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Water build-up on planets orbiting M-Stars via secondary outgassing from the interior

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Abstract

Rocky planets residing within the habitable zone of main-sequence M dwarf stars experience high stellar irradiation during their early evolution due to the prolonged pre-main sequence phase of these stars. It has been suggested that this high early irradiation may lead to the desiccation of these planets. However, since this early stage of high luminosity is relatively short compared to the stellar lifetime, and a significant amount of water can be stored in the bulk silicate mantle during planet formation, we study whether a secondary atmosphere and water reservoir may subsequently build up via mantle melting and volcanism.

We have carried out interior evolution calculations of Earth-like stagnant-lid planets (i.e. without plate tectonics) for different interior volatile reservoirs and computed their potential outgassing, as described in Tosi et al. 2017. We use the amounts of CO_2 and H_2O outgassed from the interior to calculate the habitable zone boundaries and their evolution for these planets around M, K, G, and F-type stars.

Assuming that a water reservoir can be preserved in the planetary interior, we show that a surface water reservoir and an atmosphere may build up via secondary outgassing. Taking into account the uncertainty in interior composition we determine minimum and maximum extent of the continuous habitable zone for these stagnant-lid planets.

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References

[1] Tosi, N. , Godolt, M., Stracke, B. et al.: On the Habitability of a Stagnant-Lid Earth, Astronomy and Astrophysics, Vol. 606, A71, 2017.