We would like to thank the reviewer providing critical feedback to our manuscript. We provided a reply to each comment which is followed by the revisions we made to the manuscript. The text for the reviewer comments are in grey while our replies and revisions are in black.

Reviewer 1:
Specific comments
Overall, the paper is well written but can be improved in what concerns the Methods section organization.

I have two main comments:
1) The first is related to the the choice of the value of the parameter βc . I think it is a key parameter for the study and should deserve further discussion (or results) on its impact on the results.

We agree with the point raised by the reviewer on the parameter βc. We adapted the manuscript in Section 5.2 page 11 from line 1. The text now reads:

"Weaknesses: The first aspect that needs further investigation is the selected βc value for identifying the decoupled soil moisture range. Although the selection in this study was based on trends identified from time series datasets, the methods applied should be tested further using other datasets to confirm the suitability of βc = 1 for other depths and soil types. The choice of βc is crucial as it dictates which soil moisture values are expected to be decoupled. For instance, at the sites where decoupling occurs during dry conditions, a higher βc value would enlarge the decoupled range. A similar effect would be expected for the site with decoupling during wet conditions. However, a lower βc value could result to decoupling only during extreme soil moisture conditions (e.g very wet or very dry)."

2) While the authors include different stations characterized by different vegetation cover (grass, corn and forest) its potential effect on the results is not examined in deep, especially for station SM20 which is located in the forested area, this effect could be significant. Can the authors provide further discussion on it?

We agree with the reviewer that the discussion on the controls, such as the effect of vegetation was not very extensive. This is because our main focus for the study was to investigate the methodology applied to quantify coupled and decoupled soil moisture values. However, we do realize that providing further discussion on said topic would improve the quality of the discussion in the paper. We adapted the manuscript in 5.1 in page 9 starting from line 25

"The vegetation type at each site exerts some influence on the soil moisture variability and the resulting (de)coupled values. First, the vegetation type affects how much ground surface is directly exposed to atmospheric conditions. Forested areas and grass fields are almost fully covered by vegetation compared to a corn field where the crops are organized in equidistant rows. Vegetation or canopy cover will determine how atmospheric conditions affect the soil moisture values. For instance, the amount of intercepted precipitation and evaporation are both dependent on vegetation cover. This in turn will have direct impacts to the surface soil moisture dynamics at each of the sites. For comparison, the variability given by the standard deviation bars in fig.4 and variance in fig.5 at for the cornfield (SM09) is higher compared to that of the grass field (SM05) or the forested area (SM20). In addition, the forested area (SM20) has the smallest range of soil moisture values among the four sites. This may be due to the high amounts of intercepted rainfall by the forest canopy. Root water uptake (RWU) is another way by which vegetation affects soil moisture variability. RWU can have significant influence on the subsurface dynamics. The influence of RWU may vary for different vegetation types as it can be exerted over a range of depths, leading to differences in the resulting (de)coupled values."

I have some additional and technical comments that I will list below in order of appearance in the manuscript:

1) Section 3.1: It is not clear to which figure the authors are referring to. Please point to a

specific figure when describing graphic features or speak more in general. This section should contain method description and choices made for carrying out analysis.

We adjusted the text in section 3.1 and added a schematic diagram which the text refers to.

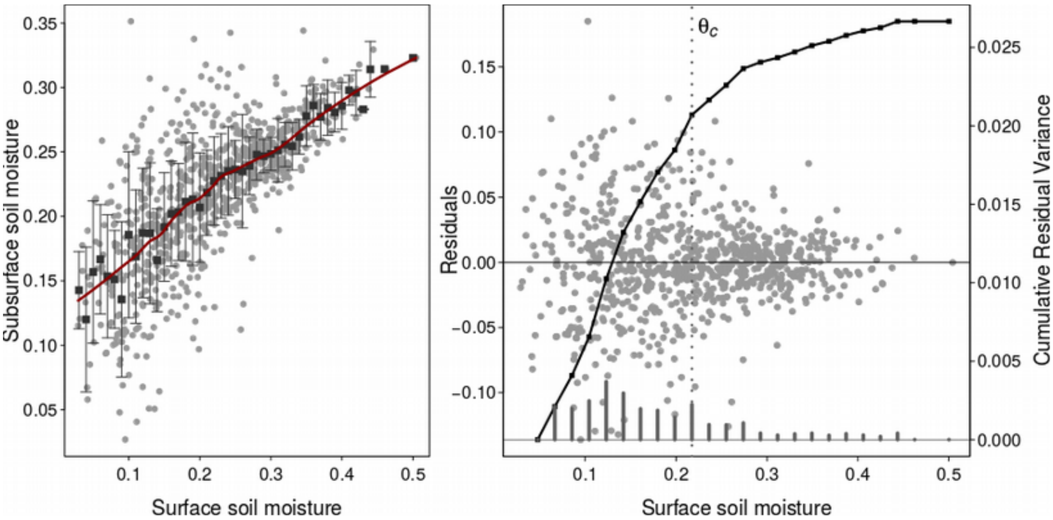

Figure 3. Schematic diagram using hypothetical soil moisture values to show vertical variability. Left side of the figure shows the trend with a fitted loess function. The variability can be seen using the standard deviation bars. The right side shows the residuals of the fitted function. Soil moisture variability is more visible from the variance given by the vertical bars and the cumulative variance is given by the black line. A change in variability at an intermediate soil moisture value is marked by a change in the slope of the cumulative variance line, marked by θc

2) Section 3.1: Define what vertical variability exactly means.

We added a line in Section 3.1 in page 4 line 6:

"We referred to vertical variability as the uneveness or irregularity in soil moisture distribution within a certain depth of interest along the vertical profile, in this case up to depths of 40 cm"

3) The cumulative variance is presented in Figure 4. Same as before, here the authors speak about slope but it is not clear at all for the reader to what slope they are referring to. Please define what cumulative residual variance means and clarify better all the related concepts.

-We adjusted the text in section 3.1 and added a schematic diagram, which is now figure 3, to refer to the parts of the graph being described in the text. Please see response for technical comment #1

4) Section 3.2.2 Distributed lag model: It is not clear enough how the DLNM model is used with soil moisture observations. I suggest to describe the basic concepts here rather than mathematical details (which could be included in an appendix). Please try to simplify and clarify this section so as it can be more easily interpreted

We realize the difficulty encountered by the reviewer in following the description of methods applied using the DLNM. We completely revised 3.2.2 section of the manuscript. The section now becomes:

"3.2.2Distributed lag model

We incorporated delayed or lagged effects in evaluating the relation between surface and subsurface values, and eventually in determining (de)coupled values. It should be emphasized that the analysis was primarily focused on examining the trends and relations between surface and subsurface soil moisture. Moreover, it was not intended to contradict or replace other models for estimating soil moisture or examining its patterns.

A distributed lag non-linear model (DLNM) developed by Gasparrini et al. (2010) was applied to the 5 cm and 40 cm time series datasets at the study sites. Briefly, the model is capable of simultaneously representing both functional dependency and delayed response between exposure and response values. We considered surface soil moisture as the *exposure values that produced delayed effects to the response values at the subsurface. A non-linear model was selected in order to capture the non- linear dynamics of flow and transport along the soil profile (Mohanty and Skaggs, 2001; Kim and Barros, 2002). Furthermore, DLNM offered enough flexibility to model a variety of dependencies in the time series dataset by selecting a suitable basis function. DLNM could be thought of as equivalent to a linear time series model (e.g. autoregressive model) just as a generalized linear model is equivalent to a linear model.*

In assessing lagged dependence, event scale patterns were of interest rather than large scale trends within the time series (Wilson et al., 2004). This required seasonal patterns to be addressed prior to applying the DLNM. This was done by fitting a loess function to the time series and then subtracting it from the original soil moisture values (Cleveland et al., 1990). Removal of seasonality was further justified by the scatterplot results (see Section 4.1). The influence of seasonality on the vertical soil moisture variability is indicated by clustering of observation points occurring within the same months (fig.4). De-seasonalized soil moisture values were used for identifying (de)coupled soil moisture conditions.

For consistency in modeling, the range of surface soil moisture values used was from 0-0.50 $cm^3 cm^{-3}$. This was based on the highest surface soil moisture value encountered among the four sites. A lag value of up to 30 days was considered long enough to investigate delayed effects. This period also approximated the recurrence of heavy rainfall within the study sites. A spline function was the basis function chosen to represent the functional dependence as well as delayed effects as it offered flexibility to capture non-linearities. In addition, contributions from daily rainfall data were used to incorporate current and past meteorological conditions. This was applied as a covariate and was represented with an additional basis function. We only considered delayed effects in vertical flow as lateral movement is deemed negligible in flat to slightly sloping terrain (Table.1). The analysis was performed in R software using dlnm (Gasparrini, 2011) and mgcv (Wood, 2006a) packages.

The following section concisely describes the mathematical formulation of a DLNM. However, the reader may choose to skip this section as the general methods applied have already been described in the text above. For a more detailed explanation, readers are referred to Gasparrini et al. (2010) and Gasparrini et al. (2017).

####Some lines for the mathematical description of DLNM is not included here. The structure of this section was not revised#########

3.3 Evaluating (de)coupled soil moisture values
Application of a DLNM resulted in the estimation of parameter β for each surface soil moisture value. This indicated the strength of dependence between surface and subsurface soil moisture. Higher β values indicated stronger dependence or coupling between the two. Hence, we referred to β as the relative influence of surface soil moisture on subsurface values."

5) Pag. 6 lines 19-24: here the authors seem to anticipate the results of the paper about the value to be assigned to β_c . However, I suggest to try to organize the paper in a way that the choice of β_c is described in the results section (and supported by analysis).

We agree with the reviewer that this paragraph is more suitable in the results section. This was moved to section 4.3 in page 7starting from line 24.

6) Pag 8 lien 17-19. Clarify this sentence.

We changed the text in page 8 line 17-19. It now reads as:
"For instance, at SM05 and SM09, there is a general increase in β from dry towards wet surface soil moisture values. SM20 also shows increasing β over a limited soil moisture range (0.1 −0.25 $cm^3 cm^{-3}$). Outside this range, the estimated β values for SM20 were less than one and have very broad confidence intervals. Recall that the range used for DLNM was only for uniformity among the four study sites. The lack of or very few observations for very dry or very wet soil moisture conditions led to wider confidence intervals not only for SM20 but also for the other three sites. Compared to the three sites, the estimated β values for SM13 show decreasing values towards the wet soil moisture range (> 0.3 $cm^3 cm^{-3}$). From the intermediate to dry soil moisture conditions, the values fluctuate around the designated $\hat{\beta}_c$."

7) Pag 8 line 11. Replace 40cm with “40 cm”

This was now changed. The whole manuscript was also reviewed for similar errors.

8) Pag 9 . Line 25. T is missing.

A "T'" is added in the beginning of the sentence. There was another round of proof reading to check for similar textual and grammatical errors.