Final Reply of Hess-2013-307

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.

To handling editor

Other revision of introduction in revised manuscript

In order to indicate the difference between this paper and former TSSM researches, we readjusted the fig 10 of manuscript to the introduction section in revised manuscript, and added the explanation of some abbreviation showed in that figure, and this change could be beneficial to understanding the framework of TSSM study in this paper.

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

13) The 16 microplots were randomly arranged over the hillslope with the slope gradient ranging from 17.6?(Referee#MA)

Response: Actually, we did not understand the meaning of the question. In our study, all of these mciroplots are randomly distributed along one southwest—northeast aspect 26.8% hillslope which was located in the middle part of Yangjuangou Catchment, and the 60×60cm size design of each microplot area help us distinguish the different land uses/cover more easily and clearly, we also perpendicularly inserted the impervious PVC sheets along the whole slope into the approximate 50cm depth of the soil to form the boundary of each mcrioplot, and made each single-plant being in the middle of fenced microplot.

14) How long have those plants been in each plot, are they natural plants or grown by researchers?(Referee#MA)

Response: The distance between two plants microplot is decided by the distribution of the 16 microplots, the shortest distance between two plants is near three meters, and the longest is about five meters. And all the selected vegetation microplots represents three types land covers such as grassland (plot2), low shrubland (plot3) and tall shrubland (plot4), and these plants experienced approximate 20 years' growth by nature since the implementation of the Grain-for-Green program in the Loess Plateau. All the information was supplemented in Table 2 of revised manuscript.

15) How were a central point and four ambient points distributed in each plot? Were they arranged relative to the main plant in each plot? (Referee#MA)

Response: In every microplot, we determined two soil-moisture-sampling methods, one was central point of sampling (CP), and the other was ambient point of sampling (APs). Specifically, CP was mainly sited in the middle of each plot1 and plot2 which represented bareland and grassland respectively. however CP was sited near the base of each vegetated microplot such as plot3 and plot4 both of which have obvious canopy structure on the ground. 4 APs each of which was near 30cm away from corresponding CP location were distributed around CP in terms of four different directions in each microplot. All the detail information was supplemented in *2.2.1 CP/APs sampling method* of revised manuscript.

16) State clearly the measuring interval during 43 days of experiment, but in figure 4, the experiment was less than 43days, it needs correction (Referee#MA)

Response: This question is related to the period of soil moisture sampling. Because we did not express the relationship between figure 3 and figure 4 clearly, the referee MA may feel puzzle about the experimental period. Actually, figure 3 showed in the manuscript indicated the different hydrological responses of soil moisture in all land uses/cover to the precipitation and radiation over the whole rainy season (from 2012/7/8 to 2012/9/16), it acted as a sketch to show the general dynamics characteristics of soil water content. However, we needed to select some specific hydrological processes in terms of DTW and WTD processes (from 2012/7/8 to 2012/8/20) from the whole rainy season to analyze the TSSM characteristics of different land uses/covers affected by precipitation and radiation. Therefore, we depended on figure 4 to detail the information of figure 3, which could satisfy with the content and objects of the research. The reasons for selecting the time interval from July 8th to August 20th were on basis of two considerations. Firstly, in the selected time interval of figure 4, there existed obvious two different hydrological processes (DTW and WTD) as well as the corresponding soil moisture pulses of different land uses/cover, both of which supplied the TSSM study with reasonable samples; Secondly, compared with the number of soil moisture data logged after August 20th, more soil water content data collected in the selected time interval, which probably more satisfied with the condition of employing statistical analysis. And some supplementary explanations were added in the footnote of figure3 and 4 in revised manuscript.

17) The holes on the ground as a result of every TDR measurement was mended right after, how did you do that? Referee#MA)

Response: With respect to specific sampling process, in each microplot, the selected measuring area of CP or APs location was actually a circle area of 8cm radius whose center was CP or AP (Figure 2b), 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 and to measure the average volumetric water content in 0~15cm depth soil layer of every microplot. 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, the sharp of every probe was similar to a cylinder with 10cm height and 2mm diameter. Theoretically, the disturbed soil volume was nearly $2\times1^2\times3.14\times100=628\text{mm}^2$ after every measuring, which require a little amount of fine soil particles to been filled with. Consequently, the designating the CP/APs circle areas and mending the disturbing holes aimed to reduce the system error derived from the inevitable disturbance of the soil surface layer. And some of related information was supplemented in the *2.2.1 CP/APs sampling method*.

18) I don't understand Eq(13), the i is quite confusing, and explain the Eq (13~15), and carefully check the symbols used in these Eqs, such as (i and k)(Referee#MA)?

Response: According to the suggestion of referee MA, we carefully revised the equations (13~15) and made related interpretation of these revised equations as follow:

Former equations in manuscript	Revised equations in revision
Eq(12) $\bar{\theta}_{CP(i)}=(1/n)\sum_{j=1}^{n}\theta_{CP(i,j)}$	$\bar{\theta}_{CP(i\cdot*)}=(1/n)\sum_{j=1}^{n}\theta_{CP(i,j)}$ $\bar{\theta}_{CP(i\cdot*)}$ is the average soil moisture of the *i* th microplot (*i*=1~16) at CP location over different hydrological processes (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process) Dimensionless.
Eq(13) $\theta_{CP(i)}=\sum_{i=1}^{16}\bar{\theta}_{CP(i)}=(1/n)\sum_{j=1}^{n}\sum_{i=1}^{16}\theta_{CP(i,j)}$	$\theta_{CP(*\cdot*)}=\sum_{i=1}^{16}\bar{\theta}_{CP(i\cdot*)}=(1/n)\sum_{j=1}^{n}\sum_{i=1}^{16}\theta_{CP(i,j)}$ $\theta_{CP(*\cdot*)}$ the average soil moisture of all microplots at CP location over *n* times, (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process), dimensionless.
Eq(14) $p(\bar{\theta}_{CP[1]})=\bar{\theta}_{CP[1]}/\theta_{CP(i)}$ $p(\bar{\theta}_{CP[1]})\in(0,1]$	$p(\bar{\theta}_{CP[1\cdot*]})=\bar{\theta}_{CP[1\cdot*]}/\theta_{CP(*\cdot*)}$; $p(\bar{\theta}_{CP[1\cdot*]})\in(0,1]$ all the different values of $\bar{\theta}_{CP(i\cdot*)}$ should be ranked from lowest to highest, such as $\bar{\theta}_{CP[1\cdot*]}<\bar{\theta}_{CP[2\cdot*]}<\ldots<\bar{\theta}_{CP[16\cdot*]}$ in which the number in the square bracket indicates the order of the average soil moisture, dimensionless. And $p(\bar{\theta}_{CP[i\cdot*]})$ is the probability of lowest average soil moisture of some microplots over specific observational times, dimensionless

Eq(15) $Cumup\left(\theta_{CP[k]}\right)=\sum_{k=1}^{k}p\left(\theta_{CP[k]}\right)$	$Cumup\left(\bar{\theta}_{CP[k\cdot*]}\right)=p\left(\bar{\theta}_{CP[1\cdot*]}\right)+p\left(\bar{\theta}_{CP[2\cdot*]}\right)+\ldots+p\left(\bar{\theta}_{CP[k\cdot*]}\right)=\sum_{k=1}^{k}p\left(\bar{\theta}_{CP[k\cdot*]}\right)$ $Cumup(\theta_{CP[k]})$ the cumulative probability of the k th highest average soil moisture of a microplot over specific observational times, dimensionless, abbreviation of TSSM-CumuP

TSSM-CumuP determines whether the rank distribution of soil moisture owned by the same microplot was the same over different hydrological processes which formed different observational times. Actually, TSSM-CumP reflects the rank stability of soil moisture based on the probability density function conforming normal distribution. Moreover, the soil moisture of same-rank-distribution microplot with a 0.5 value of TSSM-CumuP characterizes the mean soil water content of all land uses/cover for both the WTD and DTW processes. Consequently, in contrast to the TSSM-MRD and TSSM-STD both of which describe the dynamic characteristics of the TSSM, the TSSM-CumuP of the soil water content represents a related static feature of the TSSM. And all the interpretations and equation revisions were rewrote in *2.2.2 Quantification of TSSM* of revised manuscript.

19) The three standards you listed here were quite confusing (#MA) "The CumuP should be closer to 0.5 representing the mean soil water content of all land uses/cover for both the WTD and DTW processes, representing what? Also how low can be called "as low as possible"?(Referee#MA)

Response: (1) According to referee MA's suggestion, we changed the confusing expression about the "three standard", and readjusted the former logical structure related to the description of the "three standards" by using two paragraphs to interpret the meaning of three TSSM indices (TSSM-MRD, TSSM-STD and TSSM-CumP) and four principles of TSSM parameter selection respectively. Specifically, a reasonable parameter representing the characteristics of TSSM in the different land uses/cover microplots over DTW and WTD processes should satisfy with four principles as follow:

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

Reason: if we regarded the average soil moisture over the change processes occurred in the spatial patterns of soil moisture as one of indicator to evaluate the characteristic of TSSM, then the TSSM-MRD indicates the fluctuation of every measuring point compared with the average value over a different hydrological processes (DTW or WTD) at distinct positions (CP or APs). And 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. TSSM-MRD could reflect one of characteristics in TSSM of four different land uses/cover.

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

Reason: TSSM-STD reflects the fluctuation of TSSM-MRD in a specific microplot over specific interval, which represents the fluctuant degree of given specific soil moisture to the average soil moisture derived from the spatial change processes of soil moisture in all microplots during the corresponding hydrological process. If 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, TSSM-STD could be another indicator to describe the characteristics in TSSM of four different land uses/cover.

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.

Reason: TSSM-CumuP determines whether the rank distribution of soil moisture owned by the same microplot was the same over different hydrological processes which formed different observational times. In fact, TSSM-CumP reflects the rank stability of soil moisture based on the probability density function conforming normal distribution. The less difference between TSSM-CumP values meant that the corresponding microplot's soil moisture has the more similar rank order distribution over two hydrological processe

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

Reason: The soil moisture of same-rank-distribution microplot with a 0.5 value of TSSM-CumuP characterizes the mean soil water content of all land uses/cover for both the WTD and DTW processes.

Consequently, based on the four principles, we determine the TSSM parameter (θ_S) representing the average soil moisture of the corresponding microplot, which could be, theoretically, quantified the TSSM characteristics in different land uses/cover condition and be beneficial to introducing the TSSM concept into specific some hydrological processes.

(2) The expression "as low as possible" was very vague, and we deleted it in revised manuscript. And all the information was supplemented in *2.2.3 Evapotranspiration-TSSM model (ET-TSSM)* and *2.2.2 Quantification of TSSM method* sections of the revised manuscript.

20) According to your statement $t_{s(n)}$ referred to the time when temporal stability condition was reached, but the problem is how did you define the temporal stability, what is the threshold you mentioned? Temporal stability in (Vachaud et al 1985) meant no matter at what time, the rank distribution of soil moisture at each spatial location was almost the same, then, the soil water content at one or two location can always represent the average moisture in the research area, you need more explanation in the section (#MA)?

Response: (1) Explanation o the TSSM concept in Vachaud et al (1985)

The evaluation system of TSSM in *Vachaud et al (1985)* was composed of two parts, one is based on the statistical method to describe the mean relative difference and standard deviation of soil moisture distributing on distinct spatial patterns, and the other is depend on the probability density function to analyze the rank stability of soil moisture spreading on different spatial patterns. In the question, the referee MA mentioned that "temporal stability in (*Vachaud et al 1985*) meant no matter at what time, the rank distribution of soil moisture at each spatial location was almost the same", which was definitely defined by Vachaud et al in 1985. However, after that, in the many other TSSM-related literatures whose authors were *Martinez-Fernandez et al., (2003), Brocca et al., (2009), Coppola et al., (2011), Heathman et al., (2012),* the rank distribution of soil moisture at each spatial location was not the same, especially in extremely conditions—such as wettest and driest condition, the rank distribution was definitely different. And there may be two reasons for the difference of soil moisture rank distribution.

First of all, the complexity of soil condition—such as the different soil textures existing in large spatial scales—could probably lead to the different abilities to the soil water conservation at corresponding spatial scales, especially under the extremely hydrological conditions, the difference was more significance, which probably cause the different rank distributions of soil moisture at each spatial location. Secondly, the different rank distribution of soil moisture maybe as the result of different soil moisture measuring methods. *Vachaud et al* employed neutron scattering methods to measure the soil water content, but other researcher mentioned above mainly depended on the time domain reflectometry to log the soil moisture data. Actually the different measuring apparatus being distinct sensitive to soil water content could also affect the rank distribution

Although the rank distribution of soil moisture at each spatial location was different in later studies, there also existed some of locations with same or similar rank order, which was regarded as one of principles to the selection of TSSM parameter in this paper, and moreover, if the cumulative probability of the selected location with same rank order was close to 0.5, then this soil moisture could characterizes the mean soil water content of all land uses/cover in both the WTD and DTW processes. Essentially, in this paper, we changed the larger spatiotemporal scale focused by former TSSM studies into finer spatiotemporal scale, defined the TSSM concept as the fluctuation between the specific soil moisture of different land uses/cover and average soil moisture of all mcrioplots distributing on the whole spatial patterns over the WTD and DTW hydrological processes, and finally combined the different hydrological functions owned by all of land uses/cover with the TSSM concept, which constructed the ET-TSSM model.

(2) Explanation of the parameter $t_{s(n)}$($t_{s(m)}$)

In the revised manuscript, we changed the $t_{s(n)}$ into $t_{s(m)}$. The parameter $t_{s(m)}$ represents how quickly the soil moisture of the four different land uses/cover reach the TSSM condition which indicates the soil moisture was most close to the average soil moisture of all mcrioplots distributing on the whole spatial patterns over the WTD with lowest temporal fluctuant.

21) Equation (9) and (11)of the standard deviation are wrong, and the denominator of the two equation should be "n" or "n+1", and please check other equations(Referee#1).

Response: Yes, the equation (9) and (11) in the manuscript are wrong, and we checked other equations and concluded the corrigendum as follows:

Former equations in manuscript	Revised equations in revision
Eq(9) $\varsigma\left(\bar{\delta}_{CP(j)}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{CP(i,j)}-\bar{\delta}_{CP(j)}\right)^2}{6}}$	$\varsigma\left(\bar{\delta}_{CP(i\cdot j)_n}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{CP(i,j)}-\bar{\delta}_{CP(i\cdot j)_n}\right)^2}{n}}$ $for\ n=1\sim2\quad DTW$; $for\ n=3\sim7\quad WTD$ $\bar{\delta}_{CP(i,j)_n}$ is the mean relative difference of TSSM on CP of the *i* th microplot (*i*=1~16) at *j* th observation time (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process) dimensionless, abbreviation of TSSM-MRD
Eq(11) $\varsigma\left(\bar{\delta}_{AP(j)}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{AP(i,j)}-\bar{\delta}_{AP(j)}\right)^2}{6}}$	$\varsigma\left(\bar{\delta}_{AP(i\cdot j)_n}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{AP(i,j)}-\bar{\delta}_{AP(i\cdot j)_n}\right)^2}{n}}$ $for\ n=1\sim2\quad DTW$; $for\ n=3\sim7\quad WTD$ $\bar{\delta}_{AP(i,j)_n}$ is the mean relative difference of TSSM on AP of the *i* th microplot (*i*=1~16) at *j* th observation time (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process) dimensionless, abbreviation of TSSM-MRD
Eq(8) $\bar{\delta}_{CP(j)}=(1/n)\sum_{j=1}^{n}\left(\frac{16\theta_{CP(i,j)}-\sum_{i=1}^{16}\theta_{CP(i,j)}}{\sum_{i=1}^{16}\theta_{CP(i,j)}}\right)$	$\bar{\delta}_{CP(i,j)_n}=\frac{\sum_{j=1}^{n}\left(\frac{16\theta_{CP(i,j)}-\sum_{i=1}^{16}\theta_{CP(i,j)}}{\sum_{i=1}^{16}\theta_{CP(i,j)}}\right)}{n}$ $for\quad n=1\sim2\quad DTW$; $for\quad n=3\sim7\quad WTD$ $\varsigma\left(\bar{\delta}_{CP(i,j)_n}\right)$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 (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process) dimensionless abbreviation of TSSM-STD
Eq(10) $\bar{\delta}_{AP(j)}=(1/n)\sum_{j=1}^{n}\left(\frac{16\sum_{p=1}^{4}\theta_{AP(i,j,p)}-\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}{\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}\right)$	$\bar{\delta}_{AP(i,j)_n}=\frac{\sum_{j=1}^{n}\left(\frac{16\sum_{p=1}^{4}\theta_{AP(i,j,p)}-\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}{\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}\right)}{n}$ $for\quad n=1\sim2\quad DTW$; $for\quad n=3\sim7\quad WTD$ $\varsigma\left(\bar{\delta}_{AP(i,j)_n}\right)$is the standard derivation of mean relative difference of TSSM on AP of the *i* th microplot (*i*=1~16) at *j* th observation time (if *j*=*n*=1~2, then represented the DTW process; if *j*=*n*=3~7, then represented the WTD process) dimensionless, abbreviation of TSSM-STD

Specifically, the different ranges of the value of *n* evaluated by *j* represent the different hydrological processes, which was beneficial to determining the calculation methods of TSSM-MRD and TSSM-STD over WTD and DTW processes. Moreover, we further interpreted the meaning of TSSM-MRD and TSSM-STD both of which composed a part of TSSM indices and represented different characteristics of TSSM in finer spatiotemporal scales.

First of all, the distribution of soil water in 16 microplots varies with the different observational periods, which formed the various spatial patterns of soil moisture over the whole hydrological processes (from DTW to WTD), if we regarded the average soil moisture over the change processes occurred in the spatial patterns of soil moisture as one of indicator to evaluate the characteristic of TSSM, then the TSSM-MRD indicates the fluctuation of every measuring point compared with the average value over a different hydrological processes (DTW or WTD) at distinct positions (CP or APs). Furthermore, 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.

And as the standard derivation of TSSM-MRD, TSSM-STD reflects the fluctuation of TSSM-MRD in a specific microplot over specific interval, which represents the fluctuant degree of given specific soil moisture to the average soil moisture derived from the spatial change processes of soil moisture in all microplots during the corresponding hydrological process. If 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. Therefore TSSM-STD also reflects one of features in TSSM. And some of related interpretations and equation revisions were rewrote in *2.2.2 Quantification of TSSM* of revised manuscript.

22) It is not clear to me why the different parameters WP_n,WD_n,…..are defined and what they represent, a clear definition of these parameters and why the authors intend to use these specific values to characterize the soil moisture dynamics is missing (Referee#1).

Response: According to the suggestion of referee #1, we tried to interpret two questions:

(1) What is the definition of derivate parameters of ET-TSSM model?

Evapotranspiration process indicates the dynamic change of soil moisture in WTD processes, and TSSM reflects the temporal stability of soil moisture in different spatial patterns. The combination of evapotranspiration application and the TSSM concept composed the framework of ET-TSSM model in terms of bringing the TSSM parameter (θ_S) into evapotranspiration curves (ET curves). Therefore, the processes of deducing these seven derivate parameters was divided into seven steps: a) the selection of TSSM parameter (θ_S) from three TSSM indices; b) the construction of evapotranspiration curve (ET curve) of different land uses/covers over WTD process; c) the deduction of $t_{s(m)}$ from ET curve and θ_S; d) the deduction of WP_m by integral of curve, t_0 and θ_S; e) the deduction of WD_m by integral of curve, t_e and θ_S; f) the deduction of $\Delta\theta_m$ by subtraction between WP_m and WD_m; g) the deduction of $t_{c(m)}$ and $\theta_{c(m)}$ by ET curve and $\Delta\theta_m = 0$ condition. And the physical significance of each parameter showed in a table as follow:

Parameters	Deduction components	Physical significance
θ_S	TSSM-MRD TSSM-STD TSSM-CumuP	This parameter represents the soil moisture of a specific microplot over a specific hydrological process based on the four selection principles[a] which indicated the physical significance of this parameter. It means that the corresponding soil moisture not only has the same rank order distribution of all microplot over different hydrological processes, but also likely has least fluctuation from the average soil moisture of all mcrioplots distributing on the whole spatial patterns over the WTD and DTW hydrological processes. This parameter, in this paper, connected the TSSM concept with distinct hydrological functions owned by different land uses/cover microplots, which was the first step to evaluate the temporal characteristics of soil moisture under finer spatiotemporal scale in terms of ET-TSSM model.
$t_{s(m)}$	θ_S ET Curve	$t_{s(m)}$ represents how quickly the soil moisture of the four different land uses/cover reached the TSSM condition which indicated the soil moisture was most close to the average soil moisture of all mcrioplots distributing on the whole spatial patterns over the WTD processes with lowest temporal fluctuant. It also could be regarded as the threshold of soil moisture coming from temporal stability condition to fluctuant conditions.
WP_m	θ_S $t_{s(m)}$ t_0 ET Curve	WP_m represents the cumulative effect of the soil moisture in different land uses/cover on the observational time when the soil water contents decreased from the relative saturation conditions ($\theta_m(t_0)$) to the same TSSM condition (θ_S). Compared with the average amount of soil moisture of all mcrioplots distributing on the whole spatial patterns over the WTD processes, WP_m could reflect the possibility that the soil water storage of a specific land uses/cover is under the "water profit" condition before the soil water reached the threshold of the temporal stability condition $t_{s(m)}$

WD_m	θ_S $t_{s(m)}$ t_e ET Curve	WD_m represents cumulative effect of the soil moisture from TSSM condition (θ_S) to the end of WTD process $\theta_m(t_e)$, Compared with the average amount of soil moisture of in whole spatial pattern, WD_m reflects the possibility of the soil water storage of a given land uses/cover being under the "water deficit" condition with the continuous decrease of soil moisture.
$\Delta\theta_m$	WP_m WD_m	$\Delta\theta_m$ was defined as the different extents of the soil moisture transforming "water profit" condition to "water deficit" condition in four types of land uses/cover microplots during the WTD process.
$t_{c(m)}$	$\Delta\theta_m$ ET Curve	$t_{c(m)}$ represent that how quickly the soil moisture condition of the four different land uses/cover transformed the "water profit" into "water deficit" and finally reaching into the "profit-deficit offset" condition ($\Delta\theta_m = 0$) during the WTD process. The parameter also could be regarded as the temporal thresholds of the soil water storage balance owned by different land uses/cover, which was used to evaluate the different abilities to soil water conservation of these land uses/cover based on the application of TSSM concept to the specific evapotranspiration process.
$\theta_{c(m)}$	$\Delta\theta_m$ ET Curve	$\theta_{c(m)}$ was defined as the corresponding soil moisture of the specific microplot whose soil water water content transformed the "water profit" into "water deficit" and finally reaching into the "profit-deficit offset" condition ($\Delta\theta_m = 0$) in the WTD process.

[a]: Four principles include 1) The absolute value of TSSM-MRD in the selected microplot should be lowest than others; 2) The absolute value of TSSM-STD should also be lowest; 3) The difference between the TSSM-CumP values of the soil moisture in the selected microplot should be less than 0.1; 4) Based on Principle 3), the TSSM-CumP value in the selected microplot should be close to 0.5.

And the related interpretations were revised in *2.2.3 Evapotranspiration-TSSM model (ET-TSSM)* of revised manuscript.

(2) Why did we use these parameters to characterize the soil moisture dynamics?

The purpose of using these parameters to characterize the soil moisture dynamics was exploring an approach to introduce the TSSM concept into the specific hydrological processes under finer spatiotemporal scale. ET curve indicates the dynamic change of soil moisture in WTD processes, and TSSM parameter reflects the temporal stability of soil moisture in different spatial patterns, both of which deduced the seven parameters by means of the ET-TSSM model. This combination at least has two advantages on characterizing the soil moisture dynamics. Firstly, from the view of TSSM, ET-TSSM model actually enriched the implication of TSSM concept through expanding this concept on specific evapotranspiration processes of different vegetation-land uses, and quantificationally evaluated the temporal characteristics of soil moisture dynamic in these vegetation land in terms of some values of these ET-TSSM model parameters; Secondly, from the view of evapotranspiration or WTD process, ET-TSSM model further particularized the time variable of ET functions formed by different land uses/cover, which was the result of the determination of ET-TSSM parameters including $t_{s(m)}$ and $t_{c(m)}$. Specifically, based on the ET-TSSM model, the TSSM-trait evapotranspiration processes finally characterized that the soil moisture of the four different land uses/cover transformed the temporal fluctuant condition into TSSM condition and at last reaching into the fluctuant condition again, which was probably a new aspect to understand the hydrological processes.

23) Difficult to understand the figure 2 and its equation and symbols(Referee#1)

Response: We revised in figure 2 in manuscript more understandable and changed the symbols, moreover we supplemented new figure in revised manuscript to describe the relationship between TSSM indices—including TSSM-MRD, TSSM-STD and TSSM-CumP—and the derivate parameters of ET-TSSM model, which could probably sketch the general formational process of ET-TSSM.

24) Thirdly, the sentence "some evapotranspiration curves are fitted to the data," but which curves are employed? Which type (linear, polynomial power)? Which are the parameters of these curves? I strongly suggest describing the main rationale behind the proposed ET-TSSM model at the beginning of this section.(Referee#1)

Response: With respect to the evapotranspiration curves fitting, we mainly fitted the ET curve by using composite function way $(f \circ g)(t) = f(g(t))$ to describe the relationship between soil water content and time. Specifically, $\theta_m(t)$ was the composite function of time which was composed of exponential function ($g(t) = a^t$) and linear functions ($f(t) = bt \pm c$), and the parameters *a*,*b* and *c* are all constants. Compared with other function fitting patterns such as linear, polynomial power, logarithmic and exponential types, composite function could have higher degree of the explanation of the variables (higher value of R) and lower value of P. In the revised manuscript, we supplemented the value of *P* and *m* in the table 4, and according to referee #1's suggestion, we also briefly interpreted the fitting type of ET curves in *2.2.3 Evapotranspiration-TSSM model (ET-TSSM)* of revised manuscript.

25) Rewritten all the equation in a general form(Referee#1)

Response: We rewrote all the equation in a general form in revised manuscript.

To handling editor

In the Material and Method section, according to the three referees' suggestions as well as self-check, we made a major revision in the section. And the final subheading structure system was showed as follows:

2 Material and methods

2.1 Material

2.1.1 Description of study area

2.1.2 Description of microplots

2.2 Methods

2.2.1 CP/APs sampling method

2.2.2 Quantification of TSSM

Mean relative difference (MRD) in TSSM (TSSM-MRD)

Standard Deviation of MRD in TSSM (TSSM-STD)

Cumulative Probability Distribution (CumP) in TSSM (TSSM-CumP)

Interpretation of three TSSM indices

2.2.3 Evapotranspiration-TSSM model (ET-TSSM)

Principle of TSSM parameter selection

The framework of ET-TSSM models

Specifically, in 2.1.2 *Description of microplots,* we increased the information of the distribution of microplots, soil physical characteristics, vegetation morphological characteristics; in 2.2.1 *CP/APs sampling method*, we further detailed the whole sampling processes which included 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 to make reader understand the sampling method; in 2.2.2 *Quantification of TSSM*, we readjusted the whole subheading system to indicate the calculation of three TSSM indices—TSSM-MRD, TSSM-STD, and TSSM-CumP, and made interpretation of these indices; finally, in 2.2.3 *Evapotranspiration-TSSM model (ET-TSSM)*, based on the determination of three TSSM indices, we rewrote the four principles of TSSM parameter's selection which was the preparation for the construction of ET-TSSM model , after that, we indicated the derivation processes of seven parameters in ET-TSSM model, and explain the physical significance of each parameter. At end of Material and methods section, we also added the symbol index table to briefly conclude the meaning of all the symbols appearing in whole equations of this section as follow:

Symbol	Meaning
i	location of four land uses: plot1(1~4)(i=1~4); plot2(1~4)(i=5~8);plot3(1~4)(i=9~12);plot4(1~4)(i=13~16)
j	observation time, if j=1~2, then represented the DTW processes; if j=3~7, represented the WTD processes
k	the rank code of average soil moisture of all microplots at CP location ordered from lowest to highest over different hydrological processes, dimensionless
m	the code of land uses/cover, m=1~4 represent bare land cover (plot1), *Andropogon* (plot2), *Artemisia coparia* (plot3), and *Spiraea pubescens* (plot4) respectively.
t_0	beginning of a specific evapotranspiration processes observation, hour
$t_{s(m)}$	how quickly the soil moisture of the mth land uses/cover reach TSSN condition, hour
WD_m	cumulative effect of the soil moisture in the mth land uses/cover on the observational time when the soil water contents decreased from the relative saturation conditions (θ_S) to the end of WTD process $\theta_m(t_e)$, which represents the soil water storage of the mth land uses/cover is under the "water deficit" condition, dimensionless
WP_m	cumulative effect of the soil moisture in the mth land uses/cover on the observational time when the soil water contents decreased from the relative saturation conditions $\theta_m(t_0)$ to the same TSSM condition (θ_S), which represents the soil water storage of the mth land uses/cover is under the "water profit" condition, dimensionless
$\theta_{AP(i,j,p)}$	the soil moisture AP on ith microplot and the pth position at jth time, dimensionless
$\bar{\theta}_{AP(i,j)}$	average soil moisture of the 4 APs located in different positions on the ith microplot at the jth time, dimensionless
$\bar{\bar{\theta}}_{AP(*\cdot j)}$	average soil moisture located in the APs of all microplots at the jth time, dimensionless
$\theta_{CP(i,j)}$	the water volume content of CP on the ith microplot at the jth observation time, dimensionless
$\bar{\theta}_{CP(*\cdot j)}$	average soil moisture in CP of all microplots at the j th time, dimensionless
$\theta_{CP(*\cdot *)}$	average soil moisture of all microplots over different hydrological processes, dimensionless
$\bar{\theta}_{CP(i\cdot *)}$	average soil moisture of the ith microplot at CP location over different hydrological processes, dimensionless
$\bar{\theta}_{CP[k\cdot *]}$	the kth highest soil moisture of average soil moisture of all microplots at CP location ordered from lowest to highest over different hydrological processes, dimensionless
$\theta_{c(m)}$	corresponding soil moisture of the mth microplot whose soil water water content transformed the "water profit" into "water deficit" and finally reaching into the "profit-deficit offset" condition ($\Delta\theta_m = 0$) in the WTD process, dimensionless
$\theta_m(t)$	evapotranspiration curves function based on the relationship between time and soil moisture in the mth land uses/cover
$\theta_m(t_0)$	initial soil water volume content at the beginning of a specific evapotranspiration processes observation in the mth land uses/cover, dimensionless
$\theta_m(t_e)$	final soil water volume content at the end of a specific evapotranspiration processes observation in the mth land uses/cover, dimensionless
$\theta_m^{-1}(x)$	evapotranspiration curves inverse function based on the relationship between time and soil moisture in mth land uses/cover
θ_S	TSSM parameter represents that the corresponding soil moisture has the same rank order distribution of all microplot over different hydrological processes, and also fluctuated from the average value of the whole spatial patterns of soil moisture formed by all microplot over specific hydrological processes (WTD or DTW process) with least range during it approaching the average soil moisture, dimensionless
$\delta_{AP(i,j)}$	relative difference of AP on the ith microplot at the jth observation time, dimensionless
$\bar{\delta}_{AP(i\cdot j)_n}$	mean relative difference of AP on the ith microplot at the jth time, if j=n=1~2, represented the DTW processes; if j= n=3~7, represented the WTD processes, dimensionless
$\delta_{CP(i,j)}$	relative difference of CP on the ith microplot at the jth observation time, dimensionless
$\bar{\delta}_{CP(i\cdot j)_n}$	mean relative difference of CP on the ith microplot at the jth time, if j=n=1~2, represented the DTW processes; if j= n=3~7, represented the WTD processes, dimensionless
$\varsigma(\bar{\delta}_{AP(i\cdot j)_n})$	standard deviation of the mean relative difference of AP AP on the ith microplot at the jth time, if j=n=1~2, represented the DTW processes; if j= n=3~7, represented the WTD processes, dimensionless
$\varsigma(\bar{\delta}_{CP(i\cdot j)_n})$	standard deviation of the mean relative difference of CP AP on the ith microplot at the jth time, if j=n=1~2, represented the DTW processes; if j= n=3~7, represented the WTD processes, dimensionless
$\Delta_{AP(i,j)}$	difference between soil moisture of AP on ith microplot at jth time and average soil moisture of all microplots at jth time, the fluctuation of soil moisture of AP on ith microplot at j time, dimensionless
$\Delta_{CP(i,j)}$	difference between soil moisture of CP on ith microplot at jth time and average soil moisture of all microplots at jth time, the fluctuation of soil moisture of AP on ith microplot at j time, dimensionless
$\Delta\theta_m$	different extents of the soil moisture transforming "water profit" condition to "water deficit" condition in the mth land uses/cover microplots during the WTD process, dimensionless

C) Results

26) 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.

27) 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	$\varsigma\left(\bar{\delta}_{AP(i\cdot j)_n}\right)=\sqrt{\sum_{j=1}^{n}\frac{\left(\delta_{AP(i,j)}-\bar{\delta}_{AP(i\cdot j)_n}\right)^2}{n}}\quad \begin{matrix} for\ n=1\sim 2 & DTW \\ for\ n=3\sim 7 & WTD \end{matrix}$ 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.

28) 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				WTD Processes			
		CumP($\bar{\theta}_{[k\cdot*]}$)	[c]OEM $\bar{\delta}_{(i\cdot j)_n} > 0$	[d]UEM $\bar{\delta}_{(i\cdot j)_n} < 0$	$\varsigma(\bar{\delta}_{(i\cdot j)_n})$	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	$\bar{\delta}_{CP(i,j)_n} = \frac{\sum_{j=1}^{n}\left(\frac{16\theta_{CP(i,j)} - \sum_{i=1}^{16}\theta_{CP(i,j)}}{\sum_{i=1}^{16}\theta_{CP(i,j)}}\right)}{n} \quad \begin{matrix} for & n=1\sim 2 & DTW \\ for & n=3\sim 7 & WTD \end{matrix}$ $\varsigma\left(\bar{\delta}_{CP(i,j)_n}\right)$ 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	$\bar{\delta}_{AP(i,j)_n} = \frac{\sum_{j=1}^{n}\left(\frac{16\sum_{p=1}^{4}\theta_{AP(i,j,p)} - \sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}{\sum_{i=1}^{16}\sum_{p=1}^{4}\theta_{AP(i,j,p)}}\right)}{n} \quad \begin{matrix} for & n=1\sim 2 & DTW \\ for & n=3\sim 7 & WTD \end{matrix}$ $\varsigma\left(\bar{\delta}_{AP(i,j)_n}\right)$ 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

29) 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.

Selection of parameter of TSSM in ET-TSSM model

SS	Plot Code	Principle C: [a]Similar Rank $\bar{\theta}_{[k\cdot*]}$	Principle C: Same Rank MRD	Principle D: TSSM-CumP CumP($\bar{\theta}_{[k\cdot*]}$) [b]DTW/WTD	Principle A: TSSM-MDR ($\bar{\delta}_{(i\cdot j)_n}$) [c]DTW/WTD	Principle B: TSSM-STD $\varsigma(\bar{\delta}_{(i\cdot j)_n})$ [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	Plot4(3)
	Plot2	×	×	×	×	×	
	Plot3	×	×	×	×	×	
	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	Plot3(2)
		(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**	
		(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

(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.

30) 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.

31) Only one WTD and one DTW period may not be enough (Referee#MA)

32) Another important drawback of this study is that a single DTW (and WTD) period is analyzed. This is not sufficient to understand the real soil moisture dynamics as the recession of soil moisture varies a lot during different WTD periods as a function of climate forcing (e.g. higher/lower evapotranspiration). The analysis of a single WTD period can only characterize a single recession period and it can be hardly generalized to understand the overall soil moisture behavior. This issue should be underlined in the paper and, possibly, different WTD periods should be analyzed in previous studies *Wang et al. (2012, 2013)*, the same authors analyzed continuous soil moisture time series obtained from fixed probes in the same study area. This data could be used to better generalize (if possible) the soil moisture behavior through the ET-TSSM model (Referee#1)

Response: We admitted that a single WTD and DTW process may not be enough, and agreed it was the limitation of the study, which, as the referee #1's mention, could hardly generalized to understand the overall soil moisture behavior. However, we had to interpret the reason for analyzing only a single WTD and DTW process, due to some of reasons been caused by some uncontrollable natural factors. There actually existed at least two limitations to our determining more DTW and WTD processes in this paper.

The first limitation is the field experimental condition. The precipitation mainly occurs between June and September which is the rainy season of the study region. The difference distribution of inter-monthly precipitation, to some extent, was difficult for us to acquire a whole DTW/WTD processes by using TDR to measure the soil moisture. As to all of different land uses/cover microplots, we expected to select a series of soil moisture whose hydrological response on precipitation and radiation could form obvious response pulses during an ideal DTW/WTD processes, however, in reality, this expectation was difficult to come true in both WTD and DTW processes. Specifically, on the one hand, due to being lack of enough precipitation or rainfall duration, the hydrological response of soil moisture on precipitation was not obvious during the DTW process; On the other hand, because of being short of enough radiation duration after heavy precipitation or long rainfall duration, the hydrological response of soil moisture on radiation was not obvious over the WTD period. Therefore, the probability to find out a whole and ideal DTW/WTD processes became smaller under the actual field experimental condition.

The second limitation is the CP/APs sampling strategy. We employed the FieldScout TDR 300 Soil Moisture Meter owning two 10cm length probes to insert into the CP or APs in every measuring time. Although we took some ways—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, the inevitable disturbance of the soil surface layer could be intensified if we increased the frequency of soil moisture measuring during other DTW/WTD processes, and finally lead to the increase of the system error. That is the why we reduced the measuring time after a whole and ideal DTW/WTD processes (from 2012/7/8 to 2012/8/20) of soil moisture data logging. Consequently, reducing the frequency of soil layer disturbance was an anther important limitation factor.

Essentially, the determination of WTD and DTW processes represented the downscaling the temporal scale, and the designing of CP/APs sampling was aim to downscale the spatial scale, both of which composed a fine spatiotemporal scale of TSSM study. Due to the scale and content of this study being different from former TSSM studies, especially when we integrated the TSSM concept with WTD/DTW process 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, although the one typical WTD/DTW processes could hardly generalize overall soil moisture behavior and supplied limited data with the ET-TSSM model, the seven deduced parameters by means of the ET-TSSM model enriched the implication of TSSM concept and further particularized the time variable of ET functions, which could be regarded as the first step to understand the hydrological processes affected by different land uses/cover from a new aspect. However, we definitely accepted referee #1's suggestion, and in the "*limitation and uncertainties*" of the discussion section of revised manuscript, we mentioned the limitation of one WTD/DTW processes, and point out that increasing the soil moisture data to the application of ET-TSSM model was one of direction of future TSSM-study.

In addition, referee #1 also mentioned the previous study of soil moisture in the Yangjuangou Catchment (*Wang et al. (2012, 2013)*), we also listed the similarities and differences of Wang's study and ours in a table to discuss with referee #1.

difference	Wang et al.,(2012) in HESS	Zhou et al.,(2013) in HESSD
research contents	systematically described the evapotranspiration processes curves of different land uses and soil moisture pulses curves over multiply WTD and DTW processes, analyzed the relationship between other soil information (such as temperature) and soil moisture as well.	analyzed the probable influencing factors of the TSSM under the finer spatiotemporal condition, and further combined the TSSM characteristics with one WTD and DTW processes in terms of model construction,
research methods	applied HOBO automatic soil moisture-temperature logger system to monitor the soil moisture and temperature on different soil layers at programmable interval, which could collect huge number of soil moisture and temperature data under unmanned condition.	applied TDR apparatus to collect the soil moisture data on fine spatiotemporal scale in terms of the CP/APs sampling (fine spatial scale) designing and a WTD/DTW processes (fine temporal scale) partition, which limited by the field experimental condition
similarity	Based on the different land uses/cover condition, both of them focused on the hydrological response of soil moisture on the precipitation and radiation, and describe the soil moisture pulses over the WTD and DTW processes.	

Therefore, compared with the systematically description of the response characteristics of soil moisture in Wang's research, in this study, we paid more attention to quantificationally particularize these hydrological response characteristics through introducing the TSSM concept into specific DTW/WTD processes, and to emphasize the soil moisture pulses of different land uses/cover influenced by the evapotranspiration process by enriching the TSSM concept as well as detailing the time variable of ET function. Theoretically, in Wang's study, the huge number of soil moisture collected by automatic soil moisture-temperature logger could be supplied with the ET-TSSM model of this study, but these data should be collected in some ideal DTW/WTD period over which the soil moisture have obvious hydrological responses on the precipitation and radiation. And actually, not all of the soil moisture collected by automatic satisfied with the condition, therefore, further selection of these soil moisture data was required before applying them on ET-TSSM model, which was also the next study of TSSM. And the related indication of the limitation was added in the 4.4 *Limitation and uncertainties* of the revised manuscript.

33) In fig 3, I would suggest to use lines with scatters to better show the change in soil moisture with time, if possible, different colors can be used as well.(Referee#MA)

Response: According to referee MA's suggestion, we colored the figure 3 and changed the scatters type into lines with scatters.

To the handling editor

In the Results section, according to the suggestion of three referees as well as self-check, we made a major revision in the section. And the final subheading structure system was showed as follows:

1.1 Hydrological responses of different land uses/cover
1.2 TSSM of different land uses/cover based on hydrological processes
1.2.1 CP sampling-traits TSSM
1.2.2 AP sampling-traits TSSM
1.3 Application of ET-TSSM on hydrological processes
1.3.1 Determination of TSSM parameter
1.3.2 TSSM's application

We readjusted the results section and tried to match the subheading system in Results section to the subheading of Method section in revised manuscript. Specifically, we made a deep-going analysis of the characteristics of TSSM and its application on evapotranspiration at finer spatiotemporal scale. In 3.1 *Hydrological responses of different land uses/cover*, we 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, and further illuminated the response of average soil moisture in CP/APs sampling-trait location in four types of microplots to the precipitation and radiation over DTW and WTD processes as well, which act as the sketch of soil moisture dynamics characteristics. After that, in 3.2 *TSSM of different land uses/cover based on hydrological processes*, the TSSM characteristics of average soil moisture in CP/APs location of every microplot were emphasized in terms of the description of figure 5~figure 8, which indicated more detailed information about TSSM characteristics, and became the main part of results section as well. And finally, on ground of the above results, in 3.3 *Application of ET-TSSM on hydrological processes*, we found out the TSSM parameter depended on four principles and combined the parameter with evapotranspiration curves to construct the ET-TSSM model. Moreover, we calculated the values of seven parameters derived from ET-TSSM, and applied TSSM concept on further detailing the time variable of ET functions.

（E）Discussion

34) “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.

35) 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.

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

36) Related to the above issue, the generalization described in Figures 10, 11 and 12 is not clear. Many information are provided in these figures and probably it is not sufficient a paper for describing them. The description of the hydrological processes provided in these figures and in the corresponding text is too general and is not really related to the results reported in the study. In my opinion, this part should be removed or strongly smoothed(Referee#1)

Response: Firstly, in order to help readers to understand the difference between the former TSSM studies and TSSM studies processes in this study more clearly, we readjusted the figure 10 in manuscript to the introduction section in revised manuscript, which could assist word description to illuminate the framework of finer spatiotemporal scale of TSSM research. Secondly, according the referee #1's suggestion, we smoothed the figure 11 and 12, only retained the description of WTD/DTW processes, and deleted some vague expressions such as "water input pattern", "direct response" and "indirect response" in figure 11 and 12. We changed them into "upon the ground", "on the surface" and "under the ground" correspondingly, which could correspond to the content of new table (as follow)—Table *Main influencing factors of WTD/DTW processes*—added in the discussion section. Meanwhile, we combined the table with "*Table2 main characteristics of TSSM parameters in hydrological processes*" "*Table4 characteristics of parameters derived from ET-TSSM model*", figure 11 and figure 12 in manuscript 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 under different land uses/cover condition.

To the handling editor

In the discussion section, according to the suggestion of referee #1 and #2 as well as self-check, we made a revision in the section. And the final subheading structure system was showed as follows:

- 4.1 Spatiotemporal downscaling
- 4.2 Effect of hydrological processes on CP/AP sampling-trait TSSM
  - 4.2.1 Influence of DTW processes on CP/AP-TSSM
  - 4.2.2 Influence of WTD processes on CP/AP-TSSM
- 4.3 Implication of ET-TSSM's application on soil hydrological processes
- 4.4 Limitation and uncertainties

In the 4.1 *spatiotemporal downscaling* subsection, we readjusted the figure 10 in manuscript to the introduction section in revised manuscript, which could be beneficial to understanding the difference between the former TSSM studies and TSSM studies processes of this paper. In the 4.2 *Effect of hydrological processes on CP/AP sampling-trait TSSM*, according to the suggestion of referees, we supplemented the more information about the morphological characteristics of vegetation, and added the litter layer photos and root distribution photos into the 4.2.1 *Influence of DTW processes on CP/AP-TSSM* and 4.2.2 *Influence of WTD processes on CP/AP-TSSM* respectively, which could intensify the explanation of the effect of morphological characteristics on the DTW/WTD processes. Moreover, we made *Main influencing factors of WTD/DTW processes* table and combined these influencing factors with characteristics of TSSM indices and parameters derived from ET-TSSM model to analyze the effects of these influencing factors on the WTD/DTW processes under the framework of finer spatiotemporal scale of TSSM research.

D) Conclusion

37) 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.

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

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