Changing Air Quality in the Southeast U.S. and Potential Implications for Regional Solar Radiation Budget

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Numerous publications have discussed the potential role of aerosols in the Southeast (SE) U.S. 'warming hole' during the 20th century. However, long-term measurements of aerosol optical depth (AOD) made by NASA's Moderate Resolution Imaging Spectrometer (MODIS), aboard the polar-orbiting Terra and Aqua satellites reveal decreasing trends in aerosol loading over the SE U.S. Trend studies from surface-based NASA AERONET and NOAA/ESRL network sites also show decreases in AOD (Li et al., 2014; Yoon, 2012) and lower tropospheric aerosol light scattering coefficient (Collaud-Coen et al., 2013) over much of the U.S. However, there were a lack of network sites in the SE U.S. during these study periods and satellite-based estimates of aerosol direct radiative effect in the background SE U.S. may be overestimated (Sherman and McCommiskey, 2017), in addition to a negative MODIS AOD bias (~ 0.03) over the AERONET site at Appalachian State University (APP; Sherman et al., 2016). The APP facility is home to the only co-located NOAA/ESRL, NASA AERONET, and (beginning 2016) NASA MPLNET sites in the SE U.S., with continuous measurements of aerosol radiative and microphysical properties initiated in June 2009. Though the 8-year record at APP is slightly less than that required for analysis of statistically-significant aerosol trends (Collaud-Coen), several apparent trends are evident that are both consistent with and advance results from previous studies. MODIS-measured AOD above APP from 2001-2016 reveals a decrease in AOD, which is supported by the 6.5 years of AOD measurements as part of AERONET. Lower tropospheric light scattering and absorption (measured as part of NOAA/ESRL) are both decreasing at similar rates, leading to little change in single-scattering albedo. The decreases are modulated by months with large wildfire influence, which could become more frequent in a warmer, drier, climate. Hemispheric backscatter fraction (proxy for sub-micron aerosol size distribution) is increasing, indicating a trend toward smaller particles. Aerosol number concentrations show a smaller change over the 8-year period, indicating that changes in aerosol size distribution are likely the primary contributor to lower light scattering at APP.

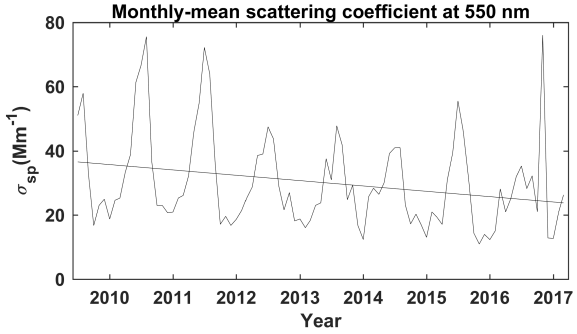

Figure 1. Time series of monthly-mean PM_{10} aerosol light scattering coefficient at 550 nm.

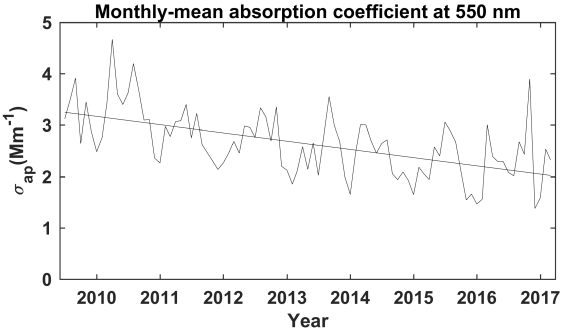

Figure 2. Time series of monthly-mean PM_{10} aerosol light absorption coefficient at 550 nm.