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A multi-station matched filter and coherent network processing approach to the automatic detection and relative location of seismic events

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Correlation detectors facilitate seismic monitoring in the near vicinity of previously observed events at far lower detection thresholds than are possible using the methods applied in most existing processing pipelines. The use of seismic arrays has been demonstrated to be highly beneficial in pressing down the detection threshold, due to superior noise suppression, and also in eliminating vast numbers of false alarms by performing array processing on the multi-channel output of the correlation detectors. This last property means that it is highly desirable to run continuous detectors for sites of repeating seismic events on a single-array basis for many arrays across a global network. Spurious detections for a given signal template on a single array can however still occur when an unrelated wavefront crosses the array from a very similar direction to that of the master event wavefront. We present an algorithm which scans automatically the output from multiple stations – both array and 3-component – for coherence between the individual station correlator outputs that is consistent with a disturbance in the vicinity of the master event. The procedure results in a categorical rejection of an event hypothesis in the absence of support from stations other than the one generating the trigger and provides a fully automatic relative event location estimate when patterns in the correlation detector outputs are found to be consistent with a common event. This coherence-based approach removes the need to make explicit measurements of the time-differences for single stations and this eliminates a potential source of error. The method is demonstrated for the North Korea nuclear test site and the relative event location estimates obtained for the 2006, 2009, and 2013 events are compared with previous estimates from different station configurations.