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Interactive comment on "Utility of late summer transient snowline migration rate on Taku Glacier, Alaska" *by* M. Pelto

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The reviews provide excellent guidance for improving this paper. I will focus here on the three major points raised, leaving all the valuable short comments aside, each specifically will be addressed in the revision. Each of the three point below will be addressed in detail in the revised paper.

1)Does the author know the dates for which the elevations represent on the DEM? To my knowledge, most of the USGS DEM elevations were derived originally from aerial photographicstereo pairs, which for this portion of Alaska goes back to 1948. So, I wonder if this will have any bearing on the balance gradient results calculated from the use of the USGS DEMs?

The USGS DEM is from 1948. In this study we assume use the elevations in this DEM to ascertain the ELA. This does lead to an error in the specific altitude of the ELA. This error can be defined based on existing surface elevation assessments and the ELA could be adjusted. However, it is prudent to wait to adjust these until a new detailed DEM is obtained for the region. The surface elevation of the Taku Glacier in the region of the ELA rose by approximately 10-20 m from 1948-1993 based on JIRP survey results (Pelto et al 2008; Welsch et al, 1996), airborne laser profiling (Echelmeyer et al, 1996; Arendt et al, 2002) and assessments by Roman Motyka (Nolan et al, 1995). In this paper we assume for the period of study that the surface elevation is static. From 1993-2007 Larsen et al (2007) indicate changes of -0.2 to -0.3 ma-1, while JIRP surface studies for the same period find a change of 0.24 ma-1. This is a cumulative thinning of 3-4 m. The likely cumulative change in glacier elevation in the study region is then 6-17 m from 1948-2007. The JIRP longitudinal profile data and Larsen et al (2007) data both indicate that the changes are relatively homogenous in the study region. To affect the balance gradient would require a differential rate of elevation rise with altitude in the study reach.

2)To calculate the accuracy of the MODIS (500 m) measurement of the TSL, as compared to Landsat (30 m), one could easily determine the elevation of the TSL on MODIS and on Landsat on the same dates, and compare the differences in various years to calculate the mean errors in measuring the TSL using the (poorer-resolution) MODIS relative to using Landsat TM. Then one could use MODIS as a surrogate for Landsat, when Landsat is not available, and show the error bars.

Going forward the consistent and temporally rich MODIS data will be the primary source of snowline data, and not Landsat imagery. For this study MODIS was not readily available for a sufficient number of years to rely solely upon it. Only since 2007 is there available usable imagery. I will look to ascertain the errors by comparing the MODIS and Landsat data from the same dates where available in the data set used in this study, there are six such dates. This will be quite valuable in the long run, at this juncture I am not sure if the number of overlapping dates will be sufficient to gain insight. Given the low surface slope of Taku Glacier the actual changes in elevation due to the better resolution of the Landsat imagery will likely be small.

3)The author should emphasize the overall reasons for doing the work and discuss, briefly, how the work fits into other glaciological research, other climate-change work and the long-term measurement program at JIRP. The author mentions applicability to other glaciers. It would be nice to see the relationships of TSL change rate and any other mass balance or proxy data. For applicability to other glaciers to be a strong point, the author needs to address the question of consistent rate of rise for various glaciers and years.

In the revision more attention will be given to the context of the work both on the Juneau Icefield and it potential applicability elsewhere. Changes in the TSL rate of rise would be largely controlled by the balance gradient and local climate conditions. In general the balance gradient of a glacier near the equilibrium line has been found to be consistent from year to year. Hence, changes in the TSL rate of rise should reflect climate primarily. In this study we are looking at the use of the TSL rate of rise to enhance mass balance assessment, not its annual variations or trends in the rate as a separate climate proxy. Going forward monitoring the TSL rate of rise is a worthy suggestion to pursue with the availability of MODIS. The TSL rate of rise is an independent measure from mass balance or the ELA and may indeed have climatic value. This will have to be a separate undertaking from the current study. This study cannot adequately address how consistent the TSL rise is for other glaciers, as the focus is on the utility for the Taku Glacier and its mass balance record. Data is available for the nearby Brady Glacier that can be referenced as an example. Establishing the TSL rate of rise on other glaciers is an important future task and can be done in the absence of mass balance data, since the rate of TSL rise is a measure simply of rate of elevation change of the TSL. It is not anticipated that the rate of TSL rise will be consistent from glacier to glacier.

References

Arendt, A.A., Echelmeyer, K.A., Harrison, W.D., Lingle, C.S., and Valentine, V.B.: Rapid wastage of Alaskan glaciers and their contribution to rising sea level. Science, 297(5880), 382-385, 2002.

Echelmeyer K.A., Harrison W.D., Larsen C.F., Sapiano J., Mitchell J.E., Demallie J., Rabus B., Adalgeirsdöttir G. and Sombardier L.: Airborne surface profiling of glaciers: a case study in Alaska, J. Glaciol, 42(142) 538-547, 1996.

Larsen, C.F., Motyka, R.J., Arendt, A.A., Echelmeyer, K.A., and Geissler, P.E.: Glacier changes in southeast Alaska and northern British Columbia and contribution to sea level rise. Journal of Geophysical Research, 112 doi:10.1029/2006JF000586, 2007.

Nolan, M., Echelmeyer, K., Motyka, R. and Trabant, D.: Ice thickness measurements of Taku Glacier, Alaska, USA, and their relevance to its recent behavior. Journal of Glaciology, 41(139), 541-552, 1995.

Pelto M.S. , Miller M.M., Adema G.W., Beedle M.J., McGee S.R., Sprenke K.F., and Lang M.: The Equilibrium Flow and Mass Balance of the Taku Glacier, Alaska 1950-2006. The Cryosphere, 2, 147-157, 2008.

Welsch W., Lang, M. and Miller, M.M.: Geodetic Activites – Juneau Icefield, Alaska 1981-1996. Schriftenreihe des Studiengangs Vermessungskunde. Universität der Bundeswehr, Heft 50, 1996.

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