EPSC Abstracts
Vol. 13, EPSC-DPS2019-1781-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Use of NOMAD Observations (Trace Gas Orbiter) for Mars surface depositions

Luca Ruiz Lozano (1, 2), Ö. Karatekin (2), A. Caldiero (2, 3), O. Temel (2), I.R. Thomas (4), S. Robert (4), G. Bellucci (5), F. Altieri (5), J.-J. Lopez-Moreno (6), A.C. Vandaele (4), V. Dehant (1, 2)
(1) Université catholique de Louvain (UCLouvain), Louvain-la-Neuve, Belgium, (2) Royal Observatory of Belgium (ROB), Brussels, Belgium, (3) Technische Universiteit Delft (TU Delft), Delft, Netherlands (4) Royal Belgian Institute for Space Aeronomy (IASB-BIRA), Brussels, Belgium (5) Agenzia Spaziale Italiana (ASI), Rome, Italy (6) Instituto de Astrofísica de Andalucía (IAA-CSIC), Granada, Spain

Abstract

This project takes advantage of the NOMAD spectrometer observations, on board the 2016 ExoMars Trace Gas Orbiter. These observations will help to determine the Martian surface properties. This work is focus on surface ice detection.

1. Introduction

Seasonal and interannual variability of the CO_2 and H_2O ices on the Martian surface is important for the understanding of Mars' current atmospheric dynamics and its variability. In addition, atmospheric angular momentum variations of a planet are associated with the global atmospheric mass redistribution and the wind variability. The exchange of angular momentum between the fluid layers and the solid planet is the main cause for the variations of the planetary rotation at seasonal time scales. In other words, the rotation of Mars is only approximately uniform and variations in the length-of-day (LOD) exist. An important part of the LOD variations of Mars is due to the changes in the icecaps resulting from the sublimation and condensation process of CO_2 [3]. To better understand the CO_2 cycle on Mars, the Trace Gas Orbiter (TGO) observations, especially the NOMAD data, are used.

2. The NOMAD instrument

The ExoMars Trace Gas Orbiter is an ESA-Roscosmos joint mission consisting of an orbiter (Trace Gas Orbiter - TGO). The Mars orbit injection for the orbiter took place on 16 October 2016, while the nominal orbit was reached in April 2018. The first science observations finally started [5]. The Nadir and Occultation for MArs Discovery (NOMAD) is one of the four instruments on board TGO. The instrument is a suite of three spectrometers designed to observe the atmosphere and the surface of Mars in the UV, visible and IR. NOMAD operates in three different channels [1] (Figure 1).

In particular, for this study, the Limb, Nadir and Occultation (LNO) channel, operating in the IR, is selected. Indeed, with the LNO mode, NOMAD is constantly pointing perpendicularly to the surface right below it. In this way, the spectrometer provides Martian surface information (Figure 2). The goal of this project is to investigate how NOMAD data could be helpful to detect surface ices and furthermore, distinguish H_2O and CO_2 ices.

3. Surface ice detection

Ice deposits exhibit specific IR signatures in the 2.3-4.0 μm range of NOMAD, which reveal information on their composition, texture and size of the ice grains (Figure 3). In this project, the method is focus on the definition of spectral indices, which relate with simple formulas based on the spectral features [7]. These indices generally measure the absorption band depth at a specific wavelength. They refer to the radiance factor I/F given by

$$I/F = L_{Mars} / (E_{Earth} * d_{AU}^2) \quad (1)$$

where L_{Mars} is the spectral radiance of Mars, E_{Earth} is the spectral irradiance of the Sun at Earth's location and d_{AU} is the distance between the Sun and Mars in astronomical unit.

Considering the spectral difference between H_2O and CO_2 ices, different indices should be developed in order to be able to put thresholds on the detection or not of ice caps.

4. Figures

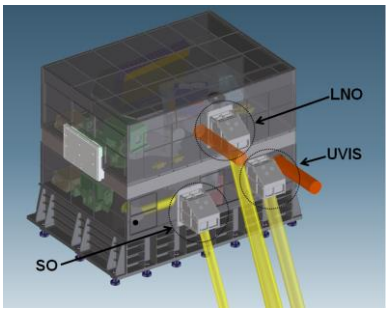

Figure 1: NOMAD spectrometer [4]

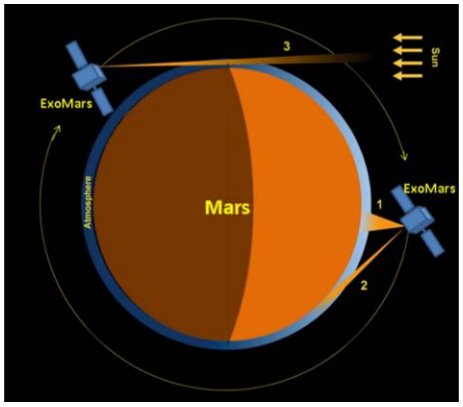

Figure 2: NOMAD observation modes: LNO (1,2) and solar occultation (3) [2]

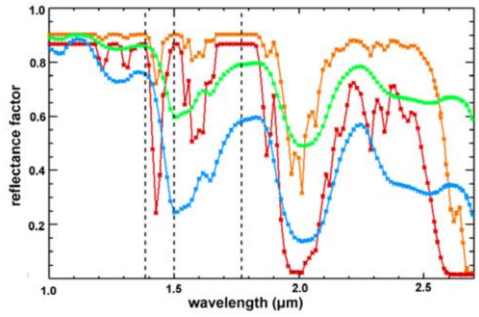

Figure 3: Example of simulated spectra of CO_2 compared to the size of the grain [7]

5. Conclusions

Today, the Trace Gas Orbiter of the ExoMars 2016 mission is producing exciting results. Several other space missions have already given important information about Mars. The methodology using the definition of spectral indices to detect H_2O and CO_2 ices was already applied in the past. Nevertheless, because of the spectral range of NOMAD, new indices have to be defined. They will permit to detect surface ices, and especially, to determine the surface icecaps changes. In this way, the sublimation and condensation process of CO_2 between the atmosphere and the polar caps will be better understand. The results could be discussed in the frame of the interpretation of the future observations of the RISE (Rotation and Interior Structure Experiment) and LaRa (Lander Radioscience) experiments [6], on the NASA 2018 InSight and ExoMars 2020 spacecraft respectively.

6. Acknowledgements

This work is financially supported by the Belgian *Fonds de la Recherche Scientifique – FNRS/FRIA*.

References

[1] A.C. Vandaele et al., Optical and radiometric models of the NOMAD instrument part I: the UVIS channel. Optics Express, 23(23):30028–30042,2015.
[2] E. Neefs et al., NOMAD spectrometer on the ExoMars trace gas orbiter mission: part 1—design, manufacturing and testing of the infrared channels. *Applied optics*, 54(28):8494–8520, 2015.
[3] Karatekin et al., 2005, Adv. Space Res., 38(4),739-744.
[4] Robotic exploration of Mars, *http://exploration.esa.int/mars/48523-trace-gas-orbiter-instruments/?fbodylongid=2187*
[5] S. Robert et al., Expected performances of the NOMAD/ExoMars instrument. *Planetary and Space Science*, 124:94–104, 2016.
[6] V. Dehant et al., Lander radioscience for obtaining the rotation and orientation of Mars. *Planetary and Space Science*, 57 (8-9):1050–1067, 2009.
[7] Y. Langevin et al., Observations of the south seasonal cap of Mars during recession in 2004–2006 by the OMEGA visible/near-infrared imaging spectrometer