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Three-dimensional turbulence-resolving modeling of the Venusian cloud layer and induced gravity waves

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The impact of the cloud convective layer of the atmosphere of Venus on the global circulation remains unclear. The recent observations of gravity waves at the top of the cloud by the Venus Express mission provided some answers. These waves are not resolved at the scale of global circulation models (GCM), therefore we developed an unprecedented 3D turbulence-resolving Large-Eddy Simulations (LES) Venusian model (Lefèvre et al, 2016 JGR Planets) using the Weather Research and Forecast terrestrial model. The forcing consists of three different heating rates : two radiative ones for solar and infrared and one associated with the adiabatic cooling/warming of the global circulation. The rates are extracted from the Laboratoire de Météorlogie Dynamique (LMD) Venus GCM using two different cloud models. Thus we are able to characterize the convection and associated gravity waves in function of latitude and local time. To assess the impact of the global circulation on the convective layer, we used rates from a 1D radiative-convective model. The resolved layer, taking place between 1.0 10^5 and 3.8 10^4 Pa (48-53 km), is organized as polygonal closed cells of about 10 km wide with vertical wind of several meters per second. The convection emits gravity waves both above and below the convective layer leading to temperature perturbations of several tenths of Kelvin with vertical wavelength between 1 and 3 km and horizontal wavelength from 1 to 10 km. The thickness of the convective layer and the amplitudes of waves are consistent with observations, though slightly underestimated. The global dynamics heating greatly modify the convective layer.