VARIATIONS IN SURFACE TEXTURE OF THE NORTH POLAR RESIDUAL CAP OF MARS. S. M. Milkovich[1] S. Byrne[2], P. S. Russell.[3] [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA, 91011, sarah.m.milkovich@jpl.nasa.gov [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ; [3]Center for Earth and Planetary Studies, Smithsonian Institution, Washington DC.

Introduction: The northern polar residual cap (NPRC) of Mars is a water ice deposit with a rough surface made up of pits, knobs, and linear depressions on scales of tens of meters [1]. This roughness manifests as a series of bright mounds and dark hollows in visible images; these bright and dark patches have a characteristic wavelength and orientation (Fig 1). Spectral data indicate that the surface of the NPRC is composed of large-grained (and therefore old) water ice. Due to the presence of this old ice, it is thought that the NPRC is in a current state of net loss of material [2] a result potentially at odds with impact crater statistics, which suggest ongoing deposition over the past 10-20Kyr [3].

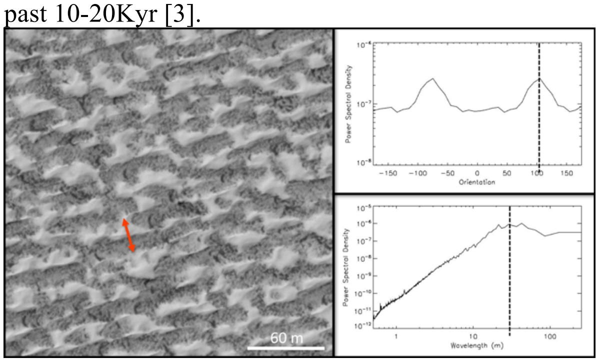

Figure 1*: North Polar Residual Cap material. Left: subframe of HiRISE image ESP_018598_2745. Red arrow indicates the orientation and wavelength results of FFT analysis. Upper right: result of orientation analysis; dotted line indicates dominant orientation. Lower right: result of wavelength analysis; dotted line indicates dominant wavelength.*

The NPRC provides a link between the current martian climate and the historical climate recorded within the layers of the underlying north polar layered deposits. By characterizing and mapping the variations in surface texture of the NPRC, we seek to understand what factors (distance from the pole, wind direction and strength, etc) are currently at work in resurfacing the deposit, and may have been at work in shaping the layers below.

Methods: The quasi-regular spacing of the depressions and knobs that make up the NPRC surface texture lends itself to quantitiative, automated analysis via two-dimensional Fourier analysis. This technique reconstructs an image using many sinusoidal functions of varying wavelengths and power; the functions that have wavelengths and orientations matching patterns within the image will have more power.

Maps of NPRC texture wavelength and orientation are produced from images taken by the High Resolution Imaging Science Experiment (HiRISE) onboard Mars Reconnaissance Orbiter (MRO). 65 HiRISE images have been analyzed thus far; these images were acquired over an Ls range of 65° to 161°.

2D FFT analysis is performed upon two 256 meter x 256 meter regions (corresponding to 512 x 512 pixels in 0.5 cm/pxl images, or 1024 x 1024 pixels in 0.25 cm/pxl images) within each image analyzed. The dominant wavelength of the resulting peak power spectrum corresponds to the average size of a pit-knob pair in the image, and so is a proxy for the scale of the surface roughness. The orientation of the surface roughness (i.e., the trend of a chain of pits and mounds) is measured from a narrow range of wavelengths encompassing the dominant wavelength. An example can be seen in Fig. 1. Results for both locations examined within an image are consistent ~80% of the time.

Orientation Results: Images located near troughs tend to have surface textures that trend in the same direction as the troughs. However, images located in the polar flats (i.e., Gemini Lingula and the polar dome) do not have any general trend (Fig 2).

Howard [4] examined the orientations of frost streaks in Viking imagery to infer the direction of the wind around the polar deposits. When we compare these results to our orientation results, we see that near the troughs, the wind tends to run perpendicular to the surface texture orientation (Figure 2). Thus, wind direction may have an influence on texture orientation. However, there is no general relationship between surface texture orientation and wind direction away from the troughs, so wind direction cannot be the only factor determining texture orientation.

Wavelength Results: No trends were observed when comparing wavelength results to solar azimuth or incidence angle. However, wavelength roughly tends to increase with increasing elevation (Figure 3). Due to the shape of the polar dome, higher elevation is correlated with higher latitude. Thus, ablational processes may have a role in controlling the size and spacing of the NPRC surface texure.

Seasonal dependence. Five locations were observed at multiple Ls within a single year. Generally images show an increase in wavelength with Ls until ~130°, at which time the wavelength decreases slightly with Ls (e.g., Fig 4). The location closest to the pole shows decreasing wavelengths before Ls 120, but only two images were analyzed at this location.

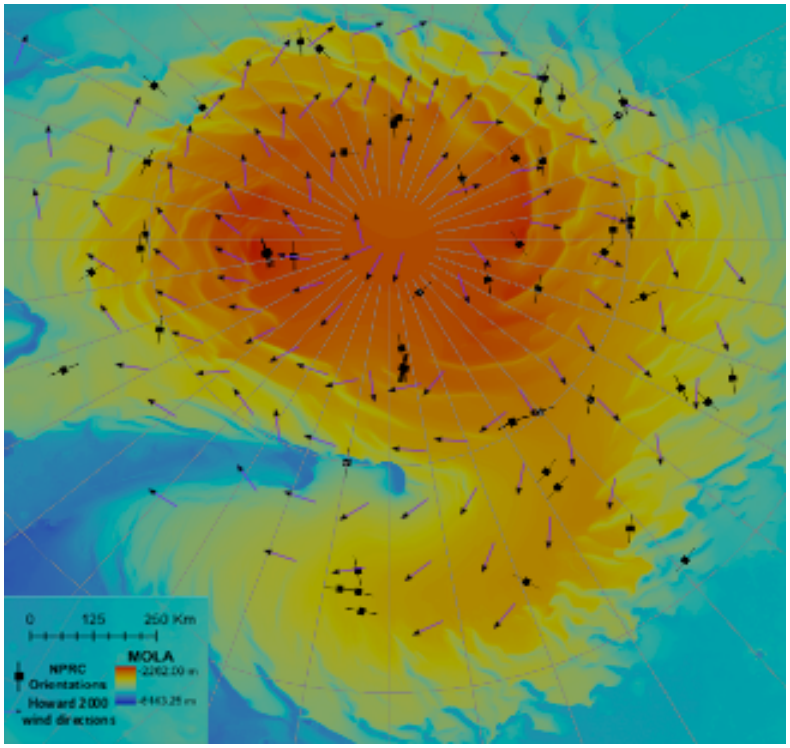

Fig 2*: Orientation results (black lines) and wind directions inferred from frost streaks in Viking images by [4] (purple arrows).*

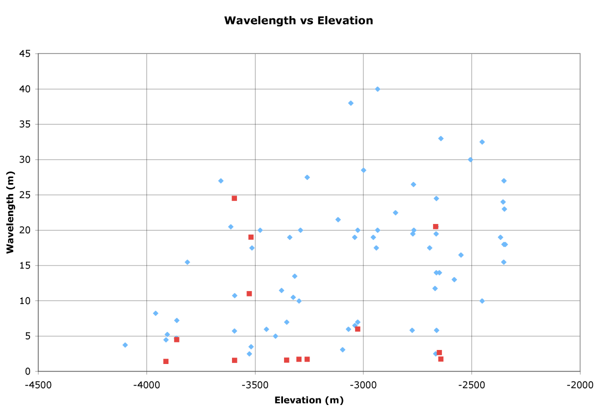

Fig 3. Wavelength vs Elevation. Several locations contained two wavelengths; second wavelength indicated in red.

We speculate that in northern spring and early summer, perennial CO_2 frost may be covering portions of the surface and changing the apparent wavelength of the surface texture. No one factor is able to fully explain the orientation and wavelength features observed in the NPRC. It is probable that many processes are at work shaping the surface texture, and thus their effects are tangled together. Surface frost, elevation or latitude, and wind direction appear to have significant effects.

Future Work: We will begin to explore the factors shaping surface texture by including a new parameter in this analysis: distance from nearest trough. This will allow us to examine the effect of regional topography on surface texture. In addition, comparisons will be made to recent maps of surface brightness from MARCI [e.g., 5]. Variations in local albedo within a single year have been observed with MARCI; we will compare the seasonal progression of our results with the MARCI observations at locations where these variations are seen and locations where they are not.

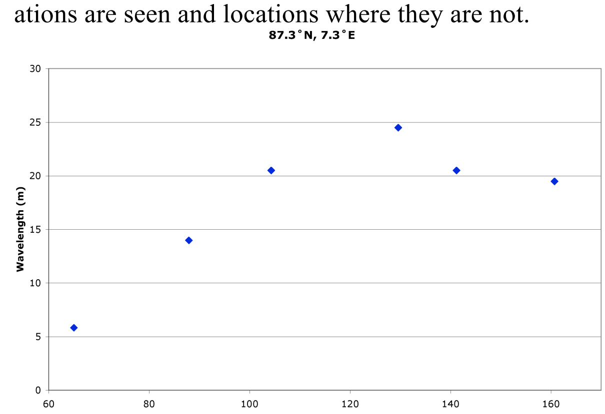

Fig. 4. Wavelength vs Ls for a set of images at 87.3˚N, 7.3E.

References: [1] P. C. Thomas et al, Nature 404, 161-164, 2000. [2] Y. Langevin et al, Science 307, 5715, 1581-1584, 2005. [3] Banks et al., JGR, 2010 [4] A. Howard, Icarus 144, 267-288, 2000. [5]W. M. Calvin, et al, abstract 2401, LPSC, 2011.

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