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Differences in Three Unique High Resolution VIIRS Sea Surface Temperature Datasets

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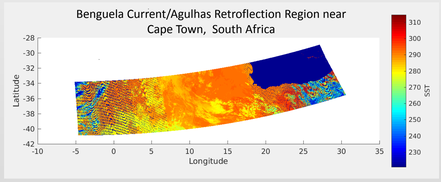
Introduction

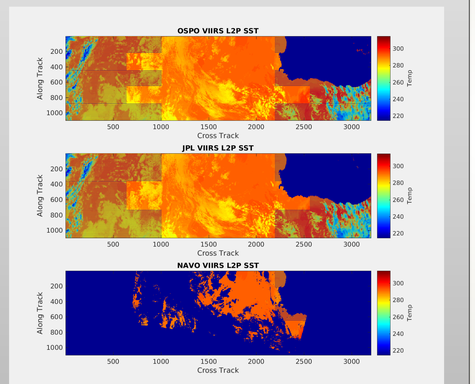
Deciding on which oceanographic dataset to choose among the multiple data sources is often a challenge for users. Understanding the difference among Sea Surface Temperature (SST) datasets is a critical factor in the successful applications of using SST in research. The Level 2 VIIRS SST datasets archived at the Global Data Assembly Centre (**GDAC/PO.DAAC**) come from multiple producers, including US Naval Oceanographic Office (**NAVO**), NOAA Office of Satellite and Product Operations (**OSPO**), NASA Jet Propulsion Laboratory (**NASA/JPL**), and others. Even though they may be generated with the same well-known 2 or 3 infrared-channel algorithms, for example the VIIRS L2P SST, their solution could vary across the data producers which could use different cloud masking, contamination detection, and algorithm quality assessments. In this study, we present and analyze the differences that arise from comparing several VIIRS L2P infrared SST datasets for the region of Benguela Current/Agulhas Retroflection. We have discovered that the quality_level and l2p_flags used in different SST datasets are sometimes not consistent, which could be a potential error source for SST aggregation and climatic modeling. The implications of these differences could be significant for users in selecting the proper SST datasets for their science research and/or applications. The main objective of this study aims to reveal these differences in the SSTs from independent VIIRS satellite processing algorithms.

Three unfiltered VIIRS L2P SST datasets in study region

Datasets:

1. Location of study region (Top Fig) is bounded by Lat = [-6^0, 32^0] and Lon = [-28^0, -42^0], covering partial Benguela Current and Agulhas Retroflection region near Cape Town, South Africa. Equivalent to 1100x3200 pixels in size.
2. Three VIIRS L2P SSTs (Bottom Fig) are of 750 m high resolution, but packed in different file sizes.
   1) OSPO VIIRS L2P SST: 10-min scans (5392x3200 pixels).
   2) JPL/OBPG VIIRS L2P SST: 6-min scans (3248x3200 pixels).
   3) NAVO VIIRS L2P SST 1-meter: 1.5 min scans (768x3200 pixels).
3. Granule matchup is applied to match the three datasets to the study region.

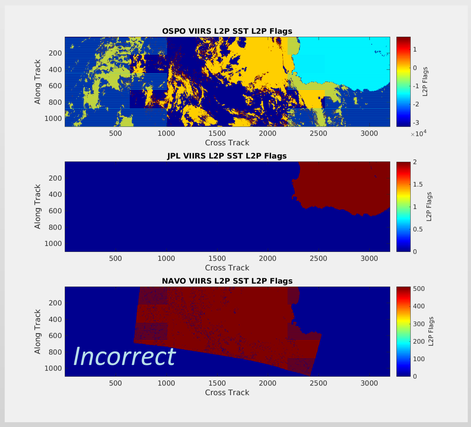


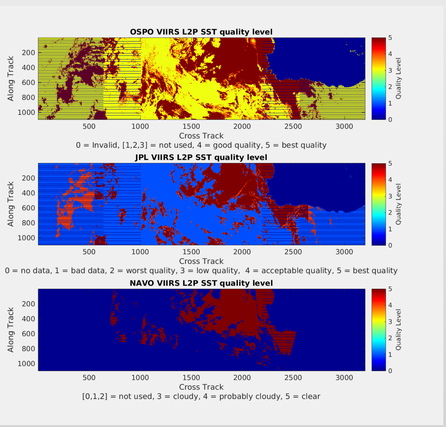


Comparison:

- NOAA OSPO (top) and NASA JPL (middle) images show very similar SST retrievals over the entire ocean surface.
- NAVO (bottom) shows the SST 1-meter retrievals only within high quality region (clear sky), having much less SST retrievals.

Differences in VIIRS SST L2P Flags and Quality Level





Comparing L2P Flags and Quality Level:

- L2P Flags (left Fig) shows that OSPO SST has much more flagging information, including surface type, day/night, twilight, sun glint, snow/ice, and more, but JPL SST defines the l2p_flags only as "microwave land ice lake river". ***Warning**: NAVO SST v3.0 l2p_flags currently is incorrect, and will be fixed soon.*
- Quality Level (right Fig) comparisons:
  1. All three datasets have same range of quality levels from 0 (low) to 5 (high).
  2. Each dataset assigns the quality level differently, except highest level.
  3. The NAVO dataset in the study area only provides two quality levels: 'clear' or 'not_used', even though it has levels of "probably cloudy" and "cloudy".
  4. Meaningful comparison can only made within highest quality region.

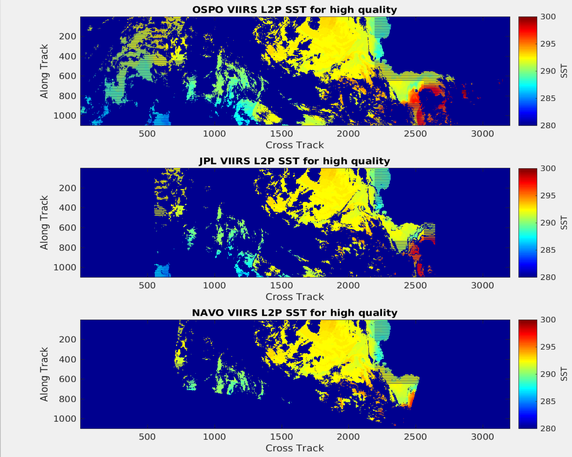
Comparing Three VIIRS SST retrievals in highest quality region

Method:

- Filtering the three VIIRS SST retrievals with the quality_level = 5, the highest quality level (clear sky or best quality).
- All the other areas are filled with _Fillvalues (NaN in matlab).
- Three SST Imageries (right Fig) have been rescaled in between 280-300 degree (kelvin).

Comparison:

- The highest quality regions in the three datasets show significant different coverages.
- The OSPO SST has the most overage with about 897520 pixels or 25.5%, JPL SST has 634000 pixels, or 18%, and the NAVO SST has 625160 pixels or 17.7%



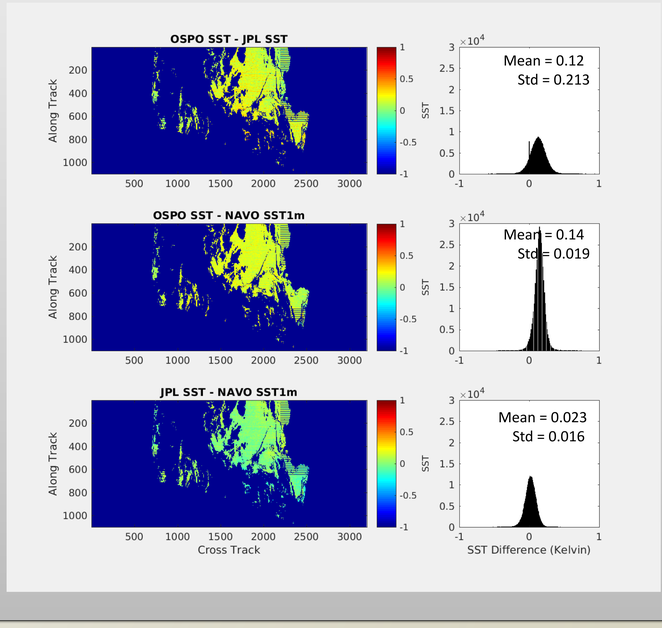
Three SST Differences in a common highest quality region

Method:

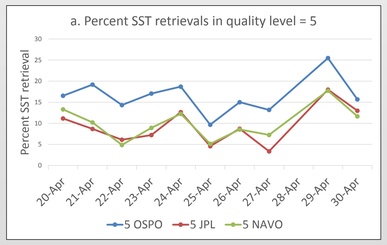
- Construct a common mask for all three SSTs within the highest quality_level.
- Take the difference of any paired SSTs filtered by the common mask.
  1. OSPO SST – JPL SST (Top)
  2. OSPO SST – NAVO SST (Middle)
  3. JPL SST – NAVO SST (Bottom)
- Plot the histogram (right) of the SST difference and compute its mean and std dev.

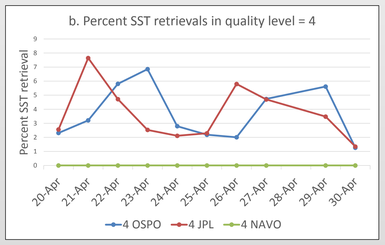
Comparison:

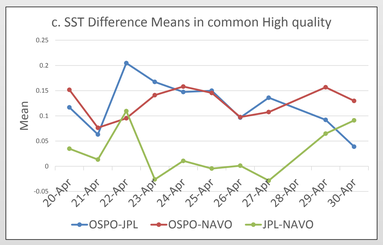
- Bigger difference (bias) between OSPO and JPL, and between OSPO and NAVO with mean = 0.12 and 0.14.
- The JPL and NAVO SSTs are very close with mean = 0.023 and std =0.016.
- More variation between OSPO and JPL with std = 0.213.

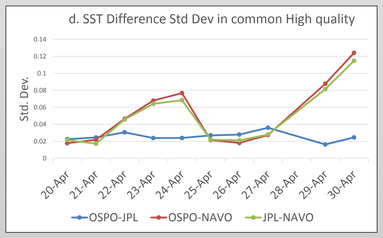


Three SST retrievals vary in 10 days in study region









Method:

- Select a region with 1100x3200 pixels in size from April 20th to 30th.
- Calculate the total pixels and percentage of SST retrievals in the region for quality_level = 5 (Fig. **a**) and 4 (Fig. **b**) per day.
- Compute the Mean (Fig. **c**) and Std Dev (Fig. **d**) of SST difference within the **common** mask at quality_level = 5.

Comparison:

- For quality-level = 5 (Fig. **a**), the OSPO produces more SST retrievals than other two constantly. JPL and NAVO produce very close amount of SST retrievals, but less.
- For quality-level = 4 (Fig. **b**), NAVO has no SST retrievals, but OSPO and JPL do. However, Fig. **b** doesn't show obviously correlation trend between them.
- Within the common mask:
  1. Fig. **c** shows that JPL and NAVO SSTs have the smallest mean difference (close to 0^0 k bias), while OSPO has relative bigger mean difference compared to JPL and NAVO SSTs with 0.1^0 k bias.
  2. The std dev plot (Fig. **d**) shows that OSPO and JPL SSTs have the smallest spatial variation (~ 0.02), while NAVO SST has relative bigger spatial variation compared with OPSO and JPL SSTs.

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