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Using Wavelets to Examine Persistence in Aeolian Sand Transport and Wind

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This paper examines the long-range persistence (memory) in time series of aeolian sand transport and near-surface wind speed, using both wavelets and Fourier power spectral analysis. The measurements of aeolian sand transport intensity and near-surface wind speed were obtained during a field experiment on top of a sand mound near Windy Point, California, USA. Time-series at 20 Hz frequency were collected with a spanwise (flow perpendicular) array of saltation flux impact responders (Safires) and co-located thermal anemometry probes at 4 cm above the sand surface. Time series of wind speed show no distinct periodic pattern in the fluctuations, and sand transport displays a highly intermittent and event-driven behaviour. The relationships between wind forcing and sand transport response were investigated using wavelets and Fourier power spectral analysis. Results of the analyses indicate that forcing and response show varying degrees of long-range persistence, with the strength of persistence changing at effective periods of roughly 1, 7, and 30 seconds. The transition points between types of behaviour compare favourably with physically meaningful scales, such as the minimum temporal scale of saltation response to wind speed fluctuations, and the integral time-scale of the observed internal boundary layer turbulence dynamics. Analyses and comparisons over varying spanwise distances reveal the extent and breakdown of the observed force-response correspondence as a function of spatial scale.