Joint Polar Satellite System (JPSS) Calibration/Validation Plan for Imagery Product

Version 2.0

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LIST OF ACRONYMS

ATBD	Algorithm Theoretical Basis Document
AVHRR	Advanced Very High Resolution Radiometer
AWIPS	Advanced Weather Information Processing System
CIRA	Cooperative Institute for Research in the Atmosphere
CLASS	Comprehensive Large Array-data Stewardship System
CSPP	Community Satellite Process Package
DNB	Day Night Band
EDR	Environmental Data Record
EOC	Early Orbit Checkout
GRAVITE	Government Resource for Algorithm Verification Independent Testing and Evaluation
GTM	Ground Track Mercator
ICVS	Intensive Calibration/Validation System
IDL	Interactive Data Language
IDPS	Interface Data Processing Segment
IPOPP	International Polar Orbiting Processing Package
JPSS	Joint Polar Satellite System
KPP	Key Performance Parameter
L1RD	Level 1 Requirements Document
L1RDS	Level 1 Requirements Document SUPPLEMENT
LTM	Long Term Monitoring
LUT	Look Up Table
LWIR	Longwave InfraRed
McIDAS	Man-computer Interactive Data Access System
MODIS	Moderate Resolution Imaging Spectroradiometer
MWIR	Medium-wave InfraRed
NCC	Near Constant Contrast
NEIC	National Environmental Information Center
NHC	National Hurricane Center
NIC	National Ice Center
NIR	Near InfraRed
NWP	Numerical Weather Prediction
OLS	Operational Line Scanner
PLT	Post-Launch Test
RGB	Red, Green, Blue
S-NPP	Suomi National Polar Orbiting Partnership
SDR	Sensor Data Record
SWIR	Shortwave InfraRed
VIIRS	Visible Infrared Imaging Radiometer Suite

1. OBJECTIVE

1.1. Purpose of this Document

This Product Calibration/Validation Plan document provides a description of how the *Imagery product* will be validated during the pre-launch and post-launch phases of the JPSS program.

1.2. Specific Objectives

The objective of the product validation plan is to describe, in as much detail as possible, how the Imagery products specified in the JPSS Program Level 1 Requirements Document (L1RD) and L1RD SUPPLEMENT (L1RDS) will be evaluated and validated. It will describe the validation methodologies undertaken to establish the scientific validity of the product, the required datasets, and how accuracy and precision specifications will be confirmed. During the pre-launch phase of the JPSS-1 program, the validation activities are aimed at characterizing uncertainties of the sensors and data products (derived from instrument proxy and/or simulated data, S-NPP) resulting from parameterizations and algorithmic implementation artifacts. During the post-launch phase of the JPSS-1 program, the emphasis will be on characterizing the performance of the products (derived from real on-orbit instrument data) as well as identifying and making necessary product algorithm refinements. This document will also provide schedules/milestones of calibration/validation activities to be performed for the JPSS Program.

1.3. Scope of Document

This document outlines the plans for validation of the Imagery products during the pre-launch phase (current time up to time of launch) and post-launch phase (time of launch out to the life of the sensor) of the JPSS-1 program. It describes the validation approach and identifies correlative datasets, including those from known/planned community field campaigns or dedicated JPSS field campaigns, which will or could be used to validate the products.

1.4. Related Documents

List of related documents:

VIIRS Imagery Products Algorithm Theoretical Basis Document (ATBD)
JPSS Program Level 1 Requirements Document (L1RD)
JPSS Program Level 1 Requirements Document SUPPLEMENT (L1RDS)
S-NPP Cal Val Plans
S-NPP Cal Val OpsCons

1.5. Revision History

List all revisions of this document, including author of revision, description of revision, motivation for revision, and revision number and date.

Table 1. Revision History

Version	Author	Description	Revised Sections	Date
1.0	Don Hillger, Thomas Kopp	First draft		2015-06-30
2.0	Don Hillger, Thomas Kopp	Second draft after feedback from initial reviewers	2.1 2.2 2.3 3.1 3.2.1 3.2.2 3.3.2 3.3.3 3.3.4 3.5 4.1 4.2.1	2015-11-10 and 2015-12-15

2. PRODUCT DESCRIPTION

2.1. Product Overview

The Visible Infrared Imaging Radiometer Suite (VIIRS) Imagery Environmental Data Record (EDR) is comprised of three different sets of Imagery products. These are five Imaging or I-band Imagery products, six Moderate or M-band Imagery products, and the Near Constant Contrast (NCC) Imagery derived from the Day Night Band (DNB). Each of these is placed on a Ground Track Mercator (GTM) projection, the I-band with 375 m resolution and the others at 750 m resolution. Details on the GTM method may be found in the VIIRS Imagery Products Algorithm Theoretical Basis Document (ATBD). This document and others related to VIIRS products may be found at: http://www.star.nesdis.noaa.gov/jpss/Docs.php#S325275.

The VIIRS Imagery EDR benefits from the many programs which preceded it, and many of the bands chosen to be created as Imagery products were based on heritage from such sensors as the Moderate Resolution Imaging Spectroradiometer (MODIS), the Advanced Very High Resolution Radiometer (AVHRR), and the Operational Line Scanner (OLS). Details on the bands transformed into Imagery Products by the JPSS ground system are shown in Tables 1 and 2 below. The products in Table 1 are explicitly spelled out in the L1RD, the ones in Table 2 are all of the remaining Imagery products created at present.

Table 2. Required Imagery EDR Products

Imagery EDR Product	VIIRS Band	Wavelength (µm)	Spatial Resolution Nadir (km)/Edge-of-Scan (km)
Daytime Visible	I1	0.60 – 0.68	0.4/0.8
Short Wave IR (SWIR)	I3	1.58 – 1.64	0.4/0.8
Mid-Wave IR (MWIR)	I4	3.55 – 3.93	0.4/0.8
Long-Wave IR (LWIR)	I5	10.5 – 12.4	0.4/0.8
LWIR	M14	8.4 – 8.7	0.8/1.6
LWIR	M15	10.263 – 11.263	0.8/1.6
LWIR	M16	11.538 – 12.488	0.8/1.6
NCC	DNB	0.5 – 0.9	0.8/1.6

Table 3. Other IDPS-generated Imagery EDR Products

Imagery EDR Product	VIIRS Band	Wavelength (µm)	Spatial Resolution Nadir (km)/Edge-of-Scan (km)
Near Infrared (NIR)	I2	0.846 – 0.885	0.4/0.8
Visual	M1	0.402 – 0.422	0.8/1.6
Visual	M4	0.545 – 0.565	0.8/1.6
SWIR	M9	1.371 – 1.386	0.8/1.6

The Imagery products shown in Table 2 were driven by the needs in the Alaskan weather theatre, and are Key Performance Parameters (KPP) in the L1RD. Since no geostationary satellite properly covers the Alaskan region, their dependency on polar-orbiting products in much greater than any other United States location. Bands I1, I4, and I5 are the basic building blocks for standard Imagery applications in the visual, MWIR, and LWIR portions of the radiative spectrum. The other three moderate band images are LWIR bands that assist in locating clouds and in determining their composition (water or ice).

In August 2015 NOAA decided to include two additional bands as KPPs. These two bands are I3 and NCC. NCC Imagery has found widespread use across NOAA and the NWS. NCC is capable of providing visual images at night, even under no moon conditions. While the quality varies with the amount of moonlight, NCC has proven useful at night in locating clouds, ice edge, snow cover, tropical cyclone centers (eyes), fires and gas flares, lightning, and dust storms. I3 is very effective at discriminating snow and ice from clouds and locating ice edges during the day.

Of the remaining bands, use may vary with the location of the atmospheric and ground features of interest to that particular location. Band I2 compliments band I1 in the visual spectrum. Both bands M1 and M4 assist in the creation of “false color” Imagery, while band M9 is superior to any other at identifying thin cirrus.

Although the above list encompasses all of the Imagery products created by the Ground System, many derived products use the Sensor Data Records (SDR) and create their own Imagery, using any of the 22 bands provided by VIIRS. The Imagery Cal/Val team is aware of many of these efforts, and will work with these users to insure any Imagery derived from VIIRS is of operational quality. (DNB radiances in particular are heavily used in quantitative applications.)

2.2. Product Requirements

There is a single component of the VIIRS Imagery products that is considered a KPP. The KPP itself reads as follows:

“VIIRS Imagery EDR at 0.64 µm (I1), 1.61 µm (I3), 3.74 µm (I4), 11.45 µm (I5), 8.55 µm (M14), 10.763 µm (M15), 12.03 µm (M16), and Near Constant Contrast EDR for latitudes greater than 60^0N in the Alaskan region”

There is no other provided detail on how to prove that has been achieved. Nevertheless any Cal/Val effort must emphasize that the KPP has been met. The overarching view taken by Cal/Val is that the requirements below must be met first and foremost by the bands noted above in the Alaskan region. Furthermore the application of this Imagery, which the Alaskan region has experience with via Imagery from the Suomi National Polar-orbiting Partnership (S-NPP), must meet the user’s expectations as exemplified by their experience with S-NPP.

The requirements for Imagery as stated in the L1RD-S are in Table 4.

Table 4. Product Requirements

Attribute	Threshold	Objective
1. The Imagery EDR shall be delivered under all weather conditions, including any rain rate		
a. Horizontal Spatial Resolution for visible and IR Imagery bands		
1. Nadir	0.4 km	0.1 km
2. Edge of Swath	0.8 km	0.1 km
3. Night-time visual, Nadir	2.6 km	0.65 km
b. Horizontal Spatial Resolution for moderate resolution bands		
1. Nadir	0.8 km	NS*
2. Edge of Swath	1.6 km	NS*
c. Mapping Uncertainty		
1. Nadir	1 km	NS*
2. Edge of Swath	3 km	0.5 km
3. Night-time visual, Nadir	TBS*	1 km
d. Refresh for Visible and IR bands	At least 90% coverage of the globe every 12 hours	NS*

*TBS = To Be Supplied, NS = Not supplied

A careful reader will note while there are spatial resolution requirements, there are no requirements that specifically address the quality of the EDR Imagery products. Nevertheless that is a critical aspect to Imagery which makes it an important consideration in the Cal/Val process. Ultimately, it is the users who decide if the quality of the Imagery is acceptable, and as such including the users in the Cal/Val process for Imagery is a key consideration in the strategy for Imagery validation, as discussed next section.

2.3. Product Examples

A limited number of VIIRS images are presented, merely to represent the types of Imagery products that VIIRS is capable of producing. Many of the individual VIIRS bands (both I and M bands) can be combined in various ways. One general category of product are RGB composite images, of which true-color imagery is just one type of RGB. Another common RGB product is natural-color imagery, a term made popular with Meteosat imagery. Figure 1 is an example of a VIIRS I-band (375 m resolution) natural-color RGB composite, of a hurricane to the east of the Hawaiian Islands. Ice clouds are predominantly in cyan and vegetated land surfaces are green.

An example of a VIIRS DNB/NCC pair is given in Figure 2, showing not only the mapping of the DNB imagery into the GTM grid, but the change from DNB radiances to NCC pseudo-albedos. NCC imagery changes the wide range of DNB radiances (up to 7 orders of magnitude) into a much smaller range of NCC pseudo-albedos (up to 3 orders of magnitude) even though the lighting changes from moonlight on the dark side of the day/night terminator, to solar illumination on the day side of the terminator. Note that cloud details are easily seen in the NCC image that are dark in the DNB image.

Many more examples of VIIRS Imagery can be found in the following published literature (Hillger et al 2013, Hillger et al 2015).

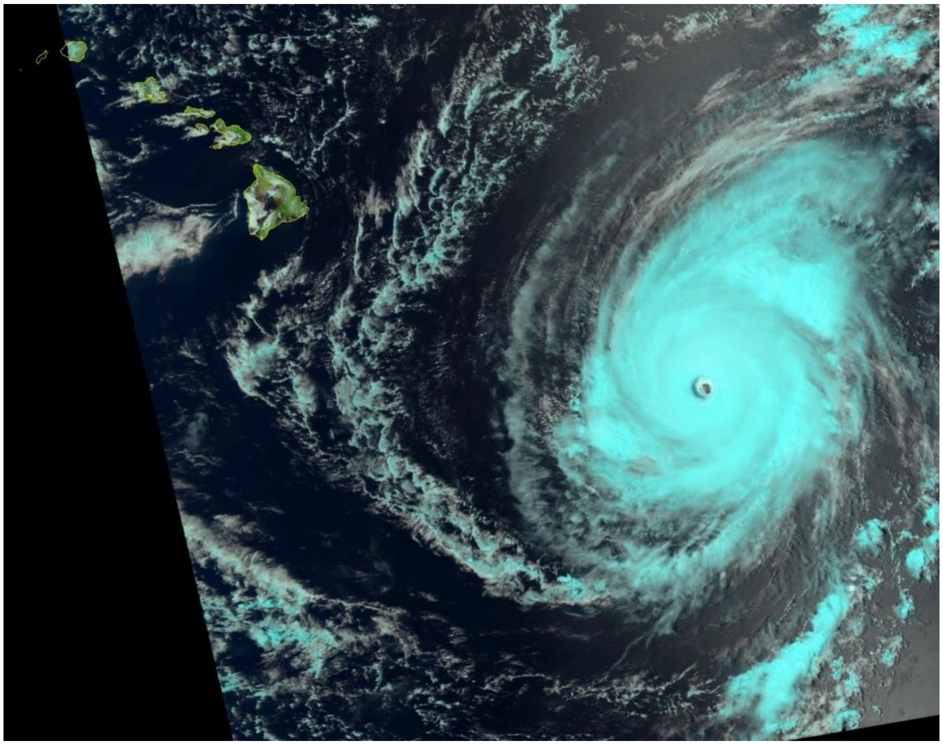

Figure 1. A VIIRS natural-color RGB composite image that assigns the VIIRS I3 (1.61 µm) band to the red component, the I2 (0.86 µm) band to the green component, and the I1 (0.64 µm) band to the blue component. The image shows Hurricane Ignacio as a Category 4 hurricane approaching Hawaii on 29 August 2015 at 2248 UTC.

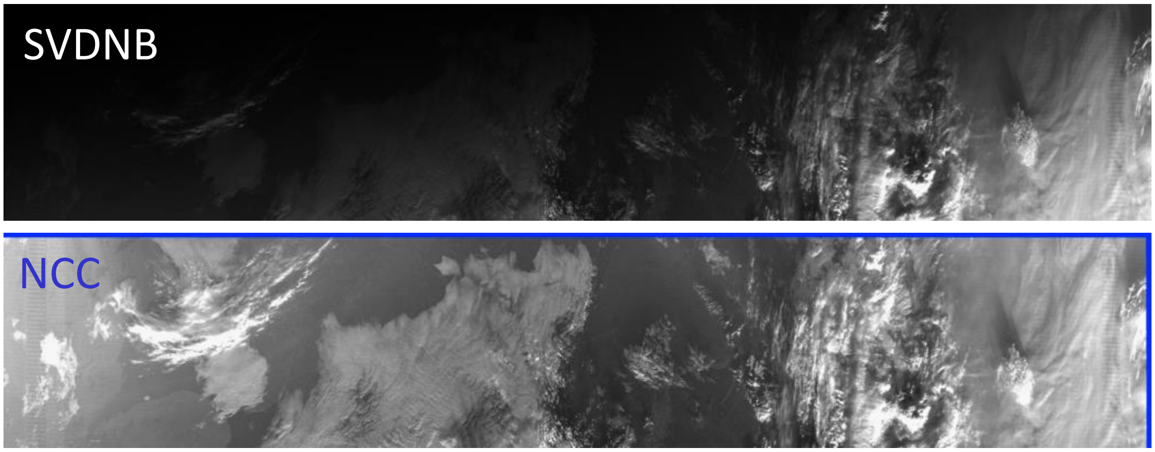

Figure 2. Examples of (SDR) DNB Imagery (top) and (EDR) NCC Imagery (bottom) derived from DNB. NCC Imagery is more useful than DNB for cases that cross the day/night terminator such as this. The NCC pseudo-albedos allow users to view cloud and surface features across wide variations in solar or lunar illumination. Fill values on the edges of the GTM grid are highlighted in blue.

3. CALIBRATION/VALIDATION STRATEGY

3.1. Calibration/Validation Overview

3.1.1. Cal/Val methodology/strategy

The overall strategy for the Imagery Cal/Val effort is to validate the Imagery is of suitable quality for operational use. Many of the explicit requirements in Table 3 are met by the use of the GTM projection, whose resolution is 400 m for the I-bands and 800 m for all of the others, independent of the satellite zenith angle of the input SDR, and hence independent of the actual sensor resolution as it increases from nadir to the edge of the scan. Put another way, the resolution of GTM is constant from nadir to edge-of-scan. Refresh is driven by the orbit and not dependent on any component of the Imagery algorithm. Mapping accuracy will be worked in coordination with the VIIRS SDR team.

Insuring the Imagery is of sufficient quality is driven by the ability of a human user to easily locate atmospheric and ground features of interest. Such features include clouds and their type, especially convection and low clouds/fog, ice edge, volcanic eruptions, tropical cyclone analysis, and dust storms. In many of these cases it takes multi-spectral imagery to best identify what exists over a given location, but the bands necessary are already known. Those band combinations available via the VIIRS Imagery product will be analyzed to determine they appropriately can be used to locate the items noted above, considering both single and multi-spectral applications as appropriate.

Both single and multi-spectral images will also be analyzed to look for artifacts such as striping, banding, noise, and collocation differences between bands that may blur a multi-spectral image. In many of these cases the root cause lies with the sensor, and our results will be shared with the SDR team as needed.

Because Imagery is a KPP, it also is required to meet "Minimum Mission Success" in the Post Launch Test (PLT) time frame. This time frame ends at launch +85 days (L +85). The objective of the Imagery Cal/Val team is to show Imagery indeed meets the KPP criteria at L +85, with the caveat that the limited time frame and season may limit the completeness of the Alaskan data set. For example, if the L +85 period is primarily in the Northern Hemisphere winter, little visual data (Imagery) would be available to analyze north of 60^0N latitude. Furthermore, certain key atmospheric events that drove the KPP for Alaska, such as volcanic ash, may not occur in the PLT time frame over Alaska. In these cases, the Imagery team will use appropriate Imagery from other locations to show JPSS-1 Imagery products will be sufficient or better for any and all potential uses in the Alaskan region. Such use of alternative locations where necessary will complement the images over Alaska itself, and will be adequate to show JPSS-1 Imagery attains Minimum Mission Success.

3.1.2. Cal/Val Tools

There are many tools available that are designed to exploit the Imagery from S-NPP that are equally applicable to use with JPSS. The primary tools for the JPSS effort by the Cal/Val team are the Man-computer Interactive Data Access System (McIDAS), along with Terrascan and display tools built from the Interactive Data Language (IDL). IDL-based Imagery tools exist at both the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University, Fort Collins CO, and at the Aerospace Corporation's field office in Omaha, Nebraska. Each of these will be used during the Cal/Val process for Imagery. The primary operational user, the NWS, has built display tools on the Advanced Weather Information Processing System (AWIPS). Special emphasis will be given to the Alaskan NWS given the definition of the KPP. Field terminals may display Imagery using with the Community Satellite Process Package (CSPP) or the International Polar Orbiting Processing Package (IPOPP). Feedback from these displays will also be considered during validation.

3.2. Pre-Launch Calibration/Validation

3.2.1. Proxy and Simulated Instrument Data

The primary source of pre-launch data for JPSS will be proxy data from S-NPP. Since the format of the input SDR, with the exception of the DNB, does not change, and neither does the format of the output, using proxy data is sufficient to exercise the Imagery algorithm pre-launch. Simulated data, outside of the DNB, would only be of use if it was known *a priori* of major differences in the radiances of the SDRs. There is ongoing discussion if that is the case of I3, where there is a known bad detector, but all other bands may reliably use S-NPP data as proxy data for JPSS-1.

Regarding the DNB, it is known the aggregation scheme regarding geolocation will change with JPSS-1, such that nadir will displaced from the center of the DNB SDR array and that "extended scenes" will exist on one side of the DNB, as in Figure 3. The Imagery team worked extensively with simulated DNB SDR data, as it would be constructed with JPSS-1, during October 2015, and proved the NCC Imagery correctly handles both. Nadir is located in the center of the NCC display, while the extended scene component is truncated. With the completion of this testing, no further proxy or simulated DNB data is needed regarding the validation of NCC Imagery.

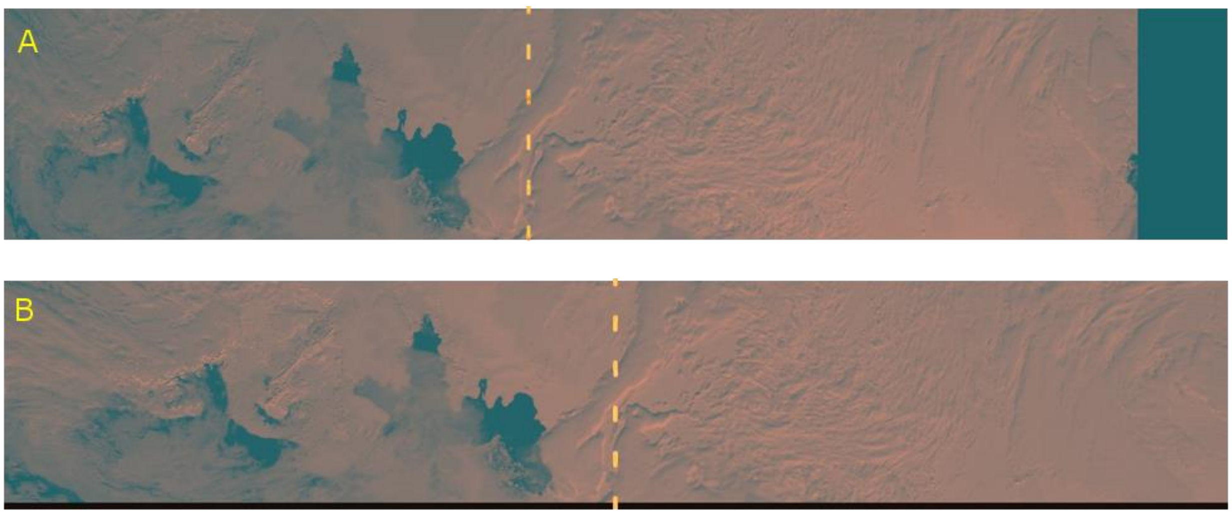

Figure 3. (a) DNB from S-NPP used to display how DNB will look from JPSS-1, with the blue area on the right filled with extended scene imagery (currently missing in this simulation); (b) The DNB remapped into the GTM mapping used for NCC, showing that the NCC shifts the DNB imagery to the right, placing nadir at the center and ignoring the extended scene data on the right. In each image, the dashed line shows the approximate location of nadir.

3.2.2. Algorithm Evaluation and Characterization

The Imagery algorithm is not expected to evolve between S-NPP and JPSS. The fundamental method of creating the GTM projection works without modification for the Imagery derived from the VIIRS sensor for both S-NPP and JPSS. This holds true even for the NCC Imagery and the changes in the DNB SDR geolocation. The only Look-Up Tables (LUT) used for Imagery are tied to the NCC Imagery product. These LUTs are not expected to require updating for JPSS, however the Imagery Cal/Val team plans to perform an exercise of updating these LUTs pre-launch in case the post-launch characterization of the JPSS DNB results indicates an update to these LUTs is required. Note the Imagery algorithm itself does not need to be characterized, but Imagery does need to be aware of major characterization differences in the SDRs between S-NPP and JPSS, as those may manifest themselves in the Imagery products.

3.2.3. Product Calibration/Validation Tool Development

All tools necessary for the evaluation of Imagery from JPSS have been completed. No additional validation of these tools is necessary. As noted above, the output of the Imagery EDR will not change in format between S-NPP and JPSS. Any tool that operates with S-NPP based Imagery will work for JPSS, and those tools have already completed their development.

3.3. Post-Launch Calibration/Validation

3.3.1. Early Orbit Checkout Phase

During early orbit and checkout Imagery products will be created as soon as the SDRs are activated. Visual bands are expected first, with IR bands following approximately 30 days later. Since the SDRs themselves are still being calibrated, early looks at Imagery will be confined to the Cal/Val team, with the goal of providing useful feedback to the VIIRS SDR team. This initial data will be retrieved from the Government Resource for Algorithm Verification Independent Testing and Evaluation (GRAVITE) and/or the Comprehensive Large Array-data Stewardship System (CLASS), as the VIIRS data on JPSS will not be available via operational paths during early orbit and checkout.

3.3.2. Intensive Calibration/Validation Phase

There are two fundamental aspects for Imagery in the intensive Cal/Val phase. First and foremost is establishing **beta** and, approximately 30 days later, **provisional** status for the Imagery products. The Imagery team will work with the SDR team to verify those requirements to Imagery that are tied to the SDR (e.g. mapping accuracy/refresh). The spatial resolution of the Imagery EDR is tied to the GTM projection, and is straightforward to verify.

However, as noted earlier, Imagery can only pass through its verification stages as users agree it is of operational quality. Hence the second component is a combination of Imagery Cal/Val team and operational users performing analysis on the Imagery itself. Because JPSS will fly in relatively close orbit to S-NPP, comparing the Imagery produced by both is an overall effective way to show how well JPSS based Imagery is performing, as Imagery from S-NPP is already employed by many users. Initially the primary user is the NWS in Alaska, and they will have a direct say in determining when **provisional** has been reached. The Imagery team will perform detailed analysis of single and multi-spectral Imagery to determine the presence of striping, banding, noise, and any blurring from substandard spatial correlation between bands. Band combinations used explicitly for clouds and cloud types, ice clouds, snow/ice on the surface, and dust storms will be especially emphasized. The Alaskan NWS will evaluate the Imagery for suitability for their operations, as they define operations. Once the Imagery is past **provisional** other users will be brought into the analysis to accomplish the **validated** maturity level, approximately 6 months later.

The analysis of NCC Imagery is a special case. Due to its unique nature, its extensive use for multiple purposes, and the known changes in the DNB SDR aggregation scheme, additional analysis and attention is warranted. Given its use for such features as ice edge at night and tropical cyclone fixing, bringing in additional users such as the National Hurricane Center (NHC) and the National Ice Center (NIC) is appropriate. Imagery Team members with additional expertise at CIRA and the National Environmental Information Center (NEIC) will evaluate NCC for glare issues and specialized applications such as gas flares, fishing boats, and auroras. In this manner the Imagery team will be able to give a comprehensive report on the performance of NCC that encompasses its many applications already in use through S-NPP.

3.3.3. Long Term Monitoring Phase

Long term monitoring of Imagery depends primarily on the monitoring of the input SDRs. It also must include communication channels for all users, who at any time may spot an odd artifact. There are no quantitative measures that specifically may be used to track Imagery "errors". Hence long term monitoring stays focused on the quality of the product as determined qualitatively by its users. NCC will be monitored by the Imagery team for the potential to update its related LUTs, though such an update has proven unnecessary for the NCC produced with the DNB SDR from S-NPP. As Imagery is a qualitative product, and is not used as a climate parameter, its' validation has no need for reprocessing of any data from VIIRS.

3.3.4. Algorithm Refinements

No refinements are expected, as the GTM projection is simply a method used to present Imagery is a uniform manner. If the JPSS program desired to change this projection, it would be the job of the Imagery team to accomplish that, however that is far more than a "refinement". It is possible if striping or issues with the DNB and/or I3 could not be addressed by the SDR team such issues would be passed to the Imagery team. This has not happened with S-NPP, but if it occurred with JPSS we would correct them as needed. The details would depend upon the problem being resolved, but (as an example) de-striping techniques are well understood and the Imagery team would then test the appropriate options and work through the JPSS algorithm change process to implement the optimal correction as needed.

3.4. Correlative Data Sources

3.4.1. Ground-based Measurements

Because Imagery is used in a qualitative manner, no ground based measurements are employed for the validation of Imagery.

3.4.2. Satellite Derived Products

The Imagery EDR requires only the related SDRs and, for NCC, various LUTs that are created offline. Therefore no "satellite derived" products from JPSS are necessary. Because JPSS will be in close orbit to S-NPP, the Imagery from one may be compared to the Imagery created by the other. That is the only "satellite derived" product required for Imagery validation.

3.4.3. Field Campaign Measurements

Imagery may be used to support certain field campaigns but actual validation of the Imagery EDR does not require field campaign output.

3.4.4. Numerical Weather Prediction Forecast/Analysis Fields

There are no Numerical Weather Prediction (NWP) products used in the Imagery algorithm, nor is any needed for its validation. While historically synthetic Imagery may be produced from NWP output, the use of S-NPP as proxy data negates the need for such synthetic data in this case.

3.4.5. Special Collections

No special collections are necessary to validate Imagery.

3.5. Challenges

There are three challenges tied to the validation of Imagery, in no particular order they are: 1) no requirements reflect the need for quality Imagery or what it is supposed to accomplish; 2) it is the users (not the program) that understand best how Imagery is employed; and 3) the DNB and potentially I3 SDR characteristics will be different for JPSS than for S-NPP.

The first two challenges are addressed in the same manner; that is bringing into the Imagery Cal/Val process a combination of experts and users such that errors are properly identified and that the Imagery product is suitable for operational use. Imagery is the first product that will draw attention from both upper-level managers who wish to "see" JPSS and from users whose first impression will be based on the Imagery they can obtain. It is incumbent on the program to capture quickly any artifacts that detract from effective Imagery and an analysis that can identify what requires correction. There are high expectations from JPSS, as S-NPP has provided excellent and well-regarded Imagery around the world. Much of this is mitigated during the SDR calibration pre-launch, and as of October 2015 there are no signs (other than the DNB, see below) the Imagery will not retain the same quality for JPSS. But it must be recognized the success of the Imagery from S-NPP results in high expectations from JPSS; that may prove difficult to meet.

And that challenge is greatest for NCC. The Imagery produced from the DNB has modified the use of Imagery from NOAA systems. Uses never before possible from any NOAA weather satellite have been revolutionized by the DNB, the first ever radiometer capable of producing useful Imagery at night. This plan has already written about its applications, but in the case of NCC a known issue has developed with the DNB on JPSS that does not exist for S-NPP. The resolution of the input DNB SDR will not be what it is for S-NPP, unlike S-NPP it will noticeably degrade towards the edge of the scan, with unclear consequences. The noise characteristics are expected to be different as well. While the Imagery algorithm itself will handle the format differences between S-NPP and JPSS, something already proven using proxy and simulated DNB SDRs from S-NPP, its output will reflect any issues present in the input. It will take the combined efforts of the VIIRS SDR team and the Imagery team to adequately address any negative consequences, if any, from these differences. However the program should be prepared to address user concerns if the quality of the JPSS DNB-derived Imagery cannot achieve the same quality available via S-NPP. Because there are no quality requirements, the guiding principle will be for JPSS retain the same capability as S-NPP, but in the case of the DNB that may prove impossible.

4. SCHEDULES AND MILESTONES

4.1. Cal/Val Maturity Timeline

Beta/Provisional/Validated Maturity Timeline (KPP Imagery EDRs):
Beta at Launch plus 70 days
Provisional at L + 90 days (Minimum Mission Success Criteria)
Validated at L + 9 months

Schedule for Beta/Provisional/Validated Maturity Readiness Review (KPP Imagery EDRs):
Beta at L + 75 days
Provisional L + 90 days (Minimum Mission Success Criteria)
Validated at L + 10 months

Beta/Provisional/Validated Maturity Timeline (non-KPP Imagery EDRs):
Beta at Launch plus 5 months (L + 5)
Provisional at L + 6 months
Validated at L + 12 months (one year data analysis)

Schedule for Beta/Provisional/Validated Maturity Readiness Review (non-KPP Imagery EDRs):
Beta at L + 6 months
Provisional L + 7 months
Validated at L + 14 months

4.2. Pre-Launch Activities/Milestones

Pre-launch cal/val schedule: tasks/activities, deliverables, and timeline.

4.2.1. Year 1 (2015)

Work with the VIIRS SDR team to determine the impacts of the DNB SDR aggregation change to the NCC Imagery EDR. Much of this work was accomplished in October 2015.

4.2.2. Year 2 (2016)

Run a test of the update process for the LUTs required by the NCC Imagery, so that the process is well understood and may be run efficiently should an update for JPSS be required (August 2016).

4.3. Post-Launch Activities/Milestones

Post-launch cal/val schedule: tasks/activities, deliverables, and timeline.

4.3.1. Year 3 (2017, EOC to ICV)

Long term monitoring will continue through online displays of realtime VIIRS Imagery and image products. Some of the products may be transitioned to StAR's Intensive Calibration/Validation System (ICVS) developed for satellites operated by NOAA. For VIIRS selected VIIRS SDR and EDR products are already on display (http://www.star.nesdis.noaa.gov/icvs/status_NPP_VIIRS.php).

NWS users will be better served via increased VIIRS availability to AWIPS sites, including VIIRS products developed through Proving Ground efforts.

4.3.2. Year 4 (2018, ICV)

The development of VIIRS image products (differences and multi-band combinations, which detect and discriminate among various land and cloud features) will continue. Those products also bring out the true (down to noise level) quality of VIIRS that may be hidden or masked by the large signal (to noise) in single-band imagery.

Any improvements to VIIRS Imagery or software for display and product generation will be made available for integration into CSPP.

5. SUMMARY/CONCLUSIONS

The Imagery Cal/Val team is well positioned for the efficient validation of all Imagery products derived from JPSS. All tools have already been tested and are ready for the evaluation of JPSS Imagery. The team has the required expertise. Arrangements are in place to bring in users at the appropriate stage, with an emphasis on the Alaskan region, as dictated by the Imagery KPP requirement. Additional expertise and tools are in place to work NCC imagery and the possibility of additional challenges due to the different characteristics of the DNB SDR.

6. AREAS OF CONCERN

The two primary areas of concern deal with items outside of the Imagery Cal/Val teams' control. The first is access to the Imagery itself. There is a non-zero risk that the delivery systems will not be in place to supply Imagery to the multiple locations of personnel and users involved in the Cal/Val process. Latency is a critical factor in the employment of Imagery, and any items that compromise the ability of either a validator or user to access Imagery in a timely manner will interfere with its evaluation. The second, already noted in the challenges section, is the differences in the input DNB SDR. It is unknown at this time what, if any, negative impacts will occur to the Imagery from these differences.

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