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Composite moment tensor – A tool for studying multiple earthquakes

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The composite moment tensor is defined in analogy to the composite focal mechanism as the averaged representative seismic moment tensor characteristic for a focal area under study. In contrast to the composite focal mechanism which provides information on shear faulting, the composite moment tensor can provide additional information on non-shear rupture mode and on physical conditions along the fault. The composite moment tensor is calculated by a joint inversion of multiple earthquakes which are associated with the same fault system and display a similar focal mechanism. The method utilizes amplitudes of P and/or S waves or full waveforms. Since the inversion is linear, it is fast and applicable to datasets of many earthquakes. The method is particularly suitable for the analysis of microseismicity, earthquake swarms or aftershock sequences, where observations of multiple earthquakes are available. The composite moment tensor can be retrieved even when the station configuration or data quality prevent from inverting for full moment tensors of individual earthquakes.

The composite moment tensor inversion is illustrated on a dataset of 111 microearthquakes that occurred during the 2008 earthquake swarm in West Bohemia, Czech Republic. First, the moment tensors are calculated using the standard moment tensor inversion of P-wave amplitudes measured at vertical records of the West Bohemia seismic network (WEBNET) stations. The minimum number of local seismic stations used in the inversion is 18. The moment tensors are predominantly double couples and have similar focal mechanisms. The non-double-couple parts are mostly less than 30% and consist of negative ISO and CLVD components. The composite moment tensor inversion is run for amplitudes measured at 4, 6, 8 and 10 stations. The results show that the inversion is robust and the composite moment tensor fits well the accurate moment tensors of individual earthquakes.