**MEMORANDUM FOR:** The Record

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**SUBJECT:** NPP VIIRS SDR beta status and public release

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The successful launch of the Suomi National Partnership Program (SNPP) Spacecraft on Oct. 28, 2011 with the Visible Infrared Imaging Radiometer Suite (VIIRS) ushers in a new generation of capabilities for operational environmental remote sensing for weather, climate, ocean, and other environmental applications. VIIRS succeeds the NOAA AVHRR and NASA EOS MODIS with 22 spectral bands covering wavelengths from 0.41 to 12.5m, providing data for the production of 22 Environmental Data Records (EDRs) with its calibrated and geolocated Sensor Data Record (SDRs).

VIIRS significantly outperforms the legacy AVHRR in spatial, spectral, and radiometric areas by design. The 22 spectral bands in the visible, near-infrared, mid-infrared, and long-wave infrared regions of the electromagnetic spectrum are acquired at two spatial resolutions: 375 m for imagery bands, and 750 m at nadir for moderate resolution radiometry bands. The VIIRS design has sophisticated spatial sampling that controls the pixel growth from nadir to end of the scan using a pixel aggregation strategy and manages data compression with several strategies including the so-called “bow-tie” removal. Bow-tie deletion creates the visual artifact and impression that part of the scan-line is missing when the data are plotted in the pixel based “raster scan” space but in fact the data show continuity when plotted with a map projection, because the deleted portion is redundant in geographic space. Similar to MODIS, VIIRS has onboard calibration devices for all bands to ensure the accuracy and stability of the measurements, except that VIIRS does not have the on-board capability for spectral calibration that is provided to the MODIS in the Spectro-Radiometric Calibration Assembly. VIIRS not only outperforms MODIS in geospatial sampling for the radiometry bands, but also provides high spatial resolution infrared imagery of 370 m compared to the 1km resolution in MODIS, including an imaging band for the short-wave, mid-wave and long-wave infrared bands.. Finally, the VIIRS Day Night Band (DNB) is a unique capability for night time environmental applications with 750m spatial resolution. More information about VIIRS can be found at the following VIIRS websites: <http://www.star.nesdis.noaa.gov/jpss/VIIRS.php>, and <https://cs.star.nesdis.noaa.gov/NCC/VIIRS>, where users can find the user’s guide, algorithm theoretical basis documents (ATBD), instrument performance data on-orbit, sample codes to read the VIIRS SDR data, conference presentations, and image gallery, etc.. Finally, a wealth of information on VIIRS is stored in the CasaNosa portal, accessible to the VIIRS SDR/EDR team members.

Following a series of spacecraft and sensor activation and checkouts, the first VIIRS image was acquired on November 21, 2011, and all 22 VIIRS bands are producing early images by January 20, 2012. Since launch, the VIIRS Sensor Data Record (SDR, or the Level 1B equivalent) calibration/validation has been progressing well. A team of experts from NOAA, NASA, Aerospace, University of Wisconsin, MIT/Lincoln lab, and industry partners Northrop Grumman and Raytheon have worked intensively and performed a thorough evaluation of the VIIRS on-orbit performance with 58 cal/val tasks.

On April 5, 2012, a VIIRS SDR Review Meeting was held at the World Weather Building in Camp Springs, Maryland, hosted by NOAA/NESDIS/STAR. The Review had more than 60 attendees including SNPP/JPSS VIIRS SDR Team members, Program and Project Scientists, Joint Center for Satellite Data Assimilation, and representatives from Numerical Weather Prediction (NWP) Centers, and NRL. The purpose of this meeting was to assess the readiness of the VIIRS SDR data product maturity level to be declared “Beta” by the Algorithm Executive Review Board (AERB).

The VIIRS SDR team members presented progress on the 58 cal/val tasks, and EDR users also offered their independent assessments of data product quality based on their early analyses. A total of 15 presentations were made. Through interactions with the data product users, the SDR chairs and team collected feedback on recommended VIIRS SDR product improvements. The discussion provided an overview of the overall performance of the VIIRS instrument and algorithms as known at this time.

After a thorough review, the VIIRS SDR team, EDR users, and the review panel members reached consensus that although the level of maturity differs in difference aspects, the VIIRS SDR product overall has reached beta status and therefore is recommended to be approved by the AERB, and be made available to the public through CLASS from the point that Beta status is declared onward. Release of pre-Beta VIIRS SDR data should remain restricted to verified users.

At the same time, data users should be aware that the VIIRS SDR team is working hard to address several issues in order to achieve the next milestone of “provisional status”. These issues include:

1. The larger than expected instrument responsivity degradation centered near the 0.86 um band (primarily in bands M7, M6, M5, M8, I2, and I1): After a thorough investigation by the SNPP Anomaly Resolution Team (ART), it was concluded that this is due to the scan mirror contamination with tungsten and tungsten oxide or other coating error in the manufacturing process and subsequent on-orbit ultraviolet (UV) exposure which leads to the mirror darkening in those spectral bands. The VIIRS SDR team has developed a strategy to mitigate the effects of this degradation through more frequent update of the calibration lookup tables (LUT). A weekly LUT update is currently implemented which significantly reduces the impact of degradation but with a residual effect of 0.8% between weekly updates. A dynamic gain adjustment based on SD gain tracking on each orbit for solar reflected band s is currently being investigated. This will eliminate the calibration shift. The degradation is being closely monitored. Based on early studies, the current calibration update scheme makes the degradation impact negligible for most EDR products, except for more calibration sensitive products such as ocean color. It is also estimated that the signal to noise ratio for all bands should still meet the specification by end of the mission, according to model predictions by the instrument vendor.
2. A-side vs. B-side electronics calibration differences: it is known that the B-side was better characterized and analyzed prelaunch than the A-side, and therefore the B-side is preferred for routine use. However, we find that the electronics B-side is having minor difficulties with 1394 communications interface and Spacecraft Computer anomalies. The Flight Project currently is assessing whether the A-side may be more stable for these performance matters, and so it is possible that VIIRS will be transitioned to the electronics A-side of the system at some time to test this hypothesis. The current VIIRS SDR “Beta” status is based on the B-side calibration and if the electronics side is switched to the A-side, then the ‘Beta Quality’ indicator will be removed until the data quality for the A\_side is verified to be Beat Quality..
3. M6 band radiance saturation and “fold-over”: during the postlaunch cal/val, it was found that when the M6 band saturates (Lsat), and scenes were observed with M6 radiance greater than Lsat, then the digital signal values would start to decrease with increased radiances. This situation creates the impression that the radiance is less than Lsat. While the impact of this behavior should be small because M6 is used for atmospheric correction for ocean color with low radiances, the saturated pixels are not flagged and users are advised to handle the data accordingly based on the radiance/reflectance values. Very high radiance values in M7 is one indicator that the M6 value may be the result for fold-over.
4. Early VIIRS SDR data: It is recommended that VIIRS SDR data before Feb. 6, 2012 should not be used for quantitative analysis due to issues with the LUT used in the ground processing system. Reprocessing of the all data before the implementation of the SD-based dynamic gain adjustments may be needed in the future if these data are to be used for research purposes.
5. Striping in some VIIRS bands: It is known that striping occurs in several VIIRS bands especially over uniform scenes. However, the magnitude of striping is either comparable or less than that of the MODIS. Residual effects of striping are currently being studied by the VIIRS SDR team.
6. Instrument and spacecraft maneuvers and tests: User’s should be aware that maneuvers and special tests are still being performed to VIIRS to better characterize instrument performance. These include but not limited to, the monthly lunar maneuver, blackbody WarmUp CoolDown (WUCD) tests quarterly. During such events, the data may not be optimal. Data users are encouraged to contact the VIIRS SDR team if any related issues arise.
7. Aerospace has tested a witness sample for the VIIRS NPP telescope mirrors and finds a UV exposure spectral degradation that has similar signal degradation rate to what we see in the VIIRS gain reduction observations using the solar diffuser. [See a) above for the description of the on-orbit behavior.] We advise our users that one hypothesis for this anomalous degradation is to treat this degradation as exclusively due to changes in sensor spectral throughput. We still are at work to correlate the Aerospace test data to the SD on-orbit observations. Users are encouraged to assess the differences in potential errors for their products when they use the at-launch (pristine) RSRs rather than the anomaly-degraded RSRs for their products, and we will provide further guidance in how to handle evolving RSRs for those users wishing to test their EDR performance against this hypothesis.

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