The 449th Geodynamics Seminar

Numerical experiments on mantle convection of super-Earths with strong adiabatic compression

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Abstract

We conduct a series of numerical experiments of thermal convection of highly compressible fluid in a two-dimensional rectangular box, in order to study the mantle convection on super-Earths. The thermal conductivity and viscosity are assumed to exponentially depend on depth and temperature, respectively, while the variations in thermodynamic properties (thermal expansivity and reference density) with depth are taken to be relevant for the super-Earths with 10 times the Earth's. Our experiments showed the change in convecting flow patterns depending on the depth-dependence in thermal conductivity and the temperature-dependence in viscosity. This is largely due to the change in the thermal state in the convecting mantle, whose interplay with the adiabatic temperature change in turn reduces the activity of hot plumes from the base of the mantle. In particular, for the cases with strong interplay, we found that a ``basal stagnant region'' of stable thermal stratification can be formed at the base of the mantle where the fluid motion is insignificant particularly in the vertical direction. We also found that the presence of ``basal stagnant region'' not reduces but enhances the overall heat transport through the mantle, owing to its high thermal conductivity. Our findings may further imply that super-Earths can have their own intrinsic magnetic fields even though they are lacking in both plate tectonics and hotspot volcanism on their surfaces, because the ``basal stagnant regions'' may effectively cool the underlying metallic cores.

詳細は当センターホームページ: http://www.grc.ehime-u.ac.jp/をご覧ください

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