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Seismic event locations by tri-partite array analysis and high resolution waveform cross-correlation

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We developed an algorithm for inversion of tri-partite array data. The algorithm allows to obtain reliable back-azimuth and apparent velocity from seismic records of very low magnitude events even in bad signal-to-noise conditions. The analysis starts with a cubic-spline interpolation of the waveforms and the determination of the differences between the arrival times of pairs of the array elements. The time differences are directly computed from the cross-correlation function of the respective seismograms. The advantages of this technique are: (a) it is not necessary to manually pick up the exact arrival time at each array element; (b) the interpolation allows to detect time differences with a resolution higher than the sampling rate of the digital waveforms; (c) the consistency among the three determinations obtainable choosing one of the elements as reference allows to check the reliability of the results; (d) the value of the apparent velocity provides a way to guess the nature of the recorded wavelet and a physical check of the results. The algorithms have been developed on a Matlab platform. They have been tested on data collected by a tri-partite array (with an aperture of about 250m) deployed in 1998 by the National Data Center of Israel, during an experiment installation, in Southern Israel 20 km southwest of the Dead Sea. The data included shallow explosions and natural earthquakes in both good and bad signal-to-noise conditions. The procedure developed in this study is considered suitable for a potential use in the search of small aftershocks subsequent to an underground explosion in the context of an eventual on site inspection according to the Comprehensive Nuclear-Test Ban Treaty.