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Impacts of variable particle size distribution on dust optical properties and radiative effects

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Aeolian dust, the most dominant atmospheric aerosol by mass, influences the weather and climate directly through absorbing and scattering the radiation. Particle size distribution (PSD) controls the magnitude of these impacts through modulating the dust residence time in the atmosphere and optical properties. Although the dust PSD varies during the atmospheric transport, current models usually neglect the effect of these variations on dust optical properties.

This study investigates the impact of variable PSD on dust optical properties and radiative impacts using the next-generation atmospheric modeling system ICON-ART (ICOsahedral Nonhydrostatic with Aerosols and Reactive Trace gases). Two sets of numerical experiments are conducted assuming fixed and variable PSD. A parameterization is developed to account for the effect of variable PSD on dust optical properties in the model. This parameterization is then implemented in ICON-ART to simulate a period of 1 month on a global grid with 80 km horizontal resolution.

Results show that the consideration of a variable PSD increases the dust AOD. However, the magnitude of the changes depends on the dominant size modes. Although the optical properties of the fine mode show the highest sensitivity to the variable PSD, the median diameter of this mode hardly changes during transport. Thus, the new parametrization does not have a significant impact on AOD where fine mode is dominant. In contrast, when coarse mode is prevailing, the increase of AOD is more pronounced. This makes the surface slightly warmer (+0.2 K) in the source regions.