Ozone observed by TGO/NOMAD-UVIS solar occultation: an inter-comparison of three retrieval methods

A. Piccialli, A. C. Vandaele, Y. Willame, *Royal Belgian Institute for Space Aeronomy, Belgium,* **A. Määattäanen,** *LATMOS/IPSL, Sorbonne Université, UVSQ, CNRS, Paris, France,* **L. Trompet[1], J.T. Erwin[1], F. Daerden[1], L. Neary[1],** *Royal Belgian Institute for Space Aeronomy, Belgium,* **S. Aoki,** *Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Japan,* **S. Viscardy, I. R. Thomas, C. Depiesse, B. Ristic,** *Royal Belgian Institute for Space Aeronomy, Belgium,* **J. P. Mason, M. R. Patel,** *School of Physical Sciences, The Open University, Milton Keynes, U.K.,* **M.J. Wolff,** *Space Science Institute, Boulder, CO, USA,* **A.S.J. Khayat,** *NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; Center for Research and Exploration in Space Science and Technology II, University of Maryland, USA;* **G. Bellucci,** *Istituto di Astrofisica e Planetologia Spaziali, IAPS-INAF, Rome, Italy,* **J.-J. Lopez-Moreno,** *Instituto de Astrofisica de Andalucia, IAA-CSIC, Granada, Spain.*

Introduction:

The NOMAD-UVIS instrument on board the ExoMars Trace Gas Orbiter has been investigating the Martian atmosphere with the occultation technique since April 2018 (Vandaele et al. 2015). In the solar occultation mode, it is mainly devoted to study the climatology of ozone and aerosols content (Patel et al. 2021; Khayat et al. 2021). Here, we will present an inter-comparison of retrieval codes for ozone observed with NOMAD-UVIS.

NOMAD-UVIS solar occultations:

We analyzed almost two Mars Years of ozone vertical distributions acquired at the day-night terminator, corresponding to more than 8300 solar occultations, acquired between April 2018 (MY 34, L_S=163°) and November 2021 (MY 36, L_S=132°).

Inter-comparison of three retrieval methods:

As in the work of Määttänen et al. (submitted to Icarus), the NOMAD-UVIS ozone retrievals proved more difficult than expected due to the presence of spurious detections of ozone caused by instrumental effects, high dust content, and very low values of ozone. This lead us to compare the results from three different retrieval approaches:

1) an onion peeling method (OP);
2) a full occultation Optimal Estimation Method (FOEM), and
3) a direct onion peeling method (DOP).

The OP method is similar to that used for Mars and Venus stellar occultations (Quémerais et al., 2006; Piccialli et al., 2015). The FOEM and DOP approaches are based on ASIMUT-ALVL, the BIRA-IASB radiative code (Vandaele et al., 2008, Piccialli et al. 2021).

The main challenge was to find reliable criteria to exclude spurious detections of O_3, and we finally adopted two criteria for filtering: i) a detection limit, and ii) the $\Delta\chi^2$ criterion. Both criteria exclude spurious O_3 values especially near the perihelion, where based on the simulations from a general circulation model, we do expect very low values of ozone.

Comparison of filtering methods between UVIS and SPICAM:

We compared the results of filtering with SPICAM-UVIS observations. The SPICAM team applied very similar criteria for filtering their data to the ones implemented here (Määttänen et al. submitted to Icarus). Even if the two instruments observed during different Martian Years, the agreement on the filtered O_3 retrievals is very good, and both filtering approaches lead to very similar results (see Figure 1).

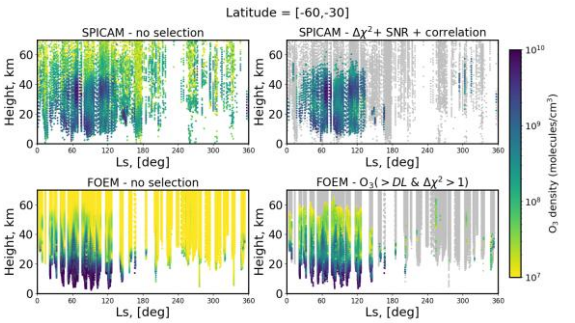

Figure 1: An example of the effect of the selection criteria for SPICAM-UV and NOMAD-UVIS observations for a latitude band (-60°;-30°). Left panels show the ozone vertical distribution before applying the filtering; right panels shows O_3 profiles after the selection criteria.

References: Khayat et al. (2021) https://doi.org/10.1029/2021JE006834; Määttänen et al. Icarus, in review; Patel et al. (2021) https://doi.org/10.1029/2021JE006837; Piccialli, A. et al., (2015) https://doi.org/10.1016/j.pss.2014.12.009; Piccialli et al. (2021) https://doi.org/10.1016/j.icarus.2019.113598; Quémerais et al., (2008) https://doi.org/10.1029/2005JE002604; Vandaele et al. (2006) https://doi.org/10.1029/2008JE003140; Vandaele et al. (2015) https://doi.org/10.1364/OE.23 .030028