Observations of the 2008 Summer Wildfires by GASP, MODIS, and CALIPSO

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Between June – August of 2008, northern California experienced a large number of wildfires dubbed the Northern California Lightning Series by the California Department of Forestry and Fire Protection. A severe thunderstorm, which produced over 6,000 lightning strikes, ignited 2,096 fires which burned nearly 1.2 million acres (4,856 km^2). Extremely dry conditions caused by the first statewide drought in over a decade exasperated the problem, resulting in one of the worst wildfire situations in state history. Several exceedances of the National Ambient Air Quality Standards (NAAQS) for PM2.5 throughout the California Central Valley have been attributed to the wildfires. Exceedances are a rarity during the summer within the region. Satellite measurements from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard the Aqua satellite, GOES Aerosol/Smoke Product (GASP) from GOES-West, and Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) aboard CALIPSO were used to show the impact on air quality from the wildfires.

Twenty-four-hour in-situ mass concentrations from eight surface PM2.5 monitors in the Sacramento Valley Air Basin (Chico, Yuba City, Sacramento, and UC Davis) and San Joaquin Valley Air Basin (Stockton, Fresno, Corcoran, and Bakersfield) were correlated with coincident aerosol optical depth (AOD) measurements from GASP and MODIS. Coincidences were defined as the nearest MODIS/GASP pixel within ±0.05-degrees latitude/longitude of the PM2.5 monitor. Correlations of PM2.5 and AOD in the western United States are typically poor due to high surface reflectances, variations in aerosol type, and higher occurrences of smoke and elevated aerosol plumes. In this analysis, the R^2-correlations using MODIS and GASP were 0.47 and 0.23, respectively. Though MODIS had stronger correlations than GASP, both instruments gave similar estimates of PM2.5 when a linear-fit model was used. Examples of the analysis for Chico and Sacramento are shown in Figure 1, below. In either case, the average slope of the linear fit was approximately 30-μg m^{-3}/AOD and the intercept was approximately 10-μg m^{-3}. The results are less than the accepted static relationship that unity AOD is approximately 60-μg m^{-3}. Furthermore, the results showed that stronger PM2.5-AOD correlations existed near the origin of the fires in the Sacramento Valley (toward the north) than in the San Joaquin Valley (toward the south) where more smoke pollution came from transport. There was also better agreement between GASP and MODIS AOD in the Sacramento Valley when compared to the San Joaquin Valley.

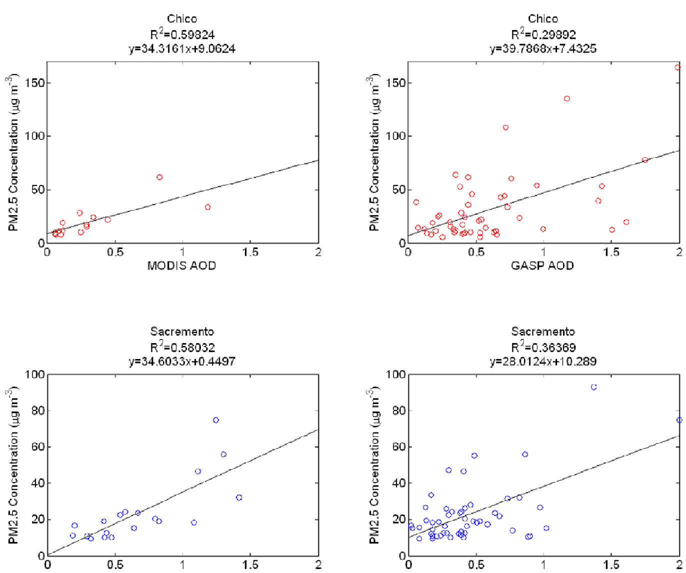

Figure 1. PM2.5-AOD correlations for GASP and MODIS in Chico (top) and Sacramento (bottom).

Finally, the vertical aerosol distributions determined from CALIOP were used identify elevated smoke plumes associated with transport. The analysis provides evidence that the PM2.5-AOD relationship is improved when aerosol loading is contained primarily within the boundary layer.

This presentation will demonstrate the ability of satellite instruments to monitor air quality during a large pollution event. The comparison of GASP, MODIS, and CALIPSO will highlight advantages of each instrument.