

## ***Interactive comment on “Spatial variation of shallow and deep soil moisture in the semi-arid loess hilly area, China” by L. Yang et al.***

**L. Yang et al.**

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Received and published: 28 June 2012

We thank Anonymous Referee #3 for contribution and insightful comments and suggestions on our manuscript. We have gone through all the comments and will amend the original manuscript base on the comments and suggestions. We would like to take this opportunity to answer his/her questions and explain our points of view:

Reviewer: The authors present a novel dataset of soil moisture measurement form the Loess Plateau of China and the topic is appropriate for publication in HESS. The disturbed samples were made in soil cores from 0-2 m and 2-8 m over different time periods and a range of vegetation types, slope, aspect, and hillslope position. While I found the mean behavior the of measurements and conclusions interesting, I had

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a difficult time reading the paper because of grammar and word choice, please see technical comments for a few examples. I suggest the paper be edited for basic English grammar, as it is not acceptable in its current form. In addition to the grammar problems, I have reservations about the conclusions of the paper given the inherent uncertainty of point soil moisture measurements. It was not clear to me whether the mean values were statistically significant given the standard error; please see specific comment 2 below. I believe the paper needs major revisions before publication.

Authors: Thanks for this comment and suggestion. The revised manuscript will be polished by a native English speaker before submission. Combined the comments and suggestions of reviewers, the original manuscript will be thoroughly revised. Some explanation will be elaborated below.

Reviewer: The grammar of the paper made it difficult to read and is not appropriate for publication in its current form. Words were commonly conjugated incorrectly or the completely wrong word was chosen making understanding the paper difficult. While I have provided a list of technical comments here it may be most appropriate to have professional scientific writer proofread the manuscript.

Authors: Thank for the comments and suggestions, we have paid more attention to the problem and make efforts to improve the English in the revised manuscript. The revised paper will be polished by a native English speaker before submission.

Reviewer: It is not clear to me that any of the mean soil moisture values for vegetation type, slope, aspect, position are significant different from the other mean values. The authors state that 3 random sample points were chosen to estimate the mean behavior (Page4560 L15). The authors state that 30 individual samples were used to estimate the average soil moisture of 0-2 m in 20 cm increments. Is seems to me that there should only be 3 independent samples, not 30. Given the standard deviations in Tables 2-5 are on the order of 1-2%, I am not sure the standard errors of  $1-2\%/s^{0.5}$  are statistically significant given the small differences in the reported means? Also, it is

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not clear whether the soil moisture content is gravimetric ( $\text{g}^3\text{g}^{-1}$ ) or volumetric ( $\text{m}^3\text{m}^{-3}$ ). The authors should include the units instead of the ambiguous %. If the units are indeed volumetric then the authors must have assigned average bulk density values to convert the disturbed gravimetric measurements to volumetric. Table 2 illustrates the variability in bulk density, where samples were only taken at 0-5 cm and 20-25 cm (pg4561, 1-2). From table 2 the sample bulk densities vary between 0.8 and 1.2  $\text{g cm}^{-3}$  and may account for the variation in mean behavior reported by the authors. The authors report the loess is homogeneous (pg 4556, 12) but the variation in bulk density indicates otherwise or the samples are too small to get a representative sample. I suggest the authors clean up the soil moisture units, include their assumptions about bulk density estimates if needed, and redo the uncertainty analysis but with individual sample sizes of 3 instead of 30 as I think it has been currently done to see if the get the same statistically significant differences.

Authors: In our study, deep soil moisture was measured in the depth of 2-8 m. A total of 30 soil samples were collected from each sampling points, and three sampling points were randomly chosen to obtain average soil moisture content at each experimental site. Thus, the depth-averaged deep soil moisture content was calculated by these soil samples. Because shallow soil moisture varied with annual rainfall, in our study the temporal- and depth-averaged soil moisture was used to provide accurate characterization of the temporal changes in soil moisture and represent the soil moisture conditions in shallow layers. Shallow soil moisture data was collected biweekly from April to October of 2009 and April to September of 2010. The total field sampling times is 26. At each sampling time, 10 soil samples were collected at each sampling point. Furthermore, three sampling points were chosen to obtain average soil moisture content each sampling time at each experimental site. Thus, the number of independent soil samples collected in each experimental site is  $26 \times 10 \times 3$ . The temporal- and depth-averaged shallow soil moisture content is calculated by using these soil samples. Perhaps method section in our original manuscript is unclear. Combined comments and suggestions of reviewers, the method section will be reorganized to clearly state how

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many soil samples were collected in each experimental site.

The soil moisture data was measured by the oven-drying method. Gravimetric soil moisture content was used in this study. In this paper, we have not assigned average bulk density values to convert the disturbed gravimetric measurement to volumetric. Combined the comments and suggestions of reviewers, the units of soil moisture content will be changed with  $\text{g g}^{-1}$  instead of the % to avoid ambiguous. Soil texture in the Loess Plateau is quite uniform, and soil properties have limited effect on soil moisture content. The soil properties vary with vegetation only in surface layers. Soil texture and bulk density below surface layers are homogeneous in the semi-arid Loess Plateau. Compared with topographical factors and soil properties, vegetation has more influence on soil moisture, especially for soil moisture stored in deep layers. In this study, we want to know how spatial variation of shallow and deep soil moisture would change after planting. Thus, the difference of soil moisture content was used to reflect the soil hydrological process affected by introduced vegetation between shallow and deep soil layers. Combined the suggestions of reviewers, the method section will be reorganized to clearly state how the experiment be conducted.

Reviewer: The authors conclude that there are differences in the deep soil moisture pools due to vegetation differences of water use. However, without any direct measurements of water flux in the top layer (either deep drainage inferred from modeling results of the observed state variable of soil moisture or evapotranspiration from latent energy measurements), it is difficult to believe the small observed differences in the mean soil moisture, particularly given the small number of disturbed samples as discussed in 2. The authors suggest the rooting profiles and abstraction rates are the likely cause but the provide only above biomass differences. Is there any direct evidence of different rooting profiles for the different vegetation types or for different about ground biomass? Direct evidence would greatly strengthen the authors' argument and conclusions.

Authors: Introduced vegetation has been planted in study area for years. The introduced vegetation has significant influence on soil moisture content and its spatial vari-

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ation. We want to understand the dynamic of soil moisture between shallow and deep soil layers under the influence of introduced vegetation. In our study, difference of deep soil moisture appeared due to vegetation differences of water use. Undeniably, plants with good growth conditions would consume more soil water. Thus, spatial variation of deep soil moisture was determined by vegetation growth conditions. Direct evidence such as water flux in the top layer, rooting profiles for the different vegetation types or different above ground biomass indeed would greatly strengthen our conclusion. In our study, we focus on the spatial variation of soil moisture between shallow and deep layers under the influence of topographical factor and vegetation. We compared soil moisture content on different slope positions, aspects and gradients. Our findings reveal that dynamic role of topographic factors on soil moisture differs between shallow and deep layers. Topographic factors such as slope aspect only affect soil moisture in shallow layers, and no direct influence on deep soil moisture in the introduced vegetation types. Slope gradient however, has significant influence on both shallow and deep soil moisture. Furthermore, the plant growth conditions are considered as the main factor for spatial variation of deep soil moisture. Each comparison in Fig. 2-Fig. 7 was conducted in the same vegetation. Thus, plant growth conditions in each comparison are suitable to express the difference of deep soil moisture. However, vegetation growth conditions of grass, shrub and forest cannot be identified by one simple index. Combined the suggestions of reviewers, canonical correspondence analysis will be implemented in revised manuscript. Thanks for this comment.

Reviewer: A scientific writer for basic sentence structure, conjugation, and word choice should edit the manuscript. Here are a few examples but it is not an exhaustive list.

Authors: Thanks for the comments and suggestions, we have paid more attention to the problem and make efforts to improve the English in the revised manuscript. According to your constructive recommendations in the detailed comments, the grammars have been carefully revised. Furthermore, the revised paper will be polished by a native English speaker before submission.

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Reviewer: Pg 4554, 7-9: The sentence does not make sense, rewrite. I believe you mean variations in slope, aspect. . .

Authors: Yes. Thanks for the suggestion. The sentence could be reworded as: "The vegetation type of each sampling site for each comparison is same, while varies with position, gradient, or aspect."

Reviewer: Pg4555, 5-9: the introduced vegetation phrase does not make sense in the sentence

Authors: The sentence could be reworded as: "Meanwhile, to control serious soil erosion in the Loess Plateau, large-scale implementation of the "Grain to Green Program" (GTGP, also known as the Sloping Land Conversion Program and the Farm to Forest Program) initiated by the central government in recent years (Chen et al., 2010; Liu et al., 2008). Alien species are planted to restore the local ecosystems, and introduced vegetation thus has become the main vegetation type in this region (Wang et al., 2007)."

Reviewer: Pg4555, 11, should be needs

Authors: Yes. The sentence could be reworded as: "However, introduced vegetation usually needs more soil moisture than local natural plants and could rapidly deplete the limited soil moisture resources stored in the deep layers (Wang et al., 2009, 2010b)."

Reviewer: Pg4556, 4, In fact, factors is an awkward phrase

Authors: The sentence could be reworded as: "In fact, a dozen of factors may have impacts on deep soil moisture."

Reviewer: Pg4556, 8, complicated should be complex

Authors: Yes. The sentence could be reworded as: "Specially, the detailed topographic variability as represented by complex hills and gullies in the Loess Plateau results in significant local redistribution of precipitation, solar radiation and surface runoff (Qiu et

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al., 2010; Zhu and Shao, 2008).”

Reviewer: Pg4556, 11, should be are homogeneous

Authors: Yes. The sentence could be reworded as: “Because the soil properties in the Loess Plateau are homogeneous (Yang and Tian, 2004).”

Reviewer: Pg4556, 24, should be are the same

Authors: Yes. The sentence could be reworded as: “(2) to investigate whether the deep soil hydrological processes are the same as the shallow under the influence of topography;”

Reviewer: Pg4557, 11, should be the rainfall had a uniform. . .

Authors: The sentence could be reworded as: “The rainfall had a uniform distribution in the watershed based on five spatial-distributed auto-recording rain gauges during 2008-2010.”

Reviewer: Pg4557, 24-26, start sentence with, Because the study area is located. . . then water shortage major constraint. . .

Authors: The sentence could be reworded as: “Because the study area is located in the semi-arid climatic zone, then water shortage is actually the major constraint to vegetation growth and agriculture production.”

Reviewer: Pg 4558, 3, should be native natural

Authors: The sentence could be reworded as: “Based on vegetation distribution characteristics in the study area, the native natural grassland, farmland and planted vegetation lands were selected for analysis.”

Reviewer: Pg4559, 4, should be soil moisture variations

Authors: The sentence could be reworded as: “Eight typical transects with different vegetation covers (NG, PO, AF, AL, KP, CP, CA, and SA) were selected to compare soil

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moisture variations on different slope positions.”

Reviewer: Pg4559, 8, and 4562, 5, phrase should be top and bottom and head and foot

Authors: The sentence could be reworded as: “All transects were covered with the same vegetation from top to bottom of the hillside along with the flow direction and increasing of upslope contributing area.”. “The SMC in alfalfa transect increased from top to bottom of the hillside.”

Reviewer: Pg4559, 15, meanwhile is an awkward transitional statement

Authors: In revised manuscript, the “meanwhile” will be changed by “Furthermore”.

Reviewer: Pg4559, 19, should be From the limited. . .

Authors: The sentence could be reworded as: “From the limited vegetation distribution characteristics in the study area, not all the eight different types of vegetation can be found in different slope aspect or gradient.”

Reviewer: Pg4561, 18, should be of mean values

Authors: The sentence could be reworded as: “The basic statistical features of mean values (Mean), standard deviation (S.D.) were analyzed and reported for each site.”

Reviewer: Pg4563, 1-2, sentence doesn't make sense

Authors: This sentence will not appear in the revised manuscript.

Reviewer: Pg4563, 6-7, showed what difference?

Authors: This sentence could be reworded as: “However, the comparison of mean value and vertical distribution of deep SMC was different with that in shallow layers.”

Reviewer: Pg4564, 12, not sure what is full of capillary pore

Authors: The sentence could be reworded as: “The loess has homogeneous soil tex-

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ture and the soil is full of capillary pore. Soil with this characteristic has strong capacity of evaporation, stable low shallow SMC was always found in this region (Yang and Tian, 2004).”

Reviewer: Pg4564, 23, led is wrong word

Authors: Combined the suggestions of reviewers, the sentence could be reworded as: “Low SMC in shallow layers make the difference of SMC between different environmental variables became no significant.”

Reviewer: Pg4565, 27, should be proven by previous studies

Authors: The sentence could be reworded as: “The spatial distribution characters of SMC in these patterns have been proven by lots of previous studies (Francis et al., 1986; Legates et al., 2011; Western and Blöschl, 1999) and models (Cantón et al., 2004; Western et al., 1999).”

Reviewer: Pg4567, 19, leaded should be led

Authors: The sentence could be reworded as: “Thus, high planting density led the lower deep SMC on these positions (Figure 2h, Figure 3h).”

Reviewer: Pg4567, 28, should be field investigations?

Authors: Yes. Thanks for the detection of this typo.

Reviewer: Table 1. Add phrase year sense disturbance

Authors: This table will be reorganized in the revised manuscript.

Reviewer: All tables and figures should have soil moisture units of  $\text{g g}^{-1}$  or  $\text{m}^3 \text{m}^{-3}$  to avoid confusion

Authors: Thanks for this comment. This problem will be carefully solved in the revised manuscript. The unit of soil moisture content will be changed with  $\text{g g}^{-1}$  instead of % to avoid confusion.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 4553, 2012.

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