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What drives intermittent aeolian saltation at high-frequency?

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Most aeolian sediment transport models are predicated on the assumption that transport results from an equilibrium in the momentum transfer between the wind and grains in the airstream. However, it is difficult to confirm this longstanding conceptualization in the field because at certain scales transport is highly intermittent, spatially non-uniform (i.e. streamers) and difficult to predict based on wind alone, even when surface conditions are ideal. While it might be important to filter this variability (i.e. time-averaging) for predictive purposes, it is also important to evaluate discrepancies between measurements and models over a range of timescales and levels of transport. To address this, we measured saltation at high frequency under controlled conditions in a wind tunnel. The goal was to determine how the statistical properties of saltation change under different flow conditions, and whether the steady state approximation of the saltation system commonly used in models is an accurate characterization of the transport system at high-frequency. We performed a series of experiments by applying a constant airflow to a granular surface and recording the aeolian transport rate near the bed with a laser particle counter at 10 Hz. From experimental runs at different constant velocities we resolved differences in the statistics of transport that hint at the underlying controls. At low free-stream velocities saltation was highly intermittent. Long periods (> 1 min) without detectable saltation were interrupted by brief ‘pulses’ of saltation activity so that the gap between the typical transport rate and the mean was large, yielding right-skewed (pseudo power law) frequency-magnitude distributions. We interpret these conditions in the context of bed state since flow remained constant. Near threshold parts of the bed develop into a critical state such that the size of saltation pulses is unpredictable. This bears some resemblance to the concept of self-organized criticality. However, when free-stream velocity was much higher the statistical properties and character of the transport series changed, ultimately yielding continuous saltation and more symmetric frequency-magnitude distributions. This suggests that saltation activity near the threshold of motion is strongly imprinted by the bed state, but once saltation becomes continuous the flow velocity exerts more influence on transport rate. Greater emphasis on the bed state from a granular physics perspective may improve the understanding of saltation at high resolution.