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THE INTERPRETATION OF DATA FROM THE VIKING MARS ATMOSPHERIC WATER DETECTORS (MAWD): SOME POINTS FOR DISCUSSION; Stephen M. Clifford, Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058.

Properly interpreted, water vapor column abundance measurements can provide important insights into many of the processes that govern the diurnal, seasonal, and climatic cycles of atmospheric water on Mars. Presently, the largest body of such data comes from the Viking Orbiter Mars Atmospheric Water Detectors (MAWD). These instruments were operational from 1976 to 1979; their mode of operation and preliminary results have been discussed in detail by Farmer et al. (1977), Jakosky and Farmer (1982) and Jakosky (these abstracts).

Unfortunately, some uncertainty exists over the correct interpretation of the MAWD data — particularly with regard to estimates of the magnitude and direction of atmospheric H_2O transport (e.g., James, 1985) and the identification of possible regolith sources and sinks (i.e., Huguenin and Clifford, 1982). This uncertainty stems from our almost complete inability to 'ground-truth' the interpretations made from orbital data. Indeed, there are only two locations on the martian surface for which we have any quantitative meteorological information. This consists of limited measurements of windspeed, direction, atmospheric pressure, temperature, and opacity, at the landing sites of VL 1 (22.4°N, 47.5°W) and VL 2 (44°N, 226°W).

While direct tests of the various interpretations of the MAWD data are not possible, an alternative approach may exist. Since the mid 1950's, a number of detailed studies have been made of the diurnal and seasonal behavior of atmospheric water vapor on Earth. Over the past decade many of these studies have included atmospheric H_2O column abundance measurements made from Earth orbit. The functional similarities between these Earth orbital instruments and the MAWD experiment are striking. In terrestrial studies, the existence of numerous concurrent surface and airborne meteorological observations greatly aids the task of interpreting the dynamic behavior of H_2O from orbital measurements. This experience may provide an important observational foundation from which to analyze and interpret any similar Mars data - whether it be measurements already obtained by the Viking MAWD, or those anticipated from Mars Observer.

Among the questions that might benefit from a comparative analysis of Earth and Mars water vapor observations are:

What factors and processes govern the storage and exchange of H_2O between planetary surfaces and atmosphere on diurnal and seasonal time scales?

Do regolith sources and sinks of H_2O have uniquely identifiable water vapor column abundance signatures?

How much can be learned about the diurnal and seasonal cycles of H_2O from an analysis of water vapor data alone?

What levels of time and spatial resolution are necessary for determining dynamic behavior?

Can the direction of vapor transport be accurately inferred from the magnitude and direction of atmospheric column abundance gradients, or do processes exist that can drive vapor transport counter to the observed gradient?

What specific design and operational similarities exist between the various Earth and Mars orbital instruments?

Finally, how might our experience with Earth orbital instruments and the Viking MAWD benefit our understanding of the data we hope to receive from Mars Observer?

References:

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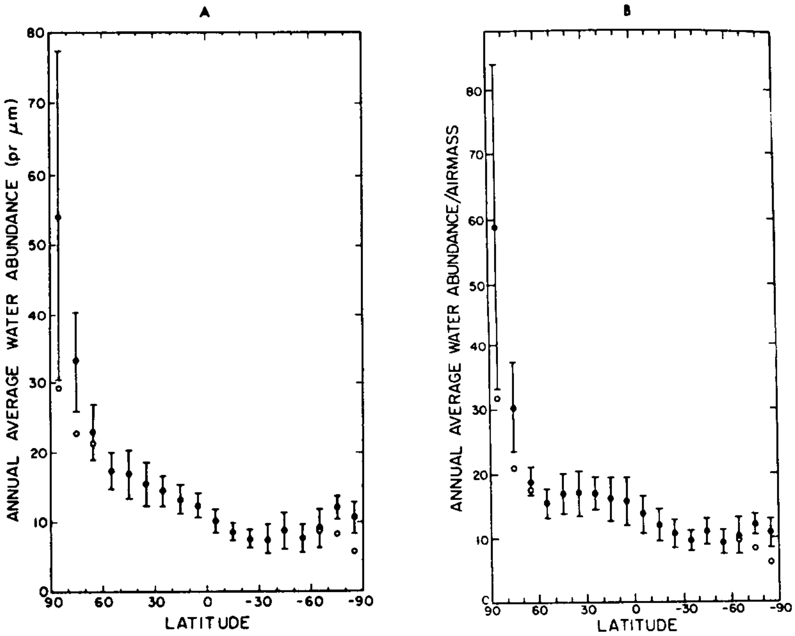

Fig. 1 . (*a*) Latitudinal behavior of the annual average vapor abundance. One-sigma bars show the variation at each latitude rather than errors. The near-polar data have been corrected (open circles) for lack of observations during the polar night by assuming zero abundance at that time. (*b*) Latitudinal behavior of the annual average vapor abundance/airmass. [*Jakosky and Farmer*, 1982].

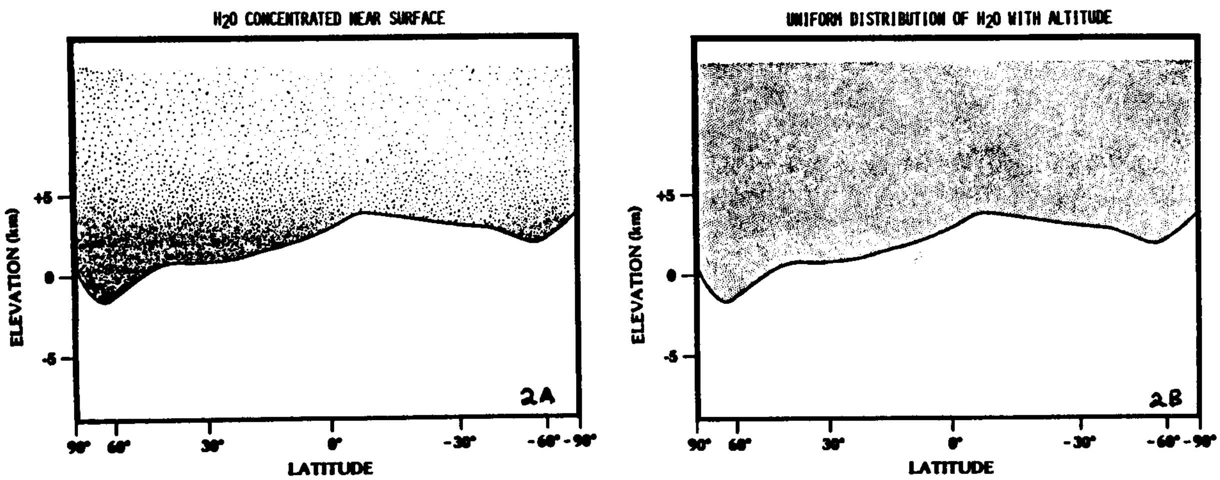

Figure 2. The apparent north to south gradient in zonally averaged vapor abundance seen in Figure 1, may result from an inadequate correction for airmass. Figures 2a and 2b depict the relationship between zonally averaged airmass and topography. Although the horizontal latitude scale for these figures is projected from a sphere (in contrast to the linear scale in Figure 1), a distinct inverse correlation is readily identified between the zonally averaged topography and the zonally averaged vapor abundance. The magnitude of the vapor gradient should reflect the vertical distribution of H_2O in the atmosphere. Clearly, the gradient will be strengthened by vapor concentrated within the lowermost scale height (Figure 2a) and weakened by uniform mixing to several scale heights (Figure 2b). Since the concentration of vapor in either case is constant for a given geopotential, no net hemispheric exchange of vapor is implied.