Climate of a tidally locked terrestrial planet with a global cloud-resolving model

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Recently, the discussion of the habitability of exo-terrestrial planets has been based on simulations with a three-dimensional climate model(3D GCM). Additionally, GCM simulations are beginning to be widely used in proposals with space telescopes and in the interpretation of observational data. In the next decade, we should characterize the climate of habitable planets because they will be the primary targets for observation of life on exoplanets.

For a tidally locked exo-terrestrial planet, the cloud stabilizing feedback has been considered to maintain surface water because of a difference in the distribution of insolation, causing a permanent day-night side. Clouds pose significant uncertainties in models for exoplanetary atmosphere. Traditionally, conventional GCMs with a $O(10^2)$ km horizontal mesh have used cumulus parameterization and large-scale condensation schemes to evaluate cloud-related processes. These treatments cannot explicitly resolve sub-scale physical phenomena, such as cloud microphysics.

Here, we introduce NICAM(Non-hydrostatic ICosahedral Atmosphere Model), known as a global cloud-resolving model(GCRM). This model can explicitly resolve cloud distribution and the vertical moisture transport of water vapor. We performed high-resolution climate simulations with NICAM to compare to previous studies with a conventional GCM. In my presentation, I will share and discuss a primary result with NICAM for Trappist planets. A global cloud-resolving model, such as NICAM, will open a new era of understanding habitable worlds.

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