We thank Nora Krebs and Dr. Paul Schattan (hereafter "the reviewers") for their comments that improved the quality and clarity of our manuscript. Our responses to each comment are highlighted in blue. The line number used in the responses are the line numbers in the non-marked manuscript.

Review on "Influence of Snow Spatial Variability on Cosmic Ray Neutron SWE: Case Study in a Northern Prairie" by Kim et al.

Minor comments

- Line 10: "[..] noninvasive (or aboveground) [...]
    - "Please consider, that the method is both, non-invasive and above ground.
    - Thank you to the reviewers for pointing this out. We meant that noninvasive and aboveground were interchangeable, however, we apologize if that meaning was not clear as previously written. We have edited line 10 to read "[...] noninvasive, aboveground [...]".
- Line 24: "[...] while CRNS SWE values match more closely."
    - Please provide the reference (compared against what?).
    - Thank you to the reviewers for pointing out the lack of clarity. We have edited the sentence to read "CRNS showed better agreement with lidar-derived SWE at our prairie site compared to several gridded snow products."
- Line 67-71: "In addition, continuous SWE monitoring through snow pillows or snow scales like those found in the snow telemetry (SNOTEL) network from the US Department of Agriculture Natural Resources Conservation Service (USDA NRCS) (Serreze et al., 1999), are not as effective in the prairie due to wind erosion and transport."
    - This is a great argument to use CRNS. Maybe consider to mention this point in the discussion to support your point that CRNS is especially well suited in a prairie environment.
    - We thank the reviewers for the constructive feedback. We agree that CRNS is well suited for snow research in a prairie environment. We apologize if this statement was not made clear in our manuscript, since we felt our results and discussion in sections 4.2 and 4.3 were making these claims. We acknowledge that this claim may not have been made explicitly within our manuscript. Therefore, we have made minor edits to our manuscript so that this point is stated clearly. We have edited the sentence beginning on line 77 to clearly respond to the previous claims: "To overcome these limitations in snow observations in the prairies, [...]". Furthermore, we have edited the sentence starting on line 476: "These results indicate that CRNS provides

value for large-scale SWE estimates in the prairies, and well suited to measure SWE in prairie environments compared to the conventional, smaller-footprint sensors."

- Line 117: "[…] during DJF[…]"
    - Please specify DJF
    - We apologize for not specifying DJF. We have rewritten line 117 to "December-February (DJF)".
- Line 177-181: "Thus, we utilized a 2-layer density scheme to calculate spatially distributed SWE at the CARC, using snow density values derived from the snow pit measurements. The thickness of the lighter and basal snow layers on a given date was determined by differencing the lidar DSMs on different dates. These 2-layer snow density and depth maps were used to specify the "natural" snow cover conditions in the neutron transport simulations (section 3.2)."
    - This description seems to indicate that you defined a stratified snow layer in URANOS consisting of a denser bottom layer and a less dense top layer when simulating the neutron interactions with the lidar derived heterogeneous SWE maps. In section 3.2 (line 236) you write, however, that you created "[…] a snow layer with uniform thickness and density". The latter phrase in section 3.2 may correspond only to the uniform SWE cases, such that the provided information is not contradicting. However, to make your model setup more clear, please describe in section 3.2 also how you set up the heterogeneous snow scenarios in URANOS.
    - We apologize if this was not clear. Most of this work was built off of the modeling that was done in the Water Resources Research (WRR) article of Woodley et al. (2024). However, since not every reader will have not read this article, we agree that not clearly describing our methodology for the heterogeneous snow cover model runs would be confusing. As a result, we have added a brief summary by changing the sentence on line 204. The sentence now states: "Our "natural" or heterogeneous model setups are similar to the simulations described in Woodley et al. (2024), with a stratified 2-layer snow density model as described in Sect. 3.1 and split into semi-regular layers (see colorbar on Fig. 3)." In addition, we moved the first sentence of the following paragraph (line 228) into this paragraph to add more context in the beginning of our methodology to be clear about the three different snowpack scenarios.
- Line 233: "[…] snow water volume was divided"
    - Not clear. Maybe "was derived"? Please consider to reformulate.

    - We thank the reviewer for catching this lack of clarity. The sentence was reformulated to be clearer. It now reads: “We derived the uniform snowpack thickness by dividing the total amount of snow water volume by the snow density of hard coded material values of different snow types in URANOS.”
- Line 370-375: “We noticed skews in neutron origins due to the relation of the model geometry, namely the position of the virtual detector and the source geometry. Virtual detectors placed closer to the edges of our domain had neutron origins that were skewed towards the center of the domain. Therefore, we limited the neutron counts to within a 200 m radius of the virtual detector.”
    - Please consider to move this paragraph on how you have been dealing with model boundary artefacts to the methodology section (3.2), since this effect must have affected all URANOS simulation runs.
    - We have carefully considered this comment, but we have not moved this paragraph to our methodology section. The reason that we did not make the suggested change is that we did not apply the 200 m radius restriction to all of our model results in the manuscript, but instead only for the analysis shown in Fig. 6. Therefore, we felt that moving this paragraph might mislead readers to think that this method was applied to all of our model results.
    - With regards to why the 200 m radius restriction was not applied to the rest of our analysis (e.g., the results shown in Fig. 4), the comparisons we make between the uniform and heterogeneous URANOS runs will be equally skewed based on the location of the virtual CRNS within the model domain. For example, for location P05 on 17 Feb. 2021 for uniform vs heterogeneous snowpacks, the location of the virtual detector will have the same effect on the neutron field for both scenarios, as both virtual detectors are situated in the same location within the model domain. However, the snow distribution does change, and thus the difference in the neutron counts between the two scenarios will reflect only the change in the snowpack. In Figure 6, we wanted to compare the neutron counts near the 171 m footprint of the CRNS and how the snow drift would have affected the neutron counts in its immediate surroundings where we know the CRNS is the most sensitive.
    - We apologize if our methodology was not clear in the manuscript. We have edited the last sentence of this section to clearly state that we this analysis was applied to Figure 6 results only: “[…] within a 200 m radius of the virtual detector only for the results shown in Fig. 6(a)-6(d)”.
- Line 387-388: “P05, P07, and P19 which were modelled closer to the snow drift.”
    - Incomplete sentence

    - Thank you to the reviewers for catching this sentence clause. We have incorporated this clause into the previous sentence. Additionally, to be clearer about our results and discussion, we have made changes to Lines 387-394.
- Line 390: "[…] which enhances the neutron counts on the snow side in the heterogeneous runs."
    - Is the figure not showing a decrease in neutron counts on the snow side (in line with what you wrote previously in this paragraph)?
    - Thank you to the reviewers for catching this mistake. We have changed the sentence to read: "[…] which reduced the neutron counts on the snow side."

Illustration remarks

- Figure 3:
    - Thank you for visually distinguishing snow-free from snow covered areas! This gives more in-depth information to the figure. Please consider to add an additional field to the legend, indicating that grey color corresponds to snow-free areas (instead of describing it only in the figure caption).
    - Thank you to the reviewers for pointing this out. We have added a label for the snow free areas to the legend of Figure 3.
- Figure 5:
    - Please consider coloring the point plot in 5 (a) after bare ground (in the same fashion as in Figure 4 (a)), as this would make the influence of the distance of snow drifts to the detector location even better visible.
    - Thank you for this suggestion. We have made this change and thank the reviewers for improving the quality of our figure. It adds more context to our results. Additionally, it allows us to make our unique points more distinct. We have also changed the markers for P05, P07, and P19 from circles to their own unique shape (square, hexagon, and diamond, respectively) to add additional context where each point is located. We have updated the caption to Fig. 5 to reflect the changes made to the figure.
- Figure 4 (page 17):
    - The numbering of the figure should continue as Figure 7.
    - Thank you for the reviewers for catching this typo. We have renumbered this figure and all figures to be numbered correctly.
    - For c, d, e, and f: Please use the same color scale as in Figure 3 (where snow-free areas are indicated in grey).

    - We have carefully considered this comment, but ultimately chose not to make the suggested change to Figure 7. We agree with the Reviewers that consistency in visualization throughout a manuscript is important. However, Figure 7 is in some ways distinct from the previous figures in what it shows and in what we hope to convey. First, Figures 7c-7f are plotting different variables than Figure 3 (SWE instead of snow depth), and the SWE shown in Figure 7 is from synthetic calculations to compare what a CRNS or snow scale might measure, rather than an observed SWE distribution. In this sense, the idea of "snow-free" areas becomes slightly abstract, especially for panels 7(c) and 7(d) that show synthetic CRNS SWE estimates (derived from spatial integration of lidar-derived SWE estimates). Most importantly, the goal of Figure 7 is to illustrate the difference in representativeness of a CRNS compared to a snow pillow, so the differences in the spatial coverage and distribution of the red areas between 7(c) and 7(e), and 7(d) and 7(f), are the most important takeaway for the reader. We feel that adding gray to panels 7(e) and 7(f) but not panels 7(c) and 7(d) (because panels 7(c) and 7(d) do not have any "snow-free" areas, given the spatial weighting function of the synthetic CRNS SWE) would makes this comparison visually difficult.
- Figure 85 (page 19):
    - The numbering of the figure should continue as Figure 8.
    - Thank you for the reviewers for catching this typo. We have renumbered this figure and all figures to be numbered correctly.

Other minor changes:

- To be consistent, we have changed all instances of "modelled" to "modeled" in the "manuscript" to be consistent throughout the manuscript.
- To keep our abstract under 250 words, we have made a small edit on line 20 from "low amounts of SWE" to "low SWE".