Relevance of field observations as boundary conditions for understanding ice-sheet–ocean interactions

– a compilation of results from coastal Dronning Maud Land –

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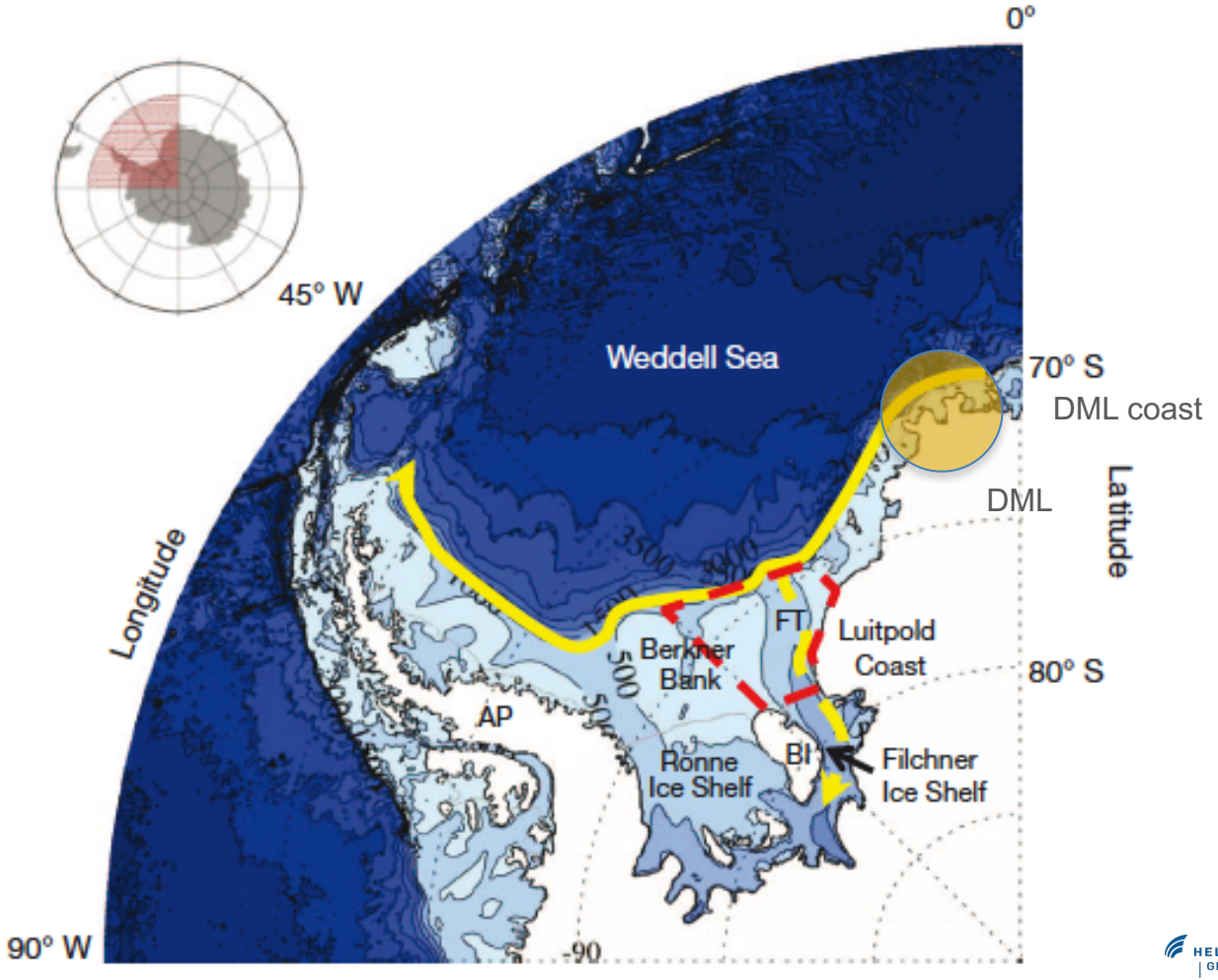
East meets West: Filchner inflow

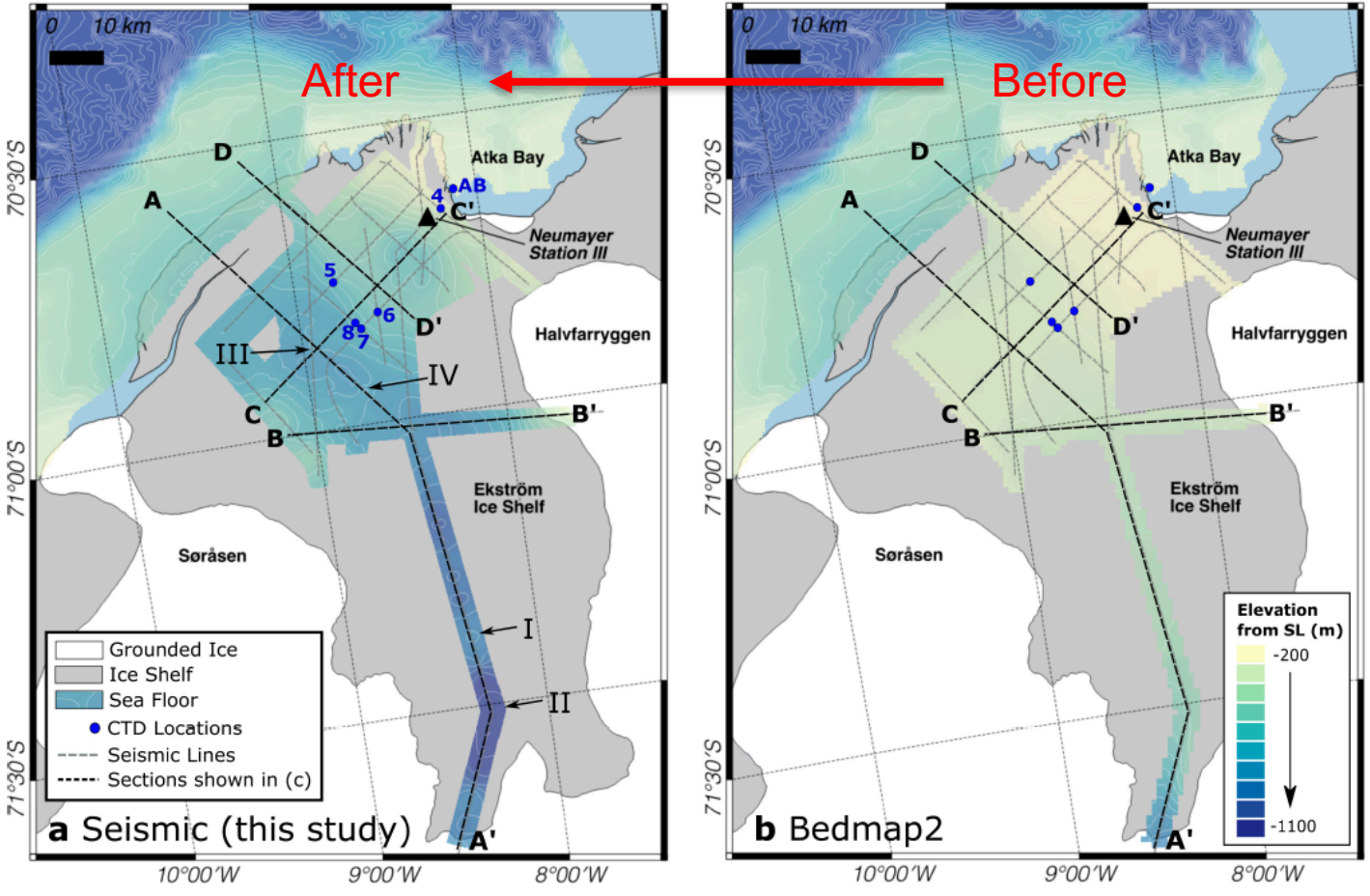


Hellmer et al.,
Nature, 2021

Key Projects & Methods

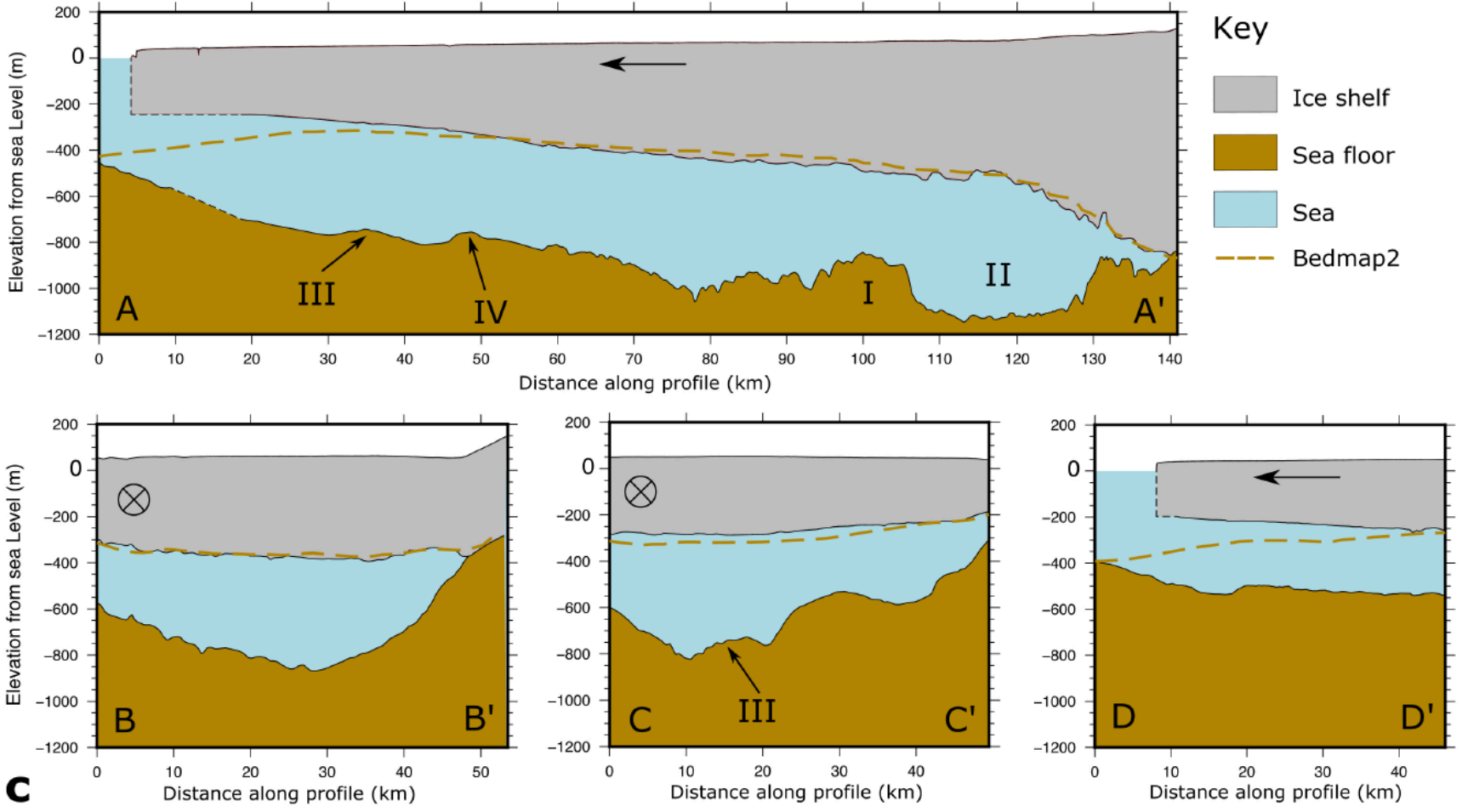
- LIMPICS 2008-13, (AWI, U. Bergen)
  - initial seismic surveys, discovery of Explora Wedge Outcrop (Kristoffersen et al., 2014)
- EKSEIS 2014 (AWI)
  - first operational vibroseismic survey
- COST–S2S (AWI, UTü, KEG, 2015-20)
  - satellite-based surface velocity
- Sub-EIS-Obs (AWI & BGR, 2016-dato)
  - seismic pre-site survey -> bathymetry, geomorphology, geology
  - sea-floor sampling
  - CTD profiling: water masses
- MIMO (BESLPO: ULB, CSL, AWI)
  - satellite observations: sfc topography & velocity
  - pRES ice thicknesses & melt rates
- GEA/VISA (AWI & BGR, 2001-dato)
  - airborne geophysics: geology, spatially distributed bathymetry

Bathymetry from active seismics



Smith et al., GRL, 2020

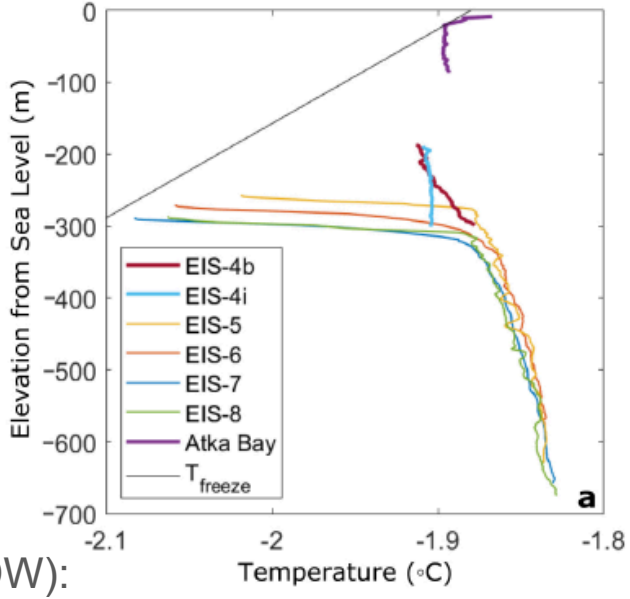
Bathymetry from active seismics

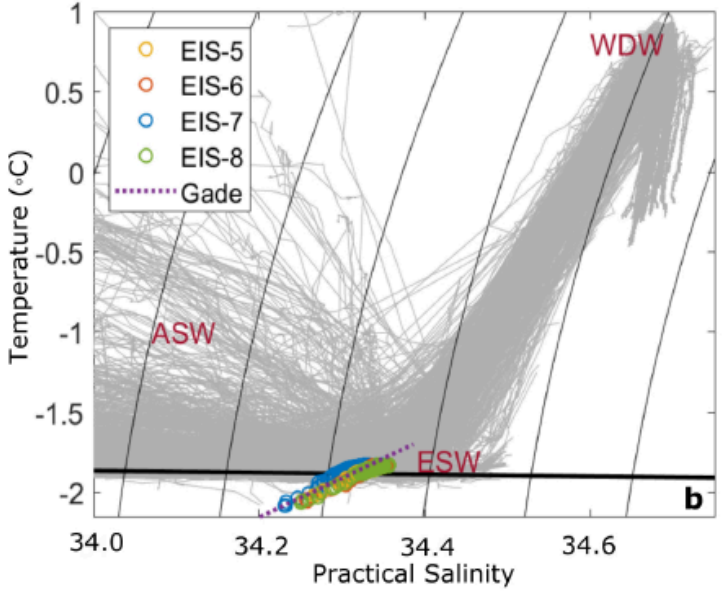


Smith et al., GRL, 2020

Ocean circulation in EIS cavity

CTD measurements:
- 2018/19 season
- HWD boreholes
- simple add-on to sampling runs





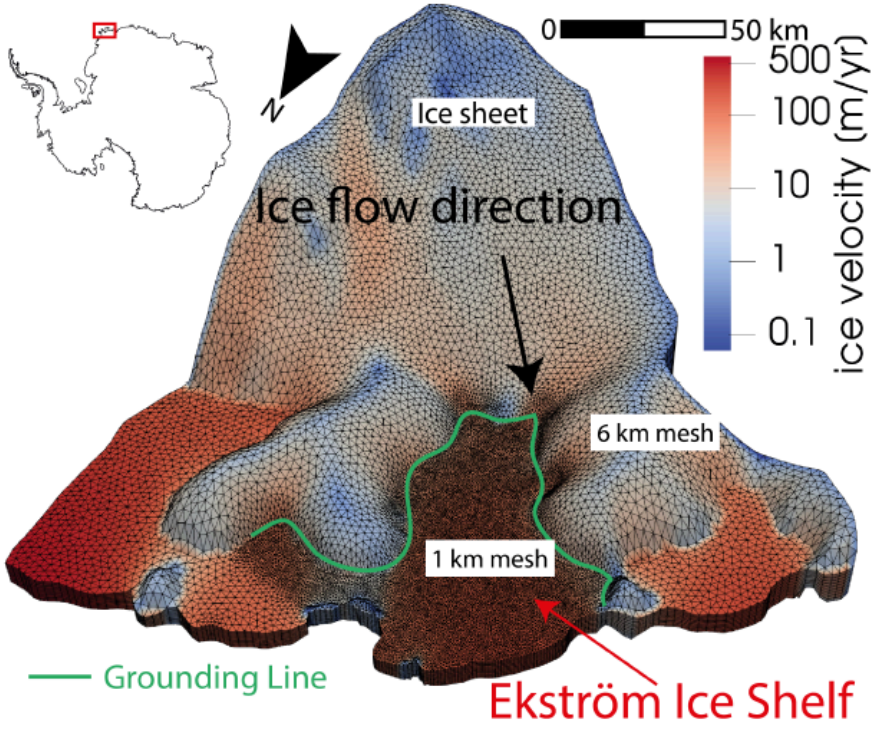
Smith et al., GRL, 2020

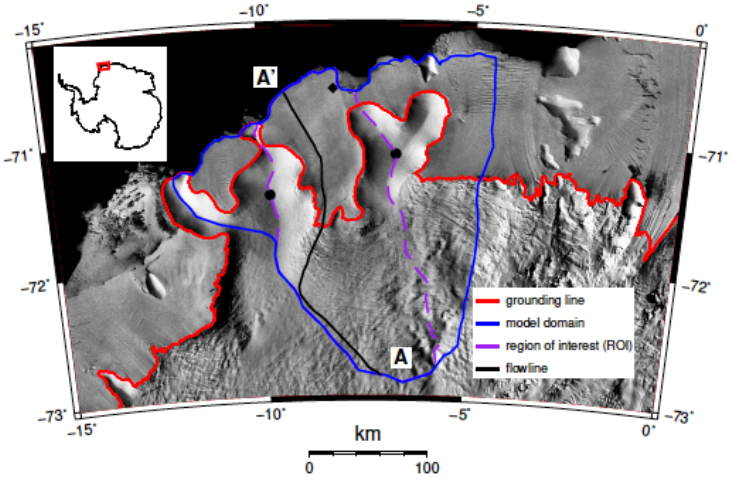
Warm Deep Water (WDW):
- not in cavity yet, but inflow possible over sill
- occasionally during specific ocean events
- under future warming (rising T, changing circulation)

Two circulation regimes in cavity:
- overturning circulation in glacial trough
- tidal mixing in eastern part towards Atka Bay with high production rate of platlet ice

ELMER-ICE Ekströmisen

- Model implementation at Tü and KEG on SuperMUC
- Solver: ParStokes (iterative) vs MUMPS (direct)

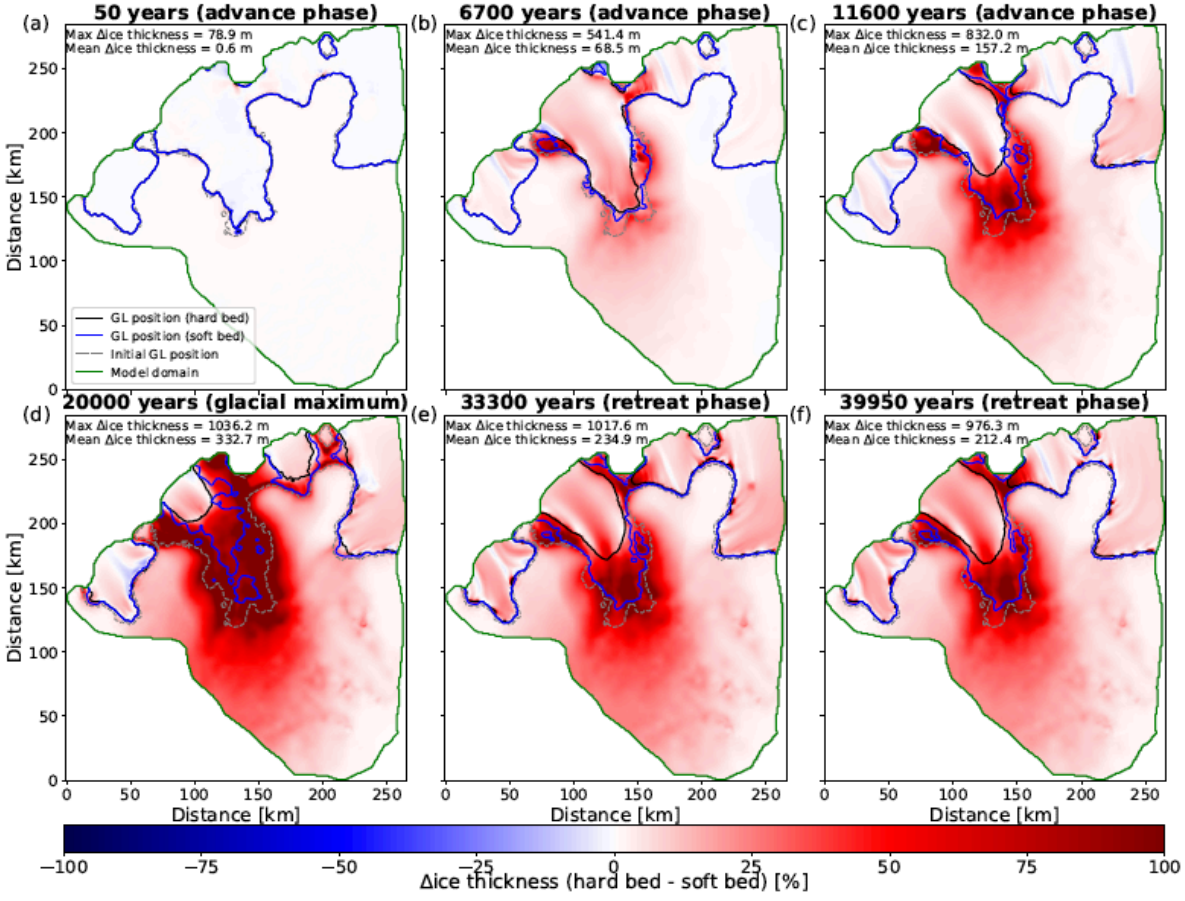




- HO vs FS
- Free GL
- 6 km, locally 1 km
- PD sfc vel – Sat.
- PD smb – Lenaerts
- Paleo T – Graf/EDML
- Paleo SL – Lambeck

Schannwell et al., in revision TCD, 2020

Pseudo glacial cycle: hard vs. soft bed



Weertman type basal sliding law:

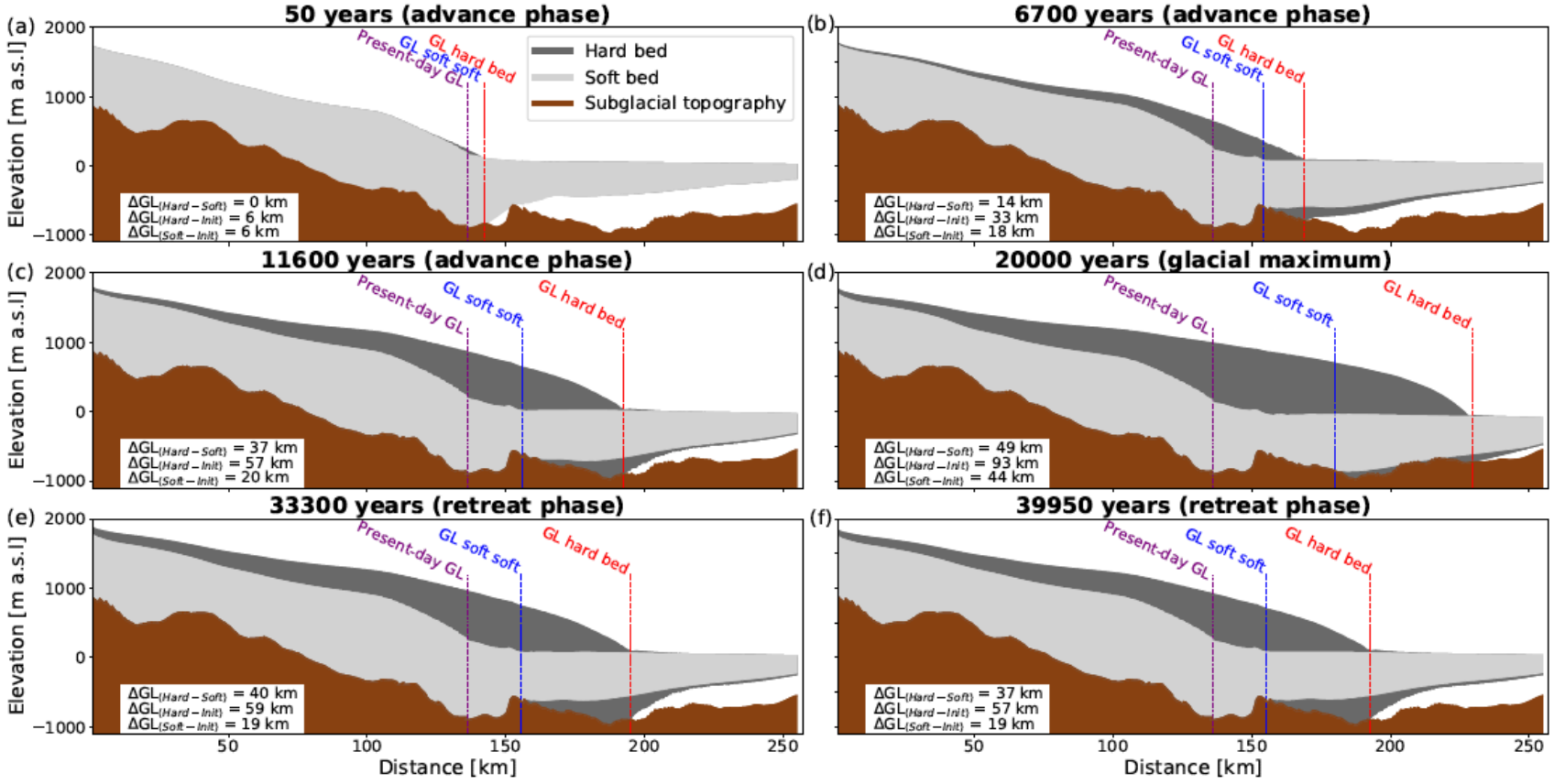
$$\boldsymbol{\tau_b} = C|\boldsymbol{u_b}|^{m-1}\boldsymbol{u_b}$$

Basal friction exponent :
m = 1

Basal traction coefficient:
C = 10^{-1} MPa m/a for sediments
C = 10^{-5} MPa m/a for crystalline rock

Schannwell et al., in revision TCD, 2020

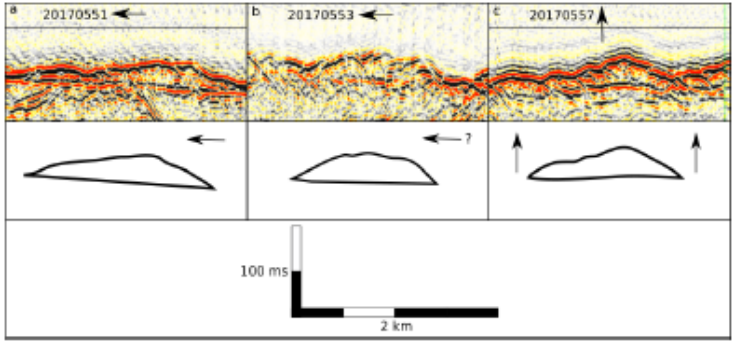
Pseudo glacial cycle hard vs. soft bed



Always short periods of advance and long periods of stability

Schannwell et al., in revision TCD, 2020

Observations of past ice sheet



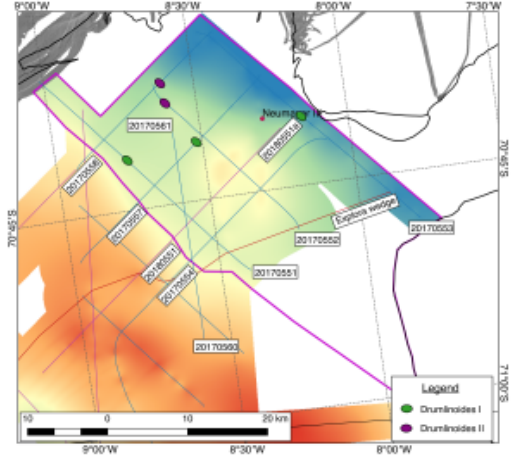
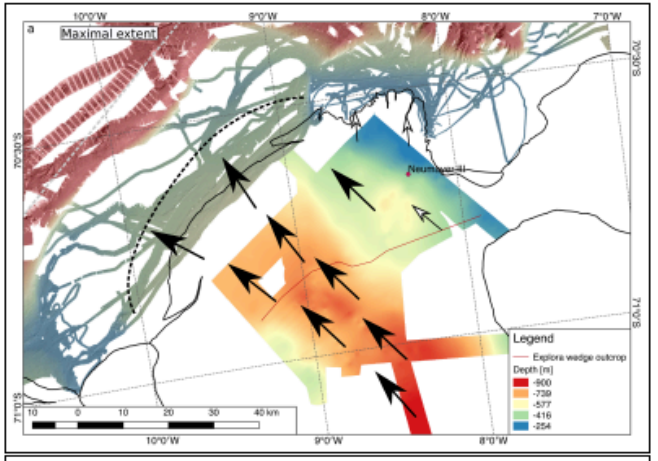


Figure 25: **Displayed are the locations of the Drumlinoides I and II.**

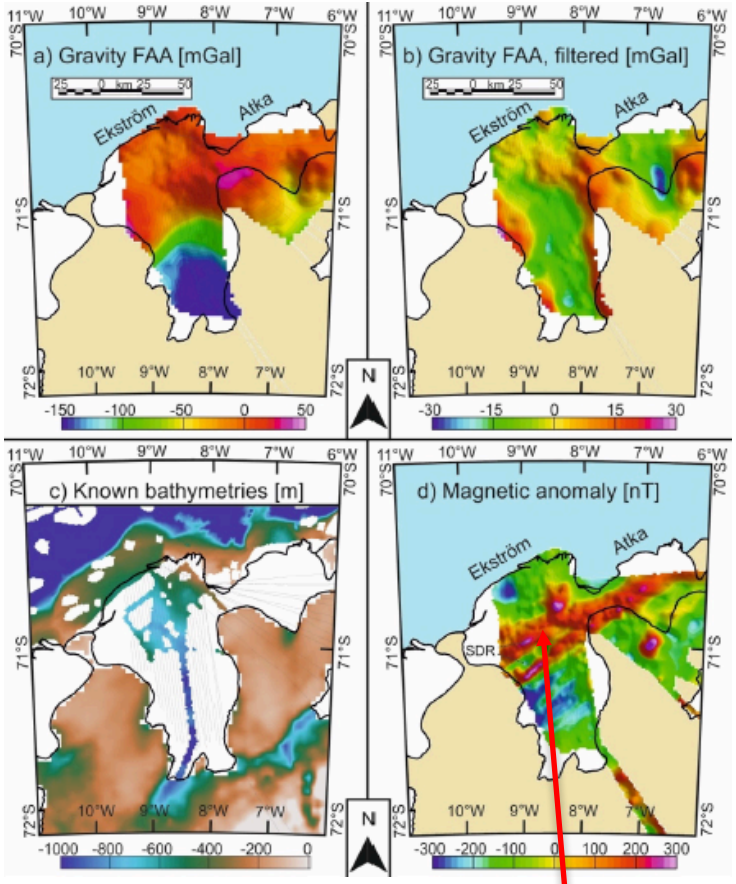
Grounding line during LGM
at continental shelf
-> case for hard bed (related to
Explora Volcanic Wedge outcrop)

Ötting, MSc, 2019

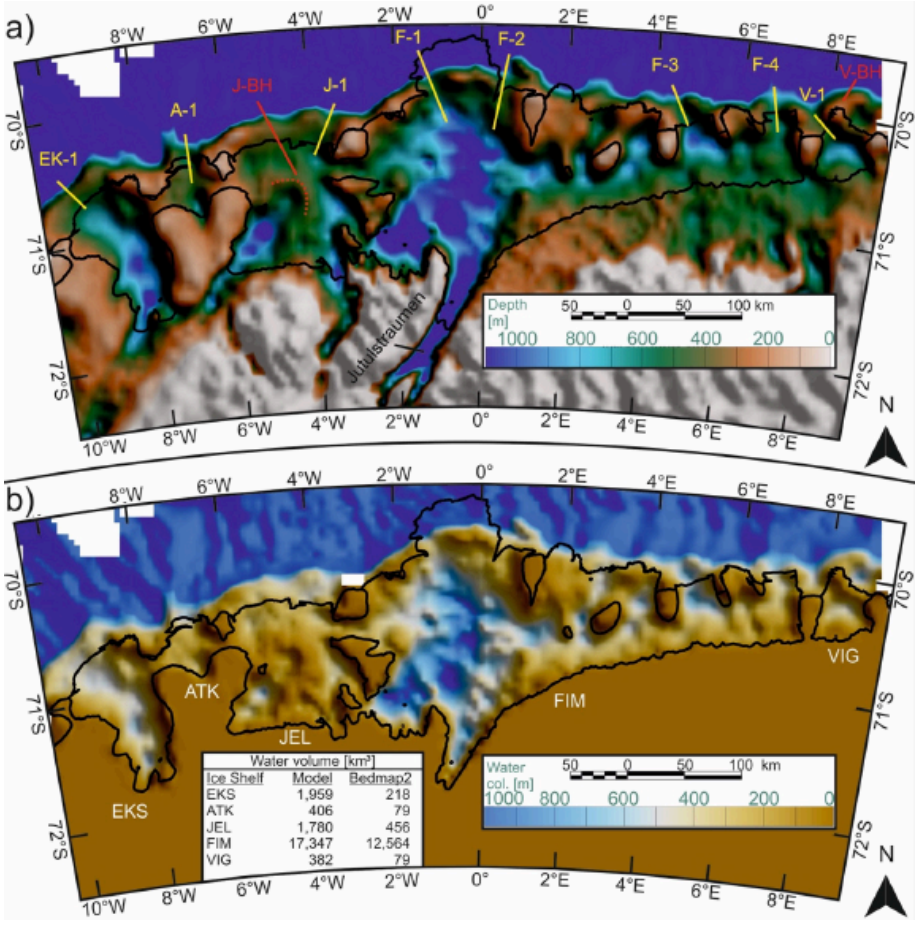


Arrows: main retreat directions

Larger context: local to regional

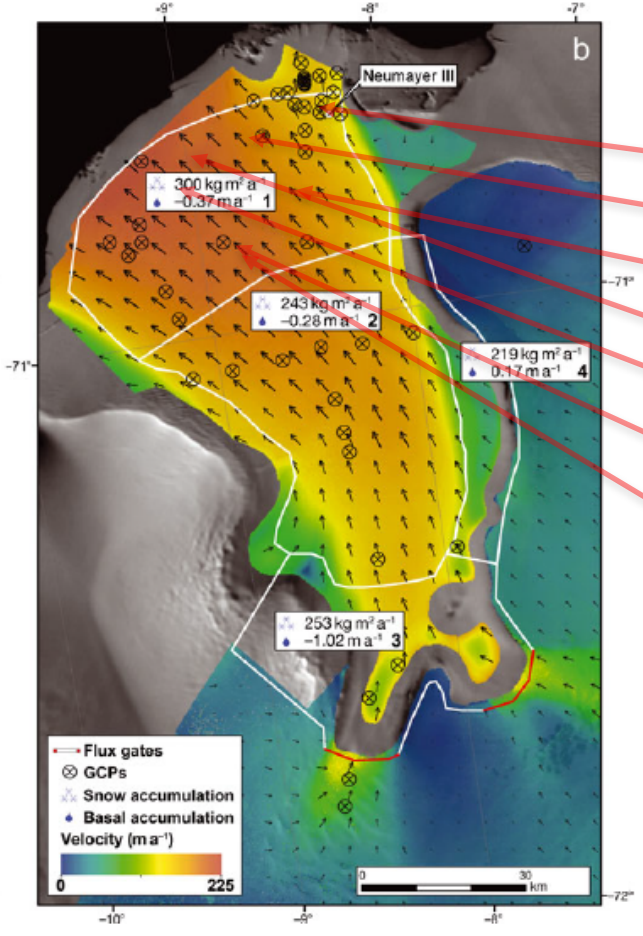


Explora Volcanic Wedge outcrop
(cf. Kristoffersen et al, 2014)



Eisermann et al., GRL, in press, 2020

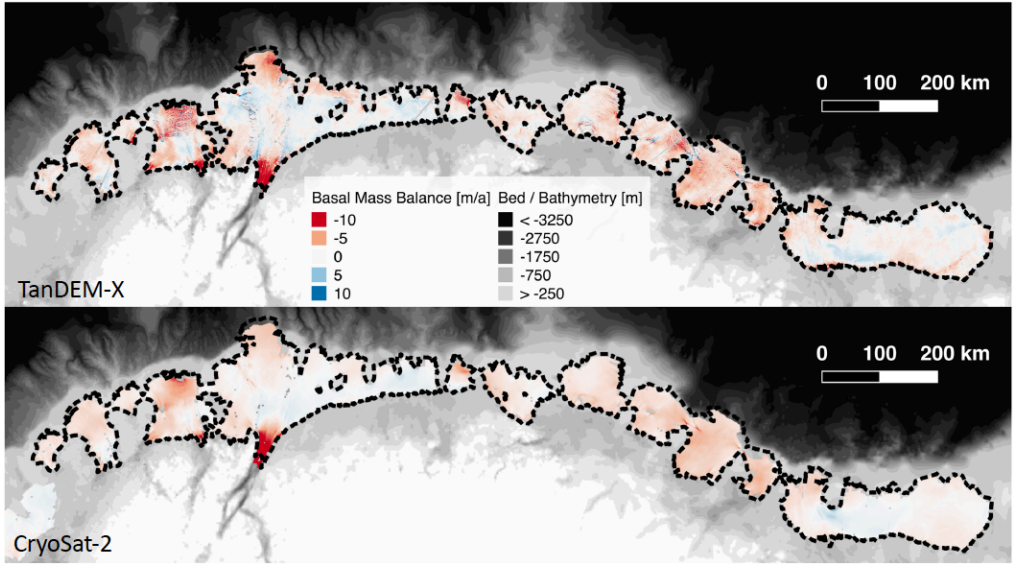
Basal melting



Neckel et al., 2012

Observed basal melt (pRES)
in m/a

1.90
0.45
0.48
0.39
0.45
0.44
0.48



Observed basal melt (sat.)

Berger et al., AGU, 2019
(prelim., paper in prep.)

Summary

- Ekströmisen: small ice shelf provides unique opportunity to acquire large number of different observations
- EIS: subglacial trough, no deep access to open ocean
- Ice dynamics: bathymetry and subglacial strata make the difference -> geology (Explora Wedge) important
- LGM: GL at continental shelf break
- DML: many small ice shelves, EIS as prototype

  -> regional extrapolation/upscaling

Outlook

- 4/2020: installed ApRES on EIS
- 202?: install ocean mooring in glacial trough (=protected!)
- Assemble results to obtain regional overview
- Increase coverage of bathymetry (seismics & grav.)
- Replicate observations with modelling studies
- BC: use observations for properties of subglacial material (e.g. Explora Volcanic Wedge outcrop)