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Saturation of water vapor in the mesosphere and thermosphere of Mars as measured by the ACS occultation experiment of the ExoMars/TGO mission

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We present water vapor distribution encompassing the mesosphere and thermosphere of Mars, altitudes from 50 to 125 km. The vertical profiles emphasize Martian Years (MY) from 34th to 37th including the last Global Dust Storm (GDS) in MY34. Our results are based on solar occultation measurements in the 2.66-2.70 μm wavelength range by Atmospheric Chemistry Suite (ACS) on board the ExoMars Trace Gas Orbiter (TGO) [1]. This spectral range possesses strong CO_2 and H_2O absorption lines allowing sensitive temperature and density retrievals in the mesosphere and thermosphere [2, 3].

We report that the maximum water mixing ratio varies from 20 to 50 ppmv at 100-125 km during dust seasons (GDS and regional storms), as well as at every southern summer of MY34-MY37. During other seasons water remains below 2 ppmv, especially at aphelion. We have also estimated the condition of water saturation using simultaneously retrieved temperature and pressure profiles [3]. A supersaturation of water is observed during perihelion above 80 km, where the saturation ratio exceeds 10. Those values confirm recent results by Fedorova et al. [4] derived from the near-IR channel of ACS below 100 km. The observed seasonal high water abundance and saturation in the transit zone of mesosphere/thermosphere increases density of the atomic hydrogen fed by photolysis of H_2O molecule that subsequently rises its escape from the planet. This study is supported by the grant of RSF #23-12-00207.

References:

[1] Korablev O.I. et al., 2018. The Atmospheric Chemistry Suite (ACS) of three spectrometers for the ExoMars 2016 trace gas orbiter. Space Science Reviews. https://doi.org/10.1007/s11214-017-0437-6. [2] Belyaev D.A. et al., 2021. Revealing a high water abundance in the upper mesosphere of Mars with ACS onboard TGO. Geophysical Research Letters. https://doi.org/10.1029/2021GL093411. [3] Belyaev D.A. et al., 2022. Thermal structure of the middle and upper atmosphere of Mars from ACS/TGO CO_2 spectroscopy. Journal of Geophysical Research: Planets. https://doi.org/10.1029/2022JE007286. [4] Fedorova A.A. et al., 2022. A two-Martian years survey of the water vapor saturation state on Mars based on ACS NIR/TGO occultations. Journal of Geophysical Research: Planets. https://doi.org/10.1029/2022JE007348.

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