Inversions for radially anisotropic upper mantle structure with the new fifth anisotropic parameter η_κ using multi-mode surface waves

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Seismic anisotropy estimated from surface waves provides us with fundamental information to unravel dynamics and structure of the Earth's mantle. Radial anisotropy is 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 (1968), but its physical proprieties have been rather unclear compared with other four parameters related to elastic velocity.

A newly proposed definition of the fifth anisotropic parameter η_κ by Kawakatsu et al. (2015) makes it easier to understand its physical proprieties compared with the conventional parameter η. The introduction of η_κ causes non-negligible influence on shape of sensitivity kernels of Rayleigh wave phase speeds with respect to η_κ, and PH-wave speeds α_h and PV-wave speeds α_v (Kawakatsu, 2016b). Since the sensitivity kernel for η_κ becomes higher than that for η, we may have a possibility of resolving η_κ. 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 η_κ may easily occur, which makes it difficult to interpret the resultant model.

In this study, by incorporating η_κ with several combinations of *a priori* parameters, we performed inversions for five elastic parameters in the upper mantle, based on an iterative nonlinear least-squares inversion method (Tarantola and Valette, 1982). We employed multi-mode dispersion data sets of surface waves in the Australian region to construct a preliminary 3-D anisotropic model. Regional variations of η_κ can be observed between Coral/Tasman seas and Australian continent . Beneath the continent, a positive anomaly of η_κ at asthenospheric depth was observed, which is located deeper than that beneath the oceanic region. In this preliminary model, the depth where η_κ is close to 1.0 seems to coincide well with the lithosphere-asthenosphere boundary. Care needs to be taken, however, for the interpretation of the η_κ model, since it can readily be affected by SV wave speed β_v due to the strong trade off, which should be examined in more detail.

