The Cryosphere Discuss.,
doi:10.5194/tc-2016-56-RC2, 2016


The Cryosphere Discussions
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# *Interactive comment on* "A fully automated methodology for differentiating rock from snow, clouds and sea in Antarctica from Landsat imagery: A new rock outcrop map and area estimation for the entire Antarctic continent" *by* A. Burton-Johnson et al.

**Anonymous Referee #2**

Received and published: 11 April 2016

## Overall Assessment

Burton-Johnson et al. present a novel methodology, using freely-available remote sensing data, to perform a classification for the surface of Antarctica. The techniques used in the manuscript improve on existing methodologies which have inconsistencies for the presented problem (automated differentiation between rock, ice/snow, and water). I have included further comments / questions below, but ultimately recommend this manuscript for publication with minor revisions addressed.



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Impact

I'd like to comment about the availability and quality of existing Antarctic geospatial (vector) datasets; the Antarctic Digital Database (ADD) has been the de facto standard for open, continent-wide, generally non-scientific base data layers (e.g. coastlines, lakes, rock outcrops, contours, etc.). With this manuscript and the resulting vector dataset of rock outcrops, the authors have contributed significantly to the improvement of Antarctic mapping and geospatial data. Moreover, the methodology presented here allows for the continued refinement of the aforementioned dataset using more recently acquired Landsat 8 imagery or imagery from other, higher-resolution multispectral optical sensors. Although some parameters may need to be revisited for other sensors, the authors presentation of the methodology and delivery of the ArcPy script provide a great launch point for further application (even for novice remote sensing scientists).

Specific Comments/Questions

1) Data Selection The Landsat 8 OLI sensor is an appropriate sensor for this study, given its spatial resolution, revisit frequency, multispectral bands, and cost. Notwithstanding the data incapacity at extreme southern latitudes, can the authors comment on the selection of individual images to be used? Did the authors set any threshold for to certain sun elevations, time of year, or cloud-cover percentage [mentioned P1 L25] Also, given that Antarctic's rock can be covered in snow at any time, were there efforts to exclude those types of images by manual inspection? If either case, for the selection of images in the study, these thresholds should be noted.

2) Accuracy Assessment I believe that the authors have provided a thorough assessment of the accuracy of their methodology and succinctly describe its use and limitations. Can the authors comment if any ground-based verification has been completed? For example, spectrometer samples from the various classification types (e.g. shaded rock, shaded ice) would verify the spectral signatures and further refine (or confirm) the threshold values used.





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3) Total Outcrop Area The total outcrop area, I anticipate, is going to be highly cited. Please provide the methodology or source for calculating the "total land area of Antarctica." The final result of 0.18% will vary based on that value. Moreover, it may be beneficial to provide error bars for the final figure.

4) Methodology The authors are lacking sufficient explanation of the dataset merging procedure, especially for overlapping tiles. The authors state that for overlapping tiles if any of the "pixel stack" was classified as rock it was included as rock. Please provide justification for this technique. Furthermore, I believe that the algorithm could be greatly improved with the inclusion of many overlapping tiles. This would remove outliers (e.g. seasonal snow differences) and offer a measure of statistical significance; for example for 5 overlapping images all 5 images provided the same result, that pixel would be assumed to reduce both omission and commission disagreements.

5) Future Considerations Please note that in Section 4.3, many of these satellites have already launched, not "under development or planned for launch" – please update this for the currency of publication date. I do appreciate the authors' consideration for higher resolution datasets and that this technique is not sensor specific (although does have certain requirements, e.g. band availability).

Technical Comments [P2 L5] "several" seems unnecessary [P2 L15] "more strongly" –> "stronger" [P2 L33] Remove extra space after "ablation" [P3 L26] How do you define "strong illumination" and "minimal cloud cover" [P5 L26] "LANDSAT" –> "Landsat 8" [P8 L13] "Digitalglobe's" –> "DigitalGlobe" [P8 L13] "Worldview-3" –> "WorldView-3" [P8 L26] Period, not comma, before "The new map, . . ." [P9 L1] Note the acknowledgements section is included twice in the manuscript [Fig 4] The box containing "create a new raster for sunlit rock..." should read "four" requirements, not "three" [Fig 7] These figures, in general, are very difficult to understand given the scale of the map and density/overlap of the outlines. Although the authors' intention is valid, the detail provided by the outlines are indiscernible for several of the figures. Moreover, the underlying satellite imagery is often covered by the outlines. I suggest reducing the number of

examples and subsequently enlarging them to provide the reader with more detail to better communicate the purpose of the figure. [Fig 8] Should the new rock outcrop dataset only include areas where there is tile coverage? Can the authors be certain that there are no outcrops >82°40'S (the stated domain) that do not have a tile for this analysis? For example, there is a tile gap on the margin (Bryan Coast, Ellsworth Land). [Fig 11] It is very reasonable for manual digitization to clean up the dataset. Can the authors provide the areas that were manually edited after the analysis? If that metadata is unknown, the reproducibility for a given tile is in question.

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