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Dispersion characteristics of surface waves inferred from 2D noise array measurements: time stability, noise sources azimuthal distribution and environmental effects

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Surface wave methods have been widely developed in recent years as an alternative to invasive techniques (i.e. boreholes) for near surface site characterization at geotechnical engineering scale. In order to assess repeatability and time stability of surface waves dispersion estimates, seismic ambient noise have been recorded during 6 months by a 21-element broad band seismological dense array deployed in the small size alluvial basin of Argostoli, Greece. The array was composed of CMG40T broad-band sensors buried in 50 cm depth holes and connected to Taurus (nanometrics) acquisition units. The stations were placed along four concentric circles, with radii of 5, 15, 40 and 80 m, around the central station. All stations are located on the same geological unit. Ambient noise data have been processed by using frequency-wavenumber and spatial autocorrelation techniques within the frequency range from 1 to 20 Hz. Phase velocity estimates were found to be overall very stable over time (in terms of coefficient of variation and standard deviation) in the frequency range within the theoretical array resolution capabilities, provided however a minimum duration analysis of about thirty minutes.
Furthermore, a frequency- and time- dependant fluctuation of phase velocity from 1 up to 10 % was also observed with the following characteristics. Phase velocities variation are periodic with periodicity of 5 days, 24 hours, 12 hours and 6 hours whatever the frequency, most probably in relation with human activity and sea tide. Time variation of relative energy partitioning between fundamental and higher modes also contribute to phase velocity fluctuation. Most of the abrupt change of phase velocity at high frequency (above 5 Hz) is clearly correlated to the rain activity. Finally, wind was found to have major effect on the phase velocity (variation of phase velocity up to 10%) over a wide frequency range by exciting vibration of trees located nearby the array and thus generating non-planar wave fronts.