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FACTORS GOVERNING WATER CONDENSATION IN THE MARTIAN ATMOSPHERE: D. S. Colburn, J. B. Pollack and R. M. Haberle, NASA Ames Research Center, Moffett Field CA 94035

In a previous paper (1) we described the use of atmospheric optical depth measurements at the Viking lander sites to show diurnal variability of water condensation at different seasons of the Mars year. Factors influencing the amount of condensation include latitude, season, atmospheric dust content and water vapor content at the observation site. A one-dimensional radiative-convective model is used here based on the diabatic heating routines under development for the Mars GCM (General Circulation Model). The model predicts atmospheric temperature profiles at any latitude, season, time of day and dust load. From these profiles and an estimate of the water vapor one can estimate the maximum and minimum condensation in the diurnal cycle, the maximum occurring at an early morning hour (AM) and the minimum in the late afternoon (PM). Measured variations in atmospheric optical density between AM and PM measurements have been interpreted as differences in AM and PM water condensation.

A parametric study has been undertaken to investigate further the condensation process. Figures shown here represent model predictions of AM and PM condensation at the two lander sites (Figure 1 for VL1 and Figure 2 for VL2) at various times of the Mars year, as represented by Ls, the solar longitude (Ls = 0 is northern vernal equinox). The water vapor content of the atmosphere is fixed for these computations at 11 precipitable microns (pr-μ), which appears to be a typical value in data supplied by the MAWD experiment (B. Jakosky, private communication). While the amount of water vapor normally changes during the year, it was fixed for this study in order to identify the effects of other parameters. Calculations not shown here indicate that condensation increases with larger water vapor content. Both water vapor and dust are assumed to be uniformly mixed with the atmosphere. Each figure shows the AM and PM condensation predicted for two values of dust content, i.e. with the atmospheric optical depth tau equal to 0.3 and 2.0. The value tau=0.3 is approximately the lowest measured at the lander sites, and can be considered to be background level in the absence of global dust storms. The higher value represents a typical value during the two global dust storms encountered at the lander sites.

Figure 1 shows the maximum AM condensation to occur near Ls=270, the northern winter solstice, when atmospheric temperatures are lowest. The lack of symmetry for Ls values less than and greater than 270 is attributed to the eccentricity of the orbit, which places Mars closest to the sun at Ls=251. The PM condensation at the latitude of VL1 (22.4 N) is nearly negligible over the whole year, and the AM-PM difference is nearly equal to the AM value. For low dust content, the AM value is appreciable over the whole year, with a maximum of 2.2 pr-μ.

The effect of the higher dust content (tau=2.0) varies according to the season. Over most of the year it warms the atmosphere sufficient to keep the AM condensation much lower than for lower dust content. However, at Ls=270 , the AM condensation for tau=2.0 is higher than for lower dust content values. The explanation is believed to lie in the variation in temperature profiles with season, which is being explored using the model, but not shown here.

Figure 2 shows predicted condensation at the latitude of VL2 (47.9 N). At Ls=270 condensation for AM and PM for both dust levels is nearly 11 pr-μ, i.e. the temperature is cold enough over the whole day to condense nearly all of the available water vapor. (For this simplified condensation model, the value 11 pr-μ represents the total of vaporous and liquid H2O rather than vapor alone.) On either side of Ls=270, i.e. $180 \le Ls \le 360$, an increase of dust content increases the AM condensation and decreases the PM condensation, thereby increasing the AM-PM difference in two ways. However, at $45 \le Ls \le 135$ an increase in dust decreases the AM and PM condensation and their difference.

Consequently, because of the saturation effect at the latitude of VL2, the AM-PM difference is small at Ls=270, and there are two peaks during the year, one near Ls=225 and the other near Ls=360.

In conclusion, it is seen that the diurnal variation in condensation is a complicated function of the latitude, the season, the water vapor content and the dust content of the atmosphere.

REFERENCES

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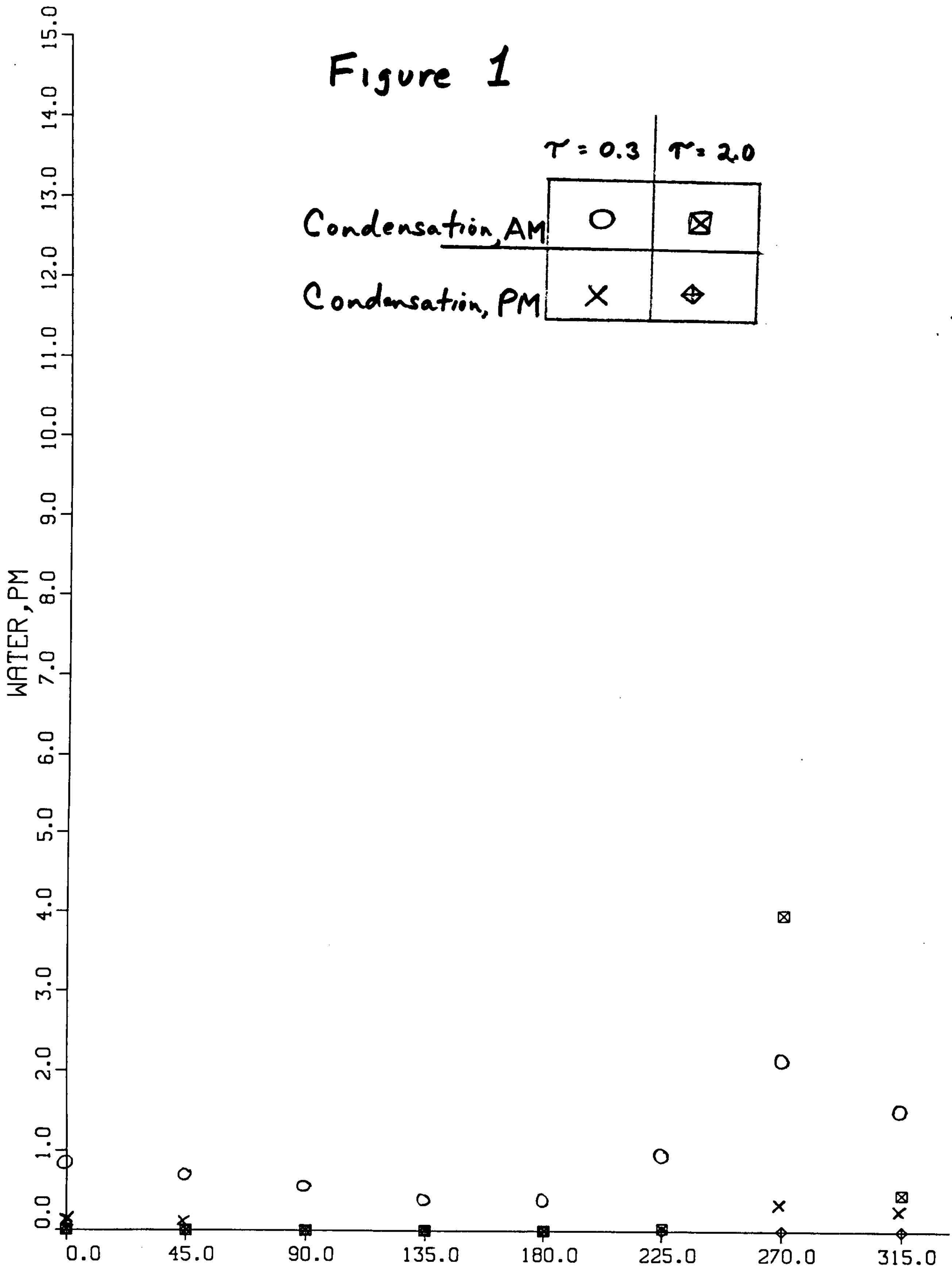
Figure 1
τ = 0.3
τ = 2.0
Condensation, AM
Condensation, PM
WATER, PM
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
0.0
45.0
90.0
135.0
180.0
225.0
270.0
315.0

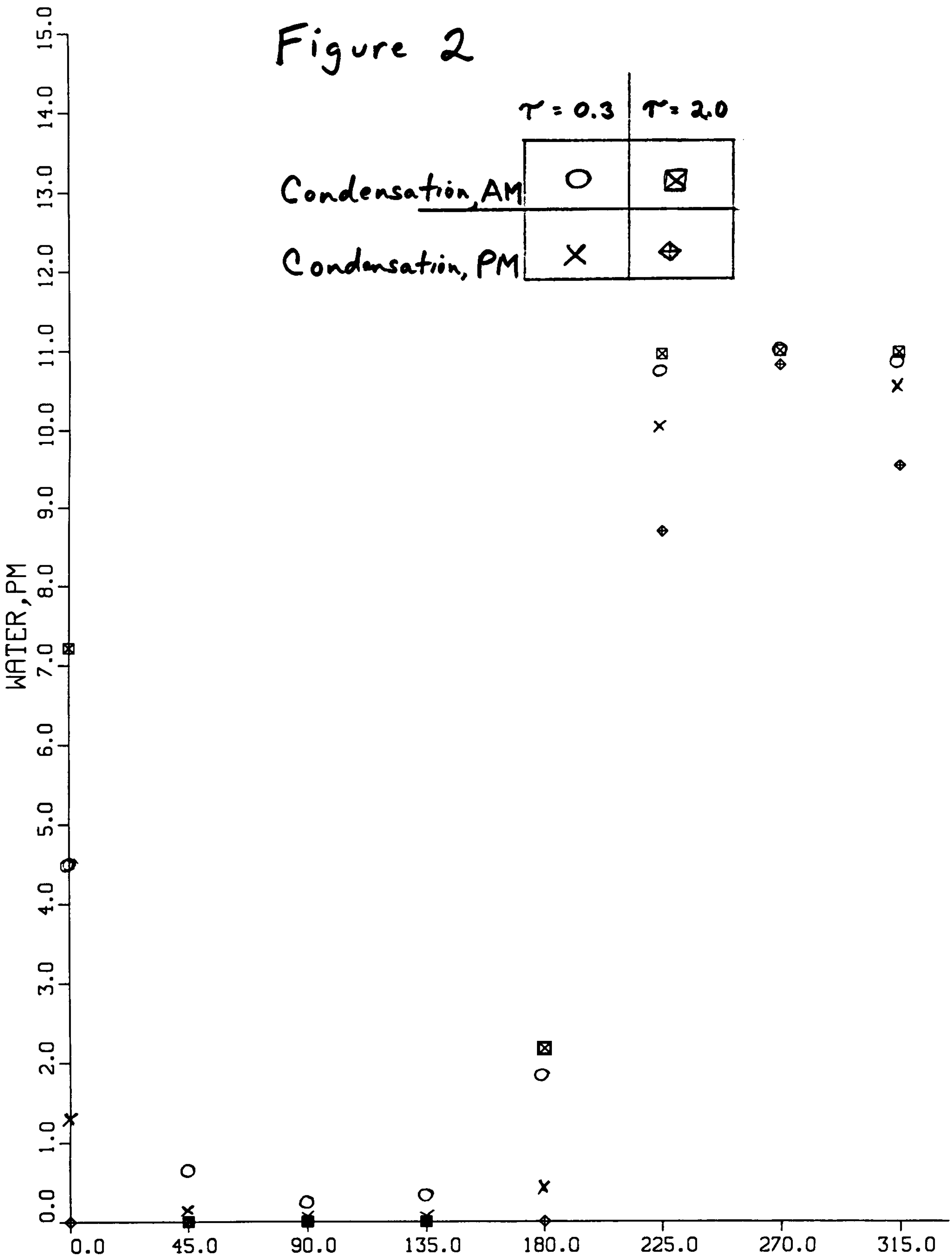
Figure 2
τ = 0.3
τ = 2.0
Condensation, AM
Condensation, PM
WATER, PM
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
0.0
45.0
90.0
135.0
180.0
225.0
270.0
315.0