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Tracking signal propagation through landscapes using a granular avalanching system

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Landscapes have the ability to transmit environmental signals or inhibit them. The mechanisms by which landscapes do this are largely unquantified, but is probably due to the ability of landscapes to transiently store and release sediment which acts as a medium for energy to propagate. Previous experiments using 1D avalanching rice piles suggest that stochastic collapses can overprint, or shred, periodic sedimentary signals (Jerolmack and Paola (2010), as measured using mass efflux from the experimental rice pile. Jerolmack and Paola (2010) defined a threshold for successful surface signal propagation: Tx, where signals with a period less than Tx are shredded, unless the magnitude of the signal is sufficiently large. We aim to utilise the rice pile to further investigate signal propagation across a landscape, and the thresholds for this, by quantifying inter-particle interactions and the mechanics of how signals propagate using a quasi-2D rice pile model, built using MFiX-DEM code. This open source, physics model utilises individual particles which compose the solid phase whilst treating the fluid as a continuum. The rice grains in the model are represented by spherical particles, where each individual particle, or cluster of particles, can be tracked through each time step using a coordinate axis system, allowing internal dynamics, such as avalanche sizes and sediment residence times, to be quantified. To certify the model replicates the self-organised nature of an experimental rice pile, sensitivity tests were performed by systematically changing two key parameters controlling grain interactions: the friction coefficient and the coefficient of restitution, alongside the sediment flux. To calibrate the results of the sensitivity analysis, mass efflux through time and the corresponding power spectra are compared to real experimental rice pile results and statistical rice pile models. It is hoped this work will provide fundamental insights into how a signal propagates through a landscapes, and how they are shredded in the process.