

Seasonal Variability in the Southeast U.S. Background Aerosol Direct Radiative Effect – An Initial Measurement-based Climatology from a Regionally-representative Location

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On a global average, the measurement-based estimates of the aerosol direct radiative effect (DRE) are 55-80% greater than the model-based estimates (Yu et al., 2009). The differences are even larger on regional scales and for the anthropogenic component. One of the high-priority tasks recommended (Kahn et al., 2009) to reduce the uncertainty in aerosol radiative effects is to “Maintain, enhance, and expand the surface observation networks measuring aerosol optical properties for satellite retrieval validation, model evaluation, and climate change assessments”. 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). Established in 2009, the Appalachian Atmospheric Interdisciplinary Research Facility (AppalAIR) at Appalachian State University (36.21°N, 81.69°W, 1080 m) is home to the only co-located NOAA/Earth System Research Laboratory and NASA/Aerosol Robotic Network aerosol monitoring sites in the SE U.S. The recent addition of a micro-pulsed lidar, a vertically-pointing radar, and detailed instrumentation for aerosol chemical and microphysical properties and gas-phase aerosol precursor chemistry complement existing measurement capabilities and will facilitate the most comprehensive long-term study of aerosol/climate interactions in the SE U.S. Multi-year AppalAIR and Moderate-Resolution Imaging Spectroradiometer (MODIS) satellite data products will be presented to estimate the degree and geographic extent that aerosol radiative properties measured at the semi-rural, high-elevation AppalAIR facility are representative of the SE U.S. The aerosol optical depth (AOD), aerosol radiative properties, and top-of-atmosphere (TOA) and bottom-of-atmosphere (BOA) aerosol DRE exhibit large seasonal variability, with a significant summer-time aerosol cooling effect at both the TOA and the surface. The difference between TOA and BOA DRE is less than that quoted in other published studies conducted in the region. The regionally-representative aerosol optical properties, as evidenced by a statistical cluster analysis of backward air trajectories, and the fact that AOD and surface properties are fairly homogeneous over the region suggest that the long-term aerosol DRE climatology being developed at AppalAIR likely is a good measure of the background DRE in the SE U.S.

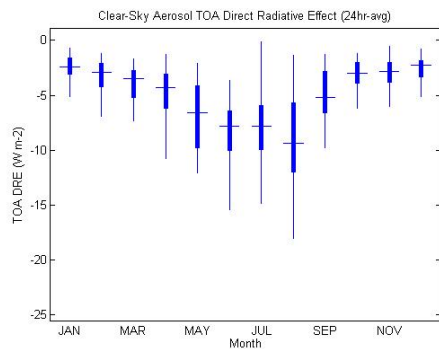


Figure 1. Monthly TOA daily-averaged clear-sky DRE for the period June 2009-May 2011, using hourly-averaged aerosol intensive optical properties from AppalAIR and MODIS-retrieved AOD and surface albedo. The whiskers correspond to 50th percentile. The box extends from 25th to 75th percentile and the line extends from 5th to 95th percentile.

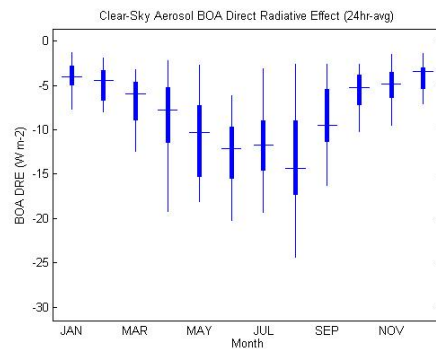


Figure 2. Monthly BOA daily-averaged clear-sky DRE for the period June 2009-May 2011, in the same context as the TOA plot shown in Figure 1.