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Interactive comment on "Responses of energy partitioning and surface resistance to drought in a poplar plantation in northern China" *by* M. Kang et al.

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With our heartful thanks and appreciations, we have carefully read all the insightful reviews and comments by two anonymous reviewers for our paper submitted to your journal. We do think that all those review comments are addressable, therefore, we have revised the whole paper and answered all the questions raised accordingly.

The reply on each of comments is as following:

General Comments

1. The researchers investigated an important topic related to the exacerbation of

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drought conditions due to large-scale afforestation of high water-use hybrid poplar in China. Four years (2006-2009) of continuous eddy-covariance flux and climate measurements were made above and within the Daxing Forest Farm located in Beijing, China. This appears to be a valuable dataset with fluxes achieving high energy balance closure. The climatic controls on surface resistance, calculated from the inverted Penman-Monteith equation, and the subsequent partitioning of net radiation into turbulent energy fluxes (latent and sensible heat) were discussed. 2. The authors need to justify using the term “drought” when there was one year with below-average precipitation followed by two years with above average precipitation and a final year with below-average precipitation. Perhaps it should be described as four years with seasonal dry periods. Reply: Yes, there were seasonal dry periods within the four years. As we have already reported the effects of timing of drought occurrence on the carbon exchange throughout growing season for the plantation from 2006 to 2009 (Zhou et al., 2013), therefore, we focused on the contrasting of energy balance and surface resistance between the dry and wet year for accessing the suitability of poplar plantation in water-limited regions. As we stated in BGD Page 353, Line 5-8, we classified four studied years into “dry” and “wet” years. The dry year referred to the meteorological drought when yearly precipitation less than 75% of the multi-year average according to the National Standard of People’s Republic of China (GB/T 20481-2006). Therefore, we have revised the content in BGD Page 353, Line 5-8 as “Four year study period was classified as “wet” or “dry” year distinctively. The dry year referred to the meteorological drought when yearly precipitation less than 75% of the 20-year average according to the National Standard of People’s Republic of China (GB/T 20481-2006) (China, 2006). Years 2007 and 2008 were classified as “wet” while 2006 and 2009 were “dry” year, respectively.”

3. A further concern is that adding irrigation of 86 and 195 mm in the first and fourth years brings all four years above the long-term mean precipitation. Was this irrigation scheduling part of regular stand management? If so make it clear. Considering these amounts of irrigation water that were applied, distinguishing between "dry" and "wet"

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years becomes very difficult. The question arises: if the hybrid poplar had not been irrigated in 2006 and 2009 (the years with low precipitation) how would that have affected the conclusions? Reply: Thanks for raising these questions. The plantation was designated as "ecological forest" other than "commercial forest" after 2004, therefore, the application of irrigation and other management practices were nonscheduled and not well documented. We have revised the text in Material and methods section (see in BGD Page 351, Line 6-7as "The amount of flood irrigation was applied by pumping groundwater and back calculated based on records of water meters from three wells on a weekly basis from 2006 through 2009." It surely becomes difficult to distinguish the "dry" and "wet" years when irrigation water was applied. However, the dry year really referred to the meteorological drought according to the national standard. Our result indicated that the drought triggered physiological stress (higher surface resistance) in the dry years even with the irrigation applied. It is a pity that we could not compare the situation without irrigation due to our study was not a controlled one. Comparison with irrigation and without irrigation would have drawn more insights on the effects of meteorological drought and seasonal drought on energy partitioning and resistance parameters.

4. It was found that the latent heat flux accounted for 62% and 53% of the available energy flux in the wet and dry years, respectively. The authors also report this in terms of the ratio of LE to LEeq (0.81 and 0.68, respectively). Certainly the fraction for the wet years is higher than for the dry years but it is not a large difference. Unfortunately it is not known how much lower the values in the dry years would have been with no irrigation. Could the same irrigation totals have been applied in different amounts at different times during the year resulting higher latent heat flux totals and presumably higher growth rates? This is an important question since the soil is coarse textured with limited water holding capacity. These issues need to be addressed in the introduction to the paper when addressing the objectives and the experimental design. Reply: Yes, unfortunately, we could not calculate the values in the dry years if irrigation would not have been applied. Given that this was not a controlled experiment, the

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carbon and water exchanges of the plantation with the atmosphere have been studied under different soil moisture conditions (Zhou et al., 2013). Due to the coarse textured sandy soil and flood irrigation applied, we assumed that timing and amount of irrigation would have shorter time scale effects on the energy partitioning and surface resistance. Therefore, we have revised the content in BGD Page 349, Line 22-25as "The goal of the current study was to examine how forest water and energy balances vary under different climatic conditions and how to best manage the plantation forests to maximize ecological benefits in water limited region. Therefore, we evaluated drought responses in energy partitioning in a ten-year-old poplar (Populus euramericana CV. "74/76") plantation on sandy soil in northern China. We hypothesized that drought would trigger significant changes in the surface resistance and energy partitioning in the water-demanding poplar species."

5. The conclusions need to be made clearer. For example, the authors concluded that "partitioning of available energy to latent and sensible heat differed significantly between wet and dry years" but also concluded that "overall low LE/LEeq and high surface resistance values in all years indicated that the study area was under water stress even in the wetter years". The implications of these somewhat different statements need to be explained. The final concluding statement (repeated in the Abstract) needs to be rewritten. It states "In conclusion, the dry surface conditions dominated in this poplar plantation ecosystem regardless of soil water availability suggesting that fast-growing and water use-intensive species like poplar plantations are poorly adapted for the water limited region". I suggest that the authors make it very clear what is meant by "dry surface conditions". Are they referring to surface resistance or surface soil moisture content? What criterion is being used in determining that conditions are dry? How do these conditions lead to the conclusion that "fast-growing and water use-intensive species like poplar plantations are poorly adapted for the water limited region"? If less water is used (low LE), and the trees remain healthy (or are the trees dying?), doesn't this suggest they quite well adapted? Reply: Thanks for your suggestion and sorry for not clarifying the statement. LE/LEeq less than 1 and higher surface resistance even in

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the wet year indicated that the low LE of poplar plantation was actually caused by the soil water deficit and drought stress rather than low water demand. Therefore, irrigation was needed to maintain the poplar plantation by extracting groundwater in the water limited region. We could then conclude that "fast-growing and water use-intensive species like poplar plantations are poorly suited for the water limited region". We have revised the conclusion in BGD Page 365, Line 1-21 as "The seasonal drought stress affected the dynamics of individual turbulent energy fluxes and the surface resistances in the poplar plantation during growing seasons. Partitioning of available energy into latent (LE) and sensible heat (H) flux responded to meteorological drought and correspondingly displayed higher β in dry years (1.57) than that in wet years (0.83). Similar to the response of the Bowen ratio on drought conditions, the LAI normalized surface resistance (Rs:LAI) in dry years was 33% higher than that in wet years. Accordingly, the contrasting impact of Rs and Ri on the Bowen ratio were stronger in dry years than in wet years, while the effect of Ra was stronger in wet years, Rs was the major factor in controlling energy partitioning during the growing season, as indicated by the relatively low decoupling coefficient (Ω) values. Furthermore, the overall low LE/LEeq (< 1) of poplar plantations indicated that dry climate dominated in this water limited region, which suggested that the fast-growing and water-intensive species like poplar plantation are poorly adapted for the water limited regions."

6. There is considerable poor grammar and composition which should be corrected by the native English-speaking co-authors. Reply: Thanks for your suggestion for ensuring the publication quality. The native English speaking co-authors have edited the paper for language. Revised content can be seen in authors' changes in manuscript.

7. After addressing the above concerns and the specific points below, the paper would make a valuable contribution to ongoing international hybrid poplar water use research.

Specific Comments

1. Page 347, Lines 6 and 8: In line 6 you refer to "canopy resistance" and then to "bulk

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canopy resistance" in line 8. Throughout the paper and within equations you refer to "surface resistance". I think you should change both resistances mentioned in lines 6 and 8 to surface resistance to remain consistent. Reply: Thanks for careful reading and sorry for the confusions. Corrected.

2. Page 347, Line 6: Insert "fluxes" after CO2. Reply: Thanks for careful reading. Corrected.

3. Page 347, Line 7: What is meant by "true" ecosystem functions? Make this clearer. Reply: Sorry for inappropriate expression. We have revised the expression;

4. Page 347, Line 11: I suggest using ", calculated as net radiation (Rn) minus soil heat flux (G), was partitioned into" rather than "(Net radiation Rn minus Soil Heat Flux, G) Reply: Thanks for your suggestion. We have revised the content in BGD Line 11-17, Page 347 as "The partitioning of available energy (Net radiation Rn minus Soil Heat Flux, G) partitioning to latent heat (LE) decreased from 0.62 to 0.53 under meteorological drought. A concomitant increase in sensible heat (H) resulted in the increase of a Bowen ratio from 0.83 to 1.57.".

5. Page 347, Line 12: Define what is meant by climatological drought. Reply: Sorry for the confusion. We have revised "climatological drought" to "meteorological drought", which was defined based on whether the precipitation in a period exceed the average precipitation over the same period during years (China, 2006).

6. Page 347, Line 13: 62%. I'd suggest this be written as 0.62 to be consistent with other ratios you've reported. Reply: Thanks a lot. Corrected.

7. Page 347, Line 21: Start a new sentence "The LE/LEeq. . .". Reply: Sorry for the confusions, the statement "and the LE/LEeq ratio ranged from 0.81 and 0.68 in wet and dry years, respectively." is juxtaposed with "the decoupling coefficient (Ω = 0.45 and 0.39 in wet and dry years, respectively),", so we have revised the statement as "as indicated by the decoupling coefficient (Ω= 0.45 and 0.39 in wet and dry years,

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respectively) and the LE/LEeq ratio ranging from 0.81 and 0.68 in wet and dry years, respectively.".

8. Page 347, Line 21-24: This last sentence is not clear enough (dry surface conditions vs soil water availability...?); should be rephrased to make it clearer. Reply: Thanks for this review comment. We have revised the statement as "In general, the dry climate dominated the poplar plantation ecosystem regardless of soil water availability suggesting that fast-growing and water use-intensive species like poplar plantations are poorly suited for the water limited region".

9. Page 348, Line 14: I suggest using "increased" rather than "a growing". Reply: Corrected.

10. Page 349, Line 24-25: I suggest using "resistance" throughout the paper rather than "conductance" to keep consistent with equations and maintain clarity. An advantage of conductance is that tends to be proportional to LE, whereas resistance is very nonlinear with LE, e.g., you get a wide range of high Rs values that correspond to low values of LE. Reply: Thanks a lot, corrected parts as followed: Page 349, Line 4, change "lower canopy conductance" to "higher canopy resistance"; Page 349, Line 24, change "conductance" to "resistance"; Page 355, Line 10, change "conductance" to "resistance"; Page 361, Line 14, change "conductance" to "resistance".

11. Page 350, Line 23: Is the wind coming from OR going toward "the southern and northwest directions". Usually wind is described in terms of which direction it is coming from. Reply: Sorry for the inappropriate expression. We have revised the statement as "and it mostly comes from southeast (during growing season) and northwest (during non-growing season)."

12. Page 352, Lines 7-8: It should be indicated at which depths the CS616 probes are placed. Were they all placed at 50 cm? Reply: Thanks for raising this question. The CS616 probes were placed at 20cm and 50cm depth. We have corrected the statement in BGD Line7-8, Page 352 as "Soil water content was measured with TDR

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sensors (CS616; CSI) buried at 20 and 50 cm."

13. Page 354, Line 6: Gu et al. (1999) does not present the energy balance ratio in summation notation as you do in Eq (3). If the summation notation is kept, the interval over which the summation is calculated should be specified. 24 hr, half-hourly, etc. Reply: You are right that the paper of Gu et al. (1999) that did not make this statement and we are sorry for this mistake. We have revised Equation (3) and corrected the content in BGD Page 354, Line 5 as "Based on the daytime half-hourly and daytime totals of turbulent energy fluxes, the energy balance ratio (EBR) is calculated as Eq. (3):".

14. Page 355, Line 16: "Equilibrium" should not be capitalized. Reply: Corrected.

15. Page 357, Lines 2-4: "Long-term drought stress (REW< 0.4) occurred during period in late growing season of 2006 and 2009, in spring in 2007 and 2009, but not at all in 2008 (Fig. 2a–d)." would read better as "Long-term drought stress (REW< 0.4) occurred during periods in the late growing season of 2006 and 2009, the spring of 2007 and 2009, but not at all in 2008 (Fig. 2a–d). Reply: Thanks a lot. We have revised this sentence to "Seasonal drought stress (REW< 0.4) occurred during periods in the late growing season of 2006 and 2009, the spring of 2007 and 2009, but not at all in 2008 (Fig. 2a–d)."

16. Page 357, Line 9: The drought stress periods for 2007 should be introduced in a consistent manner, formatted as they were in on Page: 357 Line: 7 for 2006 (#2_06). Reply: Thanks for this review comment. We have corrected the statement as "drought stress occurred during DOY 110-143 (#1_07) and DOY 151-200 (#2_07).".

17. Page 358, Line 18-19: I don't think H can be a dominant factor controlling Rn. Explain. Reply: You're right. We are sorry for inappropriate expression. We have corrected the text as "H became the main consumer of the growing season Rn in October for dry years and in November for the wet years.".

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18. Page 358, Line 21-22: “LE/(Rn - G) was significantly higher in 2008 (64.8 %) than in 2006 (57.1 %), 2007 (60.3 %) and 2009 (50.4 %)”. These aren’t really large differences. Reply: Yes, the magnitudes of these seasonal average LE/(Rn-G) look similar to each other. On the basis of ANOVA, LE/(Rn-G) in 2006 was not significantly lower than that in 2007 and 2008 ($p > 0.254$), LE/(Rn-G) in 2008 was significantly higher than that in 2007 and 2009 ($p < 0.031$), LE/(Rn-G) in 2009 was smallest among four years ($p < 0.001$); but there was a significant difference between dry and wet year, with $F=17.599$, $p < 0.001$. We have revised the text as “Partitioning of Rn into LE and H differed significantly between the wet and dry years ($F = 17.599$, $p < 0.001$).” (in BGD Page 358, Line 22-23).

19. Page 358, Lines 25-27: “The dominant part in energy partitioning” should be changed to “The dominant turbulent energy flux” throughout the paper. Reply: Thanks for this comment. Changed.

20. Page 358, Line 27: “dominate” should be “dominant”. Reply: Sorry for the mistake. Corrected.

21. Page 360, Line 4: “Difference” should be “differences” and “year” should be “years”. Reply: Thanks for your careful reading. Corrected.

22. Page 360, Line 14: “dramatic” should be “dramatically”. Reply: Thanks for your patience for ensuring the publication quality. We assume that the referee means the “dramatic” in Line 18, Page 360. Correct it to “much”.

23. Page 360, Line 4: The sentence “Drought is also an expected source of inter-annual variation in Rs (Wilson et al., 2002b).” seems redundant and should probably be removed given you make this apparent in previous sentences. Reply: Thanks for your suggestion. We think that the referee refers to BGD Page 363, Line 16. We have deleted the text “Drought is also an expected source of interannual variation in Rs (Wilson et al., 2002b).”

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24. Page 360, Line 14: “The mean Ω for the studied years were 0.41, 0.46, 0.43 and 0.39”. The magnitudes of these numbers are very similar. Reply: Thanks a lot. Yes, the magnitudes of these seasonal mean decoupling coefficient (Ω) look similar to each other. But on the basis of ANOVA, the significant differences were only showed between 2007 (0.46) and 2009 (0.39) among four years ($p < 0.01$), but there was a significant difference between dry and wet year, with $F=9.460$, $p=0.002$. We have revised “($p < 0.01$)” (in BGD Page 360, Line 16) as “($F=9.460$, $p < 0.01$)”.

25. Page 360, Line 17-18: The drought periods within the brackets (#1, #2, etc.) should be consistent with the format in which they were introduced on page 357. Reply: Thanks for your patience. We have corrected the expression as “(#1_06, #2_06; #1_07, #2_07 and #1_09, #2_09, #3_09)”.

26. Line 362, Line 16-19: “Our current findings corroborate that hypothesis.” But you report you observed low rates of evapotranspiration (LE) on Page 364, Line 17. Regarding the statement “Growing poplar trees by irrigation in a water stress region is not sustainable, and the productivity of the plantation was water-limited even during the wetter years, as indicated by the resistance terms.” What is your evidence of that productivity was limited by water supply? Why would there be an adverse regional region’s groundwater reserves if evapotranspiration is low? Reply: Sorry for the confusions. We agree that we could not reach this conclusion based on the results from energy partitioning, therefore, we have revised the text in BGD Page 362 Line 16-19, as “Our current findings corroborate the hypothesis that drought would trigger significant changes in energy partitioning of water-demanding poplar species in a water-stressed region.”; “Why would there be an adverse regional region’s groundwater reserves if evapotranspiration is low?”—- To maintain the ecological function of poplar plantation, the low evapotranspiration due to soil water limitation lead to irrigation in this water shortage region by pumping groundwater, which would intensify the water shortage in the water limited regions.

27. Page 362, Line 22: quantifies? Reply: Thanks for careful reading and sorry for the

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mistake. Corrected “qualifies” to “quantifies”.

28. Page 365, Lines 2-4: Delete sentence. It is unnecessary. Reply: Thanks for your suggestion. Corrected.

29. Page 365, Line 6: I think they are really seasonal drought periods rather than long-term drought periods. Reply: Thanks for this revise comment. We have revised the statement “long-term drought periods” as “seasonal drought periods” throughout the manuscript. See corrections in the following sentences in BGD, Page 357, Line 2, 6; Page 359, Line 11, 19; Page 360, Line 17; Page 362, Line 5, 9; Page 363, Line 6; Page 364, Line 23; Page 365, Line 6.

30. Page 365, Lines 18-21: See General Comment 5. Reply: See reply for General comment 5

31. Page 379, Fig. 1: Insert “respectively” after “brace”. Reply: Corrected.

32. Page 380, Fig. 2: Were the soil moisture sensors installed at a location that received all irrigations? I see only a small effect of the 30 mm irrigation on DOY 290 in 2006. Is that because the moisture sensors are so deep? Reply: Thanks for raising this question. As we stated earlier in Reply of General Comment 3(Referee #2), the management operations were not well documented, the irrigation of the plantation was applied by workers in Daxing Forest Farm according to their personal experience, and the irrigation was only applied for young plantation, and some of young plantation was apart from the location of soil moisture sensors. Therefore, the small effect of the 30 mm irrigation on DOY 290 in 2006 may be caused by the irrigation for the young plantation which was relatively close to the sensors location.

33. Page 381, Fig. 3: Plotting 5-day running means or weekly numbers will likely show clear distinctions among years by reducing crowding. Reply: Corrected (see Figure 3).

34. Page 382, Fig. 4: Renumber the y axis with the inclusion of “0”. I’d suggest -2, 0, 2, 4, 6, and 8. Reply: Corrected (see Figure 4).

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35. Page 383, Fig. 5: 5-day means or running means would make the 4 years more distinguishable from each other. Reply: Corrected (see Figure 5) .

36. Page 384, Fig. 6: This figure is virtually the same as Fig. 9b. Delete Fig. 6 or Fig. 9b. Reply: Thanks for this comment, we have deleted Fig.9b. Corrected Fig.9 as follow: (see Figure 9).

37. Page 386, Fig. 8: Unexpected values for the Bowen ratio and LE/(Rn – G) for WS < 50 mm. Specify for what depth of the root zone does the 50 mm apply (1 m depth?). How is WS calculated when the sensors are all at 50 cm depth? Reply: Thanks for raising this question and sorry for the confusion. As we displayed at Table 3(in BGD Page 377), the amount of water supply (WS) during each drought stressed and non-stressed periods was calculated as the sum of precipitation and irrigation. The 50mm of WS was not related to the depth of sensors location.

38. Page 388, Fig. 10: It can be shown that the data can be separated (stratified) into increasing values of Ri with higher values for dry years. Reply: Thanks for suggestion. We are not sure that we really follow the referee's advices. Accordingly, we have added the content in BGD Page 363, Line 28-29, as "during which the sensitivity of Bowen ratio on Rs increased with the growing Rs.".

Author changes in manuscript, except for replys on each comment of C161: 1. Page 347, in BGD, revised "S. McNulty" to "S. G. McNulty"; and corrected "Eastern Forest Environmental Threat Center" to "Eastern Forest Environmental Threat Assessment Center";

2. Page 347, Line 1-24 in BGD: the Abstract has been revised as "Poplar (Populus sp.) plantations have been used broadly for combating desertification, urban greening, and paper and wood production in northern China. However, given the high water use by the species and the regional dry climate, the sustainability of these plantations needs to be evaluated. Currently, the understanding of the acclimation of the species to the semiarid environment is limited, impeding assessments of their long-term success and

impact on the environment. In this study we examine the variability of bulk resistance parameters and energy partitioning over a four-year period encompassing both dry and wet conditions in a poplar (Populus euramericana CV. “74/76”) plantation located in northern China. The partitioning of available energy to latent heat (LE) decreased from 0.62 to 0.53 under meteorological drought. A concomitant increase in sensible heat (H) resulted in the increase of a Bowen ratio from 0.83 to 1.57.Partial correlation analysis indicated that surface resistance (Rs) normalized by leaf area index (LAI) (i.e., Rs:LAI) increased by 50% and became the dominant factor controlling the Bowen ratio. Furthermore, Rs was the major factor controlling LE during the growing season, even in wet years, as indicated by the decoupling coefficient (Ω =0.45 and 0.39 in wet and dry years, respectively) and the LE/LEeq ratio ranging from 0.81 and 0.68 in wet and dry years, respectively. In general, the dry climate dominated the poplar plantation ecosystem regardless of soil water availability suggesting that fast-growing and water use-intensive species like poplar plantations are poorly suited for the water limited region. The required irrigation for sustaining these forests also presents a thread to the adjacent ecosystems because of their role in reducing ground water table, and may compromise long-term sustainability and livelihoods in the region.”;

3. Page 348, Line 11-13 in BGD: revised the content as “However, indiscriminate use of the same species beyond its native range and habitats may result in unanticipated consequences. For example, the use of poplars in water limited regions may increase the risk of environmental degradation, soil moisture deficit, hydrologic and vegetation changes”.

4. Page 350 in BGD, Line 8 and 9: change “removed and replanted” to “replaced with new saplings”, and change “given” to “provided”; Line 11-13: change the sentence to “The average leaf area (LAI) of the stand increased over time. During the growing season, shrubs as the understory layer were low at density due to manual removal.”; Line 16-21: change sentences to “The local climate is classified as sub-humid warm temperate zone, with a mean (1990–2009) annual temperature of 11.6°C, and maxi-

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mum and minimum temperature are 40.6 °C and -27.4 °C, respectively. The annual precipitation ranges from 262 mm to 1058 mm (1952-2000), with an average of 556 mm, of which 60%-70%"; Line 24-26: change "belong to" to "is on", add "the" before "Yongding River", remove "with";

5. Page 351 in BGD, Line 2: change "average annual depth of 16.5 m below ground" to "annual average of 16.5 m below the ground" Line 12 to 13: change "at the 32 m central instrument tower" to "at a 32 m tower"; Line 16: change "measured using the eddy-covariance" to "calculated based on the eddy-covariance (EC)"; Line 17: correct "eddy-covariance" to "EC"; Line 22 to 24: revise sentences "To sure that . . .in February." to "This was increased to about 18 m before the start of the growing season in 2007, and again to 20 m in February 2009 to ensure that the sensors remained well above the tree canopy"

6. Page 352 in BGD, Line 3: remove "with sampling points"; Line 5: remove "above the ground"; Line 14: revise the sentence to "The raw 10Hz data were processed with an EC Processor,"; Line 15: correct "eddy covariance" to "EC"; Line 17: add "the" before "planar fit method"; Line 22-23: Delete sentence "Data gaps were filled using the MDV (mean diurnal variation) method (Falge et al., 2001).", which duplicated with Page 352, Line 28 in BGD;

7. Page 353 in BGD, Line 3: remove "the"; Line 10: revise "much stonger" to "strong"; Line 13: revise "PAR > 4 umol m-2 s-1, the controlling processes" to "PAR > 4 μmol m-2 s-1. The regulations"; Line 14: correct "and" to ", with", and delete "are"; Line 15: change "reliable than" to "station than those"; Line 22: change ":" to ","

8. Page 354 in BGD, Line 1: revise "As an indicator of water stress, the" to "The"; Line 3: change "the midday" to ". The midday"; Line 6-7: add the equation for calculating the heat storage term as Eq. (4) Line 8: change ":" to ","; Line 9: change "(4)" to "(5)"; Line 14: revise "Ri, the climatological resistance (s m-1) indicates" to "Ri is the climatological resistance (s m-1) indicating"; Line 15: change "in Eq. (5):" to "as," ; Line

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16: change “(5)” to “(6)”;

9. Page 355 in BGD, Line 4: change “:” to “,”; Line 5: change “(6)” to “(7)”; Line 6: revise “transfer and rb” to “transfer, and rb is”; Line 14: change “:” to “,”; Line 15: change “(4)” to “(5)”; Line 17: revise “it is calculated as:” to “is dependent only on Rn and temperature. It is calculated as,”; Line 19-21: delete the sentences “The LEeq is dependent only on . . ., respectively (Wilson et al., 2002b)”;

10. Page 356 in BGD, Line 1: revise “can denote” to “reflects”; Line 3-7: revise to “An LE/LEeq of < 1 represents an ecosystem under water stress and, therefore, experiences reductions in evapotranspiration; whereas LE/LEeq of > 1.26 indicates an ecosystem of unrestricted water supply and only available energy limits evaporation (Arain et al., 2003). The LE/LEeq is dependent on”; Line 12-13: revise “to compare the environmental factors, the energy fluxes and” to “for quantifying the changes of all biophysical variables, energy fluxes, and”; Line 14: change “different studies” to “the differences of biophysical variables among different studies.” Line 15-16: revise “Bowen ratio values with the other two as the control variables” to “Bowen ratios”; Line 21: delete “the”; Line 22-23: revise the sentence “Whereas in 2007 and 2008 rainfall exceeded the 20 year mean by over 100 mm” to “Whereas rainfall exceeded the 20-year mean by over 100 mm in 2007 and 2008.”; Line 24: revise “the growing season (i.e., April-October)” to “April-October,”;

11. Page 357 in BGD, Line 8: insert “throughout the year” after “distributed”; Line 10: correct “accounted for 57 mm of the total annual precipitation” to “(57 mm)”; Line 11-12: revise “(P > 25 mm d-1) in July also presented a large portion of the total annual sum.” To “(i.e., > 25 mm d-1) in July were recorded.”; Line 13: correct “and” to “of which”; Line 13-17: revise the sentences “, mostly . . . of the sandy soil” to “. There were several short droughts across the growing season of 2009 (Fig. 2d). Despite the higher-than normal rainfall in the two wet years. there was no flooding or overland runoff.”; Line 18: correct “The Ta” to “The growing season Ta”, and delete “during growing season”; Line 21: delete “overall”; Line 23: change “reached” to “was”; Line 24: revise “Mean”

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to “The mean”; Line 27: add “those” behind “than”;

12. Page 358 in BGD, Line 1-2: revise the sentence “the VPD of . . . (i.e., $p < 0.01$).” to “the VPD was the highest in June 2009 (i.e., 2.3 ± 1.1 kPa, $p < 0.05$) and the lowest in 2008 (i.e., 1.0 ± 0.5 kPa, $p < 0.01$).”; Line 4: change “Seasonal and inter-annual” to “The”; Line 7: delete “at”, revise “and” to “, ”, and remove “then”; Line 10: revise “On the other hand, even though the” to “The”; Line 11: change “between” to “among”; Line 12: revise “the value of wet years was lower than” to “with a lower value in wet years”; Line 13: change “Also” to “Additionally”; Line 13-14: revise “which ranged from 2.1 (in 2007) to 4.9% (in 2006)” to “which ranged from 2.1 in 2007 to 4.9% in 2006” Line 17: correct “except in August for the year of” to “but August for”; Line 20: add “the” before “four years”; Line 21: add “those” before “in 2006”; Line 22: revise “in the other” to “those in other”; Line 27: correct “during which” to “when”;

13. Page 359 in BGD, Line 1: delete “even”; Line 4-5: revise “(from April to June) and end (from September to October)” to “(April-June) and end (September-October)”; Line 7: revise “DOY 180 to 250” to “DOY 180-250”, and change “DOY 180 to 290” to “DOY 180-290”; Line 8: change “wet year” to “the wet year”; Line 11-12: revise “The Bowen ratio . . . in 2008” to “The Bowen ratio was smaller than 1 during drought stressed periods in 2008”; Line 16: change “(DOY: from 190 to 250)” to “(DOY 190-250)”; Line 20: correct “in the no stressed” to “those in unstressed”; Line 21: add “a” before “significantly”; Line 22: change “wet year” to “wet years”; Line 23: revise “July and August, before” to “July/August before”; Line 24: insert “a” before “mean value”; Line 26: change “between” to “among the”, and revise “depicts” to “presents”;

14. Page 360 in BGD, Line 3: correct “during” to “that of”, and change “than in dry year” to “than that in dry years”; Line 6: revise the sentence to “The changes of LE/LEeq value varied between 0.4 and 1.0”; Line 7: change “of four years” to “of the four years”; Line 10: correct “was” to “were”; Line 11: revise “was observed” to “existed”; Line 14: change “the studied years were” to “the four years was”; Line 16: revise “than in dry year” to “than that in dry year”; correct “non-stressed” to “unstressed”; Line 18:

change “show” to “was”; Line 21: change “one” to “a”, and correct “eddy covariance” to “EC techniques”; Line 22-24: change “0.85” to “0.88”; correct “over 0.95” to “> 0.96”; change “daily” to “daytime”, and correct “value” to “values” ; Line 26: change “with 50 site-year” to “with the 50 site-year”;

15. Page 361 in BGD, Line 1-2: delete the sentence “It should be . . . additional measurements.”; Line 4: correct “between” to “among the”; Line 5-6: revise the sentence “At our site. . .energy balance closure” to “In addition to the known reasons for decreasing energy balance closure”; Line 7-8: revise the sentence “management operations . . . partial felling,” to “management operations at our site (e.g., irrigation, tilling and partial felling)”; Line 10-11: delete the sentence “to the extent that . . . turbulent flux data,” Line 16: delete “and”; Line 19: revise “even at specific forest site” to “by even at any site”; Line 21: revise “was” to “were”; Line 23-25: correct “avaiability” to “availability”; change “timescale” to “scale”, correct “was” to “appeared”, correct “precipitation amount of growing season” to “growing season precipitation”; Line 28-29 in BGD: revised the sentence “β during the most of growing season in 2008 and non-stressed periods in other 3 years varied from 0.18 to 0.71, with a mean of 0.35 $\pm$ 0.15,” as “β varied from 0.18 to 0.71, with a mean of 0.35 $\pm$ 0.15 during the most of growing season in 2008 and non-stressed periods in other 3 years,”;

16. Page 362 in BGD, Line 1-2: correct “in a deciduous forest” to “for a deciduous forest”, change “. Similar to” to “, similar to”; and delete “of Bowen ratio”; Line 3: correct “in a deciduous” to “a deciduous”; Line 7, 9: change “Loblolly” to “loblolly”, and change “resulted” to “might be resulted”; Line 21: change “dependent on” to “dependent of”; Line 25: correct “exchange of ecosystem” to “exchange of an ecosystem”;

17. Page 363 in BGD, Line 3-5: correct the sentence “similar to Kutsch et al. (2008), Rs varied seasonally with plant phenology, and showed similar seasonal characteristics with the other deciduous forests during the course of the growing season (Cabral et al., 2010; Li et al., 2012)” to “similar to Rs varied seasonally with plant phenology, and showed similar seasonal characteristics with the other deciduous forests during the

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course of the growing season (Cabral et al., 2010; Kutsch et al. 2008; Li et al., 2012)"; Line 6-7: revise "were much higher than in" to "was much higher than that in"; Line 19-20: revise "impacted" to "also influenced"; and change "(soil evaporation, canopy structure and turbulence)" to "(e.g., soil evaporation, canopy structure and turbulence)"; Line 22: change "over 50%" to "$\sim$ 50%"; Line 23: change "for a vineyard" to "in a vineyard"; change "due to" to "likely due to"; Line 25: revise "timescale" to "scale";

18. Page 364 in BGD, Line 1: revise "not" to "not be"; Line 2: change "(such as. . .)" to "(e.g.,...)"; Line 3: change "factors" to "roles", and revise "were" to "was"' Line 4: correct "than in wet years" to "than that in wet years"; Line 5: revise the sentence "but no impact . . . in earlier studies." to "but not in dry years."; Line 6: change "in this site, similar to" to "at our site, which is"; Line 8: delete the sentence "which ranged from 0.58 to 1.06"; Line 9: change "(ranging from 0.39 to 0.46)" to "(0.39-0.46)"; Line 15: delete "universal"; Line 20: revise "coefficient" to "coefficients";

19. Page 365 in BGD, Line 24: insert text "First author also thanks the scholarship support by Beijing Municipality Educational Committee under the graduate student training program."

20. Page 376 in BGD: revised Table 2. (see in supplyment)

21. Page 380 in BGD: revise the Figure 2, revise the caption to "Figure 2. The seasonal variation of environmental conditions during 2006–2009, (a–d): the relative extractable water (REW) (drought periods longer than 20 days are shaded), daily sum of precipitation (P); (e-h): daytime mean air temperature (Ta), daytime mean air vapor deficit (VPD)";

22. Page 381 in BGD: revise the Figure 3, and correct the caption to "Figure 3. Seasonal patterns of daytime energy components (5-day running average) during the growing season from 2006 to 2009, including net radiation (Rn), latent heat (LE), sensible heat (H) and soil heat flux (G) and heat storage term (S).";

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23. Page 382 in BGD: revise the Figure 4, and correct the caption to "Figure 4. Seasonal and inter-annual variability of the midday mean Bowen ratio (β) (5-day running average) across the growing season, with detailed β between DOY 185 and 255 representing in small pane; Midday means the time course from 10:00 am to 15:00 pm at local standard time";

24. Page 383 in BGD: revise the Figure 5, and correct the caption to "Figure 5. Seasonal dynamics of the midday mean surface resistance (Rs), climatological resistance (Ri), aerodynamic resistance (Ra), LE/LEeq and decoupling coefficient (Ω) (5-day running average) across the growing season from 2006 to 2009. Midday means the time course from 10:00 a.m. to 15:00 p.m. LST."

25. Page 387 in BGD: revise the Figure 9, and correct the caption to "Figure 9. Seasonal variations of monthly average LAI and Rs during the growing season in wet year 2007 and 2008." Reference: Chen, R., Kang, E., Zhang, Z., Zhao, W., Song, K., Zhang, J., and Lan, Y.: Estimation of tree transpiration and response of tree conductance to meteorological variables in desert-oasis system of Northwest China, Science in China Series D: Earth Sciences, 47, 9-20, 2004. China, S. A. o. t. P. s. R. o.: Classification of meteorological drought. In: National Standard of People's Republic of China GB/T 20481-2006, China Standard Press, Beijing, 2006. Ding, Y. H., Ren, G. Y., Zhao, Z. C., Xu, Y., Luo, Y., Li, Q. P., and Zhang, J.: Detection, causes and projection of climate change over China: An overview of recent progress, Adv Atmos Sci, 24, 954-971, 2007. Guo, H. Q., Zhao, B., Chen, J. Q., Yan, Y. E., Li, B., and Chen, J. K.: Seasonal Changes of Energy Fluxes in an Estuarine Wetland of Shanghai, China, Chinese Geogr Sci, 20, 23-29, 2010. Jamiyansharav, K., Ojima, D., Pielke, R. A., Parton, W., Morgan, J., Beltrán-Przekurat, A., LeCain, D., and Smith, D.: Seasonal and interannual variability in surface energy partitioning and vegetation cover with grazing at shortgrass steppe, J Arid Environ, 75, 360-370, 2011. Kim, H.-S., Oren, R., and Hinckley, T. M.: Actual and potential transpiration and carbon assimilation in an irrigated poplar plantation, Tree Physiol, 28, 559-577, 2008. Li, Y., Qin, H., Xie, Y., Wang,

BGD
12, C1262–C1290, 2015

W., Chen, X., and Zhang, C.: Physiological mechanism for the reduction in soil water in poplar (Populus deltoides) plantations in Dongting Lake wetlands, Wetl Ecol Manag, 22, 25-33, 2014. Migliavacca, M., Meroni, M., Manca, G., Matteucci, G., Montagnani, L., Grassi, G., Zenone, T., Teobaldelli, M., Goded, I., Colombo, R., and Seufert, G.: Seasonal and interannual patterns of carbon and water fluxes of a poplar plantation under peculiar eco-climatic conditions, Agr Forest Meteorol, 149, 1460-1476, 2009. Qiu, G., Yin, J., and Geng, S.: Impact of Climate and Land-Use Changes on Water Security for Agriculture in Northern China, Journal of Integrative Agriculture, 11, 144-150, 2012. Richardson, B., Skinner, M. F., and West, G.: The role of forest productivity in defining the sustainability of plantation forests in New Zealand, Forest Ecol Manag, 122, 125-137, 1999. Stanturf, J. A. and Oosten, C. v.: Operational Poplar and Willow Culture. In: Poplars and willows: trees for society and the environment, Isebrands, J. G. and Richardson, J. (Eds.), The Food and Agriculture Organization of the United Nations and CABI, Available from: http://www.fao.org/forestry/ipc/69946@158687/en/, 2014. Sun, G., Noormets, A., Gavazzi, M., McNulty, S., Chen, J., Domec, J.-C., King, J., Amatya, D., and Skaggs, R.: Energy and water balance of two contrasting loblolly pine plantations on the lower coastal plain of North Carolina, USA, Forest Ecol Manag, 259, 1299-1310, 2010. Takagi, K., Kimura, R., and Şaylan, L.: Variability of surface characteristics and energy flux patterns of sunn hemp (Crotalaria juncea L.) under well-watered conditions, Theor Appl Climatol, 96, 261-273, 2009. Wang, E., Yu, Q., Wu, D., and Xia, J.: Climate, agricultural production and hydrological balance in the North China Plain, Int J Climatol, 28, 1959-1970, 2008. Watt, M. S., Coker, G., Clinton, P. W., Davis, M. R., Parfitt, R., Simcock, R., Garrett, L., Payn, T., Richardson, B., and Dunningham, A.: Defining sustainability of plantation forests through identification of site quality indicators influencing productivityâĂŤA national view for New Zealand, Forest Ecol Manag, 216, 51-63, 2005. Wu, J. B., Guan, D. X., Han, S. J., Shi, T. L., Jin, C. J., Pell, T. F., and Yu, G. R.: Energy budget above a temperate mixed forest in north-eastern China, Hydrol Process, 21, 2425-2434, 2007. Zhang, Y., Zhang, Z., Sun, G., Fang, X., Zha, T., Noormets, A., McNulty, S., Chen, J., Liu, c., and Chen, L.: Water Bal-

ances of a Poplar Plantation Forest in Suburban Beijing, China In: J Environ Manage, 2014. Zhou, J., Zhang, Z., Sun, G., Fang, X., Zha, T., McNulty, S., Chen, J., Jin, Y., and Noormets, A.: Response of ecosystem carbon fluxes to drought events in a poplar plantation in Northern China, Forest Ecol Manag, 300, 33-42, 2013. Zhu, G., Lu, L., Su, Y., Wang, X., Cui, X., Ma, J., He, J., Zhang, K., and Li, C.: Energy flux partitioning and evapotranspiration in a sub-alpine spruce forest ecosystem, Hydrol Process, 28, 5093-5104, 2014.

Interactive comment on Biogeosciences Discuss., 12, 345, 2015.

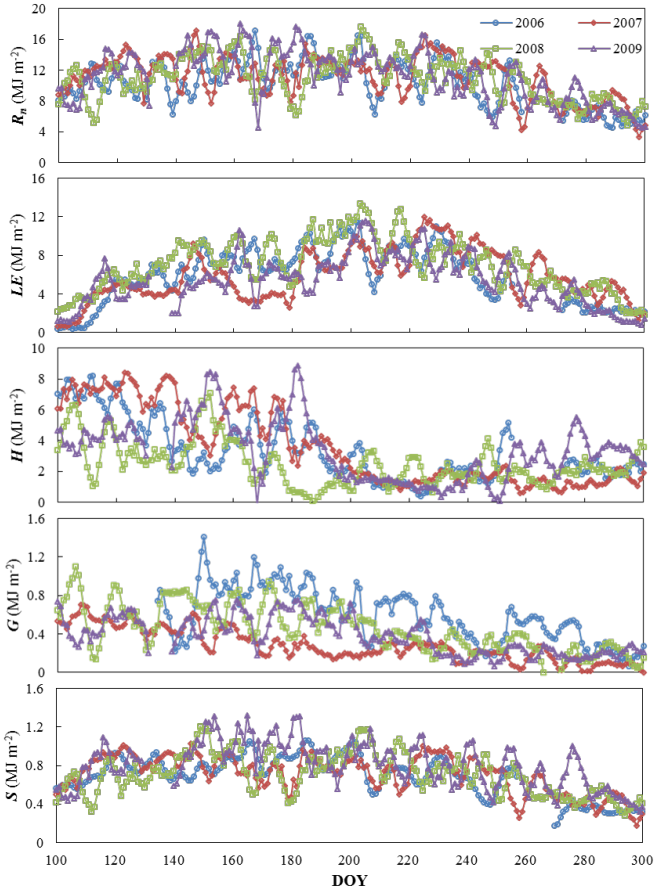

Fig. 1. Figure 3

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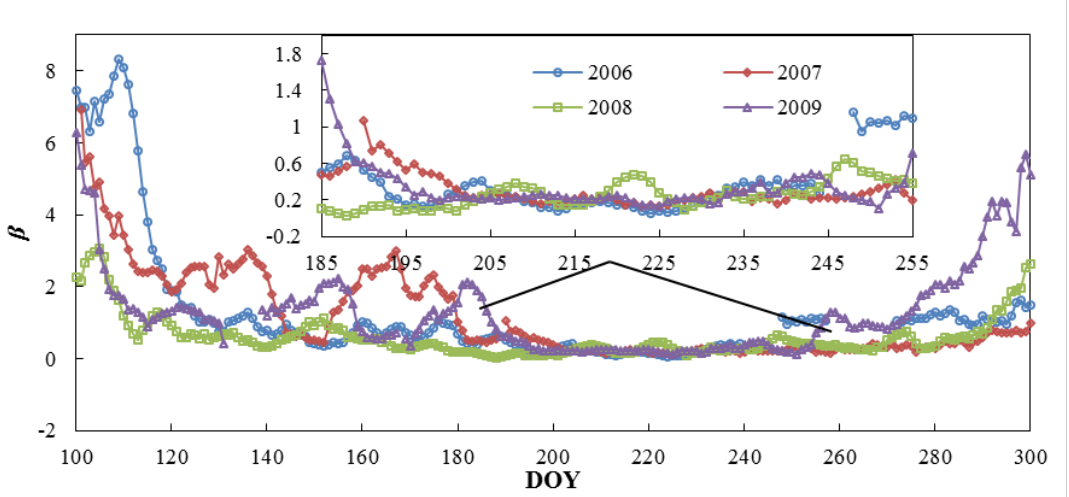

Fig. 2. Figure 4

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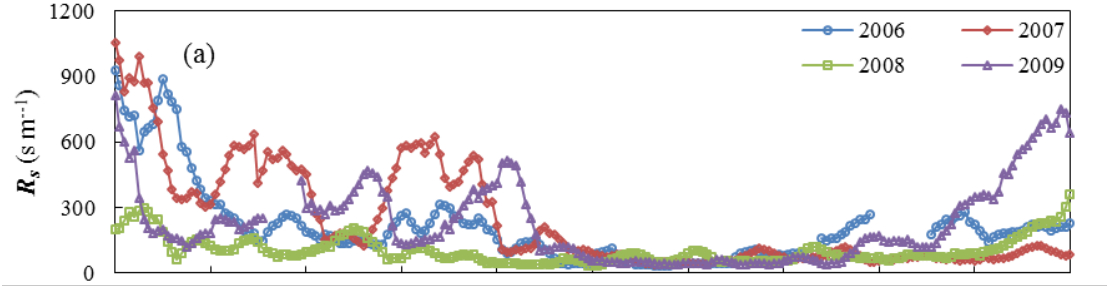

Fig. 3. Figure 5a

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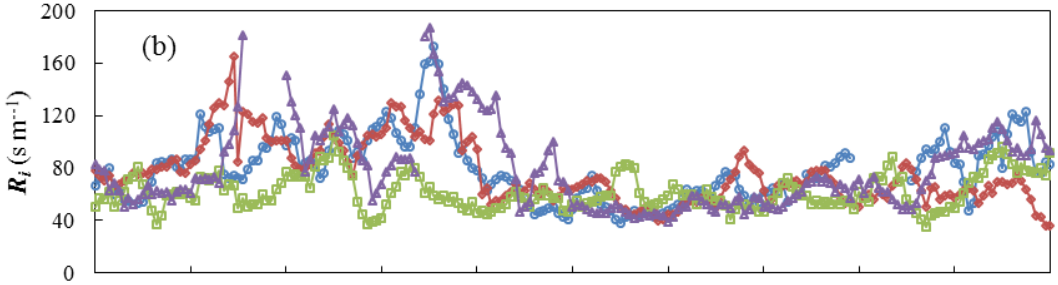

Fig. 4. Figure 5b

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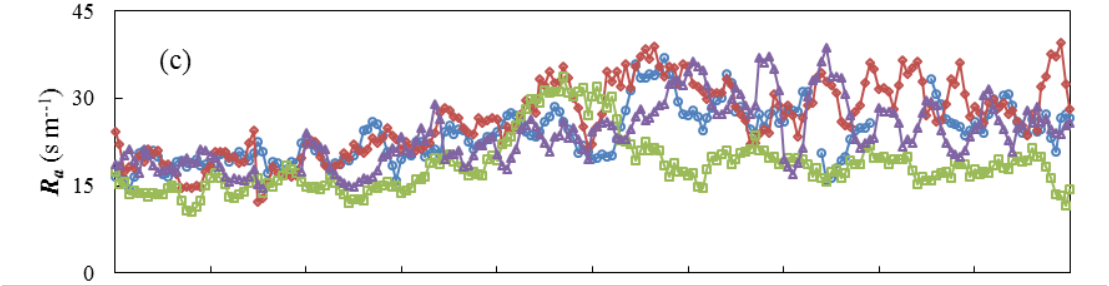

Fig. 5. Figure 5c

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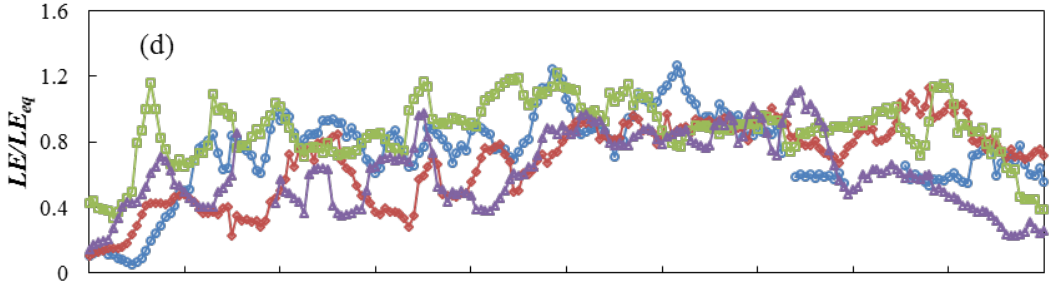

Fig. 6. Figure 5d

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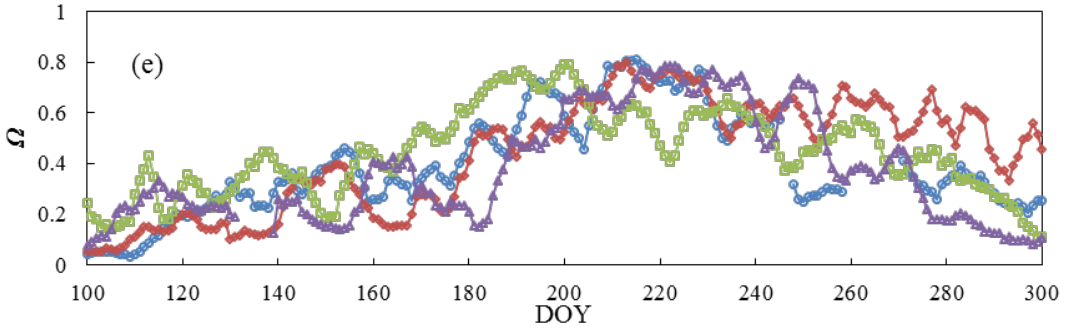

Fig. 7. Figure 5e

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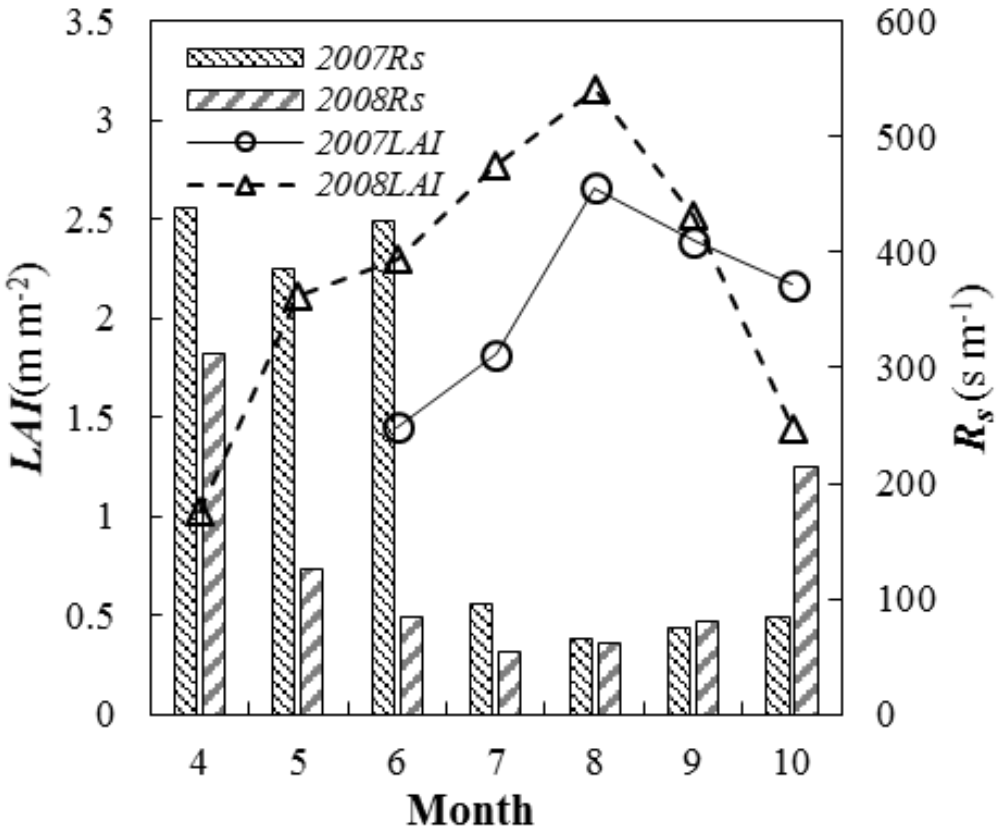

Fig. 8. Figure 9

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