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An investigation into seasonal and regional aerosol characteristics in East Asia using model-predicted and remotely-sensed aerosol properties

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Abstract. In this study, the spatio-temporal and seasonal distributions of EOS/Terra Moderate Resolution Imaging Spectroradiometer (MODIS)-derived aerosol optical depth (AOD) over East Asia were analyzed in conjunction with US EPA Models-3/CMAQ v4.3 modeling. In this study, two MODIS AOD products (τ_{MODIS}: $\tau_{M\text{-}BAER}$ and τ_{NASA}) retrieved through a modified Bremen Aerosol Retrieval (M-BAER) algorithm and NASA collection 5 (C005) algorithm were compared with the AOD (τ_{CMAQ}) that was calculated from the US EPA Models-3/CMAQ model simulations. In general, the CMAQ-predicted AOD values captured the spatial and temporal variations of the two MODIS AOD products over East Asia reasonably well. Since τ_{MODIS} cannot provide information on the aerosol chemical composition in the atmosphere, different aerosol formation characteristics in different regions and different seasons in East Asia cannot be described or identified by τ_{MODIS} itself. Therefore, the seasonally and regionally varying aerosol formation and distribution characteristics were investigated by the US EPA Models-3/CMAQ v4.3 model simulations. The contribution of each particulate chemical species to τ_{MODIS} and τ_{CMAQ} showed strong spatial, temporal and seasonal variations. For example, during the summer episode, τ_{MODIS} and τ_{CMAQ} were mainly raised due to high concentrations of $(NH_4)_2SO_4$ over Chinese urban and industrial centers and secondary organic aerosols (SOAs) over the southern parts of China, whereas during the late fall and winter episodes, τ_{MODIS} and τ_{CMAQ} were higher due largely to high levels of NH_4NO_3 formed over the urban and industrial centers, as well as in areas with high NH_3 emissions. τ_{CMAQ} was in general larger than τ_{MODIS} during the year, except for spring. The high biases ($\tau_{CMAQ}>\tau_{MODIS}$) may be due to the excessive formation of both $(NH_4)_2SO_4$ (summer episode) and NH_4NO_3 (fall and winter episodes) over China, possibly from the use of overestimated values for NH_3 emissions in the CMAQ modeling. According to CMAQ modeling, particulate NH_4NO_3 made a

14% (summer) to 54% (winter) contribution to σ_{ext} and τ_{CMAQ}. Therefore, the importance of NH_4NO_3 in estimating τ should not be ignored, particularly in studies of the East Asian air quality. In addition, the accuracy of $\tau_{M\text{-}BAER}$ and τ_{NASA} was evaluated by a comparison with the AOD ($\tau_{AERONET}$) from the AERONET sites in East Asia. Both $\tau_{M\text{-}BAER}$ and τ_{NASA} showed a strong correlation with $\tau_{AERONET}$ around the 1:1 line (R=0.79), indicating promising potential for the application of both the M-BAER and NASA aerosol retrieval algorithms to satellite-based air quality monitoring studies in East Asia.

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