We thank the reviewer for the helpful comments. Our replies below are highlighted in italic.

Reviewer 1:
This manuscript provides a valuable contribution to the literature on bias correction, focusing on the issue of 'handling' inter-variable dependencies and consequences for derived impact metrics (here a heat stress index and a fire index). Overall the paper is well written and figures are of good quality. My comments are minor in nature and often addressed by technical edits.

My comments are as follows:
1. It would be meaningful to see an argument for why you are focusing on a global scale here (using GCM output) rather than output from regional climate models, that typically provide outputs used for impact models. I can see motivations for this, e.g. spatial (global) completeness, addressing the source of the change signal (as provided by the GCM – and then translated to a finer resolution by a RCM). I have no objection to the GCM focus but given that bias correction is typically a problem for impact studies, and many of these use downscaled data, you might want to provide a motivation for the experimental setup. I think it is also noteworthy that in the context of downscaling, some argue for bias correcting the input fields to the RCM –so to avoid propagation of error in the RCM. You might also want to talk to/refer to the issues of dealing with spatial dependencies – if corrections are applied to grid cells, how is spatial dependencies (and indeed temporal dependencies) preserved/modified.

Our focus on GCMs is motivated by global-scale impact modelling frameworks (assessing flood risk, crop impacts etc., as e.g. performed within ISIMIP). ISIMIP for instance remaps coarse-scale GCMs to 0.5 degrees and then applies bias adjustment. It is correct that for more local assessments often RCMs are used. However, since our study is quite general and of a more conceptual nature, the issues raised here also apply to RCMs. We will slightly revise the introduction and motivate the use of GCM output better.

Adjusting spatial and temporal dependencies might indeed be relevant for a number of impacts. Yet, selecting the appropriate spatial and temporal scales for each location and adjusting time, space and multiple variables at the same time seems rather infeasible at the global scale as it would lead to an explosion in the number of dimensions that need to be bias adjusted. We mention this aspect for hydrological impacts on P11 L21: "In these cases, the adjustment of the spatial and temporal distribution of precipitation might by more relevant than the adjustment of dependencies between precipitation and other climate variables." We agree however that this an important point to comment on and will extend the discussion in this regard. In particular, we will refer to a recent paper by M Vrac (Multivariate bias adjustment of high-dimensional climate simulations: the Rank Resampling for Distributions and Dependences (R^2D^2) bias correction, HESS, 22, 3175-3196, 2018) which proposes a bias adjustment method that can adjust spatial dependencies and works for a very high dimensionality.

2. I think you need a more detailed description of the model simulation datasets used in this study. I don't think it is enough to list what projects they are associated with, it would be meaningful to have details such as ensemble configuration, range of model resolutions, use of initial condition members (or not) etc. Under 'data' you could provide details on the re-

analysis dataset as well as on model ensembles (if you wanted to keep obs from model simulations you could use different sub headings). As it currently reads, different model names crop up in various places of the text and figures, which causes a bit of confusion upon reading.

Thank you for this comment. All models are taken from the CMIP5 archive, probably one of the most used model archives in current climate research. Listing the model configurations of all used models here (nearly 30) is not very informative for the readers as it has no relevance for the results. We therefore refer here to the original publication (Taylor et al., 2012). Nevertheless, we agree that in its current form the data section is not so easily accessible to researchers who are not familiar with the used datasets. We therefore extend the description of the used datasets and provide information on the rationale of the model simulations and their usage as well as more detailed information on the observational datasets.

3. I think it would make sense to explicitly state (in an appropriate place in the introduction) that we assume that bias correction to stationary, i.e. that it is valid to develop a correction under current climate and apply this in a warmer world.

Thank you, we will add this information to the introduction.

4. I would consider putting the bias correction methods into the manuscript as mathematical formula – this would enhance clarity in terms of understanding the methods, and it makes the paper self-contained (rather than pointing to another paper for understanding the specifics of the method).

Thank you for this suggestion. We will add more information, including formulas, on the used bias correction methods to make the paper more self-contained.

5. In section 15, instead of writing 'We then' I wonder if you should start with 'firstly' (or similar) – to reflect that this is the first step of the analysis? Or perhaps I have misunderstood.

We agree and will adjust the wording.

6. In the same section as above, I think it would be helpful to be more specific about what you mean with 'all other runs', all other CMIP5 current climate runs – all of them? Also, do you bias correct towards all of the CanESM ensemble members - all five? I wonder for this type of paper if you might want to think about some form of infographics, illustrating your experiment setup, what comparisons are made etc.

We mean all other runs of the CMIP5 subset used in this study (i.e., from 29 model simulations of the historical time period). We bias correct towards all CanESM runs to propagate the uncertainty related to internal variability through the bias adjustment. We will think about a small infographic to illustrate the perfect model approach.