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► **To cite this version:**

Miguel Angel Lopez-Valverde, Brittany Hill, Bernd Funke, Francisco González-Galindo, Adrian Brines, et al.. CO₂ and Temperature vertical profiles in the Martian atmosphere from solar occultation measurements at 2.7 micron by instruments NOMAD and ACS on board the Exomars Trace Gas Orbiter. 15th Europlanet Science Congress 2021, Sep 2021, Virtual Meeting, Unknown Region. pp.EPSC2021-109, 10.5194/epsc2021-109 . insu-04497355

HAL Id: insu-04497355

<https://insu.hal.science/insu-04497355>

Submitted on 9 Mar 2024

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Europlanet Science Congress 2021

Virtual meeting

13 September – 24 September 2021

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EPSC Abstracts

Vol. 15, EPSC2021-109, 2021

<https://doi.org/10.5194/epsc2021-109>

Europlanet Science Congress 2021

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CO₂ and Temperature vertical profiles in the Martian atmosphere from solar occultation measurements at 2.7 micron using NOMAD and ACS on board the Exomars Trace Gas Orbiter

Miguel Angel Lopez-Valverde et al.

Introduction

Vertical profiles of CO₂ and temperature with good vertical resolution are key measurements to characterize the Martian atmosphere, although difficult to obtain from remote observations [1]. For the first time these vertical profiles can be obtained using the solar occultation technique by the instruments NOMAD and ACS on board the Exomars Trace Gas Orbiter [2]. The sounding scheme designed to derive atmospheric profiles of CO₂ and temperature from the bottom to the top of the atmosphere is adapted to solar occultation and applied to exploit the operational sounding of these two instruments. The main goal of this work is to characterize the Martian thermal structure from the troposphere up to the thermosphere with a vertical resolution and also to cross-validate both TGO instruments as best as possible, with a single retrieval and inversion analysis approaches.

Retrieval approach

This work is focussed on the solar occultation channels NOMAD-SO and ACS-MIR, in routine operation. To derive these unique datasets, it is of paramount importance to examine the performance of the two instruments and to retrieve the retrieval results as accurately as possible. For this purpose we apply a flexible and well tested Earth sounding retrieval algorithm [5,6,7], to both of them, after adaptation to Mars atmospheric conditions [4] and the necessary adjustments to the instrument characteristics [8]. The retrievals use calibrated transmittance spectra to tackle three targets, CO₂ column density, CO₂ loading, in a simultaneous global-fit inversion, with updated hydrostatic equilibrium in every iteration. The retrieval is similar to the one used for H₂O, and after a pre-processing/data cleaning analysis which is also similar in both instruments. A validation of the retrieval for both instruments with the help of synthetic retrievals and a series of sensitivity tests performed with realistic data and similar treatment of the key error terms (measurement noise and systematics).

Comparison of results

We will present data obtained in the 2.7 μm region, dominated by a well known ro-vibrational band of CO₂ in a mixture of diffraction orders that are used routinely in the operational sounding in the vertical. The vertical resolution is 1 km.

orders in one of the ACS-MIR diffraction positions, which contain a sufficient number of CO₂ lines in capability to sample the whole atmosphere, up to about 180 km, in a single vertical scan. For both lowest troposphere is limited by the amount of atmospheric dust, which is also retrieved simultaneously will compare the vertical profiles obtained in a small sample of profiles from each instrument which and atmospheric dust loadings, during the first year of TGO operations. The comparisons take into account individual solar occultation scans are non-coincident in time and space. Comparisons are also performed by other groups in the NOMAD and ACS teams [9]. Two important applications of the obtained retrieved appropriate inputs to the retrieval of other atmospheric species from the same instruments and the we assume a prior or first guesses from global circulation models (GCM), see companion contributions to to validate predictions from these GCMs, and therefore, to help to improve them, particularly at high where these datasets are particularly valuable [1].

Acknowledgements

The IAA/CSIC team acknowledges financial support from the State Agency for Research of the Spanish Excellence Severo Ochoa' award for the Instituto de Astrofísica de Andalucía (SEV-2017-0709) and fund B-100 (MCIU/AEI/FEDER, EU). ExoMars is a space mission of the European Space Agency (ESA) experiment is led by the Royal Belgian Institute for Space Aeronomy (IASB-BIRA), assisted by Co-Principal Italy (INAF-IAPS), and the United Kingdom (Open University). US investigators were supported by the Administration. Thanks are extensive to all members of the NOMAD Science Team and the ACS Science

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How to cite: Lopez-Valverde, M. A., Hill, B., Funke, B., González-Galindo, F., Brines, A., Stolzenbach, A., Trompet, L., Aoki, S., Thomas, I., Vandaele, A. C., Villanueva, G., Belyaev, D., Trokhimovskiy, A., Korablev, G., and Patel, M.: CO₂ and Temperature vertical profiles in the Martian atmosphere from solar

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