A simple, autonomous, non-linear inversion method for the analysis of occultation observation of the dusty atmosphere of Mars.

Hubert B.(1), L. Soret(1), J.-C. Gérard(1), G. Wautelet(1), G. Munhoven(1), A. Piccialli(2), I. R. Thomas(2), A.-C. Vandaele(2)

1. LPAP, STAR Institute, University of Liège, Liège, Belgium.

2. Royal Belgian Institute of Space Aeronomy, Belgium.

Ozone (O3) is an important atmospheric specie of planet Mars, capable of absorbing ultraviolet (UV) radiation. Occultation of solar (or stellar) radiation and measurement of the extinction of UV photons by the atmosphere is a standard O3 remote sensing method. Both O3 and carbon dioxide (CO2) absorb UV photons in the 200 – 300 nm range, the O3 Hartley absorption band peaking near 250 nm. Dusts also contribute to, and sometimes dominate, the UV extinction by the atmosphere of Mars. The wavelength-dependent dust extinction coefficient (k) is often described using a power law k=k0 (λ0/ λ)α with reference value k0 at wavelength λ0. The ad-hoc α exponent stems from the properties of the dusts.

We develop a simple autonomous, nonlinear method to retrieve the vertical profiles of CO2, O3 and dust properties from solar occultation profiles, under a spherical symmetry assumption. The gas concentration and dust reference extinction (k0) are represented using a combination of triangle functions of the radial distance (r), producing a piecewise linear profile. The α parameter is represented similarly using triangle functions of log(r). Slant line-of-sight optical thickness results from the Abel transform of these profiles, producing hypergeometric 2F1 functions for the dusts. The different parameters are retrieved by inverse Abel transform using a least squares minimization, which depends linearly on the CO2, O3 and k0 profiles, and non-linearly on α. The linear parameters are considered as functions of the α, reducing the fitting to a non-linear minimization over the α profile only. This drastically reduces the number of dimensions of the parameter space. We show that this method allows efficient retrieval of all the parameters. Noise is expected to be present when analyzing occultation data from the NOMAD-TGO instrument, which can reduce the ability to retrieve the minimization parameters. The k0 and O3 profiles can, nevertheless, be expected to be retrieved over about two orders of magnitude, while the CO2 density profile can be expected to be fairly retrieved at relatively low altitude.