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The Cryosphere Discussions

Interactive comment on "An energy-conserving model of freezing variably-saturated soil" *by* M. Dall'Amico et al.

Anonymous Referee #3

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Overall evaluation: Acceptable with minor revision

Comments

The scientific problems discussed in this paper are very relevant to the scope of Cryosphere journal. Recent climate warming has a profound effect on permafrost in most areas of the Northern Hemisphere. Changes in permafrost should be realistically predicted in any efforts related to prediction and mitigation of below ground surface changes in many permafrost regions. The authors address a very important aspect of permafrost research such as the numerical modeling of permafrost dynamics. The most important achievement of this paper is exactly the combination of freezing/thawing process with the solution of Richards's equation, and therefore able to approximate water movement near the liquid-solid phase transition. The methodology

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is sound and the assumptions are clearly identified. It is a good paper and the publication of this kind of paper will be very timely and beneficial for researchers working in the same field, as well as for many other researchers conducting a wide spectrum of environmental studies. The paper in review needs minor revision before it could be published in the Cryoshere journal.

Minor comments.

Introduction. P1245, L10. It is hard to believe that the energy conserving freezing algorithm based on the apparent heat capacity method is the new formulation. Of the various approaches for modeling problems in heat conduction with phase change (the classical Stefan problem) the apparent heat capacity formulation still appears to be one of the popular or preferable methods, judging from the literature (Hashemi and Sliepcevich, 1967, Ivanov, 1957, Samarsky, 1968, Harlan, 1973, Voller, V. and Swaminathan, 1990, Smirnova, et al., 2000, and much more references available). However, it is well known that this formulation suffers from a singularity problem for a phase change that occurs at a fixed temperature.

P1260, L10. Open acronym SFCC

Figure 4 (left) the curves of unfrozen water content. The shape of the curves of unfrozen water content looks very similar for various soil structures. Actually, the clay curve is more gently sloping. Assouline and Tartakovsky (2001) tested them expression for relative hydraulic conductivity against different soil types and found that it fits data better than the widely used models of Brooks and Corey (1964) and van Genuchten (1980).

Interactive comment on The Cryosphere Discuss., 4, 1243, 2010.