Hydrol. Earth Syst. Sci. Discuss., 9, C6226–C6230, 2013
www.hydrol-earth-syst-sci-discuss.net/9/C6226/2013/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Is bias correction of Regional Climate Model (RCM) simulations possible for non-stationary conditions?" *by* C. Teutschbein and J. Seibert

Anonymous Referee #1

Received and published: 10 January 2013

Review of "Is bias correction of Regional Climate Model (RCM) simulations possible for non-stationary conditions?" by C. Teutschbein and J. Seibert.

This paper assess whether bias correction techniques can be tested for non-stationarity, and if it is either possible or not to assess this. Although the paper is well-written well presented, the presentation of the methodology is somewhat unclear. The methods are tested on a few very small catchments in Sweden, so the generality of the results is questionable. The question posed is relevant, but the conclusions are not enough supported by the results. I would also recommend that the reference list

is updated. I therefore recommend that the paper undergoes a major review and is resubmitted to the journal.

Major comments

1. The authors perform a differential split-sample validation test (DSST) to assess the effect of bias correction methods. This was done by calibrating the methods on the coldest (driest) years for temperature (precipitation) and validating over the warmest (wettest) years over the period 1961-1990. The periods were selected from the observed data series. However, it is not clear to me how the wet/dry and cold/warm periods were selected from the RMCs. If the RCMs would have been driven by ERA40 (as in the Christensen 2008 paper) one can assume that a wet year in observations also would correspond to a wet year in the RCM-driven precipitation. However, since the RCMs in this paper are all driven by GCMs under scenarios this is not the case anymore. It is not true that the specific climate of a GCM projection will correspond to the same climate in observations, not even over a time period such as 30 years. A specific run of a GCM/RCM might have a cold and wet bias over the modelled period due to long-term climatic modes in the model. A bias correction using differential split-sample validation might then correct for biases that are caused by long-term climatic trends rather than model biases. This could have been avoided if the authors would have chosen the RCMs driven by ERA40, which are also available from the ENSEMBLES project, and I suggest that these are added to the study to see whether the conclusions are still valid.

2. The authors claim that the split-sample test on different climate situations is novel, but it has been applied in earlier studies and can hardly be called novel (for a full discussion on stationarity, see Maraun et al 2010). Also, to fully use the method the opposite calibration-validation should be tested (warm-cold and wet-dry) to see whether the method is non-stationary. I suggest that full cross-validation to evaluate the performance of the bias-correction techniques. This should also be done over seasons or months, since a wet/dry year does not necessarily tell you anything on the distributions

of rainfall. A few large events could turn an otherwise dry year into a normal or wet year. Furthermore, a validation over a control climate does not necessarily guarantee a valid method in a future climate. For a longer discussion on stationarity and validation methods, see Maraun et al. 2010.

3. Stationarity is a problem when it comes to downscaling, but it is more related to statistical downscaling methods than dynamical. In a statistical downscaling method this assumption is fundamental. However, if RCMs are bias-corrected, this is more likely not so crucial, since the underlying precipitation derives from a dynamical model. On the other hand, also GCMs/RCMs have large inherent assumptions of stationarity incorporated in the parameterisation, especially in the land surface component.

4. In one of the methods, variance scaling is used (Chen et al, 2011). However, von Storch (2000) showed how variance inflation is built on the wrong assumption that the variance of the predictor, and that it the inflated variable will have larger squared errors than the original.

5. The conclusion of the study is that the proposed methodology can evaluate the transferability of the methods to other climates, but I do not think that the results are strong enough to draw such conclusion. Firstly, the areas are very small and limited to Norhtern Europe. Secondly, a method that is applied to current conditions can only be valid under current conditions, even if it can separate different weather situations during that period. If a method is to be valid under future conditions it has to be tested under those conditions as well. One approach would be to test the methods in a "pseudo-reality", as in Maraun 2012.

Minor comments

1. P12766, L26-27. The authors mention the use of simpler bias-correction methods, but these are quite outdated, and methods using quantile matching or distributions to correct precipitation are more common now. See for example Maraun et al 2010, Themessl et al 2012 and Eden et al 2012

2. P12769, L4. You use 11 RCMs from the ENSEMBLES project, but there are a lot more available, why not use them all? Then you can also see how much bias originates from the GCM rather than the RCM. But as mentioned above, the ERA40-driven RCMs would be needed to be added to the analysis.

3. P12769. The first paragraph of section 2.3 could be moved to the introduction, since it is more of descriptive character.

4. P12770. L15-L24. The last paragraph could be moved to the discussion or the introduction, since it is rather arguing the drawbacks/benefits of bias correction.

5. P12770. L15. In the paper of Ehret et al 2012, they set out to discuss whether bias correction should be applied or not, since they claim that it hides the biases in climate models. It is a discussion paper, and therefore they are entitled to their opinion. However, In my opinion they are attacking bad science rather than actual bias correction, and they are depicting a too black and white picture of the science. If all the methods and results are clearly stated in a paper, then everything is transparent and the effects of bias correction are visible. Then their main argument fails. The paper also has errors in their interpretation of previous research. I am not saying that you should not use the reference, I am merely expressing my opinion that the particular paper is rather weak, which can also be seen in the interactive comments.

6. P12771. L22-23. I do not agree with this point. There are numerous bias papers who uses split sample approach and also DSST to evaluate their results, and I suggest that the authors do a more thorough literature review here.

7. P12772, L16-19. I would argue that these differences are most likely within the natural variability of current climate, and not a sign of climate change. Climate changes is expressed as changes in the mean climate over a long period, but the changes described have more to do with natural variability.

8. P12774. Why would you get larger relative mean errors and variability in the valida-

tion period for precipitation and temperature? Could this be related to the setup of the methods?

9. P12777, L1-3. I do not agree with this conclusion. There is very little difference between wet/dry years and cold/warm years over the observational time period, and I would hardly call this to push the bias correction to its limits. A full cross-validation over over regions with different climates would answer this question better.

References

Eden, J., M. Widmann, D. Grawe, and S. Rast, 2012: Skill, correction, and downscaling of GCM-simulated precipitation. J. Climate, 25, 3970-3984.

Maraun, D. F. Wetterhall, A. M. Ireson, R. E. Chandler, E. J. Kendon, M. Widmann, S. Brienen, H.W. Rust, T. Sauter, M. Themessl, V. K. C. Venema, K. P. Chun, C. M. Goodess, R. G. Jones, C. Onof, M. Vrac, I. Thiele-Eich, Precipitation downscaling under climate change. Recent developments to bridge the gap between dynamical models and the end user, Reviews of Geophysics, 48 doi:10.1029/2009RG000314, 2010.

Maraun: Nonstationarities of regional climate model biases in European seasonal mean temperature and precipitation sums. Geophys. Res. Lett. 39, L06706, 2012

von Storch, H. (1999), On the use of “inflation” in statistical downscaling, J. Clim., 12(12), 3505–3506.

Themessl MJ, Gobiet A, Heinrich G. 2012. Empirical-statistical downscaling and error correction of regional climate models and its impact on the climate change signal. Climatic Change 112: 449–468.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 12765, 2012.