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Toward CO_2 surface ice properties of Martian terrains with the NOMAD/LNO channel data

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Abstract

The surface of Mars is a place of constant interaction between CO_2, water and dust cycles. Thus, the characterization of the physical properties of the icy deposits allow to effectively constrain the climate history of the CO_2 ice condensation / sublimation, water and dust impurities. Here we propose to investigate the surface properties such as the ice thickness, compactness, volume proportion and size of the impurities of the Martian terrains in the IR using data of the NOMAD/LNO channel.

1. Introduction

Previous study of the Martian terrains showed that condensation and sublimation of CO_2 are part of the current major Martian climatic cycle leading to seasonal deposits. A theoretical model [1] proposes a link between the physical properties of the CO_2 ice and the seasonal activity such as cold jets and 'Spiders'. However, no jet has been observed in activity and the physical properties of the ice have not been fully investigated, such as the role of the impurities on the geyser mechanism and their potential link to other morphological evidence (gullies, dark flow activities…). The NOMAD LNO [2] channel on board ESA TGO spacecraft is able to cover the IR spectral range (2.3 – 3.8 µm) with a high spectral resolution of about 0.3 nm and an instantaneous footprint of 8.5 km^2 in nadir mode. Initially designed to derive trace gas abundance in the atmosphere at various local times, it is suited for a precise determination of the microphysical state of the ice trough space and time, including local time variability.

2. Dataset

The LNO spectrometer uses an AOTF crystal to select diffraction order to be measured. This work will focus on particular orders, where CO_2 ice displays strong absorption features, such as order 158 covering the 2.88-2.90 µm spectral range. Despite the high inclination angle of TGO's orbit, the spacecraft flew over the southern hemisphere where seasonal deposits were identified.

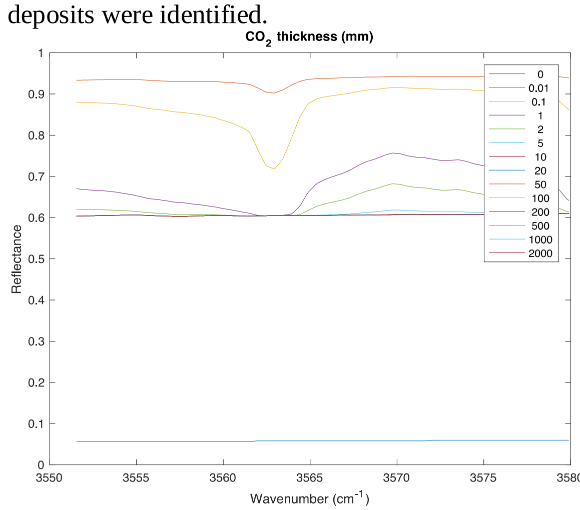

Figure 1: Synthetic spectrum variation related to the evolution of the CO_2 ice thickness for the diffraction order 158.

3. Method

Our team has recently developed a radiative transfer model for compact ice [3] able to estimate the ice thickness, its compactness and the characteristics of the impurities (composition, quantity, grain size, roughness) that was validated on laboratory measurements [4]. We have also developed a rapid method of data inversion / assimilation, particularly suited to massive remote sensing data [5] and showed that this approach is valid for Mars. A first study showed that the CO_2 ice is in translucent state in the Richardson crater [5] using CRISM hyperspectral images. To properly investigate surface ice properties with the LNO data, we first have to perform the radiometric calibration to establish the radiance of the spectra recorded. Then, the absorption features from the atmosphere have to be corrected. Finally, the radiative transfer model will be used to retrieve surface properties, as shown in Figure 1 and 2.

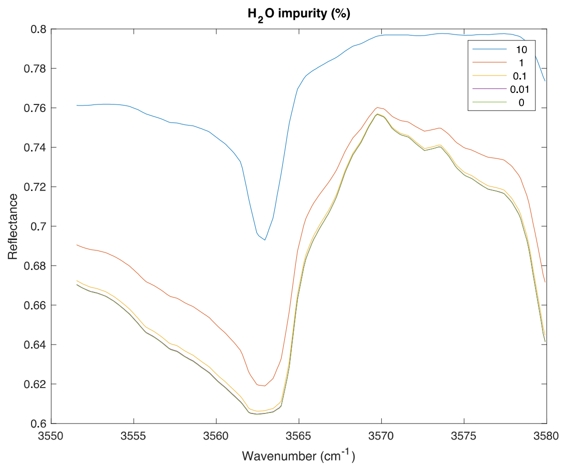

Figure 2: Synthetic spectrum variation related to the amount of H_2O impurities for the diffraction order 158.

4. Perspectives

This study will be done at high spectral resolution allowing deciphering complex mixture effects [6]. We also plan to produce new maps of spatial and temporal evolution of ice microphysics on Mars.

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References

[1] Kieffer, H. H.; Christensen, P. R. & Titus, T. N. CO_2 jets formed by sublimation beneath translucent slab ice in Mars' seasonal south polar ice cap Nature, 2006, 442, 793-796

[2] Vandaele, A. C. et al, NOMAD, an Integrated Suite of Three Spectrometers for the ExoMars Trace Gas Mission: Technical Description, Science Objectives and Expected Performance, Space Science Reviews, Springer Nature, 2018, 214

[3] Andrieu François, Douté Sylvain, Frédéric Schmidt, and Bernard Schmitt, Radiative transfer model for contaminated rough slabs, Appl. Opt. 54, 9228-9241 (2015).

[4] Andrieu, F.; Schmidt, F.; Schmitt, B.; Douté, S. & Brissaud, O. Retrieving the characteristics of slab ice covering snow by remote sensing The Cryosphere, 2016, 10, 2113-2128.

[5] Andrieu, F.; Schmidt, F.; Douté, S. & Chassefière, E., Ice state evolution during spring in Richardson crater, Mars, Icarus, Elsevier BV, 2018, 315, 158-173.

[6] Schmitt, B., Quirico, E., Trotta, F. & Grundy, W. M. Schmitt, B., de Bergh, C. & Festou, M. (ed.) (1998), Optical Properties of Ices from UV to Infrared, Solar System Ices, Kluwer, 227, 199-240.