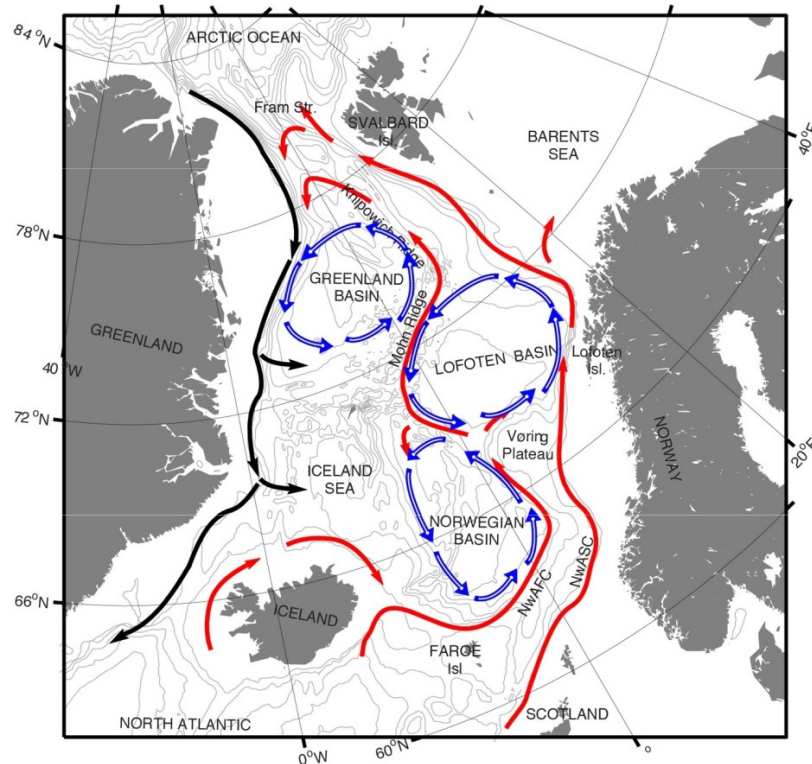


Influence of Nordic Seas dynamics on the Atlantic Water (AW) propagation and its impacts on sea ice concentration

EGU21-14798 | OS 4.6: The Copernicus Marine Service (CMEMS)

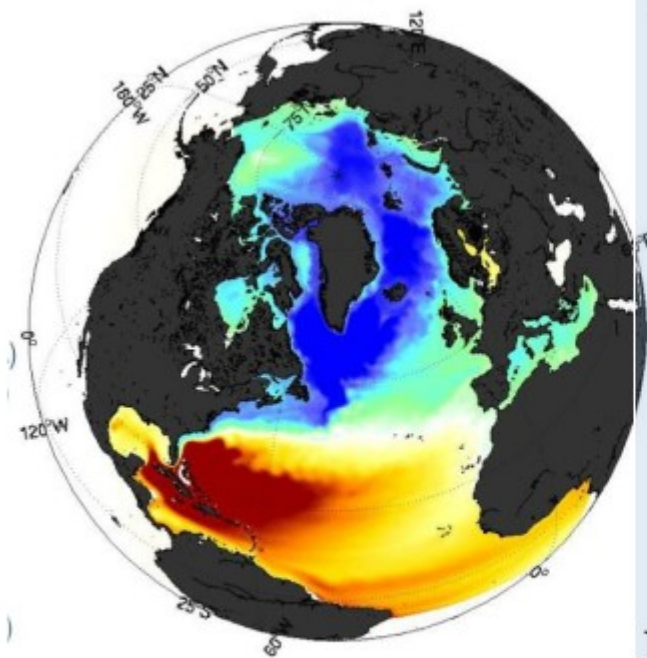


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Nansen Environment and Remote Sensing Centre, Bergen, Norway





*The TOPAZ4 domain:
North Atlantic and Arctic*

TOPAZ4:

- HYCOM + EVP sea-ice model
- 11-16 km horizontal resolution
- 28 hybrid vertical layers
- ECMWF forcing

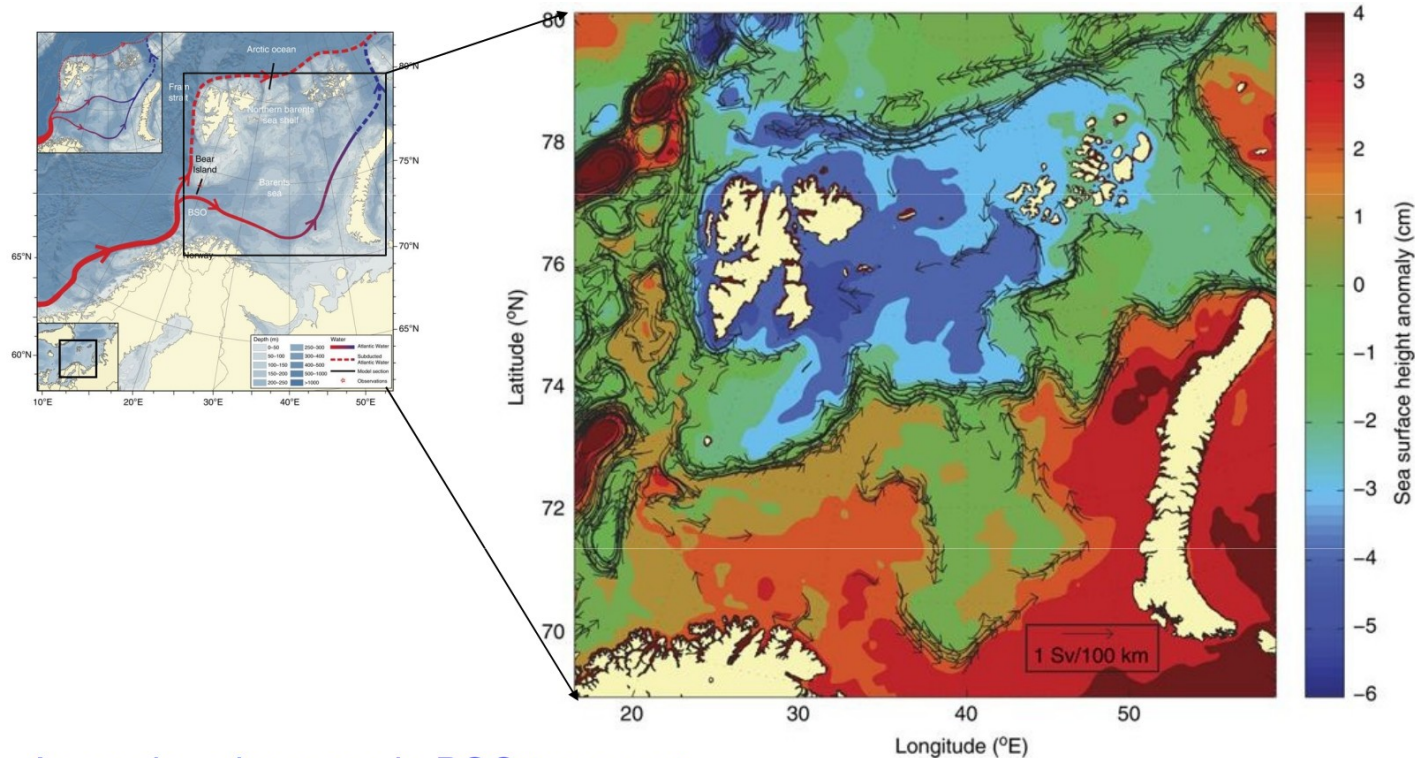
Observations: CMEMS

- Sea level anomalies
- Sea surface Temperature
- Sea ice concentrations
- Sea ice drift
- ARGO T/S and Ice-Tethered Profilers

Data Assimilation: EnKF

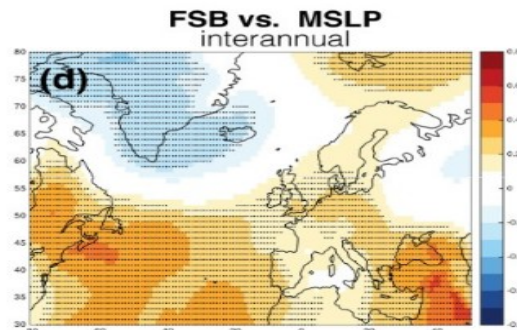
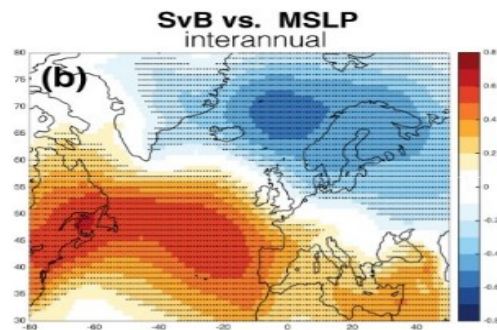
- 100 members
- Assimilates weekly, runs forecasts daily

Bifurcation of AW inflow into FS and BSO Branch

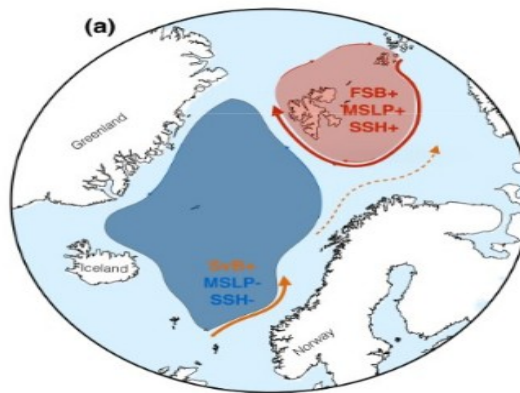
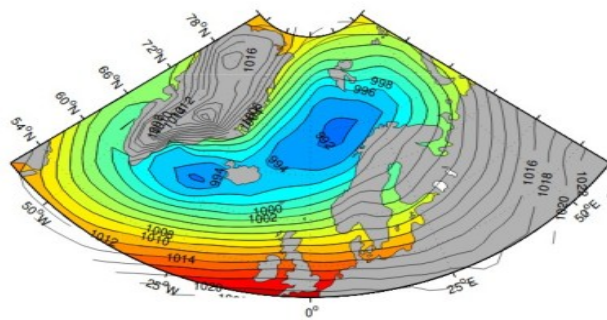


Anomalous increase in BSO transport
Due to Northern Barents Sea SSH anomaly

Lien et al., 2013

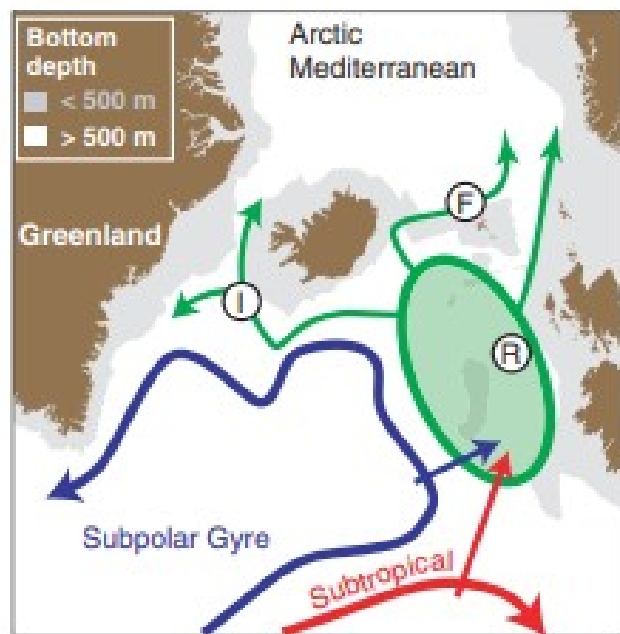


Correlation between MSLP and volume transport at Barents Sea and Fram Strait

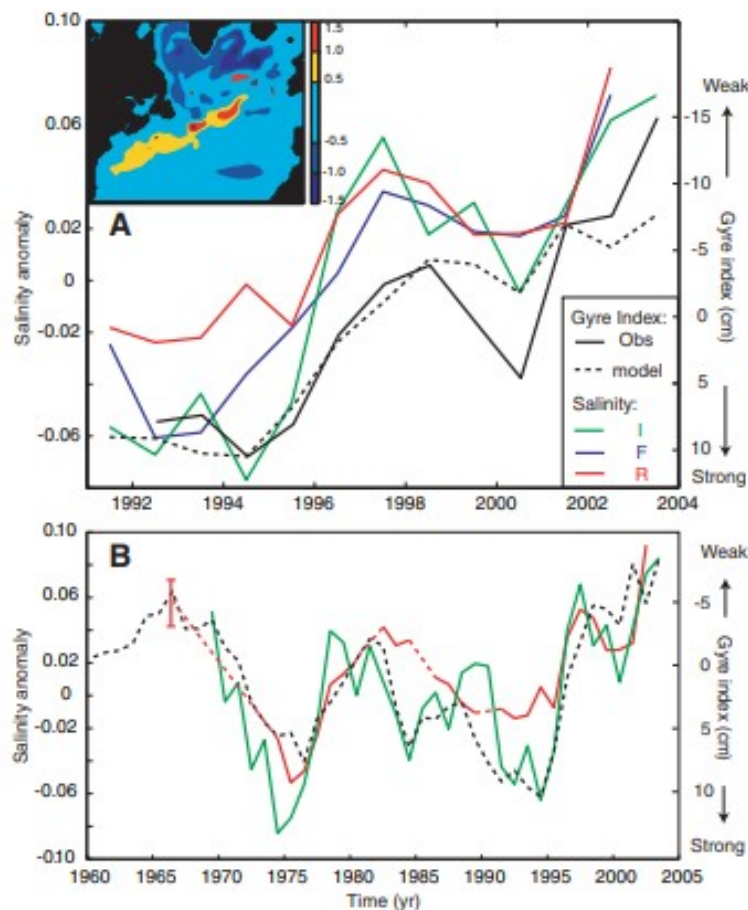


Skagseth et al., 2008
Chakif et al., 2017

AW anomalies into the Nordic Seas



Hatun et al., 2005



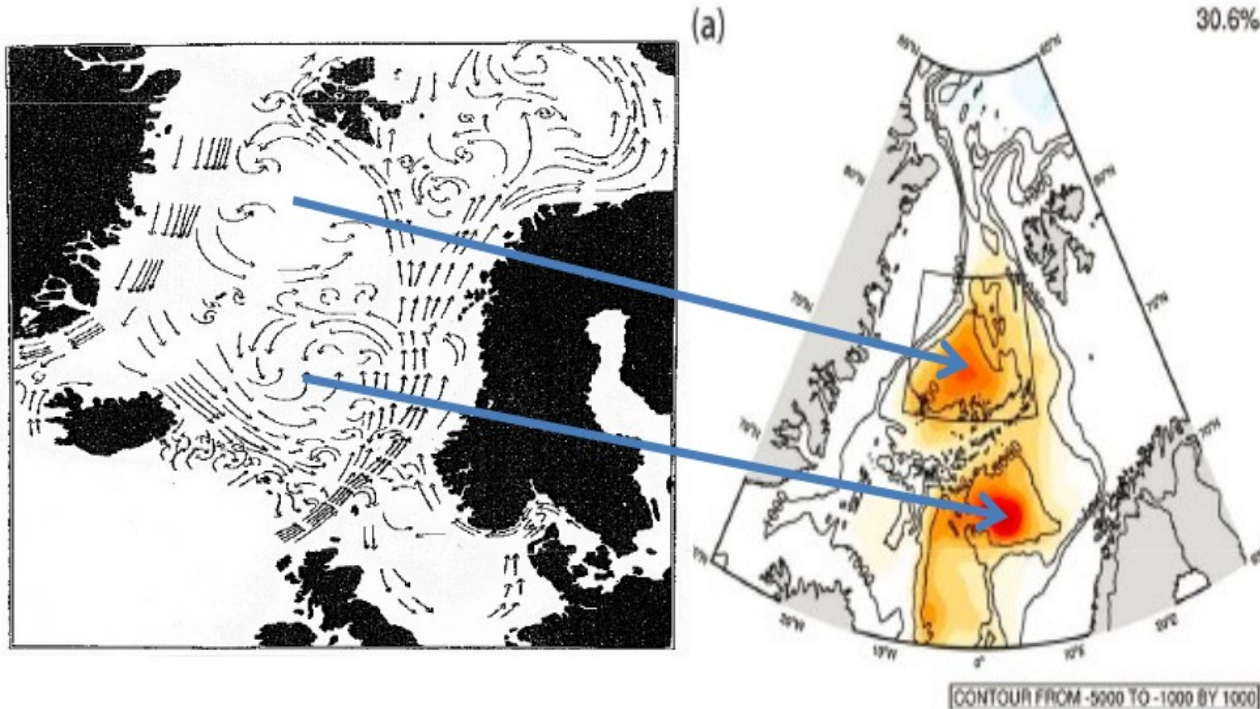
The variability in sub-polar gyre Strength can lead to anomalous AW inflow into the Nordic Seas.

Is this the only mechanism responsible for AW anomalies in the AW entry points to the Arctic ocean interior?

Is the Nordic Seas are only Passive conduit of AW anomalies Generated upstream at SPG?

Can the Nordic Seas dynamics Induce further AW anomalies (apart from AW modification due to heat flux)?

Major large scale circulations in the Nordic Seas



Hansen and Nansen, 1909

Chatterjee et al., 2018

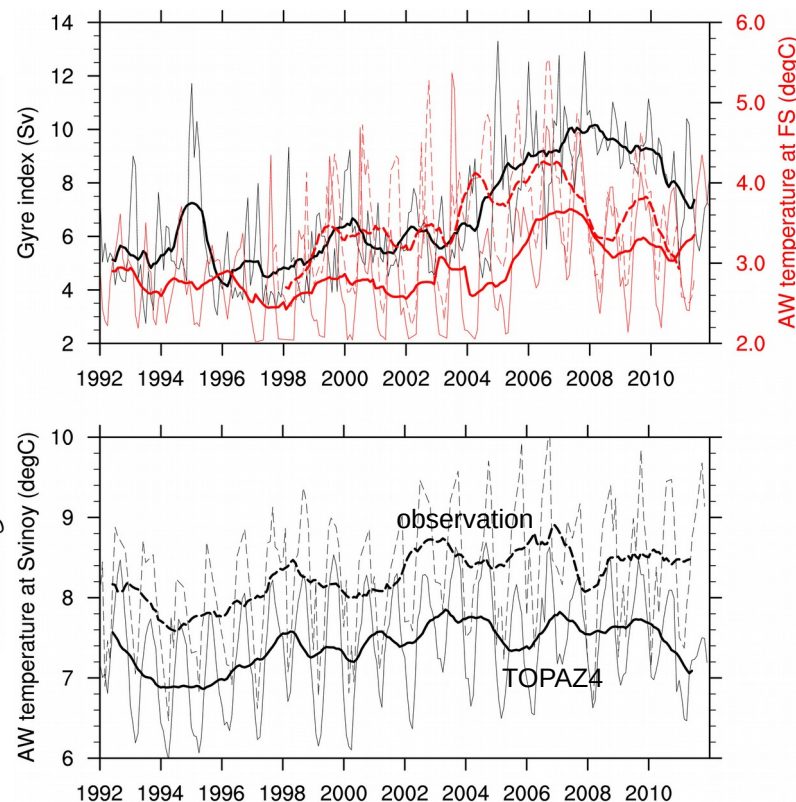
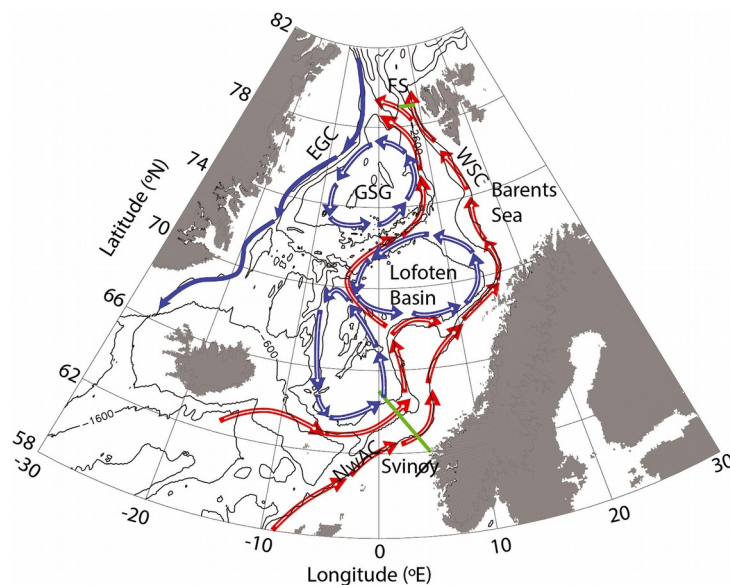
The EOF1 of barotropic Streamfunction in the Nordic Seas shows two major Gyre circulations.

1. Greenland Sea Gyre (GSG)
2. Lofoten basin Gyre

Do they induce any anomalies in AW on its way to the Arctic Ocean?

We concentrate here on GSG Due to its close proximity to Fram Strait.

AW temperature variability in the Fram Strait



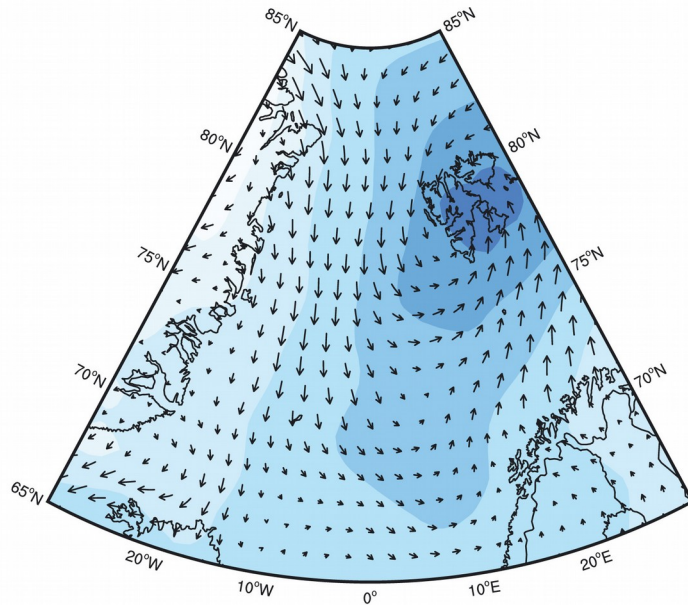
Although TOPAZ4 underestimates the AW temperature, a known model deficiency, it captures the variability reasonably well.

The rapid increase in AW Temperature in the FS since 2004 is not found in upstream Svinoy section

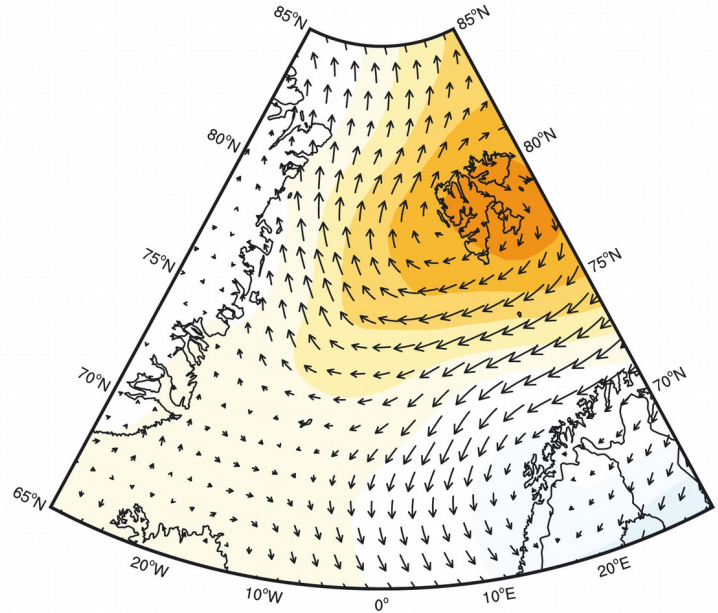
However, the increase in AW temp. is concurrent to strengthening of the GSG.

Atmospheric circulation associated with AW temperature variability in the Fram Strait

Composites of SLP and 850hPa winds anomaly



Warm AW temp anomaly in FS



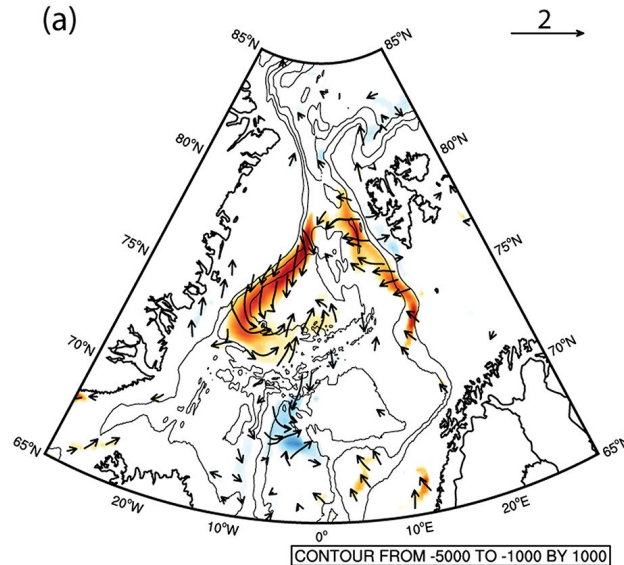
Cold AW temp anomaly in FS

Warm AW temperature
Anomalies in the FS is
Associated with a low SLP
anomaly over Nordic Seas

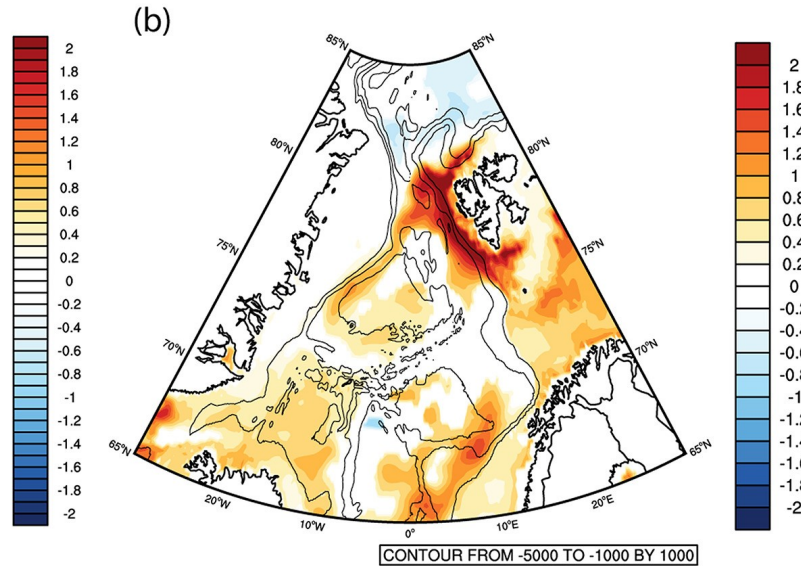
The associated wind anomalies
don't directly explain the AW
temperature variability

However, the low SLP anomaly
Can strengthen the cyclonic GSG
circulation

Impact of a stronger GSG circulation in the FS



Reg(Gyre index, currents), cm/s



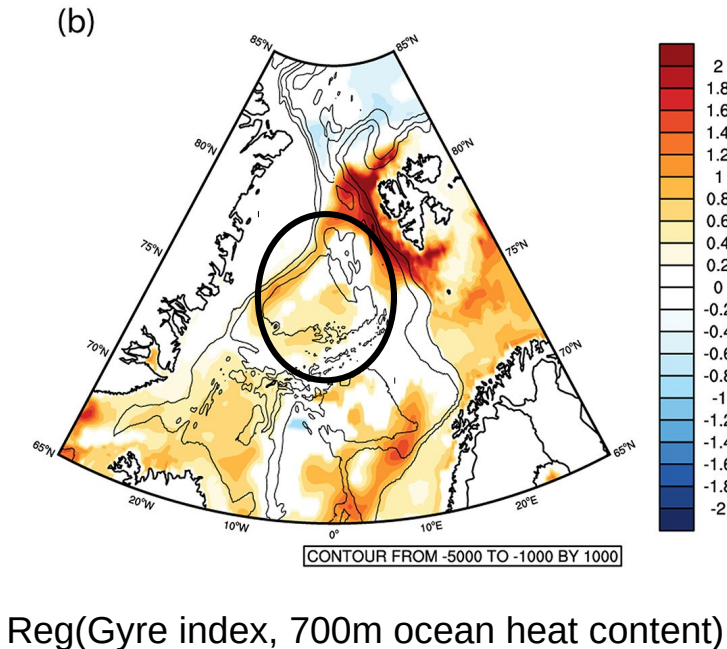
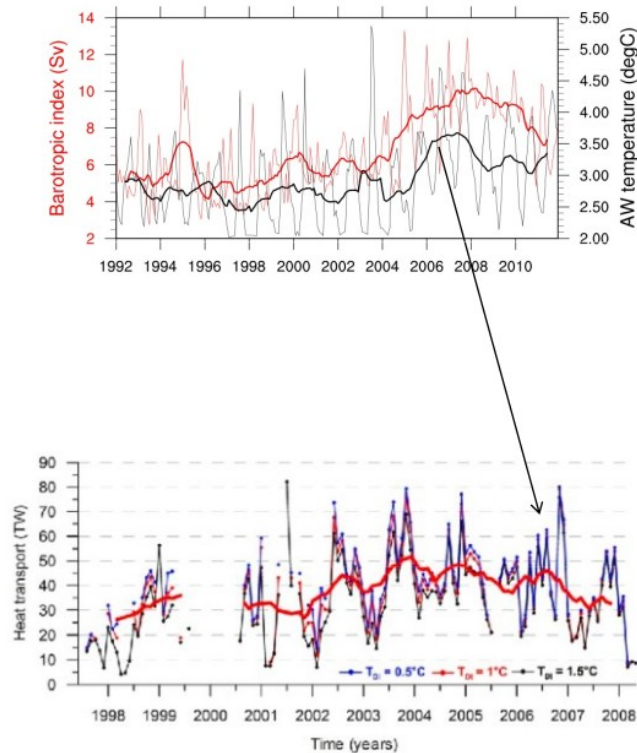
Reg(Gyre index, 700m ocean heat content), 10^9 J m^{-2}

A stronger GSG circulation
Strengthens the northward
AW flow towards FS.

Stronger flow in turn reduces
The heat loss to atmosphere
And thus increases the heat
content, resulting in warm
AW anomaly in FS.

What happens to this excess
Heat transported toward FS?

Impact of a stronger GSG circulation in the FS

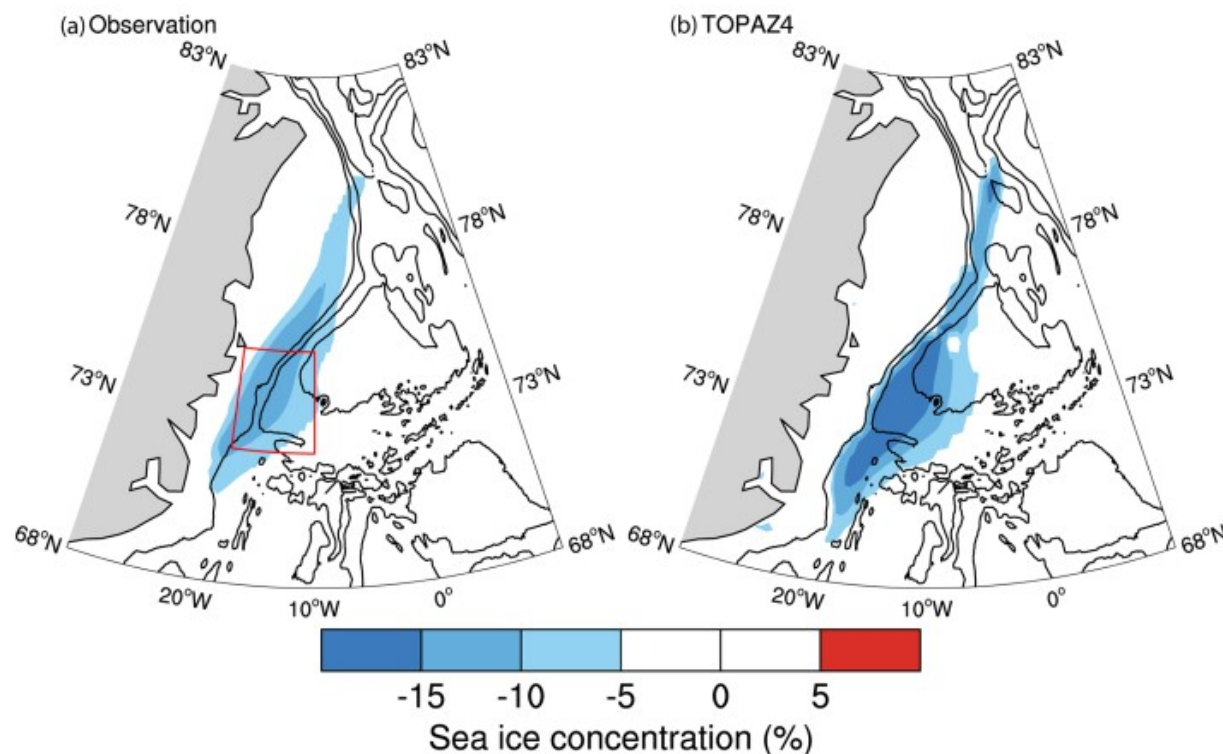


The heat transport towards Arctic ocean didn't increase inspite of warming in the Fram Strait!!

Rather a significant amount of Heat is transported back toward Greenland Sea by the stronger Recirculating branch of GSG.

Does this influence the sea ice in Greenland Sea?

Impact of a stronger GSG circulation on sea ice in Greenland Sea



Reg (SIC, Gyre Index)

Here, we focus on the winter mean (DJF) Sea ice concentraion in the Greenland Sea And the GSG strength during DJF as well.

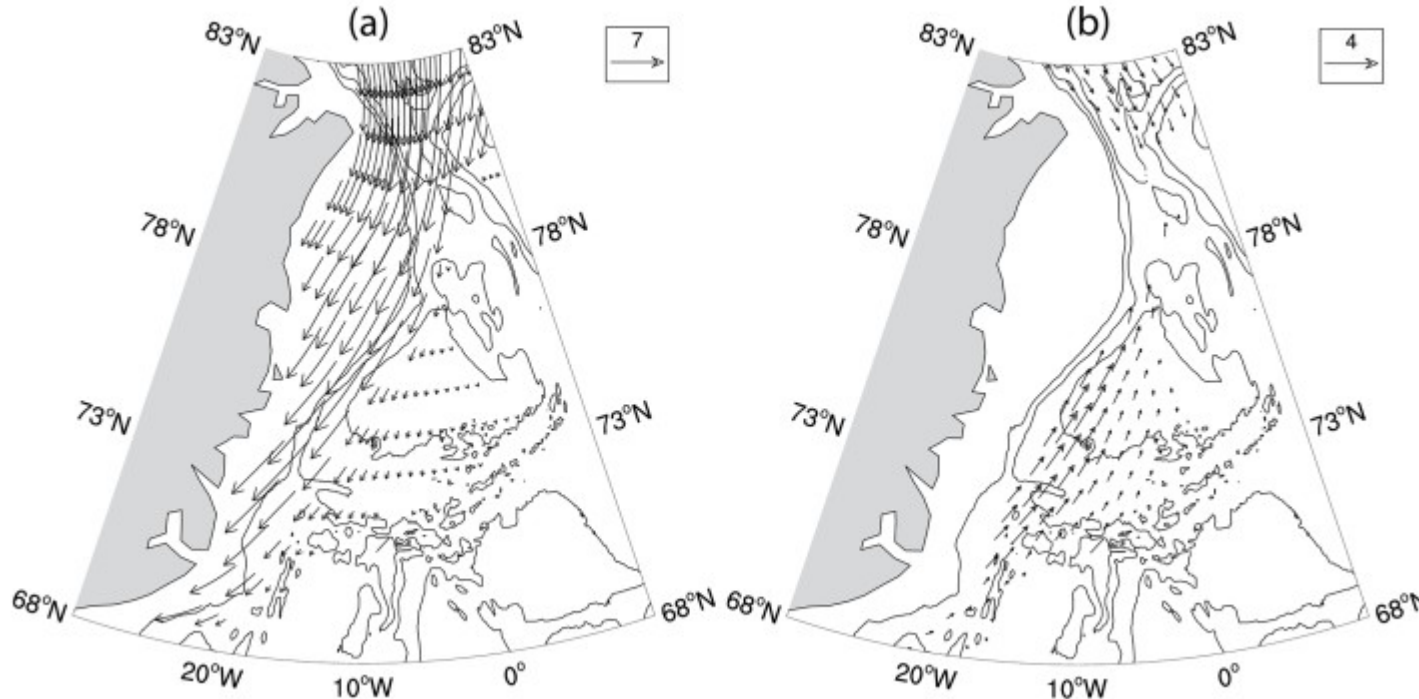
A strong GSG circulation is associated with Reduced SIC in the western Greenland Sea.

The major large scale drivers of SIC variability In this region is:

1. Sea ice export through Fram Strait
2. Local sea ice melting

How are these processes influenced, in Context of GSG circulation?

GSG circulation and atmospheric influence on Sea ice export through Fram Strait in the Greenland Sea



Sea ice vectors (climatology)

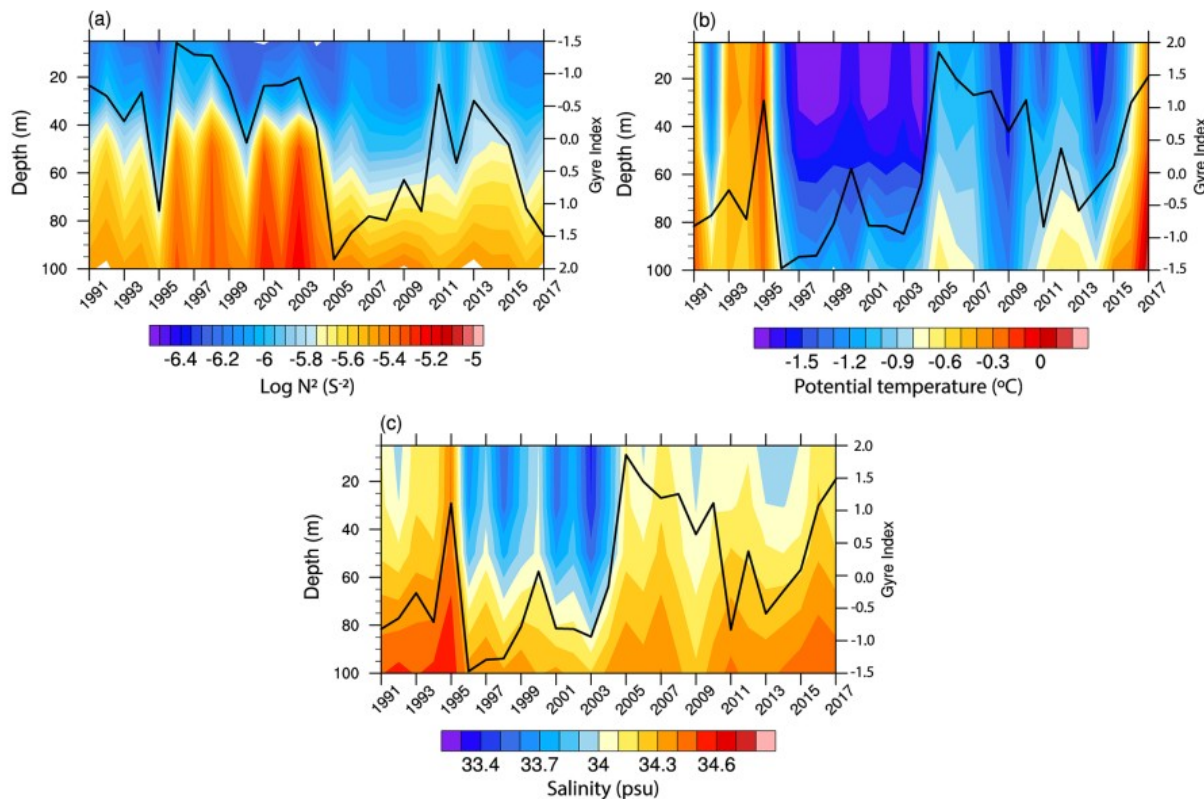
Reg(Sea ice vectors, gyre index)

Note that the GSG circulation strengthens with a low SLP anomaly over Nordic Seas.

The associated northerly winds along the Greenland coast and also the stronger cyclonic GSG induce enhanced divergence of sea ice toward the Greenland coast. This in turn reduces the mean southward ice velocities in the west-central Greenland Sea.

Does this change in sea ice export influence the GSG associated ocean dynamics in this region?

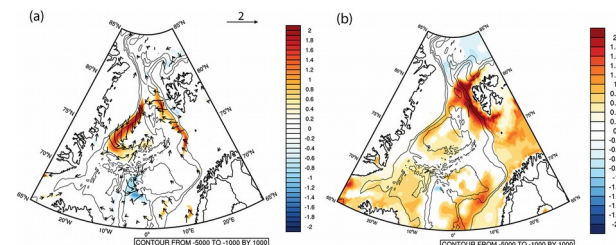
GSG circulation and oceanic influence on Sea ice export through Fram Strait in the Greenland Sea



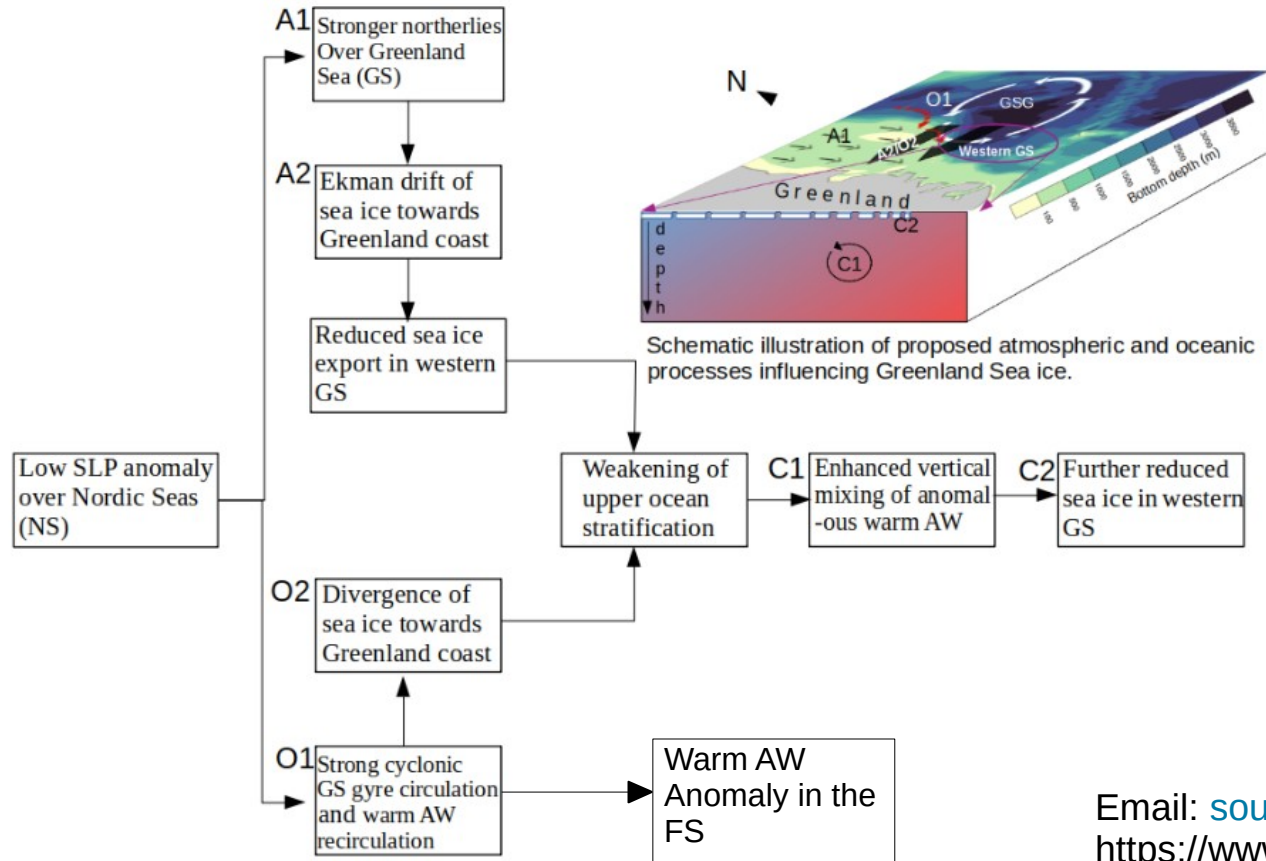
(a) A reduced sea ice export in the western Greenland Sea weakens the upper ocean Stratification.

At the same time note that stronger GSG Recirculates anomalous AW into the Greenland Sea.

(b,c) This AW anomalies are vertically mixed Under a weakly stratified upper ocean. This can further lead to bottom melting or Hinder the new sea ice formation.



Summary and Conclusions



References:

Chatterjee et al. 2018: Role of Greenland Sea gyre circulation on Atlantic Water temperature variability in the Fram Strait. GRL, 45, 8399–8406. <https://doi.org/10.1029/2018GL079174>

Chatterjee et al., 2021: Combined influence of oceanic and atmospheric circulations on Greenland sea ice concentration, The Cryosphere, 15, 1307–1319, <https://doi.org/10.5194/tc-15-1307-2021>

Thank You!

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