Regional validation and potential enhancements to NOAA polar ACSPO SST products

Yanni Ding[1,2], Alexander Ignatov[1], Michael Grossberg[3], Irina Gladkova[1,3], Calvin Chu[3]

[1]STAR, NOAA Center for Weather and Climate Prediction (NCWCP), USA
[2]CIRA, Colorado State University (CSU), USA
[3]City College of New York, USA

❖ Introduction

The ACSPO (Advanced Clear-Sky Processor for Ocean) Regional Monitor for SST (ARMS; www.star.nesdis.noaa.gov/sod/sst/arms/) system has been developed to monitor NOAA SST products online in near-realtime. ARMS is designed to complement the global validation in the SST Quality Monitor (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam/), with a focus on areas users interested in: coastal and internal waters, high-latitudes, dynamic or cloudy regions. These regions are often challenging for SST producers too (e.g., dynamic ocean are often masked by cloud mask, SST algorithms are subject to large errors in the high-latitudes, etc.) In addition, the ARMS is a first step towards development of high-quality gridded L3C (collated) and L3S (super-collated) products. Data from different passes/satellites are studied for consistency, in presence of variable diurnal cycle, cloud cover, and view geometry.

❖ ARMS (ACSPO Regional Monitor for SST)

- Fig. 1 shows a screenshot of the ARMS system. On the left is the control panel. The SST map is generated using the NOAA Coast Watch Data Analysis Tool (CDAT).
- Currently monitored in ARMS are 20 regions in the Atlantic, Pacific and Arctic Oceans, and one inland sea.
- ARMS monitors clear- and all-sky ACSPO SSTs and ΔSST (SST – reference SST).

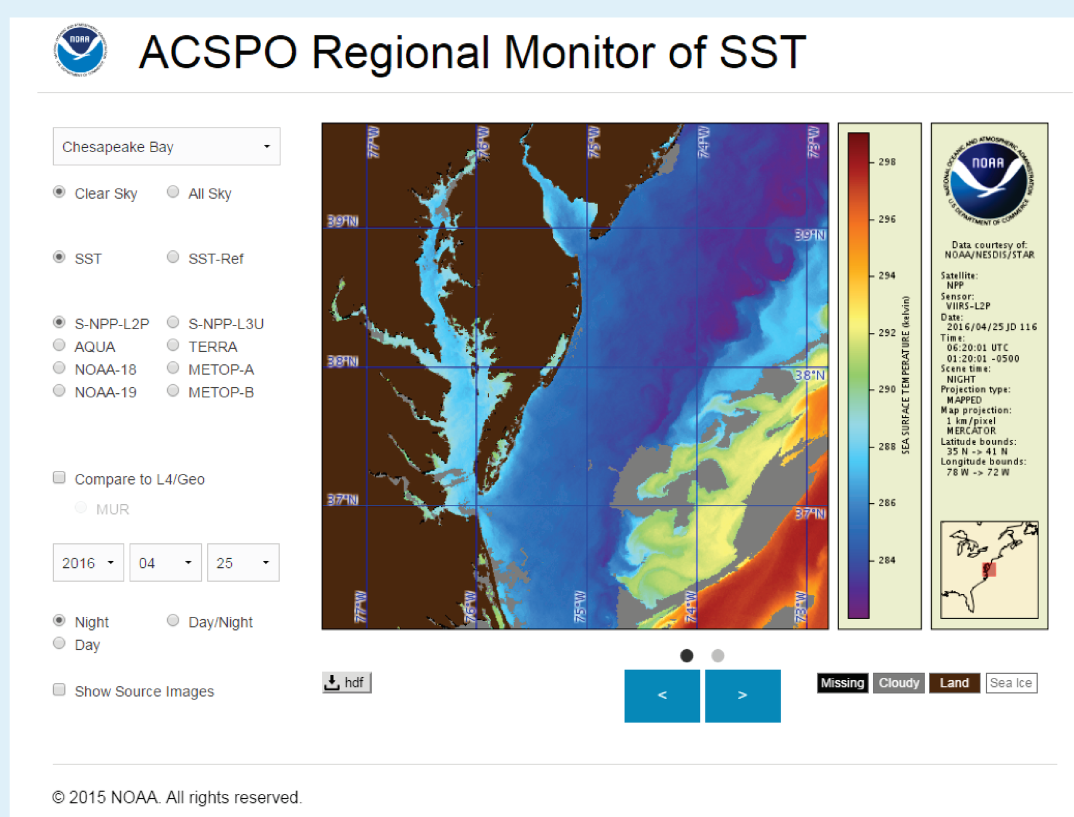

Fig. 1: A screenshot of the ARMS system.

- Monitored are the following polar satellites:
  - ◊ L2: S-NPP VIIRS; NOAA-18/-19, Metop-A/-B AVHRR; Terra/Aqua MODIS
  - ◊ L3U (un-collated): S-NPP VIIRS
- User can compare w/geostationary (Himawari-8 AHI L2) and MUR L4 SSTs. AHI is available in 3 regions: Kuroshio, Korean Strait and South China Sea.
- Time coverage: Jul. 18th 2015 – present.
- Figures are sorted into 3 time categories: day, night, and day/night (including both daytime and nighttime pixels; often met in high-latitudes).
- Data are available for downloading using the hdf button.

❖ Using ARMS to identify improvements in ACSPO

- In most cases, the ACSPO clear-sky mask (ACSM) successfully identifies clouds (blue contours, Fig. 2). However, sometimes it may be conservative in coastal zones (purple contour) and dynamic areas (green contour). The ACSM may also be conservative in high-latitudes, including marginal ice zones.

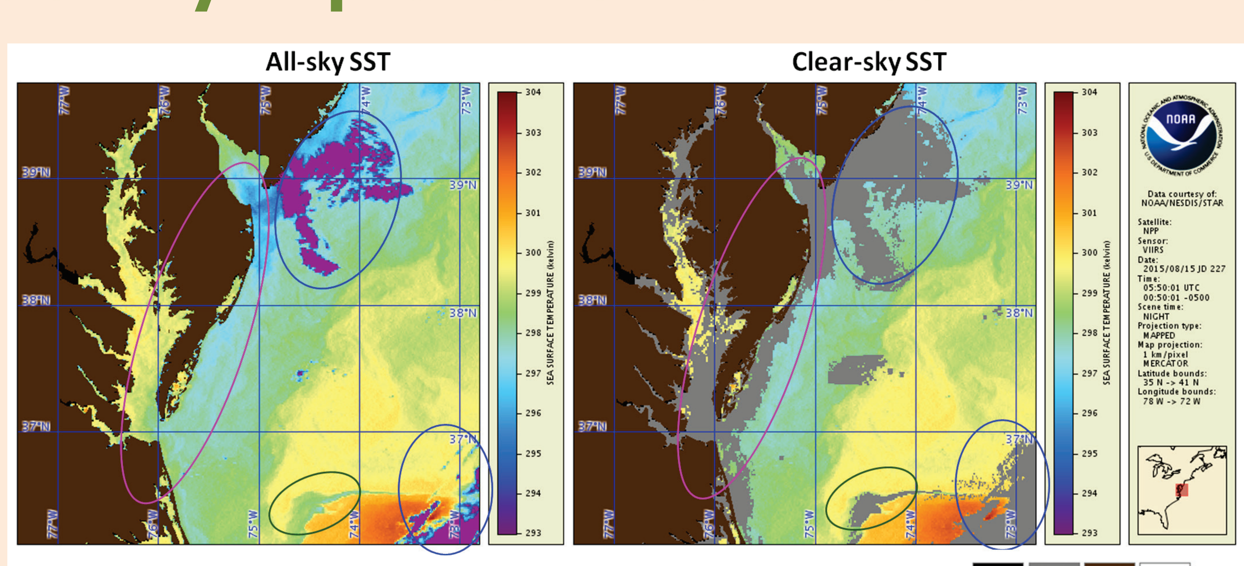

Fig. 2: An example of over-conservative clear-sky mask in the coastal and dynamic regions.

- Fig. 3 is an example of discontinuity in both SST algorithm and cloud mask in the day/night transition area, identified in ARMS. The discontinuous SST is a result of using different bands used in the daytime and nighttime SST algorithms. The ACSM can be improved using the Reflectance Ratio Contrast Filter (RRCT) in the twilight zone, instead of the currently used Reflectance Gross Contrast Test (RGCT).

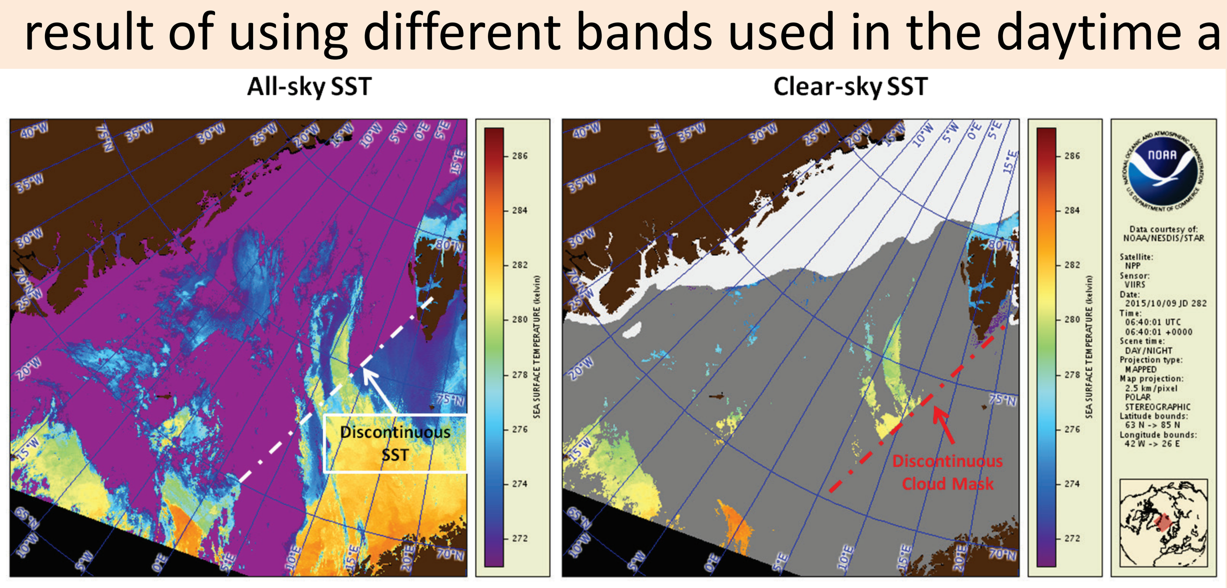

Fig. 3: Left panel: An example of discontinuity in SST algorithm in the day/night transition zone. Right panel: An example of discontinuity in clear-sky mask.

❖ Towards L3C (collated)

1. Diurnal cycle

- Satellite overpasses at different times are subject to different phases of diurnal cycle.
- Fig.4 shows two overpasses in the early afternoon over the southeast US coast. The right image was obtained 1hr 40min later after the left. The histograms show that the SST gets warmer in 1hr 40min. There are very few cloud over the area, and the warmer SST is largely due to the diurnal warming.

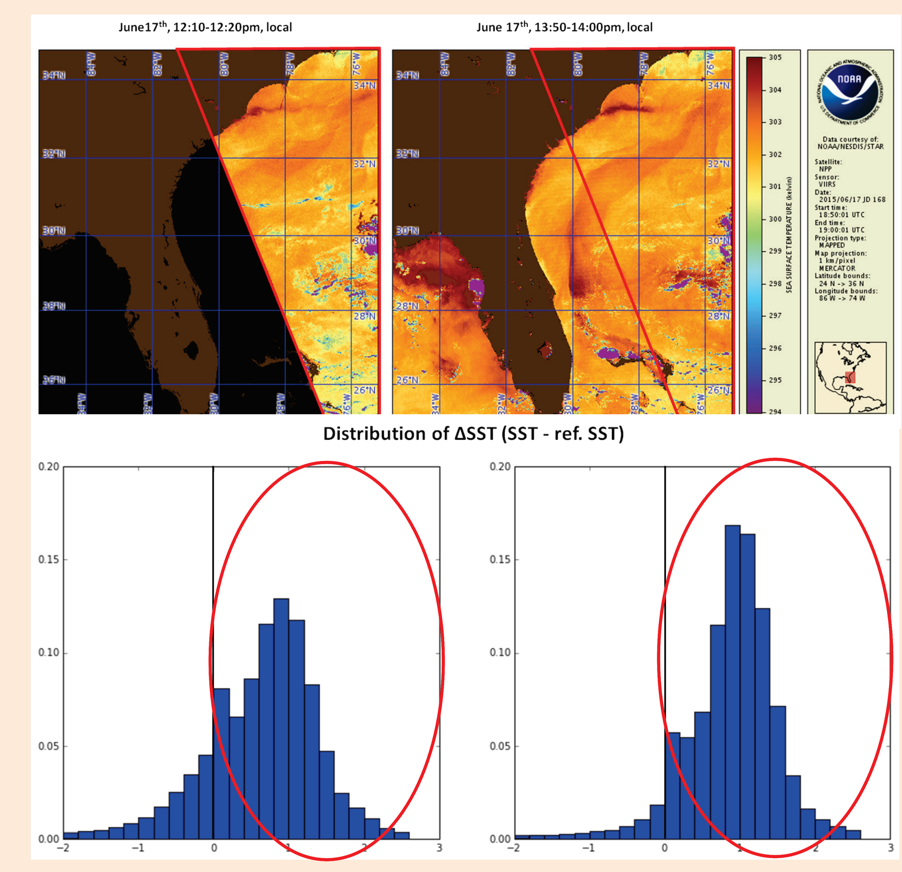

Fig. 4: Upper two panels: spatial maps of two VIIRS overpasses over the southeast US coast during daytime. Lower two panels: histogram of ΔSST for the overlapped region (red boxes).

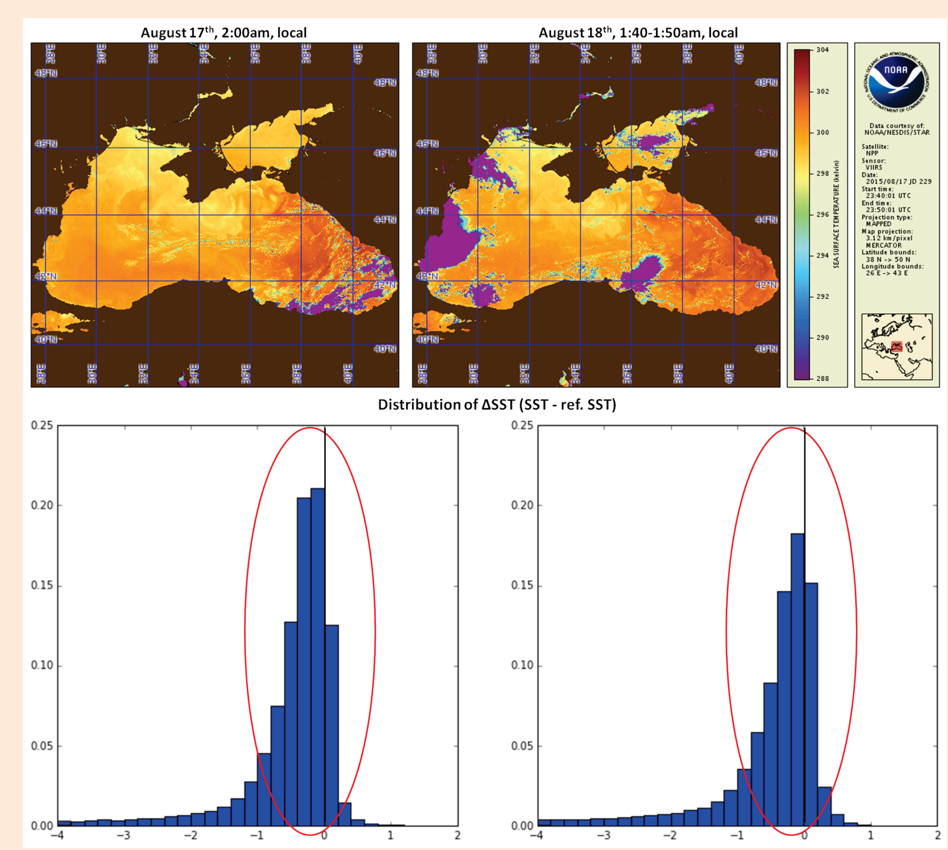

Fig. 5: Similar to Fig. 4, but for two VIIRS overpasses over Black Sea.

2. Cloud variability

- Cloud patterns also change with time, which also needs to be considered when fusing different overpasses together.
- Fig.5 shows two nighttime overpasses with different cloud patterns. The time interval is close to 24 hours, which minimizes the diurnal change. Thus, the different cloud patterns contribute to the differences in the histograms.

❖ Towards L3S (super-collated)

- We attempted to initially characterize diurnal cycle based on both satellite observations and L4 data, and get a reasonable daily mean for L3C/S.
- Now UK MO provides an *experimental* OSTIA (Operational Sea Surface Temperature and Sea Ice Analysis) diurnal SST product (courtesy of Simon Good, James While and Matthew Martin at UK MET Office)

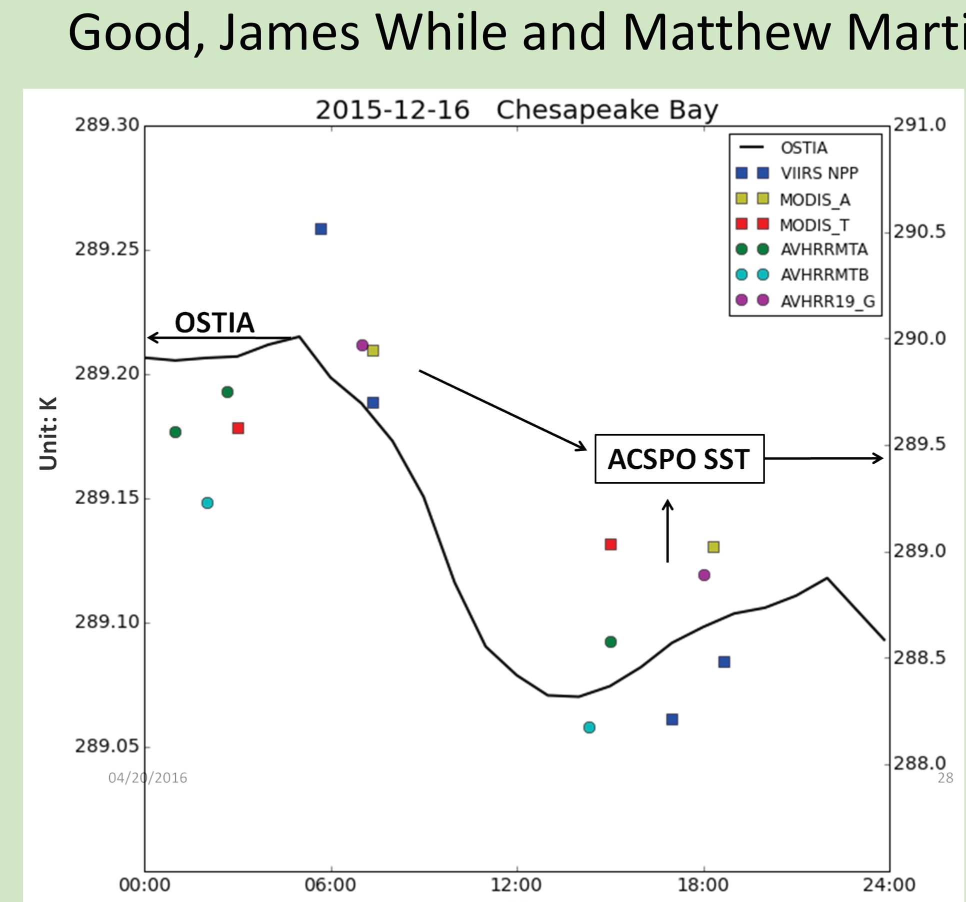

Fig. 6: Example of diurnal cycle retrieved from experimental OSTIA diurnal SST product (black line, left axis) and ACSPO clear-sky SSTs (scattered plots) for Chesapeake Bay on 2015-12-16.

- Variables in OSTIA-diurnal are: skin, sub-skin, and foundation SSTs.
- Spatial resolution: 0.25°×0.25°.
- Time resolution: hourly.
- Similar SST diurnal trend is shown for both experimental OSTIA diurnal SST and ACSPO SSTs with SST maximum at 06:00 UTC. However, the magnitude of OSTIA diurnal SST (~0.2 K) is ~10 times smaller than in ACSPO SST (~2 K).
- Work is underway to analyze the diurnal cycle based on geostationary satellites.

❖ Summary

- The ACSPO Regional Monitor for SST (ARMS: www.star.nesdis.noaa.gov/sod/sst/arms/) website is in advanced stage. It provides a convenient way to monitor and examine the performance of the current ACSPO L2P and L3U SST products in several representative regions of the ocean.
- Our experience suggests that: (1) the ACSPO clear-sky mask may be conservative in coastal and dynamic areas of the ocean, and in the high latitudes, and should be improved; (2) the day/night discontinuities in SST and clear-sky mask are also occasionally observed, and they can and should be minimized.
- To obtain high-quality L3C/L3S products, we started from analyzing SST diurnal cycle in the OSTIA L4 diurnal SST, and in the satellite observations (geostationary data, and multiple polar overpasses). Preliminary comparisons with polar SST suggests that the magnitude of OSTIA diurnal SST appears somewhat smaller.