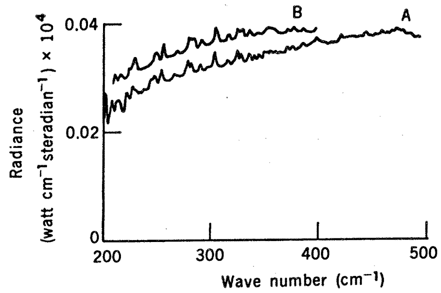

Fig. 4. The 200- to 500-cm^{-1} portion of the spectrum of the south polar cap of Fig. 1B shown on an expanded scale (curve A). The numerous spectral lines appearing in emission are due to rotational H_2O vapor lines in the lower Martian atmosphere. A synthetic H_2O vapor spectrum (curve B) is included for comparison; the spectrum has been shifted upward by 0.005 radiance unit.

is responsible for the fact that the CO_2 bands are seen partly in emission as in the polar spectrum shown in Fig. 1B. Surface pressure estimates are not yet available in this region, but the basic behavior of the profile was essentially unaffected as the surface pressure varied from 5 to 20 mb. Only the profile obtained with a surface pressure of 10 mb is shown. Figure 3 shows isotherms for a vertical cross section along a single scan pass down onto the cap and back off the cap again. The lower part of the diagram is uncertain because of the neglect of dust in the analysis and lack of knowledge of the surface pressure. The cross section shows a highly localized region of warm air at approximately 1 to 2 mb in the vicinity of the cap. The substantial solar illumination during the south polar summer, the reflection of solar energy by the cap, and atmospheric dynamical effects are all possible mechanisms that could produce this effect.

The polar spectra also show rotational lines of H_2O vapor in the region between 200 and 350 cm^{-1}. This portion of the IRIS spectrum from Fig. 1B has been expanded in Fig. 4. Consistent with atmospheric temperatures warmer than surface temperatures, the H_2O vapor lines appear in emission. Also shown in Fig. 4 is a synthetic slant path spectrum composed by the use of the two-surface temperature model described above. The excellent spectral correspondence verifies the existence of atmospheric H_2O vapor in the south polar region. Spectral features of H_2O vapor appear more weakly over other regions of the planet. Possible reasons for the fact that H_2O vapor is not more prominent there may be sought in the near-isothermal nature of the temperature profiles, the shielding effect of the dust, or possibly a lower H_2O vapor concentration away from the south pole.

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Infrared Radiometry Experiment on Mariner 9

Abstract. *The brightness temperatures at 10 and 20 micrometers measured by the Mariner 9 infrared radiometer differ substantially from those predicted by the radiometer results of Mariners 6 and 7. The results indicate a significant latitude-dependent contribution of the atmospheric dust to the observed thermal emission.*

A two-channel infrared radiometer similar to that carried on Mariners 6 and 7 was included on Mariner 9 in order to extend and improve the surface coverage and spatial resolution obtained on the earlier flights (*1*). The radiometer measures the 10- and 20-μm radiation over an area coaxial with, and equal to about two-thirds of, that covered by the high-resolution television camera. At periapsis, the linear scale resolved by the radiometer approaches 20 km. The temperature resolution is on the order of 0.5°K. The radiometer has operated in orbit as expected. We now present preliminary results provided by the radiometer, particularly those related to the dust storm prevalent on Mars during these observations. This discussion is qualitative because geometry data and local times have not been available for most of the orbits.

In 1969, radiometric measurements of the largely dust-free planet could be explained in terms of simple thermal models with no appreciable influence by the Martian atmosphere. In 1971, in contrast, the general features of the observed thermal variations do not follow such simple models. The most striking difference is exhibited by the amplitude of the diurnal variations. On the basis of a typical 1969 model (thermal inertia = 0.006 cal cm^{-2} sec$^{-1/2}$°K^{-1}, albedo = 0.3), the surface temperatures at a latitude of about −30° were expected to range from 185°K near the morning terminator to a peak of 290°K near the local noon. In fact, the observed brightness temperatures at this latitude have ranged only from 195°K just before sunrise to a maximum of 225°K. The maximum temperatures measured (around 250°K) occur at latitudes close to −65°. This observed thermal behavior cannot be explained by a simple conductive model without invoking unreasonable values of the thermal inertia. On the other hand, qualitative agreement with the observations can be obtained using simple models that incorporate an atmospheric dust layer with modest visual absorption and reflectivity, with infrared emissivity and absorption coefficients of about 0.5, and with a heat capacity corresponding to that of the lower scale height of the atmosphere. The properties of the dust layer must be latitude dependent in the sense that its optical thickness must decrease toward the southern polar region.

The television experiment on Mariner 9 has shown that the southern polar region, as well as certain other isolated areas of Mars, are relatively clear of obscuration by the dust. The residual polar cap is the most well defined feature observed in the thermal scans of Mars, and typically appears 35°K colder than the surrounding terrain.

At the surface of Mars, solid CO_2 must be at its saturated-vapor equilibrium temperature of 148°K. This temperature was observed by Mariner 7 for the south polar cap during the early Martian spring, indicating that the bright deposit was predominantly frozen CO_2 at that time. In contrast, the minimum brightness temperature observed by the Mariner 9 radiometer over the shrinking south polar cap, slightly after Martian southern midsummer, is at least 25°K above the temperature that would correspond to frozen CO_2. From television images obtained simultaneously with the radiometer measurements, the observations correspond to an area at least 95 percent of which is covered with a high albedo deposit.

If the cap is frozen CO_2, these data can be taken to indicate significant emission from the dusty atmosphere. The infrared optical thickness cannot, however, exceed unity as temperature variations have been observed which correlate with sharp features seen in visual images. The net amount of particulate matter required to produce the needed opacity is on the order of 1 mg cm^{-2} if its absorption coefficient is typical of silicates in the 10-μm range (*2*). The possibility that some or all of the residual deposit is now frozen water cannot be excluded on the basis of these data alone.

The southernmost dark feature in Tharsis, at latitude $\sim 11°$, longitude $\sim 119°$W, also revealed on television images (*3*), was recognized by the radiometer as a region of about 300 km in length with a temperature about 8°K warmer than its surroundings. A straightforward interpretation of this phenomenon is that locally the atmosphere is more transparent, allowing increased energy to be absorbed by a darker surface. It is of interest to note that near this point radar topographic mapping (*4*) shows an apparent ridge about 8 km higher than the mean elevation of Mars at this latitude. This provides a measure of the height of the effective dust layer.

Further analysis of the data is necessary to substantiate these preliminary interpretations.

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Mariner 9 Ultraviolet Spectrometer Experiment: Initial Results

Abstract. *The ultraviolet airglow spectrum of Mars has been measured from an orbiting spacecraft during a 30-day period in November–December 1971. The emission rates of the carbon monoxide Cameron and fourth positive bands, the atomic oxygen 1304-angstrom line and the atomic hydrogen 1216-angstrom line have been measured as a function of altitude. Significant variations in the scale height of the CO Cameron band airglow have been observed during a period of variable solar activity; however, the atomic oxygen and hydrogen airglow lines are present during all the observations. Measurements of the reflectance of the lower atmosphere of Mars show the spectral characteristics of particle scattering and a magnitude that is about 50 percent of that measured during the Mariner 6 and 7 experiments in 1969. The variation of reflectance across the planet may be represented by a model in which the dominant scatterer is dust that absorbs in the ultraviolet and has an optical depth greater than 1. The atmosphere above the polar region is clearer than over the rest of the planet.*

Two major objectives of the ultraviolet spectrometer experiment are (i) measurement of the structure and composition of the upper atmosphere and (ii) photometric and spectral mapping of the lower atmosphere and surface of Mars (*1*). The upper atmosphere measurements are performed by observing the sunlit limb of the planet as the spacecraft motion causes the field of view of the instrument to pass through successively lower levels of the atmosphere. Measurements of the lower atmosphere are obtained by pointing the instrument directly at the area of the planetary disk that is being mapped. The Mariner 9 spectrometer is similar to those used on Mariners 6 and 7 and OGO-4 (*2*). During the first 30 days of the mission, the ultraviolet spectrometer measured the temperature and density of the upper atmosphere of Mars and discovered that this atmosphere, like the earth's, responds to changes in solar activity. The spectrometer also measured the spectral and photometric properties of the atmosphere during the protracted dust storm of 1971.

During the first 30 days, observations of the airglow above the bright limb of Mars made on 14 orbits were of sufficient quality to provide good altitude profiles. The principal spectral emissions observed during these limb crossings were those first measured in 1969 by the ultraviolet spectrometers on Mariners 6 and 7 (*3*): namely, the atomic hydrogen 1216-Å Lyman-alpha line; the atomic oxygen 1304-, 1356-, and 2972-Å lines; the atomic carbon 1561- and 1657-Å lines, the carbon monoxide A-X fourth positive and a-X Cameron bands, the ionized carbon monoxide B-X first negative bands, and the ionized carbon dioxide B-X and A-X bands. This Martian airglow is produced by the action of solar ultra-