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Session02: Structure, evolution, and heterogeneity of Antarctica's continental lithosphere

# Quantitative assessment of Antarctic crustal models using numerical wave simulations

Erica Emry[1 †] , Samantha Hansen[2] , Ashish Kumar[2] , Yang Shen[3]

*[1]New Mexico Tech, USA, [2]The University of Alabama, USA, [3]The University of Rhode Island, USA*

The structure of the Antarctic crust is important to our understanding of processes occurring within the Antarctic cryosphere as well as to the Earth’s response to ice mass loss. With the increase in geophysical studies of Antarctica, crustal structure has become much better defined beneath many regions. Several crustal models have been created from seismic-derived and/or gravity-derived data, and some of these models incorporate sets of crustal receiver functions either as a priori constraints or to validate model results. However, receiver function constraints do not exist throughout large regions of Antarctica due to a lack of seismic coverage; given this, we search for additional metrics by which we can compare and contrast Earth models. One approach that has been utilized for other continents is to forward model accurate synthetic waveforms through existing seismic velocity models to identify which models most accurately reproduce seismic waveform datasets. Such waveform datasets may come from accurately determined seismic events1,2 or from ambient seismic noise3.

In an effort to assess existing Antarctic crustal models using a different metric to identify regions where crustal structure is still most uncertain, we have collected a suite of available seismic- and gravity-derived Antarctic crustal models. In the absence of accurately determined ‘ground-truthed’ seismic events in Antarctica1, we use a frequency-time normalization approach4 to extract Rayleigh waves from ambient seismic noise, with periods of 15-55 seconds that are sensitive to crustal structure. We split the observations into two separate validation datasets. The first dataset includes all station-station cross-correlations, with at least one seismic station in each pair that has not been previously used to constrain prior tomographic inversions (a true validation dataset), and the second dataset includes all available station-station cross-correlations, including those that may have been used to constrain some of the models we are testing. We construct sets of Earth models from the available crustal models underlain by two different upper mantle models. We forward model synthetic waveforms using a finite difference approach5 through each of the Earth models and measure the phase delays between the synthetic waveforms and the ambient seismic noise dataset. Results from our waveform validation study and identification of the poorly characterized regions of Antarctic crust are forthcoming and will be presented.

1 IASPEI Ground Truth (GT) reference events (2019), http://www.isc.ac.uk/gtevents/
2 Bao and Shen (2016), J. Geophys. Res., 121.
3 Gao and Shen (2012), Bull. Seism. Soc. America, 102(6), 2611-2621.
4 Shen et al. (2012), Bull. Seism. Soc. America, 102(4), 1872-1877.
5 Zhang et al. (2012), Geophys. J. Int., 188, 1359-1381.