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

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Reply to comments of reviewer 1:

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). Threespecies 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: table4 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".

Introduction

2. P5L93"…affected by …".

Reply: The "by" was added in P6 L97.

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 P6Line 118-122.

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. Please find this change in P6Line 121-122."

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 3700m was cited (Gong et al., 2002). And we added this reference in the manuscript and reference list. Please find this change in P6 Line 125.

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

Reply: We agree with the reviewer's point, and we added corresponding contents at the end of the conclusions: "Our study revealed that $d_{moisture}$ of the surface air at continental locations can be significantly altered by local processes under both high and cold mountain area (Qilian Mountains) and extremely dry environment (Ejina), so we can conclude that our results are universal phenomenon and can be found in other climatic regions. We will validate this phenomenon in Qinghai-Tibet Plateau in the further study."

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

Reply: We changed "dominant" to "dominated" in P7 Line 128 and Line 130.

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 inP9L178-182. 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. P10L195"composition" should be "compositions".

Reply: We changed "composition" to "compositions" in P10 Line 200 according to reviewer's suggestion.

11. PllL224-226 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. P11L233-235It 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.

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. This is 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 (P12 Line 234-237) 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 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. P13L274-277Please use consistent expression for time format (h:mm am or h:mm).

Reply: We made time format consistent as h:mm am 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 $d_{mositure}$ 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 $d_{mositure}$/RH value at S5 was found in Table 6.Then, how to estimate whether the $d_{mositure}$/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 $d_{mositure}$ 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. Thanks for catching this.

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

Reply: At S4-Aug and S5-Aug, all study time was sunny day. Thus, the $d_{mositure}$/RH, $d_{mositure}$/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 (original Table 6).

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 all data of both the sunny and cloudy days. 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. Please find in P4 Line 60-67.

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 checked the original data, and found that 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 P7L126. 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" inthecaptionof 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-figure5f   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.