Studying the Earth with ambient seismic noise

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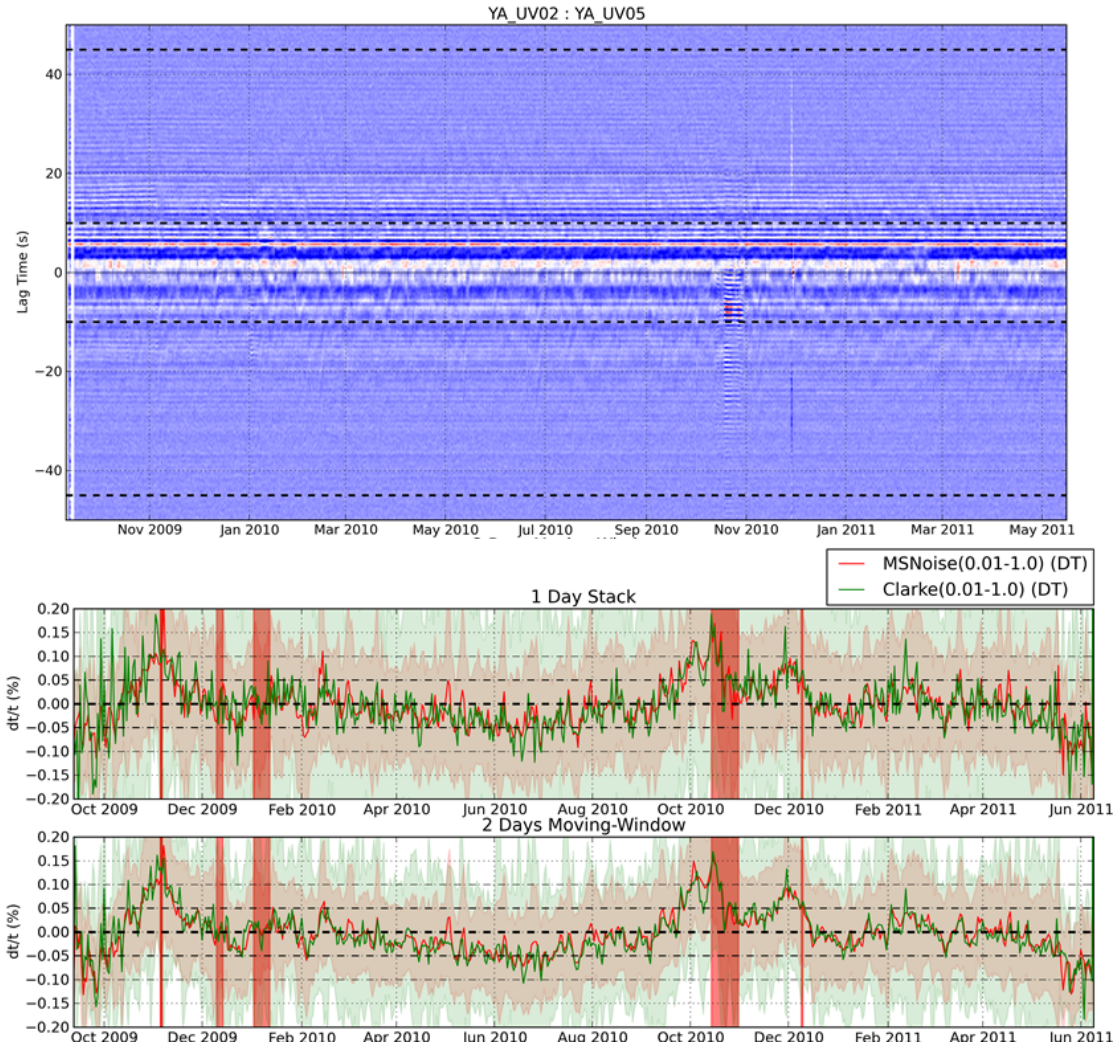
Earthquakes occur every day all around the world and are recorded by thousands of seismic stations. In between earthquakes, stations are recording "noise". In the last 10 years, the understanding of this noise and its potential usage have been increasing rapidly. The method, called "seismic interferometry", uses the principle that seismic waves travel between two recorders and are multiple-scattered in the medium. By cross-correlating the two records, one gets an information on the medium below/between the stations. The cross-correlation function (CCF) is a proxy to the Green Function of the medium. Recent developments of the technique have shown those CCF can be used to image the earth at depth (3D seismic tomography) or study the medium changes with time.

We present **MSNoise**, a complete software suite to compute relative seismic velocity changes under a seismic network, using ambient seismic noise. The whole is written in Python, from the monitoring of data archives, to the production of high quality figures. All steps have been optimized to only compute the necessary steps and to use 'job'-based processing. We present a validation of the software on a dataset acquired during the UnderVolc[1] project on the Piton de la Fournaise Volcano, La Réunion Island, France, for which precursory relative changes of seismic velocity are visible for three eruptions between 2009 and 2011.

[1]The data used for the analysis were collected by the Institut de Physique du Globe de Paris, Observatoire Volcanologique du Piton de la Fournaise (IPGP/OVPF), and the Institut des Sciences de la Terre (ISTerre) within the framework of ANR_08_RISK_011/UnderVolc project. The sensors are property of the French transportable seismic network, Sismob (INSU-CNRS).


YA_UV02 : YA_UV05
Lag Time (s)
40
20
0
−20
−40
Nov 2009
Jan 2010
Mar 2010
May 2010
Jul 2010
Sep 2010
Nov 2010
Jan 2011
Mar 2011
May 2011
MSNoise(0.01-1.0) (DT)
Clarke(0.01-1.0) (DT)
1 Day Stack
dt/t (%)
0.20
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.20
Oct 2009
Dec 2009
Feb 2010
Apr 2010
Jun 2010
Aug 2010
Oct 2010
Dec 2010
Feb 2011
Apr 2011
Jun 2011
2 Days Moving-Window