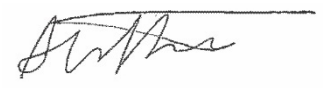
Dr Alex Burton-Johnson
British Antarctic Survey
Natural Environment Research Council
High Cross, Madingley Road
Cambridge
CB3 0ET

E-mail: alerto@bas.ac.uk

Dear Anonymous Reviewer RC2,

Thank you for taking the time to provide your review of our submission to *The Cryosphere*. Along with reviewer RC1, implementation of your comments has greatly improved our manuscript. We have addressed all of your points, and list them below alongside your review.

All the best,



Dr Alex Burton-Johnson

Anonymous Referee #2

Manuscript Title: “Rock and snow differentiation from colour (RGB) images”

General comments: This study presents a new Polynomial Thresholding (PT) for differentiation of rock and snow using high resolution coloured images of the Polar region. Overall, the work lacks reasonably in scientific content and several fundamental errors. PT is the sole contribution of the current work, however, since the method is empirical it needs rigorous evaluation in terms of its scientific viability. The writing style followed in the manuscript is casual with basic references of certain well-established methods simply missing (For example Linear mixture modelling (LMM) or Fuzzy Membership as called here: Settle and Drake (1993)). The scientific quality of the work needs to be upgraded considerably in line with the comments.

- Thank you for the reference, this has now been added.

Specific and Technical comments: 1. The Introduction section fails to properly justify the need of the current work.

- On this matter I’m afraid we have to disagree. We state explicitly in the original manuscript the unexploited potential for high resolution classification using RGB imagery; the lack of existing evaluation of this application of RGB data (in contrast to methods using infrared imagery); the application of this data to a range of scientific fields; and the aim of presenting the method to non-specialists in remote sensing. We addressed requests by the subject editor prior to acceptance for peer review to ensure the clarity and aims of the manuscript.

2. The results from the proposed PT method are compared with other supervised (MLC) and unsupervised (FM and RB-NDSI) methods. However, this is not a justified comparison except for MLC which performs at-par with the proposed method. Classic NDSI is modified to RB-NDSI as per the availability of the bands and the results of FM are degraded for the sake of comparison. Reframing the NDSI in itself meant that it would not perform well or at par because the spectral difference which is its basis is lacking in its new version (RB-NDSI). Incase of FM or linear mixture modelling neither the method has been properly explained nor correctly implemented. The LMM can be applied in both supervised as well as unsupervised modes and since it is a subpixel or soft classifier it results in fraction images equal to the number of target classes (Bastin, 1997). This is usually applied when data has sizable mixed pixels (i.e., in case of moderate to coarse resolution data). Its actual potential is revealed while classifying the low-resolution data and it constitutes an advanced classification method. In this work the output from the LMM has been degraded by thresholding which convert the ‘soft’ output to a ‘hard’ one. In light of this the comparisons made with RB-NDSI and FM are not fair and justified.

- The target users and aims of the paper are explicitly stated at the start of the original manuscript, requiring a “hard” output of differentiated rock and snow, not a probabilistic “soft” output. Consequently, despite the advanced classification output by the LMM/FM method, the outputs (once converted to the required “hard” classification) are unable to provide the required output required by this study and our stated target audience at sufficient accuracy. We are aware that many other FM classifiers exist (as stated in Section 2.2.1. of the original manuscript), but (as also stated in the original manuscript), Albert (2002) has shown that LMM is the most accurate FM classification method for differentiating snow and rock.

3. Besides, the authors should have compared their method with the Object based image analysis (OBIA) instead of the methods they have currently chosen. This is because, similar to PT, the OBIA work well in case of high-resolution datasets. It would be interesting to see this comparison.

- In the introduction to Section 2 in the original manuscript, we state that "we have selected methods here which can be easily implemented by the reader using the Esri ArcGIS® and ArcMap™ Spatial Analyst toolbox ("Maximum Likelihood Classification" for MLC, "Fuzzy Membership" for FM, and "Raster Calculator" for PT and the RB-NDSI), or similar tools in other GIS software (e.g. QGIS)." Whilst other methods exist, they require more specialist image analysis software and expertise. The aim of this paper is to enable differentiation of snow and rock by non-specialists in remote sensing, as stated in the opening sentence of the abstract in the original manuscript. In light of your comments and RC1, we have expanded on this in the introduction to Section 2 to be even more explicit, with the following text: "We are aware that more sophisticated image analysis and machine learning techniques (e.g. Object Based Image Analysis) can be implemented in specialist remote sensing software packages (e.g. ENVI), but this paper aims specifically to enable non-specialists with a basic background in GIS to quickly and easily derive their required basemap data without further training or software."

4. The accuracy assessment portion needs better clarifications and description. Proper explanation and justification in support of the usage of the chosen accuracy metrics (i.e., CAtot and CArock) should be given. Also, for comparison of any set of algorithms the processing speed/time makes a very important parameter which must be considered and which is lacking here.

- The justification for using CA_{Tot} and CA_{Rock} have now been added to the introduction of Section 3. The implementation and processing times for MLC and PT are stated in Section 4 of the original manuscript. They of course depend on the size of the image, the number of training pixels, and the processing power of the computer.

5. The number of figures can be reduced.

- This was also noted by RC1. As suggested by RC1, we have removed Fig. 9 and have combined Fig. 4a and 4b.

References J. J. SETTLE & N. A. DRAKE (1993) Linear mixing and the estimation of ground cover proportions, International Journal of Remote Sensing, 14:6, 1159- 1177, DOI: 10.1080/01431169308904402 L. BASTIN (1997) Comparison of fuzzy c-means classification, linear mixture modelling and MLC probabilities as tools for un-mixing coarse pixels, International Journal of Remote Sensing, 18:17, 3629-3648, DOI: 10.1080/014311697216847