Geophysical Research Abstracts
Vol. 17, EGU2015-15521, 2015
EGU General Assembly 2015

Temporal dynamics of salt crust patterns on a sodic playa: implications for aerodynamic roughness and dust emission potential

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Salt pans (or playas) are common in arid environments and can be major sources of windblown mineral dust, but there are uncertainties associated with their dust emission potential. These landforms typically form crusts which modify both their erosivity and erodibility by limiting sediment availability, modifying surface and aerodynamic roughness and limiting evaporation rates and sediment production. Here we show the relationship between seasonal surface moisture change and crust pattern development on part of the Makgadikgadi Pans of Botswana (a Southern Hemisphere playa that emits significant dust), based on both remote-sensing and field surface and atmospheric measurements. We use high resolution (sub-cm) terrestrial laser scanning (TLS) surveys over weekly, monthly and annual timescales to accurately characterise crustal ridge thrusting and collapse. Ridge development can change surface topography as much as 30 mm/week on fresh pan areas that have recently been reset by flooding. The corresponding change aerodynamic roughness can be as much as 3 mm/week. At the same time, crack densities across the surface increase and this raises the availability of erodible fluffy, low density dust source sediment stored below the crust layer. We present a conceptual model accounting for the driving forces (subsurface, surface and atmospheric moisture) and feedbacks between these and surface shape that lead to crust pattern trajectories between highly emissive degraded surfaces and less emissive ridged or continuous crusts. These findings improve our understanding of temporal changes in dust availability and supply from playa source regions.