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In the early part of the Mars Global Surveyor mission, the spacecraft was in an elliptical orbit that provided good views of the south polar region on each orbit. During most orbits, the Thermal Emission Spectrometer, TES [1], was operated in a special scan mode designed to view the planet during a portion of each 100 minute roll. Extensive full spectral coverage of latitudes south of -55° were acquired during the southern spring. These data allow mapping of the polar cap regression, atmospheric temperatures, dust and ice-cloud opacity and occurrence of warm bare ground in the interior of the cap.

The low temperatures of the martian seasonal caps represent a challenging target for thermal spectroscopy. Corrections in addition to the regular TES radiometric calibration procedures are required, and reflected solar radiation must be considered. To mitigate the low SNR for single spectral points, TES spectra are used to synthesize a number of square bands, as well as the Viking IRTM bands [2].

During the period observed, the seasonal south polar CO_2 cap retreated continuously, and the atmosphere above the cap gradually warmed. There were indications of local, temporary incursions of moderately dusty air over the cap, with atmospheric dust generally being greatest near the cap edge. The outer few hundred km of the cap do not appear as a blackbody at the expected CO_2 condensation temperature, but, in the spectral regions with relatively low atmospheric absorption, have brightness temperatures increasing to higher wave number indicative of a mixture of frost and warmer bare ground, consistent with the caps visual appearance.

Throughout much of this period, the upper atmospheric temperature (T_{15}, equivalent to 0.6 mbar) had a consistent thermal gradient of about 0.2K per degree latitude away from the pole; the minimum (polar) temperature rose gradually, from 148K at L_S 185 to 170K at L_S 202. By L_S 222, dust opacity had reached a uniform value of 0.3 over nearly all the cap, and atmospheric temperatures showed a strong diurnal dependence. At this time, surface brightness temperature contrast was correlated with time of day and extended over the entire cap, indicating partial frost coverage.

Analysis for atmospheric opacity over a surface of mixed temperatures required development of inversion algorithms stable against the large apparent brightness temperature variations at high wave number due to noise. The cap regression curve has been determined using a thermal definition of the cap edge that represents the steepest gradient of surface conditions. During early spring, the resulting cap radius is smaller than was derived from telescope and imaging observations using reflected sunlight [3].

Early in this period, there was little contrast between the atmospheric temperature and the surface frost, and derived opacities have a large uncertainty. At L_S 191.5, τ was about 0.15 over the cap, rose to about 0.4 in the last 4° toward the cap edge, and dropped abruptly to about 0.05 off the cap. By L_S 204 atmosphere/ground thermal contrast was about 15 K; localized dust clouds of opacity about 0.2 have made incursions over the cap to within 10° of the pole. At L_S 223.5, when the atmosphere was about 30K warmer than the cap, the average opacity over the cap is 0.3, and off the cap τ is near 0.1. A sequence with about 45 km resolution reveals localized variation of dust clouds of about 200 km extent over the cap.

Thermal contrast between the surface frost and the atmosphere increase steadily during this period. For some later observations with resolution better than 50 Km, spectral variations within the cap can be associated with specific locations, indicative either of early partial frost removal or localized atmospheric dust.

References Cited: [1] Christensen, P. R. and 10 others, 1992; *J. Geophys. Res*., 97(E5), pp. 7719-7734; [2] Chase, S.C. Jr., Engel, J.L., Eyerly, H.W., Kieffer, H.H., Palluconi, F.D., and Schofield, D., 1978, Applied Optics, 17, pp. 1243-1251; [3] James, P.B.; Kieffer, H.H., and Paige, D.A., in *MARS*, Univ. of Arizona Press, Tucson, pp. 934-968.