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Quantifying controls on aeolian dune processes and dynamics: a review of current understanding

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Many issues regarding the mechanisms by which aeolian sediment is entrained, transported and deposited remain unresolved. This is surprising given that knowledge of the processes governing windblown sediment is fundamental to our understanding of desert dune dynamics, desertification, dust storm activity, agricultural wind erosion and beach/dune sediment systems, all of which are prominent in debates regarding future climate change. In particular, our understanding of the processes by which individual dunes and dune systems adjust to changing airflow conditions and sediment transport in time and space are poorly known. This is partly due to our inadequate knowledge concerning sediment transport processes.

Concurrent with developments in fluvial-based sedimentary research, recent aeolian research has questioned our reliance on time-averaged flow parameters arguing that higher frequency turbulent flow structures may be more relevant to our understanding of aeolian sediment transport systems. There is now compelling evidence of the role played by flow separation in the generation of turbulence and subsequent sediment transport on dune surfaces. Subtle changes in bedform spacing can also have a profound influence on the production of turbulence and in some cases result in rapid changes in sediment flux and bedform evolution even in the case of uniform flow.

This paper reviews recent developments in field, wind tunnel and mathematical modelling experiments relating to sediment transport and dune dynamics. Discussion focuses on our understanding of the development of turbulent flow structures and how they might influence rates of aeolian sediment flux. A key future objective is seen to be applying such understanding at the dune scale. In this regard results from analytical models suggest a requirement for further understanding of the dynamics of sediment

transfers at the dune scale with specific emphasis on exploring the mechanisms by which systems of bedforms might adjust to unsteady winds.