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Solid Earth Discussions

Interactive comment on "Influence of the Ringwoodite-Perovskite transition on mantle convection in spherical geometry as a function of Clapeyron slope and Rayleigh number" *by* M. Wolstencroft and J. H. Davies

Anonymous Referee #2

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This study focuses on the influence of Clapeyron slope of phase transition on the flow regime of mantle convection. The phase transition with negative Clapeyron slope around 660 km depth of Earth mantle has been thought as a cause of mantle layering or slab stagnation, but systematic study to check the probability in 3-D spherical shell geometry can be realized in recent years for Earth-like Rayleigh number. The problem is important for the structure and dynamics of the mantle, and also important for the long-term evolution of the Earth. In this study, with carrying out sufficient cases of simulations, the authors classified three regimes of mantle flow pattern in Rayleigh number

vs. Clapeyron slope plane, those are, whole mantle convection, two layer convection, and transitional behavior. The classification in this study is widely applicable to the flow regime of mantle convection, and their discussion points are clear. The authors noted that the Earth mantle is in whole layer or transitional regime, which is a reasonable conclusion. There is a published work on this subject by Yanagisawa et al. (2010) for the same geometry. The authors are comparing their result with that thoroughly. The result proposed in the present study is consistent with that in the overlapping range, and has more data points especially at low Rayleigh numbers. I think this paper is worth publishing with several improvements listed below.

Many of the parameter setting is in common with Yanagisawa et al., but the treatment of internal heating Rayleigh number is different. In the present study Rayleigh number ratio Ra/Rah (basal heating Rayleigh number/internal heating Rayleigh number) is fixed to be 0.054, while Yanagisawa et al. decreased this value from 0.1 to 0.03 with the increase of Ra. It means that the proportion of basal heat flow for the surface (total) heat flow is set to be nearly constant. In the present study, the relative contribution of basal heating increases for higher Ra cases. I think that each of the treatment for Rah has validity. The difference of Ra/Rah may cause a slight difference between these two studies, for the behavior of the flow in low Rayleigh number region. The authors should note this difference of parameter setting.

The authors should explain further details on criterion of regime classification, especially the boundary between the whole layer and transitional, in relation to the last sentence in 2 Methods. Transitional case may be most important for the application of the Earth. If the authors can provide statistical information relating to the reduction of radial mass flux with negative Clapeyron slope, the value of this paper may be much enhanced.

As the referee #1 pointed out, the information in figures for regime diagram are overlapping. Figure 4 and 5 can be arranged in one figure by using bolder or different types of lines for the boundaries.

Interactive comment on Solid Earth Discuss., 3, 713, 2011.