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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 #1

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General comments: This work focused on developing a new watershed-scale salt ion fate and transport model based on SWAT model, which can account for salt loading for each major hydrologic pathway in a watershed setting for each major salt ion (SO4, Ca, Mg, Na, K, Cl, CO3, HCO3). This is very interesting work trying to quantitatively estimate the chemical and physical characteristics of the common ions, which is important for soil salinity control in semi-arid areas with shallow water table depth. Since most current research mainly focused on the transport of total salt in surface and subsurface system while not distinguish the contribution of different ions and the reactions, this work provides the new view and method for soil salinity control. I would think this work is valuable and can be published by major revision.

Major revisions: (1) The numerical integrating method to couple the ion reactions and

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water flow and solute transport model SWAT should be illustrated in details. This will help for understanding the model. (2) How many parameters were included in this model? There is no any introduction about the parameters used in the model calibration and validation, e.g., the salinity percolation coefficient βSi, the surface runoff lag coefficient surlag. How do you set the value of these parameter, which are important to judge the reasonability of the model? (3) Line 60-61," The soil water and groundwater concentration of each salt ion is also affected by equilibrium chemistry reactions: precipitation-dissolution, complexation, and cation exchange". Actually, the reactions also happen in the surface water, why not consider the chemical reactions in surface water? (4) Line 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. Targeted parameters were the solubility product of CaSO4 precipitation-dissolution, and the soil fraction of CaSO4." Why is only the CaSO4 used to calibrate the model? Is this due to the major ion is SO4 in this region? (5) What are the principle for setting the HRU with 5270? In Line 225, "Initial concentrations are required for each HRU." Were all the salt concentration of these 5270 HRU measured? Otherwise, how would you set the initial value? (6) Line 350. The simulations for TDS and SO4 are much better than other ions, what are the possible reasons? Is this related to the targeted parameters of CaSO4 been used in calibration mentioned in Line 294? So, if the model is used in other cases, how would you choose the targeted parameters in the calibration? How about choosing other targeted parameters in this case? (7) As shown in Fig.5, the simulation results in Rocky Ford Site are much better than those in Crooked Arroyo Site. What are the reasons? The simulation results of Na, Mg should be also shown to judge the model accuracy since the relative high concentration of these two ions as shown in Table 2. (8) From Fig.5 and Fig.6, the simulated ion concentration fluctuated much stronger than the observed value, even the simulated value closed to zero. Is this caused by the numerical instability of coupling the ion reaction module with SWAT? Or what are the major factors resulting in the strong fluctuations? (9) More discussion about the contribution of different ions on salt accumulation should be added in the

case discussion. Only the salt balance components for TDS were analyzed in Fig.12. (10) Line 329-332, are the portions of salt load calculated by the model? How would you judge the reasonability of the results?

Minor revisions: (1) Line 33, SO4-, should be SO42-. All the ions should be shown with positive and negative charges in all the other parts in the manuscript. (2) Line 88, “later”, should be “lateral”? (3) Line 133, “mas”, should be “mass”. (4) Line 176, “C and D are reactants.” Should be “C and D are products.” (5) Line 177, what is the equation of iA? (6) Line 180, “mi”, should be “mi”. (7) Line 197, there is two “in” in the sentence. (8) Line 250, “SO4” should be “SO42-”. (9) Line 295, “produce” may be “product”? (10) Line 382, “mas” should be “mass”.

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