**NOAA GOES-R Air Quality Proving Ground**

**3rd Annual Advisory Group Workshop**

**March 14, 2013**

**Case Study Worksheet: July 4, 2012**

**Goals:** The goals of this breakout session are to give you the opportunity to view simulated GOES-R ABI and observed Suomi-NPP VIIRS aerosol products in detail, anticipate how they will enhance air quality forecasting and/or analysis, and provide feedback to NOAA on data visualization and format options.

**Instructions:** The case study is for July 4, 2012 (fires and haze). An accompanying Power Point file contains general air quality and meteorological information about the event; review this information first to familiarize yourself with the air quality event. Then review the **simulated GOES-R ABI products** and **observed Suomi-NPP VIIRS products** for the event, which are available on a special section of the NOAA IDEA website. Use the steps below to guide your analysis.

***Please answer the questions about the satellite aerosol products on the accompanying Case Study Questionnaire.*** Your answers will be the basis of the Group Discussion this afternoon.

**Case Study Event Summary:** Large fires were burning in Colorado and Wyoming, resulting in localized Code Yellow (Moderate) and Code Orange (Unhealthy for Sensitive Groups) and isolated Code Red (Unhealthy) PM2.5 conditions. Haze combined with smoke from the fires was also widespread across the eastern U.S., resulting in Code Yellow PM2.5 conditions.

1. **Open the accompanying “July 4 2012\_AQI\_Met” Power Point file *and activate it in “slide show” mode.*** The file can be downloaded from the AQPG website (<http://alg.umbc.edu/aqpg/>). Review the air quality and meteorological information in the Power Point file:
* **24-hour average PM2.5 AQI values (slide 2)**
* **Synoptic surface analysis and radar for 12-15 UTC (slides 3-4)**
* **Terra MODIS true color and aerosol optical depth (AOD) images (slides 5-6).** The Terra satellite has a morning overpass, so these images correspond to observations at approximately 10:30 AM local time. Note the smoke plumes (grey diffuse features) associated with the fires, which are particularly evident in SD, MN, IA, and WI. If you are having trouble seeing the smoke plumes in the true color image, look at the AOD image (slide 6). Areas of higher AOD values (red, orange, and yellow colors) in the image correspond to high concentrations of PM2.5 from smoke. Also note the areas of higher AOD associated with haze/smoke in the Mid-Atlantic and Southeast.
* **GOES Aerosol and Smoke Product (GASP) animation (slide 7).** GASP is AOD from the GOES geostationary satellite. It is similar to MODIS AOD but has 30 minute temporal resolution, so there are many more observations per day, which can be more useful for near real-time analysis. Areas of high AOD corresponding to smoke from the fires should be evident, originating in Colorado and Wyoming and streaming out to the northeast.
1. **Simulated GOES-R ABI aerosol products.** Simulated ABI products are a representation of what images from the ABI will look like when the GOES-R satellite launches in 2015. ***Since they are generated from model output, you should not expect the simulated images to be completely faithful representations of the observed conditions.***

Go to the special section of the NOAA IDEA website for the GOES-R AQPG demo (accessible from AQPG website or from slide 8 of the “July 4 2012\_AQI\_Met” Power Point file): <http://www.star.nesdis.noaa.gov/smcd/spb/aq/aqpg_v3/>.

Click on the “GOES-R” tab at the top of the IDEA homepage. You should see 4 products: *GOES-R Simulated Natural Color and Aerosol Images*, *GOES-R Simulated 3-Hour Composite AOD*, *48-Hour Aerosol Foreword Trajectory with Model Winds and Precipitation*, and *PM2.5 Estimates and Suspended Matter*.

**2a. GOES-R Simulated Natural Color and Aerosol Images.** On the IDEA home page (GOES-R tab), click on the upper left-side image to access the GOES-R simulated natural color and aerosol imagery. Explore the data and visualization options in the toolbar on the right-side of the images:

* The default images are **NCI & AOD**. Experiment with stopping and starting the **animation** and controlling the animation speed with the controls in the toolbar.
* Adjust the **NCI opacity** and the **AOD opacity** slider bars to highlight the natural color and aerosol images. Review the animated loops of NCI and AOD images.
* Toggle **AOD contours** using the button in the toolbar. Contours of AOD values of 0.4 and 0.7 are provided to help focus on areas that roughly correspond to Moderate (Code Yellow) and USG (Code Orange) PM2.5 air quality. This feature is not as useful for wildfires, which have high AOD values; the contours are more effective for dust or haze events.
* Toggle **fire hotspots** using the button in the toolbar. The overlay of fire hotspots is provided by the NOAA GOES Wildfire Automated Biomass Burning Algorithm (WF-ABBA).
* Toggle **county** boundaries using the button in the toolbar.
* Experiment with the **zoom** feature using the controls on the left-side of the image. Or double click on an area of interest in the image to zoom in. Additional clicking on the image will zoom in further.
* Experiment with the different **backgrounds** for the imagery by clicking on the **labels**, **map**, and **black** buttons at the top right-side of the imagery.
* **Plot Select.**  Click on the box for **Aerosol Type** in the toolbar to see the simulated daily aerosol type (dust, mixed aerosol, urban, or smoke).
* The NCI, AOD, and Aerosol Type imagery are available in **KML format** for visualization in **Google Earth**. If you have Google Earth (or other KML-compatible virtual globe software) on your computer, click on the links at the bottom of the toolbar to download the KML files.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.

**2b. GOES-R Simulated 3-Hour Composite AOD.** On the IDEA home page (GOES-R tab), click on the lower left-side image to access the GOES-R simulated 3-hour composites.

* Composite AOD images are available at 14:00, 17:00, 20:00, and 23:00 UTC.
* Composites are useful for visualizing changes in AOD in locations where AOD may be periodically missing due to interference from clouds or bright surfaces.
* Experiment with the **animation**, **AOD opacity**, **toggle** **fire hotspots**, **toggle** **county boundaries**, **zoom**, and **background** features.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.

**2c. 48-Hour Aerosol Forward Trajectory.** On the IDEA home page (GOES-R tab), click on the upper right-side image to access the 48-hour aerosol forward trajectory based on the simulated GOES-R AOD.

* This product is an animated aerosol forward trajectory, forecast 48 hours into the future, in 3 hour increments.
* The trajectories were initialized at 15:00 UTC on July 4 for areas of high simulated ABI AOD (AOD > 0.4). The air parcel trajectories were run using 12:00 UTC NOAA NCEP NAM (North American Mesoscale Model) forecast data.
* The trajectories were initialized at 50 mb, 100 mb, 150 mb, and 200 mb above surface level, with a maximum number of 100 trajectories per swath. The pressure levels of the trajectories are plotted in mb and colored with a magenta-white scale (shown in the color bar at the bottom right of the image).
* 850 mb wind field vectors are plotted to show wind direction/speed, and the locations of 3 hour accumulated precipitation are plotted in yellow.
* Experiment with the **animation**, **zoom**, and **background** features.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.

**2d.** **PM2.5 Estimates and Suspended Matter.** On the IDEA home page (GOES-R tab), click on the lower right-side image to access the estimates of PM2.5 concentration from simulated GOES-R AOD and suspended matter.

* The default image is **PM2.5 estimates**. Surface PM2.5 concentrations (g/m3) are estimated from the average daily simulated ABI AOD values for the CONUS using the linear regression relationships between MODIS AOD and surface PM2.5 concentrations over ten EPA-defined regions and four seasons derived by Zhang et al. (2009).
* **Plot Select.** Click on the box for **suspended matter**. Suspended matter (g/cm2) is the simulated column measurement of aerosols in the atmosphere, between the top of the atmosphere and the Earth’s surface.
* Toggle the overlay of **in situ daily observed** **24-hr average PM2.5 concentrations** (g/m3) from State and Local Air Monitoring Stations (SLAMS) and National Ambient Monitoring Stations (NAMS), which are represented by colored circles. The color of the circles corresponds to the daily PM2.5 concentration (g/m3), shown in the color bar at the bottom of the image, and is related to U.S. EPA Air Quality Index (AQI) color scale.
* Experiment with the **opacity control**, **toggle** **county boundaries**, **zoom**, and **background** features.
* If you have **Google Earth** (or other KML-compatible virtual globe software) on your computer, click on the link at the bottom of the toolbar to download the **KML files** for the PM2.5 estimates and the in situ overlay of observed AQI values.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.
1. **Observed Suomi-NPP VIIRS aerosol products.** The Suomi-National Polar-Orbiting Partnership (NPP) satellite was launched on October 28, 2011. The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument on Suomi-NPP has 20 spectral bands (channels) and is making land, ocean, and atmosphere measurements similar to the MODIS instrument on NASA’s Terra and Aqua satellites.

***VIIRS aerosol products are currently only -level maturity,*** so keep in mind that the VIIRS aerosol data for the July 4, 2012 case study are:

* An early release product,
* Initial calibration has been applied,
* Minimally validated and may still contain significant errors (additional changes are expected),
* Available to allow users to gain familiarity with data formats and parameters,
* Not appropriate as the basis for quantitative scientific publications, studies and applications.

Click on the “VIIRS” tab at the top of the IDEA homepage. You should see 2 products: *VIIRS Natural Color and Aerosol Images* and *PM2.5 Estimates from VIIRS AOD*.

**3a. VIIRS Observed Natural Color and Aerosol Images.** On the IDEA home page (VIIRS tab), click on the upper left-side image to access the VIIRS natural color and aerosol imagery.

There are two operational VIIRS AOD products:

* The **Intermediate Product (IP)**, which has **750 m nadir resolution** (pixel level).
* The **Environmental Data Record (EDR)**, which is an aggregated product from IP with **6 km nadir resolution**.

Explore the VIIRS products and visualization options in the toolbar on the right-side of the images:

* **Plot Select.** Click on the boxes for **6 km AOD**, **750 m AOD QF0**, **750 m AOD QF1**, and **750 m QF2** to see the different operational VIIRS AOD products. There are several levels of **quality flags (QF)** for the IP AOD. QF0 is the highest quality, QF1 is moderate (high/medium) quality, and QF2 is lower quality (high/medium/low) quality. Note the differences in the AOD data available for the various QF products.
* Note that there is **no animation** for VIIRS NCI and AOD because VIIRS makes only one measurement per day at approximately 1:30 PM local time.
* Experiment with the **NCI and AOD opacity**, **toggle AOD contour**, **toggle fire hotspots**, **toggle county boundaries**, **zoom**, and **background** features.
* If you have **Google Earth** (or other KML-compatible virtual globe software) on your computer, click on the link at the bottom of the toolbar to download the **KML files** for the VIIRS natural color and AOD imagery.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.

**3b. PM2.5 Estimates from VIIRS AOD.** On the IDEA home page (VIIRS tab), click on the upper right-side image to access the PM2.5 estimates from VIIRS AOD.

* Surface PM2.5 concentrations (g/m3) are estimated from the daily VIIRS AOD values for the CONUS using the linear regression relationships between MODIS AOD and surface PM2.5 concentrations over ten EPA-defined regions and four seasons derived by Zhang et al. (2009).
* Move the **opacity control** slider bar all the way to the left to see the daily observed 24-hr average PM2.5 concentrations, and then move the slider bar gradually toward the right to see the PM2.5 concentration estimates from VIIRS AOD.
* Experiment with the **toggle in situ** daily observed 24-hr average PM2.5 concentrations, **toggle** **county boundaries**, **zoom**, and **background** features.
* If you have **Google Earth** (or other KML-compatible virtual globe software) on your computer, click on the link at the bottom of the toolbar to download the **KML files** for the PM2.5 estimates and the in situ overlay of observed AQI values.
* Click the **IDEA logo with the light bulb** at the top left-side of the page to go back to the IDEA home page.
1. Answer questions 1-7 on the **Case Study Questionnaire** about the simulated GOES-R ABI and observed Suomi-NPP VIIRS aerosol products, visualization options, and data delivery.