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A Climatology of Dust-Emission Events over North Africa Based on 27 Years of Surface Observations

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The huge quantity of mineral dust emitted annually from North Africa makes this area crucial to the global dust cycle. Once in the atmosphere, dust aerosols have a significant impact on the global radiation budget, clouds, the carbon cycle and can even act as a fertilizer to rain forests in South America. Current model estimates of dust production from North Africa are uncertain. At the heart of this problem is insufficient understanding of key dust emitting processes such as haboobs (cold pools generated through evaporation of convective precipitation), low-level jets (LLJs), and dry convection (dust devils and dust plumes). Scarce observations in this region, in particular in the Sahara, make model evaluation difficult.

This work uses long-term surface observations from the MIDAS data set ($\sim$120 stations in the arid part of North Africa) to explore the diurnal, seasonal, decadal and geographical variations in dust emission events and their associated wind thresholds. The threshold values are determined from probability density functions of observed 10-minute anemomenter wind speeds. Emission events are defined using the present weather codes (WW) of SYNOP reports. These codes represent events of smaller intensity such as "Dust or sand raised by wind" to severe dust storms. During the 27-year study period (1984-2011) stations are required to have a minimum of 1000 dust observations to be included in the analysis. Dust emission frequency (DEF) is calculated for different time intervals (e.g. monthly, 3-hourly) taking into account the different number of measurements available at each station.

North of 25°N a maximum during March-May is evident and relatively consistent over the whole North African region. Wind-speed thresholds for dust emission north of 25°N are higher than south of 25°N in the Sahel, where station-to-station variability is larger, and enhanced DEF activity during February-March is observed. The variability in this region is closely linked to the advance and retreat of the summer monsoon. The diurnal cycle in DEF shows reflections of the individual emission mechanisms. At night, winds are usually light and dust emission is low. Many stations show a sharp increase in wind speed and DEF between 06 and 09 UTC, a probable result of the downward mixing of momentum from nocturnal LLJs. Peaks at both midday and 15 UTC are common in the diurnal cycles of both winds and DEF. Midday peaks are likely due to small scale dry convection, while the afternoon peaks may contain signals from both dry convection and gusty winds associated with haboob outflows. Into the evening and overnight the DEF signal gets smaller and is often caused by long-lived haboobs.