The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-5-RC1, 2020

The Cryosphere Discussions

Interactive comment on "Variability of glacier albedo and links to annual mass balance for the Gardens of Eden and Allah, Southern Alps, New Zealand" *by* Angus J. Dowson et al.

Anonymous Referee #1

Received and published: 30 January 2020

This is a welcome contribution that provides details of an alternative remotely sensed method for monitoring glacier albedo as a potential mass balance proxy. Direct measurement of mass balance on mountain glaciers is resource intensive and often only provides a small number of point data that still require interpolation. Improving remote monitoring methods is essential as this will enable a more comprehensive and sustainable approach to mass balance monitoring. This is a key rationale present for this project. Increased use of remote sensing techniques is a key way scientists can reduce the carbon footprint of their climate-science. Research that progresses such techniques is timely.

However, despite the authors making a strong case for the benefit of remote sensing over on-site measurement it is noted in the acknowledgments (and in a media campaign) that the authors did undertake field work at this remote, protected site. The strength of this method will lie in it being able to be robustly applied to any glacier without the need for onsite calibration. So some questions arise; 1. What data was gathered at the site and was this used to tune processing? 2. Could the method calibration have been done at an already high-use glacier site (e.g. Franz, Fox, Tasman Glaciers), thereby providing more support for using RS at sensitive sites, and 3.What confidence do the authors have that this method can be applied to sensitive, protected sites without the need for onsite measurement?

Generally the paper is well written and contains sufficient background information and detailed (RS) methods section. However, the interpretation of results is compromised by inadequate information (Figure 1) of the actual glaciers used in analysis. Figure 1, the location map, does not make clear the locations of all the individual glaciers contained in the text. This becomes rather frustrating when reading results and attempting to consider them in a spatial context. Consultation of the official topographic map for the area provided some assistance, but it was still unclear exactly what ice bodies the authors were referring to for the two unnamed glaciers, and for a glacier like Colin Campbell, which has multiple branches, it is not clear what branch has been used for analysis.

The decision to separate the 12 glaciers into 3 classes would benefit from a little more explanation. For example Eve Glacier appears more topographically similar to Abel and Colin Campbell (when one makes some assumptions about which branch has been used for the Colin Campbell). It is also unclear whether statistics for elevation and slope include the upper accumulation zones or just focus on themore defined glacier trunks. Having all 12 glaciers clearly defined on a map would benefit result interpretation.

Figure 5 is a key Figure, but I found myself looking for a third panel showing the the average albedo over time, which could potentially be added to Figure 5 (right). If the

timing of the ablation minimum is getting later, does this mean that the minimum albedo is also decreasing due to a longer alation season? Or Not?

As noted above, the lack of a detailed location map hinders spatial thinking, as does the organisation of Figure 6. While clearly the authors have opted to organise both graphs in Figure 6 by the scale of the x-axis values in doing so the reader is left with no clues as to how these glaciers are actually related in space, again is there a spatial influence on the data presented? It is very difficult to compare results of the left and right graph for an individual glacier as the order of the y-axis (by giving priority to the x-axis value) are different for each graph. While it is appreciated that a 'progressional' x-axis approach might be the 'neatest' presentation, something is lost in regards to the actually physical process or characteristics that might be driving the patterns being presented. For example can something more be said about W/E or N/S trends? If one colour-codes the class sizes some patterns appear, for example class 1 glaciers tend to have lower albedo and a later minimum timing, whereas class 2 (n=2, should potentially include Eve) have higher albedo and earlier minimum timing.

While it is appreciated that this paper is 'methods' focused there is missed opportunity to engage more fully with some of the glaciological findings. In particular, the finding that the timing of the minimum albedo is occurring later in the summer, which could signal a later onset of the first winter snowfall (i.e. lengthening of the ablation season). This result also makes one wonder if there is any trend (across all the glaciers measured) of a decreasing minimum albedo over time, for if the ablation season is becoming more protracted then the snow surface would likely become more discoloured. Or alternatively, is the minimum albedo the same and the trend is associated with a later start to the ablation season (i.e. more spring snow delaying the onset of melting). It would be great to see a little more discussion of these important mass balance feedbacks.

Should the authors wish to include a reference for the Rolleston Glacier mass balance programme, they could cite Purdie, H., Rack, W., Anderson, B., Kerr, T., Chinn,

T.J., Owens, I. and Linton, M. 2015: The impact of extreme summer melt on net accumulation of an avalanche fed glacier, as determined by ground-penetrating radar. Geografiska Annaler, Series A: Physical Geography 97, 779-791.

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