

Basal terraces on melting ice shelves

see also Dutrieux et al., GRL 2014



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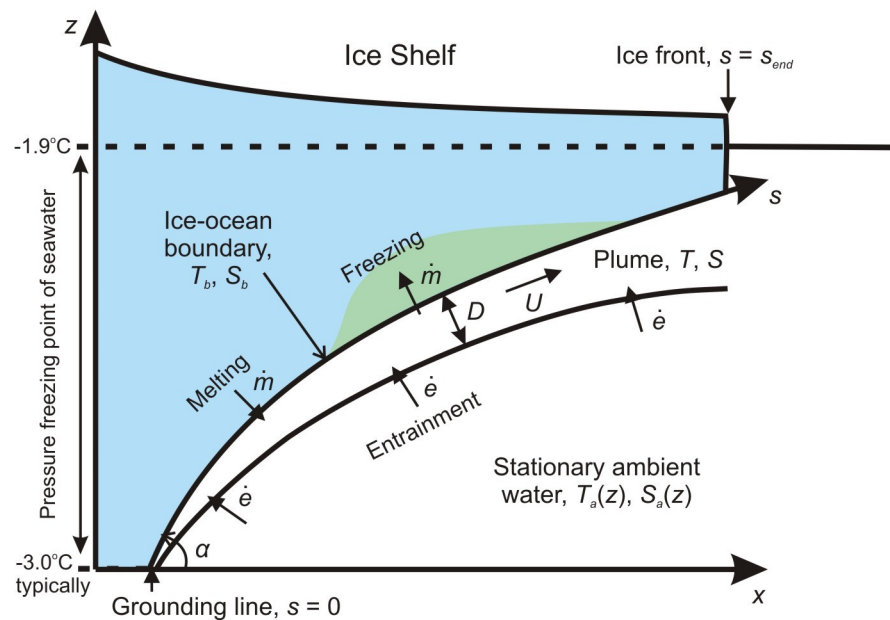
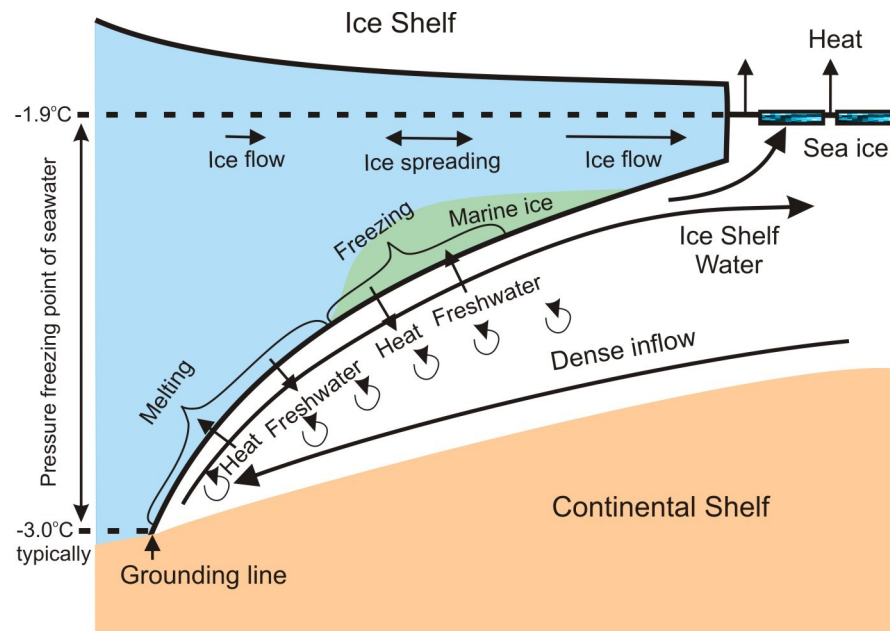
⁵Department of Earth System Science, University of California, Irvine, California, USA

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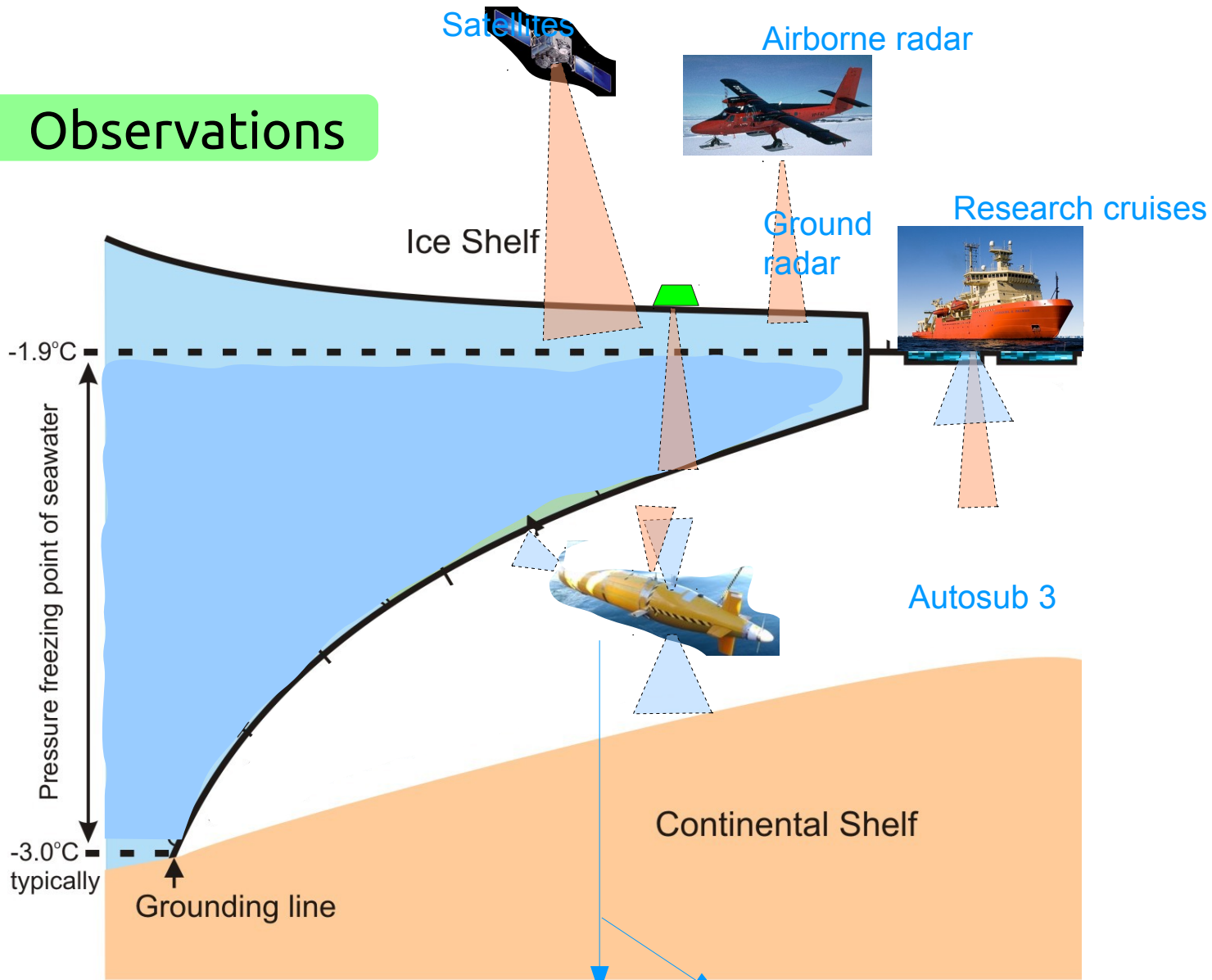
⁷Institute for Atmosphere and Climate, Swiss Federal Institute of Technology, Zürich, Switzerland

A model

[Jenkins 1991-2011]



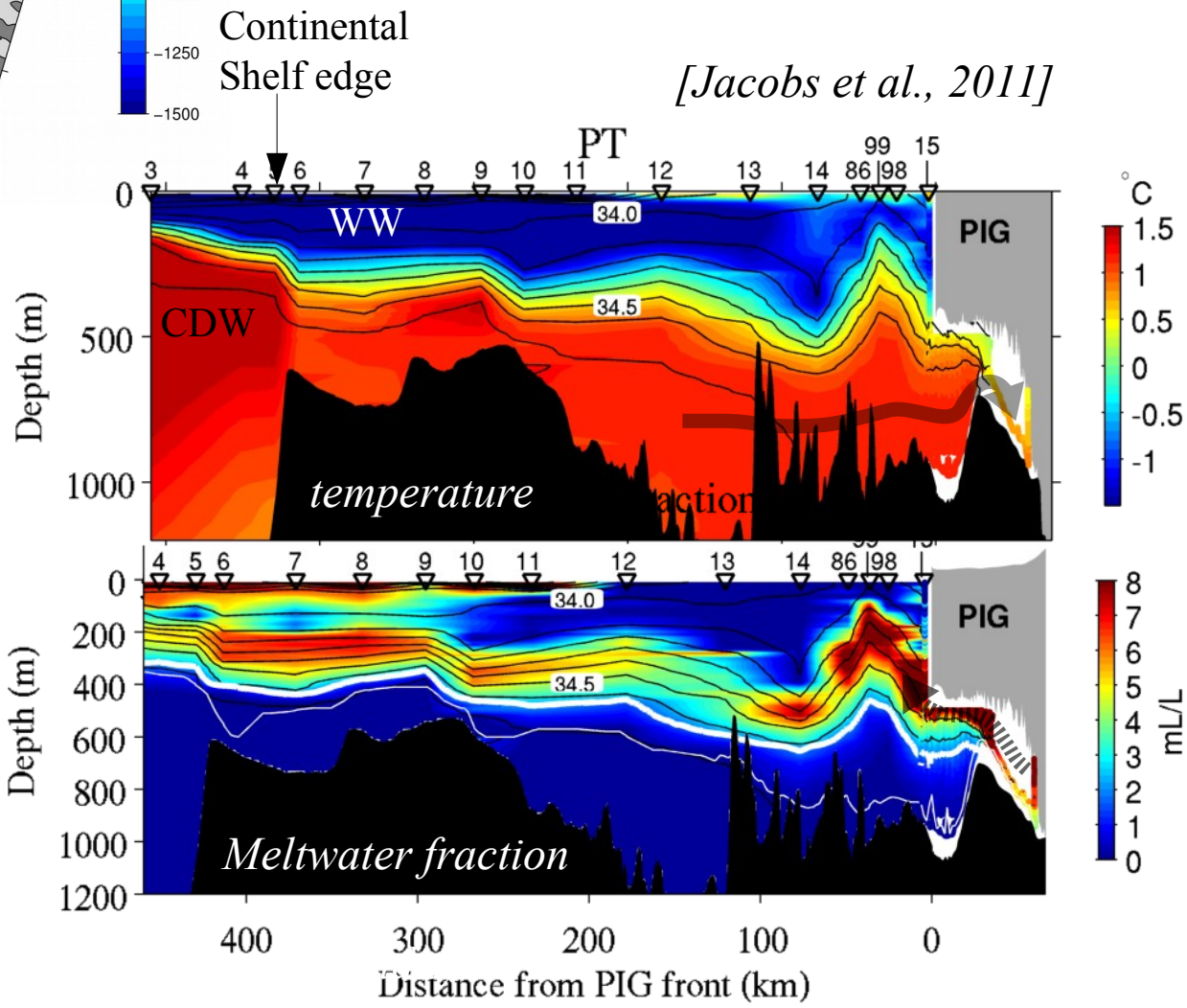
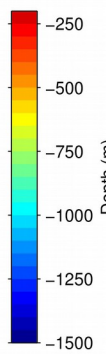
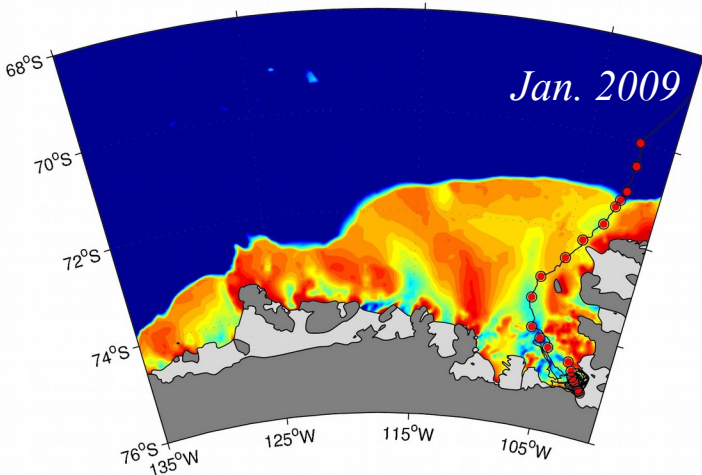
Observations



- CTD, DO, Tr
- Upward ADCP
- Downward ADCP
- Forward looking altimeter
- Multibeam echo-sounder

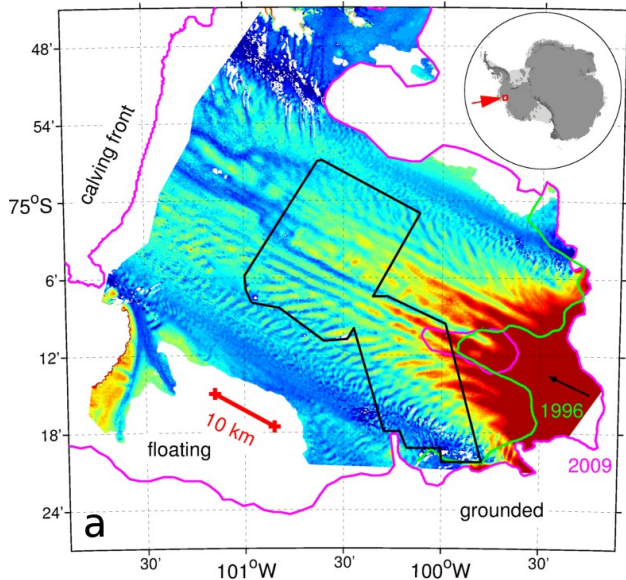
Pine Island

[Jacobs et al., 2011]

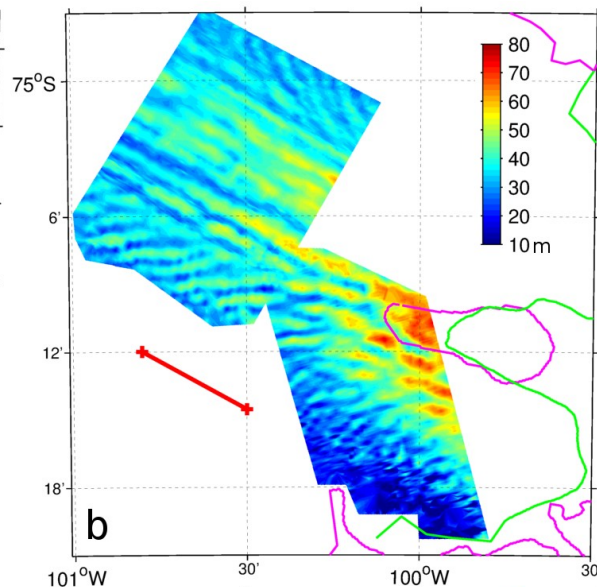


A detailed pattern of melt

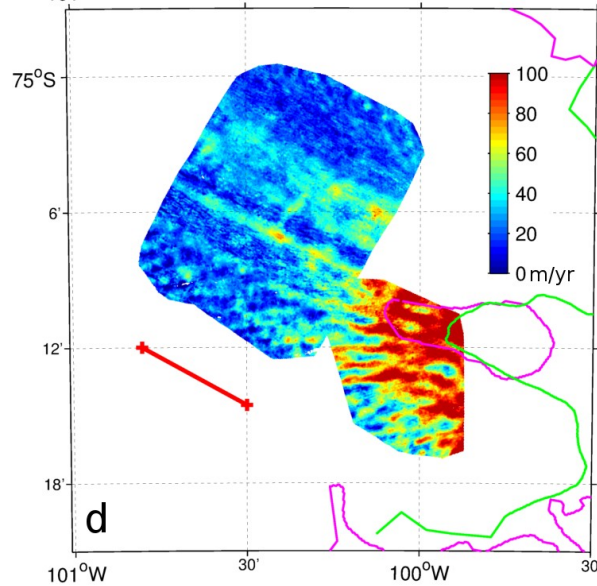
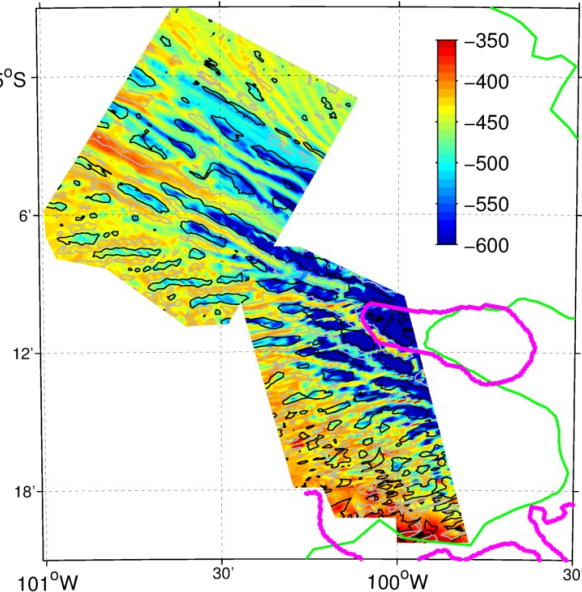
Surface elevation, SPIRIT 2008



Surface elevation, BAS airborne 2011



basal elevation

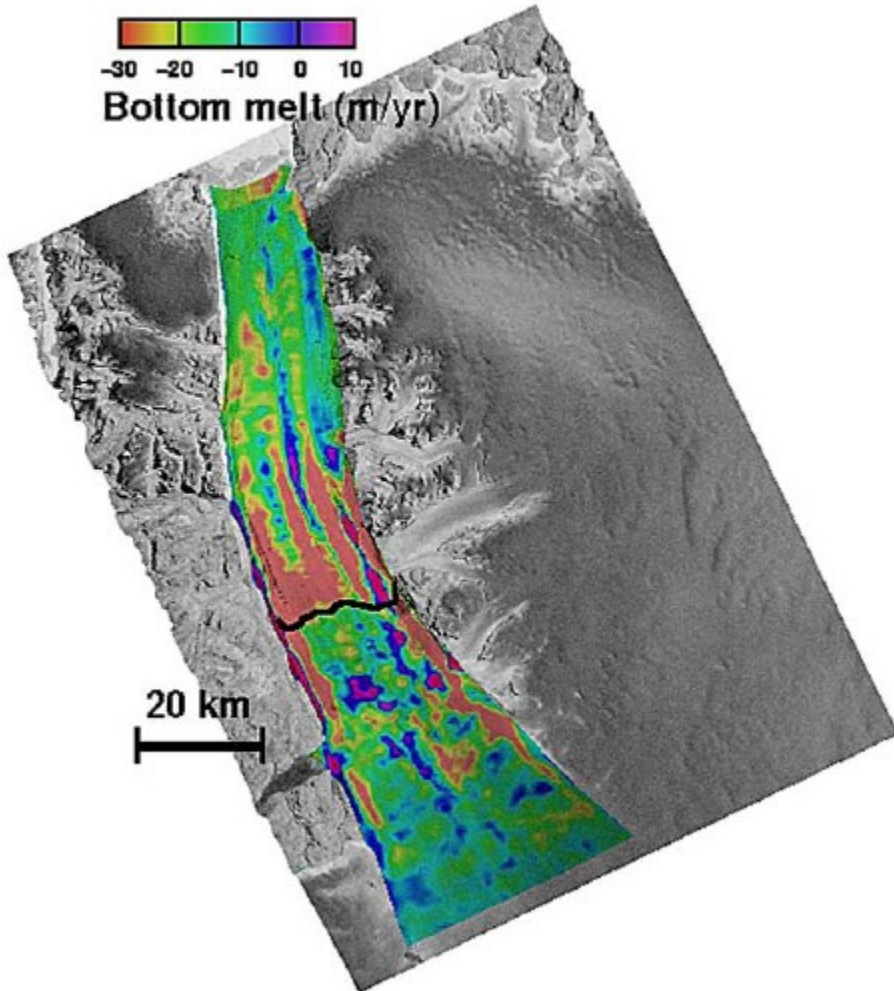


Oceanic melt

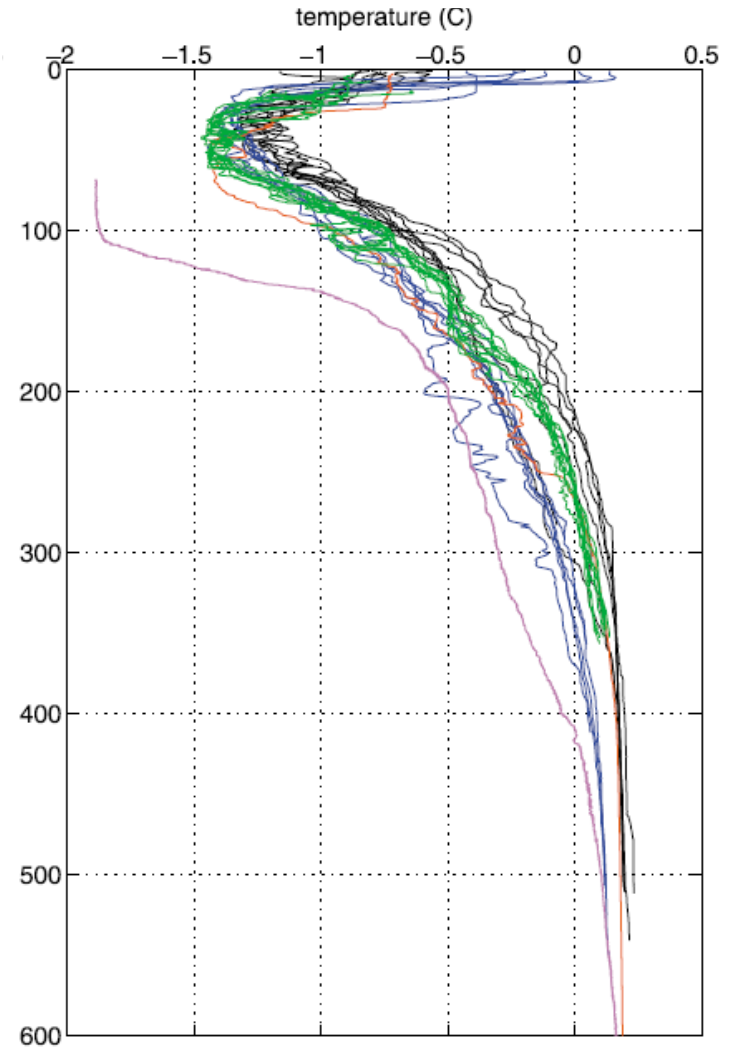
[Dutrieux et al., 2013]

Petermann, an 'analogue' in Greenland

RIGNOT AND STEFFEN: PETERMANN GLACIER
GRL, 2008



JOHNSON ET AL.: OCEANOGRAPHY OF PETERMANN FJORD
JGR, 2011



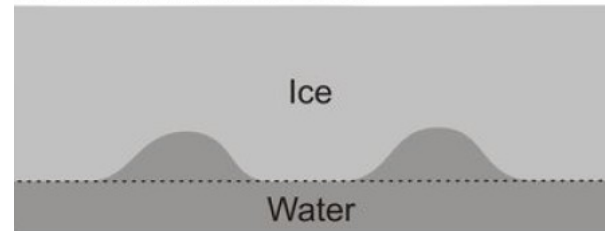
Conclusions:

Oceanic melting under Pine Island and Petermann glacier ice shelves is critically distributed by the geometry of their ice base:

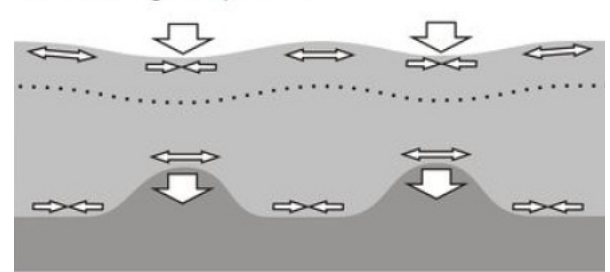
- near the grounding line,
- along kilometre scale channels.

This matters because ice dynamics is sensitive to melt distribution at large to channel scales...

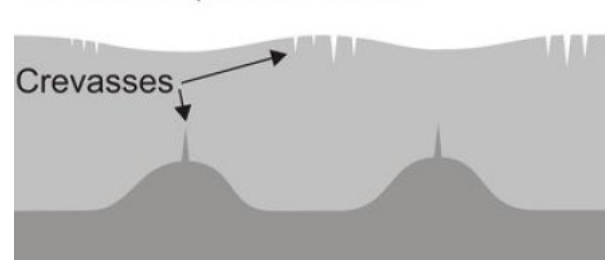
a. Undeformed ice shelf



b. Flexing response

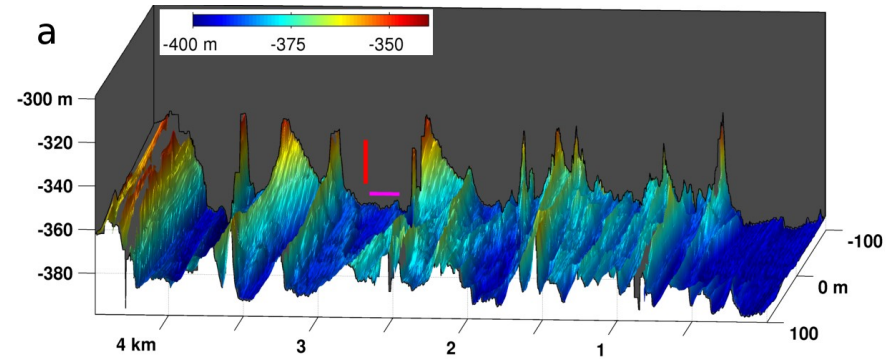
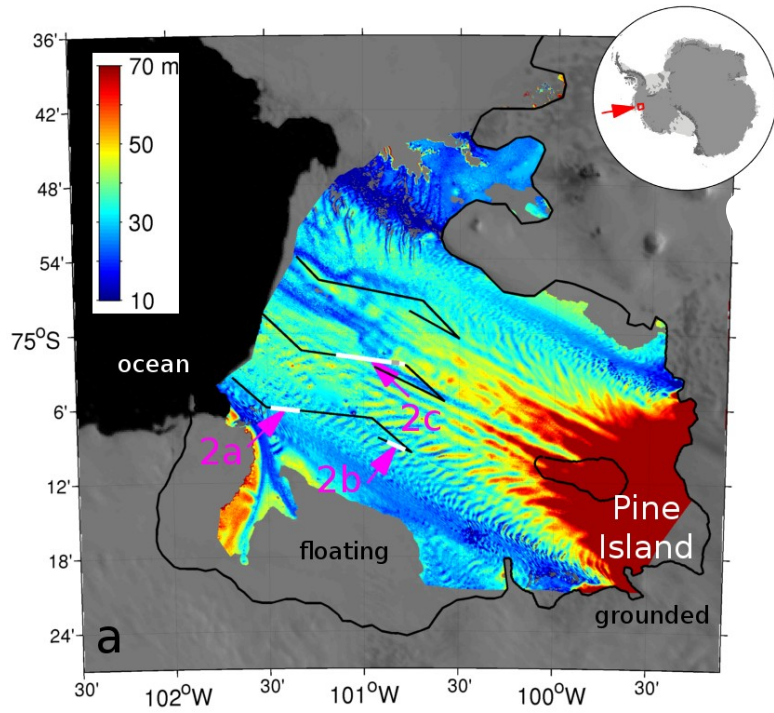


c. Zones of possible failure

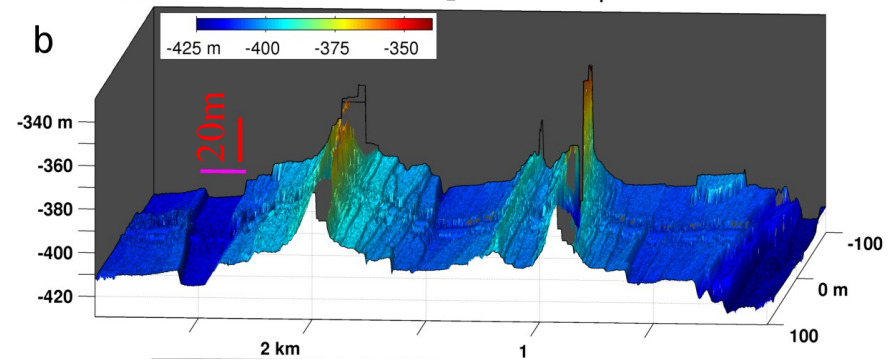
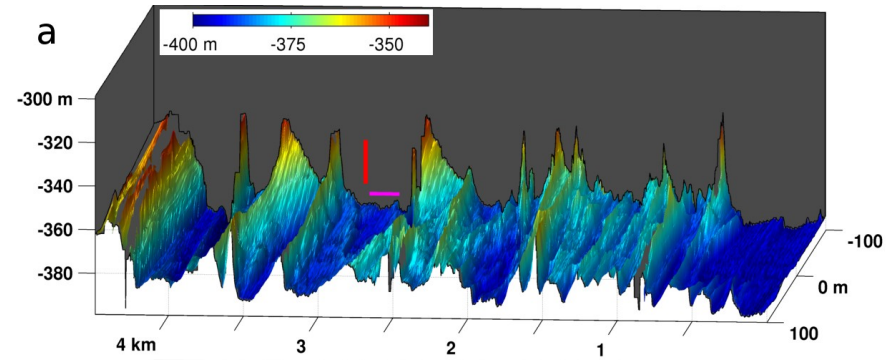
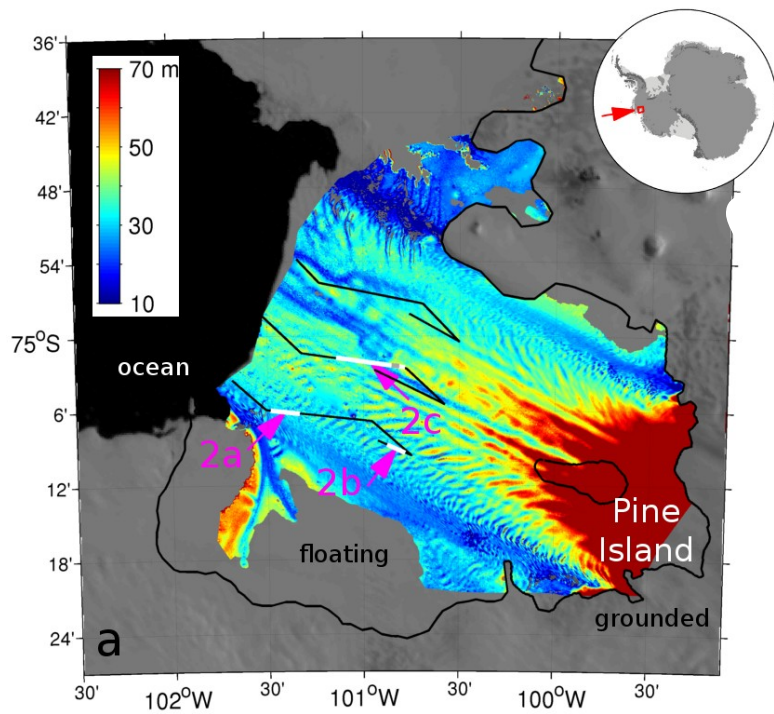


from Vaughan et al, JGR 2012

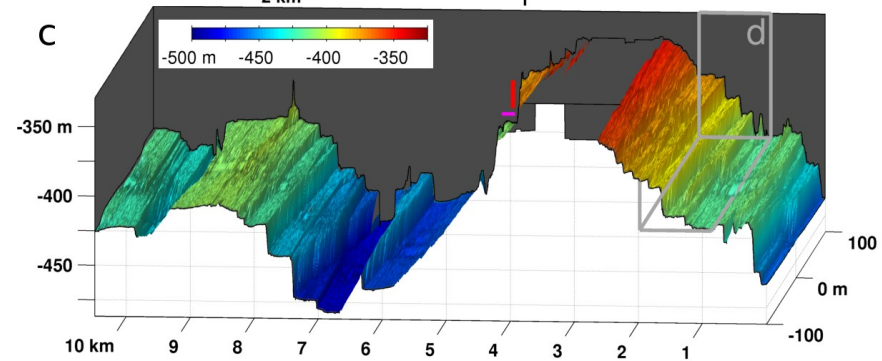
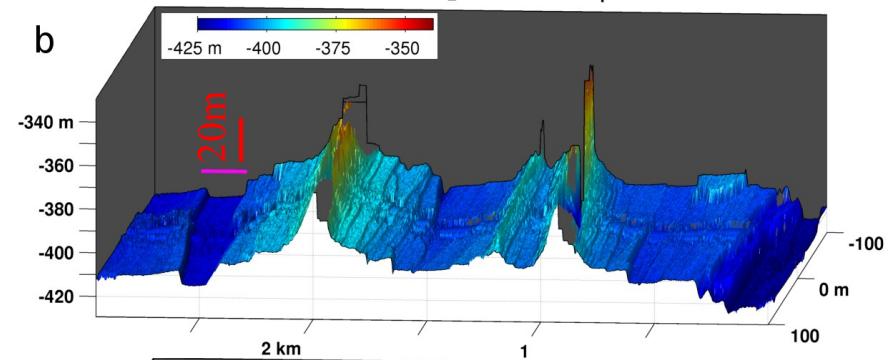
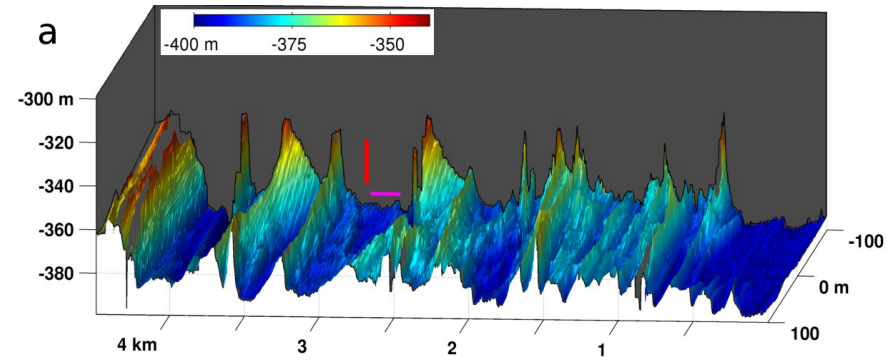
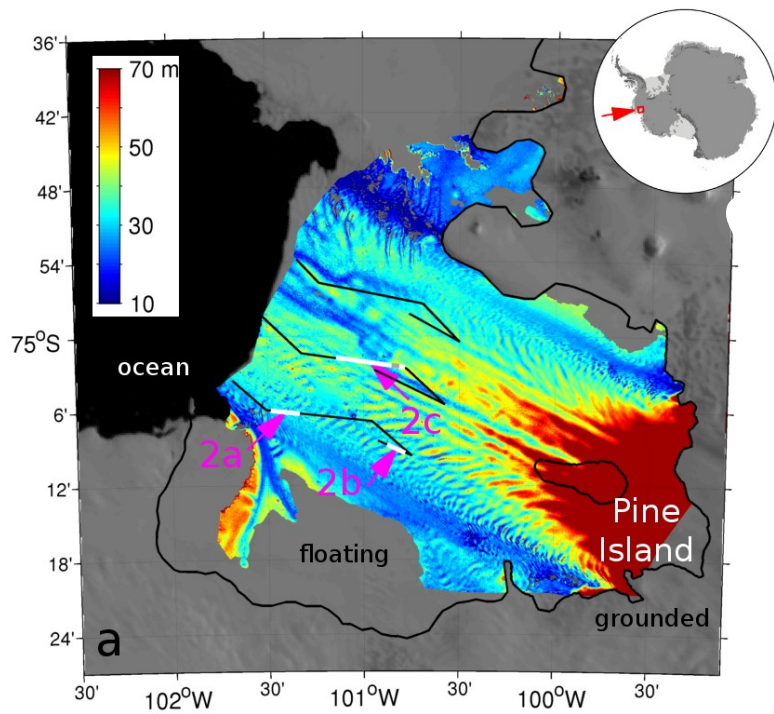
How about even finer scale?



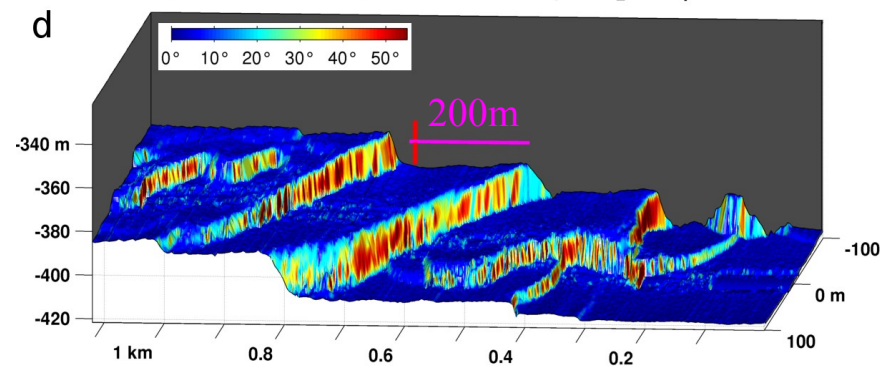
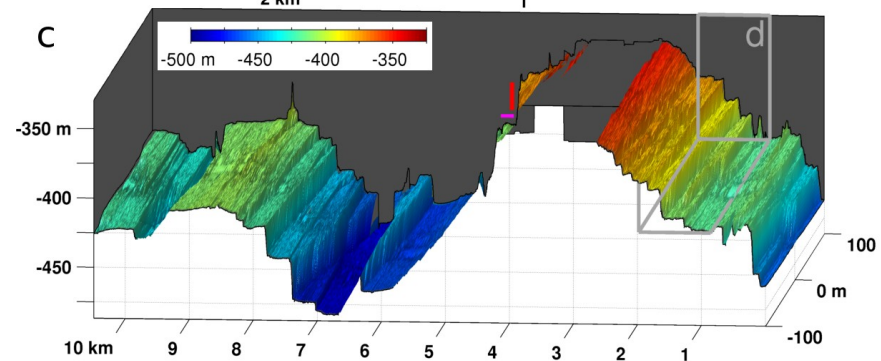
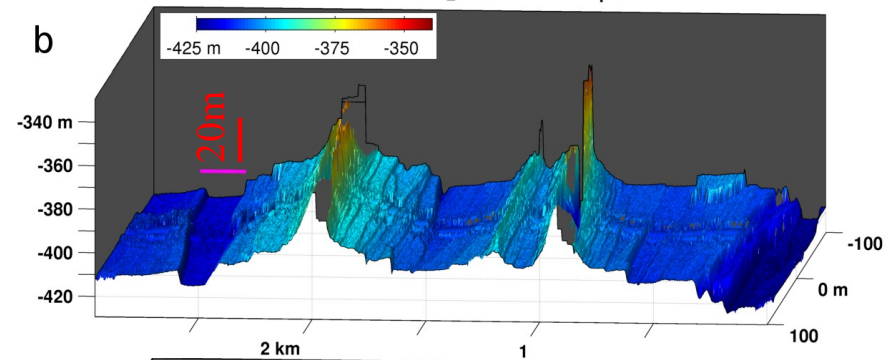
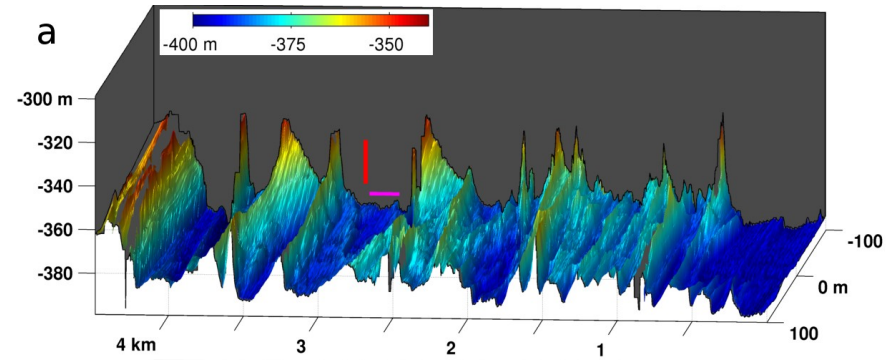
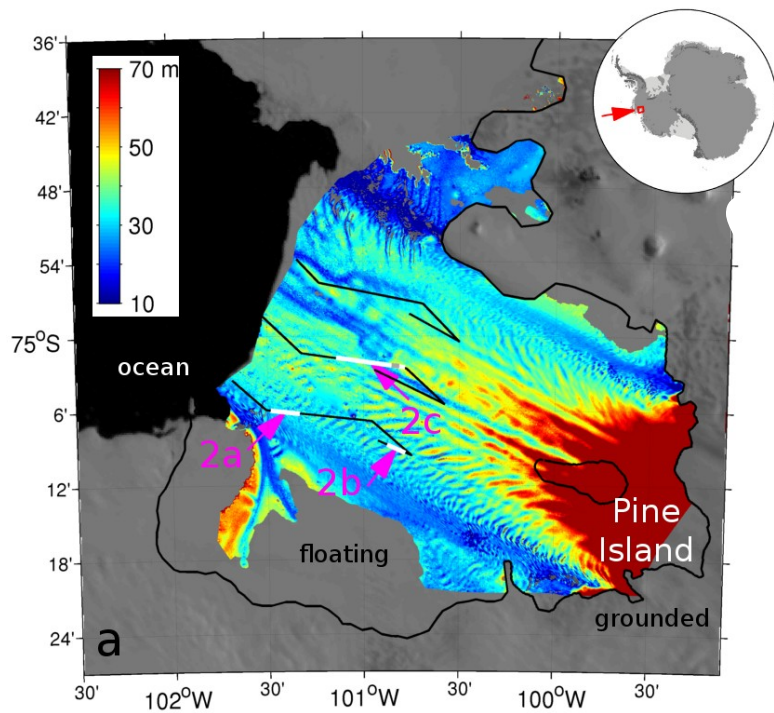
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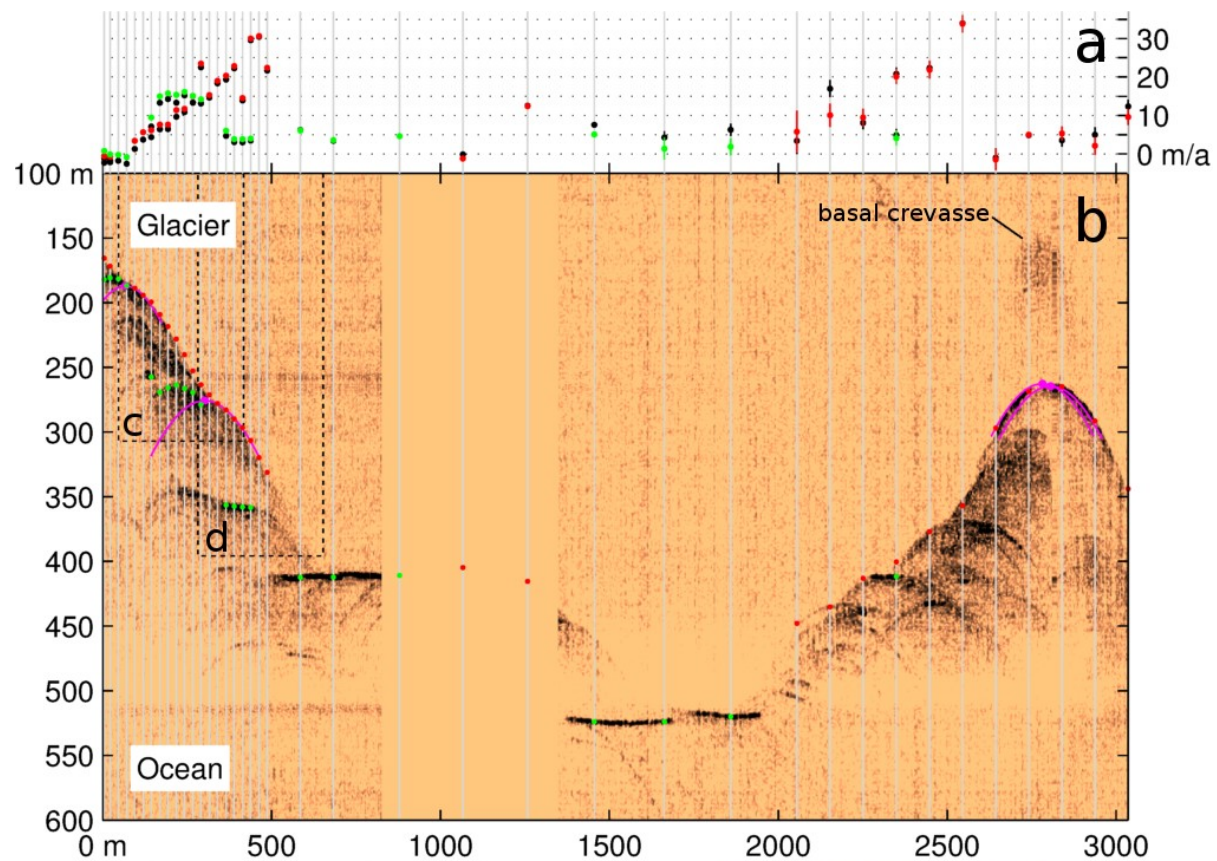
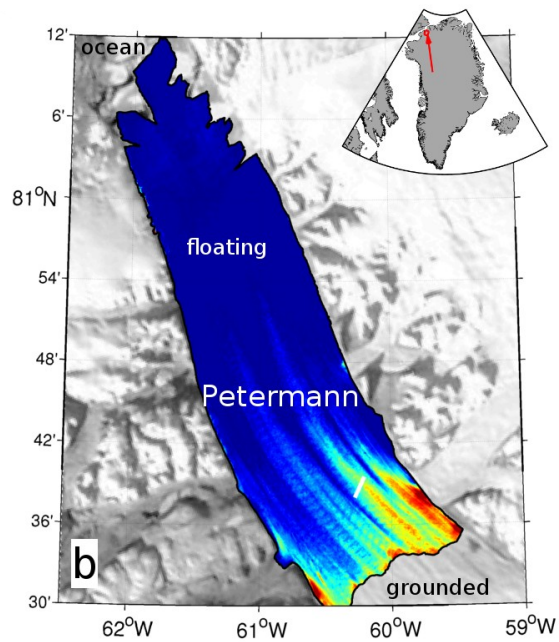


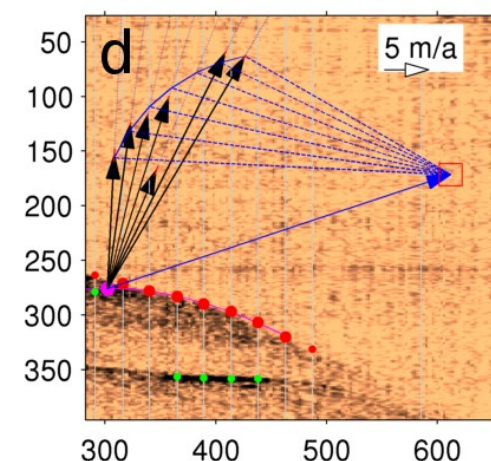
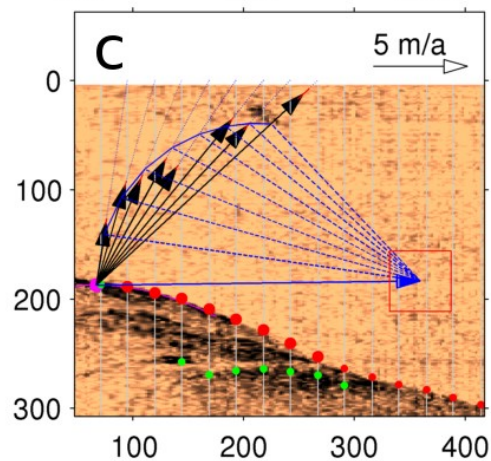
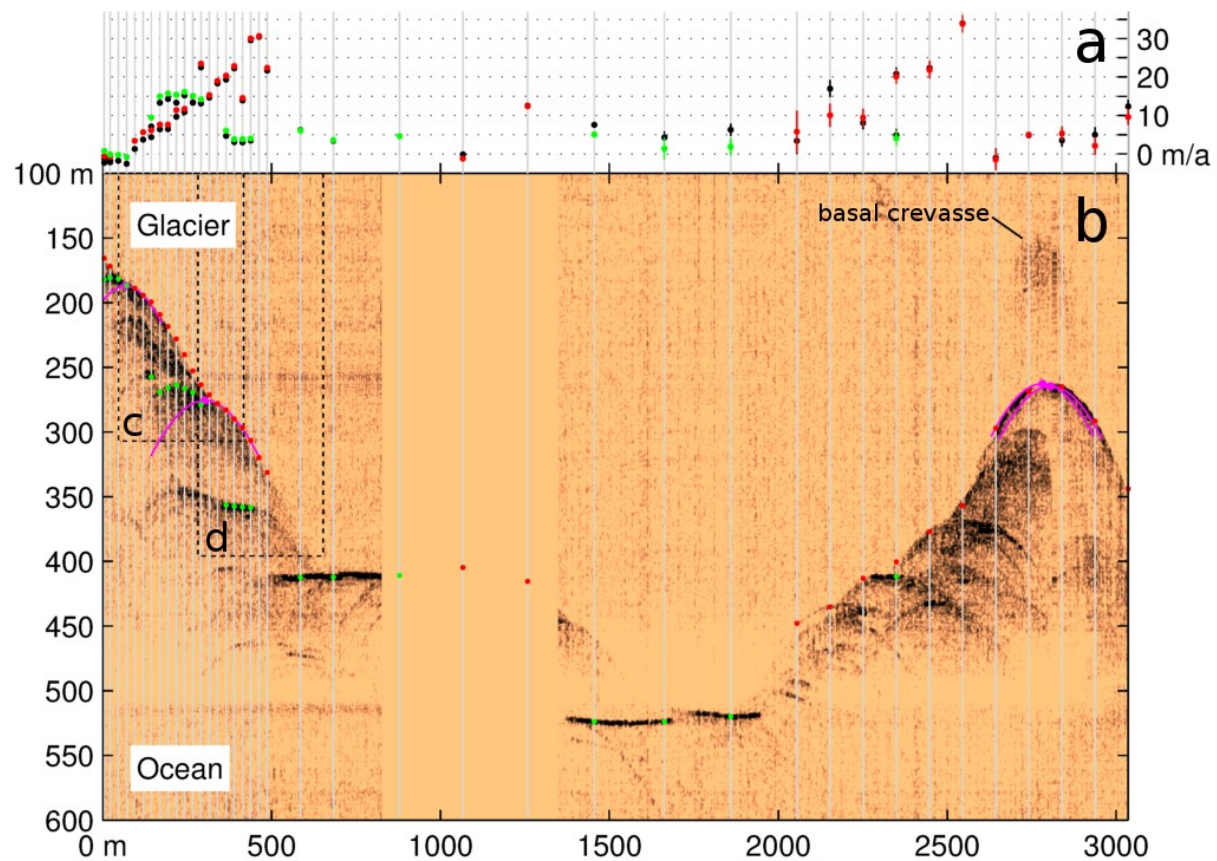
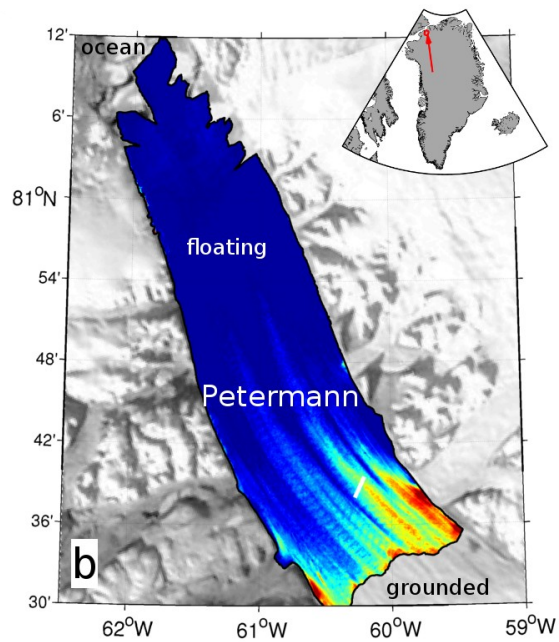
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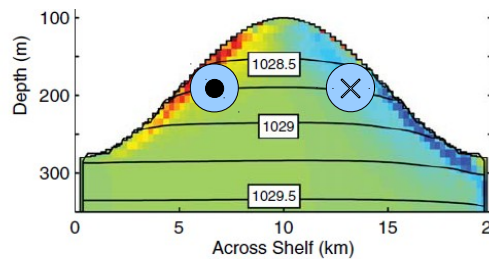
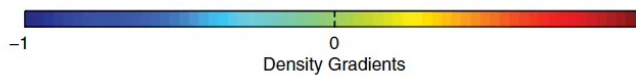
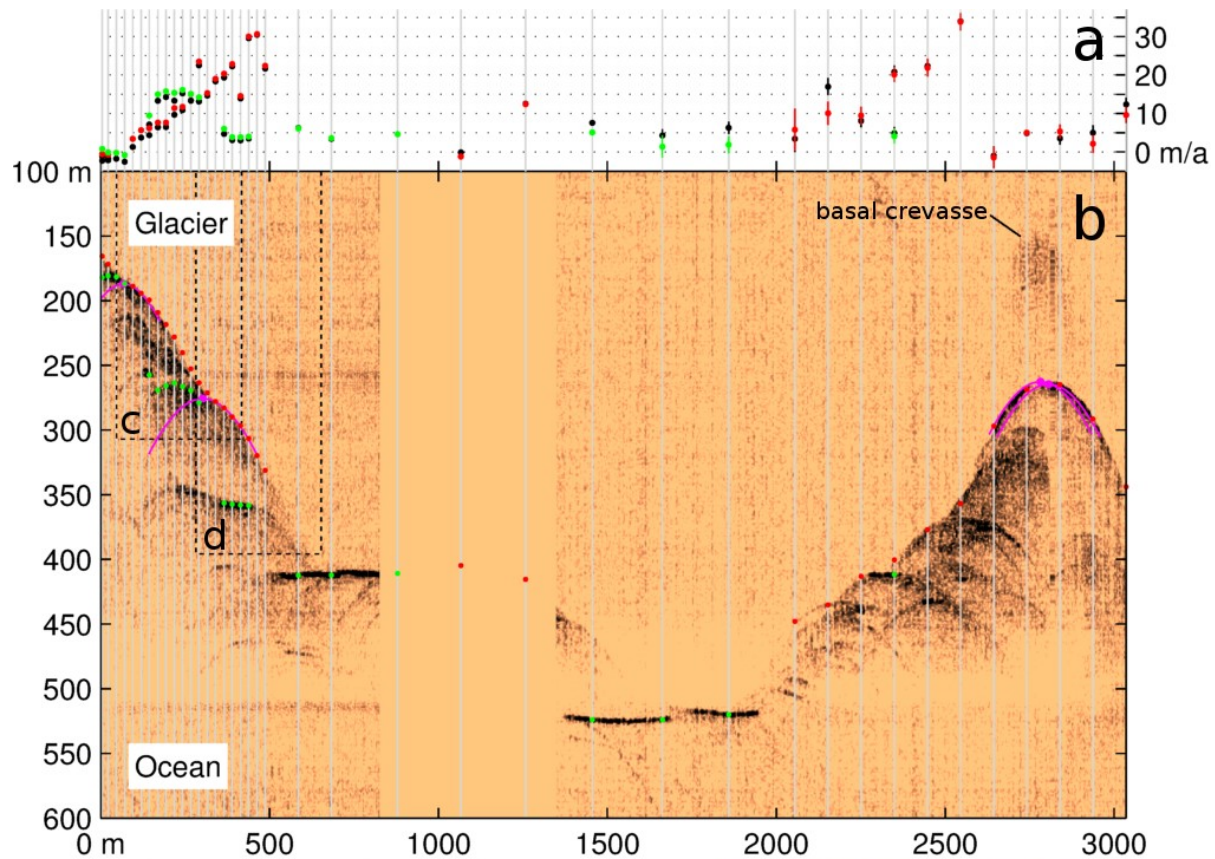
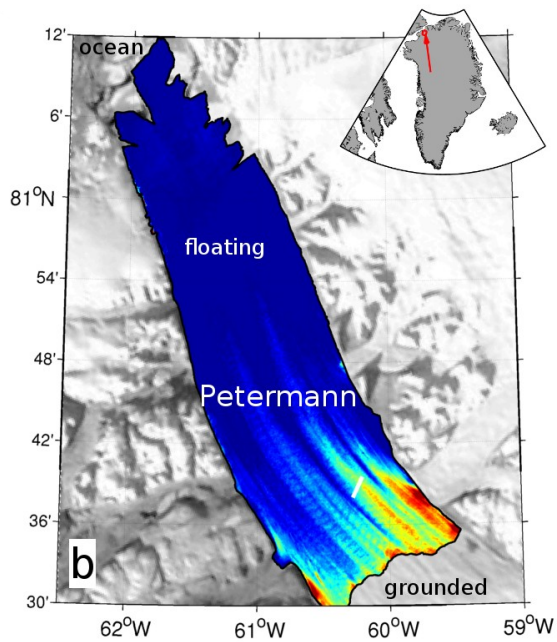


How about even finer scale?









Adapted from Millgate et al, 2013

Conclusions

- Oceanic melting under Pine Island glacier ice shelf is critically distributed at kilometre scales,
- Ice-ocean interaction is also largely modulated by finer scale terraces!



© BBC Operation Iceberg

→ How are the terraces created?
→ How important are they for the bigger picture?

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