

Blog Help Files: Aerosol Optical Depth (AOD)

Aerosol optical depth (AOD) is a measure of the scattering and absorption of visible light by particles in a vertical column of the atmosphere. AOD is useful for air quality analysis because it is proportional to the concentration of particulates in the atmosphere.

There are several limitations of AOD images for use in air quality analysis. Since AOD is measured using visible wavelengths, AOD images are only available for daylight hours. Clouds prohibit the measurement of AOD because visible light is reflected off of cloud-tops, and AOD cannot be measured over bright surfaces, such as deserts and ice sheets. Furthermore, AOD is a vertical column measurement, which means that it represents the total concentration of particulates in the atmosphere between the satellite and the Earth's surface. As a result, high values of AOD do not always correspond to high concentrations of particulates at the surface, because pollutants can be located aloft in the atmosphere.

There are two sources of AOD satellite measurements: **MODIS**, the Moderate Resolution Imaging Spectroradiometer, which flies on the polar-orbiting NASA Terra and Aqua satellites,* and **GASP**, the GOES Aerosol and Smoke Product, which is derived from GOES geostationary satellite measurements.* The main difference between MODIS AOD and GASP is temporal resolution; only two MODIS AOD images are available per day, from the Terra and Aqua overpasses, while GASP images are available every 30 minutes from the GOES geostationary satellites.

Figure 1 is an example of a MODIS AOD image taken from the Terra satellite for the continental U.S. on August 11, 2009. AOD values are unitless, and they typically range from zero to around 1 in the United States; higher values of AOD correspond to higher concentrations of particulates in the atmosphere. For the continental U.S., AOD values greater than approximately 0.5 are correlated with moderate-to-high concentrations of aerosols. AOD images are color coded, with reds and oranges corresponding to high AOD values, and blues corresponding to low AOD values. In Figure 1, there are two main areas of high AOD, from two different types of sources. In Northern California, very high values of AOD were caused by a wildfire, and moderate-to-high values of AOD over the Atlantic Ocean, off the East Coast, were due to haze. Black areas in Figure 1 are areas of missing AOD data that correspond to clouds or bright surfaces.

Figure 2 is a GASP image from 20:15 UTC* (4:15 PM EDT) on the same day, August 11, 2009. GASP is somewhat less accurate than MODIS AOD, but GASP has the advantage of higher temporal resolution, so there are measurements every 30 minutes during daylight hours. The same two main areas of high AOD that were evident in the MODIS AOD image in Figure 1 are also prominent in Figure 2. GASP images typically include a measure of Cloud Optical Thickness (COT), which are the white and grey areas in Figure 2. Black areas correspond to missing AOD data. GASP images can have "false positives" of high AOD readings along cloud edges, so interpret GASP with caution in areas of cloud cover.

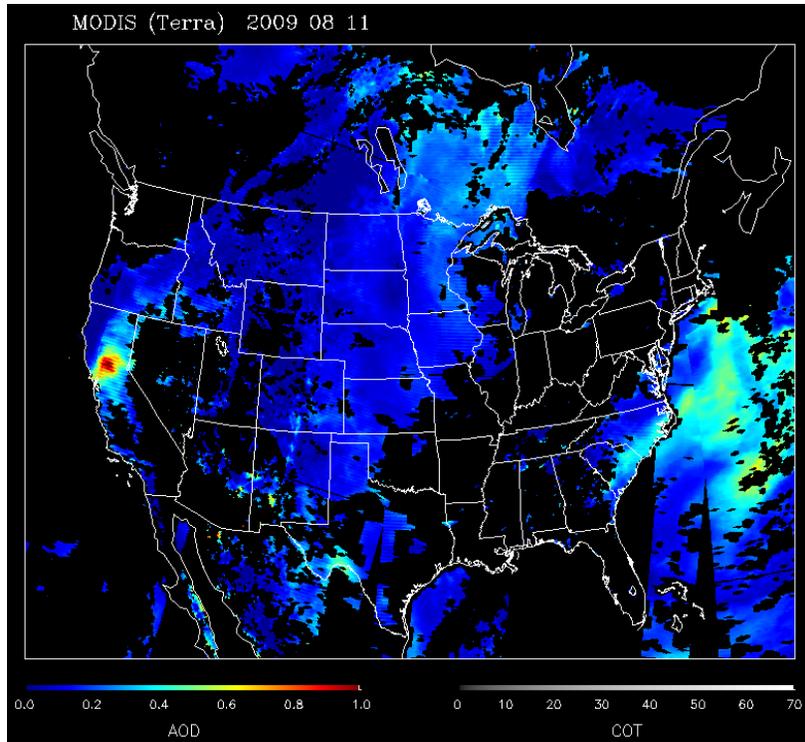


Figure 1. Terra MODIS AOD image for August 11, 2009.

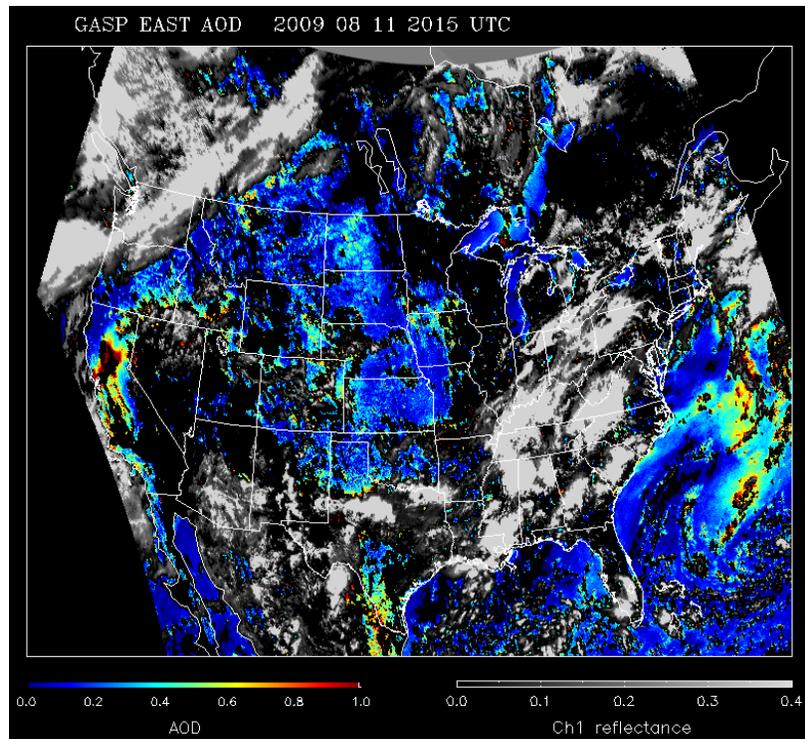


Figure 2. GASP image for 20:15 UTC, August 11, 2009.

AOD images are particularly powerful when used in conjunction with MODIS true color images,* because the images are complementary. True color images can indicate possible areas of smoke, haze, or dust, and AOD images can confirm that these areas correspond to elevated particulate concentrations in the atmosphere. Figure 3 is an example of side-by-side MODIS Terra true color and AOD images of a haze event in northern India, Nepal, and Bangladesh on February 5, 2006, illustrating the complementary nature of the images.

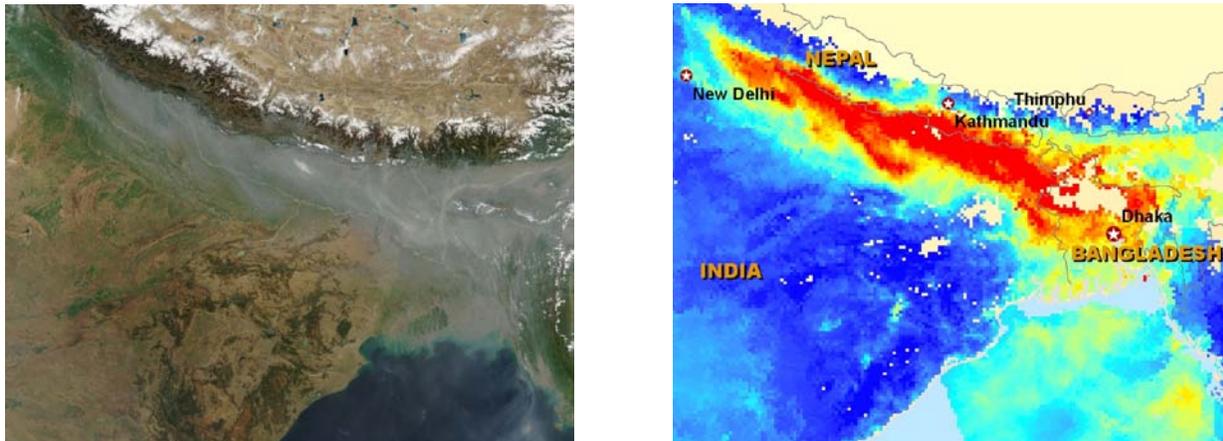


Figure 3. Terra MODIS true color and AOD images for February 2, 2006.

*For more information about:

- Polar-orbiting satellites, geostationary satellites, Terra, and Aqua, see the **Satellite Basics Help File**
- GOES, see the **GOES Imagery Help File**
- UTC, see the **Universal Coordinated Time Help File**
- True color images, see the **MODIS True Color Images Help File**