Seasonal trends of ACSPO VIIRS SST product characterized by the differences in orbital overlaps for various waters types

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Abstract

The uncertainty of the Advanced Clear-Sky Processor for Oceans (ACSPO) Sea Surface Temperature (SST) products from the Visible Infrared Imaging Radiometer Suite (VIIRS) satellite is examined using consecutive orbital overlaps in coastal waters of the Gulf of Mexico. The overlapping region on the left and right side of the VIIRS swath at 23-35 degree latitude covers approximately 500 pixels, which occur within 100 minutes and can provide a total of 4 SST products (2 day and 2 night) per day. By assuming the ocean SST should be similar on each side of the swath in this short time period, diel changes are examined and the uncertainty of SST retrieval is determined by comparing with buoy-derived SST. The VIIRS ACSPO product from NOAA STAR was used to determine the difference in SST within the overlapping regions. These SST changes are evaluated between consecutive orbits to validate the accuracy of SST algorithms on each side of the swath at high sensor angles. The SST product differences across the swath can result from surface glint, sensor angular impacts and sensor characteristics such as half angle mirror side (HAM) and calibration. The absolute diurnal SST changes that can occur within 100 minutes are evaluated with the buoy and VIIRS-derived SST. Sensitivity of the SST to water types is evaluated by measuring diurnal differences for open ocean, shelf and coastal waters. The 100 minute VIIRS SST overlap shows the capability to monitor the diurnal ocean heating and cooling which are associated with water mass optical absorption. The seasonal trends of the difference in SST at the overlaps for these water masses were tracked on a monthly basis. The unique capability of using the same VIIRS sensor for self-characterization can provide a method to define the uncertainty of ocean products and characterize the diurnal changes for different water types.

Objective :

- **Characterize the uncertainty in ACSPO SST retrievals for VIIRS Coastal, Shelf and Offshore waters in Gulf of Mexico**
- **Examine the SST retrieval using the VIIRS Orbital Overlap**
  - **Examine the SST changes within 100 minutes**
  - **Left and Right sides**
- **Evaluate the uncertainty in SST retrievals as a diurnal response in day and night.**
- **Examining differences in the SST in the overlaps change with season**
- **ACSPO NOAA STAR processing algorithms.**

https://podaac.jpl.nasa.gov/dataset/VIIRS_NPP-OSPO-L2P-v2.3

SST Data set used:

- **NOAA ACSPO – VIIRS Processed – from JPL**
  - **Cloud mask - Only used the Confidently Clear data.**
- **Selected overlap imagery within 100 minutes in Gulf of Mexico**
  - **Day and Night overlaps**
  - **Began on May 2014 to Jan 2015.**
- **Selected Different water types.**
  - **Offshore, Shelf and Coastal Mobile Bay waters.**
- **Buoys from different water locations provided diurnal in situ SST- Validation hourly SST .**
- **Extracted SST Match analyses using individual pixel and within 60 minutes**

Questions to Address:

- **What are SST differences occur between VIIRS overlaps?**
  - **How do Side 1 and Side 2 of VIIRS SST retrievals compare?**
  - **Evaluate the Day and Night retrievals in the Overlap.**
- **How does the VIIRS SST differences compare with the insitu?**
- **Can VIIRS Overlaps of 100 minutes resolve the diurnal SST from the Buoy?**
- **How does the SST retrievals compare in Coastal and Offshore waters?**
- **Do we observed a seasonal trend in the difference in SST VIIRS Overlaps and Buoy?**

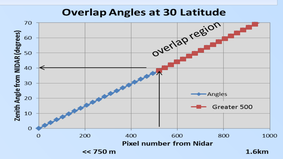
19 Over laps set to define the Seasonal from May 2014 to Jan 2015 Gulf of Mexico

OverLap can occur in Day and Night for a total of 4 images perday.

At 30 degrees Latitude there is approximately 512 Pixels overlap within 100 minutes.

Satellite Zenith angles range from 40 – 70 degrees

The same ocean location is being viewed from a different angle with 100 minutes and changes should be small



WHAT Can Cause Differences in SST in the overlap ?

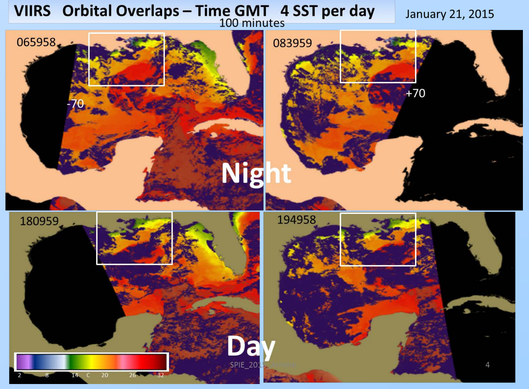
- **The SST retrievals algorithms account for angular impacts.**
- **Sensor calibration .**
- **Diurnal variability , surface waters heating or cooling .**

Can we use orbital overlap SST to track the trends in the SST accuracy?

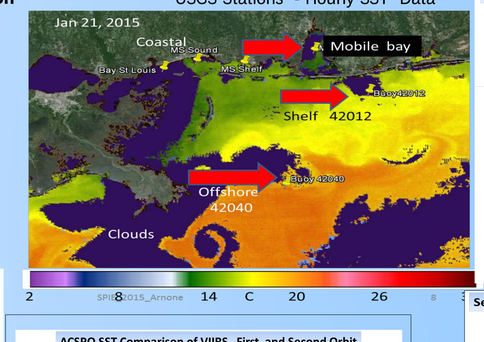
Does SST overlap differences change throughout the year and do these trends come from natural variability or sensor calibration?

VIIRS Orbital Overlaps – Time GMT 4 SST per day

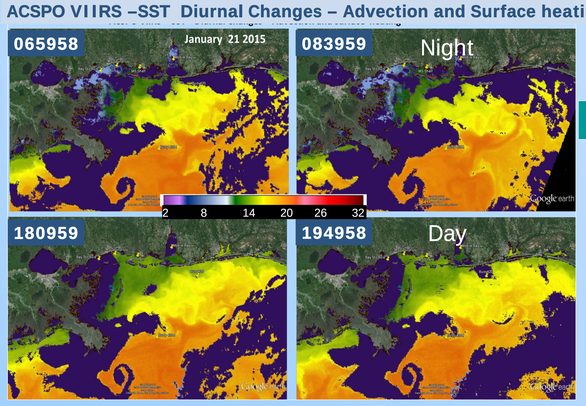
January 21, 2015



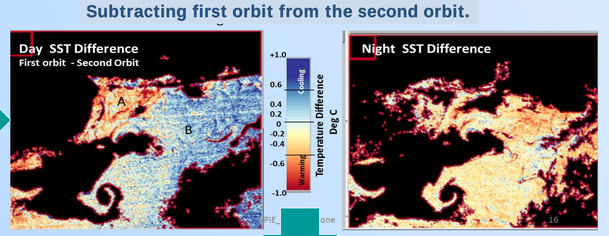
Watermass – Coastal , Shelf and Offshore
Buoy Locations for SST used in matchup
USGS Stations - Hourly SST Data



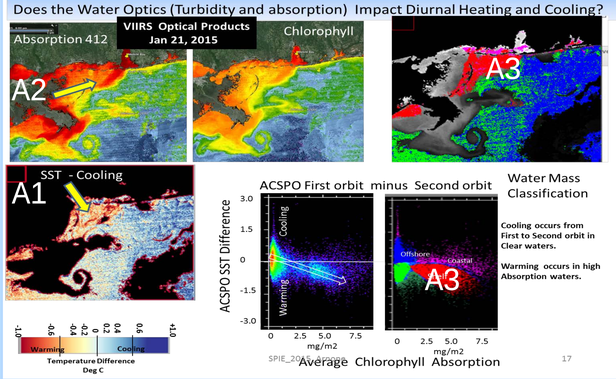
ACSPO VIIRS –SST Diurnal Changes – Advection and Surface heating



Subtracting first orbit from the second orbit.



Does the Water Optics (Turbidity and absorption) Impact Diurnal Heating and Cooling?



Diurnal changes in SST overlaps can be linked with the ocean color and optics water properties. VIIRS regions of high absorption 443 defined by ocean color, are areas where diurnal heating can occur. The coastal areas (A) which are shown as high warming in the SST overlaps (A1) are areas of elevated Absorption (A2).

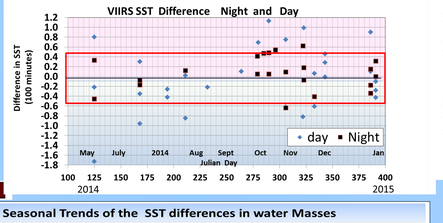
The water mass classification shows the relationship of diurnal heating and cooling and absorption.

Seasonal Trend of SST differences between VIIRS overlaps?

How do Side 1 and Side 2 of VIIRS SST retrievals compare?
Evaluate the Day and Night retrievals in the Overlap.

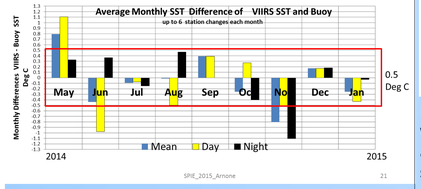
Night is Closer to 0 (Black) Not as much Difference.
Day may have a diurnal heating and Larger Difference.

Average Difference 0.01885°
Absolute Difference = 0.41°



Monthly Trends of SST Coastal Data Set

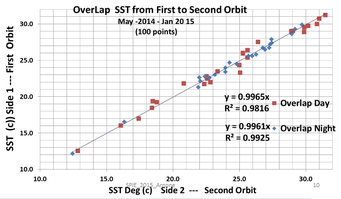
- Matchup of the SST from VIIRS with Buoy in the 3 Waters types
- Majority fell within the ranges of 0.5 degree C
- Trends showing improvements



ACSPO SST Comparison of VIIRS First and Second Orbit

First orbit Side 1 Right
Second orbit Side 2 Left

- SST within 100 minute of First and Second orbits similar
- Similar for both the Day and Night orbits. .



SST Comparison - ACSPO First and Second Orbit with Buoy

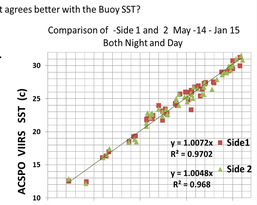
Which Orbit agrees better with the Buoy SST?

Includes both day and night Matchup
50 points both day and night.

Both sides show similar Correlations
Includes All water types.

Matchup Uses the hourly Buoy Time to orbit.

First Orbit Side 1 Right
Second Orbit Side 2 Left



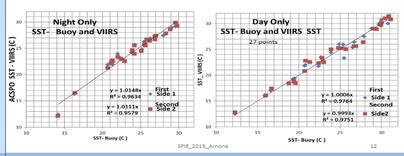
How does the Day and Night matchup compare?

Day or Night

SST Comparison of Left and Right Orbital Swath with Buoy (100 minutes)

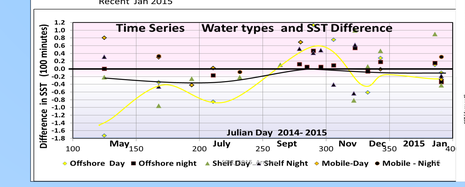
First Orbit Side 1 Right
Second Orbit Side 2 Left

Minimal Difference in first or second orbit for Day or Night



Seasonal Trends of the SST differences in water Masses

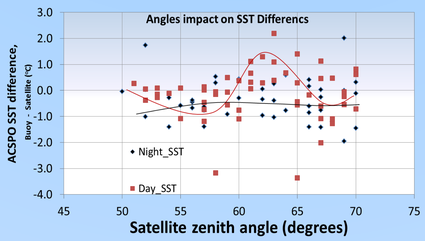
How do Side 1 and Side 2 of VIIRS SST retrievals compare?
Evaluate the Day and Night retrievals in the Overlap.
Night is Closer to 0 Black
Day has a diurnal heating and Larger Difference.
Is the Day Difference coming from Diurnal heating?\
Offshore, Shelf and Mobile water masses are all similar ..
Recent Jan 2015



Does the Satellite Zenith Angle affect the SST ?

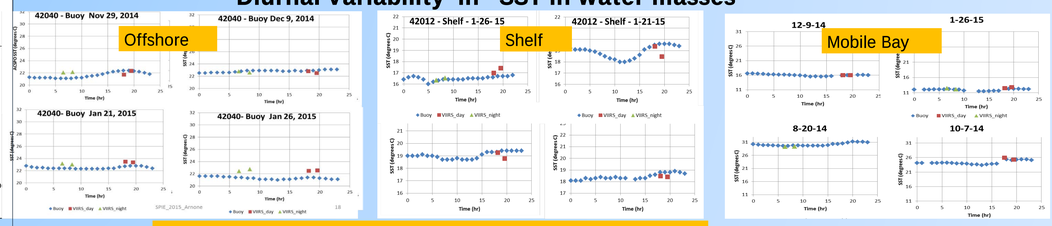
Angles difference vs SST difference Satellite from Buoy (Day and Night)

- Trends show similar differences of ACSPO VIIRS and Buoy -- independent of angle



ACSPO SST algorithms are handing the angles correctly

Diurnal Variability in SST in water masses



Diurnal Changes in the SST are validated in VIIRS Overlap

Summary and Conclusions

1. **VIIRS 100 minute Orbital overlap used to evaluate the ACSPO SST in coastal waters**
2. **Show excellent agreement between overlaps SST overlap orbits**
   - **SST algorithms are handling high satellite zenith angles and Half Angle Mirror Side**
3. **ACSPO SST matchup with buoys in coastal , shelf and offshore waters was excellent.**
4. **Overlaps SST differences appear associated with diurnal warming and cooling**
   - **Higher SST changes occur in Day time Compared with Night**
   - **Different water masses (Turbidity) have different diurnal warming and cooling**
5. **ACSPO SST can define diurnal changes in coastal and offshore waters**
   - **Suggests that SST validation should account for short term heating and cooling that can occur.**
6. **Minimal trends of the overlap SST difference suggests the stability of the product.**
   - **Future efforts will examine if differences are linked with the seasonal heating cycle**

Arnone, R., Vandermeulen, R. · Ignatov, A. Cayula , J.-F. (2015) "Seasonal trends of ACSPO VIIRS SST product characterized by the differences in orbital overlaps for various waters types", 2015 SPIE *Proc. SPIE* Ocean Sensing and Monitoring VII, 9459 (June2015), Baltimore Ocean Sensing and Monitoring VII Proc of SPIE Vol 9495)OT-1 – OT-7 edited by W. Hou and R. Arnone editors.

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