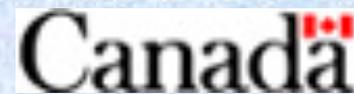


Tidal Mixing, Polynyas, and Human Settlement in the Canadian Arctic Archipelago

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Charles Hannah, Bedford Institute of Oceanography, Halifax

State of the Arctic Conference 16-20 March 2010, Miami



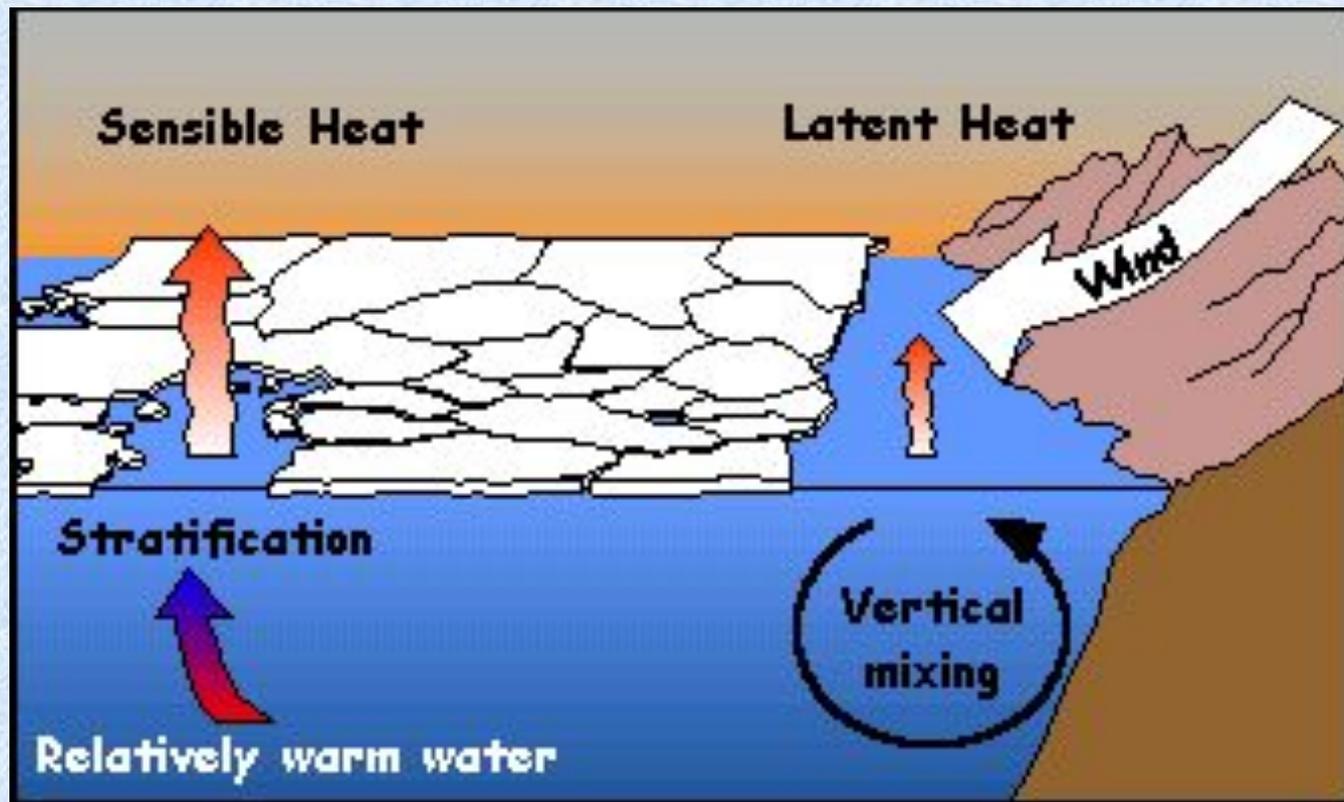
Attempt to link

- Tidal currents (hard core physics)
- Polynyas – a dominant feature of the system
- Tidal mixing fronts – dominant feature of mid-latitude marine ecosystems.
- Human settlement

Hannah, C.G., F. Dupont and M. Dunphy.
2009. Polynyas and Tidal Currents in the
Canadian Arctic Archipelago. *Arctic*
62:83-95.

- The ecological importance of polynyas is thought to have important influence on human settlement patterns in the Canadian Arctic (Schledermann 1980).
- There is recent work to suggest that presence of tidal mixing fronts have had an impact on human settlement patterns in western Sweden (Schmitt et al. 2005).

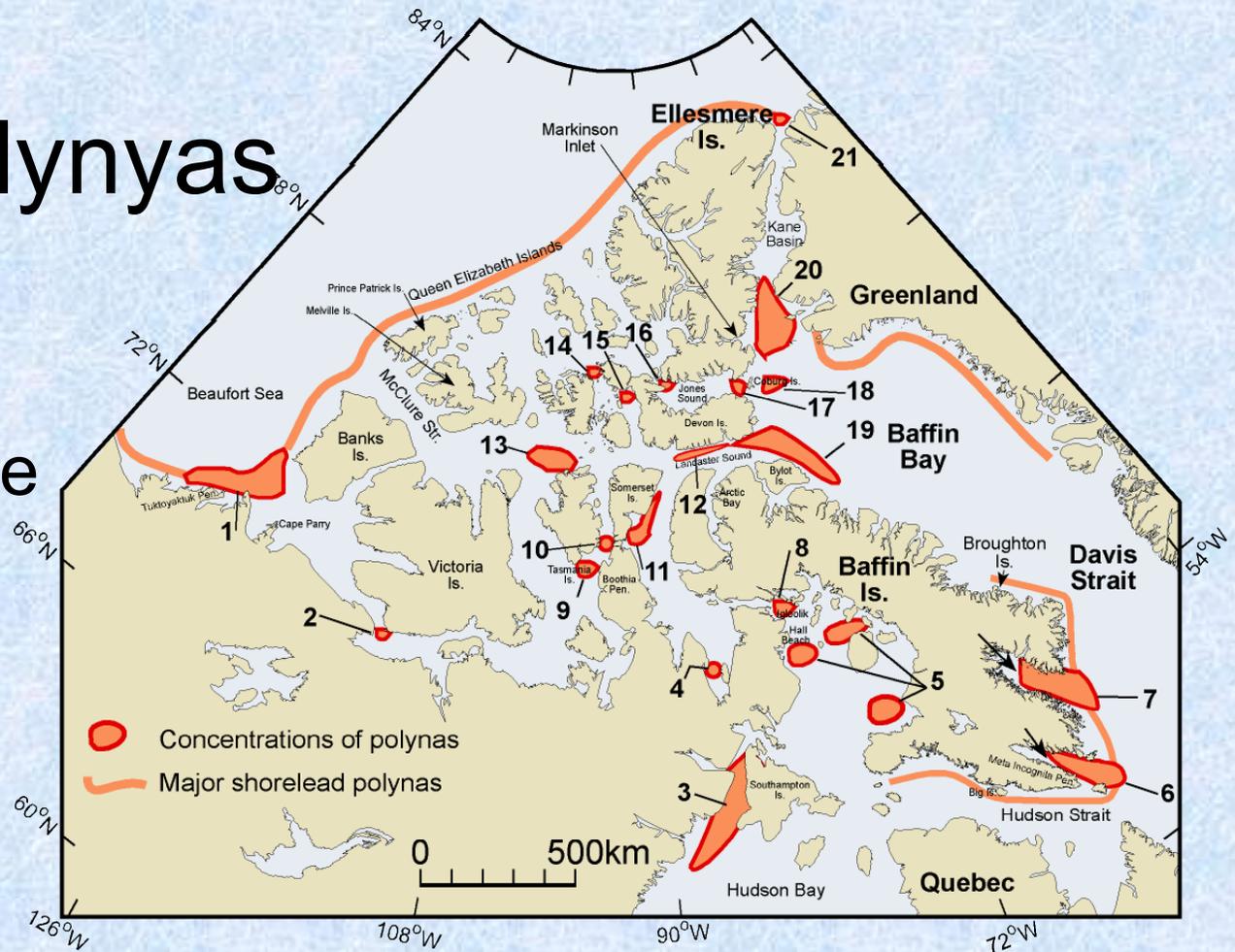
Polynya Formation



From North Water Polynya website

Known Polynyas

An area of ice free water in the midst of ice covered water (some or most of the time)



- | | | |
|----------------------|------------------------------------|--------------------------------|
| 1 Cape Bathurst | 8 Fury and Hecla Strait | 15 Dundas Island |
| 2 Lambert Channel | 9 Franklin Strait | 16 Hell Gate - Cardigan Strait |
| 3 Roes Welcome Sound | 10 Bellot Strait | 17 Lady Ann Strait |
| 4 Committee Bay | 11 Prince Regent Inlet | 18 Coburg Island |
| 5 Foxe Basin | 12 Lancaster Sound | 19 Bylot Island |
| 6 Frobisher Bay | 13 Viscount Melville Sound | 20 NOW (Northwater) |
| 7 Cumberland Sound | 14 Queens Channel and Penny Strait | 21 Lincoln Sea |

Barber and Massom 2007

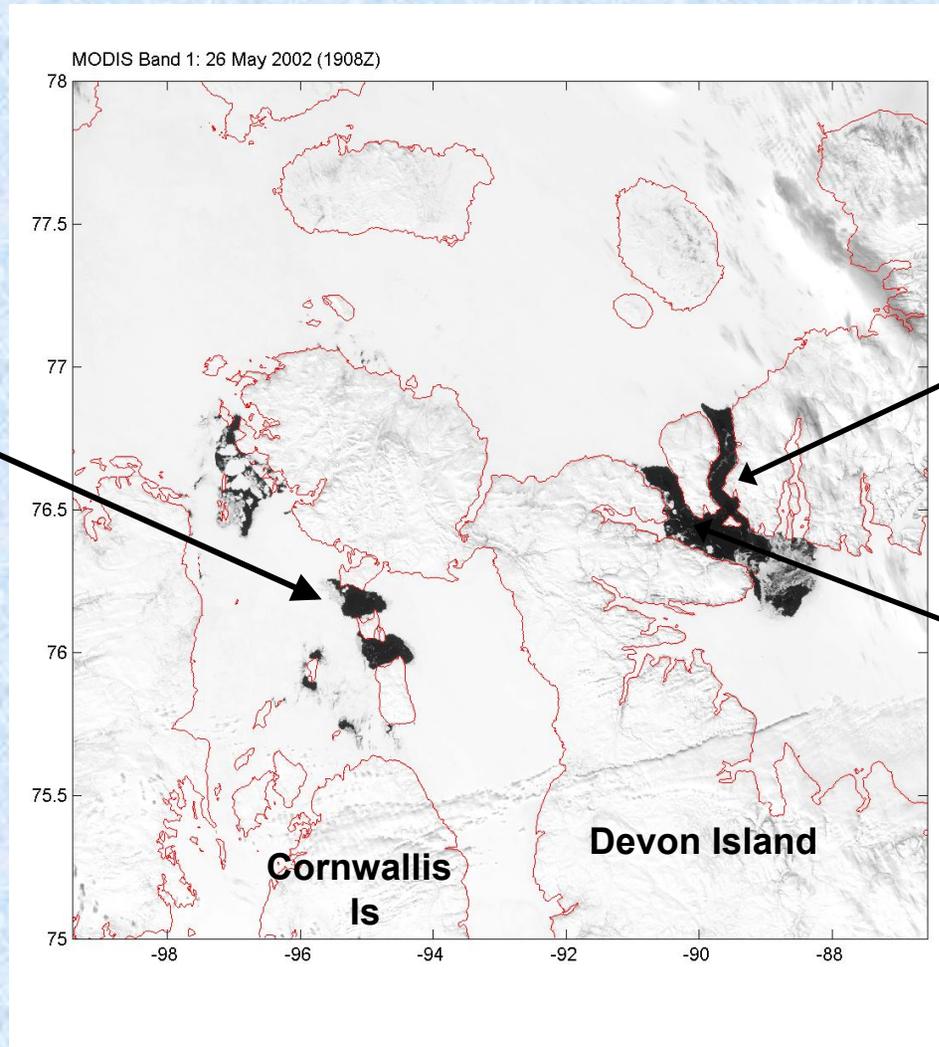
26 May 2002

Black is open water

Dundas Island
polynya

Hell Gate

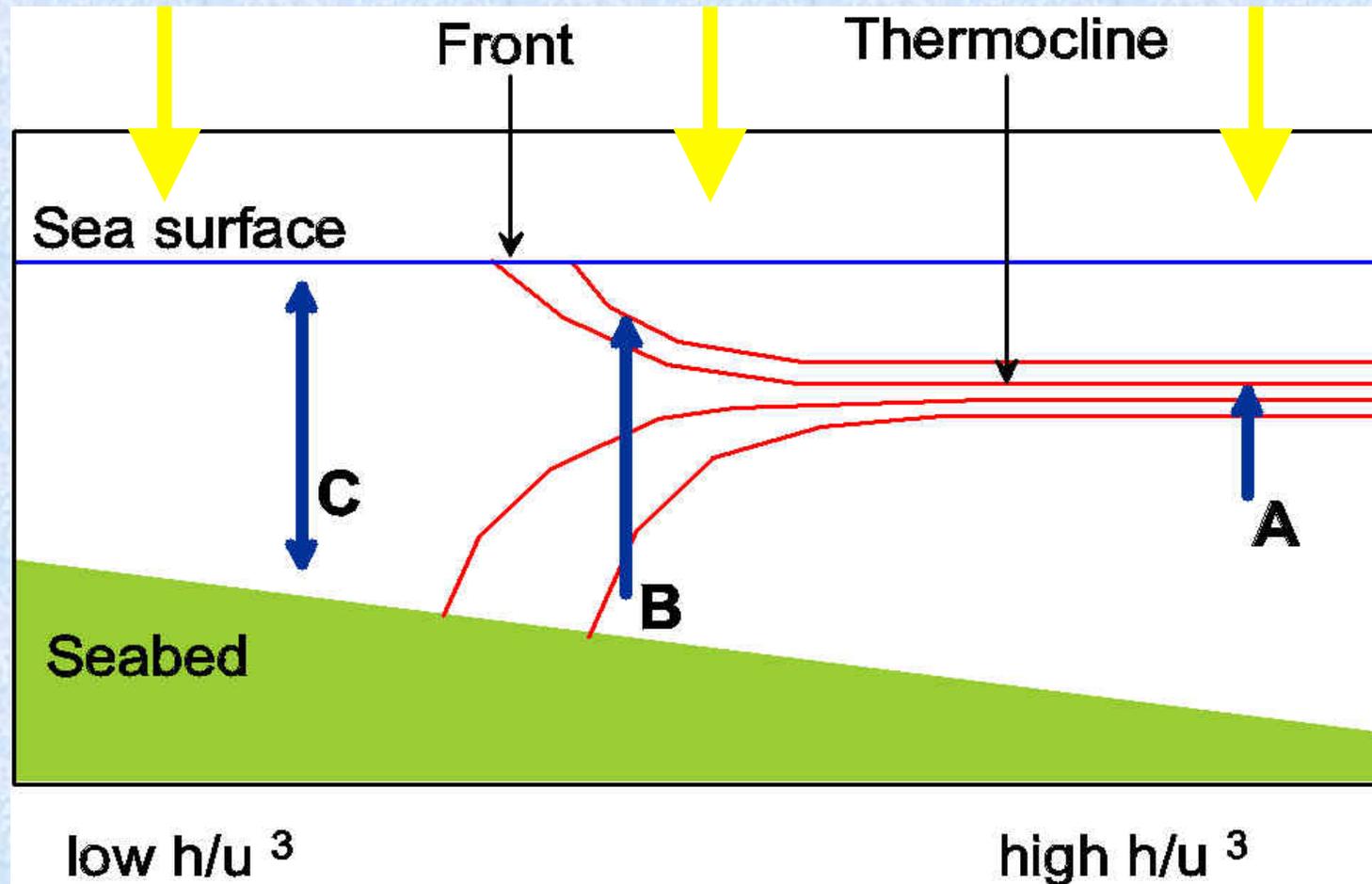
Cardigan Channel



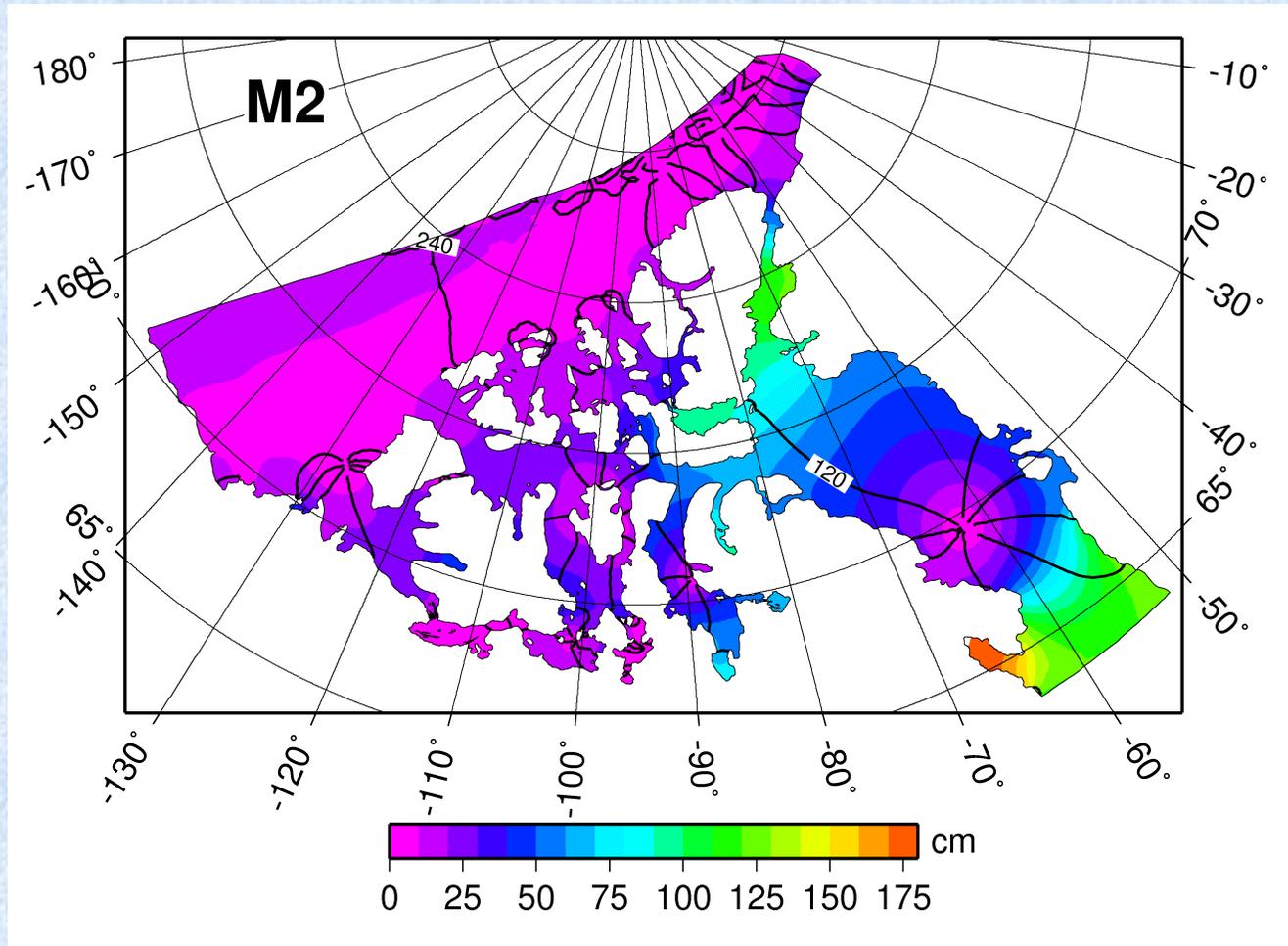
Basic Idea

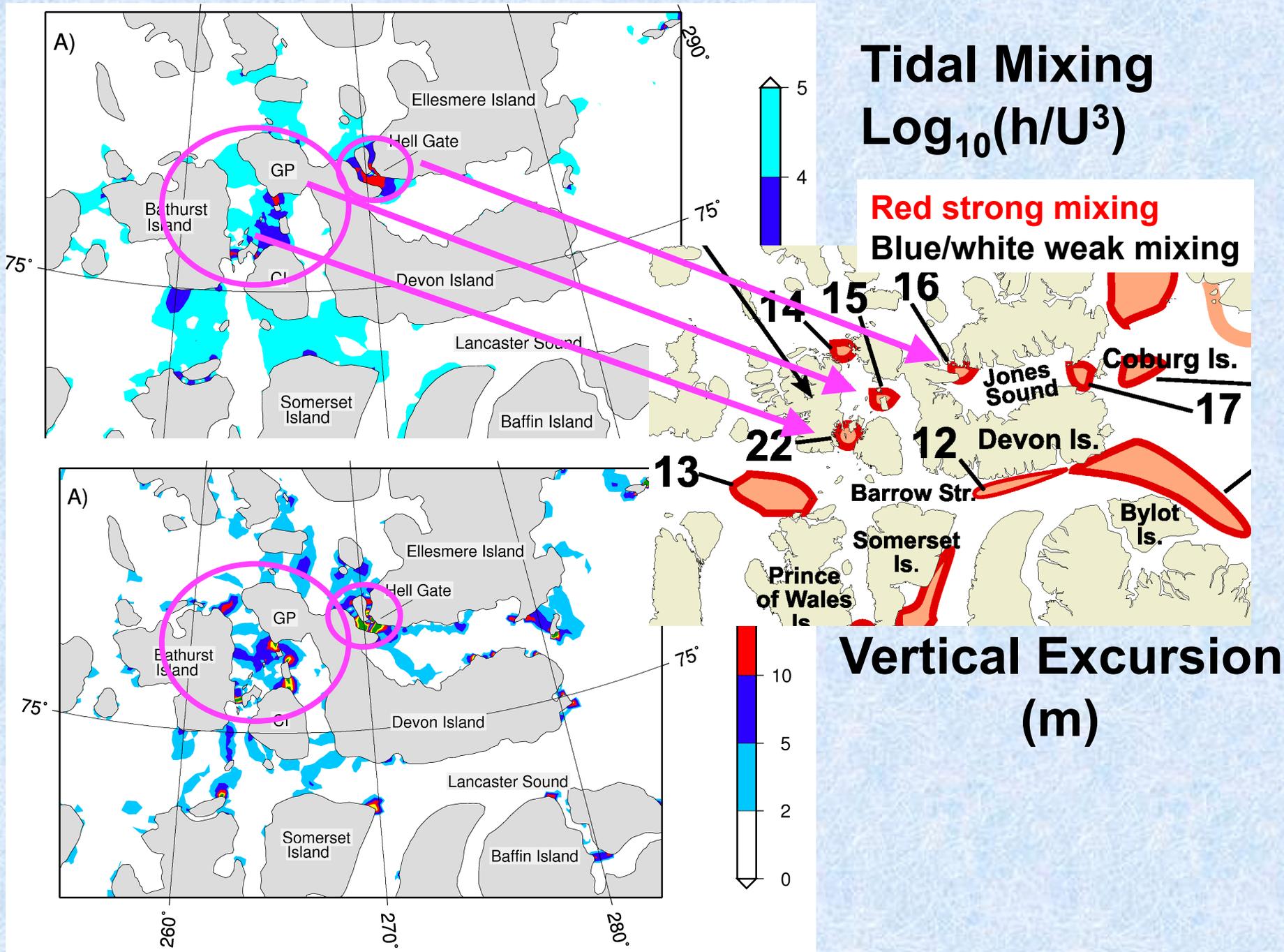
- A tidally-driven sensible heat polynya requires that the local tidal mixing be strong enough to mix heat vertically in the face of the regional stratification.
- A similar concept exists in mid-latitude systems: the tidal mixing front.

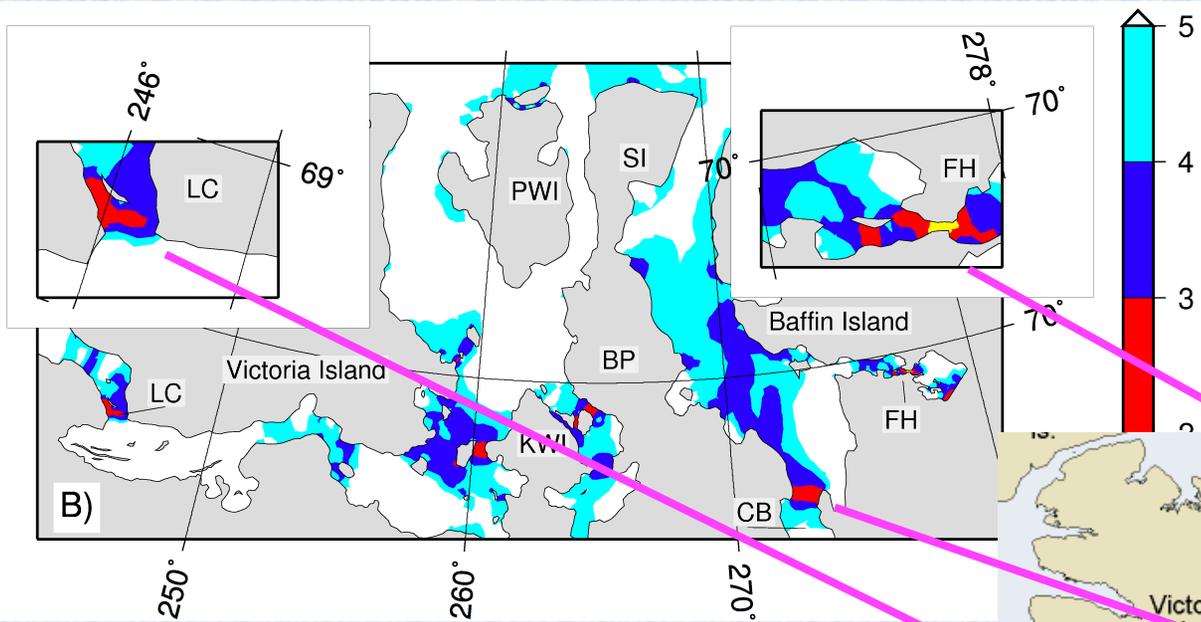
Tidal Mixed Front



M2 tidal heights

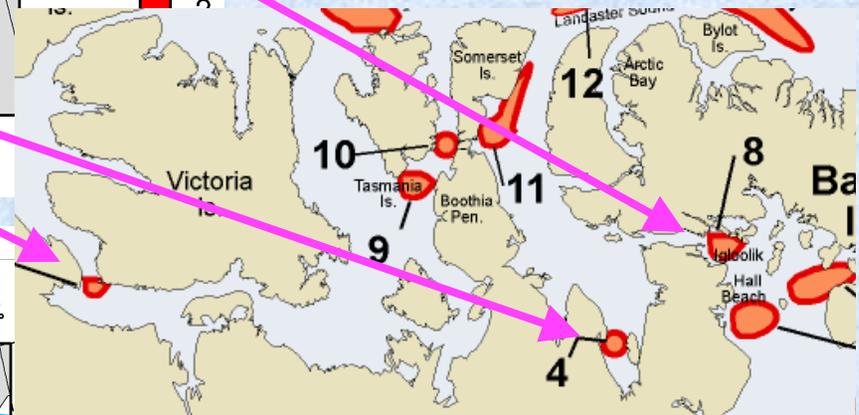




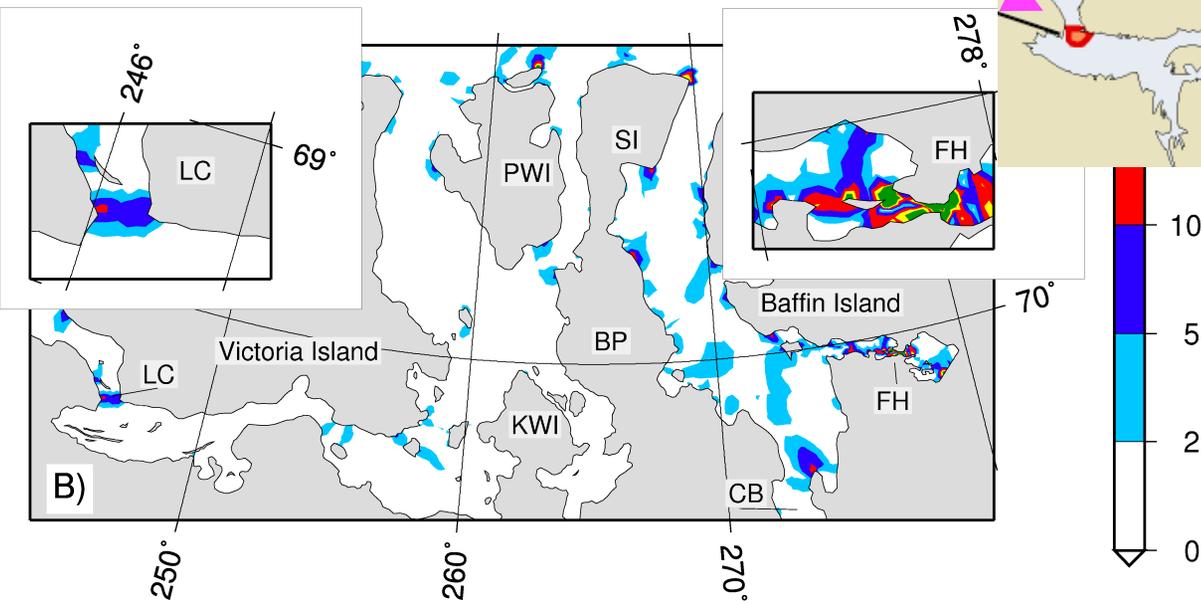


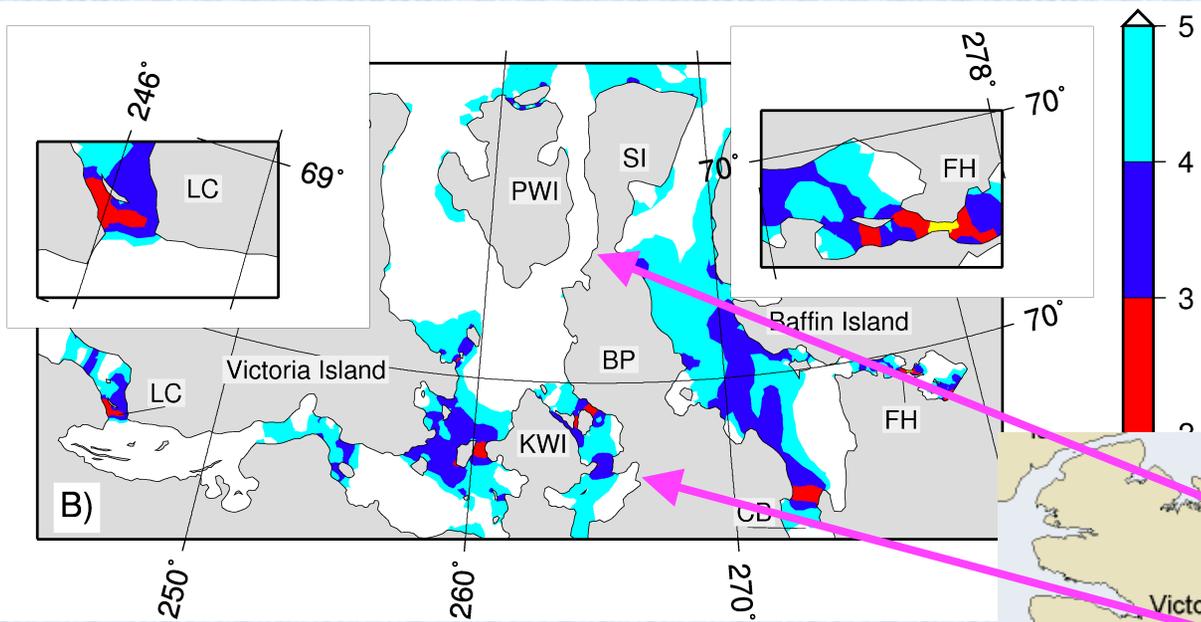
Tidal Mixing $\text{Log}_{10}(h/U^3)$

Red strong mixing
Blue/white weak mixing



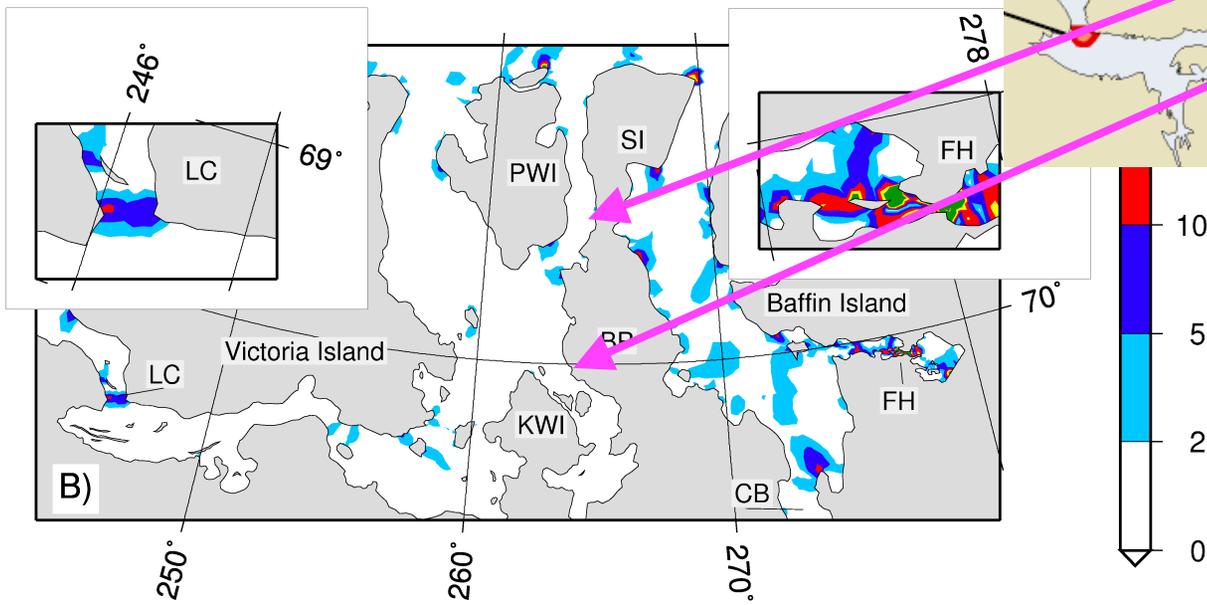
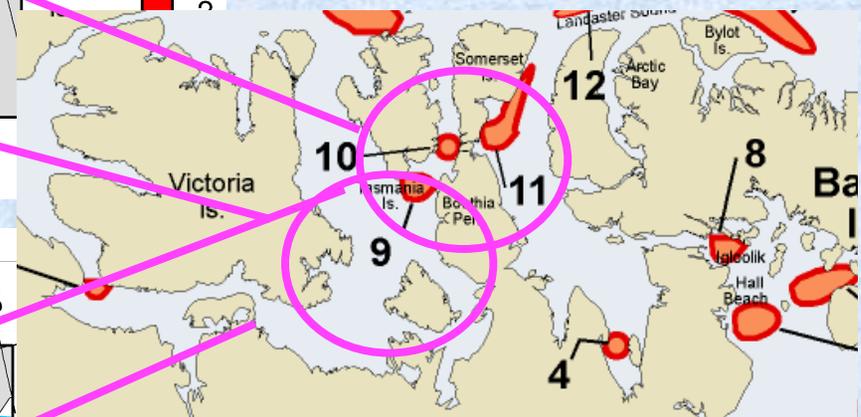
Vertical Excursion (m)





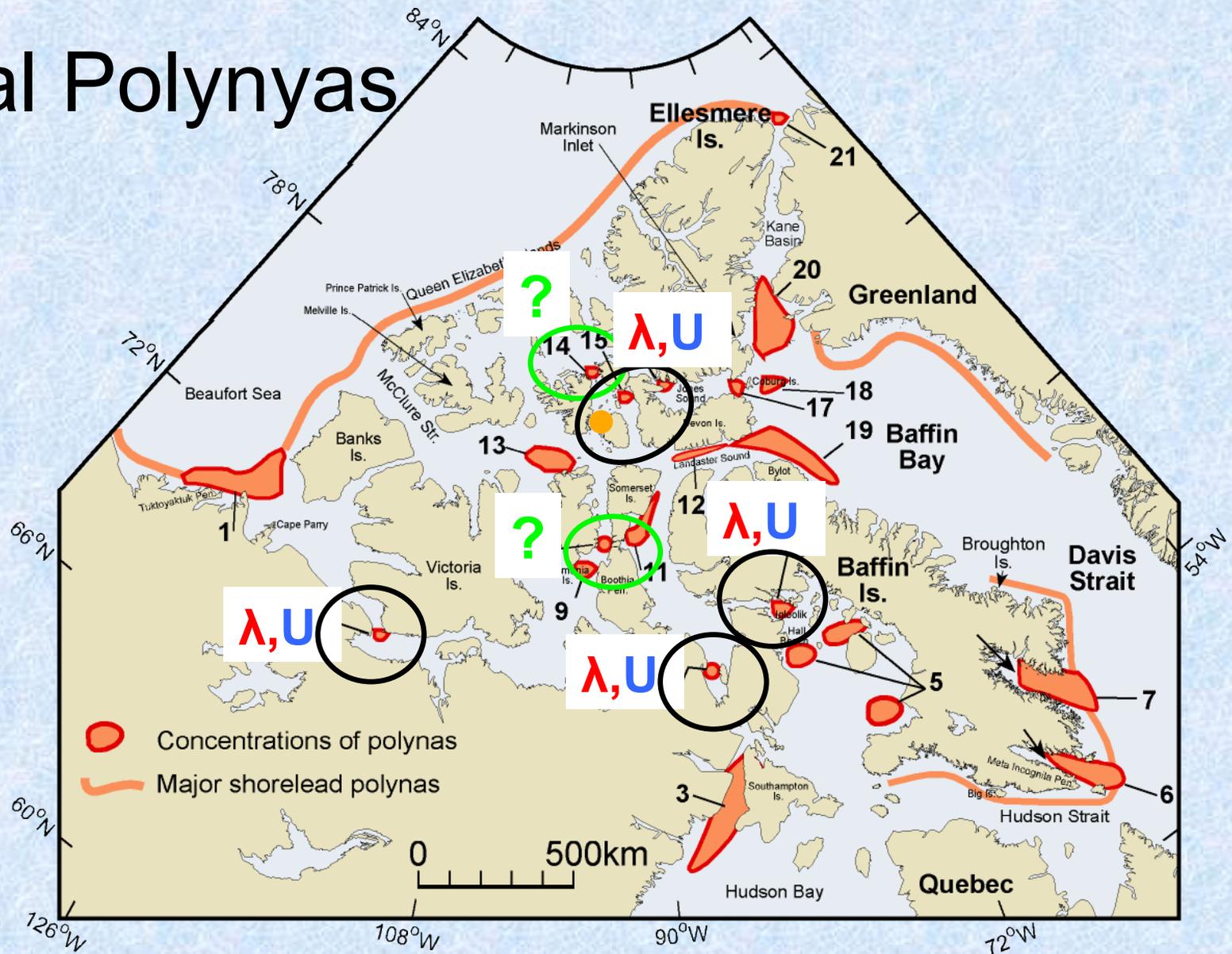
Tidal Mixing $\text{Log}_{10}(h/U^3)$

Red strong mixing
Blue/white weak mixing



Vertical Excursion (m)

Tidal Polynyas

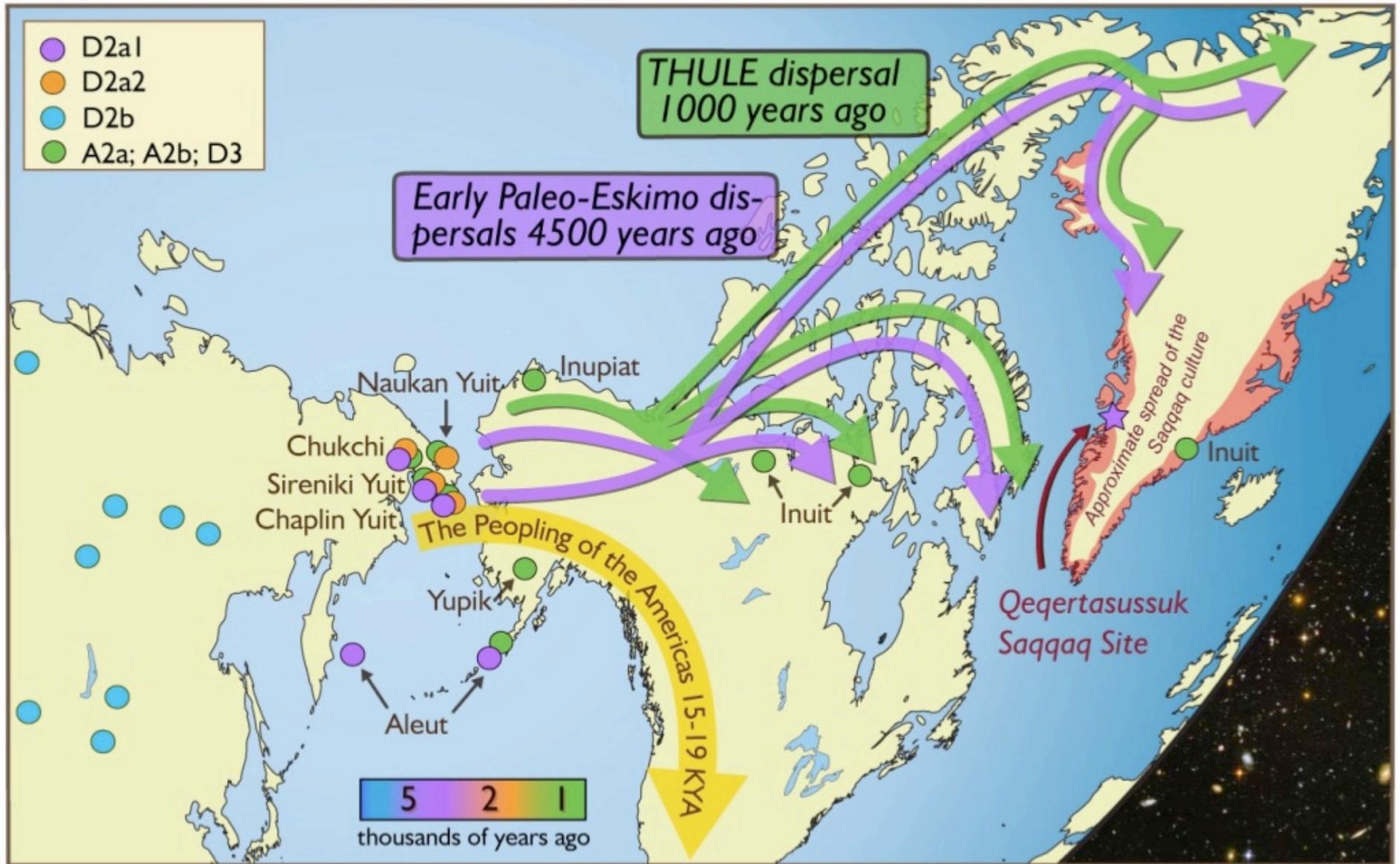


So What?

- **Both tidal mixing fronts and polynyas are regions of enhanced biological productivity relative to the surrounding ocean.**
- **Any area where a tidal mixing front exists in the summer and a polynya reliably occurs in the winter should have enhanced biological productivity year round.**
- **Importance of tidal mixing fronts as a nutrient pump will increase as ice cover decreases.**

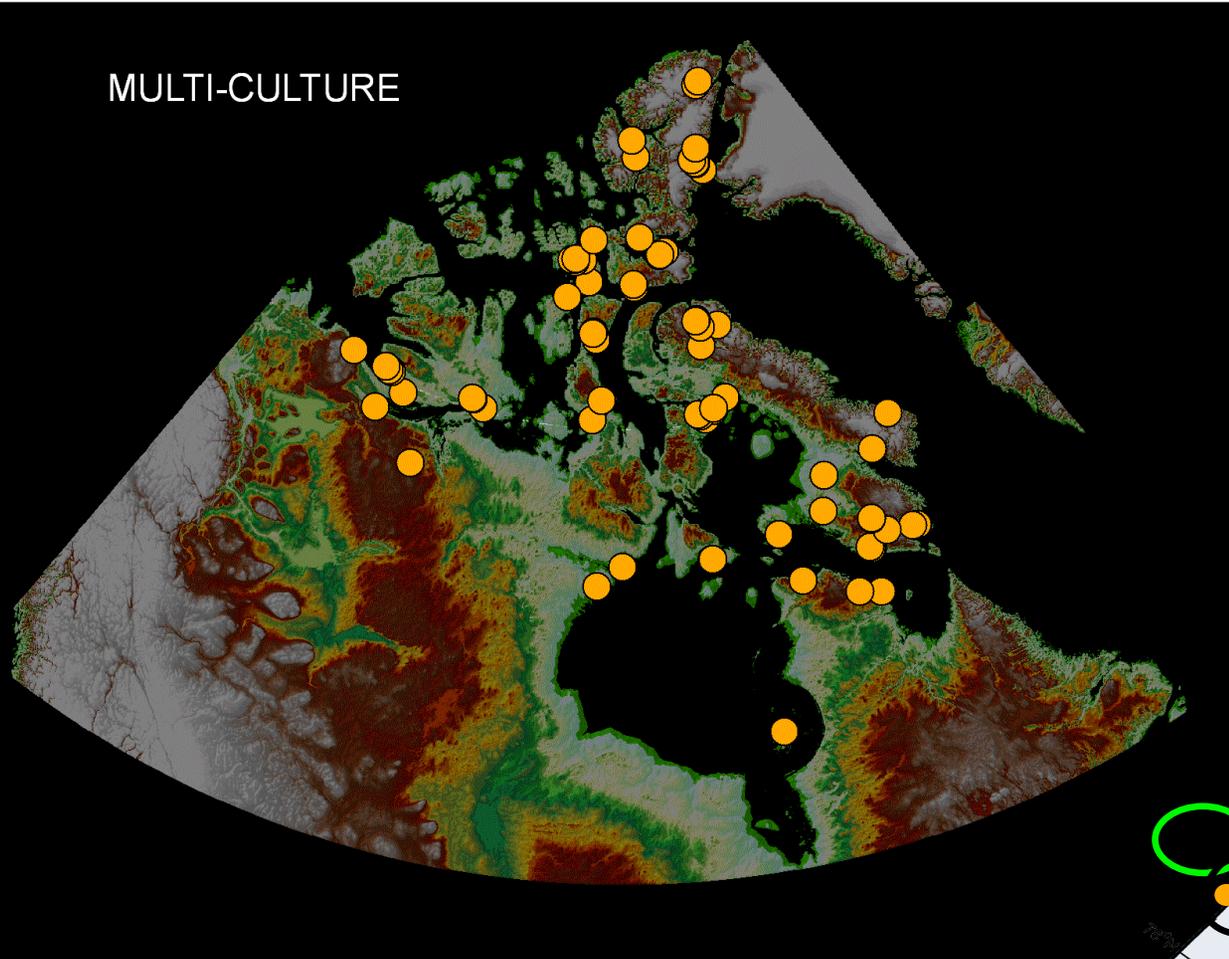
Archaeological Cultures

- PreDorset (Paleoeskimo) ca. 45-2300 BP
- Dorset (Paleoeskimo) ca. 2300-1000 PB
- Thule (Ancestral Inuit) ca. 800-200 BP

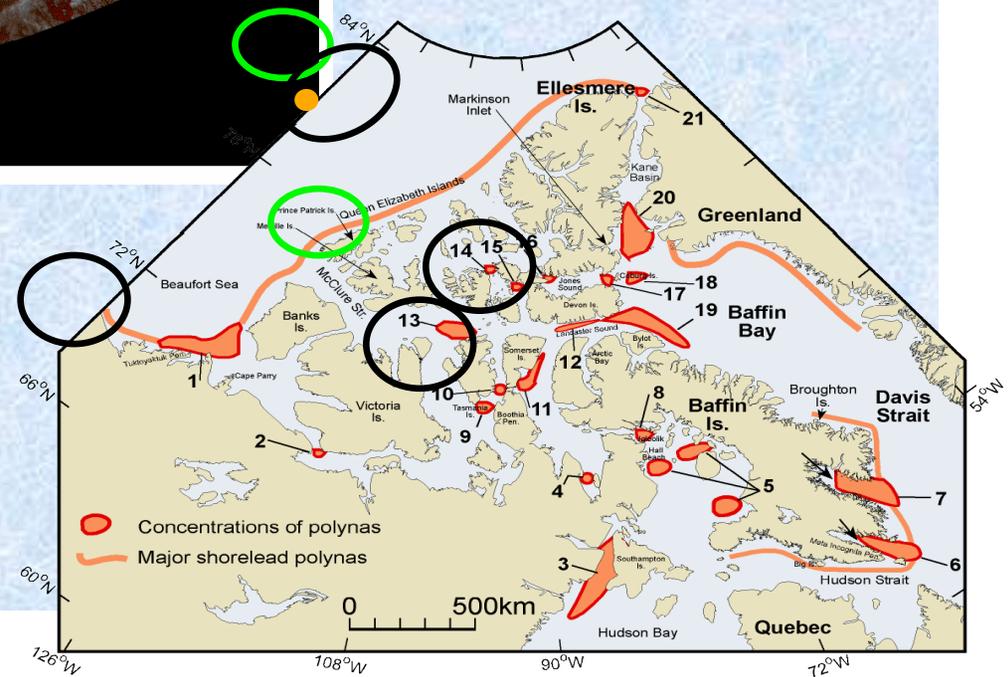


GENETICS: Ancient DNA From Frozen Hair May Untangle Eskimo Roots
 Michael Balter (30 May 2008) *Science* 320 (5880), 1146b. [DOI: 10.1126/science.320.5880.1146b]

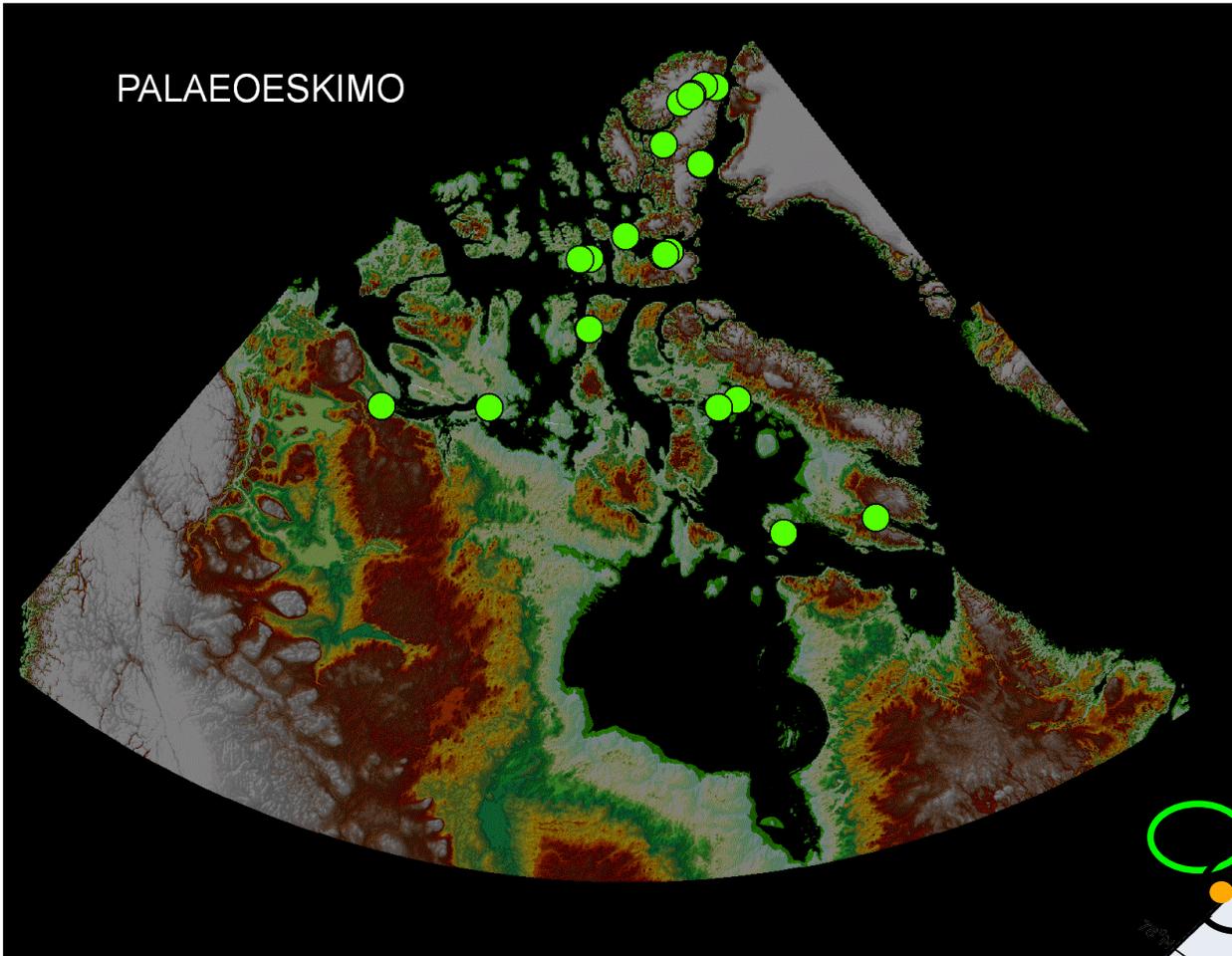
MULTI-CULTURE



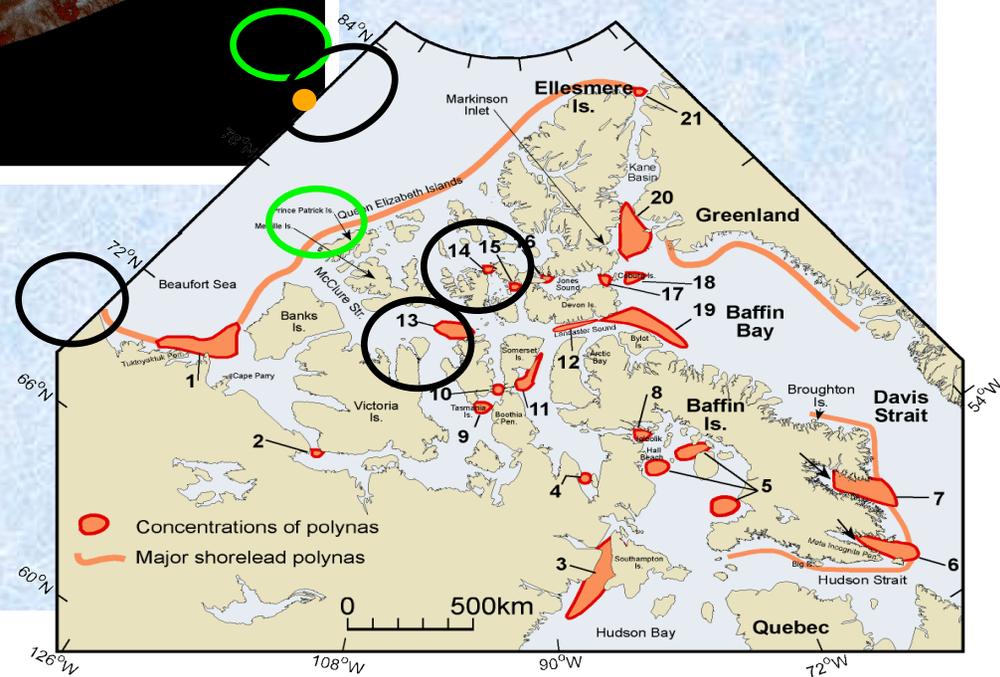
4500-200 BP



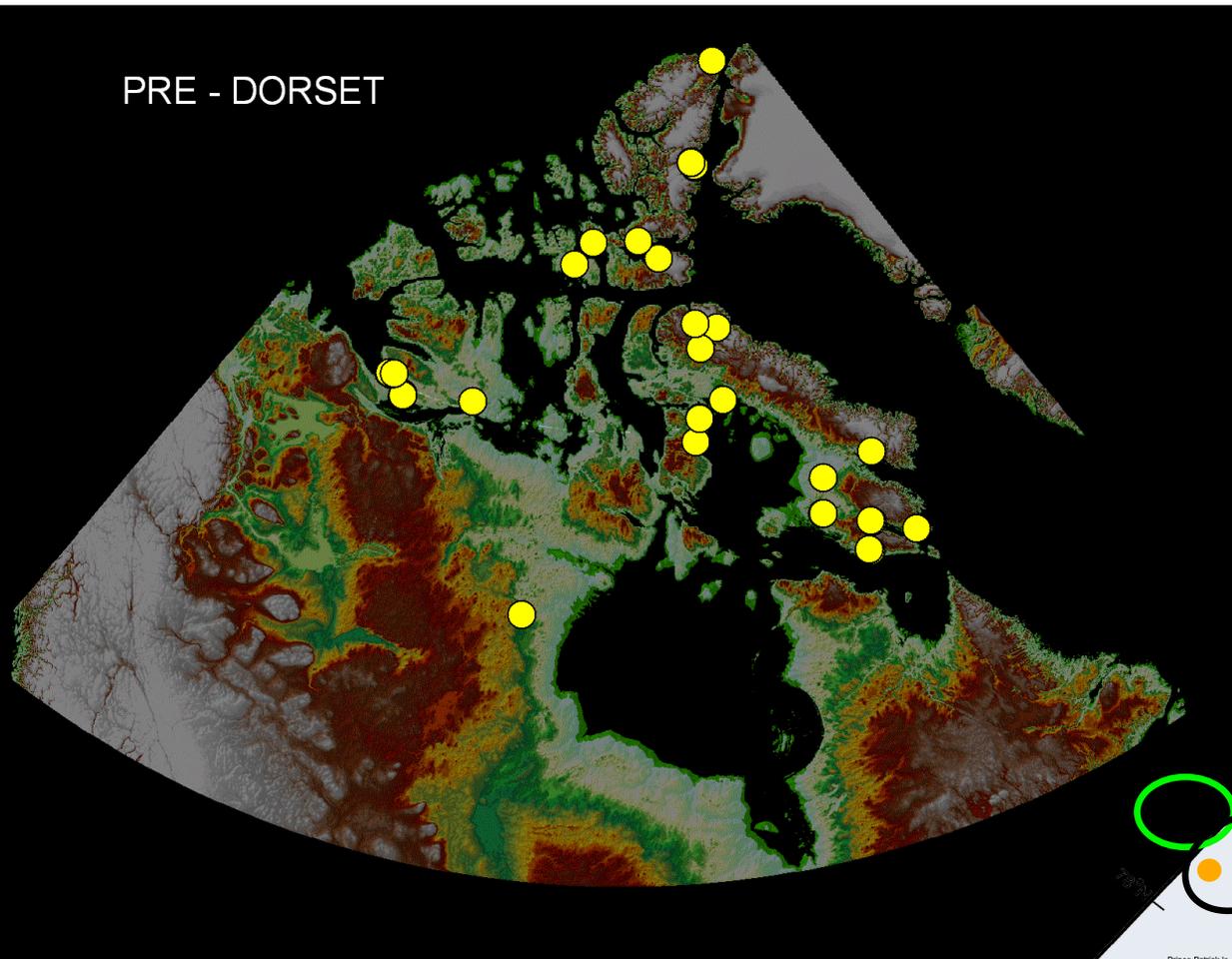
PALAEOESKIMO



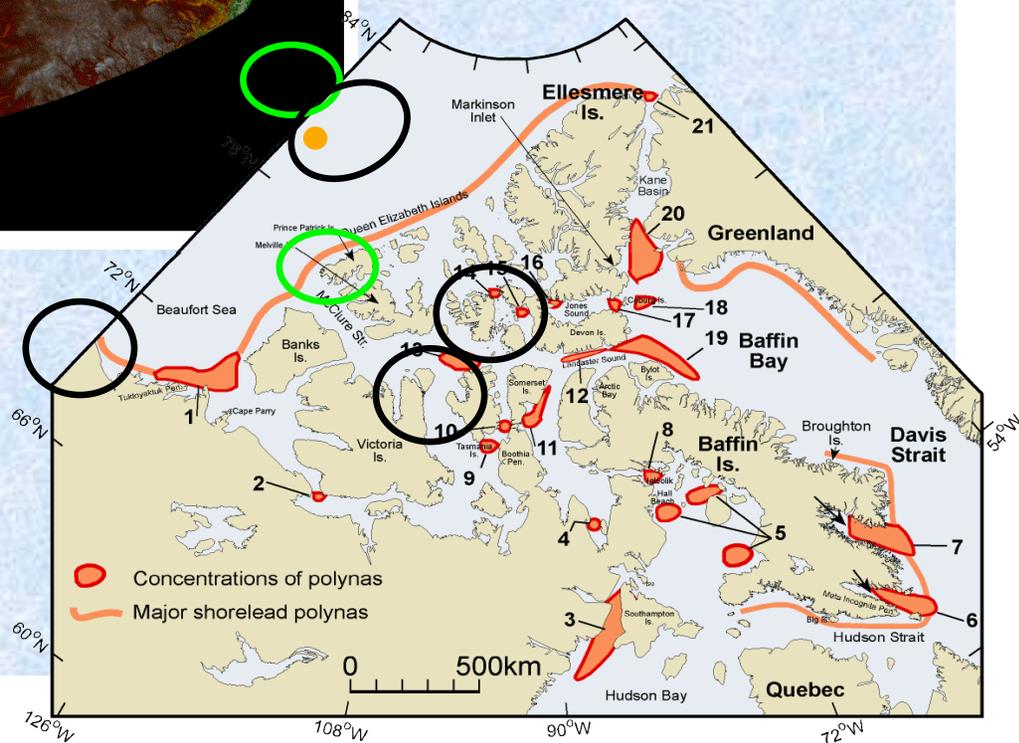
4500-1000 BP



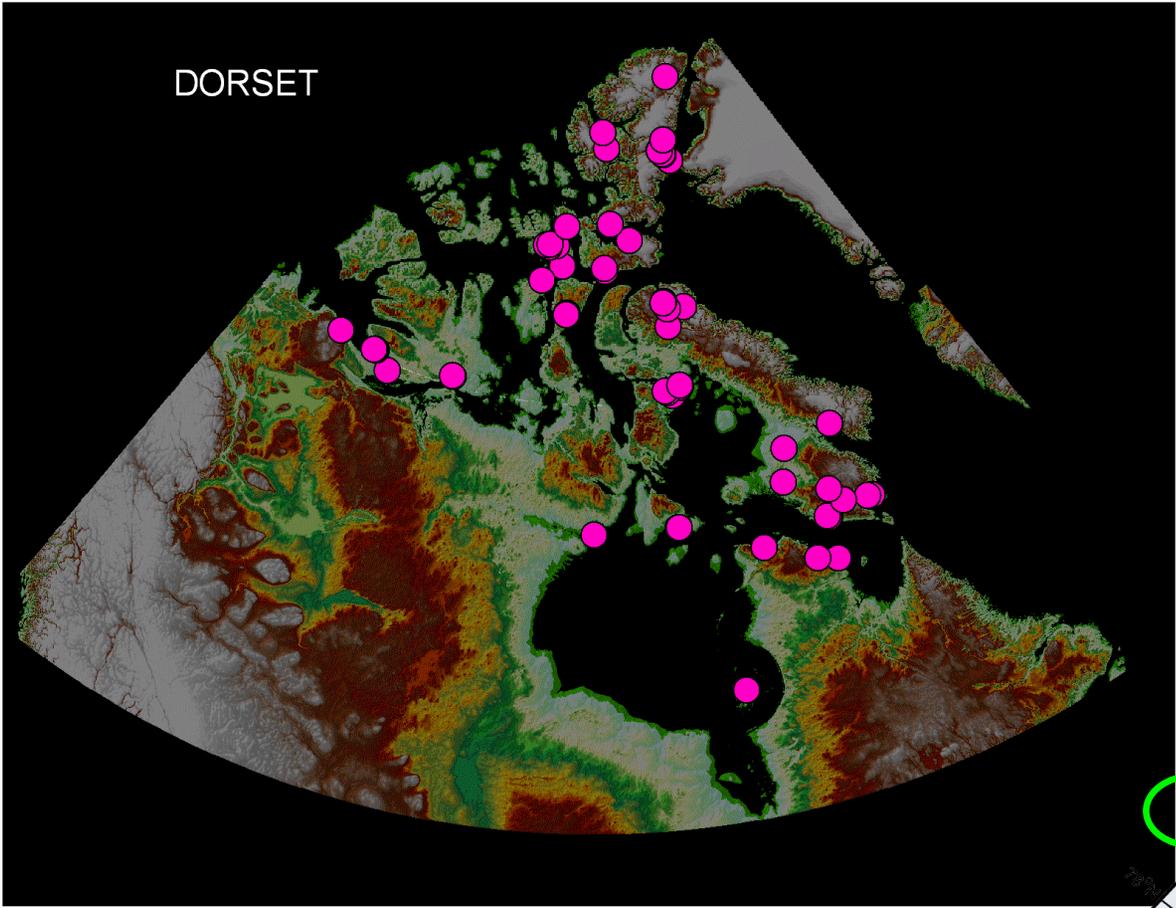
PRE - DORSET



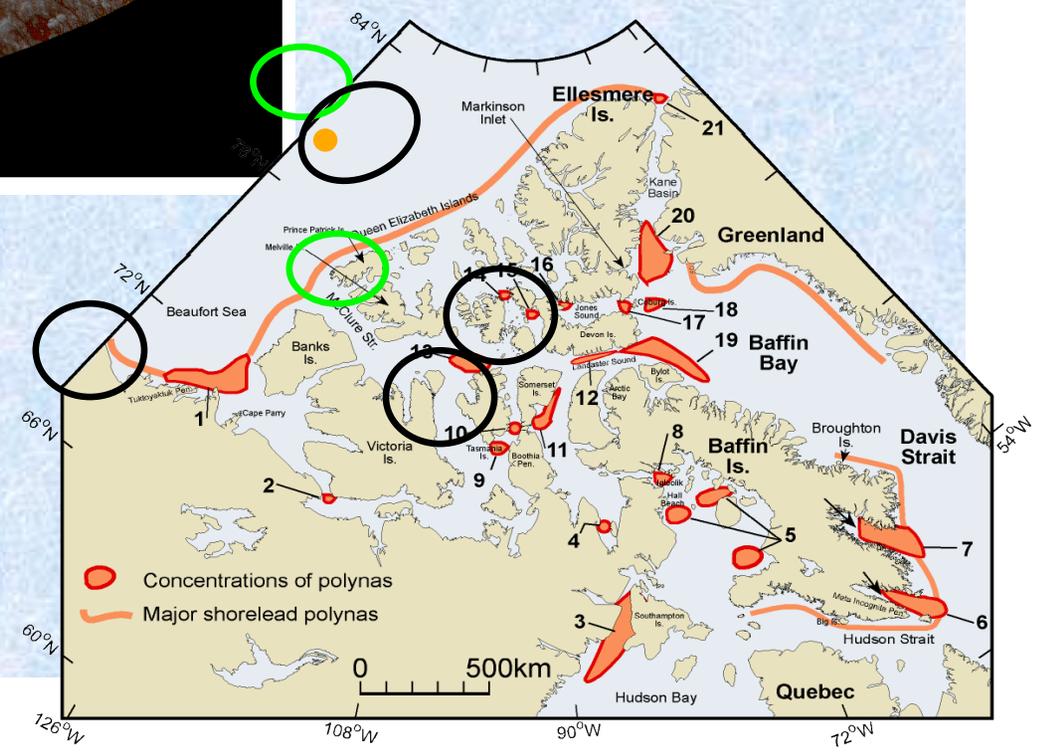
45-2300 BP



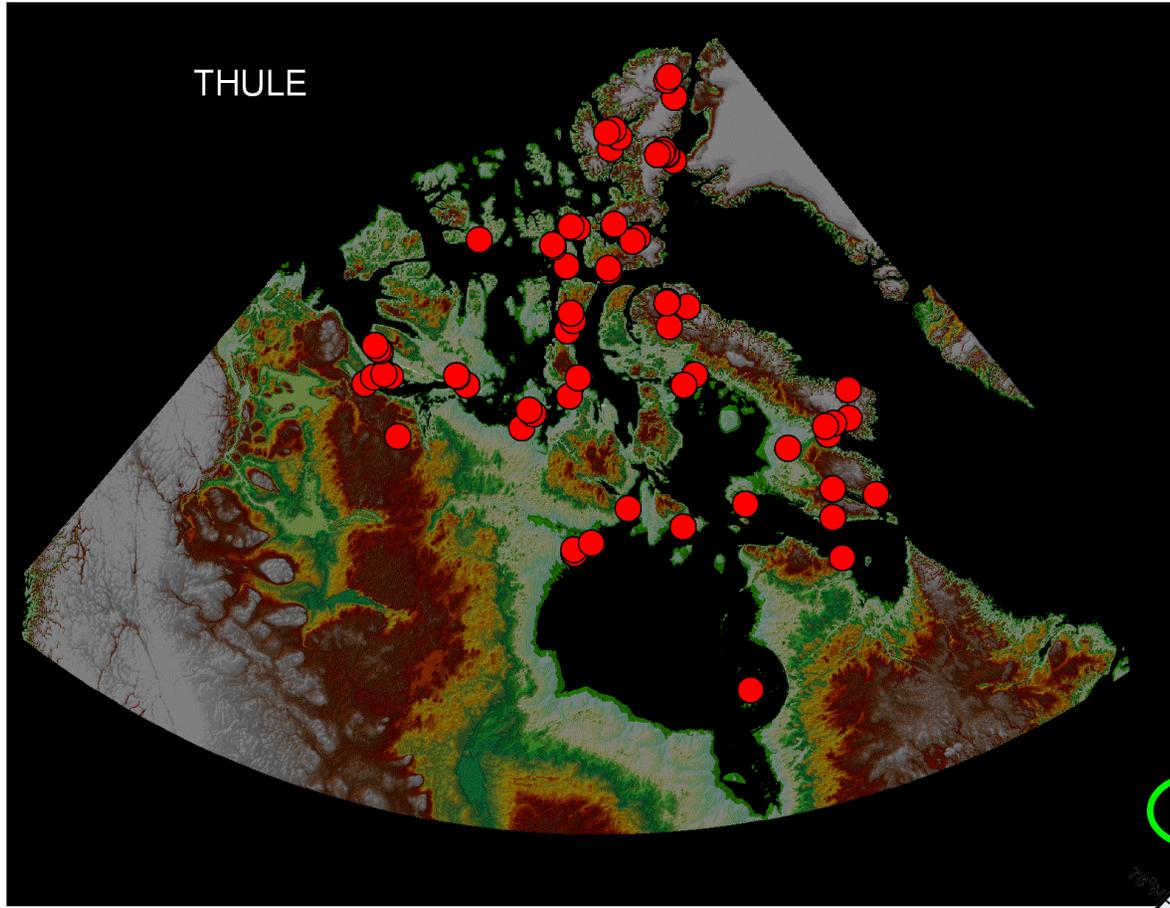
DORSET



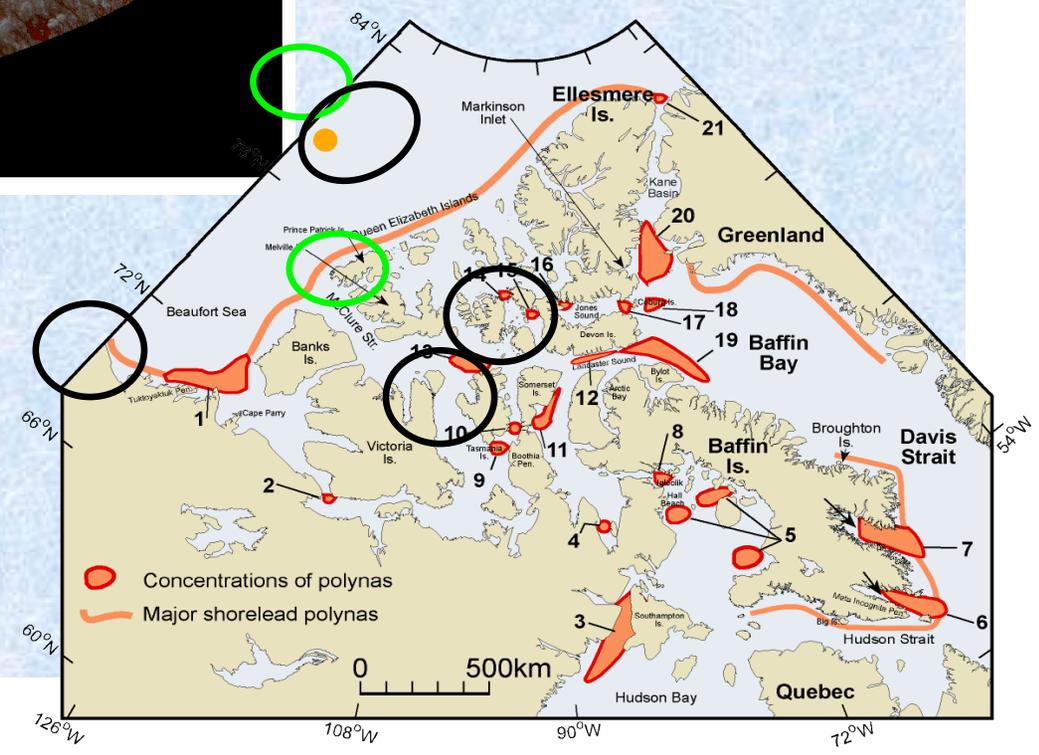
2300-1000 BP

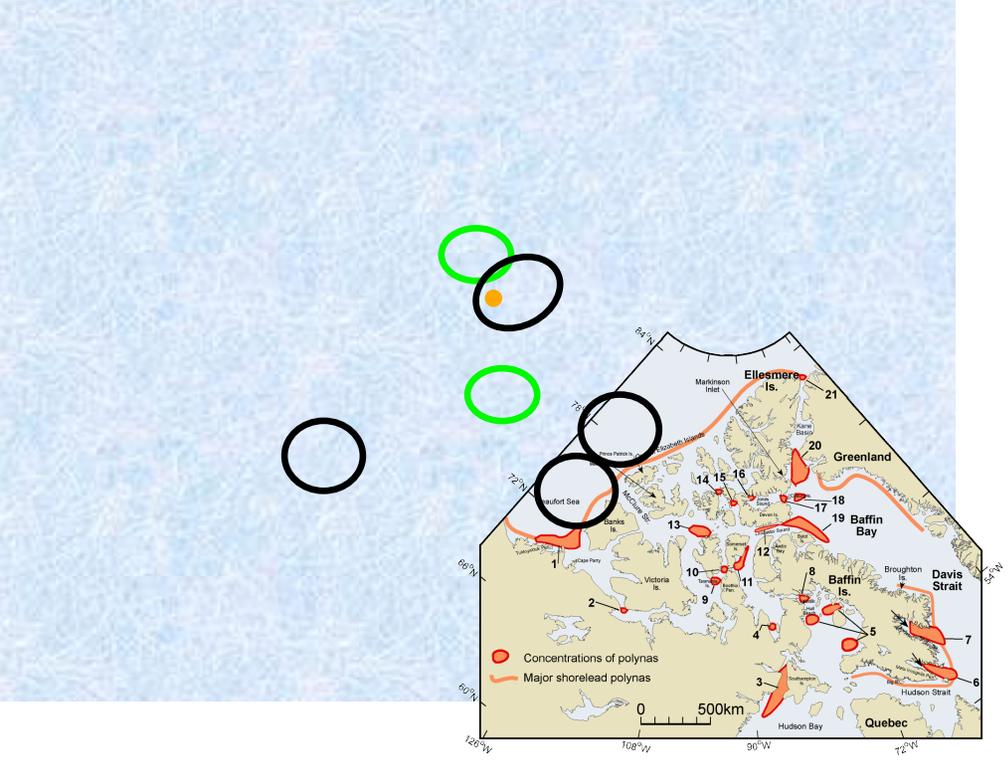
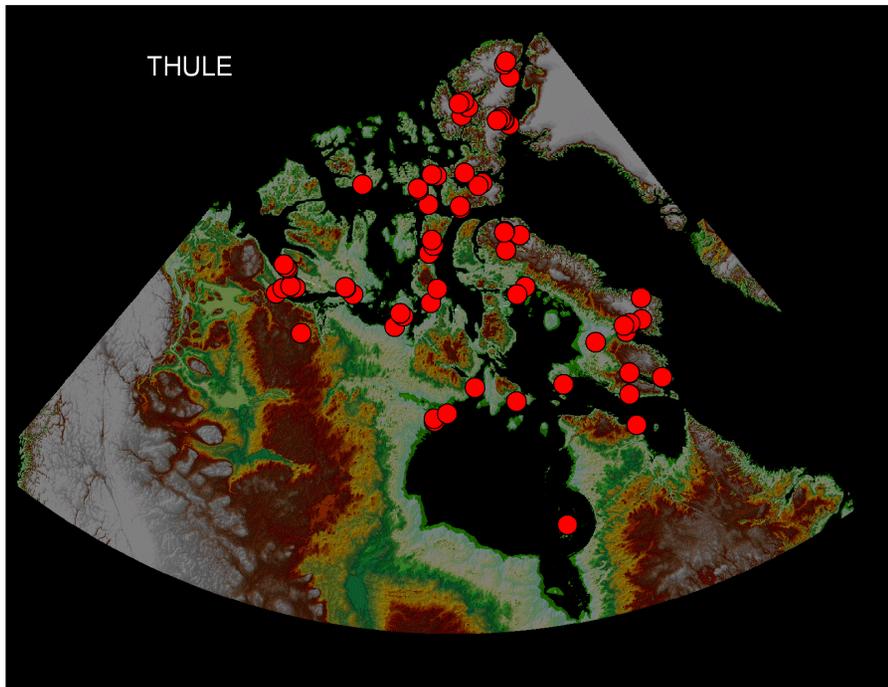
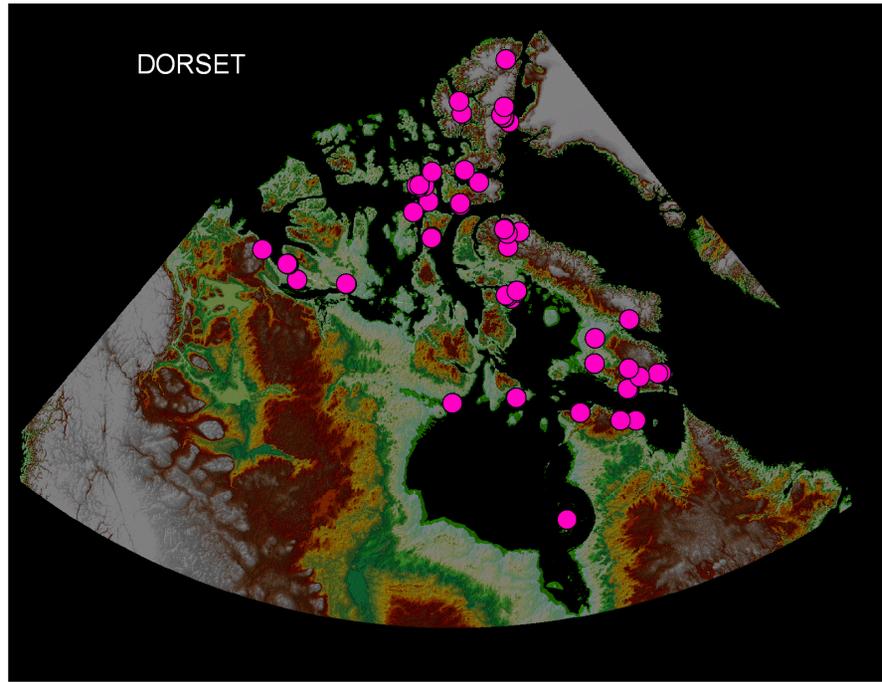
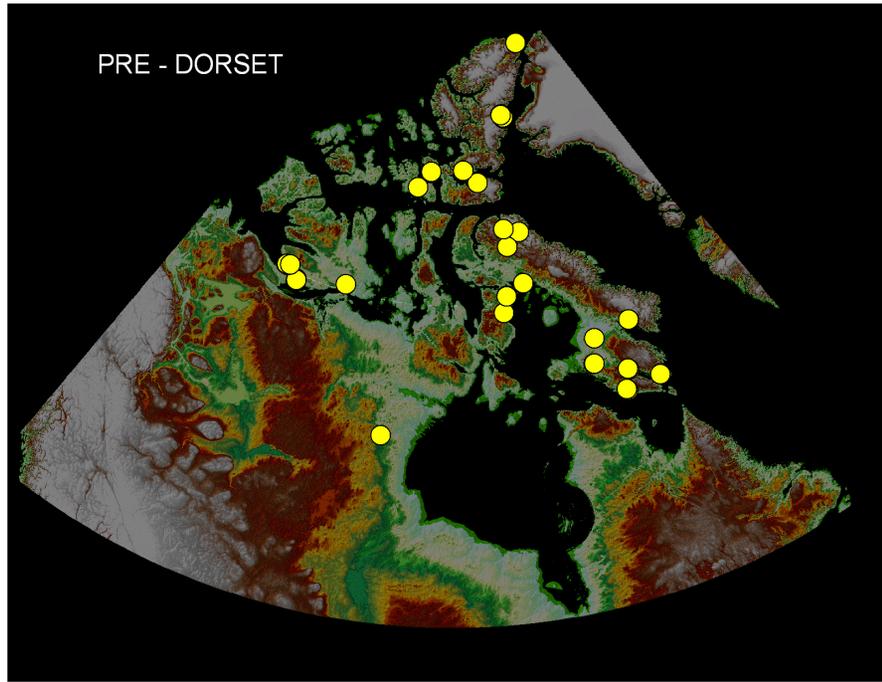


THULE



800-200 BP





Conclusions

- The distribution sites appears to be coupled some polynya locations
- These ecological hot spots were critical to the human settlement of the archipelago and were probably established at the time of colonization
- Late settlement suggests that ecological and/or oceanographic conditions conducive to human occupation of the region may have been a relatively recent phenomenon, possibly linked to wider mid-Holocene environmental changes.
- Next step is to move down to a finer scale and incorporate sea level data, site elevations etc.

Thanks to...

- Eddy Carmack and the crew of the LSL
- C3O Science Policy Interface Workshop Participants
- David Atkinson, UAF
- Grant Humphries, UAF and fellow Newfoundlander
- Julie Ross, Territorial Archaeologist Nunavut

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