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Apparent S-wave Splitting Parameters under Various Two-Layer Models

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Having a robust knowledge of seismic anisotropy at varying depths significantly contributes to our understanding of past and present geo-dynamic events (e.g. subduction zone dynamics, convecting mantle processes etc.) in relation to the evolution of tectonic settings. There have been several methods used to quantify seismic anisotropy. Shear waves splitting measurements are well-established way for determining the direction and strength of seismic anisotropy. In the present study, for various two-layer anisotropy cases, we tested patterns of directional dependency of apparent S-wave splitting parameters using mathematical expressions defined by Silver and Long (2011).

The main purposes of this study are to investigate i) under what two-layer model conditions station averaged time delays of splitting parameters converge to minimum, ii) the role of anisotropic layer thickness and iii) the effect of circular and non-circular event variation on station averaged splitting parameters.

Theoretically estimated curves for apparent splitting parameters under various two-layer cases implied the minimum averaged delay times when anisotropic directions in two equally thick layers are established to be orthogonal to each other. This indicated the cancellation effect of orthogonally oriented horizontal symmetry axes. Diverging from the orthogonality case leads to higher time delay averages. In cases where significantly different layer thicknesses (around 150%) and orthogonally oriented horizontal symmetry axes exist, our calculations indicate a constant distribution of apparent S-wave splitting parameters with the behavior of a single-layer anisotropy with thick layer properties.

We also simulated that station averaged S-wave fast polarization directions inferred from limited number of individual theoretical splitting parameters (with an error range of <30°) deviate considerably (reaching up to 50°) compared to those average values obtained from circularly distributed events. Our tests eventually suggest that the error in the individual splitting observations, azimuthal distribution as well as the number of measurements can have a big impact on station averaged values that are used for making geodynamic interpretations in the literature.