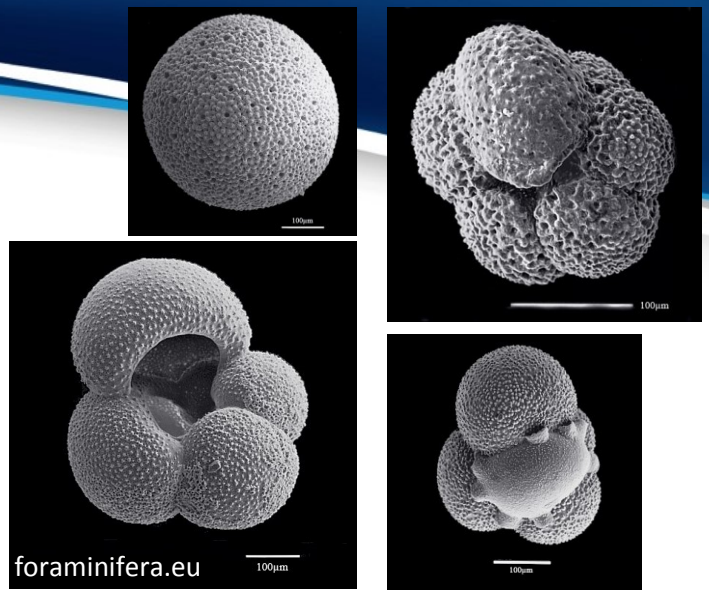
atlas

UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS



Anomalous North Atlantic oceanography and overturning during the last 250 years

David Thornalley, Peter T. Spooner, Delia Oppo, Pablo Ortega, Jon Robson, Alan Fox, Chris Brierley, Renee Davis, Svetlana Radionovskaya, Jack Wharton, Emma Cooper, Laura Thrower, Rebecca Garratt, Tanya Monica, Ian Hall, Paola Moffa-Sanchez, Penny Holliday, Neil L. Rose, Igor Yashayaev & Lloyd Keigwin

University College London, Woods Hole Oceanographic Institution, Reading, Edinburgh, Cardiff, Southampton, Bedford Institute of Oceanography

www.eu-atlas.org

The Leverhulme Trust

NSF

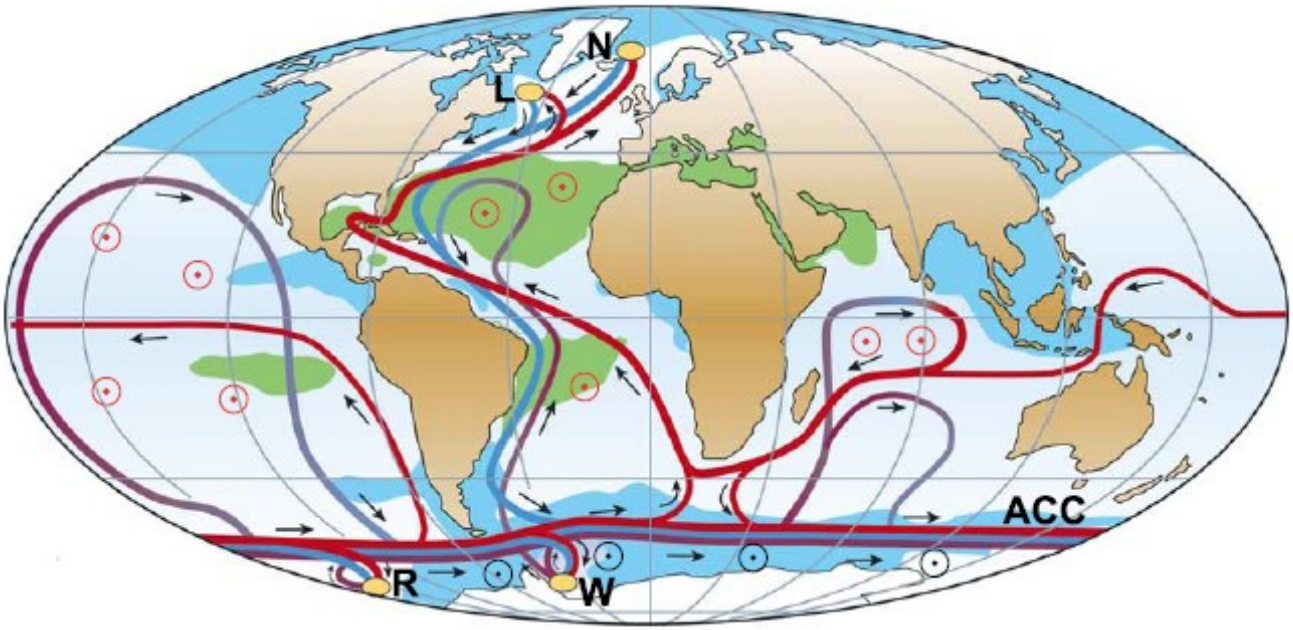
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

Context

The North Atlantic is important as:

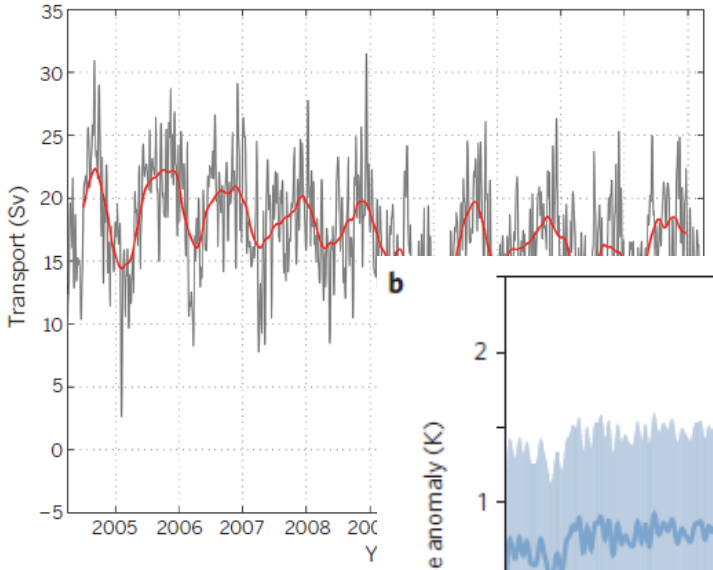
- A crucial site of deep water formation
- A connection between the Arctic and other water bodies
- A home of incredible ecosystems

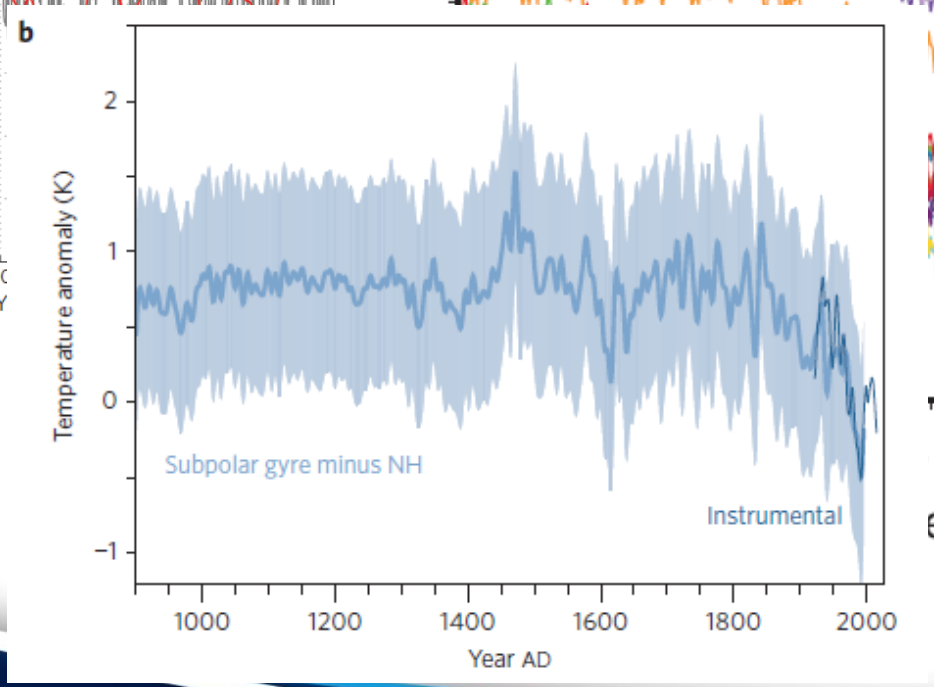
Looking at the large scale: The AMOC



The AMOC is made up of many moving parts. We can monitor some of these both in the present and in the past.

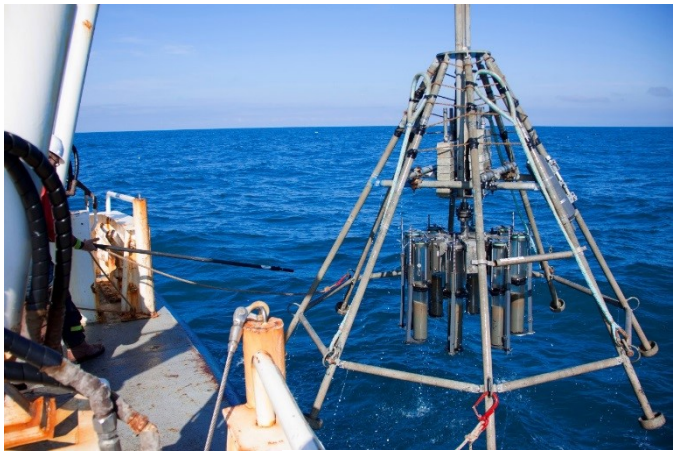
Is the AMOC slowing down?

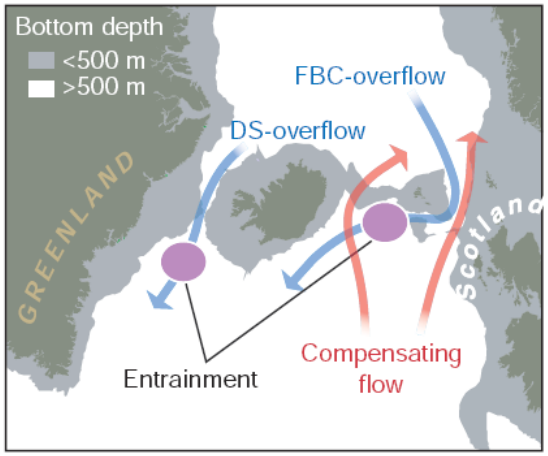


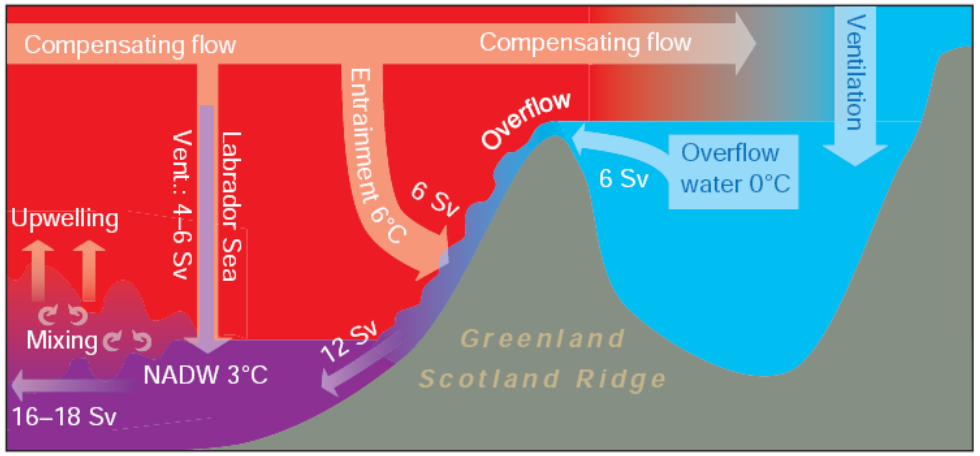


Records from ocean sediments
Context for modern change

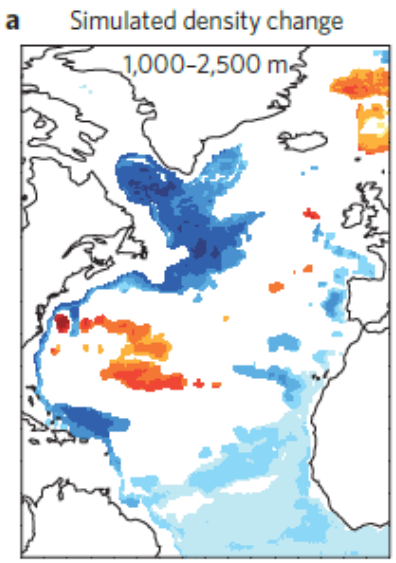
What can we learn from mud? 1: Current Speed

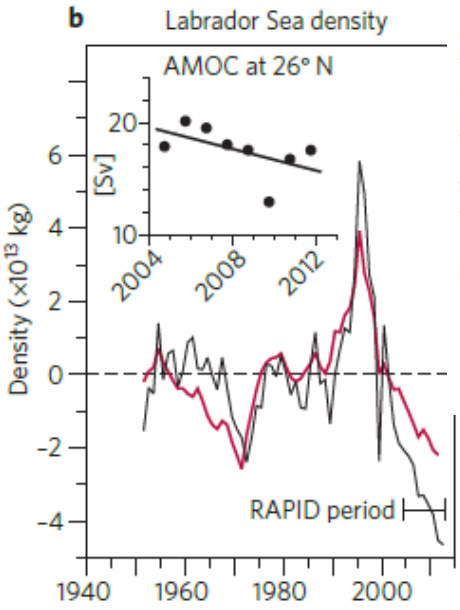


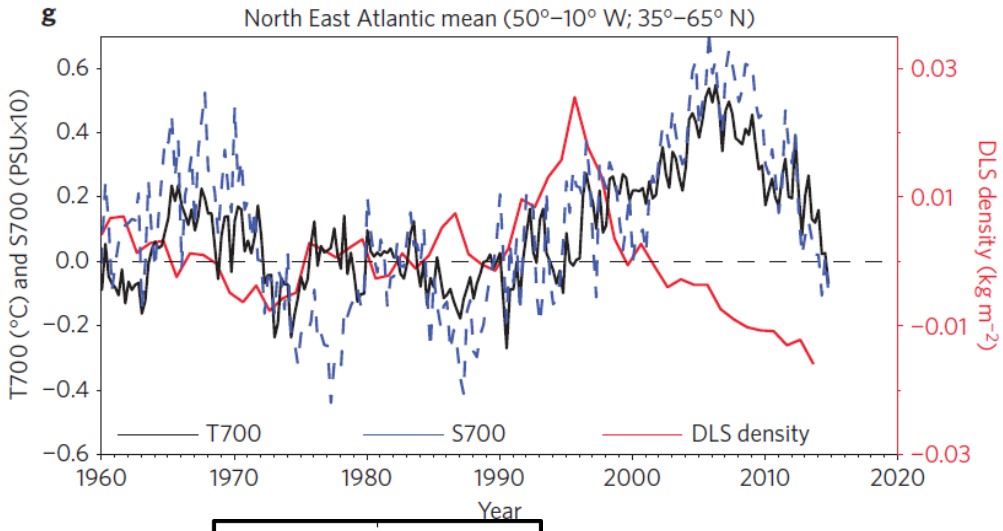


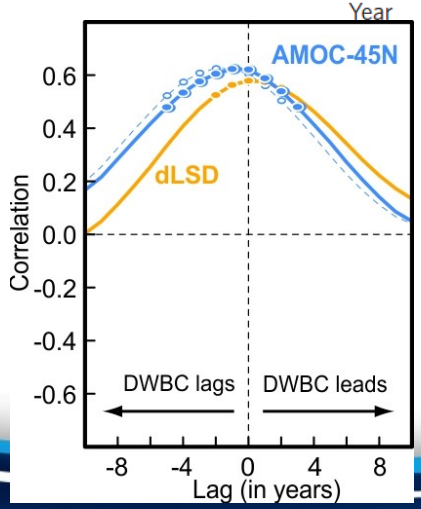


Labrador Sea density and the western boundary



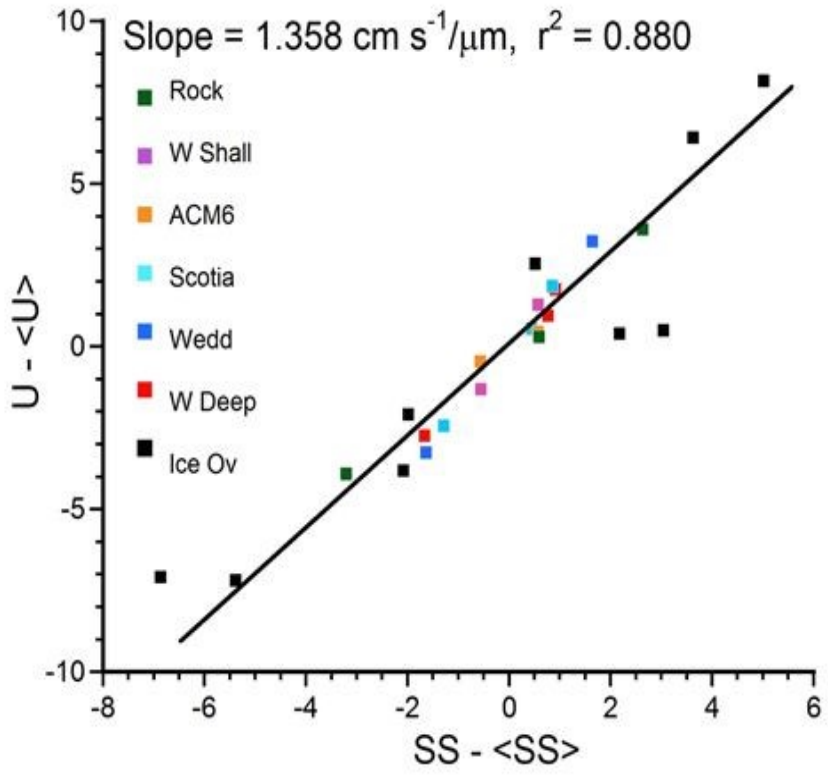






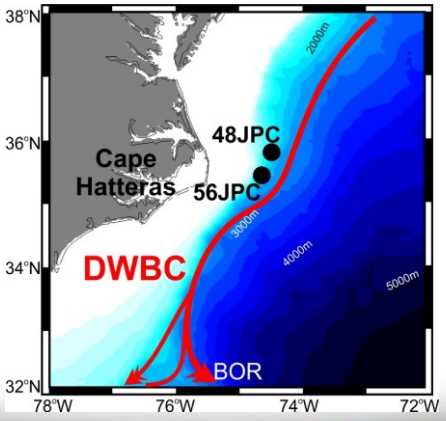
Robson et al., 2014; this study; also see Jackson et al 2016

Sortable Silt



"Relation of sortable silt grain size to deep-sea current speeds: Calibration of the 'Mud Current Meter'" (McCave, Thornalley & Hall, 2017, *Deep Sea Res.*)

Proxy for vigour of near-bottom currents. Calibrations suggest linear relationship between SS and flow speed.



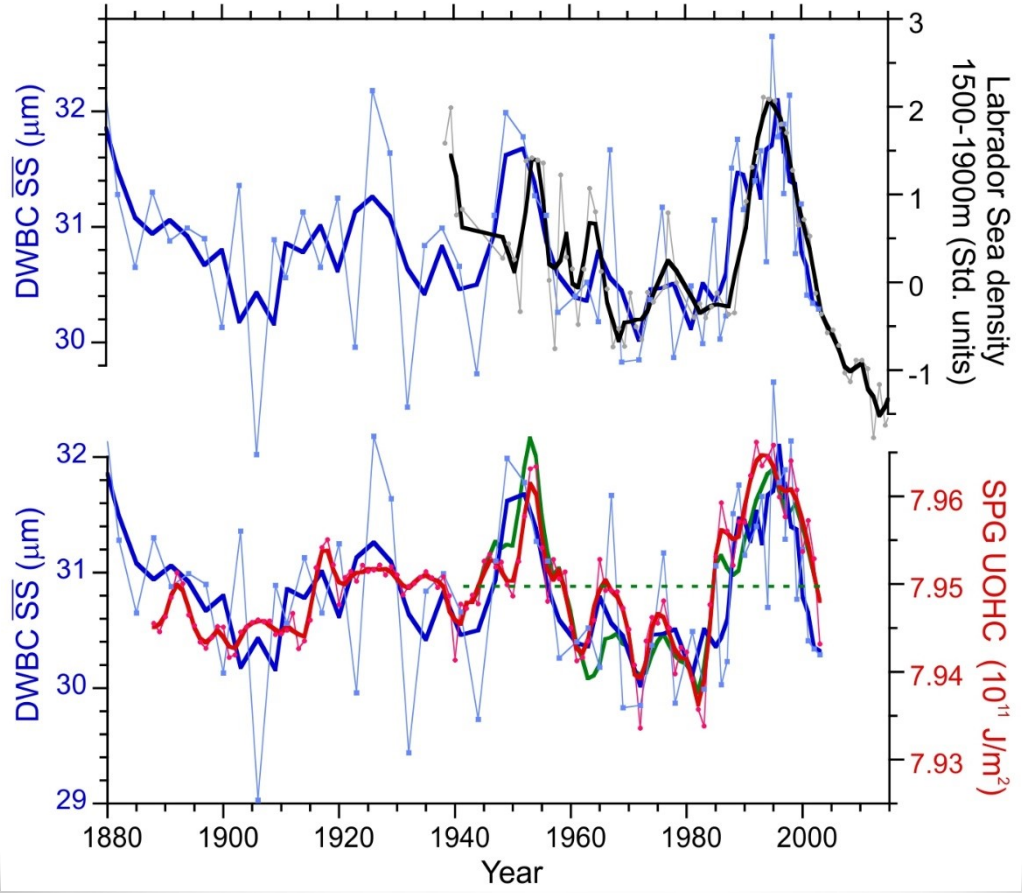
Does sortable silt relate to AMOC?

Variability of inferred flow speed of DWBC (56JPC) over last 130 years compares well with modern observations of:

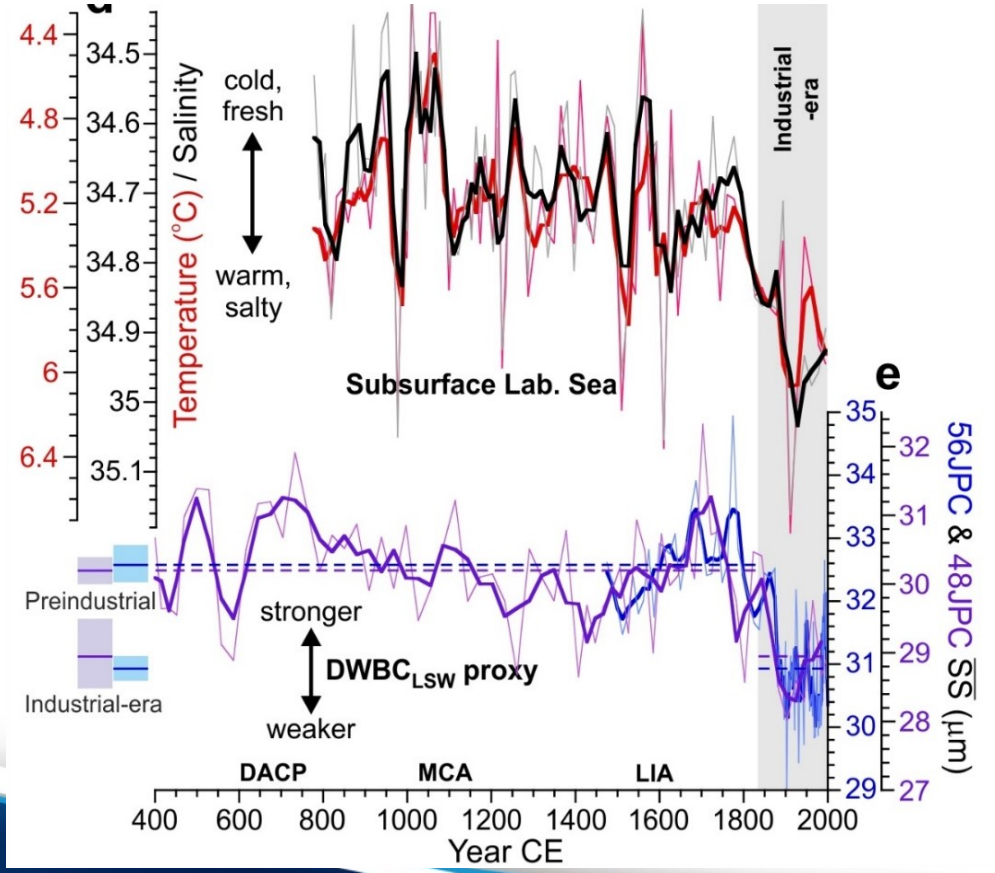
-Deep Labrador Sea density [from Yashayaev]

-Subpolar gyre upper ocean heat content (12 yr lag) [EN4 data]

-Tsub AMOC fingerprint (12 yr lag) [from Joyce and Zhang 2010; WOD09 data]



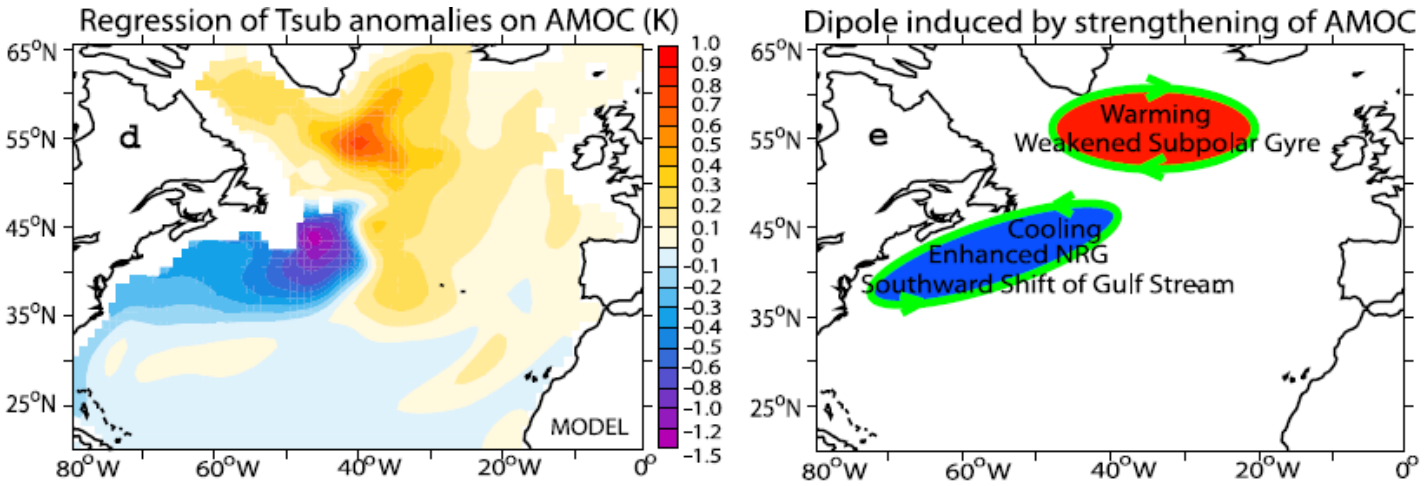
Weakening of AMOC since 1850 AD



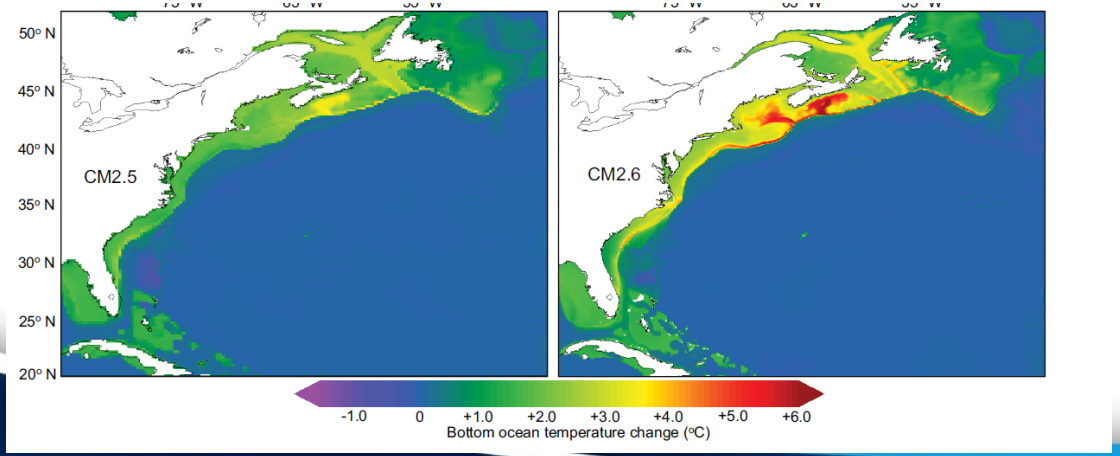
Shift to weaker flow at ~1850 AD; seen in both 56JPC and 48JPC (replication). ~15-20% faster flow pre-Industrial.

→ Prior to 1850 AD, AMOC predominantly in 'strong' mode, comparable to1990s (when deep convection occurred in the Lab Sea).

What can we learn from mud 2: Temperature

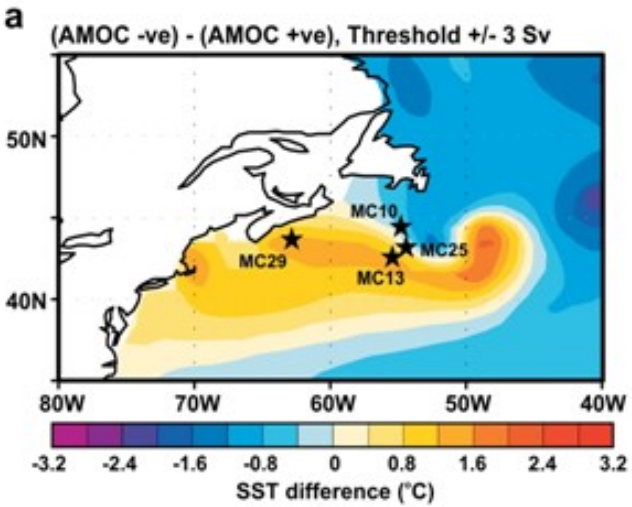


Zhang, 2008; Saba et al 2016

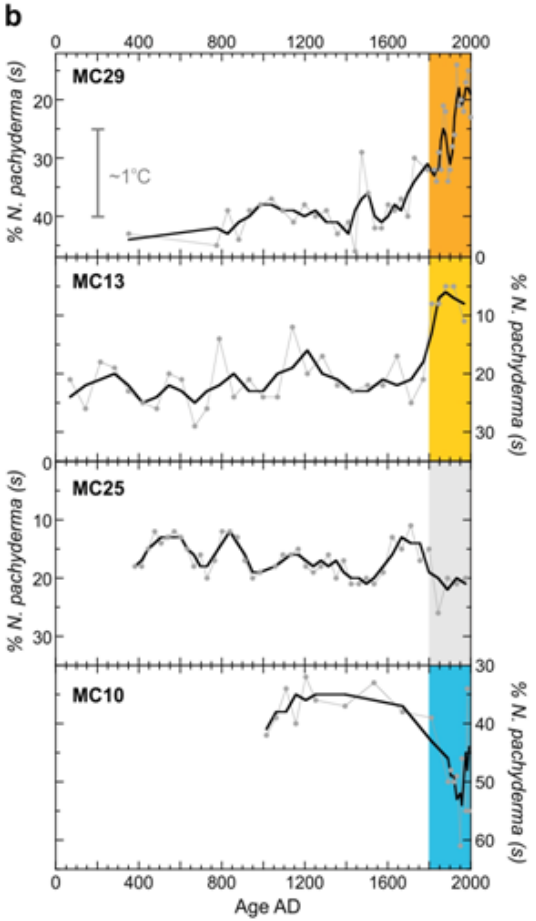


High resolution models suggest AMOC weakening causes prominent warming of shallow basins of NW Atlantic shelf

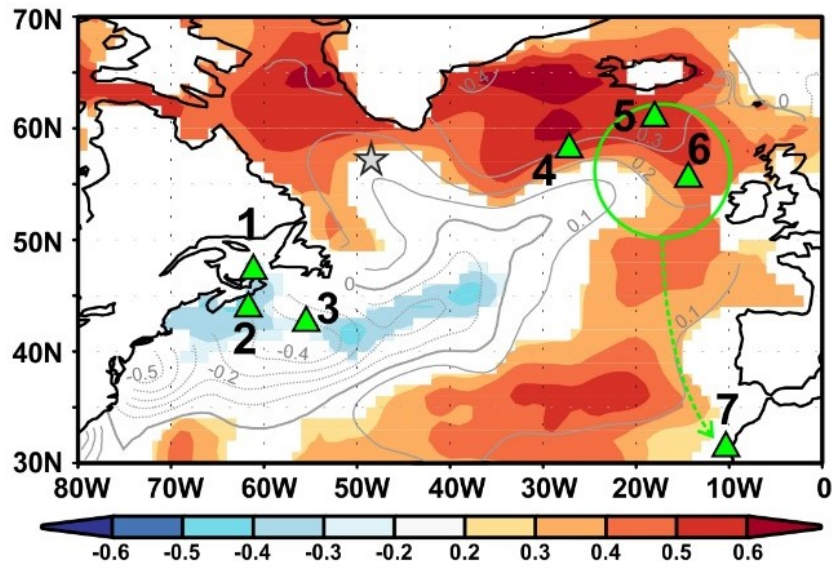
Temperature records from the western margin

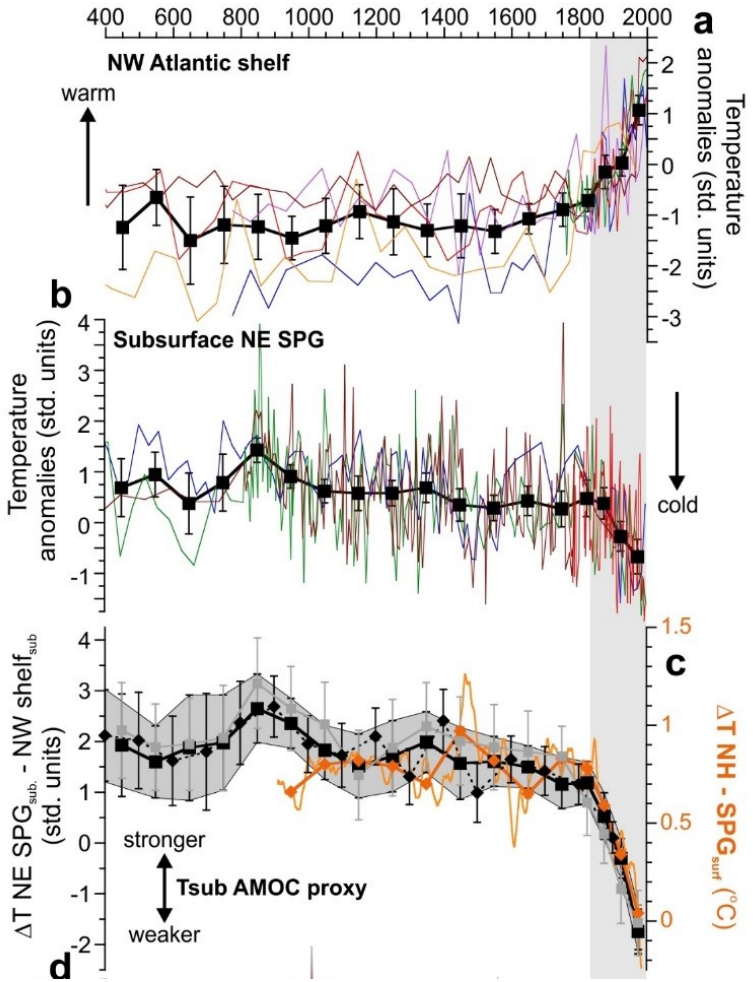


This study; Joyce and Zhang, 2010; Keigwin & Pickart, 1999; Wharton student project



Basin-wide temperature change





So what do we think we know?

- The AMOC is weakening, and will likely continue to weaken.
- Paleocean records suggest that the AMOC has been weakening since 1850, by about 20%. (Thornalley et al. Nature, this Thursday!)
- Observed temperature trends also suggest a weaker AMOC since the late 1800s, with a 16% decrease since 1950. (Caesar et al. Nature, this Thursday!)

What does all this mean?

1) What is the relevance of current ocean state to assessing existing/past coral presence/connectivity?
2) It looks like centennial oceanic trends have been very important. More important than decadal-multidecadal cycles?
3) The data imply that some models may be too stable in their AMOC representation.
4) What implications does this have for future projections of connectivity?

Opportunities

1) The Atlantic Ocean may have already undergone changes similar to those we might expect in the coming decades.
2) Can we use existing collections/new collections to try and understand how ecosystems have reacted on these relatively short timescales?
3) Our extended records may allow better comparison of broad physical oceanography with known changes in coral mound occurrence and growth.