EPSC Abstracts
Vol. 12, EPSC2018-211-3, 2018
European Planetary Science Congress 2018

NOMAD on ExoMars Trace Gas Orbiter: status and preliminary results

Ann C. Vandaele. (1), Jose-Juan Lopez-Moreno (2), Giancarlo Bellucci (3), Manish R. Patel (4), Frank Daerden (1), Ian R. Thomas (1), Eddy Neefs (1), Bojan Ristic (1), Sophie Berkenbosch (1), Bram Beeckman (1), Roland Clairquin (1), Claudio Queirolo (1) and the NOMAD Team
(1) Royal Belgian Institute for Space Aeronomy (IASB-BIRA), av. Circulaire 3, 1180 Brussels, Belgium, (2) Instituto de Astrofisica de Andalucia (IAA/CSIC), Granada, Spain, (3) Istituto di Astrofisica e Planetologia Spaziali (IAPS/INAF), Via del Fosso del Cavaliere, 00133 Rome, Italy, (4) School of Physical Sciences, The Open University, Milton Keynes, UK - Space Science and Technology Department, STFC Rutherford Appleton Laboratory, UK (a-c.vandaele@aeronomie.be)

Abstract

The NOMAD ("Nadir and Occultation for MArs Discovery") spectrometer suite on board the ExoMars Trace Gas Orbiter (TGO) has been designed to investigate the composition of Mars' atmosphere, with a particular focus on trace gases, clouds and dust. The detection sensitivity for trace gases is considerably improved compared to previous Mars missions, compliant with the science objectives of the TGO mission. This will allow for a major leap in our knowledge and understanding of the Martian atmospheric composition and the related physical and chemical processes. The instrument is a combination of three spectrometers, covering a spectral range from the UV to the mid-IR, and can perform solar occultation, nadir and limb observations. In this paper, we will report on the status of the instrument, and present the first results obtained during the commissioning phase and then the Science phase which started in April 2018.

1. Introduction

NOMAD will conduct a spectroscopic survey of Mars' atmosphere in ultraviolet (UV), visible and infrared (IR) wavelengths covering large parts of the 0.2-4.3 µm spectral range [1,2]. NOMAD is composed of 3 spectrometers: a solar occultation only spectrometer (SO – Solar Occultation) operating in the infrared (2.3-4.3 µm), a second infrared spectrometer (2.3-3.8 µm) capable of doing nadir, but also solar occultation and limb observations (LNO – Limb Nadir and solar Occultation) [3], and an ultraviolet/visible spectrometer (UVIS – UV visible, 200-650 nm) that can work in the three observation modes [4].

NOMAD will provide vertical profiling information for atmospheric constituents at unprecedented spatial and temporal resolution. Indeed, in solar occultation, the vertical resolution is less than 1 km for SO and UVIS, with a sampling rate of 1 s (one measurement every 1 km), and occultations will range from the surface to 200 km altitude (height-dependent sensitivities for species will be presented in this paper). NOMAD will also provide mapping of several constituents in nadir mode with an instantaneous footprint of 0.5 x 17 km^2 (LNO spectrometer) and 5 km^2 (UVIS spectrometer) respectively, with a repetition rate of 30 Martian days. The TGO orbit will allow NOMAD to sample a wide range of local times, hence strongly improving existing climatologies for water vapour and carbon monoxide, and developing new climatologies for e.g. HDO and methane. By providing the best-to-date measurements of H_2O and, co-located and simultaneously, HDO, hence D/H, NOMAD will contribute significantly to improve our knowledge of the Martian water cycle and the hydrogen escape process, and as such to the long-term fate of the Martian atmosphere. A highly sensitive monitoring of the well mixed, moderately long-lived gas CO will allow NOMAD to provide better insights in important mixing processes related to trace gases that are enriched upon condensation of the main atmospheric constituent, CO_2. NOMAD will also allow for a highly sensitive diurnal monitoring of CH_4 throughout 1 Martian year, allowing for the first time to assess and understand the presence or absence of this unstable organic trace gas, and in the case of confirmed presence, to provide constraints to its origin and fate.

2. Status of the instrument

The Mars commissioning phase started in early March 2018 just after the end of the aerobraking operations which placed the spacecraft in its final circular orbit around Mars. A series of observations were planned to assess the state of the instrument, including calibration observations and observations dedicated to test the thermal dissipation within the instrument. Observations were performed to verify the pointing accuracy. We will present some results of this analysis showing that the instrument is performing as expected.

3. Preliminary results

Science phase started in April 2018. Since then NOMAD performed solar occultation and nadir observations using different options to test the instrument under various conditions. Several atmospheric species have been targeted, delivering profiles from solar occultation from 200km down to the surface and integrated abundances from nadir measurements. Observations optimized for the detection of dust and clouds have also been performed. The nominal strategy for solar occultations consist in measuring 5 different spectral intervals within 1 s, to derive densities for CO_2, CO, H_2O/HDO, CH_4, and dust. Nadir observations were carried out using different numbers of spectral intervals recorded sequentially to investigate the signal to noise ratio. These measurements also focused on the same species as mentioned above. We will give an overview of the results so far obtained.

Acknowledgements

The NOMAD experiment is led by the Royal Belgian Institute for Space Aeronomy (IASB-BIRA), assisted by Co-PI teams from Spain (IAA-CSIC), Italy (INAF-IAPS), and the United Kingdom (Open University). This project acknowledges funding by the Belgian Science Policy Office (BELSPO), with the financial and contractual coordination by the ESA Prodex Office (PEA 4000103401, 4000121493), by Spanish Ministry of Economy, Industry and Competitiveness and by FEDER funds under grant ESP2015-65064-C2-1-P (MINECO/ FEDER), as well as by UK Space Agency through grant ST/P000886/1 and Italian Space Agency through grant 2018-2-HH.0. The research was performed as part of the "Excellence of Science" project "Evolution and Tracers of Habitability on Mars and the Earth" (FNRS 30442502).

The NOMAD Team

Scientific team: Vandaele, Ann Carine; Lopez Moreno, Jose Juan; Bellucci, Giancarlo; Patel, Manish; Allen, Mark; Alonso-Rodrigo, Gustavo; Altieri, Francesca; Aoki, Shohei; Bauduin, Sophie; Bolsée, David; Clancy, Todd; Cloutis, Edward; Daerden, Frank; D'Aversa, Emiliano; Depiesse, Cédric; Erwin, Justin; Fedorova, Anna; Formisano, Vittorio; Funke, Bernd; Fussen, Didier; Garcia-Comas, Maia; Geminale, Anna; Gérard, Jean-Claude; Gillotay, Didier; Giuranna, Marco; Gonzalez-Galindo, Francisco; Hewson, Will; Homes, James; Ignatiev, Nicolai; Kaminski, Jacek; Karatekin, Ozgur; Kasaba, Yasumasa; Lanciano, Orietta; Lefèvre, Franck; Lewis, Stephen; López-Puertas, Manuel; López-Valverde, Miguel; Mahieux, Arnaud; Mason, Jon; Mc Connell, Jack; Mumma, Mike; Nakagawa, Hiromu, Neary, Lori; Neefs, Eddy; Novak, R.; Oliva, Fabrizio; Piccialli, Arianna; Renotte, Etienne; Robert, Severine; Sindoni, Giuseppe; Smith, Mike; Stiepen, Arnaud; Thomas, Ian; Trokhimovskiy, Alexander; Trompet, Loïc, Vander Auwera, Jean; Villanueva, Geronimo; Viscardy, Sébastien; Whiteway, Jim; Willame, Yannick; Wilquet, Valérie; Wolff, Michael; Wolkenberg, Paulina – *Tech team:* Alonso-Rodrigo, Gustavo; Aparicio del Moral, Beatriz; Barzin, Pascal; Beeckman, Bram; BenMoussa, Ali; Berkenbosch, Sophie; Biondi, David; Bonnewijn, Sabrina; Candini, Gian Paolo; Clairquin, Roland; Cubas, Javier; Giordanengo, Boris; Gissot, Samuel; Gomez, Alejandro; Hathi, Brijen; Jeronimo Zafra, Jose; Leese, Mark; Maes, Jeroen;Mazy, Emmanuel; Mazzoli, Alexandra; Meseguer, Jose; Morales, Rafael; Orban, Anne; Pastor-Morales, M; Perez-grande, Isabel; Queirolo, Claudio; Ristic, Bojan; Rodriguez Gomez, Julio; Saggin, Bortolino; Samain, Valérie; Sanz Andres, Angel; Sanz, Rosario; Simar, Juan-Felipe; Thibert, Tanguy

References

[1] Vandaele, A.C., et al., 2015. Planet. Space Sci. 119, 233-249.
[2] Vandaele et al., 2018. Space Sci. Rev.
[3] Neefs et al., 2015. Applied Optics 54, 8494-8520.
[4] Patel et al., 2017. Applied Optics 56, 2771-2782.