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# Three-dimensionnal turbulent-resolving modeling of the Venus cloud convective layer.

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## Abstract

## 1. Introduction

Venus hosts a global sulfuric acid cloud layer between 45 and 70 km which has been investigated in detail by the Venus Express mission. One of the main questions that remains unclear about the dynamics of the Venusian atmosphere, and its interaction with the photochemistry is how this convective cloud layer mixes momentum, heat, and chemical species and generates gravity waves. Gravity waves emitted by the convection have been proposed to promote a significant contribution to the maintenance of the super-rotation [1]. However, these waves develop from regional to local scales and cannot be resolved by global circulation models (GCM) developed so far to study Venus' atmospheric dynamics.

## 2. Model

Therefore we developed an unprecedented 3D turbulence-resolving Large-Eddy Simulations (LES) Venusian model with the Weather Research and Forecast terrestrial model [2]. Following the idealized LES model [3] using prescribed vertical profile of heating rates from the GCM, we coupled the Venus LMD physics to the dynamical core. Instead of constant interpolated profile, the solar and IR heating rates are directly calculated on the pressure level. The solar rate is computed with short waves radiation fluxes from Haus et al [4]. The radiative transfer is based on Eymet et al [5], using NET matrix with latitudinal varying cloud model from Haus et al [6]. As shown with the previous model, the general circulation has a strong impact on the convective layer. Therefore a third heating rate is added with an interpolated vertical profile from the LMD Venus GCM [7].

## 3. Results

The results shown here are for the Equator at midnight with no wind shear. Fig 1 shows the convective layer.

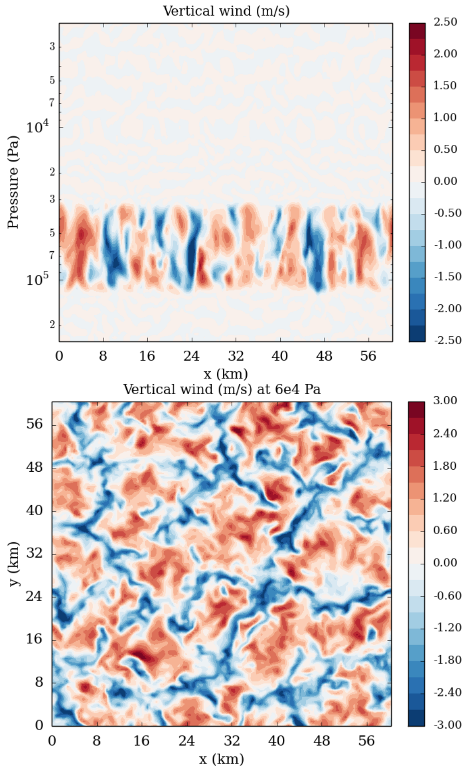

Figure 1: The convective layer. Top : vertical cross-section of the vertical wind (m/s). Bottom : horizontal cross-section of the vertical wind (m/s) at 6.0 $10^4$ Pa.

The convective layer extends from 1.2 $10^5$ Pa to 3.2 $10^4$ Pa (i.e. 46 to 55 km) against a 5 km thick for the idealized LES model. These values are consistent with the radio occultation by Venus Express instrument VeRa [8]. The amplitude of the vertical wind, about ± 3.5 m/s is also consistent with the VEGA balloon measurement [9].

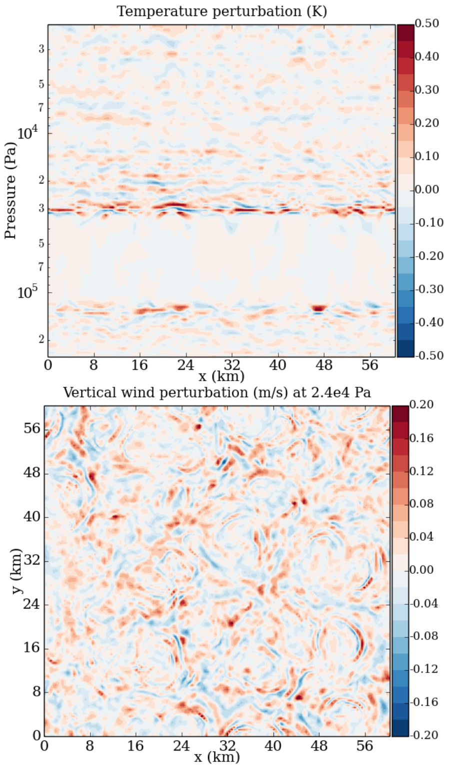

Figure 2: The induced gravity waves. Top : vertical cross-section of the temperature perturbation (K). Bottom : horizontal cross-section of the vertical wind perturbation (m/s) at 2.4 $10^4$ Pa.

Fig 2 shows the induced gravity waves through the temperature perturbation (top) and the vertical wind perturbation (bottom). The amplitude of the waves, ± 0.9 K, is the same order of magnitude as the observations [10]. The vertical wavelength is about 2.5 km and the horizontal wavelength between 1 and 5 km which is on lower part of the spectra [11].

## 4. Summary and Conclusions

The coupling with the LMD Venus physics engender a thicker convective layer with stronger gravity and therefore more consistent with the observations. The variability of the convective layer with latitude and local time will be discuss as well as the impact of wind shear and the impact of the latitudinal variation of the cloud mdel. Convective activity at cloud top will also be discuss.

We are currently working on the modeling of the deep atmosphere, especially the planetary boundary layer, as well as the implementation of the topography.

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