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Ambient Noise characterization at the Larderello-Travale Geothermal Field (Italy)

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Given a pair of receivers, the cross-correlation function of ambient noise wave-field (NCF) provides an estimate of the Green's Function between the two sites, which allows extraction of the associated group velocity dispersion curve. Such a procedure is valid under the assumption that noise sources and/or scatterers are isotropically distributed and uncorrelated each other; these conditions can be achieved once the NCFs are averaged over long time intervals. At frequencies lower than 1 Hz, ambient noise wavefield is essentially composed by surface waves that are mostly associated with oceanic sources; as a consequence, the noise wavefield may exhibit marked directional properties over short (day) to intermediate (weeks) time scales. A detailed assessment of the nature and duration of these sources is therefore required in order to define the optimal conditions for retrieving the Green's functions from NCF analysis. Following these premises, this study focuses on the quantitative analysis of the ambient seismic noise as observed at the Larderello-Travale Geothermal Field (Italy). We use data collected by a temporary seismic array consisting of 20 broad-band instruments, with inter-station distances ranging from 2 to 50 Km. Below 1 Hz, the most energetic sources are those associated with both primary and secondary microseisms, whose dominant spectral peaks span the 0.05-0.5 Hz frequency range. Focusing on the secondary microseism band (f > 0.1 Hz), we determine the kinematic properties of the noise wavefield using frequency-domain beamforming. For the May-November 2012 time span, our results show that the most energetic and persistent wavefield components propagate from WNW (Gulf of Marseille and Genoa) and SW (Sardinia channel). In the late part of the observation period, additional wavefield components are observed to propagate from the NE-SE quadrant, corresponding to sources located throughout the Adriatic sea. Most of the noise energy propagates with apparent velocities spanning the 2-3 km/s range, thus suggesting a dominance of surface (Rayleigh) waves. The directional and spectral properties of the noise derived from Beamforming analysis are then compared to outputs from WaveWatch III simulations, which predict the significant wave height and dominant periods throghout the Mediterranean Sea. The good agreement between seismological observations and wave models suggest the possibility of adopting seismological noise observations for ocean climate studies. The temporal variability of the spatial distribution of marine noise sources indicates that the conditions for the application of the NCF technique can be met by averaging cross-correlation estimates over a period of a few months. Noise recordings are then subjected to NCF analysis, allowing for the retrieval of inter-station Green's functions. These latter ones are then subjected to a frequency-time analysis (FTAN), in order to obtain group velocity dispersion curves for each station pair. For the cases in which the ratio between the inter-station distance and the wavelength of interest was lower than ∼3, we adopted the Spatial Autocorrelation Function (SPAC), which relates the frequency-dependent spatial autocorrelation functions to the phase velocity dispersion curve. In the analyzed frequency band we also found evidences for signals traveling with high apparent velocities (> 8 km/s). Beamforming and polarization analysis indicate that these waves are likely associated with P-waves generated in deep water far from coastlines. Further studies are however needed to better understand location and processes originating these signals.