NEW MODELS FOR SHORT-TERM VARIABILITY OF MARTIAN VOLATILE ESCAPE. M. S. Chaffin[1], J. I. Deighan[1], A. I. Stewart[1], and N. M. Schneider[1], [1]University of Colorado Laboratory for Atmospheric and Space Physics, 1234 Innovation Drive, Boulder CO 80303.

Introduction: Analysis of UV airglow data gathered by SPICAM on Mars Express has recently revealed a large variation in the rate of hydrogen escape from the upper atmosphere of Mars, which may greatly increase estimates of the water lost to space over Martian history [1]. These observations are not compatible with the present understanding of the Martian hydrogen cycle as developed through analysis of early Mariner flyby and orbiter data [2,3,4,5]. It is not known whether this variation is seasonal or dust-driven in nature, as elevated escape rates were observed during Southern summer and fall of Mars Year 28, during the declining phase of a global dust storm. Analysis of additional SPICAM data cannot resolve the question of the cause, as the available data from Southern summer and fall are all from Mars Year 28 [6]. Here, we present new time-dependent models of the Martian hydrogen cycle designed to capture this variability, making predictions for upcoming MAVEN observations of the upper atmosphere of Mars.

Background: Early observations of the Martian upper atmosphere with Mariner 6 and 7 established an escape rate for hydrogen of 1.8×10^8 cm/s, consistent with a total loss (at a constant rate) of 5 m of water distributed evenly over the globe throughout all of Martian history. Subsequent independent observations by SPICAM [7] and Rosetta [8] produced estimates generally consistent with this rate, in accordance with the prevailing explanation that escaping atomic hydrogen has its source in long-lived molecular hydrogen that slowly diffuses upward into the escape region from lower altitudes [2,3,9].

The first study to search for time-dependent effects revealed a large variation in escape rate, inconsistent with predictions of constant escape with time. Escape rates were found to vary over two orders of magnitude, high escape rates being strongly correlated with both southern summer and lower atmospheric dust content *(Fig. 1)*. In addition, the highest escape rates measured are more than ten times larger than previously measured, greatly increasing estimates of the escape thought to have occurred throughout Martian history.

Because the volatile inventory and oxidation state of the Martian surface are largely controlled by hydrogen escape to space, understanding the magnitude and variability of this process is of critical importance to determining the early environment of Mars.

Current work: We model variable hydrogen escape using a 1D coupled troposphere/ionosphere/thermosphere model, using both a seasonal and impulsive (i.e. dust) source for enhanced transport of water to high altitude and subsequent increase in escape rates. We determine the ionospheric and lower atmospheric conditions required to support the variable escape rates observed in SPICAM airglow data, and make predictions for the abundance and variability of ionospheric and thermospheric species observed by SPICAM and scheduled to be observed by MAVEN's imaging ultraviolet spectrometer IUVS.

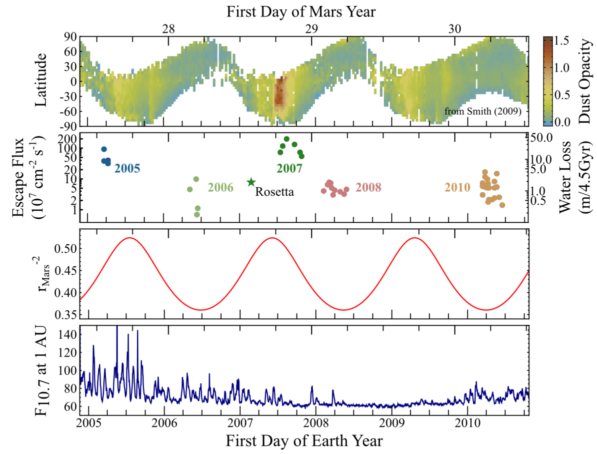

Figure 1: Variability of escape rates derived from airgow data (second from top) with lower atmospheric dust content (top panel, from THEMIS/TES [10]), Mars-Sun distance (second panel from bottom), and solar activity (bottom panel), from [6]. While most escape rates are modest and consistent with earlier results, escape was greatly enhanced in Southern summer and fall of Mars Year 28 during the global dust storm.

We present the results of these models and determine the degree to which seasonal or dust-driven variation can account for the change in escape we observe.

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