Radial anisotropy in the upper mantle using multi-mode surface waves incorporating the η_κ parameter: Application to the Pacific and Australian regions

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Radial anisotropy can be described by five elastic parameters; four parameters related to seismic wave speeds (β_v, β_h, α_h, α_v) and an additional fifth anisotropic parameter (η). One of the anisotropic parameters, η, was originally defined by Anderson (1961), but its physical proprieties have been rather unclear compared with other four parameters related to elastic velocity.

The re-defined fifth anisotropic parameter η_κ by Kawakatsu et al. (2015) makes it easier to understand its physical proprieties compared with conventional η. The introduction of η_κ affects the shape of sensitivity kernels of Rayleigh wave phase speeds with respect to η_κ, PH-wave speeds α_h and PV-wave speeds α_v (Kawakatsu, 2016b). Since the sensitivity of Rayleigh wave phase speeds to η_κ becomes greater than that to η, we can expect a possibility of resolving the η_κ parameter. However, since the inverse correlation between the sensitivity kernels of SV-wave speed β_v and η_κ becomes rather stronger, the trade-off between β_v and may easily occur. Therefore, the independent determination of η_κ parameter from the inversions of surface-wave dispersion curves is not a straightforward issue.

In this study, incorporating η_κ, we performed inversions for five elastic parameters in the upper mantle, employing a classical iterativenonlinear least-squares inversion method (Tarantola and Valette, 1982). We used multi-mode dispersion data sets of surface waves in the Australian region (Yoshizawa, 2014, PEPI) and Pacific (Isse et al., 2019, EPSL) to reconstruct 3-D radially anisotropic model. In these inversions, we used isotropic PREM as a starting model to avoid the influence of reference anisotropy model.

The retrieved spatial distribution of the η_κ parameter can be mostly explained by trade-offs with SV wave speed β_v at many locations in Australia and Pacific. Still, we can find structural features in our 3-D β_v and η_κ models, particularly in some major structural boundaries such as ridges and the Tasman Line in eastern Australia, which cannot simply be attributed to the trade-off between β_v and η_κ, indicating possible intrinsic character of η_κ in the upper mantle.

Keywords: radial anisotropy, surface waves, inversion

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