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Discussions

Interactive comment on "Emerging climate signals in the Lena River catchment: a non-parametric statistical approach" *by* Eric Pohl et al.

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Pohl et al. derive a new metric that enables measuring the time-of-emergence (ToE) of time series. They apply the method to temporal-spatial climate data for the Lena River catchment. In general, the paper is well written and easy to follow. The figures have a high quality although they are very difficult to read in grayscale prints. A more printer-friendly colorscheme might be chosen by the authors when revising their manuscript.

Major comments

The study aims to present a novel ToE approach but the paper mainly focuses on the application of the ToE rather than its evaluation. An in-depth evaluation would be necessary to enable readers to acknowledge the benefits and shortcomings of a new

metric. A possible solution is to include an extra section that evaluates the sensitivity and power of the method using simulated data.

It remains shrouded whether the authors use a kernel density estimator (KDE) that enables comparing the pdfs. Looking at the code (toe_calc.py), the authors seem to use a gaussian KDE, but this is not shown in the manuscript. As it stands, the HD is calculated for discrete probability distributions. If a KDE approach is actually chosen, than kernel bandwidth is an additional hyperparameter that most software choose automatically but that should be controlled.

Finally, I am not entirely convinced whether the HD-based ToE approach presents a sufficiently sophisticated new technique. Uncertainties in the metric have mainly been addressed using different climate models. However, there are other uncertainties that are not sufficiently captured by the method. First, each pdf presents a sample itself which is subject to uncertainties. This uncertainty is related to the window width. As a consequence, the HD-based ToE is a stochastic variable, which is prone to uncertainty. I think that this uncertainty is not sufficiently addressed by the authors, although it is recognized (17.14f).

In summary, I think that the paper needs major revisions to address some shortcomings in uncertainty quantification and evaluation of the HD-based ToE. Moreover, the possible impact of the KDE bandwidth on the results should be assessed.

Minor comments

5.29 - The equation lacks a term on the right (e.g HD(Q,R) =). In addition, I don't understand how you obtain the PDFs from the data. Do you use a kernel density approach? Otherwise, the equation is valid for discrete probability distributions only.

6.27 - Again, if a kernel density approach is used, then there are other parameters that include the type of kernel (gaussian, triangle, ...) and the bandwidth. These parameters should be kept constant if pdfs are compared. Automatic bandwidth determination is challenging if you have skewed, multimodal, and bounded data (e.g. only positive data such as precipitation).

7.4 - The coefficient of determination (r2) is actually a poor measure because it only evaluates the linear fit between the datasets. However, it may be more interesting whether the models capture the means and variability correctly and thus, the Nash-Sutcliffe efficiency (NSE) as used later may be a better choice.

9.12 - Is it possible that CRUNCEP was actually derived using empirical data from these stations? That would explain the very good correlation. This would also explain that areas far from stations show these artifacts (9.19). You may discuss this in more detail in section 5.3.

15.7 - basically non-parametric -> remove basically.

16.43 - avoid qualitative statements such as "huge"

19.37 - These other ToE methods relying on thresholds or statistial test actually rely on continuous metrics, too. Thresholds are derived from some metric, e.g. max. distance between two distributions such as the KS-test, and tests often rely on p-values which are continuous, too. In this respect, the HD-based ToE is not much different.

Fig.7 - The colorbar does not allow distinguishing regions that have years of emergence in 1960 or in 2088.

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