

Interactive comment on “Subduction or delamination beneath Apennines? Evidences from regional tomography” by I. Koulakov et al.

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Dear Editor, dear Reviewers,

Thank you for considering and careful reading our paper “Subduction or delamination beneath Apennines? Evidences from regional tomography” submitted to Solid Earth.

We have carefully addressed all your comments and made the corresponding changes in the text. In particular, after the question of Dr. Maximiliano Bezada, we have added a paragraph with the discussion of the cause of the Adrian lithosphere detachment along Apennines.

In the rebuttal letter, which is appended below, we give detailed responses to all critical remarks of the reviewers. All changes in the Manuscript (see supplement file) are

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highlighted with violet.

We hope that you will find our paper improved and suitable for further consideration at Solid Earth.

Best regards,

Ivan Koulakov, on behalf of the authors, Novosibirsk, 22 of April 2015.

Rebuttal letter with responses to the reviewer’s comments on the paper by Koulakov et al. “Subduction or delamination beneath Apennines? Evidences from regional tomography” submitted to Solid Earth

Responses to the reviewer’s comments are marked with “Rep”.

Comments by Dr. Lapo Boschi:

The manuscript by Koulakov et al. presents a new model of both P and S velocities in the upper mantle under Italy and the Alps. The agreement between the P and S models is, I believe, something new, indicating a possibly important progress in our understanding of this region via seismic imaging. So far as the seismology is concerned, I think this manuscript can be published in its present form (but please take a look at my specific comments below). The tectonics discussion is also well written and interesting but I feel that I am not sufficiently competent to provide an insightful review of that, so I will mainly comment on the seismology. I assume that the manuscript will be reviewed by a tectonicist as well?

Other comments: main question about algorithm: you are presenting a P and an S model together, however, I believe each of the two models are obtained in a separate inversion. Or, is there some a-priori constraint linking P to S anomaly? I think it would be good to be explicit on this. REP: In this study, P and S models are computed simultaneously together with correcting the source parameters. Strictly speaking, they are linked in one inversion via source corrections, but in practice, this coupling is very weak and P and S models can be considered as fully independent. We have added a

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few sentences about this in the text (L150-152).

P865 L8-9 "the value of damping" → what "damping" are we talking about, i.e. what is minimized? roughness (and how do you define roughness), norm (and how do you define norm), etc. REP: In the algorithm description, we have specified the method of the regularization used in the algorithm (L154-156). In the resulting part, we provide specific values of smoothing factors used to compute smoother and sharper models (L170-172).

P867 L17 in both P and S anomalies. → in both P and S models. Done P868 L26 active mounting building → active mountain building Done P868 L28-29 The observed in our tomography model high P velocity anomaly → The high P velocity anomaly observed in our tomography model Done Fig. 4: you labeled all the panels "P anomalies", but I believe you are showing both S and P models, aren't you? Corrected Fig. 5: you should state explicitly in the caption which image was obtained after reducing the damping, both for the horizontal and vertical sections. REP: For this figure, we have corrected the "P" to "S" in the bottom vertical section, and added the phrase: "compared to the main model shown in Figures 3 and 4" as requested by the reviewer.

Comments by Maximiliano Bezada: The paper presents new tomographic imaging of The Apennine region. While the images are similar to what has been shown in previous publications cited by the authors, the interpretation is significantly different to what has been proposed in the past. Their interpretation accounts for the Alpine-Tethys subduction without attributing it to the fast anomaly beneath the Calabrian arc. Instead, they propose that this is delaminated mantle lithosphere from Adria, which is an intriguing idea. This interpretation seems to be adequately supported by their observations, and is well developed and explained in the paper. In my opinion, the tectonic history that they propose is plausible and consistent with available data. My only concern is that the detachment of the delaminated lithosphere from 'undeformed' or 'stable' Adria to the Northeast does not receive enough attention. The authors do discuss the tearing of this detached mantle lithosphere on the Alpine side, but it

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must have been initially continuous along its whole length with the mantle lithosphere beneath undeformed Adria (i.e. the part that has not lost its mantle lithosphere or been accreted onto the wedge). There must have been a long detachment or tear running NW-SE that would allow the 'sausage' to separate and sink into the mantle, instead of dangling there like a curtain. I would like to see the authors' thoughts on this process more clearly laid out in the manuscript. REP: We have added a paragraph related to this question in L305-313. Technical comments: It seems like the tomography was divided into three circles shown in Fig. 2. How were these inversions merged? And how did you deal with the overlaps? REP: We have added more details on the merging algorithm in L143-148. I will echo Lap Boschi's comments about being a bit more explicit about "damping". REP: See our reply to the corresponding issue. Details: P860-L6: I don't think "behaves" is the right word here. Perhaps "has the appearance of". "Behaves" implies to me that it has a sausage-like rheology or something. Corrected P863-L10: Beneath the central Mediterranean. Corrected P863-L13: use of a large amount of data. Corrected P863-L18: Prior to using. Corrected P864-L7: One of the key inversion parameters. Corrected P864-L28: 2 by 2 and 4 by 4. Thanks. Corrected. P866-L2: Earth. Corrected P866-L9: For. Corrected P867-L2: Perhaps add references to the different models that you judge to be inconsistent. We have added "discussed in the next section" where all references are given. P867-L9: extends down. Corrected P867-L25: conveyor. Corrected P868: Not sure what you mean by dipping attitude. REP: We have reformulated this phrase as: "whereas the flat plate slides down along the inclined bottom surface of the plate." P868-L18: by approximately Corrected P868-L26: active mountain building. Corrected P868-L27: I don't think you can attribute the formation of the Apennine crust to this process, perhaps the modification, deformation or accretion. REP: We have replaced "formation" with "strong deformation". P868-L28, 29: The high P velocity anomaly observed in our tomography model. Corrected L870-L10, 11. I don't understand what you mean by the phrase: "Vertical sinking of the "Calabrian sausage" causes the breaking of the oceanic lithosphere in the African side". How exactly would this

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happen? REP: We have removed the part of the phrase with "breaking of the oceanic lithosphere". The present version of this sentence is "Vertical sinking of the "Calabrian sausage" causes the slab retreat of the contact zone between the newly formed Tyrrhenian Sea and the Ionian-African foreland lithosphere." (L302-304).

Please also note the supplement to this comment:

<http://www.solid-earth-discuss.net/7/C507/2015/sed-7-C507-2015-supplement.pdf>

Interactive comment on Solid Earth Discuss., 7, 859, 2015.