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Solid Earth Discussions

Interactive comment on "Three-dimensional thermal structure of subduction zones: effects of obliquity and curvature" *by* A. K. Bengtson and P. E. van Keken

Anonymous Referee #2

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General comments:

This paper represents a compact, focused study that addresses the thermal structure and flow regime in the mantle wedge for the case of slabs with complex morphology modeled in three dimensions. The study aims to answer two specific and well-defined questions: 1) if a two-dimensional model is used to approximate three-dimensional flow for a straight trench model and oblique convergence, which cross-sectional geometry is appropriate?, and 2) can a two-dimensional model ever serve as a useful approximation for the case three-dimensional flow in a system with a highly curved trench? Overall I found this to be a very good paper that is very close to being ready for publi-

cation as is. It is well written and the models themselves are very well documented and have been carefully benchmarked. The goals of the study are fairly modest, but both questions that the paper aims to address represent important questions that should be explored and that the paper answers fully. The conclusions are well supported and the steps taken to reach them are well explained. I have a very few suggestions that may help to strengthen the presentation of the material, as listed below. After very minor revision, this paper will make a good contribution to Solid Earth.

Specific comments:

- One of the nice technical innovations presented in this paper is the approach of prescribing the slab velocity only along the slab surface, solving the Stokes equations in the slab, rather than prescribing the velocities everywhere in the slab volume, as is done in most kinematic-dynamic slab models. As the authors point out, a comparison with a 2D benchmark model shows that this way of defining the velocity BCs does not have a large effect on the solution, but it does make it easier to define a kinematic slab in a 3D model with complex slab morphology. This is a nice point, and I would suggest adding a sentence to the abstract that summarizes this finding.

- p. 929, line 5 - suggest rewording sentence slightly to read "Only in the case of cross-sections that run subparallel to the convergence direction (alpha $\sim$ theta) are the 2-D models reasonable."

- Captions to figures 3 and 4 appear to be swapped - please check.

- Figure 5 - please supply units for velocities (as indicated by color bar). Also - from the context of the figure it was fairly clear to me that the gray lines represent streamlines in the wedge entering from the -x direction, but I would suggest explicitly stating that in the caption.

- The authors state in the introduction that 2-D models have generally been fairly successful at predicting slab surface temperatures inferred from geochemical observa-

tions, citing papers such as Plank et al., 2009, Skora and Blundy, 2010, and Cooper et al. 2012. Given that their example model run matches the geometry of the Mariana subduction system fairly well, I wonder if they might be in a position to comment specifically on whether their 3D Mariana model yields an estimate for slab surface temperature(s) that is closer to what is inferred from geochemistry. I'm not sure whether any of the cited references have a slab temperature estimate for the Marianas, but at least one appears to be a global study, so perhaps. It would be interesting if the authors could specifically document whether their 3D model yields an estimate that is closer than previous 2D models (for example, the model of Syracuse et al. 2010 mentioned in the paper) for this region.

Interactive comment on Solid Earth Discuss., 4, 919, 2012.