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Modelling magma ocean solidification and volatile outgassing during early planetary evolution.

Athanasia Nikolaou (1,2), Nicola Tosi (1,2), and Ana-Catalina Plesa (1)

(1) Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany, (2) Department of Astronomy and Astrophysics, Technische Universität Berlin, Germany

The early phases of the evolution of the Earth and terrestrial planets likely included a state characterized by one or multiple vigorously convecting magma oceans. Even super earths at a close distance to their host star can presently be in a similar hot state. Understanding magma ocean's evolution can serve to better characterise terrestrial planets that have passed through such a state in their history and possibly constrain that state in our planet.

However, the temporal evolution of a vigorously convecting magma ocean is poorly known due to missing constraints on the mechanical and thermal properties of the molten material and on the blanketing effect of the overlying atmosphere, which can strongly influence the heat flowing out of the planet and retard its cooling and solidification. The outgassing of volatiles with greenhouse potential is a key process that affects both aforementioned factors.

Using a simple 1D model we simulate the evolution of a primitive magma ocean coupled with a grey atmosphere. The evolution of the potential temperature dictates the rate of mantle crystallization, which proceeds from the bottom upwards because of the steeper slope of the mantle adiabat compared to the melting curve. This model allows us to represent the complex physical state of simultaneous regimes of liquid and solid convection in the mantle. In future steps we are going to replace the grey atmosphere model with a more sophisticated 1D model of radiative-convective equilibrium to better represent the emissivity of the atmosphere generated by magma ocean outgassing.