IDEA-like GOES-R air quality data distribution system

Hai Zhang (hazhang@umbc.edu)[1] , Raymond M. Hoff[1] , Shobha Kondragunta[2]

1. University of Maryland Baltimore County
2. STAR/NOAA NESDIS

1. Project Goals

NOAA maintains and supports the Infusing Satellite Data into Environmental Applications (IDEA) product at http://www.star.nesdis.noaa.gov/smcd/spb/aq/. Designed to disseminate NOAA GOES Aerosol and Smoke Product (GASP) data, NASA MODIS data, and EPA ground-based PM2.5 measurements, IDEA has become a core product in the toolkits used by State and local air quality analysts and forecasters. The first goal of the project is to provide air quality community continuous service and make seamless transition of IDEA product using GOES-R data when the satellite is launched. The system is used as a tool for the GOES-R Air Quality Proving Ground (AQPG) team to demonstrate the GOES-R air quality product to the air quality community users and acquire feedbacks. The IDEA system will also be a useful platform for the near-real-time delivery of VIIRS aerosol products.

Two aerosol retrieval algorithms over land are under development for GOES-R ABI data: one of them uses a method similar to MODIS dark pixel algorithm; the other one uses a MAIAC (Multi-Angle Implementation of Atmospheric Correction) method. MAIAC algorithm can complement dark pixel algorithm on bright surfaces since the latter only works on dark pixels. The second goal of the project is to examine the performance of MAIAC algorithm on the geostationary satellite geometry and to make modification of the algorithm so that it can work well on GOES-R data. The geostationary datasets used for the examination include current GOES data, SEVIRI (Spinning Enhanced Visible and Infrared Imager) data, and the simulated GOES-R proxy data.

2. Accomplishments

2.1 GOES-R AQPG demo

We worked together with GOES-R AQPG team on setting up GOES-R AQPG demonstration system. The system uses CMAQ (Community Multi-scale Air Quality modeling system) and CRTM (Community Radiative Transfer Model) to generate TOA reflectance at GOES-R geometry. The TOA reflectance is then feed as input for GOES-R ABI aerosol retrieval algorithm. The final data output is displayed on an experimental web site (Figure 1). The system was demonstrated in near-real-time in July,2011 and was also demonstrated in the GOES-R AQPG workshop held in January,2012.

Following accomplishments are achieved:

- Regrid MODIS BRDF on CMAQ grid for six visible/NIR/SWIR channels of GOES-R, which are then used in the CRTM for calculating TOA reflectance.
- Evaluate TOA and surface reflectance from CRTM and compare it with MODIS, GOES TOA and surface reflectance. Identify problems in the simulated TOA reflectance.
- Develop web page for displaying the imagery from CRTM and aerosol algorithm output.
- Develop IDL code for generating the images. The displayed components include natural color images, AOD images, aerosol model images, derived AQI (Air Quality Index) from AOD and their animations.

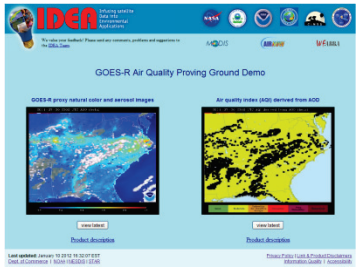

Figure 1. GOES-R Air Quality Proving Ground Demo site (http://www.star.nesdis.noaa.gov/smcd/spb/aq/aqpg_v2/).

2.2 Natural color image generation for GOES-R

A method was developed for generating synthetic natural color image for GOES-R and was used in the AQPG demonstration. The method uses the linear regression relationship between green band reflectance and the other two visible bands reflectance, which is derived from MODIS land surface BRDF and MODIS TOA reflectance. We built a look-up-table of the slopes and intercepts since the relationship varies over different types of surfaces, seasons, and atmospheric conditions.

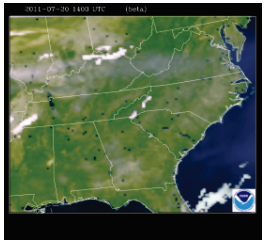

Figure 2. An example natural color image generated from simulated GOES-R proxy data.

2.3 AOD retrieval algorithm development

2.3.1 SEVIRI data

MAIAC algorithm developed for MODIS is applied on SEVIRI data to examine the applicability of the algorithm on geostationary satellite geometry. In this algorithm for MODIS, the surface BRDF shape is assumed to be the same between the 2.1 μm channel and the red and blue channels. For SEVIRI data, we use the 1.6 μm channel to substitute the 2.1 μm channel and assume the 1.6 μm channel BRDF shape is the same as that in the red channel. After revising the MAIAC code and applying it on SEVIRI data, we found that the 1.6 μm BRDF shape is different from that in the 0.6 μm channel. Therefore, we modified the algorithm: first we estimate the average daily AOD, then we use the average AOD and TOA reflectance to retrieve surface BRDF ratio between 0.6 μm channel and 1.6 μm channel, the ratio is used in the following day to retrieve surface reflectance and AOD. The initial test results over two European sites are shown in Figure 3.

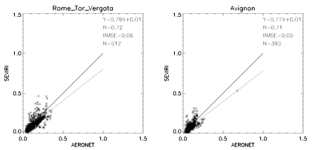

Figure 3. Scatter plot between AOD retrieval from SEVIRI data and AERONET AOD for two European sites (Mar 1-Apr 30, 2006).

2.3.2. Current GOES data

An algorithm was developed using both GOES-East and GOES-West data to retrieve AOD over the western US. The algorithm first uses MAIAC for GOES-East AOD retrieval to estimate average daily AOD, then retrieve surface BRDF from GOES-East and GOES-West data, the surface BRDF shape is used in the following day for surface reflectance and AOD retrieval. The algorithm can retrieve consistent single AOD value from the two satellite data instead of two different AOD values from GASP algorithm. The algorithm also makes a full use of the sensitivity of the TOA reflectance to AOD variations from the two satellites. A near-real-time system was set up and the AOD imagery is available at http://idea.umbc.edu/~hzhang/GAODW/ (Figure 4).

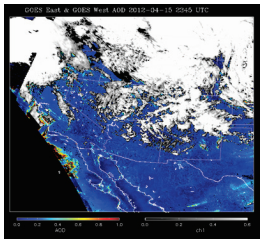

Figure 4. An example image from AOD retrieval algorithm that uses both GOES-East and GOES-West data over the western United States.

2.4 PM2.5 estimates from AOD

We collaborate with EPA scientists for AIRNOW site to deliver near-real-time PM2.5 estimates from MODIS AOD, which uses the algorithm developed by Aaron van Donkelaar from Dalhousie University. The algorithm is implemented on IDEA system.

3. Accomplishments anticipated at the end of Year 2

- Support GOES-R AQPG on the near-real-time demonstration to the users
- Revise and improve the IDEA system for GOES-R according to user feedbacks
- Improve the modified MAIAC algorithm for SEVIRI data
  - Remove assumption of 1.6 um channel not affected by aerosol
  - Analyze whether we can retrieve more information if we add 0.8 um channel in the algorithm
  - Analyze the effect of aerosol model on the retrieval
- Thoroughly test MAIAC algorithm for SEVIRI data over AERONET sites in both Europe and African. Perform regional case studies.

4. Initial feedback from potential users

We got a lot of feedbacks from users in the GOES-R AQPG demonstration and workshop. The suggestions include changing of the display methods and adding new features into the system. Following are several selected suggestions:

- Overlay of fire hotspots, major cities, model winds, etc.
- Make products available in kml/kmz format
- 48-hr aerosol trajectory forecast
- RGB/AOD slider

5. What could be accomplished with a 3rd year of funding

- Continue to support GOES-R AQPG activities and improve IDEA system based on user feedbacks
- Apply modified MAIAC algorithm on the GOES-R proxy dataset generated from GOES-R AQPG experiments
- Prepare IDEA system and MAIAC algorithm for the near-real-time run so that they are ready when GOES-R is launched.

Acknowledgement
This project is supported by NOAA GOES-R risk reduction program NA11NES4400005
.