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High-frequency source imaging of the 2016 April 16 Kumamoto (Japan) earthquake by backprojection of strong motion waveforms

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The seismic source spatio-temporal evolution of the Mw 7.0 event on 16 April 2016 in Kumamoto (Japan) is imaged by backprojection of strong motion waveforms. Normalized high frequency (2-8∼Hz) S-waveforms from recordings on stations of the K-NET and KiK-net networks are used to scan a predefined 3D source volume over time.
Backprojection methods provide the alternative novel approach to image the spatiotemporal earthquake rupture. This is achieved by stacking the seismic waveforms along predicted traveltimes for the corresponding seismic phase and source–receiver paths. The method is now widely used in large and damaging earthquakes at teleseismic distances. At local distances and higher frequencies, the method was applied to the 2004 Parkfield earthquake by Allmann & Shearer (2007), the 2011 Van earthquake by Evangelidis & Kao (2013) and the 2014 Northern Aegean earthquake by Evangelidis (2014). They used S-wave arrivals recorded at strong motion stations to backproject into a 3-D grid by stacking waveforms shifted in time to focus on the known hypocentre.
Here, the advantages and limitation of the method are explored using waveform data from a well recorded event at local distances (70 borehole KiK and 152 K-NET strong motion stations within 200 km radius from the epicenter). The recordings are forced to focus at the hypocenter by applying the appropriate station corrections. This is done without any a-priori constraints on the geometry, dimension and size of the source. Any well resolved high frequency asperity should be also imaged by synthetic tests. In this way, the spatio-temporal resolution for each particular event would be revealed based on the available local station distribution, indicating if the event has ruptured on different fault segments and the nature and speed of the rupture propagation.

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