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Interactive comment on "A field validated surrogate model for optimum performance of irrigated crops in regions with shallow salty groundwater" *by* Zhongyi Liu et al.

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Responses to the comments of Reviewer #2:

We would like to thank reviewer 2 for his extensive and thoughtful 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. The equations, figures and tables were not showed in this text version. Please see the full responses of PDF version. Thank you so much. Zailin, Tammo and Zhongyi

General comments: Comment 1. Because the manuscript considers shallow groundwater and surface irrigation, it would help the reader to clarify what is meant by "surface irrigation" (which I assume to indicate flood type irrigation) and differentiate this from irrigation that is supplied from surface water (as opposed to groundwater supplied irrigation).

Response: Thanks for your suggestion. It was revised as

"In arid and semi-arid surface irrigation districts with flood irrigation and without a drainage infrastructure, the groundwater table is close to the surface because more water has been applied than crop evapotranspiration."

Actually, in the section 3.2, we explained it is flood irrigation "The fields were irrigated by flooding the field from two to five times during the growing season (Table 1)."

Comment 2. In the introduction, the authors discuss basic soil physics of hydraulic flow under conditions which require considering matric potential. This is one of the primary contributions of this model and analysis. Regarding the potential for the model to inform irrigation optimization, additional review of salinity management in surface irrigated systems would be appropriate. A model of hydraulic flow and salinity is interesting and potentially very helpful, but should be posed in terms of operational considerations that are relevant to irrigators.

Response: We are grateful for your suggestion. The model can potentially be used to optimum water use efficiency and crop yield but this was not explored in this manuscript. Therefore, the title of the manuscript was revised as

"A FIELD VALIDATED SURROGATE CROP MODEL FOR PREDICTING ROOTZONE MOISTURE AND SALT CONTENT IN REGIONS WITH SHALLOW GROUNDWATER"

Besides, the last three paragraphs in the introduction part was revised as

"The change in matric potential is often ignored in these surrogate models for soils with a deep groundwater table. However, for areas with shallow aquifers (i.e., less than approximately 3 m), the matric potential cannot be ignored. The flow of water is upward when the absolute value of matric potential is greater than the groundwater depth or downward when it is less than the groundwater depth (Gardner, 1958; Gardner et al., 1970a; b; Steenhuis et al., 1988). The field capacity in these soils is reached when the hydraulic gradient is constant (i.e., the constant value of sum of matric potential and gravity potential). In this case, the soil water is in equilibrium and no flow occurs. Xue et al. (2018) and Gao et al. (2017), developed models for the shallow groundwater, but used field capacities and drainable porosities that were calibrated and independent of the depth of the groundwater. This is inexact when the groundwater is close to the surface. Liu et al. (2019), used for simulating shallow groundwater the same type of model as described in this pater but calibrated crop evaporation and did not simulate the salt concentrations in the soil. This made their model less useful for practical application. Because of the shortcomings in the above complex models, we avoided the use of a constant drainable porosity and considered the crop growth and thus improved the surrogate model in our last study (Liu et al., 2019). The objective of this research was to develop a field validated surrogate model that could be used to simulate the water and salt movement and crop growth in irrigated areas with shallow groundwater and salinized soil with a minimum of input parameters. To validate the surrogate model, we performed a 2-year field experiment in the Hetao irrigation district that investigated the change in soil salinity, moisture content, groundwater depth and maize and sunflower growth during the growing season."

Comment 3. The authors employed five standard statistical measures of model performance (RMSE. MRE, Nash-Sutcliffe, RËĘ2, and regression coefficient). It would add to the manuscript to discuss why these particular measures reflect model performance, or how they complement each other in evaluating the robustness and representativeness of the model outputs. It would strengthen the results if the analysis included some hypothesis testing, beyond the validation and sensitivity analysis which are presented. There is certainly sufficient sampling (both experimental and modelled) to prepare a compelling significance test.

Response: Thanks for your suggestion. When only one indicator was used to quantify the goodness-of-fit of observations against model simulated values may lead to incorrect verification of the model (Ritter and Muñoz-Carpena, 2013). The combination of these statistical indicators were used to quantify the performance of model. In this manuscript, five indicators which were widely used to evaluate the performance of hydrological models were used (Ren et al. 2016; Xu et al., 2016). As this reviewer point out, we will add an explanation about roles of these indicators in the method section. In addition, we will consider further analysis on the field and simulated data.

Comment 4. The authors refer to "soil moisture content" and "soil water potential" somewhat interchangeably. Here moisture content is referred to at -33kPa, which is a potential. Please be careful is clarifying this distinction here and throughout the manuscript. From line 248, the Brooks and Corey characteristic curve was used to relate soil moisture content to matric potential. The explicit treatment of the water and salinity flux in section 2.3.2 is helpful, but not sufficient, for me or the average reader to keep track of which parameters are modelled explicitly and which are derived, so keeping the units and variables clear will help a great deal.

Response: We are grateful for your suggestion. In our manuscript, we assume that the field capacity is not constant but a unique relationship as function of the matric potential. The matric potential is equal to the height above the water table (when expressed as a suction in length units).

The reason is that we refer to the moisture content at –33KPa that we do not use the traditional definition of field capacity for soil with at water table below 3.3 m when the conductivity becomes limiting. So we need to call the traditional field capacity something different, (i.e., moisture content at -33Kpa or 0.33 bar) the matric potential is -33kpa, which can also be expressed as the distance of the point above the water table. In the revised manuscript, we improved the readability of the section 2.3.2

"2.3.2 VADOSE Module For modeling the daily soil moisture content and groundwater depth, first we need calculate the soil moisture content at field capacity and the drainable porosity first based on the soil moisture characteristic curve. Besides, considering the water and salt movement is different when there have irrigation and/or precipitation, we simulate the daily soil moisture content and salt with downward flux or upward flux. 2.3.2.1 Parameters based on soil moisture characteristic curve for modeling Moisture content at field capacity Field capacity with a shallow groundwater is different than in soils with deep groundwater where water stops moving when the hydraulic conductivity becomes limiting at -33 kPa. When the groundwater is shallow, the hydraulic conductivity is not limiting and the water stops moving when the hydraulic potential is constant and thus the matric potential is equal to the height above the water table (Gardner 1958; Gardner et al.,1970a, b; Steenhuis et al. 1988; Liu et al., 2019). Assuming a unique relationship between moisture content at field capacity and matric potential (i.e. soil characteristic curve), the moisture content at field capacity at any point above the water table is a unique function of the water table depth. Thus, any water added above field capacity will drain downward. When the groundwater is recharged, the water table will rise and increase the moisture contents at field capacity throughout the profile. The moisture contents at field capacity were found by Liu et al. (2019) using the simplified Brooks and Corey soil characteristic curve (Brooks and Corey, 1964) (Eq. 8a and 8b), in which θ is the soil moisture content (cm3 cm-3), θ_s is the saturated moisture content (cm3 cm-3), φ_b is the bubbling pressure (cm), φ_m is matric potential (cm), and λ is the pore size distribution index. The moisture content at field capacity, θ_fc (z,h), for any point, z, from the surface water for a groundwater at depth, h, can be expressed as (Liu et al. 2019) (Eq. 9a and 9b), where h (cm) is the depth of the groundwater and z (cm) is the depth of the point below the soil surface. Thus (h-z) is the height above the groundwater and this is equal to the matric potential for soil moisture content at field capacity. For shallow groundwater, the matric potential at the surface is -33kPa when the groundwater is 3.3 m depth. For this matric potential, as mentioned above, the conductivity becomes limiting. This depth of the groundwater is therefore the lower limit over which the VADOSE module is valid. Evapotranspiration can lower

the soil moisture content below field capacity. Thus, the maximum moisture content in the VADOSE module is determined by the soil characteristic curve and the height of the groundwater table, and the minimum is the wilting point that can be obtained by evapotranspiration by the crop. Note that the saturated hydraulic conductivity does not play a role in determining the moisture content because inherently it is assumed that it is not limiting in the distribution of the water. Drainable porosity The drainable porosity is a crucial parameter in modelling the groundwater depth and soil moisture content. According to the soil water characteristic curve at field capacity, the drainable porosity can be expressed as a function of the depth. The drainable porosity is obtained by calculating the field capacity, W_fc (h) (cm) for each layer at all groundwater depths. The total water content at field capacity of the soil profile over a prescribed depth with a water table at depth h can be expressed as Eq.10, where θ_fc (j,h) is the average moisture content at field capacity of layer j that can be found by integrating Eq. 8 from the upper to the lower boundary of the layer and dividing by the length L(j) which is the height of layer j. The matric potential at the boundary is equal to the height above the water table. The drainable porosity, μ(h), which is a function of the groundwater depth h, can simply be found as the difference in water content when the water table is lowered over a distance of 2Δh (Eq. 11), where Δh =0.5L(j) (cm). 2.3.2.2 Downward flux (at times of irrigation and/or precipitation) and model output At this situation, the model can simulate the daily soil moisture content of different layer, the percolation from the upper layer to the next layer, the recharge to the groundwater, the soil salt concentration of different layer and the salt concentration of groundwater and the groundwater depth. Water A downward flux occurs when either the precipitation or irrigation is greater than the actual evapotranspiration. In this case, upward flux will not occur because the actual evapotranspiration is subtracted from the input at the surface. We consider two cases when the groundwater is being recharged and when it is not. When the net flux at the surface (irrigation plus rainfall minus actual evapotranspiration) is greater than that needed to bring the soil up to equilibrium moisture content, the groundwater will be recharged and the distance of the groundwater to soil surface decreases and the moisture content will be equal to the moisture at field capacity. The fluxes from one layer to the next can be calculated simply by summing the amount of water needed to fill up each layer below to the new moisture content at field capacity. Hence, the percolation to groundwater, R_gw (t), can be expressed as Eq. 12, where n is the total number of layers, θ(j,t) is the average soil moisture content in day t of layer j (cm3 cm-3), E_a (t) is the actual evaporation (mm), T_a (t) is the actual transpiration (mm), P(t) is the precipitation (mm), and I(t) is the irrigation (mm). When the groundwater is not recharged, the rainfall and the irrigation are added to uppermost soil layer and when the soil moisture content will be brought up to the field capacity and the excess water will infiltrate to next soil layer bringing it up to field capacity. This process continues until all the rainwater is distributed. Formally the soil moisture can be expressed as Eq. 13, where θ(j,t) is the average soil moisture content in day t of layer j (cm3 cm-3), R_w (j-1,t) is the percolation rate to layer j (mm) (Eq. 14) and can be found with Eq. 12 by replacing j-1 for n in the summation sign. For the uppermost soil layer, the water percolation can be expressed as Eq. 15. Salinity The salt concentration for layer j can be expressed by a simple mass balance as Eq. 16, where C(j,t) is the salt concentration of layer j at time t (g L-1). The equation can be rewritten as an explicit function of C(j,t) as Eq. 17. For the surface layer j=1, we obtain Eq. 18, where C_I is the salt concentration in the irrigation water (g L-1).The salt concentration of the groundwater Cgw(t) can be estimated as Eq 19. Where C(5,t) is the soil salinity concentration of the soil layer 5 on day t (g L-1), G(t-1) is the difference of the groundwater depth and the depth that the largest groundwater table fluctuations depth of groundwater table on day (t-1) (m) (Xue et al., 2018), C_gw (t) is the soluble salt concentration of groundwater at day t (g L-1). 2.3.2.3 Upward flux and model output For the upward flux period, the downward water flux to groundwater is zero. The evapotranspiration leads to the decrease of soil moisture content in the vadose zone and lowers the groundwater table due to the upward movement of groundwater to crop root zone and soil surface. The soil moisture content is calculated by taking the difference of equilibrium moisture content associated with the change of groundwater depth. At this situation, the model can output the daily soil moisture content of different layer, the upward groundwater flux, the groundwater depth, the soil salt concentration of different layer and the salt concentration of groundwater. Water The groundwater upward flux, U_gw (h,t), is limited by either the maximum upward flux of groundwater, U_(gw,max) (h), or the actual evapotranspiration, formally stated as: Eq. 20-22, where U_(gw,max) (h) is the actual upward flux from groundwater (mm), E_a (t) is the actual evaporation at day t (mm), T_a (t) is the actual transpiration at day t (mm), E_a (j,t) is the actual evaporation at day t of layer j (mm) and T_a (j,t) is the actual transpiration at day t of layer j(mm). The maximum upward flux can be expressed as Eq. 23 (Liu et al., 2019; Gardner et al., 1958), where a and b are constants that need to be calibrated, h is the groundwater depth (cm). Two cases are considered for determining the moisture contents of the layers depending on whether the actual evapotranspiration is greater or less than the maximum upward flux. Case I: In this case, where the maximum upward flux is greater than the evaporative demand, the groundwater depth is updated as Eq. 24, where μ(h ÌĚ) is the average drainable porosity over the change in groundwater depth h. The moisture content after the change in groundwater depth becomes as Eq. 25. Note that when the layer is at field capacity and the upward flux is equal to the evaporative flux, the layer remains at field capacity for the updated groundwater depth at time t. Case II: In this case, the groundwater depth is updated as Eq. 26. When the upward flux is less than the sum of the actual evaporation and transpiration, the moisture content is updated with the difference between the two fluxes, U_(gw,max) (h) and [E_a (t)+T_a (t)], according to a predetermined distribution extraction of water out of the root zone (Eq. 27). The upward flux of water can be found by summing the differences in moisture content above the layer j similar to Eq 14, but starting the summation at the groundwater. Salinity The salt from groundwater is added to the soil layers according to the root function. The soil salinity concentration in layer j at day t can be expressed as Eq. 28. Since water is extracted from the reservoir that has the same concentration as in the reservoir, the concentration will not change, hence the equation used to estimate the groundwater salt concentration can be expressed as Eq.

29.”

Comment 5. In Figure 9, it is hard to relate how the predicted soil characteristic curve has been fitted to the observed data. The explanation about points being located to the left of the curve due to mismatched rates of recharge and root extraction makes sense, but not if virtually all the observations do not fall on or near the curve. This becomes more important in the next section on sensitivity analysis. If the sensitive input parameters are, as the authors say, related primarily to soil hydraulic properties, then it would help the reader to understand how the authors addressed uncertainty in these parameters. It is clear that the authors have done substantial work to calibrate the model to Response: We agree that we could have explained this section better: The points that are to the left of the curve are those when the evaporative demand is greater than the upward flux. At these moisture content the soil moisture content is less that the traditional definition of field capacity at -33 KPa and hence the Darcy flux is extremely small and the soil dries out due to water uptake by the roots. Therefore, we omit these points when fitting the soil characteristic curve parameters (the bubbling pressure, the saturated moisture content and the exponent). Only the saturated moisture content is a very sensitive parameter (see section 4.3 Parameter uncertainty). There is little uncertainty in defining the saturated moisture content. There is a certain art in finding the other two parameters, but they are not very sensitive luckily in the final model outcome. (See section 4.3 on the sensitivity analysis). In performing the next experiment, a tensiometer should be installed in the soil and measure the suction and moisture content at the same time). This would avoid the current uncertainty. We changed the text in the paragraph as follows:

“To simulate the soil moisture content and to derive drainable porosity as a function of water table depth, the soil moisture characteristic curves were derived by plotting the observed soil moisture content in 2017 and 2018 versus the height above the water table to the soil surface for the five soil layers in Fig. 9. The Brooks-Corey equation (Brooks and Corey, 1964) was fitted through outer envelope of the points. The param-

eters of the Brooks-Corey equation were adjusted through a trial and error to obtain the best fit (Table 3a). In Fig. 9, points on the left side of the soil moisture characteristic curve (moisture content smaller than the field capacity) were due to water removal at times when evaporative demand was greater than the upward water flux. Under these conditions the conductivity is limiting in the soil and there is no relationship between groundwater depth and matric potential. Since we take the water table depth as proxy for matric potential, these points are omitted when drawing the soil characteristic curve. The few points at the right of the soil moisture characteristic curve indicate the soil moisture was greater than field capacity and matric potential and groundwater were not yet at equilibrium after an irrigation event.”

Minor comments:

Comment 1. Line 168: I generally agree with the statement that "Finer resolution is not needed for managing water and salt content for irrigation". However, other aspects of irrigation management are managed on shorter time periods and consider environmental variables that are not well represented by daily averages. I think it is important to specify the limits of any model, especially surrogate models and models that couple processes that operate over different time and spatial scales. As noted by the authors (line 89), surrogate models are not as versatile as complex models. In keeping eiththe intent of making the model generally useful under real world conditions, please be more explicit about the range of conditions under which this model has been shown to work.

Response: Thank you for your suggestion. Here, we aimed to stress our study is daily time step and cannot be used to simulate the instantaneous change of water and salt. Furthermore, In the revised manuscript, the section 2.3, it was revised as:

“In the next section, the equations of the CROP in the VADOSE modules are presented. The calculations are carried out sequentially on a daily time step. This model predicts field daily soil water, salt content and crop growth, which are critical parameters for irrigation water management. For field and regional water management and irrigation policy development, resolution of daily time step is sufficient. Finer resolution is not needed for managing water and salt content for irrigation. . .”

Comment 2. Line 206: Considering that maize and sunflowers have very different responses to drought and salinity, and different root development/depth, please discuss further why the same δ values were used for both crops. Otherwise the discussion of root functions is adequate for this presentation.

Response: We tried to find a reference for “δ” of sunflower, but we did not come across a reference. The study of Chen et al. (2019) also used the same δ for all crops in his model. For both sunflower and maize the main roots are both in the upper 90cm. Thus we use the same δ here.

Comment 3. Line 393: It is a minor point, since Figure 3 is not used except to provide a general visual reference, but please check your citation of the GE imagery. In general, include date of the image, and the date that the image was downloaded.

Response: Thanks for your suggestion. Figure 3 was used to show the geographical location of experimental field in section 3.1. The GE imagery is the day of April 8, 2019 and was downloaded on April 8, 2019. We add this information in the revised manuscript. Fig. 3 Location of the Shahaoqu experimental field (Note: The figure was downloaded from Google earth. The imagery is taken on April 8, 2019)

Comment 4. Lines 411-421: Were manual measurements of soil moisture taken in field B at any point in 2018 to calibrate/corroborate the Hydra Probe sensor measurements?

Response: Yes, the soil moisture content of field B was also manual measured to calibrate the Hydra Probe sensor. And in the manuscript we only show the calibrated data of the Hydra Probe sensor to compare with the simulation results. In the section 3.2,we add this information:

“. . .The soil moisture content for the four experimental fields in 2017 and for field C in 2018 during the crop growing season was measured every 7-10 days at the depths

of 0-20, 20-40, 40-60, 60-80, 80-100 cm by taking soil samples and oven drying. In 2018, in addition the soil moisture content at same depths was monitored daily using Hydra Probe Soil Sensors (Stevens Water Monitoring System Inc., Portland, OR, USA) in field B except the oven drying method. The Hydra Probe was calibrated using the intermittent manual measurements. In 2017, the groundwater depths were manually measured in all four experimental fields about every 7-10 days. . ..”

Comment 5. Line 437 and elsewhere: Some symbols (such as theta for volumetric water content) are italicized at some points in the text, but not in other places or in tables. Please use a consistent symbol and font so that notation is clear throughout the manuscript, and define each symbol at first usage. Also, please be consistent with notation subscripts (f.c., 33, 15, etc.). Because the manuscript describes calculation steps and several equations and several cases for each equation, a table with all notation for variables and subscripts may be very helpful to the reader. Also, I could not find the first usage of ms cmËĘ-1, which may need to be explained as millisiemens per centimeter, and is typically noted as mS cmËĘ-1, with siemens capitalized.

Response: Our apologies for missing this. The first mS cmËĘ-1 appeared in Eq. 6 which used to calculate the salt stress coefficient. We revised the notations to keep it consistent and a table with all notations for variables and subscripts was added in the revised manuscript.

Comment 6. Line 485: While the period in 2017 is five weeks longer than the period in 2018, this is still a remarkably large difference in reference ET between the two growing seasons. Please offer some explanation why ETref would differ so much in 2017 and 2018. Response: The Penman-Monteith equation was used to calculate the reference evapotranspiration (Allen, 1998). The total precipitation was 63mm and 108mm in 2017 and 2018 during study period, respectively. There were more rainfall days in 2018 than in 2017, which lead to the total ET0 is greater in 2017 than in 2018 during June 1 to September. Besides, the wind speed was high and the evapotranspiration was high in May. In the study of Ren et al. (2017) and Miao (et al. 2016), the daily ET0 is over 6 mm per day. Hence, the ET0 during the study period in 2017 is greater than in 2018. In the revised manuscript, we add this explanation:

“. . .The reference evapotranspiration ranged from 1 mm d-1 to a maximum of 6.4 mm d-1 during crop growing period (Fig. 4). The total reference evapotranspiration from May 10 to September 30, 2017 was 595 mm and 368 mm from June 1 to September 15, 2018. The reason was that there were more rainfall days in June, July and September in 2018 than in 2017, which increased the amount of water available for the evaporation by the crop in 2018. In addition, the wind speed was high in May that increase the evapotranspiration was elevated. In the study of Ren et al. (2017) and Miao (et al. 2016), the daily ET0 was over 6 mm per day on May. Hence, the ET0 during the study period in 2017 was greater than in 2018.”

Comment 7. Lines 543-546: Even if there is not proper documentation, is there some supporting information to corroborate the suspected spillover event? Why would this event occur five times (twice in 2017 and three times in 2018) in field C (located in the center of the other fields) and not be observed in the adjacent fields?

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. The spillover event is just our guess about this strange phenomenon and we have no supporting information to corroborate this suspect. In our last study (Liu et al., 2019), we also have same phenomenon. And our hypotheses of the increase of the groundwater depth 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 explanation might be that in a nearby field was irrigated increasing the water table. Since pressure travels with the speed of sound and there is only a tiny amount of water displacement necessary to change the water table height when the pressure is changed, this could also cause the water table height increase. Clearly more research is needed to define the cause.

We changed the paragraph to include the above as:

“The variation in groundwater depth during the growing season was very similar for both years and in all fields. The groundwater depth for all fields was between 50 and 100 cm from the surface after an irrigation event and then decreased to around 150 cm before the next irrigation or rainfall (Fig.7). Only after the last irrigation in August 2017 did the water table decrease to below 250 cm and to around 200 cm in 2018. Field D followed the same pattern but the groundwater was more down from the surface. In several instances, the groundwater table increased without an irrigation or rainfall event in sunflower field C (Fig. 7c and 7e). This was likely related to an irrigation event either from an irrigation in nearby field that affected the overall water table or an accidental irrigation that was not properly documented. We estimated the amount of irrigation water based on the change in moisture content in the soil profile (orange bars in Fig. 7c and 7e). Finally, there was a notable rise in the water table of an mean 375mm “autumn irrigation” after harvest between the end of 2017 (Figs. 7 a, b, c) and the beginning of 2018 (Figs. 7 d, e, f), which is a common practice in the Jiefangzha irrigation district to leach the salt that has accumulated in the profile during the growing periods.”

Comment 8. Figures 11-13: Enclose the legend within a box so that legend entries can’t be mistaken for data. This is especially evident in figure 11, where the legend entry is the same size as the data.

Response: Thanks for your suggestion. And the legend was enclosed in a box.

Comment 9. Section 4.4.3: Apart from a visual resemblance of correlation between the predicted and observed salinity in figure 16, the RËĘ2 and NSE do not support the idea that "the observed and predicted values were in close agreement (Fig. 6, 16 ", nor the claim that " the model can predict the law of salt concentration fluctuation during crop growth period and the prediction results are acceptable." Based on my reading, it might be more accurate to say that variability was low on a daily time step, and that initial salt concentration is the most important parameter to measure on a seasonal basis. However, I can see how this would undermine the usefulness of the model, and I do think the model and this work merit further attention. The authors have attributed a potential cause of low NSE to the low variability, but this is also related to the relatively small sample size. It might help to assess this with some kind of significance test. Here is one possible approach which I found with a quick google scholar search: Ritter et al., 2013, "Performance evaluation of hydrological models: Statistical significance for reducing subjectivity in goodness-of-fit assessments" https://doi.org/10.1016/j.jhydrol.2012.12.004

Response: Thank you for providing the reference for the Ritter et al (2013) reference. We agree that overstated the goodness of fit for the salinity concentration in the soil. Visually the fit is reasonable, but the statistics do not show that. Clearly more work is needed, but before it can be modeled, other and detailed information is needed. Especially we the effect of the autumn irrigation after crop harvest and the freezing of soil on salt transport need to be studied Based on the comment above we changed section 4.3.3 as “The only parameter that could be adjusted each year for calibration of the salt concentrations was the initial salt concentration. The predicted salt concentrations in the top layers decreased after an irrigation event similar to the limited observed values (Figs. 6). Despite that the salt concentration fitted visually reasonably well as shown in Figures 6 and 16, there was a bias of 8% in the data and consequently the Nash Sutcliff efficiency could not be applied (Table 4) (Ritter and Muñoz-Carpena, 2013). Similarly, to the moisture contents, the salt concentrations in the layers below 40 cm were predicted more accurately than the layers above the 40 cm. More data should be collected during the whole year on the salt concentrations in the soil in order to better predict the salt concentrations”

References

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Please also note the supplement to this comment:
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