VERTICAL DISTRIBUTION OF WATER VAPOR IN THE ATMOSPHERE OF MARS: ERROR ANALYSIS AND PRELIMINARY RESULTS, H. M. Hart and B. M. Jakosky, Laboratory for Atmospheric and Space Physics, University of Colorado.

Viking Orbiter Mars Atmospheric Water Detector (MAWD) observations have previously been analyzed to obtain estimates of the global and seasonal abundance of atmospheric water. These estimates were obtained by matching observed transmit-tances to those for homogeneous paths with specified water abundance, pressure and temperature (W, P, T). The pressure and temperature were set to fixed values for the matches, yielding effective water vapor abundances. We are extending the data analysis to obtain, in addition to the water abundance, the effective pressure and temperature of the atmosphere where the water resides, in order to place limits on the vertical distribution of water vapor in the atmosphere.

The inversion routine takes transmittances calculated from MAWD radiances and recovers values of W, P and T by minimizing the difference between the input transmittances and the transmittances associated with homogeneous paths. The inversion can be used to simultaneously recover all three variables, or values of P and T may be fixed so that the inversion recovers only W. To date, we have checked the inversion for internal consistency and evaluated the effects of noise in the radiance measurements on the inversion. This has enabled us to make error estimates for water abundances derived from the MAWD data set. We have also inverted some data, recovering values for W, P and T, with interesting results.

The error analysis consisted of evaluating the effects of noise on the recovery of W, P and T; the effects of averaging large amounts of data; and the effects of fixing P or T incorrectly in an inversion. The one-sigma radiance noise has been found to be 1-2%. To evaluate the effects of noise on the inversion, radiances perturbed by a fixed percentage were input to the inversion routine and the perturbation in the resultant values of W, P and T recorded, producing a mapping of radiance error bars into WPT space. The one-sigma uncertainty for the recovery of W alone (fixed P, T) from a single measurement is thus found to be 20-30%. For the simultaneous recovery of W, P and T from a single measurement, the one-sigma uncertainty is much larger than 100%. Averages over 400 data points reduce the one-sigma uncertainty in the radiances to 0.1%. The uncertainty in the recovery of W alone then becomes 2-3%, and the uncertainties in the recovery of W, P and T become 20-30% for W and P and 5-15% for T. Therefore, averaging over a large number of points reduces the WPT error bars to acceptable levels. We have found that there is very little difference between recoveries made with averaged radiance measurements and averages of recoveries made for single measurements. This linearity in the inversion allows the averaging of large numbers of individual measurements in order to reduce the uncertainties.

Fixing P and T in the inversions allows the possibility of fixing P and T incorrectly, which will affect the recovery of W. If water vapor is assumed to be uniformly distributed in altitude, the effective pressure of the atmospheric column can be set to 1/2 the surface pressure, using the Curtis-Godson approximation. Inversions have previously been done fixing T to 200 K and fixing P to 1/2 the surface pressure. However, if the water is in reality concentrated near the surface, for example, P and possibly T would have been fixed in the inversion to values lower than their appropriate effective values. The abundance recovered by the inversion in such a situation would be systematically higher than the actual abundance by a factor of about 2. There is no global mechanism for concentrating water vapor near the surface, however, so errors of this magnitude should occur at extremely localized places and times.

A small subset of the data has been inverted to simultaneously recover values of W, P and T. We expect that scattering of light by dust in the atmosphere will affect the transmittance in such a way as to make matching observed transmittances to those for homogeneous paths more difficult. Accordingly, we have examined binned averages of radiances during clear times, moderately clear times, and dusty times. Of 103 bins, eight were successfully matched to homogeneous paths. Of these eight, none were during the clear periods. All were during moderately dusty periods, and all matches were for bins over dark albedo features. Recovered abundances ranged from 4 to 9 precipitable microns, pressures from 3 to 11 mbar, and temperatures from 213 K to 291 K. We compared the abundances from these simultaneous inversions with those from inversions with P and T fixed. The recovered pressures were compared to the surface pressure, and the temperatures to 200 K. These comparisons indicate that for five of the bins the water vapor is close to being uniformly distributed with altitude. In the remaining three bins the water vapor appears to be concentrated in the lower part of the atmosphere.

The inversions during the clearest times did not yield any successful matches. It is possible that there is always too much dust in the atmosphere to allow successful recovery of W, P and T, and that the matches we did find are special cases. The correlation between matched bins and dark surface albedo indicates that there is something subtle going on with the radiative transfer that will have to be modeled in detail. Dark regions may be less dusty than bright regions. Also, dark regions could have a lower incidence of ice clouds. This would be consistent with obtaining no matches during the least dusty periods, which occurred during northern spring, a time of increased cloudiness. We are constructing radiative transfer models to examine the effects of dust and ice clouds on the transmittances.