Title: The patterns and implications of diurnal variations in d-excess of plant water, shallow soil water and air moisture

Authors: Liangju Zhao, Lixin Wang, Xiaohong Liu, Honglang Xiao, Yunfeng Ruan, Maoxian Zhou

---

Reply to comments of reviewer 1:

All revised contents were used red and bold text in the manuscript.

General comments

This paper presents the patterns and implications of diurnal variations in d-excess of plant water, shallow soil water and air moisture in Heihe River Basin, China. The analysis is conducted based on water samples taken in August 2009, June and September 2011 at five sites (S1-S5). Three species of plants (tree, shrub and grass) were selected to extract water from leaves, stems and roots. Overall, the paper is interesting and valuable for the understanding of the process of vegetation activity in controlling the dynamics of d-excess values in air moisture. Still, it could be even more valuable to the general public if the second objective of the article, i.e. "what are the mechanisms of the observed patterns?" would be further answered.

Reply: In the revision, we expanded the discussion on the mechanisms of the observed d-excess patterns.

Throughout the paper, there are some iteration problems-especially concerning the discussion sections and the captions of tables and figures.

Reply: We revised the manuscript thoroughly and removed the iteration components. The revised contents were highlighted in the manuscript.

Manuscript: Multiple places;

Captions of tables: Table 4 and 5.

Captions of figures: Figure 3, 4, 5, 6, 7, 8 and 9.

Additionally, the authors often try to use defined location ID (e.g., S3 in P7L144), location ID with sampling time (e.g., S3-Aug in P11L234) and place names (e.g., the riparian forest site in P12L248)

mixed together to represent the sampling locations, which prevent the reader from understanding the content.

Reply: We unified all location ID as sampling site with sampling time, such as S1-Sep, S1-Jun, S2-Jun, S3-Aug, S4-Aug and S5-Aug.

Manuscript: Multiple places;

Captions of table: from Table 2 to 7;

Captions of figures: from Figure 2 to Figure 10.

Therefore, I recommend a thorough review of language.

Reply: According to the suggestions of the reviewer, we thoroughly went through the manuscript and further improved the grammars, wording and flows. The revised contents are highlighted in the manuscript with red and bold letters.

Specific comments

Key words

1. The keyword "deuterium" is same as "hydrogen" and "stable isotope". The keyword "water pools" is ambiguous.

Reply: The keywords were changed as "ecohydrology, deuterium excess, the Heihe River Basin, hydrogen and oxygen isotopes, different water pools". Please find in P3 Line 50-51.

Introduction

2. P5L93"…affected by …".

Reply: The "by" was added in P6 L103.

Materials and Methods

3. P6L113-118 Does the temperature is lowest in January, and is highest in July in Dayekou and Ejin? How does the characteristics of rainfall over Dayekou? Why do you choose the sampling periods in June, August and September?

3A:P6L113-118 Does the temperature is lowest in January, and is highest in July in Dayekou and Ejin?

Reply: Yes, the temperature is lowest in January, and is highest in July in both Dayekou (Zhao et al., 2011b) and Ejina. The related reference was cited in the manuscript and reference list. Please find this new addition in P6 Line 126-131.

Temperature of Ejina

1965-2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T	-11.34	-6.09	2.17	11.26	19.23	24.84	26.85	24.70	17.75	8.26	-1.73	-9.93

3B: How does the characteristics of rainfall over Dayekou?

Reply: The characteristics of rainfall over Dayekou were "Mean annual precipitation is 369.2 mm, **with over 71% of the rainfall occurring between June and September, and the rainfall in July is the highest". This revised section was added in the manuscript.**

3C: Why do you choose the sampling periods in June, August and September?

Reply: Our study focuses on June, August and September because these are the months when plants are mostly active. July wasn't selected because it typically rains continuously in July at the upper reaches of the Heihe River Basin, which makes the field logistics too challenging.

4. P6L119

4A: Where did you get the number of 3700 mm? Calculated, cited or observed? Please specify the reference?

Reply: The number of 3700 m was cited (Gong et al., 2002). And we added this reference in the manuscript and reference list.

4B: If the Ejina is the driest regions in China, I think a discussion on the applicability of this article's results on other climatic regions should be given.

Reply: We agree with the reviewer's point, and we added corresponding contents at the end of the conclusions: "Our study shows that dmoisture of the surface air at continental locations can be significantly altered by local processes at both mountain areas (Qilian Mountains) and extremely dry environments (Ejina), therefore such effect is likely a universal phenomenon across various climatic regions." We will validate this phenomenonin

Qinghai-Tibet Plateau in the further study."

5. P6L121, P7L23 "dominant" should be "dominated".

Reply: We changed "dominant" to "dominated" in two places.

6. P7L125-128Which species do the P.E., S.A. and R.S. belong to? Tree, shrub or grass?

Reply: The P.E. belongs to tree, and S.A. and R.S. belong to shrub. And this information was added in the manuscript.

7. P7L143 Which one does the S.C. represent, "Stipa capillata" or "Stipa capillata Linn" (P7L124)?

Reply: The S.C. represents "Stipa capillata". The "Stipa capillata Linn" was removed in the manuscript.

8. P8L149-152 The abbreviations of the name of sampled plants have been given in section 2.1. That's no necessary to use both the whole name and the abbreviations together to describe the plants. Same type of iteration also exist in P9L178-182. Please avoid this type of iteration.

Reply: We deleted the repetitions, and revised contents were highlighted in the manuscript.

9. P8L161 The citation "Wang and Yakir (2000)" is missed in the references section.

Reply: We added the citation "Wang and Yakir (2000)" in the reference list.

Results

10. P10 L195"composition" should be "compositions".

Reply: We changed "composition" to "compositions" according to reviewer's suggestion.

11. Pll L224-226 I didn't find any plot represents "xylem water of S.C." in Fig. 4. Do you mean "xylem water of Q.S."? If so, could you please circle the range of "xylem water of Q.S." and "5 cm soil water" for easily distinguishing the difference between the isotopic compositions of these two water bodies?

Reply: We thank reviewer for pointing out our oversight. The "xylem water of Q.S." is correct.

The "xylem water of S.C." should be "root water of S.C.", and Fig 4 was revised.

The range of d-excess of xylem water of all plant species and 5cm soil water were showed in the Table 4.

12. P11 L233-235 It is difficult to distinguish which figure represents S2 or S3 in Fig. 4. Please point it out clearly that which figure represents which sampling site?

Reply: Fig. 4. was revised according to reviewer's suggestion. We added the note: "The panels a, b, c and d refer to the Qinghai spruce forest at S1-Sep, S1-Jun, S2-Jun and S3-Aug. The panel e and f refer to S4-Aug and S5-Aug." were added in figure 2's captions. The figures' captions from Figure 3 to figure 6 and Figure 9 were added as "the panels a, b, c, d, e and f were same as the Figure 2" and the figures' captions of Figure 7 and 8 were added as "the panels a, b, c and d were same as Figure 2".

13. P12L247-250, P12L252-254 Please describe the same sampling location in a consistent way within the article including figures and tables. It will benefit the readers to understand. Please use either defined location ID (e.g., S2), defined location ID with sampling time (e.g., S2-Jun) or place names (e.g., Gobi site).

Reply: We unified all location ID as sampling site with sampling time, such as S1-Sep, S1-Jun, S2-Jun, S3-Aug, S4-Aug and S5-Aug. We used defined location ID with sampling time (e.g., S2-Jun) within the article including figures and tables.

14. P12L256-257 Does the temporal trends of d_{soil} at S3 was caused by rainfall? The soil samples were taken during two periods at S3, i.e. from 6:00 August 1 to 18:00 August 2and from 6:00 to18:00August 3, 2009. Which day do you selected for analyzing the spatial and temporal variation of soil water d-excess at S3 in Fig.5? Same to other figures.

14A. Does the temporal trends of d_{soil} at S3 was caused by rainfall?

Reply: Yes we think so. Because the temporal variations of d_{soil} and RH and T were contrary during the first sunny day after rain.

14B. The soil samples were taken during two periods at S3, i.e. from 6:00 August 1 to 18:00 August 2 and from 6:00 to18:00 August 3, 2009. Which day do you select for analyzing the spatial and temporal

variation of soil water d-excess at S3 in Fig.5?

Reply: We selected both two days' data: from 6:00 August 1 to 6:00 August 2 and from 6:00 to 18:00 August 3, 2009. We added this information in the manuscript.

14C. Same to other figures.

Reply: We added clarifications to other figures as well. "All the sunny days were selected for analyses. For example, S1-Sep: from 6:00 to 18:00 September 7 and 8; S1-Jun: from 6:00 to 16:00 June 23; S2-Jun: from 6:00 to 16:00 June 27; S3-Aug: from 6:00 August 1 to 16:00 August 2 and from 6:00 to 18:00 August 3, 2009. At S4-Aug and at S5-Aug, all data were selected". And these information were added in the manuscript as well as in the captions of the Figure 4 and Table 6.

15. P13L271-272 How much significantly do the d_{leaf} values during the cloudy days higher than those of the sunny days, and the d_{leaf} values lower than d_{xylem} values during the cloudy days? Were the d_{leaf} values lower than d_{xylem}values in all the sampling site during the cloudy days or just in some site? As shown in Fig.7a, the range of d_{leaf} values are not so much different from the range of d_{xylem} values.

Reply: According to reviewer's suggestion, we calculated the differences of d_{xylem} and d_{leaf} under the sunny and cloudy day. And we added these results in new Table 5 and revised contents were added in the manuscript.

Table 5 Differences of d_{xylem} and d_{leaf} under the sunny and the cloudy day. The location ID were same as table 2, and abbreviations of plant's Latin name were same as the table 3.

Study sites	Plant species	The sunny day			The cloudy day			Difference of d_{leaf}	Difference of d_{xylem}
		d_{leaf}	d_{xylem}	d_{xylem}-d_{leaf}	d_{leaf}	d_{xylem}	d_{xylem}-d_{leaf}	d_{cloudy}-d_{sunny}	d_{cloudy}-d_{sunny}
S1-Sep	Q.S.	-51.9	11.8	**63.7**	-6.8	12.0	**18.8**	***45.1***	***0.1***
	P.F.	-60.6	2.7	**63.3**	-4.9	2.7	**7.6**	***55.7***	***0.0***
	P.V.	-42.0	10.6	**52.7**	11.1	8.3	**-2.8**	***53.2***	***-2.3***
S1-Jun	Q.S.	-72.0	5.0	**77.1**	-47.4	5.2	**52.6**	***24.7***	***0.2***
	P.F.	-37.8	-0.6	**37.2**	-15.5	-1.1	**14.4**	***22.3***	***-0.5***
	P.V.	-20.4	5.5	**25.9**	-4.6	6.4	**11.0**	***15.9***	***1.0***
S2-Jun	Q.S.	-114.0	2.9	**116.9**	-116.9	-0.2	**116.7**	***-2.9***	***-3.1***
	S.C.	-52.9	-15.9	**37.0**	-59.5	-23.7	**35.8**	***-6.6***	***-7.8***
S3-Aug	Q.S.	-64.9	1.4	**66.3**	-52.8	4.0	**56.8**	***12.0***	***2.5***
Mean		-57.4	2.6	**60.0**	-33.0	1.5	**34.5**	***24.4***	***-1.1***

16. P13L274-277 Please use consistent expression for time format (h:mm am or h:mm).

Reply: We made time format consistent as h:mm throughout the manuscript.

17. P14L283 The phrases of "significantly positive/negative correlations" and "significantly positive/negative relationships" appear many times in the article. Could you please elaborate how do you judge the "significantly correlations" or the "significantly relationships"? Which statistical parameters do you selected to use, and what's the threshold value to judge the relationship is significant or not?

Reply: "The $p < 0.001$ indicate statistical significance at the 99% significance level, and the $p < 0.05$ indicate statistical significance at the 95% significance level." We added this in the captions of Tables 6, 7, 8 and 9.

18. P14L295-297 What does the "overall values" mean? Does the "overall values" mean $d_{moisture}$/RH at all the sites? I find the slope of $d_{mosiuture}$versus RH near the ground in the forest is "-0.36" in Table 6, but not "0.36" as stated by the authors. Besides, no $d_{mosiuture}$/RH value at S5 was found in Table 6.Then, how to estimate whether the $d_{mosiuture}$/RH value is high or low at S5?

18A: P14L295-297 What does the "overall values" mean? Does the "overall values" mean $d_{moisture}$/RH at all the sites? I find the slope of $d_{mosiuture}$versus RH near the ground in the forest is "-0.36" in Table 6, but not "0.36" as stated by the authors.

Reply: The "overall values" means all data were used. We changed "overall values" to "the results based on all the values" for clarity. We mistakenly missed the "-"sign in this place, and we added them in the manuscript. Thank you!

18B: Besides, no $d_{mosiuture}$/RH value at S5 was found in Table 6. Then, how to estimate whether the $d_{mosiuture}$/RH value is high or low at S5?

Reply: At S4-Aug and S5-Aug, all study time was sunny day. Thus, the $d_{mosiuture}$/RH, $d_{mosiuture}$/T, d_{leaf}/RH and d_{leaf}/T were shown in the Table 6 and 8. We also added these results in the Table 7 (7a) (original Table 6). If the editor/reviewer deem it as necessary, we will use Table 7a.

Table 7a Correlations of d-excess of various water bodies with RH (%) and T (^{o}C) and $d_{moisture}$ with d_{leaf} during the sunny days at each site.

Study area	The d-excess values versus RH (%)				The d-excess values versus T (^{o}C)			
	Slope	Intercept	r	p	Slope	Intercept	r	p
$d_{moisture}$ near the ground	-0.36	27.643	-0.712 (84)	<0.001	1.18	-4.574	0.771	<0.001

	$d_{moisture}$ at the canopy	-0.31	28.269	-0.617 (101)	<0.001	1.11	0.695	0.716	<0.001
	d_{leaf} of wood	1.26	-131.626	0.600 (102)	<0.001	-3.84	-19.327	0.63	<0.001
	d_{leaf} of shrub	1.26	-121.121	0.629 (25)	<0.001	-3.66	-15.489	0.547	<0.001
S1-Sep	d_{leaf} of herb	1.21	-99.962	0.635 (37)	<0.001	-3.17	-1.134	0.563	<0.001
S1-Jun	d_{leaf} of wood vs $d_{moisture}$ near the ground	-1.47	-63.237	-0.360(84)	<0.001	/	/	/	/
S2-Jun	d_{leaf} of wood vs $d_{moisture}$ at the canopy	-1.4	-52.568	-0.340 (101)	<0.001	/	/	/	/
S3-Aug	*d_{leaf} of shrub versus $d_{moisture}$ near ground*	*-0.14*	*3.69*	*-0.599 (24)*	*0.039*	/	/	/	/
	d_{leaf} of grass versus $d_{moisture}$ near ground	*-0.12*	*12.72*	*-0.648 (12)*	*0.023*	/	/	/	/
	$d_{moisture}$ at the canopy	**-0.13**	**17.42**	**-0.602**	**0.003**	**0.54**	**0.95**	**0.773**	**<0.001**
	d_{leaf} of P.E.	**1.41**	**-171.76**	**0.844**	**<0.001**	**-4.4**	**2.274**	**-0.642**	**<0.001**
S4-Aug	**d_{leaf} of S.A.**	**1.21**	**-166.99**	**0.947**	**<0.001**	**-2.15**	**-64.28**	**-0.56**	**<0.001**
	d_{leaf} of woodvs $d_{moisture}$ at the canopy	-0.06	7.163	-0.543 (32)	<0.001	/	/	/	/
	d_{leaf} of shrub vs $d_{moisture}$ at the canopy	-0.10	1.827	-0.534 (32)	<0.001	/	/	/	/
	$d_{moisture}$ at the canopy	**-0.68**	**18.47**	**-0.526**	**<0.001**	**0.83**	**-18.23**	**0.684**	**0.001**
S5-Aug	**$d_{moisture}$ of R.S.**	**1.77**	**-243.96**	**0.716**	**<0.001**	**-1.82**	**-158.14**	**-0.742**	**<0.001**
	d_{leaf} of shrubvs $d_{moisture}$ at the canopy	-0.28	-57.737	0.540 (25)	<0.001	/	/	/	/

19. P14L297-298 The coefficients of d_{soil}/RH range from -0.046 to -0.483, at site S1-Jun, S1-Sep and S3. It seems nosignificant relationship between d_{soil} and RH at these three sites.

Reply: Yes, we revised this section as "However, the relationships between d_{soil} of 10cm at S1-Sep and S3-Aug were significantly, and only d_{soil} at S1-Jun of 10cm and RH were significantly correlated (Table 6).") And the revised contents were highlighted in the manuscript.

20. P14L301-302 The authors mentioned "Significantly negative relationships were found between d_{leaf} and T … in the upper reaches." Does the same relationship also exist in the down reaches?

Reply: Yes, we revised this sentence, and the revised version is "Significantly negative relationships were found between d_{leaf} and T except in Q.S. at S1-Jun in the upper reaches and in the lower reaches (Table 8).")

21. P15L312-314 What does the "overall values" mean here?

Reply: The "overall values" means "the results based on all the values". And the revised contents were highlighted in the manuscript.

Discussion

22. P16L336-342 I think may be it is better to move this paragraph to the introduction section. "fingerprint" or "footprint"?

Reply: We moved this paragraph to the introduction section, as suggested.

We refer to use isotope to pinpoint the specific source location of water, so "fingerprint" is more appropriate here.

23. P19L407-410 Grammar mistakes.

Reply: We revised this paragraph and corrected the grammar mistakes.

24. P19L410-413 The authors state that "…d-excess of moisture through soil evaporation also has an important role on changing the $d_{moisture}$ of local air moisture during the sunny day after the rain events, …". Could you explain from which paragraph or figure you get this result? How does the soil evaporation affect the $d_{moisture}$ of local air moisture? Please specify what "the meteorological conditions" mean? Temperature? Moisture? Or rainfall? If it is possible, please discuss which meteorological condition play a more important role?

Reply: We explained our result from the Tables and Figures, and we added these results in the manuscript: "At S3-Aug, during the first day after rain event, the negative relationship between d_{soil} at 5cm and 10cm and T (Table 8), the clear diurnal variations of d_{soil} at 5cm and 10cm (Fig. 5D) and the opposite patterns between the diurnal variations of d_{soil} and $d_{moisture}$ (Fig. 10) were found. These results indicate that d-excess of moisture through soil evaporation also has an important role on changing the $d_{moisture}$ of local air moisture during the sunny day after the rain events, and this role was controlled by meteorological conditions. **In addition, the effect of soil evaporation on local air moisture was same as plant transpiration, and this effect was mainly controlled by temperature due to the negative significant relationship between d_{soil} and T (Table 8).**"

25. P19L417-418 Why the observed values in this study higher than that of previous reports? The authors should explain why and expand on the implication of this phenomenon.

Reply: We added discussion regarding the higher peak-trough amplitude of d-excess.

26. P20L432-434 I didn't find the diurnal variation for $d_{moisutre}$ near ground at S1-Jun is clear in Fig. 8b. Besides, the variation tendency of $d_{moisture}$ in other sub-figures of Fig.8 seems also agree with the variation tendency of d_{leaf} at corresponding sites shown in Fig.7, although the tendency is not very clear. If so, please elaborate the implication of this phenomenon.

Reply: We stated that no clear diurnal variation of $d_{moisutre}$ during the cloudy day when plant activity is low, which supports our argument of the role plants play in regulating $d_{moisutre}$. We agree there some tendency of weak correlation between $d_{moisutre}$ and d_{leaf}, which makes sense since plants transpire even during cloudy days, just at a much lower rate.

27. P20L437-P21L442 This information has already been given on Page 14 Line 283-289. Please check other iterations in the discussion section.

Reply: We removed this iteration here and checked through the manuscript for other iterations.

28. P21L449-451 The authors state "… the water evaporation of soil surface may play a similar role to leaf transpiration as an important source to affect the isotopic composition of atmospheric vapor." Please elaborate how did you get the result from the relationship between d_{soil} and RH/T?

Reply: We explained our result from the Table and Figures, and we added these results in the manuscript: "At S3-Aug, during the first day after rain event, the negative relationship between d_{soil} at 5cm and 10cm and T (Table 8), the clear diurnal variations of d_{soil} at 5cm and 10cm (Fig. 5D) and the opposite patterns between the diurnal variations of d_{soil} and $d_{moisture}$ (Fig. 10) were found. These results indicate that d-excess of moisture through soil evaporation also has an important role on changing the $d_{moisture}$ of local air moisture during the sunny day after the rain events, and this role was controlled by meteorological conditions. **In addition, the effect of soil evaporation on local air moisture was same as plant transpiration, and this effect was mainly controlled by temperature due to the negative significant relationship between d_{soil} and T (Table 8).**"

29. P21L456-460 As shown in Table 5, the correlation coefficient for d_{soil} and RH at S3 is 0.289 at 5cm, 0.255 at 10 cm, respectively. It seems no significantly positive relationships between $d_{soil}$and RH at S3.

Reply: We check the original data, and find we had a mistake. 0.255 at 10 cm should be 0.403. It was highlighted in Table 6.

30. P22L488 The authors state "…high significantly relationships between $d_{moisture}$ with RH/T are found…". Please clarify which statistic parameter indicate the high significantly relationships.

Reply: We added the ($p<0.001$) after between $d_{moisture}$ with d_{leaf} and between $d_{moisture}$ with RH/T ($p<0.001$).

Revisions: "significantly negative relationship between $d_{moisture}$ with d_{leaf} **($p<0.001$)** and high significantly relationships between $d_{moisture}$ with RH/T **($p<0.001$)** (Table **6, 7 and 8**) were found."

Conclusions

31. P23L505

31A: Please point out which previous observations and what theoretical predication?

Reply: We added the specific references.

31B: Also, the authors should discuss and conclude why the peak-through amplitude of d-excess values observed in this study is higher than previous studies.

Reply: We added discussion regarding the higher peak-trough amplitude of d-excess in Discussion section.

Tables and Figures

32A: Table 3 Please try to shorten the captions of all the tables and figures, and avoid iteration in the captions of tables and figures.

Reply: The captions of all the tables and figures were shortened according to the reviewer's suggestion.

32B: Does the "Sophora alopecuroides L." in the caption of Table 3 is same as "Sophora alopecuroides" in P7L126?

Reply: Yes, the "Sophora alopecuroides L." in the caption of Table 3 is same as "Sophora

alopecuroides". In the revision, we used "Sophora alopecuroides" only.

33. Table 6 The authors state "m, b and r" would be used to represent "slope, intercept and correlation coefficient" in the caption of Table 6. However, "m, b, and r" were not appeared in the Table6.

Reply: We added "slope, intercept, r and p" in Tables 6, 7, 8 and 9.

34. Figure 1. What does the filled stars represent in Fig.1? Please add the legend. Please label the study area and the country's name in bottom right corner of the map.

Reply: We agree with the reviewer's point, and we added the legend of filled stars, study area and country's name according to reviewer's suggestion. Fig. 1 was remade according to suggestions of reviewer 1.

35. Figure2. I think it will easier to understand the article to add the sampling date in the title of horizontal axis.

Reply: We added the sampling date in the title of horizontal axis, and Fig. 2 was made. Please check the Fig. 2.

36. Figure 3 The citation "He (2011)" in the caption is missed in the references section. "water pool" should be "water pools".

Reply: We added the citation "He (2011)" in the reference list, and we changed "water pool" to "water pools" according to reviewer's suggestion.

37. Figure 5 No sub-figure 5f was found. Please check.

Reply: We added the d_{soil} of the S4-Aug and S5-Aug in the Figure 5e. So there is no Figure 5f.

38. Figure 9 What do the "AC" and "NG" represent in Fig. 9?

Reply: The "AC" is the air moisture at the canopy, and the "NG" is the air moisture near the ground. We added clarification in the Fig. 9.

Title: The patterns and implications of diurnal variations in d-excess of plant water, shallow soil water and air moisture

Authors: Liangju Zhao, Lixin Wang, Xiaohong Liu, Honglang Xiao, Yunfeng Ruan, Maoxian Zhou

---

Interactive comment on "The patterns and implications of diurnal variations in d-excess of plant water, shallow soil water and air moisture" by L. Zhao et al.

Anonymous Referee #2

Reply to comments of reviewer 2:

All revised contents were used "trace change" in the manuscript.

The manuscript of Zhao et al presents a detailed set of investigations into the deuterium excess (dex) of waters in of plants, soils, and the surface atmosphere across a basin in central China. At five sites over a period of 1-3 days these quantities were measured at1-2 hour frequencies, and thus present an interesting dataset with which to explore the role of vegetation in controlling the diurnal cycle. While I find the objective of this paper an interesting topic, I feel that more could be done to demonstrate the how plants, soils and meteorological conditions influence isotopic cycling in these environments.

Many of the results of this study are consistent with previously understood dynamics in the soil-plant-atmosphere continuum. The isotopic enrichment of waters as it moves from soils into xylem, from xylem to leaves, and from leaves to the atmosphere has been actively studied by Farquhar, Cernusak, Ehleringer, Dawson, and many others. The authors demonstrate a diurnal cycle in leaf dex values, but no attempt is made to reconcile these observations with well-understood dynamics of leaf enrichment. In order to justify the authors conclusions about the role of plants in mediating the dex content of surface vapor, these models should be tested to see what the diurnal cycle of leaf transpiration dex would be based on theory.

Reply: We appreciate reviewer's positive comments on the scope and significance of this research. We agree with the reviewer that incorporating modeling exercise will enhance the

implication of results. So we modelled the leaf water $\delta^{18}O$ and δD enrichment using the Craig–Gordon model and calculated the d-excess by the equation d-excess = $\delta D - 8.0 \times \delta^{18}O$ (Dansgaard, 1964). At the same time, we want to note that the main body of modeling work of isotopic enrichment is focusing on ^{18}O and on leaves only. ^{2}H enrichment is not commonly seen in literature with several unconstrained parameters. This work provides valuable data to advance the modeling work in the future.

In addition, we don't think observation data alone won't be able to justify our conclusions of the role of plants in mediating the d-excess dynamics. We had done extensive statistical analyses between d-excess and environmental variables and multiple lines of evidence support our conclusions. In the revised manuscript, we have carefully revised many parts of the discussion to strengthen the logic flow.

The trend in dex of soil moisture observed at S3 is very puzzling. The limited explanation that the authors give is not sufficient nor justified by any mechanistic process know to occur in soils. Much more detailed assessment of these data are needed or this section should be removed as it is not adequately addressed. Overall, I find the analysis of the collected data in this manuscript weak. The figures (with the exception of F1 and F3) all plot observed data with respect to time, yet many claims are made about the relationship between dex and meteorological conditions are made.

Reply: We have re-wrote the discussion section for d-excess of soil moisture. The unique pattern of d-excess of soil moisture at S3 is very interesting. Multiple evidence showed that it's caused by strong evaporation and we have elaborated this by adding additional evidence. In terms of overall analysis, like we mentioned earlier, we had done extensive statistical analyses between d-excess and all the available environmental variables to explore the controlling factors of d-excess dynamics, we adjusted several sections for better flow and reduced repetition. The plots showed the observed data with respect to time and tables showed the statistical results between d-excess and all the available environmental variables.

P4434:

L9: Add in note about the ecosystem types assessed for those not familiar withthe Heihe Basin.

Reply: We added more information about the ecosystem types such as "5 sites of *Qinghai*

***Spruce* forest, riparian forest and Gobi under** two climatically different locations within the Heihe River Basin, **northwestern China. The ecosystem types in these locations ranges from forest to desert" here. Please find in P2 Line 31-33.**

L10: This wording implies that measurements were made over multiple days (please clarify)

Reply: Yes, the measurements were made over multiple days. Please find the detailed sampling times in the Table 1 and Fig. 2.

L11: Change 'plots' to 'values'

Reply: We changed 'plots' to 'values' according to reviewer's suggestion. Please find in P2 Line 34.

L12: The conclusion that dex values vary between different pools, or that there is a diurnal cycle in the atmosphere is not a novel finding.

Reply: Yes, "There were significant differences in d-excess values among different water pools at all the study sites" and "there is a diurnal cycle in the atmosphere" are not a novel finding per se and they are introduction sentence of their corresponding conclusion.

L17-22: Many of these relationships are expected from classic models such as Craig-Gordon, why is this novel?

Reply: Yes, in theory, the general direction of many relationships could be predicted using models like Graig-Gordon. However, the magnitude, the variations, and the diurnal patterns are not easy to predict due to the uncertainty in ^{2}H calculations as we mentioned earlier. And field observed d-excess variations are not readily seen in literature yet, not to mention the high-resolution ones of multiple pools. So we selected P. E. in S5-Aug. to predict the leaf water $\delta^{18}O$ and δD enrichment using the Craig–Gordon model (Craig and Gordon, 1965) and calculated the d-excess by the equation d-excess = $\delta D - 8.0 \times \delta^{18}O$ (Dansgaard, 1964). Please find related results in the manuscript.

P4435 L17: Explain this with respect to the physical processes that affect dex first, then note the

graphical relationship afterward.

Reply: We revised this sentence as suggested. Please find in P4 Line 73.

P4436:

L5: dex 'in surface atmospheric vapor'

Reply: We added 'in surface atmospheric vapor'. Please find in P5 Line 88.

L20: The theory of Merlivat and Jouzel was developed for open water evaporation where delta_ET = delta_A, why is this theory relevant here?

Reply: The soil evaporation process is similar to open-water evaporation (i.e., the application of Craig-Gordon model for soil evaporation). And the prediction of Merlivat and Jouzel is one of the few that theoretically predicts the quantitative relationship between d-excess with T and RH.

L25: This is an interesting point. What do model like those of Farquhar and Cernusak predict?

Reply: As far as we know, Farquhar and Cernusak model didn't report d-excess, though in theory they could. Therefore, according to reviewer 2's suggestion, we try to calculate d-excess through model ^{18}O and ^{2}H under stable state using the Craig–Gordon model (Craig and Gordon, 1965), and the modeled results are shown in the Figure 11, and related contents were added in many places of the manuscript.

P4437 L10: I feel that (2) is not addressed sufficiently.

Reply: We have thoroughly revised the discussion to provide more mechanistic understanding of d-excess. Please find in P6 Line 121 and P7 Line 1.

P4439 L14: How many locations, where were they located relative to the vegetation?

Reply: We added the contents: "We used a method similar to Wang and Yakir(2000) for short-term sampling of ambient air moisture at different locations **such as Qinghai Spruce forest (S1-Sep, S1-Jun, S2-Jun and S3-Aug) in the upper reaches, riparian forest (S4-Aug) and Gobi (S5-Aug) in the lower reaches. At the S1-Sep, S1-Jun and S2-Jun, the sampling of air moisture**

were collected within a canopy and near ground (about 20cm above the ground). At S3-Aug, S4-Aug and S5-Aug, the sampling of air moisture were collected within a canopy (Figure 1 and Table 1).”

P4440 L5-12: A better description of the weather stations would be helpful. What instruments were used, at what height above ground were the measurements made?

Reply: We added additional description of the weather stations as highlighted below.

“At S3-Aug, T, RH and PAR were measured every 30 min with a weather station permanently installed at the station**(HMP45C for measuring T and RH, LI190SB for measuring PAR) at 2m, 10m and 24m height. At S1-Sep, S1-Jun, S2-Jun, S4-Aug and S5-Aug**, RH, T and PAR were measured every 10 min with two portable weather stations **(Davis Vantage Pro2 portable weather station) at 2m.We compared the T and RH measured with two different weather stations and different height, and no remarkable differences and diurnal variations were found among them. Thus, only 2m height weather data such as T, RH and PAR were used in this paper.** We measured T, RH and PAR due to their significant effects on soil evaporation and transpiration”.

P4444:

L6: Much of this section is just stating what’s in tables 5 and 6.

Reply: We shortened this section.

“Significantly positive correlations were found between d_{leaf} and RH at all the study sites during the study periods (from June to September) in the upper reaches of the HRB (Table 6). As RH increased by 1%, the increasing magnitude of d_{leaf} **ranged from 0.49‰ to 2.53‰ in the upper reaches**. In the lower reaches, as RH increased by 1%, **the increasing magnitude of d_{leaf} ranged from 1.21‰to 1.77‰**. Significantly positive correlations were also found between d_{leaf} and RH at all the study sites during the sunny day (Table 7).”

L17: Again, what at what heights were measurements made? This clearly affects your results.

Reply: Height information was added.

P4446:

L21: What is the justification for this statement?

Reply: We changed this statement as "Our results show that there are significant differences in δD and $\delta^{18}O$ among leaf and xylem water, soil water and air moisture, and different δD-$\delta^{18}O$ plots patterns due to **hydrogen and oxygen isotopic discrimination** related to soil evaporation, plant transpirations and plant physiology."

L24: Leaf water enrichment during transpiration has been understood for a long time, as is the influence of T and RH on this process.

Reply: Yes, we agree with your suggestion and we explained this in the manuscript: "For example, compared to that of xylem water and shallow soil water, leaf water have the highest average δD and $\delta^{18}O$ values and the largest ranges, and showing the greatest variation in $\delta^{18}O$ values in all the study sites. In addition, the δD-$\delta^{18}O$ plots of leaf water highly deviate from their corresponding LMWL (Table 2; Fig. 3), suggesting a strong transpiration enrichment effect. With the decrease of RH and increase of T, leaf water δD and $\delta^{18}O$ values increased and the δD-$\delta^{18}O$ plots gradually deviate from their corresponding LMWL due to stronger transpiration, suggesting that climatic conditions have significant effect on variations of leaf water δD and $\delta^{18}O$ and their correlations by affecting transpiration (Table 2 and Table 3)."

P4448:

L23: What does the Farquhar and Cernusak model (or something similar) predict for the effects of transpiration on dex in leaves. What role does RH and T play in this as well?

Reply: As mentioned earlier, the main body of modeling work of isotopic leaf enrichment is focusing on ^{18}O. ^{2}H enrichment is rarely seen in literature with several unconstrained parameters. This makes the d-excess modeling difficult to be validated. In addition, according to our results, significantly negative relationships were found between d_{leaf} and T, and significantly positive correlations were found between d_{leaf} and RH. These results indicated that T and RH changed d_{leaf} by controlling plant transpiration.

L26: Is this always true? What if the original oceanic source of some of the vapor had a low

RH and the dex of entrained atmospheric moisture is quite high?

Reply: We revised this sentence to make it more accurate. Please find in P21 Line 457-458.

P4449 L11-21: This 'trend' in dex of soil moisture I find very confusing? You state multiple times, and is often reported in the literature, that root uptake doesn't fractionate. Then the only other mechanism to alter the soil dex is evaporation. But evaporation will result in enriched soils and result in a lower dex. How do you possibly explain the increases in dex at the end of the day? Why does only this sample show this trend? This finding is very puzzling and not explained adequately!

Reply: We re-wrote this section of discussion and aimed to better explain the pattern. Please find in P22 Line 468-482.

F1: This map is difficult to read, and may print poorly in black and white. Perhaps swap the locations of the North arrow and the legend (after removing Yagan) and use a color for the rivers not found in the terrain gradient.

Reply: We revised the legends of all figures, and we remade the Figure 1 according to reviewer's suggestion.

F2: The legends for this and other plots are very unclear. Please state which panel corresponds to which site. Please use the same tick spacing on x-axis (12hrs) on each plot so that the observational windows can be compared more easily. Also remove the minutes (here and elsewhere) since they are all zero.

Reply: We revised the legends of all figures, and we remade the figure 2 according to reviewer's comments. We also removed the minutes as reviewer suggested.

F4: Combine this and figure 7 and plot as in F2. This would allow us to see the difference between sunny and shady days more clearly.

Reply: We combined mean RH and T at the sunny day in the Figure 4.

We combined RH and T at the cloudy day in the Figure 7.

F5:

Combine this and figure 8 as above.

Reply: We combined RH and T at the cloudy day in the Figure 8.

What does the shaded area and the grey arrow signify. Plot the relationship between dex in the various pools with PAR, T, and RH. Where are there strong relationships?

Reply: We added a note in the Figure 5 to explain the shaded area and the grey arrow.

There will be too many figures if we plot all the relationship between dex in the various pools and PAR, T, and RH. Therefore we used tables to show their relationships. In addition, we only analyzed the relationship between dex in the various pools with T and RH. The strong relationships were indicated with P values in the Tables 6, 7, 8 and 9.

What does the relationship between dex of leaf water and dex of the atmosphere look like?

Reply: Negative relationships were found between dex of leaf water and dex of the atmosphere. Please find this in Figure 9 and Table 7.