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First measurements of Martian CO by NOMAD/EMTGO

Séverine Robert (1), Justin T. Erwin (1), Shohei Aoki (1, 2, 3), Loïc Trompet (1), Ann Carine Vandaele (1), Ian R. Thomas (1), Michael D. Smith (4), Geronimo L. Villanueva (4), Marco Giuranna (5), Brittany Hill (6), Bernd Funke (6), Manuel Lopez Puertas (6), Miguel A. Lopez Valverde (6), Frank Daerden (1), Lori Neary (1), Bojan Ristic (1), Sébastien Viscardy (1), Arianna Piccialli (1), Valérie Wilquet (1), Giuseppe Sindoni (5), Giancarlo Bellucci (5), José Juan Lopez-Moreno (6), Manish R. Patel (7) and the NOMAD team

(1) Royal Belgian Institute for Space Aeronomy, BIRA-IASB, Belgium, (2) Fonds National de la Recherche Scientifique,FRS-FNRS, Belgium, (3) Tohoku University, Japan, (4) NASA Goddard Space Flight Center, Greenbelt, MD, USA, (5) Istituto di Astrofisica e Planetologia Spaziali (IAPS), Istituto Nazionale di Astrofisica (INAF), Rome, Italy, (6) Instituto de Astrofisica de Andalucia (IAA/CSIC), Granada, Spain, (7) Open University, Milton Keynes, UK, (severine.robert@aeronomie.be)

Abstract

As of 21st April 2018, ExoMars Trace Gas Orbiter entered the Science Phase. The first measurements of NOMAD onboard EMTGO were planned, driven both by validation and by science. Spectra of Martian CO were recorded using the two infrared channels of NOMAD, in nadir with NOMAD-LNO and in solar occultation with NOMAD-SO. A preliminary analysis has been performed leading to the first vertical profiles of CO and a sparce map of CO. These results will be presented and compared to the latest results of CRISM/MRO and PFS/MEX.

1. The NOMAD instrument

NOMAD, the "Nadir and Occultation for MArs Discovery" spectrometer suite [1] is part of the payload of the ExoMars Trace Gas Orbiter mission 2016. The instrument will conduct a spectroscopic survey of Mars' atmosphere in UV, visible and IR wavelengths covering the 0.2 - 0.65 and 2.3 - 4.3 μm spectral ranges. NOMAD is composed of 3 channels: a solar occultation channel (SO) operating in the infrared wavelength domain, a second infrared channel observing nadir, but also able to perform solar occultation and limb observations (LNO), and an ultraviolet/visible channel (UVIS) that can work in all observational modes. The spectral resolution of SO and LNO surpasses previous surveys in the infrared by more than one order of magnitude (λ/d$\lambda \sim$ 15000).

Both SO and LNO consist of an echelle grating in combination with an acousto-optic tunable filter (AOTF): the dispersive element provides the spectral discrimination, while the filter selects the diffraction order [1]. An infrared detector array is actively cooled in order to maximise the signal-to-noise ratio. The design of the three channels has been fully described in [3] and in [4] for the UVIS and the IR channels respectively.

Calibration and validation have been performed and will be discussed in [5]. Level 1.0 data were made available to the NOMAD team in order to fully exploit the analysis.

2. Martian carbon monoxide

Carbon monoxide is a non-condensable species playing a major role in the photochemical cycle of CO_2. Local and seasonal variations are expected and will give valuable constraints to model the dynamical processes in the Martian atmosphere. A climatology has been established recently using the CRISM data[6]. Continuous monitoring of the Martian water, carbon, ozone and dust cycles is part of the NOMAD science objectives. This would enable to extend existing datasets made by successive space missions in the past decades. In this presentation, we will focus on carbon monoxide (CO). The 2–0 band of CO centered at 2.35μm is measured by NOMAD-LNO and NOMAD-SO channels, mainly in its diffraction orders 189-191. The corresponding wavenumbers are given in Table1.

2.1. In nadir, with NOMAD-LNO

The footprint of a 15 sec measurement will cover a spatial region from 0.5x68 km^2 up to 17$\times$51 km^2 for NOMAD-LNO. Considering the circular orbit

Table 1: Wavenumber limits in cm^{-1} of the diffraction orders for the two infrared channels of NOMAD.

	SO	LNO
189	4247.48-4281.33	4248.36-4282.30
190	4269.95-4303.99	4270.84-4304.96
191	4292.42-4326.64	4293.32-4327.61

of EMTGO, a global revisit time of 7 sols with varying local times is expected. These characteristics enable us to derive a first map of CO column-integrated abundances using the NOMAD-LNO measurements. The a priori information and the results of the retrievals will be presented. If any overlap with previous measurements of CRISM[6] and PFS[7] is obtained, the comparison will be shown.

2.2. In solar occultation, with NOMAD-SO

The sampling rate for the solar occultation measurement is 1 km, which provides unprecedented vertical resolution spanning altitudes from the surface to 200 km. This allows us to investigate vertical profiles of the atmospheric constituents. Solar occultation spectra have not been analysed yet but the transmittances were calculated using the method developed for the SOIR/VEX instrument[8]. The first profiles of CO abundances will be retrieved using these transmittances.

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