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Hydrology and Earth System Sciences Discussions

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

J. O. Haerter et al.

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Reviewer #1 Received and published: 4 November 2010

We thank the reviewer for her/his comments. We believe that they have greatly helped improve the clarity of the manuscript.

Reviewer #1 rejects the manuscript. The main reason for this is what the reviewer detects as a 'misunderstanding of what bias correction can actually correct in principal'. The reviewer goes on to point out that misrepresentations of dynamical processes, such as ENSO and storm tracks, cannot be corrected by the bias correction methodologies put forth in this paper. In the following 3 paragraphs, the reviewer effectively

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Interactive Discussion

Discussion Paper

illustrates cases where a grid point based bias correction may be effective and cases where it will not. The critiques put forth by the reviewer are pertinent and well founded but do not, we believe, stem from a misunderstanding of what bias correction may achieve. Instead we feel that the goal and motivation behind grid based bias correction has not been effectively put across. In particular we have failed to define terms used in a way acceptable to a wider audience of climate scientists. Most importantly, as the reviewer points out, we failed to discuss which 'errors' can be corrected by bias correction and which cannot. In this paper, as in past bias correction papers, bias is intended as the time independent component of the error. The error is the difference between the simulated value and the observed. Bias correction is done as part of the post processing of simulated data. It cannot add information or skill to the simulation and it most certainly cannot eliminate the error. The only thing a bias correction can do is eliminate the time independent component of the error if it exists. Crucially, if there is no bias, that is if there is no constant portion to the error, the bias correction methodology leaves the simulation unaltered. We agree with the reviewer, as any competent climatologist would, that, in the two examples she/he puts forth in paragraph 3, our bias correction method would probably bring no improvement whatsoever to the simulation. In both of these cases we can expect there to be little or no correlation between the simulated grid point value and the observed. In case 2, in the simulation the grid-point would be under the influence of the storm tracks and in the observations it would not. Most likely the difference between the two time series would have no constant component either in the mean, variance, skewness or other statistical property. A grid point based bias correction cannot remedy this. We will add to the authors critique in that, along with spatial offsets, a grid-based bias correction cannot even compensate for temporal offset. If the monsoon in India is appearing with 1 or 2 weeks delay in the model compared to observations, this cannot be corrected by this method for similar reasons. This is explained in the first two articles published, earlier this year, which presented the simple, non cascade, version of this bias correction method (Piani et al, 2010a&b). The reviewer's comments clearly indicate that we have been negligent in

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explaining the setting of the paper. We have added text to the discussion to explain this clearly and emphatically. Regarding the applicability of a grid point based bias correction to future scenario simulations we fully understand the reviewer's misgivings. We would suggest a change in perspective. When hydrological models, or other impact models, are forced with simulated scenario data, some form of bias correction must be and is routinely done. We are proposing a method that will improve on the way bias correction has been done in the past. When only the trend or anomaly in precipitation and temperature is taken from the simulations and is added to the observed fields to force hydrological models, it is tantamount to bias correcting with an additive constant. When the standard deviation is 'inflated' to match observations, it is tantamount to bias correction with a multiplicative constant. The bias correction methodology presented in Piani et al. 2010b has the potential to correct the bias, not the error, in all moments of the intensity spectrum using a more sophisticated transfer function. The evolution presented in this paper addresses the problem that the moments of the intensity spectrum vary depending on the time scale of the statistic (for example daily values versus monthly). The problem of applicability of the bias correction parameters to a time period different from the one used to derive the parameters is, as the reviewer points out, crucial. That is why, in this as in past papers, we show results from the application of the bias correction method to time intervals different from the ones used to derive the parameters. Hence, we stress that we are not discussing potential benefits of the methodology, we illustrate and discuss the measured improvements in the statistical properties of the corrected fields in the appropriate experimental setting to gauge the applicability to future scenario impact studies. In Piani et al. 2010b we advanced the point further proposing a method to take into account the uncertainty associated with the bias correction parameters and we regret not to have mentioned those results here. The reviewer's comments indicate that the discussion of these issues cannot be dispensed with or delegated to referenced work. We have added text in the first paragraph of the introduction and the first paragraph of the discussion section to discuss: - The uncertainty associated with applying grid-based bias correction to future scenario runs. (discussion) - The limitations of bias correction with particular regard to a) The distinction between bias and error (introduction and discussion) b) The inability to fix dynamical misrepresentations in the model (discussion) c) The inability to correct bias in the seasonal onsets. (discussion) - The potential physical inconsistency between independently corrected fields (discussion).

In short, given that we find no fault with the reviewer's rationale, we believe her/his main critiques uncover a lack of clarity rather than competence on our part. We hope the reviewer will find that the revised manuscript correctly and exhaustively discusses the scope and limitations of grid-based bias correction.

Minor comments:

Rev 1: The authors do not cite state of the art literature. E.g., the papers by Widmann et al and Schmidli, 2006, using scaling for precipitation bias correction have not been mentioned at all.

Haerter et al.: We are aware that not all related bias correction papers have been cited. We have had to make a selection in order to limit the total number and therefore cited the review article by Maraun et al. (2010) on precipitation downscaling. This review includes references to both articles the reviewer mentions.However, we have now added the reviewer's suggested references to make sure they receive sufficient attention. We feel that a large number of very recent bias correction papers are now cited.

Rev 1: The authors should state whether they apply the so-called delta method (corrected scenario = scenario transformation of the observations) or the direct method (corrected scenario = corrected model scenario). As the authors only discuss mean values but never state how a single corrected value is calculated, this is not clear at all.

Haerter et al.: We feel that the terminology 'delta method' or 'direct method' is not essential to describe all bias correction methods. We agree with the reviewer that

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the paper lacks clarity regards to how the method is applied and have added text to remedy this. To make clear that the actual simulated time series for the future scenario computation is preserved, but corrected using the transfer functions derived from the control period, in section 2.1 we add "To apply the bias correction to a modeled time series, for each individual value of the model data, the transfer function is used to map this value onto a modified (bias corrected) value. A more detailed description of the method is available from Piani et al. (2010b)."

Rev 1: If I am not completely wrong, the first term in equation (3) should be exactly zero by construction

Haerter et al.: This is not generally the case for two reasons: First, we are using the same formula for the daily and monthly mean fluctuations. In the monthly mean case, but for bias corrections based on daily values only, the result for the monthly means does not become zero. Second, in an actual bias correction the linear fit to the data is never perfect. Hence, small discrepancies result when the variance of the bias-corrected is compared to that of the observations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 7863, 2010.