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The impact of turbulent flow on aeolian dune dynamics

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Studies in both the aeolian and fluvial literature have recognised turbulence as a driving force in sediment transport and have highlighted the importance of coherent flow structures, particularly sweep and outward interactions, in sediment transport systems. Furthermore, research in the fluvial environment has identified the significance of turbulence and coherent flow structures for bedform morphology and spacing. However, equivalent research in the aeolian domain is absent. This paper reports the findings of research carried out to characterise turbulent energy and turbulent structures around an individual barchan dune.

Measurements of wind velocity (using sonic anemometers) and sand transport (using grain impact sensors) at a sampling frequency of 10 Hz were made across transects on a 9 m high barchan dune located in the Skeleton Coast, Namibia. Vertical profile data from the sonic anemometers were used to compute key measures of turbulence and turbulent stress (Reynolds stress, -*uw*; instantaneous horizontal and vertical fluctuations, u' and w'; coherent flow structures defined from quadrant analysis) and their relationship with respect to sand transport and evolving dune morphology.

Results demonstrate the development and modification of turbulence and sediment flux in key regions on the surface important for the developing dynamics of the dune: toe, crest and brink. Analysis suggests that these modifications are directly controlled by developing streamline curvature and flow acceleration. Conflicting models of dune development, morphology and stability arise when based upon either the dynamics of measured turbulent flow or mean flow.