DUNE MIGRATION IN THE NORTH POLAR REGION OF MARS. M.C. Bourke[1] and E.J.R. Parteli[2], S. Byrne[3], and D. Berman[1]. [1]Planetary Science Institute, Tucson, Arizona mbourke@psi.edu, [2]Institute for Multiscale Simulation, University of Erlangen-Nürnberg, 91052 Erlangen, Germany. [3]Lunar and Planetary Laboratory, University of Arizona.

Introduction: It has recently been established that sand is mobile under the current Martian climate, including at the North Pole [1,2]. Here we present a detailed study of the morphometry and migration of barchan and dome dunes in the North Polar Region of Mars.

Study Area: The dunes are located at the head of an unnamed Polar Cavi located at 83.5°N, 118.9°E (Figure 1). Previous studies at this site have shown that the dunes are sourced from the Basal Unit exposed in the adjacent Cavi wall. In addition, the dunes are enriched with gypsum derived from the Upper Layered Deposits [3]. The dunefield is composed of barchan and barchanoid dunes that traverse a number of topographic steps away from the Cavi head wall.

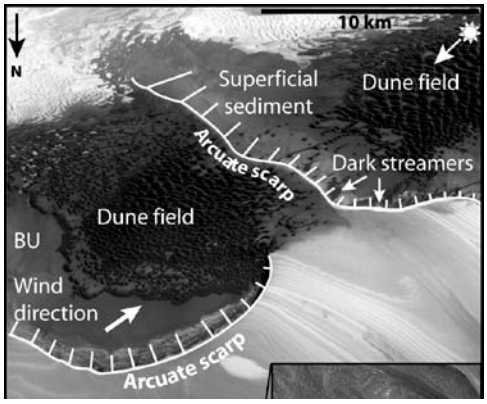

Figure 1. Location of the study area after Masse et al. (2010)

Methods: Dune width and length of 34 dunes were measured from 25 cm/pixel resolution HiRISE Images. In order to estimate dune heights, a HiRISE stereo pair was processed in ISIS and imported into BAE Systems Socet Set software. Multi-Sensor Triangulation was then used to solve for relative and absolute horizontal orientation (by measuring tie points) and the pair was then controlled to a MOLA DEM and MOLA Track points for vertical orientation. We were then able to extract true elevations for x,y points. The height of 22 dunes was estimated in this way.

Change in dune morphology and position was mapped using HiRISE images taken at two time steps. PSP_001593_2635 was taken November 28th 2006 and ESP_019143_2635 was taken August 27th, 2010, covering a total of 1.99 Mars years (3.75 Earth years).

In order to measure dune displacement distances, subsets of HiRISE images were cropped around individual sample dunes and georectified in ARC GIS. The interdune polygonal surface and rocks were used as tie points. Two measurements of displacement were made for each dune: the change in the dune centroid and the maximum advancement in the dune brink.

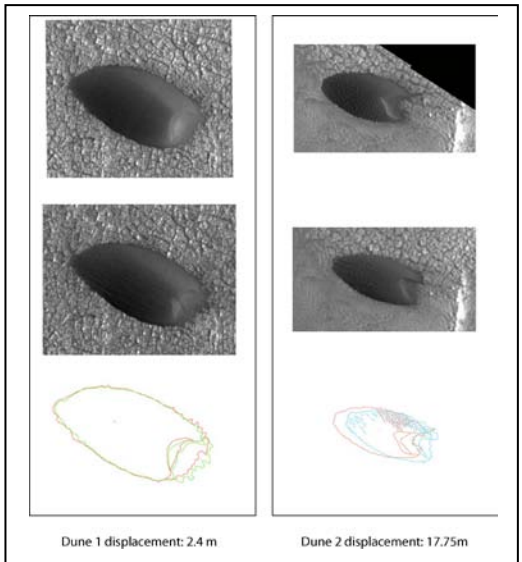

Figure 2. Example of displacement of two dunes. Between 2006 (top) and 2010 (bot)

Dune Simulations: We applied the dune model of Sauermann et al. [4-6] to reproduce the shape of the Cavi dunes. Our aim is to use the model to

estimate the average wind speed and grain size through comparing simulation results with morphology of the Cavi dunes.

This approach is similar to that of Parteli *et al.* [7], but with the difference that now the grain diameter (d) is an unknown to be determined from the modeling. In contrast to Parteli *et al.* [7] d was assumed to be 500 μm [8], while the interdune flux (q_{in}) was not known. Here we assume q_{in} to be 20% of the saturated flux (q_s), which is a reasonable value for fields of barchan dunes moving on the bedrock [9]. In summary, there are two unknowns we want to fit from the model results: the average shear velocity u_* of sand-moving winds at Cavi and the grain diameter d.

Results:

Dune Morphometry. Dunes are on average 170 m long and 121 m wide. Mean dune height is 18 m and is positively correlated with dune width (R^2 = 0.71). 68% of the sample dunes are asymmetric suggesting that, similar to Earth, barchan asymmetry is a morphological norm.

Dune Displacement. Although data are few, it has been established that asymmetric barchans migrate at rates comparable to non-asymmetric barchans in the same region [10]. Dunes at the Cavi sample site have migrated 5 m on average over 2 Mars Years. The individual dune rates are highly variable, measuring between 0.57 and 17.7 m. Dune displacement distances decrease with dune height, but the relationship is poorly correlated.

Dune Modeling: The threshold wind speed at Cavi estimated using the equation of [11] for d = 380 μm and Cavi atmospheric conditions is u_{*t} = 1.31 m/s. Using this value of u_{*t} and the pair d = 380μm, u_* = 2.33 m/s, the saturated flux $Q_s \approx 0.14$ kg m^{-1} s^{-1} — in comparison, on Earth $q_s \approx 0.015$ kg m^{-1} s^{-1} under typical u_* = 0.4 m/s. The bulk sand flux at Cavi is $Q_s = q_s/[0.62\rho_{grains}] \approx 2237.4$ m^2/year.

Conclusion:

● Dunes in the North Polar Region are migrating under the current climate regime.

● Rates are variable and may be influenced by topography, proximity to other dunes but not dune form.

● The smallest dunes have migrated the greatest distance. These include both dome dunes and dunes that are transitional forms between dome and barchan.

● Modeling of dunes using observational data from Mars can be used to obtain information on grain diameter and wind speed.

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