SPRING DEFROSTING OF MARTIAN POLAR REGIONS: MARS GLOBAL SURVEYOR MOC AND TES MONITORING OF THE RICHARDSON CRATER DUNE FIELD, 1999–2000.

K. S. Edgett, K. D. Supulver, and M. C. Malin, Malin Space Science Systems, P.O. Box 910148, San Diego, CA 92191-0148, USA.

Synopsis: Changes in the appearance of a defrosting dune field in the martian southern hemisphere are tracked from late winter into early summer. Changes become noticeable shortly after the dune field emerges into sunlight as winter transitions to spring. These changes, in the form of small dark spots formed on and along the base of the dunes, occur while surface temperatures are still around the freezing point of CO_2 (~148 K). Most of the changes occur over the course of spring, while temperatures are transitioning from those of frozen CO_2 toward the H_2O freezing point (~273 K). Late spring and early summer views acquired ~2 a.m. local time exhibit higher albedos than ~2 p.m. views obtained during the same period, suggesting that frost forms on these surfaces as the sun dips toward the horizon during early morning hours in these seasons.

Introduction: Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) images have shown that dune fields in the polar regions of Mars are the first surfaces to show signs of becoming frosted in autumn and defrosted in spring [1]. Repeated observations of the same dune field by both MOC and the MGS Thermal Emission Spectrometer (TES) provide a record of visual change as a function of temperature and season. In this preliminary study, we look at the dune field in Richardson Crater, located at 72.4°S, 180.0°W, as it was observed by MOC and TES between L_s 150° (June 1999) and L_s 310° (Feb. 2000).

Observations/Discussion: Figure 1 has 21 sub-frames of MOC images of the Richardson Crater dune field acquired between late winter and early summer. Each picture is shown at the same scale, covers an area approximately 2.2 by 3.4 km, and is oriented such that north is up. Figure 2 shows the size and location of each MOC sub-frame relative to a Viking orbiter view of the dune field. Although the sub-frames cover different portions of the dune field, each sample is presumed to be representative of what the entire dune field looked like—in terms of seasonal frost patterns—on the basis of other MOC observations of frosted dune fields which show that one area is fairly representative of the whole (*e.g.*, images in [1]). In general, the MOC images in Figure 1 show a slow transition from a dune field that is completely covered with seasonal frost at L_s 150° (Fig. 1A) to one that has no frost at L_s 306° (Fig. 1U). The L_s 150° and 164° views were obtained while the dune field was still in winter darkness—sufficient light was scattered over the horizon to allow images to be obtained. The summer views (Figs. 1S–1U) show that the dunes are darker than the substrate upon which they occur. The albedo contrast between the dunes and substrate does not become obvious until late spring (Figs. 1P–1R), which suggests that frost reduces this contrast until at least ~L_s 250°. During the middle spring period (Figs. 1I–1Q), a combination of dark- and light-toned spots and streaks are evident (note that the two long, wide dark surfaces in Fig. 1J are caused by underexposure in shadowed areas, not albedo). As of this writing we do not know what these bright and dark spots represent—perhaps the dark ones are patches of low albedo sand that have become exposed by defrosting, while light spots are patches of water frost formed by outgassing of the dunes as they begin to warm up. Alternatively, the bright and dark spots might all represent changes in the particle size and/or physical state of surface-covering frosts. Particle size is a suspect because these materials form streaks in response to local winds, and are thus thought to either have saltated (particle size) or settled to the surface (from outgassing at point sources on the dune surfaces).

Figure 3 shows changes in albedo and temperature as a function of L_s in the Richardson Crater dune field. All data used here were obtained at the same times that MOC images in Figure 1 were acquired. Filled circles represent data obtained at local time ~2 p.m., open circles are data from ~2 a.m. The temperatures are derived from the TES thermal bolometer (5.5–100 µm single band), the albedos from the TES visual bolometer (0.3–2.7 µm). The dunes in late winter are at temperatures consistent with frozen CO_2. Temperatures rise toward that of frozen H_2O throughout the spring, corresponding to the period in which the varied spots and streaks are observed. By late spring, temperatures reach ~273 K and all visual evidence for frost disappears—except in early morning images such as Fig. 1T, which has a corresponding albedo of 0.22 while the dune field and substrate typically have an afternoon albedo of 0.14.

Reference: [1] Malin M. C. and Edgett K. S. (2000) *LPS XXXI*, abstract #1056.

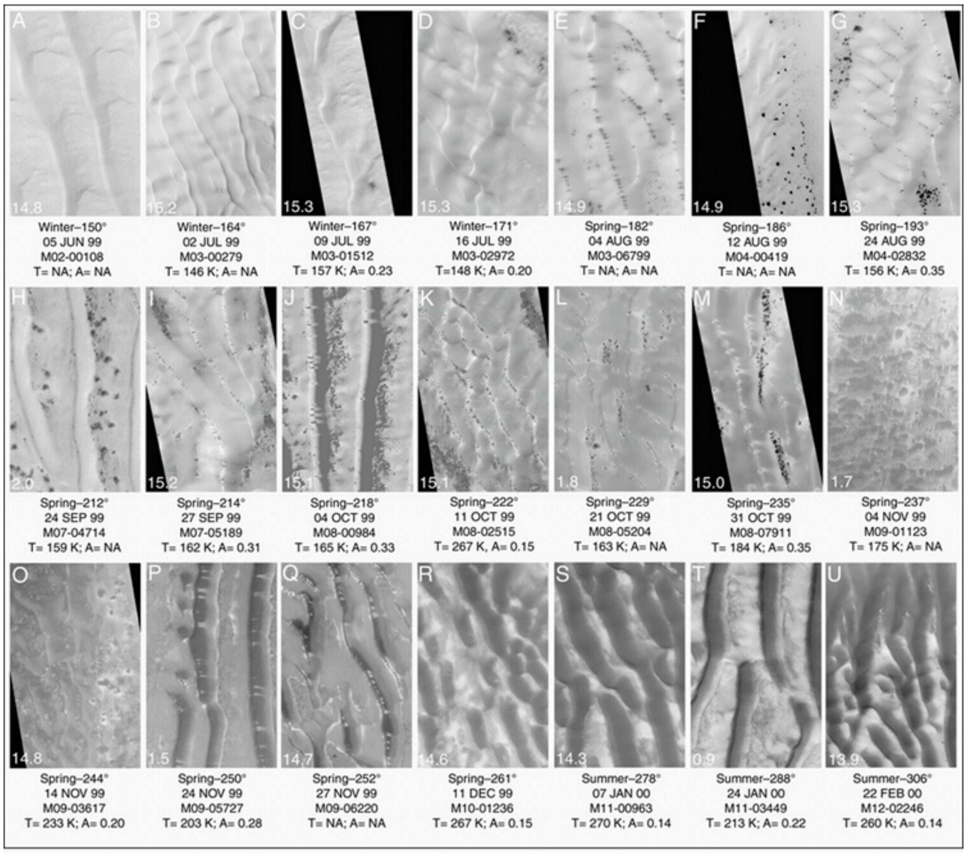

FIGURE 1

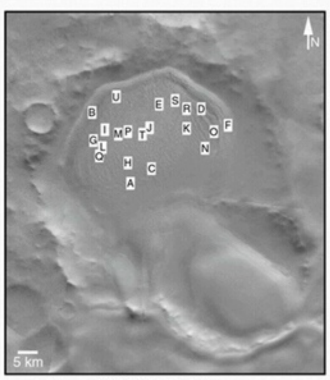

FIGURE 2

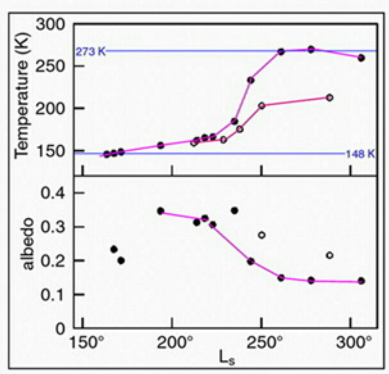

FIGURE 3

Figure 1: MGS MOC views of Richardson Crater dune field, L_s 150°–306°. Local time of day is given in lower left corner of each. See text for additional details. **Figure 2:** Context of each MOC image sub-frame in Figure 1. White boxes are same size (2.2 by 3.4 km) as Figure 1 images. **Figure 3:** MGS TES thermal bolometer temperatures and visual bolometer albedos obtained at the same time as MOC images in Figure 1. Filled circles are at ~2 p.m. local time, open circles ~2 a.m.