Status of S-NPP VIIRS Level 1B

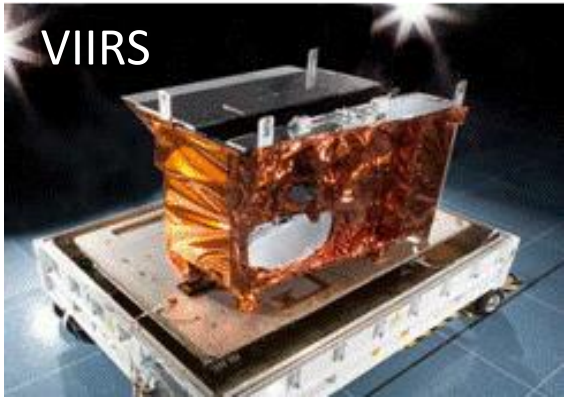
Jack Xiong, Vincent Chiang, Ning Lei, and Ben Wang

VIIRS Characterization Support Team (VCST), NASA GSFC, MD 20771

Acknowledgements:
NOAA JPSS VIIRS SDR Team (Lead: Changyong Cao)

Contents

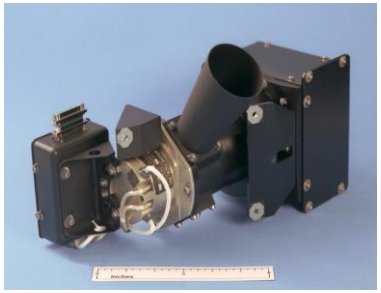
- **Status of S-NPP VIIRS Calibration**
  - Calibration Approaches
  - Performance
- **Status of S-NPP VIIRS L1B**
  - Changes and Improvements
- **What's Next**



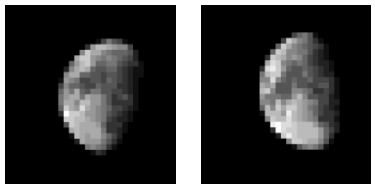
S-NPP VIIRS On-orbit Operation and Calibration

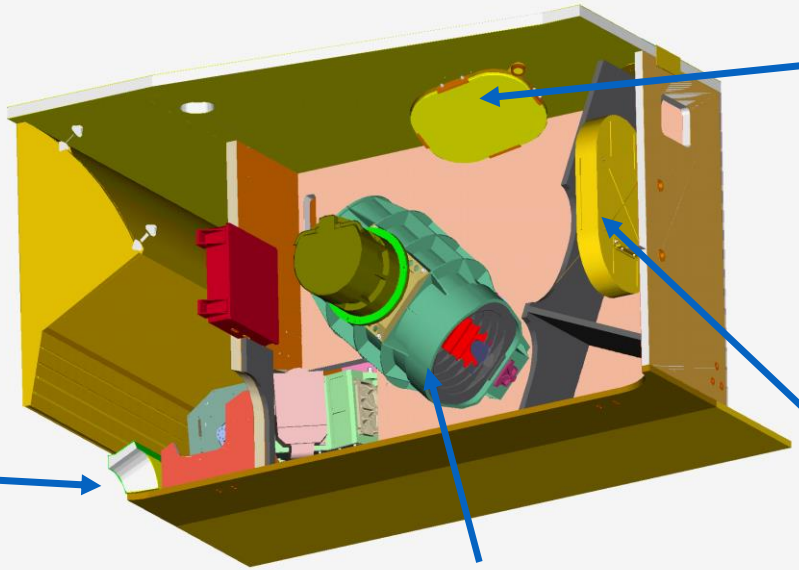
Approaches and Strategies: Experience and Lessons from Terra and Aqua MODIS

Solar Diffuser Stability Monitor (SDSM)



Extended SV Port





Rotating Telescope Aft Optics and HAM

Solar Diffuser (SD)

V-groove Blackbody (BB)

Spectral bands: 14 RSB, 1 DNB, 7 TEB; 7 dual gain bands

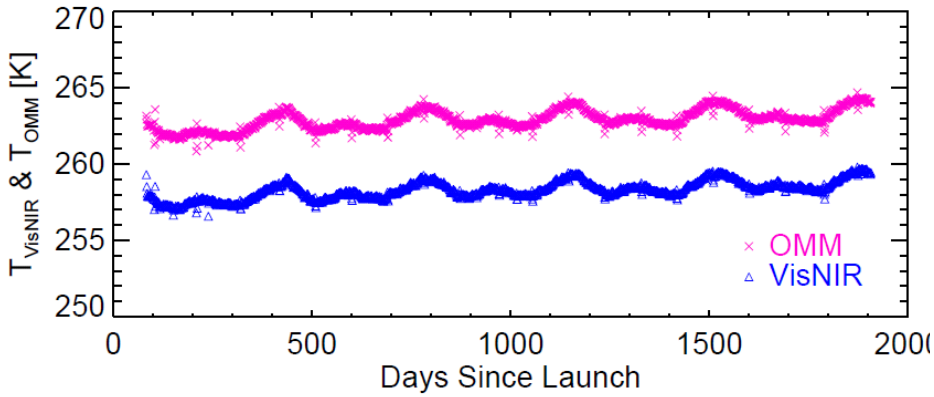
Spatial resolutions: 375/750 m for I/M bands

OBC: SD (each orbit), SDSM (3/week), BB (292.5K + quarterly WUCD)

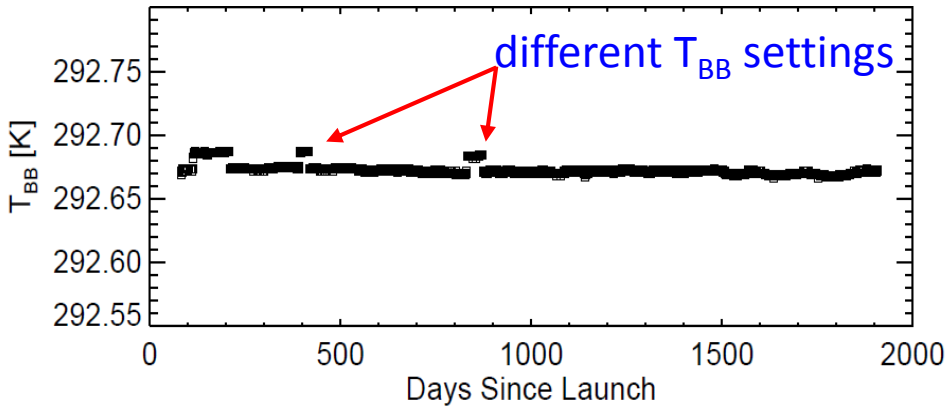
Moon: 8-10/year

Instrument and OBC Performance

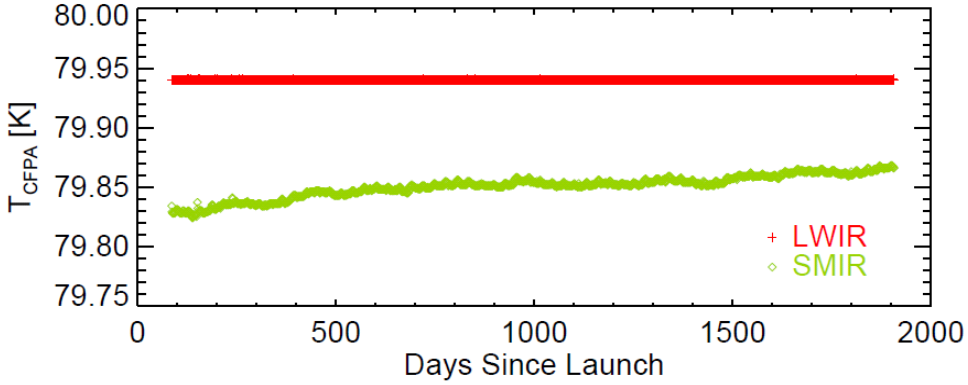
Dedicated effort and constant monitoring by VIIRS OP and CAL teams



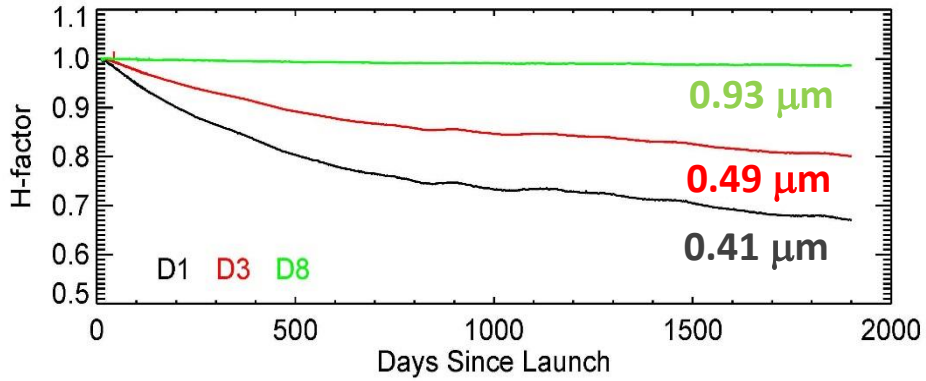
Very stable SC environment



BB temperatures: stably controlled



Sufficient margin for CFPA control



SD degradation: large at short λ

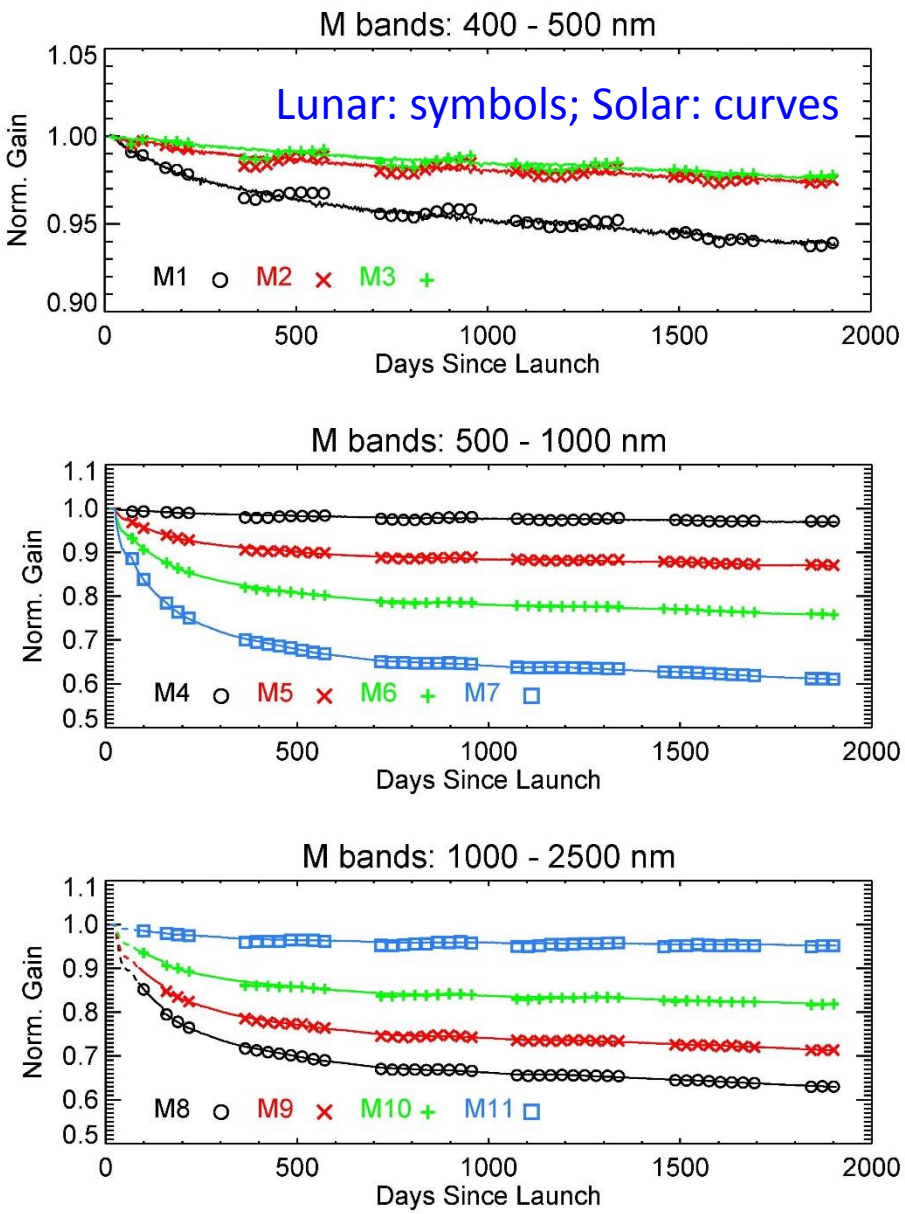
Performance Summary (RSB)

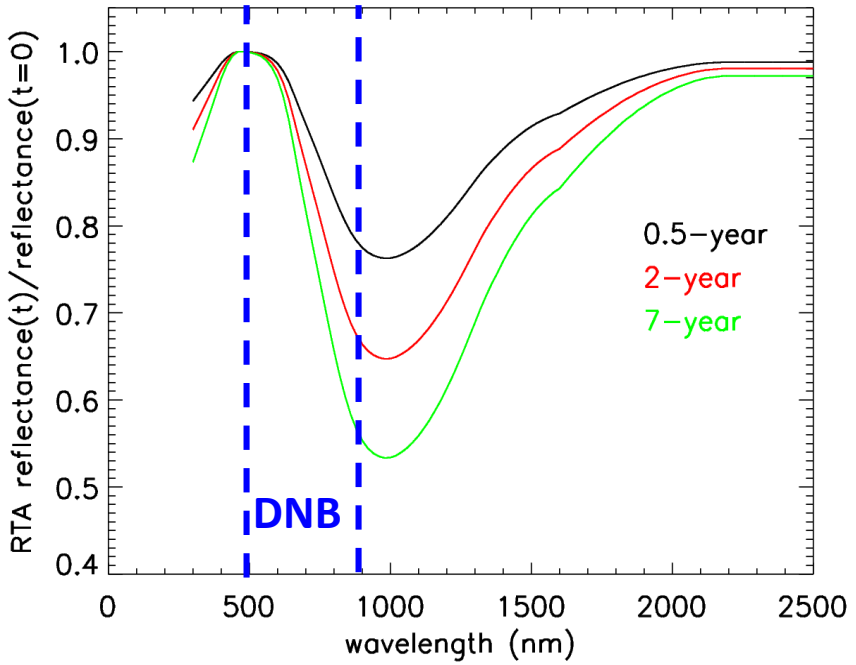
- Changes in spectral band responses: large in the NIR/SWIR, small in the VIS
- SD degradation: strong wavelength-dependent; large at short wavelengths
- Lunar calibration: overall agreements with SD calibration; small differences in long-term trends (corrected in RSB calibration LUTS)
- SNR: continue to meet specifications with sufficient margins
- Spectral: time-dependent modulated RSR (large impact on DNB, large effect at mission beginning)
- Spatial: little changes in BBR (monitored using lunar observations)

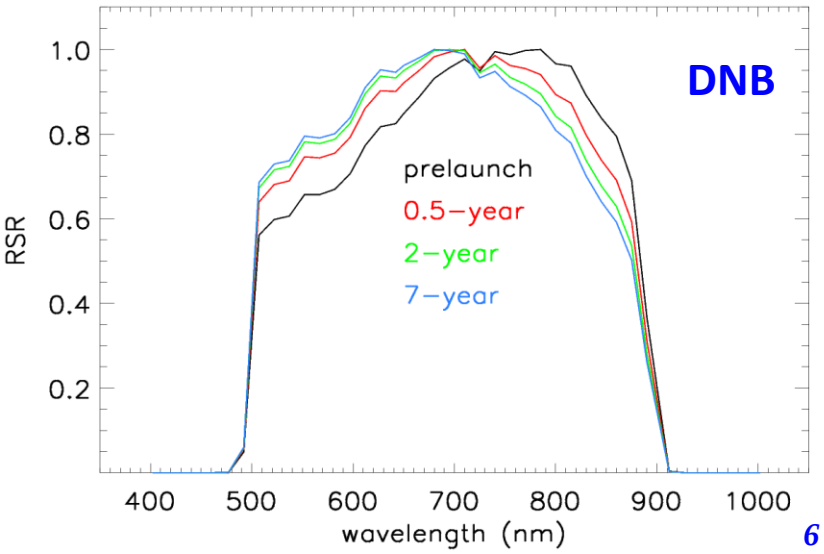
Xiong and Butler et al, Remote Sens., 8(2), 84, 2016; doi: 10.3390/rs8020084

Xiong and Cao, et al, IGARSS proc. pp: 1976 - 1979, 2016, DOI: 10.1109/IGARSS.2016.7729509

Wavelength dependent degradation in optics => modulated RSR







Improvements for NASA L1B Processing/Re-processing

- SDSM screen transmission (τ_{SDSM})
- SD screen transmission and $\tau_{SD}BRDF_{SD}$(SDSM_View)
- SD screen transmission and $\tau_{SD}BRDF_{SD}$(RTA_View)
- SD degradation (H)
  - Revised extrapolation of H to the mission very beginning
  - Model H to cover SWIR wavelength
  - Fit H at RTA view to lunar trending
- Correction for the solar vector error
- DNB offsets and stray light correction LUTs (forward processing)
  - DNB offsets tracked using BB observations during night time orbit
  - Weighted average of the "same" day LUTs from previous years

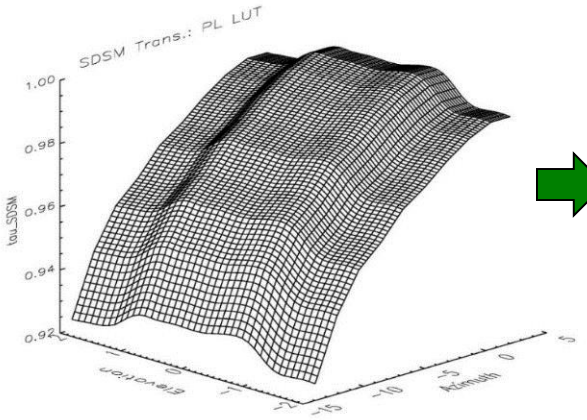
yaw data + regular data

⇨ yaw data

References: Lei and Xiong, TGRS papers published in 2015, 2016, and 2017

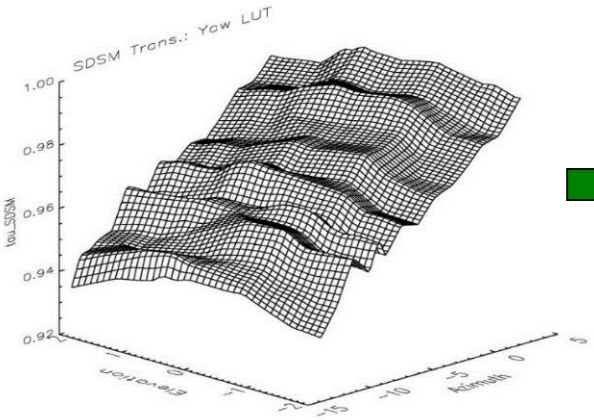
Calibration Improvements: RSB

SDSM PL_LUT



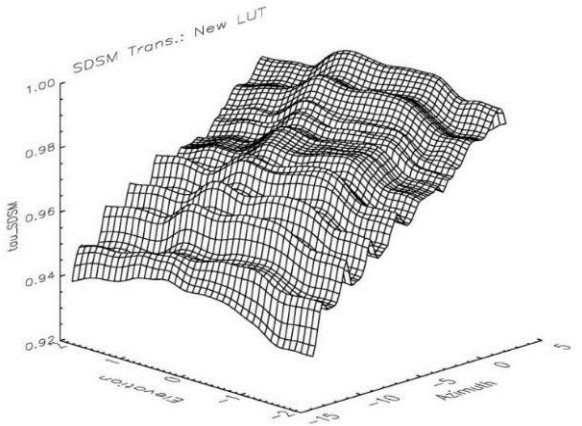
limited viewing geometries

SDSM Yaw_LUT

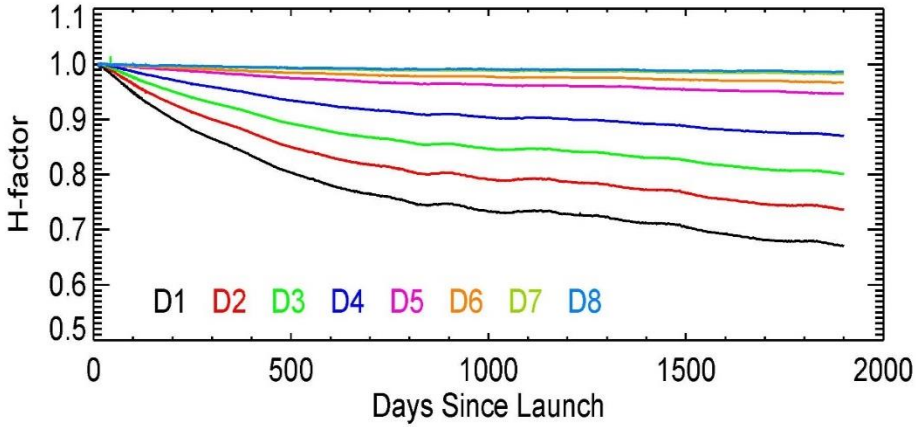


additional viewing geometries

SDSM New_LUT

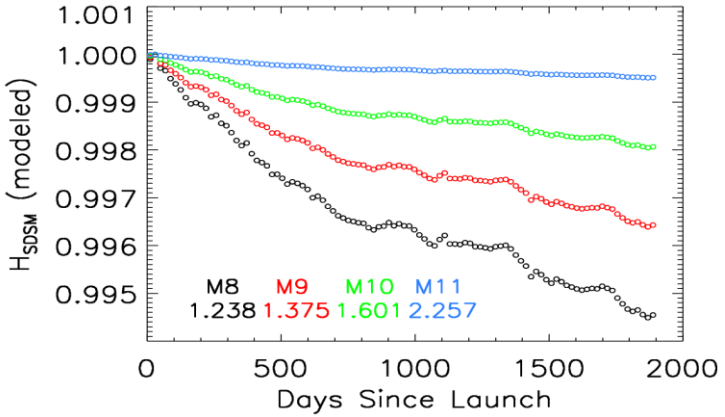


all viewing geometries



SDSM detectors: 0.41 to 0.93 μm

Modeling



4 SWIR bands: 1.2 to 2.3 μm

Status of S-NPP VIIRS Level 1B

- **NASA SIPS L1B Software**
  - **V2.0.0** was officially released to SIPS on Oct 18, 2016 (testing and evaluation: July-Oct).
  - VIIRS L1A and L1B software are developed under NASA EDOS/SIPS. The L1A, L1B, and LUTs data are in NetCDF4 format.
  - L1A granule (6-min) and L1B LUTs are required as input to generate 6-min L1B geolocation and radiometric products, including On-Board Calibrator (OBC) files for calibration and trending purpose.
  - L1B LUTs are computed using on-orbit SD/SDSM screen transmission & SD BRDF, modulated RSR, and consistent fitting methods throughout the mission
  - Monthly L1B LUTs updates are provided to SIPS by VCST.
  - The first L1B software **V1.1.0** was released in Jan 2016, based on IDPS SDR code version Mx8.10. The contents of NASA L1B V1.1.0 match with NOAA IDPS SDR Mx8.10 or Mx8.11 (current) if the same calibration coefficients and parameters are applied.

Collection	Code Base	# of LUTs	Delivery Time	Note
V1.1.0	L1B V1.1.0	13	2016.02 - 2017.02	Redesigned L1B software, LUTs, and data format using L1A data input.
V2.0.0	L1B V2.0.0	7	2016.08 - 2017.02	Improved L1B software functions and algorithms.

Status of S-NPP VIIRS Level 1B

- **Changes in V2.0.0 (compared to V1.1.0)**

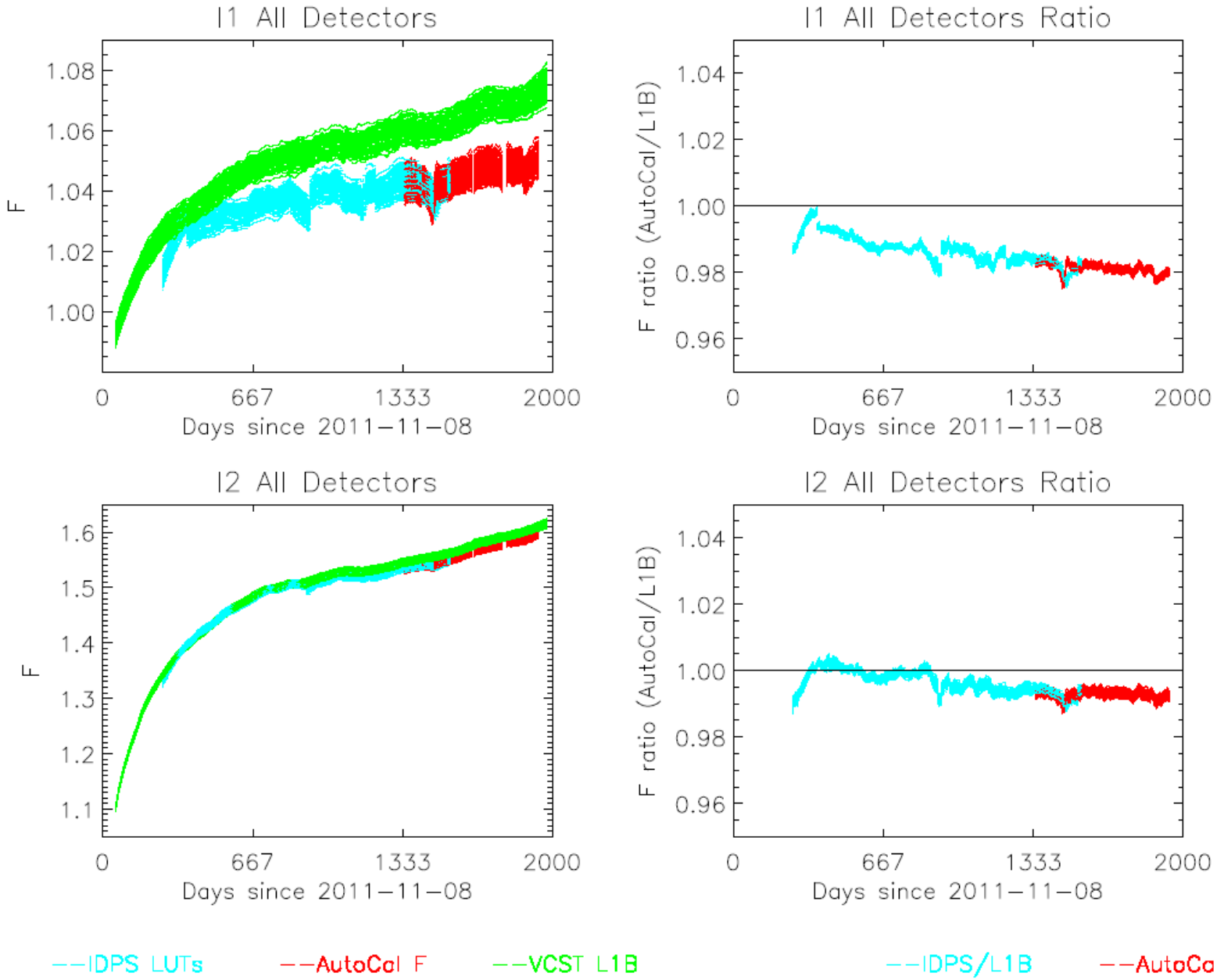
A. Functional changes

- Add fill values for specific data states requested by Land team.
- Partial scan line processing capability to support along-scan extracts.
- Dual gain bands un-aggregated L1B becomes official product.
- Add RSR tables in RSB LUT. Remove radiance tables from TEB LUT.
- Single resolution processing and output in geolocation.
- Add moon phase angle and moon illumination fraction in DNB geolocation.
- Add limit checks on attitude angles in geolocation.
- Add a new field (placeholder) for uncertainty index – under development.

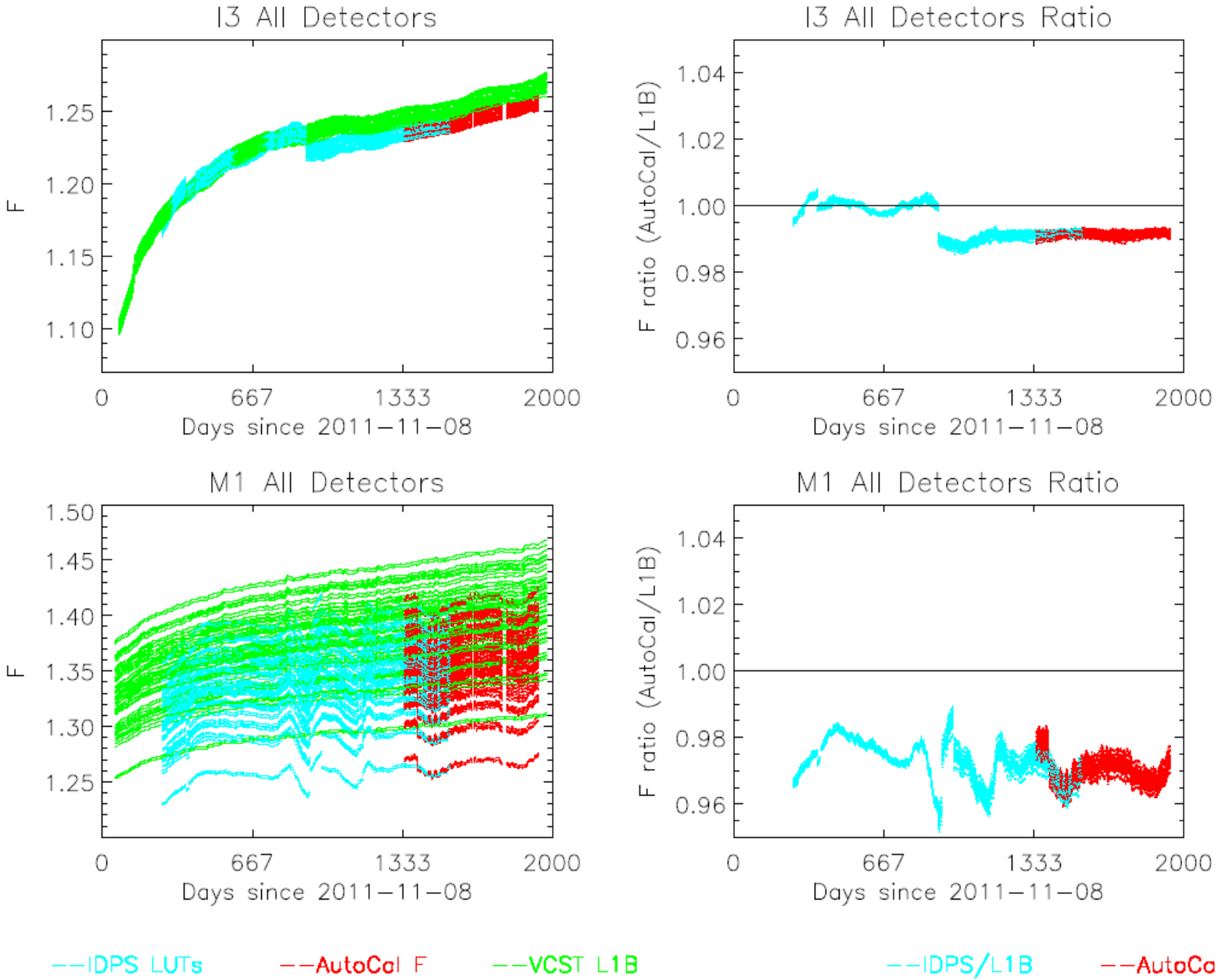
B. Algorithm changes

- Use solar irradiance at 1 AU distance to avoid computation of large number in meters.
- Temperature dependent coefficients for RSB Cal.
- Apply time-dependent modulated RSR in RSB Cal.
- Add running average option for TEB F-factor in TEB Cal.
- BB thermistors weighting (selection) to decrease orbital variation in F-factor for TEB Cal.
- Alternative calibration when moon is in SV.
- Apply out of range limits based on dn instead of radiances.

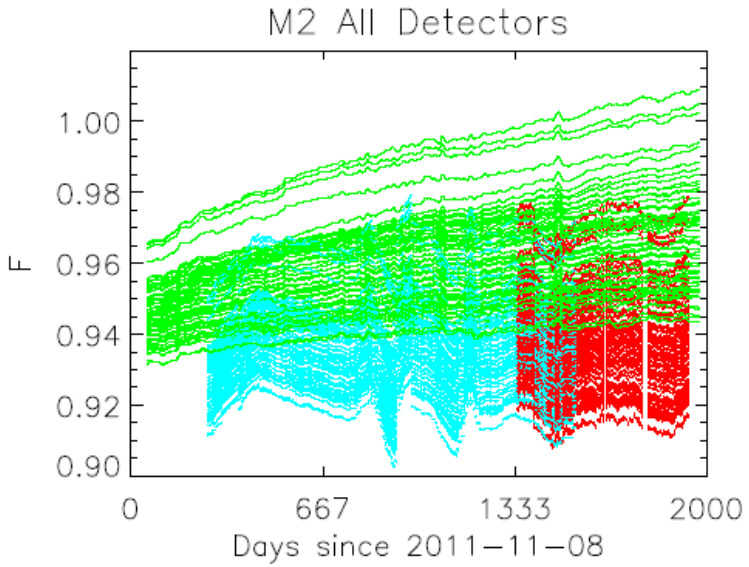
Calibration LUT Differences (IDPS/NASA L1B)

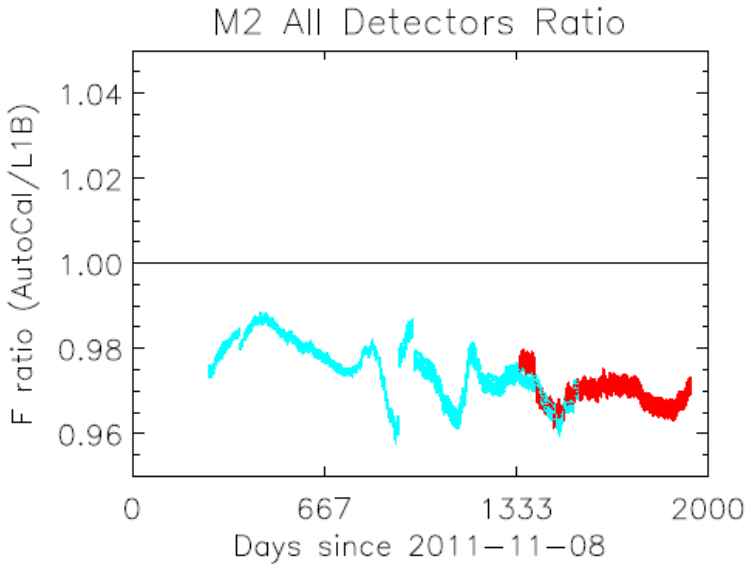


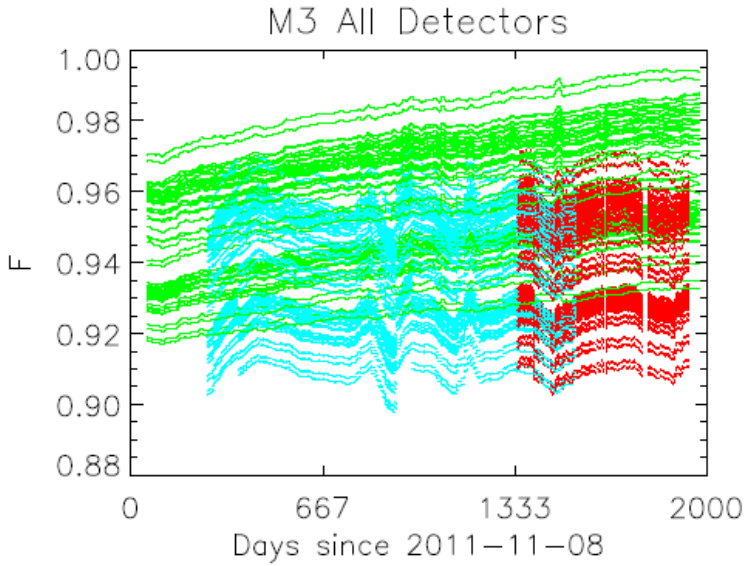
Calibration LUT Differences (IDPS/NASA L1B)

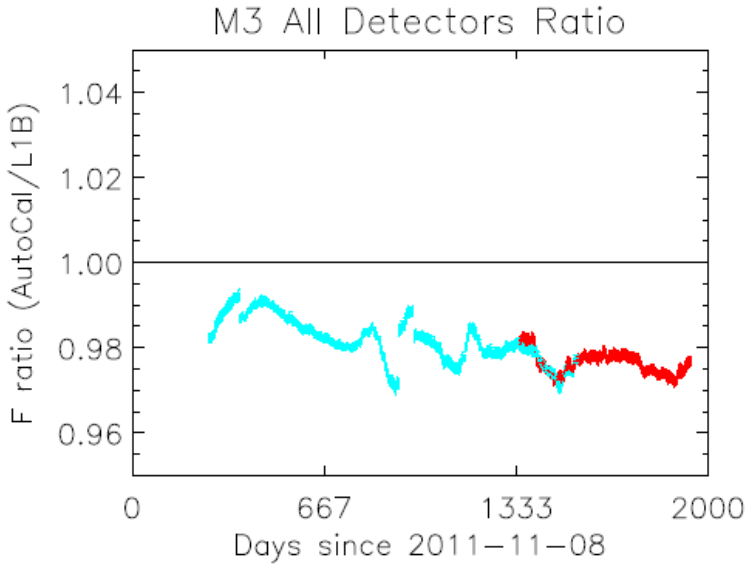


Calibration LUT Differences (IDPS/NASA L1B)



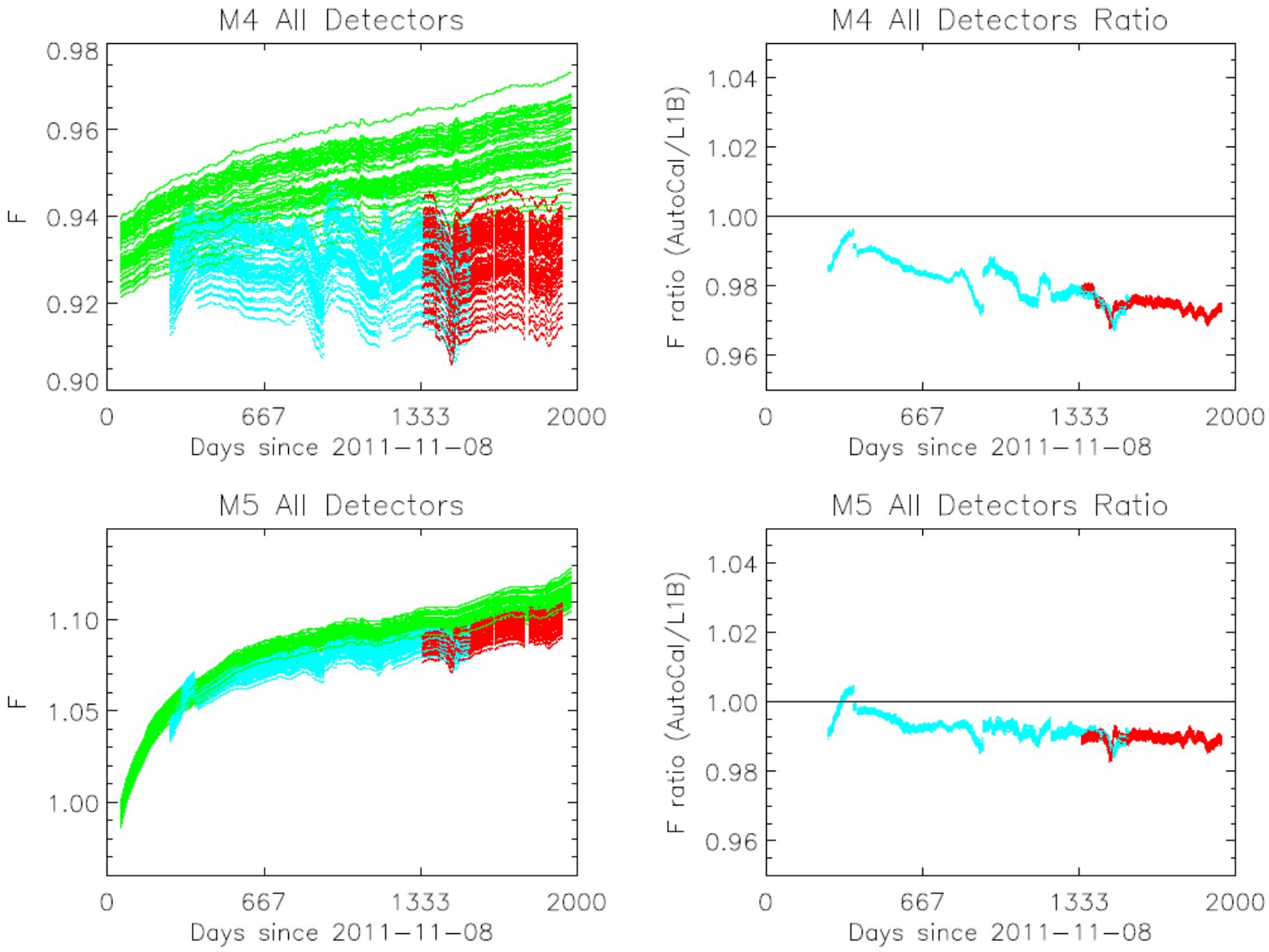






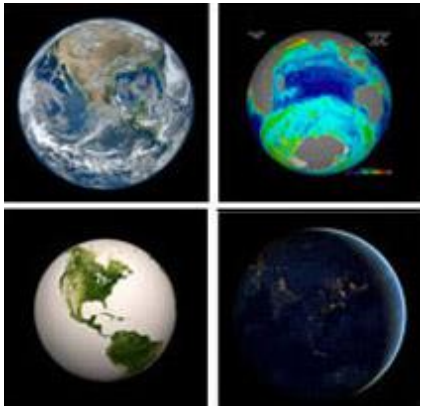
−−IDPS LUTs −−AutoCal F −−VCST L1B −−IDPS/L1B −−AutoCal/L1B

Calibration LUT Differences (IDPS/NASA L1B)



What's Next

- Improve calibration approach (combining both SD and lunar calibration)
- Maintain long-term calibration stability
  - Monitor potential changes in RVS
  - Track and characterize potential changes in polarization characteristics
- Characterize (and resolve) calibration differences between Aqua MODIS and S-NPP VIIRS (and soon JPSS-1 VIIRS)
- Enhance coordination and communication with NOAA SDR team, science and user community (e.g. GSICS users)



Good Images => Better Products

https://jointmission.gsfc.nasa.gov/viirs_sciencegallery.html

VIIRS and MODIS Spectral Bands

16 Moderate (radiometric) bands, 5 Imaging bands, 1 DNB

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

1 DNB

14 RSB
(0.4-2.3 μm)

Dual Gain Bands:
M1-M5, M7, M13

7 TEB