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# Optimizing master event templates for CTBT monitoring with dimensionality reduction techniques: real waveforms vs. synthetics.

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The Master Event technique is a powerful tool for Expert Technical Analysis within the CTBT framework as well as for real-time monitoring with the waveform cross-correlation (CC) (match filter) approach. The primary goal of CTBT monitoring is detection and location of nuclear explosions. Therefore, the cross-correlation monitoring should be focused on finding such events. The use of physically adequate waveform templates may significantly increase the number of valid, both natural and manmade, events in the Reviewed Event Bulletin (REB) of the International Data Centre. Inadequate templates for master events may increase the number of CTBT irrelevant events in REB and reduce the sensitivity of the CC technique to valid events. In order to cover the entire earth, including vast aseismic territories, with the CC based nuclear test monitoring we conducted a thorough research and defined the most appropriate real and synthetic master events representing underground explosion sources. A procedure was developed on optimizing the master event template simulation and narrowing the classes of CC templates used in detection and location process based on principal and independent component analysis (PCA and ICA). Actual waveforms and metadata from the DTRA Verification Database were used to validate our approach. The detection and location results based on real and synthetic master events were compared. The prototype of CC-based Global Grid monitoring system developed in IDC during last year was populated with different hybrid waveform templates (synthetics, synthetics components, and real components) and its performance was assessed with the world seismicity data flow, including the DPRK-2013 event. The specific features revealed in this study for the P-waves from the DPRK underground nuclear explosions (UNEs) can reduce the global detection threshold of seismic monitoring under the CTBT by 0.5 units of magnitude. This corresponds to the reduction in the test yield by a factor of 3 for any location and depth. Considering the history of seismic monitoring of UNEs this is a radical improvement which can be enhanced by a more effective use of IMS array stations.