HIRISE OBSERVATIONS OF RECENT PHENOMENA IN THE NORTH POLAR REGION OF MARS. K. E. Herkenhoff[1], S. Byrne[2], K. Fishbaugh[3], C. Hansen[4], M. Milazzo[1], M. Rosiek[1], P. Russell[5], and the HiRISE Team, [1]USGS Astrogeology Team, 2255 N. Gemini Dr., Flagstaff, AZ 86001 (kherkenhoff@usgs.gov), [2]LPL, University of Arizona, [3]CEPS, Smithsonian Institution, [4]Caltech/JPL, [5]Universität Bern, Switzerland.

Introduction: The High Resolution Imaging Science Experiment (HiRISE) on MRO has observed both polar regions throughout the spring and summer seasons on Mars. Full-resolution HiRISE images are typically 20,000 monochrome pixels (~6 km) wide with color data in the central 4000 pixels [1]. Here we summarize preliminary analyses of the data from MRO's primary science phase, focusing on active and recent processes including evolution of the seasonal caps, frost streaks, and the residual caps. HiRISE observations of north polar craters will be discussed by Banks *et al*. [2] and the stratigraphy of the north polar layered deposits will be discussed by Fishbaugh *et al*. [3].

Seasonal Processes: HiRISE has completed a campaign to image the sublimation of Mars' northern seasonal CO_2 polar cap throughout the spring and early summer. The images show a number of interesting phenomena associated with the dunes in the north polar erg, including slope streaks, circular defrosting features, and evidence for explosive gas release. Time-lapse sequences show how these features evolve through the spring as the seasonal frost disappears.

The vigorous activity associated with the sublimation of CO_2 mobilizes slope streaks, which are observed to lengthen as the season progresses, and promotes mass wasting from the crests of the dunes. Roughly circular albedo features associated with defrosting show alternating bright and dark rings. They are found preferentially at the crests of dunes and at the interface of the bottom of the dunes with the substrate. The brightness contrast is most pronounced early in the spring and gradually fades as more and more CO_2 ice is sublimed. Observations of the evolution of these features indicate that they are a surficial albedo effect, and are not due to underlying surface morphology. The degree of cementation of the substrate below the ice layer has a significant effect on sublimation features, indicating that material found on dunes, but not on the interdune surface, is mobilized (Fig. 1).

Some evidence for translucent CO_2 ice similar to the seasonal ice found at southern high latitudes has been found at northern sites by Piqueux and Christensen [4]. Dark and bright streaks are observed, with orientations determined by the prevailing wind. We have not observed the araneiform (spider-like) terrain with its radial channels as found in many locations in the south polar region. Frost-filled polygons are observed in the north polar region.

Figure 1. This color sub-image of PSP_007725_2600, centered at 80°N, 123°E, acquired at L_s = 47.5°, shows the difference in sublimation phenomena mobilizing loosely-consolidated dune material (right) and the ice-cemented substrate (left). Area shown is 1.2 km across, illumination from upper right.

North Polar Residual Cap: The north polar residual cap (NPRC) on Mars has long been known to be composed of water ice [5]. Based on Viking Orbiter and MRO Context image crater counts, the surface of the NPRC is only about 10,000 years old [2,6]. HiRISE images of the NPRC show few fresh craters [2]. Relatively dark patches observed within the NPRC during the summer indicate that the cap is very thin or very transparent in places. The correlation between topography and albedo at meter scales suggests that the NPRC is roughly a meter thick [7].

During processing of a stereo pair of HiRISE images to generate a digital elevation model, the stereo correlator was unable to find matching features in an area covered by the NPRC. Upon closer inspection, it became apparent that the appearance of this area had changed significantly in the 10 sols (Mars days) between the images (Fig. 2). These changes suggest that material on the NPRC is currently being redistributed, but the difference in solar illumination between the images cast doubt upon this conclusion. Therefore, a campaign of HiRISE observations of four NPRC tar-

gets near 87°N latitude (the maximum latitude of the MRO ground track) was undertaken during the Martian northern summer of 2008. The images acquired during this campaign, with nearly nadir viewing geometry and similar solar azimuth, do not show evidence for current redistribution of NPRC material. Hence, the resurfacing that is responsible for the paucity of fresh craters on the NPRC, which implies a resurfacing rate of at least 1 mm/yr [6], is not evident in HiRISE images.

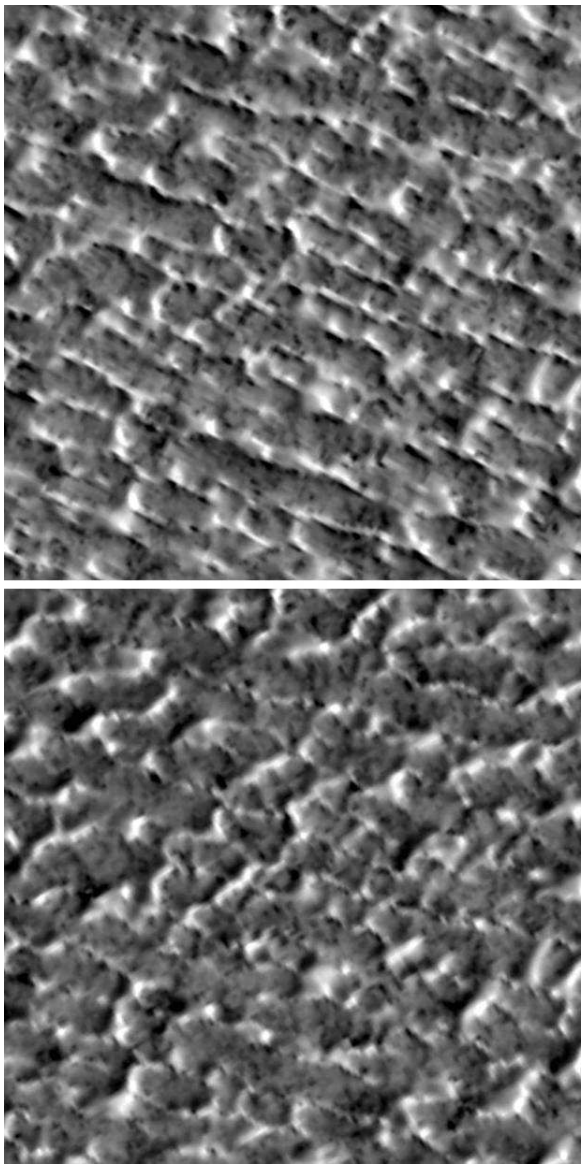

Figure 2. HiRISE images of part of the NPRC, taken 10 sols apart, showing apparent changes in surface topography. Each subframe is 200 m square, north is up. (top) Part of HiRISE image PSP_001738_2670, illumination from upper right. (bottom) Part of HiRISE image PSP_001871_2670, illumination from lower right.

This result is consistent with the average NPRC resurfacing rate: changes of a few mm in a season would not be visible to HiRISE. However, it is unlikely that the resurfacing rate is the same every year, as interannual variations in Martian weather (dust storms) are observed. We will therefore continue to monitor the NPRC for changes during the MRO mission.

Bright and dark streaks have been observed at the periphery of the NPRC by previous Mars orbiters and were the target of several HiRISE observations. Some of these HiRISE images (*e.g*., Fig. 3) indicate that formation of the streaks involves processes more complex than the emplacement of dark veneers as proposed by Rodriguez *et al*. [8]. Bright and dark streaks are seen to evolve during the northern summer, evidence for active eolian redistribution of frost and perhaps dark (non-volatile) material.

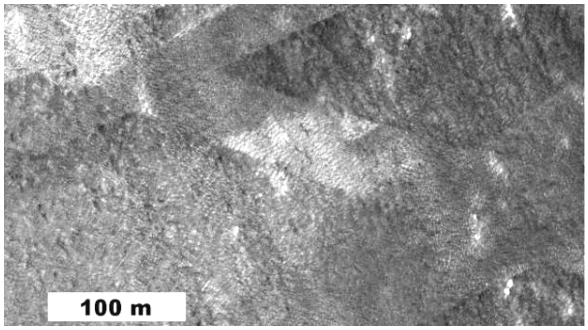

Figure 3. Part of HiRISE image PSP_009273_2610 of complex streak superposition at 80.8°N, 330.6°E.

The HiRISE seasonal imaging campaign of the north polar region has demonstrated the rapid nature of small-scale (<10 m) surface changes that occur. Such observations highlight the importance of both long and short-term monitoring of targets to further our understanding of time-variable phenomena in these regions.

Acknowledgement: This research was supported by NASA's Mars Reconnaissance Orbiter project.

References: [1] McEwen, A. S. *et al*. (2007) *JGR 112*, doi:10.1029/2005JE002605. [2] Banks *et al*. (2009) *LPS XL*, this volume. [3] Fishbaugh, K. *et al*. (2009) *LPS XL*, abstract #1998. [4] Piqueux and S., P. Christensen (2008) *JGR 113* E06005. [5] Jakosky, B. M. and Haberle R. M. (1992) In *Mars* (H.H. Kieffer *et al.*, Eds.), pp. 969-1016. Univ. Arizona Press, Tucson. [6] Herkenhoff, K. E. and Plaut, J. J. (2000) *Icarus 144*, 243. [7] Byrne *et al*. (2007) *LPS XXXVIII*, abstract #1930. [8] Rodriguez, J.A.P. *et al*. (2007) *Mars 3*, 29.