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Wind-invariant saltation heights imply linear scaling of aeolian sand flux with shear stress

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Wind-driven sand transport generates atmospheric dust, forms dunes, and sculpts landscapes. However, it remains unclear how the flux of particles in aeolian saltation – the wind-driven transport of sand in hopping trajectories – scales with wind speed, largely because models do not agree on how particle speeds and trajectories change with wind shear velocity. Here, we present comprehensive measurements from three new field sites and three published studies, showing that characteristic saltation layer heights remain approximately constant with shear velocity. These results support the assumption of constant particle speeds in recent models predicting linear scaling of saltation flux with shear stress. In contrast, our results refute widely-used older models that assume particle speed increases with shear velocity, thereby predicting nonlinear 3/2 stress-flux scaling. This conclusion is further supported by direct field measurements of saltation flux versus shear stress. Our results thus support adoption of linear saltation flux laws and constant saltation trajectories for modeling saltation-driven aeolian processes on Earth, Mars, and other planetary surfaces.