A cool runaway greenhouse without magma ocean

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Résumé

When the insolation of an ocean bearing planet exceeds a certain threshold, the runaway greenhouse process vaporizes the atmosphere. Current models predict that this would be sufficient to melt the surface. This has far reaching consequences for the early evolution warm rocky planets. In this paradigm, the solidification of Venus' mantle occurs only after its desiccation.

However, these conclusions rely on the assumption of fully convective atmospheres introduced in key seminal papers but whose validity has not been assessed thoroughly. Using a new climate model specifically designed to model runaway greenhouse atmospheres self-consistently, we show that very little sunlight reaches the surface to power convection. The lower atmosphere becomes almost isothermal. Surface temperatures are much lower than previously thought and often insufficient to melt the surface. This changes completely our view of the early evolution of Venus, with even more drastic changes for planets around redder dwarfs.

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