Watermass Variability Barents Sea: Atlantic Water Advection versus Sea Ice Import

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Outline of Topics

Barents Sea's role: AW transformation and polar climate

Atlantic Water inflow to Barents Sea

Hydrographic data 1950-2000: climatology and trends

Forcing mechanisms of hydrographic variability

Summary and Outlook

Outline

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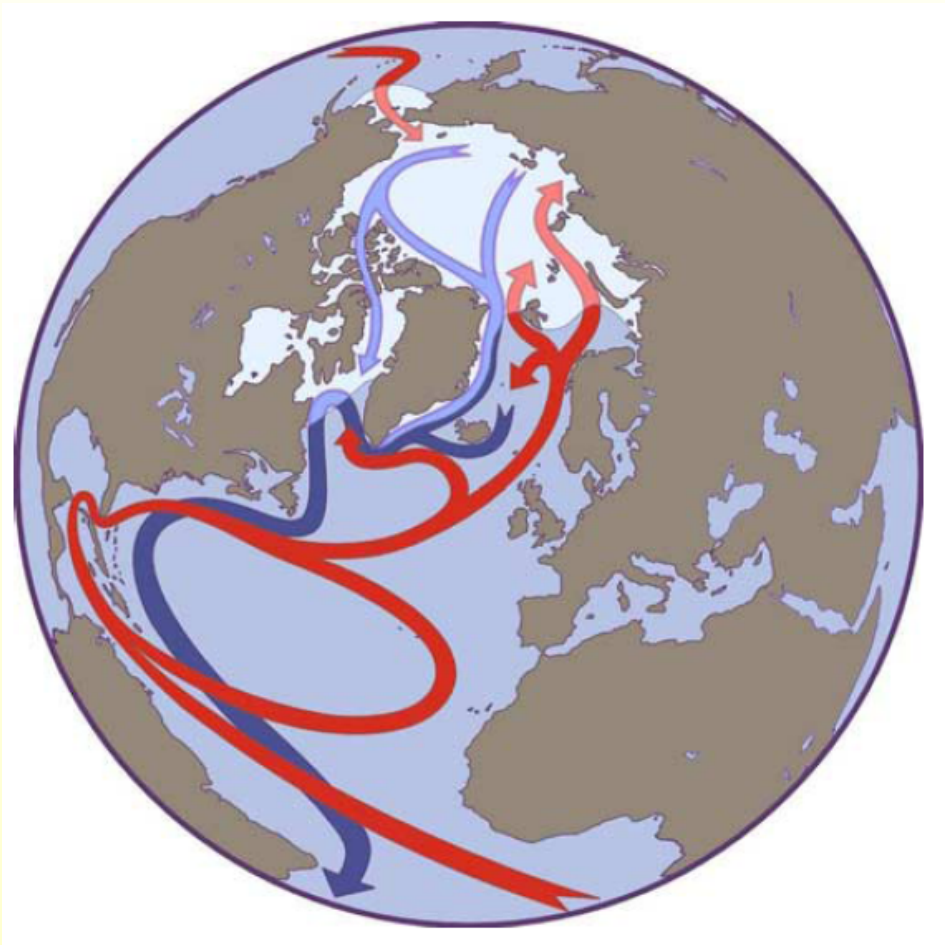
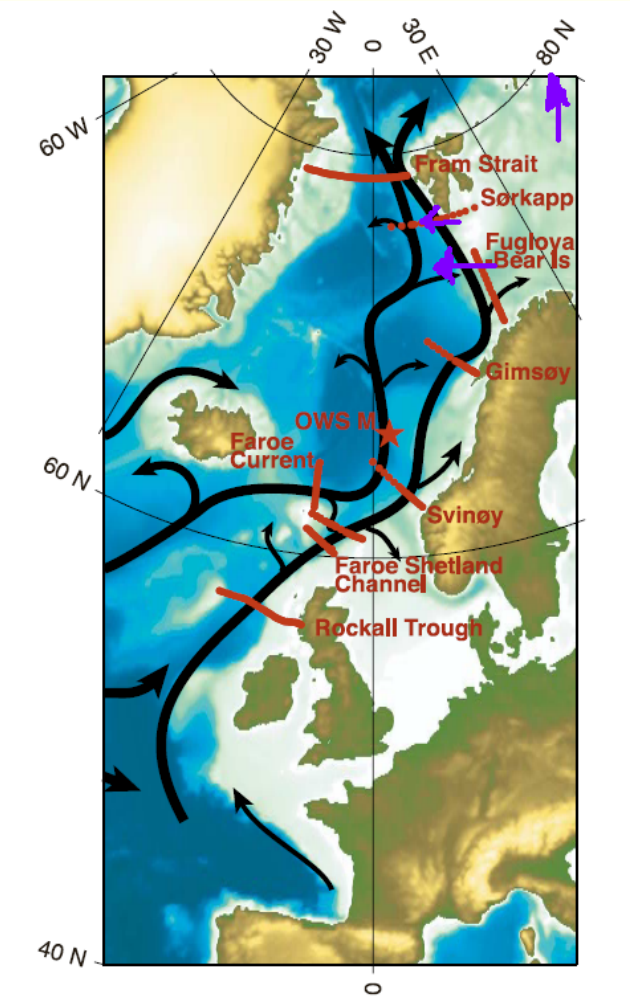
NwAC and global circulation



From Holloway et al. (2008)

NwAC and Barents Sea Throughflow

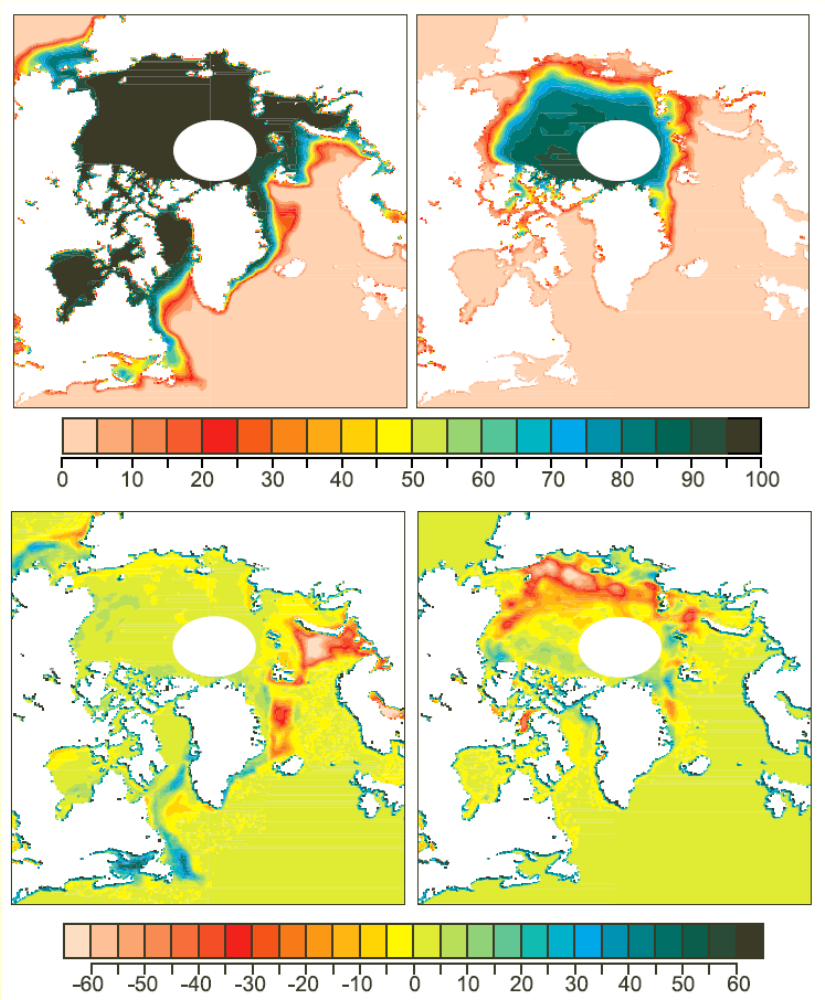


Barents Sea

- transformation of Atlantic Water
- 2-3 Sv intermediate and deep water outflow
- 40-50 % of overflows

Figure: After Holliday et al. (2008)

Major sea ice cover change: Barents Sea



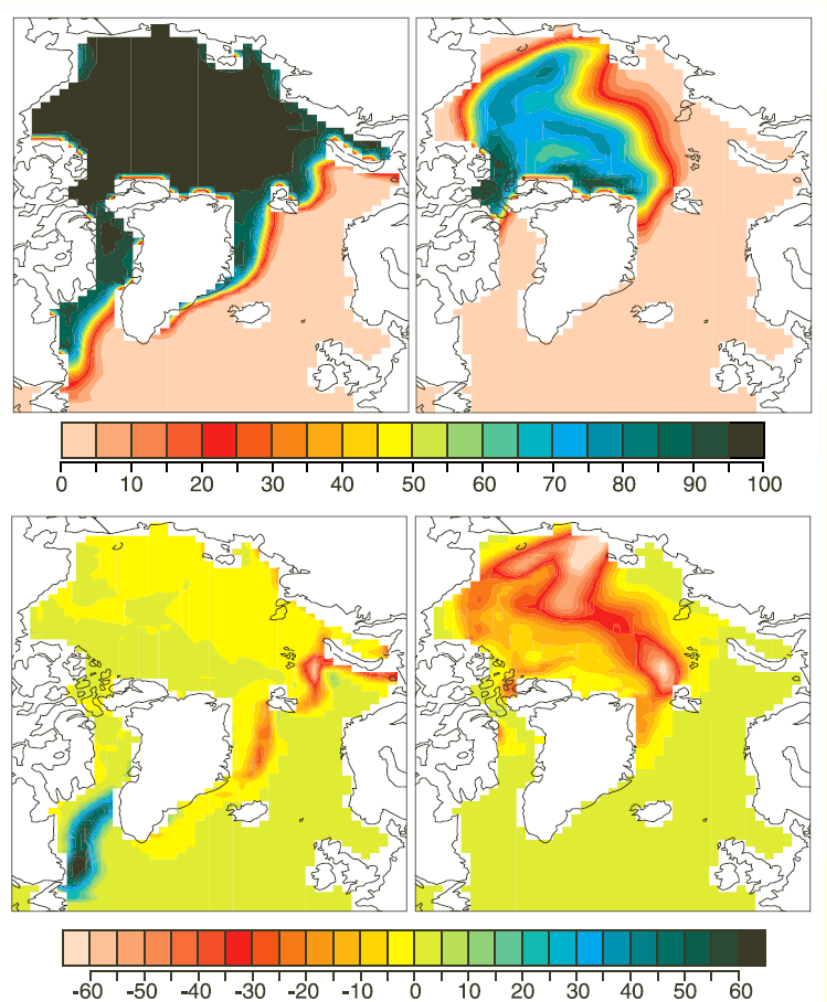
Observed sea ice cover change

- Barents Sea: winter coverage
- Arctic Ocean: summer coverage
- Forcing: atmospheric or AW advection?

Figure: Kauker et al. (2008)

note: 1997-1997 change

Modeled sea ice cover change



Modeled sea ice cover change

- Barents Sea: winter coverage
- Arctic Ocean: summer coverage
- Somewhat different from observations

Figure: Kauker et al. (2008)

Model deficiencies, e.g., tides...

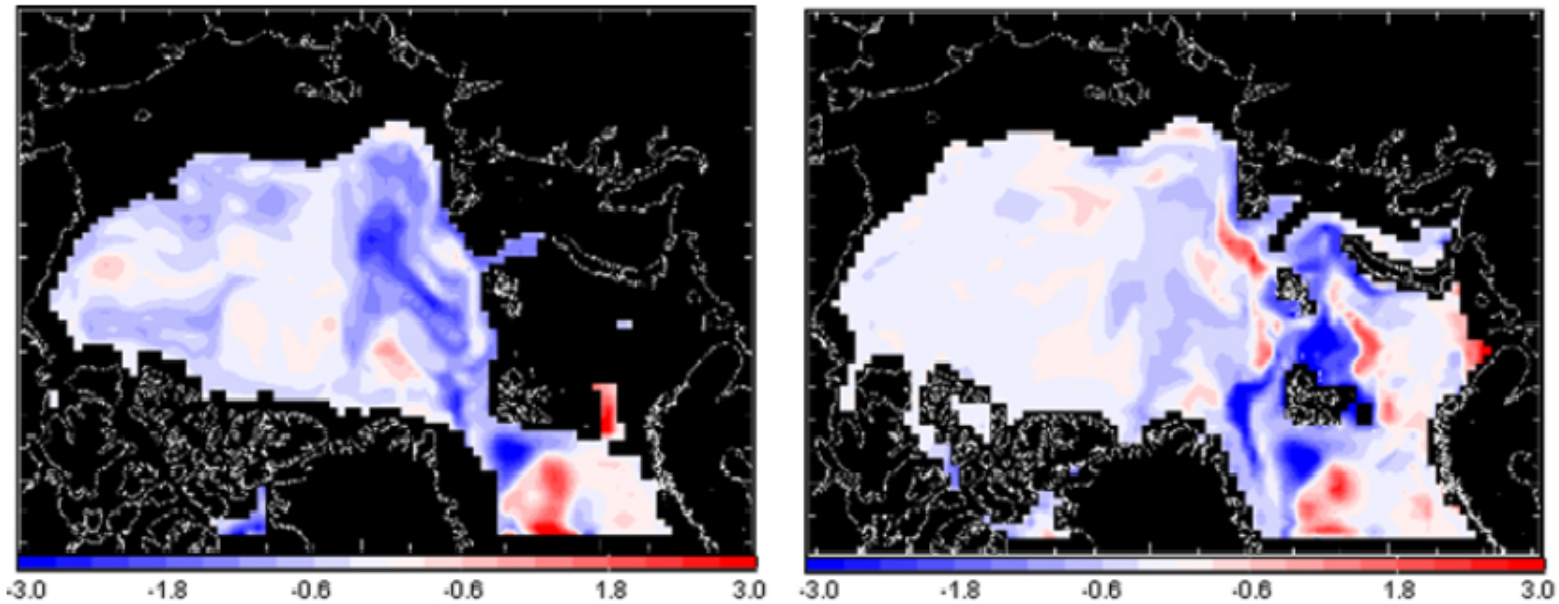
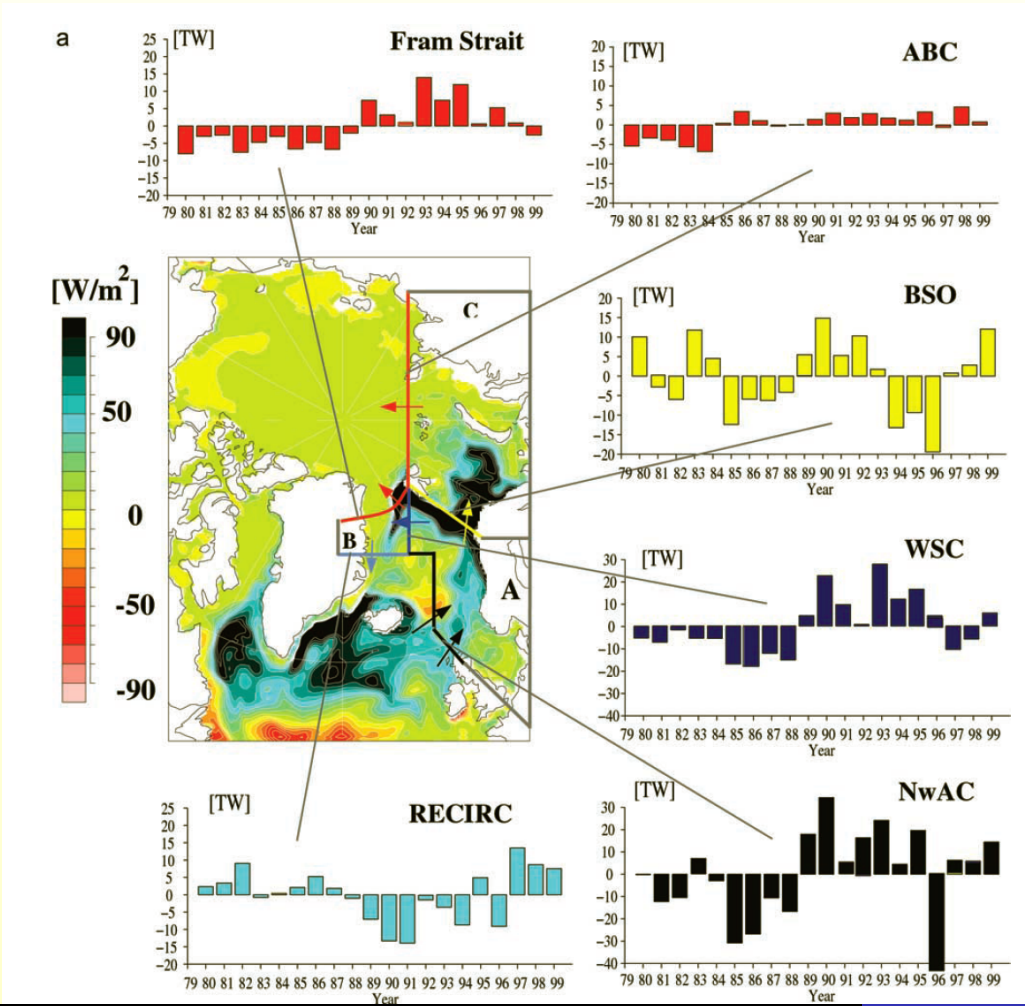


Figure 7. The difference of potential temperature (°C) between the cases with tides and with no tides (namely, Figure 6). (left) At 320 m. (right) At 80 m.

Temperature effect of tidal mixing From Holloway et al. (2008)

Heat transports and ocean-atmosphere fluxes



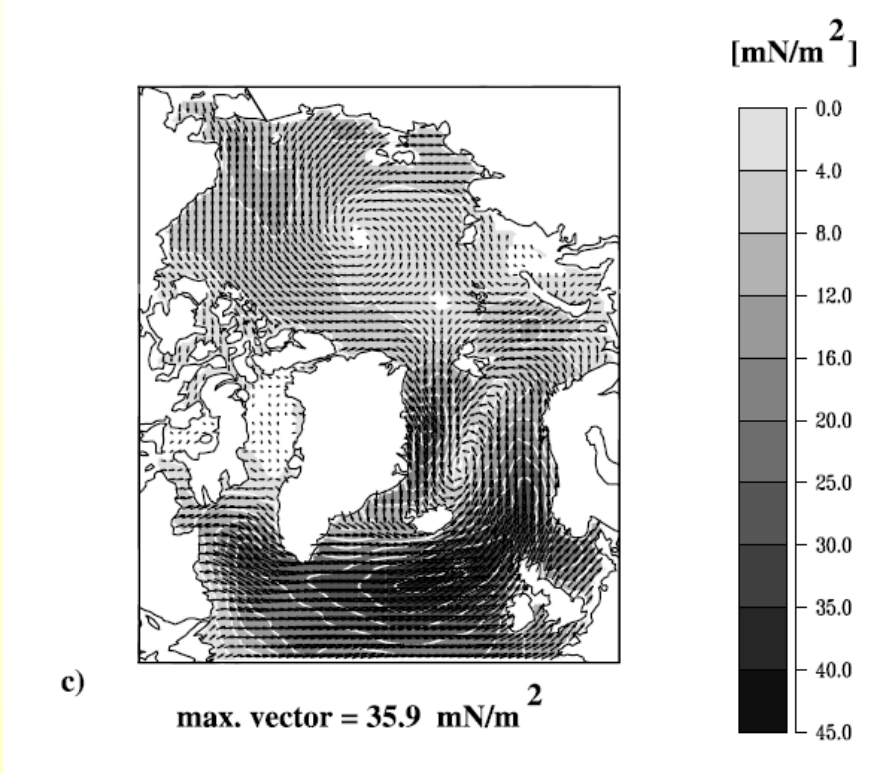
Heat fluxes domianted by Barents Sea and WSC

Heat transports

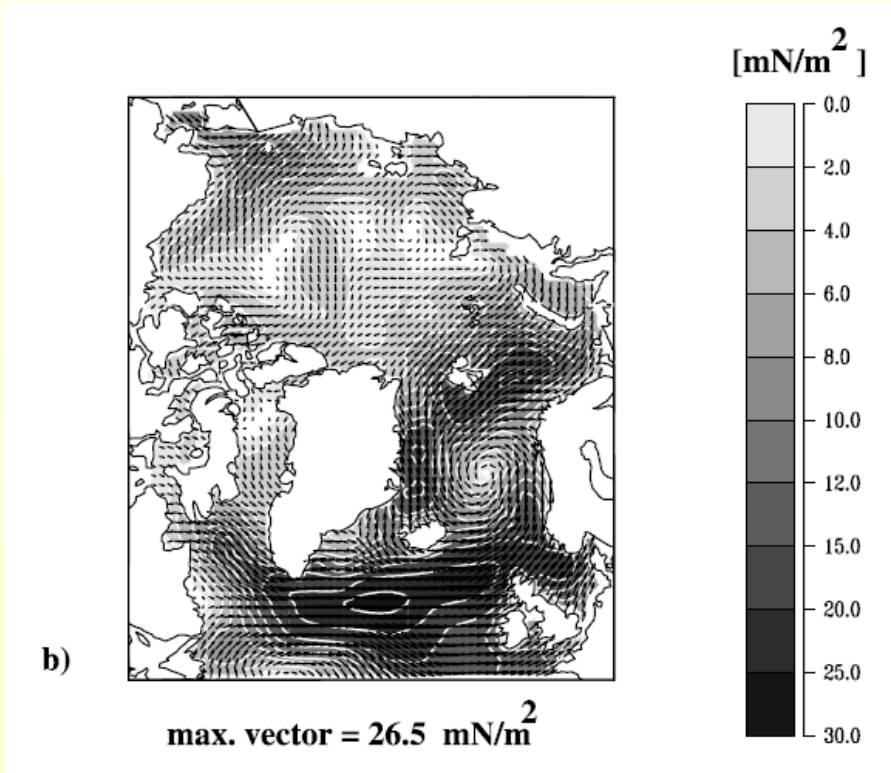
- Different variability: BSO and WSC
- 1983-1991 in phase
- 1992-1998 out of phase

Figure: Karcher et al. (2003)

Wind stress driving transports



Iceland-Faroe transport



Barents Sea (Karcher et al., 2003)

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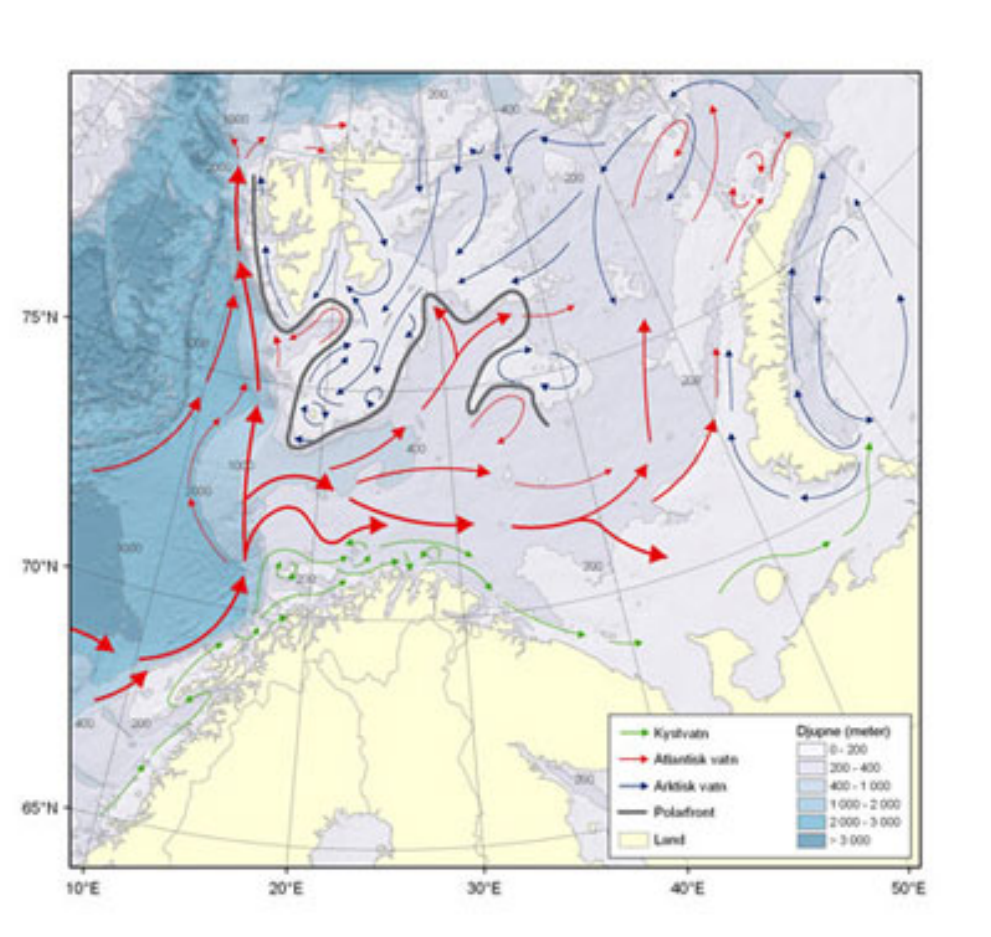
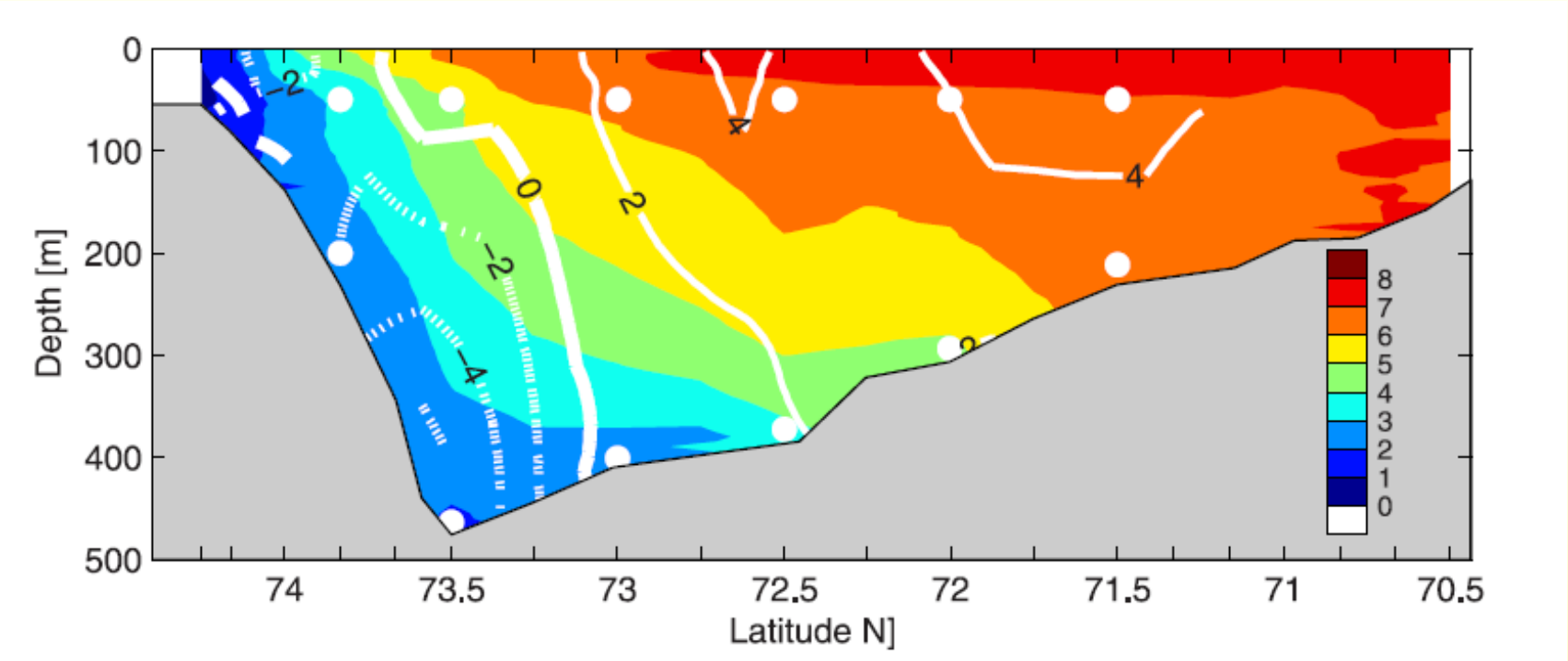
Barents Sea currents



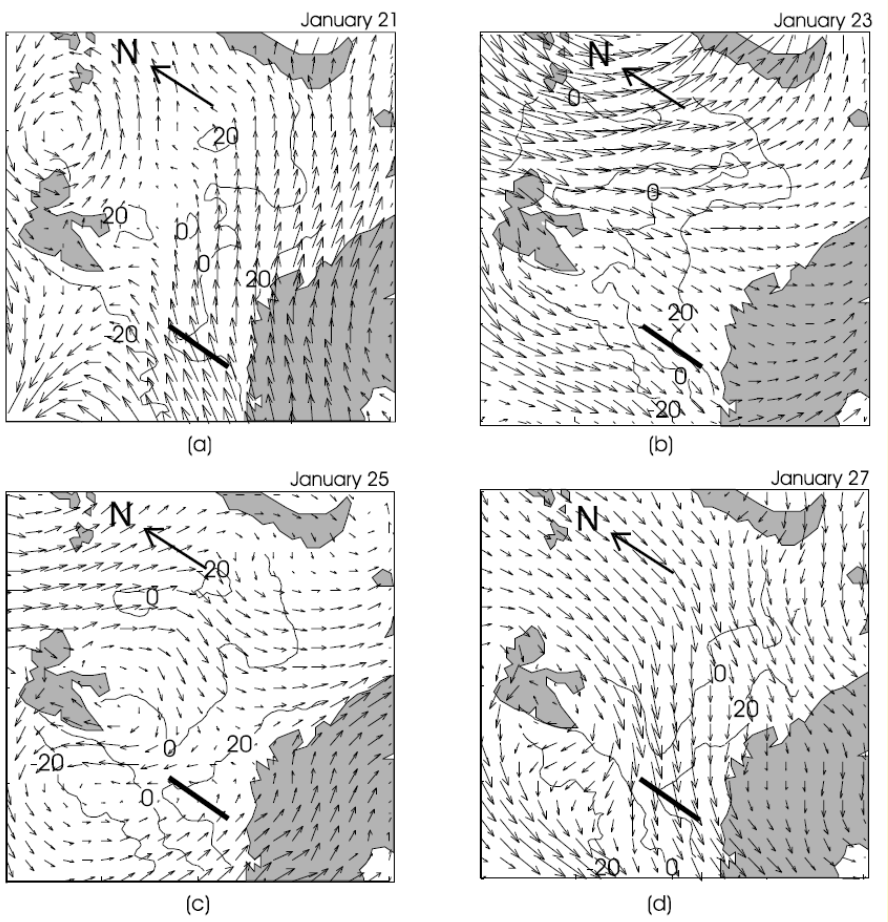
(Loeng and Drinkwater, 2008)

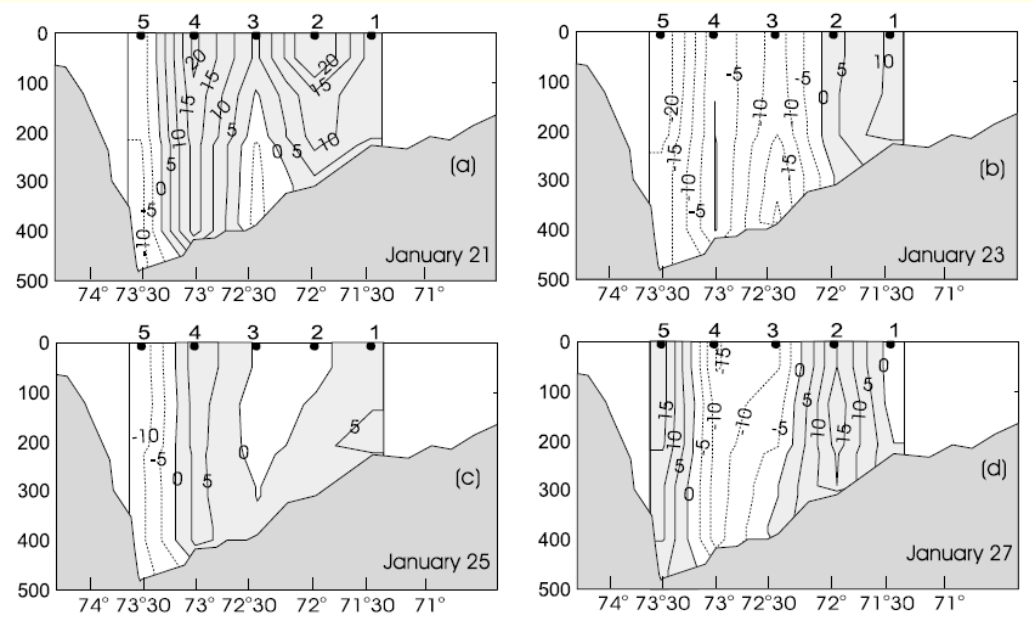
Average Barents Sea inflow



Average velocity field of BSO inflow 2003-2005 (Skagseth, 2008)

Wind forcing and current structure variability





Wind forcing variability versus
Current structure variability

(Ingvaldsen et al., 2004)

Inflow to Barents Sea: SLP pattern

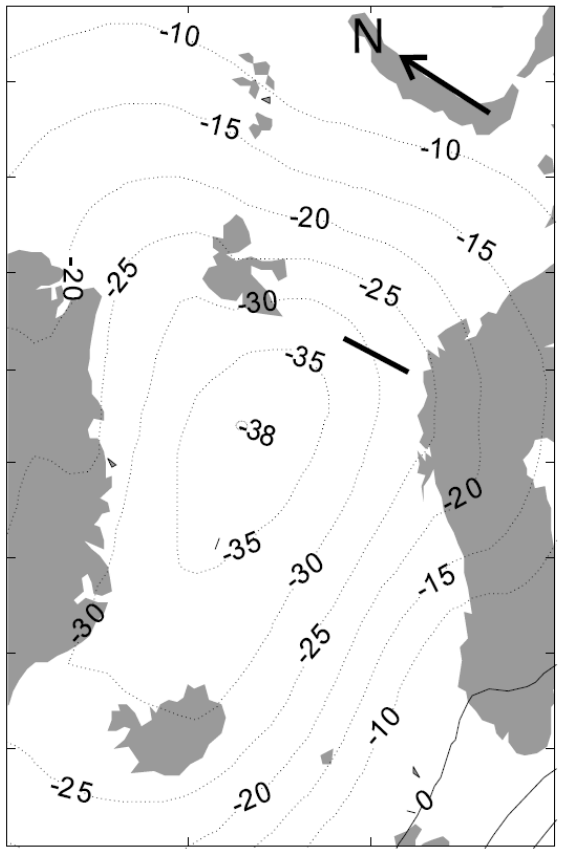


Figure 13. Correlation coefficients (multiplied by 100) between the principal component of EOF1 and atmospheric pressure. Location of mooring array is indicated.

Correlation with 1. EOF

- SLP Pattern of uniform inflow
- NAO-like pressure field
- Ekman transport towards Norway

Figure: Ingvaldsen et al. (2003)

Wind stress and NAO

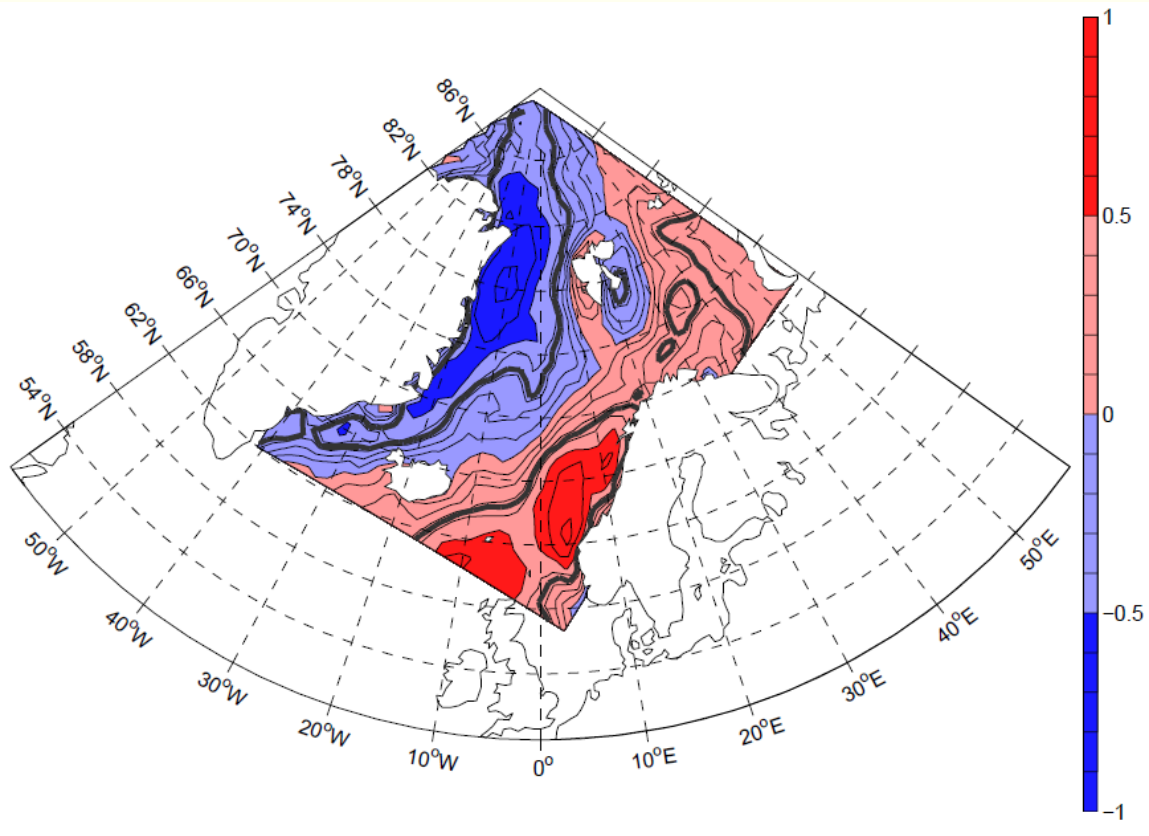
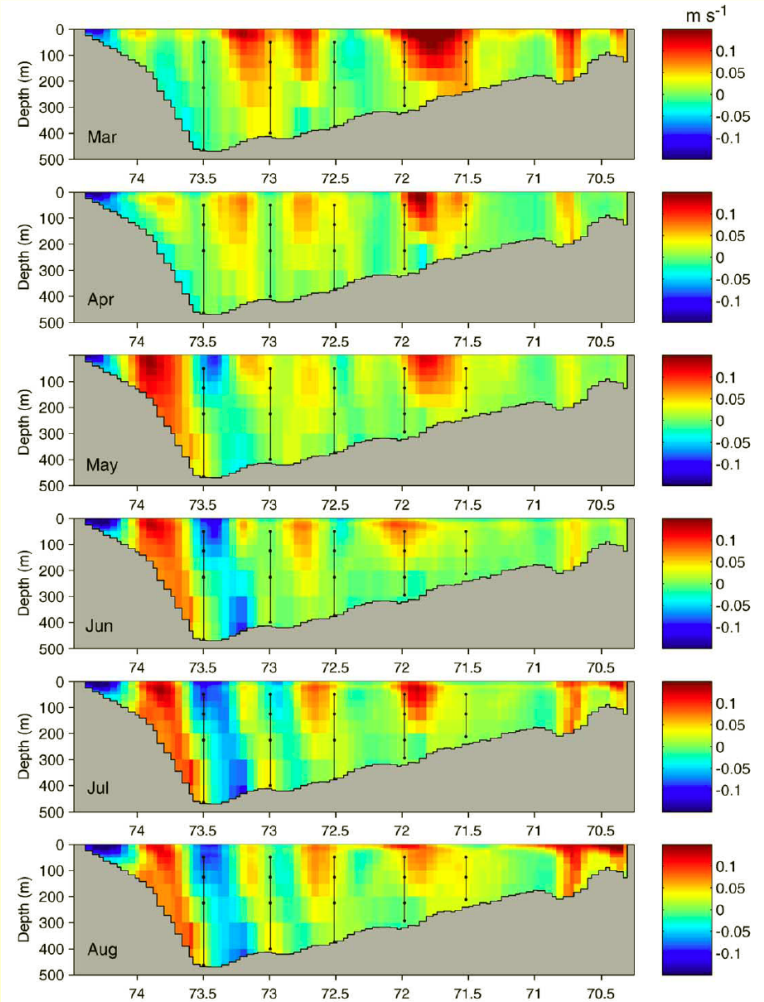


Figure: Weigel (2005)

Correlation τ_{north} and NAO

- High correlation along Norwegian coast
- Ekman transport geostrophic adjustment
- NAO associated with enhanced slope branch

Atlantic Water inflow to Barents Sea: Monitoring



Questions

- fine-structured inflow properly resolved?
- retrograde slope-current?
- true or artificial variability?

Figure: Slagstad et al. (2003)

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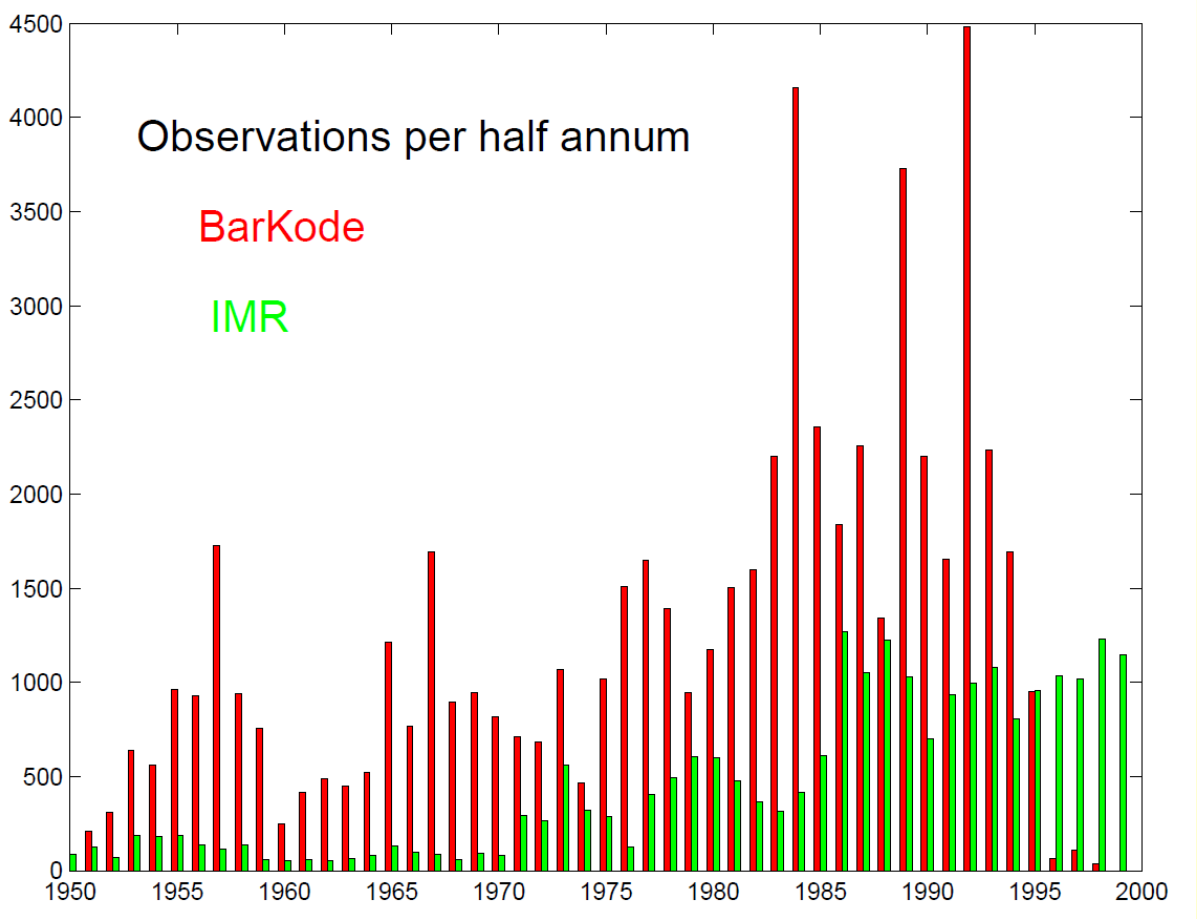
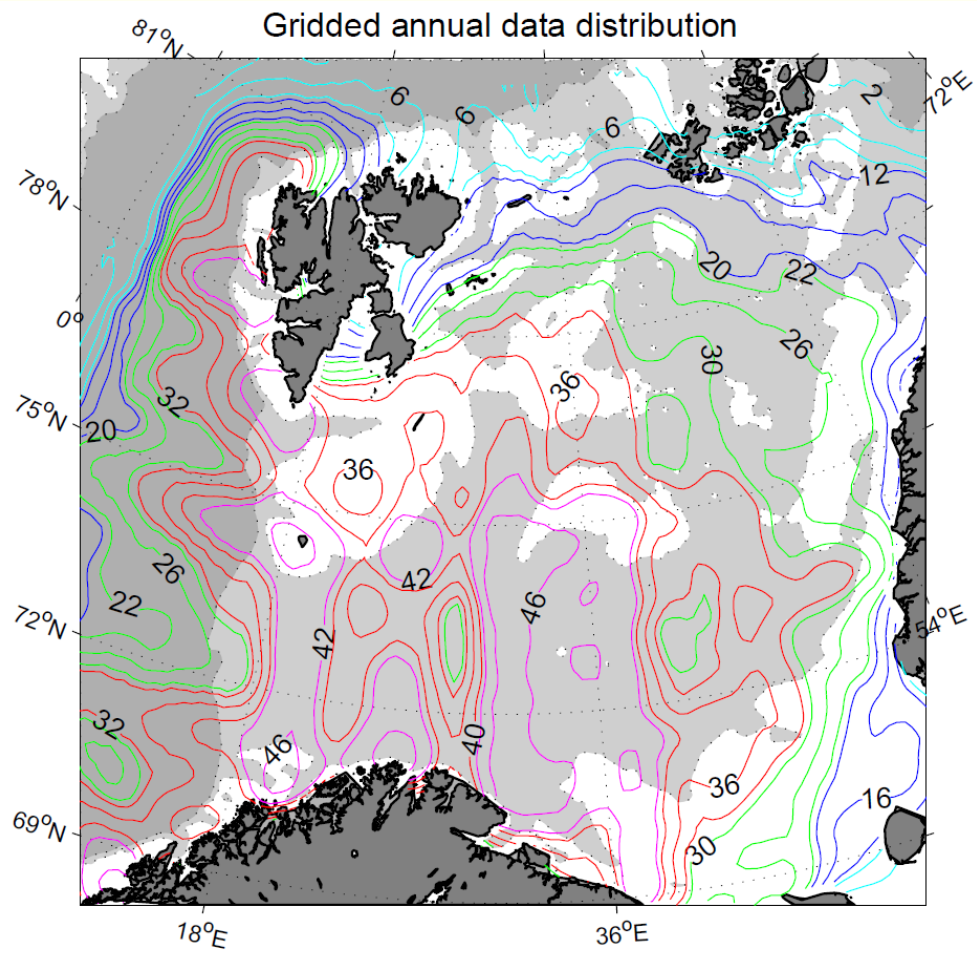
Barents Sea hydrographic data



Data from

- BARKODE (Matishev et al., 1999)
- Institute of Marine Research
- VEINS, NPI, BSH (not shown)

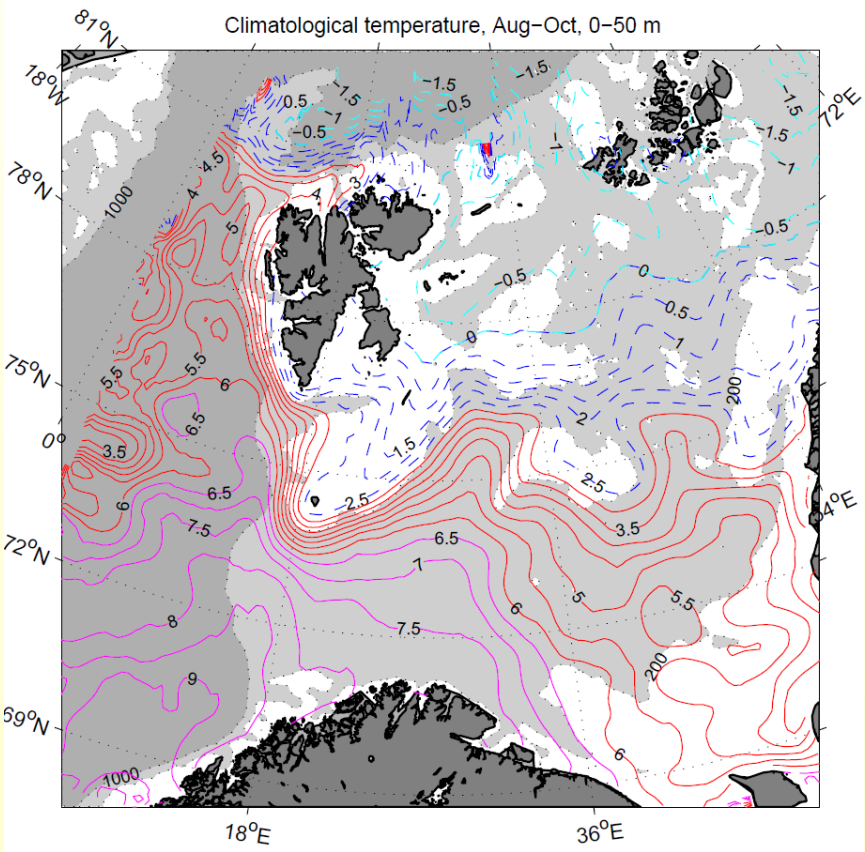
Barents Sea hydrographic data



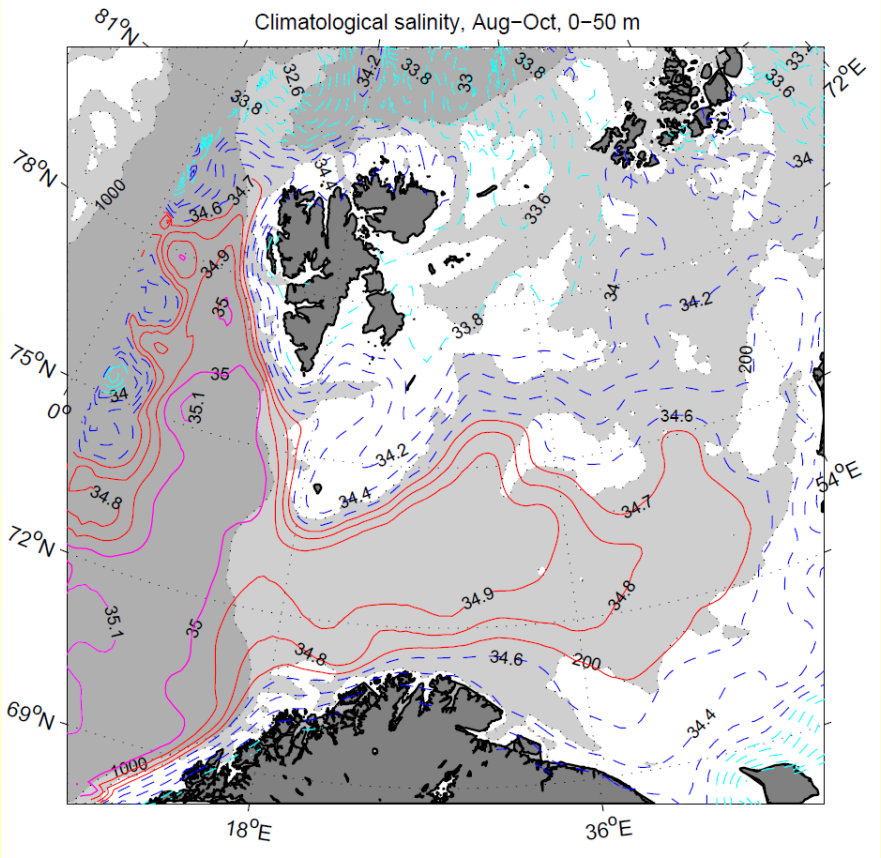
Spatial distribution 1950-2000

- Aug-Oct interpolated to 15. Sep
- gridded to 25 km
- SW Barents Sea 40-50 years
- NE Barents Sea 10-30 years

Temperature and salinity climatology

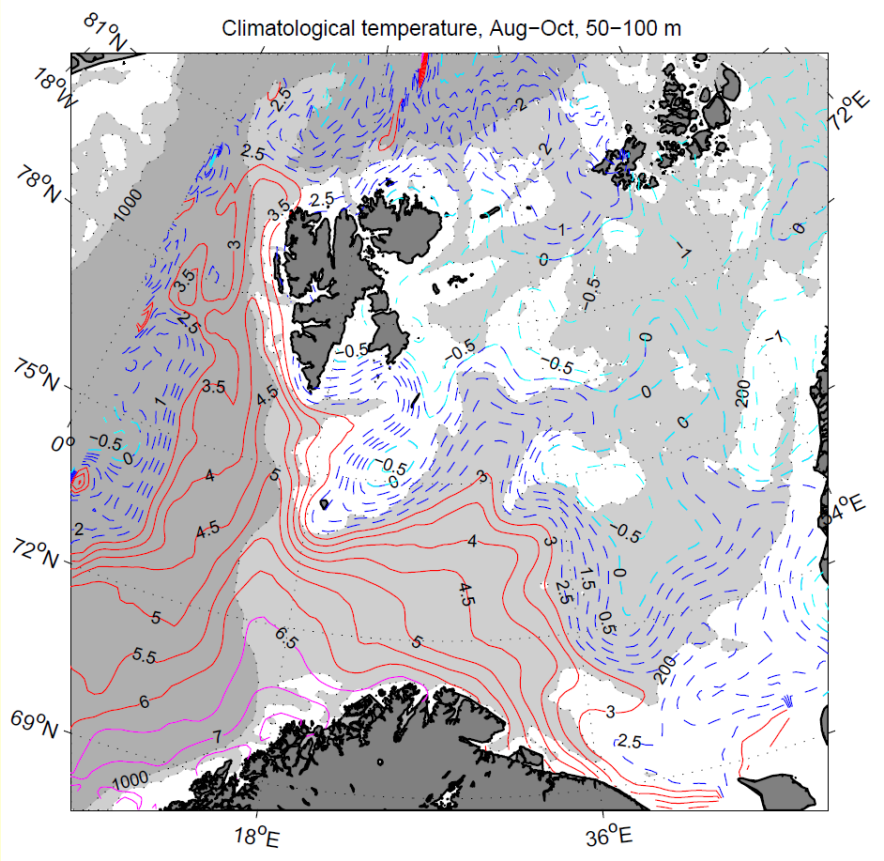


Temperature 0-50 m

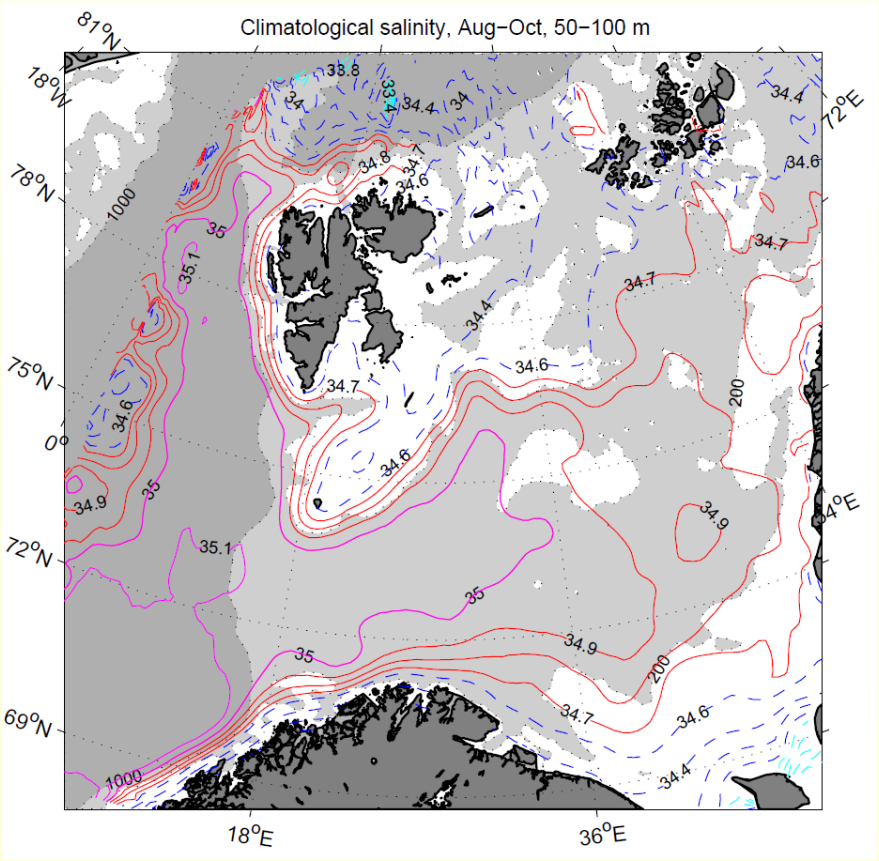


Salinity 0-50m

Temperature and salinity climatology

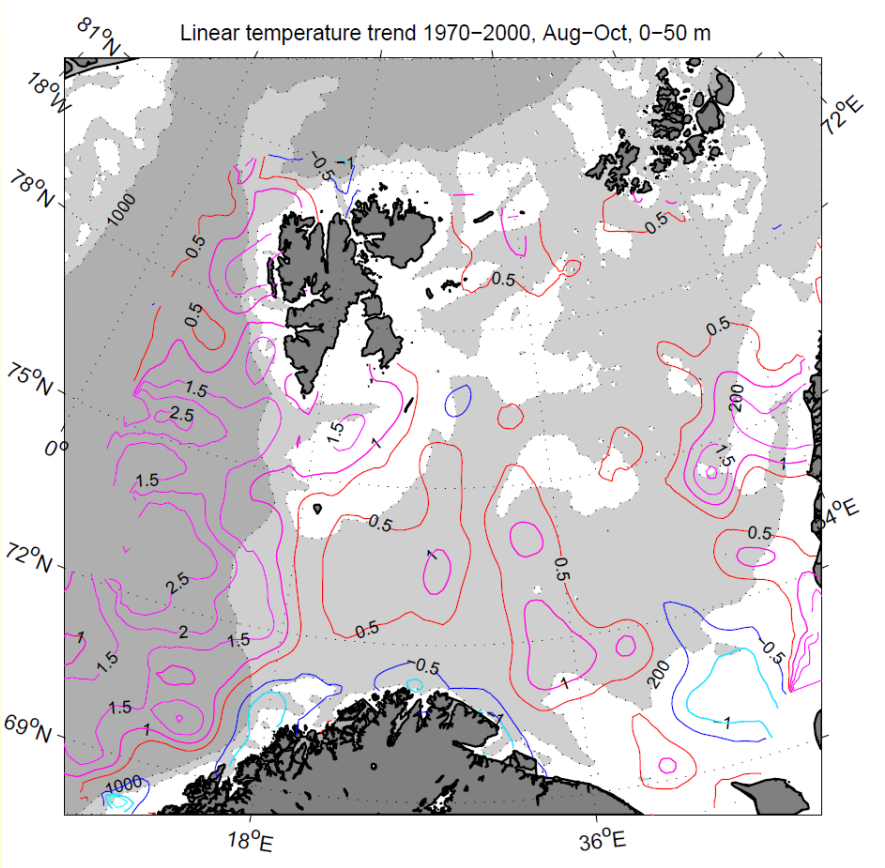


Temperature 50-100 m

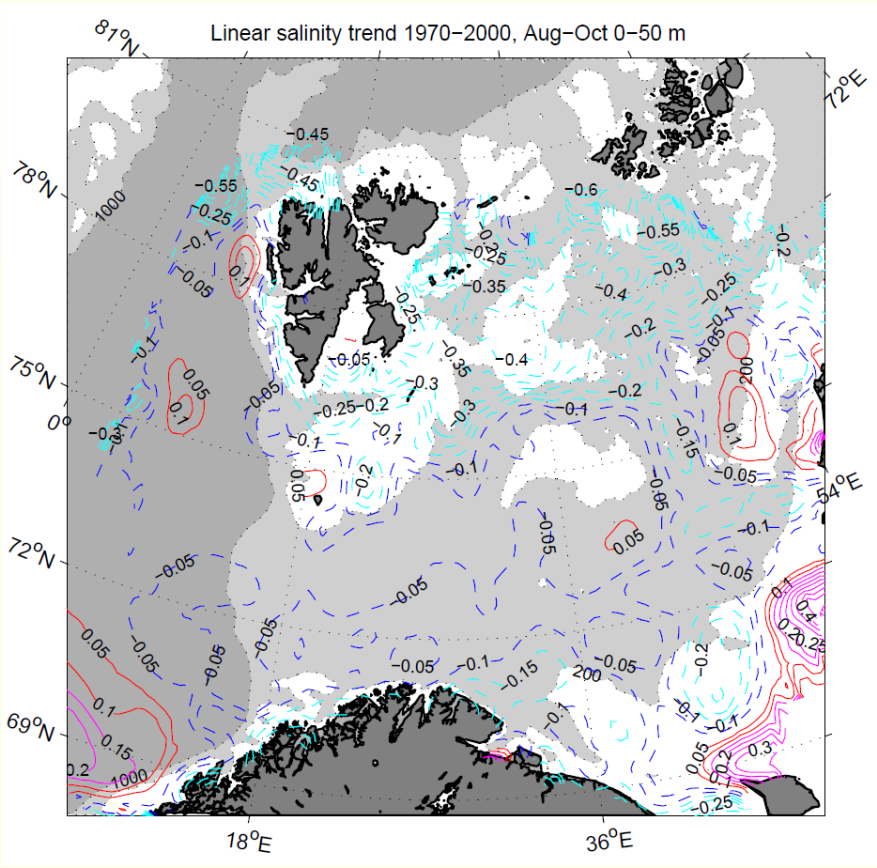


Salinity 50-100m

Temperature and salinity trends

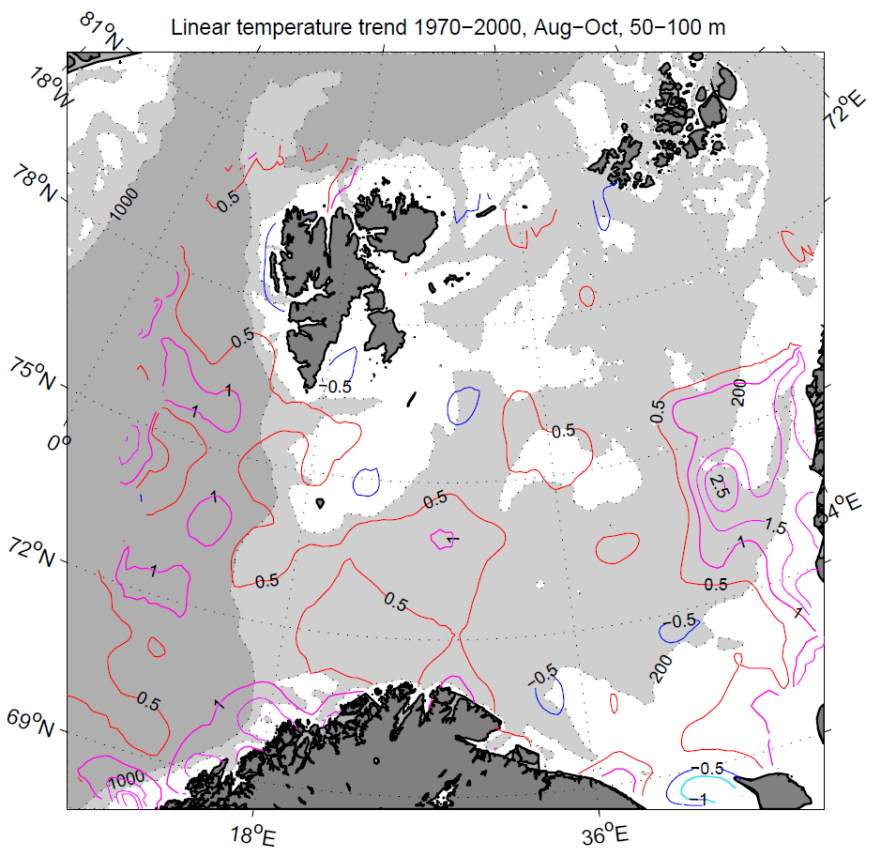


Temperature trend 1970-2000, 0-50 m

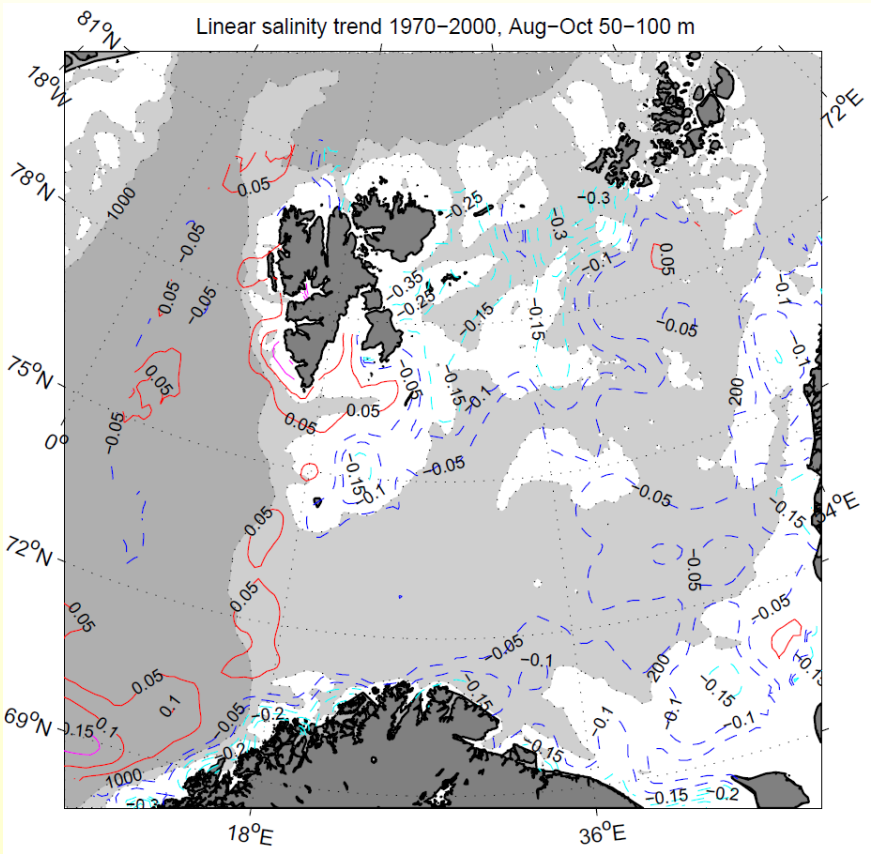


Salinity trend 1970-2000, 0-50m

Temperature and salinity trends

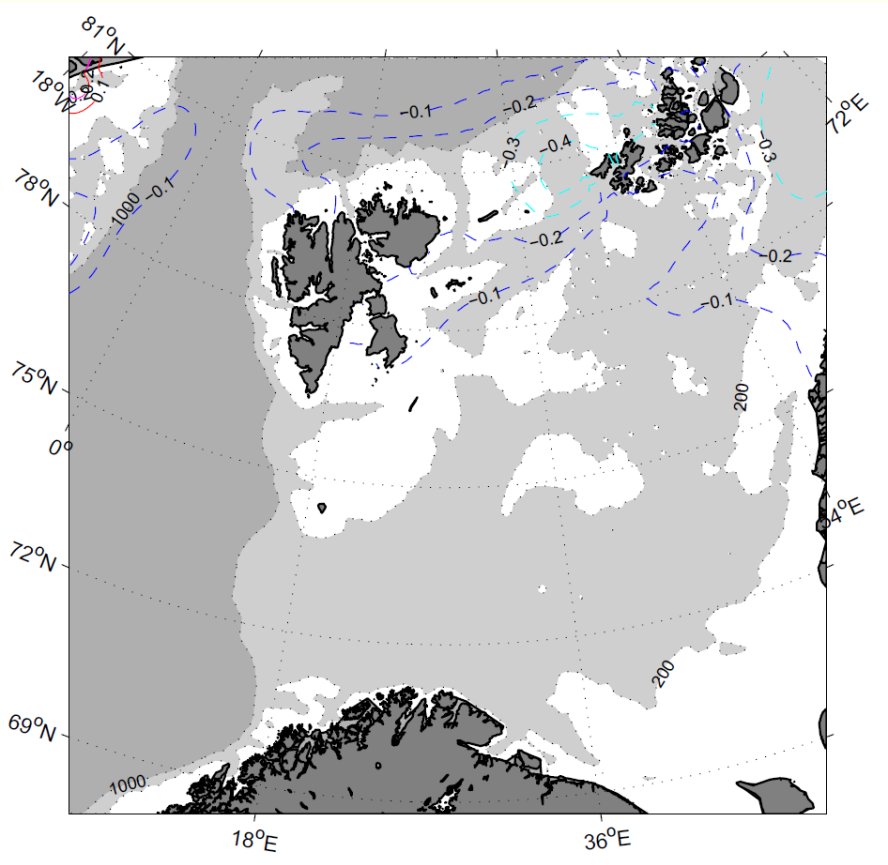


Temperature trend 1970-2000, 50-100m

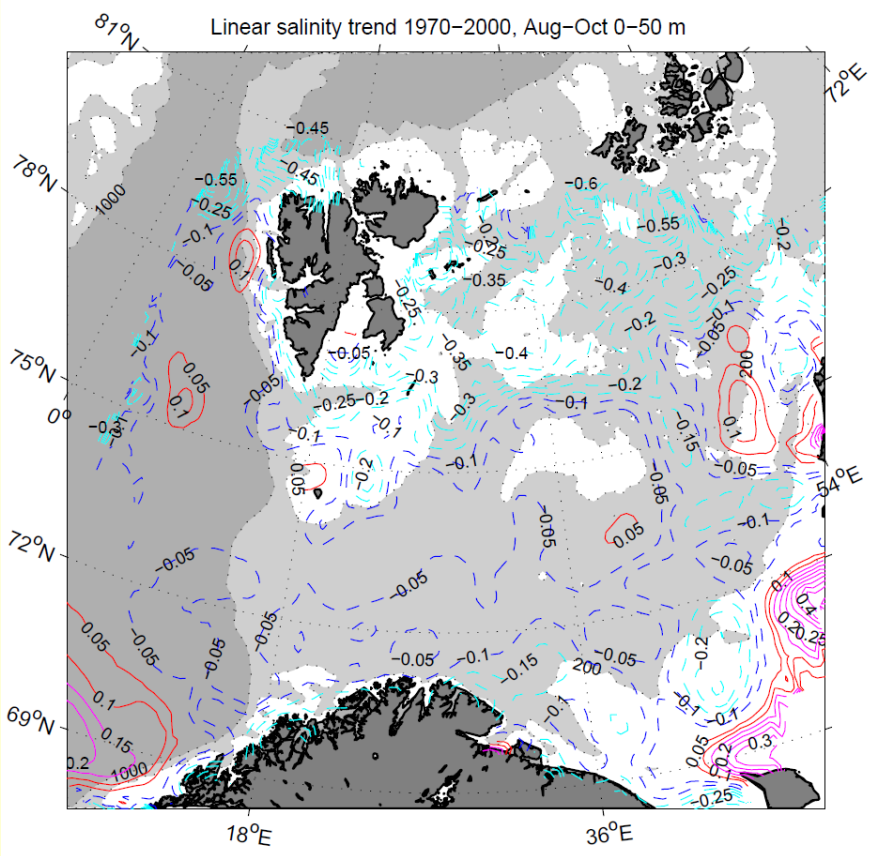


Salinity trend 1970-2000, 50-100m

Sea ice and salinity trends



Summer ice conc. trend 1979-2007



Salinity trend 1970-2000, 0-50m

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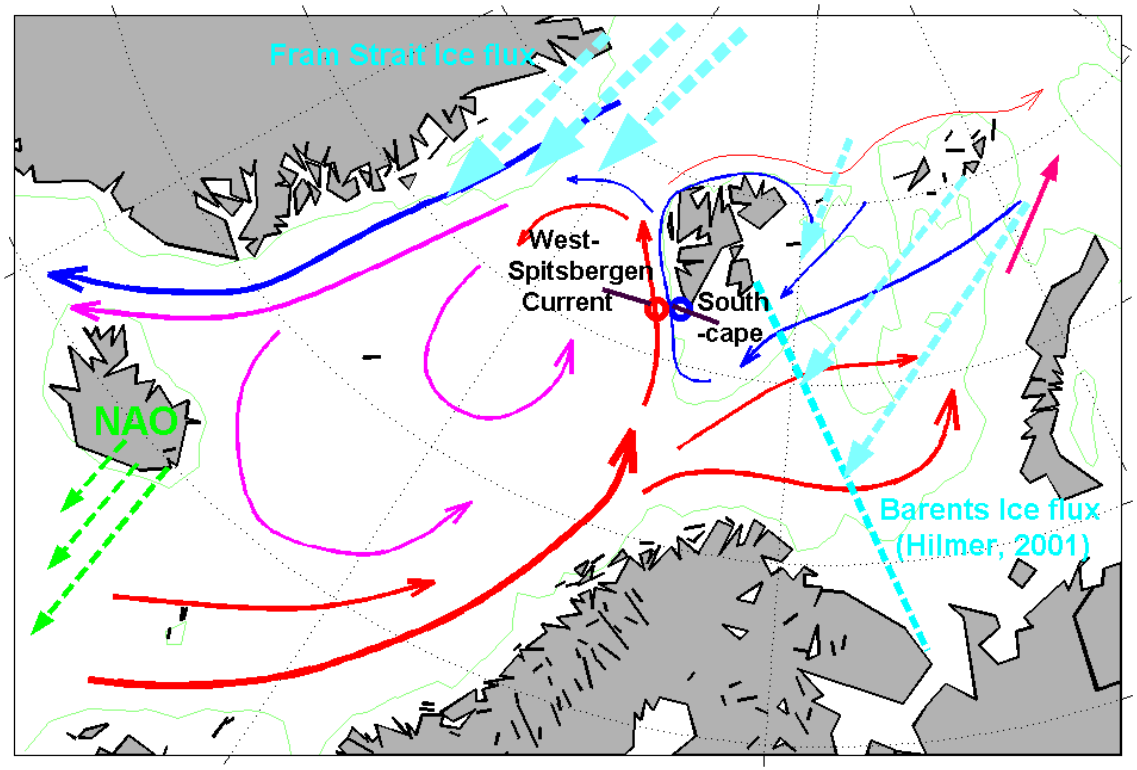
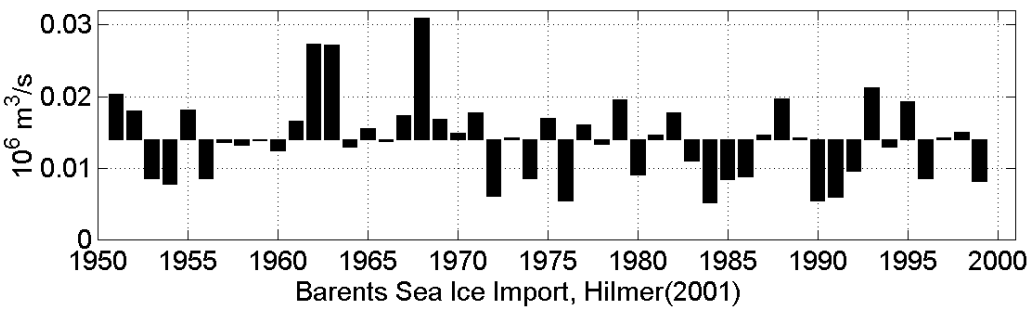
Barents Sea ice import

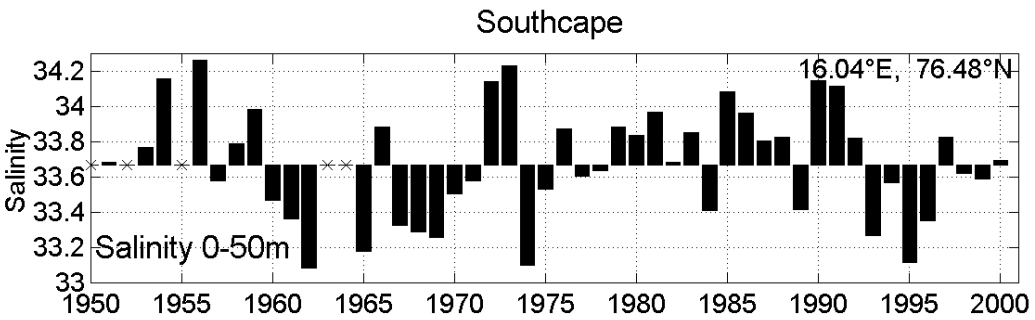


Ice import

- from Kara Sea and Arctic Ocean
- Ekman transport northwestern Barents Sea
- Upper layer freshening

Barents Sea ice import

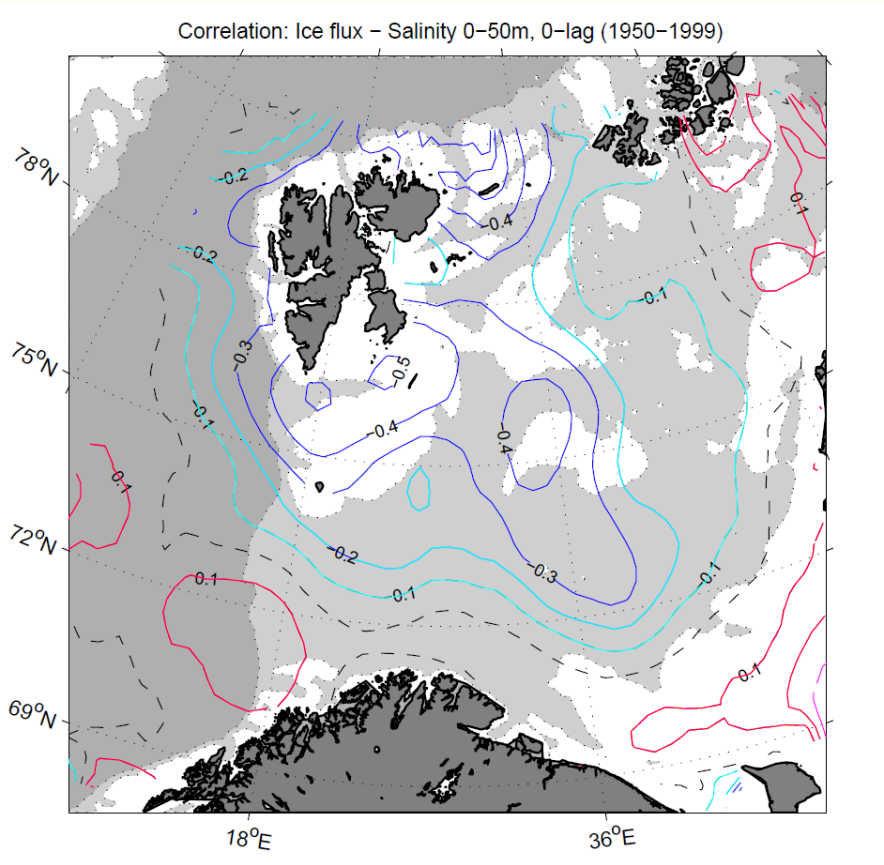




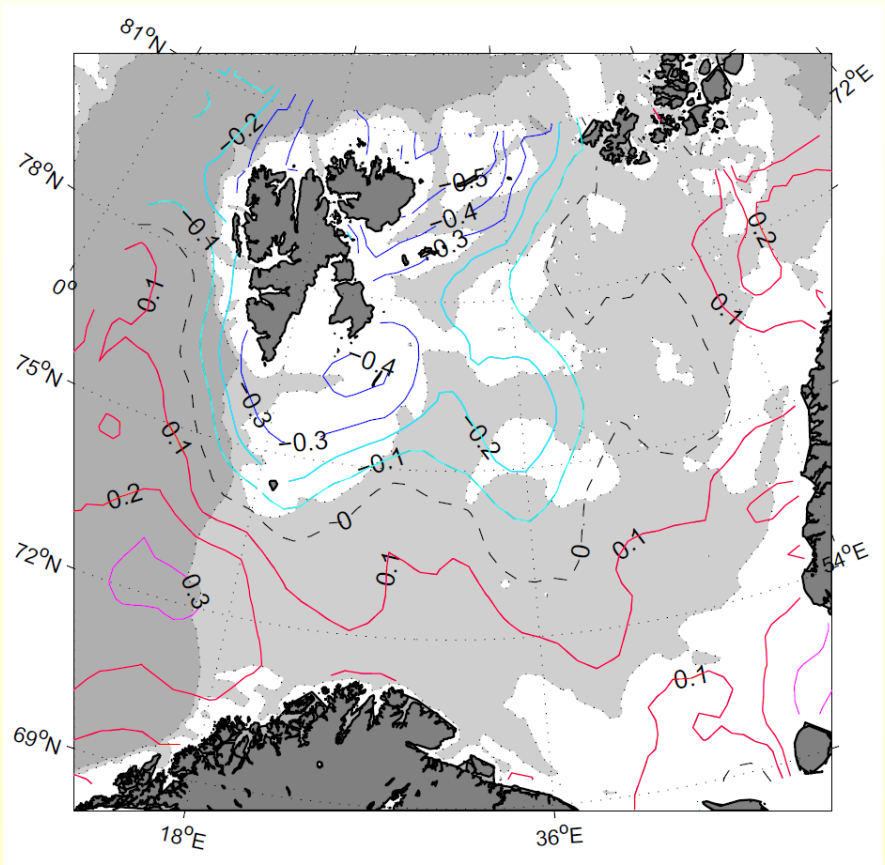
Ice import

- leads southcape 0-50m salinity by 0-1 year
- low salinity 1960s
- initiation of GSA

Ice import effects northwestern Barents Sea

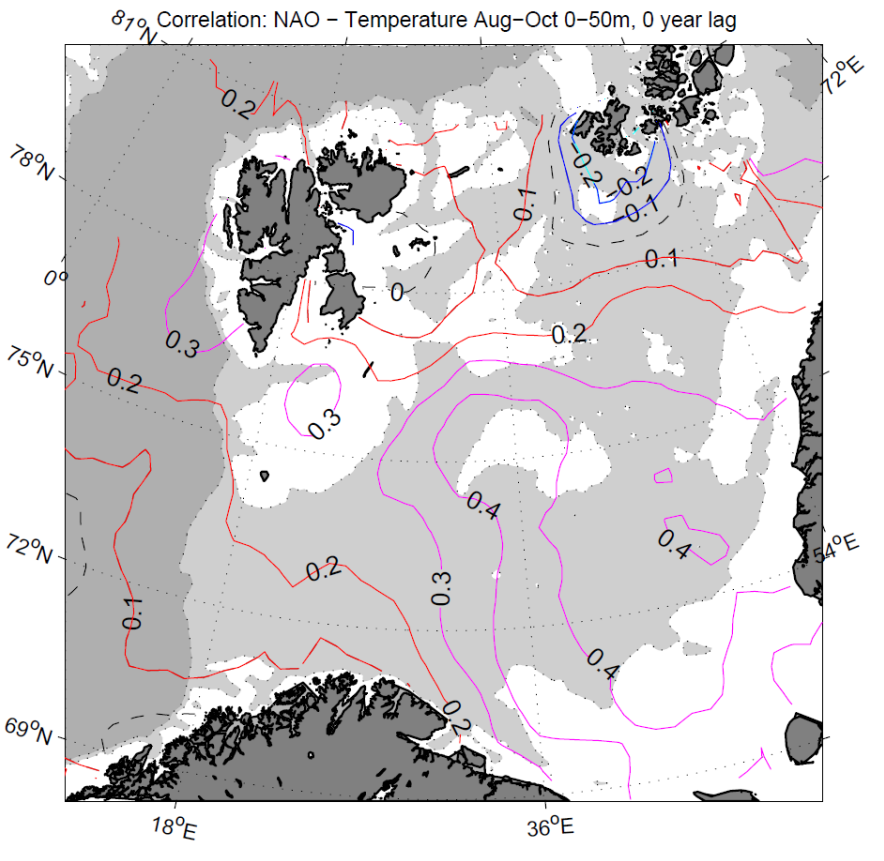


Correlation ice flux with 0-50 m salinity

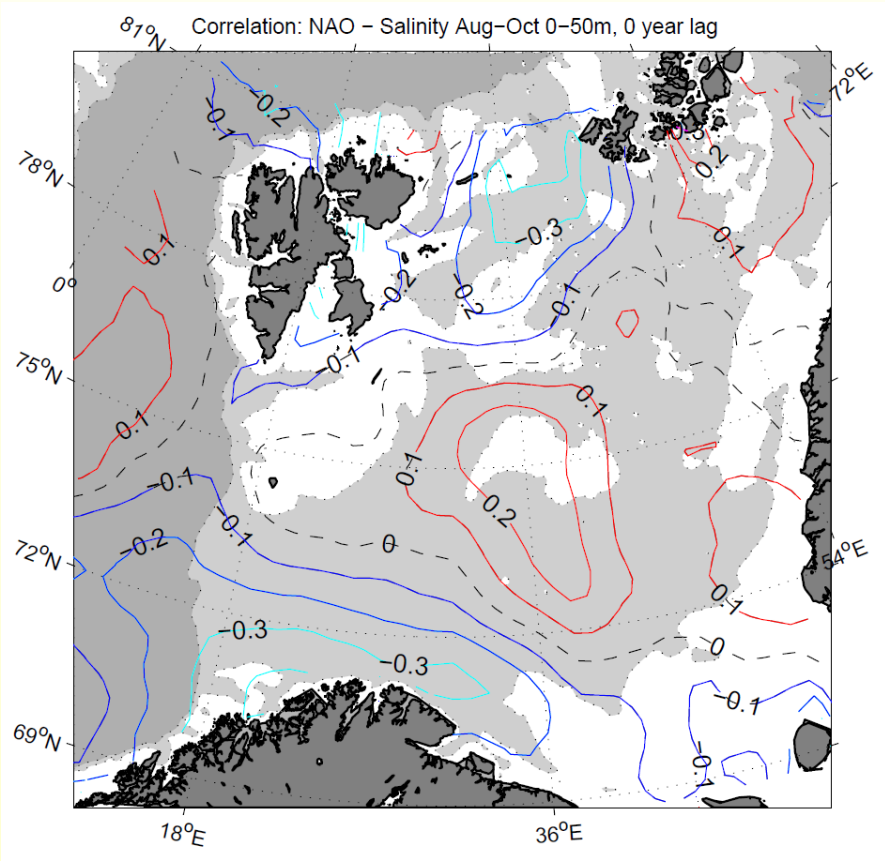


ice flux with 0-50 m density

NAO correlation with temperature and salinity

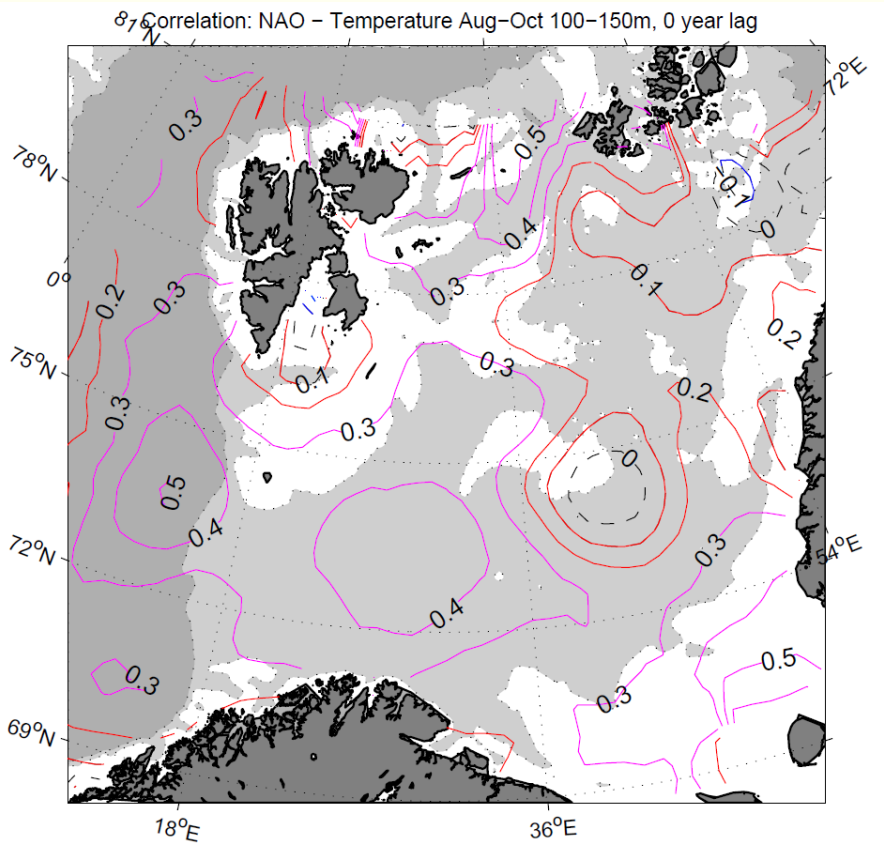


NAO with 0-50m T, 0 year lag

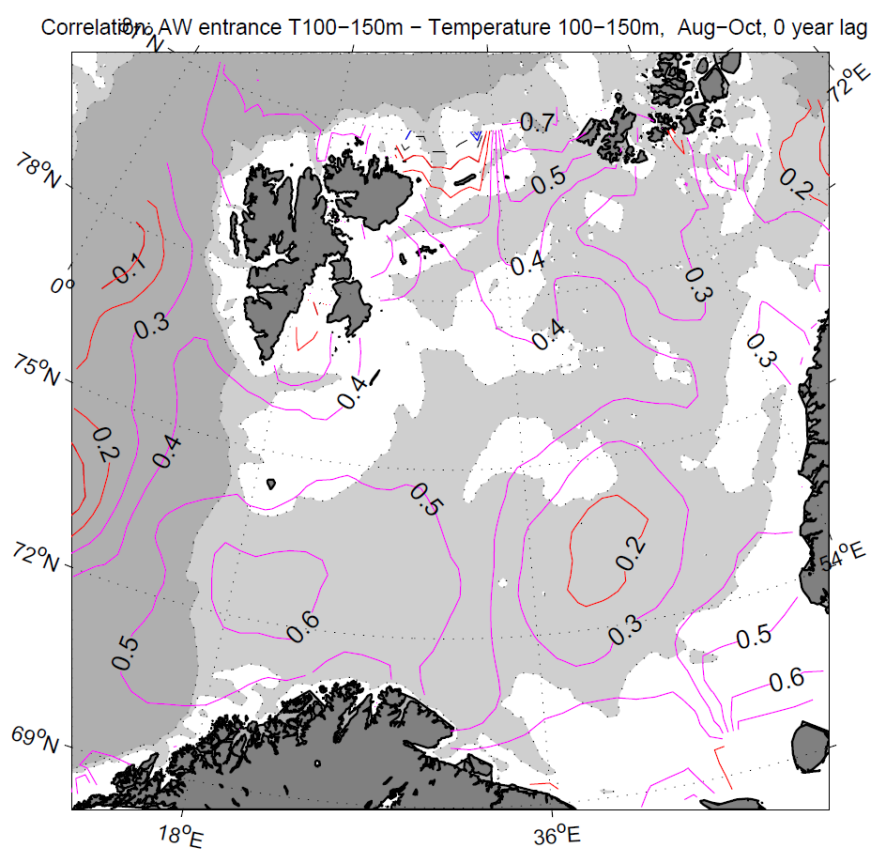


NAO with 0-50m salinity, 0 year lag

NAO and AW inflow correlation with temperature

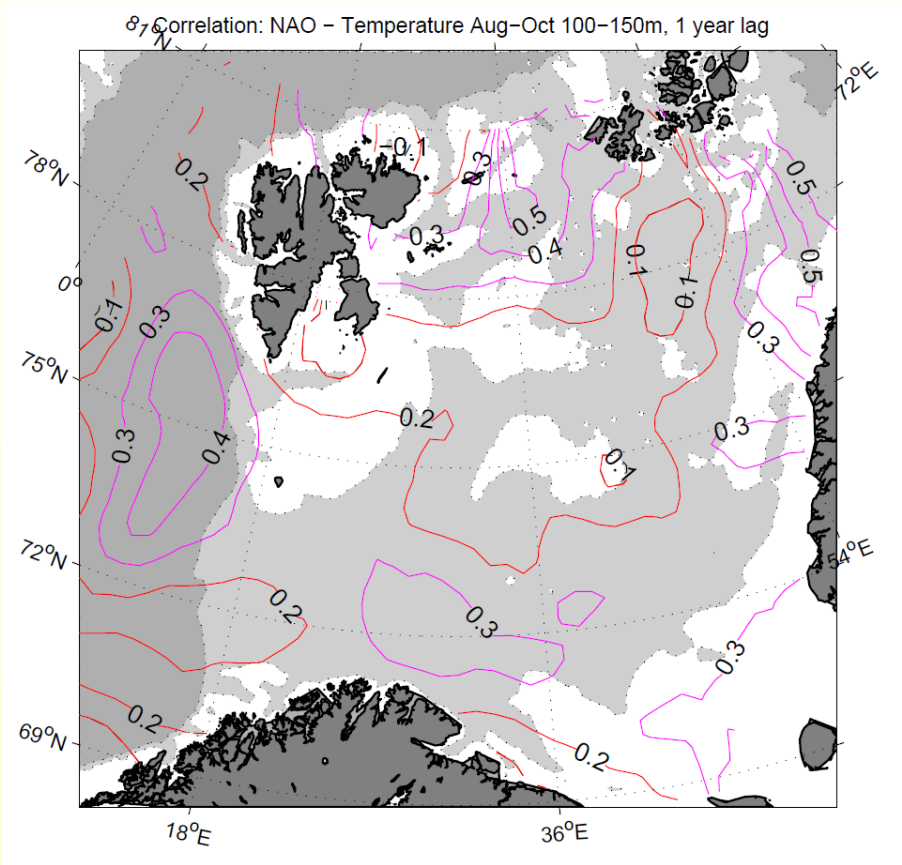


NAO with T 100-150m, 0 year lag

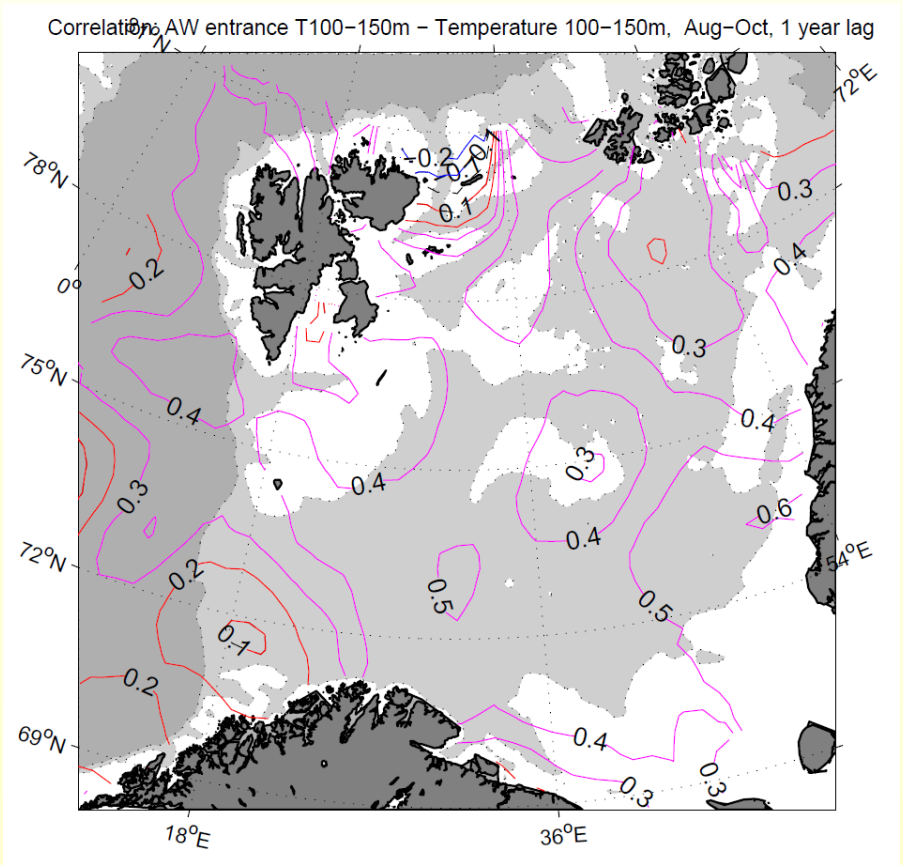


BSO inflow T with 100-150m, 0 year

NAO and AW inflow correlation with temperature

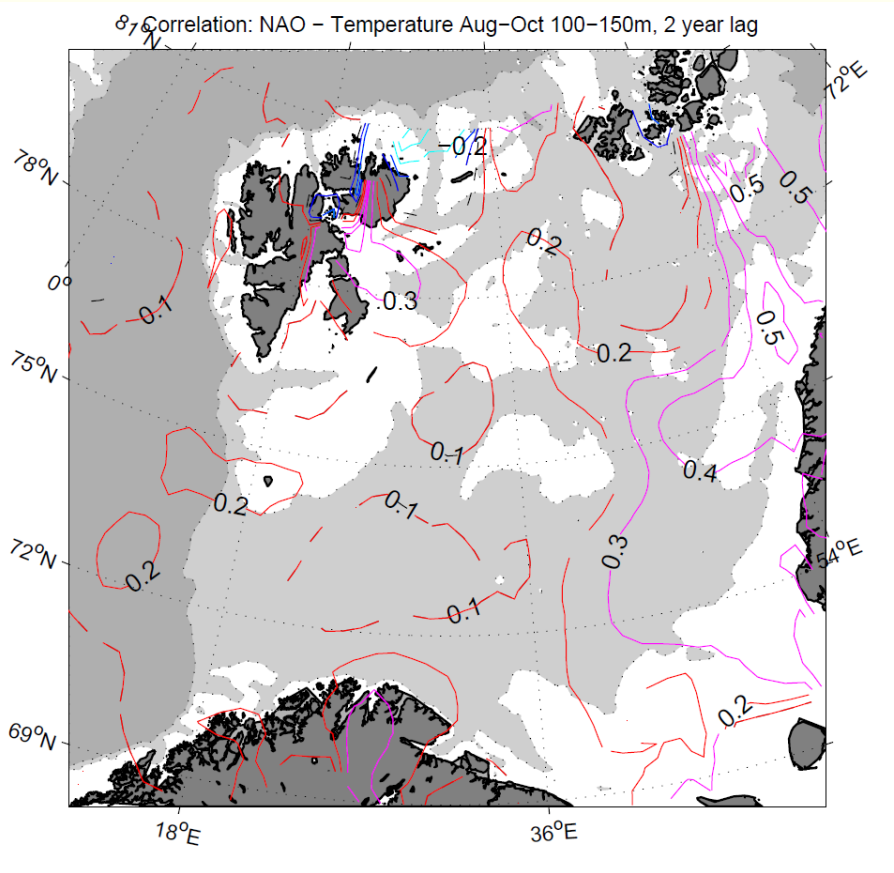


NAO with T 100-150m, 1 year lag

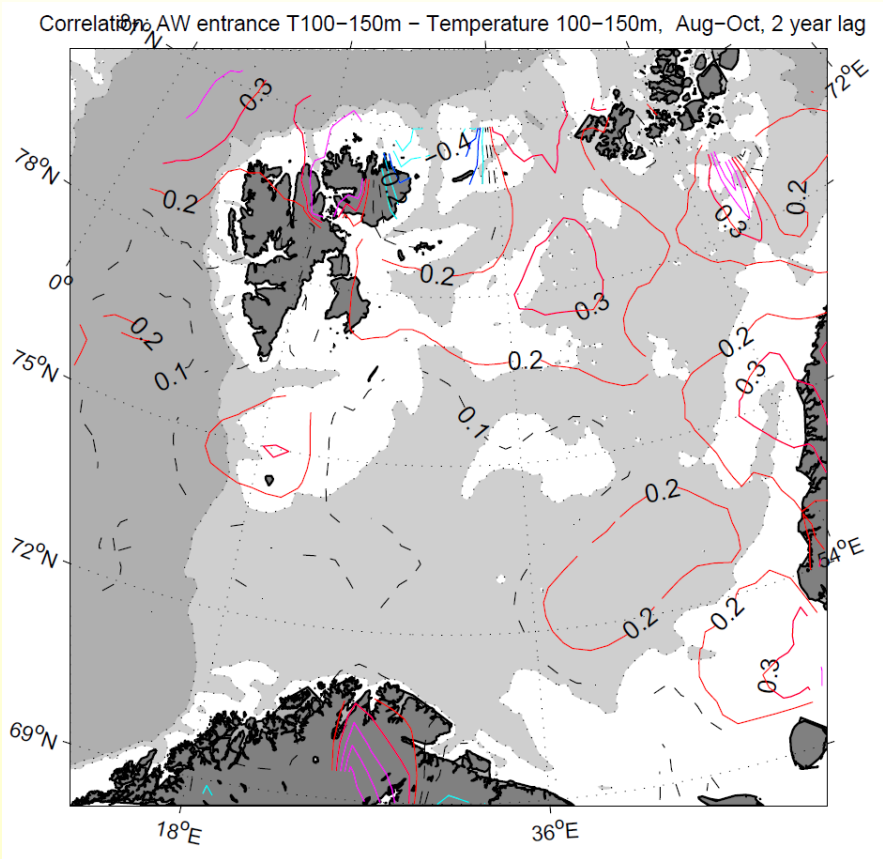


BSO inflow T with 100-150m, 1 year

NAO and AW inflow correlation with temperature

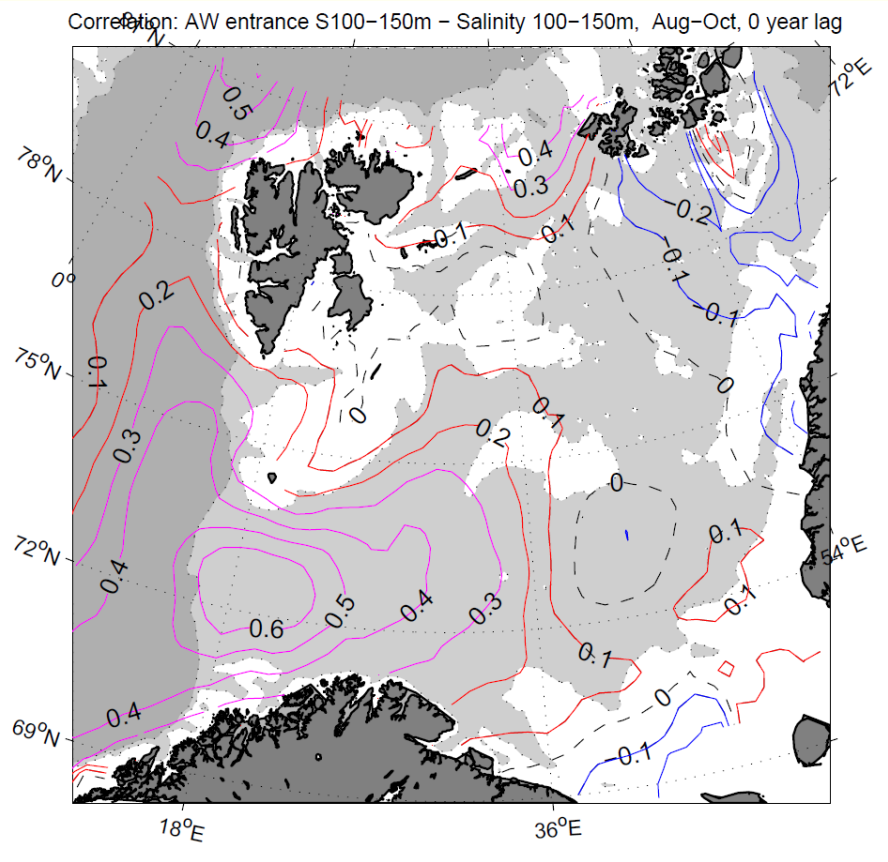


NAO with T 100-150m, 2 year lag

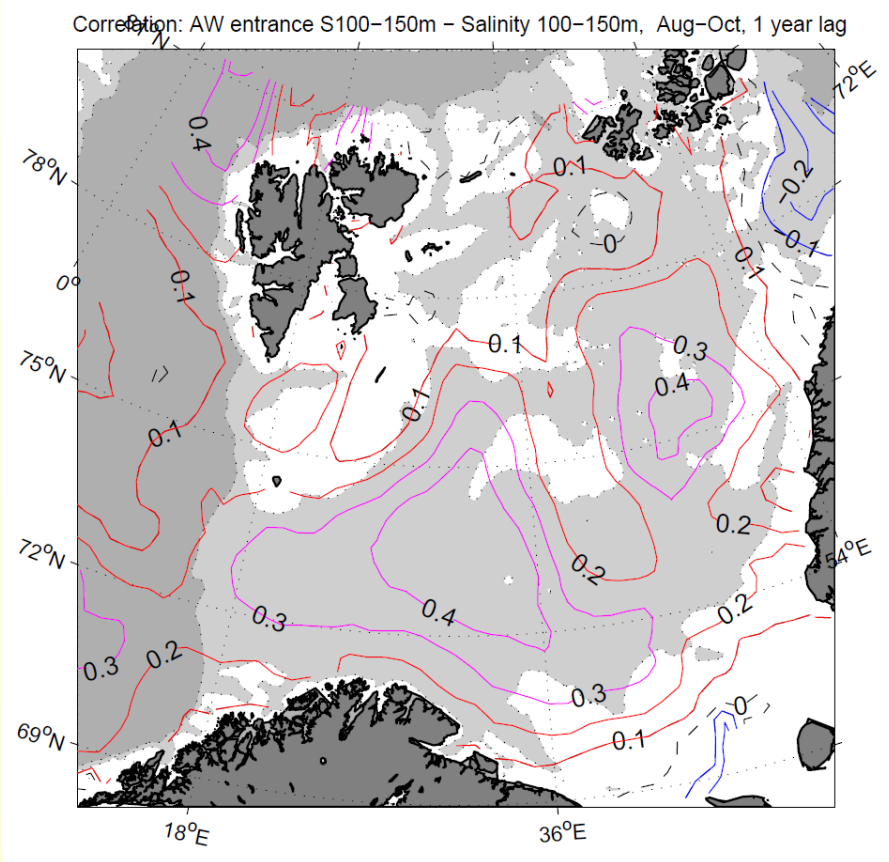


BSO inflow T with 100-150m, 2 year

Great Salinity Anomaly: Fresh water advection

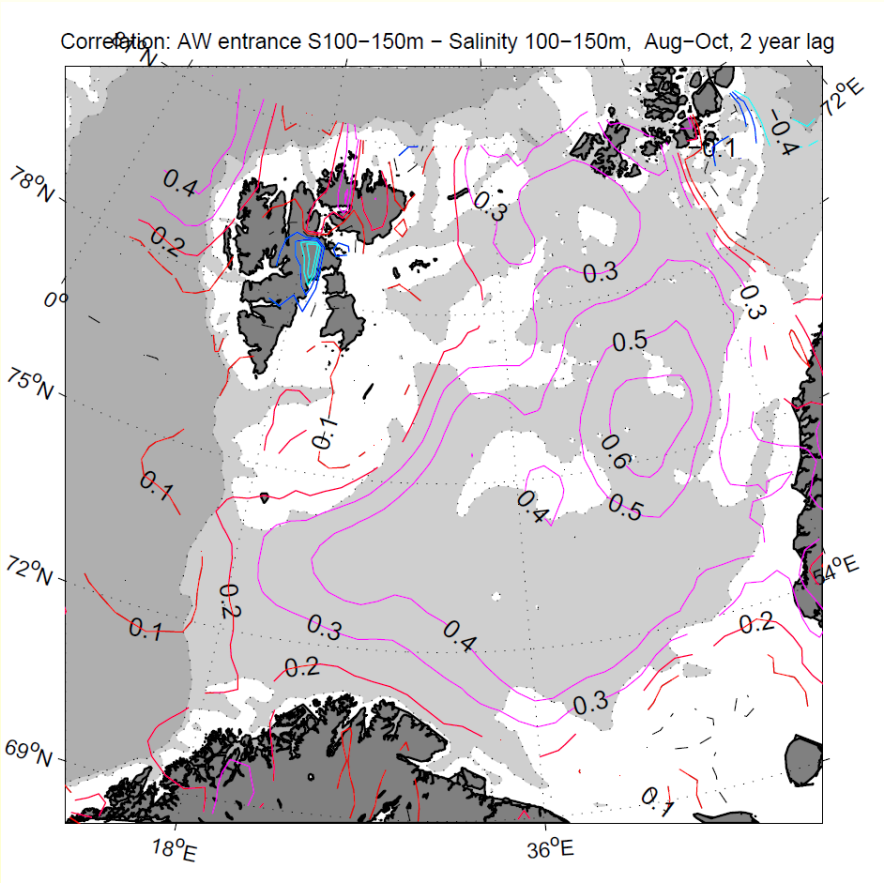


BSO inflow S with 100-150m, 1 year

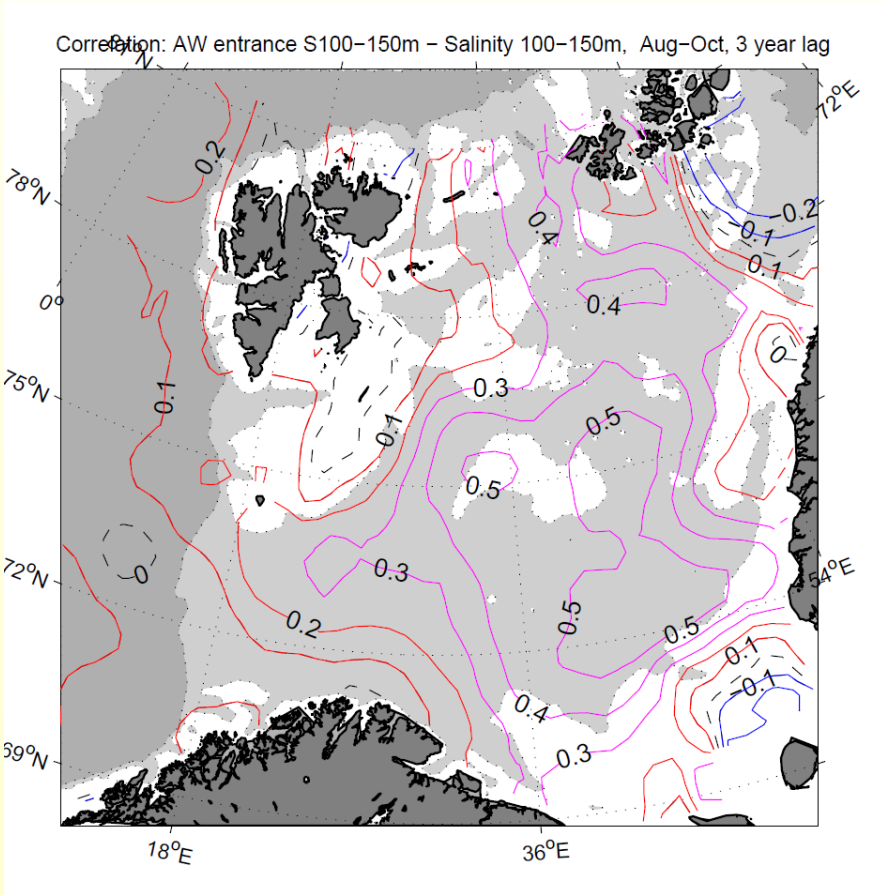


BSO inflow S with 100-150m, 1 year

Great Salinity Anomaly: Fresh water advection

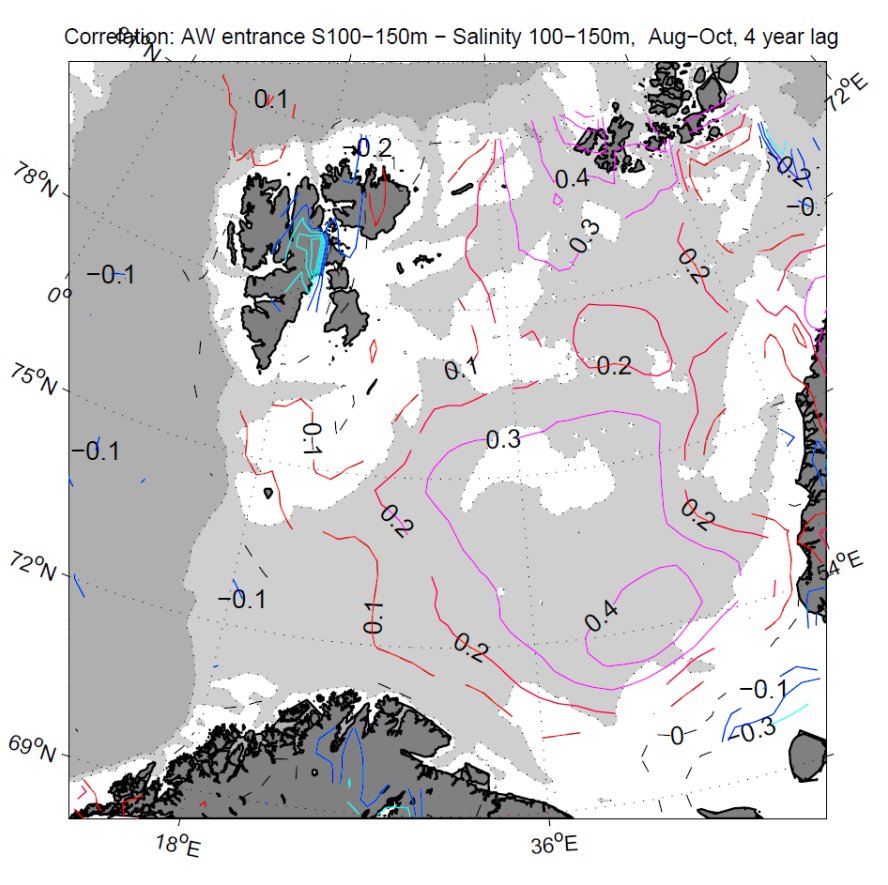


BSO inflow S with 100-150m, 2 year

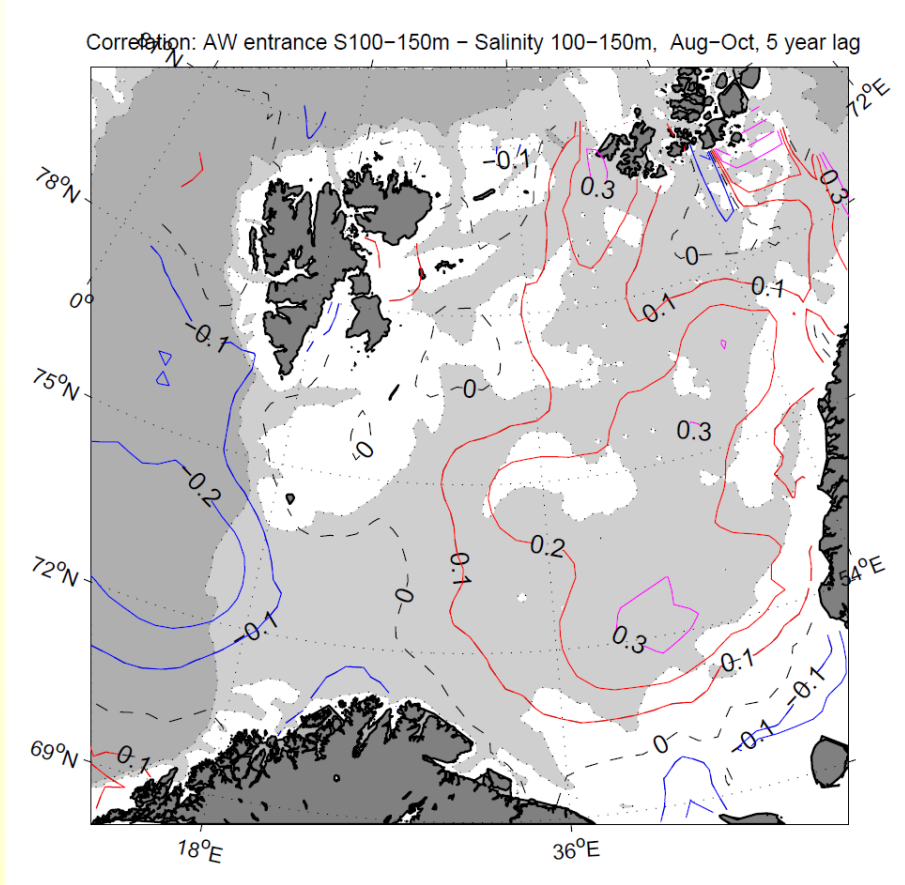


BSO inflow S with 100-150m, 3 year

Great Salinity Anomaly: Fresh water advection



BSO inflow S with 100-150m, 4 year



BSO inflow S with 100-150m, 5 year

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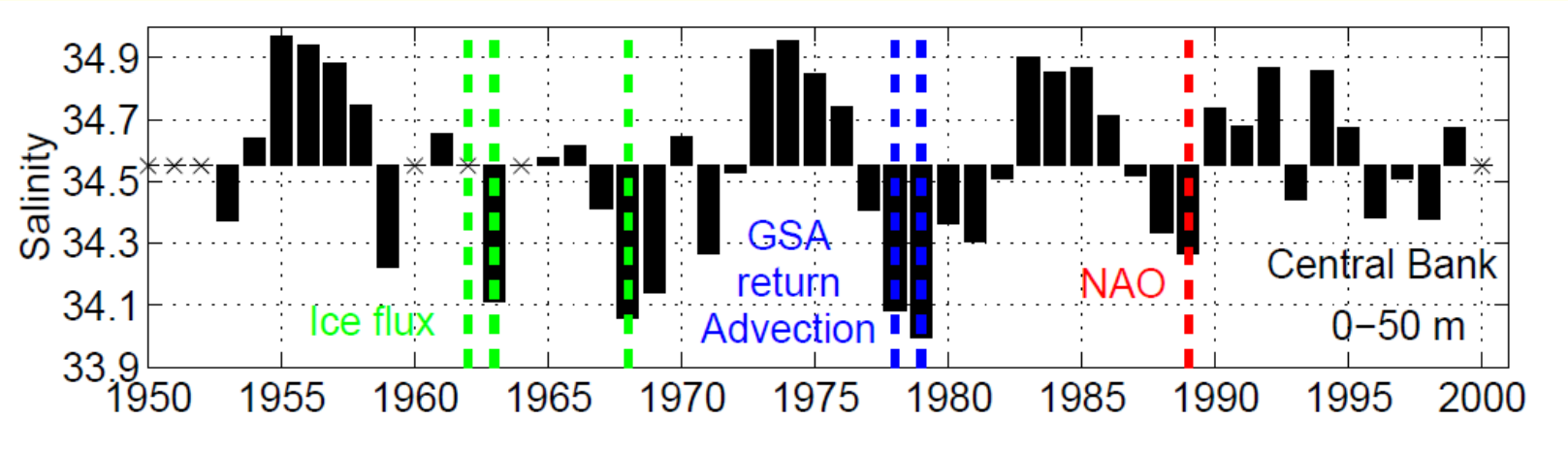
Barents Sea transformation of NwAC



Different mechanisms transform Atlantic Water:
Example, e.g., salinity on the Central Bank

Barents Sea Branch Summary

Barents Sea Branch of NwAC
$\Rightarrow$ Important source of intermediate and deep water formation

- Ice, salt and heat advection are all relevant for AW transformation
- Most extensive dataset of NwAC $\Rightarrow$ 3-dim Barents Sea data analysis promising
- T-S model-observation comparison important
- Monitoring of the throughflow: Current measurements should be critically evaluated