Data Analysis for Global Security

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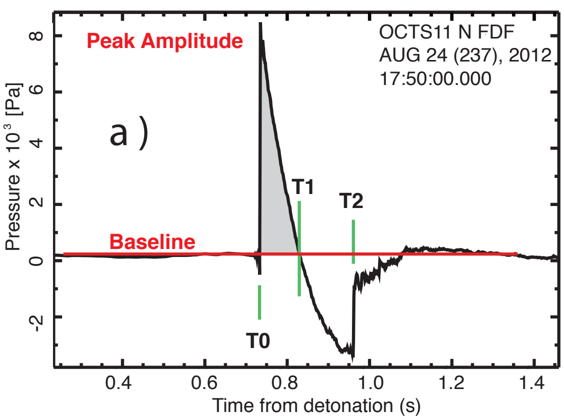
The LANL Seismoacoustics Team combines expertise in data analysis in general with in-depth expertise in geophysical waveform (e.g., seismic, acoustic/infrasound, and electromagnetic) manipulation and analysis. Our data analysis capabilities focus on the source characterization of explosive events, which includes seismic and acoustic analysis for yield estimation, phase detection and identification, array analysis, noise characterization, and data quality control.

Parameter extraction:

Analysis of raw seismic and acoustic waveforms provides information to constrain source characteristics, such as source size and type, location, emplacement.

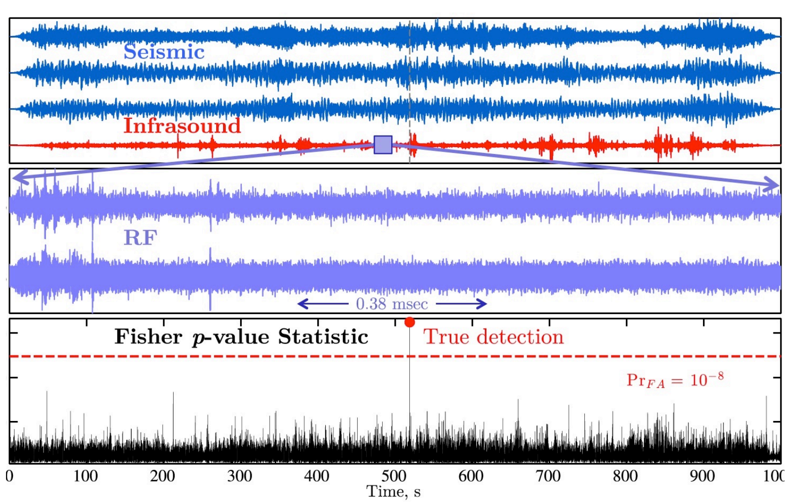


Seismic and acoustic waveforms from explosive events, e.g., nuclear and chemical explosions, are the event's fingerprints that can be collected remotely. Identifying and extracting waveform features is the first step for constraining source characteristics. Blast waves (pressure discontinuities that travel in the air faster than speed of sound) are recorded in the local field of explosions. The precise measurement of arrival time (T0), time of zero crossing (T1), and arrival of the secondary shock (T2) are features that can be extracted and used to estimate yield using complementary waveform features.

Merging different phenomenologies:

Combining information extracted from different technologies following an event improves source characterization and event detection. The Seismoacoustics Team has developed rigorous statistical techniques that allow merging of inferences from complementary waveform technologies.

Seismic signals propagate in a very heterogonous but static medium (solid Earth), while acoustic/infrasonic signals propagate in a more homogenous but highly dynamic medium (atmosphere). Features extracted from different streams can be combined to improve source characterization, detection, and localization. Combining the probability of detections from algorithms applied to seismic, acoustic, and RF waveforms results in a combined Fisher p-value with improved performance.



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Recent Publications

Arrowsmith, S., **G. Euler, O. Marcillo, P. Blom**, R. Whitaker, G. Randall (2015), Development of a robust and automated infrasound event catalogue using the International Monitoring System, *Geophys. J. Int*., 200, 1411-1422, doi:10.1093/gji/ggu486.

Carmichael, J., R. Nemzek, S. Arrowsmith, K. Sentz (2016), Fusing geophysical signatures of locally recorded surface explosions to improve blast detection, *Geophys. J. Int*., 204, 1838-1842, doi:10.1093/gji/ggw006.

Carmichael, J. (2016), A waveform detector that targets template-decorrelated signals and achieves its predicted performance, Part I: Demonstration with IMS data, *Bull. Seismol. Soc. Am*., 106, 1998-2012, doi:10.1785/0120160047.

Cleveland, K. M., C. J. Ammon (2015), Precise relative earthquake magnitudes from cross correlation, *Bull. Seismol. Soc. Am*., 105, 1792-1796, doi:10.1785/0120140329.

Marcillo, O., S. Arrowsmith, **P. Blom**, K. Jones (2015). On infrasound generated by wind farms and its propagation in low-altitude tropospheric waveguides, *J. Geophys. Res.: Atmospheres*, 120, 9855-9868, doi:10.1002/2014JD022821.

Marcillo, O., S. Arrowsmith, R. Whitaker, E. Morton, **W. S. Phillips** (2014). Extracting changes in air temperature using acoustic coda phase delays, *J. Acoust. Soc. Am.*, 136, EL309-EL314, 10.1121/1.4896404.

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