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VARIABILITY OF MARS' UPPER ATMOSPHERE

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Atmospheric escape to space is a key process that shaped the evolution of the Martian atmosphere from being relatively dense and warm billions of years ago to the current thin and cold state [1]. The upper atmosphere of Mars (ranging from about 80 to 250 km altitude above the surface) provides the main drain pipe for atmospheric escape. Given its direct exposure to the solar activity and its strong coupling with the lower atmosphere, this atmospheric region is subject to a strong variability driven both from above (e.g. variations in the solar radiation reaching the planet) and from below (e.g. atmospheric expansion/contraction due to temperature changes in the lower atmosphere, effects of vertically propagating gravity waves, etc.) [2]. This variability has a significant impact on the rate of atmospheric escape [3]. From a practical perspective, the upper atmosphere of Mars is the region where aerobraking maneuvers take place upon spacecrafts' orbit insertion. These operations are critically affected by variations in the atmospheric density. A good characterization of the temperature and density structure and of the variability of the upper atmosphere is thus mandatory both for better understanding the past evolution of Mars and for planning future space missions.

We used a simulation of a ground-to-exosphere Global Climate Model (GCM), the LMD-Mars GCM [4], covering 8 Martian Years, to analyze the geographical and temporal variability of the temperatures in the upper atmosphere of Mars. The model takes into account the day-to-day variability of the two main forcing mechanisms of this atmospheric region, the UV solar flux and the dust load in the lower atmosphere [5]. In this contribution we will focus on the variability with the 11-years solar cycle and with Local Time (LT) at two critical layers, the exobase (around 1e-6 Pa) and the mesopause (~1e-3 Pa).

The model predicts a linear dependence of the exobase temperatures with the solar activity (Fig. 1), but with important variations at different latitudes and seasons. The mesopause temperatures, on the other hand, present a small response to solar variability

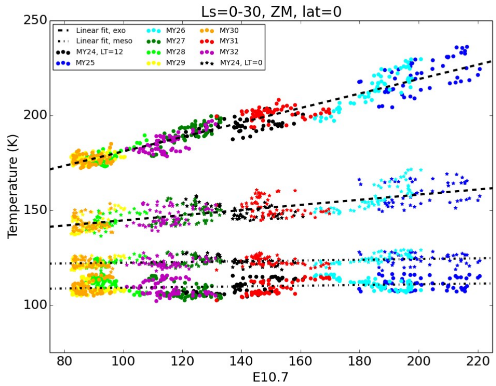

Figure 1: Solar cycle variability of the exobase (top lines) and mesopause (bottom lines) for the Ls=0-30 season and the equator. We show temperatures at LT=12 (circles) and LT=0 (stars). Different colors indicate temperatures obtained at different simulated Mars Years

Regarding the LT variability, while minimum temperatures at the exobase are usually obtained before dawn, the LT of maximum temperature is not fixed but depends on season and latitude.

We will also show comparisons with observational datasets, as the SPICAM stellar occultation temperature profiles [6]. In addition we will also present the Mars Climate Database, a publicly available tool created to make freely available to the community the results of the LMD-MGCM.

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