Development of size-resolving aerosol microphysics scheme for use in a global non-hydrostatic cloud-resolving model

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To simulate the evolutions of aerosol size distributions and their contributions to the aerosol-radiation and aerosol-cloud interactions, we develop the size-resolving scheme as an extension from the original NICAM-SPRINTARS (Suzuki et al., 2008) framework. A flexible bin-type size representation is introduced for the major atmospheric aerosol species considered in SPRINTARS: sea salt, mineral dust, sulfate and carbonaceous aerosols. Each size bin is characterized with size-dependent properties such as terminal velocity, CCN property and optical parameters, and evolves as an independent tracer. For sulfate aerosols, aerosol dynamical processes (new particle formation, condensation and coagulation processes) are represented with explicit size-dependency of the processes.

Here we present the early results from the ongoing model development, including its validation through comparisons to ground-based observations from AERONET and satellite observations from MODIS. While aerosol models are usually validated using observed aerosol optical depths and Ångström exponents, the knowledge of size distributions provided by the size-resolved model also allows direct comparisons with the observed size distribution from ground based measurements. For example, the annually averaged size distributions at several AERONET sites are fairly reproduced by the size-resolved model, and the underlying compositions by different aerosol species can also be inferred.

In comparison with the original version, the size-resolving model produces contrasting spatial distribution, optical depths and mass budgets due to explicit representations of size dependency of optical properties and physical process rates. Results indicate a more distant transport of sulfate aerosols owing to the size-resolved distributions. These results suggest that size-resolving microphysics will lead to different estimates of aerosol forcing, and should be considered in global models in order to reduce the uncertainties of aerosol radiative forcing.

Key words: aerosols, size distribution, NICAM, SPRINTARS, MODIS, AERONET

References

Suzuki, K., Nakajima, T., Satoh, M., Tomita, H., Takemura, T., Nakajima, T. Y., & Stephens, G. L. (2008). Global cloud‐system‐resolving simulation of aerosol effect on warm clouds. Geophysical research letters, *35*(19).