

VIIRS Surface Albedo EDR Release, Validated Stage 1 Data Quality
March 2015
Read-me for Data Users

The JPSS Algorithm Engineering Review Board (AERB) released the Suomi NPP VIIRS Surface Albedo Environmental Data Record (VIIRS-SA-EDR) to the public with a Stage 1 Validation level maturity with an effectivity date of Nov 21, 2014 corresponding to the Transition to Operations of IDPS Mx8.6, which included the implementation of updated BRDF LUTs (DR7635/474-CCR-14-1722). This assessment is based on both qualitative and quantitative analysis of the land component of the VIIRS-SA-EDR product. Therefore, although the VIIRS surface albedo EDR is defined as a combination of the land surface albedo, ocean surface albedo, and sea ice surface albedo, **the current release of SA EDR only has the land surface albedo validated.** Quantitative evaluation is predominantly based on retrievals from the local computation facility. The land component of VIIRS-SA-EDR is at Stage 1 validation level with limited validation datasets.

Validated Stage 1 quality is defined as:

- Using a limited set of samples, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

The Board recommends that users be informed of the following product information and characteristics when evaluating the VIIRS-SA-EDR:

1. **Product Requirements:** Product requirements are now documented in the Joint Polar Satellite System (JPSS) Level 1 Requirements Supplement (L1RDS) and apply only to future satellites, starting with JPSS 1. Appendix D of the L1RDS describes performance exclusions for the Suomi NPP products.
2. **Algorithm Description.** Land surface and sea ice surface components of the Suomi NPP VIIRS VIIRS-SA-EDR algorithm are based on direct estimation methods, adapted for use with the VIIRS data. Land surface albedo (LSA), together with ice surface albedo and ocean surface albedo, are combined into one final product --VIIRS surface albedo EDR. Two types of algorithms were originally proposed to retrieve LSA: Dark Pixel Sub Algorithm (DPSA) and Bright Pixel Sub Algorithm (BPSA). DPSA uses the Bi-directional Reflectance Distribution Function (BRDF) information from the 17-day gridded albedo IP to first calculate spectral albedo and then convert spectral albedo to broadband albedo using empirical models. BPSA directly estimate broadband land surface albedo from VIIRS TOA radiance. Some critical refinement of the algorithm has been carried out since Suomi NPP was launched. In addition to the use of latest spectral response function of VIIRS, the major improvement to the original BPSA is the incorporation of the surface BRDF in the construction of regression models. Currently, BPSA is used to generate LSA from VIIRS, and only the land surface albedo is validated.
3. **Product Evaluation.** The internal evaluation on the quality flag, maps, geolocation etc reveals no significant problems with upstream SDR, EDRs and IPs. The external evaluations include inter-comparison with MODIS albedo data, validation against field measurements of land surface albedo. Quantitative evaluation to date is predominantly based on correlative analysis with measurements at various ground monitoring networks. Because the VIIRS data are available after 2012, not many stations currently provide measurements of these recent years. Data at 35 sites, including AmeriFlux, BSRN, GC-Net and SURFRAD, were obtained. High spatial-resolution satellite imagery was

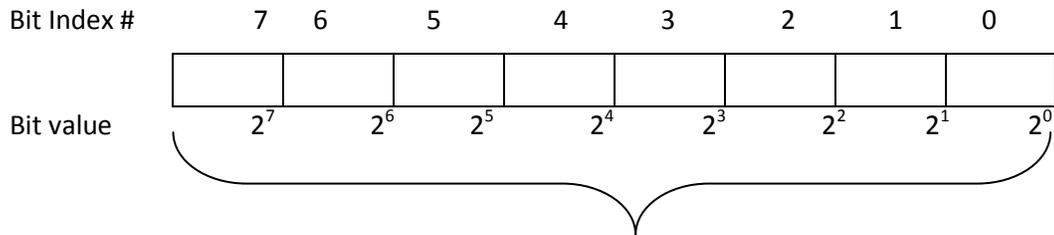
then used to evaluate the spatial representativeness of the ground measurements. Only spatially homogeneous sites were used for product validation. The validation results indicate that the LSA retrieved from the current BRDF LUT is able to meet the requirement of accuracy and precision in general. Relatively large errors still exist for LSA over snow surfaces, although the quality of the current VIIRS snow albedo is comparable to existing LSA products (e.g., MODIS LSA data). The VIIRS algorithm utilizes a single observation identified as “clear” by the cloud mask to estimate instantaneous value of LSA. Therefore, quality of the LSA retrievals is highly dependent on the quality of the cloud mask and other upstream input data. The undetected cloud and cloud shadow may generate spurious LSA retrievals.

4. VIIRS LSA Data Description

- The VIIRS LSA EDR is pixel level (~ 750 m) retrieval in a swath. Two granule products are available at user’s choice: a single swath granule dataset with the dimension of 768x3200, and a 4-swath aggregated granule dataset with the dimension of 3072 X 3200.
- The VIIRS LSA is a scaled value ranging from 0 to 65527 stored as unsigned 16-bit integers with the corresponding scale and offset stored separately in the granule. The LSA value beyond 65527 is fill value representing different reasons for non-retrieval.
- Corresponding Geolocation data is available in a separate file (prefix of GMTCO) or packaged with the VIIRS SA data at user's preference in the configuration of CLASS.
- The valid LSA range is from 0 to 1.

5. Quality Flags

There are 3 separate quality flags in the VIIRS SA EDR stored in 8-bit unsigned char(QF1_VIIRSSAEDR, QF2_VIIRSSAEDR, and QF3_VIIRSSAEDR). Note that the bits in a quality flag is numbered from right (bit index #0) to left (bit index #7). A visual example of this format is shown below.



The Quality flag details:

Byte	Bit	Flag Description Key	Result
0 (QF1_VIIRSSAEDR)	0-1	Albedo Retrieval Quality	Bit_1 Bit_0 0 0 = Good 0 1 = Poor (Exclusion) 1 0 = No Retrieval
	2	Out of Range	0 = False, 1 = True
	3	Stray light maximum radiance exclusion	0 = False, 1 = True

	4	Input Chlorophyll Concentration	0 = Available 1 = Not available (Climatology used)
	5-6	Input Wind Speed	0 0 = MIS 0 1 = NWP 1 1 = Not available
	7	Spare	
1 (QF2_VI IRSSAEDR)	0-1	Cloud Confidence	Bit_1 Bit_0 0 0 = Confidently Clear 0 1 = Probably Clear 1 0 = Probably Cloudy 1 1 = Confidently Cloudy
	2	Cloud Shadow Detected	0 = False, 1 = True
	3-4	Algorithm Branch	Bit_1 Bit_0 0 0 = Land 0 1 = Sea Ice 1 0 = Ocean 1 1 = Not Produced
	5-6	Solar Zenith Angle Degradation/Exclusion	Bit_1 Bit_0 0 0 = None (Solar Zenith < 65 degrees) 0 1 = Degraded (65 degrees <= Solar Zenith <= 85 degrees) 1 0 = Ocean 1 1 = Not Produced
	7	Spare	
2 (QF3_VI IRSSAEDR)	0-1	Aerosol Source (Indicates source of the 550nm aerosol information used in the retrieval)	Bit_1 Bit_0 0 0 = None 0 1 = Interpolation Only 1 0 = Interpolation & Climatology / NAAPS 1 1 = Climatology / NAAPS
	2	Exclusion – AOT (at 550nm) > 1.0	0 = False 1 = True
	3	Coccolithophore degradation with calcite concentration due to coccolithophores ≥ 0.3 mg/m ³	0 = False, 1 = True
	4-5	Input Data Quality (Quality of Surface Albedo is degraded or not retrieved due to bad input data in horizontal cell)	Bit_1 Bit_0 0 0 = Good 0 1 = Degraded 1 0 = No Retrieval
	6-7	Spare	

6. Known issues

- a. The quality of LSA retrievals rely on the accurate information of cloud and land cover. Undetected cloud/shadow will generate spurious high/low values.
 - b. LUT of sea ice albedo is out of date. Evaluation of current sea ice albedo data and development of a new LUT is greatly needed.
 - c. The current BPSA algorithm estimates albedo from a single clear-sky observation. It is sensitive to errors in cloud mask and random effects. Temporal filter is proposed to generate smoother and gap-free albedo with improved accuracy.
 - d. Only limited validation has been done. More comprehensive validation is necessary.
7. **Future Work.** The next steps in the VIIRS-SA-EDR validation process, for Stage 2 validation maturity, include further refinement of the retrieval algorithm and more comprehensive assessments of data precision and accuracy, include:
- a. Global/comprehensive validation of VIIRS LSA product. The team is extending the LSA validation effort to different continentals and regions. Users involvements are warmly welcome.
 - b. Improvement of the BPSA algorithm is necessary to reduce temporal noise due to the cloud contamination impact. Temporal filtering process will be implemented; daily or weekly gridded LSA data will be evaluated for possible replacement to the current instantaneous granule albedo data.
 - c. Intensive monitoring of the current VIIRS LSA production
 - I. Monitor the VIIRS LSA product quality at spots (available ground in-situ network), regional and global scale.
 - II. Monitor the VIIRS LSA product quality through the cross satellite comparisons.
 - III. Monitor possible impacts of latest changes in SDR, VCM, AOT on VIIRS LSA quality.
 - d. Promotion of the VIIRS LSA data usage in a variety of applications. User's feedback on their applications is greatly appreciated

More information about VIIRS and the VIIRS-SA-EDR product can be found at the following websites, where users can find the Algorithm Theoretical Basis Document (ATBD), Operational Algorithm Description (OAD) document, Common Data Format Control Book (CDFCB), and product examples:

<http://www.star.nesdis.noaa.gov/jpss/>

Additionally, the VIIRS Sensor Data Record (SDR) provisional quality Read-me document is available at:

<http://www.nsof.class.noaa.gov/saa/products/welcome>

VIIRS LSA product is available for download at the above website under the "JPSS Visible Infrared Imaging Radiometer Suite Environmental Data Record (VIIRS_EDR) " category.

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