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Numerical Modeling of Cloud Convection Layer in Jupiter's Atmosphere: Structure of Convection with three condensible components

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http://www.gfd-dennou.org/arch/deepconv/

Three cloudy layers are expected in Jupiter's atmosphere: H_2O liquid/ice layer in the deepest, solid NH_4SH layer in the middle, and, uppermost NH_3 ice layer. All of them are possibly convective. The interaction among the convective motions in these three cloud layer is still poorly understood. In this study, our purpose is to examine a structure of moist convection in Jupiter's atmosphere that established through a large number of life cycles of convective cloud elements by using numerical model. The numerical model used in this study incorporates condensation of H_2O and NH_3 and production reaction of NH_4SH (Japan Geoscience Union Meeting 2006, M144-P016). The abundances of condensible volatiles used in the each numerical simulations are taken at 0.1, 1, 5, and 10 times solar.

The results of our numerical simulations show that convective motion tend to be separated at the H_2O condensation level and that the NH_3 condensation level and the NH_4SH reaction level don't act as a stationary dynamical boundary when the abundances of condensible volatiles are larger than 1 times solar. The H_2O and NH_4SH cloud particles is advected above the NH_3 condensation level, and cloud layer which consists of H_2O, NH_4SH, and NH_3 cloud particles forms. As the abundances of condensible volatiles increase, moist convection occurs intermittently. It is also shown that the cloud layer which contains both H_2O and NH_4SH cloud particles and the NH3 cloud layer form at separated levels. On the other hands, when the abundances of condensible volatiles are taken at 0.1 times solar, the result show that H_2O condensation level don't act as a stationary dynamical boundary and that downdraft takes dry air from upper levels to several ten bars level.

The characteristics of the cloud convection structures obtained by the numerical simulations are obviously different from the static three layer structure that has been expected by using equilibrium cloud condensation model. The intermittency in the convection layer as a whole including interaction between the three cloud layer results from the feedback from cloud formation to the average stratification, which is affected both by the release of latent heat and by the change of mean molecular weight.