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THE DIRECTION OF WATER TRANSPORT ON MARS: A POSSIBLE PUMPING MECHANISM.

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William Herschel (1) first recognized that a seasonal volatile cycle was revealed by variations of the martian polar caps which, by analogy with Earth, he assumed were composed of water ice. Leighton and Murray (2) demonstrated that carbon dioxide was a more likely candidate for the polar volatile, and this was confirmed by the infrared observations of Mariner 7 (3). Surface pressure measurements by Viking landers (4) as well as accurate polar cap measurements from Viking orbiter images (5) have afforded the opportunity to quantitatively model the CO_2 cycle thereby constraining the physical mechanisms which play a role in the martian climate system.

Viking data also revealed an active hydrologic cycle on Mars through observations of a water ice residual north polar cap (6) and vapor in the atmosphere (7). The surface ice and atmospheric water vapor abundances observed by Viking experiments are quite asymmetric in their latitudinal distributions. This has raised the interesting question of the direction of net water transfer on Mars at the present time; is water transferred from north to south or from south to north when integrated over an entire seasonal cycle? Jakosky (8) has correctly noted that transfer should be in the direction of the negative gradient of the net vapor distribution if no pumping mechanisms are present. Scavenging of vapor by the cold CO_2 permanent cap in the south should also cause a north to south transfer.

A mechanism which can "pump" water from south to north on Mars does exist for the current orbital parameters of Mars. It is provided by the asymmetric seasonal temperature distribution produced by the eccentric

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martian orbit and by the associated seasonal asymmetry in the carbon dioxide cycle. The alternating condensation and sublimation of CO_2 at the poles produces condensation winds (9) which, in turn, contribute to the meridional transport of water vapor. For the current values of orbital elements, the phasing of these asymmetric condensation winds with the surface temperatures is such as to provide net south to north transport during the seasonal cycle (10). This pumping action is strong enough to overcome the tendency of vapor to diffuse down the gradient and can maintain the asymmetric water distributions observed. The question of long term entrapment of water by a permanent CO_2 cold trap in the south is less clear cut; the pumping mechanism will reduce the rate of condensation, but long term effects depend on the long term stability of the residual south cap, which is not certain.

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