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A detailed view of the crust and lithospheric mantle beneath eastern Australia from transportable seismic array tomography

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The WOMBAT transportable seismic array project has been ongoing in eastern Australia since 1998, when a 40 station temporary array of recorders was first installed in western Victoria. To date, 16 consecutive array deployments have taken place with a cumulative total of over 700 stations installed in an area spanning Tasmania, New South Wales, southern Queensland and much of South Australia. Station separation varies between 15 km in Tasmania and 50 km on the mainland, with the majority of stations 3-component 1 Hz instruments, although a number of broadband instruments are interspersed. Although best suited to P-wave tomography, the recorded seismic wavefield has also proven to be useful for ambient noise tomography and crustal receiver functions, thus allowing detailed information on both the crust and lithospheric mantle structure to be retrieved.

In order to apply teleseismic tomography using a transportable array of instruments, a robust background model is required which contains the long wavelength features suppressed by the use of relative arrival time residual datasets which are array specific. Here, we use the recently released AuSREM mantle model which is based on regional surface and body wave datasets. Crustal and Moho structure, which is poorly resolved by teleseismic data, is also included (from the AuSREM crustal model) as prior information to minimise smearing of crustal information into the mantle. The final model exhibits a variety of well resolved features, including a low velocity zone associated with Quaternary intraplate volcanism; a pronounced velocity gradient transition zone between the Precambrian shield region of Australia in the west and the Palaeozoic orogens in the east; and the presence of a high velocity salient which extends almost to the east coast in northern New South Wales, which is interpreted to be Precambrian lithosphere.

The ambient noise tomography results, which are now continuous between Tasmania and mainland Australia thanks to a new dataset collected from a temporary broadband array of stations that surrounded Bass Strait, were generated using a Bayesian transdimensional inversion scheme. This is applied to obtain both the 2-D period dependent velocity maps and the 1-D shear wave models which are then combined to form a 3-D model of the region. Despite requiring 4-5 orders of magnitude more computing power to invert the data compared to conventional linearised techniques, the transdimensional scheme is worth the cost as it produces demonstrably better results. Crustal features such as sedimentary basins in Bass Strait, the Curnamona Craton along the eastern edge of the Gondwana margin, and the Torrens Hinge Zone which separates the Archean Gawlor Craton from younger Proterozoic and Palaeozoic lithosphere to the east are revealed in high detail. Although only separated by the Moho, similarities between the crustal model obtained by ambient noise tomography and the mantle model obtained by teleseismic tomography are not common, with the exception of the Curnamona craton (negative S-wave anomaly in the crust, positive P-wave anomaly in the upper mantle) and the transition from Precambrian to Palaeozoic lithosphere.