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Vertical profiles of Martian aerosols distribution parameters and composition retrievals from NOMAD-SO

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1. The NOMAD-SO database and retrieval procedure

The NOMAD-SO channel [1] is an infrared spectrometer onboard ExoMars TGO working in the 2.2 to 4.3 µm spectral range (2200-4500 cm-1). During a solar occultation measurement, NOMAD-SO scans six diffraction orders each second. These diffraction orders are recorded on four bins leading to a vertical sampling lower than one km. We use vertical profiles of calibrated transmittance and evaluated noise from level 1 data provided by the PI team. These level 1 scans are pre-processed by an in-house algorithm set up to clean the data of possible spectral shifts and/or bending. In order to retrieve the extinction vertical profile due to aerosol we use the model a state-of-the-art line by line radiative transfer forward model code called KOPRA, in conjunction with the iterative non-linear inversion scheme RCP, conceived and developed at the Institute of Meteorology and Climate Research (IMK) of Karlsruhe Institute for Technology and previously used in [2]. *A priori* and first guess profiles of the atmospheric thermal structure and composition, required by RCP, are taken from specific runs of the LMD Mars-GCM available through the MCD [3]. To minimize vertical error propagation we adopted a global fit inversion instead of a classical onion-peeling method. A first order Tikhonov regularization matrix is used for the aerosol extinction retrieval. For stability, RCP uses Levenberg-Marquardt damping method. Pre-processing and regularization parameters required fine-tuning, a task performed using a sample of orbits. We confirmed that these parameters are valid for all other scans.

2. Aerosols characterization and vertical profiles

Aerosols in Martian atmosphere play a major role in several chemical and radative processes, affecting local to global dynamics and energy budget (see [4] for an exhaustive review of this subject). One crucial parameter is the aerosol composition and distribution, i.e the dust, water ice or CO_2 ice content and its variation with with altitude, with a better vertical resolution than previous instruments. TGO offers an excellent opportunity to study it in detail for the first time because of its high vertical resolution. Using the vertical profile of aerosol extinction obtained from NOMAD-SO measurements as described above, we then apply a model/data fitting strategy of the aerosol extinction, as described in [5] in order to evaluate key parameters of the aerosol's content in the martian atmosphere. We compare the retrieved aerosol extinction to a precomputed look-up table in the same spectral range from a Lorenz-Mie code to compute the scattering properties of an ensemble of polydisperse spherical particles [6] and using refractive indexes for martian dust, water ice and CO_2 ice. This procedure allow us to evaluate two other key parameters besides the composition of aerosol present in the martian atmosphere, namely, the effective radius (r_{eff}) and the effective variance (v_{eff}). These characteristic parameters of the aerosol's distribution are of great interest constraining microphysics and dynamics. We will detail this procedure and compare the early results with available data for several chosen scans of NOMAD-SO observation during the first year of TGO operations, which include the GDS 34 [7].

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