ArcticNet
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Decreasing ice – increasing ice hazards?

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Research school on cross-disciplinary science in the Arctic and collaboration with local communities

02 – 07 December 2018 UNIS, Longyearbyen, Svalbard

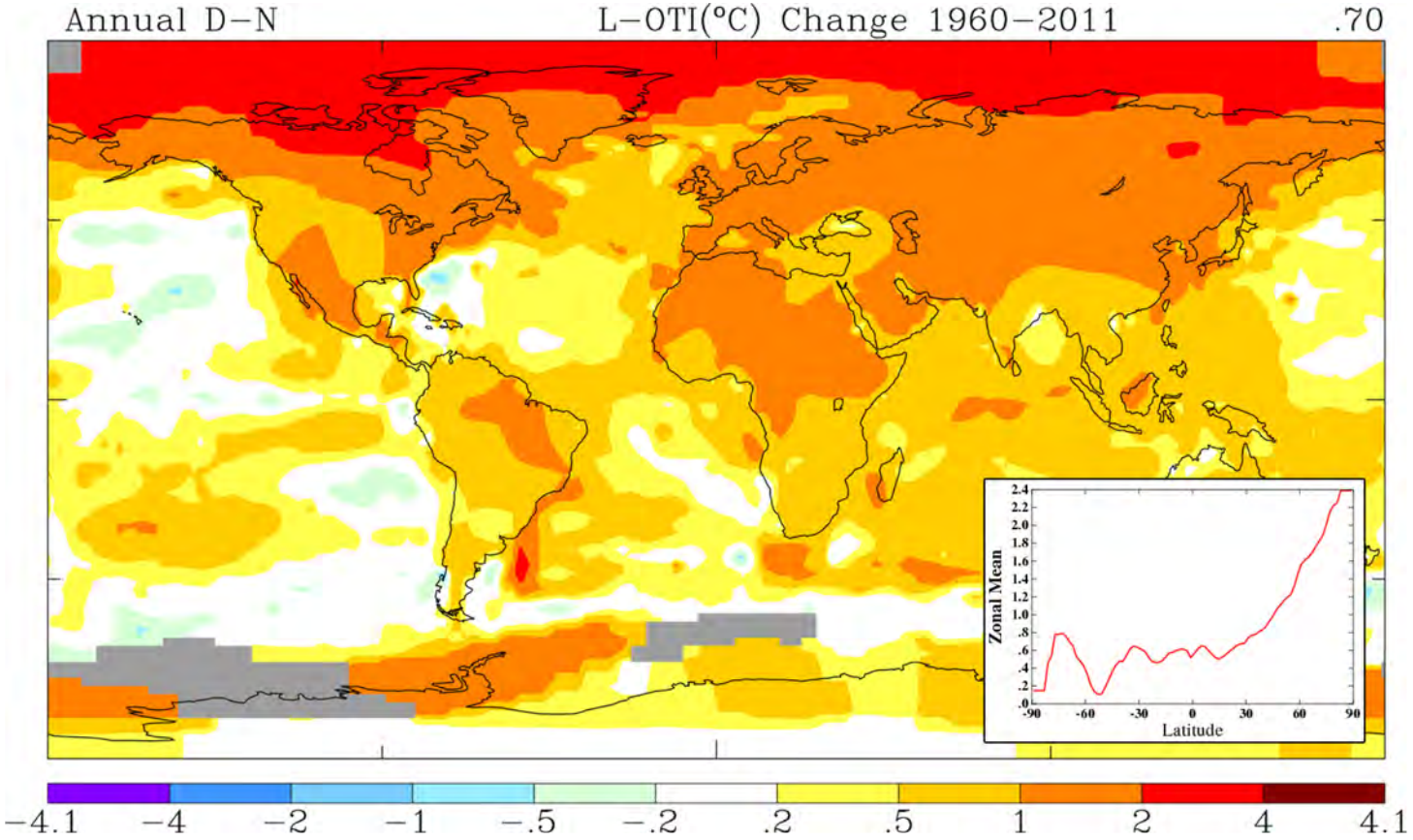
ASP Arctic Science Partnership

University of Manitoba

Aarhus Universitet

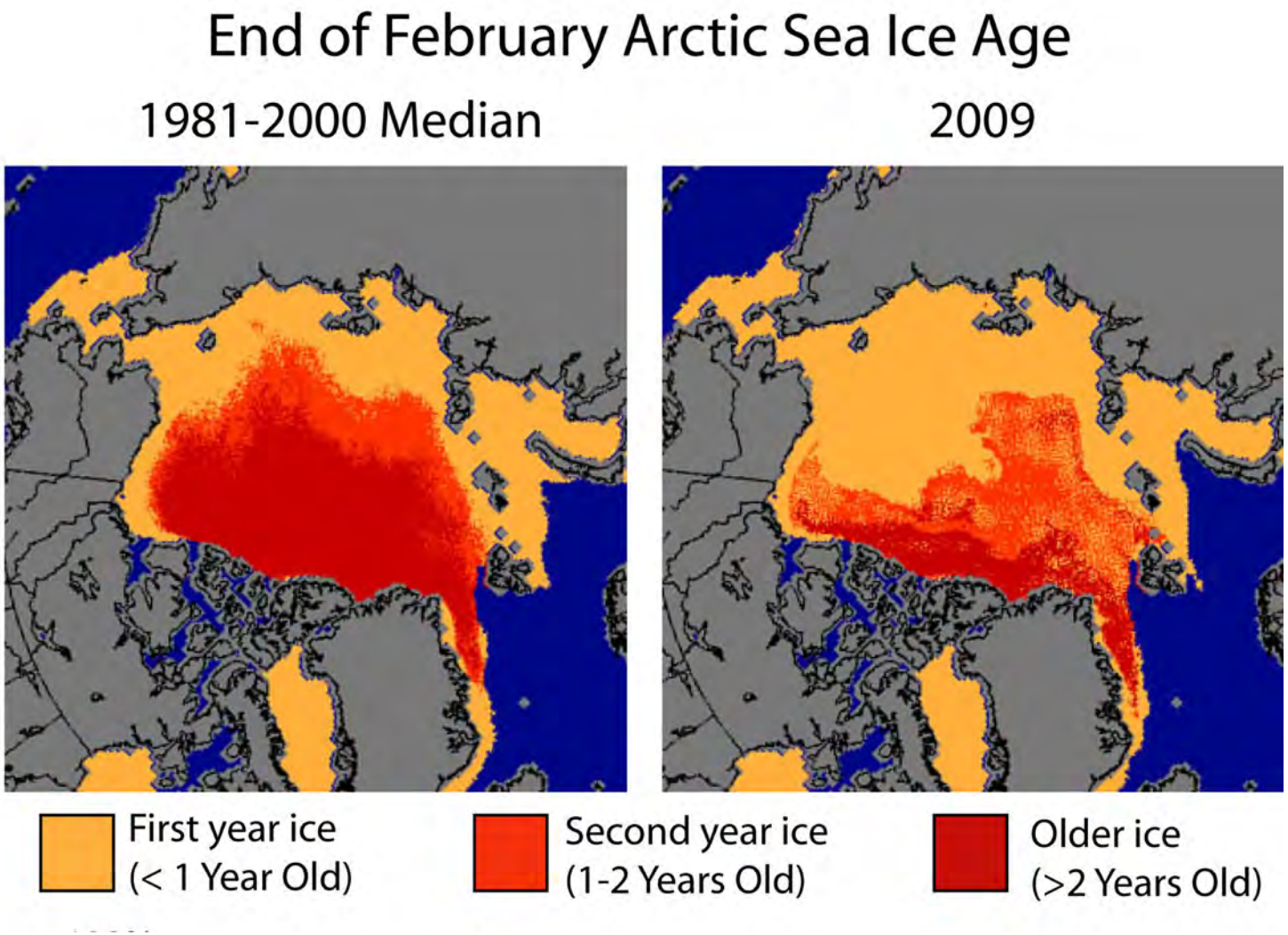
Pinngortitaleriffik
Greenland Institute of Natural Resources
Grønlands Naturinstitut

It’s getting warmer

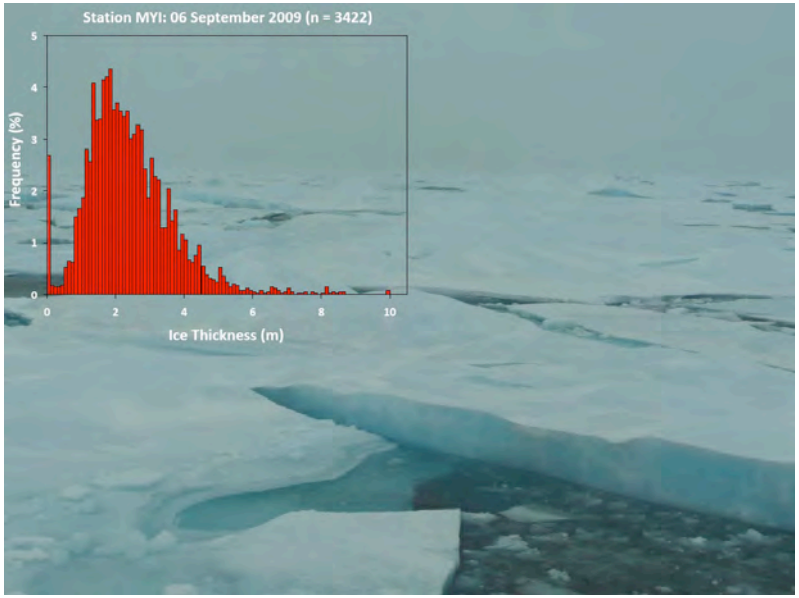


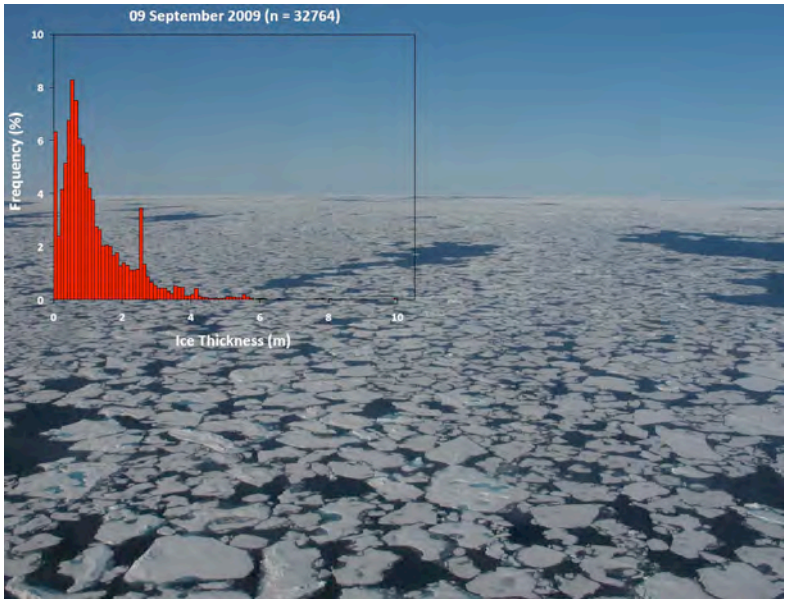
This image shows trends in mean surface air temperature over the period 1960 to 2011. Notice that the Arctic is red, indicating that the trend over this 50-year period is an increase in air temperature of more that 2° C (3.6° F) across much of the Arctic, which is larger than for other parts of the globe. The inset shows linear trends over the period by latitude. —

We get less sea ice



Effect of storms

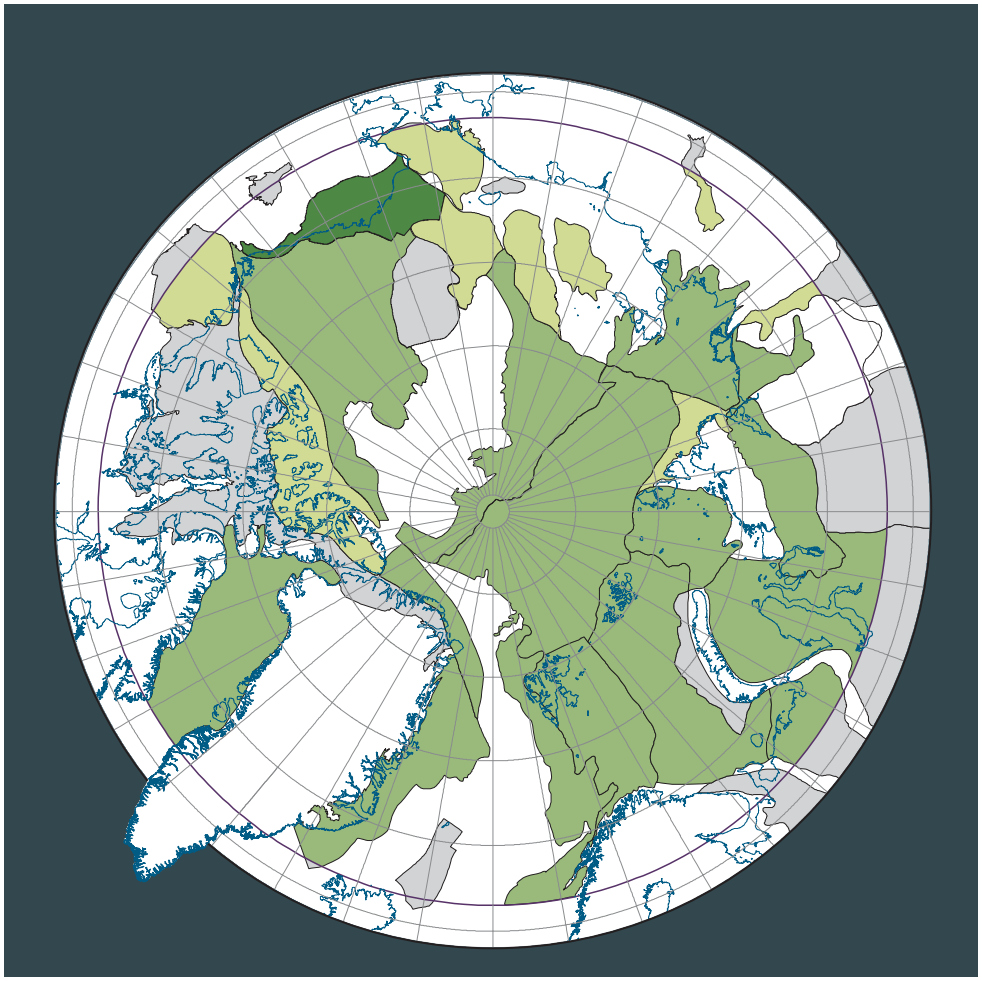




Waves in ice

Asplin et al. 2012

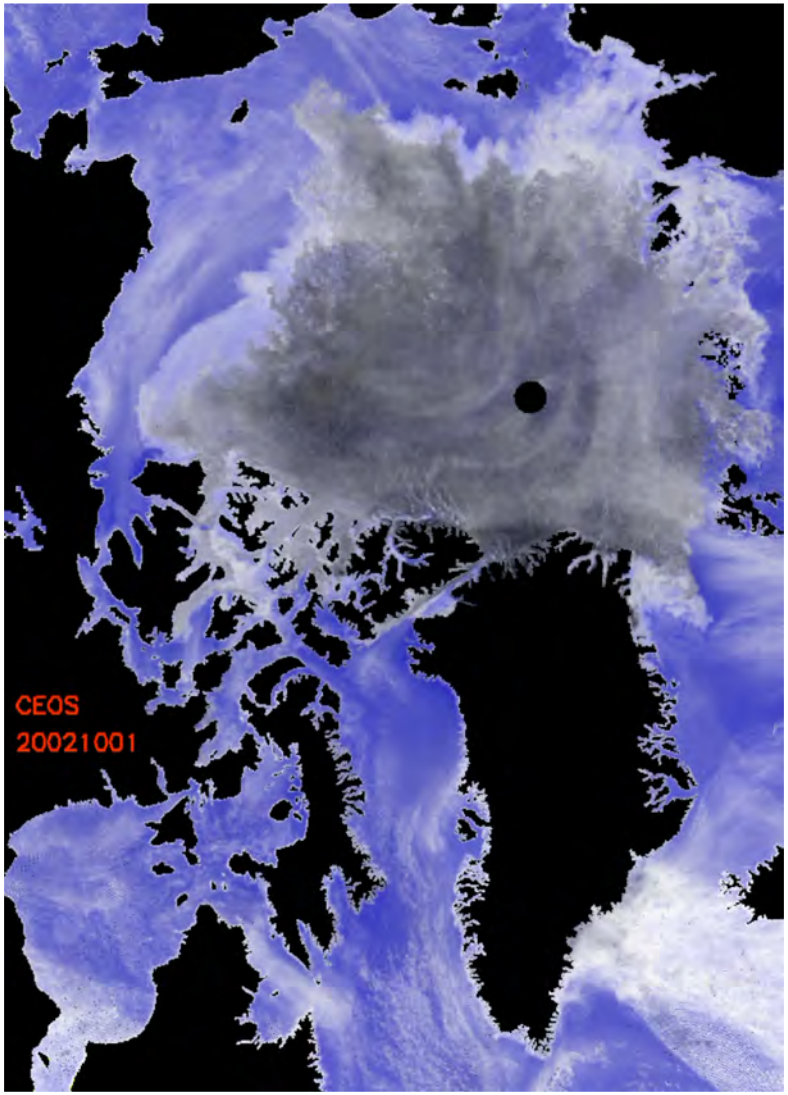
Likely there is oil and gas up here



Provinces in the Circum Arctic Resource Appraisal (CARA) color-coded for mean estimated undiscovered oil in oil fields. Only areas north of the Arctic circle are included in the estimates. Dark green >10 billion barrels, medium green 1010 billion barrels, light green <1 billion barrels, grey area not quantitatively assessed, white area of low petroleum potential.

Increase in investigations and drillings

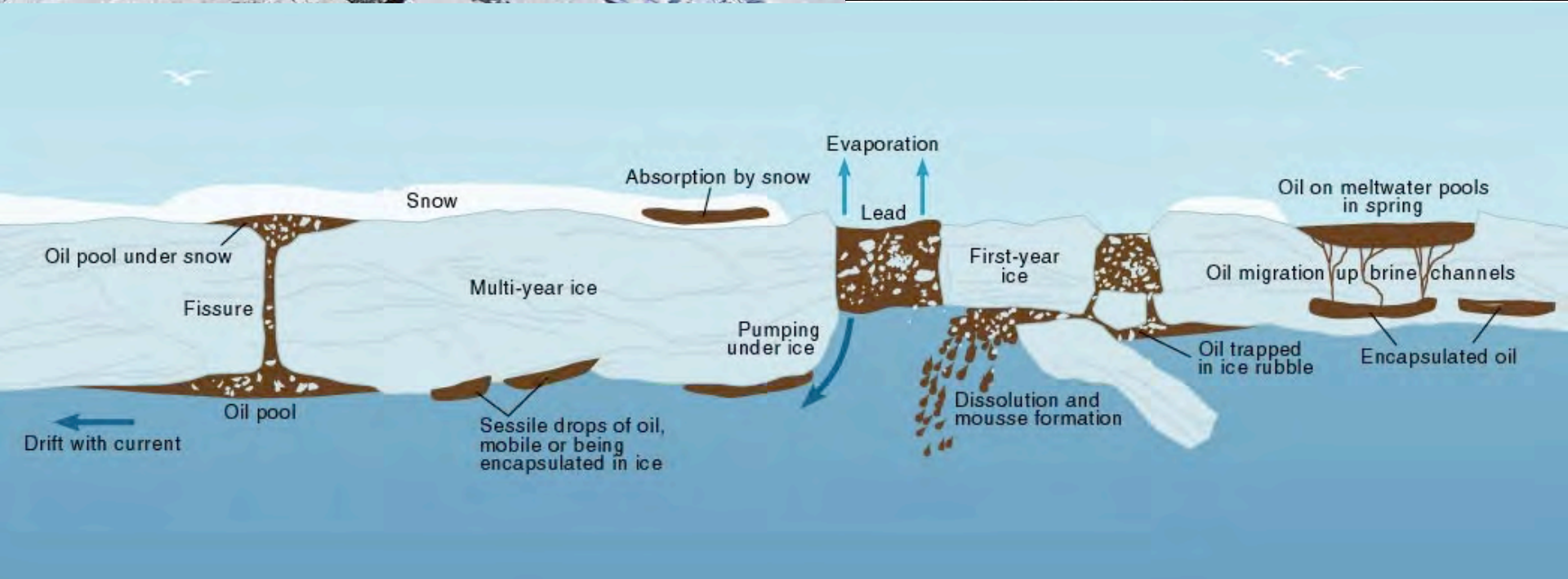
Opportunities and vulnerabilities



- Development of a new global ocean

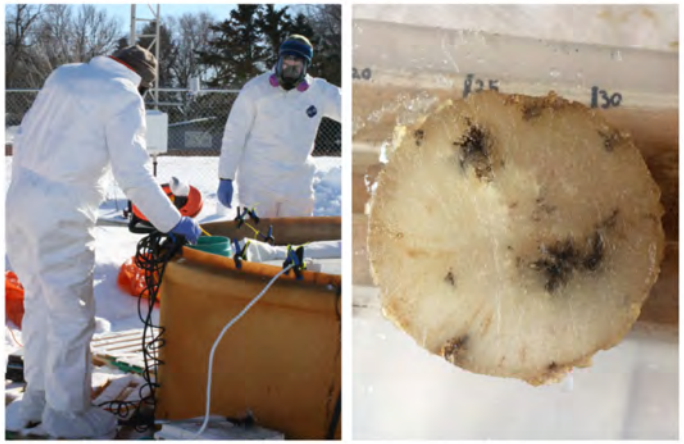
- New oil licenses and opening shipping routes

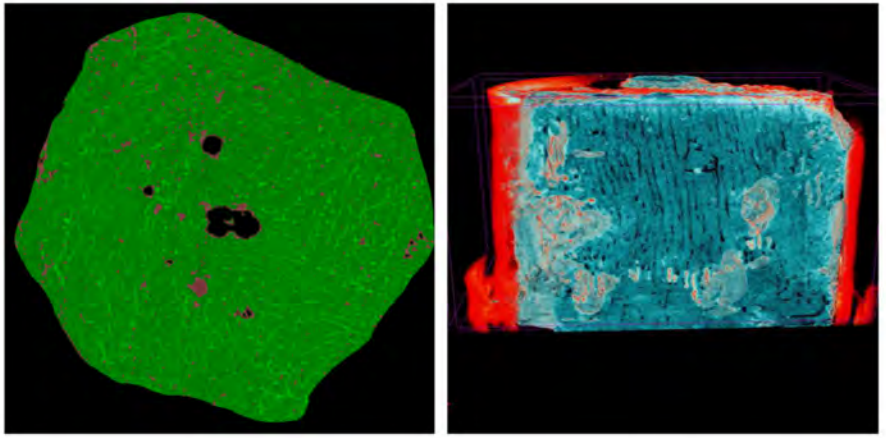

МЛСП «ПРИРАЗЛОМНАЯ»


Evaporation
Absorption by snow
Snow
Lead
Oil on meltwater pools in spring
Oil pool under snow
First-year ice
Oil migration up brine channels
Fissure
Multi-year ice
Pumping under ice
Oil trapped in ice rubble
Encapsulated oil
Dissolution and mousse formation
Oil pool
Sessile drops of oil, mobile or being encapsulated in ice
Drift with current

Tracking oil from remote sensing

Fig. 1. Oil pool setup for injection of oil underneath thin sea ice.

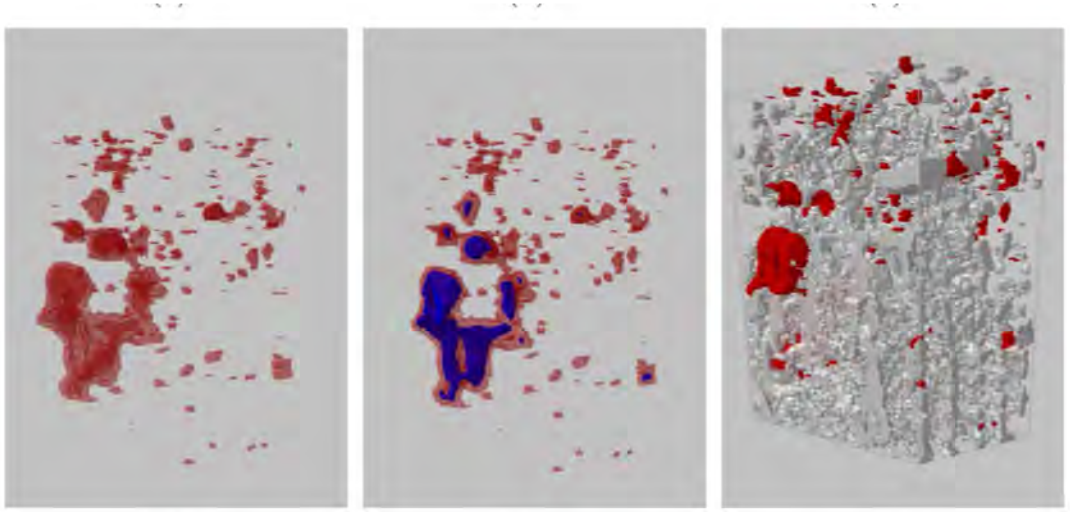




(a) (b)

Fig. 6. Reconstructed image of Core 9. (a) Horizontal slice showing oil (pink), ice (green), brine (light green), and air (black). (b) Slices ensemble in a 3-D view.

Neusitzer et al 2017 IEEE; Firoozy et al 2018 IEEE

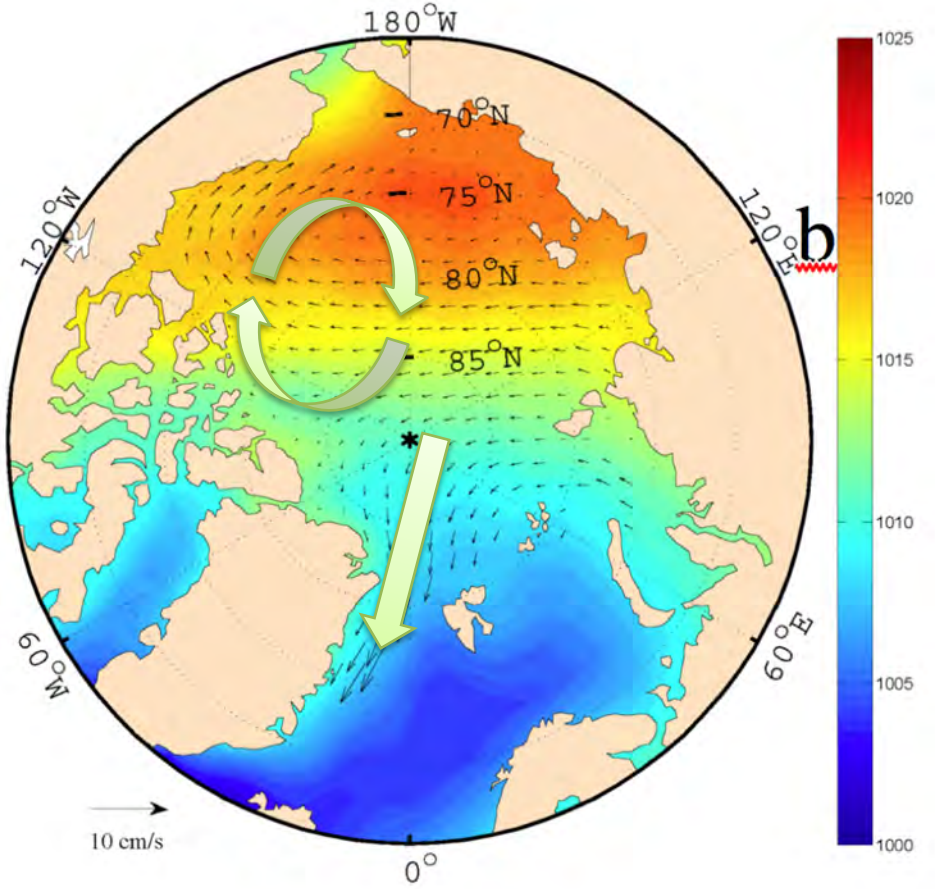


(d) (e) (f)

Fig. 7. 3-D decomposition of the sample extracted from Core number 9 (5–7.5-cm core depth) depicted in the figures (a)–(c), and Core number 16 (4–6-cm core depth) depicted in the figures (d)–(f). Oil, air, and brine are presented in red, blue, and white, respectively. Data processing included removal of ring-artifacts corrections, beam-hardening, postalignment, and Gaussian smoothing.

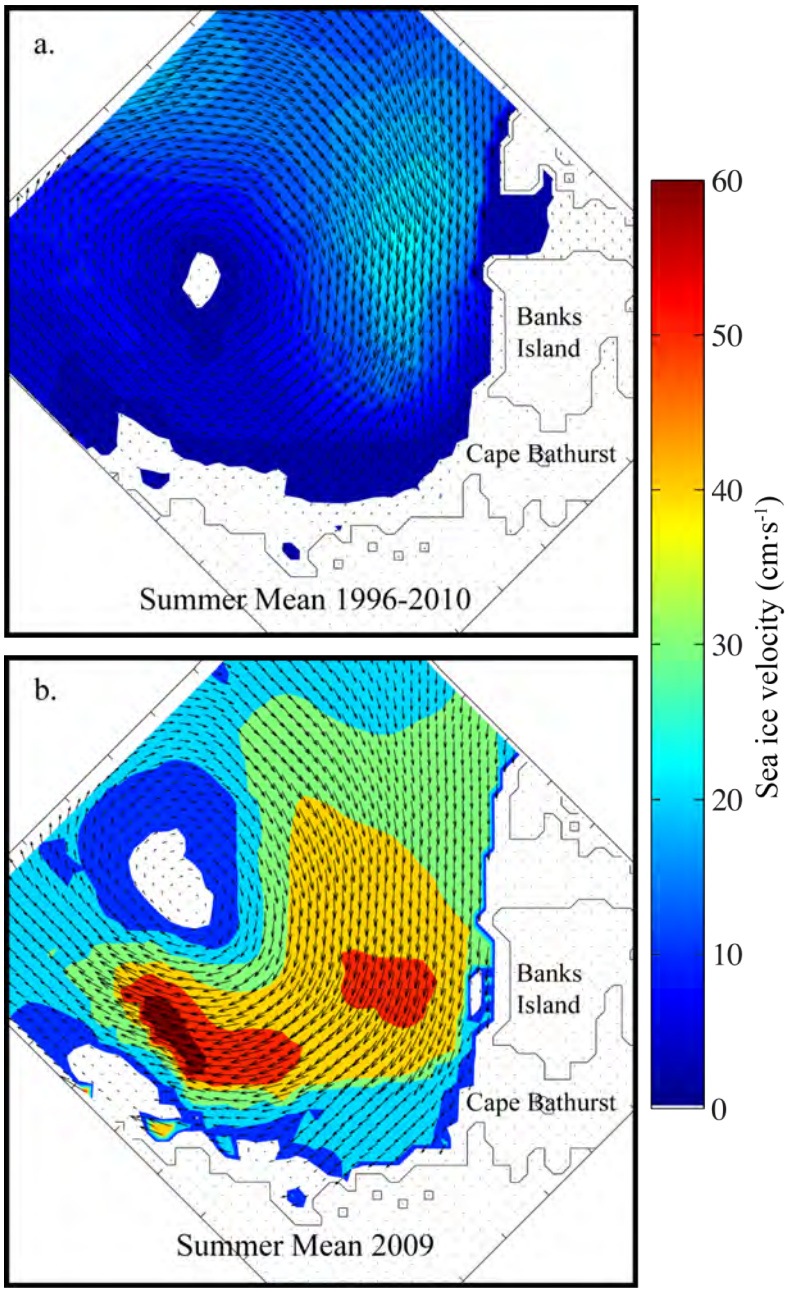
Neusitzer et al 2017 IEEE; Firoozy et al 2018 IEEE

Sea ice transport
The two sea ice gyres

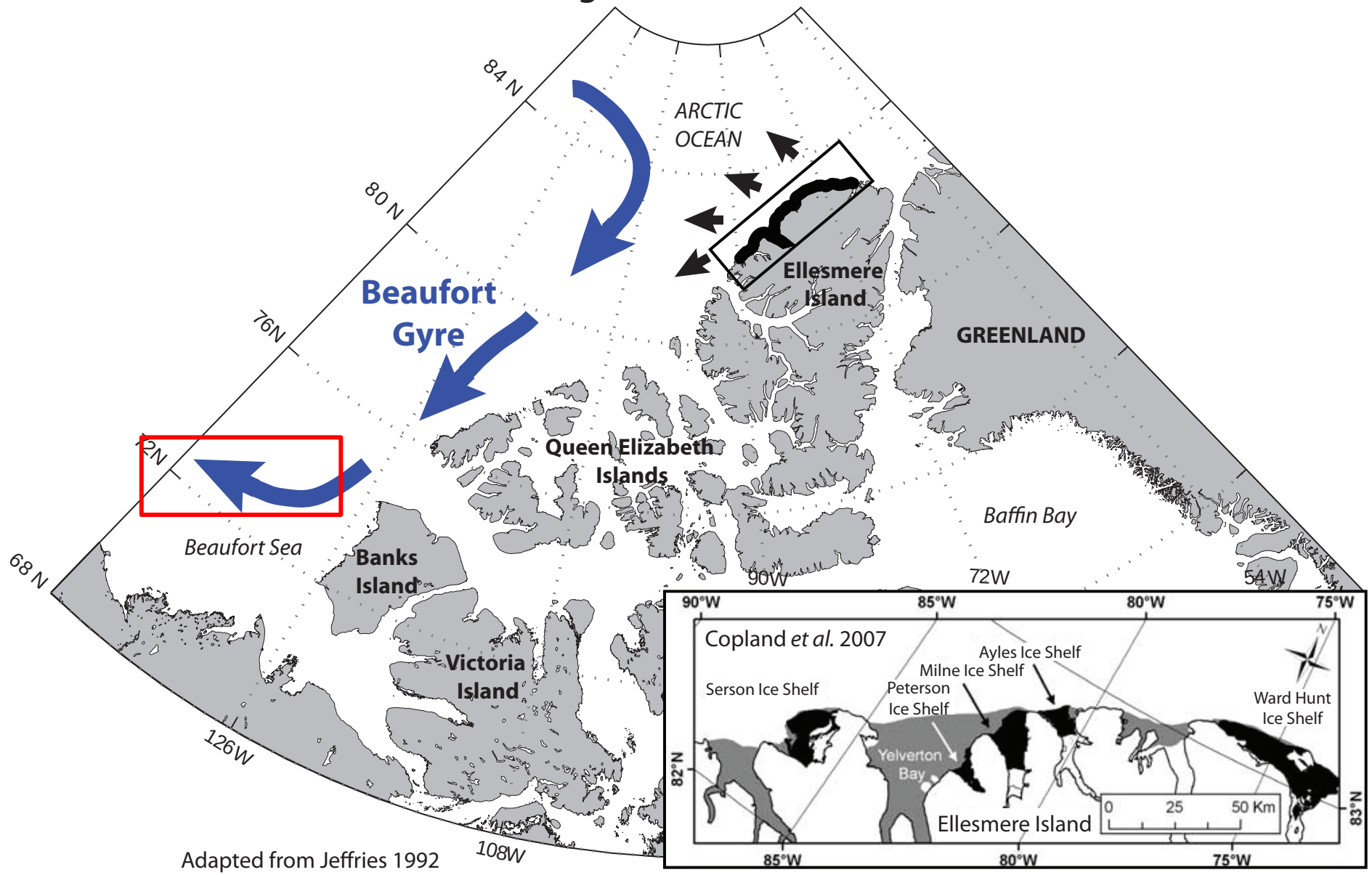


Ice Velocity

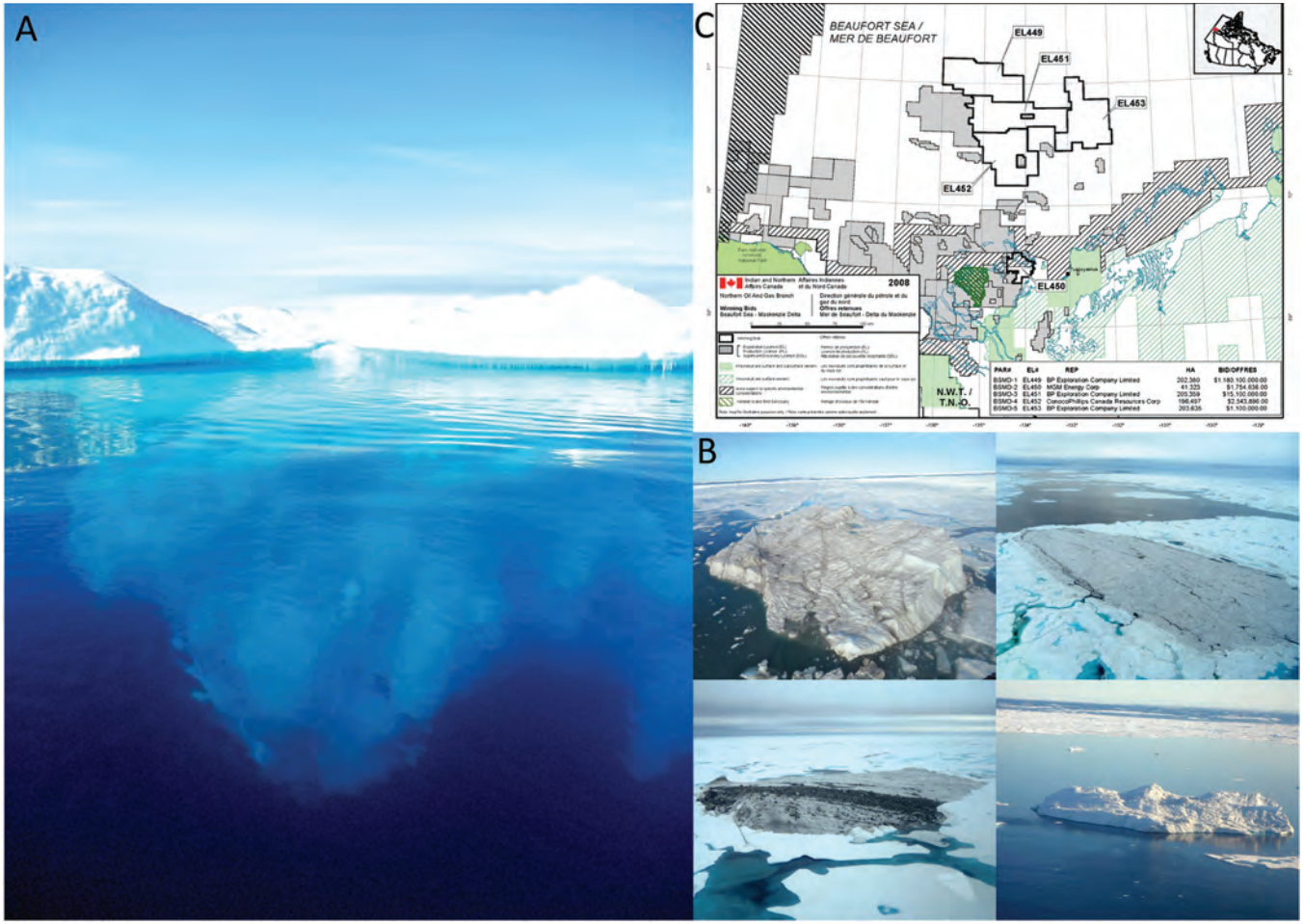
Velocity of ice has increased significantly making it more difficult for industry to manage ice hazards.



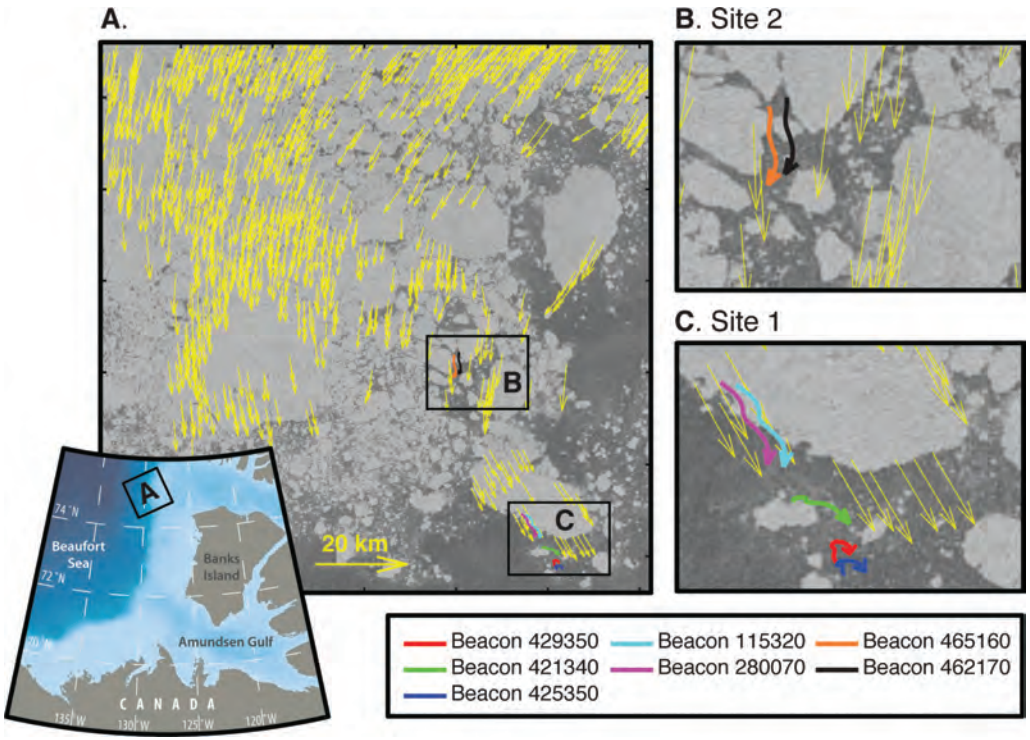
The origins of Arctic Ice Islands



Ice hazards – ocean and atmos. forcing

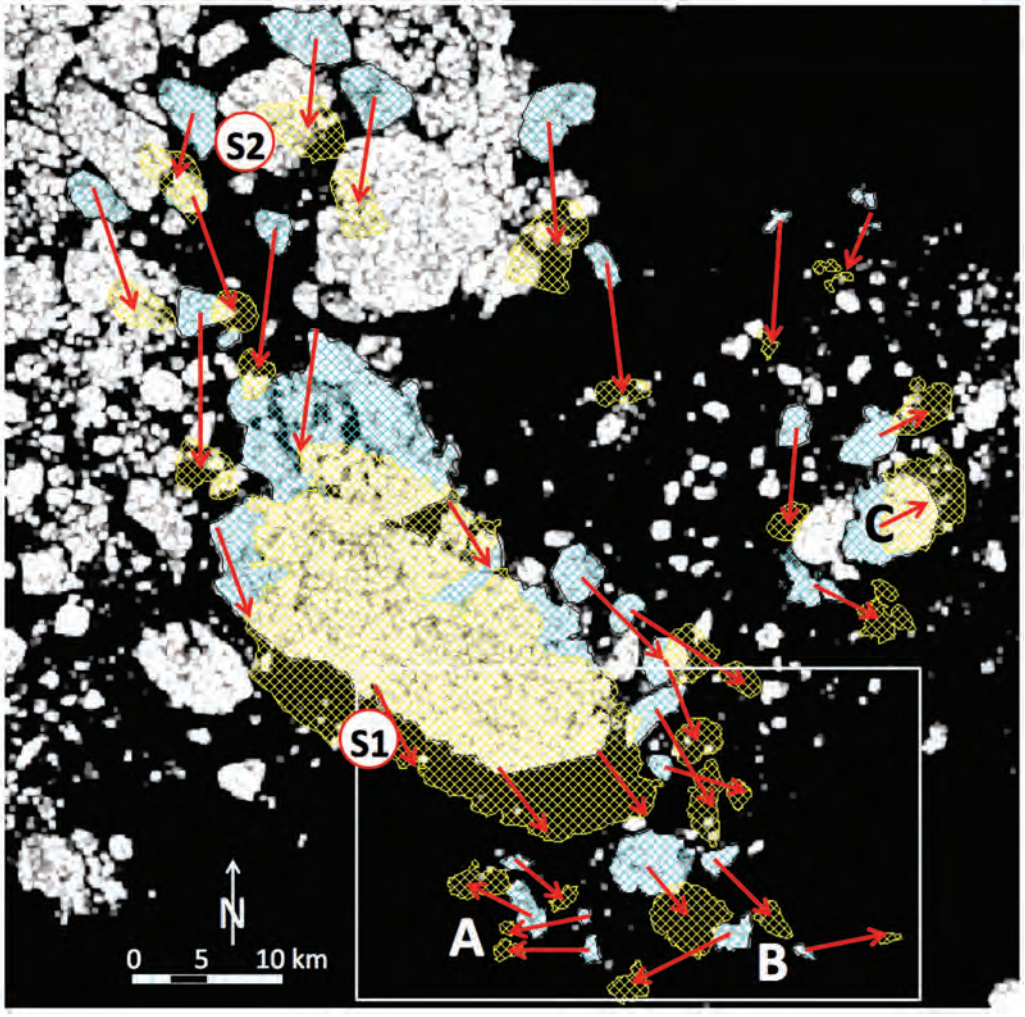


Thick MYI, glacial ice and maps showing the location of industrial exploration – source: Barber et al (2014) Elementa, 2. 000025



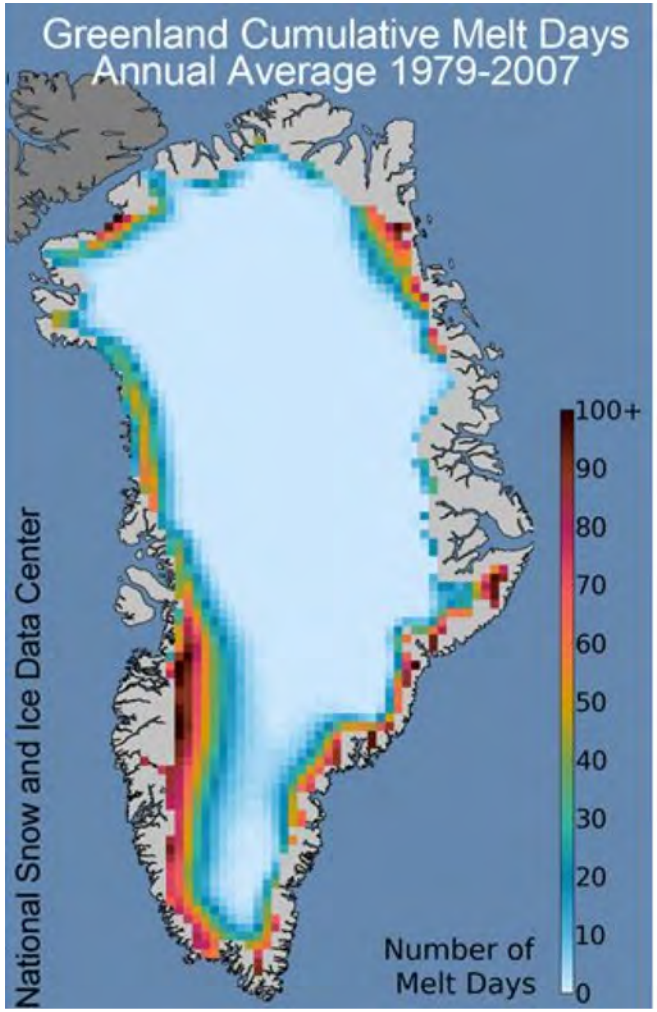
RADASAT derived ice motion
– source: Barber et al. (2014) Elementa, 2. 000025

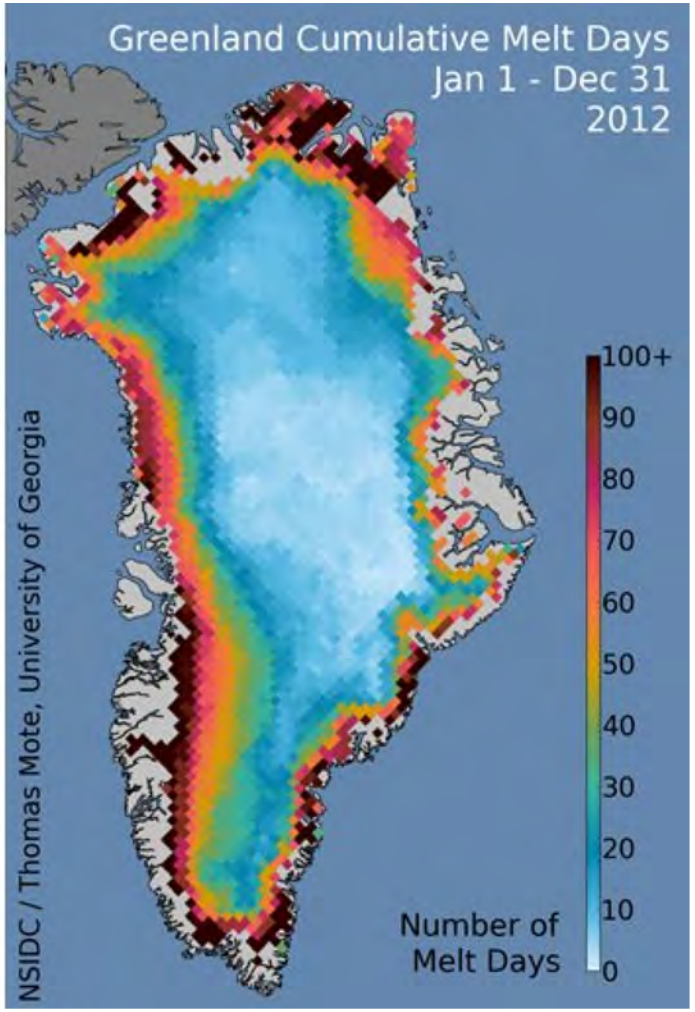
Displacement of selected floes over 24 h.



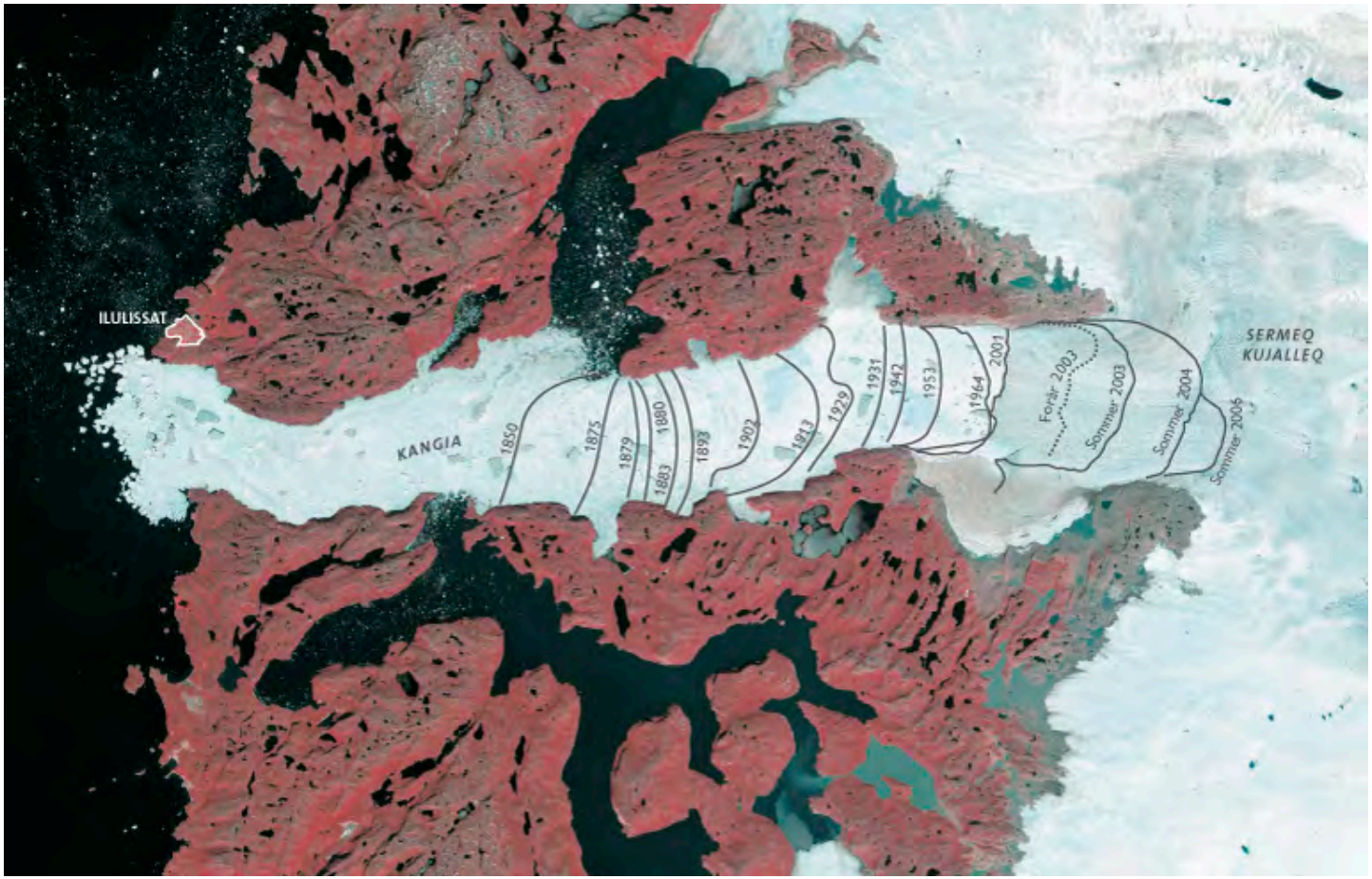
– source: Barber et al. (2014) Elementa, 2. 000025

The Greenland Ice Sheet is melting



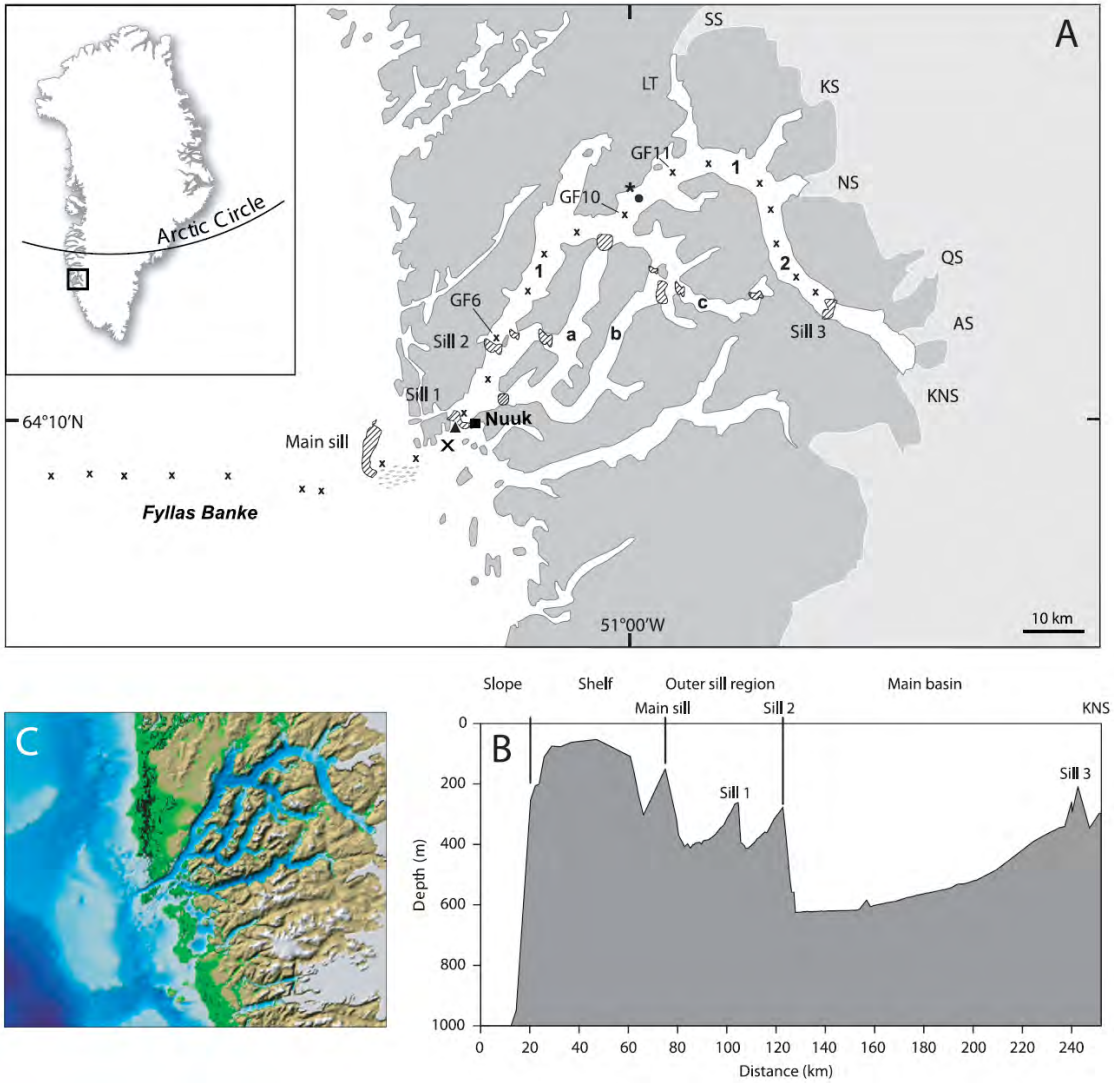


Glaciers are retreating



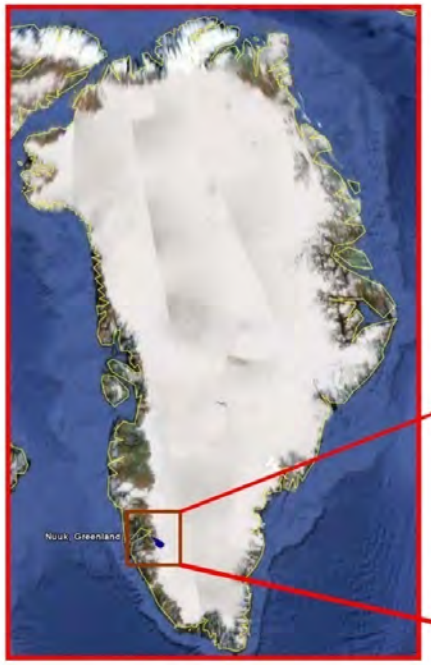
KNS glacier in Godthåbsfjorden (Nuuk Fjord), West Greenland

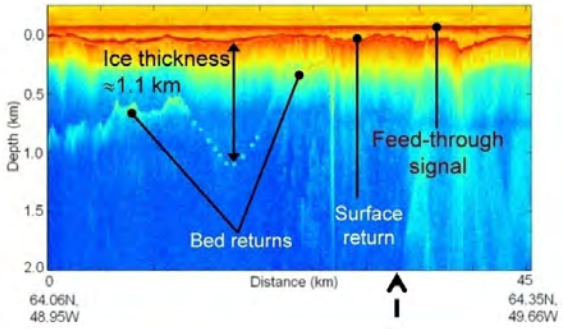
Sills are an important control for the size and export of icebergs

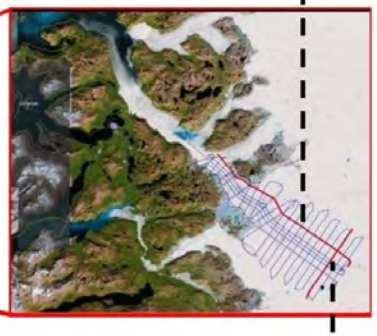


Mortensen et al 2011, J. Geophys Res.

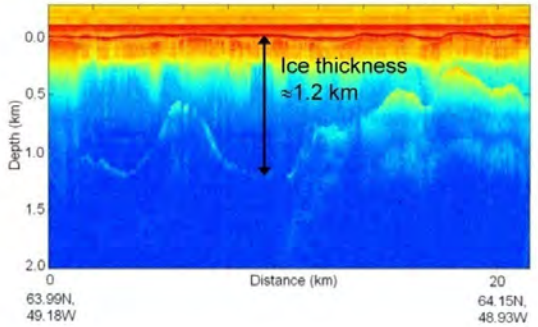
What's below the Greenland Ice Sheet?



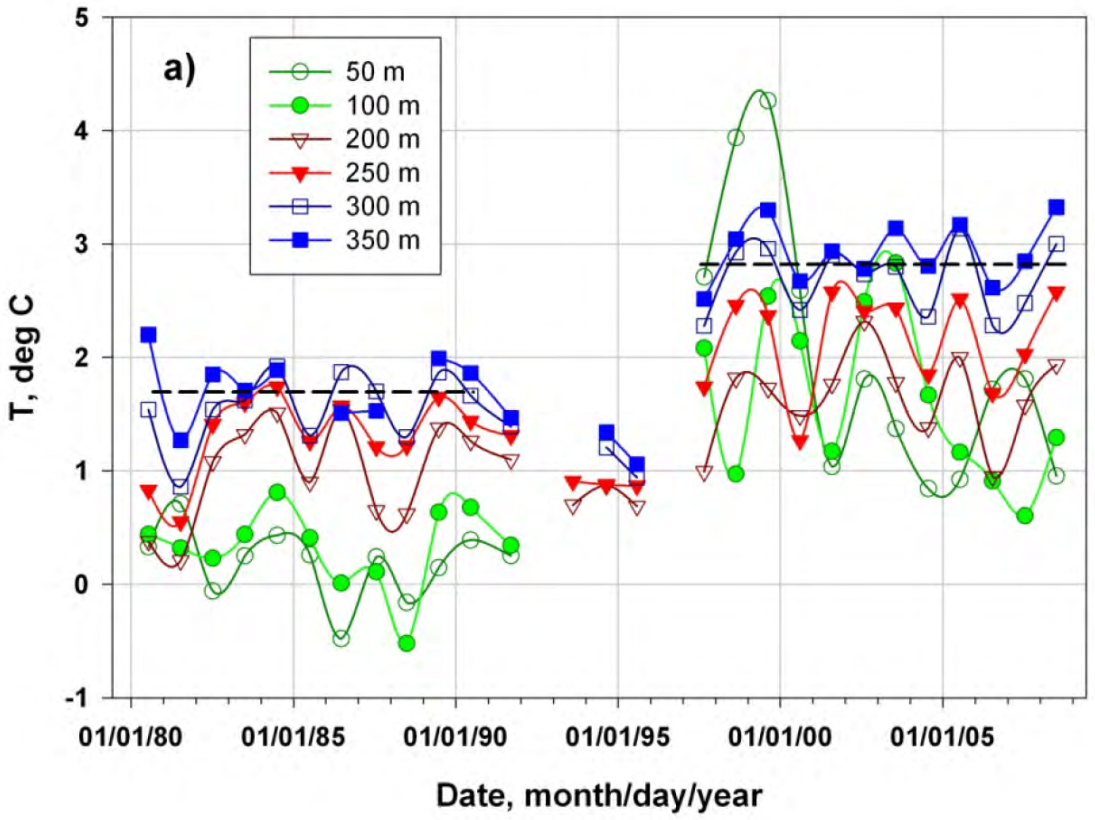




Aerial view of the surface of the glacier.



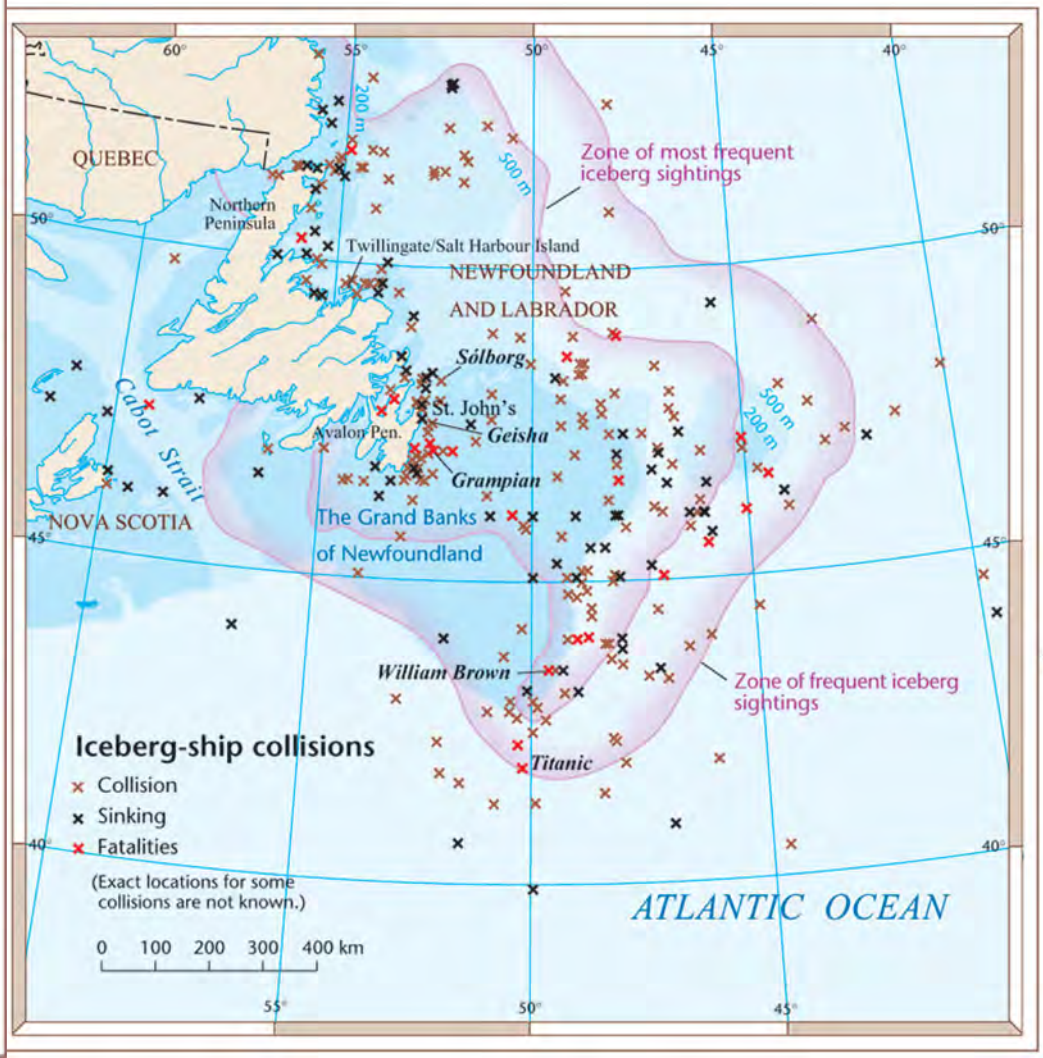
Warm ocean water also seems to play a role



Motyka et al. 2011, J. Geophys. Res, 116

Ice islands are huge

Ice bergs and collisions



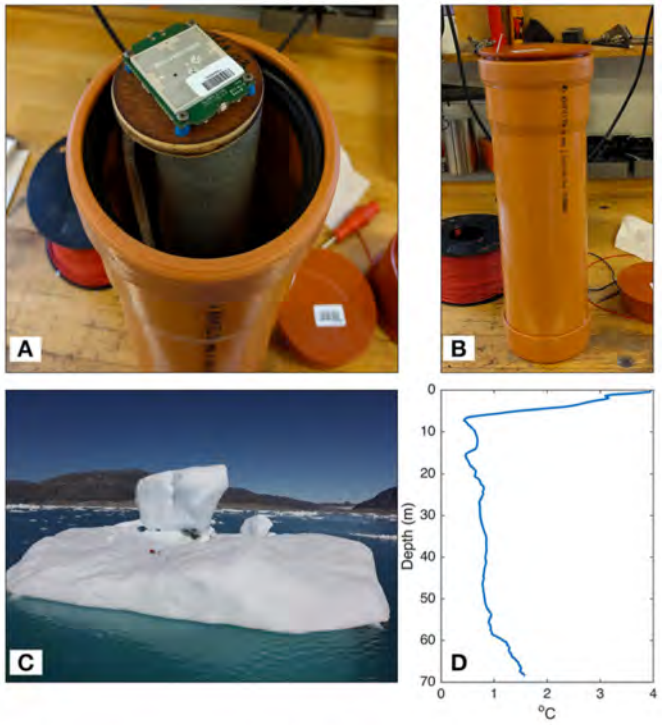


FIGURE 2 | (A) An EXITE tracker showing Spot Trace GPS antenna mounting in a section of PVC drain pipe. **(B)** An assembled EXITE tracker. **(C)** EXITE on bergy bit with complex sail geometry resulting from ice debris. **(D)** A CTD profile of temperature with depth obtained in the vicinity of the EXITE deployment location.

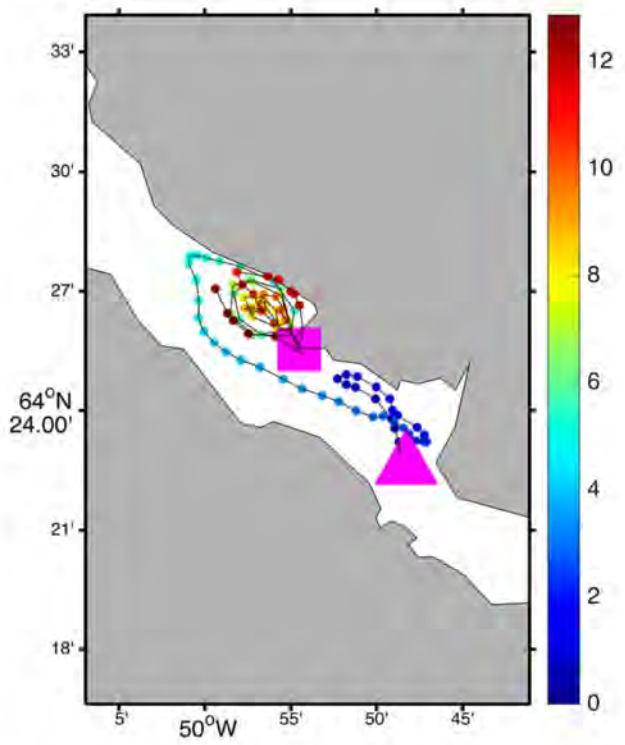
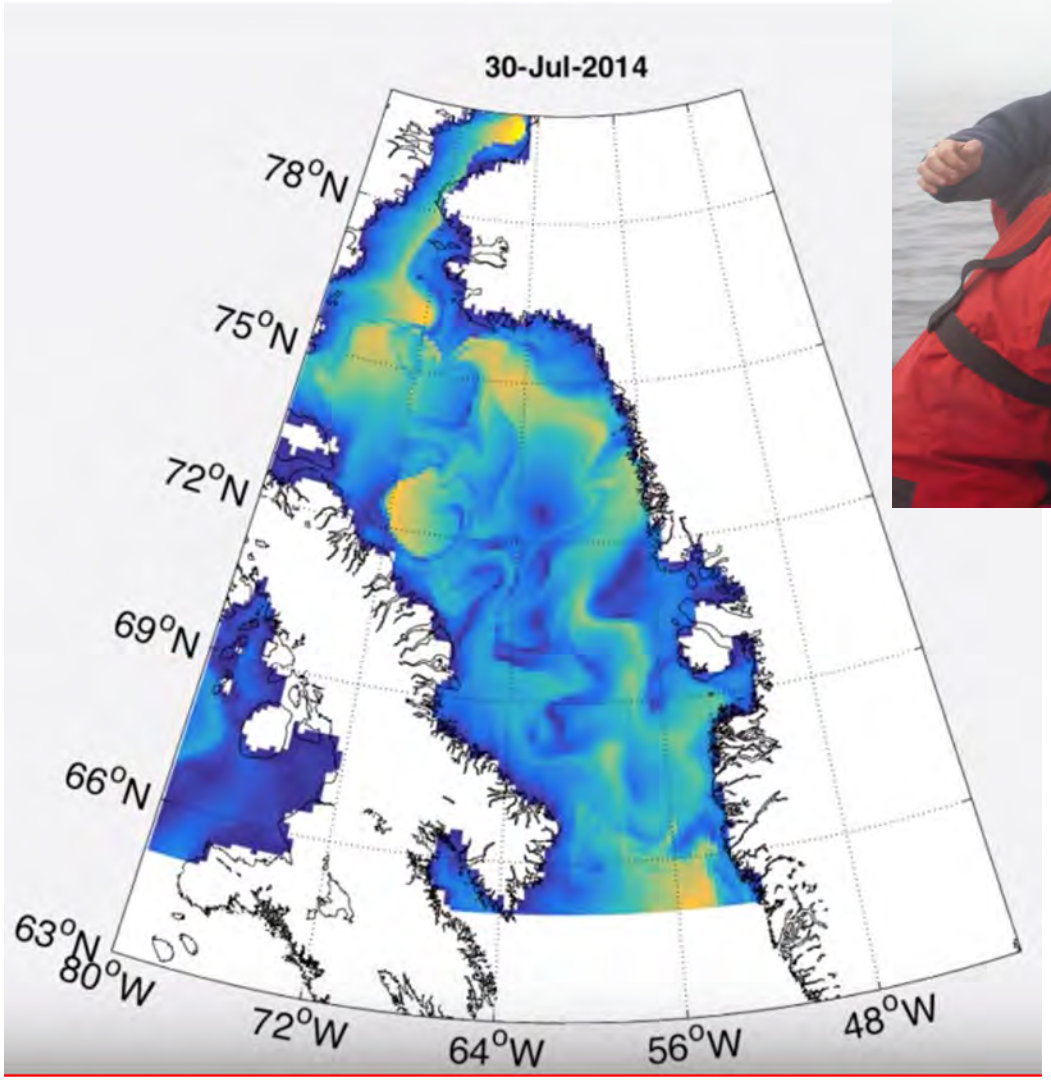
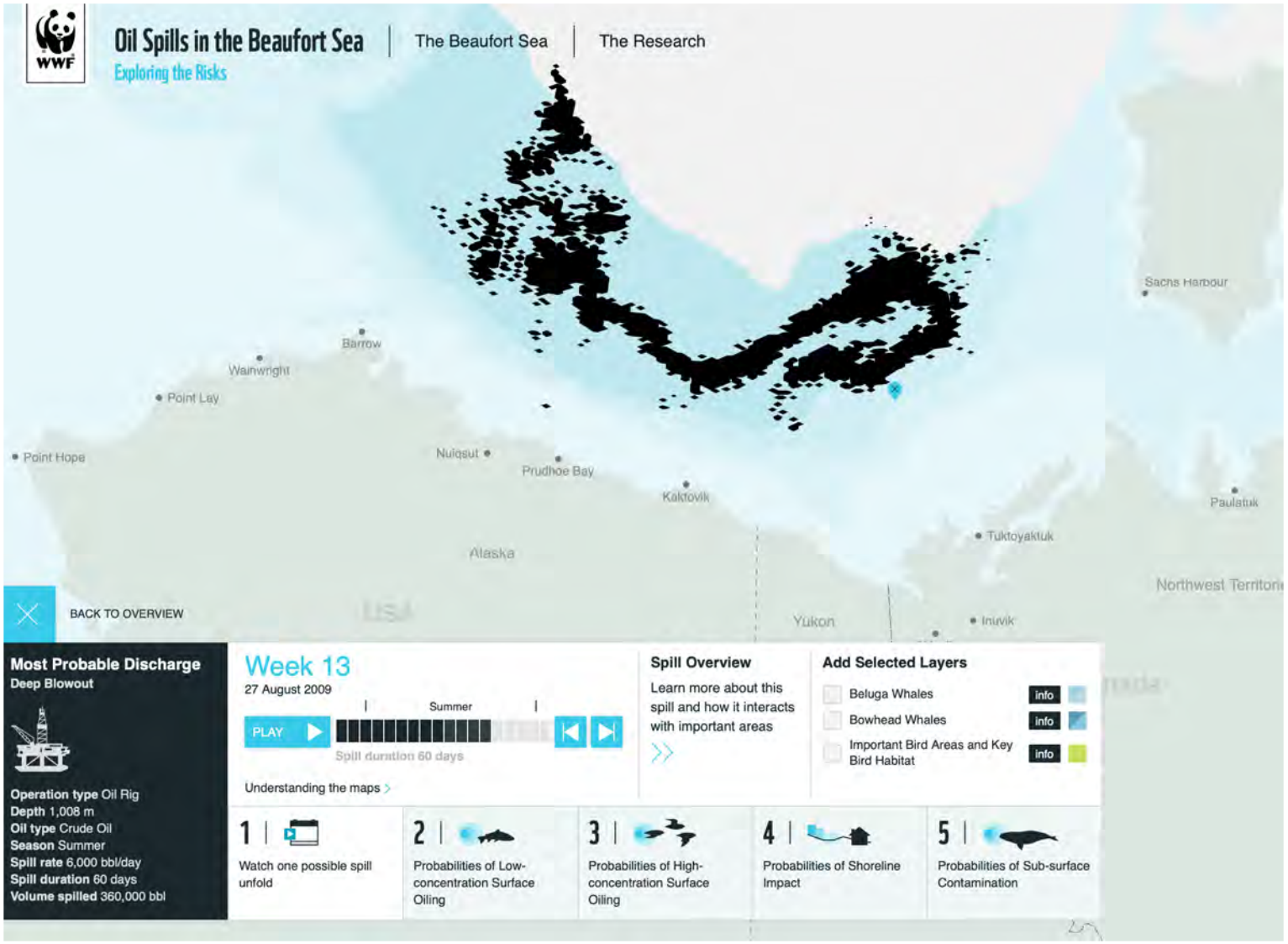


FIGURE 5 | A trajectory of an EXITE beacon initially deployed at the large pink triangle. Locations are color-coded according to time, in days, since deployment. Every 4th measurement is shown for clarity. The location where the critical acceleration was exceeded is indicated by the large pink square.

Carlson et al 2017, Frontiers

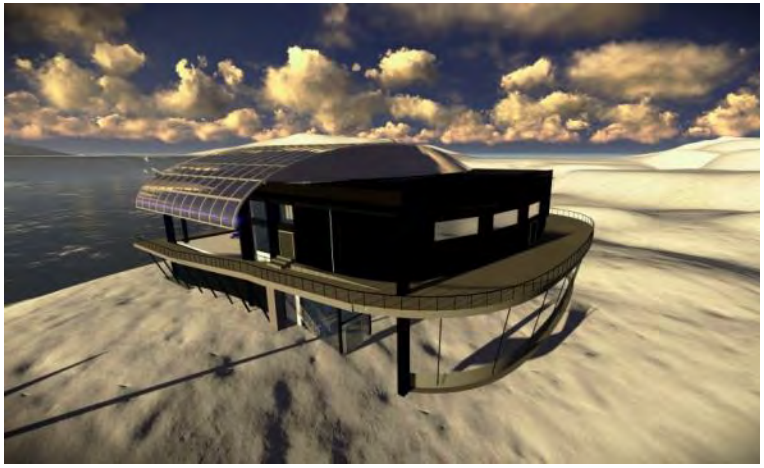


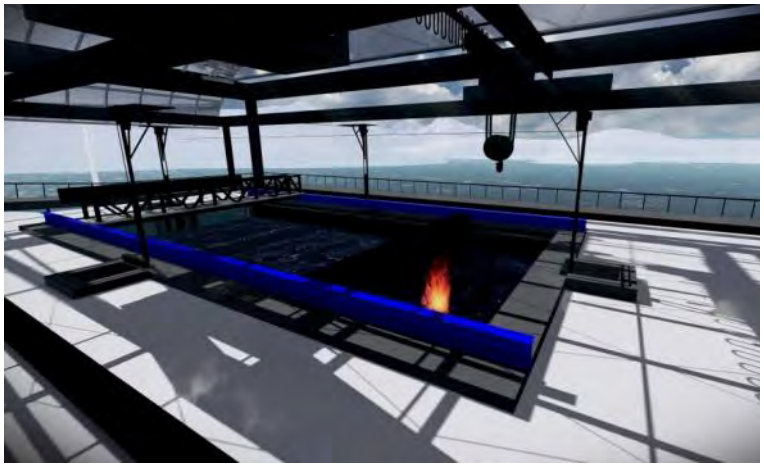
Carlson & Rysgaard et al, ‘on the go’



https://arcticspills.wwf.ca/

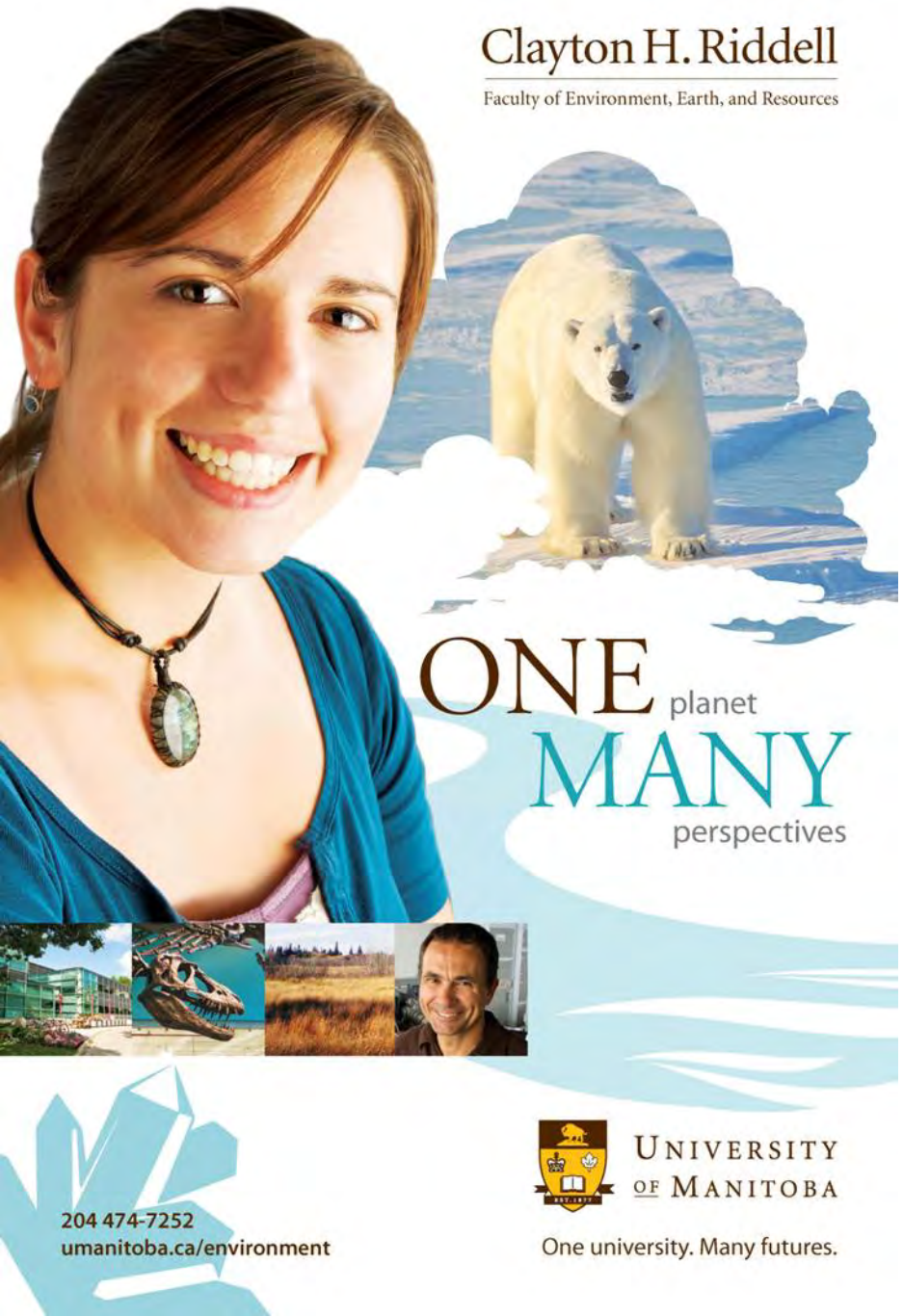
Oil in Sea Ice Mesocosm - OSIM





- A concept to allow controlled testing of the ocean-sea ice system response to oil and contaminants.

- Science will concentrate on
  - **Detection** (of oil in sea ice)
  - **Impacts** (of oil spills on marine ecosystems)
  - **Mitigation** (of oil spills in sea ice using both genomics-enhanced bioremediation technologies and conventional techniques)



In closing:

- MY ice remains a barrier to development and we expect this to continue for several decades.
- Glacial ice will remain at the level we have now (but may increase) over the next several decades
- We expect ice motion to increase in speed and it will become less predictable as sea ice decreases
- Management tools are not fully tested and are in need of further development.
- We need to educate the next generation to provide and maintain local expertise on environmental issues
- Perhaps we need to think different (global)
- Oil in ice is a big concern for us!