Review of Manuscript

'Scaled distribution mapping: a bias correction method that preserves raw climate projected changes'

by M. Switanek et al.

Dear Editor, dear Authors,

I have reviewed the aforementioned work. My conclusions and comments are as follows:

1. Scope

The article is within the scope of HESS.

2. Summary

The authors present three analyses related to methods of univariate bias correction methods for climate model projections, mainly related to Quantile mapping (QM) and Quantile Delta mapping (QDM) approaches, and present a new method called Scaled distribution mapping (SDM). All work presented is based on daily mean temperature and precipitation data of the KNMI-RACMO22E regional climate model and E-OBS quasi-observational data for the periods 1951-2005 and 2006-2100.

The first analysis investigates the validity of the stationarity assumption inherent to QM bias correction. The authors show, by using two different calibration periods, that the difference in correction magnitude is in the same order as the climate change signal itself. The authors conclude that stationarity hence is not a generally valid assumption for bias correction methods.

The second analysis compares nonparametric and parametric ways to compare (and bias-correct) cumulative probability density functions of meteorological variables of interest. Using cdfs sampled from gamma-distributions, the authors show that differences in value at the extreme quantiles can often be attributed to insufficient sampling size rather than real differences of the underlying distributions. The authors show that fitting theoretical distributions to the samples mitigates this effect.

The third analysis addresses the validation of bias-correction methods by split-sampling tests. Here the authors demonstrate that this approach is not suited to distinguish performance of the raw model and the bias correction method. The authors argue that evaluation should focus on whether a bias correction method preserves raw model projected changes over time.

Based on these analyses, the authors present a parametric bias-correction method related to QDM (and hence free of the stationarity assumption) called Scaled distribution mapping, which uses different approaches for temperature and precipitation data, taking into account the particularities of each variable and aims at preserving the raw model projected changes. The methods are applied in a sliding window approach to capture the temporal evolution of climate change. Comparing SDM to QM and QDM approaches reveales that the first outperformes the others with respect to preserving the raw model projected changes.

3. Overall ranking

The work is ranked 'Major revision'.

4. Evaluation

The three analyses presented by the authors have been conducted in a sound manner, the conclusions drawn by the authors are correct. The new SDM approach is a reasonable advancement of existing bias-correction methods of the QDM type.

My concerns with the study are hence not related to its direct content, but to the validity of bias-correction methods to climate change projections in general. My arguments in this respect can be found in detail in Ehret et al. (2012). In my opinion, in order to make bias correction of climate change projections a valid procedure, the following questions need to be answered:

- Reliability: How can we justify that climate models with such large deficiencies that bias correction is required are nevertheless able to correctly predict climate change?
- Physical limits: Does the bias correction avoid pushing corrected values beyond physically based limits?
- Spatiotemporal field covariance: One of the main strengths of climate models is that they provide thermodynamically consistent spatio-temporal fields of all meteorological variables. Bias correction methods applied separately to each field potentially destroys this advantage. How to prove that a given bias correction method does not do so, or how to prove that the field covariance is of minor importance for the task at hand?
- Minor role of feedbacks among variables. This is related to the above point. How to prove that the feedbacks between the variables (e.g. in land surface - atmosphere coupling), that will be potentially impaired by bias-correcting individual variables, will either not be severely altered by the bias-correction, or that the feedbacks only play a minor role?
- How can we assure that a model deficiency manifesting as spatio-temporal offset will not falsely be treated as a magnitude bias (and hence be bias-corrected)?

Please note that these points are mainly of concern in climate change studies, where the future is unknown. I have no fundamental problem with post-processing of short-term forecasts, as here stationarity of climate and model deficiencies can reasonably be assumed, which allows to link post-processing methods directly to recognized, stationary model deficiencies and to evaluate their effectiveness.

Yours sincerely,

Uwe Ehret

References

Ehret, U., E. Zehe, V. Wulfmeyer, K. Warrach-Sagi and J. Liebert (2012): HESS Opinions "Should we apply bias correction to global and regional climate model data?" Hydrol. Earth Syst. Sci. 16 (9), 3391-3404, 10.5194/hess-16-3391-2012.