

Initial Study of the Roles of Chemical Composition and Meteorology on Aerosol Radiative Effects in the Southeast U.S. - Results from a Regionally-representative Site

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The Southeastern U.S. (SE U.S.), home to large warm-season aerosol loading, is one of only a few regions where surface temperatures did not increase in the 20th century (Trenberth, et al., 2007). One of the major objectives of the Secondary Organic Aerosols (SOAs) 2013 and other multi-institutional field campaigns scheduled for the upcoming summer is to better understand the chemistry of SOAs and SOA precursor gases and the radiative impacts of SOA in the SE U.S. However, there are very few long-term datasets for even a subset of the variables needed to place the results of these field campaigns into a long-term context and even fewer from locations that could be classified as representative of the regional background conditions. Established in 2009, the high-elevation Appalachian Atmospheric Interdisciplinary Research facility at Appalachian State University in Boone, NC (36.21°N, 81.69°W, 1080m) is home to the only co-located NOAA-ESRL and NASA AERONET aerosol monitoring sites in the SE U.S., along with a micro-pulsed aerosol/cloud lidar and a suite of Volatile Organic Compounds (VOCs) and other trace gas and meteorological instrumentation. These datasets are leading to the first continuous climatology of aerosol direct radiative forcing (DRF) in the SE U.S. With the addition of an Aerodyne quadrupole mass spectrometer in June 2012, we are now able to relate aerosol properties and DRF to size-segregated aerosol chemical composition and source region. Continuous measurements of dry aerosol chemical composition made over the initial 7-week period in summer 2012 will be presented, along with key aerosol optical properties, aerosol loading, and aerosol DRF. Organic and sulfate aerosol components accounted for the dominant fraction of non-refractory aerosol components during the summer of 2012. The relationships of the aerosol optical properties and DRF with the organic and sulfate mass fractions and with meteorology (temperature, dewpoint) were investigated. The source relationships of aerosol chemical and optical properties were studied using the clustering of Hybrid Single Particle Lagrangian Integrated Trajectory back-trajectories. The results show that the aerosol radiative properties and organic/sulfate mass fractions are strongly influenced by meteorology, therefore a synergistic long-term study of aerosol chemical and optical properties, key VOC precursor gases, and meteorology is necessary to better understand aerosol/climate interactions in the SE U.S.

	NH ₄ (μg/m ³)	NO ₃ (μg/m ³)	SO ₄ (μg/m ³)	Org (μg/m ³)	Chl (μg/m ³)	Total (μg/m ³)	NH ₄ %	NO ₃ %	SO ₄ %	Org%	Chl%
Mean	0.181	0.076	0.557	1.627	0.006	2.447	7.3	3.3	22.4	67.0	0.3
Stdev	0.112	0.039	0.379	0.833	0.003	1.217	2.5	1.9	7.3	9.4	0.4

	AOT ₅₀₀	σ _{sp}	σ _{ap}	σ _{ext}	ω	b	a	R _{sp}	R _{sp}
Mean	0.21	44.2	3.0	47.1	0.927	0.146	0.598	0.90	0.94
Stdev	0.10	25.3	1.3	26.2	0.038	0.023	0.264	0.08	0.10

* Total mass loading refers to the sum of NH₄, NO₃, SO₄, Org and Chl

Figure 1. Summer 2012 statistics of non-refractory aerosol chemical composition, aerosol optical thickness at 500nm, and sub-10μm aerosol scattering, absorption, extinction, single-scattering albedo, and back-scatter fraction at 550nm.