Read-me for Data Users

MEMORANDUM FOR: The JPSS Program Record
SUBMITTED BY: JPSS VIIRS SDR Team (Changyong Cao and Slawomir Blonski)

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SUBJECT: NOAA-20 VIIRS SDR validated maturity status
DATE: 06/15/2018

Validated maturity status declaration for VIIRS SDR Maturity
Review Date: **06/15/2018**
Effective Date: **04/30/2018**
Operational System: **IDPS with Block2.1 Mx1**

1. Background:

The Joint Polar Satellite System-1 (JPSS-1) was successfully launched on November 18, 2017 and renamed NOAA-20 after reaching the polar orbit. Eleven days after launch, on November 29, 2017, the NOAA-20 Visible Infrared Imaging Radiometer Suite (VIIRS) was activated. Like the Suomi National Polar-orbiting Partnership (S-NPP) VIIRS, NOAA-20 VIIRS is a scanning imaging radiometer that produces global imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans in the visible and infrared bands with moderate spatial resolutions and 22 spectral bands. VIIRS Sensor Data Record (SDR) corresponds to radiance, reflectance and brightness temperature. The operationally produced VIIRS data are widely used globally to monitor hurricanes/typhoons, measure cloud and aerosol properties, ocean color, sea and land surface temperature, ice motion and temperature, active fires, and Earth's albedo.

The VIIRS SDR team for supporting calibration and validation of SDR products consists of experts from NOAA, NASA, Aerospace, University of Wisconsin and industry partner such as Raytheon. The team has worked intensively on evaluating the instrument performance since launch and updating the calibration using post-launch developed look up tables (LUTs) to significantly improve the radiometric and geometric accuracy of VIIRS SDR.

NOAA-20 VIIRS SDR data product was declared beta maturity on January 25, 2018 after the preliminary data quality check, and provisional maturity on 2/18/2018 after an intensive cal/val on-orbit.

2. Validated maturity stage definition:

1. Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
2. Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
3. Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
4. Product is ready for operational use based on documented validation findings and user

feedback.

5. Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

3. Justifications for declaring validated maturity for VIIRS SDR data product:

After NOAA-20 VIIRS reached provisional maturity, VIIRS SDR team members continued the assessment and analysis of VIIRS on-orbit data that includes VIIRS science RDR, telemetry RDR, diagnostic RDR, SDR, and GEO data products, and special post-launch tests (PLT) data such as those from yaw maneuver, pitch maneuver, DNB South Atlantic Anomaly (SAA) observations, warm-up/cool down, as well as outgassing. Based on intensive evaluation of VIIRS SDR calibration quality and update of calibration coefficients through multiple LUT updates, the following assessments of the VIIRS instrument and data products are given:

1) The VIIRS instrument noise performance is very stable for the entire period from global data, as shown in the SNR and NEDT charts in the presentations.
2) The VIIRS instrument temperatures are stable, comparable to those on the Suomi NPP VIIRS.
3) The VIIRS instrument degradation in the reflective solar band and day/night band are very small, and the degradation is calibrated out by routine updates of the calibration coefficients (aka LUT) prepared offline by the STAR VIIRS SDR team.
4) The VIIRS LWIR degradation stopped after the outgassing on March 14, 2018. As a result, the VIIRS LWIR re-gained the responsivity in those bands with a stable trend.
5) NOAA-20 VIIRS radiometric biases for all bands have been compared and quantified with similar bands on Suomi NPP VIIRS and MODIS, with positive results, as shown in the presentation slides.
6) Mitigations of VIIRS artifacts such as M6 saturation rollover have been developed, tested, and ready to be transitioned to operations.
7) Documentation has been updated, including the VIIRS SDR user's guide, with an appendix added for the NOAA-20 VIIRS DNB unique features.
8) The VIIRS SDR product is ready for operational use based on validation findings and user feedbacks.
9) The NOAA-20 VIIRS performance will continuously be monitored using well established procedures and tools.
10) The VIIRS SDR team will continue working closely with all users to ensure the data quality meet specification and user needs.

The detailed justifications for declaring VIIRS SDR validated maturity are attached in the presentation slides. The following table summarizes the VIIRS on-orbit SNR and NEΔT as per specification and on-orbit computed values.

Band	L_{typ}	SNR spec	NOAA-20 (on-orbit) Jan 2018	NOAA-20 (on-orbit) May 2018	S-NPP (on-orbit)
M1 LG	155	316	1102	1115	1045
M1 HG	44.9	352	631	644	588
M2 LG	146	409	998	1012	1010
M2 HG	40	380	564	573	572
M3 LG	123	414	1061	1057	988
M3 HG	32	416	693	686	628
M4 LG	90	315	848	857	856
M4 HG	21	362	549	551	534
M5 LG	68	360	774	762	631
M5 HG	10	242	385	383	336
M6	9.6	199	417	413	368
M7 LG	33.4	340	715	708	631
M7 HG	6.4	215	532	523	457
M8	5.4	74	321	319	221
M9	6	83	297	297	227
M10	7.3	342	673	653	586
M11	1	90	199	198	22*
I1	22	119	225	224	214
I2	25	150	286	285	264
I3	7.3	6	180	174	149

Band	T_typ	NEDT Spec	NOAA-20 (on-orbit) Jan 2018	NOAA-20 (on-orbit) May 2018	S-NPP (on-orbit)
M12	270	0.396	0.12	0.12	0.12
M13	300	0.107	0.04	0.04	0.04
M14	270	0.091	0.05	0.05	0.06
M15	300	0.07	0.02	0.02	0.03
M16	300	0.072	0.03	0.03	0.03
I4	270	2.5	0.42	0.42	0.4
I5	210	1.5	0.42	0.42	0.4

* For S-NPP M11, L_{typ} = 0.12 W/m^2-sr-µm

4. VIIRS validated maturity SDR data product caveats

The following caveats are offered to validated product users:

1. Saturation in M6 and other bands: M6 saturation occurs typically at 30 radiance units and is flagged in the SDR but not corrected. An improved algorithm has been developed for the flagging and will be operationalized in the near future.
2. I3 bad detector: NOAA-20 VIIRS I3 has one bad detector which can cause striping. Mitigation has been developed at EDR level to replicate the nearby pixels.
3. Based on intersatellite comparisons using various methods, it was found that there is a systematic bias for all reflective solar bands (RSB) which leads to a lower reflectance values observed by NOAA-20 VIIRS by approximately 2% in absolute reflectance. This is likely due to its traceability to prelaunch laboratory measurements which establishes this absolute value.
4. In addition to the systematic bias, a radiometric biases on the order of -2% in M5 & M7 bias relative to Suomi NPP VIIRS is confirmed based on all studies up to date. It is believed that NOAA-20 VIIRS M5 and M7 radiometric values are more accurate than those for Suomi NPP as previously found.
5. Sync loss between the half angle mirror and the rotating telescope continues to cause data outages for approximately 2 minutes during each event, which occurs approximately every two weeks.
6. The solar model used for NOAA-20 VIIRS is based on the Thuilliur 2002, which is different from the one used for Suomi NPP. This can cause radiometric biases when comparisons are made in radiances, although it has no impact on reflectance based comparisons if done properly (Cao et al. 2013, JGR).

5. Path forward

The team will continue support the operational calibration/validation of NOAA-20 VIIRS with the following activities:

1. Continued monthly Lunar calibration
2. Continued DNB straylight LUT development:
    a. Require monthly update of DNB straylight correction LUT;
    b. 12 LUTs (month by month) will be developed during the first year on orbit
3. Continued vicarious monitoring using DCC, cal/val sites, and geolocation
4. SDSM uncertainty reduction: continue characterize based on seasonal data using various methods to reduce uncertainties.
5. WUCD reduction (from quarterly to once per year)
6. Possible field campaign: VIIRS DNB SI traceable calibration in collaboration with SDSU and USGS calibration center. Leverage light source developed under NOAA SBIR;
7. Other studies (see presentation slides).

Additional information is available in the VIIRS Algorithm Theoretical Basis Document (ATBD) and provisional maturity review briefing, which can be accessed at:

https://www.star.nesdis.noaa.gov/jpss/Docs.php

Read-me for Data Users

NOAA-20 VIIRS Spectral Response Function (SRF) Dataset:

https://ncc.nesdis.noaa.gov/NOAA-20/J1VIIRS_NOAA20_SpectralResponseFunctions.php

NOAA-20 VIIRS near real time status and performance monitoring web page is available at the following URL at:

https://www.star.nesdis.noaa.gov/icvs/status_N20_VIIRS.php

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