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Exploring moisture-constrained aeolian sediment transport through a discrete particle modelling framework

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Moisture is a crucial environmental factor that shapes the dynamics of aeolian sediment transport along coastal beaches. Despite the existence of empirical formulations, little is known about the mechanism through which moisture influences this dynamic process. To address this knowledge gap, we present a numerical modelling framework implemented in the open-source software package MercuryDPM [1].
This framework combines a discrete particle model, a one-dimensional airflow model and a liquid migration model. The two-way coupling between the discrete particle model and the airflow model can accurately represent the momentum exchange between these phases, yeilding reasonable sediment transport rates [2]. The inter-particle moisture distribution is modelled by a liquid migration law, which governs the presence of liquid films covering the particle surfaces and liquid bridges spanning the particle contacts [3]. The liquid bridge model introduces a static capillary force as well as a dynamic lubrication force, which is necessary to model the dynamic effects of moisture. This comprehensive model effectively captures particle behaviour under moist conditions and demonstrates the dependence of bed erodibility on particle impact and wind entrainment for varying moisture levels.
Our approach provides valuable insights on the moisture effect in aeolian sediment transport. It advances our understanding of this complex phenomenon, and gives insights on the development of geomorphological patterns at coastal sandy areas. With its flexilibity and versatility, it can be extended to study many more specific processes related to sediment transport.

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