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CO₂ and temperature retrievals in the Mars atmosphere during solar occultation by NOMAD-SO and ACS-MIR: performance validation.

Miguel Angel Lopez-Valverde et al.

Abstract

We present simultaneous retrievals of vertical profiles of CO₂ and temperature obtained from a small selection of observations by the NOMAD-SO [1] and ACS-MIR [2] instruments on board the ExoMars *Trace Gas Orbiter* (TGO). The two sets of each instrument's observations are sufficiently close in time and space so that the atmospheric variability can be compared, and a meaningful comparison of the performance of both instrument channels is possible. This is an on-going validation of both instruments. We will present a small selection of retrievals that can be used for validation and as a first step into the mutual validation of NOMAD-SO and ACS-MIR.

1. Instruments and observations

Our work is focussed in the NOMAD-SO and the ACS-MIR channels, those specifically devoted to CO₂ retrieval during solar occultation. Several groups in the NOMAD and ACS teams are performing retrievals of species abundances and temperature, which are reported in this conference [3,4]. We focus on the retrieval of CO₂ and temperature in the 2.7 μm region of the spectra, which is covered by SO and ACS [5]. The spectra correspond to calibrated transmission spectra from diffraction orders 164 and 165 and from MIR position 4 spectra. About a dozen strong CO₂ lines are observed at very high tangent altitudes, around 170-180 km. The present study targets at both solar occultation and limb observations, but unfortunately, due to some unexpected miss-alignments among the different channels in each instrument, ACS, an entirely simultaneous observation of the solar disc as it emerges or hides behind the atmosphere is not possible in the ACS and MIR channels. Instead this work studies the inversions from the two channels in nearly coincident observations during changes in latitude, longitude, solar longitude and time.

2. Retrieval Scheme

We have performed the present retrievals using an inversion code previously used in the Earth upper atmosphere by the MIPAS instrument on board the Envisat mission [6]. The inversion scheme, which has been re-

sounding in emission from the OMEGA spectrometer on board the Mars Express spacecraft [7], observations. At the core of the inversion scheme is the forward model KOPRA (Karlsruhe Optimize Algorithm [8]) and the inversion processor (RCP), jointly developed by the Institute for Meteorology the IAA [9].

As mentioned above we used here CO₂ calibrated transmittances obtained from routine processing injection into the inversion algorithm, a *pre-processing* of every orbit or scan is performed in order to avoid spurious effects. These are essentially two: residual spectral shifts and artificial bending in single spectral effects changes from order to order and between SO and ACS. In spite of these differences, the pre-processing is applied to both signals, and is actually performed with the same Python code. Further, the ILS associated with the spectra is reproduced by a double gaussian, whose detailed description (parameters describing their FWHM and peak position) is also a precise determination by the user, as apparently it slightly varies with time and observing conditions.

It is specially useful to obtain both density and temperature information from a single scan, and this is the goal of the present study. The simultaneous retrieval from a given scan actually derives a CO₂ density profile, and after an inversion step a temperature profile assuming hydrostatic equilibrium. An adjustment for the pointing is also introduced, and the interference from species like H₂O are also considered during the inversion to obtain the best fits.

3. Results

We will discuss the first comparisons of CO₂ and temperatures from NOMAD-SO and ACS-MIR, using the inversion code. The retrievals perform in a similar manner, as in both cases the number of lines, the spectral region are similar. Small differences in noise and spectral resolution have some impact but do not prevent sounding the Mars atmosphere up to the upper thermosphere with just one single scan. Averaging of multiple scans provides resolutions around 4-6 km in the middle atmosphere (50-100 km), both in CO₂ and temperature. The dust loading and in general degrades below about 30 km and above 150 km due to saturation and noise.

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