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Dust emission from different sol types and geomorphic units in the Sahara – implications for modeling dust emission and transport

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Mineral dust plays multiple roles in mediating physical and biogeochemical exchanges among the atmosphere, land and ocean, and thus is an active component of the global climate system. To estimate the past, current, and future impacts of dust on climate, sources of dust and their erodibility should be identified. The Sahara is the major source of dust on Earth. Based on qualitative analysis of remotely sensed data with low temporal resolution, the main sources of dust that have been identified are topographic depressions comprised of dry lake and playa deposits in hyprarid regions. Yet, recent studies cast doubts on these as the major sources and call for a search for others. Moreover, the susceptibility of soils to aeolian erosion (wind land erodibility) in the Sahara is still poorly known. In this study we identify and determine the soil types and geomorphic units most important as Saharan dust sources by correlating between the number of days with dust storms (NDS), derived from remote-sensing data of high temporal resolution, with the distribution of the soil types/geomorphic units. During 2006–8 the source of over 90% of the NDS was sand dunes, leptosols, calcisols, arenosols, and rock debris. Few dust storms originated from dry lake beds and playas. Land erodibility by wind for each soil type/geomorphic unit was estimated by a regression of the NDS and the number of days with high-speed wind events; the regression is relatively high for sand dunes and gypsisols. We use these regressions to differentiate between sources of dust that are supply-limited to those that are transport-limited. We propose that the fracturing of saltating sand and the removal of clay coatings from sand grains through eolian abrasion is the dominant dust-emission mechanism for the sand-rich areas covering large portion of the Sahara. Our results also explain the increased dustiness during the last glacial period, when sand dunes activity has been more common than during the Holocene. This study has the potential to improve regional scale dust-transport models that aim to assess future effects of dust on the climate.