The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-277

Anonymous Referee #1

Referee comment on "Brief communication: Application of a muonic cosmic ray snow gauge to monitor the snow water equivalent on alpine glaciers" by Rebecca Gugerli et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-277-RC1, 2021

The authors present a prototype sensor to measure SWE based on muonic cosmic ray. They derive SWE by fitting the count rate with a few manual measurements which were performed during one season on swiss glacier.

Reliable methods to measure SWE temporally continuously in alpine environments are urgently needed. Studies as presented in this paper are therefore highly welcome and fit well into TC. I liked reading the manuscript, which has a clear structure and illustrative figures. The language is with a few exceptions easy to read. I suggest to accept the manuscript as soon as the following points, have been addressed:

- The described potential for reliable daily data seems much too optimistic when looking at Fig. 3a. The daily fluctuation shown therein make physically no sense. Even neglecting the large fluctuation in February, the daily signal (for the μ-CRSG and n-CRSG) often demonstrates strong negative changes during the accumulation season (e.g. April), which make only sense if you have large snow erosion. Please show a comparison with the daily snow depth change and discuss this problem. In light of the problem with daily values, a sentence like "the μ-CRSG promises to infer sub-daily SWE estimates with a higher precision than the n-CRSG" is quite bold!
- You defined the uncertainty of the manual observations as the standard deviation of several observations during the same field day. These measurements usually have different SWE because neither the glacier surface nor the snow depth is perfectly homogenous. The account for these differences all same day measurements are usually referred to common snow depth (assuming that the bulk snow density is constant), which is often the one from the snow depth sensor, because this location should be undisturbed throughout the whole season. The same should be done when comparing the CRSG measurements with the manual measurements as both measurements usually have a different snow depth. Could please elaborate your procedure to deal with this issue?
- I cannot get the SWE numbers shown in Fig 3a with the given Equation 6 using the relative muon count rate as input? For a muon count rate of 0.7 for example, I get 89 and not ca. 1000 mm SWE as given by Figure 3a?
- Is there a physical explanation behind the two-part conversion function, i.e. why there is a change in slope between 1000 and 1500 mm water depth in Fig. S1? Looking at

Fig. 3a it may rather be a three-part conversion function?

- Please better discuss if the application of a μ-CRSG in other locations will always need some site-specific calibration or not.

Minor points:

L17: … measures the attenuation of incoming secondary neutrons on the ground below the snowpack to infer SWE.

L21: with an n-CRSG above the snowpack

L43: Would be nice to have a picture to demonstrate the setup of the instruments.

L45: …parameterizations have previously been investigated (please reference).