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A test case: new retrievals of ozone at the terminator on Mars

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Abstract

ASIMUT, the BIRA-IASB radiative transfer code, was modified in order to take into account the changes in the atmospheric composition and structure across the martian day/night terminator. Here, we will discuss the impact of this implementation on the retrievals of ozone profiles derived from SPICAM solar occultations in the ultraviolet.

1. Introduction

The martian atmosphere at the day-night terminator is a region of great interest characterized by gradients of density and temperature, driven by differences in the solar illumination, and by sharp transitions in the chemical regime. Ozone, in particular, displays rapid changes due to photolysis across the terminator [1]. Nowadays, most of the retrieval algorithms for solar and stellar occultations rely on the assumption of a spherically symmetrical atmosphere. In order to handle concentration gradients along the line of sight it is necessary therefore to improve the retrieval scheme used to analyse occultation observations.

2. Observations

SPICAM (SPectroscopie pour l'Investigation des Caractéristiques Atmosphériques de Mars), on board the ESA's mission 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 05555A02. The signal below 200 nm has a poor S/N ratio due to the low emission of the Sun at those wavelengths. The ozone absorption band (Hartley band) is clearly visible around 250 nm.

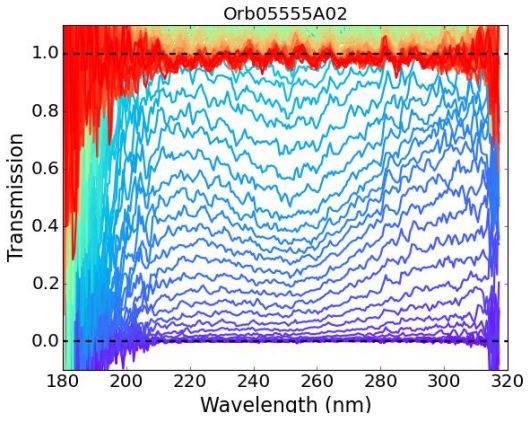

Figure 1: Example of SPICAM transmission spectra at different altitudes: (blue) low altitudes; (red) high altitudes.

3. Retrieval technique

SPICAM-UV spectra are simulated using the line-by-line radiative transfer code ASIMUT-ALVL developed at IASB-BIRA [4]. 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 line of sight (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 a 1D model with high temporal resolution [5] driven by the 3D GEM-Mars v4 Global Circulation Model (GCM) [6,7]. Figures 2 and 3 show examples of temperature and density profiles obtained around the terminator by the GEM-GCM.

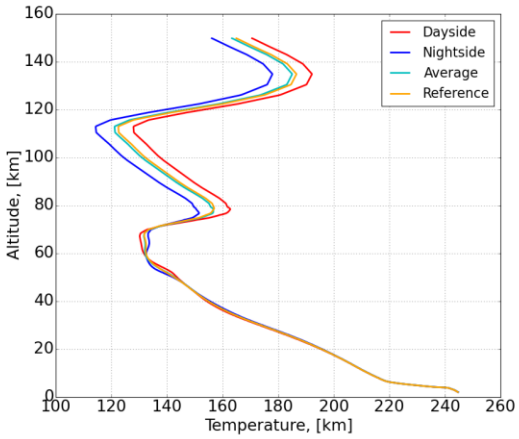

Figure 2: Vertical temperature profiles obtained by the GEM-GCM. The reference profile (yellow) is obtained at the terminator; the average profile (green) is the mean of the day (red) and night (blue) side profiles.

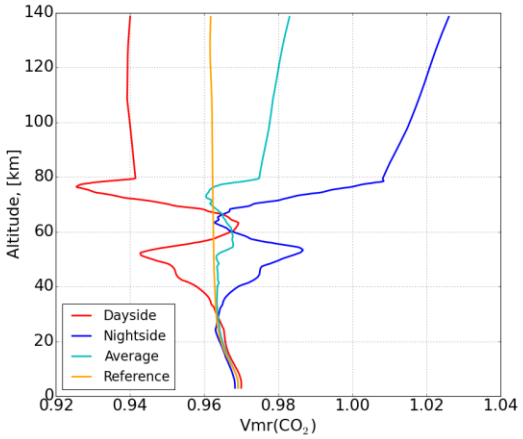

Figure 3: Vertical CO_2 mixing ratio profiles obtained by GEM-GCM. Colours code as in Fig. 2

4. Summary and Conclusions

We will apply the ASIMUT improved retrieval scheme to SPICAM-UV solar occultation data, focusing on ozone (O_3). The main objective is to test the impact of these gradients on ozone retrievals. 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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References

[1] Lefèvre, F., Bertaux, J.L., Clancy, R. T., Encrenaz, T., Fast, K., Forget, F., Lebonnois, S., Montmessin, F., Perrier, S., Aug. 2008. *Heterogeneous chemistry in the atmosphere of Mars.* Nature 454, 971–975.

[2] Bertaux, J., Korablev, O., Perrier, S., Qu´emerais, E.,Montmessin, F., Leblanc, F., Lebonnois, S., Rannou, P., Lef`evre, F., Forget, F., Fedorova, A., Dimarellis, E., Reberac, A., Fonteyn, D., Chaufray, J. Y., Guibert, S., Oct. 2006. *SPICAM on Mars Express: Observing modes and overview of UV spectrometer data and scientific results.* JGR (Planets) 111 (E10), 10–+.

[3] Määttänen, A., Listowski, C., Montmessin, F., Maltagliati, L., Reberac, A., Joly, L., Bertaux, J.L., Apr. 2013. *A complete climatology of the aerosol vertical distribution on Mars from MEx/SPICAM UV solar occultations.* Icarus 223, 892–941.

[4] Vandaele, A.C., M. De Mazière, R. Drummond, A. Mahieux, E. Neefs, V. Wilquet, O. Korablev, A. Fedorova, D. Belyaev, F. Montmessin, and J.L. Bertaux, *Composition of the Venus mesosphere measured by SOIR on board Venus Express.* J. Geophys. Res., 2008. 113 doi:10.1029/2008JE003140.

[5] García Muñoz, A., J.C. McConnell, I.C. McDade, and S.M.L. Melo, *Airglow on Mars: Some model expectations for the OH Meinel bands and the O2 IR atmospheric band*, Icarus 176 (2005) 75–95.

[6] Daerden, F.; Whiteway, J. A.; Neary, L.; Komguem, L.; Lemmon, M. T.; Heavens, N. G.; Cantor, B. A.; Hébrard, E.; Smith, M. D. *A solar escalator on Mars: Self-lifting of dust layers by radiative heating.* GRL, 2015, Vol. 42, Issue 18, pp. 7319-7326.

[7] Neary, L. and F. Daerden, *The GEM-Mars General Circulation Model for Mars: Description and Evaluation*, Icarus, 2017, in review.