



EGUsphere, referee comment RC2  
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## **Comment on egusphere-2022-475**

Anonymous Referee #2

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Referee comment on "Numerical assessment of morphological and hydraulic properties of moss, lichen and peat from a permafrost peatland" by Simon Cazaurang et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-475-RC2>, 2022

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The submitted manuscript deals with the assessment of the porosity and hydraulic conductivity of Western Siberian Lowland ground vegetation samples (lichens, Sphagnum mosses, peat). Twelve samples are analysed throughout a numerical method instead of a classical experimental field determination (that they have also carried out). Based on digital X-CT reconstructions the study confirms the high values of porosity presented by such a biological media. Due to numerical constraints, a single numerical method could not be implemented and the authors used both Direct Numerical Simulations (DNS) and Pore Network Modeling (PNM), which did not provide the same results... but are closer together for the evaluation of the hydraulic conductivity which is several orders of magnitude lower for the experimental field method.

The subject of the study is interesting and suitable for publication in HESS and as the authors reported in their introduction, the results could be of great importance to model the evolution of these natural environments impacted by climate change. The manuscript is globally well written and of good scientific quality. I think that a few modifications can still be made to improve its quality.

### **General comments:**

References are numerous and I guess that they cover the state of art.

The purpose of the study should be more clearly stated.

The station can be described briefly, the field work is important and deserves a few words.

A complete flowchart describing the different steps of the methodology will be appreciated.

The quality of the figures is good but the use of colors is not always clear and understandable. The works in the supplements are not highlighted enough.

The distinction between homogeneous and heterogeneous is not clearly defined, although this aspect seems to have an impact on the typology and the possibilities of implementing the proposed methods.

Some misunderstandings in the presentation of the results for porosity.

The definition of the sample typology is done twice and is not consistent (?)

### **Comments:**

L 97: I am not a specialist of the topic but what about the study by Potkay et al. (2020) ?

*Potkay, A., ten Veldhuis, M. C., Fan, Y., Mattos, C. R., Ananyev, G., & Dismukes, G. C. (2020). Water and vapor transport in algal-fungal lichen: Modeling constrained by laboratory experiments, an application for Flavoparmelia caperata. Plant, cell & environment, 43(4), 945-964.*

L105: what is the main purpose of the present study? The authors want to assess hydraulic properties of lichens and Sphagnum mosses by numerical methods but I do not understand the "justification" of this way? What kind of problems / difficulties arise from

the experimental measurements? The question is of primary goal and I think that the issue of measurements scale should also be mentioned especially if the results are intended to be used in a modelling approach.

L122: please indicate the coordinates of the station where samples were collected. Besides, I would appreciate synthetic details on the climatic condition of this location.

L161: you refer to the drying experiment carried out by Kämäräinen et al. (2018). A different drying temperature (40°C instead of 50°C) has been applied for the preparation of samples that have a larger size in your case. It is not exactly the same protocol. The most important finding is that the morphological structure is preserved, and since you don't expect to know the actual water content of your various samples, this is probably not a critical point.

L190: in the main text, Fig. 4 is used before figures 2 and 3? It is quite difficult to distinguish colors in your picture. Is there a link between the colors used for your planar porosity plots and the averaged versions? I don't think so, but it's not clear.

L202: please indicate that  $p_{open}$  refers to the open porosity proportion. In table 3, this variable should be multiply by 100? And to be consistent with equation (2), you should indicate "%" in Table 1.

L258: You should refer to Supplement A. Also, I think you did not mention in the main text supplement B1 where some pictures present the evolution of porosity with the size of measurement. I'm wondering how you fix the final value of the sample's REV of porosity. It is not obvious to understand your results (final sizes) when comparing curves, for

instance, for samples Hollow2.7, lichen1.3 and lichen2.1.

L265: I don't think that figure 3 is required.

L280: I guess the numerical method developed by Patankar (1980) has been improved to solve faster the single-phase flow problem. I understand that the numerical aspects are not a key point of this study but your choice induces limitations in the sample processing capacity (only type I) and that's a bit bothering.

L282: how did you select your 4 REV sizes? If I clearly understand, choosing a small REV size involves performing many simulations. However, are 4 sizes enough to detect the impact of the size on the fluctuation of your variable?

L344-354: The conclusion is that DNS and PNM did not lead to compatible results for hydraulic conductivity measurements. The authors should probably indicate a way to - a priori - select the better method for each sample. Is there a link with homogeneity of the sample (the authors have indicated that in the manuscript, L276 for instance) and how can they mathematically or physically define the frontier between homogenous and heterogeneous sample?

L349: Fig. 9-Right does not describe the hydraulic conductivity computation as mentioned in the manuscript.

L359: the lowest porosity value is obtained for the Mound1.1 sample.

L365: according to Table 3, the average porosity for mound mosses is 65.8 +- 23%?

L373: Lichen1.3 has a total porosity lower than 85%

L375: correct definition is "medium high porosity" or "low basal porosity" (L193) for type II ? Besides, total porosity is not comprised between 70 and 85%.

L376: for type III, the total porosity is lower than 73%

L469: Did Shirokova et al. (2021) make a link between their biological results and the properties you focused on? I don't think that they talk about porosity, hydraulic conductivity, and specific surfaces. Either you add a reference that show this link, or you add this part later in your discussion...

L472: your experimental results are quite similar than other studies mention in Table 2. I would include them (not only "published results" but experimental results in general, including your own).

L477: What is the interest of sub-section "4.1 Numerical reconstruction after scanning" in the discussion part? I have the feeling that the main elements are given again between L 510 and 520?

L523-526: I think the main justification and interest of the present study lies in the fact that field experiments carried out to obtain hydraulic conductivity could be inaccurate because of an excessive compression of the biological media. I would appreciate references that could highlight this aspect, also the difference between natural rainfall and field experiments and finally the lack of such kind of experimental measurements. Besides, in the perspective of numerical modelling of these biological media located in the upper part of the soil, is it possible to hide unsaturated flows (cf. L488)? I guess it's not possible to directly measure water flow, but do you know of any experiments or field measurements where high velocity is consistent with your very high hydraulic conductivity?

**Minor comments:**

L52 "increases"

L93, L109 and in Table 2:Ref. Hamamoto et al. → Date of publication is 2016

L159: IMFT ?

L386: 1.00 mm

L722: "response" a typo in the original title?!

L591: problem with the words in italics "*Sphagnum*"

L690: problem with the words in italics "*Sphagnum*"

L770: Date of publication is 2012 instead of 2014 ? (it is correctly mention in the main text: "McCarter & Price, 2012")

L840-841: problem with subscript and italics in the reference title "Extending a land-surface model with *Sphagnum* moss to simulate responses of a northern temperate bog to whole ecosystem warming and elevated CO<sub>2</sub>"