

Relationships between surface and column aerosol radiative properties and air mass transport at a rural New England site

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Chemical, physical, and radiative properties of surface and vertical column aerosols were measured at a rural site in southern New Hampshire from July 2000 to September 2001. The primary objective was to determine how intensive and extensive aerosol properties vary in air masses originating in different upwind regions. The data set also allows for an investigation of some of the relationships between surface and column aerosol properties at the site, and provides an estimate of direct radiative forcing by aerosols during the study period. Extensive properties (e.g., optical depth and chemical concentration) were at maximum values during times of south-southwest (S-SW) transport, while minimum values were seen during north-northeast (N-NE) transport. Certain intensive properties such as fine particle mass scattering efficiency did not vary significantly between times of transport from different source regions. Mean optical depth (wavelength = 500 nm) was 0.24 during S-SW transport, compared to 0.10 during N-NE transport. The study period average scattering efficiency for $(\text{NH}_4)_2\text{SO}_4$ was $6.54 \pm 0.26 \text{ m}^2 \text{ g}^{-1}$ (\pm standard error) and $3.36 \pm 0.49 \text{ m}^2 \text{ g}^{-1}$ for organic carbon, while the absorption efficiency of elemental carbon was $12.85 \pm 0.80 \text{ m}^2 \text{ g}^{-1}$. Top of the atmosphere aerosol direct radiative forcing was $-0.35 \pm 0.83 \text{ Wm}^{-2}$ (± 1 standard deviation) in winter 2000–2001 and $-9.06 \pm 3.77 \text{ Wm}^{-2}$ in summer 2001, differences that can be primarily attributed to seasonal changes in surface reflectance (high in winter, low in summer) and the relatively low values of single scatter albedo observed in winter. The annual average direct radiative forcing was $-5.14 \pm 4.32 \text{ Wm}^{-2}$. We generally observed a moderate correlation between surface and column aerosol light extinction, suggesting that vertical column aerosol radiative properties measured by surface-based radiometers should be supplemented by boundary layer measurements of aerosol chemical, physical, and radiative properties to help understand the mechanisms contributing to global aerosol variability.