

## ***Interactive comment on “Crustal Thickness of Antarctica estimated using data from gravimetric satellites” by Muriel Llubes et al.***

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The authors constructed maps of crustal thickness and density of Antarctica by using new data of gravimetric satellites. Since deep structure of Antarctica are least known, any effort to improve the knowledge on it is valuable. Gravity observations can offer reliable information about variations in Moho topography, but not absolute thickness values, therefore, absolute thicknesses from seismic studies are often taken as a priori constraints in gravimetric inversion. The constraints used in this manuscript are from global model, CRUST1.0, but it gives little information on Antarctic interior. Most of Antarctic interior had never been reliably measured before the Fourth International Polar Year (IPY) (2007-2008). Since 2007, the seismic works under GAMSEIS (<http://epsc.wustl.edu/seismology/GAMSEIS/>) and POLENET ([www.polenet.org](http://www.polenet.org))

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projects firstly obtained reliable information on the Antarctic interior. New results (e.g., AN1 model) showed that the crust of Antarctica is very different with those (e.g., CRUST1.0) imagined previously. However, the new results were not considered in the manuscript.

Specific comments:

(1) In section “2.3 Crustal thickness models from seismology”, several points confused me.

The text in the manuscript about the observations used in An et al. (2015) is that “*in Antarctica there are very few seismological observations and the Chinese model is poorly constrained*” (page5, lines 11-12). This statement is completely wrong. It is true that there had ever been few seismological observations in Antarctic before 2007. However, since the IPY (2007–2008), intensive seismological surveys under GAMSEIS and POLENET projects have been conducted in Antarctica. Those observations significantly improved the coverage of seismic observations in Antarctica. As one work of the GAMSEIS project, An et al. (2015) not only used almost all seismological observations before the IPY, but also the observations of GAMSEIS and POLENET. Their model was constrained by the best data coverage on entire Antarctica to date.

After a comparison with AN1 of An et al. (2015), the manuscript concluded that “*CRUST1.0 has a better spatial resolution*” (Page 5, line 15). On the contrary, in my view, the comparison of the manuscript only demonstrated that CRUST1.0 has no valid information on Antarctic interior. Seismic studies under GAMSEIS and POLENET projects since 2007 have shown that the crust of Antarctic interior is very different from previously imagined. The results of GAMSEIS project are overviewed by An et al. (2016) (<http://www.aps-polar.org/paper/2016/27/02/A160908000001>). Body-wave receiver function (RF) analysis is a good method to detect Moho depth beneath seismic stations and the results are normally considered as reliable. RF studies showed that crust in central East Antarctica is thick (>50 km and even to be ~60 km) (Hansen et al.,

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2010; Feng et al., 2014), in West Antarctica is thin (~20-30 km) (Chaput et al., 2014). However, in CRUST1.0 model, the crust in west Antarctica is >30 km thick, and in East Antarctica is <42 km (Figure 8d). The text (“*The comparison with the CRUST1.0 model reveals large differences between them. As seen in Figure 3, from -26 to +19 km, AN1 has higher values, mainly localized in the East Antarctic craton. West Antarctica is much thinner*” in “*the AN1 model*”) and Figure 8d in the manuscript shows that AN1 is compatible with the RF studies. From these comparison, we can just conclude that AN1 is more reliable. It is opposite with that “*CRUST1.0 has a better spatial resolution*”.

Another comparison (“*The latter seems also rougher, with a less precise coast limit. CRUST1.0 has a better spatial resolution.*”) is meaningless. Spatial resolution of a model is controlled by observations, but is not related with roughness of the model. More “*precise coast limit*” in CRUST1.0 indicates that the model around coast areas of Antarctica may be constrained mostly by topography but not seismic observations. The roughness in the model of AN1 around the coast lines is related to its resolution. Figure S3 in Auxiliary material of An et al. (2015) can be taken as resolution-length map of crustal thicknesses of AN1. The figure shows that the resolution length for crustal thicknesses in AN1 is ~120 km in Antarctica. This resolution length is similar to that (77-~200 km) of gravity data used in this manuscript.

(2) The manuscript used the thickness of CRUST1 as constraints to analyze gravity observations. “*In areas where there is a lack of seismic observations crustal thickness is constraint by gravity observations using maps from British Antarctic Survey (Laske private communication)*” (page 5, lines 6-8). In this case, the results for those areas in the manuscript are little significant because the constraints at those areas used in this study of gravity observations are from gravity observations, and their reliability is unknown.

(3) The very-thick crust in central EANT and very-thin crust in WANT may indicate that Antarctica is special. Density may be also special in the areas. Gravity observations may be useful to detect this.

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Technical corrections:

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Line 10: “*another crustal model has been proposed by a Chinese team*” ==> “a regional model on Antarctic crust (AN1) (An et al., 2015) has been proposed”. The AN1 model is one of results of the efforts from international (US, China, France, Japan) collaborations under GAMSEIS and partly under POLENET. The model AN1 is a regional model, but CRUST1.0 is a global model.

Lines 11-12: delete “*but in Antarctica there are very few seismological observations and the Chinese model is poorly constrained*”

Line 15: delete “*CRUST1.0 has a better spatial resolution*”

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Lines 3-5: “*According to previous studies (Block et al., 2009; Ritzwoller et al., 2001), the mean depth in West Antarctica is about 40 km and in East Antarctica is about 30 km. We fix to the mean value, 35 km, as mean depth for the whole continent*” ==> “According to global 1-D model of AK135 (Kennett et al., 1995), we fix to the mean value, 35 km, as mean depth for the whole continent”.

The studies (Ritzwoller et al., 2001; Block et al., 2009) did not use new seismic observation or results. It is not true that “*the mean depth in West Antarctica is about 40 km and in East Antarctica is about 30 km*”. Since only a general mean value (35 km) is used, it is acceptable to cite a global 1-D model of AK135.

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