Characteristics of a surge of Franklinbreen detailed from remote sensing

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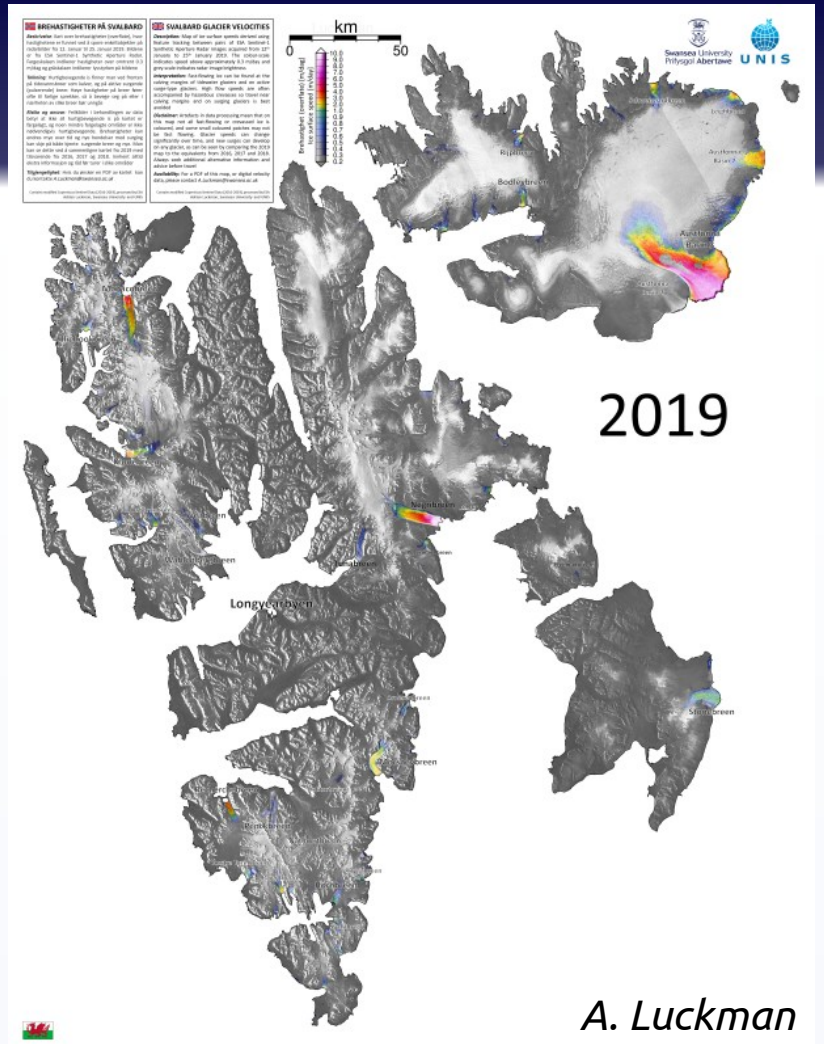
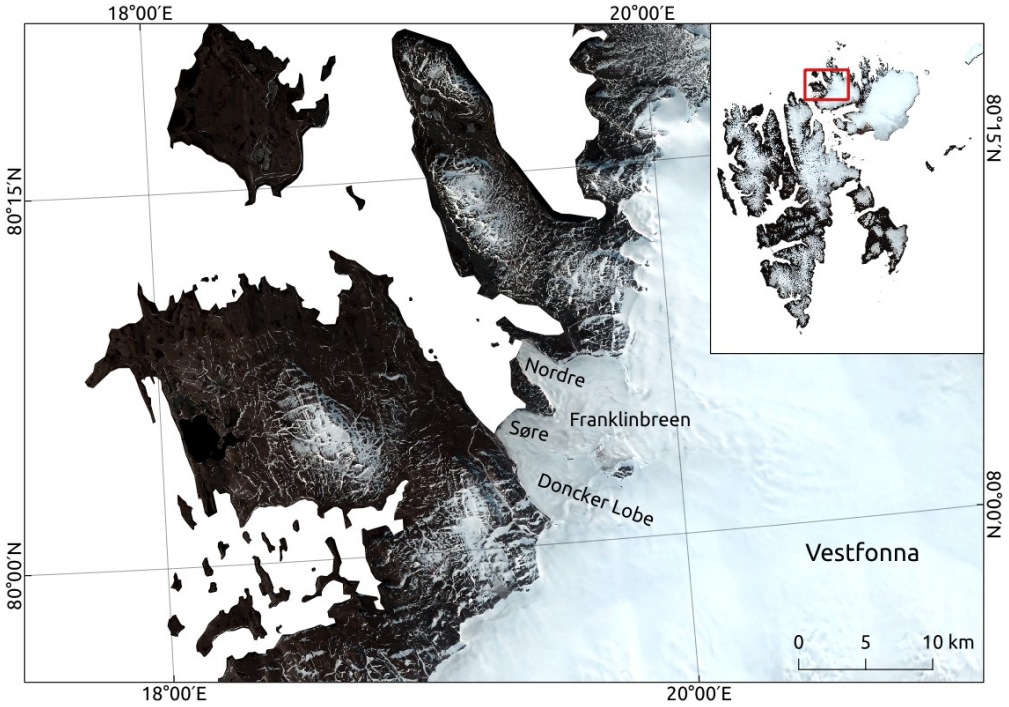
Motivation

- Over past decade, a number of high-profile surge events in the Arctic
  - High speeds (up to 25 m d^{-1})
  - Dramatic surface lowering
  - Rapid terminus advance
- Contrast to many documented surge events:
  - Slower speeds
  - Little (documented) surface elevation change
  - Limited terminus advance
- Q: what makes a surge ‘spectacular’?



Franklinbreen

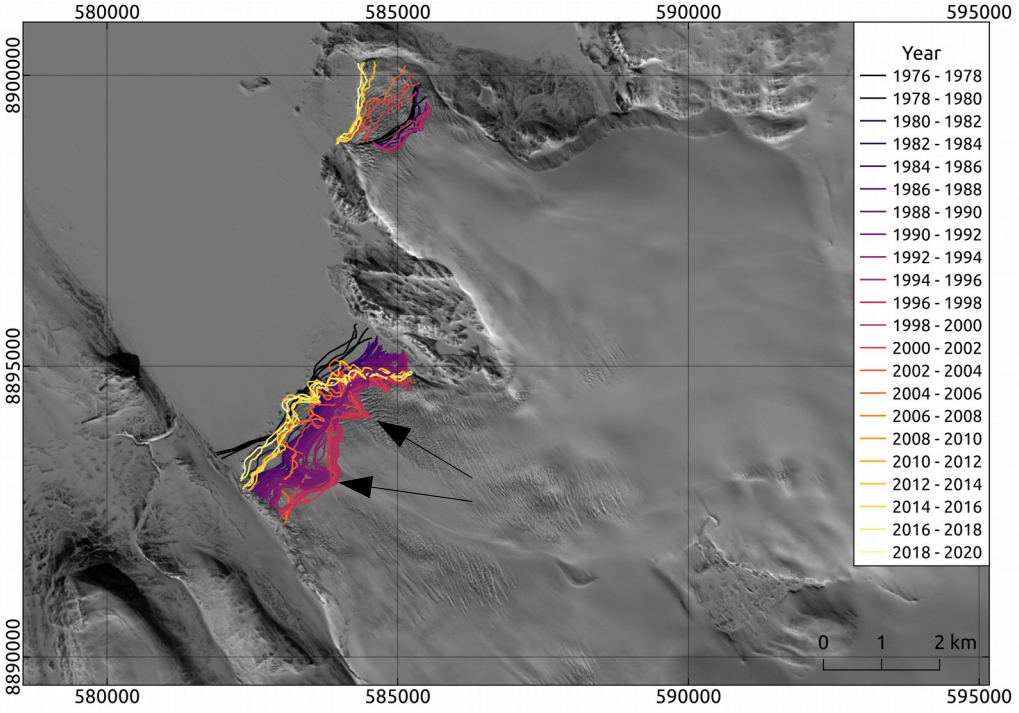
- Outlet glacier of Vestfonna, Nordaustlandet
- 1956 surge event reported (Hagen et al., 1993)
- Dramatic increase in speed, 1995/96 – 2008 (Pohjola et al., 2011)
  - “we … speculate the outlet is having a surge phase.”
- 2008 InSAR speeds: ~ 1 m d^{-1} at ice front (winter)

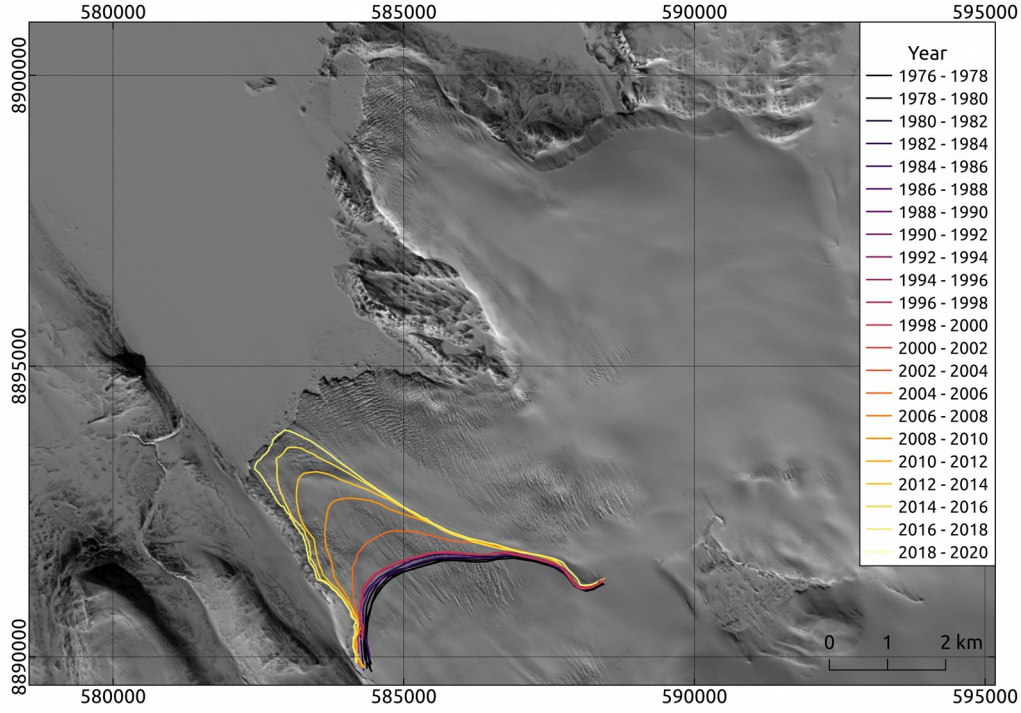


Data

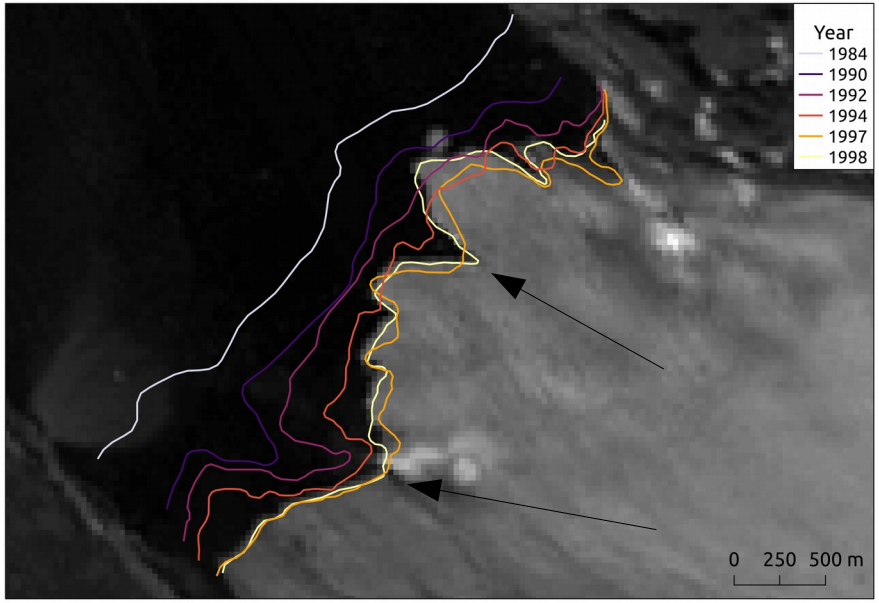
- Landsat images, 1976-2020:
  - L1GS: register to cloud-free mosaic, orthrectify to NP 50m DTM
  - L1GT: de-orthorectify using GTOPO30 DEM, re-orthorectify as for L1GS
- ASTER DEMs, 2000-2018
  - Processed using MicMac ASTER (Girod et al., 2017)
- ArcticDEM Strips, 2011-2017 (Porter et al., 2018)
  - Same-day strips co-registered, mosaicked
- GoLIVE velocities, 2014-2019 (Fahnestock et al., 2015)

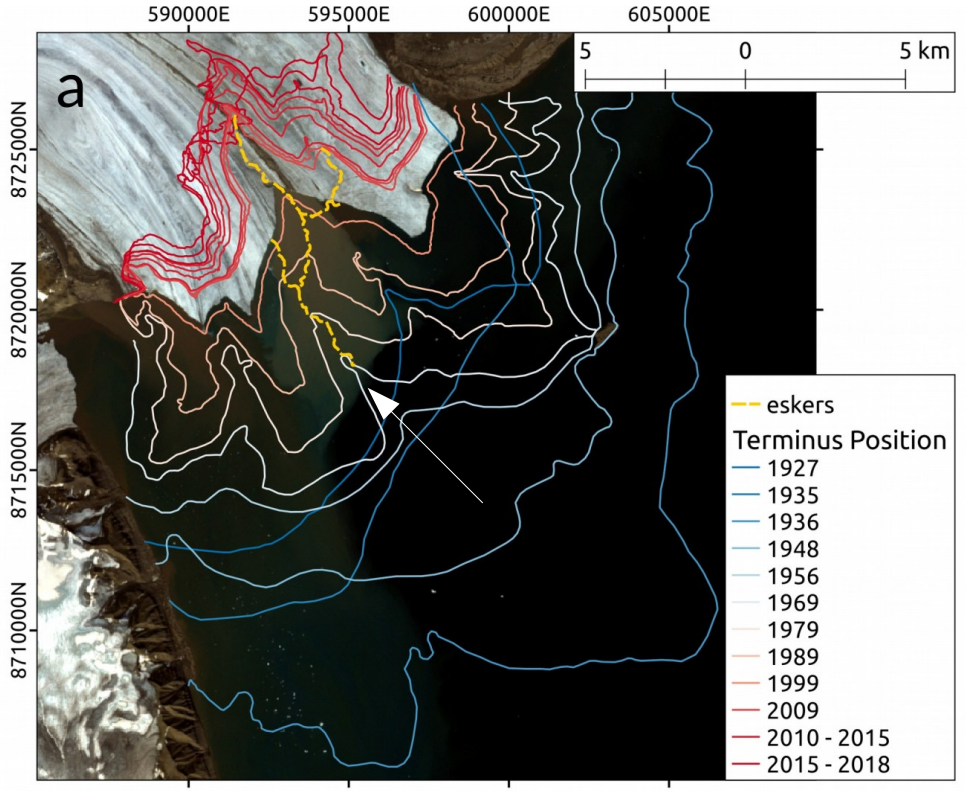
Front positions





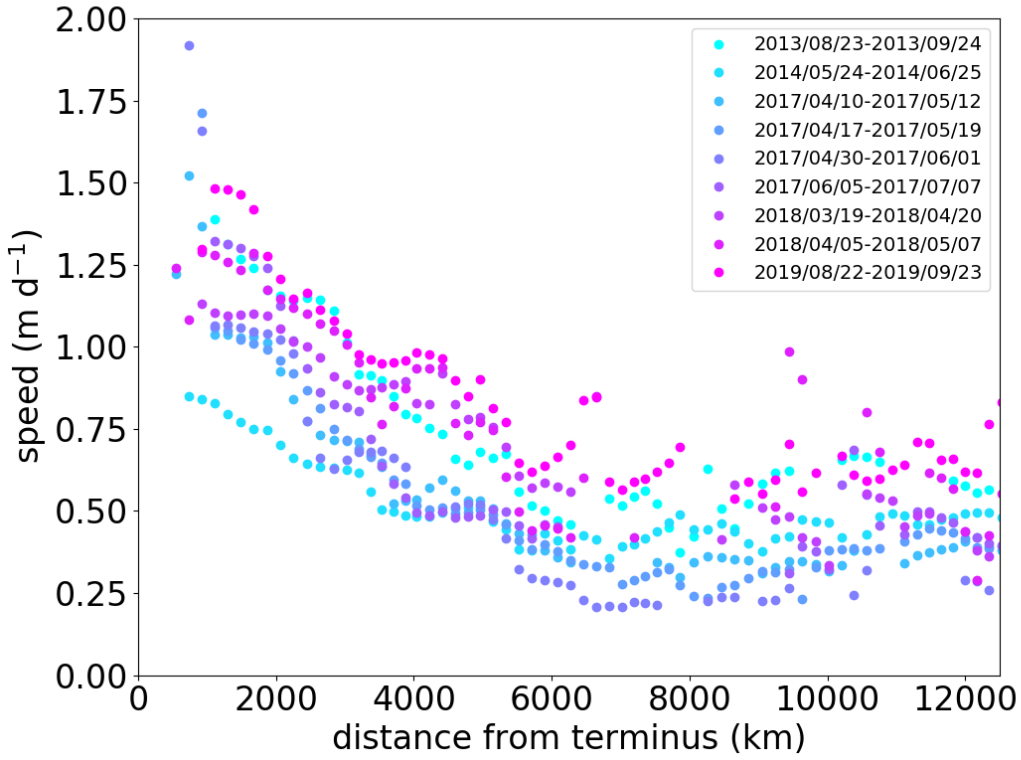
Terminus notch development

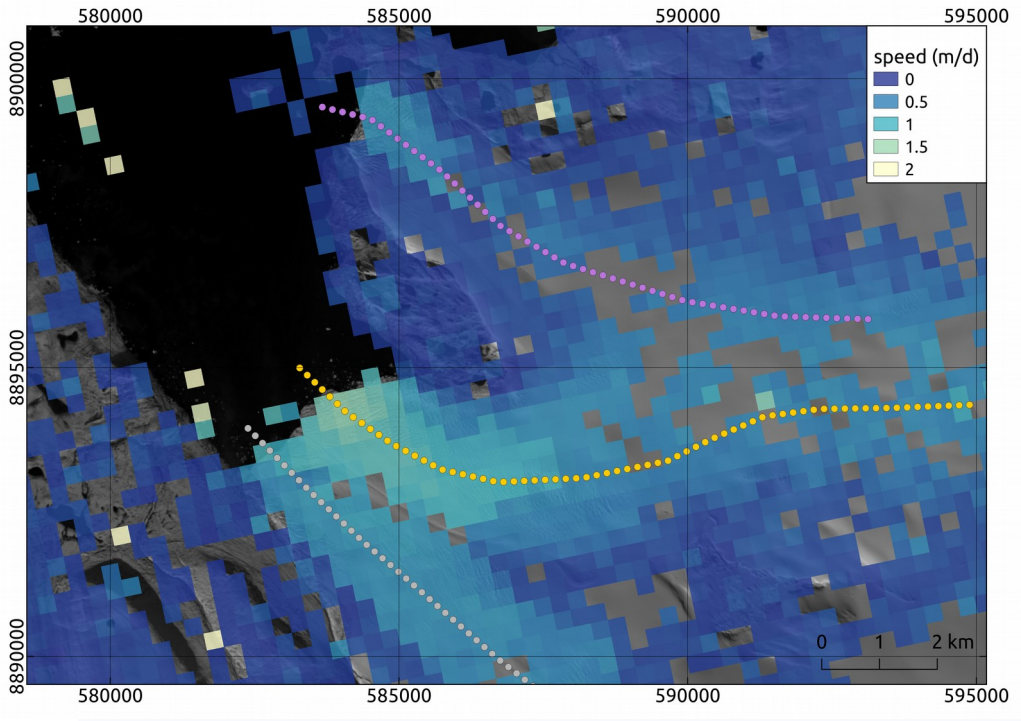




Haga et al., *in press*

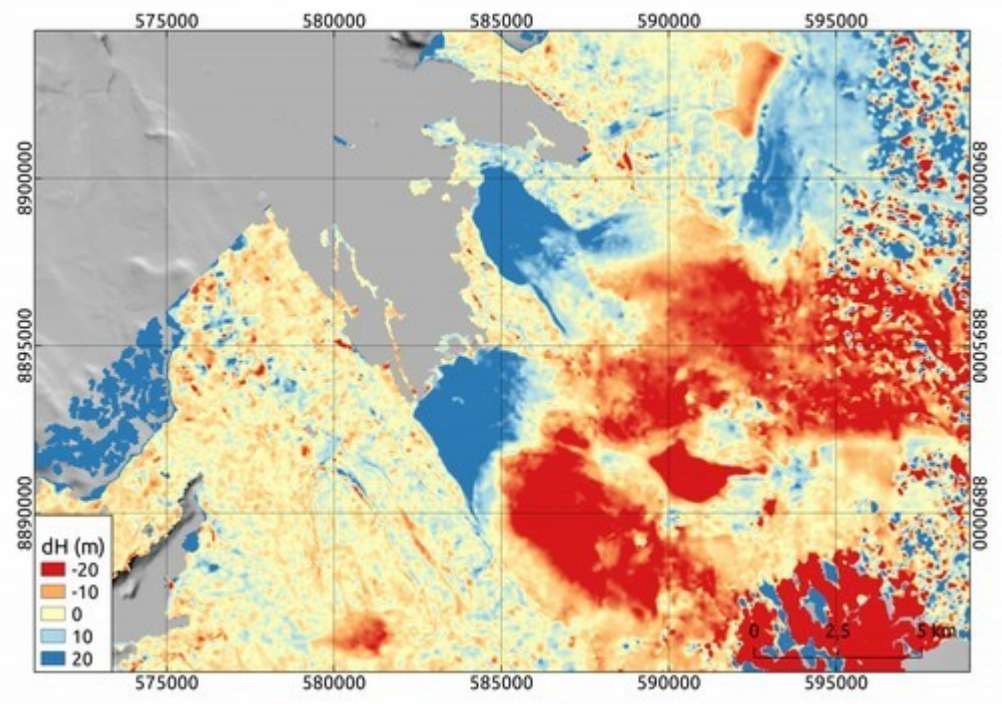
Ice velocities



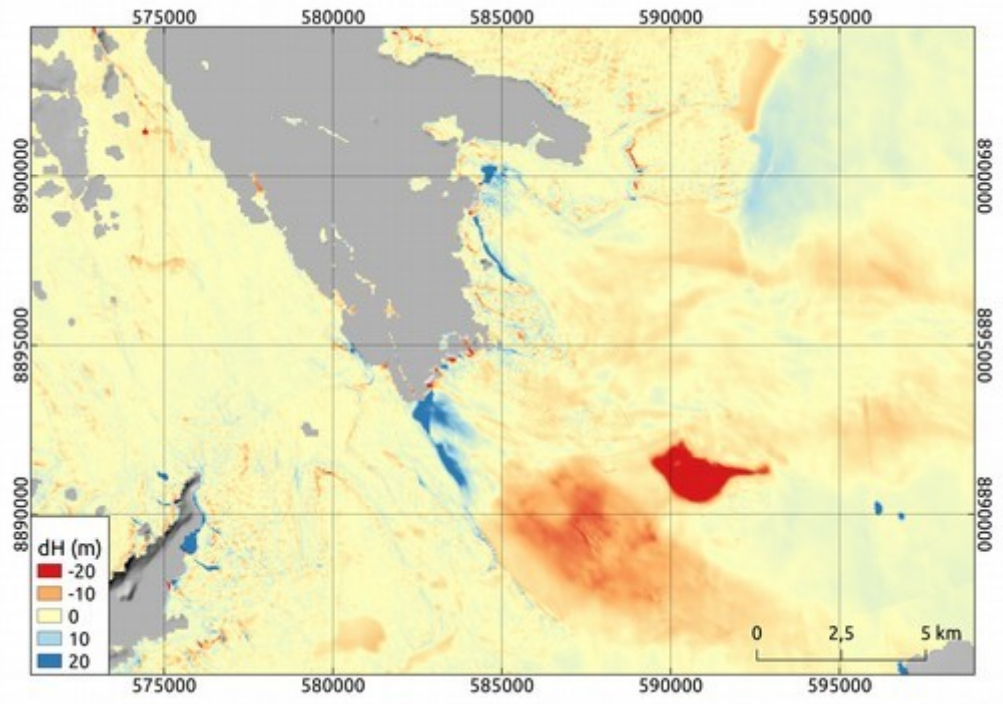


Elevation changes, 2000-2017

2000-2017



2010-2017



Summary

- Long-term near-stagnant ice at terminus
- Active surge initiated in winter 1998/99
  - Summer 2000, >4 m d^{-1} at front
  - Modulated to ~2 m d^{-1} post-2002
- Notch(es) develop in similar manner to Negribreen (Haga et al., *in press*)
  - Collapse of persistent drainage channels?
- Advance/thickening at both termini
  - Most elevation change happens before 2010
- Thinning upstream

Further work

- Finish digitizing terminus positions
- Elevations, 2000-present: well-covered
  - Before 2000, lack of currently available data
- Process velocity maps, 1999-2013
  - Possibly earlier?
- ERS 1,2, other radar imagery
  - Crevasse development, winter 1998/99
  - Potential winter ice velocities

References

- Landsat orthorectification/registration: https://github.com/iamdonovan/pybob
- MMASTER processing: https://mmaster-workflows.readthedocs.io/en/latest/
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- Haga ON, et al. (*in press*). From high friction zone to frontal collapse: dynamics of an ongoing tidewater glacier surge, Negribreen, Svalbard. *J. Glaciology*.