INTERANNUAL VARIABILITY OF ICE WITHIN NORTH POLAR LAYERED DEPOSITS CRATERS ON MARS.
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Introduction: The North Polar Layered Deposits (NPLD) on Mars are layers of dusty ice that have long been postulated to contain a readable climate signal [1]. Much work has gone into understanding this possible climate signal [e.g., 2-5], but the current mass balance of the North Polar Residual Ice Cap (NRIC, widely to be considered the currently forming layer of the NPLD) is not known. Evidence suggests it could be gaining or losing mass [e.g., 6, 7]. Thus, a fundamental process in linking the current climate to current NPLD/NRIC behavior is currently not well understood.

The High Resolution Imaging Science Experiment (HiRISE) aboard the Mars Reconnaissance Orbiter (MRO) has been imaging the martian surface for over seven Mars Years (MY). Images of some small (< 250 m diameter) impact craters on the NPLD [8, 9] indicate they host bright interior deposits. Their seasonal and interannual persistence suggests water ice to be a major component. Measuring the changes in these bright crater interiors could shed light on the present-day mass balance of the NRIC.

In this abstract, we present examples of data for these craters over the timespan of the MRO mission, and describe changes within these craters.

Previous predictions of crater ice-fill changes: Based on the lifetimes of craters on the NRIC calculated in previous work [8, 10], pixel-scale changes in HiRISE images could be detectable over the course of MRO's mission lifetime. This assumes infill of bowl-shaped craters at a uniform rate. An examination of the available data is needed to determine if small changes have occurred, and if they are linked to location or atmospheric events, like planet encircling dust events.

Crater monitoring sites: We identify a total of 21 sites on the NPLD that have ice-filled craters (Fig. 1). Based on data availability, there are 9 sites with digital terrain models (DTMs) from HiRISE stereo pairs that were useable for in-depth study. The other 12 craters have less complete interannual coverage and no stereo pairs at time of writing, making the generation of quantitative interpretations from orthorectified images not possible. However, these sites provide key context for the detailed study sites and are included in the overall analysis.

Interannual variability: In order to initially quantify interannual variability, we examine several sites in successive Mars years of HiRISE data. While incidence angle and solar longitude (L_s) do vary between images, we have reduced this by matching the L_s (within ~10 degrees) and lighting conditions (using the HiRISE HiKER tool) as closely as possible in MY 34 and subsequent images.

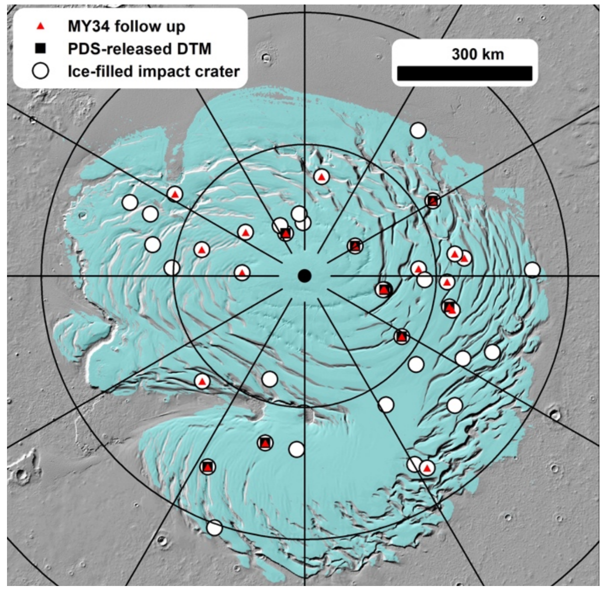

Fig. 1. Map of the locations of NPLD craters of interest in this work. Background: MOLA hillshade topography. NPLD/NRIC extent as defined in [8].

Craters in Site 17 (a ~59 m diameter crater at 85.64 N, 57.94 E) and Site 4 (a ~157 m diameter crater at 81.85 N, 333.08 E) from [9] are shown in Fig. 2 and Fig. 3. Both show changes to the bright deposits on the crater floors. However, the extent of these changes varies. Site 17 has a large bright deposit relative to the crater floor and shows consistent changes especially around the margins of the bright deposit over the Mars years it was observed. However, Site 4 has a smaller bright deposit relative to the crater interior, including bright material in two nearby small secondary features. Both Site 17 and Site 4 have pre-existing DTMs and will be targets for further quantified study that we will report on at the conference.

This preliminary assessment does find significant changes in icy crater fill, which indicates that within craters, the NPLD has accumulated new material within the last few thousand years [8, 9]. Whether or not this net accumulation is due to the lower temperatures within small craters or representative of surrounding NPLD terrain is the subject of future study.

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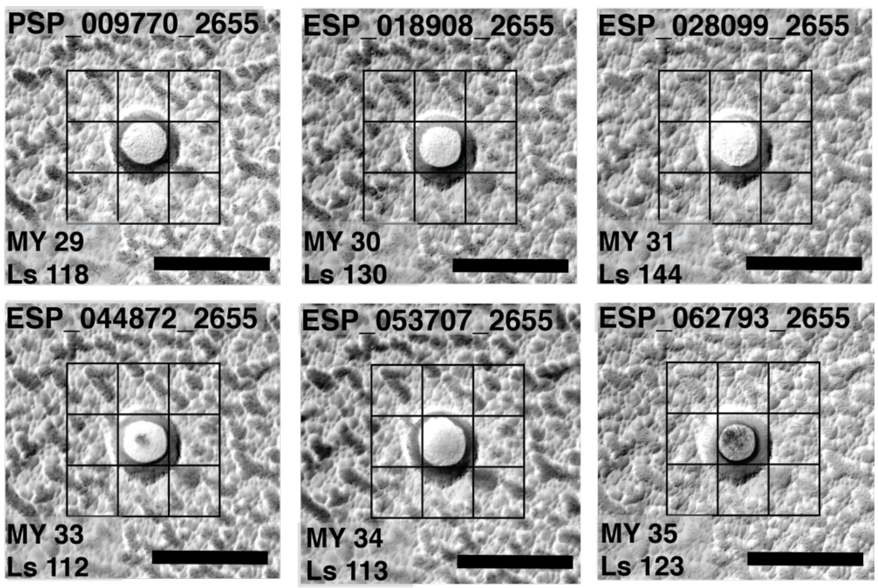

Fig 2. A ~57 m diameter crater on the NPLD is shown in HiRISE images from MY 29-35 (Site 17). We will focus on changes that occur from MY 29-34 due to a planet encircling dust storm in MY 35, likely a disruption from typical interannual changes on the NRIC. North is up in all images. Scale bar is 100 m.

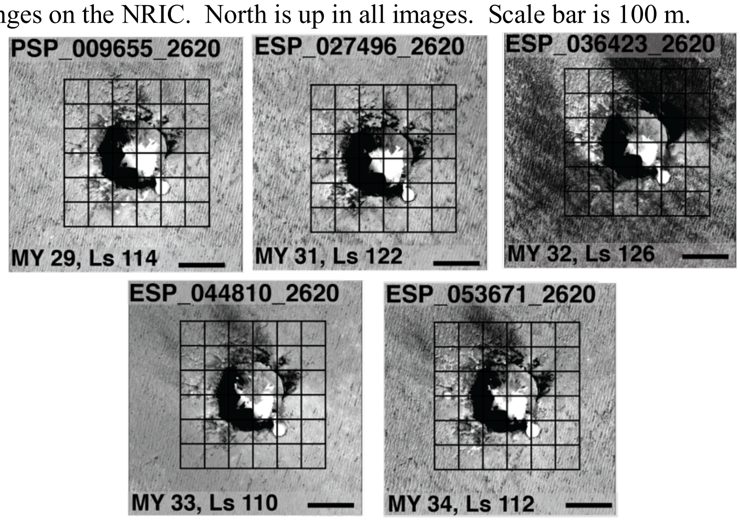

Fig. 3 A ~157 m diameter crater with two smaller depressions near it is shown from MY 29-34 in HiRISE images (Site 4). The bright material within the interior of the main crater shows changes over time, though quantifying if this a net gain or loss in mass is key future work. Scale bar is 100 m.