

Interactive comment on “Basal sliding of temperate basal ice on a rough, hard bed: pressure melting, creep mechanisms and implications for ice streaming” by M. Krabbendam

M. Krabbendam

mkrab@bgs.ac.uk

Received and published: 5 May 2016

Reply to interactive comment by Doug Benn: ‘Ice facies evidence of grain boundary melting’ on “Basal sliding of temperate basal ice on a rough, hard bed: pressure melting, creep mechanisms and implications for ice streaming” by M. Krabbendam

Thank you for pointing out the paper by Lovell et al. (2015); it is really interesting, and I shall, in the revised version, indeed discuss their paper. Indeed, the formation of the basal ‘dispersed facies’ of bubble-free glassy ice by strain induced metamorphism, including partial melting, is pretty much the process I had in mind within the temperate ice that I pursue in the manuscript, and it is good to see this being documented, even though the glaciological situation (surging glacier vs. ice sheet ice streaming) is

somewhat different.

However, we need to be careful to distinguish 'basal ice facies' from 'temperate ice'. Firstly, it is of course possible to have temperate ice that is not a basal ice facies, see for instance the Glacier de Tsanfleuron (Tison and Hubbard, 2000), where there's clearly different ice facies, but the glacier appears to be temperate throughout. It would be interesting to study the different mechanical behaviours of these different ice facies all at the pressure melting point, to study the effects of grain size and bubble/debris content. Secondly, even if the 'bubble-free' ice is produced at or near the base by partial melting, it is possible to cool this ice subsequently to below the melting temperature. This is potentially the case in large polythermal ice sheets (e.g. Greenland) where large scale folding (with 100s metres amplitude, for instance: Bell et al. 2014) have brought up 'featureless' basal ice higher up into colder ice. Given sufficient time, thermal conduction will cool these uplifted basal ice facies to well below the melting temperature. So 'basal ice facies' and 'temperate ice' do not necessarily equate: one is an ice facies, the other is purely a thermal state.

References:

Bell, R. E., Tinto, K., Das, I., Wolovick, M., Chu, W., Creyts, T. T., Frearson, N., Abdi, A., et al.: Deformation, warming and softening of Greenland's ice by refreezing meltwater, *Nature Geoscience*, 7, 497-502, doi:10.1038/ngeo2179, 2014.

Lovell, H., Fleming, E. J., Benn, D. I., Hubbard, B., Lukas, S., Rea, B. R., Noormets, R., and Flink, A. E: Debris entrainment and landform genesis during tidewater glacier surges., *Journal of Geophysical Research: Earth Surface*, 120, 1574-95, doi: 10.1002/2015JF003509, 2015.

Tison, J. L. and Hubbard, B.: Ice crystallographic evolution at a temperate glacier: Glacier de Tsanfleuron, Switzerland, Geological Society, London, Special Publications, 176, doi: 10.1144/GSL.SP.2000.176.01.03, 2000.

[Printer-friendly version](#)

[Discussion paper](#)

