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Hydrology and Earth System Sciences Discussions

Interactive comment on "Mapping mean and variance of runoff in a river basin" *by* L. Gottschalk et al.

L. Gottschalk et al.

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1. GENERAL COMMENTS This is a landmark paper. If we are to make progress in scientific hydrology we need to deal with spatial and temporal hydrological variability in a consistent way and here the paper proposes a clever way forward. The paper is technically sound and the assumptions made in the paper are consistent with the exploratory nature of the analysis. Although all the processes are assumed to be linear this is an obvious starting point. There are numerous developments that could flow from this theory which will be interesting to see in the future.

Authors: The positive views of the reviewer are appreciated. The theoretical developments in the paper are indeed in an exploratory stage and it is open for further developments. The spatial and temporal variability of hydrologic variables in a river basin are of a special nature as they are linked by the lateral water transport through this basin system. The paper is an attempt to develop a theoretical base for this with

concepts from stochastic hydrology . A suggestion for a proper name for this theory would be - Hydrostochastics. A basic assumption of linearity is accepted for the time being. We are aware of the role of non-linearity of the basic processes resulting in changing scales of variability with the intensity of the processes. It is a topic that might be include in the theory at a later stage. A second critical point is the structure of the time-space covariance function for processes in a basin which for the moment only has been postulated. Including more of basin process understanding might help to improve the structure of this function. A third aspect to be developed is to separate the part of the variability induced by the basin processes from those of the atmosphere.

The paper is written clearly but it is not an easy read. I have a number of minor comments that may assist in enhancing the readability of the paper.

Authors: The very constructive detailed comments of the reviewer are gratefully acknowledged. The suggestions will indeed make it easier for a reader to follow the theoretical parts of the paper. We fully agree to most of the detailed comments and accordingly changes/corrections have been made in the final manuscript.

2. DETAILED COMMENTS (P=page, L=line): P300 L1-5 I would suggest to replace the first lines of the abstract by something like this: "The study presents an approach to represent the two first order moments of temporal runoff variability as a function of catchment area and aggregation time interval, and to map them in space. The problem is divided into two steps. First, the first order moment (the long term mean .."

Authors:The text change is accepted.

P302 L4-5 " in theory .. observations allow us .. time resolution" I do not think this is the case. Today, runoff data are usually collected by data loggers in most countries of the world and these are almost instantaneous values. Also, "resolution" usually refers to sampling rate which is not what is meant here. Perhaps replace by "aggregation time interval" or something similar.

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Authors:We partly agree. In many countries where we have worked around the world data loggers are still not in use due to lack of technical resources. The text is changed to better adapt to the real situation

L7 and L8 "space A and time D": I would suggest to replace this by "as a function of catchment area and duration" which is quite different from space and time (coordinates) even though the units are the same.

Authors:We agree and the text is changed.

P304 L23 "the discharge stations are shown in Appendix A": I think this should read "Ě are shown in Fig. 1".

Authors:Yes, the stations are shown in Fig. 1 while the map of the drainage network is shown in Appendix A. The text is corrected

L27: Please say how long the runoff records were.

Authors:Data for a common period 1970-1997 have been used. Not all stations had complete records for this period. Stations with a record of minimum 15 years were included in the study. This text is inserted.

P305 L3-4: I do not understand "around zero" Suggest to leave it out.

Authors:It is deleted.

L24: More rapidly than what?

Authors:The text is corrected.

L24: "time scales" is ambiguous - lag or interval? If interpreted as interval - as suggested by the mention in the previous line - I would have thought the opposite is the case.

Authors:We agree. The whole paragraph is reformulated avoiding “time scales”.

P309 L23: Add "and rho is a one-dimensional correlation function to be specified."

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Authors:The sentence is added.

L23: I think "h/v" should read "lambda/v"

Authors:Yes, it is corrected.

P310 L21-22: Maybe I have missed something but I think the two lines should read ".. is independent of time of concentration because the aggregation is linear and it is unity as it represents a normalised value (see Eq. 3)."

Authors:Yes, this is clearer formulation. The text has been changed

P311 L8-9: It is not the distances but the points that are chosen at random, i.e. according to U(O,T). The sentence should hence read ".. distances h between two points chosen at random within the two line segments that are separated by a specified distance tau. For .."

Authors:Yes, this is correct. The text has been changed.

L10: "-" should be replaced by ", ".

Authors:Corrected.

P313, L6 "approximated by a linear reservoir": I suspect there are implicit assumptions that go with this statement. Do the authors imply here that local runoff is a random variable that is uncorrelated in space and time which is then convoluted with an exponential IUH (i.e. a linear reservoir) to produce an exponential type correlation function? Please clarify.

Authors:The implications are not clear what basin processes the empirical covariance functions reflect at this early stage of development. The sentence is deleted.

P314 "as a rule": See comment above, on data loggers and instantaneous measurements. Suggest to replace by "sometimes"

Authors:The sentence is corrected.

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P315 L5: I think this should read "equals the coefficient of variation squared of the original variable X." I'm not sure what the "averaged" in this sentence refers to.

Authors:Corrected.

L8: Suggest to add a reference to simple scaling.

Authors:A reference is added.

P316 L3-4: There is an intercept in both cases, so they are not proportional.

Authors:"proportional" is changed to "function of"

L14: I would suggest that the authors simply give the values of the parameters in line 8. Also, what parameters are used for A$<$43.5? Please give the units of all parameters.

Authors:The recommendation has been followed. For an area less than 50 km2, the value for 50 km2 is used. An explaining text is inserted. The smallest catchment area in the study is 73 km2.

L18: What are the units of 0.29 or is this dimensionless error variance? It would be good to be able to figure out whether this is a close fit or not.

Authors:This is the absolute standard error in the Cv, to be compared to its range 0.3-2.6. A clarification is insterted in the text.

P318 L3 "In general the agreement is acceptable": I think the agreement is very good given the exploratory nature of the analysis. The main features are indeed reproduced.

Authors:Yes, we agree. It gives hope that we are on the right track.

Figs. 1, 2 and 5: It would help to use colour instead of the dashed lines to better identify the branches. Fig. 2 shows about 30 points but there are 17 gauges in Fig. 1. Have residual catchments been plotted here? Please clarify. Fig. 2: I would suggest to replace the caption by something like: "Estimated first moment of runoff (i.e. long term mean runoff) of the Moselle stream gauges. Figs. 4 and 7: I would suggest to increase

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the font size of "a) b) c) d)" and move the letters to places where they are better linked to the respective panels. Fig. 4 d: Is this for a duration of one day? Please add to caption. Fig. 5: I would suggest to replace the caption by something like: "Estimated first moment of runoff (i.e. long term mean runoff): Diamonds are the local estimates from the stream gauge data, grey points are the mapped values along the streams." Fig. 6: I would suggest to replace the caption by something like: "Temporal coefficients of variation of runoff. Plusses are the estimates from local stream gauge data; crosses are the estimates of the stochastic model for the gauged sites; grey points are the estimates of the stochastic model for the grid cells of the DEM (see App. A)." Fig. 7 d: Is this for a duration of one day? Please add to caption. Fig. 7: Please shorten caption - "The corresponding Ĕ curves" is mentioned in the main text, so does not have to appear in the caption.

Authors:The figures and figure caption has been changed in agreement with the suggestions above. There should be only 17 points in the figures, and the figures have now been modified. We regret the confusion.

The English of the manuscript needs some streamlining. I have forwarded a number of suggestions directly to the authors.

Authors:The suggestions are well taken and the text is changed accordingly.

3. RECOMMENDATION This is an excellent paper. The authors should be encouraged to include the changes suggested above and streamline the English. As all the changes are minor, no re-review is needed before publication in HESS.

Interactive comment on Hydrology and Earth System Sciences Discussions, 3, 299, 2006.