<u>Responses to the comments of Reviewer #2:</u>

We would like to thank reviewer 2 for the detailed comments. In this document we give a detailed response to all comments. Below we cite first the comment, this is followed by our response and often by a section how the text will be revised in the manuscript. The text in blue are changes and additions in the original text. For clarity we do not show any of the removed text. Thanks so much
Tammo and Zhongyi

Major comments:

Comment1. Why does the introduction refer to Darcy type models while this manuscript does not include Darcy's law? Please clarify in the manuscript.

Response: The intent was to make a distinction between our model and other models. However, the this and the other reviews remarked that we missed the mark. Therefore, we rewrote the introduction

In the revised manuscript, the section that relates to the model classification is as follows.

> "“There is tendency with the ever increasing computer power, to include all processes and the highly heterogeneous field conditions in hydrological models (Asher et al 2015). In case of simulating moisture contents these models become complex and often fully distributed in 3-D (Cui et al. 2017). Examples of these fully developed models are HYDRUS (Šimůnek et al., 1998), SWAP (Dam et al., 1997) and MODFLOW (Langevin et al., 2017) These models have long run times when applied to real world problems, In addition, calibration effort increases exponentially with the number of model parameters (Rosa et al., 2012; Flint et al., 2002).. This makes the use of the complex models for real time management and decision support cumbersome where many model runs are needed (Cui et al 2017).
>
> To overcome the disadvantages of the full and completer models, computationally efficient surrogate models have been developed that speed up the modeling process without sacrificing accuracy or detail. Surrogate models are known under several names such as metamodels reduced models, model emulators, proxy models and response surfaces (e.g., Razavi et al., 2012a; Asher et al 2015). The complex models we will call "full" or comprehensive models.
>
> Computational efficiency is the main reason for applying surrogate models in place of full models. Other advantages of surrogate models are shortening the time needed for calibration; identifying insensitive and irrelevant parameters in the full models [Young and Ratto, 2011]; Most importantly, surrogate models allow investigating structural model uncertainty [Matott and Rabideau, 2008] Finally, surrogate models might be able to deal with better with the self- organization of complex system prevalent in hydrology than the full models (Hoang et al., 2017. For example, full models based on small scale physics (Kirchner, 2006) not necessarily can model the repetitive wetting patterns observed in humid watersheds and for that reason simple surrogate models often outperform their complex counterparts in predicting runoff when a perched water table is present in sloping terrains (Moges et al, 2017; Hoang et al 2017)

Surrogate models can be classified in two categories (Todini, 2007; Asher et al., 2015): data driven and physics derived. Data driven surrogates analyze relationships between the data available and physically derived surrogates simplify the underlying physics or reduce numerical resolution. In recent years, most emphasis in the research literature has been data driven surrogate approaches (Razavi et al. 2012a). Relatively little research has been published on physically derived approaches. Despite its popularity, data-driven surrogates can be an inefficient and unreliable approach to optimizing complex field situations especially when data is scarce such as in ground water systems (Razavi et al. 2012b) The physically derived surrogates overcome many of the limitations of data-driven approaches and are therefore superior over data driven methods (Asher et al., 2015)"

Comment2. The importance of the shallow water table effects on soil moisture content is important, as this manuscript shows. Authors should refer to Brooks et al. (2007) who showed the importance of the drainable porosity to establish water table heights, and presented a similar calculation. The manuscript can emphasize more clearly the truncation of the soil moisture characteristic curve when water tables become less than 3.3m below the soil surface as part of the equilibrium moisture content calculation. (Brooks, E.S., J. Boll, and P.A. McDaniel. 2007. Distributed and integrated response of a GIS-based distributed hydrologic model. Hydrologic Processes 21:110-122.)

Response: The Brooks et al (2007) paper is indeed very interesting. It should have been cited in our original manuscript because the approaches are very similar. There is a small difference however. We are interested in the drainable porosity due to a change in water table, while the Brooks et al. (2007) in interested in the total porosity in the soil that can be filled up before overland flow occurs.

The explanation similar to Brooks et al. (2007) but modified to the conditions with a decreasing water table is given with the description of the model.

> "The drainable porosity, or specific yield, is defined as the amount of water drained from the soil for a unit decrease of the groundwater table when the soil moisture is at equilibrium. It is a crucial parameter in modeling the moisture content in our case or amount of runoff for a shallow erched water table when there is rain (Brooks et al., 2007).
>
> By subtracting the total moisture content at equilibrium in the profile at the initial water table depth and at the new position one unit lower, we obtain the drainable porosity. For example, the area between the orange and blue curve is the amount of water drained for a decrease in the water table from 130cm to 150cm (Fig.3).

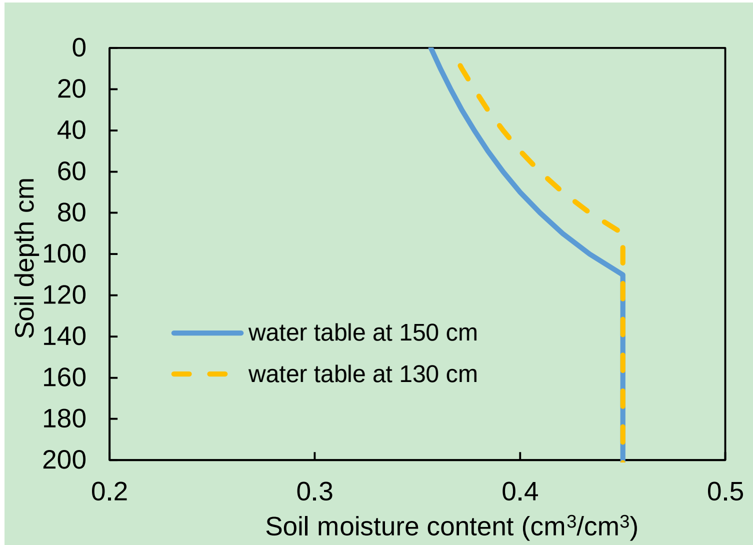

Figure. 3 Illustration of drainable porosity for a soil characteristic curve with a bubbling pressure of 40 cm. The yellow and the blue line are the equilibrium moisture contents for the groundwater depth at 130 and 150 cm, respectively. The area between the two lines represents the amount of water for the decrease of groundwater table drained from the profile when the groundwater decreases from 130 to 150 cm.

The total water content amount of the soil over a prescribed depth with a water table at depth *h* can be expressed as

$$W_{eq}^{h} = \sum_{j=1}^{n} L_j \overline{\left(\theta_{eq}^{z,h}\right)_J} \qquad (6)$$

where $\overline{\theta_{eq}^{z,h}}$ is the average equilibrium moisture content of layer *j* for *h* taken at the midpoint of the layer, *n* is the number of layers in the profile, L_j is the height of soil layer *j*. And the drainable porosity, μ^h, with the groundwater at depth *h,* can simply be found as

$$\mu^h = \frac{W_{eq}^{h-\Delta h} - W_{eq}^{h+\Delta h}}{2\Delta h} \qquad (7)$$

where Δh =0.5L_j.”

Comment3. What is the reason that the fit of soil moisture is so close and the water table depths are not? Is it entirely due to soil variability or something that the model does not represent physically? Please clarify in the manuscript.

Response: One of the main problems is that the soil properties are only obtained till 90 cm. In addition the equation is likely to simple. I would be interesting if a full model can do better. The text was revised as follows:

“3.2.3 Calibration of the parameters related to groundwater depth

The final step was to calibrate the groundwater table coefficients with the 2016 data for both fields. We found that for fields not in the same location (e.g., A, B) the subsurface was sufficiently different so that the same set of parameters could not be used (Table 6). The difference between the calibrated parameters for the two fields was small (Table 6). The measured and simulated groundwater depths were in good agreement with the chosen set of parameters (Fig. 5a, b) with coefficient of determination R^2 being 0.67 for Field A and 0.85 for Field B with most slopes of the regression line of around 1 (Table 7-1). Only from July 15 to July 25 did the observed water table on Field B decrease slower than the simulated water table. This is partly related to the fact that the properties of the soil below 90 cm were not measured, and the assumption was made the soil characteristic curve below 90 cm was the same as that from 70-90 cm. Thus the drainable porosity of the soil which is very sensitive parameter might be different than what was used in the model. Another reason might be that the equation for upward movement might be too simple. Other statistical indicators showed the good fit as well (Table 7-1)".

Note that Figure 4 was revised as Figure 5 and Figure 5 was revised as Figure 4 in the revised manuscript.

Comment4. The manuscript includes 'additional irrigation' from an adjacent field. I assume this means water moved laterally to the study fields. This begs the question if the reverse did not also occur when the study fields were irrigated and water moved laterally to adjacent fields (some type of 'mounting' in the experimental fields). Three out of the four fields show layers with increased hydraulic conductivity, which can be responsible for such lateral movement. Please clarify.

Response: We discovered this increase in water table without rainfall or irrigation during testing of the model. It is therefore difficult to reconstruct exactly what happened. It is indeed likely that the opposite occurred as well, however since the field was close to saturation only a small amount of water is needed to increase the water table. This might have not been noticeable on the field that was irrigated since it was only as small portion of the water applied.

As stated in the response comment 6 reviewer1: One of the hypotheses of the increase in groundwater level due to irrigation in a nearby field is that early in the season the cracks in the structured clays were not fully closed and these could have transported some of the water across the field. It is not something that can be predicted by a standard finite difference or element model since the conductivity is so small for this site. So it is unexpected (or curious).

Another is that that a wetting front can proceed rapidly laterally through the root zone when the groundwater is near the surface. In this case only a very small amount of water μ is needed to bring the soil from nearly saturated to fully saturated. It could be as little as 0.1 cm3cm-3. The wetting front velocity can then be found by v=q/μ. Thus the wetting from can move faster by the ratio of θs/μ which could be in the order of hundreds greater than the bulk of the water. Moreover, when the soil has been plowed the conductivity of plow layer could be greater than the bulk density. So, taken both effects together, we can imagine a wetting front movement of 10-20 m/day through the root zone. Although the effect on the groundwater table is significant flux wise only a small amount of water is involved.

Since this "curious effect" only occurs with the first irrigation we believe that water movement either through cracks or root zone somehow plays an important role. Finally, we should point out that our surrogate model cannot predict it, but it is also unlikely that any "full" model will have the required equations and more importantly the input data to simulate this phenomena.

Editorial comments:

Comment1. Choose 'groundwater' or 'groundwater' throughout the manuscript.

Response: Sorry for the inconsistent writing. It has been corrected as "groundwater" in the revised manuscript**.**

Comment2. Line 39: change 'physical' to 'physically' (also elsewhere)

Response: Thanks for your suggestion. It has been changed to "physically" in the revised manuscript**.**

Comment3. Line 51-54: break up this long sentence.

Response: Thank you for your suggestion. The long sentence was amended in the revised manuscript as

> "Years of rapid population growth has squeezed the world water resources. The available fresh water per capita decreased 7500 m^3 from 13400 m^3 in 1962 to 5900 m^3 in 2014 (World Bank Group, 2019).".

Comment4. Line 68: change 'is' to 'will be'

Response: We changed it to "will be" in the revised manuscript as your suggestion.

Comment5. Line 72-73: the positive and negative effects are not clearly defined. In addition, the sentence needs rewording to: "A combination of field experiments and physically- based modeling has the benefits of both approaches with few negative effects.

Response: Apologies for the unclear statement. We revised the paragraph as follows:

> "In the Yellow River basin, crop irrigation accounts for 96% of the total water use (Li et al., 2004). Due to the increased demand for irrigation, the river has stopped flowing downstream for an average of 70 days per year (Hinrichsen, 2002). Saving water upstream in Inner Mongolia by improved management practices means that more water will be available downstream (Gao et al., 2015). In addition, the Hetao district is suffering from salinization which leads to the land degradation (Guo et al., 2018; Huang et al., 2018) . Salinization is caused by upward migration of water (and salt) from shallow groundwater table that leads to salt accumulation at the surface (Ren et al., 2016; Yeh and Famiglietti, 2009). Designing improved management practices to save water and decrease salinization can be achieved by field trials or with the aid of computer simulation mode measuring the fluxes. Field trials are time consuming, expensive and only a limited set of water management practices can be investigated. Models can test many management practices; however, the modeling results are often are questionable because they have not been validated under local field condition and have not been validated for the future conditions A combination of field experiments together with models has the benefits of both approaches."

Comment6. Line 74-77: this is a single sentence paragraph without any relevant information.

Response: Thank you for your comment. The paragraph was amended as

> "Central to modeling irrigation management practices under shallow groundwater conditions (such as in the Yellow river basin) is simulating the soil moisture content accurately (Batalha et al., 2018, Gleeson et al., 2016; Jasechko and Taylor, 2015; Venkatesh et al., 2011a) because the moisture content plays a critical role in the growth of crops (Rodriguez-Iturbe, 2000), groundwater recharge (Hodnett and Bell, 1986), upward movement of water to the rootzone in areas (Gleeson et al., 2016; Jasechko and Taylor, 2015; Venkatesh et al., 2011a; Batalha et al., 2018). The latter is unique to shallow groundwater areas where the moisture content and thus the unsaturated conductivity are high and where the drying of the surface soil sets up hydraulic gradient that causes the upward capillary movement from the shallow groundwater (Kahlown et al., 2005; Liu et al., 2016; Luo and Sophocleous, 2010; Yeh and Famiglietti, 2009). The upward moving water contains salt that is deposit in the root zone and at the surface. ."

Comment7. Line 78: suggest to change 'grouped' with 'divided' Line

Response: Thank you for your suggestion. Since we revised the introduction section, this line was deleted in the revised manuscript**.**

Comment8. Line 79: it is not clear what is meant here with the 'full Darcy's law'. I would expect it to be the full Richards equation. – Delete 'the'

Response: As stated above we rewrote the introduction. Hopefully the following is an improvement:

> "There is tendency with the ever increasing computer power, to include all processes and the highly heterogeneous field conditions in hydrological models (Asher et al 2015). In case of simulating moisture contents these models become complex and often fully distributed in 3-D (Cui et al. 2017). Examples of these fully developed models are HYDRUS (Šimůnek et al., 1998), SWAP (Dam et al., 1997) and MODFLOW (Langevin et al., 2017) These models have long run times when applied to real world problems, In addition, calibration effort increases exponentially with the number of model parameters (Rosa et al., 2012; Flint et al., 2002).. This makes the use of the complex models for real time management and decision support cumbersome where many model runs are needed (Cui et al 2017).
>
> To overcome the disadvantages of the full and completer models, computationally efficient surrogate models have been developed that speed up the modeling process without sacrificing accuracy or detail. Surrogate models are known under several names such as metamodels reduced models, model emulators, proxy models and response surfaces [e.g., Razavi et al., 2012a; Asher et al 2015]. The complex models we will call "full" or comprehensive models.
>
> Computational efficiency is the main reason for applying surrogate models in place of full models. Other advantages of surrogate models are shortening the time needed for calibration; identifying insensitive and irrelevant parameters in the full models [Young

and Ratto, 2011]; Most importantly, surrogate models allow investigating structural model uncertainty [Matott and Rabideau, 2008] Finally, surrogate models might be able to deal with better with the self- organization of complex system prevalent in hydrology than the full models (Hoang et al., 2017. For example, full models based on small scale physics (Kirchner, 2006) not necessarily can model the repetitive wetting patterns observed in humid watersheds and for that reason simple surrogate models often outperform their complex counterparts in predicting runoff when a perched water table is present in sloping terrains (Moges et al, 2017; Hoang et al 2017)

Comment9. Line 90: are you sure SWAT uses a regionalized Darcy's law model?

Response: We agree that the whole section was poorly written The SWAT hydrology model is based on the water balance equation (Arnold et al., 1998). The TOPMODEL (Beven and Kirkby, 1979) and SAWT model are both mainly focused on studies in watersheds and large river basins. This study is focused on field hydrological process and we amended the narration about the model classification method in the revised manuscript. And the statement about the TOPMODEL and SWAT model was deleted in the revised manuscript.

To the question if SWAT used a regionalized Darcy Equation: In SWAT uses Darcy's law for each HRU that can be at many places in the landscape. Not sure if we can call this regionalized.

Comment10. Line 91: delete 'water'

Response: The "water" was deleted in the revised manuscript**.** Please see the response to comment 6 for the whole paragraph. Here are the specific sentences

"The latter is unique to shallow groundwater areas where the moisture content and thus the unsaturated conductivity are high and where the drying of the surface soil sets up hydraulic gradient that causes the upward capillary movement from the shallow groundwater (Kahlown et al., 2005; Liu et al., 2016; Luo and Sophocleous, 2010; Yeh and Famiglietti, 2009)."

Comment11. Line 95: why is this cutoff 3.3m? If this is related to field capacity water tension, please mention it here.

Response: Yes, it was related as indicated in the comment. The paragraph is as follows

"In the Yellow River basin various models have been developed to simulate the soil water content and water fluxes. Full models that have been used are the HYDRUS-1D (Ren et al., 2016), and finite difference model application by Moiwo et al., (2010). Surrogate models for the North China plain where the groundwater is more than 20 m deep have been published by Wang et al. (2001); Kendy et al (2003); Chen et al. (2010); Ma et al. (2013); Yang et al. (2015, 2017); Li et al., (2017). In these models, the matric potential is ignored, and the hydraulic potential is equal to the gravity potential and thus the thus the gradient of the hydraulic potential is unity (at least when it is expressed in head units). Under these conditions the water flux becomes negligible when the soil reaches field capacity at -33 KPa (equivalent to -3.3 m in head units) at what point the hydraulic conductivity becomes limiting . These models are not valid for irrigation projects along the Yellow river with shallow groundwater because the matric potential cannot be ignored over the short distance between the water table and the surface of the soil. Since the gravity and matric potential are of the same order, the water moves either down to the groundwater or up from the groundwater to the root zone depending on the matric potential at the soil (Gardner 1958; Gardener et al, 1970a,b). In summary, thus for shallow ground water at less than 3.3 m from the surface equilibrium is reached (i.e. fluxes negligible) when hydraulic gradient is zero (i.e., matric potential and gravity potential add up to constant value) and thus not when the conductivity becomes limited at a matric potential of -33 KPa ".

Comment12. Line 113: change to 'soil moisture characteristic curve' .

Response: Thank you for your suggestion. The sentence was change to

> "The moisture content at field capacity (which we call equilibrium moisture content in this manuscript) is thus a function of the groundwater depth and can be found with aid of the soil moisture characteristic curve"**.**

Comment13. Line 125: delete 'main'

Response: We deleted it in the revised manuscript**.**

Comment14 .Line 127: check on the unit a-1 (not superscripted) as a valid metric unit for 'year' as you do later.

Response: "a" is the official SI unit for year (see for example https://www.iau.org/publications/proceedings_rules/units/). It is therefore being used in manuscript but we agree it is not very common. We have reverted back to "y" for year in the manuscript. The particular sentence was revised as

> "The average annual precipitation is 180 mm and the annual potential evapotranspiration is 2225 mm (Luan et al., 2018)".

Comment15. Line 129: what is the reason to mention the number of daylight hours per year?

Response: We were of the opinion that it was the basic information for the study. Actually, it is not necessary, and we deleted this in the revised manuscript**.**

Comment16. Line 135-136: Change to 'The sowing dates were respectively.

Response: We revised the sentence to

> "The sowing dates were April 24, 2016 and May 13, 2017".

Comment17. Line134: for clarity, call the fields in 2017 B1 and B2?

Response: Thank you for your suggestion and we changed the fields C and field D to the fields B1 and B2 in the revised manuscript**.**

Comment18. Line 140: change 'on' to 'at'.

Response: Thanks for your suggestion. We changed "on" to "at" in the revised manuscript.

Comment19. Line 142: change 'were showed' to 'are shown'; I think you mean to say 'during the growing season' because you are not identifying any growth stages explicitly in the figures.

Response: The sentence has been revised as

> "Precipitation and ET_0 during the growing season are shown in Fig. 2" in the revised manuscript**.**

Comment20. Line143: change 'experiment' to 'experimental'

Response: We corrected "experiment" to "experimental" in the revised manuscript.

Comment21. Line 159: change 'crop growth period' to 'the growing season'

Response: Thanks for your suggestion. The Title of the Figure 2 was changed to

> "Daily reference evapotranspiration (ET_0), and Precipitation during the growing season".

Comment22. Line 161: reword to 'soil moisture at field capacity () and at saturation ()

Response: We changed the "field capacity" to "soil moisture at field capacity" and "saturated soil moisture" to "soil moisture at saturation" in the revised manuscript**.** The text is now as follows

> "Soil samples were collected in rings from the same five layers where moisture contents were measured and used for determining soil physical properties including soil moisture at field capacity (θ_{fc}), soil moisture at saturation (θ_s), dry bulk density (ρ), and saturated hydraulic conductivity (K_s) (Table 3). For Fields A, B, B1 and B2, the saturated hydraulic conductivity was determined by the constant head method. Field capacity was determined at -33 kPa and bulk density was determined by oven drying and dividing by the volume of the ring…"

Comment23 Line 163: change 'measured' to 'determined' twice in this sentence.

Response: Thank you for your suggestion. The sentence was revised as

> "For Fields A, B, B1 and B2, the saturated hydraulic conductivity was determined by the constant head method. Field capacity was determined at -33kPa and bulk density was determined by oven drying and dividing by the volume of the ring." in the revised manuscript.

Comment24 Line 166: please add texture classification to

Response: The American soil texture classification was used in this study and this information was added in the revised manuscript.

Comment25 Line 168: change Table heading to 'Soil physical properties : : :.' – If fields C and D are the same as field B, what might explain the difference in soil properties shown? I suggest you add standard deviations for the average values provided.

Response: The soil in the field was deposited when the Yellow River flooded and therefore variable, explain the differences in properties

The heading of the table was changed to

> "Soil physical properties of the Fenzidi experimental fields" in the revised manuscript as your suggestion."

Comment26. Line 180: change heading to 'Soil texture of Fields A and B'

Response: Thank you for your suggestion and we changed the heading to

> "Soil texture of Fields A and B".

Comment27. Line 188: change to 'in hydrological and soil sciences'

Response: we change in the revised manuscript, the phrase to

> "in hydrological and soil sciences"**.**

Comment28. Line 192: add comma after 'effective saturation'; note that only S and phi variables are used in this equation, so theta variables do not need to be defined.

Response: Thanks. The paragraph is as follows

> "The Brooks-Corey model can be expressed as (Gardner et al., 1970a; Gardner et al., 1970b; Mccuen et al., 1981; Williams et al., 1983).

$$S_e = \left(\frac{\varphi_m}{\varphi_b}\right)^{-\lambda} \qquad for \ |\varphi_m| > |\varphi_b| \qquad (1a)$$

$$S_e = 1 \qquad for \ |\varphi_m| \leq |\varphi_b| \qquad (1b)$$

in which S_e is the effective saturation φ_b is the bubbling pressure (cm), $\varphi_m$is matric potential (cm), and λ is the pore size distribution index. The effective saturation is defined as

$$S_e = \frac{\theta - \theta_d}{\theta_s - \theta_d} \qquad (2)$$

in which θ is the volumetric moisture content, θ_s is the volumetric saturated moisture content, θ_d is the residual air dry moisture content (all in cm^3/cm^3). Equation 2 can be simplified to the form by setting $\theta_d = 0$

$$S_e = \frac{\theta}{\theta_s} \qquad (3)$$

For cases when the groundwater is close to the surface, under equilibrium conditions when the water flow is negligible (i.e., hydraulic potential is constant with depth), the matric potential can be expressed as height above the water table. For our field experiment the bubbling pressure, φ_b, and the pore size distribution index, λ, in the Brooks and Corey model can be obtained through a trial and error procedure by using the measured moisture content and matric potential derived from the groundwater depth after an irrigation event when equilibrium state was reached and sum of the gravity potential and matric potential was constant with depth.

Comment29. Line 196: reword (is it reasonable here to assume theta_d = 0? Figure 6 does not support this assumption.

Response: θ_d is the airdry moisture content. Thus, the assumption is fine especially since we are only interested in the "wet" part of the soil characteristic curve. The words "air dry" are added the residual moisture content to clarify the meaning. See response to comment 28.

Comment30. Line 201: check wording here

Response: The changed wording is given at the end of the response to comment 28.

Comment31. Line 204: delete the second 'the'

Response: Thanks. We removed "the" as shown below

"The soil of the crop root zone is divided into several soil layers and each soil layer has its specific soil water characteristic curve. After a sufficiently large irrigation and rainfall event, the moisture content is at equilibrium after the drainage stops. After such an event, the soil moisture of vadose zone stays at the equilibrium moisture content as long as the evapotranspiration is less than upward flux from the groundwater"**.**

Comment32. Line 203-206: the paragraph needs better wording; should the vadose zone stay at equilibrium moisture content instead of the groundwater?

Response: Hopefully we clarified the confusion in the rewrite. The changed text can be found in the response to comment 31.

Comment33. Line 209: change to 'dependent on' Figure 3: does this Figure assume a capillary fringe (bubbling pressure) of _40cm? Maybe make note of this in the Figure caption

Response: We changed "dependent of" to "dependent on" in the revised manuscript and revised the figure 3 title to

"Figure.3 Illustration of drainable porosity for a soil characteristic curve with a bubbling pressure of 40 cm. The yellow and the blue line are the equilibrium moisture contents for the groundwater depth at 130 and 150 cm, respectively. The area between the two lines represents the amount of water for the decrease of groundwater table drained from the profile when the groundwater decreases from 130 to 150 cm”

Comment34. Line 224: delete ‘drained’

Response: We deleted ‘drained’ in the revised manuscript.

Comment35. Line 254: should the first ‘and’ be deleted, or is a word missing? Add ‘flux’ after second ‘upward

Response: Thanks for finding the mistake. The first “and” was deleted and we add “flux” in the revised manuscript**.**

Comment36. Line 255: check spelling in ‘prede[te]rmined’ Figure 5: what explains the earlier predicted changes in groundwater depths compared to observed in 2017C and D?

Response: “Predermined” was corrected to “predetermined” in the revised manuscript.

The honest answer is that we do not know. If the initial water table for field C (B1) would have been greater and similar to that in field D (B2) the prediction in field C would have been closer to the observed value. .

Comment37. Line 321: the term ‘additional irrigation’ is not explained well here (but better in Lines 328-332). Does it mean that irrigation was applied to an adjacent field causing lateral inflow? If this is a possible effect, is there a similar lateral outflow flux possible to surrounding fields?

Response: We attempted to answer this comment under comment 4. Please see that response.

Comment38. Line 334: change ‘while’ to ‘whereas’

Response: Thank you for your suggestion and we changed “while” to “whereas” in the revised manuscript.

Comment39. Line338: switch the order of Figures 4 and 5, so they match the order of describing ground- water and soil moisture results.

Response: Thanks, we switched the order of Figures 4 and 5 in the revised manuscript.

Comment40. Line 345: change ‘at’ to ‘during’

Response: “at” is changed to “during” as your suggestion in the revised manuscript.

Comment41. Line 352: Can you include the value of the bubbling pressure?

Response: The values of the bubbling pressure were shown in Table 5 and we added this information in this sentence in the revised manuscript.

“It is interesting that while the soil profile was saturated (Fig. 4), the groundwater table was between 75-100 cm (Fig. 5). Before equilibrium moisture content was reached the water table was likely near the surface during the irrigation event. Because the drainable porosity was extremely small, even a minimum amount of evaporation or drainage would cause the water table to decrease to roughly the height of the capillary fringe equal to the bubbling pressure, φ_b, in Eq. 5. The bubbling pressure are listed in Table 5."

Comment42. Line 377: change 'indicates' to 'indicate'

Response: Done, thanks.

Comment43. Line 392: add 'the' in 'to the maturing stage'

Response: Thank you for your suggestion and we amended it to "the maturing stage" in the revised manuscript.

Comment44. Line 393: move parenthesis for the citation to just around the year (and remove the comma)

Response: We amended the phrase as your suggestion in the revised manuscript**.**

Comment45. Line 399: change to ': : : in general are in agreement : : :'

Response: Thank you for your suggestion. The sentence was revised in the revised manuscript.as

"The calibrated soil moisture contents of the five soil layers for the two fields in general are in agreement with the measured values in 2016 (Fig 4a, b)"

Comment46. Line 400: change 'one' to '1'

Response: This is indeed an exception to the general rule**.** It is changed.

Comment47. Line 403: change to 'realistically'

Response: We changed "realistic" to "realistically" in the revised manuscript**.**

Comment48. Line408: change 'less good' to 'worse'

Response: Thanks. We made the change.

Comment49. Line 409: change to 'coefficient of determination'

Response: Thank you for your suggestion and we changed it to "the coefficient of determination" in the revised manuscript.

Comment50. Line 416: change to 'depths'

Response: We made the change. The text is now as follows:

> "The moisture contents predicted by the Shallow Aquifer-Vadose Zone Model were validated with the 2017 data on Fields B1 and B2. Although the validation statistics of the five layers were slightly worse than for calibration in Table 7, the overall fit was still good as shown in Fig. 4c, d. The coefficient of determination varied between 0.39 and 0.90. The *MRE* varied between -0.09 and 0.19, and the mean *RMSE* range was from 0.01 to 0.07 cm^3/cm^3 for the five soil layers (Table 7-2)."

Comment51. Line 421: no need to write out RME; change 'is' to 'being'

Response: Thanks for your suggestion. The information about RME was deleted here. We amended the sentence as

> "Others statistical indicators show a good fit as well (Table 7-1)" in the revised manuscript."

Comment52. Line 422: no need to write out RMSE

Response: We delete the sentence about the RMSE in the revised manuscript.

Comment53. Line 428: insert 'to' as in 'related to groundwater depth'

Response: We corrected the phrase as "related to the groundwater depth" in the revised manuscript**.**

Comment54. Line 454: add period after 'al'

Response: We changed the sentence as follows:

> "In general, this surrogate model simulated the soil moisture content in each soil layer well, certainly when compared to other models that attempted the soil moisture contents in the Yellow River basin such as North China Plain (Kendy et al., 2003) and the Hetao Irrigation District by Gao et al. (2017b) during the crop growth period."

Comment55. Line 459: change to 'indicate'

Response: We changed "indicates" to "indicated" in the revised manuscript**.** Past tense is more appropriate.

Comment56. Line 466: change to 'relatively'

Response: We corrected it as "relatively" in the revised manuscript**.**

Thank you so much for the careful reading and all your suggestions**.**

References:

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