Response to Dr. J. Niu (RC1)

General comments

Estimation of soil water components is crucial for the optimum irrigation strategies, especially for the ecologically fragile region in Northwest China. The soil moisture is regarded as a more integrated one as it may have the memory features for the antecedent hydrological effects. This study tried to estimate the fields-scale water budget based on six experimental plots with different cropping patterns, NT1 to NT6. The evapotranspiration and soil water components are calculated by employing data-driven method, which combines the soil water balance method and the inverse Richards function. The manuscript is generally well-structured and the study is well-founded. There are several concerns/suggestions that may be helpful for the improvement listed as below.

Response: We warmly thank the Dr. J. Niu for the overall favorable impression of the work, and for the constructive suggestions, with which our manuscript is significantly improved in both its clarity and organization. Please see our point-by-point response (in blue) in detail below.

Specific comments

1) The research findings should be more effectively highlighted in the Abstract. There is some too detailed information listed in the current abstract.

Response: These too detailed information listed in the abstract has been largely simplified, and only the most important ones will be kept in the revised version.

2) How to explain the largest K_s value 1007 for NT3 in Table 2?

Response: As we all know, hydraulic conductivity can exponential change with soil water content in near-saturated or saturated conditions (Horton, 1992), so that the slight variation in soil physical property could potentially cause extreme value in K_s (i.e., 1007 cm/day). Previous works done in this region have also shown that the value of K_s in sandy soil could range between ~100 cm/day and >1000 cm/day in the sandy soils of the ecotone between desert and oasis (Yao *et al.*, 2013; Xiu-Rong *et al.*, 2014; Sun *et al.*, 2015). Thus, it is reasonable that such extreme value exists in the measured values of K_s. To eliminate the potential disruptions caused by extreme value of K_s, the averaged value of K_s were used to do the inverse estimation for each soil profile. We will further clarify this point in our revision.

3) Where is the rainfall observation station?

Response: the weather station is located about 150 m from the experimental site. This information will be included in the revision.

4) Wrong explanation for ε in Table1. There are two same explanations with "field capacity" and "wilting point" in Table 1, but no explanation for soil water potential Ψ in Table 1.

Response: Thanks for pointing out the mismatch for the parameters in Table 1. It will be corrected in the revision.

5) For the case of NT1, both the irrigation amount and drainage amount are the highest, but no big differences about ET with other cases. Based on the energy balance, this high amount of irrigation may reduce the temperature profile (see Chen et al. 2018, Soil of the Total Environment, for the

irrigation effects on energy balance in the Heihe River basin), which possibly affect actual ET requirement for the crops in NT1. Following the above point, the inverse Richards method employed for the soil water budget in this study did not consider the energy effects of different irrigation scenarios, which is possible to affect the water budget during different phases. This should be discussed.

Response: Very useful suggestion. Yes, the high amount of irrigation may reduce the temperature of soil profile, because the irrigation usually accompanied by an increase of latent heat flux, which is often relate to evapotranspiration (Haddeland *et al.*, 2006; Zou *et al.*, 2017; Chen *et al.*, 2018). Due to the higher amount of irrigation, it is natural that NT1 should get higher ET than the other cases, however, no big differences were detected in ET values from our calculation. One reason behind this phenomenon is that all the six experimental plots were fully irrigated at each irrigation event, and most of the over-applied water at NT1 and occasionally occurred at other plots (NT2-6) were deep drained during the short periods following irrigation because of the poor water holding capacity of sandy soils (as evidenced in Figure 5), so that the differences in the temperature regimes in the soil profiles caused by the different irrigation volumes across the plots could be largely ignored, and thus ET is strictly a function of ambient atmospheric conditions (Rahgozar et al., 2012). We will add related discussion in the coming revision to solve this concern.

6) Another concern is the scale issue. As we have recognized the larger variability for different sets, we can imagine how difficult for a large agricultural land. So, the potential for using soil moisture measurement to improve irrigation strategies is still on the way.

Response: Yes, each soil moisture probe can monitor only a small volume in heterogeneous soils. We agree that the potential for using soil moisture measurement to improve irrigation strategies is still on the way. However, it still provided a valuable reference for coarse-textured soils like sandy soil in this region for improve the irrigation efficiency. Discussion upon this issue will be included in the revision.

7) Line 443: I don't think one-year experiment could be called as "long-term" for hydrological processes.

Response: OK, we will remove the word of "long-term" here to clarify this, although what we mean here is that the cropping experiment rather than the hydrological processes monitoring is a long-term work.

8) There are many duplicate sentences between Abstract and Conclusions.

Response: Following this suggestion, we will reorganize Abstract to make it more concise and remove the duplicated part with conclusions.

References:

Chen Y, Niu J, Kang S, Zhang X. 2018. Effects of irrigation on water and energy balances in the Heihe River basin using VIC model under different irrigation scenarios. Science of The Total Environment, **645**: 1183-1193.

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Zou M, Niu J, Kang S, Li X, Lu H. 2017. The contribution of human agricultural activities to increasing evapotranspiration is significantly greater than climate change effect over Heihe agricultural region. Scientific Reports, **7**.