WATER ICE GRAIN SIZE EVOLUTION OF MARTIAN NORTH POLAR RESIDUAL LAYERED DEPOSITS FOR LATE SUMMER MY28 AND 30 FROM CRISM/MARCI OBSERVATIONS.

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Introduction: The seasonal evolution of the north polar cap is of great importance for the energy balanace of the planet. Here we report on our ongoing investigation using CRISM and MARCI of the seasonal changes in the north polar region [1,2].

The albedo of the north polar cap has recently been investigated by Kiefer and Titus [3], Bass et al. [4], James et al. [5], Hale et al. [6], Byrne et al. [7] and Cantor et al. [8] and grain size of the cap has been reported using OMEGA for L_s=93-127 by Langevin et al. [9] and L_s=280-95 by Appere et al. [10].

We extend these works referenced by reporting grain size variations as observed by CRISM for two Martian summers from Ls=130-167 for MY28 and L_s=86-144 for MY30.

CRISM: The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) is a visible to near-infrared spectrometer sensitive to photons with wavelengths from ~0.4 to ~4.0μm. In high-resolution mode, CRISM's instantaneous field of view (pixel) size corresponds to ~18.75m on the ground. CRISM has 640 pixels in the FOV, however only 605 see the surface, therefore the swathe width covers ~10.8km on the ground. In mapping mode (primarily used in this study) 10x binning is employed in the cross-track direction, therefore a mapping swathe has 60 pixels covering approximately 10.8km on the surface. Along-track binning is controlled by exposure time.

MARCI: The MARs Color Imager (MARCI) camera is a super wide angle, fish eye lens instrument with 1024 pixels-wide CCD. We produced images using MARCI daily global maps projected to polar stereographic projection.

Methods: We produced two week mosaics of CRISM multispectral and hyperspectral mapping polar (MSP and HSP) observations over the north pole of Mars for all data that were available. We only present mosaics here which contain more than 100 CRISM swathes.

We display CRISM-adjusted H_2O ice index [11] derived using these mosaics. The formula for this index is:

$$H_2Oindex = 1 - \frac{R(1.500)}{R(1.394)^{0.7} R(1.750)^{0.3}}$$

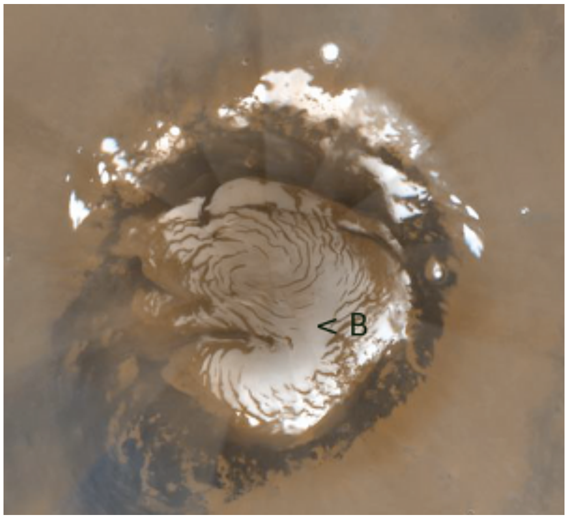

Figure 1 – MARCI image of north polar cap MY28 L_s=130 showing location of CRISM spectra from Figure 2 (point 'B').

Essentially it reports the strength of the 1.5 micron H_2O ice band.

We also show spectra from a region of interest on the cap – this region is shown on Figure 1 as point B. This is at 45E, 85N, (point 550,550 on 1000x1000 image) which is as close to Langevin's point B at 42.5E, 85.2N we could get and still obtain CRISM spectra for each mosaic. We believe from spectral and MARCI observations that the Langevin point B and our point B are closely geophysically related and likely to behave similarly during late summer.

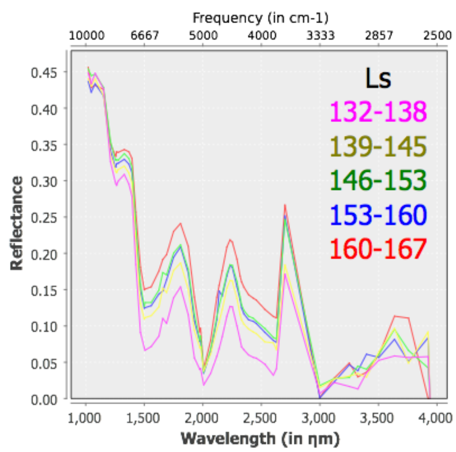

Figure 2 – CRISM spectra from point B for MY 28 L_s=132-167. All spectra from x=550,y=550 except L_s 160-167 which is from 550, 551 (pixels are ~180m across).

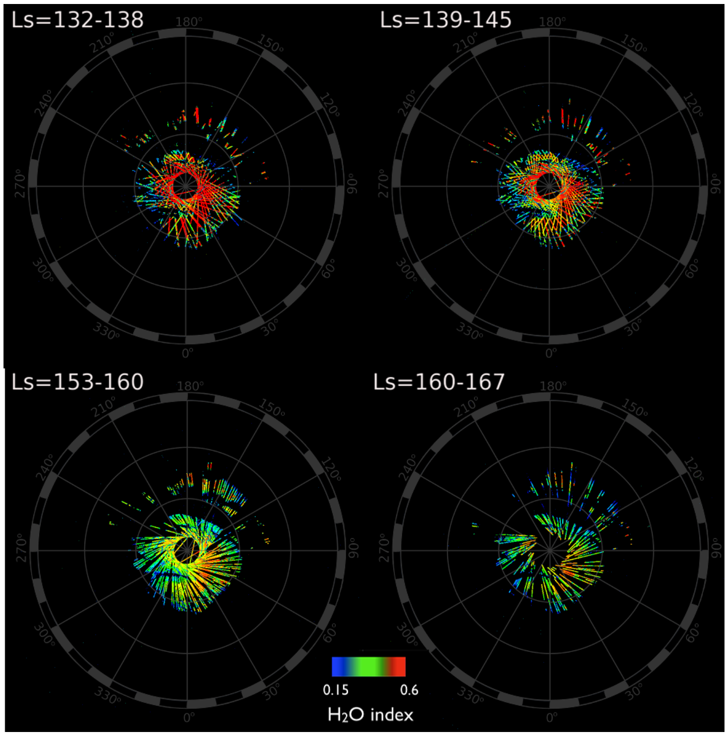

Figure 3 – MY28 northern summer H_2O ice index mosaics. Note high H_2O index over Planum Boreum which decreases as summer progresses.

Results: Figure 2 shows an unmistakeable increase in albedo across the VNIR (1250-2500nm), particularly from L_s=152-153, and then it appears to stabilize.

We interpret this as being due to a decrease in grain size, perhaps due to the deposition of a fine surface frost in late summer at point B for MY28. This is supported by the decrease in strength of the H_2O index generally in Figure 3 at Point B and on Planum Boreum (the residual ice cap) as a whole.

Alternative explanations: There is a possibility that this may be related to water ice clouds, however we consider this a less likely explanation, for MARCI data show only very light H_2O ice clouds forming around L_s=158 for MY28 by which time the albedo has stabilized. MARCI daily mosaics show no significant dust activity until Ls=158.

Brown and Calvin [1] reported that during summer (Ls=119-160) period, ice on Mrs Chippy Ring (polar cap outliers) appeared to be fining in grain size. Figure 3 shows the decrease in H_2O index across that time period, the CRISM spatial coverage is not as repeatable across this outlying region so we feel this observation still requires more data.

Implications: If there are many locations like our Point B that repeatedly undergo a decrease in grain size over the late summer period (and Figure 3 suggests this behavior is common) this process may play a role in stabilizing the north polar cap.

Byrne et al. [7] reported in their Fig. 7 the seasonal albedo of a region at 30-40E, 84.5-85N, which overlaps our Point B. In Byrne et al.'s Fig. 7, there is a slight suggestion of an increase in albedo to Ls=150, however the 1064nm lambert albedo from L_s=105-150 looks rather flat (at ~0.6) in their Figure 7. The lambert albedo at 1000nm in Figure 2 does not fluctuate as much as the NIR spectrum (staying around 0.45 while at 1750 nm the variation is almost 0.1), which is evidence for differing NIR and VIS albedo trends, for which we have no ready explanation at this time.

Future work: We intend to investigate the Visible channel of the CRISM instrument for supporting information, and conduct RT modeling to derive grain size estimates and these will be reported at the meeting.

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References: [1] Brown A.J. and Calvin, W.M. (2010) *LPS, XXXXI,* Abstract #1278 [2] Brown A. J. et al. (2011) *5th Mars Polar Conf.,* Abstract #6060. [3] Kieffer H. H. and Titus T. N. (2001) *Icarus*, *154, 1,* 162-180 [4] Bass D.S. (2000) *Icarus* **144** 382-396 [5] James P.B. and Cantor B.A. (2001) *Icarus* **154** 131-144 [6] Snyder Hale A. et al. (2005) Icarus 174 502-512 [7] Byrne, S. (2008) *PSS* **56** 194-211 [8] Cantor B.A. et al (2010) *Icarus* **208** 61-81 [9] Langevin, Y. et al. (2005) *Nature* **307** 1581-1584 [10] Appere T. et al. *JGR* **126** doi:10.1029/2010/JE003762 [11] Brown A.J. et al. (2009) JGR **115** doi:10.1029/2009JE003333

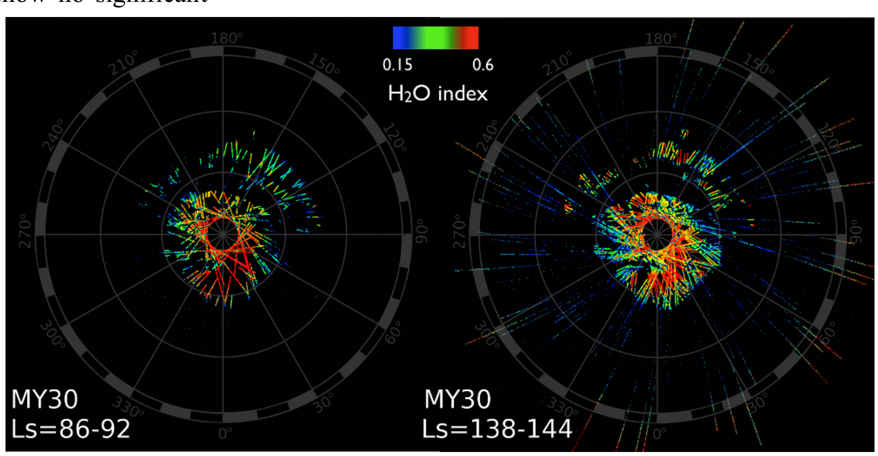

Figure 4 – MY30 northern summer H_2O ice index mosaics.