

## ***Interactive comment on “The sensitivity of GNSS measurements in Fennoscandia to distinct three-dimensional upper-mantle structures” by H. Steffen and P. Wu***

**Anonymous Referee #2**

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The new research offers a set of calculations of the sensitivity “Frechet kernels” that are so familiar in seismic tomographic imaging and here applied to a finite-volume description of mantle heterogeneous viscosity and sensitivity to “GNSS velocity responses”. Hence the possibility to probe for 3-D mantle variations in viscosity is explored by using perturbations to the viscosity and mapping those perturbations to variability in individual station responses.

The research is logically organized and provides interesting results. But the paper suffers from a kind-of “laissez-faire” approach to self-editing for the writing of the manuscript. The authors should be reminded of the proverb: “La gatta frettolosa fece i gatinni ciechi” (or ‘The hasty cat makes blind kittens’).

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As it stands, the paper also fails to provide convincing evidence that the results are more than a small ‘epsilon’ improvement over what has been done in the past and I offer suggestions of how this might be improved.

The very poor use of proper grammar and sentence structure undermines the scientific presentation. This can be improved by the authors by performing iterative reading and rewriting (as most of us do) or by using a formal technical writing assistant for English. (It is not the reviewer’s job). The paper needs a major revision before being acceptable to publish.

Before giving a detailed list comments, I give the following examples of the egregious nature of poor writing. I know these authors are capable of better communication.

1st sentence of the abstract is a run-on sentence. 2nd sentence of the Introduction: “The GIA process is indicated in and also affects multiple . . .”

Or the 1st sentence in the Discussion. “It becomes evident that sufficient sensitivity mainly yields for viscosity blocks that are located inside the former glaciated area.”

This passes the Microsoft Word Tool Menu “sniff test” but is a completely illogically organized sentence.

Finally the paper is too long for it’s content and the Discussion and Conclusion sections need to be shortened.

Detailed comments.

Abstract. I. See above for 1st sentence.

II. Line 13. “about 20 differently shaped areas . . .” is insufficiently descriptive. Replace with something like “The analysis proceeds by considering amalgamations of blocks that form different shapes. In each layer, there are about 20 such amalgamations, on average.” (My helpful point here is that there has been an attempt to ‘short-cut’ the description of what is done. That is OK in principle if you are very good at the

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language. If not, then it will help the writing if there is iteration and re-iteration – sort of like kneading clay.

III. Lines 21-22. Replace “only small” with “limited”.

IV. Lines 26-27. Sorry – the sentence starting “They can be further grouped to address certain areas” is devoid of meaning to me. Again: ‘La gatta frettolosa fece i gatinni ciechi !!’.

V. A recommendation is given at the end of the abstract: to give more weight to certain stations. Why not go further and recommend clusters of new stations that can heighten the sensitivity of geodetic observations to lateral heterogeneity?

Introduction. I. Lines 6-7 (see above)

II. Line 9 “employed ones” ???

III. Line 15 Poor structure - “sensitive class A”. Also please define “Class A” before introducing the phrase using it. Again: ‘La gatta frettolosa ...’

IV. Line 12 “computation” -> “computational”

V. Line 13 What does “were enabled” mean?

VI. Line 18 needs the appropriate commas separating the phrase “such as mentioned above” (a poor choice of sentence construction in the 1st place).

VII. Line 21 Please clean up the “... i.e. how much ...”

VIII. Line 23-26 The fundamentals of Frechet kernel sensitivity is also (and mostly) developed in seismology. Please reference some thing like Dahlen and Tromp (1998) Theoretical Global Seismology, page 337, or/and Sneider, R. (1993) Global inversions using normal modes and long-period surface waves, Chapter 3 of Seismic Tomography: Theory and Practice (ed. H.M. Iyer and K. Hirahara), Chapman and Hall, London, pp. 842.). It is a little wrong not to acknowledge that the tiny GIA-community were not

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the ones to invent this.

IX. The lines 7-9 of page 2392 (forming the opening of a paragraph) do not form an actual sentence. (La gatta frettolosa ...)

X. Last sentence of that same paragraph “In this regards, ...” should be removed, as it is an idea that seems injected without rationale. Either expand on this relevance (minus the ‘frettolosa’ which also bothers the structure of this sentence).

XI. Prior to the last paragraph (pages 2392-2393) of the Intro., please refer to the theoretical paper that contains the integral.

XII. Line 27, “In this regards, ...” is incorrect grammar.

XIII. Line 1 of page 2393 Please explain in more detail what the new viscosity structure model is and why you think it is better that what was used previously. The reference is to a 16-year old paper (Ekstrom and Dziewonski) . Why could this be a source for such improvement?

XIV. In this same paragraph it should be stated explicitly what the current accuracy is of the velocity data used here.

XV. Finally another word on the “gatta frettolosa” problem: I have attempted to give diligent instructions for correction up to this point. But this is not the real role for a reviewer. The remainder of the paper is loaded with poor or incorrect phrasing. Occasionally, there even laughable ones, I have to say. From here on the authors must do their own editorial reading. Remembering all the while our dear Italian proverb.

Modelling I. The lower mantle viscosity is set to  $2 \times 10^{22}$  Pa s. Please motivate. Why?

II. The authors have detailed upper mantle layering. Paulson, Zhong and Wahr published a paper some years back stating that lateral heterogeneous viscosity (and its indeterminability) makes it impossible to trust such fine layers. Please comment.

III. Prior to the last paragraph (pages 2394-2395) of the Intro., please refer to the theo-

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retical paper that contains the integral.

IV. It seems that the sensitivity for only ONE among a large (almost limitless) ensemble of relations to get from shear wave velocity to rheology is examined here. Why not examine another? This should really be explored. I would not think that this would be so much work.

V. Page 2397. It is mentioned that the threshold is 0.015 mm/yr on line 12. This seems very unrealistic – if for no other reason than for the existence of unmodelable geophysical sources. It would therefore seem to be important to explore how the series of sensitivity tests work out (map-wise) if the threshold were raised by a factor of 6. Doing this is important to the disposition of the submission after the second round of reviews – at least from this reviewer.

VI. Page 2398 lines 6-30. This material should be condensed. The map figures make these relations straightforward to see. There are many awkward sentences again.

Discussion Again, there are numerous non-sentences. This section needs to be completely rewritten. Most of the material should be condensed to one paragraph. It is redundant to the previous descriptive section, and lacks any physical interpretation.

Conclusions The authors repeat themselves several times. The results are straightforward enough that all should be concluded in about 1/4th the number of words used. There is consistent redundancy throughout.

In summary, this paper is flawed in three areas: English grammar and structure - for which they must face the fact that they need many hours of self-editing or professional assistance. Secondly, there is no examination of the parameters involved in shear wave to viscosity, and increase in threshold value. Thirdly, there is much redundancy in the conclusion and discussion session, for which they should seek a revision that has about half the verbiage. Without the authors seriously attending to these three things AND heightening their attention to the poor English throughout, I predict that this paper

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should go directly to the “reject” basket on the second round of reviews. There is valuable information to be conveyed in the research and, hopefully, the authors will do a better job in their revision.

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Interactive comment on Solid Earth Discuss., 5, 2389, 2013.

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