**Hydrology and
Earth System
Sciences
Discussions**

Interactive comment on "Climate model bias correction and the role of timescales" *by* J. O. Haerter et al.

Anonymous Referee #2

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1   General Comments

The manuscript "Climate model bias correction and the role of timescales" by J.O. Haerter, S. Hagemann, C. Moseley and C. Piani discusses the influence of climate model bias corrections on processes living on different time scales. They introduce bias correction approaches, particularly one based on (affine) linear transfer functions and exemplify the problem on a global daily temperature data set. The pivotal finding for the bias corrected daily model data set is that the variability of the monthly means does not correspond to the observed variability of monthly means. They consequently suggest an augmented bias correction involving anomalies on different time

scales, i.e. monthly means additionally to daily values, to overcome this problem. A generalised version of this approach has been exemplified for hourly model data for one station. The manuscript ends with a theoretical motivation for this approach based on a one-dimensional energy balance model.

It is important to raise awareness that matching the variance of daily model values and observed daily values does not necessarily imply that the variances of the monthly means are equal. As the authors mention, the process governing the monthly means is certainly different from the one governing the fluctuations of daily values. The augmented bias correction algorithm presented here is certainly useful for those who want to perform one bias correction procedure and need to rely on the property that the variances of hourly, daily and monthly means match those of the observations. But a discussion what these bias corrected values actually mean should be included in the manuscript.

The paper is understandable but extensive with some lengths here and there. I find the algorithm described in a reproducible way but the presentation of concepts and notations are in some cases not consistent or not presented in the proper order, see below. The title is adequate, the abstract, however, is not easy to understand beforehand. It would also be interesting to discuss some more general questions on bias correction and GCMs, see below.

2   Specific Comments

2.1   Abstract

You might consider to give an example, e.g. daily temperature, "time scale of the fluctuations" was too vague to grasp the idea of what is coming.

The word "persistence" is used in a misleading way, the word "stationarity" might be mode adequate.

2.2 Introduction

I think the introduction could be shortened and more focused. I was surprised by the concept "fitting probability density functions (pdfs) to the histograms". Usually pdfs are fitted to the data and not to histograms.

2.3 Statistical bias correction

There seems to be a back and forth between a general quantile mapping and a correction of the first two moments. A simple formula would also help to explain the quantile mapping: $TF(x_{mod}) = F_{obs}^{-1}(F_{mod}(x_{mod}))$.

I find the presentation of the bias correction algorithms in Sec. 2.1. not very easy to understand. Subscripts are not explained or explained too late in the text. Furthermore, I have the impression that affine linear ($Ax + b$) and linear transformations (Ax) are mixed.

The last but one paragraph of Sec.2.1 is hard to understand and should be revised.

2.4 Bias correction with GCM data

I find the measure in Eq.3 not really intuitive. It would be good to motivate it a little more. Why not using the ratio instead of the difference?

P. 7871, l. 6: Here you might add that the computation is repeated for the monthly mean values of temperature obtained from the bias correction based on daily values.

P. 7871, last paragraph: you state "no systematic" pattern and say subsequently that ECHAM5 generally underestimates. The latter would be a systematic pattern for me.

P. 7871, l.28: Please check the sentence: "Clearly, the bias in the day-to-day ...". Is that right?

2.5 Improved statistical bias correction

This section might benefit from the use of the concept "anomalies".

2.6 Discussion

Is the presentation of the energy balance model really necessary? I find it too long. Maybe it can be shortened?

2.7 Further General Questions

Reading the paper, I was surprised that it is actually expected, that a bias correction on the daily level should compensate also for a mismatch of variances on the level of monthly means. Is this really expected in the community?

Remember that only the first two moments are matched by the procedure you describe (or the affine linear TF in general). This is a quite good approximation for Gaussian-like data, e.g. for daily (and larger time scale) temperature. But might not help a lot for values with a distribution very different from normal.

Are GCMs really made to yield "realistic" daily values? Does it really help to scale the variance of daily GCM data such that it matches the observed daily variance? This is only one characteristic of daily values. I am asking that to encourage a discussion on that topic, not because I think it might not be helpful in some cases.

3   Technical Corrections

I am surprised about the use of some English words. You might consider to let a native speaker check. Some examples are:

- detrimental

- couched

- "tier" cascade

- "Utility" of the statistical bias correction

- resort

- We caution that ...

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