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Interactive comment on "Spatial variations of deep soil moisture and the influencing factors in the Loess Plateau, China" *by* X. N. Fang et al.

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We thank reviewer for the detailed comments. We have gone through all the comments and will amend the original manuscript base on the suggestions and comments. In the following pages we provide brief answers to the reviews comments and we will make corresponding changes when we receive the editor decision.

Reviewer: The title of the manuscript is misleading. The paper does not explore the spatial variability of the soil moisture, it rather analyses how locally observed soil moisture values are related with both natural and human induced local factors.

Authors: Following the reviewer's suggestion, we will revise the title in the revised manuscript, and the "Spatial variations" will be removed.

Printer-friendly version

Discussion paper

Reviewer: The manuscript is too long, it provides several details that are not relevant for the key messages of the paper. Some data could be provided as supplementary material attached to paper.

Authors: Following the reviewer's suggestion, we will exam the manuscript carefully and remove/condense some sections, especially for figures, and tables that are of less relevance with key findings. We will move these figures and tables as supplementary materials.

Reviewer: Since the main scope of the paper is to assess the effect of the vegetation on soil moisture profile, a description of the root architecture of the different vegetation species in the examined sites would facilitate the analysis of the results. At lines 15-17, page 19, the authors state that "despite the deep root system of the apple orchard . . .the soil moisture in the apple orchard was higher than in native grasses". But how deep is the "effective" rooting system of the apple trees? Is it really deeper than native grasses? And what about the other species?

Authors: We agree a description of the root architecture of the different vegetation species can really help facilitate the analysis of the results. However, it is nearly logistically impossible for us to dig out the whole rooting system of all the plants in the 151 sampling sites. Thus, root architectures of the eight vegetation species in the study area will be obtained through other publications. In the revised manuscript, we will display the root architecture of different vegetation types.

Reviewer: It is well known that the soil moisture profile in the inter-storm periods is influenced by the vertical distribution of the active roots. Previous studies (e.g. Laio et al., Geophysical Research Letters, 2006) showed that the vertical root distribution in water controlled ecosystems is the result on an equilibrium condition affected by the local climate and soil properties. The data provided in the paper do not prove an unbalance "between soil availability and water utilization by plants". The observed soil moisture profiles could be representative of a stationary equilibrium condition.

Authors: We agree the vertical distribution of the active roots can influence soil moisture profile in the inter-storm periods. However, based on the EM50 dynamic monitoring data (shallow-root system native grasses and deep-root system Caragana korshinskii), we can conclude during the sampling period (July 10 - August 6), root distribution mainly influenced the soil moisture no deeper than 80cm, and deeper soil moisture (80-500cm) was not influenced. Thus, in the revised manuscript we will add the EM50 dynamic monitoring data, and clarify the roots influences on soil moisture.

Reviewer: Line 5-7 page 2 and Figure 2: it is not clear if the meteorological data collected during the sampling period have been exploited for the soil moisture data analyses. Apparently not. Therefore the sentence (lines 5-7) and Figure 2 can be removed. The authors should clarify to what extent the soil moisture observed in top layers could have been influenced by the rainfall events during the same sampling period.

Authors: The reviewer is correct, we didn't analyze the meteorological data collected during the sampling period in terms of soil moisture data analyeses, it was used to illustrate the climate condition of sampling period (July 10 - August 6). Thus, we will remove the sentence (lines 5-7) and Figure 2 in the revised manuscript. Besides, based on the observations, the rainfall events during the sampling period influenced soil moisture no deeper than 80cm. This can be verified by our EM50 dynamic monitoring data which will be added in the revised manuscript.

Reviewer: Equations 1 and 2 can be removed. They describe simple metrics (depth-average soil moisture values) but are quite confusing. The same symbol SMC is used with different subscripts to describe different metrics in a way that does not appear to be consistent. From Equation 2 and the corresponding description, is not clear that SMCs represents the average soil moisture within the same type of land management at a given layer depth.

Authors: Following the reviewer's suggestion, we will remove Equations 1 and 2 in the revised manuscript.

Reviewer: Table 2 provides details (such as Kurtosis, Skweness, K-S normality test) that are not commented in the manuscript.

Authors: Following the reviewer's suggestion, the detailed description of Table 2 (including Kurtosis, Skweness, K-S normality test) will be added in the revised manuscript.

Reviewer: Lines 10-22, page 15. The classification of the different layers is rather subjective and not supported by experimental evidences. The first layer should be influenced by both evaporation and transpiration. Not clear while the second layer is a "rainfall infiltration layer": transpiration could be significant in this layer in case of deep-rooted vegetation.

Authors: We agree the classification of the different soil layers by only considering soil moisture variation in native grassland is subjective. In the revised manuscript, we will further improve the classification method based on experimental evidence and take transpiration of deep-rooted vegetation into consideration.

Reviewer: Section 3.3 could be removed. It does not add information relevant for the main outcomes of the paper.

Authors: As suggested, we will remove the section 3.3 due to its loose relationships with the main points of the manuscript.

Reviewer: Line 15-18, page 20. It is not clear how the correlation of the soil moisture with the average annual rainfall has been computed. No data about rainfall height at the different sampling sites have been provided. The result is rather surprising. Since surface soil moisture is highly variable in time, due to evapotranspiration and rainfall events, what is the motivation of this "significant correlation"? Despite what is stated in the manuscript, Table 4 does not highlight the correlation value as "significant" (I do not see it in bold or underlined).

Authors: The average annual rainfall (2006-2013) was provided by 29 rain gauges in or around the Ansai watershed, and the Ordinary Kriging method was performed by ArcGIS10.0 to obtain the average annual rainfall at each sampling site. In order to further illustrate this result, we will add a distribution map of rainfall in the supplement documents. Besides, we further checked Table 4, and found that all the bold style in this table is missing. There must be something wrong when we uploaded the manuscript. We apologize for this oversight and we will correct this table in the revised manuscript.

Reviewer: From pages 9-10, it seems that soil properties (particle size distribution, bulk density, porosity) have been measured only from soils cores collected from the surface. Are these properties expected to be uniform along the soil profile? Soil moisture values are significantly influenced by soil texture and organic carbon content. Do the correlations presented in Tables 4-6 refer to surface soil properties?

Authors: Yes, all the soil properties have been measured only from soils cores collected from the surface (0-20cm). In loess Plateau, loess soil thickness in this area ranges from 30-80 m, and groundwater below this depth can merely influence deep soil moisture that are available for plants growth. Thus, the deep soil moisture in this region is mainly determined by land surface rainfall infiltration and evapotranspiration. As we know, surface soil properties (such as particle size distribution, bulk density, porosity, and organic carbon content) are usually more important in influencing surface rainfall infiltration and evaporation than deep soil properties, thus in this study we mainly analyzed surface soil properties influence on deep soil moisture. In the revised manuscript we will further explain related reasons.

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