VIIRS Ocean Color Products

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Objectives

• Ocean color products from the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (SNPP) are evaluated and assessed, with comparison of in situ data and MODIS-Aqua ocean color products measurements.

• In addition, VIIRS Sensor Data Records (SDR, Level-1B data) are evaluated.

Data & Methods

- VIIRS Raw Data Records (RDR, or Level-0 data) and SDR are downloaded routinely from SNPP central technical support infrastructure GRAVITE and the NOAA CLASS (http://www.class.ngdc.noaa.gov).
- NOAA Multi-Sensor Level-1 to Level-2 (NOAA-MSL12) is the official NOAA ocean color data processing system for VIIRS.
- NOAA-MSL12 (*Wang et al.*, 2013) has been used to process VIIRS SDR data to ocean color Environment Data Records (EDR or Level-2). Ocean color Level-2 EDR products derived from the MSL12 ocean color data processing system were used. The new near-infrared (NIR) atmospheric correction algorithm (*Jiang & Wang*, 2014) is used for VIIRS EDR products
- The global near-real-time VIIRS ocean color data processing system produces VIIRS global Level-3 data at 9-km spatial resolution (daily, 8-day, & monthly).
- Daily and monthly MODIS-Aqua Level-3 ocean color data from the NASA Ocean Biology Processing Group (OBPG) (http://oceancolor.gsfc.nasa.gov/) are used to compare with VIIRS Level-3 data in global ocean.
- In addition, VIIRS ocean color radiance data are compared with in situ radiometric measurements from the Hawaii Marine Optical Buoy (MOBY) site.

VIIRS Global Climatology Images

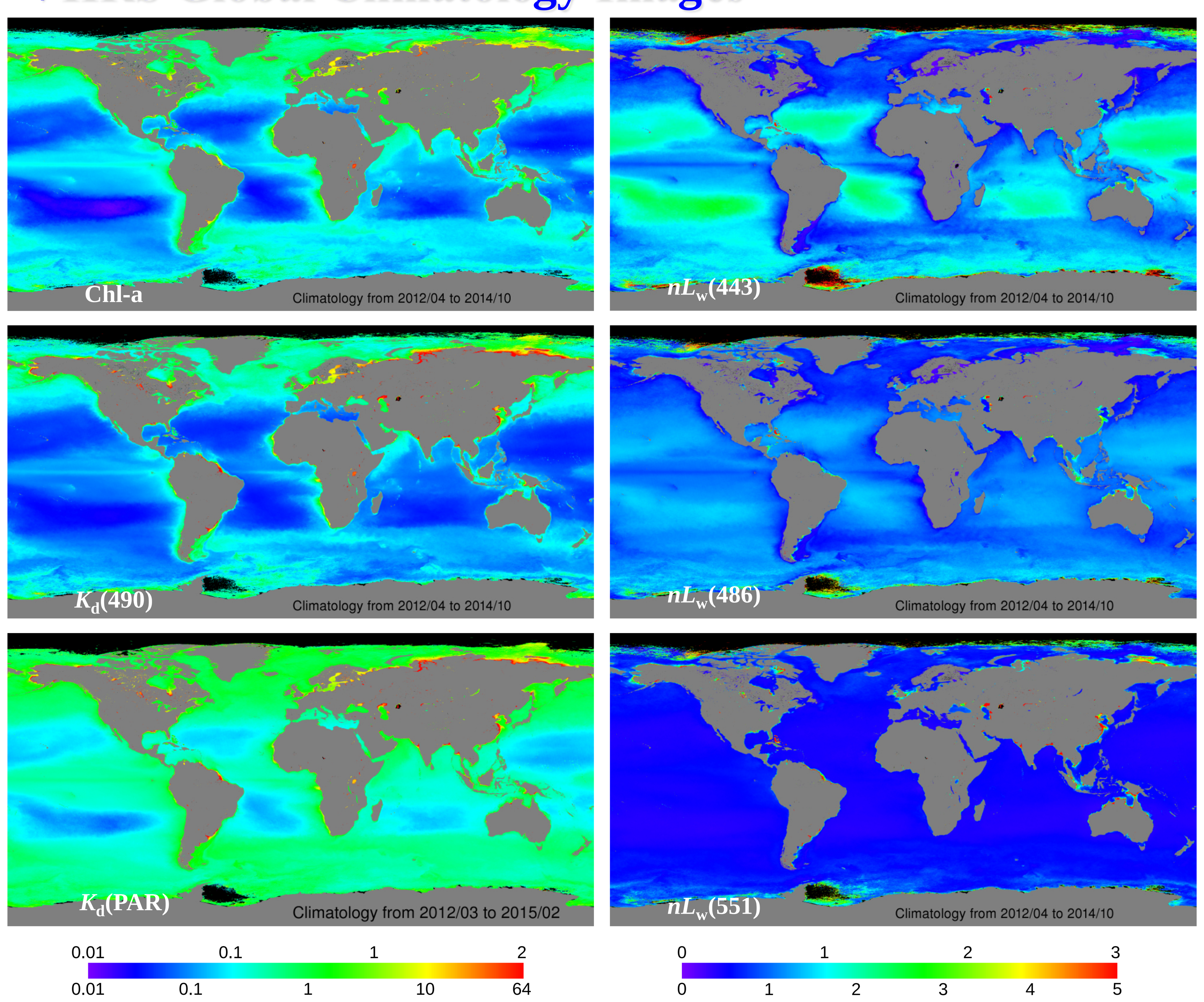

Fig. 1. VIIRS Global climatology (March 2012– February 2015) images of Chl-a (0.01–6.4 mg m^{-3}), $K_d(490)$ (0.01–2.0 m^{-1}), and K_d(PAR) (0.01–2.0 m^{-1}) in log scale, and $nL_w(443)$ (0–5 mW cm^{-2} μm^{-1} sr^{-1}), $nL_w(486)$ (0–5 mW cm^{-2} μm^{-1} sr^{-1}), and $nL_w(551)$ (0–3 mW cm^{-2} μm^{-1} sr^{-1}), in linear scale.

- In general, VIIRS Chl-a data provide similar spatial distributions as those from MODIS-Aqua (not shown here): Chl-a are low in the centers of major ocean circulation gyres, and high in high latitudes and equatorial regions.
- VIIRS $K_d(490)$ are equivalent to MODIS-Aqua in most of open oceans, but significantly improved in turbid coastal waters. VIIRS K_d(PAR) has similar spatial distribution to $K_d(490)$, but are generally higher than $K_d(490)$ in open ocean, while K_d(PAR) values are slightly lower in turbid coastal waters
- VIIRS global $nL_w(443)$, $nL_w(486)$, and $nL_w(551)$ images are consistent with those from MODIS-Aqua images.

BMW--New NIR Ocean Reflectance Correction Algorithm

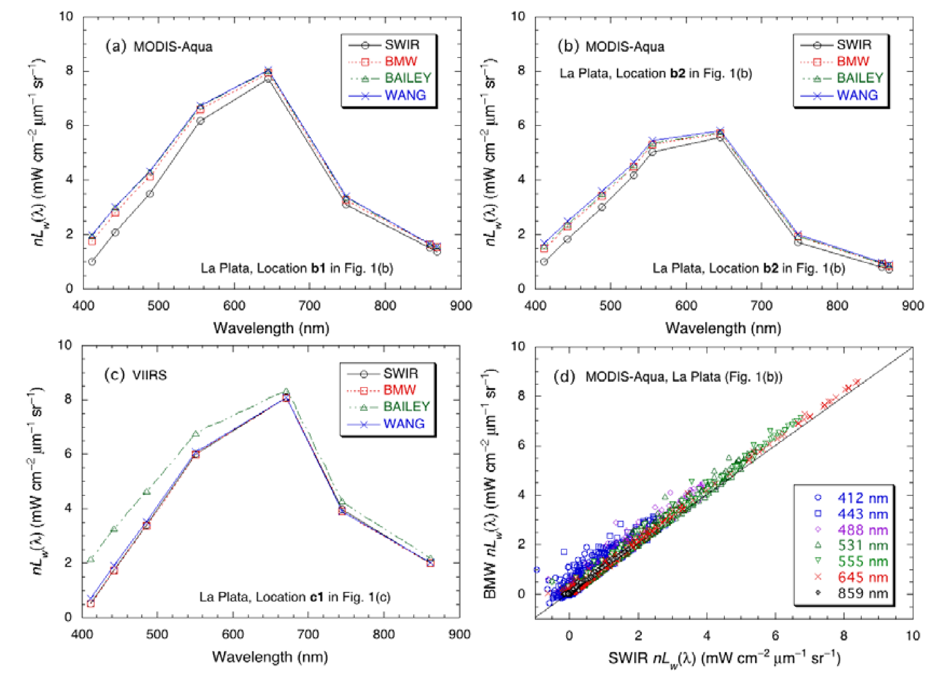

Fig. 2. Comparisons of VIIRS and MODIS-derived $nL_w(\lambda)$ spectra for 4 atmospheric correction algorithms (SWIR, BMW, Bailey, and Wang) at three stations in the La Plata River estuary (reproduced from *Jiang & Wang* (2014)).

- All atmospheric correction algorithms produce similar and typical spectral $nL_w(\lambda)$ shapes for highly turbid waters with peaks at the red band.
- *Wang et al.* (2012) algorithm performs quite well, and is very close to the BMW (*Jiang & Wang*, 2014) and SWIR (*Wang*, 2007) results at all three stations. The three NIR algorithms produce comparable but slightly higher $nL_w(\lambda)$ spectra than the SWIR results at stations b1 & b2. At station c1, Bailey (2010) method overestimates $nL_w(410)$ by ~1.5 mW cm^{-2} μm^{-1} sr^{-1}.
- The agreement between BMW and SWIR is remarkably good for $nL_w(\lambda)$ values at all bands.

Comparison with MOBY In Situ Data

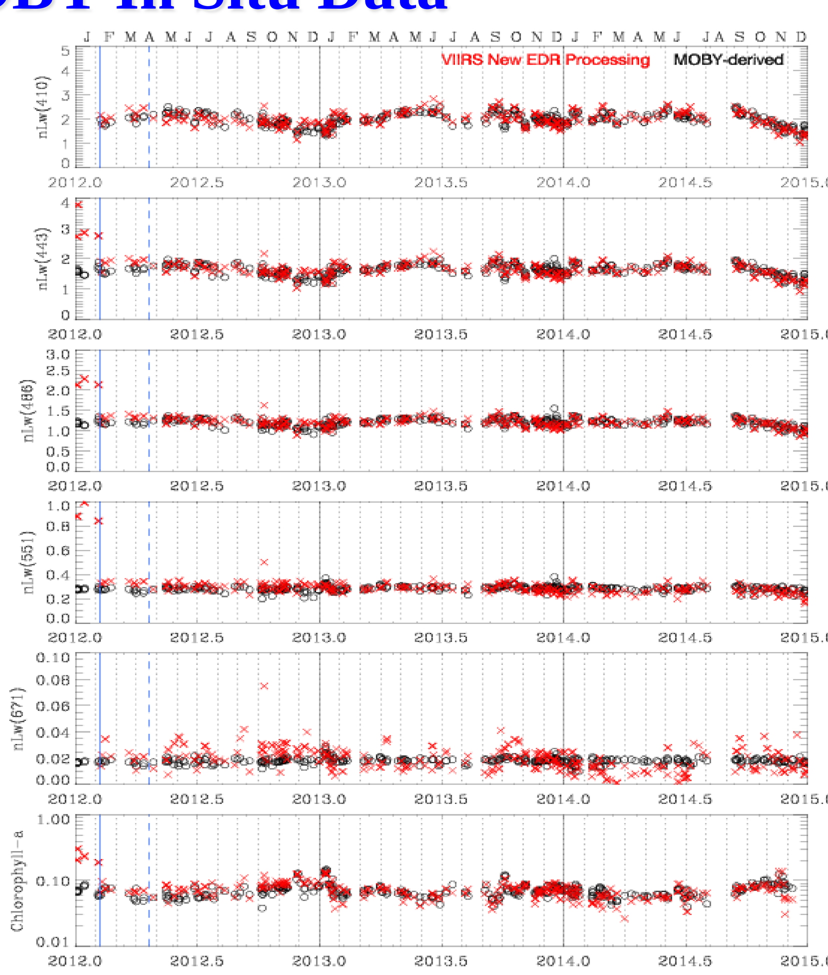

Fig. 3. Time series of VIIRS-derived $nL_w(\lambda)$ at wavelengths of 410, 443, 486, 551, and 671 nm, as well as Chl-a data (red ×) compared with those from MOBY in situ measurements (black circles). Vertical lines indicates February 6, 2012 (Solid blue), April 20, 2012 (dashed blue), and January 1 of 2013 & 2014 (dotted black).

- VIIRS ocean color products have a poor data quality before February 6, 2012, due to the incorrect use of the at-launch F-LUTs for the SDR calibration.
- VIIRS ocean color products were significantly improved since April 20, 2012, indicating importance of vicarious calibration.
- VIIRS-derived $nL_w(\lambda)$ and Chl-a data are reasonably well matched with MOBY-measured data.

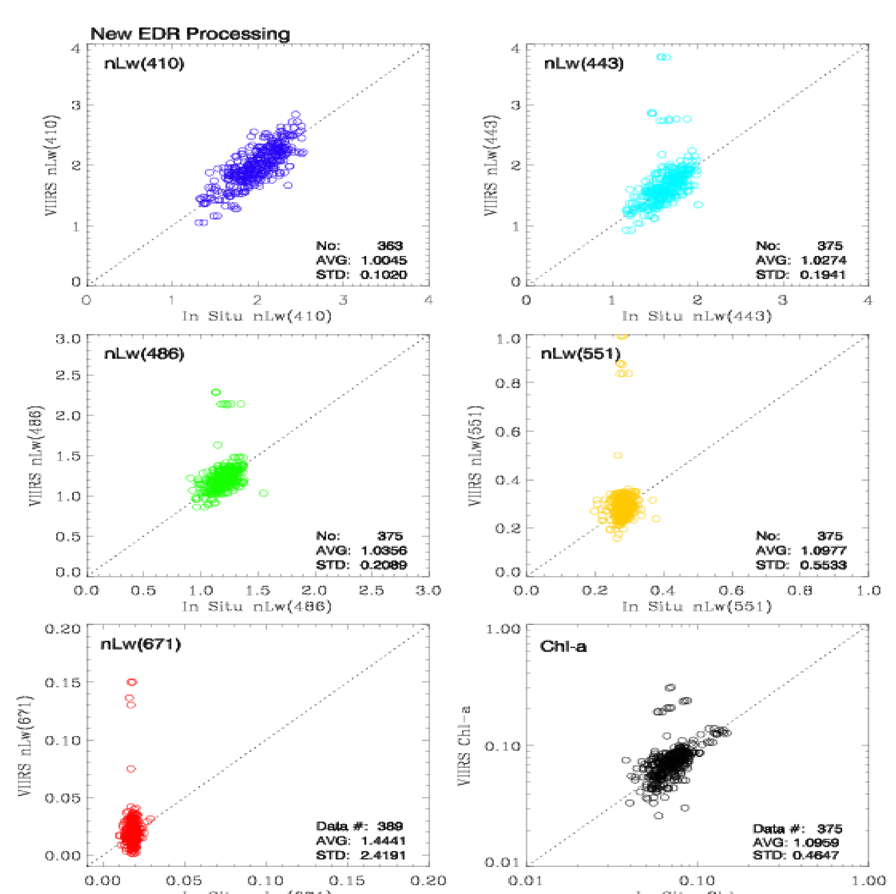

Fig. 4. Comparison of VIIRS MSL12 $nL_w(\lambda)$ at wavelengths of 410, 443, 486, 551, and 671 nm, as well as Chl-a data with MOBY in situ measurements (No: data number for the matchup comparison, AVG: average, STD: standard deviation of the ratio of VIIRS/MOBY measurements). Note that VIIRS data were derived using the new F-LUTs, and the new stray light flag was applied to VIIRS data.

- VIIRS-MSL12-derived $nL_w(\lambda)$ and Chl-a data using the new F-LUTS developed by the NOAA Ocean Color Team are compared with MOBY in situ measurements.
- With improved SDR data, VIIRS-derived ocean color data are quite accurate and highly stable.

VIIRS Compared with MODIS-Aqua at Hawaii Site

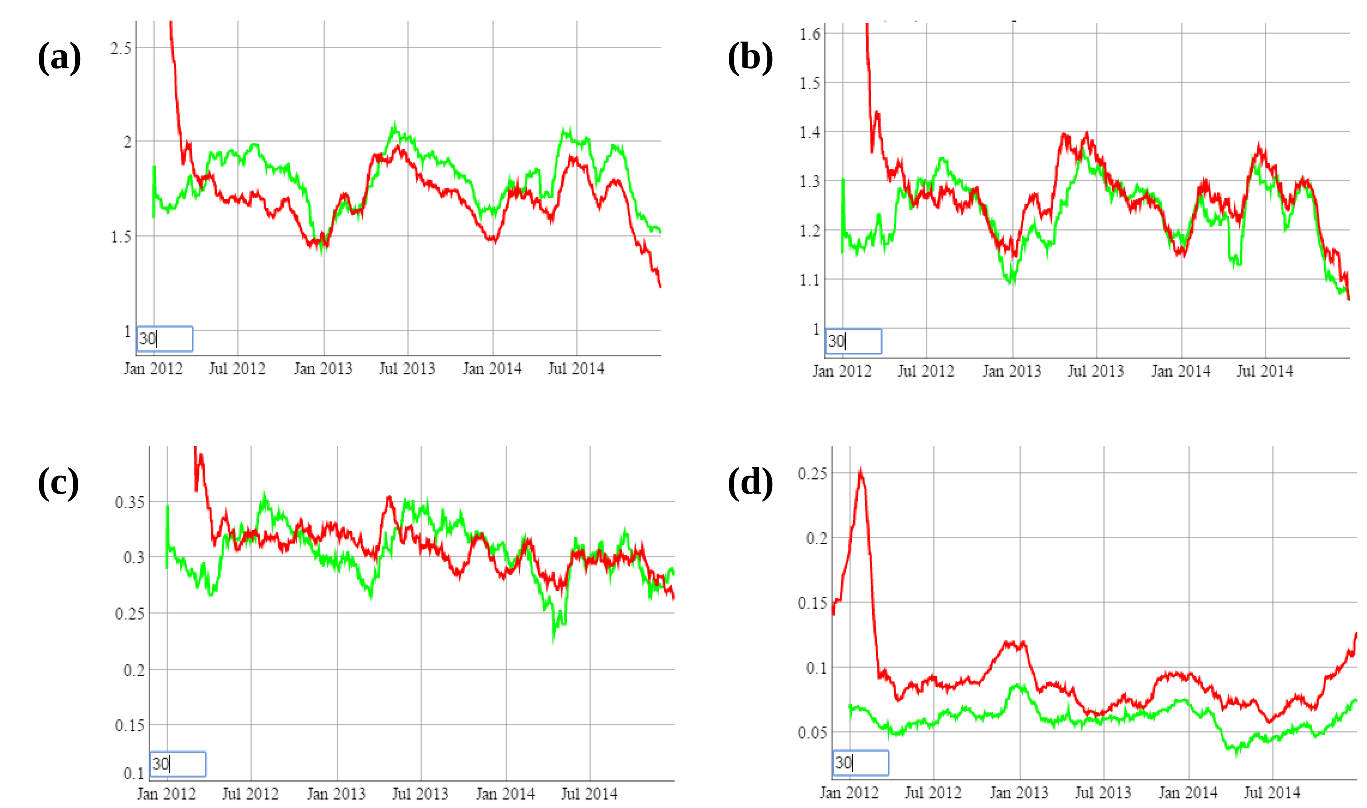

Fig. 5. Time series of reprocessed VIIRS ocean color EDR data (red) compared with those of MODIS-Aqua (green) (30-day running means) at around MOBY location for (a) $nL_w(443)$, (b) $nL_w(486)$, (c) $nL_w(551)$ (unit: mW cm^{-2} μm^{-1} sr^{-1}) and (d) Chl-a concentration (unit: mg m^{-3}).

- VIIRS $nL_w(443)$, $nL_w(486)$, and $nL_w(551)$ data are compared well and close to those of MODIS-Aqua after April 20, 2012. However, VIIRS $nL_w(\lambda)$ data are significantly higher than those of MODIS-Aqua data before April 20, 2012 due to sensor calibration issue.
- Temporal pattern of Chl-a around MOBY location derived from MODIS-Aqua and VIIRS are consistent after April 20, 2012, but the VIIRS Chl-a values are systematically higher than those from MODIS-Aqua.

Conclusions

- ➢ VIIRS ocean color EDR products using the NOAA-MSL12 data processing system are evaluated and compared with MODIS-Aqua ocean color products and in situ measurements as well as VIIRS SDR data.
- ➢ Improvements of ocean color EDR algorithms and fine-tunning of vicarious gains have significantly improved the accuracy of VIIRS ocean color products.
- ➢ Sensor calibration issues are found to lead to the difference between 2012 and 2013 in ocean color products. The current VIIRS SD/SDSM-based calibration methods were re-examined to resolve these issues (see *Sun and Wang* poster).
- ➢ The reprocessed ocean color EDR products based on the new sensor calibration are significantly improved (see *Sun and Wang* poster).
- ➢ Results show that VIIRS is capable of providing high-quality global ocean color products in support of the science research and various operational applications.
- ➢ VIIRS ocean color data have been routinely produced in support of various science research and operational applications.
- ➢ The VIIRS evaluation and monitoring results can be found at the website: http://www.star.nesdis.noaa.gov/sod/mecb/color/index.html

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