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The influence of mantle internal heating on lithospheric mobility: implications for super-Earths

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Abstract

Super-Earths, a recently discovered class of exoplanets, have been inferred to be of a similar rock and metal composition to the Earth. As a result, the possibility that they are characterised by the presence of plate tectonics has been widely debated.

However, as the super-Earths have higher masses than Earth, it is assumed that they will also have higher Rayleigh numbers and non-dimensional heating rates. Accordingly, we conduct a systematic 2D study to investigate the influence of these parameters on the surface behaviour of mantle convection.

The main focus of our work considers the response of surface motion to the mantle's internal heating. However, we also include an analysis of other parameters scaling with planet mass, such as viscosity.

In agreement with the findings of Valencia & O'Connell (2009) and van Heck & Tackley (2011) we find plate-like surface mobilisation for increased Rayleigh numbers. But increasing the internal heating leads to the formation of a strong stagnant-lid because the mantle heating effects thermally activated viscosity. Additionally, viscosity is affected by the increased pressures and temperatures of super-Earths.

In total, our findings indicate that surface mobility will likely be reduced on super-sized Earths.

References

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