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# Stability of thermal boundary layers for convection in spherical shell : Application to the dynamics of Earth mantle.

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Improving the knowledge of convection into mantle of terrestrial planets required a better understanding of its physical and chemical state. Recently, with the help of massive computational resources, significant progresses were achieved in the numerical modeling of planetary mantles convection. Models with a high degree of complexity (including realistic viscosity laws, mixed mode of heating, spherical geometry, thermo-chemical convection, . . . ) are now available. Among the parameters that recently became accessible, spherical geometry is a key ingredient because it affects the relative strength of the top and bottom thermal boundary layers. Despite these progresses, many details of planetary mantles convection remain unclear and so far, no model of Earth's mantle convection fits all available geophysical, geochemical, and geological constraints. Using STAGYY, which solve the usual conservative equations of mass, energy and momentum, we explored the on a yin-yang grid, we explored the influence of various parameters on convection in spherical geometry. First, we have performed several numerical experiments on varying important parameters including the Rayleigh number, the curvature (ratio between radius of the core and the planet one), the mode of heating (only from below or with an internal heating component), rheology (isoviscous or temperature dependence). In particular, we studied the evolution of the style of convection, average temperature, heat flux and critical Rayleigh number depending on these parameters. We have then built scaling laws between the parameters and observables, for instance between the Nusselt and Rayleigh number, and between the temperature and curvature factor. Our results suggest that extrapolations previously made from Cartesian models may not be valid in spherical geometry. In particular, the dependence of temperature on curvature differs significantly from that expected by Cartesian scaling laws. In addition, it also depends on the Rayleigh number. A possible explanation for these discrepancies is the asymmetry between the top and bottom thermal boundary layers, which may alter their relative stability. The new scaling laws we obtained enable to reconsider some aspects of thermal evolution and physical states of terrestrial planets like Earth, Mars, Mercury or some giant planets satellites.