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A comprehensive numerical model of wind-blown sand to study dust aerosol emission

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We present a comprehensive numerical model of steady-state wind-blown sand, or 'saltation.' Saltation is the physical process that ejects dust aerosols into the atmosphere and also creates sand dunes and erodes geological features. Our model explicitly simulates the motion of saltating particles due to gravity, fluid drag, particle spin, fluid shear, and turbulence. We also account for the retardation of the wind due to drag from saltating particles, and developed a novel physically based parameterization of the ejection of surface particles by impacting saltating particles. A wide range of saltation processes are correctly predicted by our model, such as the wind shear velocity at the impact threshold (i.e., the lowest shear velocity for which saltation is possible), profiles of wind speed and particle mass flux, the size distribution in saltation, and the aerodynamic roughness length. Our model is the first to reproduce such a wide range of experimental data. Since we utilize a minimum number of empirical relations, our model can be easily adapted to study saltation under a variety of physical conditions, such as saltation on other planets, saltation under water, and saltating snow. Moreover, we aim to use our model to develop a more physically based dust emission scheme for use in climate models.