Review of “Warming of SE Greenland shelf waters in 2016 primes large glacier for runaway retreat” by Bevan et al. (2018), *The Cryosphere Discussions*

The paper uses remote sensing data to generate an up-to-date time series of the Kangerdlugssuaq Glacier (KG) frontal position, thickness and flow velocity. The glacier has recently destabilised and is likely to retreat further in the near future due to sloping bedrock topography. Glacier destabilisation is attributed to anomalously warm surface waters breaking up ice melange which otherwise inhibits winter calving.

The paper is very well written with a clear, direct message and nice figures/animation. The work is highly topical and the data evidencing the latest KG destabilisation should be published promptly. The proximity of the grounding line to a region of retrograde bed slope is a particularly important point for predicting future mass loss. The authors put forward a compelling mechanism to explain the recent retreat, ultimately attributing it to high sea surface temperatures on the shelf in 2016. However, I think more rigour is required to definitively establish a causal connection there, otherwise the proposed mechanism should be qualified somewhat.

I am not a glaciologist, but a physical oceanographer with expertise in this region. I can therefore only review the work from this viewpoint and can provide little feedback on, for example, the remote sensing or glacial dynamics aspects of the study.

Specific comments

1. The high sea surface temperatures in Kanger Trough in 2016, melange breakup episodes and destabilisation of KG could all be driven by a common forcing, namely either increased subsurface ocean heat content or increased atmospheric heating/solar radiation. Increased temperatures at depth will increase melting/calving at the terminus and, in particular, may have destabilised the terminus via undercutting. Increased atmospheric/solar heating would act to increase runoff and strengthen estuarine circulation, drawing shelf waters towards KG terminus at a greater rate. In both these scenarios, the breakup of melange may have played a role in KG’s destabilisation or may simply be an additional symptom of the large scale forcing. You need to eliminate these possibilities before you can attribute the recent retreat and acceleration of KG to sea surface temperatures alone.

2. Can you be more quantitative about the forces involved with the melange stress bridges? You cite the Burton 2018 paper, but I think it would be appropriate to translate some of those results to this study as it is a crucial part of the proposed mechanism. Can you say that this is a more effective mechanism for mass loss than, for example, terminus undercutting (i.e. in ablation rate per Watt). Clearly the stress bridges are not strong enough to prevent terminus advance during a “normal” winter. It is not then clear that they may remain intact during these periods and prevent calving. I couldn’t see any evidence of these stress bridges in Figure 4 or the animation, with icebergs seemingly spaced apart. I acknowledge the image resolution may prevent smaller icebergs being distinguished from the surrounding sea ice. You say on P2L26 that the raw image data has an 8-30 m resolution. Could you use this to generate a zoomed-in, high-resolution image of the melange highlighting the potential for stress bridges?

3. I think the paper could say a little bit more about the mechanisms for exchange between fjord and shelf. Particularly, how do the warm surface waters on the shelf penetrate the fjord and flow all the way to the melange/terminus area. Simulations of Kanger fjord (e.g. by Cowton (2016) and Fraser (2018c)) indicate the net flow in the surface layer is out-fjord. This is not to say that surface layer inflow is impossible, and there is a reasonably large literature on fjord-shelf exchange in SE Greenland which could be referred to in order to fill-in this part of the picture.

4. I am not convinced the residence times within KF are sufficient for these warm surface waters to remain on annual to inter-annual timescales. It is a very dynamic environment with wintertime along-shelf winds driving rapid exchange events which punctuate the background circulation. Several estimates for the exchange through the fjord mouth exist (e.g. Sutherland 2014, Cowton 2016, Fraser 2018), and these can be used to generate back-of-the-envelope fjord flushing times on the scale of a few weeks or months. There are also regular katabatic winds driving strong outflow at the surface, described by Spall (2017) for Sermilik Fjord (I'm sure this can be extended to KF). Furthermore, the surface layer will be cooled by the atmosphere hence the formation of sea ice. I therefore cannot picture a scenario in which warm surface water simply "hangs around" in KF. It must be supplied via advection from the shelf or delivered from depth via either vertical mixing or buoyant overturning near the terminus/icebergs.

Technical corrections

P1L23: Should "fjord and shape" read "fjord size and shape"?

P2L8: I'd lose the word "ice" as it is implicit in the acronym "GrIS".

P4L21: "WGS84" had a space earlier on line 12.

P6L2: See specific comment 2.

P6L34: Were the subsurface or atmospheric temperatures anomalously warm during this period?

P7L5: See specific comment 4.

Figure 3: Most of this information is already in Figure 2. Perhaps they could be combined e.g. by making this an inset.

Figure 6 caption: "The dashed yellow line marks indicates the …". Lose either "marks" or "indicates".

Animation: I like this a lot, it communicates the severity of the recent retreat really well. But it would be nice to download it and be able to go through frame by frame.

Overall, a succinct and well written paper which I have enjoyed reading and reviewing. Another fascinating twist in the tale of Kangerdlugssuaq Glacier!

Kind Regards,

Neil Fraser