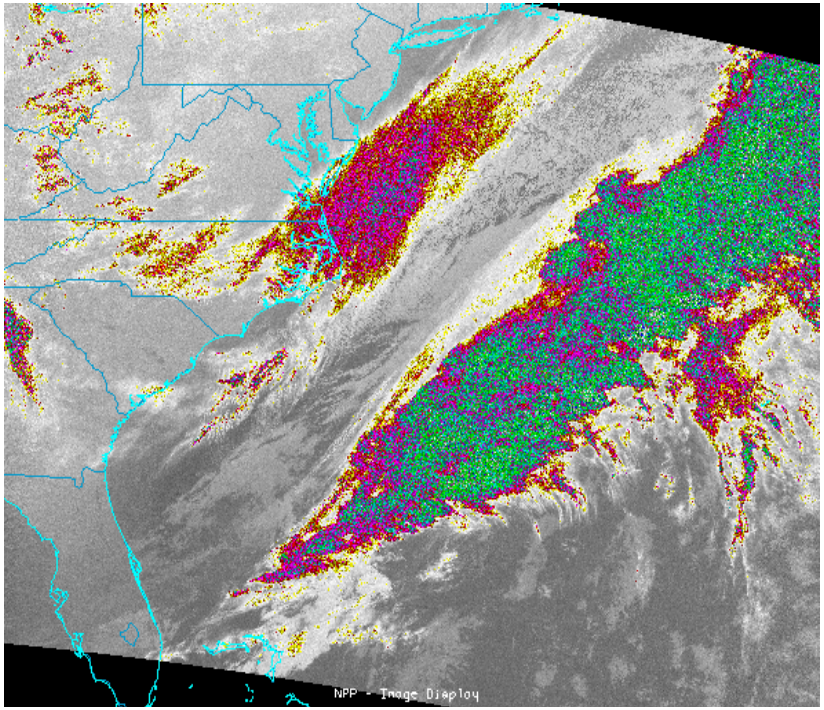
VIIRS Infrared Channel Monitoring



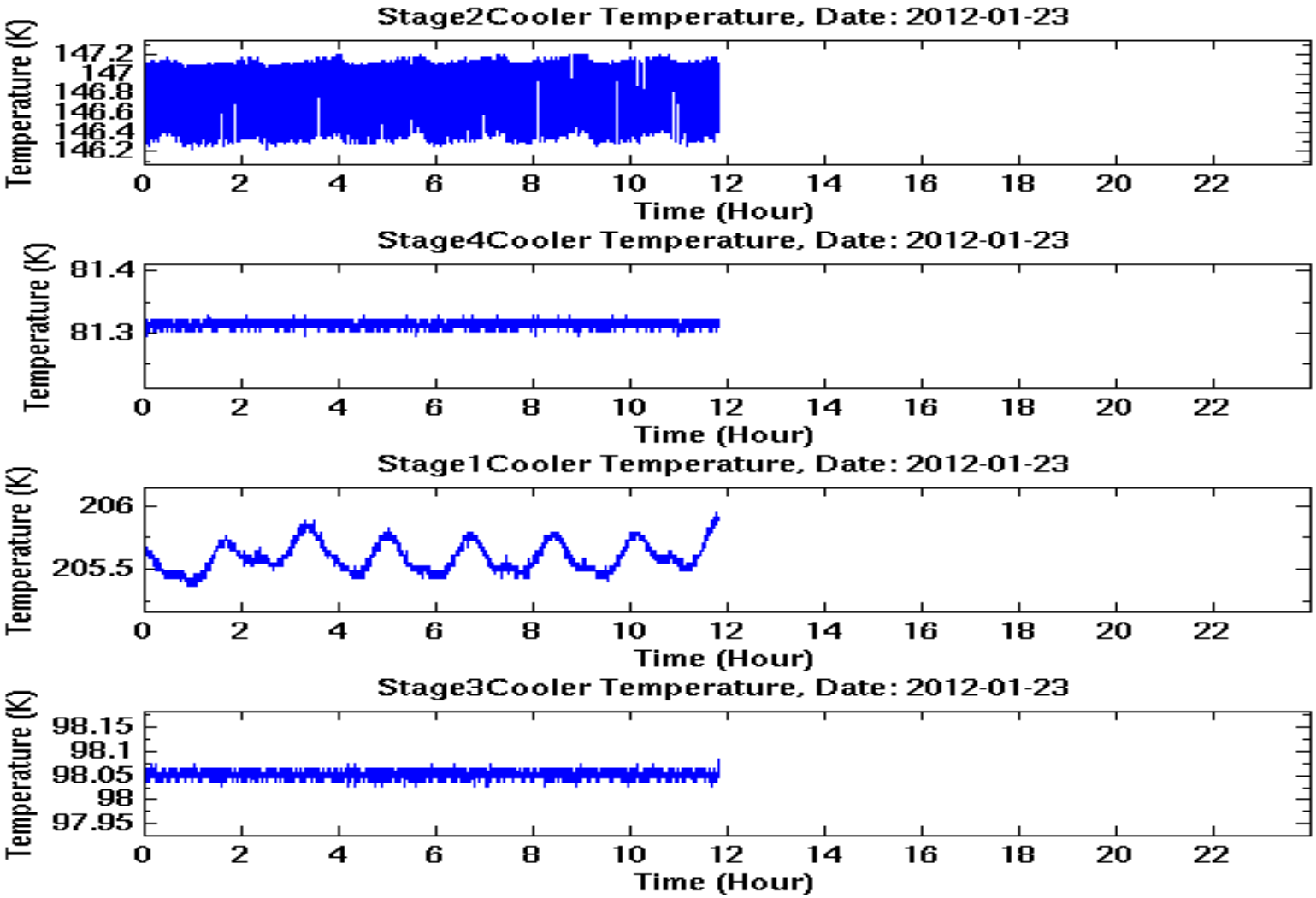


VIIRS Observed FIRE and Storm Imagery

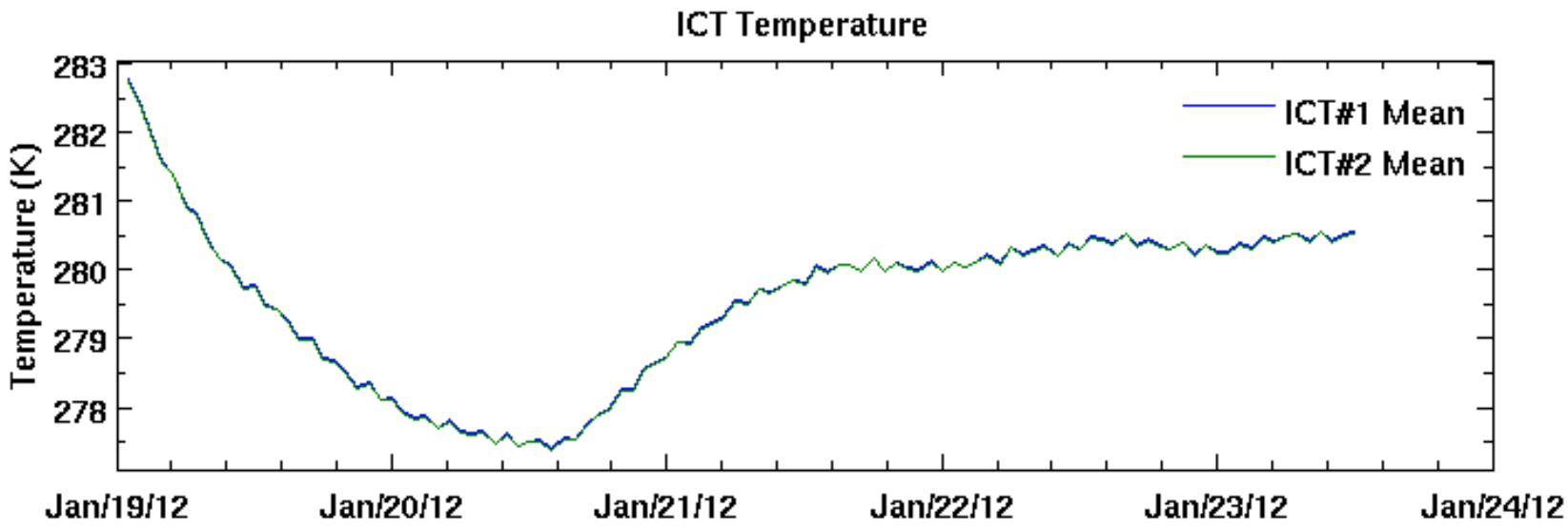




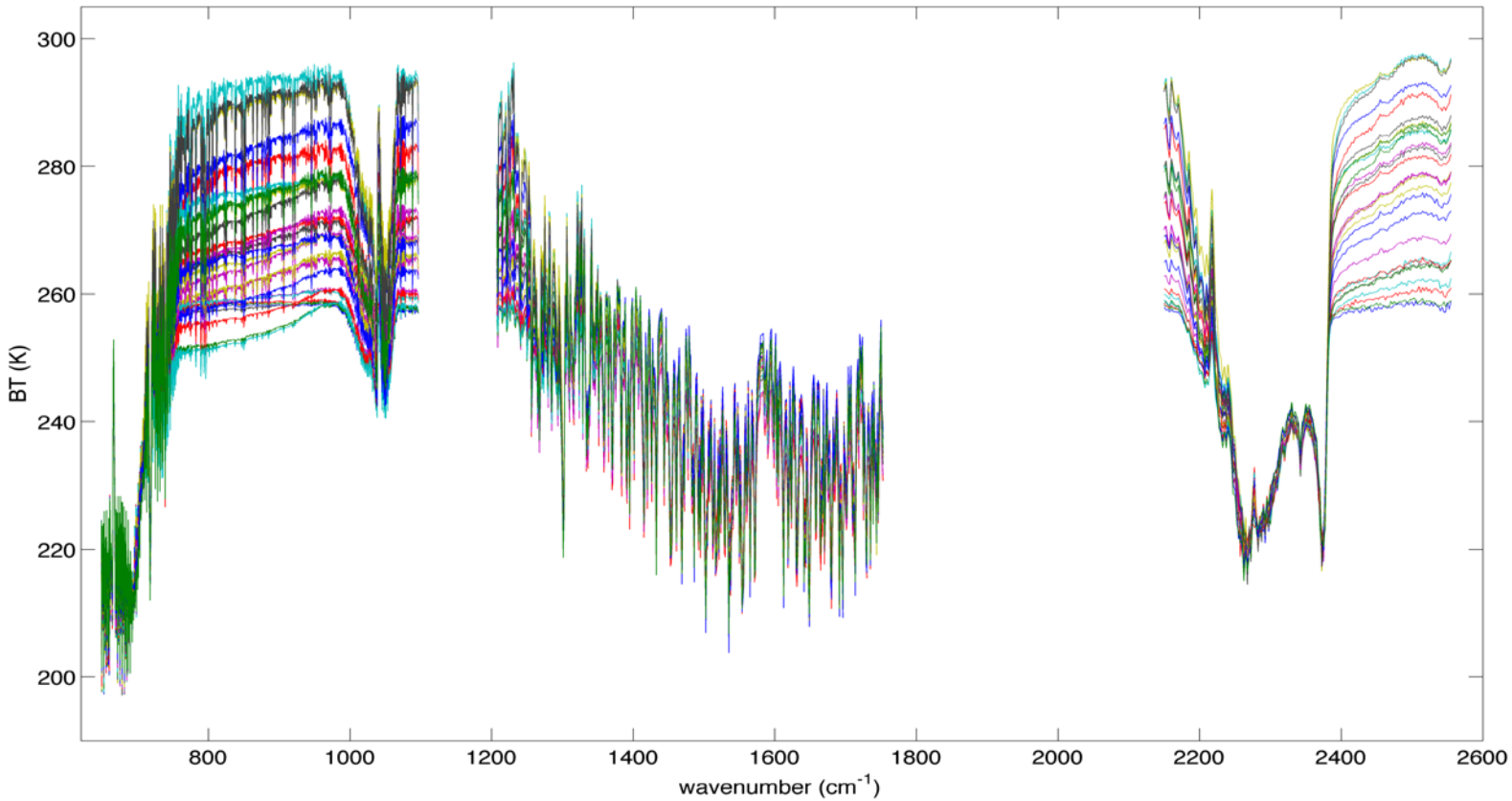
CrIS Activation Status (Stage Cooler Temperature)



CrIS Activation Status (Internal Calibration Target)

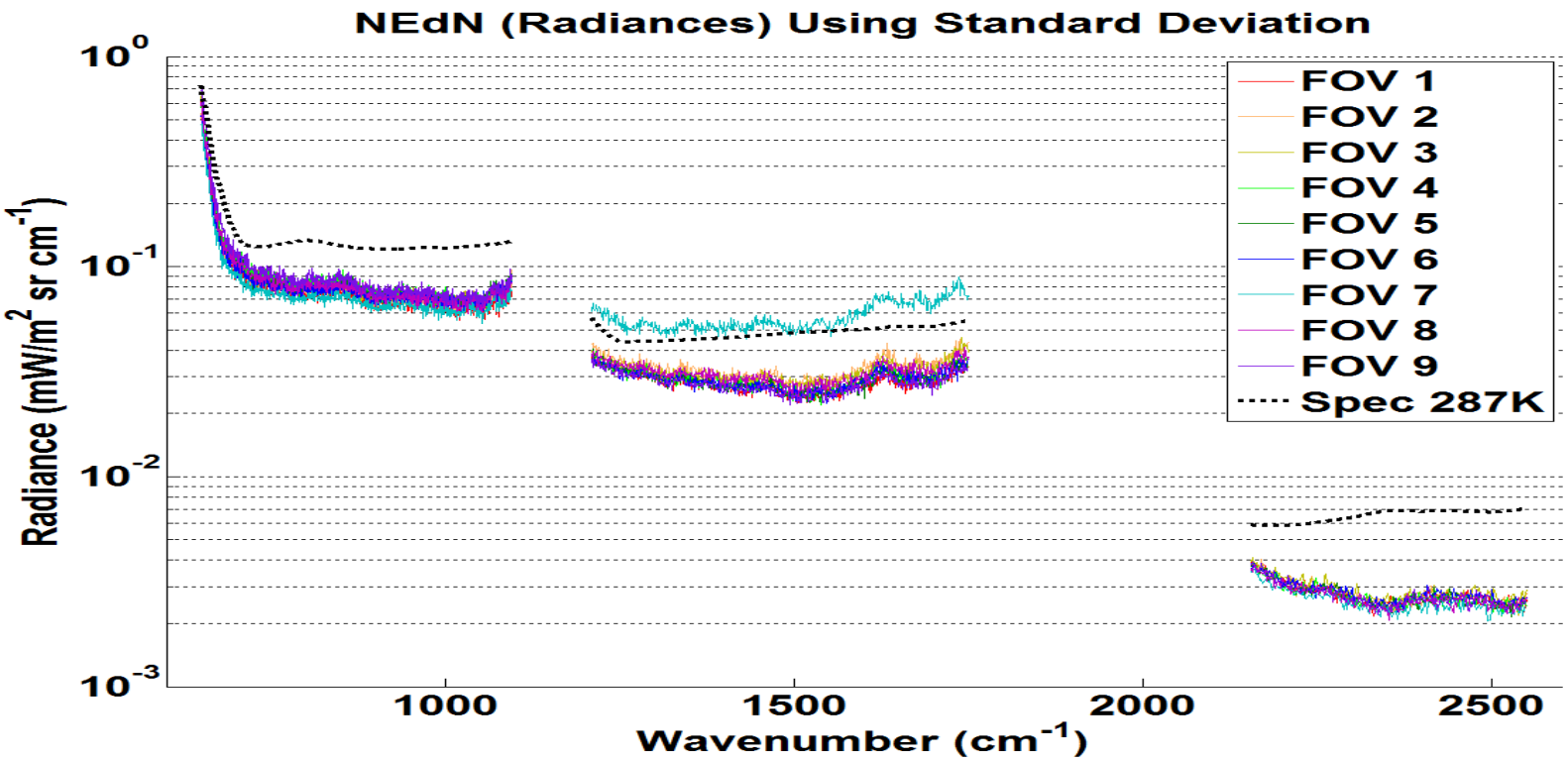


CrIS Observed Atmospheric Infrared Spectrum



Courtesy of D. Tobin, SSEC

CrIS LW NEDN from First Orbit Data (January 20, 2012)



All CrIS NEDNs are getting close to requirements

Courtesy of Vladimir.Zavyalov, SDL

Summary

- **NPP satellite and instruments work well and SDR calval activities are progressing smoothly**
- **The major NWP centers start ingesting ATMS data and evaluating ATMS data in their data assimilation systems. It is shown that NPP ATMS data has reached its provisional level.**
- **NOAA integrated developed an integrated calval system (ICVS) for NPP/JPSS program(http://www.star.nesdis.noaa.gov/smcd/spb/icvs/instrument_npp.php) is monitoring and trending the instrument performance including noise, telemetry, and house-keeping parameters**
- **The root-causes for VIIRS RTA and SDSM degradation are understood and their future degradation is monitored through its instrument gain and SDSM H-parameter**
- **VIIRS and CrIS cooler doors were open and science RDR/SDR data are being collected for ICV. Initial CRIS and VIIRS data look great!**