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Hydrology and Earth System Sciences Discussions

Interactive comment on "Evaluation of drought indices at interannual to climate change timescales: a case study over the Amazon and Mississippi river basins" *by* E. Joetzjer et al.

E. Joetzjer et al.

emilie.joetzjer@meteo.fr

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1. It would be useful to cross-reference the following paper, which is also in HESS-D, and is relevant to this paper: Contributions to uncertainty in projections of future drought under climate change scenarios I. H. Taylor, E. Burke, L. McColl, P. Falloon, G. R. Harris, and D. McNeall Hydrol. Earth Syst. Sci. Discuss., 9, 12613-12653, 2012.

Ok, cf. our list of added references at the end of our response.

2. The paper above did not apply bias correction to the climate data - it might also be useful to consider the findings of this excellent review on bias correction for hydrological

applications: HESS Opinions "Should we apply bias correction to global and regional climate model data?" U. Ehret, E. Zehe, V. Wulfmeyer, K. Warrach-Sagi, and J. Liebert Hydrol. Earth Syst. Sci. Discuss., 9, 5355-5387, 2012

This is indeed a limitation of our study which has been highlighted in the revised manuscript. Apply a bias correction technique would be interesting for our projections but is beyond the scope of our study. Recent studies (e.g. Hagemann et al. 2011) indicate that bias correction techniques represent an additional source of uncertainty in hydrological scenarios. Therefore, given the lack of consensus about the best practices in this field, it might be wise to work with raw model outputs in our study. Moreover, the normalization procedure of all drought indices and the relative consistency between the skill scores obtained with observations and raw model outputs suggest that model biases are not a major issue for our study. Ref: Hagemann S., C. Chen, J.O. Haerter, J. Heinke, D. Gerten, 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, 556–578.

3. Note that there are no flow gauges actually AT river mouths, and they can be a considerable distance away (P13235 line 5) ok, we have selected the most downstream gauge station and the corresponding drainage area (which is relatively close to the total drainage area). This has been clarified in the revised manuscript.

4. A table describing the drought indices used would be useful. Ok cf. Table 2

5. Falloon et al. 2011 showed that GCM-driven annual river flows were moderately skillful for some basins, while in general skill was poorer for monthly flows. How does this affect your results, regarding the comparison of observationally forced or GCM forced river flows? Falloon, P, Betts R, Wiltshire A, Dankers R, Mathison C, McNeall D, Bates P, Trigg M (2011). Validation of river flows in HadGEM1 and HadCM3 with the TRIP river flow model. Journal of Hydrometeorology,12,1157-1180. doi: 10.1175/2011JHM1388.1

The off-line ISBA-TRIP land surface model driven by observed atmospheric forcings has been shown to simulate realistic monthly mean river discharges over both Amazon and Mississippi (cf. Alkama et al. 2010). As far as the CNRM-CM5 coupled hydro-climate simulations are concerned, and in line with our response to your comment #2, the focus is not so much on the realism of the runoff climatology compared to river discharge observations (and we did not apply any bias correction) but on the consistency between the meteorological and hydrological drought indices. Despite significant biases in CNRM-CM5 precipitation and surface temperature, the comparison between the various drought indices derived from the simulations corroborates the results obtained with those derived from the observations.

6. It was unclear to me which driving data were used in the plots throughout- please can you make this clearer (raw GCM or observationally driven).

This has been clarified in the revised manuscript.

7. P13237 line 10: re. precipitation driving the difference in skill: is there any evidence for that? It might be useful to show a comparison of GCM vs observed precipitation (and snow?) as an appendix?

Idem

8. P13238 last 2 lines: discussion of Amazon findings: does CNRM include a dynamic/interactive vegetation scheme? Falloon et al. 2012 note that this could lead to additional feedbacks via evaporation changes (from the vegetation changes), and also note the role of carbon dioxide fertilisation on stomatal conductance (and hence on ET/runoff). Falloon, P. D., Dankers, R., Betts, R. A., Jones, C. D., Booth, B. B. B., and Lambert, F. H.: Role of vegetation change in future climate under the A1B scenario and a climate stabilisation scenario, using the HadCM3C earth system model, Biogeosciences 9, 4739-4756,doi:10.5194/bg-9-4739-2012

CNRM-CM5 has no dynamic/interactive vegetation scheme and no direct CO2 effect

on evapotranspiration. This caveat could be emphasized more clearly in the revised manuscript (cf. our response to the reviewer #2, point 1). We claim that such effects are still highly uncertain and, more importantly, would not change our main conclusions about the comparison between the various meteorological drought indices. This could have been a problem if we had chosen a vegetation drought index, but not with our hydrological benchmark which is expected to be less sensitive to such processes.

9. Discussion and conclusions: only one climate model has been applied here, with a relatively small ensemble - the implications of using a wider set of models, or larger ensembles (e.g the Taylor et al. 2012 paper noted above), to better capture uncertainties, would be beneficial here.

Indeed, model uncertainties have not been discussed in our study but have been illustrated by many multi-model CMIP3 and CMIP5 studies about precipitation (e.g. Joetzjer et al. 2012). Here the focus is on index-dependent projections and our 5-member ensemble is sufficient to illustrate this problem. We have clarified the objectives of the paper in the revised manuscript.

10. P 13239 line 0-15, discussion on ET: but these ET calculations also lack consistency with what would be produced by the climate model itself - please can you mention this? ok

11. Last paragraph on p 13240 (lines 20-21) on the use of LSMs - the following references might also be useful, on assessments of skill, cross model comparison, bias correction, and the role of CO2 on runoff: ok

Falloon, P, Betts R, Wiltshire A, Dankers R, Mathison C, McNeall D, Bates P, Trigg M (2011). Validation of river flows in HadGEM1 and HadCM3 with the TRIP river flow model. Journal of Hydrometeorology,12,1157-1180. doi: 10.1175/2011JHM1388.1 Haddeland, I., and Coauthors, 2011: Multimodel estimate of the global terrestrial water balance: Setup and first results. J. Hydrometeor., 12, 869–884. U. Ehret, E. Zehe, V. Wulfmeyer, K. Warrach-Sagi, and J. Liebert Hydrol. Earth Syst. Sci. Discuss., 9, 5355-

5387, 2012 Hagemann, Stefan, Cui Chen, Jan O. Haerter, Jens Heinke, Dieter Gerten, Claudio Piani, 2011: Impact of a Statistical Bias Correction on the Projected Hydrological Changes Obtained from Three GCMs and Two Hydrology Models. J. Hydrometeor, 12, 556–578. Betts RA, Boucher O, Collins M, Cox PM, Falloon P, Gedney N, Hemming DL, Huntingford C, Jones CD, Sexton D & Webb M. (2007). Projected increase in continental runoff due to plant responses to increasing carbon dioxide, Nature 448, 1037-1041 (30 August 2007) | doi:10.1038/nature06045.

12.Linked to points 7 and 8: GCM variation in P and ET in general over river basins needs to be better discussed. Ok cf. the revised manuscript and the answer to B Orlowsky.

List of added references

Bell, Victoria A., Nicola Gedney, Alison L. Kay, Roderick N. B. Smith, Richard G. Jones Robert J. Moore, 2011: Estimating Potential Evaporation from Vegetated Surfaces for Water Management Impact Assessments Using Climate Model Output. J. Hydrometeor, 12, 1127–1136. doi: http://dx.doi.org/10.1175/2011JHM1379.1

Betts RA, Boucher O, Collins M, Cox PM, Falloon P, Gedney N, Hemming DL, Huntingford C, Jones CD, Sexton D & Webb M. (2007). Projected increase in continental runoff due to plant responses to increasing carbon dioxide, Nature 448, 1037-1041 (30 August 2007) | doi:10.1038/nature06045.

Joetzjer, E., Douville, H., Delire C., Ciais P. (2012), Present-day and future Amazonian precipitation in global climate models: CMIP5 versus CMIP3 , Climate dynamics, DOI 10.1007/s00382-012-1644-1.

Orlowsky, B. & Seneviratne, (2012a) S. I. Global changes in extreme events: Regional and seasonal dimension Clim. Change, 110, 669-696

Orlowsky,ÂăB. and Seneviratne,ÂăS.ÂăI. (2012b) Elusive drought: uncertainty in observed trends and short- and long-term CMIP5 projections, Hydrol. Earth Syst. Sci.

Discuss., 9, 13773-13803, doi:10.5194/hessd-9-13773-2012,

Sheffield, J.; Wood, E. F. & Roderick, M. L. Little change in global drought over the past 60 years, Nature, 2012, 491, 435-438

Seneviratne, S.I., N. Nicholls, D. Easterling, C.M. Goodess, S. Kanae, J. Kossin, Y. Luo, J. Marengo, K. McInnes, M. Rahimi, M. Reichstein, A. Sorteberg, C. Vera, and X. Zhang, 2012: Changes in climate extremes and their impacts on the natural physical environment. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 109-230.109

Wahba G. 1990: Spline models for observational data. Society for Industrial and Applied Mathematics (SIAM)

Wilks S Statistical Methods in the atmospheric sciences second edition (international geophysics series), 624pp

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 13231, 2012.