



Read-me for Data Users

MEMORANDUM FOR: The JPSS Program Record
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SUBJECT: NOAA-21 Aerosol Optical Depth and Aerosol Particle Size Product
 Beta maturity status

DATE: 06/22/2023

Beta maturity status declaration for Aerosol Optical Depth and Aerosol Particle Size

Maturity Review Date: 06/22/2013
Effective Date: 02/10/2023
Operational System: NDE Version 3r2

The JPSS Algorithm Maturity Readiness Review Board approved the release of the Aerosol Optical Depth and Aerosol Particle Size Product to the public with a Beta maturity level quality as of 02/10/2023 (effective date), based on JPSS Validation Maturity Review held on 06/22/2013 (link to review artifacts).

- Maturity stage definition** (reference to the AMM webpage for maturity definition: <https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>)
- Algorithm Description:**
Products (Collection Short Name (CSN))
 - Aerosol Optical Depth (AOD)
 - Aerosol Particle Size (APS) (reported as the Angstrom Exponent)

Product requirements/Exclusions (DPS)

| Attribute | AOD | | APS | |
|--|--|------------------|-----------------|------------------|
| <i>Applicable Conditions</i> | Clear sky, daytime only, zenith angles $\leq 80^\circ$ | | | |
| <i>Vertical Coverage</i> | Total column | | | |
| <i>Horizontal Cell Size</i> | 0.75 km at nadir, 1.6 km at edge of scan | | | |
| <i>Vertical Cell Size</i> | Total column | | | |
| <i>Mapping Uncertainty, 3σ</i> | 4 km | | | |
| <i>Measurement Range</i> | -0.05 to +5 | | -1 to +3 | |
| <i>Measurement</i> | <i>Accuracy</i> | <i>Precision</i> | <i>Accuracy</i> | <i>Precision</i> |

| | | | | |
|---------------------|--|---|-----|-----|
| <i>Over Ocean</i> | 0.08 (AOD< 0.3) 0.15 (AOD≥ 0.3) | 0.15 (AOD≤ 0.3) 0.35 (AOD≥ 0.3) | 0.3 | 0.6 |
| <i>Over Land</i> | 0.06 (AOD< 0.1); 0.05 (0.1≤AOD≤0.8) 0.20 (AOD>0.8) | 0.15 (AOD< 0.1) 0.25 (0.1≤AOD≤0.8) 0.45 (AOD>0.8) | n/a | n/a |
| <i>Refresh Rate</i> | 90 minutes (~100 minutes) | | | |

Quality flags

| Name | Bits | Quality Flag Name | Meaning |
|---------|------|---|---|
| QCExtn | 0,1 | Input cloud mask | 0: confidently clear; 1: probably clear; 2: probably cloudy; 3: confidently cloudy |
| | 2 | Input snow mask | 0: no; 1: yes |
| | 3 | Input cloud shadow mask | 0: no; 1: yes |
| | 4 | Input fire mask | 0: no; 1: yes |
| | 5 | Input glint mask | 0: no; 1: yes |
| | 6 | Input heavy aerosol mask | 0: no; 1: yes |
| | 7 | Ephemeral water from input land/water mask | 0: no; 1: yes |
| QCInput | 0 | Input location | 0: good; 1: bad - if 1. longitude beyond [-180°,180°] 2. latitude beyond [-90°,90°] |
| | 1 | Input geometry | 0: good; 1: bad - if 1. zenith angle beyond [0°,90°] 2. azimuth angle beyond [-360°,360°] |
| | 2 | Input ancillary data | 0: good; 1: bad - if 1. TPW beyond [0,20] cm 2. ozone beyond [0,1] atm-cm 3. surface pressure beyond [500,1500] mb 4. wind speed beyond [0,100] m/s 5. wind direction beyond [0°,360°] |
| | 3 | Input reflectance and brightness temperature | 0: good; 1: bad - if 1. M1-M11 reflectance beyond [0,1] 2. M15 or M16 brightness temperature beyond [200,350] K 3. M6 reflectance is saturated |
| | 4 | Shallow ocean from input land/water mask | 0: no; 1: yes |
| | 5 | Shallow inland water from input land/water mask | 0: no; 1: yes |
| | 6 | Coast line from input land/water mask | 0: no; 1: yes |
| QCTest | 0 | Cloud test | 0: no; 1: yes |
| | 1 | Cirrus test | 0: no; 1: yes |
| | 2 | Thin cirrus test | 0: no; 1: yes |

| | | | |
|--------|---|--|---|
| | 3 | Inhomogeneity test | 0: no; 1: yes |
| | 4 | Snow/ice test | 0: no; 1: yes |
| | 5 | Ephemeral water test | 0: no; 1: yes |
| | 6 | Shallow water test | 0: no; 1: yes |
| | 7 | Heavy aerosol test | 0: no; 1: yes |
| QCPath | 0 | Pixel over water | 0: no; 1: yes |
| | 1 | Bright land surface | 0: no; 1: yes |
| | 2 | Sunglint over water | 0: no; 1: yes |
| | 3 | SW scheme over dark land | 0: no; 1: yes |
| | 4 | SWIR scheme over dark land | 0: no; 1: yes |
| | 5 | Retrieval over bright land | 0: no; 1: yes |
| | 6 | Retrieval over bright land with dark land scheme | 0: no; 1: yes |
| QCRet | 0 | Retrieval failed | 0: no; 1: yes 1. Missing critical channel reflectances (M3/5/11 over dark land; M1/2/3/5 over bright land; M6 over ocean) 2. Cannot calculate NDVI and redness ratio over dark land 3. Missing ancillary surface reflectance dataset over bright land 4. Arithmetic error (divide by 0) |
| | 1 | Large airmass | 0: no; 1: yes |
| | 2 | Barren land cover type | 0: no; 1: yes |
| | 3 | Extrapolation | 0: no; 1: yes |
| | 4 | Large residual | 0: no; 1: yes Larger than 0.5 over land; 0.3 over ocean |
| | 5 | NDVI _{SWIR} out-of-range | 0: no; 1: yes Beyond [-0.1,0.8] over land |
| | 6 | Redness ratio out-of-range | 0: no; 1: yes Beyond [0.4,1.6] over land |
| | 7 | Adjacent to cloud or snow | 0: no; 1: yes |

Product evaluation/validation

Evaluation of NOAA-21 AOD and APS retrievals used NOAA-21 retrievals from the NDE I&T string. Global gridded (0.25 degrees) fields of AOD and APS from NOAA-2, NOAA-20 and S-NPP for the period 2/10/2023 – 6/10/2023 were examined. AOD fields are very similar; somewhat larger differences are present in APS, especially compared to APS from S-NPP. Evaluation with ground-based AERONET data indicates AOD and APS retrieved from NOAA-21 reflectances meet requirements. NOAA-21 Accuracy and Precision are similar to those from NOAA-20.

Product availability/reliability

NOAA-21 AOD and APS data were produced since early January 2023, but data before February 10, 2023 were not evaluated.

Algorithm performance dependence



Read-me for Data Users

The VIIRS aerosol optical depth and aerosol particle size algorithm requires good-quality Sensor Data records (SDR), primarily reflectances in bands M1-M11 and brightness temperatures in M15 and M16. Degradation in reflectances will affect the quality of AOD; the impact on APS is expected to be more severe. Good quality of various masks (cloud, land/water, snow/ice, sunglint, fire, cloud shadow and heavy aerosol) used to screen out pixels where aerosol retrieval should not be attempted is also important. Out of these masks the quality of cloud mask is especially important. Reliable model data of total precipitable water, column amount of ozone, surface pressure and wind speed and direction are also required for high quality AOD and APS.

Known errors/issues/limitations: None

3. **Changes since last maturity stage:** None

4. **Review board recommendations:**

5. **Path Forward/Future Plan:** A longer record (several months) of NOAA-21 AOD from NDE Ops string will be evaluated by comparing NOAA-21 retrievals of AOD and APS to corresponding products from NOAA-20, S-NPP and ground-based reference from AERONET.

Spectral land-surface reflectance relationships will be updated using data from NOAA-21 VIIRS observations. Calculation of residual over bright land surface will be eliminated to increase number of retrievals.

There are also potential Algorithm Science updates beyond Provisional/Validated Maturity that the STAR Aerosol Science Team is planning to undertake. This includes developing and testing regional and seasonal aerosol models to improve regional and seasonal accuracy of AOD retrieval.

6. **Additional Items to note:** None

Additional information is available in the EPS Aerosol Optical Depth (AOD) Algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

<https://www.star.nesdis.noaa.gov/jpss/Docs.php>

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