Geophysical Research Abstracts
Vol. 16, EGU2014-11237, 2014
EGU General Assembly 2014

Estimating aerodynamic roughness over complex salt pan and sandur dust emitting surfaces

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Salt pan and sandur surfaces typically consist of complex patterns of small-scale roughness which differ to more commonly studied larger roughness elements. It is important to understand how these surfaces interact with the wind as both sandar and salt pans (or playas) are potential dust emitters, and so improving our understanding of surface-atmosphere interactions over surfaces in these areas is vital. These complexly patterned surfaces are also relative flat, lack vegetation and typically have a large fetch which makes them the ideal experimental surfaces to develop empirical estimations of aerodynamic roughness from terrestrial laser scanner (TLS) datasets. We investigated 20 surfaces with element heights ranging from 1 to 199mm during four field campaigns. Co-located anemometer towers at each location measured actual aerodynamic roughness to compare to a myriad of surface metrics derived from TLS datasets. Using cluster analysis height, shape, spacing and variability metric groups were compared to decipher which best estimated aerodynamic roughness. When height metrics were employed, it was found that over 90% of the variability was explained and height is a better predictor than both shape and spacing. This finding is in juxtaposition to wind erosion models that assume the spacing of larger-scale isolated roughness elements is most important in determining aerodynamic roughness. The study recognizes that when small-scale surface roughness is accurately quantified (with millimetre accuracy using TLS), height is most significance for estimating aerodynamic roughness, irrespective of comparator metric choice. This has very significant implications for the development of aerodynamic roughness predictors which are fundamental to the efficiency of wind erosion models, and, particularly, dust emission schemes in climate models.