Final Reply of Hess-2013-307 to Referee#2

A) Introduction

1) Introduction is not very clear and logic and is not easy to understand and follow.(Referee#2)

Response: According to the referee#2's suggestion, we readjusted the logical structure of the introduction, and divided the introduction into four sections. The brief explanation of all the sections as follows:

A) Section one (first paragraph)

In this section we mainly focused on making the definition of the temporal stability of soil moisture (TSSM) with more reasonable and understandable way. Therefore, in addition to citing the traditional definition of TSSM by (*Vachaud et al*., 1985) in manuscript, we further added the sentence "*Although the distribution of soil water content varies with the time and space in the field observation, the order of the soil moisture or of the average soil moisture arranging in the spatial pattern does not change with the observational period, which, deduced an exploratory method to describe the stability characteristics of temporal distribution of the soil water content.*" into revised manuscript to further interpreted the concept of TSSM.

B) Section two (second paragraph)

Section two was literature review related to TSSM research. In this section, we summarized that larger spatial scale, mathematical-based evaluation system of TSSM calculation, and influencing factors of TSSM were the main three characteristics of former TSSM studies by citing literatures. Compared with the manuscript, we actually reordered the key points of former TSSM studies to emphasize that larger spatial and gridding soil moisture sampling method were the common features in former TSSM researching, all of which was prepare for the proposal of new method of TSSM study in next section. In the section we tried to help the readers understand what the background of problem been needed to resolve.

C) Section three (third paragraph)

In section three, we mainly proposed our thought of TSSM studies and tried to expand the TSSM concept and method on the finer spatiotemporal scales. Meanwhile we explained the specific form of finer spatiotemporal scales by choosing microplots as the research objects as well as selecting hydrological processes-trait soil moisture sampling method. Meanwhile, we analyzed the probability of the combination TSSM studies with hydrological processes in finer spatiotemporal. And finally, we pointed out the value of TSSM researching in this paper which could not only enrich the implication of TSSM, but also supply new method to analyze the hydrological features of soil moisture in finer spatial scale.

Due to the most importance of this section in the introduction, we rewrote the section in revised manuscript, and stressed that what is the difference between the problems proposed by us and other problems concerned by former TSSM studies, how we resolved the problems, and believed that the meaningful studies was beneficial to understanding hydrological mechanisms being greatly significant for the strategy of vegetation layout in water-controlled ecosystems, also to exploring the causes of these mechanisms which was, in a theoretical view, also a challenging issue for certain related interdisciplinary research fields.

D) Section four (fourth paragraph)

Based on the "general to specific" logical structure, in the fourth section, we introduced the former TSSM studies in our study region (The Loess Plateau) and briefly described the study contents and objectives in this paper.

We made a major revision in introduction, and furthermore, in order to help readers to know the difference between the TSSM studies processes and former TSSM studies more clearly, we readjusted the fig 10 in manuscript to the introduction in revised manuscript to assist word description to illuminate the framework of finer spatiotemporal scale of TSSM research.

2) What is meaning of "uniform sampling strategy"? How to approve the "uniform sampling strategy" used by former TSSM study?(Referee#2)

Response: Actually, "uniform sampling strategy" was a vague expression though it also appeared in former literatures about TSSM studies, in the revised manuscript, we changed the description into "gridding pattern of soil moisture sampling strategy", and explain the meaning—a gridding pattern distribution of soil moisture sampling regardless of the diversity of land use/cove in the sampling field to determine the characteristics of spatial pattern and temporal stability of soil water. The purpose of this sampling strategy was to describe the different spatial pattern of soil moisture in different interval of observational period. Specifically, in a larger spatial scale (usually in hillslope scales, watershed scales or even landscape scales), former researchers could analogy with different spatial patterns of soil moisture distribution over different observational period, and finally evaluate the characteristics of corresponding TSSM through integrating the gridding pattern of soil moisture sampling method with specific frequency of sampling time. Therefore, the revised expression could be more clear to describe the sampling method.

3) What means of "coarser spatial scale"?(Referee#2)

Response: As a term which was usually used to describe the spatial pattern in landscape ecology, coarser spatial scale was a relative concept in the spatial scale description. Compared with finer spatial scale, the coarser (or larger) spatial scale was always the site owning more complex flow of material, energy and information, not just larger area. Therefore, people use coarser to express the complexity and expanse of some larger specific spatial scale. And in the revised manuscript, we also added the related reference in the introduction to explain the term.

4) How can you speak your study is based on finer spatial scale? not a coarser scale, and reference system?(Referee#2)

Response: In this paper, compared with the hillslope scale, watershed scale and even landscape scale focused by form TSSM studies, 16 square microplots (60×60cm per one), as the research objects, obviously represented the finer spatial scales, and follow to the referee#2's suggestion, we explained the term of finer or coarser scale by citing the related reference book named "landscape ecology in the theory and practice" in the revised manuscript.

5) What is the "important temporal information of the soil moisture existing at finer spatial scales"?(Referee#2)

Response: The "important temporal information" was surely an inexplicit expression, and the important temporal information mainly indicated the temporal dynamic characteristics of soil moisture existing in the finer spatial scales. According to the whole sentence, we wanted to express that what the characteristics of temporal dynamic of soil moisture in finer spatial scales, whether we could quantificationally evaluate this characteristics through the introduction of TSSM concept. Consequently, in the revised manuscript, we deleted the inexplicit expression and employed other sentence pattern to convey the meaning of important temporal information, such as "temporal characteristics of specific hydrological processes" in finer spatiotemporal scale.

B) Material and Methods

6) Why the plots are designed by 60×60cm and not other size? What is the depth? (Referee#2)

Response: (1) There were three reasons for designing each microplot with 60×60cm in study area. First, the designed area could satisfy with the demand of site condition owned by the *Spiraea pubescens* (plot4) which was the largest shrub of the three selected vegetation types. Therefore, it is beneficial to comparing with the different hydrological of all land uses/cover in the study area under the same area condition; Secondly, based on the observation of these single-plant which were randomly distributed on 10-meter-long hillslope, the 60×60cm area not only represented the site condition of largest shrub, but also effectively excluded other type of plants from each microplot, all of which made the vegetation in every microplot was singleness and typicality; Thirdly, the 60×60cm designing plan was a preparation for the up-scaling the hydrological feature of microplot spatial scale to runoff-plot (3×5m per) scale spatial scale, which was the key point in further research.

(2) The Loessal soil was the main soil type in the Yangjuangou catchment, and the TSSM research mainly focused on the soil layer with 0~15 cm depth. And the related explanation was added into the *2.1.1 Description of study area* and 2.1.2 *Description of microplots* in revised manuscript.

7) What is the material to separate the plots? Do you have the lateral effects on soil moisture by those separating material? And how to deal with the lateral effects?(Referee#2)

Response: The separating material of the microplot is impervious PVC sheet, and every square microplot was fenced by four PVC sheets each of which was 2mm thick and 80cm wide. These PVC sheets were perpendicularly inserted along the whole slope into the approximate 50cm depth of the soil and formed the boundaries of each microplot. Therefore, the height of the PVC sheet part exposed on the ground was about 30cm. Moreover, due to the TSSM of 0~15 cm depth soil layer being the critical zone in this research, the part of PVC fence inserted the soil layer could effectively prevent the lateral effect from occurring. Some of indications were added into the 2.1.2 *Description of microplots* of the revised manuscript

8) Why these four land use types or plants used? How about their growing? (Referee#2)

Response: (1) There were two reasons for selecting the four land uses/cover. First, from the view of the vegetation distribution characteristics, the three vegetation types including *Andropogon* (plot2), *Artemisia coparia* (plot3), and *Spiraea pubescens* (plot4) were very typical vegetation in our study region most of which were widely distributed on hillslopes and on the two sides of gullies in the Loess Plateau. Secondly, from the view of different hydrological functions of the four land uses/cover, the spatial distribution pattern of vegetation probably played role of collecting the runoff and sediment during the erosion process and formed the "sink area" of hydrological response, however, the bare land (plot1) usually became the source of runoff and sediment transport in hillslope over the erosion process. Consequently, Based on the two reasons—species representativeness and hydrological functional diversity—we tried to understand the hydrological response and process influenced by the land uses/cover in the water-controlled ecosystem through comparing with the TSSM characteristics in terms of different hydrological functions designed by the experiment.

(2) The information about plant morphological characteristics was in table 1 of manuscript which included average height of vegetated land uses, average Length of stem and average Crown width. And according to the suggestion of referee#2, we split the Table 1 of manuscript into two tables which described the soil physical characteristics and plant morphological characteristics respectively. We supplemented more plant information including aboveground biomass, underground biomass, leaf area index, growth duration. Furthermore, we added the photos showing the root distribution of these three kinds of vegetation-microplot as well as the litter layer conditions owed by *Artemisia coparia* (plot3) and *Spiraea pubescens* (plot4) in discussion section of the revised manuscript.

9) About plant information description, what is the aboveground biomass and underground biomass? Leaf are index? And distribution of root and stem system? And what is litter above ground (Referee#2)?

Response: We will add the plant information including aboveground biomass and underground biomass, Leaf area index, growth years, average height, average length of stem, and average crown width in a new table, and display the root distribution and litter layer through photos.

10) About soil information description, is there any soil crust or biological soil crust? (Referee#2)?

Response: Due to the small area of every bare microplot, in fact, there is no obvious soil crust.

11) How do you measure the soil water in CP position, especially in plot4? How do you deal with the effect of root?(Referee#2)

Response: As the mention of referee#2, the difficulties of the determining and measuring soil moisture in CP location increased with the complexity increase of pattern upon the ground of microplot. Because the main roots were also distributed in CP location which could lead to the measuring value of soil moisture being lower than the real value. Therefore, with respect to the specific measuring in vegetation plot, we mainly employed three steps to deal with the difficulty. First and most important step was the designating of CP/APs circle areas which was a circle area of 8cm radius whose center was CP/APs (showed figure 2b in revised manuscript), this step could, on the one hand, effectively avoid the measuring probe meeting those huge soil pores formed by main roots and soil medium during the measuring process, on the other hand, prevent the measuring apparatus from repeatedly disturbing a same location. And secondly, we used brush to softly removed the litter layer covering upon the surface of CP or APs circle area in each vegetated microplot before we started to take measure the soil moisture in the corresponding area. Thirdly, we employed the FieldScout TDR 300 Soil Moisture Meter (Spectrum Technologies, Inc, Aurora, Illinois, USA) owning two 10cm length probes to insert into the CP or APs circle area in each microplot, and measured the average volumetric water content in 0~15cm depth soil layer by using data logger. Finally, when the logging processes of soil moisture data was over in some microplot, we carefully filled every disturbing hole formed by probes of TDR with fine soil particle and recovered the former litter layer condition in each vegetated microplot.

Actually, designating the CP/APs circle areas, removing and recovering the litter layer condition as well as mending the disturbing holes all of which were taken at different stages of measuring processes aimed to reduce the system error derived from the inevitable disturbance of the soil surface layer. And all the supplementary content was added in the *2.2.1 CP/APs* *sampling method* of revised manuscript.

12) The sampling scheme in methodology is not clear (Referee#2)

Response: According to the referee#2's suggestion, we readjusted the logical structure of method section, firstly, we explained CP/APs sampling methods, and defined the abbreviation of CP and APs. Secondly, we detailedly described the sampling processes including the designating the CP/APs circle areas, removing and recovering the litter layer condition, logging the soil moisture data as well as mending the disturbing holes, all of which were measures to reduce the system error derived from the inevitable disturbance of the soil surface layer. Thirdly, we briefly indicated the purpose of applying the CP/APs sampling scheme which was primarily depended on the different soil moisture pulses affected by the heterogeneous vegetation owning the obvious diversity of morphological features

C) Results

13) What is the implication of "*But, according to the significant difference analysis, in both the WTD and DTW processes, the soil moisture of the different land uses/cover at the same sampling position showed no significant difference, and the soil moisture in the same land uses/cover at different sampling positions also showed no significant difference.*"? It would affect the correction of result? Or accuracy of result in the paper? Explain why no-significant-difference data among sampling points and plots could be used in the paper, or in the research? What level of errors would be induced in the result?(Referee#2)

Response: Due to the logical relationship between the subsection 3.1 *Hydrological responses of different land uses/cover* and the other subsections of the result section been not explained clearly, referee #2 was confused about the implication of "*But……difference*". In the results section, there existed three processes each of which went forward one by one to describe the characteristics of TSSM and its application on evapotranspiration at fine spatiotemporal scale. And the analysis of these characteristics also was fulfilled by the continuous detailed information of soil moisture showed from figure 3 to figure 8 of manuscript. The three processes were displayed as follow:

Process One (in 3.1 *Hydrological responses of different land uses/cover*): This process was showed in figure 3 of manuscript which described the general hydrological responses of soil moisture in four different types of land uses/cover to the precipitation and radiation over the whole rainy season (from 2012/7/8 to 2012/9/16), actually, it sketched the average soil moisture dynamics characteristics of each land uses/cover over relative larger temporal scale (whole rainy season of the study region).

Process Two (in 3.1 *Hydrological responses of different land uses/cover*): On the basis of the sketch of general soil moisture dynamics, we further selected some specific hydrological processes in terms of DTW and WTD processes (from 2012/7/8 to 2012/8/20) from the whole rainy season (displayed in figure 4 of the manuscript), which was also a way to downscaling the larger temporal scale to finer temporal scale. Moreover, the finer spatial scale information also appeared in the process by means of showing the response of average soil moisture in CP/APs sampling-trait location in four types microplots to precipitation and radiation over DTW and WTD processes, rather than the responses of soil moisture in four different types of land uses/cover. Therefore, compared with processes one, in the processes, the fine spatiotemporal information of soil moisture was further particularized and determined.

Process Three (in 3.2 *TSSM of different land uses/cover based on hydrological processes*): From the view of researching object, in the process, we focused on the TSSM characteristics of average soil moisture in CP/APs location of every microplot over the DTW and WTD processes without considering their land uses/cover, which was showed in figure 5~figure 8; Moreover, from the view of evaluation method, we introduced three TSSM-trait indices including TSSM-MRD, TSSM-STD, and TSSM-CumP into the TSSM analysis instead of merely using the average value of soil moisture to analyze the TSSM characteristics. Therefore, main results of this paper were all appeared in the process.

And the "*no significant different*" problem proposed by referee #2 was related to the response of average soil moisture in CP/APs sampling-trait location in four types of microplots to precipitation and radiation over DTW and WTD processes, which was the main result of the Process Two. Actually, first of all, the result was not the main content of the this study, and it just sketched the general dynamic characteristics of soil moisture of four land uses/cover over two different hydrological process, which merely supplied the soil moisture background with the subsequent specific TSSM feature study. Therefore, we believed that the "*no significant different*" of soil moisture in four land uses/cover over WTD and DTW processes would probably have less influence with the analyzing the TSSM characteristics of average soil moisture in CP/APs location of every microplot over the corresponding processes in Process Three.

Secondly, the reason for appearing "*no significant different*" problem was probably related to the spatiotemporal scale of this paper. Merely applying the average value of soil moisture on the significant difference analysis could not describe the significant difference hydrological repose of soil moisture in four land uses/cover under finer spatiotemporal scale, which was one of reasons why we further particularized the TSSM characteristics of average soil moisture in CP/APs location of every microplot over the DTW and WTD processes, and found out the difference of TSSM characteristics among microplots in Process Three. Consequently, Process Three was the core content of the results section. And we also supplemented the related indication of the two processes (Process One and Process Two) in 3.1*Hydrological responses of different land uses/cover* of results section in revised manuscript.

14) Is it contradictive of the "*In the rainy season of 2012, the bare land cover appears to be more sensitive to the influence of rainfall and radiation….* " and " *the soil water content in the bare land cover displayed a stronger temporal stability during the WTD process….*"?(Referee#2)

Response: In fact, we did not illustrate the different backgrounds of the two sentences mentioned by the referee #2, which lead he/she to consider that the two sentences were in contradictive.

In the first sentence "*In the rainy season of 2012, the bare land cover appears to be more sensitive to the influence of rainfall and radiation….*"which means that the average soil moisture (including CP and APs location) of all the bare land microplot was more affected by the precipitation and radiation over the whole rainy season of 2012 (from 2012/7/8 to 2012/9/16) than other three types of vegetation microplots. The two data12.00%±1.01% and 26.35%±1.51% represented the lowest and highest average value of soil moisture in the bare land respectively, which quantificationally described the fluctuant range of the average soil moisture in rainy season.

In the second sentence "*the soil water content in the bare land cover displayed a stronger temporal stability during the WTD process….*" which expressed the meaning of the calculation result of one TSSM index (TSSM-STD). In fact, this sentence indicated that the fluctuant degree of soil moisture of bare land microplot in AP location to the average soil moisture of AP location in all mcrioplots distributing on the whole spatial patterns during WTD process. Due to the value of TSSM-STD in AP location (0.0053) of bare land approaching zero more closely than other land uses/cover types microplot, the soil moisture of bare land microplot in AP location had higher stability process when it gradually closed to the whole-spatial-pattern average soil moisture of AP location than other land uses/cover micrplot, which quantificationally described one of TSSM characteristics in WTD process.

In addition, we further concluded the difference between the first sentence and the second sentence in five aspects and listed them in a table as follow

Difference	First Sentence	Second Sentence
Meaning	average soil moisture of all the bare land microplot was more affected by the precipitation and radiation than other microplot	soil moisture of bare land microplot in AP location had higher stability process when it gradually closed to the whole-spatial-pattern average soil moisture of AP location than other land uses/cover micrplot,
Time	whole rainy season (from 2012/7/8 to 2012/9/16)	Part of whole rainy season(from 2012/7/31 to 2012/8/20)
Location	CP and APs location of every bare land microplot	APs location of every bare land micropt
Hydrological process	no clearly hydrological process, just the combination of multiply hydrological processes	a definite hydrological process: WTD process representing a typical evapotranspiration process.
Calculation method	The average and standard deviation of original soil moisture data	$\varsigma\left(\bar{\delta}_{AP(i\cdot j)_n}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{AP(i,j)}-\bar{\delta}_{AP(i\cdot j)_n}\right)^2}{n}}\quad for\ n=1\sim 2\quad DTW;\ for\ n=3\sim 7\quad WTD$ standard derivation of mean relative difference of TSSM on AP of the *i*th microplot (*i*=1~16) at *j*th time (*j*=*n*=3~7 represented the WTD process)

Moreover, in the revised manuscript, we changed the vague expression “temporal stability” in the second sentence into “soil moisture of bare land microplot in AP location had higher stability process when it gradually closed to the whole-spatial-pattern average soil moisture of AP location than other land uses/cover micrplot,”, which was the explanation of TSSM-STD index. And the related interpretation of the two sentence was added in the 3.2.1 *CP sampling-traits TSSM* and 3.2.2 *AP sampling-trait TSSM* of the revised manuscript.

15) Is it contradictive between the statement of “*With respect to the MRD, the soil moisture of the vegetated land uses tended to underestimate the mean soil water content due to their MRD values being larger than zero*” and “*With respect to the AP-TSSM, in the DTW process, the soil moisture of Artemisia coparia was overestimated, with its MRD being larger than zero*”?(Referee#2)

Response: The two sentences were not contradictive. In the first sentence, there existed a clerical error in manuscript, and we changed the sentence “With respect to the MRD,……due to their MRD values **being larger** than zero”into“With respect to the MRD,……due to their MRD values **being smaller** than zero”. The determination of the two sentences was derived from the description and calculation of one TSSM index (TSSM-MRD) in terms of Fig 6, Fig 8 and Table 2 in manuscript.

The TSSM-MRD indicates the fluctuation of specific measuring point to the average soil moisture of all mcrioplots distributing on the whole spatial patterns at CP/APs location over the corresponding interval. The more closely the absolute value of TSSM-MRD in some microplot approaches to zero over specific hydrological process, the more likely the corresponding soil moisture represented the average value of the whole-spatial-pattern average soil moisture over the corresponding interval. And it also represents whether the value of the soil moisture in a specific microplot overestimates ($\bar{\delta}_{CP(i,j)_n} > 0$;$\bar{\delta}_{AP(i,j)_n} > 0$) or underestimates ($\bar{\delta}_{CP(i,j)_n} < 0$;$\bar{\delta}_{AP(i,j)_n} < 0$) the average value, which, therefore, could reflect one of characteristics in TSSM of four different land uses/cover.

The first sentence indicated the calculation result of TSSM-MRD in CP location over DTW process, which was showed in blue box of TSSM indices table. Actually, the TSSM-MRD value of 75% vegetation microplots (plot2~plot4) were less than zero in CP location during DTW process, which could concluded that the soil moisture of vegetation microplot underestimated the average soil moisture of the whole spatial patterns of soil moisture formed by all microplot in CP locations during DTW process.

The second sentence showed the calculation result of TSSM-MRD in AP location over DTW process, which was stressed in red box. In the TSSM indices table, the TSSM-MRD value of all *Artemisia coparia* microplots (plot3) were more than zero in AP location during DTW process, which concluded that the soil moisture of *Artemisia coparia* microplots overestimated the whole-spatial-pattern average soil moisture in AP locations during DTW process. Actually, the difference TSSM-MRD characteristics of *Artemisia coparia* (plot3) between CP and AP location respectively during DTW process was probably depended on the hydrological-process-trait soil moisture sampling method, which implicated that there probably existed different hydrological response of soil moisture on precipitation in CP/APs locations in *Artemisia coparia* (plot3). Furthermore, we summarized the difference between the first sentence and the second sentence in two aspects. And the related interpretation of the two sentences was added in the 3.2.1 *CP sampling-traits TSSM* and 3.2.2 *AP sampling-trait TSSM* of the revised manuscript.

Main characteristics of TSSM indices in hydrological processes

[a]SS	Plot Code	Hydrological Processes: DTW Processes CumP($\bar{\theta}_{[k\cdot*]}$)	[c]OEM $\bar{\delta}_{(i\cdot j)_n} > 0$	[d]UEM $\bar{\delta}_{(i\cdot j)_n} < 0$	$\varsigma(\bar{\delta}_{(i\cdot j)_n})$	WTD Processes CumP($\bar{\theta}_{[k\cdot*]}$)	OEM $\bar{\delta}_{(i\cdot j)_n} > 0$	UEM $\bar{\delta}_{(i\cdot j)_n} < 0$	$\varsigma(\bar{\delta}_{(i\cdot j)_n})$
CP	Plot1	×	(2)(3)(4)	(1)	0.09	[e]×	(1)(2)(3)(4)	×	0.08
	Plot2	[b](4)/0.47	(4)	**(1)(2)(3)**	0.15	(2)/0.47	(2)	(1)(3)(4)	0.09
	Plot3	×	(1)	**(2)(3)(4)**	0.08	(1)/0.53	(1)	(2)(3)(4)	0.04
	Plot4	(2)/0.53	(1)	**(2)(3)(4)**	0.13	×	(1)(4)	(2)(3)	0.16
AP	Plot1	(1)/0.46	(1)(2)(3)(4)	×	0.05	×	(1)(2)(3)(4)	×	0.07
	Plot2	×	(1)(2)	(3)(4)	0.08	(1)/0.48, (4)/0.54	(1)	(2)(3)(4)	0.12
	Plot3	(1)/0.53	**(1)(2)(3)(4)**	×	0.09	×	×	(1)(2)(3)(4)	0.10
	Plot4	×	(1)	(2)(3)(4)	0.08	×	×	(1)(2)(3)(4)	0.10

[a]: Sampling Scheme; [b]: means the cumulative probability of soil moisture in Plot2(4) was 0.47 in the DTW processes;

[c]: Overestimation; [d]: Underestimation; [e]: means no plot meet the corresponding condition of the MRD and cumulative probability

Difference	First Sentence	Second Sentence
Object	all vegetation microplots	*Artemisia coparia* microplots (plot3)
Location	CP location	APs location
Calculation Method	$\bar{\delta}_{CP(i,j)_n} = \sum_{j=1}^{n}\left(\frac{16\theta_{CP(i,j)} - \sum_{i=1}^{16}\theta_{CP(i,j)}}{\sum_{i=1}^{16}\theta_{CP(i,j)}}\right) / n$ *for* $n=1\sim2$ *DTW*, *for* $n=3\sim7$ *WTD* $\varsigma(\bar{\delta}_{CP(i,j)_n})$ is the standard derivation of mean relative difference of TSSM on CP of the i th microplot (i=1~16) at j th observation time (j=n=1~2,represented the DTW process, abbreviation of TSSM-STD	$\bar{\delta}_{AP(i,j)_n} = \sum_{j=1}^{n}\left(\frac{16\sum_{p=1}^{4}\theta_{AP(i,j,p)} - \sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}{\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}\right) / n$ *for* $n=1\sim2$ *DTW*, *for* $n=3\sim7$ *WTD* $\varsigma(\bar{\delta}_{AP(i,j)_n})$ is the standard derivation of mean relative difference of TSSM on AP of the i th microplot (i=9~12) at j th observation time (j=n=1~2,represented the DTW process, abbreviation of TSSM-STD

16) To the statement of "*Consequently, plot4(3) and plot3(2) which had an average soil moisture in the WTD process of approximately 16.6% and 16.4 %, respectively, were determined to represent the TSSM in the CP and AP sampling schemes, respectively*." Please give the reason why plot4(3) and plot 3(2) could be selected as the representatives of TSSM? Do they have deterministic topography? Plant growth duration? Soil texture?(Referee#2)

Response: (1) Why did we select the soil moisture of plot4(3) and plot3(2) as the representatives of TSSM in CP and AP location respectively?

The selection of representatives of TSSM was depended on the TSSM parameter determined by three TSSM indices--TSSM-MRD, TSSM-STD, and TSSM-CumP all of which should satisfy with four principles as more as possible. And we explain the choosing process of TSSM parameter depended on the "selection of parameter of TSSM in ET-TSSM model" table in which some important indices were emphasized in the three different color boxes as follow:

Principle A: The absolute value of TSSM-MRD in the selected microplot should be lowest than others.

Principle A indicated that the more closely the absolute value of TSSM-MRD in some microplot approaches to zero over specific hydrological process, the more likely the corresponding soil moisture represented the average soil moisture of all mcrioplots distributing on the whole spatial patterns over the corresponding interval, which could reflect one of characteristics in TSSM of four different land uses/cover.

According to the principle A, showed in the table, compared with other microplots, the absolute TSSM-MRD value of soil moisture in plot4(3) at CP location during the DTW and WTD process were lowest (-0.034 and -0.004 respectively) ; And at AP location, the soil moisture in plot3(2) had also lowest absolute TSSM-MRD value (-0.040 and -0.005 respectively) than other microplots. Therefore, based on the CP/APs sampling, the moisture of plot4(3) and plot3(2) satisfied with the principle A in the whole hydrological processes.

Principle B: The absolute value of TSSM-STD should also be lowest.

Principle B implied that the absolute value of TSSM-STD in a given microplot approaches zero more closely, then it is considered to be better representing the lower fluctuant of TSSM-MRD, and higher stability process over which the corresponding soil moisture gradually closed to the whole-spatial-pattern average soil moisture, which could be another indicator to describe the characteristics in TSSM of four different land uses/cover.

On basis of the principle B, compared with other microplots, the absolute TSSM-STD value of soil moisture in plot3(2) at AP location during the DTW and WTD process were lowest (0.028 and -0.004 respectively), which satisfied with the principle B; but the soil moisture in plot4(3) at CP location during the DTW and WTD process (0.200 and 0.129 respectively) were larger than plot1(4)(0.073 and 0.074 respectively). Therefore, both of plot4(3) and plot1(4) were needed to further select on the next principle.

Principle C: The difference between the TSSM-CumP values of the soil moisture in the selected microplot over different hydrological processes should be less than 0.1.

The purpose of Principle C was to determine whether the rank distribution of soil moisture owned by the same microplot was the same over different hydrological processes in terms of the calculation of TSSM-CumuP value. And the difference between TSSM-CumP values being less than 0.1 meant that the corresponding microplots' soil moisture has the more similar rank order distribution over two hydrological processes.

According to the table, plot1(4), plot4(1),plot4(3) all satisfied with the principle C at CP location during the DTW and WTD processes, and there were more plots—including plot4(3) and plot1(4)—satisfying the principle C at AP location during the corresponding processes. Also both of them needed to further select on the next.

Principle D: Based on Principle C, the TSSM-CumP value in the selected microplot should be close to 0.5.

Principle D indicated that the TSSM-CumuP value of soil moisture in same-rank-distribution microplot was 0.5, which characterized the mean soil water content of all land uses/cover for both the WTD and DTW processes.

And based on the principle, compared with other microplots, the TSSM-CumP value of soil moisture in plot3(2) at AP location during the DTW and WTD process were more closed to 0.5 (0.66 and 0.67 respectively) than others, which satisfied with the principle D; And the soil moisture in plot4(3) at CP location during the DTW and WTD process were more closed to 0.5 (0.59 and 0.59 respectively) than others—including plot1(4) whose TSSM-CumP values were both 0.86. Therefore, Both plot4(3) and plot3(2) satisfied with principle D.

Finally, on the basis of a tradeoff between the four selection principles and the plots whose soil moisture satisfied with these principles as more as possible, we selected the soil moisture in the plot4(3) (satisfying with 3 principles) and plot3(2) (satisfying with all principles) as the TSSM parameters at CP and AP location respectively during the whole hydrological processes.

(2) Do they have deterministic topography? Plant growth duration? Soil texture?

In this paper the TSSM parameter was determine by the three TSSM indices which satisfied with four principles. With respect to the other factors mention by referee #1, as the description of figure 1 in manuscript, all of these plots are randomly distributed along one southwest—northeast aspect hillslope whose gradient was 26.8%. And also as the analysis of soil physical characteristics showed in table 1of manuscript, there was no significant difference of soil texture among different land uses/covers. And the selected vegetation microplots representing grassland (plot2), low shrubland (plot3) and tall shrubland (plot4) respectively were all experienced approximate 20 years' growth since the implementation of the Grain-for-Green program in the Yangjuangou Catchment of the Loess Plateau. Therefore, theoretically, the three factors—topography, plant growth duration as well as soil texture were not the deterministic factors to the TSSM parameter.

Selection of parameter of TSSM in ET-TSSM model

SS	Plot Code	**Principle C** [a]Similar Rank $\overline{\theta}_{[k\cdot*]}$	**Principle C** Same Rank MRD	**Principle D** TSSM-CumP CumP($\overline{\theta}_{[k\cdot*]}$) [b]DTW/WTD	**Principle A** TSSM-MDR ($\overline{\delta}_{(i\cdot j)_n}$) [c]DTW/WTD	**Principle B** TSSM-STD $\varsigma(\overline{\delta}_{(i\cdot j)_n})$ [d]DTW/WTD	θ_S
				DTW to WTD Processes			
CP	Plot1	(4)	(4)	0.86/0.86	0.081/0.091	0.073/0.074	
	Plot2	×	×	×	×	×	
	Plot3	×	×	×	×	×	**Plot4(3)**
	Plot4	(1)	(1)	0.93/0.93	0.125/0.101	0.045/0.115	
		(3)	**(3)**	**0.59/0.59**	**-0.034/-0.004**	**0.200/0.129**	
AP	Plot1	(2)	(2)	0.93/1.00	0.115/0.120	0.068/0.053	
		(3)	(3)	0.86/0.93	0.085/0.114	0.032/0.066	
	Plot2	×	×	×	×	×	
	Plot3	**(2)**	**(2)**	**0.66/0.67**	**0.040/-0.005**	**0.028/0.055**	**Plot3(2)**
		(3)	(3)	0.79/0.79	0.043/-0.014	0.188/0.141	
	Plot4	(1)	(1)	0.34/0.42	0.005/-0.042	0.076/0.071	
		(3)	(3)	0.05/0.06	-0.156/-0.042	0.067/0.102	
		(4)	(4)	0.11/0.18	-0.148/-0.045	0.072/0.162	

[a]: the difference between cumulative probability of the same land uses/cover in WTD and DTW processes was less than 0.1,

[b]: the specific cumulative probability value in WTD and DTW processes which have the similar rank cumulative probability

[c]: the specific mean relative difference values of soil moisture in WTD and DTW processes which have the same rank about mean relative difference

[d]: the specific deviation of average soil moisture in WTD and DTW processes which the same rank about mean relative difference

17) What is the statistic characteristic of the data? The groups of data obtained in the paper are significantly different? Or the data are normal distribution? Please evaluate the data by yourselves in view of statistics.(Referee#2)

Response: In manuscript, we general calculated the average value of soil physical characteristics and plant morphological characteristics including the soil bulk density, soil texture (clay, silt and sand), soil moisture at CP and AP locations of different land uses/cover, the height of different vegetation types, the length of stem only owned by *Spiraea pubescens* (plot4), and the crown width, and in the revised manuscript, we calculated average value of aboveground biomass, underground biomass, leaf area index, the thickness of litter layer, not all the data are significantly different.

D) Discussion

18) "Uncertainties and limitation" exactly exits in the paper. But readers need much more detailed explanation not only theoretical "uncertainties and limitation" description.(Referee#2)

Response: With respect to the "Uncertainties and limitation", in manuscript we generally discussed three aspects including the limitation of system error derived from the soil moisture measuring, the limitation of ET-TSSM model construction, and the uncertainty of the application of ET-TSSM during more hydrological processes. Firstly, in the Material and Method section of the revised manuscript, as to the system error of CP/APs sampling, we further pointed out that we took three measures—designating the CP/APs circle areas, removing and recovering the litter layer condition as well as mending the disturbing holes—at different stages of measuring processes to reduce the system error derived from the inevitable disturbance of the soil surface layer; Secondly, with respect to the limitation of ET-TSSM model construction, in the discussion section of the revised manuscript, we made a new table concluding the main influencing factors of WTD/DTW processes, and combined it with "*Table2 main characteristics of TSSM parameters in hydrological processes*" "*Table4 characteristics of parameters derived from ET-TSSM model*", figure 11 and figure 12 to analyze the effects of these influencing factors on the WTD/DTW processes, all of which could be beneficial to explaining the effect of hydrological processes on CP/AP sampling-trait TSSM in different land uses/cover microplots. Thirdly, we accepted another referee #1's suggestion which mentioned the limitation of one WTD/DTW processes, and added it in the revised manuscript and emphasized that increasing the soil moisture data to the application of ET-TSSM model was one of content in future TSSM-study.

In this study, due to the finer spatiotemporal research scale and new TSSM-related research content being different from former TSSM studies, especially when we initially tried to integrate the TSSM concept with WTD/DTW process and to analyze the hydrological characteristics of different land uses/cover depended on the construction of ET-TSSM model, this study was probably seemed to have more exploratory characteristics rather than being merely an experiment-driven paper. Therefore, it was inevitable that there would existed many uncertainties and limitation which should be discussed in this study, however, in this paper, the meaning of seven parameters deduced by ET-TSSM model enriched the implication of TSSM concept and further particularized the time variable of ET functions as well, which could be regarded as the first step to understand the hydrological processes affected by different land uses/cover from a new aspect. Admittedly, we also decreased the theoretical description in the "*uncertainties and limitation*" section as possible as we can in revised manuscript.

19) In the section of "discussion", the paper used much more theoretical description in words to explain how the function and effect of "canopy", "litter layer" and "root system", or "stem flow", "the point-based litter" and "infiltration zone of main root zone", or "diversity of morphological structure" to act in the hydrological processes of WTD or DTW in different vegetation types, but what on earth the differences in the four specific land use types used in the paper?(Referee#2)

Response: In the discussion section, we discussed the effect of hydrological processes on CP/APs sampling-trait TSSM in different land uses/cover during DTW and WTD processes. In order to explain that how the function and effect of morphological characteristics of plants on the TSSM characteristics of different land uses/cover, we added the factor table (as follow) in revised manuscript, and combined it with table 2 (calculation of TSSM indices characteristics) and figure 11~12 (analysis of hydrological processes) in manuscript to interpreted the roles of influencing factors playing on the specific hydrological processes.

Firstly, During the DTW processes, based on the analysis of factors table, table 2 as well as figure 11, the soil moisture of vegetation mciroplot in CP location was lower than the bare land mciroplots in corresponding location. Because the migration environment of water in vegetation microplot over precipitation period was more complexity than the bare land, specifically, the interception of canopy and the conservation of litter lay existed in vegetation microplots could decrease the water inputting into the soil medium, from the TSSM view, the time lag effect of soil moisture in vegetation microplots led to the low soil moisture in CP location of vegetation microplots.

Apart from the explanation of the soil moisture difference in CP location, we also analyze the soil moisture difference in AP location owed by different vegetation types (*Artemisia coparia* (plot3), and *Spiraea pubescens* (plot4)). We concluded two reasons for the soil moisture difference, and in revised manuscript we added the litter layer photos of the two types microplots which could be beneficial to explaining the diversity. On the one hand, from the difference of litter layer in both microplots view, the litter layer of plot 4 was thicker than plot3 which have less time lag effect of soil moisture in AP locations; On the other hand, from the difference morphological characteristics of both plots view, plot 4 owned obvious stem structure which sustained more complex canopy structure than the plot 3 which has no obvious stem structure, therefore, under the same precipitation condition, the AP location at plot 3 could receive more water input than plot4 in terms of throughfall, which lead to the soil moisture of plot3 in AP location being higher than plot 4 in corresponding location.

Secondly, During the WTD process, according the description of table as follow, table 2 and figure 12, both in CP and AP location, the soil moisture of vegetation microplots was lower than bare land, which indicated that the effect of evapotranspiration imposed on soil water in vegetation mciroplots was more obvious than the effect of evaporation imposed on soil moisture in bare land. The results also reflected that the vegetated land uses which have a higher water consumption capacity by virtue of evapotranspiration processes would likely lead to a greater degree of soil water content storage reduction under radiation conditions. Moreover, in order to explain the complex effect of evapotranspiration, we added the root distribution photos of *Artemisia coparia* (plot3), and *Spiraea pubescens* (plot4) in revised manuscript, and further combined these distribution photos with the hydrological processes analysis showed in figure 12 in manuscript to interpreted that the root distribution lead to the complex root-soil environment in which the soil water migration occurred, and the complexity could cause more stronger fluctuant processes over which the soil moisture in vegetation mciroplots gradually closed to the whole-spatial-pattern average soil moisture in terms of higher absolute value of TSSM-STD in vegetation mciroplots.

Finally, in 4.3 *Implication of ET-TSSM's application on soil hydrological processes* of discussion section, we analyzed the parameters of ET-TSSM including $t_{c(m)}$,WP_m and WD_m to further indicated the diversity of morphological characteristics owned by different vegetation caused the different hydrological function, which lead to the different soil conservation ability owned by three type vegetation microplots during the WTD processes.

Consequently, in the discussion section, we supplemented more information about morphological characteristics of vegetation by means of the description of photos and tables to explain the relationship between hydrological process and CP/APs sampling-trait TSSM characteristics deduced by different microplots as possible as we can.

E) Conclusion

20) At last, the "Conclusion" is much more like "abstract" and "abstract" like "conclusion" isn't it? (Referee#2)

Response: According to the referee's suggestion, we will generally depend on the "BPMRC" principle—Background, Purpose, Method, Results and Conclusion—to revise the abstract, and further refine the meaning of this study in conclusion.

F) Others: Language problem and grammatical flaws (#1#2#MA)

Response: We will carefully exam the grammatical flaws and try to make correct and clear expression in this paper.

Main influencing factors of WTD/DTW processes									
DTW		Plot1		Plot2		Plot3		Plot4	
	Partitions	HE	HB	HE	HB	HE	HB	HE	HB
CP	UPG	×	×	CS	Int(-)	CS	Int/Thf (-/+)	CS	Int/Stf/Thf(-/+/+)
	OSF	SS	RF/Inf (-/+)	CS/SS	Inf(+)	SS/TNLL/MRS	Inf/Cons (+/-)	SS/TKLL/MRS	Inf/Cons(+/-)
	UDG	SubS	Inf(+)	SRSD/SubS	Inf(+)	DRSD/SubS	Inf(+)	DRSD/SubS	Inf(+)
AP	UPG	×	×	CS	Int(-)	CS	Int/Thf(-/+)	CS	Int/Stf/Thf(-/+/+)
	OSF	SS	RF/Inf(-/+)	CS/SS	Inf(+)	SS/TNLL	Inf/Cons(+/-)	SS/TKLL	Inf/Cons(+/-)
	UDG	SubS	Inf(+)	SRSD/SubS	Inf(+)	DRSD/SubS	Inf(+)	DRSD/SubS	Inf(+)
WTD									
CP	UPG	×	×	CS	TR(-)	CS	TR(-)	CS	TR(-)
	OSF	SS	EV(-)	CS/SS	EV(-)	SS/TNLL/MRS	EV/Cons(-/+)	SS/TKLL/MRS	EV/Cons(-/+)
	UDG	SubS	×	SRSD/SubS	Asm/HL(-/?)	DRSD/SubS	Asm/HL(-/?)	DRSD/SubS	Asm/HL(-/?)
AP	UPG	×	×	CS	TR(-)	CS	TR(-)	CS	TR(-)
	OSF	SS	EV(-)	CS/SS	EV(-)	SS/TNLL	EV/Cons(-/+)	SS/TKLL	EV/Cons(-/+)
	UDG	SubS	×	SRSD/SubS	Asm/HL(-/?)	DRSD/SubS	Asm/HL(-/?)	DRSD/SubS	Asm/HL(-/?)

HE: Hydrological Environment; HB: Hydrological Behavior; UG: Upon the Ground; OSF: On the Surface; UDG: Under the Ground

SS: Surface Soil; SubS: Subsurface Soil; CS: Canopy Structure; SRSD: Shallow Root System Distribution; DRSD: Deep Root System Distribution; TNLL: Thin Litter Layer; TKLL: Thick Litter Layer; MRS: Main Root System

RF: Runoff; Inf: Infiltration; Int: Interception; Thf: Thoughfall; Stf: Stemflow; Cons: Conservation by Litter layer ; EV: Evaporation; TR: Transpiration; Asm: Absorption of soil moisture by root system distribution; HL: Hydrological Lift

+: Positive effect on the increment of soil water by different hydrological behaviors; -: Negative effect on the increment of soil water by corresponding hydrological behaviors;

?: Unknown effect on the increment of soil water by hydrological lift