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**Turbulent vertical mixing in the Venus cloud layer.** M. Lefevre<sup>1</sup>, E. Marcq<sup>2</sup> and F. Lefevre<sup>2</sup>

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**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 Venesian 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 acid.

**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 subsolar point (Fig 1).

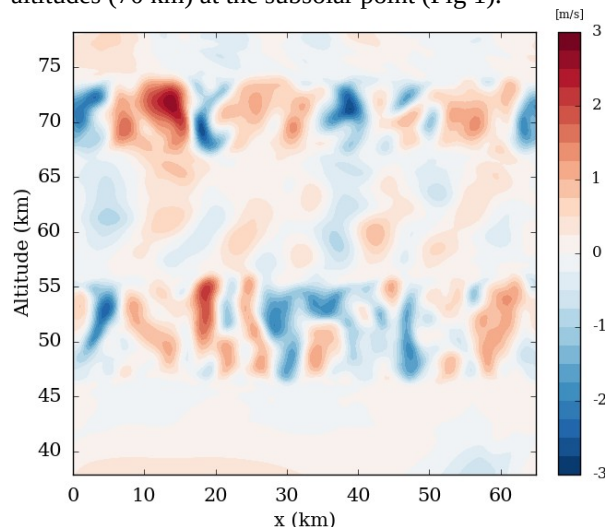


Figure 1: Vertical cross-section of the vertical wind (m/s) at the Equator at noon. Between 47 and 55 km is the main convective layer, between 55 and 67 km are the gravity waves induced by convection and between 67 and 73 km is the cloud top convective layer presents only at the subsolar point.

Tracers have been included in the model representing SO<sub>2</sub> and H<sub>2</sub>O, the chemistry and photo-dissociation sources and sinks are modeled by a linear relaxation of the tracer abundance toward a prescribed vertical profile with a relaxation timescale. The

relaxation time ranges from 10<sup>2</sup> to 10<sup>6</sup> s. The prescribed vertical tracer profiles are constructed using observed abundance visible in Fig 2.

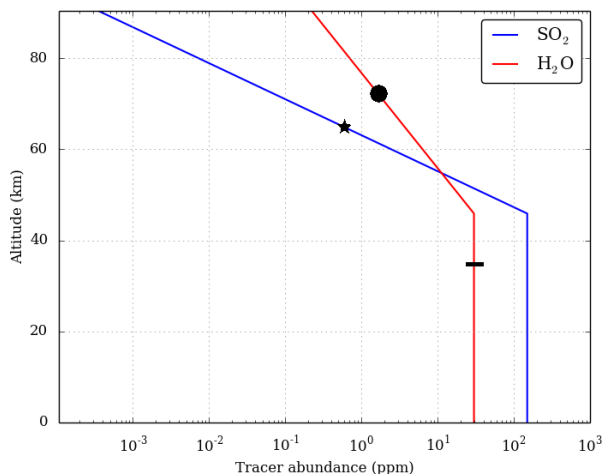


Figure 2: Vertical profile of the tracer abundance relaxation profile. The black represents the value for the deep atmosphere [4], the star is the SO<sub>2</sub> ground-based observations at 65 km [5] and the circle is the cloud top H<sub>2</sub>O Venus Express value [6, 7].

**Results:** This simple model is able to quantify the vertical mixing of SO<sub>2</sub> and H<sub>2</sub>O in the cloud layer [8]. The chemical timescale plays an important role, when it is lower than the convective timescale, around 10<sup>2</sup> s, the vertical mixing is small. The vertical eddy diffusion was estimated, and exhibits values between 10<sup>2</sup> to 10<sup>4</sup> m<sup>2</sup>/s, several orders of magnitude higher than the values commonly used in chemical modelling. The resolution of 500 m allows an estimate of the horizontal turbulent spatial features, induced by the convection and gravity waves, for SO<sub>2</sub> and H<sub>2</sub>O.

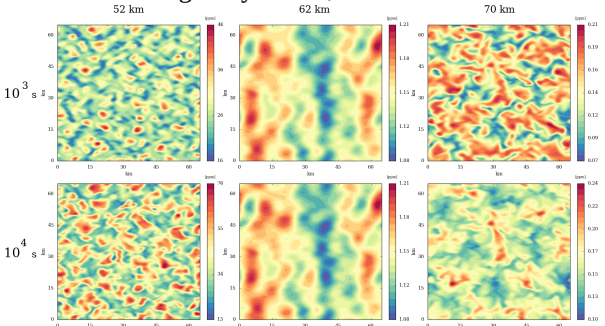


Figure 3: Snapshots of horizontal cross-section of SO<sub>2</sub> at 3 altitudes, 52 km (left), 62 km (middle) and 70 km (right) for a relaxation timescale of 10<sup>3</sup> (top) and 10<sup>4</sup> s (bottom).

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