The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-92-RC1, 2020

The Cryosphere
Discussions

Interactive comment on "Small scale spatial variability of bare-ice albedo at Jamtalferner, Austria" *by* Lea Hartl et al.

Mauri Pelto (Referee)

mauri.pelto@nichols.edu

Received and published: 12 June 2020

This study by Hartl et al (2020) compares a detailed field survey of albedo on Jamtalferner with synchronous remote sensing derived albedo from Sentinel and Landsat images. The methods for both approaches to albedo determination are well explained. The comparison of the field albedo and remote sensing derived albedo is the key output of this paper and is well illustrated in Figures 7-9. The study provides a richer data set for understanding how Landsat or Sentinel images could be used and is simply interesting. The primary comments below are seeking more context: 1) On the value of detailed spatial and temporal albedo observations. 2) For connections with energy balances. I am not suggesting additional data or figures be presented, but instead additional reference to other work and how the data here fits with these.

9: The first sentence reverses the cause and effect. "As Alpine glaciers recede, they are quickly becoming snow free in summer and, accordingly, spatial and temporal variations in ice albedo increasingly affect the melt regime. " Instead I suggest, "As alpine glacier become snow free in summer, recession occurs, and further spatial and temporal variations in ice albedo increasingly accentuate the melt regime."

16: Finishing the sentence with fluid is confusing since that could be a surface type, "Spectra can roughly be grouped into dry ice, wet ice, and dirt/rocks, although transitions between types are fluid." Maybe finish with, "although gradations between these groups occur". Replace "fluid" with gradations throughout.

24: Explain that firn cover is lost when persistent loss of snow cover in the accumulation zone exposes the firn (Fischer, 2011).

59: "...relatively recent times", be more specific.

74: Azzoni et al. (2016) also found a significant impact from rain water.

76: What is the basis for Brun et al (2015) stating importance of remote sensing in albedo assessment?

77: Resolution of Naegeli et al. (2015) aerial albedo observations?

96: Is it worth observing that for degree day modelling changing albedo with time would alter parameters in the model.

109: Given the illustrations in Figure 2 leverage these with terminus retreat from 1990-2017 and for the accumulation zone what is the mean AAR during this same period 1990-1999, 2000-2009 and 2010-2017?

117: "Along each profile line spectra are gathered at equal intervals, with 14 profile lines containing 11 spectra spaced at 2(?)m and 2 profiles containing 40 spectra gathered at a higher resolution of 0.5(?) m." 132: "Google Earth Engine"

161: "gradational" instead of "fluid"

196: Profile 8 seems to have the least agreement in Figure 9 between field are remote sensing data, why?

204: Figure 8 has excellent potential for the direct spatial correlation of the Sentinel albedo to the point measurements. I think showing all the profiles prevents being able to visualize the relationship. I suggest focusing on a few of the same profiles that were a focus of Figure 5 and provide a range of conditions ie. P 3, 5, 8, and 11. Anzoni et al (2016) noted a future goal of generating an albedo map. Is that feasible for the area of the glacier shown in Figure 1?

210: This is a key observation. What have other studies found in terms of the over/under-estimate transition?

226: The variation in energy balance as albedo/debris cover changes spatially and temporally was a focus of Nicholson and Benn (2006) provided a nice overview of this from Ghiacciaio del Belvedere. They observed for debris cover areas the dominant energy contribution varied from sensible heat to shortwave radiation due to decreased albedo and higher surface temperatures. They further found that for dry debris cover, sensible heat flux became negative as debris cover thickened, because of higher surface temperatures and that longwave radiation became negative even for thin debris cover.

231: How significant is the time of day variation in albedo? How consistent would this variation be from day to day? Moller and Moller (2017) provide one measure of this in an examination of spatiotemporal variations of albedo across Svalbard glaciers, recognizing this is a larger scale model albedo product. Nicholson and Benn (2012) examining Ngozumpa Glacier identify surface albedo variation across an area of varied debris cover, as well as the changing diffusivity through the melt season. The surface temperature variation of this glacier in the Himalaya would be much different than in the Alps, yet the continuous record compiled does provide context to the degree of variation and the potential importance of ongoing point measurments. They observe

the importance of distinguishing wet vs dry surfaces. Azzoni et al (2016) note the increased albedo due meltwater presence during the middle of the day to albedo, while rain led to increased albedo for several days.

249: Similarly, the question of how well the albedo variations need to be resolved to model or understand surface processes need to be acknowledged/discussed. One reason a relatively sparse ablation stake network can represent ablation during a melt season is that despite significant surface changes the spatial distribution of energy balance over time tends to balance. Your Figure 5 illustrates this that though albedo varies considerably along the Profile 3 and 11, and the profiles have been exposed ablation ice for some period, the ice surface is relatively even. Energy balance distribution across an ice surface in a small area responds to the variations in surface level, albedo and debris cover.

260: A significant source of uncertainty for what?

271: Need a reference from a different region to emphasize this point.

280: Did you sample spectra at any location over a period of time? If so, this helps relate the logistical challenge of temporal albedo monitoring.

Azzoni, R., Senese, A., Zerboni, A., Maugeri, M., Smiraglia, C. and Diolaiuti, G.: Estimating ice albedo from fine debris cover quantified by a semi-automatic method: the case study of Forni Glacier, Italian Alps, The Cryosphere, 10, 665- 679, 2016.

Moller, M. and Moller, R.: Modeling glacier-surface albedo across Svalbard for the 1979–2015 period: The HiRSvaC500-a data set. J. Adv. Model. Earth Syst., 9, 404–422, 2017.

Nicholson, L. and Benn, D.: Calculating ice melt beneath a debris layer using meteorological data. Journal of Glaciology 52(178): 463–470, 2006.

Nicholson, L. and Benn, D.: Properties of natural supraglacial debris in relation to modelling subâĂŘdebris ice ablation. Earth Surf. Process. Landforms, 38: 490-501, doi:10.1002/esp.3299, 2012.

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-92, 2020.