Visible Infrared Imaging Radiometer Suite

Suomi NPP VIIRS SDR Calibrated/Validated Maturity Overview

Changyong Cao, VIIRS SDR Lead

Suomi NPP SDR Product Review
NOAA Center for Weather and Climate Prediction (NCWCP)
5830 University Research Park, College Park, Maryland
December 18-20, 2013

Outline

- The VIIRS SDR Team
- Previous findings at the Provisional Review
- Major accomplishments since Provisional Review
- Discrepancy Report (DR) Status at IDPS
- Justifications for VIIRS SDR at Validated Maturity Level
- Path forward
- Summary

VIIRS SDR Team Subject Matter Expertise

	STAR/CI	Aerospace	NASA	NG
VIIRS SDR RSB	S. Blonski, S. Uprety, J. Sun	J. Cardema, E. Haas	J. Xiong*, N. Lei	
VIIRS SDR TEB	M. Liu*, C. Moeller, W. Wang*, F. Padula	D. Moyer	B. Efremova, J. McIntire	
VIIRS SDR DNB	S. Shao, W. Wang	K. Rausch*, J. Cardema, V. Le	J. Fulbright	L. Liao*, S. Weiss
Validation (SNO, cal/val sites)	S. Uprety*, S. Blonski, W. Shi		Aisheng Wu	
VIIRS SDR ADL, ICVS-LTM, G-ADA	W. Wang, V. Lin, Z. Yin, L. Tan	S. Houchin		
RTM, Image Analysis, data, User support, Knowledge base, QA	F. Padula, Y. Bai, S. Uprety, C. Moeller			L. Liao, F. Sun, R. Chu, T. Ohnuki
Geo-spatial	F. Padula, J. Choi, D. Pogo		R. Wolfe*, G. Lin, M. Nishihama	L. Liao
Prelaunch	S. Blonski, F. Padula, A. Pearlman, R. Datla	F. Deluccia, K. Rausch, D. Moyer	H. Oudrari, J. McIntire	L. Liao, S. Weiss, F. Sun
Operations and maneuver			V. Chang	

Org. Leads: STAR/CI (S. Blonski); Aerospace (F. Deluccia); NASA VCST (J. Xiong/R. Wolfe); NG (L. Liao)

* 1^{st} author journal publication; Not all members are shown.

Product Maturity Definition

- Beta (L+150)
  - Early release product, initial calibration applied, minimally validated and may still contain significant errors
  - Available to allow users to gain familiarity with data formats and parameters
  - Product is not appropriate as the basis for quantitative scientific publications studies and applications

- Provisional (Beta+2mo)
  - Product quality may not be optimal
  - Incremental product improvements are still occurring as calibration parameters are adjusted with sensor on-orbit characterization
  - 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 NPP Cal/Val Team representatives prior to use of the data in publications

- **Validated/Calibrated (L+1 yr)**
  - **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**

Previous findings from the Provisional Review

- Stable instrument performance and calibration
- All the VIIRS channels have noise much lower than specification
- VIIRS RTA degradation has slowed down
- VIIRS calibration lookup tables (LUT) are routinely updated
- Geolocation errors for all the channels were quantified and meet specification
- Radiometric biases between VIIRS and MODIS are within specifications, after accounting for spectral differences and the MODIS correction in collection 6.
- Warm up and cool down (WUCD) of the blackbody are routinely performed, with reduced impact on users
- Lunar calibration data are routinely collected and data have been analyzed for validation
- A 0.4 K bias was identified for VIIRS M15 compared to CrIS at 200K (meet spec.)
- DNB straylight was characterized and correction tools were being developed
- RSB Autocal was being developed to improve the calibration performance

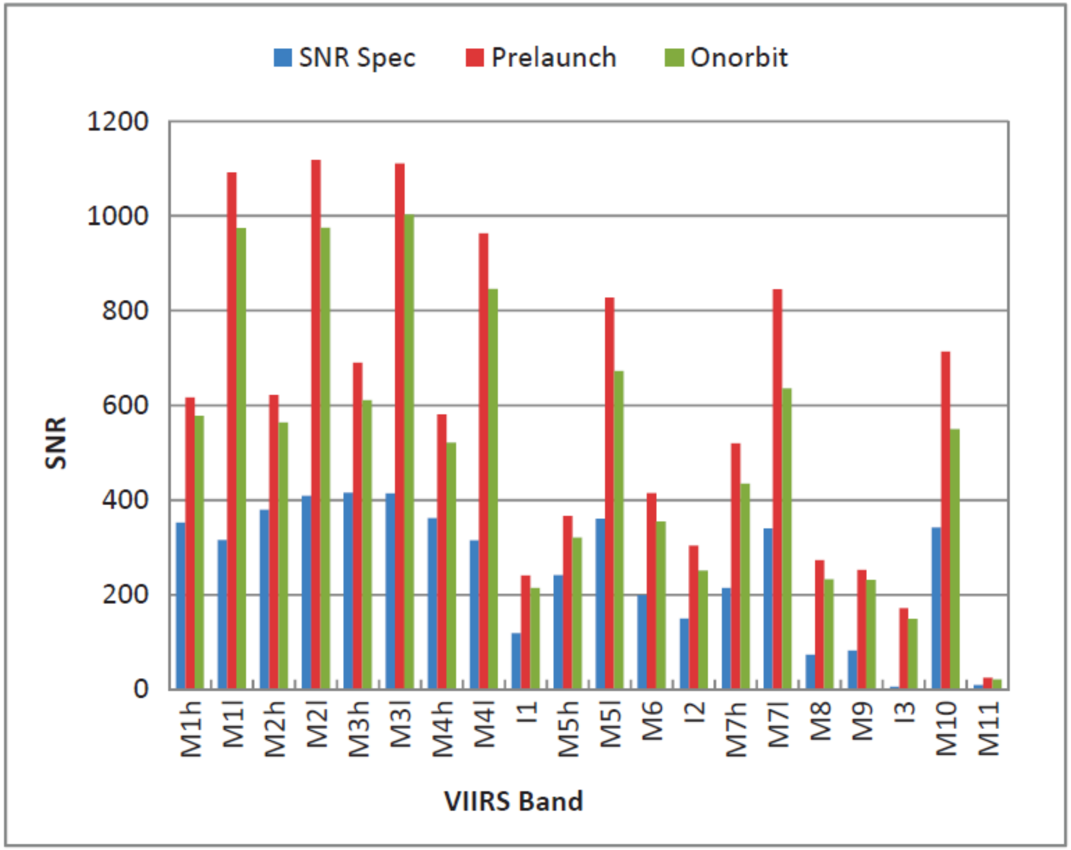
VIIRS SDR Requirements and Performance

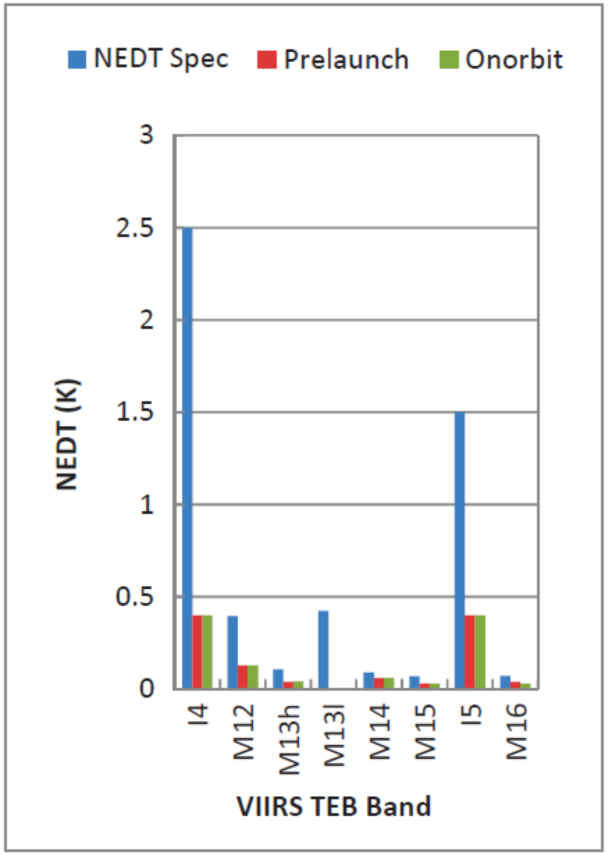
(all performance values are stable since provisional)

Band	Driving EDR(s)	Center Wavelength (µm)	Equiv. Width (µm)	Horizontal Sample Interval (km) (track × scan)		Band Gain	Ltyp or Ttyp (Spec)	Lmin or Tmin	Lmax or Tmax	Spec SNR or NEdT (K)	On Orbit SNR or NEdT (K)	MODIS equiv. band
				Nadir	End of Scan							
VisNIR												
M1	Ocean Color Aerosol	0.411	0.0198	0.75×0.75	1.60x1.58	H	44.9	30	135	352	588	B8
						L	155		615	316	1045	
M2	Ocean Color Aerosol	0.444	0.0143	0.75×0.75	1.60x1.58	H	40	26	127	380	572	B9
						L	146		687	409	1010	
M3	Ocean Color Aerosol	0.486	0.0190	0.75×0.75	1.60x1.58	H	32	22	107	416	628	B10
						L	123		702	414	988	
M4	Ocean Color Aerosol	0.551	0.0209	0.75×0.75	1.60x1.58	H	21	12	78	362	534	B4/B12
						L	90		667	315	856	
I1	Imagery EDR	0.639	0.0775	0.375x0.375	0.80x0.79	S	22	5	718	119	214	B1
M5	Ocean Color Aerosol	0.672	0.02	0.75×0.75	1.60x1.58	H	10	9	59	242	336	B13/B1
						L	68		651	360	631	
M6	Atmosph. Correct.	0.745	0.0146	0.75×0.75	1.60x1.58	S	9.6	5.3	41	199	368	B15
I2	NDVI	0.862	0.0394	0.375x0.375	0.80x0.79	S	25	10.3	349	150	264	B2
M7	Ocean Color Aerosol	0.862	0.0387	0.75×0.75	1.60x1.58	H	6.4	3.4	29	215	457	B16/B2
						L	33.4		349	340	631	
DNB	NCC Imagery	0.700	0.200	0.75×0.75	0.75×0.75	LG/MG/HG	3E-9	3E-9	0.02	6	>9	-
S/MWIR												
M8	Cloud Particle Size	1.238	0.0271	0.75×0.75	1.60x1.58	S	5.4	3.5	165	74	221	B5
M9	Cirrus/Cloud Cover	1.375	0.0150	0.75×0.75	1.60x1.58	S	6	0.6	77.1	83	227	B26
I3	Binary Snow Map	1.602	0.0572	0.375x0.375	0.80x0.79	S	7.3	1.2	72.5	6	149	B6
M10	Snow Fraction	1.602	0.0587	0.75×0.75	1.60x1.58	S	7.3	1.2	71.2	342	586	B6
M11	Clouds	2.257	0.0467	0.75×0.75	1.60x1.58	S	0.12	0.12	31.8	10	22	B7
I4	Imagery Clouds	3.753	0.360	0.375x0.375	0.80x0.79	S	270	210	353	2.5	0.4	B20
M12	SST	3.697	0.192	0.75×0.75	1.60x1.58	S	270	230	353	0.396	0.12	B20
M13	SST/Fires	4.067	0.165	0.75×0.75	1.60x1.58	H	300	230	343	0.107	0.04	B23
						L	380		634	0.423		
LWIR												
M14	Cloud Top Properties	8.578	0.324	0.75×0.75	1.60x1.58	S	270	190	336	0.091	0.06	B29
M15	SST	10.729	0.990	0.75×0.75	1.60x1.58	S	300	190	343	0.07	0.03	B31
I5	Cloud Imagery	11.469	1.75	0.375x0.375	0.80x0.79	S	210	190	340	1.5	0.4	B31
M16	SST	11.845	0.866	0.75×0.75	1.60x1.58	S	300	190	340	0.072	0.03	B32

VIIRS On-orbit Performance

-SNR and NEDT (all values are stable since provisional)

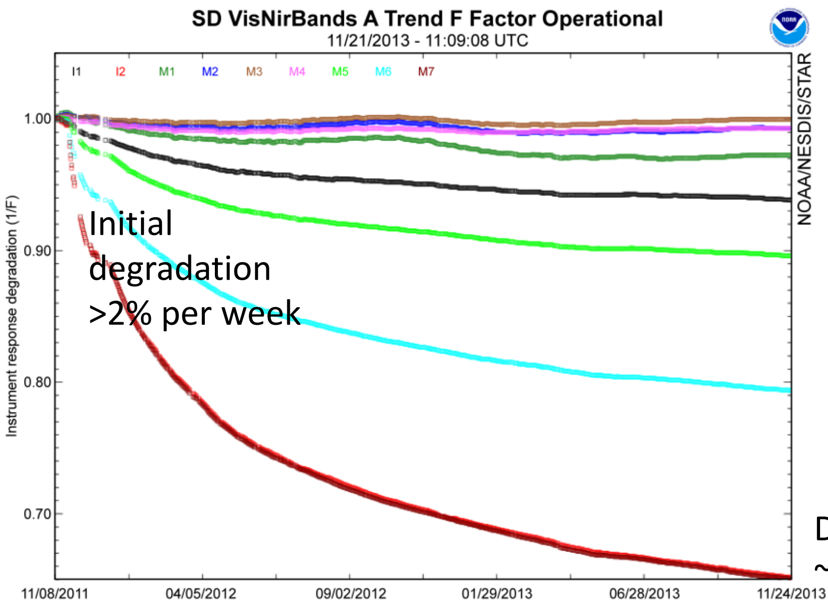




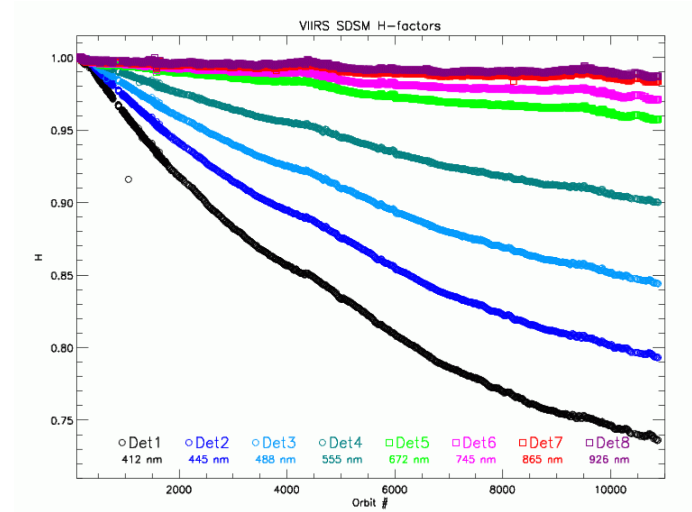
VIIRS SDR Accuracy

	Requirement (absolute uncertainty for uniform scenes)	Prelaunch and onboard calibration	Validation: Relative to MODIS/CrIS/IASI/other thru Inter-comparisons	Note
VIIRS RSB	2% typical reflectance; 0.3% stability; 0.1% desirable for Ocean Color Applications	1.2% for M1-M7; 1.5% for M8&9 1.4% for M10 1.3% for I1&I2 1.6% for I3	2% (±1%) for matching bands	Except bands with very low signal (ex. M11); 0.1% accuracy and stability for OC is very challenging. Geolocation error: expectation is half I-band pixel; achieved better than quarter I-band pixel (1-σ)
VIIRS TEB	M12/M13: 0.7%(0.13K) @270K M14: 0.6% (0.26K) @ 270K M15/M16: 0.4% (0.22K/0.24K) @270K I4: 5% (0.97K) @270K I5: 2.5% (1.5K) @270K	Better than 0.13K for all M bands except M13 (0.14); 0.47K for I4; 0.23K for I5	0.1K based on statistical comparison with MODIS and CrIS ER-2/SHIS Aircraft underflight shows excellent agreement M15 0.4 K bias relative to CrIS at 200K (in spec.)	M15 at 190K requirement is 2.1% radiance or 0.56K Geolocation uncertainty: expectation was half I-band pixel; achieved better than quarter I-band pixel (1-σ)
VIIRS DNB	• 5%, 10%,30% L_{min} (LGS,MGS,HGS)	3.5%, 7.8%, and 11% (LGS, MGS, HGS)	• 4%, 7.7%, 11.8% (LGS, MGS, HGS)	Geolocation error is a ~10th of a pixel (1-σ) on the ellipsoid earth but can exceed 1km (up to 24 km at the edges of scan) without terrain correction

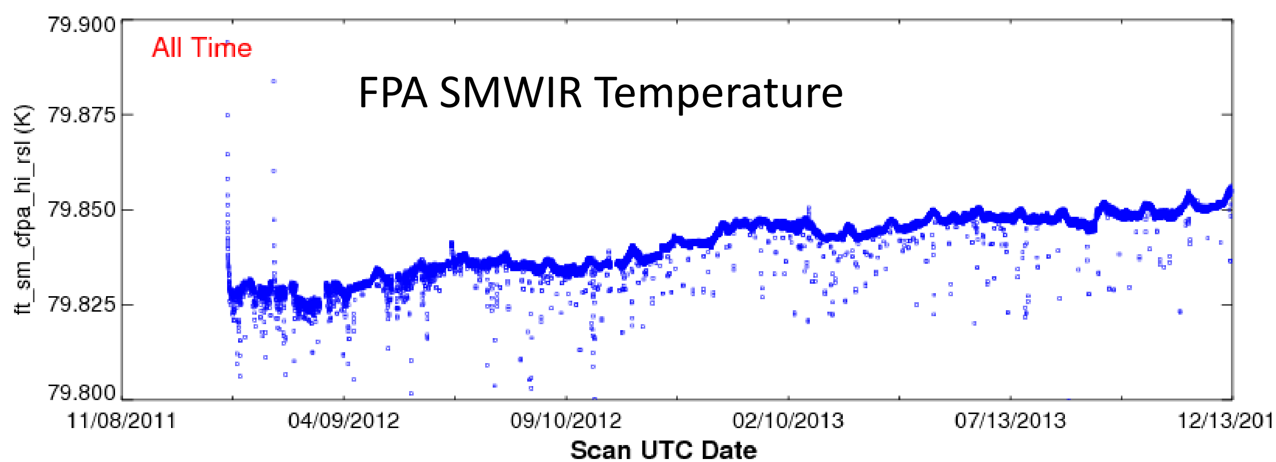
VIIRS Long-term Trending



Degradation(M7) ~0.1% per week



- RTA degradation leveling off
- For M7, initially > 2% per week; Currently ~0.1% per week
- H-factor degradation continues Impact on OC requires additional studies



Major Achievements since provisional

- RSB Autocal being tested (MX8.0) and independently validated by STAR.
- VIIRS DNB Straylight Correction implemented (Aug. 2013); tool kit has been evaluated by STAR.
- Implementation of modulated RSR (April 2013)
- Updates to the SD and SDSM attenuation screens transmission look-up tables (for improved offline derivation of the radiometric calibration coefficients)
- SST striping studies
- TEB validation (further cross comparisons with CrIS, aircraft underflight, DCC analysis)
- I2/M7 correlation analysis
- Ocean Color LUT effects and comparisons
- QF map on ICVS
- Continued monitoring (SNO, LTM)
- Continued bias time series analysis between VIIRS and MODIS
- Continued longterm trending and monitoring
- Continued WUCD, and Lunar data acquisition
- Publications and conference papers

VIIRS SDR Peer Reviewed Publications (10+)

- Cao, C., F. Deluccia, X. Xiong, R. Wolfe, and F. Weng, 2013a, Early On-orbit Performance of the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (Suomi-NPP) Satellite, IEEE Transaction on Geoscience and Remote Sensing, DOI:10.1109/ TGRS.2013.2247768, in press (available online at IEEEXplore).

- Cao, C., X. Xiong, S. Blonski, Q. Liu, S. Uprety, X. Shao, Y. Bai, F. Weng, 2013, Suomi NPP VIIRS sensor data record verification, validation, and long-term performance monitoring, JGR Special Issue, DOI: 10.1002/2013JD020418

- Xiong, X., J. Butler, K. Chiang, B. Efremova, J. Fulbright, N. Lei, J. McIntire, H. Oudrari, J. Sun, Z. Wang, A. Wu (2013), VIIRS On-orbit Calibration Methodology and Performance, JGR Special Issue, DOI: 10.1002/2013JD020423.

- Wolfe, R., G. Lin, M. Nishihama, K. P. Tewari, J. C. Tilton, A. R. Isaacman et al., 2013, Suomi NPP VIIRS prelaunch and on-orbit geometric calibration and characterization, DOI: 10.1002/jgrd.50873, JGR special issue.

- Liao. L.B., S. Weiss, S. Mills, B. Hauss (2013), Suomi NPP VIIRS Day-Night-Band (DNB) On-Orbit Performance, Journal of Geophysical Research-Atmosphere, DOI: 10.1002/2013JD020475.

- Rausch, K. et al., VIIRS RSB Autocal, JGR special issue , in press.

- Uprety, S., C. Cao, X. Xiong, S. Blonski, A. Wu, and X. Shao, 2013, Radiometric Inter-comparison between Suomi NPP VIIRS and Aqua MODIS Reflective Solar Bands using Simultaneous Nadir Overpass in the Low Latitudes, JTech , doi: http://dx.doi.org/10.1175/JTECH-D-13-00071.1.

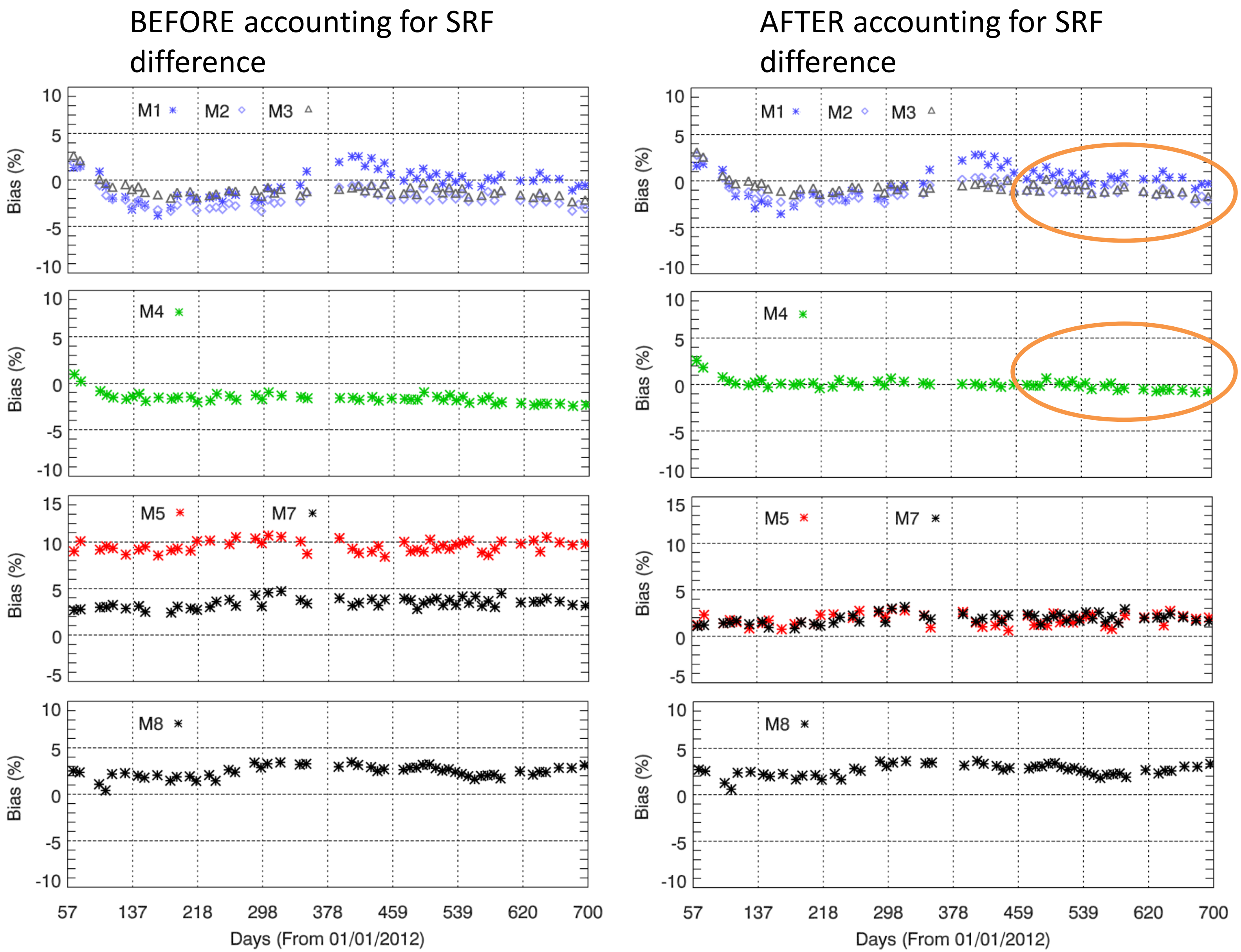
- Cao, C., X. Shao, S. Uprety, (2013b), Detecting Light Outages After Severe Storms Using the Suomi-NPP/VIIRS Day Night Band Radiances, IEEE Geoscience and Remote Sensing Letters, DOI: 10.1109/LGRS.2013.2262258, in press.

- Liu, Q., C. Cao, and F. Weng, 2013, Assessment of Suomi National Polar-Orbiting Partnership VIIRS Emissive Band Calibration and Inter-Sensor Comparisons, IEEE JSTAR, 10.1109/JSTARS.2013.2263197.

- Liu, Q., C. Cao, and F. Weng, 2013: Striping in the Suomi NPP VIIRS Thermal Bands through Anisotropic Surface Reflection, J. Atmos. Oceanic. Technol., 30, 2478–2487. doi: http://dx.doi.org/10.1175/JTECH-D-13-00054.1

- Plus over ~80 conference papers.

VIIRS and MODIS RSB Inter-comparison at SNO-x (over desert)

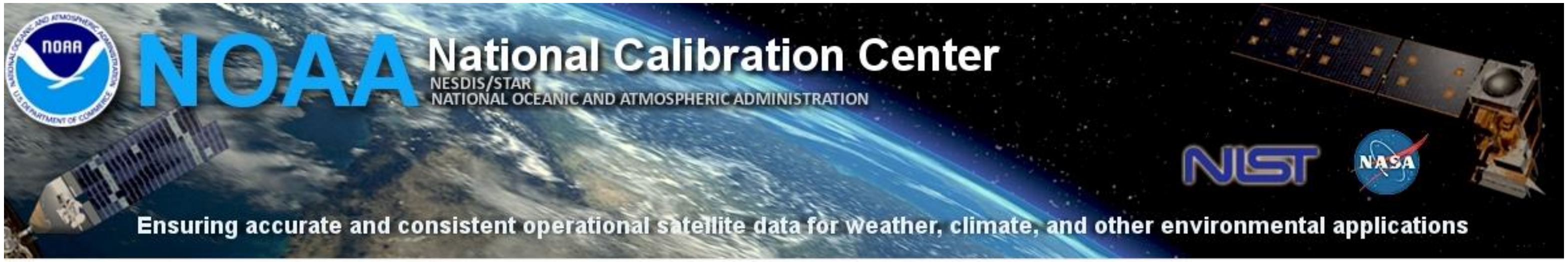


DRs status since provisional

DR #	Description	Status Impact
4663	Modified Operational Code for Increased RSB Calibration Autonomy	Ontrack(new algorithm being tested)
4589	Improved SDSM Screen Transmission LUT	Done
4716	Day-Night Band Stray Light	Done
4890	VIIRS DNB Geolocation Residual Error Recommendation	Done
4710	Warm-Up/Cool-Down Tests Need to Be Flagged	Done
4742	Erratic Solar Eclipse Flag	Closed
4767	HAM/RTA Sync Loss and Sector Rotation Need to Be Flagged	Closed
4894	Unexpected High Values of Satellite Zenith Angles	Closed
4913	Missing Terrain-Corrected Geolocation Data	Closed
4916	Missing Radiance/Reflectance/Temperature Data	Closed
4892	Wrong RSR LUT Used in Mx6.2 from 8/9 to 9/5/2012	Closed
4917	IDPS Incorrect Handling of Leap Seconds	Closed
7294	Radiance/BT/Reflectance max limit discrepancies	Being investigated

VIIRS Calibration Knowledge Base Updated

One stop shop for VIIRS SDR information



NCC

You are here: Foswiki > NCC Web > VIIRS (21 Nov 2013, ChangyongCao)

- Home
- Terms of Reference
- Publication Database
- About
- GOES-R
- NPP/JPSS/VIIRS
- NPP/JPSS/OMPS
- NOAA/AVHRR
- NOAA/SSU
- MetOp
- JASON
- DSCOVR
- Space Weather
- Standards
- Lunar Calibration
- Calibration Sites

Visible Infrared Imaging Radiometer Suite (VIIRS)

The Visible Infrared Imaging Radiometer Suite (VIIRS) is one of the key instruments onboard the Suomi National Polar-Orbiting Partnership (Suomi NPP) spacecraft, which was opened on November 21, 2011, which enables a new generation of operational moderate resolution-imaging capabilities following the legacy of the AVHRR on NOAA an operational environmental monitoring and numerical weather forecasting, with 22 imaging and radiometric bands covering wavelengths from 0.41 to 12.5 microns, providing tl records including clouds, sea surface temperature, ocean color, polar wind, vegetation fraction, aerosol, fire, snow and ice, vegetation, , and other applications. Results from calibration and validation have shown that VIIRS is performing very well. **VIIRS paper:** Cao, C., F. DeLuccia, X. Xiong, R. Wolfe, F. Weng, Early On-orbit Performance of the

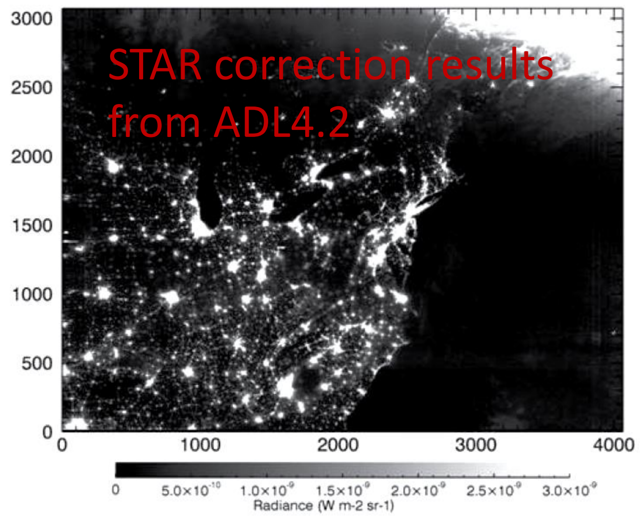
News and Documents	VIIRS Performance and Monitoring	Data and Software
News	VIIRS Longterm Monitoring	VIIRS Image Gallery
Publication Database	VIIRS On-orbit Performance Table	VIIRS data on CLASS
VIIRS Users Guide	Standardized Calibration Parameters	VIIRS data on ftp site (90 days)
VIIRS Calibration ATBD	VIIRS Spectral Response Functions	Data on GRAVITE
Conference Presentations	VIIRS Event Log Database (experimental)	VIIRS Software Tools
VIIRS Novel Applications	NPP/AQUA SNO Predictions	Planck Calculator for Infrared Remote Sensing
VIIRS SDR Data Format	Radiometric Intercomparison with MODIS	VIIRS Line Spread Function along scan
VIIRS SDR Meetings	VIIRS at Cal/Val Sites	VIIRS Cloud Mask (VCM)
VIIRS FAQ	Lunar Calendar for DNB	SDR/EDR Team
About VIIRS	Moon in Space View Events	Standard Radiometric Test Scenes

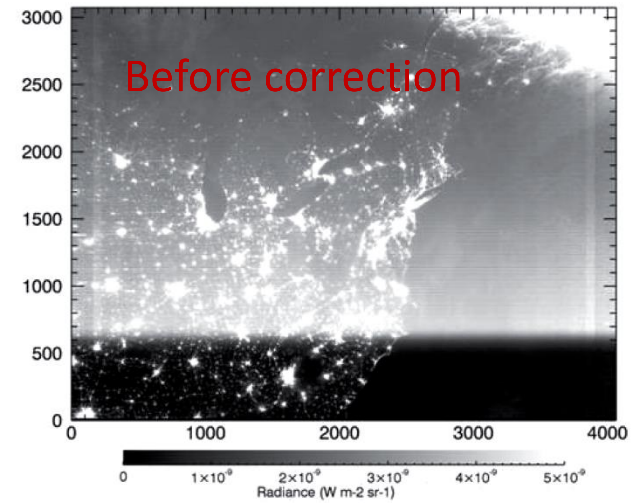
VIIRS SDR Validated Maturity Checklist

Validated Version	VIIRS				Explanation for the Calibrated/Validated Maturity Assessment
	RDR	TDR	SDR	rSDR	
On-orbit sensor performance characterized and calibration parameters adjusted accordingly	N/A		TRUE		Both radiometric and geospatial performance of VIIRS have been characterized. Both noise and accuracy meet specifications for all bands except M11 (waiver). Minor issues are on-track to be resolved. Calibration parameters have been fine tuned and routinely updated. However, the 0.1% goal of radiometric accuracy and stability for Ocean Color is challenging.
There may be later improved version	N/A		TRUE		Improvements are still being made, in such areas as RSBAutocal, RSB calibration stability, and some LUT fixes. Striping is being investigated which may lead to improved algorithms in the future.
There will be strong versioning with documentation	N/A		TRUE		Code change controled by AERB and IDPS build (currently Mx8.0). LUT changes monitored by AERB. Procedure well established for testing and version control.
Ready for use in applications and scientific publication	N/A		TRUE		VIIRS SDR data are available on CLASS for public access. The VIIRS SDR team has been responding to inquiries and QA issues from users worldwide. Users are in general satisfied with the quality of the VIIRS SDR data.

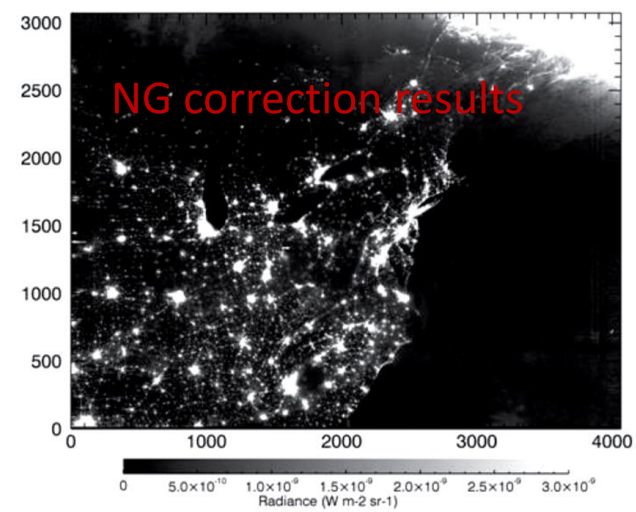
STAR Support to DNB Straylight Correction

(Example achievement)

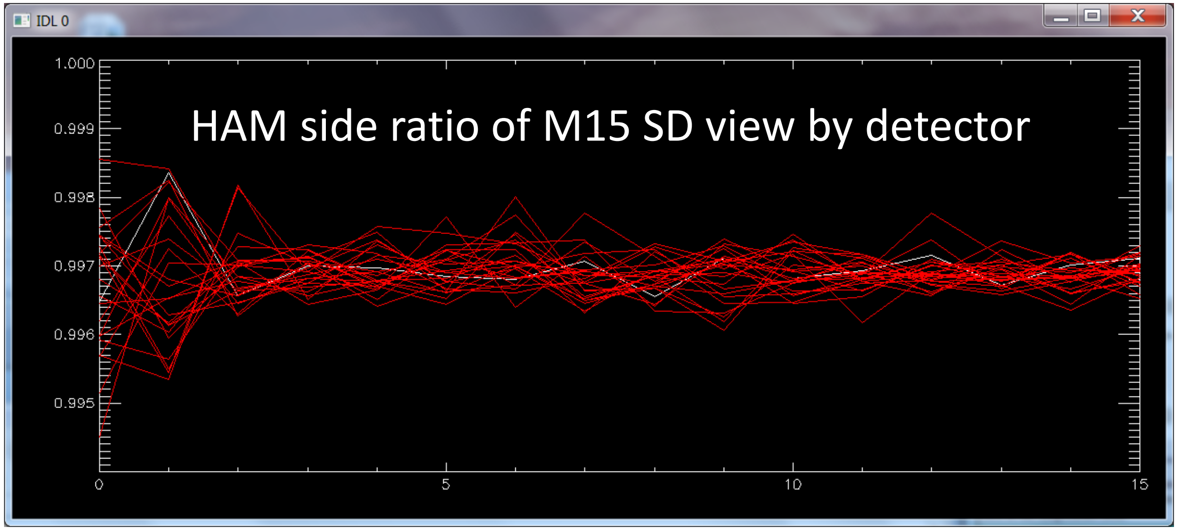


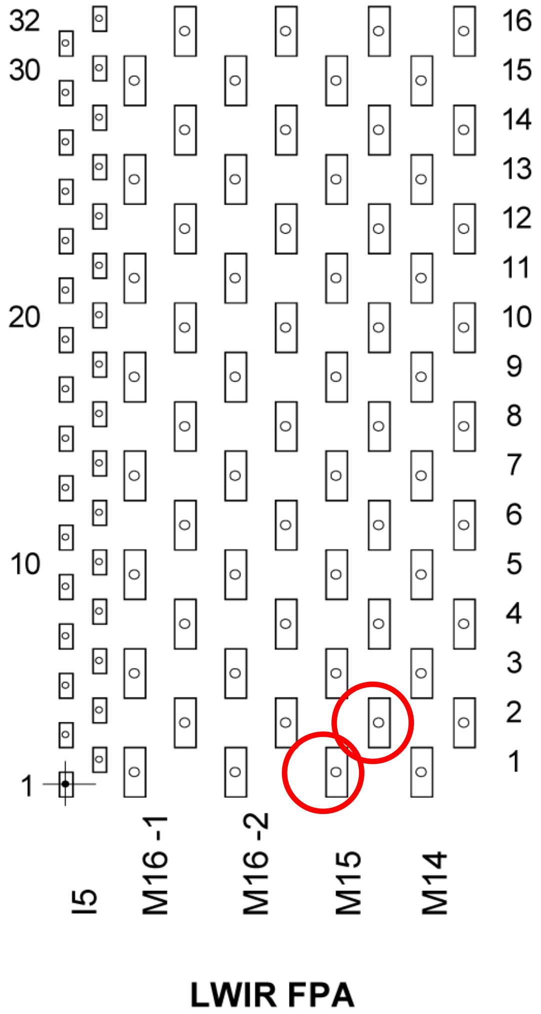


- STAR team has recently evaluated the DNB straylight correction toolkit by NG
- Run the software in Matlab & generated LUT
- Used the LUT to generated straylight corrected DNB data
- Compared results with those by NG
- Thank the team for a job well done!



VIIRS Detector Level Performance Analysis (Example achievement-Deep Dive Analysis on Striping)





- Solar diffuser view helped in identifying the M15 detectors with less stable gains which appears to be the major root cause for SST striping
- Striping is at noise level which has little impact on meeting the requirement, nevertheless SST amplifies the striping by ~4x.
- Analysis confirmed by independent analysis (B. Emfreva, D. Moyer, W. Wang, S. Uprety)
- Detector level RSR difference and impacts through RTM studies (see Padula)
- Addressing user concerns

Gain Stability by Detector

(Example achievement-Deep Dive Analysis on Striping)

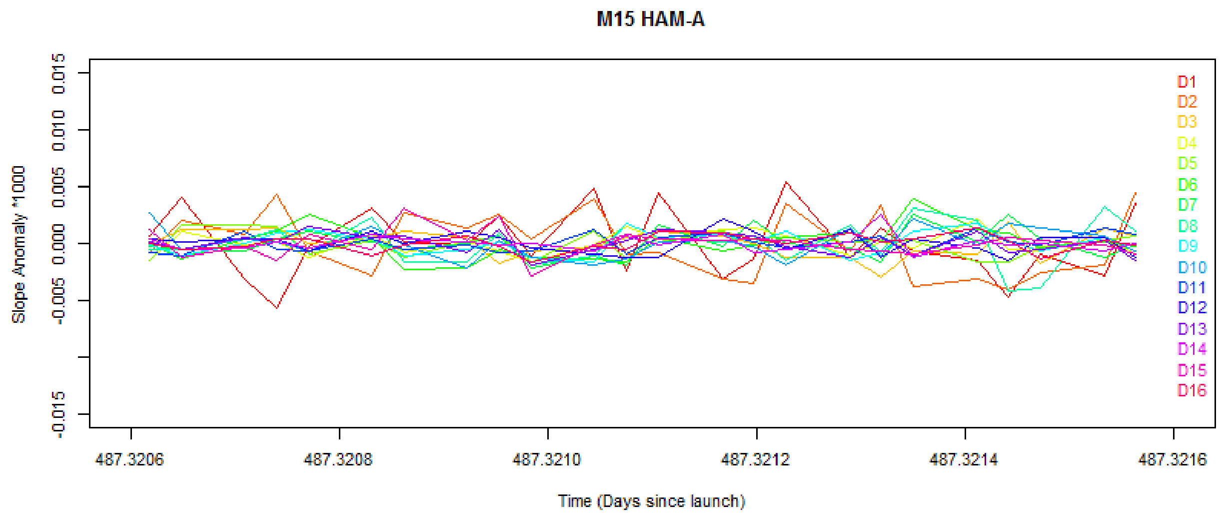
Noise (48 samples) are comparable for all detectors

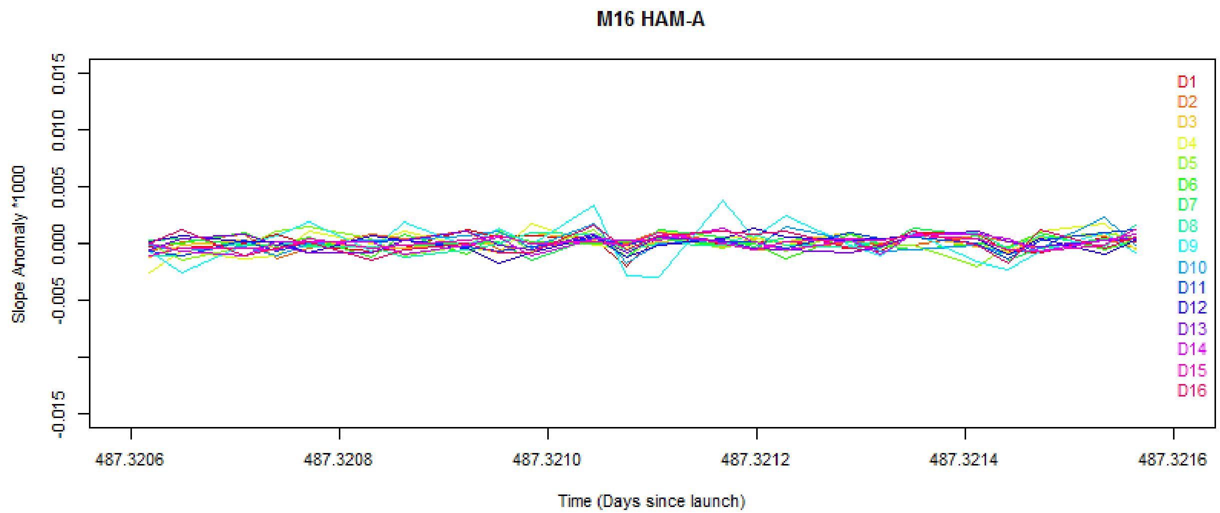
D1, D2, and D8 for M15 gains are not as stable as the other detectors which is identified as the root cause for the striping

However, the magnitude of the striping is at the noise level which doesn't affect the maturity

Algorithms are being investigated to reduce the striping

Implications for J1 & J2 need to be studied

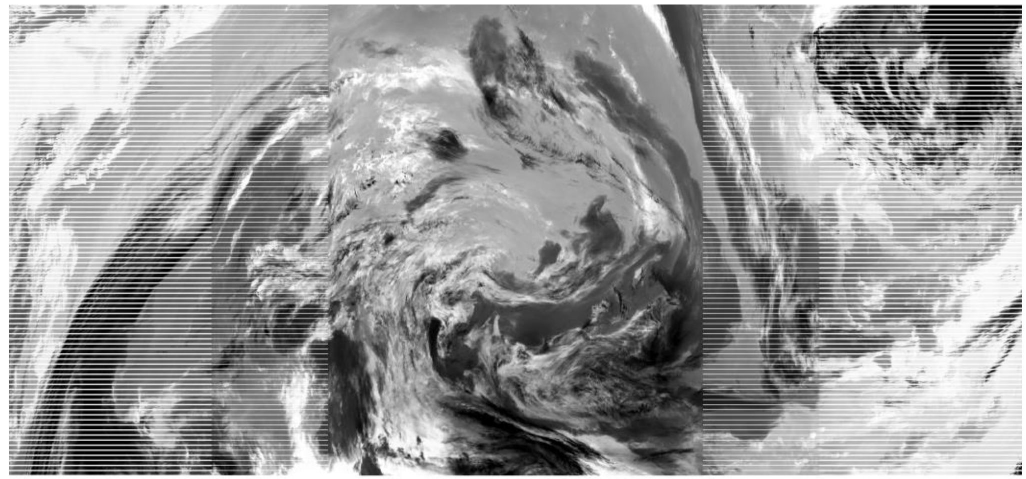




IVOBC_npp_d20130121_t0741066_e0742307_b06398_c20130121093732128234_noaa_ops.h5
(Slope = 1/gain)

Major Challenge -Sync loss

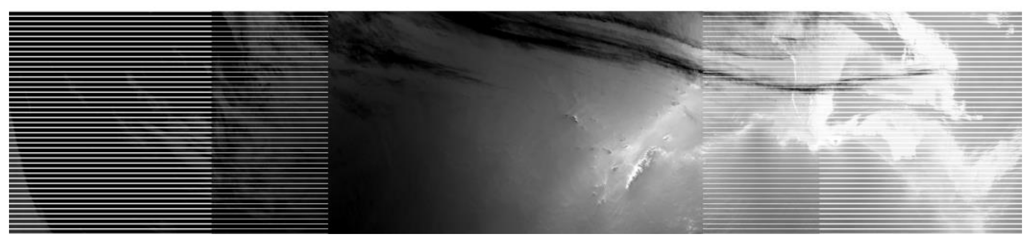
First sync loss occurred on 2011-11-22 15:52:52



Occurs ~monthly

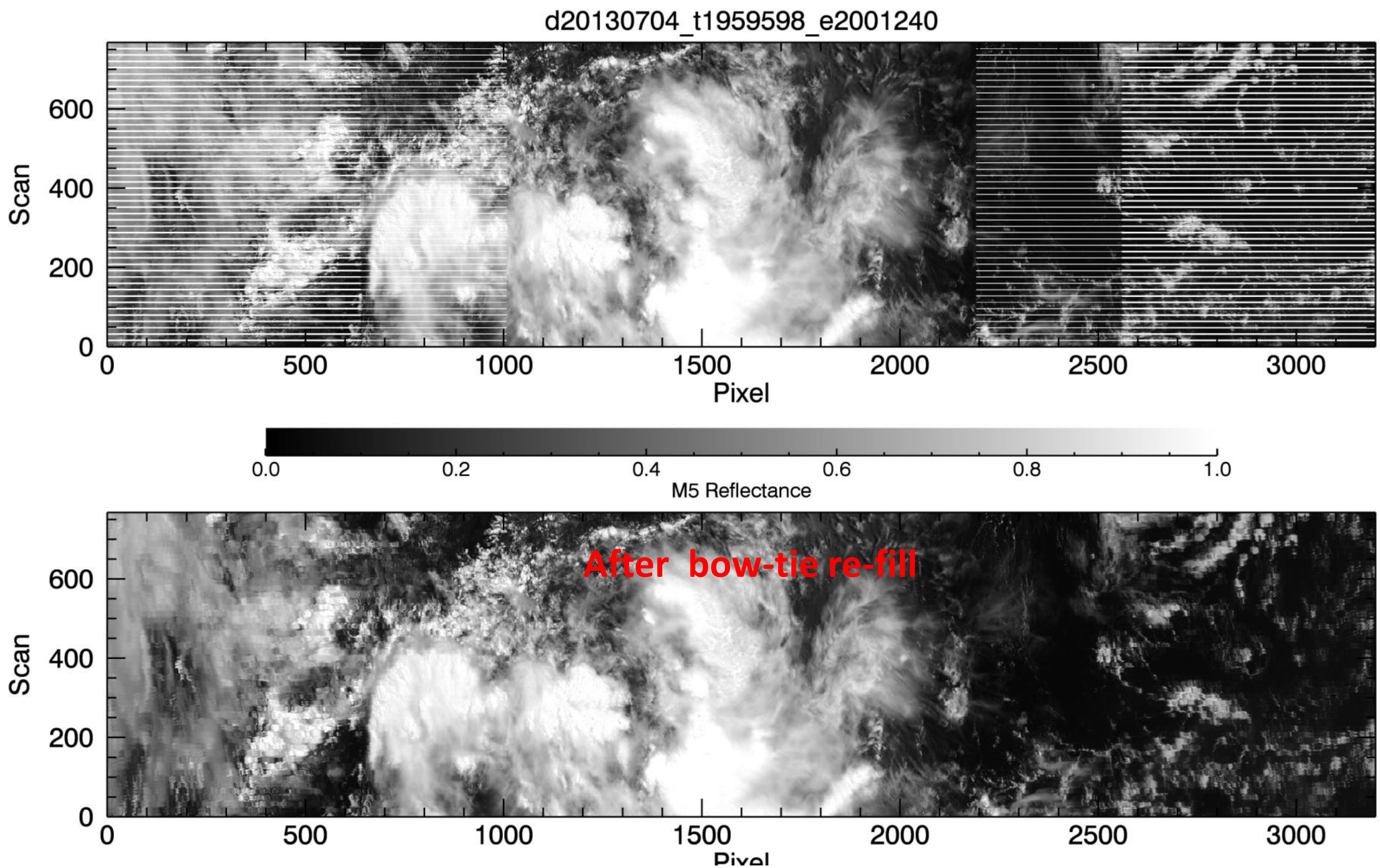
Last sync loss (#35): 20131123_1146291_1152095

Event log database: https://cs.star.nesdis.noaa.gov/NCC/VIIRS



User Complains
Bow-tie Impacts and Bow-tie Refill

Before



A refiller software can be made available but it doesn’t solve the fundamental problem

Path forward

- **Overall, both VIIRS SDR radiometric and geolocation performance have reached calibrated/validated maturity status.**
- **Future work focus on refinements and long term monitoring. Topics include:**
  - More rigorous calibration/validation to ensure ocean color requirements are met
  - DNB geolocation terrain correction
  - Striping in SST bands and RSB
  - 0.1K bias during WUCD relative to CrIS
  - Polarization effects
  - M13 low gain calibration points
  - Accurate assessment of BBR for bands saturated by the moon

-Within-orbit thermal correction for further enhanced geolocation

-**J1 Prelaunch calibration**

Summary

- VIIRS SDR has achieved calibrated/validated maturity status for both radiometric and geolocation performance
- Near term focus on:
  - More rigorous cal/val for ocean color
  - Operationalization of RSBAutocal
  - Transition of the DNB straylight correction
  - DNB terrain correction
- Future work focus on:
  - J1 calibration support
  - Further enhancements in instrument performance through research (such as striping, etc)
  - Long term monitoring
- Thank the entire VIIRS SDR team for their dedication, hard work, and enthusiasm!

- Backup slides

VIIRS Sensor Specification
- RSB sensitivity

Table: 3.1.5.6.1-1 Sensitivity requirements for VIIRS Sensor reflective bands

Band	Center Wavelength (nm)	Gain Type	Single Gain		Dual Gain			
.	.	.	.	.	High Gain		Low Gain	
.	.	.	Ltyp	SNR	Ltyp	SNR	Ltyp	SNR
M1	412	Dual	-	-	44.9	352	155	316
M2	445	Dual	-	-	40	380	146	409
M3	488	Dual	-	-	32	416	123	414
M4	555	Dual	-	-	21	362	90	315
M5	672	Dual	-	-	10	242	68	360
M6	746	Single	9.6	199	-	-	-	-
M7	865	Dual	-	-	6.4	215	33.4	340
M8	1240	Single	5.4	74	-	-	-	-
M9	1378	Single	6	83	-	-	-	-
M10	1610	Single	7.3	342	-	-	-	-
M11	2250	Single	0.12	10	-	-	-	-
I1	640	Single	22	119	-	-	-	-
I2	865	Single	25	150	-	-	-	-
I3	1610	Single	7.3	6	-	-	-	-

Notes:
The units of spectral radiance for Ltyp are watt m^{-2} sr^{-1} μm^{-1}.
The SNR column shows the minimum required (worst-case) SNR that applies at the end-of-scan. Elsewhere in the scan, aggregation will yield a larger SNR.
Within the same gain setting, at radiances larger than Ltyp, the SNR will be larger than what is specified in this table.

Absolute radiometric calibration uncertainty for uniform scenes: < 2%

Source: JPSS VIIRS Performance Requirement Document
Code 472 472-00124

VIIRS Sensor Specification

- TEB sensitivity

Table: 3.1.5.6.2-1 Sensitivity requirements for VIIRS Sensor emissive bands

Band	Center Wavelength (nm)	Gain Type	Single Gain		Dual Gain			
.	.	.	.	.	High Gain		Low Gain	
.	.	.	Ttyp	NEdT	Ttyp	NEdT	Ttyp	NEdT
M12	3700	Single	270	0.396	-	-	-	-
M13	4050	Dual	-	-	300	0.107	380	0.423
M14	8550	Single	270	0.091	-	-	-	-
M15	10763	Single	300	0.070	-	-	-	-
M16	12013	Single	300	0.072	-	-	-	-
I4	3740	Single	270	2.500	-	-	-	-
I5	11450	Single	210	1.500	-	-	-	-

Notes:
The NEdT column corresponds to the minimum required (worst-case) SNR that applies at the end-of-scan. Elsewhere in the scan, aggregation will yield a larger SNR.
Within the same gain setting, at scene temperatures larger than Ttyp, the SNR will be larger than at Ttyp.
For reference, the NEdT values in Table 15 are related to the noise equivalent spectral radiance (NEdL) by the following formula:

Source: JPSS VIIRS Performance Requirement Document
Code 472 472-00124

VIIRS Sensor Specification
- TEB Uncertainty

Table: 3.1.5.9.2.3-1 Absolute radiometric calibration uncertainty of spectral radiance for moderate resolution emissive bands

Band	λc (μm)	Scene Temperature				
.	.	190K	230K	270K	310K	340K
M12	3.7	N/A	7.0%	0.7%	0.7%	0.7%
M13	4.05	N/A	5.7%	0.7%	0.7%	0.7%
M14	8.55	12.3%	2.4%	0.6%	0.4%	0.5%
M15	10.763	2.1%	0.6%	0.4%	0.4%	0.4%
M16	12.013	1.6%	0.6%	0.4%	0.4%	0.4%

Table: 3.1.5.9.2.4-1 Radiometric calibration uncertainty for imaging emissive bands

Band	Center Wavelength (nm)	Calibration Uncertainty
I4	3740	5.0%
I5	11450	2.5%

Source: JPSS VIIRS Performance Requirement Document
Code 472 472-00124

VIIRS SDR 58 Cal/Val Tasks

STAR

- SDR VALIDATION
  - SDR COMPARISON WITH MODEL (RAD-7)
  - SDR COMPARISON WITH AVHRR (RAD-8)
  - SDR COMPARISON WITH MODIS (RAD-9)
- Performance and Telemetry Trending (PTT-1-5- all)

UNIVERSITY OF WISCONSIN

- SPECTRAL EVALUATIONS
  - OUT-OF-BAND (OOB) SPECTRAL LEAKAGE (RAD-1)
  - IN-BAND SPECTRAL RADIANCE COMPARISON WITH CRIS (RAD-12)
  - RELATIVE SPECTRAL RESPONSE REFINEMENTS
- HAM REFLECTANCE (RVS) INFLUENCE ON RADIOMETRIC CALIBRATION (RAD-04)
- AIRCRAFT BASED CAL/VAL OF VIIRS SDR RADIANCE (RAD-18,-20, -21)

NGAS

- ASF/PGE DEVELOPMENT
- CODE EVALUATION AND SUPPORT
- RADIOMETRIC EVALUATIONS
- DNB IMAGE ANALYSIS
- DNB CALIBRATION SUPPORT (RAD-26)
- DUAL GAIN ANOMALY FLAGGING (RAD-25)
- GEOMETRIC ANALYSIS SUPPORT (GEO-X)
- QUALITY FLAG VALIDATION & UPDATE (RAD-27)
- BRIGHT PIXEL ALGORITHM VERIFICATION

LINCOLN LABORATORY

- STRAYLIGHT VIIRS RSB SOLAR DIFFUSER STRAYLIGHT - ANALYSIS OF NON-POLAR SD DATA (CSE-3)

RAYTHEON

- IDPS Support
- ADL Support

VIIRS SDR 58 Cal/Val Tasks -continued

AEROSPACE

- **EOC TASKS**
  - OPERABILITY, NOISE, SNR VERIFICATION WITH NADIR DOOR CLOSED (FPF-2)
  - DUAL GAIN BAND AND DNB TRANSITION VERIFICATION (FPF-4)
  - DC-RESTORE FUNCTIONALITY AND PERFORMANCE CHECK (FPF-6)
  - CALIBRATOR VISUAL INSPECTION (FPF-7)

- **RSB CALIBRATION**
  - SD AND SDSM CHARACTERIZATION (CSE-1)
  - TEMPORAL ANALYSIS OF SD SIGNAL OVER POLAR REGION (CSE-4)
  - TEMPORAL ANALYSIS OF SOLAR DIFFUSER STABILITY MONITOR (SDSM) DATA (CSE-5)
  - DNB OFFSET VERIFICATION (PTT-4)
  - DNB OFFSET/GAIN DETERMINATION (RAD-26)

- **TEB CALIBRATION**
  - EMISSIVE BAND RESPONSE CHARACTERIZATION (RAD-15)

- **RADIOMETRIC EVALUATIONS**
  - OPERABILITY, NOISE, SNR VERIFICATION (PTT-1)
  - RDR HISTOGRAM ANALYSIS (PTT-2)
  - NOISE AND SNR FOR UNIFORM EV SCENES (PTT-3)
  - ELECTRONIC GAIN MEASUREMENT (PTT-5)
  - CROSSTALK, ECHO, AND GHOST INVESTIGATION (IMG-1)
  - CROSSTALK FROM EMISSIVE BANDS TO REFLECTIVE BANDS (RAD-2)

NASA

- **EOC TASKS**
  - IN-SCAN AGGREGATION VERIFICATION – NON-DNB BANDS (FPF-3)
  - ON-BOARD BOW-TIE DELETION VERIFICATION (FPF-5)

- **MANEUVER PLANNING & ANALYSIS**
  - YAW MANEUVER ANALYSIS – SOLAR ATTENUATION SCREEN (SAS) TRANSMISSION(CSE-6)
  - ANALYSIS OF SDSM DATA WITH MODEL ASSISTED EXTRAPOLATION OF SCREEN CALIBRATION DATA(RAD-22)
  - LUNAR DATA ANALYSIS - ROLL MANEUVER (RAD-19)
  - ANALYSIS OF PITCH MANEUVER DATA (TEB RVS)(CSE-5)
  - RADIOMETRIC EVALUATIONS
  - DYNAMIC RANGE AND LINEARITY(RAD-3)
  - RESPONSE VS. SCAN ANGLE (RSB) (RAD-4)
  - RELATIVE BAND-TO-BAND CALIBRATION ANALYSIS USING LUNAR DATA (RAD-5)
  - RELATIVE BAND-TO-BAND CALIBRATION ANALYSIS USING SD DATA (RAD-6)
  - MOON IN SPACE VIEW CORRECTION (RAD-16)
  - IMAGE ANALYSIS (STRIPING, GLINTS AND OTHER ARTIFACTS (IMG-2)
  - GEOLOCATION & GEOMETRIC ANALYSIS
  - INITIAL VALIDATION OF SC AUXILIARY EPHEMERIS AND ATTITUDE DATA(GEO-1)
  - INITIAL VALIDATION OF VIIRS ENCODER DATA, SCAN TIME, SCAN PERIOD, AND SCAN RATE STABILITY(GEO-2)
  - ASSESS REASONABLENESS OF FIRST- PERIOD SDR GEOLOCATION (GEO-3)
  - BUILD FIRST-PERIOD SIMULATED VIIRS IMAGES FROM GCP CHIPS, (5) BUILD FIRST PERIOD VIIRS IMAGE CHIPS FROM SELECTED SDR PIXELS,(6) PERFORM FIRST PERIOD VIIRS SIMULATED IMAGE MATCH-UP (GEO-4-5-6)
  - ANALYZE FIRST PERIOD VIIRS GCP RESIDUALS (GEO-7)
  - ANALYZE INITIAL INTRA-ORBIT THERMAL EFFECTS ON GEOLOCATION (GEO-8)
  - DEVELOP AND TEST INITIAL GEOLOCATION PARAMETER & THERMAL LUT UPDATES (GEO-9)
  - LSF/MTF VALIDATION (IMG-4)
  - BAND-TO-BAND REGISTRATION (BBR) VERIFICATION (RAD-17)