A multi-year study of aerosol optical properties from four North American regions

P. Sheridan[1], J. Sherman[2], J. Ogren[1], E. Andrews[3], D. Hageman[3], L. Schmeisser[4], A. Jefferson[3], and S. Sharma[5]

[1]NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, 80305, USA
[2]Department of Physics and Astronomy, Appalachian State University, Boone, 28608, USA
[3]CIRES, University of Colorado, Boulder, 80309, USA
[4]Department of Atmospheric Sciences, University of Washington, Seattle, 98195, USA
[5]Environment and Climate Change Canada, Toronto, M3H 5T4 Canada
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Presenting author email: patrick.sheridan@noaa.gov

Aerosol optical property (AOP) measurements from four North American stations in the NOAA Federated Aerosol Network were used to conduct a multi-year study of lower tropospheric aerosol variability and observed systematic relationships. The data discussed in this presentation and many other results are available in a recent publication (Sherman *et al*, 2015).

Atmospheric aerosols are continuously sampled and their optical properties measured at our regional surface aerosol monitoring stations in the US southern Great Plains (SGP) region, the US Midwest region (BND), the US southern Appalachian Mountains (APP), and the Canadian Great Lakes region (EGB). Measurements at all sites are made with identical or very similar instruments and sampling protocols and all data are acquired, processed, quality-checked and edited using the same software and methodology.

Day of week and diurnal variability in most AOPs is minimal at the four sites. One exception is for the aerosol light absorption coefficient (σ_{ap}), whose variability on shorter timescales can rival seasonal variability in some cases. In this presentation, we focus on seasonal variability. Figure 1(a) shows the annual cycle of σ_{ap} at 550 nm for PM1 aerosols. σ_{ap} is highest for all sites in summer and lowest in winter, although the σ_{ap} cycle is weaker than that of the scattering coefficient (σ_{sp}) at all sites. The monthly-average absorption Ångström exponent (α_{ap}) values (Figure 1(b)) for all months at BND and SGP are ~ 1.0 ± 0.2. α_{ap} values close to 1.4 during winter at APP are consistent with a mixture of BC and biomass burning aerosols. Wood burning is common during winter in the region. Summer α_{ap} well below 1 at APP could be due to coating of BC cores with organic and sulfate mass.

Annual cycles of PM1 single-scattering albedo (ω_0), hemispheric backscatter fraction (*b*), and direct radiative forcing efficiency (DRFE) are also discussed. In general, months with high aerosol loading (summer) are accompanied by high ω_0 and low *b* and vice versa. Summer-to-autumn σ_{sp} decreases are larger than those of σ_{ap}, leading to minimum ω_0 in October at all sites. Co-variability of ω_0 and *b* leads to a very small annual cycle in monthly-mean DRFE at APP and SGB but larger DRFE cycles observed at BND and EGB. The effect is most noticeable in autumn.

Statistically significant trends in PM1 σ_{sp} (decreasing), PM1 *b* (increasing), and PM1/PM10 σ_{sp} ratio (decreasing) are found at BND from 1996-2013 and at SGP from 1997-2013. Similar trend were observed in other studies, although the trend magnitudes were different, possibly due to differences in the study period considered. Trends in these AOPs since ~ 2009 are more pronounced than in earlier years. Similar or even larger reductions in PM1 σ_{sp} may have occurred during this period at APP and EGB, based on large reductions in SO_2 and sulfates in eastern US during this period.

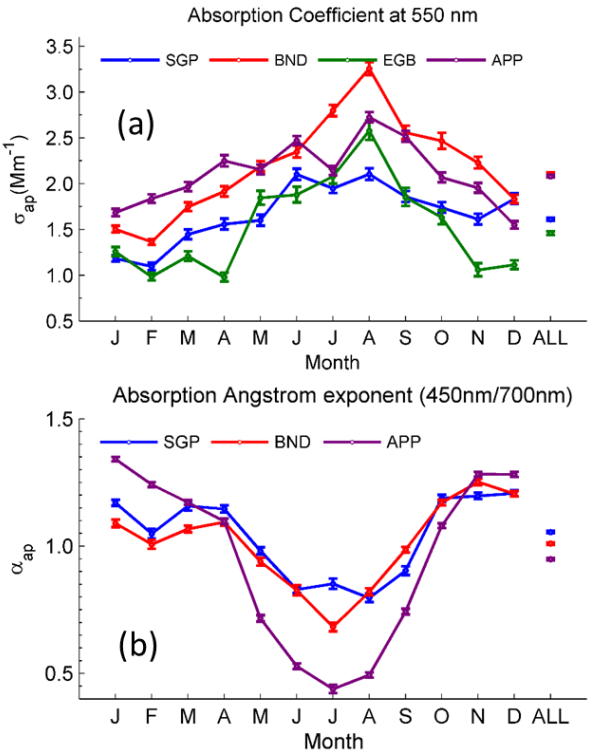

Figure 1. Annual cycle of monthly-average (a) σ_{ap} and (b) α_{ap} at North American stations.

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