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Seismicity of the North Atlantic as measured by the International Data Centre using waveform cross correlation

Ivan Kitov, Dmitry Bobrov, and Mikhail Rozhkov
CTBTO, IDC, Vienna, Austria (ivan.kitov@ctbto.org)

The Technical Secretariat (TS) of the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO) will carry out the verification of the CTBT which obligates each State Party not to carry out nuclear explosions. The International Data Centre (IDC) receives, collects, processes, analyses, reports on and archives data from the International Monitoring System. The IDC is responsible for automatic and interactive processing of the International Monitoring System (IMS) data and for standard IDC products. The IDC is also required by the Treaty to progressively enhance its technical capabilities. In this study, we use waveform cross correlation as a technique to improve the detection capability and reliability of the seismic part of the IMS. In order to quantitatively estimate the gain obtained by cross correlation on the current sensitivity of automatic and interactive processing we compared seismic bulletins built for the North Atlantic (NA), which is a seismically isolated region with earthquakes concentrating around the Mid-Atlantic Ridge. This allows avoiding the spill-over of mislocated events between adjacent seismic regions and biases in the final bulletins: the Reviewed Event Bulletin (REB) issued by the IDC and the cross correlation Standard Event List (XSEL). To begin with, we cross correlated waveforms recorded at 18 IMS array stations from $\sim$1500 events reported in the REB between 2009 and 2011. The resulting cross correlation matrix revealed the best candidates for master events. We have selected 60 master events evenly distributed over the seismically active zone in the NA. High-quality signals (SNR>5.0) recorded by 10 most sensitive array stations were used as waveform templates. These templates are used for a continuous calculation of cross correlation coefficients in the first half of 2012. All detections obtained by cross-correlation are then used to build events according to the current IDC definition: at least three primary stations with accurate arrival times, azimuth and slowness estimates. The qualified event hypotheses populated the XSEL. In order to confirm the XSEL events not found in the REB, a portion of the newly built events was reviewed interactively by experienced analysts. The influence of all defining parameters (cross correlation coefficient threshold and SNR, fk-analysis, azimuth and slowness estimates, relative magnitude, etc.) on the final XSEL has been studied using the relevant frequency distributions for all detections vs. only for those which were associated with the XSEL events. These distributions are also station and master dependent. This allows estimating the thresholds for all defining parameters, which may be adjusted to balance the rate of missed events and false alarms.