Peer review: Does the simple dynamical systems approach provide useful information about catchment hydrological functioning in a Mediterranean context? Application to the Ardèche catchment (France)

Authors of Article: M. Adamovic, I. Braud, F. Branger, and J.W. Kirchner

Summary

This manuscript by Adamovic et al. presents and evaluates Kirchner's method, which until now has not yet been evaluated in a Mediterranean climate. Rainfall regime in this region can be described with dry spells and drought in summer contrasted with high-rainfall periods in autumn. It therefore focuses on the applicability of Kirchner's method and its limitations; and what we can learn about dominant hydrological processes using this methodology. Most catchments show a large degree of variability and heterogeneity in both space and time, which in turn raise questions about degrees of model complexity in order to describe their behavior. Large-scale equations like Darcy's or Richards' equation might not be sufficient in describing catchment behavior and heterogeneity at catchment scale (Kirchner, 2006). Kirchner (2009) represents a catchment with a simple dynamical model, where system parameters are directly derived from the detected stream flow fluctuations during recession periods. This includes one essential assumption: discharge depends only on the total water stored in the catchment. Until now, this method has mostly been applied in small humid catchments. The four study areas mainly consist of granite and basalts lithology. The results of this manuscript show good discharge simulation for winter (humid) conditions in catchments characterized predominantly by granitic lithology. Under dry conditions, poor model performance is generally related to the disturbed water balance terms, high actual evapotranspiration and imprecise discharge measurements. It's important to know whether this model also holds for other than humid catchments and therefore makes a valuable contribution to the hydrological literature in this field of research.

The general impression is that the article is that tables are clear and graphs are well-illustrated, however the structure could use some improvements. In terms hydrological modelling it is of great interest for, when applicable, Kirchner's model is easy to use, whereas some of the techniques used to modify the data and timescale used are debatable. This manuscript shows that while the model is applicable to humid conditions in multiple areas, it does not work well in summer. In my opinion it is an interesting article for readers of HESS, however I have a few corrections and minor revisions which, in my opinion, will improve the paper.

General comments

First I would like to focus on the type of climate in the Ardèche. When looking into climate classifications of the study area it is found that regarding to the index of Köppen that the area in the Ardèche around Meyras is classified as 'Cfb' (climate-data.org, 2014) which corresponds to a Oceanic climate described as: Temperate, without dry season, warm summer (Peel, et al., 2007). I'm puzzled why one would classify this area thus as a Mediterranean climate indexed by Köppen as: 'Cs(a/b)' described as: Temperate, dry summer, (hot/warm) summer (Peel, et al., 2007).

Secondly I am puzzled as to why the authors decided to average out the data for the temperatures as well as rainfall distribution throughout the year in the Ardèche vary, which would in term result in a varying AET (Redaud, et al., 2012). According to FAO (Allen, et al., 1998) minimum temperatures on monthly scale vary up to 15 degrees Centigrade and maximum temperatures up to 20 degrees Centigrade for the Meyras area (climate-data.org, 2014). This is also supported by Amatya (Amatya, et al., 1995), who compares the Penman-Monteith equation to various REF-ET estimating equations (among others: Makkink, Turc, and Thornthwaite) over monthly and annual timescale. For Turc's estimation of the REF-ET, the best result was obtained on a monthly timescale the R-

square was 0.94 as for annual timescale this was 0.80 (Amatya, et al., 1995). A better estimation of the AET will therefore possibly increase the model's performance during summertime. As plotted in Figure 1 temperature and rainfall have a great influence on Turc's estimation of AET. When stating that the model performs poorly during summer, it would be an improvement if this would be shown in a graph.

Thirdly the rescaling of both precipitation and AET caught my attention. The reason given as to why precipitation requires rescaling, in three out of four cases, is that the equation from obtained data doesn't add up. This is based on actual measurements over a 9 year time-scale, which are thus of limited use. However due to the elevation differences in the study areas, differences in precipitation on different elevations and therefore the location(s) of rain gauges and their need for correction in those areas is evident (Legates & Willmott, 1990). The need for rescaling in areas 2, 3 and 4 is clear, however I'm puzzled as to why the first study area doesn't need to be rescaled, otherwise the scaling should be 1. I think what the authors mean to do with rescaling for AET is combining the SAFRAN ET_0 (which does describe a seasonal variability) with AET_{Turc} but this would be clearer when showing this reanalysis in further detail including a graphical presentation.

Last

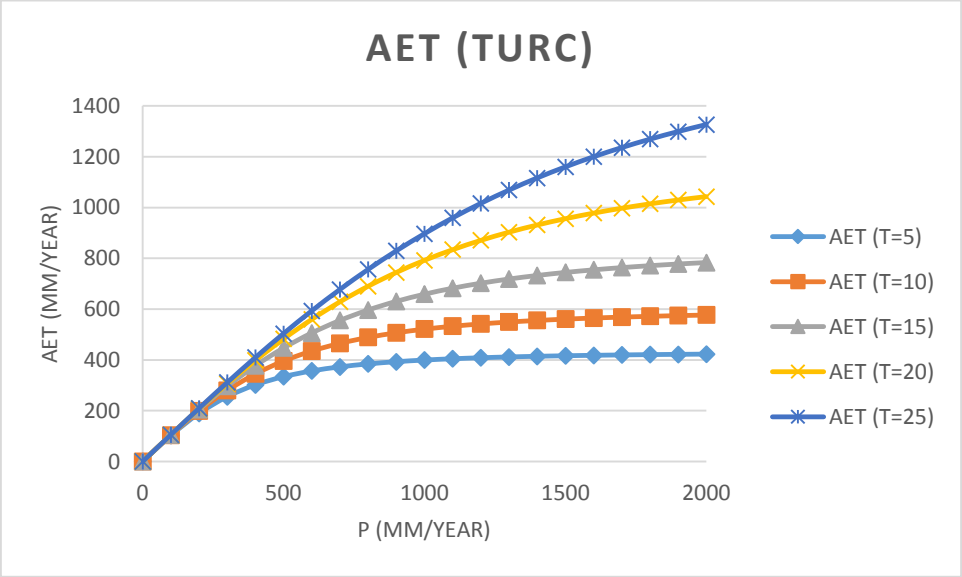

Figure 1. Turc's actual evapotranspiration

Specific comments

Page 10739, line 14: Possible typo: "We select hourly records for nighttime (defined as a period between sunrise and sunset)"; Improvement: "We select hourly records for nighttime (defined as the period from [1 h?] after sunset to [1 h?] before sunrise) during which there was a total recorded weather radar rainfall amount of less than 0.1 mm within the preceding 6 h and the following 2 h (Krier, et al., 2012). The part between the square brackets was also included in Krier et al.

References

Allen, R., Pereira, L., Raes, D. & Smith, M., 1998. Crop evapotranspiration - Guidelines for computing crop water requirements. *FAO Irrigation and drainage paper.*

Amatya, D. M., Skaggs, R. W. & Gregory, J. D., 1995. Comparison of methods for estimating REF-ET.. *Journal of Irrigation and Drainage Engineering,* pp. 427-435.

climate-data.org, 2014. *Climate: Meyras.* [Online]
Available at: http://en.climate-data.org/location/98501/

Krier, R. et al., 2012. Inferring catchment precipitation by doing hydrology backward: A test in 24 small and mesoscale catchments in Luxembourg. *Water Resources Research.*

Legates, D. R. & Willmott, C. J., 1990. Mean seasonal and spatial variability in gauge-corrected, global precipitation.. *International Journal of Climatology,* pp. 111-127.

Peel, M., Finlayson, B. & McMahon, T., 2007. Updated world map of the Koppen-Geiger climate classification. *Hydrology and Earth System Sciences,* pp. 1633-1644.

Redaud, J. L. et al., 2012. Climate change and its impacts on the water regime in France.. *Ministère de l'Ecologie et du Dévelopment Durable. Toulouse..*