Answer to reviewers

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submitted to
Earth System Dynamics

July 13, 2023

Dear Dr. Franzke,

Please find attached our last responses to reviewer comments and our revised manuscript. We hope this revised version will address all remaining concerns.

We take this opportunity to thank you and the reviewers for your time and constructive comments, which considerably improved our manuscript.

Best wishes,

Alexandre Tuel and Olivia Martius

Response to comments by reviewer #1

Comment 1.1 *I think the paper is suitable for publications as is. There is a small misprint. The section number 5.1.1 is repeated twice. The second one should be numbered 5.1.2*

Answer: Thank your for your useful comments during this review process. The typo is now fixed.

Response to comments by reviewer #2

Comment 2.1 *The added first figure did make the overall concept clearer. However, the author did not reference the figure in the main text. A related issue is whether the author could create another figure or modify Figure 1 to include all the sections, rather than just Section 4 and Section 5.*

Answer: Thank you for this comment. We added a reference to this figure at the end of the introduction. We also updated the figure to refer to section 2 as well. However, for the sake of keeping it legible, we would rather not make it more complex.

Comment 2.2 *Regarding the indication of equations, there seems to be inconsistency in the author's approach. Sometimes the authors simply mention the equation number in the sentence, while other times they do not. To reduce the chance of misunderstanding, I suggest that the author maintain consistency when referring to specific equations. For example, they could use the format "Equation 1," "Equation 2," or another form such as "Eq1," "Eq2."*

Answer: Good point. All equations are now referenced by "equation (n)".

Comment 2.3 *In relation to the research questions (L54-57), it may be beneficial to discuss or provide clarification regarding stationarity or recurrence in this section.*

Answer: We expanded the introduction of the stationarity/recurrence topics at the beginning: "*Surface weather persistence at sub-seasonal to seasonal (S2S) timescales can have severe impacts on human and natural systems. Long-lasting dry conditions, for instance, can lead to droughts and wildfires and can affect agriculture and energy production. Long-lasting wet spells may cause severe flooding and crop loss. Persistent surface weather can result either from quasi-stationary, long-lived atmospheric circulation conditions (stationarity) or from repeated, shorter-lived circulation features (recurrence). Recurrence refers to the repeated occurrence of similar large-scale circulation types or weather systems within some (S2S) time interval, usually with brief interruptions. Many recent high-impact weather and climate events were linked to persistent quasi-stationary or recurrent weather conditions. An example for recurrence are the Western European floods in July 2021 that occurred at the end of an extreme wet spell in Western Europe. The wet spell resulted from repeated atmospheric blocks and Rossby wave breaking episodes (Tuel et al., 2022b). Other examples of recurrence include the floods in the UK during winter 2013-2014 and in Queensland (Australia) in February-April 2022 both were caused by sequences of cyclones (Huntingford et al., 2014) (Wikipedia, 2022; Floodlist, 2022). An example for quasi-stationarity is the catastrophic flooding in Pakistan in summer 2022 that resulted (in part) from long-lasting and particularly heavy monsoon rains (Mallapaty, 2022). Intense heatwaves and associated atmospheric circulations also tend to be persistent (often arising from a combination of recurrence and quasi-stationarity) (Lorenz et al., 2010), as in Western Europe in 2003 (Black et al., 2004; García-Herrera et al., 2010), Western Russia in 2010 (Drouard and Woollings, 2018; Di Capua et al., 2021) or China (WMO, 2022) and India (Bloomberg, 2022) in 2022.*"

Comment 2.4 *L24: merge the citations.*

Answer: Done, thanks.

Comment 2.5 *L73: in spring 2019? – it seems you indicated 1979.*

Answer: It is indeed 1979, thanks for noticing this typo.

Comment 2.6 *L100-120: I suggest the author rephrase or emphasize main points at the beginning. It takes time to grasp the idea (could be my problem).*

Answer: Please see our answer to your Comment 2.3.

Comment 2.7 *L233: is the ()t consistent with the previous one?*

Answer: Since we specify "the set of values" then the index is not really needed. We changed to "*They require the set of all* $\mathbf{x}(t)$ *values...*"

Comment 2.8 *Figure 12: the caption: 1975-2004.*

Answer: Thanks, change made.

Comment 2.9 *Figure 16: what are the differences between the different shadings?*

Answer: Thanks for noticing. The stippling/hatching refer to positive blocking/cyclone frequency anomalies. We added the following sentence to the caption: "*Stippling (respectively hatching) indicates atmospheric blocking (respectively cyclone) frequency anomalies larger than 30%.*".