

Interactive comment on “Optimal locations of sea-level indicators in glacial isostatic adjustment investigations” by H. Steffen et al.

H. Steffen et al.

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Received and published: 4 March 2014

Comments to the reviewers’ report on ‘Optimal locations of sea-level indicators in glacial isostatic adjustment investigations’ by Holger Steffen, Patrick Wu and Hansheng Wang.

We have revised the paper taking into account both reviewers’ comments. Below follows a detailed list of how we have responded to the individual comments (marked in *italics*) by Anonymous reviewer #1

The reviewer finds our study interesting and concludes that our results serve as a potential guide to search for new relative sea-level (RSL) indicators not only along the coasts, but also in lakes and the deep sea. He/she suggests to modify Figs. 3-8 as they

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are important. We have taken this comment very seriously and thus have revised these figures and also rearranged them. We note that some information in the figures was not presented as intended due to the special format of the discussion paper. However, this is our own fault, and we have learned to be more careful in this regard in future. We kindly ask the reviewer to check the attachment of this rebuttal letter to see the figures as we had planned them.

Individual scientific questions/issues

- *Can the authors comment on the potential effect of including the contribution from Earth rotation? Would that significantly alter their findings?*

The effect of rotational feedback on sea levels has been investigated by many studies including Milne & Mitrovica (1998), Peltier & Luthcke (2009) and us. This effect is largest at glacial maximum and is less than about 4 m. The effect of rotational feedback on the sensitivity is therefore much smaller than this and is less than the RSL error. Thus, the effect of rotational feedback is not expected to affect the conclusions of this paper.

- *What is the size of the elements which define the surface mesh of the 3-D Earth model?*

The surface mesh equals to a 2 degree × 2 degree grid. We have included this information in the text now.

- *This study confirms that the sensitivity of post-LGM rsl data to the ice-load history dominates over the solid earth parameters. Are we allowed to safely conclude that sophisticated 3-D GIA models with lateral heterogeneities are not necessary when investigating older than late Pleistocene glacial cycles? Or, what should one at least consider? Maybe lithospheric thickness variations?*

The reviewer raises an interesting question here. Our statement is that as long as the ice-load history of glacial cycles older than the late Pleistocene one is not sufficiently known, lateral heterogeneities are not necessary to be included in a

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GIA model. However, it is unclear to us how rheologic changes in the oceans (see e.g. Austermann et al., 2013) may interfere, which has to be further investigated.

Technical comments, corrections and questions

Abstract

- *Page 2420, Line 5. I suggest to change “global change” with “past and current global sea-level change”.*
We did indeed mean “global change”, not “sea-level change”. Thus we leave it as is.
- *Page 2420, line 13. “Assuming an accuracy of 2 m ...”. I suggest to shortly mention how and why a 2m accuracy was assumed.*
Information added.
- *Page 2420, line 24. “...the more recent the data are, the smaller is the area...”. I would also add something about the location w.r.t. ice and continents of these areas (i.e. narrower/thicker areas around the ice-sheets margins? narrower/thicker areas around the continent margins?)*
We have revised the summary of results in the abstract and have included a sentence as suggested.

1 Introduction

- *Page 2421, Line 14. Change “comparing the observation” with “comparing the observations”*
Changed as suggested.
- *Page 2422, Lines 26-28. Given the historical taste of the sentence, I suggest to add some older but important references as well (i.e. Clark, JGR, 1980; Tushingham and Peltier, 1992,1993)*
Added as suggested.

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- *Page 2423, Line 20. I suggest to remove the whole following sentence: “We can only use what has survived...”*
Sentence dropped.

2 Relative sea-level data

- *Page 2425, Line 8. I would remove the following sentence: “, but new data emerge occasionally and are added to existing databases”*
We have rephrased this to “and new data are added occasionally.”
- *Page 2425, Line 10. Is there a formal reference to the RSL database used in this work? Is it maybe Steffen and Wu, 2011? Also, would it be possible to add to Figure 1 a global map showing the RSL locations used in this work?*
There is, unfortunately, no formal reference. We avoid to give a complete reference list as this would blow up the whole section and reference list, and would exaggerate the rather small exercise of analysing the error bars performed here. Figure 1 shows, as stated in the text, all RSL locations used in this work, therefore there is no reason to change this figure.
- *Page 2425, Line 13. Is there a Reference to the observed transgression in the North Sea?*
Yes. We referenced Vink et al. (2007, QSR).

3 Modelling

- *Page 2427: Sentence at Lines 14-15 is sort of a repetition to sentence at Lines 9-10.*
Whole sentence is dropped as it is actually not needed.
- *Page 2427, Line 24. I suggest to remove the whole following sentence: “This is not anticipated...”*
We deleted the first part of this sentence and merged it with another one.

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4 Results

- *Page 2428, Line 15. The colored contour lines in Figure 3 are really hard to interpret. Maybe making larger maps would help the reader. Also, I suggest to add some intermediate-value contour lines (i.e. 50m until 12ka, 25m until 8ka as well as 7ka in Figure 4)*

The figure layout was due to the format of the discussion paper. We will provide maps of pagewidth size in the final manuscript (see also attachment). We do not add contour lines as suggested. This is because the intervals, especially in North America, are already at such a level that any additional line (like an intermediate-value) in between will result features that look like filled contours. We think that larger figures of pagewidth in portrait layout already do the job as wished by the reviewer.

- *Page 2429, Line 6: "Comparing the patterns...". I would rephrase as follows: "Compared to the solid Earth parameters, ice-load history has significantly larger sensitivity", or something like that.*

Rephrased to the suggestion.

- *Figure 5. It is really hard to spot the green areas (sensitivity to lithospheric thickness variations)*

Dark green is used now to increase figure quality.

5 Discussion

- *Page 2433, Lines 21-24. What does "glaciation" mean in this context? LGM (hence 18ka in the ice-sheet model) or the time span between 18 and 7ka? At the same manner, does "after glaciation" indicates the time between 7ka and present-day?*

Glaciation refers here to the time span between 18 and 7 ka, and "after glaciation" between 7 ka and present day. We clarified that in the text.

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6 Conclusions

- *Page 2434, Line 26. Change "RSL data" with "coastal RSL data"*
Sentence deleted due to rewrite request of the second reviewer.
- *Page 2435, Line 25. "...partly significantly" sounds a bit confusing.*
Sentence rephrased.
- *Page 2436, Lines 14-15. Add references to "...more than 14000 RSL data samples have been determined..."*
References added.
- *Page 2436, Line 25. The sentence "...data should be searched around the world" should be rephrased as it is a bit at odds with the previous sentence at Lines 22-24 "... adding hundreds of newly-determined far-field data... may introduce error to such an investigation".*
Agreed. The whole paragraph has been rephrased.

Please also note the supplement to this comment:

<http://www.solid-earth-discuss.net/5/C1072/2014/sed-5-C1072-2014-supplement.pdf>

Interactive comment on Solid Earth Discuss., 5, 2419, 2013.