Stability of liquid methane on Titan's surface

*Shuya Tan[1], Sho Sasaki[2]

1.Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 2.Department of Earth and Space science, Graduate School of Science, Osaka University

Titan has liquid methane on the surface due to surface conditions affected by the temperature profile of its thick nitrogen atmosphere. The purpose of this study is to discuss the stability of the surface environment, by estimating relationships between liquid methane on the surface and parameters which affect characteristic of the atmosphere. The typical parameters are the solar flux, the gravitational acceleration and so on.

Strictly speaking, present state of body like Titan depends on the evolution from its formation. But there are different scenarios for the formation of icy satellites, and moreover, the evolution is modified by external factors such as impacts and tidal heating. Here, we conduct parameter changes on the basis of the present Titan’s condition.

We use an analytic radiative-convective model for plate-parallel atmosphere (Robinson et al., 2012). On convective region, we consider the condensation of methane.

In Titan’s atmosphere, radiation is affected by absorption of thermal infrared by gas molecules and absorption of visible light by photolysis organic haze, which mainly exists in its stratosphere. The visible absorption by haze causes cooling the surface. We relate the mole fraction of methane to infrared absorption coefficient (Nakajima et al., 1992). The strength of visible absorption is probably changed by methane concentration in stratosphere and haze optical property and so on. In the present study, for simplicity, we hypothesize the simple cases, the strength of haze absorption is constant or expressed by simple function.

On this model, about liquid methane on the surface, the solar flux has lower limit caused by methane condensation. And if greenhouse effect is stronger than cooling by haze, the solar flux can have upper limit. Nitrogen partial pressure on the surface only affects the latter, and the gravitational acceleration affects both.

When the strength of visible absorption by haze is constant, the solar flux has the upper and lower limits regardless of nitrogen pressure on the surface and gravitational acceleration. The present solar flux matches the lower limit when nitrogen partial pressure is 1.06×10^6 Pa or the gravitational acceleration is $0.15\ m/s^2$.

