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Towards 3D Multiscale Adjoint Waveform Tomography of the Lithosphere and Underlying Mantle beneath Southeast Asia

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Southeast Asia is one of the most complex tectonic regions on Earth. This is mainly a result of its location within the triple junction of the Australian, Eurasian and Philippine Sea plates which has created a complicated configuration of active plate tectonic boundaries. Adjoint waveform tomography is especially suitable for imaging such complex regions. By simulating the 3D wavefield, it is possible to directly compare observed and simulated seismograms, thereby taking into account both body and surface waves. The method can account for the effects of anisotropy, anelasticity, wavefront healing, interference and (de)focusing that can hamper other seismological methods.

To date, sparse instrument coverage in the region has contributed to a heterogeneous path coverage. In this project, we make use of publicly available data as well as our recently deployed networks of broadband seismometers on Borneo and Sulawesi. This, in addition to access to national permanent networks, provides data from over 300 stations which promises a significant improvement in data coverage around the Banda Arc, Borneo and Sulawesi. We employ a geographical weighting scheme to minimise the effect of dense regional arrays and compile a catalogue of 118 well-constrained earthquakes, optimising for coverage, signal-to-noise ratio and data availability. An optimised window selection algorithm allows us to balance amplitude differences and include as much signal as possible while avoiding noisy data.

Here, we present a seismic waveform tomography for upper mantle structure in Southeast Asia, imaging radially anisotropic S velocity, P velocity and density. We use a gradient-based optimisation scheme (L-BFGS) and adjoint methods to obtain sensitivity kernels as the corresponding gradients. In the first part of the inversion, periods down to 50 s are used to update a 1D initial model, adapting a multi-scale approach in which long periods are inverted for first to avoid cycle skipping. In our long-period results, we observe a strong regional low S-velocity structure with an underlying high-velocity anomaly. The results are consistent with the global *S40RTS* model.