Spectral Analysis for Earthquake Source (SAES) Parameters

1.Description

SAES code is intended to perform a spectral analysis to calculate earthquake source parameters, i.e. corner frequencies, f_c, and long-period spectral amplitude, Ω_0 , which can be used to calcualte seismic moment, M_w, stress drop, $\Delta\sigma$, and source dimension, r in subsequent analysis. Through the input control file, the code allows the user to specify the following:

1. desired source model (e.g., Brune's model, Boatwright model)
2. choice of single spectrum fitting and/or spectral ratio fitting
3. stations and events blacklisting or whitelisting
4. signal-to-noise (SNR) threshold
5. instrument response removal
6. free-surface effect correction

Computation can be performed in parallel by setting numworkers larger than 1 in the control file.

2.Installtion

```
cd $SAES_DIR
python setup.py install
```

3.Usage

```
from saes.saes_core import saes_core
saes_obj=saes_core('path/to/your/control.file')
```

4. Input

catalog.dat
It includes the list of events to be analyzed in *Pyrocko* format. Alternatatively, the users can provide event list in a 11-column table, as specified in /input/events.dat , and the code will conver it into catalog.dat

cclist.dat
In case of spectral ratio analysis, the cross-correlation file should be stored as in /input/cclist.dat .

control.file
This file contains parameters that control the computations. See the example in /input/control.file and comments therein.

pre_filt.dat *[OPTIONAL]*
This file is used to specify the bandpass corners for instrument response correction in the code.

stations.xml
This file should contain the station location and instrument response information in *FDSN XML* format. It is required for instrument response correction and for calculating epicentral and hypocentral distances.See the example in /input/stations.xml .

tt_pyrocko.dat and **tt.dat**

The files should contain the phase arrival picks in **snuffler** format (tt_pyrocko.dat) or in a 4-column table (tt.dat). See examples in /input/ .

5. Output

The code will create a folder that contains solution results (.dat file) as well as waveform fit figures (.pdf files) for each event. The examples in /ouput include solutions for two events: 201307112016 (for single spectrum and spectral ratio analysis) and 201307112058 (for single spectrum analysis).

6. Citation

To cite the software and manual, use:

- Onwuemeka, J., Liu, Y. and Harrington, R.M., 2018. Earthquake stress drop in the Charlevoix Seismic Zone, eastern Canada. *Geophysical Research Letters*, *45*(22), pp.12-226.
- Zhang, H., Eaton, D.W., Li, G., Liu, Y. and Harrington, R.M., 2016. Discriminating induced seismicity from natural earthquakes using moment tensors and source spectra. *Journal of Geophysical Research: Solid Earth*, *121*(2), pp.972-993.

7. References

Pyrocko is an open-source seismic analysis toolbox, and **snuffler** is a seismic wave visualization tool in **Pyrocko**.

Heimann, Sebastian; Kriegerowski, Marius; Isken, Marius; Cesca, Simone; Daout, Simon; Grigoli, Francesco; Juretzek, Carina; Megies, Tobias; Nooshiri, Nima; Steinberg, Andreas; Sudhaus, Henriette; Vasyura-Bathke, Hannes; Willey, Timothy; Dahm, Torsten (2017): Pyrocko - An open-source seismology toolbox and library. V. 0.3. GFZ Data Services. https://doi.org/10.5880/GFZ.2.1.2017.001