

# **Response to interactive comments on “Seasonal and diurnal variations in moisture, heat and CO<sub>2</sub> fluxes over a typical steppe prairie in Inner Mongolia, China”**

**Dear Anonymous Referee #1**

We greatly appreciate your effort in reviewing our article. We have incorporated all of your comments in this revised manuscript where each revision is highlighted. We greatly appreciate your helpful comments.

We respond to your comments item-by-item here. Our replies are in blue.

General comments

The authors present new eddy covariance data obtained on a prairie site in Inner Mongolia (China) and put the results in the perspective of other prairie and grassland sites in the world. The Asian steppes represent a large area of which little is known with respect to energy and carbon budgets. Therefore these data are more than welcome to develop process understanding and to serve as model verification. Radiation budgets, albedo, energy and carbon fluxes are presented and discussed in the form of seasonal and diurnal cycles, which gives a good overview of orders of magnitude and variation. The authors argue that the data are important to understand the role of prairie in a changing climate. However, they make no effort to explain and understand the variability in sensible and latent heat fluxes and carbon dioxide fluxes as a function of weather or climate conditions and/or vegetation stature. This is the deficiency I have the most problems with. An explanation of how these fluxes behave as a function of environmental conditions would add considerable to the process understanding as well as to the comparability of the site with others. Without addressing this, the paper does not address a broad scientific community. The paper is well written and to the point. The figures are clear, to the point and appropriate in numbers.

Thanks for encouragements.

Specific comments

p1942, line 16: please clarify what is meant with ‘asymmetrically’.

We changed this word to be ‘nonlinearly’ which may be easier to be understood.

p1942, line 25: In the paragraph above you discuss grasslands in general and in this paragraph you focus on your natural steppe prairie. Please explain how that prairie is the same or different in terms of climate, vegetation, geography, hydrology, from other grasslands, because that information is needed to later understand the differences in flux observations.

We inserted a short paragraph between these two paragraphs to make the transition smooth to address the issues you mentioned.

p1944, line 16: Linear interpolation is fine for short gaps (a few half hours maximum). Please provide gap statistics to allow judgment whether linear interpolation is acceptable.

We did not apply linear interpolation for the period during and after rain events. Instead, we treated the individual short gaps with linear interpolation. To clarify it, we rewrote the sentence in text.

p1944, line 26 to p1945, line 29: This part may be better placed in the results section, particularly because section 2.3 looks a bit mislocated in between.

We moved this part to the beginning of result section.

p1945, line 29: what are the typical snow depth and length of the period of snow cover in the climatic sense?

We did not measure these. We are sorry about that.

p1950, line 8: how are 'clear days' selected, and how often do they occur relatively?

We changed 'clear' to be 'sunny', and showed that there 334 sunny days during that observation period.

p1951, first paragraph: This discussion is not entirely clear: It appears that the authors state that Hao et al (2007) do not observe a clear diurnal cycle in  $G_0$ . However, fig. 4 in Hao's paper shows a clear diurnal cycle in  $G_0$ . Do the authors intend to say that Hao did not observe a clear seasonal variation in the amplitude of the diurnal cycle? Please clarify.

We clarified that in our text. Hao et al.(2007) used soil heat flux measured at 0.05 m depth and did not account for the heat storage within the soil layer above (Li et al., 2006), so it is reasonable that the diurnal variations in soil surface heat flux ( $G_0$ ) is more significant in our results than that in soil heat flux ( $G$  at 0.05 m depth).

p1951, line 10: 'but in the reverse phase' should read 'but of opposite sign'.

We corrected it.

p1951, line 13: -0.21 mg/m<sup>2</sup>/s is still 1/3 of the peak value. How do you explain that the grass is taking up carbon in the winter? Is it still growing then?

We explained it by adding "the reason that the grass was taking up carbon in the winter was probably caused by fact that there were some leaves alive in winter season." into our text.

p1951, line 16: what do you mean with 'climate indicators'?

The term of climate indicator is usually used in climate research. In our text, "both  $H$  and  $F_{CO_2}$  may be more significant climate indicators than  $LE$  and  $G_0$ " means "both  $H$  and  $F_{CO_2}$  respond the climate change stronger than  $LE$  and  $G_0$ ".

p1951, line 23: The study of Bi was performed in Southern China, in a probably very different climate region. Why do you compare your results only with that study, and not also with studies in similar climate zones?

We explained it in our text by appending "Comparison of our current results against those of Bi et al.(2007) shows that surface turbulent fluxes in different climate zones in China respond to climate change in different patterns." to this paragraph.

p1951, line 14-24: This paragraph could better be moved to the discussion.

We did not separate result section and discussion section.

p1951, line 26-p1952, line 11: The observed seasonal variations in  $H/R_n$ ,  $LE/R_n$ , Bowen ratio are extremely small, it would be better to state that they are constant and not focus on the monthly variations.

We improved this section to address the issue you mentioned.

p1952, line 2: ' $G_0/R_n=9\%$ ': does mean that  $G_0$  summed over a day/season/year does not approximate 0 W/m<sup>2</sup>? If not,  $G_0/R_n$  is not a very useful metric.

Yes.  $G_0$  summed over a day/season/year does not approximate 0 W/m<sup>2</sup>.

p1952, line 2: Explaining 11% of residual energy as heat storage in the grass is not realistic, because the heat storage capacity of grass is not sufficient. It is more realistic to explain it as measurement error.

Yes. We deleted this sentence, and we gave a detailed discussion on surface energy imbalance observed.

p1952, line 12-19: This part belongs to the discussion.

We did not separate result section and discussion section.

p1954, section 3.6: Writing down the values of the variables is unnecessary and inhibits good readability. Let the graphs speak for themselves.

We improved it.

p1954, section 3.6: why do you not show H,LE and fCO<sub>2</sub> on summer days with high and low soil moisture, to highlight the impact of soil moisture?

We just wanted to compare the surface turbulent fluxes for summer and winter seasons. In this way, we decided to use two representative days in summer and in winter.

p1955, section 4: The introduction of this paper puts the work in the context of CO<sub>2</sub> and climatic change, as well as climate modelling. I do not see anything of that coming back in the results and conclusions. It would be particularly interesting to a broad scientific audience to know how H, LE and fCO<sub>2</sub> depend on weather and climate conditions, soil moisture, vpd, global radiation, temperature. What is the net annual carbon balance and how is it composed of GPP and ecosystem respiration?

In introduction, to emphasize the importance of our work, we mentioned climate change and modeling. This article is just to inspect the seasonal and diurnal variations in turbulent fluxes during our experimental period. We will broaden our work in a subsequent paper to investigate how surface turbulent fluxes respond to weather and climate conditions, soil moisture, vpd, global radiation, and temperature, what the net annual carbon balance is and how it is composed of GPP and ecosystem respiration.