The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-280-AC1, 2020


The Cryosphere Discussions
Open Access
EGU



# *Interactive comment on* "Soil infiltration characteristics and pore distribution under freezing-thawing conditions" *by* Ruiqi Jiang et al.

**Ruiqi Jiang et al.**

liudong9599@yeah.net

Received and published: 28 November 2020

Dear Dr. Aaron Mohammed: Thank you very much for your attention and the referee comments on our manuscript "Soil infiltration characteristics and pore distribution under freezing-thawing conditions". We are honored to have the opportunity to communicate and learn from you. If you have any other suggestions or questions after reading the responses, please feel free to contact us. Response to General Comments I'm sorry that our English is not good enough, resulting in some sentences that feel awkward to you. About the General Comments, we did ignore the potential effect of the soil porosity, so we measured the soil porosity in the column using a soil three-phase instrument in a recent supplemental test. The values of the pre-freezing soil moisture content were measured with sensors, and the values were distributed within 0.30 ±



Printer-friendly version

Discussion paper

0.02. The main reason for using refilling soil columns is to avoid the impact of large pores such as worm holes and plant roots; before the freezing process, all soil columns were precisely controlled and maintained at the same moisture content, so we believe there is no need to be overly concerned about the impact of this aspect. The experimental data like the soil porosity and pre-freezing soil moisture content will be added to the supplement and also to the revised manuscript if needed. We have benefited a lot from your valuable comments; the following is the responses and explanations to address your specific comments. Responses to Specific Comments As you suggest, the assumptions and limitations of large pore flow will be added in section 2.2, and we believe this will give the paper a more solid theoretical support. The following are references, and further comments are welcome if they are not comprehensive. Relevant referencesïijŽ Nimmo J R . Theory for Source-Responsive and Free-Surface Film Modeling of Unsaturated Flow [J]. Vadose Zone Journal, 2010, 9(2):295-306. Nimmo J R . Preferential flow occurs in unsaturated conditions [J]. Hydrological Processes, 2012, 26(5):786-789. Beven K , Germann P . Macropores and water flow in soils revisited [J]. Water Resources Research, 2013, 49(6):3071-3092.

The pre-freezing moisture content of the soil column was preset to 0.3, and after the column was filled, the sensor showed a moisture content distribution in the range of $0.30 \pm 0.02$. Some of the specific data from the sensors will be provided in the supplement as a reference.

The porosity of the samples was measured by a soil three-phase instrument and determined to be $0.50 \sim 0.55$. Due to the effects of the pre-freeze snowfall and snowmelt water, the water content of the field soil was relatively high, so we set the water content of the soil column at 0.3.

For each of the four temperature treatments, at least three soil columns were made for each soil type. We made over 40 soil columns in total, and the columns that were subjected to the BF tests were not subjected to other treatments. We forgot to detail that in the manuscript. We will explain this in “2.1 Test plan” in the revised manuscript.





Printer-friendly version

Discussion paper

The theoretical questions about these related assumptions have not been carefully considered by us before. May I ask for a further suggestion or note?

Each soil column was treated with only one type of temperature treatment test, so the pre-freeze water content of each soil column is approximately the same, controlled at about 0.3.

L51: Such a reference is indeed inappropriate. The paper of Jarvis (2016) only briefly describes the influence of the soil freezing and thawing in cold climates on the dynamics of the soil macroporosity and preferential flow in the Concluding Remarks. Of the papers cited by Jarvis, another review paper of Hayashi (2013) is more appropriate as a reference. Relevant references Hayashi, Masaki. The Cold Vadose Zone: Hydrological and Ecological Significance of Frozen-Soil Processes [J]. Vadose Zone Journal, 2013, 12(4):37-49.

L56: Please forgive our limited English. What I really mean is a quantitative study of the infiltration process in freezing/thawing soils.

L60: We have corrected the names of the authors of the references and read the studies on frozen soil infiltration and deeper soil percolation and refreezing effects that you recommend. These papers will be cited in the appropriate sections of the revised manuscript.

L71-73: Sorry to have confused you again. We only mean that the method used by Zhao in his article is related to the impedance coefficient; we do not consider the 'impedance concept' to have been proposed by Zhao.

L75: The problem arises from our negligence; the correct form here would be 'resulting in hydraulic conductivity overestimation'.

L89: Yes, the 'freezing profiles' here are the soil freezing characteristic curves.

L152: The infiltration solution for the unfrozen experiments we used is still deionized water; this will be stated clearly in the revised manuscript. As we have mentioned

before, all soil columns were subjected to only one temperature treatment test, so there is no need to adjust the pre-freezing soil moisture.

L279: The correct phrase here should be 'because the unfrozen water content and saturated hydraulic conductivity were low after the soil freezing'. The reason for this error is that there is only a one-word difference between the saturated water content (éěśåŠŇåŘńæřťçŐĞ) and saturated hydraulic conductivity (éěśåŠŇåŕijæřťçŐĞ) in Chinese, and writing errors lead to subsequent translation errors. We are so sorry about this mistake.

L282-289: As we stated in L317-318, we also believe that some specific experimental phenomena may be related to the higher organic matter content or clay content of black soils. However, we did not do any further research on these and nor did we find any suitable references to support this point, so we did not discuss it. If you have a better idea, please give us further suggestions.

L322-341: I also think this is the most valuable part of our study. Geophysical imaging techniques are indeed an effective method, and our department is in the process of purchasing an NMR analyzer for soil research. However, these instruments are often expensive and difficult to carry around. The tension infiltrometer used in this article is affordable and widely used, and we believe that this article can provide an important reference for its use in winter field tests.

L353: We did not measure soil ice content in our previous experiments because our neutron meter was banned and recycled by the local environmental agency. In this supplemental experiment, we used an electric drill to collect soil samples and then dried them, but due to the soil disturbance caused by the drill, I personally believe that the data is only suitable as a reference. These data will be provided in the supplement.

L368-372: Despite the fact that air-filled macropores will conduct most of the water, the freezing of the soil moisture could considerably change the arrangement and bonding of the soil particles and thus change the soil structure (Bullock et al. 2001). Freezing





Printer-friendly version

Discussion paper

and thawing could also lead to the mechanical fragmentation of coarse soil particles and the aggregation of fine soil particles (Zhang et al. 2016). Therefore, the pore connectivity and hydraulic conductivity of freezing and thawing soils will also be affected. Relevant references Bullock M S , Larney F J , R.César Izaurralde, et al. Overwinter Changes in Wind Erodibility of Clay Loam Soils in Southern Alberta[J]. Soil ence Society of America Journal, 2001, 65(2):423-430. Ze Z , Wei M A , Wenjie F , et al. Reconstruction of Soil Particle Composition During Freeze-Thaw Cycling: A Review[J]. Pedosphere 26:167–179.

L376-403: We believe that the data in Figures 6 and 7 about the number of pores, the effective porosity, and the percentage of the pore flow in the saturated flow have been able to show that macropores may still play a role in re-packed soil samples. The macroporosity did decrease after freezing, but the thawed soil had a higher porosity and a greater number of pores of different sizes compared to unfrozen soil, which does not conflict with the study (Ding et al., 2019) whose conclusion is 'FTCs resulted in larger pores and more small pores maintaining high infiltration'. In addition, the research methods used in this article are significantly different from ours, for example, prior to the start of each FTC, the injection solution was added from the top into the soil column to the point of saturation. Indeed, just as you suggest, it is possible that our conclusions may be an artifact of the fact that this was the first freeze-thaw cycle after the sample was repacked, so this speculation will be added to the discussion.

Please also note the supplement to this comment:
https://tc.copernicus.org/preprints/tc-2020-280/tc-2020-280-AC1-supplement.zip

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-280, 2020.