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Impact of gradients at the Martian terminator on the retrieval of ozone from SPICAM/MEx

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1. Introduction

Rapid variations in species concentration at the terminator have the potential to cause asymmetries in the species distributions along the line of sight (LOS) of a solar occultation experiment. Ozone, in particular, displays steep gradients across the terminator of Mars due to photolysis [1]. Nowadays, most of the retrieval algorithms for solar and stellar occultations rely on the assumption of a spherically symmetrical atmosphere. However, photochemically induced variations near sunrise/sunset conditions need to be taken into account in the retrieval process in order to prevent inaccuracies.

Here, we investigated the impact of gradients along the LOS of the solar occultation experiment SPICAM for the retrieval of ozone under sunrise/sunset conditions. We used the diurnal variations in the ozone concentration obtained from photochemical model calculations together with an adapted radiative transfer code.

2. SPICAM solar occultations

SPICAM (SPectroscopie pour l'Investigation des Caractéristiques Atmosphériques de Mars), on board the ESA's spacecraft Mars Express, is a remote sensing spectrometer observing in the ultraviolet (118–320 nm) and in the near infrared (1–17 μm) [2]. In the solar occultation mode, the UV sensor is particularly well suited to measure the vertical profiles of O_3 and aerosols of the Martian atmosphere [3]. Figure 1 displays transmission spectra obtained at different altitudes for the observation 00633A02.

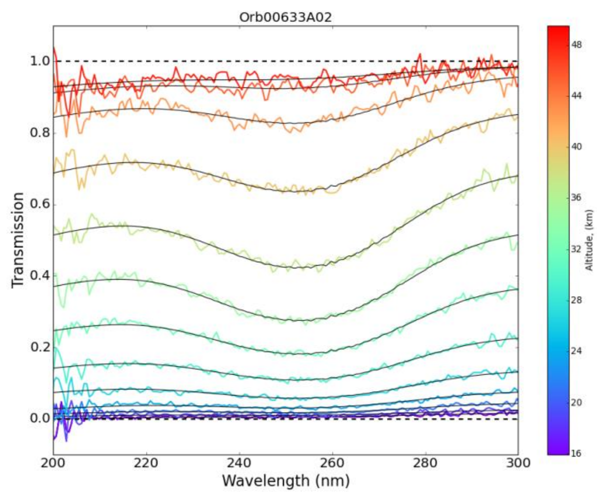

Figure 1: Example of SPICAM transmission spectra at different altitudes: (blue) low altitudes; (red) high altitudes.

We followed the same method described in [4] to check that the spectra are correctly calibrated and accurately normalized to the solar spectrum.

3. Retrieval technique

SPICAM-UV spectra are simulated using the line-by-line radiative transfer code ASIMUT-ALVL developed at IASB-BIRA [5]. ASIMUT has been modified in order to take into account the atmospheric composition and structure at the day-night terminator. Three different gradients along the LOS can be considered: temperature, total density gradients and the variations of the concentration of specific species. As input for ASIMUT, we used gradients predicted by the 3D GEM-Mars v4 Global Circulation Model (GCM) [6,7]. Figure 2 shows the diurnal cycle of ozone derived by GEM-Mars. Ozone is more abundant during the night time, especially above 40-50 km. As the Sun rises, the destruction of O_3, although stronger in the high atmosphere, is observed at all altitudes.

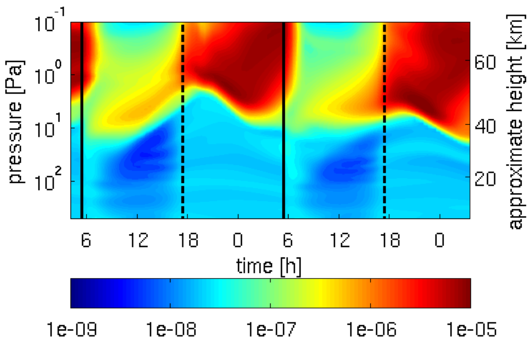

Figure 2: Diurnal cycle of ozone predicted by the 3D GEM-Mars v4 GCM.

4. Preliminary results

As preliminary study, we selected four occultations at sunrise and at sunset each. As first step, we retrieved O_3 profiles without taking in account gradients and we obtained results in agreement with previous studies. Then, we investigated the effects of ozone density gradients on the retrieval of ozone. The retrieved ozone profiles are lower compared to retrievals without gradients, even if differences are within the error bars. These effects will be analysed in more detail.

5. Future work

We will extend our analysis to the whole SPICAM-UV solar occultation dataset. The main objective is to investigate fully the impact of these gradients on ozone retrievals. We will compare our retrievals with those from a similar study carried out at LATMOS within the UPWARDS project. Results of this study will then be used for the analysis of the data expected from the NOMAD instrument on the ExoMars 2016 Trace Gas Orbiter.

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