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Broadband seismic effects from train vibrations

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Seismologists rarely study train induced vibrations which are mainly regarded an unwanted source of noise for classical seismological applications such as earthquake monitoring. A few seismological studies try to utilize train vibrations however as active sources, e.g. for subsurface imaging, but they do not focus on the characteristics of the train signal itself.

Most available studies on train induced vibrations take an engineering approach and aim at better understanding the generation and short-distance propagation of train induced vibrations, mainly for mitigation and construction purposes. They mostly rely on numerical simulations and/or short-period or accelerometer recordings obtained directly on the train track or up to few hundred meters away and almost no studies exist with seismic recordings further away from the track. In some of these previous studies sharp and equidistant peaks are present in the vibration spectrum of heavy freight trains, but they do not attempt to explain them.

Here we show and analyze various train vibration signals obtained from a set of seismic broadband stations installed in the context of the temporary, large-scale regional seismic network AlpArray. The geometrical restrictions of this seismic network combined with budget and safety considerations resulted in a number of broad-band instruments deployed in the vicinity of busy railway lines. On these stations we observe very characteristic seismic signals associated with different types of trains, typically showing pronounced equidistant spectral lines over a wide frequency range. In this study we analyze the nature of such signals and discuss if they are generated by a source effect or by wave propagation effects in near-surface soil layers.