Seasonal Dependence of Column-averaged and Near-surface Aerosol Optical Properties Measured at Appalachian State University (APP)

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Appalachian State University (APP) is home to the only co-located NOAA ESRL, NASA AERONET, and NASA MPLNET aerosol monitoring sites in the U.S., with all but the MPLNET datasets extending back to at least 2010. Measurements of surface-level aerosol mass concentrations for dried particles smaller than 10μm (PM_{10}) and smaller than 2.5μm ($PM_{2.5}$) were added in November 2016. The vast datasets have led to studies of aerosol variability (Sherman et al., 2015), aerosol direct radiative effect and its uncertainties (Sherman and McComisky, 2018), and evaluations satellite-based aerosol measurements (Sherman, et al., 2016; Krintz and Sherman, manuscript in progress). Satellite-measured aerosol optical depth (AOD) is gaining more applications in climate and air quality studies. One application is to estimate surface-level aerosol mass concentrations. However, some studies (Goldstein, 2009; Heald and Ford) have hypothesized that a significant upper-level summer aerosol layer can explain the lack of seasonal dependence of surface-level $PM_{2.5}$ in the SE U.S., relative to the seasonal dependence of AOD. Other studies have instead hypothesized that summer venting of the planetary boundary layer (PBL) heights or increase in relative humidity with height may instead be the source of these seasonal discrepancies.

Three years of lidar-measured vertical aerosol profiles at APP (as part of MPLNET) indicate that most of the aerosols reside in the PBL, even in summer. AOD at APP is much higher in summer than in winter (by factors of ~5-6) and $PM_{2.5}$ mass concentrations demonstrate small seasonal dependence, both of which are consistent with the above-mentioned (and other) studies. However, near-surface aerosol light scattering coefficient (σ_{sp}) for PM_{10} and PM_{10} aerosols measured at low relative humidity does show a summer enhancement (factor of ~2-3), relative to winter. While the seasonal variations in the AOD and σ_{sp} have decreased in recent years, it is still key to understand why there is a difference in observed seasonal dependency between AOD, $PM_{2.5}$, and σ_{sp} in order to assess the feasibility of space-based estimates of surface-level air quality. In this presentation, seasonal relationships between AOD, $PM_{2.5}$, and σ_{sp} measured at APP will be presented, along with select column-averaged and near-surface aerosol optical properties that could shed light on the relationships amongst them.

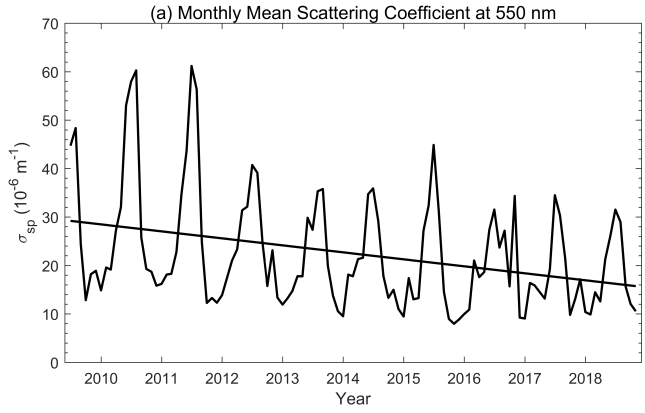

Figure 1. The scattering coefficient at 550 nm is shown over an eight-year period using the mean for each month.

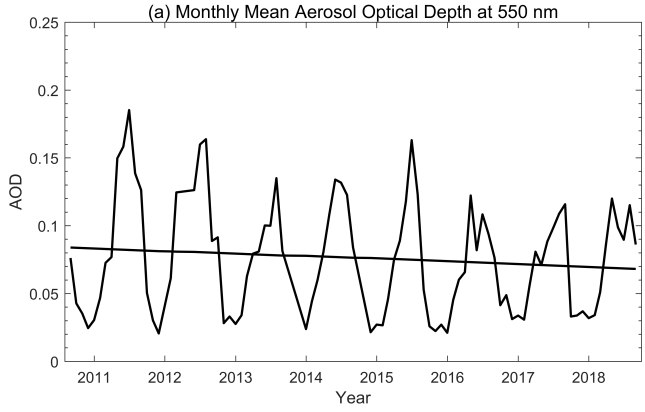

Figure 2. The aerosol optical depth at 550 nm is shown over an eight-year period using the mean for each month.