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Interactive comment on "A 3-D shear velocity model of the southern North America and the Caribbean plates from ambient noise and earthquake tomography" *by* B. Gaite et al.

Anonymous Referee #1

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Review of A 3-D shear velocity model of the southern North America and the Caribbean Plates from ambient noise and earthquake tomography by B. Gaite, A Villasenõr, A. Iglesias, M. Herraiz, and I. Jiménez-Munt; Solid Earth Discussions (se-2014-90).

General Comments: This article by Gaite et al describes the construction of a vertically-polarized 3D shear velocity model of the crust and upper-most mantle beneath southern North America and Caribbean plates. The model is constrained by a dataset of fundamental mode Rayleigh-wave group and phase velocity measurements derived from both ambient noise and earthquakes; the ambient noise measurements were obtained from a previous study performed by the authors. The main features of the model are interpreted in terms of their tectonic significance, and are compared with previ-

ous results and interpretations. Some of the striking features of the model include the low crustal velocities along the USA-Mexico Border, as well as the distinct elevated mantle velocity structure of the Yucatan Block and Isthmus of Tehuantepec from the surrounding lower velocities.

The article is well-structured overall and fairly-well written. The clarity of some of the arguments and interpretations would benefit from additional editing for grammar and syntax. I have suggested some specific changes, as well as highlighted some confusing or unclear sentences in the Technical Comments below. The figures are nicely presented and well-constructed. In Figures 9 and 11, the horizontal slices through the model, it would be helpful to make each of the panels larger. This would allow the font size of the labels to be increased, as currently they are quite hard to read. I'd also like to commend the authors for making their model available for download, as this dissemination is very helpful for the rest of the community.

Following are a number of specific comments which I would like to see addressed.

Specific Comments:

- Please comment on the effects of neglecting azimuthal anisotropy in the inversions?

- Pg 2973, Line 4: (Shaprio and Ritzwoller, 2002; Pasyanos et al 2013). The CUB model is an excellent model, however there are many other global models which would be considered more "recent" which attain similar resolutions. Consider including one or two other additional references (such as SEMum2, DR2012, SL2013sv, SAVANI, etc.), or alternatively remove the word recent.

- Pg 2974, Lines 16-25: Please be more specific when discussing the inversion parameters (α, β, σ). If they are going to be given values, a short description of what each is should be included (ie one sentence total). Also, please clarify what is meant by "with less smoothed damping parameters" when referring to the difference between the two inversions. The smoothing is probably not applied to the damping parameters,

but rather to the model. Given the numeric values of the parameters, is the regularization being increased or decreased between the two inversions? The value of α (data misfit damping) is reduced by a factor of 2; the value of σ (Gaussian sensitivity kernel smoothing parameter) is increased from 400 to 500; the value of β (smoothness of the model) is unchanged. To me this suggests the smoothing length is larger in the second inversion compared to the first, therefore the resolution is lower?

- Pg 2975, Equation 1. The symbol δU is used, however it is called a "travel-time" residual. Is this the group velocity (U) residual?

- The maximum spatial resolution of the model is said to be 2°, and limited by the distance between the nodes of the grid. If the computed resolution is limited by the grid, why not decrease the grid-spacing further to take full advantage of the potential resolving power?

- Although the ANT method is well-documented in previous papers (ie Gaite et al, 2012), it would help to have a short description of the procedure (a paragraph or in section 3.2) Figure 7 and description on Pg 2977, Lines 19-21. The figures are described to show misfits, but they are labelled as L2 Norms. I would suggest changing the labeling to reflect the fact that they are misfit norm values.

- Figure 8 and Section 4. In Figure 4a, the black lines denote the best-fitting model. However, few of the models fit the data at periods >=40s for Phase velocity and >80s for Group velocity. Can you comment on the effect this has in the inversion, and why none of the models seem to fit these data. Are the data at longer periods (relatively speaking for phase and group velocity) wrong, or is the 3-layer 4-parameter model too simplified to be able to fit those data?

- How is the "best-fit" model determined (solid black line)? Please specifically state how this is computed, as in the text the misfit criteria are stated but not what constitutes the final best-fit profile. Do you compute the average of each parameter from the ensemble of accepted models (grey lines)? Also, plotting the ensemble of solutions (grey curves)

instead as a density of sampling would be more informative to show where the most likely solution lies in the tested model space. This could be done as a 2D histogram, or alternatively, each curve could be coloured by their misfit. The best-fitting (black) curve would be expected to follow roughly the maximum.

- Related to the above point, it is stated that tests show the Vs model is sensitive to 5-km-thick layers. This is quite a high vertical resolution for surface waves, even with the short periods obtained from ANT. The results of the tests that demonstrate this resolution should be included in the paper. There would be strong trade-offs between the layer depths and velocities, such that a variety of depths for a given interface can have equal misfit simply by adjusting the velocities in the surrounding layers. Intuitively this would have a serious effect on the resolvable sharpness of the 3 vertical discontinuities that make up the model at each node.

- The high velocities at 12km are interpreted to represent the crustal signature of the Laurentian margin (Page 2979, Paragraph 2). If these features delimit the southern extent of the Laurentian margin, should these high Laurentian velocities not also persist further northwards into Laurentia? What could be the explanation for their absence? Is it possible the data coverage is not high enough to capture the high velocities which may extend further north?

- In discussing the upper mantle (section 4.2), several references are made to specific velocity contours. It would be helpful for the reader to follow the exact boundaries you are discussing by including the actual contour lines superimposed on the figure (Figure 11b for instance).

Technical Corrections:

- Pg 2973, Lines 1-2: "...stations deployments in the last decade facilitates getting a denser path coverage." Reads awkwardly, consider changing to "...station deployments in the last decade has facilitated a higher path density."

- Pg 2973, Line 4: “...2 or 1° of resolution...”; remove “of”

- Pg 2973, Line 27: “coverage on California”; chance to “coverage in California”

- Pg 2973, Line 1: “has recently improved significantly the station coverage in the Caribbean region.”; change to “has significantly improved the station coverage in the Caribbean.”

- Pg 2974, Line 24: “...and invert again the remaining...”; change to “...and re-invert the remaining... ”

- Pg 2975, Line 7-8: “...are well covered for all period range, while the east of the Caribbean for periods longer than 20s.” First change “for all period range” to “across all periods” and “...while the east...” to “...whereas the east...” Finally, the sentence is incomplete. Do you mean the coverage east of the Caribbean plate at periods longer than 20s is poor?

- Pg 2975, Line 10-12: “The tomography method used...sensitivity of the surface waves.” Please re-phrase, awkward.

- Pg 2975, Line 17: “...lower or equal than...”; change to “...lesser than or equal to...”

- Pg 2976, Line 2: “...from 8 to 100s of period.”; remove “of”

- Pg 2976, Lines 11 to 18. Awkward wording in these sentences. Please re-phrase to make it more clear to the reader.

- Pg 2976, Line 20: “We invert simultaneously...”; change to “We simultaneously invert...”

- Pg. 2976, Line 23: “...can vary in a wide range...”; change to “...can vary across a wide range...”

- Pg 2977, Line 1: “...of tectonic domains on the...”; change to “...of tectonic domains in the...”

- Pg 2977, Line 20: “Figure 7b shows the misfit geographical distribution.” Change to “Figure 7b shows the geographical distribution of the model misfit.”

- Pg 2978, Lines 14-16: Awkward, re-phrase.

- Pg 2978, Lines 24-26: Unclear, please re-phrase to clarify. Really only one of the depths shows the oceanic crust (5km), and none of the profiles extends far off-shore.

- Pg 2980, Line 2: Typo in Basin and Range.

- Pg 2980, Line 7: “-GofC-.“; change to “(GofC).”

- Pg 2981, Lines 15-19: Please re-phrase to help clarify the point being made.

- Pg 2982, Lines 22-25: I may have missed it, but I couldn’t see the Veracruz Basin labelled on the figures.

- Figure 6: The grey contours marking the inversion area are almost impossible to see with the grey colours in the background. Perhaps it could instead be a white line outlined by black (visible on essentially any colour).

- In Figure 8b, the light grey lines denote the acceptable models “smaller than or equal to 2 times the smallest fitting.” Please change the wording to clarify what this means.

- Figure 9: This is a very nice figure, though its impact could be made greater if it was larger. This would make it much easier to follow the discussion in the text. The labels are quite hard to read; please increase their size (+/- change colour) to make them more clear.

Interactive comment on Solid Earth Discuss., 6, 2971, 2014.