MARTIAN ATMOSPHERIC VERTICAL PROFILES: RESULTS FROM THE FIRST YEAR OF TGO/NOMAD SCIENCE OPERATIONS. J. T. Erwin[1] (justin.erwin@aeronomie.be), S. Aoki[1], I.R. Thomas[1], L. Trompet[1], A. C. Vandaele[1], S. Robert[1], F Daerden[1], B. Ristic[1], G. L Villanueva[2], G. Liuzzi[2], J. J. Lopez-Moreno[3], G. Bellucci[4], M. R. Patel[5]. [1]Royal Belgium Institute for Space Aeronomy, Belgium, [2]NASA Goddard Space Flight Center, USA, [3]Instituto de Astrofisica de Andalucia (IAA/CSIC), Granada, Spain, [4]Instituto di Astrofisica e Planetologia Spaziali (IAPS/INAF), Rome, Italy, [5]School of Physical Sciences, The Open University, Milton Keynes, UK.

Introduction: 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 vertical profiles for several species in the Martian atmosphere from the first year measurements of the TGO/NOMAD. In particular, we present our progress on retrieving CO, H_2O, and CO_2 vertical profiles.

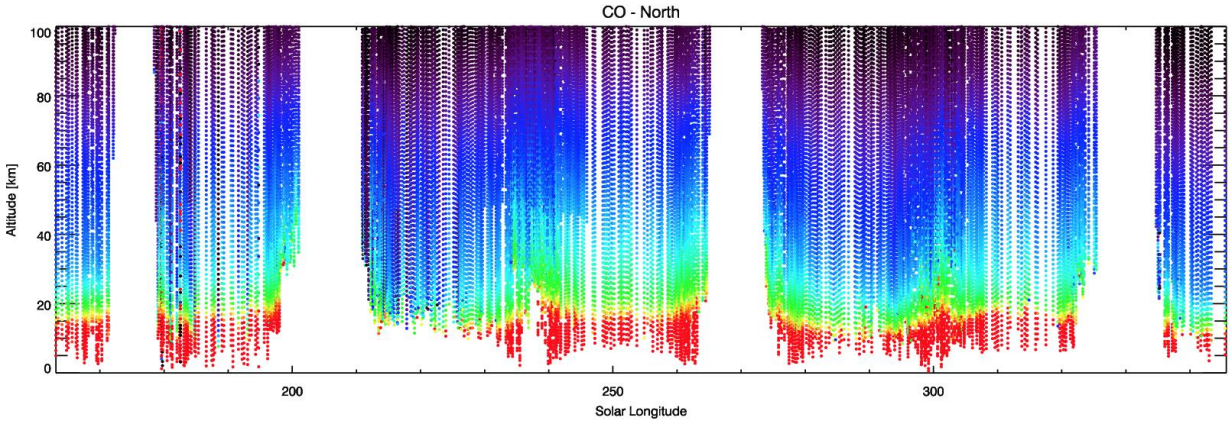
NOMAD Instrument: NOMAD, the "Nadir and Occultation for Mars Discovery" spectrometer suite [1], is part of the payload of the ExoMars Trace Gas Orbiter mission 2016. The instrument will conduct a spectroscopic survey of Mars' atmosphere in the UV, visible and IR wavelengths covering the 0.2-0.65 and 2.3-4.3μm spectral ranges. NOMAD is composed of three channels: a solar occulation channel (SO) operating in the IR, a limb and nadir channel (LNO) also operating in the IR, and an ultraviolet/visible channel (UVIS) that can perform all observation modes. The spectral resolutions of SO and LNO is a significant improvement on previous infrared surveys of Mars ($\lambda/d\lambda \sim 15000$). Both SO and LNO consist of an acousto-optic tunable filter (AOTF) in combination with an echelle grating. Several spectral ranges are measured simultaneously at a high spectral resolution, allowing for the study of different molecular species. The design of the three channels is fully described in [2] and [3].

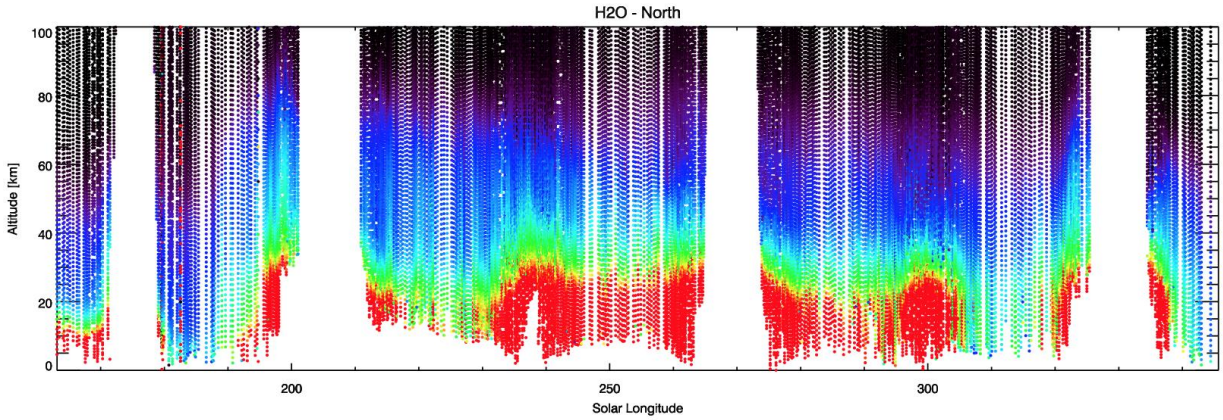
Vertical Profile Retrievals: The vertical sampling rate of the SO channel is typically ~1km, which provided an unprecedented vertical resolution from the surface up to ~200km. ExoMars TGO has a ~2 hour orbital period, and the SO channel operates on ~50% of the potential occultations, which leads to great monitoring of the climatology. The calibration of SO is a collaborative exercise (?) with retrievals, but inherits many of the techniques used for the SOIR/VEX instrument described in [4]. The retrievals are performed using the software ASIMUT developed at BIRA-IASB [5], which can use Optimal Estimation Method [6] among other algorithms to retrieved atmospheric profiles.

Discussion and Results: 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 for the dynamical processes in the Martian atmosphere. The 2-0 band of CO centered at 2.4μm is positioned in the SO orders 186-192 (4200-4350cm^{-1}). It is easily measurable in transmittances up to ~110km.

Measurements of water vapor vertical profiles are key diagnostic to the escape processes acting on water on Mars. Water vapor has many absorption features thought the NOMAD range, but the most commonly measured orders are 134 (3110-3035cm^{-1}) and 168 (3775-3805cm^{-1}), with sensitivity up to ~80km.

Carbon dioxide profiles, as the principle component, will enable the determination of pressure and temperature. Not only is it important for our climatological models, but also it will improve the spectral fitting of the other molecules. Similarly to H_2O, CO_2 had spectral features through much of the NOMAD range, but the most common orders are 149 (3350-3375cm^{-1}) and 165 (3710-3740cm^{-1}), with sensitivity to ~150km and above. Unfortunately, CO_2 retrievals are





complicated by line saturation, which occurs at high altitudes. Therefore, a combination of orders and strong and weak line is necessary retrieve CO_2 over a large vertical extent.

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 [7].

References:

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