THE LATITUDE VARIATION OF WATER VAPOR ON MARS

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Abstract. Spectra of Mars, centered on the 8200 Å band of H_2O, have been obtained using the coudé spectrograph of the 107-inch telescope at McDonald Observatory with reciprocal dispersion of 1.9 Å/mm. The plate scale (4.4 arc sec/mm) and angular resolution (3″–6″) were sufficient to measure the strength of the Doppler-shifted H_2O lines at 5 points across the disk.

The spectra were obtained in March and April 1969, when the apparent diameter of Mars was 10″ to 16″ during mid-summer of the northern hemisphere; the Doppler shift at 8200 Å varied from −0.42 Å to −0.28 Å. On the first plate, obtained on March 27, 1969 the abundance reached a maximum of about 48 μ precipitable H_2O at 30° to 40° north latitude and decreased to about 20 μ at 30° south latitude. The second plate, taken on April 28, 1969 showed the same north-south decrease in abundance but the total amounts were about two-thirds of the March abundances.

Observations

Three spectra of Mars have been obtained at 1.9 Å/mm dispersion and with a plate scale of 4.4 arc sec/mm, centered on the 8200 Å H_2O band, using the coudé spectrograph of the 107-inch (2.7 m) telescope at McDonald Observatory (Tull, 1969).

The observational parameters are summarized in Table I. Twenty-nine weak absorption lines have been detected on these plates, near the expected Doppler-shifted positions of unblended lines due to water vapor in the atmosphere of Mars. These are on the violet wings of strong telluric H_2O lines. Of these, 10 lines on plate 16, and 6 lines on plate 45, were of high enough quality for the measurement of equivalent widths, and hence of total atmospheric water abundance, as a function of latitude on Mars.

TABLE I
The observations

Plate	1969 date	L_s	Phase angle	Velocity	Slit	Emulsion
16	3/27	132°	35°	−15.6 km/sec	no rotator	Ammoniated IV–N
45	4/28	148°	24°	−11.2	N–S	Ammoniated IV–N
47	5/2	150°	22°	−10.4	E–W	Ammoniated IV–N

Reductions

The equivalent widths were measured with the aid of a Joyce-Loebl microdensitometer at 4 and 5 points across the spectrum and were calibrated against weak Fraunhofer lines of known equivalent widths (Moore *et al.*, 1966). These were corrected to total H_2O abundance along the double path through the atmosphere, using the tables of Janssen and Korb (1968) and the H_2O line strengths determined in the laboratory by Farmer (1971), and were then corrected to unit air mass, taking into account the seeing and guiding smear across the spectrum.

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Results

Figures 1 and 2 show the resultant water vapor distributions as a function of effective distance from the center of the disk, along the spectrograph slit. In Figure 2, this distance is expressed as latitude on Mars. For Figure 1, the image rotated on the slit over the area indicated in the diagram; the observed abundances, therefore, represent the integrations of the actual abundances over the rotation of the slit. The filled circles are reductions from microdensitometer tracings using a 60 μ slit width (projected on the plate), while the open circles result from a second reduction of the same plate, using a 30 μ slit width. Vertical error bars are probable error of the means; horizontal bars are effective microdensitometer slit length. The solid curve represents the resultant of an integration over the rotation of the slit, of an assumed H_2O distribution given in Table II.

The work presented here will be described in full in a forthcoming publication (Tull, 1970).

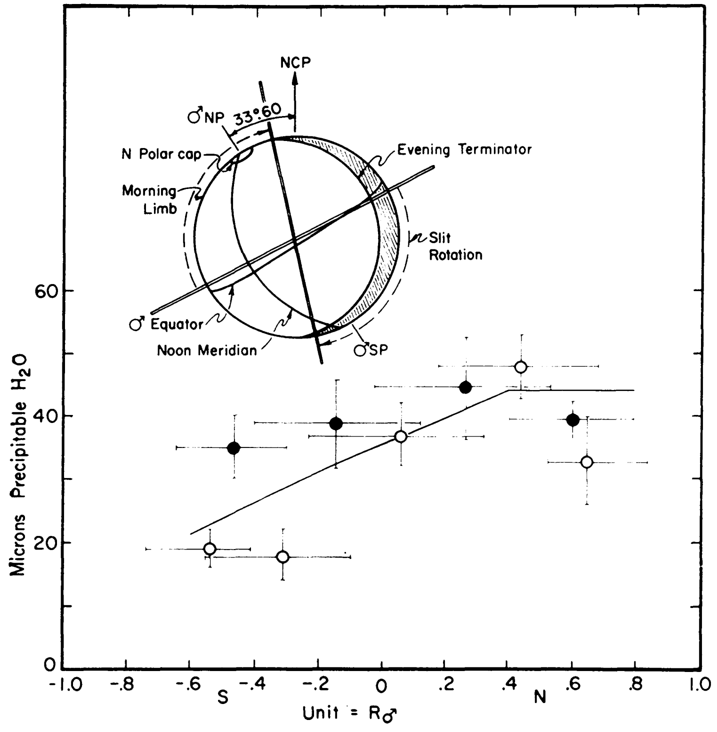

Fig. 1. Geometrical configuration, and measured distribution of water vapor in the Martian atmosphere, from Plate 16 (27 March, 1969). Filled circles result from a microdensitometer tracing with a projected slit width of 60 μ; open circles were obtained using a 30 μ projected microdensitometer slit. The image rotated on the spectrograph slit through 105° during the 7-hour exposure, as indicated in the diagram. The solid curve represents an integration, over the rotation of the slit, of the assumed H_2O vapor distribution given in Table II. Vertical bars are probable error of the means; horizontal bars represent the effective location and length of the microdensitometer slit.

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TABLE II

Assumed distribution of H_2O on March 27, 1969

Sine (Latitude)	Abundance
+0.8	45 μ precipitable H_2O
+0.6	46
+0.4	48
0.2	42
0	35
−0.2	28
−0.4	21
−0.6	13

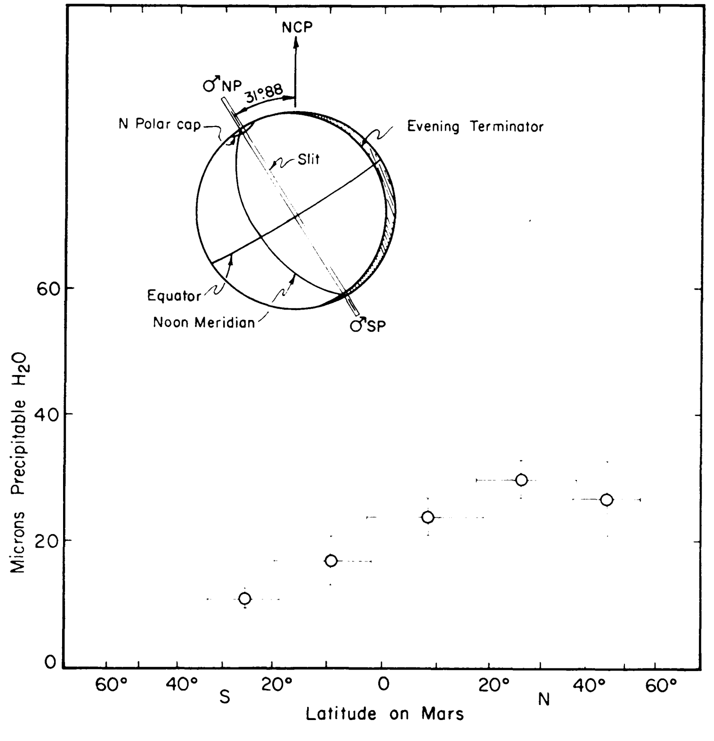

Fig. 2. Geometrical configuration and measured H_2O distribution from Plate 45 (28 April, 1969), as in Figure 1 except that the image was held fixed on the slit by an image rotator. Exposure 6 hours.

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