THE MARTIAN UV DAYGLOW: GLOBAL SIMULATION, MARS EXPRESS MEASUREMENTS AND PERSPECTIVES FOR EXOMARS

F. González-Galindo[1], J.-Y. Chaufray[2], F. Forget[3], M. García-Comas[1] , F. Montmessin[2], and S.K. Jain[4]

[1]Instituto de Astrofísica de Andalucía-CSIC, Granada, Spain, [2]LATMOS, IPSL, Paris, France, [3]Laboratoire de Météorologie Dynamique, IPSL, Paris, France, [4]Laboratory for Atmospheric and Space Physics, Boulder, Colorado, USA

Introduction: Since the beginning of the space era, remote sensing of UV atmospheric emissions has been used to derive information about the temperature and composition of the upper atmosphere of Mars (e.g. [1], [2], [3], [4]). The dayglow arising from Mars is dominated by the CO Cameron bands and the CO_2^+ UV doublet, ultimately produced by the effects of UV solar radiation and photoelectrons on CO_2, the main constituent of the Martian atmosphere. The UV channel of the SPICAM instrument on board Mars Express has been observing the Martian dayglow during 4 Martian Years. However, only the data obtained during the first Martian Year have been fully analysed and published ([2], [5], [6]).

Different theoretical models have been developed in order to simulate the Martian UV dayglow spectra ([5], [6], [7], [8], [9]). They are 1D models, that is, they only consider variations in the vertical. This allows for a detailed treatment of the different processes producing atmospheric emission, but decouples these models from the atmospheric variability produced by a variety of photochemical and transport processes.

We have included in the LMD Mars Global Climate Model (LMD-MGCM) a physical model of the Martian dayglow, providing a natural coupling between the UV airglow and the atmospheric variability. Here we will present the dayglow global maps produced by the model, we will compare them with the SPICAM full dataset of dayglow observations, and discuss possible future observations with the UVIS channel of the ExoMars NOMAD instrument.

Model description and selected results: The dayglow model has been incorporated into the most recent version of the ground-to-exosphere LMD-MGCM [10]. In order to simulate the CO_2^+ UV doublet and the Cameron bands, models of the creation and of the energy degradation of photoelectrons, based on the Analitical Yield Spectra technique [11], have been implemented.

Different simulations for a full Martian Year, using different solar UV and dust scenarios, have been performed to produce the first global maps of the UV dayglow on Mars (Fig. 1). The balance between the different processes at the origin of the emissions has been studied, showing an important seasonal variability in the contribution of the photoelectron impact excitation of CO to the Cameron bands. The variability of the dayglow with different geophysical parameters will be discussed.

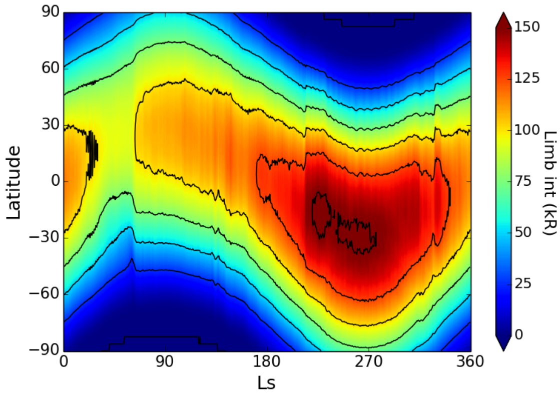

Figure 1: Seasonal and latitudinal variability of the peak limb emission of the UV doublet at noon

All the available SPICAM observations of the UV dayglow, covering 4 Martian Years, have been analyzed. The predictions of the model have been compared with the SPICAM observations. The peak altitude of the emissions is very well predicted by the model, indicating a good representation of the upper atmosphere densities in the LMD-MGCM. An increase of the peak altitudes during the global dust storm for MY28 is seen both in the model and in the SPICAM data, although the increase seems to be larger in the data than in the simulations. The peak intensities are in general overestimated by the model. However, when taking into account the important uncertainties in the measurements of the electron impact cross sections on CO_2 and CO, the predicted intensities of the Cameron bands show a reasonable agreement with the observations.

References:

[1] Stewart, A.I. et al., ***Icarus,*** 17, 469–474, 1972
[2] Leblanc, F., et al, ***JGR***, 111(E9), E09S11, 2006.
[3] Stiepen, A. et al. (2015), ***Icarus***, 245, 295-305, 2015.
[4] Jain, S.K. et al. (2015), ***GRL***, 42, 9023–9030.
[5] Simon, C., et al., ***PSS***, 57(8-9), 1008–1021, 2009
[6] Cox, C., et al., ***JGR*** 115(E4), E04010, 2010.
[7] Fox, J. L., and A. Dalgarno, ***JGR,*** 84, 7315–7333, 1979.
[8] Shematovich, V. I. et al., ***JGR***, 113, E02011, 2008.
[9] Jain, S.K., and A. Bhardwaj, ***PSS***, 6364, 110 – 122, 2010.
[10] González-Galindo, F. et al., ***JGR,*** 120, 2020–2035, 2015
[11] Bhardwaj, A., and S.K. Jain, ***JGR***, 114, A11309, 2009

Acknowledgements: This work has been partially funded by the European Union Horizon 2020 Programme (H2020 Compet -08-2014) under grant agreement UPWARDS-633127