# Analysis Tools and Software for Global Security

## Seismoacoustics Team, EES-17

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The LANL Seismoacoustics Team has developed a set of software tools to do routine and special analyses, as well as core data management, access, and visualization. These tools and libraries support large-scale data processing, array analysis, seismic particle motion analysis, and many other applications. Several open-source codes can be found online at https://lanl-seismoacoustics.github.io/.

Signal isolation, filtering, and detection:

The Seismoacoustics Team has a number of tools to isolate/filter signals, which can be used in detection or in characterization of target or non-target/ background signals in data. For example, some research applications deal with time-varying signals, and they benefit from time-frequency analysis in addition to traditional time-series or spectral approaches. The Stockwell Transform is a multi-scale time-frequency data transform that can be used to isolate transient signals that are restricted in time and frequency. The PyStockwell library is written in Python, with core processing implemented in C for speed.
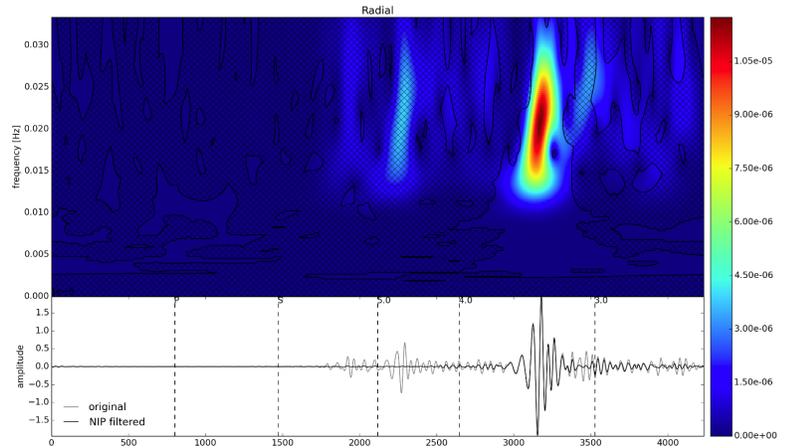
A seismogram from a distant earthquake, filtered to extract elliptically polarized Rayleigh waves, using the time-frequency Stockwell Transform.
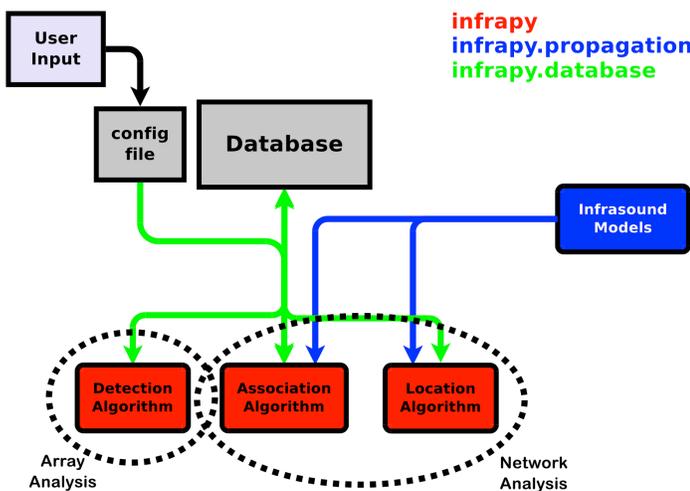
Seismo-acoustic processing pipeline architecture underlying the InfraPy project.

Large-scale data processing:

When datasets grow beyond desktop-scale, different processing strategies are needed. InfraPy is a tool for processing infrasound and seismic array data that implements a database-centric approach for analysis. The pipeline includes analysis at station and network levels (using beam-forming and clustering techniques, respectively) for the detection, association, and location of events. The pipeline relies on the interaction of the algorithms with a relational database structure to organize and store waveform data, the parameters for the analysis, and results of both levels of analysis. Our implementation can interact seamlessly with traditional (e.g., Oracle) and serverless (e.g., SQLite) relational databases.

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Recent Publications and Software Releases

Blom, P. (2015), GeoAc: Infrasonic ray tracing, https://github.com/LANL-Seismoacoustics/GeoAc.

MacCarthy, J. (2016), PyGeoTess: Python interface to the GeoTess gridding and earth model library, LA-CC-16-055, https://lanl-seismoacoustics.github.io/PyGeoTess/.

MacCarthy, J. (2016), Pisces, v. 0.2, LA-CC-15-103, https://jkmacc-lanl.github.io/pisces/.

MacCarthy, J. (2016), PySAC: Python interface to the Seismic Analysis Code format, LA-CC-15-106, https://lanl-seismoacoustics.github.io/pysac/.

MacCarthy, J., C. Rowe (2014), Pisces: A Practical Seismological Database Library in Python, *Seismol. Res. Lett.*, 81, 905-911, doi:10.1785/0220140013.