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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Using lagged dependence to identify (de)coupled surface andsubsurface soil moisture values" *by* Coleen D. U. Carranza et al.

Anonymous Referee #3

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This is a strong paper which makes a clear contribution. In particular, I appreciate the attempt to inject more rigor into the discussion surrounding vertically-coupling among multi-depth soil moisture measurements. I view the paper's contribution as being mainly methodological; however, some interesting preliminary conclusions regarding the occurrence of vertical de-coupling are presented (specifically, that – at least at one site – de-coupling is not limited to dry soil conditions).

The overall presentation of the manuscript is very good and the topic is of sufficient interest for HESS' readership. Therefore, I recommend publication following adequate response to the following minor points:

1) The manuscript would benefit from a more detailed description of exactly how their approach(es) can be used to improve the performance of a land data assimilation system. There are really two issues here. The first is a fundamental observability issue (i.e., what is the upper limit on how effectively surface soil moisture can be used to constrain sub-surface soil moisture given a perfect data assimilation issue). The second issue is the vertical accuracy of the assimilation paper. That is, even if you have high theoretical observability (i.e. high vertical coupling) at a particular point, you can still squander this potential constraint by using an assimilation model that does not properly represent this coupling. This is the model accuracy issue addressed previously by the Kumer et al. 2009 JHM paper (already cited in the original paper). To me, the second point is really the most important; however, addressing it requires the additional step of cross-comparing observed vertical coupling to the vertical coupling predicted by the assimilation model (when run off-line). It sounds like this is the ultimate intention of the authors; however, it is not explicitly spelled out in the current manuscript. So, in summary, I would encourage the authors to be more specific/detailed in describing exactly how these results can be used to improve the performance of a land data assimilation system.

2) The discussion in Section 3.2.2 is not very accessible. For example, equation (1) is introduced as describing the time series of "outcomes" Y_t, yet Y_t only appears on the LHS of the equation as g(E(Y)). "g" is apparently a "monotonic link function" (??) and E is some kind of a an expectation operator (in space, in time, across an ensemble?). So it's hard for me to see how Yt is actually "described" here. In the next function sentence "s" is introduced as a "basis function" (?) and all this is before the actual DLNM model is introduced. I suspect that all this terminology is correct and adequate for an applied math audience; however, HESS readership will likely need a bit more help and conceptual background to get through this section. I'd strongly recommend that the authors revise/expand Section 3.2.2 with an eye towards making it more accessible to a general earth science audience. Especially the early part of the section between equations (1) and (2)...I struggled there to follow the authors'

approach.

3) The analysis here is based solely on vertically-discrete soil moisture measurements (i.e. soil moisture observed at a depth of 40 cm). However, in remote-sensing, modeling and data assimilation, soil moisture estimates reflect vertically-integrated values (within the measurement depth of the remote sensor or across the vertically-discrete soil layer specified in a land model). Will the transition between vertically-discrete versus vertically-averaged soil moisture values affect the applicability of these results in a modeling or data assimilation context? I would recommend more discussion on this point.

4) While the manuscript is generally well-written, it does contain a large number of minor English usage errors. Additional proof-reading is recommended.

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