MRO HIRISE OBSERVATIONS OF RECENT PHENOMENA IN THE NORTH POLAR REGION OF MARS. K. E. Herkenhoff¹, S. Sutton², and the HiRISE Science Team, ¹U. S. Geological Survey Astrogeology Science Center (2255 N. Gemini Dr., Flagstaff, AZ 86001; kherkenhoff@usgs.gov), ²University of Arizona Lunar and Planetary Laboratory (1541 E. University Blvd., Tucson, Arizona, 85721).

Introduction: The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) has observed the north polar region of Mars during 6 summer seasons. Here we summarize analyses of the north polar data, focusing on active and recent processes including evolution of frost streaks, the north polar residual cap, and small pits on the north polar layered deposits (NPLD).

Full-resolution HiRISE images are up to 20,000 monochrome pixels (~6 km) wide with color data in the central 4000 pixels [1]. Such HiRISE images of the north polar region at scales of ~30 cm/pixel show morphologic details and reflectance variations indicative of currently- or recently-active processes. The observations discussed here highlight the importance of both long- and short-term monitoring of north polar targets to further our understanding of time-variable phenomena in this region.

North Polar Streaks: Bright and dark streaks have been observed at the periphery of the north polar residual cap (NPRC) by previous Mars orbiters and were the target of repeated HiRISE observations. The complex interactions between overlapping bright and dark streaks in some of these HiRISE images (Fig. 1) indicate that formation of the streaks involves processes more complex than the emplacement of dark veneers proposed by Rodriguez et al. [2]. Bright and dark streaks are seen to evolve during the northern summer, evidence for active eolian redistribution of frost and perhaps darker (non-volatile) dust or sand. But the sharp boundaries of the streaks remain unexplained.

Figure 1: Subframe of red HiRISE image PSP_009273_2610 showing complex streak superposition at 80.8°N, 330.6°E.

To constrain hypotheses for the formation of the crossing streaks, HiRISE has been observing the area shown in Fig. 1 during the early summer of multiple Mars years. Images acquired to date do not provide definitive evidence for formation mechanisms, but the most recently acquired images suggest that dark material has been mobilized.

Figure 2: Subframes, 300 m across, of HiRISE images of the north polar residual cap near 87°N, 270°E. (Top) Image taken at Ls = 143.7° in 2008. Average Lambert albedo = 0.46. (Bottom) Image taken at Ls = 142.4° in 2010. Average Lambert albedo = 0.40.
Residual Ice Cap: The NPRC on Mars has long been known to be composed of water ice [3]. Relatively dark patches observed within the NPRC during the summer indicate that the cap is very thin or very transparent in places. Counts of craters in MRO Context Camera (CTX) and HiRISE images indicate that the NPRC is accumulating at a rate that might result in observable changes in crater morphology during the MRO mission [4]. HiRISE and CTX images of the NPRC show few fresh craters. It is likely that NPRC resurfacing is temporally episodic rather than continuous, and that recent changes may be detectable at HiRISE image resolution. Therefore, a campaign of HiRISE observations of four NPRC targets near 87°N latitude (the maximum latitude of the MRO ground track) was initiated during the Martian northern summer of 2008 and continued through the summer of 2016. The images acquired during this campaign, with nearly nadir viewing geometry and similar solar azimuth, have been searched for evidence of current redistribution of NPRC material. Only minor albedo changes are observed (Fig. 2), consistent with the resurfacing rate discussed above.

Small Pits in the NPLD: Roughly circular pits about 1-5 m in diameter were first recognized on the NPLD in a HiRISE stereo pair (PSP_010198_2645 and PSP_010014_2645) near 84.4°N, 254.6°E. Similar pits were subsequently observed elsewhere on shallowly-sloping NPLD exposures; their depth/diameter is at least 0.53 [5]. More recent images indicate that new pits are forming in the discovery area, and that pit size varies seasonally (Fig. 3). Pit diameters appear to increase during early spring, followed by a decrease in size in late spring, suggesting that volatiles such as CO₂ are involved in modifying these features, but their origin is unknown. One pit disappeared during Mars Year 32 [5]. HiRISE monitoring of these areas of the NPLD continues, and will hopefully help to constrain hypotheses for their formation and evolution.

Summary: HiRISE and other MRO data show evidence for multiple types of ongoing activity in the north polar region, consistent with the apparent youth of the NPRC surface [4]. The latest HiRISE images of recently-active features will be shown and discussed at the conference.

References: