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Mineral dust influence on West-African Sahel rainrates as observed by MODIS and TRMM

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Mineral Dust in the West-African Sahel, either advected from source regions in the Sahara or mobilised by local sources, interacts with the local climate system by modulating the radiation balance and also by changing cloud properties and rainfall. Mineral dust affects rain rates and precipitation amounts of clouds subject to the dust entrainment mainly by the increased number of available cloud condensation nuclei leading to a larger number of cloud droplets with overall smaller droplet sizes.
Aerosol observations from the MODerate resolution Imaging Spectroradiometer (MODIS) on the Aqua satellite and rainfall data from the Tropical Rainfall measuring Mission (TRMM) are used to examine the interactions of mineral dust and rainfall in the West-African Sahel. Five years of daily TRMM rainrates and droplet sizes are analysed with respect to atmospheric dust loadings in the West-African Sahel as inferred from MODIS AOD observations (only AOD observations showing mineral dust aerosol as inferred from MODIS aerosol type classification and Ångstrom exponents are used).
The ratio of observed precipitation event numbers and total cloud observation numbers in the Sahel is significantly reduced in the presence of mineral dust, reaching up to rainfall reduction by more than 50% in scenes with high dust loading. Not only the number of precipitation events but also the rain rates and raindrop sizes for precipitating clouds are found to be generally reduced under dusty conditions. As well median rain rates as also the spread of the 25%- and 75%-quantiles of the observed rain rate distribution are significantly lower under dusty conditions.
From these results it can be concluded that also year-to-year variations of monsoon onset and overall precipitation amount of the summer monsoon, an important factor for both, vegetation and human life in the region, are sensitive to mineral dust export from the Sahara towards the Sahel and to the amount of locally mobilised mineral dust.
Furthermore this analysis strengthens the findings that mineral dust can play an active feedback role in desertification as suggested by several modelling studies and ground-based observations.