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11:45〜12:00

Water vapor vertical distributions on Mars: Results from three years of TGO/NOMAD science operations

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Nadir and Occultation for Mars Discovery (NOMAD) onboard ExoMars Trace Gas Orbiter (TGO) started science measurements on 21 April, 2018. Here, we present results on the retrievals of water vapor vertical distributions in the Martian atmosphere from three years of TGO/NOMAD science operations.

NOMAD is a spectrometer operating in the spectral ranges between 0.2 and 4.3 um onboard ExoMars TGO. NOMAD has 3 spectral channels: a solar occultation channel (SO - Solar Occultation; 2.3-4.3 um), a second infrared channel capable of nadir, solar occultation, and limb sounding (LNO - Limb Nadir and solar Occultation; 2.3-3.8 um), and an ultraviolet/visible channel (UVIS - Ultraviolet and Visible Spectrometer, 200-650 nm). The infrared channels (SO and LNO) have high spectral resolution (R˜10,000-20,000) provided by an echelle grating used in combination with an Acousto Optic Tunable Filter (AOTF) which selects diffraction orders. The sampling rate for the solar occultation measurement is 1 second, which provides a good 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), order 136 (3056-3080 cm-1), order 168 (3775-3805 cm-1), and order 169 (3798-3828 cm-1) acquired by the SO channel in order to investigate water vapor vertical distributions.

Knowledge of the water vapor vertical profile is important to understand the 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 distributions through the whole Martian Year and obtain a good latitudinal coverage for every ˜20 deg 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. The NOMAD and ACS observations therefore fully cover the majority of the global and regional dust storms and offer a unique opportunity to study the trace gases distributions during the dust storms. We 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., 2020, Geophysical Research Letters, accepted, Volume47, Issue7, e2019GL084354, doi: 10.1029/2019GL084354). This study presents the results with the extended dataset, which covers a full Mars year. The extended dataset newly includes aphelion season that involves interesting phenomena such as sublimation of water vapor from the northern polar cap and formation of the equatorial cloud belt, which are known as key periods to understand the large north-south hemispheric asymmetries of Mars water vapor. Yet, only a few papers report the water vapor vertical distributions in the aphelion season. The extended dataset also includes the southern summer season (dusty season) in MY 35, which will allow us to compare the water vapor distributions in the global dust storm year with those in the non-global dust storm year. In the presentation, we will discuss the water vapor vertical profiles as well as the aerosols vertical distributions retrieved from the three-year measurements of the TGO/NOMAD.