

## VISUALIZATION, EXPLORATION, AND MODEL COMPARISON OF NASA AIR QUALITY REMOTE SENSING DATA VIA GIOVANNI

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### 1. INTRODUCTION

Giovanni is a web based tool for visualization and exploration of NASA Earth Science data [Acker and Leptoukh, 2007, Berrick et al., 2008]. Air Quality satellite data products available through Giovanni include gridded total and fine mode aerosol optical depth (AOD) observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument; UV Aerosol Index, AOD, SO<sub>2</sub> column, and tropospheric NO<sub>2</sub> column from the Ozone Monitoring Instrument (OMI); AOD from the Multiangle Imaging SpectroRadiometer (MISR) instrument; and CALIPSO vertical profile aerosol information. A newly launched Air Quality Instance also includes gridded EPA AIRNow surface PM<sub>2.5</sub> concentrations for easy comparison to satellite data. Recently, we have added the capability of visualization and comparison of satellite and in-situ aerosol observations to GOCART model aerosol data through the Aerosol Optical Thickness Measurement and Model Comparison Giovanni Instance. GOCART is a NASA global chemistry and transport model with gas phase and aerosol chemistry [Chin et al., 2002]. GOCART daily and monthly data at 1x1.25 degree resolution available through Giovanni include black carbon, organic carbon, sulfate, sea salt and dust fine and coarse mode Aerosol Optical Depth.

### 2. GIOVANNI VISUALIZATION TOOLS

Giovanni model data output, along with the above mentioned satellite and in-situ observations

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can be visualized through a variety of tools including latitude/longitude maps, Hovmoller plots, time series, and image animation loops for user selected regions and time periods.

NO<sub>2</sub> Tropospheric Vertical Column Density (30% Cloud Screened) [molec/cm<sup>2</sup>] (25Oct2007)

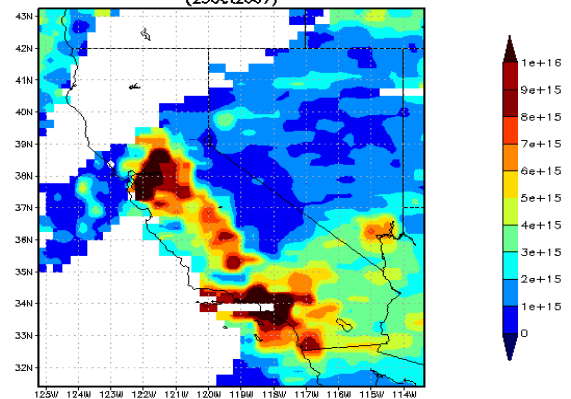


Figure 1: Tropospheric column NO<sub>2</sub> over California from the OMI instrument

AIRNOW\_PM.001 Fine Particulate Matter [unitless] (24May2007)

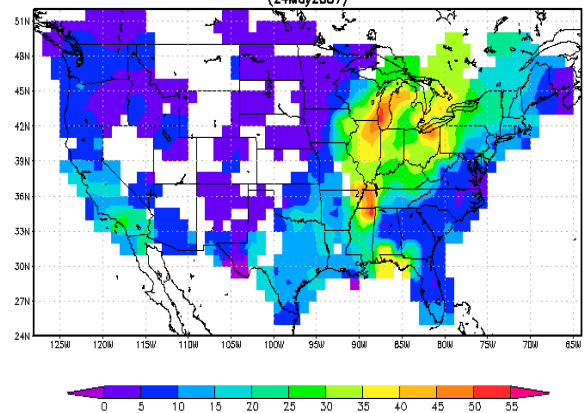


Figure 2: Gridded PM<sub>2.5</sub> concentrations. Obtained at DataFed from AIRNow and then accessed from DataFed via WCS.

Figure 1 is a map of tropospheric NO<sub>2</sub> column over California showing areas of elevated pollution due to the intense fires in October 2007. Figure 2 is a US map of fine particulate matter concentrations. The PM<sub>2.5</sub> observations in Giovanni are accessed via WCS from DataFed (<http://datafed.net/>)

### 3. GIOVANNI TOOLS FOR AIR QUALITY DATA ANALYSIS

Because most Giovanni satellite data products are global, they can also be used to monitor and analyze global air quality

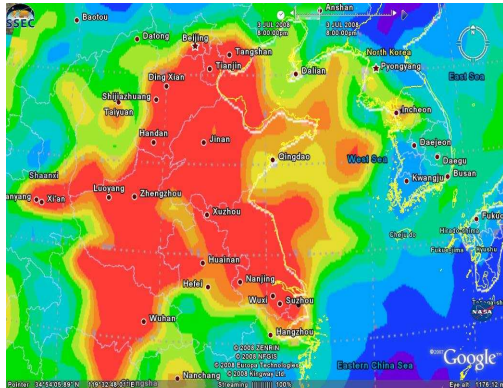


Figure 3: MODIS Aerosol Optical Depth over eastern China from July 4<sup>th</sup> – August 4<sup>th</sup>, 2008

During the summer of 2008 China reduced point and mobile sources emissions in advance of the Olympics. Figure 3 shows the mean AOD over eastern China from early July to early August, 2008. Giovanni allows customized views of U.S and global air quality by geographical location and time period.

Giovanni also has analysis tools for intercomparison of the various air quality data sets, including time series and correlation and scatter plots that can be used for air quality analysis and pollutant source attribution globally and over the continental U.S. [Prados et al., 2008a]

Figure 4 shows a time series of GOCART model data for June 15<sup>th</sup> – July 15<sup>th</sup>, 2006 over the southeastern U.S. Notice the dominant black carbon and organic carbon, relative to sulfate in early July due to fire burning emissions. Figure 5 shows a correlation map between satellite and ground based data for the same time period. The satellite data are column measurements and may or may not be representative of ground level air quality. MODIS is sensitive to both free

tropospheric and Planetary Boundary Layer (PBL) aerosols.

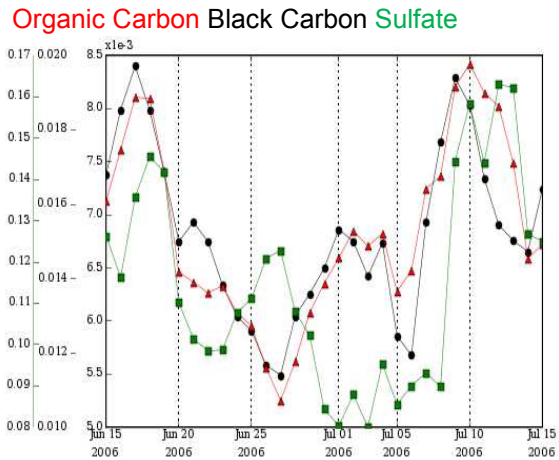


Figure 4: Time series of GOCART model organic carbon, black carbon, and sulfate AOD from June 15<sup>th</sup> to July 15<sup>th</sup>, 2006.

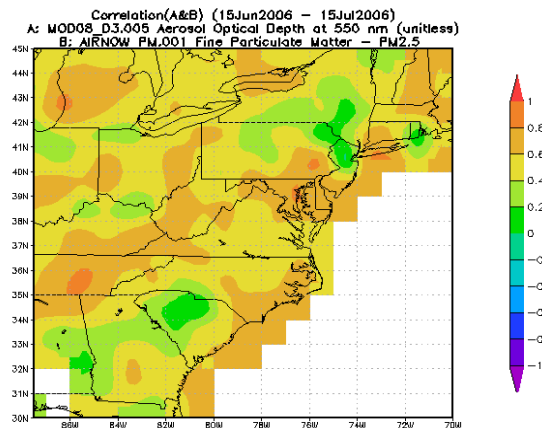


Figure 5: Correlation map between satellite Aerosol Optical Depth from MODIS and AIRNow PM<sub>2.5</sub> concentrations over the eastern US.

Moderate to good correlation between the satellite and surface measurements was found for this time period over most regions over the eastern half of the US. This indicates that the satellite was sensitive to the increased aerosol concentrations during this time period. There are a few regions where the correlation was poor, such as in the southeastern U.S. This could indicate the presence of elevated smoke plumes that would not be reflected in the surface PM<sub>2.5</sub> measurements but were detected by the MODIS instrument.

#### 4. 3D VISUALIZATION OF AIR QUALITY

Giovanni can generate KMZ data files, which are particularly useful for examining the vertical distribution of pollutants [Chen et al., 2008; Prados et al., 2008b]. An example can be seen in Figure 6, which shows a Google earth composite of AIRNow PM<sub>2.5</sub> and a CALIPSO vertical curtain plot on July 31<sup>st</sup>, 2007. By combining 2D latitude/longitude plots with 2D vertical curtain plots we can get a 3D view of air quality.

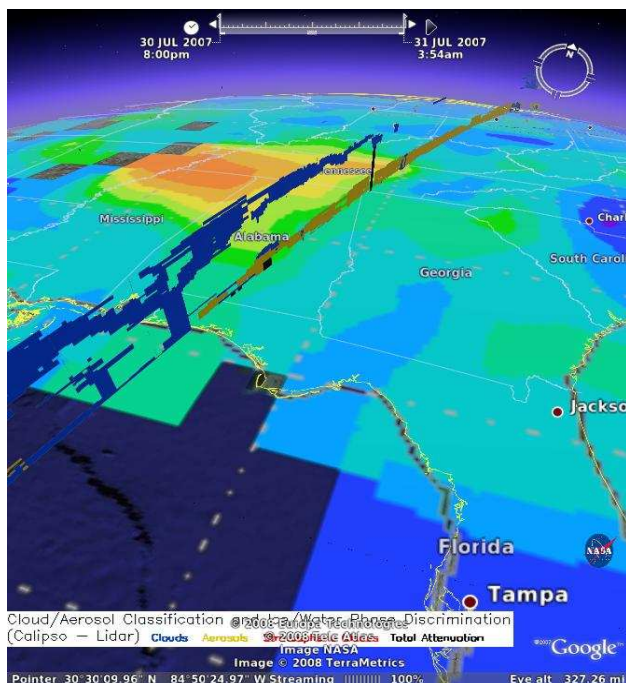


Figure 6: PM<sub>2.5</sub> Concentrations (background) and Calipso curtain plot (blue is clouds, yellow is the aerosol flag) on July 31, 2007.

Instruments aboard the CALIPSO satellite measure vertical aerosol extinction and clouds. The blue color indicates the presence of clouds, the yellow indicates the presence of aerosols.

#### 5. CONCLUSIONS

Numerous satellite based air quality products are available for easy analysis and visualization through the Giovanni online tool. With the addition of surface PM<sub>2.5</sub> gridded data and GOCART model data, Giovanni services such as time series, correlation plots, and scatter plots also allow intercomparison among monitor, model,

and satellite observations. Maps, curtains plots, and other Giovanni graphics can also be visualized through tools such as Google Earth, and enable a 3D-View of U.S and Global air quality.

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#### 6. ACKNOWLEDGEMENTS

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