General comments

Authors: We thank the two reviewers for taking the time to re-read and comment on our project, and we are glad to learn that the consensus is that the project has been improved in their estimation. We have adopted the suggestions made, and attempted to clarify issues that remained unclear. We agree with both reviewers, and with the editor, that this project would be best classified as a review paper, rather than a research article.

Reviewer #1

In my view, the manuscript has been improved through revision, but I still have some recommendations, primarily regarding phrasing and language use. Also, after reading this revised version, I believe that the manuscript has not been correctly classified, as it seems more like a review article rather than a research article to me. This point may justify some of the critical comments of the other reviewers regarding the lack of an explicit research question

Main points

1) The manuscript presents a review of the types of noise found in different classes of proxy records. As such, I found it informative, as it summarises information scattered throughout the paleoclimate literature on the nature of proxy noise and offers some interesting insights into its interpretation. However, the manuscript does not clearly address a stated research gap, so I would not classify it as a research paper.

Authors: We would agree with this assessment, and would be very happy if the paper were published as a review article in CP.

2) The language used, mainly in the introduction, is too often unspecific, too ambiguous and thus more challenging to grasp than it should. I have included some examples below, but the authors may want to review the introduction again with this comment in mind.

Particular points:

3) ' For example, “white noise” equally affects all timescales, where “red noise” dominates only on long timescales, similar to longwave red light. ..'

This paragraph and another one of the same nature later in the manuscript, explaining the meaning of the red spectrum or blue spectrum, are, in my view, not necessary for the readership of Climate of the Past.

Authors: We appreciate this comment, but we are here responding to a comment by the editor, who requested a more general overview of colored noise, and color in time series more generally, so we have determined that –if classified as a review paper – it is appropriate to leave in these more general statements.

2) Here, we provide concrete definitions of types of timescales-dependent errors and review methods for estimating these errors in different types of proxy data

I would not agree with this sentence. Do the authors mean that the definitions 'red,blue,or white' need to be defined again, or do they mean something else? If they mean something else, I did not see those definitions later in the manuscript. It can be confusing for some readers.

Authors: Here are referring to the distinction we draw between noise which we consider to be generally stochastic and smoothing, which produces error but through a reduction in variance. We have edited this phrasing to be more general (Line 14-16).

3) 'We then synthesize the results of several studies that use a common empirical approach for estimating the noise spectrum in ice core'

This sentence is to me quite unclear, perhaps due to the use of the word 'synthesise'. In my understanding, this word means to produce or to combine, not to summarise (?). I understood the sentence as if the authors were to recreate the results of previous studies.

Authors: This is correct – we are taking single results from multiple published students and reproducing them.

4) Modification of proxy records can result in the addition of variance

What does 'modification' mean here ? does it mean to change a posteriori the numerical values of the proxy record or does it refer to natural process that modify the climate signal in the proxy? After reading this paragraph several times, I was still left in doubt.

Authors: It could be either, an 'a posteriori' effect resulting from observational or measurement error, or from a natural process might be redistribution of sediments or snow, or smoothing due to previous year's effects over growth, for example. We have edited this sentence to improve clarity (Line 35).

5) 'whereas the loss of variance through smoothing also constitutes error, but not technically noise.'

Again, I had to read this sentence several times, unsuccessfully. Does it mean that smoothing may introduce an additional uncertainty or bias (error?) ? I would not generally agree with it. Continuous physical smoothing, in theory, reduces the time resolution, but it does not introduce per se uncertainty or bias.

Authors: We would agree that smoothing can reduce time resolution, although we would also argue that smoothing introduces uncertainty. For example, in tree rings, biological smoothing doesn't reduce time-resolution since tree rings can still be precisely dated. However, it does introduce uncertainty, for example in estimates of past climate anomalies which may appear

dampened or extended due to this memory. We have edited this line to include a definition of error as any discrepancy between true and reconstructed climate at a given timescale (Line 41).

6) 'By contrast, noise is typically independent,..

Independent of what?

Authors: Independent between records – clarification made (Line 58)

7) 'The timescale-dependent variations of a time series can be analyzed in the spectral domain and referred to using colors by loose analogy to the frequency spectrum of light ...'

Again, the authors may want to reconsider whether this explanation is really necessary

Authors: Here, we were responding to the previous comment by the editor requesting an overview of color in time series more generally so we have opted to leave this section.

8) Section 2
This section starts with the sentence 'Our synthesis demonstrates that tree rings and corals ...' but the reader will wonder where these results come from . How was the noise estimated? Or do the authors rely on noise estimations from the original publications? The reader needs some information here.

Authors: We have added the citations to the original studies at the end of this phrase and the one below on ice cores (Lines 173, 223)

9) ' the proxy signal which, in theory, can be accounted for using deterministic modeling..'

accounted for by using... is perhaps clearer for non-native speakers, at least for me.

Authors: Edit made (Line 252)

Reviewer #2

The manuscript in its new version was substantially improved, including additional studies and according references, rendering the style of the manuscript into a comprehensive review paper rather than a summary of individual studies published earlier by the authors. The new version includes also an extension of the main chapters on proxy noise and its implications, and additional chapters on signal and signal-to-noise estimates and simulated effects of time uncertainty within the appendix. It is also appreciated that the comments raised in the first review round were comprehensively addressed, putting the main criticisms into context.

Being a review and synthesis paper on this specific topic, I think in its present form the manuscript is now suited for publication in Climate of the Past.

Specific minor comments:

Headings for sections 2 and 3:

I suggest to extend the headings being a bit more specific. e.g. The colours of proxy noise in different archives and Implications of proxy noise on time scales of climate signals or similar.

Authors: Change made (Headings sections 2&3)

Figure 2:

Is the right column intended to be on a log-log scale? Then it might be advisable to adapt the ticks for the axes resembling a log-log plotting structure with irregular spacing of the x- and y-ticks (cf. Fig. 3).

Authors: It is a log-log scale, we have modified the tick marks as suggested, and note that it is also mentioned in the caption that the noise spectra are visualized on a log-log plot (Fig 2).

Code Availability:

The authors might add a link to the respective software repositories on Zenodo to easier and more efficiently access the code.

Authors: We have added the appropriate software citations to the reference list (Reference section Lines 720)