GOES-17 ABI L2+ Sea Surface Temperature (SST) Release
Provisional Data Quality
July 25, 2019
Read-Me for Data Users

The GOES-R Peer/Stakeholder Product Validation Review (PS-PVR) for the GOES-17 Advanced Baseline Imager (ABI) Baseline L2+ Sea Surface Temperature (SST) Provisional Maturity was held on July 25, 2019. The PS-PVR panel recommended that the ABI Baseline SST product be declared Provisional for the cold, stable periods of the day, during favorable seasons.

Up to date information on the GOES-17 cooling system issue can be found on the following web sites:
https://www.goes-r.gov/users/GOES-17-ABI-Performance.html
http://cimss.ssec.wisc.edu/goes-r/abi-/band_statistics_imagery.html

The table shown below is pulled from the above web site and is an estimate of times of peak interruption for 2019. The table represents potential saturation. The user should be more vigilant of potential anomalies during these times. The SST may be usable during some of these time blocks.

Date Range	Saturation increase/decrease	Time of Day
1 Jan - 26 Feb	Channel saturation goes from marginal to unusable by 26 Feb.	Saturation can occur between 0830 - 1730 UTC.
26 Feb - 20 Mar	Channel saturation goes from unusable to marginal.	Saturation can occur between 0900 - 1700 UTC.
20 Mar - 13 Apr	Channel saturation goes from marginal to unusable by 13 Apr.	Saturation can occur between 0900 - 1700 UTC.
13 Apr - 26 May	Channel saturation goes from unusable to marginal.	Saturation can occur between 0900 - 1700 UTC.
26 May - 20 Jul	No Channel saturation	
20 Jul - 30 Aug	Channel saturation goes from marginal to unusable by 30 Aug.	Saturation can occur between 0900 - 1700 UTC.
30 Aug - 23 Sep	Channel saturation goes from unusable to marginal.	Saturation can occur between 0930 - 1630 UTC.
23 Sep - 16 Oct	Channel saturation goes from marginal to unusable by 16 Oct.	Saturation can occur between 0900 - 1700 UTC.
16 Oct - 12 Dec	Channel saturation goes from	Saturation can occur between

	unusable to marginal.	0900 - 1700 UTC.

The GOES-R Series Level I Requirements (LIRD) are not yet updated to reflect the operational Mode 6; however, for completeness the LIRD requirements are stated here: Sea Surface Temperature shall be produced every hour for Full Disk.

GOES-17 was placed into Mode 6 on April 2, 2019. Despite this change, the SST product continues to be generated every hour for ABI Full Disk (FD) of the Earth.

GOES-17 ABI Baseline SST product is generated consistently with GOES-16 ABI Baseline L2 SST product. For each 10 minute Full Disk (FD) image, SSTs are derived using a regression equation, applied to brightness temperatures (BTs) in the four longwave ABI window bands 11 (8.5 μm), 13 (10.35 μm), 14 (11.2 μm), and 15 (12.3 μm). A single regression equation is used across day and night, which greatly facilitates the derivation of a smooth and continuous diurnal cycle. SSTs are calculated and reported in all ocean pixels (including e.g. cloud, ice, etc.) up to 10 km inland. Subsequently, all 10 minute images within 1 hour are aggregated into 1-hr composites. Only clear-sky pixels (i.e. marked with the good quality flag, DQF=0), are recommended for use. The DQF is set using the ABI Clear-Sky Mask (which is external to the SST algorithm) and the SST Quality Control (QC; performed as a part of the SST algorithm). The SST QC uses the same four ABI bands employed for SST retrievals, plus bands 2 (0.64 μm) and 7 (3.9 μm).

A full description and format of the SST product can be found in the Product Definition and User's Guide (PUG) document (http://www.goes-r.gov/products/docs/PUG-L2+-vol5.pdf). The algorithm used to derive the SST product from GOES-17 ABI observations is described in detail in the "GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Sea Surface Temperature" (https://www.star.nesdis.noaa.gov/goesr/documents/ATBDs/Baseline/ATBD_GOES-R_SST-v2.0_Aug2010.pdf).

Provisional maturity, by definition, means that:
- Validation activities and quality assurance activities are ongoing and the general research community is now encouraged to participate.
- Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.
- Incremental product improvements may still be occurring.
- Product performance has been demonstrated through analysis of a small number of independent measurements from select locations, periods, and associated ground truth and field campaign efforts.
- Product analysis is sufficient to establish product performance relative to expectations.

- Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, and tested.
- Testing has been fully documented.
- Product is ready for operational use and for use in comprehensive Cal/Val activities and product optimization.

The nominal temperature of the GOES-17 ABI focal plane module (FPM) is set to 81 K (compared with 62 K for GOES-16 ABI). However, due to the limited LHP capacity, it further increases during the times of the day when more sun light impinges on ABI, especially during certain unfavorable seasons. The major impact of LHP anomalies on SST retrievals from GOES-17 are as follows:

- **Elevated Sensor Noise**: The nominal noise (during cold periods) for GOES-17 is up to 5x higher than for GOES-16, in the thermal IR bands used for SST retrievals, due to higher FPM temperature. It further increases during unfavorable "warm" periods.
- **Increased Striping**: Again due to warmer FPM temperatures, neighboring detectors have independent and time-varying biases, and as a result generate stripe artifacts in the SST imagery produced by GOES-17 ABI. Artefacts are increase during the "warm" periods.
- **Unstable and Inaccurate Calibration**: In addition to systematic biases as a result of increased nominal FPM temperature, the ABI calibration algorithms cannot follow its fast variation throughout the day (especially during the warm periods).
- **Saturation**: In the most extreme heating conditions, some of the thermal IR bands will saturate, yielding no useful data during this time. The 12.3μm band is especially susceptible.
- **Gain Switching**: In order to help reduce saturation, GOES-17 ABI is switched from gain mode 1 to a cruder gain mode 3 setting before heating is expected to occur. Each switch introduces discontinuities and extra noise in the brightness temperatures. The switch is not enforced during the "cooler" periods, and its' "on" and "off" times may change during the warm periods.

Status of the current SST product and any remaining known issues that are being resolved:
1. Summary of the performance of the SST product as measured against reference *in situ* data:
    - The GOES-R SST accuracy specification (defined as a FD mean bias with respect to quality controlled *in situ* data) of ±3.1K is easily met for a large fraction of retrieval conditions, when ABI is close to its nominal regime.
    - The GOES-R SST precision specification (defined as a FD standard deviation, SD, with respect to quality controlled in situ data) of 1K is easily met for a large fraction of retrieval conditions, when ABI is close to its nominal regime.
    - However, the accuracy of the GOES-17 ABI SST product may be severely degraded or the product may contain fill values between the hours of 09-18 UTC at times of the year when the ABI FPM temperature is significantly elevated as a result of the GOES-17 LHP issue. No special quality flag is currently reported in the data to

identify such degraded performance periods.

2. Several technical issues have been identified to facilitate the use of the SST data
    - Large QF/SST outages may appear as rectangular blocks of highest quality data (which in fact may be cloud or otherwise degraded SST data).
    - Time Stamps/Bounds in file names/attributes may occasionally be set wrong.
    - Information on the algorithm version is not included in files' global attributes.
3. Other issues not described above may be identified by users.

In order to mitigate some of the known GOES-17 ABI issues and limitations, transition to the NOAA Enterprise SST system, Advanced Clear-Sky Processor for Ocean (ACSPO), is underway. It is planned that the Baseline SST product in the GOES-R ground system will be replaced by the ACSPO SST before the end 2020, rendering many of the previous descriptions and issues irrelevant. Until then, there are no planned mitigations for the currently operational baseline SST product. Users of the GOES-17 ABI Provisional maturity Baseline SST product (be it for scientific and technical investigations, or for any other applications), should be aware of serious limitation of the GOES-17 Baseline SST product, and encouraged to consult the STAR Algorithm Working Group scientists for feasibility of the planned applications.

Contact for further information: OSPO User Services at SPSD.UserServices@noaa.gov

Contacts for specific information on the ABI Baseline L2 SST product:
Alexander Ignatov Alex.Ignatov@noaa.gov
Matthew Pennybacker Matthew.Pennybacker@noaa.gov