

***Interactive comment on “A new perspective on the spatio-temporal variability of soil moisture: temporal dynamics versus time invariant contributions” by H. Mittelbach and S. I. Seneviratne***

**Anonymous Referee #2**

Received and published: 13 March 2012

Summary

The manuscript of Mittelbach et al. introduces a new framework for analysing the spatio-temporal variability of soil moisture. The main underlying idea is to decompose the spatial variance of absolute soil moisture over time in its time variant and time invariant contributions. The concept is applied to the soil moisture recordings from the SwissSMEX network. In their case study the authors conclude that the contribution of the time variant component is small compared to the time invariant spatial variance of the mean soil moisture at all sites. They further argue that commonly used frameworks

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do not apply to temporal soil moisture anomalies.

### General comments

I found the manuscript of Mittelbach et al. both innovative and informative. The topic is relevant for the community of HESS and represents an interesting follow-up to previously published papers on the same subject.

I have to admit that I read the revision that was published earlier and I agree with the comments of the reviewer.

- It is necessary to correct the errors in the formulae 4-8.
- It is necessary to correct the labels in Figure 6d.
- Because of an extensive usage of symbolism it is at times hard to follow this manuscript. The manuscript would therefore benefit from being more concise. I know that there is no straightforward solution to this problem because of the nature of the study, but I believe that the previous reviewer gave some good recommendations in this respect. In my opinion, some analyses are indeed rather trivial and could be removed from the manuscript (e.g. comparison between the temporal mean of differences and the corresponding absolute values, see e.g. Fig. 6a,c; comparison between absolute differences and relative differences, see e.g. Fig6a,b).
- It is necessary to be more precise concerning the data preparation (e.g. p.827 “aggregation” of soil moisture data).
- I recommend improving the readability of Fig. 3 (e.g. put the x-axis label only once, increase size of the subplots).
- It is necessary to provide the units (or indicate [-]) on all plots.
- It is not necessary to “prove” that the contributions in Eq. 8 sum up to 1 (Fig. 3 & 4).
- In general, it would be preferable to develop the interpretation of the findings of this

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study and to make a better link to underlying hydro-meteorological processes and area characteristics (p. 831 l.15). Did you observe systematic differences between the individual sites that could be related to differences in climatology, lithology, topography or land use?

Moreover, it is important to bear in mind that the area covered by this study is 150 x 210 km. The contrasting climatologies may partly explain why the time invariant variance outweighs the time variant variance. However, there is only little information provided on this subject. Please provide more information on the spatio-temporal variability of precipitation in the area and how it may have affected the spatio-temporal variability of soil moisture. There is some information in Fig. 3a, but this is hardly readable.

It is important to relate the findings of this study to the particular characteristics of the study area and to refrain from jumping to general conclusions (e.g. p.833 l.1-3). In fact it is important to corroborate the findings of this study by applying the same evaluation framework to different data sets before any meaningful generalization can be envisaged.

Overall, I think that this is an interesting addition to the existing body of published research on soil moisture analysis. I recommend publishing this manuscript in HESS, subject to some minor revisions.

Minor comments: - p.828 l.2-4 why would the variability be minimal for moisture conditions close to the mean? Please clarify - p.832 l.19 “sequence of the sites” please clarify the meaning of this sentence

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 819, 2012.

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