

Interactive comment on “Soil moisture: variable in space but redundant in time” by Mirko Mälicke et al.

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The authors present an interesting analysis of soil moisture variability. However they forget to acknowledge that many of the main results have been known for decades (like "Our most interesting finding is that even a few soil moisture time series bear a considerable amount of information about dynamic changes of soil moisture."), and some of the literature is ignored or cited in a wrong context.

The first to observe that soil moisture exhibits so-called temporal stability (persistence in the spatial pattern) were Vachaud et al (1985). Afterwards, there have been numerous (probably hundreds) of studies that have shown this persistence to be a generic feature. These studies are reviewed by Vanderlinden et al., 2012. This review should

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not be referred to in the context of "Soil moisture at the headwater scale exhibits huge spatial variability and single or even distributed TDR measurements yield non-representative data", but rather to summarize the endless number of studies that have shown spatial soil moisture patterns to be persistent (such as Jacobs et al. 2004, Comegna and Basile, 1994, Grant et al.2004 among many others). It has also been argued that this pattern stability should be referred to as rank rather than temporal stability (Chen 2006).

The persistence follows directly from the water balance constraint on local soil moisture states. A powerful framework to analyse this was presented by Albertson and Montaldo (2003). Teuling and Troch used this framework to identify the spatial processes driving the persistence of soil moisture patterns and changes therein. The implications of the stability in terms of soil moisture sampling/monitoring have also been previously addressed by many other studies. The "Catchment Average Soil Moisture Monitoring (CASMM) locations" are those sites where point observations can be used to directly estimate the spatial mean (Grayson and Western 1998). We have previously shown that point-scale observations can be used to estimate the spatial mean, but due to heterogeneity in processes there is still a non-negligible error (Teuling et al 2007). More recently, Mittelbach and Seneviratne (2012) presented a framework to analysis the total soil moisture variance, and discussed the implications for spatial and temporal monitoring.

I believe the presented work needs a better positioning in the existing literature, and I hope the references presented in this comment (as well as the references in those papers) will help the authors in addressing this.

References

Albertson, J. and Montaldo, N.: Temporal dynamics of soil moisture variability: 1. Theoretical basis, *Water Resour. Res.*, 39, 1274, doi:10.1029/2002WR001616, 2003.

Chen, Y.: Letter to the Editor on "rank stability or temporal stability", *Soil Sci. Soc. Am.*

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J., 70, 306, doi:10.2136/sssaj2005.0290l, 2006.

Grayson, R. and Western, A.: Towards areal estimation of soil water content from point measurements: time and space stability of mean response, *J. Hydrol.*, 207, 68–82, 1998.

Vachaud, G., Passerat De Silans, A., Balabanis, P., and Vauclin, M.: Temporal stability of spatially measured soil water probability density function, *Soil Sci. Soc. Am. J.*, 49, 822–828, 1985

Mittelbach, H. and Seneviratne, S. I.: A new perspective on the spatio-temporal variability of soil moisture: temporal dynamics versus time-invariant contributions, *Hydrol. Earth Syst. Sci.*, 16, 2169–2179, <https://doi.org/10.5194/hess-16-2169-2012>, 2012.

A. J. Teuling, R. Uijlenhoet, F. Hupet, E. E. van Loon, and P. A. Troch, Estimating spatial mean root-zone soil moisture from point-scale observations, *Hydrol. Earth Syst. Sci.*, 10, 755–767, <https://doi.org/10.5194/hess-10-755-2006>, 2006.

Teuling, A. and Troch, P.: Improved understanding of soil moisture variability dynamics, *Geophys. Res. Lett.*, 32, L05404, doi:10.1029/2004GL021935, 2005

Jacobs, J., Mohanty, B., Hsu, E., and Miller, D.: SMEX02: Field scale variability, time stability and similarity of soil moisture, *Remote Sens. Environ.*, 92, 436–446, doi:10.1016/j.rse.2004.02.017, 2004.

Comegna, V. and Basile, A.: Temporal stability of spatial patterns of soil water storage in a cultivated Vesuvian soil, *Geoderma*, 62, 299–310, 1994.

Grant, L., Seyfried, M., and McNamara, J.: Spatial variation and temporal stability of soil water in a snow-dominated, mountain catchment, *Hydrol. Processes*, 18, 3493–3511, doi:10.1002/hyp.5798, 2004

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, <https://doi.org/10.5194/hess-2019-574>, 2019.