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Passive Assessment of Geophysical Instruments Performance using Electrical Network Frequency Analysis

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The electrical network frequency (ENF) of the alternating current operated on the power grid is a well-known source of noise in digital recordings. The noise (i.e., signal) is widespread and appears not just in close proximity to high-voltage power lines, but also in instruments simply connected to the mains powers grid. This omnipresent, anthropogenic signal is generally perceived as a nuisance in the processing of geophysical data. Research has therefore been mainly focused on its elimination from data, while its benefits have gone largely unexplored. It is shown that mHz fluctuations in the nominal ENF (50 - 60Hz) induced by variations in power usage can be accurately extracted from geophysical data. This information represents a persistent time-calibration signal that is coherent between instruments over national scales. Cross-correlation of reliable reference ENF data published by electrical grid operators with estimated ENF data from geophysical recordings allows timing errors to be resolved at the 1s level. Furthermore, it is shown that a polarization analysis of particle motion at the ENF may assist in the detection of instrument orientation anomalies at the surface. Furthermore, it is explored whether this method can be applied to determine orientations of geophones inside seismic boreholes.