Solid Earth Discuss.,
https://doi.org/10.5194/se-2018-113-RC2, 2018

Solid Earth Discussions
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Interactive comment on "Crustal Density Model of the Sea of Marmara: Geophysical Data Integration and 3D Gravity Modelling" *by* Ershad Gholamrezaie et al.

Anonymous Referee #2

Received and published: 11 December 2018

The paper addresses the question of the deep crustal structure of the submerged section of the North-Anatolian Fault within the Sea of Marmara, which may have important implications to better assess the earthquake hazard in the highly populated (> 15 Millions inhabitants) Istanbul area. A new crustal-scale 3D density model integrating geological and seismological data is presented, based on additional 3D-gravity modelling. The major result is that the crust appear to be Âńcrosscut by two large, dome-shaped mafic high-density bodies (average density of 3050 kg.m-3) of considerable thickness above a rather uniform lithospheric mantle (3300 kg.m-3)Âż. It is to be noted here that the location of these two bodies coincides with the location of two major escarpments : below the Tekirdag and the Cinarçik escarpments, respectively (Figure 9c). As

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Discussion paper

a conclusion, the authors then suggest that these high-density bodies Âń control the rheological behaviour along the NAFZ, and consequently, influences fault segmentation and propagation dynamics Âż.

The paper is well presented and well written. However, there are major concerns regarding the dataset, both for gravimetry and for bathymetry from the offshore domain in Sea of Marmara.

1) For gravity, the authors use the EIGEN-6C4 dataset (Förste et al., 2014), which is a combined global gravity field model up to degree and order 2190 correlating satellite observations (LAGEOS, GRACE, GOCE) and surface data (DTU 2'x2' global gravity anomaly grid). At the scale and wavelengths concerned by the present study : 1) the DTU 2'x2' global gravity anomaly grid, based on satellite altimetry, is predominant and 2) the density contrast is at the sea-bottom interface is of critical importance.

It is highly regrettable that no discussion is presented to compare the free-air gravity anomaly from ship-board gravimeters and the satellite derived gravity data used in the present paper for the offshore domain. In Figure 2 of Kende et al (note missing reference : J. Geophys. Res. Solid Earth, 122, 1381–1401, doi:10.1002/ 2015JB012735), the differences between the two datasets are shown along a 130 km long profile, oriented along the strike of the main fault, following the deeper parts of the Sea of Marmara. This profile represents the most favourable configuration for using gravity from radar altimetry. Still, there are major differences.

The N-S profiles (B-B' and C-C') shown in Figures 7 and 8 of the present submission represent the worst configuration for satellite altimetry-derived gravity, as they cross sharp escarpments bordering the Tekirdag and Cinarçik basins, which are expected to produce important effects on the gravity signature. A comparison between satellitre gravity and ship-board gravity must be presented and the effects related to the use of altimetry-derived gravimetry must be discussed.

2) For topography-bathymetry (shown figure 1c), the authors use a dataset exported

from 1 Arc-Minute Global Relief Model (Amante and Eakins, 2009), which integrates the 30 arc-second grid obtained from NASA's Shuttle Radar Topography Mission (SRTM) and a bathymetry dataset from the MediMap Group, 2008.

Bathymetric grids from the Medimap group have a 1 km grid-node spacing. Compared to high-resolution grids based on shipboard, multibeam echsounders (e.g. [Le Pichon et al., 2001]), such grids are expected to smooth considerably the bathymetry, when sharp escarpments are present, particularly at the Western Tekirdag and the Northern Cinarcik escarpments. A smoothen bathymetry at escarpments may induce unwanted effects in gravity modelling, by introducing artificially the need of compensating high density bodies at depth.

The concerns listed above on both the gravimetry and the bathymetry datasets, cast serious doubts on the reality of the two high density bodies found by the authors. Besides these two major issues, a geological discussion on the implications of the results is cruelly missing (gravity model solutions are not unique ; geological criteria represent the best guides for discussing non-unique solutions).

In conclusion, for the above reasons, I do not recommend publication of the submitted paper in Solid Earth Discussions.

A substantial effort is needed : 1) for testing the relevance of the gravity model they use in the case of the Sea of Marmara (particularly due to the presence of sharp escarpments) 2) for testing the relevance of the bathymetric grid 3) for presenting an in-depth, geological discussion for discriminating the different (non-unique) results.

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2018-113/se-2018-113-RC2-supplement.pdf

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2018-113, 2018.