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Modelling of the dynamic geoid with joint inversion of Vs velocities in the mantle and topography of the transition zone

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The observed geoid is one of the most important constraints on mantle parameters. However, a determination of the Earth's mantle structure has an ambiguous solution when using only surface gravity data. A usual way to cope with such a problem is to combine gravity data with other geophysical data sets. Seismic tomography models are used for these purposes most often. The tomography models, which were used in the previous works, have been obtained without considering the transition zone. This can lead to strong artificial seismic velocity anomalies and, consequently, to false inferences on the density structure of the mantle. We use the tomography model of Gu et al. (2003), in which mantle velocities have been estimated in a joint inversion with the transition zone discontinuities. The velocity-to-density scaling factor and density jump at the discontinuities are determined independently to fit the observed geoid and surface plate velocities. For the 400-km discontinuity we obtain the scaling factor and density jump, which are very close to the mineral physics prediction, therefore, we can conclude that these effects are really decoupled in the tomography model. By contrast, the velocity-to-density scaling factor for the 670-km discontinuity doesn't differ remarkably from that one for the standard tomography model, while the calculated density jump is much less than the PREM value. One possible explanation for such a disagreement is that the seismically determined 670-km discontinuity might represent to a large extent compositional boundaries related to lithospheric slabs and mantle plumes near the 670-km discontinuity.