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The Cryosphere Discussions

Interactive comment on "Velocity structure, front position changes and calving of the tidewater glacier Kronebreen, Svalbard" *by* M. Sund et al.

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This paper uses a variety of field measurements to investigate the processes controlling the terminus position of a tidewater glacier in Svalbard. Detailed field studies such as this one are useful because they can be used to test previously-proposed calving models and to gain insights into physical processes that are not currently captured by models. However, this paper feels unfinished, lacks direction, and does not reach substantial conclusions.

According to the conclusions section, the primary messages of the paper are that (1) the relationship between crevasse formation, glacier velocity, and calving is more complex than proposed in the crevasse-depth calving model, (2) there was no clear relationship between glacier velocity and calving (over a relatively short time interval), and

(3) water depth is an important control on calving.

First, when Benn et al. introduced the crevasse-depth calving model they had already acknowledged that it was a simplification of reality but argued that it "represents an important first-order control on the position of the calving front, on which other 'secondary' calving processes are superimposed." I don't see what conclusion (1) adds to our understanding of calving. I would find it much more useful if the authors used their data to show where and why the crevasse-depth model fails. One way to do this might be to plot glacier length (or area) vs. time and compare that to the position that would be predicted by Benn's model. Does Benn's model systematically under- or over-predict terminus position?

Second, according to Benn (and other studies...), calving should depend on strain rate (and not simply velocity). I wouldn't necessarily expect to find a clear relationship between velocity and calving, nor am I convinced that it would be possible to find a clear relationship between strain rate and calving when using data that only spans one summer. For example, a 10% increase in strain rate would only increase the (predicted) crevasse depth by $\sim$3%. For the strain rates cited in the paper, this amounts to an additional 1 m. Such changes are unlikely to have a large impact on the glacier's terminus position during the short time period considered here.

Third, water depth is already known to be an important control on tidewater calving – Benn's model indirectly depends on water depth (because strain rates depend on basal drag). Furthermore, this conclusion should probably reference Pfeffer (2007) or Vieli et al. (2001) (or some other theoretical studies).

The most interesting idea in the paper (which is also the basis for several papers on calving from ice shelves) may be that changes in terminus position depend on both the instantaneous strain rate at the terminus and on the glacier's "history". In other words, the terminus position is strongly influenced by crevasses that form upglacier and are advected into the terminus region. Is there a way to adjust the Benn model to account

for this flow history?

Unfortunately I don't have any simple suggestions for improving the paper. Right now it reads as though two unfinished papers were put together to create one paper. I wonder if it would be better to split it into two shorter papers: one that focuses on recent, short term variations in flow at Kronebreen, and one that focuses on secular changes in ice volume and terminus position of Kronebreen. Perhaps this would help give the study better direction.

Interactive comment on The Cryosphere Discuss., 5, 41, 2011.