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Subgrid parametrization of the venusian cloud convective activity and associated gravity waves.

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Abstract

Venus hosts a global sulfuric acid cloud layer between 45 and 70 km which has been investigated in detail by the Venus Express and Akatsuki 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. The convection has been studied using Large-Eddy Simulations (LES) [2, 3], characterising the convection between 47 and 55 km of altitude as well as the associated gravity waves. From these studies and observations we propose here subgrid parametrization of the convection and gravity waves in GCMs.

1. Model description

In order to study the impact on the large-scale dynamics of the convective activity we use IPSL Venus GCM [4] coupled to subgrid parametrization. The radiative scheme is based on correlated-k that ensure a realistic calcution of high pressure heating rate. The cloud model is based on Haus et al [5] that takes into account the latitudinal variation of the cloud. In the standard configuration the mixing by larger-scale turbulent plumes is ensured by a simple dry convective adjustment in order to compute mixed layers in situations of convectively-unstable temperature profiles and the emission of gravity waves is not taken into account.

To improve the mixing wind, energy and tracer by the cloud convective layer a thermal plume model has been coupled to the model. The convective adjustment is still used for the deep atmosphere. The thermal plume model is based on the Earth plume model implemented in the IPSL Earth GCM [6]. This thermal plume model has also been implemented into the IPSL Mars GCM [7] and the LMD Generic model for moist convection into the gas giant atmosphere [8]. The parameters has been tunes to Venus convection characteristics using LES modelling [2]. The variation of the heat capacity ith temperature is ensure into the calcution.

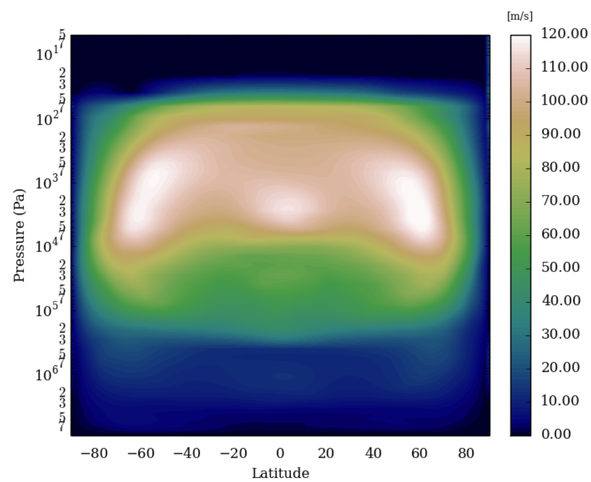

Figure 1: Mean zonal wind obtained with the IPSL Venus GCM.

The parametrization of the gravity waves emitted by the convection is using a stochastic generation of non-orographic gravity waves implemented in the ISPL earth GCM [9]. The parameters such as the momentum flux, wavelength are tuned using LES modelling. As the venusian cloud convective layer extends from about 47 to 55 km the generated gravity waves propagate both above and below the convection therefore the stochastic parametrization is applied to the waves propagatting towards space as well as towards the ground.

2. Ongoing works and perspectives

One of the discrepancy of the LMD Venus GCM general circulation to the observations is the position of the mid-latitude jets (Figure 1) that are too close to the poles. Preliminary results suggest that the non-orographric gravity waves has for impact to get the mid-latitude jets closer to the equator and to accelerate the equatorial jet. Separated impact of the gravity generated below and above the convective are studied. A latitudinal and local-time variability of the wave momentum flux is considered to reproduce the variability of the convection observed by Venus Express mission [10], Akatsuki spacecraft [11] and the turbulent-resolving model [2, 3].

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