GOES-18 ABI L2+ Fire and Hot Spot Characterization (FHS)
Full Data Quality
December 17, 2024
Read-Me for Data Users

GOES-R Advanced Baseline Imager (ABI) L2+ products will achieve Full Validation maturity by default after two years of Provisional and Operational use with no major anomalies reported (minor product improvements may still be occurring). As a result, GOES-18 Fire/Hot Spot Characterization (FHS) is considered Full Validation maturity as of January 4, 2025.

Fire and Hot Spot Characterization products are produced every 10 minutes for Full Disk (FD), every 5 minutes for the CONtiguous United States (CONUS), and every 1 minute for Mesoscale (MESO) scenes.

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.

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. 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. This behavior is a change from the FHS Algorithm Theoretical Basis Document (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 but not exclusively 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 comparable sensors on different satellites within a series (e.g., GOES-16 vs. GOES-18 ABI), there will be differences due to instrument characteristics, viewing geometry, or surface topography.

A full description and format of the FHS product can be found in the Product Definition and User's Guide (PUG) Volume 5: Level 2+ Products, located on OSPO's GOES-R documents webpage: https://www.ospo.noaa.gov/Organization/Documents/goes-r.html. The algorithm used to derive the FHS products from GOES-18 ABI observations is described in detail in the "GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Fire / Hot Spot Characterization", located on STAR's GOES-R ATBD webpage: https://www.star.nesdis.noaa.gov/goesr/documentation_ATBDs.php.

Full maturity, by definition, means that:

- Validation, quality assurance, and anomaly resolution activities are ongoing.
- Incremental product improvements may still be occurring.
- Users are engaged and user feedback is assessed.
- Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground-truth and validation efforts.
- Products are operationally optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations.
- All known product anomalies are documented and shared with the user community.
- Product is operational.

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-18 ABI Full 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.

Status of the FHS product and any remaining known issues:

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 usually occurs 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-18 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, 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. Related to #5: At times, blocks of output data will be missing as a result of the algorithm taking too long to process data in that region. This condition results from extended areas of large (> 10 K) differences between the band 7 and band 14 brightness temperatures. This causes background characterization to maximize its search for background values when processing every pixel in that area that has a brightness temperature difference that is sufficiently high to possibly represent a fire. This issue is most often observed in South America but can occur elsewhere.
7. Missing values occur randomly due to upstream L1b issues, typically as rectangular blocks.
8. We currently recommend using categories 10, 11, 30, and 31 for operational use. The other fire categories, which represent a lower confidence in fire detection, may 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.
9. L2 product pixel locations are not corrected for terrain, so GOES fires will appear offset from other data sources, particularly in elevated terrain.

Please 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

Contacts for specific information on the ABI L2 FHS product:
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