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Robust determination of S-wave velocity profiles by using mini-arrays

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Microtremor measurements represent a useful tool to study the seismic amplification in urban areas. One of the methods that permits characterizing seismic properties of soils is the H/V spectral ratio. This technique is especially useful when dealing with shallow low velocity layers, allowing an effective determination of its velocity and thickness. The H/V technique is very convenient to realize microzonation surveys because of its simplicity and low cost. However, it is recommended to combine it with other geophysical methods and geological information to better constrain the resulting models. In recent years the use of ambient noise cross-correlation has been widely used to retrieve Rayleigh wave dispersion curves between pairs of stations. These curves carry an important information about the subsoil velocity structure and have been already exploited for seismic microzonation purposes.

The aforementioned methods, H/V spectra and Rayleigh wave dispersion curves, in principle allow obtaining 1D body wave and density profiles. However, one of the most important problems when inverting H/V and dispersion curves, is the poor constraint on density and P wave velocities. This difficulty can be partially solved by imposing some constraints over the inverse problem (e.g. fixing the Vp/Vs ratio) or by devising inverse methods allowing the different parameters to be determined in different steps.

We propose a novel approach which consists of a joint inversion of H/V spectra and Rayleigh wave dispersion curves, realized simultaneously for all the elements of the mini-array. This allows increasing the ratio between the number of available data and the number of parameters to invert, improving the stability of the inverse problem and reducing the uncertainties on the estimated parameters. For the evaluation of the retrieved model, we used the trans-dimensional Monte Carlo exploration which has shown to be very efficient in evaluating the quality of the resulting model, through an intensive exploration of the “a posteriori” probability density function over the model parameter space.

We show the improvement in the obtained results on synthetic tests as well as on actual data. In

particular we apply this method, named method **MARISMA** (**M**ini **AR**rays for se**IS**mic **M**icrozon**A**tion) on a dataset recorded in the town of San Cristóbal de La Laguna (Tenerife, Canary Islands, Spain) during the summer of 2019.