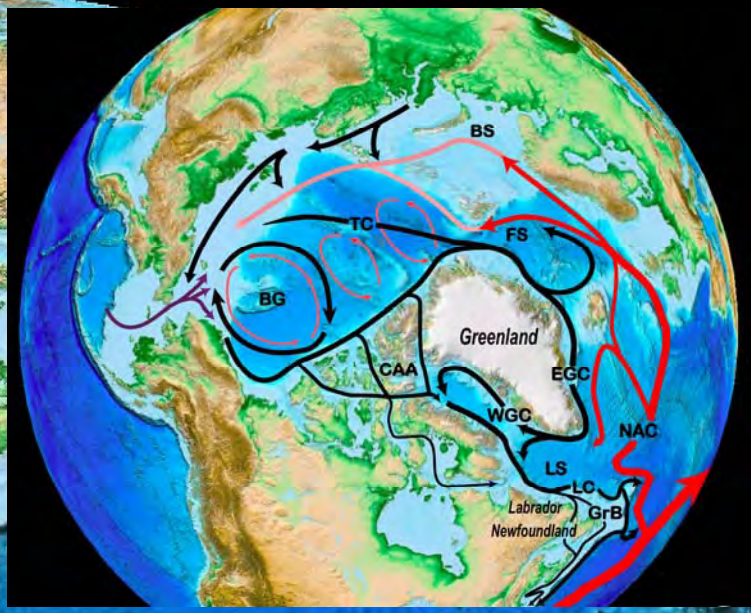
Remote Climate Forcing of Northwest Atlantic Shelf Ecosystems

MERCINA*

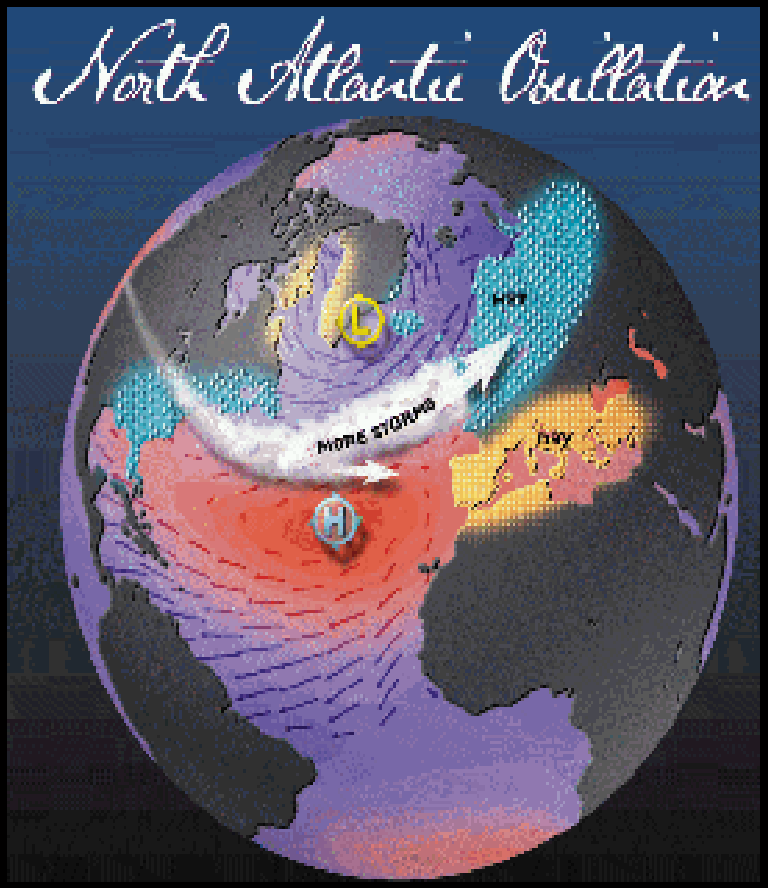
*Marine Ecosystem Responses to Climate in the North Atlantic

US GLOBEC
NW Atlantic/Georges Bank Field Study



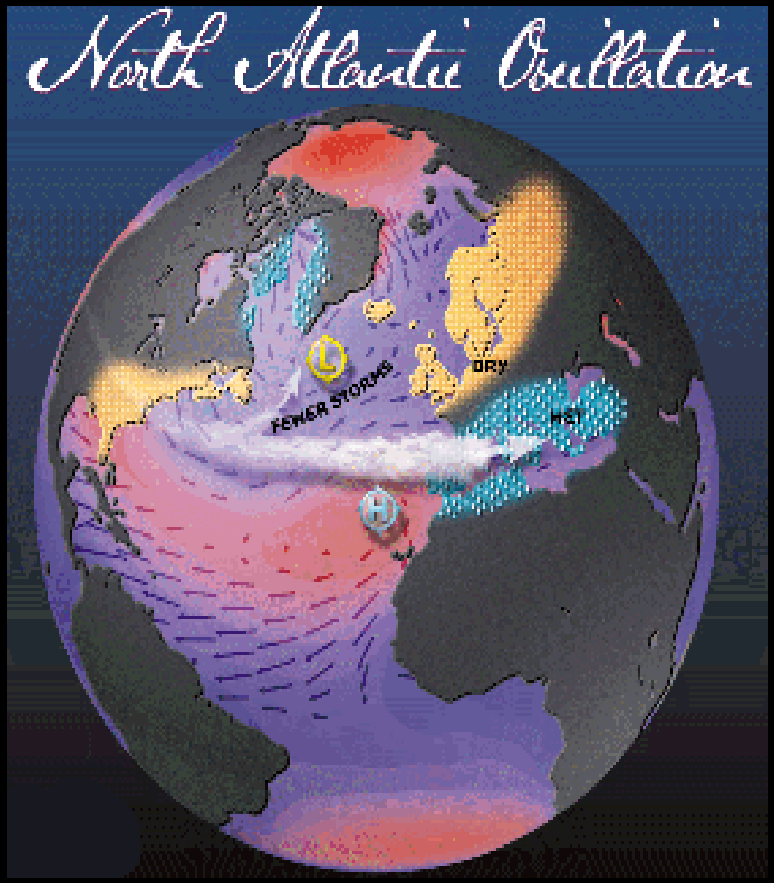
Gulf of Maine/Georges Bank region is an oceanographic transition zone in the NW Atlantic.

The North Atlantic Oscillation (NAO)



NAO +

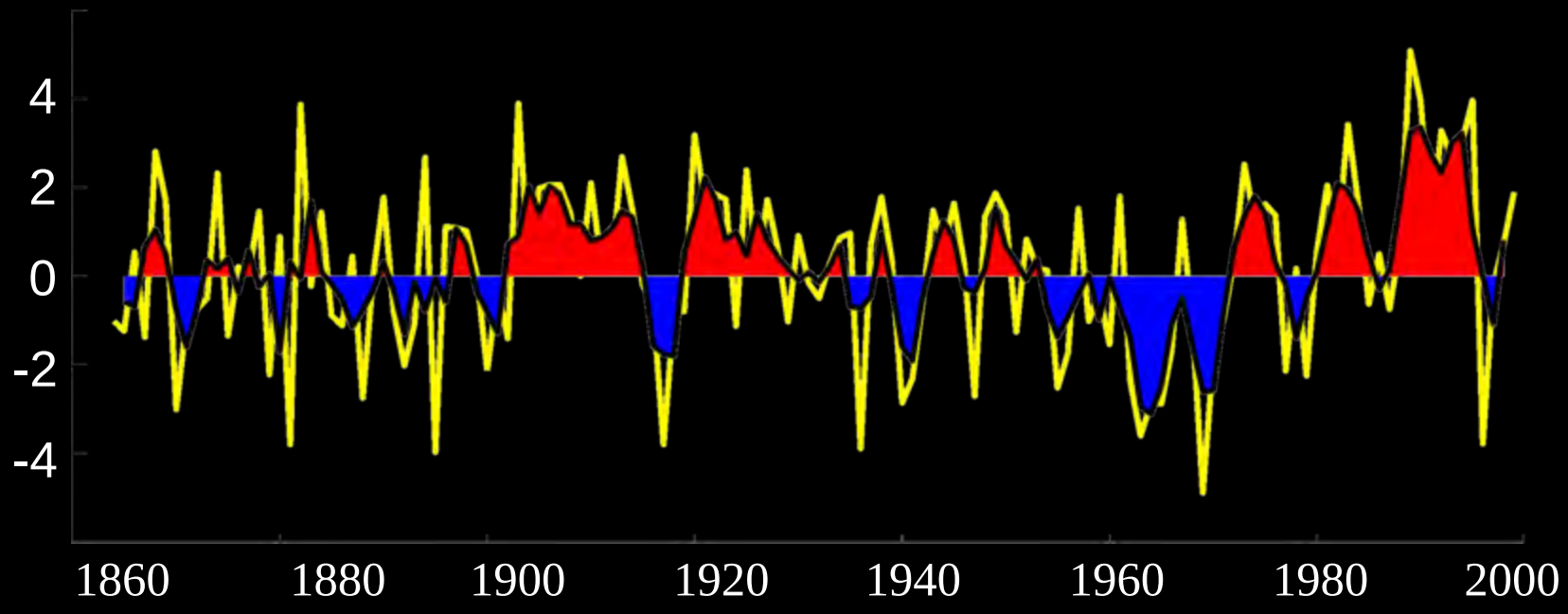
- Strong H and L pressure cells
- Westerlies strengthen
- Storm track shifts North



NAO -

- Weak H and L pressure cells
- Westerlies weaken
- Storm track shifts South

The Winter NAO Index



North Atlantic Ocean Circulation Responses to the NAO

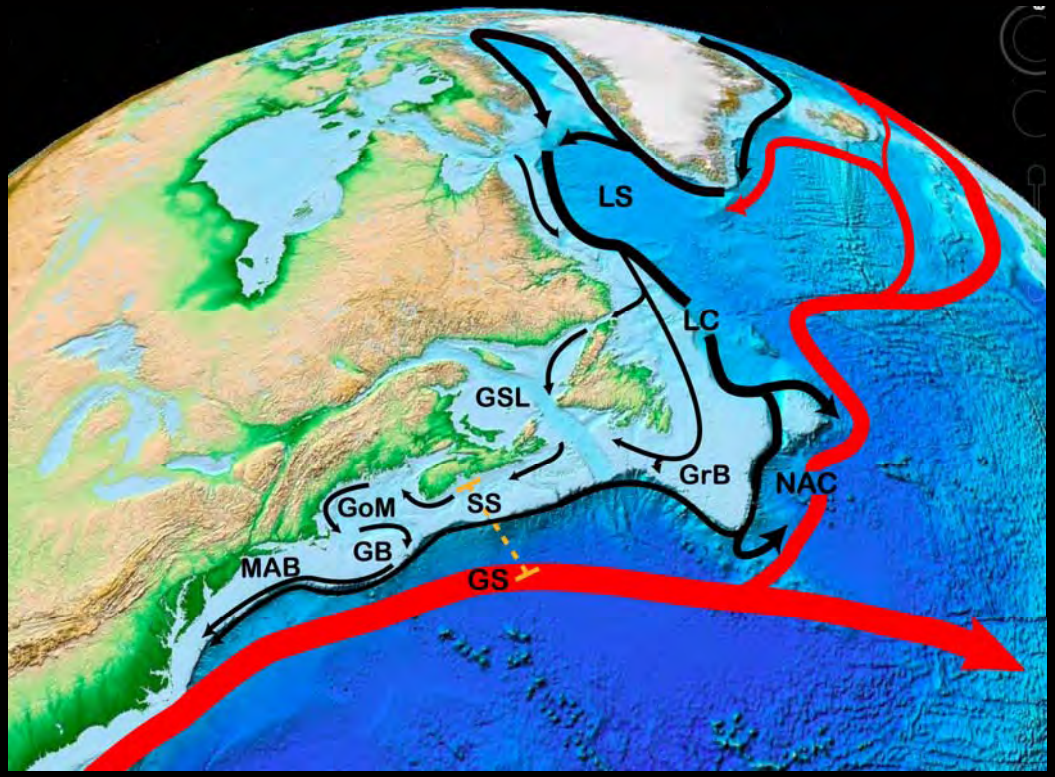
Emphasis on NW Atlantic

NAO +

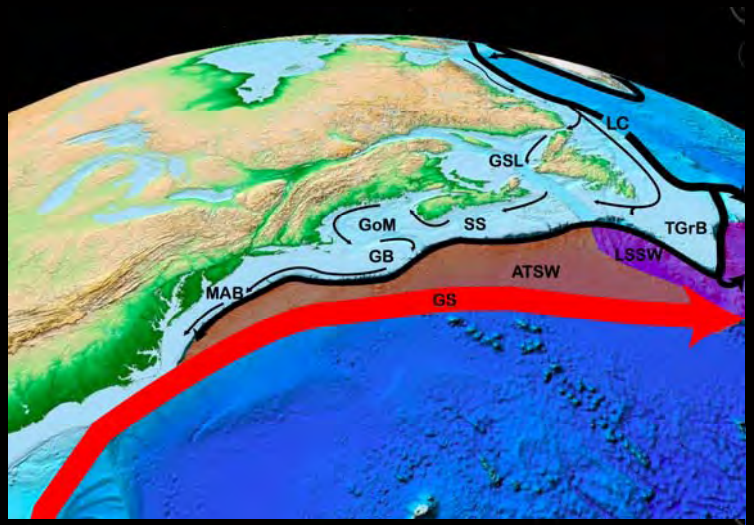
- Enhanced production of LSW and intensification of DWBC
- Labrador Current transport around Tail of Grand Bank weakens
- Gulf Stream north wall shifts North

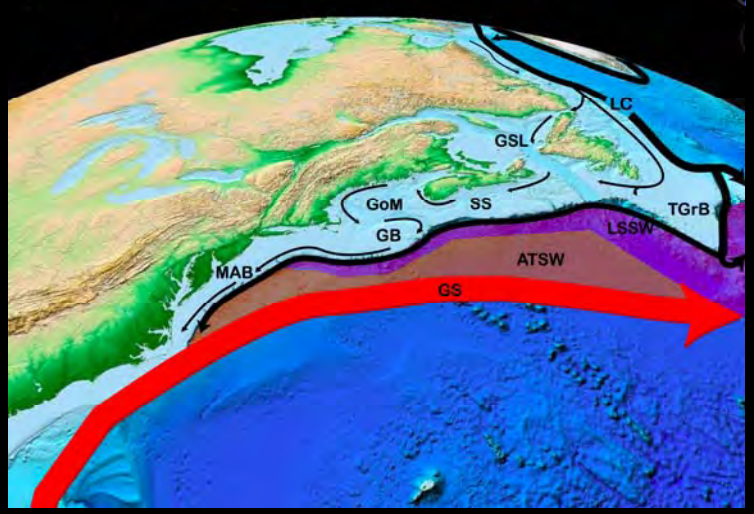
NAO -

- Reduced production of LSW and weakening of DWBC
- Labrador Current transport around Tail of Grand Bank intensifies
- Gulf Stream north wall shifts South



NW Atlantic's Coupled Slope Water System





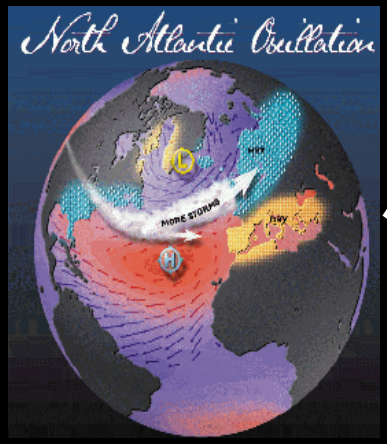
- **Maximum Modal State**
  Associated with NAO +

- **Minimum Modal State**
  Associated with NAO -

MERCINA. 2001. Oceanographic responses to climate in the Northwest Atlantic. Oceanography 14: 77-83.

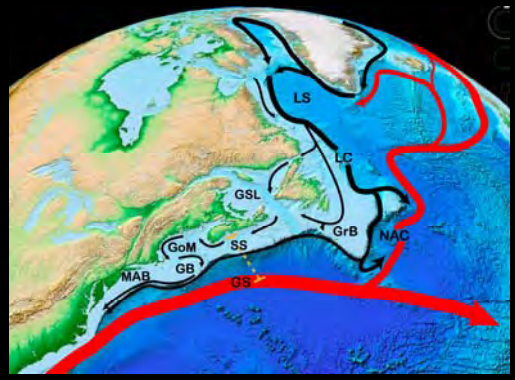
Complex Linkages

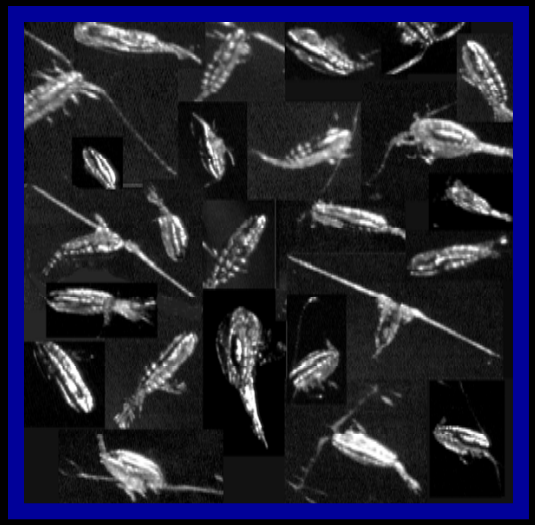
right whales



climate

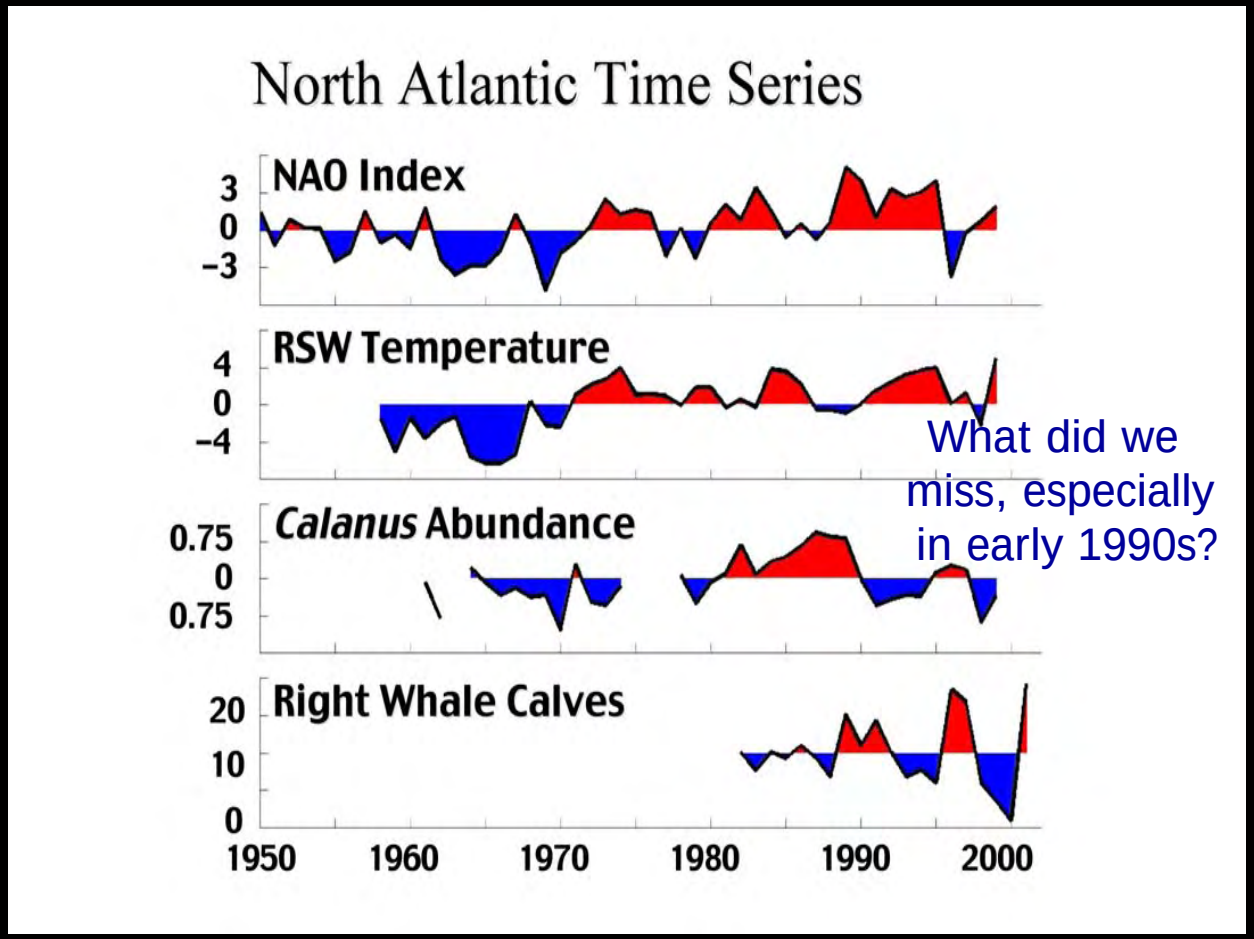
physical oceanography



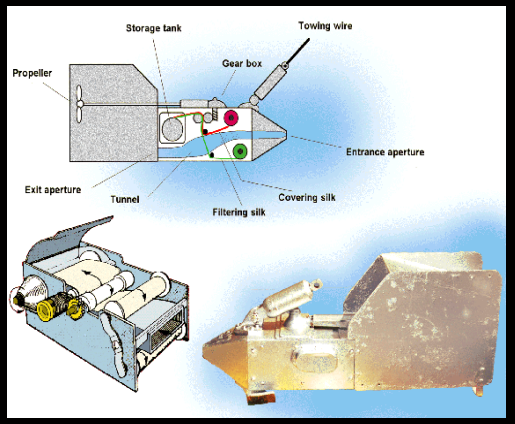


Calanus

North Atlantic Time Series



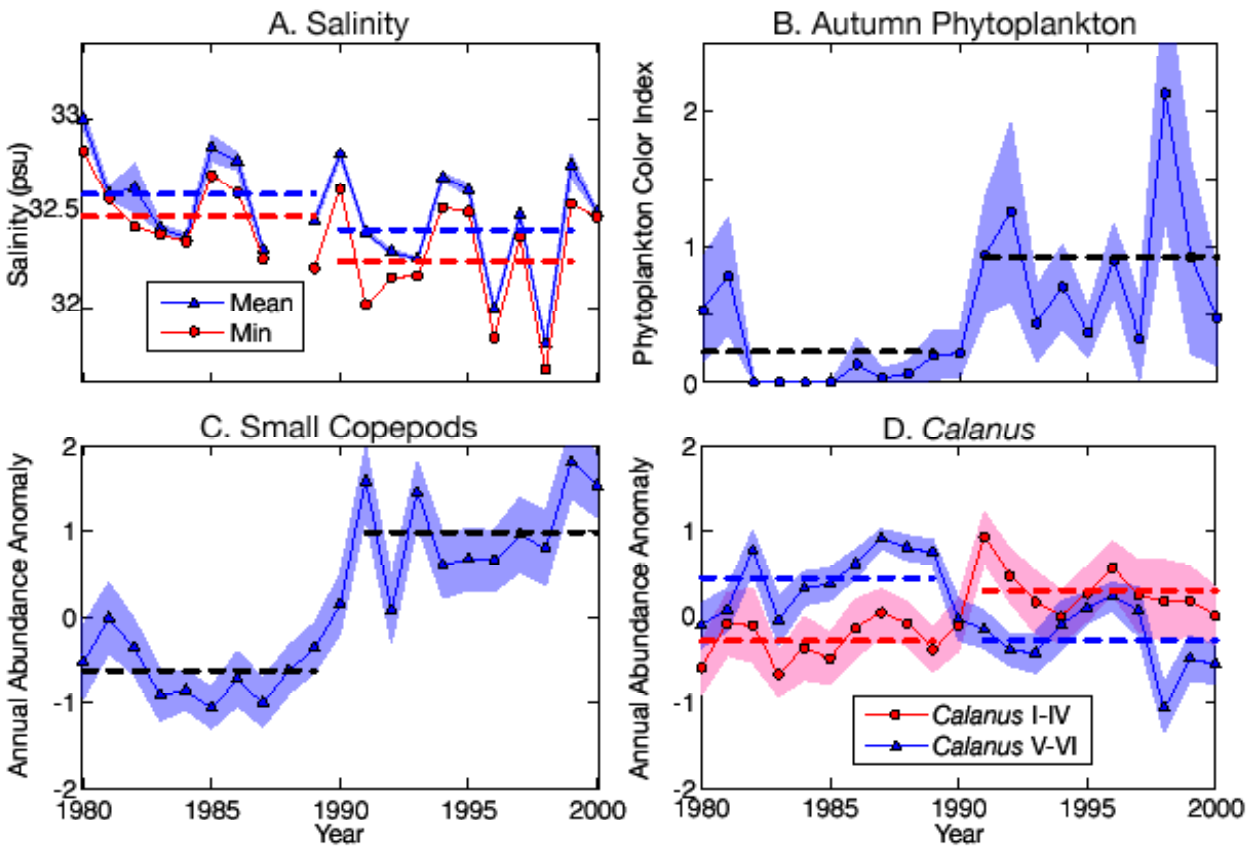
What did we miss, especially in early 1990s?



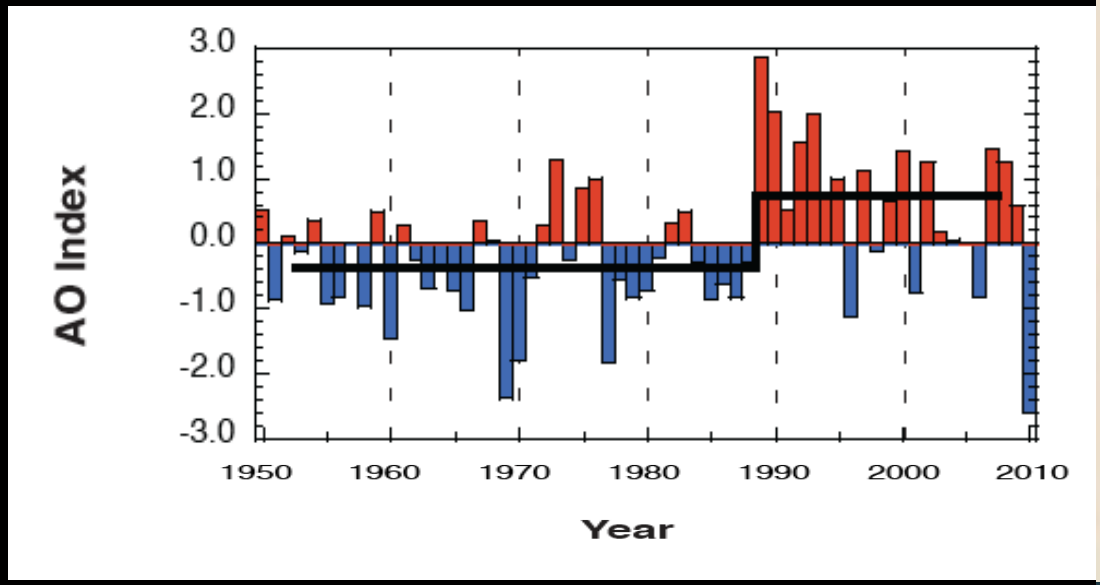
Gulf of Maine CPR survey conducted by NMFS.

Right whale survey conducted by New England Aquarium.

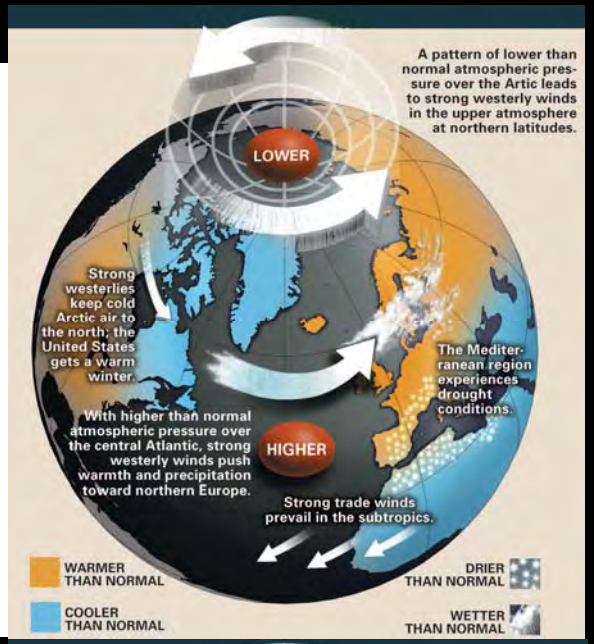
Ecosystem Regime Shift in the NW Atlantic



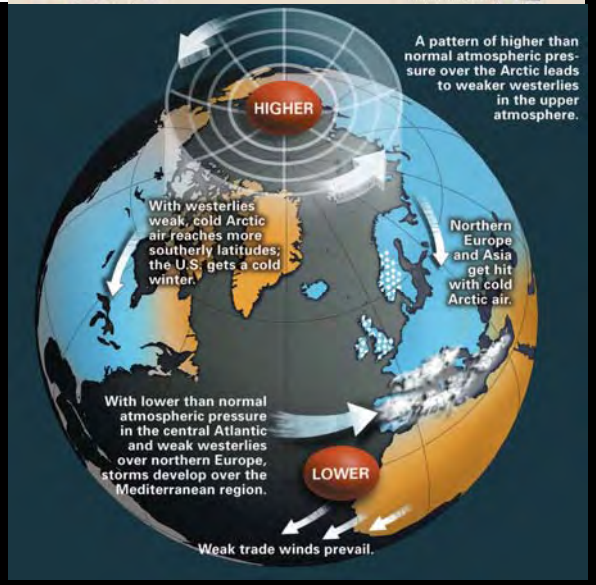
Arctic Oscillation



AO+



AO-



- Dominant pattern of winter sea-level pressure (SLP) variations in high latitudes of Northern Hemisphere.

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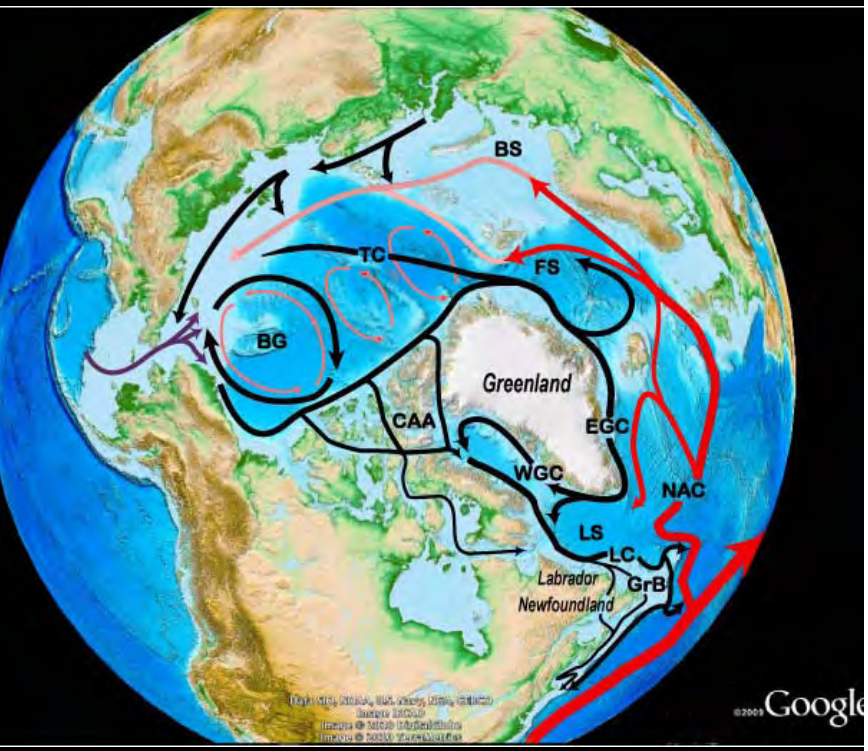
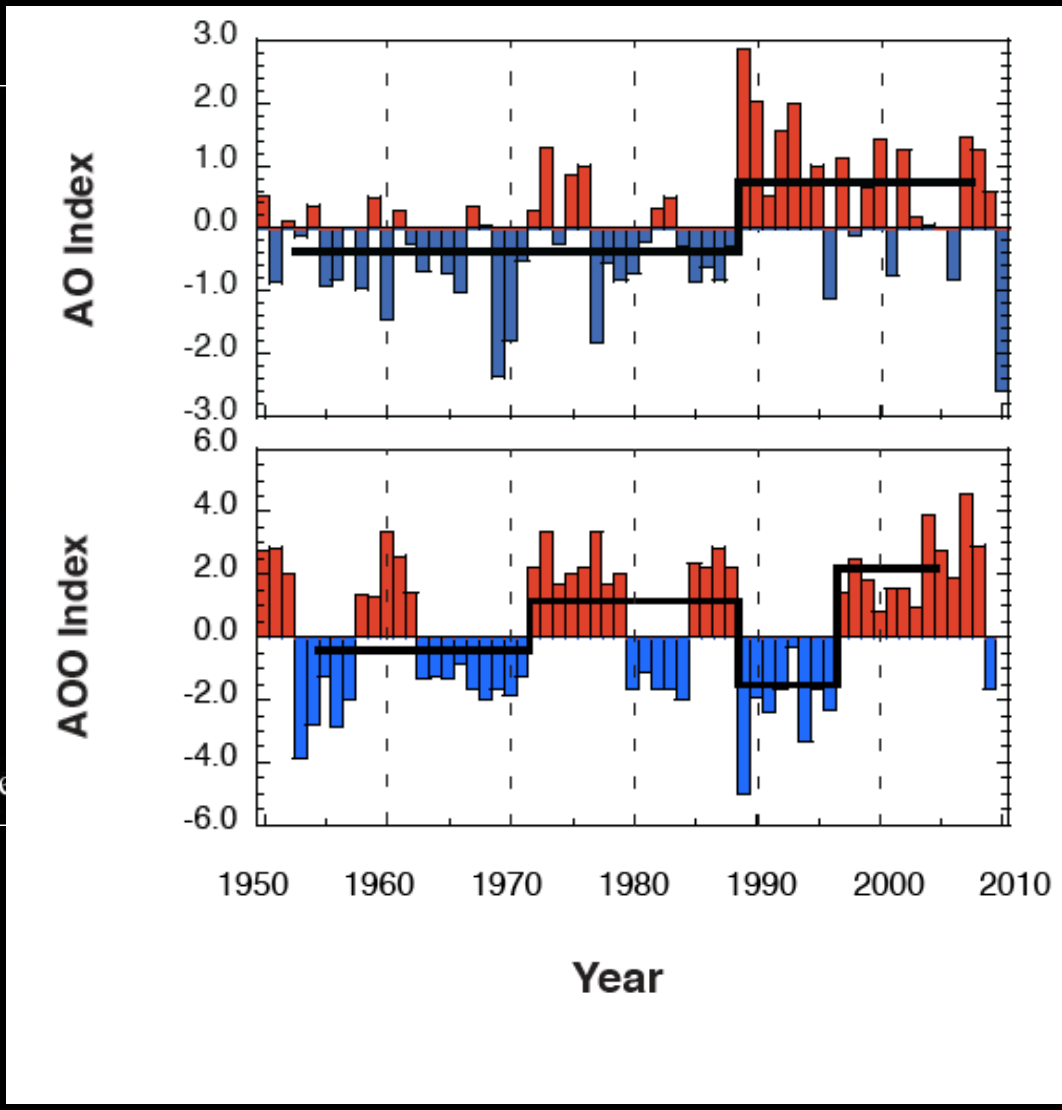
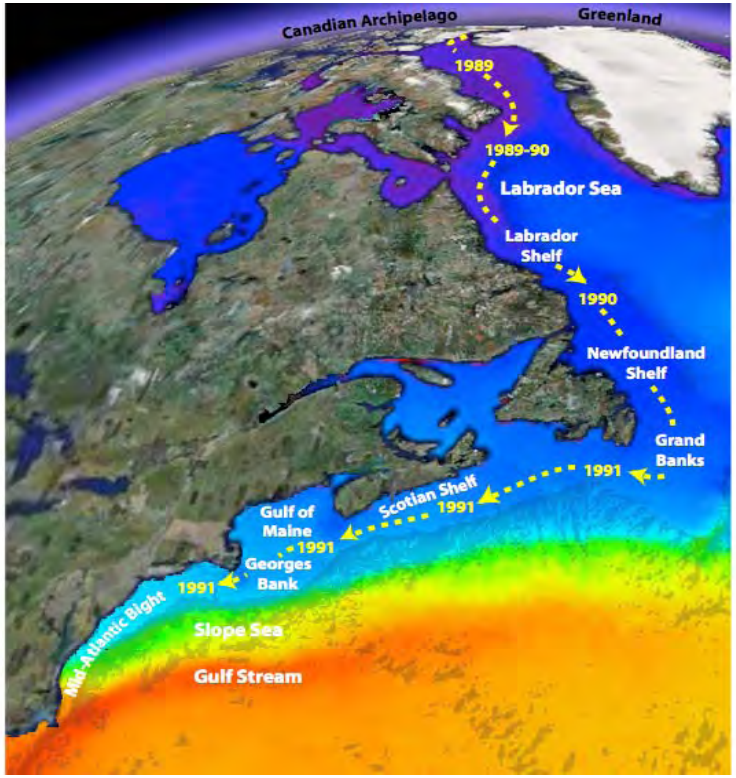
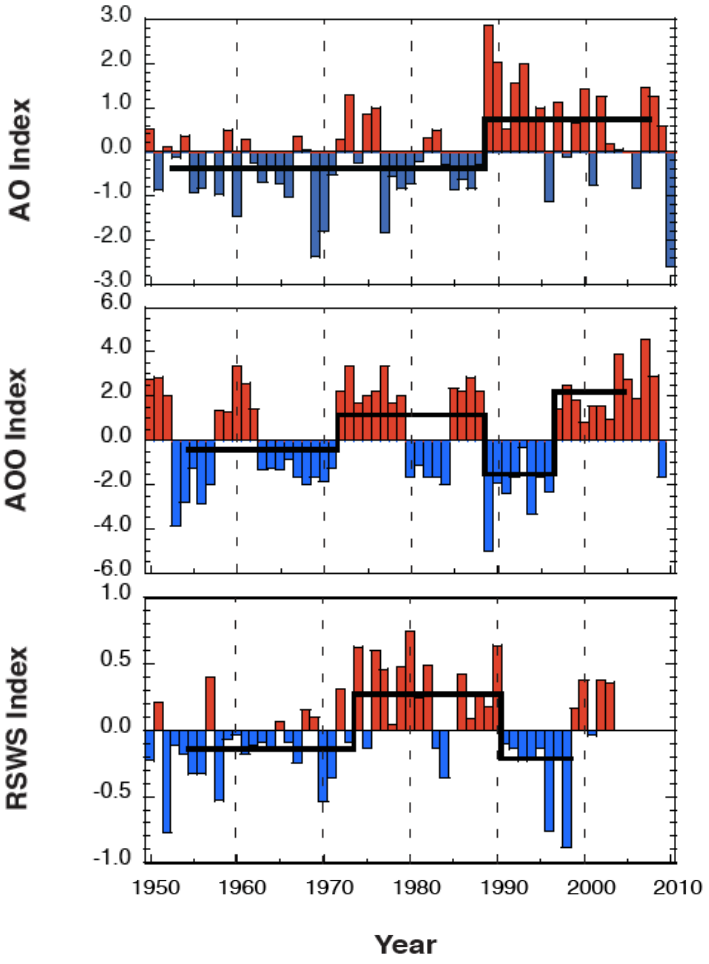
Arctic Climate Regime Shift



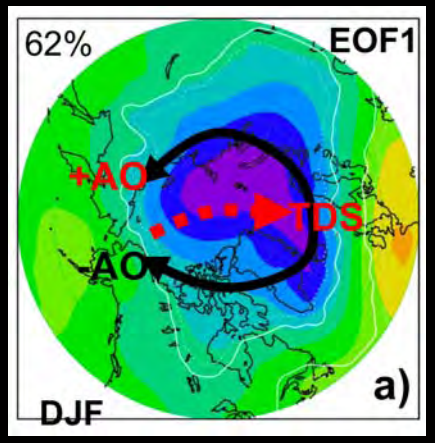


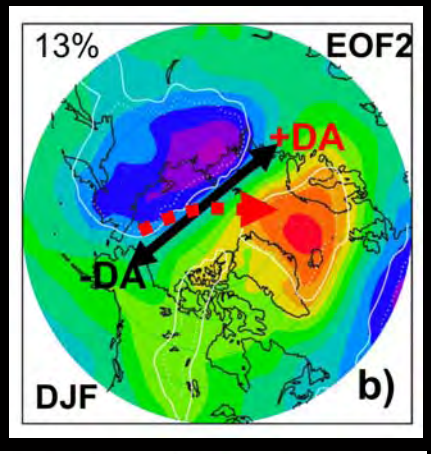
1990s Great Salinity Anomaly

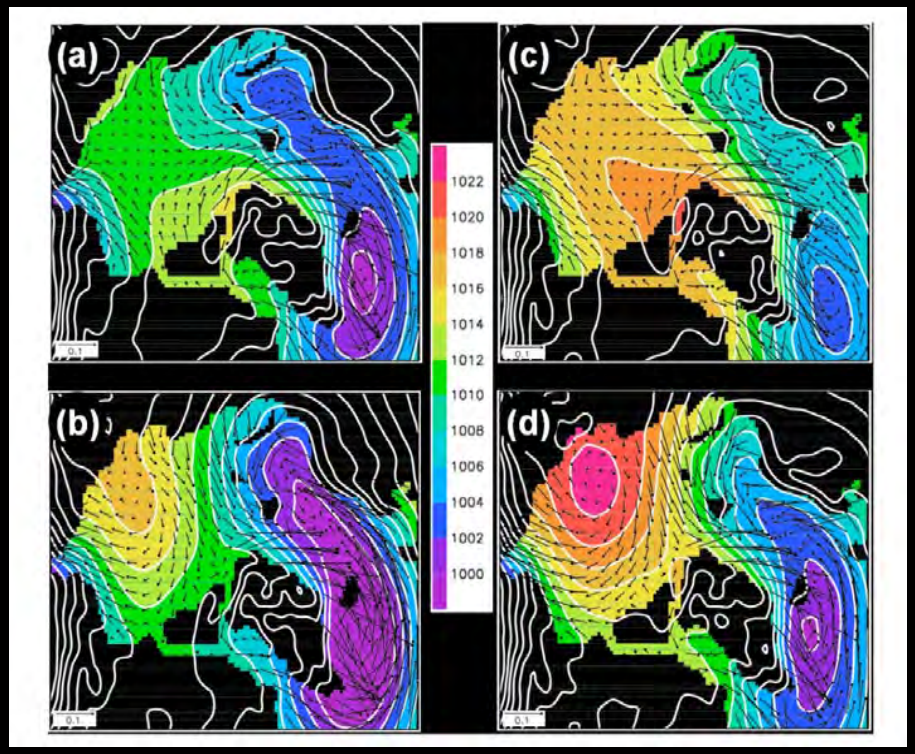




Arctic Oscillation and Dipole Anomaly





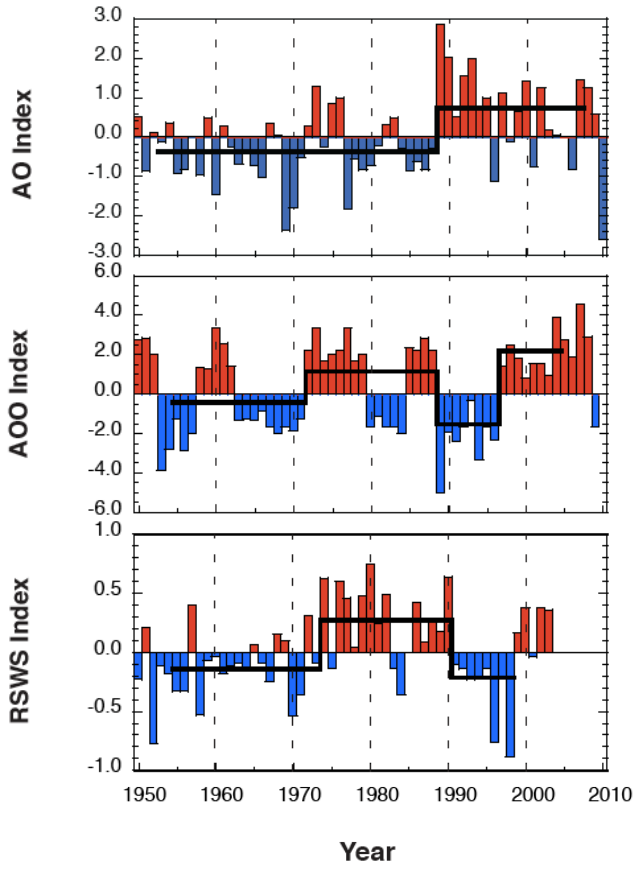


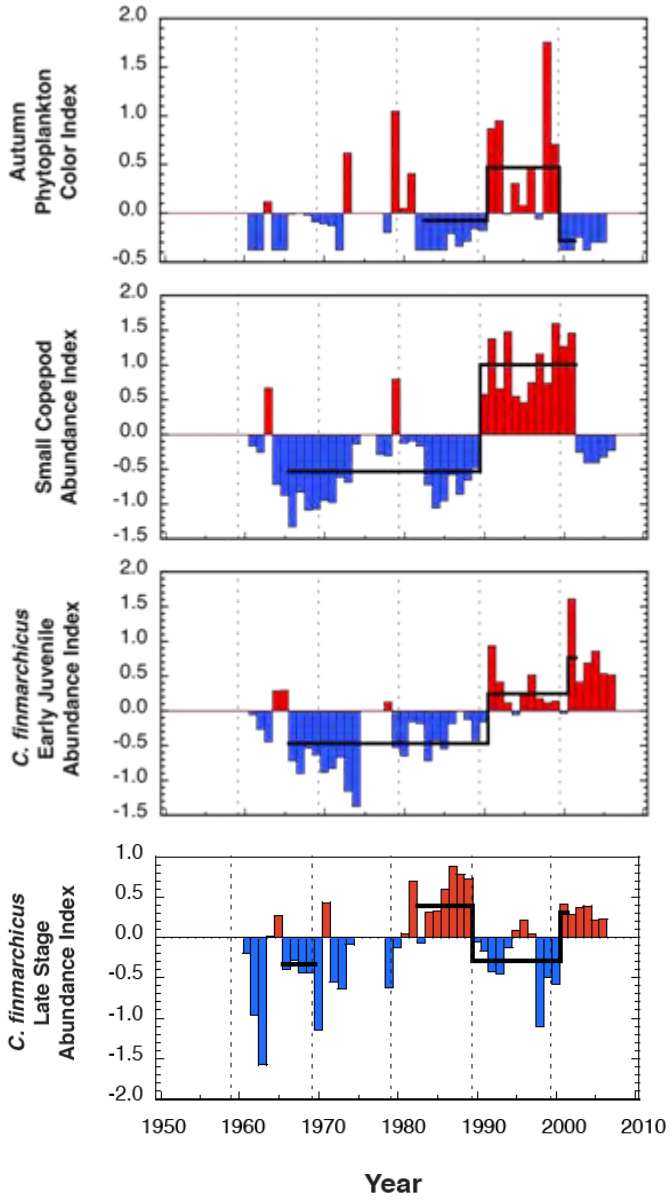
- a. State 1: AO + DA +
- b. State 2: AO + DA -
- c. State 3: AO – DA +
- d. State 4: AO – DA –

Hypotheses:

- State 1 favors freshwater export as ice through Fram Strait.
- State 2 favors liquid fresh-water export through Canadian Archipelago.

Ecosystem Regime Shifts in the NW Atlantic





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Questions for the Audience:

- We can following salinity anomaly pulses during late 1990s from Grand Banks downstream. What can we say about tracking propagation upstream to Arctic (origin, routes, timing)?

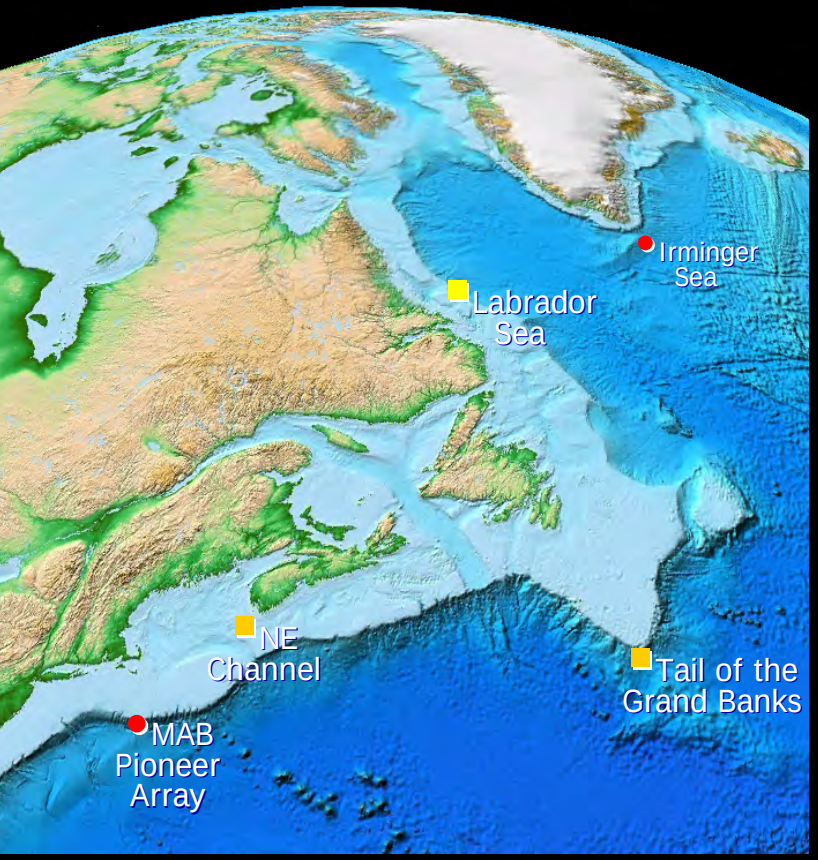
- Can our models hindcast last 50 years to track origins and routes of GSAs entering North Atlantic from Arctic?

- Record freshwater storage has been observed in Beaufort Gyre during recent years. Has stage been set for another GSA?

- Arctic Oscillation Index and Arctic Ocean Oscillation Index have been “misbehaved” during the 2000s. Will we be able to predict when the next GSA will be exported and whether it will emerge from Fram Strait or CAA?

- 2009-2010 strongest negative NAO index of past 40 years. How will Arctic and North Atlantic Oceans respond, both physically and biologically?

Implications for the Ocean Observing Initiative



- Currently, there are plans for a buoyed observatory site in the Irminger Sea and a Pioneer Array in the Middle Atlantic Bight.
- These are good end members for observing the impacts of remote forcing by climate on NW Atlantic shelf ecosystems.
- However, we really need long-term observational capabilities in the Labrador Sea, the Tail of the Grand Grand Banks, and the NE Channel line between Yarmouth, NS and the North Flank of Georges Bank.