Hydrology and Earth System Sciences

Discussions

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Interactive
comment

Interactive comment on "Exploring hydrological similarity during soil moisture recession periods using time dependent variograms" *by* Mirko Mälicke et al.

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Dear Referee,

Thanks for your helpful comment on our work. Your comment is highly appreciated.

First of all, we have to clarify that the objective of the presented study is not interpolation. We did not want to give the impression that geostatistics are generally not suitable. Space-time geostatistics can surely be used to interpolate based on spatial as well as temporal dependencies in the data.

Additionally we wanted to stress that we think that during drying and wetting different

processes are dominant. Thus data should be stratified according to their dynamic controls, and we think that the covariance reflects different controls.

In the revised manuscript we will clarify that a key focus of our study is on the memory of the soil. How long does it take until the soil 'forgets' about the rainfall disturbance in a sense that soil water dynamics and its spatial covariance are dominated by the soil and vegetation characteristics? This time scale will certainly depend on the observation depths (as the soil is a low pass filter), and the soil hydraulic properties (the water capacity and hydraulic conductivity). We think that the proposed approach is well suited to quantify this relaxation time scale.

From your comment we gather that our reasoning so far is not sufficient to motivate our approach. We will gladly take up your suggestions and will compare our method to the one you suggested to make it easier for the reader to understand the differences in the methods and the application of ours. In our study we want to demonstrate how long it takes for the dominant processes to switch and in what manner this transition happens. The evolution of a spatial dependency and how it converges into stationarity was found to be useful in this context. However, the studies named by the referee seem to be helpful and we are happy to test a replacement of the used variograms by the named space-time variograms as a moving window function. We will re-structure our introduction and methods to better clarify this main focus of our study.

Next, we completely agree that rank statistics take out a lot of information. This will surely complicate a geostatistical interpolation and the transformation back to absolute values. However, we are looking at a more general development and evolution of co-variance, or variogram shapes, in the recession of soil moisture. Here, the ranks might be more appropriate for exactly this decoupling from the absolute values. For comparison in our specific case, we re-run the moving variogram analysis part for the absolute values (figure 1). We used the Cressie estimator here, which is more robust on extreme values, just like the ranks are (Cressie, N., & Hawkins, D. M. (1980). Robust estimation

of the variogram: I. Journal of the International Association for Mathematical Geology, 12(2), 115–125. https://doi.org/10.1007/BF01035243). The variogram shapes are comparable and our study focuses on the clustering and shape of variograms. We would argue to keep the variograms based on ranks to be more consistent with the analysis concerning our hypothesis 1, which is based on ranks as well. We will clarify in the manuscript, that these variograms are not suitable for interpolation for the named reasons.

Finally, we agree that 15 sensors are not enough to estimate a proper spatial model that can be used for interpolation. In fact there is more data available, all located within the same geology. The other sensor locations can be found in figure 1 of the manuscript. Our original intention in limiting the sample size was to conduct a study on similarity evolution on the scale of one hillslope. We will test our method applied to more sensors and compare to the current results. This will, however, move the focus of the study to stable patterns developing on a much larger spatial scale.

In summary, we want to thank the referee for this most helpful comment on our work and hope that the outlined changes and clarifications will substantially improve the manuscript.
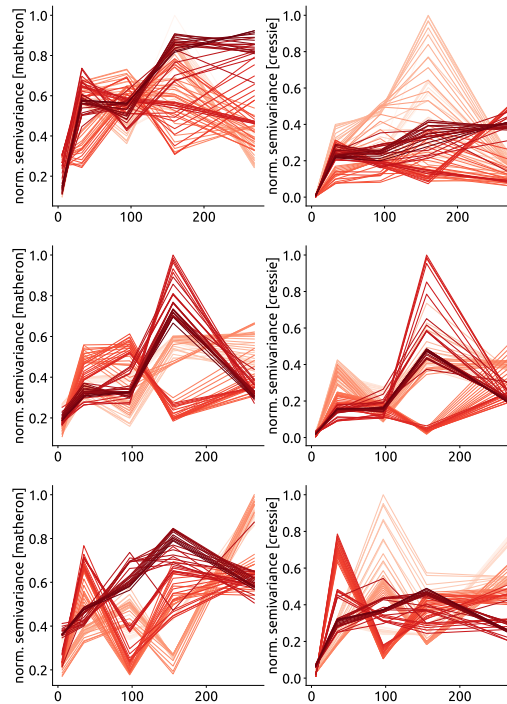

Fig. 1. Left: Result as in the study, based on semivariance of normalized ranks in 10 cm (top row), 30 cm (middle) and 50 cm (bottom); Right: Result based on Cressie-semivariance of absolute values