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Approaches to Array and Network Processing for Enhanced Nuclear Explosion Monitoring

Single and multiple seismic array stations can provide an exquisitely sensitive monitoring capability for nuclear test sites which exceeds significantly that for general seismicity using standard algorithms. We here outline some methods for enhanced seismic monitoring employed at NORSAR. A detection on a single array with parameters consistent with a signal anticipated from a given site can initiate an Alert, followed by an automatic search in specific time-windows for corresponding detections at other global stations. For sites with available waveform templates from previous events, pattern detectors can identify similar signals even at low SNR; correlation detectors recognize wavetrain repetition on single or multi-channel datastreams and matched field detectors recognize the wavefront-specific phase and amplitude relationships between sensors of an array. Both are effective on arrays where scattering and incoherence preclude classical array processing. Spectrogram beamforming may be applied to larger arrays to detect and classify incoherent signals. Site Specific Threshold Monitoring uses data from a network of arrays to produce a continuous "threshold trace" indicating the upper bound of the magnitude of a seismic event which could have occurred at that site at any given time. The above methods are demonstrated for monitoring of the North Korea nuclear test site.

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