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Improvement of a global tropospheric sulfate aerosol model

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Aerosols can greatly influence the climate system and are important factors to understand climate change. Their effects to the radiation budget are divided into two pathways. One is the effect to modify the radiation fluxes through directly scattering and absorbing the atmosphere radiation (aerosol direct effect). Another is to modify the cloud microphysics properties and the precipitation rate through acting as a cloud condensation nuclei and then aerosols can change the radiation fluxes indirectly (aerosol indirect effect). As human activities increase after Industrial Revolution, many aerosols are emitted to the atmosphere. One of the most important components for anthropogenic aerosol radiative forcings is a secondary aerosol, which mainly includes tropospheric sulfate. Among global tropospheric sulfate aerosol models, however, the prediction is still uncertain largely due to uncertainty of the simulated sulfate burden.
To reduce this type of uncertainty, we first modified a sulfur module in our global aerosol model, SPRINTARS developed by Takemura et al. [2005], with taking account of two major understandings: (1) previous models show that SO_2liquid-phase production is major process in the sulfate production and (2) the liquid-phase reaction rate and a timescale of equilibrium between gas-aerosol phases through Henry's law is generally faster than that used in global model calculations. The new module can solve the SO_2liquid-phase reaction with an analytical solution in finer sub-cycle timestep keeping Henry's partitioning between gas-aerosol phases. Additionally, we upgraded SO_2dry deposition process, which is also important for the sulfur cycle.
As a result, the predicted sulfate mass concentrations near the surface in this study were in much better agreement with in-situ measurements than those in the original SPRINTARS. Its vertical distributions in this study were also much closer to the flight measurements. At the same time, these improvements also led to be smaller differences in sulfate burdens and vertical distributions between SPRINTARS and other AEROCOM models. In this conference, we also would like to show results for its radiative forcings.

Keywords: sulfate aerosol, GCM