Manuscript: hessd-9-10205-2012: On the need for bias correction in regional climate scenarios to assess climate change impacts on river runoff

Major remarks

Within the last few years, the bias correction of climate model output has become a hot topic within climate impact research. Here, the authors investigate the impact of bias correction on simulated runoff regimes and the relative change in selected runoff indicators over two mountainous catchments. They used bias-corrected RCM output to force four different hydrology models of various complexities. The paper is a valuable contribution to the bias correction topic and associated uncertainties attached to the GCM-RCM-Hydrology model modelling (HM) chain. Generally, the paper is well structured and concisely written. But the conclusions section needs some rewriting. Especially the following issues should be clarified and discussed more thoroughly.

1. Even though the paper generally writes about bias correction, it actually uses a specific bias correction method: "Local intensity scaling" for precipitation, additive correction for temperature, both on a monthly basis. Thus, in some aspects the results might be specific for this combination of methods.

2. Results and main conclusions may be specific for the climate regime covered by the two catchments considered, i.e. mountainous regions with snowfall/snowmelt dominated hydrological regimes.

3. It is written (P. 10229 – line 9-10) that "Bias correction can be seen as mostly unnecessary to obtain the climate change signal." In this respect, you have to specify what climate change signal means. Clearly, if you want to obtain the climate change signal from the corresponding climate model, you don't need bias correction. Presumably you want to obtain the climate change signal in the simulated runoff. If only one or a few GCM-RCM-HM ensembles are used, this is certainly not correct if the climate change signal of the climate model output is changed by the bias correction. Thus, your conclusion requires the use of a large ensemble where these changes in the climate change signal of the climate model output cancel each other.

4. It is written that "In particular, more strongly biased climate simulations are more likely to have their climate change signal affected by bias correction." This, in fact, is a mathematical property of the bias correction method and depends on the structure of the bias. A systematic constant (independent of the value of the specific variable) bias is easy to correct, e.g. by subtracting the bias, and this would not change the associated climate change signal, even if the bias would be very large. Using a quantile mapping based transfer function approach (statistical bias correction) is used, the impact of the bias correction method of the climate change signal has been visualized graphically by Haerter et al. (2011). Dependent on the specific method the mean signal changes or remains unchanged.

In the method section (p. 10214-10215), research questions are described. This is usually part of the paper's outline/purpose in the introduction section and should consequently be moved to the introduction. Why do you mention that the HYDROTEL model uses two potential ET formulations? Do you use both? If yes, do you count this as an extra hydrological model (I

don’t think so)? Is this important for the paper’s outcome? If not please restrict yourself to one formulation.

The description of the hydrological model ensemble (Sect. 2.4) lacks some clarity in the presentation. I suggest making a table with the different model characteristics that allows an easier comparison between the models. Please provide also the spatial resolution (in ° or km) for each of the models.

In summary, I suggest accepting the paper for publication after some revisions have been made.

Minor Comments

In the following suggestions for editorial corrections are marked in *Italic*.

p. 10206 – line 7
… layer of *uncertainty*.

Introduction – p. 10210
In the discussion of bias correction, I suggest referring also to Themeßl et al. (2010) who compared different bias correction methods and found that quantile mapping based approaches show the best performance in reducing biases, particularly at high precipitation quantiles. Also noteworthy is the study of Hagemann et al. (2011) who showed that bias correction may have an impact on the climate change signal for specific locations and months.

p. 10211 – line 10-12
Sentence is difficult to read. Please rewrite!

p. 10212 – line 10
… *winter, only* ….

p. 10212 – line 15
… *Alps, therefore, the* ….
It seems you are using too much “;” in places where they are not used in English. Please check manuscript appropriately.

p. 10216 – line 23 to p.10217 – line 2
Lengthy sentence is difficult to read. Please rewrite!

p. 10217 – line 4
… couple *a* RCM …

p. 10217 – line 10
It is written:
“This cold bias is also present at a much larger scale in the corresponding CGCM simulations (not shown), suggesting that large temperature biases in the driving data propagate through the modeling chain.”

This is one possible explanation. If CGCM and CRCM use similar model formulations and parameterizations, it might also point to a model problem that this specific model family

might have over Haut Saint-Francois. As CGCM has not been used to force different RCMs over this area, no specific conclusion can be made.

p. 10217 – line 29
It is written:
… a monthly correction is performed at the RCM grid point scale on air temperature by subtracting the 30-yr mean monthly biases.

This leads to unrealistic jumps in daily temperature time series at the end of the month to the beginning of the next month , which may cause some problems. Did you take this into account? Please add a note on that!

p. 10218 – line 20-23
Complicated sentence is difficult to read. Please rewrite!

p. 10226 – line 2-3
… climate *models* for winter … … contributes to *runoff*.

p. 10226 – line 4
… compared *to* the …

p. 10226 – line 14
It is written:
"… the importance of the ensemble is front and center here …"

I don't understand! Please rewrite!

p. 10226 – line 16-17
It is written:
" … give a pessimistic outlook on the possibility of reaching a conclusion …"

I don't understand! Please rewrite!

p. 10227 – line 3
… impact *on* the …

p. 10227 – line 15
It is written:
"… is clearly shown in the results for all scenarios …"

I don't understand. You do not use different emission scenarios! Please rewrite!

p. 10227 – line 17
… all *for* the …

Fig. 3,4,7,8
The legend text and axis descriptions are too small! Please increase size

Fig. 3

You should indicate temperature and precipitation panels in the figure caption as well as the catchments, such as you are doing for Fig. 4.

Fig. 4
… temperature *(upper panels)* and precipitation *(lower panels)* over…

Fig. 7,8
The dots are small and hard to separate Figs. need to be improved.

References mentioned above:

Haerter, J.O. , S. Hagemann, C. Moseley and C. Piani, 2011: Climate model bias correction and the role of timescales. Hydrol. Earth Syst. Sci. 15, doi:10.5194/hess-15-1-2011: 1065-1079

Hagemann, S., C. Chen, J.O. Haerter, J. Heinke, D. Gerten and C. Piani, 2011: Impact of a statistical bias correction on the projected hydrological changes obtained from three GCMs and two hydrology models. J. Hydrometeor. 12, 10.1175/2011JHM1336.1: 556-578.

Themeßl, M.J., A. Gobiet and A. Leuprecht, 2010: Empirical-statistical downscaling and error correction of daily precipitation from regional climate models. Int. J. Climatol., doi:10.1002/joc.2168.