The North Icelandic Jet and its relationship to the North Icelandic Irminger Current

Robert Pickart *Woods Hole Oceanographic Institution*
Mike Spall *Woods Hole Oceanographic Institution*
Dan Torres *Woods Hole Oceanographic Institution*
Hedinn Valdimarsson *Marine Research Institute*
Kjetil Våge *University of Bergen*
Carolina Nobre *Woods Hole Oceanographic Institution*
Kent Moore *University of Toronto*
Steingrimur Jonsson *University of Akureyri*
Dana Mastropole *Woods Hole Oceanographic Institution*

Prins Christian Sund, summer 2016

Outline

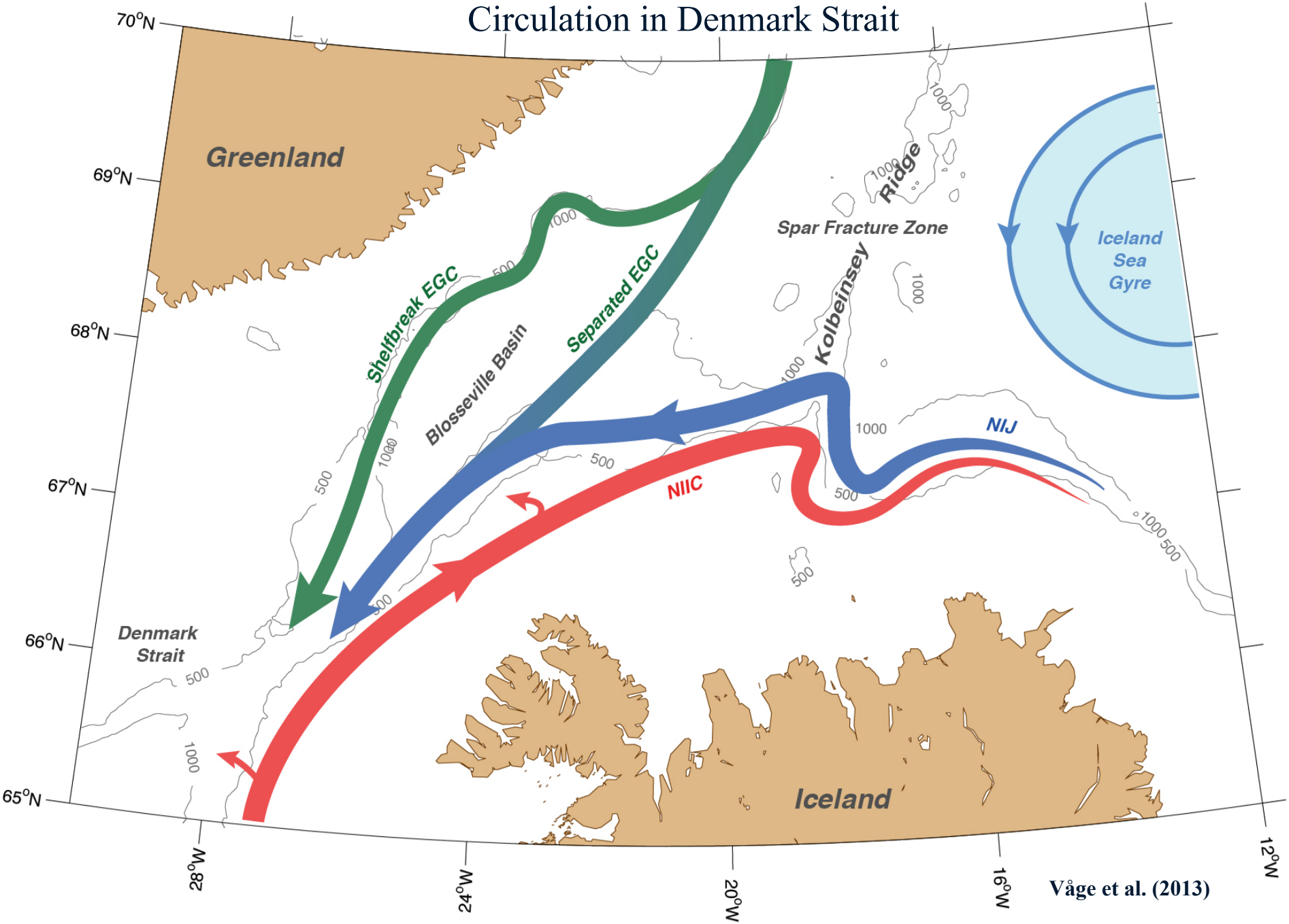
Brief overview of the circulation in the vicinity of Denmark Strait

Mean and seasonal fields of the NIJ

Pathway of the NIJ and its relationship to the NIIC

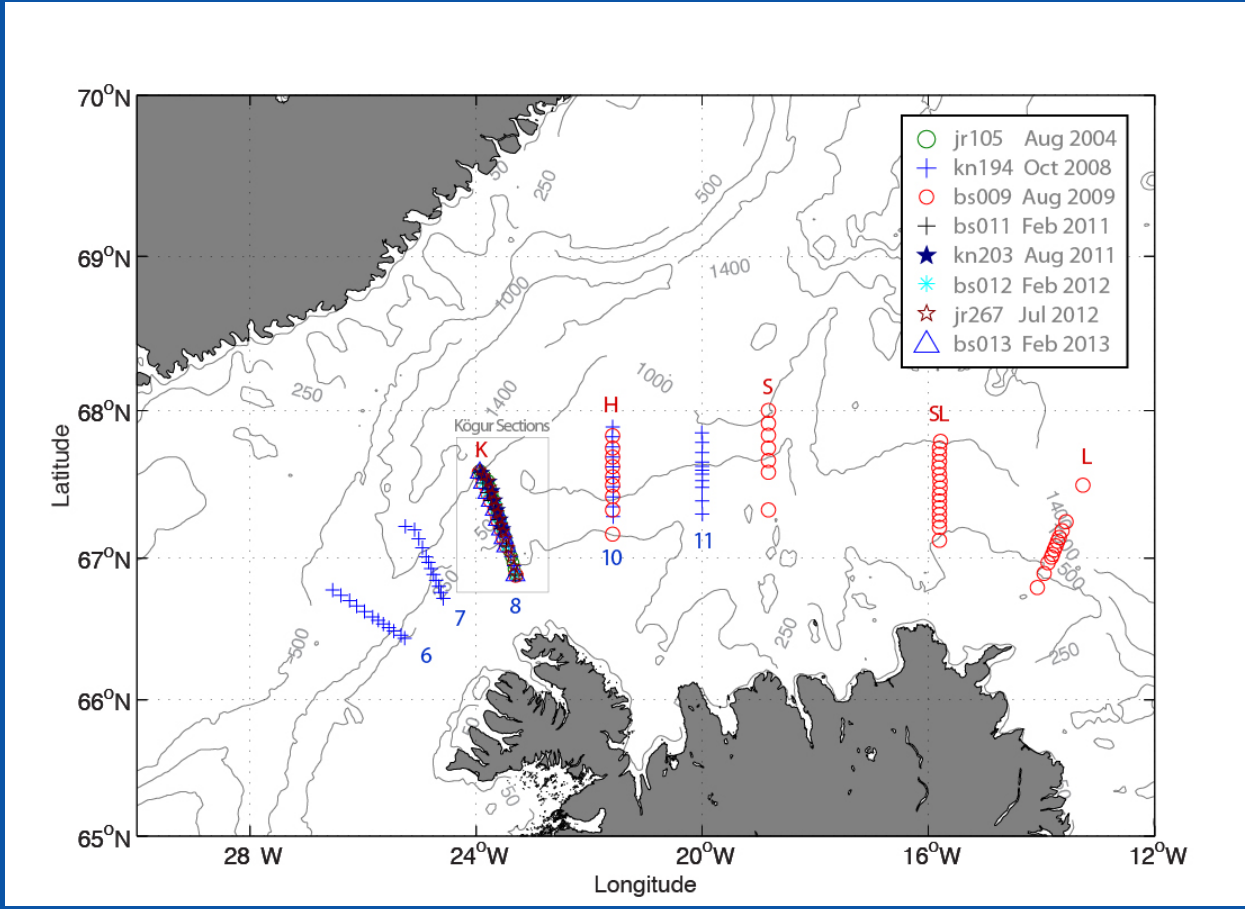
Interannual variability of the subtropical inflow vs. the dense outflow

Circulation in Denmark Strait

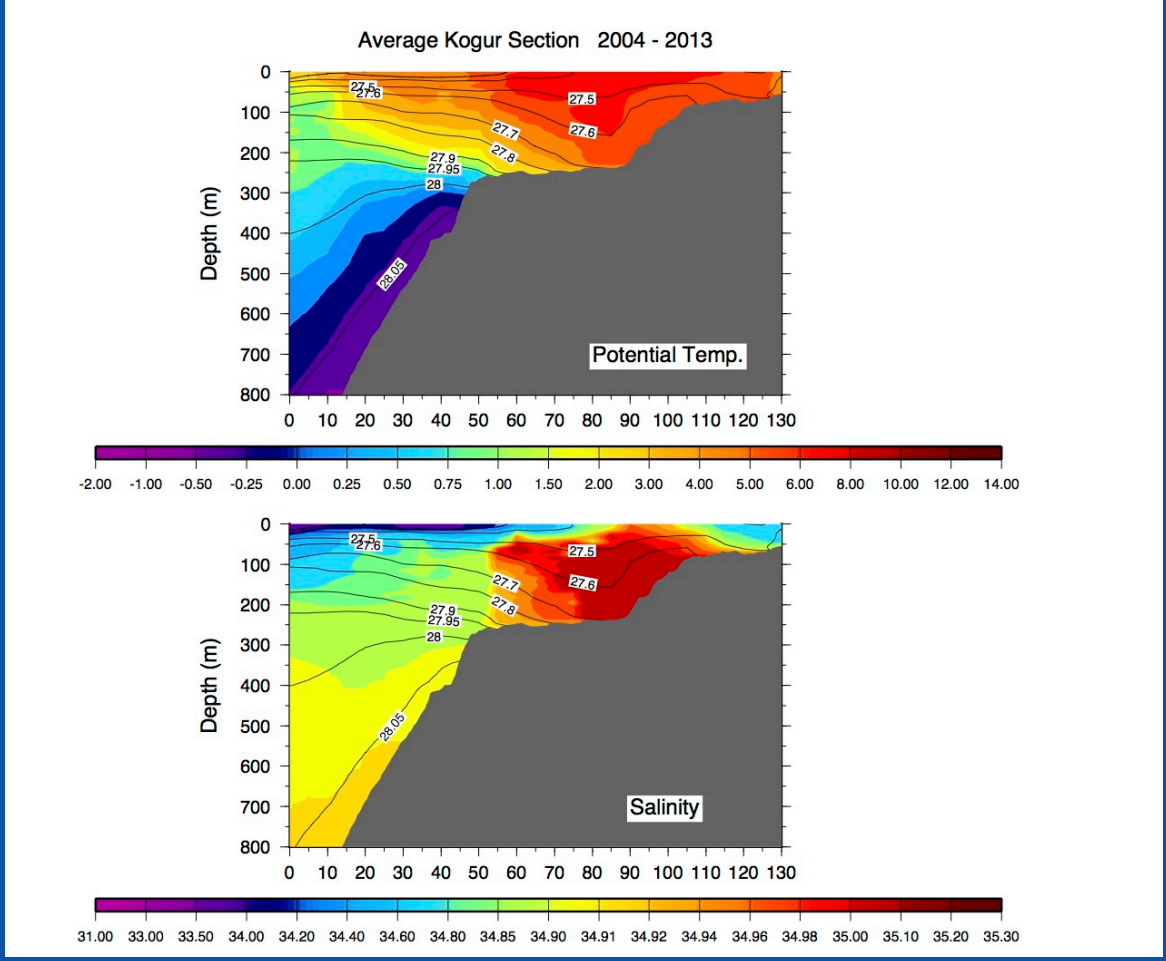


Våge et al. (2013)

Shipboard data used in the study (2004-2013)



Mean Kögur Sections



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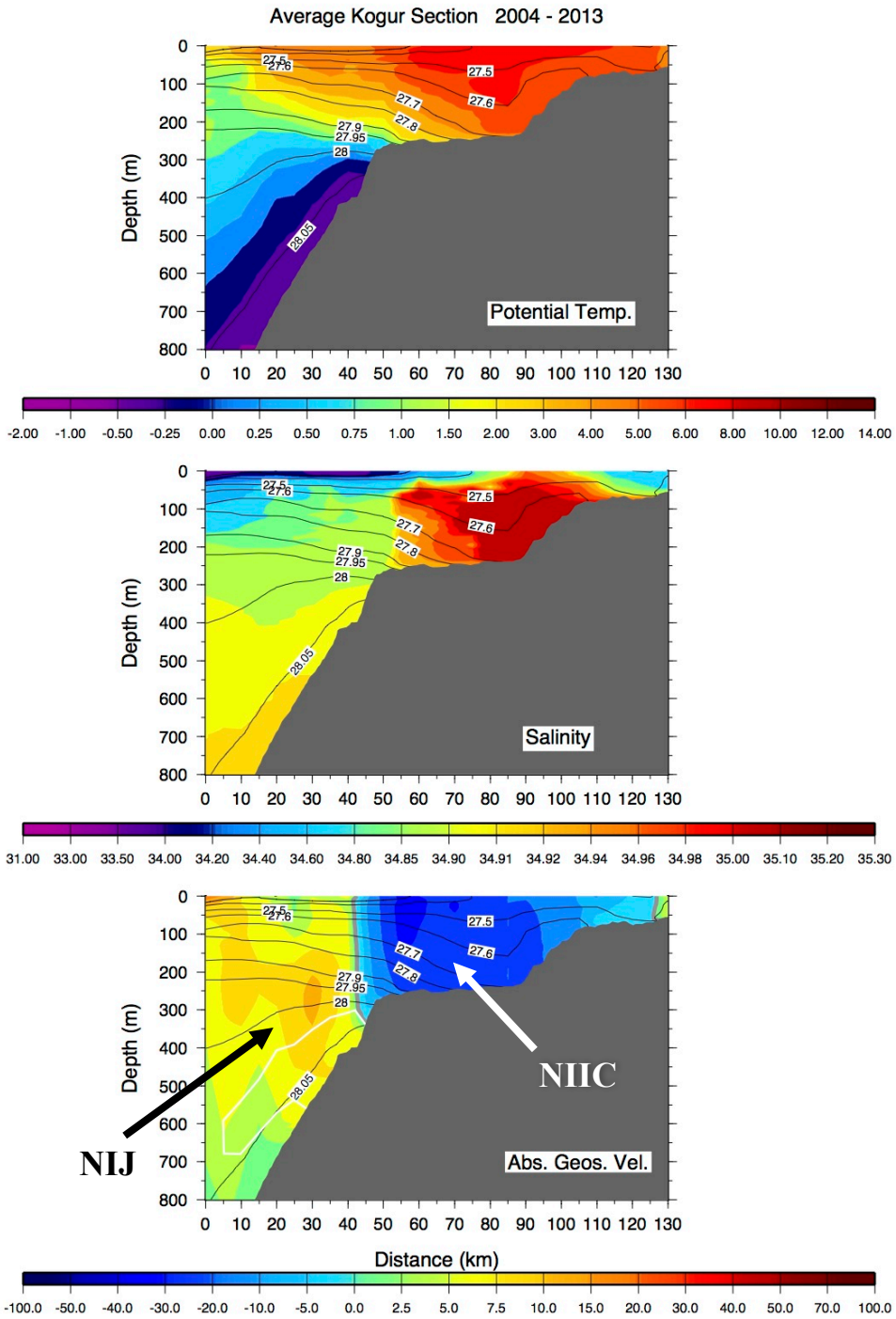
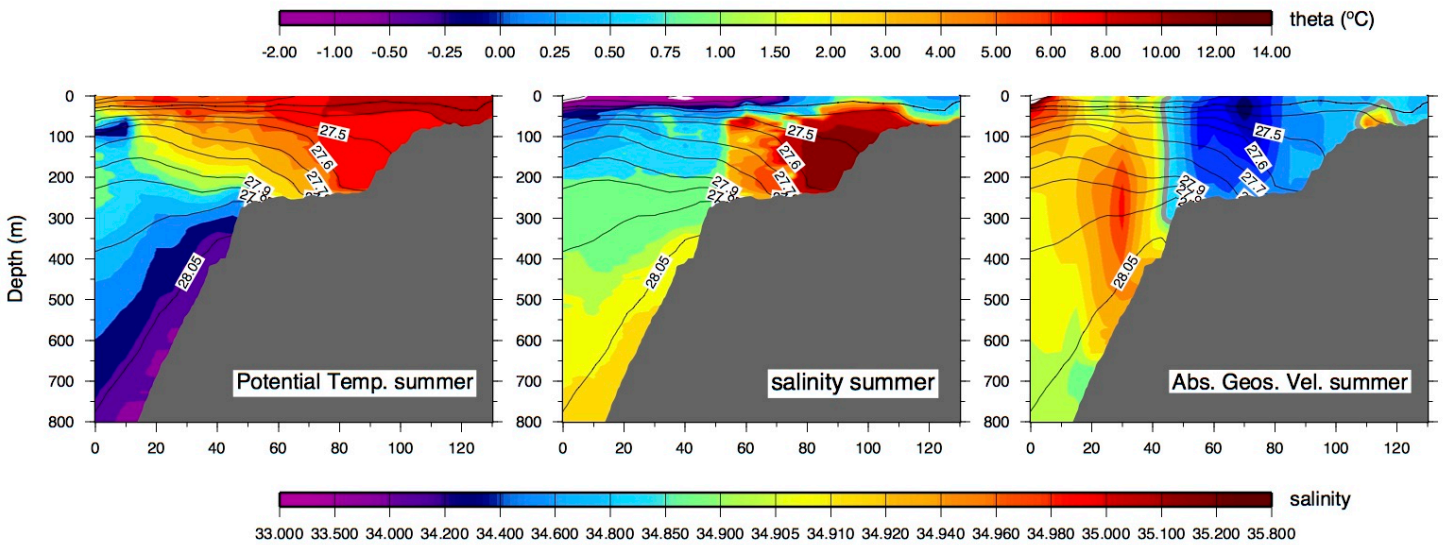
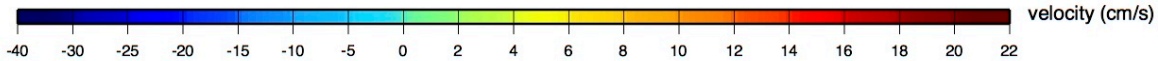
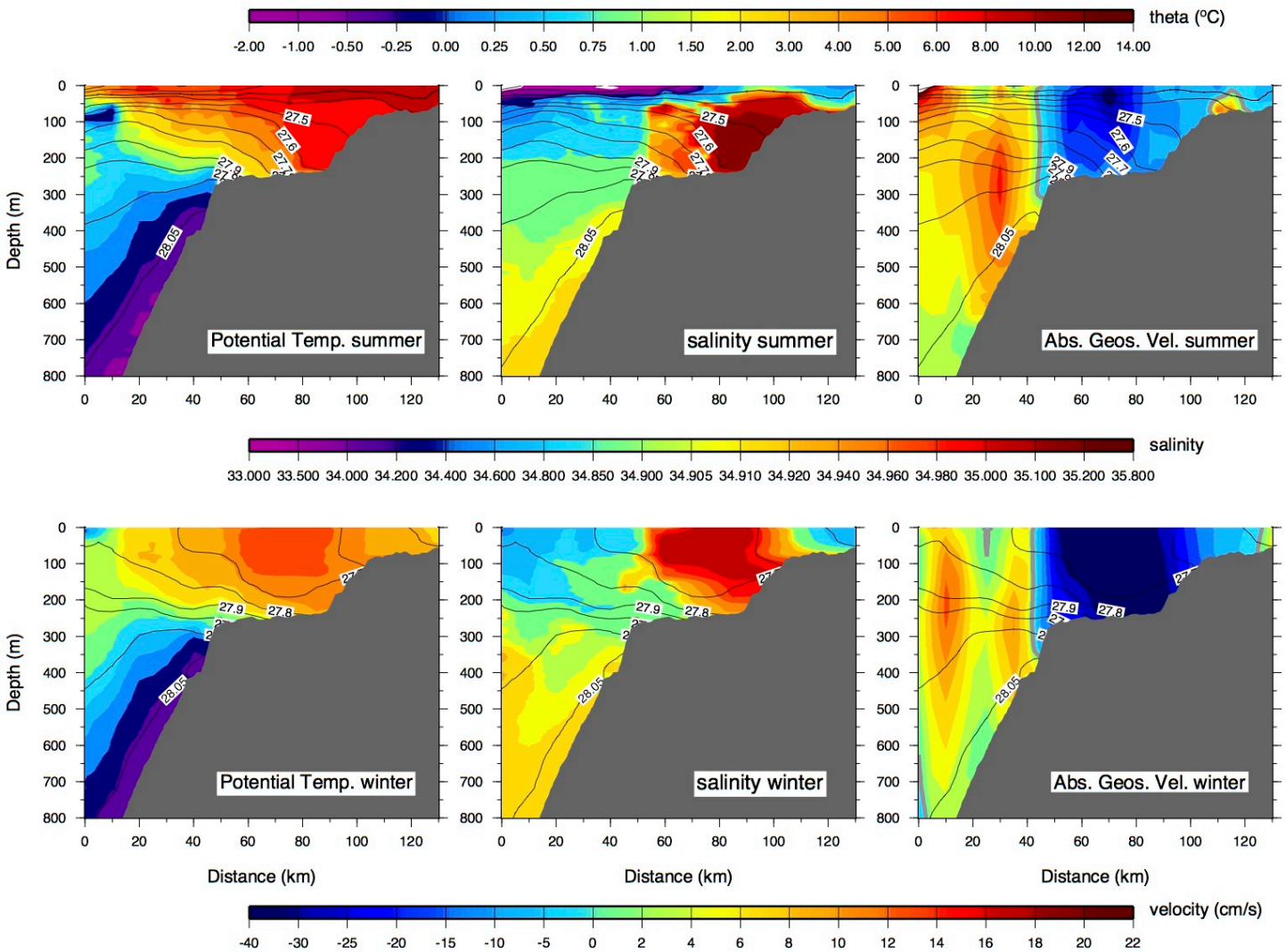


Seasonal Kögur Sections

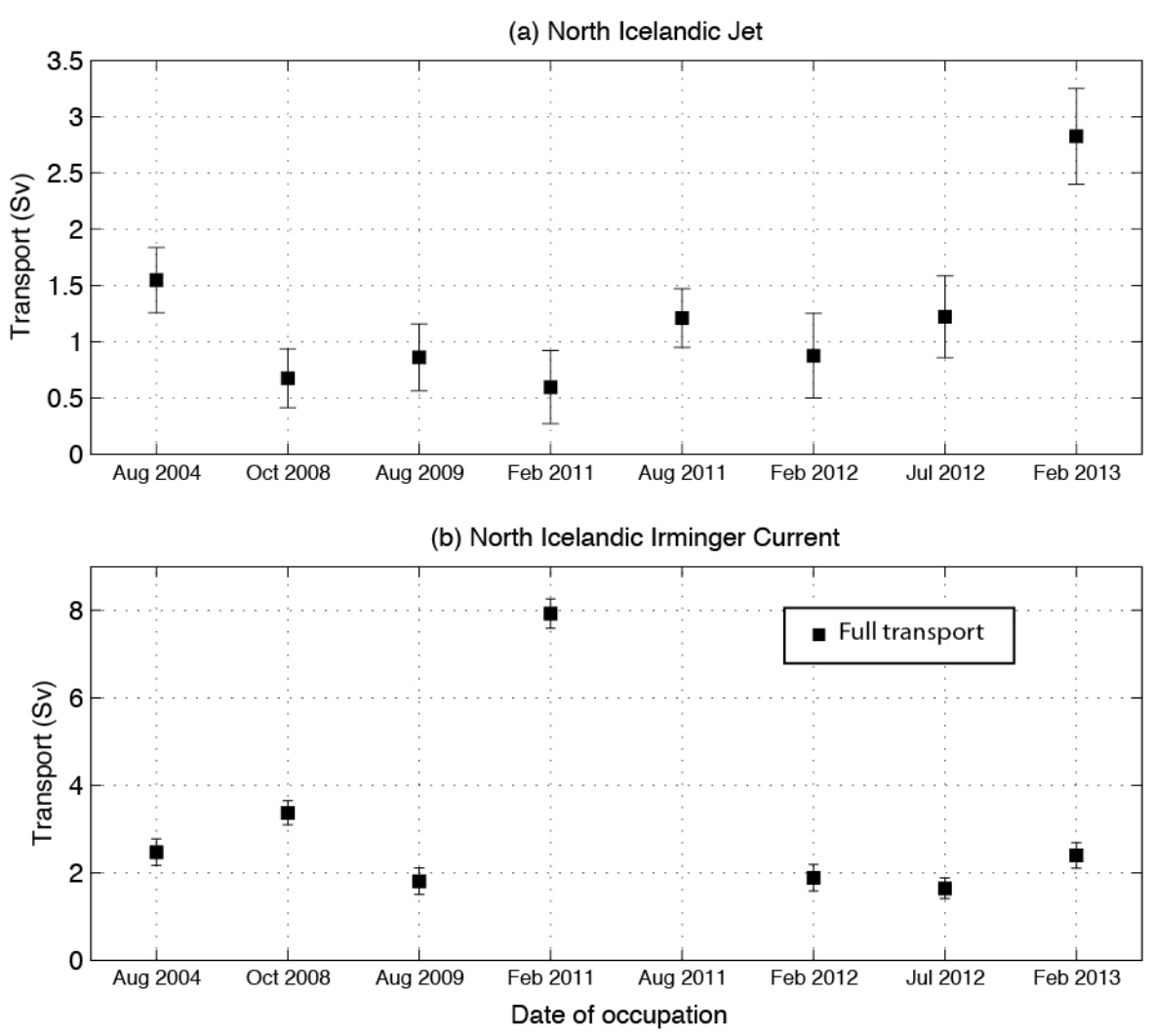




Seasonal Kögur Sections



Transports at the Kögur line



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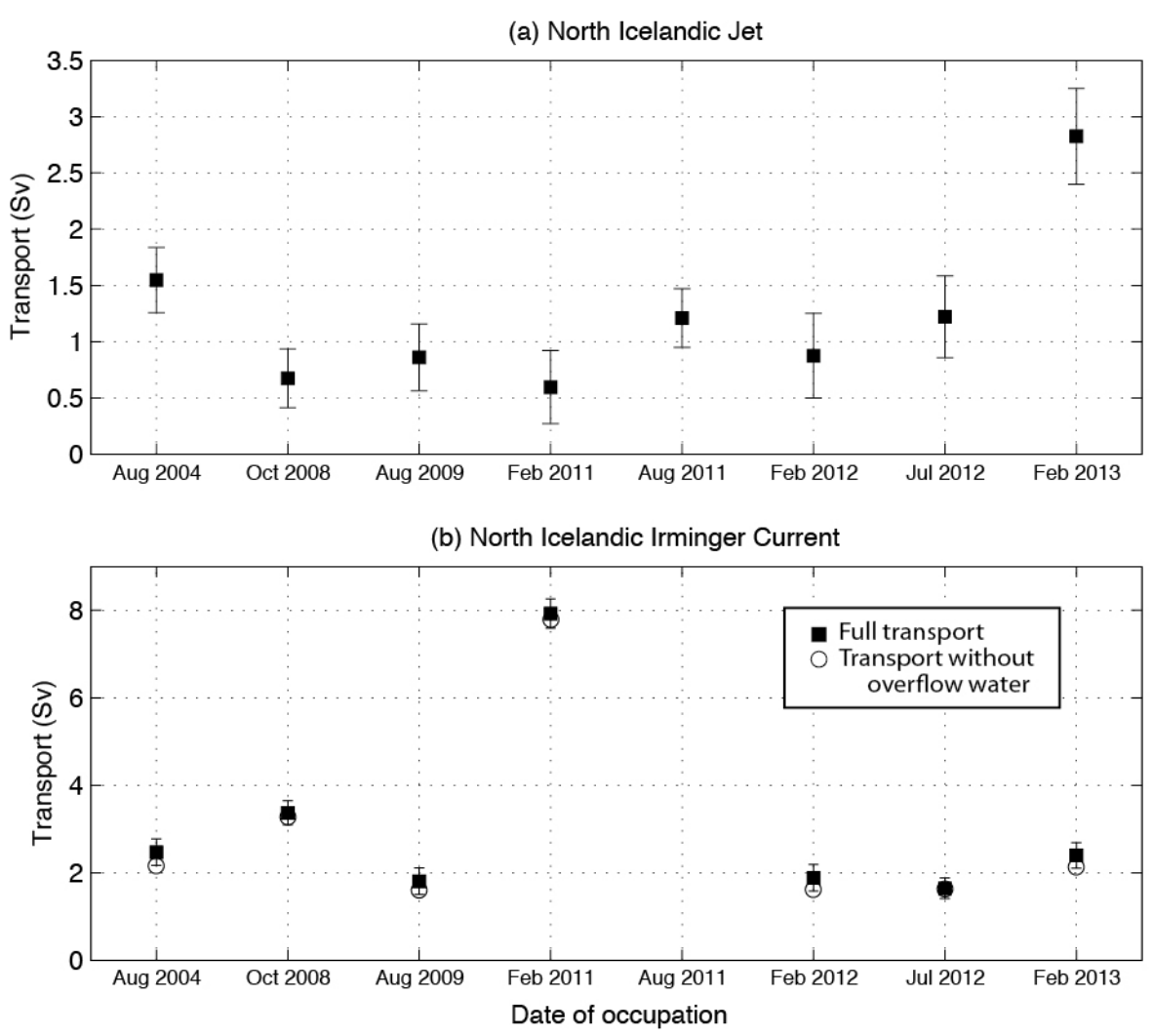

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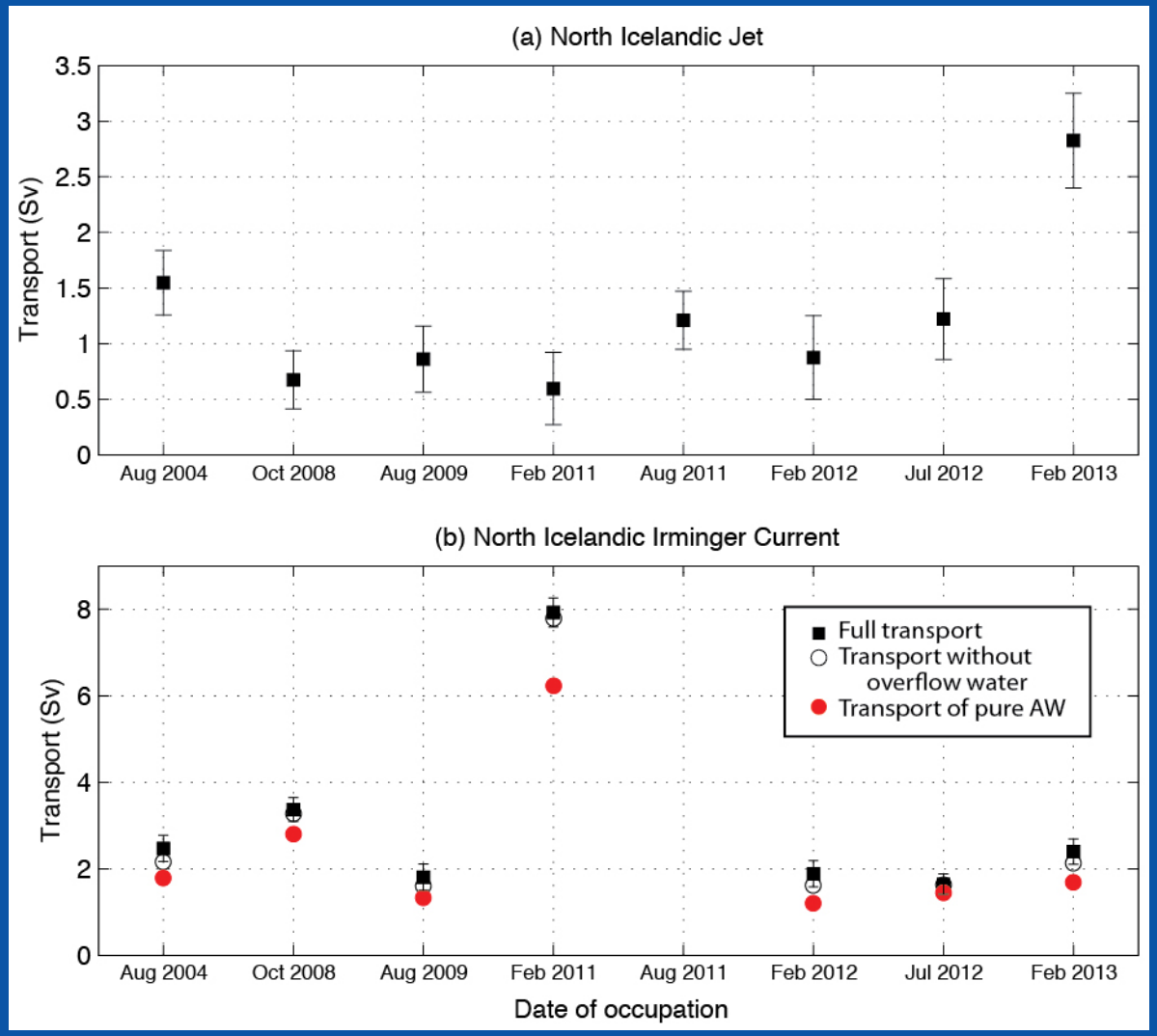


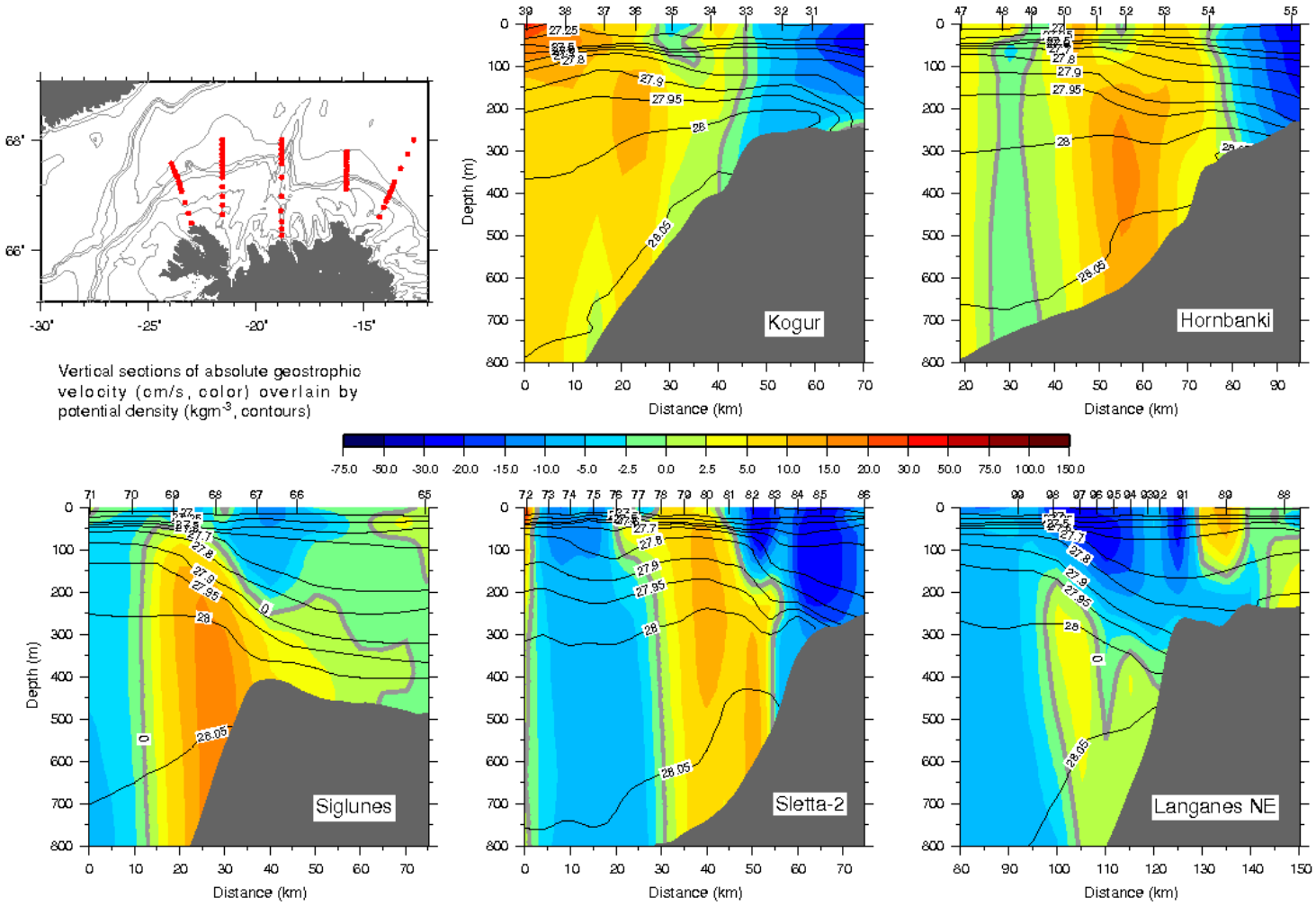
NIJ 1.3±0.33 Sv

NIIC 1.7±0.22 Sv

Pathway of the NIJ

Absolute geostrophic velocity (cm/s, color) overlain by potential density (kg/m^3, contours)

August 2009



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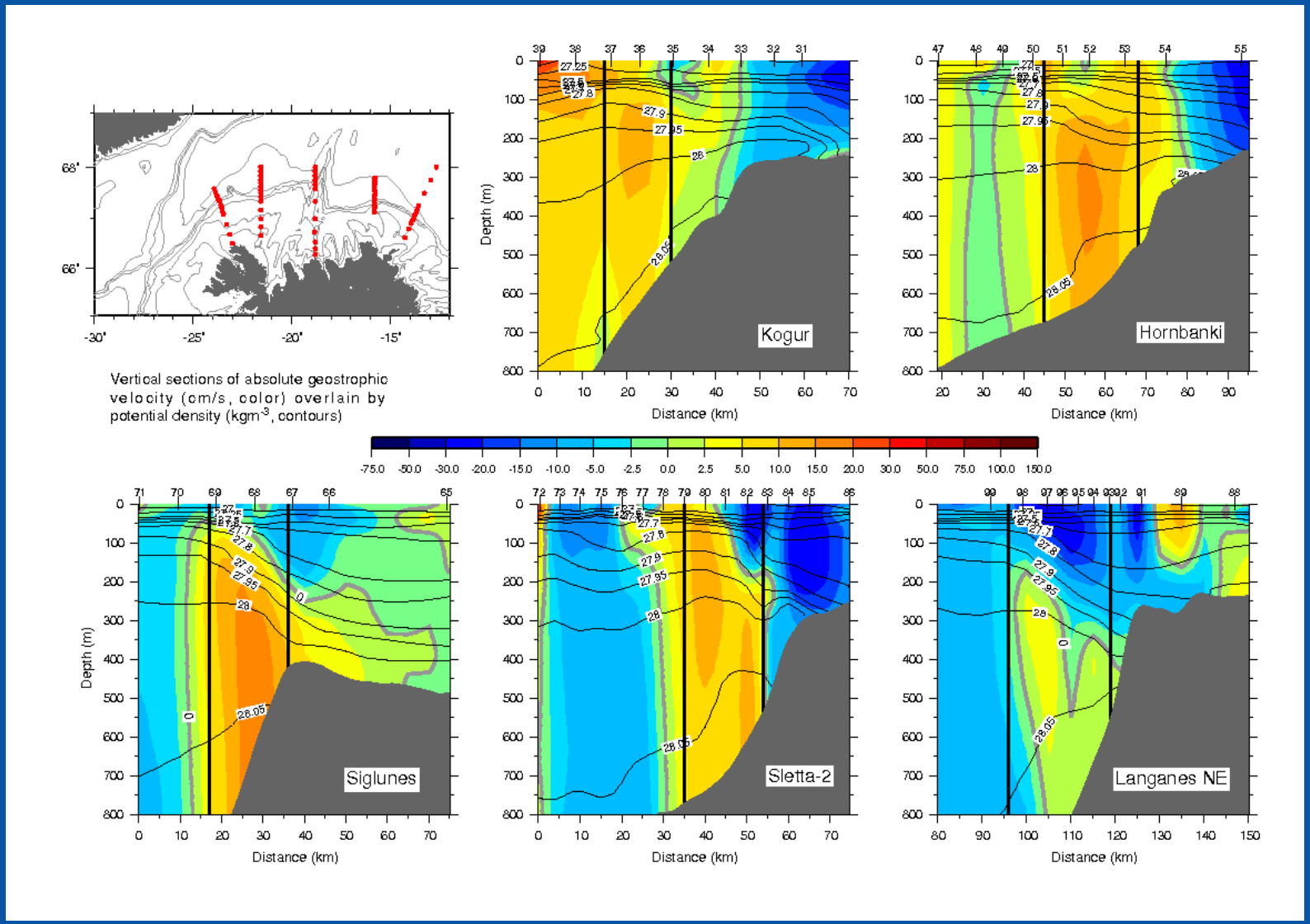
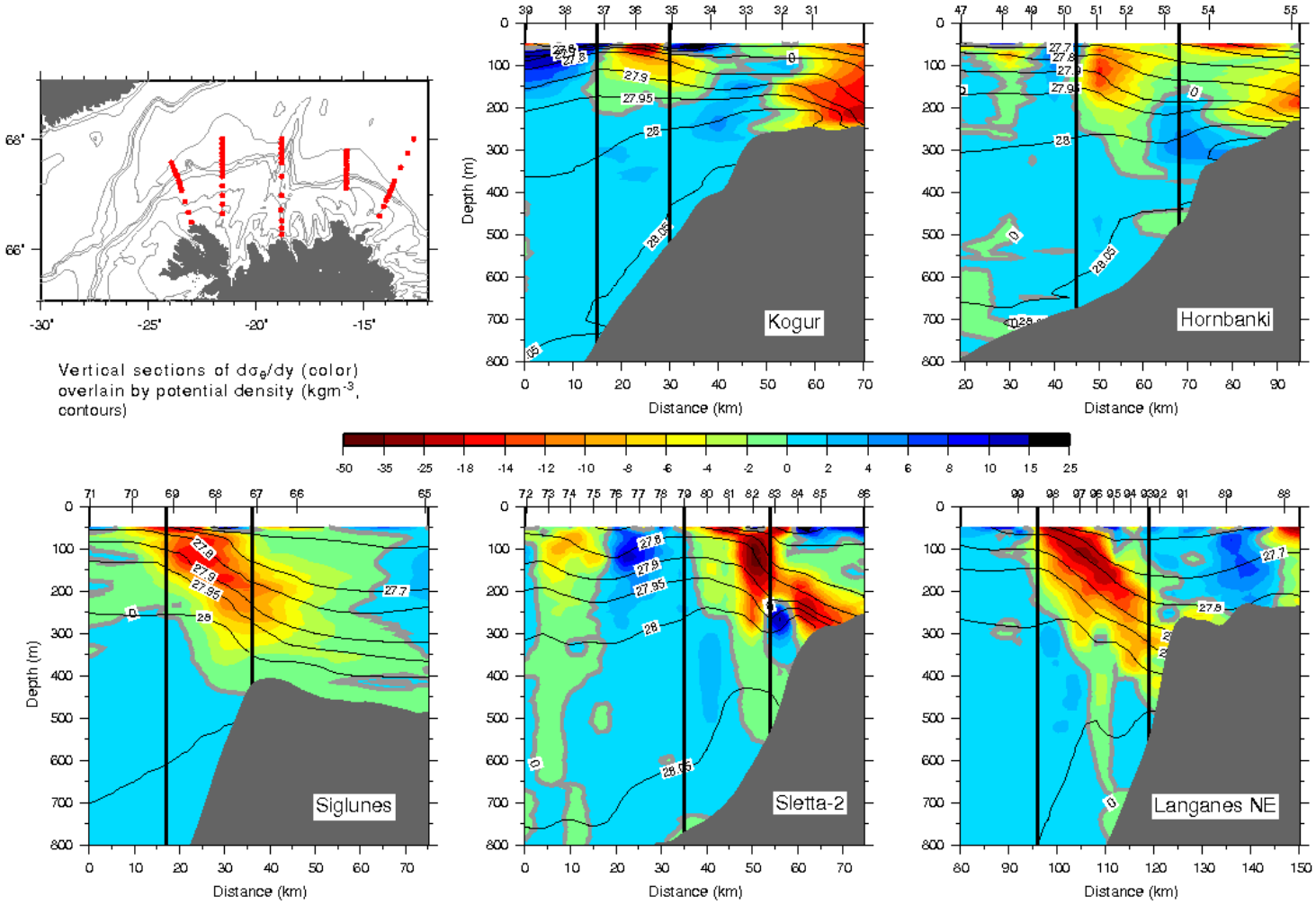
August 2009



$d\sigma_0/dy$ (cm/s, color)
overlain by potential density (kg/m^3, contours)

August 2009



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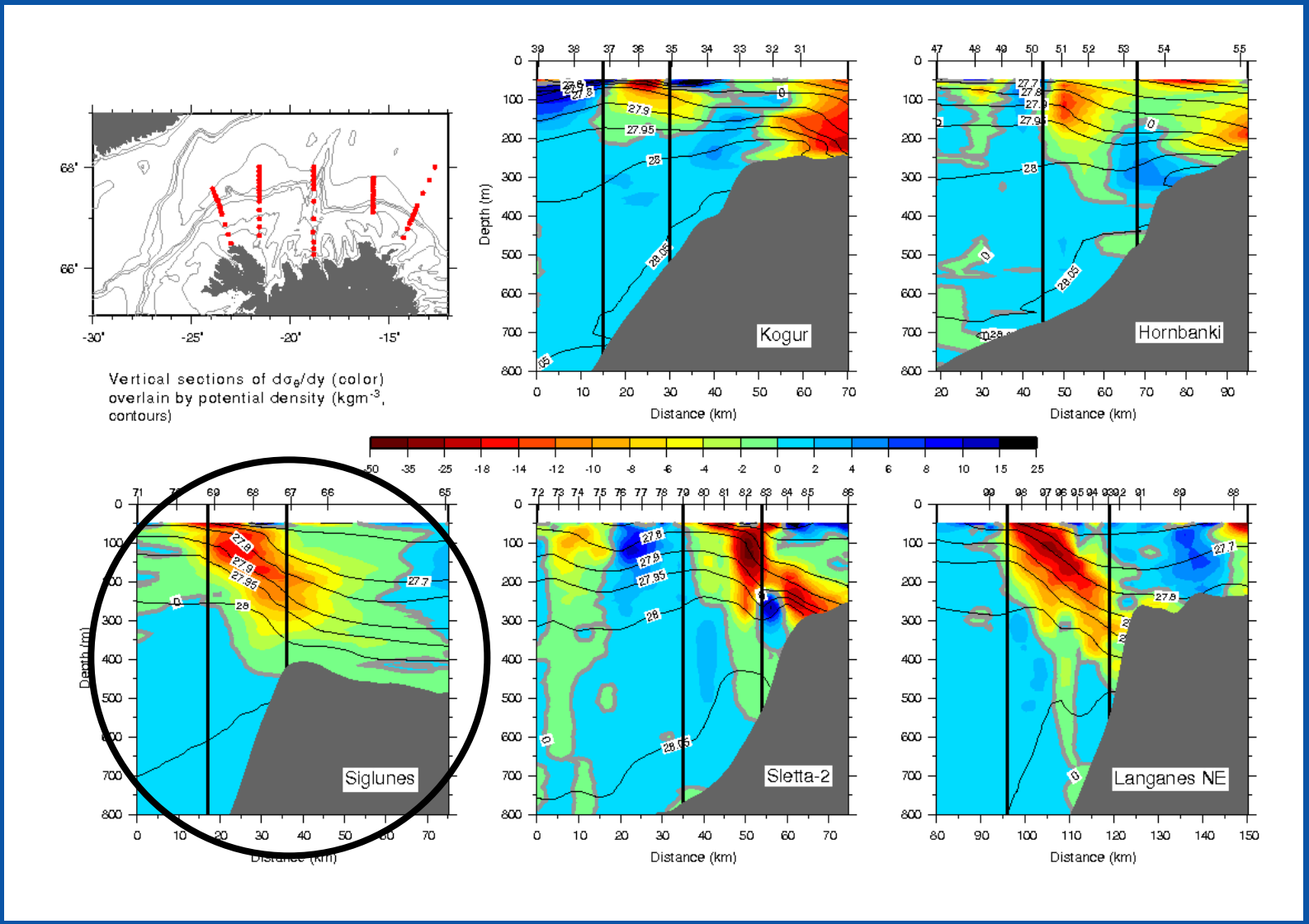
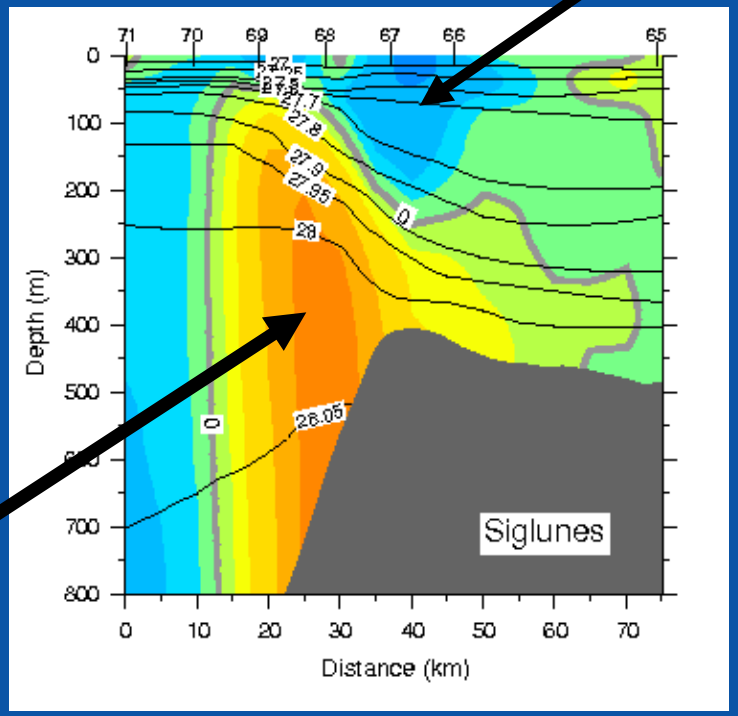


Absolute geostrophic velocity (cm/s, color)
overlain by potential density (kg/m^3, contours)

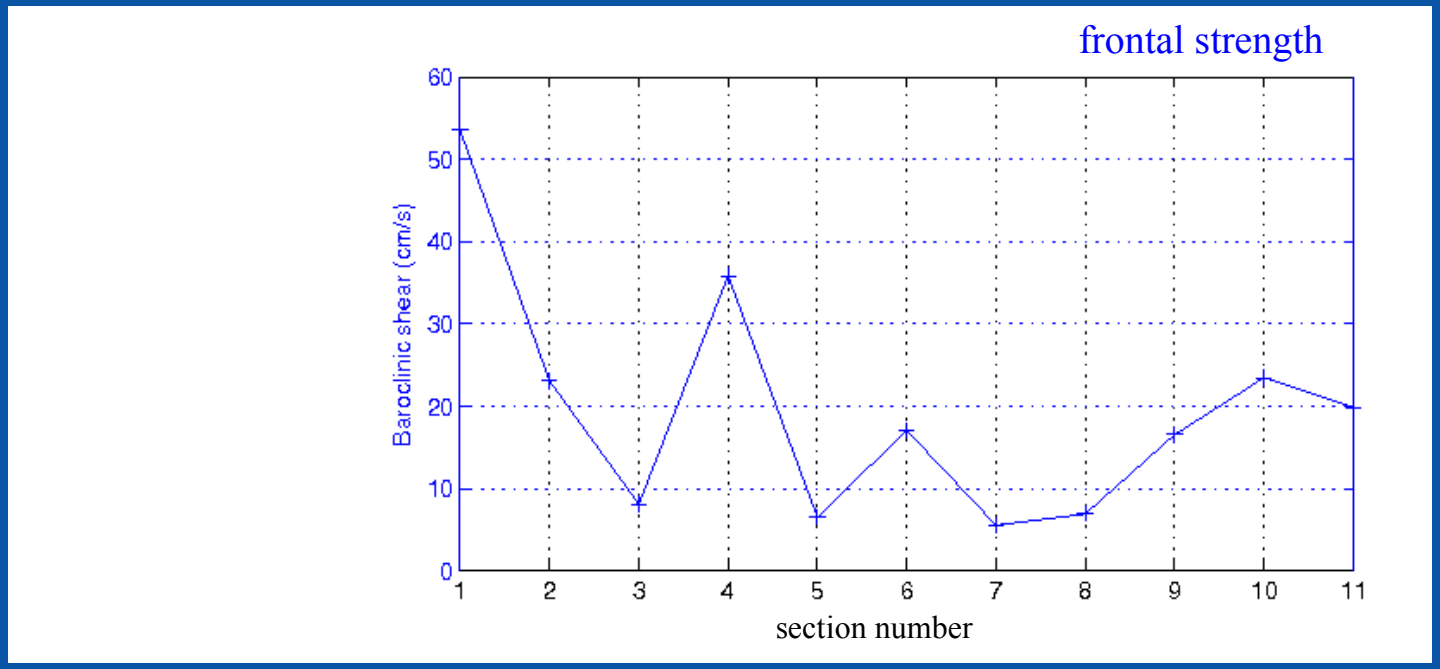
August 2009

Poleward flow

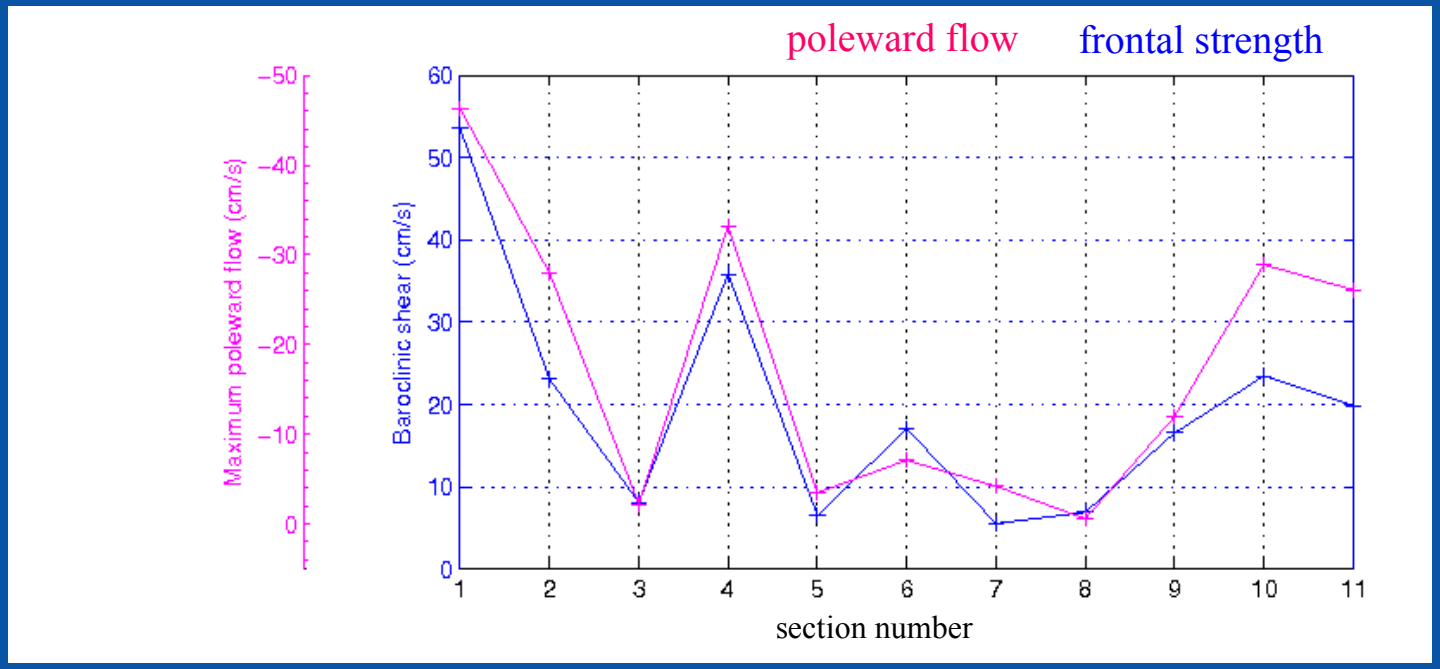


Equatorward flow

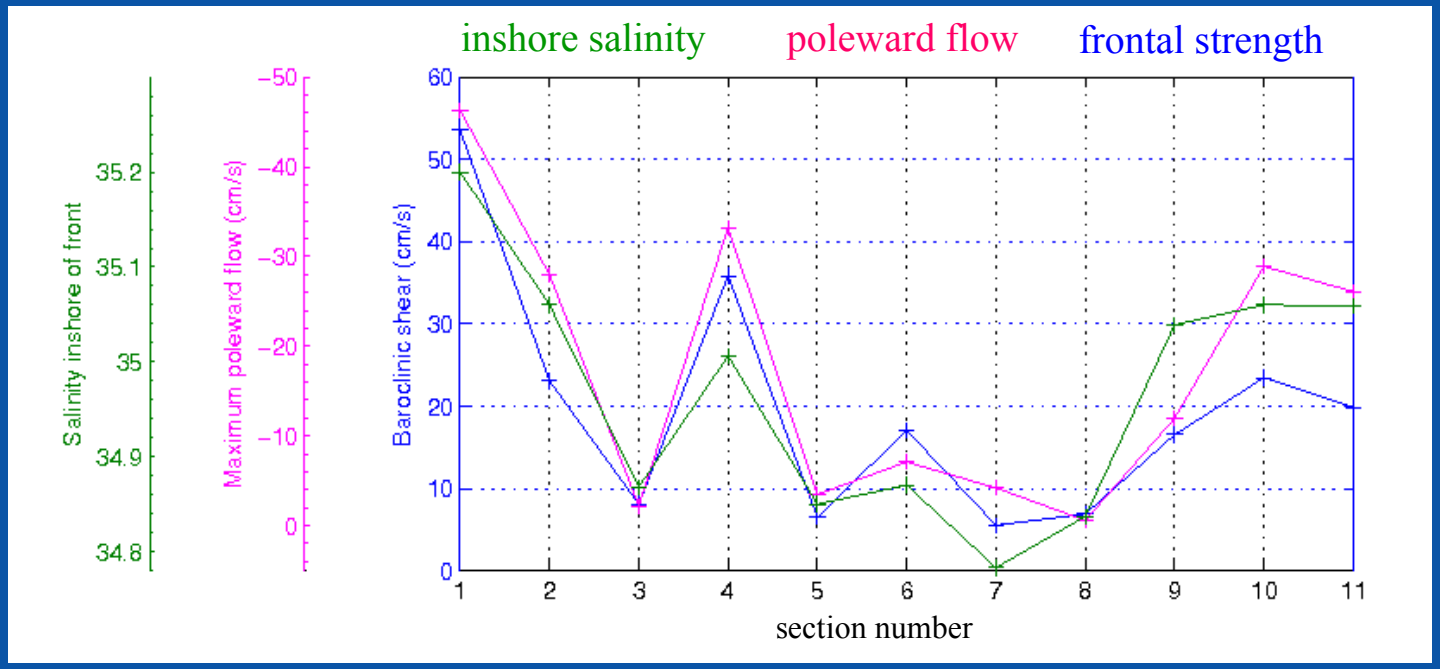
Metrics


frontal strength
Baroclinic shear (cm/s)
0
10
20
30
40
50
60
1
2
3
4
5
6
7
8
9
10
11
section number

Metrics

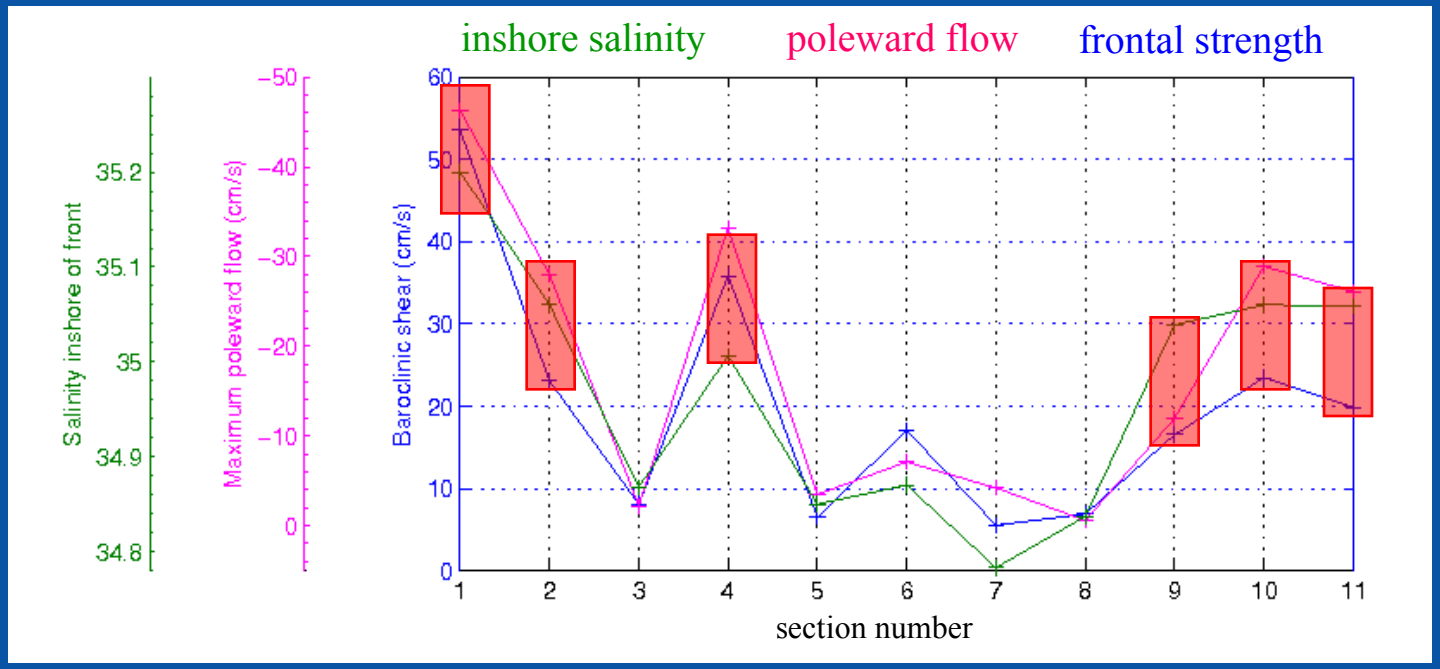

poleward flow
frontal strength
Maximum poleward flow (cm/s)
−50
−40
−30
−20
−10
0
Baroclinic shear (cm/s)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
section number

Metrics


inshore salinity
poleward flow
frontal strength
Salinity inshore of front
35.2
35.1
35
34.9
34.8
Maximum poleward flow (cm/s)
−50
−40
−30
−20
−10
0
Baroclinic shear (cm/s)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
section number

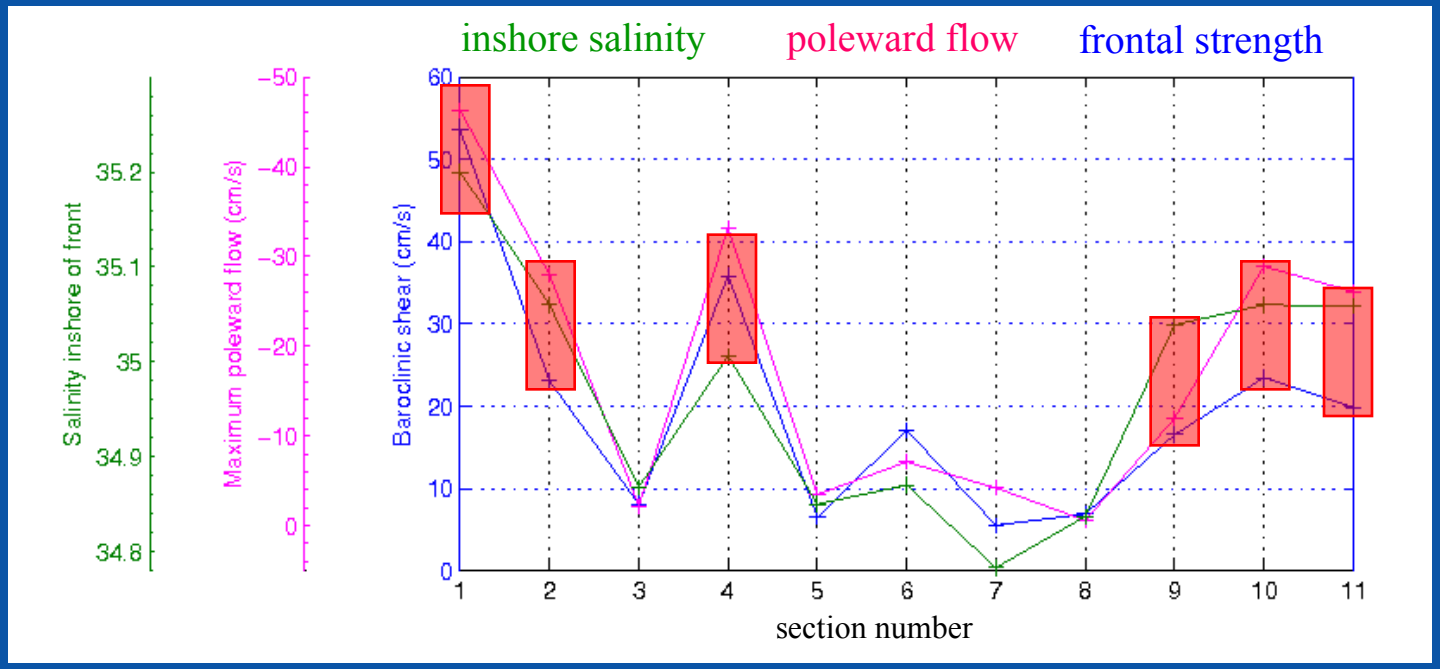
Metrics

= NIIC



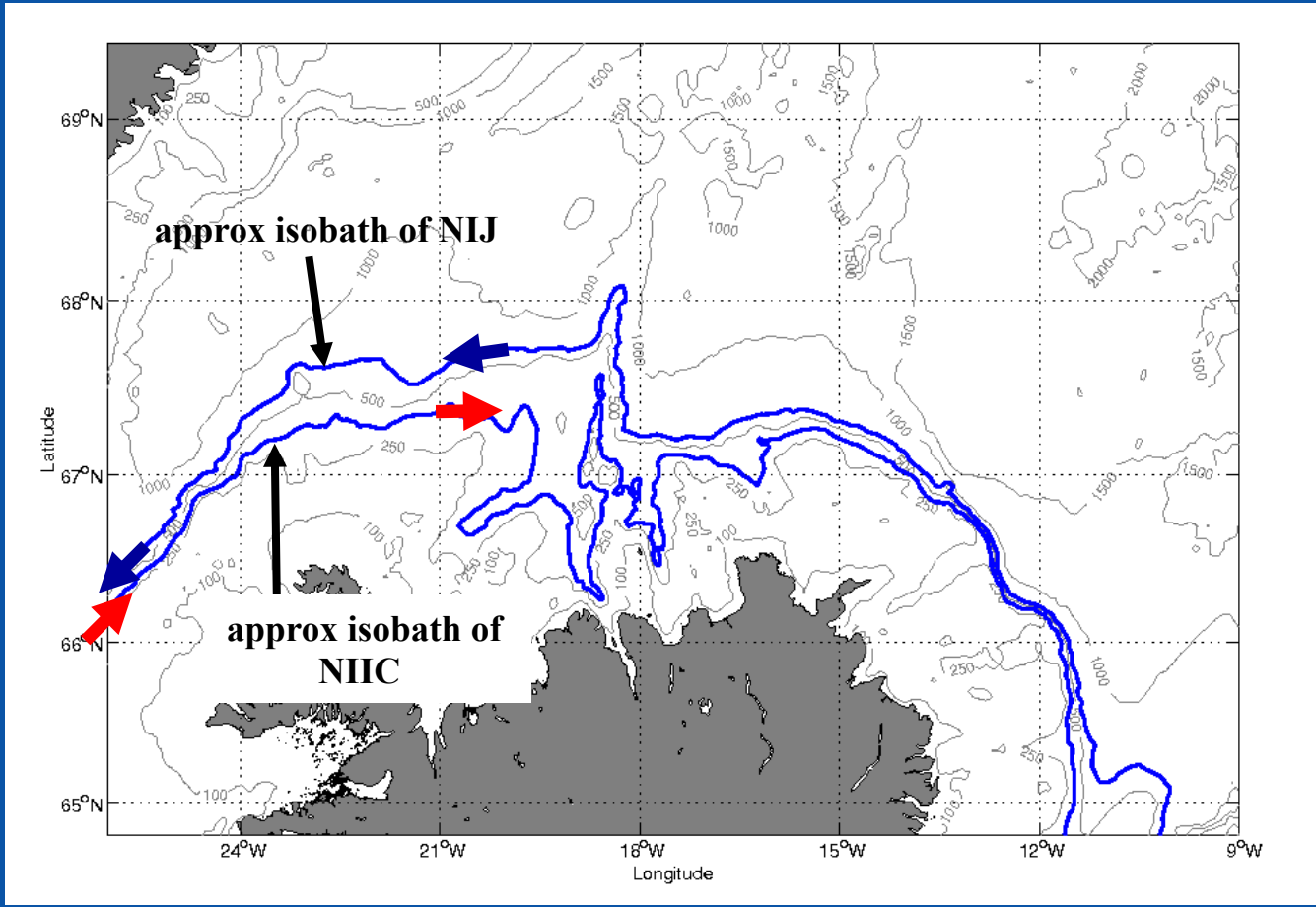
Metrics

= NIIC

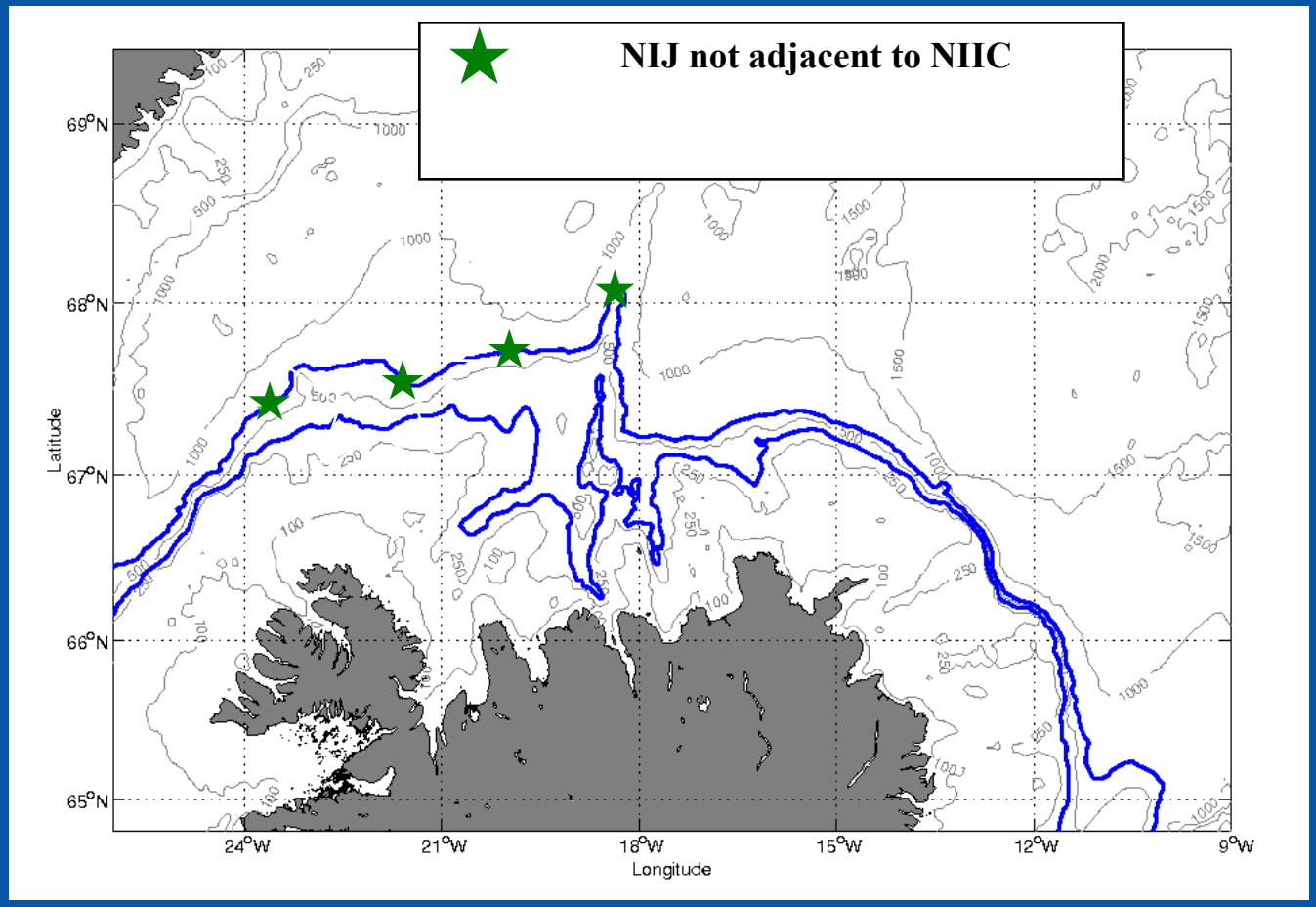


Sometimes the NIJ is associated with the NIIC, sometimes it isn't

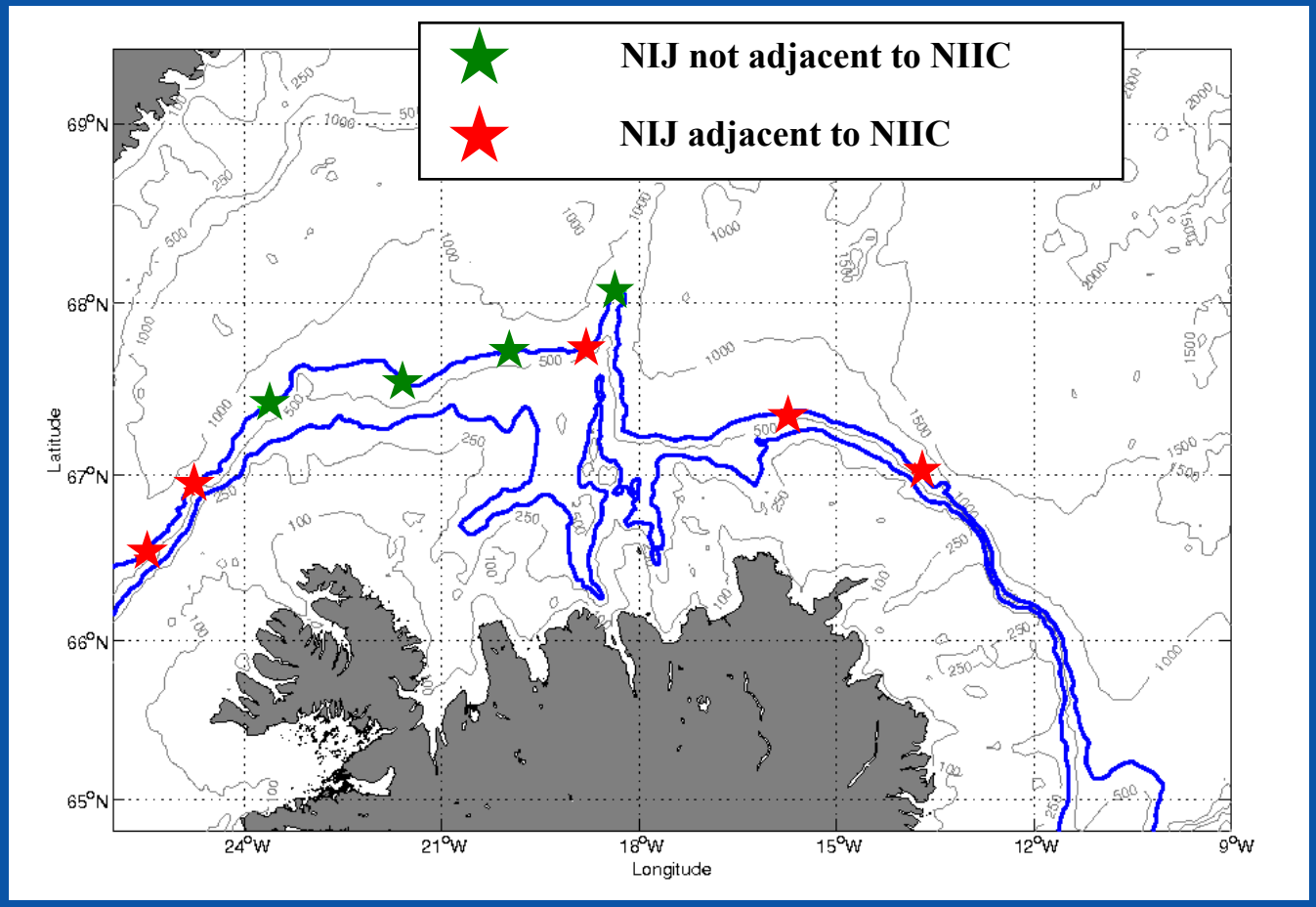
Bathymetric considerations



Bathymetric considerations



Bathymetric considerations



Overall impression:

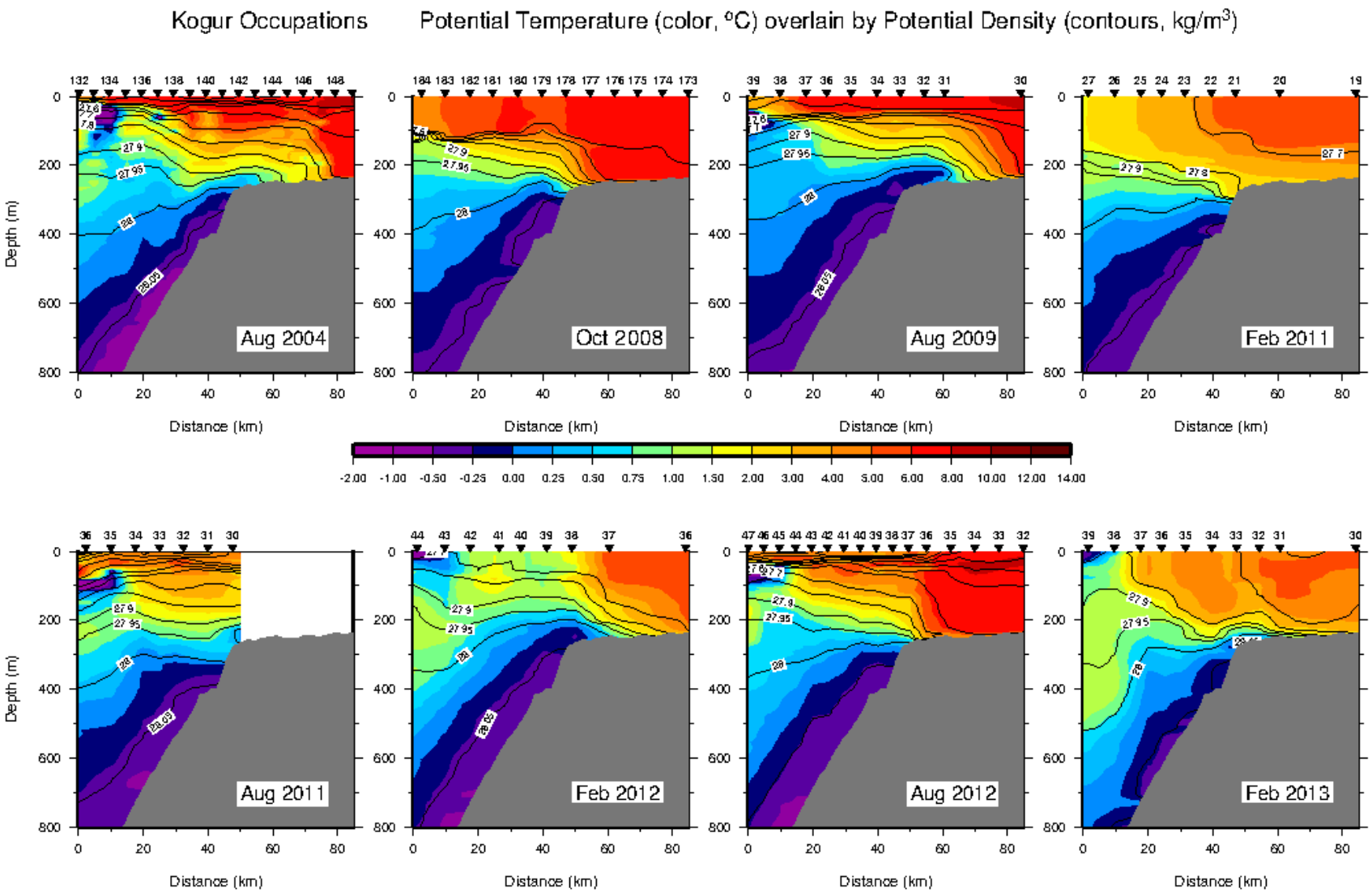
The NIJ appears to be coupled to the NIIC when the two are in close geographical proximity to each other.

Even when they are de-coupled, the NIJ is flowing adjacent to a (weaker) inflow of warm water.

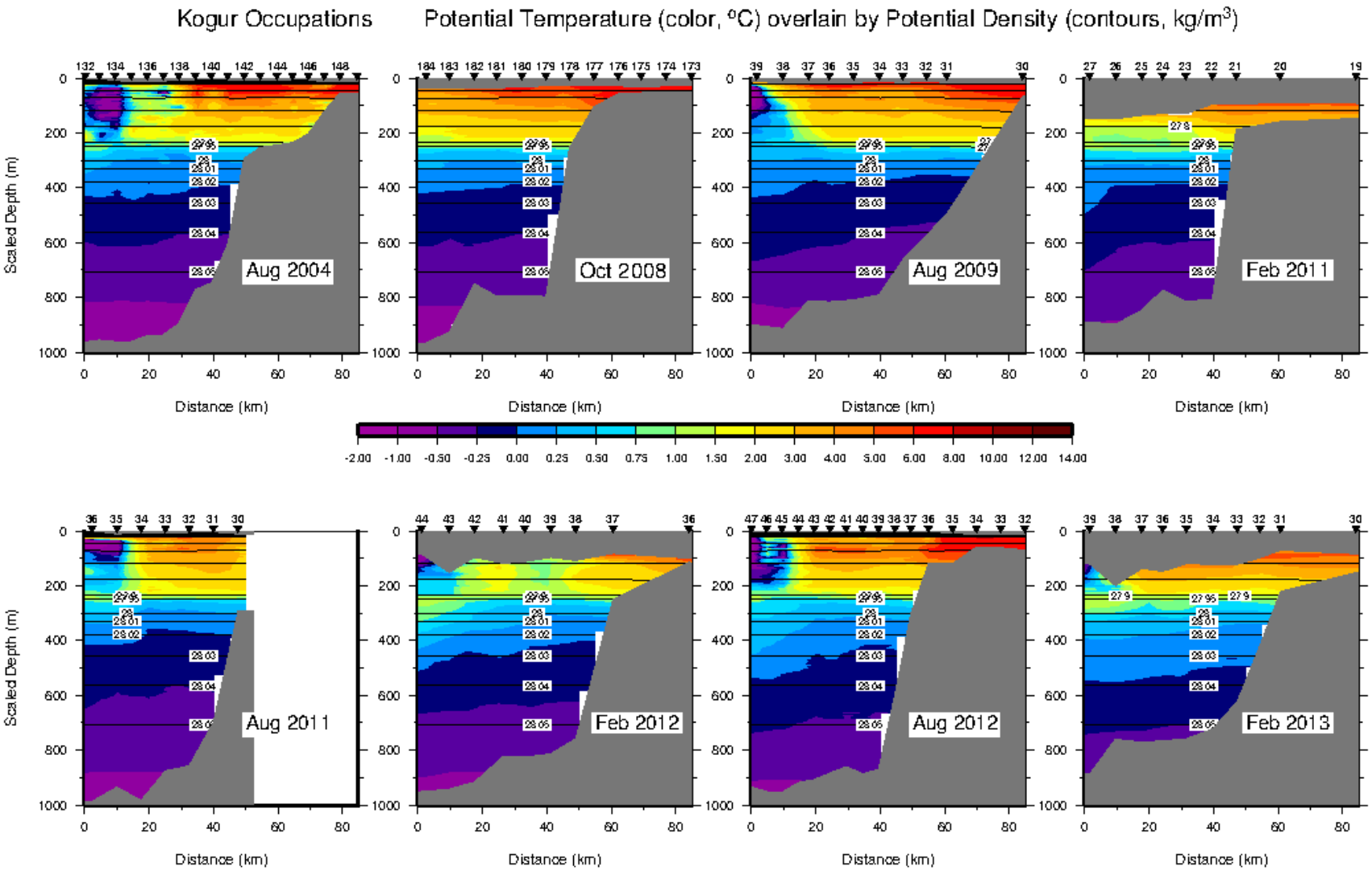
Interannual variability:

subtropical inflow vs. dense outflow

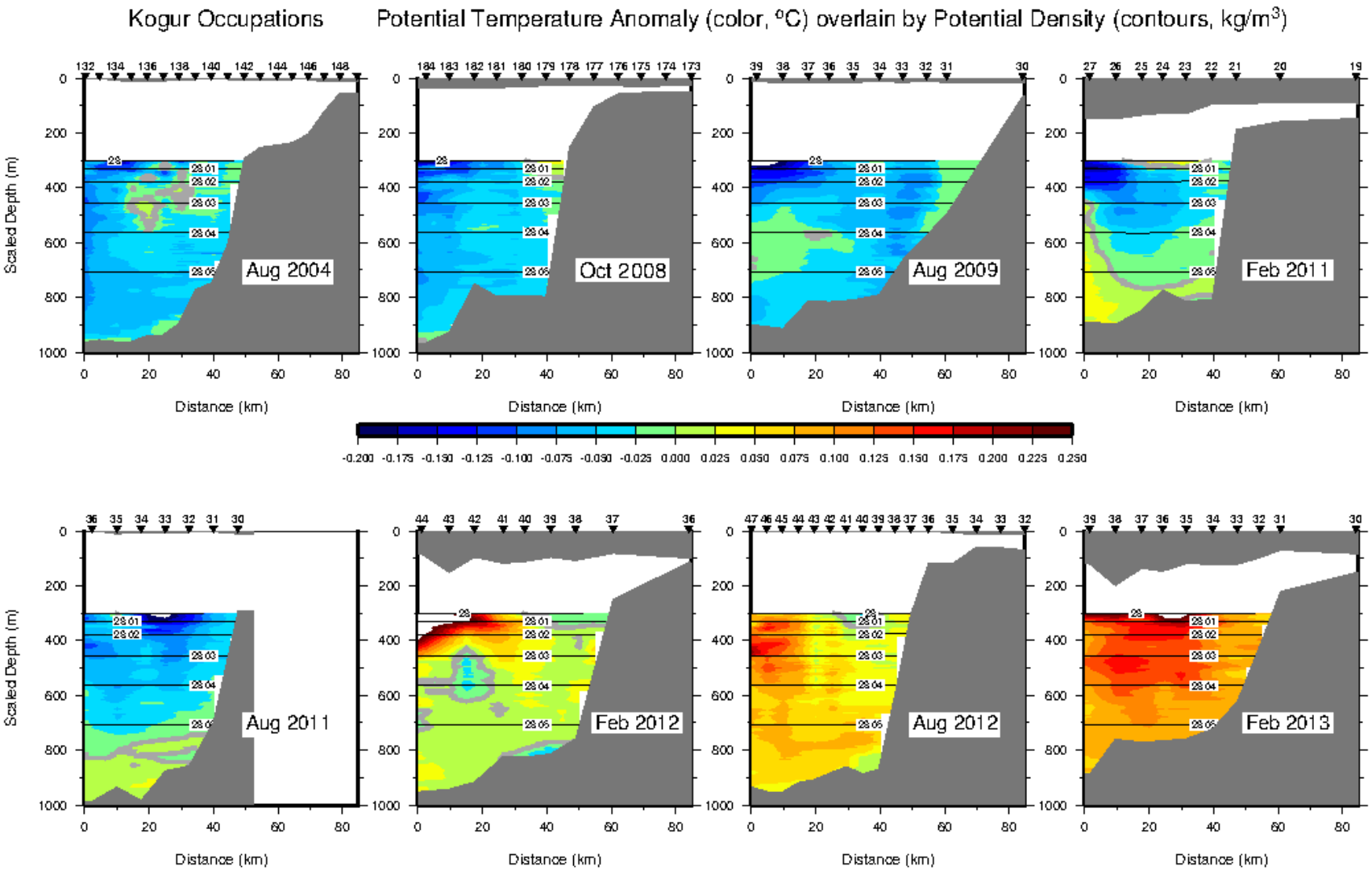
Depth-space

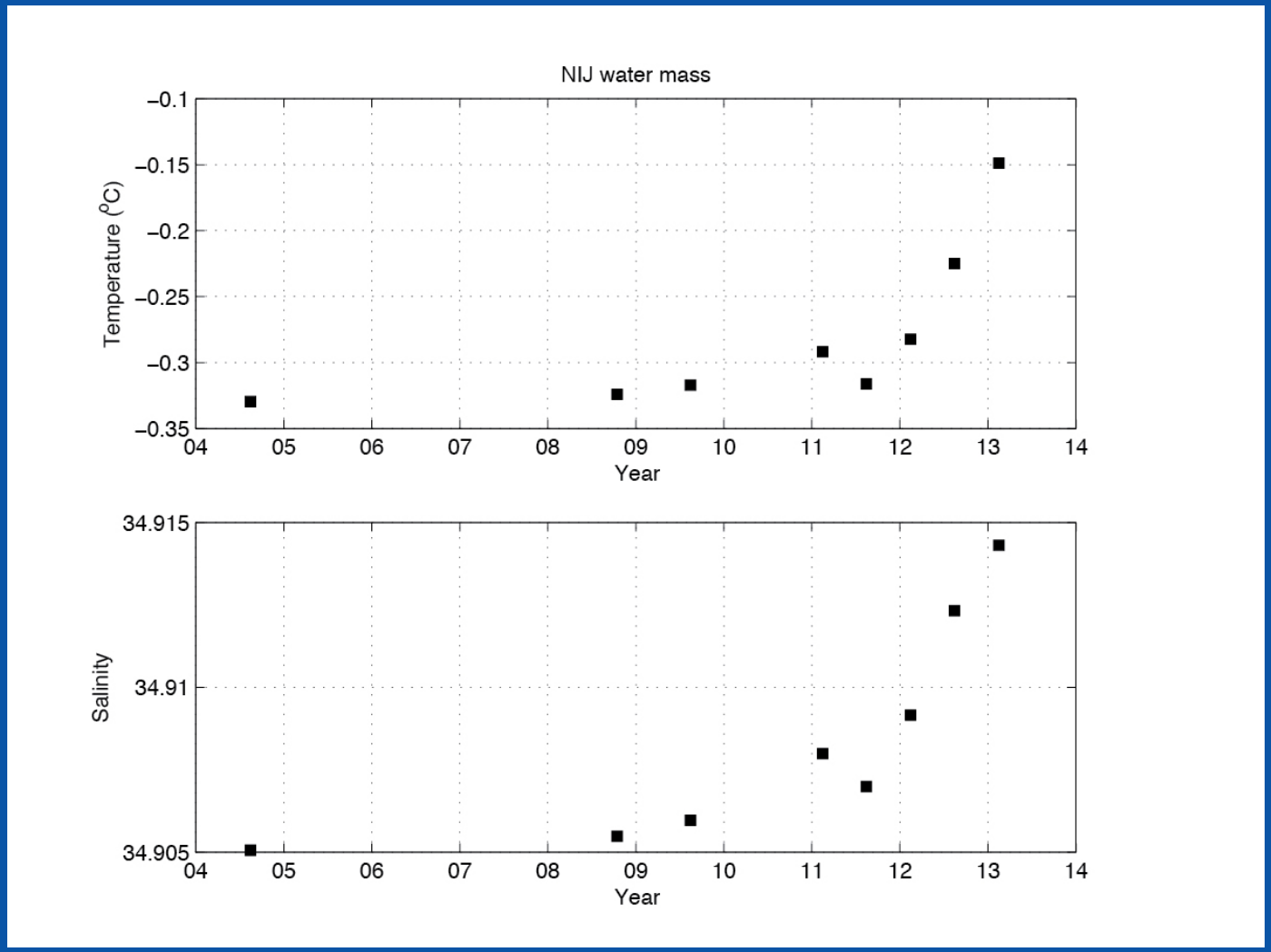

Kogur Occupations
Potential Temperature (color, °C) overlain by Potential Density (contours, kg/m3)
Aug 2004
Oct 2008
Aug 2009
Feb 2011
Aug 2011
Feb 2012
Aug 2012
Feb 2013
Depth (m)
Distance (km)
-2.00 -1.00 -0.50 -0.25 0.00 0.25 0.50 0.75 1.00 1.50 2.00 3.00 4.00 5.00 6.00 8.00 10.00 12.00 14.00

Density-space



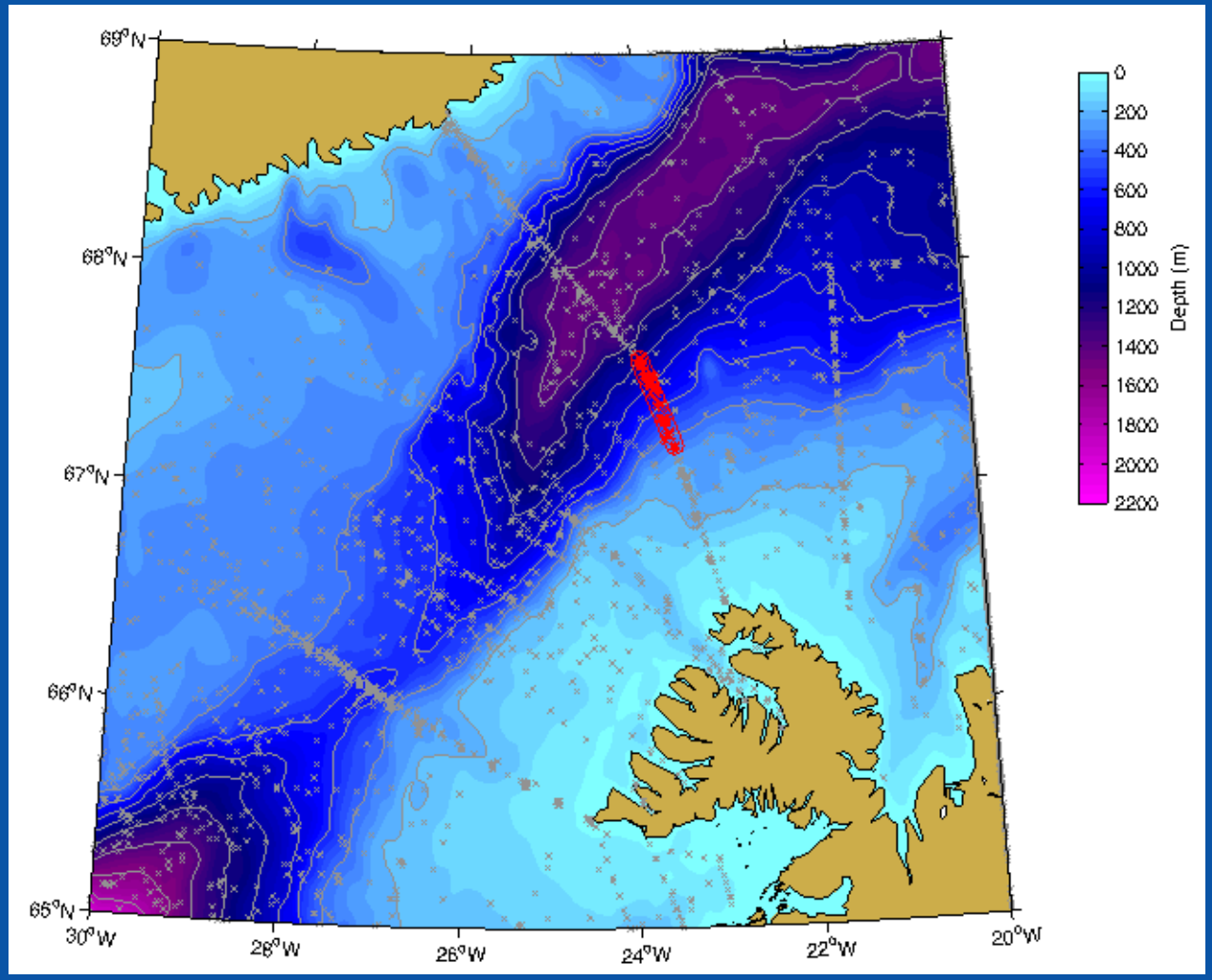
Anomaly in depth-space



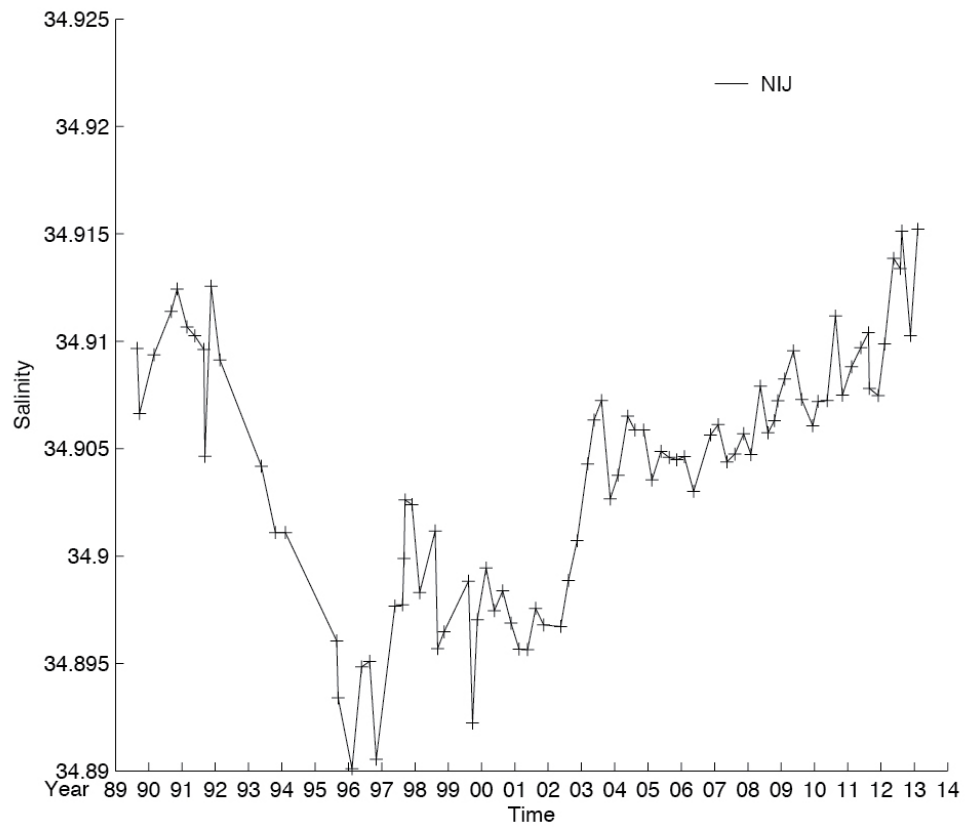


For the densest component of the NIJ (σ_Θ> 28.035)

Changes in the NIJ water



Longer term interannual variability



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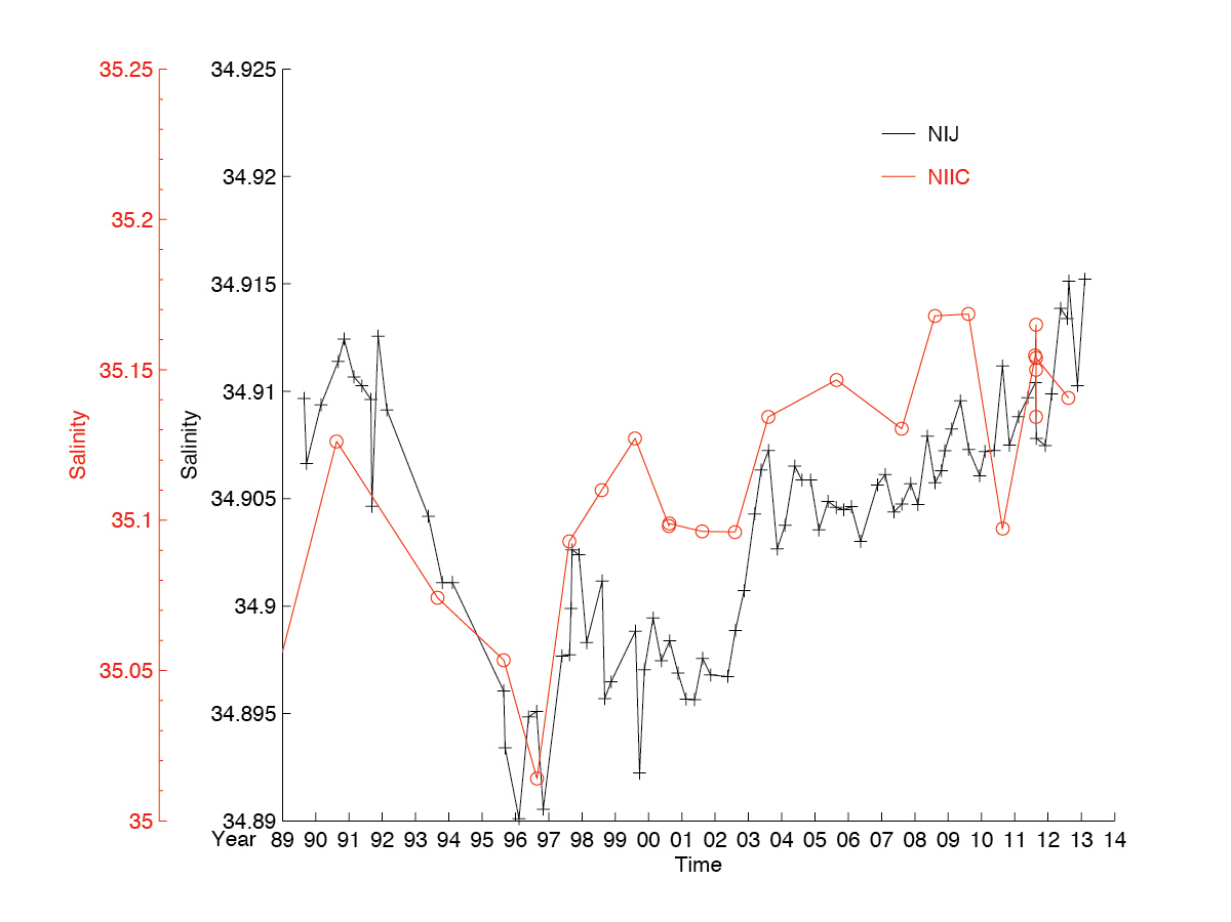
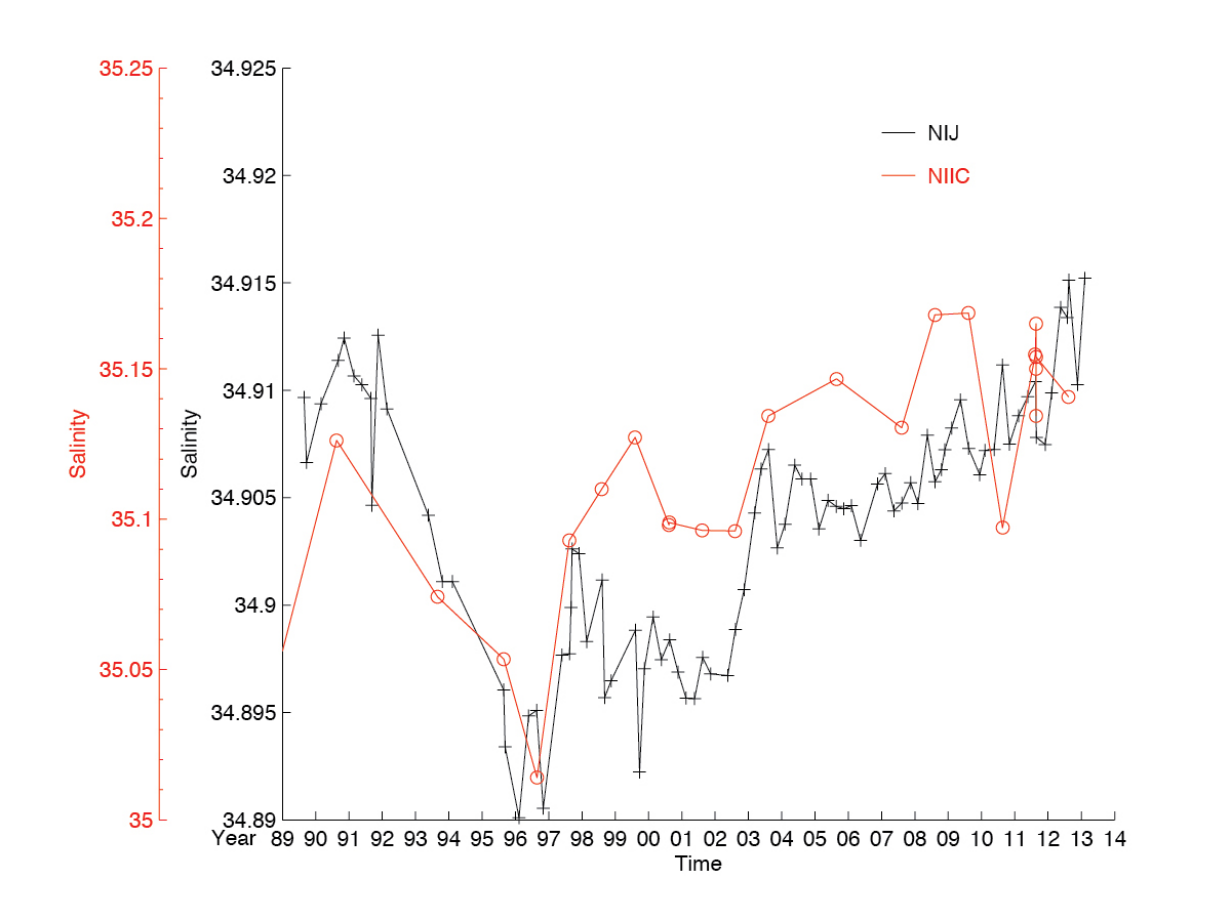


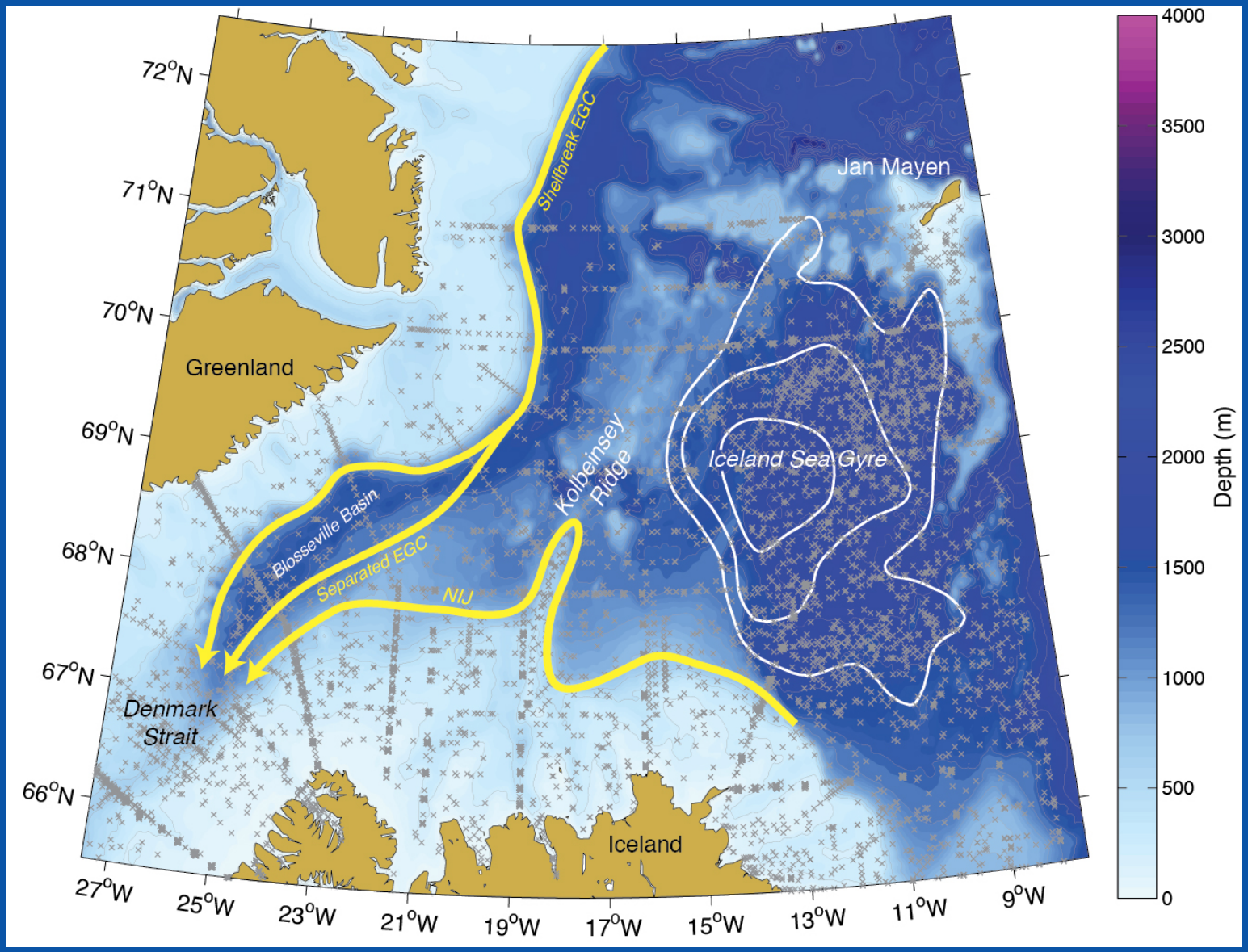
Longer term interannual variability



Aspects to consider:

1. **The curves are nearly in phase**
2. **The outflowing salinity is ~0.2 fresher**
3. **The salinity fluctuations of the inflow are much greater than the outflow**

1. Variations of the inflow and outflow are in phase



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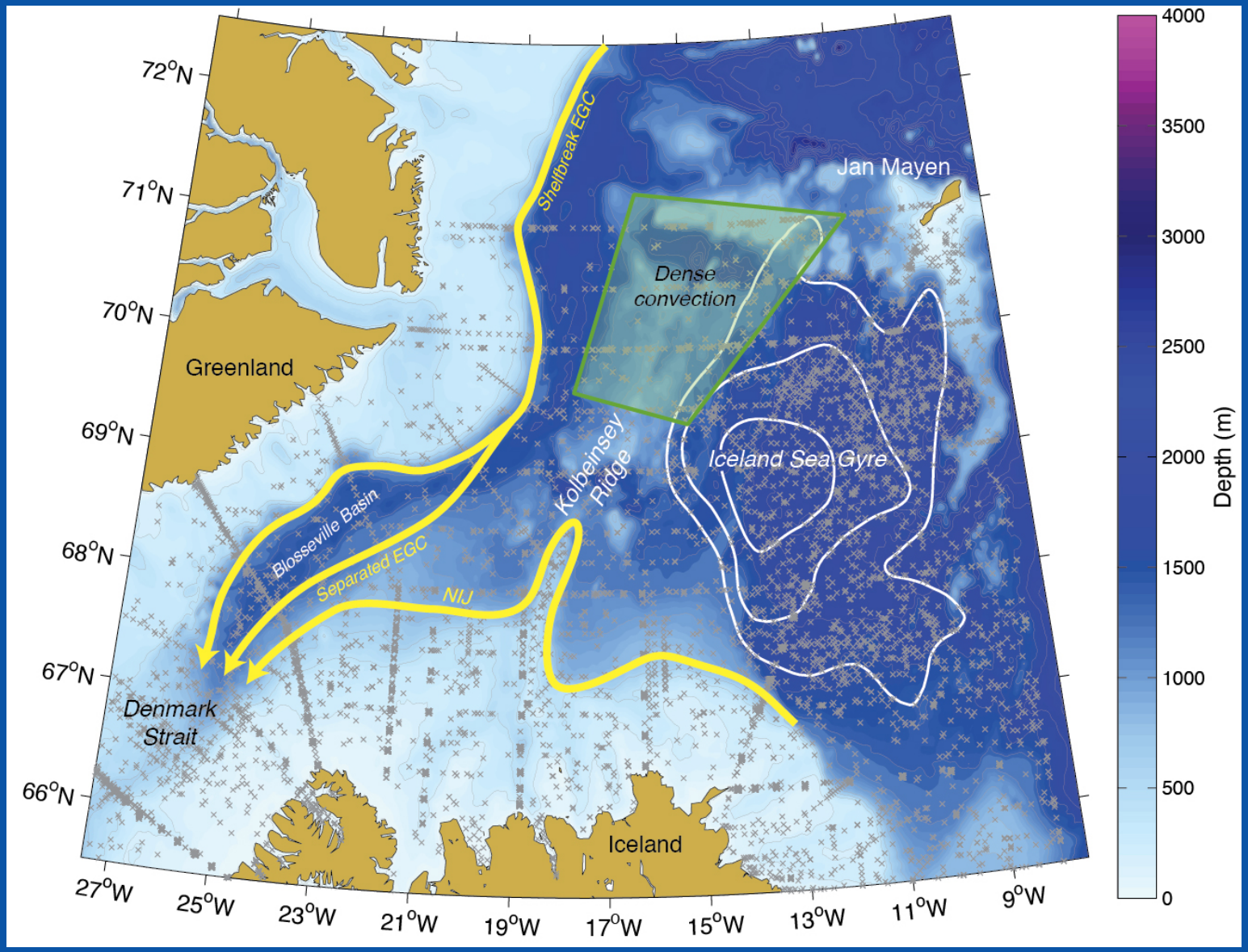

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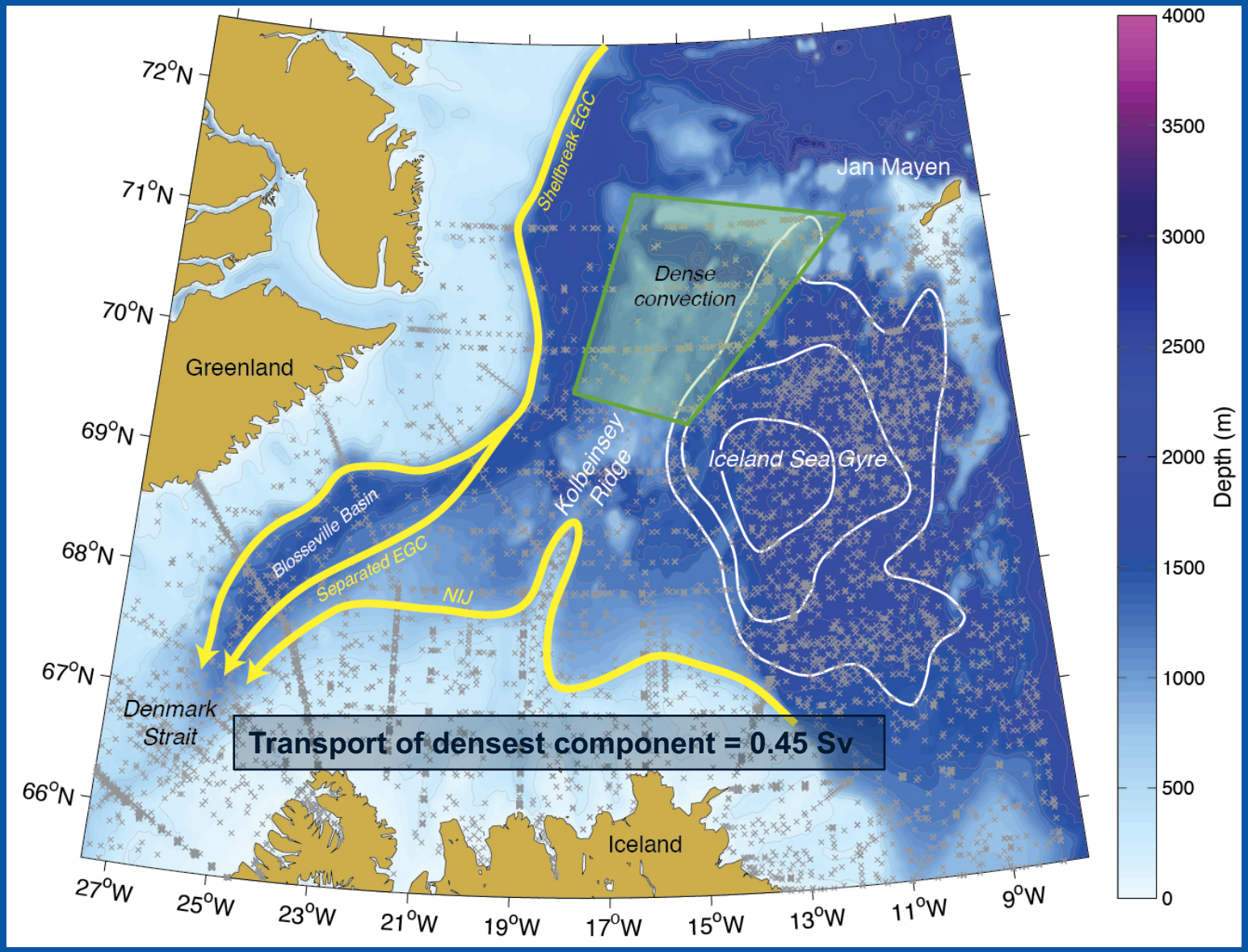

2. Need to freshen ~0.5 Sv of inflow by 0.2

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This requires approximately 100 mSv of freshwater to mix with the inflowing salinity

Possibilities:

1. **Precipitation**
2. **Liquid freshwater flux from EGC**
3. **Solid freshwater flux from EGC**

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1. **Precipitation an order of magnitude too small**
2. **Offshore flux of liquid freshwater is O(50 mSv) (Håvik et al., 2017)**
3. **Offshore flux of solid freshwater is O(50 mSv) (Dodd et al., 2009)**

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Cannot evaluate this

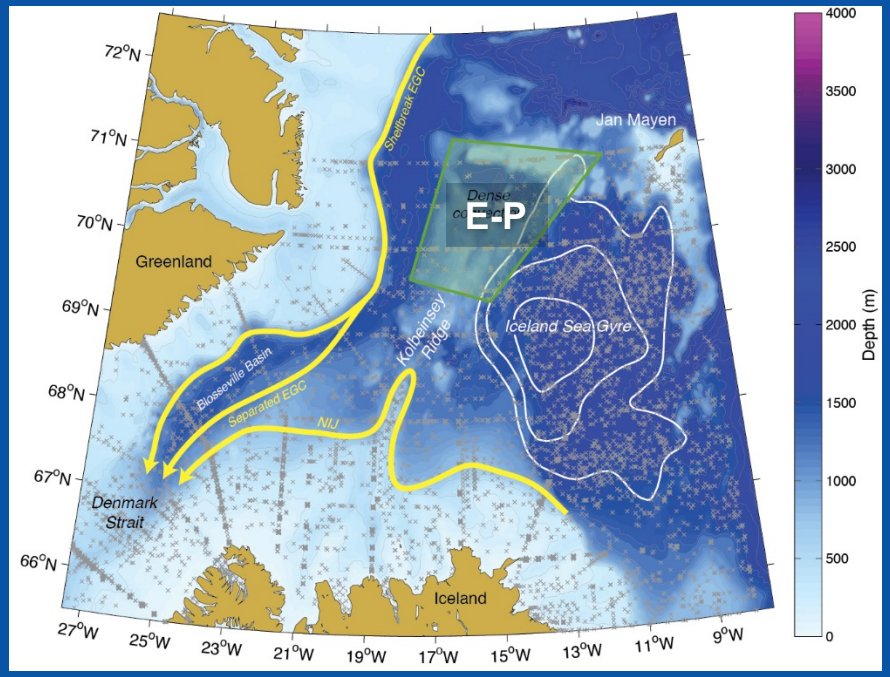
3. Salinity fluctuations of NIJ much smaller than NIIC

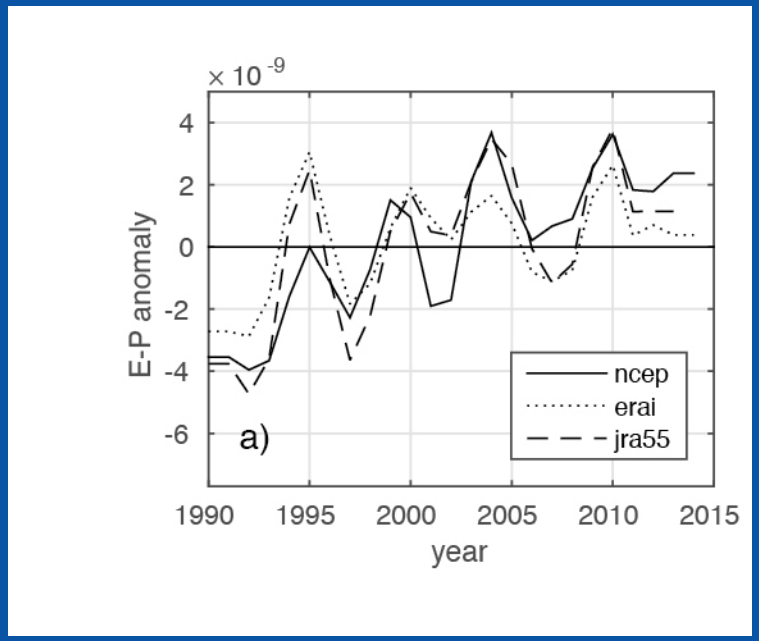
Possibilities:

1. Precipitation
2. Liquid freshwater flux from EGC
3. Solid freshwater flux from EGC

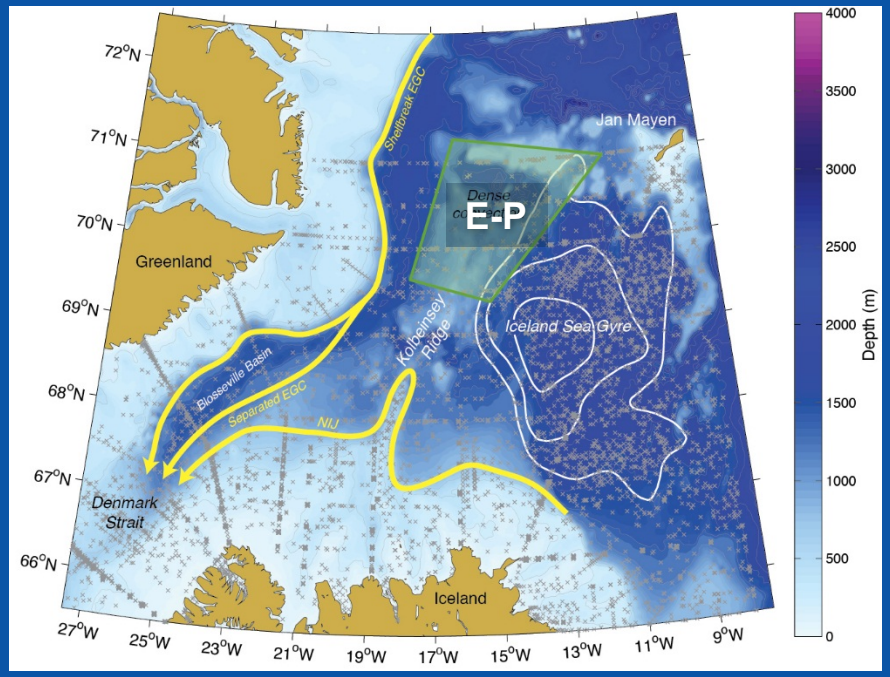
What about this?

Cannot evaluate this





three different reanalysis products



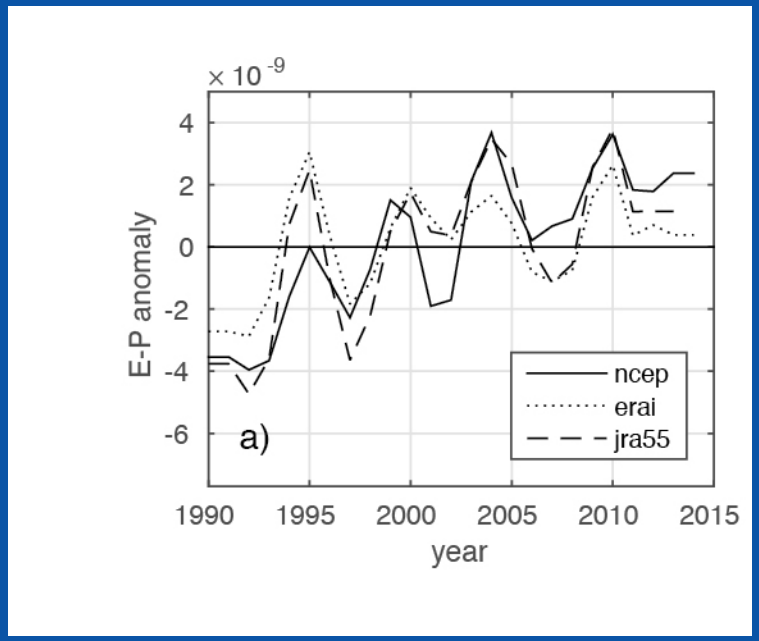
1-D mixing model

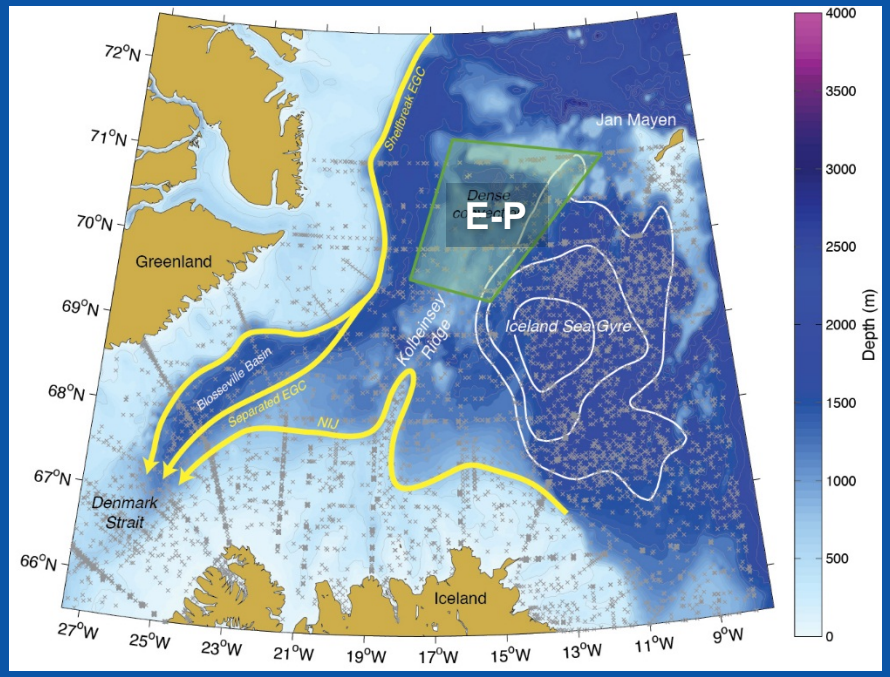
$$\partial S/\partial t = SrE'/H$$

S_r = reference salinity

E' = anomaly of E-P

Assume H = 500m





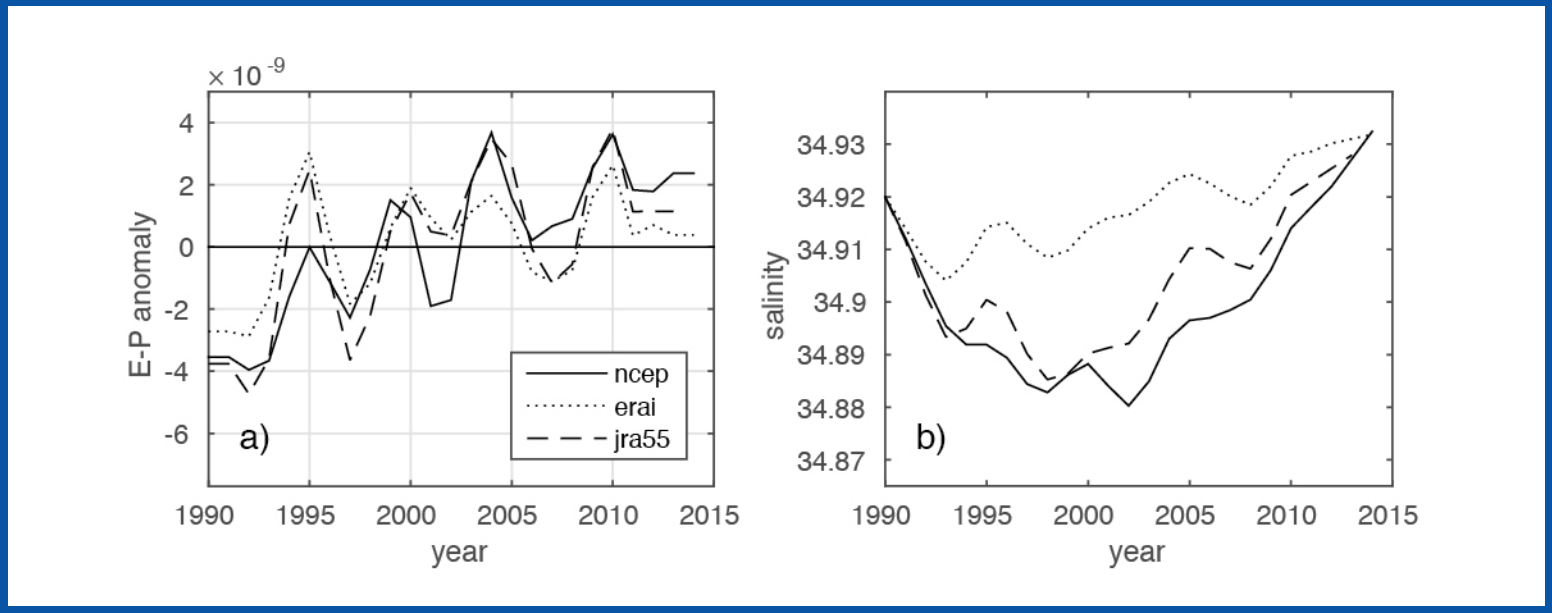
1-D mixing model

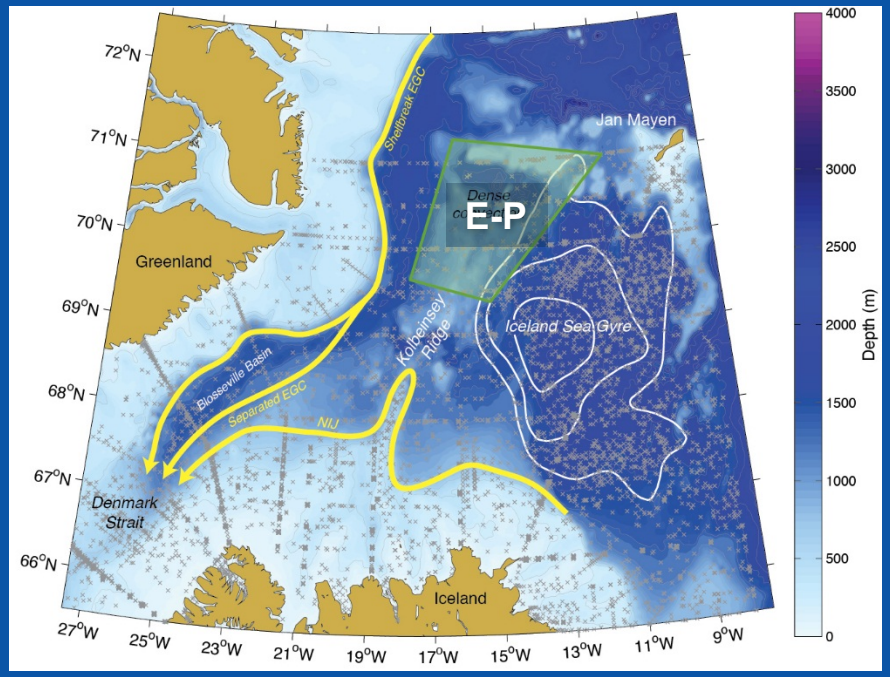
$$\partial S / \partial t = S r E' / H$$

S_r = reference salinity

E' = anomaly of E-P

Assume H = 500m





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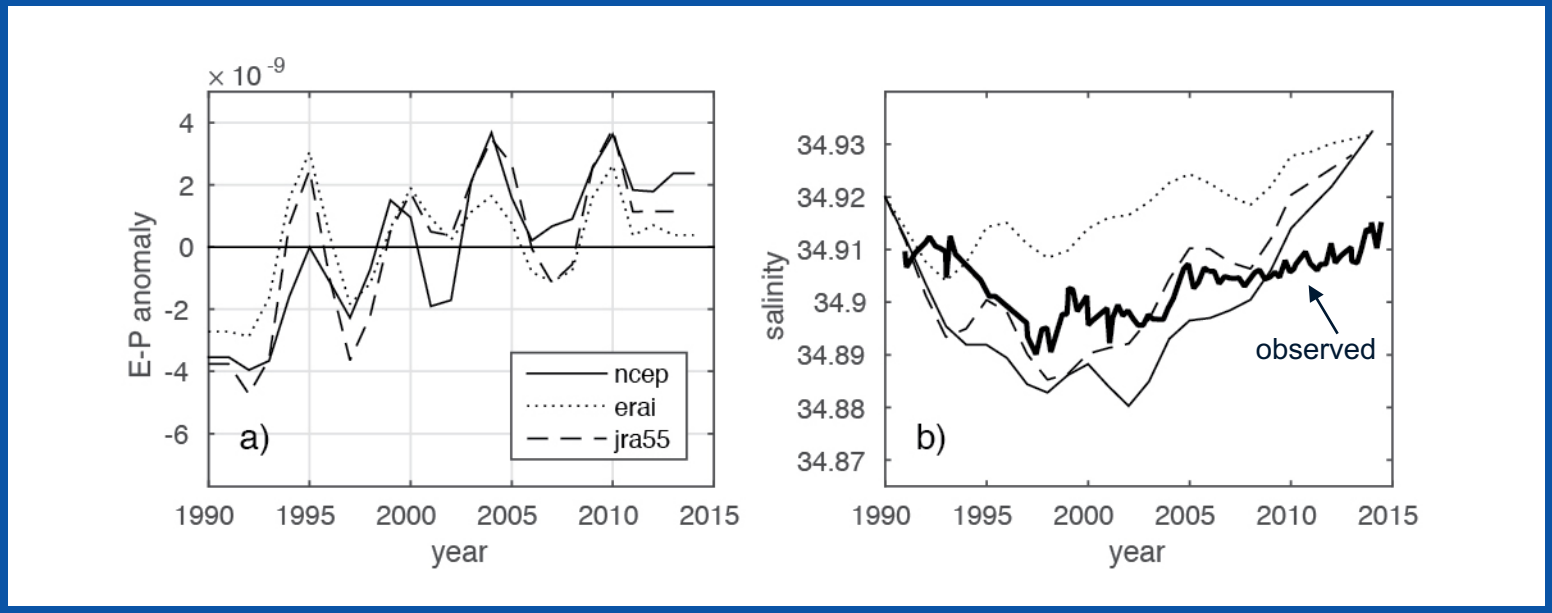

If E-P determines the outflow salinity variations, what determines the inflow salinity variations?

And why are the inflow and outflow in phase?

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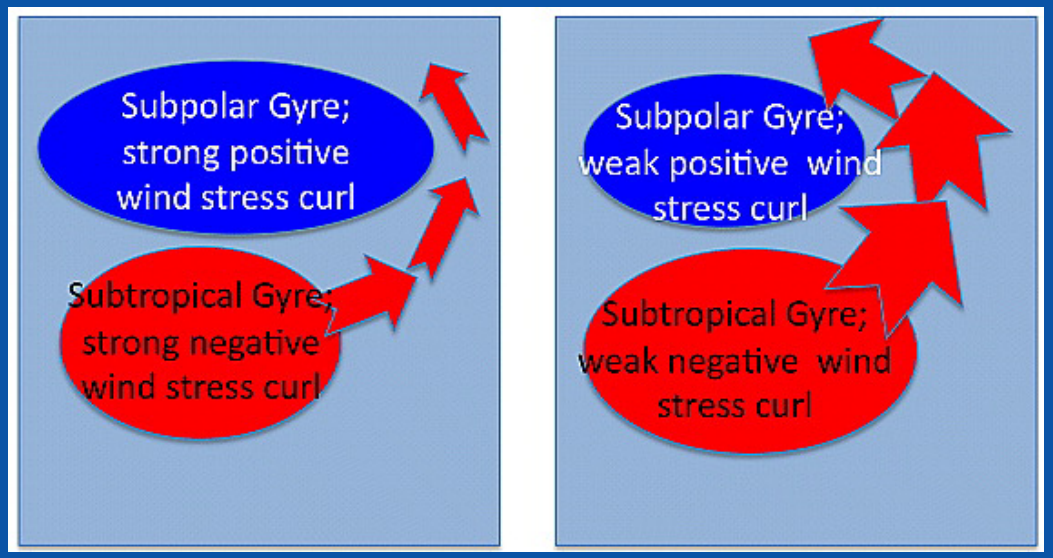
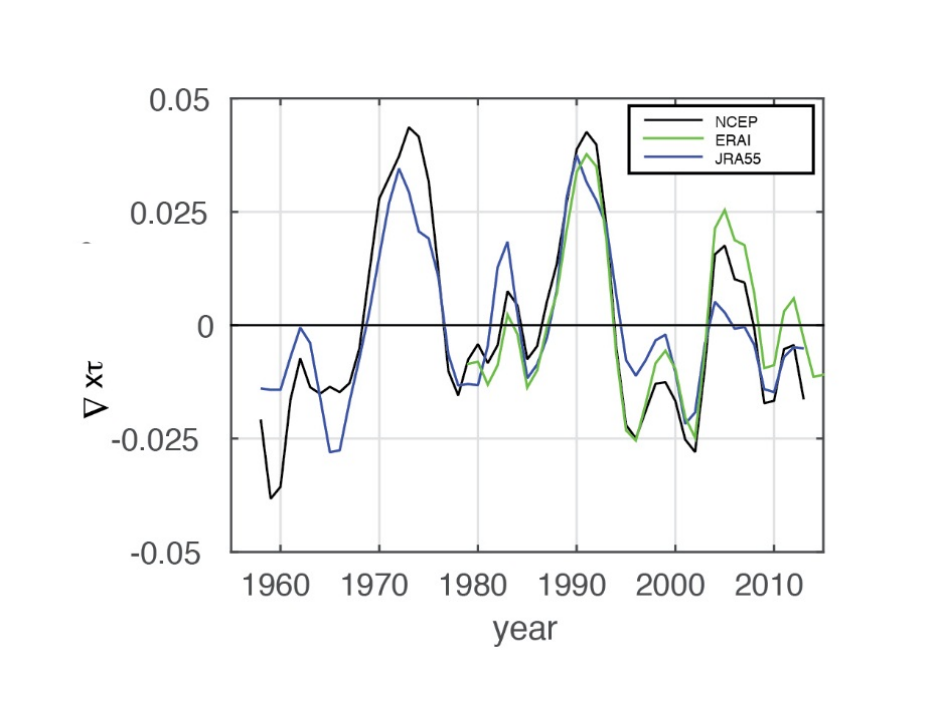
And why are the inflow and outflow in phase?

As demonstrated by previous studies, the wind stress curl over the subpolar gyre helps dictate the supply of subtropical water into the Nordic Seas

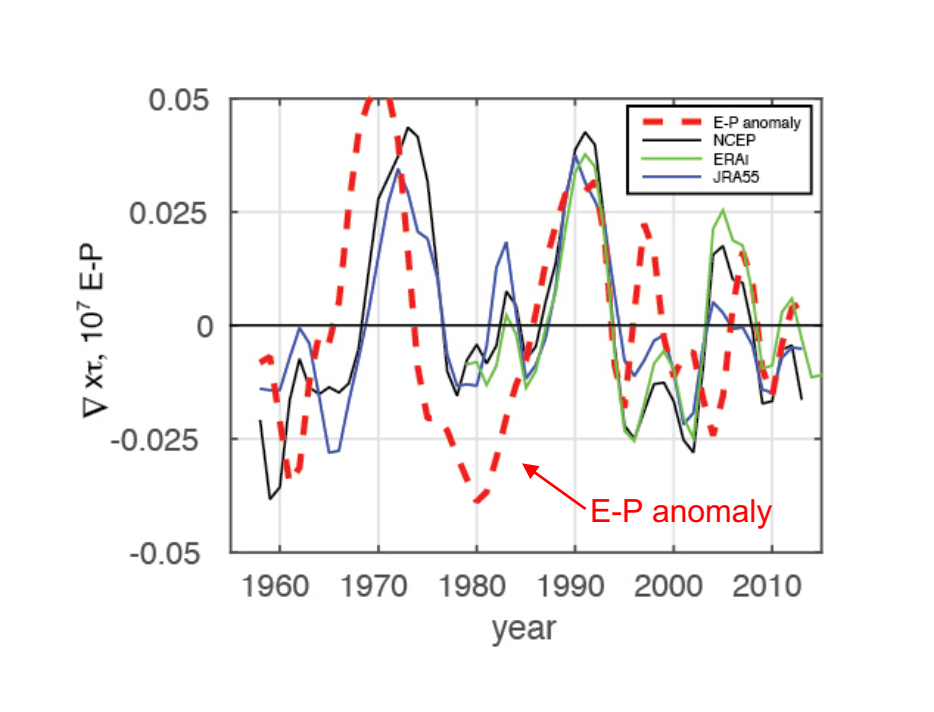


Hakkenin et al. (2011)

decreased inflow **increased inflow**



Wind stress curl anomaly averaged over the subpolar gyre



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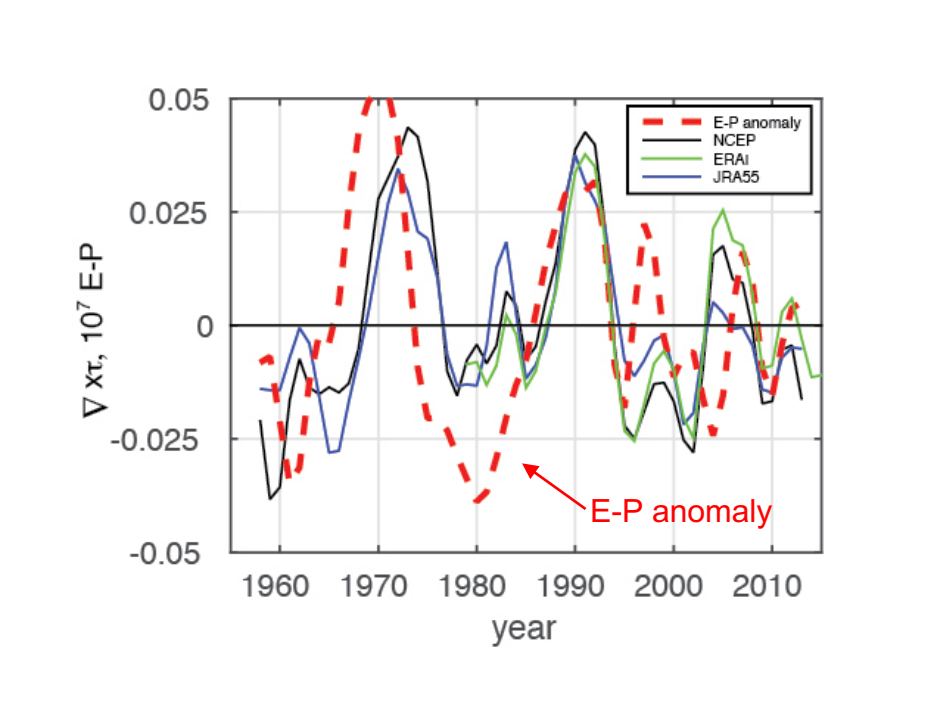
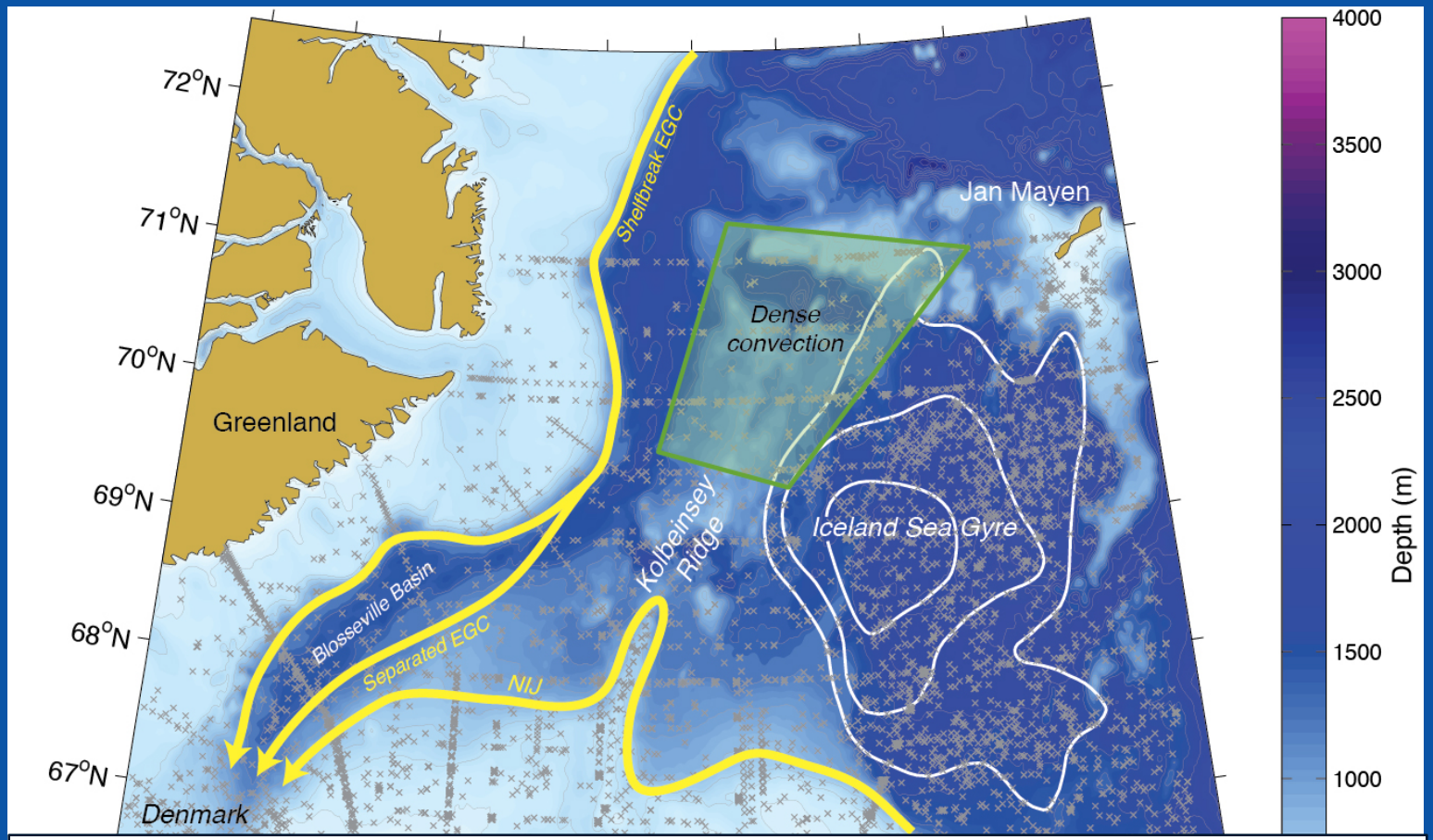


Wind stress curl anomaly averaged over the subpolar gyre

This implies that the large-scale weather patterns that control the low frequency variability of the wind stress curl over the subpolar North Atlantic also influence the E-P fields over the Iceland Sea



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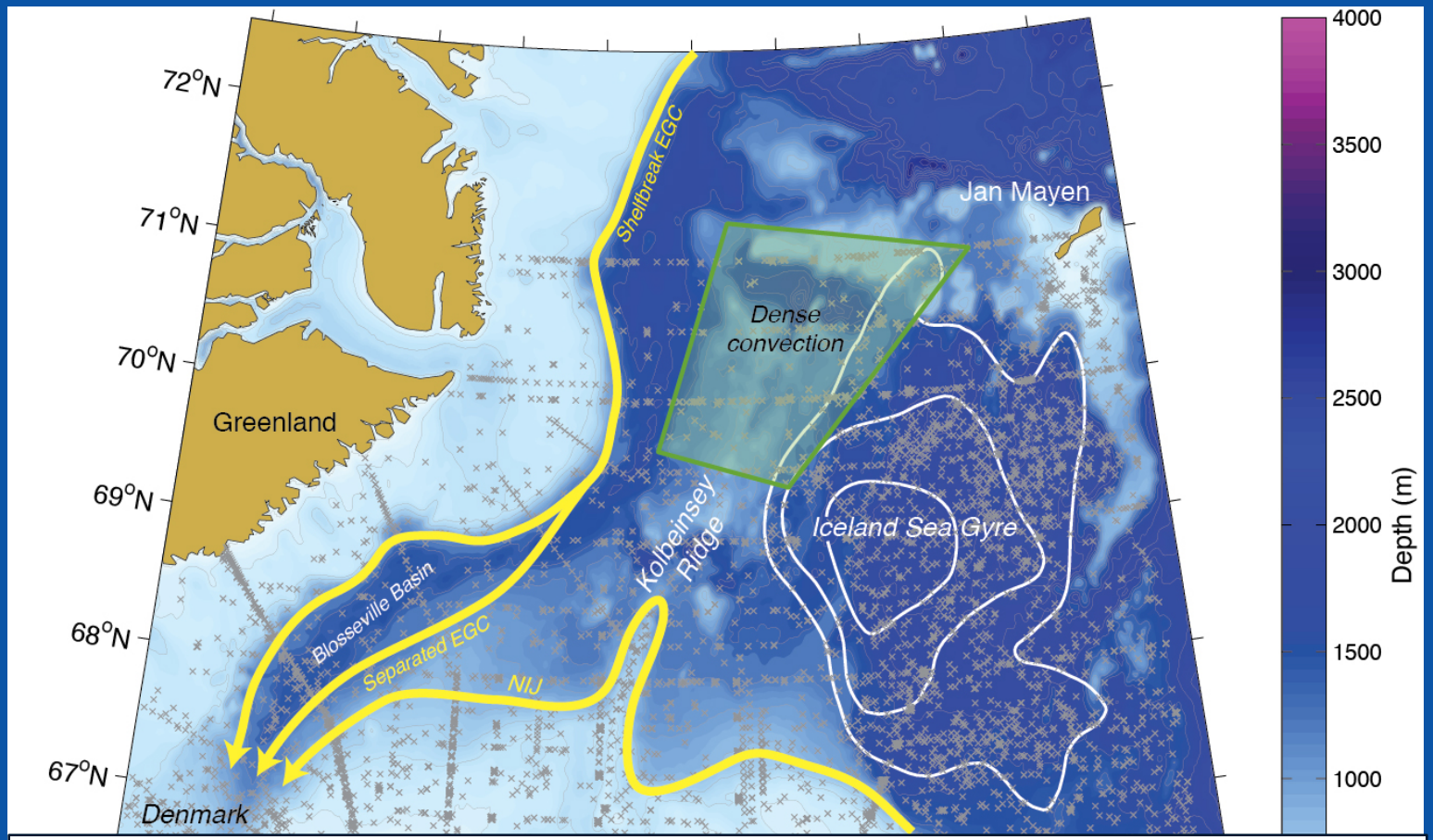

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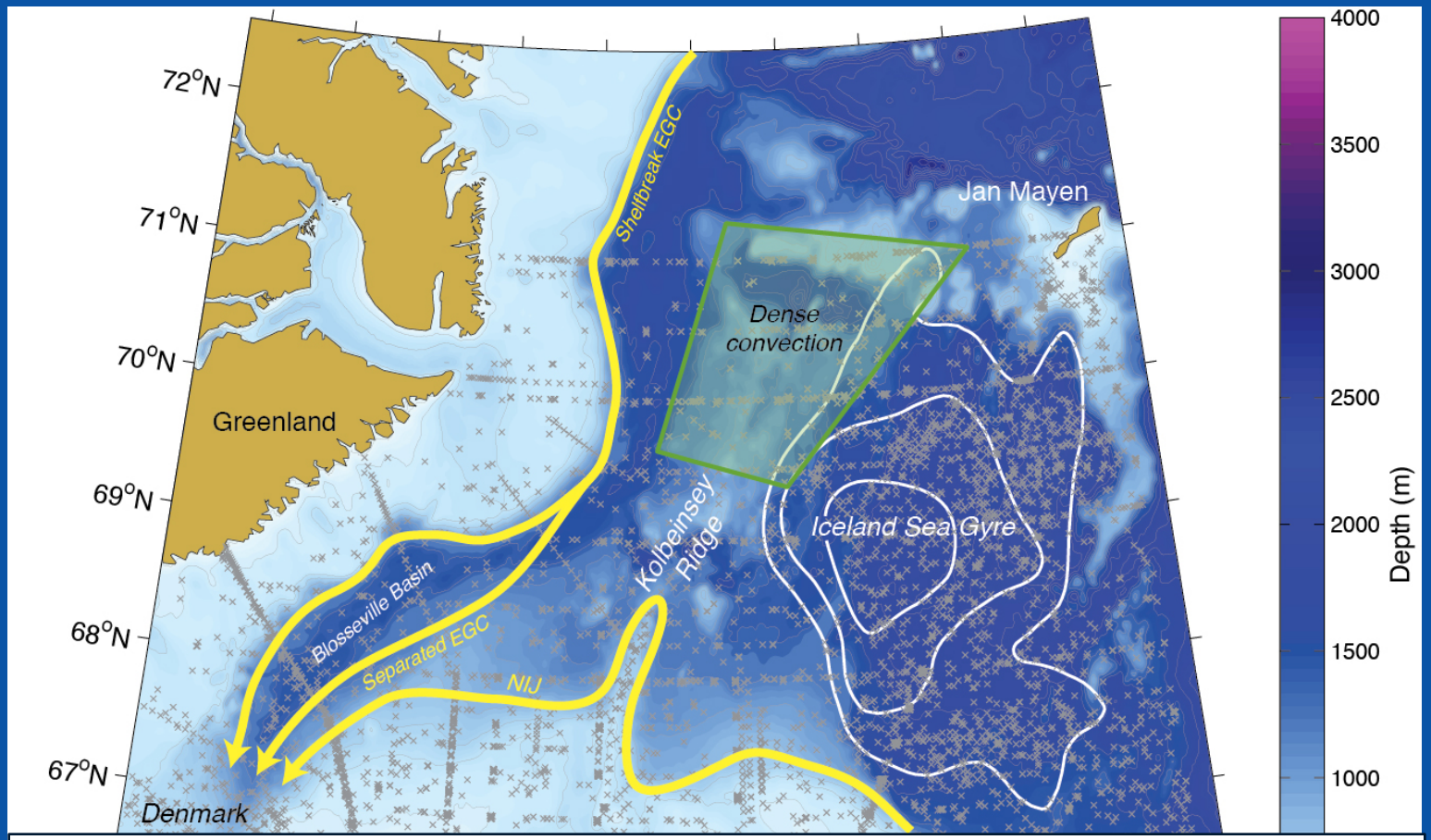

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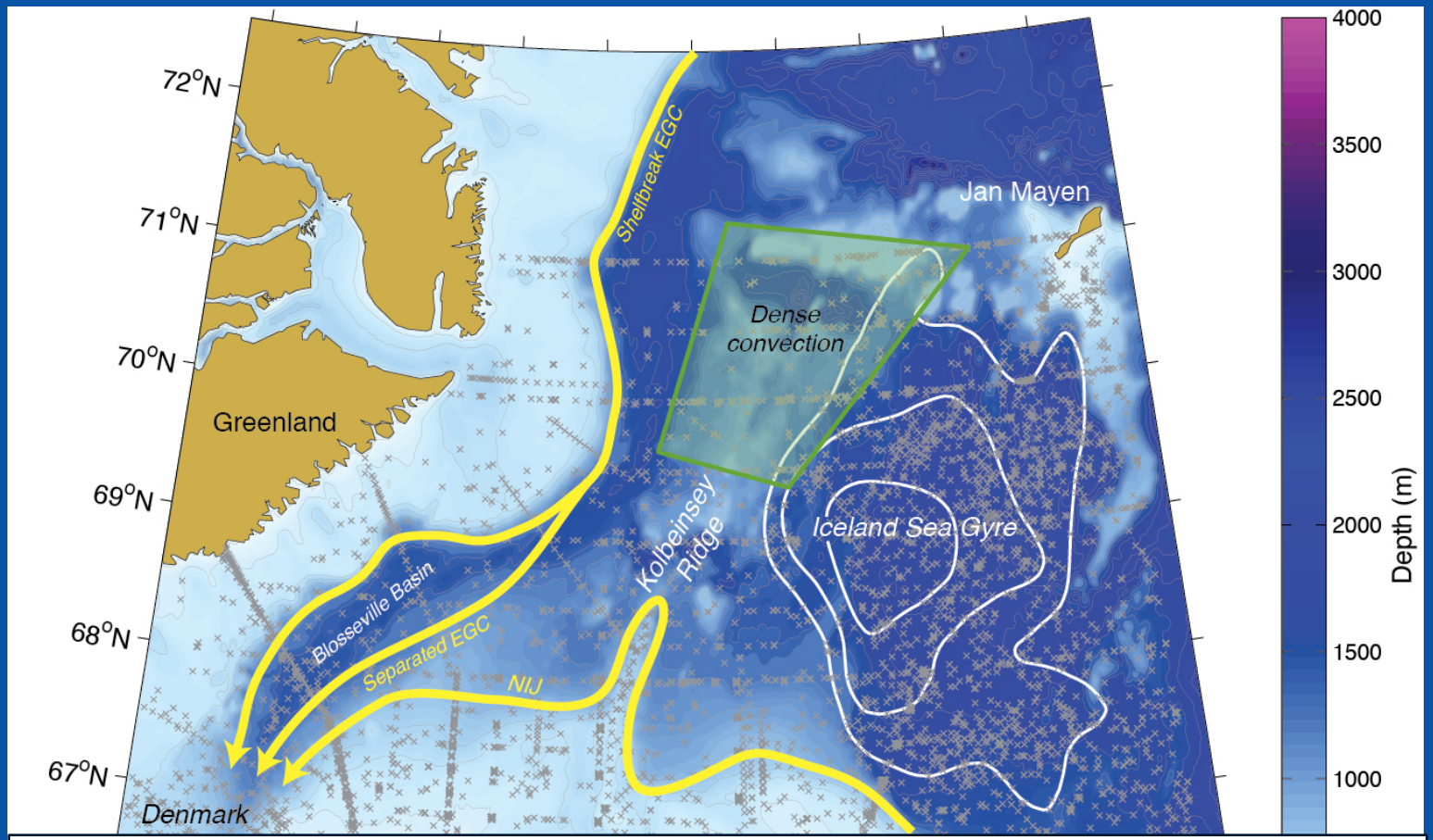

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1. **The E-P imprint on the NIJ seems to happen within 1 year**
2. **The flushing time of the dense water reservoir for 0.5 Sv and 500m is 1 year**
3. **With a modest advective speed of 1 cm/s the advective time from the dense water reservoir to the NIJ is less than 1 year**

Summary

As the NIJ and NIIC flow along the north side of Iceland they appear to “lock” to each other when the bottom topography steers them close together.
Even when they are separate, there is a poleward flow inshore of the NIJ.

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The interannual variability of the inflow salinity is dictated by wind stress curl over the subpolar gyre; the variability of the outflow can be explained by in-phase changes in E-P over the Iceland Sea.