Formulation of non-hydrostatic atmospheric model for moist convection in the Martian atmosphere

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One of the features of the Martian atmosphere is condensation of carbon dioxide which is major component of the Martian atmosphere. Condensation of carbon dioxide almost occurs near the surface in present Mars, while it occurs in the atmosphere in early Mars where atmospheric mass may be much larger than that of present Mars. According to numerical simulation by using one-dimensional radiative convective model with 2 bar carbon dioxide atmosphere, moist convection associated with condensation of carbon dioxide occurs between several and 30 km hight and dry convection layer exists below the moist convection layer. This structure is similar to that of the terrestrial atmospheric covection which moist convection layer associated with condensation of water vapor exists above shallow dry convection layer below near the surface. However, it is not evident whether the circulation pattern of Martian moist convection is also similar to that of terrestrial moist convection, because water vapor is one of minor components of the terrestrial atmosphere while carbon dioxide is major component of the Martian atmosphere.

Non-hydrostatic atmospheric models (NHMs) which have been developed by several meteorological research groups in the world are useful for investigation the circulation pattern of terrestrial moist convection. However, present NHMs cannot be adapted for the Martian moist convection with no modification, since many of them are based on quasi-compressible system where atmospheric density variation associated with acoustic wave is only considered in the continuity equation and those based on fully compressible system which has no approximation in the continuity equation also don't consider density variation associated with condensation of atmospheric major component. In this presentation, formulation of governing equations which are used for present NHMs is reviewed and that adequate for the Martian moist convection is examined. In addition, the technique of numerical calculation of the Martian moist convection will be discussed by using results of some numerical simulations with ideal setup.