Geoscientific

Model Development

Discussions

[GMDD]

Interactive

comment

Interactive comment on "Spatio-temporal consistent bias pattern detection on MIROC5 andFGOALS-g2" *by* Bo Cao et al.

Anonymous Referee #1

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This paper presents a new method for detecting and analyzing spatial-temporal consistent bias pattern in climate models. A good introduction is given about the general context, the methods used for climate model evaluation and their limitations in section 1. The method is presented clearly in the method section and the results of the application on precipitation from MIROC5 and FGOALS-g2 compared to the precipitation from GPCP data set are presented in section 3. A very short summary and discussion is found in section 4. The method proposed here is relatively original and could become a useful tool for the analysis of climate data (not only model outputs) through the analysis of anomalies. However, the discussion is very short and lacks comments about the limitations of the method. My main concern is that the authors seem to have compared directly time series from observations and freely evolving climate models. The limita-

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[Discussion paper]

tions associated with this issue should be treated with care and properly discussed. Other possible applications of the method as suggested below should be considered in order to propose a more robust analysis of the method and its limitations. The introduction could be slightly improved by adding a couple more information about the context, some perspectives and a few more references. The form of the text is understandable and the number of grammar errors limited although the paper could be improved by having it checked (once again ?) by an English native speaker (which the reviewer is not). I think the paper should undergo major revisions before being accepted.

General comment about the introduction :

Climate models biases spatio-temporal consistency or "stationarity" has important implications for the validity of climate model bias corrections methods (in this regards, see publication by Krinner and Flanner, 2018). This might be worth mentioning in the introduction.

General comment about the method and its application :

1) It is unclear to me whether the matrix of biases (or residuals) for MIROC-5 and FGOALS-g2 were obtained by directly comparing time series of the model to the monthly time series of GPCP data set or to the monthly climatology of GPCP ? In any case, it is challenging or even questionable to directly compare the time series of freely evolving climate models to an observational time series due to the independence between the two time series as freely evolving climate models own their inner variability. Differences for a given month should therefore in any case not being called a "bias". Possibly, the fact that the bias detection algorithm is applied on a long climate period with thresholds on the size of the area and the length of the period to identify "bias families" allows for the method to identify actual biases of the climate model but this issue should be handled with care, more deeply explored and discussed. In my opinion, the application of the method proposed in this paper is more straightforward and easier to justify for the detection of biases in climate simulation (GCM or RCM) nudged towards

meteorological reanalysis and directly compared to time series from observations (discussion of surface climate biases mostly in this case) or for the detection and analysis of climate anomalies as suggested by the authors in their discussion.

2) Why focusing particularly on these two climate models and only on precipitation ? Extending the analysis on other climate models would increase the robustness of the results and the conclusion drawn from them, while applying it to other climate variables (e.g. temperatures) would open possibilities for exploring links between biases among different variables (e.g. temperatures and precipitation) as the method is meant to be a tool for a better understanding of the sources of the climate model biases as the authors mentioned. If an extent of the application and the analysis on other climate models and/or other climate variables, the authors should at least justify why they restrained their analysis to these two climate models and to precipitation.

3) Applied on monthly values as it is in this paper hampers the method from detecting model biases that evolve with the daily cycle (which is often the case for temperatures and precipitation). Would the method proposed in this paper be able to deal with this type of biases ? If this is not explored by a short application of the method on data at a higher time resolution, this should at least be briefly mentioned and discussed.

More particular, minor comments :

Title : If the method is meant to become a useful tool for climate models analysis a more general and "attractive" title should be considered, for example "Spatio-temporal consistent bias pattern detection method : application on MIROC5 and FGOALS-g2 precipitation"

P1 L18 : I would rather recommend the use of AOGCM or CGCM (used but nor defined in P2) acronym when speaking precisely of coupled atmosphere-ocean general circulation models.

P1 L20 : May-be add a more general reference about biases and evaluation of climate

models (e.g. Flato et al., 2013 from IPCC AR5).

P1 L22 : Since it is a widely spread and studied bias, may-be, add one or two more references about the double ITCZ.

P2 L30 : "Highlight" or "evidence" may be more appropriate here than "discover" ?

P3 L13-28 : A brief summary of the method (already present in the abstract) as well as of the results might not relevant at this point in the paper. At this point, readers might just want to know about what they will find in the different sections of the paper.

P4 L8 : Which statistical tests will be available for users to determine significance of the biases ?

P7 L7 : How were the values of the parameters determined ? Did you performed some sensitivity tests ?

P8 L8 "Positive residuals are plotted in red and negative residuals are plotted in blue". I think this sentence should only appear in the caption of the figure.

P9 L13 "In longer time series, the percentage will be even lower, which indicates that analysis or similarity calculations based on the entire series could be misleading" → I am not entirely sure about this statement, and it should in my opinion be explained more clearly if it is a meaningful result.

P9L21 "One mainly consists of negative biases while the other mainly consists of positive biases. As a result...." This result might simply just be the consequence of the model and observational time series being completely independent and disconnected. As already mentioned, I think the authors should deal more carefully with this issue.

References :

Flato, G., Marotzke, J., Abiodun, B., Braconnot, P., Chou, S. C., Collins, W. J., Cox, P., Driouech, F., Emori, S., Eyring, V., et al.: Evaluation of Climate Models. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the

Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Climate Change 2013, 5, 741–866, 2013.

Krinner, G. and Flanner, M.G., 2018. Striking stationarity of large-scale climate model bias patterns under strong climate change. Proceedings of the National Academy of Sciences, 115(38), pp.9462-9466. https://doi.org/10.1073/pnas.1807912115

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