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Aeolian dust emissions in Southern Africa: field measurements of dynamics and drivers

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Airborne dust derived from the world's deserts is a critical component of Earth System behaviour, affecting atmospheric, oceanic, biological, and terrestrial processes as well as human health and activities. However, very few data have been collected on the factors that control dust emission from major source areas, or on the characteristics of the dust that is emitted. Such a paucity of data limits the ability of climate models to properly account for the radiative and dynamical impacts triggered by atmospheric dust. This paper presents field data from the DO4 Models (Dust Observations for Models) project that aims to understand the drivers of variability in dust emission processes from major source areas in southern Africa.

Data are presented from three field campaigns undertaken between 2011 and 2015. We analysed remote sensing data to identify the key geomorphological units in southern Africa which are responsible for emission of atmospheric dust. These are the Makgadikgadi pans complex in northern Botswana, the ephemeral river valleys of western Namibia, and Etosha Pan in northern Namibia. Etosha Pan is widely recognised as perhaps the most significant source of atmospheric dust in the southern hemisphere. We deployed an array of field equipment within each source region to measure the variability in and dynamics of aeolian erosivity, as well as dust concentration and flux characteristics. This equipment included up to 11 meteorological stations measuring wind shear stress and other standard climatic parameters, Cimel sun photometers, a LiDAR, sediment transport detectors, high-frequency dust concentration monitors, and dust flux samplers. Further data were gathered at each site on the dynamics of surface characteristics and erodibility parameters that impact upon erosion thresholds. These data were augmented by use of a Pi-Swerl portable wind tunnel.

Our data represent the first collected at source for these key dust emission areas and highlight the substantial variability in erosivity and erodibility characteristics across both time and space. Such variability identifies 'hot spots' of dust emission and we show that processes of atmospheric dust production differ between each of the source regions. Recognising the sensitivity of dust emission to such variability may enable a better integration of emission processes into climate models.