The Cryosphere Discuss., 6, C458–C462, 2012
www.the-cryosphere-discuss.net/6/C458/2012/
© Author(s) 2012. This work is distributed under
the Creative Commons Attribute 3.0 License.

The Cryosphere Discussions



# *Interactive comment on* "Observations of widespread accelerated thinning in the upper reaches of Svalbard glaciers" *by* T. D. James et al.

**M. Pelto**

mauri.pelto@nichols.edu

Received and published: 1 May 2012

James et al (2012) provide detailed description of the methods and results of an extensive study of elevation change across six Svalbard Glaciers over the last 40-45 years. This is an important and well designed study. The comments focus specifically on the important issue of losses at the higher elevations of the Svalbard Glaciers. The reader cannot be sure the title of the paper is accurate in stating there is wide spread accelerated thinning in the upper reaches of the Svalbard glaciers. I agree with the authors that this is an important finding, that it is real, and as such deserves both more accurate description and greater discussion of possible causes.

Comments by the authors on page 1194: "The most important finding from our analysis is that some of the greatest increases in mean annual elevation change occurred in the



Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

higher reaches of the glaciers in areas of former snow accumulation. Plotting these changes in mean annual elevation change against elevation for each site emphasizes how the glaciers' upper reaches are consistently experiencing similar or indeed greater increases in thinning rates than at their termini."

In Figure 4 the variation in thinning rate with elevation for three time periods is shown on Austre Brøggerbreen (AB) (b) Grønfjordbreen (GB); (c) Midtre Lovenbreen (ML); (d) Albrechtbreen (AL); (e) Gullfaksebreen (GF); and (f) Slakbreen (SB). Figure 4 does not indicate a consistent increase in thinning over the glaciers upper reaches. GF, AL and SB are close to having minimum thinning at the upper reach of the glacier. AB, ML and GB do show significant increases in thinning at the upper elevation during the 1990-2005 period. This figure is of course not depicting the change in the rate of thinning between the periods. The result of the net changes in Figure 4 is Figure 7, which illustrates that the upper reaches of the glaciers do not have the greatest thinning rate, and that change in thickness has increased for all elevations of the glaciers in the most recent period.

The change in rate of thinning with elevation from the 1970-1990 period to the 1990-2005 period is indicated in Figure 5. In this GF and AB again do not have a larger change in thinning rate at the highest elevation, the other four glaciers do. Without detailed maps of the distribution of thinning in the upper reaches of the glaciers, it is not apparent that the greatest mean elevation rate changes are widespread. That two of the six glaciers do not show this trend suggests that the maximum change in rate of thinning in the upper reaches cannot be considered consistent.

To identify the importance and possible causes for the increase rate of thinning at the upper reaches of four of the six glaciers requires a map like that provided for Figure 2 illustrating the distribution of the areas of greater thinning. This may or may not show how widespread the thinning is at the upper reaches. The current Figure 2 which shows the full time period do not indicate much important thinning at the upper reaches except on AL and ML.



TCD
6, C458–C462, 2012





The above does not take away from the importance of extensive significant rates of the thinning in the upper reaches of the glaciers. What about the causes of this thinning? The authors offer one suggestion, regional albedo. Below I offer three other suggestions and comment on the albedo suggestion. Each of these suggestions arises from recent research, and I am not advocating for any particular one, but each warrants brief attention.

1) The lack of consistency in the thinning rates changes does not argue for regional albedo change due to a factor such as black carbon. The upper reaches of several of the glaciers do back up to steep mountain ridges which would likely be the major source of particles on the glacier, AB and ML in particular. Glacier thinning has exposed new headwall areas that would aid in providing additional debris. This could be as likely an explanation for an albedo change. That the peak elevation range of thinning is 100-200 m is not the area where black carbon or regional albedo change should have the greatest impact.

2) The lack of internal accumulation in the upper reaches could lead to a larger response due to enhanced ablation. This increased ablation if retained partially as superimposed ice could cause an increase in thinning in the upper reach versus the elevations just below that. Zwinger and Moore (2009) Figure 1 indicate that a portion of the upper reach of Midre Lovenbreen is temperate ice where there is no superimposed accumulation. They indicate that superimposed ice formation is crucial to the heat balance of a sector of the glacier above the ELA between 400-450 m, just below the upper reaches. Annual ice loss or gain in this area of the glacier is determined by the amount of superimposed ice formed that year. It has been noted by Wright et al (2007) that superimposed ice accounts for an average 37% of the total net accumulation under present conditions.

3) Another possibility to at least mention is changes in solar radiation for the upper reaches. Hodson et al (2007) observed that surface melting is dependent mainly upon net shortwave radiation fluxes (74-100%). With thinning the headwall of a couple of



TCD
6, C458–C462, 2012





the glaciers become larger and the bare rock is exposed for longer this can alter the radiation balance.

4) Reduction in the ablation gradient could lead to increased comparative thinning of the upper reach of the glaciers. Solovyanowva and Mavlyudov (2007) in examining mass balance of Vøring Glacier, and Western Grønfjord Glacier note that in 2001-2004 ice melting was a uniform distribution over the glaciers area. In 2005-2006 there was a clear elevation-ablation dependence, with decreased ablation in the upper parts on the lower parts of the glaciers ablation intensity increased but in upper glacier parts. This difference they suggest is caused in part by changes in atmospheric stratification above the glaciers. If this were a more persistent feature toward a pattern with a reduced ablation gradient, thinning rates would rise comparatively in the upper reaches of a glacier.

References

Hodson, A. Kohler, J. Brinkhause, M. and Wynn, P.: Multi-year water and surface energy budget of a high-latitude polythermal glacier: evidence for overwinter water storage in a dynamic subglacial reservoir. Ann. Glaciol., Volume 42, 42-46 2005.

Solovyanova, I.Y. and Mavlyudov, B.R.:Mass balance observations on some glaciers in 2004/2005 and 2005/2006 balance years, Nordenskiold Land, Spitsbergen. In “The Dynamics and Mass Budget of Arctic Glaciers, 115-120, 2007.

Wright, A. P., Wadham, J. L., Siegert, M. J., Luckman, A., Kohler, J., and Nuttall, A. M.: Modeling the refreezing of meltwater as superimposed ice on a high Arctic glacier: A comparison of approaches, J. Geophys. Res., 112, F04016,doi:10.1029/2007JF000818, 2007.

Zwinger, T. andMoore, J.: Diagnostic and prognostic simulations with a full Stokes model accounting for superimposed ice of Midtre Lovenbreen, Svalbard. The Cryosphere, 3, 217–229, 2009.





CC BY

Interactive comment on The Cryosphere Discuss., 6, 1085, 2012.