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Interactive comment on "Effective buoyancy ratio: a new parameter to characterize thermo-chemical mixing in the Earth's mantle" *by* A. Galsa et al.

Anonymous Referee #1

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This paper addressed the evolution of a primordial dense layer at the bottom of the mantle using numerical simulations of 2-D cylindrical mantle convection. Authors induced a new parameter, the effective buoyancy ratio, to characterize the evolution of the dense layer and dynamics of the thermo-chemical convection. According to their conclusion, there is four fluid dynamic stages during the evolution of the dense layer, and the dense layer is eventually diluted by the inner convection. The present-day Earth's mantle, which is dominated by two seismically slow domains (thermo-chemical domes) beneath Africa and the south Pacific, is in the process of entire mixing phenomenon in the whole mantle. I believe that their results are very robust and give significant constraints on mantle dynamics. I recommend that this paper should be published in Solid Earth after moderate revision. My comments and suggestions are as follows:

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(1) The Rayleigh number authors used is one order smaller than that of the real Earth's mantle by taking the reference viscosity asãĂĂone order larger value than the reference viscosity of the real mantle (10**21 Pa s for the upper mantle; e.g., Mitrovica, 1996). How did authors define time in this simulation; simple thermal diffusion time? Or rescaled time by using surface velocity (e.g., Gurnis and Davies 1986; Richards et al. 1999) or mantle transit time (Zhong and Gurnis 1993) or boundary layer theory (e.g., Yoshida, 2013)? Authors should clarify this point.

(2) I do not know well if the definition of the effective buoyancy ratio (Eq. 7) is appropriate. Authors should more explicitly explain physical (fluid dynamic) implication of the effective buoyancy ratio.

(3) It may be better to discuss the history of the primordial dense layer in the real mantle. Do authors mean that the dense materials are uniformly-layered in the Archaean mantle? When and how did the present-day two thermo-chemical domes form during the Earth's history?

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Interactive comment on Solid Earth Discuss., 6, 2675, 2014.