Analysis of the Water Leaving Radiance Contribution to Top of Atmosphere Radiance in Oceanic and Coastal Waters

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Abstract

It is well known that the top of atmosphere (TOA) radiance signal measured by Ocean Color (OC) satellite sensor observing oceanic targets is predominantly made up of scattering of the incident solar irradiance by atmospheric components, with contributions from the water leaving radiance signal accounting for only around 10% on spectral average. However, depending on the constituents of the sea water being observed, the spectral shape of the water leaving radiance signal can vary significantly. In addition, other factors, such as aerosol load and atmospheric pressure, can also influence the magnitude and spectral shape of the TOA signal. As a result magnitude of the water leaving radiance contribution to the satellite measured total TOA signal varies spectrally. In this study we will attempt to determine the water leaving radiance contribution to TOA signal at each wavelength. TOA radiance data from The Visible Infrared Imaging Radiometer Suite (VIIRS) onboard Suomi NPP spacecraft will be used. SeaDAS OC data processing software and MATLAB programming language will be extensively utilized to analyze the data.

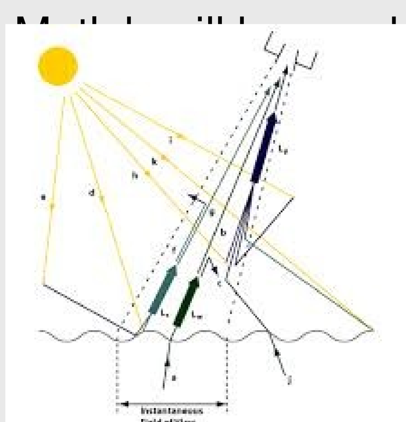
Introduction

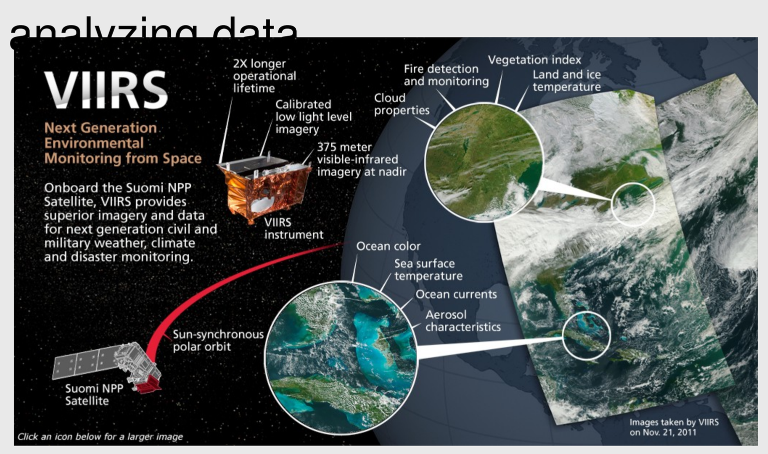
- The ocean has vital roles on Earth. For example it contributes to climate and weather, human industry, and so forth. It is well known the ocean covers 70% of the Earth's surface.
- It is necessary to monitor oceanic and coastal regions.
- Remote sensing through ocean color (OC) imagery is one of the major and efficient methods towards monitoring the ocean.
- Although current satellite OC remote sensing algorithms for analyzing oceanic waters are reasonably accurate, improvements are still necessary for OC data retrievals at the coastal waters for accurate monitoring of their conditions.

Knowledge Needed

- Radiance - a measure of the amount of electromagnetic radiation leaving or arriving at a point on a surface. It is the radiant intensity in a given direction of a small element of surface area divided by the orthogonal projection of this area onto a plane at right angles to the direction.
- The atmospheric correction algorithm
  - ($L_t = L_a + L_r + L_g + {}_{top}L_w$)
  - L_t= Total Radiance
  - L_a= Aerosol Radiance
  - L_g= Glint Radiance
  - ${}_{top}L_w$= Top Layer of Water Leaving Radiance

- Visible Infrared Imager Radiometer Suite (VIIRS) sensor aboard the Suomi National Polar-orbiting Partnership (SNPP) satellite will be used to study radiance
- Aerosol optical thickness is overestimated by satellite
- NASA Ocean Color Data will be used
- [illegible] for analyzing data





Objectives

- To quantify the contributions of different radiances to satellite measured total top of atmosphere radiance (L_T) at each wavelength.
- To analyze the data separately for oceanic and coastal regions and compare the results to identify the differences between them.

Method

- Retrieve radiance data for ocean , heavy coastal and light coastal region data from NASA Ocean Color Data which is measured by VIIRS
- Locations of regions
  - Light coastal - Gulf of Mexico
  - Heavy coastal – Long Island Sound
  - Oceanic - Hawaii
- Period :
  - Coastal regions - 2 years (2012-2013)
  - Oceanic region - 6 months
- Use Atmospheric Correction Algorithm to analyze data
- Use Matlab to:
  - Analyze the data
  - Make graphs to show correlation between radiance and wavelength
  - Make graphs to show correlation between radiance contribution and wavelength
- Limitations-changes/stability

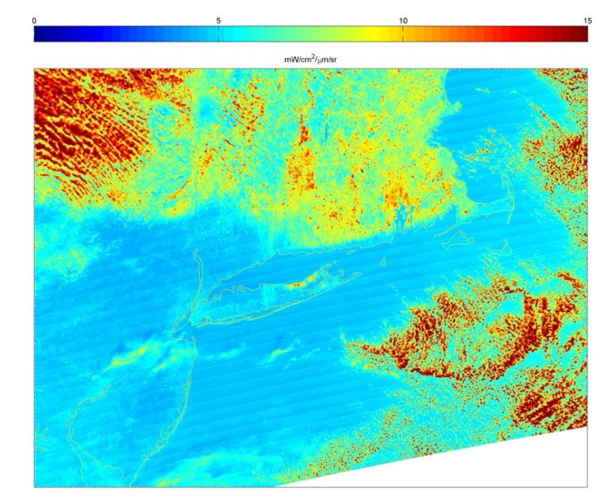
Conclusion

- The oceanic region has the greatest water-leaving radiance (L_w) contribution in blue part of the spectrum; coastal regions had the higher aerosol radiance (L_a). Also, some coastal L_w data retrievals are negative (which are subsequently excluded from the analysis); in contrast oceanic L_w data had no negative retrievals.
- For both heavy and light coastal regions, their radiance contributions reveal that L_w composes less than 10% radiance contribution of the total top of atmosphere radiance (L_T). Notably, L_w had its greatest contribution for 550 nm (green light). From 750 nm to 862 nm (red end), L_w contribution decreases close to 0. L_a exceeds molecule radiance (L_r) at 750 nm and higher (red).
- For the oceanic region, its radiance contribution shows a L_w up to 18%. In contrast to the coastal results, L_w contribution is greatest at 443 nm (blue light). From 750 nm and greater (red), the L_w contribution is 0. Distinctly, L_w contribution is greater than L_a from 443 to 550 nm (purple, blue and green).

Citation

- http://www.opticsinfobase.org/ao/abstract.cfm?uri=ao-33-3-443
- http://oceancolor.gsfc.nasa.gov/
- http://www.researchgate.net/publication/256720717_Evaluation_of_the_VIIRS_ocean_color_monitoring_performance_in_coastal_regions

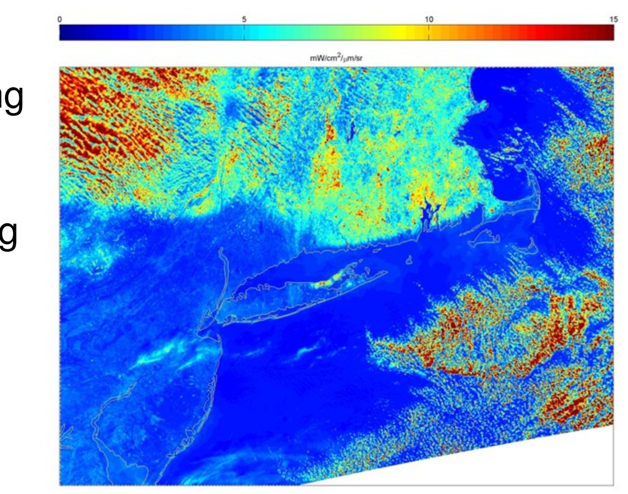
Results

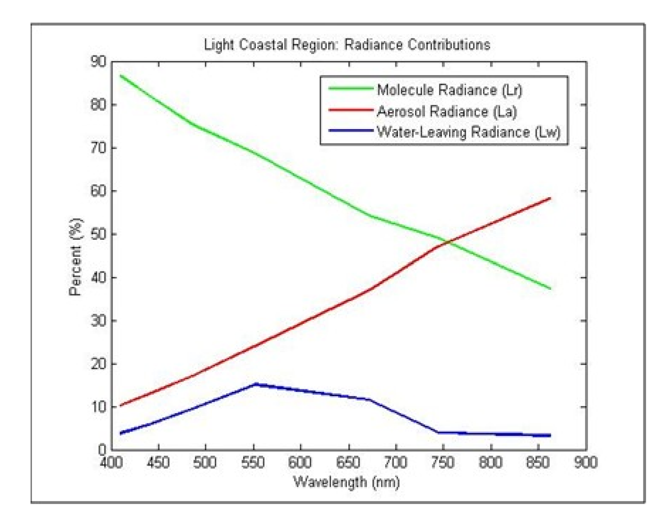


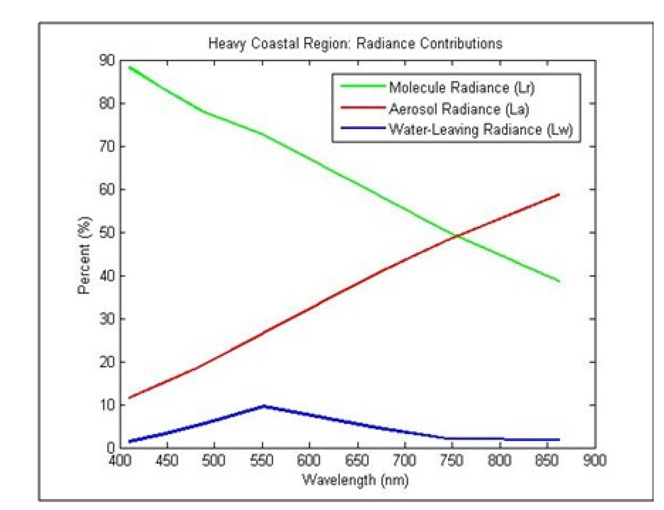
On the left is the VIIRS images of Long Island region at 412 nm channels.

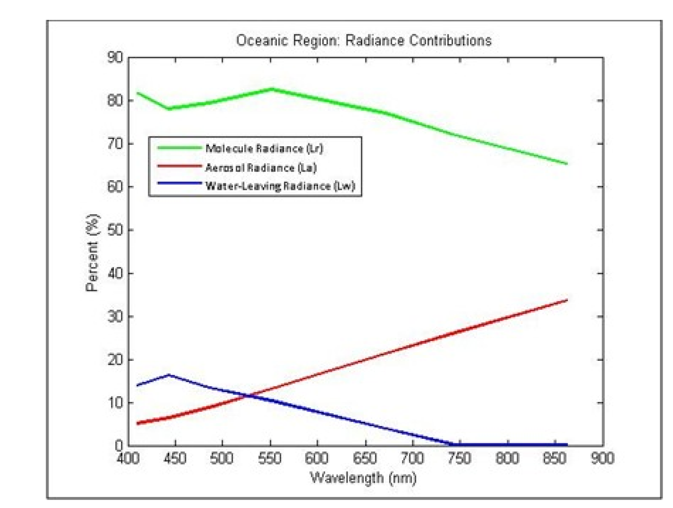
On the right is the VIIRS image of Long Island region at 551 nm channels.

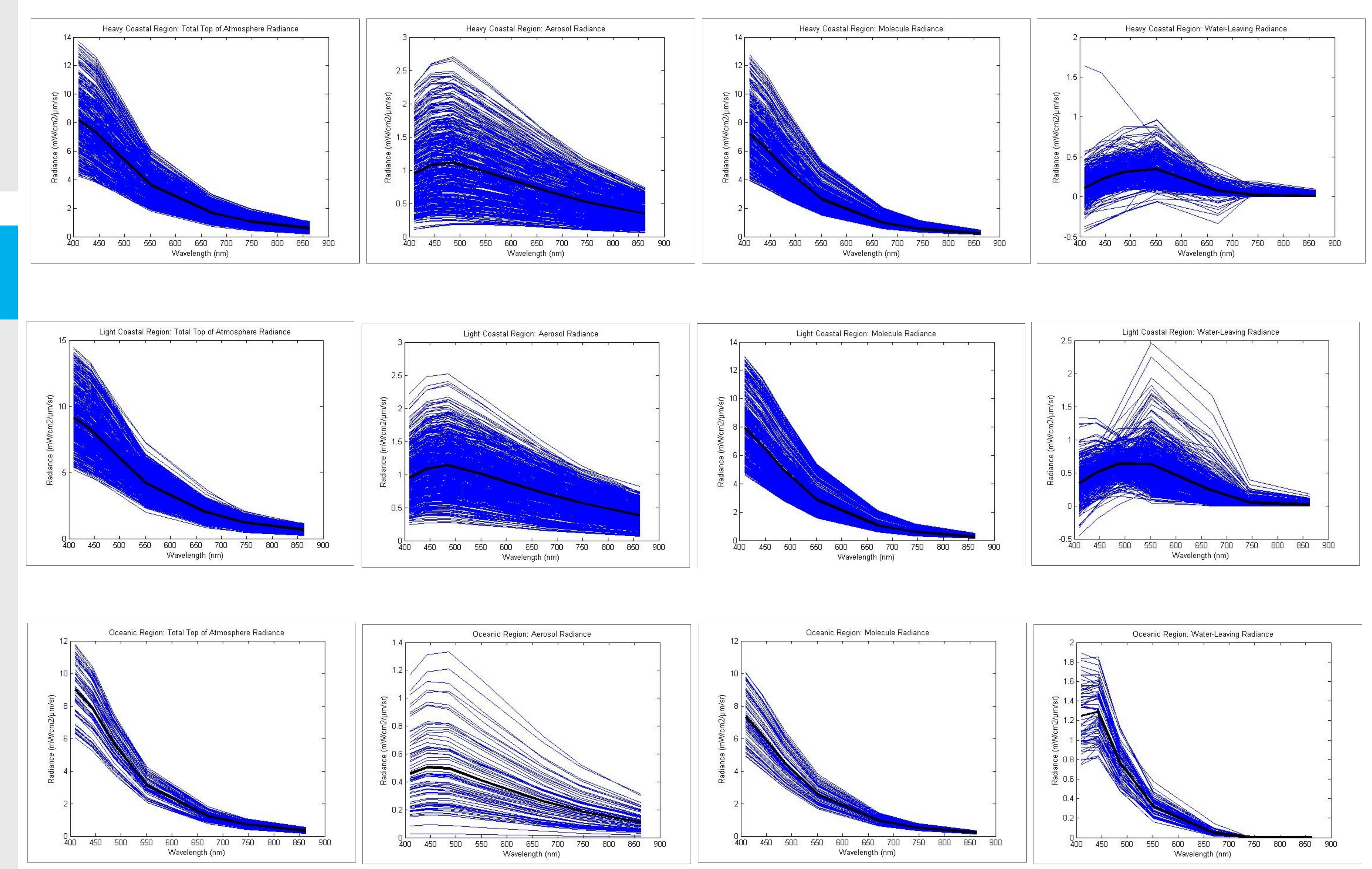
These images are obtained from the VIIRS sensor on January 20th 17:41 GM.











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