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Mixing and Deposition of Saharan Dust during Transatlantic Transport

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Mineral dust from arid and semi-arid regions plays an important environmental role due to its ability to alter the Earth's energy budget by aerosol-cloud-radiation interactions as well as due to its impact on the biogeochemical cycle and air quality. The Sahara desert is the world's main dust source contributing at least 50% to the global dust load. Large amounts of dust are carried towards the Caribbean within the Saharan Air Layer (SAL), with maximum transport in late boreal spring and early summer. During long-range transport, the dust particles are transformed by aging and mixing, which may have significant but as yet unquantified effects on the dust impact on radiation, cloud properties, and the biogeochemical processes of ecosystems.
This study focuses on the important role of mixing and deposition processes on the distribution, lifetime, and particle properties of mineral dust. Regional dust modelling and trajectory analysis are used to investigate the long-range transport of Saharan dust across the Atlantic Ocean towards the Caribbean. Specifically, we address the questions of (1) how the Saharan dust export is influenced by the atmospheric circulation over West Africa and (2) which role the different removal and mixing processes play during long-range transport? Modelling the emission, transport, and deposition of Saharan dust as well as the effect of dust radiative forcing is performed with the regional model COSMO-MUSCAT. The COSMO-MUSCAT simulations are combined with a LAGRANTO trajectory analysis. The consistent dataset is then evaluated to study the boundary layer impact on deposition and dust-cloud interactions along transport paths.
The results show that as the source activity, dust deposition is driven by the atmospheric circulation patterns over West Africa. Convective mixing controls dry deposition in the tropics and can explain sporadic deposition events in the subtropics. Overall, this study provides an improved model-based assessment of the varying contribution of Saharan dust to the aerosol burden across the Atlantic Ocean.