Transfer Functions and Seismic Discrimination: a KNET Case Study

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The basic challenge of nuclear test monitoring lies in quantitatively identifying earthquakes from explosions. At regional distances (<1500 km from the source), small-yield explosions are generally best detected from natural seismicity. However, regional seismograms can show both great complexity due to the crust-mantle waveguide and great variability for different source-station paths (Figure 1 illustrates an explosion detonated at Lop Nor recorded at the KNET network, which is approximately 1000 km away). To effectively develop regional discriminants at any given station requires a ground-truth database consisting of waveforms from both earthquakes and explosions. Newly-installed stations lack such a database, which severely affects confidence in successfully discriminating between different types of events. To address this problem, we have developed a procedure to predict a discriminant at a newly installed seismic station using the actual discriminant at a long operating station and a transfer function for that specific station pair.

The dataset consists of six explosions and nine earthquakes at or within 100 km of the Lop Nor Chinese nuclear test site (Figure 2) and recorded at the ten-station, very broadband KNET network in Kyrgyzstan. The KNET network is supported by IRIS; data were obtained from the IRIS DMC. We have predicted four discriminants (two phase ratio and two cross spectral ratio) using transfer functions for all possible station combinations. Initial results show good correlation (for three of four discriminants) between the discriminant predicted with a transfer function and the actual discriminant recorded at each station (Figure 3). We also investigated what role interstation distance plays in the success of the prediction; F-statistics suggest that interstation distance does not affect the prediction, implying that historical stations need not be in close proximity. However, placing bounds on this parameter will be important when applying the technique to other regions.

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