NPOESS/NPP VIIRS SDR Calibration and Validation Plan

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Goals of VIIRS SDR Cal/Val Program

The Visible/Infrared Imager/Radiometer Suite (VIIRS) is a key National Polar-orbiting Operational Environmental Satellite System (NPOESS) sensor. It will generate 21 Environmental Data Records (EDRs), of which two, sea surface temperature (SST) and imagery, include Key Performance Parameter attributes. Given the importance of the EDRs to be generated from VIIRS measurements, the integrity and quality of the VIIRS Sensor Data Record (SDR) are essential for NPOESS mission success. To ensure integrity and quality, the VIIRS SDR calibration/validation activity will develop, validate, and maintain the VIIRS SDR over the entire mission lifetime.

Figure 1 shows how Calibrated and Validated SDRs are produced from the raw data records (RDRs). Depending on the phase of the program, Cal/Val activities modify the algorithm or the Look-Up Tables (LUTs) based on the analysis of instrument test data or SDR performance. The computing resource employed in the performance of a particular analysis depends on the data volume: high data throughput tasks are performed on NPOESS Science Investigator-led Processing System (NSIPS) while low data volume tasks are performed with either desktops or a linux computing cluster located at NGAS.

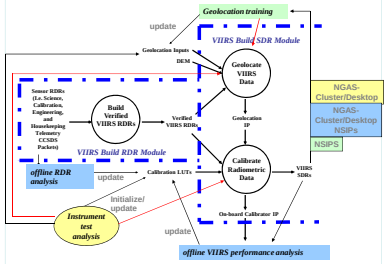


Figure 1. SDR Processing Flow and Interaction with CalVal

The VIIRS SDR CalVal Program consists of four phases of activity, each with its own distinct objectives. These four phases with their associated tasks and objectives are shown in Figure 2. VIIRS has just recently completed sensor environmental testing and characterization.

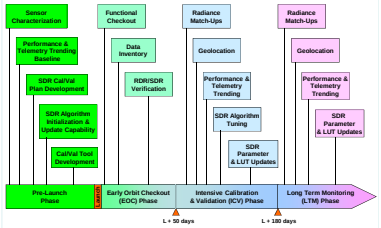


Figure 2. Phases of Cal/Val Activities

Format, Functional and Imagery

One of the first goals after launch will be to verify the integrity of the RDRs. The tasks in the EOC period perform this function:

- Visual inspection of images of the various calibration views. (Figure 5)
- Histogram analysis of data
- Inspection/analysis of engineering telemetry. (Figure 6)
- Visual inspection of earth view images against reference images degraded to same resolution and sampling. (Figure 7)

Radiometry

VIIRS is a self-calibrating radiometer. It incorporates on-board calibration systems in the reflective and emissive regions to maintain radiometric calibration. Figure 3 shows a simplified block diagram of VIIRS. The calibration system is depicted on the left-hand side of the figure. It consists of a Solar Diffuser (SD), SD Stability Monitor (SDSM) and Space View (SV) for reflective band calibration and an On-Board Blackbody (OBCBB) and SV for emissive band calibration.

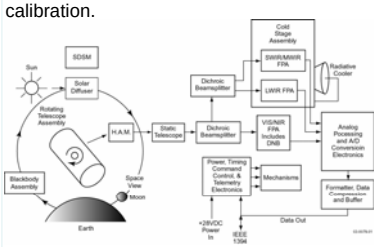


Figure 3. Block Diagram of VIIRS

In addition to trending and monitoring the performance of the internal calibration systems, the calibration and validation of VIIRS radiometry will employ heritage techniques already demonstrated with various operating space systems. Some sources of data required are depicted in Figure 4. Both reflective band and emissive band radiometric Cal/Val will utilize:

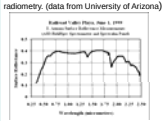
- Vicarious calibration with instrumented ground sites for high accuracy single point validation.
- Cross comparison with sensors on the A-train for global coverage and validation across the dynamic range
- SNO (Simultaneous Nadir Overpass) comparison with other polar orbiting sensors for validation over polar region.

In addition, reflective band radiometry will involve:

- lunar calibration to track long term degradation.

Railroad Valley Playa for reflective band radiometry. (data from University of Arizona)

Moon to track long term stability



Radiometers at Lake Tahoe for emissive band radiometry

Figure 4. Radiometric Data Sources

Spatial and Geolocation

VIIRS on-orbit geolocation calibration and validation will employ the MODIS heritage technique of image matching with Landsat ground control points. Residuals from the matching are used to update the geolocation LUT to improve future geolocation of data. On-orbit evaluation of modulation transfer function and band to band registration will utilize an NGAS developed model-based spatial characterization technique as shown in Figure 8.

Cal/Val Milestones

The generation of LUTs from sensor data is expected to be completed in March 2010 and Cal/Val readiness review is expected to occur in mid-2011.

Examples of Cal/Val Techniques and Tools

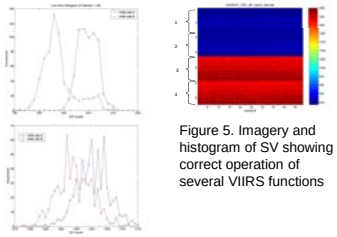


Figure 5. Imagery and histogram of SV showing correct operation of several VIIRS functions

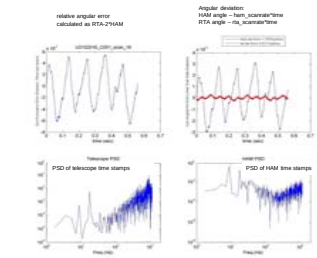


Figure 6. Analysis of scan mechanism to monitor instrument motor health

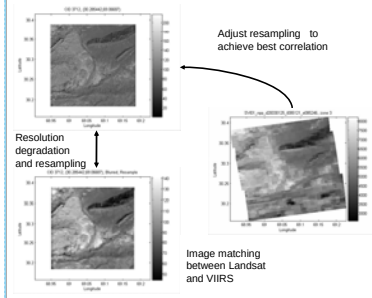


Figure 7. Tool for mapping/displaying sensor data with different resolution and sampling on the same grid.

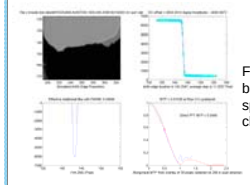


Figure 8. Model based evaluation of spatial performance characteristics.