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Satellite-based Dust Source Identification over North Africa: Diurnal Cycle, Meteorological Controls, and Interannual Variability

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Mineral dust aerosol emitted from arid and semi-arid areas impacts on the weather and climate system by affecting e.g. radiation fluxes and nutrient cycles. To estimate the effect of dust aerosol, detailed knowledge on the spatio-temporal distribution of active dust sources is necessary. For a better representation of dust-related processes in numerical models and climate change projections the knowledge on the natural variability of dust source activity has to be improved. As dust sources are mostly located over remote areas satellite observations are suitable for identifying active dust sources. The accuracy of dust source identification using such an indirect method is limited by the temporal resolution and the ambiguities of the retrieval.
Here, a data set on the spatial (1°x1°) and temporal (3-hourly) distribution of dust source activations (DSA) over North Africa is compiled by analyzing 15-minute Meteosat Second Generation (MSG) infra-red (IR) dust index images since March 2006. The index is designed using radiances measured by the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) on-board MSG at 8.7 μm, 10.8 μm and 12.0 μm which are converted to brightness temperatures (BTs). To strengthen the dust signal, differences of BTs are used to compute RGB-composite images. This newly data set providing information on the diurnal cycle of dust emission has been used (1) to identify most active dust source areas, and (2) to investigate on the temporal distribution of DSAs. Over the Sahara Desert 65% of dust sources become active during 06-09 UTC pointing towards an important role of the break-down of the nocturnal low-level jet (LLJ) for dust mobilization besides other meteorological features like density currents, haboobs, and cyclones. Furthermore the role of the nocturnal LLJs for dust mobilization over the Sahara is investigated by weather observations and a regional modeling study.
Four years of DSA observations indicate an interannual variability in frequencies of local dust source activations (DSAF). Dust emission is mainly controlled by the occurrence of strong surface wind speeds and surface conditions like vegetation cover which may differ for individual years depending on the climatic conditions. The role of interannualy changing wind and precipitation pattern for DSAF variability is investigated.