DOCUMENTATION OF RECENT SURFACE WINDS ON SMALL SAND DUNES WEST OF MARS' HELLAS BASIN. Z.Y.C Liu[1] and J. R. Zimbelman[2], [1]Department of Geological Sciences, Brigham Young University, Provo, UT 84602; *zacqoo@byu.edu*. [2]CEPS/NASM, Smithsonian Institution, Washington, DC, 20013-7012.

Introduction: The High Resolution Imaging Science Experiment (HiRISE) provides the capability to obtain orbital images of Mars with a resolution of 25 cm/pixel [1,2]. HiRISE images are then of sufficient resolution to record wind ripple patterns on the surfaces of sand dunes, which have been proven to be capable of providing valuable insights into aeolian erosion and deposition on Mars [3-5]. In this study, we mapped the sand ripple orientations and created surface process maps to evaluate the recent wind flow over the dunes. The results of local wind flow studies are expected to facilitate the research on martian wind modeling and atmospheric circulation modeling. Notably, this study was conducted in an attempt to expand upon the findings of Johnson and Zimbelman [4,5]. Instead of mapping small dunes globally [4,5], this study focused on producing more detailed geological maps in chosen regions. In addition, detailed maps with carefully examined dune morphology and sand shadows not only allow us to interpret the bimodal wind patterns (Fig. 1) [4,5] but also the actual wind orientations.

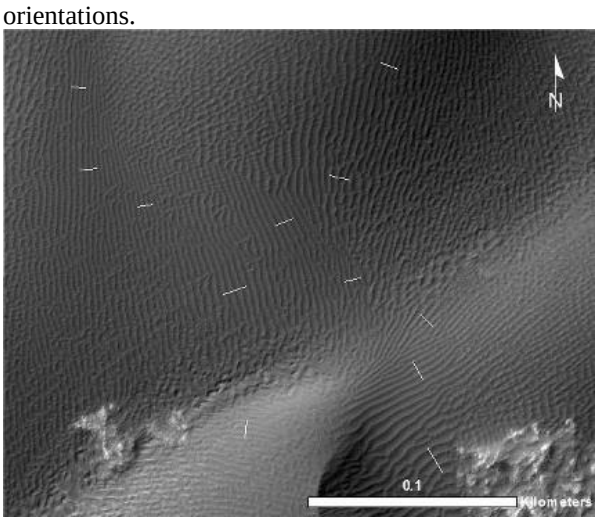

Fig. 1. Mapping method on sand ripples used by Johnson and Zimbelman (Figure 2 of [5]). Mapped white lines represent the length across three ripple crests, and are oriented to be perpendicular to these ripples.

Methodology: We adapt the mapping method of dunes on Earth, based on Nielson and Kocurek [6], and establish a procedure to (1) map sand ripples on Mars in HiRISE images and (2) interpret the direction of wind and airflow. We first define the mapping units, which include primary crestlines, secondary crestlines, ripple marks, transverse aeolian ridges (TARs), frost (when present), wind direction and inferred airflow (Fig. 2). To distinguish mapping ripples from TARs TARs typically have wavelengths of 20 to 60 m [7], while ripples have wavelengths < 10 m. We incorporate a HiRISE image into ArcGIS and create shapefiles for lines and polygons. Lines are drawn to trace the ripple crests and dune crestlines. Polygons are drawn to define the frost boundaries. We standardize (1) the ripple symbol to capture pattern variations without substantial over-sampling: each ripple symbol is mapped with a spacing of 60-100 m and with the length of 60-100 m, and (2) the density of ripple marks (DR), where DR = total length (m) / dune areas (m^2) ~ 5-7 (100 m/m^2). We followed a similar standard to map TARs. Then, we map airflow and wind direction according to the ripple marks. Airflow is shown by a long arrow with an arc shape and wind direction is a short arrow. Both attributes are interpreted and mapped perpendicular to ripple marks. Each wind direction mark is defined by three ripple marks. See fig. 2 for an illustration of these units on HiRISE image.

The line orientation gives azimuth [4]. We extract the azimuths from shapefiles of crestlines, ripple marks and wind direction to create rose diagrams (Fig. 3), which are length-weighted by division into segments of constant orientation. Rose diagrams highlight the dominant orientation of crestlines, ripple marks and wind directions.

Results: The initial effort of this study has included mapping sand ripples in HiRISE image ESP_019702_1295, which covers a sand field west of the Hellas Basin. This image is centered at 50.075^o S latitude, 32.621^o E longitude with 50 cm/pixel resolution, and was taken on Oct 9 of 2010 during northern summer (Ls = 161.4^o). We used this HiRISE image to establish the mapping procedure to create (1) a detailed surface process map with interpreted wind direction and simplified airflow (Fig. 2) and (2) rose diagrams of crestlines, ripples and wind directions (Fig. 3 Additional dune sites will be chosen near the Hellas Basin in order to compare the surrounding areas and test the feasibility of the established mapping procedure developed in this project. Ripple patterns will provide valuable information about recent wind flow and the identification of areas with wind patterns.

Discussion: The shape of dunes and location of frost suggest that the local wind flow direction was from south to north. Based on rose diagrams of crestlines, ripples and wind direction, interpreted local wind direction is strongly correlated with the dune

crest orientation in this region. Future work will undertake more rigorous statistical analyses to examine the correlation between wind direction and crest orientation. By analyzing small martian dunes in HiRISE images, wind regimes in these areas can be inferred and compared to current terrestrial and martian wind models.

This project was carried out while ZYCL visited the National Air and Space Museum during the summer of 2013, supported by funds from NASA MDAP grant NNX12AJ38G.

References: [1] McEwen, A.S., et al. (2007) *JGR, 112*, E05S02. [2] McEwen, A.S., et al. (2010) *Icarus, 205(1)*, 2-37. [3] Bridges, N.T., et al. (2007) *GRL 34*, L23205. [4] Johnson, M. B. and Zimbelman, J.R. (2013) *LPS 44th*, Abstract #2111. [5] Johnson, M. B. and Zimbelman, J.R. (2014) *LPS 45th*, Abstract #1518. [6] Nielson, J. and Kocurek, G. (1987) *Geological Society of America Bulletin 99*, 177-186. [7] Wilson, S.A. and Zimbelman, J.R. (2004) *JGR, 109*, E10003.

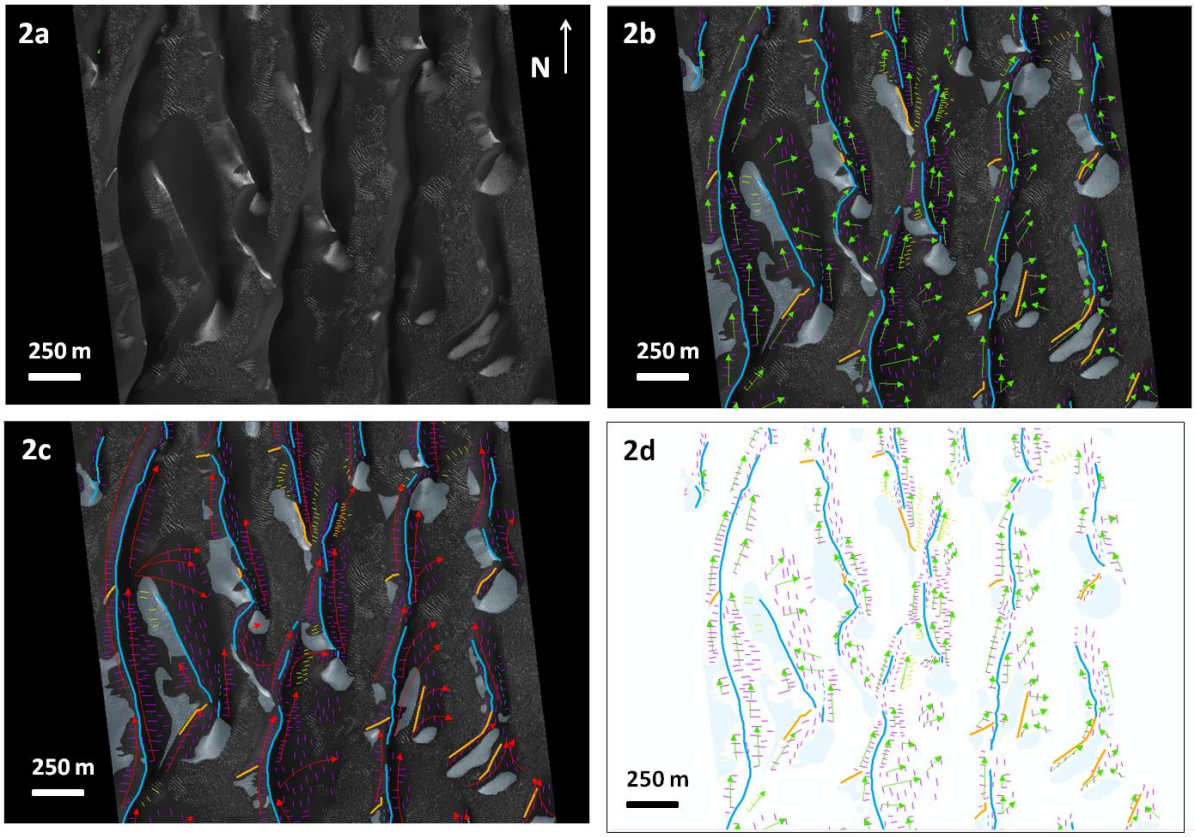

Fig. 2. Surface process map in HiRISE image ESP_019702_1295. Geological units and legend show in the left side. (a) HiRISE raw image, (b) image mapped with crestlines, ripples, TARs, frost, and interpreted wind direction, (c) mapped with crestlines, ripples, TARs, frost, and interpreted airflow, (d) crestlines, ripples, TARs, frost, and interpreted wind direction; without HiRISE image background.

Fig. 3.

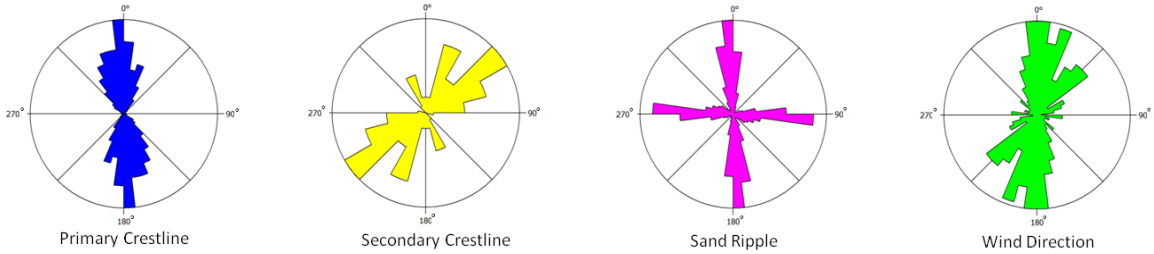

Fig. 3. Rose diagrams of primary crestline, secondary crestline, sand ripple and interpreted wind direction, which indicate that interpreted local wind direction is strongly correlated with the dune crest orientation in this region.