
SEG 2014 Post Convention Workshop

~ Latest developments in time-frequency analysis ~

Organized by:

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Outline of the time-frequency workshop

- Time frequency analysis:
 - A cornerstone in geophysical signal processing and interpretation.
 - Why are we going to the T-F domain?
- Challenge:
 - Normal T-F transforms limited by the Heisenberg - Gabor uncertainty principle => either good time or frequency resolution
 - True for most common transforms: STFT, CWT, S-trans. etc
- Motivation:
 - The last 10-15 years have seen the development of many new high-resolution decompositions \neq Fourier and Wavelet Transforms.

The “workhorses” of spectral analysis

Outline of the time-frequency workshop

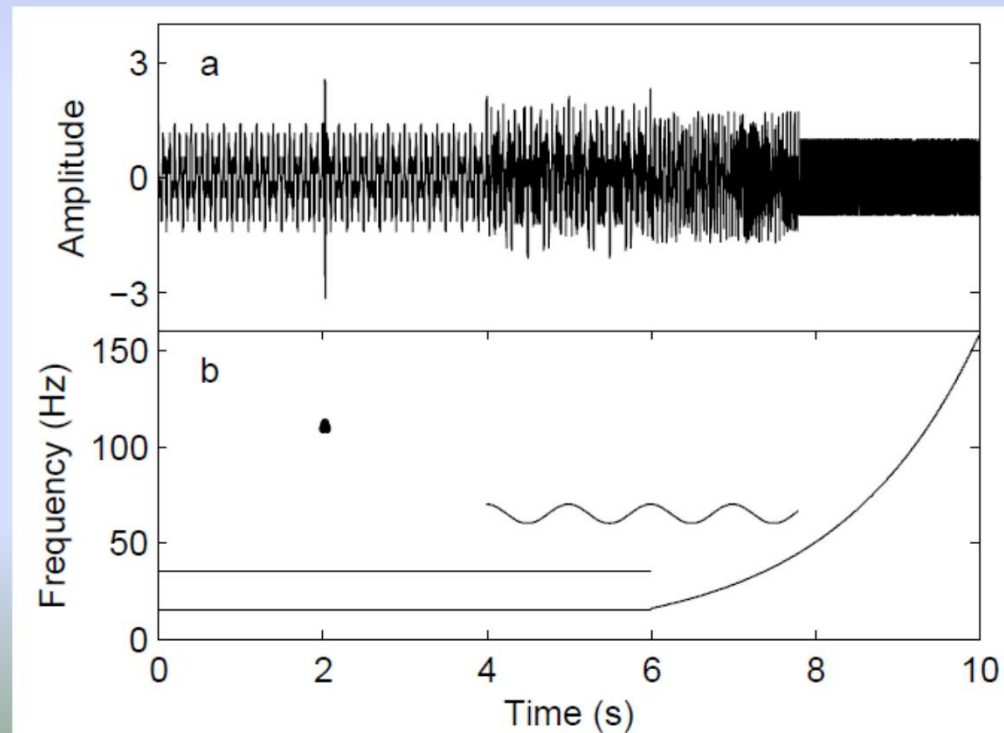
- Techniques and benchmark signals:
 - Fair comparison of methods and signals using the 5 benchmark signals provided, especially regarding resolution, adaptability and parameterization.

Benchmark signals

1. A Toy Example – Synthetic signal.
2. A laughing voice.
3. A volcano tectonic event – Gliding tremor. (Redoubt Volcano on March 31, 2009; Hotovec et al. 2013)
4. A microseismic event. (Rolla Hydraulic Frac. 2011)
5. A global earthquake signal (Tohoku 2011, Mw9)

Benchmark signals

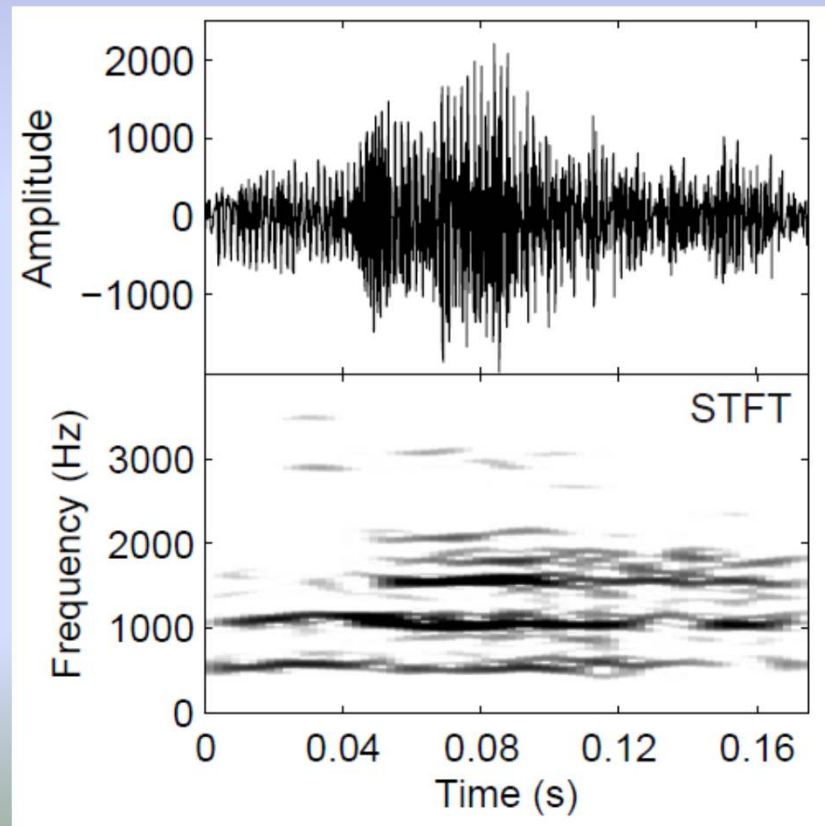
- Toy example – synthetic signal
 - Two spectral lines at 15 and 35 Hz, one frequency modulated line at 65 Hz, one gliding line between 15 and 155 Hz, and one Morlet atom at 113 Hz.
 - Numbers of samples: 8192
 - Sampling frequency: 800 Hz



File:
synthetic.txt

Benchmark signals

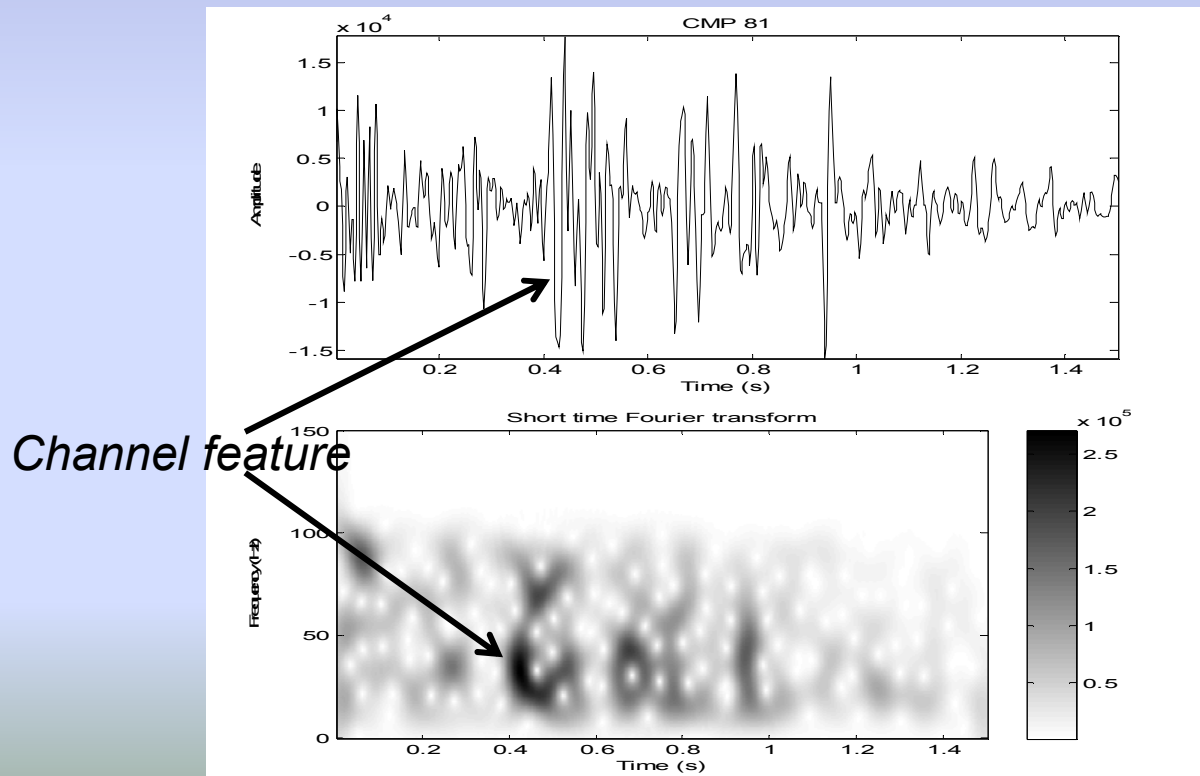
- Speech example – laughing voice
 - Numbers of samples: 1400
 - Sampling frequency: 8000 Hz



File:
speech.txt

Benchmark signals

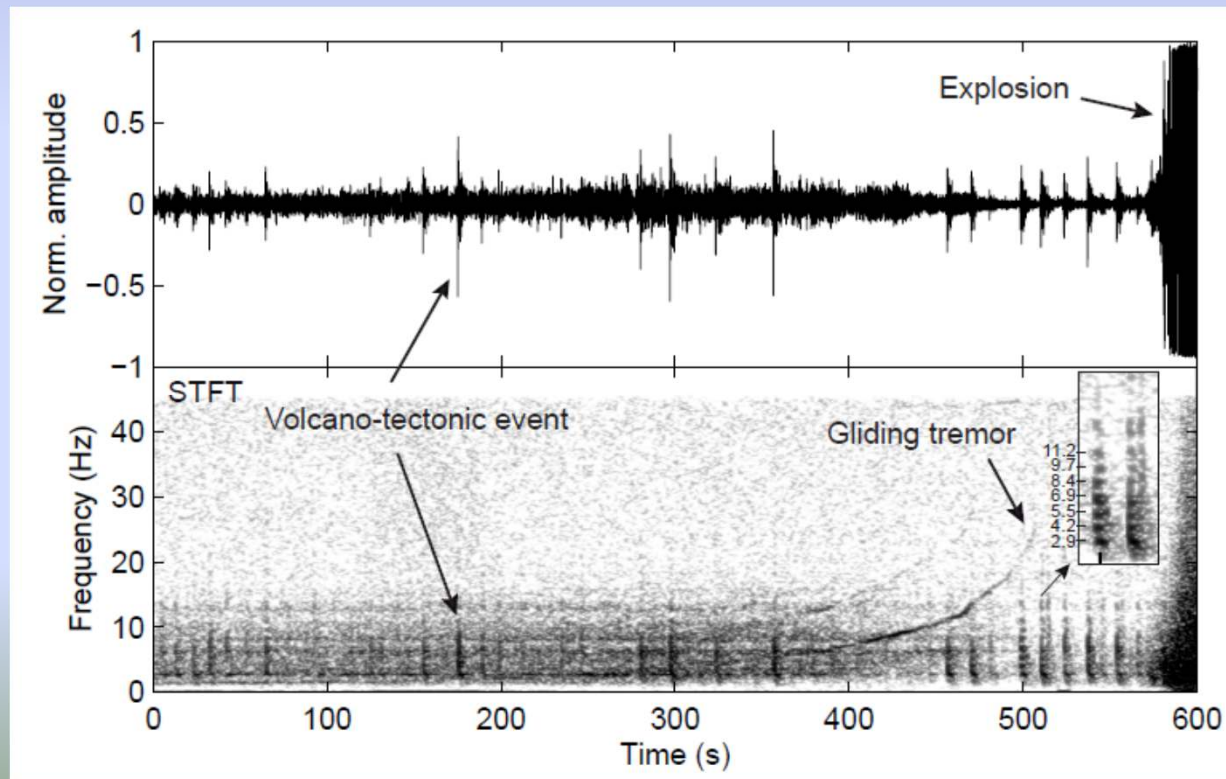
- Geophysical example – Seismic trace
 - Seismic trace containing a channel
 - Numbers of samples: 751
 - Sampling frequency: 500 Hz



File:
seismic_trace.txt

Benchmark signals

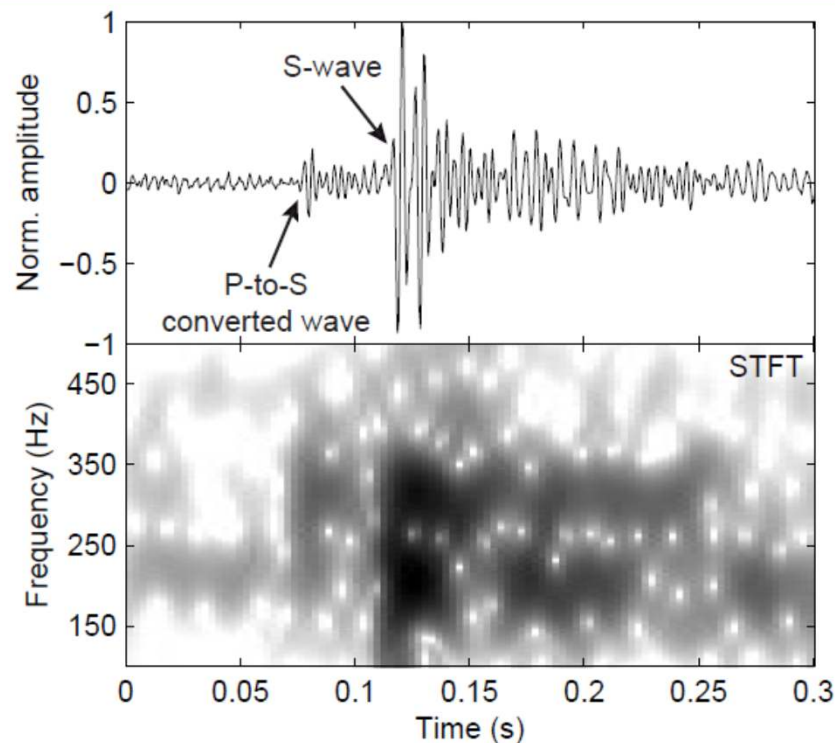
- Geophysical example – Volcanic signal
 - Numerous volcano-tectonic events, and two gliding tremors
 - Numbers of samples: 60001
 - Sampling frequency: 100 Hz



*File:
tremor.txt*

Benchmark signals

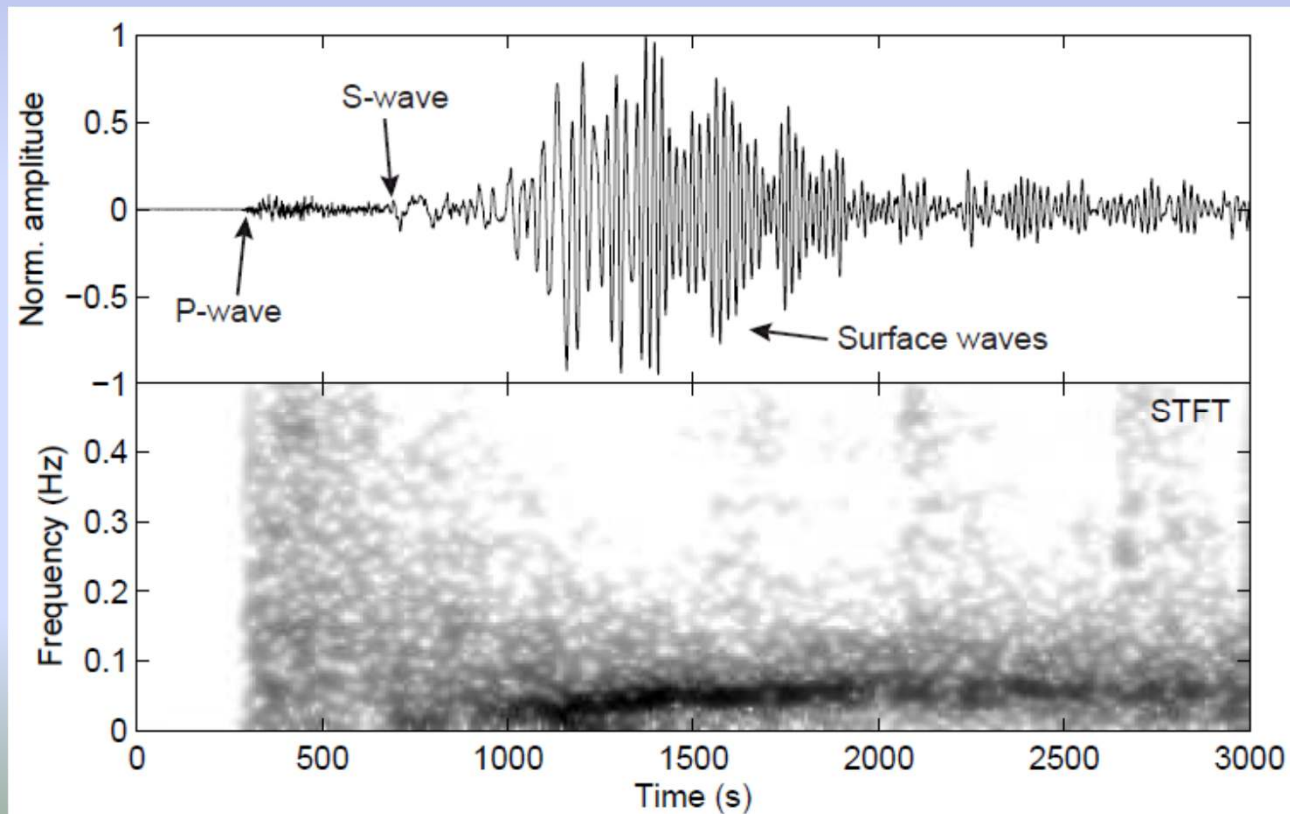
- Geophysical example – Microseismic signal
 - Three main frequency components corresponding to two different wave arrivals
 - Numbers of samples: 601
 - Sampling frequency: 2000 Hz



File:
microseismic.txt

Benchmark signals

- Geophysical example – Tohoku mega-earthquake
 - Numbers of samples: 60000
 - Sampling frequency: 20 Hz



*File:
tohoku.txt*

Outline of the time-frequency workshop

- Main methods presented by the organizers

Methods

1. Short-time Fourier Transform (STFT)
2. Continuous Wavelet Transform (CWT)
3. Stockwell Transform (ST)
4. Matching Pursuit (MP)
5. **Synchrosqueezing Transform (SST)**
6. **Short-time Autoregressive (ST-AR)**
7. **Kalman Smoother (KS)**
8. **Empirical mode decomposition (EMD)**

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For any information regarding this workshop, please contact one of the organizers:

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