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Aeolian Transport in Coprates Chasma, Valles Marineris.

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Abstract

One of the most conspicuous active surface processes on Mars is aeolian transport (the movement of particles by wind), which has the potential to transport large volumes of sand across the martian surface, forming ripples and dunes of various morphology. In this study, we attempt to quantify the wind speeds occurring in Valles Marineris by measuring dune migration.

1. Introduction

Aeolian processes are the main agent of sediment transport on Mars. The wind is responsible for both the creation of landforms and erosion of the surface, thus shaping the martian landscape we see today. Aeolian landforms such as sand dunes, can aid our understanding of annual and seasonal climatic variations, such as changes in wind speed [1]. Dune fields on Mars have been observed to migrate, providing information about saltation [2, 3]. Although saltation is harder to initiate on Mars than Earth, because strong winds are rarer, once saltation is initiated, the sand flux is higher on Mars and so saltation is more easily maintained [4]. Saltation flux is one of the main controls on dune migration [5]. Migrating dunes illustrate that there are active winds occurring over the entire planet.

1.1 Study Site

Our study focuses on sand dunes in the equatorial region of Mars in the eastern part of Valles Marineris. The study site is the Coprates Chasma dune field (Figure 1), which lies within the southern Coprates Chasma trough, which is 4000m deep. The dune field is ~1 km in length and ~0.5 km width, covering an area 111km^2, and contains both barchanoid and longitudinal dunes.

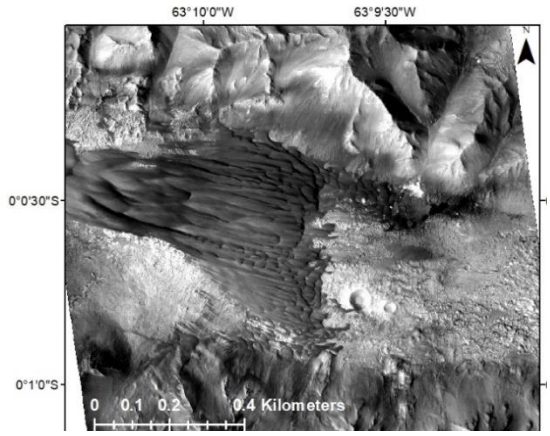

Figure 1. *CTX image F10_0396383_1658, showing the dune field at Coprates Chasma.*

2. Methods

We use a series of multi-temporal images from the Context Camera (CTX; 6 m/pixel [6]), with the Co-registration of Optically Sensed Images and Correlation (COSI-Corr) software package, [7] to measure the dune migration rates in the Coprates Chasma dune field over a 10 Earth year period (Figure 2). This should allow change across the dune field to be observed and a displacement rate to be calculated. Previous studies have used COSI-Corr with HiRise imagery due to the greater resolution; however, CTX has greater coverage in space and time, which is why CTX imagery has been chosen for our research.

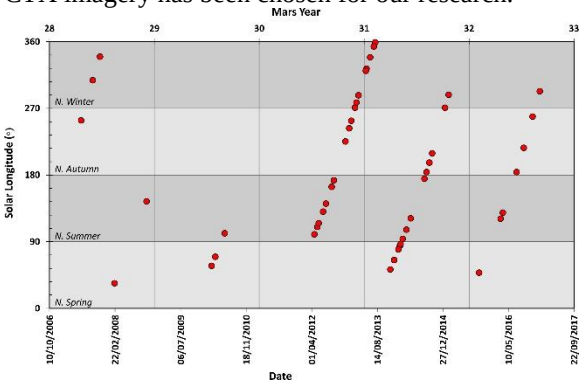

Figure 2*. CTX image coverage for our study area.*

2.1 Height and Dune Orientation Measurements

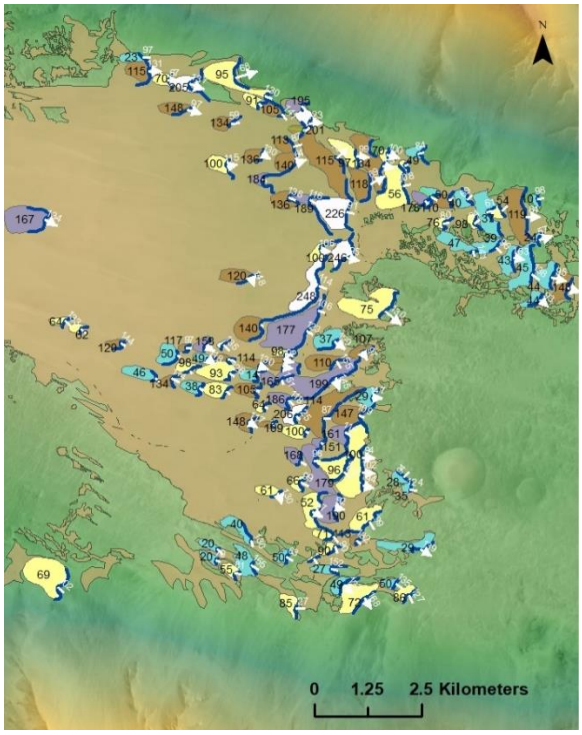

***Figure* 3**. *Outline of the dune field with the measured heights of individual dunes shown. Dunes are colour coded based on the height measurement. 0-50m blue, 51-100m yellow, 101-150m brown, 151-200 purple and 201-250m white. The white arrows show the orientation of the dune.*

Height measurements of the dunes have been taken to aid calculation of the sand flux that is occurring in this region. Dune heights in the dune field range from 10m to 248 m. These measurements were calculated from a CTX stereo-derived digital terrain model (DTM). We also measured the orientation of the dunes: the majority of the dune slipfaces have a south-east orientation (mean 113◦).

2.3 COSI-Corr

We have used CTX DTMs and orthorectified images in COSI-Corr to create preliminary displacement rate maps of the dune field. The images chosen cover a range of time scales (up to 10 years), to observe annual migration changes, as well as potential seasonal migration.

The displacement rate maps provide the measurements needed to calculate annual migration rate of the dunes. Previous studies have calculated annual migration rates on the order of 1-10 m/yr in Nilli Patera [2].

3. Summary and Future Work

We will use the displacement rate maps to measure dune migration in Coprates Chasma, which will then allow theoretical dune-forming wind speeds to be calculated. These results can then be compared to climate and atmosphere models to assess the wind regimes present in this area. This method can be applied to other areas in Valles Marineris to investigate the regional variations in the wind regimes. Furthermore, this method could be applied to bedform monitoring at future landing sites, providing an independent method of estimating wind speeds and sand fluxes, and which could then be used to assess their relative safety.

4. Acknowledgements

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