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Discussions
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Interactive comment on "Investigating effects of different evapotranspiration (ET) schemes on soil water dynamics and ET partitioning: a large lysimeter case of summer maize in a semi-arid environment northwest of China" *by* L. Yu et al.

L. Yu et al.

yulianyu257@gmail.com

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We thank Dr. M. Coenders-Gerrits for valuable comments that help us to improve the manuscript. We would like to provide point to point reply to all the comments and questions. (Q: Qestion, A: Answer)

Response to the comments from Dr. M. Coenders-Gerrits:

The paper investigates the effects of two different methods to estimate ET (direct and indirect) on the output of the STEMMUS model. This model couples the transfer of heat, water, and vapor in the soil. Furthermore the authors look at the sensitivity of the STEMMUS model on the ET partitioning. The paper describes the STEMMUS model and compares the output with lysimeter results for a single growth cycle in a semi-arid region (China). The paper is well written and structured, except for the abstract which should be improved.

Q: Considering the structure, I would change the order of presenting the results. Currently, the authors first show the model output for moisture content, water storage, and soil temperature. Thereafter the comparison of the ETdir and ETind are shown. Personally, I think it is more logical to first present the comparison of the two ET-methods and then show the soil water dynamics more as validation. A: Thank you very much for your useful comments. Your suggestion is reasonable as the soil water dynamics could be used to validate the model performance in simulating ET rates. The original idea for the structure is first to present and compare the model output for soil moisture content and soil water storage (Fig. 3-4). Then a water balance closure checking (Fig. 4) is used to confirm the validation of the proposed model with two ET-methods. After that, the other outputs, such as soil temperature and ET rates at different time scales, are presented to highlight the difference performance of two ET methods.

Q: Furthermore, I am a bit puzzled why for some time scales the ETdir preforms better, and for other time scales the ETind (and v.v.). How is this possible? Does this mean that depending on the time scale of your model you should the one or the other ET method? A: Thank you very much for your questions. If we understand correctly, the confusing part is about Figure 4. Figure 4 is presented to check whether two different approaches, used for estimating soil water storage (V1,ind vs V2,ind or V1,dir vs V2,dir), can lead to the same estimation of soil water storage in the root zone or not. It can be seen that the overall simulation results are satisfied. The surface boundary condition, i.e. irrigation, will slightly affect the simulation results of soil water storage when using two different approaches.

Q: P9977: Title: personally, I am not happy with the term ET-schemes. I think 'method' or 'calculation' is a better term. This was one of the reasons I did not understand the abstract without reading the paper A: Thank you very much for your comment. We agree and would like to change the term ET-schemes to ET methods.

Q: P9978: abstract: I think the abstract should be rewritten. First of all the structure, but it also contains quite some typos/language errors: L4: should be e.g.: "... and climates. The accurate understanding is crucial to determine effective irrigation schemes." L10: ".. and uses LAI to.." L19-21: I don't get this sentence. A: Thank you for your comments. we have made some changes in abstract. L4: We've replaced "... and climate, the accurate understanding of which is crucial to determine the effective irrigation." with "... and climate. The accurate understanding is crucial to determine effective irrigation schemes.". L10: We've replaced ".. and use LAI to.." with ".. and uses LAI to..". L19-21: We have rewritten the sentence L19-21 as "The impact of maximum rooting depth and root growth rate on calculating ET components could be intensified when the soil was drying. The influence of maximum rooting depth was more important at the late growing season while the influence of root growth rate dominated at the early growing season." Finally, considering the structure and language errors we present the abstract as "Different evapotranspiration (ET) methods can affect significantly the performance of land surface models in capturing the soil water dynamics and ET partitioning over various land cover and climates. The accurate understanding of such impact is crucial to determine the effective irrigation schemes. Two evapotranspiration (ET) methods were discussed: one is based on reference crop evapotranspiration (ET0) theory and uses LAI to partition into soil evaporation and transpiration, denoted as the ETind method; the other is the one-step calculation of actual soil evaporation and potential transpiration by incorporating canopy minimum resistance and actual soil resistance into the Penman-Montieth model, denoted as the ETdir method. In this study, a soil water model, considering the coupled transfer of water, vapor and heat in the soil, was used to investigate how different ET methods could affect the soil water dynamics and ET partitioning in a crop field. Results indicated that the coupled model with the two different ET methods differed in simulating soil water content and crop evapotranspira-

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tion components while agreed well for the simulation of soil temperature. Considering the aerodynamic and surface resistance terms made the ETdir method better in simulating soil evaporation especially after irrigation. Furthermore, the results of different crop growth scenarios indicated that the uncertainty in LAI played an important role in estimating the relative transpiration and evaporation fraction. The impact of maximum rooting depth and root growth rate on calculating ET components could be intensified when the soil was drying. The influence of maximum rooting depth was more important at the late growing season while the influence of root growth rate dominated at the early growing season. ".

Q: P9980-L18: typo in partitioning A: Thanks a lot. We've changed "portioning" into "partitioning".

Q: P9981-L5: The authors suddenly introduce that a lysimeter is uses. This is new information for the reader. I would write somewhere a general approach where you say that the model results are compared with observations of a lysimeter A: We agree. We would like to add "comparing with observations of a lysimeter experiment, we investigate..." to the objective part(Page 9980,L13) as "The objectives in this paper are twofold: i) comparing with observations of a lysimeter experiment, we investigate...". Then "The lysimeter experiment was conducted..." in P9980-L23 and "The lysimeter is made of..." in P9981-L5 were introduced.

Q: P9981-L8: description => drawing A: We've changed "description" into "drawing".

Q: P9981-L13-14: Unclear sentence. Please rewrite. A: L13-14 "The amount of irrigation was crop ET measured by the lysimeter during the intervals of two irrigation events." is trying to say that the amount of irrigation was crop water consumptions between two adjacent irrigation events. Now L13-14 is rewritten as "The amount of irrigation was to replace crop water consumptions ever since the last irrigation, which could be measured by the lysimeter."

Q: P9981-L14-15: why where there 2 extra irrigation moments applied? A: Thank you for your question. During the seedling stage of summer maize, some seedlings were growing well while some others were in poor growth conditions. In order to make the maize seedlings uniformly grown, we applied two supplemental irrigation. It could reduce the measurements errors due to the space heterogeneity.

Q: P9981: more details on the lysimeter are required. How does the weighing systems works and what is the measuring interval, etc. A: Page 9981, L7: Thank you for your comment. We add some details on the lysimeter, including measuring interval and precision as “Weight data generated by the weighing system and drainage system were stored in the datalogger. The data collector was programmed to record weight readings hourly with the precision of 139g (i.e. 0.021mm of water) for the weighing system and 1g for the drainage system respectively.” before “In order to apply the irrigation. . .” in the Page9981-L7.

Q: P9981-L17: Please provide details soil moisture and temperature sensors. A: That is a critical comment. Thank you very much. We would like to present the sensors details in the manuscript as “The type of soil moisture sensors used was ThetaProbe ML2x (Delta-T Devices Ltd, Cambridge, UK). Sensor specifications are: ranging from 0 to 100% volumetric water content; precision 1% under condition of 0-40°C and 2% under condition of 40-70°C. Soil temperature was measured by QYWD100, which were made by Xi’An QingYuan Measurement & Control Technology Co. Ltd. Sensor specifications are: ranging from -30 to 50°C; precision lower than 1°C.” before “Hourly measurements . . .” in Page 9981-L18.

Q: P9981-L2428: Please provide more details on the micro-lysimeter. How does this work? Why is the micro lysimeter representative for the soil evaporation? A: Thank you for your comment. We have added some details about the micro-lysimeter, including the structure, how it works and underlying assumption. “The micro-lysimeter, contained a small isolated volume of bare soil, was placed between two crop rows with the diameter of 12cm and the depth of 20cm (Fig.1). Soil evaporation (E) was measured by weighing the micro-lysimeter at 8:00 a.m. daily. After significant precipitation and irrigation, we replaced the soil in the micro-lysimeter to keep the soil moisture in the micro-lysimeter similar to that of surrounding field conditions. Changes in the weight of micro-lysimeter were assumed to be equivalent to the water evaporated from soil surface (Boast and Robertson, 1982). The source of error inherent in micro-lysimeter method was discussed and some recommendations for use of micro-lysimeter were made in our study area (Kang et al., 2003;Wang et al., 2007)." will replace the sentence "Soil evaporation (E) was measured by weighing the micro-lysimeter at 8:00 a.m. daily. The micro-lysimeter was placed between two crop rows with the diameter of 12cm and the depth of 20cm. After significant precipitation and irrigation, we replaced the soil in the micro-lysimeter to keep the soil moisture in the micro-lysimeter similar to that of field conditions. Other details are referred to previous studies over this lysimeter (Kang et al., 2003;Wang et al., 2007)." in page 9981, L24-p9982, L2.

Q: P9983-Eq2: units LHS and RHS are not equal. Multiply RHS with rho_L?? A: Eq2: Many thanks. We've multiplied RHS with rho_L in Eq2.

Q: P9984-Eq6: Twice is the subscript _L missing in the theta of the LHS (I think). A: Eq6: Yes. We've added the subscript _L twice to the term Theta in Eq6.

Q: Section 2.3.3: Maybe make two subparagraph with the title "calculation of ETdir" and "Calculation of ETind". A: Section 2.3.3 (Page9985, L20-Page998,L21):We agree and make two subparagraph with the title "Calculation of ETind method" and "Calculation of ETdir method".

Q: P9986-L6: actual or potential transpiration?? Can not be both. A: Thank you for your comment. We've changed "the actual potential transpiration" into "the potential transpiration".

Q: P9986-L10: add "Several research studies have related.." A: We've replaced "Several researches have related. . ." with "Several research studies have related. . .".

Q: P9987-Eq13: Are these equations correct? Not sure, but to me it seems that the lower two Es-estimations should be multiplied with Ep. A: Thank you very much for your question. What Eq. 13 would like to tell is that, for the soil of a given dryness, there is a maximum rate (Em) at which water can evaporate (note that this maximum evaporation rate Em is different from potential evaporation rate Ep). When Ep<Em (e.g. the energy limited evaporative stage), the actual evaporation Es should equal to Ep; When Ep > Em (e.g. water limited evaporative stage or water vapor diffusion stage) then Es should equal to Em. The value of Em is assumed to be proportional to a power of relative moisture in evaporative soil layer (Linacre 1973). These equations were adapted from Kemp et. al. (1997).

Q: P9989-L24: "..see Fig. 2c..." (not 2b) A: We've changed "..see Fig. 2b..." to "..see Fig. 2c...".

Q: P9999-L7: symbol T is already used for soil temperature, and there for plant transpiration should get a different symbol. A: Many thanks for this point. After examining the whole manuscript, we find that symbol T is used for soil temperature and symbol Ta is also used for air temperature (section 2.3.3 Eq. 9). Thus we use symbol Tc for crop transpiration.(changes are section 2.5.1 Eq. 21 Ta => Tc; P9999-L7 T => Tc; section 3.5 P10000-L5,L8; P10012 Table 4 T=> Tc; Figure 10 T=> Tc)

Q: P10013: caption: "Schematic drawing of the large..." A: We replace "Schematic of the large..." with "Schematic drawing of the large..."

Q: Figure 3-5: Re-scale y-axes, so the dynamics (and deviations) are better visible. A: Thank you for your useful comment. We have re-scaled the y-axes of Figure 3-5.

Q: Figure 6a-b: to small. Improve. Maybe scatter plot? A: Thank you for your useful comment. We changed Figure 6 into scatter plot. When we changed Figure 6 into the scatter plot, the results would be as follows: "3.4.1 ET at hourly time scale The performance of both ET methods to estimate the diurnal pattern of ET throughout the growing season was shown in Fig. 6 and Table 3. The hourly ET rates simulated using the ETdir method generally agreed well with lysimeter-observed ones (Fig. 6).

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There was no significant underestimation throughout the growing season. The results summarized in Table 3 suggested that the main disagreement for the ETdir method occurred at early the growing stage. The values for d-index and RMSE were 0.90 and 0.10 mm h-1, 0.96 and 0.09 mm h-1, 0.98 and 0.08 mm h-1, 0.93 and 0.06 mm h-1 for the initial, crop development, mid-season and late season growing stages, respectively. Compared to the ETdir method, there was no significant difference for the ETind method when the values of ET rates were small (Fig. 6). However, a more underestimation was found when simulating higher ET values. The greatest disagreement among the growth stages occurred at the initial growing stage with the values of d-index and RMSE being 0.84 and 0.10 mm h-1, compared to 0.94 and 0.11 mm h-1, 0.93 and 0.11 mm h-1, 0.90 and 0.07 mm h-1 during other development stages."

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 9977, 2015.

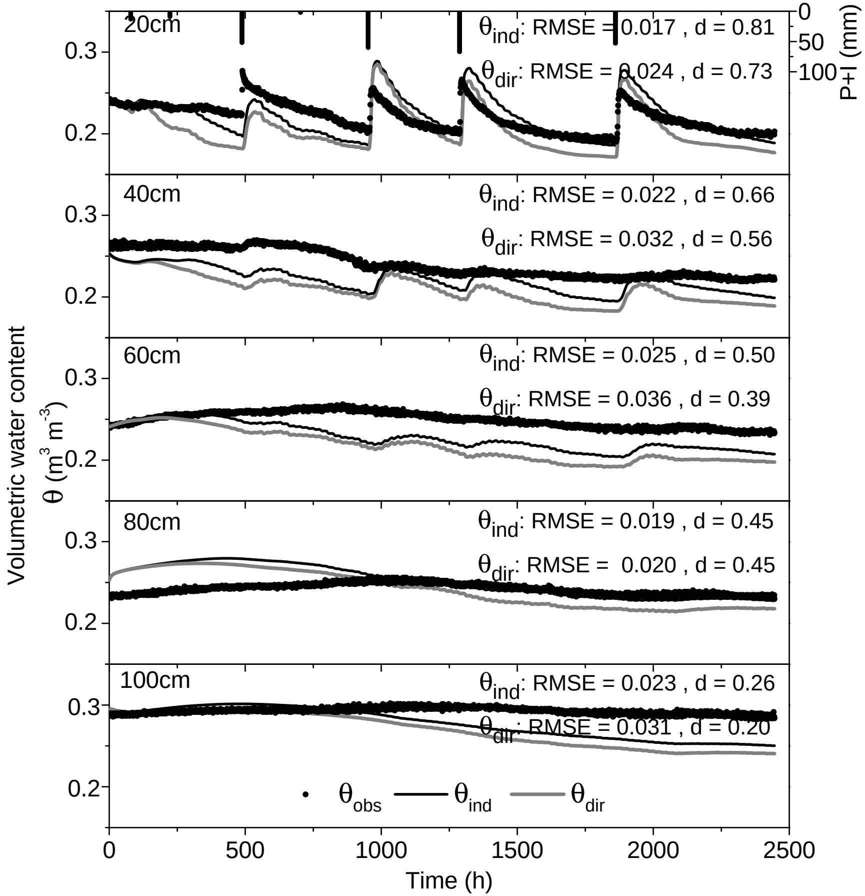

Fig. 1. Re-scaled Figure 3

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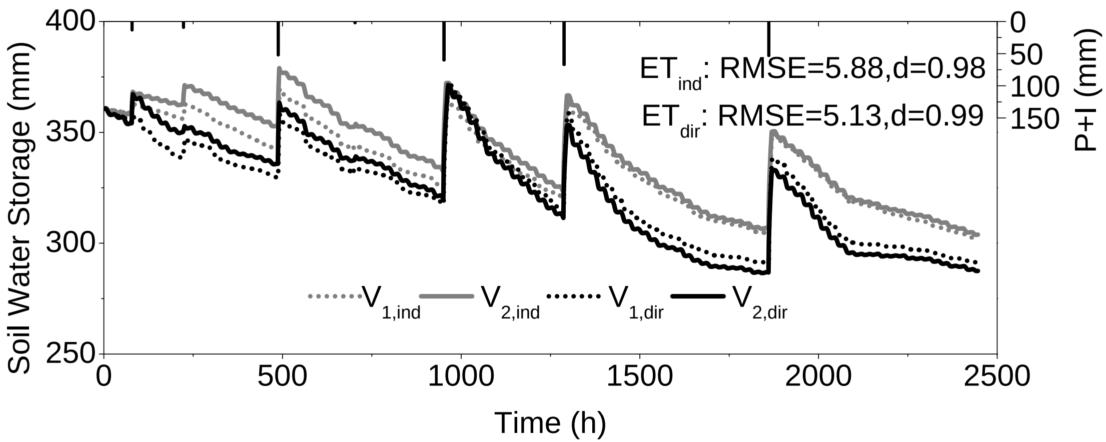

Fig. 2. Re-scaled Figure 4

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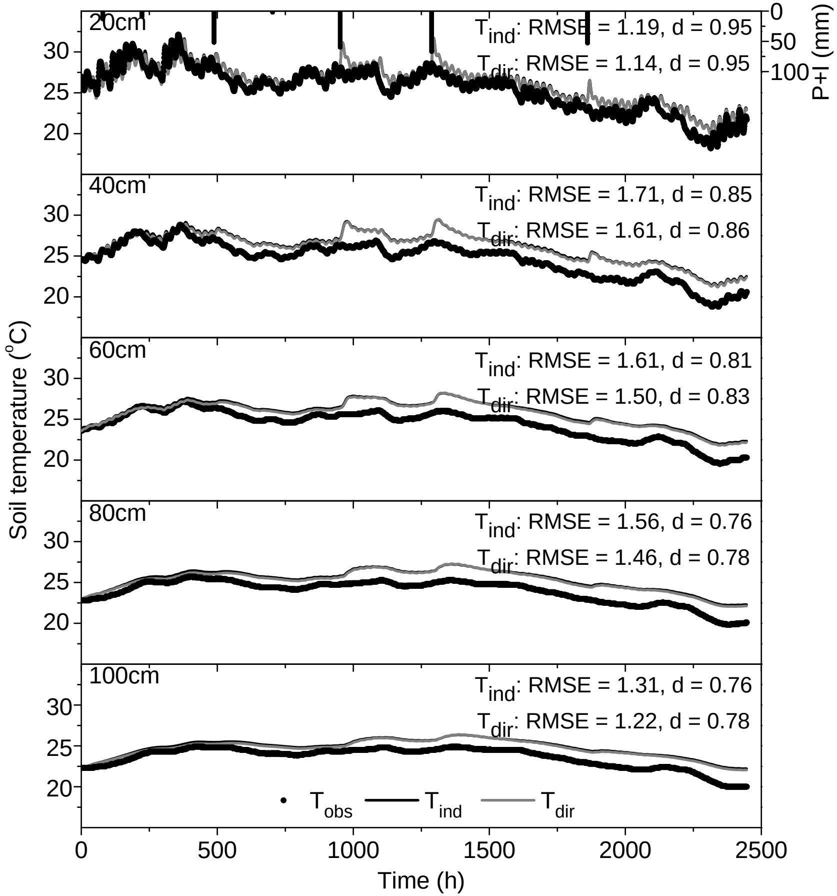

Fig. 3. Re-scaled Figure 5

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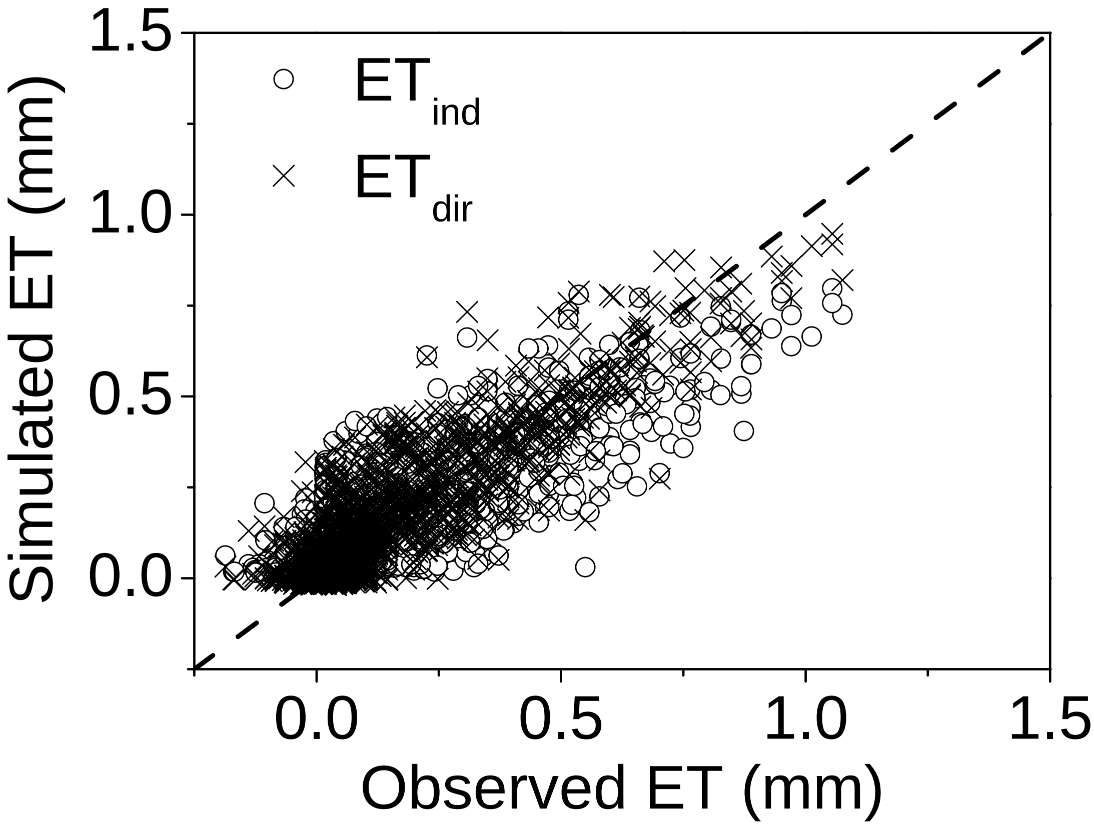

Fig. 4. Scatter plotted Figure 6

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