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Antoine Martinez, Sébastien Lebonnois, Enora Moisan, Ehouarn Millour,
Thomas Pierron, Gabriella Gilli, Franck Lefèvre

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Exploring the variability of the Venusian Thermosphere with the IPSL Venus GCM

Antoine Martinez et al.

- Introduction

Based on the simulations provided by the IPSL Venus GCM, our team is now ready to offer access to a reference climatological model for use by the scientific community that study the atmosphere of Venus and by engineers that develop mission designs and instrumentation for Venus exploration. The VCD is now available (see <http://www-venus.lmd.jussieu.fr>), and provides a climatology (mean values and variability) for many characteristics of the Venusian atmosphere from the surface to the exosphere, validated against available observations.

In order to provide a predicted atmosphere reproducing as closely as possible the observations, a few adjustments and tunings were done to the IPSL Venus GCM model ([1,2]) basic processes in the context of the Venus Climate Database (VCD). To validate the thermosphere model and tuning, temperature, mass density and number densities measurements from Pioneer Venus, Magellan and Venus Express mission are used around the equator and at the poles for maximum and minimum-intermediate solar cycle conditions.

The results of these improvements, tuning and comparisons will be presented in this study.

- Recent improvements and tuning

Improvements have been made on the parameterization of non-LTE CO₂ near-infrared heating and on the parameterization of non-orographic gravity waves. To reproduce O and CO number densities in the thermosphere, a tuning was done by increasing significantly (by a factor 10) the photodissociation of CO₂ into CO and O for altitudes above 135 km. This raises many questions that we are currently investigating: role of the ionospheric chemistry and uncertainties associated with the molecular diffusion. The validation was performed using temperature, number densities and mass density data from the Pioneer Venus, Magellan and Venus Express missions.

- Results and raised questions

Despite the initial underestimation of the atomic oxygen number density above 130-140 km by a factor of 10, the increase by the same factor of the CO₂ photodissociation into O and CO above these altitudes range allow to fit very well the vertical profile of the PV-ONMS number density and to reproduce the temperature and density evolution of the Venusian thermosphere during high solar activity (180-230 s.f.u). The reduction of the nightside temperature compared to [3] comes mainly from changes in the non-orographic gravity wave parameterization. Our results suggest that the increase of their amplitude and the altitude where the waves break (above 130 km) have weakened the day-to-night transport. The difficulty in tuning the GW parameterization comes from the lack of systematic GW observations which are necessary to constrain the model parameters. However, observations of wave structure at 140 km altitude and above 160-200 km altitude at the poles led us to parameterize our GWs so that they propagate above 140 km.

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Discussion

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