Observed and simulated black carbon and absorption profiles during the TCAP campaign

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Recent studies have shown that some of the differences in radiative forcing among global climate models can be attributed to differences in simulated black carbon (BC) profiles. The U.S. Department of Energy's Two Column Aerosol Project (TCAP) Phase I was designed to address this issue by providing key measurements of aerosol composition, size, and optical properties needed to evaluate both detailed process models and 3-D atmospheric models. Airborne in situ measurements on the G-1 aircraft and measurements from the new NASA Langley airborne High Resolution Spectral Lidar (HRSL-2) collected during July 2012 indicated a range of aerosol layers in the vicinity of Cape Cod, including large variability of aerosol extinction within residual layers transported from the continent over the ocean and thinner aerosol layers at various altitudes in the free troposphere. In this study, we use the TCAP data to quantify how well a regional model represents the vertical structure of aerosol layers, the concentration of BC and other aerosol species within those layers, and absorbing and scattering properties in the vicinity of Cape Cod. Simulated profiles of BC are compared with SP2 measurements, profiles of scattering and absorption with nepholometer and PSAP meaurements, and profiles of exinction, backscatter, and absorption at multiple wavelengths with HSRL-2 measurements. Sensitivity studies quantify the relative contribution of anthropogenic, biomass burning, and natural sources of aerosols on absorbing aerosol as well as the layering structure. Observed profiles of aerosol composition and size are also used to drive the model's aerosol optical property module to assess the relative contribution of absorption errors due to simulated aerosol mass, composition, and size compared to uncertainties in the treatment of BC mixing rules in Mie calculations and mixing state of aerosols.