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# *Interactive comment on* "On the sensitivity of 3-D thermal convection codes to numerical discretization: a model intercomparison" *by* P.-A. Arrial et al.

**P.-A. Arrial et al.**

parrial@ucdavis.edu

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Thank you very much for your helpful comments and corrections. We are going to answer these comments and provide some revisions for the paper.

Your comments focus on the dodecahedral pattern and the reasons that contribute to its destabilization. We think that there is no definitive answer to figure out which parameter influences the destabilization and the final convection pattern. However, we agree with you that the most probabilistic factor is the location of numerical noise or error that perturbs the position of the plumes and lead to different final convection patterns. We can provide more information and description of the results and how the destabilization occurs to highlight this hypothesis, especially for CitcomS. We propose to add the following paragraph on page 2044 after line 9.

*For CitcomS, the mesh discretization shows a symmetrical effect. The shell is initially divided into 12 caps. Each cap is diametrically opposite to another one (Zhong et al., 2000). Thus during the transition, we can observe that destabilization occurs in symmetrical pairs with respect to the caps. As a result it is reasonable to presume that mesh discretization and the cap divisions influence the distribution of numerical errors and favor even modes. In these conditions, CitcomS won't reproduce the tetrahedral or the five-cell pattern observed with the RBF method, without adding an additional initial perturbation representing these odd modes.*

You also suggested persuading CitcomS to converge to the tetrahedral pattern by adding an additional tetrahedral perturbation. We agree with you that a modification of the initial condition could modify the final convection pattern counterbalancing the numerical noise. However, one cannot conclude what is the best final pattern of convection nor is there a preference for one or the other. We could also try to impose an additional cubic perturbation to the RBF models or even a five-cell perturbation, and see what happens. There are many possibilities to investigate. The original goal of this paper was to compare the results with the same initial conditions, this is why we are not going to present other models for this part of the paper.

However, we also agree with your last comment and we encourage other codes to try to reproduce these results and see if a consensus can be reached. We added the following sentence to the page 2048 line 27:

*We hope that this paper will stimulate further investigation on how the type and order of numerical discretization affects pattern formation in the context on benchmarking community codes.*

Minor corrections:



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1) Section 6 line 16: Indeed, CitcomS is a finite element code. We apply this correction in the text.

2) Figure 5: The labels in the image are correct and we modified the caption accordinglyto it:

*Fig5. Time trace of (a) the outer Nusselt number and (b) the RMS Velocity for Ra=70000 and delta=0.08 with CitcomS and $\delta = 0.09$ with RBF. Both methods converge to an unsteady oscillating axisymmetric pattern dominated by the $\ell = 2$ mode (see Fig. 4).*

3) Figure 12: In the caption the references to the final convection pattern need to be shifted from (b-d) to (c-e). The new caption is:

*Fig. 12. Time traces of the evolution of the average temperature as a function of the parameter at Ra = 7000 for (a) the RBF-PS model and (b) CitcomS. (c–e) show the final convection patterns for each of these models with (c) $\gamma = 0$, (d) $\gamma = 0.5$, and (e) $\gamma = 1.0$.*

Other corrections:

- Page 2044 line 10: the section 4 title (Stability at higher order of symmetry) is not at its right place and must move to page 2043 line 13. The statement and description of the dodecahedral initial condition begin at this line.
- Page 2043 line 23: an dodecahedral becomes a dodecahedral.

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