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Discussions
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Interactive comment on "Simulations of water, heat, and solute transport in partially frozen soils" *by* Mousong Wu et al.

Anonymous Referee #2

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General comments

The manuscript send by Wu et all provides a study of simulating water and solute infiltration in partially frozen agricultural soil in northern China. Two winter periods were simulated. They used 1D subsurface, surface and atmosphere model (CoupModel) that is capable of simulating heat transfer, and soil water distribution in frozen and partially frozen soil. CoupModel is highly tested and quite well recognize model in cold snow dominated regions, and can be the most sophisticated model to assess water infiltration in partially frozen soils in cold regions.

The author uses novel technique in calibrating the highly parameterizes model. Even though Monte Carlo method is well used and has been (and should be) a standard process in every simulation exercise this paper provides some new information of sensitiv-

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ity of parameters affecting simulated soil water content and temperature (heat transfer) in frozen soils, new insight is also given to account solute in the model calibration, although it seems that CoupModel cannot provide a very good solute transport solvers (as author also clearly recognize this) and there can be better tools available for that. This study also reveals that where the pitfalls are if solute transport is taken into account, and show that the results can be improved if solute transport is taken into account.

There is some moderate/major issues that the authors need to take into account prior to publication.

Abstract

Lines 24-25, the author mention “novel techniques” but this study do not explore these techniques in depth, this needs to be removed from the abstract because is not really the scope of the study.

Introduction

In recent literature there has been debate of using impedance factor, that CoupModel uses, in hydraulic conductivity function to account the blocking effect of ice (see Painter et al. 2016; Kuryluk and Watanabe 2013). The author could shorty improve introduction and discuss about this matter, because it has been raised up in the recent literature.

REF

Kurylyk, B. L., and K. Watanabe (2013), The mathematical representation of freezing and thawing processes in variably-saturated, non-deformable soils, Adv. Water Resour., 60, 160–177

Painter, S. L., E. T. Coon, A. L. Atchley, M. Berndt, R. Garimella, J. D. Moulton, D. Svyatskiy, and C. J. Wilson (2016), Integrated surface/subsurface permafrost thermal hydrology: Model formulation and proof-of-concept simulations, Water Resour. Res., 52, 6062–6077, doi:10.1002/2015WR018427.

In lines 54-73, the author brings up a lot of literature about previous studies but do not mention the most important results of them. Maybe the most relevant studies with respect to this study should only bring up, and the most important results of them and how they are correlated or not with this study. The author mention very lightly (see line 71) the most common results: that soil condition and boundary conditions have an effect but this is way too general outcome of these previous studies. Line 93, ATS model should be mention in this list (see Painter et al 2016, WRR paper) because they have freezing/thawing included in distributed hydrological modeling.

Line 103, delete “the” before neglecting

Line 104, delete “the” before neglecting

Line 121 “ , “ delete empty space

Materials and Methods

Line 187-191, why the observation interval was not denser and not the same as observations from the meteorological station?

Line 193, delete “theory”, because it is not only CoupModel theory but theory in general (flow etc..), maybe the author could invent a new headline.

Line 195, why groundwater level was chose as a lower boundary condition and not e.g. bedrock?

Line 196 “CoupModel could be. . .” what this “could” means? maybe “could” should be deleted

Line 199 and line 203, check the meaning of kw

Line 217, the CoupModel neglects diffusion, maybe the author could discuss about the effect of neglecting diffusion a little bit more in detail, the simulated results are not that good and maybe this is the major issue here.

Line 222-223, is the lower boundary “groundwater” level or “drainage”, I think the choice of groundwater level, or drainage may affect the results. If drainage is used, then the drainage equation should be clearly showed. The author only mention that this equation appears in the table S2.

Line 232, T0 ?, please refer to equation

Line 284, what the author mean that you focus on calibration and not validation? What do you mean by validation?

Results and discussion

Line 341 How “temperature gradients” affect the soil water and solute transport, please explain.

Line 350, define NP

Line 365- 371, this is difficult to follow, if the reader is not aware of the equations, maybe the equation should be explained in the text, at least a proper references should be provide that reader immediately knows what equations should be looking at in the appendix.

Line 377-380, what this means in practice? Be more specific.

Lines 381-384, what this means in practice? Be more specific.

Line 388-394, the resolution (time interval) of observations seems to be very important, why not taking data hourly?

400-403, can this be also an issue of the model, see lines 205-207?

Line 436-437 unclear, please reword

Line 440-441 unclear, please reword

Line 458, “Simulated liquid water content. . .”? delete “in comparison with the measured”

Line 466-467, unclear, please reword. The equations should be clearly showed or referred.

Line 482 “validation”, calibration instead?

Line 485 delete “work”

Line 485 “surface water”? do you mean “soil water”?

Line 484-487 unclear, please reword

Line 494, delete “work” after calibration

Line 496 change “assumption of” to “assumption that”

Line 504-505 unclear, please reword

Line 517 carefully. , delete”.”

Line 517-518, be specific that what type of data should be collected.

Line 555 “surface water”? do you mean “soil water”?

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