# Habitable zone for a land planet

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Most of the studies for habitable planets have focused on Earth-like planets with globally abundant water on the planetary surface. Liquid water vaporizes entirely when planets receive the insolation above a certain critical value, which is called runaway greenhouse threshold. On the other hand, the planetary climate state lapses into a snowball state when planets receive insolation below a certain value, which is called the complete freezing threshold. The habitable zone, in which planets can maintain liquid water on their surface for a long term, is determined by these thresholds.

Abe et al. (2011) focused on so-called land planets with a very small amount of water, and investigated these thresholds using a three-dimensional general circulation model. As results, they found that land planets have a wider habitable zone than Earth-like planets have. However, it is not enough to understand the relationship between the distribution of water and the climate because their range of the amount of water is extremely narrow, leading the almost same distribution of liquid water on the planetary surface.

We assumed various types of the surface water distribution, and investigated the effect of those on both the runaway greenhouse threshold and the complete freezing threshold for Earth-sized planets using a three-dimensional general circulation model. We consider the surface water distributions as longitudinally uniform water distribution and a 1-bar atmosphere whose composition is similar to the current Earth’s atmosphere. As results, both thresholds change gradually depending on the distribution of surface water. Additionally, they are dominated by the atmospheric circulation which determines the surface condition.

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