New Nearly Continuous High Accuracy Satellite Aerosol Products for Fires, Dust, and Haze from GOES-16

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Satellites Identify Aerosols in the Atmosphere

- Satellites indicate areas of high particulate matter in the atmosphere associated with smoke plumes, blowing dust, and haze
- Aerosol satellite products have many air quality applications:
  - Modeling
  - Exceptional Events packages
  - Outreach/media
- But not very useful for forecasting – until now!!
Geostationary Operational Environmental Satellites R-Series (GOES-R)

- Revolutionary new geostationary satellites
- “Like going from black and white TV to HD”
- GOES-16 launched Nov 19, 2016 (now GOES-East)
- GOES-S scheduled launch March 2018 (will be GOES-West)
 ABI: New Generation GOES Imager

• **Advanced Baseline Imager (ABI)** is one of 6 instruments on GOES-R series satellites

• Huge leap forward in geostationary satellite technology

• ABI has **16 spectral bands** vs. 5 on previous GOES imager
  – New products!
  – Higher accuracy!
  – Higher spatial resolution!

• Faster scan rate compared to previous GOES imager
  – More frequent observations! (higher temporal resolution)
  – Routine CONUS and full disk views!
ABI Scan Mode 3 ("Flex Mode")

Previous generation GOES imager:
- 26 min for full disk scan (every 3 hrs)
- 7 min for CONUS scan (every 30 min)
- No Mesoscale in routine scans
ABI Products: GeoColor Imagery

• During daytime, closest approximation to true color imagery (combination of red, green, and blue spectral bands)
  – ABI doesn’t have a green band, so it’s simulated
• At night, multispectral IR shows low-level liquid water clouds and higher-level ice clouds
• New product from ABI! Not available from previous Imager!

GOES-16 ABI GeoColor imagery, full disk view:
• 4 km spatial resolution
• 15 min temporal resolution
ABI Products: Aerosol Optical Depth (AOD)

- AOD is a **quantitative** measure of aerosols in the atmosphere
- Measure of scattering/absorption of visible light by aerosols
  - High AOD (red, orange, yellow): smoke, blowing dust, haze
  - No AOD retrieval in regions with clouds or bright surfaces
- ABI has **high accuracy** AOD from multi-channel retrieval (similar to VIIRS and MODIS AOD)

Previous GOES Imager:
- 4 km, 30 min, lower accuracy

GOES-16 ABI:
- 2 km, 15 min, high accuracy
ABI Products: Aerosol Detection

- Aerosol detection is a **qualitative** measure of aerosols
  - **Smoke mask**: indicates smoke plumes
  - **Dust mask**: indicates blowing dust

- Derived using satellite measurements in visible and IR
- New product from ABI! Not available from previous imager!

Smoke Mask: May 6, 2017
Dust Mask: March 31, 2017

$\beta$-maturity data
Not for scientific use
ABI Products: Dust RGB

• Made from a combination of three IR spectral bands on ABI (brightness temperature at 8.4 µm, 11.2 µm, 12.3 µm)
• Indicates areas of blowing dust in the atmosphere: appears as a magenta feature
• New product from ABI! Not available from previous imager!
# At a Glance: Advantages of ABI Aerosol Products

**ABI aerosol products are ideal for forecasting!**

- Imagery begins streaming at sunrise; low latency
- Choice of routine CONUS and full disk views!
- High accuracy, high spatial resolution observations!

<table>
<thead>
<tr>
<th>Data Characteristic</th>
<th>ABI</th>
<th>Previous Imager</th>
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<tbody>
<tr>
<td><strong>Observation Time</strong></td>
<td>Continuous during daylight</td>
<td></td>
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<tr>
<td><strong>Routine Views</strong></td>
<td>CONUS and full disk</td>
<td>CONUS only</td>
</tr>
<tr>
<td><strong>Temporal Resolution</strong></td>
<td>5 min (CONUS) 15 min (full disk)</td>
<td>30 min (CONUS)</td>
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<tr>
<td><strong>NRT Imagery Latency</strong></td>
<td>20 min</td>
<td>30 min</td>
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<tr>
<td><strong>Spatial Resolution</strong></td>
<td><strong>GeoColor</strong></td>
<td></td>
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<tr>
<td></td>
<td>1 km (CONUS) 4 km (full disk)</td>
<td>N/A</td>
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<tr>
<td></td>
<td><strong>AOD</strong></td>
<td></td>
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<tr>
<td></td>
<td>2 km (CONUS) 4 km (full disk)</td>
<td>4 km</td>
</tr>
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BC/Western US Wildfires: Aug/Sept, 2017

- Wildfires raged last summer in western US and British Columbia
  - Huge ridge of high pressure over western US; record-breaking heat wave in Pacific NW
- Seattle and Portland, OR hit particularly hard; days of Code Orange/Red PM$_{2.5}$ air quality

VIIRS true color courtesy NASA EO
Lots of Media Coverage

All photos courtesy of the New York Times

Mt Rainier on Aug 1, 2017

Mt Rainier on Aug 2, 2017

Lake Union, Seattle on Aug 5, 2017

Portland, OR on Aug 7, 2107
Western US/BC Fires: ABI GeoColor Loop (Aug 29-Sept 5)


New York Times article, Sept 16, 2017

15-min loop of ABI GeoColor, fire hotspots Aug 29 to Sept 5, 2017

As Wildfires Burn in West, Ash Rides Wind High Across U.S.

By TROY CRIGGS, K.K. LAI, JEREMY ASHKENAS and JUGAL K. PATEL  SEPT. 16, 2017

Wildfires in the Pacific Northwest this summer gave rise to dangerous air quality throughout the region, and generated plumes of smoke that spread across vast swaths of North America.
Western US/BC Fires: ABI AOD and GeoColor Animation (Sept 4)

β-maturity AOD data
Not for scientific use
Access to ABI Aerosol Products Data Files

• Download data files in netCDF4 format from CLASS: https://www.class.ncdc.noaa.gov

• Variety of data readers available:
  – HDFView
  – Panopoly
  – NOAA’s Weather and Climate Toolkit
  – NOAA standalone IDL reader for ABI data

• Links to data readers, tutorials, and sample data files: https://www.star.nesdis.noaa.gov/smcd/spb/aq/aqpg/2017/ (Google “2017 NOAA Aerosol Workshop”)
New NOAA AerosolWatch Website: Access to NRT ABI Aerosol Imagery

https://www.star.nesdis.noaa.gov/smcd/spb/ag/AerosolWatch/

AerosolWatch is being updated based on user feedback! Many changes coming soon!
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Many changes coming soon!
Exciting Plans for 2018

• ABI GeoColor and dust RGB currently provisional maturity
  – Can be used now, no changes expected unless issues develop with calibration or sensor artifacts

• ABI AOD and smoke/dust mask currently β-maturity
  – Do not use for scientific applications yet
  – Wait for provisional maturity products, anticipated May 2018
  – Fully validated products expected Fall 2018

• AerosolWatch website updates complete ~Spring 2018
  – Your destination for imagery to use for forecasting
  – Streamlining ABI imagery animation and product options
  – Adding additional products (AOD composites, 48-hr trajectories)
  – Incorporating polar-orbiting VIIRS satellite data

• GOES-S launches in March!
  – β-testing products begin flowing ~60 days after launch
  – Drift to GOES-West planned for ~ 200 days after launch
Acknowledgements

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