Response to Dr. Michael W. I. Schmidt (SC1)

General comments

*A note upfront from the submitting person:

This review was prepared by Basil Frefel and Michèle Bösiger, both master students in geography at the University of Zurich. The review was part of an exercise during a second semester master level seminar on "the biogeochemistry of plant-soil systems in a changing world", which I organize. We would like to highlight that the depth of scientific knowledge and technical understanding of these reviewers represents that of master students. We enjoyed discussing the manuscript in the seminar, and hope that our comments will be helpful for the authors.*.

Addressing sustainable irrigation in semi-desert regions, Li et al. observed in a soil moisture time series the soil-water holding ability in the Heihe River Basin, northern China. Soil properties such as saturated hydraulic conductivity and soil retention capabilities were combined with the soil water balance method and the inverse Richards equation (water movement in unsaturated soil) in order to estimate the Soil Water Base Components (evapotranspiration, irrigation, drainage). The measurements were taken at six sites in sandy soils, which differed in agricultural technique (rotational, permanent cultivation), plant species and mulching application. The results show that the estimation of the Soil Water Base Components corresponds to the soil-moisture time series and thus should be helpful for future irrigation planning.

Overall, the issue addressed by Li et al. is of great importance regarding future water management. Especially with increasing water scarcity, the study lays the foundation for a sustainable water strategy for one of the biggest agricultural producers worldwide for rice and wheat and thus is a valid contribution to the present scientific knowledge. The article is well structured, and the thinking steps are described profoundly, in addition to the reflected approach to the results. However, we have also found some caveats.

In general, the type size is too small, and the sentences tend to be too long and interlaced to comprehend the article at the first read (see further comments). Moreover, the exact time span of the experiment is unclear, and it should be mentioned what (important) role sandy soils play in the agricultural production of China and the world. Besides, the abstract should be shortened to stay attractive for the reader and abbreviations such as NT1-NT6 should not be used in this very first paragraph. In our opinion, many explanations are too complicated; Keep explanations short and simple. In contrast to the detailed abstract, the conclusion is too short, again overloaded with abbreviations and therefore not understandable standing alone. More detailed remarks are listed below.

RESPONSE: We would like to thank Dr. Michael W. I. Schmidt for organizing the seminar to discuss our manuscript. We also warmly thank Basil Frefel, Michèle Bösiger for their thoughtful review, and for the specific suggestions, with which our manuscript is significantly improved in both its clarity and organization. We have taken the time to think through all the review comments and have adequately addressed all the comments item-by-item in the following pages.

Specific comments

1) Lines 12: SWBC: In this paper the term soil water budget components and its abbreviation SWBC is used as if it were a standard term in soil science or hydrology. is this really the case? Otherwise it should be mentioned that this

term as such is only used in this paper.

RESPONSE: Thanks for the nice suggestion. No, this abbreviation is not a standard term both in soil science and hydrology, and it is only used in this paper. We have defined that in the Introduction and then to use it in the following text to reduce repeated use of the term and thus to make the paper as concise as possible. According to the suggestion, we have mentioned that "this term as such is only used in this paper" in the revision.

2) Lines 22: Since the inverse Richards equation is of great importance in this work, but is not necessarily known to the general public, a brief description of what this method is used for, e.g. in parentheses, would be helpful.

RESPONSE: Thanks for pointing out this issue. A brief description of what this method is used for have been added in our revision.

3) Lines 26: Why only one site without film-mulch? Comparison to other sites without mulching would have been helpful.

RESPONSE: As we mentioned in Section 2.2, this long-term field experiment was set up in 2007, and the six experiment plots have very different treatments, i.e., from NT1 to NT6, they were sequentially set as: (1) continuous pasture cropping, (2) continuous maize cropping, (3) continuous maize cropping with straw return, (4) maize-maize-pasture rotation, (5) maize-pasture rotation, (6) maize-pasture intercropping. In general, only the maize fields need to be film-mulched, and maize were planted in all the plots except NT1 (which was planted with alfalfa in the growing season of 2016), so that NT1 is the only one plot without film-mulch in this study.

4) Lines 29: What should be special about an obvious correlation between the volume of irrigation and drained water? is this really a significant result of the study or could this statement also be omitted?

RESPONSE: Yes, we do think this is a significant result of the study. Although similar results were also reported by other works, we found that this linear positive correlation is particularly noticeable in the coarse textured soils like the desert oasis in arid China, as we also discussed in Section 4.2. We think this is a useful result for further improve irrigation strategies, and thus would like to keep it here.

5) Lines 47: What is a high leaching fraction? Explain.

RESPONSE: Leaching fraction (LF) represent the ratio of the actual depth of drainage to the depth of irrigation (Dudley et al., 2008), we have explained it in the coming revision. Please see line 48 (Page 1) for details.

6) Lines 40-54 and 55-69: The second paragraph is redundant.

RESPONSE: The second paragraph will be slightly shortened to eliminate any redundant in the coming revision.

7) Lines 106-107: Reference is needed for the sentence "The annual average precipitation..."

RESPONSE: Added as suggested.

8) Lines 107: What does a dryness index of 15.9 mean. Please put this number into context. Is this a high or a low value compared to the surrounding region or the rest of China? Is the dryness Index a common value which is need to be stated?

RESPONSE: Dryness index adopted here is a climate index that was widely used to reflect the degree of dryness in the atmosphere; it often defined as the ratio of potential evaporation to precipitation (Xiao et al., 2013). A dryness index of 15.9 means a very dry climate, under which potential evaporation rate could be ~15 times higher than the precipitation received. The dryness index of 15.9 is a common value for the arid northwestern China, but much higher than the rest regions of China. We have clarified this point in our coming revision. Please see Line 107-108 (Page 3) for details.

9) Lines 111: What exactly is meant with sandy soil? What official soil name does it correspond to? leave out "…coarse texture and….". Scotch or Scots pine? Use familiar expression.

RESPONSE: According to Yang and Liu (2010), the zonal soils in our study region are loamy sand and sandy soil, which are two soil types typical for arid and semiarid environments (Zhao et al., 2010), we will further clarify this point in our revision. As suggested, "coarse texture" has been removed from the revision, and "Scotch Pine" was replaced with "Scots pine" too.

10) Lines 124-126: Please explain why the different treatments used in the study were chosen.

RESPONSE: As we mentioned at the beginning of this paragraph, the different treatments used in the study were chosen to investigate the accumulative effect of different cropping systems and agronomic manipulation on soil property evolution. More details have been included in the revision to solve this concern.

11) Lines 127: Why using exactly this type of irrigation (furrow irrigation)? Please explain in more detail.

RESPONSE: Because it was the most widely used irrigation type in our study area, and even the entire northwestern China. More details have been added in the revision to solve this concern

12) Lines 128: Why just using one site with no film-mulching and five with mulching? Not a sufficient comparison possible between the sites.

RESPONSE: Please refer to our response to Question 3.

13) Lines 242: Is it not unrealistic to use a ground level of the soil matric potential, even though the water level never reaches that high up?

RESPONSE: I guess this question may be raised by some misleading description about the lower boundary, for example, "i.e., $h = -5$cm". In fact, we adopted a free drainage boundary, which also can be descripted as "a unit vertical hydraulic gradient boundary condition which can account for a variable flux". To clarify this point, we have reorganized this sentence as "A free-drainage boundary condition was applied along the bottom boundary".

14) Lines 245: Which software? Please specify.

RESPONSE: We do this calculation by coding in MATLAB environment. It has been clarified in the revision. Please see page 7 line 249 for details.

15) Lines 343: In what dimension is the soil water content measured?

RESPONSE: According to the Operator's Manual, each TDR sensor (5TE, Decagon Devices Inc. Pullman, WA, USA) uses an electromagnetic field (dimensions: 9.3 x 2.4 x 6.5 cm) to measure the dielectric permittivity ε and thus the soil water content of the surrounding medium. In this study, the TDR sensors were installed at 5 different depths (20, 40, 60, 80, and 100 cm) at each plot, to monitor the soil water moisture of the root zone (0-110 cm).

16) Lines 55-59: The sentence is too long, therefore hard to follow and should be divided into two or three sentences. End the first sentence with a full stop after (Wright, 1971).

RESPONSE: We have divided this sentence into two ones as suggested. Please see page 2 line 56-59 in the revision.

17) Lines 92-95: Unorganized sentence order makes it even harder to follow the content.

RESPONSE: To make it clearer and more understandable, we have reorganized this sentence as "Exploring a reliable farmland *SWBC* estimation model, which can make the most of the vast amounts of soil moisture data, is crucial for irrigation management optimization in arid regions with coarse-textured soils (Musters and Bouten, 2000;Sharma et al., 2017)". Please see Page 2 Line 93-94 in the coming revision.

18) Lines 165-171: Subdivision into subsets probably better for this sentence.

RESPONSE: Changed as suggested.

19) Lines 219-226: Hard to follow the derivation.

RESPONSE: We have reorganized this part to make the derivation easier to follow in the revision.

20) Lines 42: missing 'the' …the Heihe river basin (HRB) is one of the largest…

RESPONSE: Corrected as suggested.

21) Lines 81: Cross out "…quite common and…"

RESPONSE: Corrected as suggested.

22) Lines 83: Cross out "…and more…"

RESPONSE: Corrected as suggested.

23) Lines 85: Also, with this process_, …

RESPONSE: Corrected as suggested.

24) Lines 86: ..., almost no work_ have been...

RESPONSE: Corrected as suggested.

25) Lines 112: ... (planted since the 1970s), include Haloxylon anmmodendron, ... →either no comma or 'including'

RESPONSE: Corrected as suggested.

26) Figure 1: The figure is not entirely clear→to what do the roots belong on the right?/figure on the left→layout and position of the legend and unprecise placement of the small map of China.

RESPONSE: We have reorganized this figure to make it clearer and more understandable in the revision according to this comment.

27) Figure 2: Probably better 'day of year' as axis label instead of DOY.

RESPONSE: We have added the explanation in the note. Please see page 6 line 183 in the revision.

28) Lines 140: 'was' instead of 'were'.

RESPONSE: Corrected as suggested.

29) Lines 195: 'dominates' instead of 'dominants'.

RESPONSE: Corrected as suggested

30) Table 1: we propose to insert this nomenclature-table at the beginning of the chapter.

RESPONSE: We decide to keep them at the original places just for the tidy layout.

31) Table2: Vertical lines between wilting point value of one study site and the saturated water conductivity of the next study site could probably increase readability (see attached pdf).

RESPONSE: Thanks for the nice suggestion, we have added vertical lines for Table 2 in the revision.

32) Figure 5: Does it need this figure at this place? and what exactly, apart from the clearly visible irrigation events, should be shown with it?

RESPONSE: This figure shows all the soil moisture dynamics that we used in this paper to further do our calculations, analysis and discussions.

33) Figure 6: left graph: use other scaling, since nothing is readable/ right graph: why is the scale in the middle of the graph (a bit weird position), why using such fancy boxplots if normal rectangular ones could be used?

RESPONSE: Both the two panels in Figure 6 have been reorganized as suggested in the revision.

34) Lines 437: explains

RESPONSE: Corrected as suggested.

35) Lines 381: 'Literature' instead of 'literatures'?

RESPONSE: Corrected as suggested.

36) Lines 443: ... (Fares and Alva, 2000), suggesting that there is... In general: Reflect on the placement and use of figures and tables in the work, so that these stylistic tools fulfil their purpose of increasing the attractiveness of a scientific paper.

RESPONSE: Added as suggested.

37) Lines 1-2: as the use of soil moisture measurements is a major part of the scientific work, we would adjust the title as follows: Estimation of Evapotranspiration and Other Soil Water Budget Components, Using Soil Moisture Measurements, in an Irrigated Agricultural Field of a Desert Oasis Or also the following possibility seems easier to understand to us: Estimation of Evapotranspiration, Irrigation and Drainage, Using Soil Moisture Measurements, in an Irrigated Agricultural Field of a Desert Oasis

RESPONSE: According the suggestion, we have changed the title as "Estimation of Evapotranspiration and Other Soil Water Budget Components, Using Soil Moisture Measurements, in an Irrigated Agricultural Field of a Desert Oasis".

38) Lines 29-30: Leave out the obvious parts and concentrate on the findings

RESPONSE: Because this part is one of the most important findings and we would prefer to keep in the abstract.

39) Lines 106: lowest and highest temperatures for winter and summer, respectively→that's logical, no need of repetition. Pleonasm. It would be probably better to use the terms 'minimum' and 'maximum' in this context.

RESPONSE: Corrected as suggested.

40) Lines 323-324: water content values are difficult to read in the presented form of a listing.

RESPONSE: We have reorganized this sentence as "For the same interval of time, the water contents in the 40-, 60-, 80- and 100-cm depths of soil decreased from 25.4%, 19.8%, 18.5% and 14.2%, to 15.7%, 14.3%, 15.4% and 12.8%, respectively". Please see Page 10 Line 322-323 in the revision.

41) Lines 512: Setting upper boundaries would have been a nice addition.

RESPONSE: Yes, we agree, but we don't have more detailed information to set such a special upper boundary for inter-cropping treatments in this study. However, uncertainty that may be caused by this simplicity have been discussed in our manuscript.

42) Lines 566: It would be desirable for the conclusion to mention what would be appropriate irrigation methods for this variety of agricultural soil.

RESPONSE: Good idea, but this is beyond the scope of this article, and we are preparing another paper to discuss this issue.

References:

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