Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
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# Comment on gmd-2022-106

Anonymous Referee #1

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Referee comment on "Empirical Assessment of Normalized Information Flow for Quantifying Causal Contributions" by Chin-Hsien Cheng and Simon Redfern, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-106-RC1, 2022

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The manuscript 'Empirical assessment of normalized information flow for quantifying causal contributions' by Cheng and Redfern considers how causal sensitivity could be measured through information flow in the context of climate science. The main potential contribution lies in the empirical definition of measuring causal influences between variables (i.e. causal sensitivity) as a product of a constant maximal causal sensitivity and a modified normalized information flow.

This version of the manuscript is much improved over a previous one that I reviewed, especially at the beginning. However, with the Results section when first test cases are evaluated the clarity is again lost (for me, at least). I also still find the mathematical notation confusing, possibly because I am not familiar with a few papers frequently cited in the manuscript. Variables seem to come and go, become multidimensional and scalar as you wish, and I don't see how different locations and time lags are fed into the overall picture. A good example is also Figure 1 where a thorough mathematical notation would allow the reader to immediately comprehend the meaning. I suggest introducing a consistent notation in a subsection that differentiates between all these points, which is then used throughout the manuscript and its figures.

Specific comments:

- l. 68: allow for a comparison?
- l. 69: 'for simplicity' probably suffices/is simple enough
- l. 79-81: I am slightly confused wrt the notation here. If X and Y are single variables (as implied by the text), how can then there be a maximum that is different from the same term itself? The text appears to imply that this is a statement over different locations and times, however, should this not lead to some sort of vector or matrix notation? L. 83/84 also seem to imply that there are at least multiple X. Bold notation needed?

- l. 110-115: here it is implied that somehow local or non-local does not play a role, so I am starting to wonder here how this relates to the notation above. I also don't understand at this point the link between the interchangeability over causes at different times and locations/identification of particular causes and how that links to natural methane emissions and global mean temperature. Is the global mean not exactly the opposite of identifying locations where specific processes lead to methane emissions? Maybe only rephrasing is needed? Could you clarify?
- l. 137-140: this raises the question as to why one would not use lagged relationships of X and Y in the set of variables? Is the discrete nature of lags a problem?
- Eqs (11)-(13) my first impression would be that the importance of shared causal influences will be problem-dependent. Could you clarify how each treatment would help/or not/ to generalize the concept, i.e. if problem-dependence in how information flows would affect the validity of the choice for Z?
- l. 185: word 'noise' missing here somewhere?
- l. 187: I don't understand why 21 steps of time lag equal 21% of each time analysed window? Can you explain the idea?
- l. 190: might be worth explaining that teleconnections stand for spatial interactions here? Again, how could the additional spatial dependency be better included in the mathematical notation employed here?
- l. 198-199: similar – suddenly X1, X2, X3 and Y1, Y2, Y3 are introduced, which I assume should indicate a problem with three X-variables and three Y-variables? Why this choice? Where was this introduced?
- Figure 1: again clarity of notation, e.g. in (b) what is the meaning of multiple arrows between X and Y? Representing multiple variables? Time lags? Spatial points? I don't understand why there are no teleconnections here, but there are in the other subfigures? Somehow this has to do with the crossing arrows, but I doubt that many will understand why this is a way to symbolize teleconnections (or how they are imagined here). For me, the notation throughout the manuscript is confusing and still reduces the clarity too much. There are multiple processes (X and Y) which are related spatially and temporally (with potential lags)? However, how do these differ in the notation, how are they made obvious? Maybe write a subsection where you formally introduce the notation you are using and be consistent afterwards.
- Figure 2 - I am lost here: what do the different colours stand for? How is this a test? I need a clear instruction as to how to read this plot. Why are the results good? Why do they confirm the hypothesis? Why does the second column sometimes look like a flat line? Which lines should be the same? The previous section already became less clear, but latest here I have literally no idea what is going on anymore. The reader has to work really hard to keep track. This needs to be improved.
- Figure 3 same.
- This could partly be helped, of course, by more clearly explaining what is going on in the Results sections here.
- Figure 5 same.