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Interactive comment on "Biophysical controls on net ecosystem CO_2 exchange over a semiarid shrubland in northwest China" *by* X. Jia et al.

X. Jia et al.

tianshanzha@bjfu.edu.cn

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Thank you for providing helpful comments. The authors have made revisions and clarifications to the manuscript in light of your suggestions. The response to each of your comments is detailed below.

1. An arbitrary approach in used to separate the environmental factor into different levels, for example, soil water content > 0.1 or <0.1 m3 m-3, is there any valid bases to justify this? Similarly, for vapor pressure, and so on.

RE: We have clarified the bases for selecting such threshold values in the revised manuscript. These threshold values were not arbitrarily chosen. In data analysis, we explored a range of values for a given environmental factor (VPD, soil water content or

air temperature), and finally selected the values to most clearly show the differences between levels. Secondly, we tried to choose the threshold values which could avoid having too few data points in a certain group. Thirdly, the selected threshold values were equal or close to those used by previous studies in dryland areas, so that our results can be easily compared with other studies.

2. In data processing, 29% of the data has been determined as bad data and excluded and gap-filled. Although you have used approaches to linearly gap-fill the small gaps with but NEE-PAR relation for a large gaps (e.g., gaps lasting for a few days), a gapfilling with consideration of solar radiation may be too coarse as described in Xing et al (Ecological modeling, 2007, 2008). In addition, you have also found "at the half-hourly scale, water stress exerted a major control over daytime NEE, and interacted with heat stress and photoinhibation in constraining C fixation by the vegetaion". How can you justify your approach to fill gaps.

RE: We clarified the gap-filling method in the revised manuscript. Firstly, although 29% of the annual dataset was missing/rejected and filled with estimated values, 87% of all the gaps occurred during nighttime. Similar to many previous studies, the low turbulent mixing at calm nights rejected a large proportion of nighttime fluxes. As a result, only 7% of all daytime data needed to be gap-filled in order to obtaining annual sums of carbon fluxes, compared to a proportion of 52% at nighttime. In fact, there was only one gap longer than 24 h in 2012 (4-12 May). Therefore, using a simple NEE-PAR relationship for filling daytime gaps would not have caused a large bias in estimating annual sums of carbon fluxes (although it might be too coarse when modeling NEE dynamics at the hourly scale). Secondly, we did not apply a single parameterization of the NEE-PAR relationship to the entire growing season, but rather fit the light response function to consecutive windows of 500 non-missing daytime data points to obtain seasonally-varying parameter values. The seasonality of the parameter values could reflect the ensemble effects of confounding factors on daytime NEE, including soil water content, VPD, air temperature and leaf area index. Thirdly, many previous eddy-covariance

studies have used non-linear regression (NLR) gap-filling methods very similar to that in the present study, although many other kinds of techniques exist (for a comprehensive review see Moffat et al., 2007). Most of the NLR methods also applied the light response curve to consecutive time intervals to (empirically and implicitly) incorporate the effects of confounding factors.

3. In your examination of rain pulse, you illustrated a period of 61 mm rainfall event (Day 178-184). Although there is no clue how long the event lasted but I am pretty sure that figure 9 is providing other information as well. If you look at the panel a in the figure, there are other small rainfall events as well but their NEE do not show a significant responses to the rainfall events as the largest rainfall event, in particular the event around Day 210. Therefore, a further explanation may be useful. By the way, I would suggest to add rainfall data to panel b so that reader can clearly see the delay of 1-2 day described in your paper. In addition, the figure can be enlarged at the x direction to see a clear trend.

RE: We agree with the referee and have added the following passage in the revised manuscript: "It is worthy of note that not all rain events caused an equal response of NEE (Fig. 9a). For example, NEE seemed relatively insensitive to a smaller rain event on DOY 202 (31 mm). This may be due to other biophysical factors that confound the NEE responses to sudden increases in water availability (Chen et al., 2009). Both temperature and radiation were much less affected over the DOY 202 rain event (data not shown) than over the DOY 179-180 event (61 mm, Fig. 9b and c), which could partially explain the result that the DOY 202 rain event did not cause a large fluctuation in NEE. The behavior of NEE over a rain event also depends on the size and timing of water pulse, the environmental conditions prior to the rain, plant phenology, functional type and rooting depth, all of which affect the rainfall-response of NEE (Aires et al., 2008; Liu et al., 2011; Gao et al., 2012).". We also revised Fig. 9 according to the referee's suggestions. However, we did not add rainfall data to panel b because rainfall was measured with a manual rain bucket before DOY 204, and with a tipping bucket

rain gauge thereafter. Therefore, only daily rainfall data were available for the selected rain event (DOY 179-180). We added the daily rainfall values on figure 9, and also added a shadow pattern on the two rainy days so that the responses of NEE to the rain event could be clearer to reader.

4. The abbreviation PPT during growing season is not accurate. I would use term rainfall instead.

RE: We agree with the referee and have made revisions accordingly.

5. Line 17 on page 5092, Mu Us desert, not clear to me.

RE: The "Mu Us desert" is also referred to as the "Mu Us sandland", which is located in northern China. The northern edge of the Mu Us desert touches the Ordos Plateau, Inner Mongolia and the southern edge boarders on the Loess Plateau. Our research site (Yanchi Research Station) lies in the southern edge of the Mu Us desert.

6. Figure 2, the June and July pattern are similar. There is a third order polynomial pattern, any explanation to this?

RE: We also noticed the third-order polynomial pattern. It also appeared in Figure 3, for example, for both the high and low soil water level. This was an unexpected yet interesting pattern. We propose that the third polynomial pattern may be related to confounding factors such as VPD and temperature. Although VPD and temperature covaried with PAR at the diurnal scale, they lagged PAR by 3-4 hours (Fig. 10). Therefore, their depression effects on NEE could be strongest when PAR is below its daily maximum. We mentioned this hypothetical explanation in the revised manuscript. Further studies are needed, however, to corroborate this hypothesis.

7. Figure 3, the marker size in the top panels is too big.

RE: We reduced the marker size in the revised manuscript.

8. Figure 5 is in poor quality. The letter font in the figure is not proportion to the figure

size.

RE: We have made revisions accordingly.

9. Figure 9, reduce the marker size on the top two panels.

RE: We have made revisions accordingly.

References

Moffat, A. M., Papale, D., Reichstein, M., Hollinger, D.Y., Richardson, A. D., Barr, A. G., Beckstein, C., Braswell, B. H., Churkina, G., Desai, A. R., Falge, E., Gove, J. H., Heimann, M., Hui, D., Jarvis, A. J., Kattge, J., Noormets, A., Stauch, V. J.: Comprehensive comparison of gap-filling techniques for eddy-covariance net carbon fluxes, Agr. Forest Meteorol., 147, 209-232, 2007.

Interactive comment on Biogeosciences Discuss., 11, 5089, 2014.