4.045 Evaluation of Radiative Effects during a Typical Wintertime Black Carbon Episode over the Yangtze River Delta in China .

Early Career Scientist

Presenting Author:
Yichen Li, School of Atmospheric Sciences, Nanjing University, Nanjing, China, yichen_li_1995@163.com

Co-Authors:
Jane Liu, School of Atmospheric Sciences, Nanjing University, Nanjing, China

Abstract:

Black Carbon (BC), an important aerosol component of regional haze pollution in eastern China, has been identified to impact the planetary boundary layer (PBL) structure and air quality effectively. In this study, a typical wintertime high black carbon pollution episode over the Yangtze River Delta (YRD) is analyzed using the fully coupled online Weather Research and Forecasting/Chemistry (WRF-Chem) model.

The episode is characterized by high anthropological emission and stable weather condition. The high BC concentrations (hourly value exceeded 20 μg m^{-3} in central YRD) corresponded closely to the appearance of inversion layer, low PBL height together with poor horizontal and vertical dispersions. The pollution formation mechanisms of this case are representative in eastern China during wintertime.

Analysis shows that in daytime BC increases the downward radiation in the upper boundary layer (~1200-1500 m) by 5.6 W/m^2, weakening the radiation incident on the surface by 8.4 W/m^2, and radiative forcing on short-wave radiation is about 3 times that on long-wave radiation. The radiative effect leads to upper-level warming and surface cooling. The upper-level heating reaches its maximum (>1.0 ℃) around afternoon, while surface cooling is strongest in the morning, contributing to a formation of inversion layer and a decrease in nocturnal PBL height by 20-200 m. Furthermore, the BC-boundary layer interaction could enhance the air pollution. BC radiative effect induced increases in $PM_{2.5}$ concentration by 4.4% in daytime and 8.1% in nighttime, averaged over the YRD during the pollution episode. The results indicate that although the radiative effect of BC is large during the daytime, its impact on the structure of PBL occurs mainly at night, which contributes to the nocturnal accumulation of air pollutants in winter haze events.