Increasing the temporal resolution of ambient seismic noise monitoring

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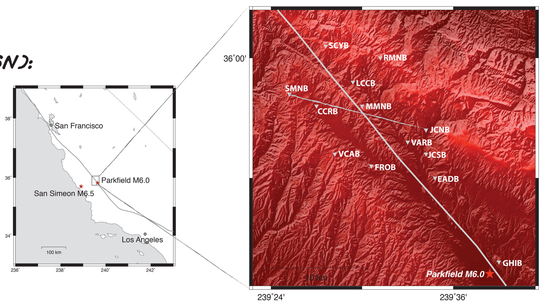
Data Used :

Parkfield High-Resolution Seismic Network (HRSN):

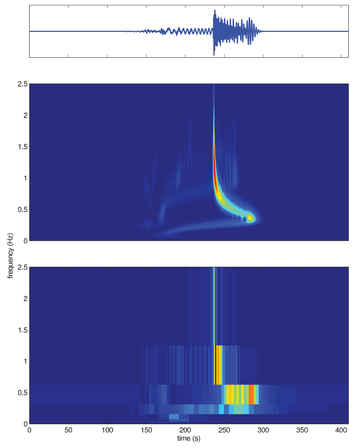
13 stations - 78 station pairs
whitening : [0.1 0.9] Hz
daily xcorrs : 2001 to 2007
reference GF : stack of 6 years

REF: F. Brenguier et al. : Postseismic Relaxation Along the San Andreas Fault at Parkfield from Continuous Seismological Observations Science 321 (2008)

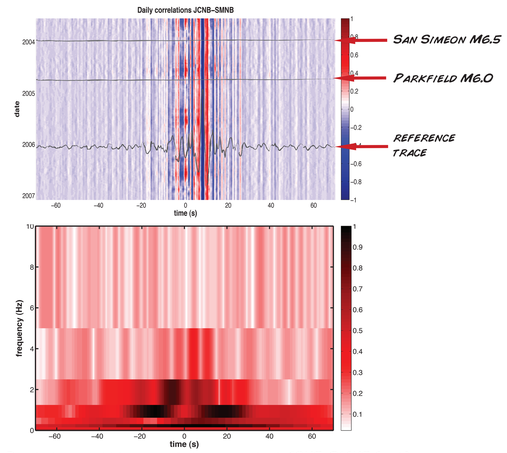


Adaptive Filter :

simultaneous resolution time & frequency
favors coherent parts of signal
maintains phase information



Example of a synthetic seismogram (top) with the absolute vallie of its S-Transform (middle) and the coefficients of the DOST basis vectors



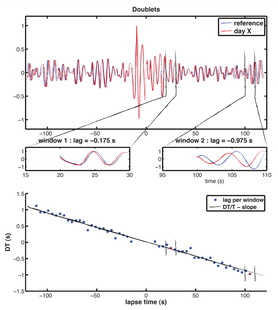
Daily cross correlations for station pair JCNB-SMNB (top) with its DOST basis vector coefficients (bottom)

REF : AM Baig, M Campillo, F Brenguier - Denoising seismic noise cross correlations - J. Geophys. Res. 114 (2009)

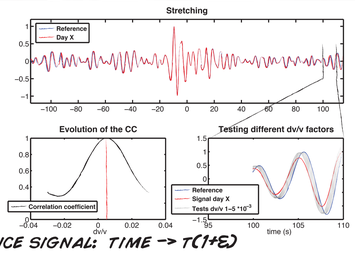
Retrieve Temporal velocity variations : 2 methods

Doublets :

Divide signal in windov
Calculate lag (ΔT)
for each window
Plot lag vs timescale
Fit slope through measurements
ΔT/T = -Δv/v



Stretching :

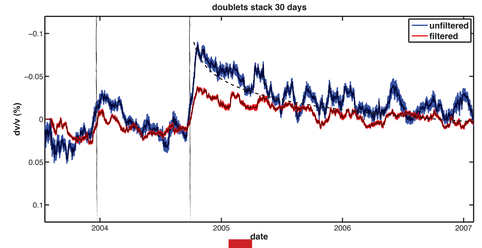


Stretch reference signal: time -> t(1+ε)
Compare to day signal: correlation coefficient (CC)
ε at maximum CC corresponds to Δv/v
CC leads to rms(Δv/v) estimate

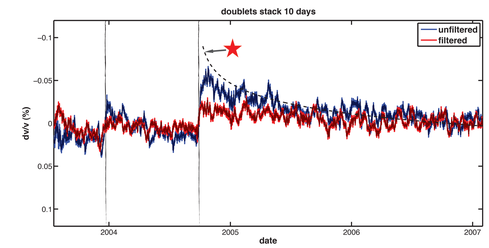
Retrieve Temporal velocity variations : 2 methods

Doublets

Stack 30 days :

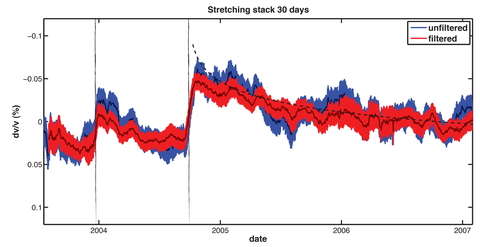


Stack 10 days :

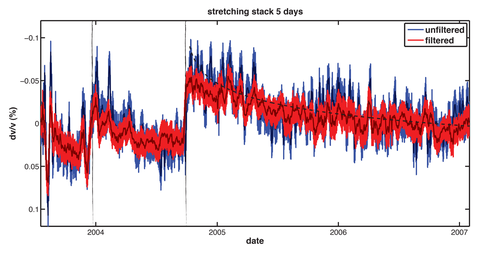


Stretching

Stack 30 days :



Stack 5 days :



DOUBLETS :

ADVANTAGES:
possible detection of inhomogeneous Δv/v
in practice: impose straight regression
can detect instrumental time errors
flexible & selective

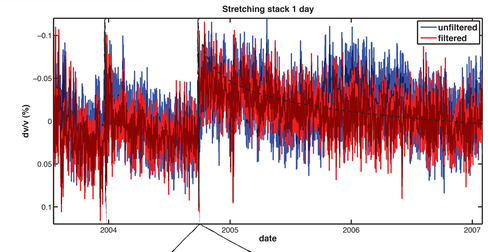
DISADVANTAGES:
more unstable when records noisy
need long stacks (at least 10 days)
'clipped' by adaptive filter

STRETCHING :

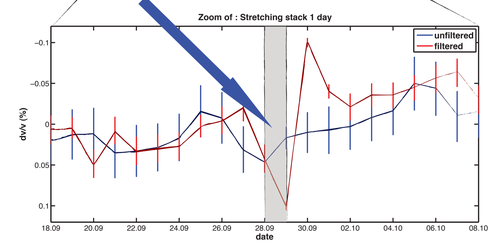
ADVANTAGES:
uses whole coda - more stable wrt noise
extra information CC leads to rms estimate*

DISADVANTAGES:
sensitive to instrumental errors
assumes homogeneous velocity change
slow

Stack 1 day :



Change = coseismic!



References :

* R Weaver, C Hadziioannou, E F Larose - On the precision of noise-correlation interferometry

★ Fault-Parallel displacement measured At 'Pomm. More information: http://quake.usgs.gov/research/deformation/twocolor/pkf_continuous_gps.html

✪ Comparison stability of Doublets and Stretching: C. Hadziioannou et al. - J. Acoust. Soc. Am. 125(6), (2009)