The Cryosphere Discuss., 6, C1914–C1916, 2012
www.the-cryosphere-discuss.net/6/C1914/2012/

The Cryosphere Discussions

Interactive comment on "Ice tectonics during the rapid tapping of a supraglacial lake on the Greenland Ice Sheet" *by* S. H. Doyle et al.

M. Pelto

mauri.pelto@nichols.edu

Received and published: 21 October 2012

Doyle et al (2012) provide a valuable and detailed description of a rapid supraglacial lake drainage event on Russell Glacier, Greenland. This paper contains the level of detail that is essential to understand the complicated processes leading up to, during and immediately after the drainage event. I congratulate the authors on undertaking a study that can provide the detailed observations. The longest comment below is merely for clarification of basic process framing in the introduction, and not the actual study described.

3865-19: This assumes the acceleration leads to an overall increase in velocity. You have cited some support for this. This maybe the case, but there is considerable literature suggesting it is not. Sundal et al, (2011) noted that ice velocity was enhanced

by high melt rates early in summer; however, this was offset by velocity during the latter portion of warm summers being less. Van de Wal (2008) noted that the melt rate and ice velocity feedback mechanism was a short lived seasonal mechanism that may have a limited impact on ice sheet velocity. Das et al., (2008) noted that other than the 24 hours following drainage pre and post drainage velocities did not differ appreciably. Bartholomew et al, (2012) note that the ice velocity at elevations below 1000 m are dominated by speed up events of 1 day to 1 week. Colgan et al (2011a). Sundal et al (2011) and Batholowmew et al (2012) all noted the similarity of the subglacial drainage system response to that of smaller alpine glaciers. That basal sliding is enhanced when meltwater input exceeds the subglacial transmissivity and that basal sliding is reduced after during periods of reduced hydrologic head.

3868-16: Any Landsat imagery from overlapping dates that could aid in assessing this error?

3869-27: When exactly did F1 open? In general somewhere in the paper I would appreciate a description of the evolution of F1 beyond the actual drainage event, note following comment also.

3874-18: What is the structure of F1 a month after the event? Is the main fracture, F1, observable in a similar orientation in imagery from previous years? Are there any other images of Lake F from before or after drainage that could illustrate this?

3875-10: This indicates the fracture is a better means of drainage than a moulin. The fracture is different than the crevasses discussed by Colgan et al (2011b) which observed that moulins propagate meltwater pulses to the englacial system better than crevasse systems. Could you describe specifically how the fracture differs.

3876-21: Could the earlier lake formation and drainage lead to a longer period of each melt season being a period of reduced basal sliding since the mature subglacial hydrologic drainage system leads to reduced hydrologic head and lower velocity? This goes back to the first comment above and the similarity of the subglacial drainage system

TCD
6, C1914–C1916, 2012

response to that of smaller alpine glaciers. Where high melwater input in the spring increases velocity as the subglacial hydrologic system is redeveloped, and is less with higher runoff later in the summer through the now efficient subglacial hydrologic system.

References

Bartholomew, I., Nienow, P., Sole, A., Mair, D., Cowton, T. and King, M.A.: Short-term variability in Greenland Ice Sheet motion forced by time-varying meltwater drainage: Implications for the relationship between subglacial drainage system behavior and ice velocity, J. Geophys. Res., 117, F03002, doi:10.1029/2011JF002220, 2012.

Colgan, W., Steffen, K., McLamb, W., Abdalati, W., Rajaram, H., Motyka, R., Phillips, T. and Anderson, R.: An increase in crevasse extent, West Greenland: Hydrologic implications, Geophys. Res. Lett., 38, L18502, doi:10.1029/2011GL048491, 2011a.

Colgan, W., Rajaram, H., Anderson, R., Steffen, K.,. Phillips, T., Joughin, I., Zwally, H. and. Abdalati, W.: The annual glaciohydrology cycle in the ablation zone of the Greenland ice sheet: Part 1. Hydrology model, Journal Glaciology, 57(204), 697-709, 2011b.

Das, S., Joughin, I., Behn, M., Howat, I., King, M., Lizarralde, D., and Bhatia, M.: Fracture propagation to the base of the Greenland Ice Sheet during supraglacial lake drainage, Science, 320, 778–781, 2008.

Sundal, A.V., Shepherd, A., Nienow, P., Hanna, E., Palmer, S. and Huybrechts, P.: Melt-induced speed-up of Greenland ice sheet offset by efficient subglacial drainage. Nature, 469(7331), 2011.

van de Wal, R. S. W. et al. Large and rapid melt-induced velocity changes in the ablation zone of the Greenland Ice Sheet. Science 321, 111–113, 2008.

Interactive comment on The Cryosphere Discuss., 6, 3863, 2012.