INVESTIGATION OF SMALL-SCALE (<50 M), WIND-DRIVEN SURFACE FEATURES ON MARS' NORTHERN POLAR CAP USING DATA FROM HIRISE. T. Giang Nguyen[1], J. Radebaugh[2], A. Innanen[1], J. E. Moores[1]. [1]Center for Research in Earth and Space Science, Department of Earth and Space Science, York University, 4700 Keele Street, Toronto, ON M3J 1P3 Canada (giang@yorku.ca). [2]Department of Geological Sciences, Brigham Young University, S-389 ESC, Provo, UT 84602 USA.

Introduction: Surface features such as dunes and ripples give insights into atmosphere and surface interactions. Aeolian activities have been widely documented on Mars in regions such as Nili Patera [1], Kaiser and Rabe Crater [2].

In this research, we focus on the Northern Polar Layered Deposits (NPLD), particularly for small-scale (<50 m) features. Using images from the High Resolution Imaging Science Experiment (HiRISE), we identify interesting aeolian patterns and analyze them via a 2D Fast Fourier Transform (FFT). We find that analysis of the orientation and spacing of small-scale dunes and ripples is useful in determining wind flow or erosion and deposition on the NPLD.

Methods: We first look at various HiRISE images, whose resolution can reach 25 cm/ pixel, and identify interesting patterns where smaller frames showcasing the patterns can be extracted. Aeolian-driven features exhibit regular trends in spacing and orientation, which make them good candidates for application of a Fourier transform. This is used to find prominent ridge wavelengths and the directions in which these waves travel.

The spacing and orientation of the features was determined by the 2D FFT [3]. To calculate the spacing, noise was randomly simulated, and subsequently we compared the power spectra of both the data and the noise. The spacing is determined to be the wavenumber that has the biggest difference in the power spectra between the HiRISE data and the noise, as shown in Figure 1.

Orientation was determined by isolating the wavenumber with the peak power from the HiRISE FFT analysis. The direction that has the highest power contribution would then be the orientation tendency of the patterns from the extracted HiRISE data. In this way, we were able to extract the orientations of dune and ripple crests from the FFT model.

Results: We looked at 499 HiRISE images spanning the NPLD and extracted 559 frames that showed interesting features. Features morphologically characteristic of aeolian activities account for 69% of the frames extracted. These features include dunes, ripples, star/complex dunes, and transverse aeolian ridges (TARs). The mapping of the aeolian features across the NPLD is shown as Figure 2.

The average dune spacing across the entire NPLD in this study is 15.43 m while the average ripple spacing is 7.51 m. By isolating aeolian features likely to be formed by unimodal wind such as transverse dunes and ripples, we can find a dominant inferred wind direction, shown as Figure 3.

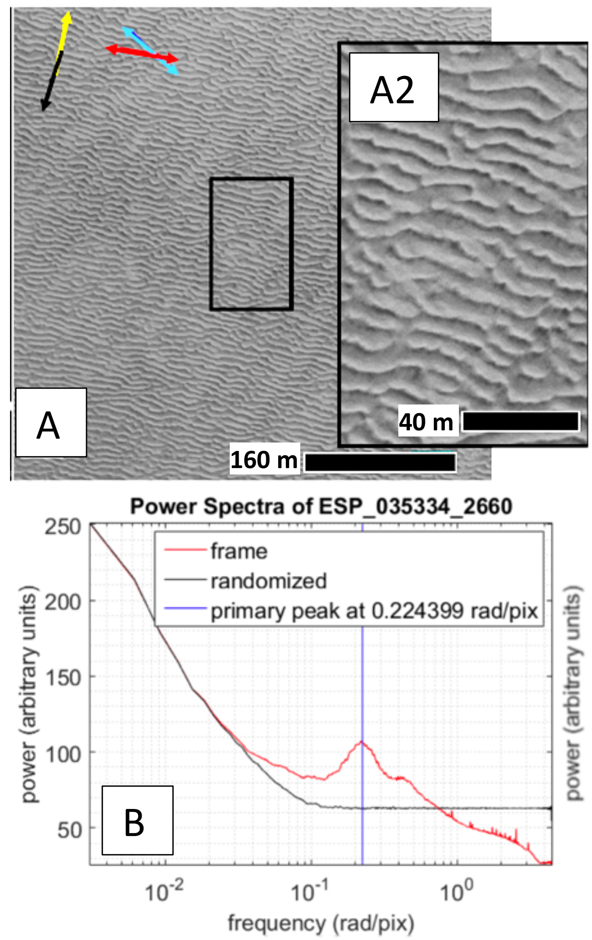

__Fig. 1:__ Panel A shows an extracted frame from HiRISE image ESP_035334_2660 where the yellow arrow points to the sun while the black points North. The red double-headed arrow is the inferred orientation tendency of the features while the blue shows the nearest kilometre-scale troughs orientation. Panel B shows the power spectra from the FFT of the original frame and "randomized" noise.

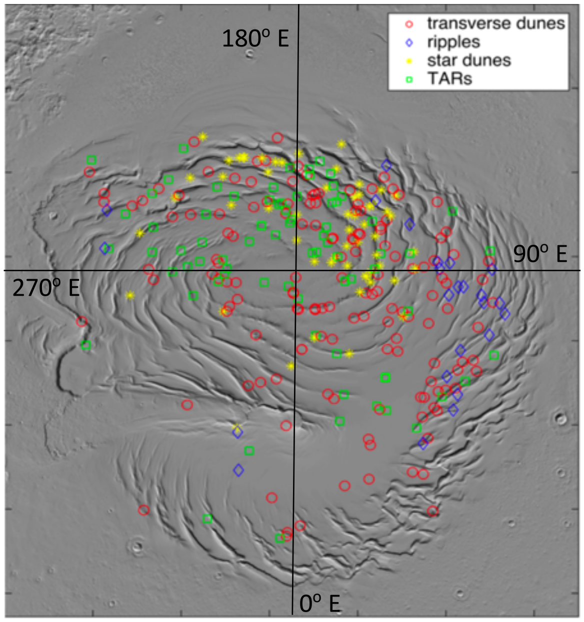

Fig. 2: *Mapping of aeolian features on the NPLD*

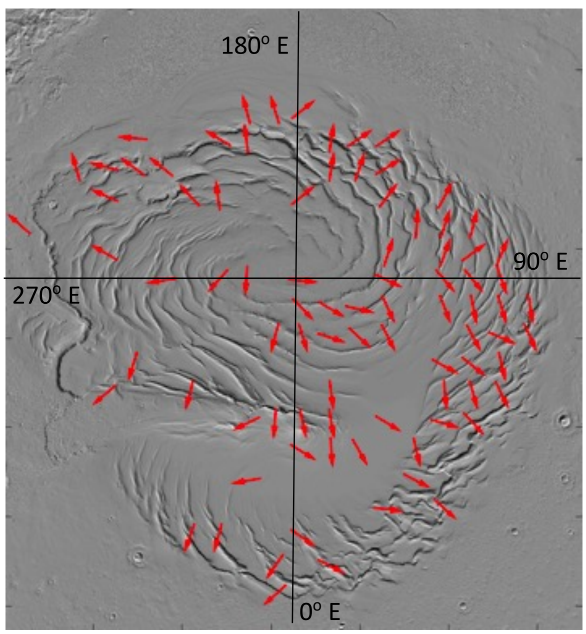

Fig. 3: *Figure shows inferred wind directions from the inferred orientation of dunes and ripples*

Discussion: On the cap from 180° – 90° E, there are more observations of aeolian landforms, although this might be affected by HiRISE coverage. Ripples tend to be located on the edge of the cap while star dunes are observed to concentrate on the cap from 120° – 240° E (Fig. 2).

Wind directions inferred from dunes and ripples tend to be perpendicular to the kilometre-scale troughs on the NPLD. This is consistent with the origin of the landforms resulting from katabatic, or cold, density-driven, winds that generally flow from the pole across the troughs [4]. However, regions where star dunes are prevalent suggest multi-directional winds are present.

Some ripples were observed to change orientations at different proximities with respect to the large NPLD troughs. Ripples close to the trough are seen to align parallel to the trough while ripples farther away become more perpendicular to the trough. This change of ripple orientations may be caused by katabatic jumps that induce sharp changes in wind conditions [6].

While dunes elsewhere on Mars are hundreds of metres in size [2], dunes on the NPLD are observed to be smaller, closer to the tens of metre scale. This may be caused by differences in grain composition and physical processes unique to the NPLD, such as the sublimation of water and CO_2. However, metre-scale wind ripples observed by NASA's Curiosity rover [5] are prevalent on the NPLD.

There are small, metre-scale features embedded in larger, wind-driven, hundred-metre scale features, each with a distinct orientation. If the smaller features are aeolian in origin, this suggests different but coexisting regimes of aeolian processes, or that the two features formed at different times. If the features are not aeolian-driven, this opens up the possibility of other processes, such as sublimation, which produces ice ridges named penitentes, with analogous features found on Pluto [8].

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