Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

AAS005-07 Room: 201B Time: May 27 10:45-11:00

Vertical transport mechanisms of black carbon over east Asia in spring observed during the A-FORCE aircraft campaign

Naga Oshima[1*], Yutaka Kondo[1], Nobuhiro Moteki[1], Nobuyuki Takegawa[1], Makoto Koike[2], Kazuyuki Kita[3]

[1]RCAST, The University of Tokyo, [2]EPS, The University of Tokyo, [3]Faculty of Science, Ibaraki University

Black carbon (BC) aerosols efficiently absorb solar radiation in the atmosphere. The absorption leads to heating of the atmosphere and cooling of the surface below, resulting in large impacts on radiation budget and the climate system. Although horizontal distributions of BC particles are important for their atmospheric heating, BC radiative forcing strongly depends on its altitude. Therefore, an understanding of the three-dimensional spatial distributions of BC is significantly important for evaluation of the effects of BC on climate. However, uplifting processes of BC (especially, wet deposition processes which can remove BC particles from the atmosphere by precipitation) from the planetary boundary layer (PBL) to the free troposphere, which control the vertical distribution of BC and its large-scale spatial distribution, have not well understood.
In order to understand these, the Aerosol Radiative Forcing in East Asia (A-FORCE) aircraft campaign was conducted over East China Sea and Yellow Sea in March-April 2009. In this study, vertical transport mechanisms of BC over east Asia are presented using a three-dimensional regional-scale chemical transport model (WRF-CMAQ). The original CMAQ model does not take into account differences in rainout and washout processes. In this study, we modified the CMAQ model to treat rainout and washout processes separately. We also estimate a removal rate of BC from the atmosphere associated with wet deposition on the basis of the simulation with wet deposition and that without wet deposition using the modified CMAQ model.
We use back trajectories of air parcels sampled from the aircraft at altitudes above 2 km and precipitations predicted by the WRF model in order to investigate a relationship between the removal rates of BC of these air parcels and accumulated precipitations along the trajectories of air from the PBL to the flight tracks. The removal rate of BC can be derived from the changes in ratios of observed BC and carbon monoxide (CO) concentrations. As a result, the air parcels uplifted over northern China had experienced smaller amounts of precipitation and therefore the observed BC removal rates were smaller. On the other hand, the air parcels uplifted over central/southern China had experienced larger amounts of precipitation and therefore the observed BC removal rates were larger. These results are consistent with those derived from the WRF-CMAQ simulations. These results indicate that the removal rate of BC associated with wet deposition is mainly controlled by the precipitation that air parcels have experienced during transport. During the A-FORCE period, an abundant moisture supply by the low-level southerlies into the central/southern China contributed to the different precipitation amounts over central/southern and northern China. Both cumulus convections and migratory cyclones contributed to uplifting of the air parcels over central/southern China. On the other hand, only migratory cyclones contributed to the uplifting over northern China.
The results presented in this study indicate that a moisture supply by the low-level southerlies and uplifting processes associated with cumulus convections and/or migratory cyclones control precipitation intensity and the removal rate of BC associated with wet deposition over east Asia in spring, playing important roles in controlling large-scale spatial distributions of BC.

Keywords: Aerosol, Black carbon, East Asia, Regional model, Transport, Wet deposition