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An automated method for depth-dependent crustal anisotropy detection with receiver function

Andrea Licciardi and Nicola Piana Agostinetti
DIAS, Dublin Institute for Advanced Studies, Geophysics, Dublin, Ireland (alicciardi@cp.dias.ie)

Crustal seismic anisotropy can be generated by a variety of geological factors (e.g. alignment of minerals/cracks, presence of fluids etc...). In the case of transversely isotropic media approximation, information about strength and orientation of the anisotropic symmetry axis (including dip) can be extracted from the analysis of P-to-S conversions by means of teleseismic receiver functions (RF). Classically this has been achieved through probabilistic inversion encoding a forward solver for anisotropic media. This approach strongly relies on apriori choices regarding Earth's crust parameterization and velocity structure, requires an extensive knowledge of the RF method and involves time consuming trial and error steps. We present an automated method for reducing the non-uniqueness in this kind of inversions and for retrieving depth-dependent seismic anisotropy parameters in the crust with a resolution of some hundreds of meters. The method involves a multi-frequency approach (for better absolute Vs determination) and the decomposition of the RF data-set in its azimuthal harmonics (to separate the effects of isotropic and anisotropic component). A first inversion of the isotropic component (Zero-order harmonics) by means of a Reversible jump Markov Chain Monte Carlo (RjMCMC) provides the posterior probability distribution for the position of the velocity jumps at depth, from which information on the number of layers and the S-wave velocity structure below a broadband seismic station can be extracted. This information together with that encoded in the first order harmonic is jointly used in an automated way to: (1) determine the number of anisotropic layers and their approximate position at depth, and (2) narrow the search boundaries for layer thickness and S-wave velocity. Finaly, an inversion is carried out with a Neighbourhood Algorithm (NA), where the free parameters are represented by the anisotropic structure beneath the seismic station. We tested the method against synthetic RF with correlated Gaussian noise to investigate the resolution power for multiple and thin (1-5 km) anisotropic layers in the crust. The algorithm correctly retrieves the true models for the number and the position of the anisotropic layers, their strength and orientation of the anisotropic symmetry axis, although the trend direction is better constrained than the dip angle. The method is then applied to a real data-set and the results compared with previous RF studies.