MEMORANDUM FOR: The Record

FROM: Dr. Menghua Wang
OCC EDR Team Lead, NOAA/NESDIS/STAR

SUBJECT: OCC EDR Beta Status

DATE: 12/12/2012

The successful launch of the Suomi National Polar-orbiting Partnership (S-NPP) Spacecraft on October 28, 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 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, providing data for the production of 22 Environmental Data Records (EDR) with its calibrated and geo-located Sensor Data Records (SDR). The ocean color and chlorophyll-a (OCC) EDR comprises use of VIIRS bands M1–M7, and produces ocean color products such as chlorophyll-a concentration, and normalized water-leaving radiance ($nL_w(\lambda)$) at VIIRS bands M1–M5.

There are mainly three sets of algorithms in the Interface Data Processing Segment (IDPS) OCC EDR processing: atmospheric correction algorithm, ocean color chlorophyll-a algorithm, and water inherent optical property (IOP) algorithm. The Gordon and Wang (1994) atmospheric correction algorithm includes corrections for ozone, Rayleigh (molecules), aerosols, ocean surface reflection, sun glint, whitecap, and sensor polarization effects. The chlorophyll-a concentration calculation uses the OC3V empirical algorithm. The IOP products, i.e., absorption (IOP-a) and backscattering (IOP-b) coefficients, are derived using the Carder IOP algorithm. However, VIIRS IOP products are considered to be experimental products. Our focus now is on VIIRS ocean color (normalized water-leaving radiance spectra) and chlorophyll-a products. The inputs of OCC EDR data processing include: M1–M7 bands SDR data, terrain-corrected geo-location file, SST EDR data (not used for the VIIRS OC3V chlorophyll-a algorithm), cloud mask Intermediate Product (IP), on-board calibrator IP, seven ancillary data files, seven lookup tables, and one configurable parameter file. The OCC EDR generates the following outputs: chlorophyll-a (Chl-a) concentration, normalized water-leaving radiance spectra ($nL_w(\lambda)$) at VIIRS M1–M5 bands, IOP (IOP-a and IOP-s) at VIIRS M1–M5 bands, and data quality flags. The OCC EDR data quality depends on the upstream VIIRS SDR, and as calibration of the VIIRS SDR improves, so does the quality of the OCC EDR.

We have evaluated the IDPS OCC EDR since calibrated SDR data were generated after February 6, 2012. Before February 6, 2012, SDR data were quite poor and VIIRS IDPS OCC EDR data cannot be used. VIIRS $nL_w(\lambda)$ data at the Marine Optical Buoy (MOBY) site were extracted from OCC EDR and compared with MOBY *in situ* measurements. The OCC EDR data were also compared with MODIS-Aqua data at the MOBY site, South Pacific Gyre, and global deep waters (regions with water depth > 1km). We also use the NOAA ocean color science-processing package (NOAA-MSL12) and the JPSS Algorithm Development Library (ADL) to reprocess ocean color data from Raw Data Records (RDR) to SDR, and from SDR to EDR/Level-2 data

with refined algorithms and updated lookup tables (LUTs). In addition, VIIRS data have been evaluated using the results from the NRL-APS data processing. The evaluation results have been presented on the JPSS Annual Program Review Meeting on September 21, 2012. For MOBY data match-up comparisons, we found that the average satellite versus *in situ*-measurement ratios of $nL_w(\lambda)$ are 0.969, 1.01, 1.04, 1.34, and 3.61 for bands M1 to M5, respectively. Thus, the VIIRS IDPS $nL_w(\lambda)$ data for bands M1–M4 match reasonably well with *in situ* measurements at the MOBY site even without vicarious calibration. Preliminary results also show that OCC EDR products are reasonably consistent with MODIS-Aqua data, NRL-APS, and NOAA-MSL12 outputs, although there are still some issues to be resolved. It is concluded that VIIRS OCC EDR has great potential to be promoted into a high quality ocean color product with further algorithm improvements and refinements.

We have submitted the following requests to improve the OCC EDR, and while some of them have been implemented, others will be implemented in future IDPS builds:

- Changed chlorophyll-a algorithm from Carder algorithm to OC3V empirical algorithm with updated coefficients for VIIRS spectral bands (DR4247, implemented in Mx5.1).
- For the significant sensor NIR/SWIR degradation issue, we submitted the request to the SDR team for updating the calibration F-LUTs at least daily instead of weekly for more accurate Reflective Solar Band (RSB) calibration (a new scan-by-scan RSB calibration code/LUT update was implemented in Mx6.2).
- Retrieval and output of Chl-a and IOPs when normalized water-leaving radiance (or remote-sensing reflectance) at M5 band is negative (DR4814, implemented in Mx6.3).
- Retrieval and output of Chl-a and IOPs for pixels with negative normalized water-leaving radiance (or remote-sensing reflectance) at some of the VIIRS ocean color bands (M1–M5) (DR4869, fixes to be implemented).
- Retrieval and output of OCC EDR over coastal and inland waters (DR4877, fixes to be implemented).
- Change Ocean Color HRI from sensor-zenith angle of 53º to 60º for more data coverage (DR4898, fixes to be implemented).
- Update OCC operational software to enable ocean color data processing up to solar-zenith angle of 80º instead of 70º (Note: the high solar-zenith angle is still 70º) (DR4940, fixes to be implemented).
- Request an improved calibration data (SDR) for the accuracy of VIIRS $nL_w(\lambda)$ at blue bands between mid-May and August (under investigation, there is a solution from SDR team).

Beta data quality is defined as:

- Early release product.
- Minimally validated.
- May still contain significant errors.
- Versioning not established until a baseline is determined.
- Available to allow users to gain familiarity with data formats and parameters.
- Product is not appropriate as the basis for quantitative scientific publication studies and applications.

Based on our evaluation, the OCC EDR has achieved all of these, and has gone beyond in some cases. With upstream SDR to be declared as the provisional status soon, the quality of future OCC EDR is expected to be consistent to (or/above) the quality of current OCC EDR. Although some issues still exist, our evaluation shows that the IDPS OCC EDR products are reasonably accurate and robust compared with *in situ* measurements, MODIS-Aqua data, NRL-APS data, and NOAA-MSL12 outputs. We conclude that the IDPS OCC EDR products should be made publically available, and it is appropriate for users to gain experience with data formats and parameters. In support from the OCC EDR Cal/Val team, we believe OCC EDR has achieved beta status.

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

- OCC EDR data were produced since November 21, 2011, but data before February 6, 2012 were not reliable because the SDR were not correctly calibrated.
- The chlorophyll-a algorithm was changed from Carder algorithm to OC3V since Mx5.1.
- Significant sensor near-infrared/shortwave infrared (NIR/SWIR) degradation has been an issue after VIIRS launch, but after the new scan-by-scan RSB calibration algorithm /F-LUT was implemented in Mx6.2; it has no negative impact on OCC EDR.
- The significant NIR/SWIR degradation is still an important issue.
- OCC EDR anomaly occurred for some scenes due to VIIRS onboard calibration duel gain switch issue. This issue was resolved in Mx6.3.
- Before Mx6.3, no Chl-a retrievals in case of negative remote-sensing reflectance in M1–M5. Since Mx6.3, Chl-a data have been retrieved in case of negative remote-sensing reflectance at the band M5. Currently, and there is no Chl-a retrieval in case of negative remote-sensing reflectance at any bands M1–M4. This issue will be fixed soon.
- No retrievals in coastal and inland waters (to be fixed soon).
- No vicarious calibration has been applied in the operational IDPS OCC EDR processing.
- IDPS OCC EDR quality flags need significant modifications/improvements.
- Sun glint masking/correction algorithm needs to be modified/improved.
- IOP-a and IOP-s products have not been evaluated yet, and these products are considered experimental products. It may require a different IOP algorithm for improved products.
- There are atmospheric correction problems in coastal turbid and inland waters due to the algorithm issue. The required algorithm for correction of the NIR water-leaving radiance contributions has not been implemented in the IDPS OCC EDR data processing.
- Some $nL_w(\lambda)$ biases in the blue bands since mid-May 2012 are due to VIIRS SDR issue. We expect that this SDR-related issue will be addressed/resolved soon.

Point of Contact
Dr. Menghua Wang
OCC EDR Team Lead
Menghua.Wang@noaa.gov
301-683-3325