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The impact of seismic noise produced by wind turbines on seismic borehole measurements

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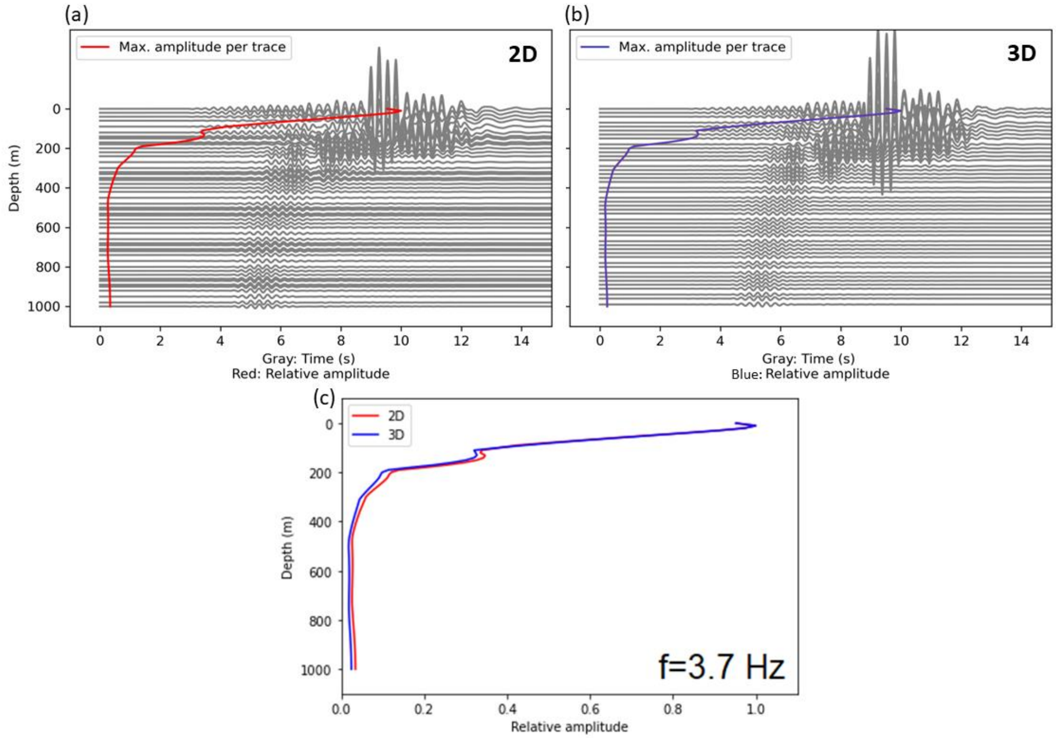

Figure S1: Comparison between the simulation of 3.7 Hz signals in two (a) and three (b) dimensions. The difference is not significant (c), hence, simulations in two dimensions are suitable to estimate the amplitudes in dependency on the depth.

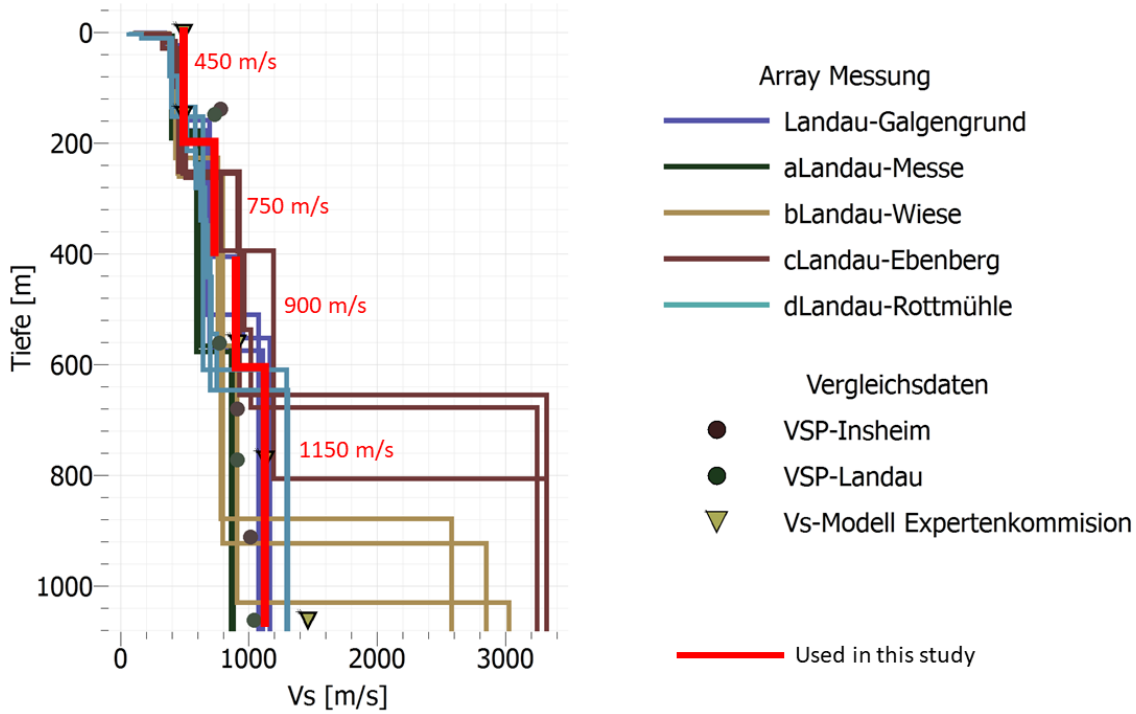

Figure S2: Models of the subsurface in the Landau Region (Rhineland-Palatinate, Germany) provided by Spies et al. (2017). The red line shows the velocity model used for the real data validation in this study. The seismic velocities are provided by the MAGS2 project. The figure is taken from Spies et al. (2017). The red line is added and indicates the velocity model used in our study.

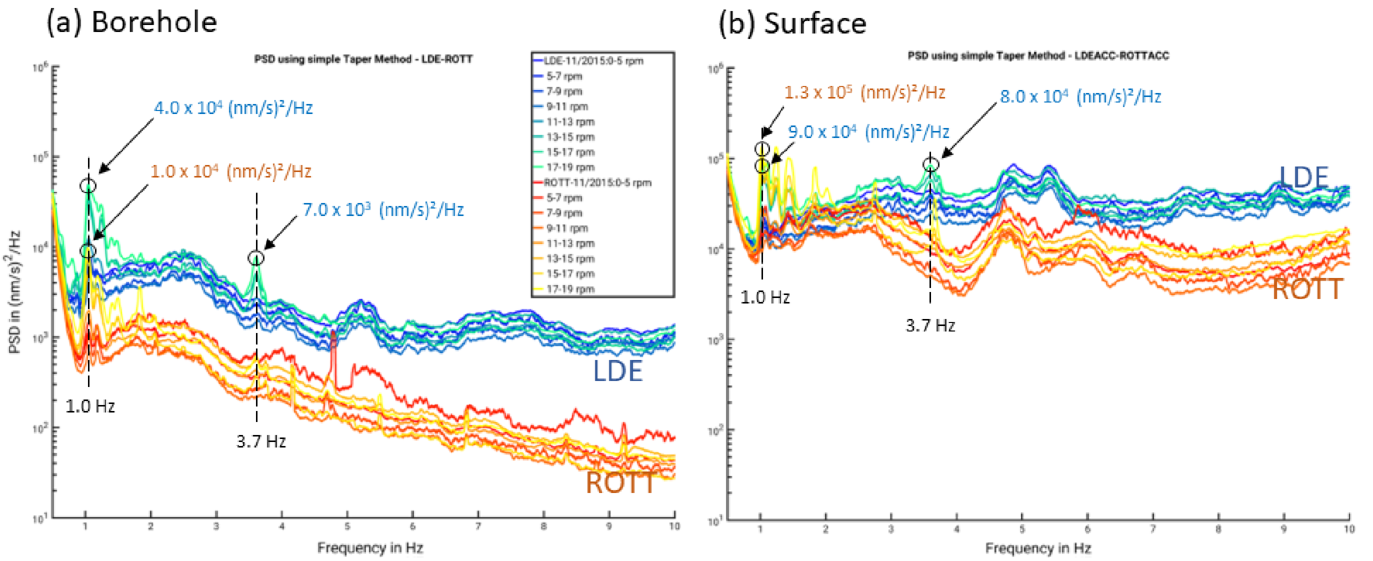

Figure S3: The figure by Zieger and Ritter (pers. comm., 2018) is modified by adding markers, arrows and numbers. PSD values by Zieger and Ritter (2018) show a reduction of amplitudes for 1 Hz (at ROTT and LDE) and 3.7 Hz (at LDE) signals due to boreholes. We transformed the PSD values into relative amplitudes by applying the root square. The comparison between the amplitude at the surface station and borehole station yields the reduction factors and percentages of 73% (ROTT, 1 Hz), 71 % (LDE, 1 Hz) and 34 % (LDE, 3.7 Hz).

The PSD amplitudes provided by Zieger and Ritter (2018) in Fig. S3 are transformed into amplitudes at the surface (AMP_{SF}) and in the borehole (AMP_{BH}) by calculating the square root. A scaling with frequency is not necessary in this case, since we compare PSD amplitudes at an identical frequency. The amplitude in the borehole is then divided by the amplitude at the surface to derive the factor F of noise amplitude reduction.

$$F_{ROTT,\ 1\,Hz} = \frac{AMP_{BH}}{AMP_{SF}} = \sqrt{\frac{PSD_{BH}}{PSD_{SF}}} = \sqrt{\frac{1.0\ \times 10^4}{1.3\ \times 10^5}} = 0.27\ (\cong 73\%\ reduction)$$

$$F_{LDE,\ 1\,Hz} = \sqrt{\frac{4.0\ \times 10^4}{9.0\ \times 10^4}} = 0.66\ (\cong 34\%\ reduction)$$

$$F_{LDE,\ 3.7\,Hz} = \sqrt{\frac{7.0\ \times 10^3}{8.0\ \times 10^4}} = 0.29\ (\cong 71\%\ reduction)$$

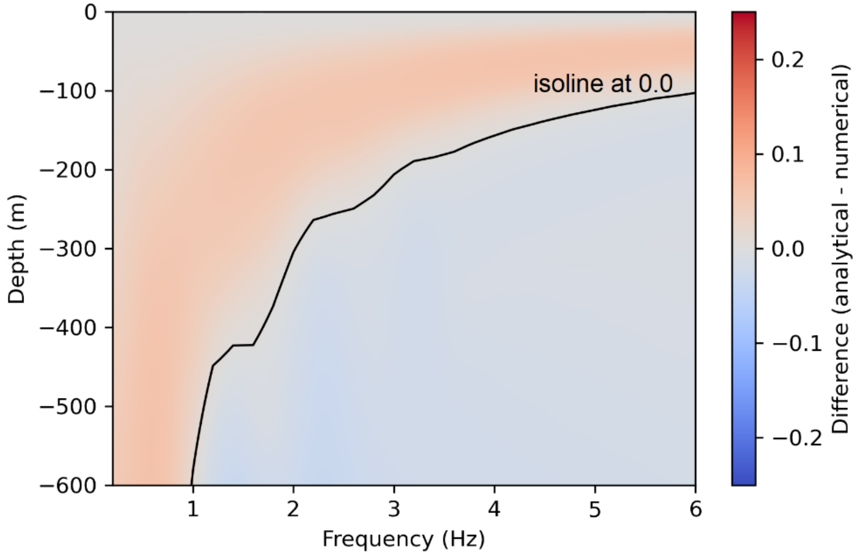

Figure S4: The difference between the amplitudes in figure 3a (numerical solution) and 3b (analytical solution). The difference is not 0 at relatively surficial areas for high frequency and in deeper regions for low frequencies. This indicates that the discrepancy between analytical and numerical solution is wavelength dependent. However, considering that the difference is about 0.1 in amplitude, the numerical and analytical solution are in good agreement. The numerical approach includes body waves, which are completely neglected in the analytical approach. This could be one explanation for the slight differences. The solid black line indicates the isoline at 0.0.