Radiative and hygroscopic properties of aerosols containing black carbon at various mixing states

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Abstract

There is a great degree of uncertainty about the role of soot or black carbon (BC) particles on the global climate. In atmosphere, BC particles interact with other aerosol particles and gas phase species, and exist mixed with organic and inorganic matters at various mixing states. The radiative forcing of BC depends on the mixing state, and the absorption of radiation by BC can increase significantly at certain mixing states. We propose to examine scattering and absorption characteristics as well as hygroscopic properties of aerosols containing black carbon (BC) mixed with hydrophilic and hydrophobic compounds at various mixing states.

The research activities of this projected will be conducted at the Chemical Engineering Department, University of Kentucky.

The absorption efficiency of aerosols mixed with BC is significantly higher than that of BC particles existing as aggregates of their own kind. The radiative forcing of BC particles depends on the four possible mixing states: (i) as aggregates (ii) randomly distributed inside aerosol droplets (i.e., as volume mixtures), (iii) attached to surfaces of droplets and (iv) in cores surrounded by well mixed layers.

We will conduct experiments on single particles suspended in electrodynamic balances under controlled humidity. Particles of desired characteristics (e.g., volumetrically distributed BC, or BC in cores or shells of layered droplets) will be generated by evaporation of droplets of solution containing suspension of BC, by vapor condensation, and by electrostatic deposition of particles. We will apply techniques based on light scattering, and radiant heating to determine the absorption by a particle. In addition, we will determine deliquescence and crystallization humidities, as well as the water content of a particle at various relative humidities.

The results of this study will greatly improve the treatment of BC aerosols in climate models, and be useful in assessing the effects of BC on solar radiation. In this project we will (i) measure optical and hygroscopic properties of properties of BC particles randomly distributed in solution droplets, (ii) measure optical and hygroscopic properties of properties of BC particles attached to surfaces of solution droplets, (iii) measure optical and hygroscopic properties of properties of BC particles concentrated as cores within solution droplets, (iv) measure optical and hygroscopic properties of properties of BC particles distributed in shells of layered solution droplets, and (v) develop models to predict optical properties of BC containing aerosols, and their dependence on the relative humidity.