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Minimising the computational time of a waveform based location algorithm

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Accurate and fast localisation of microseismic events is a requirement for a number of applications, e.g. mining, enhanced geothermal systems. New methods for event localisation have been proposed over the last decades. The waveform-based methods are of the most recent developed ones and their main advantage is the ability to locate weak seismic events. Despite this, these methods are demanding in terms of computational time, making real-time seismic event localisation very difficult. In this work, we further develop a waveform-based method, the Multichannel coherency migration method (MCM), to improve the computational time. The computational time for the MCM algorithm has been reported to linearly depend on several parameters, such as the number of stations, the length of the waveform time window, the computer architecture, and the volume of the area we are searching for the hypocentre. To minimise the computational time we need to decrease one or more of the above parameters without compromising the accuracy of the result. We break the localisation procedure into several steps: (1) we locate the event with a relatively large spatial grid interval which will give less potential hypocentral locations and less calculations as a result. (2) Based on the results of step (1) and the locations of maximum coherencies we decrease the grid volume to a quarter of the original volume and the spatial interval to half the original, focusing only around the area identified in step (1). Step (2) is repeated several times for decreased grid volumes and spatial intervals until the hypocentral location does not significantly change any more. We tested this approach on both synthetic and real data. We find that while the accuracy of the hypocentre is not compromised, the computational time is up to 125,000 times shorter.