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Solid Earth
Discussions

Interactive comment on "Improving quality of empirical Greens functions, obtained by cross-correlation of high-frequency ambient seismic noise" *by* Nikita Afonin et al.

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Improving quality of empirical Greens functions, obtained by cross-correlation of high-frequency ambient seismic noise

General overview

A main problem in exploration geophysics applications using anthropogenic sources of seismic ambient noise often is its far from ideal distribution that hinders the extraction of empirical Green's function using methods conventionally used at much larger scales using natural sources, for example, in seismology. The authors introduce a method that seek for a subset of interstation correlations that maximize the signal-to-noise ratio (SNR) after stacking to promote converge to the empirical Green's function. Overall the manuscript is interesting but the English usage has to improve and many places need for greater clarity. I just have a few comments.

Main comments

- Pg. 2: The introduction on the stacking methods is confusing. I would distinguish methods that weight correlations according to the SNR of each correlation

(Cheng et al., 2015) or that stack only correlations with high or low coherence (Boué et al., 2014) from methods that weights signal coefficients in a transformed domain after a linear stack, such as the time-frequency phase weighted stack (Baig et al., 2009; Schimmel et al., 2011; Li et al., 2018) or the time-scale phase weighted stack (Ventosa et al., 2017). A clear separation between these methods can help the reader to place your method in its proper context.

- Pg. 2, line 10 and 14: Li et al. (2017) should be Li et al. (2018).
- Pg. 2, line 25-26: Can you give detailed information on the pre-processing and the cross-correlation function you apply?
- Pg. 2, line 28-30 and Pg. 3, line 11: These sentences are misleading. Interstation correlation functions do not always give an empirical Green's function. They converge to an empirical Green's function when the distribution of source is fairly well distributed. Hence, the importance of the pre-processing, correlation, stacking methods, and potentially the method you introduce, to seek a good balance of sources.
- Pg. 3, eq. (1): This estimation of SNR is fine when the strongest signals arrive on the expected time lags (from $-t_{ds}$ to t_{ds}) and you have no signal outside. Have you considered using more robust estimators of the noise level such as median absolute deviation (MAD). What happens when signals are too weak to be observed in a cross-correlation function but arise after stacking?
- Pg. 4, lines 14-21: This paragraph is not clear. If I understood what you mean, you need to know seismic velocity in order to measure the azimuth of the strongest source; however, seismic velocity structure is often what we seek in most applications. In addition, you mention that a 2-D array is necessary. Can you further explain how you use it to estimate the azimuth distribution of sources.

- Pg. 5, around Fig. 1 & 2: I would personally emphasize in these figures which stations use MEMS and which Trillium Compact.
- Pg. 8, line 1: An extra sentence is needed here to explain how you locate high-frequency noise sources at distances from about 0.7 to 3 km from the center of the arrays.
- Pg. 8, line 17-22: Which is the portion of correlations that conventionally build up the final stack?

References

Boué, P., Poli, P., Campillo, M. and P. Roux (2014). Reverberations, coda waves and ambient noise: Correlations at the global scale and retrieval of the deep phases, Earth Planet. Sci. Lett., 391, 137–145, doi:10.1016/j.epsl.2014.01.047

Baig, A., Campillo, M. and F. Brenguier, F. (2009). Denoising seismic noise cross correlations, J. Geophys. Res., 114(B8), 2156–2202, doi:10.1029/2008JB006085

Ventosa, S., Schimmel, M. and E. Stutzmann (2017). Extracting surface waves, hum and normal modes: time-scale phase-weighted stack and beyond, Geophys. J. Int., 211(1), 30–44, doi:10.1093/gji/ggx284