Toward near-surface characterization using Distributed Acoustic Sensing and ambient seismic noise in an urban area: Granada, Spain.

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Granada, located in the southeast of Spain, is a city with a rich history and exquisite architecture. Although the seismicity in this region is relatively low, the city has been stricken by major earthquakes through the centuries (Mw ~6.5+). In addition, Granada is located on top of a sedimentary basin which amplifies local ground-motion, making Granada an area with a higher-than-usual seismic hazard in Spain. Therefore, monitoring ground motion and quantifying local site effects are crucial to better assess and refine the seismic hazard in Granada.

In urban areas, seismic measurements often suffer from sparse instrumentation. A promising alternative to traditional seismometers is the emerging Distributed Acoustic Sensing (DAS) that can convert telecommunication fiber-optic cables into ultra-dense arrays of vibration sensors over tens of kilometers. In this ongoing work, we aim to infer a detailed shear-wave velocity (Vs) structure using this technology and a telecom fiber that originally serves to transfer data from a radiotelescope at the top of the Sierra Nevada and the observatory in Granada (Fig. 1). The fiber crosses different regions of the city with a total length of 20 km, a channel spacing of 4.8m, leading to an array of 4167 channels. The dataset was recorded during two days, only during day time for a total of 19 hours.

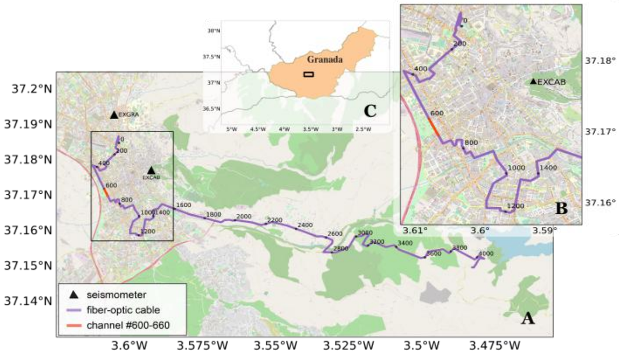

Figure 1. Location of Granada DAS array. a) DAS fiber array, the black rectangular is the extent indicator for a larger map (b); c) location of Granada, the rectangular shows the scale of map (a).

To obtain Vs models, we use high-frequency ambient seismic noise to retrieve the impulse response between pairs of receivers. We then compute and stack ambient noise cross-correlation functions (CCFs) to obtain virtual shot gathers along different sections of the cable (Fig. 2a). We apply frequency-wavenumber (F-K) filtering to the CCFs and only keep waves traveling from virtual source to receivers with a velocity window of 150-2000 m/s (Fig. 2b). We calculate dispersion spectrum using the Radon Transform, and extract multimode dispersion curves (DCs) (Fig. 2c, d). The use of multimode DCs will allow us to better constrain the deeper structure compared to only using the fundamental mode. Dispersion points are further selected to avoid spatial aliasing, which could cause artifact velocities (Fig. 2d). Finally, we will invert the DCs using a global optimization algorithm to infer the local 1-D Vs structure.

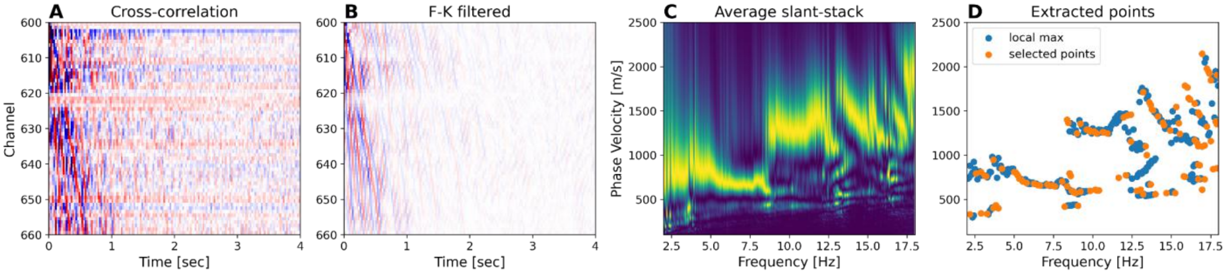

Figure 2. CCFs and DCs. a) average CCFs of anti-causal and causal parts using channels 600-660; b) F-K filtered CCFs; c) dispersion spectrum after radon transform using CCF in (b); d) extracted dispersion points from (c).