Workshop on the Norwegian Atlantic Current
Tromso 2009

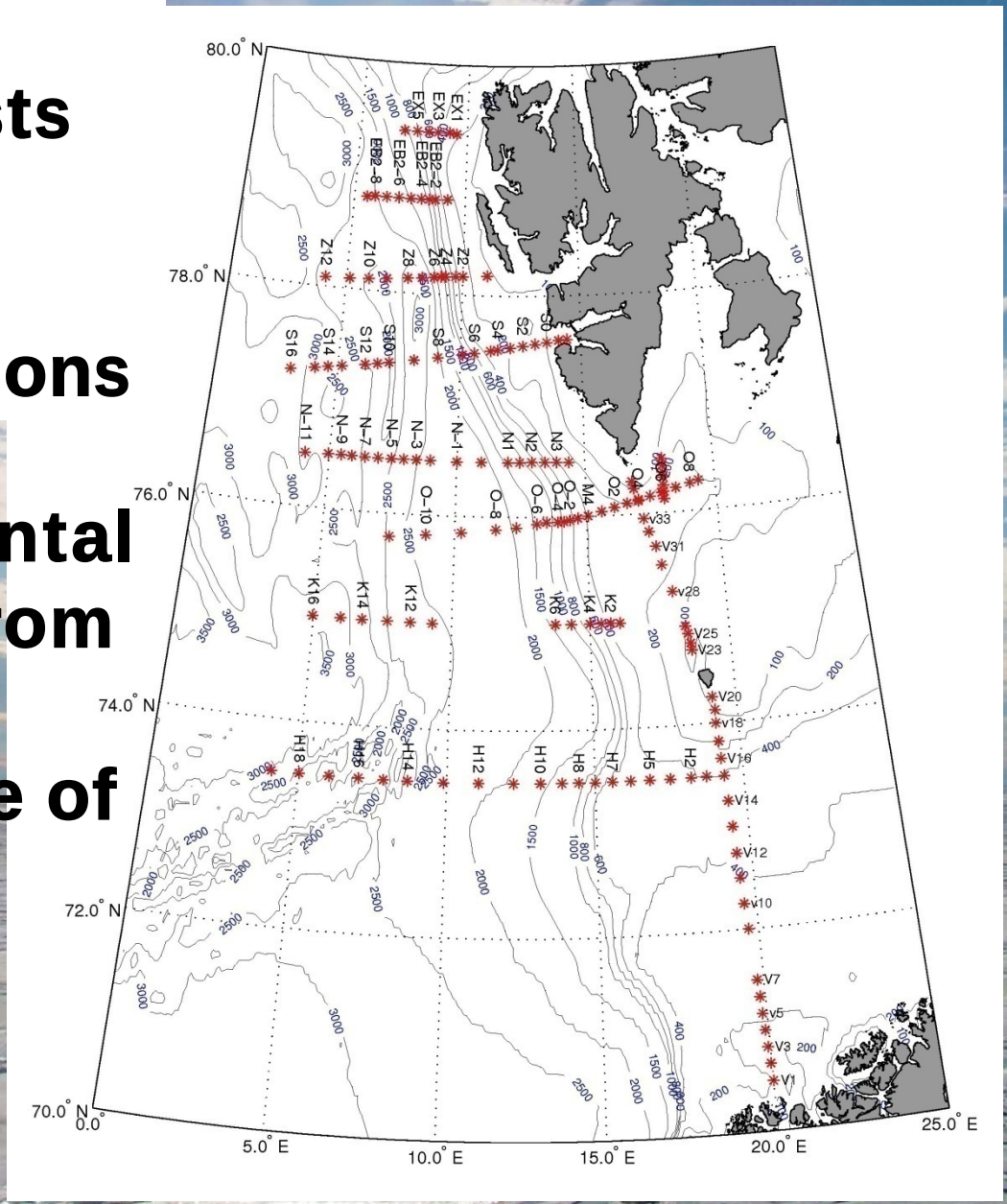
THE WEST SPITSBERGEN CURRENT NATURE AND VARIABILITY - FACTS, HYPOTHESES AND QUESTIONS

Waldemar Walczowski

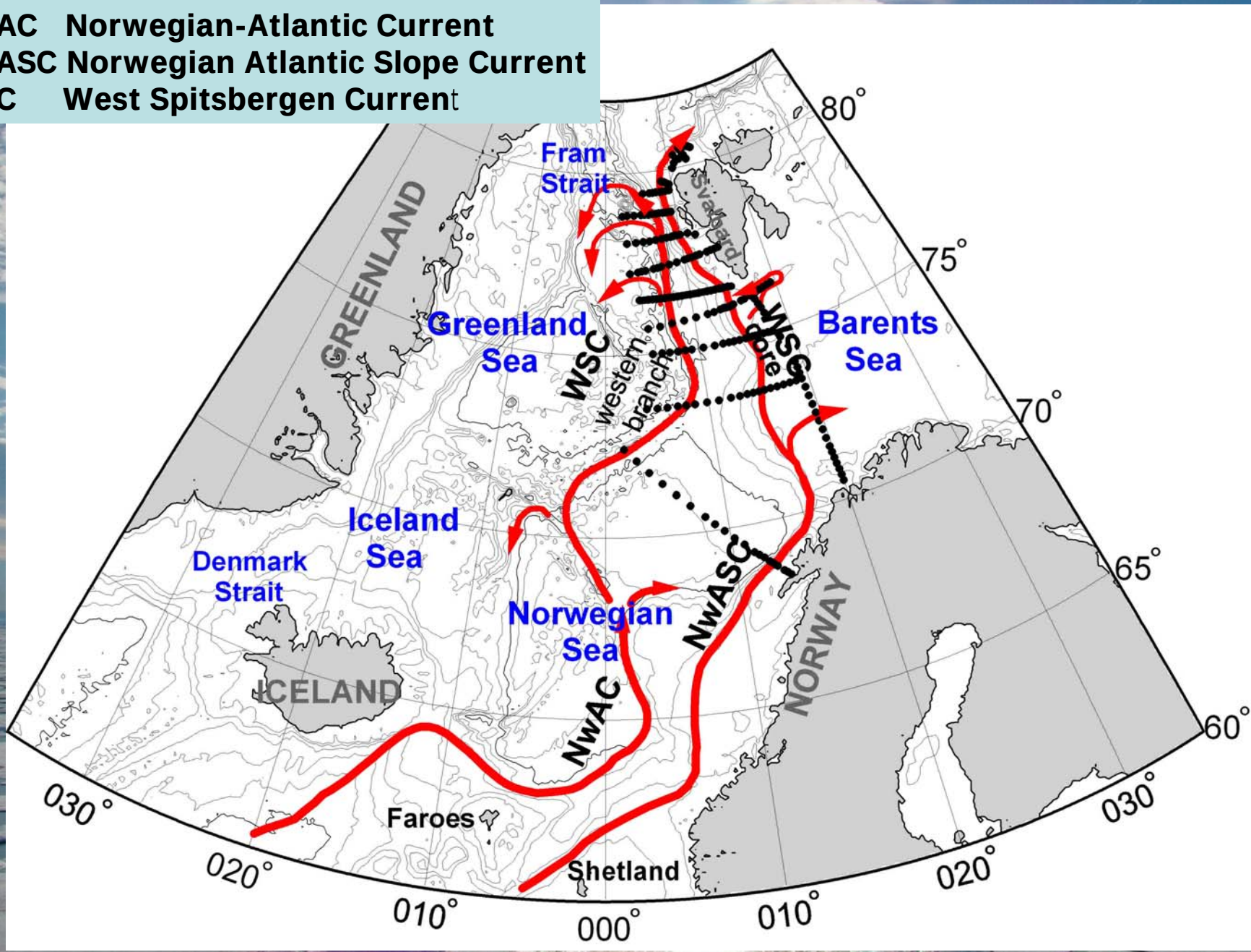
Arex 2008

11 sections
198 vertical CTD casts
198 LADCP casts
towed CTD probe / high resolution sections

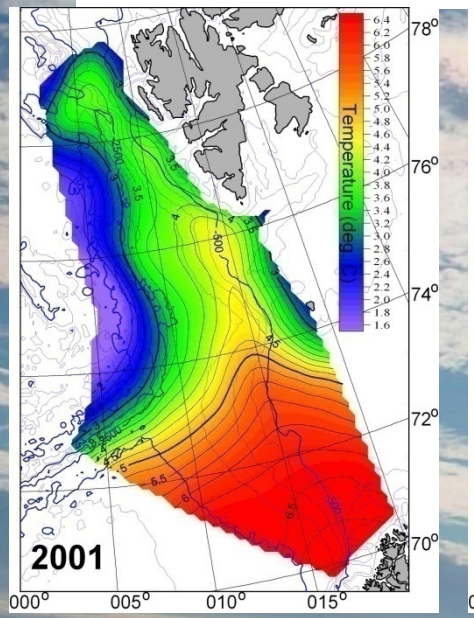
For last years horizontal distributions, data from Gimsoy Section provided by Institute of Marine Research, Bergen were used.

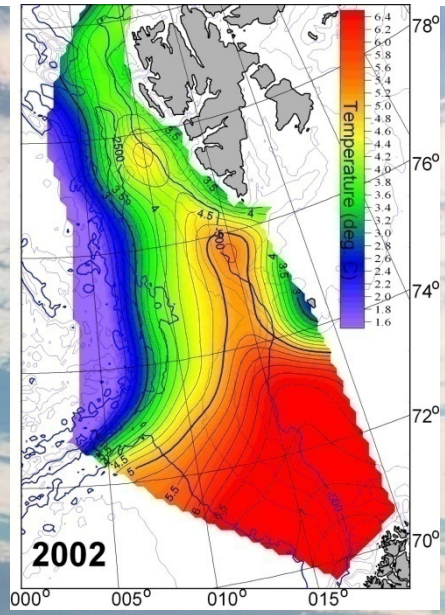


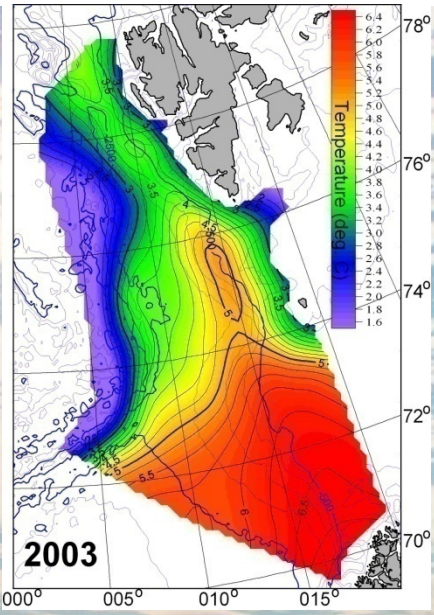
NAC North Atlantic Current
NwAC Norwegian-Atlantic Current
NwASC Norwegian Atlantic Slope Current
WSC West Spitsbergen Current

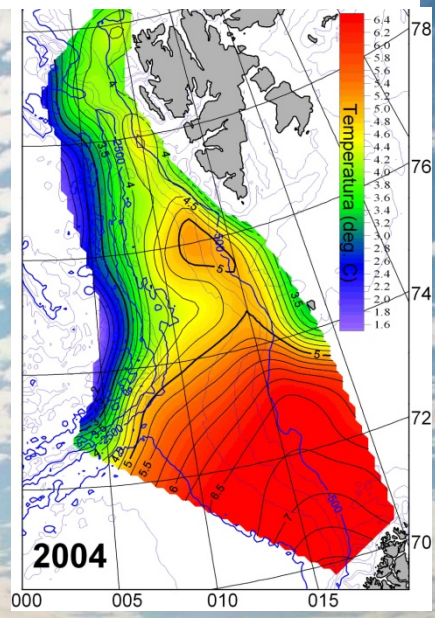


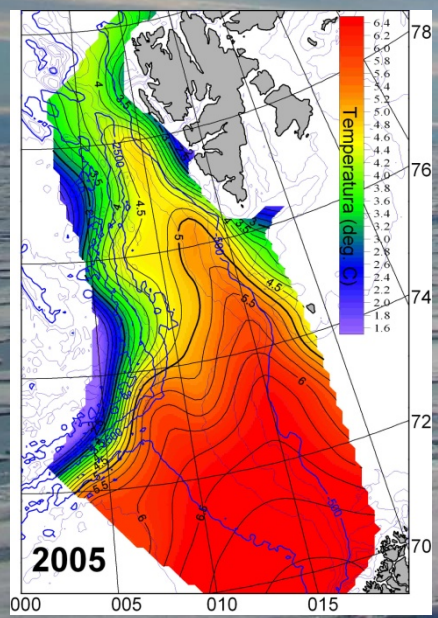
Distribution of temperature at 100 dbar in summers 2001-2008

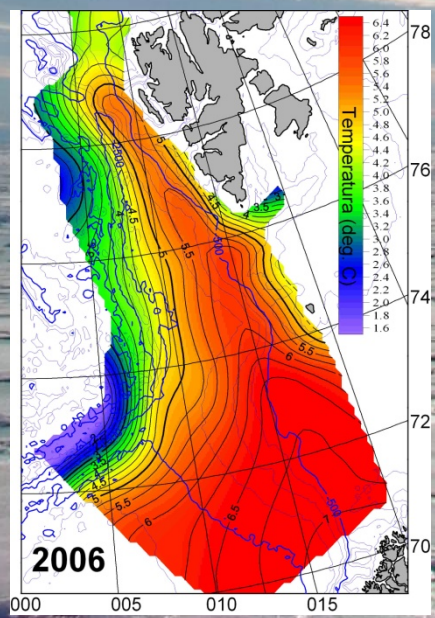


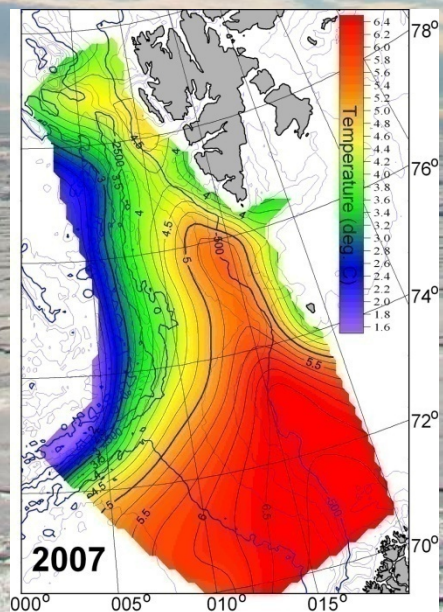


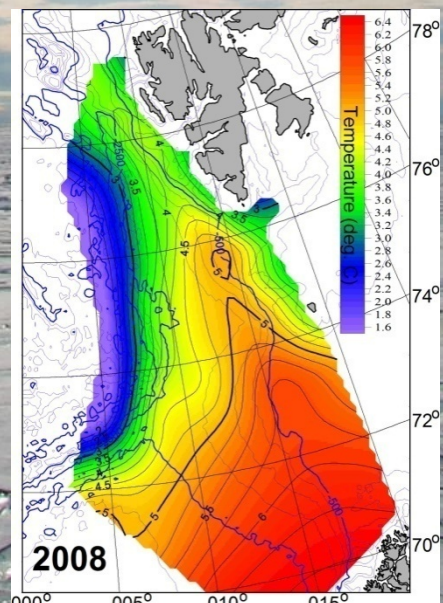




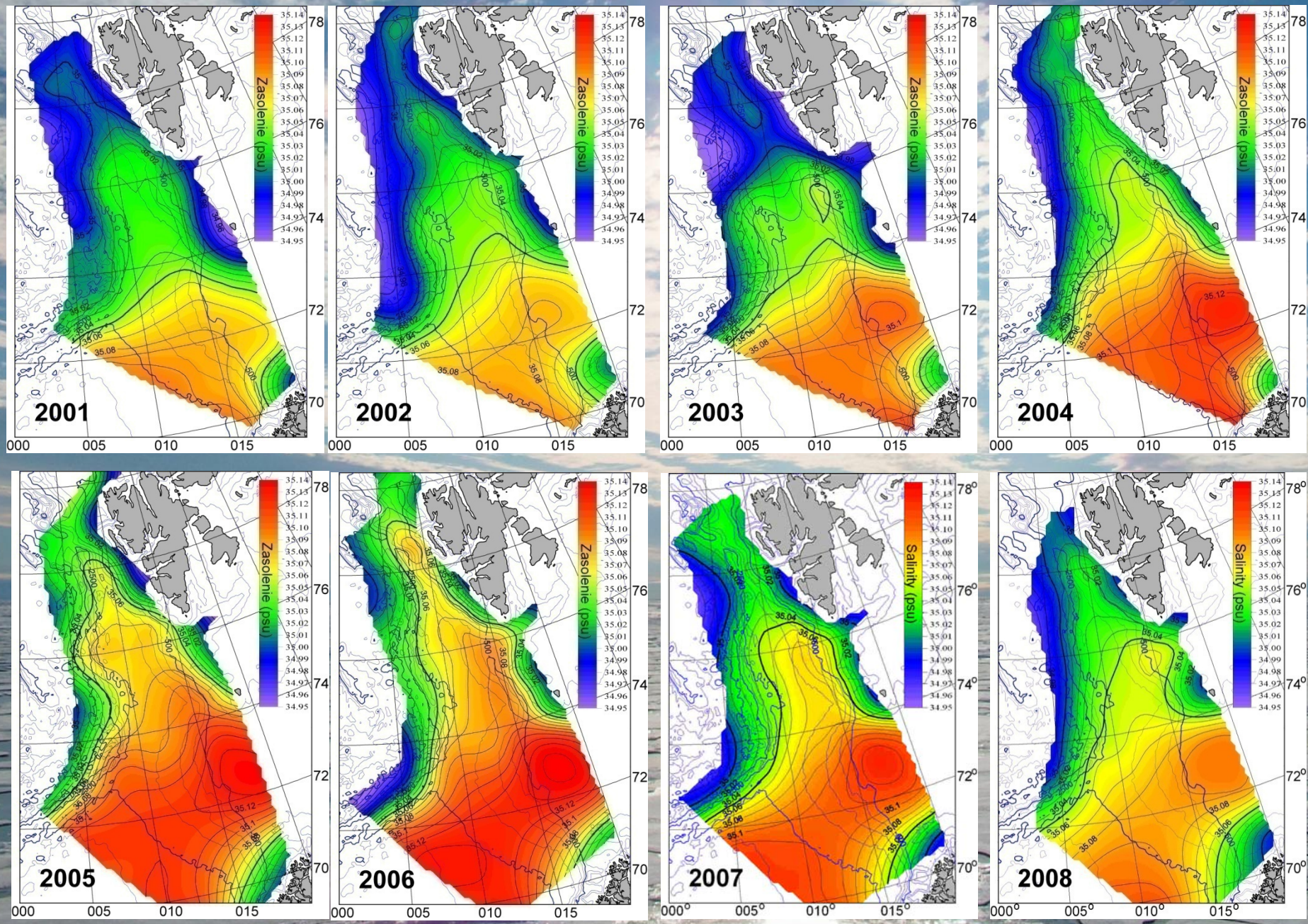




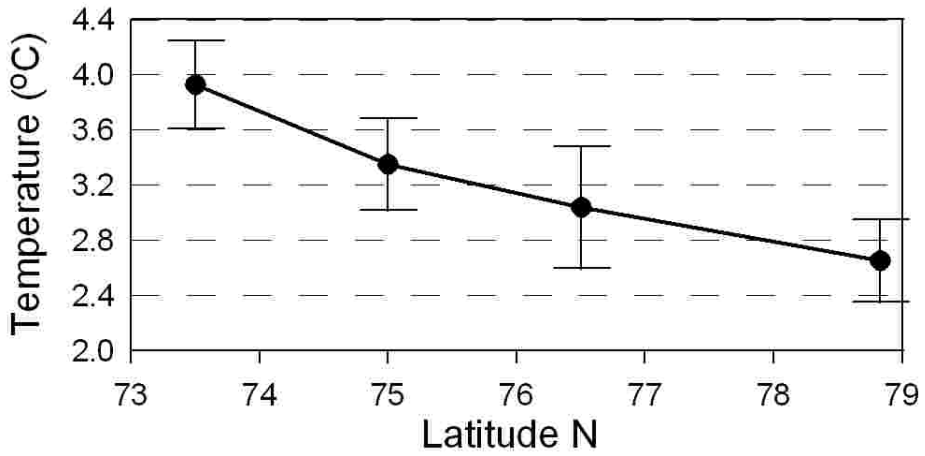


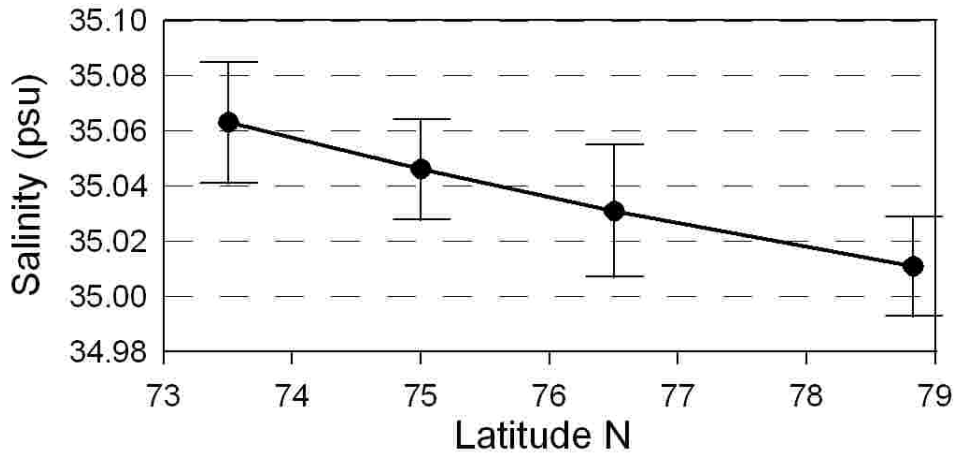


Summer 2001-2008 vertically averaged salinity of AW layer.

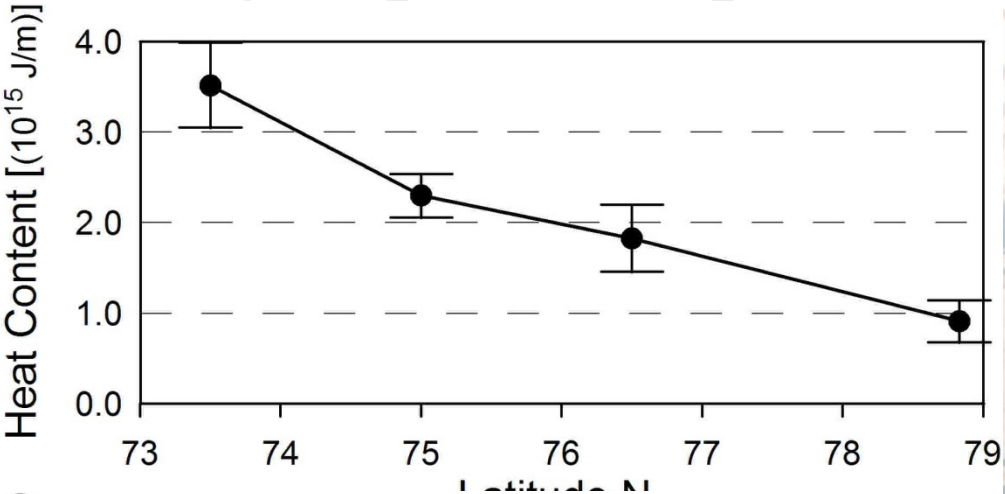


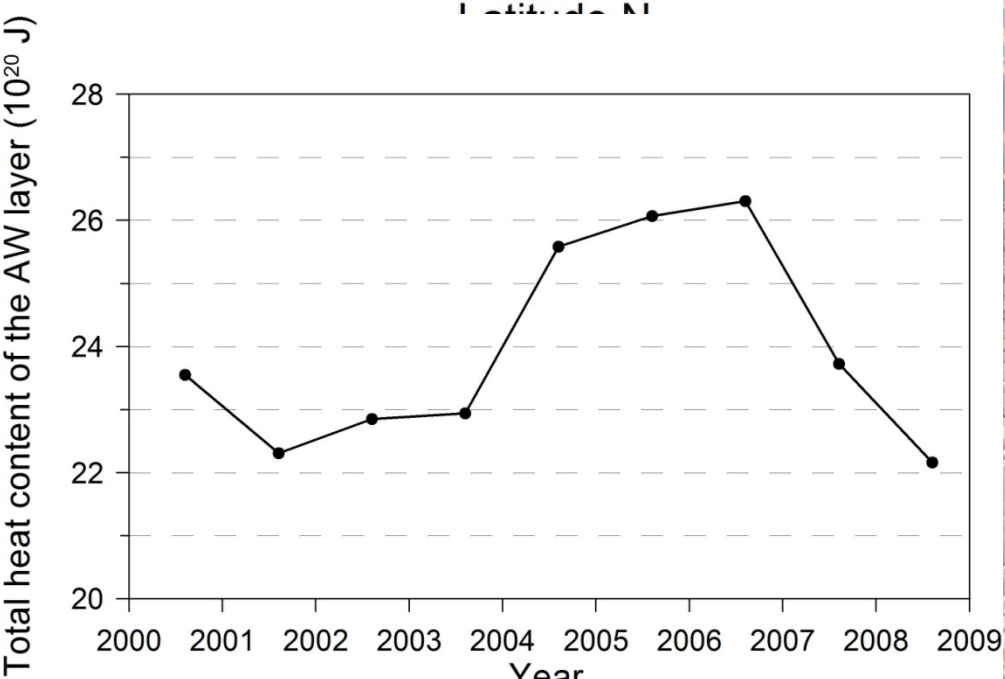
Meridional changes of AW mean properties

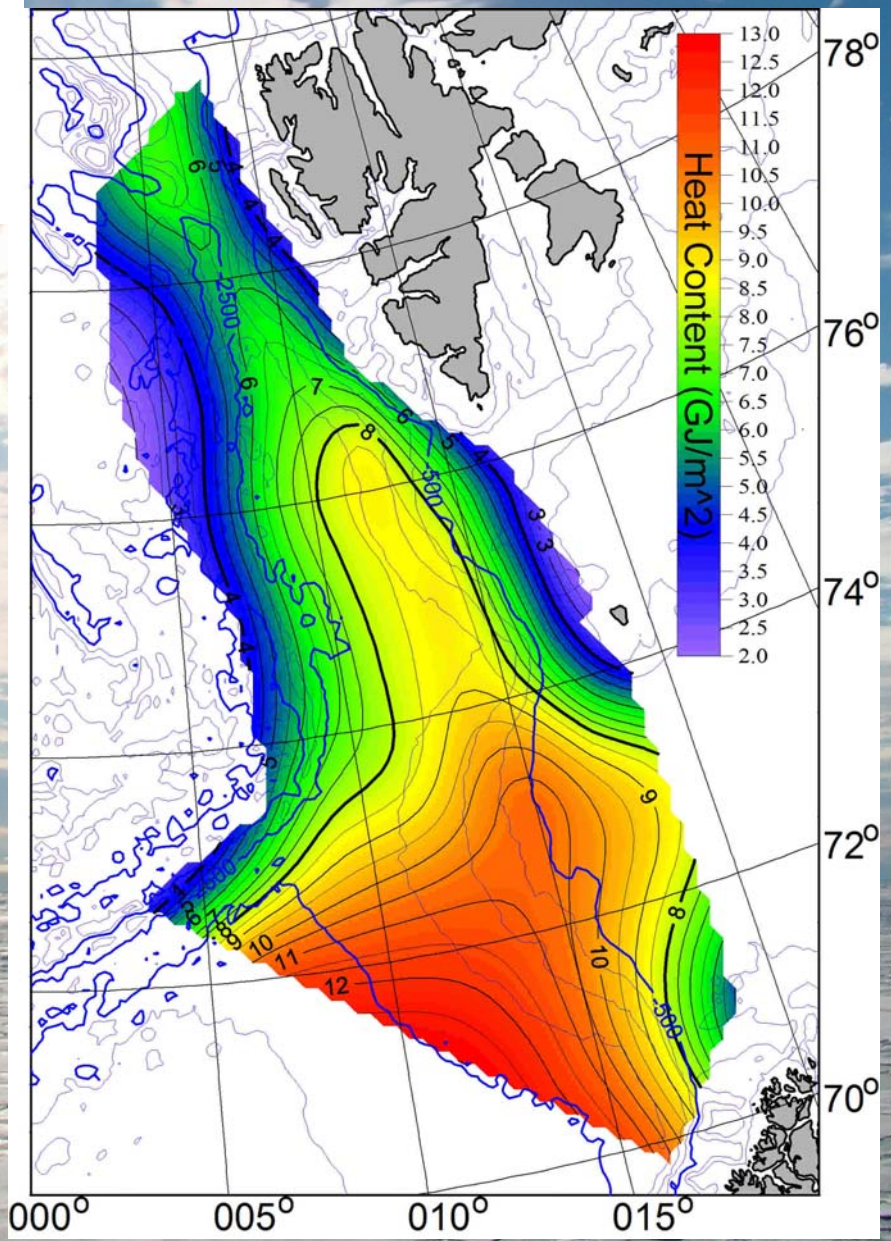




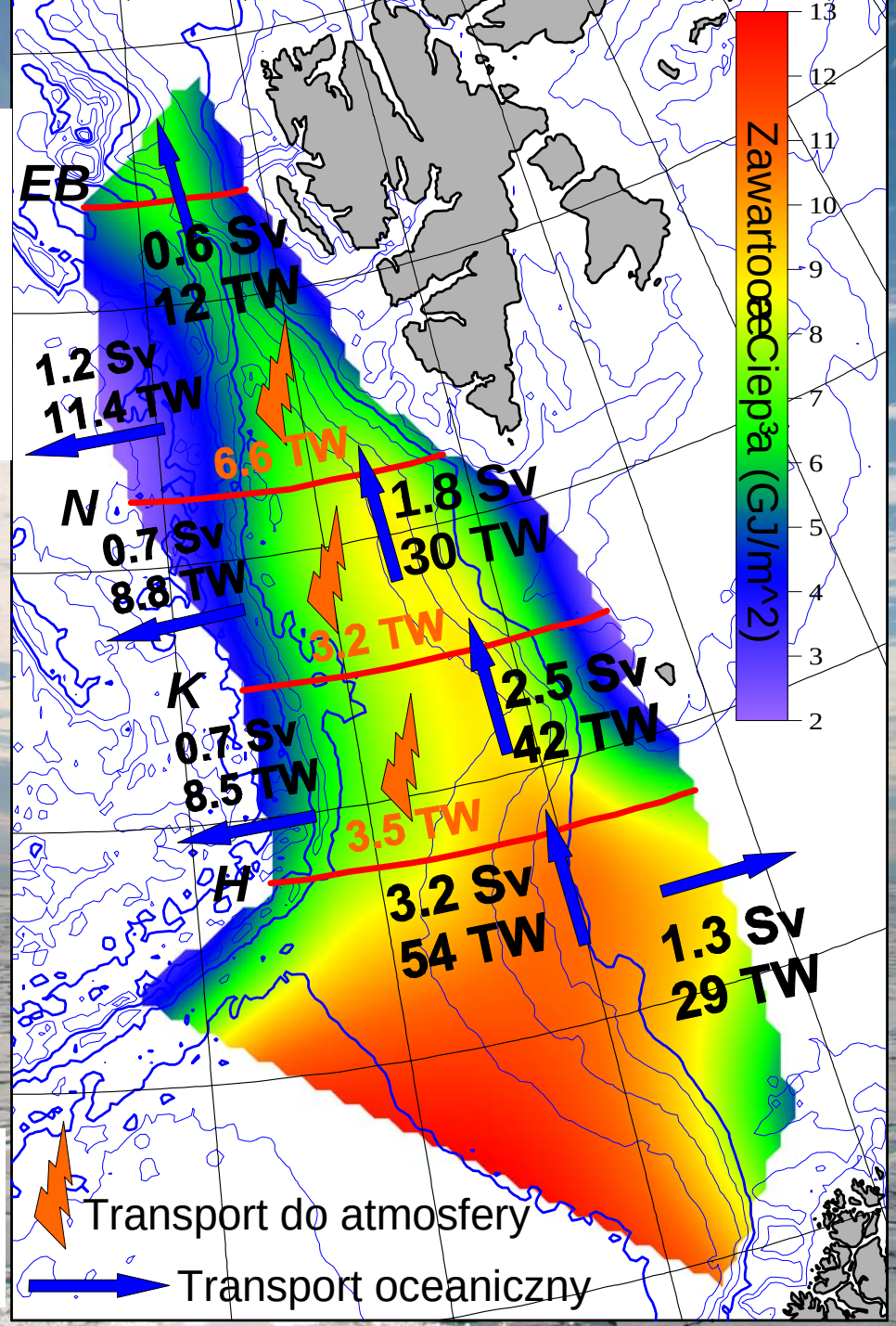
Mean summers 2000-2008 heat stored in AW layer [GW/m2]







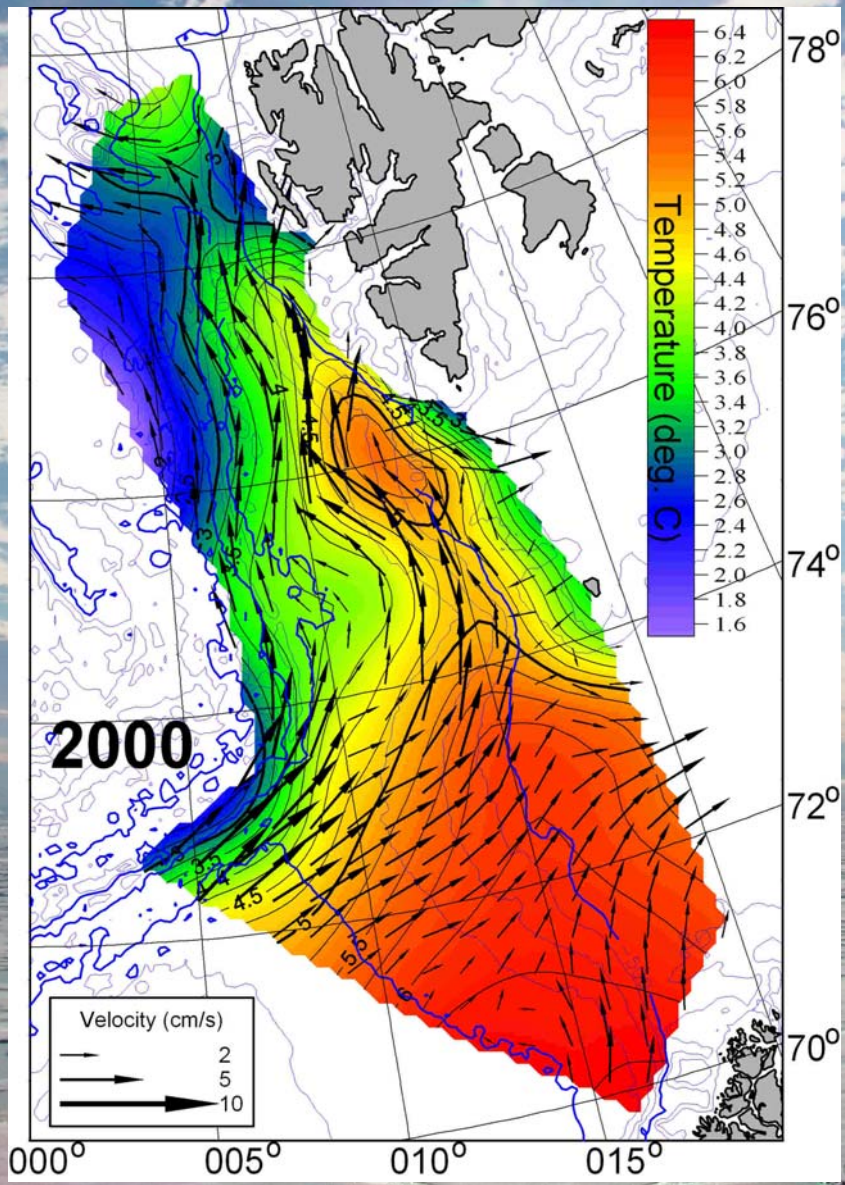
Average AW volume and heat balance for investigated region



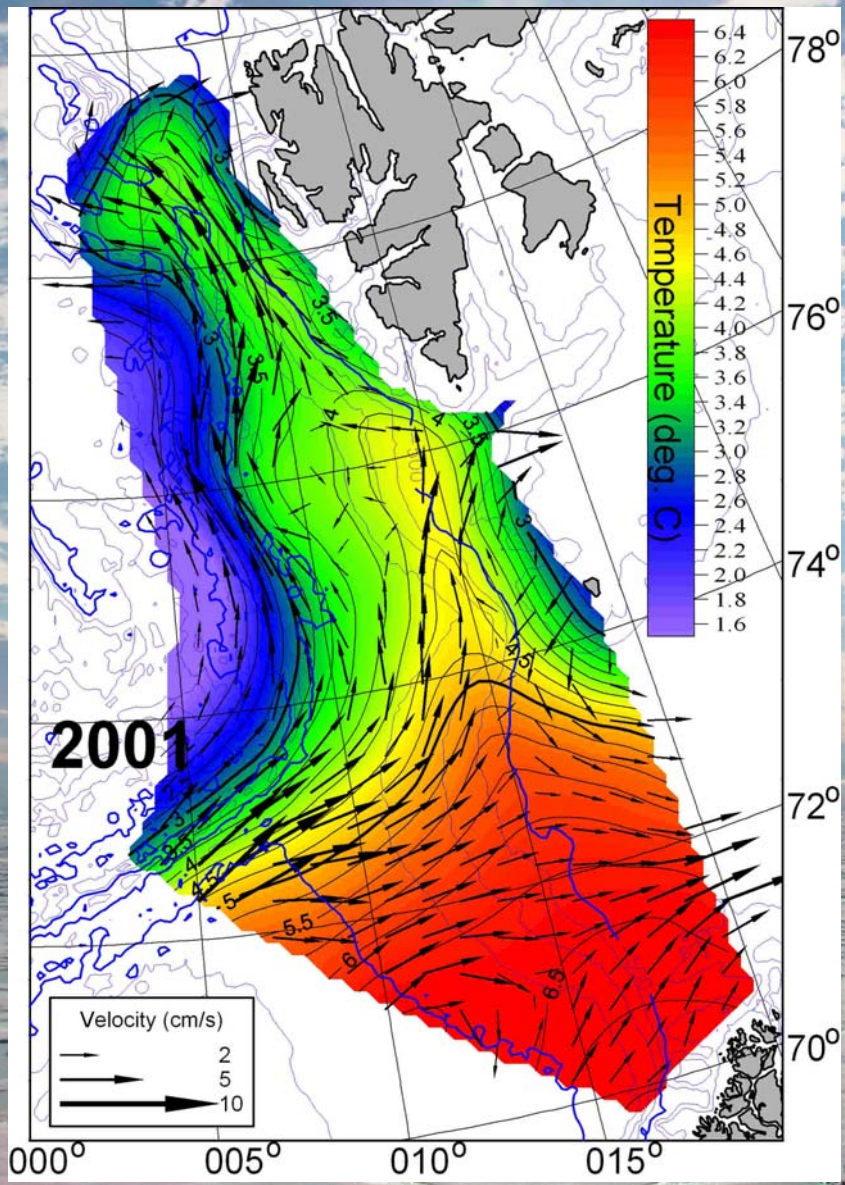
Ocean-Atmosphere exchange

Oceanic Transport

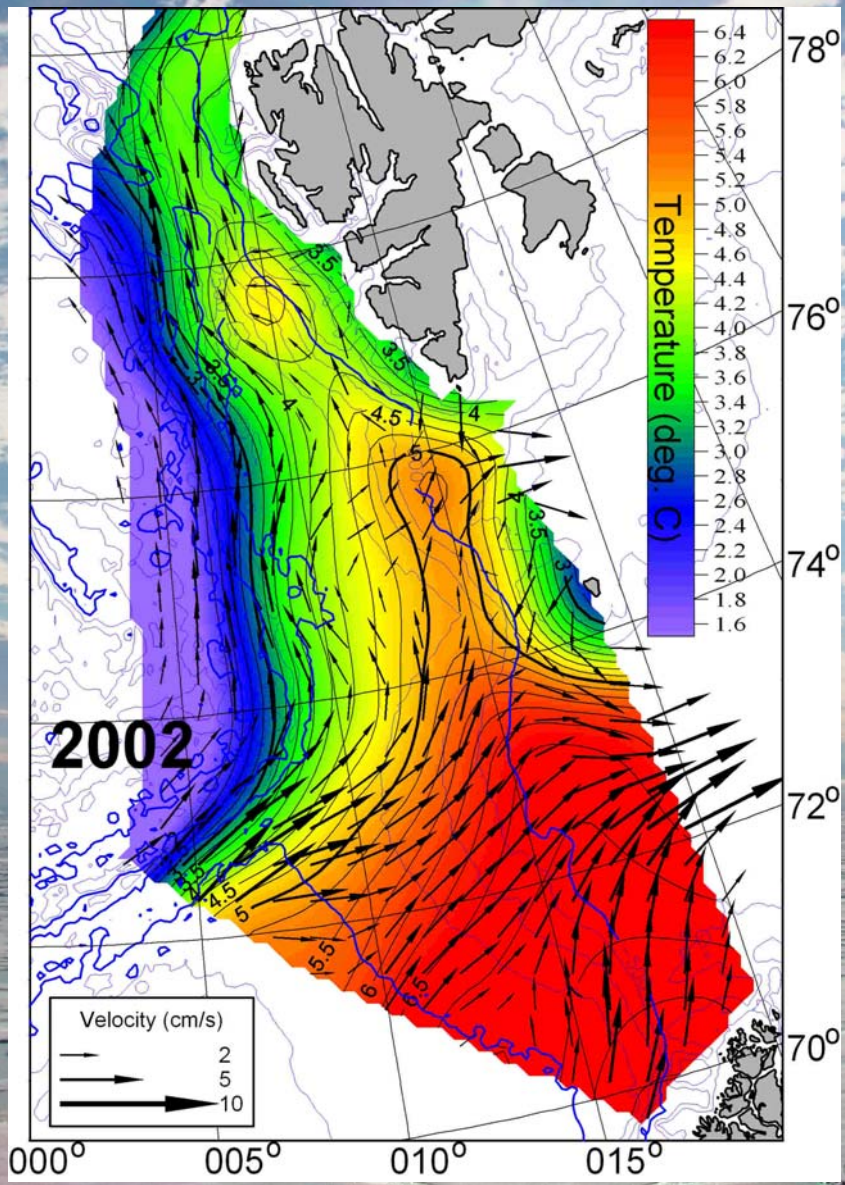
Temperature and baroclinic currents at 100 dbar



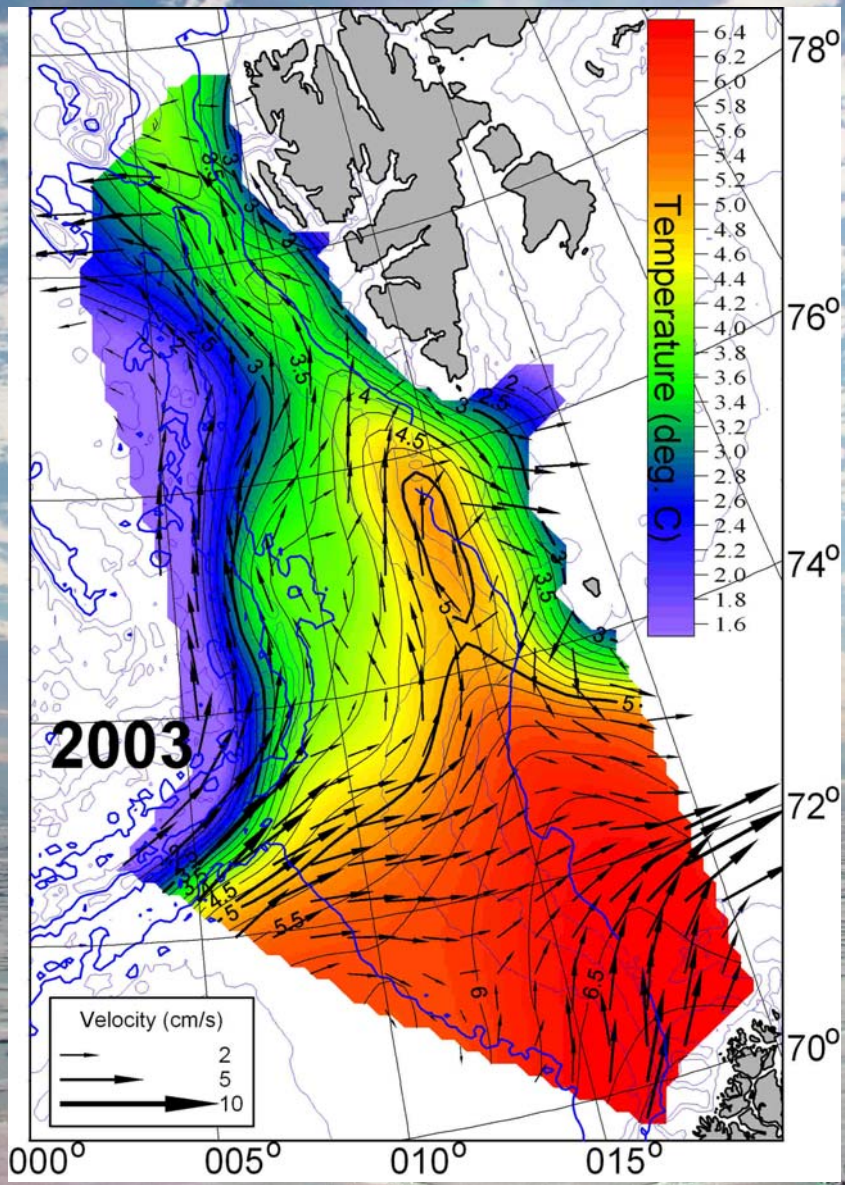
Temperature and baroclinic currents at 100 dbar



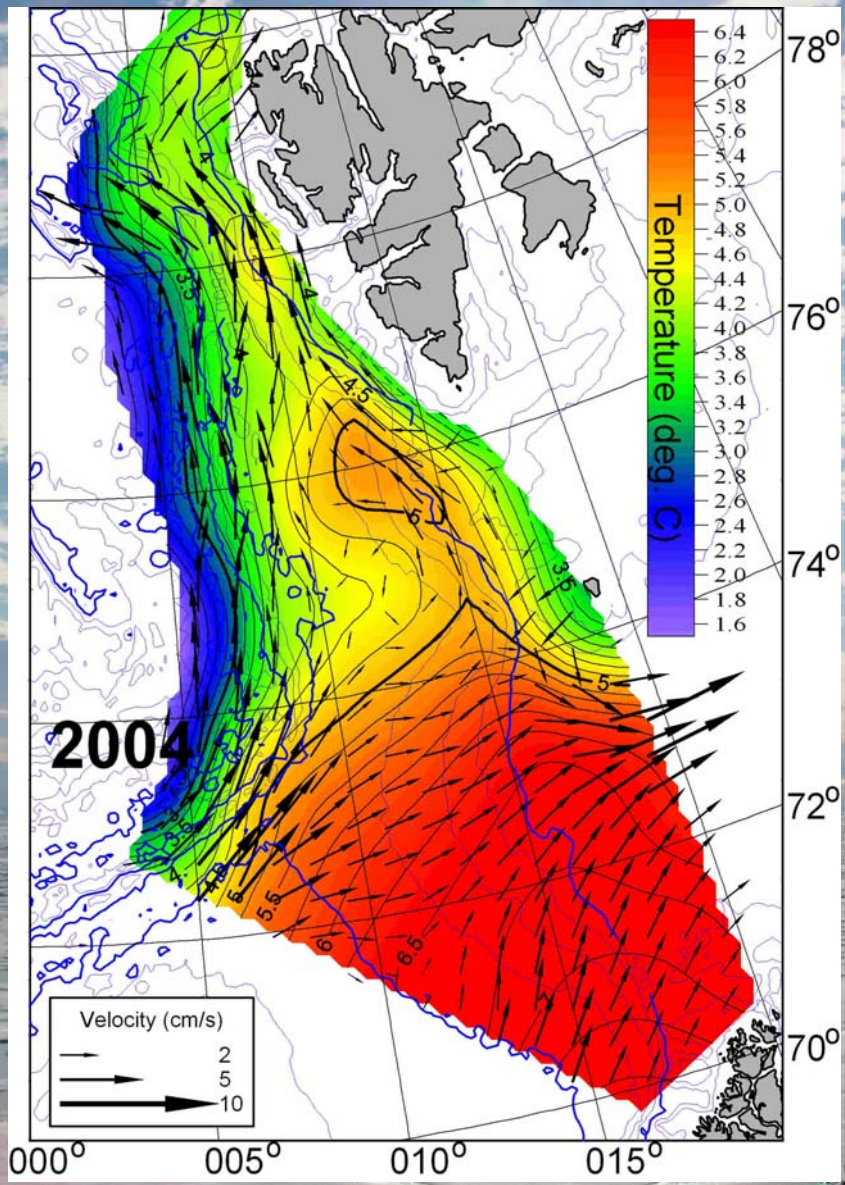
Temperature and baroclinic currents at 100 dbar



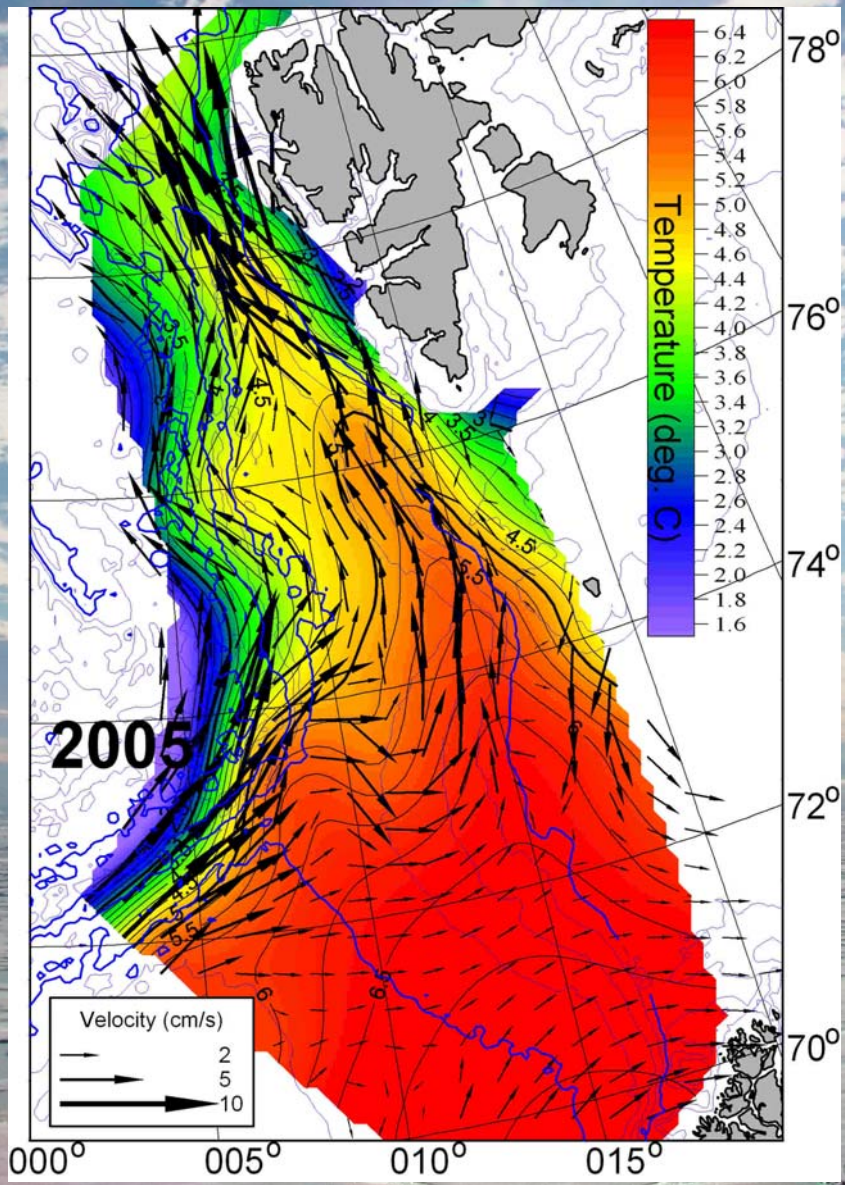
Temperature and baroclinic currents at 100 dbar



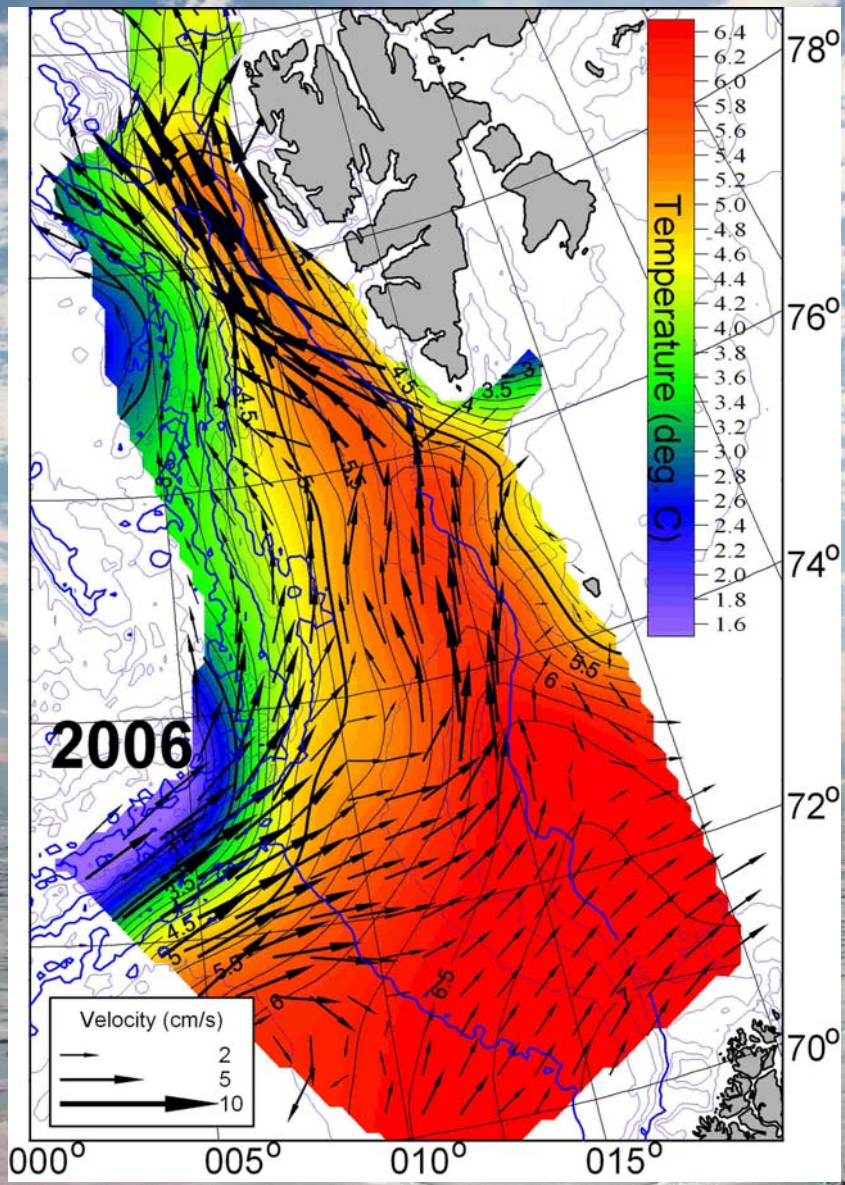
Temperature and baroclinic currents at 100 dbar



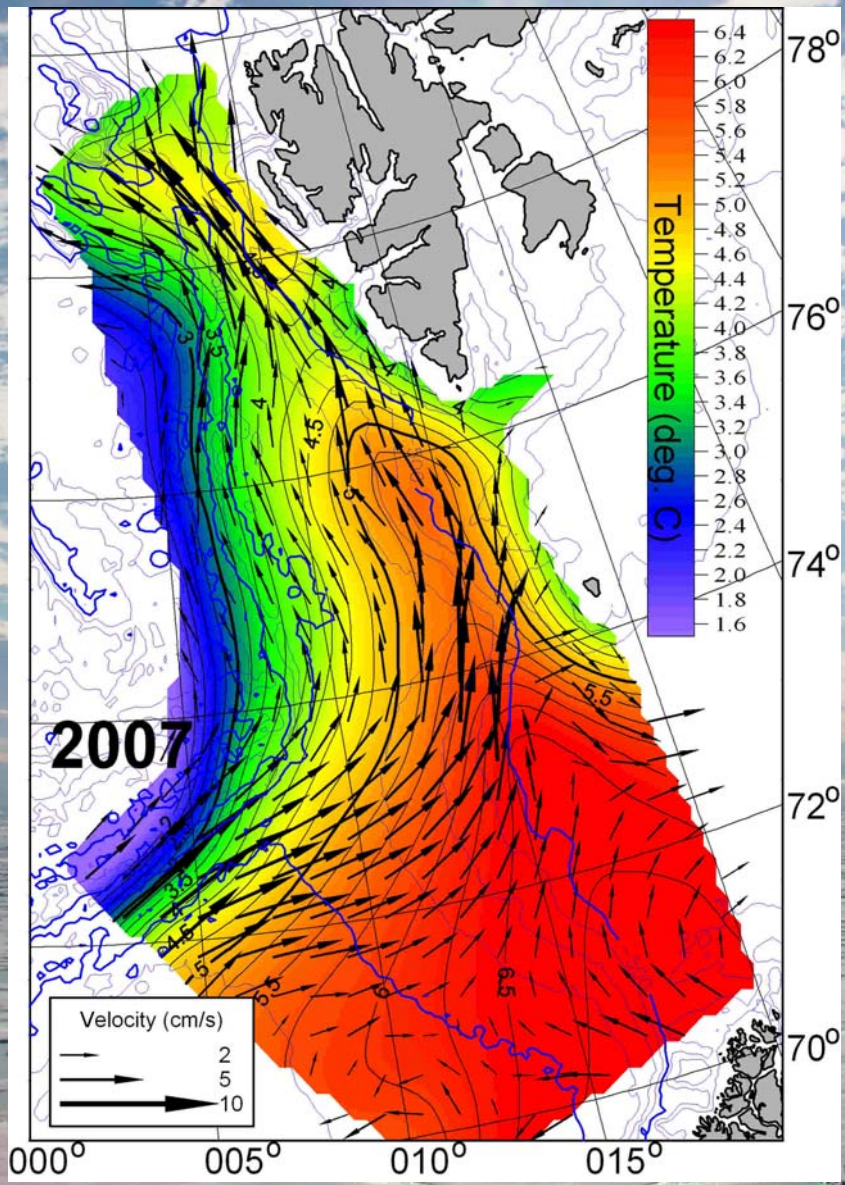
Temperature and baroclinic currents at 100 dbar



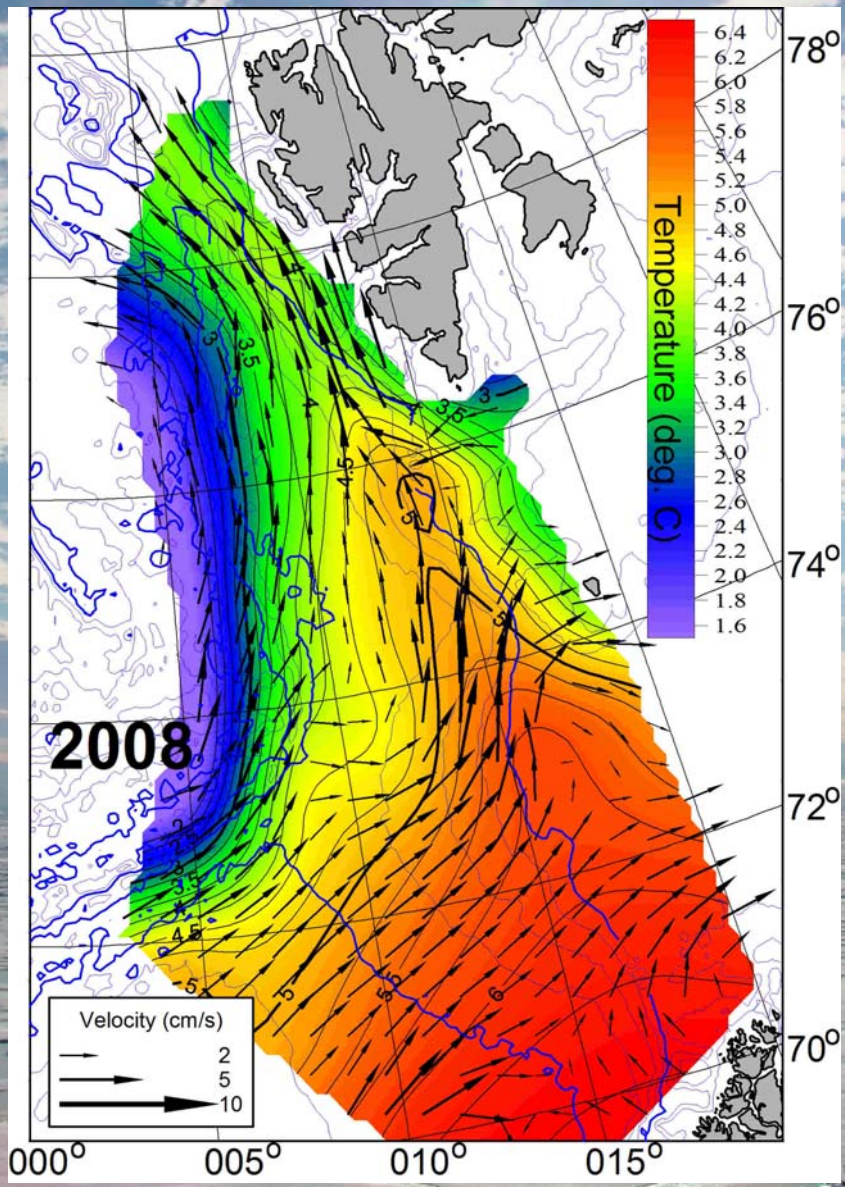
Temperature and baroclinic currents at 100 dbar



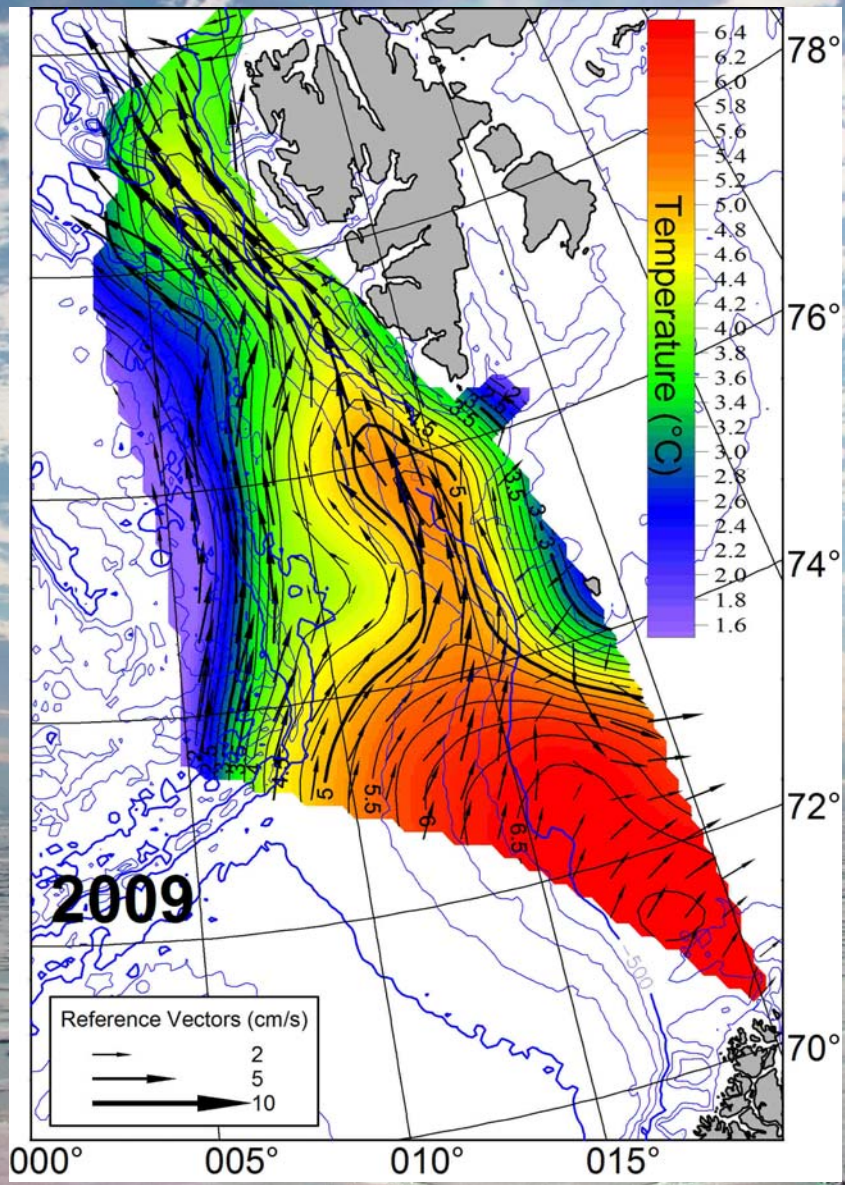
Temperature and baroclinic currents at 100 dbar



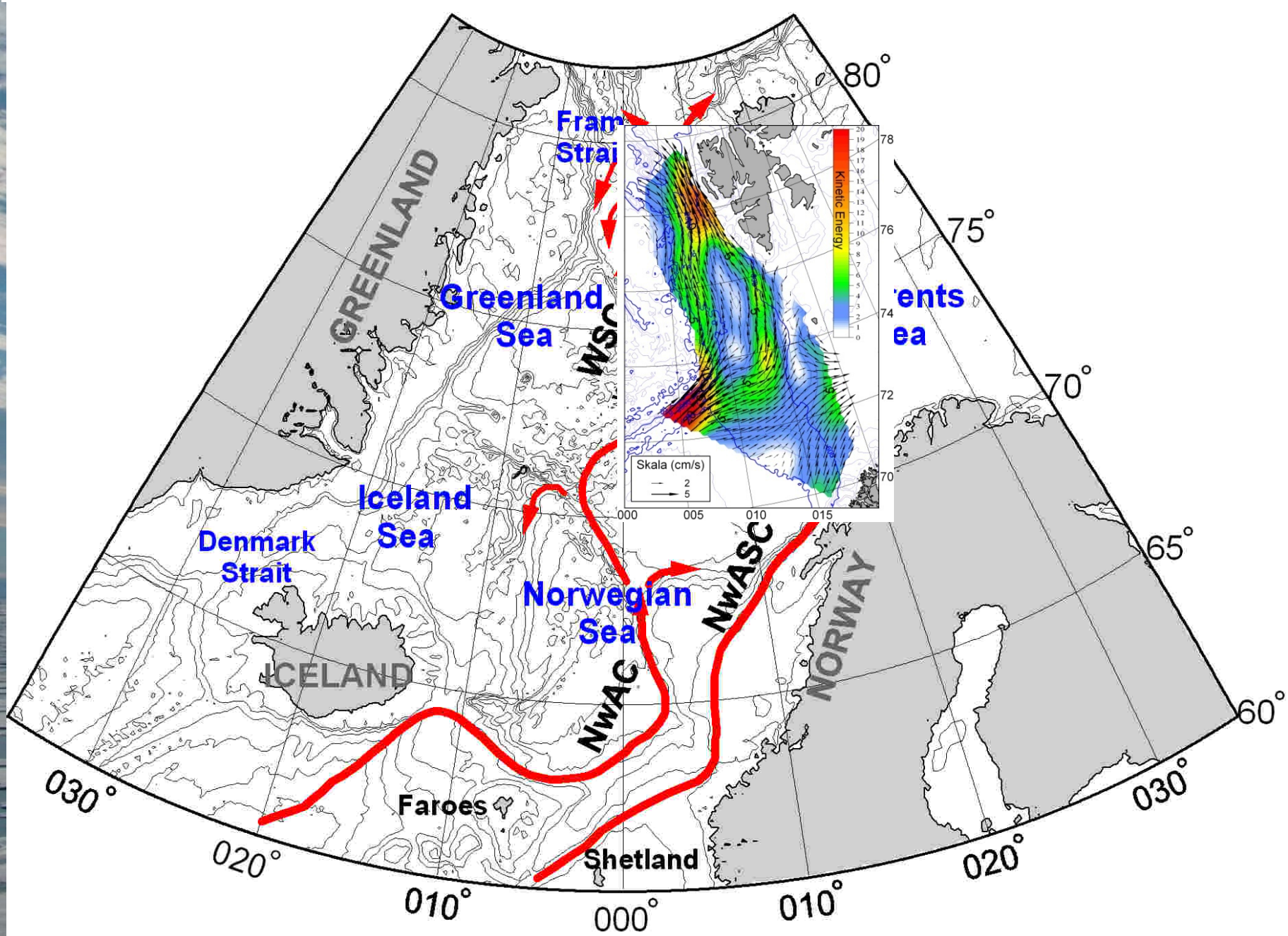
Temperature and baroclinic currents at 100 dbar

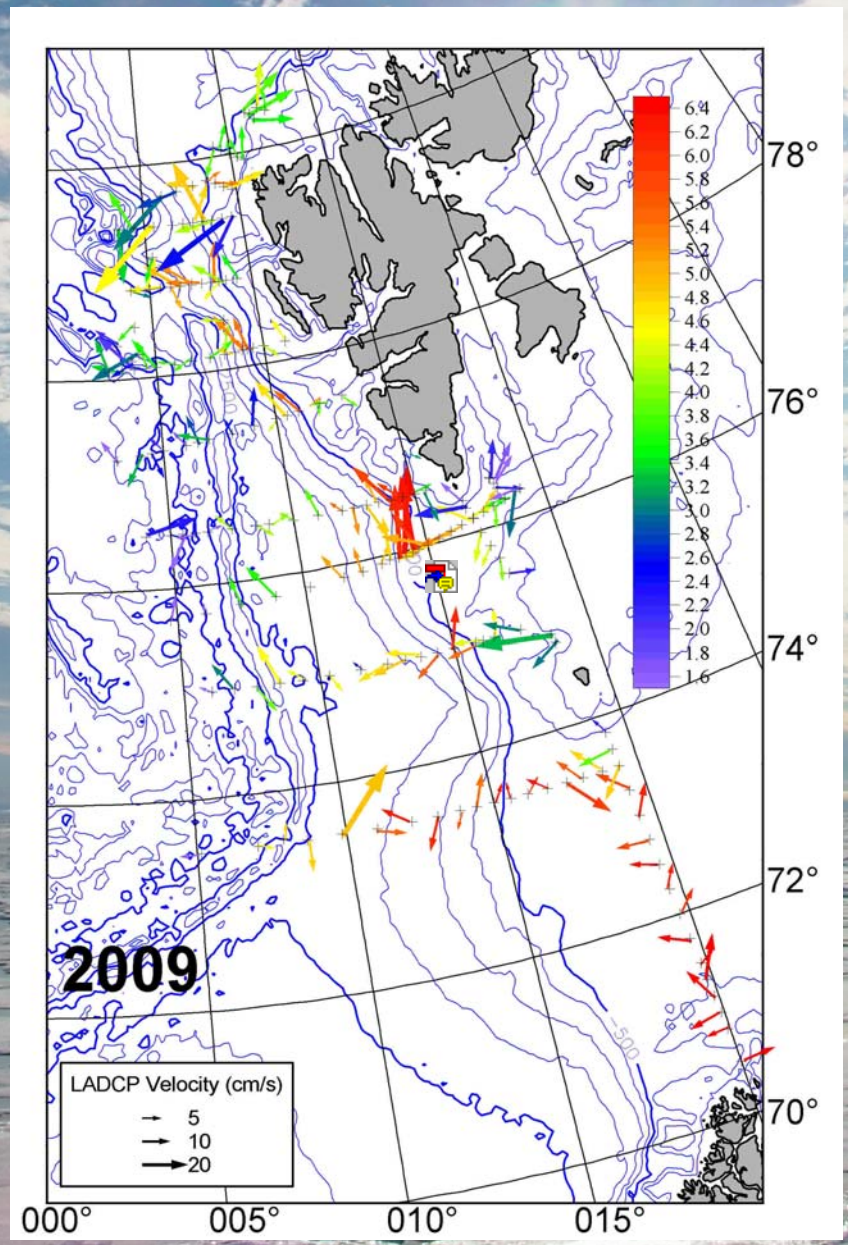


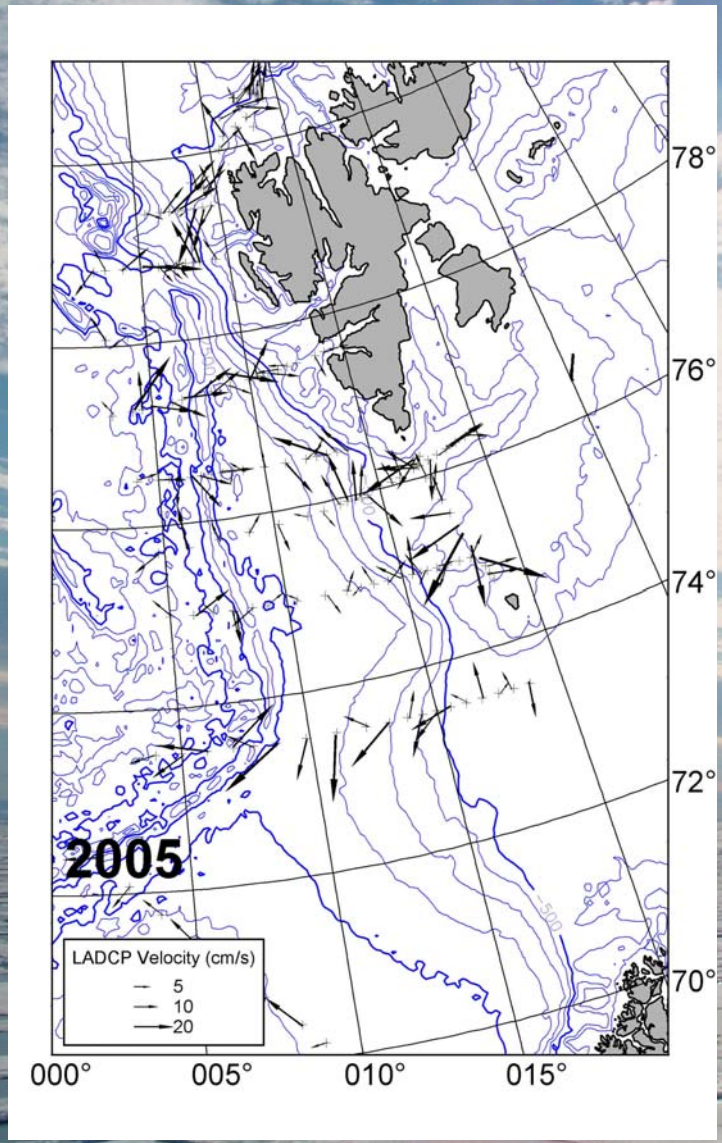
Temperature and baroclinic currents at 100 dbar

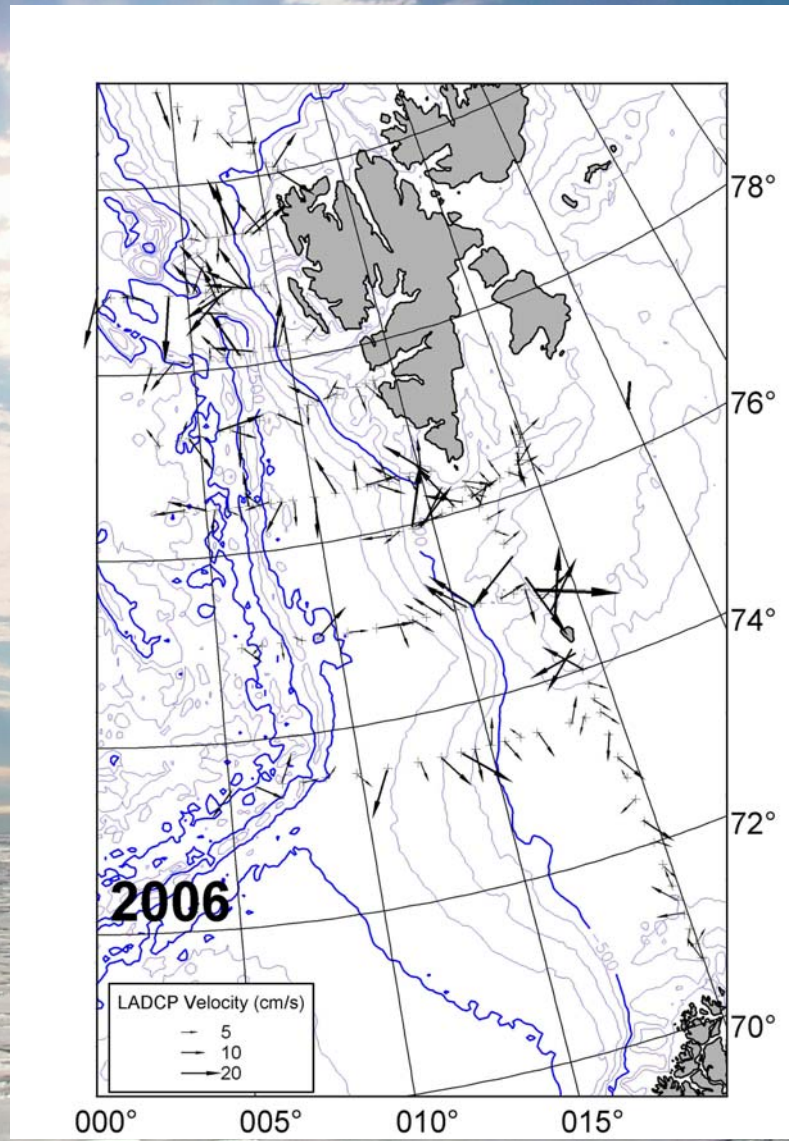


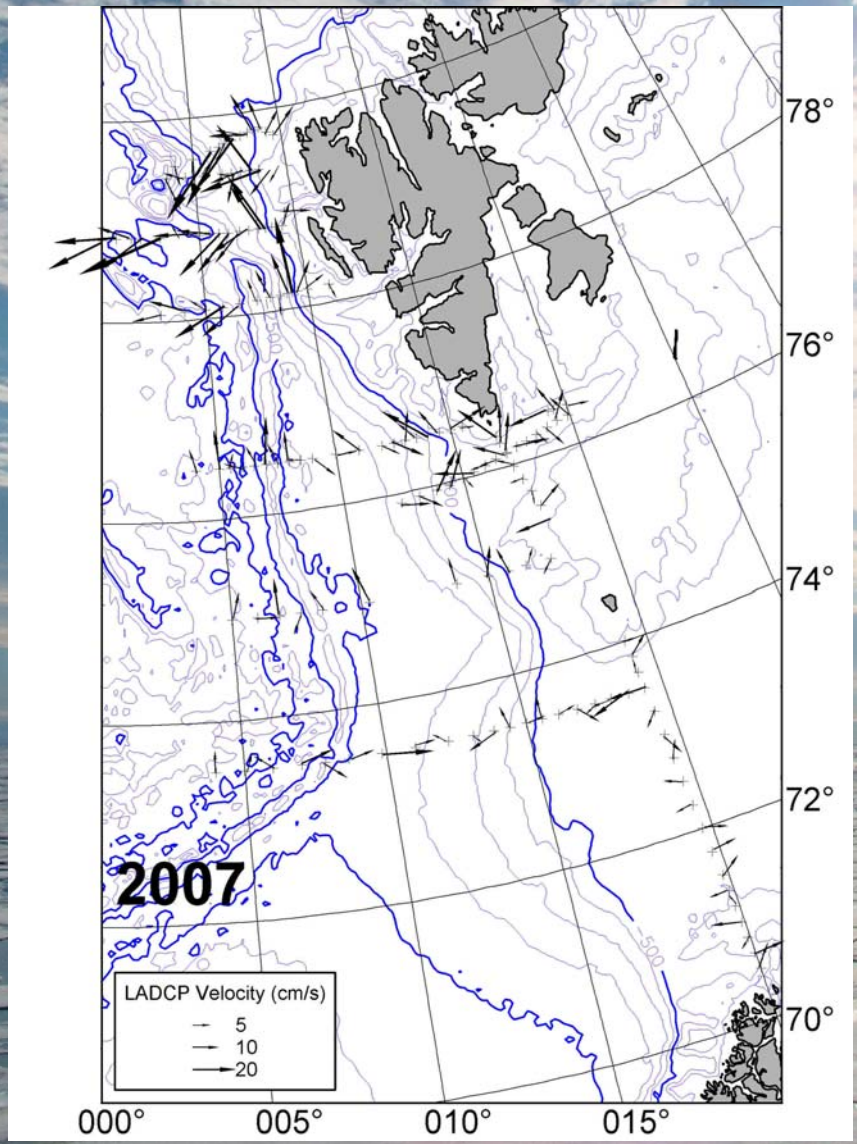
Mean summer 2000-2008 kinetic energy of the baroclinic flow

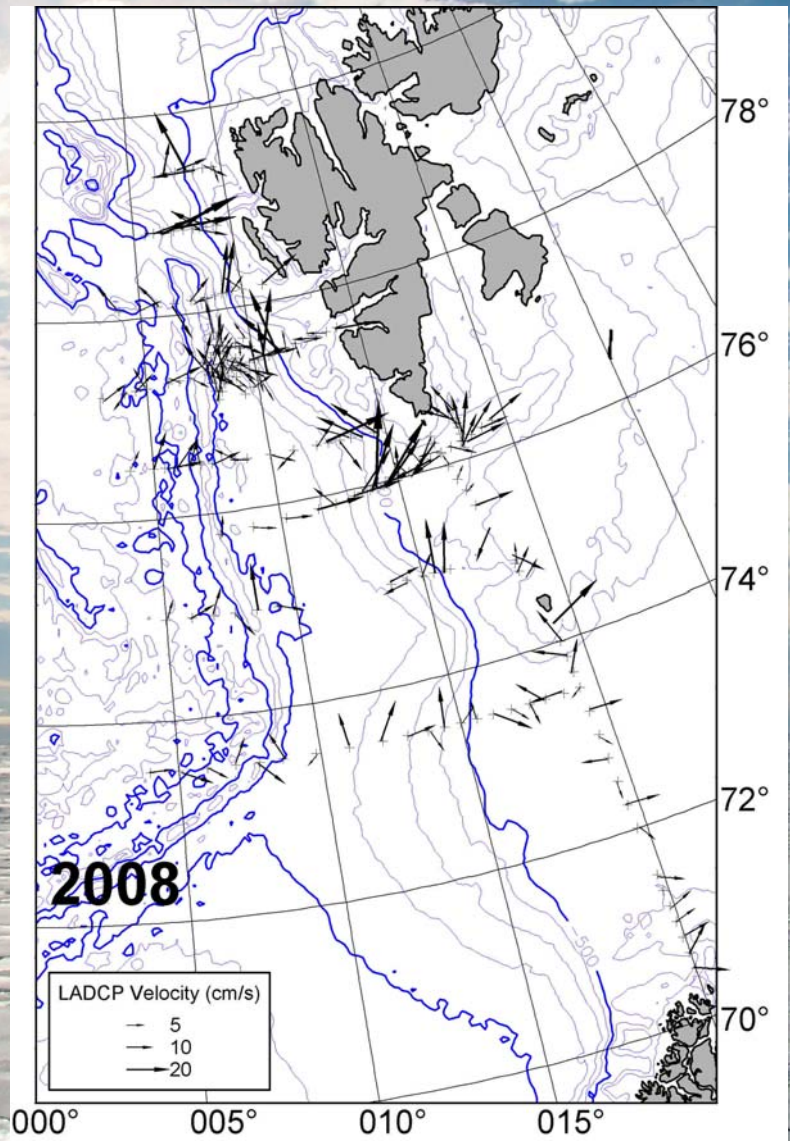


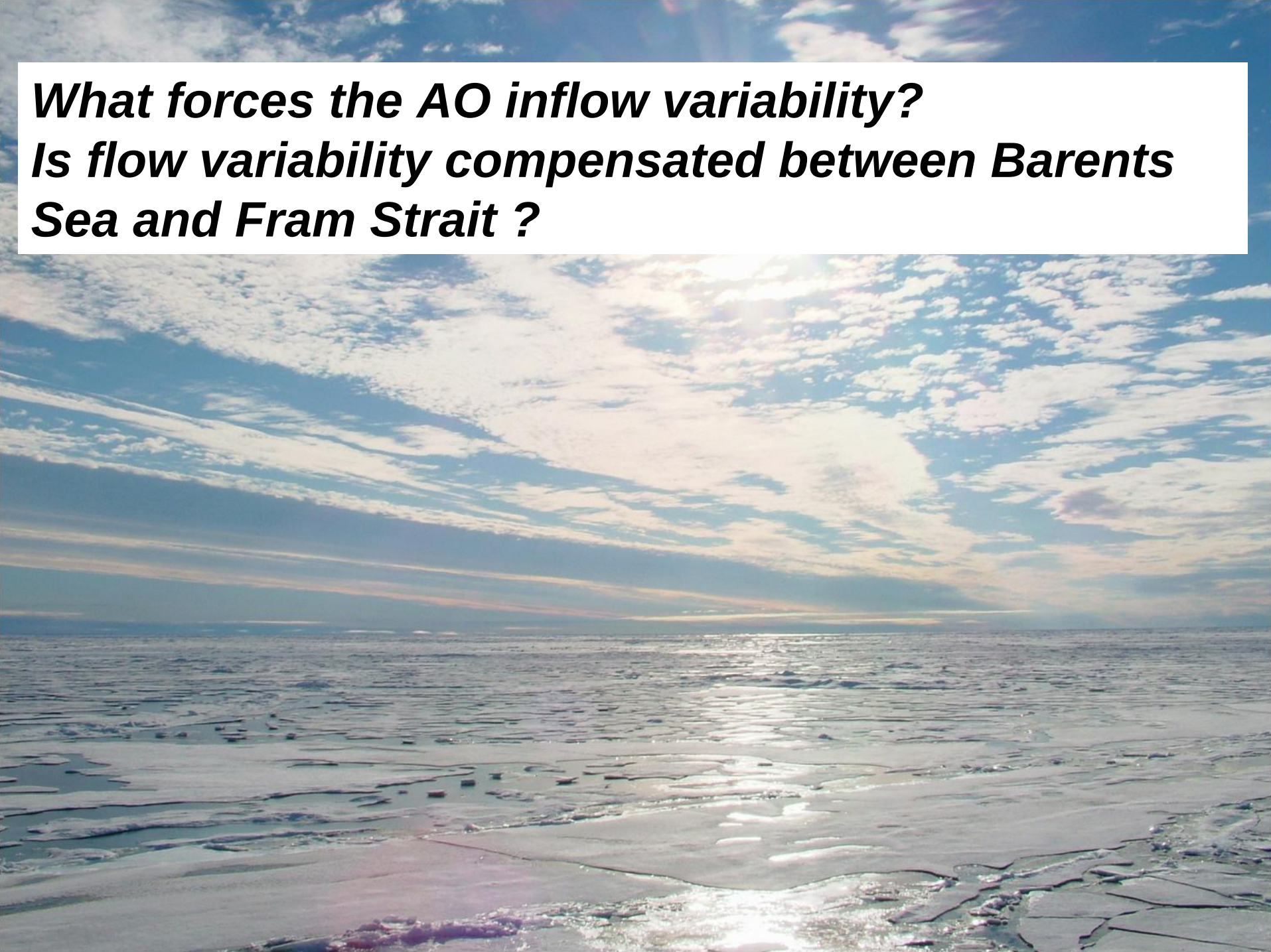

6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
78°
76°
74°
72°
70°
2009
LADCP Velocity (cm/s)
5
10
20
000°
005°
010°
015°


78°
76°
74°
72°
70°
000°
005°
010°
015°
2005
LADCP Velocity (cm/s)
5
10
20

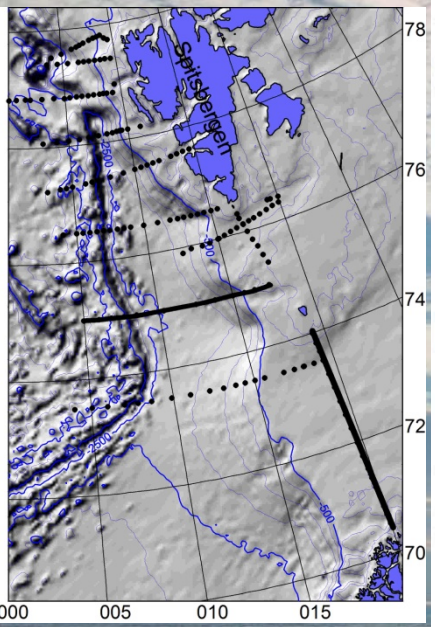

78°
76°
74°
72°
70°
000°
005°
010°
015°
2006
LADCP Velocity (cm/s)
5
10
20

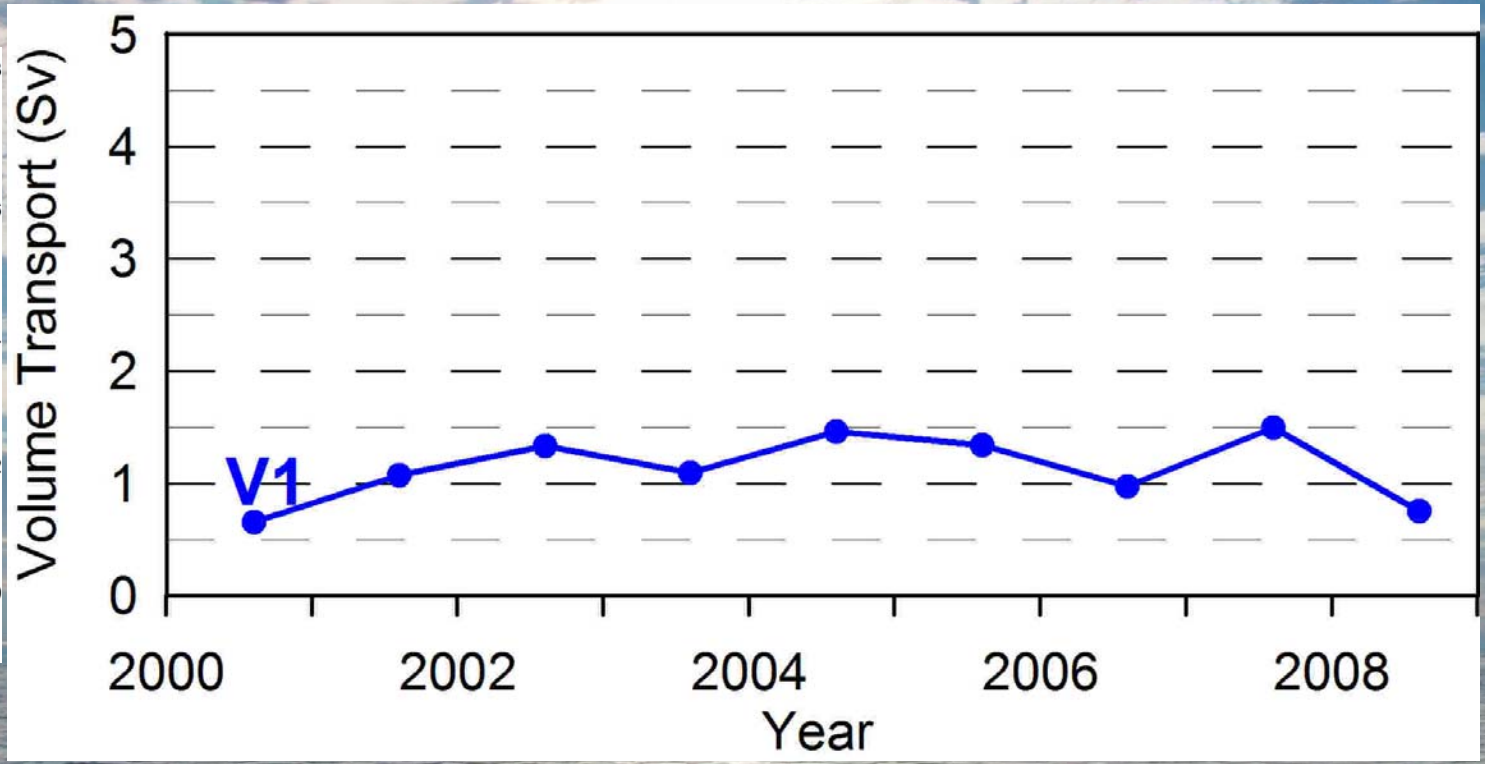

78°
76°
74°
72°
70°
000°
005°
010°
015°
2007
LADCP Velocity (cm/s)
5
10
20


78°
76°
74°
72°
70°
000°
005°
010°
015°
2008
LADCP Velocity (cm/s)
5
10
20

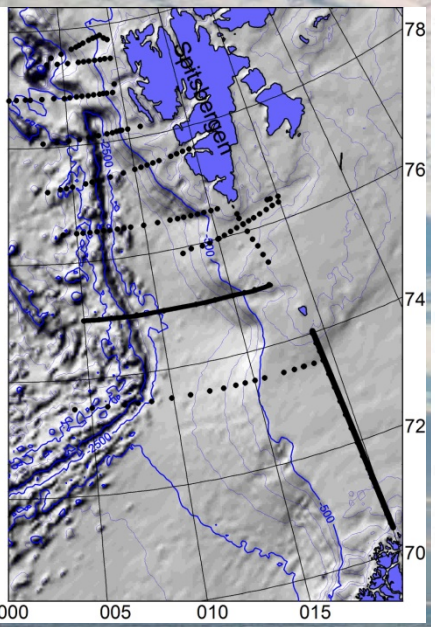


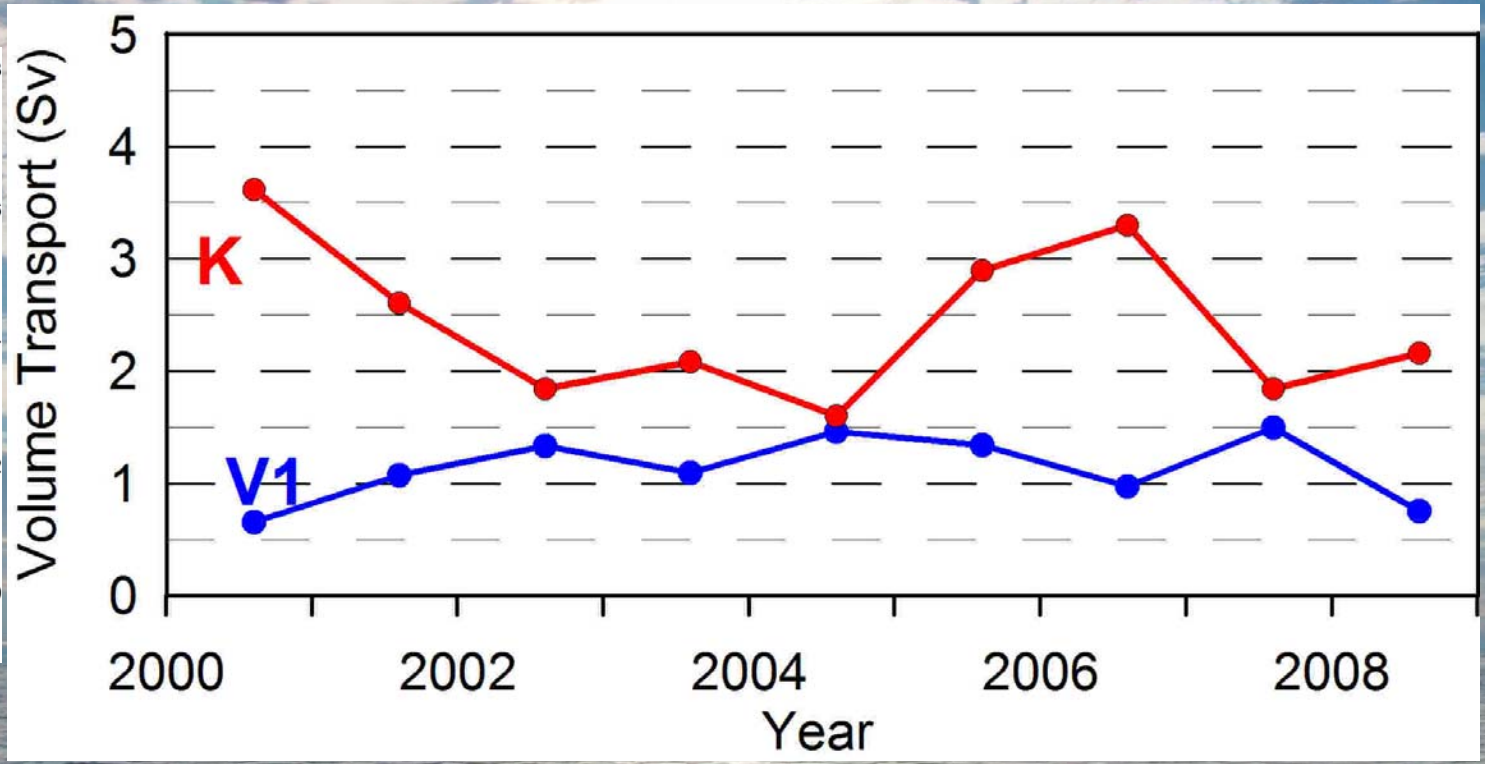
What forces the AO inflow variability?
Is flow variability compensated between Barents Sea and Fram Strait ?





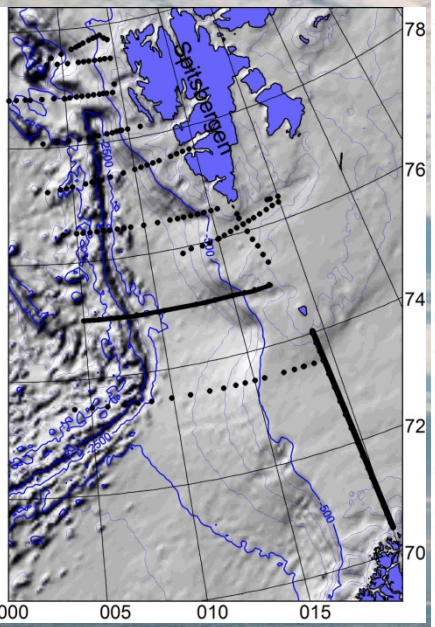
Baroclinic volume transport

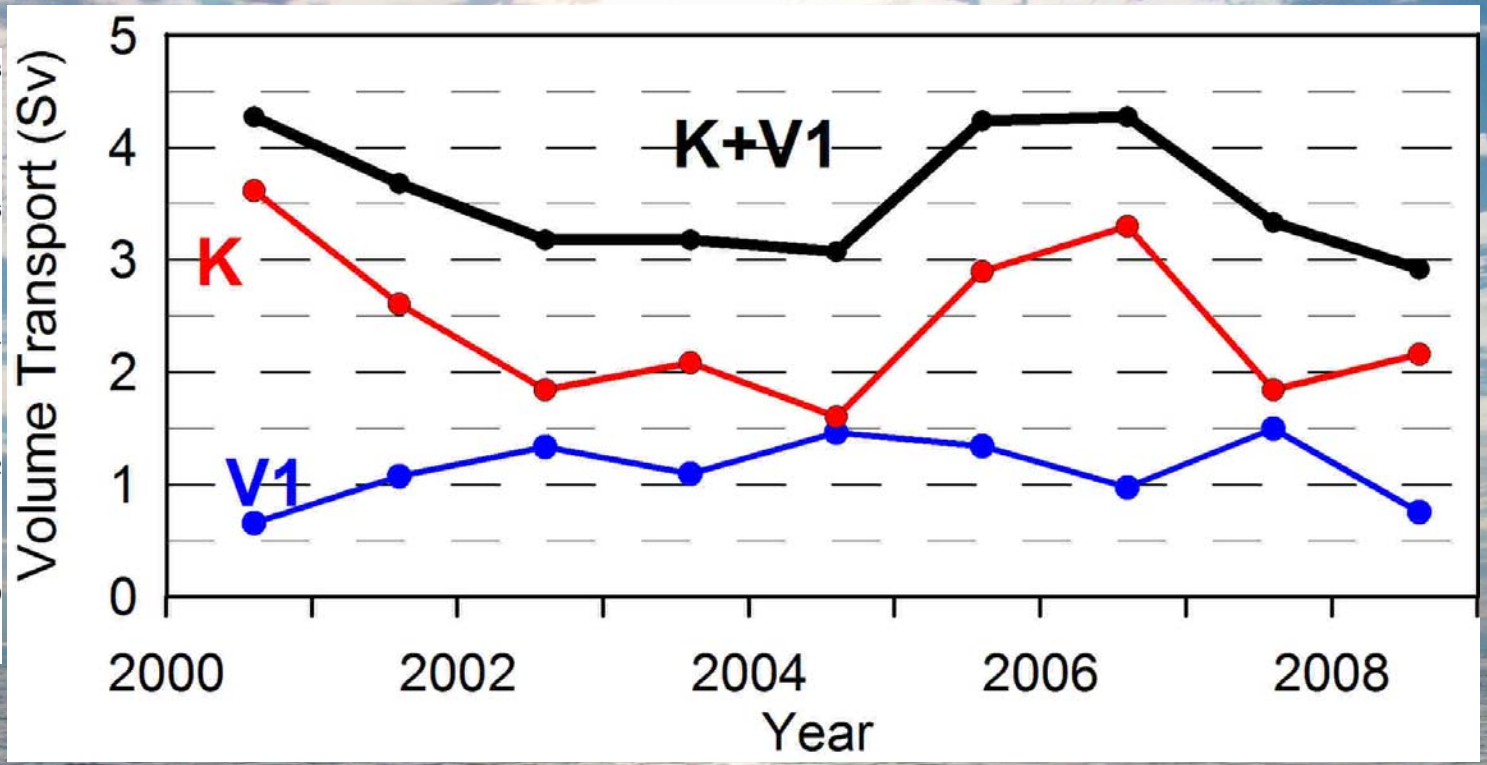




Baroclinic volume transport

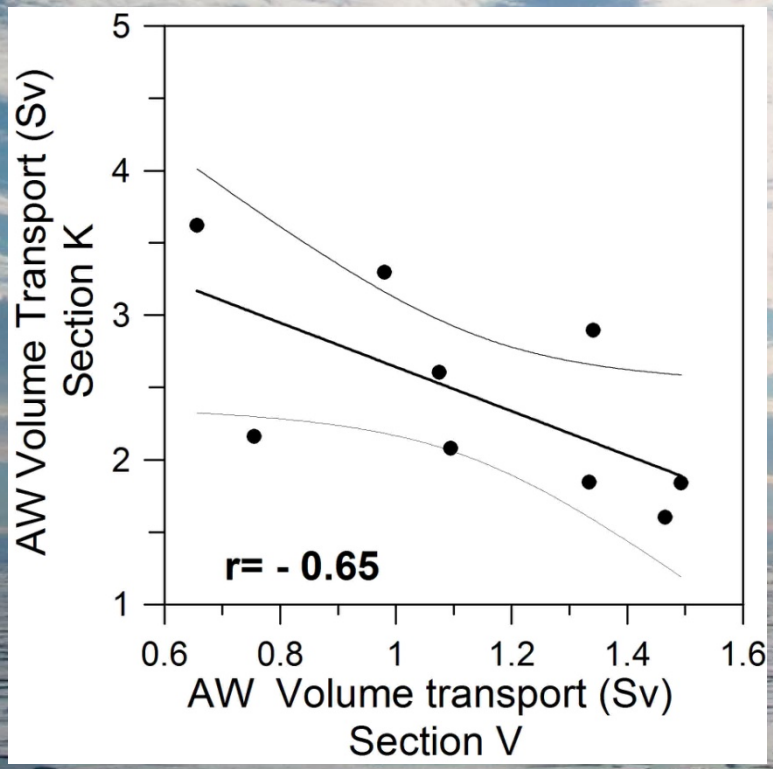
Baroclinic volume transport



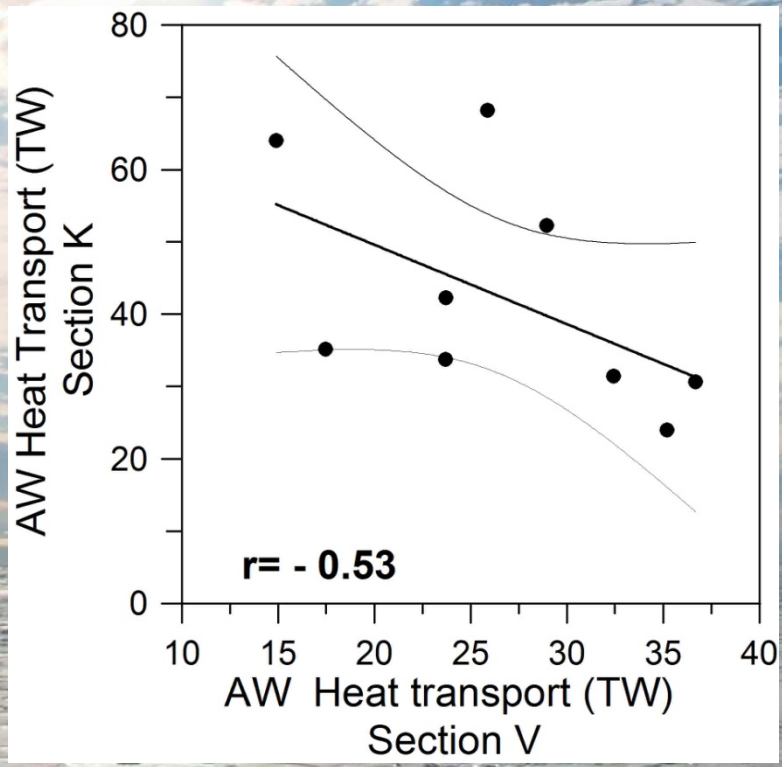


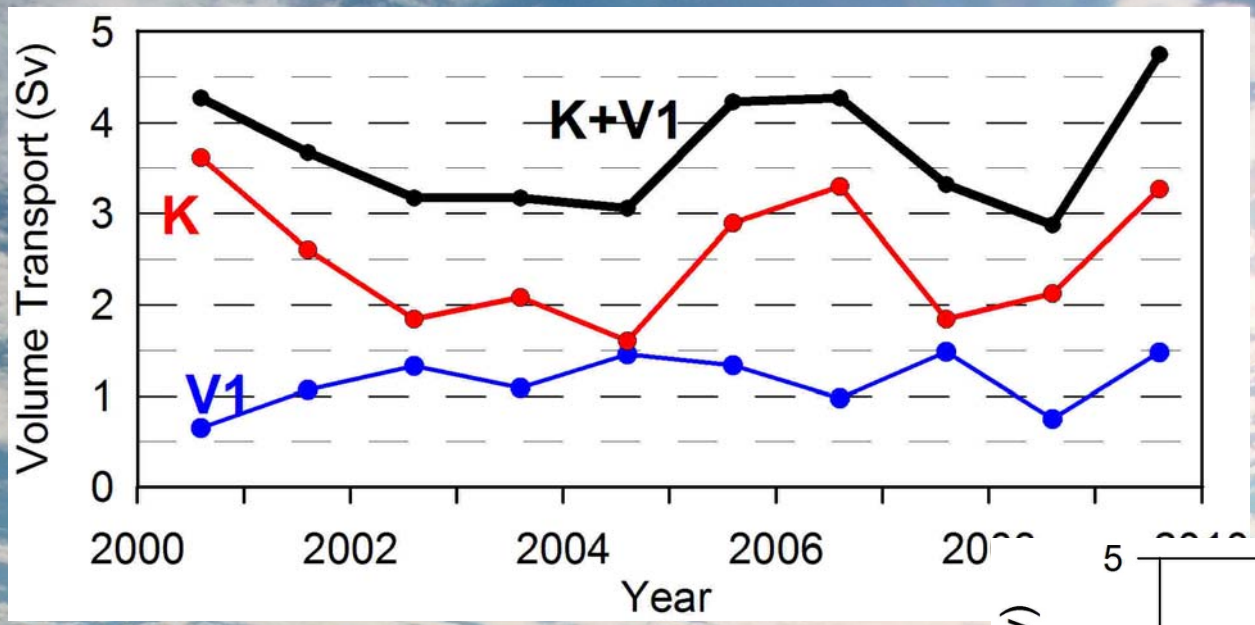
Baroclinic volume transport

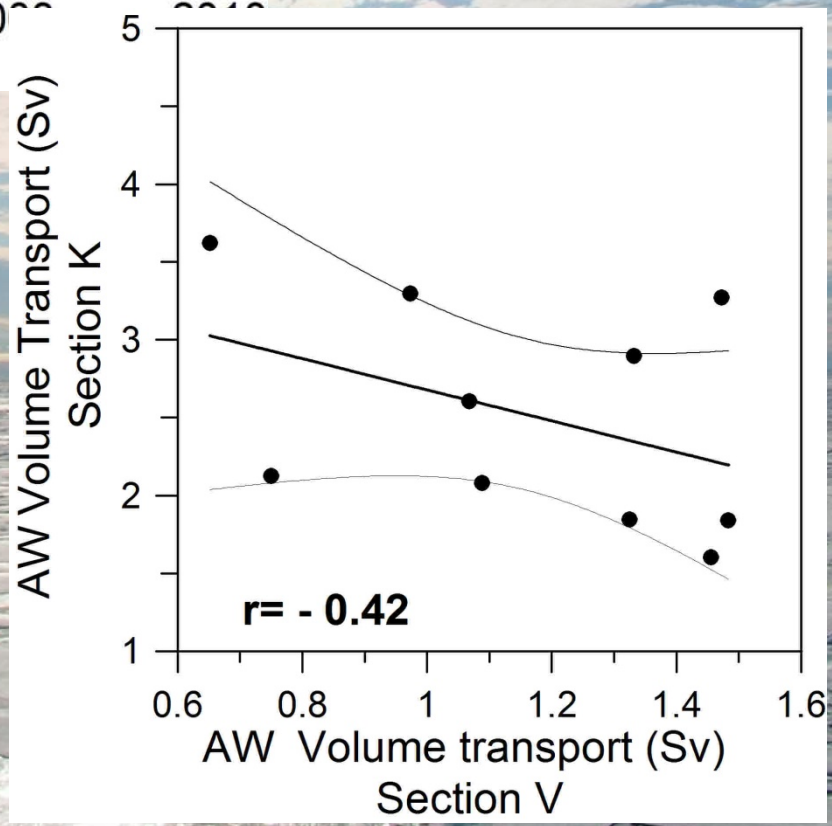
Correlogram AW volume transports through the section V and K



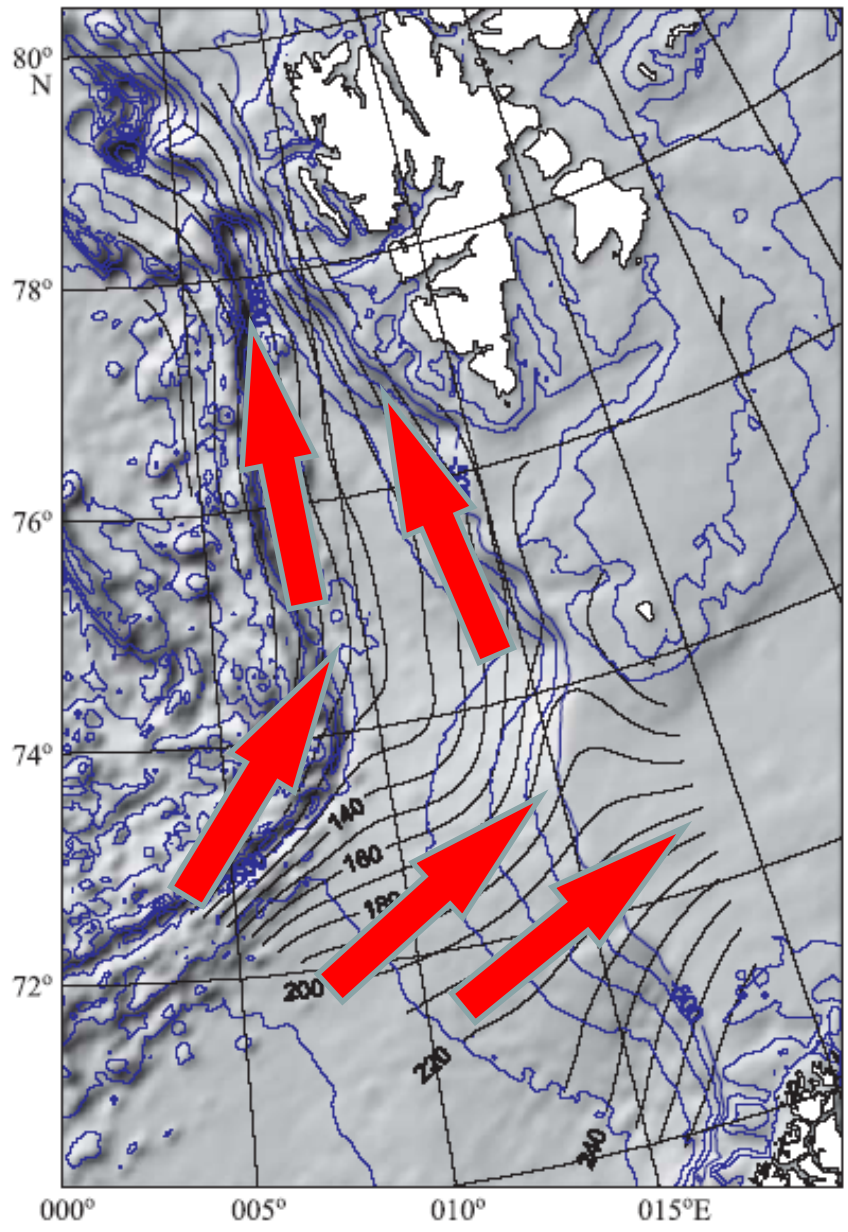
Correlogram AW heat transports through the section V and K



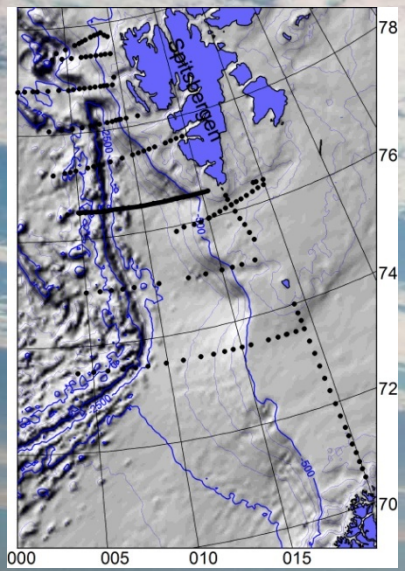

Volume Transport (Sv)
5
4
3
2
1
0
K+V1
K
V1
2000
2002
2004
2006
Year

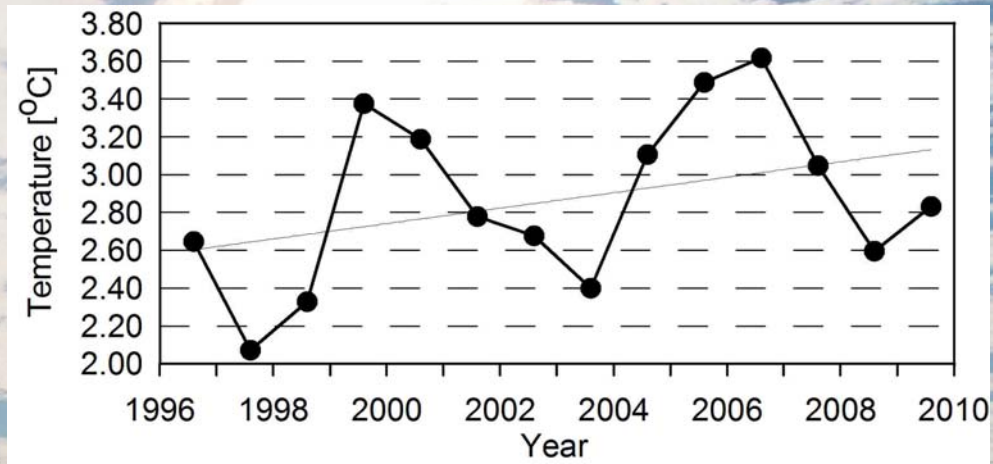

AW Volume Transport (Sv)
Section K
5
4
3
2
1
r= - 0.42
0.6
0.8
1
1.2
1.4
1.6
AW Volume transport (Sv)
Section V

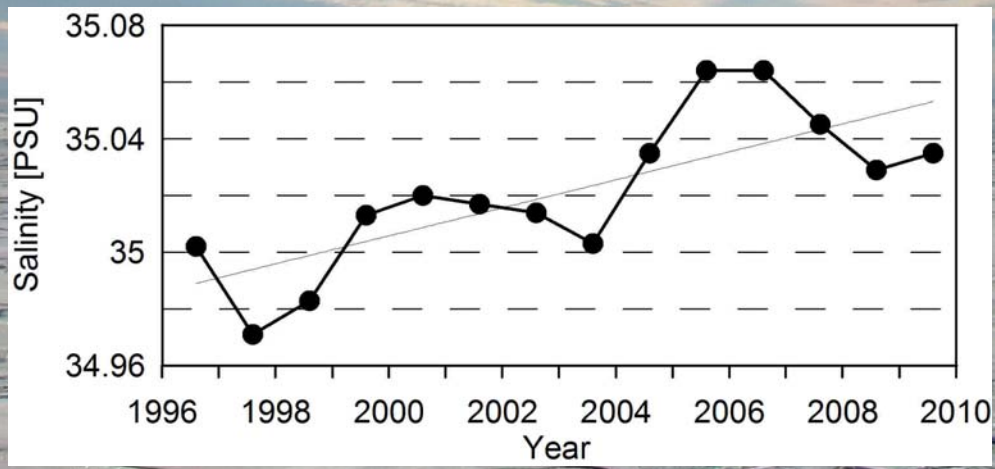
Bathymetry (blue lines) and the July 2000–07 mean geopotential anomaly at the 100 dbar level.



Are there periodic changes ?



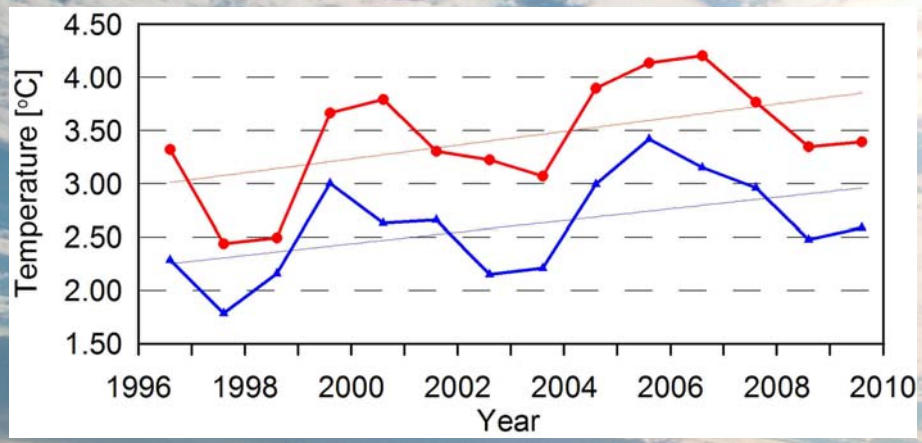


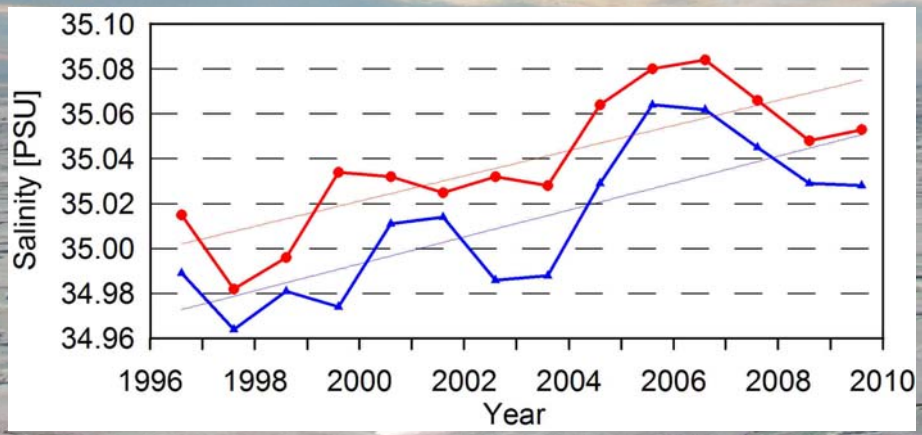


What is importence of the eastern and western branch ?

What forces it's variability ?

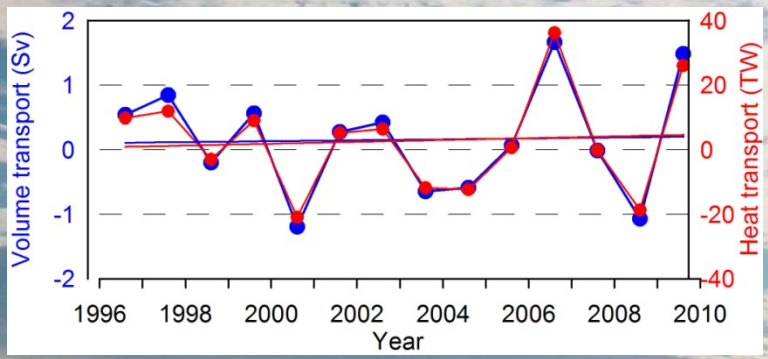
Section N.
T and S in Core and Western Branch

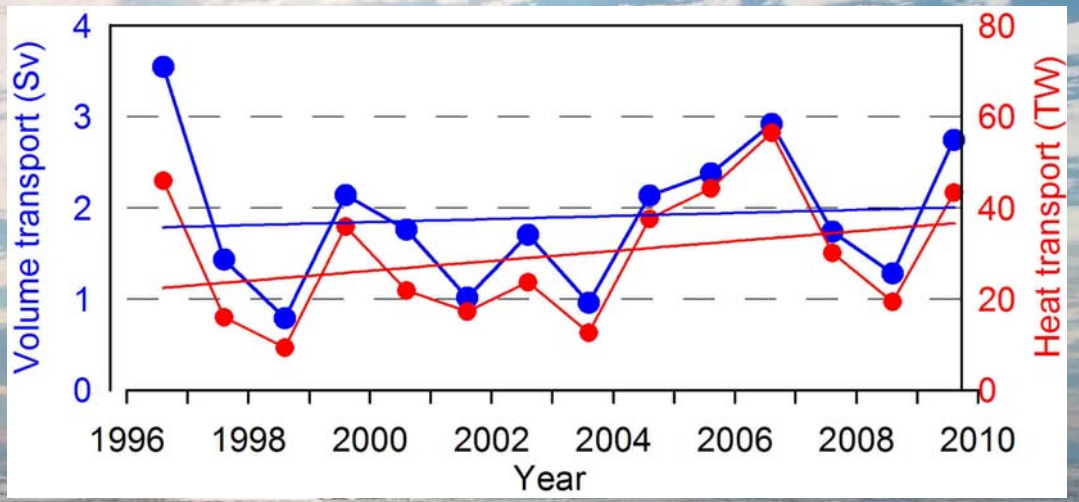




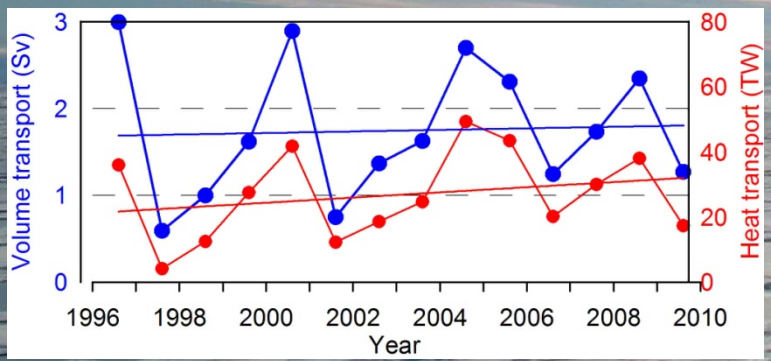
Baroclinic AW heat and volume transport cross section 'N'

Eastern branch

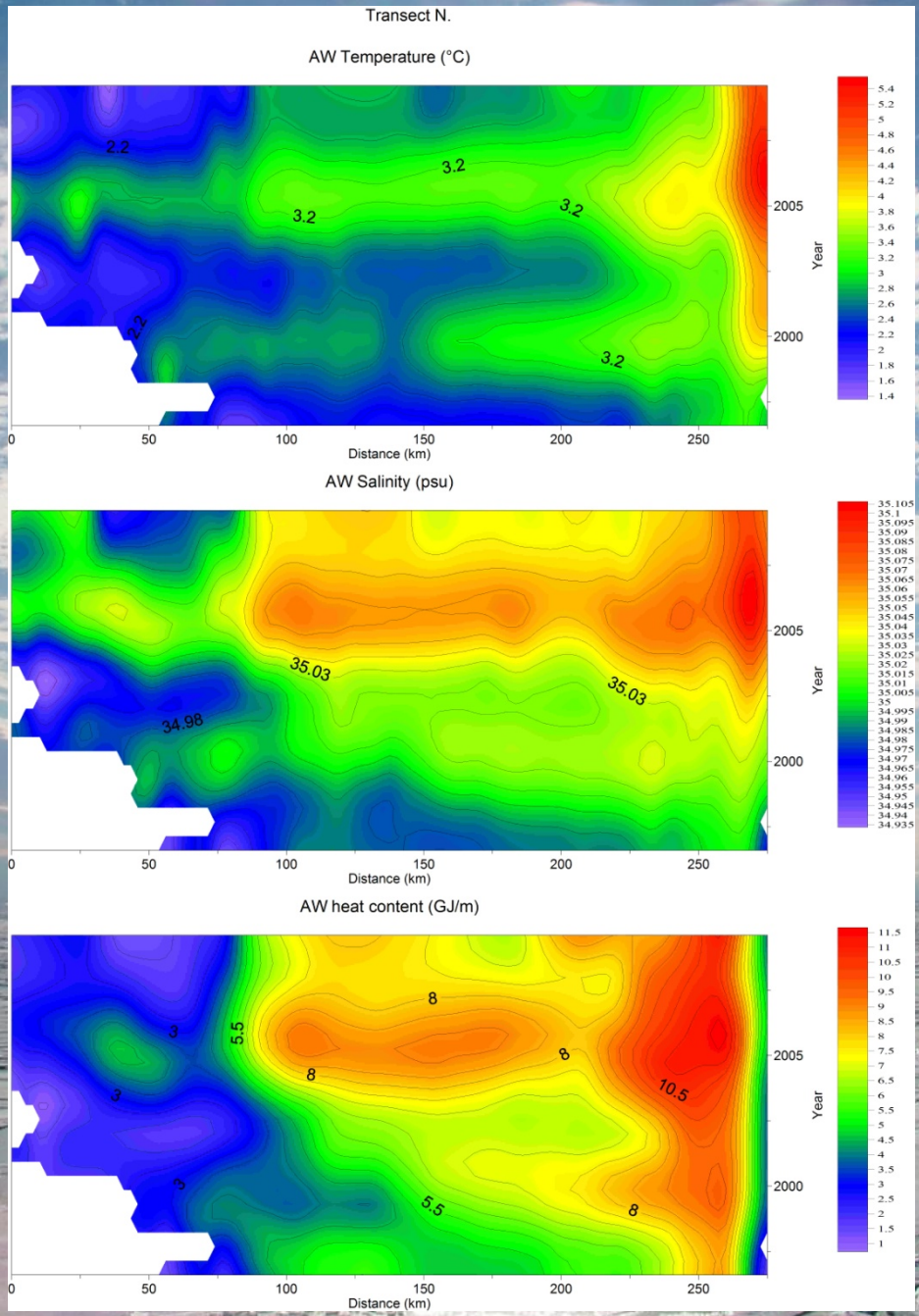




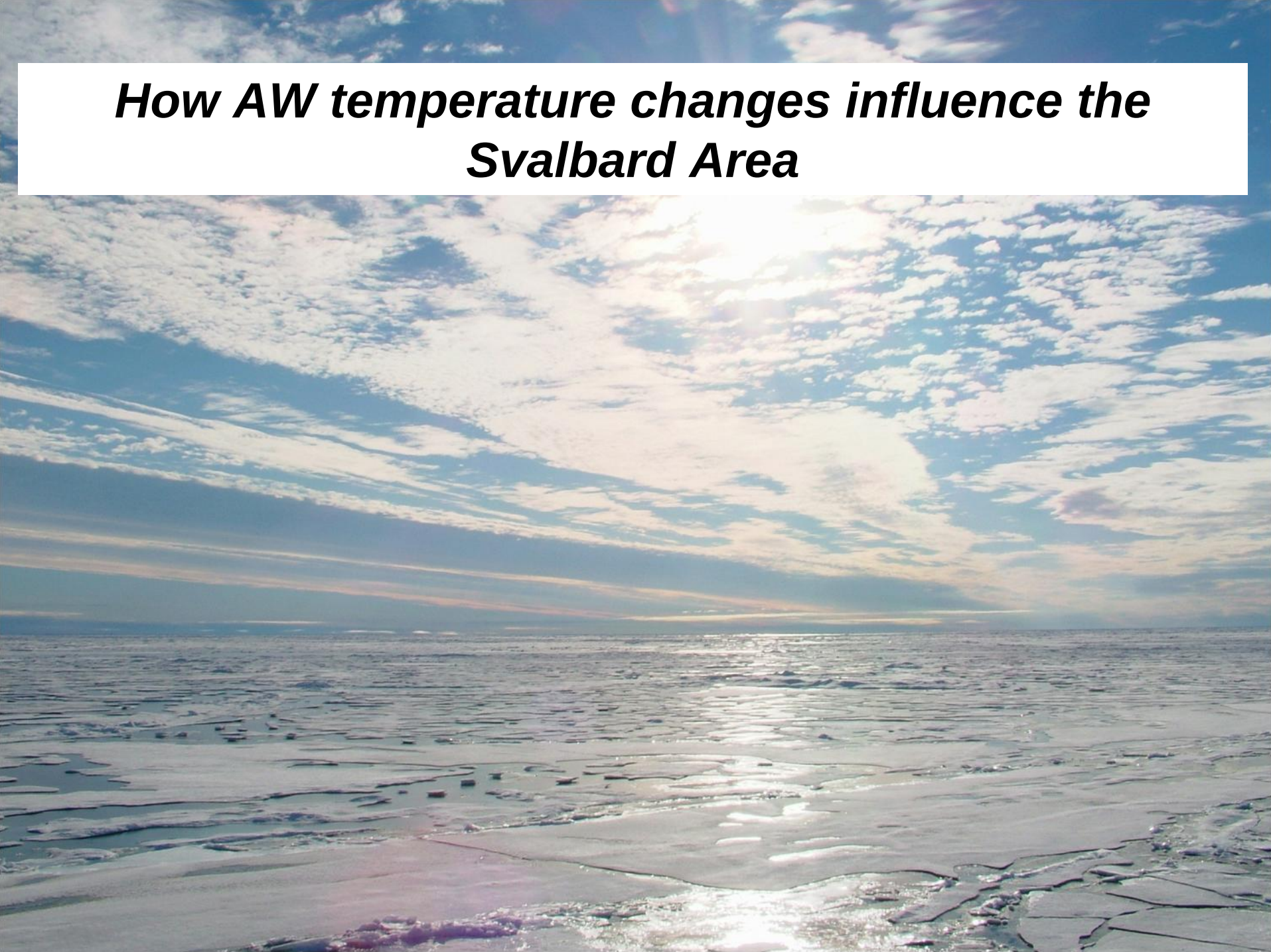
Total

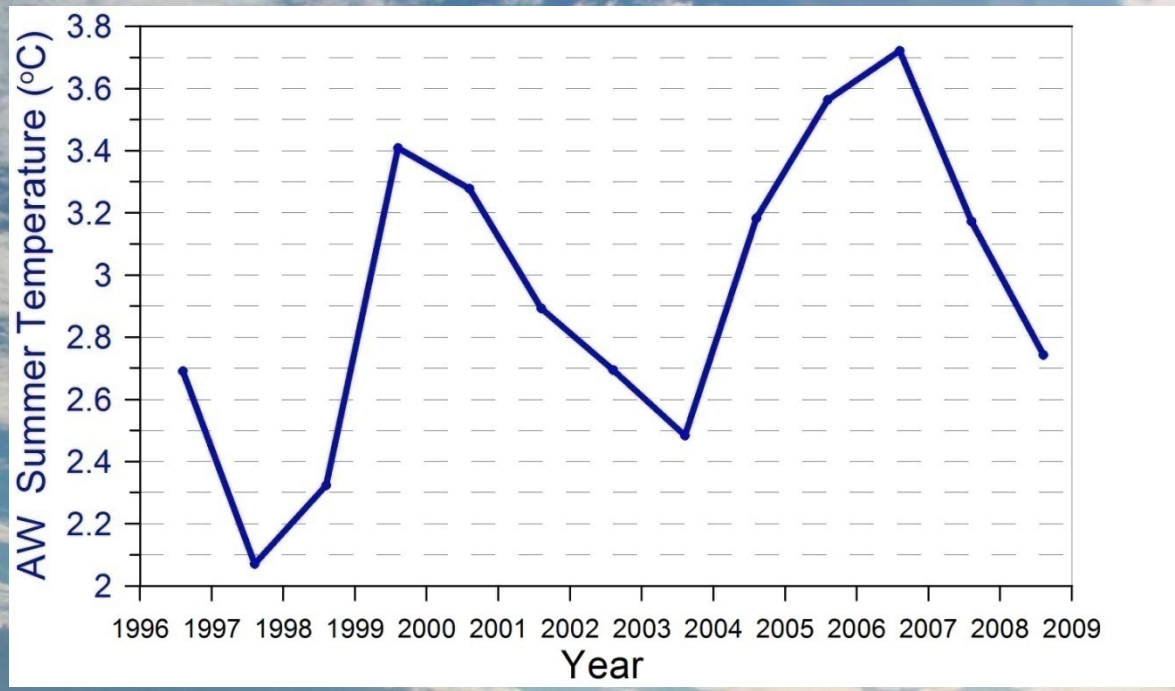


Western branch

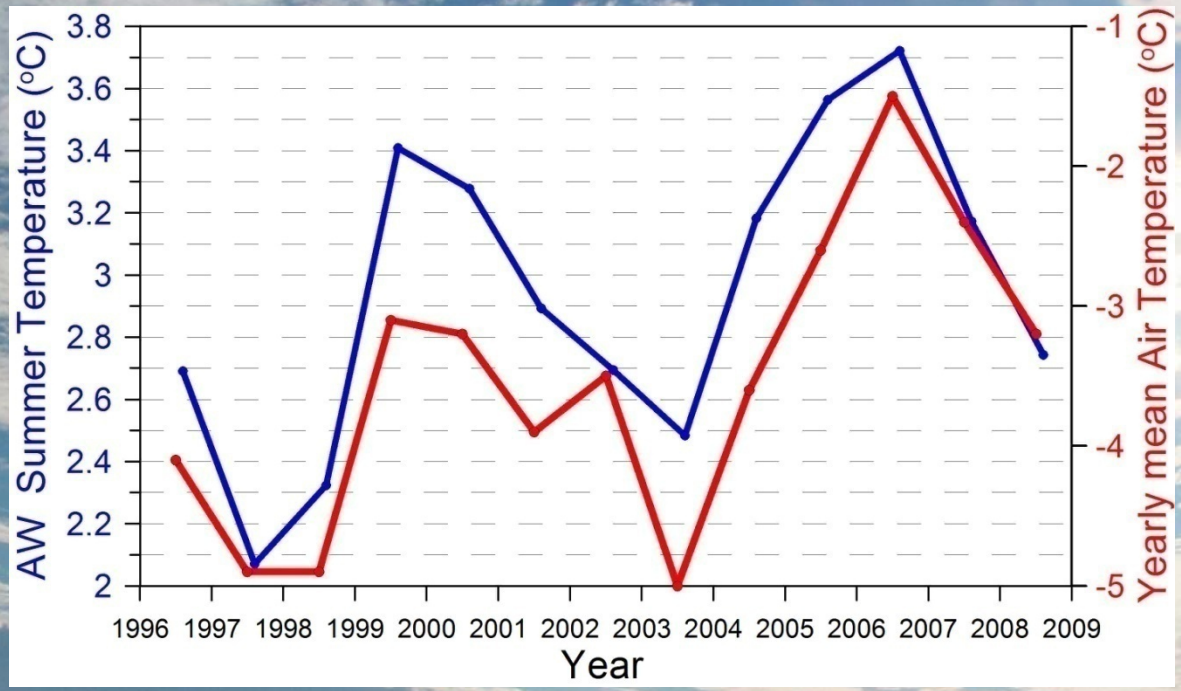

Transect N.
AW Temperature (°C)
2.2
3.2
3.2
3.2
2.2
3.2
2005
2000
Year
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
0
50
100
150
200
250
Distance (km)
AW Salinity (psu)
35.03
35.03
34.98
2005
2000
Year
35.105
35.1
35.095
35.09
35.085
35.08
35.075
35.07
35.065
35.06
35.055
35.05
35.045
35.04
35.035
35.03
35.025
35.02
35.015
35.01
35.005
35
34.995
34.99
34.985
34.98
34.975
34.97
34.965
34.96
34.955
34.95
34.945
34.94
34.935
0
50
100
150
200
250
Distance (km)
AW heat content (GJ/m)
8
3
5.5
8
8
10.5
3
3
5.5
8
2005
2000
Year
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0
50
100
150
200
250
Distance (km)

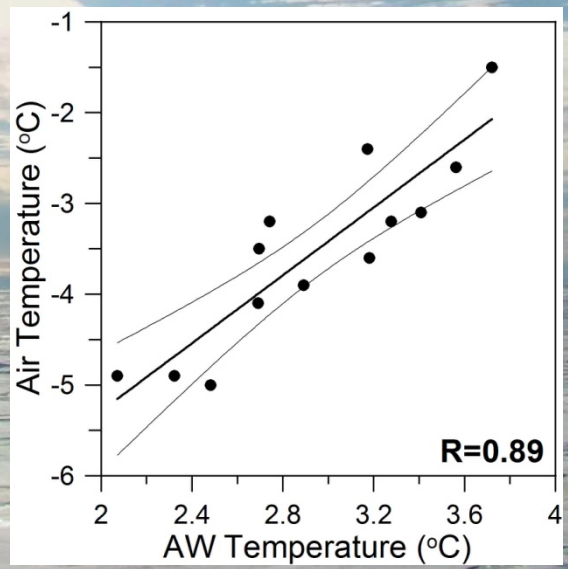
How AW temperature changes influence the Svalbard Area





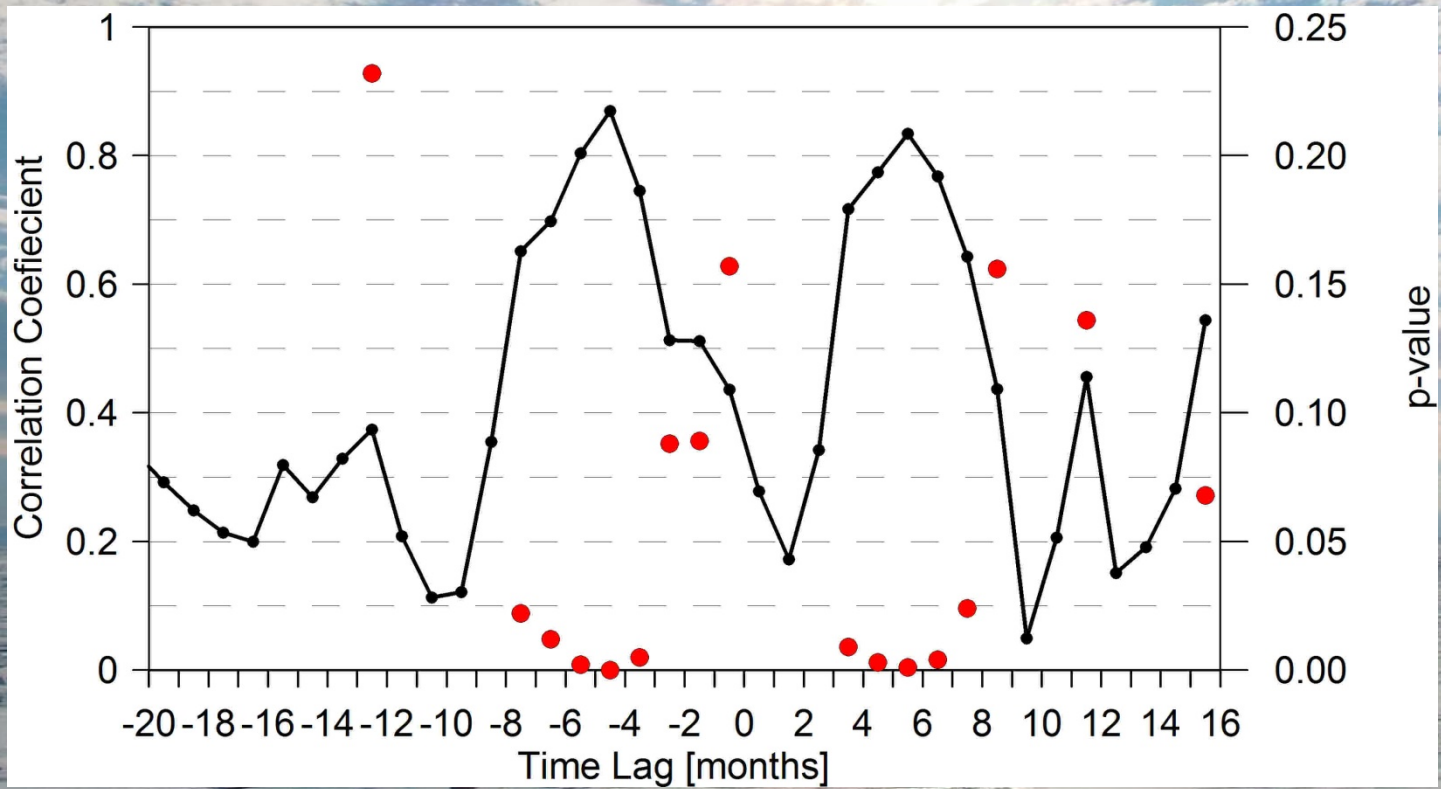
AW temperature at section ‘N’ (July)

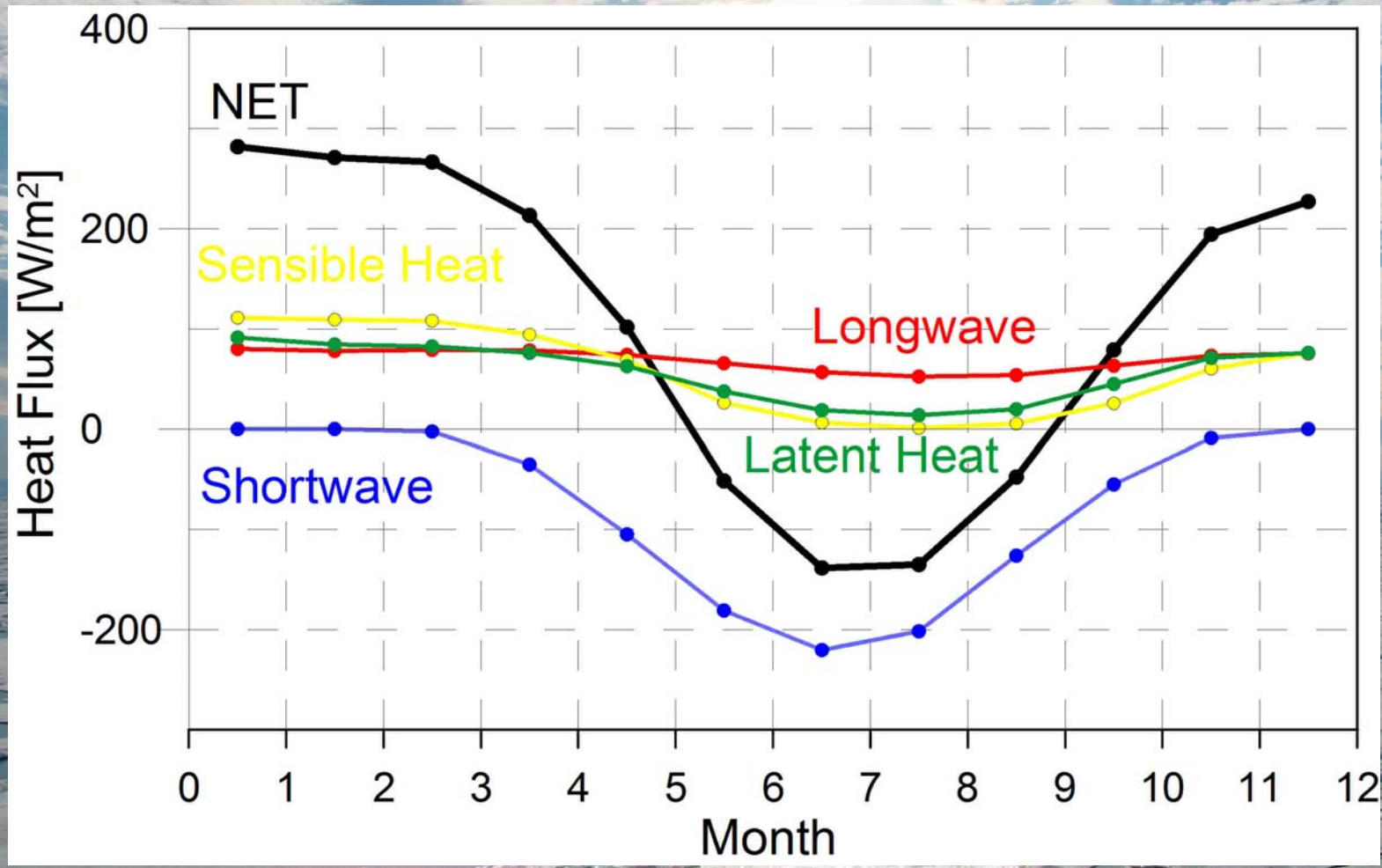




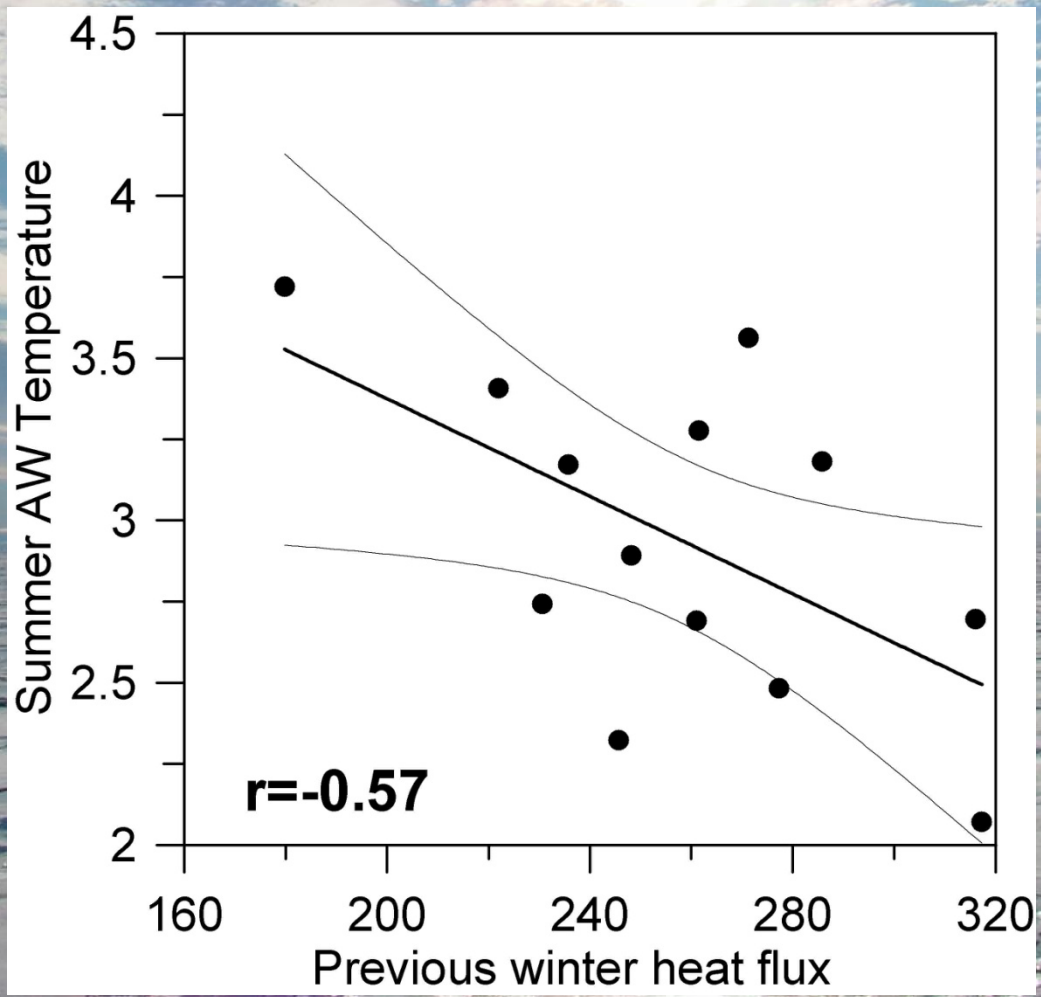
AW temperature at section ‘N’ (July) and yearly mean air temperature from Hornsund

Lagged correlation between AW temperature at section ‘N’ (July) and 4-months means air temperature in Hornsund

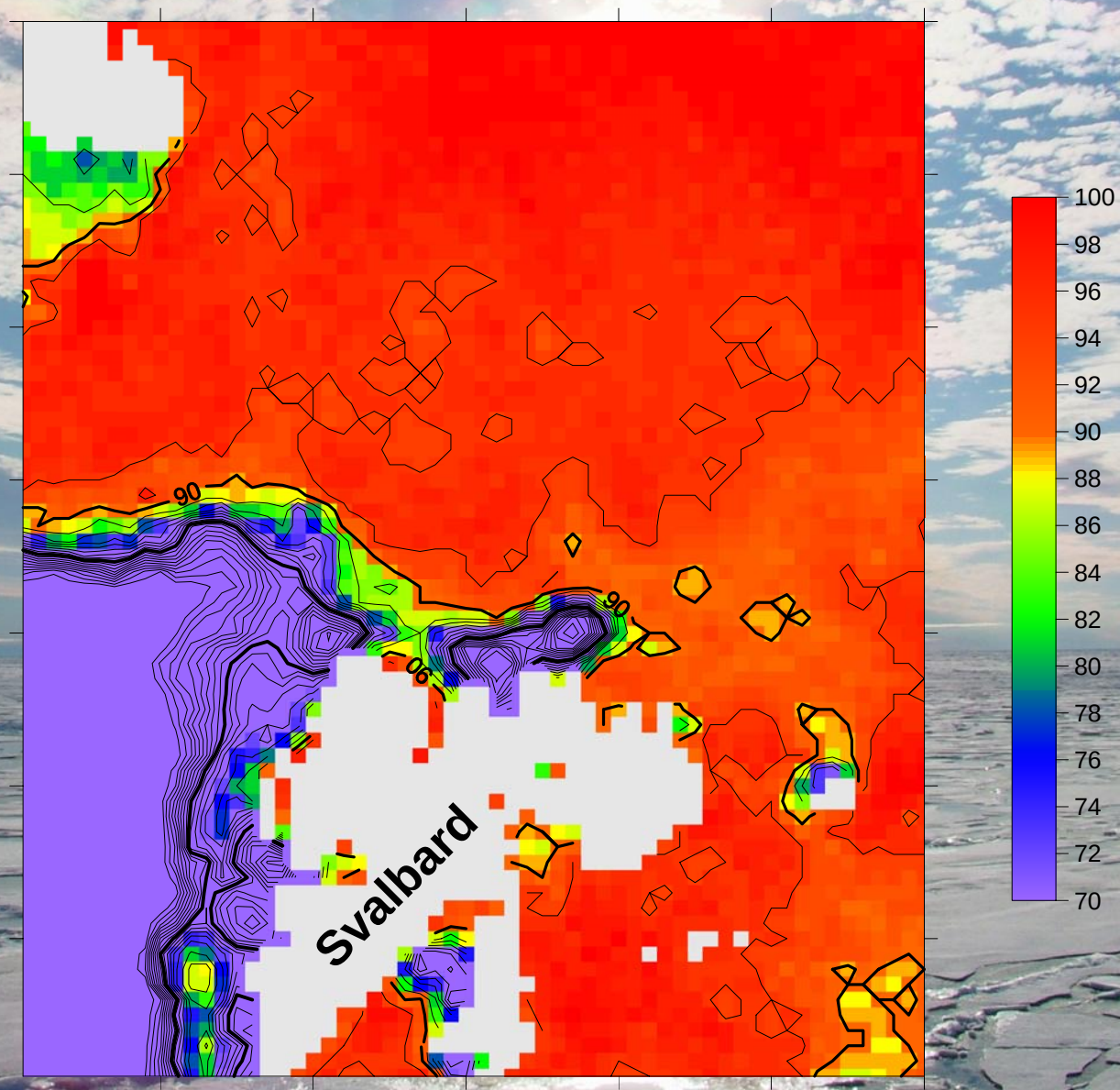



400
200
0
-200
Heat Flux [W/m²]
NET
Sensible Heat
Longwave
Latent Heat
Shortwave
0
1
2
3
4
5
6
7
8
9
10
11
12
Month

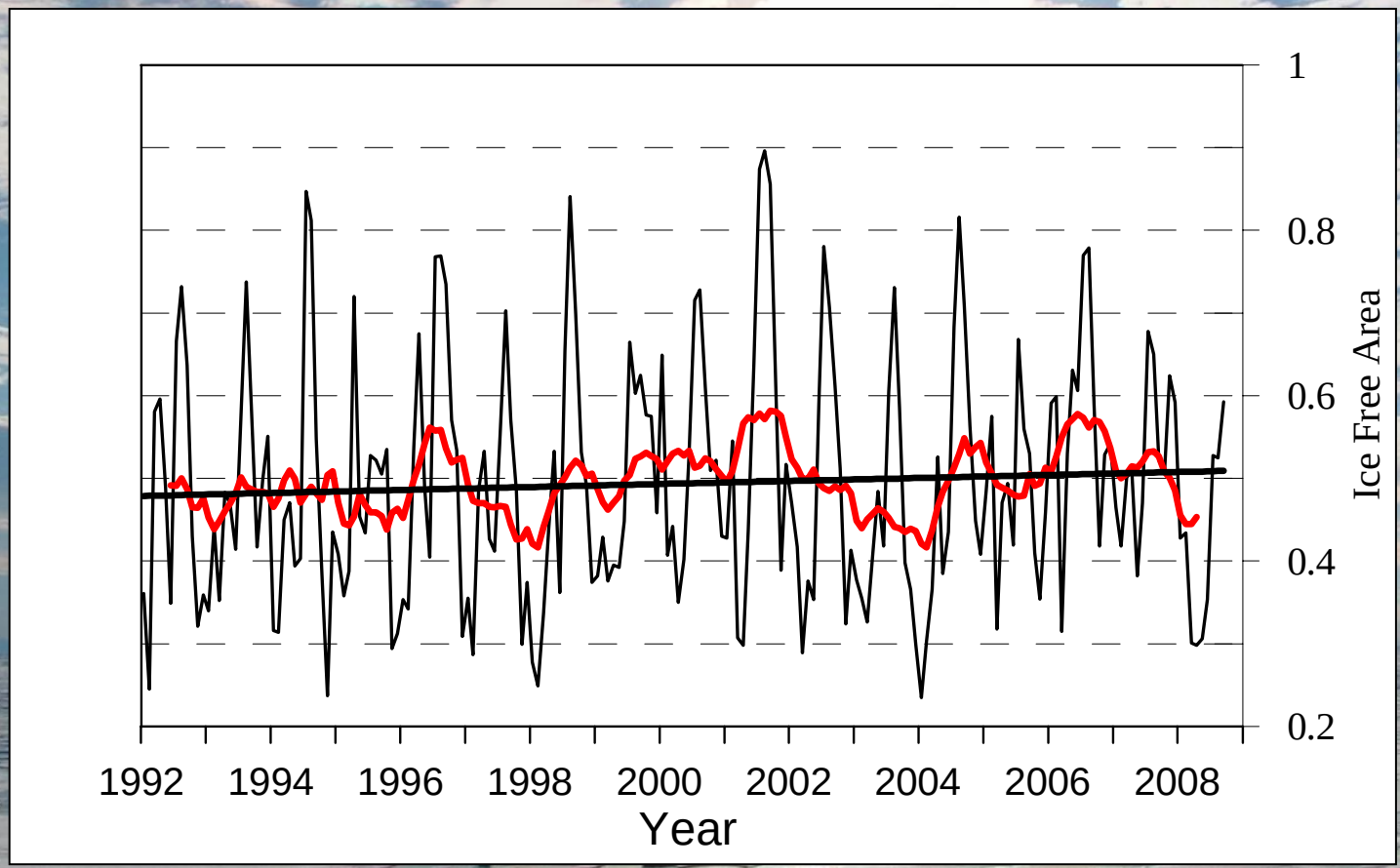
Correlation between summer AW temperature at section ‘N’ (July) and previous winter heat flux



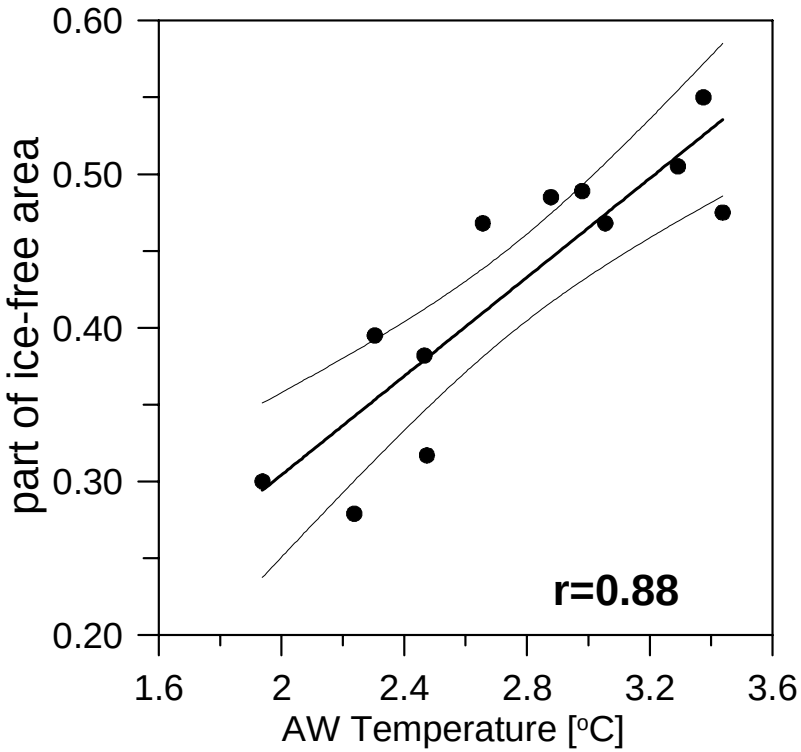
Sea Ice concentration SSMI data
30 January 2004



Ice free area ratio
Monthly means



Correlation between AW temperature and next winter ice –free area



Structure of the WSC

- **Two branches of the West Spitsbergen Current:**
  - **-eastern (core);**
  - **-western**
- **Three zones of the WSC:**
  - **- formation**
  - **- intensifiction/convergence**
  - **- divergence/bifurcation**
- **The bottom topography at latitude 79°N is critical for the WSC structure and dynamics.**

Variability

- **Increasing of the AW temperature and salinity in summers 2005-2006. Increasing baroclinic currents velocities and baroclinic northward transport;**
- **Decreasing of the AW temperature and salinity in entire region between 73º30’ -78º50’N in summers 2007-2008;**
- **Increasing of temperature occured both due to increasing of the currents velocity and advection of the warmer AW;**
- **Very important were mesoscale eddies in the western WSC branch;**
- **Some compensation between the AW inflow into the Barents Sea and northward AW flow exists;**
- **Weak increasing of the AW temperature and salinity in 2009;**
- **Results show 6-8 years long cycle.**

Importance

- **AW influences Svalbard climate and ecosystem in various ways, mostly by winter heat fluxes (up to 400 W/m^2) and warm, salty water advection into shelf and fjords;**
- **High correlation between Hornsund air temperatue and AW temperature**
- **Interaction with ice cower is also important, especially north of Svalbard**