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How much deviations in sampling sedimentary series do impact on the reconstruction of climatic cycles?

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Spectral analyses have become a key tool for detecting climatic cycles (like orbital forcing) in sedimentary series. Most of spectral analyses (like Fourier Transforms and derivative, MTM…) require a constant sample step. However, this is rarely achieved when collecting rock samples in outcrops or cores. Uncertainties in the sample positions distort the sedimentary series, which reduces the power spectrum of the short periods, like precession cycles. Here, we provide a tool for assessing how much a distortion in the sampling pattern impacts on the spectral power of a sedimentary series, with special focus on the Milankovitch band. We then assess how precise should be the control of a sample position as well as the required density of samples per precession cycle for reliably assess the spectral power in the whole Milankovitch band.

Sample distances are randomised using gamma models to simulate distortions of the sedimentary series. Such approach allows the stratigraphic order of samples to be maintained as well as to parameterise the mean and the variance of the dispersion of the sample distances. We tested this sample distance randomisation on two published geological datasets that have been sampled at different steps. The spectra of the non-distorted and distorted series were calculated using the Lomb-Scargle and the Multi-Taper Method. When randomising sample diatances with an uncertainty of 5% of the mean sample step, all frequencies above ∼1/3 of the Nyquist frequency are significantly reduced. At 10% and 15% uncertainty, all frequencies above respectively ∼1/5 and ∼1/6 of the Nyquist frequency are affected. This test illustrates that a precise stratigraphic control on the sample position as well as collecting at least 6-10 samples per precession cycle are required to reliably estimate the power spectrum in the whole Milankovitch band.