Ambient noise correlation study at the CaMI Field Research Station, Newell County, Alberta, Canada

Marie Macquet* and Donald C. Lawton
marie.macquet@ucalgary.ca

Summary

We use 14 days of continuous seismic data recorded on 98 3C geophones in October 2017 (3D patch, 10m receivers spacing) to study the potential of ambient noise correlation using daily correlations.

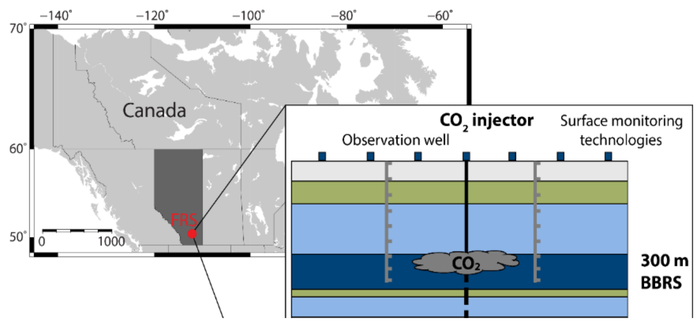
We compute the group velocity dispersion curves for a few pairs of stations. A detailed analysis will be undertaken to determine why some periods show outlier values, but the group velocities obtained are similar to those found in literature.

Daily correlations show a stable waveform for the baseline dataset with a good correlation coefficient between the reference and the daily correlations. Variations in the elastic parameters of the subsurface due to CO_2 injection will directly affect the reconstructed Green's function, and passive recording should allow us to detect the induced change of the medium.

CaMI Field Research Station

Aim : Simulate CO_2 leakage from deep storage by injecting of a small amount of CO_2 (<400/tonnes per year) at shallow depth (300m) to:

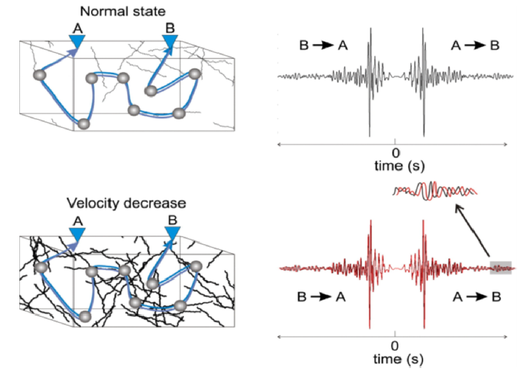
- Determine CO_2 detection thresholds at shallow to intermediate depths.
- Develop and assess technologies for continuous reservoir, cap rock, overburden, and groundwater monitoring.



Location and schematic of the CaMI Field Research Station near Brooks, AB (Canada). BBRS: Basal Belly River Sandstones.

Ambient Noise Correlation

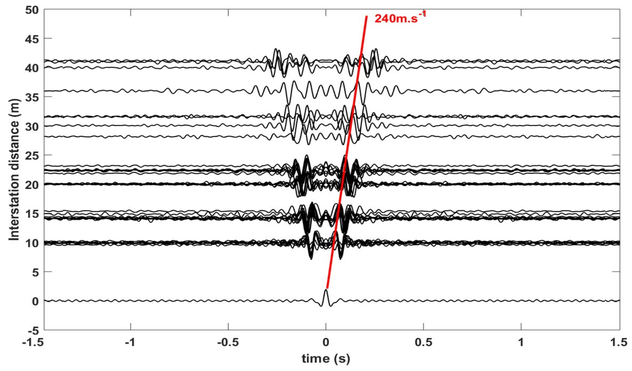
Since work by Campillo and Paul (2003), ambient noise correlation is widely used for tomography purposes. Principle is that we can reconstruct the Green's function by correlating the continuous ambient noise correlation between two captors. The changes in the sampled medium can be observed as temporal shift in the correlation and so this technique can be used for time-lapse monitoring.



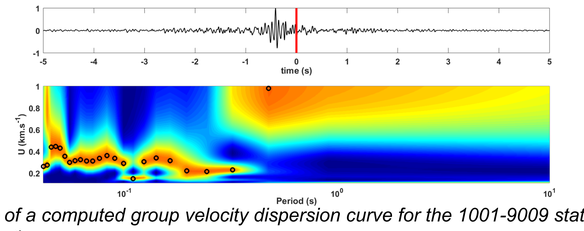
Monitoring with ambient noise correlation: In black, noise correlation function for the normal state, in red, with decreasing in the medium velocity. From Brenguier et al., 2016

Results

We use MSNoise Python code (Lecocq et al., 2014) to compute the daily correlations. Standard processing is used: mean and trend removal, 1bit, spectral whitening.



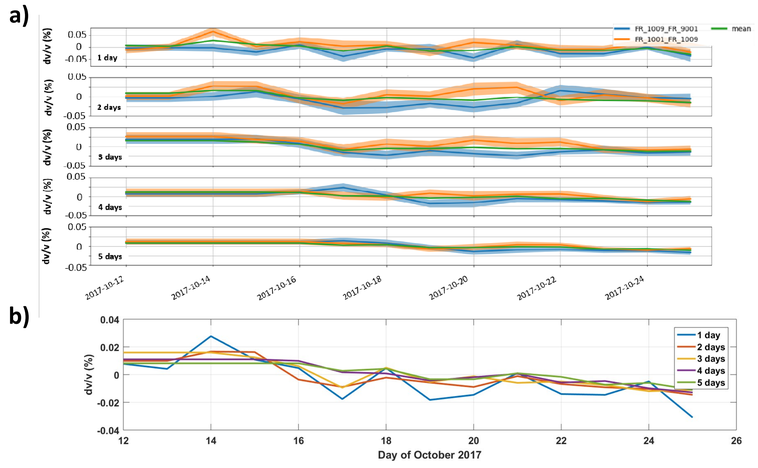
Empirical Green's function as function of interstation distance (for correlations with SNR > 12). Causal and acausal parts are stacked.



Example of a computed group velocity dispersion curve for the 1001-9009 station pair (80m apart).

Application to monitoring

We use Moving-Window Cross Spectrum analysis (MWCS,Clarke et al., 2011) to estimate the variation of velocity in the correlations. Results shows very small variations



a) δv/v obtained for two pairs of stations (orange and blue) and mean δv/v for the subset of 5 stations (green). b) Mean velocity variations for different number of stacked days.

Future Work

- Inversion of the dispersion curves to elastic models
- Comprehensive analyze of the results in the velocity changes observed on correlations
- February 2018: 25 days of continuous seismic signal on 201 stations (1 km array aperture)
- October 2018: 7 days on 10 station during "high" pressure injectivity tests

References

Brenguier, F., Rivet, D., Obermann, A., Nakata, N., Boué, P., Lecocq, T., Campillo, M., and Shapiro, N., 2016, 4-d noise-based seismology at volcanoes: Ongoing efforts and perspectives: Journal of Volcanology and Geothermal Research, **321**, 182–195.

Campillo, M., and Paul, A., 2003, Long-range correlations in the diffuse seismic coda: Science, **299**, No.5606, 547–549.

Clarke, D., Zaccarelli, L., Shapiro, N., and Brenguier, F., 2011, Assessment of resolution and accuracy of the moving window cross spectral technique for monitoring crustal temporal variations using ambient seismic noise: Geophysical Journal International, **186**, No. 2, 867–882.

Lecocq, T., Caudron, C., and Brenguier, F., 2014, Msnoise, a python package for monitoring seismic velocity changes using ambient seismic noise: Seismological Research Letters, **85**, No. 3, 715–726.