Dear Editor and Reviewers:

Thank you for your letter and for the reviewer's comments concerning our manuscript entitled “Difference of SPAC composition and control factors of different vegetation zones in north slope of Qilian Mountains” (Manuscript Number: bg-2021-127).

Based on the reviewers’ comments, we carefully checked the writing style in Introduction and Discussion, and carefully revised our manuscript. The revised parts are marked in red in the revised version of the manuscript. The main corrections and responses to the reviewers’ comments are as follows.

Responses to the reviewer’s comments:

Editor

Comment: Kindly incorporate the attached comments and submit your revised manuscript along with point by point response wherever required.

Response: We have carefully reviewed our manuscript based on your suggestions and those of other reviewers, and we have worked hard to improve the presentation quality of our manuscript. The revised content has been marked in red font of the manuscript.

Response to Reviewer #1

Reviewer #1: In the current revision, Liu et al. have addressed most of my concerns in last referee report. Particularly, they reorganized the structure of the whole manuscript and raised specific scientific question as suggested before. Nevertheless, I am still not satisfied with the manner of writing of Introduction

and Discussion, especially their language issues which were mentioned in last report. In Introduction, the first two paragraphs employed many references to underline the water cycle of SPAC and the advantages of stable isotopes. I suggest the authors to focus the scientific question and make it more specific. In Discussion, e.g., 4.22, the authors presented mainly the complete results, but they didn't try to generalize the drivers and mechanisms behind the data, and no previous studies were listed and compared with each other. In addition, I still have some specific comments.

Response: We have revised the Introduction and Discussion based on your suggestions. The revised content is as follows:

1 Introduction

The relative abundance changes of oxygen and hydrogen isotopes in water can indicate the water cycle and the water use mechanism in plants, so isotope technology has become an increasingly important method for studying the water cycle (Gao et al., 2009; Song et al., 2002; Coplen, 2013; Shou et al., 2013). The stable isotope composition of water is considered to be the "fingerprint" of water, which records a large amount of environmental information that comprehensively reflects the geochemical process of each system, and links the composition characteristics of each link (Darling et al., 2003; Raco et al., 2013; Nlend et al., 2020). As an effective tool, stable isotope technology is widely applied in studying the relationship between environmental factors and the water cycle (Araguás-Araguás et al., 1998; Christopher et al., 2009), water transportation, and distribution mechanisms (Gao et al., 2011), and ways of tracing water use by plants (Detjen et al., 2015). The understanding of the relationship between the influence of plant characteristics, water use efficiency and water sources (Ehleringer, 1991; Sun et al., 2005; Li et al., 2019) provides a new observation method for revealing the water cycle mechanism of the hydrological

ecosystem (Nie et al., 2014; Yu et al., 2007; Wang et al., 2019)

Although the isotope ratio in soil water varies with depth, it remains stable when transferred from plant roots to stems, leaves or young unbolted branches (Porporato, 2001; Meissne et al., 2014). Combined the isotopic composition changes of surface water, soil water and groundwater, precipitation infiltration and runoff generation process (Bam and Ireso, 2018; Hou et al., 2008), groundwater recharge and regeneration capacity (Smith et al., 1992; Cortes and Farvolden, 1989) can be determined. Regional meteorological and hydrological conditions and the contribution of various environmental factors can be evaluated (Hua et al., 2019) by comparing different waterline equations and analyzing changes in various water bodies. Furthermore, it has laid a foundation for studying the deep mechanism of the water cycle (Gao et al., 2009). As an important component of the global water cycle, plants control 50-90% of transpiration (Jasechko et al., 2013; Coenders-Gerrits et al., 2014; Schlesinger and Jasechko, 2014). The roots of plants have no isotope fractionation when absorbing water (White et al., 1985; Song et al., 2013), so the water isotope composition of plant roots and stems reflects the isotope composition of water available for plants (Dawson et al., 1991).

The research of the water cycle based on SPAC plays a vital role in the study of water in arid areas and the sources of plant water use (Price et al., 2012; Shou et al., 2013). Hydrogen and oxygen isotopes have been used to study the water cycle at the interface of "soil-root", "soil-plant", and "soil-atmosphere", but only a few parameters play an important role in the complex interactions between various surfaces (Durand et al., 2007; Li et al., 2006; West et al., 2010). Previous studies have shown that local factors, especially temperature, mainly control stable isotope precipitation changes in mid-latitudes (Dai et al., 2020). Through the research on the composition of hydrogen and oxygen isotopes in different water bodies, we can further understand the mechanism of water use by vegetation (Yang et al., 2015) and provide a scientific basis for vegetation restoration in arid and semi-arid areas. In the existing research, how to extend the results of the small-scale SPAC water cycle research to the large-scale area has become a hot spot and difficulty. In inland arid areas, due to the

lack of water resources, the exchange of energy and water with the outside world is small, and the water cycle is mainly the vertical circulation of groundwater-soil-atmospheric water. Therefore, studying the changes in SPAC isotopic composition in arid regions is significant for ecological restoration.

The Shiyang River Basin has the greatest ecological pressure and the most severe water shortage in China. The purpose of this study is to: (1) analyze the SPAC water cycle process in different vegetation areas and (2) identify the potential factors that control the SPAC water cycle. The research is helpful to clarify the water resource utilization mechanism and the local water cycle mechanism of different vegetation areas in high mountainous areas and provides a specific theoretical basis and guiding suggestions for the practical and reasonable use of water resources in arid areas.

4.2.2 The influence of altitude on SPAC

In Fig.7, the altitude effect of precipitation $\delta^{18}O$ is the strongest, and the relationship between plant water $\delta^{18}O$ and altitude is weakest, showing that in SPAC, precipitation isotope is most affected by altitude, and plant water isotope is least affected by altitude. From the arid foothills to alpine meadows, the elevation rises from 2097m to 3647m, and the change rate of $\delta^{18}O$ and δD were -0.11‰ $(100m)^{-1}$ and -0.41‰ $(100m)^{-1}$. As the water vapor quality rises along the hillside, the temperature continues to decline, and the isotopic values of precipitation continue to consume. In the rainy season, the squares of the correlation coefficients between $\delta^{18}O$ and δD of precipitation and altitude are 0.79 and 0.98, the change rate of $\delta^{18}O$ and δD are -0.12‰ $(100m)^{-1}$ and -1.05‰ $(100m)^{-1}$, respectively. In the dry season, the correlation coefficient squares of $\delta^{18}O$ and δD with altitude are 0.88 and 0.90, respectively, and the rate of $\delta^{18}O$ and δD change is -0.18‰ $(100m)^{-1}$ and -0.79‰ $(100m)^{-1}$, respectively. We can see that the altitude effect of precipitation $\delta^{18}O$ is stronger in the dry season

(R^2=0.88) than in the rainy season (R^2=0.79). The results showed that as the temperature increase, the temperature effect of precipitation $\delta^{18}O$ masks the altitude effect, which leads to the weakening of the altitude effect of precipitation $\delta^{18}O$. The relationship between soil water $\delta^{18}O$ and altitude is stronger in the dry season (R^2=0.26) than in the rain season (R^2=0.28). The relationship between plant water $\delta^{18}O$ and altitude is stronger in the dry season (R^2=0.11) than in the rainy season (R^2=0.10), this is consistent with the changes in the altitude effect of precipitation isotope which is related to precipitation playing a major controlling role in SPAC.

Specific comments

1. L14: Replace "studied" with "investigated" or other words.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In this study, we investigated the changes of stable water isotopes in the SPAC in three different vegetation zones (alpine meadow, forest, and arid foothills) in the Shiyang River Basin.

2. L15: Delete "soil-plant-atmosphere continuum".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In this study, we investigated the changes of stable water isotopes in the SPAC in three different vegetation zones (alpine meadow, forest, and arid foothills) in the Shiyang River Basin.

3. L28: Delete "in water technology".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The relative abundance changes of oxygen and hydrogen isotopes in water can indicate the water cycle and the water use mechanism in plants, so isotope technology has become an increasingly important method for studying the water cycle (Gao et al., 2009; Song et al., 2002; Coplen, 2013; Shou et al., 2013).

4. L41-44: I suggest the authors to modify this sentence as "As an effective tool, stable isotope technology is widely applied in studying…, and tracing the way plants use water…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

As an effective tool, stable isotope technology is widely applied in studying the relationship between environmental factors and the water cycle (Araguás-Araguás et al., 1998; Christopher et al., 2009), water transportation, and distribution mechanisms (Gao et al., 2011), and ways of tracing water use by plants (Detjen et al., 2015).

5. L47: Ehleringer.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The understanding of the relationship between the influence of plant characteristics, water use efficiency and water sources (Ehleringer, 1991; Sun et al., 2005; Li et al., 2019) provides a new observation method for revealing the water cycle mechanism of the hydrological ecosystem (Nie et al., 2014; Yu et al., 2007; Wang et al., 2019).

6. L49: Delete “stable”, “methods”.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Hydrogen and oxygen isotope have been used to study the water cycle at the interface of "soil-root," "soil-plant," and "soil-atmosphere," but only a small number of parameters play an important role in the complex interactions of various surfaces (Durand et al., 2007; Li et al., 2006; West et al., 2010).

7. L51: Modify this sentence to be specific, what the parameters are.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Hydrogen and oxygen isotopes have been used to study the water cycle at the interface of "soil-root", "soil-plant", and "soil-atmosphere", but only a few parameters play an important role in the complex interactions between various surfaces (Durand et al., 2007; Li et al., 2006; West et al., 2010). Previous studies have shown that local factors, especially temperature, mainly control stable isotope precipitation changes in mid-latitudes (Dai et al., 2020).

8. L63: Delete “of water”.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Through the research on the composition of hydrogen and oxygen isotopes in different water bodies, we can further understand the mechanism of water use by vegetation (Yang et al., 2015) and provide a scientific basis for vegetation restoration

in arid and semi-arid areas.

9. L61-66: Please rearrange this long sentence, especially the content after "such as". "…in western China"?

Response: We have condensed this sentence based on your suggestion.. The revised sentence is as follows:

Through the research on the composition of hydrogen and oxygen isotopes in different water bodies, we can further understand the mechanism of water use by vegetation (Yang et al., 2015) and provide a scientific basis for vegetation restoration in arid and semi-arid areas.

10. L67: "…extend the results of the small-scale…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In the existing research, how to extend the results of the small-scale SPAC water cycle research to the large-scale area has become a hot spot and difficulty.

11. L68: Delete "in the current research".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In the existing research, how to extend the results of the small-scale SPAC water cycle research to the large-scale area has become a hot spot and difficulty.

12. L69: I think that the stable isotope technology is not much new in studying SPAC.

Response: We have removed this content from the manuscript based on your

suggestion.

13. L74-76: Although the isotope ratio in soil water changes with depth, it remains stable when transporting from plant roots to stems, leaves or young unbolted branches.

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Although the isotope ratio in soil water varies with depth, it remains stable when transferred from plant roots to stems, leaves or young unbolted branches (Porporato, 2001; Meissne et al., 2014).

14. L89-90: "…runoff regeneration, groundwater recharge and regeneration capacity can be determined".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Combined the isotopic composition changes of surface water, soil water and groundwater, precipitation infiltration and runoff generation process (Bam and Ireso, 2018; Hou et al., 2008), groundwater recharge and regeneration capacity (Smith et al., 1992; Cortes and Farvolden, 1989) can be determined.

15. L93: What is "it"? "…studying the mechanism of the deep water cycle".

Response: We modified this sentence based on the context. The revised sentence is as follows:

Regional meteorological and hydrological conditions and the contribution of various environmental factors can be evaluated (Hua et al., 2019) by comparing

different waterline equations and analyzing changes in various water bodies.

16. L94: "…plants transpiration".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

As an important component of the global water cycle, plants control 50-90% of transpiration (Jasechko et al., 2013; Coenders-Gerrits et al., 2014; Schlesinger and Jasechko, 2014).

17. L125: "…better than that of lower reaches…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The vegetation coverage in the upper and middle alpine regions is better than that of the lower reaches, with trees, shrubs, and grass covered (Wan et al., 2019).

18. L148: "xylem stem" should be "stem".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The vegetation samples are collected with a sampling shear. First, we peel off the bark and put the stem into a 50 ml glass bottle. After that, we sealed the bottle mouth and keep it frozen before the experimental analysis.

19. L158: "…and used…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

To eliminate the memory effect of the analyzer, we discarded the values of the first two injections and used the average of the last four injections as the final result

value.

20. L159-162: Please standardize the font of "δ" throughout the manuscript.

Response: We have unified the font of "δ" in the manuscript to New Rome according to your suggestion, and the revised content has been marked in red in the manuscript.

21. L163: "modify" to "calibrate".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Due to the existence of methanol and ethanol in plant water samples, it is necessary to calibrate the original data of plant samples.

22. L175: "…normally distributed…"?

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Since the isotopic data are generally normally distributed according to the Kolmogorov-Smirnov (KS) test.

23. L202: "The slope of LMWL…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The slope of LMWL of alpine meadows (7.88), forests (7.82), and arid foothills (7.72) are all smaller than that of GMWL(8.00).

24. L215-224: As I understand, the current paragraph is only about oxygen isotope. Is it right? So it should be "stable oxygen isotope" since L215.

Response: Yes, we are introducing oxygen isotopes since L215. We have revised this sentence based on your suggestion. The revised sentence is as follows:

According to the weighted average of stable oxygen isotopes of various water bodies (Table 2), alpine meadows' soil water $\delta^{18}O$ is -9.16‰, the most depleted and the closest to the precipitation $\delta^{18}O$ (-9.44‰).

25. L216: I suggest the authors use $\delta^{18}O$ and δD in manuscript instead of "water isotope value".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

According to the weighted average of stable oxygen isotopes of various water bodies (Table 2), alpine meadows' soil water $\delta^{18}O$ is -9.16‰, the most depleted and the closest to the precipitation $\delta^{18}O$ (-9.44‰).

26. L227: "…plant water isotope…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

3.3 Relationship between soil water and plant water isotope in different vegetation zone

27. L238: "…the current experiment is divided into…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

According to the study area's precipitation, the current experiment is divided into dry season (October-April of the following year) and the rainy season (May-September) for analysis (Fig. 4).

28. L240: "…have the highest value of δ18O (-2.84‰)".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In the dry season, alpine meadow plants have the highest value of $\delta^{18}O$ (-2.84‰).

29. L251: What's the meaning of "soil underwater infiltrates the groundwater"?

Response: We originally wanted to express in this sentence that as the temperature rises during the rainy season (the average temperature is 8.72°C), plant water isotopes undergo intense evaporative fractionation and isotope enrichment. As precipitation increases, surface runoff increases, and water seeps from the soil into the groundwater. We have modified this sentence. The revised sentence is as follows:

As the increase of temperature (average temperature 8.72°C), precipitation and surface runoff increases, and water infiltrate into groundwater from soil.

30. L259: "…plant water oxygen is the most enriched…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

In the dry season, plant water oxygen is the most enriched, and the isotopic values of groundwater and soil water are close.

31. L262: "meters" to "m". "burial" to "table".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

According to the natural resources survey report of the Shiyang River Basin, the buried groundwater level in the arid foothills is 2.5-15 m, and the groundwater table is relatively shallow, making the soil water in the arid foothills mainly recharged by groundwater in the dry season.

32. L266: "…soil water isotope".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

4.1 Variation of soil water isotope and SWC between different vegetation zone

33. L270: "… (-0.15), while that of the forest…".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

The coefficient of variation of the arid foothills is the largest (-0.15), while that of the forest is the smallest (-0.25), indicating that from forest to arid foothills, the closer to arid regions, the greater the coefficient of variation and that the greater the instability of stable isotope soil water.

34. L283: "soil".

Response: We have revised this sentence based on your suggestion. The revised sentence is as follows:

Alpine meadows account for the most significant proportion in the Shiyang River Basin, which increases the soil water retention capacity in the alpine meadows and reduces the amount of soil water evaporation.

35. Fig. 2: Relative humidity.

Response: We have modified Fig. 2 according to your suggestion, and the revised Fig.2 is as follows:

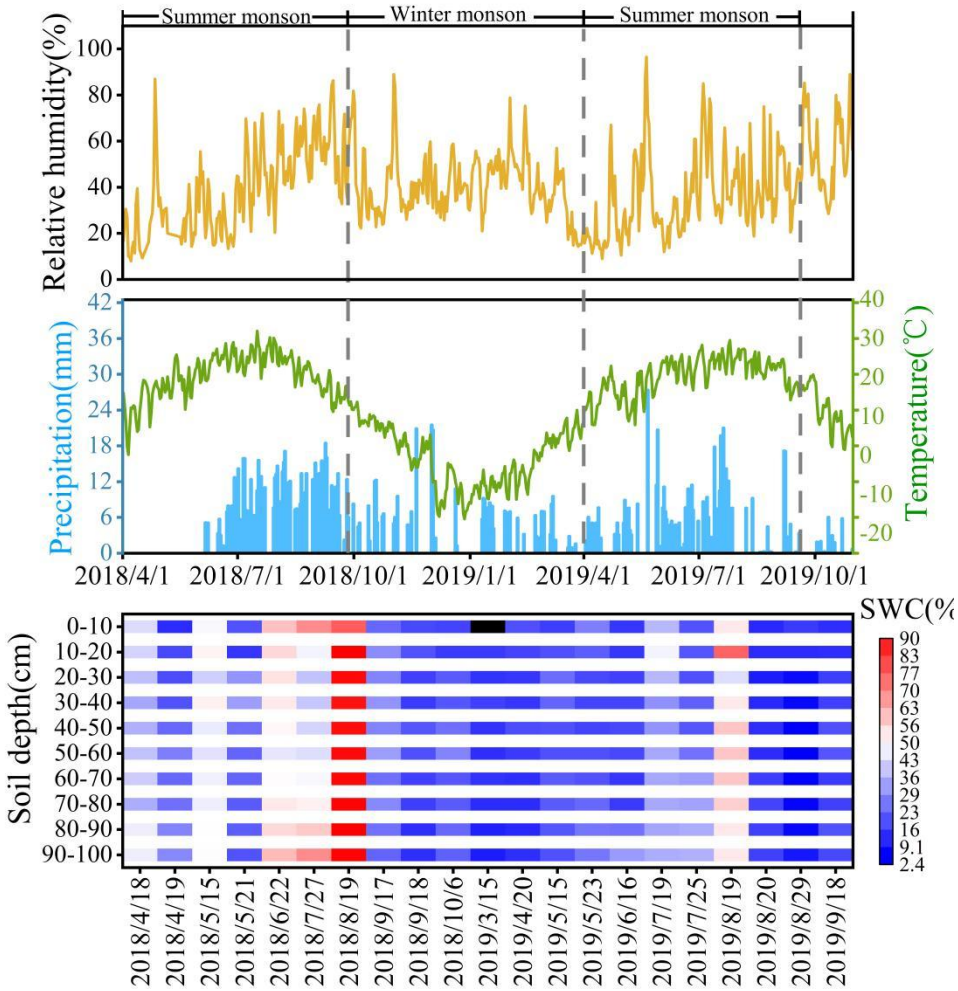

Fig. 2 Diurnal variation of relative humidity, precipitation, temperature, and swc (%) from April 2018 to October 2019

36. Fig. 4 and Fig. 5: Add "(m)" after "Soil depth" and delete "m" along the Y-axis.

Response: We have modified Fig.4 and Fig. 5 according to your suggestion, and the revised Fig. 4 and Fig. 5 are as follows:

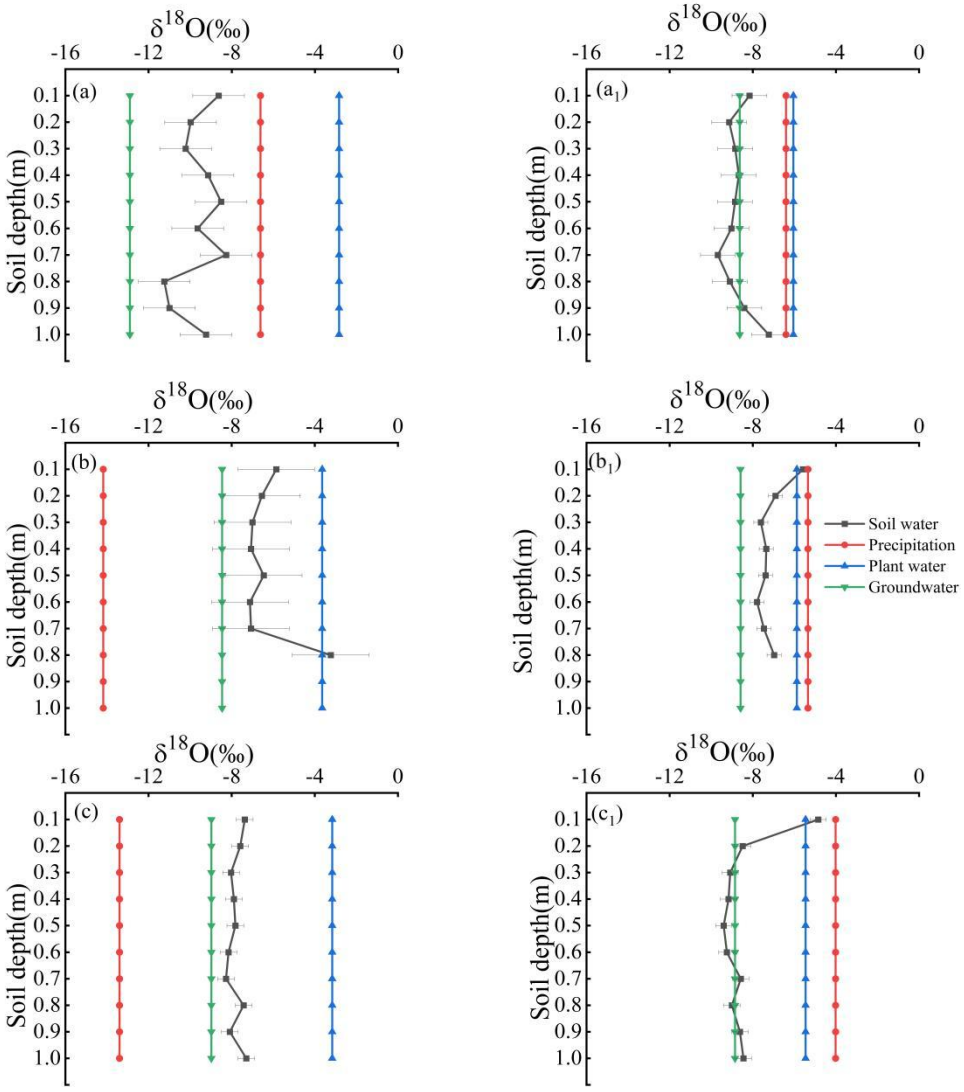

Fig. 4 (a)-(c) represents the variation of $\delta^{18}O$ of soil, plant, precipitation and groundwater with soil depth in the alpine meadow, forests and arid foothills in the dry season, and (a_1)-(d_1) represents the variation of $\delta^{18}O$ of soil, plant, precipitation and groundwater in the alpine meadow, forests and arid foothills in the rainy season

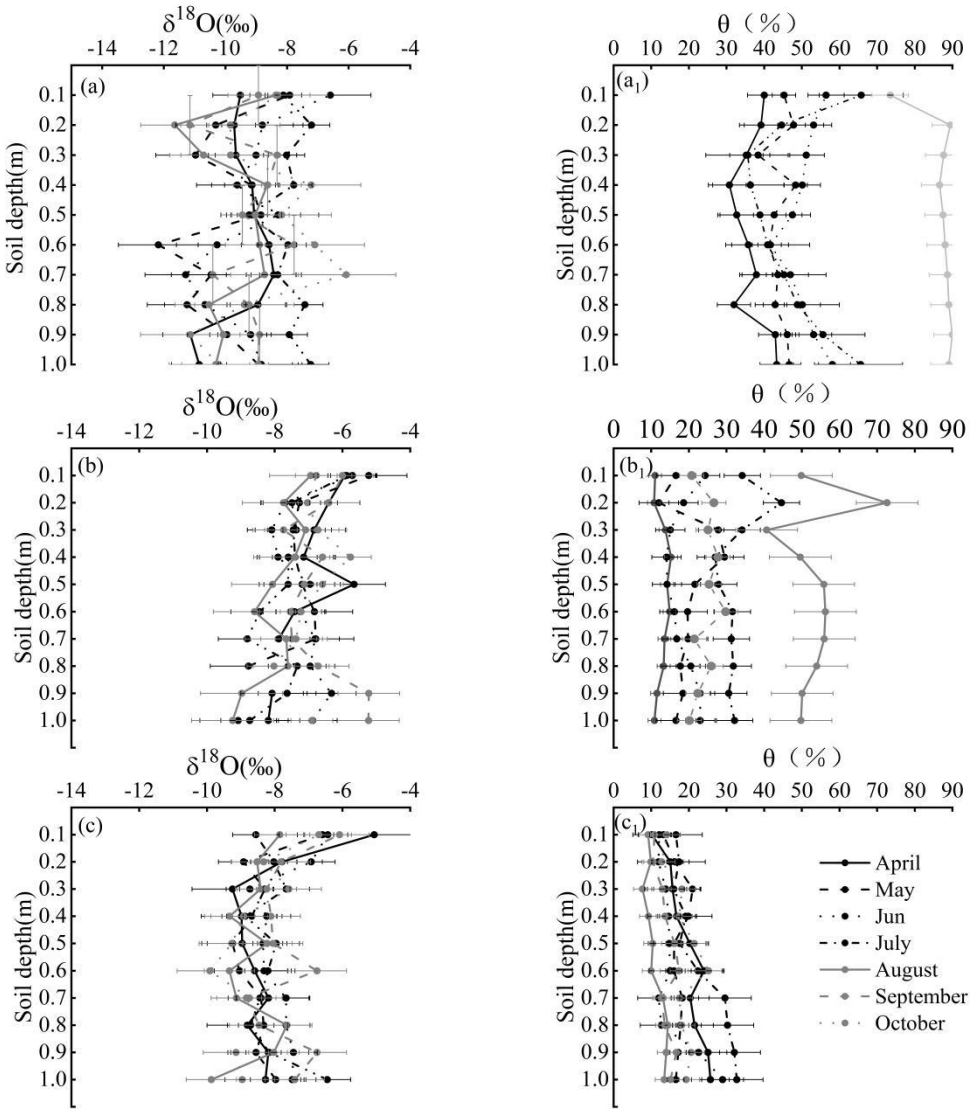

Fig.5 The variation of $\delta^{18}O$ and soil water content (θ, %) with soil depth. (a)-(c) represent alpine meadow, forests and arid foothills, respectively

36. Fig. 8: Please standardize the font size. “absoult” should be “absolute”?

Response: We have modified Fig. 8 according to your suggestion, and the revised Fig.8 is as follows:

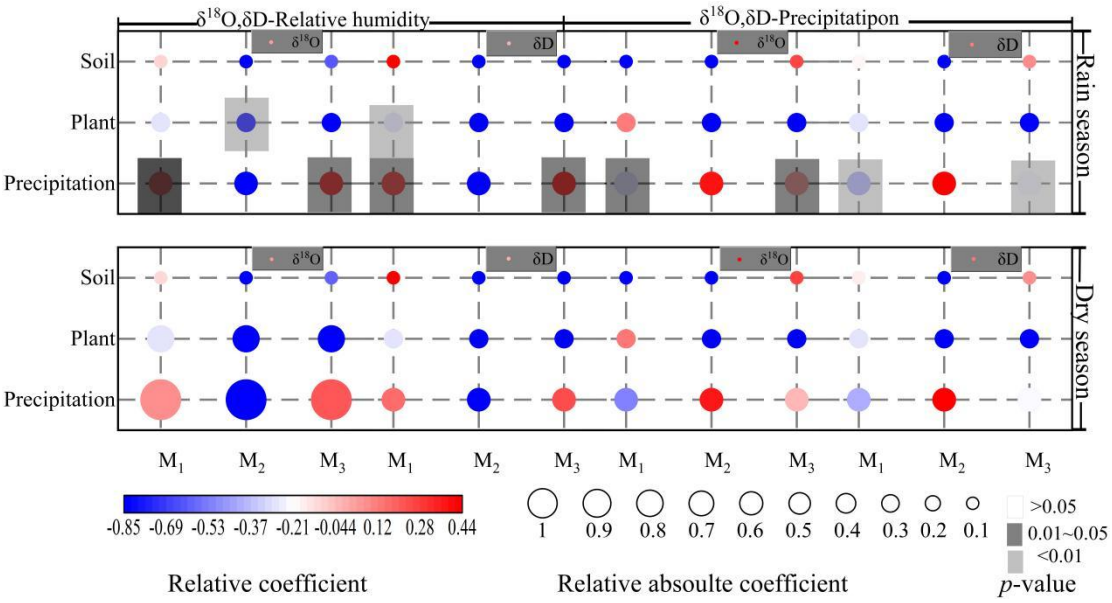

Fig. 8 Relationship between different isotope and relative humidity and precipitation, M_1 stands for alpine meadows, M_2 stands for forests, and M_3 stands for arid foothills