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Preliminary results on water vapor retrievals from the first data of TGO/NOMAD

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Abstract

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

1. The 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 ($\lambda/d\lambda \sim$ 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 are derived from the Solar Occultation in the IR (SOIR) instrument [3] onboard Venus Express. The sampling rate for the solar occultation measurement is 1 km, which provides unprecedented vertical resolution spanning altitudes from the surface to 200 km. Nadir sounding by the LNO channel will acquire spectra with an instantaneous footprint of 0.5 x 17 km^2, which allows us to obtain maps of trace gases and aerosols in the Martian atmosphere.

One of the most remarkable capabilities of NOMAD is its high spectral resolution in the near infrared range. It allows us (1) to investigate vertical profiles of the atmospheric constituents (such as carbon dioxide, carbon monoxide, water vapor, and their isotopic ratio) and (2) to perform sensitive search of organic species (such as CH_4, C_2H_4, C_2H_6, H_2CO) and other trace gases (such as HCl, HCN, HO_2, H_2S, N_2O, OCS) by solar occultation measurements with the SO channel, and (3) to obtain maps of the atmospheric constituents (such as carbon dioxide, carbon monoxide, water vapor, and their isotopic ratio) across the planet by nadir viewing with the LNO channel.

2. Retrieval of Water Vapor

Measurements of water and its heavier isotopologue (HDO) are a key diagnostic to the escape processes acting on water on Mars. These first vertical profiles provide an unprecedented view on how water is transported into the upper atmosphere, where it is further dissociated and lost into space. Deuterium fractionation also reveals information about the cycle of water on the planet and informs us of its stability on short- and long-term scales.

We plan to analyze the data measured at diffraction order 167, 168, 169, 170, 171 for the H_2O retrieval, and at diffraction order 119, 120, 121, 124 for HDO (see Table 1 for the corresponding wavenumbers). The NOMAD spectra at these diffraction orders will be compared with the one calculated by radiative transfer models in order to retrieve their abundances. In the presentation, the preliminary results of the retrievals will be discussed.

Table1: Wavenumber range of the diffraction orders for the water vapor analysis by the NOMAD SO and LNO channels.

Diffraction order	SO wavenumber limits [cm^{-1}]	LNO wavenumber limits [cm^{-1}]
119	2674.34-2695.65	2674.90-2696.26
120	2696.81-2718.31	2697.37-2718.92
121	2719.28-2740.96	2719.85-2741.58
124	2786.70-2808.92	2787.29-2809.55
167	3753.06-3782.98	3753.84-3783.83
168	3775.53-3805.63	3776.32-3806.49
169	3798.01-3828.28	3798.80-3829.15
170	3820.48-3850.93	3821.28-3851.80
171	3842.96-3873.59	3843.76-3874.46

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