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Earth System Dynamics
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Interactive comment

Interactive comment on "Minimal dynamical systems model of the northern hemisphere jet stream via embedding of climate data" *by* Davide Faranda et al.

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We thank the reviewer for her/his comments. Our answers are given in bold text, the reviewer's comments are shown as plain text.

The manuscript needs to be substantially improved before I can recommend it for publication. In particular, presentation of the CML model lacks clarity for general readership, as well as interpretation and significance of some results are overstated.

Both Reviewers have highlighted lack of clarity for ESD readership as a key shortcoming of our manuscript, and we have taken this comment very seriously.

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Discussion paper

In addition to the changes detailed in the replies to the individual comments below, we have added two appendices providing background on some key concepts leveraged in the paper: Appendix A: Coupled map lattice, and Appendix B: Average return map and noise.

Comments: 1. Please provide some background on CML and why it has been chosen for this study.

We will describe the full model at the beginning of Section 3, and further include a brief background review of CMLs, motivating their use here, as an appendix in the new version of the manuscript.

2. Please provide more mathematical details on return map in Section 3 and how it can be used to estimate f(x).

We have added a clearer mathematical background on return maps in Section 3, and also highlight its advantages in the present context.

3. Why the particular form of Eq (4) is chosen and how these coefficients are estimated?

The particular form of equation 4 is chosen as the one best fitting the data and presenting a stable state around 0. We have tried other functional forms for the maps given in Eq. 4. An account of this will be given in Section 3 in the revised version of the study.

4. What about uncertainties in the model coefficients? Fig. 3 shows that red line (Eq.4) seem to be missing excursions that are very few to begin with.

The return map is obtained by adapting the model to the data. The phenomenological properties, such as bifurcation structure, are largely independent of the selected parameters. The excursions are modelled via the stochastic escape that will add fluctuations on top of the red line. We will explain this in the new version of the manuscript.

5. It is rather hard to follow the discussion of the stochastic noise terms and it leaves impression that they are tuned without much mathematical guidance.

In the new version we will explain the rationale behind: (1) local noise, (2) spatial boundary conditions, and (3) global noise, more clearly in the manuscript. We have further made an effort to highlight that these issue from both mathematical and physical considerations, which ground our model in both dynamical systems theory and atmospheric dynamics.

6. The Fig.7 comparison of summary statistics (ACF and PDF) for the optimal value of epsilon = 0.4 does not show much qualitative agreement between the modeled and observed dynamics (also in P15 in conclusions). The space-time patterns also look visibly rather different. It makes look weaker the rest of results on bifurcation analysis and dynamical indicators.

Indeed, we realized how important it is to provide a quantitative characterization of the spatio-temporal properties of the model versus data. We proceed as follows: we binarize the data so that "1" is any shift towards the northern jet state and "0" is a shift towards the southern jet state. We then compute the time and spatial cluster size distributions for different models, including or not the noise terms and show their importance in matching the distribution of the jet position observed in the data. We will replace Figure 7 in the paper with the new Figure 1 here in which we show these analyses. This figure shows the role of the term $r^{(i)}$ in the shift of the jet position towards northern or southern latitudes. The figures show the fraction of shifts towards the north: a value >0.5 indicates that the jet's preferred position is to the north, a value < 0.5 that the jet's preferred position is to the south. a) Model with $r^{(i)}$=0 over oceans and $r^{(i)}$=-0.02 over the mountains (same domains as given in the previous version of the paper). b) Model with $r^{(i)}$=0 for all the latitudes. Red: shift frequency from data. Black: shift frequency from the model: each line corresponds to a realization of the system. The best model is now obtained for the parameters η=1.2, ϵ=0.33, $r^{(i)}$(oceans)=0,

$r^{(i)}$**(mountains)=0.02**

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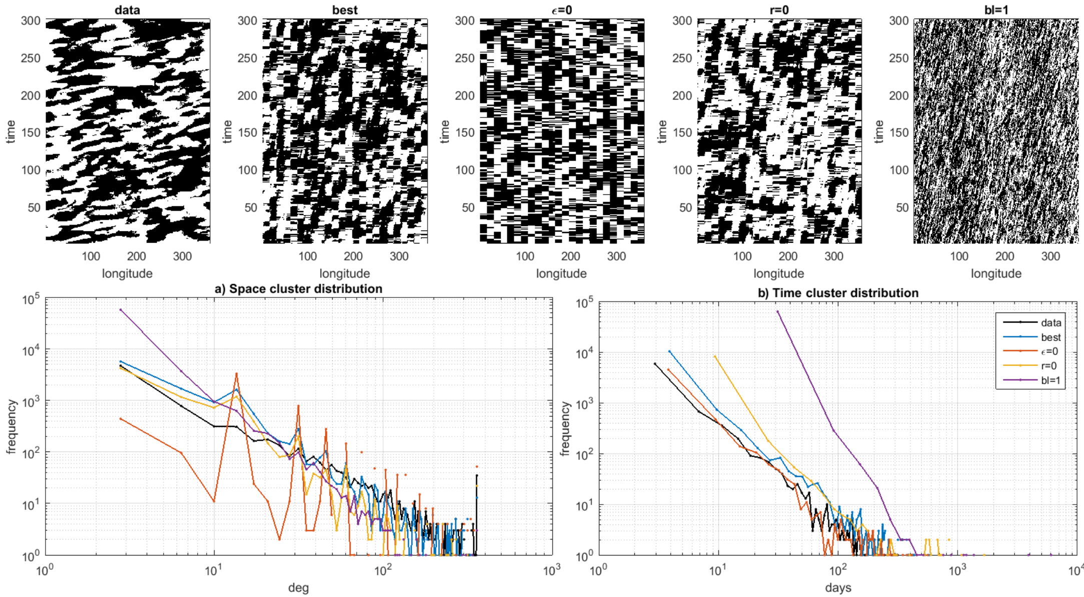

Fig. 1. . Upper plots: Temporal and spatial cluster size distribution for the ERA Interim data (top left), and few different model runs. Lower plots: space time cluster distributions

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