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Coseismic density redistribution of the Earth interior based on the spherical dislocation theory and comparison to GRACE data

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Coseismic deformation produces sudden changes in the Earth's layered density structure due to the volume and internal topography changes, which can disturb global gravitational field. Such gravitational perturbations have been detected by the gravity space mission data (Han et al., 2006; Heki and Matsuo, 2010; Zhou et al., 2011). Han et al. (2006) discussed the gravity changes produced by the density changes related to the crustal dilatation produce by the 2004 Sumatra earthquake (Mw 9.0). But he neglected the gravity changes due to the internal topography changes, and the adopted Earth model is the simple half space media. Cambiotti et al. (2011) also discussed the gravity changes due to coseismic volume changes based on the normal mode summation, in which he took the point source as the fault model. However, the maximum coseismic changes occur in the vicinity of the fault, if the point source is adopted to conduct the near-field computation, there are many errors in the results.
In this work, we present a method to compute the coseismic density changes in term of volumetric dilatation and internal topography changes based on the elastic dislocation theory. Using this computing scheme, the modelling density changes can be compared directly with the GRACE-observed ones. Combined with the finite fault model, we conduct the case study of the 2004 Sumatra earthquake (Mw 9.3) and the 2011 Tohoku-Oki earthquake (Mw 9.0). Then we compare the modelling results to the GRACE-derived surface density changes given as the equivalent water height (EWH). The comparison reveals some interesting details about the pattern and behavior of the internal density redistribution due to earthquakes at the subduction zone.