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Wavelet Spectra and ARMA Modelling of Aeolian Sand Transport Response to Wind Speed Events

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The movement of surface sediment in response to wind can be framed in the context of top-down turbulence overcoming stress thresholds and driving individual sand transport events as eddies skim across the surface. Subsequent at-a-point transport signals are erratic and intermittent in nature, with often poorly behaved distributions and non-stationarity compromising rigorous analysis and modeling.

This paper presents results of investigating temporal scaling and extremes of wind forcing related to sediment transport events, in terms of spectral domain distributions, by exploration of higher-order Auto-Regressive-Moving-Average (ARMA) models and exploration of the time-frequency domain using wavelet analysis. The results suggest two principal relaxator time-scales in the wind forcing, once of which can be conceptually linked to the single principal relaxator in the sand transport response signal. The spectral analysis reveals distinct forcing-response regimes at different temporal scales that 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. These results can inform the development of an explicitly event-driven predictive model for aeolian sand transport fluxes.