Reversal of the 1960s - 1990s Freshening Trend in the NE North Atlantic and Nordic Seas

by

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and

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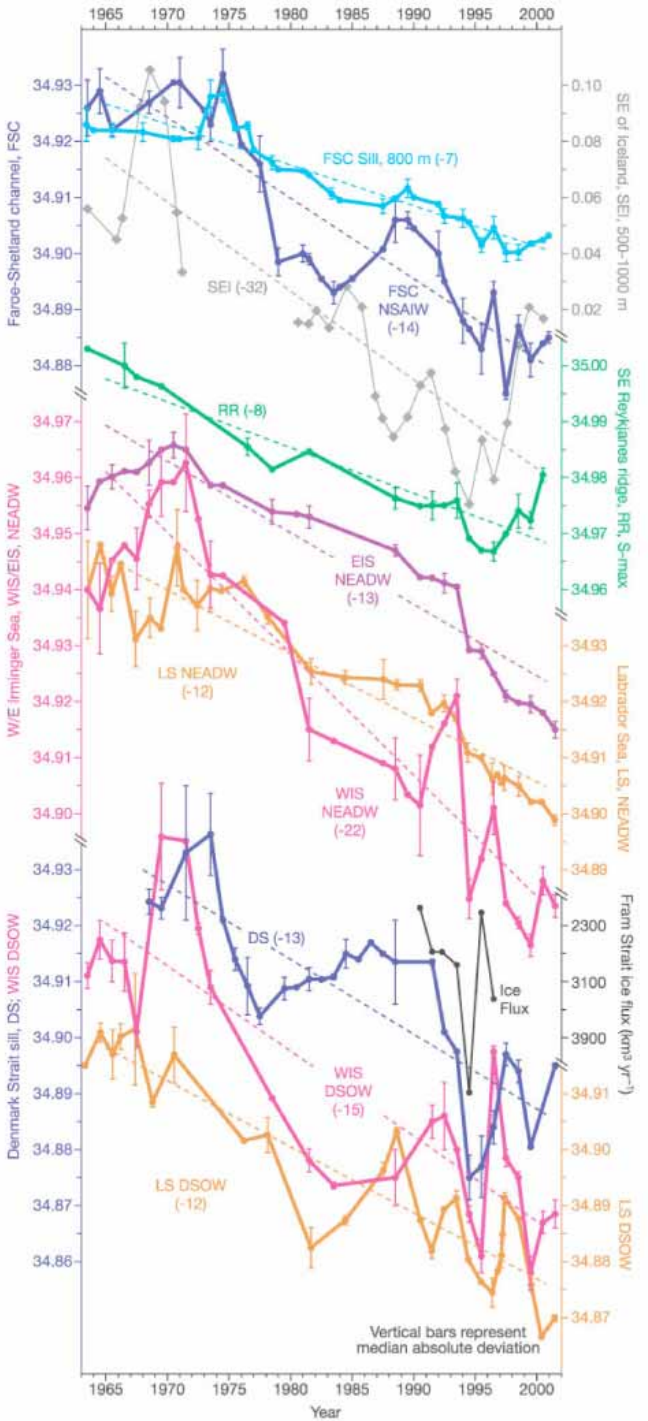
Motivation

Recent literature tells us the North Atlantic freshened dramatically since the 1950s

Changes in the balance of different elements of the freshwater system are responsible

Recent reports of warming of the Atlantic Inflow

Last decade of observations show that the NE North Atlantic and Nordic Seas are unusually warm and saline



The freshening of the
North Atlantic Deep Water
In the Labrador Sea

Evolves in the overflows, enhanced by the surface and intermediate water masses that they mix with

(Dickson et al, 2002)

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The Most Recent Observations: ICES Report on Ocean Climate 2007

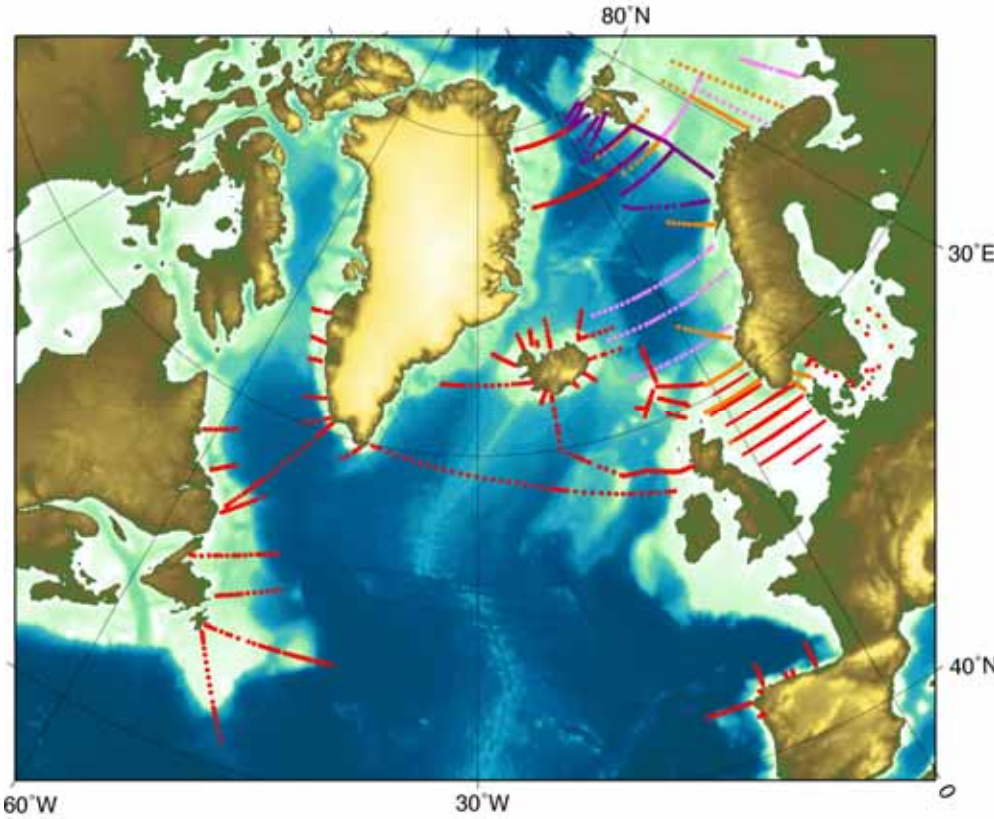
By the Working Group on Oceanic Hydrography

Synthesis of physical conditions in 2007

In the context of interdecadal records

Temperature, Salinity

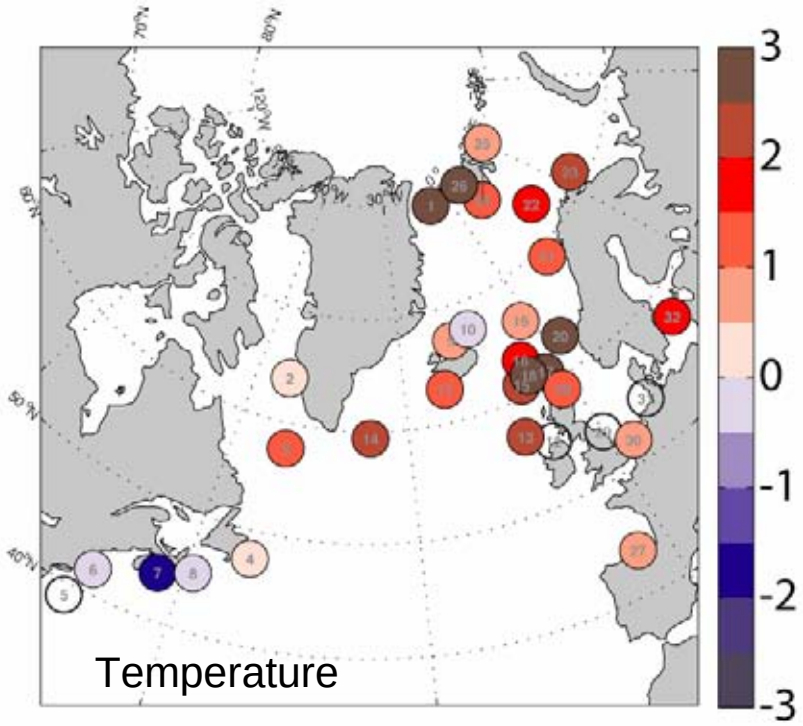
Upper and Deep Ocean

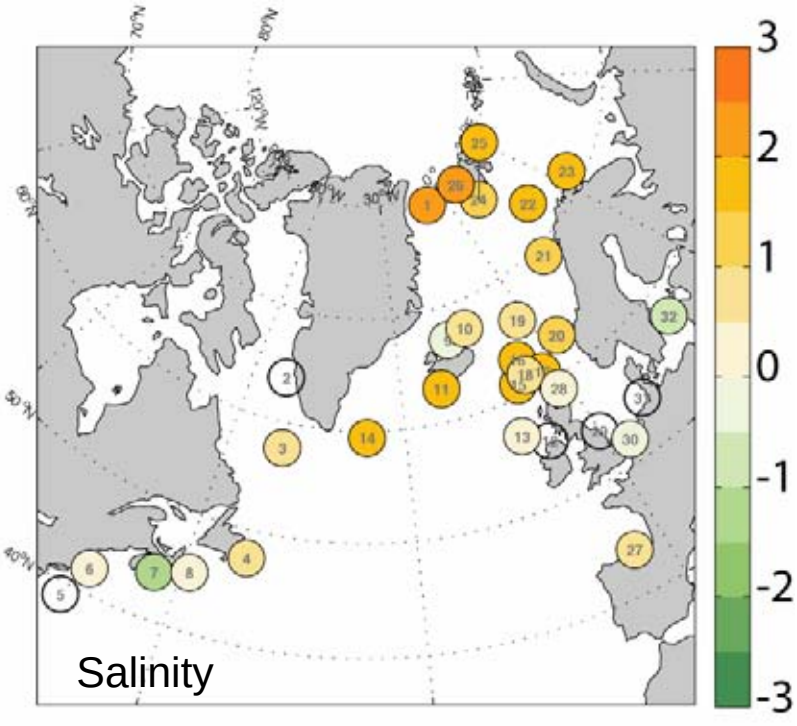


www.ices.dk/marineworld/oceanclimate.asp (to IROC2006)

The Most Recent Observations

The upper layers of the North Atlantic and Nordic Seas were warmer and more saline in 2007 than the long-term average (1971-2000).





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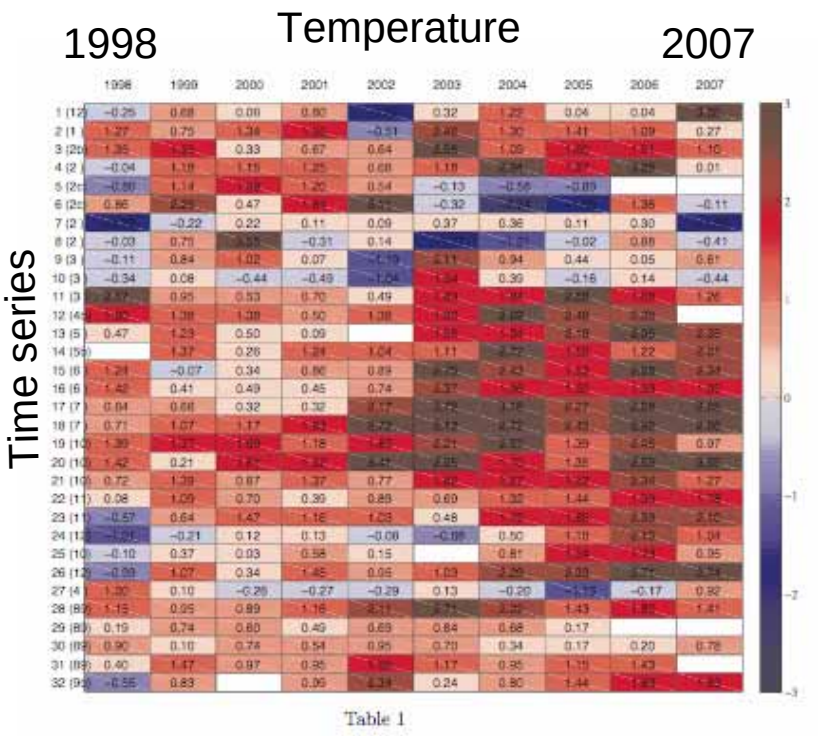
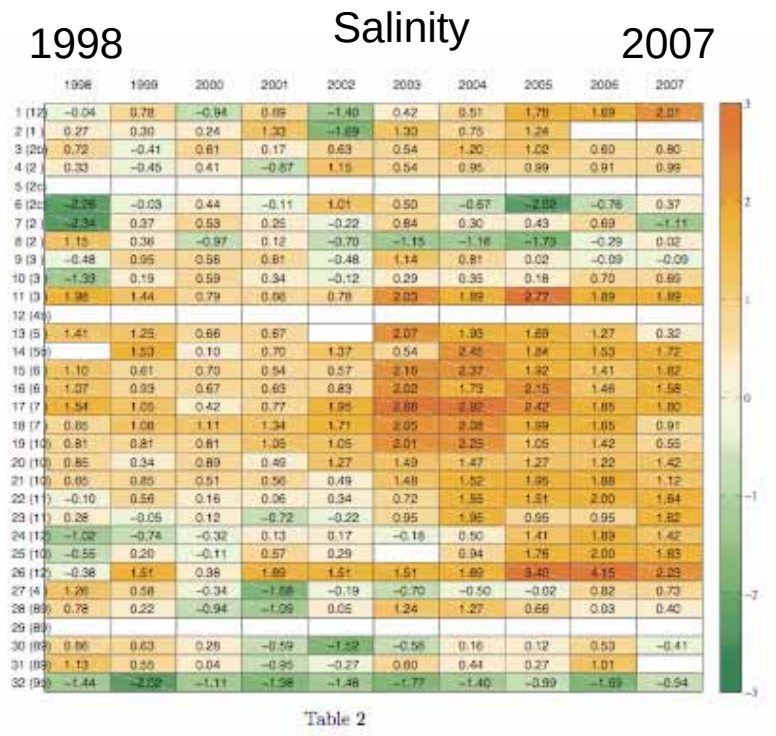
The Most Recent “Trend”

The trend in the last decade (1998-2007) has been of warming & increasing salinity in the upper ocean*.





(*upper ocean typically defined as surface to 500-800m)

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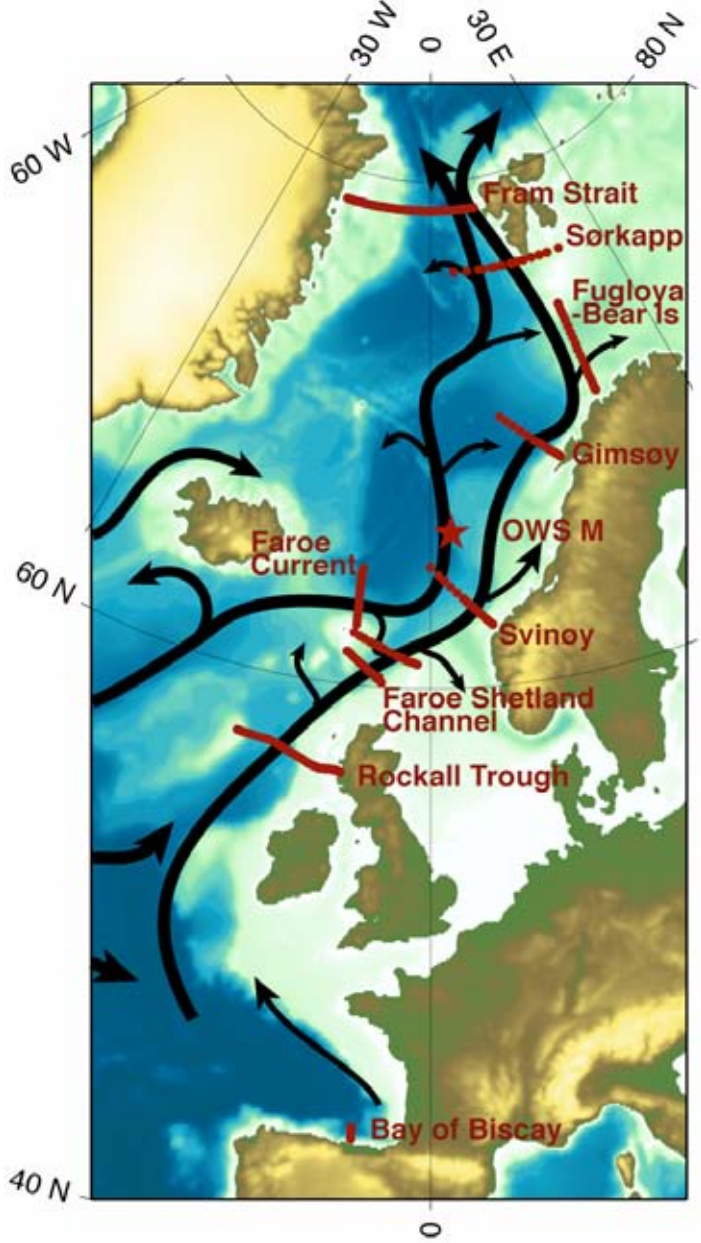


The Atlantic Inflow

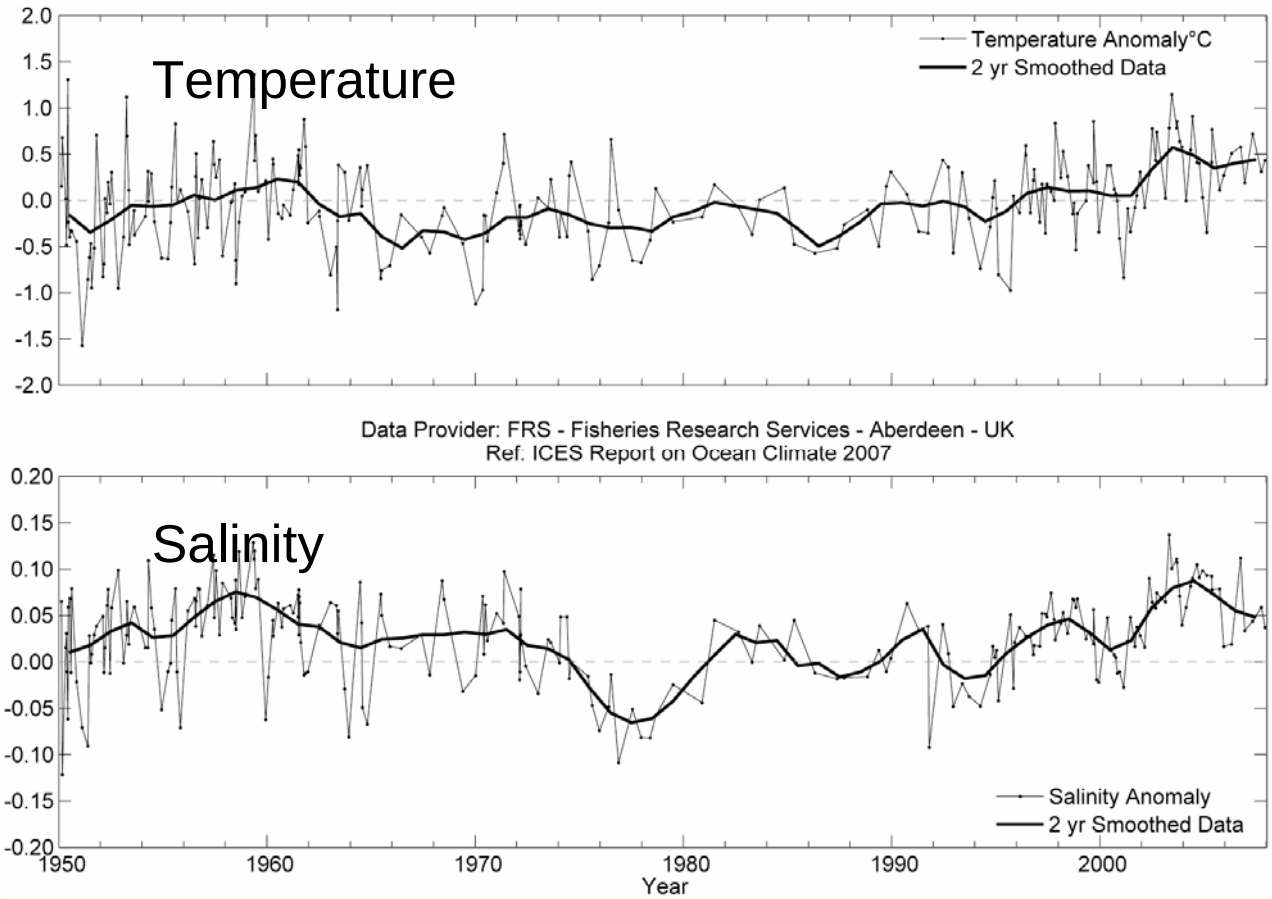
Includes

Warm saline sub-tropical NAC water (ENAW)

Cool fresh subpolar NAC water (WNAW)

Properties affected by changes in Sub-Polar Gyre circulation

Faroe Shetland Channel



Salinity Maximum in “North Atlantic Water”

Anomalies from seasonal means

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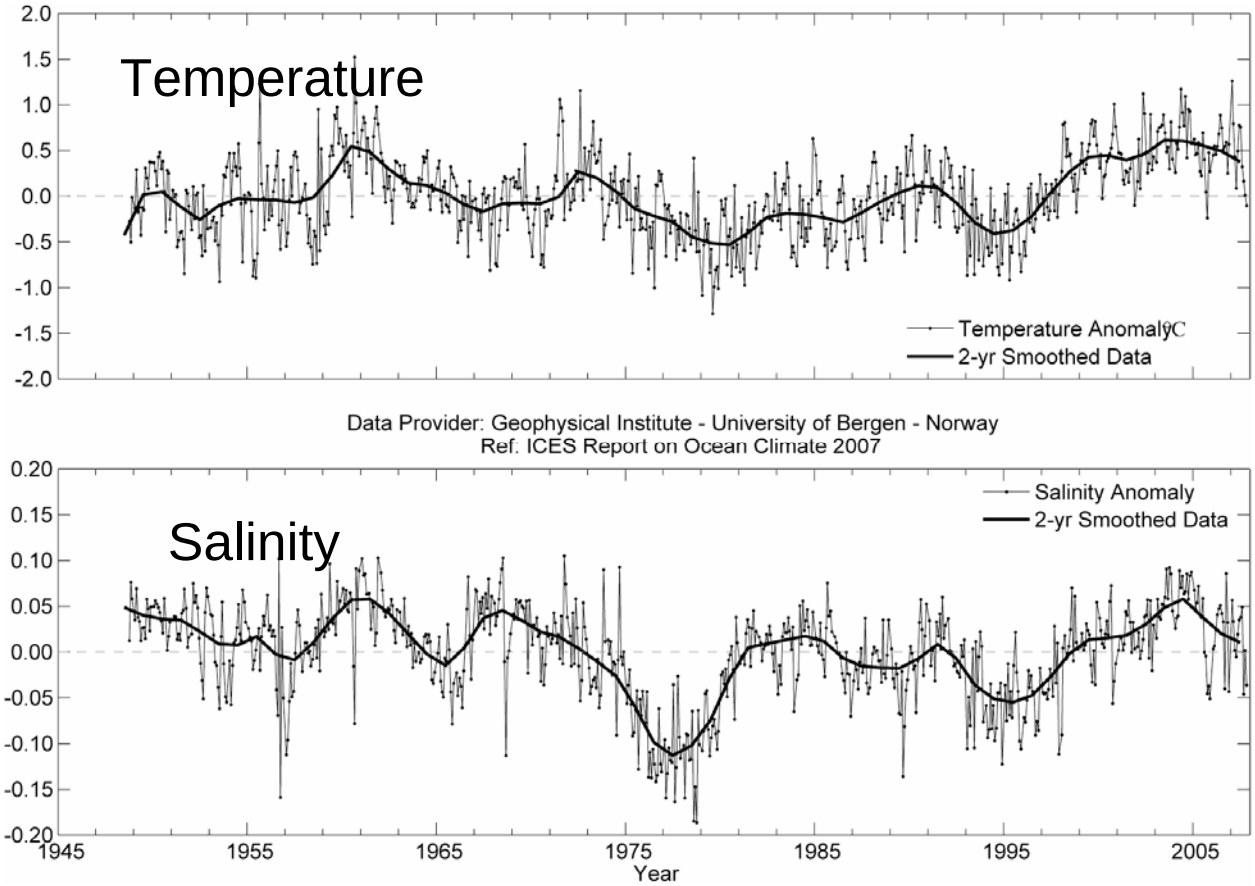
Ocean Weather Station “Mike”



Properties at 50m

Anomalies from monthly means

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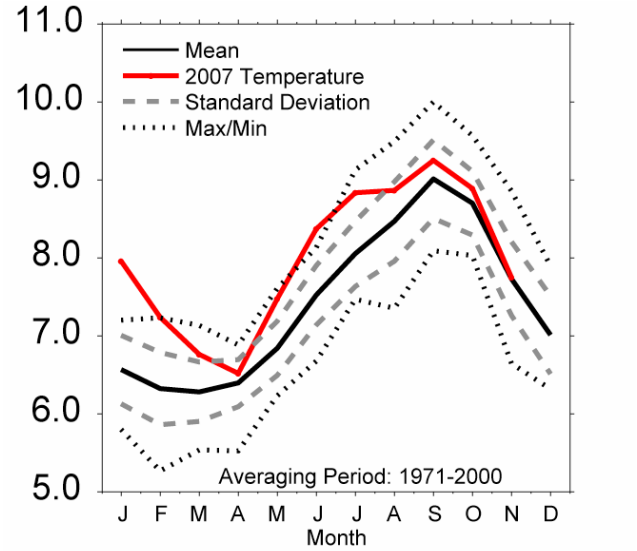
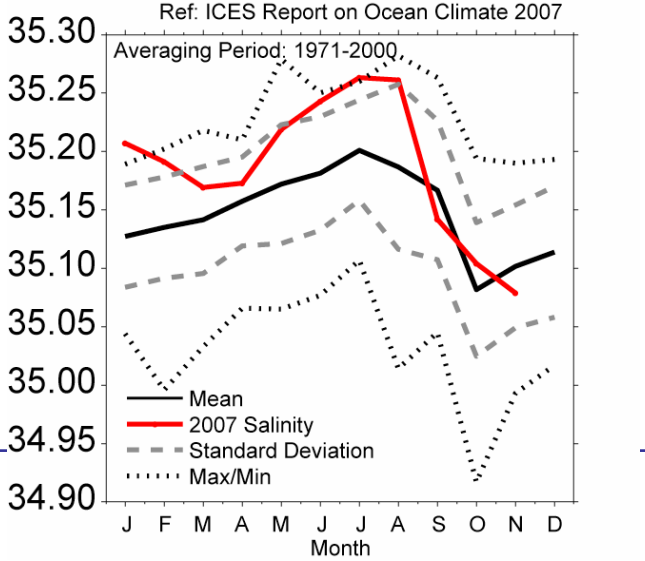
Ocean Weather Station “Mike”



Seasonal
Temperature range
of ~2-3°C

Properties at 50m

Data Provider: Geophysical Institute - University of Bergen
Ref: ICES Report on Ocean Climate 2007



Seasonal
Salinity range
of ~0.1-0.2

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Sampling Issues

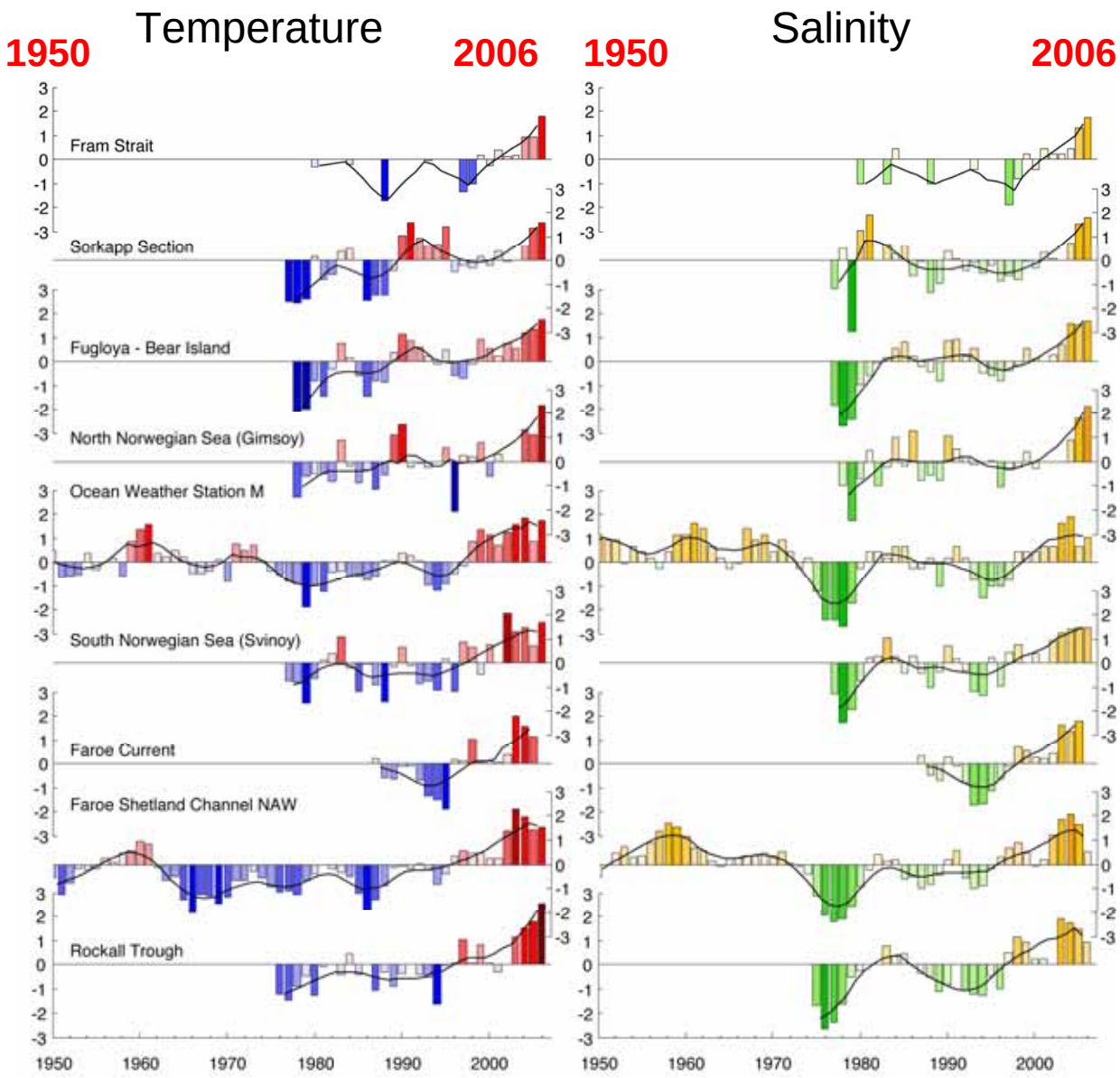
Under-resolved (and changing) seasonal cycle

Infrequent sampling (missing years)

Short time series

Data quality issues (early data)

Local influences (movement of fronts, eddies, coastal effects, etc)



Fram Strait 78°N

Atlantic Inflow (~50-800 m)

Annual anomalies
(normalised wrt stdev, ie value of +2 is 2 stdev above normal)

Rockall Trough 57°N

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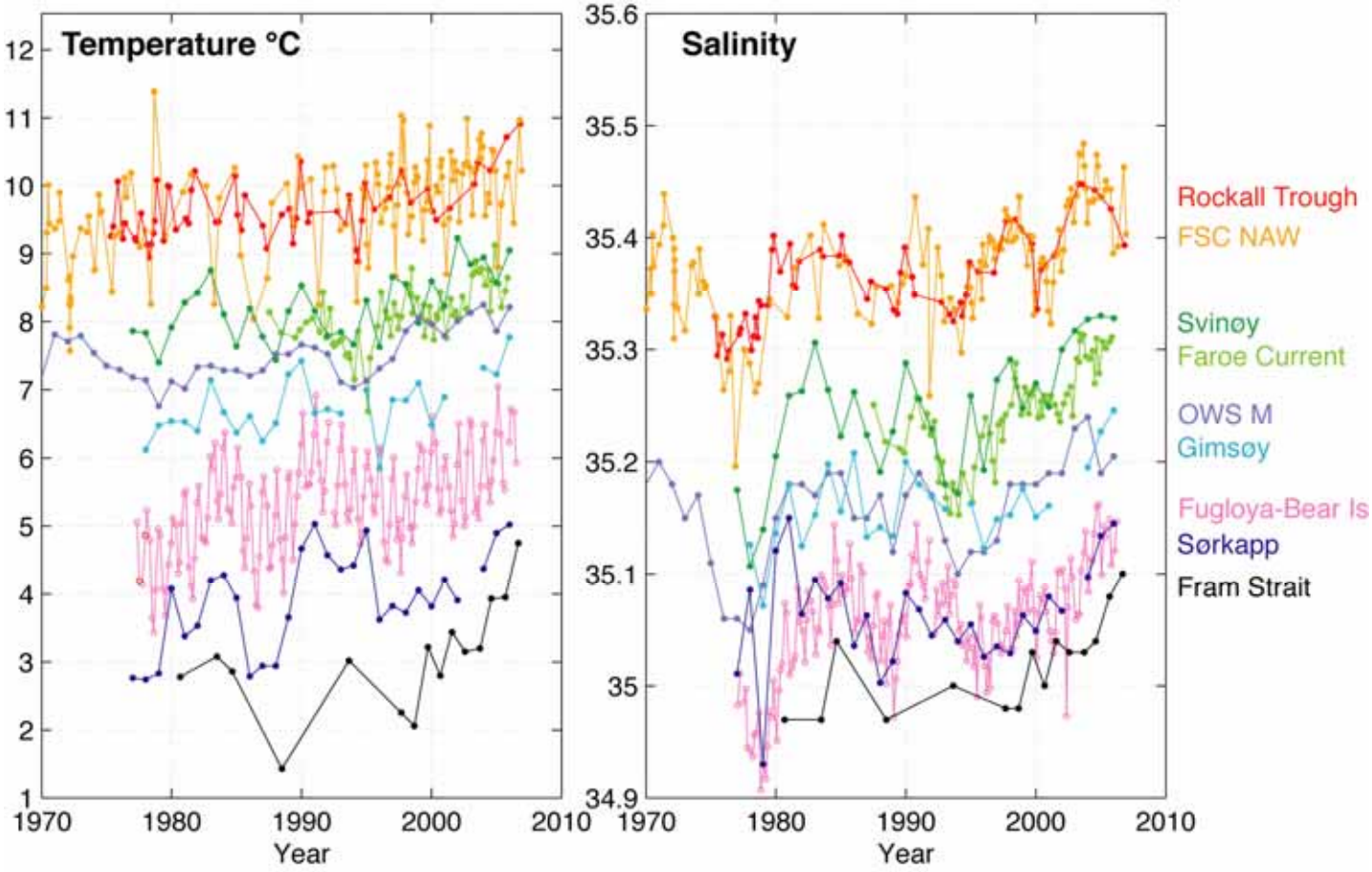
Individual Time Series



Correlations give *3-4 years* estimated transit time from Rockall Trough to Fram Strait

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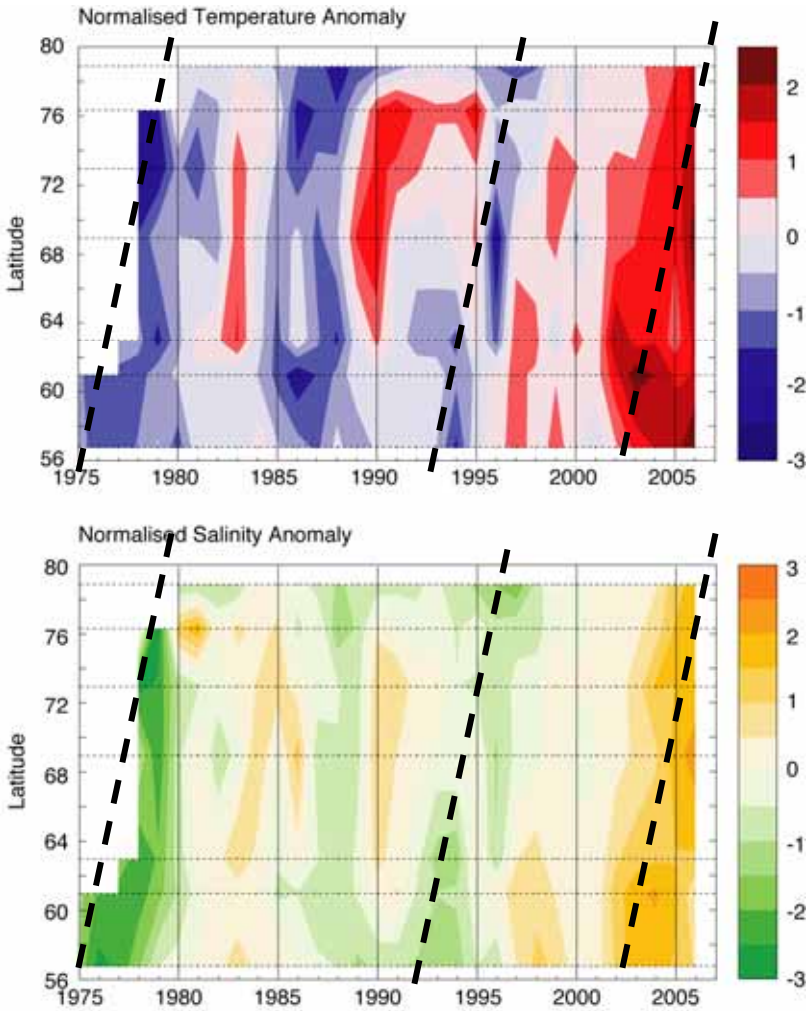
Extreme Events



1. Great Salinity Anomaly
   Rockall Trough in 1975
   Fram Strait in 1979
   4 years

2. 1990s low salinity
   Rockall Trough in 1993
   Fram Strait in 1997
   4 years

Estimated Time from
Rockall Trough to Fram Strait:
4 years

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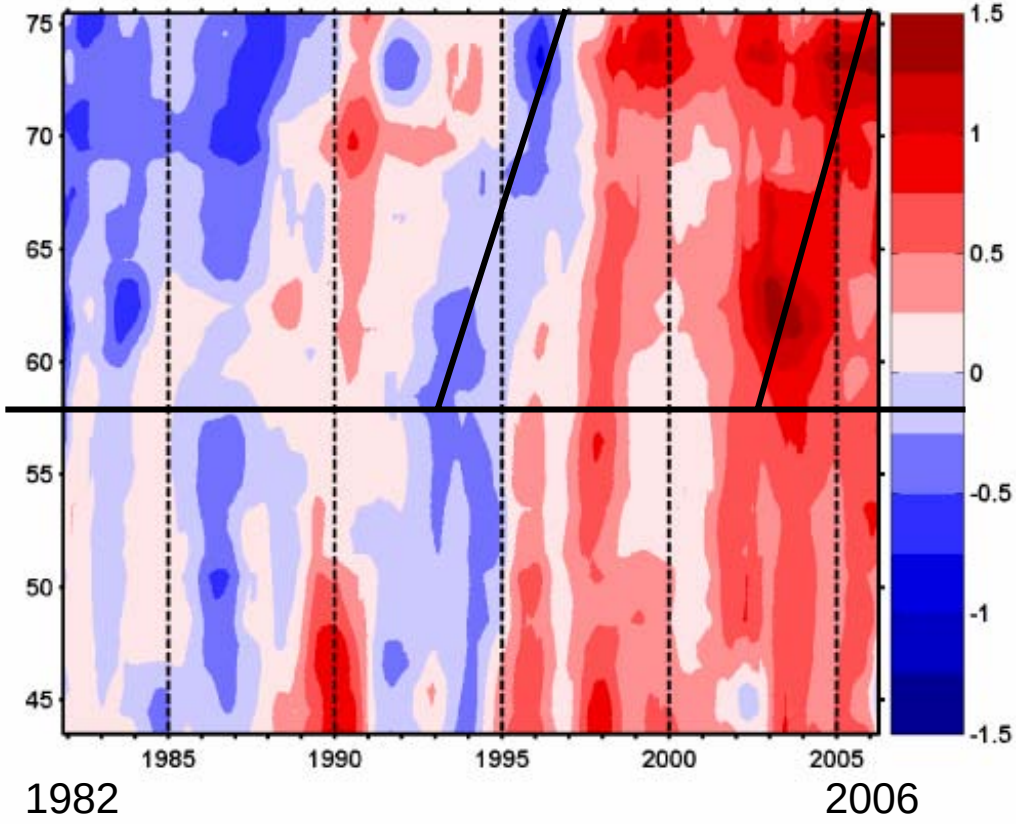
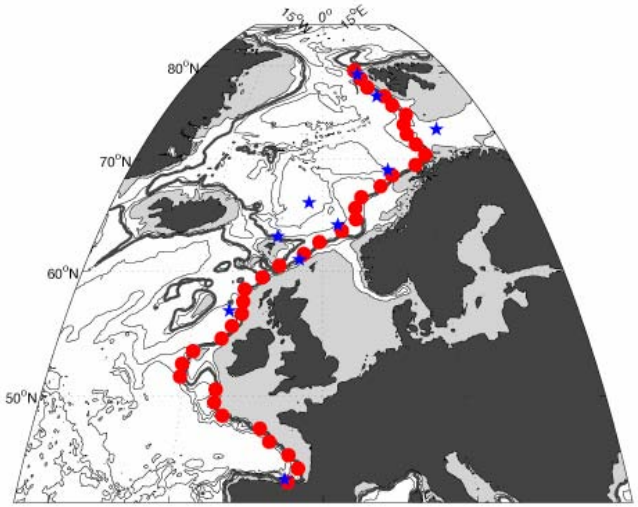
Sea Surface Temperature

SST anomalies °C



1982 2006



3 - 4 years transit time

57°N to 75°N

Predictions for the Arctic Inflow

Variability in the NE subpolar gyre properties is advected in the Atlantic Inflow

Three different estimates of transit times from the Rockall Trough to the Fram Strait: 3-4 years

Salinity peaked in the Faroe-Shetland Channel in 2004, and in 2007 remained high compared to long-term average.

Temperature peaked in the Faroe-Shetland Channel in 2003 and in 2007 remained high compared to long-term average.

We can predict that the Atlantic Inflow through the Fram Strait may decrease in T and S after 2006-2007 but will stay warm and saline (cf. long term average) to at least 2011

Summary

The 1960s to 1990s freshening trend has ended in the upper ocean of the northern North Atlantic and Nordic Seas

The “new trend” since mid-1990s is of increasing salinity (and temperature)

The T and S in the NE Subpolar Gyre can be used to predict the properties of the Atlantic Inflow to the Arctic at Fram Strait

The Atlantic Inflow at Fram Strait will become slightly cooler and fresher after 2006/7 but will remain higher than long term means for at least the next 4 years

(The warmer and more saline water has also progressed westwards in the SPG into Irminger and Labrador Seas - there is more to this story!)