Tropospheric aerosol size distributions simulated by three online global aerosol models using the M7 microphysics module

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Tropospheric aerosol size distributions are simulated by three online global models which employ exactly the same aerosol microphysics module, but differ in many aspects such as model meteorology, natural aerosol emission, sulfur chemistry, and deposition processes. The main purpose of this study is to identify the influence of these differences on the aerosol simulation. Number concentrations of different aerosol size ranges are compared among the three models and against observations. Overall all three models are able to capture the basic features of the observed spatial distribution. The magnitude of number concentration is consistent among the three models in all size ranges, although quantitative differences are also clearly detectable. For the soluble and insoluble coarse and accumulation modes, inter-model discrepancies result primarily from the different parameterization schemes for sea salt and dust emission, and are also linked to the different strengths of the convective transport in the meteorological models. As for the nucleation mode and the soluble Aitken mode, the spread of model results appear largest in the tropics and in the middle and upper troposphere. Diagnostics and sensitivity experiments suggest that this large spread is directly related to the sulfur cycle in the models, which is strongly affected by the choice of sulfur chemistry scheme, its coupling with the convective transport and wet deposition calculation, and the related meteorological fields such as cloud cover, cloud water content, and precipitation. Aerosol size distributions simulated by the three models are compared against observations in the boundary layer. The characteristic shape and magnitude of the distribution functions are reasonably reproduced in typical conditions of clean, polluted and transition areas.

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