Improvements in the extended-time multi-taper receiver function estimation technique

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Receiver functions (RFs) are calculated by deconvolving the vertical component of the P coda from teleseismic events from the corresponding radial component in order to get rid of source time functions. Not only the direct P waves but also Ps converted waves generated at S wave velocity discontinuities beneath stations are left in the obtained RFs. Since travel time differences between the Ps converted waves and the direct P waves are related to the depths of the discontinuities and the amplitudes of the Ps waves are related to the velocity jumps, we can estimate S wave velocity structure beneath the stations by analyzing the RFs.

We often used a water level technique in order to carry out stable spectral divisions in the frequency domain in the deconvolutions in calculating RFs. In this technique we intend to stabilize the divisions by replacing very small values of the vertical component power spectra in the denominators with a constant water level. This water level should be carefully determined according to the shapes of the power spectra. However, we frequently use a rather large value for all the vertical power spectra when we calculate a large number of RFs. As a result many of the RFs are distorted more than required from the stabilization.

In order to overcome the above problem Park and Levin (2000) applied a multi-taper technique in which waveform data are Fourier transformed with prolate tapers. This procedure prevents the spectra from having very small values due to spectral leakage. Moreover, it stabilizes the spectral division by adding the pre-event noise power spectra to the vertical power spectra in the denominator. However, this technique has a disadvantage that it is difficult to calculate RFs with a long time window because the prolate tapers suppress the amplitude in more than 2/3 of a whole time window.

In this study we improved the extended-time multi-taper RF estimation devised by Helffrich (2005) so that we can calculate RFs with an any time length by applying some sets of prolate tapers shifting with 75 % window overlap and adding the obtained spectra with the corresponding phase lag. We used three eigentapers whose eigenvalues are close to one among 50 s long 4pi-prolate tapers. In this case the half width of leakage free frequency bands is 0.08 Hz. This guarantees frequency resolutions for RFs which contain periods up to several seconds. We will present details of this technique and also report on some RF estimations in comparison with other techniques.