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The NOMAD spectrometer suite on ExoMars Trace Gas Orbiter: Data processing status after one year of observing the Red Planet

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Abstract

NOMAD is one of four scientific instruments on the ExoMars Trace Gas Orbiter. It consists of three spectrometers operating in the ultraviolet-visible and infrared [2]. The nominal science phase began in April 2018, almost exactly one year ago at the time of writing this abstract; and recently the first results of the TGO mission were published [1, 5].

Here we will describe the first results from the first year of NOMAD observations; with an emphasis on calibration and data processing, detailing the work that has been done so far, and improvements that will be made in future.

1. Introduction

There are two main types of observations performed by NOMAD [4]:

Solar occultations, where the Sun is continually observed as the instrument field of view passes through the atmosphere, have extremely high signal to noise ratios, but can only be performed when the orbital position of the spacecraft allows such observations to be made. Solar occultations are routinely measured in both the infrared (2.2-4.3µm) and ultraviolet-visible (200-650nm) spectral regions [2, 3].

Dayside nadir observations, where the instrument field of view is pointed towards the surface directly below the spacecraft, and reflected sunlight is observed. These observations can be measured on almost all orbits, but the trade-off is a lower signal to noise ratio than for solar occultations and therefore higher detection limit for trace gases. Nadirs are typically measured in both the infrared (2.2-3.8µm) and ultraviolet-visible (200-650nm) spectral regions; although IR observations are usually only made on half of all orbits to keep the instrument at a cooler temperature [4].

In addition to these observing modes, night-side nadirs and limbs are also routinely measured. Until recently, limb measurements have been limited to the infrared only, however it is now possible to measure the Martian limb in both the infrared and ultraviolet-visible at the same time.

2. Results

The spectrometers operate at very high spectral resolution, up to ~0.15cm^{-1} in the infrared and ~1.2nm in the ultraviolet-visible regions [2, 3]; permitting both routine monitoring of gases for climatological studies and high-sensitivity detections of trace gases. Currently CO_2, CO, H_2O, HDO and O_3 are regularly measured, plus dust and aerosol optical properties; with continued calibration improvements and further studies, new detections could be possible [1, 5].

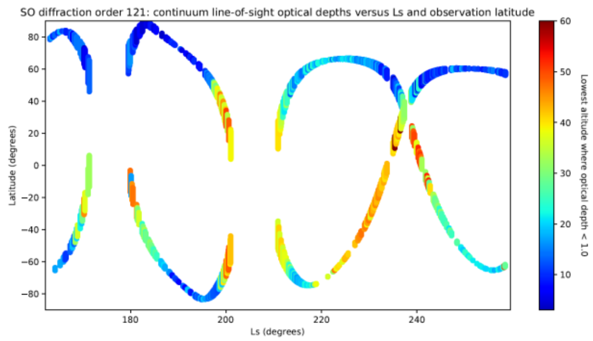

Figure 1: Attenuation of the SO channel signal as a function of altitude, as measured in solar occultation mode.

In April 2019 the first results from NOMAD and ACS (another spectrometer onboard TGO) were published, showing that (1) no methane has been detected in the Martian atmosphere during the first six months of mapping [1]; (2) D/H ratios and dust vertical profiles can be measured and were affected by the recent global dust storm [5]. As NOMAD continues to routinely observe the atmosphere of Mars, and as the dataset becomes more complete and instrument calibration improves, studies of the composition and ongoing processes in the Martian atmosphere will continue to yield new results. This presentation will highlight the current status of these efforts.

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