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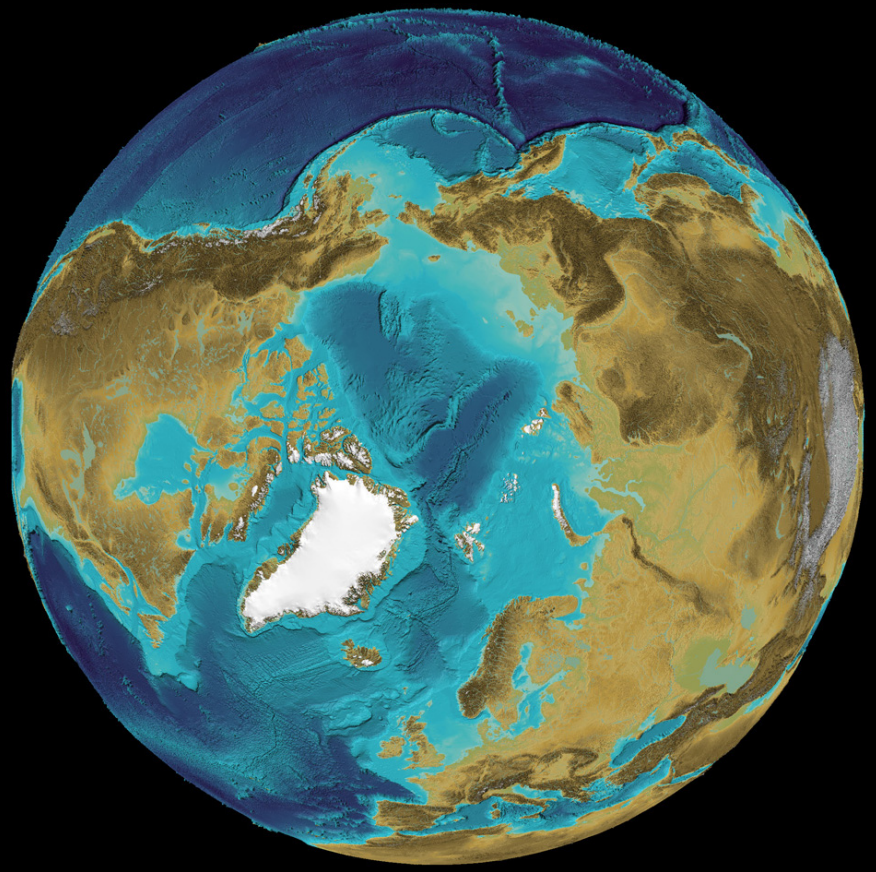
Importance of Arctic Past Climate and Climate Change Studies



Marit-Solveig Seidenkrantz

Centre for Past Climate Studies
& Arctic Research Centre
Department of Geoscience,
Aarhus University (Denmark)

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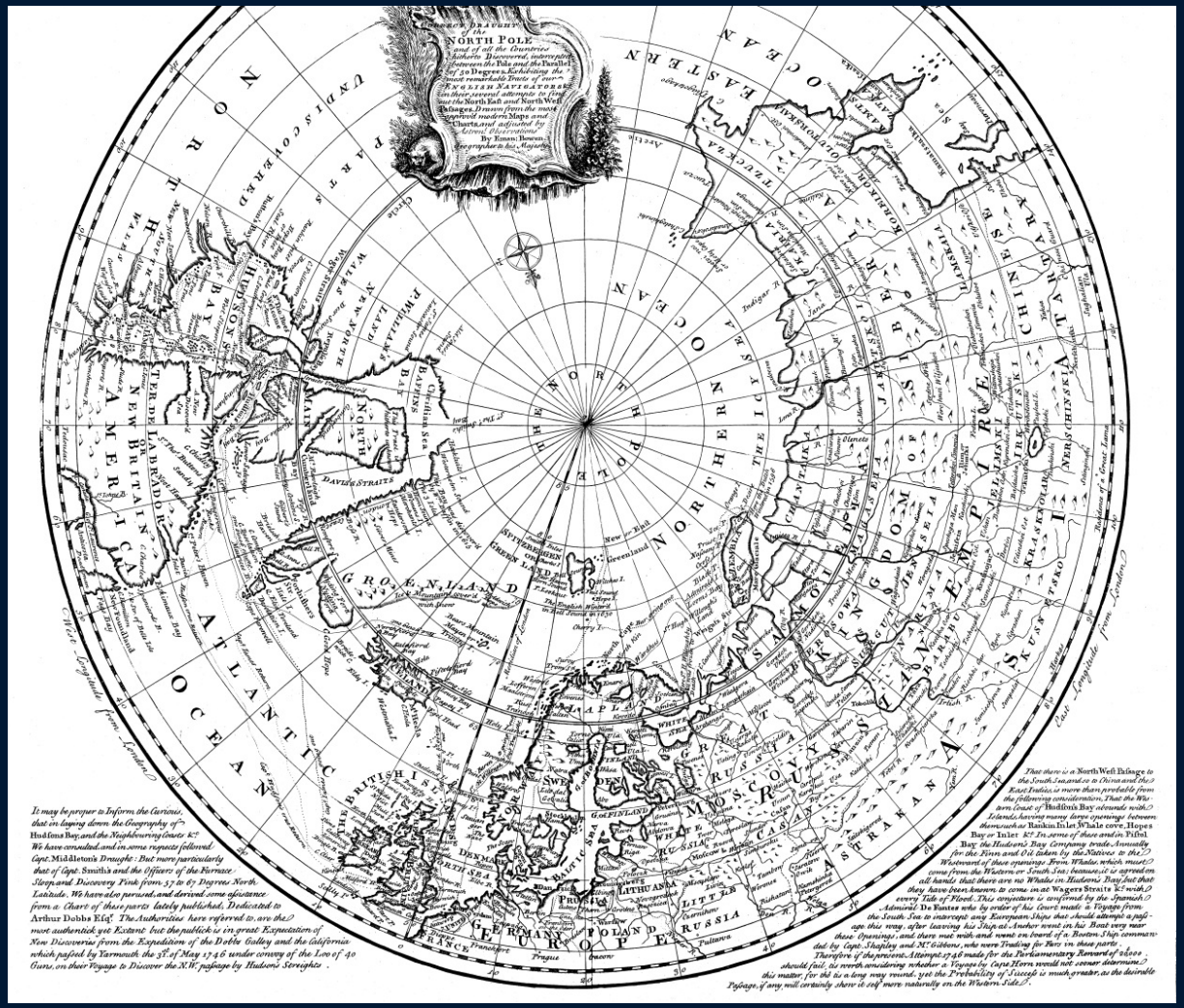
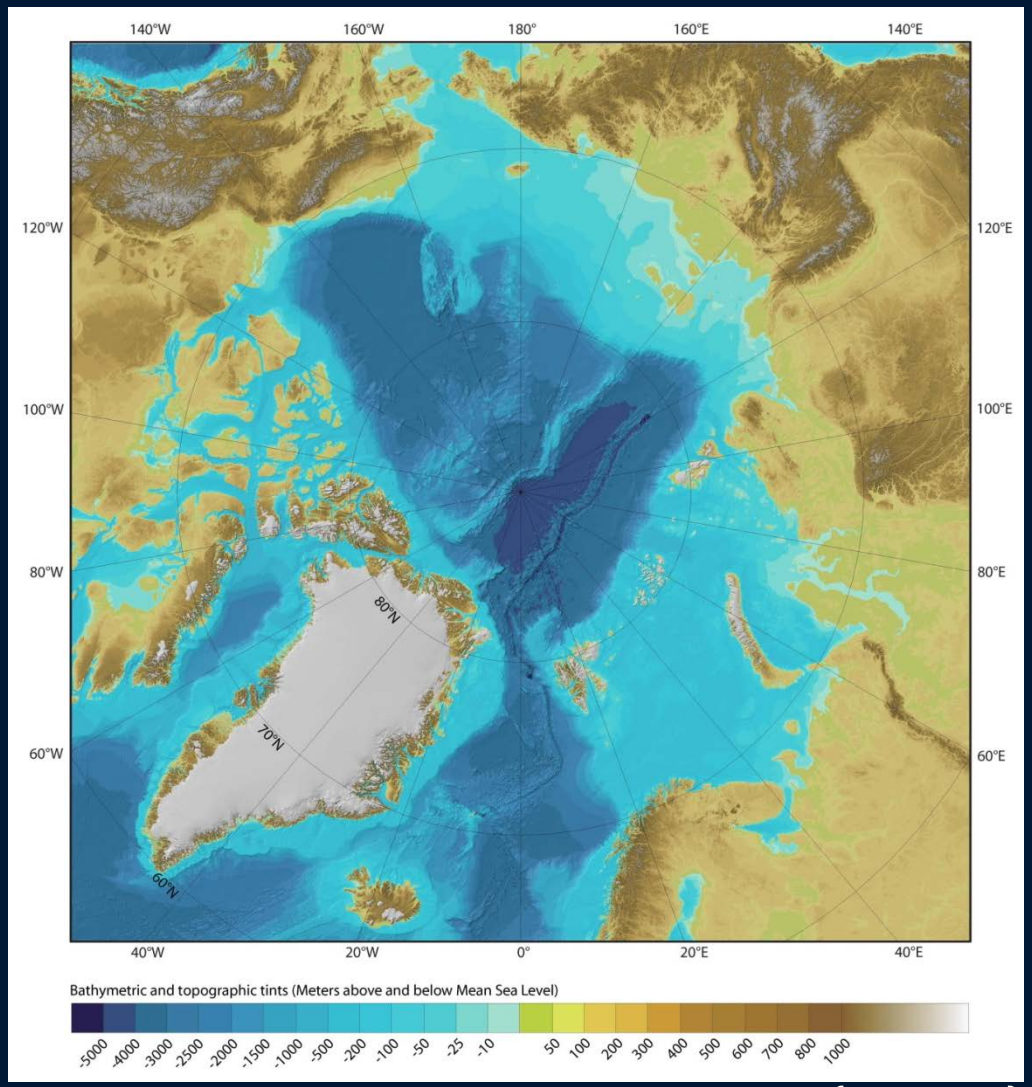
The Arctic Ocean anno1780

Emanuel Bowen's 1780s map of the Arctic features a "Northern Ocean".



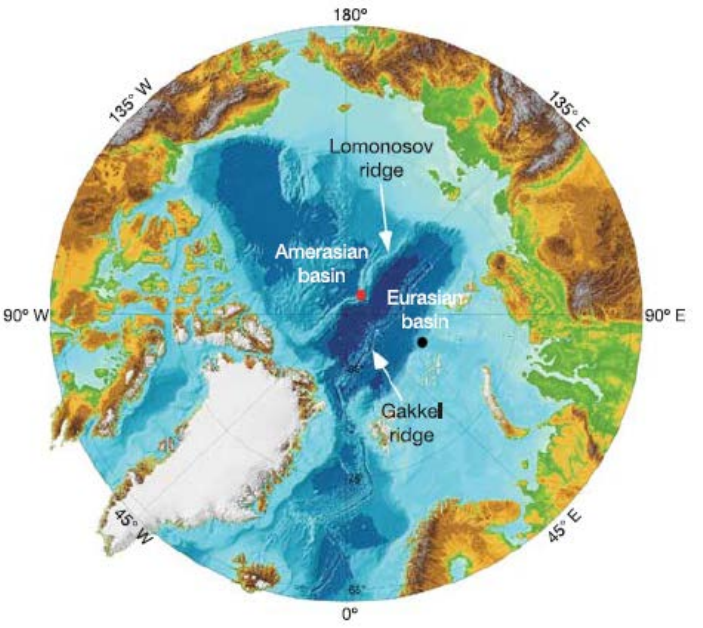
The Arctic Ocean anno 2012

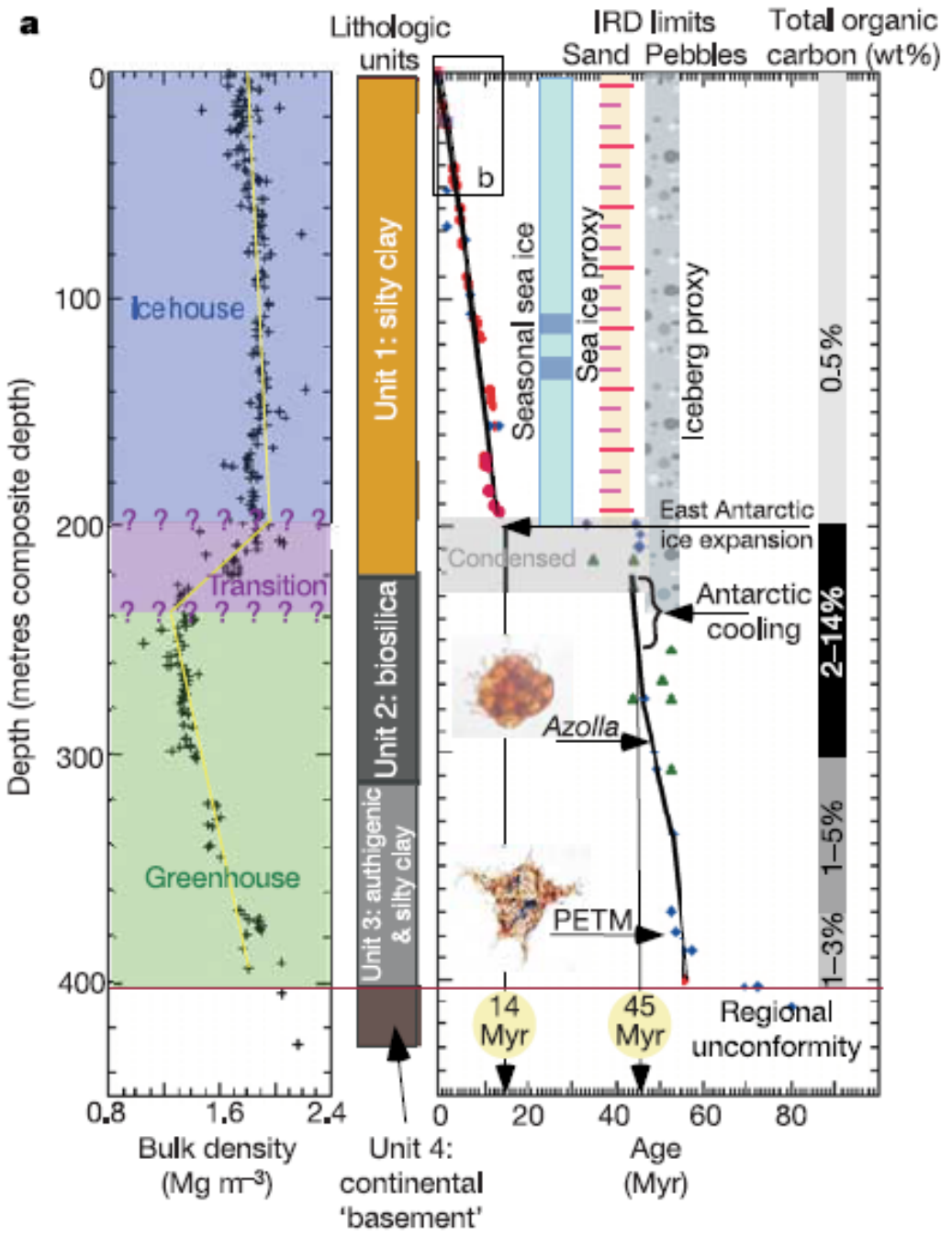
10 °C isoterm in July



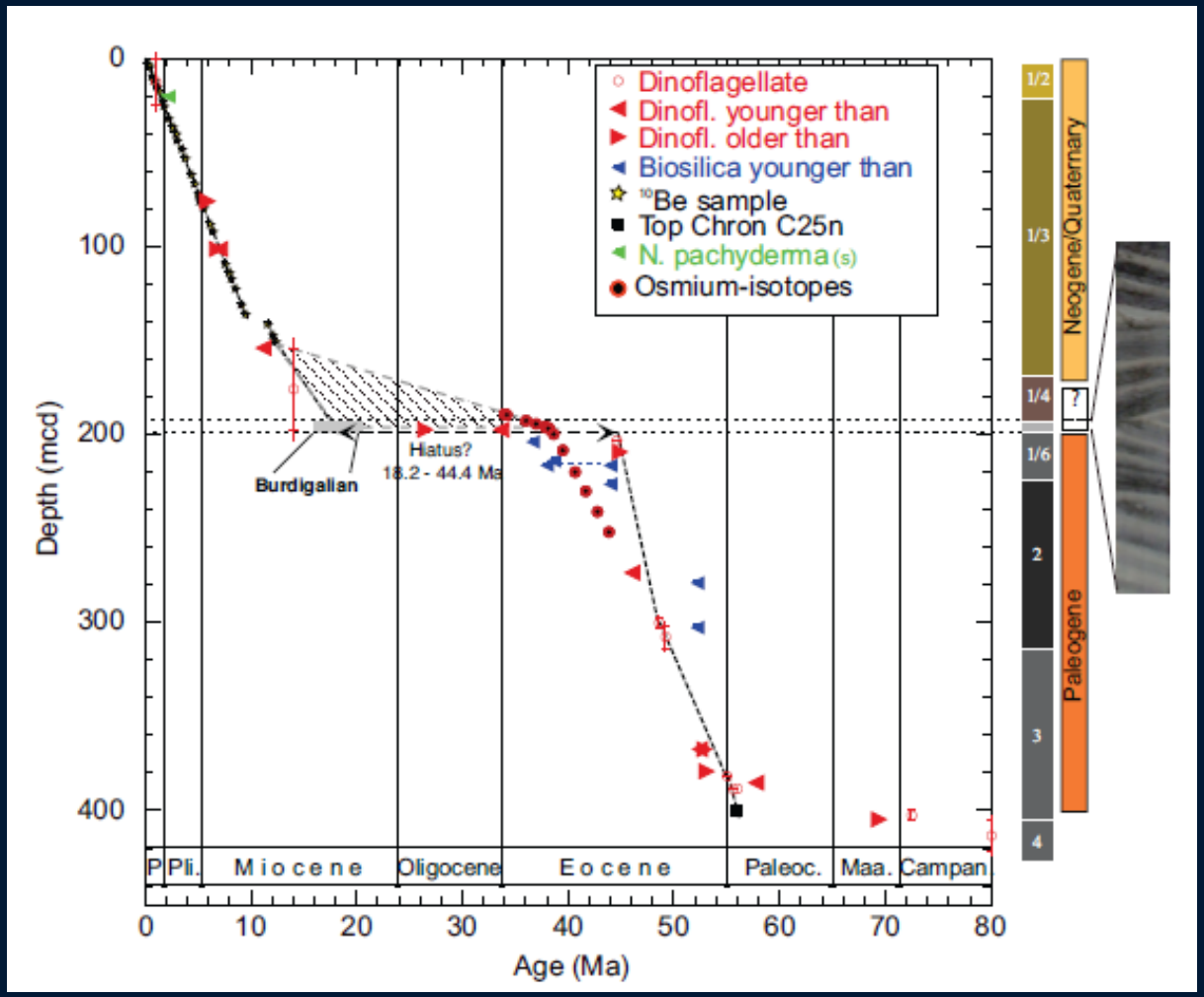
Jakobsson et al 2012, GRL: (IBCAO)

ACEX-IODP core Lomonosov Ridge



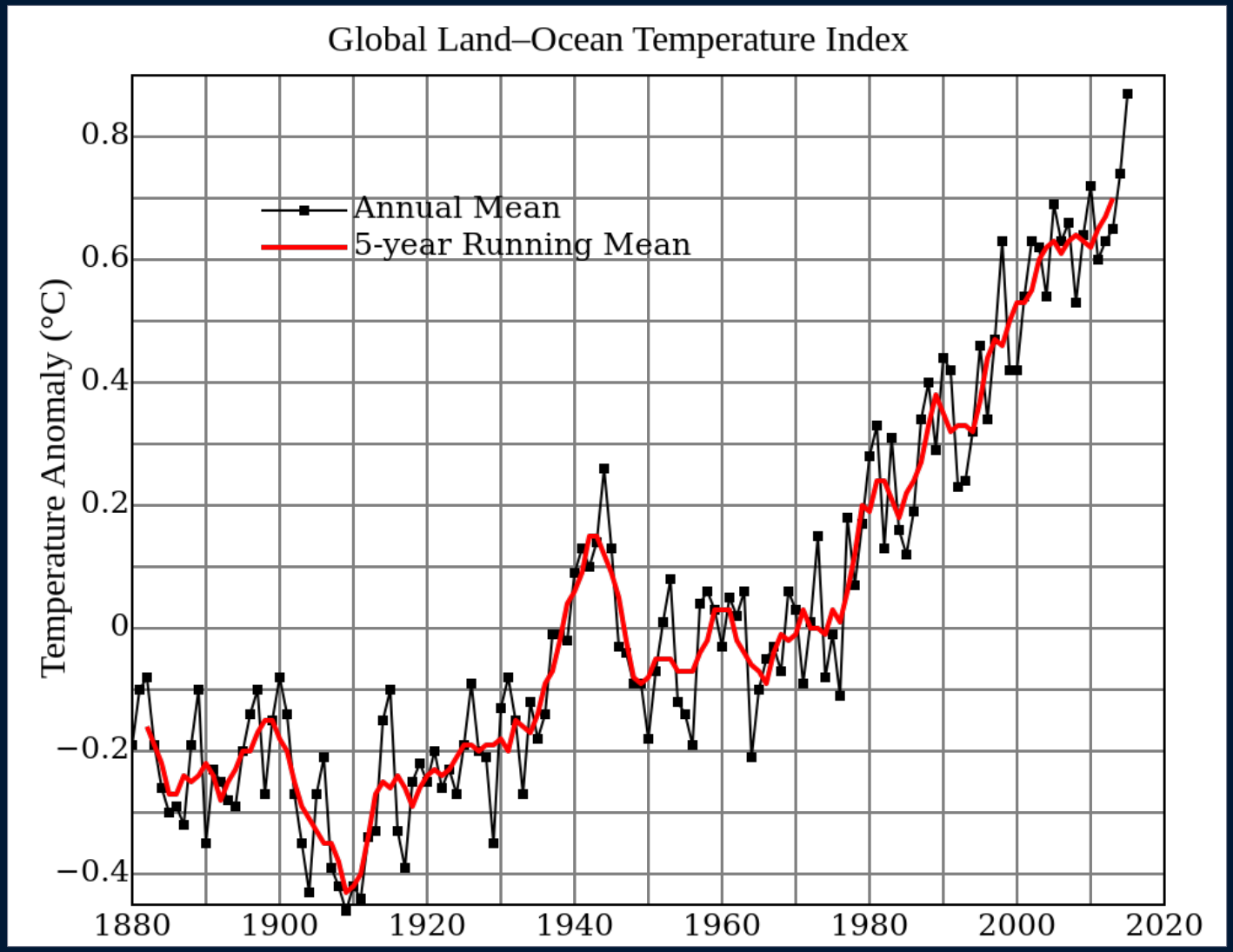


CENOZOIC OF THE ARCTIC OCEAN



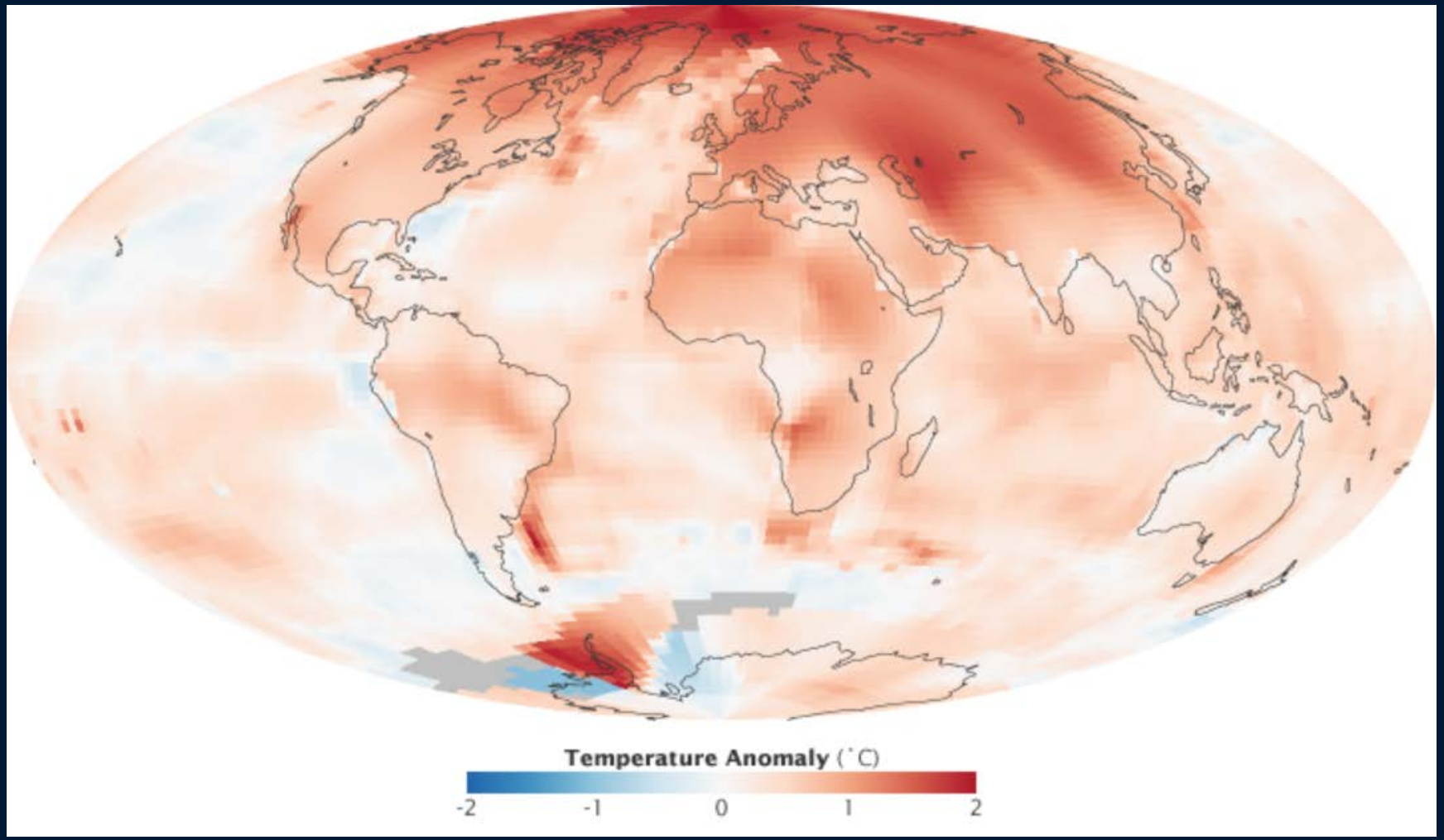
O'Regan 2011

Global temperature 1880-2015



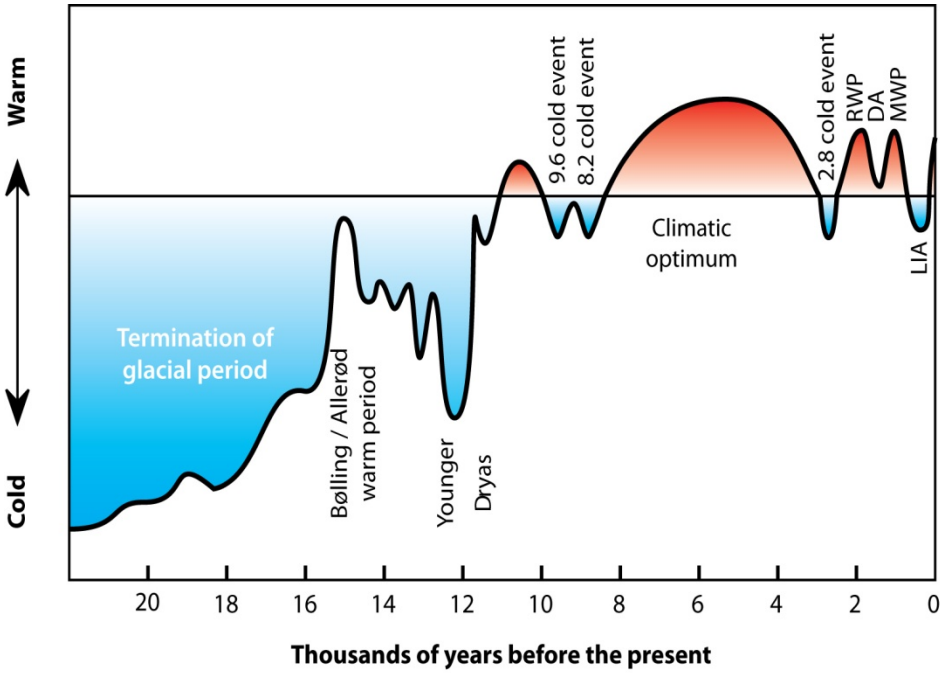
NASA Goddard Institute for Space Studies, 2016

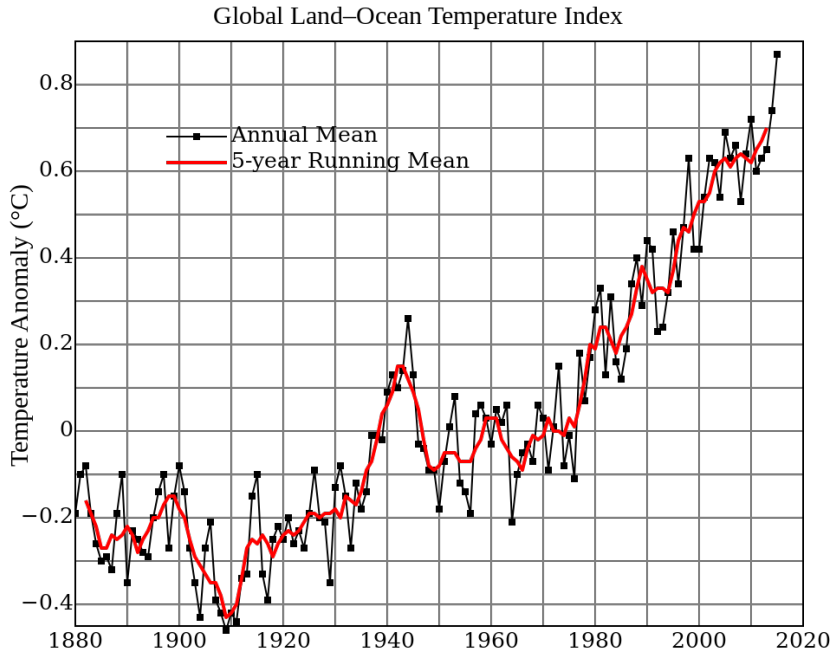
Onset and magnitude of industrial-era warming in regional temperature reconstructions



NASA GISS temperature trend 2000-2009, showing strong Arctic amplification

Past analogues for present and future climate change





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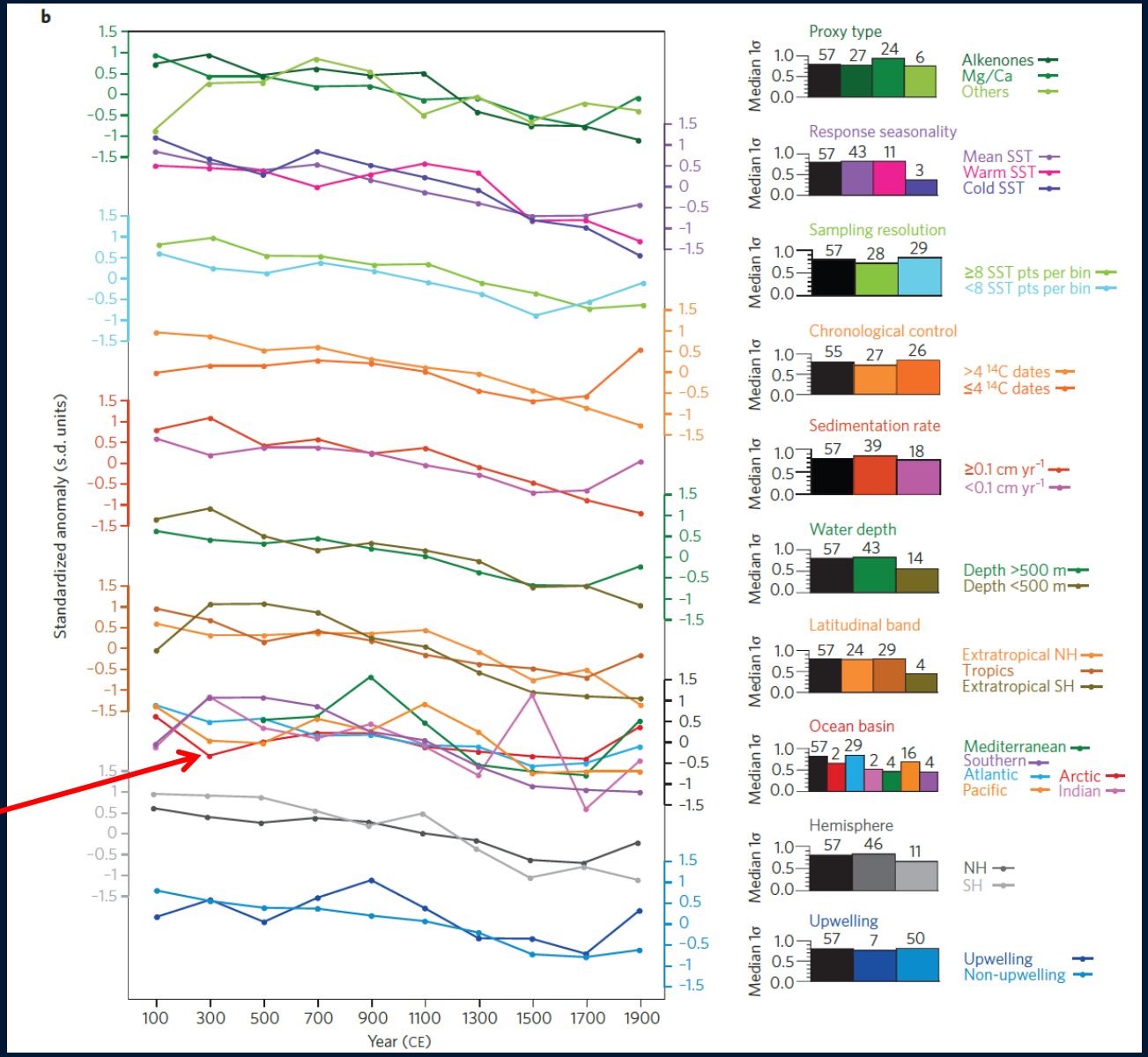
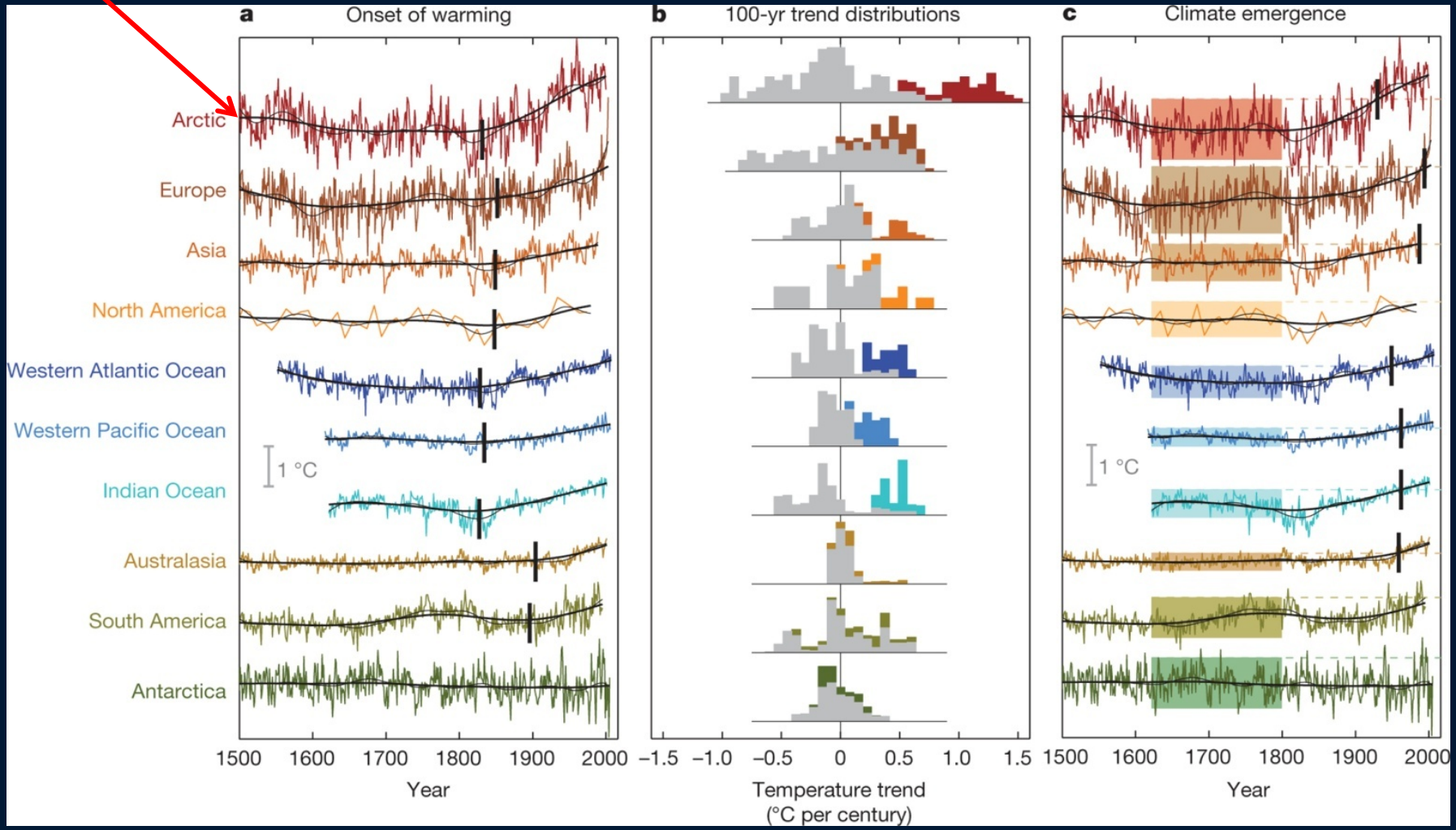
2000 years of cooling



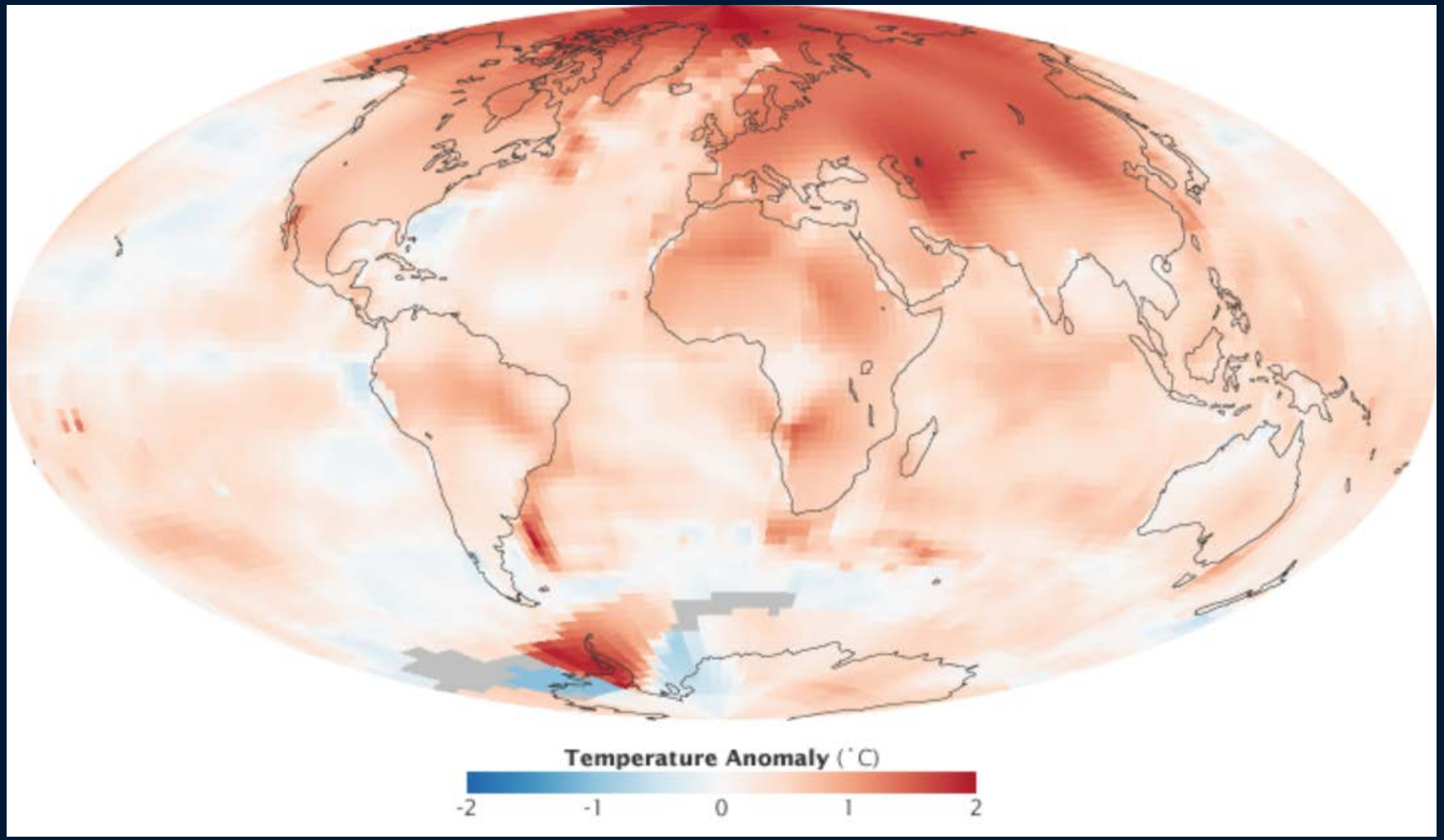
H McGregor et al. 2015. *Nature Geoscience*

Onset and magnitude of industrial-era warming in regional temperature reconstructions



N J Abram *et al. Nature* **536,** 411–418 (2016) doi:10.1038/nature19082

Onset and magnitude of industrial-era warming in regional temperature reconstructions



NASA GISS temperature trend 2000-2009, showing strong Arctic amplification

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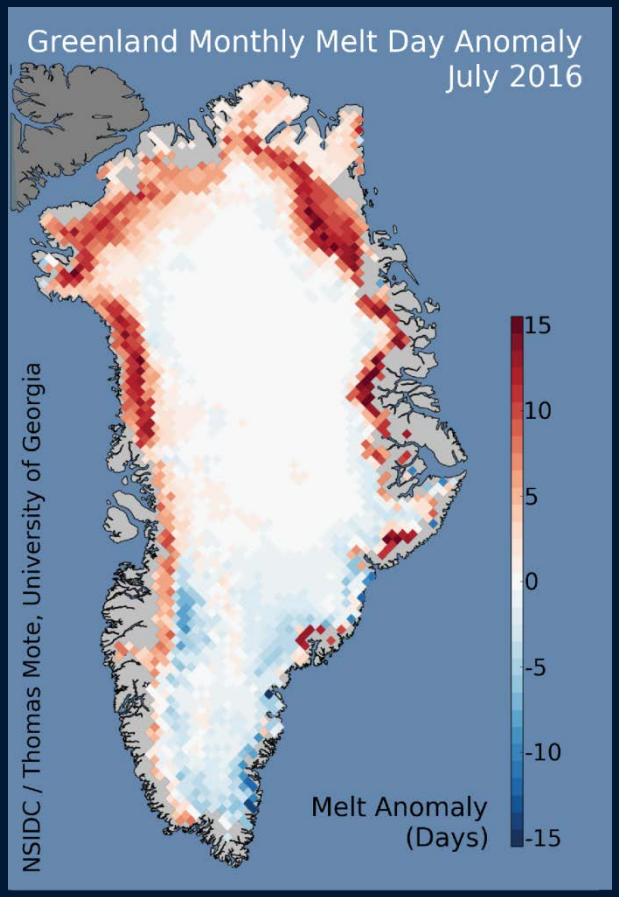
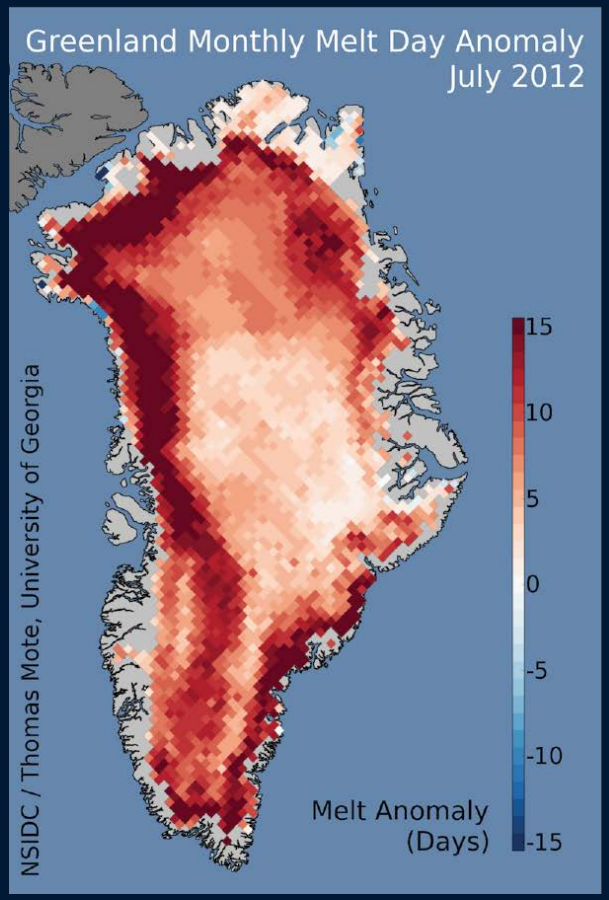
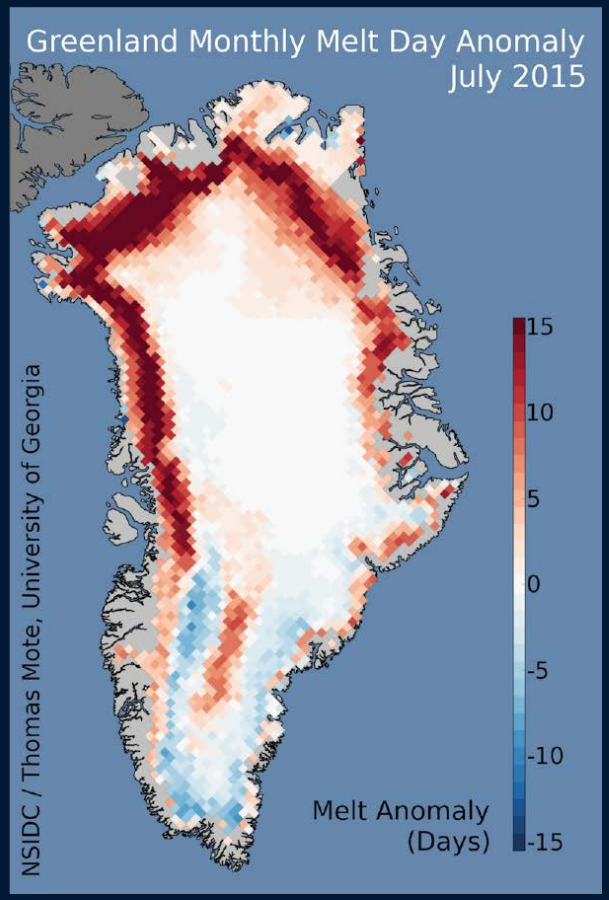


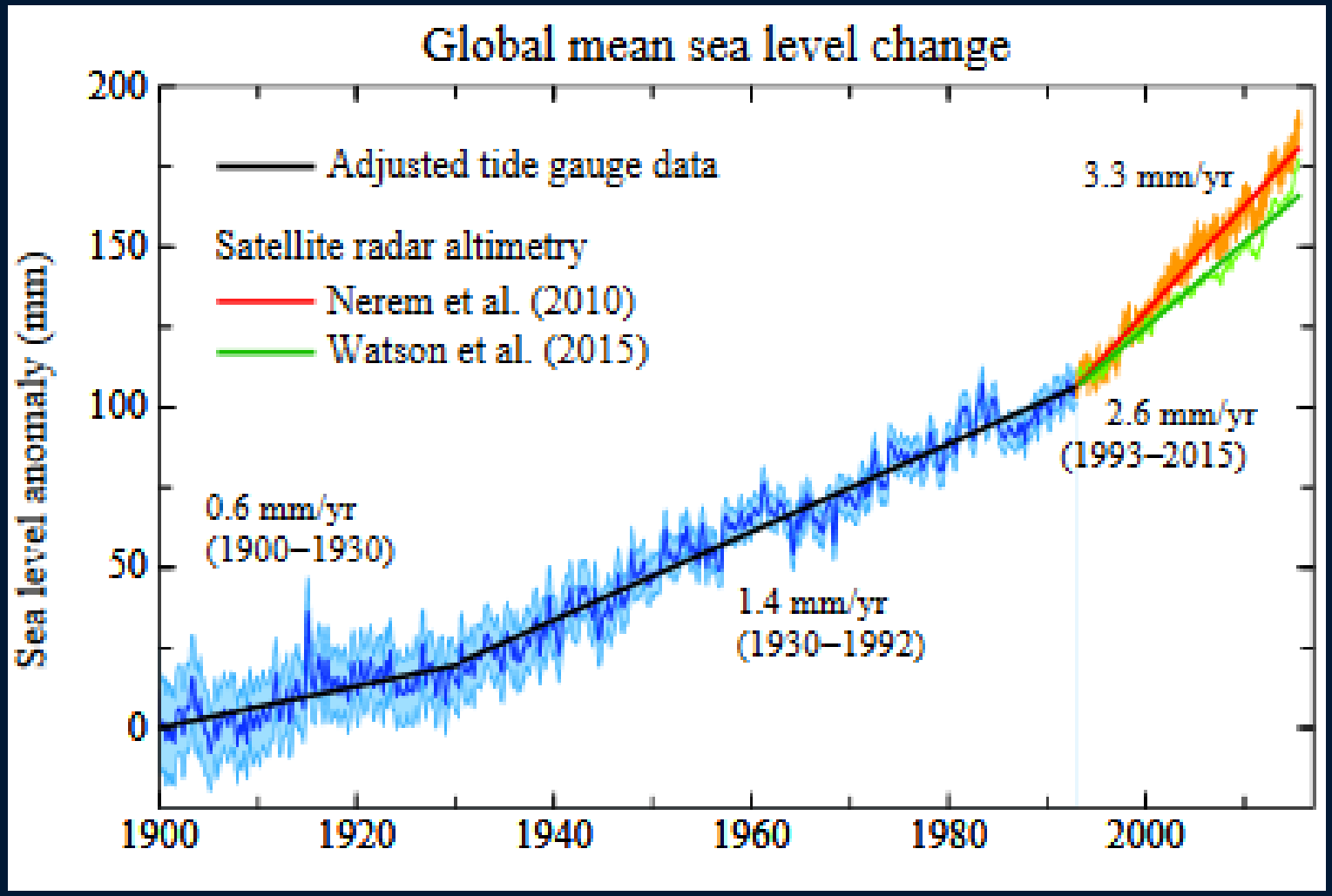




The Greenland Ice Sheet's cumulative melt day anomalies for July 2016 July 2012 and July 2015 relative to the July average for 1981 to 2010.

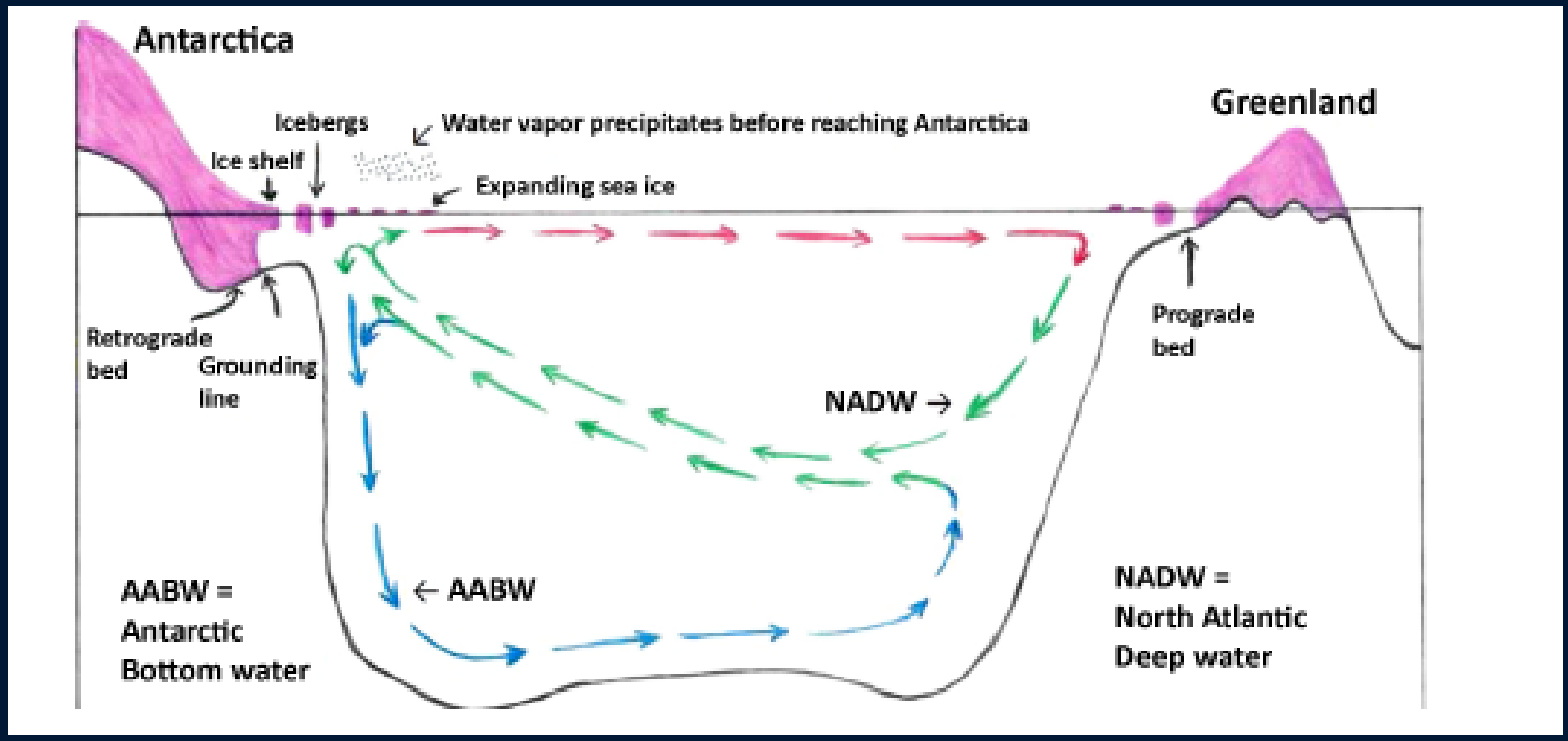
NSIDS 2016

Global sea level change change



Hansen et al. 2016, Atmosphere, Chemistry and Physics

Impact of glacier melt on ocean circulation



Hansen et al. 2016, Atmosphere, Chemistry and Physics

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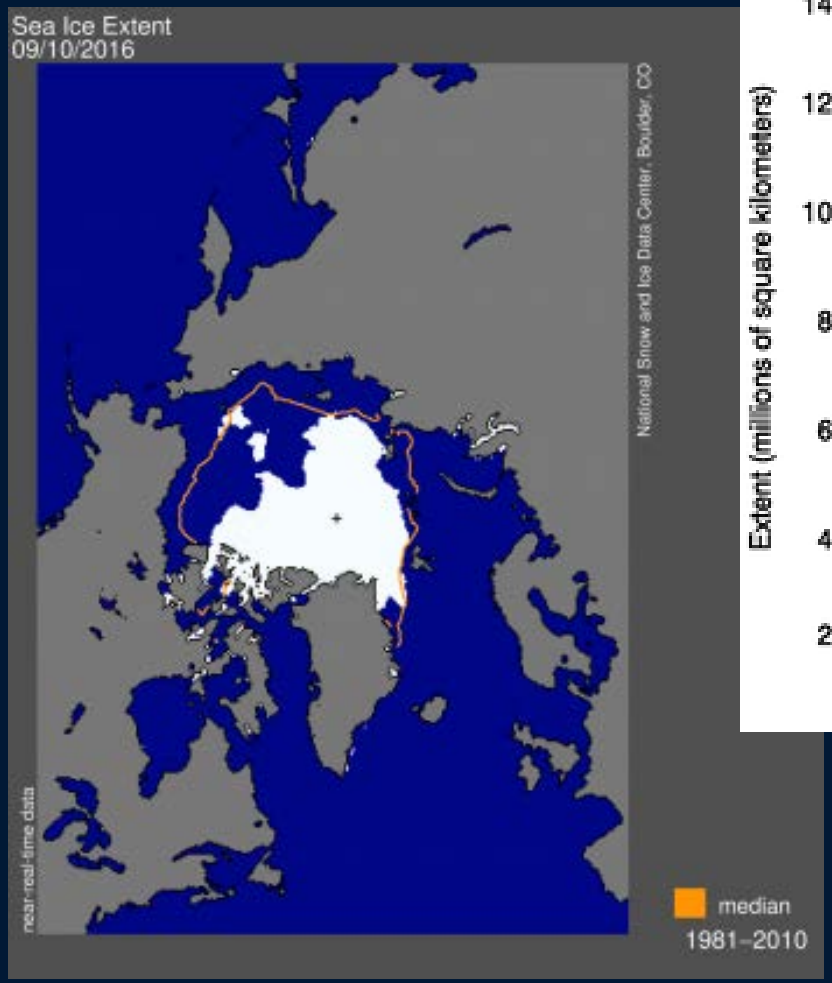
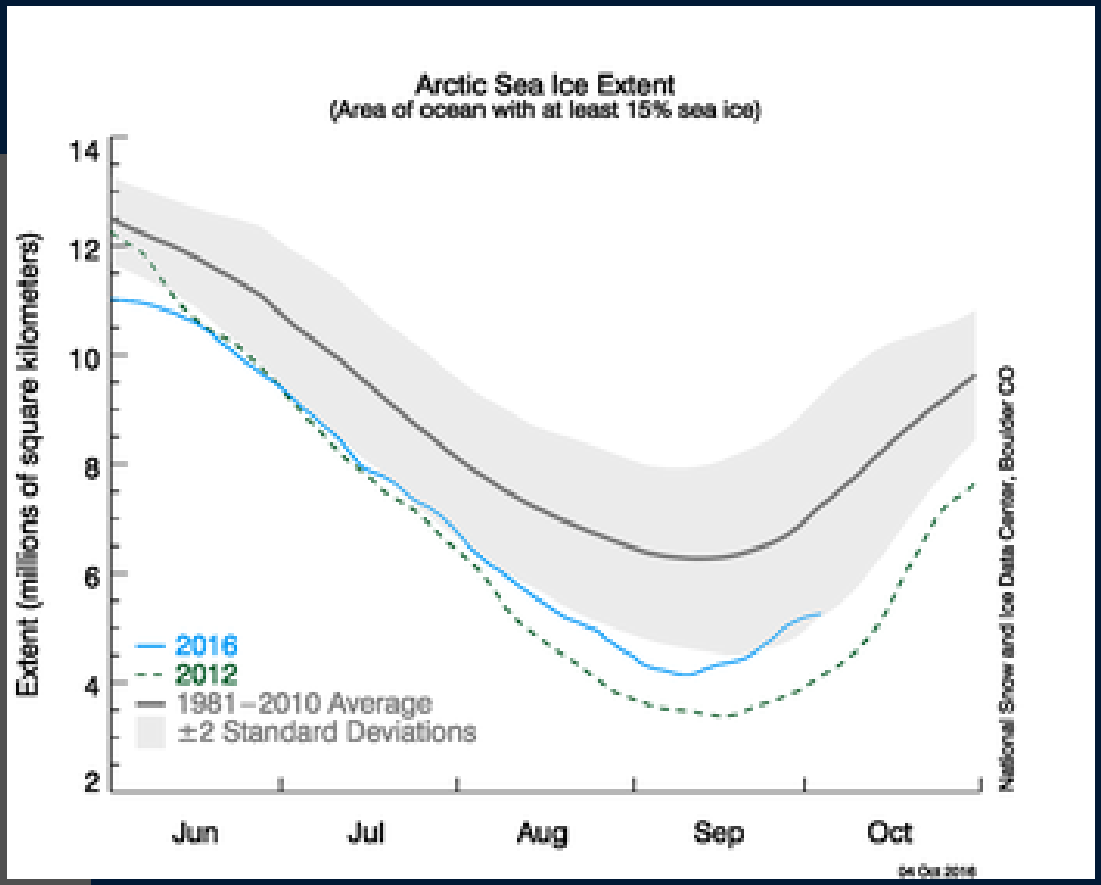
Arctic sea ice

September 10, 2016





NSIDC 2016

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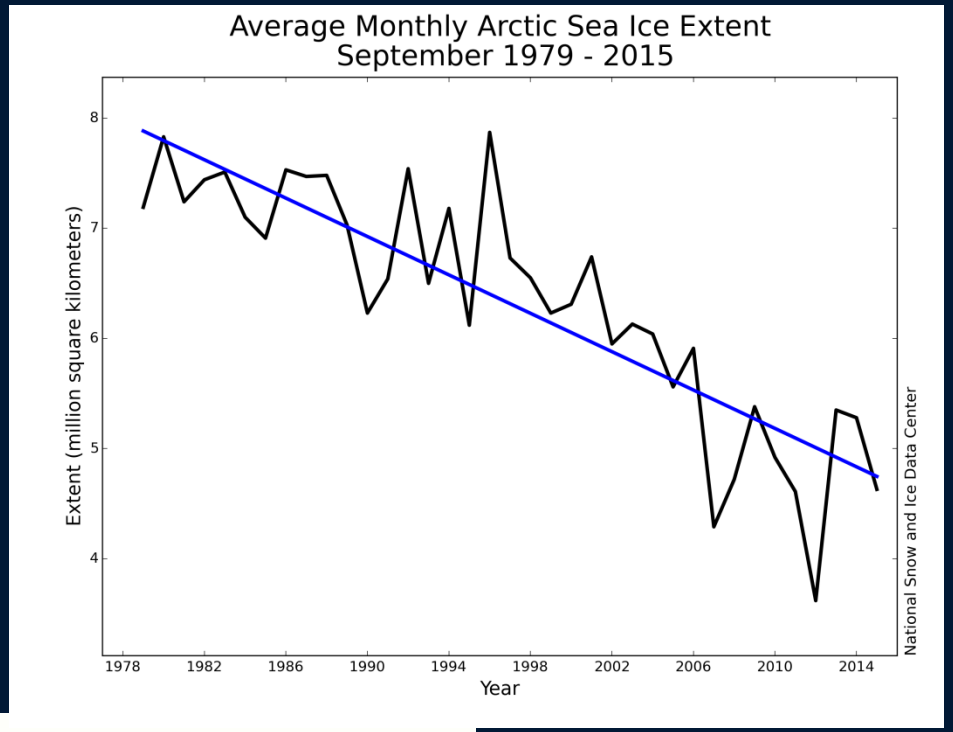
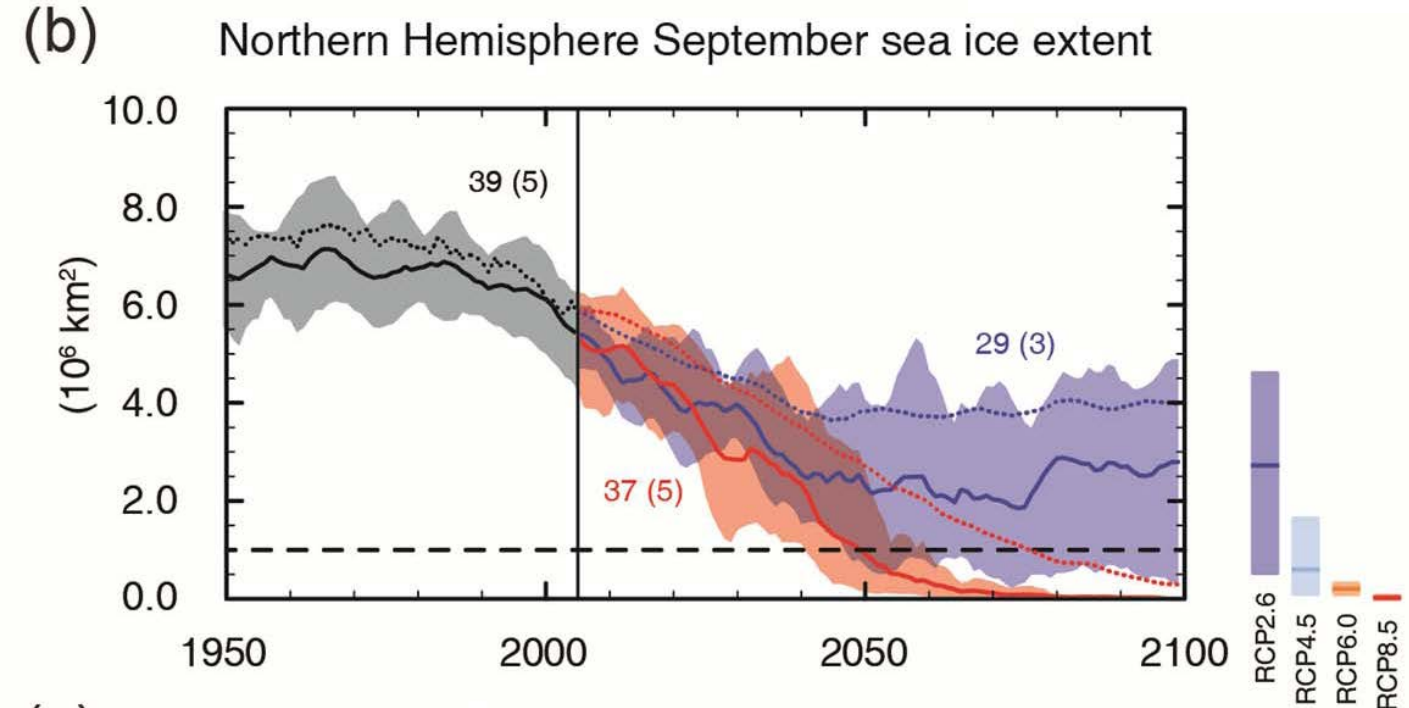
The future of Arctic summer sea ice



NSIDC 2016



IPCC 2013

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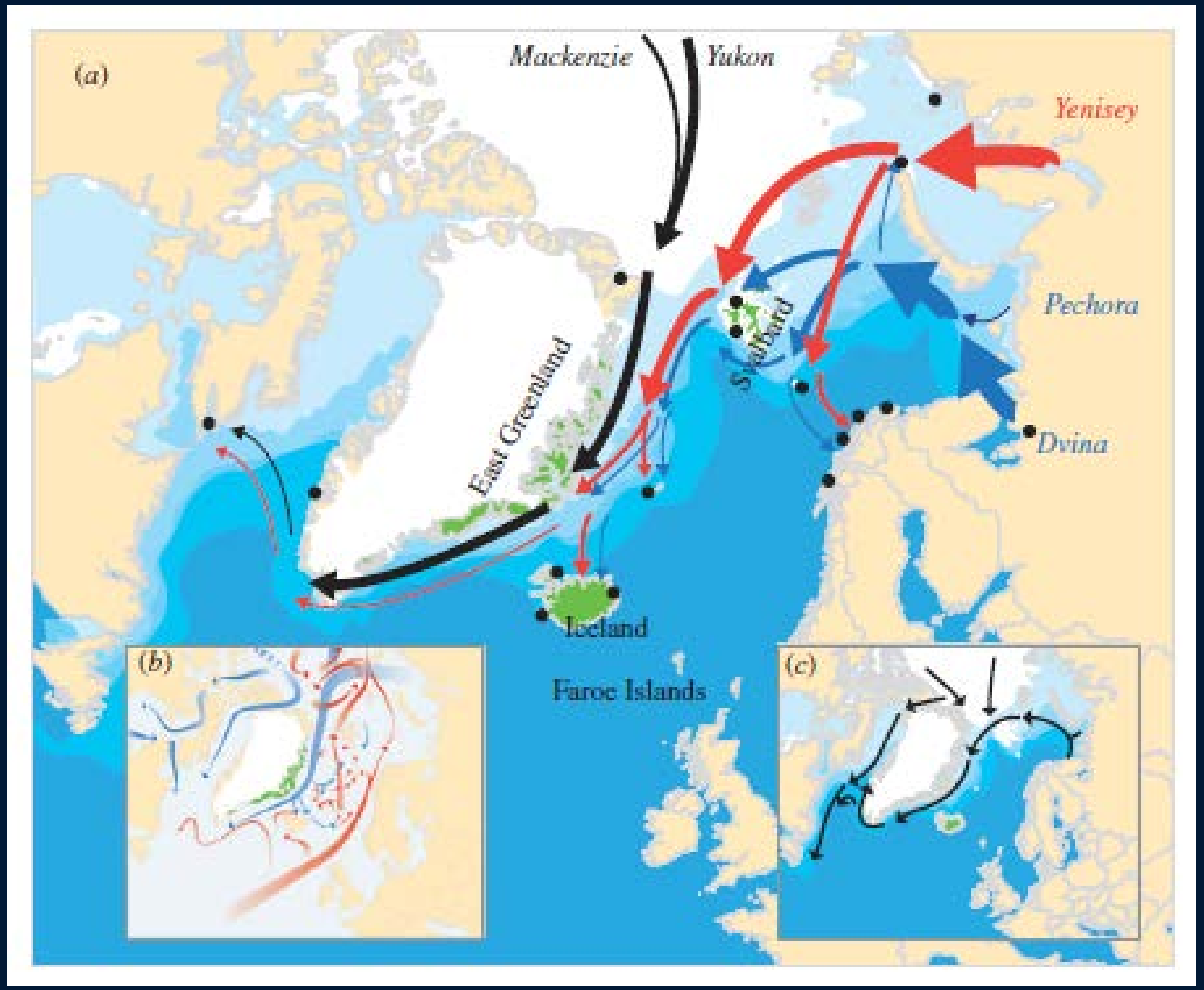
Impact on diversity and spread of plants in the Arctic



Alsos et al. 2016,
Biology Letters

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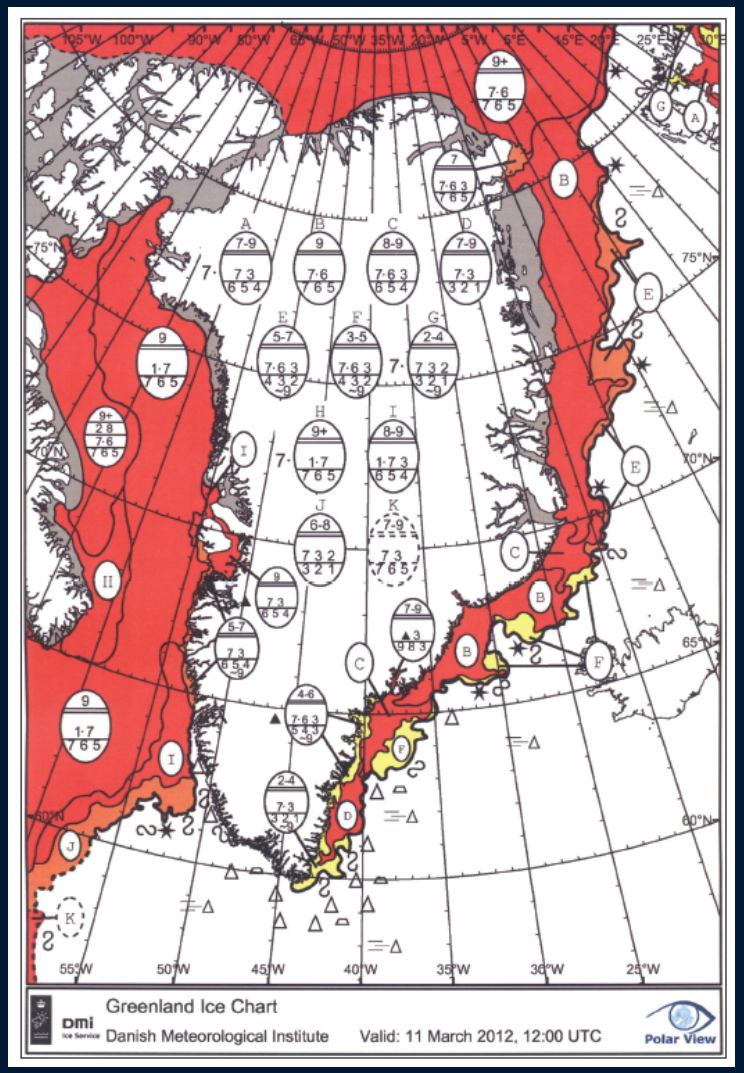
Logistics of Transportation

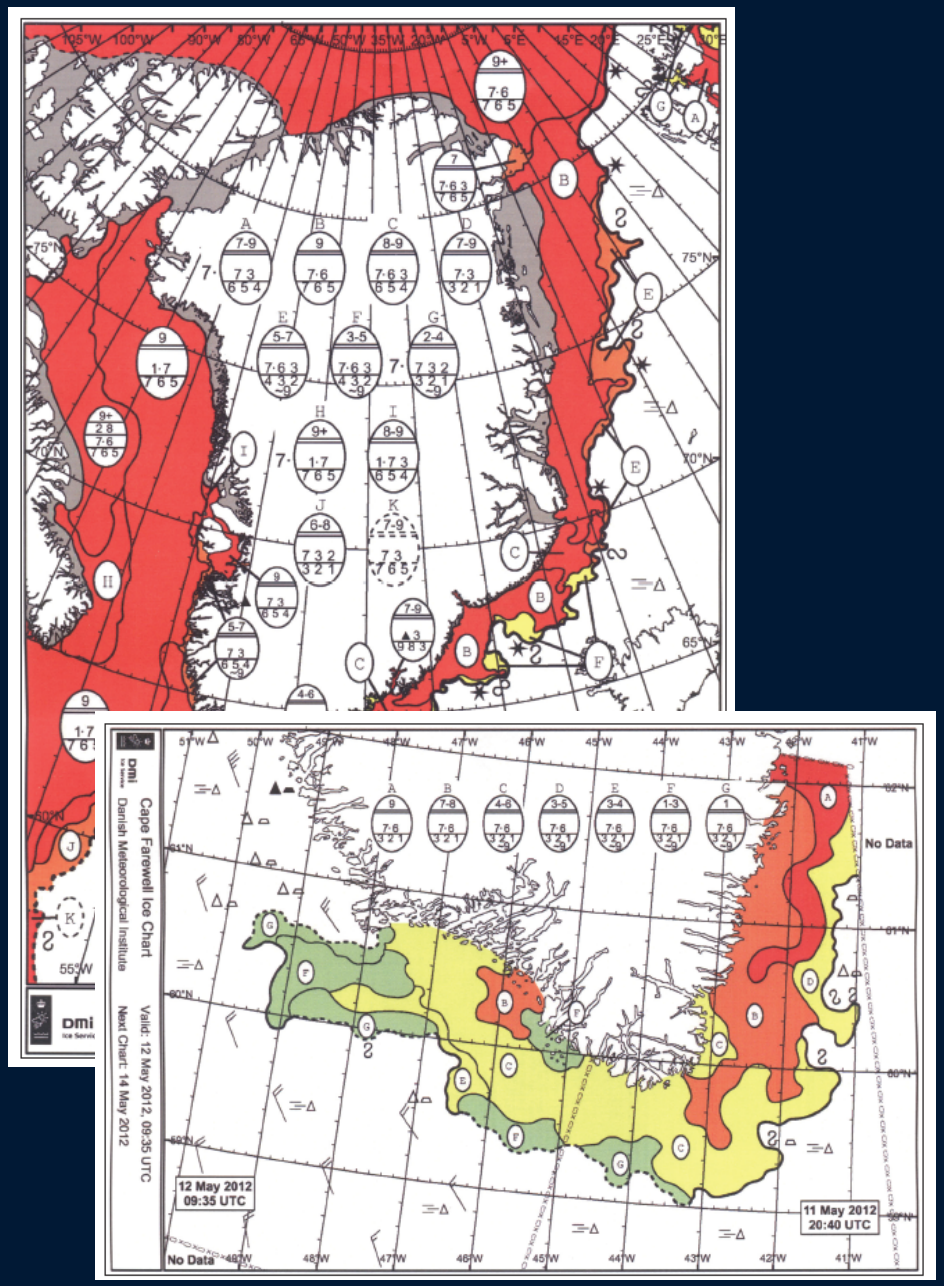
Impact on human habitation: the Norse



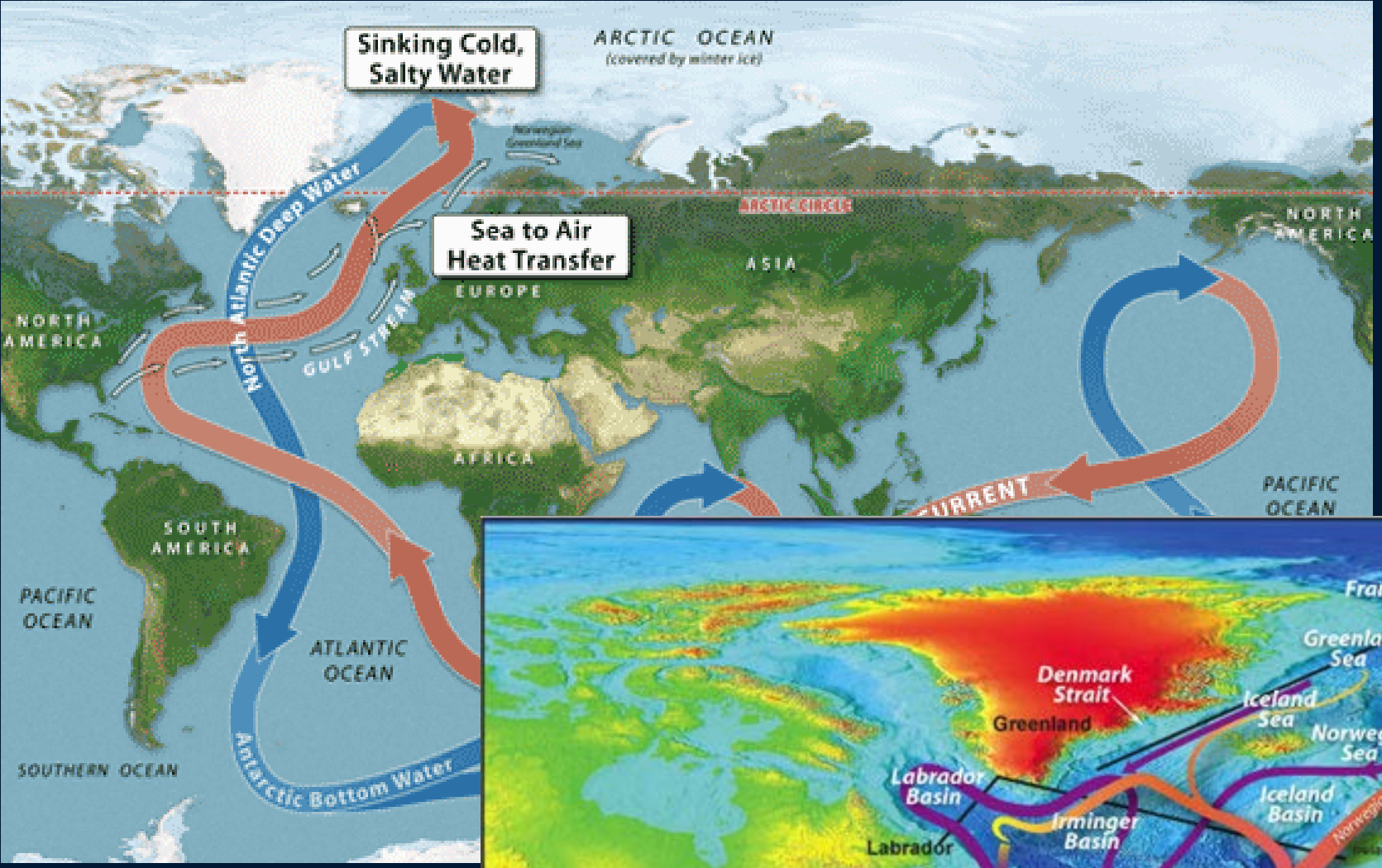
Kuijpers et al 2014, Journ. of the North Atlantic

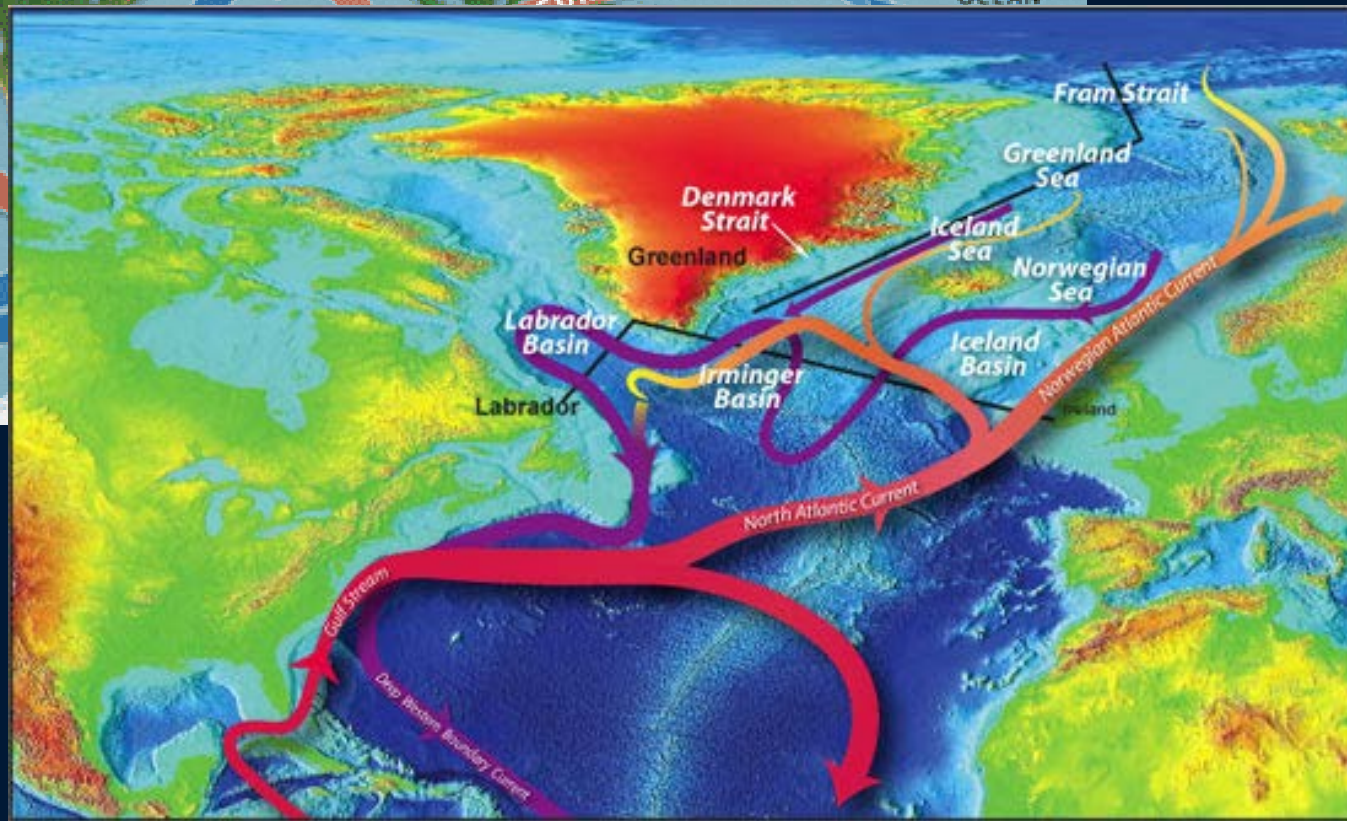
Impact on human habitation: the Norse

Kuijpers et al 2014, Journ. of the North Atlantic



11-12 May 2012: sea ice from the East Greenland Current blocked south Greenland fjords

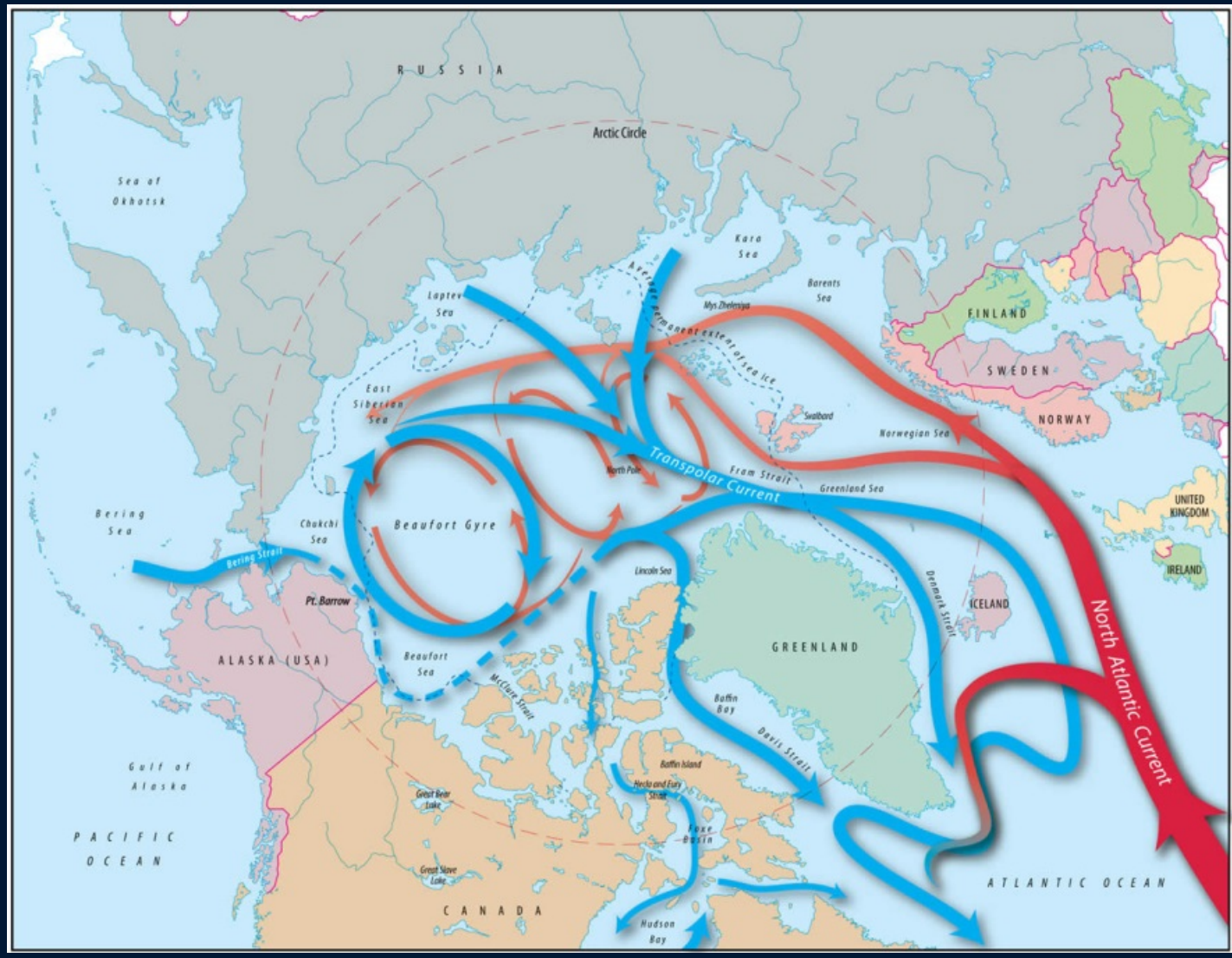

Sinking Cold, Salty Water
ARCTIC OCEAN
(covered by winter ice)
Norwegian Greenland Sea
ARCTIC CIRCLE
NORTH AMERICA
North Atlantic Deep Water
Sea to Air Heat Transfer
EUROPE
ASIA
GULF STREAM
NORTH AMERICA
AFRICA
PACIFIC OCEAN
SOUTH AMERICA
PACIFIC OCEAN
ATLANTIC OCEAN
SOUTHERN OCEAN
Antarctic Bottom Water


Fram Strait
Greenland Sea
Denmark Strait
Greenland
Iceland Sea
Norwegian Sea
Labrador Basin
Iceland Basin
Irminger Basin
Labrador
Norwegian Atlantic Current
North Atlantic Current
Gulf Stream
Deep Western Boundary Current

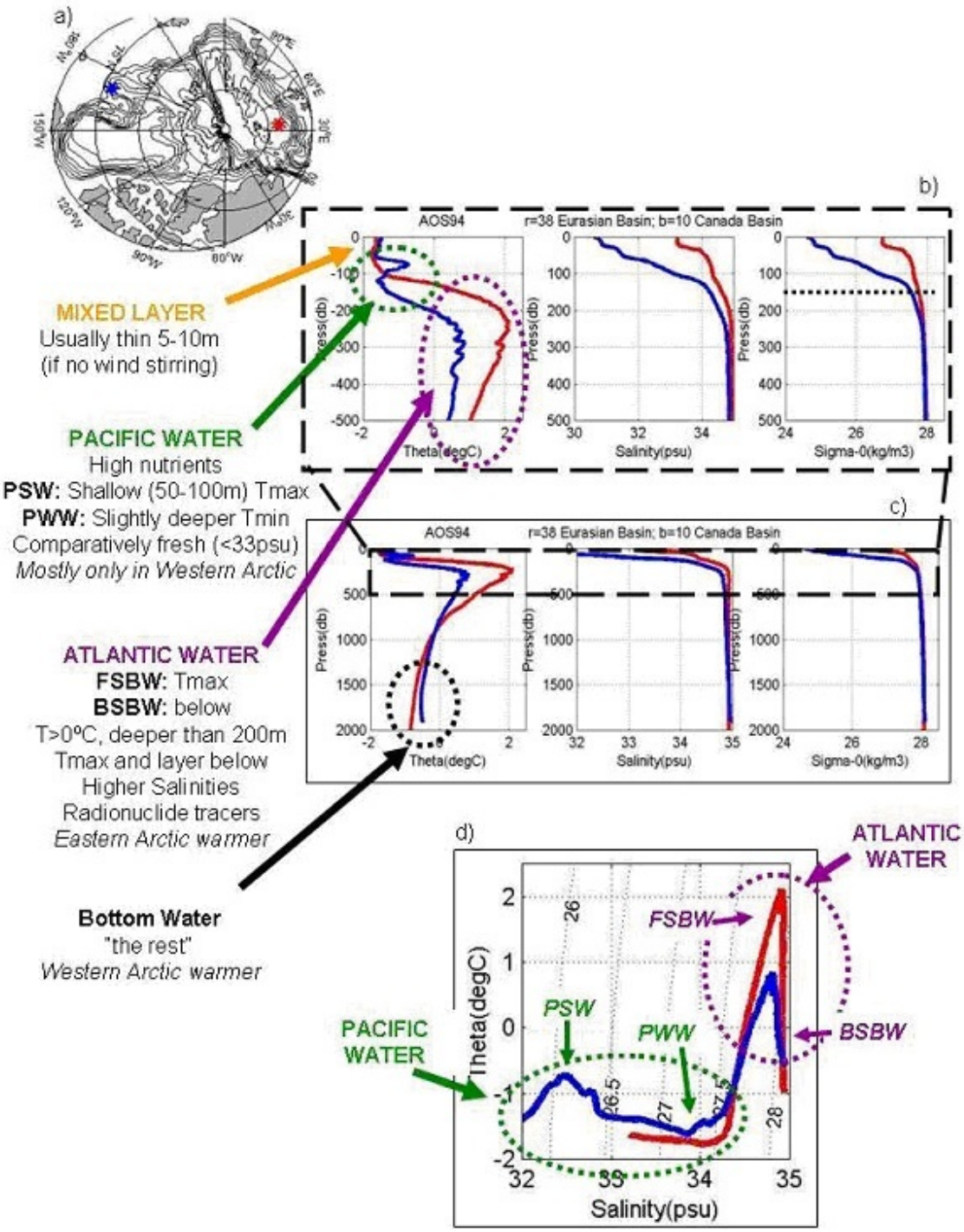
Arctic ocean currents

Blue arrows = cold, relatively fresh water.
Red arrows = warm, salty water from the North Atlantic

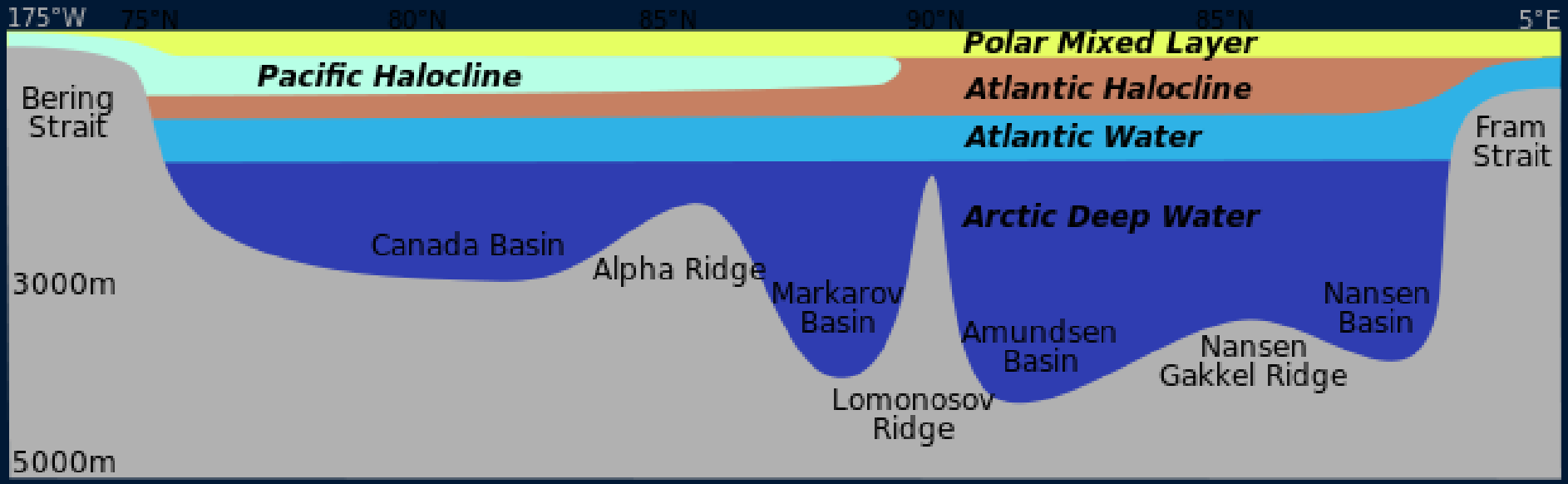
(Jack Cook, WHOI)



Arctic Ocean water masses



Nature Education 2013
Swift *et al.* 1997)


175°W
75°N
80°N
85°N
90°N
85°N
5°E
Polar Mixed Layer
Pacific Halocline
Atlantic Halocline
Atlantic Water
Arctic Deep Water
Bering Strait
Fram Strait
Canada Basin
Alpha Ridge
Markarov Basin
Amundsen Basin
Nansen Basin
Nansen Gakkel Ridge
Lomonosov Ridge
3000m
5000m

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The basis for our work

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Archives of past climate change

Gravity corer

Sediment core

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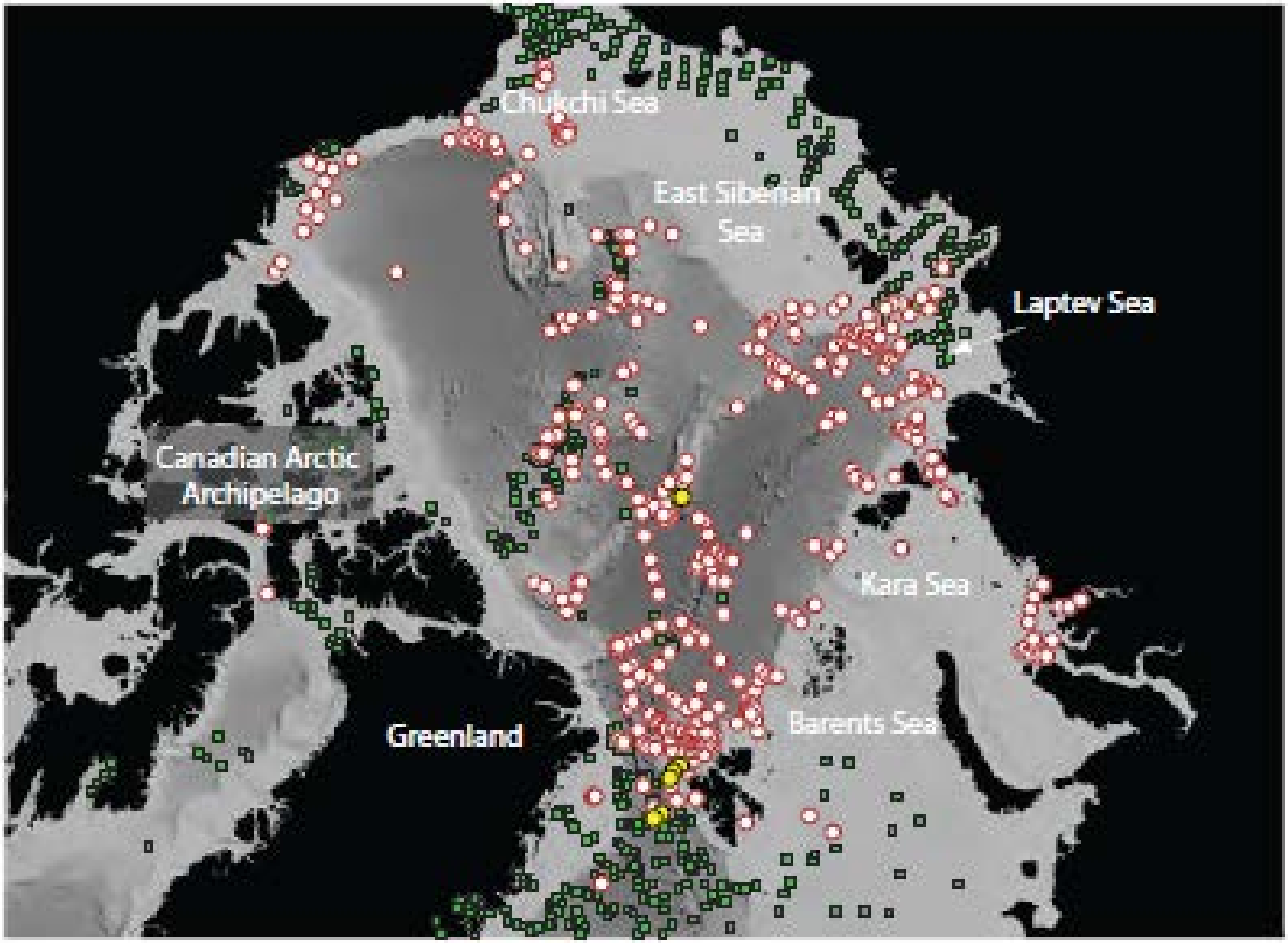
Archives of past climate change

Gravity corer

Foraminifera

Sediment core

ARCTIC OCEAN CORE SITES



O'Regan 2011

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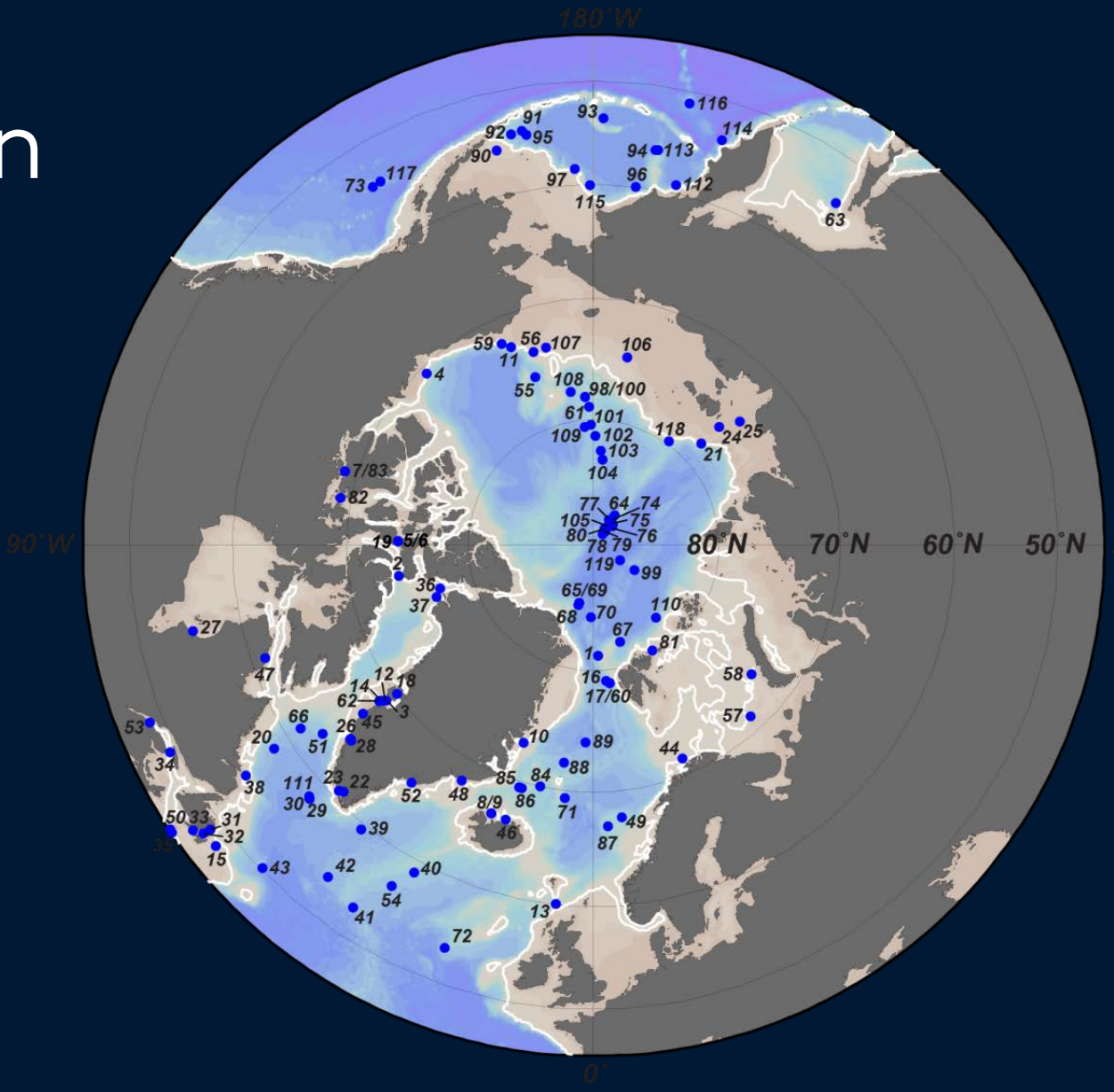
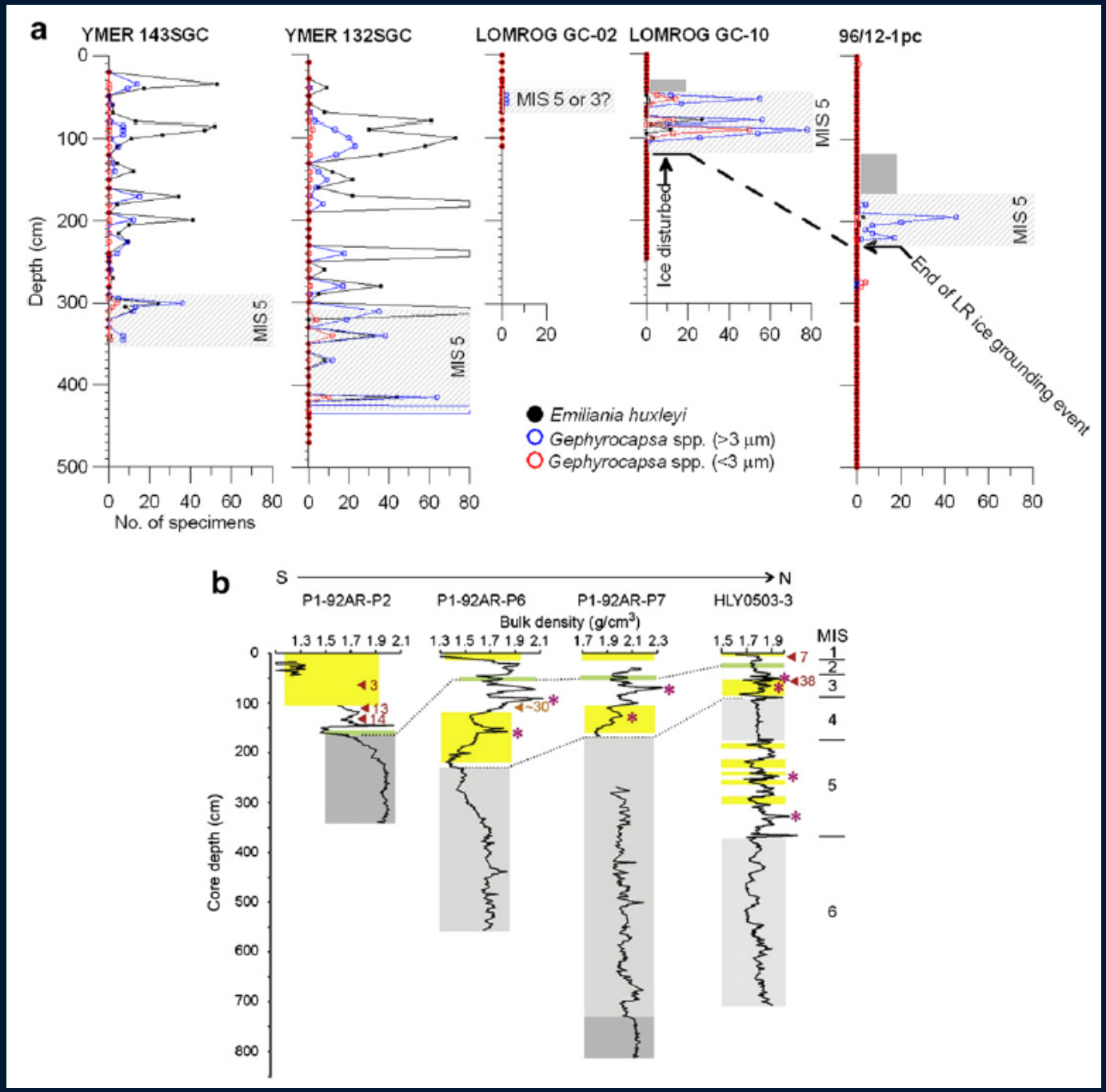
Arctic Ocean Holocene sediments

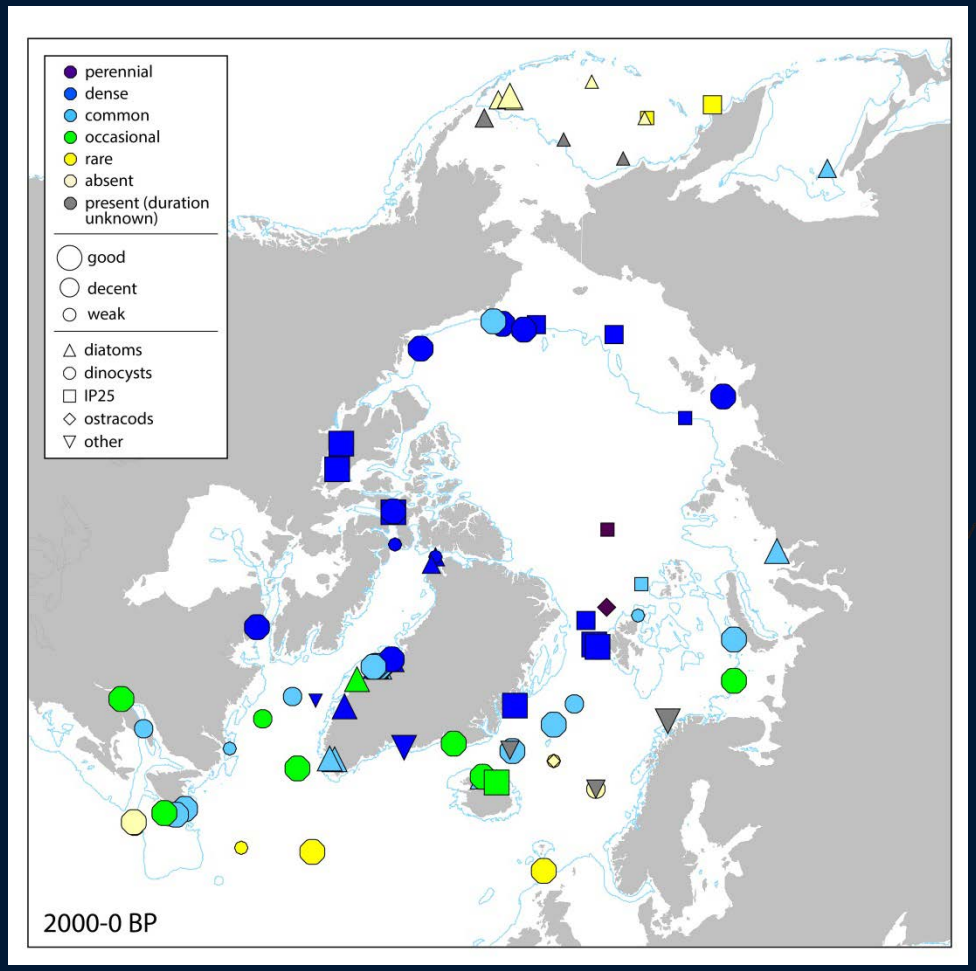


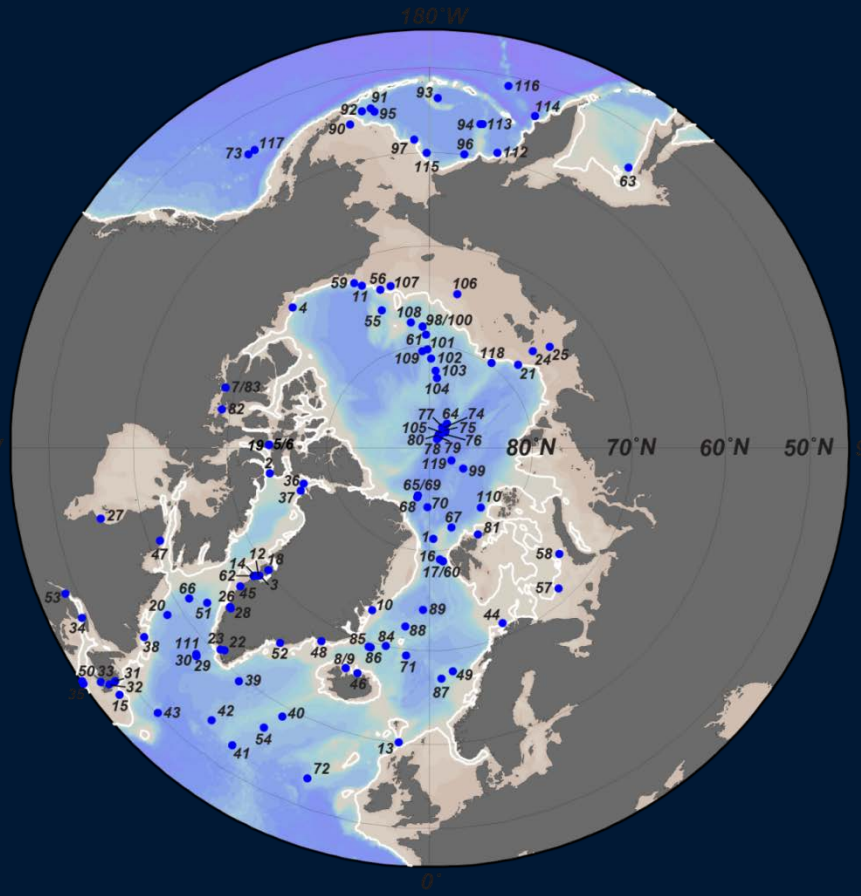
Arctic Ocean cores



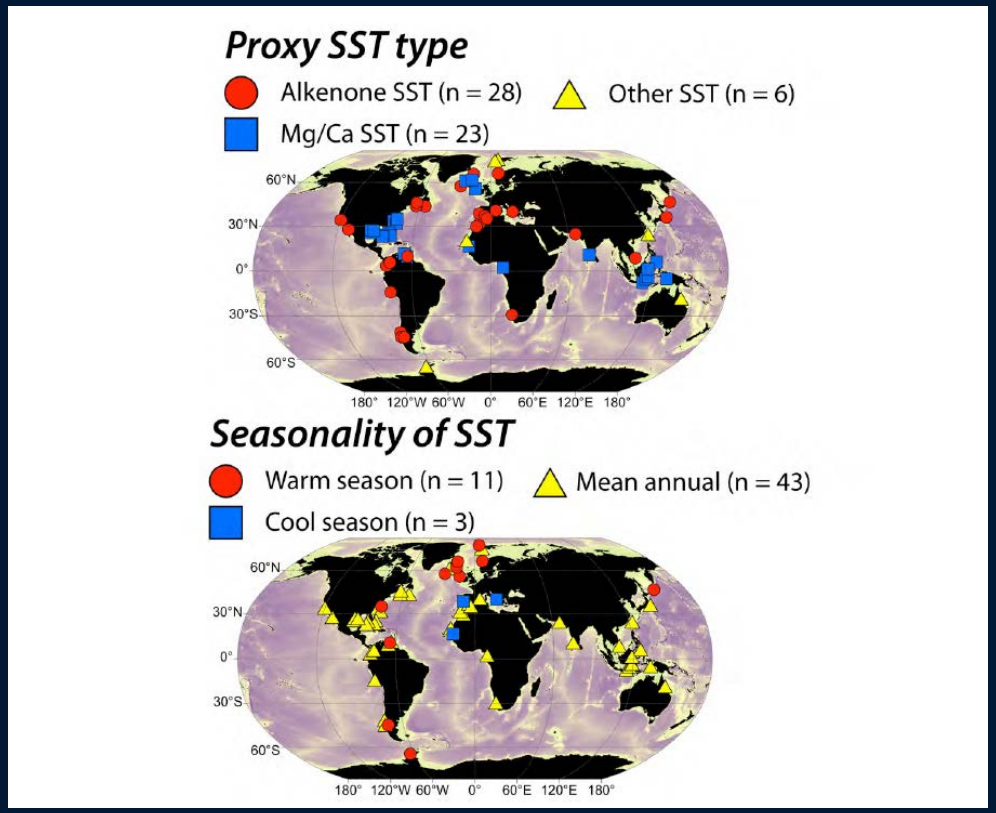
Jakobsson et al 2010, QSR

Sites with centennial to millennial-scale resolution

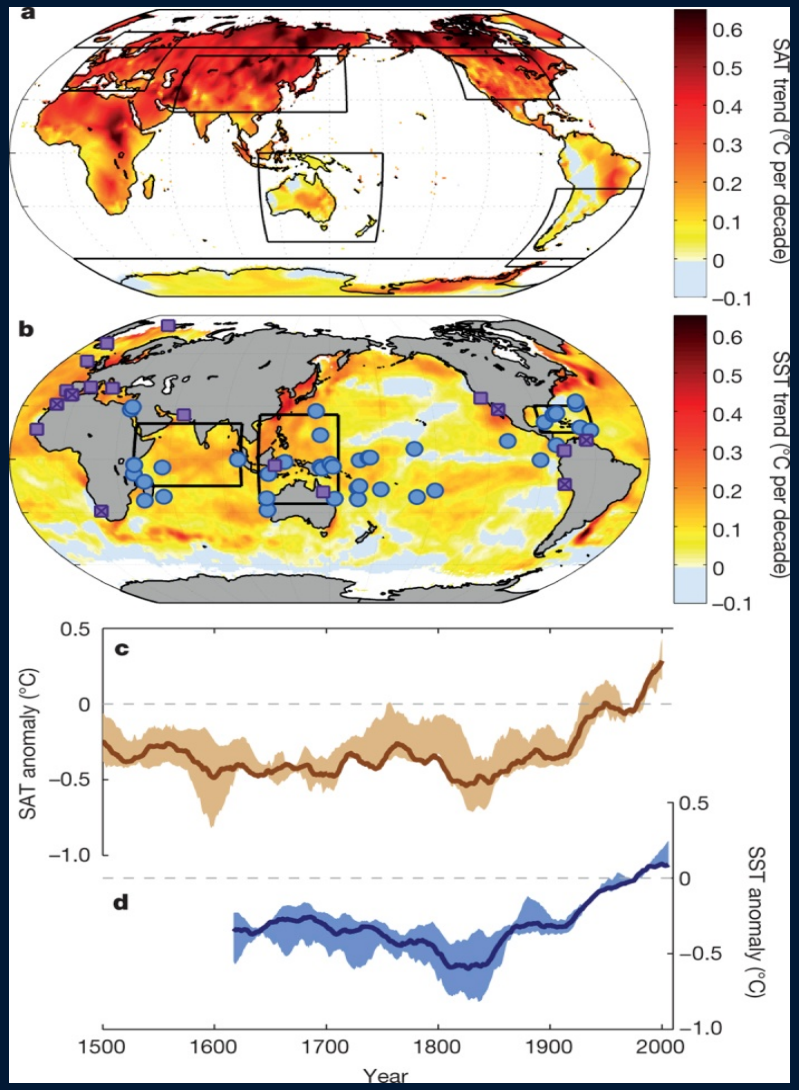




Arctic high-resolution sites



McGregor et al 2015, *Nature Geoscience*



N J Abram *et al. 2016, Nature*

What to do?

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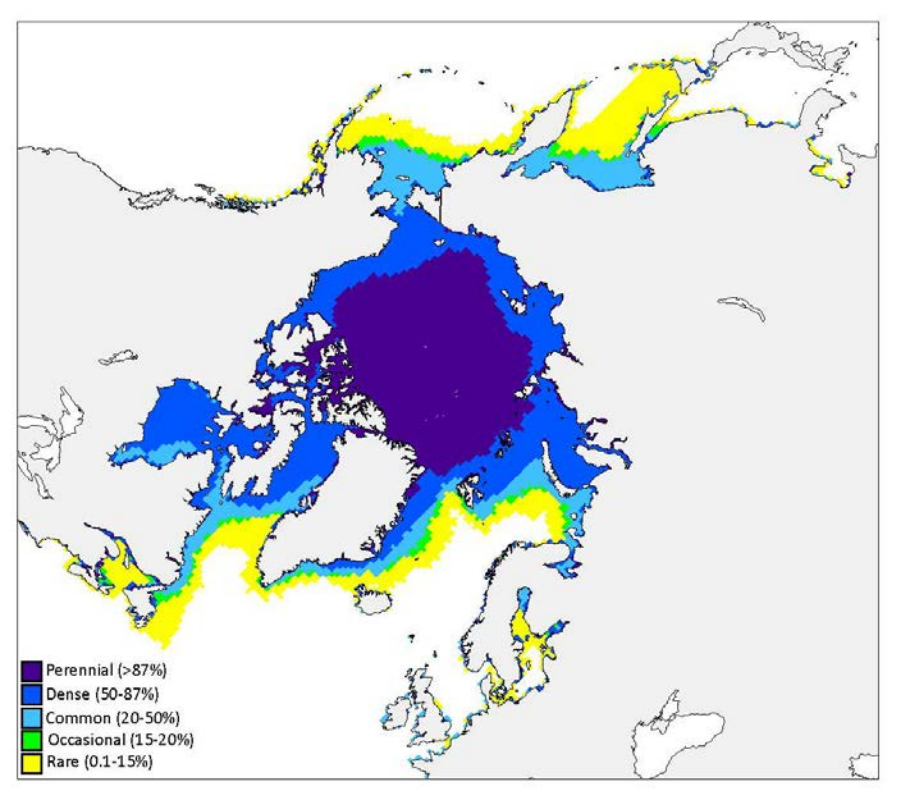
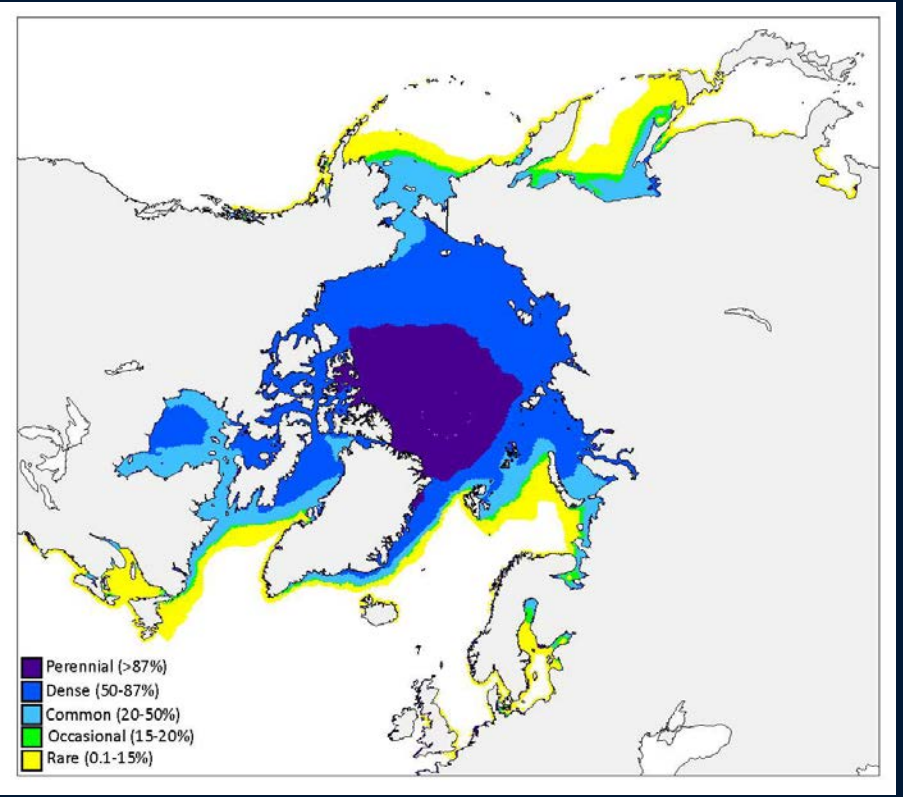
MODERN SEA ICE



1953-2003



2003-2013

Arctic ocean currents

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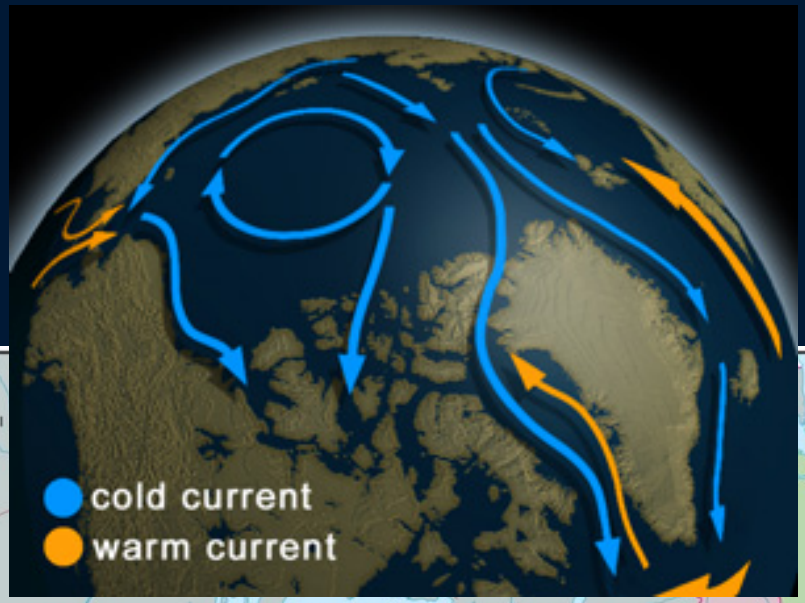
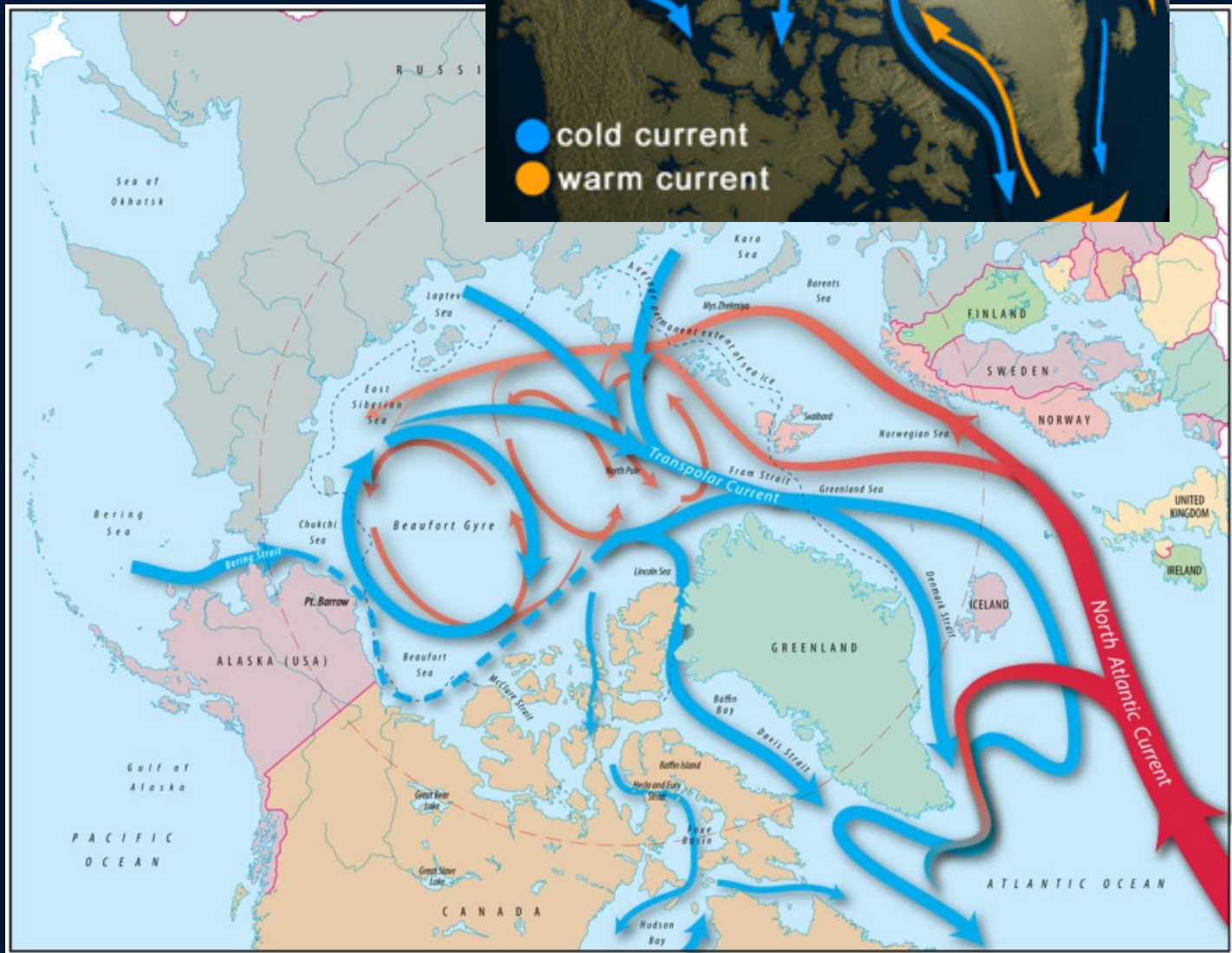
(Jack Cook, WHOI)



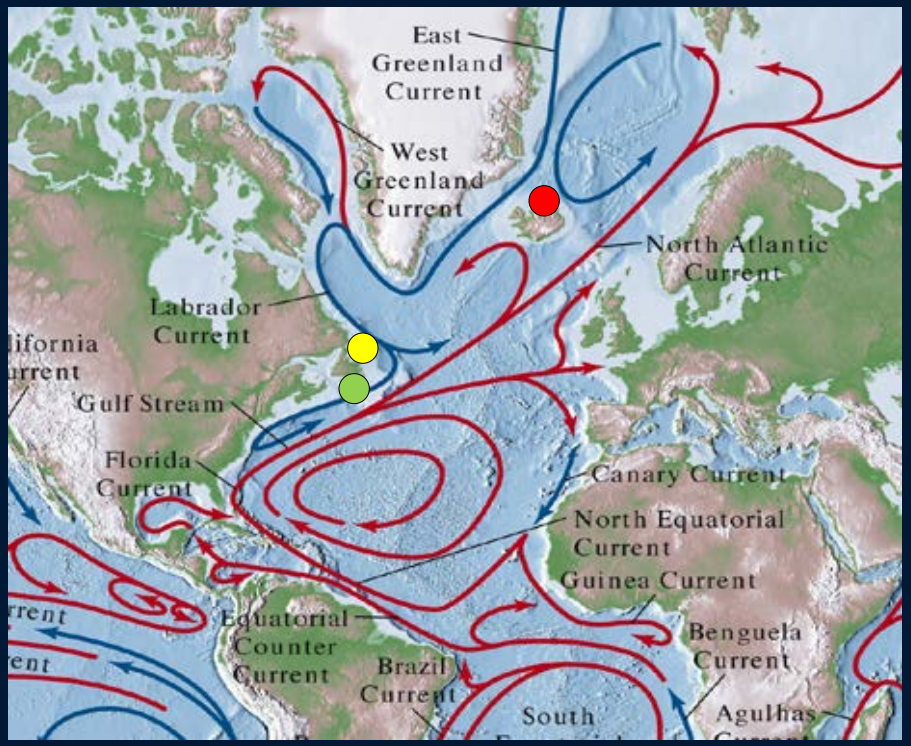


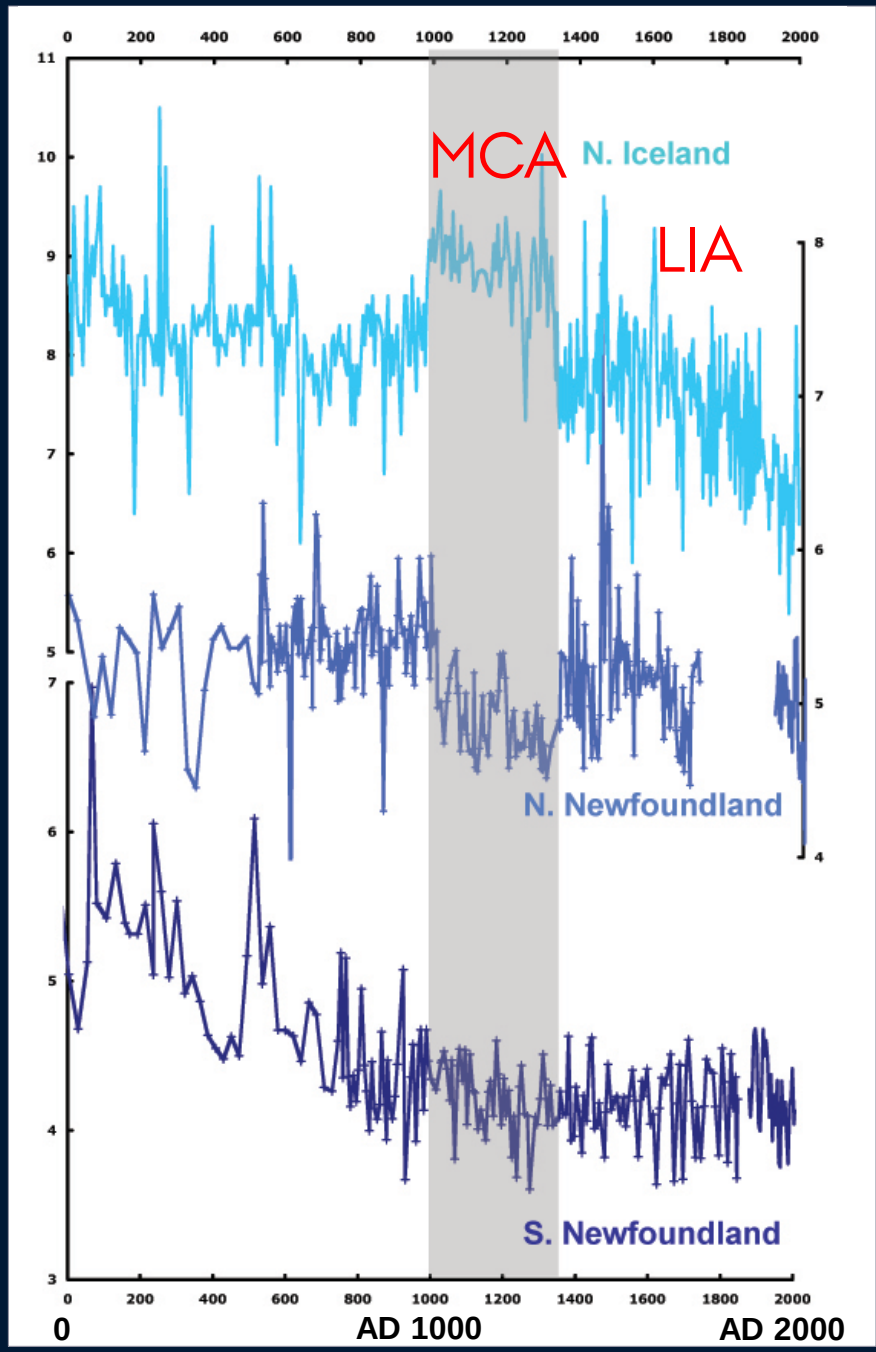
Geographical Differences Explain Mechanisms

1

2

3

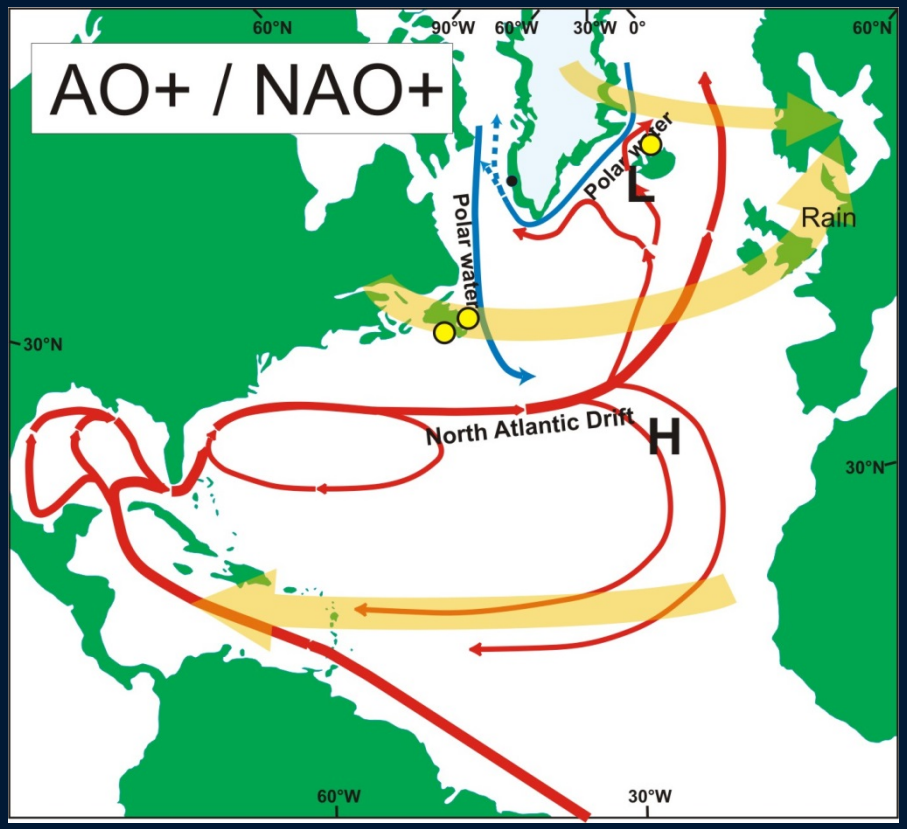


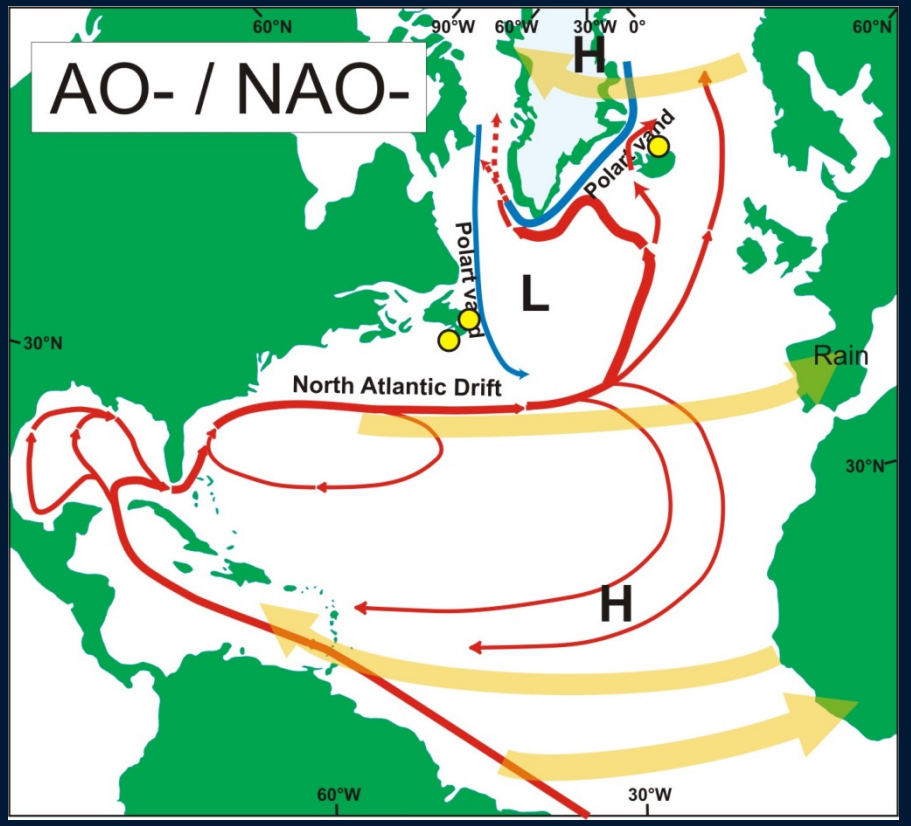


Sicre et al., submitted, Science

CENTRE FOR PAST CLIMATE STUDIES
DEPARTMENT OF GEOSCIENCE
AARHUS UNIVERSITY

Catching the Arctic Oscillation in the North Atlantic





CONCLUSIONS

- The Arctic exerts a major control on global climate.
- However, we actually know very little about Arctic climate – especially its variability and “natural state”.
- Select key (climate sensitive) sites for study.
- Further development of methods
- International collaboration.

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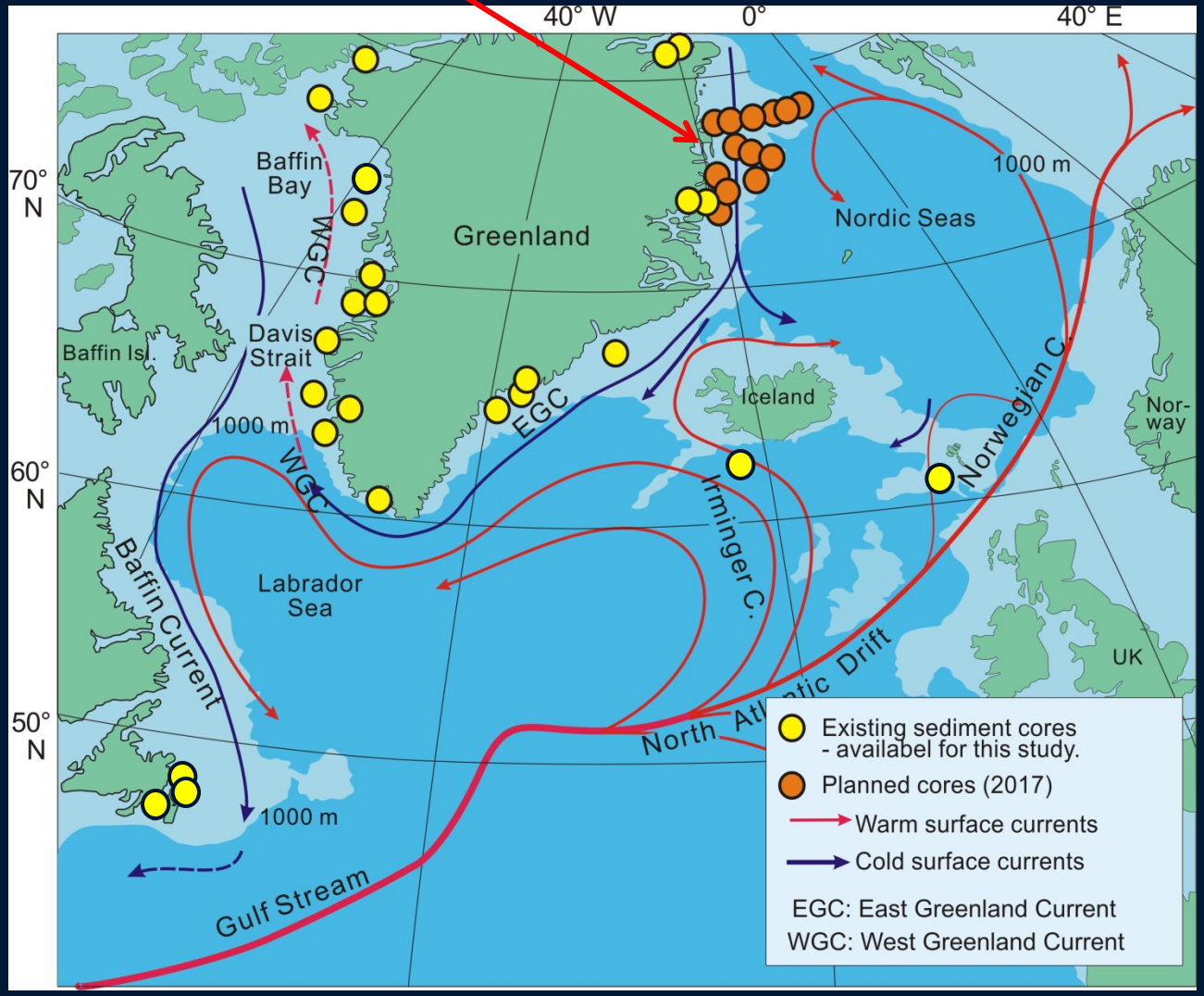
NorthGreen2017



Thank you!

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- Danish Council for Independent Research, Natural Science
- Villum Kann Rasmussen Foundation
- European Union FP7programme
- Geocenter Danmark
- … and many more