Summary of changes and response to the first referee for manuscript cp-2013-140 "Similarity estimators for irregular and age uncertain time series"

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Summary of changes

We thank the reviewer for the detailed and helpful comments. We have made all requested corrections and modifications to the manuscript and present the detailed response below. The major change is in the updated Fig. 8, now including age-uncertainty results for the updated Dandak cave data (Berkelhammer et al., 2010), and the new Fig. 9 that illustrates the timescale dependence of the statistical association between the Dandak and Wanxiang paleoclimate records.

Response to the referee

(Original report cited in italics)

To benchmark the different similarity measures, synthetic time series are generated mimicking stalagmite growth histories. Here, the paper is not fully explicit as to their construction and the uncertainty in the growth rates; reference is made to previous publications, but the reasons why the climate at one location is impacting the growth rate at the other remain unclear. At this point, a hint towards assumed teleconnections and the Indian-East Asian summer monsoon system which is relevant for the observations from the two caves could be given at this point.

We thank the reviewer for pointing this out. We have rephrased the introduction to the synthetic stalagmite data to make their derivation clearer and tied it to our real-world

example (the Dandak-Wanxiang comparison) as well as the considerations in the introduction on reasons for apparent statistical association given in Fig. 2.

Finally, the paper also includes measured data from two caves. It is quite disappointing that none of the measures is performing satisfactorily; the confidence intervals ob- tained through Monte Carlo sampling are rather wide when using the age modeling of COPRA, and thus results are rather inconclusive as to the connection between the two time series. For this example, the method could not prove its potential; the re- viewer wonders whether there are other time series pairs (showing stronger lag zero correlation) where conclusions would be different?

We agree with the reviewer that it is difficult to prove performance for real-world examples of similarity estimation in the presence of age uncertainty as "the truth" is not available. As far as our illustratory example goes, however, we are glad to be able to present updated results. Previously the age-modeling could only be performed for the Sinha et al. (2007) dataset that included less than half of the observations than the later Berkelhammer et al. (2010) proxy time series, since the depth data for the latter was not available. We have since received this data and could now reproduce the results for the original datasets, shown in the updated Fig. 8. We are particularly grateful to the reviewer for pointing out the potential time-scale dependence introduced by the detrending choice. We studied the sensitivity of the link strength on the detrending kernel width and show the results in a new Fig. 9.

The potential of the method is obvious. Accepting the fact that there is no single similarity indicator suitable for all processes and time series, the consideration and ultimately combination of several or many of them is a logical next step. Which ones to choose is a matter of taste and knowledge, the authors point out other possibilities (CRPs, RNs, distance measures) towards the end of the paper. The reviewer strongly advocates yet another, recently developed method, dedicated to the identification of causal connec- tions in the presence of noise, which is called Convergent Cross Mapping (Sugihara et al., 2012).

Reference: Sugihara, G., May, R., Ye, H., Hsieh, C.-h., Deyle, E., Fogarty, M., Munch, S., 2012. Detecting Causality in Complex Ecosystems. Science 338, 496-500.

We thank the reviewer for pointing us towards this method. We have integrated it into the list of potential extensions.

[...] Every researcher and reader of this journal is aware of the concept of a time series and does not need a definition for it, or, for that matter, one for the concept of an age model (p. 5305). At several other places, there is potential for shortening; overall, the paper is quite lengthy [...]

We have shortened where suggested and possible and reduced the number of definitions. We do, however, believe that some concepts needed to be defined in particular for people new to the field of paleoclimatology since they are often used "by custom".

On the other hand, some aspects crucial for understanding the approach and its details are left out or referred to citing other publications only. The details of interpolating one of the series to produce "observations" at the same times as the other series. Surely, also here there are plenty of possibilities which will affect the performance of iXCF and iMI.

Another example is the reasoning for using the gamma distribution for the accumulation times[...].
We hope to have improved the readability by including explicit statements concerning the interpolation routines and the Gamma-distribution into the updated version of the manuscript.
There are a number of errors in the equations (notation), typos and omissions, which are commented upon in the attached pdf document. Please consider all of these carefully. In addition, reducing the number of definitions and thus the apparent formality of the paper increases comprehensibilty and accessibility.
We thank the reviewer for the in-depth reading and have corrected where he/she pointed out mistakes or made suggestions.
The reviewer would like to see a comment whether there are other, more promising data sets demonstrating the advantages of the method; if not, how to demonstrate the advantages of the method? This is critically important.
The main advantage of the presented methods is, that time-scale uncertainty can be integrated straightforwardly in the assessment of statistical similarity. Where the former is small, associations can in principle be found with high certainty, not only for the example presented here but also in various other (yet unpublished) applications in the comparison of sediment, stalagmite, tree-ring and ice core records.
When do you expect the first edition of the NESToolbox written in R?
The translation to R is an ongoing project. We hope that by the end of the year the core of the package will be available as a GNU-R package.