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Wind Turbine Seismic Monitoring Campaign

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Wind turbines emit seismic signals due to the rotation of the blades and the movement of the tower. Seismic signals radiated from wind turbines are known to interfere with operational seismic monitoring of natural and induced seismicity. With regard to the Einstein Telescope and the design of the passive and active vibration isolation systems, the seismic radiation from wind turbines poses a major challenge.

We deployed 5 seismic mini-arrays west of the Aachen wind park and recorded the ambient seismic field over the corse of 35 days. The motivation for deploying arrays, rather than single stations, is to in-addition to analyzing the power spectral density (PSD) at each station, beamform the wavefield and extract the direction to the various sources relative to each array.

Our analysis indicates that the amplitude of distinct spectral peaks decreases as a function of distance from the wind park. These spectral peaks are at 1.1, 2.2, and 3.2 Hz and can be attributed to the seismic signal emitted by the wind turbines in the Aachen wind park. The above spectral peaks are observed at the surface seismometer (depth=0 m) and at the borehole seismometer (depth=250 m) hosted in the seismic station TERZ (Terziet, The Netherlands), more than 10 km away from the wind park. Additionally, we found that the amplitude, of the entire spectrum, but specifically of the above spectral peaks is in correlation with wind speed.

Using a time-domain Fisher detector, the data was processed in several frequency bands. The broadband processing results nicely show diurnal variations in the detection density (detections above a certain SNR threshold, per back-azimuth bin, per time window), with an increased detection density during high wind periods, and some persistent sources at certain back-azimuths.

The assumption that the upper soil layer dampens noise from anthropogenic activity at the surface is correct, but for tall structures that are founded in the hard rock, this upper soil layer is of little significance.

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