Validation of Aerosol Optical Thickness and Angström Exponent in the Suomi-NPP VIIRS Operational Aerosol Products

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• VIIRS Aerosol Products
• Validation against AERONET
• Intercomparison to Heritage
• AOT & AE Maturity Status Timeline
• Summary
• Aerosol Optical Thickness (AOT) [6 km, global] – at 11 wavelengths (10 M bands + 550 nm)
• APSP (Aerosol Particle Size Parameter) [6 km, global] – Ångström Exponent derived from AOTs at M2 (445 nm) and M5 (672 nm) over land, and M7 (865 nm) and M10 (1610 nm) over ocean
• Suspended Matter (SM) [0.75 km, global] – classification of aerosol type (dust, smoke, sea salt, volcanic ash) and smoke concentration – currently, derived from VIIRS Cloud Mask (volcanic ash) and aerosol model identified by the aerosol algorithm
VALIDATION OF AOT AND AE COMPARISON TO AERONET
Comparison to AERONET

- Matchup and Quality control criteria for MAPSS-like data:
  - AERONET L2.0 Direct Sun retrievals are averaged within ±30 minutes of VIIRS overpass time.
  - Best quality VIIRS AOTs (QF=0 for IP; QF=3 for EDR) within a radius of 27.5 km from the AERONET site are averaged.
  - A minimum of five best quality VIIRS AOT retrievals (EDR, IP) and two AERONET observations must be available within the spatial and temporal constraints.
  - AERONET AOT data, if observed at wavelengths other than 550 nm, are interpolated to 550 nm using a 2nd order polynomial relation between AOT and wavelengths in log-log space (340nm and 1040nm excluded due to large uncertainty).
LAND AOT: VIIRS vs. AERONET

LAND AOT: VIIRS EDR vs. AERONET, M2M, best QA

- N=15330
- Fit: Y=0.698X+0.057; R=0.771
- Accuracy=0.0074
- Precision=0.125
- Uncertainty=0.125
- EEP=66.6%

LAND AOT: VIIRS IP vs. AERONET, M2M, best QA

- N=22335
- Fit: Y=0.708X+0.103; R=0.648

LAND AOT Diff. (VIIRS EDR - AERONET L2), M2M, best QA, Site #: 289, Sample #: 15330

LAND AOT Diff. (VIIRS IP - AERONET L2), M2M, best QA, Site #: 312, Sample #: 22335

Graphs showing the comparison of land aerosol optical thickness (AOT) between VIIRS and AERONET for different regions and time periods.
OCEAN AE: VIIRS vs. AERONET

VIIRS AE EDR vs. AERONET L2,M2M,best QA

N=5949
Fit: Y=0.434X+0.635; R=0.637
Accuracy=0.120
Precision=0.386
Uncertainty=0.509

VIIRS AE EDR (0.865/1.61nm)
AERONET AE L2(865/1610nm)
Log10(N)

VIIRS AE EDR vs. AERONET L2,M2M,best QA

N=645
Fit: Y=0.655X+0.292; R=0.885
Accuracy=0.026
Precision=0.395
Uncertainty=0.396

VIIRS AE EDR (0.865/1.61nm)
AERONET AE L2(865/1610nm)
Log10(N)

OCEAN AE Diff. (VIIRS EDR - AERONET L2),M2M,best QA, Site #: 145, Sample #: 5949

Latitude
Longitude

Mean of AE Error (VIIRS - AERONET)

STD of AE Error (VIIRS - AERONET)
VIIRS OCEAN AOT & AE EDR vs. Maritime Aerosol Network (MAN)

MAN – VIIRS EDR Match-up Location 201205–201408 LEV20 Num=340

201205-201408 EDR QF\text{High}

\begin{align*}
N &= 340 \\
A &= 0.024 \\
P &= 0.080 \\
U &= 0.083 \\
R &= 0.934 \\
ER &= 0.653
\end{align*}

201205-201408 EDR QF\text{High}

\begin{align*}
N &= 197 \\
A &= 0.232 \\
P &= 0.365 \\
U &= 0.431 \\
R &= 0.790
\end{align*}

VIIRS AOT (0.55 \mu m) vs. MAN AOT (0.55 \mu m)

VIIRS ANG EXP (0.445 \mu m/0.865 \mu m) vs. MAN ANG EXP (0.44 \mu m/0.87 \mu m)

\text{MAN} \lambda\text{-pair}
VALIDATION OF AOT AND AE
PERFORMANCE INTERCOMPARISON TO HERITAGE
AOT: Multi-sensors vs. AERONET

LAND AOT:

OCEAN AOT:
Ocean AE: Multi-sensors vs. AERONET

**OCEAN AE:**

- **Ocean AE: VIIRS EDR vs. AERONET L2,M2M,best QA**
  - N=6060
  - Fit: Y=0.585X+0.607; R=0.761
  - Accuracy=0.181
  - Precision=0.357
  - Uncertainty=0.400

- **Ocean AE: MYD04 C6 vs. AERONET L2,M2M,best QA**
  - N=3870
  - Fit: Y=0.547X+0.705; R=0.530
  - Accuracy=0.219
  - Precision=0.582
  - Uncertainty=0.622
VIIRS AOT & AE Maturity Timeline

**LAND AOT:**

- **Initial instrument check out; Tuning cloud mask parameters**
  - 28 Oct 2011

- **Beta status**
  - 2 May 2012

- **Error status**
  - 15 Oct 2012

- **Validated status**
  - 23 Jan 2013

**OCEAN AOT & APSP:**

- 28 Oct 2011

- **Beta status**
  - 2 May 2012

- **Validated status**
  - 28 Nov 2012

**Red period:** Product is not available to public, or product should not be used.

**Blue period:** Product is available to public, but it should be used with caution, known problems, frequent changes.

**Green period:** Product is available to public; meets the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement

- AOT: Validated stage 2
- APSP: Validated stage 1
SUMMARY

• Validation showed that S-NPP VIIRS Aerosol Products provide daily global aerosol observations with competitive performance to heritage sensors

• S-NPP VIIRS AOT EDR reaches Validated Stage II (since 01/23/2013 over land and since 05/02/2012 over ocean, excluding 10/15/2012-11/27/2012) and the AE EDR over ocean reached Validated Stage I (since 05/02/2012, excluding the anomaly period of 10/15/2012-11/27/2012)

• Validated products can be used for quantitative studies and applications in scientific publications

• Data use is encouraged and feedbacks are always welcome