Evaluation of Remote Sensing Reflectance Between LISCO and VIIRS Measurements Over Coastal Waters

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Abstract

Remote sensing reflectance, also known as “Rrs”, manifests as the apparent optical measurement for remote sensing of ocean properties. Rrs is highly important in coastal waters due to the fact that about 5% of the down-welling radiance it bounces to the top of the atmosphere. The goal of this investigation is the analysis of in-situ and satellite data, Rrs measurements are analysed from the AERONET station LISCO and VIIRS sensor for the period of 2016. The VIIRS wavelength that we use are 410, 443, 486, 551, and 671 nm. Furthermore, we analyse the data on this bands for both data sets to verify correlation between LISCO and VIIRS, as a result bands 486 and 551 had a high correlation of 0.61 and 0.71 respectively. The overall correlation of all the wavelengths is 0.76.

Background

Apparent optical properties

- Depend both on the medium and on the geometric (directional) structure of the radiance distribution.
- Display enough regular features and stability to be useful descriptors of a water body. One of these AOP is the remote sensing reflectance.

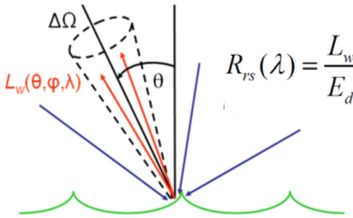


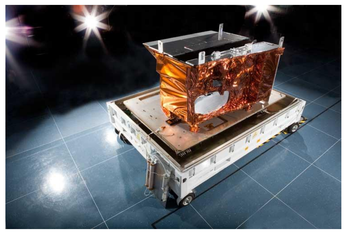
Illustration of light rays contributing to the remote-sensing reflectance (Rrs). Where is the water leaving radiance, is the down welling radiance and is the solid angle.

The Visible Infrared Imager Radiometer Suite (VIIRS) Launched October 28th, 2011.
Long time series for global climate monitoring
Specially used for Ocean color (OC) radiometry applications.

Importance:

NASA continuous temporal calibration
Based on-board calibration measurements of visible bands.

OC products that resulted from de VIIRS measurements that emphasized the sensitivity on the environmental conditions of the study.



VIIS RPhoto courtesy of Raytheon Space and Airborne Systems

AERONET

The AERONET (**AE**rosol **RO**botic **NET**work) program is a federation of ground-based remote sensing aerosol networks established by NASA and PHOTONS.
AERONET collaboration provides globally distributed observations of spectral aerosol optical depth (AOD), inversion products, and precipitable water in diverse aerosol regimes.

Methodology

Satellite data filtering procedures

- VIIRS Level 2 dataset for the period of 2016 was obtained from NASA OBPG website (http://oceancolor.gsfc.nasa.gov) .
- MATLAB code was used to match the images and measurements that were taken by VIIRS, LISCO.
- The wavelengths used in this study are 410, 443, 486, 551, 671 nm.
- The pixels used for match-up comparison are all extracted from a smaller region of 3 × 3. Pixel grid box centered at the site location.
- Pixel is excluded from the match-up comparison process if it has been flagged by land, cloud, failure in atmospheric correction, bad navigation quality, both high and moderate glint, negative Rayleigh-corrected radiance, sensor zenith angle larger than 60°, and solar zenith angle larger than 70°. Moreover, data of any individual pixels which have remote sensing reflectance with negative values in one of the wavelength. Also, data of any individual pixels which have remote sensing reflectance with negative values in one of the wavelength are also excluded.

In-situ AERONET-OC data

- LISCO Level 1.5, for the period of 2016 was obtained from AERONET website (https://aeronet.gsfc.nasa.gov)
- All in-situ data used in the quantitative match-up comparison analysis are selected from the measurements made within a ±2 h time window of the satellite overpass time of the location of the site.
- In this study, the dataset from LISCO, which is measure in normalize water leaving radiance (nLw) is converted to Remote sensing reflectance (Rrs) by using the following formula:

Rrs (sr^{-1}) = (nLw(mW sr cm^2 μm ^{1})*10)/(Fo (W m^2 μm ^{1})*c)

Where Fo is mean solar flux per wavelength, and c is the earth-sun distance correction.

Research Objectives

Problem Statement

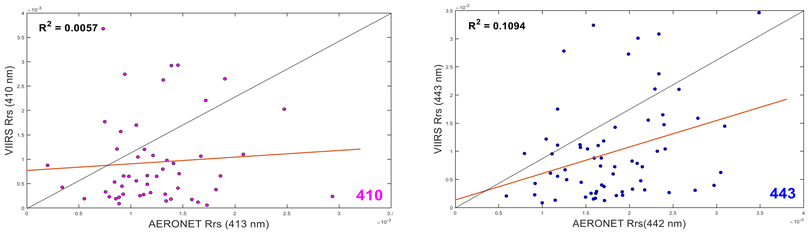
The Rrs has become the apparent optical properties (AOP) of choice for remote sensing of ocean properties. This is because we can use Rrs to calculate the concentration of chlorophyll a, turbidity, Colored dissolved organic matter (CDOM), among others ocean properties. This measurement becomes more important in coastal waters because less than 5% of the downwelling radiance is reflected into the top of the atmosphere (TOA).

Objective

The goal of this investigation is to compare Remote Sensing Reflectance between the LISCO station and VIIRS sensor at different wavelengths.

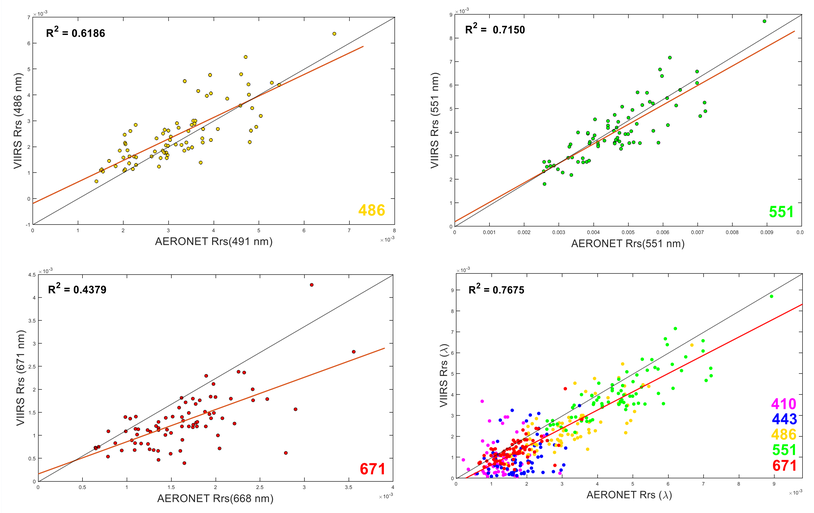
Results

AERONET vs VIIRS 2016



Results

AERONET vs VIIRS 2016



Results

High correlation between AERONET and VIIRS data for **486 and 551 nm wavelengths ranging from 0.6186 at 486 nm to 0.7150 nm at 551**. However, at **410,443,671 nm** only low to moderate correlation is attained **ranging from 0.0057 at 410 nm to 0.4379 nm at 671.**

Conclusions

The conclusion of this investigation for the period of 2016 is that the 410,443,671 nm wavelengths have low correlation and do not perform well on coastal environments. However, the 486 and 551 wavelengths have a high correlation and perform well on coastal environments. On the other hand, it is necessary to do further analysis increasing the period of time in order to observe if actual behavior is constant.

References

- AERONET (AErosol RObotic NETwork) website (https://aeronet.gsfc.nasa.gov)
- NASA OBPG website (http://oceancolor.gsfc.nasa.gov)
- Hlaing S, Harmel T, Gilerson A, Foster R, Weidemann A, Arnone R, Wang M, Ahmed S. Evaluation of the VIIRS ocean color monitoring performance in coastal regions. Remote sensing of environment. 2013 Dec 31;139:398-414.

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