

Modeling evaporation processes in a saline soil from saturation to oven dry conditions

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General comments:

In general I think that it is an interesting paper that discusses an interesting phenomenon of saline solution evaporation. This phenomenon attracts some attention recently (for example a recently published paper in *Water Resources Research* by Nachshon et al.) and I believe that indeed there are still some very interesting and unresolved related scientific questions. This paper tries to shed some new lights on the relevant mechanisms. I have one major problem with the author's results and model interpretation. They emphasize the vapors downward flow due to thermal gradient (and subsequently vapor pressure gradient) as the main mechanism which results in reduction of solution ion concentration near the evaporation front.

First I think that the major reduction in salt concentration along the soil profile is related to the fact that most of the salt is being accumulated near the matrix surface. Naturally, for mass conservation reasons, the increasing of salt mass in this region (soil surface or more accurately: at or near the evaporation front location) should be compensated by reduction in salt mass in deeper parts of the soil profile. In other words, the fact that c/c_0 (where c is the salt concentration) along the profile seen in Fig. 3 is likely to occur (per mass of soil!) regardless downward water vapor transport.

In Figure 3 the authors presents water saturation and salinity along the soil column. Does salinity concentration is expressed for the solution or for the soil? To support the reduction in solution salinity due to vapors condensation I believe that the authors are referring to solution concentration. But for the low water content regions and especially, the regions considered as "oven dry", the solution concentration is not relevant (practically speaking, there is no solution in the pores...). This is very confusing; both conceptually and practically in Figure 3.

Looking at Fig.1, it seems that there is vapor flux downward from the evaporation front. Maybe I miss something, but the water concentration below the evaporation front is supposed to be at saturation, isn't it? If so, why water vapor will move downward? Unless evaporation front here is not defined in the classical way. For example, if the "evaporation front line" is highly irregular, water vapor could move downward from "high capillary fingers" to dry area between these "fingers".

Another potential mechanism which the authors ignored is condensation of vapors on the precipitated salts crust. Subsequently, these condensed vapors can dissolve the precipitated salts and result in back diffusion of the dissolved ions downward.

Page	Line	Comment
General comment		The conceptual model is very unclear, mainly in the beginning of the paper. It is clarify a bit when getting to the Results section. I suggest to describe the conceptual model earlier in the text and to better describe it.
531	1-2	Authors mention (upon other references) that "... water flux in dry and salinized soils is controlled by salinity and temperature gradients...." without any consideration of the matrix properties. In many cases the matrix properties (e.g., permeability, porosity) may be the limiting factor for evaporation.
531	8	Authors are mentioning vapor downward migration upon the work of Gran et al., 2010. I would suggest elaborating a bit more about Gran's work as it is relatively new. It is not clear what the origin of the downward vapors is. Is it for a case of a receding evaporation front only?
532	2-3	Salt precipitation is mentioned in the text. Authors considered a salt precipitation pattern of "low permeability crust ". While the salt crust formation is correct for some salts (NaCl in particular) it is not the case for many other salts that precipitate in the pores, many times below the evaporation front. An example for these differences can be found at Rodriguez-Navarro and Doehne, 1999 (Earth Surface Processes Landforms) and in Nachshon et al. 2011 (Water Resources Resources). I suggest at least mentioning that the salt crust precipitation pattern is not the only possible salt crystallization formation.
532	3	Authors may want to mention Fujimaki et al. work from 2006 (Vadose zone journal), where salt crust effect on evaporation was modeled and compared to experimental results.
532	4-6	Unclear. Saturation of what?
532	20-28	Why do you consider only the epsomite experiments of Gran, while ignoring the Halite experiments?
532	20-28	I suggest mentioning the epsomite initial concentration, especially as at Gran et al. there are two concentrations for the epsomite experiments.
532	20-28	It is not clear from this work, nor from Gran et al., 2010 do evaporation rates (e.g., sand columns mass loss) were monitored continually during the evaporation experiments?
532	20-28	It is getting clear only at the results section why you are talking on oven dry conditions. Please try to clarify it here, as it looks strange to talk about oven dry conditions for natural, initially saturated conditions.
Figure 1		I assume the "Min. Conc." Stands for minimal concentration but I suggest to point it out. In oppose to Min. Conc., where is the maximal concentration at the pore solution is expected to be?
533	8	Indicate if talking about water content saturation or salt saturation.
533	12	It would be very useful to show your (Gran) salt concentration measurements here with a graph. If you want to leave it for the results section, at least show it conceptually. The process you are talking about is not very clear conceptually; where is the maximal salt concentration expected to be?
General comment regarding the salt concentration profile		In your conceptual model you are ignoring the ions diffusion within the solution which works against the ions advective flow with the solution capillary flow (Peclet number). As well, some works (e.g. Van Dam et al., 2009 GRL) talk

		about gravitational instabilities near the evaporation front which may drive convection flows of the pore solution which may postpone ion accumulation at the evaporation front.
General comment for equations		Nomenclature for equations variables is not good. Please go over the equations again and make sure all variables are described.
Table 1		Please make sure all variables in the equations are described.
537	5-17	Please explain why you choose initial conditions to be of two different materials. Does it mean you start your simulation for an evaporation front 1.5 cm below surface? Why did you choose the 1.5cm length? What about the process prior to this state, where matrix is fully saturated? Naturally, in the beginning there is no precipitated salt.
537	19	It could be that I miss here something, but if your initial conditions are of an evaporation front 1.5cm below the surface then it mean the evaporation process is 'on going'. Hence, it means that the radiation on the soil surface is already applied; therefore the isothermal assumption of 25°C for the entire column is somewhat problematic.
Figure 3		Does salinity concentration is expressed in mol/Kg of sand or Kg of solution? Obviously, this is an important issue.