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SS3DPacific: Structure of the Pacific uppermost mantle with 3D resolution and uncertainty

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Surface features in oceanic basins, such as mid-oceanic ridges, hotspots, seafloor subsidence, and fracture zones, result from geodynamic processes in the uppermost mantle. Insight into these processes are obtained from tomographic imaging using surface waves. However, the poor distribution of earthquakes and seismic stations, as well as noise in seismic data, give rise to spatial resolution artefacts and errors in tomography models, complicating their interpretation.

We constructed SS3DPacific, a model of the vertically-polarised shear-wave velocity structure of the Pacific uppermost mantle and surrounding regions. The model derives from Rayleigh-wave phase delays, that we measured along with an estimation of their uncertainty. SS3DPacific is accompanied by 3D resolution and uncertainty. To obtain this information, we combined the SOLA inverse method to control and produce resolution and uncertainty with finite-frequency theory for Rayleigh waves, leading to a 3D model.

In this talk, I will present SS3DPacific, its 3D resolution, and uncertainty. The model shows well-known large-scale features such as cratons, ridges, and the increase of seismic velocity with distance from mid-oceanic ridges. Detailed analysis of the 3D resolution reveals strong spatial artefacts, particularly vertically, which manifest themselves in the form of structural depth leakages. This effect, expected for this type of surface-wave tomography, will ultimately bias the analysis of the lithosphere cooling process if not accounted for. Additionally, SS3DPacific shows an intriguing pattern of bands of velocity variations aligned with fracture zones.

Given the availability of 3D resolution and uncertainty quantification, SS3DPacific can be utilised in studies aimed to assess mantle circulation models, and thus dynamic processes in the Earth.