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Interactive comment on "On the thermal gradient in the Earth's deep interior" *by* M. Tirone

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That's the thing, straight to the point!

I suppose it should be possible to relate zeta (or the pressure ratio) to the Rayleigh number (Ra) under the Boussinesq approximation assuming everything constant including viscosity. However we know that mantle properties like density, thermal expansion, Cp, viscosity etc., should vary with P,T,X, and most geodynamic models nowadays include such variations (at least for some properties somehow). Clearly by assuming a more complex formulation, zeta is not directly related anymore to a single parameter (like Ra). If we assume that density and viscosity are the most critical parameters in geodynamic models, then maybe we could run a series of simulations (say of a plume) varying these two quantities within a certain "reasonable" range (please don't ask about "reasonable"!) and try to relate zeta to these variations. Alternatively one

can run a series of thermodynamic computations varying zeta, say from 1.0 to 1.01 or 1.02 (for upwelling for example, like in fig.4), the solution with zeta>1 (but not too big) should get closer to the geodynamic thermal gradient than the thermal gradient from the isentropic model. The only risk is overestimating the irreversible effect, i.e. make zeta too big, hence the thermal gradient too steep compared to the geodynamic thermal gradient.

*** Please note in fig.2 and fig.3, the label on the x-axis P/P_g should be P_g/P (my mistake)

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