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Detection capability of the IMS seismic network based on ambient seismic noise measurements

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All nuclear explosions - on the Earth's surface, underground, underwater or in the atmosphere - are banned by the Comprehensive Nuclear-Test-Ban Treaty (CTBT). As part of this treaty, a verification regime was put into place to detect, locate and characterize nuclear explosion testings at any time, by anyone and everywhere on the Earth. The International Monitoring System (IMS) plays a key role in the verification regime of the CTBT. Out of the different monitoring techniques used in the IMS, the seismic waveform approach is the most effective technology for monitoring nuclear underground testing and to identify and characterize potential nuclear events.

This study introduces a method of seismic threshold monitoring to assess an upper magnitude limit of a potential seismic event in a certain given geographical region. The method is based on ambient seismic background noise measurements at the individual IMS seismic stations as well as on global distance correction terms for body wave magnitudes, which are calculated using the seismic reflectivity method.

From our investigations we conclude that a global detection threshold of around mb 4.0 can be achieved using only stations from the primary seismic network, a clear latitudinal dependence for the detection threshold can be observed between northern and southern hemisphere. Including the seismic stations being part of the auxiliary seismic IMS network results in a slight improvement of global detection capability. However, including wave arrivals from distances greater than 120 degrees, mainly PKP-wave arrivals, leads to a significant improvement in average global detection capability. In special this leads to an improvement of the detection threshold on the southern hemisphere. We further investigate the dependence of the detection capability on spatial (latitude and longitude) and temporal (time) parameters, as well as on parameters such as source type and percentage of operational IMS stations.