# Relationship between the ozone and water vapour vertical profiles on Mars observed by NOMAD-TGO

**Arianna Piccialli, A. C. Vandaele,** *Royal Belgian Institute for Space Aeronomy, Belgium,* **S. Aoki,** *Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Japan,* **F. Daerden, Y. Willame, C. Depiesse, L. Trompet, L. Neary, S. Viscardy, J. Erwin, I. R. Thomas, 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.,* **A. 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;* **M. Wolff,** *Space Science Institute, Boulder, CO, 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:**

Recently, [1] characterized the relation between ozone and water vapor using SPICAM simultaneous measurements of $O_3$ and $H_2O$ column densities covering four Martian years. They found that $O_3$ and $H_2O$ columns are clearly anti-correlated at high latitudes while being uncorrelated at low latitudes.

In our study, we take advantage of the NOMAD capability to measure simultaneous vertical profiles of ozone and water vapor to characterize the $O_3$ – $H_2O$ relationship at different altitude ranges and latitudes.

**Ozone and water vapor profile retrievals:**

**NOMAD** (Nadir and Occultation for MArs Discovery) is a spectrometer composed of 3 channels: 1) a solar occultation channel (SO) operating in the infrared (2.3-4.3 μm); 2) a second infrared channel LNO (2.3-3.8 μm) capable of doing nadir, as well as solar occultation and limb; and 3) an ultraviolet/visible channel **UVIS** (200-650 nm) that can work in the three observation modes [2,3].

The UVIS channel has a spectral resolution <1.5 nm. In the solar occultation mode it is mainly devoted to study the climatology of **ozone** and **aerosols** content [4, 8]. NOMAD-UVIS spectra are simulated using the line-by-line radiative transfer code ASIMUT-ALVL developed at IASB-BIRA [5] using the Optimal Estimation Method to derive the local density profile in one go (on all transmittances of one occultation observation).

Water vapor was observed by the infrared channel of the NOMAD SO. The results from a first analysis can be found in [6], while an extended dataset is presented in a companion abstract [7]. Water vapor and ozone are measured simultaneously, which allows us to investigate the water-ozone correlation, the key to address the atmospheric chemistry on Mars.

**The $O_3$-$H_2O$ relationship:**

We present correlation plots of $O_3$ vs. $H_2O$ at high latitudes (60°-90°, both hemispheres), and at the equator (30°S-30°N). It is important to notice that during a solar occultation experiment at the terminator, ozone may exhibit rapid changes due to photolysis that are uncorrelated to water vapor. As an example, we show the 60°N-90°N latitude region (Figure 1): a clear anti-correlation is observed at lower altitudes, up to 40 km. $O_3$ is roughly proportional to $(H_2O)^{-1.0}$ up to 30 km and a variation with $L_s$ seems also present.

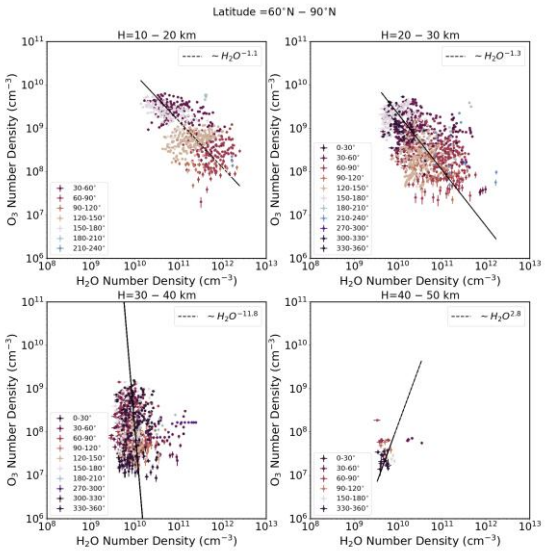


**Figure 1:** $O_3$ ($cm^{-3}$) vs. $H_2O$ ($cm^{-3}$) vertical profiles measured simultaneously by NOMAD-UVIS at high latitudes in the Northern hemisphere (60°N-90°N). (a) 10 – 20 km; (b) 20 – 30 km; (c) 30 – 40 km; (d) 40 – 50 km. Colours indicate the Ls interval. The black line shows the function $O_3 = H_2O^x$, with x varying with the altitude range.

**References:** [1] Lefèvre, F. et al. 10.1029/2021JE006838. [2] Vandaele, A.C., et al., Planetary and Space Science, Vol. 119, pp. 233–249, 2015. [3] Neefs, E., et al., Applied Optics, Vol. 54 (28), pp. 8494-8520, 2015. [4] Patel et al. (2021) [5] Vandaele, A.C., et al., JGR, 2008. 113 doi:10.1029/2008JE003140. [6] Aoki et al., 2019, Journal of Geophysical Research, Volume124, Issue12, Pg. 3482-3497, doi:10.1029/2019JE006109 [7] Aoki et al., Europlanet Science Congress 2021, ID EPSC2021-153 [8] Khayat et al. 2021, DOI 10.1029/2021JE006834.