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Preliminary results of dust and ice clouds retrieval using NOMAD/UVIS nadir measurements

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Abstract

The NOMAD instrument, onboard the ExoMars Trace Gas Orbiter (TGO) mission, began scientific measurements in mid-April 2018. The UV-visible channel UVIS will be used to monitor dust and ice clouds present in the Martian atmosphere. In this presentation, the analysis of these data will be discussed and preliminary results will be presented.

1. The NOMAD instrument

NOMAD is an instrument suite [1] onboard the ExoMars TGO. It is composed of 3 channels. Two of these are spectrometers designed for measurement in the infrared (IR) between 2.3 and 4.3 µm [2]: LNO for limb and nadir measurement and SO for solar occultation. The third channel is that of the UVIS [3], a spectrometer for measurements in the ultraviolet (UV) and visible range, between 200 and 650 nm with a spectral resolution of about 1.5 nm. UVIS can operate in limb, nadir and occultation modes.

The UVIS channel is dedicated to the study of the ozone abundances as well as dust and ice clouds.

2. Dust an ice clouds in the UV

UVIS nadir measurements will be used to monitor the dust optical depth (OD) and the ice cloud OD, as well as the ozone column (see abstract [4]). The goal of these measurements is to derive new climatologies, which will extend and provide comparisons to previous ones. Naturally included in such a dataset is the important spatial and temporal behaviours of these species. Previous studies have shown that ice clouds have repeatable seasonal patterns (i.e,.from one year to the next), while dust is known to show relatively important interannual variations that are mainly related to dust storm events (e.g. [5]).

Preliminary results of dust and ice cloud retrievals will be presented and compared to previous works.

3. Retrieval method

The analysis of UVIS data at IASB-BIRA will be performed using a retrieval algorithm specifically developed for nadir UV-visible. The code is based on the iterative use of the optimal estimation [6] and the radiative transfer model LIDORT [7] which includes accurate treatment of multiple scattering. Our retrieval method has already been used for SPICAM/UV measurements and allowed us to analyze more than 4 Martian years of data [8].

Within the NOMAD team, other institutes have also developed their retrieval method: The NEMESIS radiative [4] transfer model developed at the Open University; the MITRA code developed at IAPS-INAF [9, 10]; the ARS RT model from [11]; and the DISORT-based retrieval [12] developed at SSI. Comparisons between the results obtained by the different codes will also be presented.

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

[3] 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.

[4] Hewson et al. ExoMars TGO O3 and dust mapping with the NOMAD-UVIS spectrometer. EPSC, 2018

[5] Smith, 2008. Spacecraft Observations of the Martian Atmosphere. Annual Review of Earth and Planetary Sciences, 36(May), 191-219.

[6] Rodgers, 2000. Inverse Methods for Atmospheric Sounding - Theory and Practice. Series on Atmospheric Oceanic and Planetary Physics, vol. 2. World Scientific Publishing Co.

[7] Spurr et al., 2001. A linearized discrete ordinate radiative transfer model for atmospheric remote-sensing retrieval. Journal of Quantitative Spectroscopy and Radiative Transfer, 68(Mar.), 689{735.

[8] Y. Willame, A.C. Vandaele, C. Depiesse, et al.: Retrieving cloud, dust and ozone abundances in the Martian atmosphere using SPICAM/UV nadir spectra, Planetary and Space Science, Volume 142, 2017.

[9] Oliva, F., Adriani, A., Moriconi, M.L., Liberti, G.L., D’Aversa, E., Filacchione, G., 2016. Clouds and hazes vertical structure of a Saturn’s giant vortex from Cassini/VIMS-V data analysis. Icarus 278, 215–237. doi: 10.1016/j.icarus.2016.06.021.

[10] Sindoni, G., Adriani, A., Mayorov, B., Aoki, S., Grassi, D., Moriconi, M., Oliva, F., 2013. Development of a Monte-Carlo radiative transfer code for the Juno/JIRAM limb measurements. European Planetary Science Congress 2013, held 8-13 September in London, UK.

[11] Ignatiev, N.I., Grassi, D., Zasova, L.V., 2005. Planetary Fourier spectrometer data analysis: fast radiative transfer models. Planet. Space Sci. 53 (10), 1035–1042.

[12] Wolff, M. J., M. D. Smith, R. T. Clancy, R. et al. (2009). "Wavelength dependence of dust aerosol single scattering albedo as observed by the Compact Reconnaissance Imaging Spectrometer." Journal of Geophysical Research (Planets) 114: E00D04.