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Mass-Radius relationships of small, highly irradiated exoplanets with small water mass fractions

Hugo Vivien¹, Artem Aguichine¹, Olivier Mousis¹, Magali Deleuil¹, and Emmanuel Marcq²

¹Aix Marseille Univ, CNRS, CNES, LAM, Marseille, France

²LATMOS/IPSL, UVSQ Université Paris-Saclay, Sorbonne Université, CNRS, Guyancourt, France

This work aims to determine the mass-radius relationships of highly irradiated ($500 < T_{\text{irr}} < 2000 \text{ K}$) small planets ($0.2 < M < 2.3 M_{\oplus}$) with water contents up to 5%. To do so, we coupled an internal model of small terrestrial planets (Brugger et al., 2017) to the atmosphere model elaborated by Marcq et al. (2017, 2019), following the approach depicted in Aguichine et al. (2021) and Mousis et al. (2020).

We show that these planets, even with small water contents, can become strongly inflated and produce large radii for small masses. We also show that strongly irradiated small planets cannot sustain their atmospheres due to the lack of hydrostatic stability, implying they cannot preserve any hydrosphere. The temperature and the water mass fraction are the key parameters controlling the extent of inflation and the thickness of the supercritical layer. An important amount of water also leads to the contraction of the rocky interior. However, the composition of the rocky interior only has a limited impact on the final mass-radius relationship, and barely impacts the behavior of the hydrosphere.