**MEMORANDUM FOR:** The Record

**FROM:**  Dr. Thomas Kopp, VIIRS Imagery Validation Lead

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**SUBJECT:** NPP VIIRS Cloud Mask (VCM) beta status

**DATE:**  5/30/2012

The successful launch of the Suomi National Polar-orbiting Partnership (SNPP) Spacecraft on 28 October 2011 with the Visible Infrared Imaging Radiometer Suite (VIIRS) ushers in a new generation of capabilities for operational environmental remote sensing for weather, climate, ocean, and other environmental applications. VIIRS succeeds the NOAA AVHRR and NASA EOS MODIS with 22 spectral bands covering wavelengths from 0.41 to 12.5 m, providing data for the production of 22 Environmental Data Records (EDRs) with its calibrated and geolocated Sensor Data Record (SDRs). The VCM is a critical Intermediate Product (IP) that is also a deliverable under the program requirements. Furthermore the VCM impacts 21 downstream VIIRS Environmental Data Records (EDRs). Its validation must consider both the requirements specific to the VCM itself and its affect on dependant downstream products.

The VCM IP is heavily dependent on the upstream SDRs, hence it must follow the SDR schedule closely in determining validation status. As calibration of the VIIRS SDRs improves, so does the quality of the VCM. Radiometric accuracy and sufficient geolocation, covered by the VIIRS SDR team, are prerequisites for the VCM to attain the next stage. The VIIRS SDRs formally achieved beta status in mid-May 2012.

A VCM team of some sort or another has been active since 2004. Numerous pre-launch activities discovered code bugs and algorithm improvements during the period between 2004 and the launch of NPP. This mitigated many potential negative effects in the immediate post-launch period. The design of the VCM itself also aides in its validation and correction, as the VCM features “branches” which are isolated from one another, hence any issues with a given branch may be worked while other are not impacted. These branches are not just day and night, but also break out backgrounds such as ocean, land, desert, and snow. The VCM has been analyzed by subject matter experts at the University of Wisconsin, NOAA/STAR, Northrop Grumman, and Aerospace. The current capability of the VCM is reasonable well characterized, as shown at the VIIRS Cal/Val Workshop on April 17, 2012.

The early VCM validation effort centered on a 30 day spin-up period, where subject matter experts performed extraordinarily to tune the VCM for all known significant issues where tuning could be applied as a corrective measure. There were a total of 34 iterations of the VCM run during this period, with 74 thresholds updated by the time we had finished. In this same time frame the first four Golden Granules were completed and over 1000 matchups with CALIPSO were made and evaluated. Each of these is ultimately a subset of the larger total that will be need for the full validation effort, but represent a significant accomplishment for a 30 day period.

The status of the VCM was summarized at the VIIRS Cal/Val Workshop on 18 April 2012. A number of known issues were addressed and mitigated, among them an unnecessary large number of probably cloudy conditions, poor performance over snow during the day, missed clouds in glint regions, and under analysis of thin cirrus. By the time we were finished, the matchup results (admittedly not always statistically significant) indicated we were near MODIS performance in all evaluation categories except leakage. These were promising numbers for such an early stage of validation.

The definition of achieving “beta” includes that following considerations: initial calibration has been applied, it is minimally validated but may contain significant errors, users may gain familiarity with it, and it is not yet ready for formal publications or quantitative analysis. The VCM has achieved all of these. The 30 day spin up serves as our initial calibration. Users have begun getting familiar with the format, and the Workshop identified key flags interested parties should include when using the VCM. Quantitative analysis is in its early stages.

Included in the definition of beta is that problems are known and identified. The below is a summary of the issues being worked at this time.

1. External fields required by the VCM, notably snow and NDVI, are based on fixed fields from pre-launch exercises and are woefully incorrect. Snow is known to date back to 2002. Although the VCM cannot correct or tune for these issues, they must be corrected before we can achieve provisional status.
2. The VCM is, in specific situations, falsely identifying low ice clouds as snow cover. When this occurs the output is labeled confidently clear, when in reality it should be confidently cloudy. A fix for this problem over snow cover has already been approved by the AERB.
3. Leakage remains a main concern, especially from the SST community which has been reported poor results during the day. Collaboration with the SST team is ongoing.
4. Weaknesses in the performance near the edge of scan are being reported. Many probably clear pixels are observed over desert when they should be probably clear. There are also indications this can occur over oceans. Aerosol identification is also not performing as it should at large scan angles. Two software changes are under evaluation to address the probably clear situation, while we have begun collaboration with the aerosol team regarding dust and volcanic ash.
5. The VCM behavior at night, especially over land and snow, is in need of improvement. The VCM is showing strong sensitivity to certain thresholds, and careful analysis will be necessary to optimize these thresholds. This “trade space”, as it was identified at the Cal/Val Workshop, needs to be better understood.

By the standards set by the program the VCM team; in collaboration with the liaisons working on the other VIIRS Cal/Val teams, believe the beta standard of validation has been met for the VCM. The AERB conditionally approved this on April 20. With this memorandum, all of the requirements to attain beta have been met, and we recommend formal and official declaration of beta be declared for the VCM.

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