This study evaluated the ability to remotely sense the spatial variability of snow water equivalent (SWE) with a UAV-based passive gamma spectrometer, focusing on shallow prairie snowpacks over two snow seasons in Saskatchewan, Canada. The UAV-gamma technique successfully captured the areal mean and spatial variability of SWE with slower, lower, and denser flight lines in the second season. However, the first-year survey results showed limited ability to observe the average and spatial variability of SWE. The study also tested a combination of UAV-based gamma and UAV-based lidar to develop a high-resolution SWE map, showing improved results.

To the best of my knowledge, this study is the first to attempt testing the UAV-based passive gamma-ray technique to quantify SWE. The manuscript provides useful practical guidance for the snow remote sensing community, especially for those interested in applying and advancing the technique in other environments. The challenges of UAV-based gamma SWE are discussed, articulating the opportunities available to improve remote sensing of the spatial variability of SWE for data collection applications.

Generally, with this new UAV-based gamma approach, the study addressed clear scientific questions, presented in a well-structured way. I believe this will make progress beyond the current scientific understanding of a passive gamma-ray approach for SWE estimation for The Cryosphere community. In my opinion, however, there are a few things, particularly related to the gamma SWE retrieval approach, that need to be addressed before publication. I have provided a few suggestions below that may help to the improvement of the manuscript.

General comments

1. My understanding is that the MS-1000 gamma spectrometer measures gamma count rates of 40K, 238U, 232Th, and 137Cs radionuclides. When the authors apply Eq 2 to calculate SWE, how did they calculate the count rates (c_bare and c_snow) from the individual gamma elements? If the authors used 'total count rates' regardless of radionuclides, can the authors provide the gamma radiation spectra like Figure 12 in Offenbacher and Colbeck (1991)? That would be helpful for potential readers to better understand the passive gamma radiation technique and its attenuation effect by snowpack. I would also suggest providing spatial maps of gamma count rate for each radionuclide along with the total count rates as supplementary.
    - *Offenbacher, E. L. and Colbeck, S. C.: Remote sensing of snow covers using the gamma-ray technique (No. AD-A- 238016/0/XAB; CRREL–91-9), Cold Regions Research and Engineering Lab., Hanover, NH (United States), https://apps.dtic.mil/sti/pdfs/ADA238016.pdf, 1991.*

2. Related to Comment 1.1, it should be clearly articulated why they used total gamma count rates rather than specific radioisotope components such as 40K, which are expected to be more sensitive to better quantify the attenuation by SWE (Peck et al., 1971; Offenbacher & Colbeck 1991). I understand the authors want to avoid the empirical aspects; However, I still think some justifications would be valuable. Specifically, if possible, a simple comparison of the gamma SWE values derived from total gamma counts used here and specific gamma radioelements (e.g., previous studies were used) would be valuable for potential readers.
    - *Peck, E. L., Bissell, V. C., Jones, E. B., & Burge, D. L. (1971). Evaluation of snow water equivalent by airborne measurement of passive terrestrial gamma radiation. Water Resources Research, 7(5), 1151-1159.*

3. Regarding the overestimation of SWE in Grassland in the second winter, I agree with the discussion point (L340-348) that a melt event earlier can contribute to the SWE uncertainty. To further discuss, I think it would be helpful if a time series of soil moisture and SWE throughout the season can be provided (if the station data is available near the sites). In this context, it might also be helpful to include a time series of temperature, snow depth, and precipitation at a GWFO station in the main body or as supplementary material for a better understanding of site weather conditions before and after the surveys.

Detailed comments

L10-11 I suggest removing 'over shallow snowcovers' from the statement. Airborne applications using passive gamma-ray surveys have the capability to measure relatively moderate or deep snowpacks. The operational NOAA airborne gamma survey provides up to 1000 mm of SWE (https://www.nohrsc.noaa.gov/snowsurvey/historical.html; Mortimer et al., 2024).

> *Mortimer, C., Mudryk, L., Cho, E., Derksen, C., Brady, M., & Vuyvich, C. (2024). Use of multiple reference data sources to cross validate gridded snow water equivalent products over North America. EGUsphere, 2024, 1-31.*

L81-82 A recent effort to address the issue of the antecedent soil moisture change for the airborne program using SMAP soil moisture was presented in Cho et al. (2020). It would be good to mention it here.

> *Cho, E., Jacobs, J. M., Schroeder, R., Tuttle, S. E., & Olheiser, C. (2020). Improvement of operational airborne gamma radiation snow water equivalent estimates using SMAP soil moisture. Remote Sensing of Environment, 240, 111668.*

Section 2.1 It would be much more helpful if general snow conditions are provided including annual SWE (maximum and range), snow covered duration, and onset/offset dates with some literatures if available.

L118 snow (water equivalent) → SWE

L141-142 For the stubble survey, how much did you expect that the larger GPS error ranges might impact the gamma SWE estimation? Please provide some justification regarding this.

Figure 1. Have the authors considered providing some additional photos of both sites showing different surface characteristics along with the descriptions provided? I believe that would be informative for readers to better understand the sites.

L201 Should it be the equation “2”?

L205 high resolution → high spatial resolution

Figure 3 How were the mean biases calculated? What is the reference count rate to calculate mean bias at a certain integration time? Please describe it briefly. Also, why were the shapes of changes in mean biases with change in integration time different particularly between Fall Stubble and Spring Stubble? Were the changes negligible in terms of the amount of count rate?

Result 3.3 Please add the units of RMSE and mean bias (Figure 4) and the mean and uncertainty (Table 3). Also check the units throughout all figures and tables.

L426 Please include the areal mean SWE values with the uncertainty for each season.

L426 2.5-hectare → 2.5 x 106 m2

L432 22.5 m spatial resolution

L432 Include the mean SWE value along with RMSE