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Numerical modeling of moist convection in Jupiter's atmosphere and lightning observation in a future explorer mission

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We perform a long-time numerical simulation of moist convection of Jupiter's atmosphere by using a moist convection model that incorporates condensation of H_2O and NH_3 and the production reaction of NH_4SH developed by Sugiyama et al. (2008) for the purpose of investigating possible cloud structures and convective motion of Jupiter's atmosphere. One of the most important findings is that neither strength nor structure of moist convection reaches a statistical equilibrium state; quasi-periodic temporal variation of the convective cloud activity exists and the period of the quasi-periodic cycle is roughly proportional to the abundance of water vapor in the sub-cloud layer. It should also be remarkable that clouds composition and the altitude of the cloud base change greatly according to the quasi-periodic cycle of convective activity.

Assuming that lightning occurs in active convection region, lightning observation in a future explorer mission will give a certain restriction of the moist convective motion and the abundance of water. Actually, Jovian lightning strikes may mark locations of moist convection from the analogy of Earth's atmosphere (Gibbard et al., 1995; Yair et al., 1995, 1998), and both Galileo and Cassini show that there were often small (~500-2000 km) bright clouds near the locations of lightning strikes (Little et al., 1999, Gierasch et al., 2000, Dyudina et al., 2004).

The following two lightning observations are important in the above purpose (Sugiyama et al., AGU fall meeting 2008 AE13A-0322). (1) Observation that enhance time resolution, i.e., high-speed imaging. It will give much information on the intensity of individual flashes and the total activity of lightning. All of past observations were conducted as long time exposure imaging, which could only estimate broad measure of total optical energy of lightning escaping from the clouds. (2) Observation with two or more narrow band filters with different bandwidth. The ratio of observed intensities reflects the pressure broadening. The depth of flashes will be estimated by comparing the ratio of observed intensities with that given by the theoretical model of the pressure broadening.