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Development of new size-resolved and mixing state resolved black carbon aerosol model

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Black carbon (BC) particles in the atmosphere absorb solar radiation and have important impacts on global and regional climate through direct and indirect modification of the radiation. Although the sign and magnitude of aerosol radiative effects depend on not only the spatial distribution of the aerosol and the aerosol size distribution but also on its mixing state, previous modeling studies include quite large uncertainties in the expression of the change of BC mixing state (aging).

In order to improve these uncertainties drastically, we have developed a new size-resolved and mixing state resolved (multiple BC mixing states) aerosol model based on three-dimensional air quality model CMAQ-MADRID. Our new model can allow for an explicit treatment of the aging processes of BC by condensational growth. In addition, our model uses non-equilibrium size-resolved and chemically resolved gas-to-particle dynamic mass transfer approach and it provides more accurate coating with aerosol species on various mixing states due to BC aging.

Our model simulation results were compared with the aircraft observation data (PEACE-C aircraft campaign, conducted around Japan in March 2004). In Nagoya outflow from anthropogenic sources under non-cloud conditions in the atmospheric boundary layer, predicted BC aging due to increase of coating with aerosol was roughly consistent with observation. Our model also showed that the fractional coating of smaller BC particles grew much faster and this behavior was consistent with theoretical condensation behavior. Theses results validate that BC aging predicted by our model was reasonable and our model can explicitly estimate BC aging time scales and its controlling factors.