



Carbon cycles on super-Earth exoplanets

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On Earth, the long-term global carbon cycle primarily consists of a balance between volcanic emissions of CO₂ and the formation and burial of carbonate rocks (the carbonate-silicate weathering ‘thermostat’), with important modifications due to the biosphere. On gas giant planets, the carbon cycle is driven by photolysis in the upper atmosphere: methane is converted to longer-chain hydrocarbons such as acetylene, ethane and soot particles, which are then dissociated by thermolysis lower in the atmosphere where the temperature and pressure are much higher.

Hydrogen escape rates on terrestrial exoplanets are predicted to be a strong function of their orbital distances, ages and masses. In particular, larger exoplanets around stars with lower extreme ultraviolet (XUV) emissions may have significant difficulties in losing their hydrogen to space, and hence may retain H₂ envelopes of varying mass. It is therefore interesting to investigate what happens in the transition between the terrestrial and hydrogen-dominated regimes.

Here we present a first attempt to investigate the range of scenarios that occur for terrestrial mass (~1-10 ME) planets with varying hydrogen escape rates. We are developing climate evolution simulations for a range of cases that account for surface processes (primarily outgassing and weathering), hydrogen escape to space, and simple atmospheric chemistry. We discuss various feedbacks that may occur as a result of the influences of CO₂, CH₄ and H₂ on atmospheric and surface temperatures. Finally, we discuss the implications of our results for future observations, with a particular emphasis on the search for biosignatures on exoplanets similar to the Earth.