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Numerical modeling of Cloud-level Convection in Venus Atmosphere

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Cellular convection has long been thought to occur in the cloud layer of Venus, because some evidences for convection are obtained from radio occultation and spacecrafts data. However, the convective structure in the cloud layer is still unclear. Some numerical studies are performed to examine convective structure of the cloud layer (Baker et al., 1998, 2000, Imamura et al., 2014), but the domain of the model atmosphere in their numerical experiment is two-dimensional. In this presentation, we perform three-dimensional numerical calculation of convection using the same settings of Baker et al. (1998) in order to investigate a possible three-dimensional structure of convection in the cloud layer in statistically steady state.

The numerical model used in this paper is a cloud resolving model that is mainly used to simulate moist convection in Jupiter's atmosphere (Sugiyama et al., 2009, 2011, 2014), but condensation and chemical reaction are not considered in this experiment. The same sub-grid turbulence and radiation processes of Baker et al. (1998) are included in our model. The settings of the experiment are also based on those of Baker et al. (1998). In these settings, the altitudes of the lower and upper boundaries are 40 km and 60 km levels, respectively, and the layer between 48 km level and 55 km level is almost neutral.

The vertical motion obtained in our numerical experiment is characterized by wide, weak, warm updrafts and narrow, strong, cold downdrafts. This qualitative characteristic of convective motion is consistent with that obtained in Baker et al. (1998). The maximum velocity of downdrafts is about 10 m/s, while the mean vertical velocity is about 3 m/s. The downdrafts are driven by the cooling caused by the turbulent diffusion above the neutral layer and thermal flux at the upper boundary. The horizontal cell size is about 20 km, which is somewhat smaller than that of observed typical cloud-top cells in ultraviolet images; the sizes of the observed cells are typically 100-200 km and in some cases a few tens of kilometers across.

Keywords: Venus atmosphere, convection, numerical modeling