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Discussions

Interactive comment on "Precipitation bias correction of very high resolution regional climate models" *by* D. Argüeso et al.

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The authors present a new method for correcting model biases by using gauge data directly, instead of the common method of using gridded observational data. As point source measurements can have fewer wet days than measurements aggregated over larger areas, this reduces the number of wet days in the reference data, thus allowing the model to be drier and still fulfilling the assumption of being wetter than the reference data. Such an assumption is necessary to correct bias with most methods, without generating artificial events. The paper is well written, concise, and the case is mostly clearly presented.

Main comments:

The main point of the paper is to provide a method for bias correction for model simulations where the number of wet days in the model is lower than the observations. It is implicitly assumed that point source data (gauges) have less wet days than area integrated data (gridded). Although I do not doubt the validity of this assumption, it is not sufficient. The model could anyway have too few wet days, the proposed method has only lowered the threshold for the observations. So the original problem is not solved, as the authors argue, but rather reduced.

Furthermore, using gauge data (practically a point source) will inflate the variance of the pdf (Maraun, 2013). The authors should at least discuss this issue, or preferably investigate it further with their data.

The “drizzle effect” is a model phenomenon where the model to readily produces precipitation. It is not correct to refer to the increase in low intensity precipitation with spatial (or temporal) averaging as a “drizzle effect”.

A new figure should be provided that shows the bias in number of wet days for the WRF simulation at 2km, and for each season. This should be positive at all locations, otherwise the method was not successful in fulfilling the assumption of a “wetter model”. Possible failures of the proposed method should be discussed.

It seems the authors used the same data for both calibration and validation of the method. This is generally not good practice, but given that the topic of this paper is to present a method, not a corrected data set that will be used for further analysis, I think it is fine if mentioned. Furthermore, given that the corrections were made for the calibration period, the results of the bias correction are rather poor. I assume the remaining bias is partly due to the averaging of corrections over five stations, but are there also other effects? Is the gamma distribution not a good approximation? Please discuss also such aspects.

The skill score used to evaluate the PDFs is mostly determined by the high probability values, i.e. the high skill scores for the corrected data are basically determined by the

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correction of the first few bins. Although a claimed limit for wet day is >0mm/day, the actual limit is higher (probably closer to 0.1) due to the gauge precision. A model is not affected by such limits and will therefore deviate in the first bin of the pdf (depending on the bins used for the pdf, I assume they start at >0 as nothing else is stated). This should be mentioned when discussing the results.

Minor comments:

P8146, L8-9: Please remove “than the gridded observational products” for increase readability

P8146, L11: Please change to “model outputs” or “resolution is compared”

P8146, L15: Please remove “selected and”. Also, please add a sentence here describing why the use of gauge data alleviates the problem, and indicate the limitations.

P8146, L22: “RCMs’ “

P8148, L1: Please include that the gridded data are more compatible with model data due to the representativity of an area as opposed to a point.

P8148, L8-9: “will fail to adequately”. That is not obvious. If you correct emiprically with histogram equalization, you will expect to have a perfect bias correction if enough wet days are present in the model. If that condition is not fulfilled, the correction will not be “perfect”, but might still be “adequate” depending on some possibly subjective requirements. If a distribution-based algorithm is used, the lack of wet days in the model might give a smaller error than the assumption for the applicability of the fitted distribution. So, please change to “...migh fail to ...” or similar.

P8148, L11-12: Same as above, “might be unrealistically...”

P8148, L15-16: Please clarify what is meant with the “drizzle effect” for gridded observations. It is different from the drizzle effect in models, see major comment.

P8148, L20: I propose, “Such RCMs are likely...”

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P8149, L12: Does the 2km domain have its western boundary in the mountain range? Might this be the reason for the bias over the mountains, and perhaps as a consequence east thereof?

P8149, L24: Please provide the lower measurement limit of the gauges.

P8150, L5-6: First, please change “number of days...” to “number of wet days...”. Second, there are many reasons for the number of wet days to decrease with increasing resolution of the model, e.g. model physics and paramterizations and spatial averaging. The two are easily distinguished by averaging the higher resolution data to the coarser grid. Only then are the different data compared on equal terms. Just a comment.

P8151, L12: Please provide some comments on why 5 stations were used, and a sensitivity analysis thereof.

P8151, L15-16: What about corrections for orography etc in gridded observations. This is completely discarded in the proposed method. Perhaps note in the paper that this would be a possible extension of the method.

P8151, L28-29: I believe only stations outside the precipitation region are penalized, those inside do not get additional larger weight. Please clarify sentence accordingly.

P8152, L5: Please verify the actual lower limit as determined by the measurement threshold of the gauges. Also, please provide a sensitivity analysis due to the choice of this low wet day limit, given that others have often used a higher limit.

P8152, L9: This sentence makes it clear the an excess of wet days in the model is assumed. But no analysis is provided to validate this assumption. This is serious, since the proposed method is dealing with that very assumption. I propose that a new figure with the bias in the number of wet days for the WRF-2km simulation is provided, with data for each season. This should be positive at all locations. If not, the this should be discussed.

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P8152, L14: “each of the seasons”

P8152, L16: “outputs”

P8153, L24 and below: The expression “events” is used here, but I think the more precise term would be wet days.

P8154, L13: “method’s skill”

P8154, L15: Which reference data is used for the skill score calculations? Also, see major comment on the interpretation of the skill scores.

P8155, L7: Again, the drizzle effect is a model phenomenon.

P8155, L7: “and thus might make this assumption valid again”. It might not be sufficient depending on the model bias.

P8155, 20: Please add discussion on limitations of the method (when it can fail etc) and possible extensions of the method.

Fig.1c, Fig.4legend, and Fig.6,legend: It is difficult to see the black dots and text with the dark colors. Please change color scheme for increase readability

Fig.5: Please use the same color scheme for points and grids, i.e. remove the legend to the right and use only the legend at the bottom. Furthermore, it is difficult to separate the colors, so please change to fewer steps and increase contrast between them. It is also useful to have e.g. gray color for the steps just above and below zero.

Fig.6: It is difficult to separate the colors for WRFBC and GHCN, please change one of them to a lighter shade or different color. Also, a lin-log or log-log scale might be more revealing.

Fig.6,caption: “events”, see comment above. check spelling of precipitation.

References: Maraun, D. (2013) Bias correction, quantile mapping, and downscaling: Revisiting the inflation issue, J. Clim., 26, doi:10.1175/JCLI-D-12-00821.1.

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