The NOAA Air Quality Preparing the Air Quality Community for

by A.K. Huff, R.M. Hoff, S. Kondragunta, H. Zhang, P. Ciren, C. Xu, S. Christopher, E.-S. Yang, and J. Szykman

This article outlines the new and improved aerosol products that will be available from NOAA's next-generation GOES-R satellite, scheduled to launch in 2015, and describes the activities of the GOES-R Air Quality Proving Ground project to help the air quality community prepare for applications of the GOES-R aerosol products.

2011-07-30 1400 UTC AOD

(beta)

0.8



0.0

0.2

0.4

1.0

Proving Ground

Next-Generation Products from the GOES-R Satellite

The air quality community utilizes observations from satellites, such as NOAA's Geostationary Operational Environmental Satellite (GOES) series and NASA's Terra and Aqua satellites, for forecasting, modeling, and monitoring.^{1,2} The GOES-R satellite, scheduled for launch in 2015, is the first in the next generation of NOAA geostationary weather satellites. GOES-R is scheduled to replace the current GOES-West satellite, GOES-15. The Advanced Baseline Imager (ABI) instrument on GOES-R will provide new satellite products with higher accuracy and more frequent measurements.³ As shown in Table 1, the ABI will offer approximately three times more spectral bands, a tri-fold increase in the number of observations of the Continental U.S. (CONUS) per hour, and a doubling of spatial resolution compared to the current GOES Imager. These advancements represent a significant increase in the number and quality of satellite observations that will be available to the user community.

To prepare users for the unprecedented volume of data from GOES-R, NOAA has established the GOES-R Proving Ground (http://cimss.ssec.wisc.edu/ goes_r/proving-ground.html), which is a nation-wide, collaborative project between NOAA GOES-R product developers and users of geostationary satellite products.⁴ The GOES-R Proving Ground is bridging the gap between research and operations by allowing users to provide input on the format, display, and integration of GOES-R products into operations. The objectives of the GOES-R Proving Ground include training users on new GOES-R products and identifying any weaknesses or errors associated with GOES-R products before the launch of the GOES-R satellite in 2015.

The Air Quality Proving Ground (AQPG) project is a subset of the overall GOES-R Proving Ground that focuses on preparing the air quality community for fire and aerosol products from the ABI. This distinction is important because air quality forecasters, modelers, and analysts, many of whom work for state, local, and tribal governments, have a unique set of data user requirements related to their responsibilities for public service air quality forecasting, support of State Implementation Plans (SIPs), and regulatory activities. In addition, there is a broad clientele of air quality information users, including the private sector and general public.

The AQPG is designed to provide the air quality user community with a first look at the capabilities of the ABI, to allow users to anticipate how they will use ABI aerosol products in their daily work, and to help NOAA plan for the delivery of ABI aerosol products to the air quality community. The AQPG is led by a team of scientists from the University of Maryland, Baltimore County (UMBC); NOAA's National Environmental Satellite, Data, and Information Service (NESDIS); Battelle Memorial Institute; the University of Alabama, Huntsville (UAH); and the U.S. Environmental Protection Agency (EPA). The AQPG team is facilitating the interpretation and use of ABI aerosol products, taking into account the unique characteristics, capabilities, and needs of the air quality community as a whole.

ABI products for air quality applications will include Aerosol Optical Depth (AOD) and Suspended Matter. AOD is a measure of the scattering and absorption of visible light by particles in a vertical

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[«] Simulated ABI near real-time AOD for a subset of the Southeastern U.S. domain with county borders on July 30, 2011, 14:00 UTC, showing AOD associated with haze in VA, WV, KY, and NC (yellow and orange colored areas).



Figure 1. Overview of the main activities of the AQPG, grouped by participating organization: the University of Maryland, Baltimore County (UMBC); Battelle Memorial Institute (Battelle); NOAA's National Environmental Satellite, Data, and Information Service (NESDIS); the University of Alabama, Huntsville (UAH); and the U.S. Environmental Protection Agency (EPA).

column of the atmosphere; it is related to particulate concentration.⁵ AOD is useful for identifying and tracking areas of high particulate concentrations that correspond to an air quality event, such as a wildfire, dust storm, or haze episode.⁶ Suspended Matter, which indicates Aerosol Type (AT) and concentration, is a new product from GOES-R that will help users distinguish between smoke and dust aerosol observations. AT is derived from the minimization of the difference between observed and calculated radiances at different wavelengths using four aerosol models: dust, smoke, urban, and generic. Natural Color Imagery (NCI) will also be available from GOES-R as a decision aid. NCI serves as a complement to AOD measurements by providing visible information about areas of smoke, haze, or dust.⁶ NCI is typically generated from a combination of the visible spectral bands of a satellite instrument. The ABI will not have a green (0.55 μ m) band, however, so it will be approximated from a look-up table based on the ABI blue (0.47 μ m), red (0.64 μ m), and near-infrared (0.865 μ m) band radiances.⁷

AQPG Activities

An overview of the activities of the AQPG is provided in Figure 1. One of the project's primary tasks is generating simulated ABI aerosol imagery for use in training and interaction with the air quality user community before GOES-R launches.⁸ Simulated imagery allows users to envision what actual ABI imagery will look like and to anticipate how ABI products will fit into their forecasting and analysis duties.

The focus of the AQPG is interaction with users, and continuing input from the air quality community on ABI products is welcome. As part of a formal Advisory Group, more than 35 air quality forecasters, modelers, and analysts are providing feedback to the AQPG team on ABI product development via review of the simulated ABI aerosol products. The AQPG team has generated simulated ABI AOD, AT, and NCI for several past case studies of

Table 1. Comparison of current GOES imager and GOES-R ABI properties.

		Current GOES Imager	GOES-R ABI
Spectral Bands (Channels)		5	16
Temporal Resolution	Full Disk	3 hr	15 min
	CONUS	15 min	5 min
	Mesoscale	Ν/Α	30 sec
Spatial Resolution	AOD	4 km	2 km

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historical air quality events in the United States involving haze and smoke from wildfires. The AQPG team has presented these case studies to Advisory Group members and other representatives from the air quality community at a variety of venues, including workshops in September 2010 and January 2012 and at a training session at the 2011 National Air Quality Conference. User community input is critical for improving ABI product quality, usage, and distribution, and for developing new applications, including specific data formats.

The AQPG team has made several key improvements to ABI aerosol products based on detailed feedback received from users regarding the simulated ABI case studies. To approximate ABI observations in a more representative manner for review by the air quality community, the AQPG team began conducting periodic near-real-time streaming testbeds of simulated ABI aerosol products in summer 2011.

Near-Real-Time Streaming of Simulated ABI Aerosol Products

The near-real-time streaming testbeds are designed to estimate the process of actual ABI observations that will occur once GOES-R launches. For the first of these planned testbeds, the AQPG team generated hourly simulated ABI AOD, AT, and NCI for 12:00-23:00 UTC daily over the southeastern United States during the period July 12-30, 2011, and streamed the imagery to Advisory Group members via an interactive Web site. This initial experiment was conducted during the NASA DISCOVER-AQ field campaign to allow for validation of simulated ABI data using aerosol vertical profiles and other physical/chemical measurements made in the Washington, DC/Baltimore, MD region.9 The testbed marked the first time that simulated GOES-R retrievals were streamed to users in near-real-time.

The simulated ABI near-real-time aerosol products





Figure 2. Simulated ABI near real-time AT for a subset of the Southeastern U.S. domain with county borders on July 30, 2011, 14:00 UTC, showing dust, urban, generic, and smoke aerosols.



Figure 3. Simulated ABI near real-time NCI for the a subset of the Southeastern U.S. domain with county borders on July 30, 2011, 14:00 UTC, showing haze (diffuse grey areas) in VA, WV, KY, and NC. Clouds are bright white.

were based on output from the WRF-SMOKE-CMAQ model run at UAH.8 The UAH model was chosen for the experiment because it incorporates the GOES Automated Biomass Burning Algorithm (ABBA)¹⁰ for fire emissions. A subset of six simulated ABI spectral band radiances (0.47 µm, 0.66 µm, 0.86 µm, 1.36 µm, 1.6 µm, and 2.25 µm) were used as input into the ABI aerosol algorithm,¹¹ which produced the simulated ABI near-real-time aerosol products, including AOD and AT (see Figure 2 and model on page 32). To help with interpretation of the aerosol products, the AQPG team also generated simulated ABI NCI (see Figure 3) by deriving a synthetic ABI green band based on the relationship between the red and green bands of NASA's MODerate resolution Imaging Spectroradiometer (MODIS).12

The simulated ABI NCI and AOD products were interpolated from the 12-km resolution of the CMAQ model to 2-km resolution to match the spatial resolution that actual ABI aerosol products will have. As a result of the spatial downscaling, some pixilation existed in the simulated images; this was an artifact of the spatial resolution of the model data and will not be present in actual ABI images once GOES-R launches. Similarly, the simulated ABI products had a temporal resolution of 1 hour, set by the CMAQ model runs, but actual ABI aerosol products will have a temporal resolution of 5–15 minutes. The combination of high accuracy and high resolution that will be available from ABI AOD will be superior to the current AOD products that are available to the air quality community from MODIS on NASA's Terra and Aqua satellites or NOAA's GOES Aerosol and Smoke Product (GASP).

Selected members of the Advisory Group reviewed the simulated ABI images daily and provided feedback via e-mail. User comments focused on the process of receiving streaming images of dynamic, high-accuracy, high-temporal resolution imagery. In all cases, users responded positively to the simulated ABI products and provided suggestions for improvements. Specific comments covered a range of topics, such as modifying the colors utilized for the AOD and AT products, adding constant-value



contours to the AOD product, and adding a zoomin feature to allow for more in-depth analysis of the imagery on the city level.

Summary and Next Steps for the AQPG

The AQPG team was successfully able to conduct a near-real-time testbed of simulated ABI aerosol products for the southeastern United States during July 2011 and stream the products to users. This experiment was the first time that one of the NOAA GOES-R Proving Grounds was able to provide simulated ABI retrievals to users in nearreal-time. The AQPG team incorporated user feedback into product development and plans to stage the next near-real-time testbed for the entire CONUS in spring 2013.

The AQPG team is also working with NOAA to prototype the delivery system for ABI aerosol products to the air quality user community and is developing online training modules for ABI aerosol products. All of the materials developed by the AQPG team, including case studies of simulated ABI aerosol products and instructional tutorials, are available from the project Web site (http:// alg.umbc.edu/aqpg/).

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To ensure user readiness as soon as GOES-R is operational, NOAA plans to continue support of the GOES-R Proving Ground project through the scheduled launch of GOES-R in 2015. In the years until GOES-R launches, the AQPG team will continue to interact closely with the air quality user community through training and outreach activities to maximize the usefulness of ABI aerosol products. em

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