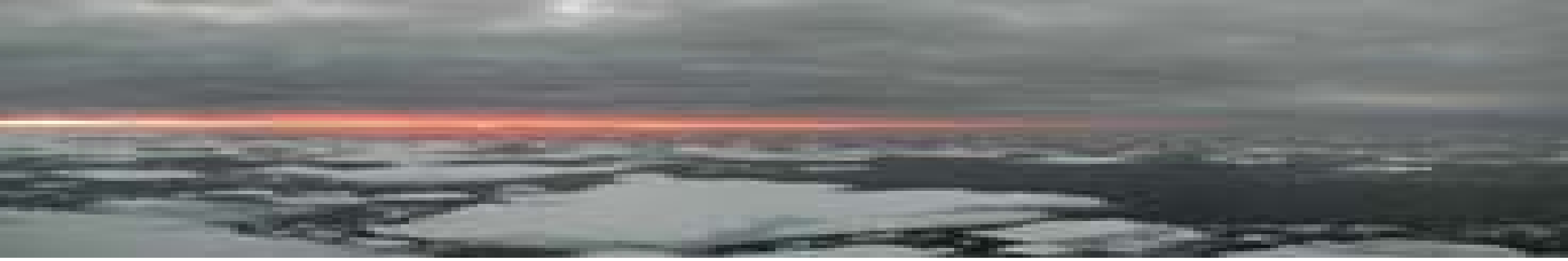


NESSAR:

A Frontal Attack during IPY

Ken Drinkwater representing a cast of Many

PICES ASM, Workshop 3, Friday Oct 24, 2008

Dalian, China

Ecosystem Studies of Sub-Arctic Seas ESSAS

IPY International Polar Year

GLOBEC

NESSAR Objective

•***quantify the impact of climate variability on the structure and function of Arctic marine ecosystems of the Nordic and Barents seas in order to predict the ecosystem response to possible future climate change, with particular focus on Fronts.***

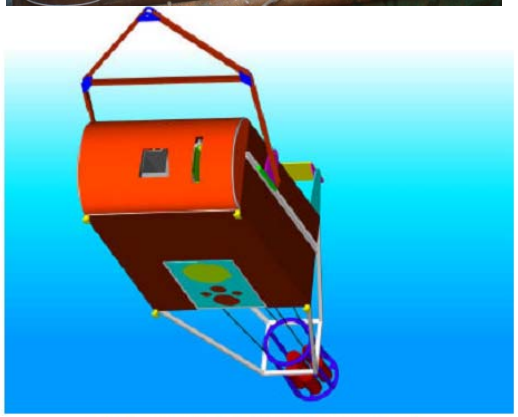
- Field studies in 2007 and 2008
- Arctic Front in the Norwegian Sea (1 cruise/year)
- Polar Front in the Barents Sea (2 cruises/year)

NESSAR Questions

- *What are the physical processes responsible for the maintenance and variability of the front?*
- *How does community structure and standing crop vary across the front?*
- *How do the physical processes influence the biology at the front?*
- *How do different spectral wavelengths of light affect phytoplankton production?*
- *How does sea ice affect ecosystem structure in and around the front?*
- *How do fish species use the front to feed?*
- *How do the Barents and Norwegian Sea fronts compare to other subarctic and arctic regions?*

Field Measurements and Instrumentation

- Currents: Moorings (Norwegian Sea), Shipboard ADCP
- Hydrography: CTD, Thermosalinograph
- Turbulence: Microstructure profiler (except Barents Sea 2007)
- Glider: T, S, Fluorescence (except Barents Sea 2008)
- Nutrients, Oxygen, Chlorophyll-a
- Dissolved Organic Carbon
- Light Spectra:
- Bacteria: From bottle samples
- Phytoplankton: Nets & bottle samples)
- FRRF: (Primary Production)
- Zooplankton: MESSOR, ScanFish, MOCNESS, Macroplankton trawl)
- Benthos: Grabs, Dredges
- Fish: Acoustics, Trawling (herring in Norwegian Sea, capelin in Barents Sea



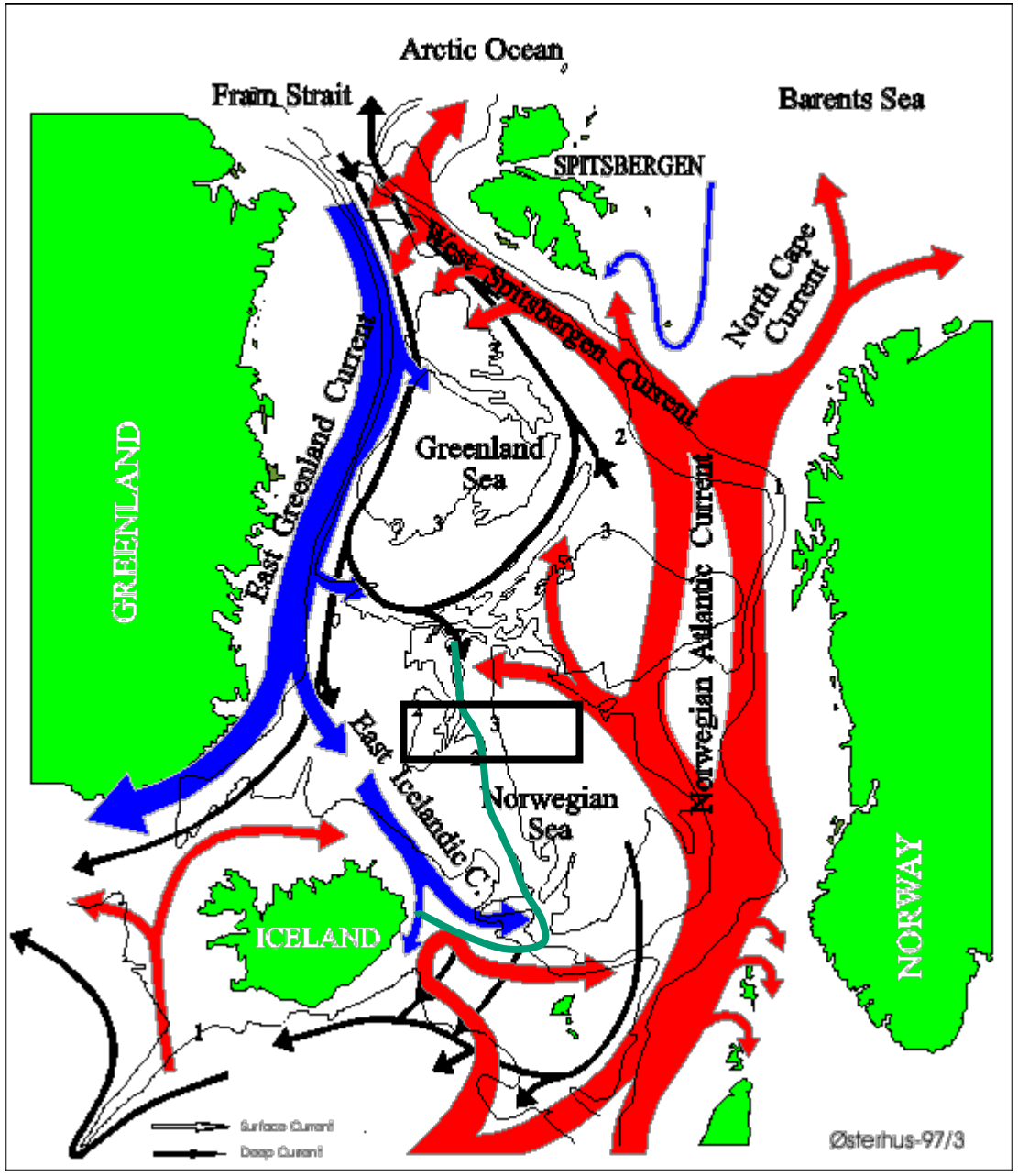
Figur 6 Farkost under med Multinett og svingere

Norwegian Sea

Jan Mayen Island

G.O. Sars – June 2007

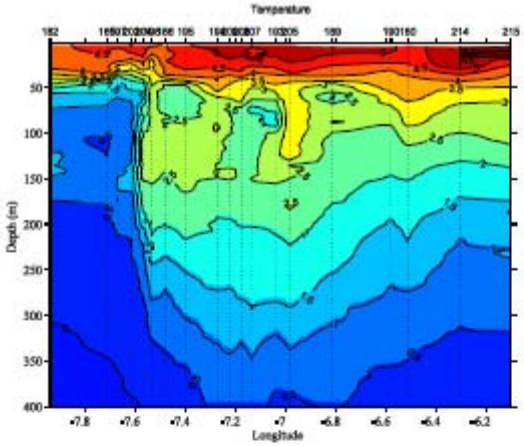
Johan Hjort- May, June 2008

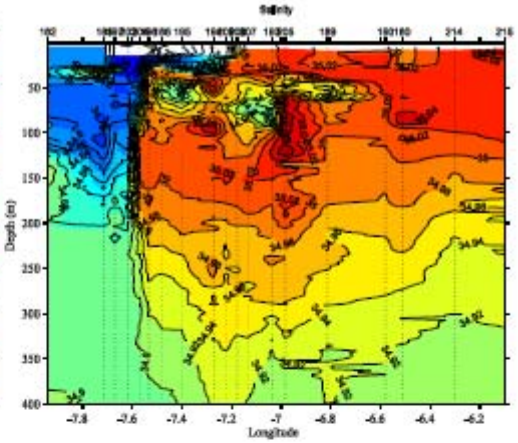

Arctic Ocean
Fram Strait
Barents Sea
SPITSBERGEN
West Spitsbergen Current
North Cape Current
East Greenland Current
GREENLAND
Greenland Sea
Norwegian Atlantic Current
East Icelandic C.
Norwegian Sea
ICELAND
NORWAY
Surface Current
Deep Current
Østerhus-97/3

From 2007
CTD data

Temperature

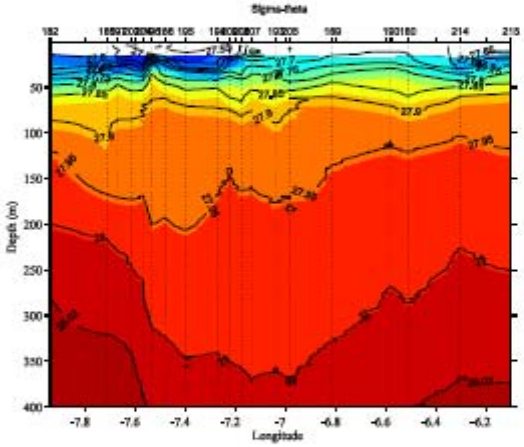
400 m

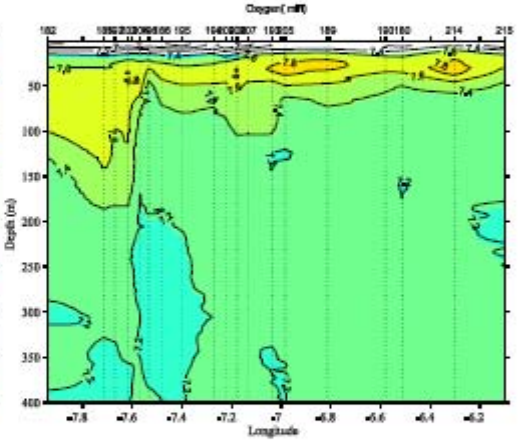




Salinity

Sigma-theta

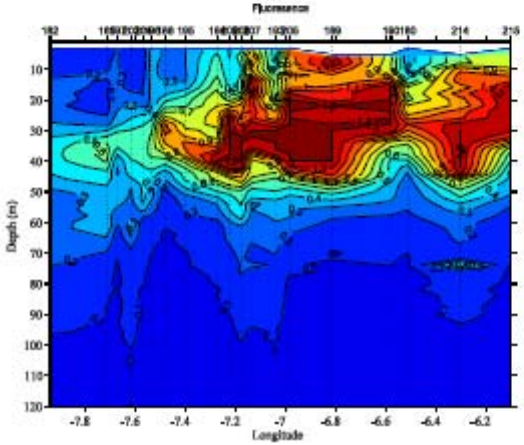




Oxygen

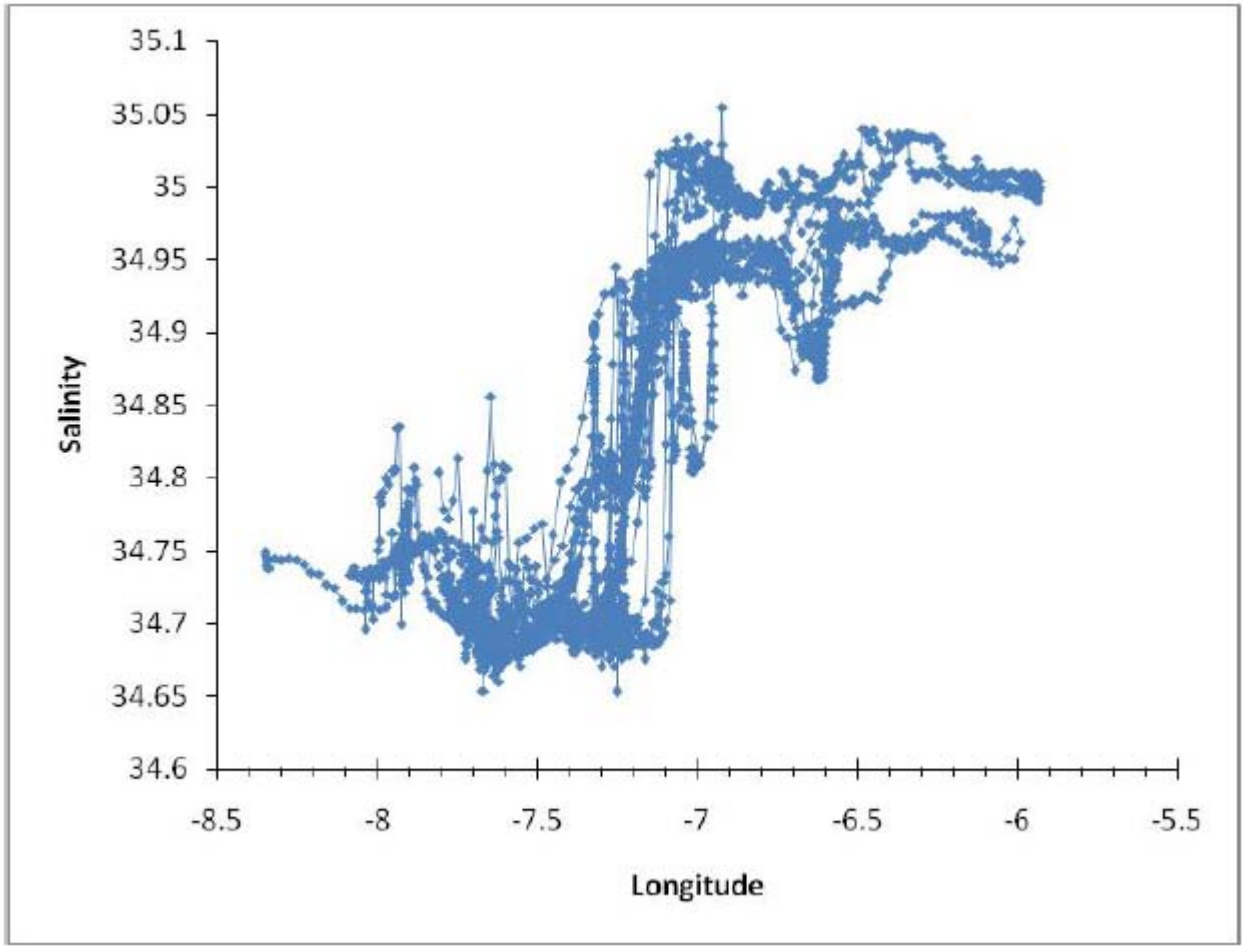
40 km

Flourescence



Note highest chlorophyll-a in Atlantic Water with no evidence of enhanced production at the Front.

Salinity Difference across the Shallow Front

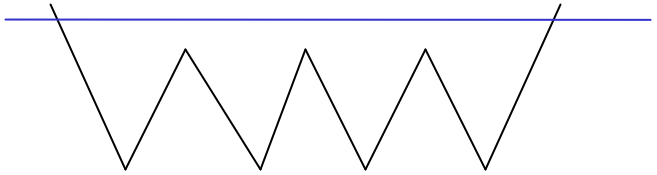


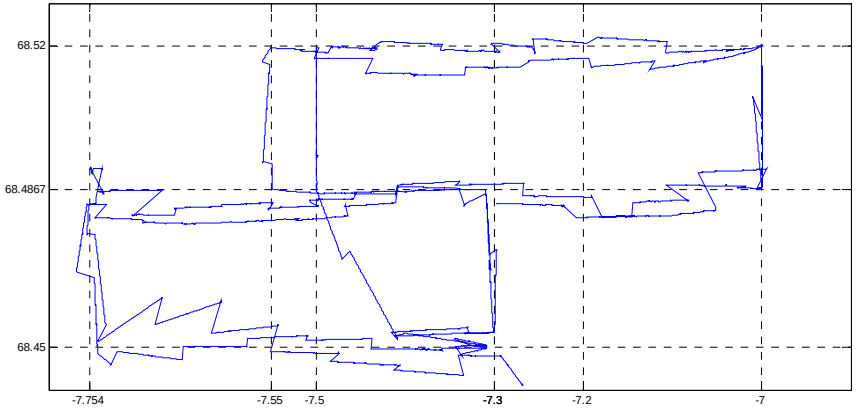
40 km

Glider Deployment

-first deployment of an autonomous glider by Norway

- Two-way Communication via satellite
- Travels between specified points
- Makes sawtooth vertical profile by variable buoyancy





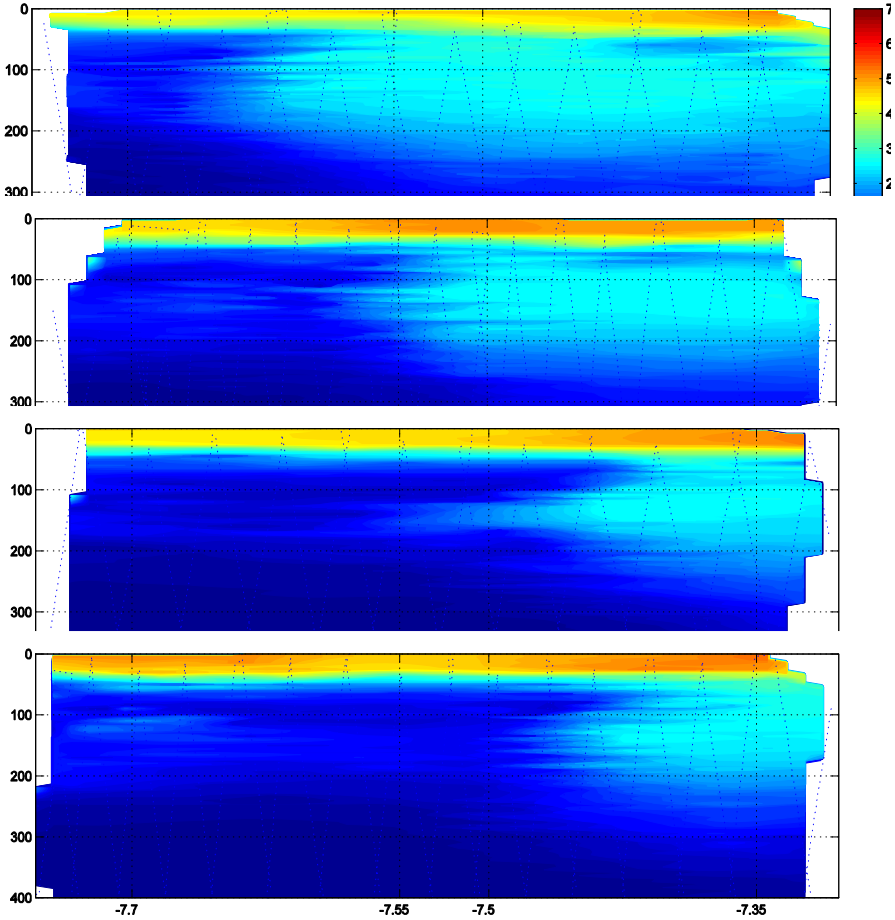
- Box-shaped transects
- Dove to 400 m
- Deployed for 10 days

Glider Results

Arctic Water

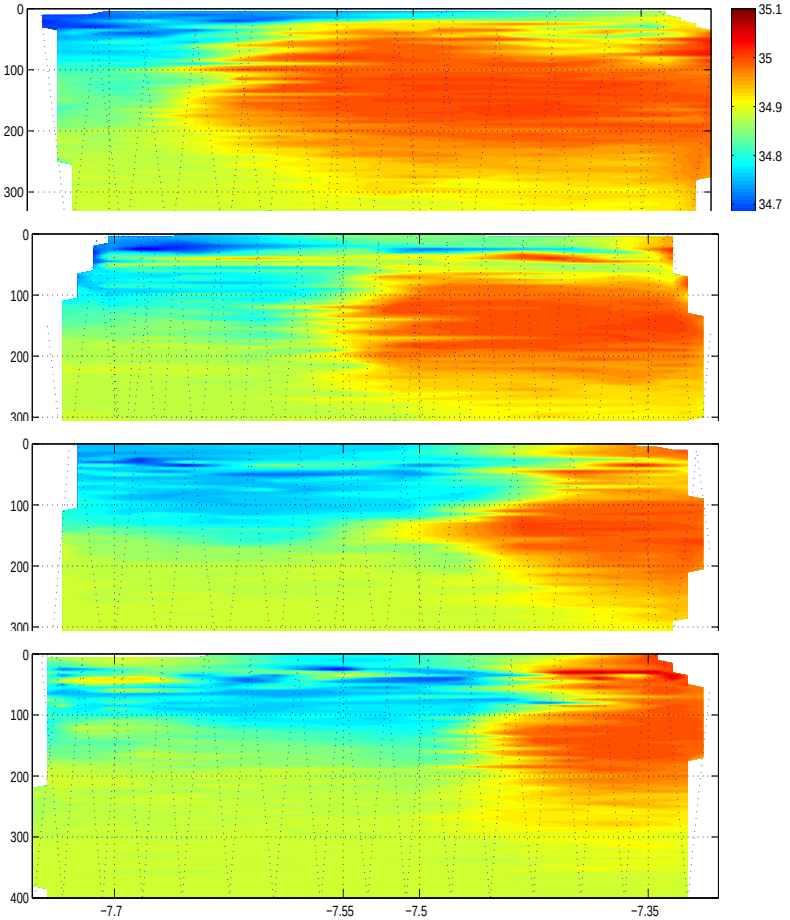
Temperature

Atlantic Water



8 km

Salinity

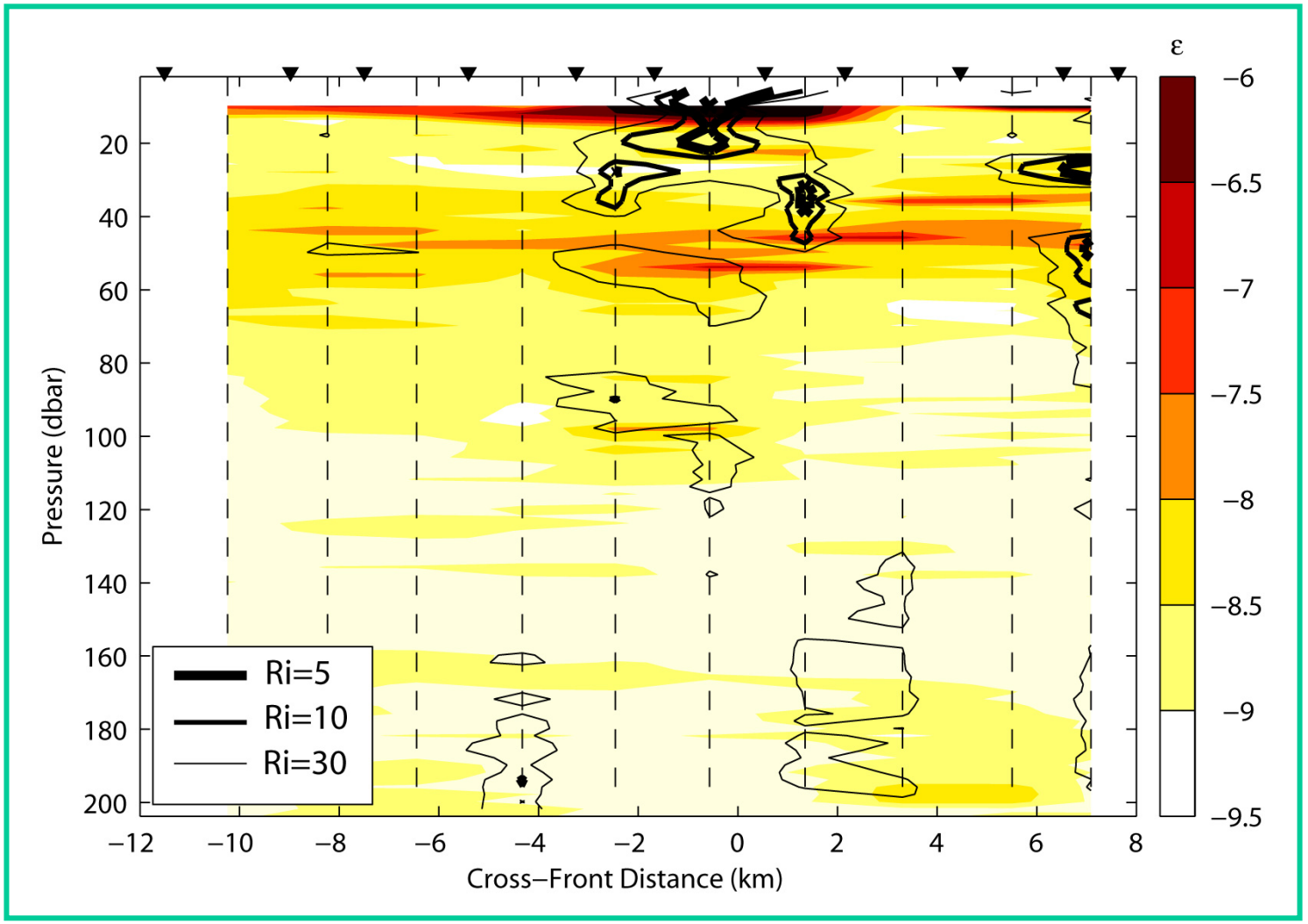


Arctic Water

Atlantic Water

Evidence of interleaving: Isopycnal mixing

Turbulence Measurements



Higher turbulence and energy dissapation in the front due to both current shear as well as double diffusive processes.

Pheopigments

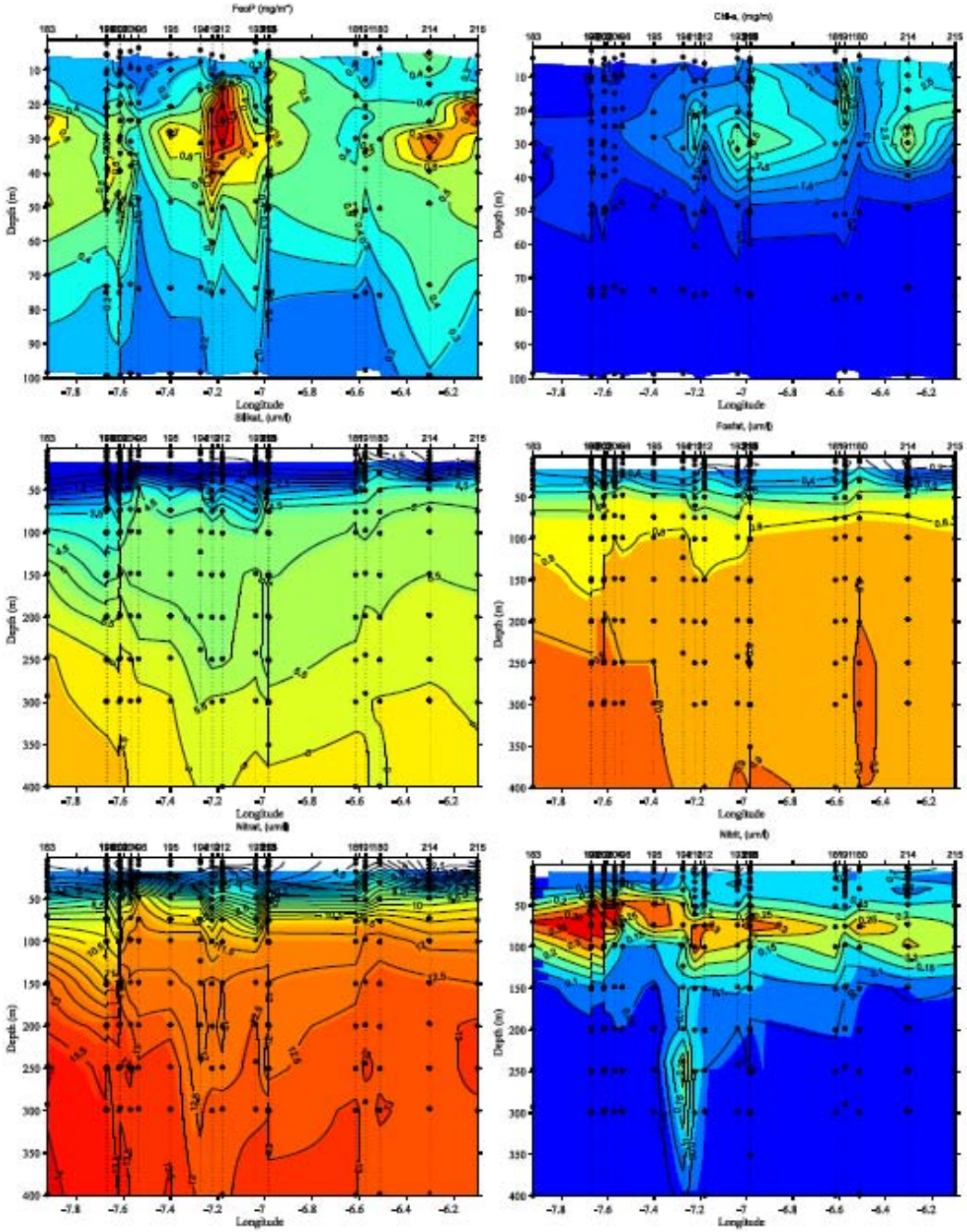
Chlorophyll-a

Silicates

Phosphorous

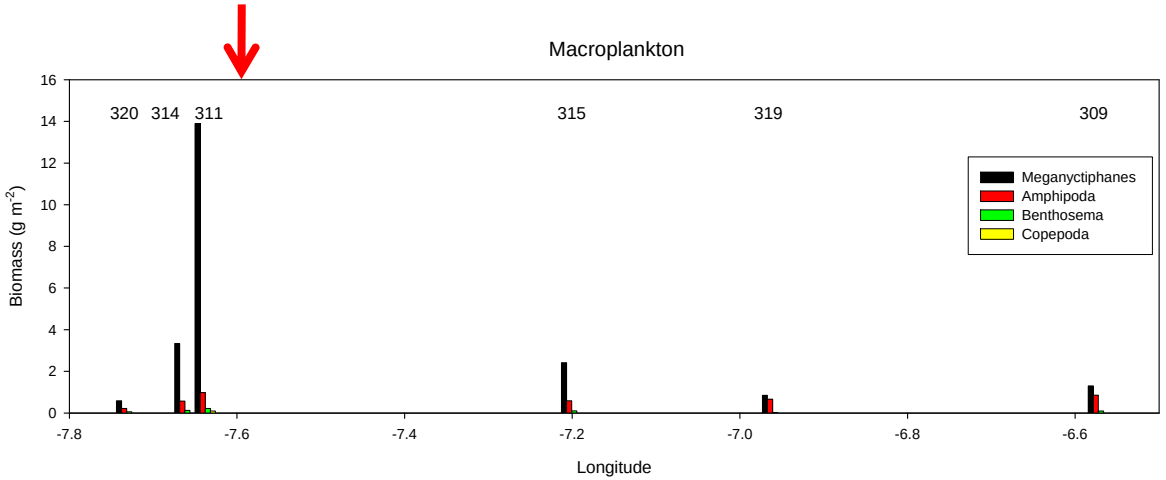
Nitrates

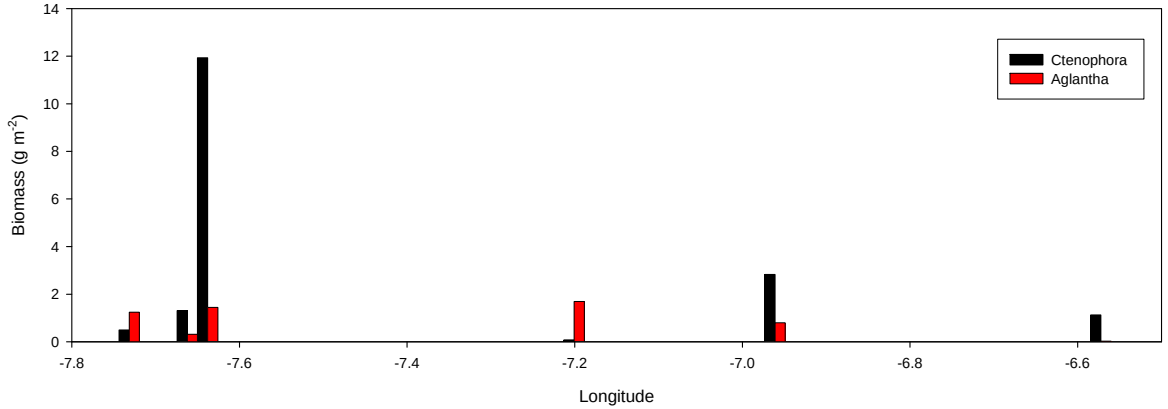
Nitrites

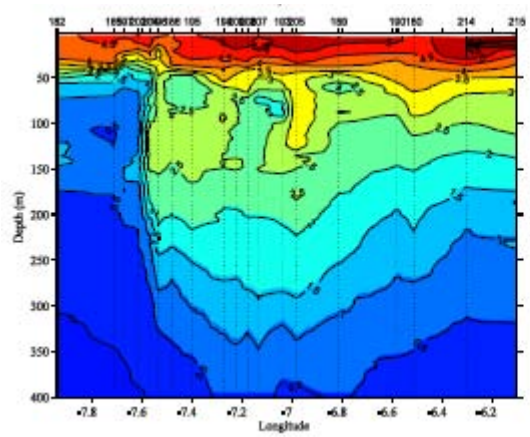


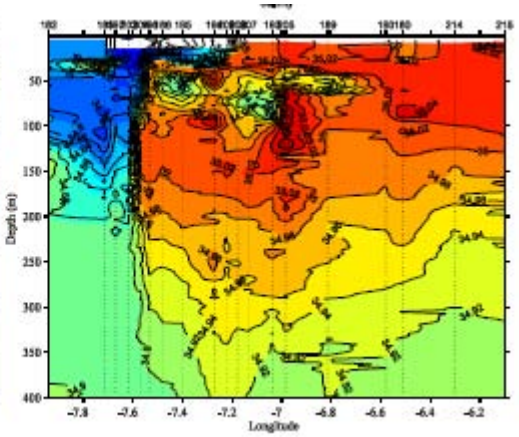
From bottle data

Macro-zooplankton

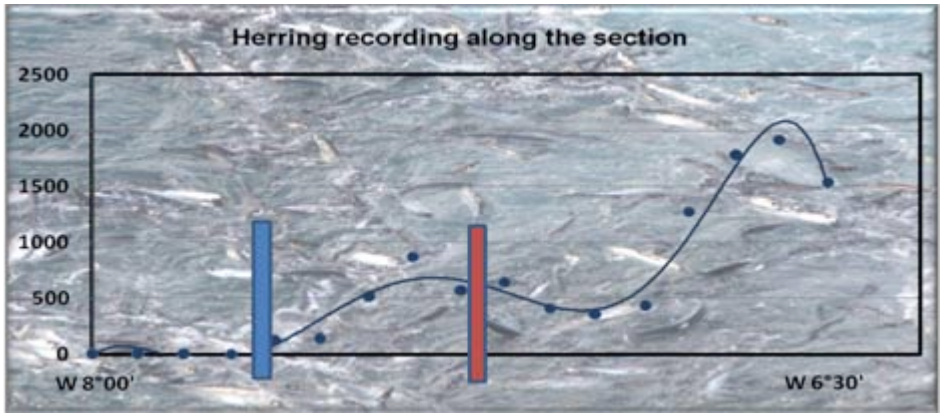


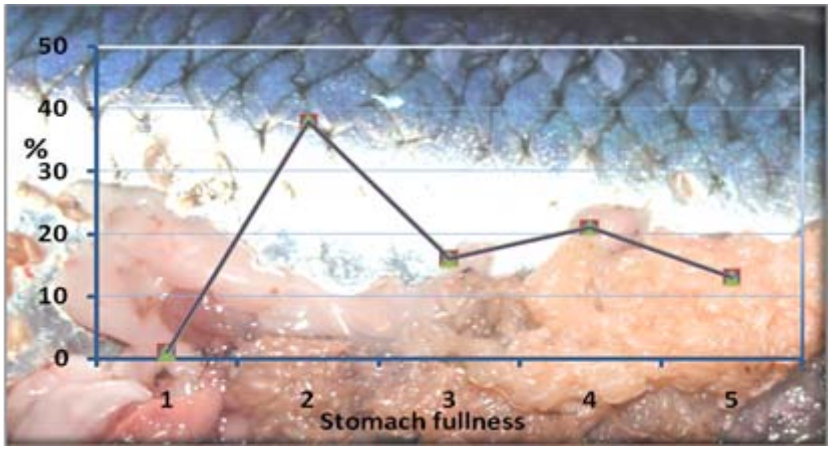


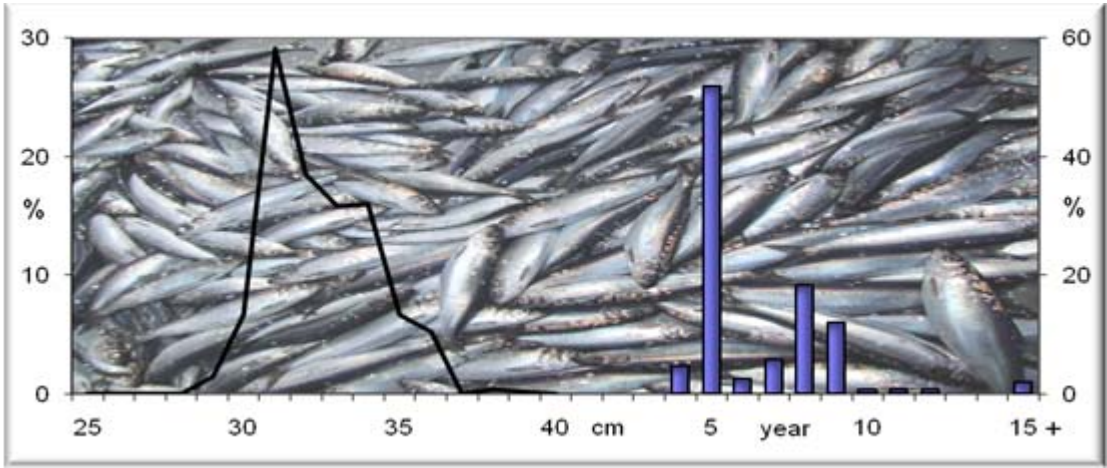


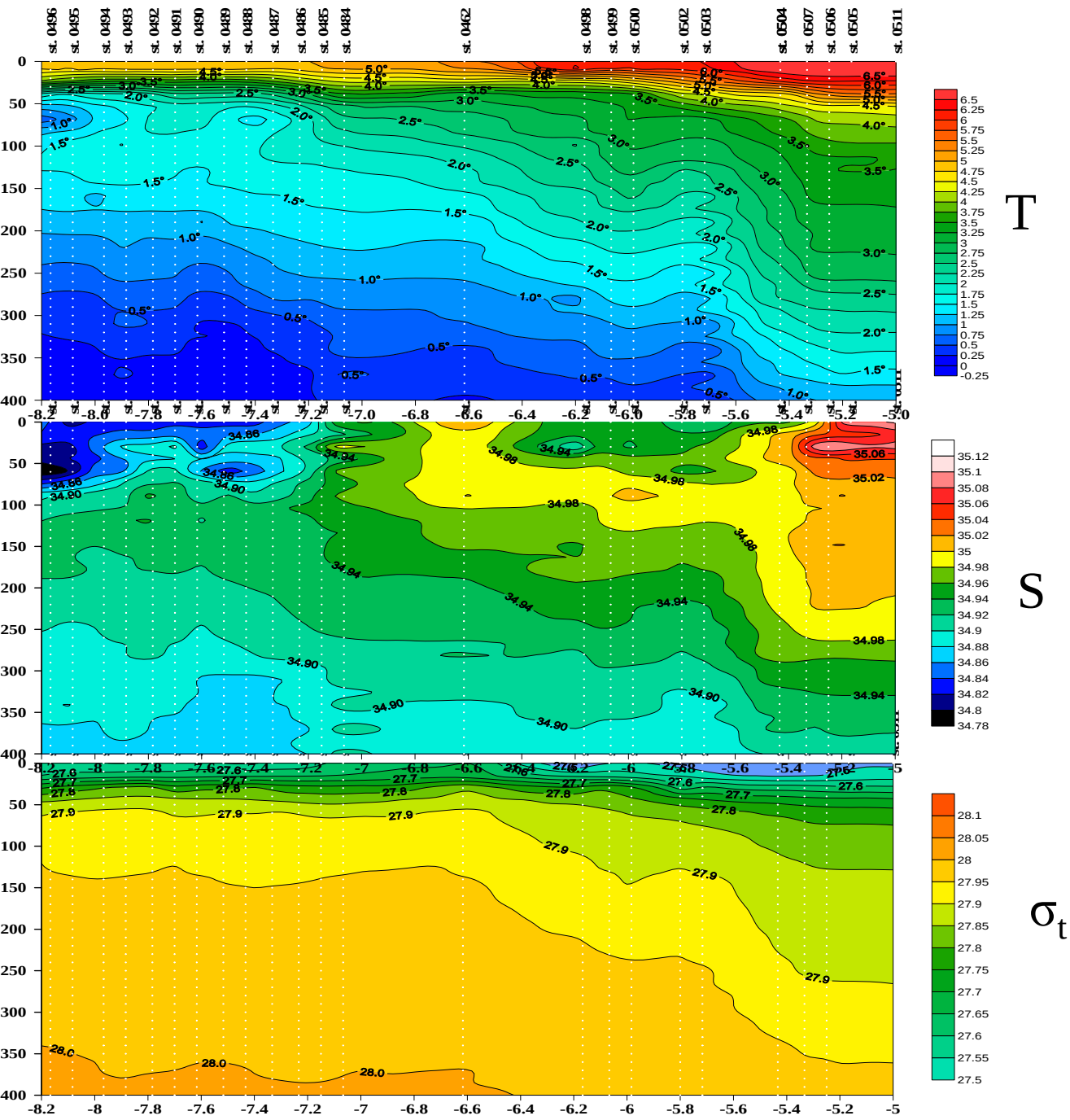


Atlantic Herring Distribution and Diet

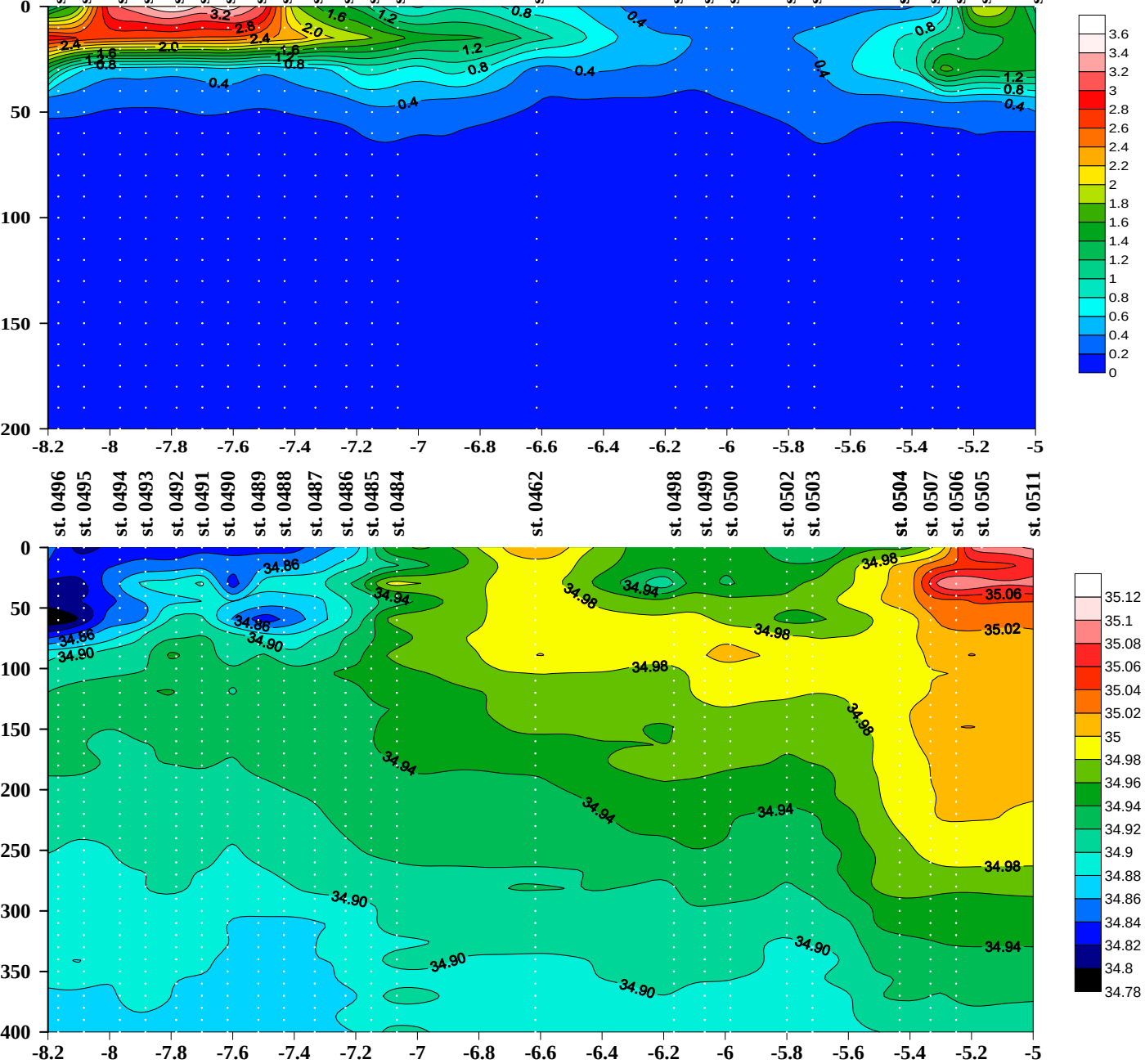




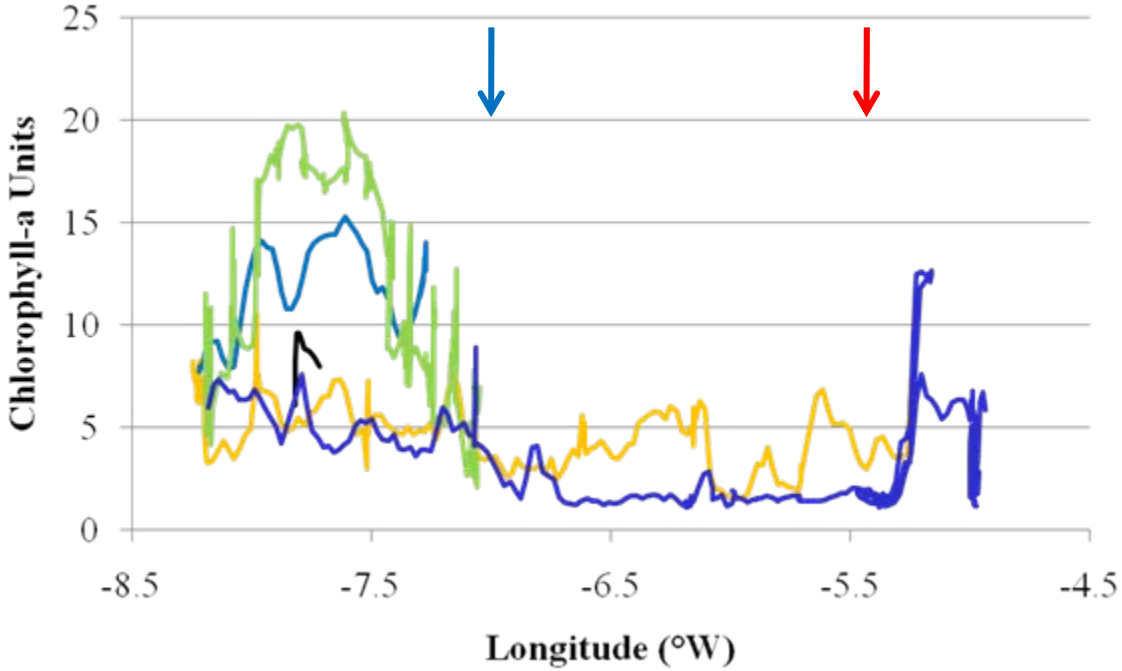




In 2008 deep Arctic Front was more diffuse and surface salinity front was to the west of the deep front.



In 2008 chlorophyll-a highest in Arctic Water but again no evidence of increased chlorophyll at the Front.



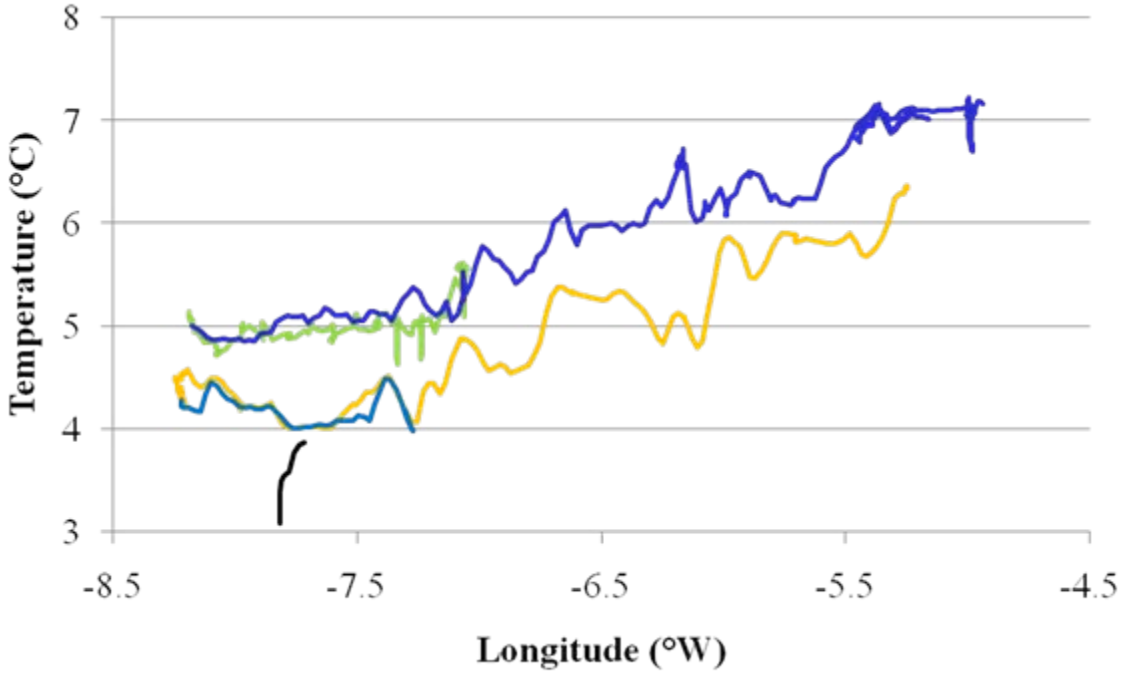
Day

148.3
152.3-153
153-153.1
154.9-156.5
156.5-157.9

Shallow Front

Deep Front

Thermosalinograph data show that we were in a time of increasing chlorophyll-a.



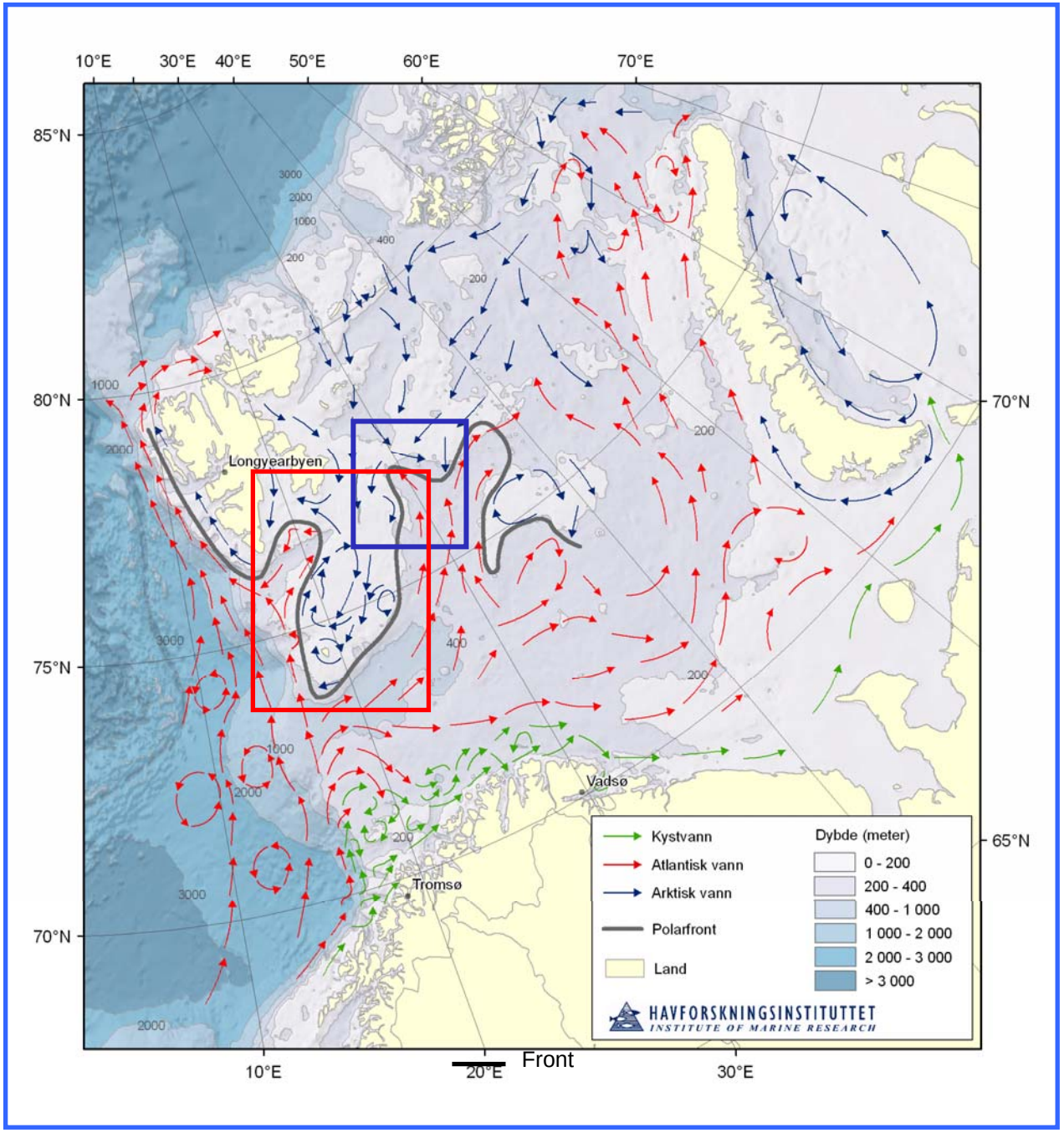
148.3
152.3-153
153-153.1
154.9-156.5
156.5-157.9

Barents Sea Cruises

R.V. Jan Mayen
August 2007
April-May 2008

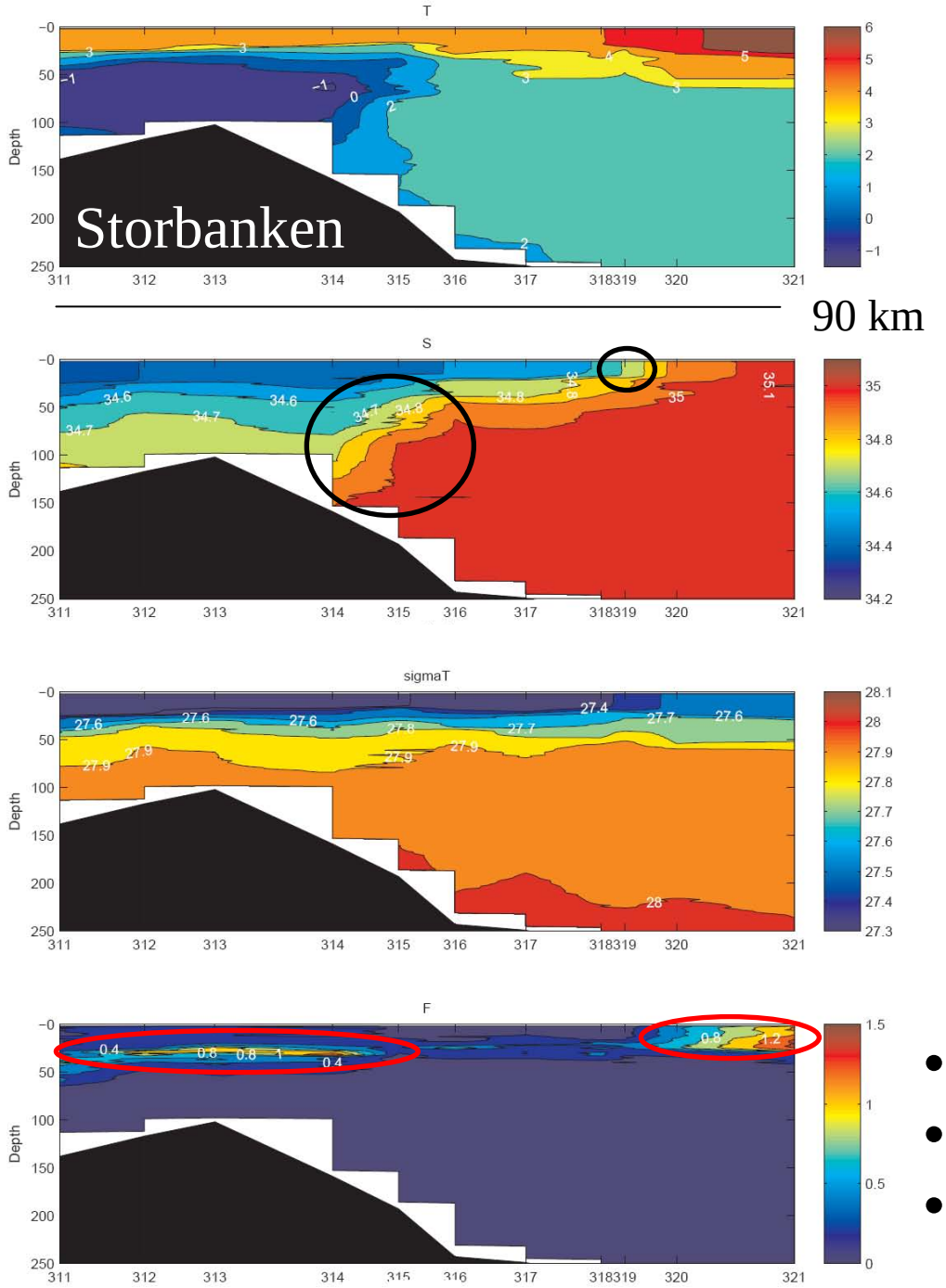
Walrus on the ice

Western



Lance
(2007-2008)

Jan Mayen
(2007-2008)



Surface Salinity Front

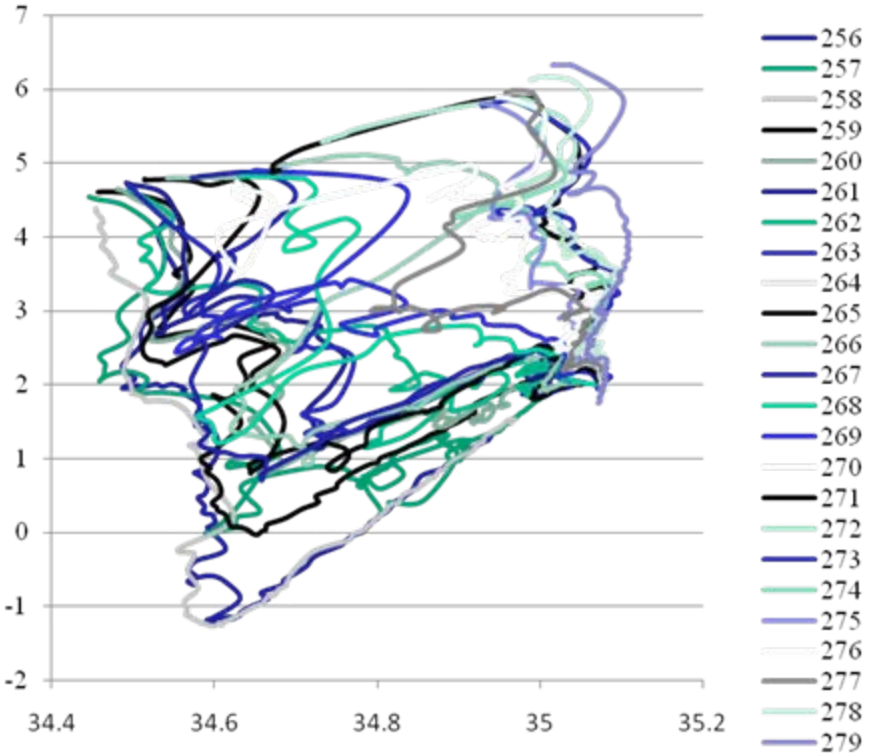
- Weak T contrast

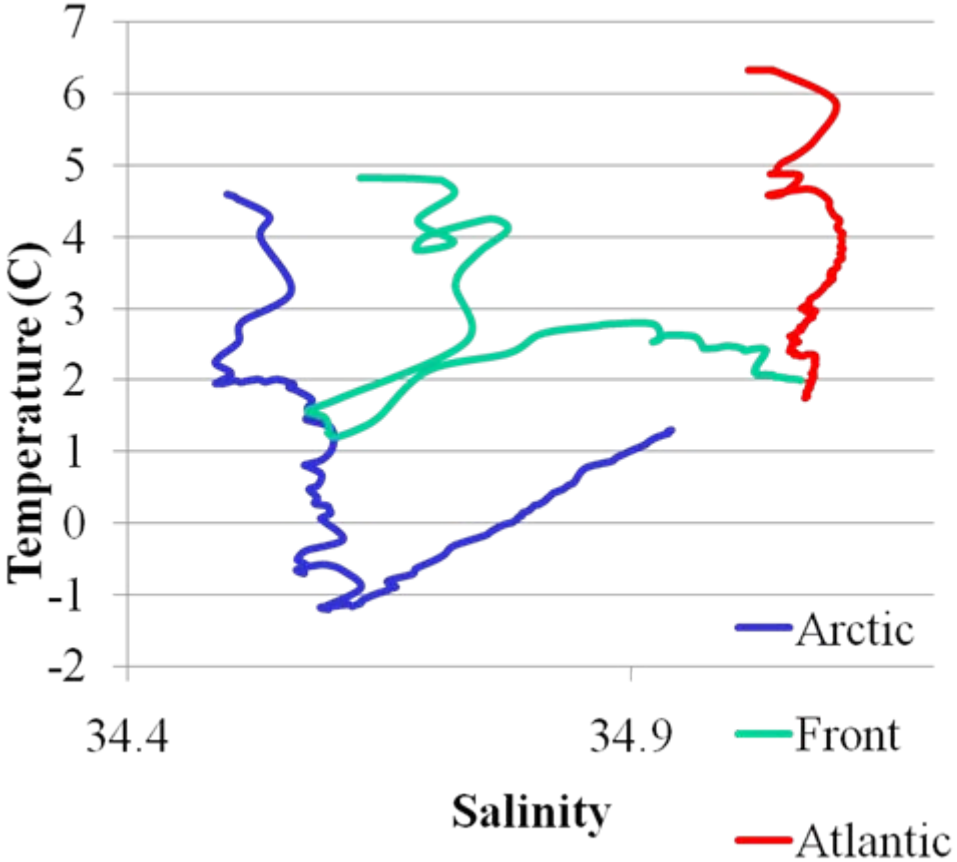
Polar Front (50-150 m)

- T, S, weak density contrast

- Surface chl-a max. in Atlantic W.
- Subsurface max. in Arctic W.
- Lower chl-a in Front

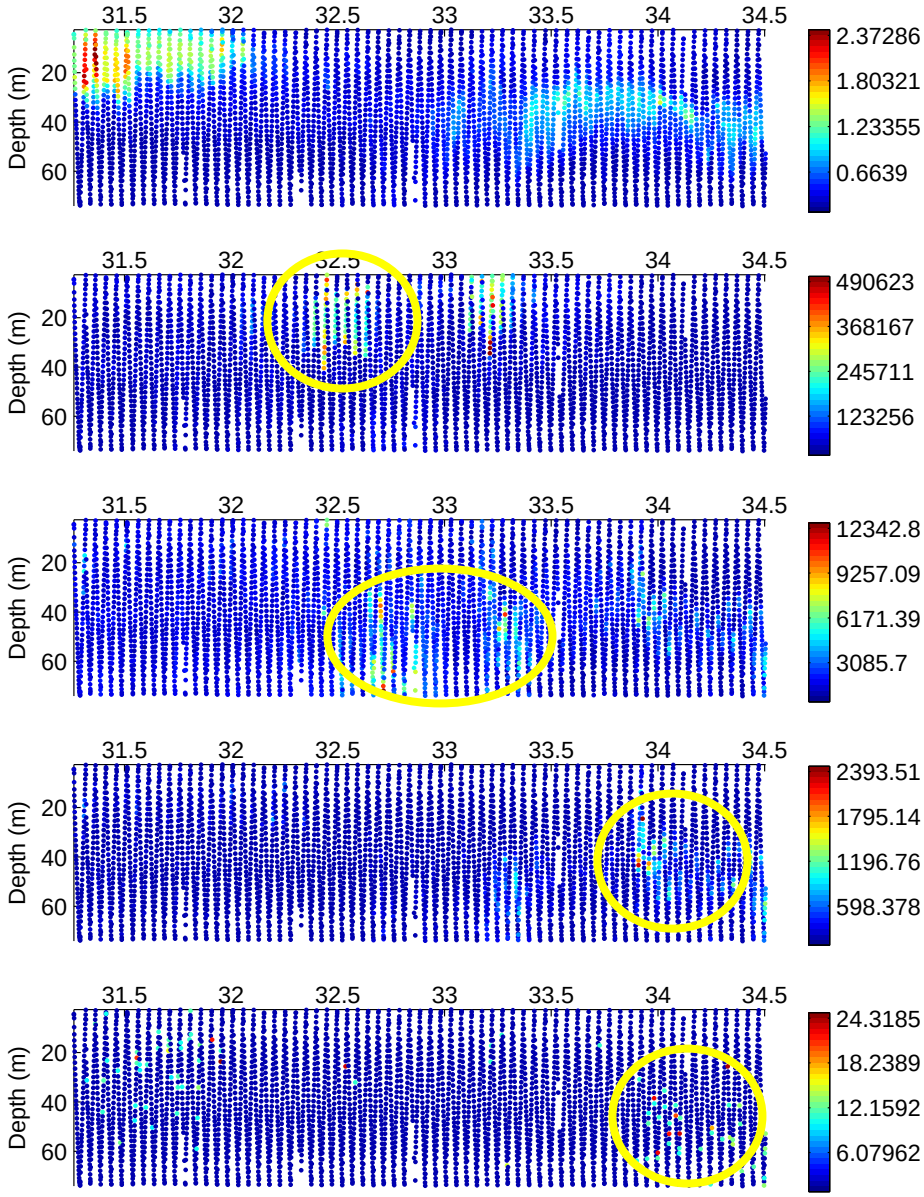
T,S Properties Storbanken Transect



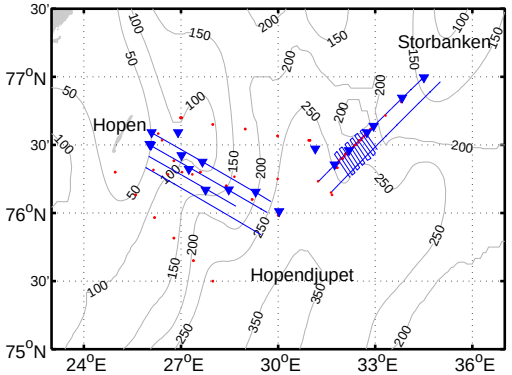


OPC Data

Atlantic Front Arctic



Flourescence



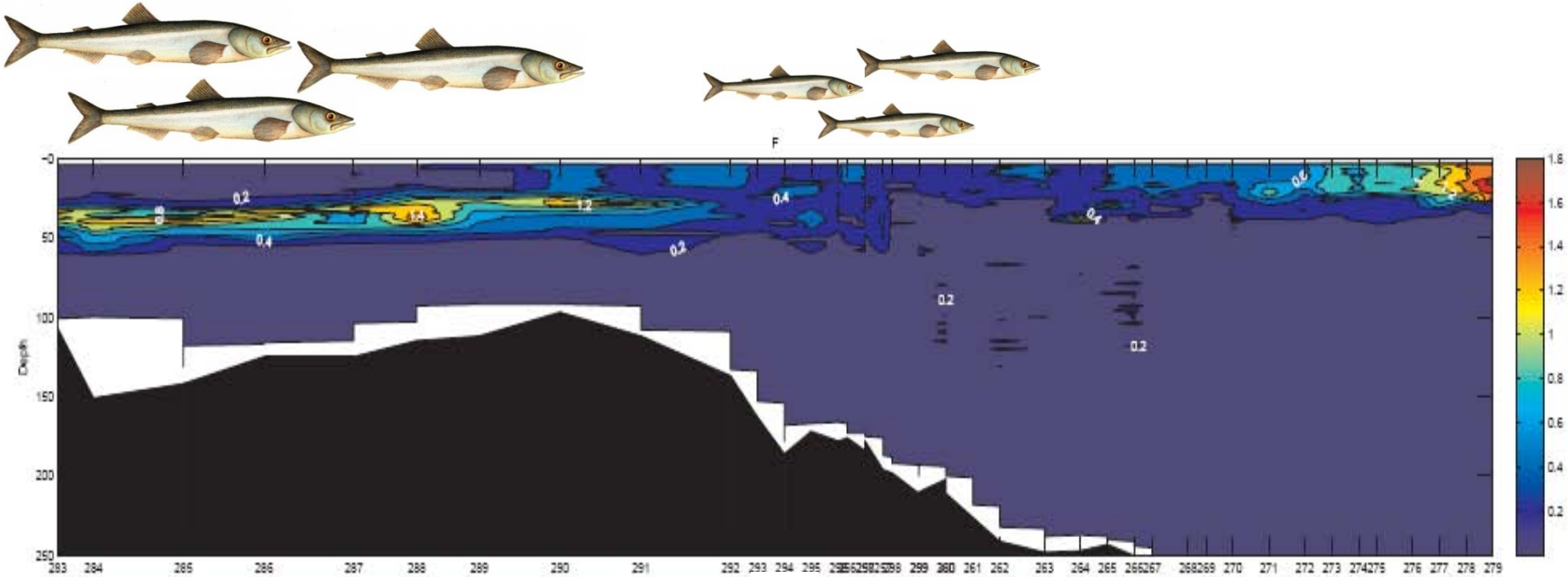
Extra Small (250-600 μm; *Oithona*, *Pseudocalanus*)

Small (600-1000 μm)

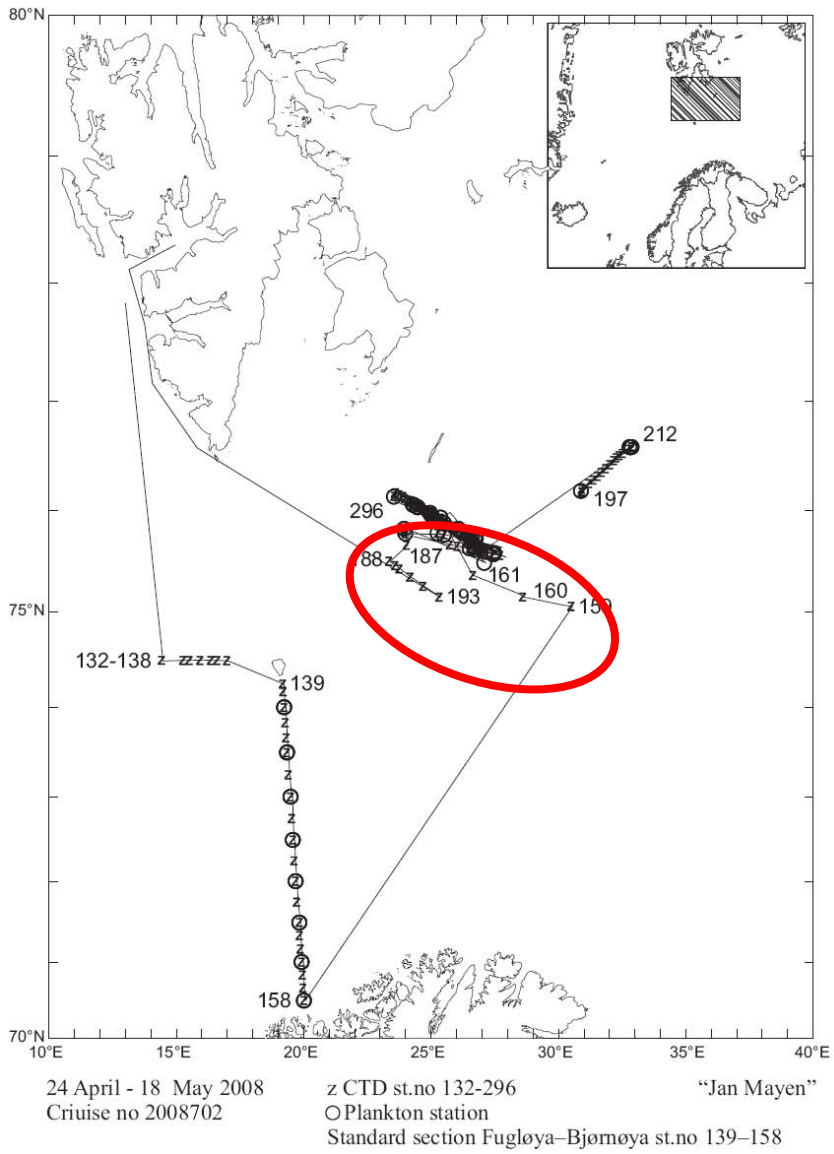
Medium (1000-1500 μm; early stage *Calanus glacialis*)

Large (1500-2000 μm; late stage *Calanus glacialis*)

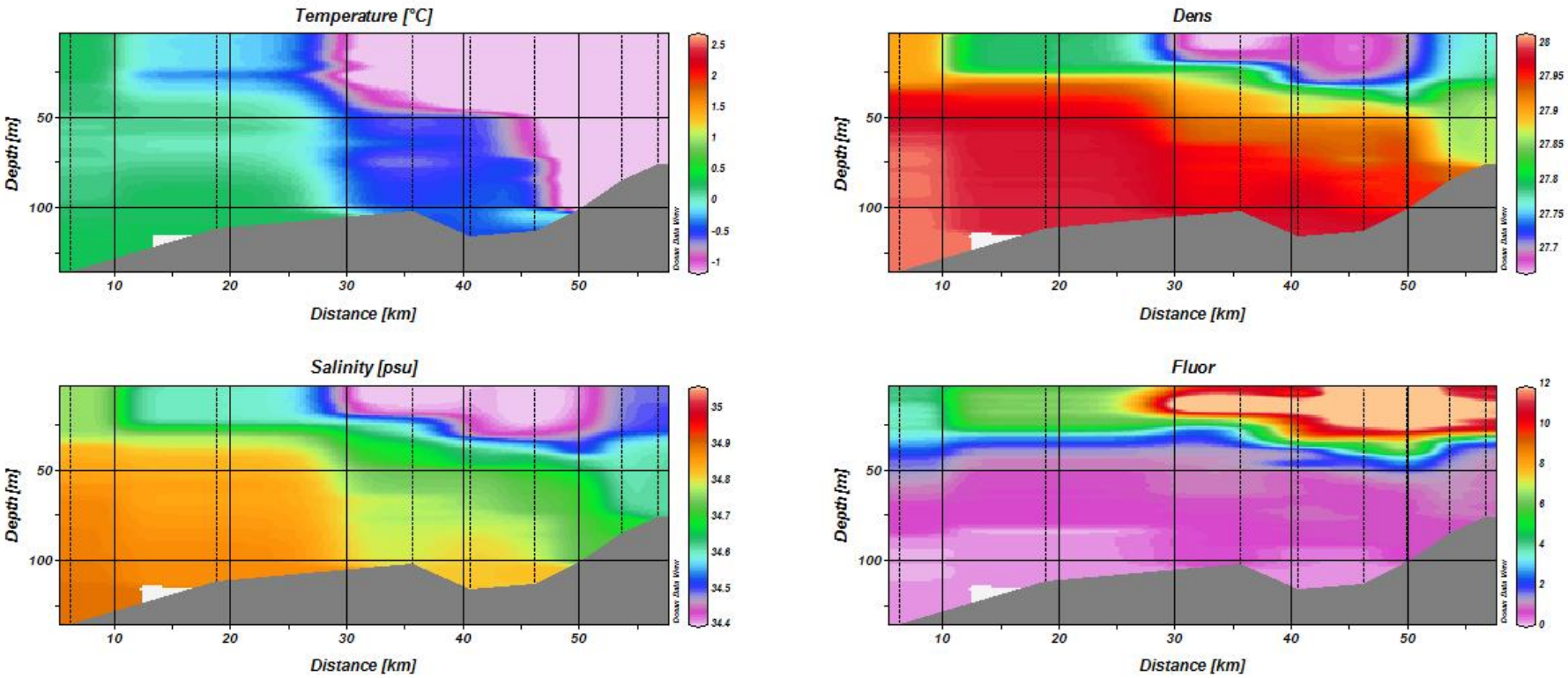
Capelin Distribution Relative to the Front

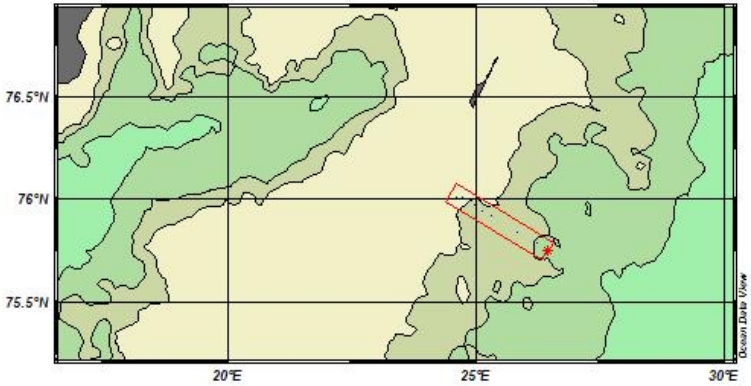


2008 Cruise



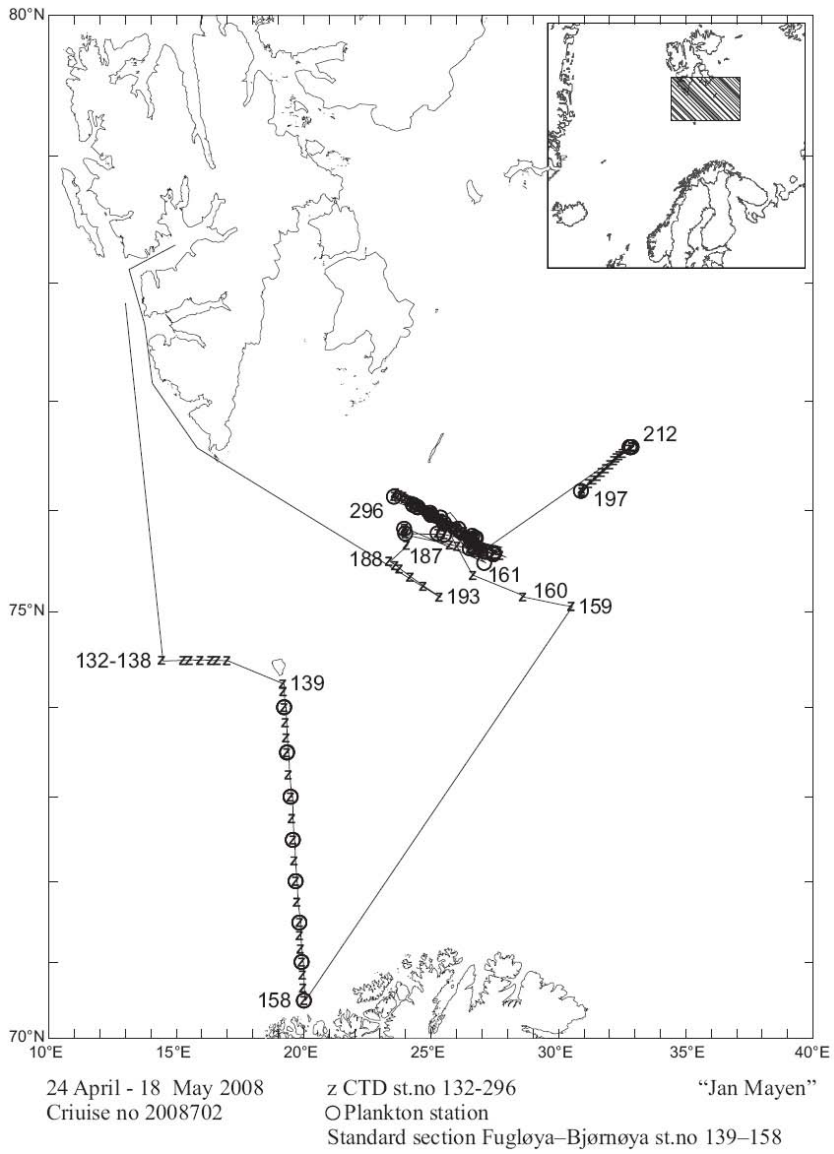
- Plan was to measure through production gradient from post-bloom in Atlantic waters, through bloom to pre-bloom at ice edge. Did this on Hopen Bank.



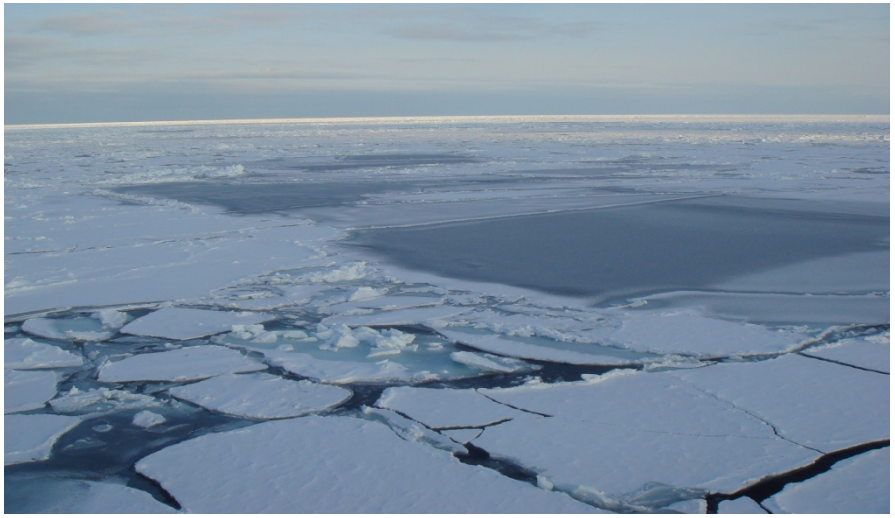


No evidence of post bloom in Atlantic Water or pre-bloom near ice edge. Bloom conditions were found in melt water near ice edge.

2008 Cruise



- Next planed to return to Storbanken to observe spring conditions when high productivity.
- Ice prevented us so headed back to Hopen.



Summary of Preliminary Results

- Strong surface salinity fronts due to melt water over top 30-50 m
- Subsurface T,S fronts below surface layer
- Appears to be isopycnal mixing at the fronts as well as some evidence of double diffusion.
- Phytoplankton and zooplankton structure differ across the fronts
- No evidence of increased phytoplankton at the front, in fact lower biomass

Summary of Preliminary Results -2

- High mesozooplankton near to but on Arctic side of front in Norwegian Sea
- Herring in Norwegian Sea generally stay on Atlantic side of front but do appear to feed in Arctic waters at times.
- At Barents Sea Front evidence of small particles in the Frontal region and larger particles away from the Front
- Frontal structure in Barents Sea appears to influence fish distributions by size






Many Thanks!