Possible multiple-equilibrium solutions obtained by a one-dimensional radiative-convective equilibrium model

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Existence of liquid water on the planetary surface is thought to be one of essential conditions for habitable planets. The runaway greenhouse effect plays an important part with regard to the problem whether the planetary oceans would completely evaporate or not.

The previous studies related to the runaway greenhouse effect by a one dimensional atmospheric model showed following results:

There is an upper limit of the outgoing infrared radiation emitted from a radiative equilibrium stratosphere(Komabayashi 1967, 1968; Ingersol 1969).

The outgoing infrared radiation at the top of the atmosphere absolutely has the upper limit and cannot exceed that found by Komabayashi and Ingersol(Nakajima et al.1992).

Thus,if the incident solar flux exceeds this upper limit, the atmosphere with the ocean could be in a runaway greenhouse state.

These studies treat the change of atmosphere with liquid water on planetary surface and clarified the condition for the complete evaporation of oceans with increasing the insolation.However, the behavior of runaway atmosphere, that is the steam atmosphere without liquid water on the planetary surface is not fully understood yet.

So we systematically investigated the atmospheric structures for the cases with finite water abundance using a one dimensional radiative-convective equilibrium model based on that of Nakajima at al(1992). We found more than one equilibrated atmospheric structures under the same surface temperature and the water mass. We will discuss about the possibility and the stability of these multiple solutions.