EARLY DEFROSTING OF THE 1999 SOUTH POLAR SEASONAL FROST CAP: EVIDENCE OF INTERANNUAL CLIMATE CHANGE? M. C. Malin and K. S. Edgett, Malin Space Science Systems, P. O. Box 910148, San Diego, CA 92191-0148, USA.

Synopsis: Year-to-year variations in the time when areas within the south polar seasonal frost cap defrost have been observed. The magnitude of the difference between 1997 and 1999 is roughly 70° of L_s. However, the margin of the seasonal cap appears to follow the same defrosting timeline from year to year. It seems likely that meteorological conditions, for example during the winter (controlling the amount of frost deposited) or during the spring (controlling the transport of heat into and out of the cap interior), are responsible for the variation. Why the cap edge and cap interior behave differently is not known.

Observations: During the first aerobraking phase of the Mars Global Surveyor (MGS) mission (September 1997 - February 1998), the Mars Orbiter Camera (MOC) was able to observe portions of the south polar region of Mars during specially designed post-periapsis "rollout" maneuvers, wherein the MGS spacecraft was rotated about its Y-Axis, permitting the line-scan cameras to sweep across the planet. Observations were made from mid-December (L_s 230°) through mid-January (L_s 260°), equivalent to mid-to-late Spring. Both wide angle (~10 km/pixel) and narrow angle (20-30 m/pixel) images were acquired. Coverage was not well or uniformly distributed in longitude, as the spacecraft was in a relatively long-period, elliptical orbit that did not well sample Mars' rotation.

Upon attaining the proper orbit in March 1999 (L_s 110°), observations of the south polar region were not possible owing to polar winter darkness. As sunlight returned to the southern hemisphere, areas seen during the spring of the preceding year were rephotographed, typically at resolutions an order of magnitude better.

Figure 1 compares several views of the landform first recognized in Mariner 9 images and called "Inca City" for its rectilinear pattern of ridges that resemble the outlines of ancient ruins. This feature is located at 81.5°S, 64.7°W. Since only a small faction of the area imaged during aerobraking could be re-imaged at the higher resolution of the mapping mission, coverage is limited to small areas. Comparison clearly shows that the pattern of defrosting is reproduced from year to year. However, what is also clear from this example is that the defrosting occurred a full 70° of L_s earlier in 1999 than in 1997, equivalent to an astonishing 5 months! Several other areas deep within the seasonal frost cap show a similar defrosting pattern. In contrast to these interior views, inspection of the margin of the polar frost shows that the retreat of the cap edge is essentially the same in 1999 as in 1997.

Interpretations and Speculations: Why is frost within the seasonal cap disappearing so much sooner in 1999 than it did in 1997? The fact that local areas within the cap show large differences from year to year, but the edge does not, suggests that local dynamic processes (*e.g.*, local meteorology such as vagrancies in wind speed and direction, etc.) may be contributing substantially to heat transport over and within the cap. Essentially, something has either imparted the equivalent of 70° of L_s worth of insolation (if the defrosting is controlled by spring processes), or engendered a deficit of frost deposited during the preceding winter.

Directions for Future Research: One fruitful area for future research may be to correlate these year-to-year defrosting variations with other remote sensing data, both for the same period of time as measured by the MGS Thermal Emission Spectrometer (TES), the MGS Radio Science experiment, and by Earth-based microwave techniques. It may be possible to see atmospheric or surface temperatures reflecting the change in state of the frosts. Theoretical considerations of heat balance—how much frost and equivalent energy is represented by the 70° of L_s may also provide insight to climatic processes.

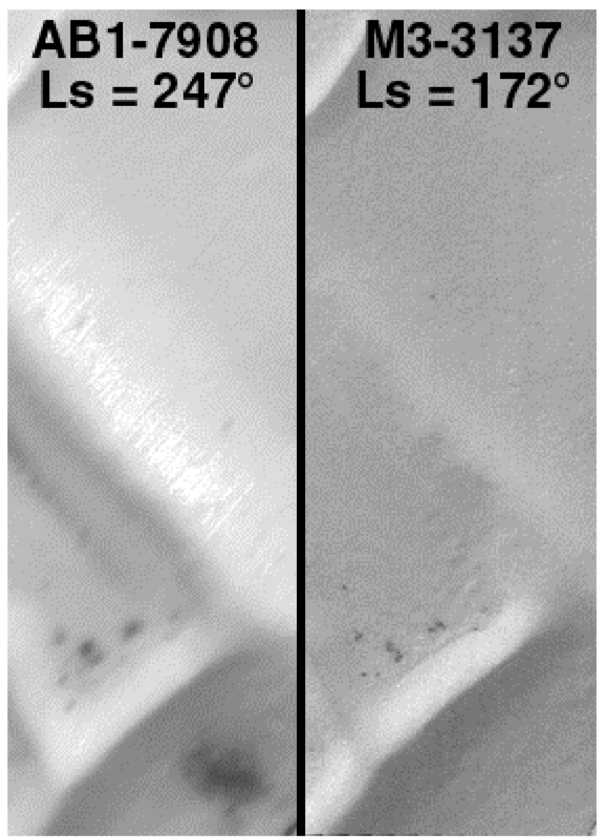

Figure 1A

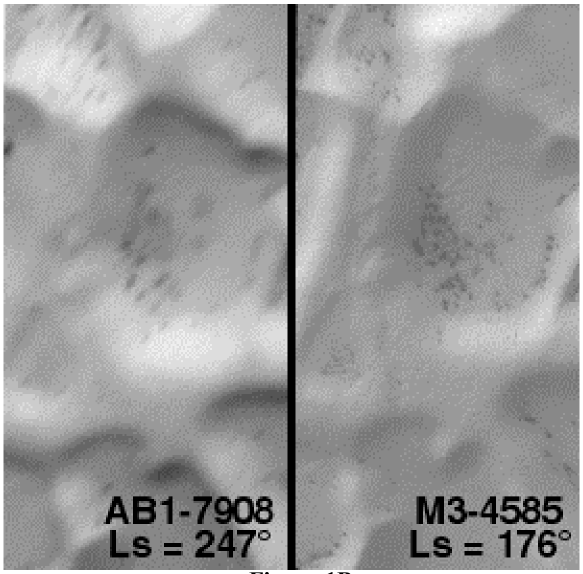

Figure 1B

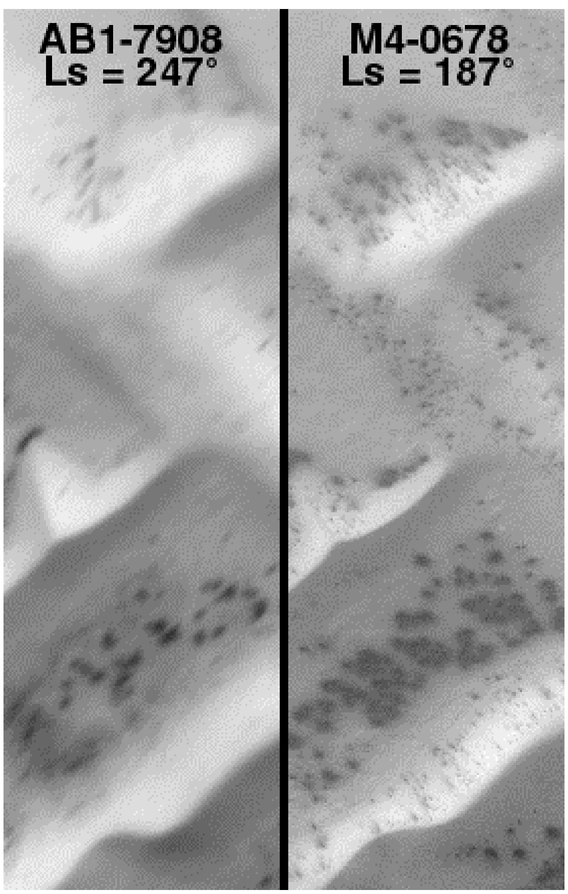

Figure 1C

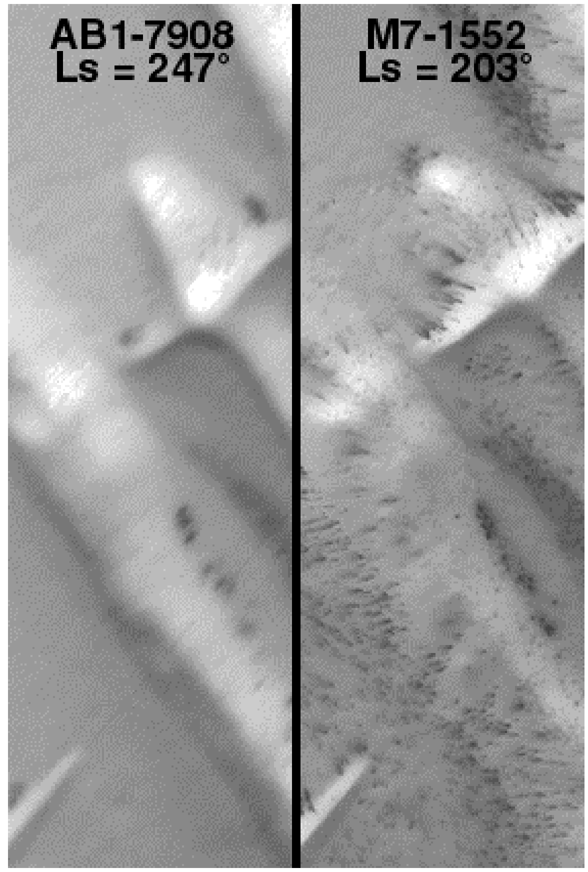

Figure 1D

Figure 1: Four subsections of aerobraking image AB1-07908 are shown on the left side of Figures 1A through 1D. This image was acquired at L_s = 247° (late spring) in Earth-year 1997. Each of the paired images (right side of each figure) shows the same area seen in Earth year 1999 at L_s ranging from 172° to 203° (very late winter to very early spring). The original AB1 image has a resolution of about 25 m/pixel; the mapping images were acquired at better than 6 m/pixel. All images shown here were stereographic map projected at a common scale of 10 m/pixel. Inspection indicates that Figure 1A shows a condition in which defrosting is more extensive in the AB1 image than the mapping image. Figure 1B shows a condition in which the two images are essentially the same. Figures 1C and 1D show more defrosting in the mapping images than in the AB1 image. Thus, defrosting in 1999 occurred about 70° earlier than in 1997.