

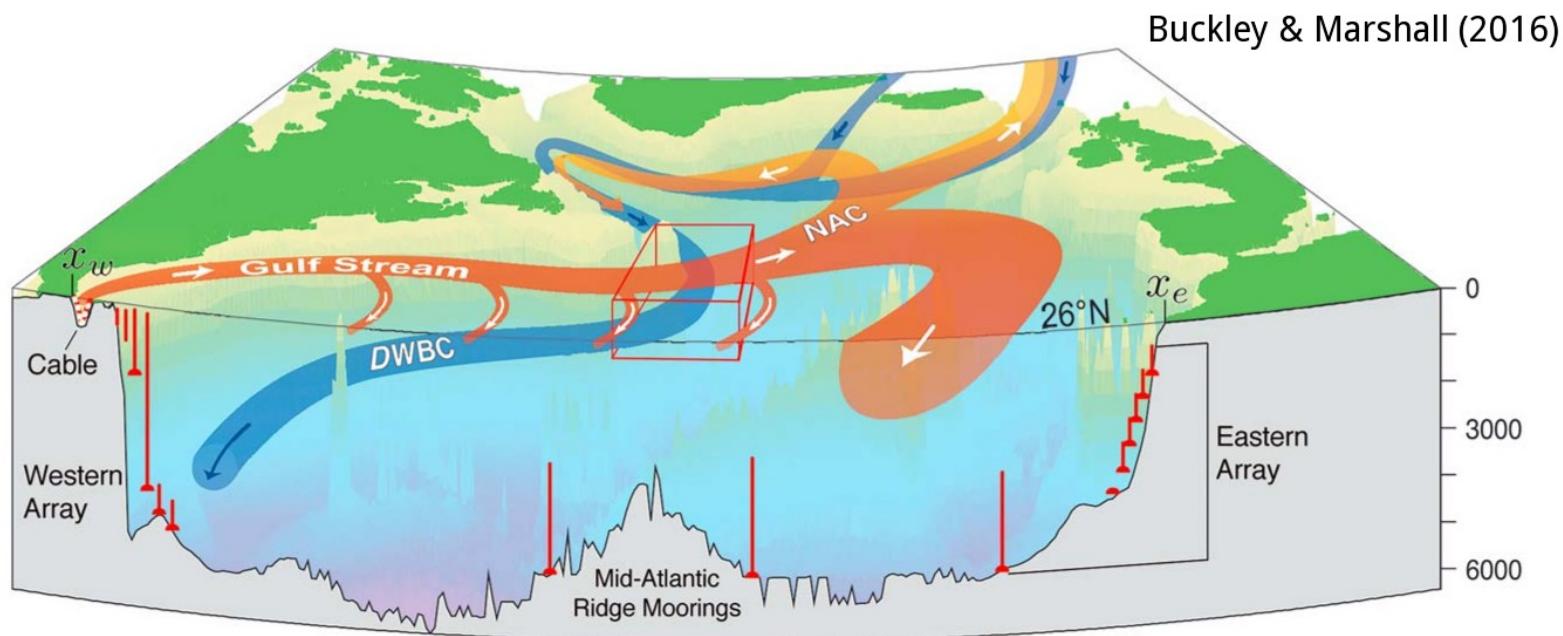


# Recent changes in Newfoundland and Labrador waters I: A dive into 7 decades of oceanic observations

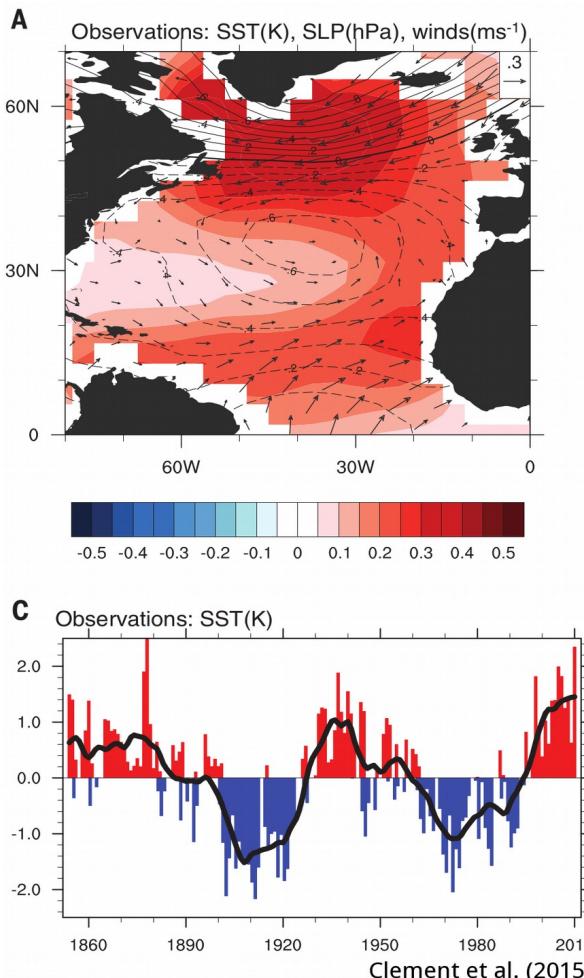
Frédéric Cyr, Ali Moridnejad & Pierre Pepin  
Fisheries and Oceans Canada,  
Northwest Atlantic Fisheries Centre,  
*St. John's, NL*



# Context: NL shelves a crossroads of the Atlantic Meridional Overturning Circulation (AMOC)



# Context: AMOC / Ocean climate is changing

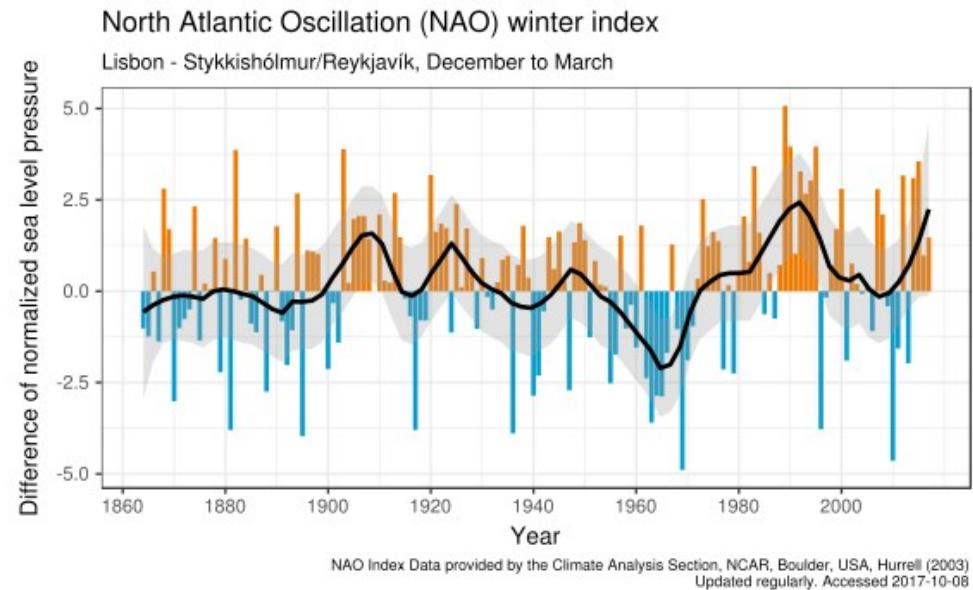
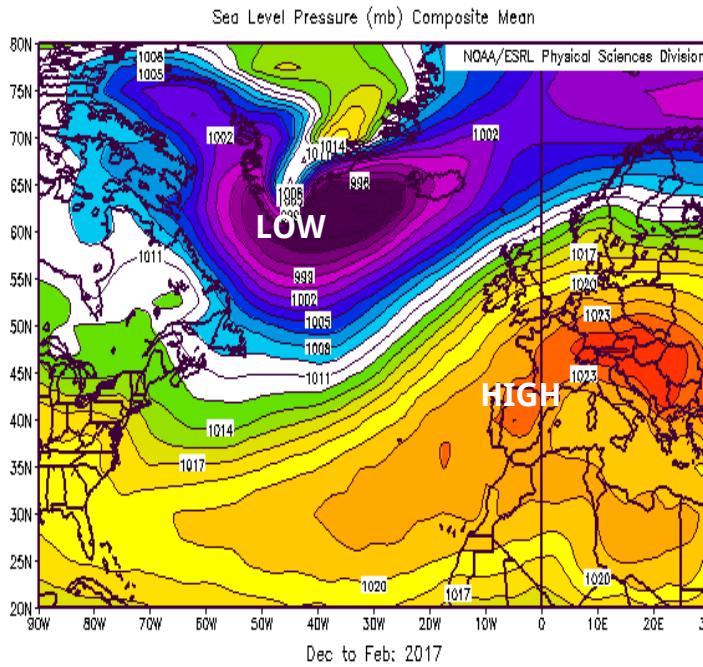


## Atlantic Multidecadal Oscillation (AMO)

- Based on North Atlantic SST
- 60-70 yr periodicity
- AMOC affected by AMO (e.g., weak when NA is warm)
- Drivers not clear

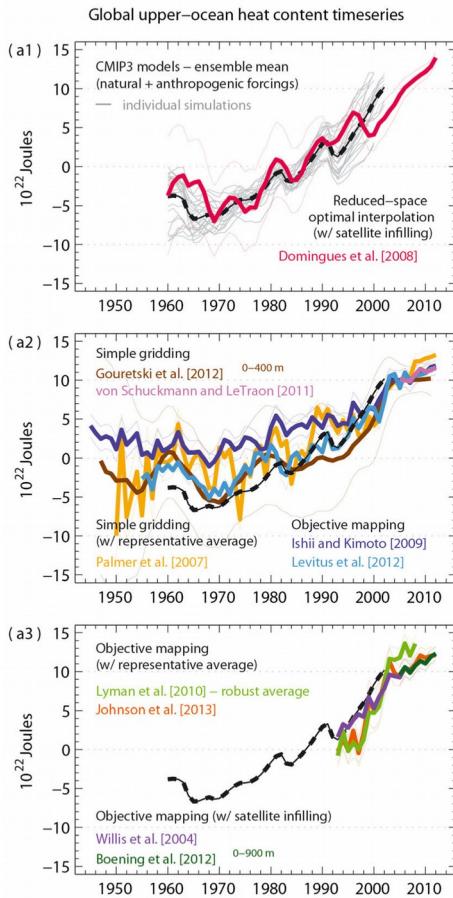
# Context: AMOC / Ocean climate is changing

## North Atlantic Oscillation (NAO)



- *Atmospheric index*
- Explains a large portion of weather variability in NA

# Context: AMOC / Ocean climate is changing

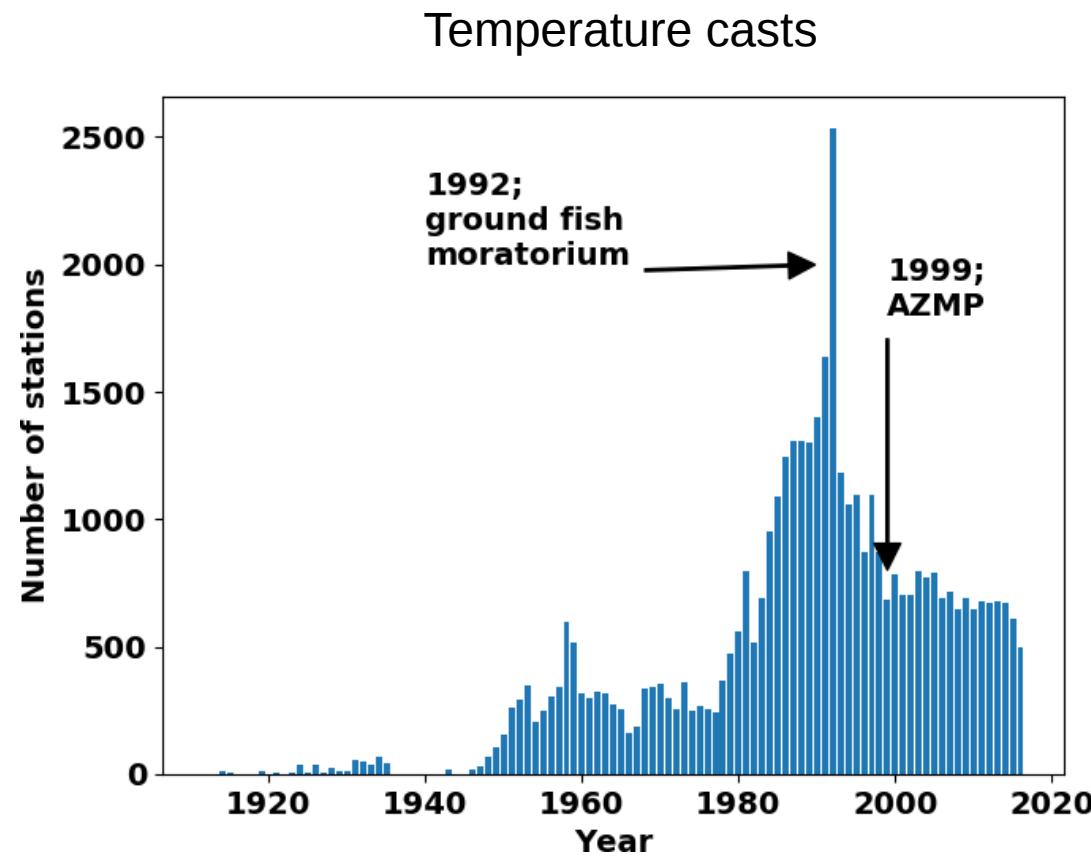
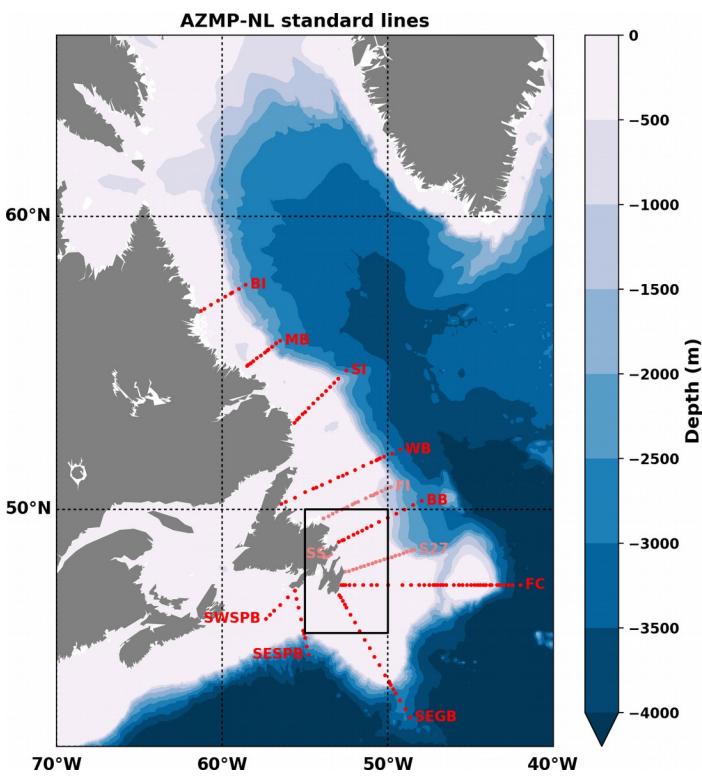


Seidov et al. (2017)

## Ocean Heat Content (OHC)

- General agreement on increase (IPCC);
- 93% of anthropogenic global warming absorbed by the ocean (90% in top 2000m);
- Effect on AMOC and ocean circulation not clear.

# Context: Long history of measurements on NL shelves (physical and biogeochemical)





# The project:

“Northwest Atlantic water masses  
biogeochemistry in a changing climate”

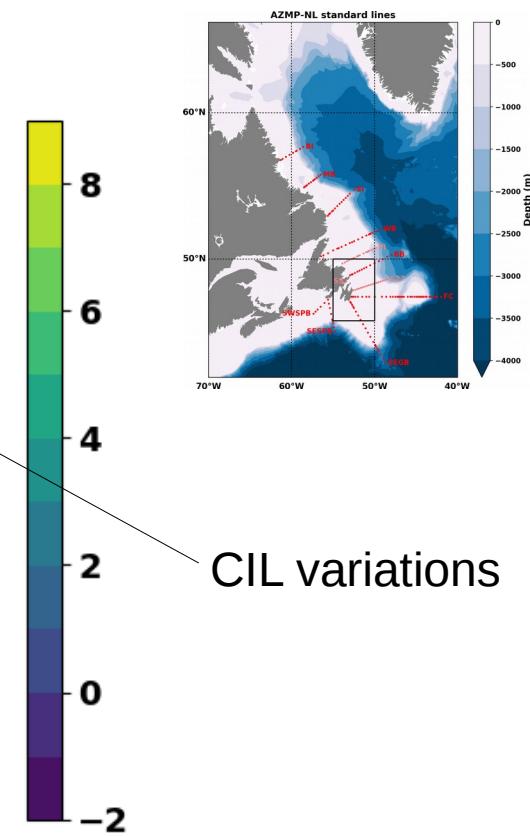
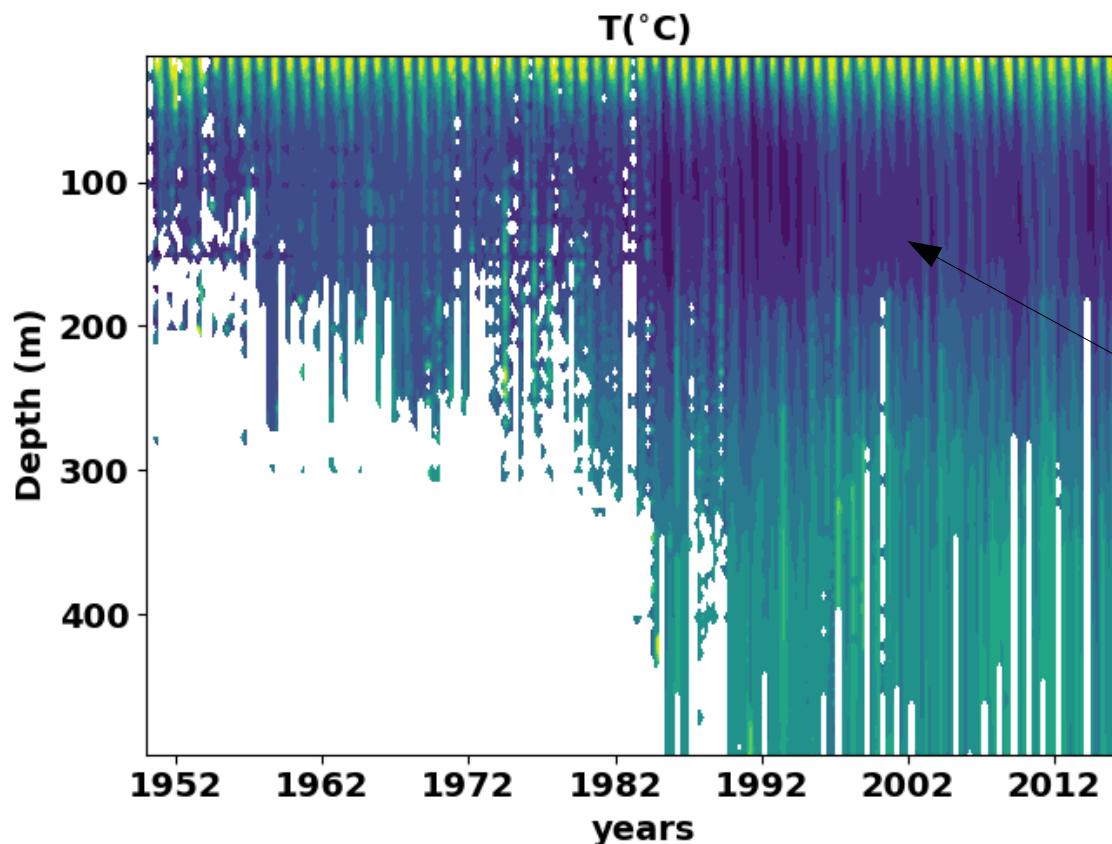
→ Short ACCASP project started Jan. 2018  
(following call for additional projects)



# Preliminary results (physics)

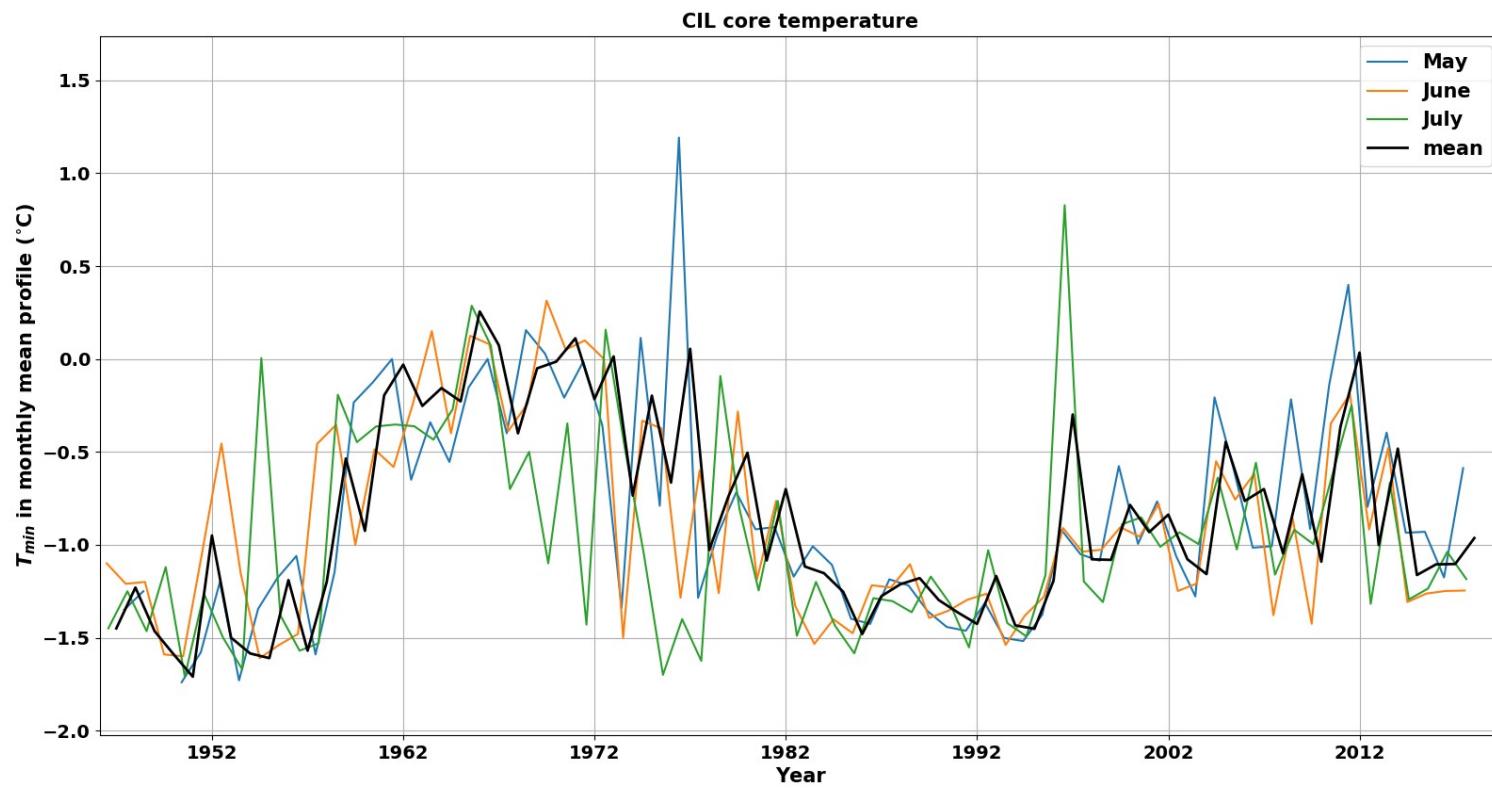


# Interannual temperature field (since 1948)



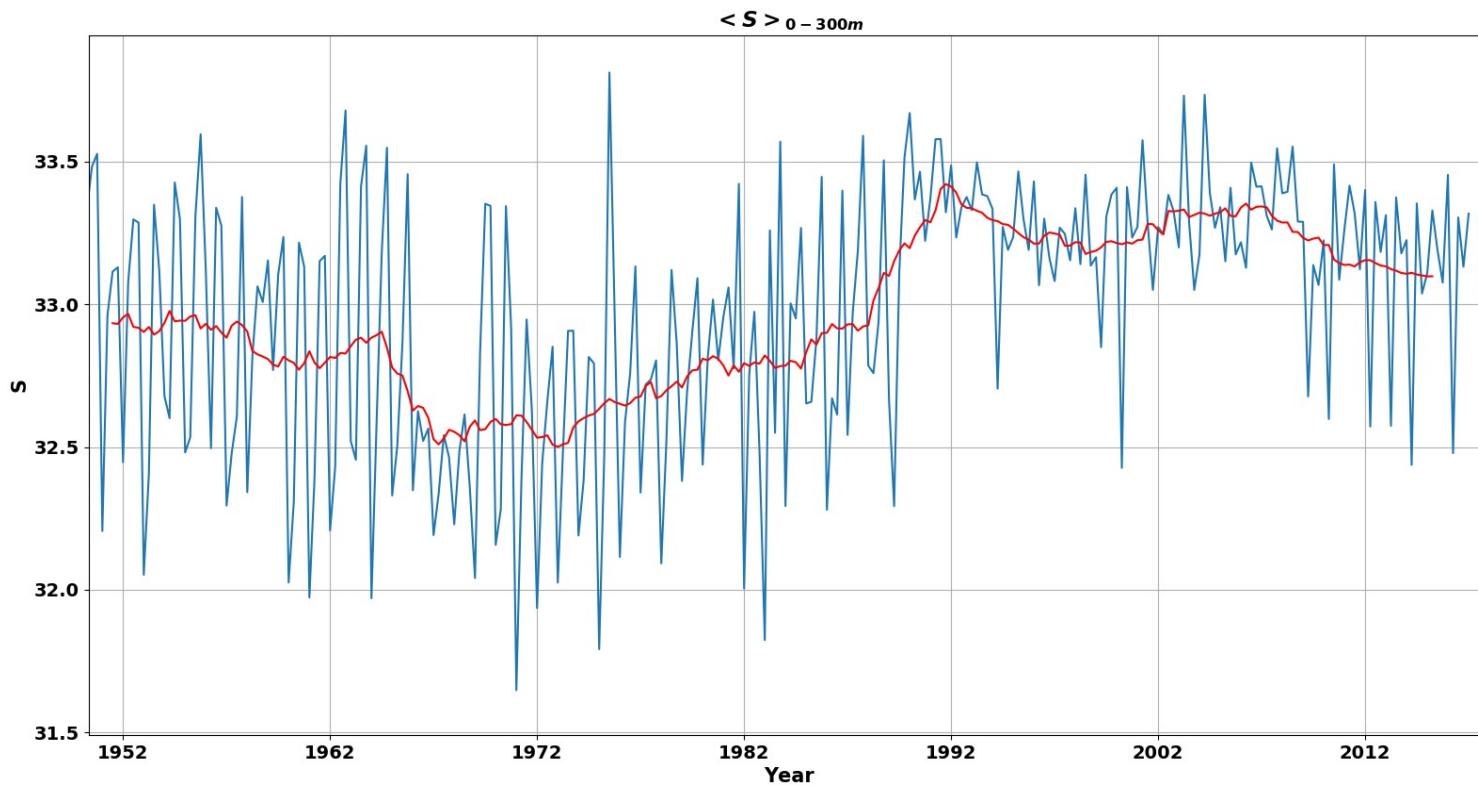


# CIL core temperature





# Salinity (0-300m average)

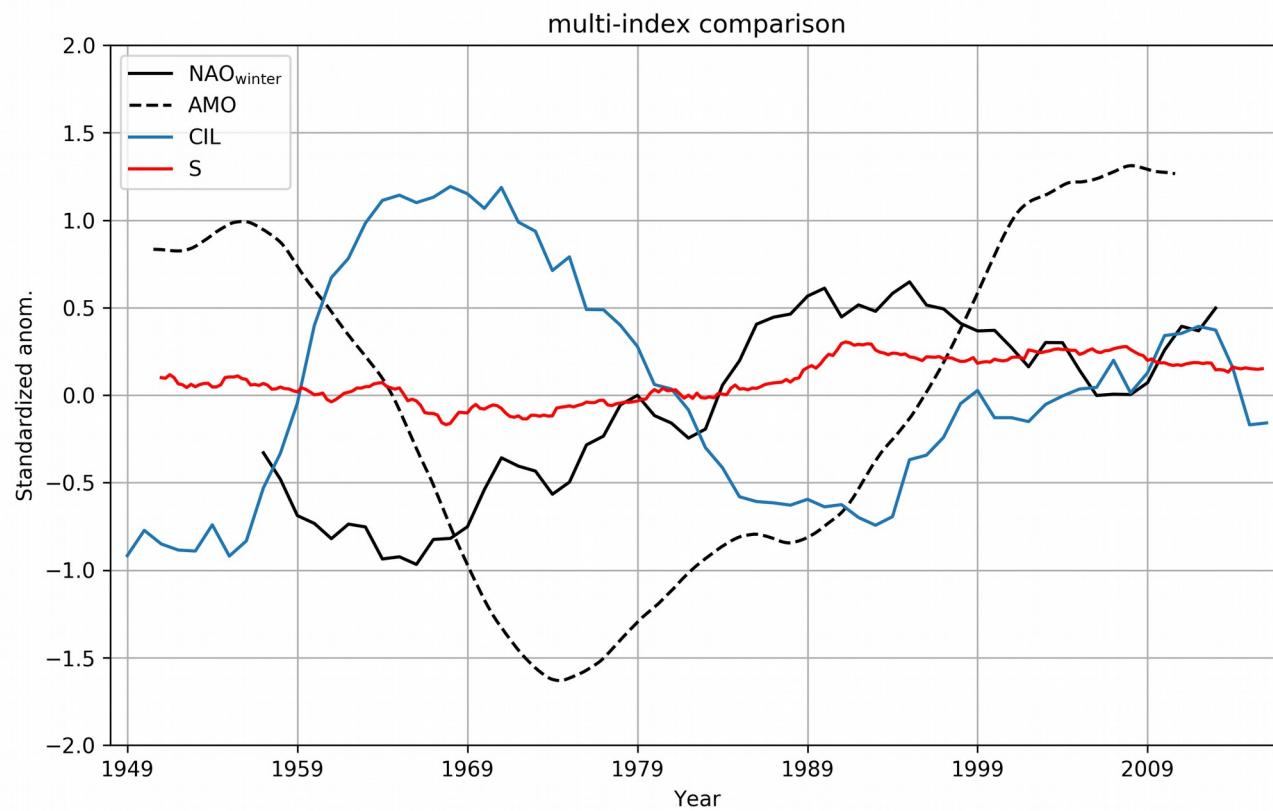




# What are the drivers of this variability?



# What are the drivers?



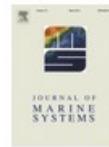


# What are the drivers?



Journal of Marine Systems

Volume 131, March 2014, Pages 21-35



Atlantic Multidecadal Oscillation (AMO) modulates dynamics of small pelagic fishes and ecosystem regime shifts in the eastern North and Central Atlantic

Jürgen Alheit <sup>a</sup>✉, Priscilla Licandro <sup>b</sup>✉, Steve Coombs <sup>c</sup>✉, Alberto Garcia <sup>d</sup>✉, Ana Giráldez <sup>d</sup>✉, Maria Teresa Garcia Santamaría <sup>e</sup>✉, Aril Slotte <sup>f</sup>✉, Athanassios C. Tsikliras <sup>g</sup>✉



# Preliminary results (biogeochemistry; 1999-2017)



# Nitrate/Phosphate ratio

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Oceans

RESEARCH ARTICLE

10.1002/2016JC012244

Key Points:

The data set reveals a large contribution of water from the Canadian Arctic to the southern Labrador shelf.

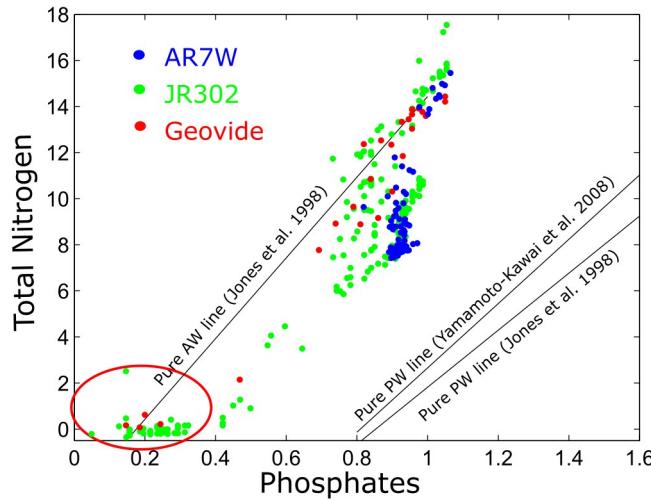
There is evidence of advection of water from the slope region to the midshelf between 55°N and 52°N.

Observations from 1995 and 2008 suggest a higher fraction of brine and Pacific water on the shelf.

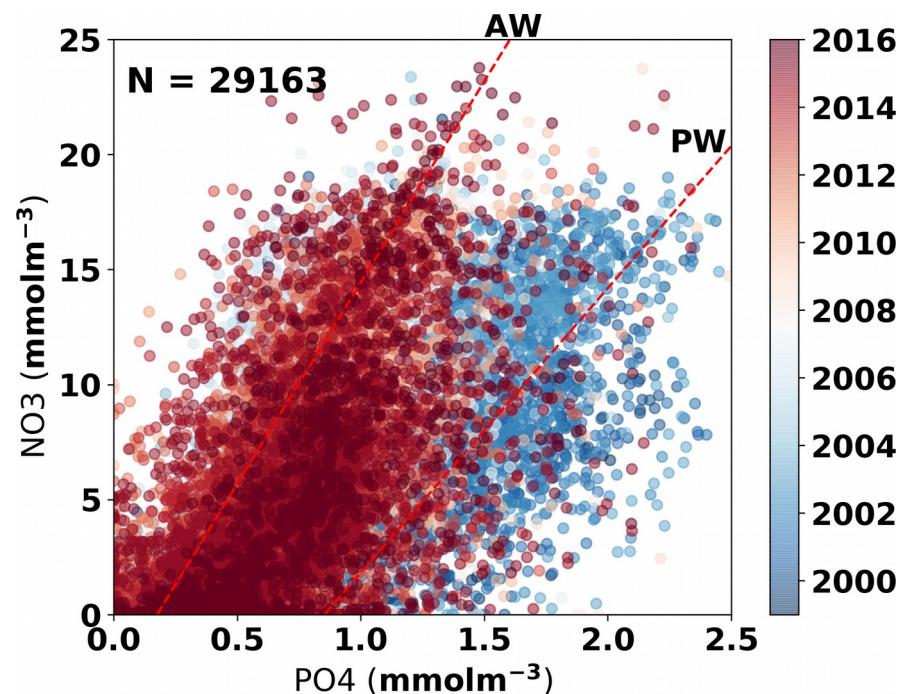
Composition of freshwater in the spring of 2014 on the southern Labrador shelf and slope

M. Benetti<sup>1,2</sup>, G. Reverdin<sup>1</sup>, C. Lique<sup>3</sup>, I. Yashayaev<sup>4</sup>, N. P. Holliday<sup>5</sup>, E. Tynan<sup>5</sup>, S. Torres-Valdes<sup>5</sup>, P. Lherminier<sup>3</sup>, P. Tréguer<sup>6</sup>, and G. Sarthou<sup>6</sup>

<sup>1</sup>Sorbonne Université (UPMC), Univ Paris 06-CNRS-IRD-ANHN, LOCEAN Laboratory, Paris, France, <sup>2</sup>Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland, <sup>3</sup>Ifremer, Univ. Brest, CNRS, IRD, Laboratoire d'Océanographie Physique et Spatiale (LOPS), Ifremer, F-29280, Plouzané, France, <sup>4</sup>Department of Fisheries and Oceans, Ocean Sciences Division, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, <sup>5</sup>National Oceanography Centre, Southampton, UK, <sup>6</sup>Laboratoire des Sciences de l'Environnement Marin (UMR 6539 CNRS/UBO/IRD/Ifremer), Plouzané, France



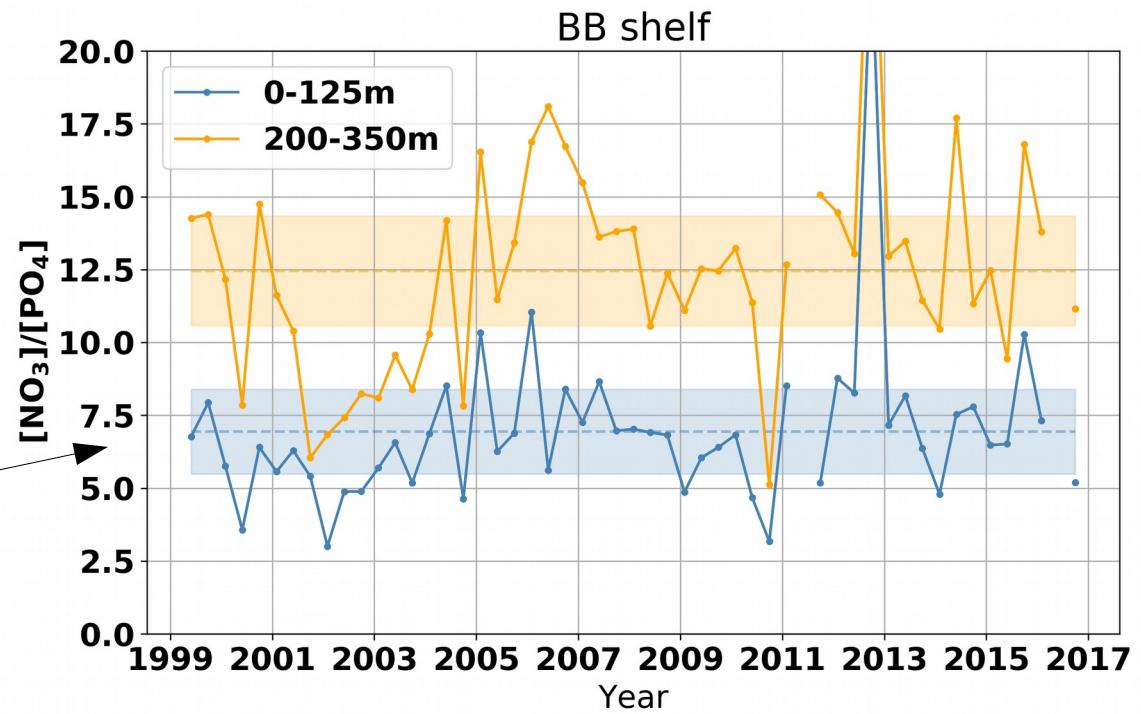
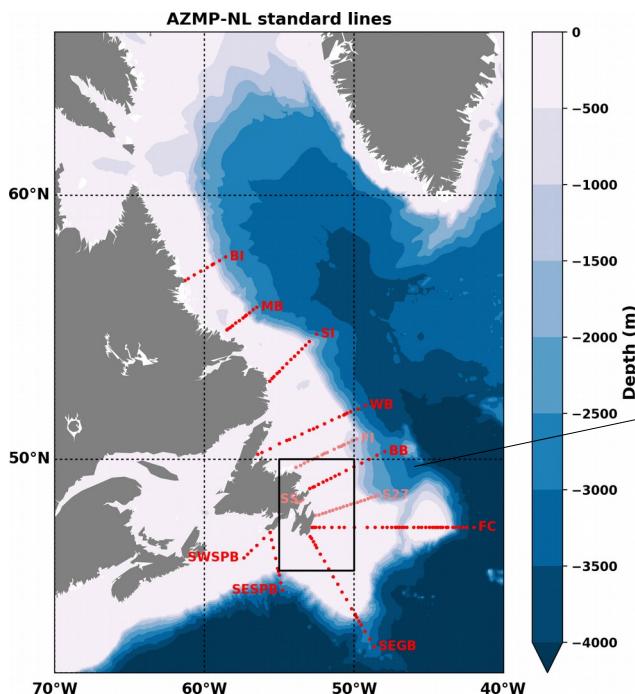
Benetti et al. (2017)



Canada



# Nitrate/Phosphate ratio

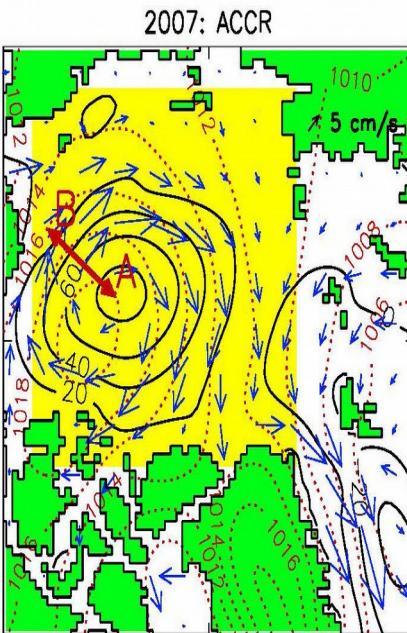
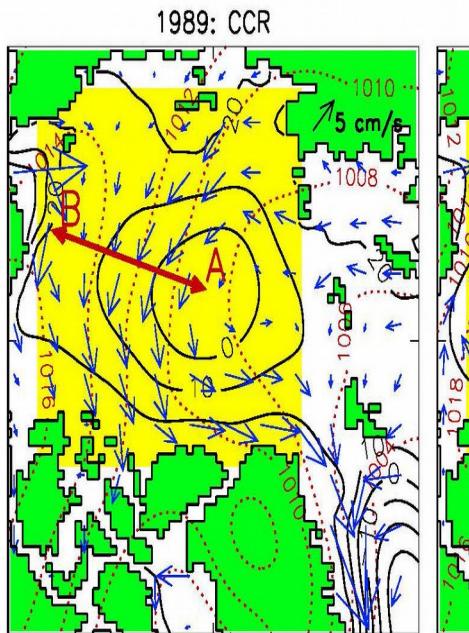




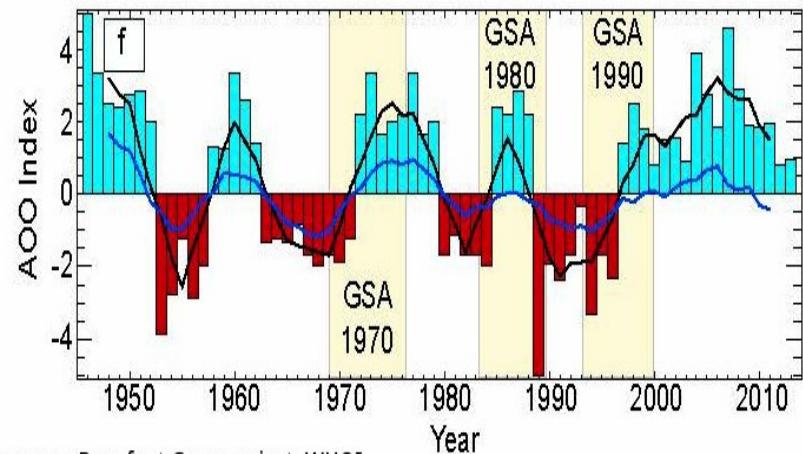
# What are the drivers of this variability?

# What are the drivers?

## Arctic Ocean Oscillation (AOO $\neq$ AO)



+



source: Beaufort Gyre project, WHOI

Source: Beaufort Gyre project, WHOI

- Index based on wind-driven SSH patterns (cyclonic / Anticyclonic)
- Explains a large portion of freshwater export from Arctic (e.g. nutrient-rich waters)



# Next step (work in progress)

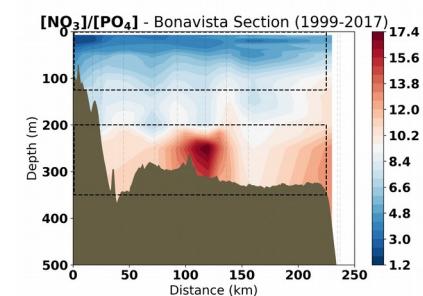
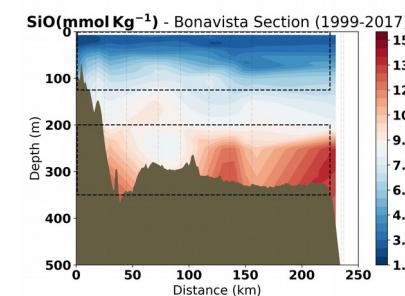
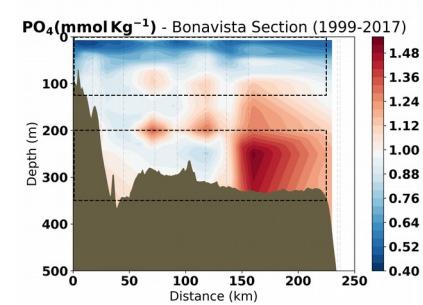
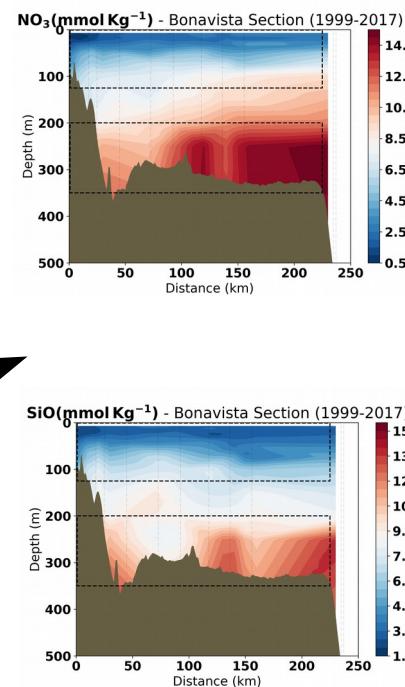
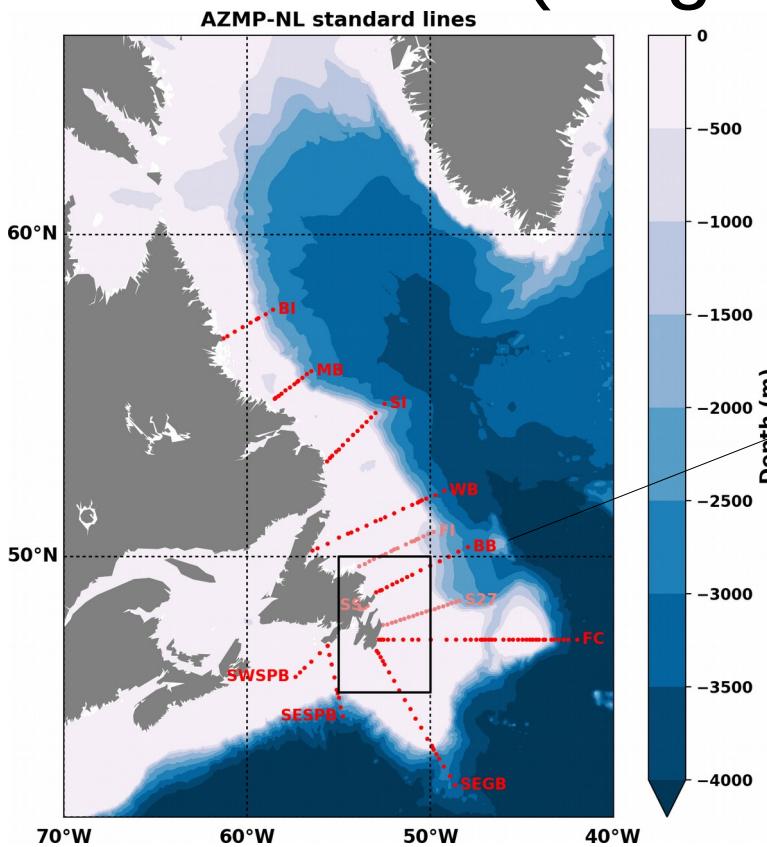
**Use Empirical Orthogonal Functions (EOFs) and Principal Components (PCs) analysis to get insights on spatio-temporal changes and their link with known large-scale patterns (AMO, NAO, AOO, etc.)**



# Thanks!

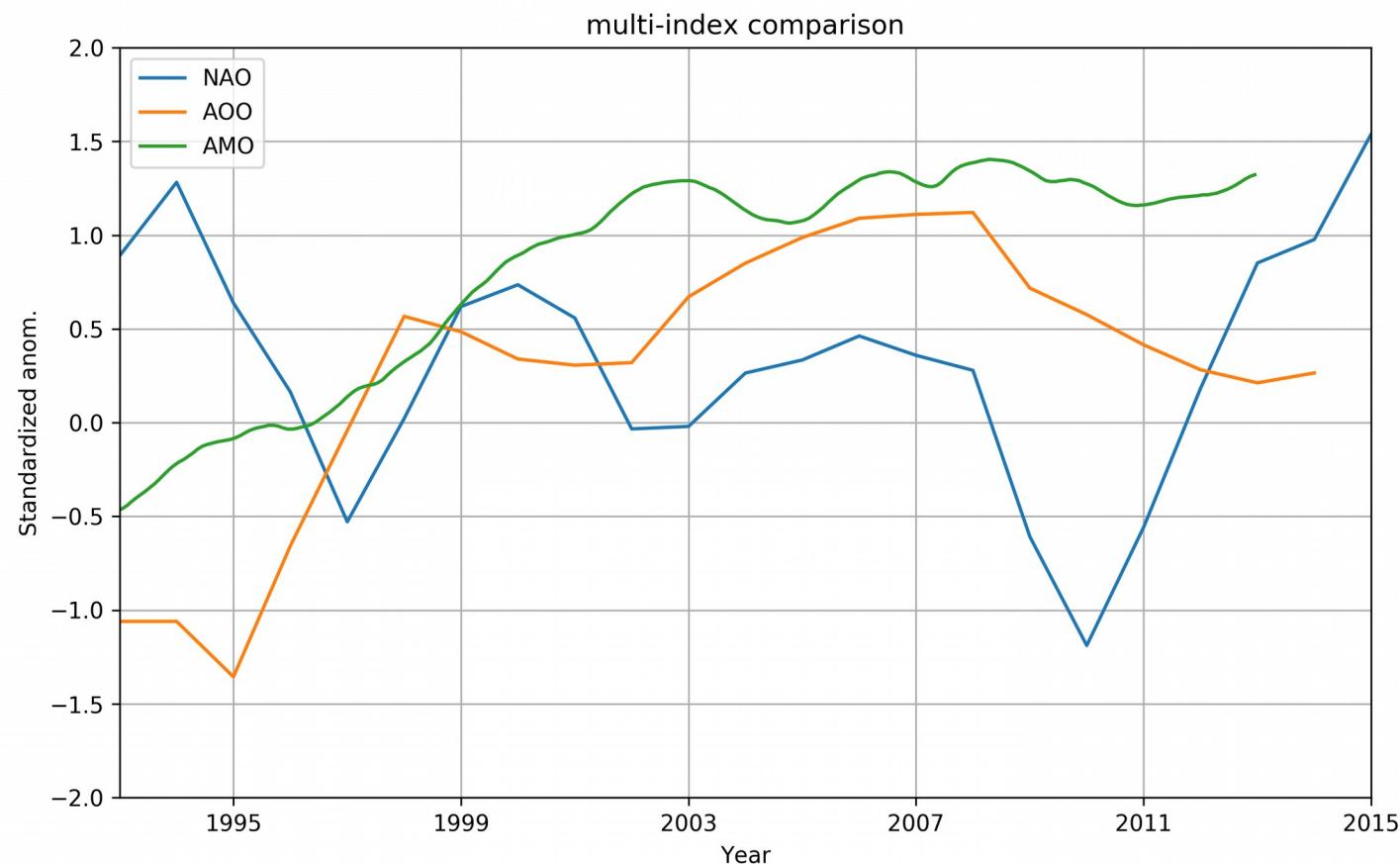
Special thanks to J. Holden, G. Maillet & cie

# Preliminary results (biogeochemistry)



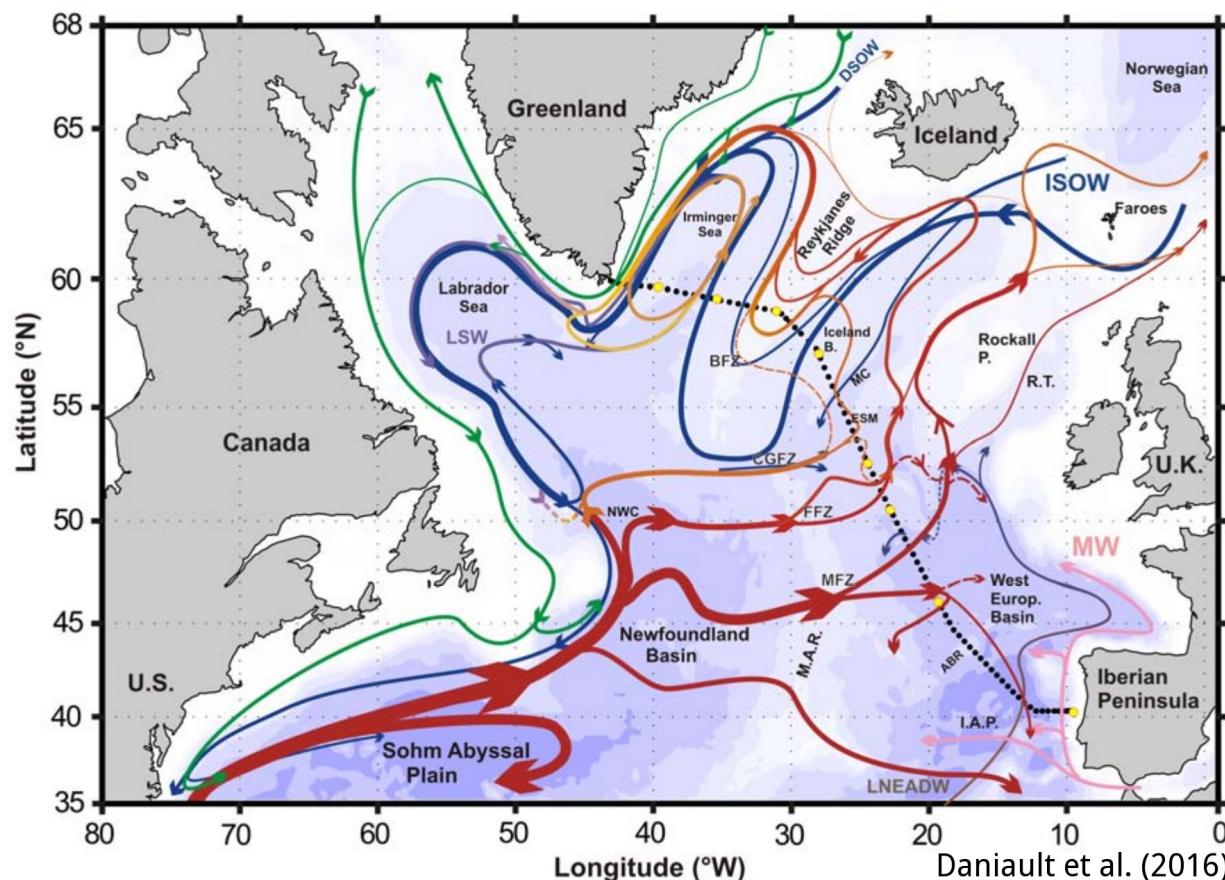


# Nitrate/Phosphate ratio



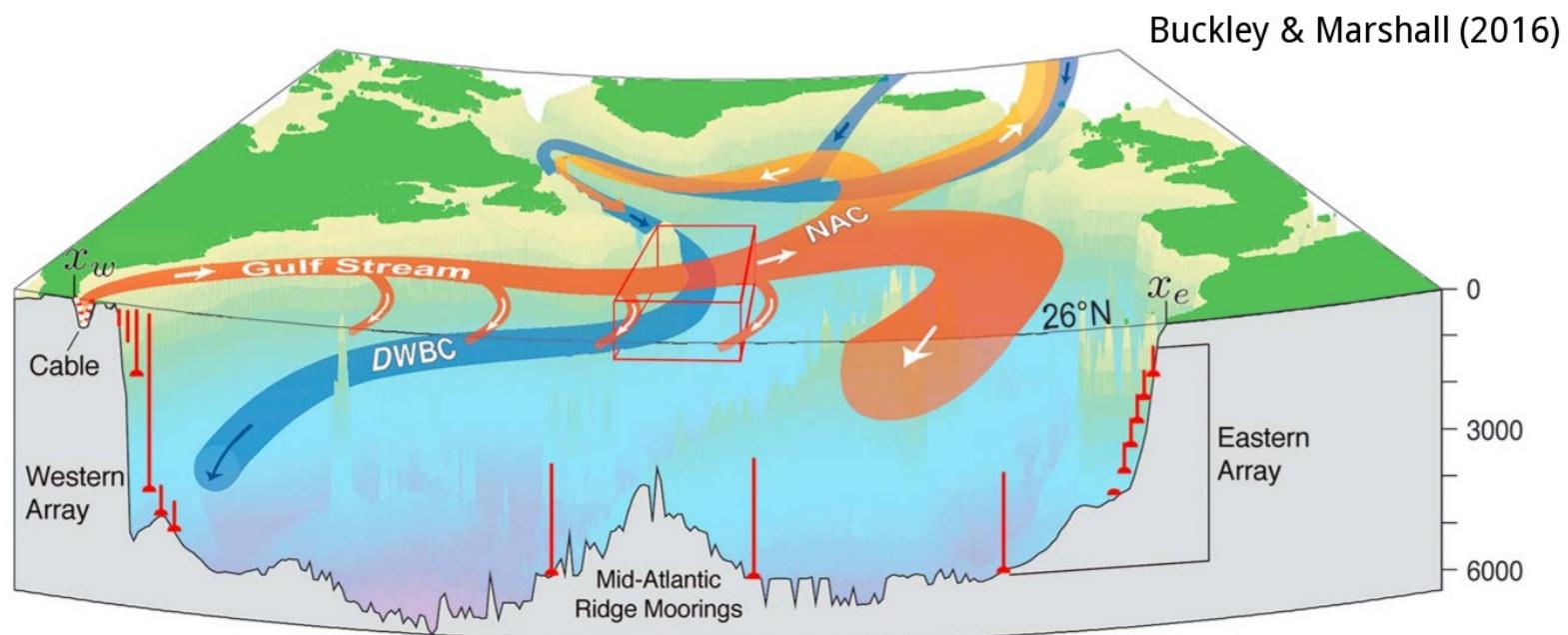


# Context: NL shelves a crossroads of Atlantic Ocean circulation



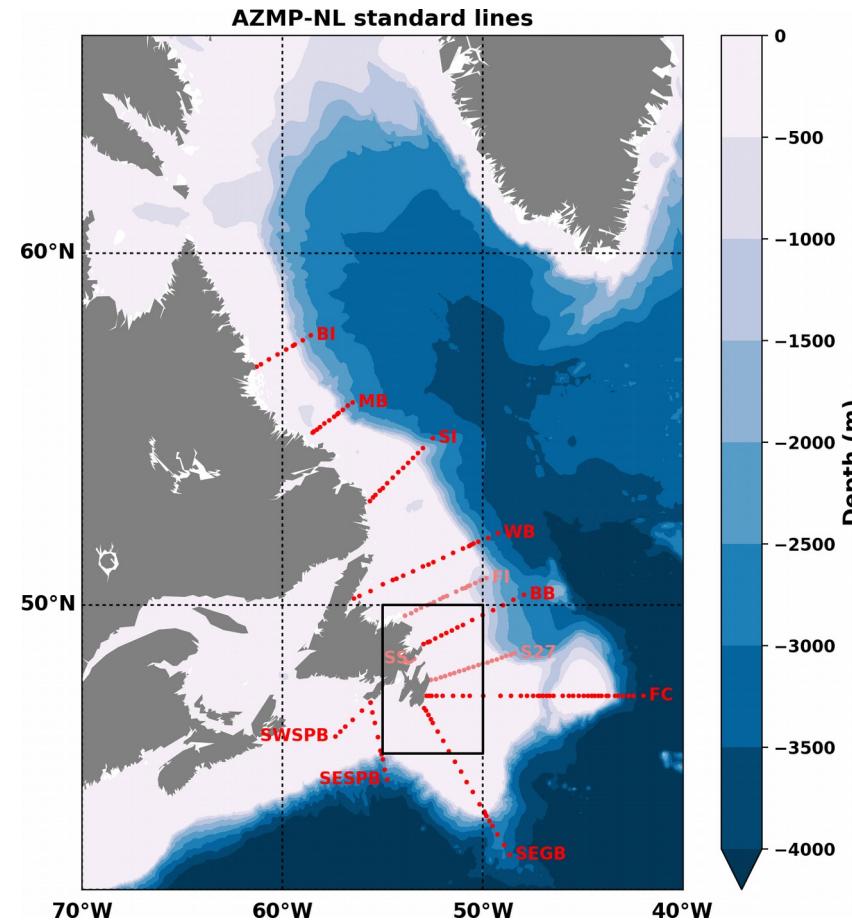


# Context: Atlantic Meridional Ocean Circulation (AMOC)



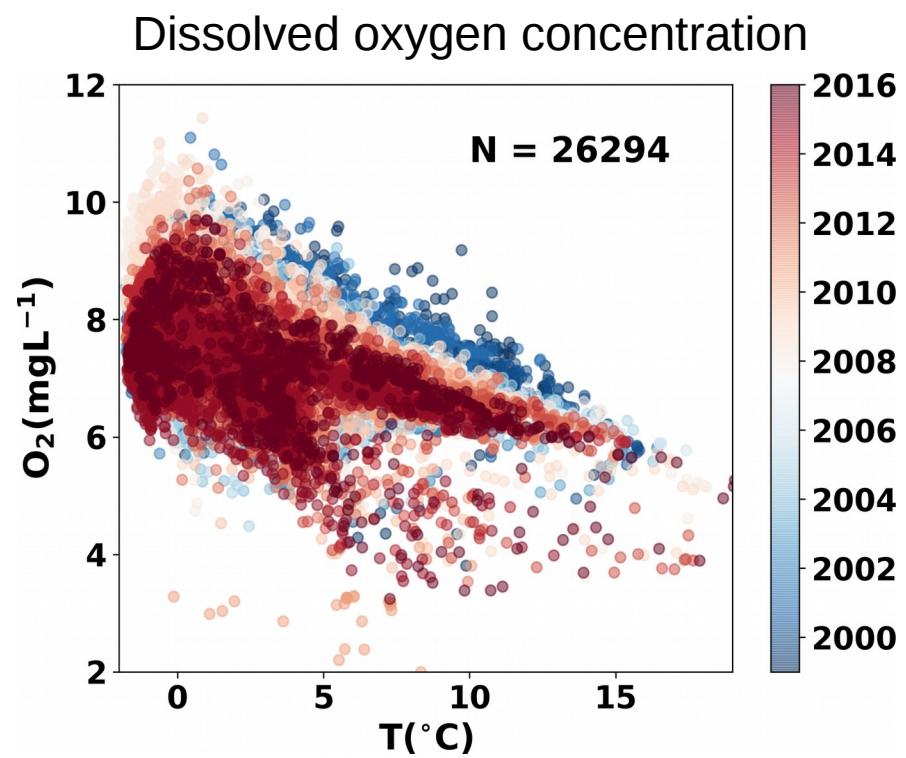
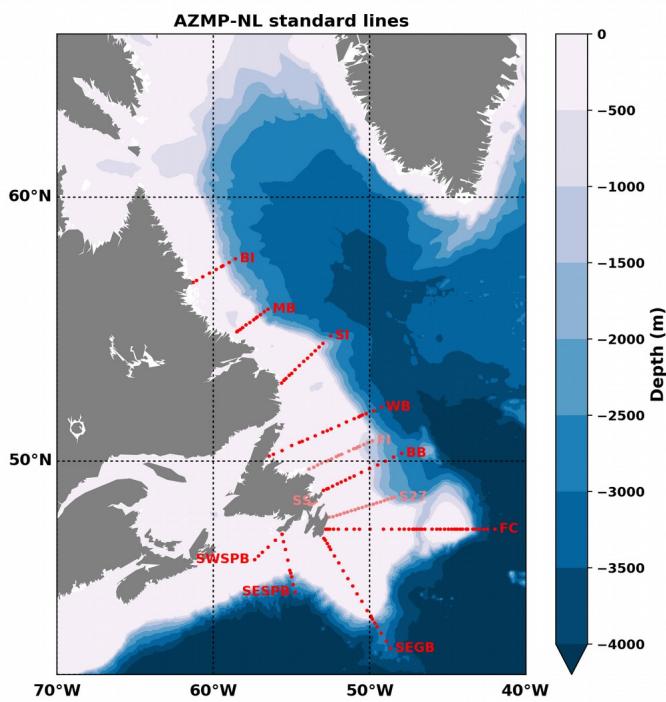


# Context: Long history of measurements on NL shelves (physical and biogeochemical)



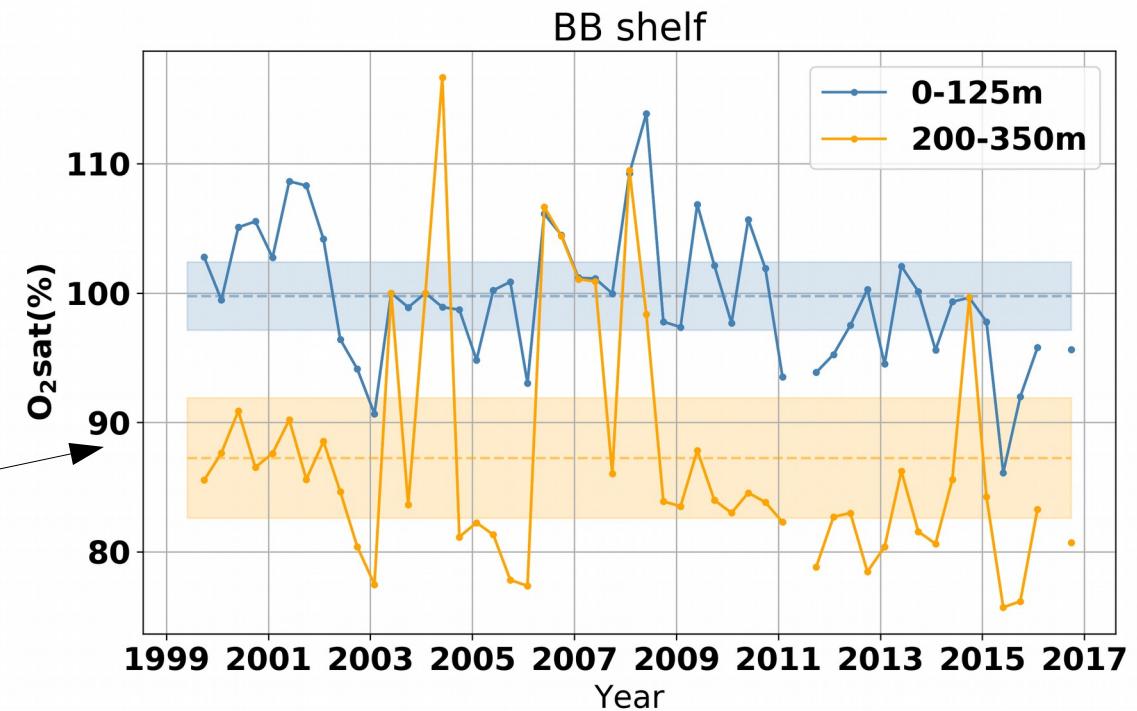
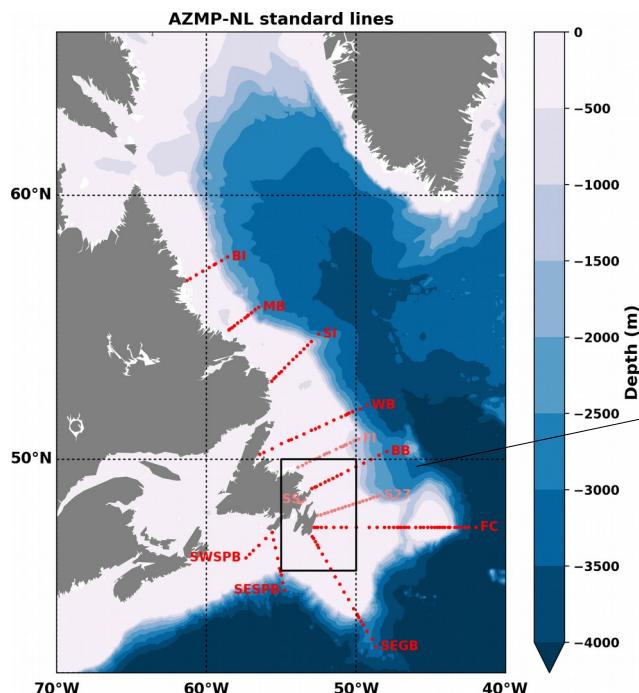


# AZMP data, 1999-2017

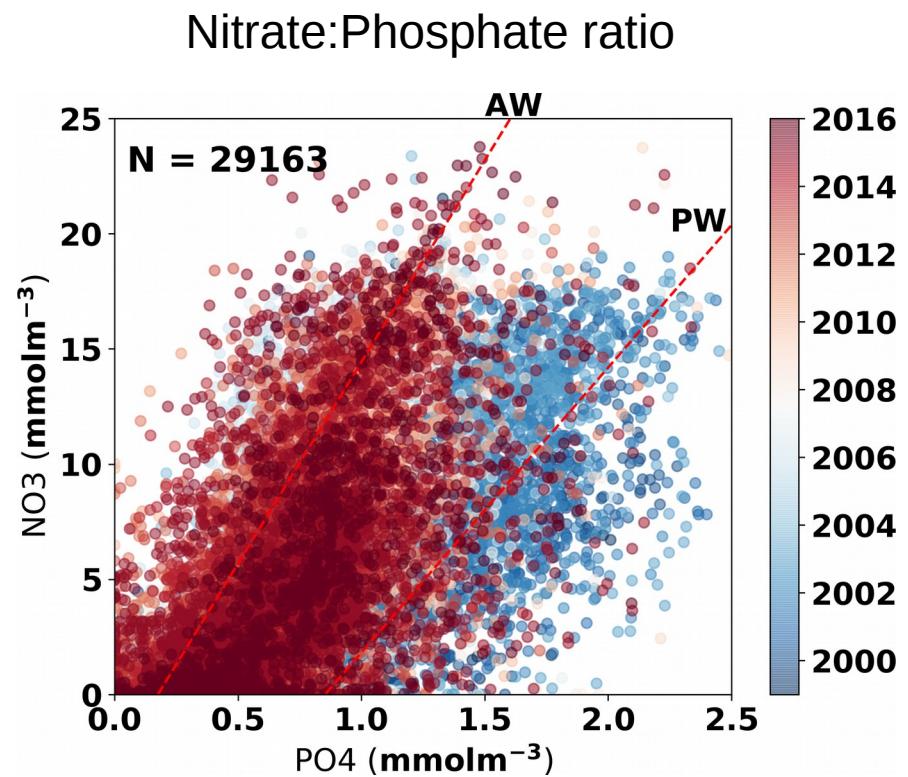
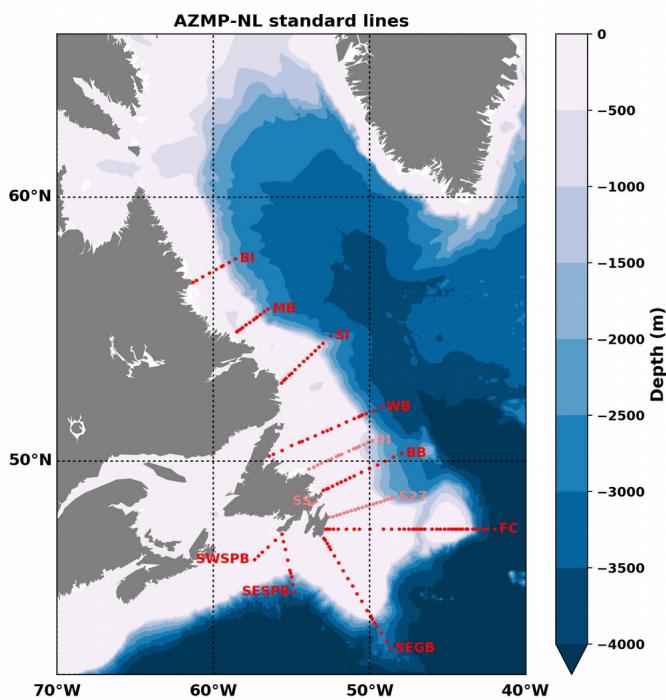




# Dissolved oxygen concentration

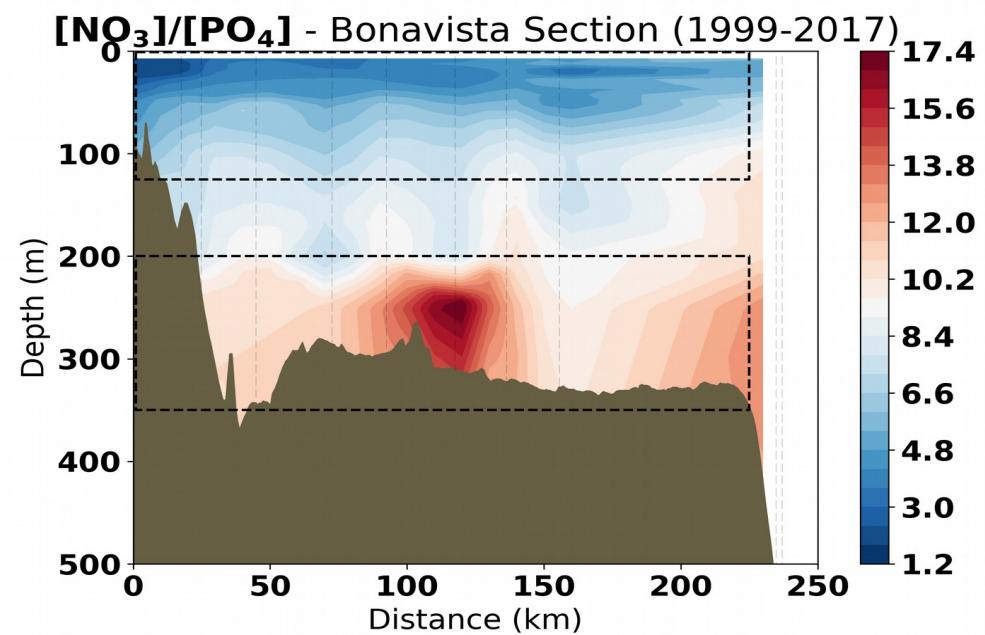
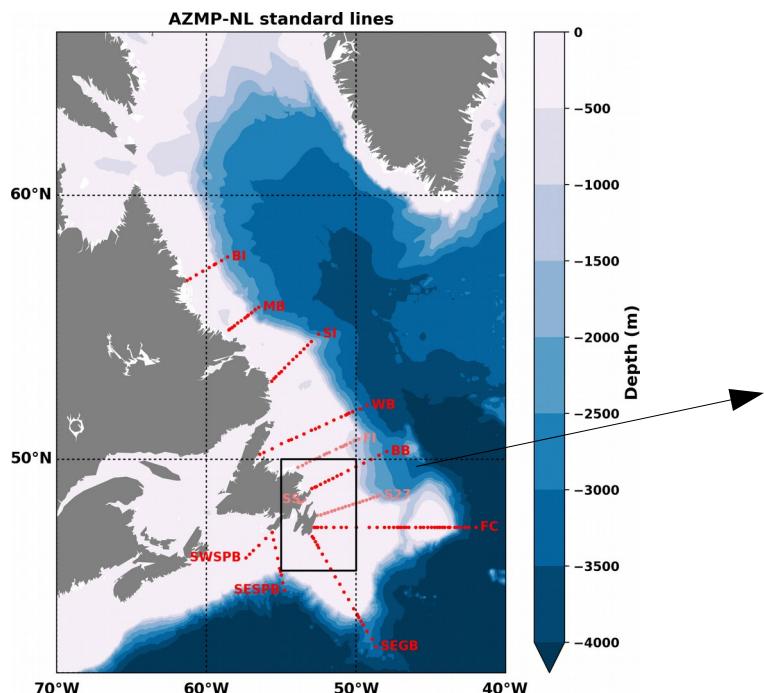


# Preliminary results (biogeochemistry, 1999-2017)



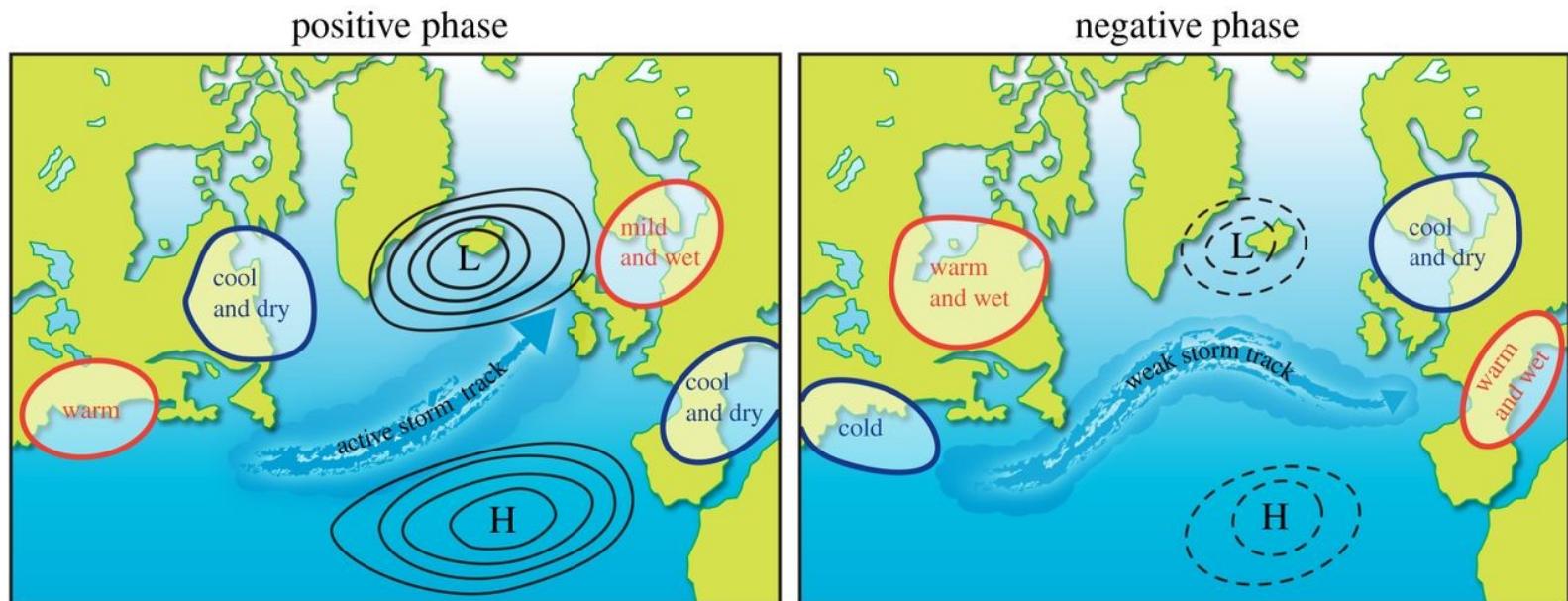


# Nitrate/Phosphate ratio



# Context: Atmospheric forcing changes too

## North Atlantic Oscillation

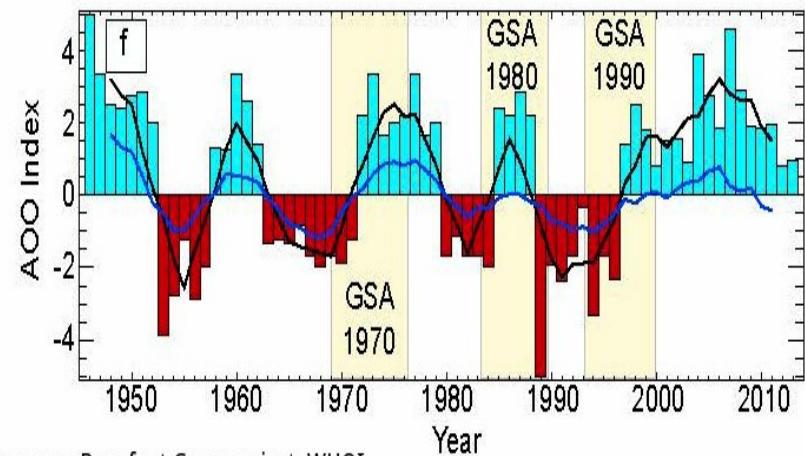
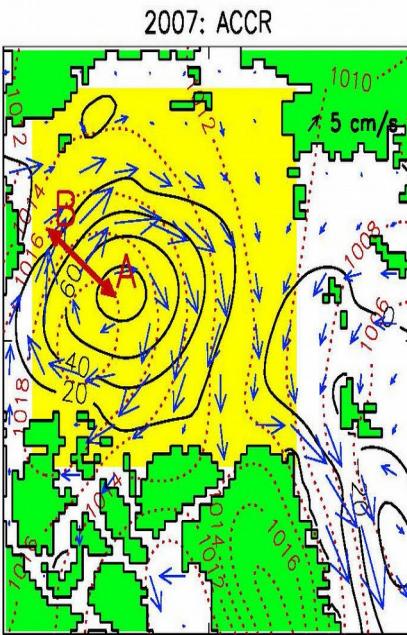
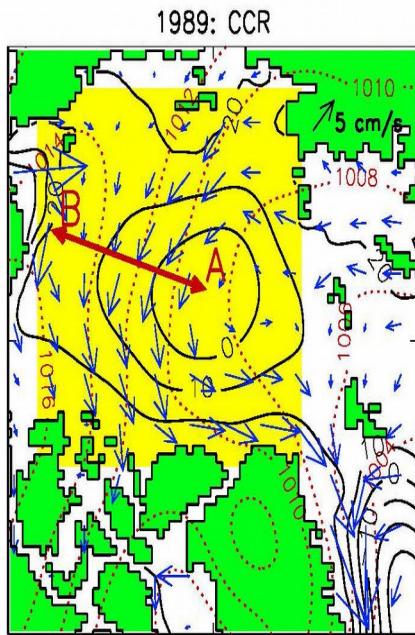


Dunstone (2014)

- *Atmospheric index*

# What are the drivers?

## Arctic Ocean Oscillation (AOO ≠ AO)



source: Beaufort Gyre project, WHOI

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- Index based on wind-driven SSH patterns (cyclonic / Anticyclonic)
- Explains a large portion of freshwater export from Arctic (e.g. nutrient-rich waters)