MARS' NORTH POLAR ERG – SCULPTED BY WIND AND DRY ICE. C. J. Hansen[1], S. Diniega[2], P. Hayne[2], G. Portyankina[3], [1]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson 85719, cjhansen@psi.edu, [2]Jet Propulsion Lab / California Institute of Technology, [3]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO.

Introduction: Every winter the north polar region of Mars is covered by a seasonal polar cap of dry ice. This seasonal cap covers the dunes of the north polar erg with a layer up to 1 m deep. The CO_2 condenses from the atmosphere or falls as snow [1, 2]. In the spring the ice sublimates and a large variety of associated phenomena proceed [3].

The Mars Reconnaissance Orbiter (MRO) has been in orbit around Mars since 2005. The MRO High Resolution Imaging Science Experiment (HiRISE) has returned thousands of images over 5 Mars years of the spring sublimation process. In the first northern spring of MRO's first Mars year in orbit, MY29, the goal was simply to document and further our understanding of the seasonal processes. In the second Mars year we started to compare ice-free images of the dunes to look for changes. The dunes of the north polar erg are particularly challenging because they are dark basalt sand and low light levels make it difficult to see subtle changes. Surprisingly however there are substantial changes from one Mars year to the next [4], as shown by the large new alcove in Figure 1.

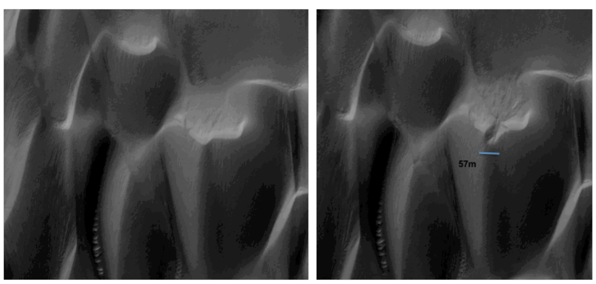

Figure 1. *Two ice-free images with similar lighting are compared. The left image, ESP_027394_2640, was acquired at L_s 118 in MY31. On the right a new alcove 57m wide has developed with sand avalanching down onto the surface for tens of meters. The image on the right, ESP_036387_2640, was taken at Ls 124. These images are at one of our standard monitoring sites known informally as "Buzzel" at lat / lon = 84.0N / 233.2E.*

New Alcoves: What process is causing these sandfalls? Is it fierce autumn winds or the presence or sublimation of seasonal ice? This has been a topic of debate ever since the discovery that the dunes are so remarkably active [5, 6, 7]. If we knew precisely when the new alcoves were forming this would be quickly solved, however there is a large swath of time that HiRISE cannot effectively image as the north polar region is cloaked by the polar hood in the fall and hidden in the darkness of polar night in the winter. HiRISE campaigns to image as early as possible in the spring and as late as possible into the fall have shown us that on the order of 80% of the alcoves form in the fall-winter timeframe that HiRISE cannot image, with the remaining ~20% happening in the spring and none showing up in the summer [7].

Interannual Variability: In the quest to find the driving process for alcove development we now have records for 4 locations that span 4 Mars years. In the process of this analysis it has become obvious that the number of alcoves that form in a given Mars year is variable. At a single site there can be a large difference from one year to the next. For example, at Buzzel between MY29 and MY30 we detected 57 new alcoves, while between MY30 and MY31 there were 97 new alcoves. Similar variability has been found at "Kolhar" (lat / lon = 84.7N / 0.7E), "Tleilax" (83.5N / 118.6E) and "Palma" (76.2N / 95.4).

It would be easy to assign this variability to global atmospheric events such as the presence or absence of a dust storm the previous summer. However the years that we see for example more alcoves are not the same across the 4 sites. The maximum for Kolhar occurred in MY30-31, Tleilax in MY28-29, Buzzel in MY30-31 but MY29-30 in Palma. This leads to a new hypothesis that alcove formation is linked in some way to regional storms.

Winter snowstorms. Data from another MRO instrument, the Mars Climate Sounder (MCS) has shown that 3 – 20% by mass of the seasonal polar cap is due to snowfall rather than direct condensation from the atmosphere [2]. Coordinated studies between the HiRISE and MCS teams are underway to correlate locations of snowstorms in the winter to enhanced numbers of new alcoves visible in the spring.

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