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Empirical investigation into vertical and horizontal resolution of the Receiver Function methodology

Nicola Piana Agostinetti
Dublin Institute for Avanced Studies, Geophysics Section, Ireland (piana@cp.dias.ie)

Receiver Function (RF) methodology has been widely used to retrieve the 1D S-wave velocity structure beneath isolated broadband seismic stations. Vertical and lateral resolution is usually roughly determined through theoretical assumptions about the frequency content of teleseismic waves, the ray-parameter and the Fresnel radius. Vertical resolution in the order of some kilometers is generally considered for the crustal and upper-mantle structures, and a lateral resolution as large as half the depth of the retrieved interfaces is a widely adopted criterium. However, focusing on the shallow crust (0-5 km depth), a more accurate determination of the resolving power of the RF is needed, e.g. to compare results from RF analysis with geological profiles or borehole lithostratigraphies. While such theoretical assumptions should still hold in the shallow crust, given the right scaling for (possibly higher) frequency content and the shallower depth of the seismic velocity contrasts, an empirical investigation of the resolving power of the RF methodology is still lacking.

In this study, RF spatial resolution (both vertical and horizontal) is investigated using teleseismic waveforms recorded by a temporary, very-dense seismic network. The seismic network is composed 41 seismic stations along a 10km-long profile. Each single RF data-set a inverted using a Bayesian approach and the posterior probability distribution of the S-wave velocity at depth is reconstructed. From such information, posterior mean Vs model and posterior probability for the depth of seismic interfaces can be easily extracted to depict a continuous Vs model along the profile, together with a 2D sketch of the main seismic discontinuities in the shallow crust. Station spacing of about 250 meters allows to investigate directly the lateral resolution of the RF methodology at different depth-level, comparing both RF data-set and retrieved 1D Vs profiles for near-by stations. Moreover, a classical seismic imaging techniques, e.g. common conversion point, is also applied along the profile, to compare the results obtained by single-station investigation with seismic structures reconstructed using a multi-station approach.