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Numerical modeling of cloud-level convection on Venus

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Venus is covered by clouds of sulfuric acid in the altitude region from 45 to 70km.Vertical winds that could be caused by convection were observed by Vega balloons at around 55 km altitude near the equator.The presence of neutral stratification at around 50-55km in the middle and lower clouds has been known from temperature profiles obtained by radio occultation.This suggests the existence of convective activity in this region. The convection is attributed to the heating of the cloud base by the absorption of upward thermal radiation from the lower atmosphere.Cellular structures with horizontal scales of a few hundred kilometers observed at the cloud top by the Venus Monitoring Camera onboard the Venus Express may be caused by this convection. However, the dynamical linkage between the convection layer and the cloud top, which are separated by 5-10 km, is not clear.

Baker et al. [1998] performed two-dimensional numerical experiments of cloud-level convection, which penetrates into stable layers above and below, assuming the background density and temperature profile and the net heat flux in this height region.A problem of their study would be that they represent radiative energy transport by diffusion, which is not a good approximation in the upper cloud region.Furthermore, the horizontal scales convective cells in the model are much smaller than to the cellular structures at the cloud top, and thus relationship to the cloud top feature is not fully understood.In order to understand the factors that determine the basic structure of the cloud-level convection on Venus, it is necessary to calculate convection based on more realistic radiative heating.

In this study, cloud-level convection on Venus is studied using the non-hydrostatic meteorological model CReSS [Tsuboki and Sakakibara, 2007].The heating by shortwave radiation is the same as that of Baker et al. [1998], but the heating and cooling by longwave radiation are given in a form more realistic than the previous study.We will discuss how the structure of convection depends on the magnitude of the heating and other background parameters based on the model result.

Keywords: Venus, convection, radiation