

# Salinity-driven centennial variability in the Arctic and North Atlantic

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## Previous work

AMOC multi-decadal to multi-centennial variability comes from:

- Arctic:
  - release of Arctic freshwater through Fram Strait in MPI-OM model (Jungclaus et al., 2005);
- Southern Ocean:
  - salinity anomalies propagating from the Southern Ocean in GFDL coupled model (Delworth & Zeng, 2012)
- Tropics:
  - freshwater imposed by north shifted and increased ITCZ in HadCM3 model (Vellinga & Wu, 2004)

## Our research

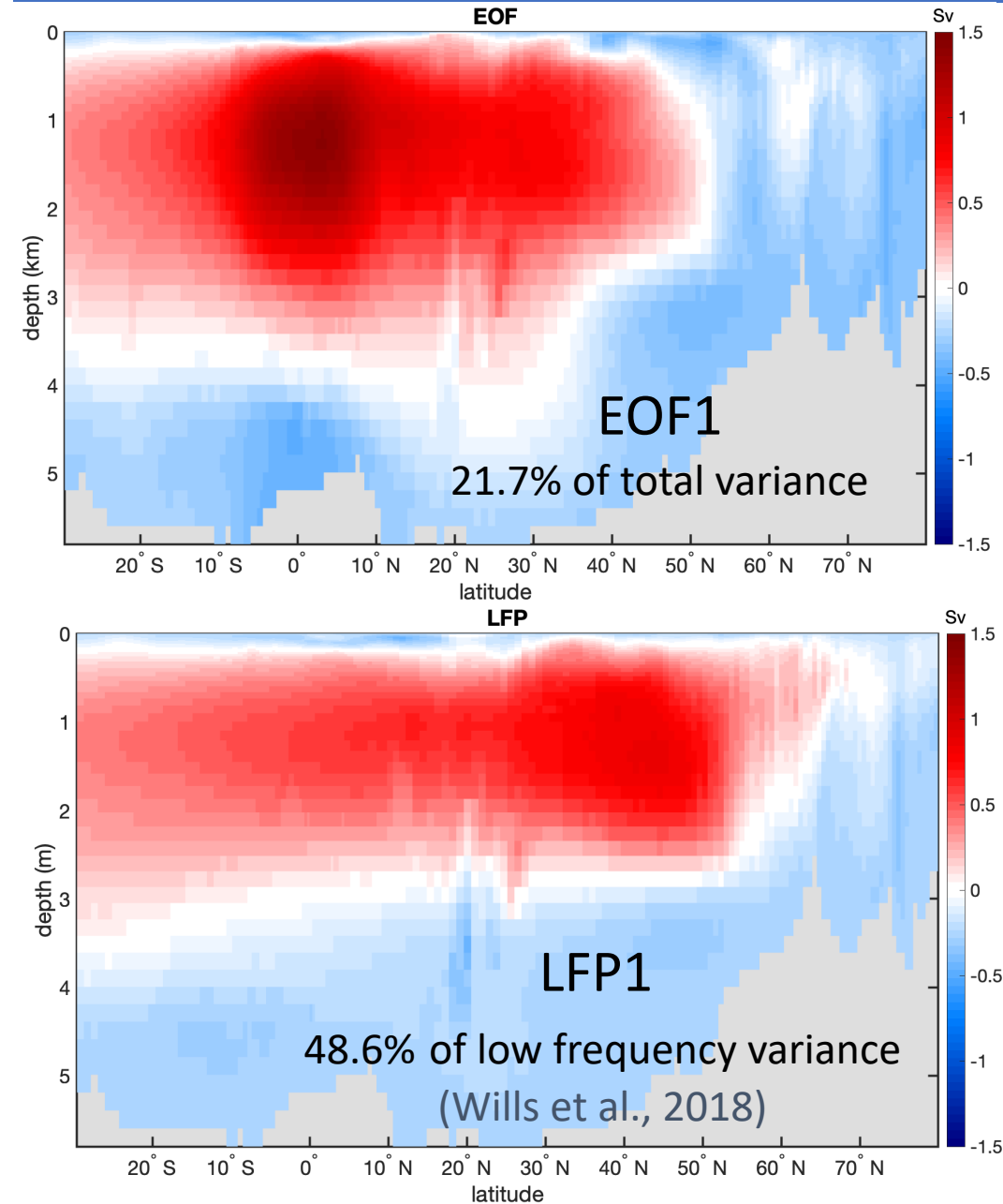
New IPSL-CMIP6-LR (Boucher et al., 2020); pre-industrial control simulation (1850 - 3049)

Atm: 2.5x1.5° (144x142) L79      Oce: 1° L75

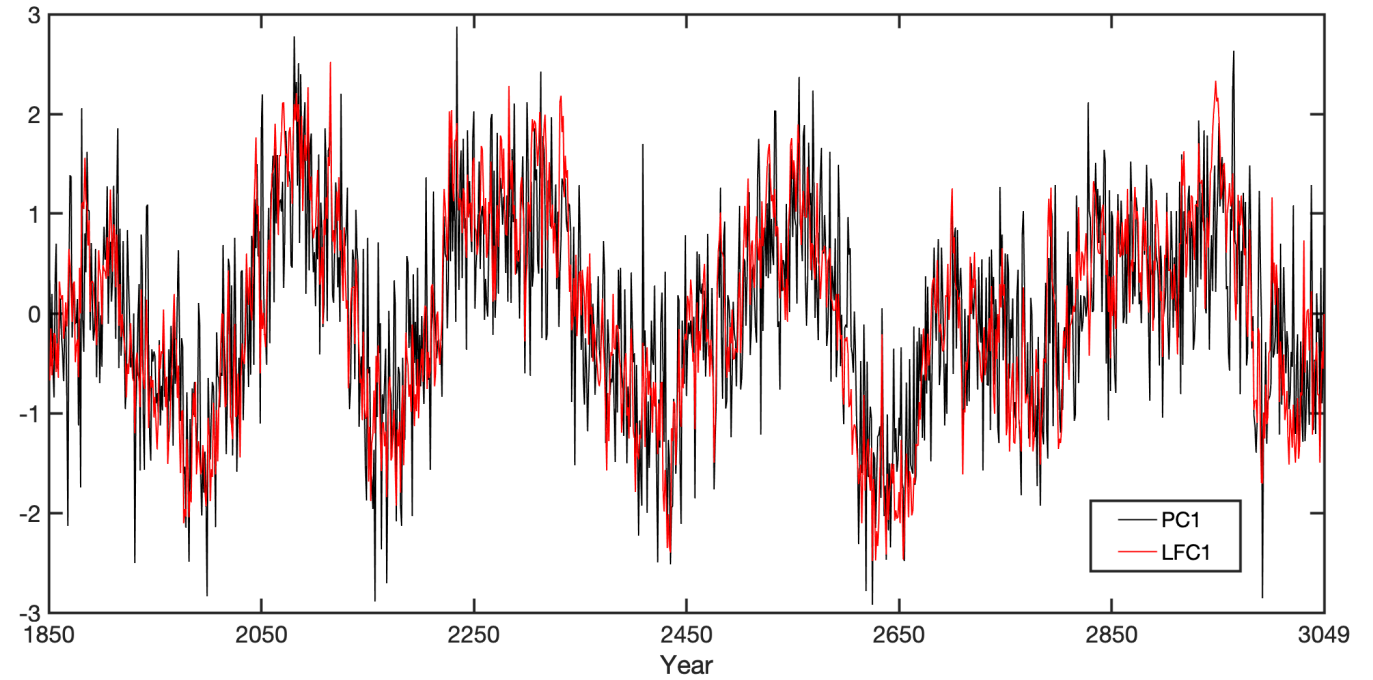
Improvements: more sea ice categories; better boundary layers and temperatures; oceanic resolution from 2° to 1°

CMIP6: Coupled Model Intercomparison Project (CMIP) phase 6

# EOF and low frequency analysis of AMOC streamfunction



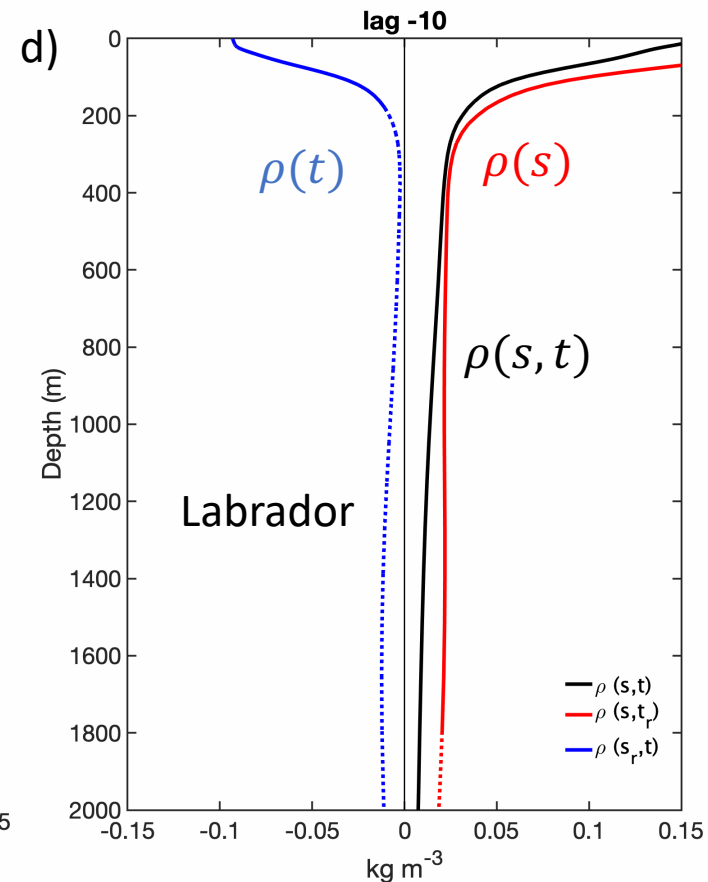
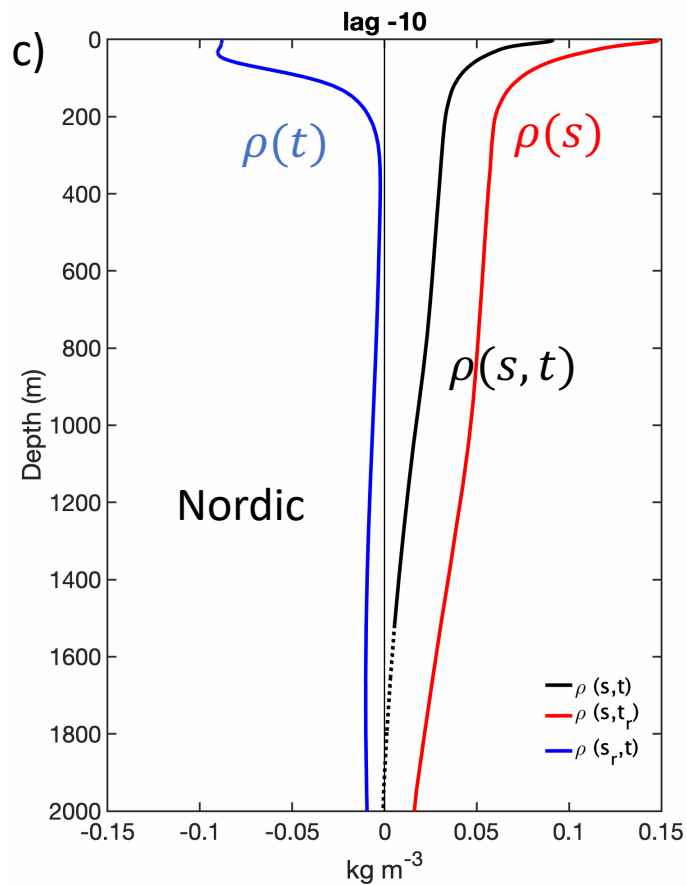
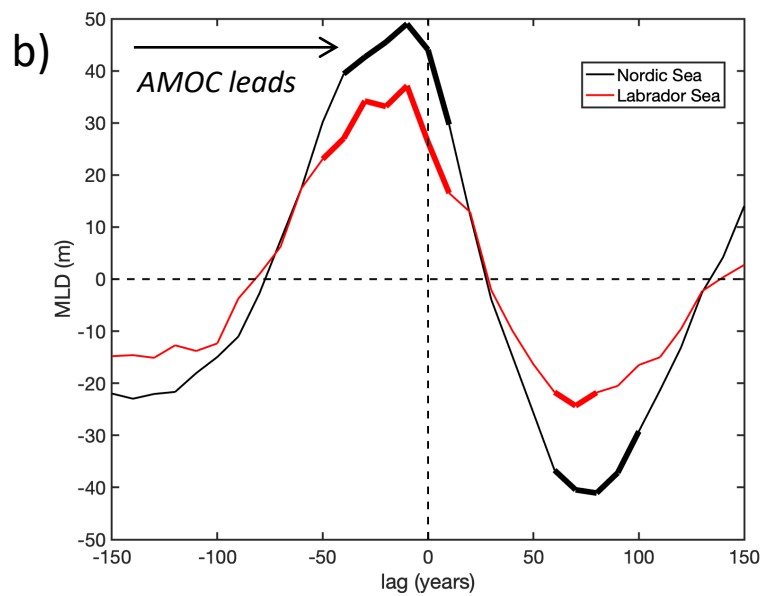
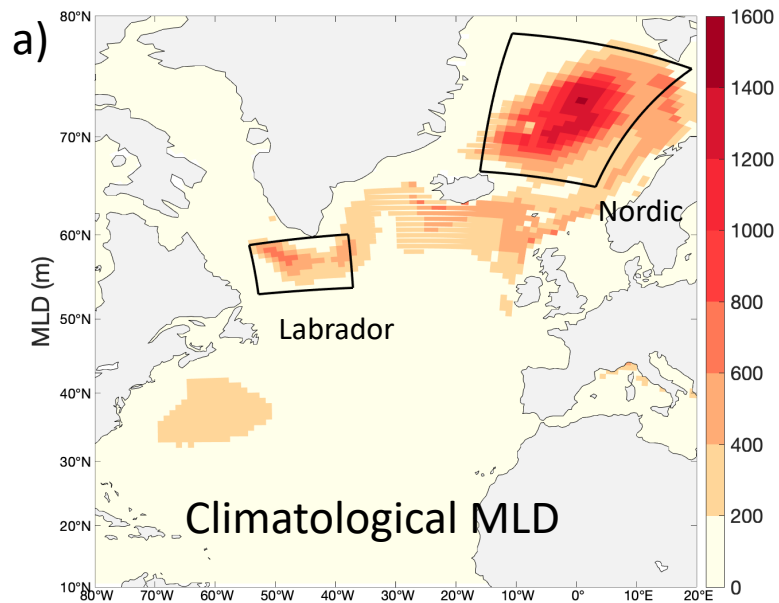
First 8 EOFs: 74% of total variance



A 20-year cutoff Butterworth lowpass filter

Dominant centennial variability of AMOC is isolated with LFC from high frequency variance at tropics.

# Regressed MLD(m), density onto AMOC LFC1

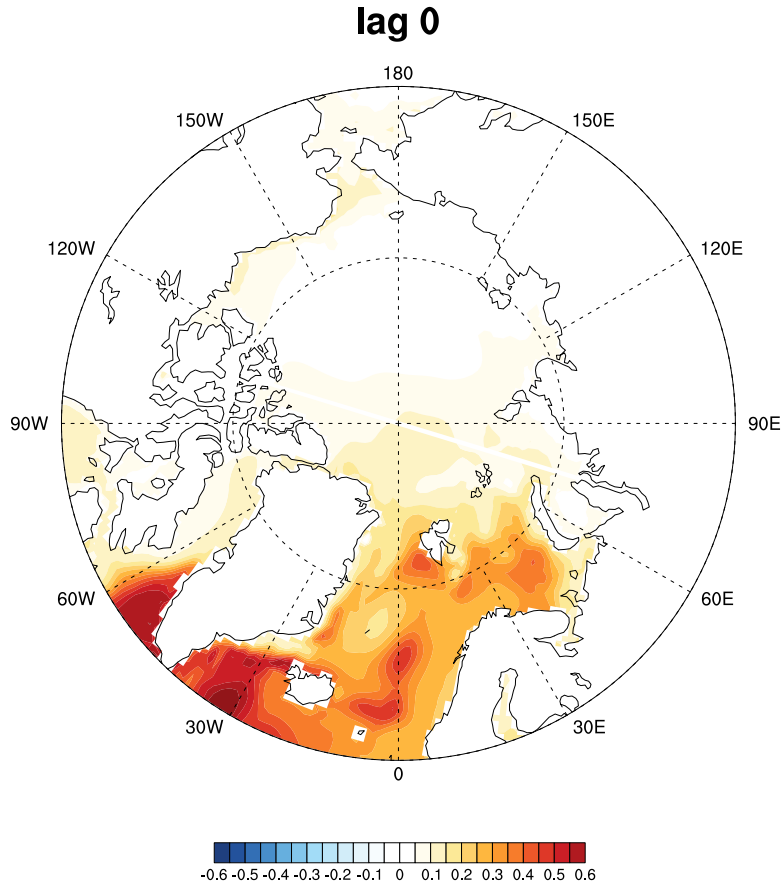


5% significance level in bold (solid)

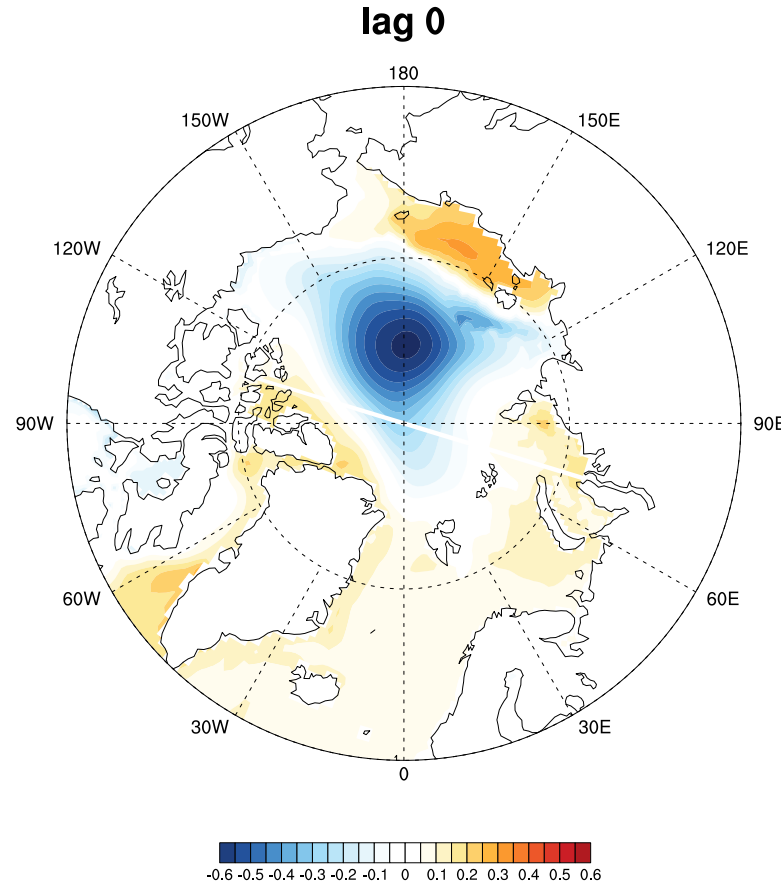
- Density anomalies are dominated by salinity
- Surface (0-200m) is more variable

# Regression of 0-150m temperature, salinity and density onto AMOC-LFC1

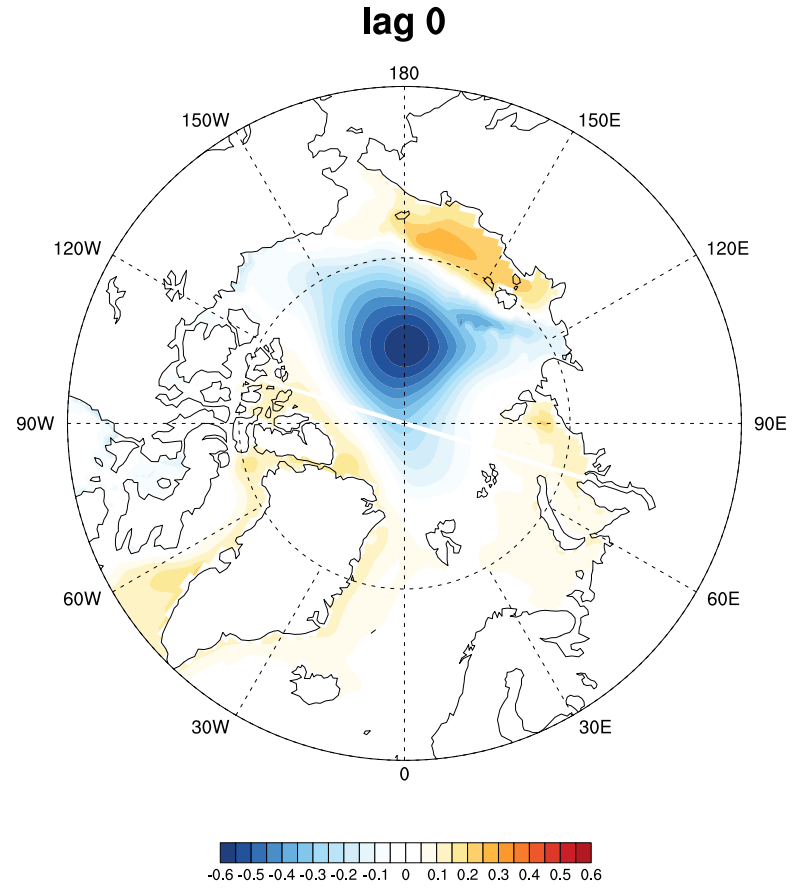
Temperature (°C)



Salinity (psu)

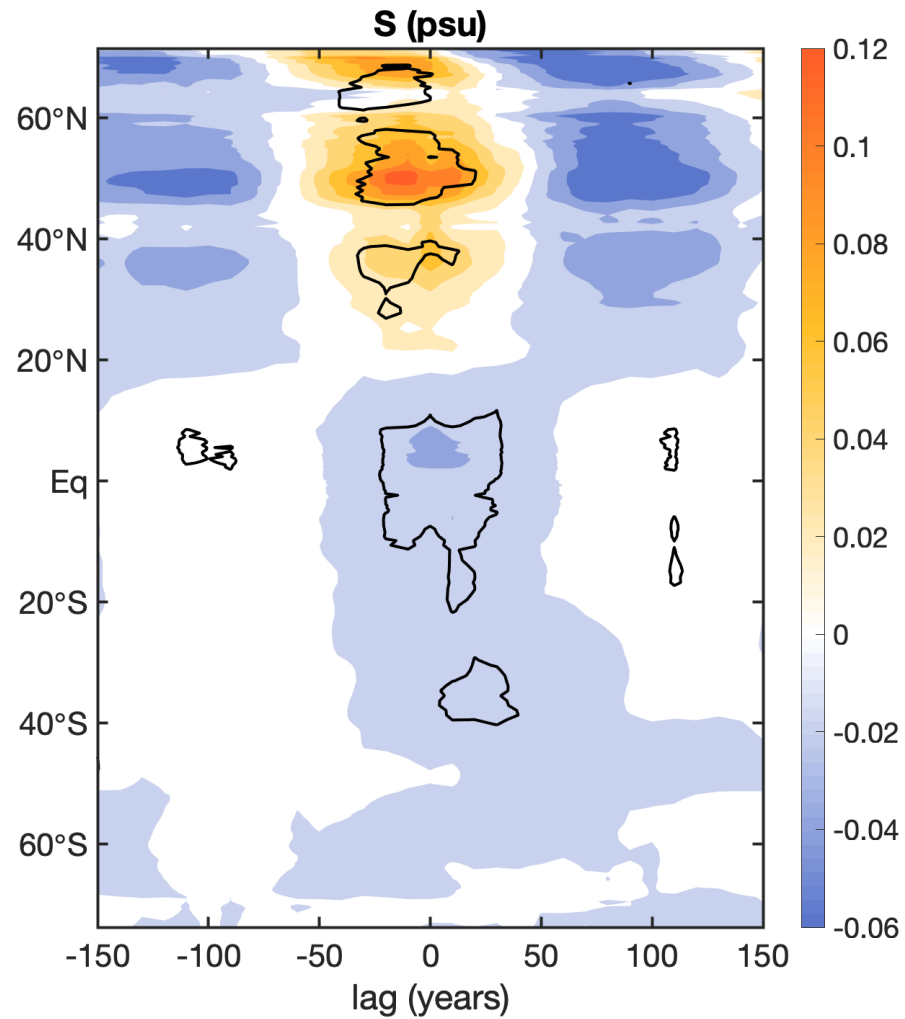


Density (kgm<sup>-3</sup>)



density anomalies dominated by salinity

# Zonally mean 0-150m salinity anomalies in the Atlantic basin

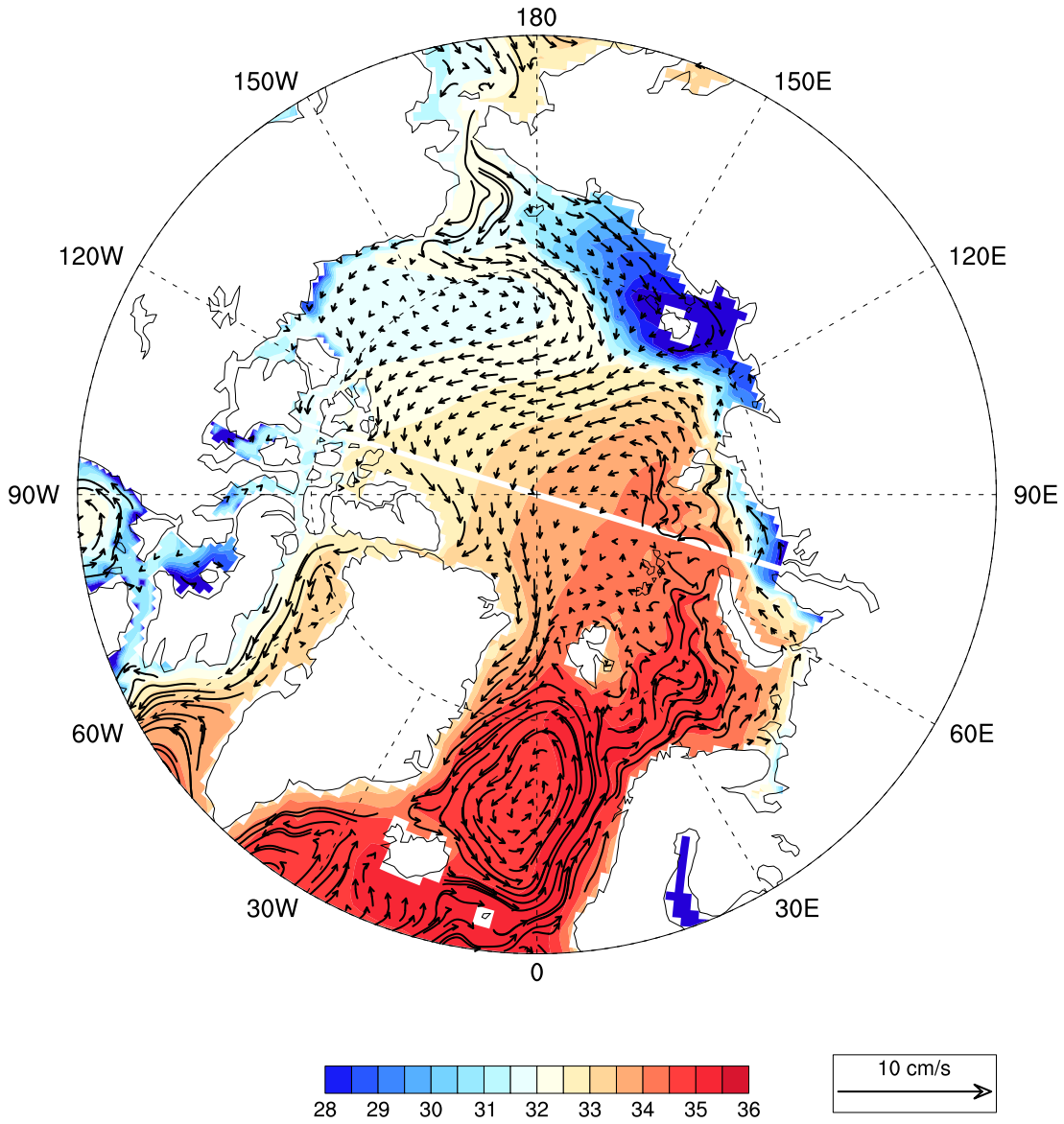


salinity anomalies come more from Arctic and high-latitude North Atlantic, not tropics

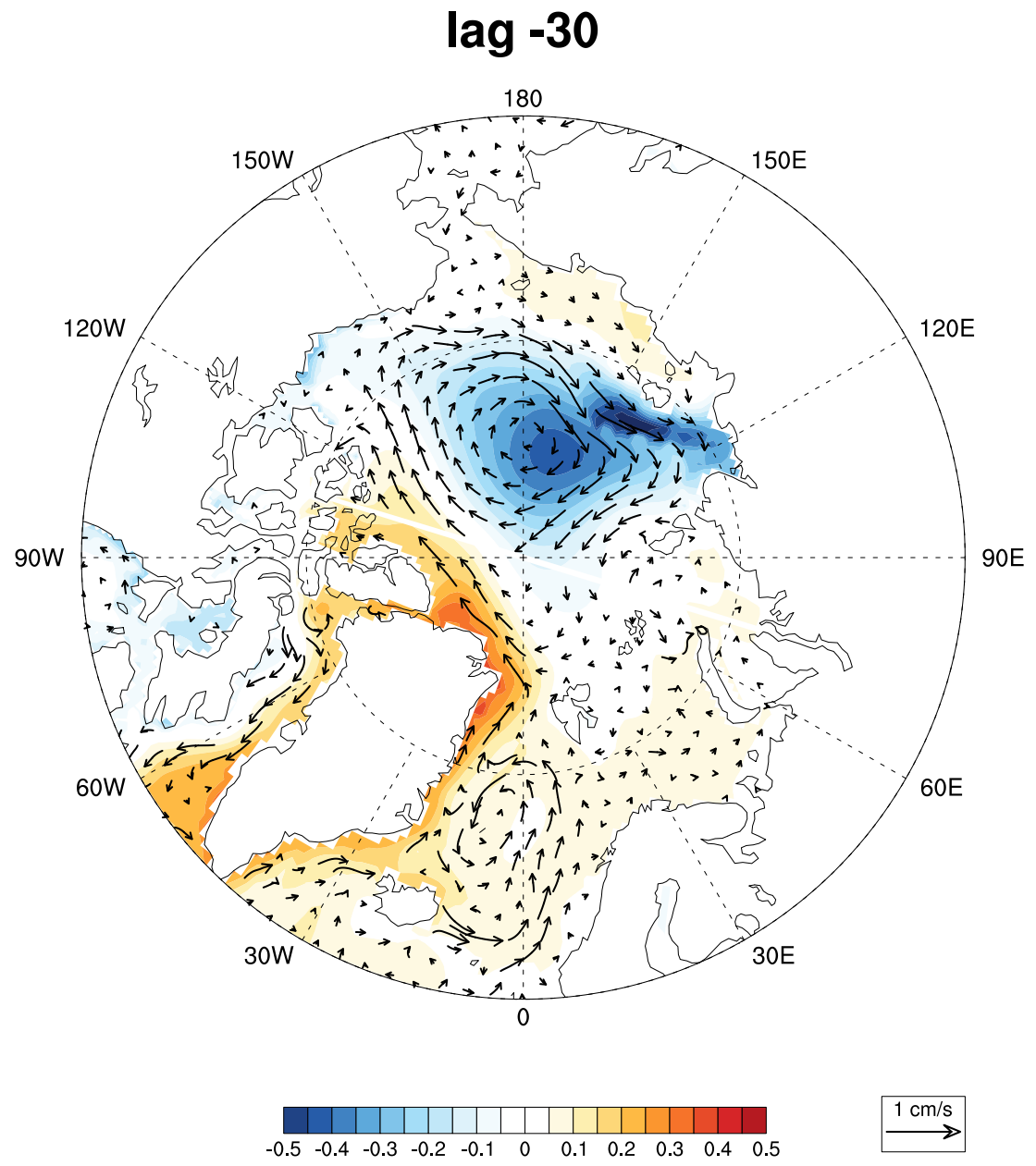
No significant atmospheric impacts:

- Sea level pressure
- Wind stress

# Climatological 0-150m salinity and currents

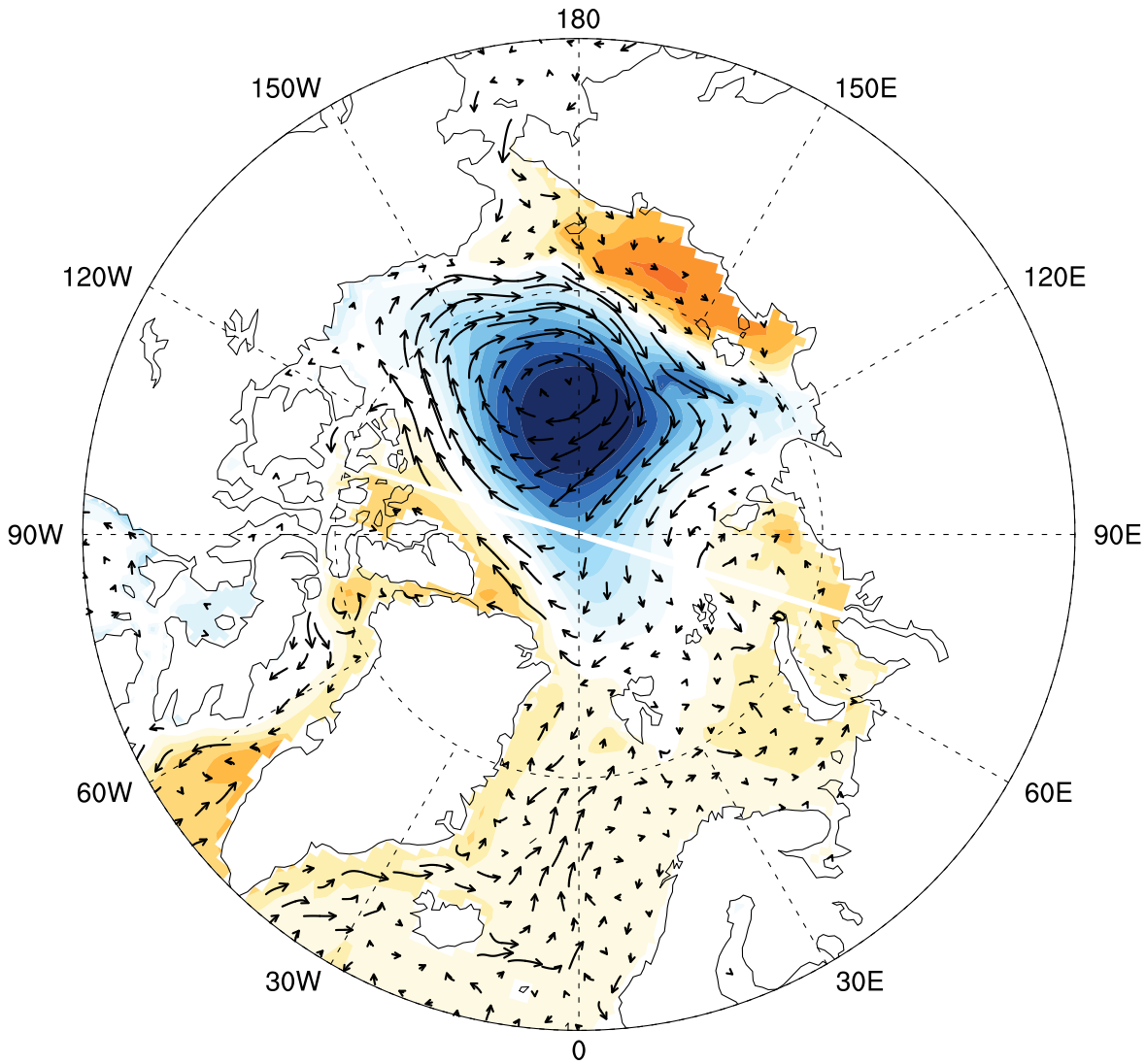


# Regressed 0-150m salinity and currents

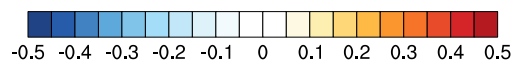
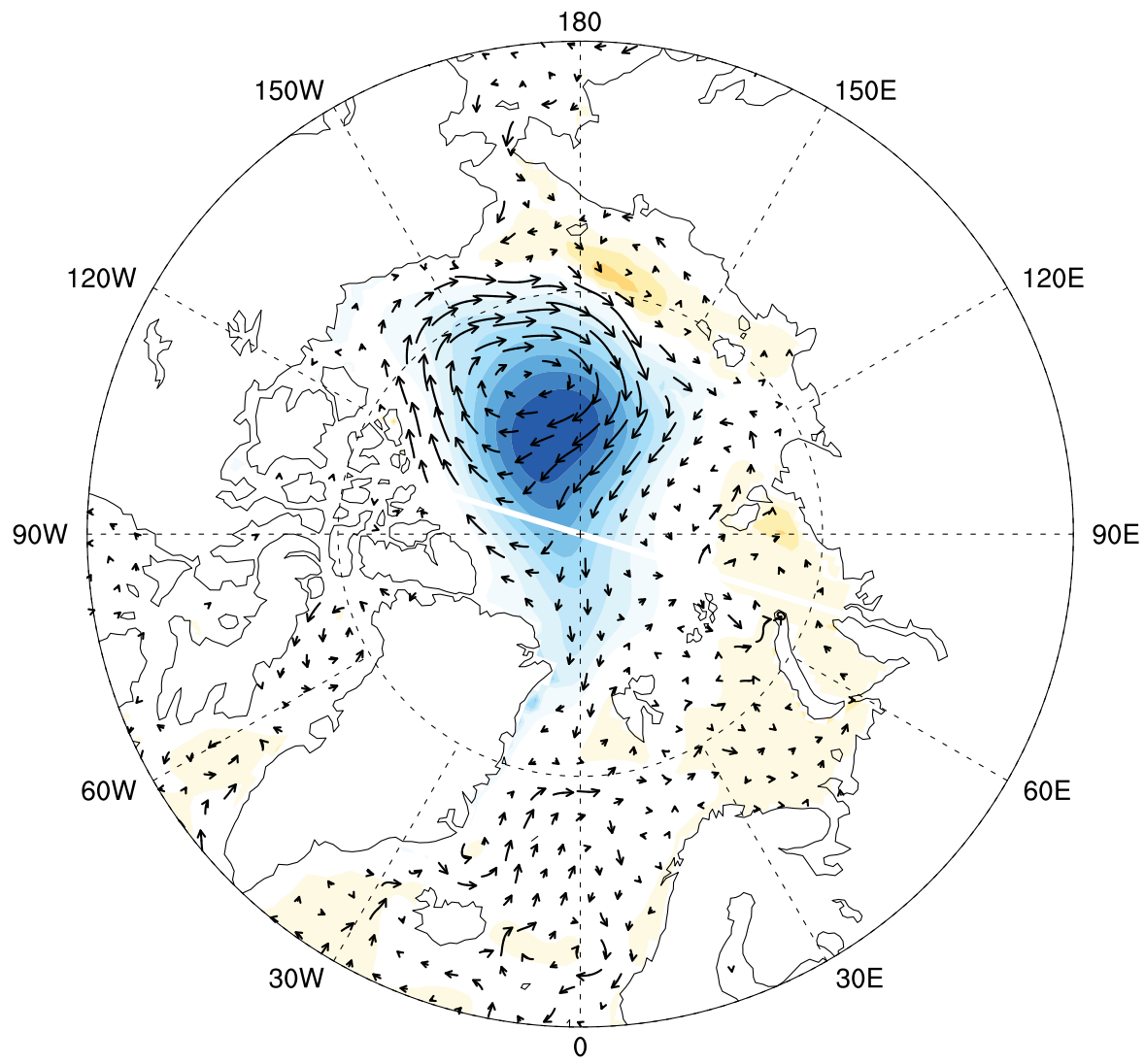




lag 0

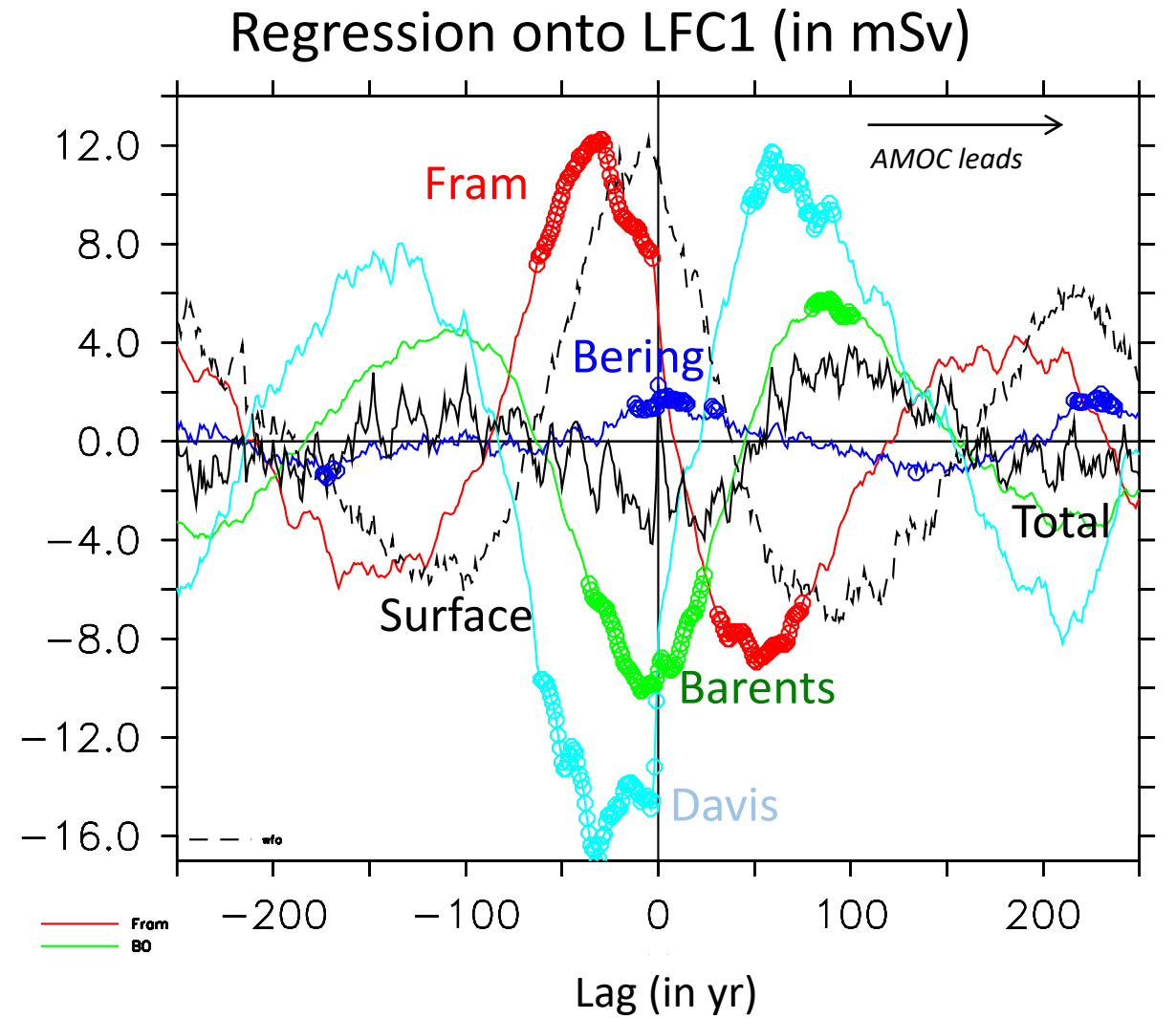
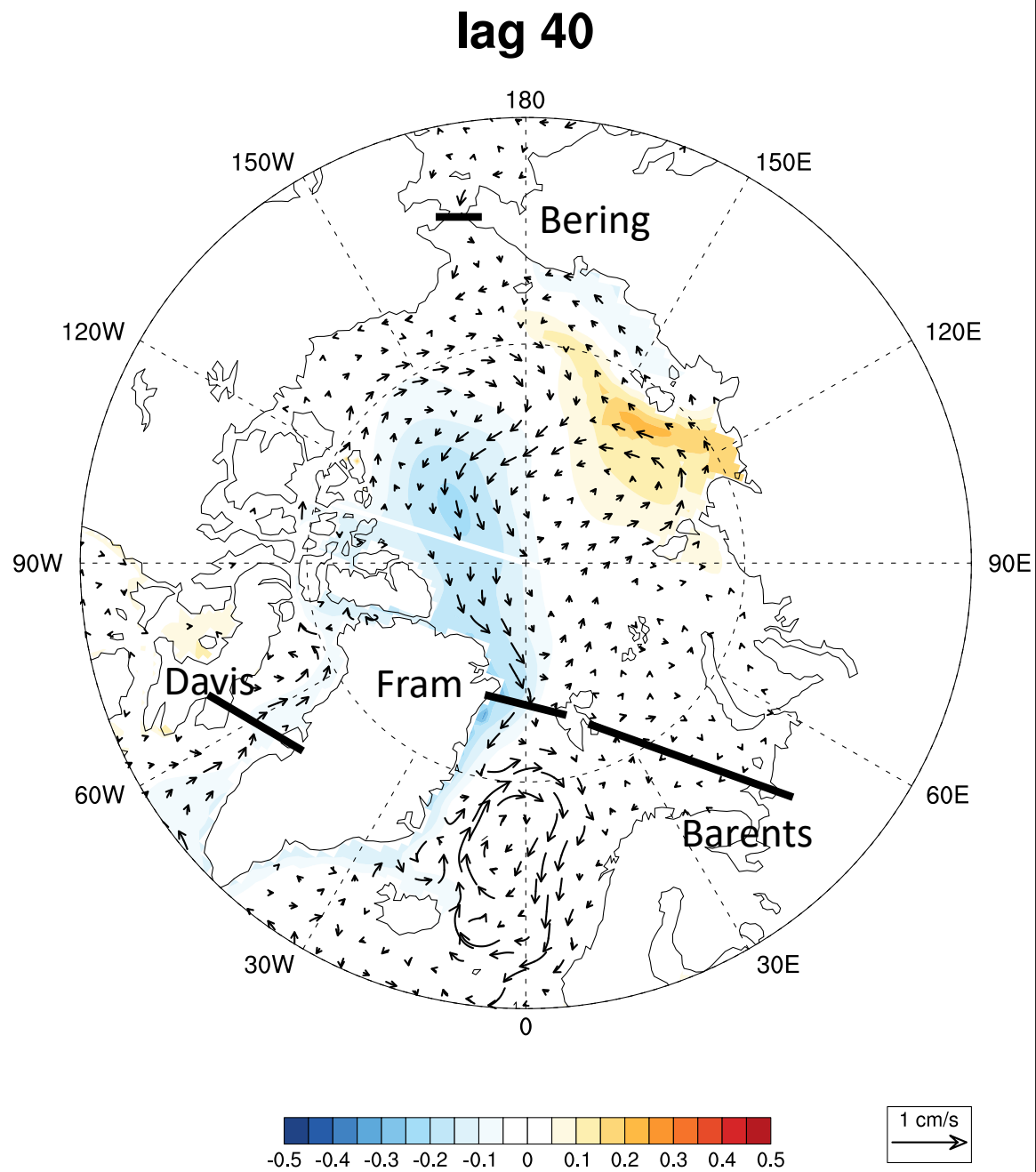


lag 20



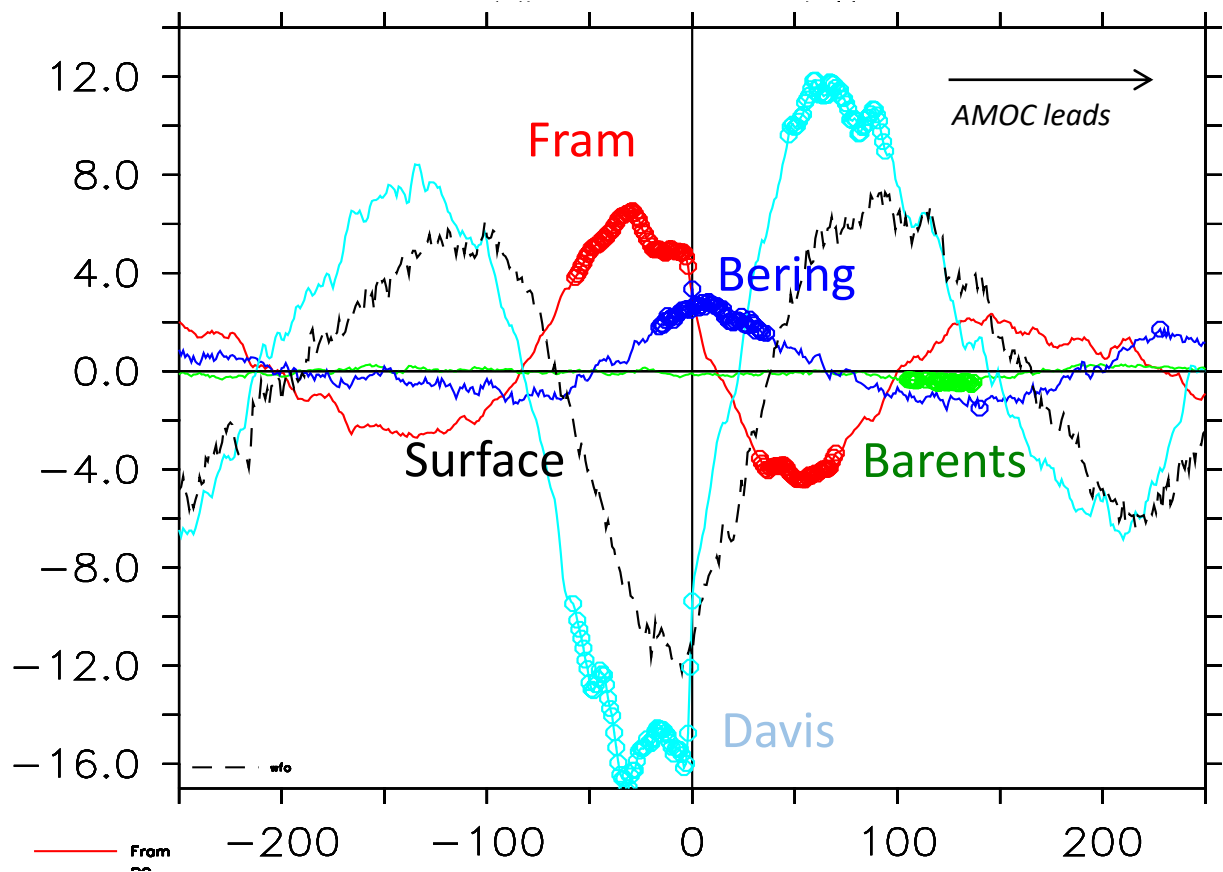


Freshwater transport toward Arctic (positive northward)

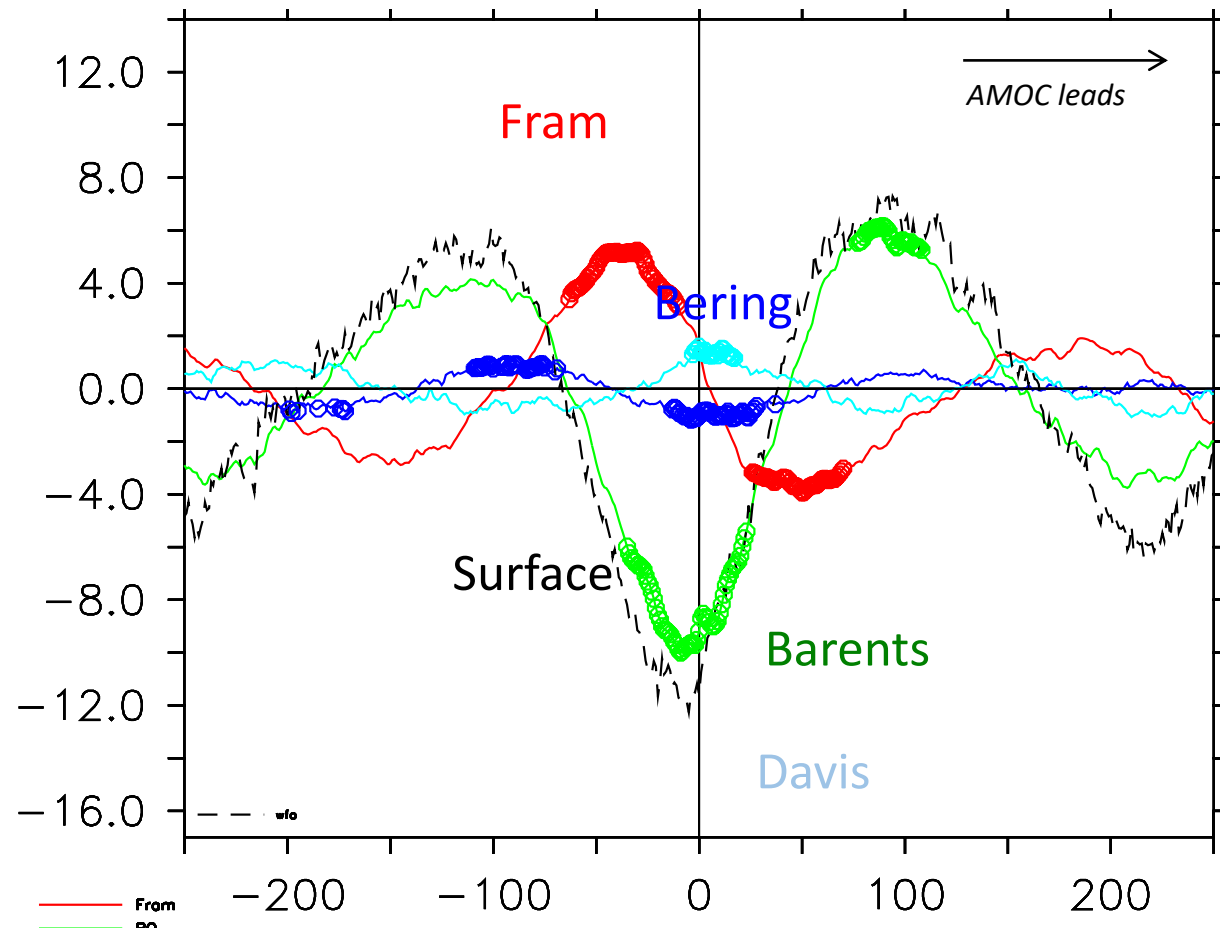


Fram  
BO

$$\bar{S} * V'$$

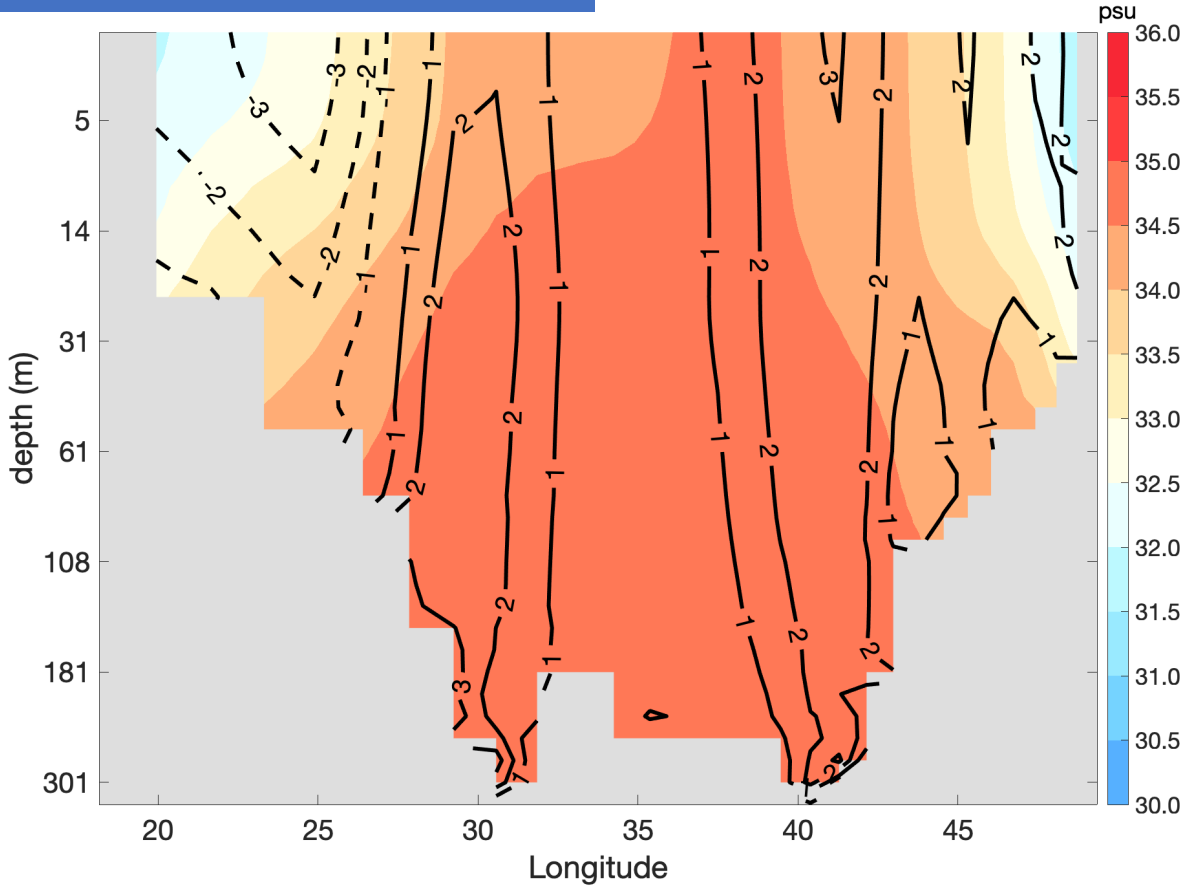


$$S' * \bar{V}$$

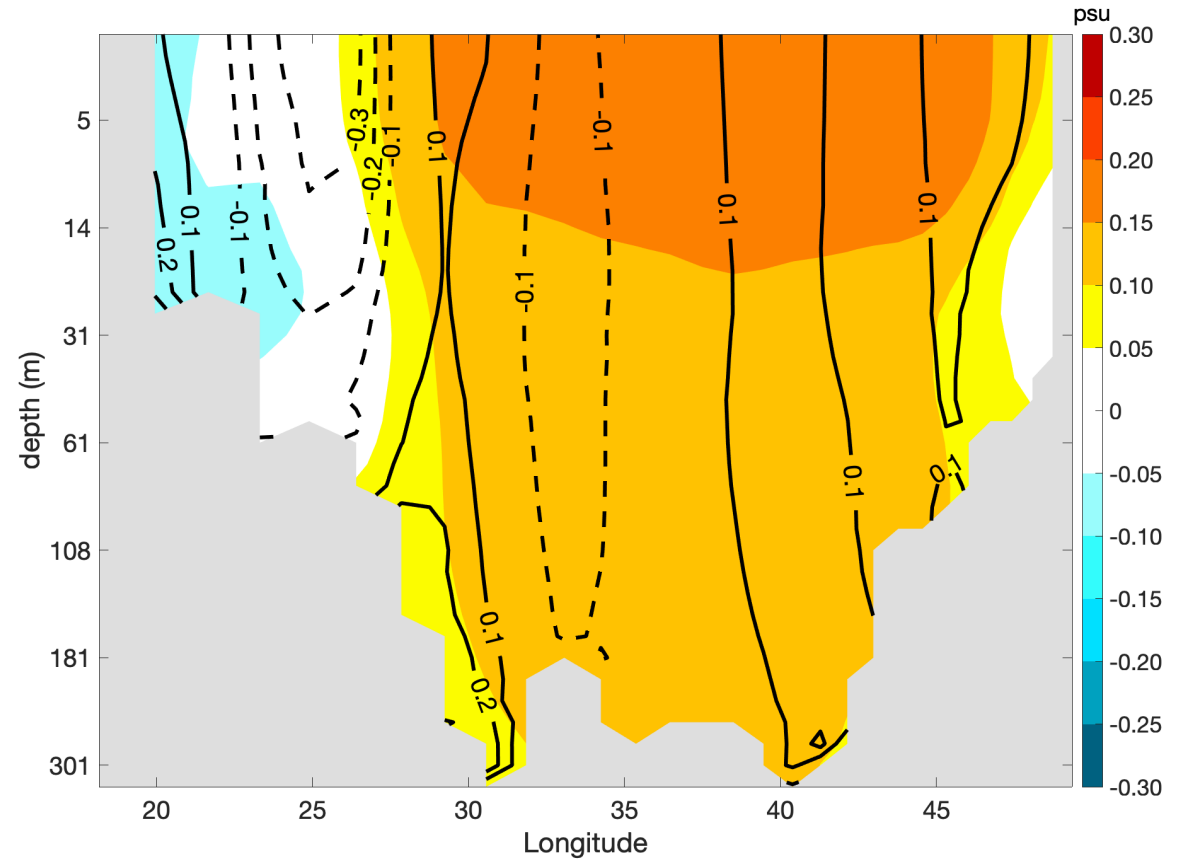


# Salinity and meridional velocity (cm/s)

## Barents cross-section

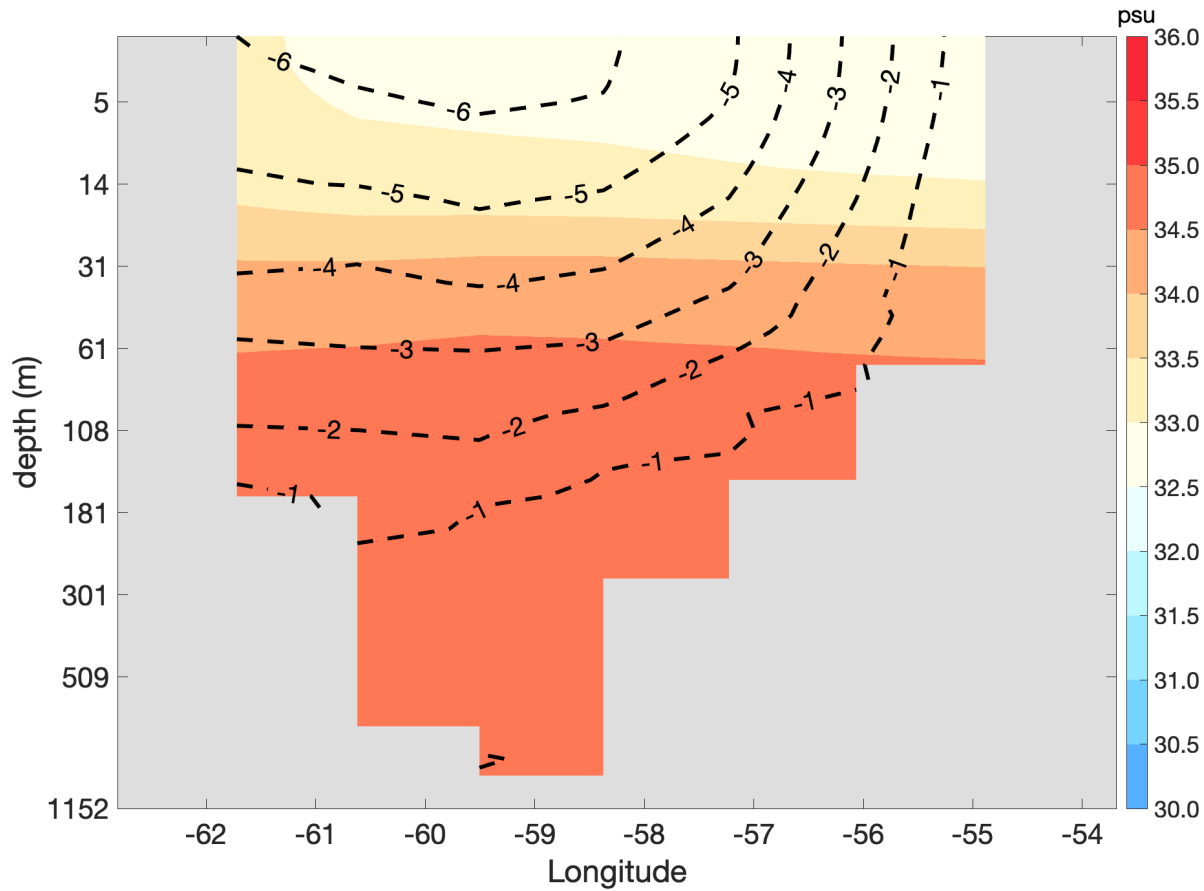


climatology

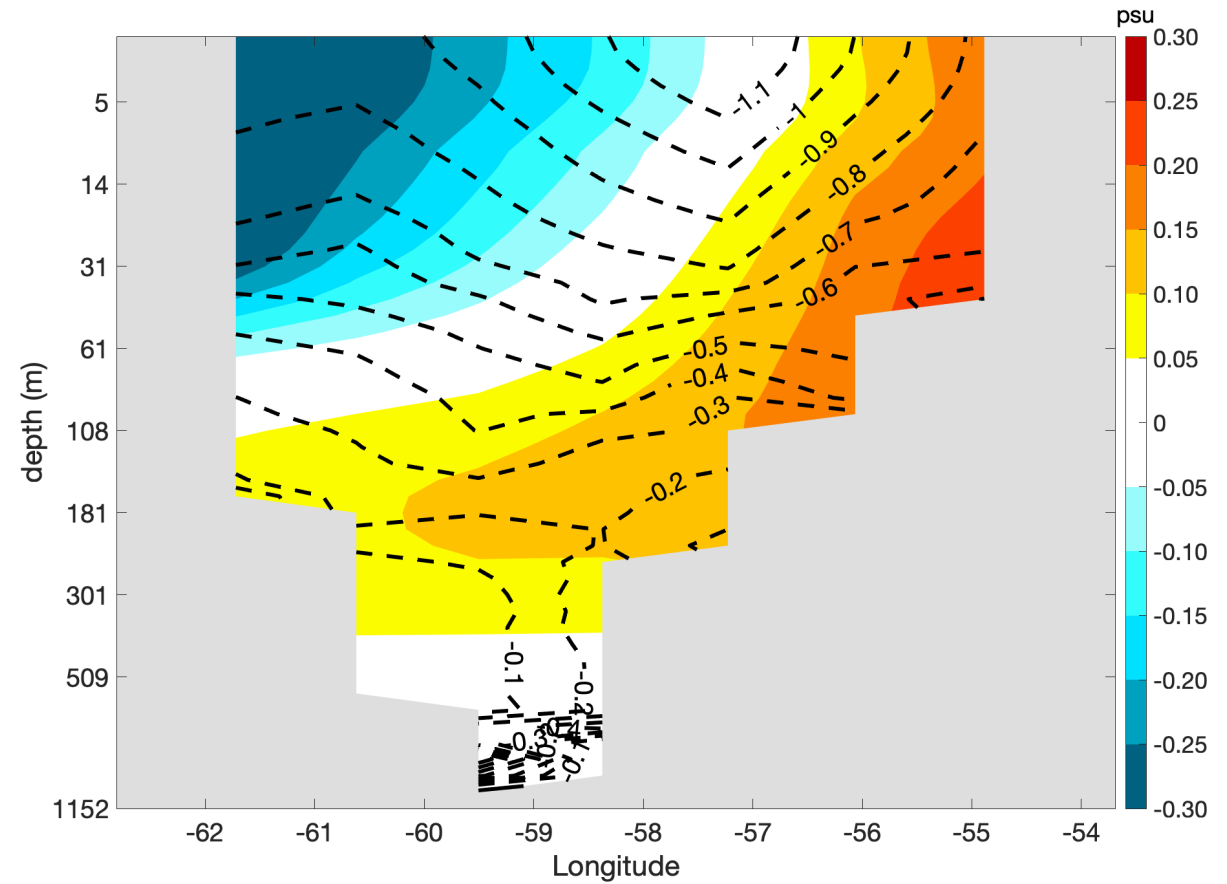


lag 0

# Davis cross-section



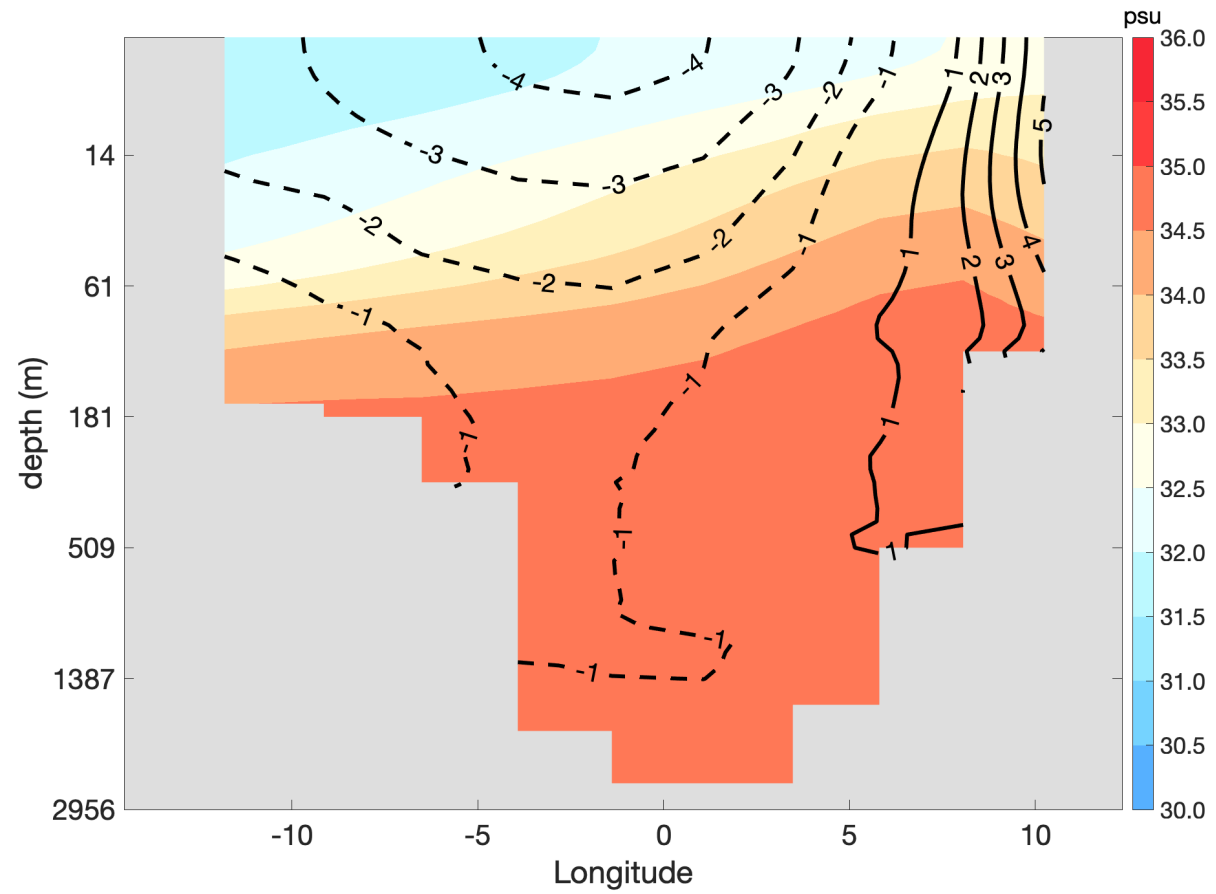
climatology



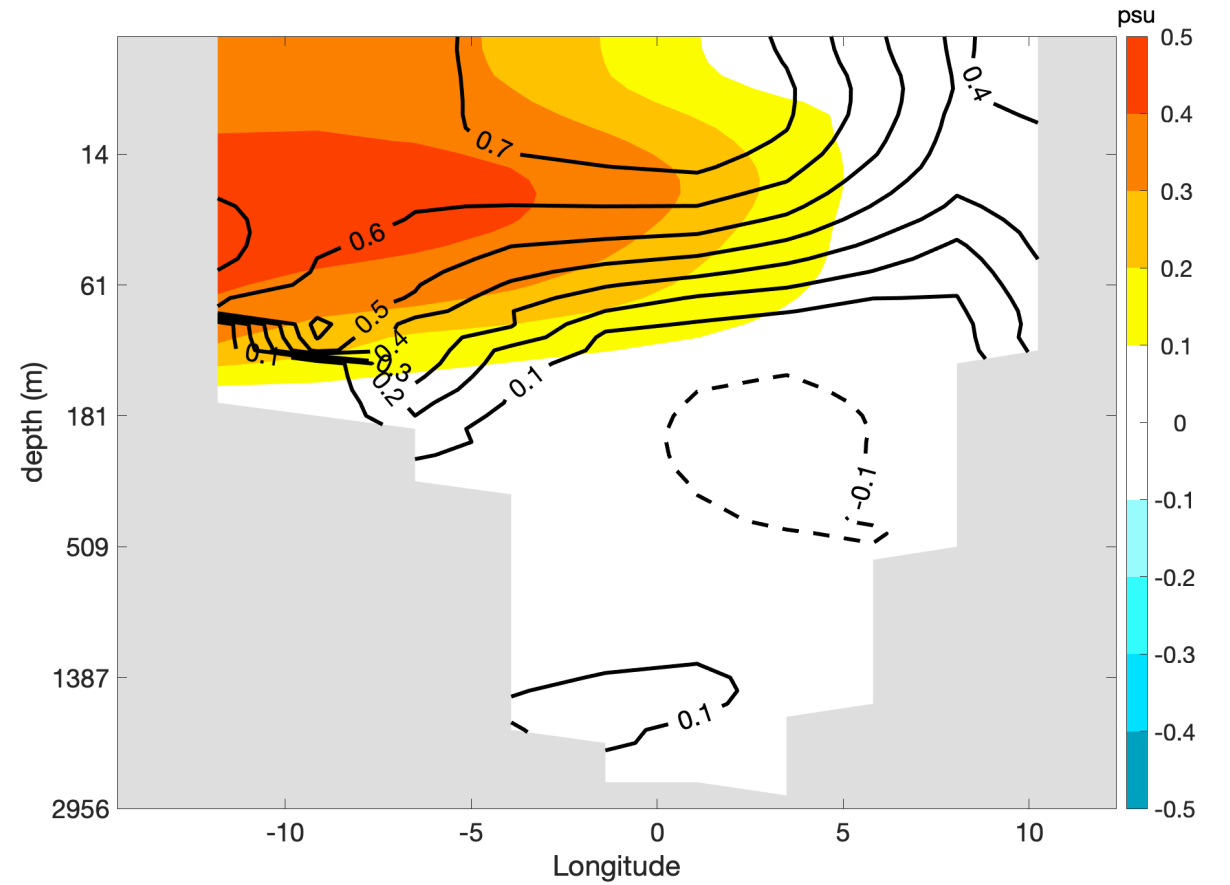
lag -40

Reference salinity: 34.8

# Fram cross-section

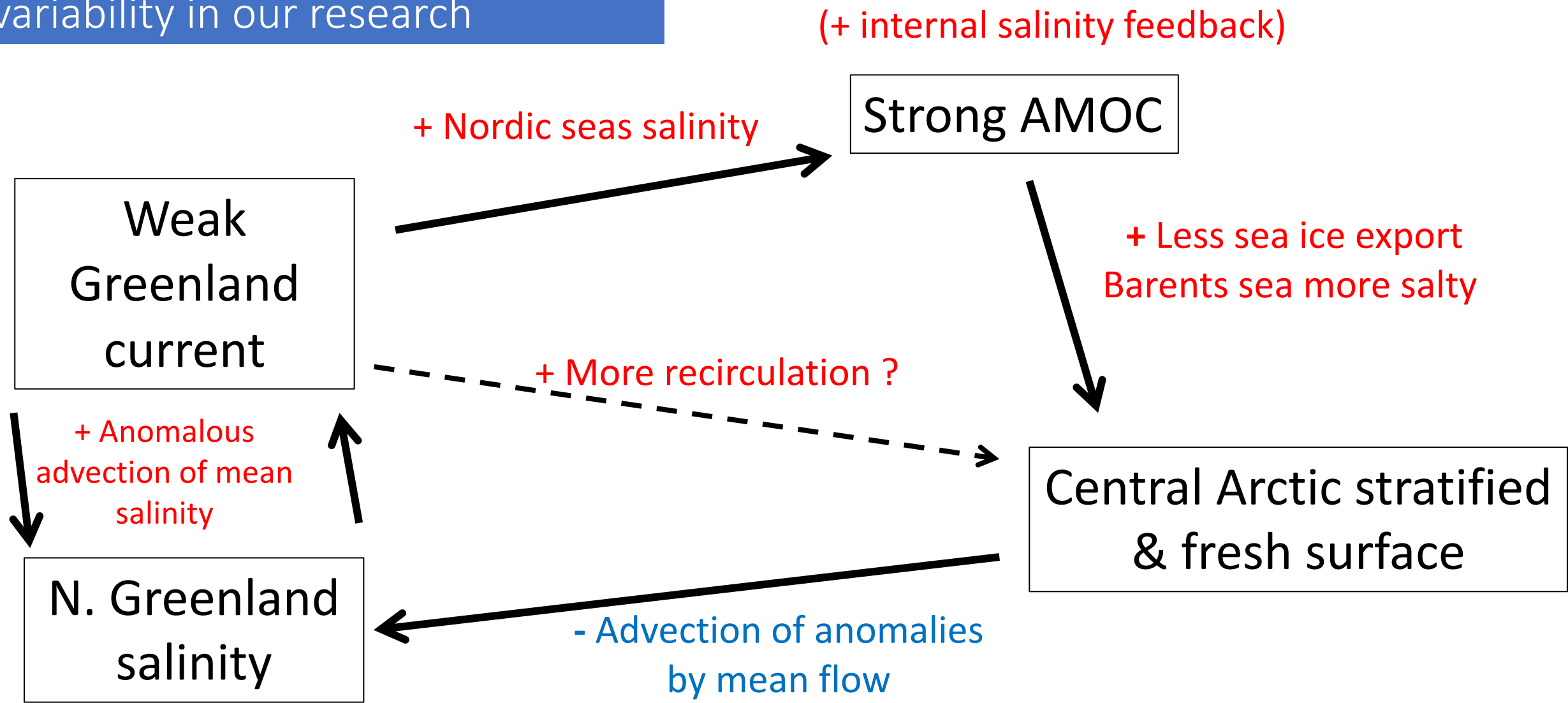


Climatology



lag -40

# Mechanism of AMOC centennial variability in our research





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