General Comments

This manuscript mainly presents a numerical assessment approach for the morphological and hydraulic properties of Western Siberian Lowland ground vegetation samples (Sphagnum moss, lichens, peat) by tomography scans. The numerical method based on digital X-CT recombination of samples can obtain the porosity and hydraulic conductivity. It provides a way to quantify hydrological properties of the bryophytic cover in permafrost-dominated peatland catchments. Overall, the contents of the manuscript are interesting. Logicality of the paper is clear, and the results are well discussed and explained. However, there are some issues I concerned after I had read through the paper.

Comments:
- It seems quite complicated to obtain the porosity with the method the authors proposed compared to the traditional experimental method. In general, the advantage of using a non-destructive test is its coverage for large area like remote sensing. However, with the method you proposed, you just measure the properties of samples as the traditional one and even way more complicated. Thus, why this method has superiority?

- The authors stated that they confirmed the REV theory, but in the paper, I only see a schematic representation in Fig.2. Where is the data from the experiments?

- A schematic figure should be given to show the detailed methodology and technologies of PNM.

- The author stated the computation of K is represented in Fig.9, but what I see is a pressure field. What is the connection? And what is the relationship between a and b in Fig.9.

- As we all know, the porosity does not represent the condition of K. In the method, how did you distinguish the effective pores for the estimation of K? and decrease the impact or uncertainty that caused by dead pores as you are only counting the size of the pores?
For all the bar plot, I suggest you use different patterns instead of colors, as these colors are really hard to distinguish especially in black and white print. Meanwhile, In Fig. 4 - Fig.8, one color represents different sample types, such as Lichen2.1, Hollow2.8, and Mound2.6. This can easily cause confusion. The same problem also appears in Fig. 5-Fig. 8. It is more appropriate to use one color to represent the same type of sample. Please modify the color of the samples again and add the description of types I-III in Fig. 4.

A flowchart is better added to show how did you estimate the n and K.

Line 110: "a thorough analysis of sample homogeneity is carried out, based on porosity...." and Line 245: "in the case of a homogeneous porous medium "and Line 25: "the most homogeneous samples" and "more heterogeneous samples", what is the criteria for judging whether the sample is "homogeneous"? Is there a mathematical relationship between the homogeneity of the sample and the porosity? And why do you have to emphasize the homogeneity. Does it mean the method gonna failed if the sample is "heterogeneous"? Is there a condition the method is valid?

In Fig. 2: the hydrological characteristics of lichen, Sphagnum moss, and peat are studied in this paper. However, Table 2 only collects references and hydraulic conductivity data for sphagnum and peat.

Line 403-405: Specific surface area of the sample obtained using PNM method is always larger than those obtained by image processing. Besides the explanation from the perspective of porosity, are there any other reasons to prove this phenomenon? Is it true? What is the reason? And how the specific surface area effect the estimation of K.
- Is the application promising like what I proposed in the beginning? Why this hard work is worthy if your only goal is to get same values.

Minor:

- In Table C1, please add the specific surface area and porosity data of samples obtained from image processing.

- In Table C4, Please check whether the symbols are correct, such as dSph, σS-T, and dThr.

- In the abstract, summary and conclusions, the authors should add supplement contents about the limitations of this proposed model method, as well as the scientific importance of this study.