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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

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The study shows that in the case of oblique subduction at a straight margin, a 2-D thermal model taken normal to the trench is more appropriate than that taken parallel to the convergence direction. The latter results in a cooler thermal condition due to a shallower slab dip that reduces the efficiency of return flow of the mantle. This clarification regarding the choice of the orientation of 2-D cross-sections is very useful to the subduction zone modeling community.

The study also shows that in the case of subduction at a curved margin, the flow pattern has "mildly 3-D characteristics". Further, oblique subduction at a curved margin results in asymmetric flow and thermal fields across the plane parallel to α=0. The comparison between 2-D and 3-D models show that slab surface temperature predicted by the 2-D model can deviate significantly (by up to$\sim$110°C) from that predicted by 3-D thermal models, particularly if the cross-section for a 2-D model is taken at a large angle from the convergence direction. This systematic analysis of the difference between 2-D and 3-D models is useful for future studies of thermal structures at curved margins, such as Marianas and Alaska-Aleutians.

This paper will make a good contribution to the advances in the subduction zone thermal modeling.

I just have a few questions about the role of the back-arc vertical boundary and editorial corrections/suggestions.

In the models, the flow and thermal fields in the mantle wedge are influenced by where the back-arc vertical boundary is placed relatively to the slab (i.e., the distance from the back-arc vertical boundary wall to the slab). Could the higher mantle temperature in the northern- and southern-most regions in Fig. 5a, for example, be caused by the proximity to the back wall? Also, in the case of oblique subduction at a curved margin (Fig. 5b), the mantle that overlies the northern slab has travelled a significantly longer distance from the back wall than that overlies the southern slab before it comes in contact with the slab. Could this also be contributing to the cooler condition at the slab surface in the north?

Page 920 Line 13 For consistency and clarity, it is better to use “curved trench” instead of “curved subduction”.

Page 920 Line 22 It should be “van Keken et al., 2011” instead of “van Keken et al., 2012”.

Page 920 Line 24 “)” is missing. It should be “Wada et al., 2012)”.

Page 921 Line 19 I suggest “rheology” instead of “properties” since T- and stressdependent properties of the wedge can include properties such as thermal conductivity and density.

Page 922 Line 27 Could you specify what "geochemistry" (e.g., geochemistry of arc lavas).

Page 923 Line 18 Could you clarify what "either domain" is referring to?

Page 923 Line 22 Remove "T is the temperature".

Page 924 Line 4 Change "potential mantle temperature" to "mantle potential temperature".

Page 926 Line 15 "that it should be taken" is unneeded. Perhaps, change "structure" to "the trench" for clarity.

Page 927 Line 9 Shouldn't "parallel to strike" be "normal to the strike (of the trench)"?

Page 927 Line 24 Insert "a" in front of "curved trench"

Page 927 Line 27 (Fig. 2) Is "the normal velocity on the sides" referring to the velocity normal to the side (i.e., vy)? If so, "v=0" in Fig. 2 should be "vy=0". Could you clarify what "v=0 slab and wedge sides" means in Fig. 2?

Page 928 Line 18 Could you clarify what "the intersection" means?

Page 928 Line 26 The sentence "Variations are . . ." applied to the case with $\theta = 0$. Could you specify this in the sentence?

Fig. 1. Caption Line 3 "angle" is unneeded.

Fig. 3 and Fig. 4 The figures are switched (and thus not matching with the captions).

Fig. 5 Does the arrow length represent anything? Units are missing from the colour bar.

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