IMPACT OF DUST ON THE RETRIEVAL OF METHANE WITH THE SO CHANNEL OF THE NOMAD/EXOMARS INSTRUMENT

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Introduction: NOMAD (Nadir and Occultation for Mars Discoveries) is one of the four instruments on board the ExoMars Trace Gas Orbiter. It is composed of three channels [1]: two infrared spectrometers (SO for Solar Occultation and LNO for Limb, Nadir and Occultation) and one UV-visible channel (UVIS Ultraviolet and Visible Spectrum).

An overview of the detection sensitivity by solar occultation and nadir measurements of the three channels of NOMAD is described in [2]. The latter considered 18 trace gases expected to be seen in the Martian atmosphere.Vandaele et al. [3] shows the detection limits of the same species but considering different aerosol loadings.
Values of the resolution and SNR derived from optical and radiometric models [4-5] were used in [2]. At 20 km, methane detection limits of 24 ppt, 50 ppt and 500 ppt have been found with the SO channel, respectively, in clear sky [2], and with aerosol optical depths of 0.1 and 1.0 [3]. This detection limit is 1000 times smaller than the level of detection described in [6].

Objectives:
This study is in continuation of the work done in [2] and [3]. The purpose is to determine the detection limit of methane with NOMAD-SO in case of dust loading using the latest characterization of the instrument [7]. A complete occultation will be considered in order to assess the detection limits at the different tangent altitudes. Therefore, the retrieval processes of NOMAD-SO spectra will be adjusted. A sequence of spectra will be analysed in one go to better represent a real looking-like solar occultation.

Implementation:
Several solar occultation sets of spectra for different methane concentrations will be simulated. These simulations will be performed using the ASIMUT program for radiative transfer calculation [8].
Several test cases will be considered. First, the atmospheric profile of methane will be constant with volume mixing ratio values from 10 ppb to 1 ppb.
The opacity values due to the dust loading will vary from 0 to 1. The characteristics of the dust from [10] will be considered in this study.
A vertical sampling corresponding to the expected NOMAD-SO value will be used. It will correspond to a scan of one spectra every second from an altitude of 150 km to the surface, on a 400 km circular orbit,.
Random noise will then be added to each spectrum using the value of the SNR of the SO channel derived from the latest in-flight calibration. This step will result in the production of a statistically representative sample of occultations. Retrievals will then be performed on these sets of spectra.
The spherical symmetry of the atmosphere will be considered, even though ASIMUT is now capable of taken into account gradients along the terminator region [see A. Piccialli et al, this workshop]. New detection limits in function of altitude will be determined.

References:

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Acknowledgements: The NOMAD instrument is led by the Royal Belgian Institute for Space Aeronomy (IASB-BIRA, Brussels, Belgium), assisted by Co-PI teams from Spain (IAA-CSIC,

Granada), Italy (IAPS, Rome), and the United Kingdom (OU, Milton-Keynes). Associated teams contributing to the design and development of NOMAD were CSL (Liège, Belgium) and IDR-UPM (Madrid, Spain). We thank all engineering and supporting personnel in these teams. Several industrial partners also associated with the project: we would like to thank in particular the Belgian prime contractor (OIP, Oudenaarde) and the different subcontractors in Belgium and other partners' countries. This project acknowledges funding by the Belgian Science Policy Office (BELSPO), with the financial and contractual coordination by the ESA Prodex Office (PEA 4000103401), by MICIIN through Plan Nacional (AYA2009-08190 and AYA2012-39691), as well as by UK Space Agency through grant ST/P000886/1. The research was performed as part of the "Inter-university Attraction Poles" program financed by the Belgian government (Planet TOPERS) and the SCOOP Brain-Be project.