Argo Floats in the Nordic Seas

Gunnar Voet

Institut für Meereskunde
KlimaCampus - Universität Hamburg

With contributions from Detlef Quadfasel, Katrin Latarius,
Kjell-Arne Mork and Henrik Søiland

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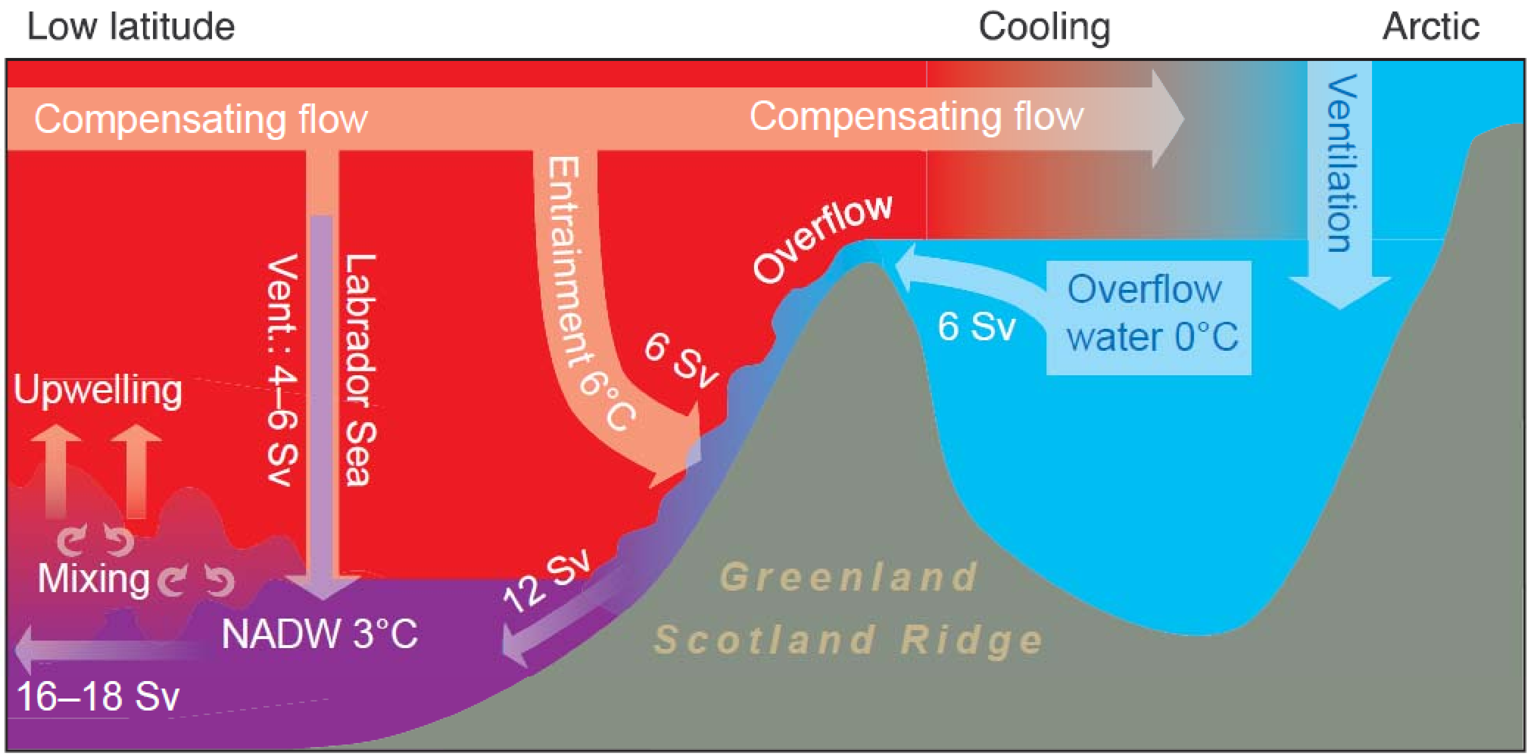
Current research questions

The Nordic branch of the Meridional Overturning Circulation

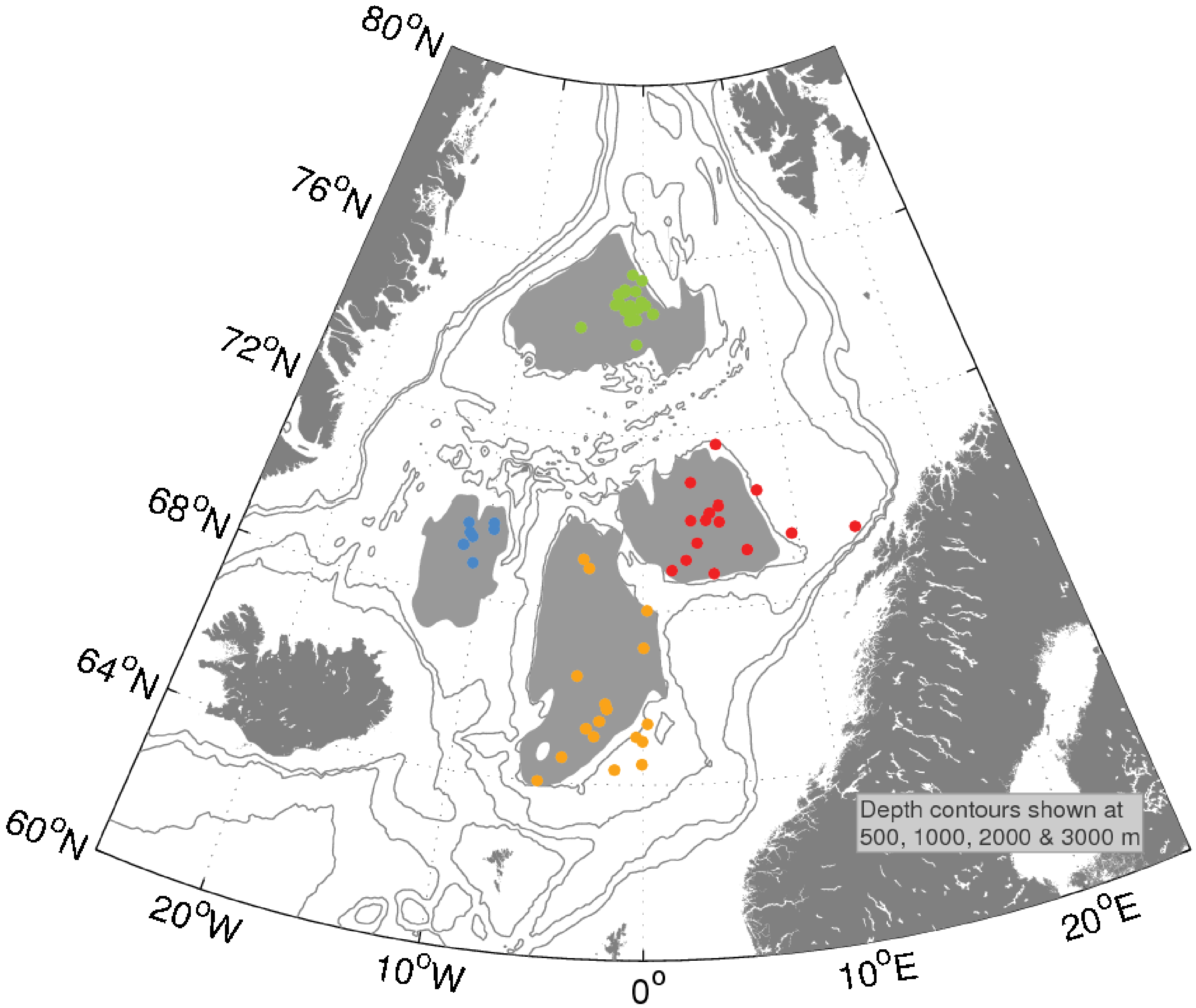


- What are the key regions for the water mass transformation?
- What are the key processes?
- What variability is observed?

Outline

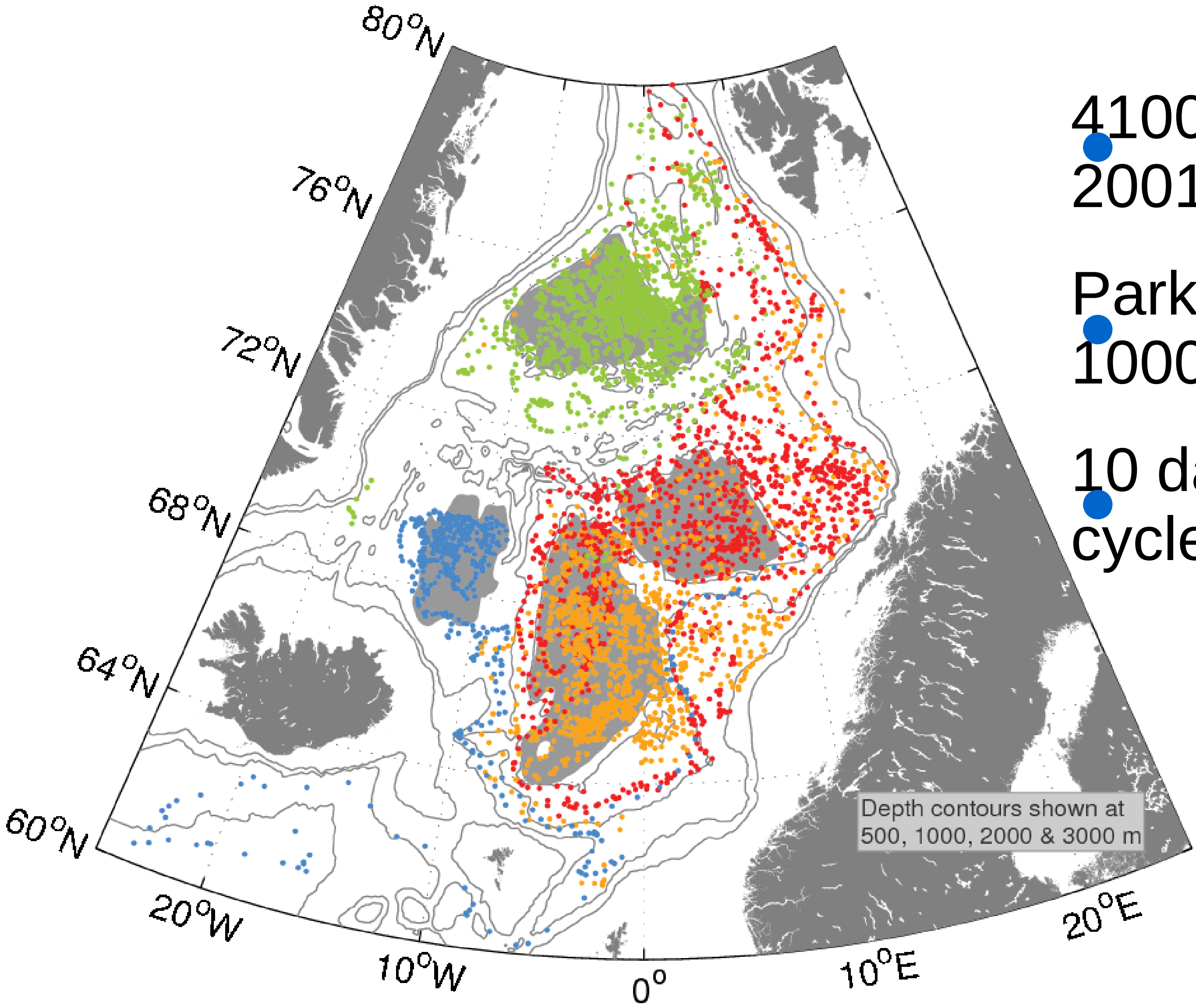
- Data set
- Mid-depth circulation of the Nordic Seas
- Hydrography of the Greenland Sea
- Conclusions

Data set



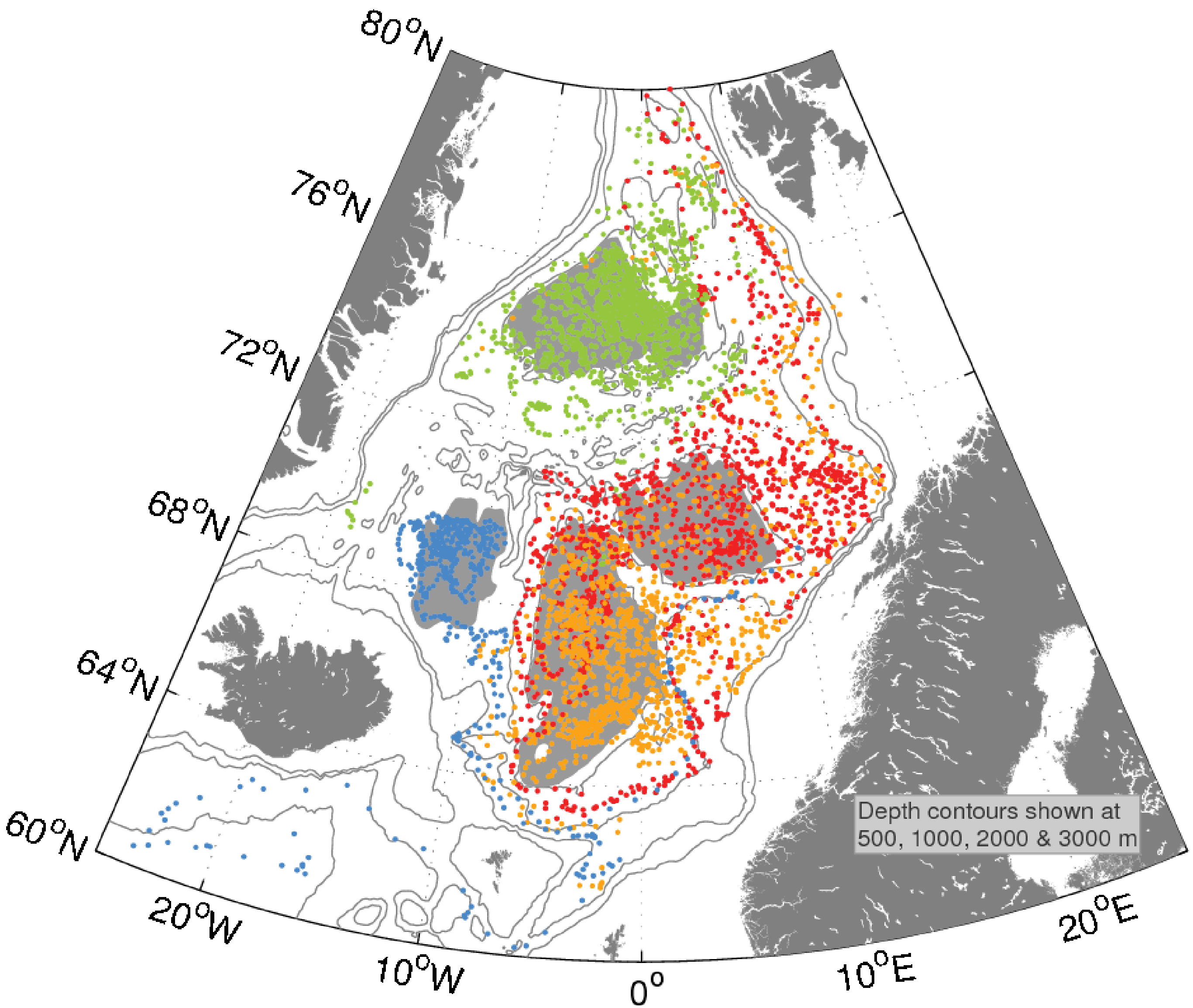
61 Argo floats deployed in the Nordic Seas

Data set



- 4100 profiles since 2001
- Parking depths 1000 & 1500 dbar
- 10 day profiling cycle

Topographically influenced mean flow

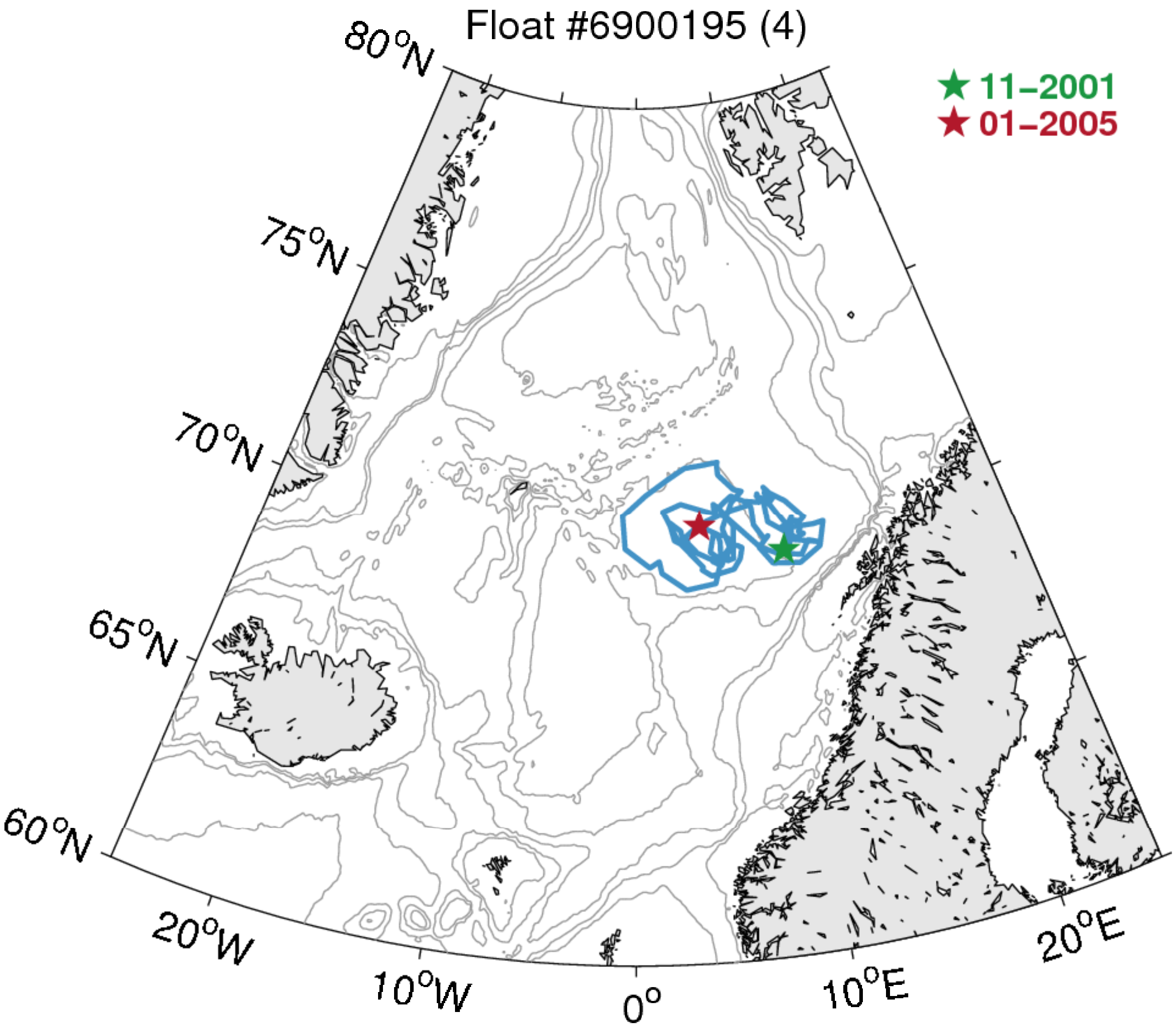


Floats mainly stay in their basins

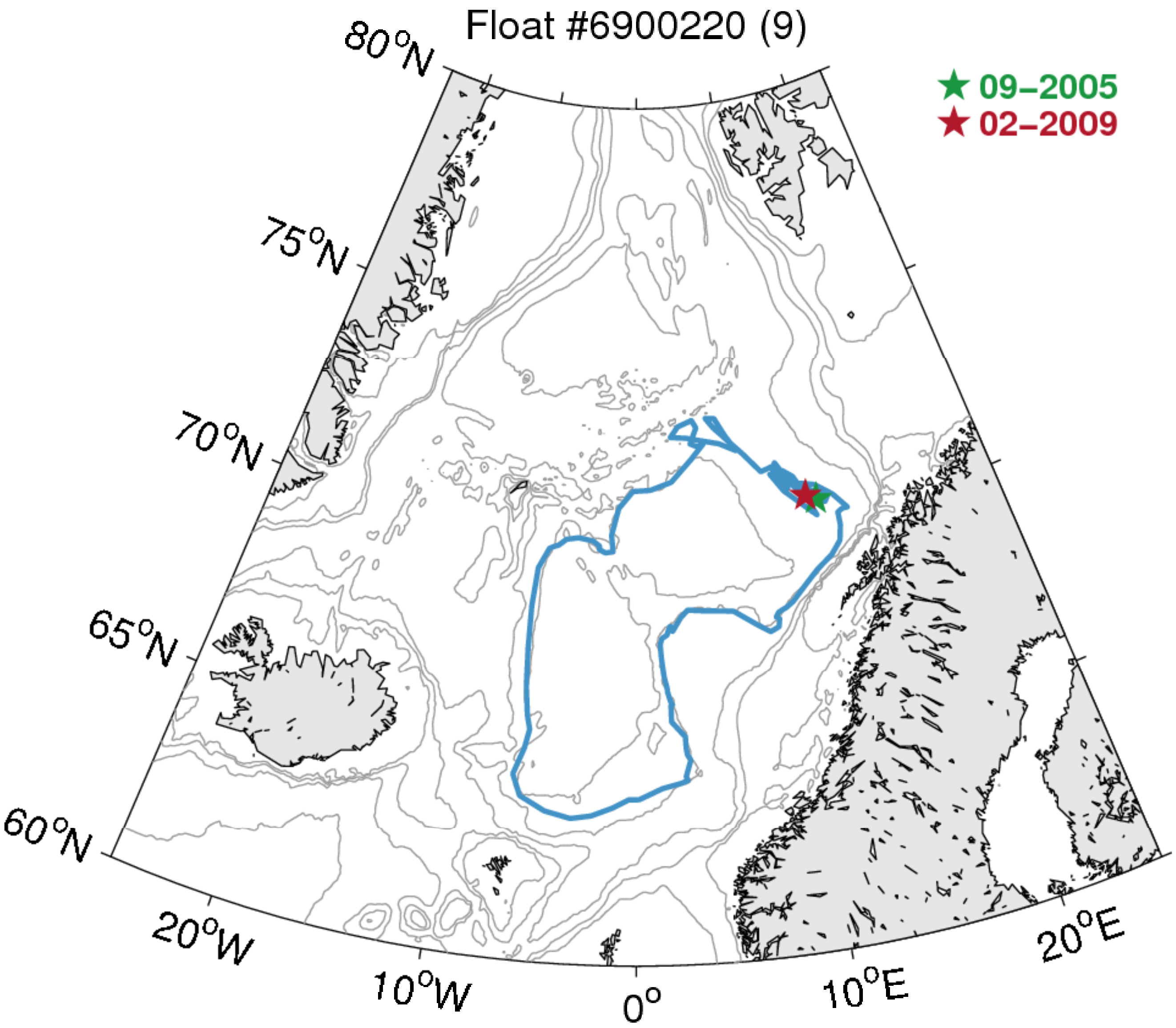
Strong advection is limited to boundary currents

Exchanges between gyres and boundary flow then must be dominated by diffusive processes

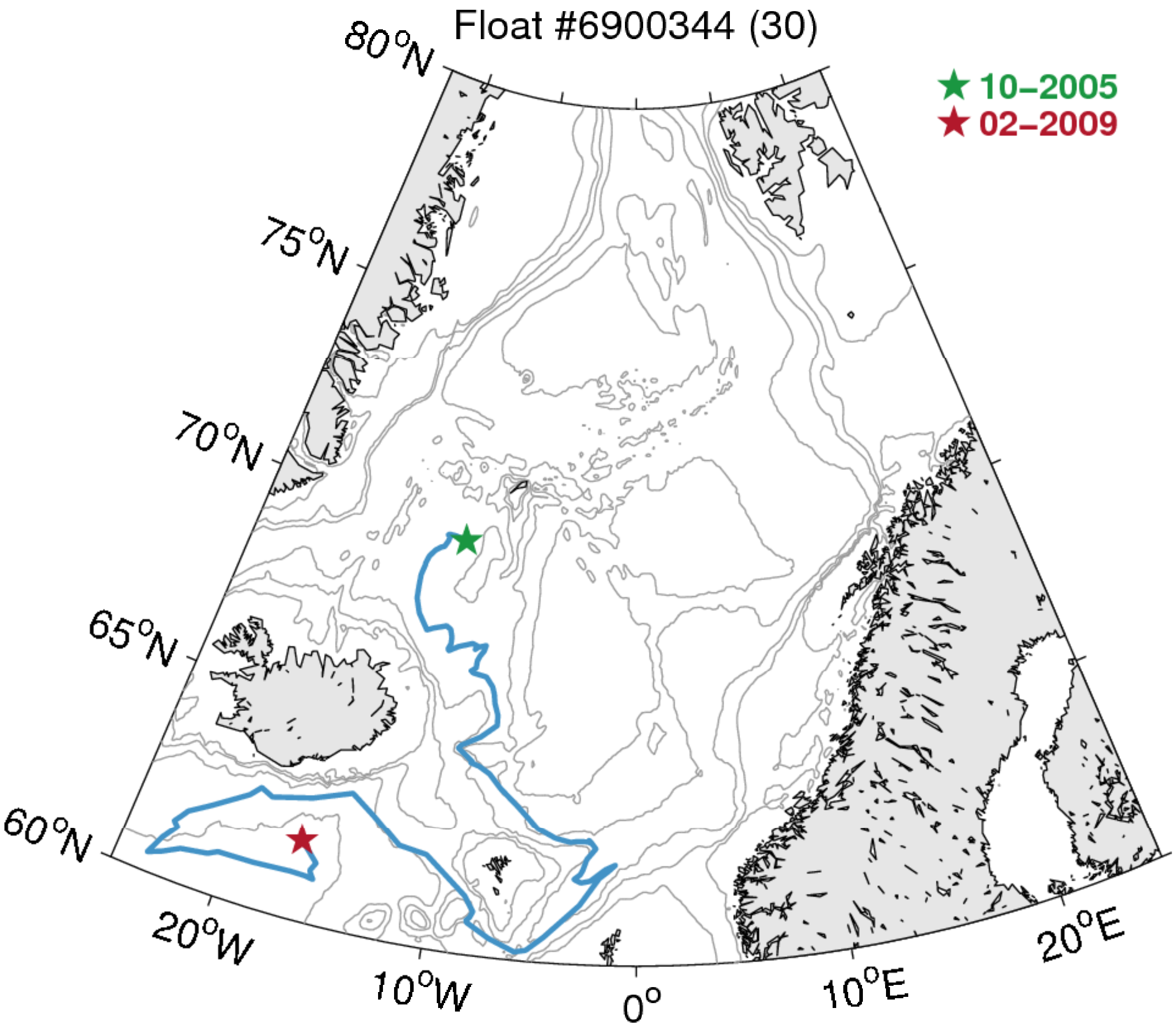
Topographically influenced mean flow



Topographically influenced mean flow

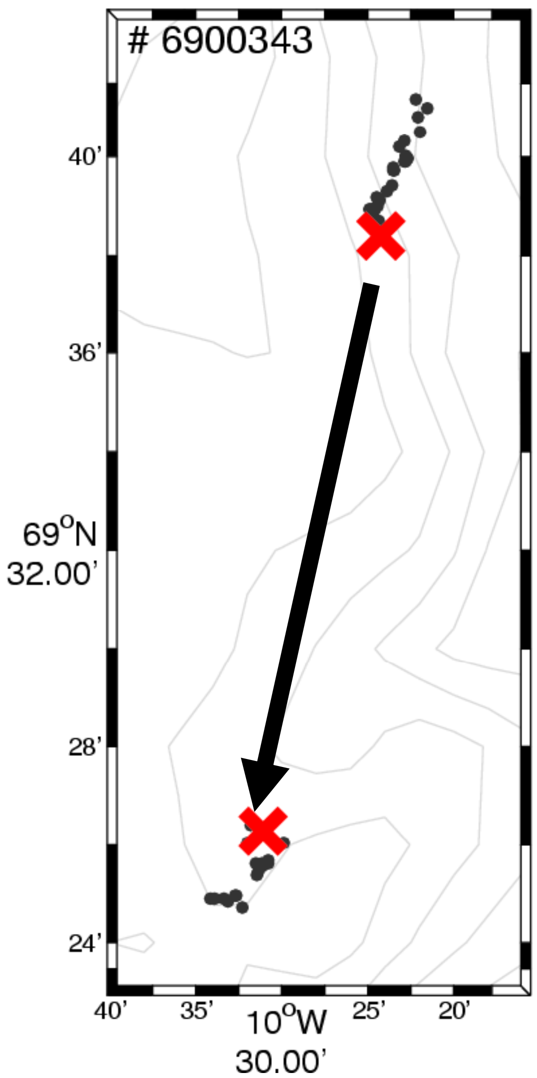


Topographically influenced mean flow



Deep drift from trajectory data

Method



Last surface position fix cycle n

First surface position fix cycle n+1

Error estimate

Argos position inaccuracy

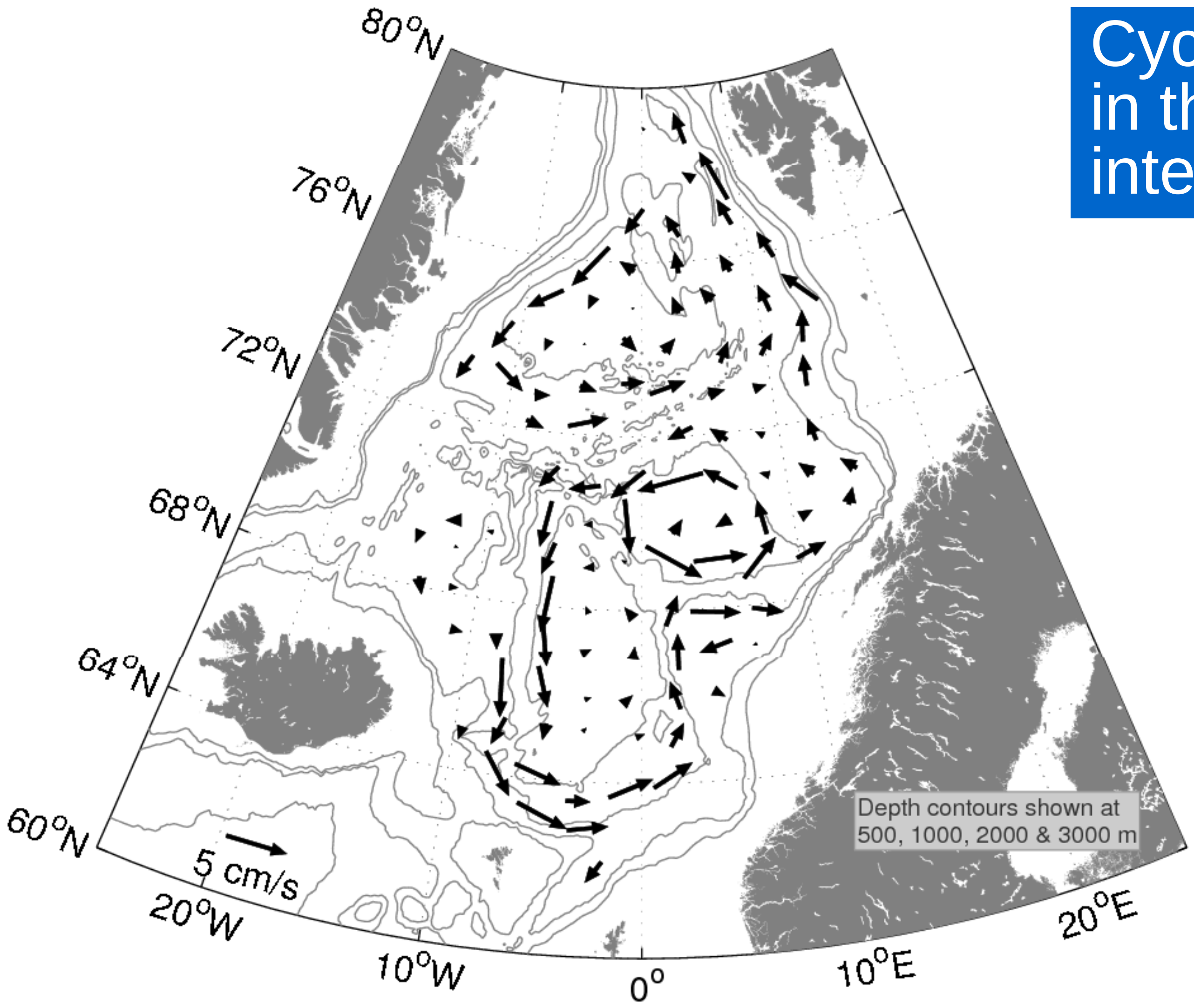
↓

~15% of the subsurface drift

↑

Velocity shear between surface and depth

Time-mean mid-depth circulation

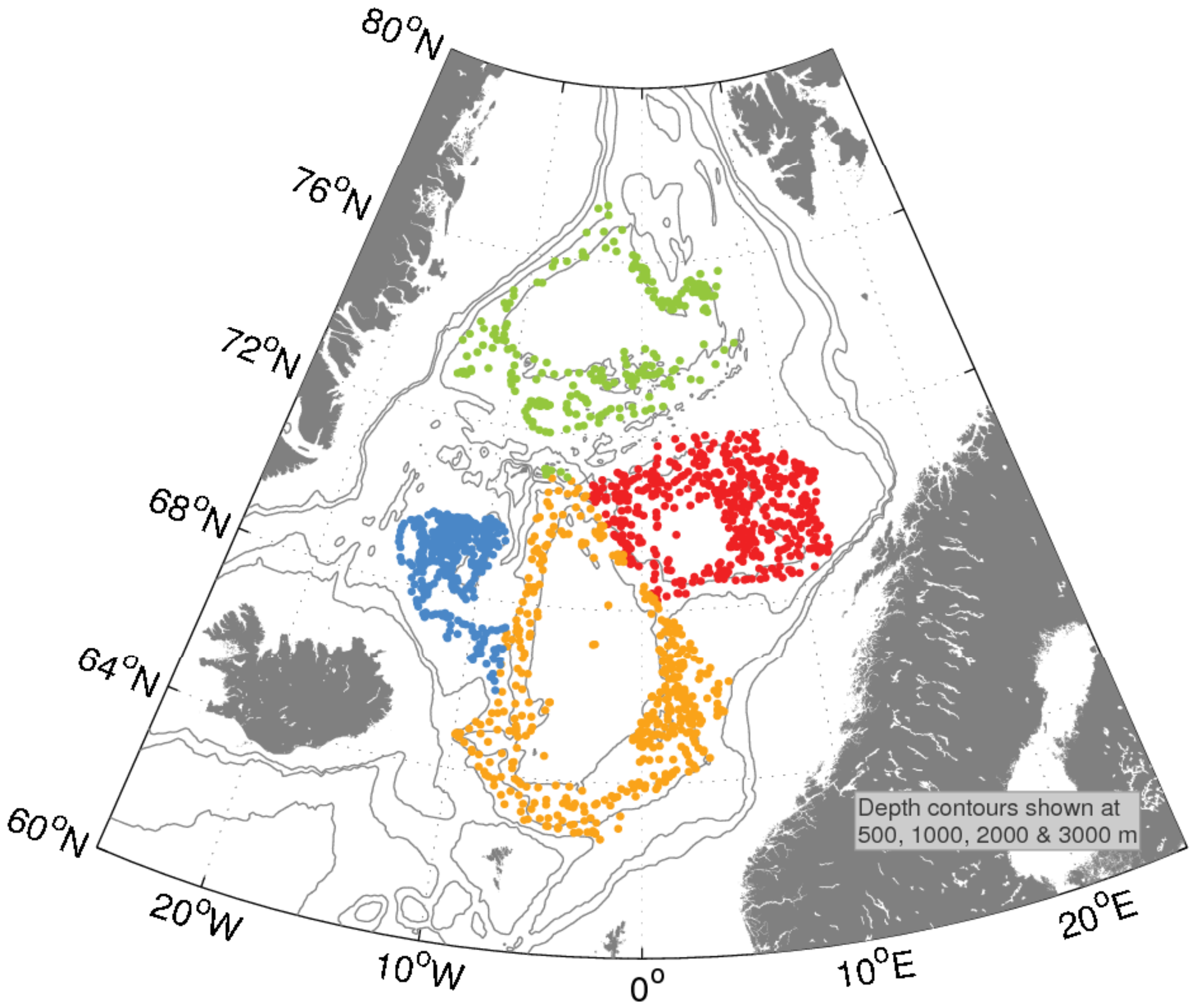


Cyclonic circulation
in the basins,
intensified at boundaries

Cyclonic forcing:

- Wind stress curl
- Buoyancy fluxes
- River runoff

Variability on the seasonal time scale

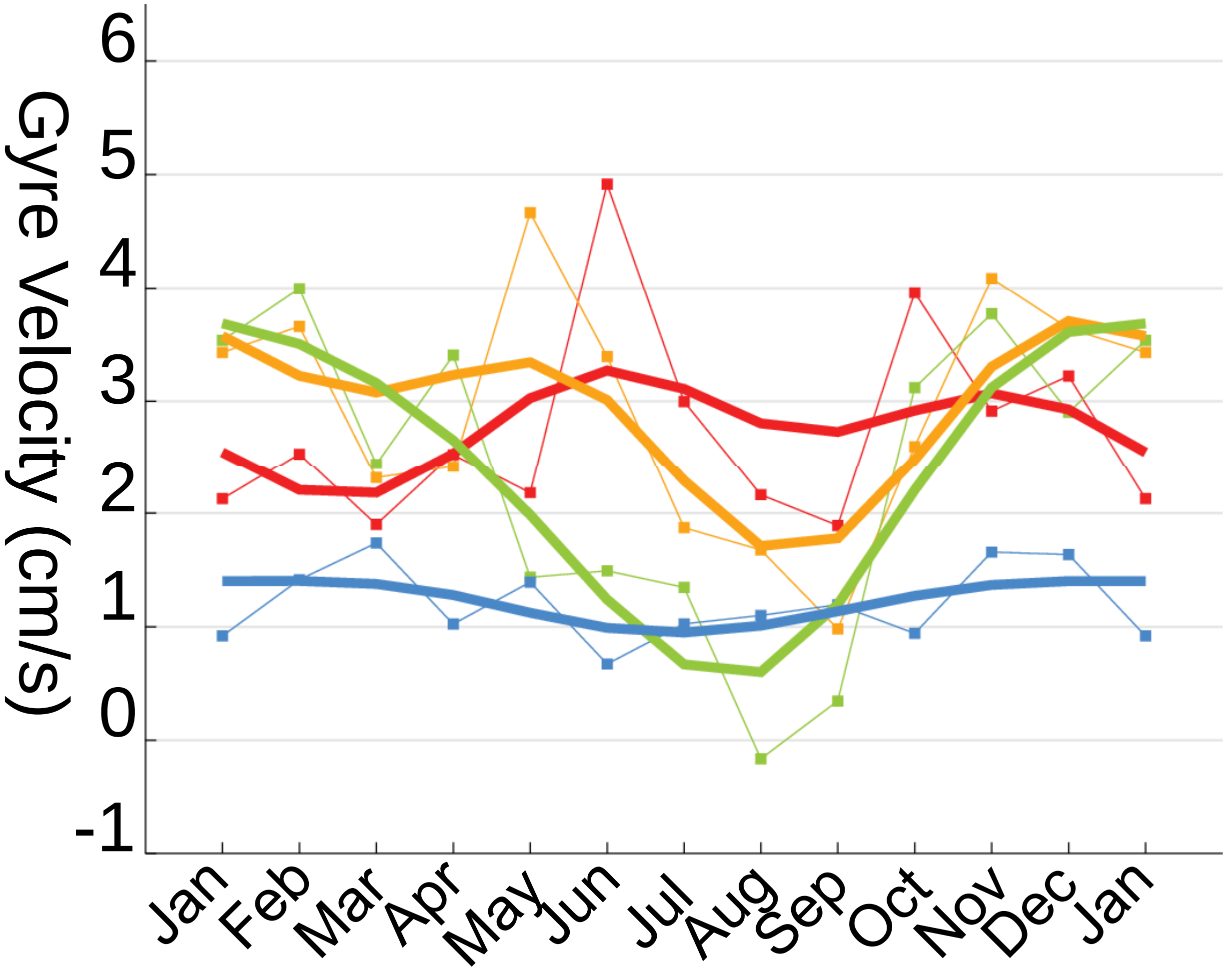


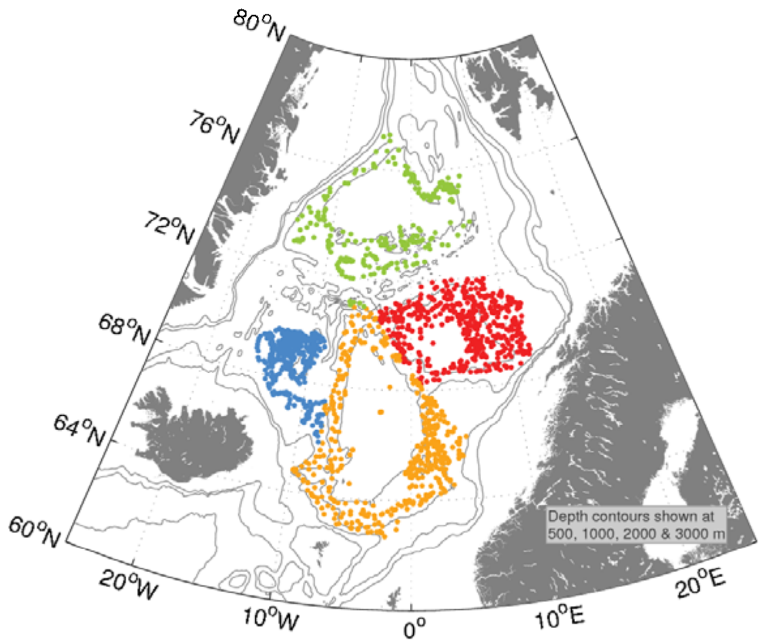
Weak circulation in the center of the basins

Observations at the rim for an analysis of the seasonal cycle on a basin scale

Variability on the seasonal time scale

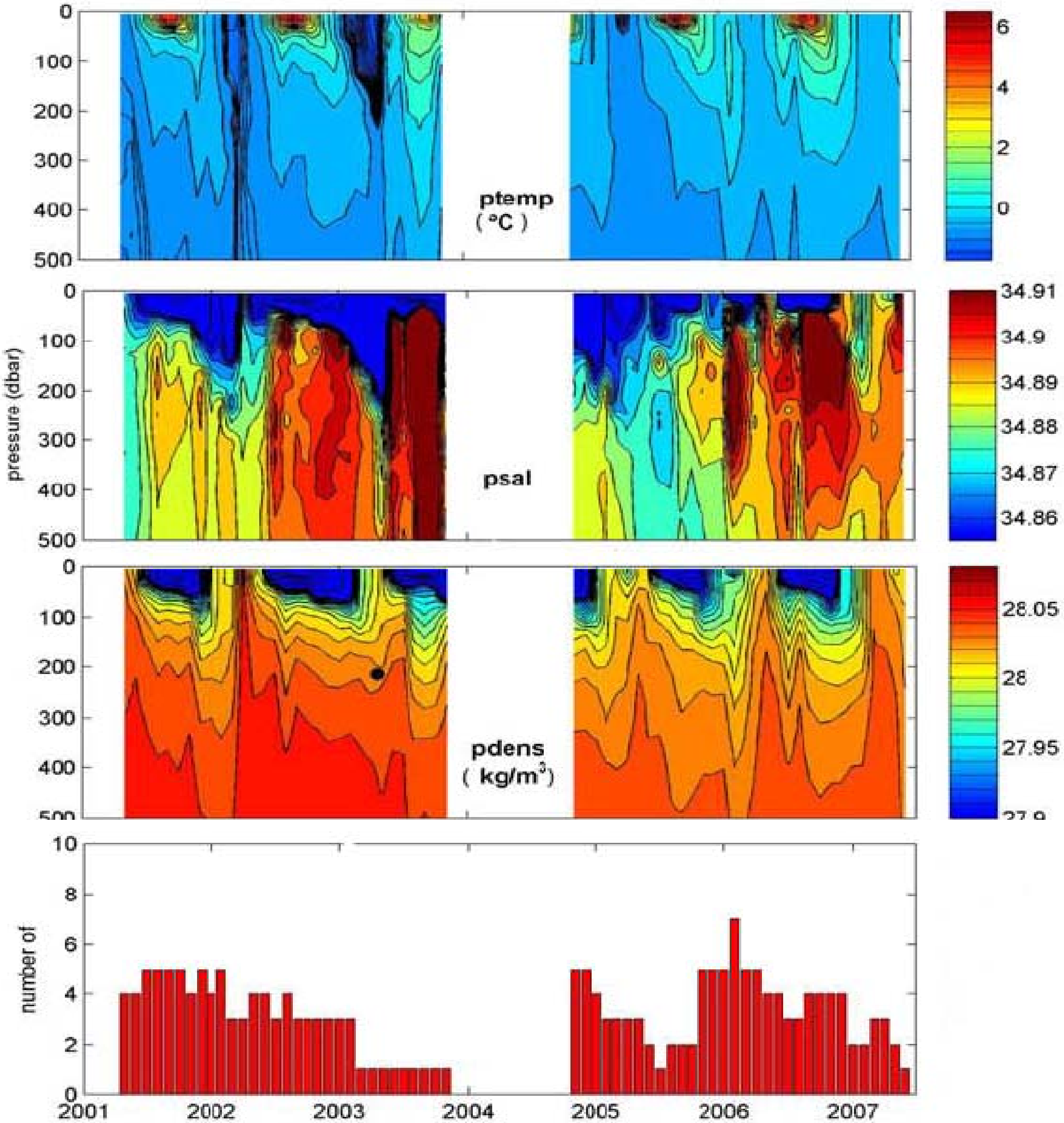
Velocity along bottom topograph

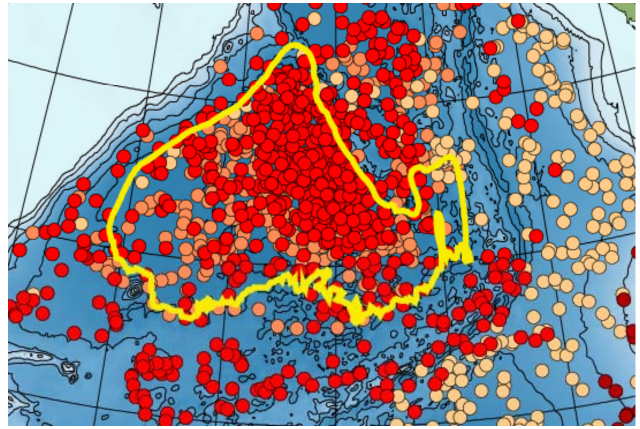




Monthly mean
Moving average

Greenland Sea Hydrography



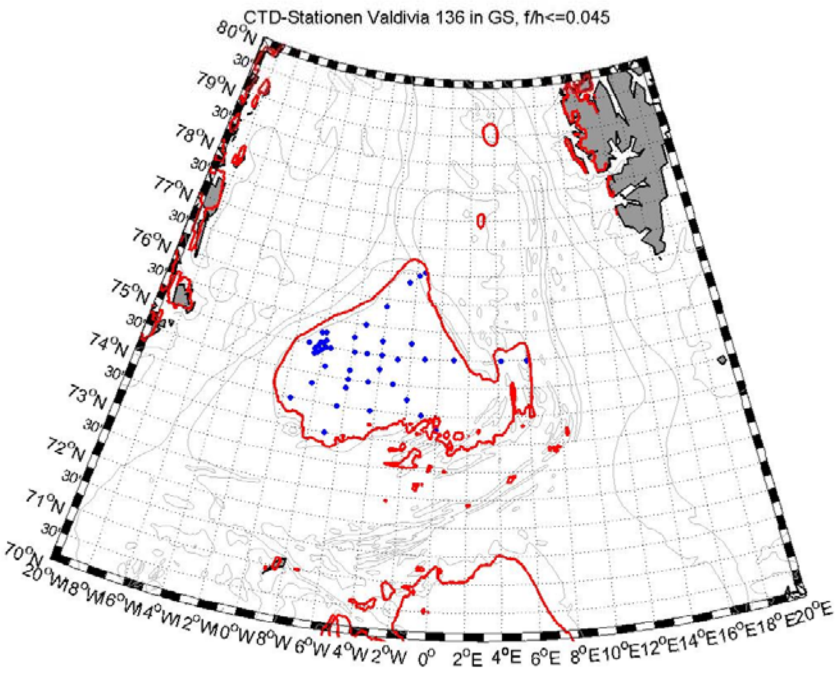


Development of monthly mean temperature, salinity and density in the Greenland Sea, 2001 – 2007.

Number of independent measurements per month.

The seasonal signal dominates, inter-annual variability is most pronounced in salinity.

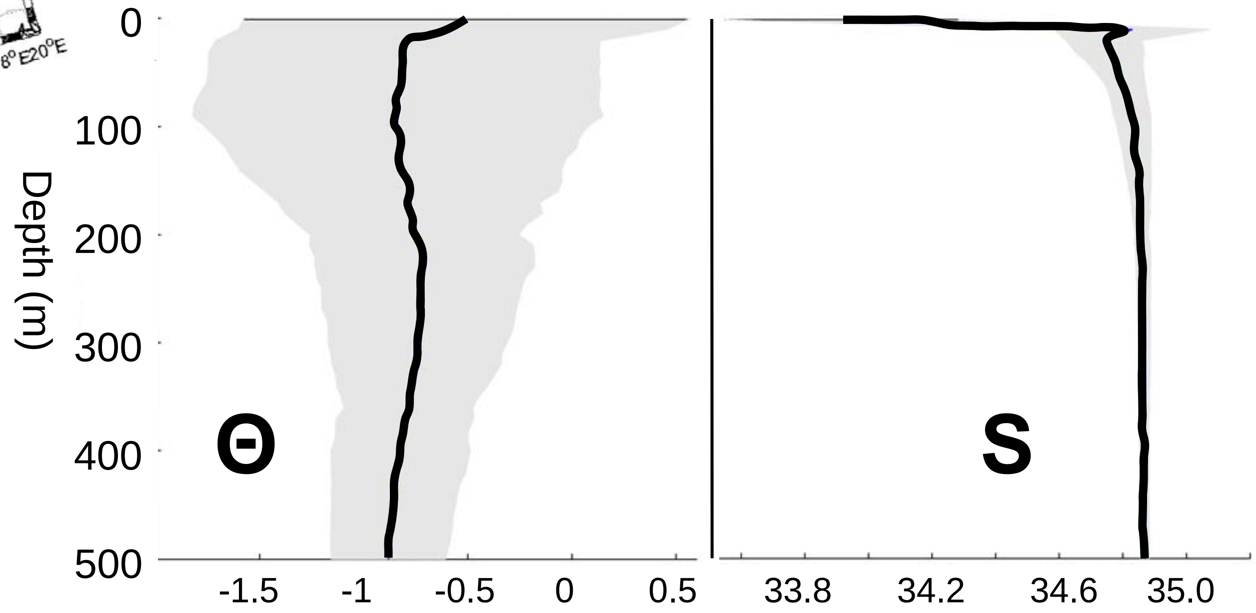
Greenland Sea – Error of the Mean



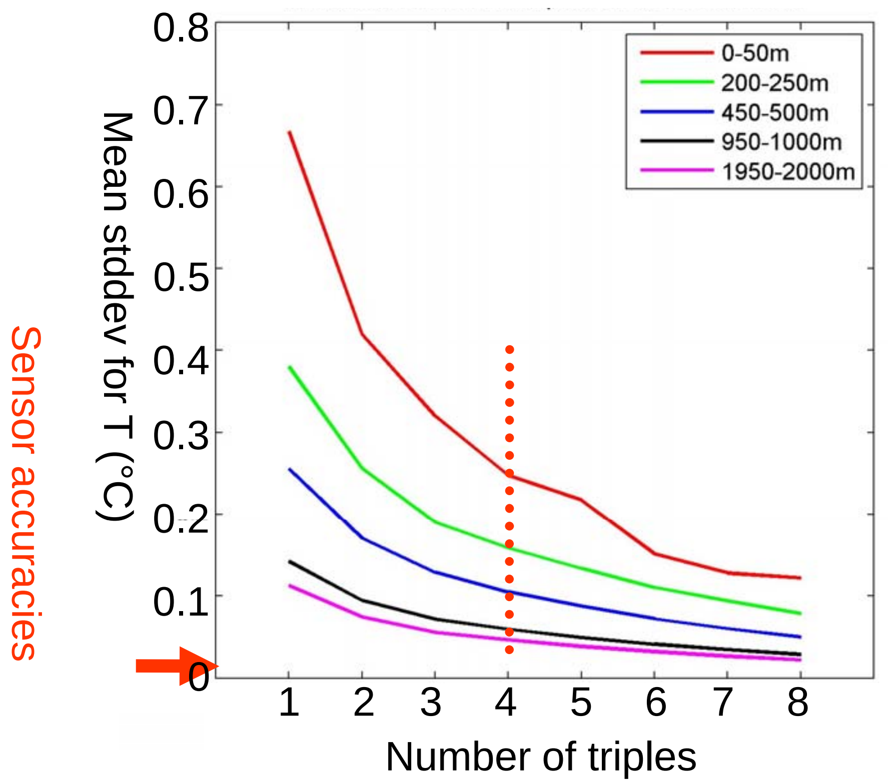
Example: Statistical analysis of data from a synoptic CTD survey (39 stations) of the Greenland Sea gyre.

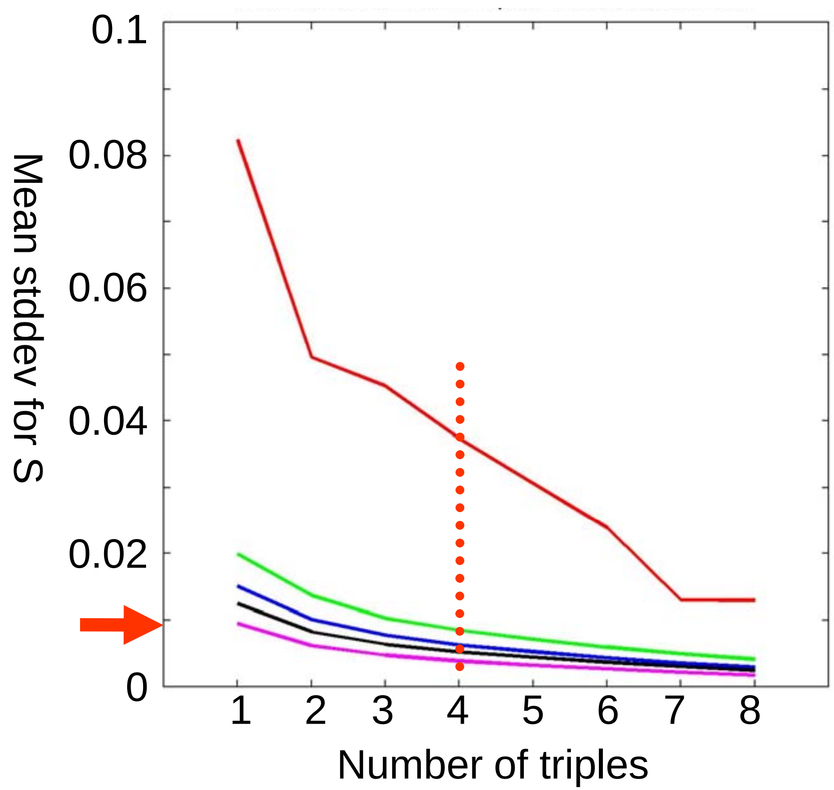
RV Valdivia cruise 136 in 1988

Natural, sub-gyre scale variability of temperature and salinity.



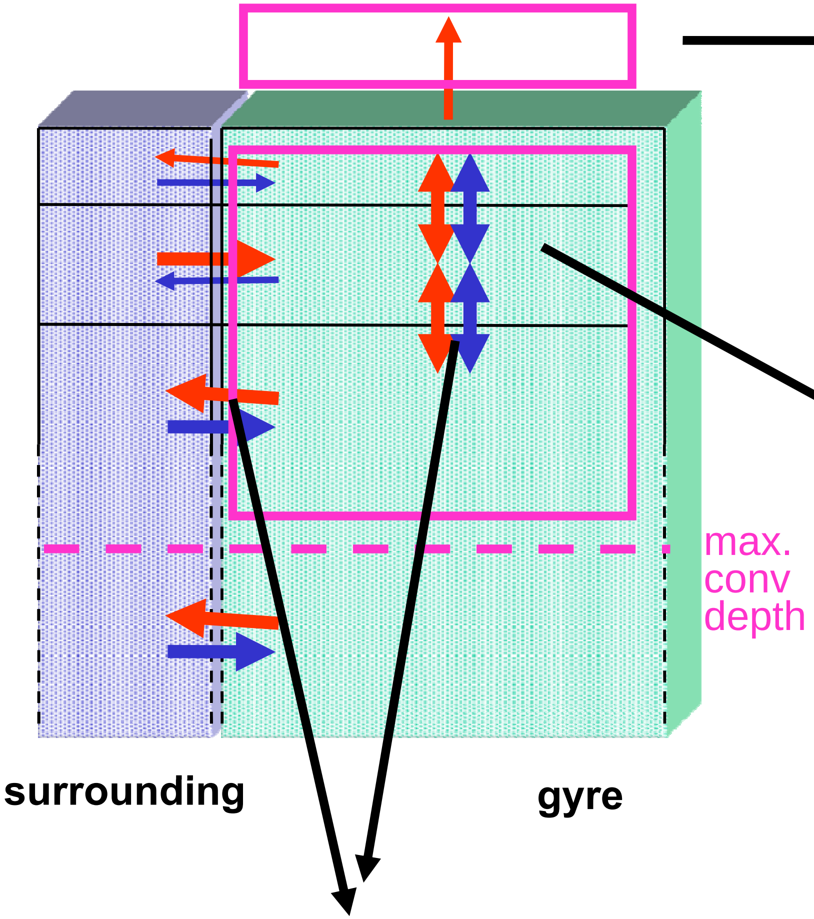
Greenland Sea – Error of the Mean





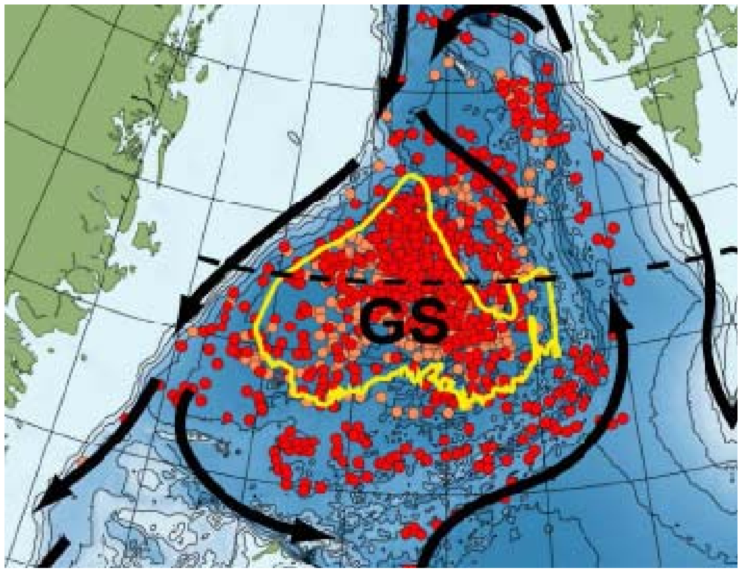
Deviation of virtual float measurements (subsamples of the CTD grid) from the basinwide CTD mean T and S.

Budget Calculations - Concept



Surface heat/freshwater flux data are taken from different meteorological models and satellite observations:
NCEP/NCAR, ECMWF, NOC, OAflux, J-OFURO, HOAPS, REMO

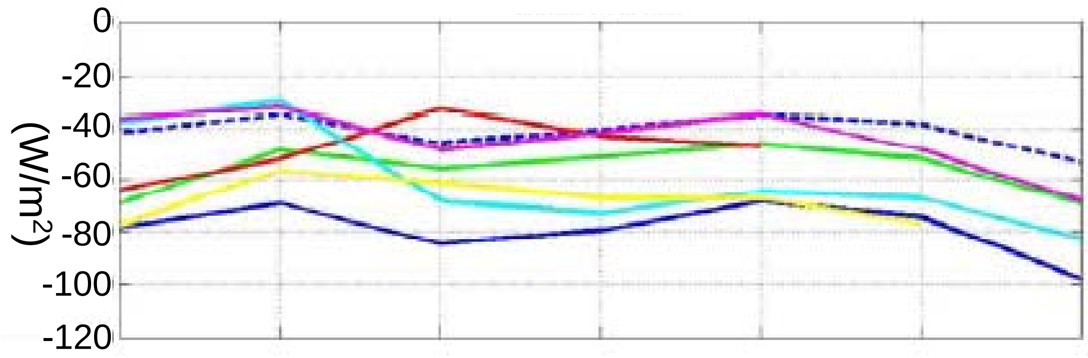
The development of the heat and freshwater content in the ocean is derived from ARGO-float profile data



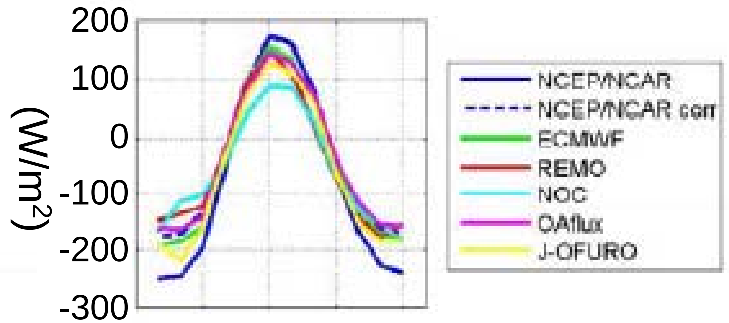
Lateral exchange and vertical convective mixing is estimated as the residuum

Budget Calculations – Surface Fluxes

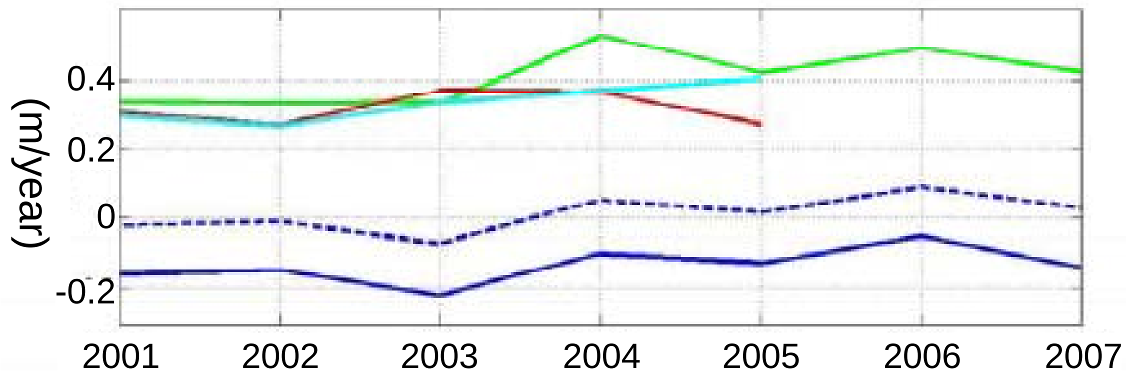
Heat



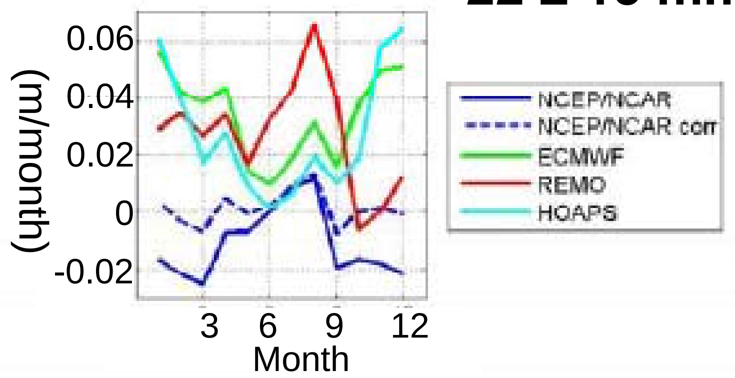
-53 ± 10 W/m²



Freshwater



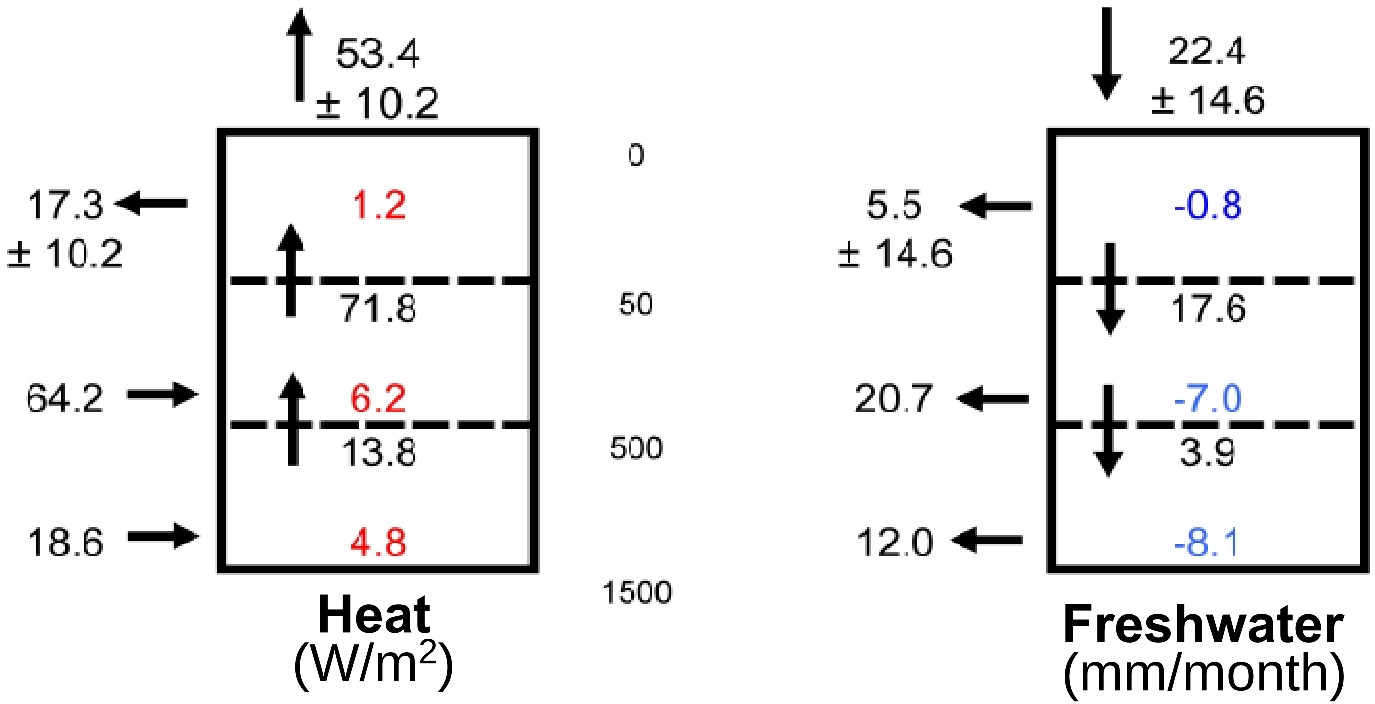
22 ± 15 mm/month



seasonal cycle **net annual mean**

Large differences in the heat and freshwater fluxes at the air-sea interface derived from atmospheric models and satellite observations.

Budget Calculations - Results

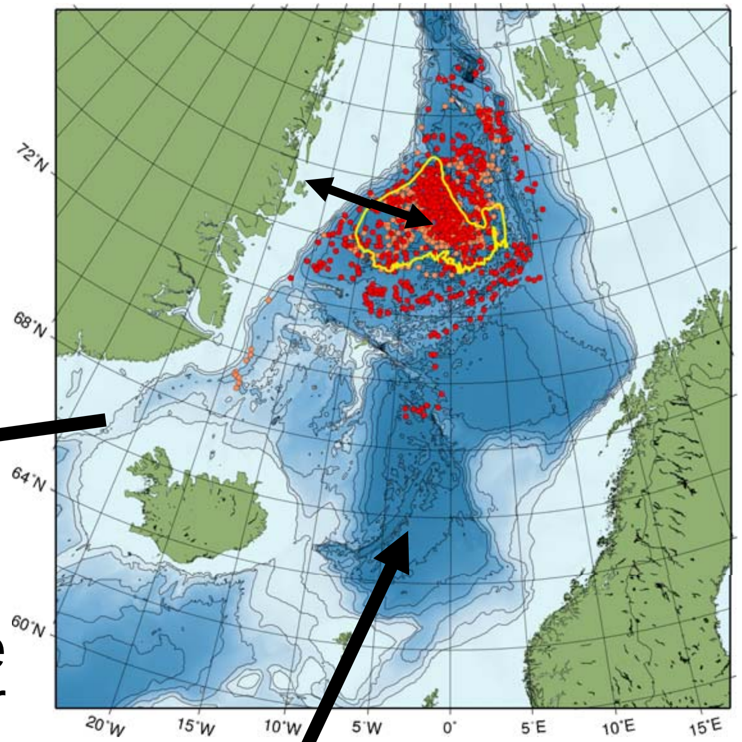


Greenland Sea Gyre: heat is imported laterally (50-1500m) and exported to the atmosphere and in the upper 50m freshwater is imported from the atmosphere and exported laterally

The **surrounding** of the gyre between 50 – 1500m looses heat and salt by exchange with the Greenland Sea Gyre

Conclusions

Contribution of the Greenland Sea Gyre to the water mass transformation within the Nordic Seas



Overflow
6 Sv, 0.2°C
34.92, 28 kg/m³
+
near the surface
2 Sv polar water

Atlantic inflow
8 Sv, 12°C, 35.25, 26.8 kg/m³

temperature:
-0.5 K
→ 3% of transformation

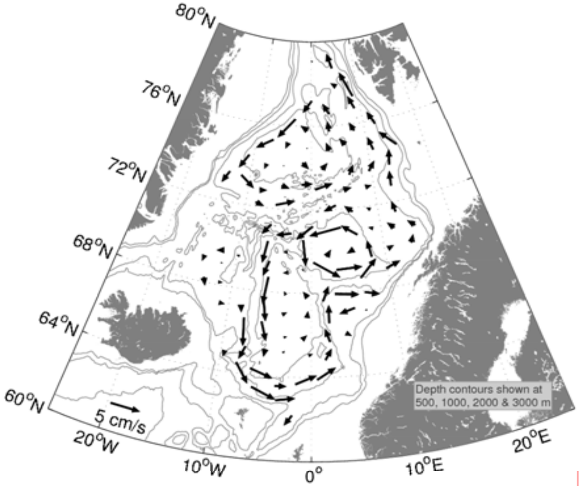
salinity:
-0.004
→ 1% of transformation

change in density ±0

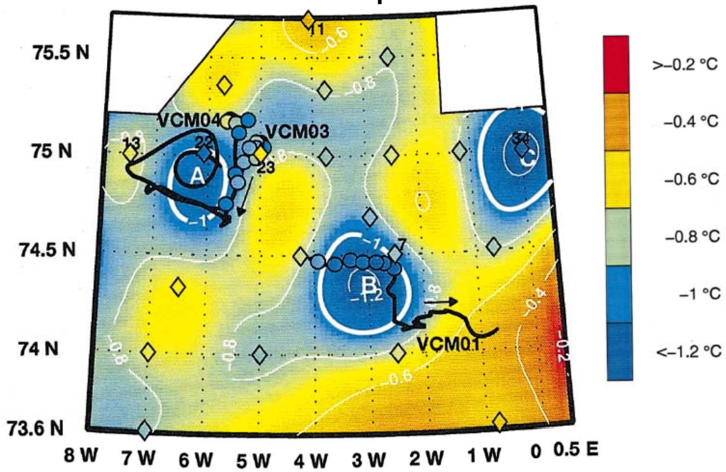
Conclusions

How is the budget closed?

5×10^{20} J/year heat loss over the entire gyre is compensated!



Greenland Sea Temperature at 400m



Lherminier et al., 1999

No mean advection of warm water from the boundary is observed

Eddy fluxes have to compensate heat loss. First estimates from East Greenland Current mooring data support the assumption.

Observations and models show eddy structure.

Future work: Examine mooring data around the gyre

Publications

Latarius, K. & D. Quadfasel
Seasonal to inter-annual variability of temperature and salinity in the Greenland Sea Gyre: heat and freshwater budgets.
Tellus A, 2010.

Voet, G., D. Quadfasel, K.-A. Mork, & H. Søiland
The mid-depth circulation of the Nordic Seas from profiling float observations.
Tellus A, 2010.

gunnar.voet@zmaw.de