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Numerical Modeling of Moist Convection in Jupiter's Atmosphere: the sensitivities to key parameters

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The averaged structure and vertical convective motion in Jupiter's atmosphere and its relationship to moist convection remain unclear, because it is difficult to observe the structure under the extensive surface cloud layer by remote sensing. For the purpose of investigating the above problem, we developed a two-dimensional numerical model that incorporates condensation of H_2O and $NH_3$and production reaction of NH_4SH (Sugiyama et al., 2009), and examined a structure of moist convection in Jupiter's atmosphere that established through a large number of life cycles of convective cloud elements. The result shows that quasi-periodic temporal variation of the convective cloud activity exists and cloud composition and the altitude of the cloud base change greatly according to the quasi-periodic cycle of convective activity. However, robustness of the space-time structure of cloud convection is not examined. In this presentation, we present the dependency of convective structure on both key parameter of cloud microphysics and abundances of condensable volatiles in the sub-cloud layer.

In our previous study, the key parameter of cloud microphysical process is assumed to be the same as that of the Earth's atmosphere. However, the validity of the assumption remains uncertain. Therefore, we perform a numerical simulation of moist convection in which the conversion rate from cloud to rain is 100 times larger than that of the previous study. The result shows that the characteristics of space-time structures are qualitatively the same, and that the period of the quasi-periodic cycle is about 2 times larger than that of the previous study.

We also perform numerical simulations of moist convection with the abundances of condensable volatiles varied from 1/10 times solar to 10 times solar, because the abundances of condensable volatiles in the sub-cloud layer remain unclear. In order to reduce CPU time required to achieve a statistical equilibrium state in the model atmosphere, the cooling rate near the tropopause is set to be about 10 times larger than that estimated for the real Jupiter's atmosphere. The results show that the quasi-periodic temporal variation of the convective cloud activity exists except for the cases in which the abundance of condensable volatiles is extremely small. It should be remarkable that the period of the quasi-periodic cycle is roughly proportional to the abundance of water vapor in the sub-cloud layer. This correspondence between the deep volatile abundance and temporal variability of cloud convection suggests possibility to constraint the H_2O abundance in sub-cloud layer, if the cloud convective activity is caught by observations.

Keywords: Jupiter's atmosphere, moist convection, numerical modeling, cloud resolution model