Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PPS001-P07 Room: Convention Hall Time: May 23 17:15-18:45

Two-dimensional numerical experiments of Martian atmospheric convection with condensation of the major component

Tatsuya Yamashita[1*], Masatsugu Odaka[1], Ko-ichiro SUGIYAMA[1], Kensuke Nakajima[2], Masaki Ishiwatari[1], Yoshi-Yuki Hayashi[3]

[1]Hokkaido University, [2]Kyushu University, [3]Kobe University

For the purpose of investigating flow fields and cloud distribution of thermal convection with condensation of major component which may occur in Martian atmosphere, we perform direct simulation of cloud convection.
Yamashita et al.(2009, JPGU) reported on modeling of condensation process which allow long time integration of convection with major component condensation. In this study, we obtain quasi-equilibrium states by long time integration, and we show the flow fields in the quasi-equilibrium states.

The model we utilize is a 2D non-hydrostatic convection model "deepconv" which we are developing (http://www.gfd-dennou.org/library/deepconv/index.htm.en). The basic equations in our model are the quasi-compressible equations of Klemp and Wilhelmson (1978) with additional terms representing the major component condensation (Odaka et al., 2005). For cloud microphysics, we follow Tobie et al.(2003). Cloud particles are assumed to grow by diffusion process, and we do not consider both the falling of cloud particles and the drag force due to cloud particles. We do not deal with radiation transfer explicitly, but we give horizontally uniform body heating near the surface and horizontally uniform body cooling in the troposphere. As initial temperature profile, we choose the profile which follows the dry adiabat in lower layer, and follows moist adiabat in middle layer, and is isothermal in upper layer. As initial perturbation, random noise is added to the lowest layer of atmosphere. In the system whose major component condenses, the degree of supersaturation is expected to have a significant influence on the convective structures because the magnitude of buoyancy may be heavily controlled by the degree of supersaturation (Colaprete et al., 2003). Following Glandorf et al. (2002), we adopt the values of critical saturation ratio (Scr) as 1.0 and 1.35.

Performing 40-day integrations, we obtain quasi-equilibrium states for both Scr = 1.0 and 1.35. Quasi-equilibrium states are quite different each other.
In case of Scr = 1.0, temperature of whole system rises and all of clouds evaporate, and strong dry convection with one cell develops.
Maximum values of horizontal and vertical component of velocity are 100 m/s, 40 m/s, respectively. In case of Scr = 1.35, all the domain except for the shallow layer near the surface is covered with clouds due to decrease in temperature.
A weak circulation develops in the cloud layer, and several small-scale circulations develop near the surface. Maximum values of horizontal and vertical component of velocity are about 10 m/s.

The temperature fields in equilibrium states are supposed to be determined according to initial thermal energy. In order to discuss the equilibrium states generally, we should perform parameter sweep experiments for both initial state and the value of Scr. We will perform experiments for initial states in the future.

Keywords: condensation of major atmospheric component, carbon dioxide ice cloud, cloud convection model, critical saturation ratio