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Review Article

The Moho depth map of the Antarctica region

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ABSTRACT

Different tectonic units cover the Antarctic territory: platform, orogens and depression structures. This structural variability is reflected both in thickness and physical properties of the crust. We present a new Moho map for the Antarctica, derived from geophysical data selected from the literature. The model covers the whole Antarctic region, from the South Pole out to the continental margin, including the Antarctic Peninsula. The Moho depth is represented with a resolution of 1°×1° on a Cartesian grid obtained by an equidistant azimuthal geographical projection. A large volume of new data has been analyzed: mostly seismic experiments, as well as receiver functions and geological studies. In general, we can identify three large domains within the Antarctic continental crust. The oldest Archean and Proterozoic crust of East Antarctica has a thickness of 36–56 km (with an average of about 41 km). The continental crust of the Transantarctic Mountains, the Antarctic Peninsula and Wilkes Basin has a thickness of 30–40 km (with an average Moho of about 30 km). The youngest rifted continental crust of the West Antarctic Rift System has a thickness of 16–28 km (with an average Moho of about 26 km). The mean Moho depth of the whole model is 33.8 km. The new Moho model exhibits some remarkable disagreements at places with respect to global model CRUST 2.0. Difference between these two models may range up to −10/+24 km. The new model is available for download in digital format. We plan to update the model in the near future by including new data, particularly in the most poorly covered regions.

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1. Introduction

The composition and thickness of the crust are characterized by discontinuities and strong lateral variations. The continental crust, in particular, may be extremely diversified as it represents an assemblage of different terrains bearing the signatures of various tectonic episodes in geological history (e.g., Christensen and Mooney, 1995). Many geophysical disciplines have to cope with the complexity of the Earth's crust. The gravity field of the Earth is very sensitive to it, so for instance to model the density structure of the mantle, strictly related to the deep geodynamic processes, it is necessary to strip the effect of crustal structure from the observed gravity field (e.g., Boschi et al., 2010; Tondi et al., 2012). Also, many seismic phases that are used to image mantle structure through seismic tomography are considerably affected by crustal structure, but do not have enough resolution to invert for it directly — thus requiring reliable descriptions as a priori constraints (e.g., An et al., 2010; Danesi and Morelli, 2000, 2001; Kobayashi and Zhao, 2004; Ritzwoller et al., 2001; Roult et al., 1994). Given such impact on our ability to decipher geodynamic processes — besides having in itself an intrinsic interest insofar it bears accounts of past tectonic episodes — notable efforts are being spent to derive comprehensive images of the crust at different spatial scales. Two widely referenced such world-wide models are CRUST 5.1 (describing seismic wave speed and density in 5°×5° latitude-longitude cells; Mooney et al., 1998) and CRUST 2.0 (with a finer resolution of 2°×2°; Bassin et al., 2000). These models — derived assembling diverse information from the literature — parameterize the crust of the Earth with a gamut of 360 key 1-D profiles that include layers representing ice, water, soft and hard sediments, upper, middle and lower crust. At a continental scale, such coarse representations may not be sufficiently descriptive, and more detailed models have been proposed in more recent years, such as EPcrust for the larger Europe (Molinari and Morelli, 2011) with a resolution of 0.5°×0.5° on a geographical latitude–longitude grid; EuCRUST-07 (Tesauro et al., 2008) for Western Europe; AsCRUST-08 for Asia (Baranov, 2010) with a resolution of 1°×1°. Other models are limited to mapping the thickness of the crust — that, given the very strong discontinuity in material properties between crust and mantle, is the most important single parameter — presenting Moho depth maps, such as ESC-Moho (Grad et al., 2009) covering the European Plate with a resolution of 0.1°×0.1°; the regional Moho model for South America based on seismic data (Lloyd et al., 2010); and others.

Antarctica represents the least-known continent but the little we know points to significant geological peculiarities. It hosts one of the largest extended and stretched continental rifts, active since Gondwana breakup (Faccenna et al., 2008) with an asymmetrical shoulder marked by the Transantarctic Mountain range. After the pioneering study by Evison et al. (1960) who, analyzing surface wave dispersion estimated crustal thickness in East Antarctica and Marie Byrd Land to be respectively around 35 and 25 km, only two, quite dated, continental-scale models of the Antarctic crust have been published by Groushinsky et al. (1992) and Bentley (1991). These authors used several old DSS profiles and gravity data but had to interpolate information across wide data gaps. In their models the Moho depth varies from 50 km for the central parts of East Antarctica to ~25–30 km near the coast. Also, using surface topography and ice thickness measurements from the BEDMAP model (Lythe et al., 2001), gravity studies found an average crustal thickness of ~35–45 km across East Antarctica (Block et al., 2009; Llubes et al., 2003; von Frese et al., 1999).

In this paper, we turn our interest to updating the knowledge of the Moho depth under Antarctica by collecting and merging various data available from different sources — notably seismic reflection, seismic refraction, and teleseismic receiver function studies. Reliability of the diverse sources is assessed and cross-checked, and critically considered during model construction. The synthesis of the model is realized via interpolation of the database collected into an integrated Moho model (ANTMoho) at a uniform grid (1°×1°). We use a

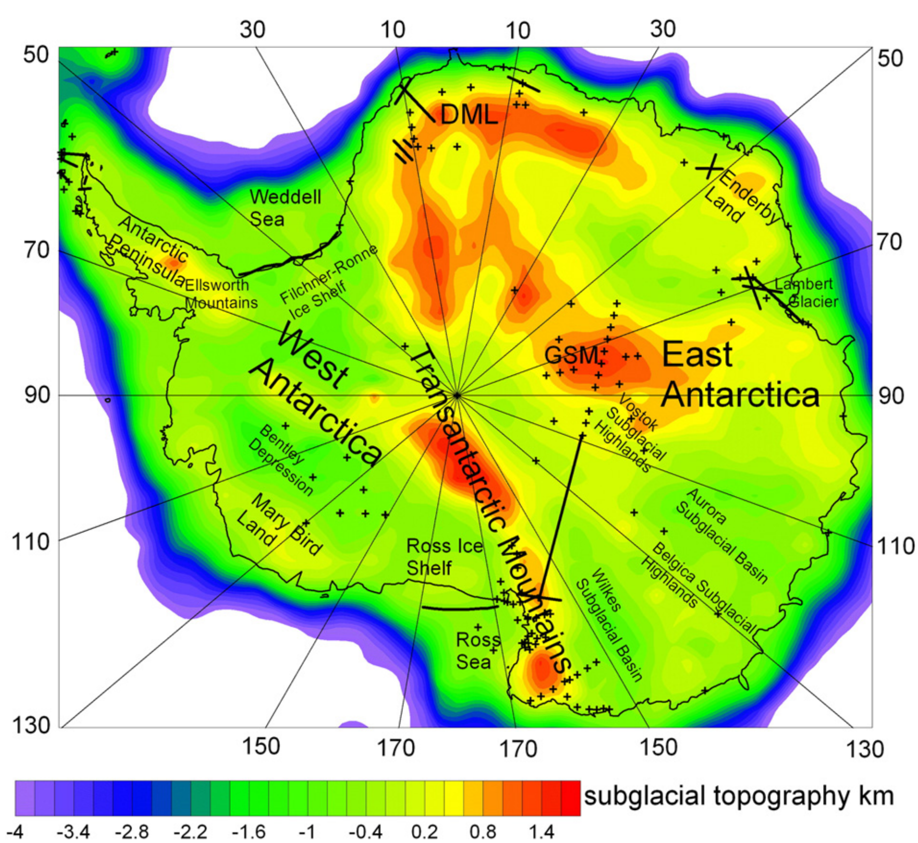

Fig. 1. Common map of Antarctica with subglacial relief (Lythe et al., 2001) covered by seismic data. Black lines show the location of the seismic profiles, black crosses show seismic stations. Abbreviations: DML, Dronning Maud Land; GSM, Gamburtsev Subglacial Mountains.