



HAL
open science

3D Modelling Of The Venus Nitrogen Chemistry

Nicolas Streel, Franck Lefèvre, Aurélien Stolzenbach, Anni Määttänen, S
Lebonnois, J C Gérard, L Soret

► **To cite this version:**

Nicolas Streel, Franck Lefèvre, Aurélien Stolzenbach, Anni Määttänen, S Lebonnois, et al. 3D Modelling Of The Venus Nitrogen Chemistry. Venus Surface and Atmosphere 2023, Jan 2023, Houston, United States. pp.LPI Contribution No. 2807, id.8021. <insu-04408816>

HAL Id: insu-04408816

<https://insu.hal.science/insu-04408816v1>

Submitted on 22 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

3D MODELLING OF THE VENUS NITROGEN CHEMISTRY. N. Stree1, F. Lefèvre1, A. Stolzenbach1,2, A. Määttänen1, S. Lebonnois3, J. C. Gérard4, and L. Soret4, 1LATMOS (Sorbonne-Université, UVSQ Paris-Saclay, CNRS, boîte 102, 75005 Paris, France, nicolas.streel@latmos.ipsl.fr), 2Instituto de Astrofísica de Andalucía (Gta. de la Astronomía, 18008 Granada, Spain), 3LMD (Sorbonne-Université, boîte 99, 75005 Paris, France), 4LPAP (Université de Liège, 4000 Liège, Belgique).

Abstract: Nitrogen chemistry has been modelled for the first time with a ground-to-thermosphere Global Climate Model (GCM) of Venus. We will present the distribution of the main nitrogen species as well as a comparison between the model results and satellite observations of the NO nightglow. A good general agreement is found both in the location and the intensity of this ultraviolet emission.

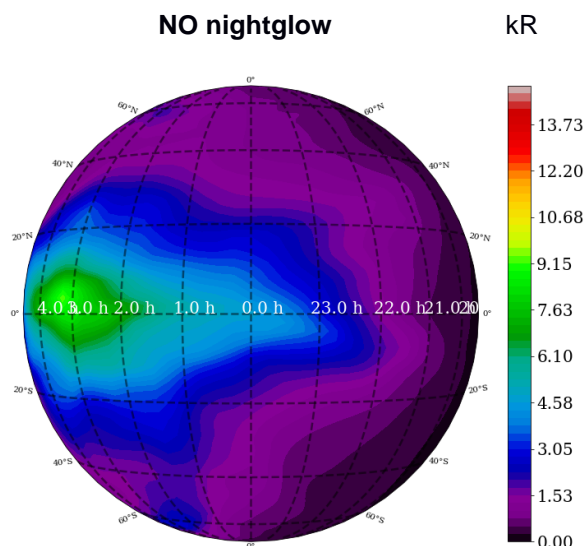


Figure 1. NO nightglow intensity (kR) calculated by the Venus PCM. The center of the circle corresponds to the antisolar point.

Method: We used the Venus Planetary Climate Model (Venus PCM, formerly known as the IPSL Venus General Circulation Model [1]) in its version extended to the thermosphere [2] and including a description of the clouds and photochemistry [3]. The model extends on a horizontal grid of 96x96 points ($3.75^\circ \times 1.785^\circ$) and from the surface up to 150 km on 78 vertical levels. For the present work, we have implemented the online computation of the photolysis rates of all species and added a comprehensive description of the nitrogen chemistry.

Results and perspective: The NO nightglow computed by the Venus PCM has been compared to observations of the Pioneer Venus Orbiter [4] and by the SPICAV spectrometer on board Venus Express. The SPICAV data were obtained both from limb [5] and nadir [6] measurements. The comparisons with the model show a good general agreement regarding the position of the maximum NO emission. The nightglow peak is shifted about 3h from the anti-solar point towards the morning side, in agreement with previous modelling studies [7]. This shift can be explained by the superposition of two dynamical patterns: First, the nitrogen and the oxygen atoms are brought to the night side by the solar-anti solar circulation. They then recombine lower in the atmosphere where the super-rotation transports the chemical species towards the morning side in the direction of the planetary spin. Thus, the position of the NO emission is also a good indicator of the speed of the zonal wind at about 100 km. The intensity of the peak of the NO nightglow calculated by the model is about 75% of the values observed by SPICAV. The altitude of the maximum is found at 105 km, i.e. 10 km lower than detected in the observations. An outstanding feature in our simulations is the strong short-term variability of both the intensity and the position of the NO nightglow, in agreement with the SPICAV observations.

References:

- [1] Lebonnois S., Hourdin F., Eymet V., Crespin A., Fournier R. & Forget F. (2010) *Icarus*, 278, 38-51.
- [2] G. Gilli, T. Navarro, S. Lebonnois, D. Quirino, V. Silva, A. Stolzenbach, F. Lefèvre, & G. Schubert. (2021), *Icarus*, 366, 114432
- [3] Stolzenbach A., Lefèvre F., Lebonnois S., Määttänen A., In revision in *Icarus*
- [4] Stewart, A. I. F.; Gérard, J.-C.; Rusch, D. W. & Bougher, S. W. (1980), *JGR*, 85, 7861
- [5] A. Stiepen and L. Soret and J.-C. Gérard and C. Cox and J.-L. Bertaux (2012). *Icarus*, 220, 981-989
- [6] A. Stiepen, J.-C. Gérard, M. Dumont, C. Cox, & J.-L. Bertaux (2013). *Icarus*, 226(1), 428-436.
- [7] Brecht, A. S., Bougher, S. W., Gérard, J.-C., Parkinson, C. D., Rafkin, S., & Foster, B. (2011), *JGR*, 116, E08004.