Cloud and methan cycle in the atmosphere of Titan

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Distinct cloud activities are found around the south pole of Titan, and their transient characteristics imply their convective origin. On the other hand, once proposed extensive hydrocarbon ocean, which might act as a reservoir of methane, seems to be rather localized. Therefore, the structure of cloud convection and its role in methane 'hydrological' cycle may be quite different from the convective clouds in the atmosphere of the Earth. Here, we examine the structure of cloud convection in Titan's troposphere and its role in methan cycle between the atmosphere and the ground surface by using a numerical model.

We conduct long-term integrations of two-dimensional non-hydrostatic cloud convection model that extends 2,048km in the horizontal direction including three-category (vapor-cloud-rain) parameterized microphysics. The supply of methane from the groud surface is caculated by the bulk formula, including a factor representing the wetness of the ground surface which may be interpreted as the ratio of the area of methane ponds to the area of dry soil.

The results show that, the relative humidity in the lower atmosphere matches the value observed by Huygens only if the wetness facter is very small (0.001), which is consistent with the relative scarcity of the liquid surface. Even with such dry surface condition, simulated cloud convection is active; sometimes strong convective cloud develops up to the tropopause generating a large amount of methane rain. But very small amount of methane rain reaches to the ground surface as a result of the evaporation in the subsaturated lower troposphere.

The simulated clouds develops considerably slower than observed growth time of mid-latitude clouds. In order to explain such strong convective clouds, additional factors such as the effects of (1) large degree of super saturation as the condensation threshold, (2) surface inhomogeniety, and (3) localized heat source, seems to be required.