EPSC Abstracts,
Vol. 4, EPSC2009-474, 2009
European Planetary Science Congress,

Impact of the size distribution representation on transport in the Titan IPSL-GCM

J. Burgalat (1), P. Rannou (1) and S. Lebonnois (2)

(1) GSMA, Université de Reims, France, (2) LMD, Université Paris 6, France

Abstract

A 3 dimensional Global Climate Model of Titan atmosphere is currently under development at IPSL (IPSL-GCM). Such a model is demanding in term of computational time, and several processes must be simplified or improved in order to perform simulations with reasonnable running times. In this work, we present a comparative study of the representation of tracer size distributions in the Titan IPSL-Global Climate Model. Tracer size distributions are currently discretized in 10 radius bins ranging from 1 nm to 10 microns. Our work consists in comparing several ways to account for the size distribution. We first define a reference case with a description of the size distribution with 40 bins, similar to the original model ([1]). We then compare this reference model to the 10-bins setup currently used in the GCM [2, 3]. We also used a new description where distributions are represented with one or two moments, or with less bins. Our scope is to define the simplest approach which still produces accurate results in term of opacity, radiative forcing, cloud cover and precipitation.

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]. The 2D version of the GCM can not account for these structures. In order to improve the GCM, one important aspect of the ANR Project EXOCLIMAT is to update the GCM into a 3D version. The first simulations are already time expensive and the model must be simplified before updated. In this study, we try to improve the simulation times of the tracer advection, using the moments of the tracer distribution in the dynamic part of the model instead of using the distribution itself.

Method and preliminary results

The current model uses 10 radius bins to describe each tracers distribution (aerosols, nuclei, methane and ethane ice). Using the moments of theses distributions in the transport processes, we can reduce the number of tracers in the dynamic, and consequently the simulation time. We calculate the moments at the beginning of the run and use them uniquely in the dynamical part. Since we need a full description of the tracers in the physic part (microphysics, radiative transfer), bin description is restored before the calculation of physical processes. In order to compare each model, we use a simulation with 40 bins used as reference model.

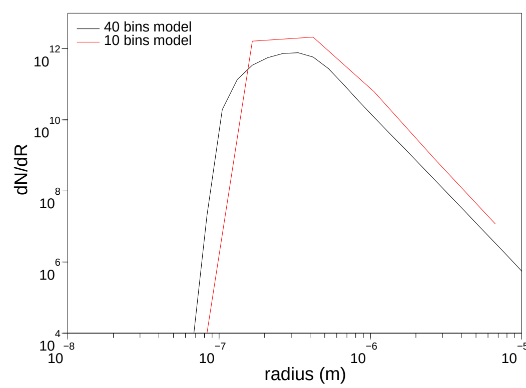

Figure 1: Aerosol granulometry (dN/dr in m^{-4}) given by the 40's bin model (in black) and the 10's bin model (in blue) at the equator during the north spring equinox. The distributions are given in the main haze layer (p=1,15 mbar - z 150km -).

An example of comparison is shown in Figure 1 and 2. In the presentation, we will show the impact of the different size distribution on the predictions of the model. We will focus our comparisons on important fields as temperature, winds, clouds and precipitations. Our purpose is to draw firm conclusion about the type of description that can be used in the 3D model. We will display the amount of time saved for each methods, and their advantages and inconvenients (?).

EPSC Abstracts,
Vol. 4, EPSC2009-474, 2009
European Planetary Science Congress,

Further we will estimates if further simplifications are needed for the 3D GCM.

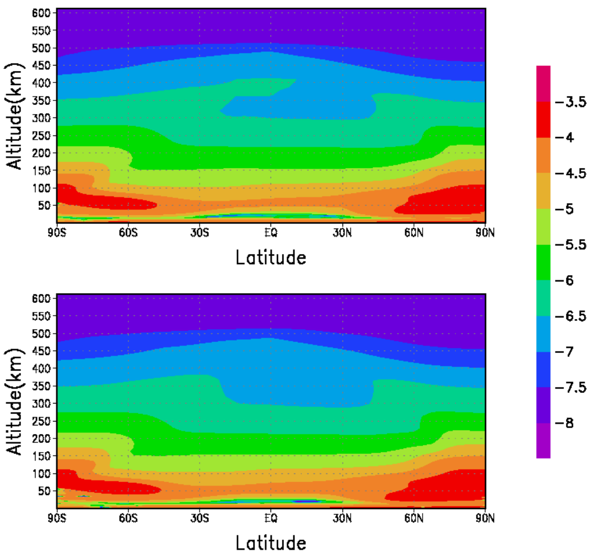

Figure 2: Haze extinction (in m^{-1}) at the north spring equinox for the 10 bins model (upper image) and the 40 bins model (bottom image).

Bibliography

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.