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Interactive comment on "Coupled cellular automata for frozen soil processes" *by* R. M. Nagare et al.

Anonymous Referee #2

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General comments

The paper of Nagare et al. describes an original approach to face the 1D modeling of a complex hydrological coupled phenomenon, such as freezing and thawing cycles in soils. In my opinion the paper deserves to be published in SOIL, even though, owing to the novelty of the approach, some specific features need to be better explained or highlighted. In the following I list some specific comments, that should be addressed by the authors.

Specific comments

I particularly liked thorough introduction and first paragraph of Section 2 (Cellular automata), even though I would suggest to consider also the concept of "Macroscopic

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Cellular Automata" (Di Gregorio and Serra, 1999) opposed to classical CA approach used for fluid dynamics problems (e.g., Lattice Gas, Lattice Boltzmann)

P 122 LL 16-18: Actually, already Cervarolo et al. (2010) considered simultaneous heat and water transport in unsaturated soils (Eq. 42) in order to calculate a component of the surface energy balance (soil heat flux), even though they do not provide many details about coupled T-qw modeling

P 125 LL 21-22: it would be better to tell the reader where Eqs. (2) and (3) are placed (i.e., in the next paragraph). However, it's not clear at this point why Eqs. 2 and 3 should be applied sequentially. Some explanation can be found only later, in Section 4, in my opinion the sentence related to sequential application of Eqs. (2) and (3) is untimely if placed here, and should be better contextualized. Maybe the period should be rephrased

Section 4: this is my main point. While describing the flow chart, it's not easy to follow both references to equation numbers in the text and Fig. 2, especially from Heat Balance Module onwards. In my opinion, the best choice would be adding a box with simplified code lines, such as it is usual in informatics journals. Anyhow, I would suggest at least to modify Fig. 2, explicitly recalling equation numbers in related boxes. Furthermore, it would be interesting to know what programming language and development environment were used.

Section 6 – Comparison with experimental data: from the cited Nagare et al. (2012) I understand that the authors already investigated effects of freezing in lab. Why did they choose to not use their data? If possible, it would add much value to the manuscript

Convergence issues are only hinted at (P 123, L 21; P 125, L 17), but this is a central point while dealing with direct explicit methods. Authors should go into more details, trying to better highlight constraints for the choice of the right time step

Conversely, a great advantage of direct explicit methods and, mainly, CA is the ease

SOIL

1, C24–C26, 2014

of parallelization. Of course this advantage cannot be appreciated with simple one-column experiments. If not possible already with this paper, it would be very interesting in the future to show computational scalability of more complex 2D/3D test cases

Technical corrections

P121 L19: it should be “Dall’Amico et al.”

P121 L28: variably, not varibaly

P 124 Eq.1: phi in this equation is written in a different way respect to L6

P 128 L6: maybe SFCs instead of SFC’s?

P 144 Fig. 2 caption: I guess it’s “through”, not “though”

Fig.3: in the figure there’s q, not theta

P129, L24-25: Ti? I think it’s not introduced before

P 135, L8: it should be Fig.7a and b, not 6

P 137 L7: not “staright” but “straight”

Suggested References

Di Gregorio, S., and Serra, R., 1999. An empirical method for modelling and simulating some complex macroscopic phenomena by cellular automata. Future Generation Computer Systems, 16, 259-271

Cervarolo, G., Mendicino, G. and Senatore, A., 2010. A coupled ecohydrological–three-dimensional unsaturated flow model describing energy, H2O and CO2 fluxes. Ecohydrol., 3: 205–225.

Interactive comment on SOIL Discuss., 1, 119, 2014.