GOES-16 ABI L2+ Aerosol Detection (ADP)
Full Data Quality
May 14, 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-16 Aerosol Detection (ADP) is considered Full Validation maturity as of December 6, 2020.

ABI L2+ ADP includes the flags describing the presence of aerosol (including smoke/dust) in the atmosphere over land and over ocean, associated quality flags to indicate the confidence level (low, medium, and high) for the detected smoke/dust, a flag to indicate within/out of the sun-glint region, and a flag to indicate within/out of valid solar/viewing zenith angle ranges. All flags are reported as binary 1/0 (yes/no). ADP is produced during the daytime over clear-sky and snow-free regions, over both land and water, when the satellite view zenith angle is less than 90° and the solar zenith angle is less than 87.5°.

- *Measurement range*: ADP is reported as a binary yes/no (present/not present) measurement for smoke/dust under conditions when aerosol loading is high (i.e., when aerosol optical depth is generally greater than 0.2).
- *Temporal coverage*: ADP is produced only during daytime with solar zenith angles less than 87.5°.
- *Refresh*: In ABI Mode 6 ("flex mode"), ADP is available every 10 minutes for the Full Disk and CONUS sectors, and every 5 minutes for the Mesoscale sectors. In ABI Mode 4 ("continuous full disk"), ADP is available every 5 minutes for the Full Disk and CONUS sectors and is not produced for the Mesoscale sectors.
- *Spatial coverage*: ADP is produced for the Full Disk, CONUS, and Mesoscale sectors. Low solar and satellite elevation (i.e., solar zenith angle larger than 60°, view zenith angle larger than 70°) reduces the spatial coverage of ADP at the high and medium confidence levels.
- *Spatial resolution*: ADP is produced on the ABI fixed grid, with a resolution ranging from 2km at nadir to ~20km at the edge of ABI's Earth view.
- *Quality*: A preliminary evaluation of GOES-16 smoke/dust detection in ADP against both AERONET measurements and CALIPSO Vertical Feature Mask (VFM) data indicates that accuracy, probability of correction detection (POCD), and probability of false detection (POFD) are about 95-99%, 87-94% and 18-22% for smoke detection, and 98-99%, 87-88% and 4-24% for dust detection.
- In general, the top 2 confidence levels (high and medium confidence), which automatically exclude smoke/dust detection within the sun-glint region and out of the valid solar/view zenith angle ranges, are recommended for quantitative applications.

The GOES-16 ABI ADP algorithm was updated to the Enterprise algorithm on April 17, 2024 at 13:30 UTC for the Full Disk sector, at 13:51 UTC for the Continental United States (CONUS) sector, and at 13:45 UTC for the Mesoscale sectors.

- The theoretical basis (physics) of the Enterprise ABI ADP algorithm is the same as the Baseline algorithm, meaning there are no major differences between the two algorithms.
- A minor difference in the way the Enterprise algorithm conducts cloud clearing results in the Enterprise algorithm retrieving more correct dust detections, especially over water.
- The ADP quality flags and values are slightly different for the Baseline and Enterprise files, as shown in Table 1.

Table 1. Differences in ABI ADP quality flags between Baseline and Enterprise algorithms

Setting	Baseline Algorithm		Enterprise Algorithm	
	Variable	Flag Values	Variable	Flag Values
Valid solar zenith angle (SZA)	DQF, bit 7	valid SZA/VZA == 0 invalid SZA/VZA == 128	PQI1, bits 2-3	valid SZA == 0 out of range SZA == 12
Valid satellite view zenith angle (VZA)			PQI1, bits 4-5	valid VZA == 0 out of range VZA == 48
Outside sun glint region (Dust only)	DQF, bit 6	outside sun glint == 0 within sun glint == 64	PQI2, bit 1	outside sun glint == 0 within sun glint == 2
Smoke detection confidence	DQF, bits 2-3	high == 12 medium == 4 low == 0	DQF, bits 2-3	high == 0 medium == 4 low == 8
Dust detection confidence	DQF, bits 4-5	high == 48 medium == 16 low == 0	DQF, bits 4-5	high == 0 medium == 16 low == 32

The full description and formats of the baseline ABI ADP are given in v2.5 of 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 enterprise algorithm description will be added to a future PUG revision.

Both the baseline and the enterprise versions of the algorithm used to derive ADP from GOES-16 ABI observations are described in their respective algorithm theoretical basis documents (ATBDs) located on STAR's GOES-R ATBD webpage: https://www.star.nesdis.noaa.gov/goesr/documentation_ATBDs.php. The baseline version is described in the document "Algorithm Theoretical Basis Document for ABI Aerosol Detection Product". The enterprise version is described in the document "Algorithm Theoretical Basis Document for ABI Enterprise Processing System Aerosol Detection Product".

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. Users desiring to use the GOES-16 ABI Full maturity ADP products 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. These products are sensitive to upstream processing, such as the quality of the calibration, navigation, snow/ice mask and cloud mask.

Known product issues:

1. False smoke detection over thin clouds over land at large view/solar angles.
2. Occasional false low confidence dust detection over bright surfaces at large view/solar angles, such as over the Andes Mountains.

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

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