Summary:

The manuscript *Automated snow cover detection on mountain glaciers using space-borne imagery* presents an analysis of machine learning (ML) models and workflow developed by the authors for automatically detecting snowlines on mountain glaciers in Western N. America, using optical imagery from Landsat, PlanetScope and Sentinel-2. After testing nine different ML models, support vector and nearest neighbor were the optimal algorithms for classifying Sentinel-2 and Landsat/PlanetScope imagery, respectfully. The authors report a high accuracy assessment using four different accuracy metrics. Overall, their paper provides a novel insight into optimal models for different image types and the usefulness of ML for glacier applications. I would recommend minor revisions before publication.

General Comments:

A strength of the paper is highlighting the accuracy of the various ML outputs and identifying which ML model works for each imagery dataset. Furthermore, the robustness of testing and validating the models allows for high confidence in the performance of the models. The authors take care to select training data from a variety of sites with varying climate, surface type and geometries. The paper is well written and organized, making it easy to follow the decisions and outcomes of the papers. The novelty of the paper comes out in the testing of several ML algorithms for snow line detection.

Snowline detection is an illustrious metric within glaciology for first order estimates of surface mass balance and for understanding melt extents/intensity. Published research in this area of remote sensing has been somewhat extensive but that is not reflected in the introduction or discussion of the paper. The authors should rewrite the introduction and discussion to reference relevant literature on machine learning and snowline detection. Currently, there is a good background on the use of NDSI in mapping snowlines, but it is missing the context of previous work on snow line detection through ML and optical imagery. Furthermore, the discussion would benefit from framing of previous studies and how their results compare with other work.

The methods section gives a good overview of each step and is nicely summarized in Figure 4. I would like to see additional sections that expands on the machine learning models, giving a brief background on the nine different types and why they are selected. For instance, identifying which models are ensemble tree types, kernel type, neural type. Perhaps, highlighting which models have been previously applied in glacier applications.

The authors conclude the manuscript with stating that the performance of the ML model depends on the image product and specific characteristics of the glacier site, which is valuable contribution to the field on snowline detection in mountain environments. The concluding remarks are supported by the main results and justify the methodology used.

Specific (minor) comments:

Title – Consider including machine learning and optical imagery in the title, such as, 'Automated snow cover detection on mountain glaciers using optical imagery AND machine learning'.

Figure 1 – Include caption for Figure (d).

Figure 2 – Include grid or scale bar/northing arrow and land boundary or better contrast in colors between land and ocean in the location image. Increase font size/bold labels.

Line 150 – Figure 3 → should be Figure 4 and order of figures needs to be reconsidered within the text.

Line 165 – Can you include the process of training and validation dataset development within figure 4? Or a separate figure to have a visual summary of how the datasets were developed.

Line 165 – This contradicts Line 270 where it mentions that Lemon Creek Glacier was used in the performance assessment, should that also be mentioned here?

Line 167 – Consider listing the nine ML models here or state that they will be listed at the end of this section.

Line 169 – Include number of folds here.

Line 172 – 188 – This paragraph could be better clarified to first talk about the validation dataset and then what's used for training. Some of the information is contained within the preceding paragraph, so it is difficult to know if it is a repeat or new information.

Line 189 – Did this result in an even number of points for each class? If not, how do you reconcile the bias within classes that are under sampled?

Line 204 – Was this at all sites for each image product?

Line 215 – Mention that this is expanded on in supplementary material.

Line 247 – Clarify that you are discussing situations for missing data.

Line 343 – Refer to either Table 2 or Figure 7 to where to look for the results of changes in snow line detection.

Line 360 – SCA has been defined earlier.

Line 366 – Refer to figure 5 (a-f) here, as is done in the next paragraph.

Line 401 – Consider renaming this section to 'Challenges in Classification' or something similar, since limitations are not necessarily being discussed here.

Line 505 – Readers should be referred to Table S2 for specifics on when glacier boundaries were updated.

Figure 6 – Include in caption what the white arrows are highlighting.

Line 510 – This section does not mention future work. Consider changing title or including future work.

Line 570 – Mention in the methods section that images were accessed with GEE.

Supplemental material:

Line 601 – Check figure numbering, Figure S4 → S3

--END OF REVIEW--