EPSC Abstracts
Vol. 6, EPSC-DPS2011-1138-1, 2011
EPSC-DPS Joint Meeting 2011

Maps of clouds modeled with the IPSL Titan 3D-GCM

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Abstract

A new climate model for Titan's atmosphere has been developed at the IPSL. This model uses the current version of the LMDZ General Circulation Model (GCM) dynamical core with the physics part of the 2D Titan's IPSL-GCM. First simulations made at the LMD (Laboratoire de Météorologie Dynamique) used a version of the model with coupled haze microphysics only. We update the model with the implementation of the clouds microphysics scheme inherited frome the previous 2D version. The model is now fully coupled with clouds processes and is a full 3D extension of the Titan IPSL-GCM ([2], [3]). Currently the model is not optimized and is demanding in term of computational time (approximatively 17 days of execution for one Titan's year simulation) and the model can not be used with its full capacities. Therefore all the microphysics is still computed as zonal averages. Nevertheless, new simulations performed including clouds, shows some encouraging results. The lack of asymmetry of the clouds coverage in the results of the 2D simulations. seems to vanish using the new model which tends to show that dissipation process in the 2D model was too strong. With this new model, we intented to get a better tool to understand Titan's climate and to interpret the large amount of data collected by the probes.

1. Introduction

In the last twelve years, the Titan IPSL-GCM gave plenty of interesting results (e.g, [2], [3],[4],[5]). However, the recent observations of Cassini and Huygens probes revealed some three dimensional structures in Titan atmosphere, like for example ethane and methane clouds, and wave activities (e.g., [6, 7, 8, 9]). The 2D version of the GCM can not account for these structures. In order to improve the GCM, one important step was to update the GCM into a 3D version with the same coupling than the 2D version.

2. Clouds Microphysics

First simulations of the new 3D-GCM was only using the coupled haze microphysics model of the previous 2D-GCM, but do not account for clouds. These simulations show some improvements concerning the tropospheric circulation essentially due to the implementation of an up-to-date boundary layer scheme ([10]). We updated the model with the clouds microphysics model inherited from the 2D-version including the radiative transfer coupling with clouds. Currently the model is not optimized in term of time executions so we have to make some simplifications to run simulations in a reasonable time. First, the microphysics (clouds and haze) is calculated only in 2D (all inputs are zonally averaged quantities). Then, optical constants for clouds are simplified and only calculted once at the beginning of the simulation. Our scope (for now) is essentially to capture the role of the 3D circulation on the average cloud and haze layer.

3. First results

The simulations were initiated from the 2D-GCM results. We run the model for 5 Titan years. During these simulations, we try to account for the surface temperature by tuning the model with the setup parameters. Surface temperature controls the methane flux at the surface which have a key role in the clouds formation. Despite that the steady state is not reached yet, the clouds activity seemed to show some improvement comparing to the 2D simulations were the clouds asymmetry was not very well reproduced. The new model present also some differences in term of precipitation which are less important than in the 2D version. In this presentation, we will compare the two models and presnet the most significant improvements of the 3D version concerning the clouds processes.

4. Perspectives

The first simulations including clouds microphysics are encouraring. It already show some improvements in term of clouds coverage despite the fact that the microphysics scheme is still in 2-dimensions. The model is already prepared to produce full 3-dimensionnal simulations (including all the microphysics calculations in 3D), but we need to improve the time executions of the model. Two major update are being prepared. The first one concerns the parallelization of the model. The second deals with the use of moments to represents tracers in the model. These two updates should significantly improve the time execution and allow the model to run with its full capacities. Then the model results should be compared to the observations in order to improve the model and give interpretations of the observations.

Acknowledgements

The authors thank the ANR project Exoclimats. This work has been supported by the regional Champagne Ardennes phD grant.

References

[1] Cabane, M., et al. (1992), *Icarus*, 96, 176–189.

[2] Rannou, P. et al. (2002), *Nature*, 418, 853–856.

[3] Rannou, P. et al. (2006), *Science*, 311, 201–205.

[4] Lebonnois, S. et al. (2003), *Nature*, 163, 164–174.

[5] Hourdin, F. et al. (2004), *Journ. Geoph. Res.*, 109, E12005.

[6] Porco, C. et al. (2005), *Nature*, 434, 159–168.

[7] Griffith, C. et al., (2005), *Science*, 310, 474–477.

[8] Griffith, C. et al., (2006), *Science*, 313, 1620–1622.

[9] Rodriguez, S. et al., (2009) *Nature* 459, p. 678–682.

[10] Lebonnois, S. et al., (2011), *Icarus*, submitted.