EPSC Abstracts
Vol. 13, EPSC-DPS2019-599-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Desiccation of the TRAPPIST-1 Planets During Their Magma Ocean Phase

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Abstract

We use a novel magma ocean model, *MagmOc*, which is a new module of the VPLanet code [1]. The model is based on the coupled atmosphere-interior model by [2]. The atmospheric composition is assumed to be 100% H_2O and the composition of the mantle to be the Bulk Silicate Earth [3]. Instead of using a line-by-line climate model, we use a grey-greenhouse gas formalism [4,5] for rocky exoplanets to calculate the outgoing long-wave radiation.

We include energy-limited and diffusion-limited atmospheric escape of water and oxygen [6], equilibrium tides [7], and the radiogenic heating from ^{26}Al, ^{40}K, ^{232}Th, ^{235}U, and ^{238}U. With this model we simulate the desiccation of the TRAPPIST-1 planets during the magma ocean state.

We test cases with initial water contents of 1 - 100 terrestrial oceans and include different scenarios for interior compositions, radiogenic and tidal heating, and atmospheric escape. The results tell us how much water is lost to space or stored in the mantle after the crust solidified and how much oxygen will build up in the atmosphere.

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