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Surface-Based 3d measurements of aeolian bedforms on Mars

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The surface of Mars hosts many different types of aeolian bedforms, from small wind-ripples with cm-scale wavelength, through decametre-scale "Transverse Aeolian Ridges" (TARs), to km-scale dunes. To date, all mobile Mars surface-missions ('Rovers') have encountered aeolian bedforms of one kind or another. Aeolian deposits of loose, unconsolidated material provide hazards to Mars Rovers: sinkage into the aeolian material and enhanced slippage can prevent traction and forward progress, forcing the Rover to backtrack (e.g., MER Opportunity) and can even 'trap' the rover ending the mission (e.g., MER Spirit).

Here, we present morphometry measurements of meter-scale ripple-like bedforms on Mars, as observed by the MER Opportunity Rover during its traverse across the Meridiani Planum region of Mars. The aim is to assess whether there is a relationship between bedforms parameters that can be measured from orbit such as length and width, and bedform height, which can only be reliably measured from orbit for larger features such as TARs. If such a relationship can be found, it might allow estimates of ripple-height to be made from remote sensing data alone. This could help understand the formation mechanism and provide a better characterization of the hazard presented by these features.

For much of the first 30 km of the traverse, Opportunity travelled across flat plains with meter-scale, ripple-like aeolian bedforms ("plains ripples") superposed upon them. During the traverse, the Rover acquired stereo imaging data of its surroundings using both its scientific Pancam cameras system and the navigational Navcam system. Using these data, and newly developed Pro3D™ and PRoViP™ software from Joanneum Research, we obtained Digital Elevation Models of many areas along the traverse, allowing us to measure the heights, widths and lengths of aeolian bedforms. In addition, the same bedforms were digitized from orbital HiRISE image data (25 cm/pix resolution) in ArcGIS software to check for agreement between the ground-based and space-based measurements.

We found that there is a clear correlation between bedform height and bedform length (as measured perpendicular to the bedform ridge crest and thus, by inference, parallel to the bedform forming wind). We find that bedform height is about 1/15th of bedform length (or bedform wavelength where bedforms are "saturated") – in agreement with terrestrial measurements of granule ripples. This relationship, and the distribution of bedforms heights observed for different bedforms lengths, can be used to provide a probabilistic method of determining the height distributions of bedforms in a given area, simply by measuring their lengths from orbit. This will be useful for determining traversability by Rovers, and so is helpful both for landing site selection and strategic planning of Rover routes.