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Poznań, 16 July 2020

Professor Damià Barceló
Co-Editor-in-Chief of *Science of the Total Environment*


Dear Professor Barceló,

I am submitting today a paper co-authored by Professors Demetris Koutsoyiannis and Zbigniew W. Kundzewicz, entitled “Hen-or-egg causality: Atmospheric CO₂ and temperature”. The paper is original and has not been submitted for possible publication elsewhere.

Having already co-authored three papers in *Science of the Total Environment* and having one more paper being considered, I feel confident that the selection of your esteemed journal as the outlet of this present paper is the most appropriate one. Our new paper is of broad potential interest to your readership and beyond, likely to generate co-benefits – for the journal, for the co-authors and for the readership and even more broadly – for the scientific community at large.

We submit our new paper now, asking you to consider the possibility of publishing it in *Science of the Total Environment*.

Yours sincerely



Professor Zbigniew W. Kundzewicz
Corresponding Member of Polish Academy of Sciences and Member of *Academia Europaea*

Conflict of Interest Statement

Poznan, 16 July 2020

In the name of both authors of the paper “Hen-or-egg causality: Atmospheric CO₂ and temperature” submitted for possible publication in Science of the Total Environment, i.e. Demetris Koutsoyiannis and myself, I solemnly declare that there are no conflicts of interest of any type, related with the work leading to this paper and the paper itself and its publication.



Professor Zbigniew W. Kundzewicz
Corresponding Member of Polish Academy of Sciences and Member of *Academia Europaea*

Subject: Your submission STOTEN-D-20-17194

From: "Kuishuang Feng" <eesserver@eesmail.elsevier.com>

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Ms. Ref. No.: STOTEN-D-20-17194

Title: Hen-or-egg causality: Atmospheric CO₂ and temperature

Journal: Science of the Total Environment

Dear Professor Zbigniew Kundzewicz,

Please see below the referees' comments on your manuscript "Hen-or-egg causality: Atmospheric CO₂ and temperature". As you can see, the reviewer(s) have some major concerns about the paper. Publishing in STOTEN is becoming increasingly competitive and while in some cases the referee's comments are not completely negative, there is limited space in the journal. With this in view, we have to prioritize papers that we publish and some good quality articles sometimes cannot be accommodated. Unfortunately, we can no longer consider the paper for publication in STOTEN. I hope that the enclosed comments will assist you in revising it for possible publication elsewhere.

In spite of the fact that the review did not go in your favor this time, we hope that you will continue to submit to STOTEN.

Sincerely yours,

Kuishuang Feng, Ph.D
Associate Editor
Science of the Total Environment

Important note: If a reviewer has provided a review or other materials as attachments, those items will not be included in this letter. Please ensure

therefore that you log on to the journal site and check if any attachments have been provided.

Reviewers' Comments:

Reviewer #1: Review of

"Hen-or-egg causality: Atmospheric CO₂ and temperature "

The authors present a study that intends to complement the conventional and established theory that increased CO₂ concentration due to human emissions cause increase of temperature, by considering the reverse causality. For doing so they examine the relationship of global temperature and atmospheric carbon dioxide concentration at a monthly time step, covering the time interval 1980-2019, in which reliable instrumental measurements are available.

They finally claim that both causality directions exist, but the causality from temperature to CO₂ being the dominant, and changes of CO₂ follow changes in temperature by about six months. Further they speculate about a possible positive feedback loop involving biochemical reactions.

Recommendation: Rejection of the paper

Reasoning for rejection recommendation:

1)

The authors are not applying causality analysis in any part of the manuscript, only time-lag correlation analysis, which is a different concept. It seems they are not familiar with scientific concepts of causality. Proven rigorous methods for calculating causality based on the information flow concept do exist and should be applied. See for example Liang, 2016 and several other related papers.

(<https://journals.aps.org/pre/abstract/10.1103/PhysRevE.94.052201>)

- 2)
Applying the causality concept of Liang to the monthly UAH temperature data and the Mauna Loa CO₂ time series gives strong significant causality only in the direction CO₂->Temp (0.51 ± 0.07), but nothing in the opposite direction. This completely invalidates all the claims the authors do, with respect to the reverse causality from temperature to CO₂ on these recent time scales.
- 3)
What is the purpose of the lengthy mathematical discussion in section 3.2 that's not used in the analysis?
- 4)
The analysis of monthly data might be irrelevant for the problem at hand. At monthly time scale temperature changes related with solar radiation changes will have an impact on the seasonal cycle of CO₂ in the atmosphere.
- 5)
Why the authors use two different temperature data sets, the satellite data set covering land and ocean, but the other data set CRUTEM4, covering only land, instead of using also the global (land and ocean CRUTEM4 data)?
The non-standard data-processing done before the analysis looks very suspicious. What is the reason to apply different 'normalization' methods for the two variables or to use a different time-span to compute annual means?
- 6)
Further, one of their initial points (lower CO₂ emission due to COVID19 while still high CO₂ in the atmosphere) is missing the real problem, natural stocks and interchanges of CO₂ are much higher than the human addition, but the main problem is the imbalance this 'small' anthropogenic amount creates in the system. Similar it has to be considered that indeed on very long time periods it seems that temperature is leading CO₂, but as many processes and effects are depending on the (time) scale, it cannot be concluded that this must also true for such short periods as considered here.
- 7)
Specifically, the authors are unaware of the progress in causality analysis during the past 30 years. They are still in the stage of "defining" causality while it has been rigorously formulated. Even if their definition would be by any chance ok to some extent, it is unacceptable without validation with the well-known benchmark problems. In this case, they "defined causality" as "time irreversibility," on the basis of some arguments such as Granger's first axiom. However, a recent paper by Palus et al., 2018, Causality, dynamical systems and the arrow of time (Chaos 28, 075307) shows that this axiom by Granger is WRONG.

In summary, the draft paper is applying a non-appropriate untested methodology for studying the problem at hand, clearly leading to wrong results and consequently in wrong conclusions and should be rejected.

Reviewer #2: Hen-or-egg causality: Atmospheric CO₂ and temperature
Demetris Koutsoyiannis and Zbigniew W. Kundzewicz

I am sorry to have to recommend rejection of this manuscript.

My prime reason is lack of originality.

The paper's finding is of two-way causality between atmospheric CO₂ and temperature. Yet precisely this has already been reported by Stern, D. I., and R. K. Kaufmann, 2014: Anthropogenic and natural causes of climate change. *Climatic Change*, 122, 257-269, doi: 10.1007/s10584-013-1007-x

From the Abstract:

We find that both natural and anthropogenic forcings cause temperature change and also that temperature causes greenhouse gas concentration changes.

This well-cited paper (93 citations according to Google Scholar) is not referred to in the present manuscript.

Secondly, the method used is a correlational method. Concerning this, I refer to M. C. McGraw, E. A. Barnes, Memory matters: A case for Granger causality in climate variability studies. *J. Clim.* 31, 3289-3300 (2018).

This also well-cited paper (30 citations according to Google Scholar since its recent publication in 2018) states in its Abstract:

In climate variability studies, lagged linear regression is frequently used to infer causality. While lagged linear regression analysis can often provide valuable information about causal relationships, lagged regression is also susceptible to over-reporting significant relationships when one or more of the variables has substantial memory (autocorrelation). Granger causality analysis takes into account the memory of the data and is therefore not susceptible to this issue. A simple Monte Carlo example highlights the advantages of Granger causality, compared to traditional lagged linear regression analysis in situations with one or more highly autocorrelated variables

The manuscript does not cite this paper nor to my reading make a case for the superiority of their method over pre-existing methods, including Granger causality, in the field.

I hope this review is of assistance.

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