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Hydrology and Earth System Sciences Discussions

Interactive comment on "Improving pan-european hydrological simulation of extreme events through statistical bias correction of RCM-driven climate simulations" *by* R. Rojas et al.

Anonymous Referee #2

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Improving pan-european hydrological simulation of extreme events through statistical bias correction of RCM-driven climate simulations Rojas et al.

General: The authors present a method of bias-correction suitable for the correction of gridbased RCM data of precipitation and temperature. This method uses transfer functions of two kinds: linear and exponential, fitted to gridbased observations on monthly scale and interpolated to daily scale. The method turns out to be capable of yielding realistic input to LISFLOOD, simulating extreme and average river discharge for several European catchments, though some discrepancies with observed discharge remain.

The paper is very well written and for the most pleasant to read, though lengthy and repetitive at some points. The results look promising and highly relevant. The methods are clear.

Of course there always remain questions/comments:

pg 3890, line 23: The correction seems to be either linear or asymptotically linear (the most significant differences between exponential and the linear correction showing at moderate precipitation amounts). But it makes me wonder whether it can be used to adjust the tail of the distribution (large quantiles). (pg 3892: transfer function approaches a constant slope for large amounts, implies that the influence on the tail is very limited). Would be nice if the effect on the distribution could be made explicit in a plot. Or, for instance, the correction of a certain quantile or the coefficient of variation.

Piani 2010 also proposes a logaritmic fit, which however turns out to be less suitable due to the fit errors. Nevertheless, it wouldn't hurt to mention it in one sentence.

pg 3890, line 5: The E-OBS grid values are not simply averages over the stations within gridvoxes. Haylock 2008 describes the use of thin-plate splines to interpolate the climatology and kiging to interpolate the anomalies, separately, selected from a variety of methods.

pg 3892, line 4: Do modelgrid and EOBS-grid match exactly or is regridding necessary? If so, what is the effect of regridding on the smoothing? (I do not expect this to influence the hydrological simulations, however).

pg 3892, line 17: If this is the most deficient model, the necessity of bias-correction of its data does not imply the necessity of applying bias-corrections to RCM-data in general. Besides, If the biases are that large, and the changes due to the needed corrections is far larger than the climate-change signal, can the (corrected) future simulation still be trusted?

pg 3893, line 13: Insert the text: "Given the availability...values derived in the range

5<b<0.2." (which also describes the correction of precipitation) here before discussing temperature.

pg 3893: Does switching to an exponential fit lead to a decrease of slope b? If the low/moderate values decrease or become zero in the transfer function, one would expect the fitted slope to be even larger.

pg 3898, line 23: It is not really a surprise that the mean bias-corrected precipitation corresponds so well with the observations.

pg 3899, line 13: moving -> switching, alternating Can it be explained why in particular mixing both correction methods makes the bias-correction less effective? Does it have to do with the interpolation between subsequent months?

pg 3900, line 5: "This implies...amounts" Why? Even if the wet-day frequency is correct, the rest of the distribution can still be off.

pg 3900, line 28: "..a tendency that....upper-end percentiles..." I doubt if the latter is common for RCM's and for different regions. I have seen many RCM's underestimating the high quantiles while overestimating the mean precipitation.

pg 3901, line 12: Underestimation of the variability of multi-day precipitation usually indicates lack of serial correlation. Was the effect of the correction on the autocorrelation (and spatial correlation) investigated? Both can influence the simulation of discharge extremes. Serial correlation of temperature and coherence between temperature and precipitation is important for the contribution of melting snowpack to extreme discharge.

pg 3902, line 4: Is this "maximum and minimum daily temperature" or "daily maximum and minimum temperature" mean here? Or is the maximum of daily max and minimum of daily min.

pg 3903, line 26: "Evapotranspration..." If one focusses purely on the effect of the bias-correction, then it suffices to compare the evapotranspiration pattern with and without the bias-correction, without having to mention that observational data is lacking.

Same for snow accumulation. If LISFLOOD calculates the actual evapotranspiration and evaporation (using Pennman-Monteith I suppose), is this still consistent with the RCM? The latter has its own water balance which should be consistent with the hydrological model (water from the soil = water into the atmosphere. Since both are models are not coupled, the total amount of moisture might not be conserved.

pg 3904, line 26 "Depending...meters" can be omitted: only SWE is important. For the both snow accumulation and soil moisture serial correlation of temperature and precipitation are important.

pg 3905, line 8: 'discharge statistics at the 554...' -> 'average discharge and average annual maximum discharge for each of the 554....' maybe more clear to the reader what he sees in this plot. Observed discharge is compared here with modelled discharge based on modelled climate data. If discrepancies are found (as in the extreme discharge) it is unclear where in the chain of models (RCM, biascorrection, rainfall-runoff) it came from. Since the focus is on correcting the climate data, maybe it is more useful to compare the discharge obtained from using corrected RCM data with that obtained with E-OBS data. Discrepancies described here can arise from the parameters in LISFLOOD and the discharge measurements, change in riverbasins, human intervention...etc.

pg 3906, line 8: Smoothing as mentioned by Haylock shouldn't have too much influence on discharges extremes, for riverbasins larger than the EOBS-gridspacing.

pg 3906, line 20: Ten out of twenty seem ok, for the rest differences between simulated and observed extremes are markedly outside the confidence intervals for the observations.

pg 3908, line 3: Remove 'Spatially' In northern Europe, the influence of dry summers on discharge extremes (taking place in winter) should be small, So the dry-summer bias is by far not so relevant as the effect on the snow.

pg 3908, line 17: ’simulated’ -> ’project’, ’found’ Is there a spatial pattern in the decrease/increase of return periods, if so why?

pg 3909, line 16: The observed gridded data are used for fitting the correction, but also for the validation of the result, So inadequacies in the gridded data should cancel eachother this way.

pg 3909, line 19: ’solely’->’separately’,’independently’

pg 3909, line 20: ’For example...evapotranspiration’ The ingredient for the evapotransp should already be discussed on page 3904 (top). Even with multiple variables which are all independently corrected, their combination can still give rise to a bias. Furthermore, (actual) evapotranspiration in LISFLOOD maybe inconsistent with the climate model, since there is no feedback from the hydrological model.

pg 3910, line 5: ’aiming at coping with’ -> ’to anticipate’

pg 3910, line 14: ’physical processes...identical time scales’ What is meant by this?

pg 3910, line 15: ’horizontal spatial’ -> ’lateral’

pg 3910, line 29:-pg 3911, line 3: The errors in the gridded data due to varying station density have already been mentioned often, contrary to the errors in discharge measurements. In the last line of this paragraph, the argument of station density suffers.

pg 3911, line 5-16: can be omitted, all issues have been mentioned already. "Other forcing...energy balance" has to do with evapotranspiration, which is not likely to dominate situations of extreme floods.

pg 3911, line 19: ’..river regulation’ and land-use changes

Conclusion and discussion should be joined to avoid unnecessary repetition.

pg 3913, line 9: ’to be subject to large error’ -> ’unreliable’

pg 3913, line 17: hardly reason to become over-confident; using an ensemble of model-

configurations will likely reveal a variety of problems in correcting and eventually a large spread of projected changes.

My recommendations to the authors would be * To separate remaining discrepancies between observed flood extremes and simulations to their source: - running LISFLOOD with gridded meteo-data (EOBS or CRU) - compare different gridded data sets to see what the largest source of error is. I suspect that discharge measurements are also part of it (trends, changes etc), in which case EOBS-driven LISFLOOD could also serve as a reference. * To inspect the effect of the correction method on spatial and temporal correlation, relevant to extreme discharge. Because of the snowmelt, also the persistence of temperature is important. * Find out why this method works so well for some river basins, while it fails for others, there must be a pattern (size and nature of the basin, geographical location). * Merge and concise Conclusions with Discussion.

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