Development of a global aerosol model using a two dimensional bin method

*Hitoshi MATSUI[1,2,3], Naga Oshima[4]

1.Nagoya University, 2.Cornell University, 3.Japan Agency for Marine-Earth Science and Technology, 4.Meteorological Research Institute

Atmospheric aerosols play an important role in Earth's climate system through radiation and cloud/precipitation processes. Estimates of these aerosol impacts on climate remain highly uncertain, and they are one of the largest uncertainties in predicting climate change. Accurate estimations of these effects through a model require good representations of number concentration, size distribution, and mixing state of aerosols. However, many of existing three-dimensional aerosol models do not represent these aerosol parameters sufficiently. In our previous studies, we developed an aerosol model, the Aerosol Two-dimensional bin module for foRmation and Aging Simulation (ATRAS), that can explicitly calculate aerosol number concentration, size distribution, and mixing state with a two-dimensional bin representation. The ATRAS model was implemented into a regional three-dimensional model WRF-chem, and we have shown the importance of aerosol simulations using a model that can treat detailed aerosol processes and parameters [Matsui et al., 2014; Matsui, 2016a, 2016b]. In this study, we developed a new aerosol model based on the ATRAS model and implemented it to a global climate model CAM5.

The computational cost is one of the most important factors in the development of a global aerosol model using a two-dimensional bin representation because global and long-term simulations are necessary in a global modeling study. To reduce the computational cost, we developed a new aerosol box model by improving the source codes of all aerosol microphysical and chemical processes in the ATRAS model and by reducing the number of aerosol variables considerably. These changes reduced the computational cost of aerosol microphysical and chemical processes by 90% compared with the original ATRAS model with keeping the accuracy of simulations for aerosol number concentration, size distribution, and mixing state.

We implemented this new box model to CAM5 and conducted five-year test simulations. The model simulations were validated through the comparison with the original aerosol model in CAM5 (MAM) and various surface and aircraft measurements of aerosols. We also calculated global distributions of some aerosol parameters that can be estimated globally for the first time by using our detailed aerosol model.

In the presentation, we would like to show the concepts and results of the new box model and the results of global model simulations such as the comparison with MAM simulations and measurements and sensitivity simulations.

References:

Matsui, H. et al. (2014), Atmos. Chem. Phys., 14, 10315-10331.
Matsui, H. (2016a), J. Geophys. Res. Atmos., 121, doi:10.1002/2015JD023998.
Matsui, H. (2016b), J. Geophys. Res. Atmos., 121, doi:10.1002/2015JD023999.

Keywords: Aerosol, Global aerosol model, Two-dimensional bin model, Number concentration, Size distribution, Mixing state

