EPSC Abstracts
Vol. 12, EPSC2018-722, 2018
European Planetary Science Congress 2018

Definition of a surface index based on previous datasets, to be used on NOMAD/EMTGO spectra

Séverine Robert (1), Ozgur Karatekin (2), Elodie Gloesener (2,3), Louis Ruel (1,2), Filippo Giacomo Carrozzo (4), Francesca Altieri (4), Ann Carine Vandaele (1), Frank Daerden (1), Ian R. Thomas (1), Bojan Ristic (1), Giancarlo Bellucci (4), Manish R. Patel (5), José Juan Lopez-Moreno (6) and the NOMAD team

(1) Royal Belgian Institute for Space Aeronomy, BIRA-IASB, Belgium, (2) Royal Observatory of Belgium, KSB-ORB, Belgium, (3) Université Catholique de Louvain, Belgium, (4) Istituto di Astrofisica e Planetologia Spaziali (IAPS), Istituto Nazionale di Astrofisica (INAF), Rome, Italy, (5) Open University, Milton Keynes, UK, (6) Instituto de Astrofisica de Andalucia (IAA/CSIC), Granada, Spain (severine.robert@aeronomie.be)

Abstract

The NOMAD instrument onboard ExoMars Trace Gas Orbiter is composed of three channels. One of those is called LNO, for "Limb, Nadir and Occultation". It is an echelle grating coupled to an Acousto-Optic Tunable Filter that enables us to measure the radiation in the nadir viewing geometry with a spectral resolution of 0.20-0.30 cm^{-1}. The 2.2 - 3.8 μm spectral range can be spanned through different diffraction orders of 20-25 cm^{-1} width. This complicates any investigation related to broad spectral features such as those produced by aerosols or surface characteristics. Nevertheless, we establish a strategy based on a surface index, i.e. the ratio between the radiation at two wavelengths. This was determined through an investigation done on already existing datasets, from CRISM/MRO and OMEGA/MEX. It enabled us to assess which diffraction orders of NOMAD should be measured. This focus was borne in mind when planning the first scientific observations of NOMAD, done in April 2018. The spectra have been analysed and a preliminary conclusion will be presented.

1. The NOMAD instrument

NOMAD, the "Nadir and Occultation for MArs Discovery" spectrometer suite [1] was selected as 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 observation modes. The design of the three channels has been fully described in [2] and in [3] for the UVIS channel and the IR channels respectively.

In the scientific preparation of the mission, we wondered how NOMAD-LNO may contribute to the surface characterization. This topic will be adressed in this abstract and in the associated presentation.

2. Characterization of the Martian surface using an index

The Martian surface has been studied by several instruments before the ExoMars mission. Among them, the imaging spectrometers OMEGA (Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité) and CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) have been observing the surface of Mars since 2004 and 2006 respectively. The measurements of these instruments, both operating in the visible to near infrared range, have dramatically sharpened our view of mineralogical and icy surface components in terms of composition. Especially, the data recorded by OMEGA and CRISM have provided useful information for the investigation of the surface and subsurface ice evolution as well as the presence of stable liquid water in the past of Mars. As an example, recent observations of erosional scarps performed by CRISM revealed the vertical structure of geologically young, ice-rich mantling deposits, near $\pm$ 55 ° latitude, likely formed during Mars' high-obliquity periods [4].

In order to evaluate the contribution of NOMAD to that topic, we analysed a set of data of CRISM and

OMEGA at similar location and L_S. On Fig. 1 and 2, we present the CRISM spectra at 5 different points of the surface at 85°N and -21°E at L_S= 133.8°.

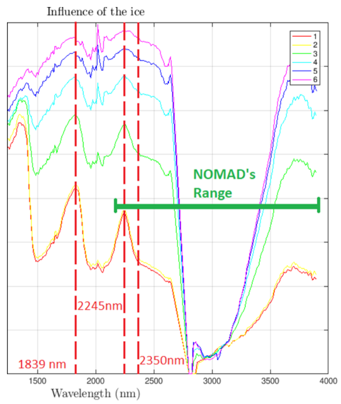

Figure 1: Corrected CRISM spectra (ref. Frt00002f7f)

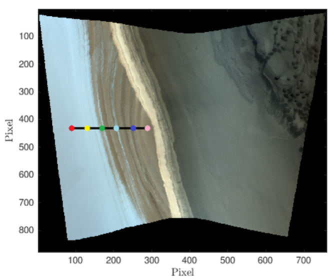

Figure 2: Projected map corresponding to the CRISM spectra

Fig. 3 shows a global map of OMEGA observations during MY 27, L_S= 90-180°. The colorbar gives an indication of the surface ice index. We concluded that the slope between 2245 and 2350 nm can be used as an indicator of the presence of ices. With OMEGA data we verified on a global scale that negative slopes about < -0.1 can map the presence of water ice (surface or thick clouds) while positive values about > 0.1 are diagnostic of the presence of surface CO_2 ice. These wavelengths correspond to the NOMAD diffraction orders 189 and 197. These two orders have then been integrated in the nominal observation and measured during the Commissionning Phase. The analysis of these spectra are ongoing and should lead to interesting perspectives that will be presented.

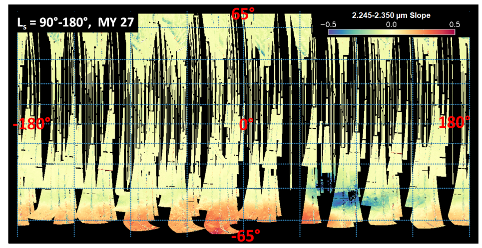

Figure 3: Surface ice index map using OMEGA data

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 MICIIN through Plan Nacional (AYA2009-08190 and AYA2012-39691), 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).

References

[1] Neefs, E., Vandaele, A.C., Drummond, R., Thomas, I.R. et al.: NOMAD spectrometer on the ExoMars trace gas orbiter mission: part 1 – design, manufacturing and testing of the infrared channels, Applied Optics, Vol. 54(28), pp. 8494-8520, 2015.

[2] Vandaele, A.C., Willame, Y., Depiesse, C., Thomas, I.R., et al.: Optical and radiometric models of the NOMAD instrument part I: the UVIS channel, Optics Express, Vol. 23(23), pp. 30028-30042, 2015.

[3] Thomas, I.R., Vandaele, A.C., Robert, S., Neefs, E. et al.: Optical and radiometric models of the NOMADinstrument part II: the infrared channels - SO and LNO, Optics Express, Vol. 24(4), pp. 3790-3805, 2016.

[4] Dundas, C. M., Bramson, A. M., Ojha, L., Wray, J. J. et al.: Exposed subsurface ice sheets in the Martian midlatitudes, Science, Vol. 359(6372), pp. 199-201, 2018.