Dear Anonymous reviewer,

Many thanks for your review. We have responded to each of the comments you made in detail below, and have revised the text as indicated. Line numbers indicate lines in the 'tracked changes' pdf that we will submit to the editor today.

Kind Regards,

Gwynfor Morgan & co-authors.

RC1.01	This manuscript presents a compelling exploration of the effects of branching and curved phase transitions on the stagnation of downgoing plates or cold anomalies in the upper and lower mantle. The study investigates the hypothesis that these transitions influence the likelihood of slab stagnation at various depths. The findings suggest that while these transitions may exert stagnation-supporting forces, the magnitude of these forces is insufficient to produce a discernible impact in global convection models. As such, the manuscript qualifies as a null-result paper—a less common but nonetheless important contribution to the field.
	Thank you.
RC1.02	The manuscript is well-written, and the results are presented in a clear and logical manner. However, some figures could benefit from refinement (detailed suggestions are provided below). The structure of the paper is somewhat unconventional, with Sections 2 and 3 each resembling standalone studies, while the discussion and conclusions synthesise findings from both sections.
	Thanks, we hope the figures are clearer in the revised manuscript
RC1.03	My primary concern is the limited motivation provided for conducting and publishing this study. While the authors cite two references that propose the 'branching' mechanism (Cottaar and Deuss, 2016; Chanyshev et al., 2022) and one for the 'curving' mechanism (Ishii et al., 2023) as contributors to slab stagnation, the rationale for exploring these mechanisms further is not sufficiently emphasised. I would encourage the authors to elaborate on why these mechanisms are worth investigating and, even if they are shown to have minimal relevance for Earth-like conditions in their models, to identify the conditions under which they might play a more significant role. The authors briefly address this for the 'branching' mechanism, suggesting relevance for stagnating flat slabs, but do not provide a similar discussion for the 'curving' mechanism. At this stage, it is unclear whether addressing this issue would require additional experiments (which would constitute a major revision) or could be achieved using existing results (a minor revision).
	Thank you for your comment. We did briefly motivate our study in the introduction (lines 44 – 56 in the revised manuscript) and this included a comment about the dynamic interest in the curved post-garnet (line 83-84 in the revised manuscript – again this is being invoked to explain slab stagnation in the mid-mantle). Whilst our response to peer review was being prepared similar arguments relating to post-spinel were discussed in Dong,

	2025 – we have added a passing reference to this (ln 84 -86 in revised manuscript, and also consider it in our concluding discussion (ln 363-ln 374)). We have added some text related to the conditions under which these phase boundary morphologies could play a more significant role (line 358-362 in the revised manuscript). Dong, J., Fischer, R.A., Stixrude, L.P. *et al.* Nonlinearity of the post-spinel transition and its expression in slabs and plumes worldwide. *Nat Commun* **16**, 1039 (2025). https://doi.org/10.1038/s41467-025-56231-z
RC1.04	**Specific Comments** 1. **Lines 120–123:** "For a downgoing body whose temperature is 500 K below the critical temperature of the reactions 'A', 'B', and 'Z', and with Clapeyron slopes of γ_A = +1.5 and γ_B = −6 MPa/K, we estimate a maximum separation between the phase transition surfaces inside the downgoing body as on the order of 100 km". Could you include this calculation, perhaps in the supplementary materials?
	We have edited the text to include the assumed pressure gradient and the calculation in the mid-mantle on line 151 in the revised manuscript – the calculation becomes straightforward but we have included it inline.
RC1.05	1. **Line 198:** Given the limitations of the models discussed in Section 3, it might be helpful to note at the beginning of Section 2 that the initial set of models is not intended to be Earth-realistic. A cross-reference to the explanation in Section 3 would be beneficial for readers who may skim certain sections.
	We have amended the text to provide this sign-posting. (ln 101-103 in revised manuscript)
	Figure-Specific Comments
RC1.06	1. **Figure 1:** Consider marking the upper material (density ρ_1) with a colour to make its presence more apparent. Additionally, reposition the text boxes for ρ_1 and ρ_2 to clearly associate them with the bulk material, avoiding any potential confusion with density variations along the dotted line.
	These edits have been made to figure 1.
RC1.07	2. **Figures 2 and 3:** These figures effectively summarise the phenomena under investigation. You might consider merging them into a single figure with two or three panels for better visual coherence.
	We wish to keep figures 2 &3 separate to help distinguish between the 'branching' post-garnet reaction modelled by Liu *et al* (2018) and the 'curving' post-garnet we consider here. We are happy to be directed by the editor if this is counter to the style of *Solid Earth*.

RC1.08	3. **Figures 5, 6, and 7:** ◦ Merge these figures into a single composite figure with six panels. Labelling each panel (e.g., with text in the red centre or a corner) would facilitate direct comparison between simulations, particularly since the text frequently refers to differences between Figures 6 and 7. ◦ To address the local versus global nature of stagnation phenomena, consider adding supplementary material showing the 3D variations of your results. Options include additional slices, volume elements (similar to Figure 10), or a video of a rotating cross-section.
	In the revised version of the manuscript, we have merged figures 6 & 7 – the combined figure is numbered figure 6 in the revised manuscript. Figure 5 relates to the akimotoite simulation and a reference, so we choose to leave it as a separate figure to keep the suites of simulations clearly distinct. To improve the discrimination between dynamic regimes, we introduce a discussion of mass flux and radial velocity rms (figure A3, and lines 209 and 227-240) in the revised manuscript) as part of our response to Scott King's review.
RC1.09	4. **Figure 8:** The diagonal line separating the two regimes does not appear to be well-supported by the data. A more accurate representation might involve marking the region between γ_cool = -17 and -13 as a transitional zone for any T_710c value. Please clarify in the text how you inferred the slope of the line and why it is presented as such.
	This figure is now numbered 7. We have provided some additional explanation in the text of how we picked the slope of the regime boundary, including a reference to the mass flux and radial velocity rms. The other reviewer is correct – that the boundary of the regimes in ɣ_cool has some dependence on T_710C is not really the key point of the figure.
RC1.10	5. **Figure 9:** • Increase the font size for axes and labels. • Provide a rationale for the behaviour of the radial viscosity factor, presumably designed to replicate Earth's mantle structure. • Clarify the factor's values at the bottom of the lower mantle and in the upper mantle, as the graph suggests these may approach zero, which would imply η = 0 according to Equation 7.
	This figure is now numbered 8. We have amended this figure so f_r is plotted on a log_10 scale to emphasise f_r drops to 1, not to near 0, as well as some explanation for why we have chosen this radial viscosity gradient.
	Minor Typographical Errors
RC1.11	1. Line 46: "consider these morphologies and to consider and in particular" – likely an extra "and"
	(line 47 in the revised manuscript) Resolved. Thanks for indicating these errors to us.
RC1.12	2. Line 105: "the model is run"

	We have attempted to clarify the language here (line 117 in the revised manuscript)
RC1.13	3. Line 199: “the simulated mid-mantles”
	We have attempted to clarify the language here (line 253-254 in the revised manuscript)
RC1.14	4. Line 281: “the full depth of the Mantle” – unnecessary capitalisation of “Mantle”
	Resolved. Thanks for indicating these errors to us.
	I hope these suggestions help refine and strengthen your manuscript.