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Turbulent vertical mixing of H₂O and SO₂ in the Venus cloud layer

Maxence Lefèvre et al.

1. Introduction

Venus is hosting a global sulfuric acid cloud layer between 45 and 70 km which has been investigated by the Venus Express and Akatsuki mission as well as its coupling with the surface. One of the main questions that remains unclear about the dynamics of the Venusian atmosphere is how this convective cloud layer mixes momentum, heat, and chemical species and generates gravity waves. Several models have been developed to study these phenomena. We proposed to use these models to study the impact of this turbulence on the chemical species, focusing on water and sulfuric dioxide.

2. Model

To study the convective layer, a Large Eddy Simulations (LES) model [1] has been developed using the Weather-Research Forecast (WRF) non-hydrostatic dynamical core [2] coupled with the IPSL Venus GCM physics package [3]. The model is able to resolve a realistic convective layer between 47 and 55 km as well as one convective layer at cloud top altitudes (70 km) at the substellar point (Fig 1).

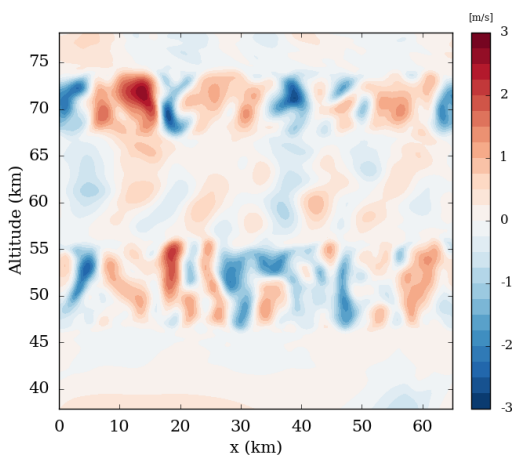


Figure 1: Vertical cross-section of the vertical wind (m/s) at the Equator at noon. Between 47 and 55 km is the main convective layer, between 55 and 67 km are the gravity waves induced by convection and between 67 and 73 km is the cloud top convective layer present only at the substellar point.

Tracers have been included in the model representing H₂O and SO₂, the chemistry and photodissociation sources and sinks are modeled by a linear relaxation of the tracer abundance toward a prescribed vertical profile with a characteristic time. The relaxation time ranges from 10² to 10⁶ s. The prescribed vertical tracer profiles are constructed using observed abundance visible in Fig 2.

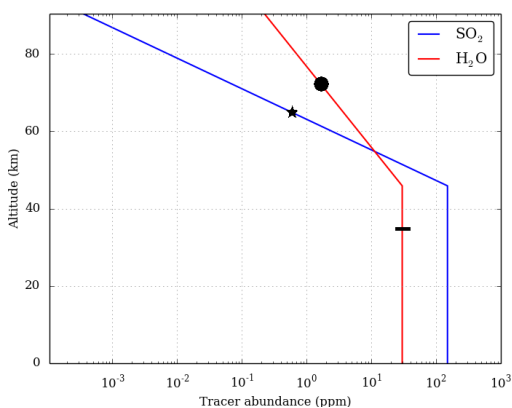


Figure 2: Vertical profile of the tracer abundance relaxation profile. The black represents the value for the deep atmosphere [4], the star is

3. Results

This simple model is able to determine the vertical mixing for SO₂ and H₂O in the cloud layer, and for which chemical timescale the convection plays an important role. The resolution of 500 m allow an estimate of the horizontal turbulent spatial features, induced by the convection and gravity waves, for SO₂ and H₂O.

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