ACSPO Collated SST Products from GOES-16/17 and Himawari-8

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Summary of ACSPO Geostationary SST Products

- The Advanced Clear-Sky Processor for Ocean (ACSPO) is used at NOAA to generate operational SST products from the Advanced Baseline Imager (ABI) onboard GOES-16/17 (G16/17) and its twin, the Advanced Himawari Imager (AHI) onboard Himawari-8 (H08).
- ACSPO v2.50 introduced support for un-collated L2P and L3U SST products from G16 and H08 at their native temporal resolution (currently 10 minutes for both).
- ACSPO v2.70, now running operationally, generates hourly collated L2P and L3C from G16 and H08 with improved coverage and reduced sensor noise and cloud contamination.
- Validation statistics for ACSPO SST products are available in the NOAA SST Quality Monitor (SQUAM; www.star.nesdis.noaa.gov/sod/sst/squam/) and Monitoring of IR Clear-sky Radiances over Oceans for SST (MICROS; www.star.nesdis.noaa.gov/sod/sst/micros/) systems.
- Images from a variety of regional targets are available in the ACSPO Regional Monitor for SST (ARMS; www.star.nesdis.noaa.gov/sod/sst/arms/).
- Real-time operational and reanalysis data from G16, along with many other ACSPO products, are available from PO.DAAC (https://podaac.jpl.nasa.gov/).
- G16 and H08 real-time operational data are also available from NOAA CoastWatch (https://coastwatch.noaa.gov/).

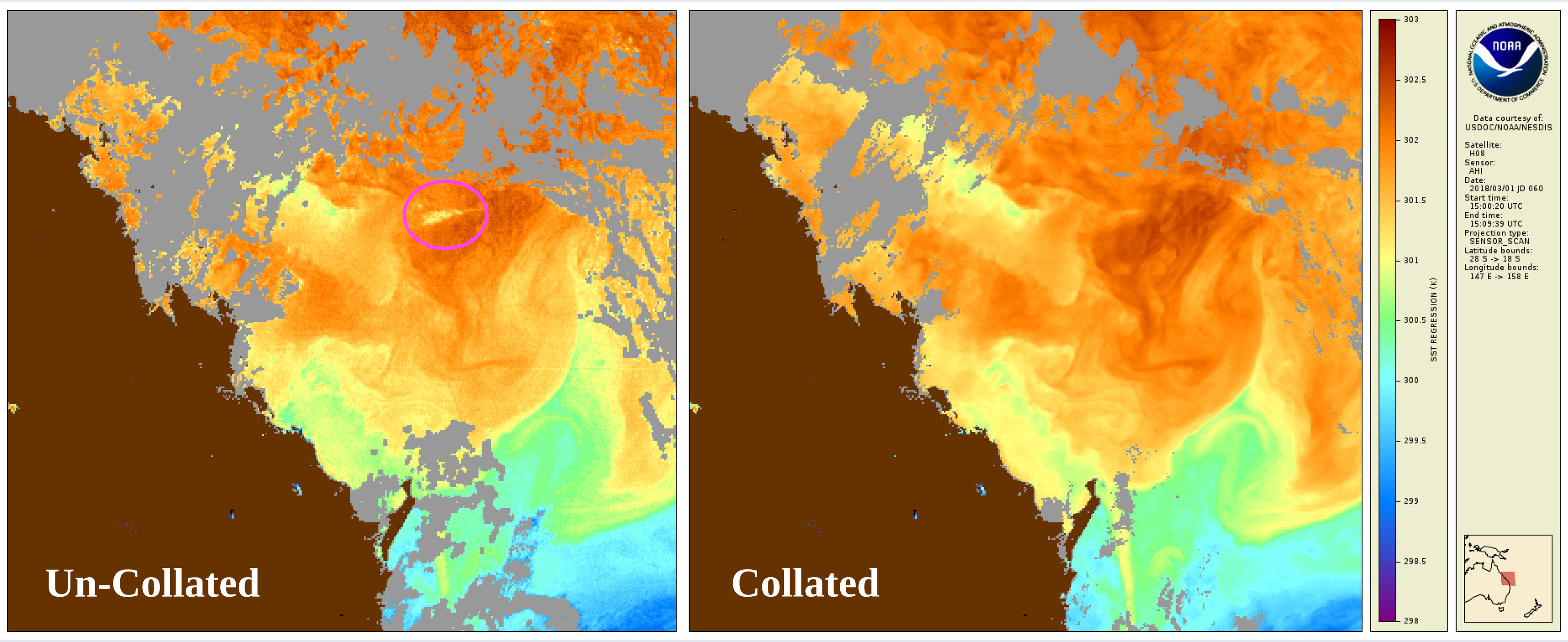

Figure 1: ACSPO un-collated L2P (left) and collated L2P (right) images of the Great Barrier Reef from H08 AHI at 1500 UTC on 1 March 2018. Note the residual cloud contamination circled in magenta that is removed by the collation algorithm, and increased coverage.

The ACSPO Geostationary Collation Algorithm

- Details of the ACSPO geostationary collation algorithm were presented at GHRSST XIX by Gladkova, *et al*.
- The clear-sky coverage of the hourly collated SST products is improved compared to the previous 10-minute uncollated products. Sensor noise and residual cloud contamination are also reduced.
- The algorithm retrieves global regression "sub-skin" SST and Single Sensor Error Statistics (SSES) from collated brightness temperatures.
- Subtracting the SSES bias yields a "depth" SST that is expected to be closer to *in situ* measurements.
- A 0.02° equiangular gridded L3C product is created from the hourly collated original projection L2P SST data using the same algorithm as other ACSPO 0.02° un-collated L3Us.
- Fig. 1 demonstrates the superior imagery of the collated L2P product compared to its un-collated counterpart.

ABI SST Reanalysis 1 ("ABI RAN1")

- We have consistently reprocessed G16 collated L2P and L3C products using ACSPO v2.70 beginning in mid-Dec'2017 when it was declared the GOES-East operational satellite.
- Fig. 2 shows validation statistics of collated L2P w.r.t. NOAA *in situ* Quality Monitor (*i*Quam v2.1; currently at www.star.nesdis.noaa.gov/sod/sst/iquam2/; will move to main *i*Quam URL, resources permitting) as reported in SQUAM.
- G16 SSTs meet the NOAA SST specs (±0.2K for accuracy and 0.6K for precision). The standard deviation (SD) for all granules falls well within the 0.6K specs, and most are within ±0.2K for global regression SST.
- SSES bias-corrected SST reduces seasonal and diurnal variations in both bias and SD compared to the global regression and beats NOAA specs by a wider margin.
- The full RAN dataset has been received for archival by PO.DAAC and is now available for download (DOI: 10.5067/GHG16-3UO27, 10.5067/GHG16-2PO27) along with real-time operational ACSPO v2.70 data.

References

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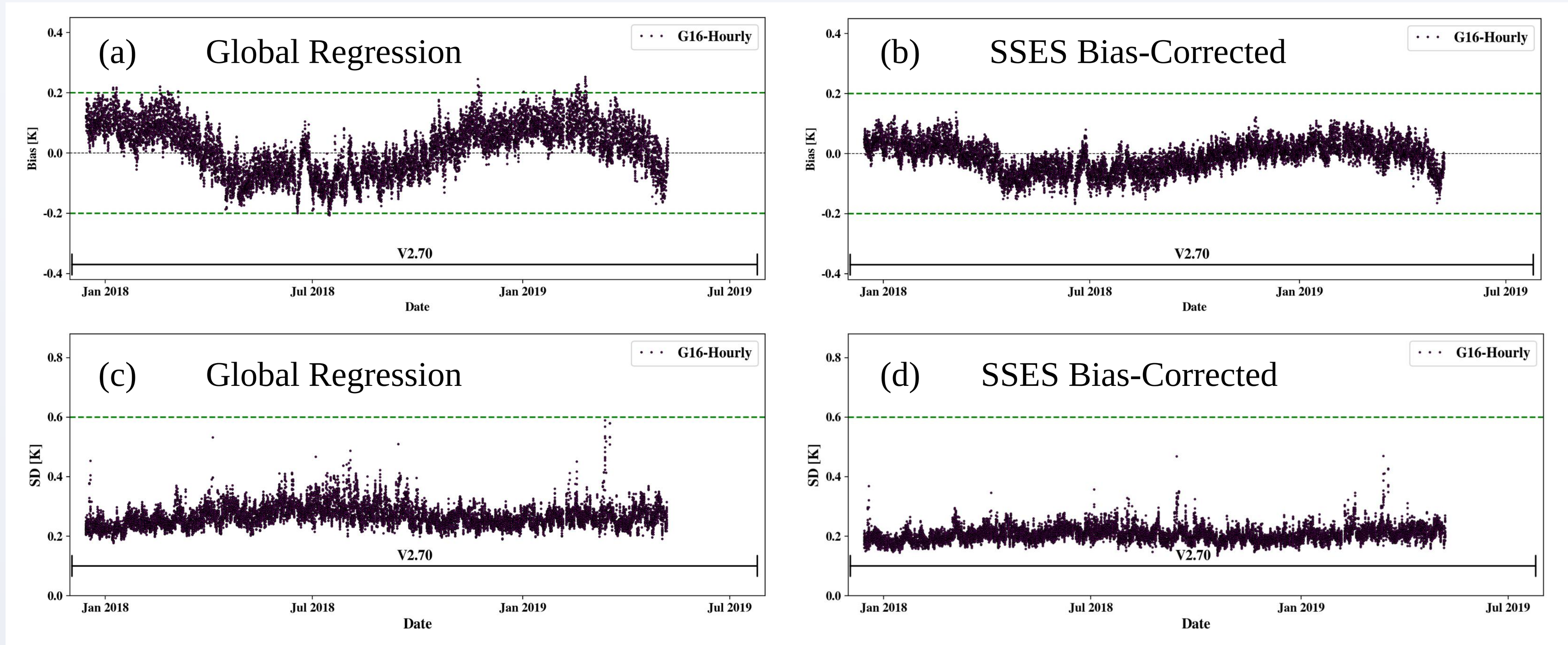

Figure 2: Global statistics of G16 RAN hourly collated L2P w.r.t. iQuam drifters and tropical moorings. (a) and (b) are mean "SST - in situ" for global regression SST and SSES bias-corrected SST, respectively; the dashed lines represent the ±0.2K NOAA SST specs. (c) and (d) are the corresponding SD of "SST - in situ"; the dashed lines represent the 0.6K NOAA SST specs.

G17 ABI Performance Issues

- Following the launch of G17 in Mar'2018, it was discovered that its ABI Loop Heat Pipe (LHP) responsible for maintaining the temperature of the ABI IR Focal Plane Modules (FPMs) was operating at a reduced capacity.
- As a result, the nominal FPM temperature of G17 is kept at ~81K (compared to ~62K for G16). The temperature is elevated further during the night, to a daily maximum of up to ~107K, when the sun impinges on the instrument.
- The elevated and time-varying FPM temperature causes a number of issues requiring mitigation with the ACSPO L2P SST and clear-sky mask, and post-processing collation algorithm:
  - *Elevated Sensor Noise*: The nominal NE∆T is up to 5x higher than for G16, in the thermal IR bands used for SST retrievals (8.4, 10.3, 11.2, and 12.3µm). Striping is also enhanced compared to G16.
  - *Unstable and Inaccurate Calibration*: In addition to systematic biases as a result of increased temperature, the calibration algorithms cannot follow its variation throughout the day.
  - *Saturation*: In the most extreme heating conditions, some of the bands will saturate, yielding no useful data during this time.
  - *Gain Switching*: In order to help reduce saturation, ABI is switched between two gain modes every ~12 hours. Each switch introduces jumps and extra noise in the retrieved SST, breaking the continuity of the diurnal cycle..
- Elevated sensor noise and striping are partially mitigated by the collation algorithm without any additional modifications.
- Unstable and inaccurate calibration affects the 11.2µm band most strongly, so it was removed from SST and SSES retrievals for G17. This has a negligible impact on global SD w.r.t. L4 and *in situ* SSTs. This suggests that the net contribution of the band is close to zero in the original regression formulas, given the increased noise.
- Currently, ACSPO produces imagery for G17 that is comparable to G16 for ~12 hours each day (2000 to 0800 UTC) when the sensor is in the nominal gain mode (*e.g.* Fig. 3).
- Additional mitigation strategies are may be explored to increase the period of usable G17 SST data, including further adjustment of collation parameters, empirical reconciliation of the two gain modes, and the use of alternative bands for SST retrievals.

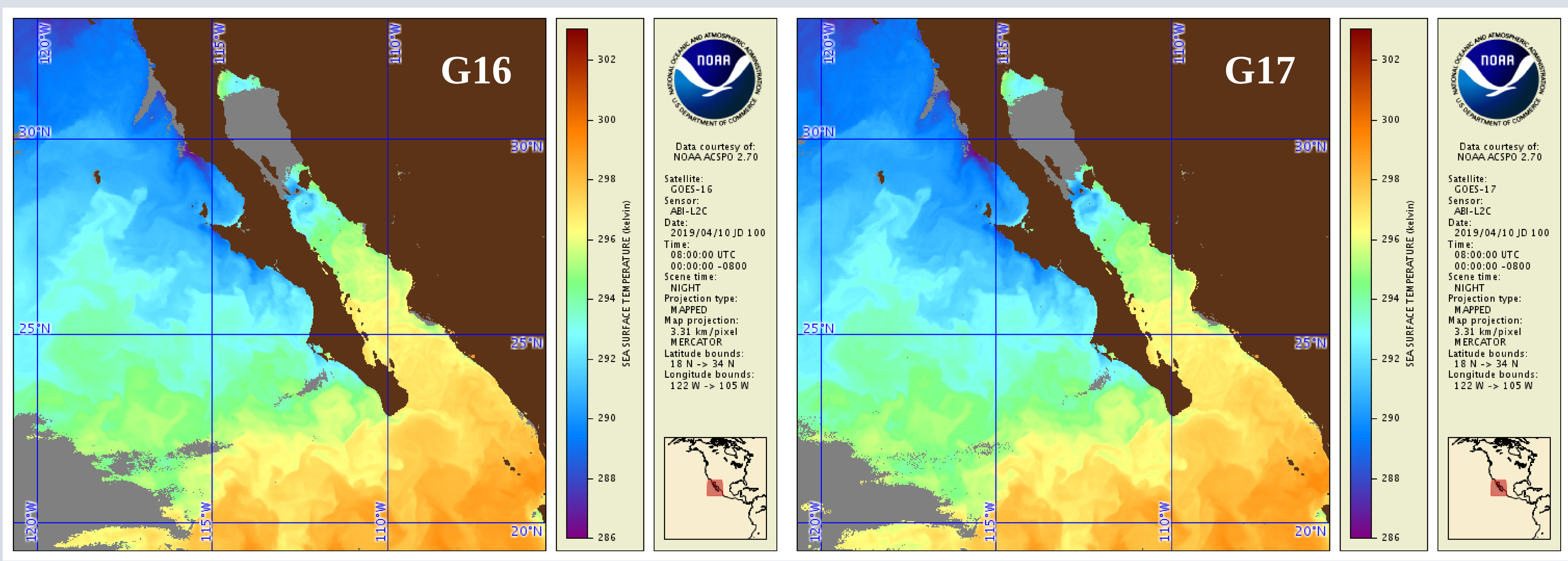

Figure 3: ACSPO collated L2P images of the Gulf of California from G16 (left) and G17 (right) at 0800 UTC on 10 April 2019. Note comparable SST image quality.

Current and Future Work

- Reprocessed ACSPO v2.70 collated L2P and L3C SST products for G16 going back to mid-Dec'2017, along with real-time operational data, are now available from PO.DAAC.
- G17 support will be included in ACSPO v2.71, planned to be released by Aug'2019. We will consistently reprocess all usable G17 data and explore archival with PO.DAAC and NCEI.
- Resources permitting, we plan to reprocess all available H08 data back to Mar'2015 and archive it fully consistently with G16/17 for a complete ACSPO record of new-generation geostationary sensors.

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