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

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Abstract

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 year measurements of the TGO/NOMAD.

1. NOMAD instrument

NOMAD is a spectrometer operating in the spectral ranges between 0.2 and 4.3 μm onboard ExoMars TGO [1]. 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 – UV visible, 200-650 nm). The infrared channels (SO and LNO) have high spectral resolution (λ/dλ~10,000-20,000) provided by echelle grating in combination with an Acousto Optic Tunable Filter (AOTF) which selects diffraction orders [2]. The concept of the infrared channels is derived from the Solar Occultation in the IR (SOIR) instrument [3] onboard Venus Express. The sampling rate for the solar occultation measurement is 1 second, which provides unprecedented vertical resolution (less than 1 km) spanning altitudes from the surface to 200 km. Thanks to the instantaneous change of the observing diffraction orders achieved by 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 (3011.44 - 3035.44 cm^{-1}) and 168 (3775.53 - 3805.63 cm^{-1}) acquired by the SO channel in order to investigate H_2O vertical profiles.

2. Water vapor vertical profiles

Measurements of water vapor vertical profiles are key diagnostic to the escape processes acting on water on Mars. Since its first scientific operation started on 21/April 2018, the TGO/NOMAD has regularly conducted solar occultation measurements that are able to provide water vapor vertical profile with unprecedented vertical resolution (< 1 km). So far, more than 2000 occultation have been acquired.

Interestingly, in 2018, for the first time after the previous one in 2007, a very strong global dust storm occurred on Mars and it lasted for two months (from June to August). The NOMAD observations therefore completely cover the period before/during/after the global dust storm, so that the NOMAD datasets offer a unique opportunity to study the state of trace gases during a global dust storm. We have analyzed those datasets and published two water vapor vertical profiles - one before the global dust storm and the other one during the storm, which present a significant conspicuous increase of water vapor during the global dust storm (see Figure 1), in [4]. This study presents the results with the extended datasets. In the presentation, we will discuss the H_2O vertical profiles retrieved from the first year measurements of the TGO/NOMAD, including the period of the global dust storm.

Figure

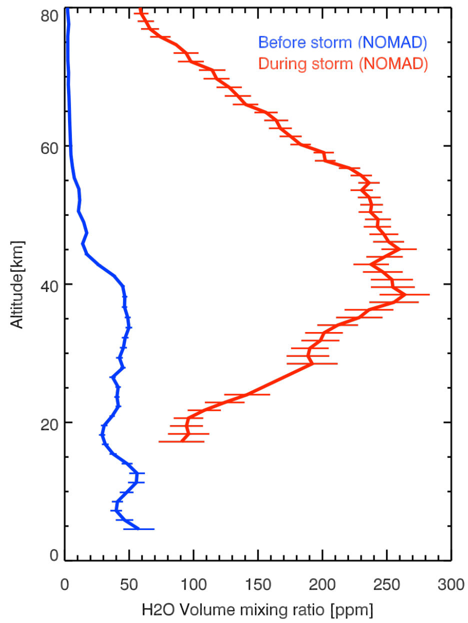

Figure 1: H_2O vertical profiles retrieved from the NOMAD-SO data before the global dust storm in 2018 (blue, *Ls* = 171.45° and latitude 43° N–68° N) and during the storm (red, *Ls* = 196.64° and latitude 51° N–59° N) [4].

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