Water vapor vertical profiles on Mars: Results from the first full Mars Year of TGO/NOMAD science operations

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Nadir and Occultation for Mars Discovery (NOMAD) onboard ExoMars Trace Gas Orbiter (TGO) started the science measurements on 21 April, 2018. We present results on the retrievals of water vapor vertical profiles in the Martian atmosphere from the first Mars year measurements of the TGO/NOMAD.

NOMAD is a spectrometer operating in the spectral ranges between 0.2 and 4.3 μm onboard ExoMars TGO. NOMAD has 3 spectral channels: a solar occultation channel (SO –Solar Occultation; 2.3–4.3 μm), a second infrared channel capable of nadir, solar occultation, and limb sounding (LNO –Limb Nadir and solar Occultation; 2.3–3.8 μm), and an ultraviolet/visible channel (UVIS –Ultraviolet and Visible Spectrometer, 200–650 nm). The infrared channels (SO and LNO) have high spectral resolution (λ /dλ ~10,000–20,000) provided by an echelle grating used in combination with an Acousto Optic Tunable Filter (AOTF) which selects diffraction orders. The concept of the infrared channels are derived from the Solar Occultation in the IR (SOIR) instrument onboard Venus Express (VEx). The sampling rate for the solar occultation measurement is 1 second, which provides better vertical sampling step (~1 km) with higher resolution (~2 km) from the surface to 200 km. Thanks to the instantaneous change of the observing diffraction orders achieved by the AOTF, the SO channel is able to measure five or six different diffraction orders per second in solar occultation mode. In this study, we analyze the solar occultation measurements at diffraction order 134 (3011-3035 cm^{-1}) and 168 (3775-3805 cm^{-1}) acquired by the SO channel in order to investigate H_2O vertical profiles.
Knowledge of the water vapor vertical profile is important to understand water cycle and its escape process. Solar occultation measurements by two new spectrometers onboard TGO - NOMAD and Atmospheric Chemistry Suite (ACS) - allows us to daily monitor the water vapor vertical profiles through the whole a Martian Year and obtain a latitudinal map for every ~20˚ of Ls. In 2018, for the first time after 2007, a global dust storm occurred on Mars. It lasted for more than two months (from June to August). Moreover, following the global dust storm, a regional dust storm occurred in January 2019. TGO began its science operations on 21 April 2018. The NOMAD and ACS observations therefore fully cover the period before/during/after the global and regional dust storms and offer a unique opportunity to study the trace gases distributions during the dust storms. We have analyzed those datasets and found a significant increase of water vapor abundances in the middle atmosphere (40-100 km) during the global dust storm from June to mid-September 2018 and the regional dust storm in January 2019. In particular, water vapor reaches very high altitude, at least 100 km, during the global dust storm (Aoki et al., 2019, Journal of Geophysical Research, Volume124, Issue12, Pages 3482-3497, doi:10.1029/2019JE006109). A GCM simulation explained that dust storm related increases of atmospheric temperatures suppress the hygropause, hence reducing ice cloud formation and so allowing water vapor to extend into the middle atmosphere (Neary et al., 2019, Geophysical Research Letters, accepted, doi: 10.1029/2019GL084354). This study presents the results with the extended datasets. In the presentation, we will discuss the H_2O vertical profiles retrieved from the first full Mars year measurements of the TGO/NOMAD.

