HIGHLIGHTS OF THE SUOMI NPP AND JPSS-1 ATMS CALIBRATION

Q. Liu, N. Sun, H. Yang, X. Zou, L. Lin, and F. Weng
and contributed from NASA, MIT/LL, and others

Presented by

Quanhua (Mark) Liu
NOAA/NESDIS Center for Satellite Applications and Research
Quanhua.Liu@noaa.gov

Outline

- Cal/Val Team Members
- S-NPP ATMS Updates
- JPSS-1 ATMS Performance
- JPSS-1 ATMS SRF
- JPSS-1 Readiness
- Summary and Path Forward

Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
Quanhua (Mark) Liu	NOAA/STAR	Ninghai Sun (technical lead), Hu Yang, Xiaolei Zou, Lin Lin	Project management, SDR team coordination and algorithm test in IDPS, ATMS calibration and geolocation science support, ATMS TDR/SDR data quality and monitoring
Edward Kim	NASA	Craig Smith, Lisa M. Mccormick	Liaison with NASA flight team
Vince Leslie	MIT/LL	Idahosa Osaretin, Mark Tolman	Liaison with NGES,and independent SDR assessments
Wesley Berg	Colorado State University		ATMS and GPM WG band cross-calibration
Wael Ibrahim	RAYTHEON		IDPS support

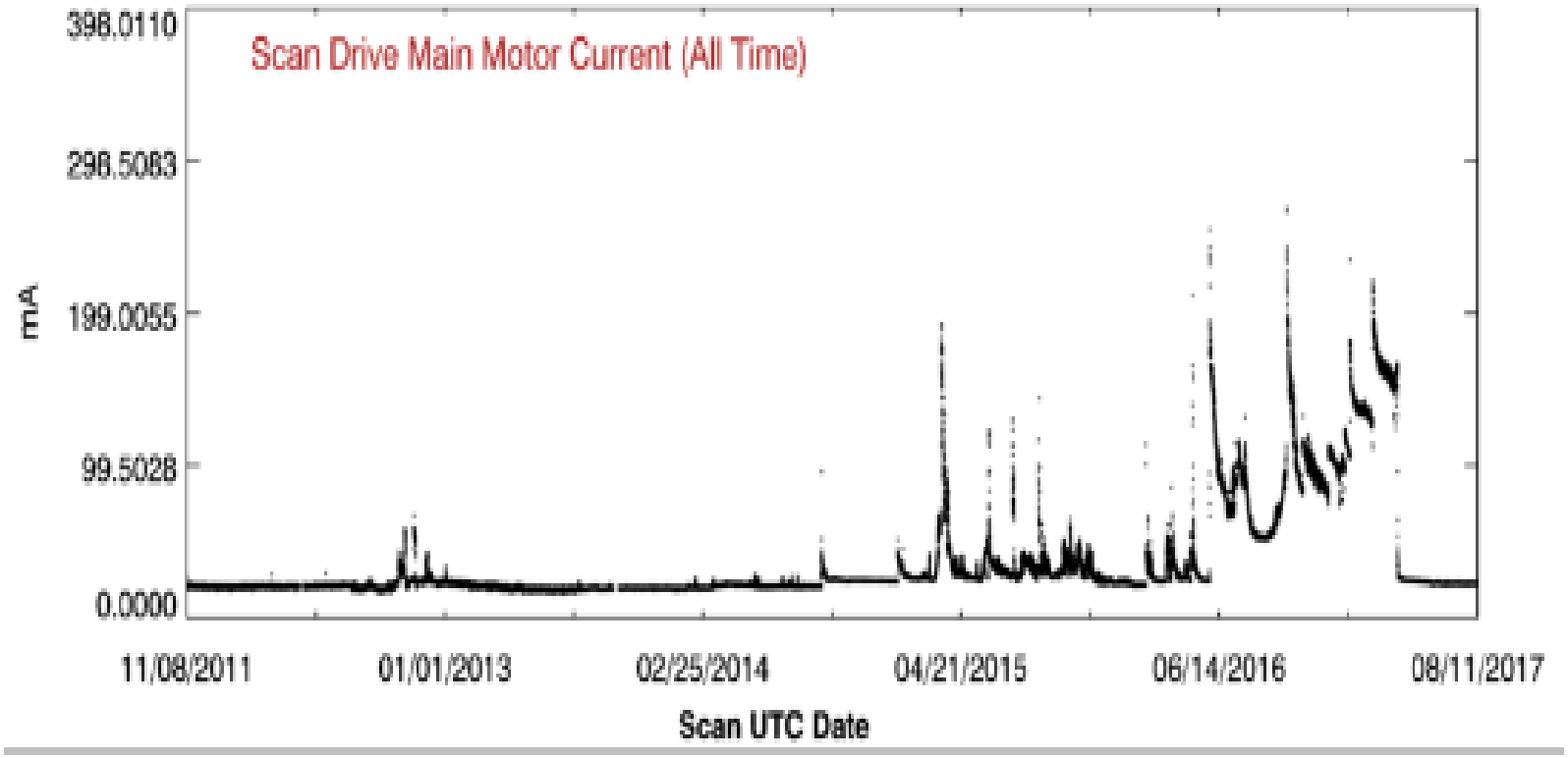
S-NPP ATMS Updates

- ATMS is healthy.
- Scan drive main motor current had been dropped down to a “normal” level.
- ATMS SDR has reached “LTM validated maturity”.
- ATMS SDR performance is better than the requirement in J1RD.
- ATMS calibration algorithm in radiance has been operational since March 08, 2017 (block 2).

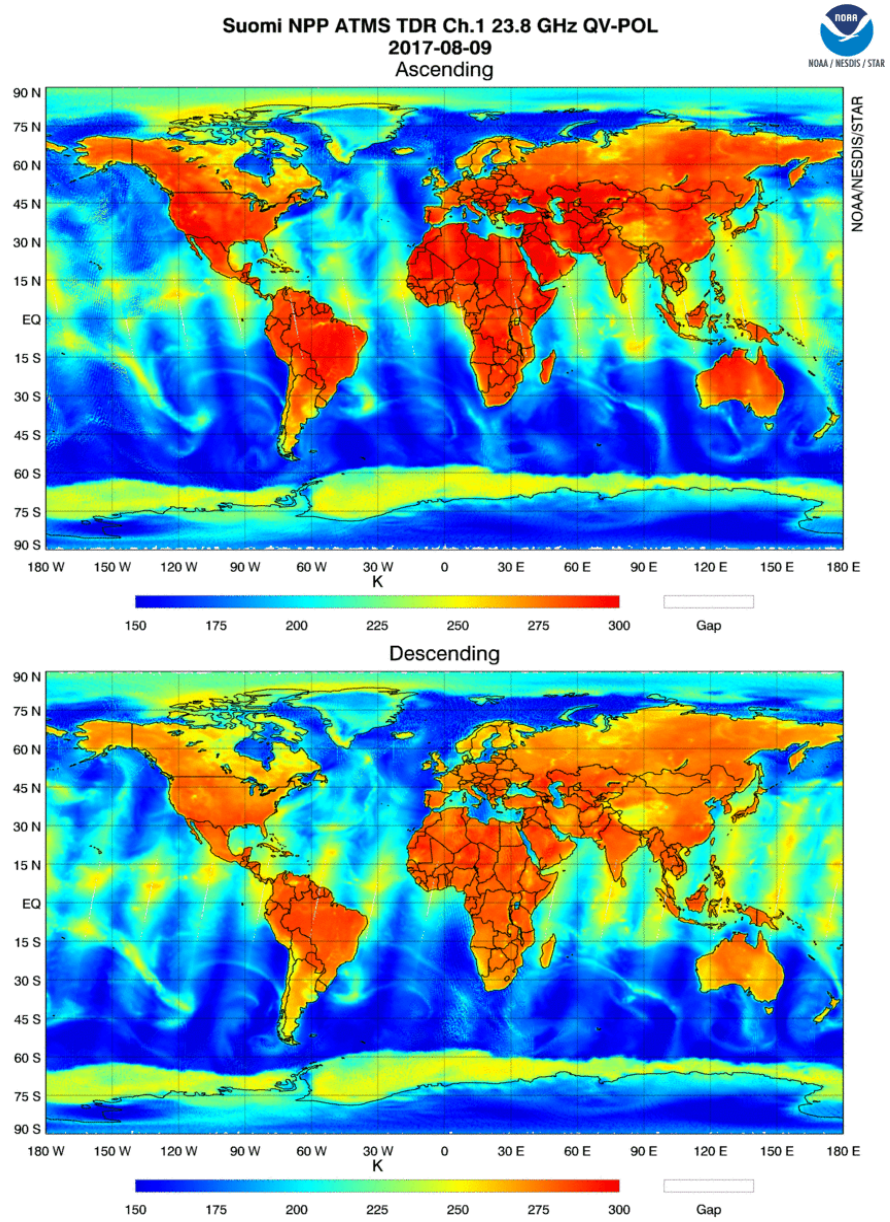
S-NPP ATMS Scan Drive Main Motor

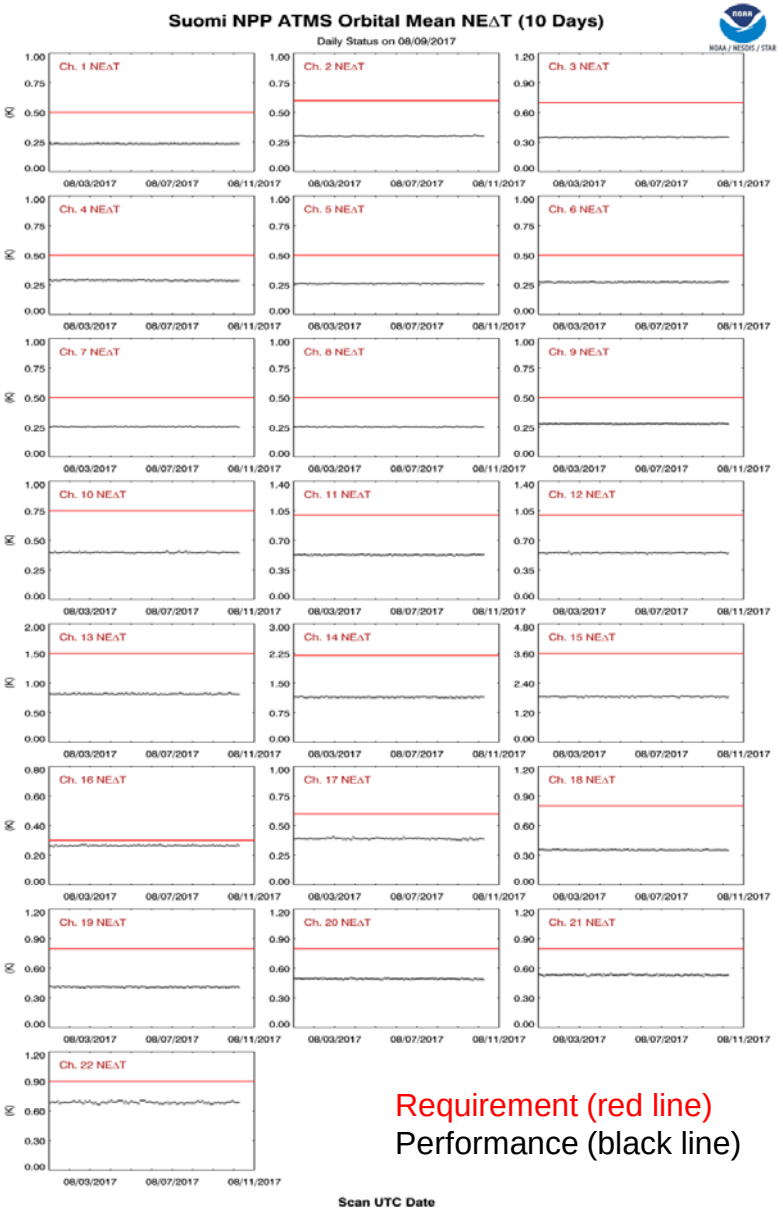
The scan drive main motor current has been dropped down to a “normal” level since April 3, 2017.

It is mystery?



S-NPP ATMS Performance





Requirement (red line)
Performance (black line)

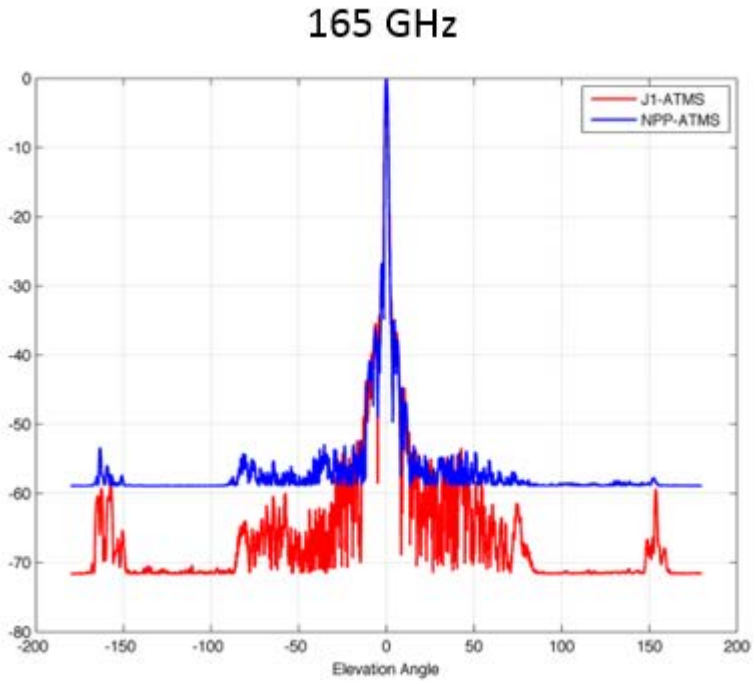
JPSS-1 ATMS Performance

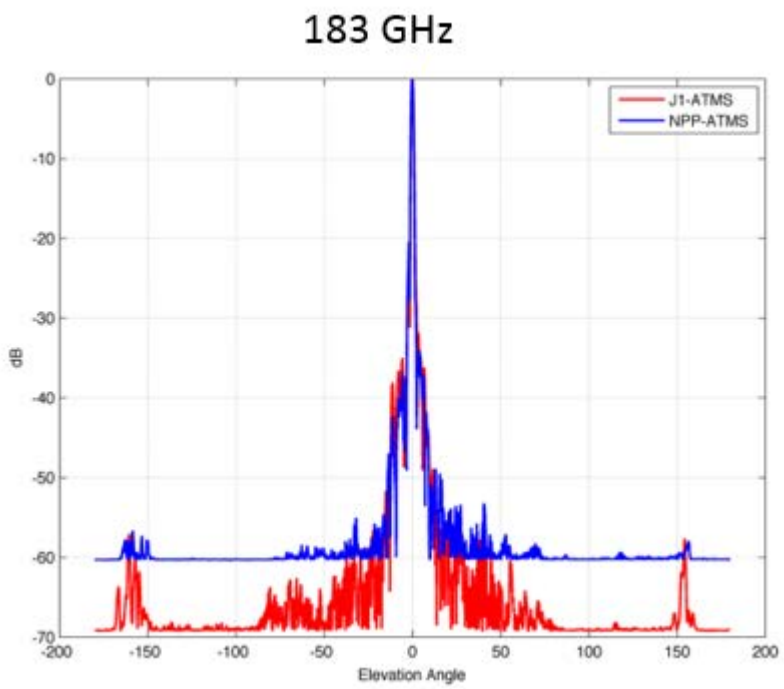
In comparison to S-NPP ATMS TVAC data, JPSS-1 ATMS TVAC data demostrate better performance:

- ✓ Smaller side lobe (i.e. higher antenna efficiency)
- ✓ Low noise (or low NEdT)
- ✓ Smaller channel noise correlation (better independent information)
- ✓ Slightly smaller striping (slightly better uniformity)
- ✓ Larger non-linearity (JPSS algorithm includes non-linearity correction.)

JPSS-1 ATMS Antenna Pattern

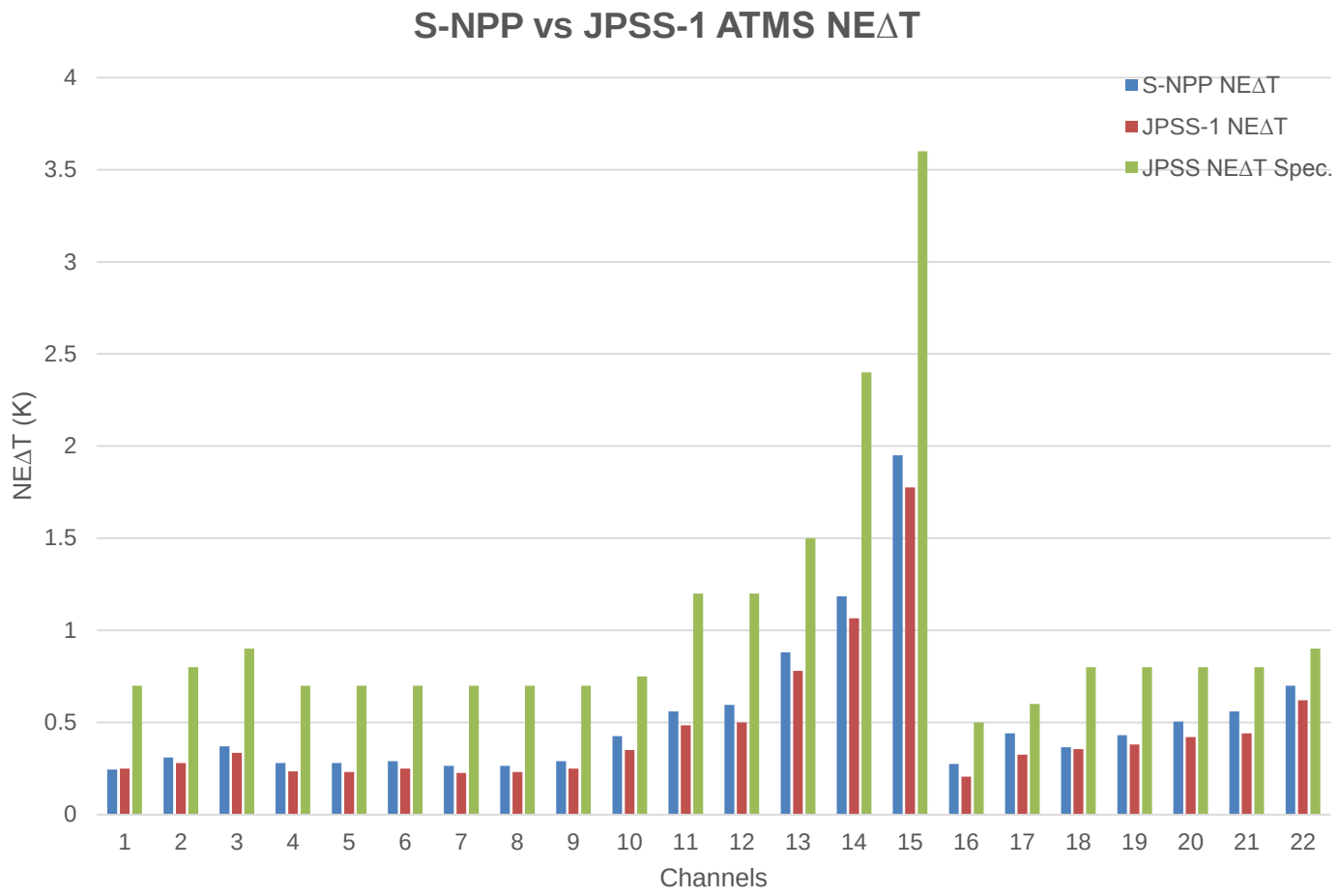
JPSS-1 AMTS antenna has higher main beam efficiency in G bands compare to S-NPP ATMS, which will improve JPSS-1 ATMS calibration accuracy for these channels.





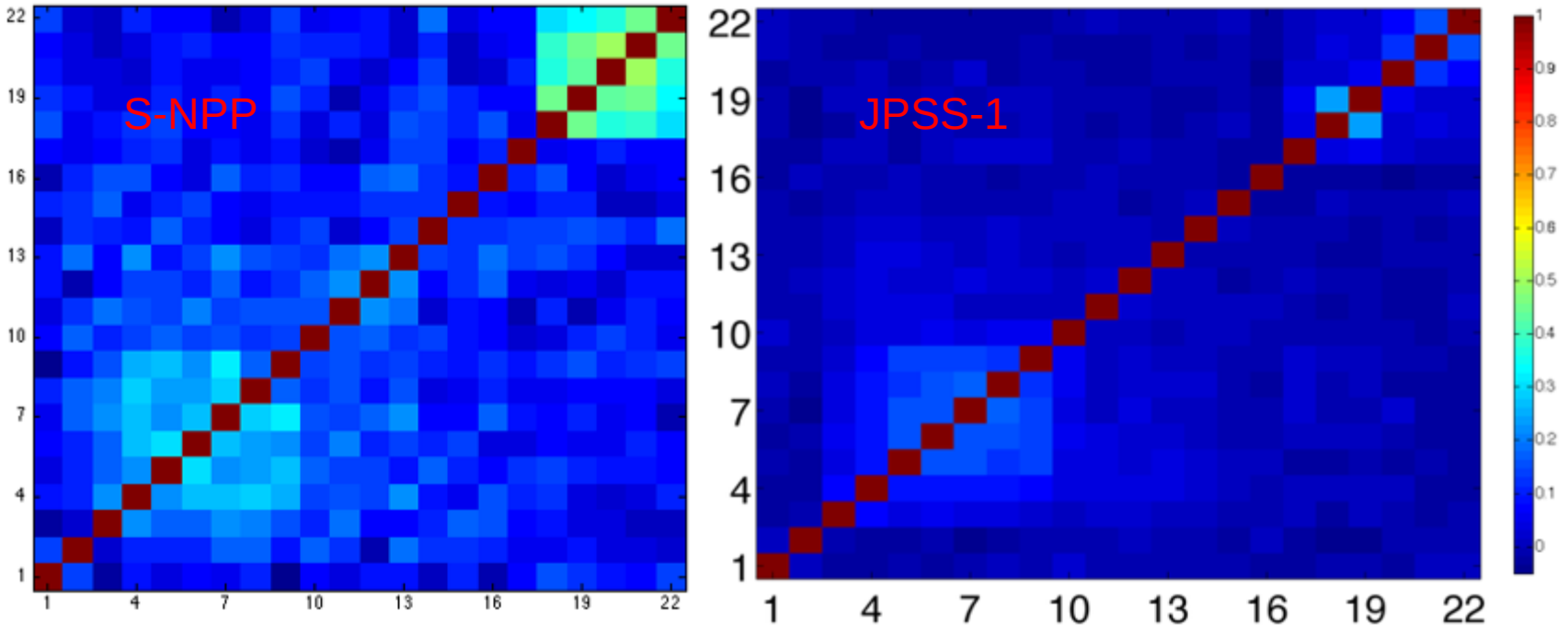
S-NPP and JPSS-1 ATMS NEdT

Both S-NPP ATMS (blue) and JPSS-1 ATMS (red) have a good margin to the specification (green). JPSS-1 ATMS is better.



JPSS-1 ATMS Channel Noise Correlation

JPSS-1 ATMS has lower channel noise correction. The lower Channel noise corresponds to better independent information that is important to radiance assimilation for weather forecasting and retrieval for satellite products (or EDRs).



JPSS-1 ATMS

- ATMS went through very hard time:
  - Sent back to factory for rework twice
- Recently (2017) found issues:
  - Ka-band data transmitter RFI
  - Heater EMI noise
  - Spectral response function (SRF) data (G bands SRF measurements are invalid.)

JPSS-1 Instrument Radiance

ATMS signal is very weak; roughly one thousand times smaller than OMPS nadir profiler, one million times smaller than CrIS, VIIRS, and OMPS nadir mapper, which requires extremely care of the instrument.

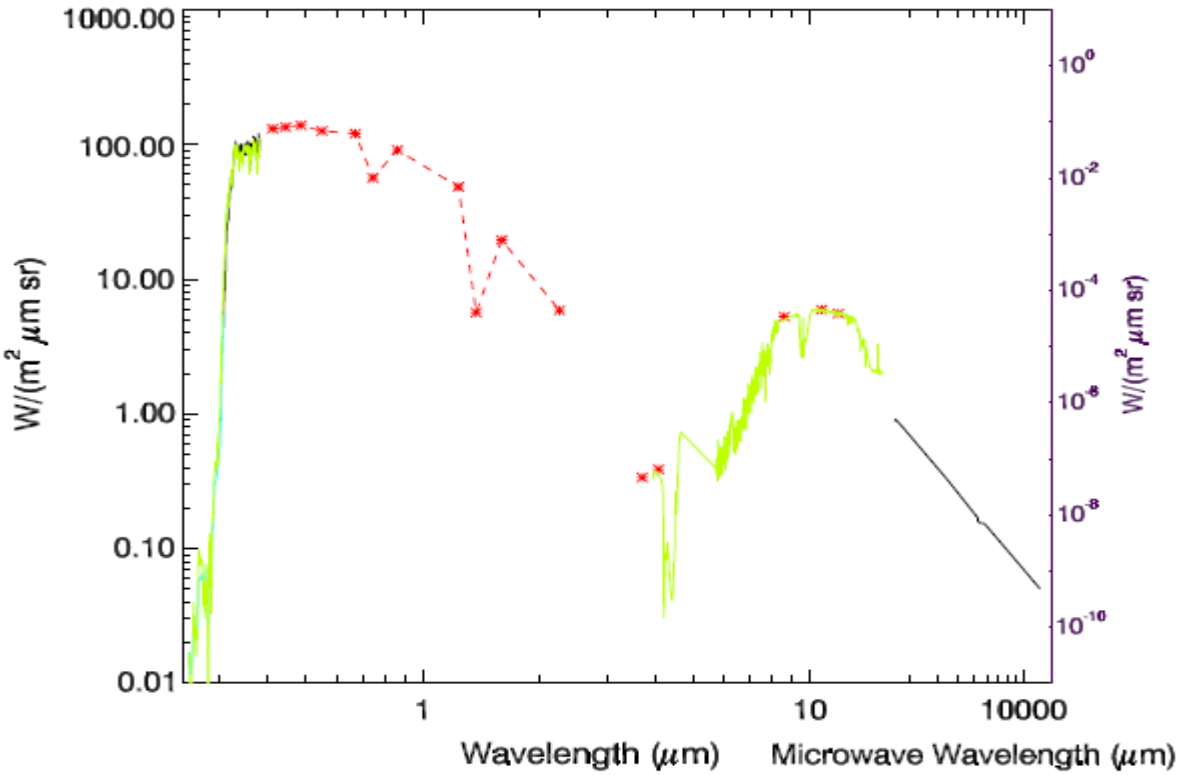
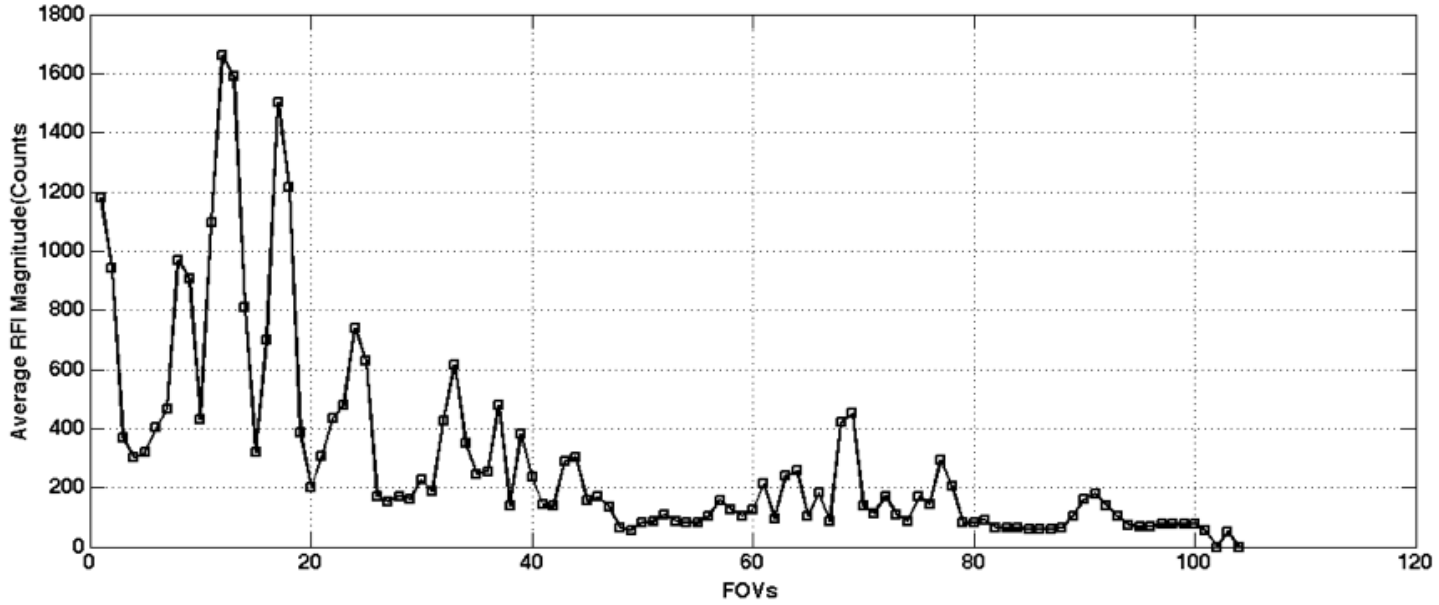


Fig. 2. SNPP measured UV (cyan line: OMPS nadir profiler, black line: OMPS nadir mapper), visible (red symbols: VIIRS), infrared (red symbols: VIIRS, green line: CrIS), and microwave (blue line: ATMS) radiances. ATMS channel center frequency for single band and the most right-side center frequency of multiple subbands are used.

Ka-band transmitter RFI in TVAC

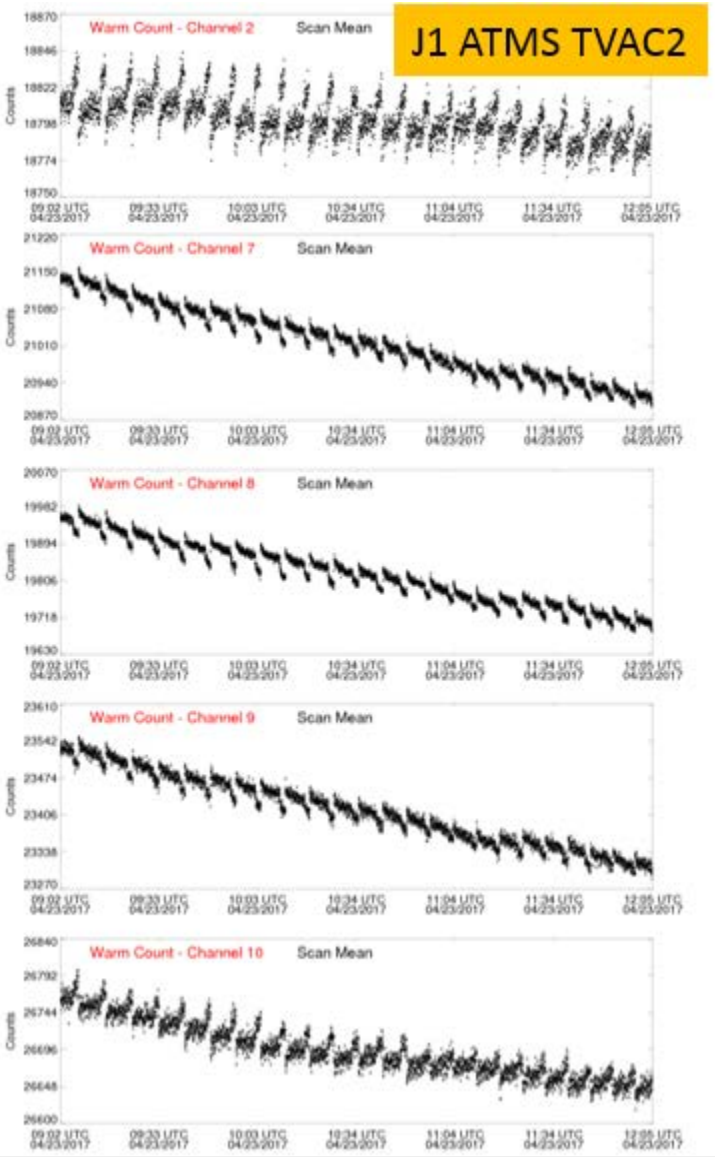
JPSS-1 has a new Ka-band data transmitter.
The ATMS team analyzed recent TVAC data and found the error up to about 30K for channel 6 caused by Ka-band transmitter RFI.

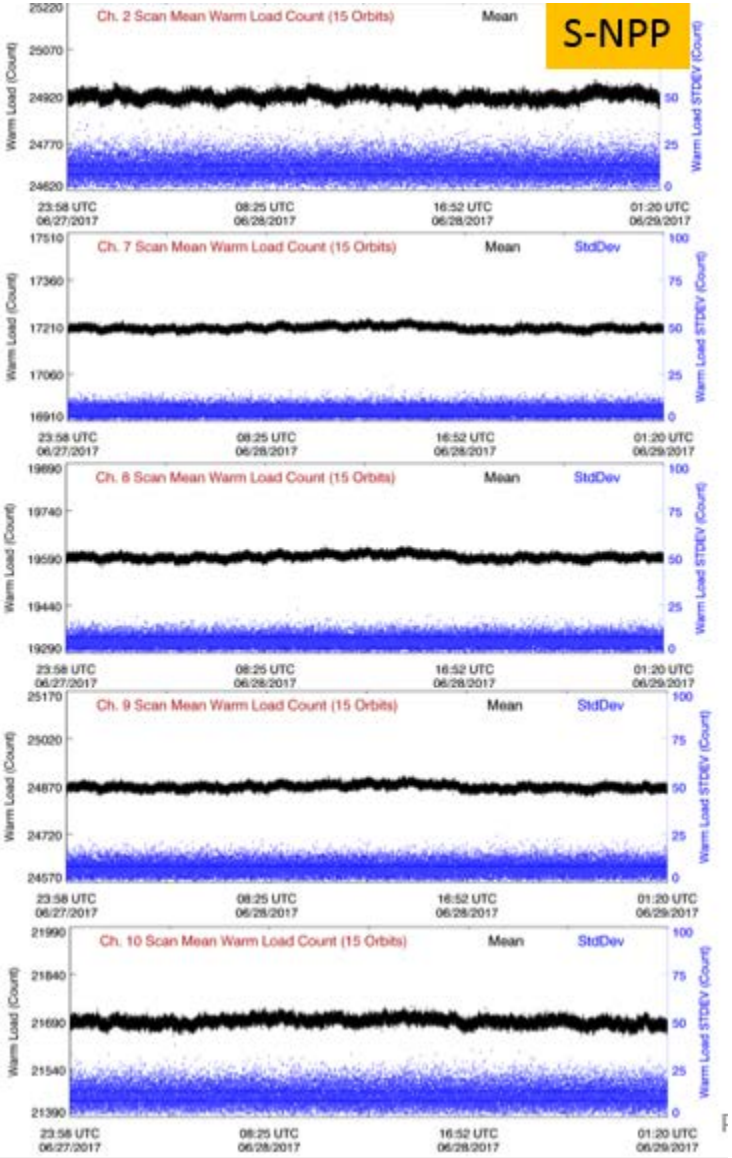


Channel 6 noise discovered in TVAC chamber is an enclosed can where RF noise inside will bounce – fill chamber.

ATMS is on the Nadir side of the spacecraft viewing the Nadir direction
The interference source is on the Zenith side of the spacecraft
No direct path to the ATMS aperture

JPSS-1 Heater EMI Noise

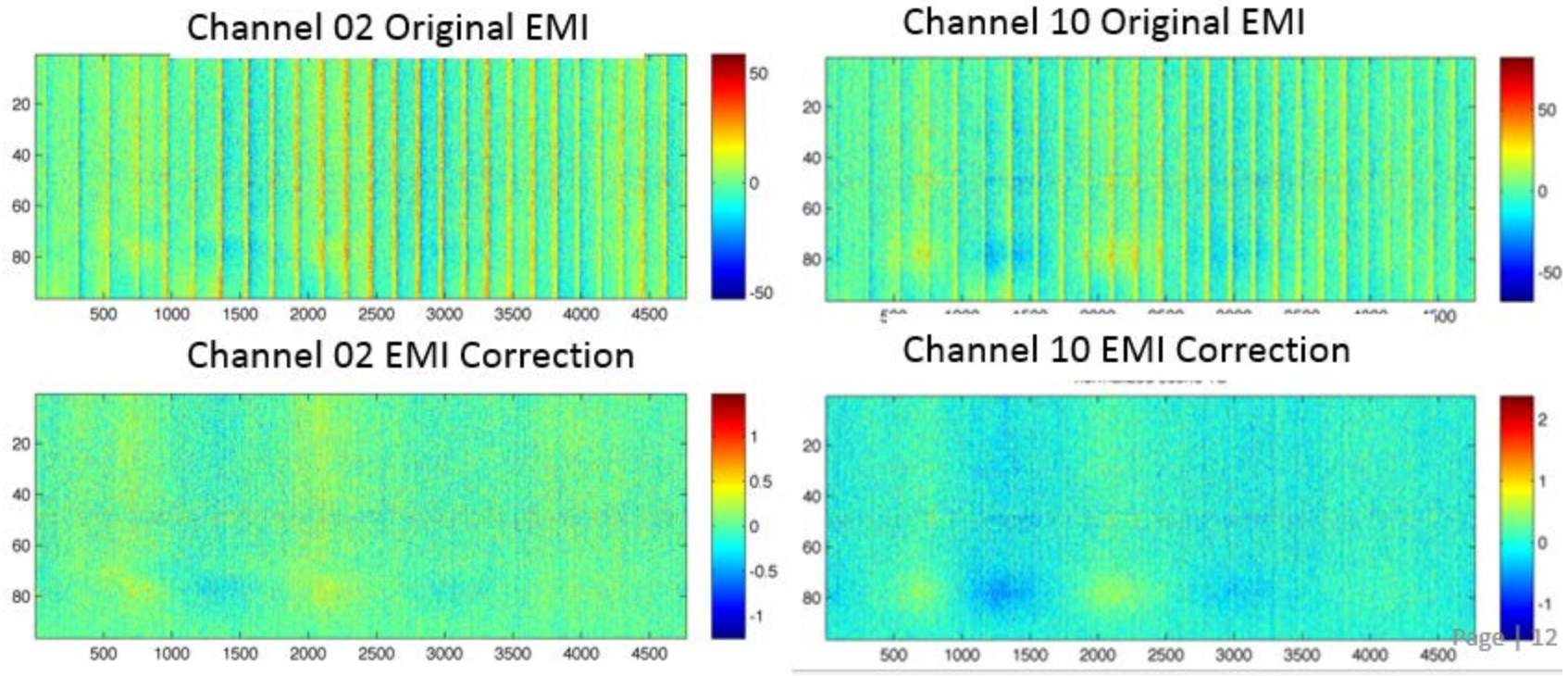




JPSS-1 Heater EMI Noise

Similar effect of the heater EMI on warm load, space, and scene counts were found. We have studied 3 mitigation plans:

1. Add QC flag;
2. Optimize scan line window size in calibration;
3. Change calibration configuration in ADL code.



The root cause had been identified and the issue was fixed just one week ago.

JPSS-1 ATMS SRF

Box-cut SRF data from ATMS ATBD; Box-cut SRF data (measured from calibration data book); measured SRF within the calibration team.

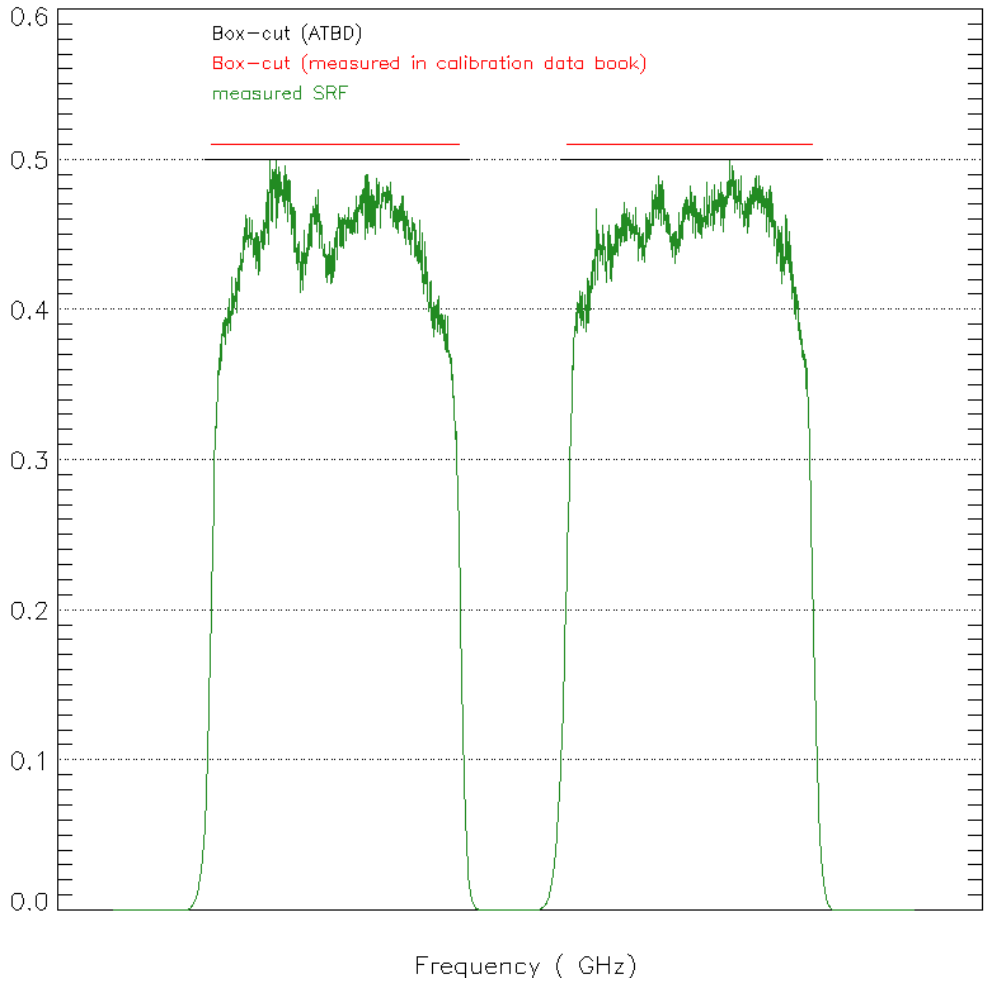


Table 1. CRTM J1 ATMS brightness temperature simulation difference in Kelvin between using SRF and box-cut (bc) for U.S. standard atmosphere over ozone at zenith angle = 50 and 0 degrees.

Channel Number	SRF, zenith=50°	bc-SRF	SRF, zenith=0°	bc-SRF
1	201.238	-0.046	156.151	0.047
2	193.671	0.006	149.121	0.008
3	229.126	0.029	219.352	0.033
4	249.615	0.110	240.735	0.117
5	254.349	-0.035	254.733	0.004
6	243.040	-0.300	251.142	-0.232
7	228.966	-0.016	236.682	-0.027
8	222.119	-0.050	227.361	-0.100
9	218.737	-0.002	221.206	-0.051
10	218.406	0.006	217.943	0.004
11	220.901	-0.006	219.763	-0.002
12	225.925	-0.096	224.038	-0.081
13	233.830	-0.085	230.882	-0.072
14	245.453	-0.127	241.401	-0.111
15	257.183	-0.009	253.309	-0.009
16	245.495	0.024	209.389	0.035
17	271.356	0.015	267.472	0.002
18	266.411	0.043	271.006	0.029
19	259.172	0.015	263.895	0.010
20	252.893	0.005	257.442	-0.000
21	245.926	0.065	250.222	0.072
22	240.043	0.014	244.297	0.018

JPSS-1 Readiness

- Pre-launch Characterization
  - TVAC calibration data were analyzed and many issues were clarified and fixed.
  - Parameters for ATMS processing coefficient table were derived.
  - JPSS-1 PCT file had been delivered.
- Post-Launch Testing and Cal/Val Activity Plans
  - Monitor the effect of Ka-band transmitter RFI and heater noise
  - Monitor telemetry and SDR data
  - Analyze instrumental performance
  - Update PCT
- Major Risks/Concerns/Issues/Challenges/ and Mitigation
  - Use SNO S-NPP ATMS and JPSS-1 ATMS data to derive non-linearity
- Partnerships/User-Developer interactions
  - NOAA/NCEP, NASA/GMAO, NAVY/NRL, JCSDA
  - Satellite product team (e.g. MiRS)
  - Others

Summary & Path Forward

- Summary
  - JPSS-1 TVAC data are analyzed and issues were found and clarified.
  - Root cause for Ka-band transmitter was found and clarified.
  - Root cause of heater noise was found and fixed.
  - TVAC ATMS performance was assessed.
  - Processing coefficient table was delivered.
  - JPSS-1 SRF data were analyzed and delivered to JCSDA.
- Path Forward
  - Derive on-orbit non-linearity parameters
  - Optimize on-orbit calibration configuration
  - Consider antenna emission term
  - Inter-calibrate SNPP ATMS and JPSS-1 ATMS
  - Update PCT
  - Mitigate ATMS striping