Source stacking followed by cross-correlation: the first application to real long period data for full-waveform inversion at the global scale

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Source stacking was proposed (Capdeville et al., 2005) to reduce the cost of numerical wavefield simulations in global mantle tomography. However high-amplitude fundamental mode surface waves dominate the summed waveform, which impedes the contribution of the overtone energy in full-waveform inversion. By cross-correlating the summed waveforms between station pairs, the contribution of overtones and body waves can be boosted (Romanowicz et al., 2019). The quality of reconstructed Green’s function is less important since we can apply the same processing to the 3D synthetics and observations, also we’ve had good knowledge of the source location and its mechanism. This approach also allows us to perform synthetic tests in a numerically efficient way, such as, for example, to investigate spatial and depth resolution and trade-offs between various physical parameters in full-waveform tomography, or accounting for the non-linear character of the inversion, which is not feasible with conventional approaches. Here we present synthetic tests based on a realistic synthetic dataset derived from SEMUCB-WM1 (French and Romanowicz, 2015), which includes a 3D crustal model and mantle structure. We computed a 3-component long-period (> 60s) waveform dataset for globally distributed 273 events and 515 stations using the Spectral Element Method. The experiments enable us to evaluate the capability of resolving the shear wave velocity and its anisotropic structure in the upper mantle. We have also collected a large dataset of real data at the global scale, for a time interval that includes first and second orbit surface waves. Regarding the existence of missing data in the real situation which might demolish the resolving power, subsets of summed waveforms are computed for replacing the missing data; also, cluster analysis can help to group the data so as to minimize the number of missing waveforms in each group. We then compare the resulting long-wavelength global 3D radially anisotropic shear velocity model to other existing models constructed by using conventional approaches.