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Beyond the limits of moment tensor inversion using stacked full waveforms: the Bárðarbunga caldera collapse (Iceland) case

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Regional and teleseismic full waveform moment tensor inversion are nowadays routinely performed to derive moment tensors for moderate to large earthquakes. The extension of moment tensor inversion to weak events and microseismicity is limited by low amplitude of seismic signals and noise contamination. Noise contaminated low frequency seismic signals are hardly usable, while high frequency seismic signals are difficult to model at larger distances, because they are affected by unresolved small scale velocity anomalies and the strong physical attenuation of amplitudes at high frequencies. Waveform matching and signal classification methods help to reveal similar rupture processes and increase the event detection rate. We discuss here a novel inversion approach, which combines waveform clustering method, waveform stacking procedures and full waveform moment tensor inversion to resolve moment tensors beyond the current lower magnitude treshold. The method applies to similar events, with similar locations and focal mechanisms, and provides a single moment tensor for a cluster of similar events. This condition is met upon the waveform correlation analysis at a reference station at close epicentral distance, which helps to recognise similar events, estimate interevent times and relative magnitudes. Through the stack of similar waveforms, we enhance the signal-to-noise ratio of full waveform signals, and are able to perform moment tensor inversion at larger distances and/or at lower frequencies. The performance of a low frequency full waveform moment tensor inversion on stacked, similar waveforms provides a stable moment tensor for the cluster of similar events. The resulting cumulative scalar moment can be used to infer the scalar moment of single events, taking advantage of the scaling of similar waveforms at the reference local station. We demonstrate the method using both synthetic and real data from the 2014/2015 collapse of the Bárðarbunga caldera, Iceland.