

# Radial anisotropy in the upper mantle using multi-mode surface waves incorporating the $\eta_\kappa$ 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 ( $\beta_v$ ,  $\beta_h$ ,  $\alpha_h$ ,  $\alpha_v$ ) and an additional fifth anisotropic parameter ( $\eta$ ). One of the anisotropic parameters,  $\eta$ , 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  $\eta_\kappa$  by Kawakatsu et al. (2015) makes it easier to understand its physical proprieties compared with conventional  $\eta$ . The introduction of  $\eta_\kappa$  affects the shape of sensitivity kernels of Rayleigh wave phase speeds with respect to  $\eta_\kappa$ , PH-wave speeds  $\alpha_h$  and PV-wave speeds  $\alpha_v$  (Kawakatsu, 2016b). Since the sensitivity of Rayleigh wave phase speeds to  $\eta_\kappa$  becomes greater than that to  $\eta$ , we can expect a possibility of resolving the  $\eta_\kappa$  parameter. However, since the inverse correlation between the sensitivity kernels of SV-wave speed  $\beta_v$  and  $\eta_\kappa$  becomes rather stronger, the trade-off between  $\beta_v$  and  $\eta_\kappa$  may easily occur. Therefore, the independent determination of  $\eta_\kappa$  parameter from the inversions of surface-wave dispersion curves is not a straightforward issue.

In this study, incorporating  $\eta_\kappa$ , 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  $\eta_\kappa$  parameter can be mostly explained by trade-offs with SV wave speed  $\beta_v$  at many locations in Australia and Pacific. Still, we can find structural features in our 3-D  $\beta_v$  and  $\eta_\kappa$  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  $\beta_v$  and  $\eta_\kappa$ , indicating possible intrinsic character of  $\eta_\kappa$  in the upper mantle.

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