Multiscale modelling of the Venus sulfur chemistry in the context of EnVision

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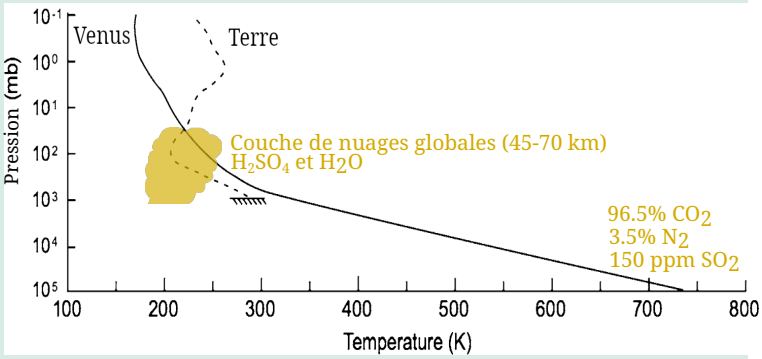
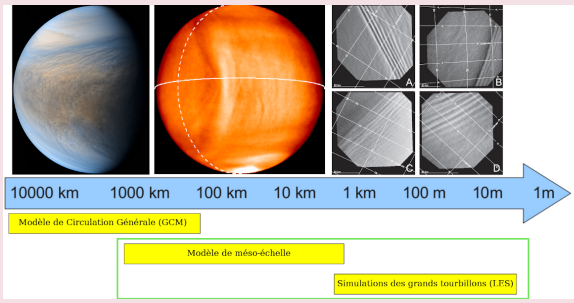
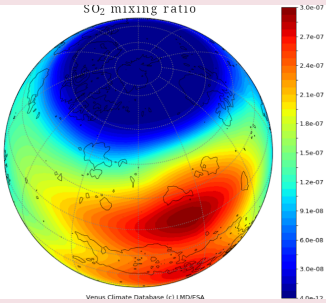
Introduction

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. In this cloud layer, strong turbulence occurs. A 10 km deep convection layer is held in which it remains unclear how this convective cloud layer and mountain waves mix momentum, heat, and chemical species. At cloud-top altitudes, large bow-shape waves stationary above the main equatorial mountain were observed with Akatsuki. The impact on cloud chemistry is not known



Model description



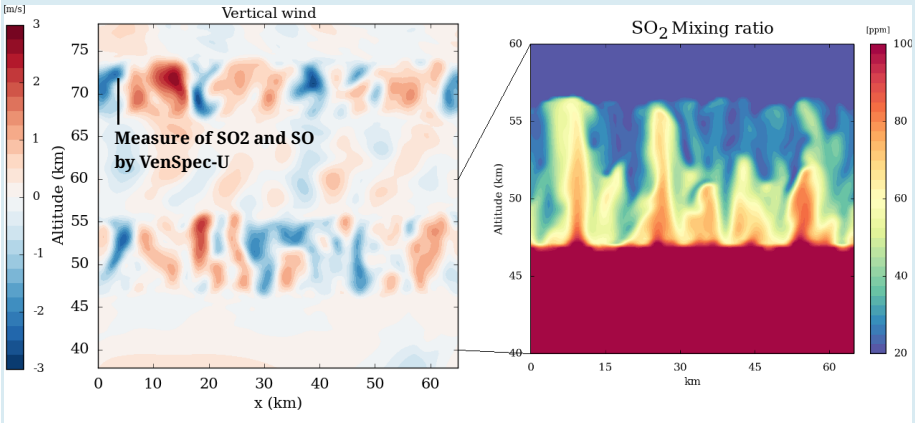


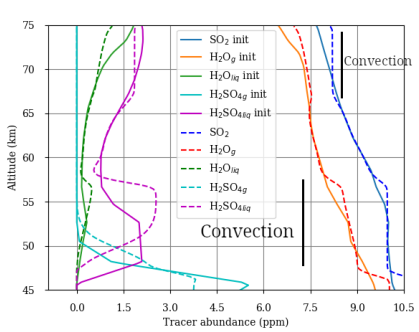
List of chemical species in the Venus PCM. (*g*) stands for gas phase, (*l*) for liquid phase.

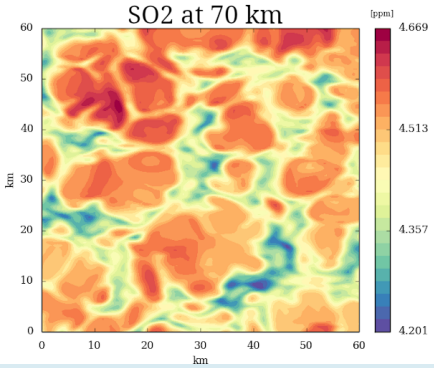
1	CO_2	10	O_3	19	HOCl	28	OCS
2	CO	11	H	20	ClCO	29	HSO_3
3	H_2	12	OH	21	$ClCO_3$	30	$H_2SO_{4(g)}$
4	$H_2O_{(g)}$	13	HO_2	22	$COCl_2$	31	$H_2SO_{4(l)}$
5	$H_2O_{(l)}$	14	H_2O_2	23	S	32	S_2
6	$O(^1D)$	15	Cl	24	SO	33	$ClSO_2$
7	O	16	ClO	25	SO_2		
8	O_2	17	Cl_2	26	SO_3	+ Nitrogen Chemistry	
9	$O_2(a^1\Delta g)$	18	HCl	27	S_2O_2		

To study the convective layer and the bow-shape waves, a Large Eddy Simulations (LES) model and a mesoscale model have been developed using the Weather-Research Forecast (WRF) non-hydrostatic dynamical core coupled with the IPSL Venus GCM physics package and the photochemistry model. The chemical network has 38 spieces as well as a simplified microphysics scheme. The LES model has a resolution of 400 m over 60 km, whereas the mesoscale model has a resolution of 40 km, both from the ground to 90 km.

Results







- First Venus LES with chemistry
- Strong mixing by the convection for species with slow chemical timescale
- Estimation of the vertical eddy diffusivity K_{zz} : several order higher than values prescribed in 1D chemical model
- Estimation of spatial and temporal variability at cloud top for VenSpec-U
- Estimation of spatial and temporal variability at cloud bottom for VenSpec-H
- Estimation of displacment of the cloud bottom boundary altitude by convection
- Estimation of spatial and temporal variability at cloud top for DAVINCI

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