



*Read-me for Data Users*

**MEMORANDUM FOR:** The JPSS Program Record  
**SUBMITTED BY:** JPSS Aerosol Team co-Lead, Istvan Laszlo  
**CONCURRED BY:** JPSS Algorithm Management Project Lead Arron Layns  
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**APPROVED BY:** JPSS Program Scientist Mitch Goldberg

**SUBJECT:** NOAA-20 VIIRS EPS AOD Validated maturity status and public release  
**DATE:** 05/16/2019

**Validated maturity status declaration for VIIRS EPS Aerosol Optical Depth (AOD)**

**Maturity Review Date:** 05/16/2019  
**Effective Date:** 03/07/2019  
**Operational System:** NDE, Version 2r0

The JPSS Algorithm Maturity Readiness Review Board approved the release of the NOAA-20 VIIRS EPS Aerosol Optical Depth (AOD) product to the public with a Validated maturity level quality as of 03/07/2019 (effective date), based on JPSS Validation Maturity Review held on 05/16/2019 ([link to review artifacts](#)).

- Validated Maturity stage definition (<http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>)
  - Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
  - Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
  - Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
  - Product is ready for operational use based on documented validation findings and user feedback.
  - Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

2. Algorithm Description:

List of Products (Collection Short Name (CSN))

- Aerosol Optical Depth (AOD)
- Aerosol Particle Size (APS) (reported as the Angstrom Exponent, AE)

Product requirements/Exclusions (LIRDS)

Attribute	AOD	APS
<i>Applicable Conditions</i>	Clear sky, daytime only, zenith angles $\leq 80^\circ$	

<i>Geographical Coverage</i>	Global			
<i>Vertical Coverage</i>	Total column			
<i>Vertical Cell Size</i>	Total column			
<i>Horizontal Cell Size</i>	0.75 km at nadir, 1.6 km at edge of scan			
<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

There are four overall quality levels assigned to the product indicated by numbers 0, 1, 2, and 3.

Quality Level	Criteria
No Retrieval (3)	<ol style="list-style-type: none"> <li>1) Cloudy: external cloud mask is cloudy and any internal cloud, cirrus or inhomogeneity test fails;</li> <li>2) Sea ice (external mask or internal test);</li> <li>3) Shallow water (internal test);</li> <li>4) Sunlint (external mask or internal test)</li> </ol>
Low (2)	<ol style="list-style-type: none"> <li>1) Out of AOD range (-0.05, 5.0);</li> <li>2) Solar zenith angle &gt; 80°;</li> <li>3) Failed internal cloud test (but external cloud mask is clear);</li> <li>4) Failed internal cirrus test (but external cloud mask is clear);</li> <li>5) External cloud mask is cloudy (but pass internal tests, not heavy aerosol);</li> <li>6) <math>\sigma_{M11}^{3 \times 3} &gt; 0.008</math>;</li> <li>7) Retrieval residual &gt; 0.3</li> </ol>
Medium (1)	<ol style="list-style-type: none"> <li>1) Cloud shadow (external mask);</li> <li>2) Thin cirrus (internal test);</li> <li>3) Adjacent to cloudy pixel;</li> <li>4) Adjacent to snow pixel (within 3-pixel distance)</li> <li>5) <math>\sigma_{M11}^{3 \times 3} &gt; 0.002</math>;</li> </ol>

	6) Retrieval residual > 0.25
High (0)	Remaining retrievals

**Product evaluation/validation**

The NOAA-20 AOD and APS products were evaluated using retrievals available from NDE (I&T and Ops) for the period of 09/28/2018-04/11/2019 and from offline runs for the period of 01/07/2018-04/11/2019. The quantitative evaluation of high-quality retrievals with similar quantities derived from ground-based AERONET V3 L1.5 data indicates that the NOAA-20 550-nm AOD and APS products meet the requirements, except for the short (6.5-month) NDE record that is slightly less accurate than the requirement in the mid-range AOD. However, the longer offline AOD product meets the requirements in the mid-range as well.

Global fields of NOAA-20 AOD and APS are very similar to those from S-NPP. However, regional differences exist; these are especially evident in 0.55/0.86- $\mu$ m AE. Relative to S-NPP, the daily global averages of NOAA-20 550-nm AOD product are systematically lower over water. The NOAA-20 - S-NPP differences of global-average 550-nm AOD are -0.016 over water and +0.017 over land. A large part of these differences is explained by the NOAA-20 VIIRS observed reflectance is being consistently lower than S-NPP for all reflective solar bands. In spite of the differences the NOAA-20 Accuracy and Precision values are similar to those from S-NPP.

**Product availability/reliability**

VIIRS AOD and APS EDR data were produced since 02/26/2018 offline in the STAR Framework (ASSISTT), but data before about 03/20/2018 (Beta maturity effective date) may not be reliable because of degradation of the VIIRS LWIR channels (M15 and M16), although evaluation of AOD with AERONET does not suggest clearly recognizable negative impact. Public access to operational AOD and APS products from NDE became available only on 03/07/2019 (well after the period that may be impacted by the degradation).

**Algorithm performance dependence**

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**

- The NOAA-20 AOD retrieval uses land-surface spectral reflectance relationships that were

generated for S-NPP. This leads to errors in over-land AOD retrieval; the impact is larger for bright surface.

- The NOAA-20 AOD retrieval uses thresholds in internal tests of sea ice and heavy aerosol over water that were generated for S-NPP. This leads to misidentification of heavy aerosol and sea ice.
- When heavy aerosol is present over a dark pixel the internal test may incorrectly indicate bright surface. This results in no retrieval because the bright-surface relationship is not available for that pixel.

### 3. Changes since last maturity stage

There are no changes in the algorithm/science for this maturity review. However, look-up tables (LUT) and processing coefficient tables (PCT) for atmosphere were updated using NOAA-20 VIIRS relative spectral responses.

### 4. Review board recommendations

#### 5. Path Forward/Future Plan

Assessment of performance of the NOAA-20 AOD and AE product will continue. The following improvements are planned in the AOD retrieval:

- Derive dark- and bright-land spectral surface relationships based on NOAA-20 measurements.
- Update thresholds of internal tests (especially for detecting heavy aerosol) for NOAA-20.
- Explore improving retrieval for urban surfaces.
- Explore improving seasonal and geometry dependence of surface reflectance relationships.

#### 6. Additional Items to note

None

Additional information is available in the JPSS Aerosol Optical Depth and Aerosol Particle Size Product algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

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

#### Point of Contact:

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