Geophysical Research Abstracts
Vol. 15, EGU2013-12921, 2013
EGU General Assembly 2013

Aerodynamic roughness above complex, three-dimensional small scale surface roughness patterns in arid environments

Joanna Nield (1), James King (2), and Giles Wiggs (2)

(1) Geography and Environment, University of Southampton, Southampton, United Kingdom (j.nield@soton.ac.uk), (2) School of Geography and Environment, University of Oxford, Oxford, United Kingdom

Surface roughness plays a key role in determining the aerodynamic roughness above a surface and so it is important to quantify its spatial variation when considering aeolian entrainment and transport of sand and dust. Whilst the aerodynamic roughness can be quantified using vertical wind profiles or sonic anemometry, large proportions of terrestrial areas and most planetary surfaces that are prone to wind erosion remain too remote for a measurement-based approach. Surface roughness metrics have been measured for some time in geomorphic research, using high resolution datasets of varying spatial scales, however few metrics for complex small-scale surfaces have been used to model aeolian processes. Most previous studies assessing element configuration find that roughness element density and height, rather than configuration has the greatest influence on wind erosion potential. However, these studies were designed to consider larger, discrete roughness elements such as vegetation and their performance for surfaces with continuous micro-topography is less well quantified. In this study terrestrial laser scanning (TLS) was used on complex polygonal crusted playa surfaces in Botswana and sandar surfaces in Iceland ranging in maximum element height from 7 to 200 mm. Aerodynamic height measured by vertical wind profiles at sites was constrained by wind direction, stability parameters, and boundary-layer scaling, to compare with TLS-based metrics on upwind surfaces. A myriad of metrics were assessed that describe the one, two and three dimensional natural of the surface, considering both roughness element size and organisation. On well organised surfaces, measures of mean element height were highly correlated with aerodynamic measurements, but on more heterogeneous surfaces, where Fourier transform analysis identified bi-or multi-modal pattern scales, semi-variogram analysis performed best as it accounted for a range of element heights. Although there is also a strong relationship between 2D or 3D roughness density and aerodynamic roughness, the spacing of the elements is less important than their height. This is in contrast to more recent wind erosion models that consider the spacing of larger-scale isolated roughness elements to be more important, and instead we suggest that the dust emission potential in the majority of dust emitting areas is mainly controlled by the height of the local roughness.