

Interactive comment on “A case study on the use of appropriate surrogates for antecedent moisture conditions (AMCs)” by G. A. Ali and A. G. Roy

Anonymous Referee #1

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General Comments

This paper describes the analysis of a detailed dataset of soil moisture measurements (121 locations, 4 depths, 16 sampling days) in order to test the ability of a variety of antecedent wetness indices to represent the soil moisture state in different parts of a small catchment. Relationships between the soil moisture at individual locations and both the mean catchment soil moisture, and catchment discharge, are also investigated. The scientific question is relevant and will be of interest to the readership of HESS, and the dataset provides a valuable opportunity for this analysis. The paper makes good use of Figures to clearly represent complex results. I would therefore recommend the paper for publication after moderate revisions to address the choice of

C1638

relationships fitted, as outlined in the following paragraph.

The paper would benefit from more careful consideration and explanation of the relationships fitted between the various surrogates for AMC and the measured soil moisture data. The authors fit in each case five different regression models (linear, quadratic, cubic, semi-logarithmic and inverse (not clear what 'inverse' is)). There is no physical justification for any of these models so I assume they are chosen purely to give a range of possible curves, with varying complexity. It is not clear whether the quadratic and cubic curves are constrained to be monotonic increasing. I suggest that to quantify only the strength of the relationship between each surrogate and the soil moisture, that a distribution-independent correlation measure such as rank correlation would be more appropriate. Although the authors state in Section 2.4 that nonlinear relationships will only be chosen where the data justifies it, no method of making that decision is identified, only that the improvement in the proportion of variation explained should be "tangible" (P10L8). A clear method for identifying when the higher-order relationships are justified is needed.

Specific Comments

On P3 L9 and P5 L27 Soil moisture is described as a 'major control on catchment response' and a 'critical hydrological state variable whose variation indicates active areas'. It would be useful here to bring in and comment on the findings by Tromp-van Meerveld, and the comment-and-reply by Western and Tromp-van Meerveld (citations below) on the question of whether soil moisture is the control on streamflow response or whether it is a passive signal, with transient saturation driving the streamflow response.

Tromp-van Meerveld, H. J., and J. J. McDonnell (2006), Threshold relations in sub-surface stormflow: 2. The fill and spill hypothesis, *Water Resour. Res.*, 42, W02411, doi:10.1029/2004WR003800.

Western, A. W., S. L. Zhou, et al. (2004). "Spatial correlation of soil moisture in small

C1639

catchments and its relationship to dominant spatial hydrological processes." *Journal of Hydrology* 286(1-4): 113-134.

Tromp-van Meerveld, H. J. and J. J. McDonnell (2005). "Comment to "Spatial correlation of soil moisture in small catchments and its relationship to dominant spatial hydrological processes, *Journal of Hydrology* 286 : 113-134"." *Journal of Hydrology* 303(1-4): 307-312.

Western, A. W., S. L. Zhou, et al. (2005). "Reply to comment by Tromp van Meerveld and McDonnell on Spatial correlation of soil moisture in small catchments and its relationship to dominant spatial hydrological processes." *Journal of Hydrology* 303(1-4): 313-315.

P3L21 - Mention here that the difficulty in collected soil moisture data is tied largely to the heterogeneity of soil moisture across a typical catchment.

P4L15 - You say that baseflow indices are less useful as they are dependent on the season of the year - however that is also a problem with the APIs you are using (stated at L5).

P4L16-19 A Key advantage of using the ABFI is that it is a proxy for a combination of shallow soil moisture and deeper groundwater conditions. Flow is extensively used as a proxy for antecedent wetness in the data-based mechanistic approach by Young (example citation below).

Young, P. C. and K. J. Beven (1994). "Data-based mechanistic modeling and the rainfall-flow nonlinearity." *Environmetrics* 5(3): 335-363.

P6L17 "the sole reference to AMCs measures" I don't understand what this means

P8L22-29 Explain why these indices were chosen over the other options mentioned (e.g. API)

P10L26 Over what timescale was PET calculated - that may strongly influence the

C1640

results

P12L5 Explain what CD_DISCH means

P14L16 "locations for which soil moisture is strongly related with AMCs can be labelled as source areas" - why?

P15L2 Nonlinear relationships are attributed to amount and timing of precip as well as ET, but the nonlinear relationship may just be a feature of the way that water is transmitted through the soil - this does not need to be linear.

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C1641