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Interactive Comment

Interactive comment on "Integrating coarse-scale uncertain soil moisture data into a fine-scale hydrological modelling scenario" *by* H. Vernieuwe et al.

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The manuscript by Vernieuwe et al. discusses the integration of course scale surface soil moisture data with a high resolution land surface model. It is timely, clearly written and illustrated, and deals with one of the key challenges in hydrological modelling and data assimilation, namely the integration of different (and uncertain) products at different scales. This makes the manuscript potentially of interest also to hydrologists not directly working on soil moisture.

General comments

My main criticism concerns the use of a single scaling relationship between the field scale mean soil moisture content and its variability. The authors make extensive use of a suite of analysis tools (to such an extent that it even becomes hard sometimes to follow the main line of argumentation), implicitly suggesting that the analysis is completely objective. However, every chain of arguments is as strong as its weakest link, and I believe the weakest link in this case is formed by the first link, namely in the generation of the model runs used to derive the scaling relationship between field scale mean soil moisture content and its variability.

As also pointed out by the authors based on a literature review of studies on real-world soil moisture variability and model simulations of this variability, the scaling relationship is non-unique and subject to hysteresis. It should be stressed that this hysteresis is a fundamental result of the model structure, and does not result from noise. In addition, in the real world the spatial variability of soil moisture is not only simply governed by topography, but by a complex interaction between past weather conditions, topography, vegetation patterns, and soil characteristics that is not, or at best only partly, accounted for in the model simulations since only topography was varied. The effective result is that there is no relationship between mean soil moisture and its variability, but only upper and lower envelopes. The actual value moves between these envelopes set by mostly by soil properties (see e.g. Salvucci, 1998) mainly as a function of past climate (see e.g. Teuling et al., 2007). Thus, any function could be generated between these envelopes based on the arbitrary choice of climate conditions during the model run. This will not only impact the variability, but most likely also the spatial pattern.

While the authors discuss the limitations of the method at the end of the paper, in particular also the use of a single scaling relationship and the fact that soil moisture patterns are dynamical, it would make the paper stronger if ideas are presented and discussed on how, at least potentially, to work around this fundamental problem. In summary, the authors should either acknowledge that the scaling relationship has been chosen somewhat arbitrary based on selected climate conditions (which also limits the applicability to this climate range-while data assimilation is mostly relevant during extreme conditions where model uncertainty is largest), or provide better arguments why their approach is physically justified.

Specific comments

Title: "Course-scale soil moisture data" suggest spatial scales of a SMOS-pixel and not a scale orders of magnitudes smaller. It would be better to be more specific about the scale of application. I would suggest to use "Field-scale" rather than "course-scale", since this is the scale of interest in the study.

References

Salvucci, G. (1998), Limiting relations between soil moisture and soil texture with implications for measured, modeled and remotely sensed estimates, *Geophys. Res. Lett.*, **25**(10), 1757–1760.

Teuling, A. J., F. Hupet, R. Uijlenhoet, and P. A. Troch (2007), Climate variability effects on spatial soil moisture dynamics, *Geophys. Res. Lett.*, **34**, L06406, doi:10.1029/2006GL029080.

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