

## ***Interactive comment on “Testing the impact of stratigraphic uncertainty on spectral analyses of sedimentary series” by Mathieu Martinez et al.***

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Dear Dr. Martinez, Dear authors,

You submitted a manuscript entitled ‘Testing the impact of stratigraphic uncertainty on spectral analyses of sedimentary series’. I was asked to review your paper, and especially pay attention whether it is suitable for climate of the past because it is quite technical.

In your manuscript you focus on a very fundamental part of spectral analysis – the sampling, and the effect of non-equally spaced sampling for spectral analysis. Using simulations you demonstrate the effect of not precisely equally spaced sampling, and make applicable suggestions for sampling strategies. Your methods are solving a scientific question and are chosen logically. These are novel aspects and without doubt

publishing prominently in the stratigraphy and paleoclimatology community. In my opinion your paper is clearly written and well structured. Figures supplement the text in a logical way.

Your paper is indeed technical, but at the same time of fundamental importance for the interpretation of (semi)cyclic paleoclimate signals. You outline all necessary technical details, and take also non-expert readers through your manuscript. In my opinion the manuscript is suitable for publication in *Climate of the Past*. However, making several rather minor adjustments can make the manuscript more accessible to a wider audience, specifically I would suggest:

- focus on more applicable and less technical results in the abstract and conclusions. The technical details are important, and you outline them well. However, I would suggest to be less technical specifically in the abstract and conclusions. Highlight that effect of sampling uncertainty alters power spectra, and that generally precession will be more affected than obliquity and eccentricity. I would suggest to directly stating that sampling uncertainty can have an effect on interpretations derived from relative precession- and obliquity power.

- the La Thure series shows both precession and obliquity. Could you exemplary discuss what the result from your test means for this example record, and how it aids the interpretation?

- explain what the Nyquist frequency represents.

Further I would suggest you to clarify several points:

- you suggest uncertainty to be fully random. I propose to briefly discuss why you assume this – and what effect(s) systematic uncertainty may have.

Lines 117-120: 106-116m is the overall spread in section thickness. From a conceptual point of view I think that this spread can hardly directly be used to estimate uncertainty in sample distance, because you see a result of  $\sim 550$  (gamma distributed) sample

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distances summed up. Several of these will be shorter and longer than 20 cm – so your relative uncertainty will probably be higher – or fully systematic.

Lines 143, 223: Do I understand correct that you interpolate all time series (also with spacing of  $\sim 0.2$  m and  $\sim 0.38$  m) at 0.01 m intervals? Is this necessary and useful, and does this oversampling influence your results?

Lines 159-164: Your approach is good, but personally I would propose to also determine 95% confidence intervals of power by considering not only the average power spectrum from simulations. This may facilitate to compare (integrated) precession and obliquity power for paleoclimate studies.

175ff: a table summarizing the results presented may be helpful in addition. - In Fig. 4 the confidence levels of the MTM and Lomb-Scargle spectra are different. I would propose to mention this in the figure caption.

Line by line comments which may improve the manuscript:

10, 13: maybe express Nyquist frequency as sampling interval to be clearer

15-17: “In addition, the simulations indicate that taking at least 6-10 samples per precession cycle should allow calculation of robust power spectra estimates in the Milankovitch band.” – This is not limited to precession I think, what about a more general statement as ‘In addition, the simulations indicate that taking at least 6-10 samples per cycle should allow calculation of robust power spectra estimates in the respective cycle band’?

28-29: “In core sediments, uncertainties in the sample position are also observed when performing physical sampling at very high resolution or because of core expansion phenomena (Hagelberg et al., 1995)” – suggestion: ‘In cored sediments, uncertainties in the sample position are also observed when performing physical sampling at very high resolution or because of core expansion phenomena (Hagelberg et al., 1995) or imperfect coring (Ruddiman et al., 1987).’

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37-38: “In this study, we address this problem by quantifying the impact of such errors on the frequency, as well as the power of higher-frequency cycles.” → the second part of this sentence (“the frequency, as well as the power of higher-frequency cycles”) may be ‘the frequency and power distributions’?

42-44: This sentence seems in contradiction to the last sentence of the abstract, more consistent phrasing may solve this.

48: delete ‘correctly’?

64: remove ‘easily’

98/99: could you mention that these are Devonian, and give a rough age as for the La Charce section?

108: are the two brackets necessary?

119/120: “with an average of  $110.3 \pm 5.1$  m, and a relative uncertainty of 4.6%” I would propose to mention that the “5.1 m” and “uncertainty of 4.6%” are estimated from only three experiments, and that these are regarded as representative, but may not be actually.

146: maybe give also reference to the R package used (‘dplr’)

155: “The confidence levels of the datasets were calculated before randomisation and directly plotted to the simulated spectra.” I am unsure how this is meant, and I would suggest phrasing this more clearly.

160-164: “Pori: the power spectrum before randomization” – as you calculate this for individual frequencies, following may be more clear: ‘Pori: power before randomization for a specific frequency’, same for Pave (if I understand this correct).

172 “with 5% uncertainty” – maybe clarify as ‘with 5% stratigraphic uncertainty’

200: with “first frequency” ‘lowest frequency’ is meant I assume – could you clarify this?

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205-211: Please make clearer that geological data usually have no precise frequencies, but frequency ranges. You mention this, but I am not sure if everyone will understand this easily.

217: I am not sure if you need to mention “that the stratigraphic order of the samples in the raw series is preserved after randomisation” again. You develop this earlier in the manuscript.

220f: “This difference realistically simulates small thickness errors, which accumulate when measuring successive sample steps.” – this can in my opinion be formulated better, and should highlight that errors may accumulate, or may also not accumulate but level out.

241: “above 40% of the Nyquist frequency”, I would suggest to also mention the frequency, maybe in brackets after this statement. Maybe bring these ratios in direct reference to precession (e.g.  $\sim 1/3$ rd of precession frequency/wavelength), so that this is more clear for readers not so familiar with time series analysis.

258/59: “As in the case of the La Charce series, the stratigraphic order of the samples is preserved in the randomised series” – In my opinion this is clear by now in the manuscript, and does not need to be repeated.

304: replace “powers” by “power”

310: “result suggest” – one of these need an “s” in the end

312/13: “This requires that more than 6 samples per precession cycle have to be taken” - samples or measurements?

355: 356: maybe also refer to (Meyers, 2015; Shackleton et al., 1995)

396: “on the field” – in the field?

Additional References Cited

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Shackleton, N. J., Hagelberg, T. K. and Crowhurst, S. J.: Evaluating the success of astronomical tuning: Pitfalls of using coherence as a criterion for assessing pre-Pleistocene timescales, *Paleoceanography*, 10(4), 693–697, doi:10.1029/95PA01454, 1995.

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