Reference seismic and thermal models for the crust and uppermost mantle beneath Antarctica from multiple datasets

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Since the last decade of the 20th Century, over 200 broad-band seismic stations have been deployed across the continent of Antarctica (e.g., temporary networks such as TAMSEIS, AGAP/GAMSEIS, POLENET/ANET, TAMNNET and RIS/DRIS by US geoscientists, as well as stations deployed by Japan, Britain, China, Norway, and other countries). In this presentation, we discuss our recent effort that builds a reference crustal and uppermost mantle shear velocity (Vs) model for continental Antarctica based on those seismic arrays. The data analysis for this effort consists of four steps. First, we compute ambient noise cross-correlations between all possible station pairs and use them to construct Rayleigh wave phase and group velocity maps at a continental scale. Coherence of the new maps with maps generated with teleseismic earthquake data from an earlier study (Heeszel et al., 2016) confirms the high quality of both maps, and the minor differences help quantify the map uncertainties. Second, we compute P receiver function waveforms for each station in Antarctica. Third, by combining all seismic measurements from the first two steps with the phase velocity maps by Heeszel et al., (2016) using a non-linear Monte Carlo (MC) inversion algorithm, a 3-D model is obtained for the crust and uppermost mantle beneath the central and western continental Antarctica and its periphery to a depth of ~ 200 km. Fourth and last, using the 3-D seismic model to provide constraints to the crustal structure, we re-invert for the upper mantle structure using the surface wave data within a thermodynamic framework, and construct a 3-D thermal model of the lithosphere of Antarctica. The resulting high resolution seismic/thermal model, that contains uncertainty estimates from the MC inversion, serves as a starting point for further development and geological interpretation. A variety of tectonic features, including a slower/hotter but highly heterogeneous West Antarctica and a much faster/colder East Antarctica, are present in the 3D model. The 3D seismic model, together with the surface heat flow map inferred from the 3-D thermal model, provide a basis for further investigation of the dynamic state of Antarctica's lithosphere and underlying asthenosphere, and provide key constraints on the interaction of the solid earth with the West Antarctic Ice Sheet.

Keywords: surface heat flow, lithosphere, antarctica, seismic tomography, thermodynamic inversion

