ABSTRACT

DIURNAL ALBEDO VARIATIONS OFTHE MARTIAN NORTH POLAR WATER ICE CAP. R. F. Troy[1] and D. Bass[2], [1] Jet Propulsion Laboratory (MS 158-241, 4800 Oak Grove Drive, Pasadena, CA 91101, Robert.F.Troy@jpl.nasa.gov) for first author, [2]Jet Propulsion Laboratory (MS 1722, 4800 Oak Grove Drive, Pasadena, CA 91109, Deborah.S. Bass@jpl.nasa.gov).

Introduction: Early studies of the ice coverage and albedo of the north residual polar cap of Mars, using Mariner 9 and Viking Orbiter images, reported that there were substantial interannual differences in ice deposition on the polar cap [1]. However, some of the data used for comparison between Martian years in these early studies was obtained at different values of areocentric solar longitude(L_s). Reevaluation of the imaging data by [2] proposed that the north polar residual cap undergoes seasonal brightening throughout the summer and presented evidence of the yearly repeatability of this cycle.

[3] presented new evidence of interannual variability. They published two images of the north polar cap acquired at the L_s=103, one obtained in 1999 and the other in 2001. Their data showed increased ice coverage between 1999 and 2001, but also areas which show decreased local coverage.

Our present study uses MOC imaging data to construct a time history of the evolution of north polar cap water ice coverage. At issue is the repeatability of the water ice cycle both spatially and temporally. MOC images are acquired at a greater frequency than were those of the previously mentioned spacecraft. We are attempting to use this smaller data time step to construct a clearer picture of the volatile cycle from year to year. This should help us determine what interannual comparisons are useful and whether the areocentric solar longitude of an observation has the degree of significance it has been attributed in previous studies.

Image Processing and Data Collection: The initial step in this study is to examine MOC images of the north polar cap for variations in areas of ice coverage and changes in albedo. Examination of albedo differences is complicated by the fact that the MOC instrument was not calibrated to measure absolute radiance. Comparison of albedo between images cannot therefore be performed without further definition of the MOC systematic and random errors. Dr. Ken Herkenhoff at USGS, Flagstaff has been working with his colleagues and with Malin Space Science Systems to resolve these issues (Personal Communication). Dr. Herkenhoff reports that the systematic errors have been successfully compensated for in the latest versions of the ISIS processing software. Work continues on bounding the random error of measured rediance between images and Dr. Herkenhoff has so far concluded that this is less than 15%. His work is continuing to establish the error range. Our work is unaffected in the meantime because the magnitude of albedo changes we are investigating exceed the conservative error estimate thus far reported.

Diurnal Albedo Variations: Careful study of a large number of MOC polar images taken during the summer between L_s=90 and L_s=145 indicates that care must be taken in interpreting albedo variations in the north polar region. Determination of surface albedo is complicated by the fact that at the high latitudes of the residual cap, the incidence angle of the suns rays is between 60 and 75 degrees, depending upon the time of day. At these high incidence angles, undulations and irregularities in terrain can lead to false interpretations of surface albedos.

The two images of the head of Chasma Boreale (Fig. 1) show a change in albedo between an image acquired at 12.54 Mars local time (MO100239) and the same region at 4.55 earlier that sol (MO100126). For the image at 12.54, the direction of solar illumination is from below at approximately the 6:30 position. For the image at 4.55, the direction of illumination is from above and to the right at approximately the 2:30 position.

Figure 1a) M0100239 L_s =134.97 Mars local time: 12.54

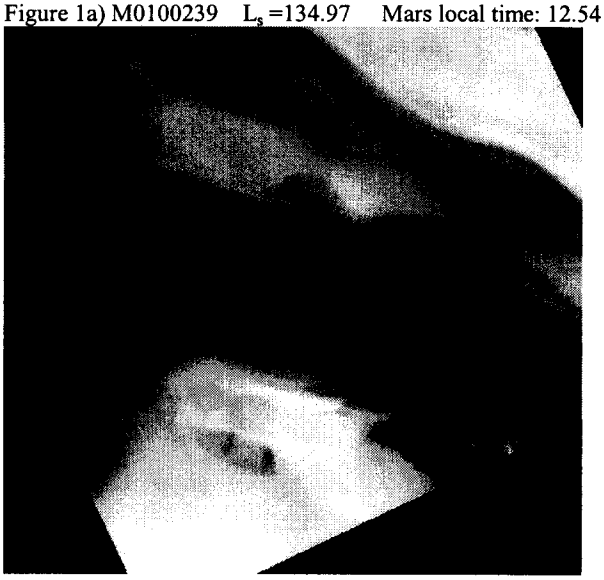
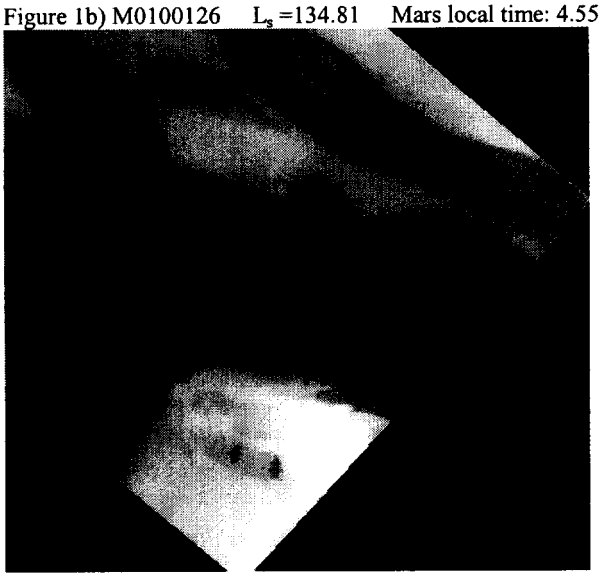


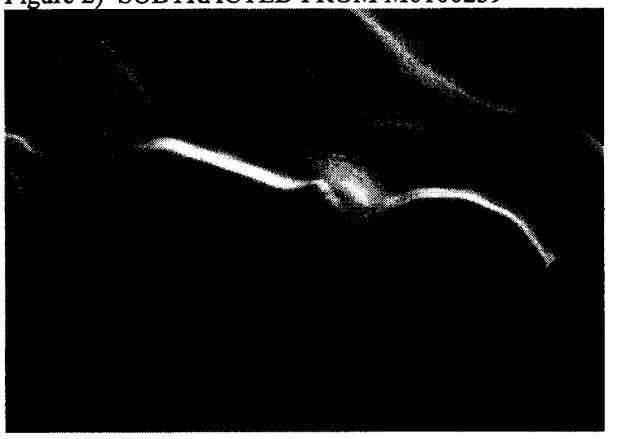
Figure 1b) M0100126 L_s =134.81 Mars local time: 4.55



We subtracted the Digital Numbers (DNs) in M0100126 at 4.55 from those in M0100239 at 12.54 and correlated these data with MOLA data. As shown in the subtraction below, the apparent change in albedo takes place along the surface of a wall that has an approximate 2 km change in altitude form north to south. It appears that the apparent change albedo is the result of large incidence angles at 4.55 and the chasma wall is completely shaded. Further, it appears there is insufficient backscattered light from surrounding terrain to cause any appreciable reflection. Therefore, the wall is very dark in the M0100239 at 4.55.

There is no evidence at this time to suggest that the diurnal variations observed in the MOC images studied to date are due to any other effect than differential shading due to large incidence angles. Therefore, to make meaningful comparisons of albedos from different areocentric solar longitudes, we must compare only images acquired at approximately the same time of day.

Figure 2) SUBTRACTED FROM M0100239



References: [1] JamesP. B. and L. Martin (1985) *Bul. Amer. Astron. Soc., 17*, 735; Kieffer, H. H. (1990) *JGR,* 96, 1481-1493. [2] Bass D. S. et al. (2000) *Icarus, 144*, 382-396. [3] Malin, M. and Edgett, K. E. (2001) *JGR, XXXXX.*

ALBEDO VARIATIONS OF THE MARTIAN NORTH POLAR WATER ICE CAP

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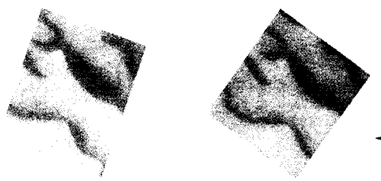
Mariner 9 and Viking data have been cited as evidence for both seasonal and interannual variations in frost coverage and albedo in Mars' northern summer season. We have re-evaluated the Mariner 9 and Viking imaging data and proposed that the north polar residual cap undergoes seasonal brightening throughout the summer and presented evidence of the yearly repeatability of this cycle.

Images acquired during the 2000/2001 Martian summer season.

Wide angle red-filtered MOC images M2300314 acquired at Ls-99 (left) and M2301643 acquired at Ls-107 (right) in the 2000 Martian northern summer season. Images show an overall regional decrease in albedo, but also show a localized increase in albedo along the sides of the troughs, indicating possible ice accumulation in these troughs.



Wide angle red-filtered MOC images M2201749 Ls-92, (left) and M230798 Ls-102, (right) show a general decrease in albedo in Mars' early summer season. However, troughs in these images appear to have narrowed, possibly implying ice deposition in these regions.

Wide angle red-filtered MOC images M2300465 acquired at Ls-100 (left) and M2301944 acquired at Ls- 110 (right) in 2000 show an increase in albedo during the early northern summer season, consistent with Mariner 9 and Viking imaging observations previously documented.

Data Set:
MGS MOC images coveraging the north Martian polar cap from latitudes fo 77° N to 90° N at image center were studied. The full range of longitudes from 0° to 360° were studied.

All images were processed identically to allow for comparison of relative albedo differences between images. Processing was performed using "ISIS" software developed by the U.S. Geological Survey, Flagstaff, Arizona.

Images examined from the 1999 Martian summer were acquired between LS~107 and LS~148.
Data is sparse between LS~107 and LS~109.
409 images make up this dataset.

Images studied from the 2000 Martian summer were acquired between LS~83 and LS~110.
60 images make up this dataset.

Conclusions:
There were no seasonal albedo changes apparent in images acquired in mid-late northern summer in 1999 (Ls = 107 - 148)

During the 2000/2001 Mars early northern summer, different regions of the north Martian polar cap displayed different albedo histories.
While much of the cap remained roughly the same albedo, it appears that some regions became brighter and some became darker.

Future work will entail expanding the data set with additional MOC data as well as TES data, and attempting to construct a time history of the entire cap through multiple Martian summer seasons.
A detailed time history may provide clues as to the processes taking place that affect variations in the albedo and frost area coverage of different regions of the cap.

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