University of California, Los Angeles

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Department of Atmospheric and Oceanic Sciences

Seminar

AOS270

CENLIN HE

University of California, Los Angeles

“Understanding Black Carbon Atmospheric Aging: Aerosol Microphysics and Radiative Effects”

ABSTRACT:

Black carbon (BC), commonly known as soot, has been identified as the second most important anthropogenic global warming agent in the current atmosphere. It strongly absorbs solar radiation (i.e., direct radiative effect), affects cloud formation by acting as cloud condensation nuclei (i.e., indirect radiative effect), and reduces snow albedo upon deposition (i.e., BC-snow albedo effect). The climatic effects of BC are significantly influenced by BC aging process in the atmosphere, which converts BC from hydrophobic (water-insoluble) to hydrophilic (water-soluble) particle and increases its light absorption. This study seeks to understand BC atmospheric aging from perspectives of aerosol microphysics and radiative effects.

In the first part, we develop and examine a microphysical BC aging scheme that accounts for condensation, coagulation, and heterogeneous chemical oxidation processes in a global 3-D chemical transport model (GEOS-Chem) by interpreting BC aircraft measurements from the HIAPER Pole-to-Pole Observations (HIPPO, 2009–2011) using the model. The microphysical aging scheme significantly improves model simulations of BC and shows important impacts on global BC distribution.

In the second part, we develop a BC optics-aging model to account for three typical evolution stages, including freshly emitted aggregates, BC coated by soluble material, and BC particles undergoing further hygroscopic growth. We employ the geometric-optics surface-wave (GOS) approach to compute BC radiative properties at each aging stage, which are subsequently compared with laboratory measurements. Optical cross sections of BC particles vary by more than a factor of 2 due to different aggregating and coating structures, suggesting that an accurate estimate of BC direct radiative effect requires accounting for realistic coating structures in climate models.

In the third part, we briefly introduce the on-going work on linking BC aging to BC-snow interaction and associated snow albedo reduction by accounting for two critical features missing in previous BC-snow studies, including 1) stochastic BC-snow multiple internal mixing and 2) non-spherical snow grain shape. We seek to develop a physically-based parameterization for BC-snow interaction that accounts for the two aforementioned features for application to climate models.

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