

Response to referee's comments

We thank referee and greatly appreciate the thoughtful and constructive comments. We have fully considered the referee's comments in the revision and improved the manuscript. Answers to referee's questions are italicized and in blue color.

General comments:

Although the topic of hysteresis of R_s and T_s has been discussed in other ecosystems, and the method and statistical method is regular, the impact of SWC on diel hysteresis is well explained in this manuscript. The data and figures are well organized. The author has provided us a relatively complete story of how low SWC affect R_s by restraining biological process, like photosynthesis. The elliptical loop of R_s and T_s diel hysteresis gives a clear explanation. However, this thesis did not explain the mechanism clearly. The mechanism of SWC regulate diel hysteresis between R_s and T_{surf} needs strong evidence to explicate other than just mentioning other people's deduction that it is due to relative contribution of autotrophic and heterotrophic respiration to total R_s . This manuscript needs carefully organize the proof of how and why respiration component affects R_s in dry land.

Answers:

In our study, we didn't have available measurements on autotrophic and heterotrophic respiration, making possible to directly determine the relative changes between the two components of soil respiration (R_s) experimentally. However, our comparatively statistical analyses on the patterns of diurnal variation in soil respiration (R_s) and soil surface temperature (T_{surf}) between the wet and dry month (Figure 2), and the relationship between relative importance of temperature and photosynthesis (RI) and soil water content (SWC) (Figure 4) were significantly enough to indirectly understand the relative changes between the two components.

In desert shrub land, soil organic matters are thin and are mainly concentrated on the soil surface (Ciais et al., 2011; Thomas, 2012; Gao et al., 2014), thus heterotrophic respiration responds primarily to T_{surf} , and thus root and rhizosphere respiration is firmly associated with photosynthesis. That is to say that autotrophic respiration responds primarily to photosynthesis.

Under low SWC condition in summer, soil surface temperature was normally higher, decomposition processes of organic matters was largely depressed, whereas roots system spread deeply into soil, thus plant may use deep soil water to maintain metabolism. Thus, autotrophic respiration dominantly contributes to R_s under low SWC, resulting in R_s being correlated more to photosynthesis than T_{surf} (line 10-11 on P6; Figure 2), leading to high RI (line 11-12 on P6; Figure 4). In contrast, under high SWC condition after rainfall events, the decomposition process was largely accelerated, as we commonly reported large CO_2 fluxes purse after rainfall events. Thus relative contribution of heterotrophic respiration largely increased after rainfall events, resulting in R_s being correlated more to T_{surf} than photosynthesis (line 8-9 on P6; Figure 2), and leading to low RI (line 11-12 on P6; Figure 4).

Base on above findings, we assumed that the regulation of SWC on diel hysteresis

between R_s and T_{surf} is affected by the changes in relative contribution between autotrophic and heterotrophic respiration to total R_s . The measurements of autotrophic and heterotrophic respiration are considered in our upcoming studies, and may then confirm our assumption experimentally.

We also added three references, see below, to the manuscript in line 27 on P7 and also into references part (see attach supplement file).

References:

- Ciais, P., Bombelli, A., Williams, M., Piao S. L., Chave, J., Ryan, C. M., Henry, M., Brender, P. and Valentini, R.: The carbon balance of Africa: synthesis of recent research studies, *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 369 (1943), 2038-2057, 2011.
- Thomas, A. D.: Impact of grazing intensity on seasonal variations of soil organic carbon and soil CO_2 efflux in two semi-arid grasslands in southern Botswana, *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 367(1606), 3076-3086, 2012.
- Gao, G. L., Ding, G. D. Zhao, Y. Y., Wu, B., Zhang Y. Q., Qin S. G., Bao, Y. F., Yu, M. H. and Liu, Y. D.: Fractal approach to estimating changes in soil properties following the establishment of *Caragana Korshinskii* shelterbelts in Ningxia, NW China, *Ecological indicators*, 43, 236-243, 2014.