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A Climatology of dust emission in northern Africa using surface observations from 1984–2012

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The huge quantity of mineral dust emitted annually from northern 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 northern 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 70 stations situated in the Sahara and Sahel to explore the diurnal, seasonal and geographical variations in dust emission events and thresholds. Quality flags are applied to each station to indicate a day-time bias or gaps in the time period 1984–2012. The frequency of dust emission (FDE) is calculated using the present weather codes (WW) of SYNOP reports, where WW = 07,08,09,30–35 and 98. Thresholds are investigated by estimating the wind speeds for which there is a 25%, 50% and 75% probability of dust emission. The 50% threshold is used to calculate strong wind frequency (SWF) and the diagnostic parameter dust uplift potential (DUP); a thresholded cubic function of wind-speed which quantifies the dust generating power of winds. Stations are grouped into 6 areas (North Algeria, Central Sahara, Egypt, West Sahel, Central Sahel and Sudan) for more in-depth analysis of these parameters.

Spatially, thresholds are highest in northern Algeria and lowest in the Sahel around the latitude band 16N–21N. Annual mean FDE is anti-correlated with the threshold, showing the importance of spatial variations in thresholds for mean dust emission. The annual cycles of FDE and SWF for the 6 grouped areas are highly correlated (0.95 to 0.99). These correlations are barely reduced when annual-mean thresholds are used, showing that seasonal variations in thresholds are not the main control on the seasonal variations in FDE. Relationships between annual cycles in FDE and DUP are more complex than between FDE and SWF, reflecting the seasonal variations in the types and intensities of dust events. FDE is highest in spring north of 23N. South of this, where stations are directly influenced by the summer monsoon, the annual cycle in FDE is much more variable. Half of the total DUP occurs at wind-speeds greater than $\sim$ 28 ms-1, which highlights the importance of rare high-energy wind events. The likely meteorological mechanisms generating these patterns are discussed.