SOILD 1, 119–150, 2014
Nagare et al. – “Coupled cellular automata for frozen soil processes”

RESPONSE TO REVIEWER COMMENTS: REVIEWER # 1

We thank Anonymous Reviewer # 1 for his/her comments. We understand that overall the reviewer does not want to us to change the manuscript. Following is our response to a couple of comments by the reviewer. The reviewer comment is placed in *italic* and our response is in normal font.

Reviewer Comment:

Meanwhile, from methodological point of view, the mathematical description of a CA model is presented rather poorly. Indeed, only global CA behavior is given formally, while cell updating rules are embedded into the flow-chart (Fig.2) Although, there is a commonly used way of CA presentation in the form of set of notions: Alphabet, Cellular space, transition rule. To describe a collection of CA, operating in common, composition techniques are used [Hoekstra, A. G., Kroc J., and Sloot P. M. A., 2010, Chapter 5]. Of course, authors have the right to choose formalism to be used in their paper. But, I think, it would be better to have a unified formalisms for CA simulation theory and methodology.

Author Response:

We acknowledge reviewer’s suggestion and have made a few changes to Sections 2, 3 and 4 to address the recommendation. In addition, we have updated the flow chart (Fig. 2) by introducing the equations that describe the local transition rules as well as other calculations into the flow chart.

Reviewer Comment:

Computation of functions in simulation thermal conduction and hydraulic conduction are independent and may be implemented in parallel yielding in decrease of computation time. But are these processes independent in real physics?

Author Response:

The processes are not independent in real physics. Although, the processes have been described as solved using parallel modules in our model, the processes are very much coupled in our solution as well. The coupling takes place in the heat balance module and through updating of model parameters and state variables at end of each time step. We have clarified this in Section 4 by introducing the following statement: “However, the processes are not independent and are coupled through updating of model parameters and state variables at end of each time step.”

Reviewer Comment:

The assumption that the soil is homogenous enough to consider its properties in bulk is very strong. Real soil pores are different in size and in form, if there are caverns and hygrophilous inclusions. It would be good if the model may be modified to simulate water movement inside the pores.

Author Response:

We agree that there is a porous media assumption associated with the validity of Richard's equation/Darcy's law as the local laws for water flow. However, the model could be easily modified to simulate the soil pore scale flow by simply implementing the relevant physics for the concerned cells. In this study, our main objective was to show the ability of CA to simulate coupled heat and water flow with soil freezing. The update rules and assumptions were therefore chosen accordingly. In near future, the soil pore scale flow could be implemented to upgrade the capabilities of the code.

Reviewer Comment:

What about 2D case and 3D case, which should be needed in case of anisotropy?

Author Response:

This is part of future research work.