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Flattening of Aeolian Ripples

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Aeolian ripple patterns shape nearly every wind-exposed sand surface. Despite the different formation origins of megaripples, impact ripples and the newly discovered aerodynamic ripples on Earth [1], their disappearance under strong winds is conventionally blamed on the same mechanism, by the fluid-entrainment hypothesis. By revealing its shortcomings and inconsistencies, the need for an update of our understanding of ripple flattening is pointed out. Based on recently discovered grain-scale characteristics of aeolian sand transport [2], we propose a robust new hypothesis for impact ripple disappearance, which we call surface-melting hypothesis. It states that impact ripples cannot form when mid-air collisions play a substantial role in the transport process. Since the latter is correlated with a scaling crossover in the total mass-transport rate as a function of surface shear stress [2], the surface-melting hypothesis predicts an upper bound on the wind- strength regime that allows impact ripples to form. We will show that it stands up well to a comparison with original and literature data, does not suffer from conflicts and inconsistencies with the disappearance of other ripple types and thus allows for a coherent and profound understanding of the stability regimes of aeolian ripples in general. We present and discuss a tentative phase diagram of ripple existence in the parameter space of Shields-number and grain diameter which, in addition to summarizing our theoretical and experimental findings, predicts the disappearance of the recently introduced aerodynamic ripples in the aerodynamically rough regime, characterized by $Re_{\square\square}$□ 20.

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