

Interactive comment on “Detecting causality signal in instrumental measurements and climate model simulations: global warming case study” by Mikhail Y. Verbitsky et al.

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Comment: This paper argues that by using method of conditional dispersion (MCD) it is possible to detect causal relationship between surface temperature anomalies and CO₂ concentrations in climatological time series (observed and simulated). The method was initially developed to estimate interrelation in low-dimensional dynamical systems and applying it to climatological time series is indeed a novel approach within the scope of this journal.

Answer: Dear Anonymous Referee #2, Thank you for your review and suggestions. We appreciate that you consider our approach to be novel and appropriate for Geoscientific

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Model Development. The following is our response to your comments:

Comment: Two points need to be clarified to better understand results presented in the paper

The transition from analyzing chaotic time series produced by two coupled Henon maps (briefly discussed in paragraph 2) to studying climatological time series is not as straightforward as it is made in the paper. In particular, it requires some underlying assumptions about the nature of climatological system and interdependences between its variables which are not clearly mentioned in the paper.

Answer: We use a hypothesis that NH temperature is an observable of the global climate system and CO₂ concentration is an observable of the system of external forcing. An observable may not necessarily have straightforward connection to (“hidden”) physical variables of the underlying system. The embedding theorem (e.g. Sauer et al., 1991) states that reconstructed space is topologically equivalent to the underlying system in a sense that there exists a continuous differentiable transform from a reconstructed to the hidden space.

Reference: Sauer, T., Yorke, J. A., and Casdagli, M.: Embedology. Journal of statistical Physics, 65(3-4), 579-616, 1991

Action: We plan to add this discussion to the paper.

Comment: In paragraphs 3.2 and 3.3, MCD is applied to a set of model simulations. It is unclear from the paper, if these models include parametrization of the effect of surface temperature on CO₂ emissions. If not, it would make the connection one-directional (see discussion in paragraph 2) which by itself explains the results presented in Figures 3 and 4.

Answer: We agree with your comment that clarification about the origin of CO₂ time series used to produce Figures 3 and 4 is needed. In fact, in all experiments we used the same atmospheric carbon dioxide concentration measurements (CO₂ NASA GISS

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Data, 2016). We assume therefore that the effect of the surface temperature on CO₂ concentration has been naturally included in the CO₂ time series.

Reference: CO₂ NASA GISS Data: <https://data.giss.nasa.gov/modelforce/ghgases/Fig1A.ext>
2012

Action: We will clarify this in the text.

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-25>,
2019.

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