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Mesoscale modeling of the water vapor cycle at Mawrth Vallis: a Mars2020 and ExoMars exploration rovers high-priority landing site

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Introduction:
The Mars Regional Atmospheric Modeling System (MRAMS) was used to predict meteorological conditions that are likely to be encountered by the Mars 2020 (NASA) Rover at several of their respective proposed landing sites during entry, descent, and landing at Ls5 [1] and by the ExoMars (ESA) Rover at one of the final landing sites. MRAMS is ideally suited for this type of investigation; the model is explicitly designed to simu-late Mars' atmospheric circulations at the mesoscale and smaller with realistic, high-resolution surface proper-ties [2, 3]. One of the sights studied for both rovers was Mawrth Vallis (MV), an ancient water outflow channel with light colored clay-rich rocks in the mid-latitude north hemisphere (Oxia Palus quadrangle). MV is the northernmost of the Mars2020 and ExoMars landing sites and the closest to the northern polar cap water source. The primary source of water vapor to the atmosphere is the northern polar cap during the northern summer. In order to highlight MV habitability implications, additional numerical experiments at Ls90, 140 and 180, highest column abundance of water vapor is found over MV [4], were performed to study how the atmospheric circulation connects MV with the polar water source. Once the winter CO_2 retreats, the underlying polar water ice is exposed and begins to sublimate. The water is transported equatorward where it is manifested in the tropical aphelion cloud belt. If transport is assumed to be the result of the summer Hadley Cell, then the polar water is carried aloft in the northern high latitude rising branch before moving equatorward and eventually toward the southern high latitudes. Thus, the mean meridional summer circulation precludes a direct water vapor connection between MV and the polar source. Around the equinoxes (Ls0 and Ls180), there is a brief transition period where the rising branch quickly crosses from one hemisphere into the other as it migrates to its more typical solstitial location. During this transition, there is surface convergence into the rising branch (similar to the inter-tropical convergence zone on Earth), and dual Hadley cells with one circulation in each hemisphere. At this time, the mean surface winds flow from the high latitudes to equator in both hemispheres, providing the possibility for a direct vapor connection [5, 6]. It is likely that transient waves (e.g., storm systems) as well as boundary currents associated with planetary-scale stationary waves could advect and mix water equatorward, along the surface, in opposition to the Hadley Cell.

Conclusion:
We are studying whether moist air in northern spring/summer makes it to the surface of Mawrth at Ls 90, Ls 140 and Ls 180, three periods with high column abundance of water vapor at mid/high latitudes. The objective is to determine if the circulation (mean or regional) is favorable for the transport of water vapor from the north polar cap to MV where it might activate hygroscopic salts and/or chlorides [7]. Relative humidity at those different seasons is estimated to test for consistency with column abundances derived from orbit observations. If moist air makes it to MV during Ls90, 140 and/or 180, it should be a go-to site due to enhanced habitability implications.

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