GOES-17 ABI L2+ Fire and Hot Spot Characterization (FHS) Release
Provisional Data Quality
February 26, 2021
Read-Me for Data Users

The GOES-R Peer/Stakeholder Product Validation Review (PS-PVR) for ABI L2+ Fire/Hot Spot Characterization (FHS) *delta* Provisional Maturity was held on February 18, 2021. As a result of this review, the PS-PVR panel chair asserted that the ABI Fire and Hot Spot Characterization (FHS; also called Fire Detection and Characterization [FDC]) product meets Provisional maturity for the warm periods due to the loop heat pipe (LHP) anomaly on GOES-17 as well as the cold, stable periods of the day.

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 2021. The table represents potential saturation. The user should be more vigilant of potential anomalies during these times. The product may not be usable during some of these time blocks.

Date Range	Saturation Increase/Decrease	Approximate Time of Day
4 Feb – 3 March	The cooling timeline is implemented. Channel saturation begins starting with bands in this order: 12, 16, 10, 8, 9, 11 from marginal to unusable by the middle of the time period (mid and late February) and back to marginal by the end of time period.	Saturation may occur between approximately 1100-1700 UTC. Peak saturation occurs at the middle of the time period at approximately 1330 UTC.
2 April – 3 May	The cooling timeline is implemented. Channel saturation begins starting with bands in this order: 12, 16, 10, 8, 9, 11, 15, 14 from marginal to unusable by beginning to middle of time period (early to mid-April) and back to marginal by the end of the time period.	Saturation can occur between approximately 1100-1600 UTC. Peak saturation occurs at the beginning to middle of the time period at approximately 1300 UTC.
3 August – 3 Sept	After a 1-day spike when the cooling timeline is turned on, Channel saturation begins starting with bands in this order: 11, 9, 8, 10, 16, 12 from marginal to unusable near the end of the time period (late August) to mostly marginal by the end of the time period.	Saturation can occur between approximately 1100-1600 UTC. Peak saturation occurs near then end of the time period at approximately 1330 UTC.
9 October – 5 Nov	The cooling timeline is implemented. Channel saturation begins starting with bands in this order: 12, 16, 10, 8, 9, 11, 15, 14 from marginal to unusable	Saturation can occur between approximately 1100-1600 UTC. Peak saturation occurs at the

	by the middle of the time period (mid October) to marginal by the end of the time period.	middle of the time period at approximately 1300 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: Fire and Hot Spot Characterization shall be produced every 10 minutes for Full Disk and every 5 minutes for the CONtiguous United States (CONUS). There is currently no MESO FHS product.

GOES-17 was placed into Mode 6 on April 2, 2019. The FHS product continues to be generated for every ABI Full Disk (FD) and every CONUS region.

The ABI L2+ FHS consists of four product outputs: metadata mask, fire radiative power (FRP), instantaneous fire temperature, and instantaneous fire size. The metadata mask assigns a flag to every earth-navigated pixel that indicates its disposition with respect to the FHS algorithm. Not all of the fire classes are appropriate for all users. Operational users who have the lowest tolerance for false alarms should use the “processed” and “saturated” categories (mask codes 10, 11, 30, and 31), but understand there can still be false alarms. There are six categories assigned for fires and probable fires, and each has a temporally filtered equivalent that is the mask code plus 20:

- Processed fire pixel (codes 10 and 30): The highest fire confidence category, includes FRP, size, and temperature estimates.
- Saturated fire pixel (codes 11 and 31): Very high confidence fires, but the pixel was at instrument saturation so no properties could be determined. FRP is calculated for these pixels but should be considered suspect and represents a low-end estimate.
- Cloud contaminated fire pixel (codes 12 and 32): A moderate confidence fire that appears to be partially obscured by cloud; intended for users with a high tolerance for false alarms. FRP is calculated for these pixels but should be considered suspect and represents a low-end estimate.
- High probability fire pixel (codes 13 and 33): A possible fire with a lower thermal signature than needed to be deemed a Processed fire pixel; FRP is calculated for almost all of these pixels; intended for users with a high tolerance for false alarms; false alarms due to water clouds (see below) are common in this category.
- Medium probability fire pixel (codes 14 and 34): A medium confidence fire with a lower thermal signature than a High probability fire pixel would have for this pixel; intended for users with a high tolerance for false alarms; false alarms due to water clouds (see below) are common in this category. FRP is calculated for most of these pixels but should be considered suspect.
- Low probability fire pixel (codes 15 and 35): Lowest confidence fire class, a large number of false alarms are to be expected, it is included as it also contains small and/or cooler fires; intended for users with a high tolerance for false alarms; false alarms due to water clouds (see below) are common in this category. FRP is calculated for some of these pixels but should be considered suspect.

The temporally filtered classes are triggered if a fire was found in the same pixel as the currently detected fire within the last 12 hours. The type of fire is assigned based on the most recent detection. Also included in the mask are flags that indicate why a pixel was excluded from consideration, including due to water, certain surface types, clouds, and bad data. This behavior is a change from the FHS ATBD, which specifies that the past fire pixels be within +/- 1 pixel of the current location.

The FRP, size, and temperature fields represent the properties of a fire that would produce the same detected radiant energy for the pixel. Fires vary throughout their burn area in intensity, but the satellite measurement is a composite signal of the entire pixel. FRP, size, and temperature represent the composite properties of that pixel. A hypothetical fire with those properties would produce the same measured radiances. Due to this mixing of subpixel elements and diffraction in the sensor there are large error bars on these retrievals. Generally speaking, FRP is calculated for all fires except those which required a large window to obtain a background temperature. Missing FRP will most often be seen with codes 15 and 35.

Be aware that when comparing simultaneous fire detections and characterizations from different sensors on different satellite platforms (e.g. GOES-R ABI vs. JPSS VIIRS) or even from compatible sensors on different satellites within a series (e.g. GOES-16 vs. GOES-17 ABI), there will be differences due to instrument characteristics, viewing geometry, or surface topography.

The mitigation for the GOES-17 cooling system issue is applied whenever the ABI focal plane temperature (FPT) exceeds 90 K for any of the bands used by the algorithm. At that point, the algorithm stops using a single longwave infrared band and creates a new longwave infrared background band from two adjacent longwave infrared bands that experience peak disruption at different times. This stabilizes cloud screening and improves confidence in the fire detections and characterization.

A full description and format of the FHS 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 FHS products from GOES-R ABI observations is described in detail in the "GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Fire / Hot Spot Characterization". The latest version of the ATBD is available at https://www.star.nesdis.noaa.gov/goesr/documentation_ATBDs.php.

Provisional maturity, by definition, means that:

- Validation 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 obtained from select locations, periods, and associated ground truth or field campaign efforts;

- Product analysis is sufficient to communicate product performance to users relative to expectations (Performance Baseline);
- 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, tested, and shared with the user community;
- Testing has been fully documented; and
- Product is ready for operational use and for use in comprehensive cal/val activities and product optimization.

Provisional users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized. Persons desiring to use the GOES-17 ABI Provisional Maturity Fire/Hot Spot Characterization product for any reason, including but not limited to scientific and technical investigations, are encouraged to consult the NOAA algorithm working group (AWG) scientists for feasibility of the planned applications. This product is sensitive to upstream processing, such as the quality of the calibration and navigation of input ABI L1b data.

Known issues at the Provisional validation stage include:

1. False alarms are known to occur due to water clouds causing reflections that appear fire-like when either the cloud is isolated (typically over a cool surface) or it is overlaid by broken ice clouds, in both cases giving the appearance of hot spots that may be labelled fires, typically in the High, Medium, and Low probability categories – this occurs most frequently at higher latitudes.
2. False alarms occur for various solar power facilities at differing times of the day depending upon the orientation and number of solar panels or mirrors at the site. For GOES-17 these false alarms tend to recur on cloud-free days during the summer in the southwestern US.
3. False alarms due to surface heterogeneity, such as bare ground surrounded by vegetated fields, power plant cooling lakes, flooded agricultural fields, urban areas that are not properly screened out, coastlines, and others, are known to occur and tend to recur in the same locations at certain times of year – these most frequently manifest as low probability and processed fires.
4. Performance is degraded for cold surfaces as open, bare ground can appear to be below the minimum threshold temperature used to distinguish clouds.
5. While generally not noticeable except in the metadata mask, at night regions with warm, moist air can appear as large clusters of code 170 (no background temperature could be calculated). At times a large cluster of low possibility fires may result from this effect. Those false alarm fires will typically have no FRP assigned to them.
6. During periods of peak focal plane heating disruptions are visible in the metadata mask, predominantly in the form of erroneous cloud detections.
7. Focal plane heating has little impact on fire detections themselves, but has some degree of impact on the fire characteristics.
8. Missing values occur randomly due to upstream L1b issues, typically in the form of rectangular blocks.

9. We currently recommend using categories 10, 11, 30 and 31 for operational use during daylight hours. The other fire categories, which represent a lower confidence in fire detection, may in some instances produce a number of false alarms that make these classes appropriate to use only by users with high tolerance of false alarms. For details see the discussion of the various fire categories above.

Please feel free to report any false alarms, missed fires, and other concerns to the AWG FHS science team.

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

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