Development of Aerosol Models for Radiative Flux Calculations at ARM Sites: Utility of Trajectory Clustering for Characterizing Aerosol Climatology

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The uncertainties associated with assumptions of generic aerosol properties in radiative transfer codes are unknown, which means that these uncertainties are frequently invoked when models and measurements do not agree. In general, the radiative calculations require specification of the aerosol optical depth $\delta(\lambda)$, single-scattering albedo $\varpi_o(\lambda)$, and asymmetry parameter $g(\lambda)$, all as functions of wavelength λ and altitude. Here we use existing aerosol data from the Atmospheric Radiation Measurement (ARM), Southern Great Plains (SGP), and North Slope of Alaska (NSA) sites to begin development of a set of "models" that describe the radiative properties of different types of aerosols at these sites.

Aerosol properties at SGP and NSA show considerable variability on multiple time scales [Delene and Ogren, *J. Atmos. Sci*., *59*, 1135-1150, 2002]. Our hypothesis is that this variability is not random, but rather is connected with changes in the types of particles prevailing at any given time. We anticipate that airmass origin will be the dominant meteorological parameter influencing the aerosol type. Here, we segregate surface aerosol properties at SGP and NSA as a function of airmass back trajectory to provide a first cut at identifying aerosol types prevalent at these two sites.

Significant differences are evident in some but not all aerosol optical properties for the trajectory clusters at the two sites (e.g., Figure 1). Aerosol loading, as indicated by extinction coefficient, varies by a factor of two among trajectory clusters. The variation in extinction is consistent with airmass source regions. Variations in aerosol size and composition, as indicated by optical properties, are also observed. Aerosol chemistry measurements at SGP and NSA allow further characterization both among all trajectory clusters and between similarly loaded trajectory clusters. This preliminary analysis illustrates the utility of including airmass trajectory in the statistical evaluation of aerosol types, but also demonstrates that airmass trajectory alone may not be adequate for identifying an aerosol type.

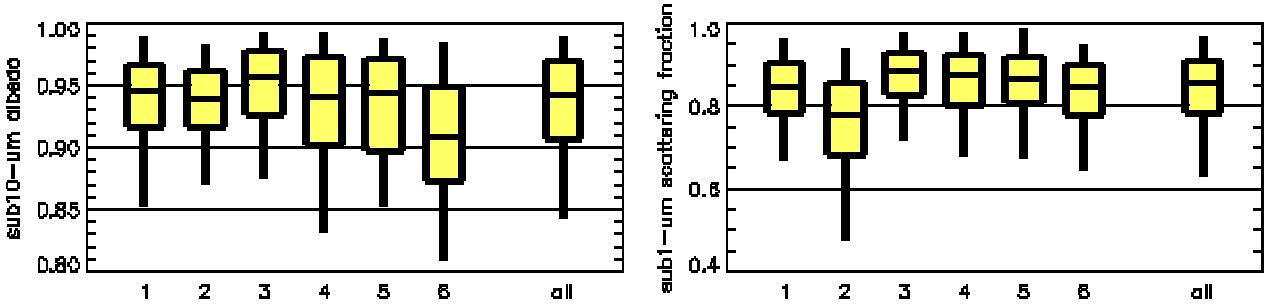

Figure 1. Box-whisker plots of aerosol single-scattering albedo (left) and sub-1-µm scattering fraction (right) for six trajectory clusters arriving at SGP between 1996 and 2002. Single-scattering albedo is lower for T6, which originates off the coast of Asia, while large particles (probably seasalt) contribute noticeably more to scattering for T2, which has a source region in the Caribbean.