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

The paper is mostly well written and tables and figures are often clear and useful. However, I still have some remarks. The first remark is about the assumption to take non-vegetation periods during night-time to be able to neglect evapotranspiration. This assumption will have the largest effect on discharge in summer, as evapotranspiration will be relatively high. A second remark is about the determination and improvement of the parameters C_1, C_2 and C_3 and the used data for this determination. The last major issue has to do with the structure of the manuscript and answering the second main question. Minor remarks are given on formulation of assumptions and some results. In addition, I have some small remarks on lay-out and typos. After these minor revisions, my advice is to accept the manuscript for publication.

The manuscript by Adamovic et al. examines the applicability of the simple dynamical systems approach of Kirchner (2009) in order to characterize the Mediterranean catchment the Ardèche and takes a look at the limitations of this method. It also investigates what the use of this methodology can tell about dominant hydrological processes in the catchment. For this, the discharge sensitivity function is estimated and used in a simple model to simulate measured discharge. Whether this model can simulate discharge and retrieve rainfall is then tested. This manuscript shows that simulation of discharge especially in wet periods can be done rather well in the Mediterranean climate and will therefore be of interest for readers of HESS. Personally, I think it is really interesting that based on only a few variables, namely precipitation, actual evapotranspiration and an initial discharge measurement, discharge can be well simulated in wet periods for humid as well as drier climates.

General comments

Major comments

Neglecting evapotranspiration

For the derivation of the g(Q)-function, Kirchner (2009) originally proposed to take periods in which evapotranspiration and precipitation are relatively very small and can be neglected. As the relative humidity is close to 100% in humid climates during night-time and therefore evapotranspiration is negligible, selecting rainless nights would be enough (Kirchner, 2009). When summers are drier, there will be a vapour pressure deficit and night-time evapotranspiration cannot be neglected, as can be concluded from Malek (1992) who found night-time evapotranspiration values of up to 16% of the daytime value and Irmak (2011), who found values of up to 5% and a maximum of 1.1 mm per night. Novick et al. (2009) even showed that this can be on average 8-9% of the mean daytime evapotranspiration and Iritz and Lindroth (1994) found on average an evapotranspiration 7% of the daytime rate, up to 37% on especially dry and windy days/nights. When the night-time evapotranspiration is not taken into account, this may lead to considerable errors especially during summer, when evapotranspiration will be relative high compared to discharge (as can be concluded from figure 3). The problem of night-time evapotranspiration was solved by taking non-vegetation periods, where evapotranspiration from vegetation during night was negligible. Still, this does not take evaporation from soils into account, although soil evaporation is usually smaller than evapotranspiration by vegetation (Iritz and Lindroth, 1994). Also, nocturnal soil evaporation is hard to separate from canopy evapotranspiration (Irmak, 2011), which makes it hard to account for separately. Therefore it is good to take a look at the hourly discharge. If a daily trend in discharge is visible, this will mean that there is a large difference in evapotranspiration during day and night (and thus it will cause a daily trend). If this is not or hardly visible, then the night-time evapotranspiration surely cannot be neglected. In the discussion of the manuscript (P10755 L23-26) it is already noted that probably the model is not adapted to the Mediterranean evapotranspiration conditions. It is good to keep in mind that also the evapotranspiration during night will be of importance for future improvements of the Kirchner model, as this term is often neglected. I understand that adaptation of the model to (nocturnal) evapotranspiration will require quite some time and is not the aim of this research (which is investigating the limits of the Kirchner method). Therefore mentioning it in the discussion might be enough.

Use of data and parameter estimation
For estimation of the g(Q)-function, the data of 2000 to 2008 is used in order to determine the parameters C_1, C_2 and C_3. Then the discharge is simulated with these parameters for all years within this range. As these years are also used in the determination of the parameters, it is more likely that the discharge is simulated correctly than if discharge was simulated for years outside this range. Thus, it might be that the model performs less for other years than 2000 to 2008, even though these parameters have been verified by Monte Carlo simulation (as this had again the same input data). It may also partially explain why the model has a better performance for all nine years than for individual years.

In the discussion (P10754, L20-26) it is mentioned that discharge in small catchments in the Ardèche have been monitored more thoroughly and continuously since 2010, but this data is not used due to the short length of the dataset. Melsen et al. (2014) found that the minimum dataset length in order to reach reasonable model efficiencies is a season of five months, which is preferably in the wet period as this gives the best results. Longer dataset lengths will only slightly increase the model efficiencies. Thus, the mentioned dataset can already be used to improve the parameter estimations, as the data is expected to have a higher accuracy. If there is data available of the same subcatchments as used in this manuscript, this data can be used to make new estimations of the parameters to simulate discharge. In this way, the effects of more accurate discharge data can be investigated by comparing the results of the two datasets. Insight in the effects of a somewhat lower data accuracy may be interesting for future research in catchments that have less accurate discharge data. A reference to the paper of Melsen et al. may also be added as extra foundation on why the non-vegetation period of November to March is used (P10739, L18-20), as this is five months and in the wet season.

To estimate the parameters in the g(Q)-function it is possible to use different calibration methods, as was done by Melsen et al. (2014). Melsen et al. showed that of the used methods, a simple automatic calibration method will give the highest model efficiencies and the best results at low discharge. This agrees with the used method in the manuscript, which is good. For parameter estimation, Melsen et al. advises to use the log-transformed data in order to get optimal parameter values for low discharge. For high discharge, calibration can be applied directly to the observed data. This was also done correctly in the manuscript.

Structure and answering main questions
The structure of the manuscript is not always very clear. In section 2, Field site and data, many formulas are given. These are used to check the quality of the data and rescale data. This pre-processing is more a methodology than a description of the field site and data and therefore fits better in section 3. Here it can be given a header like “Pre-processing of data” or “Data consistency analysis”, which gives a better overview of what is done in that section. I recommend to keep the field description (section 2.1) and the used data (section 2.2.1 up to P10733 L7) in the section Field site and data. The rest of this section, I would put in section 3.

The structure of the current Methodology and Results is fine to me: sections in Methodology have more or less the same headers as in the Results and are given in the same order in the Results. However, considering the two main questions, I expected that the second main question (What information about dominant predictors of hydrological variability can be retrieved from this analysis in such catchments?) had a section in the Results. I was surprised to see no answer to this question in the Results. The question is only answered more or less in a single paragraph in the Discussion (5.3.2) and with some recommendations for future research in the Conclusion (P10758 L16-18). The only dominant predictor that is given to answer the question is geology. This makes it very clear that the focus of this manuscript was on the first question. I think that if the second question is answered better or if this is not possible, it is explained why this question is poorly answered, this will enhance the quality of the current manuscript.

Minor comments

On P10739, L14-17, night-time is defined as “a period between sunset and sunrise” (assumed this is meant instead of between sunrise and sunset). The use of “a period” instead of “the period” makes the definition not very clear. A reference to Krier et al. (2012) is made, where they define night-time as the period from 1 hour after sunset to 1 hour before sunrise. Is exactly the same definition as mentioned in Krier et al. used in the manuscript?

In section 5.3.2 it is mentioned that the model performs better for catchment #1 and #3. I think this is concluded from P10748 L1-3 and table 6. It looks like this conclusion is solely based on the value of NSE log. Otherwise catchment #2 and #4 would have been mentioned as having better model performances than catchment #3, based on the NSE, and/or catchment #2 and #4 having better performances than catchment #1 and #3 based on the PBIAS. It might clarify the statement at P10757 L2-3 if it is mentioned that this conclusion is based on NSE log.

In section 5.3.2 it is also mentioned that catchment #1 and #3 have predominantly a granitic lithology. However, by taking a look at figure 2, catchment #2 also consists for the largest part of granite. The parameter values of this catchment, as mentioned in table 5, are very close to those of catchment #1 and #3 with only the parameter C_1 slightly higher. I then wonder why catchment #2 is not mentioned in section 5.3.2, as it looks quite similar to #1 and #3. Is this based on the slightly worse model performance as expressed by NSE log (see previous comment) and the difference in C_1? In section 6 (P10758, L8-9) it is then unclear if catchment #2 is also mentioned as having a good model performance, as it states here that catchments with dominantly granite show good results for discharge simulation.

Specific comments

- Re-scale/re-scaling -> rescale/rescaling. These words are used quite often; therefore I recommend using a search function for editing this.
- P10736 L5: P/ET_0 is mentioned as the wetness index, but in the previous line the inverse (ET_0/P) is already mentioned as the dryness index. As the wetness index is not mentioned again or used in any formula and is therefore not necessary to mention, this may be deleted.
- P10737 L26: in-consistency -> inconsistency
- P10739 L14-15: defined as a period between sunrise and sunset -> defined as the period between sunset and sunrise
- P10740 L2: maiximum -> maximum
- P10766, 10768 and 10771, table 1, 3 and 6: Units are here given between (), whereas in other tables and figures, these are given between []. The same holds for the main text (P10735 L1-2 uses (), P10738 L8-9 uses []). It would be more consistent to use either () or [].

- In some tables (1, 3, 5, 7), no unit is given when parameters are dimensionless, whereas in other tables (8, 9) it is mentioned that the parameters are dimensionless. For consistency, it might be better to either remove the [-] or add them to other dimensionless parameters. The same holds for the figures.
- P10778 caption of figure 3: julian -> Julian. Also, adding Q, ET and P to the y-axes makes the figure clearer and more consistent with other figures.
- P10779 figure 4: What does the + mean in this figure?
- P10782 caption of figure 7: Add the word Rainfall to the y-axis.

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