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Low-frequency seismic noise characteristics from the pressure-seismic plots

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Using the co-located seismic and pressure data from the USArray Transportable Array, we analyzed the effects of surface pressure changes on seismic noise generation. We show in the low frequency band (0.01-0.02 Hz) that vertical seismic noise can be modelled by the formula Sz=A*Sp + ez and the horizontal seismic noise by Sh=B*Sp + eh where Sz, Sh and Sp are the power spectral densities (PSD) of vertical ground velocity, horizontal ground velocity and surface pressure. The coefficients A and B are functions of elasticity in the medium and the pressure-wave speed on the surface and ez and eh are constant noise terms that are independent of local pressure changes. For the frequency range of our analysis (0.01-0.02 Hz), the horizontal data are dominated by ground tilt.

We found that the horizontal constant noise term can change seasonally for many stations and sometimes create separate branches in the pressure-seismic plots. This may explain why some seismic-noise reduction approaches for horizontal data, by use of a co-located pressure sensor, do not necessarily work well while it seems to work well for vertical seismic data.

We show that shallow rigidity structure in the upper 50-100 m of the Earth can be derived reliably through the determination of the coefficients A and B in the above formulas. Pressure-wave speed on the surface is also derived in the modelling process but its relation to wind speed remains unclear.

We advocate that the co-located pressure and seismic sensors are a powerful tool to gain new insights into the nature of seismic noise.