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Martian aeolian slipface dynamics: 3D airflow modelling and sediment surface changes

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In December 2015, the Curiosity rover relayed images of the Namib dune slipface in Gale Crater and presented a unique opportunity for direct comparison to terrestrial aeolian dynamics. These images delivered critical ground truth data of martian aeolian dynamics improving morphometric studies of slipface grainflow activity and aeolian modelling. The Namib dune slipface images reveal many comparable grainflow morphologies to that of terrestrial slipfaces suggesting similar mechanisms for sediment transportation and dune migration. However, much is still unknown about the specifics of martian dune migration including possible 'seasonality' of activity, the contribution of actively migrating ripples to sediment redistribution, and estimates of sediment volume moved annually. One of the leading goals in investigating aeolian processes on Mars is to explore the boundary conditions of sediment transport, accumulation, and dune morphology in relation to wind regime as well as to quantify migration rates and sediment flux.

We plan to address these goals by combining terrestrial field observations, 3D computational fluid dynamics (CFD) modelling and remote sensing data. Complex, small scale wind patterns and grainflow processes on terrestrial and martian dunes will be investigated to constrain grain flow magnitudes and frequencies that occur on slipface slopes of dunes to improve estimates of martian dune field migration and sediment flux related to wind velocity and flow patterns. Using CFD modelling, we will investigate the interaction between wind velocity, flow patterns and sediment transport at the bedform scale using real wind data collected on Mars to provide a way to examine potential triggers of processes on slipface slopes of dunes.

A series of ground-based, high resolution laser scans have been collected in the Maspalomas dune field in Gran Canaria, Spain to investigate grainflow frequency, morphology and slipface advancement. Analysis of these laser scans and simultaneous video recordings have revealed a variety of slipface activity. Terrestrial studies of slipface advancement and dune migration have identified mechanisms for triggering grainflows such as lee slope destabilization due to over steepening from grainfall accumulation and complex, turbulent airflow patterns on the slipface. The high preservation of a variety of seemingly fresh grainflow morphologies on the Mars Namib slipface may indicate that grainfall is not a primary mechanism in triggering grainflows since grainfall along with reptation is responsible for rebuilding the slipface angle of repose before another grainflow is triggered.

We plan to investigate the 3D surface dynamics of the Bagnold dune field in Gale Crater using CFD modelling to look at the interaction between wind velocity, flow patterns and sediment transport and potential slope destabilization mechanisms. This study will aim to show potential triggers of processes on dune slipface slopes including, grainflows, formation of alcoves and advancement of the slipface.