CHARACTERIZING THE DIURNAL CHANGES IN COASTAL BIO-OPTICAL PROPERTIES

Robert Arnone[1], Ryan Vandermeulen[1], Haoping Yang[1] Sherwin Ladner[2] · [1] University of Southern Mississippi Department of Marine Science, [2] Naval Research Laboratory,

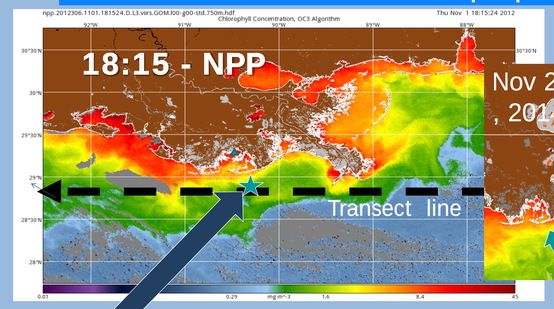
Abstract:

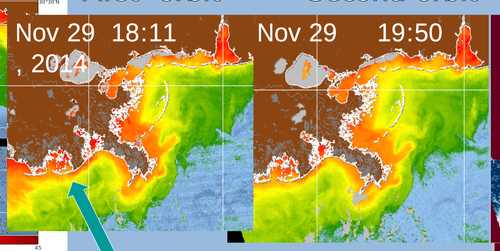
Coastal processes can change on hourly time scales, which can impact satellite ocean color bio-optical products and calibration methods for satellite comparisons. Methods to validate satellite coastal products require defining how rapidly ocean color varies. The insitu diurnal changes in ocean color in a dynamic turbid coastal region in the northern Gulf of Mexico were characterized using above water spectral radiometry from a AERONET (WavCIS CSI-06) site that provides up to 8-10 observations per day (in 15-30 minute increments). Satellite ability to detect changes in ocean color were characterized by overlapping orbits of the VIIRS–NPP ocean color sensor within 100 minutes. Changes in satellite ocean color are dependent on several characteristics with include: a) sensor characterization b) advection of water masses and c) water bio-optical changes. These insitu diurnal changes were used to quantify of natural bio-optical fluctuations while validating satellite measurements. The results show the capability of space-borne sensors to monitor ocean color in dynamic coastal regions that are impacted by tides, re-suspension, and river plume dispersion.

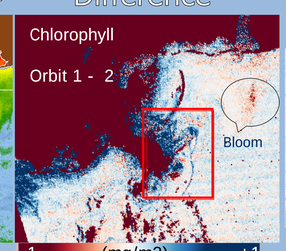
Objectives :

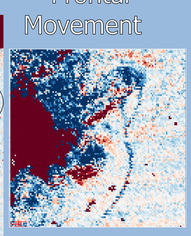
1. How rapidly do bio-optical processes change in ocean color?
2. Can the VIIRS 100 minute overlaps detect diurnal changes?
3. Changes in hourly satellite products can result from:
   a) Bio-optical changes due to blooms, decays, sediment processes and photo-oxidation
   b) Water mass advection and physical processes
   c) Sensor calibration and processing

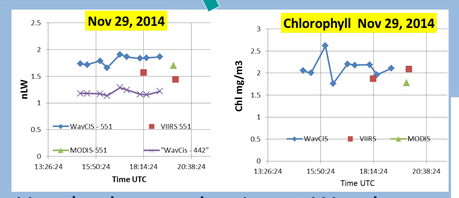
How fast can the ocean color properties change in ~100 minutes?









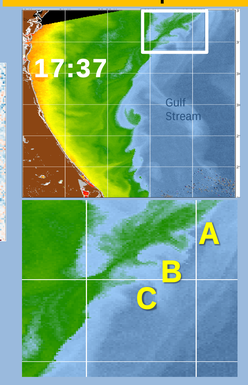


Hourly changes in nLw at Wavcis matchup VIIRS and MODIS

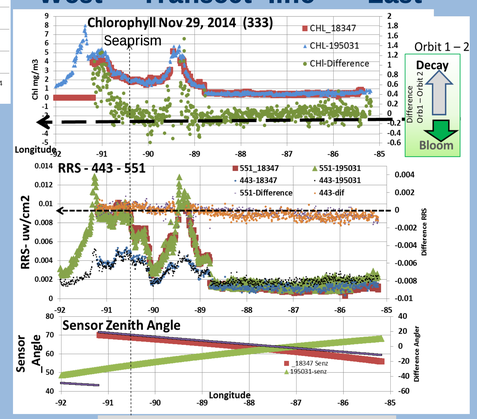
ADVECTION

Hourly changes

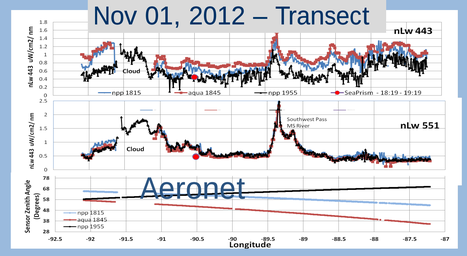
Track Bio-optics in the Gulf Stream



West Transect line East

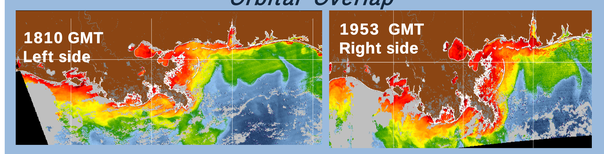


Nov 01, 2012 – Transect



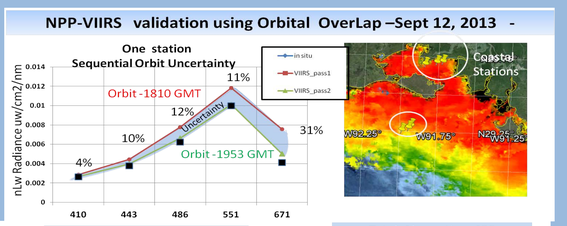
- Ocean Color product uncertainty can also be unraveled by examining values on either side of the swath.
- The color differences are not related to sensor angles - processing is being handled correctly.
- We are now looking at the BRDF Impacts !

GEOCAPE Cruise Sept 12 , 2013 - NPP –VIIRS Orbital Overlap

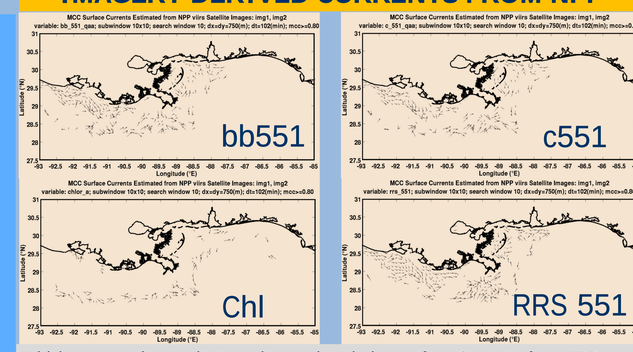


The changes in the 100 minute ocean color response can be characterized as “uncertainty”.

What is the product uncertainty between these NPP products?
Measurements or water bio-optics (Blooms, advection)?



IMAGERY DERIVED CURRENTS FROM NPP

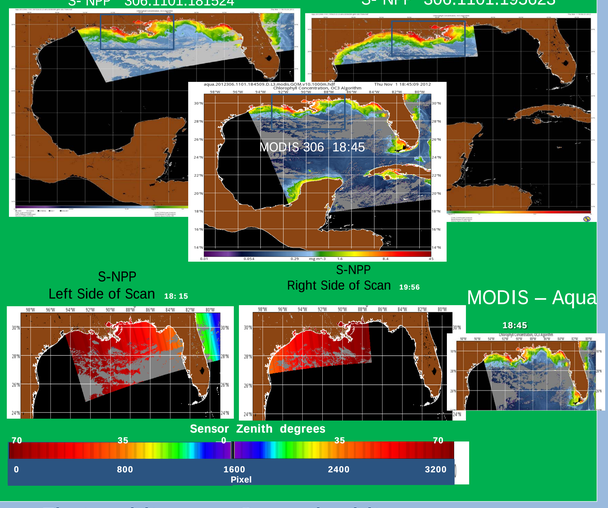


Which ocean color product can be used to derive surface Currents from NPP - overlaps?
Using Maximum Cross Correlation between images/orbits

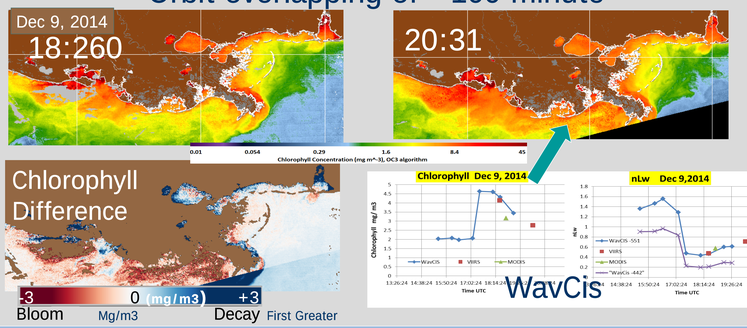
Yang, H.; Arnone, R.; Jolliff, J.; Estimating Advective near –surface currents from ocean color satellite images. Remote Sensing of Environment Volume 158, 1 March 2015, Pages 1–14

Orbital Overlapping Ocean Color Products 110 minutes!

S-NPP - Daily Orbital Overlap at ~ 30 degree latitude
~ 700 pixel Overlap - Very Similar Solar Zenith ~ 40 degrees.

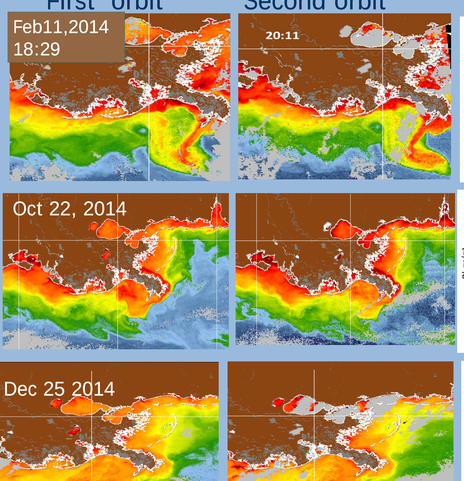


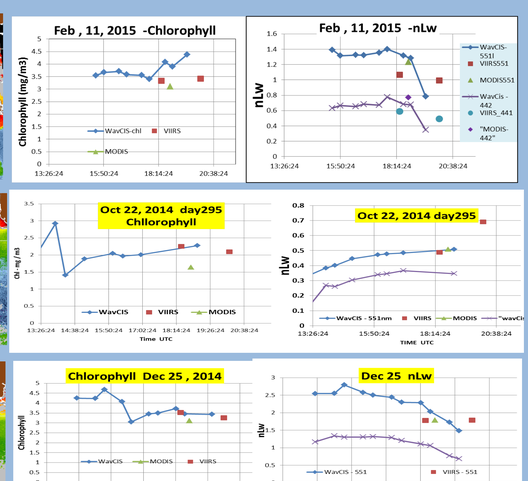
Diurnal Variability of Chlorophyll and nLw at WavCis Orbit overlapping of ~100 minute



1) The hourly changes in the ocean color are “real” as shown by the WavCis ocean color and are not satellite processing issues! Many examples of diurnal color changes.
2) The chlorophyll difference over ~100 minutes between the earlier orbit to the later orbit can identify active ecosystem coastal regions and represent the advantages of a geostationary sensor for characterizing coastal processes. These changes occur from water mass advection and biological activity (i.e. blooms, decay, etc.).
3) The difference image identifies the locations of diurnal changes and if biological activity is blooming or decaying.
4) A geostationary sensor will enable identification of the rates of changes for these processes at different locations. These rates are essential to ecological models for forecasting.

First orbit Second orbit





Summary:

- *Diurnal processes (hours) occur in coastal regions which impact the ocean color signatures.*
  - *WavCis SeaPrism shows hourly color response in the nLw*
- ***VIIRS overlaps detected the diurnal hourly ocean color !!!***
- *100 minute ocean color changes were shown in VIIRS overlapping scenes showing diurnal processes.*
- *Rapid ocean color changes “must “ be accounted for in coastal satellite calibration/validation.*
- *Ocean Color Changes occur from :*
  - *Water mass Advection → Ocean Color can be used to estimate surface currents!*
  - *Bio-optical changes (blooms and decay)*
- ***VIIRS OVERLAP ocean color can be used to derive surface currents!!!***
- ***DIFFERENCES in chlorophyll within 100 minutes identify Phytoplankton BLOOMING and DECAYING regions !***

Arnone, R., S. Ladner, G. Fargion, P. Martinolich, R. Vandermeulen, J. Bowers, and A. Lawson, “Monitoring bio-optical processes using NPP-VIIRS and MODIS-Aqua ocean color products,” *Proc. SPIE* 8724, Ocean Sensing and Monitoring V, 87240Q (June 3, 2013),

Vandermeulen, R. A.; Arnone R. ; Ladner, S.; Martinolich, P. “Improved monitoring of bio-optical processes in coastal and inland waters using high spatial resolution channels on SNPP-VIIRS sensor” *Proc. SPIE* 8724, Ocean Sensing and Monitoring V, 87240Q (June2013), http://dx.doi.org/10.1117/12.2018180. Accepted Remote Sensing of the Environment Nov 2014