Dear Referee,

Thank you very much for your comments and providing helpful suggestions on our manuscript. We paste the reviewer comments in black and our response appears in red. *Quotes from the manuscript are in red italic.*

Page 2, Line 45:

Please check the reference (Simpson ?Meyer and Simpson, 1955).

Thank you, we corrected this reference.

Page 4, Lines 88:

In the 1st step of the two-step calculation, it is necessary to introduce a region that absorbs all radiations (so-called "black-hole" region) below the scoring surface, otherwise some albedo particles are double counted as the source of 2nd step calculation because of multiple scattering between the ground and air. However, such gimmick is not mentioned neither in the text nor in Figs. 1 and 2. If the authors fully transport all radiation in the 1st step calculation, they must perform it again by introducing a black-hole region, or analyze the influence of the multiple scattering on their final results.

The reviewer is right. Our description was too rough, because the method we applied is explained with more details in an earlier paper (Brall et al., 2021) (cite before in line 83 *"The GEANT simulations described in Brall et al. (2021)"*). To clarify and address the critics of the reviewer we added following sentence:
"To avoid that secondary particles in the simulation are backscattered from the volume below the scoring region and then double counted in the scorer, vacuum has been assumed instead of air below the scoring surface (for details please see Fig. 3 in Brall et al., 2021)."

Table 1:

Please consider to provide the statistical uncertainties in the table.

We added the statistical uncertainties in the table and also added following sentence to the table caption *"...with one-sigma standard deviation of the Monte Marlo calculation"*

Figure 5:

Please consider to provide the numerical values of a, b, c parameters in this figure. It is beneficial for some readers who want to reproduce the results.

We agree, this will be useful for the reader, thank you. We added the functions of the fitted curves to the figure.

Page 11, Line 214

It is written that "For the summer months when there is no snow at the UFS, the measured values are between 2.7 and 3.6 cm SWE." Assuming the influence of the buildings of the UFS research station was negligible, what is the corresponding moisture content in the limestone as expected from Fig. 12? Then, what is the typical moisture content in the limestone? The reason why I ask these questions is that there is no experimental verification of the simulation results, and this comparison could be a clue for the verification.

The reviewer is quite right that such a comparison could be a clue for verification of our simulations. Unfortunately, we do not have any information on how much moisture might be in the building materials of the research station (concrete always contains some water, water pipes in the research station might also contribute, etc.). Moreover, the actual soil moisture in limestone depends on number of cracks in the stone, etc., which is also unknown to us. We therefore respectfully hesitate to follow the recommendation of the reviewer and do any analysis based on the assumption of zero humidity in the building materials or on the humidity content of local limestone, to avoid any over-interpretation of our results.

To address the reviewer's comment, however, we have changed the following sentence (changes marked in yellow) (page 12, 217-219):

"Thus, any contribution of the water content in the environment such as the typical 3-10 % water content of concrete, soil moisture and any additional water content in the concrete floor around the detector housing could not be considered in the simulations, due to lack of information."

Because we agree with the reviewer in principle, we have added to this sentence: "Because an experimental verification of the simulated results would be a clue for testing the proposed approach, however, BSS measurements of neutron spectra would be desirable in an environment with a defined and well-known humidity in the relevant environmental compartments."

We have also added to the end of the Conclusions section (page 17, line 298): *"More detailed and quantitative analyses would benefit from an optimized detector design with*

increased counting statistics, and from detailed BSS measurements in an environment with known hydrogen content in the relevant environmental compartments."

Reference:

Several authors have already investigated the influence of the soil moisture on the cosmic-ray neutron fluxes using Monte Carlo simulation. For examples, Sato et al. (2006)* and Hubert et al. (2016)** show graphs similar to the upper panel of Fig. 12 in this manuscript. I recommend to cite the earlier works and clarify the difference of this study in the Introduction.

*Sato et al. Radiat. Res. 166, 544 (2006)

**Hubert et al. JGR: Space Phys. 121, 12186 (2016)

Thank you, we cite these references now and write:

"Sato et al. (2006) and Hubert et al. (2016) did similar calculations on the influence of soil moisture on the neutron fluence, their results are in consistence to the results shown in Fig.12. "