SEASONAL CHANGES IN FROST COVER IN THE MARTIAN SOUTH POLAR REGION: MARS GLOBAL SURVEYOR MOC AND TES MONITORING OF THE RICHARDSON CRATER DUNE FIELD.

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Introduction: A dune field in the Martian south polar region was monitored over the course of four seasons while the dune field was in daylight or bright twilight. Images and temperature and albedo measurements show that the dunes progressed through several stages: 1) being covered with a layer of bright frost at frozen CO_2 temperatures (~148 K) in late winter when the sun first rose over the horizon; 2) exhibiting small dark patches along the base of the dunes which grew in size and number as spring progressed; 3) appearing frost-free at just below frozen H_2O temperatures (~273 K) in mid-summer; 4) showing hints of returning frost cover at frozen CO_2 temperatures at the onset of autumn when the sun set over the horizon and the terminator moved north of the dune field. Albedos ranged from as high as 0.4 when the dunes and the underlying substrate were frost-covered down to 0.1 in mid-summer.

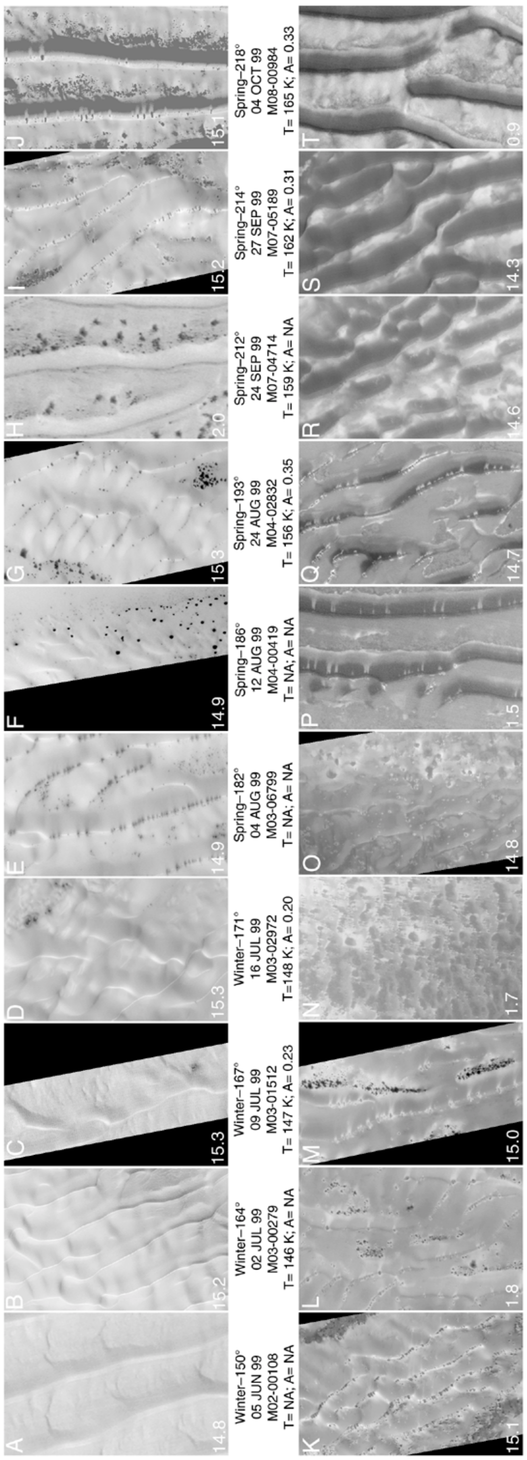
Observations and Discussion: Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) and Thermal Emission Spectrometer (TES) data reveal marked changes in the characteristics of the Richardson Crater dune field (located at 72.4°S, 180.0°W) from late southern winter through spring and summer to early autumn. This work extends earlier results presented by [1] and covers all data acquired during the MGS Primary Mission. Figure 1 shows subframes of MOC images acquired throughout the Martian year while the dunes were in daylight or bright twilight. Images at L_s 150° and 164° were acquired during winter twilight; the image at L_s 36° was acquired during autumn twilight. Each image is shown at the same scale, covers 2.2 by 3.4 km, and is oriented with north up. The images have not been adjusted for variations in incidence angle and gain/offset setting. Each image is annotated with the local true solar time (lower left corner), L_s, date of acquisition, and an average temperature and albedo derived from TES observations. Figure 2 shows the location of each of these subframes within a Viking orbiter view of the dune field. Each subframe samples a slightly different portion of the dune field; nevertheless, each sample should be a good indicator of how seasonal frost patterns across the entire dune field changed, since other MOC images in frosted dune fields show that one such sample is fairly representative of the whole field. Figure 3 shows the average temperature and albedo over the dune field as a function of L_s. The temperatures are derived from the TES thermal bolometer (5.5 – 100 µm single band) and the albedos from the TES visual bolometer (0.3 – 2.7 µm). Each large square corresponds to an image in Figure 1; the small squares do not have corresponding images. Solid squares are afternoon (2 p.m.) measurements; open squares are morning (2 a.m.) measurements.

Initial wintertime temperatures are near those of frozen CO_2 (~148 K), and the images show a covering of bright (albedo ~0.35) frost at this time. As the sun rises higher above the horizon, afternoon temperatures gradually increase at a rate of ~0.33 K/°L_s in early spring (L_s 165° to 225°) until L_s ~230°, when the temperature increases sharply (and the albedo decreases) at a rate of ~2 K/°L_s from L_s 225° to 278°. Small dark patches form during the gradual increase in temperature, and the images are dominated by frost. As spring progresses, the dark patches increase in size and merge together as the frost rapidly disappears. This rapid change could be a consequence of positive feedback – the dark dunes absorb more solar energy than the bright frost, increasing the temperature of the dunes and subliming more frost, exposing more dark dune material. Summertime images show that the frost has largely dissipated, and dark dunes and the brighter underlying substrate are clearly visible.

Early-morning temperatures are lower than afternoon temperatures in spring and summer, reaching a summertime maximum of ~220 K while afternoon temperatures are ~270 K, near the water ice sublimation temperature. Albedos are generally lower in the afternoon than in the morning at a given L_s, and the images show some evidence for frost formation in the night and early morning when the sun is lower on the horizon. Near L_s 290°, morning and afternoon albedos are nearly the same, perhaps because the afternoon observations covered an area dominated by brighter substrate material.

In late summer and early autumn, temperatures decrease as the sun sinks toward the horizon. By the time the dune field disappears from view beyond the terminator, temperatures are again near those of frozen CO_2 (~148 K). In the last image in Figure 1 at L_s 36°, a twilight image, the contrast between the dark dunes and bright substrate is reduced relative to the previous image, and bright material is visible along the dunes, likely indicating the return of frost to the dune field.

Reference: [1]Edgett K. S. *et al.* (2000) *2nd Internat. Conf. Mars Polar Sci. Explor.*, Abstr. No. 4041.



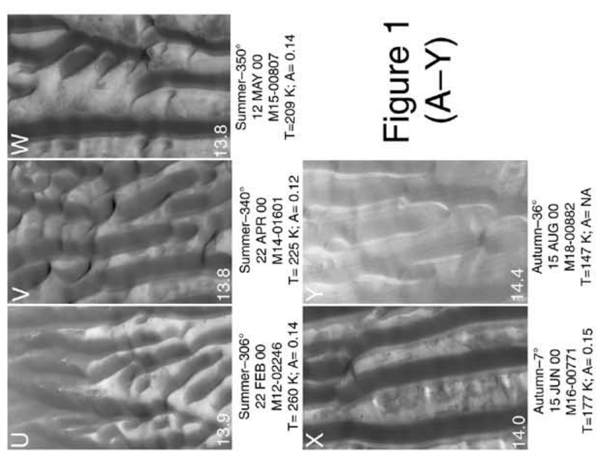


Figure 1 (A–Y)

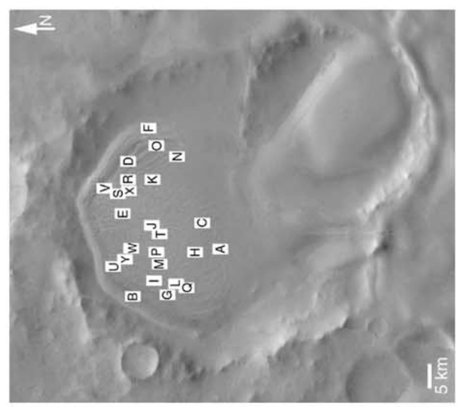


Figure 2

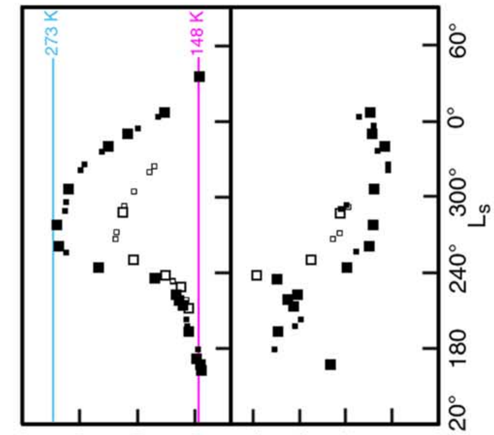


Figure 3