Interactive comment on "Detection and Explanation of Spatiotemporal Patterns in Late Cenozoic Palaeoclimate Change Relevant to Earth Surface Processes" *by* Sebastian G. Mutz and Todd A. Ehlers

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Mutz and Ehlers here present a description of their recent efforts to link GCM outputs with surface processes and landscape evolution. They analyze regions, or "clusters", across which they observe characteristic sets of changes between pre-industrial time and different times in the past. They have also published their model outputs, ensuring that the present analysis is not the only one that may be performed. Aside from a few points where I was not able to follow the argument, I found the paper to be well-organized and appropriate for publication. I feel that this paper should be accepted

with minor revisions, according to the line-by-line comments below.

Line-by-line:

16, 21, etc. I think that there should be emdashes instead of hyphens between PI and MH, LGM, and PLIO

24. explained –> described.

48–49. Modern climate is not always assumed, though. As an example with which I am quite familiar, we (Wickert et al., 2019) actually used plausible river discharges based on glacial-stage conditions including ice-sheet melt and precipitation minus evapotranspiration (Wickert, 2016) to understand incision of the Mississippi River. I strongly agree that using the appropriate past climate is important! But I am wondering if "often have to be interpreted" is a bit too strong in general – from paleo-proxy data, we generally do know something about how climate varied. But perhaps what you mean to say is that there is not a globally-spanning resource to do this and ingest it into models, which could in fact be closer to your aim (?) and a stronger way to state this.

p.2 and 3 overall: Consider ways to split this 1.5-page single paragraph – perhaps between background and what you do. (Even if it is supposed to be split at the list and I just don't see it, the p. 2 single paragraph definitely could benefit from being broken up into its sub-topics.

79. "lies on" seems awkward to me. Why not, "We focus on 4 regions..."

93, 95. Earth-surface here is a compound noun, and so should be hyphenated. It also seems that 93-95 is an accidental self-standing one-sentence paragraph

99. surface-process-relevant (compound noun)

112. Consider updating the PMIP reference, as new PMIP projects have run since 2012 – we are now on PMIP4! The following reference is an experiment overview. But in addition to just citing, I think that their science and model outputs could be quite

useful to you and your future work.

Kageyama, M., Braconnot, P., Harrison, S. P., Haywood, A. M., Jungclaus, J. H., Otto-Bliesner, B. L., ... Zhou, T. (2018). The PMIP4 contribution to CMIP6 – Part 1: Overview and over-arching analysis plan. Geoscientific Model Development, 11(3), 1033–1057. https://doi.org/10.5194/gmd-11-1033-2018

119. Consider starting a new paragraph at "Mutz"

142. "of interest to the Earth surface": rephrase. I know what you mean, but Earth's surface doesn't have the mental capacity for interests.

143. communities (plural)

144-145. hyphens to emdashes (indicating range)

163-170. In your place, I would have added evapotranspiration (or P-ET) to this list, as the sum of latter across watershed is what should control river discharge. Could you explain your decision not to include this?

175. New paragraph at "clustering".

178-180. I think that the writing would be clearer if you focus on this criterion before the preceding sentence, in which you give the appropriate values. So, methods → results.

203. I'm a bit confused here by the mention of the number of cluster members. I had thought that the clusters themselves were not yet defined. Or by this, do you mean "grid boxes"? Or "groups selected and then tested"?

Equation 4 seems unnecessary – perhaps you can just write that you maximized Γ.

Equation 6 seems strange for multiple reasons. But now I realize that what looks like strange matrix multiplication is actually really several separate matrices. Please also ensure that you have reasonable formats, including consistent positioning and orientation of ellipses, brackets that look like brackets long brackets (this is more for

typesetting, but these look like you just stretched short brackets, thus ending up with long knobs on the ends), etc. The latter comments are for style, but the former are for content.

224. Could you describe your solution technique in more detail? I do not understand why you needed to partially differentiate the equation (or with respect to what) in order to solve it.

224. Could you explain mathematically what you mean by "standardized"? This is the point at which I no longer have enough information to understand or reproduce your approach. In addition, I quite dislike two-letter variables: it is then quite difficult to know if they represent two variables that should be multiplied together, or a single variable.

253. Please read this paragraph and split it at the point at which "Erosion rates..." is no longer a good topic sentence. I suggest at, "The anomaly cluster".

262-263. The "Late Pliocene" sentence seems a bit unnecessary – if you want to add an example, consider using something with a reference to demonstrate that this would be the case.

316. Argentina, AND THE central and...

364. endashes

364. "decreases in 2m air temperature AND freeze-thaw days, and": separate decreases and increases. In general, I suggest that you use the Oxford comma; it can disambiguate your complex lists.

366. These cells are covered by more than just the Scandinavian ice sheet.

399. PLIO→MH?

423. incl. The→including the

424. temperature, and WITH (required to split lists)

458-459. large-scale

462. and→as well as to (required to split lists)

490-494. Consider noting something about changes in evapotranspiration vs. changes in erosion rate due to the physical presence of vegetation (e.g., roots)

525. erosion-relevant

525. By "high" do you mean small spatial, short temporal, both, neither?

Data availability: I suggest that you obtain a DOI for your model outputs.

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