



EGUsphere, referee comment RC1
<https://doi.org/10.5194/egusphere-2022-523-RC1>, 2022
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Comment on egusphere-2022-523

Anonymous Referee #1

Referee comment on "On the interaction of stochastic forcing and regime dynamics" by
Joshua Dorrington and Tim Palmer, EGUsphere,
<https://doi.org/10.5194/egusphere-2022-523-RC1>, 2022

This paper is concerned with the transitions between regimes in a very truncated barotropic atmospheric model with an orography, and focus in particular on the persistence of the blocking regime found in this model as a function the amplitude of an additive white noise.

The main novelties it introduces are the following:

- * The introduction in this model of a Markov model to model the transition between the regimes. The authors then study the lifetime of each regime using this model, showing that the blocking regime persistence is increased when noise is added.
- * The presentation of a mechanism to explain this increased persistence.

The manuscript is well written and for me it is worth publishing, but it also suffers from several problems:

- * The quality of the figures is very poor, with some labels and numbers barely readable.
- * I would test the peaks in the PSDs in Figure 5 against red noise surrogates to be sure that the noise generates new long-time behaviour in the system (resonances). It is done for instance in Groth, A., & Ghil, M. (2015). Monte Carlo Singular Spectrum Analysis (SSA) Revisited: Detecting Oscillator Clusters in Multivariate Datasets, *Journal of Climate*, 28(19), 7873–7893.
- * The presentation of the proposed mechanism for the delay of the regime on page 9 and 10 is poor. For instance:
 - capital letters are mixed with lower-case ones.
 - you should display the axis in Figure 8.
 - the symbol dt and dx in Figure 8 must be defined, they do not relate to anything in the text.

- line 178: you say that P has vanishing tails at x_p and I don't understand. To me you choose P with vanishing support outside $[x_0 - x_p, x_c - x_p]$ (I would rather say with support on $[x_0 - x_p, x_c - x_p]$, but alright).
 - line 179: you state something about Δx , but it doesn't mean anything, you have to express that in term of the moments of P.
 - line 193: You say that I is positive definite. I am not a native english speaker but to me this expression is reserved for matrices and bilinear forms. Please check.
 - In the case of a concave curvature (for a positively oriented variable), would the persistence be decreased? Could you comment on that?
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I have also a more general comment. The view that regimes can be described by fixed points has been criticized and is somehow a bit outdated. The authors cite Faranda et. al. (2016) as a sort of "proof" that blocking is involving an unstable fixed point. However, you have to note that this study was involving only one field (z500), while blocking is most likely a multi-dimensional problem. Also, to my knowledge, they collapsed together all blockings from all seasons in the northern hemisphere to perform their analysis, while it is well known that blocking is very different in winter and in summer. Finally, this study presents as a sort of argument of authority that their method using the concept of extremal index detects only unstable fixed points, while if you read the papers they are citing, you discover that this is valid only for idealized uniformly expanding systems, and that it can detect also periodic orbits. In that sense, I would take the claim that blocking is uniquely defined by unstable fixed points with a grain of salt. Reality is probably more complicated, with developed chaos playing probably a role. I would be surprised if the structure involved is as simple as a fixed point.

I would also suggest to the authors to read and maybe mention the work on UPOs in this framework by Lucarini & Gritsun (2020) and also the work on Lyapunov vectors by Schubert & Lucarini (2016).

Minor corrections

- lines 126-127: The expression "by the time" here seems a bit odd. Please check.
- line 167: "As the stochastic becomes". What does it mean? Please check.
- line 240: Citation should be (Dor, 2022) ? Also does not appear correctly in the references list.

References

- Lucarini, V., & Gritsun, A. (2020). A new mathematical framework for atmospheric blocking events. *Climate Dynamics*, 54(1), 575-598.
- Schubert, S., & Lucarini, V. (2016). Dynamical analysis of blocking events: spatial and temporal fluctuations of covariant Lyapunov vectors. *Quarterly Journal of the Royal Meteorological Society*, 142(698), 2143-2158.