VIIRS SDR Overview

Name of the Product: VIIRS SDR
Contributors: VIIRS SDR Team

Changyong Cao
VIIRS SDR Team Lead

Date: August 24, 2015

VIIRS Instrument Overview

•VIIRS is a scanning imaging radiometer onbaord the Suomi NPP, and JPSS satellites in the afternoon orbits with a nominal altitude of 829km at the equator, and swath width of ~3000km;

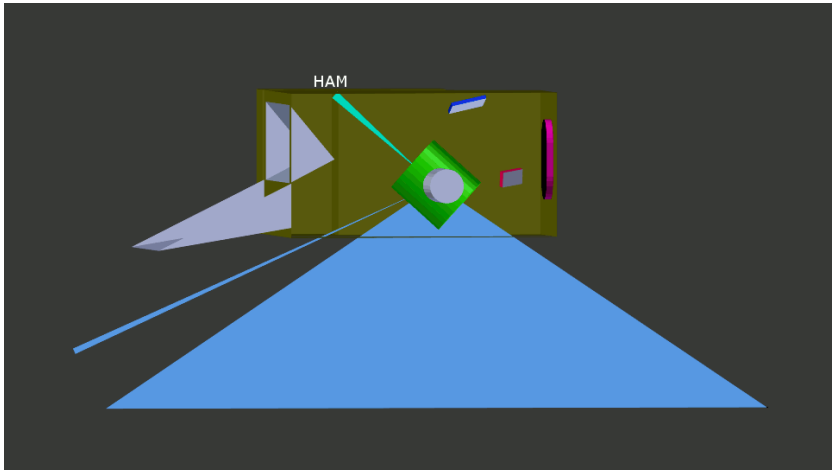
VIIRS has 22 types of SDRs:

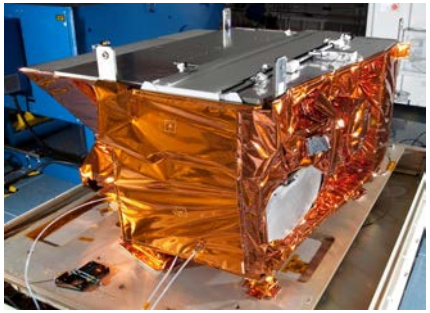
- *•16 moderate resolution (750m), narrow spectral bands (11 Reflective Solar Bands (RSB); 5 Thermal Emissive Bands (TEB))*
- *•5 imaging resolution(375m), narrow spectral bands (3 RSB; 2 TEB)*
- *•1 Day Night Band (DNB) imaging (750m), broadband*

•VIIRS Onboard calibration relies on the solar diffuser (SD), solar diffuser stability monitor (SDSM), space view (SV), and the blackbody (BB);

•Vicarious calibration also used (lunar, dark ocean for DNB, and cal/val sites);

•Calibration is performed per band, per scan, per half angle mirror side (HAM), and per detector.





VIIRS instrument

Smoke & fire in Tianjin explosion last week

Algorithm Cal/Val Team Members

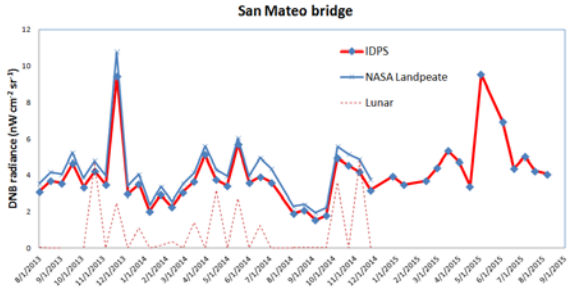
PI	Organization	Team Members	Roles and Responsibilities
C. Cao	STAR	W. Wang, S. Blonski, S. Uprety, Z. Wang, S. Shao, Y. Bai, B. Zhang, J. Choi, M. Schull, Y. Gu, C. Moeller.	VIIRS SDR calibration/validation for S-NPP, J1, and beyond. - Prelaunch calibration LUT development - Software code changes - ADL test - Vicarious calibration - Postlaunch monitoring and LUT update
F. DeLuccia	Aerospace	G. Moy, E. Haas, C. Fink, D. Moyer	VIIRS operational calibration update; RSB autocal; prelaunch TV data analysis;
J. Xiong	VCST	J. McIntire, G. Li, N. Lei, T. Schwarting	VIIRS TV data analysis; prelaunch characterization; LUT development

VIIRS SDR Product Requirements from JPSS L1RD

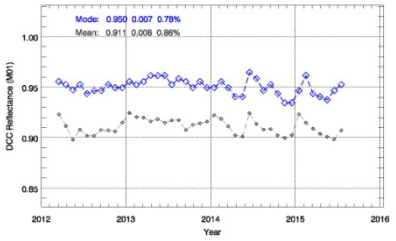
Attribute	Threshold	Objective
Center Wavelength	412 to 12,013 nm	412 to 12,013 nm
Bandpass	15 to 1,900 nm	15 to 1,900 nm
Max. Polarization Sensitivity	2.5 to 3.0 %	2.5 to 3.0 %
Accuracy @ Ltyp	0.4 to 30 %	0.4 to 30 %
SNR @ Ltyp or NEdT @ 270 K	6 to 416 or 0.07 to 2.5 K	6 to 416 or 0.07 to 2.5 K
FOV @ Nadir	0.4 to 0.8 km	0.4 to 0.8 km
FOV @ Edge-of-Scan	0.8 to 1.6 km	0.8 to 1.6 km
Ltyp or Ttyp	0.12 to 155 $W \cdot m^{-2} \cdot sr^{-1} \cdot mm^{-1}$ or 210 to 380 K	0.12 to 155 $W \cdot m^{-2} \cdot sr^{-1} \cdot mm^{-1}$ or 210 to 380 K
Dynamic Range	0.12 to 702 $W \cdot m^{-2} \cdot sr^{-1} \cdot mm^{-1}$ or 190 to 634 K	0.12 to 702 $W \cdot m^{-2} \cdot sr^{-1} \cdot mm^{-1}$ or 190 to 634 K

S-NPP Product Overview

- S-NPP Cal/Val Accomplishments
  - Developed validation time series at 30+ vacarious sites and at SNOs , DCC and Lunar;
  - Developed VIIRS DNB radiometric stability monitoring and geolocation validation using point sources;
  - Developed common geo processing capabilities;
  - Successfully transitioned DNB stray light correction LUT from NG to STAR. LUTs are being delivered monthly for IDPS operational processing since January 2015;



- Known Product Deficiencies:
  - Calibration uncertainty for reflective solar bands is within 2% for most bands;
  - SWIR bands such as M11 has large uncertainties due to lack of traceable source;
  - Bowtie deletion may cause discontinuities in imagery with satellite projection, although not an issue with earth projection;
  - M15 bias at 200k can be upto 0.5k, although meeting the spec.
  - Striping may be apparent in both RSB and TEB bands, although below noise level.
- LTM: Monitoring Tools/Website
  - VIIRS SDR home page: http://ncc.nesdis.noaa.gov
  - ICVS: http://www.star.nesdis.noaa.gov/icvs/ status_NPP_VIIRS.php



Deep Convective Clouds (M1)

JPSS-1 Readiness

- J1 Algorithm Summary

  Major changes to the product algorithm(s)/Improvements:

  - J1 VIIRS DNB nonlinear response at high scan angles required a performance waiver with the implementation of Agg mode 21 and 21/26:

- VIIRS DNB GEO code analysis shows that J1 DNB GEO product cannot be generated correctly without code change.
- Block 2 ADL VIIRS GEO code was modified to support J1 DNB agg mode change.
- J1 GEO code change was verified using MDR 28 and MDR 39 J1 RDRs
- The Modified code can support Agg21, Agg21/26 correctly
- Backward compatible with SNPP.

J1 VIIRS DNB Geo code changes

GEO_determine_DNB_sample_time_offsets.cpp — 1. Determine DNB sample time offsets

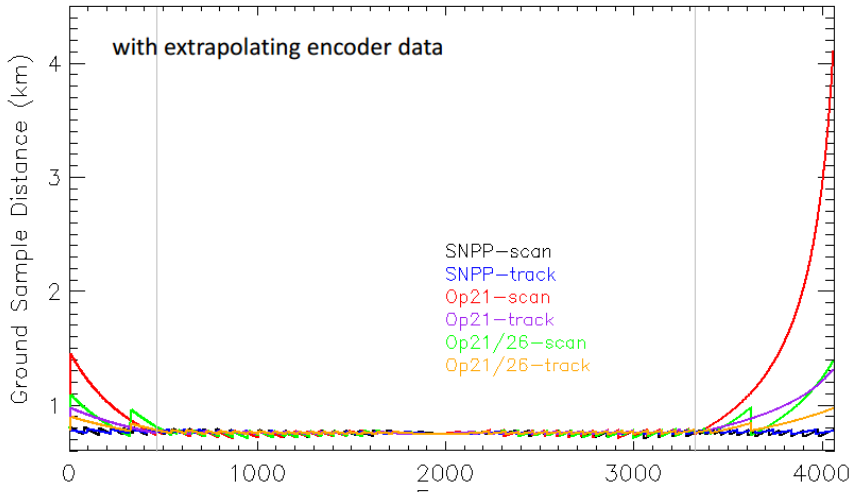
GEO_interpolate_mirror_encoder.cpp
GEO_interpolate_telescope_encoder.cpp — 2. Extrapolating of encoder data

ProSdrViirsGeoDataStructs.h
GEO_process_parameters.cpp
fixSatAngles.cpp
ProSdrViirsGeo.cpp
geolocateDecim.cpp
geolocateAllRecPix.cpp
— 3. Hard-coded nadir frame #

Files with red color have relatively more changes.

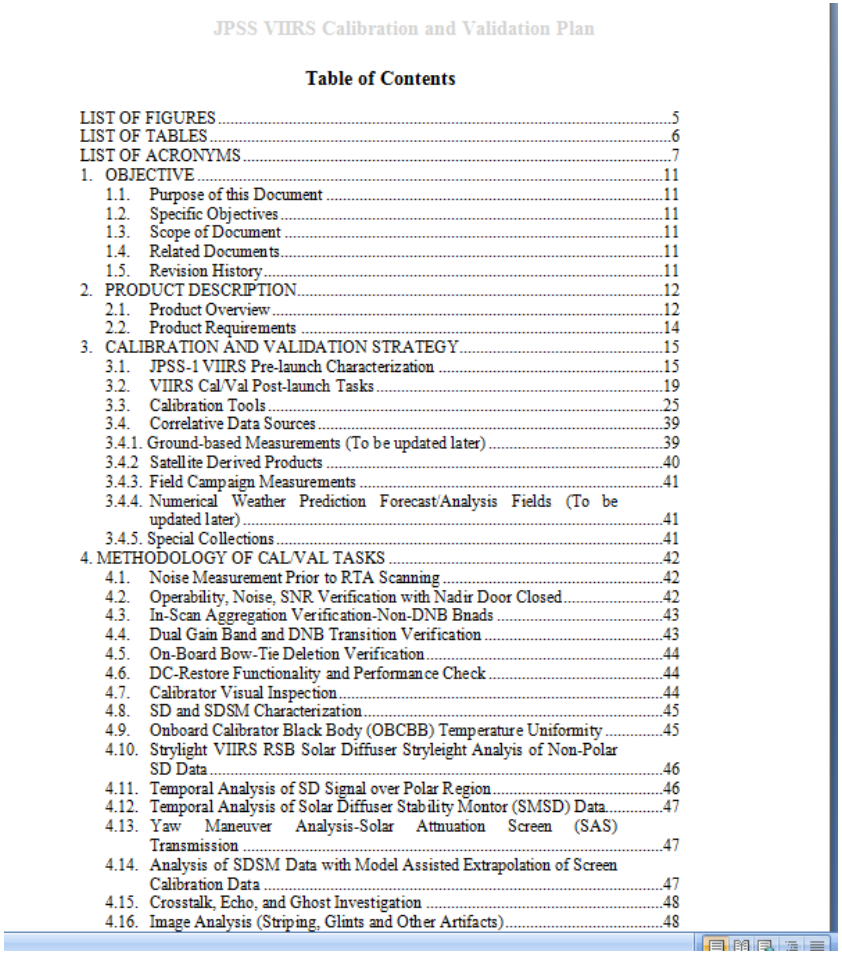
GEO_parameters.h
ProViirsGeoRectangle.h
ProGeoloc_createInterpRectangles.cpp
calcModFromImg.cpp
geolocateGranule.cpp
— 4. Interpolation rectangles

Totally 14 files were modified
All files are located at ${ADL_HOME}/SDR/VIIRS/Geo, except for *ProViirsGeoRectangle.h & ProGeoloc_createInterpRectangles.cpp are located at* ${ADL_HOME}/include & ${ADL_HOME}/Geolocation/Util/src, respectively.



JPSS-1 Readiness

- J1 Cal/Val Overview
  - Timelines for Beta, Provisional and Validated Maturity
    - Beta: L+10/40 days to L+60?
      - Initial power on: L+10
      - Outgassing: L+10 to L+39
      - Door deploy: L+40: ?
    - Provisional: L+60 to L+90?
    - Validated: L+180
  - Pre-Launch Calibration/Validation Plans
    - Cal/val plan developed, currently under review by external team members
  - Post-Launch Calibration/Validation Plans
    - Cal/val plan developed, currently under review by external team members



JPSS VIIRS Calibration and Validation Plan

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JPSS-1 Readiness

- Major Accomplishments and Highlights Moving Towards J1
  - Developed J1 VIIRS DNB waiver mitigation and delivered pre-operational software to the program on-time, which greatly reduced program schedule and cost risks (Wang & Lee), in addition to operational straylight correction.
  - Prepared all 47 J1 VIIRS LUTs (ver1.0) based on analysis of prelaunch test data, tested using ADL and simulated J1 data, and delivered to the program(Aerospace/VCST/STAR);
  - Developed and demonstrated VIIRS DNB radiometric and geolocation monitoring/characterization capabilities using nightlight point sources (Cao & Bai, 2014,RS.), which is critically needed for J1 postlaunch validation of the waivers;
  - Expanded validation time series with the 30+ validation sites worldwide, with added capabilities in the SWIR bands, as well as comparing with GOSAT FTS hyperspectral observations (Uprety & Cao, 2015, RSE);
  - Completed J1 VIIRS prelaunch test data analysis (VCST/Aerospace/STAR)
  - Improved RSB autocal maturity;
  - Geolocation thermal chip development for the infrared bands;
  - Modeled VIIRS solar diffuser degradation using surface roughness and metrology;
  - Active nightlight SBIR project feasibility study in support of VIIRS DNB cal/val.

JPSS-1 Readiness

- Issues/Mitigation
  - Need to work closely with flight to test DNB op21 and op21/26 postlaunch
  - Other waivers still need to be addressed:
    - SWIR nonlinearity
    - Bad detector
    - Saturation
- Stake Holder Interactions, Users and Impact Assessment Plans
  - List of Users/Stake Holders
    - SST, Ocean Color, Imagery, Aerosols, Ice temperature, and other products
    - User Impact Assessment (examples)

      Work with SST team to address bow-tie, striping, and other issues.

      Work with imagery team to address bad detector issue.

      Work with Ocean color team to address polarization sensitivity issues.

      Work with Cryosphere team to assess impact of M15 bias.

FY16 Milestones/Deliverables

Task Category	Task/Description	Start	Finish	Deliverable
Development (D)	• DNB&SWIR band dual calibration; • Improve straylight correction; • RDR toolkit; • Geolocation control points; • SD degradation model	10/2015	09/2016	Science code & LUTs & data
Integration & Testing (I)	J1 prelaunch LUT and code change testing support	10/2015	09/2016	Code & LUT updates
Calibration & Validation (C)	• Support the RSB autocal (operational); • Offline RSB/DNB/TEB cal/val analysis; • Quantify striping & develop mitigation; • Common geo validation; • Prepare field campaign validation for J1	10/2015	09/2016	Improved radiometric & geolocation accuracy; LUT; publications
Maintenance	• Maintain the performance trending at 30 sites • Update documentation	10/2015	09/2016	Continuity
LTM & Anomaly Resolution (L)	LTM for all RSB bands using DCC, lunar, SNOs, and other vicarious targets	10/2015	09/2016	Continuity

Summary & Path Forward

The VIIRS SDR team has made great progress:

- Supported J1 VIIRS waiver studies
- Developed and enhanced vicarious validation site time series at 30+ sites
- Developed geolocation software code modifications for J1
- Developed and delivered J1 VIIRS LUTs
- Developing common geo and geolocation validation capabilities

- **The VIIRS SDR team will continue to support SNPP, J1, J2 & beyond**
  - Refine J1 VIIRS LUTs, and expand validation capabilities
  - Feasibility study developing value-added SDR L1.5 product
  - Reprocessing
  - Support J2 enhancements