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A new approach for arriving at higher frequencies through stochastic modelling: application to site attenuation (kappa)

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We propose a framework for stochastically modelling the Fourier spectrum of the noisy seismic recording, considering that a seismic signal is a random rather than a deterministic quantity. We show that under this assumption, the noisy recording's periodogram can be modelled as independent Exponential random variables with a frequency-dependent mean. With this model, estimating seismological parameters can be tackled through Maximum Likelihood (ML), allowing a fast, accurate and robust solution. This new approach constitutes a general estimation framework applicable to any parameter estimation that uses spectral analysis. Here we apply it to the high-frequency decay parameter kappa, which is particularly important for estimating and adjusting ground motion on rock. The improved ML performance is shown through a series of experiments on synthetic and recorded seismograms. The biggest advantage of the new method is its ability to account for the noise in the recording instead of just trying to avoid it, as is typically done when any 'acceptable' frequency range is isolated through signal-to-noise (SNR) criteria. As a result, our proposed technique can achieve acceptable results even for what would be typically considered very low and often unusable SNR, pushing the boundary of what is considered usable quality in seismic recordings.