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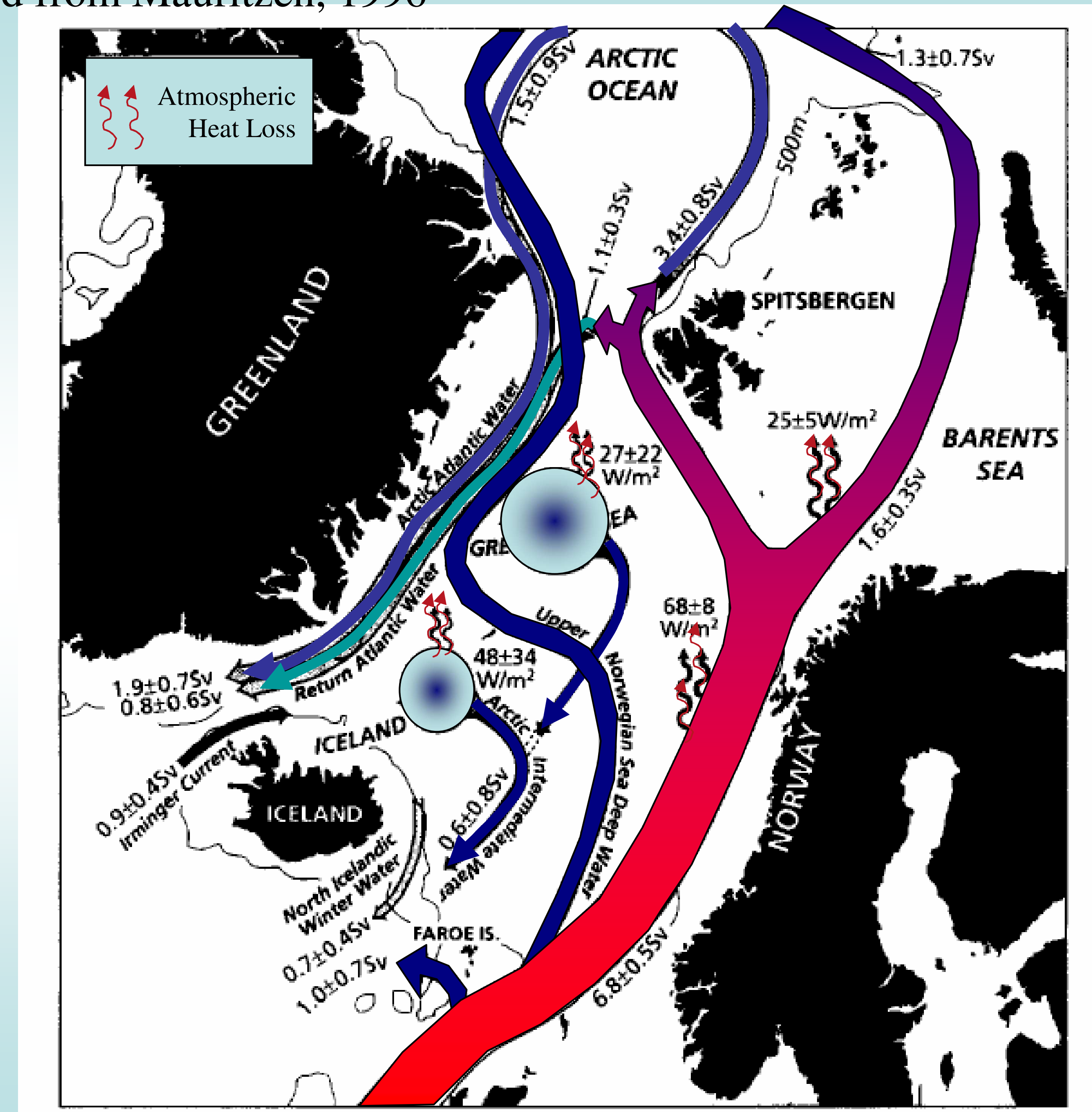
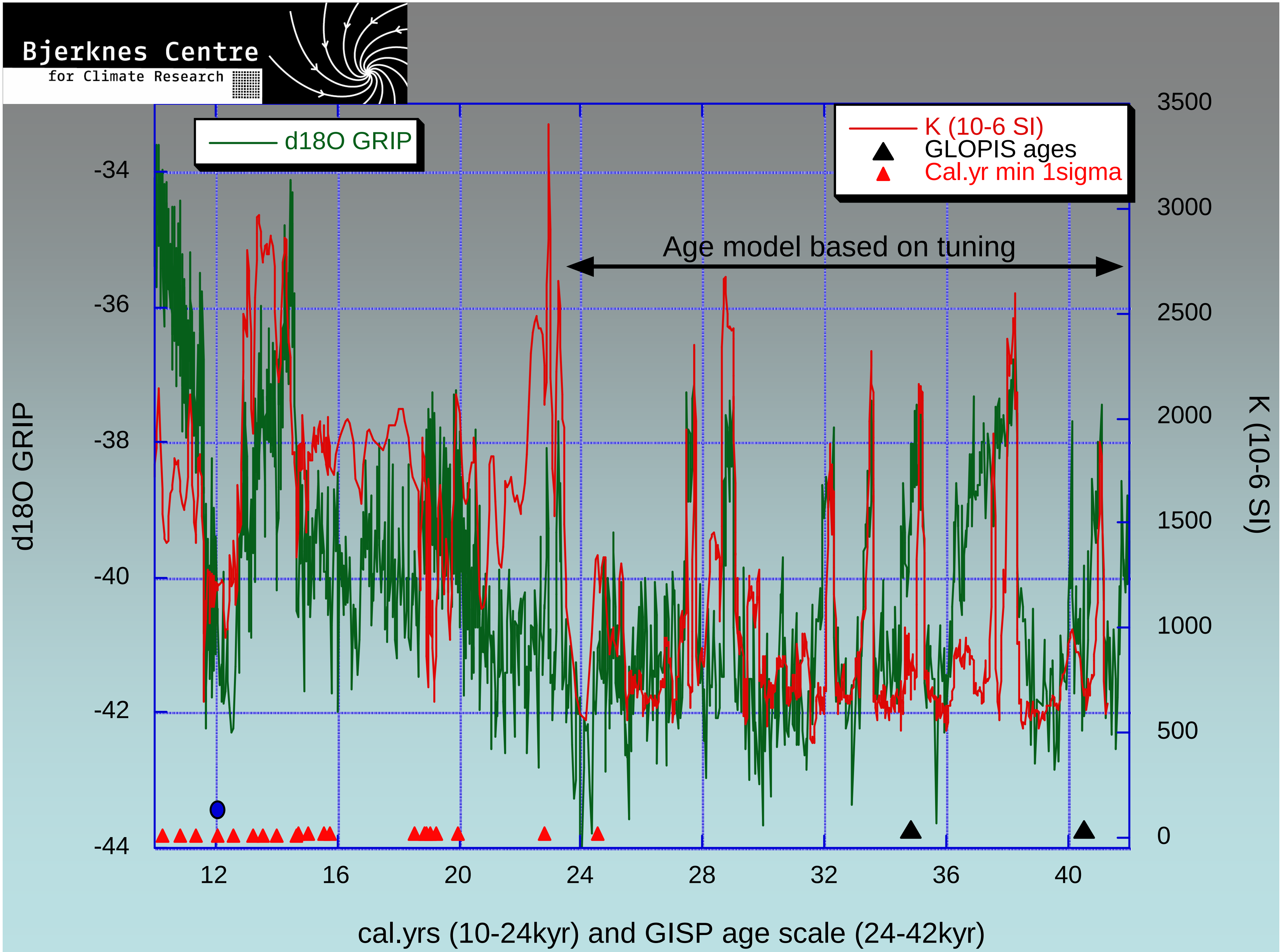
Multidecadal reconstruction of inflowing Atlantic water and front oscillation provided from paleo proxies

Birgitte F. Nyland, Trond Dokken
Bogi Hansen and Svein Østerhus

NGF September 2006

Modified from Mauritzen, 1996

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d18O GRIP
K (10-6 SI)
GLOPIS ages
Cal.yr min 1sigma
Age model based on tuning
-34
-36
-38
-40
-42
-44
3500
3000
2500
2000
1500
1000
500
0
12
16
20
24
28
32
36
40
d18O GRIP
K (10-6 SI)
cal.yrs (10-24kyr) and GISP age scale (24-42kyr)

Linked to following project:

- **NoClim II** (**N**orwegian **O**cean **Clim**ate Project **(Phase 2))**

  to significantly improve our understanding of processes which govern oceanic heat transport towards the Nordic Seas, and which provide the basis for atmospheric heat transport from the Atlantic sector towards northern Europe.

  – **Analysis of abrupt changes in the past**
    - To obtain paleo proxy data and relate them to quantitative physical oceanography
    - Calibrate proxy data collected from surface samples with present day hydrography
    - Identify each event in all the cores that will be subject for detailed investigation and chemical/sedimentological/biological analysis
    - Estimate the vertical temperature and salinity profiles through the main inflow and outflow areas between Iceland, the Faroes and Shetland during three major climate transitions
    - Quantitative reconstructions of the transport of surface and deep water through the channels connecting the Nordic Seas and the North Atlantic during climate transitions.

Hydrographic setting

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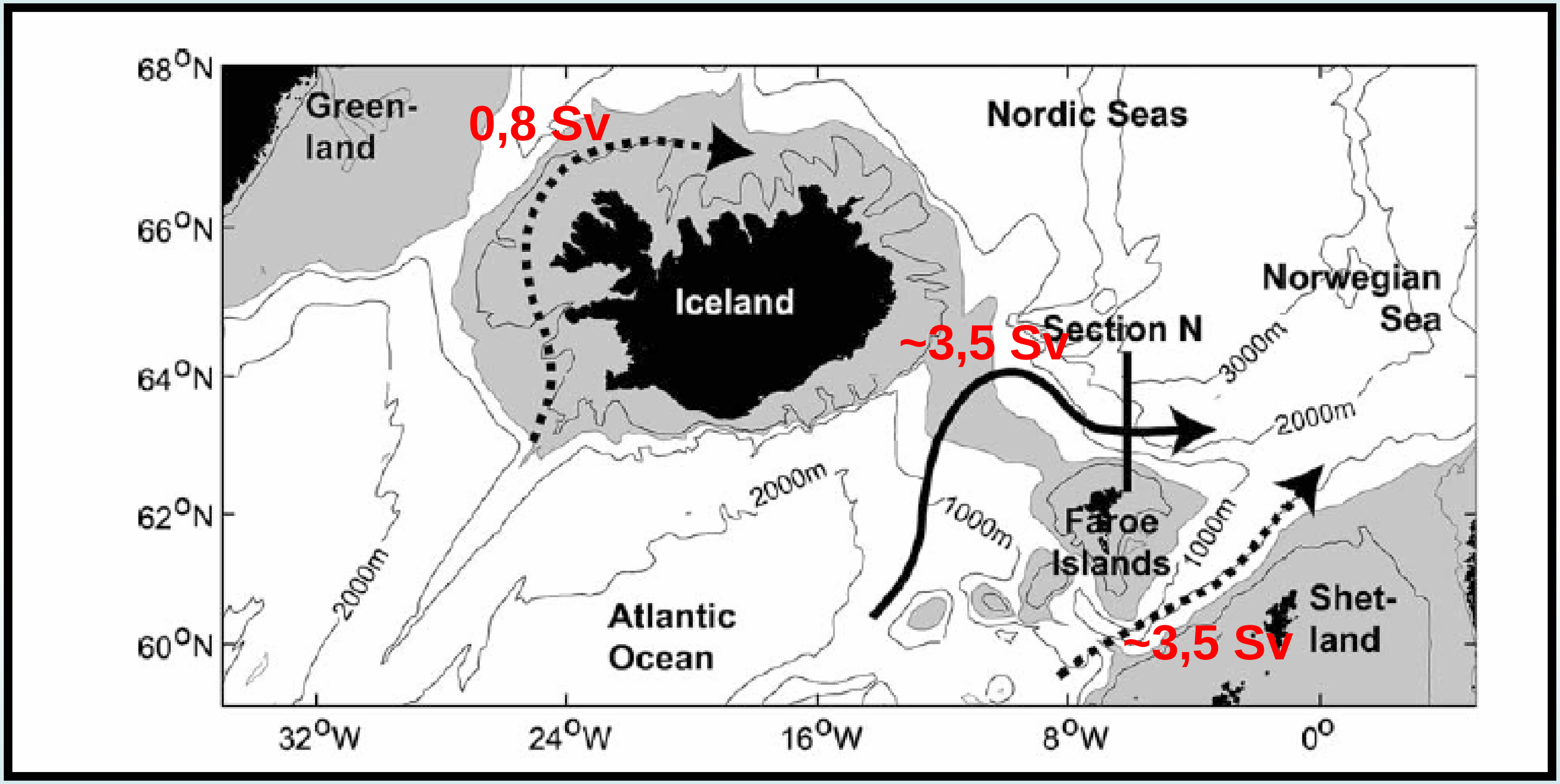

B. Hansen et al., Progress in Oceanography 59 (2003) 443-474

Available instrumental observations:

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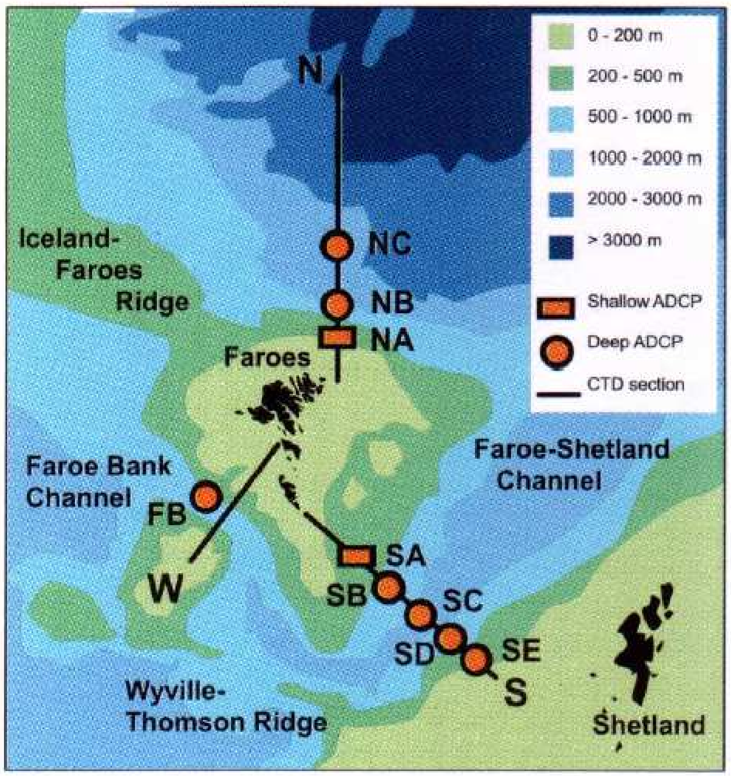
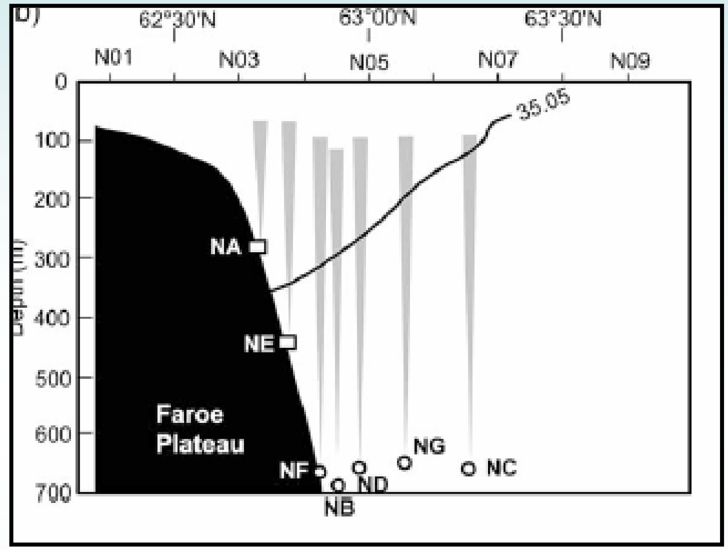


Fig. 2. The observational system covers the two main Atlantic inflow branches and the Faroe Bank Channel overflow with CTD sections (black lines) and ADCP moorings (orange circles and rectangles), identified by two-letter labels. In addition to the standard mooring sites shown, there have been a few short-term deployments at other sites.



On (b), the innermost CTD standard stations on section N are indicated as well as all the ADCP mooring sites. Rectangles indicate ADCPs in trawl-protected frames, circles indicate ADCPs in the top of moorings. Approximate ADCP ranges are indicated by gray cones. An average 35.05 isohaline (copied from Fig. 6a) indicates the typical boundary of Atlantic water on the section.

From Østerhus et al. 2001

From Hansen et al. 2003

Overview of core positions:

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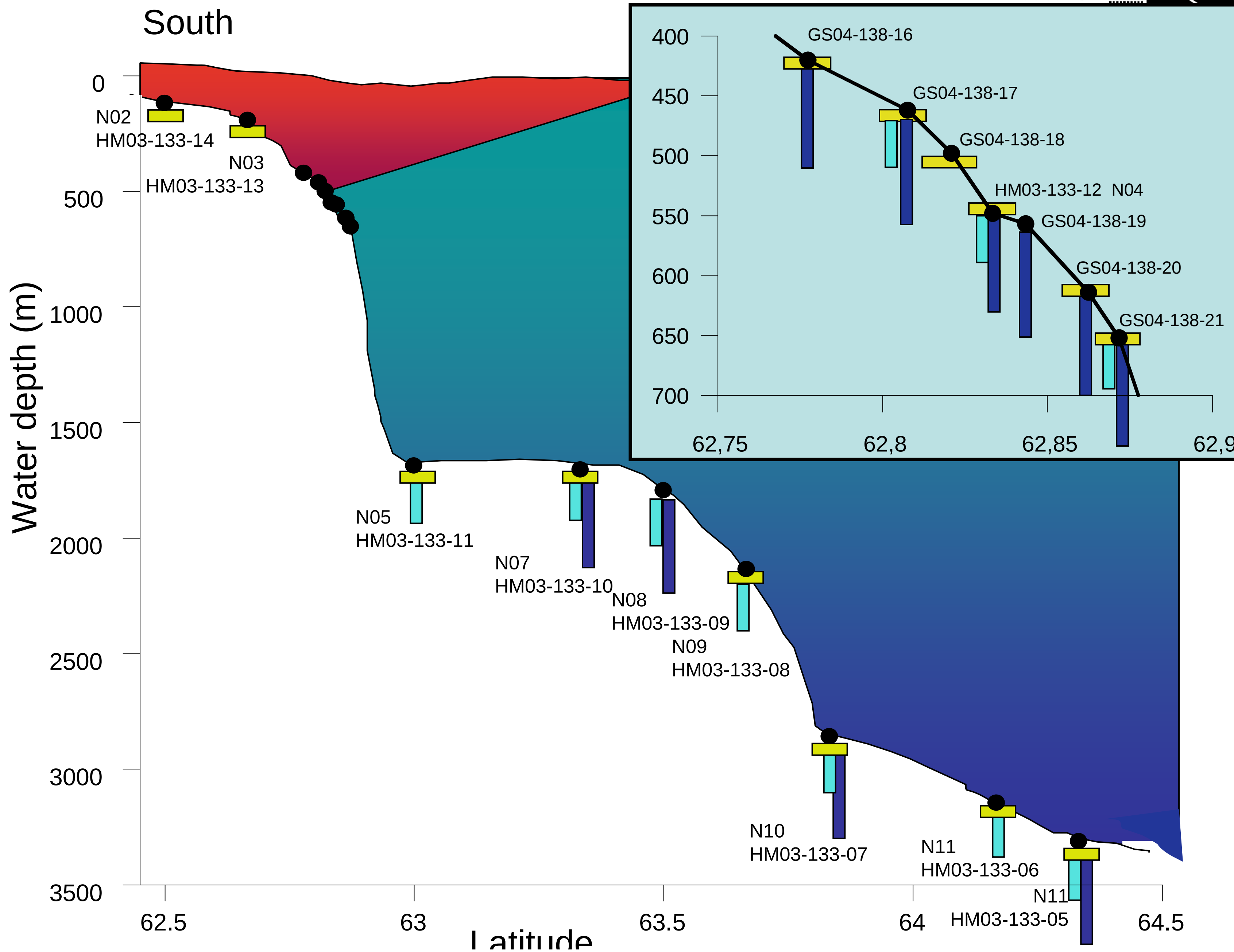
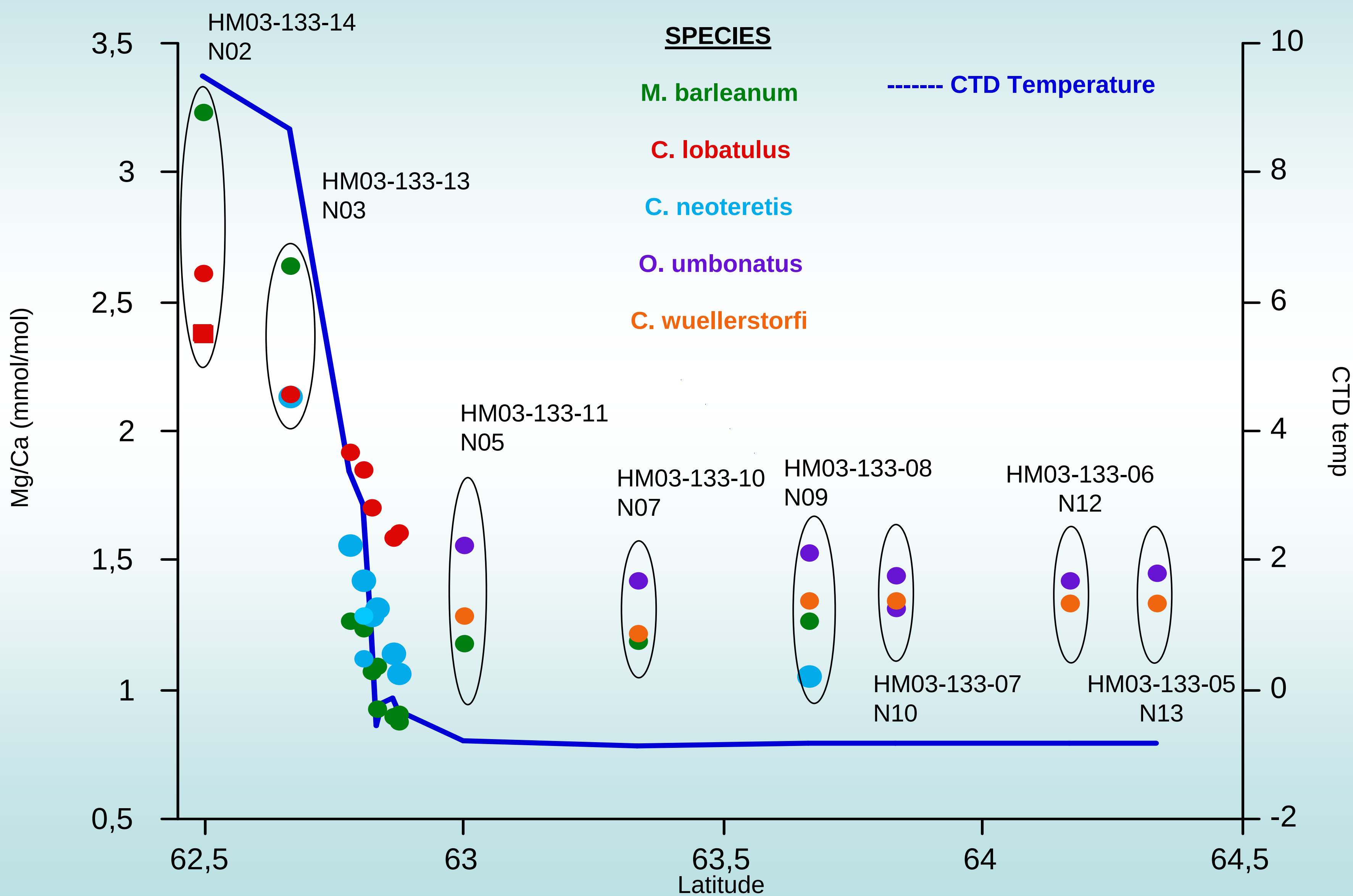


Proxy data versus CTD temperatures along th
transect



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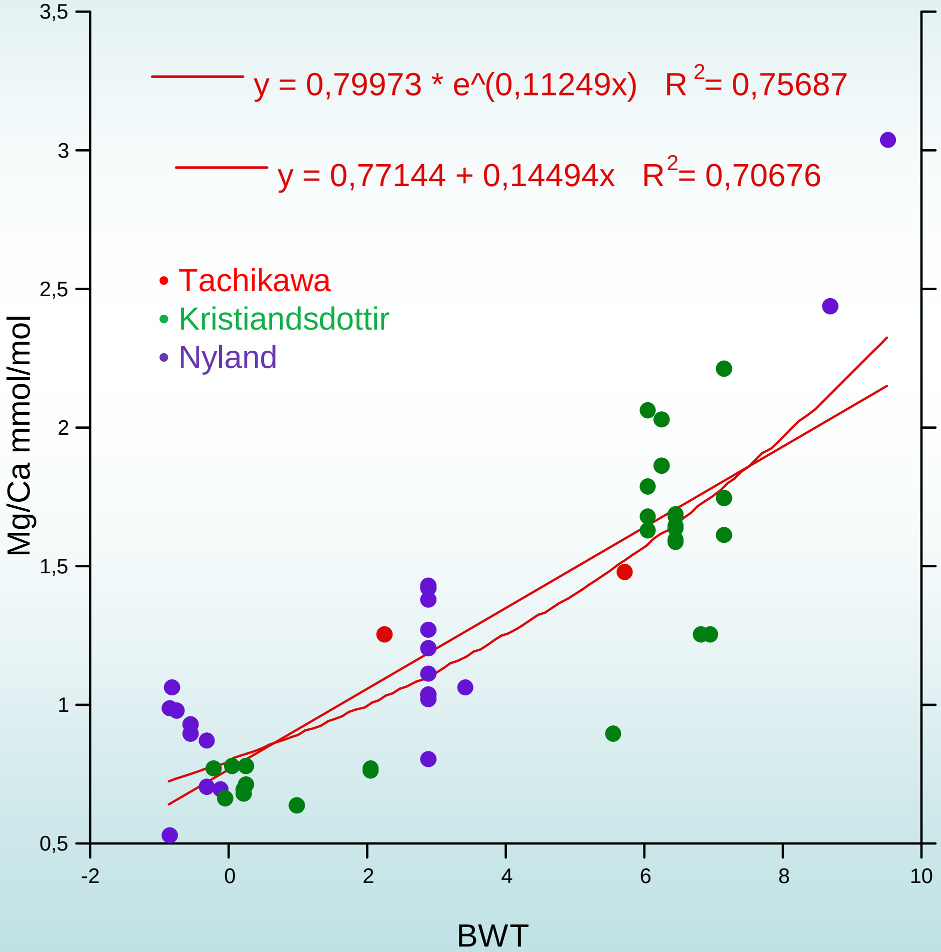
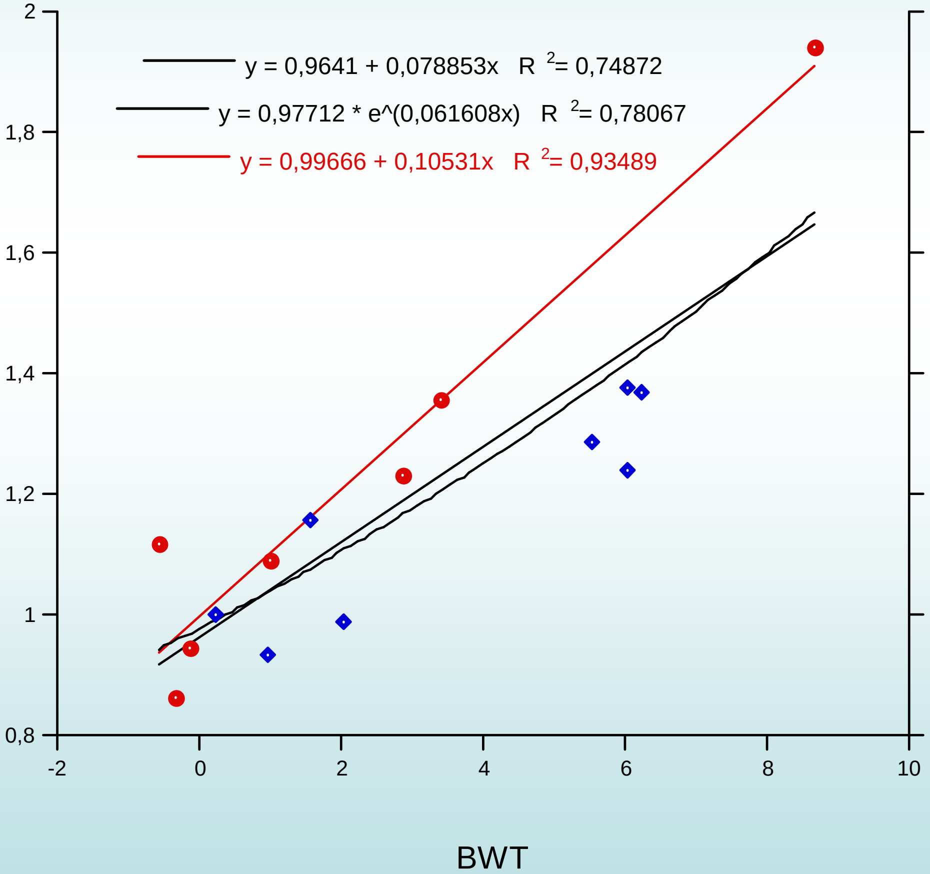
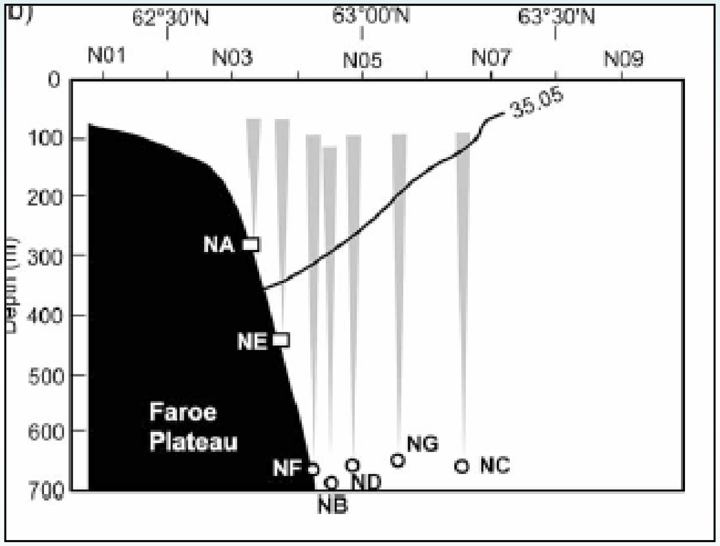
Mg/Ca vs. Bottom Water Temperature (CTD casts)

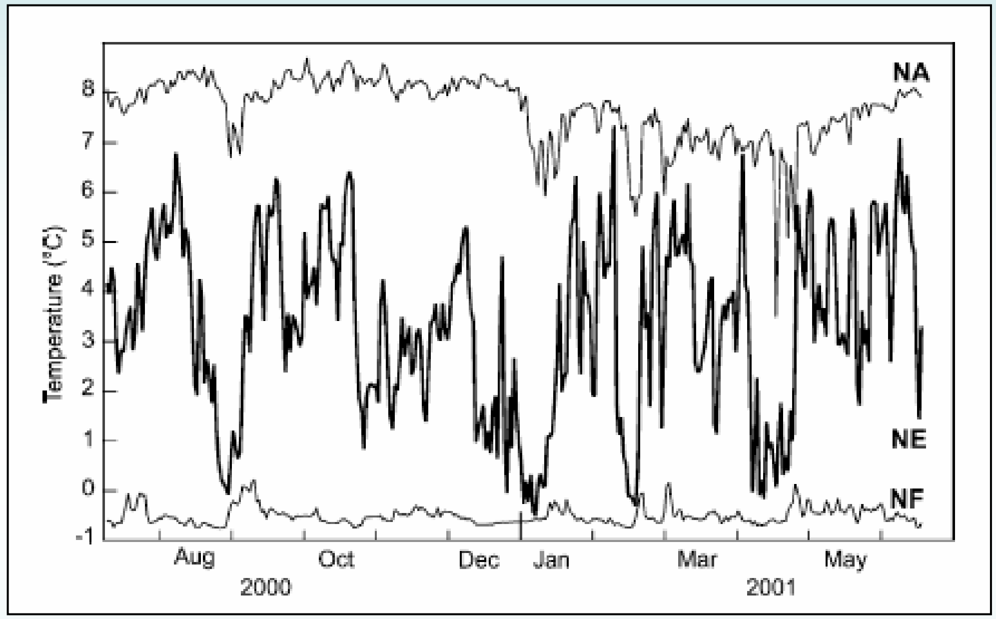
M. barleanum



C. neoteretis

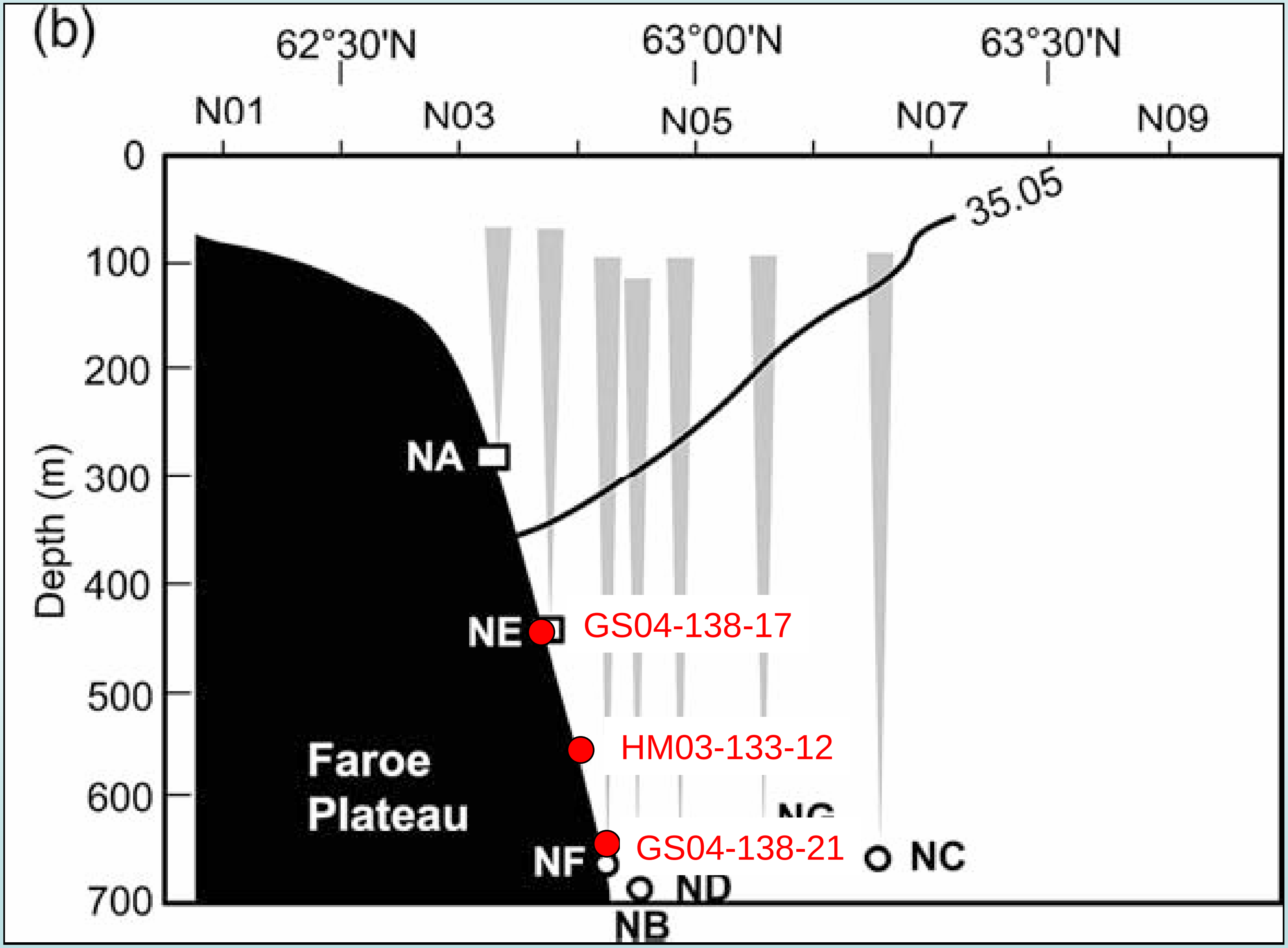






From Hansen et al., 2003

Core position relative to modern observation sites and pycnocline



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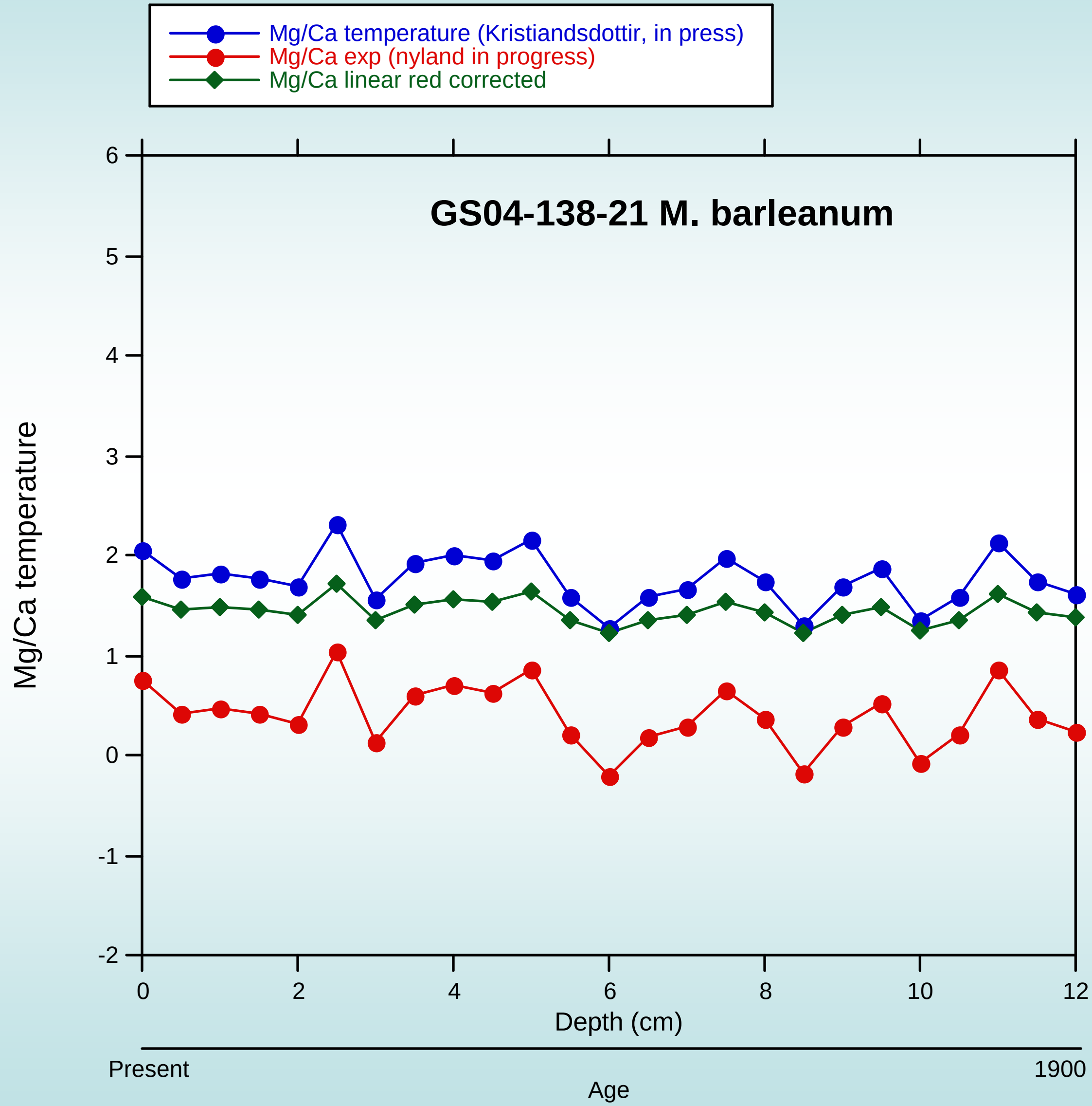
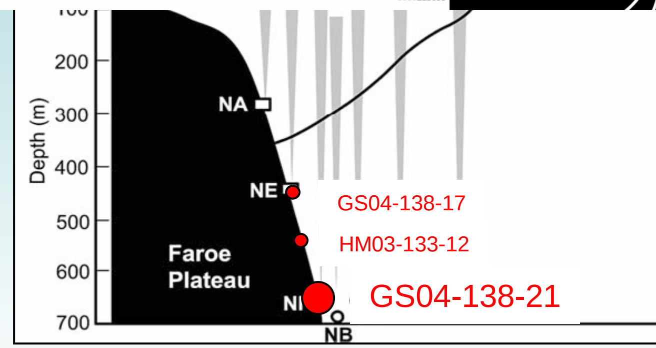
Down core results in/from GS04-138-21





<u>GS04-138-21</u>

High sedimentation rate

Low variability due to distance from transition to Atlantic water (±0.1□□ºC)

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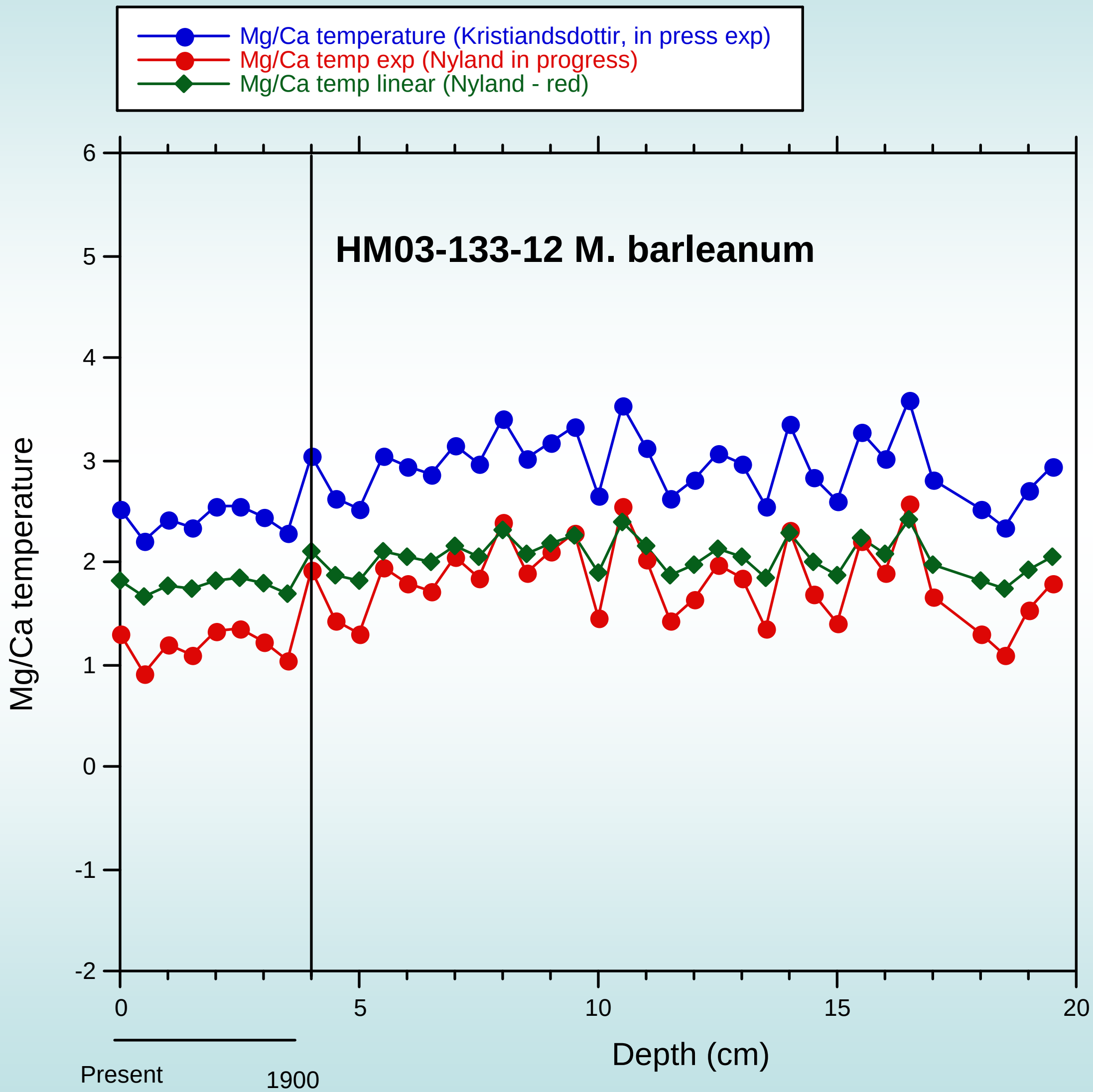
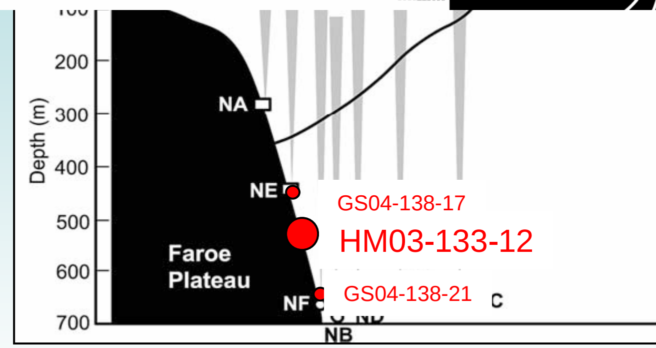
Down core results from HM03-133-12





HM03-133-12

Less variability during the last 100 yrs.

Low sediment resolution (4,5 cm = 100 yrs) and most likely high bioturbation

Less pronounced increase in temperature the last 100 years.

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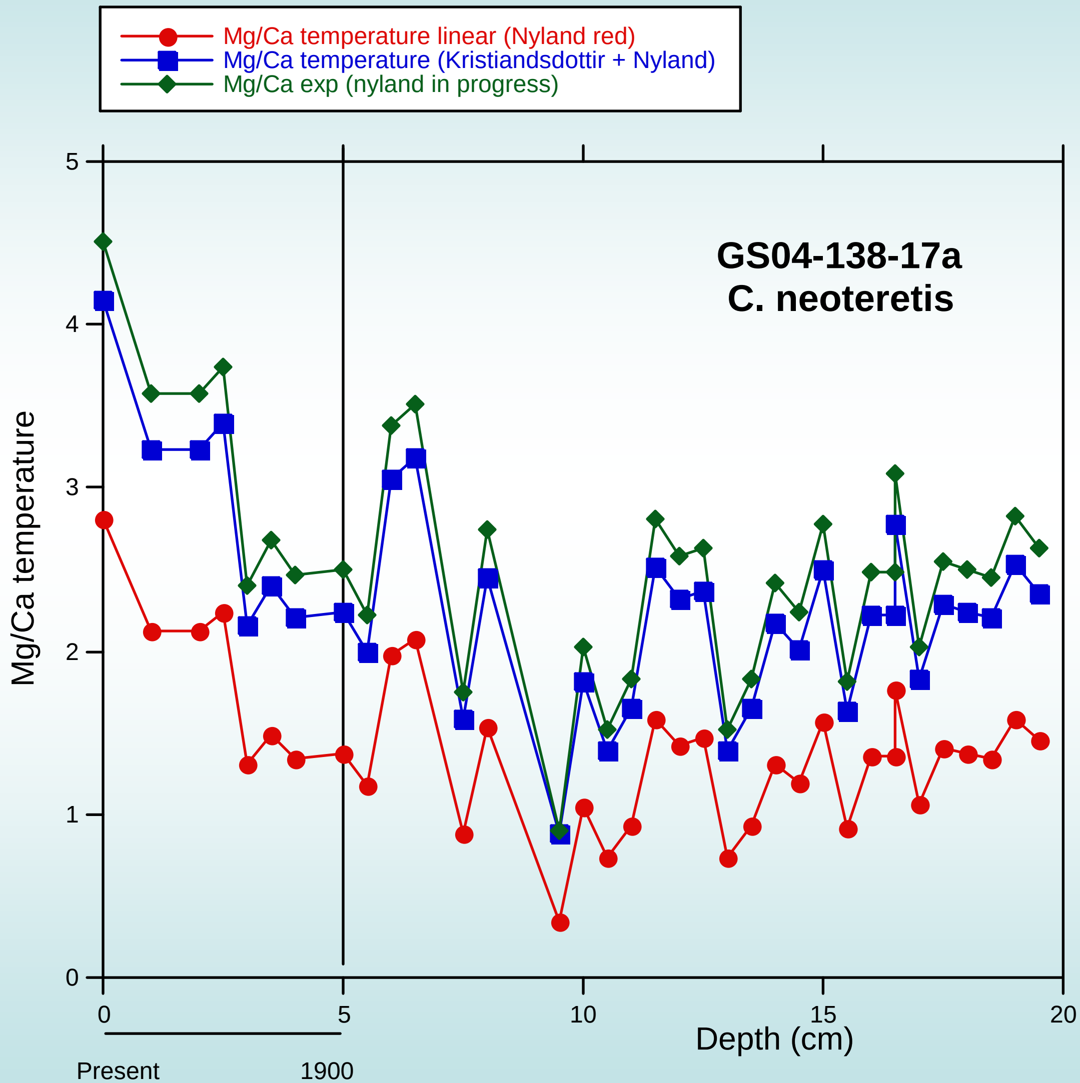
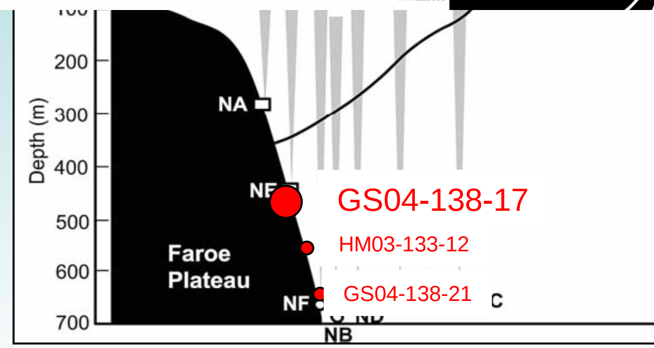
Down core results in GS04-138-17





GS04-138-17

High variability - temperature amplitude of ~2,5ºC (± 0,2ºC)

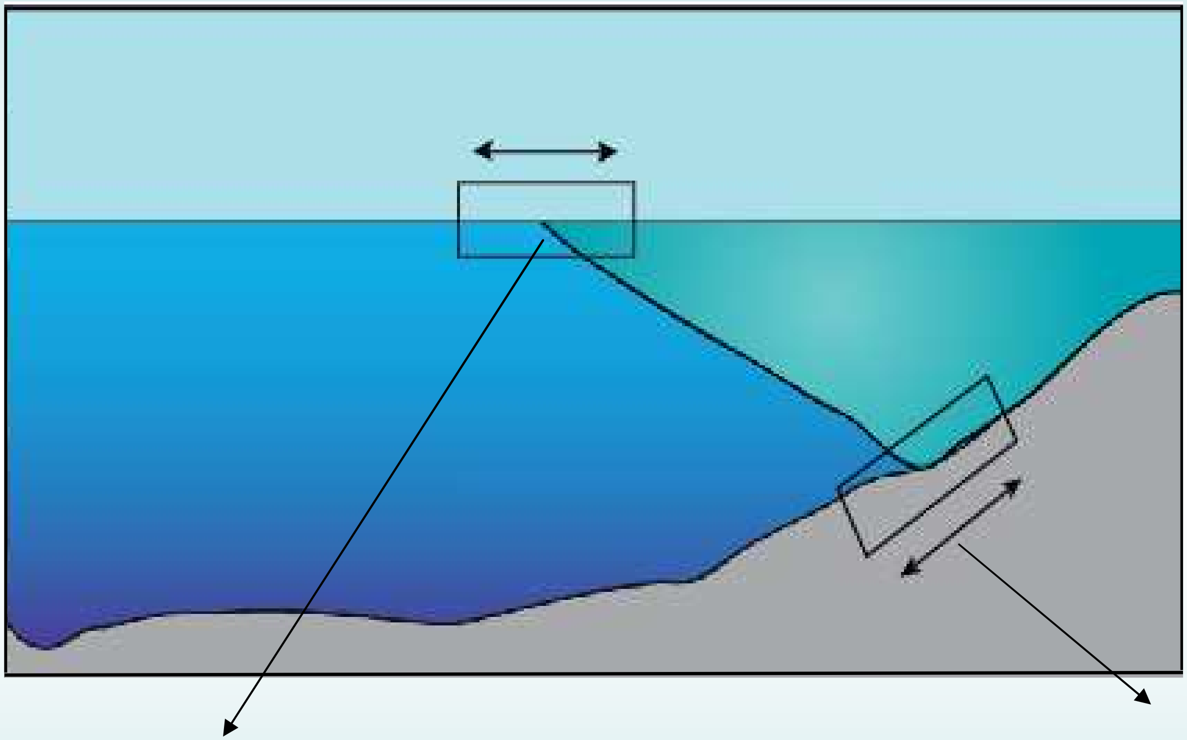
Recognising temperature increase the last 100 years.

Smaller resolution (5 cm=100 yrs)

The Faroe North Transect

North

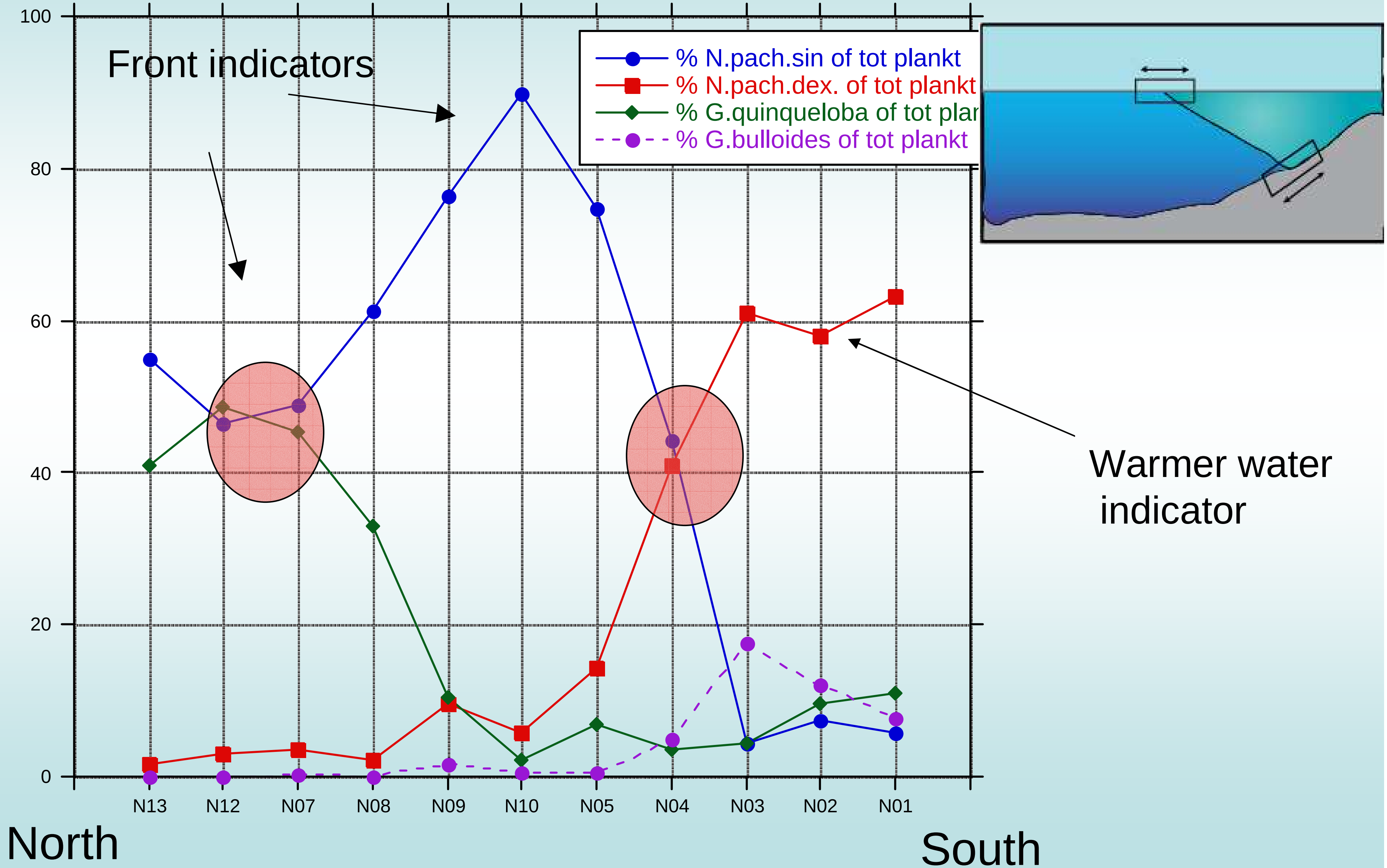
South



The position of the arctic front, which is marked where the thermocline meets the sea surface, can be reconstructed by using planktic foraminifera (subsurface dwelling species), transfer function and by the study of the production rate.

Changes in the depth of thermocline can be reconstructed by geochemical analysis like Mg/Ca and oxygen isotopes measurements in benthic foraminifera (bottom dwelling species).

Fauna counts on surface dwelling species



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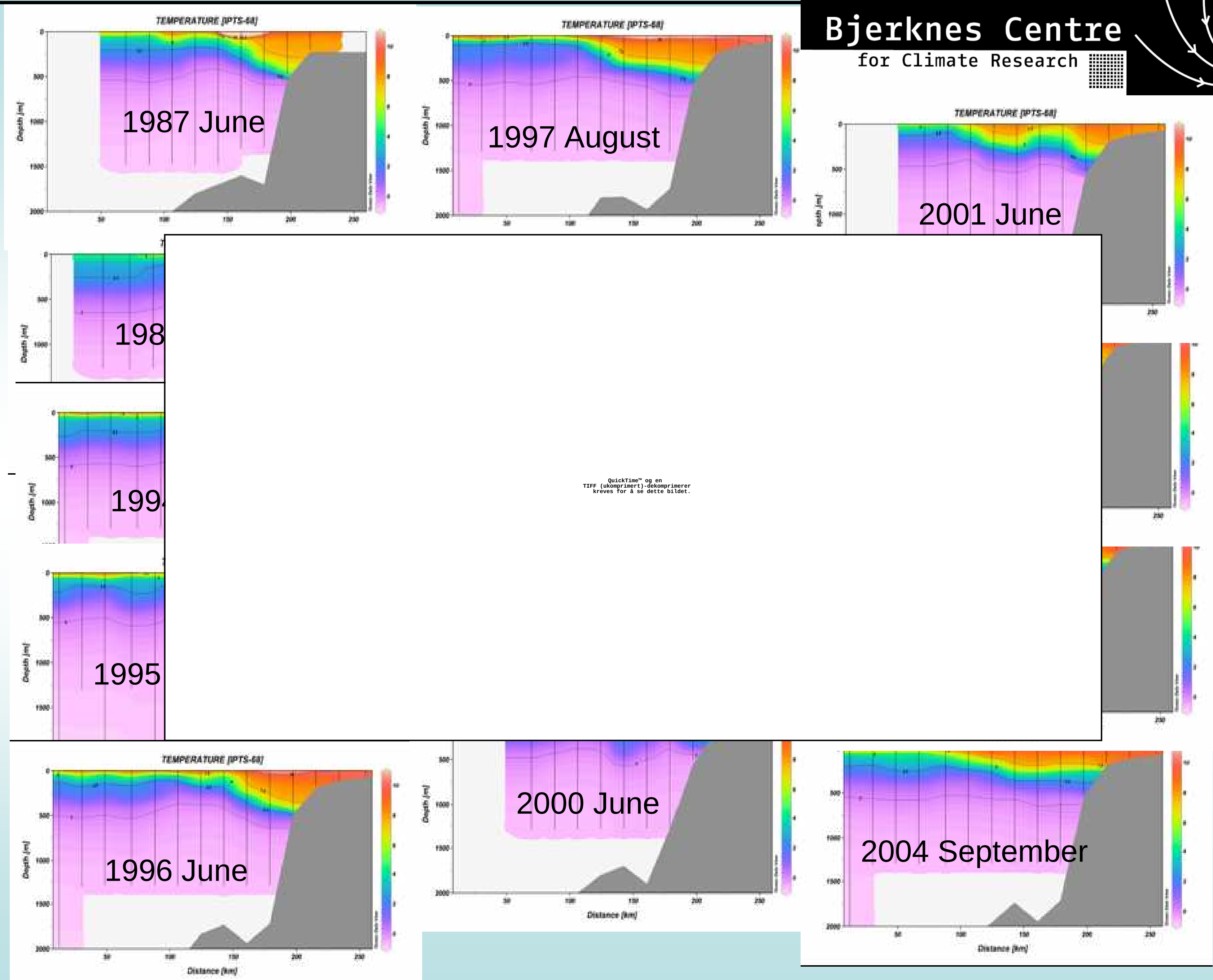


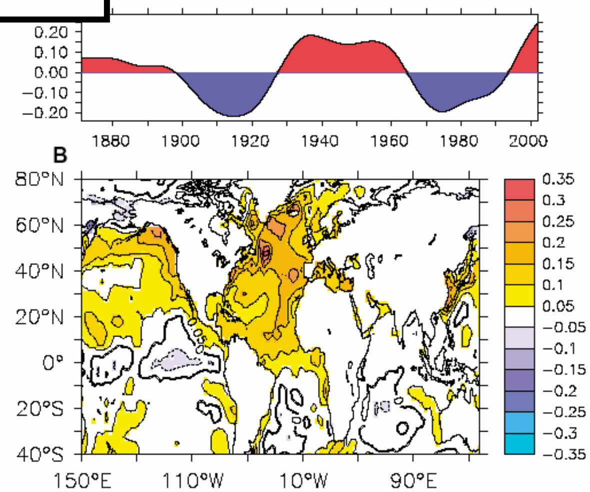
AMO-index

Atlantic Ocean Forcing of North American and European Summer Climate

Rowan T. Sutton* and Daniel L. R. Hodson

Recent extreme events such as the devastating 2003 European summer heat wave raise important questions about the possible causes of any underlying trends, or low-frequency variations, in regional climates. Here, we present new evidence that basin-scale changes in the Atlantic Ocean, probably related to the thermohaline circulation, have been an important driver of multidecadal variations in the summertime climate of both North America and western Europe. Our findings advance understanding of past climate changes and also have implications for decadal climate predictions.

AMO, 1871 to 2003. The index was calculated by averaging annual mean SST observations (29) over the region 0°N to 60°N, 75°W to 7.5°W. The resulting time series was low-pass filtered with a 37-point Henderson filter and then detrended, also removing the long-term mean. The units on the vertical axis are °C. This index explains 53% of the variance in the detrended unfiltered index and is very similar to that shown in (1). (B) The spatial pattern of SST variations associated with the AMO index shown in (A). Shown are the regression coefficients (°C per SD) obtained by regressing the detrended SST data on a normalized (unit variance) version of the index.



<u>Sutton and Hodson, 2005</u>
SST in north Atlantic to the Atlantic mulitdecadal oscillation. But no direct link to the thermohaline circulation.

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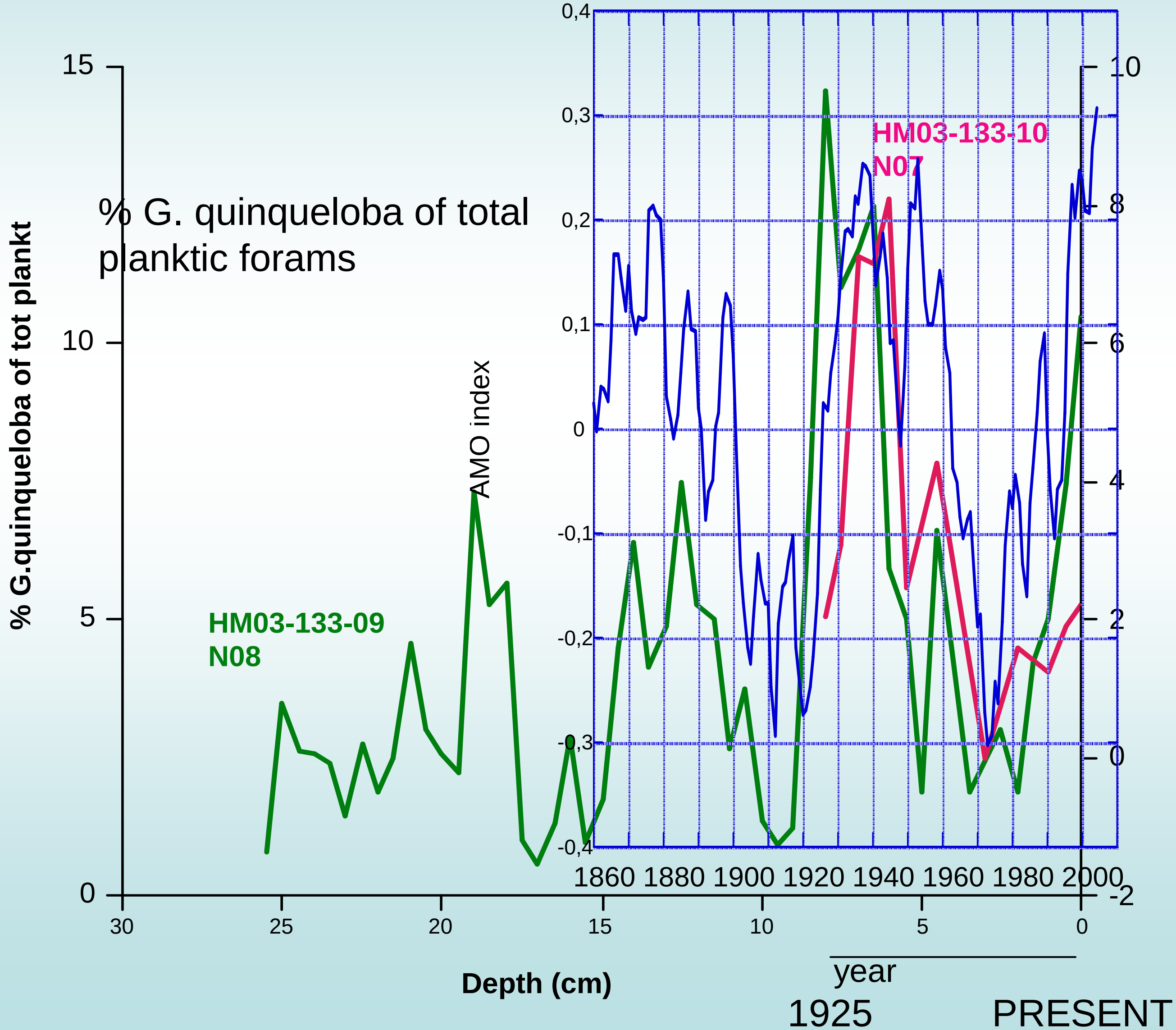
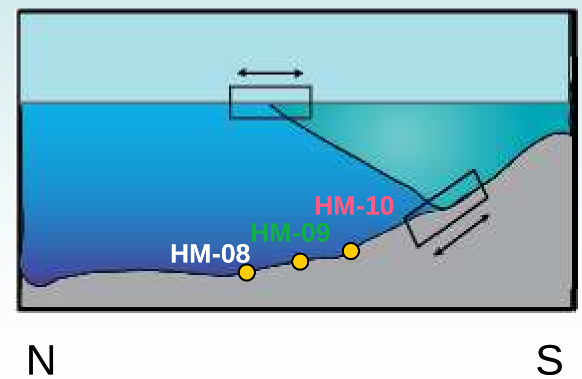
% of G. quinqueloba reflects variability in position of the front system.
These two cores show similar variability down core.





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Conclusions

- Mg/Ca in benthic foraminifera correlates with Bottom Water Temperatures
- Down-core Mg/Ca records show that interface changes in the intersection on the sea-floor/contintental slope is less than 100 m in vertical profile
- % of G. quinqueloba reflects position of a front system and correlates well with the AMO index, indicating that the AMO is linked to the thermohaline circulation

Thank you!