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Improvements in dust representation in the Community Atmospheric Model

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Mineral dust aerosols have the capacity of affecting the Earth's radiative budget by interacting with short- and long-wave radiation and with clouds. In addition dust deposited to the surface can affect biogeochemical cycles and alter the surface albedo. Given its recognized role as an active component of the climate system, the dust cycle has been included as a component in Earth system models, fostering the need of extensive validation with observations.

Here we present our results on improvements made to the representation of dust in the Community Atmospheric Model, part of the Community Earth System Model. The improvements relate to grain size distributions and spatial variability of the dust emissions, wet deposition and dust optics. We focused in particular on the dust size distribution, when considering the magnitude and spatial variability of the dust cycle. Our observational datasets include columnar and surface measurements as well as deposition data, which we use to test our changes to the parameterizations sets.

The results show the importance of taking into account at least the size range of both models and observations for validation or tuning purposes, and how the combination of the changes we made improves the model's ability to represent the global dust cycle and its spatial variability both close to the source areas and at long distance, including in terms of the dust size distributions. We also considered the dust-source relations.

We include an extensive set of sensitivity experiments on the tuning of dust parameterizations to compare to observations as well as to examine the impact on dust radiative forcing.