



MEMORANDUM FOR: The Record
FROM: Jeff Key, JPSS Cryosphere Team Lead
SUBJECT: Binary Snow Cover EDR Validated maturity status and public release
DATE: 12/15/2016

Validated maturity status declaration for VIIRS Binary Snow Cover

Maturity Review Date: 01/08/2014
Effective Date: 10/15/2012
Operational System: IDPS MX6.4

The JPSS Algorithm Maturity Readiness Review Board approved the release of the VIIRS Binary Snow Cover EDR to the public with a Validated maturity level quality as of 10/15/2012, based on JPSS Validation Maturity Review held on 01/08/2014.

The Validated Maturity stage definition is:

- Product performance is well defined over a range of representative conditions.
- The product is ready for use by the Centrals and in scientific publications.
- There may be later improved versions.
- There are three validation stages. This product was reviewed for Stage 1 Validation, which is defined as: The product performance has been demonstrated to comply with the specification using a small number of independent measurements obtained from selected locations, periods, and associated ground-truth/field program efforts.

The Suomi National Polar-orbiting Partnership (S-NPP) Spacecraft with the Visible Infrared Imaging Radiometer Suite (VIIRS) was successfully launched on October 28, 2011. VIIRS succeeds the NOAA Advanced Very High Resolution Radiometer (AVHRR) and NASA Moderate Resolution Imaging Spectroradiometer (MODIS). With 22 spectral bands covering wavelengths from 0.41 to 12.5 μm , VIIRS provides operational information on the land surface, cryosphere, atmosphere, and ocean for weather, climate and other environmental applications. The VIIRS product list includes 22 Environmental Data Records (EDR) along with calibrated and geo-located Sensor Data Records (SDR). The VIIRS Snow Cover EDR is among a number of cryosphere products generated with VIIRS data. The VIIRS Snow Cover EDR provides information on the Earth's global snow cover and incorporates two products, the Binary Snow Cover Map and the Snow Cover Fraction. This document is for the Validated maturity of the **Binary Snow Cover** product only.

The binary snow map is generated with reflectances and brightness temperatures observed in VIIRS bands I1, I2, I3 and I5. The algorithm to identify snow cover in VIIRS pixels closely follows the technique implemented for mapping snow cover with MODIS data. Snow cover is identified by applying a series of threshold-based decision-tree tests to VIIRS sensor data records (SDRs) and spectral indices derived from VIIRS SDRs. The particular spectral indices and SDRs used in the snow identification algorithm include the Normalized Difference Snow Index (NDSI), Normalized Difference Vegetation Index (NDVI), reflectance in the visible spectral band (I1) and brightness temperature in the infrared window band (I5). An externally generated cloud mask is applied to limit snow identifications to clear sky pixels. Snow retrievals are performed only in daytime conditions. The Snow Cover EDR includes the binary snow cover map and two 8-bit quality flags.

This data product is represented by Collection Short Name (CSN) VIIRS-SCD-BINARY-SNOW-MAP-EDR. There have been no changes since the Beta maturity stage. Product requirements include a measurement accuracy defined as 90% probability of correct snow/no-snow classification. The product is clear-sky only and applies only to climatologically snow-covered regions. The accuracy of snow detection does not apply over forested and mountainous areas where snow may be hidden by vegetation or topographic shading.

The quality of the VIIRS Snow Cover EDR has been evaluated since the start of the product generation in February 2012. We have routinely compared the results of VIIRS snow identification with in-situ observations of the snow cover, with snow charts generated interactively within NOAA Interactive Multisensor Snow and ice Mapping System (IMS) and with snow cover maps derived from observations of MODIS instruments onboard Terra and Aqua satellites and from observations of AVHRR instrument onboard METOP satellite. Visual analysis of VIIRS false color imagery at a full pixel resolution was also used to qualitatively evaluate the VIIRS snow cover EDR accuracy and to identify its possible failures. Qualitative analysis of snow cover maps generated with VIIRS was performed globally, whereas more detailed quantitative evaluation of the product accuracy was conducted over Northern Hemisphere as well as for individual granules.

Our analysis has shown that the VIIRS Binary Snow Cover Map product realistically reproduces the global distribution of the snow cover. It is consistent with other available remote sensing based products and to in situ snow cover observations. For the period of ten months, from November 2012 to December 2013 routine quantitative estimates of the correspondence of the VIIRS Binary Snow Maps to IMS interactive charts have been made over Northern Hemisphere whereas the correspondence of the VIIRS product to in situ data have been evaluated over the coterminous US. In both cases the VIIRS Binary Snow Maps demonstrated an over 90% agreement to the snow products used in the comparison. Issues identified in the VIIRS Binary Snow Map product cause both snow commission and omission errors. Some of these issues are due to the suboptimal performance of the VIIRS cloud mask; others may be taken care of (at least partially) by future improvement of the VIIRS snow identification algorithm.

Based on our evaluation, the Binary Snow Cover Map product of the VIIRS Snow Cover EDR meets all criteria for the Validated Stage 1 maturity level. Although some issues still exist, our evaluation shows that the Binary Snow Map product is reasonably accurate and agrees well with other remote-sensing based products and *in situ* measurements. No code changes are planned for the algorithm.

The Board recommends that users be informed of the following product information and characteristics when evaluating the Binary Snow Cover Map product of the Snow Cover EDR:

- The Binary Snow Cover Product has been generated since February 2012, however the time series of the derived product is not consistent. Inconsistency occurred due to several modifications that have been introduced to the cloud detection algorithm and hence to the cloud mask during the time period from February 2012 to December 2013.
- Performance of VIIRS Cloud Mask (VCM) remained non-uniform and suboptimal during much of the monitoring period. This adversely affected the accuracy of the Binary Snow Map product causing both snow misses and false snow identifications. Improvements to the VCM are currently underway and will be reflected in future versions of the Snow Cover EDR.



Read-me for Data Users

- The cloud mask supplied with the product is not binary (yes/no) but is formulated in terms of four-category cloud confidence. Providing four categories of cloud confidence instead of a yes/no cloud flag is somewhat confusing since it allows for generating three different snow cover maps with the same Binary Snow Map product. At this time we recommend using a conservative cloud mask that incorporates “cloudy”, “probably cloudy” and “probably clear” cloud confidence categories; i.e., binary snow cover should be based on confidently clear pixels only.
- Users should be aware that the land/water mask supplied with the product through quality flag 2 is not accurate. It contains spurious inland water bodies that result from inaccurate identification of ephemeral water and subsequent modification of the land/water mask at earlier stages of VIIRS data processing. The occurrence of ephemeral water misclassification has been traced to cloud shadows. Similar effects may occur from topographical shadows.
- The conclusion on the realistic representation of the global snow cover distribution by the current VIIRS Binary Snow Map product and on its accuracy has been made based on the analysis of the product during the 14-month time period from November 2012 to December 2013.

Additional information is available in the VIIRS Binary Snow Cover algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

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

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