COMPARISONS OF MRO-ODYSSEY OBSERVATIONS OF THE SOUTH POLAR CRYPTIC REGION GIZA TO MESOSCALE MODELS.

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Introduction: The Cryptic region was first identified as "dark as dirt" dry ice by Titus and Kieffer [1, 2,3] in 1997. While they were the first to recognize the Cryptic region as dark CO$_2$ ice, they were not the first to have observed the Cryptic region. Observations of this dark seasonal feature date back to 1845, when first seen by the American astronomer Ormsby MacKnight Mitchel [4]. At the time, the seasonal cap was believed to be composed of water ice, and so it was a logical conclusion to assume that this dark feature inside the seasonal cap was a transient polar lake, created from the melting ice of the seasonal cap. While the Cryptic region is no longer believed to be a polar lake, the processes observed are exceptionally intriguing and “out of this world.”

MOC images, with resolution as high as ~1.5m/pixel, revealed that the Cryptic region had a cornucopia of bizarre albedo features that have been referred to as a ‘‘zoo.’’ [2,5,6] Subkilometer-scale dark areas were observed within the seasonal frost. Also discovered were fields of dark, round spots with parallel-oriented tails (‘‘fans’’), fields of spots with individual or collective medium-toned halos, and fields of dark (later to become relatively light) radial and ragged branching patterns (‘‘black spiders’’), usually centered on the narrow ends of fans [7]. Some of the spots must form in the dark, as they are observed in prepolar-dawn images[8].

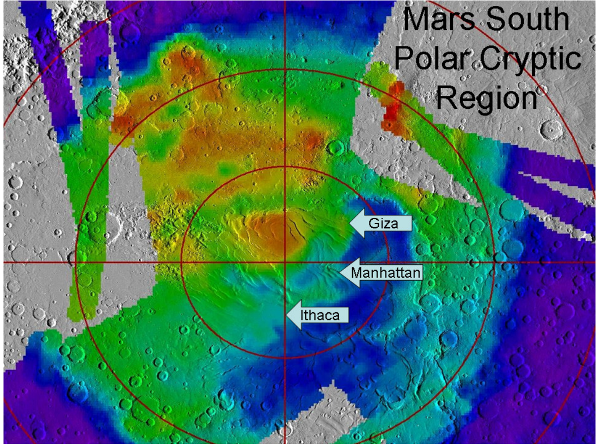

Figure 1: Mars south polar seasonal cap. This image is TES albedo (~L_s 222º) as color overlaid on MOLA shaded relief.

Regions of Interest: In order to better understand the evolution of the spots, fans, halos, and blotches within the Cryptic region, CRISM is monitoring several locations that have proven to show interesting features and evolution in THEMIS and MOC imaging data from past Mars years. Three of these locations are shown in Fig. 1, labeled by their informal names: Manhattan, Ithaca, and Giza. Manhattan, located near the head of Chasma Australe, has been actively monitored by THEMIS over multiple years [5], as well as by both HiRISE and CRISM this past Mars year. Ithaca is another area that is being studied by HiRISE.

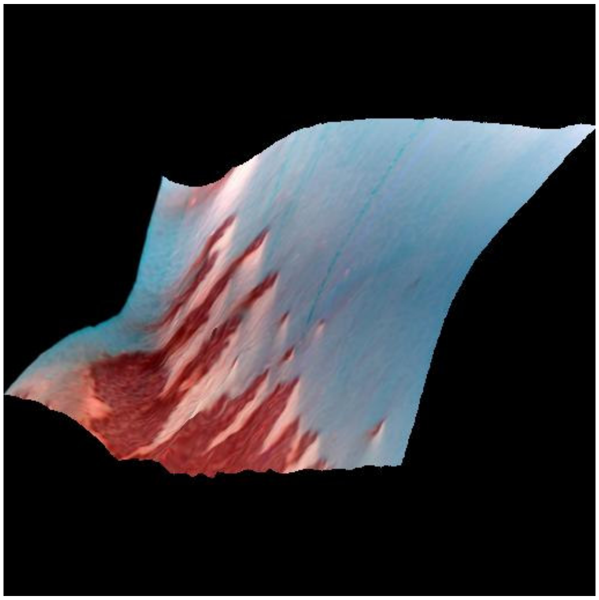

Figure 2: CRISM FRT 5A48 NIR False-color image overlaid on MOLA topography. This image was acquired at L_s 226º. The blue areas are CO$_2$ ice. The brownish-red areas are dust covered. The white areas are CO$_2$ snow.

Giza. Unlike Manhattan, Giza shows a pattern that changes very little throughout the spring. The albedo pattern, which closely matches the summer albedo pattern, is partially visible as early as L_s 178.6º. By L_s 187º, the pattern is fully visible, suggesting the ice has transformed from an opaque uniform albedo ice to a translucent ice, thus enabling the underlying albedo pattern to be seen through the ice. Fans, while not as prevalent as in Manhattan, can also be seen. TES long-wavelength (15μm – 40μm) data shows little spectral variation, thus making variations in dust content or CO$_2$ ice grain size an unlikely cause of the variations in albedo. At L_s ~ 218º, a slight thermal signature is observed in THEMIS IR images of Giza. The thermal signature remains within 5-10 degrees of the CO$_2$ frost temperature until L_s ~240°. Between L_s 240° and L_s 245°, Giza's thermal signature becomes more prominent, suggestive of partial defrosting. By L_s 250°, all the CO_2 in Giza is gone, while the area surrounding Giza remains ice-covered. The region surrounding Giza starts to defrost at L_s ~ 270°, becoming volatile free near L_s ~ 280°. As the region defrosts, it is common to observe boundary areas with intermediate temperatures (<200K) and intermediate albedo (~0.3). Giza remains warmer than its surroundings throughout the summer, mostly due to its slightly lower albedo. The formation of seasonal CO_2 ice occurs at L_s ~ 180°, with the ice forming on Giza either at the same time or within a few sols of delay from its surroundings.

CRISM Data: The data used for this study are primarily visible and near-infrared images from MRO CRISM. CRISM Full-Resolution Target (FRT) images have a spatial resolution ~20m/pix. While significantly coarser resolution than HiRISE (~0.25m/pix), CRISM has sufficient ability to resolve most observed fans.

Mesoscale Model: There are two obvious advantages of comparing fan directions to mesoscale model results over general circulation models (GCM): i) the mesoscale model uses high-resolution topography and other surface characteristics, and ii) it has no pole-point issues. Therefore, the spatial distribution of mesoscale model wind directions can be directly compared to the spatial distribution of fan directions. A disadvantage is that a single mesoscale simulation can only be run for a limited time-span (usually a few number of sols), although several of these runs placed at intervals within an L_s range can be used to characterize seasonal variations. It should be noted that the mesoscale model used here (MRAMS) [9] takes into account topographic slope, aspect (azimuth), and shadowing effects with respect to the solar radiation input at the surface. These effects may be significant to this study due to the ubiquitous low sun angles in the south polar spring. The mesoscale simulation results used in this investigation have a point-to-point spacing of 6 km or less.

Results: The regions of Manhattan, Ithaca, and Giza, each display significantly different behaviors – perhaps defining 3 distinct endmembers. Giza, the focus of this presentation, displays few dark fans, but displays bright fans that are quite long and long-lasting. They appear as if they are an accumulation of drifting snow. The white fans generally indicate wind directions different than the wind directions of the dark fans.

References: [1] Titus, T.N. et al. (1998) *DPS 30,* 1049. [2] Kieffer, H.H. et al. (2000) *JGR., 105,* 9653. [3] Titus, T.N. et al. (2008) in *The Martian Surface - Composition, Mineralogy, and Physical Properties*, Edited by Jim Bell, III. Cambridge University Press. 578-598. [4] Blunck, J., (1982) *Mars and Its Satellites: A Detailed Commentary on the Nomenclature*, 2nd rev edn., Smithtown, NY: Exposition Press. [5].Kieffer, H.H. et al. (2006) *Nature* [6] Kieffer, H.H. (2007) *JGR* [7] Piqueux et al., (2003) *JGR* 108 CiteID 5084 [8] Aharonson et al. (2004) *JGR* 109 E05004 [9] Rafkin, S. C. R., Haberle, R. M., and T. I. Michaels (2001) *Icarus*, 151, 228-256.

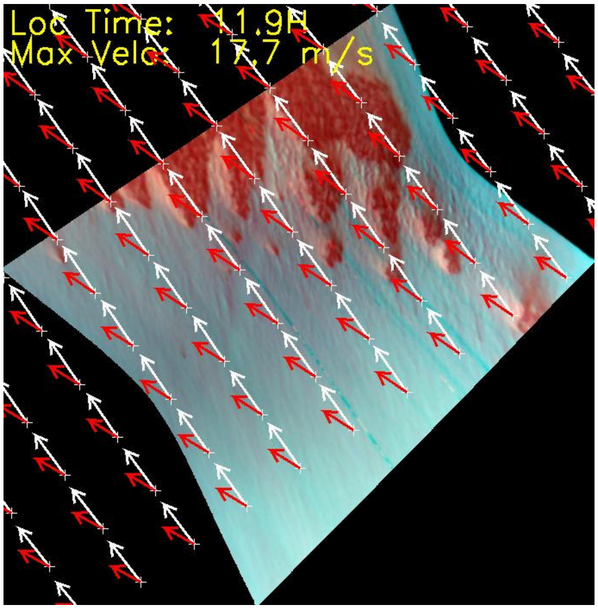

Figure 3: CRISM FRT 40FA NIR false-color image with 2 adjacent days of noontime wind velocities. The image was acquired at L_s 209° while the wind velocities are for L_s 195°. The red arrows are wind velocities from day 1 and the white arrows are from day 2.

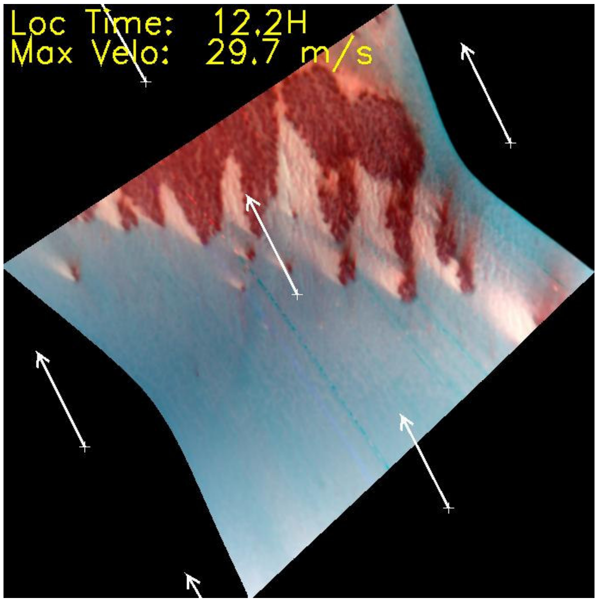

Figure 4: CRISM FRT 5A48 NIR false-color image with noontime wind velocities.