Hydrol. Earth Syst. Sci. Discuss., 9, C6894–C6898, 2013
www.hydrol-earth-syst-sci-discuss.net/9/C6894/2013/

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

Received and published: 21 February 2013

Reviewer #2

This paper discusses a set of drought metrics for two large river basins and how they change under future climate scenarios. The objective of this paper needs to be more carefully defined and explicitly addressed. For example, one objective is to assess whether the different drought metrics identify the same events and how the severity of the different events compare. This is done using both observation and model data to see whether the model has comparable characteristics to the observations. Another one may be to assess whether these different metrics identify the same events under climate change. Drought evolves following a general pattern: first there is some type of meteorological drought, then possibly agricultural drought then hydrological drought. These different types of drought manifest over different time scales and have specific and different impacts on society. This paper also evaluates the ability of the three meteorological drought metrics to detect hydrological drought (says in abstract). Why do we want to use meteorological drought metrics to detect hydrological drought? Surely we can use a direct metric of hydrological drought (e.g. the SRI) to detect these events? Are we interested in determining whether a meteorological drought metric can be used as a proxy for hydrological drought in basins where there are no streamflow measurements? Hydrological drought lags behind meteorological drought. Therefore a meteorological drought metric could be used as a predictor for hydrological drought – this is alluded to in the introduction but not directly addressed in this paper. The relationship between meteorological and hydrological drought will change in a changing climate (for example because of the CO2 fertilization effect) and therefore the ability of meteorological drought to predict hydrological drought will change.

Comments

Please note that most sections of the revised manuscript (including the final discussion) have been totally rephrased in order to address your comments (n°1,2,4,5).

1. Were factors such as changing stomatal resistance under increased atmospheric CO2 included when calculating the potential evapotranspiration using the climate change scenario (Bell et al., 2011)? This is important in a climate change scenario.

Indeed, the interactive carbon cycle has not been yet implemented in CNRM.CM5, meaning that the stomatal conductance is calculated using a common Jarvis formulation and does not depend on the atmospheric CO2 concentration. We have emphasized this caveat in the revised manuscript and quoted the reference Bell 2011 (cf section 4). We agree that a stomatal closure effect might alter the relationship be-

HESSD
9, C6894–C6898, 2013

Interactive Comment

tween meteorological and hydrological droughts in a warmer climate, but there is still no consensus about the significance and magnitude of such an effect which could be partly offset by a parallel fertilization effect whereby vegetation growth (and therefore evapotranspiration) would be favored by an enhanced CO2 concentration.

2. Why is annual data used – a monthly anomaly from climatology would provide a greater sampling size and would help diagnose time lags between the different drought indices.

cf. our response to the 2nd major comment of reviewer #1 (B. Orlowsky).

3. Why is the SRI12 used as a 'benchmark' (back to query over objectives)?

Generally speaking, drought is clearly a consequence of climate anomalies, but impacts on society are more directly related to hydrologic conditions. For most end users, meteorological drought indices are relevant only if they are strongly connected with hydrological (or agricultural) impacts and not too much sensitive to the details of their computation. Our study therefore uses a runoff index (strongly connected with the basin-scale river discharge) as a benchmark for meteorological drought indices. An agricultural drought index could have been a valuable alternative benchmark, but there is a lack of in situ soil moisture observations and satellite techniques are too recent for providing long timeseries.

4.Figure 2 – the whole period 1850 to 2100 is used. Do the correlations change between the beginning and the end of this time period? Under climate change changes in the the land surface processes are impacting runoff as well as precipitation. What are the skill scores for the future scenarios?

Skill scores are used to evaluate the ability of meteorological drought indices to detect annual hydrological droughts at the inter-annual timescale. For this purpose, all timeseries have been first detrended. Once detrended, our climate projections suggest that scores remain relatively stable over the whole 1850-2100 period. This is illustrated by

HESSD
9, C6894–C6898, 2013

the figure R4 showing sliding correlations calculated over a 49-year time span over the Amazon basin. The envelop is surrounded by the minimum and the maximum values among the 5 members of our ensemble, while the ensemble mean is in bold.

5. Soil moisture is not discussed at all but is also a possible drought metric and this should at least be noted. Cf. our response to comment #2

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

HESSD

9, C6894–C6898, 2013

Interactive Comment

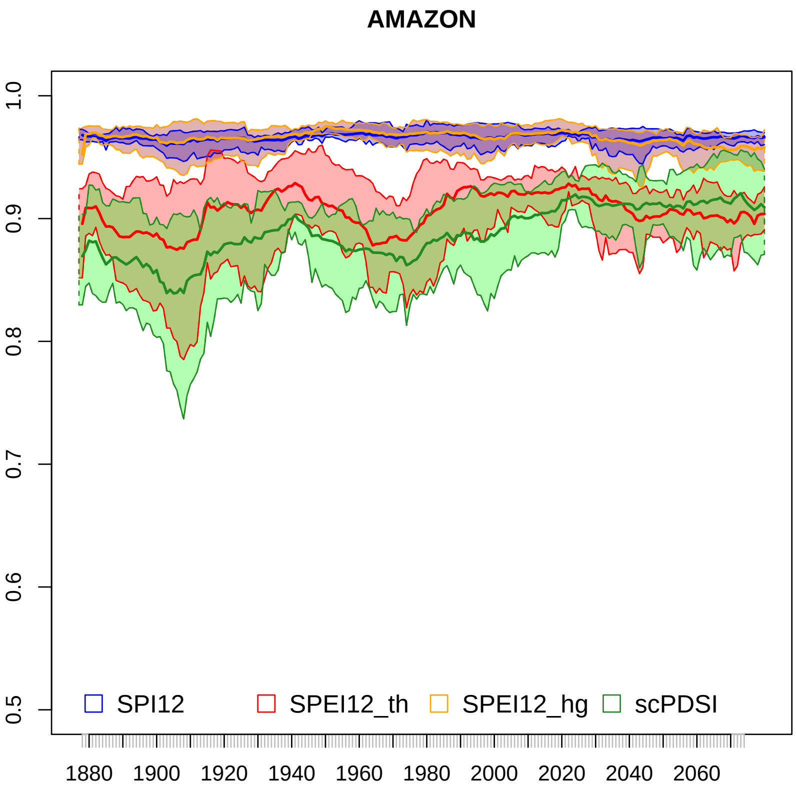

Fig. 1. R4 sliding correlations calculated over a 49-year time span over the Amazon basin

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper