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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A Salinity Module for SWAT to Simulate Salt Ion Fate and Transport at the Watershed Scale" *by* Ryan T. Bailey et al.

Anonymous Referee #2

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General comments: This work aims at simulating the fate and transport of 8 major salt ions (SO42-, Ca2+, Mg2+, Na+, K+, Cl-, CO32-, HCO3-) in a watershed hydrologic system using a new salinity transport module implemented in the SWAT code. This modelling code for salt transport includes surface runoff, percolation, soil lateral flow, groundwater flow and streamflow and also considers equilibrium chemistry reactions in soil layers and aquifers. This paper addresses with an interesting and practical approach the concerning thematic of soil and aquifer salinization. This study uses a quantification approach with salt balances performed in the watershed, includes the constituent mass in irrigation water, and the contribution of each salt ion to the salinity, which is less seen in published studies were the focus is the total of salts. Also, considering the new tool proposed that helps in predicting the impact of irrigation practices

and in controlling salinity, I suggest the publication of this work after major revision.

Specific comments: 1. Line 53 "Currently, there is no model that simulates salt transport in all major hydrologic pathways (surface runoff, soil percolation and leaching, groundwater flow, streamflow) at the watershed-scale that also considers important solution reaction chemistry." Actually there is MOHID LAND model that is also coupled with SWAT. MOHID LAND is a physically-based, spatially distributed, continuous, variable time step model for the water and property cycles in inland waters and main mediums that also includes a chemical module PHREEQC that considers chemistry equilibrium of solution, pure phases, gas phase, solid phase, exchanges and surfaces in Porous Media (soil and aquifer). The authors should include in the Introduction section the existence of MOHID-LAND and make comparisons. 2. There is some lack of detail on how the calculation routines for the new module are performed, namely how does it integrate salt ions reactions with the SWAT water flow and solute transport. How many parameters were used in the model calibration and validation? The data needed for SWAT modelling is not clear where it comes from, for e.g. the land cover, the soil, the crop and meteorological data (databases?). 3. For each HRU the mass of the several salt ions is generated by the several processes. In runoff how is defined the salinity percolation coefficient (ïĄć Si) and the surface runoff lag coefficient (surlag), what value is attributed and why? Explanation is needed. 4. Line 144-145, "The mass of each salt ion is routed through the channel network with water, with no chemical reactions changing in-stream salt ion concentration". Why no chemical reactions are considered in-stream to change salt ion concentration? Chemical reactions also happen in in-stream water, right? 5. Line 225, "Initial concentrations are required for each HRU." And Line 226-227 authors refer that "...(all HRU values are the same) concentration values yields the same result as using spatially-variable initial concentrations, if a warm-up period of several years is used in the SWAT simulation." Why it was not considered the average concentration for each sampling site spatially located near the HRU? From a theoretical point of view, does not seem correct to use as inputs non-spatially concentrations, even because the model will need a warm-up period of

several years. 6. Line 297-299, “Observed soil EC values were obtained using a saturated paste extract, and hence comparison with model results will not be as rigorous as for groundwater and surface water data.” Why the comparisons with model results will not be as rigorous as for groundwater and surface water data? EC measured in a saturated paste extract (ECe) is related to the EC of the soil water (ECsw). Have you considered to use of Ayers and Westcot (1985) conversion, Skaggs et al. 2006 or using other conversion with the % saturation? 7. Line 293-294, “Only minimal manual calibration was applied to the model, to yield correct magnitudes of salt ion concentration in soil water, groundwater, and stream water.” Why this approach of minimal manual calibration? And why just consider SO42- for calibration? Even understanding that from your sampling the SO4 accounted for 47% of total in-stream salt mass, it would be a more solid calibration using other salt ions (especially Na), and more applicable to other studies. Can you calibrate with more salt ions? 8. Line 314, “The model does not perform as well in downstream sites, with NSE at La Junta and at Las Animas”. Why the model performance is better in Rocky Ford site than in Crooked Arroyo site? What are the reasons for the weaker performance at downstream locations? Explain better in the manuscript. 9. In Fig. 14 it is observed the importance of including equilibrium chemistry into the salt transport. The no SEC simulations are underestimating the in-stream TDS. Can you explain why this underestimation is not so evident in the downstream location Las Animas? I was not expecting this.

Technical corrections: 1. All ionic forms must written considering the ionic charges (e.g. SO42-, HCO3-, etc.). Correct in all the manuscript. 2. Line 59,79, 88: where its written “soil later flow” should be “soil lateral flow”? 3. Line 123: it is written “TTlag” should it be “TTlat”? 4. Line 128: where the variable Qlat,ly is described, it should refer to Qperc,ly. 5. Line 162: refer to the 8 aqueous species writing them in the ionic form. 6. Line 180: the molality is missing the subscript (mi). 7. Line 191: the equation mentions NaCO3- that differs from the complexed specie NaCO30 in table 1. Correction needed. 8. Line 197: there are two “in” in the sentence. 9. Line 176: C and D should be the products. 10. Line 177: Present the equation for ith 11. Line 216: It is written “(meq/100)” and

it should be “(meq/100g)”. 12. Line 246: The use of commas in separation of group numbers was confusing when referring to concentrations of mg/L. In HESS guidelines for authors states that “Neither dots nor commas are permitted as group separators.” Correct this in all manuscript. 13. Line 318: The sentence “Las Animas also has an R2 value of 0.74.” appears redundant since the R2 was already commented in the previous sentence. Did the authors wanted to comment the R2 for Timpas Creek? 14. Line 324: “The relationship for Crooked Arroyo yields an R2 value of 0.80.” This refers to data not shown? 15. Line 334: There are to “a” before stochastic in the sentence. 16. Line 382: its written “mas” and should be “mass”.

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