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Solid Earth Discussions

Interactive comment on "Global patterns of Earth's dynamic topography since the Jurassic" *by* Michael Rubey et al.

Anonymous Referee #2

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Authors Rubey et al. presented a global geodynamic prediction of dynamic topography from 200 Ma to the present. They used a forward modeling approach by mostly considering the effect of sinking slabs. The results compare relatively well to other studies including those using inverse approached based on seismically converted present-day mantle density structures. I find the global framework of dynamic topography history provided in this study to be especially useful for further references in similar modeling work. I do have some minor suggestions for improvement (as discussed below). Overall, this work is solid and reasonable, and I would suggest publication with a minor/technical revision.

The topic of dynamic topography has generated enormous amount of discussion and debates recently. Part of this is due to different (sometimes erroneous) understanding on the principles of mantle dynamics, and most is due to the quantification of mantle

dynamic properties such as viscosity and density profiles of the mantle. The authors did a good job laying out this evolving discussion, especially the contrasting views on dynamic topography from numerical modeling and geopotential field studies. However, I think the paper could be further enhanced by providing more analyses on the differences between different dynamic models, especially over geographic regions where many debates exist. For example, the authors cited two earlier papers (e.g. Lithgow-Bertelloni and Silver, 1998; Gurnis et al., 2000) for African topography, but there works (especially the former) suggest much large dynamic uplift over south Africa, compared to the authors' result. A key reason, according to my understanding, is that these earlier works underestimated/neglected the compositional nature of the LLSVP below the region that has be progressively established since then (Isshi & Trump, 1999; Masters et al., 2000; Ni et al., 2002; McNamara & Zhong, 2005; Simmons et al., 2009; Liu & Zhong, 2016). I consider the current paper potential to serve as a cornerstone to establishing a framework on this important topic of dynamic topography, so some discussions like the over outline above would significantly strengthen this manuscript.

Minor comments: P 2, L5: Geoid is a result of deep density anomaly and/or surface topography. E.g., in theory, an isostatically balanced mass anomaly in the lower mantle sitting on the CMB may generate geoid without exiting dynamic topography. It is thus not entirely faire to use geoid as a direct constraint on dynamic topography.

P 3, top line: The cited work by (Glišović and Forte, 2017) is a quasi-reversibility method, instead of an adjoint method.

P 5, end of parag. 10: from the description, it is clearly that the presented model assumes no compositional anomaly for the LLSVPs on the CMB. While a forward model with a pure thermal mantle likely would predict similar dynamic topography to those inverse models (based on tomography) assuming a thermal-chemical origin of the LLSVPs, it would be worth clarifying on this, so that readers will not be confused/baffles by the apparently different modeling approaches but with similar results. This would be a good place to clarify on these existing confusions in the field.

P 7, L 10: The prediction over South Africa implies little absolute dynamic topography ($\sim$200 meters), and even less dynamic uplift since the Mesozoic (Africa is a stable platform). This is indeed in contrast to earlier models that suggest large amplitude uplift (e.g., Lithgow-Bertelloni and Silver, 1998). The likely reason is that the earlier model assumes a pure thermal origin of the LLSVP and takes the geometry of the LLSVP from tomography, leading to a much larger dynamic uplift signal. Again, this should be discussed and clarified.

Final remark: I really like the cluster analysis in this paper, and this is partly why I think this work could be used as a framework on the concept of dynamic topography.

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