

## Aerosol Optical Properties Over East Asia: Radiative Forcing and Particulate Pollution Perspective

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In order to more accurately estimate direct radiative forcing (DRF) by aerosols and to better investigate particulate pollution over East Asia, precise calculations of aerosol optical properties, such as aerosol optical depth (AOD), single scattering albedo (SSA), and aerosol extinction coefficient ( $\beta_{ext}$ ), are of primary importance. The aerosol optical properties over East Asia were investigated in this study, based on US EPA Models-3/CMAQ v4.5.1 model simulations.

The CMAQ model simulations in this study were improved in several ways, compared to the previous study (Song et al., 2008): (1) the wind fields from the MMS simulations were assimilated with observed QuikSCAT wind data; (2) the emission inventories of INTEX-B (for China and North Korea), REAS (for Japan) and CAPSS (for South Korea) were used for the year 2006 simulations; (3) for the  $\text{NH}_3$  and BVOC (Biogenic VOCs) emissions, EDGAR and MOHYCAN+MEGAN emissions were utilized, respectively; (4) monthly variations for the  $\text{NO}_x$ ,  $\text{NH}_3$ , NMVOCs and  $\text{SO}_2$  emissions were applied; (5) for the considerations of dust generation and transport, the operational ADAM (Asian Dust Aerosol Models) at Korean Meteorological Administration (KMA) were used; (6) all the MET, emission, and CMAQ model simulations were carried out in a fine grid resolution of  $30 \times 30 \text{ km}^2$  for the entire year of 2006; (7) CMAQ v4.5.1 modeling considered sea-salt particle generations and transports, and also took into account an improved secondary organic aerosol (SOA) formation scheme; (8) 4-D particulate species concentrations obtained from the CMAQ model simulations were converted into the 3-D or 4-D aerosol optical products, using recent Malm and Hand (2007)'s algorithm; and (9) finally, the CMAQ-simulated AOD products were further assimilated with the MODIS-retrieved AOD products.

The results from the CMAQ model simulations (without assimilation) showed great improvements, compared to those from the previous study. For example, in terms of regression coefficients (R), R increased from 0.48–0.68 to 0.77–0.89 for four seasonal simulations. CMAQ-simulated SSAs also agreed greatly with AERONET SSA, except at the Honk Kong and Taipei sites, where air qualities were influenced strongly by active biomass burning events from January to April. There were also great matches between the vertical profiles of CMAQ-simulated  $\beta_{ext}$  and LIDAR-retrieved  $\beta_{ext}$ . It was also found that the contributions of  $(\text{NH}_4)_2\text{SO}_4$  during summer,  $\text{NH}_4\text{NO}_3$  during winter, sea-salt during winter and dust particles during spring to total AOD were large in East Asia. In particular, the largest contribution of  $\text{NH}_4\text{NO}_3$  to total AOD during winter over East Asia was found. Therefore, it was emphasized in this study that this contribution of  $\text{NH}_4\text{NO}_3$  should not be neglected. In order to produce more accurate AOD products, the CMAQ-simulated AOD was further assimilated with the MODIS-retrieved AOD. Both the assimilated and AERONET AODs were better correlated with each other, compared to the correlations between CMAQ-simulated AOD and AERONET AOD.

The obvious benefits from this study would be that with these improved aerosol optical properties, particulate pollution (e.g., AOD can be served as a proxy to  $\text{PM}_{2.5}$  or  $\text{PM}_{10}$ ) and DRF by aerosols over East Asia can be better investigated in future.