REPORT OF THE WORKING GROUP ON OCEANIC HYDROGRAPHY

Copenhagen, Denmark

24 - 26 April 1996

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Report on the meeting of the ICES Working Group on Oceanic Hydrography Copenhagen 24 - 26 April 1996

1. Opening

The chairman Dr. Erik Buch welcomed the WG members to the Royal Danish Administration of Navigation and Hydrography.

2. Review of membership

The latest list of members from the ICES Secretariat showed that the following had been appointed members of the working group:

* K. Mclean, UK and W. Walcowski, Poland

and the following have left the group:

* D. Dillingh, Neatherlands; A.Edwards, UK; A.Grelowski, Poland; W.Krzyminski, Poland; J.Piechura, Poland and G.Wegner, Germany

3. Remarks from the Oceanography Secretary

The ICES Oceanography secretary commended on progress with the Databank and various other tasks as elaborated in his written comments (annex F).

Members of the WG expressed concern that administrative tasks not take too much time or resources away from data quality assessment and banking.

4. Results from standard sections and stations.

The reports under this item revealed a few clear trends in the hydrographic conditions.
The decrease in salinities in the whole north east Atlantic seems to be rather consistent. There are signals indicated that there is a temperature decrease in the Barents Sea, while there is evidence that temperature has started to increase off the coast of New Foundland. Also the deep water of the Norwegian Sea (below 1200m) has shown a clear temperature increase the last years.

Savi Narayanan presented results from the Labrador, New Foundland and Nova Scotian shelves. Both meteorological and oceanographic conditions continued to moderate from a very cold period of the early 1990s. The annual air temperature along the Canadian east coast were now normal or above normal in 1995. Even ice formed early and was of greater extent than normal, ice retreat commenced earlier than normal, and there was less ice and icebergs on the Grand Banks.

Observations in 1995 showed increasing temperature along the entire east coast, and the temperature was close to normal or slightly above. At the standard station 27, outside St.John's, salinities were near normal during winter, but in spring and summer month, the water was fresher than normal.

Erik Buch presented results from West Greenland waters. The air temperature has increased and was close to normal in 1995. The positive trend in air temperature was not reflected in the ocean temperature. There was a heavy influence of Polar Water along the West-Greenland coast, but at the southern most section the Atlantic influence was higher than usual.

The conditions in Icelandic waters were presented by Svend-Aage Malmberg, who reported unusual conditions off the north coast of Iceland. Both temperature and salinity decreased, and only Arctic and Polar water were observed. The seasonal warning of the water masses started much later than normal and consequently the maximum temperature was observed late in the autumn. During autumn the conditions improved, and the Atlantic water, which was absent earlier in the year, was again observed. The improved conditions continued in winter 1996.

Bogi Hansen showed that the salinities of the Faeroes waters were low in 1995 in continuation of the trend starting in the early 1990s with decreasing influence of Atlantic water as composed to the East Icelandic Current. The most extreme situation was observed in

February 1995 when Atlantic water north of the Faroe Islands was only found on the shelf. The temperature on the shelf has also been decreasing and the annual mean temperature for 1995 was below the 1915-50 average.

The results from Bogi Hansen was supported by Bill Turrell who showed some observations from the Faroe-Shetland Channel where the conditions in 1995 continued to demonstrate low salinities at intermediate and bottom depths. The decline in salinity below 800 dbar continued, with possibly an associated warming. The salinities of the Norwegian Sea intermediate water is decreasing, while the values of Arctic Intermediate water rose from a minimum in 1993/94. In surface waters, salinities remain low on the Faeroes side of the channel, while at the Scottish shelf salinity were increasing from a minimum in 1993/94.

Jens Meincke reported on observations from a section between Greenland and Iceland. The section has been worked out since 1991 (except one year) and Meincke showed that there was large changes between 1995 and 1991. There was negative salinity anomalies in the Atlantic water (upper 500m) along most of the section. In the intermediate layer (500-1000m) the salinity had increased by 0.01-0.05, while there has been a decrease in the salinity between 1500-2000m. This was caused by denser Labrador Sea water, which was found at a deeper level in 1995 compared to 1991.

Results from Norwegian waters were reported by Johan Blindheim. In the Norwegian Sea, substantial fluctuations in temperature and salinity have been observed in the upper 200m during the last 15 years. The results shows a local warning in the northern Norwegian Sea after 1989, while salinity is close to the long-term mean. In the southern area, however, the period from 1992-94 has been characterized by values below the mean. In 1995 there was an increase, and both temperature and salinity were close to the mean values.

In the Barents Sea both temperature and salinity increased after a few years with a decreasing trend. The temperature was 0.3-0.5°C above the mean values with the highest anomaly in the eastern areas. The salinities were close to the mean.

After a cooling and freshening period, the cooling closed in 1995 in the North Sea, and a slight increase in temperature and salinity occurred, so both were close to their mean values.

Jan Piechura told about the Polish observations in the Norwegian Sea. They have established a standard section along 15°E from Norway to Spitsbergen and with some sections into the Barents Sea. One of their goals is to study bottom water formation in Storfjorden and the spreading of this water into the Norwegian Sea.

Svein Østerhus reported on results from weather station M. There has been a cooling and a decrease in the salinities in the upper 1000m since 1991. Below 200m both temperature and salinities are down to levels observed during late 70's, when the so-called "Great Salinity Anomaly" passed through. These results were confirmed by results shown by Svend Aage Malmberg and Johan Blindheim. Below 100m the salinity has been rather constant while there has been an increase in temperature. This was later discussed in more detail under item 6.

Finally there were two presentation on observation from the Gulf of Biscay by Hendrik van Aken and Alicia Lavin. Their results showed an increasing temperature in the upper 100m since 1991, mainly because of high air temperature. The salinities showed a steady decrease since 1992 in the same depth layer. However, van Aken indicated that there was sign of a slight salinity increase in the outmost region of his investigation area. A section off the coast of Vigo showed values close to normal in 1995.

After almost every presentation there was a general discussion on methods for observation and analysis of data, but mainly on explanation of the changed hydrographic conditions.

5. Outcome from the "Design group on presentations of results from standard sections and stations".

The Design group met in Copenhagen in December 1995 under the chairmanship of Dr. R.R. Dickson who also reported to the working group.

There were two issues for preparing an annual status report; 1)there was a request from the ACME for such a report. and 2) The Paris Commission is also asking for similar information. Therefore, it was stated that there are two issues which requires the same job to be done. During the meeting in December the group went through some national status reports and based on this, it was agreed that the report could have a layout as follows.

1. There should be an introductory chapter to put regional descriptions into an overall context, for example Pan Atlantic climate status, NAO state, global links, regions map etc.

2. Then there could be a chapter on regional descriptions with key information for each region such as time series from standard sections and stations with descriptive text, notes on special events, information on data etc.

3. It could further include chapters for example on data quality, modelling of time series, or other topics as appropriate.

4. There should be a summary to give the essence of the year, for example deep water formation in the Greenland Sea or the Labrador Sea.

After some discussions it was agreed that it could be presented on WNW and a paper copy could be presented as a paper at the Statutory meeting. Summing up conferences should be arranged decadally and based on these a hard copy, more glossy book should be published.

6. Outcome from the "Study Group on Norwegian Sea Deep Water salinities".

Reports by S. Østerhus and van Bennekom.

At the 1995 OHWG meeting in Oban, a discussion arose about possible changes taking place in the deep adiabatic layer of the Norwegian Sea. A small group was formed to look at this question further and report back to the OHWG. This summarizes their presentations at the 1996 meeting.

The principal data sets available to address the question of salinity change in the NSDW are CCS Hudson (1982), R/V Johan Hjort (1994), TTO/NAS (1981), R/V Haakon Mosby (1984), OWS 'Mike' (66°N, 2°E) and data from van Bennekom (Oct. 1994).

In tabular form the results can be summarized as follows (adapted from reports from Østerhus and van Bennekom) and adding here GEOSECS stn #18 (below 2800m):

Survey	date	salinity range	temperature range
GEOSECS	1972	34.909 - 34.915	-1.042 to -1.056
TTO/NAS	1981	34.907 - 34.912	-1.058 to -1.060
Hudson	1982	34.910 - 34.911	-1.054 to -1.057
H.Mosby	1984	34.908 - 34.912	-1.039
J.Hjort	1994	34.908 - 34.911	-1.036 to -1.037
vBennekom	1994	34.9086 - 34.9105	-1.036 to -1.037

From the above, one may conclude that the deep adiabatic layer has warmed 15 to 20mK between 1982 and 1994. Salinity changes are less convincing since any change is right at the limit of accuracy for the best salinity determinations. There is only one GEOSECS station in the Norwegian Sea (close to the TTO stn), but it does reinforce a) the cooling trend and a possible slight freshening. The thickness of the deep adiabatic layer has decreased 200-300m during the same time.

The heating of the deep adiabatic layer may be the result of two inputs: direct input from geothermal heating (one-third of the total) and mixing down of heat by the resulting convection (the remainder). Further, the transport of new deep waters from the Greenland Sea to the Norwegian Sea through the Jan Mayen Channel has decreased sharply between two current meter studies conducted in 1983-1984 and 1992-1993. Whether or not other time scales of variation in transport exist is not known (or reported).

The Norwegian and Greenland Sea deep basins are reservoirs of the very dense waters that set the density of waters that overflow into the North Atlantic Ocean. Thus, knowledge of the processes that govern their properties and how these vary with time is of great climatological interest. It will be interesting to see how the NSDW changes in the future. But as the above data indicate, only the very best in measurement accuracy will suffice.

7. Report on the Second Backward Facing Workshop (BF II) held in Bergen, March 21-23, 1996.

Dr. R.R.Dickson informed the WGOH on the results of BFII. The first task has been to complete the analysis of the extreme cold conditions in the Middle Atlantic Bight around 1880. By tuning a isopycnal model to the circulation of a similar cold event in the 1970'es, the advection of cold water could be related to anomalous atmospheric conditions, represented by a extremely low North Atlantic Oscillation index.

By reconstructing the atmospheric pressure distribution for the 1880'es the tuned model could successfully be applied to reconstruct the 1880 cold event.

In the second task BFII worked to relate events in the low cod abundance in the Barents Sea to the cold phases. They had available to them a regional model that could explain 60% of the variability in the temperature time series from the Kola Section 1905 until today and showed a close relation to the atmospheric pressure difference between Bear Island and Fugløy. In order to extend the temperature time serie back in time as far as possible, they reconstructed the atmospheric pressure distribution back to 1870 and used the model to reconstruct the temperature time series. From this it became evident that the reported poor conditions of the Lofoten cod in early 1900's could clearly be related to the extreme in adverse hydrographic conditions observed since 1870.

As a new mean to reconstruct temperature conditions during the life span of the individual cod BFII successfully tried to use the temperature informations contained in ΔO_{18} values from the annual rings in cod otollites. For refined calibration these measurements will be carried out on farmed cod with a known tight TS-history versus wild cod that has experienced a wide range of TS-conditions. This technique will also be applied to shells from long living clams. It is expected to result in temperature time series of up to 200 years length.

The success of BF-I and II sofar have resulted in first steps on preparing for BF-III in two years form now.

8. Progress in national and international programs

Rossby reported on the North Atlantic Float Programme: 80 RAFOS floats will be deployed by Rossby's group, and some other groups will also deploy iso-pycnal floats in the North Atlantic.

Østerhus reported on the progress in Nordic WOCE: Nine ADCP moorings have been deployed and will be recovered late May. The standard sections are operated four times a year.

Blindheim reported on the Mare Cognitum programme: A mooring array in the Svinøy section are in operation. Svein Sundby is now in charge of the Mare Cognitum programme.

Meincke reported on the VEINS proposal: The application to MAST-III will be resubmitted.

Lavin reported on the MAST-III programme CANIGO: Canary Island Azores Gibraltar Observations is an integrated European research project with the common objective of understanding the functioning of the marine system in the Canary-Azores-Gibraltar region of the Northeast Atlantic Ocean and its links with the Alboran Sea through comprehensive interdisciplinary basis scale studies.

Rossby reported on results from the Bermuda ADCP section operated by URI: the ADCP is mounted on a container ship (Oleander) sailing between the east coast of US and Bermuda. Rossby also reported on a proposal for an ADCP section between Scandinavia and Greenland. A study group, Chaired by Tom Rossby, was set up to find the right shipping lines for this work and to investigate the financial possibilities. The Study Group shall report back to the WG at the 1997 meeting.

Jan Piechura from Poland reported on a research program for biodiversity and fronts south of Spitsbergen.

9. Development in GOOS

The chairman remembered that last year the WGOH decided that the standard sections and stations may be an ICES contribution to GOOS. The oceanography secretary follows the developments closely.
Hendrik van Aken reported on his experiences with EuroGOOS. This regional programme appears to be nearly completely directed towards operational oceanography with little or no emphasis on research. This tendency was confirmed by the Chairman. An overview of Danish EuroGOOS Activities, given as an example of local EuroGOOS programmes, highlighted the shelf seas accents in EuroGOOS. Disappointment was expressed by different members of WGOH on the seeming lack of GOOS activities in the open ocean. Dr. Turrell mentioned that operational ADCP-measurements are carried out in the Faroe-Shetland Channel relative to offshore activities. Unfortunately these data are discarded after use.

10. Possibilities for ocean prediction

Harald Loeng presented the background for the forecasting mainly the necessity for people working with fisheries management. He presented the existing methods and models, the institutions that works on sea temperature forecasting. After that he presented some arguments for and against sea temperature prediction.

An animated discussion took place started by Peter Lundberg on the scientific basis of using statistical forecast based on time series, where even ethical aspects were invoked.

Bob Dickson suggested there were elements of predictability in our time-series providing we also remember their limitations, to the extent that the atmospheric forcing, evolved in predictable ways such as the NAO appears to do, then we do have some ability to predict or expect some associated patterns of change in the ocean even if they are in general terms. e.g. the slow shift in the NAO index from a high index extreme state to a low index one has implications, which can legitimately use which identifies the expected trend in wind strength, wave height, storm activities, storm track, sea surface temperature.

Bob Dickson mentioned the ability to now-cast sea temperatures for the Barents Sea, not itself a prediction, but from a knowledge of the relationship between cumulative temperature (since hatching) and cod growth and / or distribution, can be fed into the process of fish stock assessment which is itself a prediction. This is a subject currently occupying the Cod and Climate Working Group.

Bogi Hansen resume that prediction of biological parameters (e.g. cod weight at ape) using existing or historical ocean conditions (e.g. temperature) may be fairly straightforward. Prediction of physical oceanic conditions is a more difficulty problem, but it is also very important. At present, statistical methods may be the only alternative in many regions, but these should only be considered as preliminary, until the physical driving forces are understood to the extent that deterministic prediction becomes practical.

Asked about what was the purpose of this item Erik Buch said that modelling activities are increasing progressively and it was convenient to give the views of the working group of this kind of models.

After the question of what component of the changes is advective and what is locally atmospheric changes. Bob Dickson said that there must be a component of change which is advective, if we can distinguish it; even in the case of Barents Sea temperature field only about 60% of the variance is explained by the local pressure gradient, leaving scope for an advective contribution and therefore to gain predictabilities from time series further upstream.

Finally Bob Dickson suggested that we can state quite definitely that lengthening time-series do not represent diminishing returns. Instead we have found that in almost every case as our time-series have lengthened we have discovered more and more instances of oceanic behaviour that we could hardly have guessed and would not expect from models. Thus the importance of lengthening our existing time-series is quite certain whether from the viewpoint of predictabilities or simple understanding.

11. NANSEN Project final report.

Bogi Hansen reported progress towards the joint publication of a group of papers which meet the NANSEN Project aims of investigating exchange across the Iceland - Scotland Ridge. A total of 12 such papers, contributed to ICES ASM's between 1986 and 1993, have been identified as describing the dynamics of exchange in this region. It was suggested that these should be published together with an expanded introductory syntesis and a bibliography of NANSEN related work published elsewhere.

The WGOH endorsed this suggestion and recommends publication by ICES in its Cooperative Research Report Series with Bogi Hansen and Svein Østerhus as editors. The WGOH made the additional recommendation that publication shall be as timely as possible in view of the current interest of this subject within the WOCE community.

12. Oceanographic instrumentation

Dr S Narayanan (Canada) related her experience analysing ADCP data collected from ships of opportunity and research vessels. Instruments were hull mounted or deployed from spars attached to the side of vessels. The oil industry in particular required estimates of near surface velocities over the Grand Banks, and until now drifter data has been sparse in this area. Dr Narayanan was funded to summarise all available ADCP data. Simple binning and averaging of the data over a grid of boxes covering the area, without initial de-tiding, produced vectors which correctly reproduced the main features of the known circulation. A comparison of the simply treated ADCP data with current meter data was also encouraging. The study will now go on to remove the tide at selected sites in order to investigate its benefits. ADCP data from the Labrador Current will be compared to geostrophic calculations in order to estimate transports. In addition the ADCP backscatter is increasingly being employed by biologists in studies of plankton.

Dr van Aken (Netherlands) reported a possible pressure dependancy of some earlier SeaBird Temperature sensors. Newer sensors have this error removed. Possible warming of the temperature sensor by flow over it in the pumped configuration was also reported, introducing errors of a few milli Kelvin. The new deep sea thermometers have been tried and proved satisfactory.

Dr Hansen (Faroe) confirmed that a pressure dependancy was possible, and that a SeaBird conductivity sensor may also have demonstrated a pressure dependance. These errors were detected using duplicate T and C sensors, which is now a recommended practice. Another possible error introduced to SeaBird calibrations was due to their use of artificial sea water. This has now stopped.

Dr van Bennekom (Netherlands) reported progress with a new method of determining dissolved oxygen. This involves measuring extinction using a spectrophotometer rather than the standard titration method. The new method is faster, requires less training and does not require the exact volume of sample to be known. Unfortunately the new method has not yet been internationally accepted.

13. Quality assurance manuals (equipment, measurements, data processing and training)

Dr. Johan Blindheim presented his manuscript "Manual on data acquisitions and sampling at hydrographic stations - CTD stations" including among other things purpose, scope, critical points, descriptions of operational methods, definitions, background references, forms and instructions.

Blindheim emphasized that his handbook was mainly for standard hydro-biological work in shelf seas. Some discussion followed about different views about the demands to procedures regarding different object of research in shelf seas and deep seas. Generally it was accepted that the same care should be taken for all sampling, whereas the guidelines should be relatively simple and easy to follow, but certainly based on more detailed instructions like those of the WOCE handbooks. A German version of a manual was also mentioned. A publication of a manual was emphasized, but it should first be further reviewed by various groups a.o. the Shelf Sea Committee. It was **recommended** to the Hydrographic Committee of ICES that a publication should be prepared on an operational manual on how to proceed in preparation and sampling on board during cruises.

Training was also discussed, both theoretically in shore laboratories but not less during research cruises at sea.

Furthermore some other data sampling such as Scan-fish, Sea-soar and ADCP data was also discussed.

14. AMAP Report

Harald Loeng reviewed progress in this field. Deadline was shifted to April 1996 and a preliminary version of the report on oceanic pathways of pollutants has already been reviewed internationally. The revised version will be subject to international scrutiny and Harald Loeng asked for possible candidates for the task. The following names were suggested: Thomas Rossby, Bogi Hansen, Svein Østerhus, Dennis Woodhead, Maff/Lowestoft.

New timeschedull is that the report is to be accepted in october 1996 and to be printed in Jan.1997.

15. Election of a new chairman

The present chairman Dr. Erik Buch wished to resign from the task as chairman due to other responsibilities at his institute.

Dr. Savi Narayanan, Canada was elected new chairman.

16. Any other business

No subjects for discussion

17. Place, date and topics of the next meeting

The working group accepted an invitation from Johan van Bennekom and Hendrik van Aken to have its next meeting at the Netherlands Institute for Sea Research, Texel. Date: 21 - 23 April 1997.

As topics for the next meeting the following subjects were proposed:

a) update and review results from standard sections and stations;

b) evaluate possibilities for ocean climate forecasting;

c) assess the developments in GOOS.

d) review progress in national and international projects in the North Atlantic;

e) assess and evaluate oceanographic instrumentation.

f) evaluate the outcome of the study group on "Transatlantic ADCP Surveys".

g) calibration of instruments

h) use of satellite altimetry in circulation studies.

i) Second Decadal Symposium

Justifications:

a) This is a standard item to enable the group to closely monitor ocean conditions. Results will be presented according to the decisions made at this years meeting.

b) A discussion of this subject was started at this years meeting based on a report from Harald Loeng, Norway. The working group believes that it is appropriate to evaluate the utility of these forecasts in a much broader perspective with a view to their potential expansion to other parts of the ICES area.

c) GOOS is, and will be for some time, at the design stage. Most ICES member countries will be formally involved, one way or another, in GOOS activities, including those components of GOOS that will monitor open ocean conditions. In order to acquire an ICES-wide perspective of national contributions and intentions, the working group wishes to keep these activities under close scrutiny. All members will provide GOOS status reports to the chairman.

d) This is an ongoing item providing information to the members and ICES. Since many activities, or planned activities, are now being coordinated via funded proposals (e.g., EU) it is important to evaluate these activities (and those of other relevant Working Groups) in relation to the potential capabilities offered by the international funding framework.

e) Rapid technological developments continue to enhance our capabilities for measuring oceanographic parameters. These lead to many possibilities for increased resolution and efficiencies. However there are many drawbacks if misused. This item therefore serves to inform members and ICES on the present status of the operational use of any new equipment

f) A proposal to install ADCP's on commercial ships crossing the North Atlantic was forwarded at this years meeting. A study group was set up to find the right shipping lines and to investigate the financial possibilities. The study group chaired by Tom Rossby will report to the WG on its results.

g) Good calibration procedures forms the basis for a high quality data collection. The WG wish to discuss the experience of the various laboratories on this subject.

h) Satellite altimetry has for a number of years been used in circulation studies. The WG wish to evaluate the results from the use of this technique.

i) It is time to start the planning of the second decadal symposium i.e. decide on a meeting place and appoint the convenors.

Appendix A

ICES Working Group on Oceanic Hydrography Copenhagen 24-26 April 1996

Agenda

1. Opening
2. Review of membership
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4. Results from standard sections and stations.
5. Outcome from the "Design group on presentations of results from standard sections and stations".
6. Outcome from the "Study group on Norwegian Sea Deep Water salinities".
7. Review the conclusions of the second Backward Facing Workshop.
8. Progress in national and international project in the North Atlantic
   * WOCE Hydrographic Programme
   * Mare Cognitum
   * EU MAST 3 programmes
   * Globec
   * Transatlantic ADCP surveys
   * Others
9. Developments i GOOS
10. Possibilities for Ocean forecasting
11. NANSEN project report
12. Oceanographic instrumentation
13. Quality assurance manuals (equipment, measurements, data processing and training)
14. AMAP report
15. Election of new chairman
16. Any other business
17. Place, date and topics of next meeting

Appendix B

List of participants

Svend Aage Malmberg, Iceland
R.R. Dickson, UK
Alecia Lavin, Spain
W.R.Turrell, Scotland
Peter Lundberg, Sweden
Jens Meincke, Germany
Hendrik van Aken, the Netherlands
Johan van Bennekom, the Netherlands
Tom Rossby, USA
Savi Narayanan, Canada
Johan Blindheim, Norway
Harald Loeng, Norway
Bogi Hansen, the Faroe Islands
Svein Østerhus, Norway
Jan Pieshura, Poland
Niels Højerslev, Denmark
Harry Dooley, ICES
Erik Buch, Denmark

Appendix C

Joint meeting of the Oceanic Hydrography and Marine Data Management Working Groups 24 April 1996, RDANH, Copenhagen

The topics for discussion between the two groups covered various aspects of oceanographic data quality assurance. J. Blindheim began by presenting an overview of the document developed at IMR, Bergen, for the quality assurance of CTD data. The document was structured around a series of procedures, each a succession of actions, with the same structure. The concept behind this was that with a set of procedures in this form, each taking no more than a few pages, it was easy to find the relevant, and was sufficiently brief to ensure that it would be used. Each procedure comprised the following elements: scope, purpose, critical control points and description of methods. The manual developed for the collection of CTD data comprises five procedures.

L. Rickards reviewed the discussions from the MDM WG on quality control procedures/ minimum requirements. The Group was drafting documents for CTD, current meter and water bottle/nutrient data. These included a list of standards that the data should reach and recommendations about the information which should be stored alongside the data. This covered both 'header' information (i.e. position, depth, instrument, etc.), calibration details and supporting information (i.e. instrumentation, collection methods, processing, etc.). She also described an intercomparison of CTD quality control methods which members of the WG were taking part in. This involved each person taking a set of data, converting to their own format, quality controlling the data and producing a brief report, noting any problems. Although this was taking some time to complete, it was found to be a very useful learning experience.

Both WGs welcomed these developments and agreed that it would be most useful to publish the CTD data collection guidelines, possibly under the ICES umbrella. The guidelines produced by the MDM WG were planned to be published on the World Wide Web, but could also be published in hard copy. It was intended that the guidelines for each data type should be short.

Some discussion followed about the information to be stored alongside the data, how to report measurements, and whether data values should be flagged. Various opinions were expressed, including calibration should be supplied alongside the data, flagging as required by WOCE was favoured by some, but not by others, it was possible to state that measurements had been carried out according to procedures laid down in particular manuals. B. Cahill mentioned that it is useful to have a checklist to know what is important to include. G. Hopwood commented that data collected according to a particular manual does not necessarily indicate the quality of the data. J. Meincke noted that each data set should be obtained with the utmost care - not necessarily the most accurate (i.e. not necessarily the third decimal place). One should not be limited to one procedure, but it is necessary to know how the data are collected. It is essential to know the quality of the data. H. Van Aken asked if the Data Centres made provision to store text alongside the data. ICES, BODC and DOD all store information.

Some discussion ensued about how to proceed. J. Blindheim mentioned that it is difficult to meet WOCE standards, on well staffed cruises. But there are not enough specialists to maintain this level of measurement for all cruises, so it is important that an acceptable level of measurement is attained. It is important to produce a set of unsophisticated guidelines. Secondary users wish to know the quality of data. The level of data acquisition can be raised by simple guidelines. People operating the CTDs may not be well trained, but given basic guidelines, one can aim to acquire the best quality data available. Training is very important, and should be in addition to manuals/guidelines, not an alternative.

The document produced by J. Blindheim has been written to conform to ISO standard - essential items are included on a list, it is simple and easy to use. The document needs to be consistent and hierarchical. It should be stressed that the manual is to be addressed to people using the instruments for the first/second time, to get the best out of them. The 2 WGs agreed that this manual on operation of CTDs should be produced for/by ICES. (and the Hydrography Committee should support this).

R. Dickson was worried about the increasing use of CTDs mounted on batfish, particularly by non-experts. The data collected for example, by biologists only interested in structure rather than absolute values. Calibration was felt to be very important for undulating instruments. It is hard to quality control. CTDs should be taken at the end of each leg. WG members felt that an expert, for example R. Pollard from the Southampton Oceanography Centre in the UK, should write up his methods and these could be taken as the standard procedure, and adapted where necessary.

J. Meincke went on to discuss other types of data which might require similar guidelines, for example RAFOS drifters and ALACE or PALACE floats. ALACE floats are still being developed, trying to add conductivity sensors. But these instruments will soon be producing data and it is important to know the minimum requirements for these, in the form of short descriptions. G. Hopwood mentioned that ICES is the project data centre for the EU MAST ESOP project, which includes these data, and could put together a short manual. T. Rossby, the expert for these instruments, noted that RAFOS floats are calibrated in pressure vessels, and have accuracies for pressure somewhere between XBTs and CTDs, for temperature the accuracy is 0.1 °degC, about the same as XBTs. ALACE floats will be used in the future.

R. Dickson thought that it would be useful to have a couple of pages describing the methods for collecting good quality batfish/SeaSoar data. T. Rossby thought that it would be advantageous to get the technical people together from various institutes periodically, as happens in the USA. Intercalibrations were also valuable, and often took place as part of large programmes. ICES should (and does) encourage the exchange of technicians and intercalibrations.

There was some feeling that the present discussions and guidelines should be restricted to CTD data collection and processing and leave the other data types at present, due to the difficulties they pose. However, J. Meincke pointed out that we are in the run up to GOOS, into which existing programmes will link, and we should sort out procedures now. There is a gap in the temperature and salinity data sets from the 1970s, when CTDs came into use, this should not be allowed to happen again with new instrumentation. It is also essential that the manuals which do exist are advertised so that people are aware of their existence.

L. Rickards raised the problem how to reconcile temperature and salinity data collected with a CTD on the downcast with nutrient samples taken on the upcast in waters with very rapidly varying conditions. S-A. Malmberg agreed that this has been a particular problem with data collected by him and his colleagues, and has been difficult to solve. It is not so much a data collection problem, as a problem of the best way of handling the data subsequently. On the whole it was thought best to treat the up and downcasts as separate stations. The discussion widened to consider new CTDs which will be able to take the bottle samples on the downcast without upsetting the CTD data collection, and also to consider the problems of knowing which bottle had fired when, as there had been some problems with this which could be time consuming to resolve. H. Van Aken also mentioned that for WOCE many calibration samples were required to obtain high quality data, and he had been surprised at how accurate the calibrations were.

R. Dickson then reported on the work of a small group who, over the year, had discussed the production of a status report for the standard sections which are reported by the OH WG each year, and appended to the WG report. It was intended to produce something which would be more readily available, together with a preamble on the general status of the North Atlantic, and a comment as to the data quality (e.g. these data have been collected and processed according to QUASIMEME). Every 10 years a decadal version of the publication should be produced and presented at the decadal symposium. In between the time series would be kept electronically at ICES, and possibly made available graphically on the World Wide Web. S-A. Malmberg noted that some people in Iceland do not wish to continue monitoring work, but he felt that it was valuable. ICES, in particular was valuable for long time series data to assess climate variability. The data must be taken care of and made accessible. Time series are expensive to collect, but essential. It is important to observe and then explain what is happening. F. Nast commented that the title environmental status might be interpreted incorrectly and it was agreed that a better name would be 'Status of the Physical Environment'.

Appendix D

Recommendations.

1) The Working Group on Oceanic Hydrography recommends that the NANSEN Project report shall be published by ICES in its Cooperative Research Report Series with Bogi Hansen and Svein Østerhus as editors. The WGOH made the additional recommendation that publication shall be as timely as possible in view of the current interest of this subject within the WOCE community.

2) Working Group on Oceanic Hydrography recommends to the Hydrography Committee that ICES shall take the initiative to produce and publish an operational manual on how to handle and operate oceanographic instrumentation. The manuals shall be small and easy read and mainly address non-oceanographers with the purpose of a general increase in data quality.

3) The Working Group on Oceanic Hydrography (chairman: Dr. Savi Narayanan) will meet in Texel, Netherlands from 21 to 23 April 1997 to:

   a) update and review results from standard sections and stations;

   b) evaluate possibilities for ocean climate forecasting;

   c) assess the developments in GOOS.

   d) review progress in national and international projects in the North Atlantic;

   e) assess and evaluate the oceanographic instrumentation.

   f) evaluate the outcome of the study group on "Transatlantic ADCP Surveys".

   g) calibration of instruments

   h) use of satellite altimetry in circulation studies.

   i) Second Decadal Symposium

Appendix E

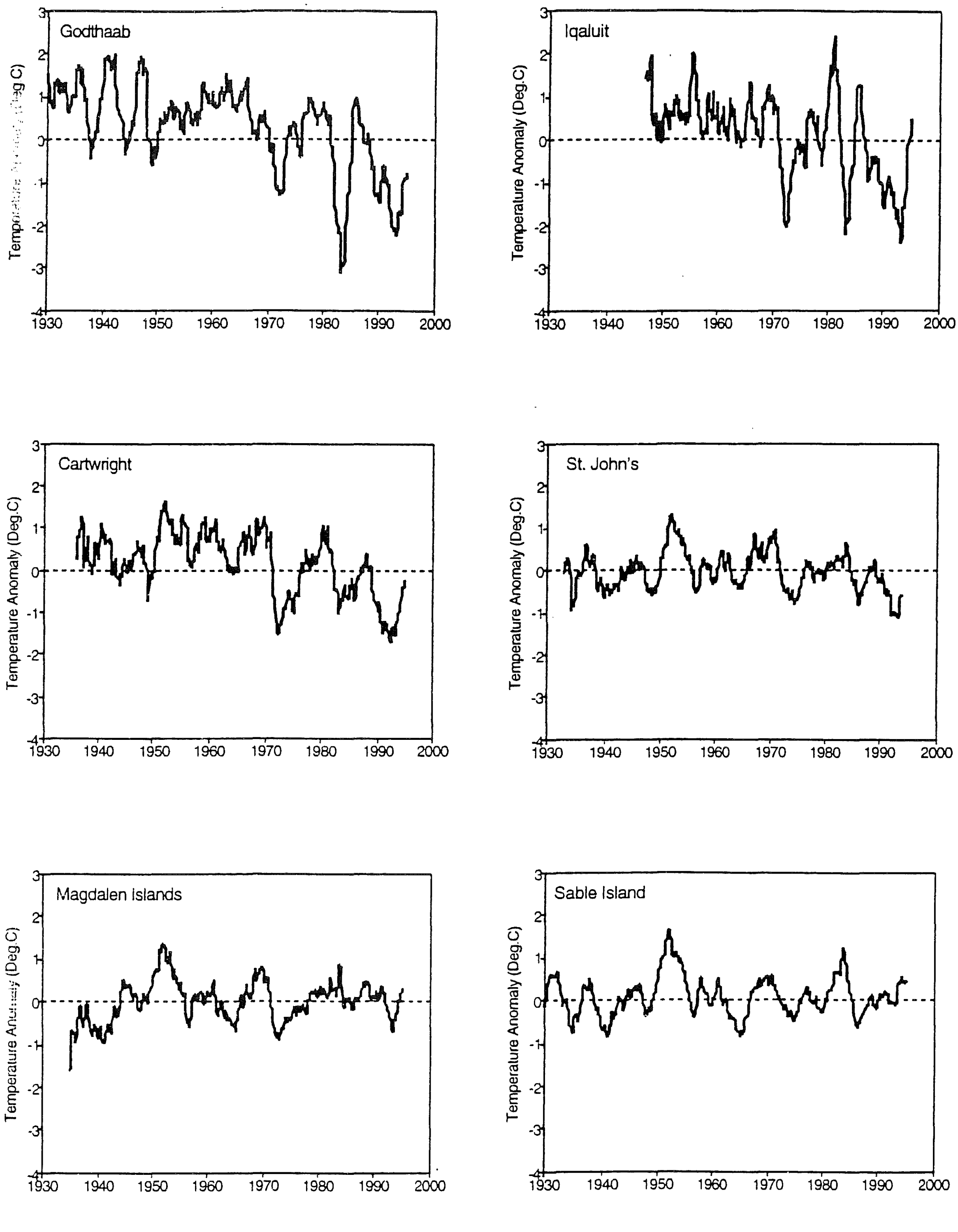
Results from standard sections and stations

Canada (Savi Narayanan):

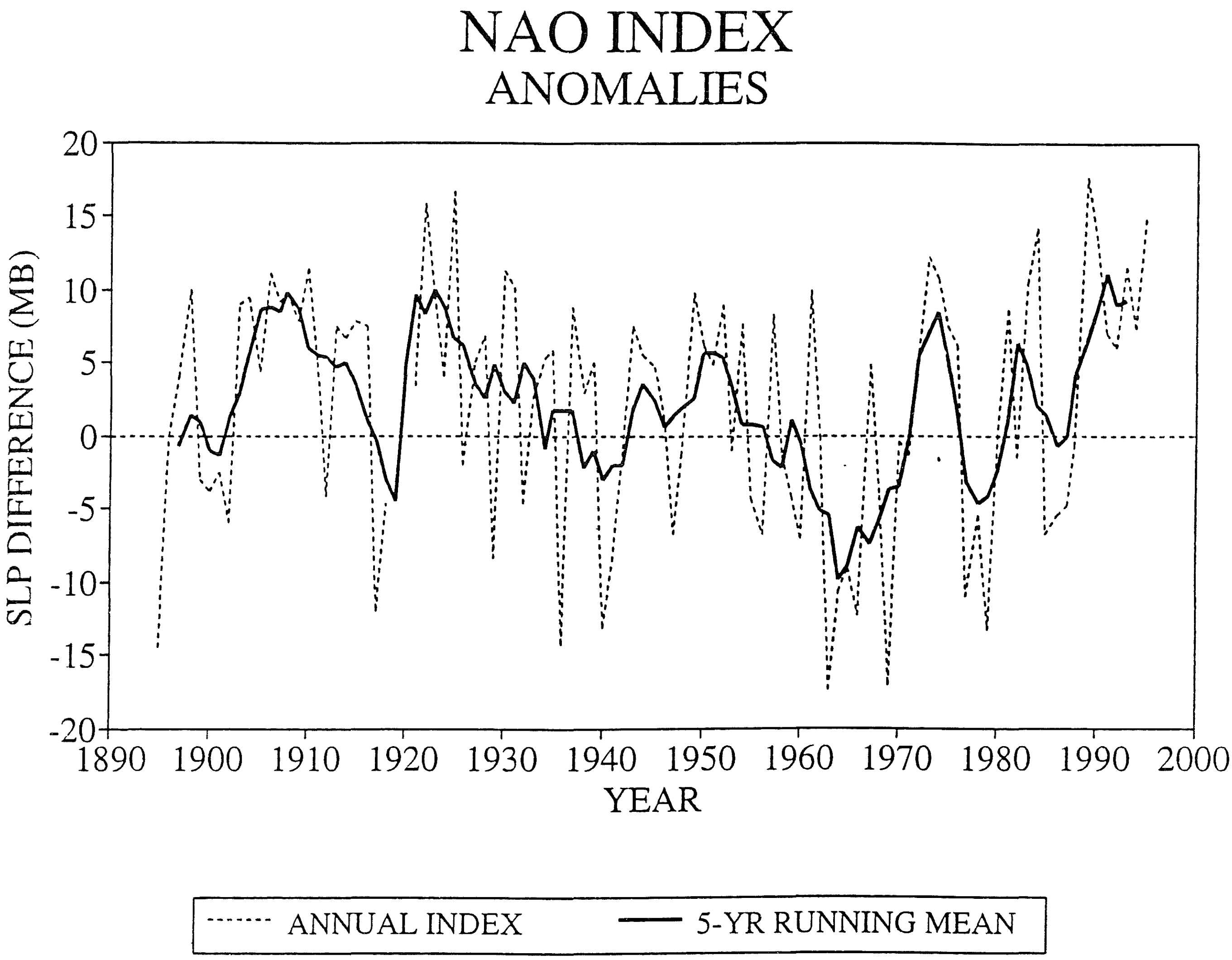
The meteorological and oceanographic conditions in the NW Atlantic continue to moderate from the very cold period of the early 1990s. Air temperatures were near normal or above normal during the spring, summer and autumn, and in winter, though below normal, not as cold as 1994 or the earlier 1990s. Consequently, the annual air temperatures along the Canadian east coast were near normal or above normal in 1995. The lower than normal winter air temperatures and accompanying stronger-than-normal northwest winds caused ice to form early and be of greater areal extent than normal. However, ice retreat commenced earlier than normal and there was less ice and less number of icebergs on the Grand Banks.

The moderating trend is clearly noticeable in the water temperatures on the continental shelf. The area of the Cold Intermediate Layer (CIL) in July was below normal (less cold water on the shelf) along the Bonavista transect (by 28%) and the Seal Island transect (by 32%), but above normal by 20% along the Flemish Cap transect. The minimum temperature in the core of the CIL was above normal along the northernmost transect, near normal on the NE Newfoundland Shelf and slightly below normal on Grand Bank. Bottom temperatures on the shelf during the fall were also above normal, indicating increased heat transport to these depths. At Station 27, water temperatures were normal during winter, cooler than normal in spring and moderate to normal conditions in the fall. Salinities were near normal during early winter over the entire water column, but in the spring and summer months, were fresher than normal.

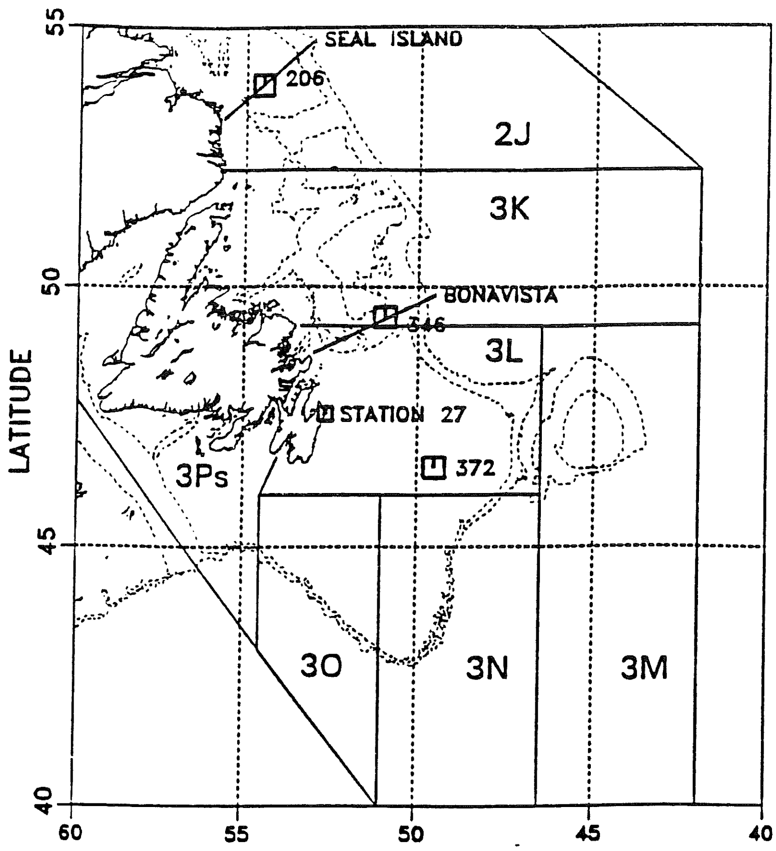
In the deep basins and channels of Scotian Shelf and in the Gulf of Maine, lower layer waters remained above normal, possible due to the presence of warm water, whereas ín the 50-100m layer over the shelf and deep waters in the northeast, temperatures remained colder-than-normal. At several of these locations where negative anomalies were present, the cold conditions have persisted since mid-1980s with 1995 temperatures being comparable to the mid 1960s. The surface temperatures were above normal at Boothbay harbour and St.Andrews throughout most of the year and below normal at Halifax. The Cabot Strait temperatures were also near normal, but lower relative to last year.

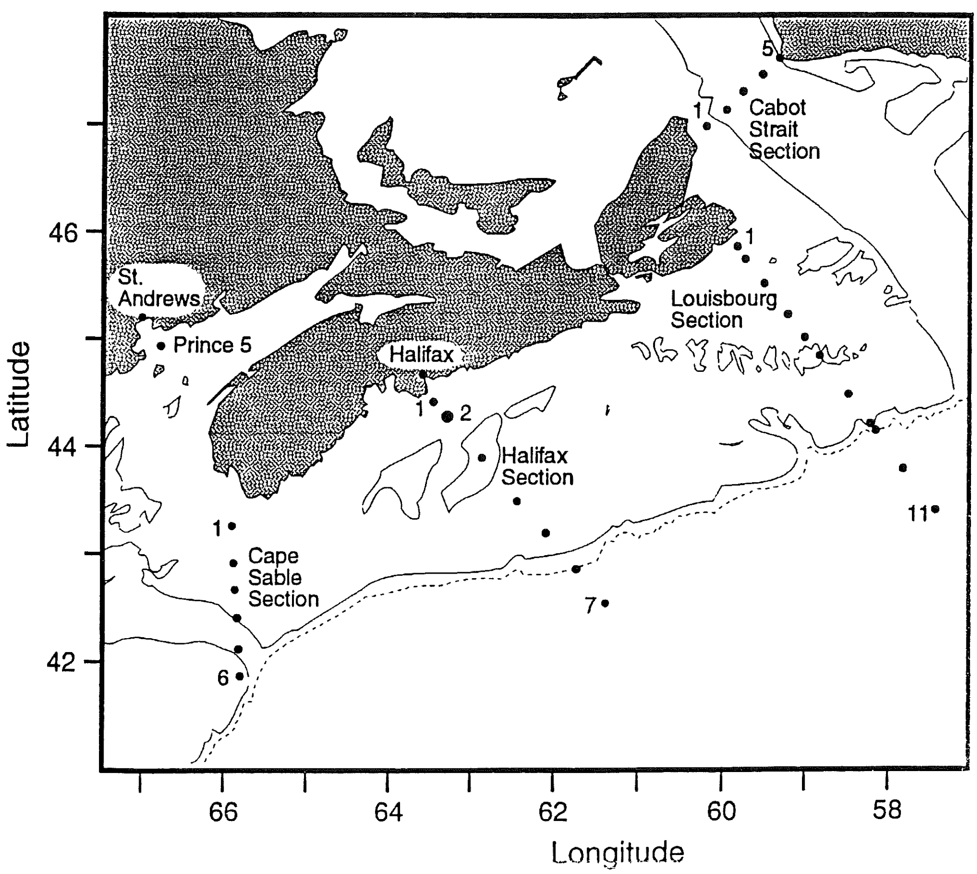


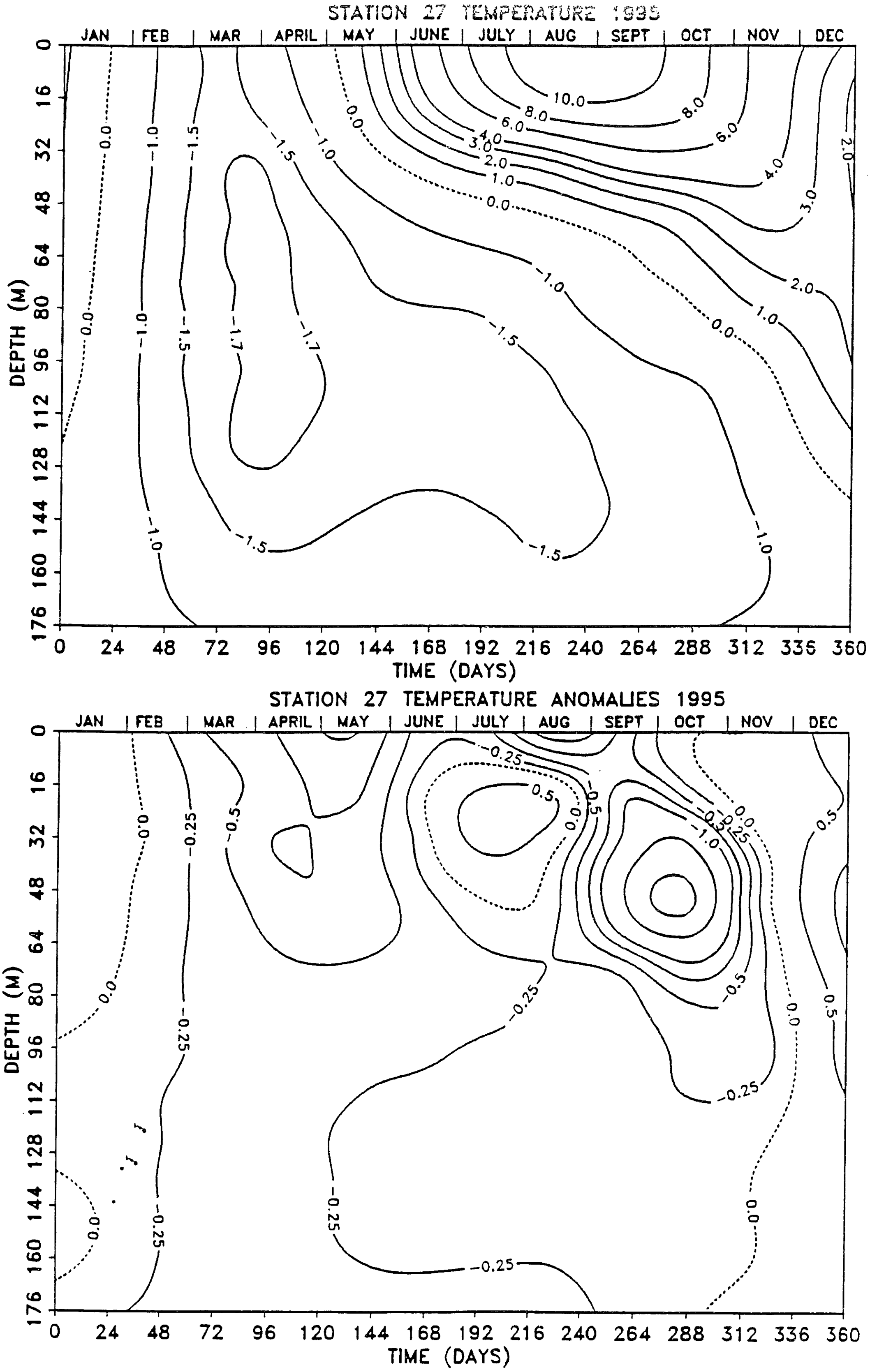
Twenty-five month running means of monthly air temperature anomalies at selected sites.



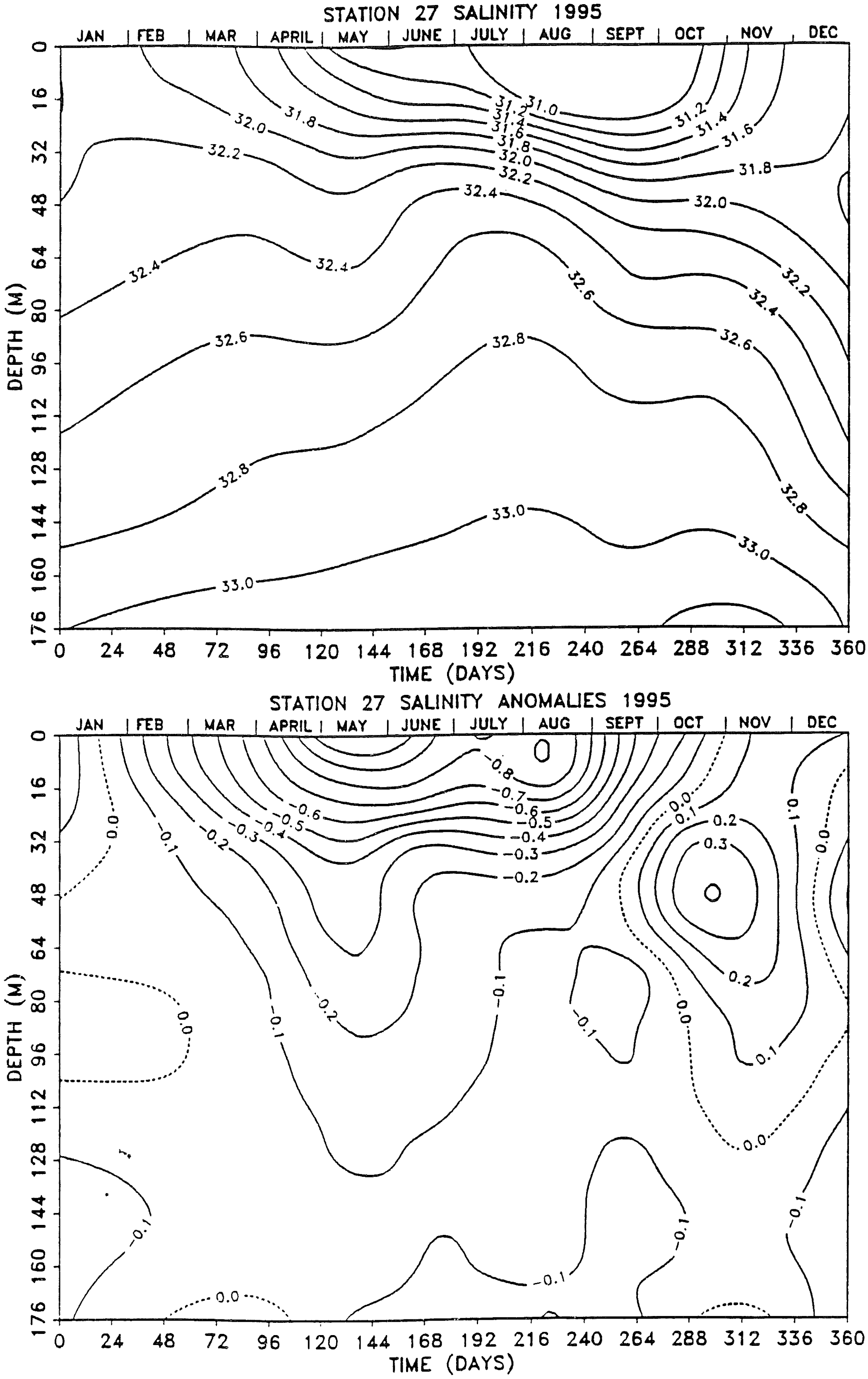
Anomalies of the North Atlantic Oscillation Index, defined as the winter (December, January, February) sea level pressure at Ponta Delgada in the Azores minus Akureyri in Iceland, relative to the 1961-90 mean.


SEAL ISLAND
206
2J
3K
BONAVISTA
346
3L
STATION 27
372
3Ps
3O
3N
3M
LATITUDE
55
50
45
40
60
55
50
45
40

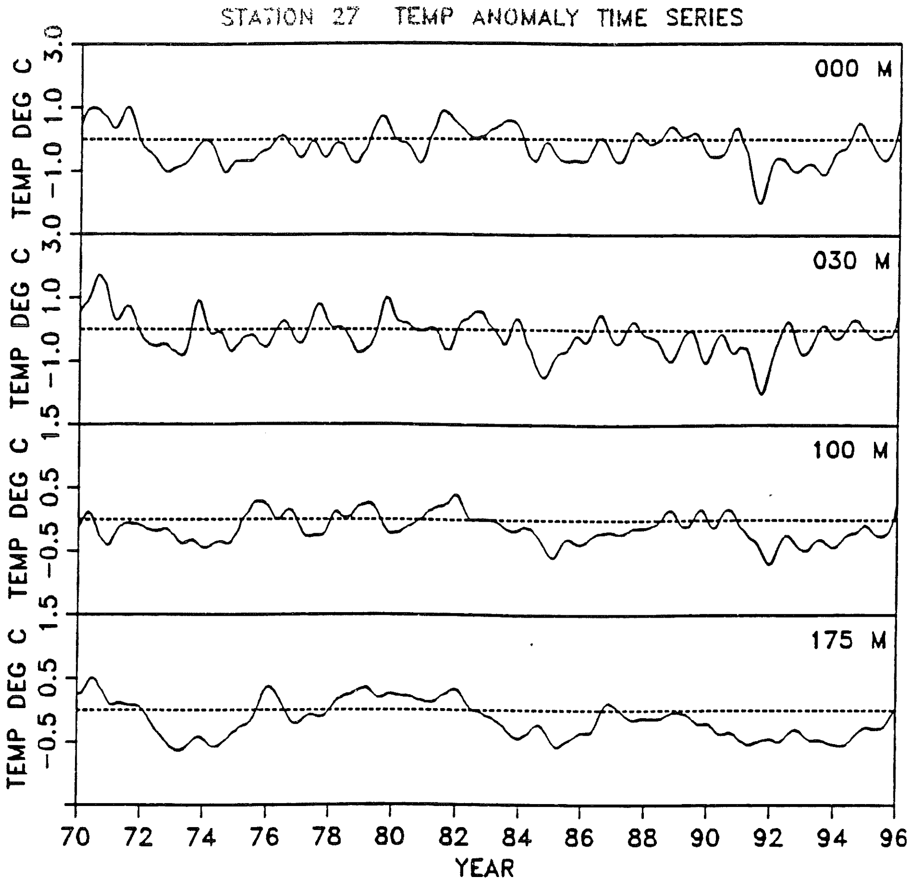

Cabot
Strait
Section
5
1
Louisbourg
Section
1
11
St.
Andrews
Prince 5
Halifax
1
2
Halifax
Section
7
1
Cape
Sable
Section
6
Latitude
46
44
42
66
64
62
60
58
Longitude

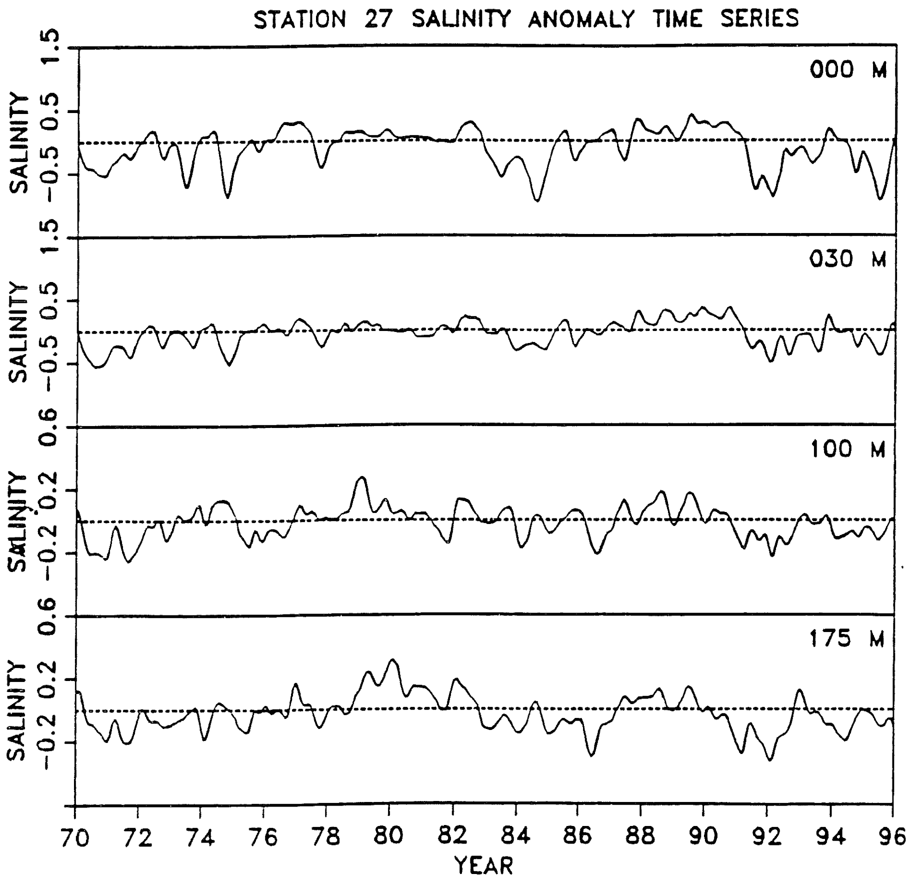


Depth versus time contour plots of temperatures and anomalies at Station 27 for 1995.

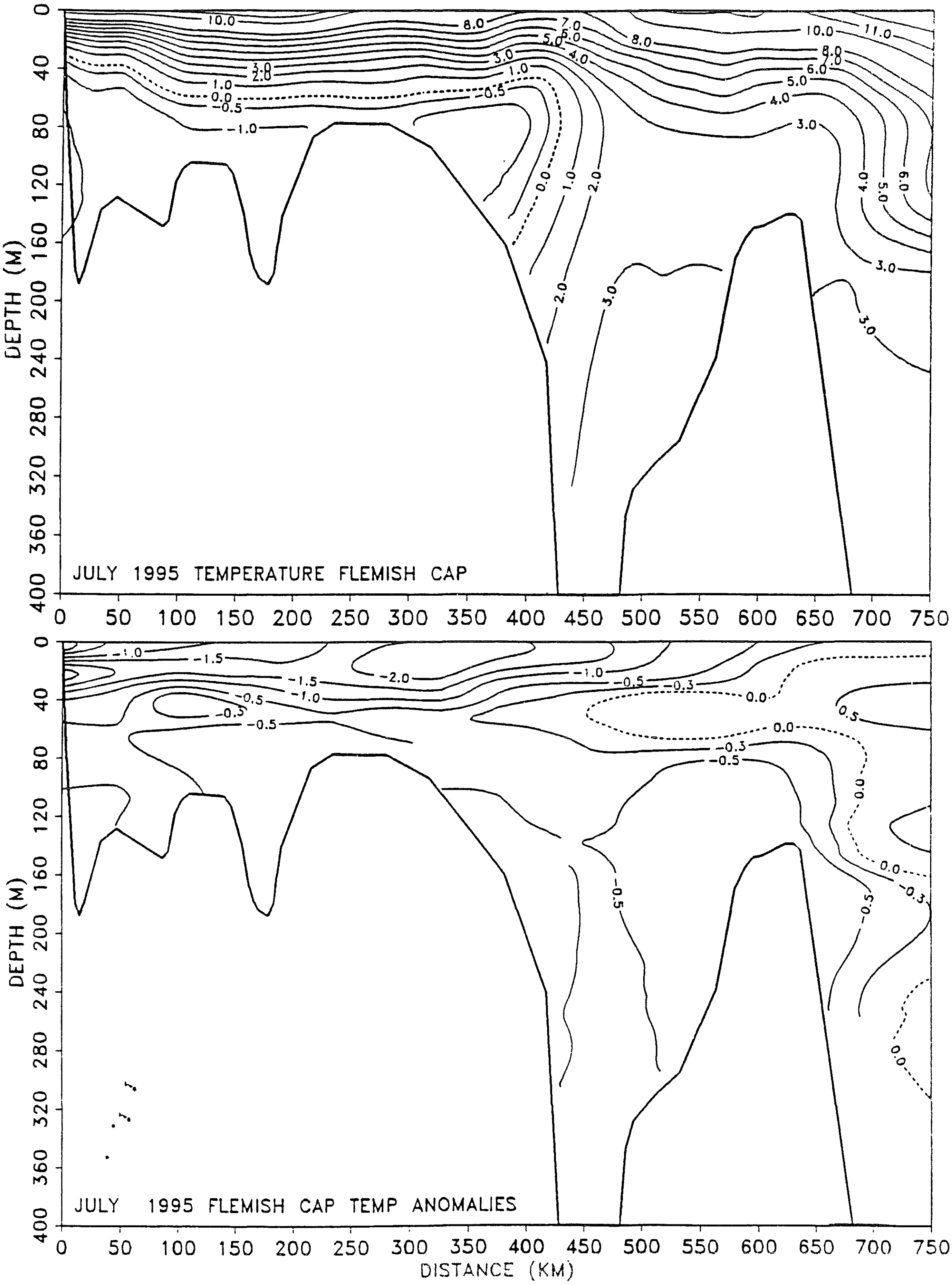


Depth versus time contour plots of salinity and anomalies at Station 27 for 1995.

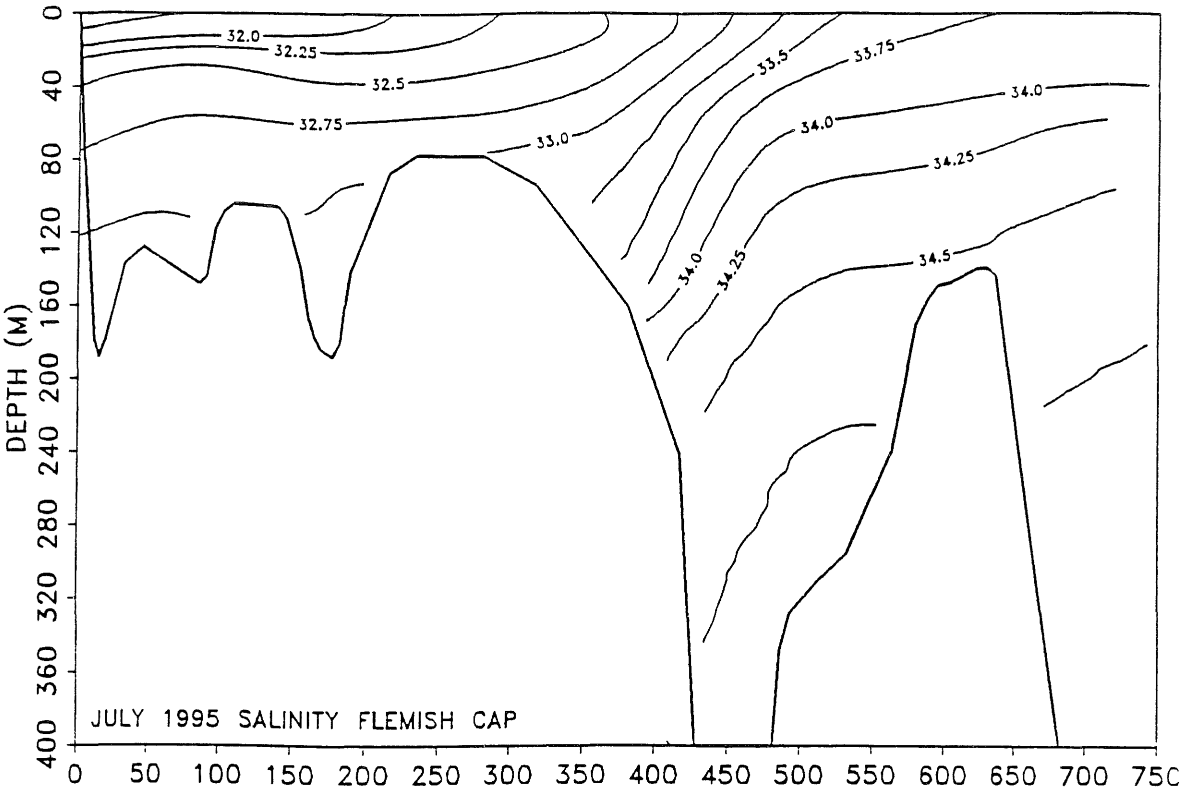


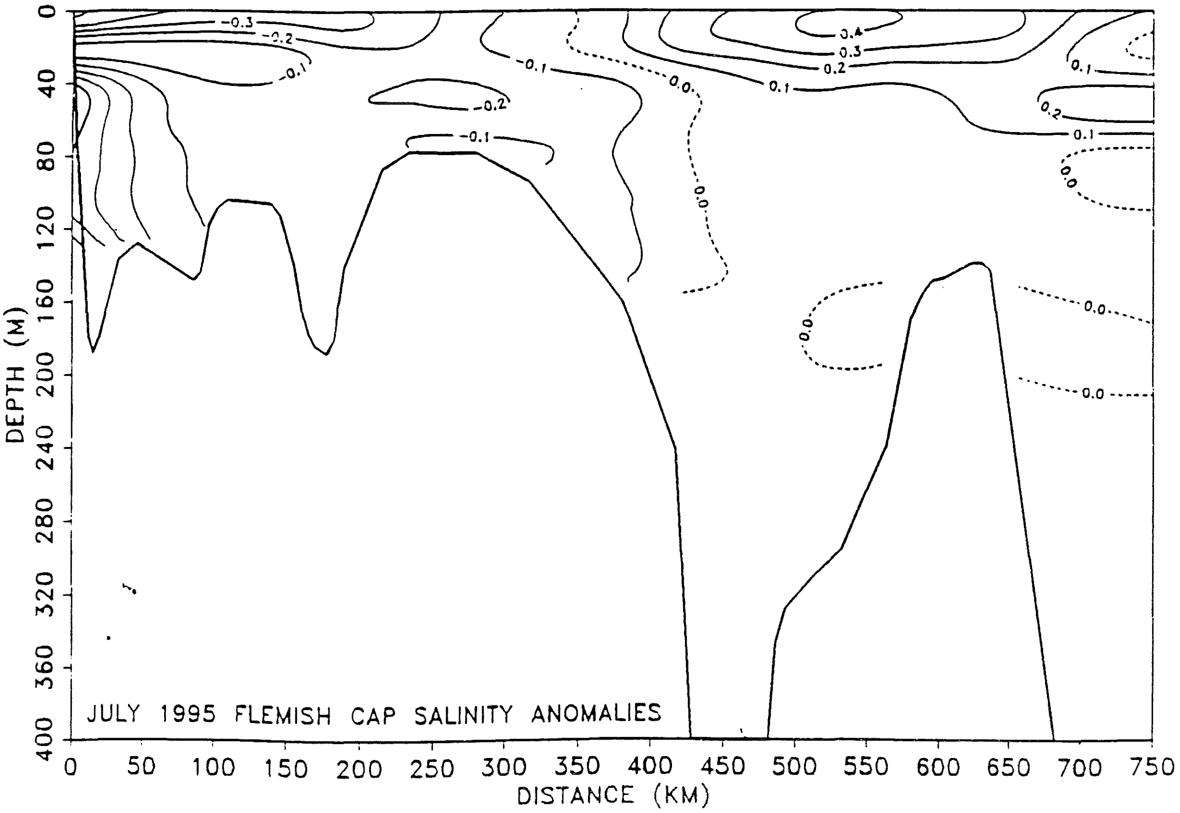


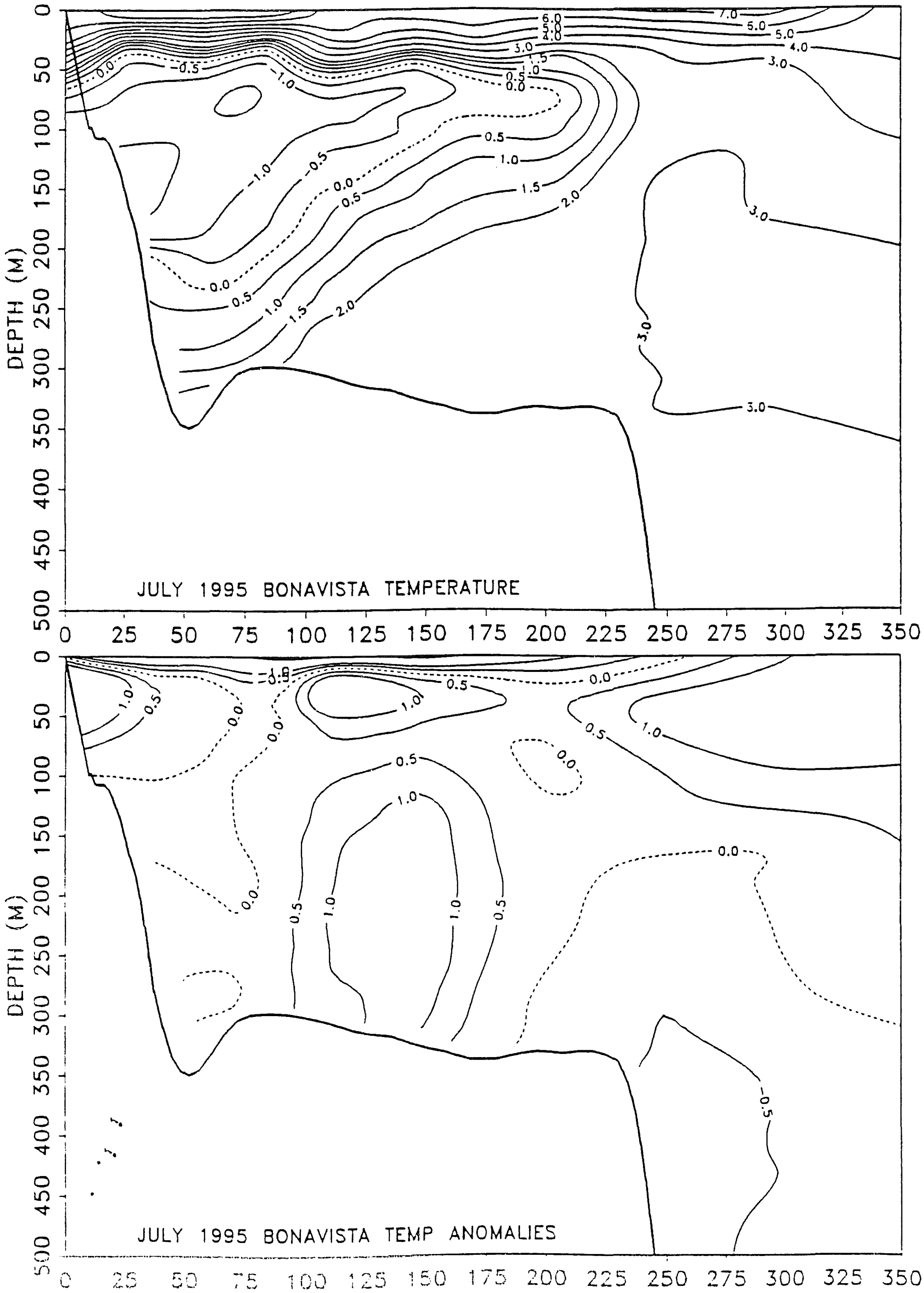
Low passed filtered time series of temperature and salinity anomalies at Station 27 at standard depths from 1970 to 1995.

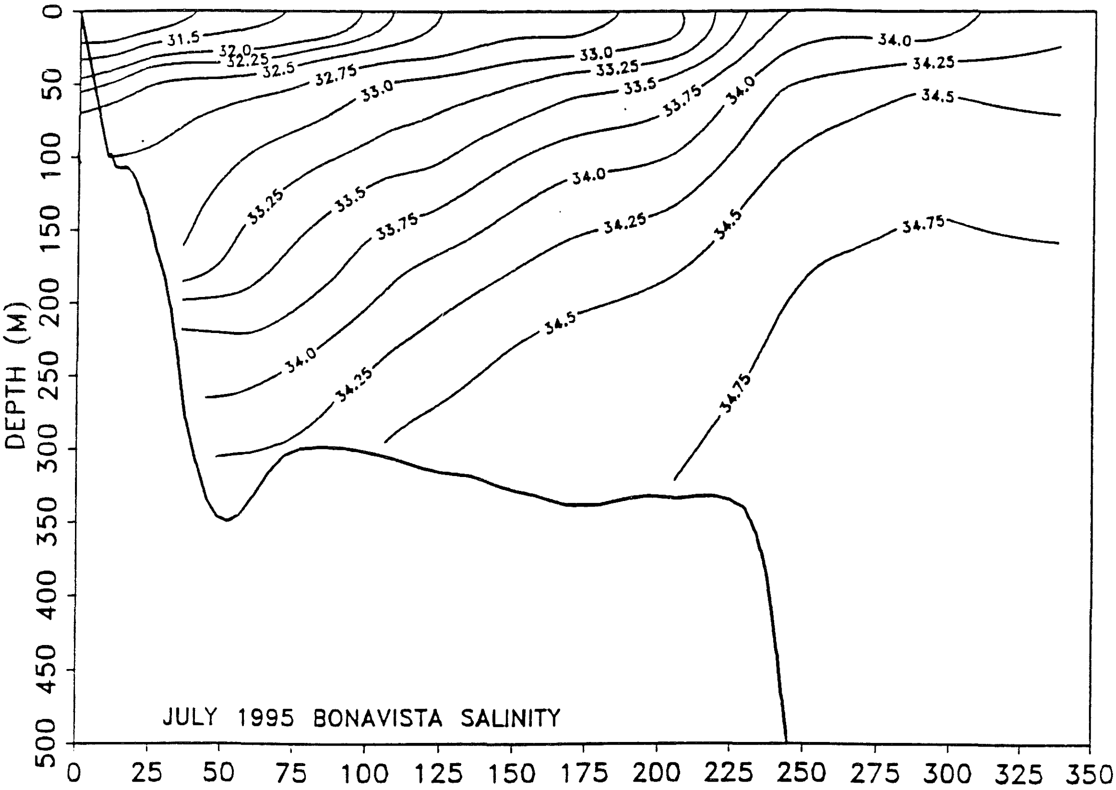


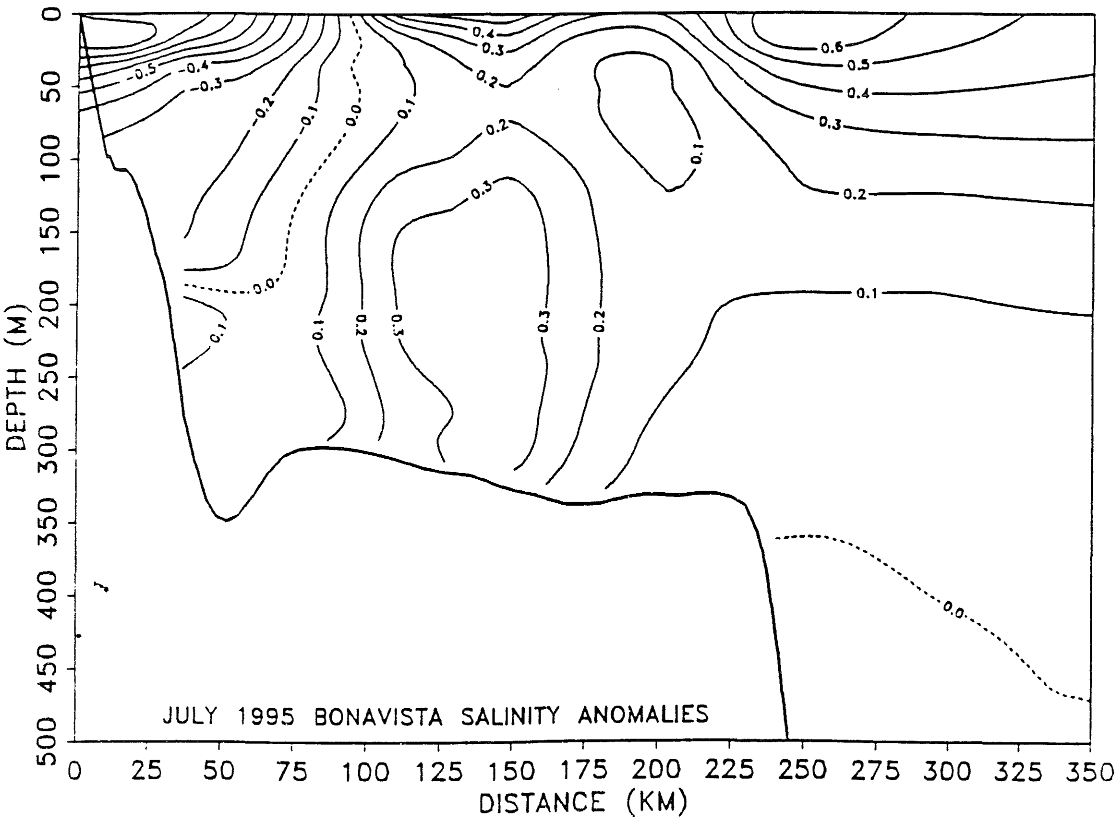
JULY 1995 TEMPERATURE FLEMISH CAP
DEPTH (M)
0
40
80
120
160
200
240
280
320
360
400
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
10.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-0.5
-1.0
11.0
JULY 1995 FLEMISH CAP TEMP ANOMALIES
-1.0
-1.5
-2.0
-0.5
-0.3
0.0
0.5
DISTANCE (KM)

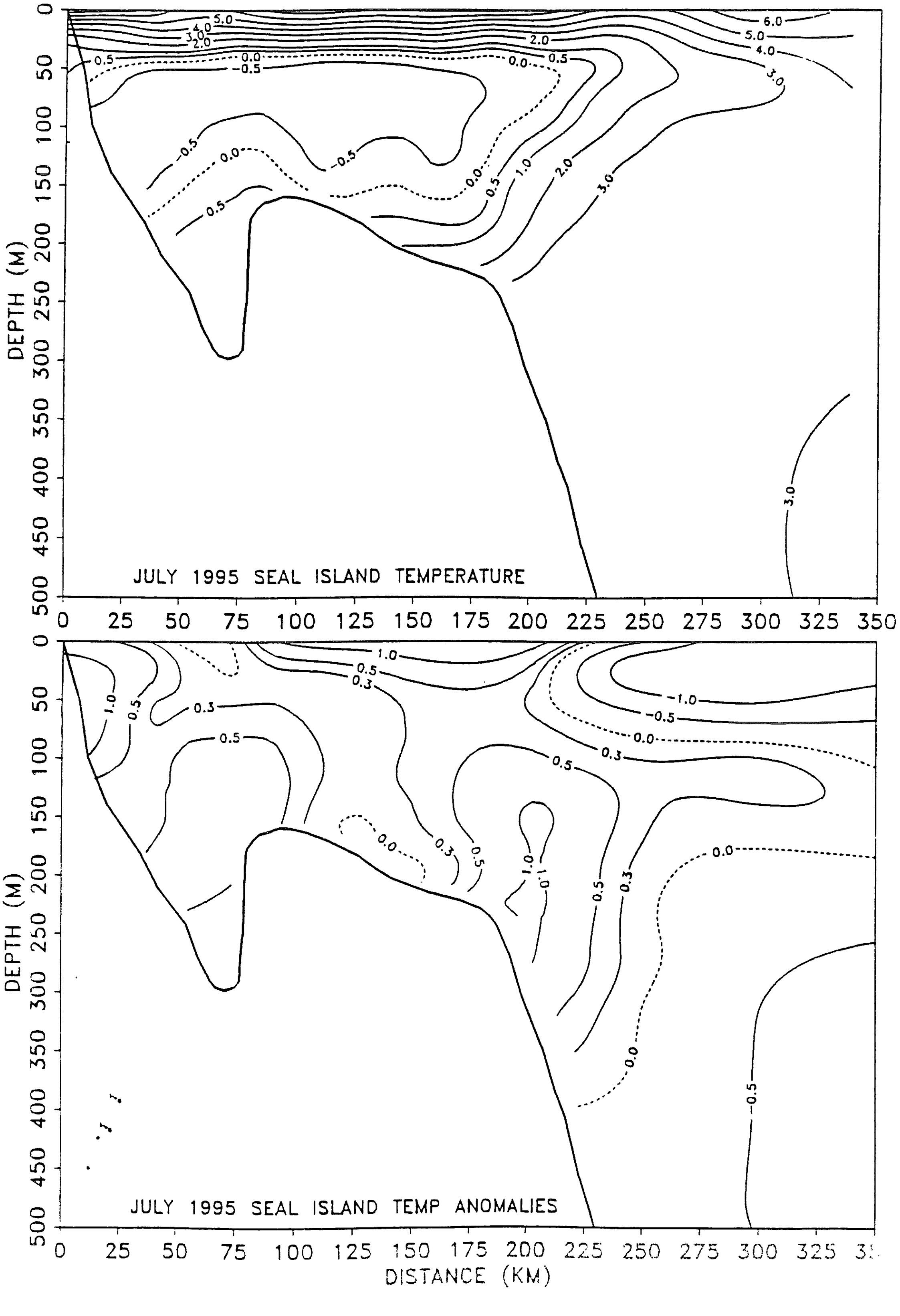

JULY 1995 SALINITY FLEMISH CAP
DEPTH (M)
0
40
80
120
160
200
240
280
320
360
400
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
32.0
32.25
32.5
32.75
33.0
33.5
33.75
34.0
34.25
34.5


JULY 1995 FLEMISH CAP SALINITY ANOMALIES
DEPTH (M)
DISTANCE (KM)
0
40
80
120
160
200
240
280
320
360
400
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4

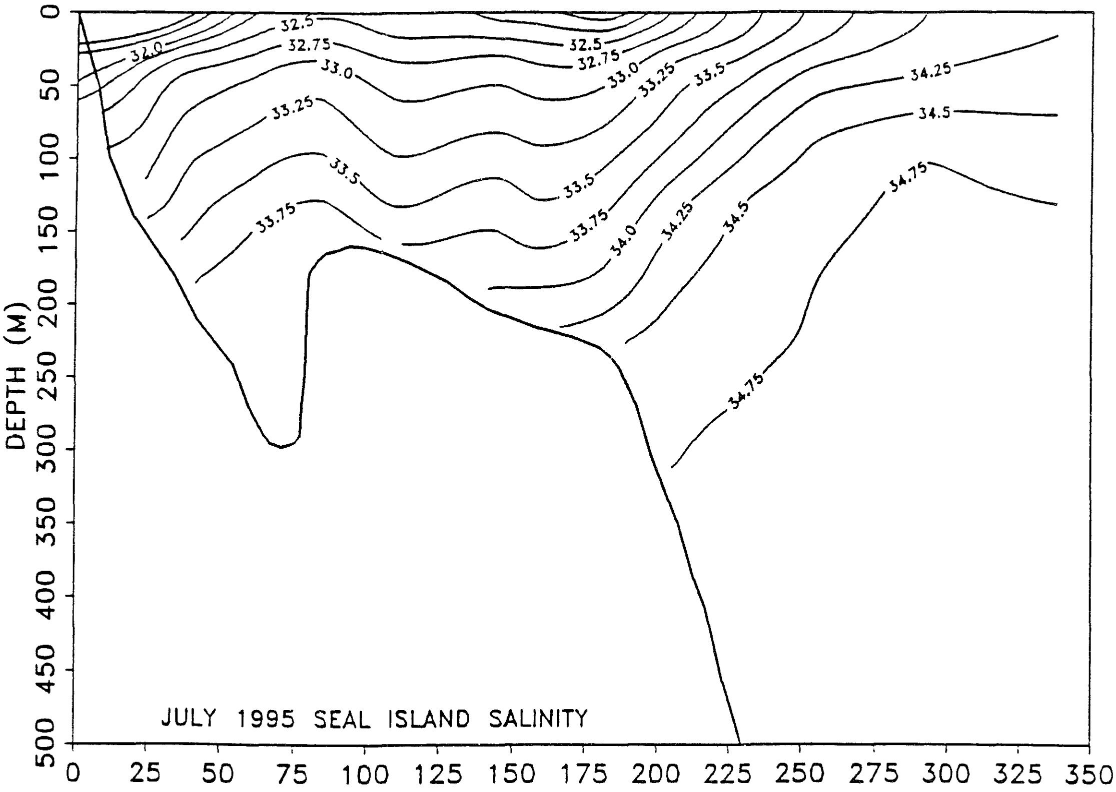

JULY 1995 BONAVISTA TEMPERATURE
JULY 1995 BONAVISTA TEMP ANOMALIES
DEPTH (M)
0 50 100 150 200 250 300 350 400 450 500
0 25 50 75 100 125 150 175 200 225 250 275 300 325 350
DISTANCE (KM)


DEPTH (M)
JULY 1995 BONAVISTA SALINITY
0
50
100
150
200
250
300
350
400
450
500
0 25 50 75 100 125 150 175 200 225 250 275 300 325 350
31.5
32.0
32.25
32.5
32.75
33.0
33.25
33.5
33.75
34.0
34.25
34.5
34.75

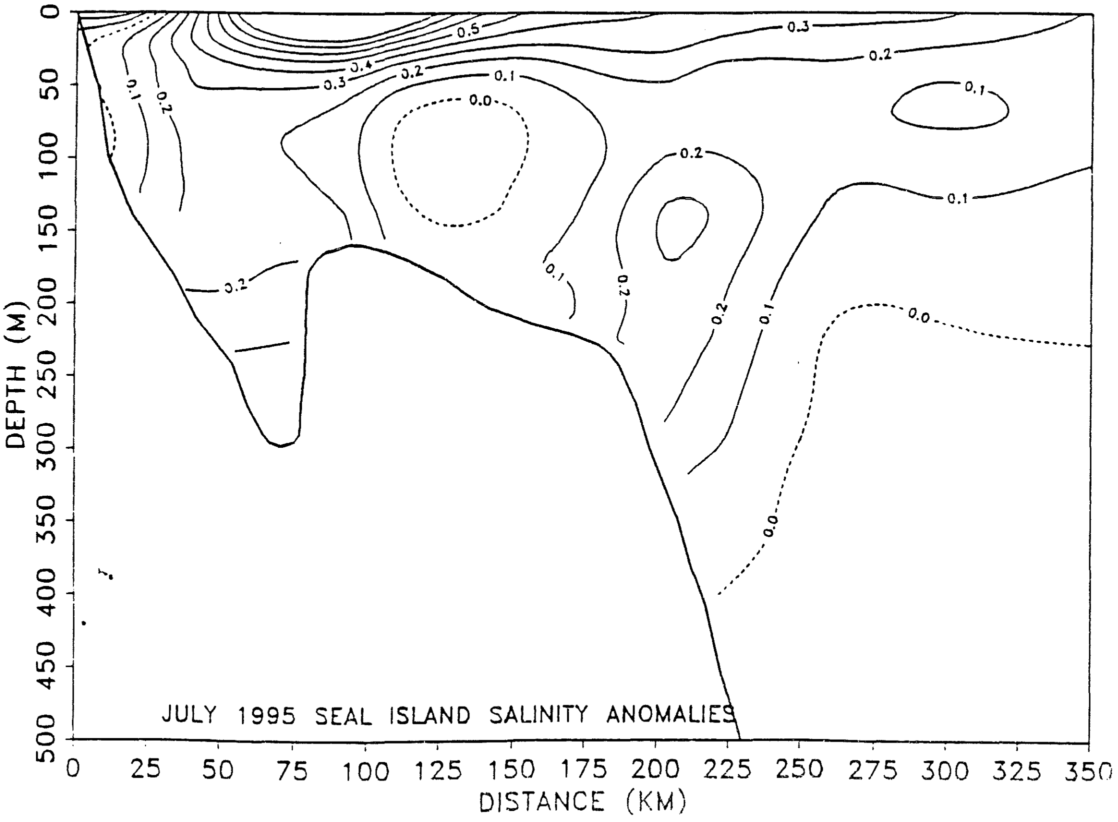

DEPTH (M)
JULY 1995 BONAVISTA SALINITY ANOMALIES
DISTANCE (KM)
0
50
100
150
200
250
300
350
400
450
500
0 25 50 75 100 125 150 175 200 225 250 275 300 325 350
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6



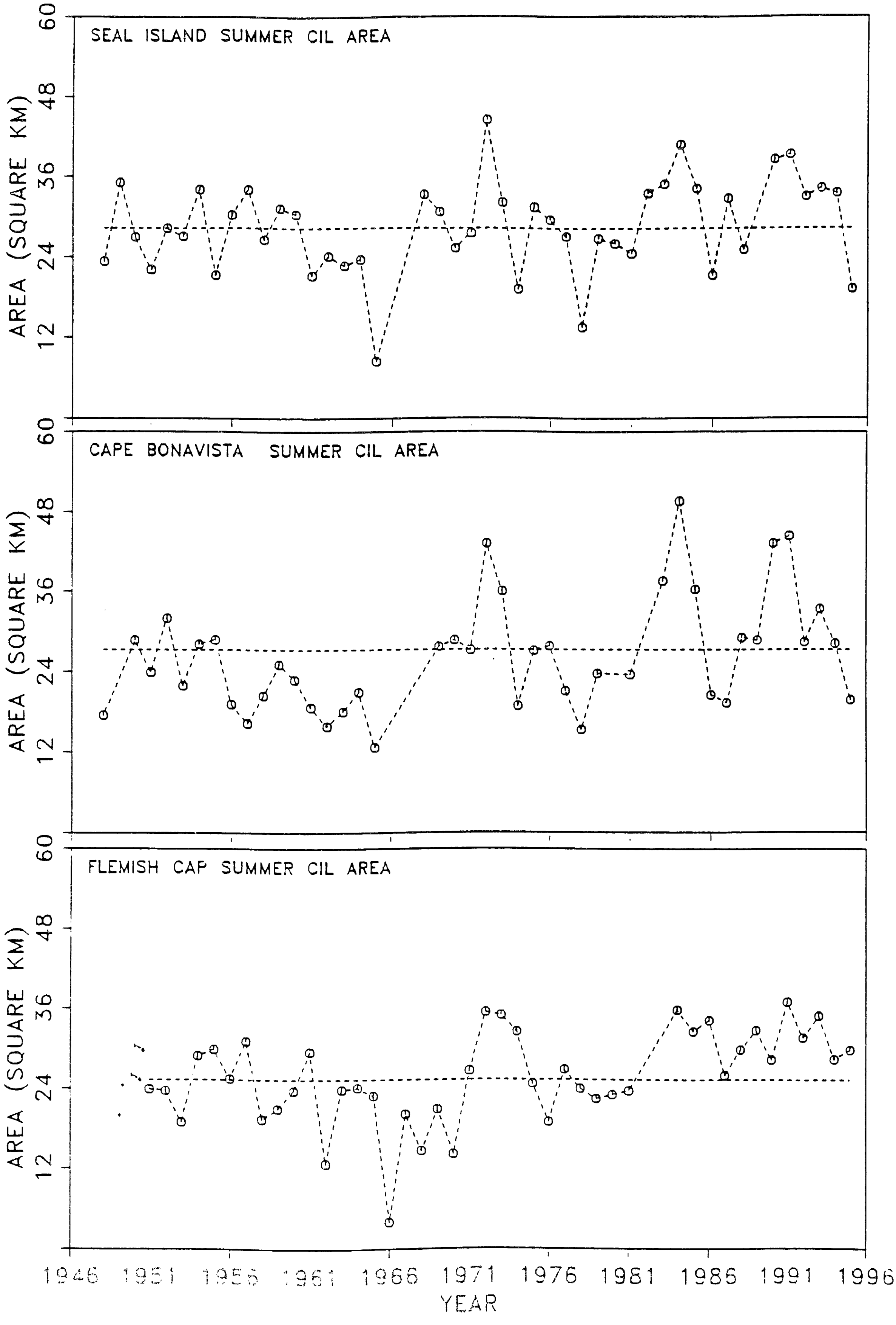
JULY 1995 SEAL ISLAND TEMPERATURE
DEPTH (M)
JULY 1995 SEAL ISLAND TEMP ANOMALIES
DEPTH (M)
DISTANCE (KM)

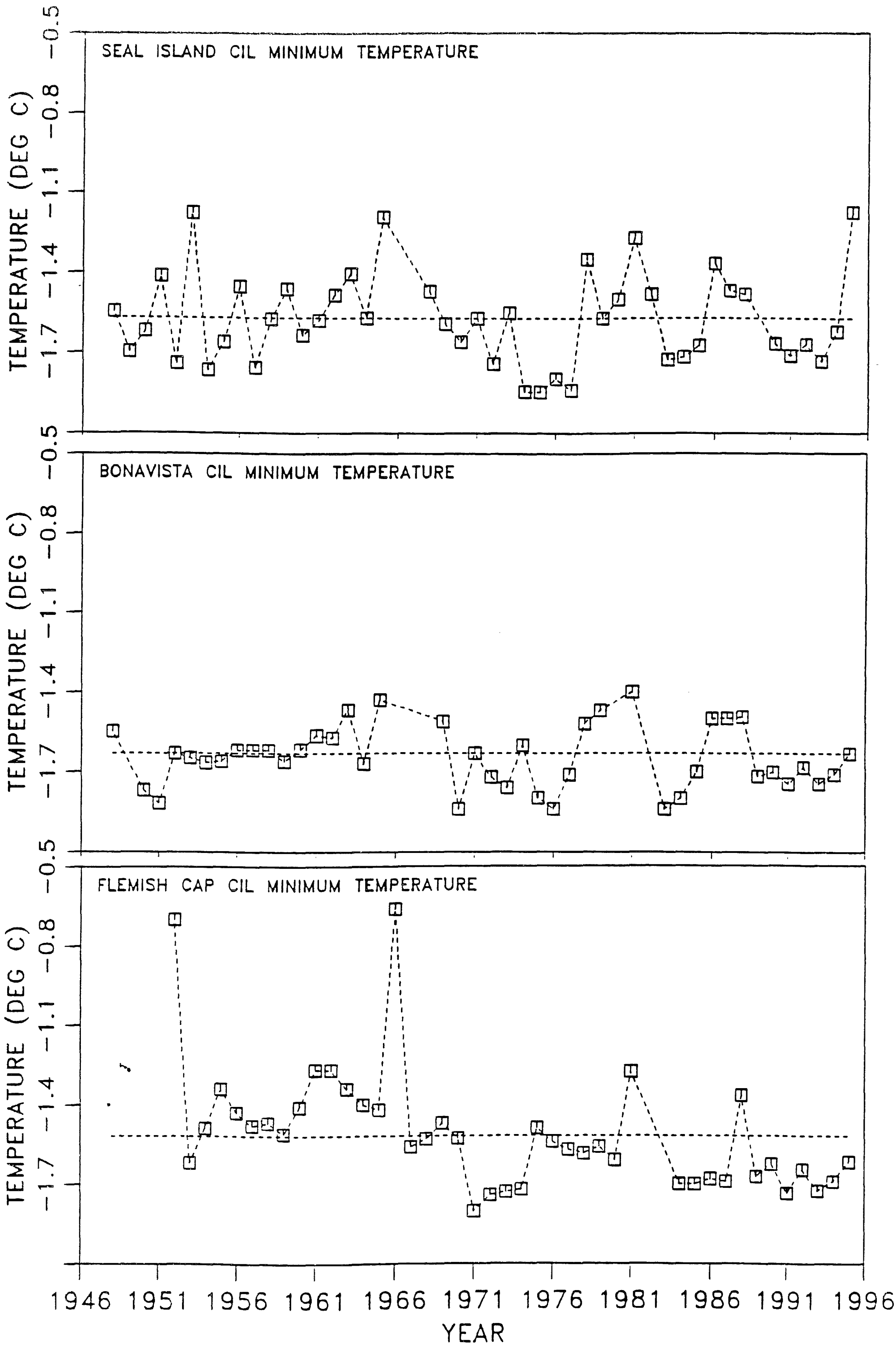


DEPTH (M)
32.0
32.5
32.75
33.0
33.25
33.5
33.75
34.0
34.25
34.5
34.75
JULY 1995 SEAL ISLAND SALINITY

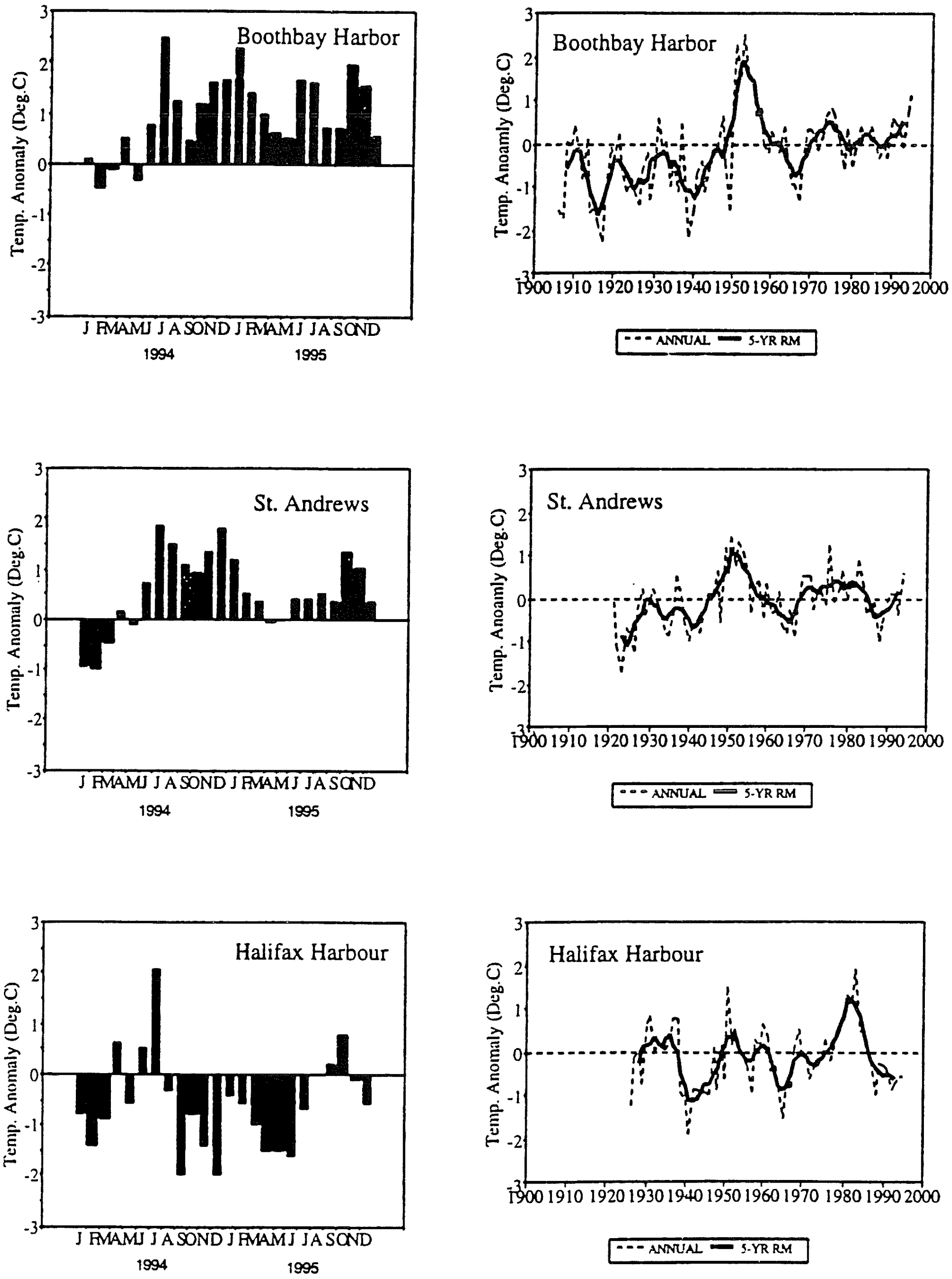


DEPTH (M)
0.5
0.4
0.3
0.2
0.1
0.0
JULY 1995 SEAL ISLAND SALINITY ANOMALIES
DISTANCE (KM)

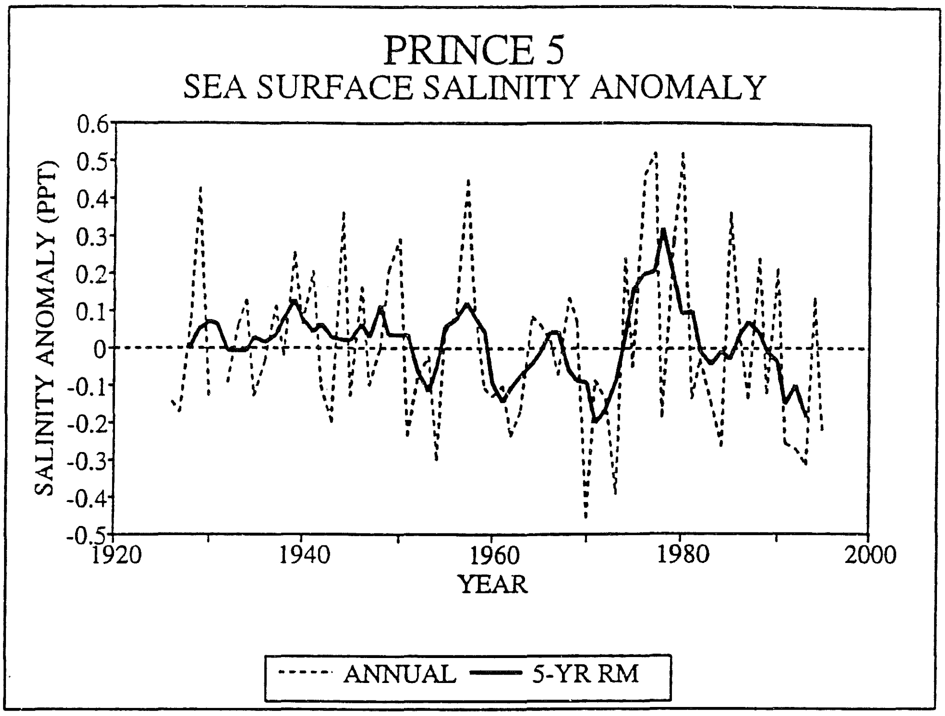

SEAL ISLAND SUMMER CIL AREA
CAPE BONAVISTA SUMMER CIL AREA
FLEMISH CAP SUMMER CIL AREA
AREA (SQUARE KM)
12
24
36
48
60
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
YEAR

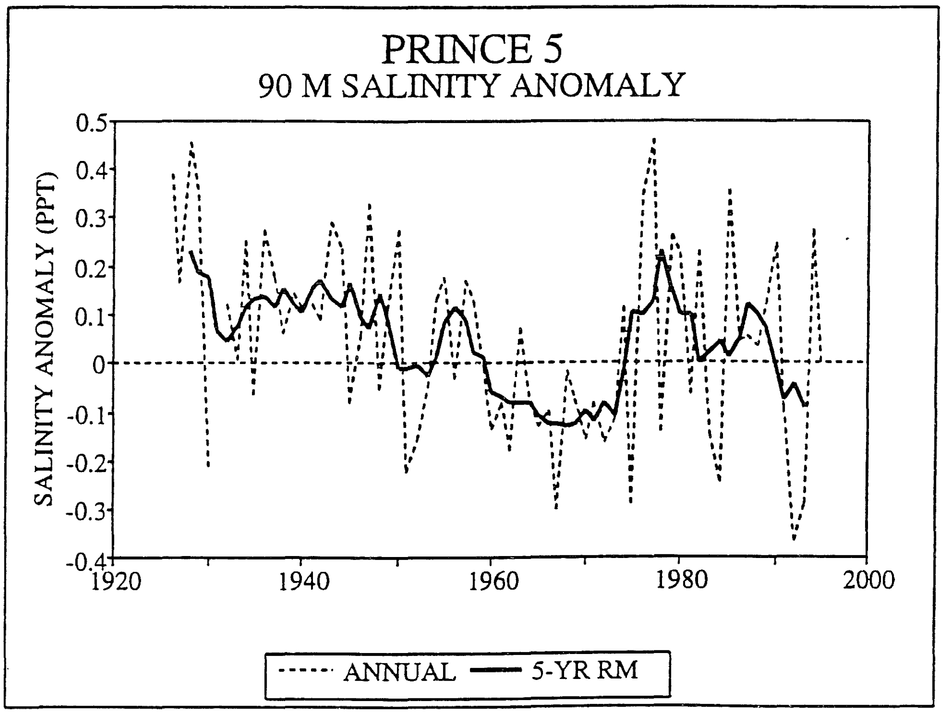


Time series of CIL minimum temperature along the Seal Island, Bonavista and Flemish Cap transects. The dashed line represents the average.

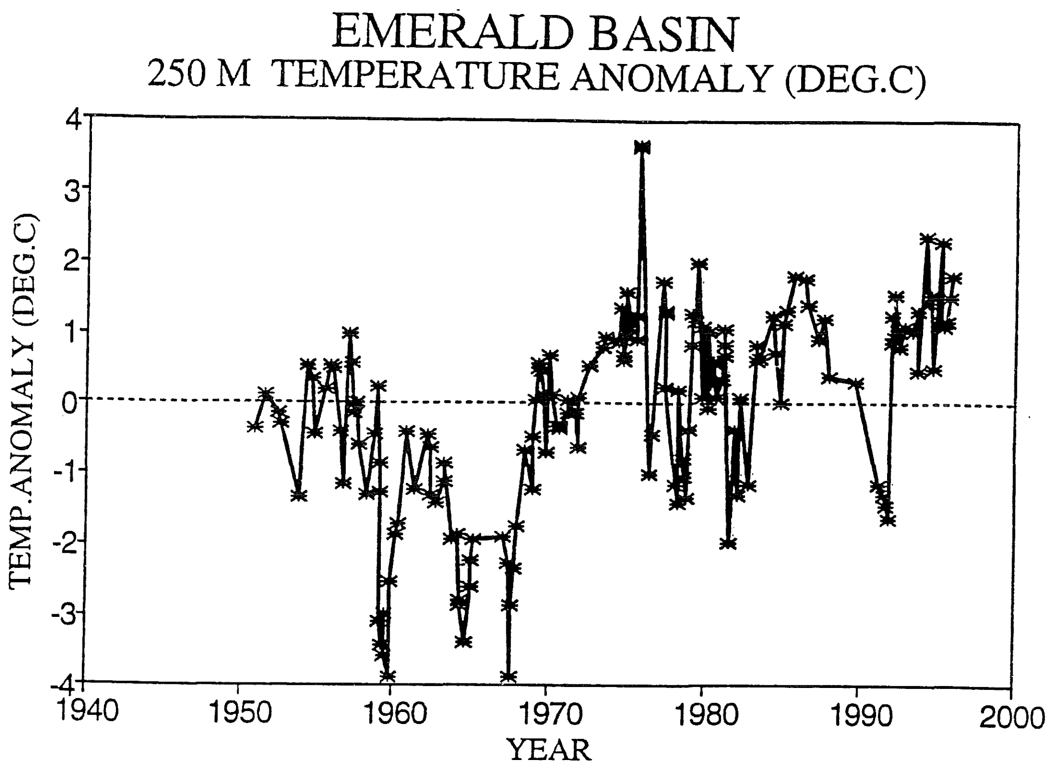


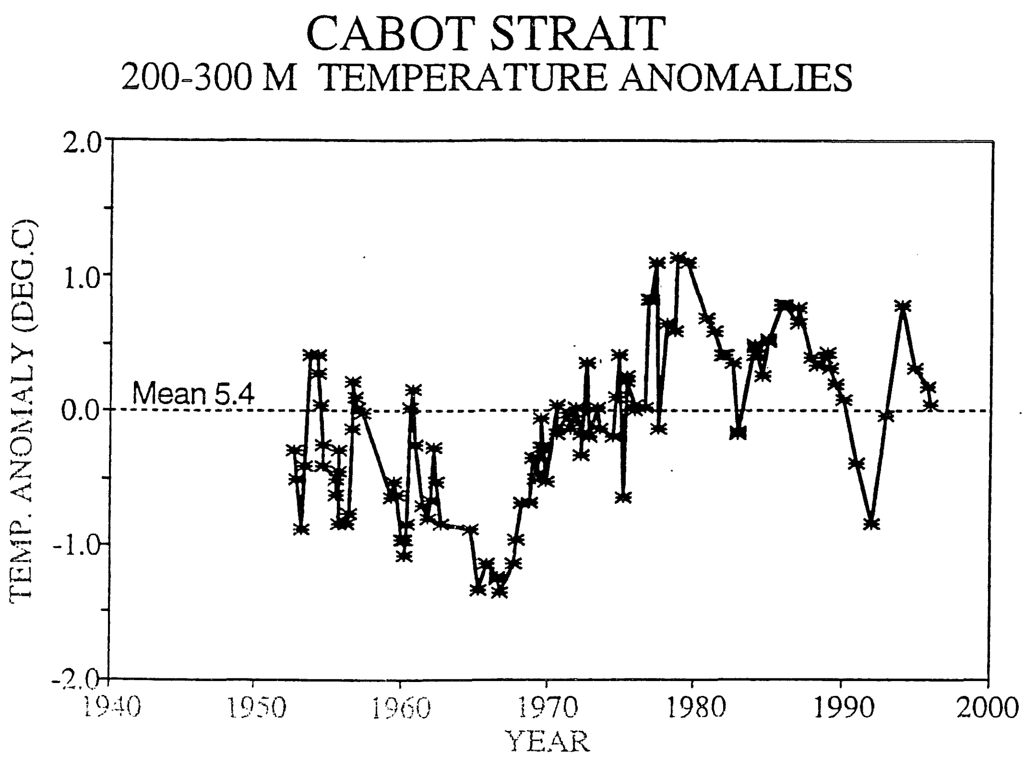
The monthly sea surface temperature anomalies during 1994 and 1995 (left) and the annual temperature anomalies and their 25-month running mean (right) for Boothbay Harbor, St. Andrews and Halifax. Anomalies are relative to 1961-90 means.





The annual means and 5-year running means of the salinity anomalies for Prince 5, 0 and 90 m.


EMERALD BASIN
250 M TEMPERATURE ANOMALY (DEG.C)
TEMP.ANOMALY (DEG.C)
4
3
2
1
0
-1
-2
-3
-4
1940
1950
1960
1970
1980
1990
2000
YEAR


CABOT STRAIT
200-300 M TEMPERATURE ANOMALIES
TEMP. ANOMALY (DEG.C)
2.0
1.0
0.0
-1.0
-2.0
Mean 5.4
1940
1950
1960
1970
1980
1990
2000
YEAR

Greenland (Erik Buch):

Since 1989 Greenland has experienced cold climatic conditions as can be seen from the monthly mean air temperatures anomalies at Nuuk, Fig.1 as well as on the mean medio June temperature on top of Fylla Bank, Fig. 2. In 1995 the temperature conditions improved in the atmosphere reflected in temperatures around normal

In 1995 a cruise to the West Greenland standard stations were performed from June 28 to July 11. The cruise was suffering from great inflows of arctic ice in Southwest Greenland.

The surface layer was totally dominated by cold and low saline Polar water, the warmer, saline water of Atlantic origin was only observed at the two outermost station off Cape Farewell. The core of the inflowing Polar water is situated at 50-100 m depth.

At greater depth pure Irminger water (T>4.5°C, S>34.93) only is found at the Cape Farewell section, while modified Irminger water (T>4.5°C, 34.88<S<34.93) only was observed as far north as Fylla Bank.. Sub-Atlantic water (3.5<T<4.5; 34.5<S<34.88) was observed at all sections.

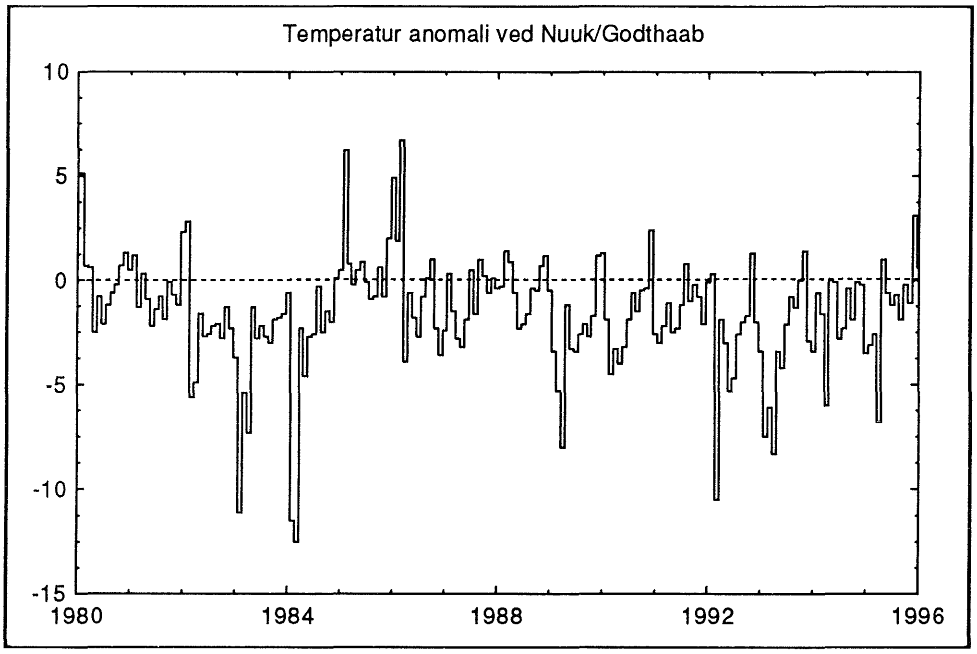


Fig.1 Monthly mean air temperature anomalies from Nuuk for the period 1980 to 1994.

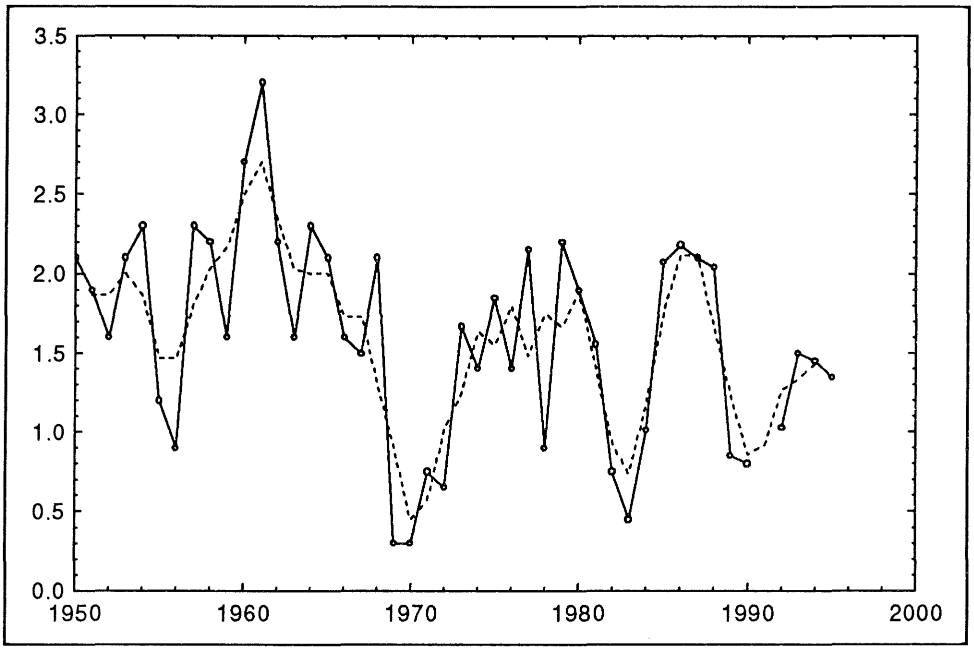


Fig.2 Mean temperatures on top of Fylla Bank, medio June 1950-94

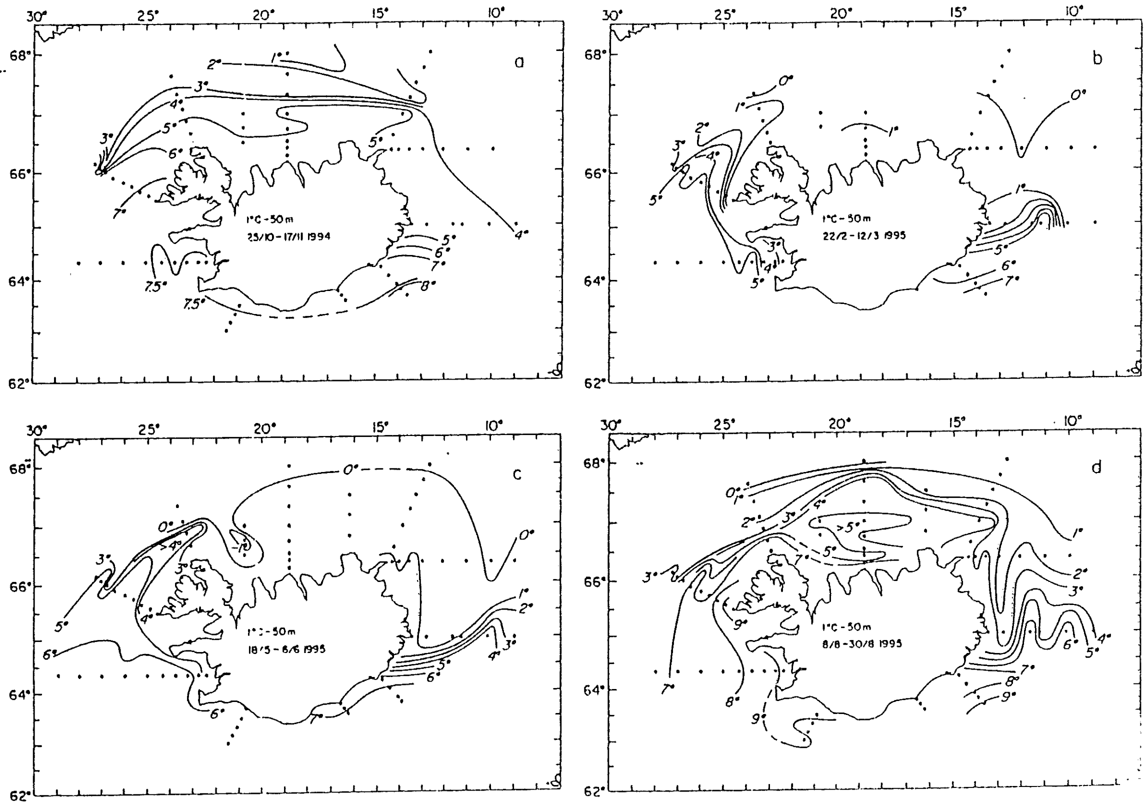
——— Observed values
——— 3 years running mean

Iceland (Svend Aage Malmberg):

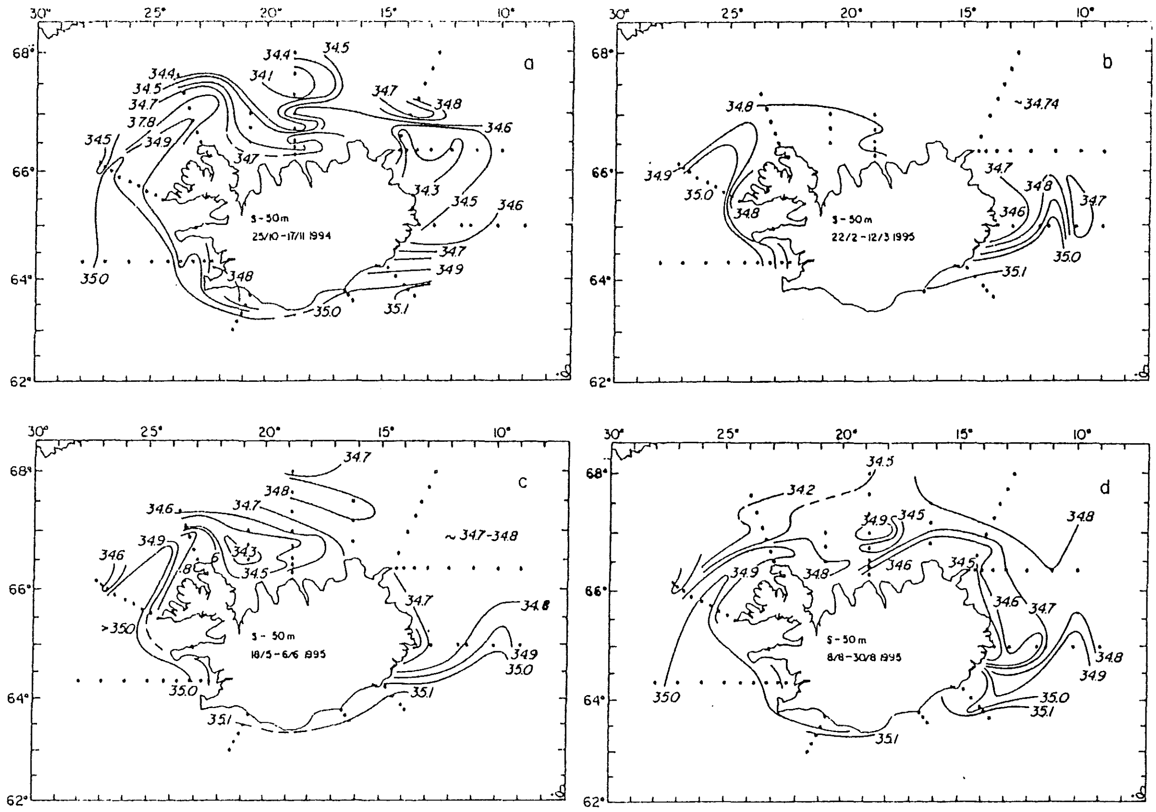
The since 1991 favourable hydrographic conditions with continuos inflow of Atlantic Water into the North Icelandic shelf area ceased in 1995. Thus in February and May/June 1995 the most unfavourable conditions found since the beginning of the investigations in 1949 were found with a dominance of cold (0-1 °C) Polar and Arctic Water covering in North and East Icelandic shelf from the very coast and outwards. In August 1995 the conditions had improved again with Atlantic Water inflow (t° >4 °C) as far east as off Langanes as well as in November 1995. The cold conditions in winter and spring in North Icelandic waters are documented in a continuos temperature recording in the sea at the island Grimsey in North Icelandic waters from 1993-1995.

During the spring survey in 1995 the zooplankton densities north of Iceland were relatively high but lower than in 1994. Nutrient densities and phytoplankton growth were also relatively favourable were stability in the surface layer was not to strong due to light polar water. The Atlanto-Scandian herring was in spring 1995 as in spring 1994 observed at the eastern and southern boundaries of the cold East Icelandic Current.

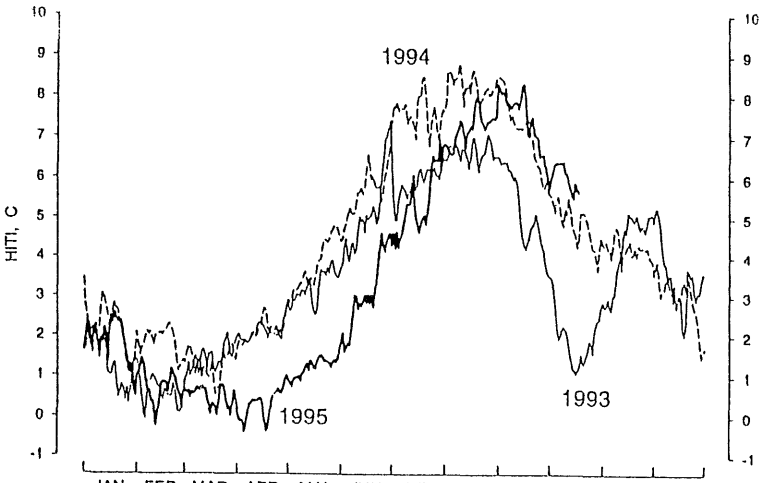
At last in 1995 relatively low salinities were observed in the Irminger Current south of Iceland as since 1992, with values below 34.15.



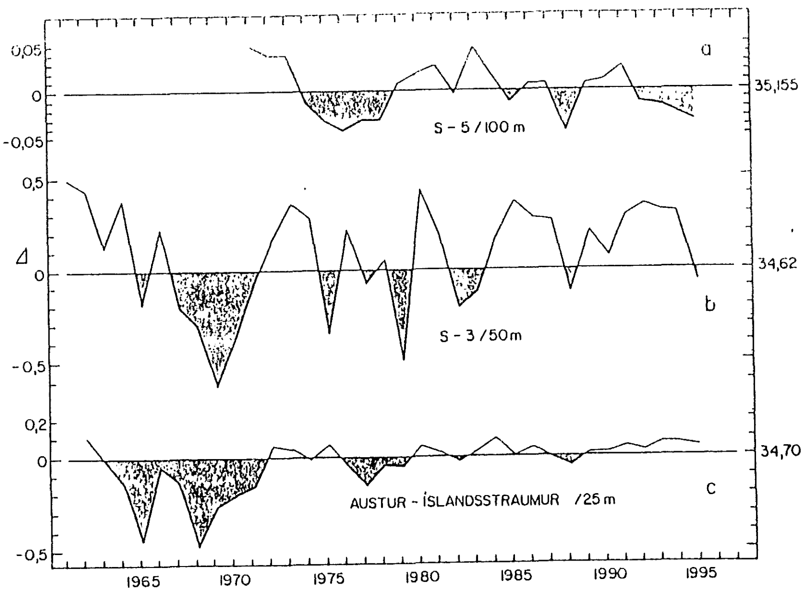
Sea temperature (°C) at 50 m depth in Icelandic waters. a) in October/November 1994, b) in February/March 1995, c) in May/June 1995 and d) in August 1995.



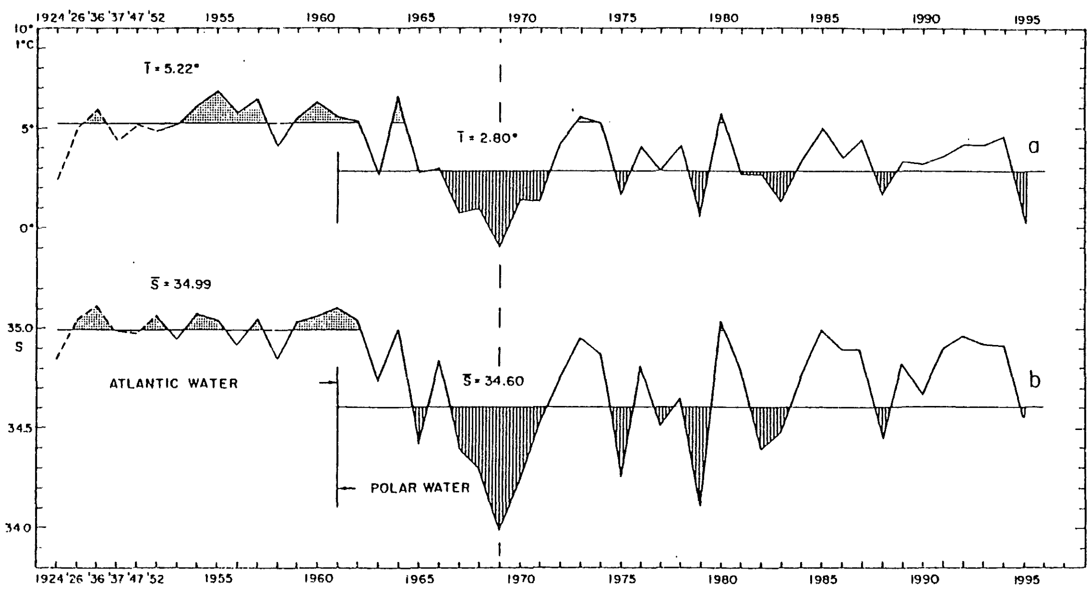
Salinity (S) at 50 m depth in Icelandic waters in a) October/November 1994, b) February/March 1995, c) May/June 1995 and d) August 1995.



Seasonal variations in sea surface temperature (°C) at Grímsey, North-Iceland, in 1993 - 1995.



Salinity deviations in spring at (a) 100 m depth in the Irminger Current south of Iceland (1971-1995), (b) 50 m depth in North Icelandic waters (1961-1995) and (c) 25 m depth in the East Icelandic Current (1961 - 1995).



Temperature and salinity variations at 50 m depth at the third station on the Sigulnes section (cf. fig. 1) in May-June 1924 to 1995.

Faroe Islands (Bogi Hansen):

Since the late eighties, the Faeroese Fisheries Laboratory has carried out CTD observations along three standard sections (E, N and W on Figure 1) around the Faeroes that have been occupied three to four times a year. In 1995 each of the three sections was occupied four times (in Feb., May, Sept. and Nov.). A fourth standard section, initiated in 1994, (S on Figure 1) was in 1995 occupied three times completely (Feb.., May, Nov.) and once (Sept.) only to the middle of the Faroe-Shetland Channel.

The water mass, dominating the upper waters surrounding the Faeroes, is the Modified North Atlantic Water (MNAW), entering the Faroe region from the open North Atlantic and flowing around the Faroe Plateau (Fig. 1). The characteristics of this water have been represented by the 100-300 m depth layer in the middle of the Faroe Bank Channel (FBC on Figure 1), which is usually fairly homogeneous in T and S from the surface down to 300-400 m. Figure 2 shows the salinity variation of this water. In the figure, older CTD and Nansen cast observations have been added to the standard section observations to give a longer time series (Hansen and Kristiansen, Stat:Meeting 1994). After the mid-seventies ("Great") low-salinity anomaly, the salinity of MNAW increased until the early eighties, when it stabilized, but since the beginning of the nineties, the MNAW salinity has been decreasing and it has been low since 1993. Low salinity values have also been observed north of the Faeroes and in the Faroe-Shetland Channel (FSC on Figure 1) as shown on Figure 3.

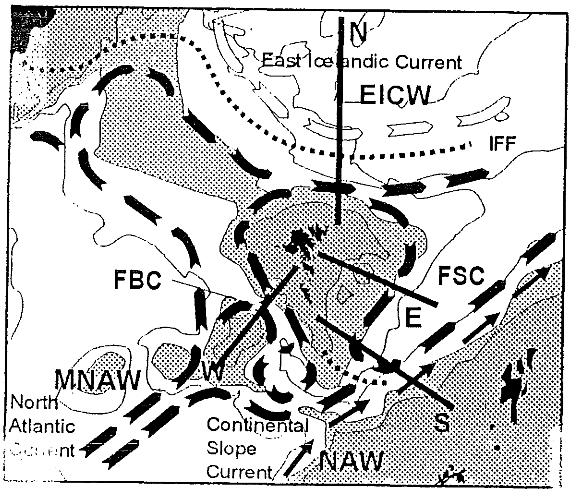


Figure 1. The bottom topography around the Faeroes is shown with isobaths and hatched for areas shallower than 500m. The arrows indicate main flow patterns in the upper layers driven by three major currents whose water masses (NAW, MNAW and EICW) are indicated IFF indicates the Iceland-Faeroes Front. The four standard sections are denoted N, W, S and E.

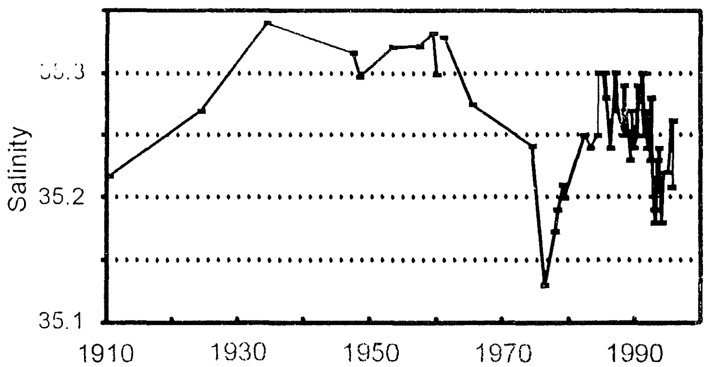
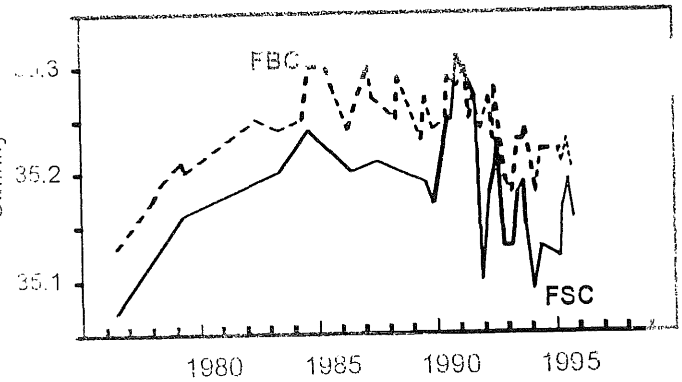


Figure 2. The salinity of the 100-300m layer in the middle of the Faroe Bank Channel (Fig.1) as determined from Nansen Casts up to 1976 and CTD observations since then.

Figure 3. Salinity variations in two regions around the Faeroes since the mid-seventies. FBC indicates the salinity of the 100-300m layer in the middle of the Faroe Bank Channel. FSC indicates the salinity of the 25-200m layer in the Faeroese (western) half of the Faroe-Shetland Channel (standard section E on Figure 1).



In 1994 the salinity on the western (Faeroese) side of the FSC approached levels, which in the observational record have not been so low except during the mid-seventies anomaly. In 1995 the salinity seems to have increased somewhat (Fig.3).

The temperature variations of the MNAW follow the salinity variations fairly well and temperature also has been decreasing during the last five years (Hansen & Kristiansen, Stat.Meeting 1994). The same trend is seen in coastal temperature observations that reflect the temperature of the well-mixed water on the shallower parts of the Faroe Shelf (Fig.4).

Associated with the changes in water mass characteristics, observations indicate changes in water mass extent, i.e. dynamical changes. These are most pronounced north of the Faeroes, where the wedge of MNAW between the Faroe Plateau and the Iceland-Faeroes Front (IFF on Figure 1) has decreased appreciably in width. Figure 5 compares the salinity distribution on a section crossing the flow in February 1995 to the distribution in June 1986 when the width of the MNAW was large. The observed long-term changes in MNAW extent north of the Faeroes are aliased by seasonal variations, but there is a clear indication of decreasing extent in the nineties (Hansen and Kristiansen, Stat.Meeting 1994). The February 1995 salinity distribution (Fig.5) indicates that the MNAW only extended slightly off the shelf at that time which is highly abnormal.

This implies that the waters of the East Icelandic Current in the last years have approached closer to the Faroe Plateau than had previously been normal. In addition these waters also have decreased in salinity. Figure 6 shows sample TS-traces north of the Faeroes for the period since the mid-seventies anomaly up to February 1995. The salinity minimum at 2-4°C seems to have been lowest in salinity during the mid-seventies anomaly in 1976, but the 1994 and especially the February 1995 observations indicate almost comparable values.

Figure 4. Shore-based observations of annual mean sea surface temperature from two sites in the Faeroes.

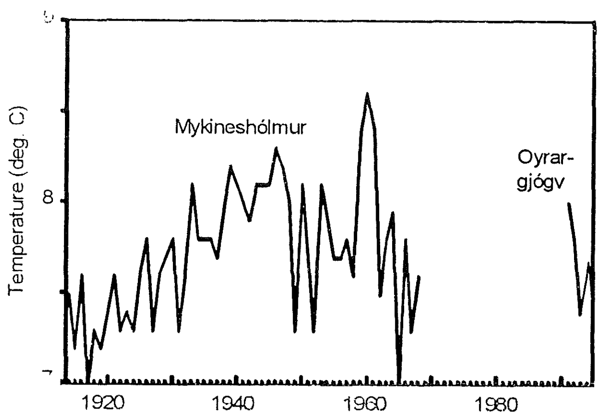


Figure 5. The salinity distribution on standard section N (shown on map) at two different times, one (June 1986) with large Atlantic water dominance and one (Feb.. 1995) with Atlantic water only on the Faroe shelf.

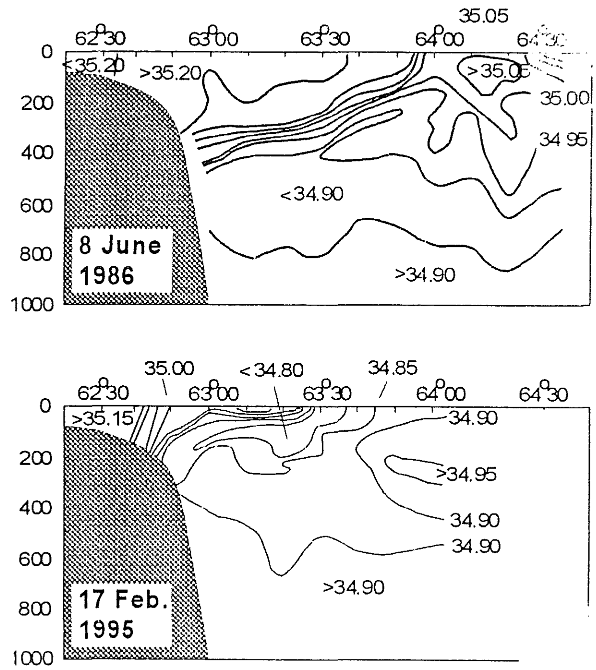
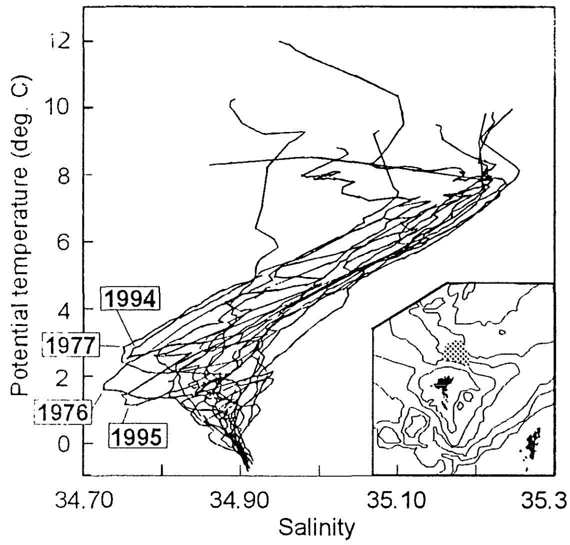


Figure 6. Sample Theta-S diagrams from a region north of the Faeroes (hatched on the map) with one trace for each year in the periods 1976-1977 and 1981-1995. (No observations were available for 1978-1980).



After February 1995, there is some indication of a return to more normal conditions. In Figures 2 and 3, an increased salinity trend is observed and on standard section N, north of the Faeroes, observations after February 1995 indicated larger extent of Atlantic water. This was accompanied, however, by the occurrence of a low-salinity layer on top of the Atlantic water. Similar conditions were observed also in the Faroe Bank Channel.

Summarizing, the waters surrounding the Faroe Plateau have in the last five years decreased in salinity and temperature. Apparently, the change may be partly attributed to low salinities of the contributing water masses (MNAW and EICW) and partly to a reduced influence of MNAW as compared to EICW. There are some indications that the low-salinity trend is about to turn, but this will not become clear until data from 1996 is available.

Scotland (W.R.Turrell)

Introduction

The two standard Faroe-Shetland Channel sections (Nolso (Faroe) - Flugga (Scotland) and Fair Isle (Scotland) - Munken (Faroe) have been occupied by the Marine Laboratory Aberdeen on two occasions since April 1995. However, unfortunately only partial surveys (on the Scottish side of the Channel) were completed in November 1995.

The preliminary results are presented here as contoured sections in Figures 1 to 4. Temperature-salinity diagrams derived from the data are presented as Figure 5, and the derived t and S values of 5 characteristic water masses which occupy the Channel are presented in Table 1. Time-series of the 5 different water masses are given in Figure 6 to 8, and of two North Sea water masses in Figure 9.

In summary, conditions in 1995 continue to demonstrate low salinities at intermediate and bottom depths in the Faroe-Shetland Channel. The decline of salinity below 800 dbar continues, with possibly an associated warming. The salinity of Norwegian Sea Intermediate (NSI) water is falling, while that of Artic Intermediate / North Icelandic (AI) water rose from minimum values in 1993/94. While salinities in surface waters remain low on the Faeroes side of the channel (Figure 5), at the Scotties shelf edge salinities are increasing from minimum values in 1993/94. Within the North Sea (Figure 9) a similar picture emerges, with salinities increasing from 1993/94.

Figures 1 and 2 - September 1995

NA water with salinities >35.35 persisted on the Scottish side of the Channel. The TS characteristics of this water were again different from the MNA water on the Faeroes side of the Channel, as indicated by a break in the slope in the TS diagram. This implies water on the Scottish side had been mixed with a high salinity source water, possibly associated with the slope current.

Figures 3 and 4 - November 1995

Only part sections were completed in November 1995. The warm saline core was evident at the Scottish shelf edge.

Figures 5-7 and Figure 9 - Time Series

Time series from 5 characteristic water masses which occupy the Faroe Shetland Channel are presented in Figure 5 - 7 and for 2 North Sea water masses in Figure 9. The methods employed to define the water masses, and to derive the time series are described below. *Please note that these are preliminary definitions and are presented for discussion.*

Surface Waters:

> *North Atlantic Water* - The temperature and salinity at the standard pressure which exhibits the maximum salinity within an individual survey of the first two stations, on both standard sections, on the Scottish side of the Channel.
>
> *Modified North Atlantic Water* - The temperature and salinity at the standard pressure which exhibits the maximum salinity within an individual survey of the first two stations, on both standard sections, on the Faeroes side of the Channel.
>
> *Removal of seasonal cycles:* As the surveys over the past have been done at quite different times of the year, in order to remove the effect of the seasonal cycle in the surface waters the monthly mean t and S derived over the period 1960-1995 for each individual station and at each standard pressure have been removed.

Intermediate Waters:

> *Arctic Intermediate / North Icelandic Water* - The temperature and salinity at the standard pressure which exhibits the minimum salinity within an individual survey of both standard sections, within the pressure range 500 dbar $\leq p \leq$ 800 dbar and with $1\,^{\circ}C \leq t$.

Norwegian Sea Intermediate Water - The temperature and salinity at the standard pressure which exhibits the minimum salinity within an individual survey of both standard sections, within the temperature range 0°C ≤ t ≤ 1°C.

Deep Waters:

Standard Pressure Levels - Mean temperature and salinity at a standard pressure, averaged over all values on that pressure level recorded during an individual survey of both standard sections.

North Sea Waters:

Fair Isle Current Water - The mean temperature and salinity at all standard pressures, averaged over the first two stations at the west end (Scottish) of the JONSIS standard section.

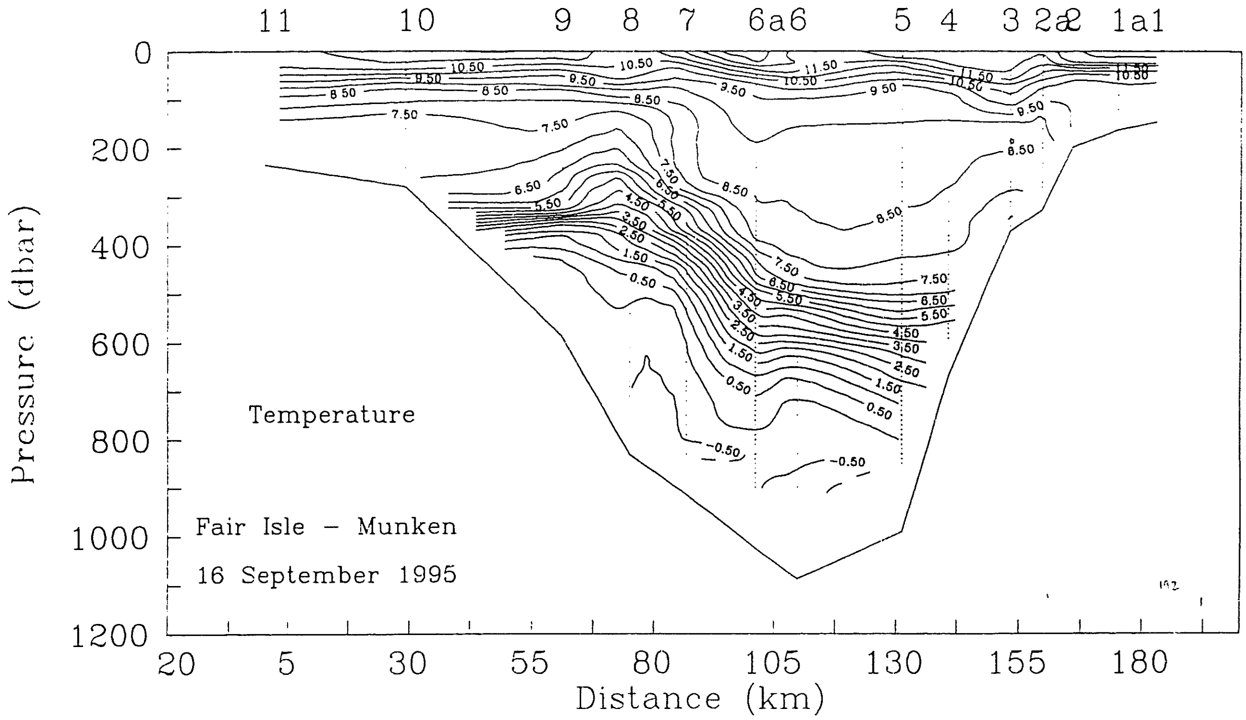
Cooled Atlantic Water - The mean temperature and salinity at all standard pressures ≥ 50 dbar averaged over the first six stations at the east end (Norwegian) of the JONSIS standard section.

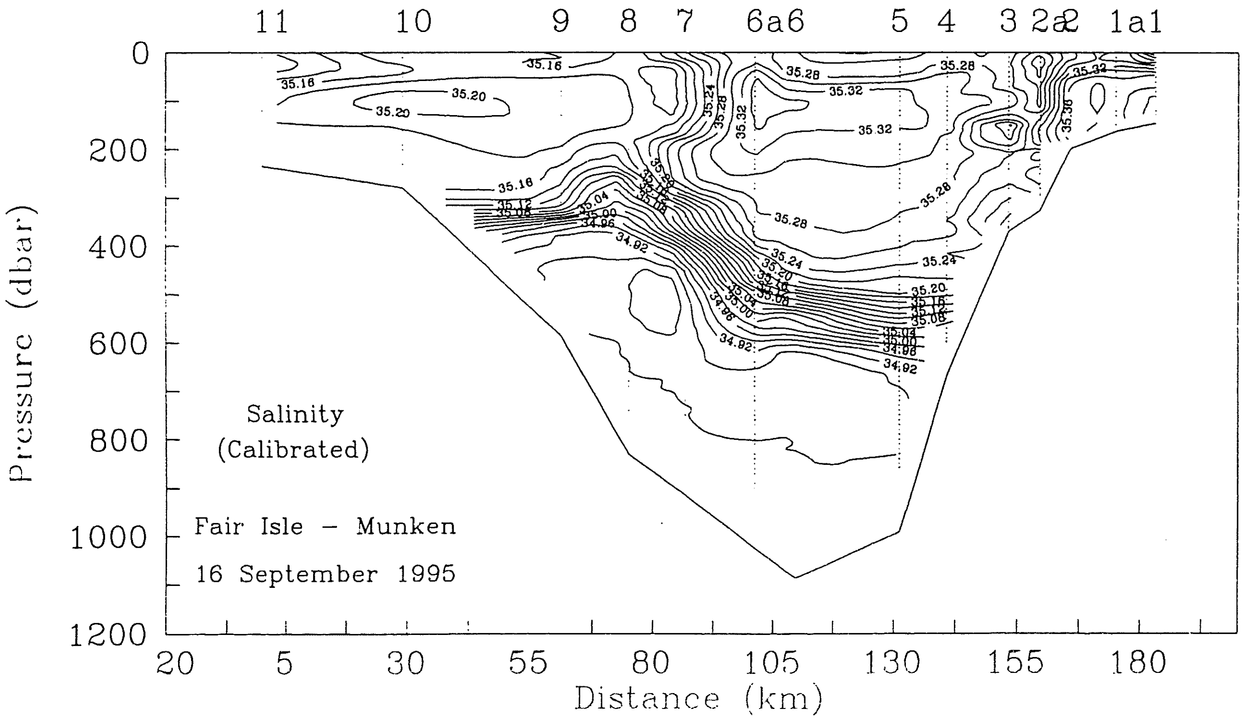
Removal of seasonal cycles: As the surveys over the past have been done at quite different times of the year, in order to remove the effect of the seasonal cycle in the surface waters the monthly mean t and S derived over the period 1960-1995 for each individual station and a each standard depth have been removed.

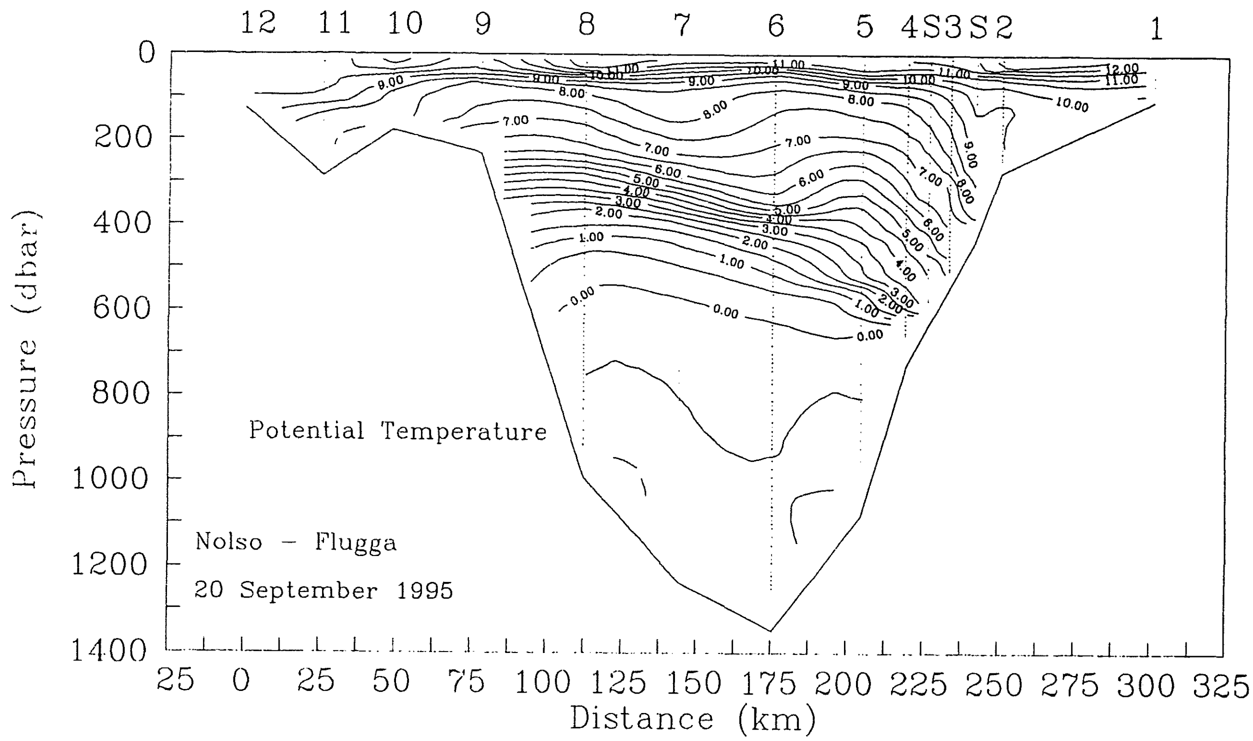
All plots show individual cruise values, along with the results of applying a two year running mean filter.

Table 1 and Figure 8. Characteristic t and S of different water masses during the two surveys.

	MNA		NA		AI		NSI		NSD	
	t	S	t	S	t	S	t	S	t	S
Sep 94	8.4	35.24	9.9	35.38	2.8	34.91	0.6	34.91	-0.6	34.93
Nov 94	8.1	35.23	9.9	35.38	3.2	34.93	0.4	34.89	-0.7	34.92
Dec 94	8.8	35.20	10.3	35.35	3.6	34.95	0.2	34.89	-0.6	34.91
Jan 95	7.5	35.18	9.3	35.36	2.9	34.93	0.4	34.88	-0.6	34.90
Sep 95	8.0	35.22	10.0	35.38	2.2	34.90	0.1	34.88	-0.8	34.91
Nov 95	7.8	35.22	9.7	35.37	2.2	34.91	0.4	34.87	-0.7	34.90


11 10 9 8 7 6a6 5 4 3 2a2 1a1
Pressure (dbar)
Distance (km)
Temperature
Fair Isle – Munken
16 September 1995


11 10 9 8 7 6a6 5 4 3 2a2 1a1
Pressure (dbar)
Distance (km)
Salinity
(Calibrated)
Fair Isle – Munken
16 September 1995


12 11 10 9 8 7 6 5 4S3S2 1
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
Potential Temperature
Nolso – Flugga
20 September 1995
25 0 25 50 75 100 125 150 175 200 225 250 275 300 325
Distance (km)

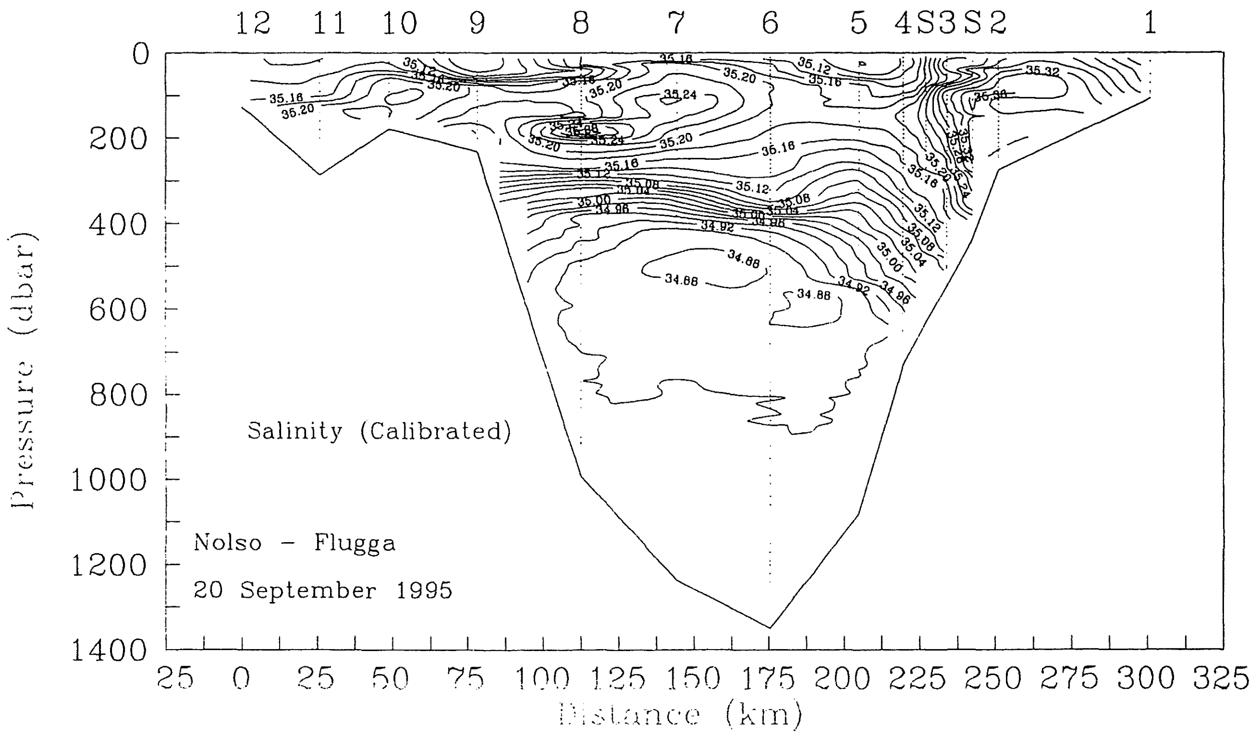
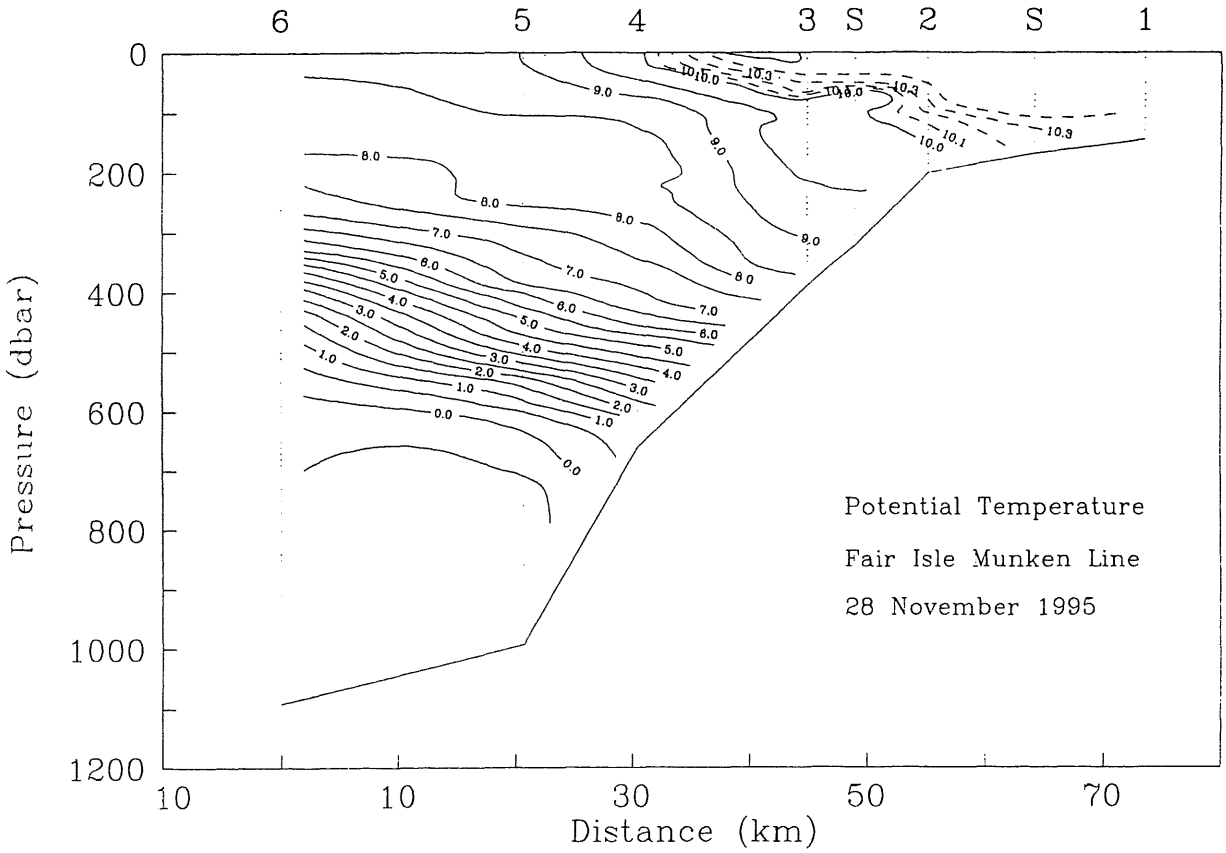
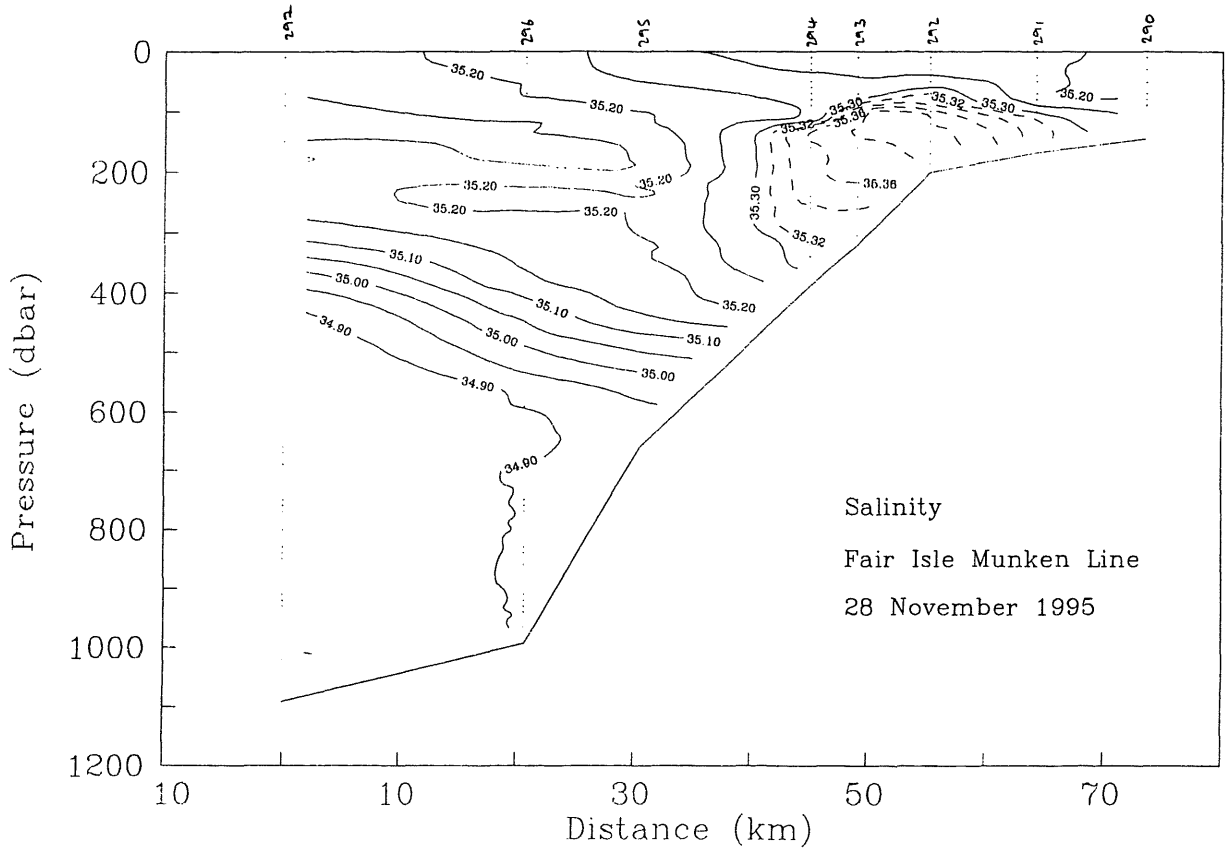
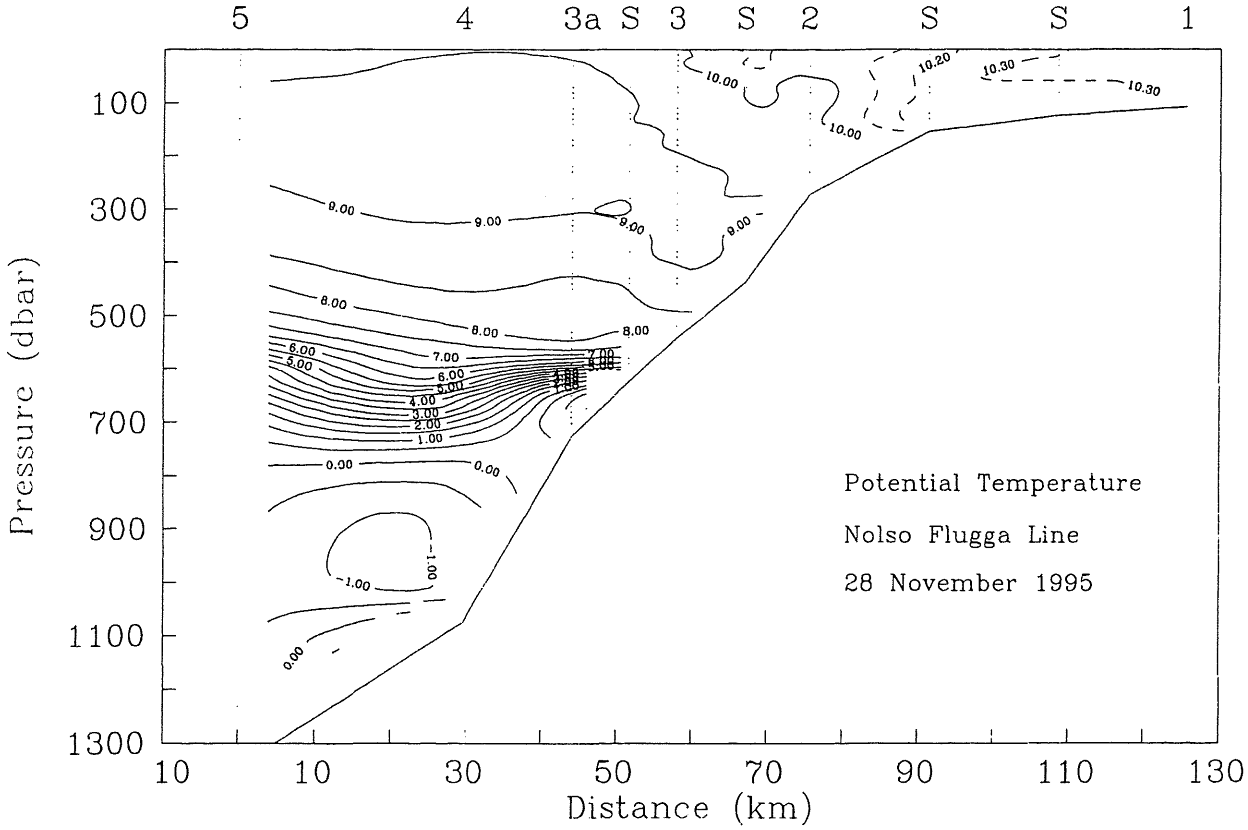
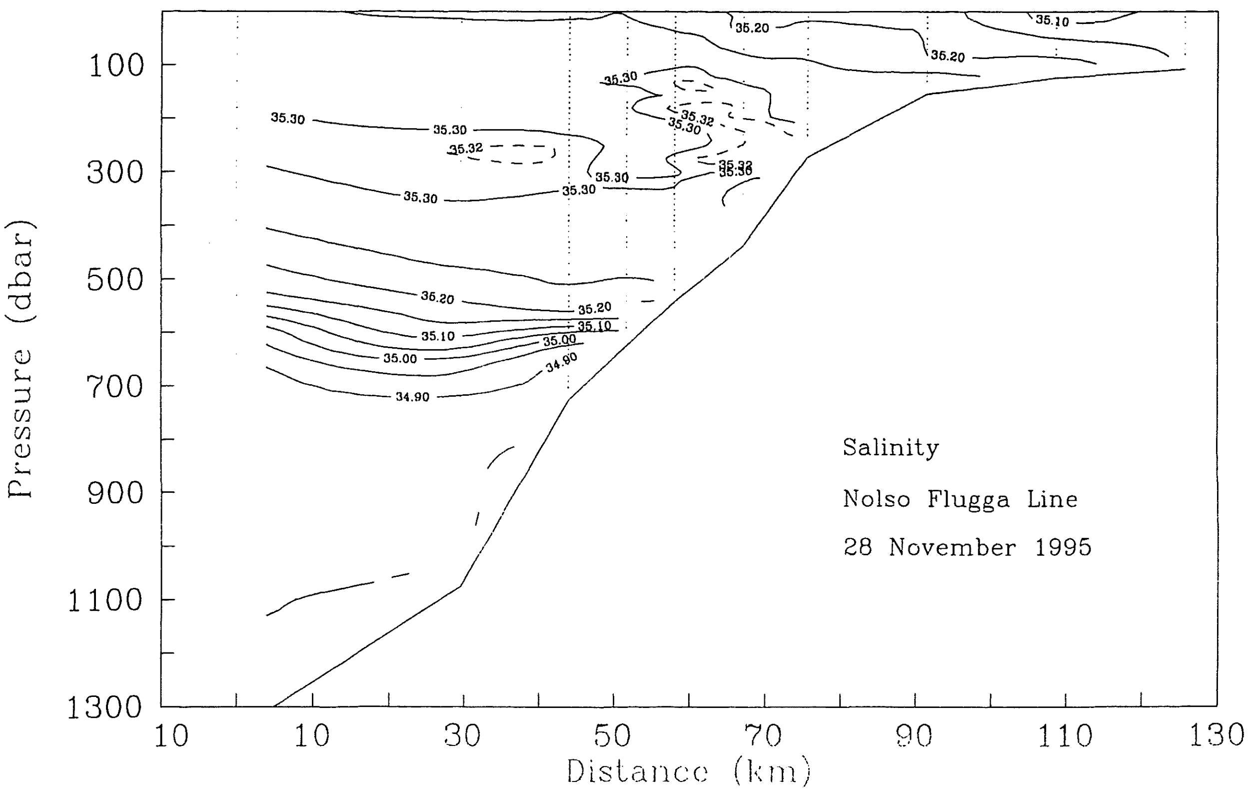

12 11 10 9 8 7 6 5 4S3S2 1
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
Salinity (Calibrated)
Nolso – Flugga
20 September 1995
25 0 25 50 75 100 125 150 175 200 225 250 275 300 325
Distance (km)

Figure 3


6
5
4
3
S
2
S
1
Pressure (dbar)
Distance (km)
Potential Temperature
Fair Isle Munken Line
28 November 1995


Pressure (dbar)
Distance (km)
Salinity
Fair Isle Munken Line
28 November 1995


5
4
3a
S
3
S
2
S
S
1
Pressure (dbar)
Distance (km)
Potential Temperature
Nolso Flugga Line
28 November 1995


Pressure (dbar)
Distance (km)
Salinity
Nolso Flugga Line
28 November 1995

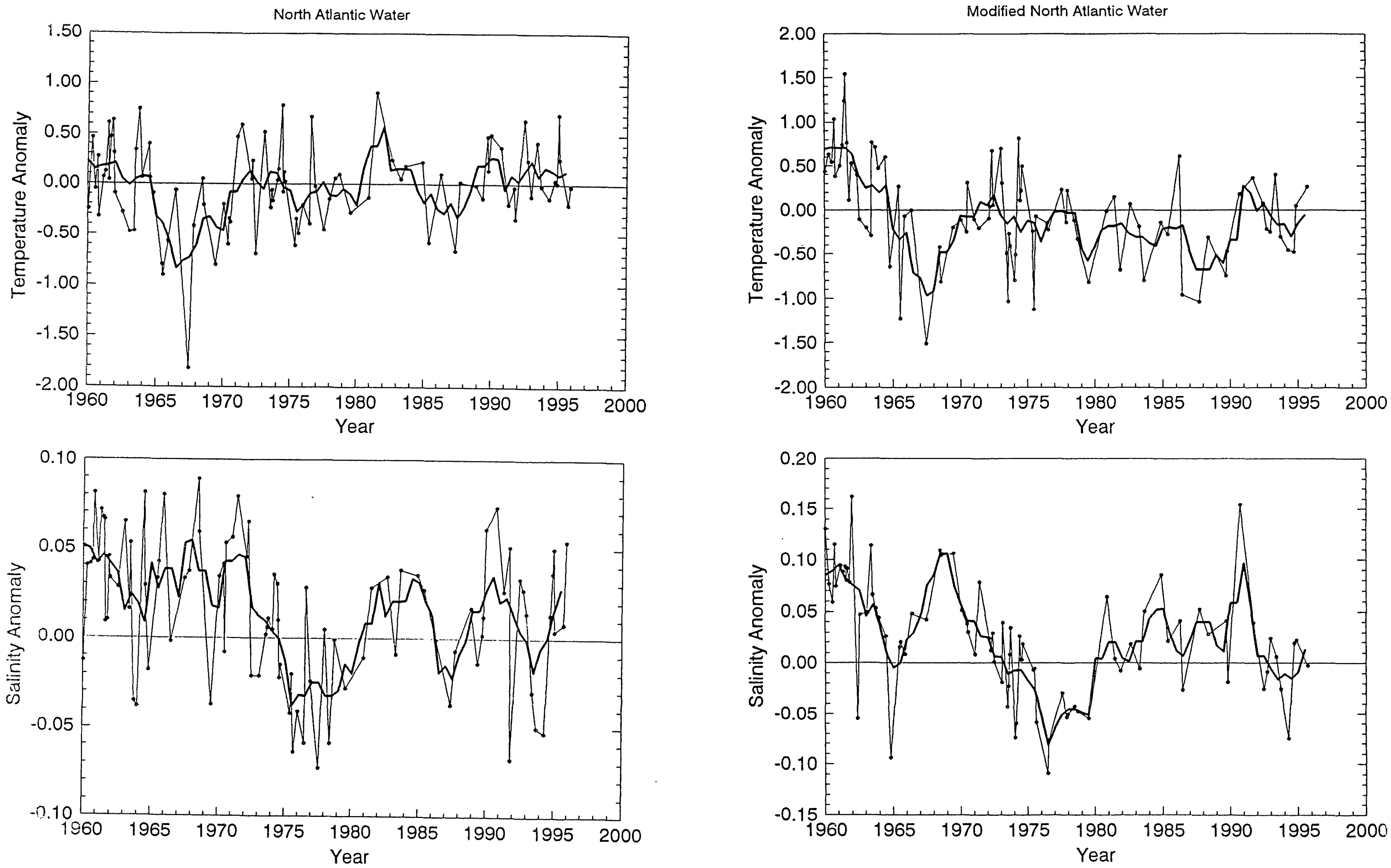

North Atlantic Water
Modified North Atlantic Water
Temperature Anomaly
Salinity Anomaly
Year
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
2.00
0.10
0.05
-0.05
-0.10
0.20
0.15
-0.15
1960
1965
1970
1975
1980
1985
1990
1995
2000

Figure 5

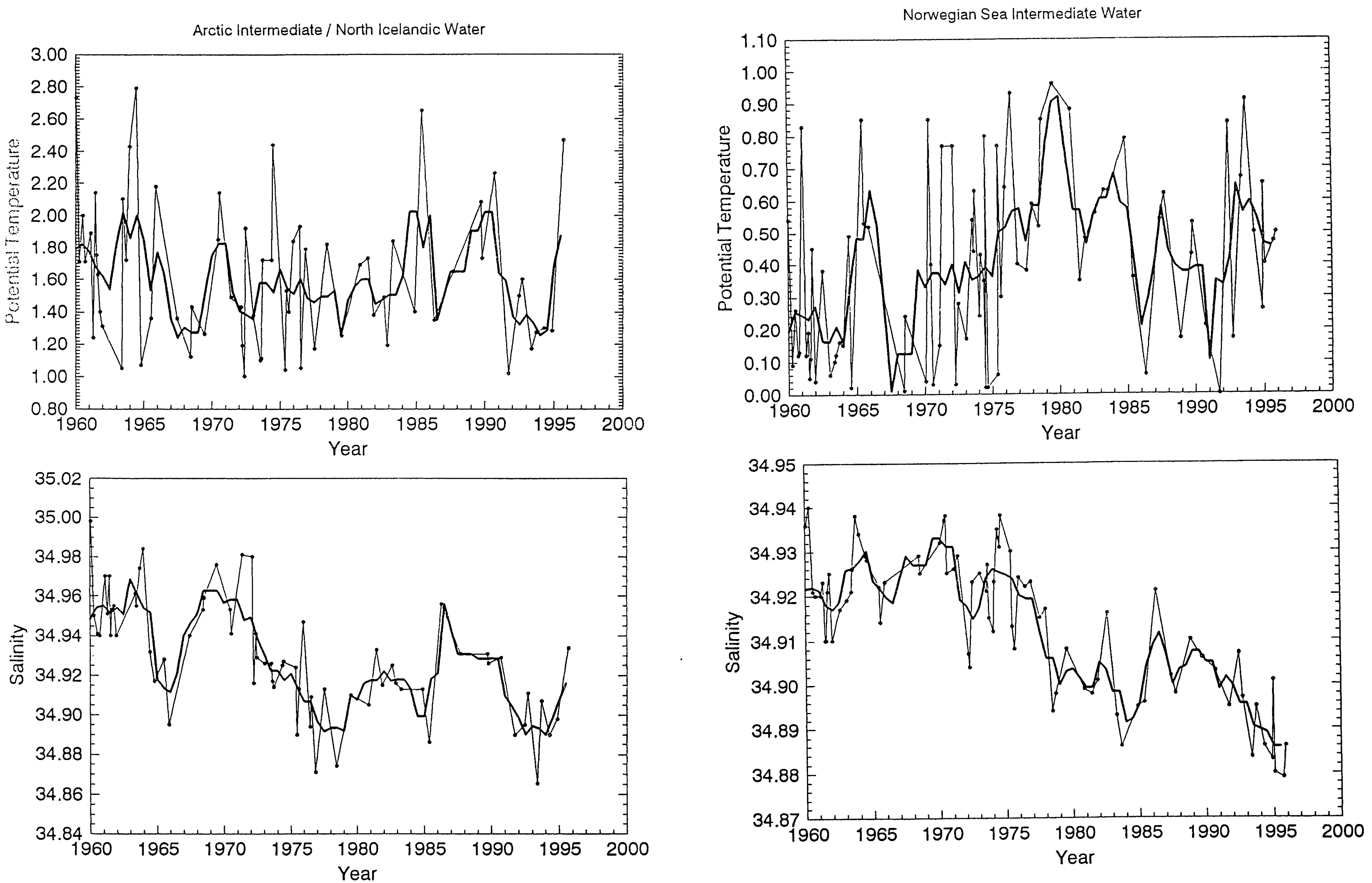
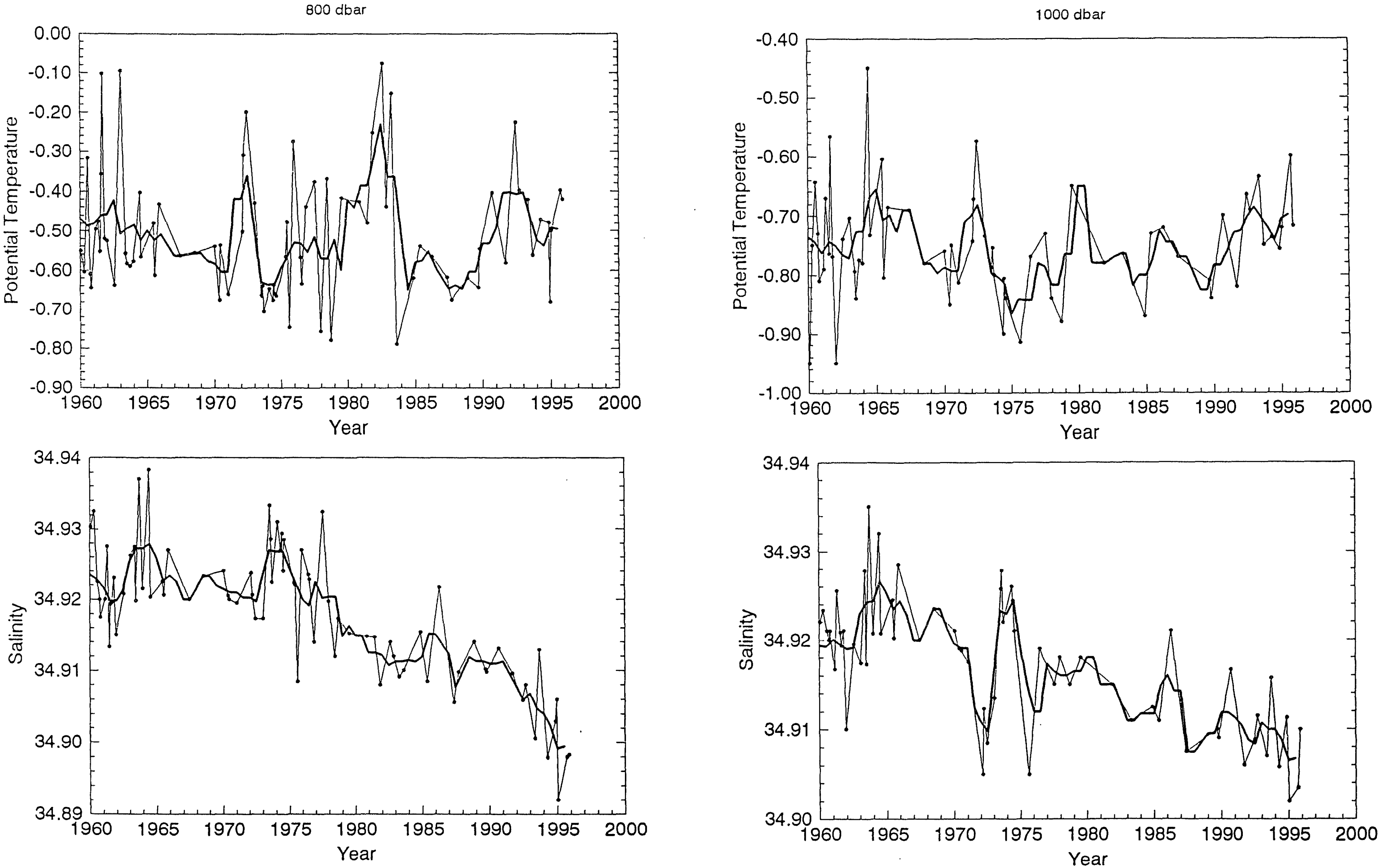

Arctic Intermediate / North Icelandic Water
Potential Temperature
Year
Norwegian Sea Intermediate Water
Potential Temperature
Year
Salinity
Year
Salinity
Year

Figure 6


800 dbar
1000 dbar
Potential Temperature
Salinity
Year
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
-0.90
-1.00
34.89
34.90
34.91
34.92
34.93
34.94
1960
1965
1970
1975
1980
1985
1990
1995
2000

Figur

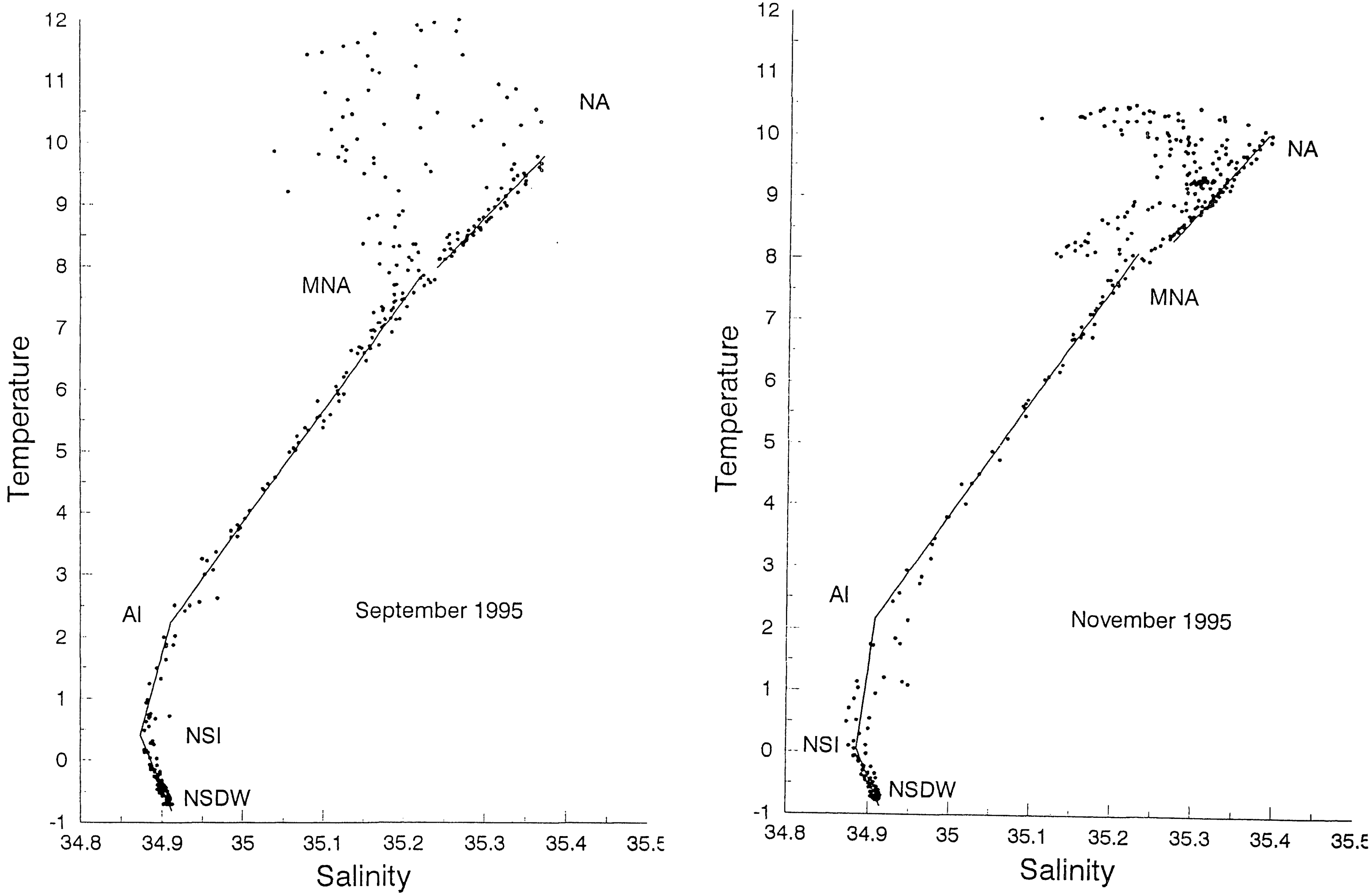

Temperature
Salinity
September 1995
NA
MNA
AI
NSI
NSDW
November 1995

Figure 8

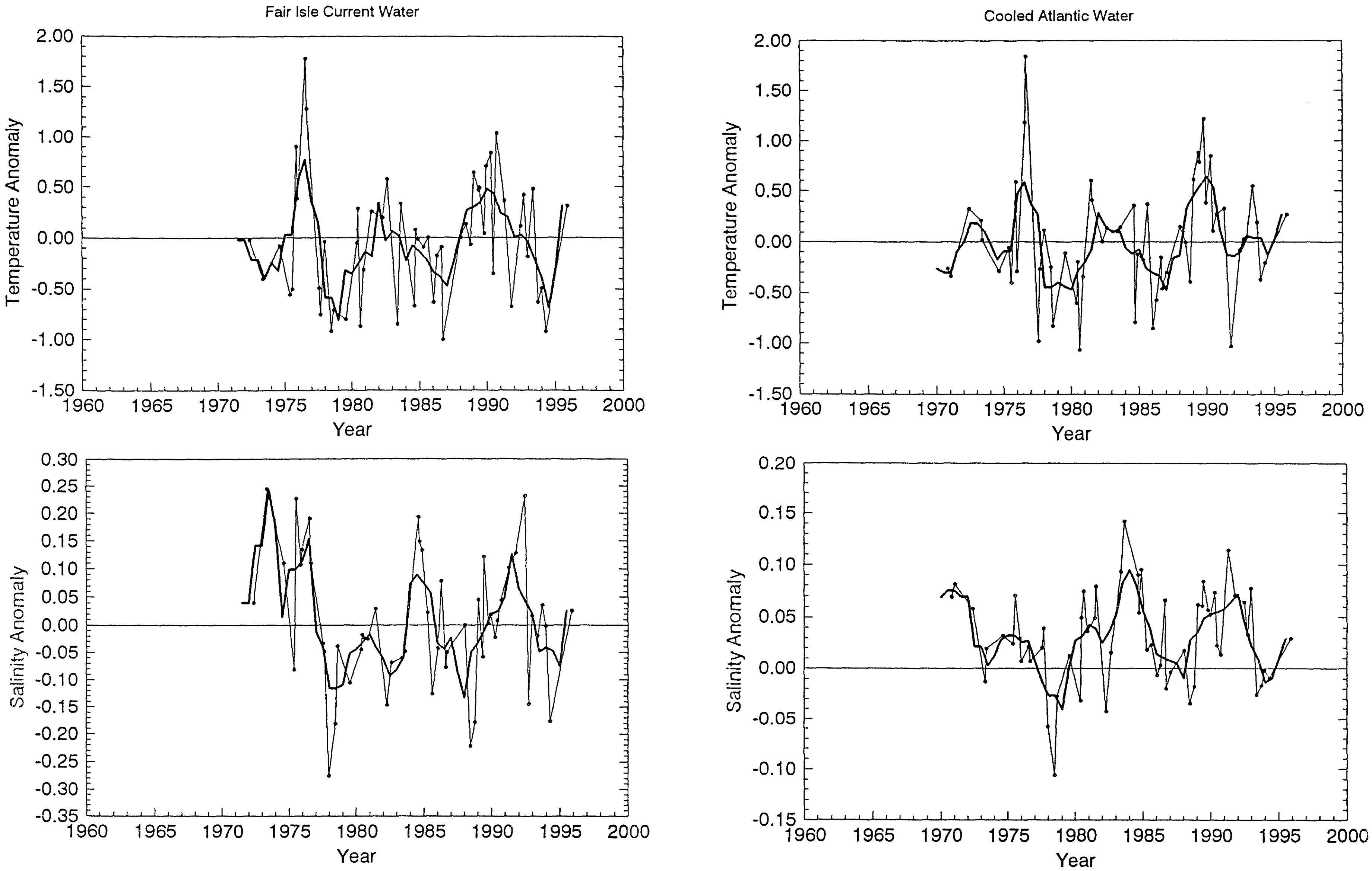
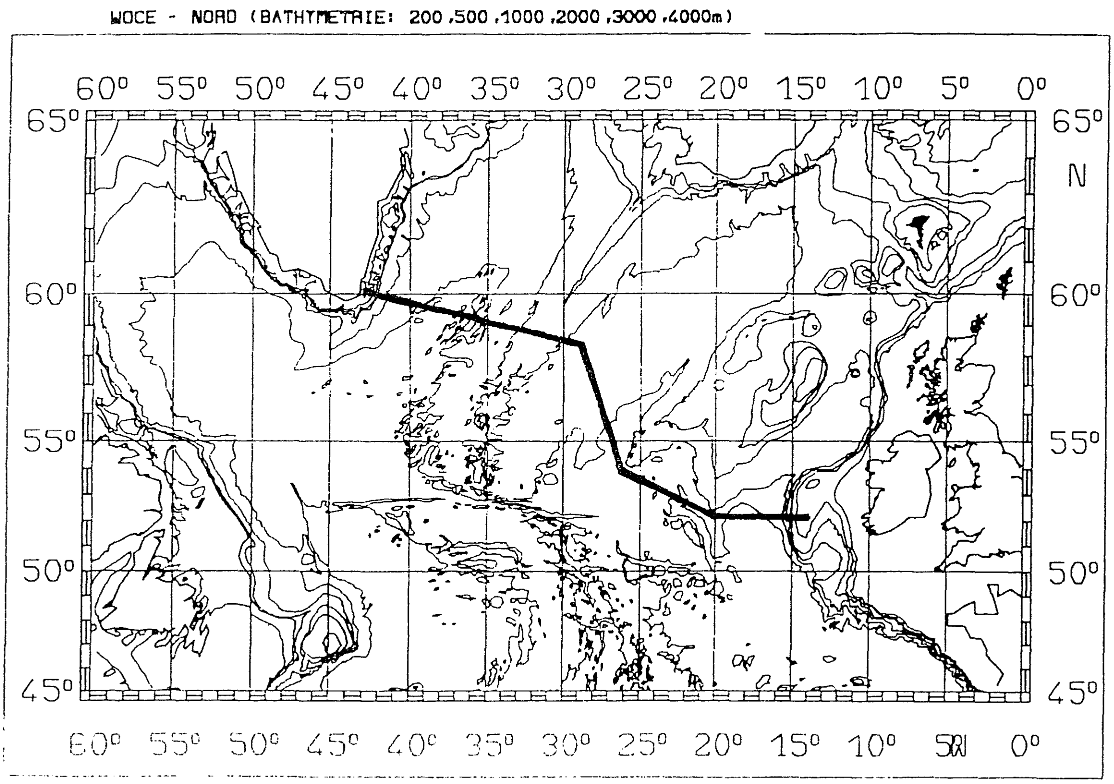

Fair Isle Current Water
Cooled Atlantic Water
Temperature Anomaly
Temperature Anomaly
Salinity Anomaly
Salinity Anomaly
Year
Year
Year
Year
1960 1965 1970 1975 1980 1985 1990 1995 2000
2.00 1.50 1.00 0.50 0.00 -0.50 -1.00 -1.50
0.30 0.25 0.20 0.15 0.10 0.05 0.00 -0.05 -0.10 -0.15 -0.20 -0.25 -0.30 -0.35
0.20 0.15 0.10 0.05 0.00 -0.05 -0.10 -0.15

Figure 9

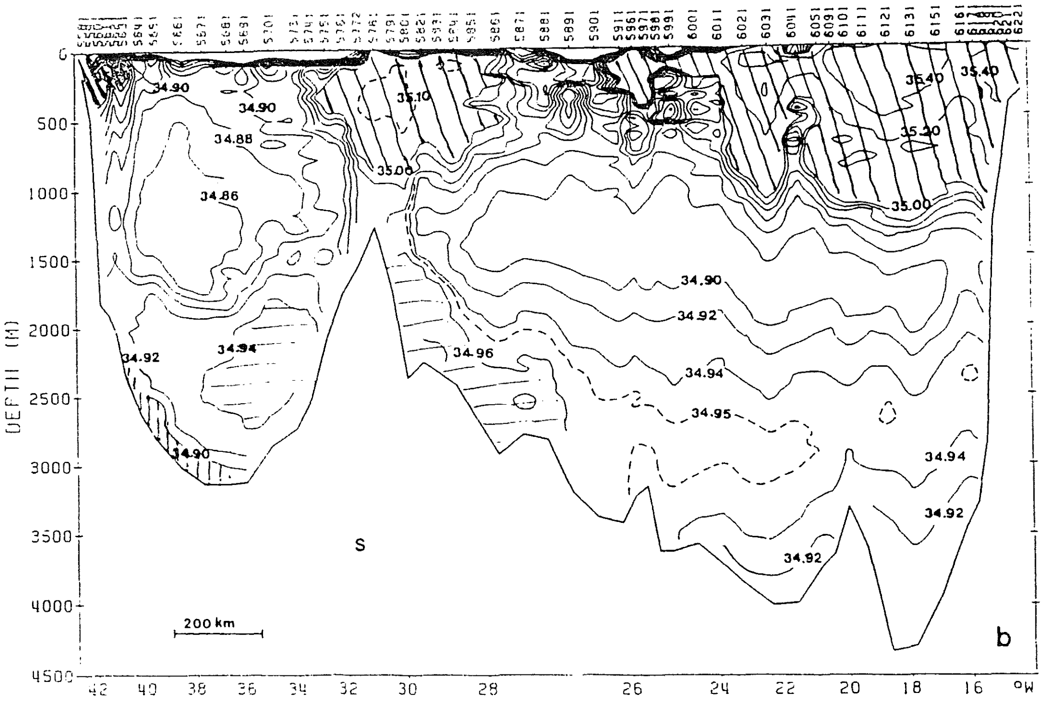
Germany (Jens Meincke)

The WOCE-Repeat Section A 1 E from Cape Farewell (Greenland) to Porcupine Bank (Ireland) has been taken in 1991, 1992, 1994, 1995 and will be continued. It is jointly carried out by the Institute für Meereskunde at the University of Hamburg and the Bundesamt für Seeschiffahrt und Hydrographie, Hamburg. Each time full depth hydrography (T, S, O_2) and occasionally (1991, 1994) nutrients are sampled according to WOCE-standards.

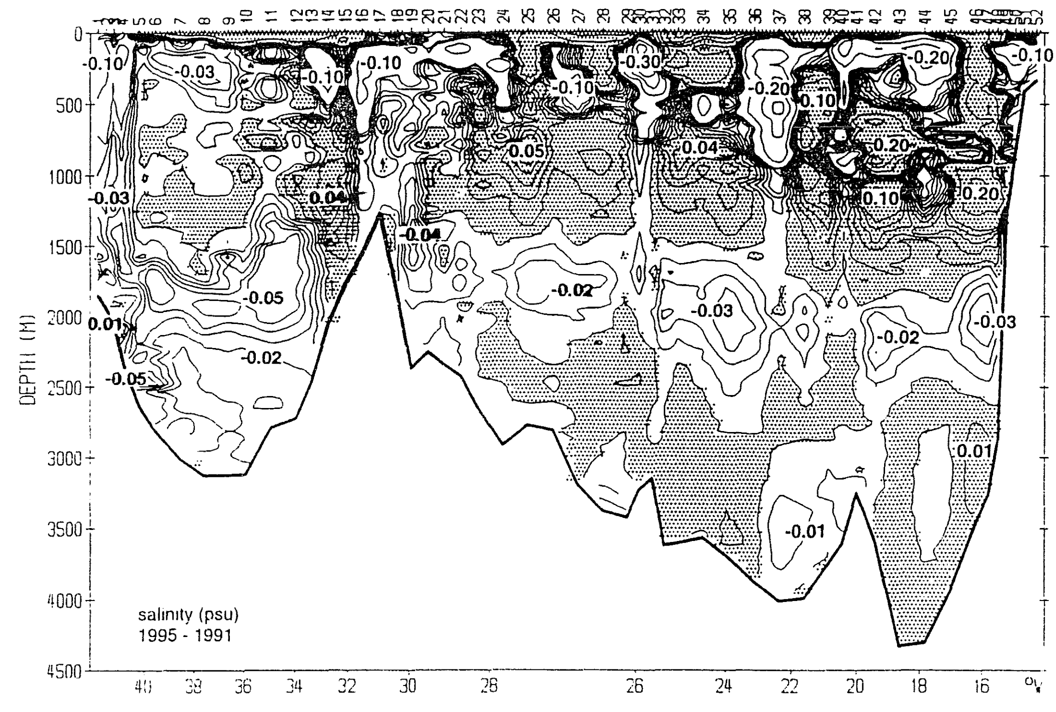
The dominant signal in the series is related to an increased production of Labrador Sea Water (LSW), which has lead to a temperature decrease and a density decrease in the salinity minimum layer in the Irminger Sea and in the region east of the mid-Atlantic ridge. This LSW-event, which started in 1988 with the outset of intense winter convection in the Labrador Sea has reached the NW-European continental slope in 1995.



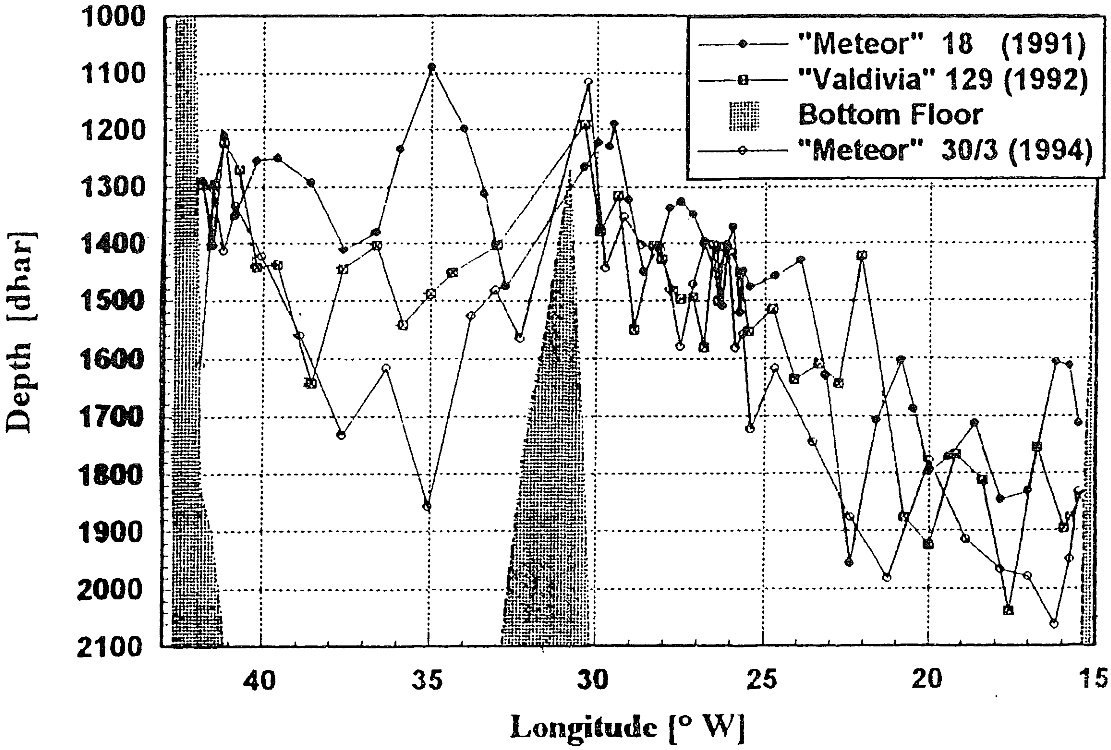
1. Location of section



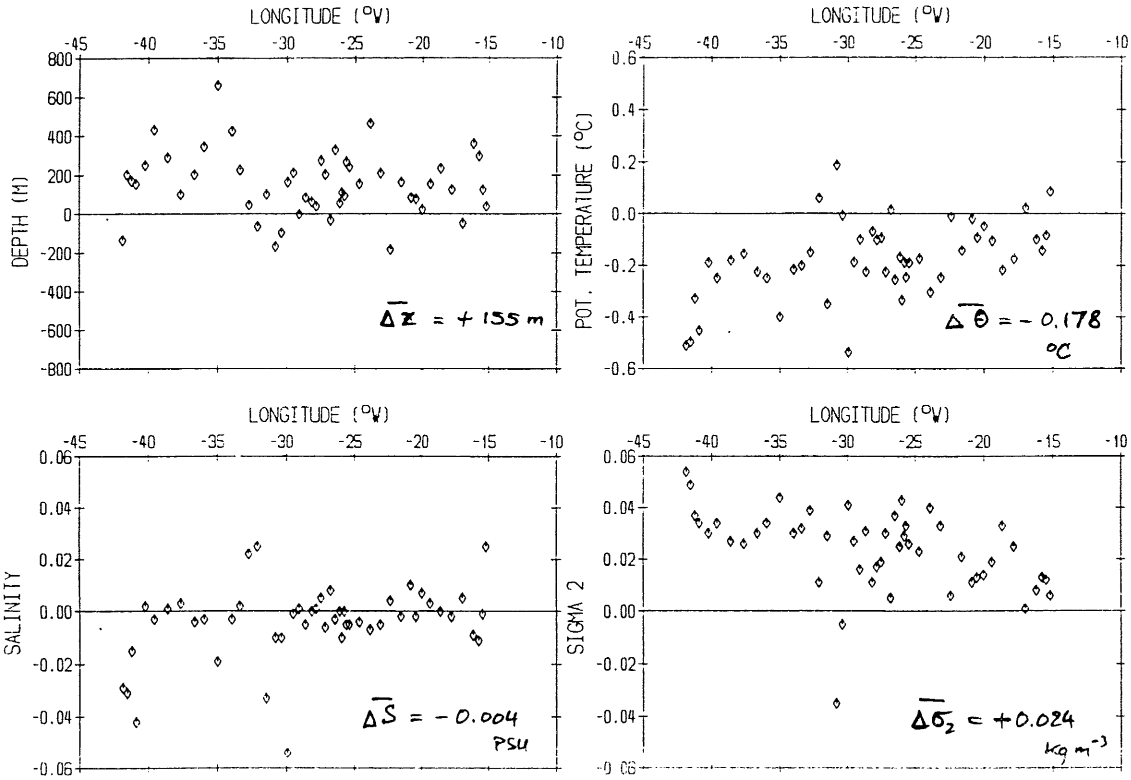
2. Salinity distribution 1991



3. Salinity difference 1995-1991



4. Depth of LSW 1991 to 1994



5. Difference of LSW properties 1995-1991

Norway (Johan Blindheim):

A map showing location of Norwegian standard sections and fixed oceanographic stations is shown in Fig. 1.

The North Atlantic Current and its continuation in the Nordic Seas, the Norwegian Atlantic Current, are the main carriers of heat into the northern areas. The transport of Atlantic water in this current system flows mainly through the Faroe-Shetland Channel, but some Atlantic inflow also crosses the Faroe - Iceland Ridge to flow east in a current branch north of the Faeroes. Although some of this water follows the bathymetry of the Faroe platform to recirculate into the Faroe Shetland Channel, a portion continues as a western branch in the Norwegian Atlantic Current. This is shown in Fig. 2 which shows mean salinity in the Svinøy section, averaged over the years 1980 - 1994. This section shows two clearly separated cores with maxima in salinity. The core off the shelf break, which is the largest, represents the flow through the Faroe - Shetland Channel while the outer core most likely indicates the current branch which comes in north of the Faeroes.

The Barents Sea

Fig. 3 shows time series of temperature and salinity in the standard sections in the Barents Sea, 1) Fugløya - Bjørnøya, 2) Vardø - N and 3) Sem Islands - N (see Fig. 1 for location). Temperatures and salinities are presented as mean values, averaged vertically between 50 and 200 m depth and horizonally over the stations which cover the core of Atlantic inflow in the sections.

In all the three sections in the Barents Sea there was a general temperature increase from 1994 to 1995 and this warming was most pronounced in the eastern part of the area. In 1995 the temperature was about 0.3 - 0.5°C above the long term mean in the western part of the Barents Sea, increasing to about 1.0 °C above the average in its eastern parts. The average salinity is close to the long term mean in all the three sections. In the western part this represents an increase of about 0.05 units since August 1994 while there has been little change in the two eastern sections

Fig. 4 shows indices of ice coverage in the Barents Sea. Positive values indicate little ice while sub-zero values represent a large ice coverage. During the winter 1994-1995 there was relatively little ice and most of the season the ice border was found between 74 and 75 °N. This represented only a small difference from the previous winter.

The Norwegian Sea

Fig. 5 shows fluctuations in temperature and salinity, observed in July/August since 1978 in two sections crossing the Norwegian Atlantic Current, Svinøy - NW and Gimsøy NW, and one across the West Spitsbergen Current, Sørkapp - W (Fig. 1). The plots show the trend of mean values which are vertically averaged between 50 and 200 m and horizontally across the core of Atlantic water just off the shelf break. While the two southern sections, in the Norwegian and Lofoten Basins, both show temperatures close to the mean over the period, conditions near Spitsbergen have been warmer than average since 1989. After little variation during 1992 - 1994, there has later been a warming and in August 1995 it was about one degree warmer than the average for the period. The salinity was at the average in all three sections. In the southern section off Svinøy this represented a rise after a three-year period with relatively low salinities.

The North Sea and Skagerrak

The North Sea is a shallow shelf sea with depths less than 100 m south of about 58 N. The deepest area is the Norwegian Channel where depths exceed 700 m in Skagerrak. Atlantic inflow occurs partly in the western area, as a southbound flow east of the British North Sea coast and partly along the western slope of the Norwegian Trench. Although the circulation to a large extent is wind driven, the general topographically steered circulation is generally cyclonic and almost all water passes through Skagerrak during its residence time in the North Sea. During winter the vertical mixing is intense so that differences between surface and bottom temperatures may be small in the shallow areas. Fig. 6 A shows time series of summer measurements of near-bottom temperature and salinity in the northern North Sea (Position A in Fig. 1). The measurements show the product of the winter mixing in the western branch of the Atlantic inflow. This is a mixture of the inflowing Atlantic water an somewhat fresher surface water. Figure 6 B shows similar observations at a station over the western slope of the Norwegian Trench, in the core of the Atlantic water flowing in from the Norwegian Sea. The temperature is on average about 1-2 °C colder and the salinity 0.1 unit lower on the North Sea plateau than in the Norwegian Trench.

A time series of temperature and salinity at 600 m depth in the Skagerrak Basin is shown in Fig. 7 (Position C in Fig. 1). The observations show that the deep water in Skagerrak was renewed in 1991, following a relatively long period with stagnation. The temperature in 1990, just before the inflow of new deep water, was the highest on record since the time series was initiated in 1947. During spring in 1994 there was supply of a colder and fresher water mass to the deep water in the basin, but in 1995 there are no signs of renewal and it is likely that the gradually increasing temperature and salinity is due to mixing from above with Atlantic water.

Coastal water

Temperature and salinity conditions at 8 fixed stations along the coast (Fig 1) are observed at standard depths 2 - 4 times monthly. Fig. 8 show variations in these variables, averaged over the first quarter at 10 m depth and over the third quarter at 150 m depth, for the period 1936 - 1995 at Skrova. Showing surface conditions in the coastal water, the 10 m graph is vulnerable to large, local variations while the 150 m graph is more reflecting conditions in the Norwegian Atlantic Current. After the relatively warm and salty period around 1990, the present conditions are colder and fresher although the decrease seems to have culminated in 1994. The seasonal variations and their standard deviation is also shown in the figure.

Long term trends and seasonal variations in temperature and salinity at the fixed station Utsira is shown in Fig. 9. Also at this station the long term trend at 10 m depth are based on averages for the first quarter and averages for the third quarter are used at 150 m depth. The conditions in the Atlantic inflow is reflected at 150 m depth also at this station and it may be noted that the decadal variations are similar to those at Skrova.

Fig. 10 shows an isopleth of the content of dissolved oxygen, entered in ml/l, in the Lofotenfjord which is a continuation of the Vestfjord in the Lofoten area. This fjord has been wintering area for the majority of the Norwegian spring spawning herring stock since 1987 and this large concentration of biomass mass has resulted in reduced oxygen content in the water mass of the fjord basin. Oxygen has been observed along with other environmental variables in November since 1977 and based on these observations, the figure shows oxygen content at a station near the town of Narvik in the inner part of the fjord. A considerable decrease occurred in 1988, the year after the invasion of the herring stock. The low values at depths greater than 100 m have remained fairly constant during the later years, mainly at 1 - 2 ml/l, and even below 1 ml/l in 1990. The November values which are shown in the figure, do not represent the seasonal minimum because the lowest oxygen concentration occur in January, just before the herring migrates out of the fjord.

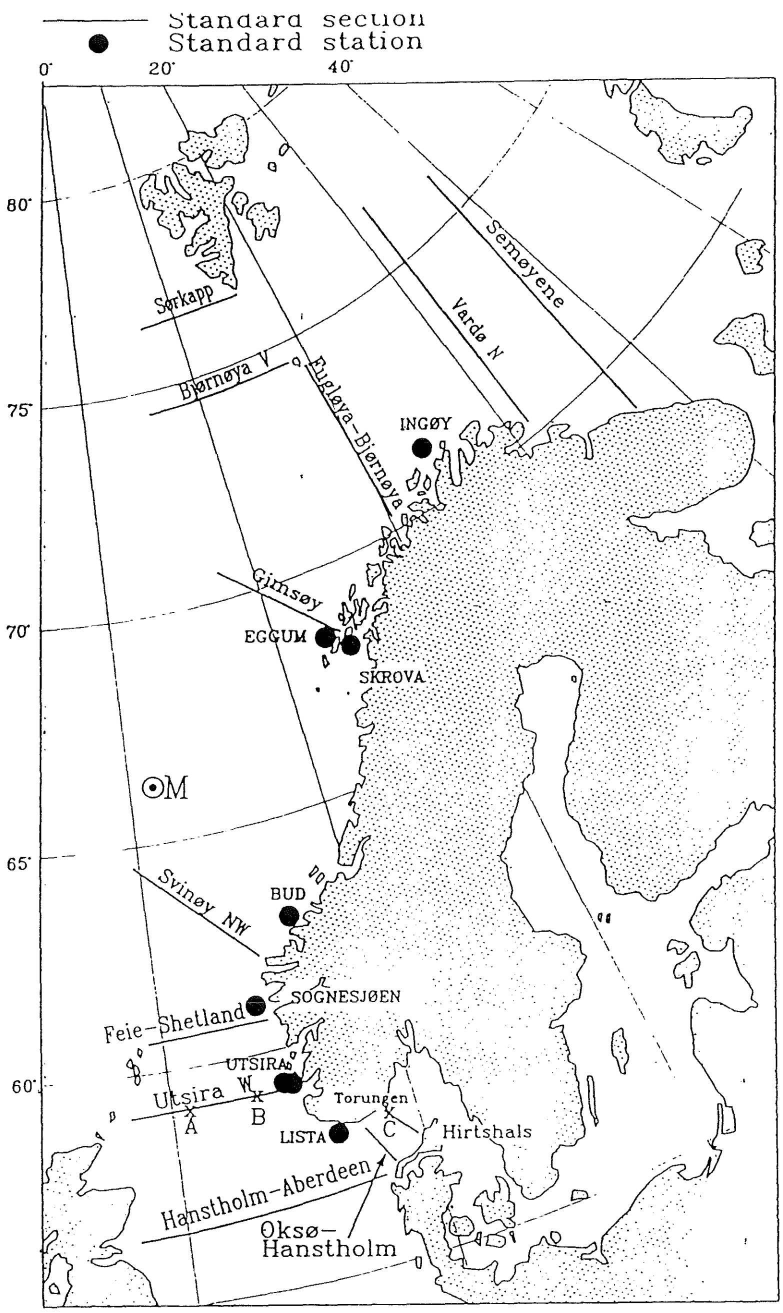


Figure 1. Hydrographic standard sections and fixed oceanographic stations.

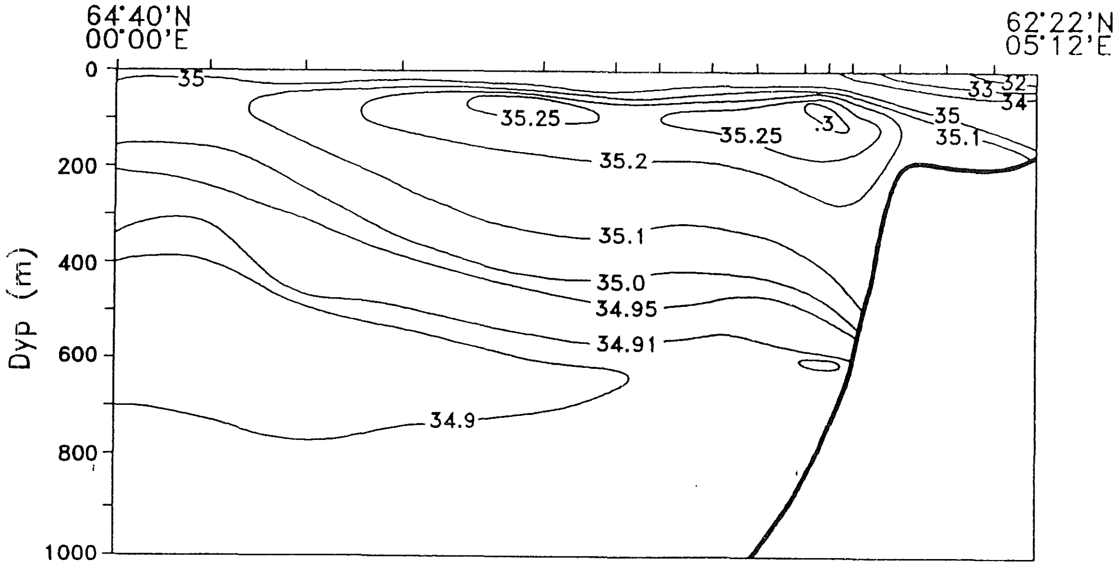


Figure 2. Mean salinity in the section Svinøy - NW, based on observations in July - August, averaged over the years 1980 - 1994.

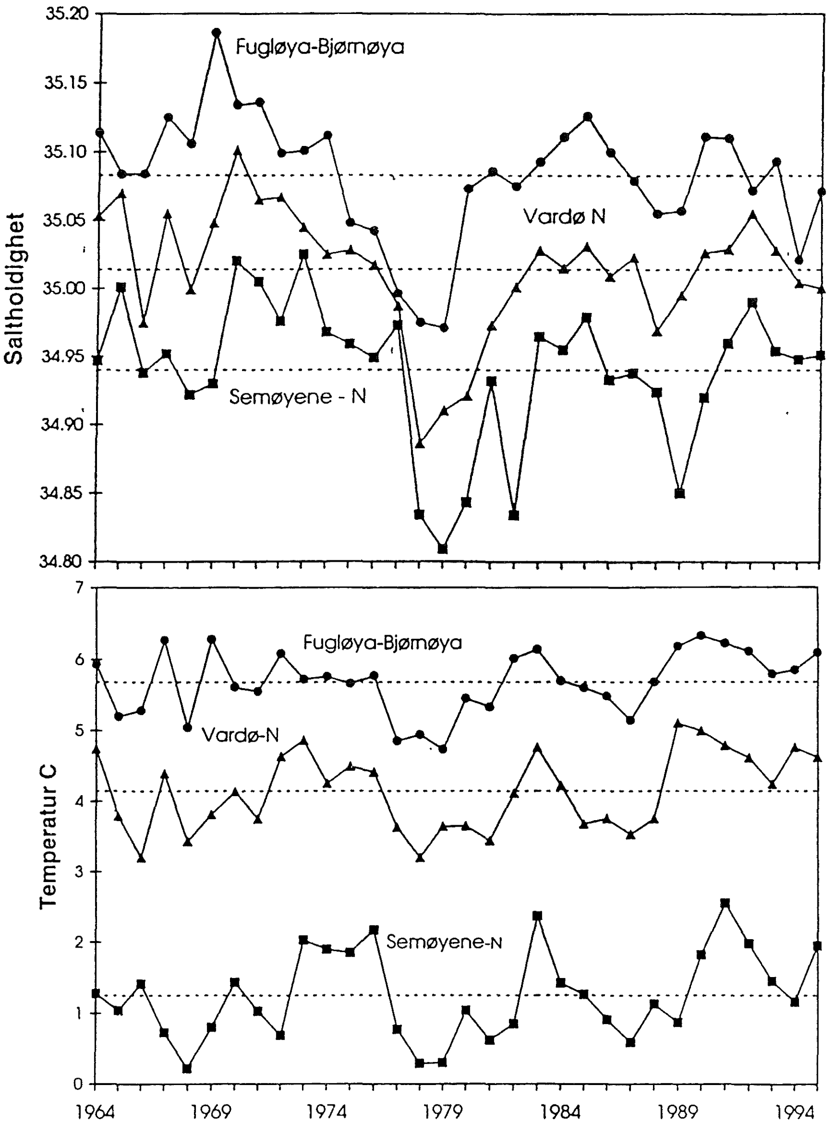


Figure 3. Mean temperature and salinity between 50 and 200 m in August/September in the sections Fugløya-Bjørnøya, Vardø-North and Sem Islands-North. 1964-1995.

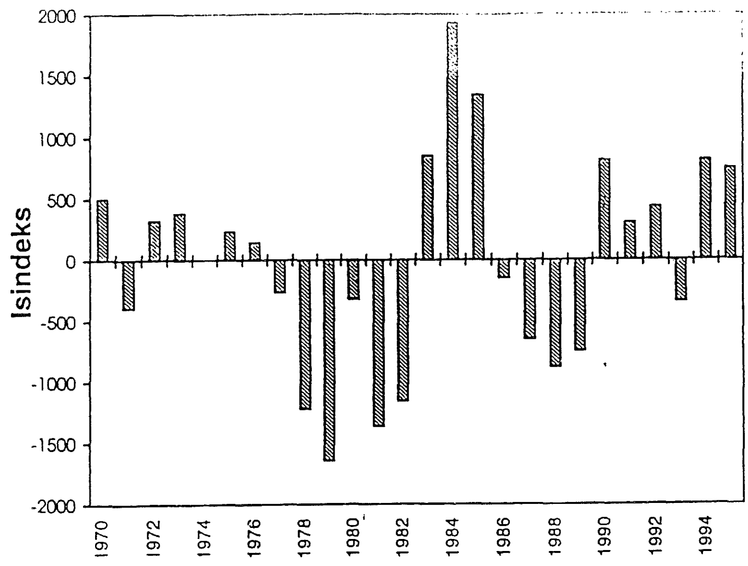


Figure 4. Ice index for the period 1970 - 1995. Positive values indicate little ice, while negative values show more severe ice conditions.

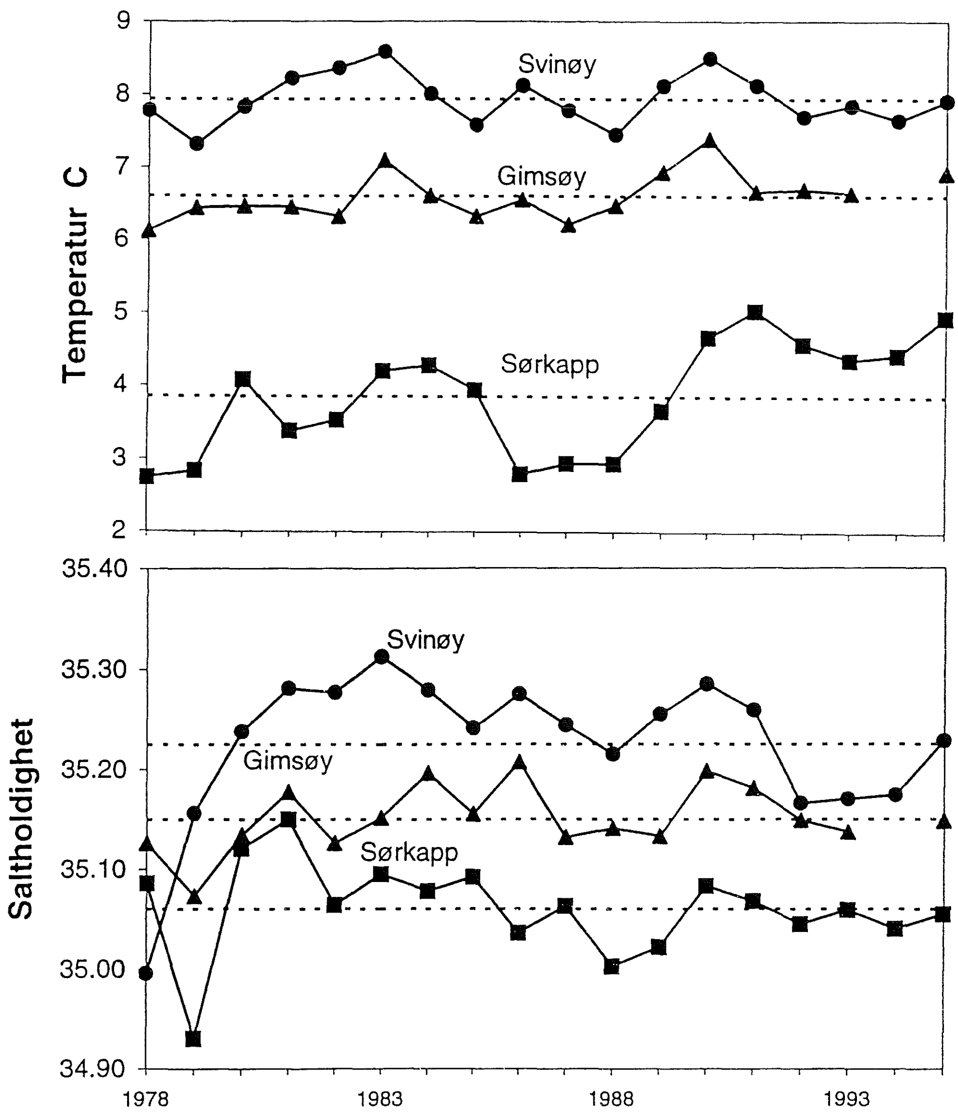


Figure 5. Temperature and salinity, observed in July/August, in the core of Atlantic water in the sections Svinøy-NW, Gimsøy-NW and Sørkapp-W, averaged between 50 and 200 m depth.

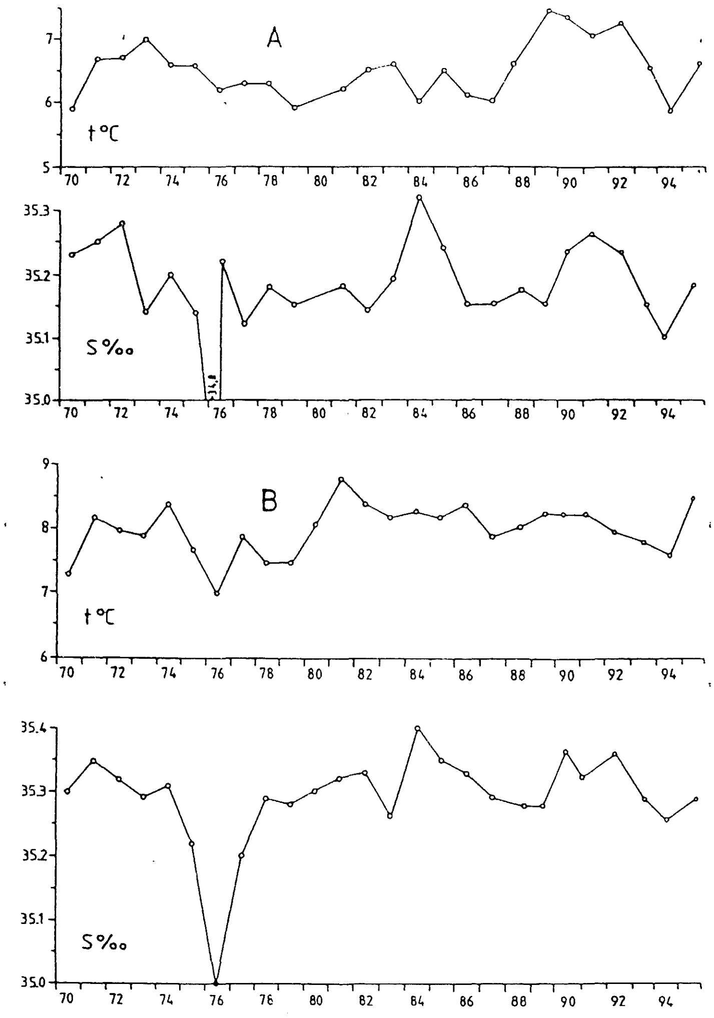


Figure 6. Temperature and salinity near bottom in the northwestern part of the North Sea (A), and in the core of Atlantic water (B) over the western slope of the Norwegian Trench.

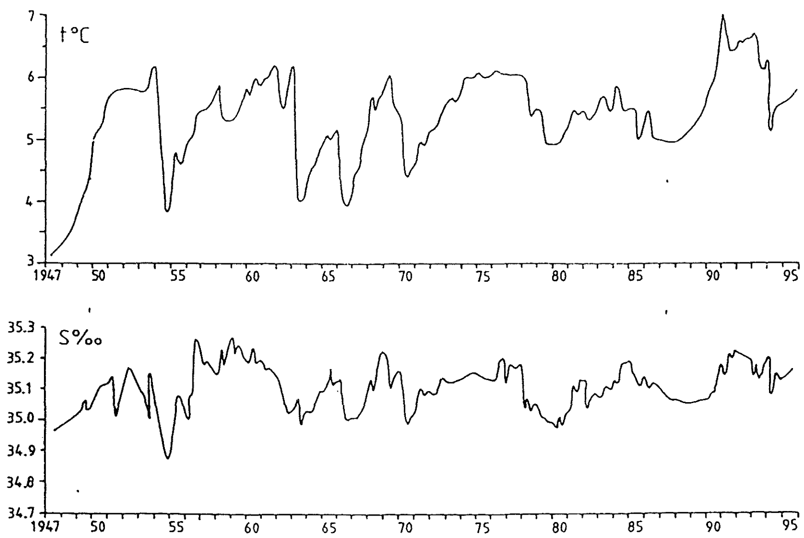


Figure 7. Variations in the temperature and salinity of the bottom water (600 m depth) in Skagerrak for the years 1947–1995

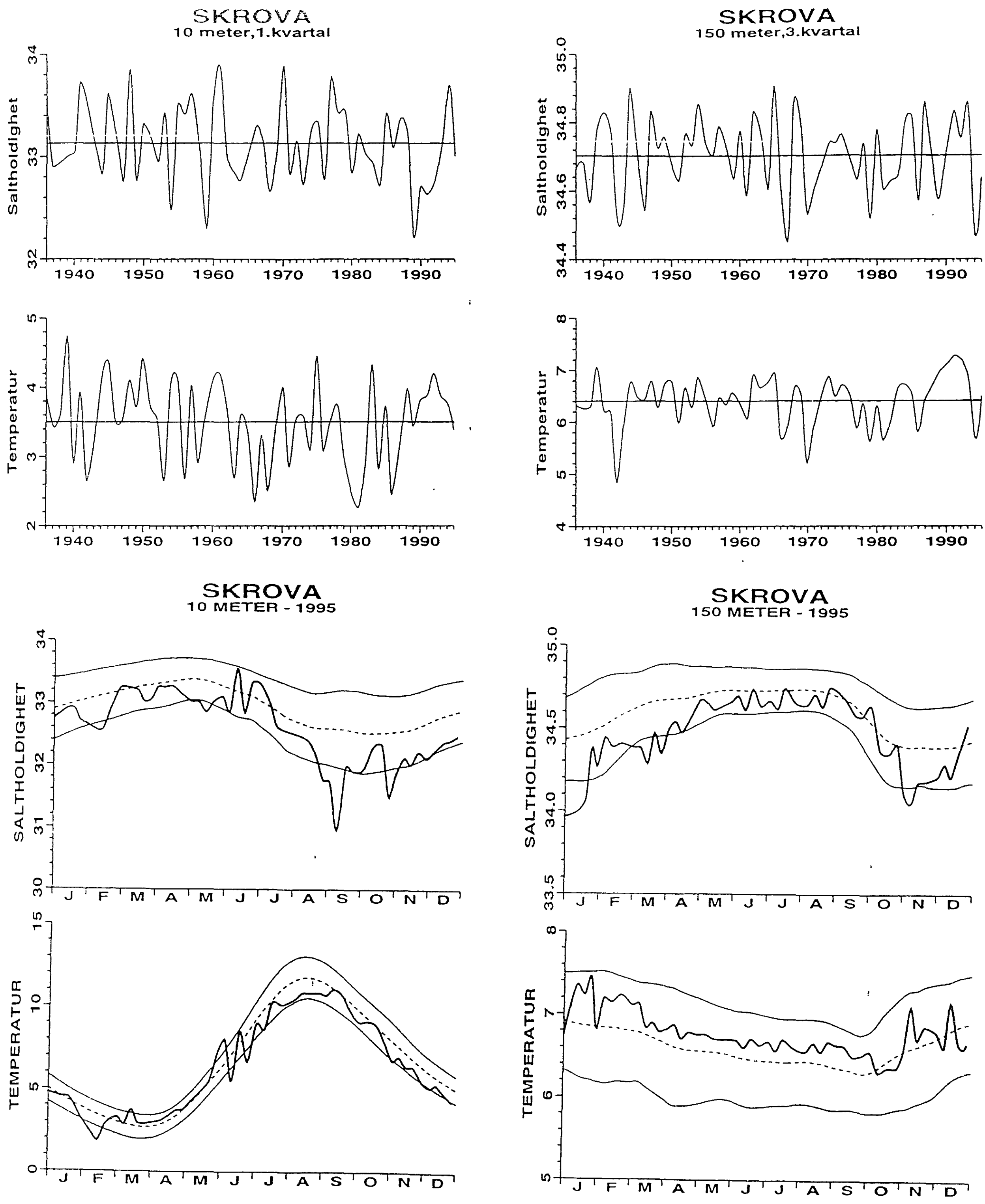


Figure 8 Upper panel. Mean values and decadal variations of temperature and salinity at 10 m (1st quarter) and 150 m depth (3rd quarter) at Skrova.
Lower panel. Temperature and salinity (thickest lines) at 10 m and 150 m depth, measured monthly at Skrova in 1995. Long term mean (broken line) with standard deviations is also shown.

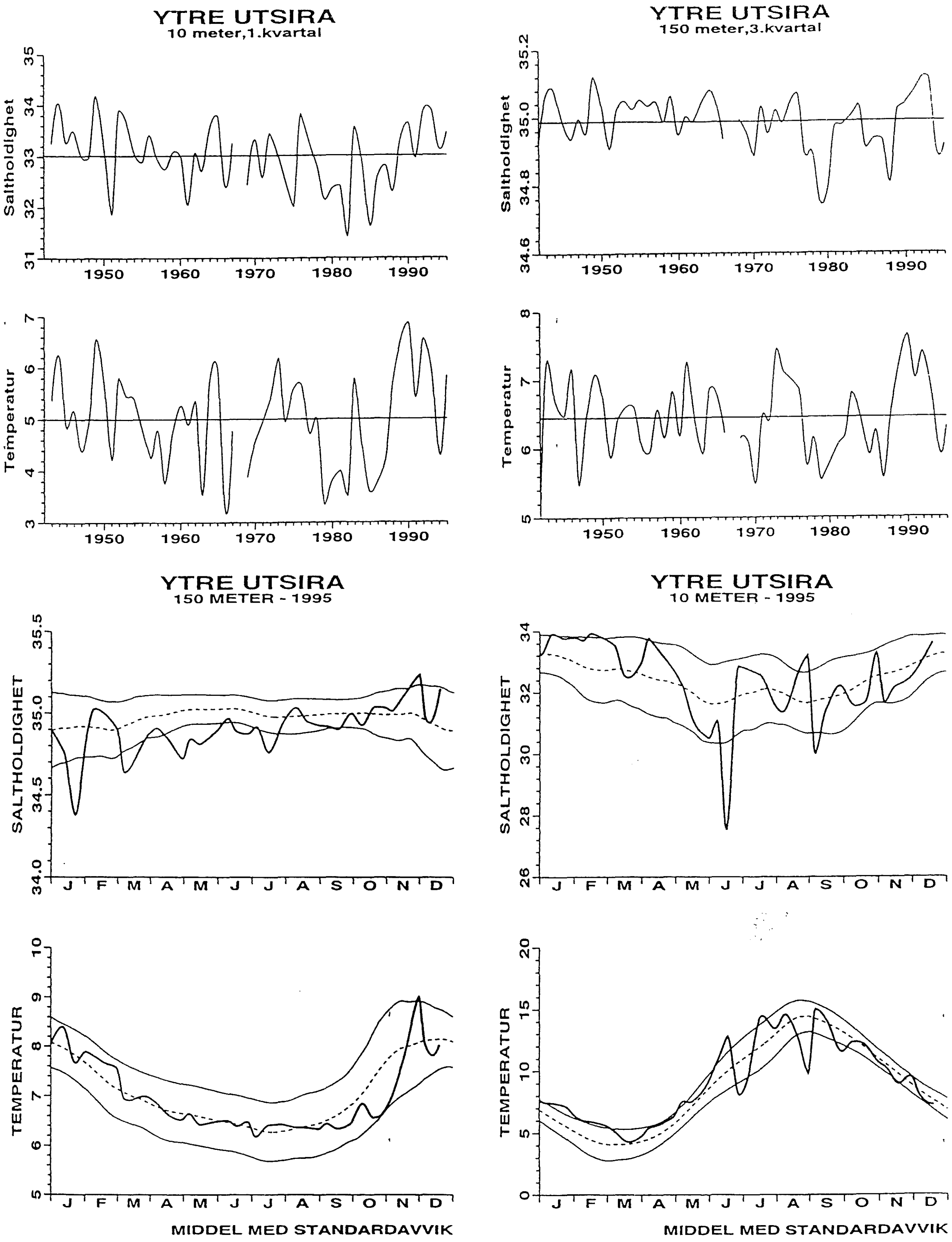


Figure 9. Upper panel. Decadal variations of temperature and salinity at Utsira, averages for 1st quarter at 10 m depth and averages for 3rd quarter at 150 m depth.
Lower panel. Temperature and salinity at 10 and 150 m depth measured approximately 3 times monthly at Utsira. Long term mean (broken line) with standard deviations is also shown.

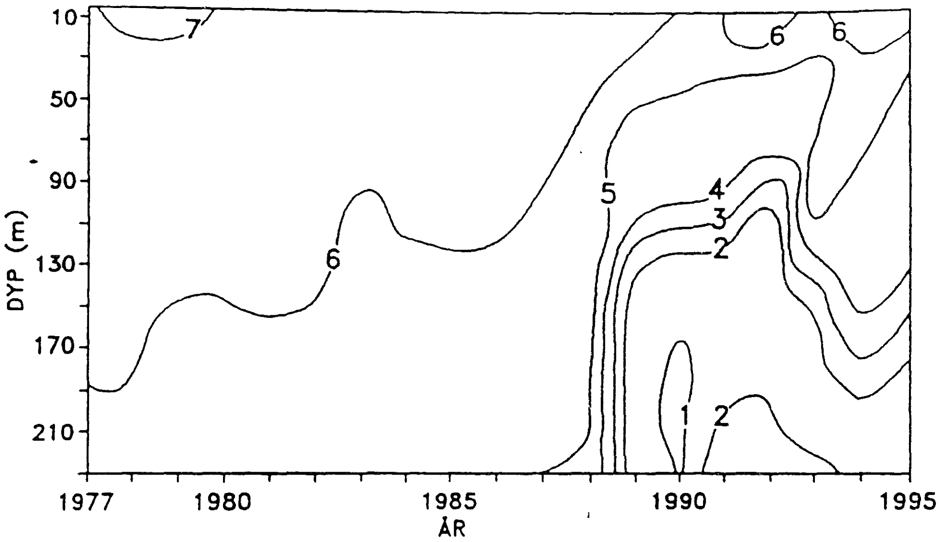


Figure 10. Vertical distribution of oxygen (ml/l), observed in November at a station off Narvik in the Ofotfjord during the period 1977-1995.

SPAIN (Alicia Lavín and Jose M. Cabanas)

Results of three stations in Santander (Fig. 1a) and two in Vigo (Fig. 1b) are presented from the shallowest station to the deepest one.

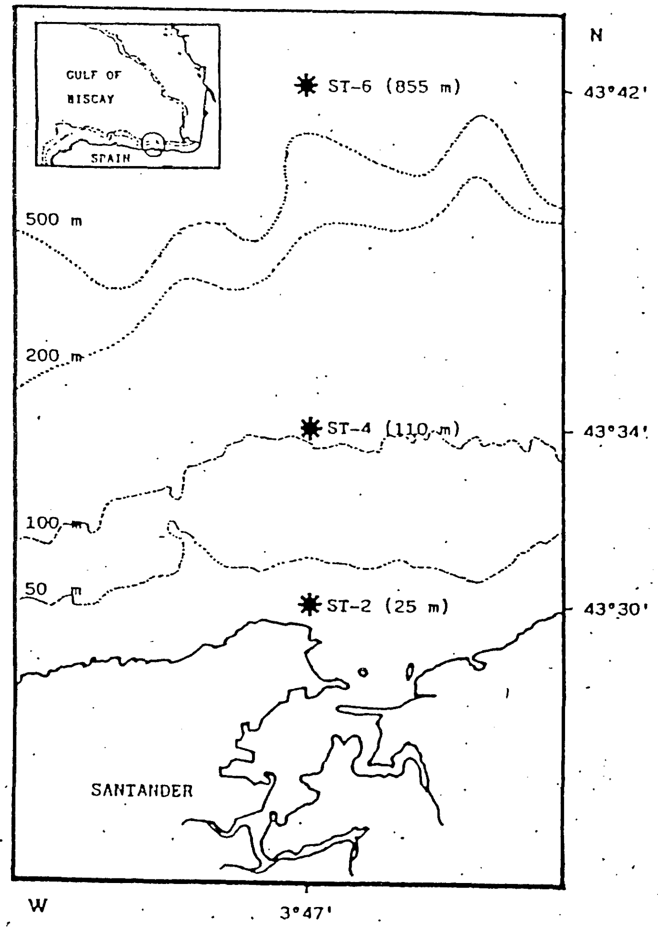
In the historical time series of mean air temperature at the Santander Observatory (Centro Meteorológico del Cantábrico) of the Instituto Nacional de Meteorología (fig.2), there is a cold period from 1962 to 1980 followed by a warmer one, and since 1980 there have been three periods of relative maximum temperatures in 1983, 1989 and 1995.

In figure 3 we present the contours of temperature (a) and salinity (b) versus depth throughout the period for station 2, which is the most coastal station. At such a small depth the water column is mixed throughout the year in temperature and salinity, with high temperatures and very low salinities covering the shallow part. Figure 4 presents contours from station 4. This station is located in the central part of the shelf, and shows a seasonal cycle in the upper 50m due to the summer warming and a cold influence at the bottom. This water was colder than 12°C in 1992. Salinity time series show high values in winter throughout the water column and at around 50m depth in summer. Figure 5 shows station 6 contours of temperature and salinity. This station is located over the shelf break and shows a similar seasonal cycle than station 4 with homogeneous waters from October-November to April-May and stratification during the remaining period.

The temperature data has been fitted at 10, 20, 50 and 100 m depth in station 4 and station 6. In the layers closer to the surface we appreciate a tendency for temperatures to increase over the last years, mainly at 10 and 20 m depth. At 50m the tendency is very low and no tendency was found at 100 m depth. The tendency at 10 m in station 4 is presented in figure 6a. A similar study was carried out for salinity values. On this occasion we found a decreasing tendency with time. For salinity this tendency is also found at as much as 100 m depth. Figure 6b presents this tendency at 50 m depth at station 4.

For the Vigo section during 1995, we present station 13 and 15, within the ria we appreciate an upwelling influence in May-June, mixing in autumn and saltier and relatively warmer waters in December (Figure 7). Outside the ria cold waters cover the surface from April to September with an upwelling signal in May June and saltier waters are observed in the autumn (Figure 8). 1995 was a normal year from the oceanographic point of view.

a



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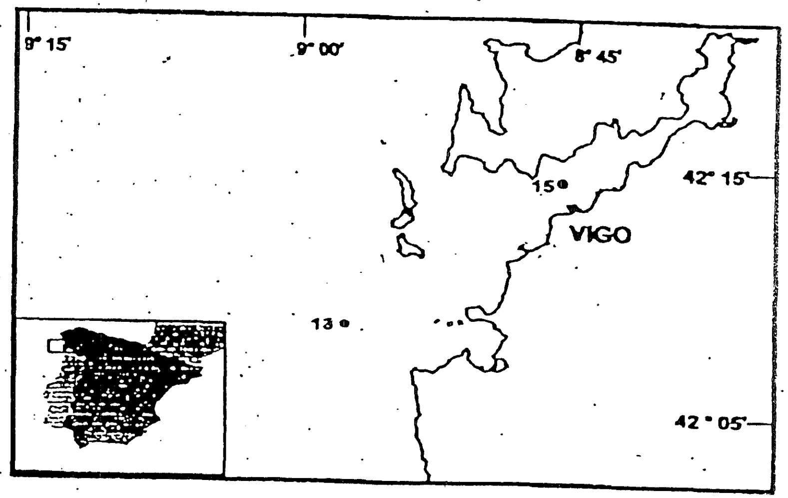


Figure 1. Location of the sections: a) Santander, b) Vigo

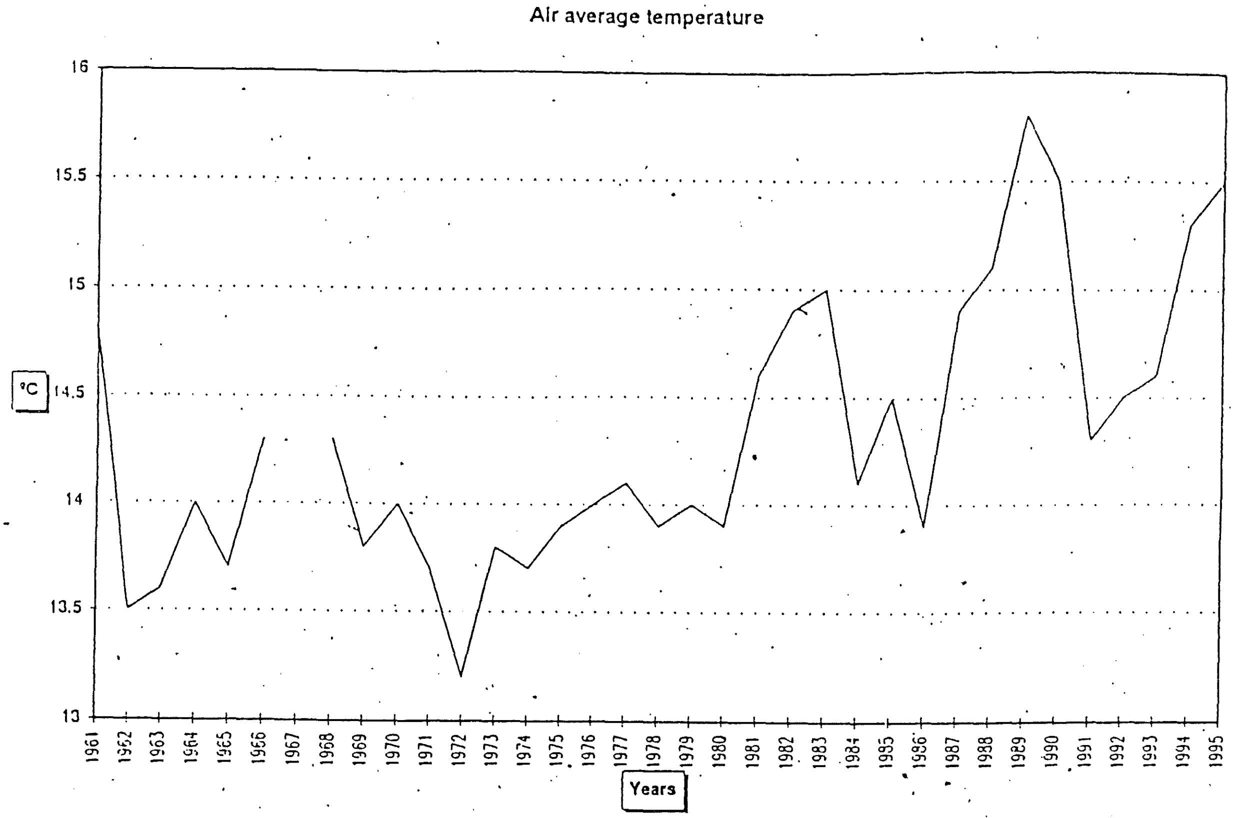


Figure 2. Average air temperature. Centro meteorológico de Santander (INM)

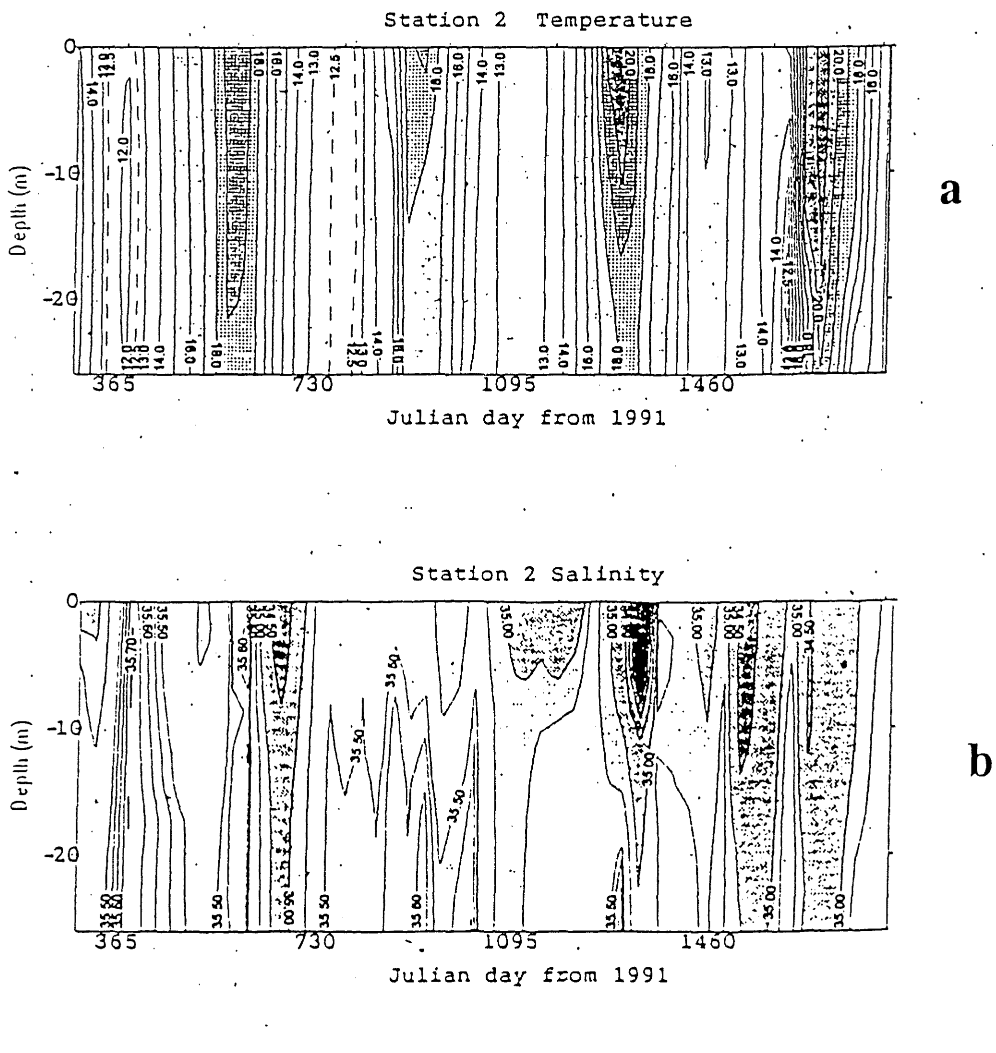


Figure 3. Distribution of a) temperature and b) salinity at station 2 (Santander section).

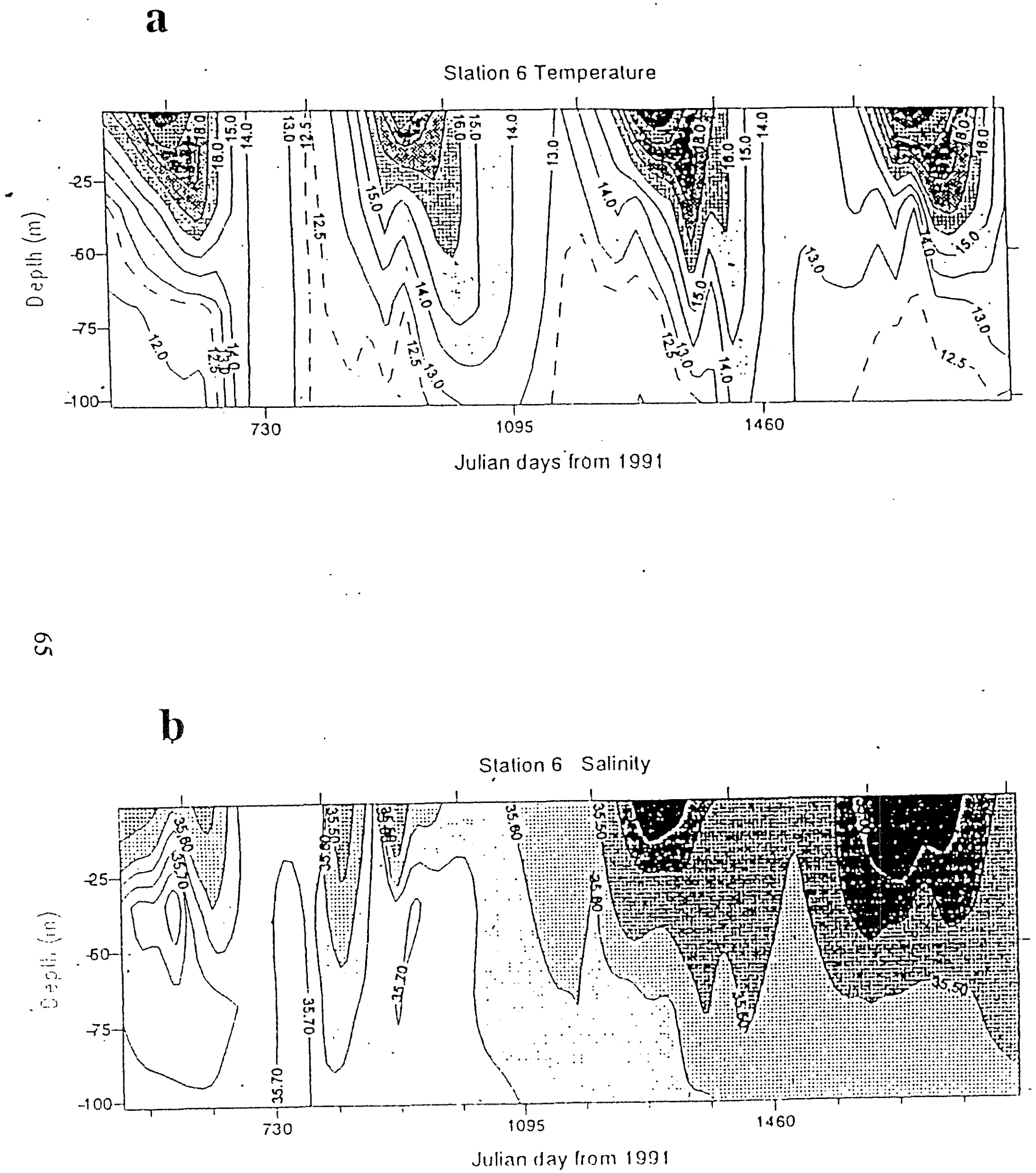


Figure 5. Distribution of a) temperature and b) salinity at station 6 (Santander section).

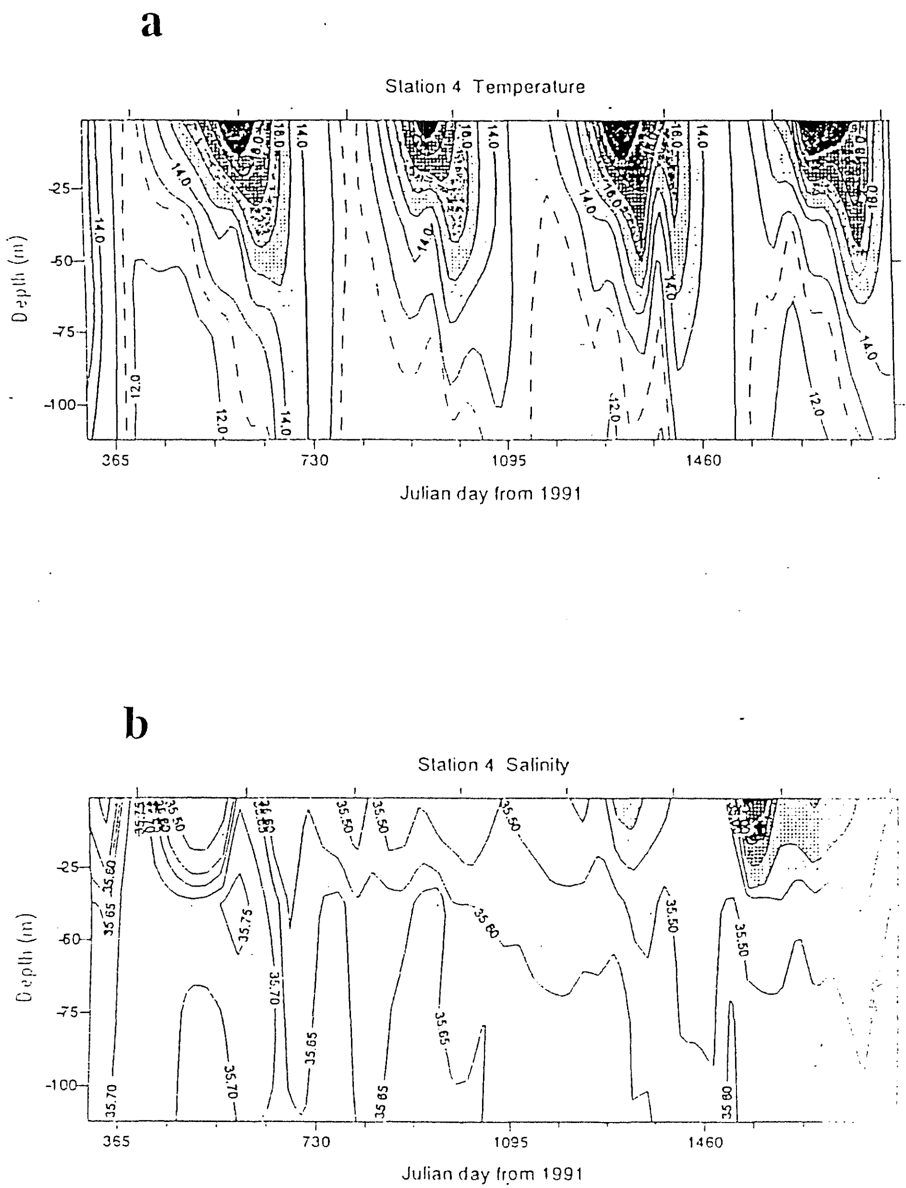
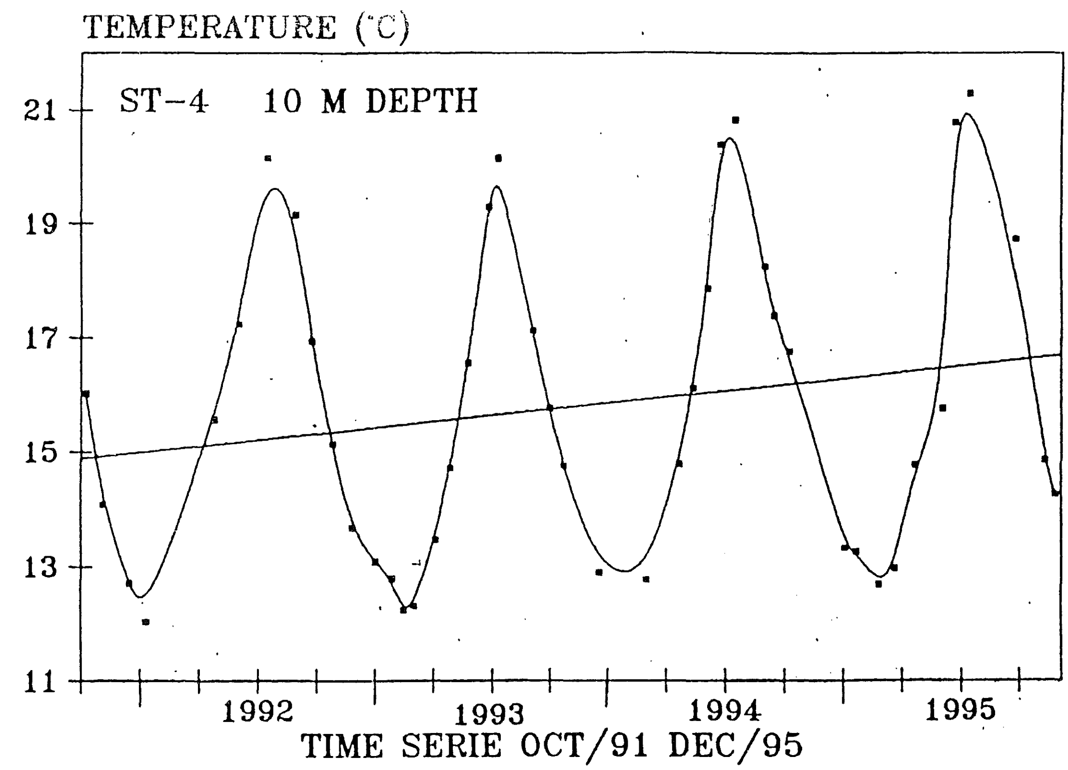


Figure 4. Distribution of a) temperature
b) salinity at station 4 (Santander sect

a



b

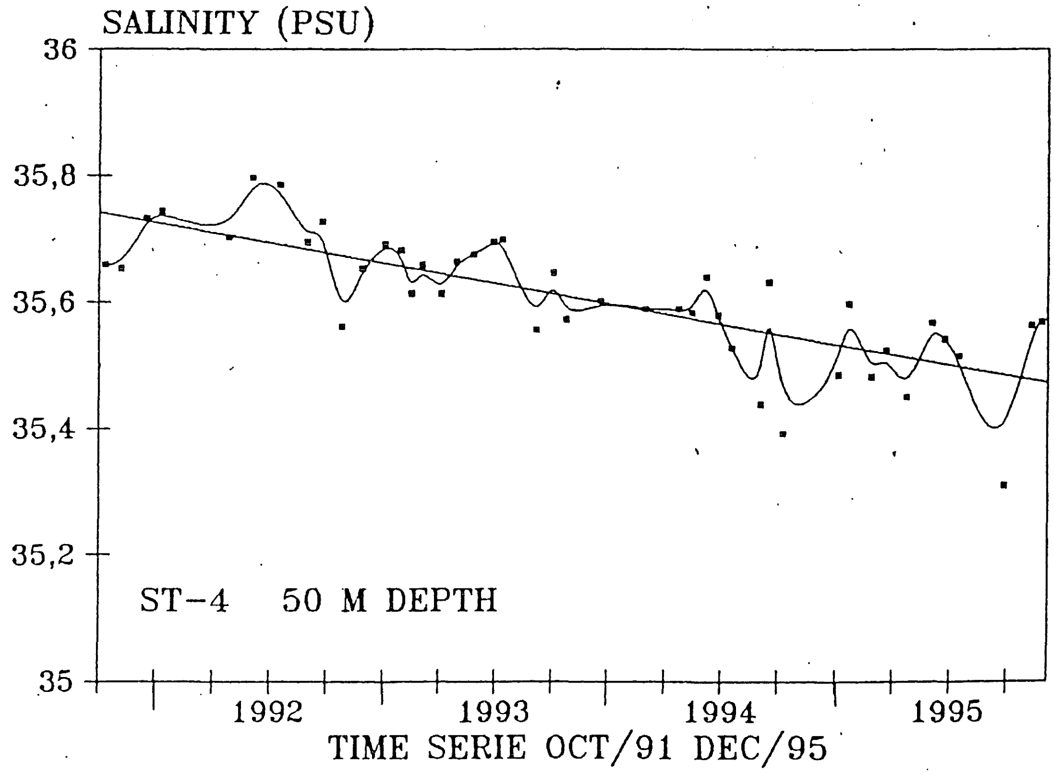


Figure 6a. Temperature at 10 m depth at station 4 (Oct 91 - Dec 95). 6b Salinity at 50 m depth at station 4. (Oct 91 - Dec 95).

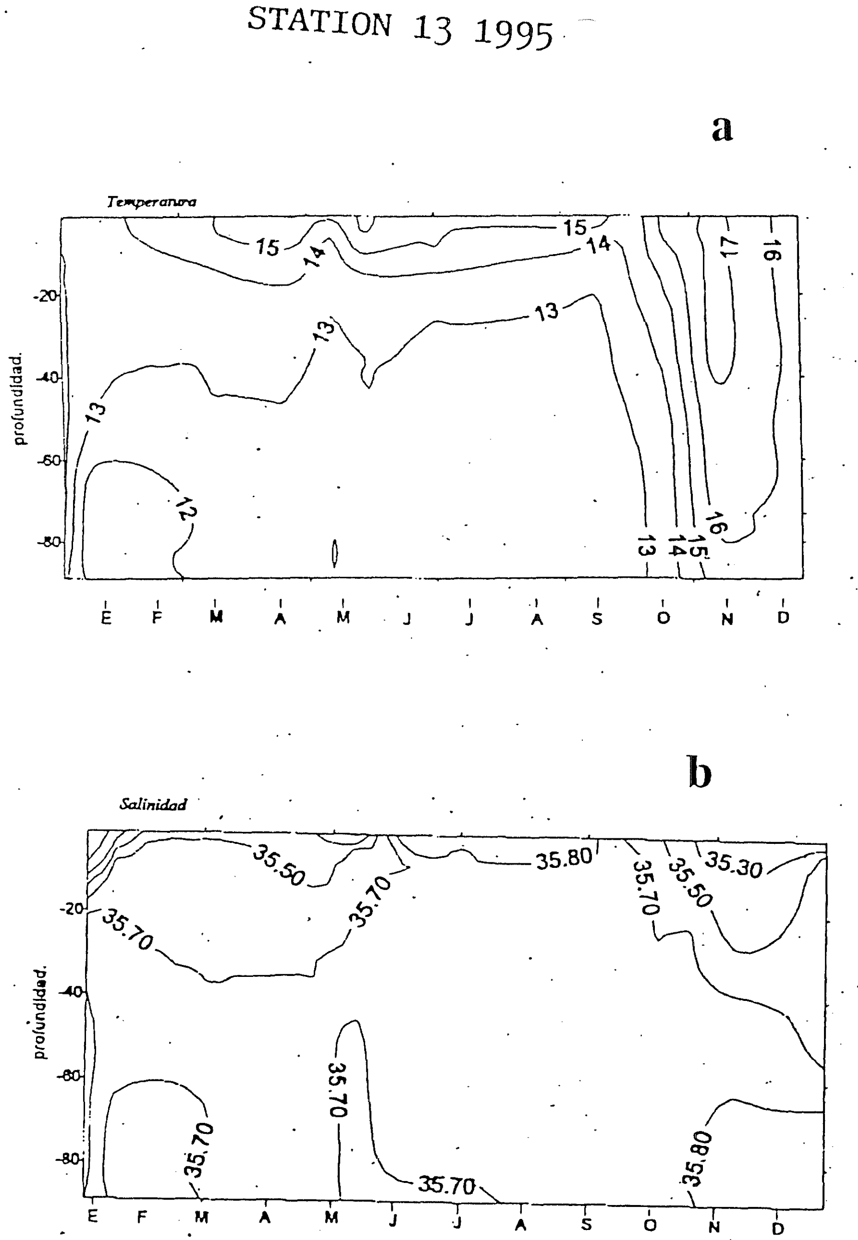


Figure 7. Distribution of a) temperature and b) salinity at station 13 (Vigo section).

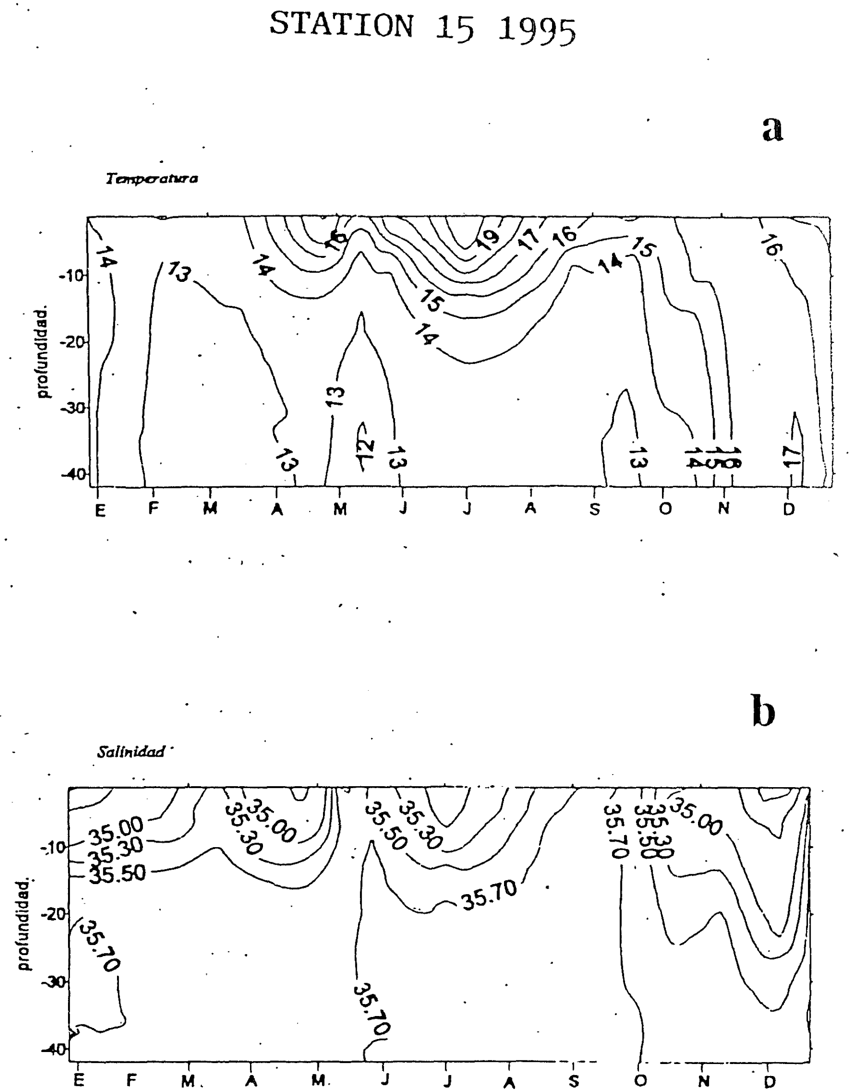


Figure 8. Distribution of a) temperature and b) salinity at station 15 (Vigo section)

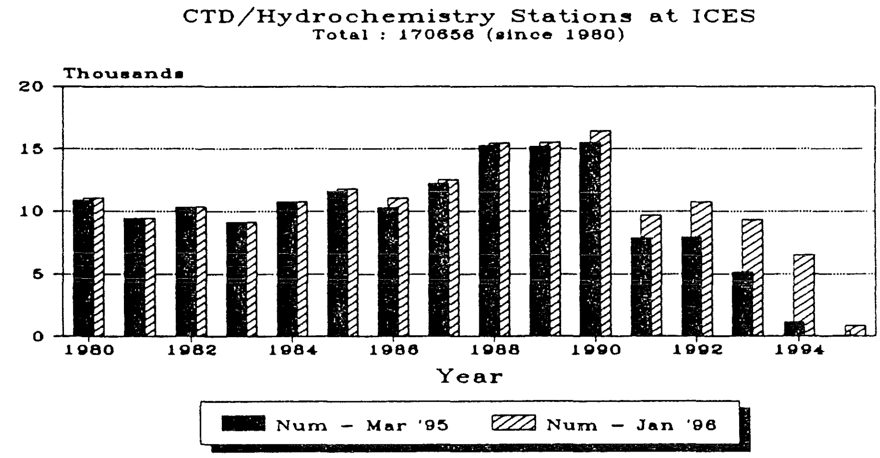
Hydrography Committee Working Groups
1996

Comments from Oceanography Secretary

1) Progress with the Databank

a) New data

New submissions of profile data are being maintained at a high level in spite of the fact much less time is being spent on data searches. Almost all of the new data submissions were for data collected with the past 5 years, 33% for 1994 alone. In the ten month period from March 1995 to January 1996 more than 17627 profiles were received which compares favourably with the 16,000 profiles reported last year. All submitted data have been quality checked, and in most cases outstanding questions have been resolved.



The Figure plots the available data by year since 1980, and reflects the excellent additional submissions for the 1990s. Unfortunately a significant amount of these additional data have been stimulated by the needs of the Oslo-Paris Commissions. Data collected by member countries on behalf of the global projects such as JGOFS and WOCE remain extremely poorly represented. Apart from Ospar data, many nutrient data that have been collected are not submitted. There is accumulating evidence that many of the data just "disappear".

In December 1995 ca 12,000 Russian (Soviet) CTD data from the late 1980s and early 1990s were received via the US Ocean Climate Laboratory but there are a number of difficulties associated with these data. As a result, they have not yet been merged into the database. In February 1996 the approximately 1000 CTD stations collected during ten of the NATO-SACLANT GIN SEAS cruises were received by the Secretariat, following a number of years of "lobbying".

b) Archaeology

Work still continues on evaluating and quality controlling the ICES historical data holdings, and the review is complete for most countries. Revision of the historical holdings of two of the ICES member countries has caused considerable extra work mainly because of serious errors that were being made by national centres in importing data to new databases. Considerable work on this topic remains, and will be tackled whenever opportunity permits. Some of the reviewed data are passed on to WDCA, but this transfer is not a high priority pending clarification of the ICES/WDCA interaction, a situation that has persisted for quite some time now.

During the course of the year, assistance has been given to the EC-MEDATLAS project which is lead by Catherine Maillard at SISMER, France. This project is making large steps in revolutionising the way oceanographic data are handled, and is rapidly building up a close knit group of Centres and individuals dedicated to the management of Mediterranean data.

(c)ROSCOP

Roscop submissions are continuing at a healthy rate. Following the introduction of the CSR in 1990, the workload required to translate both digitised and non-digitised information into a computer searchable form is increasing markedly. The problems referred to in last year's report still exist.

At the recent IODE meeting (see annex) the ICES role as the global centre for ROSCOP data was confirmed. This follows the expansion of the database beyond ICES member countries. Roscop forms submitted to ICES in digital form are from a number of countries including Australia, South Africa, New Zealand and Japan. India also intends to submit digitised ROSCOP forms soon.

2) Interactions with the EC

Involvement of Secretariat in MAST/AIR products.

Last year reference was made to the fact that Secretariat had received requests to participate in a number of MAST-III and AIR project proposals. If all of the proposals were to succeed, a substantial commitment by the Secretariat, especially the oceanographic data centre, was anticipated. Following the evaluation of the proposals there are two firm commitments which are now underway, namely "European SubPolar Ocean Programme Phase 2: The Thermohaline Circulation in the Greenland Sea" (MAS3-CT95-0015) (ESOP-2). ESOP-2 which started formally at the beginning of 1996. It will address the thermohaline circulation of the Greenland Sea, with particular regard to its sensitivity and impact on the global ocean circulation. ICES will handle the marine component of the data, and the publication of all the data collected in the project. In particular ICES will handle CTD and supporting data, self-profiling CTD data, tracer and chemistry data, float data, biological data, and current meter data. The Norwegian Polar Institute will handle all ice thickness and ice velocity data whilst the Danish Meteorological Institute will handle the remote sensing and gridded model output data. As part of the contract ICES will also assemble ESOP-1 data. Most of these data were collected in 1993, but as yet not one value has found its way to the Secretariat from the data declared on the eight ROSCOP forms received.

The Secretariat also has a small involvement with the project "TASC (Trans-Atlantic Studies on *Calanus finmarchichus*", and other potential commitments also exist.

3) Future Developments

Last year's report made reference to meetings which addressed issues relating to the future function of ICES and its Secretariat. These are the (a) Ad Hoc Group on ICES Secretariat databases, and (b) the Bureau Working Group on the Structure of ICES. Further developments with regard to these two issues are:

(a) Ad Hoc group on ICES Secretariat Databases.

It has been decided that one expert in databases/GIS from each of three or four national laboratories will visit ICES with a view to identifying its future database needs. There is an apparent interest in integrating the IBTS, IFAP, Statlant, contaminant, oceanographic and benthos databases. This possibility will be specifically examined, and a pilot study may be set up.

(b) Bureau Working Group on the Structure of ICES.

This Ad Hoc Working Group met at the Secretariat in March 1995 to review the goals of ICES, and identify future areas of development. There was considerable debate and discussion at the 1995 ASC, in the Committees, delegates, and Theme session U. As no clear consensus emerged on the main issues, the Group is to meet again (in June 1996). The main aim of this second meeting is to prepare a comprehensive plan for the future structure of ICES, including an implementation schedule.

4 ICES on the Web

In late December 1994 ICES established a home page on the World Wide Web. Its URL is http://www.ices.dk.

Development of the web pages has been relatively slow, and there has been no significant enhancements to those described in my 1995 report. The most developed section is the oceanography pages, with many other areas of the Secretariat's activities remaining virtually absent. As a result of these pages, there has been a significant increase in the number and quality of requests for data and products. Most requests are in fact for products rather than requests, but in almost all cases delivery can be made within a day of receipt, and in some cases within minutes. However such a reaction has its limits, and attempts will continue to develop routine products, and the software to produce these, as and when they can be identified.

5 Major 1996 Meeting Activities

The 1996 ICES Annual Science Conference will be held in late September in Reykjavik, Iceland. The Open Lecture will be presented by Bob Dickson who will talk on the physical and biological effects of the North Atlantic Oscillation and the programme will include a mini-symposium on "Ecosystem Effects of Fisheries". There are also a number of theme sessions with an oceanographic and environmental flavour, and include :"The North Atlantic Components of Global Programmes - Lessons to ICES-GLOBEC from WOCE/JGOFS, "Reproductive Disturbances of Marine Species", and "The Shelf Edge Current and its Effects on Fish Stocks". The WOCE/JGOFS session is likely to be supported by co-sponsorship from CLIVAR, JGOFS and SCOR.

There will be one ICES Symposium in 1996, viz. "Symposium on Seabird Ecology and Distribution in Relation to the Marine Environment" which is planned for mid-November in Glasgow, UK. The seabird fraternity anxiously require active support from oceanographers, so you should give considerable thought to participating in this Symposium. If you have not received a copy of the flyer, then please consult the ICES Web pages.

Presently, three symposia are planned for 1997, two of which have direct relevance to the interests of oceanographers. The Symposia are: "ICES/NASCO symposium on Impacts of Salmon Culture on Wild Stocks of Atlantic Salmon: The Scientific and Management Issues", "The role of Physical and Biological Processes on the Dynamics of Marine Populations" and "The Temporal Variability of Plankton and their Physico-Chemical Environment"

6 Advisory Committees

The ICES advisory activities continue to focus on the work of its two Advisory Committees, the Advisory Committee on Fishery Management (ACFM) and the Advisory Committee on the Marine Environment (ACME)

A prime concern of ACME is the provision of advice on issues relevant to the impact of Man on the marine environment. This advice is partly based on questions set by pollution Regulatory Commissions such as the Helsinki Commission (HELCOM), and the Oslo-Paris Commissions (OSPARCOM). Following on from the successful completion of the 1993 North Sea Quality Status Report which was presented to the 1995 Esbjerg Ministerial Conference on the North Sea, a further (Intermediate) Ministerial Meeting of the North Sea is planned for 1997 and this will focus on fisheries and environmental issues. This will provide a major direction for the immediate future work of both ACFM and ACME, and in particular the Working Group on Ecosystem Effects of Fishing Activities which operates under the joint parentage of ACFM and ACME. Reports of this Working Group have already been published in the ICES Cooperative Research Report Series (No 200). A further meeting is planned for 1996 at which various issues, including the evaluation of the ecosystem response to reduced fishing will be addressed. The Working Group has also been asked to consider the practicalities of broadening its area of activities to ecosystems beyond the North Sea.

At its 1995 meeting ACME also discussed with the Director of the IOC GOOS Support Office the potential role of ICES in the implementation of the various GOOS Modules. ICES has particular interest in various GOOS modules, in particular the Health of the Oceans, Living Marine Resource, and Coastal Zone Modules. ACME will continue consideration of these issues at its 1996 meeting, including the identification of ICES priorities in GOOS. In 1996 ACME will also complete the preparation of a scoping paper on the development of an ICES framework to handle issues relevant to sustainable development, biodiversity, and species and habitats. This study has been motivated by an attempt to provide a concerted ICES reaction to the recommendations of Agenda 21 of the Rio (UNCED) Conference.

7. *Collaboration with IOC*

In the past few months there has been a meeting of IOC's Working Committee on International Oceanographic Data and Information Exchange (IODE), and my report of this meeting is attached as an annex.

8. *GLOBEC*

ICES has continued to develop a firm role in GLOBEC. Furthermore, ICES maintains a close collaboration with IOC, SCOR and PICES on GLOBEC issues. During 1995 it hosted a meeting aimed at finalising the GLOBEC Science Plan for the approval of the IGBP. Such approval was received in late 1995. ICES has also now received funding from the USA and Norway to allow for the establishment of a North Atlantic Regional Office of GLOBEC and plans are currently underway to recruit a suitable marine scientist to man this Office. It is hoped that the Office will be opened by August 1996. Oversight and direction for this Office will be provided by a newly-established ICES/GLOBEC North Atlantic Regional Co-ordination Group. This Group will also seek to integrate national activities into a co-ordinated GLOBEC implementation plan, provide scientific direction for liaison with other regional bodies (e.g. PICES) and the relevant global organisations (IOC, SCOR, IGBP), develop plans for the design and implementation of an integrated data management system for the North Atlantic, and identify and direct the GLOBEC Office to implement appropriate ways to engage the widest possible involvement in scientific development and communication through workshops, the ICES Annual Science Conference, and special sessions at other scientific meetings.

In 1995 ICES/GLOBEC meeting activities were very much focused on Cod and Climate Issues which have been steered by the ICES Consultative Committee and the ICES/GLOBEC Working Group on Cod and Climate Change. Two substantive workshops assessing the state of knowledge of the interactions between the environment and various life stages of cod have so far been held. The first of these, the AGGREGATION Workshop was held in late 1994 and examined such issues as the statistical relationships between oceanographic models and cod growth and recruitment, mesoscale transport models, retentive circulation patterns, plankton production, and turbulence and feeding. Some of these issues were developed further at the Theme Session on the Influence of Intermediate-Scale Physical Processes on the Transport and Food Environment of Fish which was held at the 1995 ICES Annual Science Conference.

A second Workshop, the Backward Facing-Workshop, was held in early 1995 and examined past analogues for present and recent conditions of excessive cold from West Greenland to the Middle Atlantic Bight. This was undertaken using data from the early 1880s onwards in order to isolate the effects of fishing which dominate current data sets. A follow-up Workshop, focusing on the Barents Sea, is planned for Bergen in March 1996

The Workshop on Cod and Climate Database issues was held in November 1995. It considered current and past analyses of the interrelationships between cod and the environment and also the data structures that will be necessary to allow for a wide variety of analysis options. The Workshop also considered a potential data management plan for GLOBEC. In considering the pros and cons for distributed and centralised databases, the workshop firmly proposed the adoption of the distributed philosophy along the lines as already underway in JGOFS and US-GLOBEC. Other suggestions by the Workshop, the report of which is in Doc CM 1996/A:7, include the need for the establishment of a data policy, the need for a data catalogue (inventory) , and the need for a Thesaurus to provide a common vocabulary for referring to the elements in the inventory and GLOBEC databases, and to facilitate cross-references between them.

Harry Dooley
29 February 1996

ANNEX

Fifteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange (IODE)

Athens, Greece, 23-31 January 1996

1 More than 50 countries and organisations were represented at this meeting. ICES was represented by its Oceanography Secretary, Dr H.D. Dooley. The Session was chaired by Dr Ron Wilson, of MEDS Canada and it was supported by a contribution from the EC-MAST programme.

2. The agenda for the meeting encompassed a wide range of issues relating to the development of international collaboration in the management of oceanographic data and information, and considered in detail ways to harness the rapid expansion in computer technologies, in particular internet, in recent years. The Session also considered reports of its Group of Experts on the Technical Aspects of Data Exchange, and the Group of Experts on Marine Information Management. The former group has close contacts with the ICES Working Group on Marine Data Management. There is no comparable marine information management forum in ICES.

3 Many of the Agenda items touched on the benefits and use of the World Wide Web and other electronic technologies such as CD-ROMS. The meeting learned of the large steps made by the IOC Secretariat in exploiting the capabilities of the Web, and made a number of recommendations to IOC on how to further develop these to the best advantage of IOC, in particular IODE, and the relating supporting National Structures for IODE. Steps were also taken to ensure that the siginificant percentage of IOC countries who have poor or no access to internet can also avail themselves of the information made available via this technology.

4 The Committee agreed on a modernisation of the Marine Environmental Data Directory (MEDI) which, although it has been in existence for more that 20 years, remains relatively poorly developed. However modern technologies are enhancing capabilities in catalogue maintenance procedures, and the UK, Ireland and Australia have been asked to plan out a technical specification for a revised MEDI system. The resulting catalogue will result in comprehensive global information on the existence of all types of marine data.

5 The Committee took steps to ensure that IODE activities will take into account expertise and know-how in the increasing number of data management activities taking place outside of the IODE. In particular it noted the large data management developments on many global programmes, especially those of the IGBP. It noted in particular the similar activities in the coastal zone which is forcing a wide diversification in the data types that have to be handled in the coastal zone, including biological and marine contaminants data. Recommendations were made in order to collate information on these activities globally with a view to establishing the present areas of expertise, and to ascertain the likely future developments in this area of data management.

6 The Committee reviewed progress in the Global Data Archaeology (GODAR) project which has so far resulted in the addition of many thousands of classical oceanographic data sets to the global archives. Four regional workshops have been conducted so far, and others are now planned for South America and Africa. Following the intitiative of France, a regional GODAR exercise for the Mediterranean has been agreed. GODAR now plans to expand its data types of interest to encompass many chemical and biological parameters, and a further assessment of the scale of this need will be examined in a Workshop in Hamburg to be held in late May. The WDCA has already made considerable progress in the global compilation of zooplankton biomass data.

7 A notable success of the IODE has been the GTSPP (Global Temperature/Salinity Pilot Project) which was established several years ago at the initiative of Canada, USA, Australia, Japan and Russia. The main focus of this project has been the data submitted via the Global

Telecomunications System (GTS) by ships of opportunity, and the subsequent merging of delayed mode data. Because of this success, the Committee agreed to this becoming a "permanent" project.

8 In addition to GODAR and GTSPP, OceanPC is seen as a major contribution to the international community by the IODE. The present system has demonstrated the need for such a product, especially for use by developing countries. As a result the Committee agreed that a draft proposal for the development of a more sophisticated product should be prepared for submission to appropriate national and international funding agencies.

9 IODE continues to develop its close relations with IGOSS in order to ensure a coherent policy for data management in GOOS in particular. Such a partnership development was also strongly recommended by an IOC Think Tank held in 1995. In order to meet this need, a single IGOSS-IODE data management strategy document is to be prepared. This document will be offered to the second Planning session of I-GOOS as a contribution from IGOSS and IODE towards the development of GOSS Data Management procedures. Part of this strategy will include many of the elements discussed at this meeting, and by the Think Tank. This includes issues related to the incorporation of national and regional -scale monitoring activities, increasing data availability, data and information dissemination, and data processing. Within the context of GOOS there is a strong desire to push towards the use of standard formats, a process which is seriously in reverse at present. A strong candidate for this is the binary BUFR format which was created some time ago by a WMO Committee on Data Management. WMO has now allocated provision for the use of this format for oceanographic observations, and trials of it use in oceanography will be undertaken by the data centres of the US and Canada, and by ICES.

10 IODE initiatives and procedures are dominated by the activities of ICES Member Countries who contribute additionally to the major IOC Training Courses on Marine Data management which are overseen by this Committee. The ICES Secretariat also makes a significant contribution to the Committee and the IODE system, especially via input to GE-TADE, OceanPC, GODAR and the Global Cruise Inventory System ROSCOP. During the lifetime of the Committee, the Chairman has always belonged to an ICES Member Country. However the healthy expansion to global activities on Marine Data Management has now led to the election of a chairman who is not from an ICES Member Country (B. Searle, Australia), with Dr E Balopolous (Greece) as the Committee Vice Chairman.

Ocean Weather Ship Station M (66°N, 2°E)

The longest existing homogeneous time series from the deep ocean

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Reidun Hogstad, Geophysical Institute, Allégt. 70, N-5007 Bergen.

Introduction

Having performed daily oceanographic measurements in the deep Norwegian Sea since 1 October 1948, Ocean Weather Ship Station (OWS) Mike, at 66°N,02°E, can present the longest existing homogeneous time series from the deep ocean. Station M is operating above the eastern margin of the Norwegian Sea deep basin where a branch of the Atlantic current is entering the area, Figure 1. The location proved to be strategic both for studying the Atlantic inflow and the Norwegian Sea Deep Water. The OWS M is operated by The Norwegian Meteorological Institute (DNMI) and the hydrographic programme is carried out by Geophysical Institute, the University of Bergen.

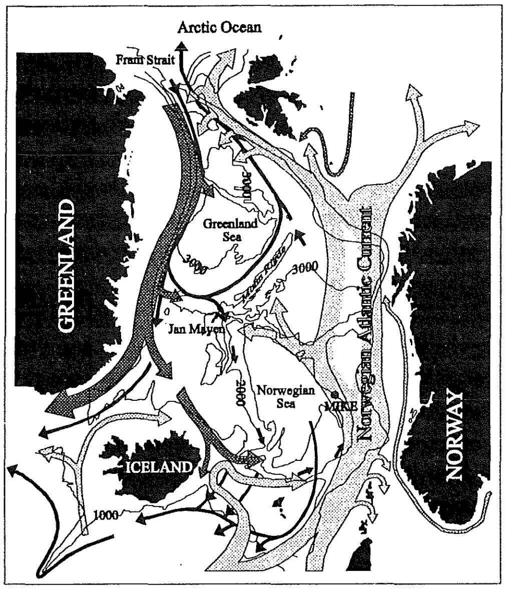

Fig. 1 The main current system (schematic) in the Nordic Seas with the position of the weather ship station MIKE. The open hatched arrows indicate the surface current patterns, and the black arrows indicate the deep/bottom current.

History

With the expansion of civil aviation and growing understanding of the impact of aerological observations on weather forecasts after World War II, ICAO (The International Civil Aviation Organization) demanded a greater network of aerological stations, primarily in the North Atlantic.

In 1946 a plan for a network of 13 ocean weather stations in the North Atlantic was set forth under the auspices of ICAO. The Stations were to supply meteorological services, search and rescue services, and navigational aids to aircraft. The USA, Canada and eighth European countries should be responsible for operating the stations, which were referred to by letters from A to M. Norway was to operate station M (phonetic name Mike) at 66°N,02°E, with financial backing from Sweden and Great Britain.

ICAO attempted to organize an international oceanographical research programme for the weather ships, but failed due to lack of interest, shortage of money and difficulties in procuring the necessary scientific equipment. In Norway, a country which held great traditions in oceanographical research, a small group of three scientists, led by the oceanographer Håkon Mosby , took upon themselves to implement an extensive research programme on station M.

The Norwegian government had bought two British corvettes which were rebuilt at a British shipyard to serve as weather ships. The ships, Polarfront I and Polarfront II, were to alternate at station M. Due to the efforts of the group mentioned above, the ships were equipped with oceanographical deck laboratories and hydrographical winches when they arrived in Bergen in the summer of 1948.

Håkon Mosby implemented a routine programme within physical oceanography, including serial observations of temperature, salinity, and (since 1953) oxygen weekly at standard depths to 2000 meters, and serial observations of temperature and salinity at standard depths down to 1000 meters 3 or 4 times a week. This programme has been running continuously since 1 October 1948 to this very day only hampered by occasionally extreme weather. The method of obtaining temperature and salinity observations (Nansen bottles with reversing thermometers) has not changed significantly either so the time series are indeed homogeneous.

The number of weather ship stations was reduced during the years, gradually they became less important to aviation and weather forecasts, as automatic weather buoys and satellites were developed. From 1990 onwards only two weather ships stations have been operating in the North Atlantic.

One may well ask why station M is still running while most other stations have been laid down. It turned out that the aerological observations of Mike, which can not be furnished by either automatic weather buoys or satellites, are very important for predicting storms that may afflict fisheries and the coastal population of Norway. The Norwegians also managed to keep costs low compared with other countries. In 1976 Polarfront I and II were replaced by one new ship, Polarfront. It leaves station M for about two days a month to sail into Kristiansund for changing crew and bunkering.

Some results

Altogether more than 9200 hydrographic stations have been performed, including more then 180000 thermometer readings and 90000 salinity samples. In addition to standard observation of hydrography and meteorology several other samples are taken (Gammelsrød et al., 1992).

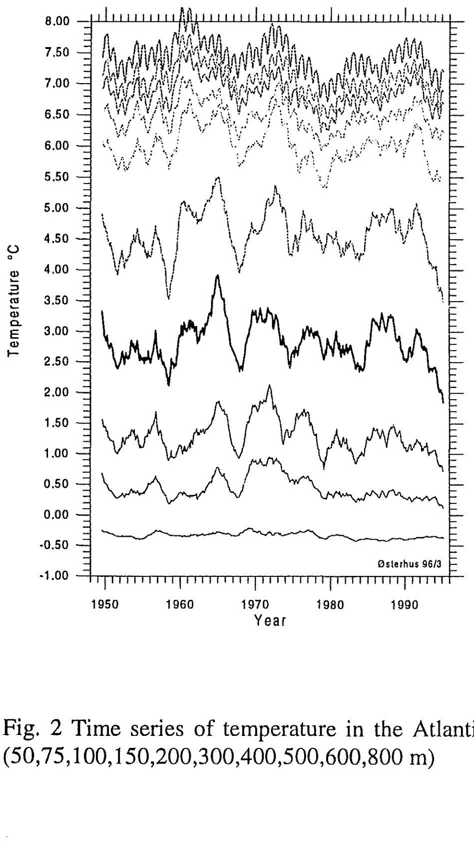

Fig. 2 Time series of temperature in the Atlantic Water (50,75,100,150,200,300,400,500,600,800 m)

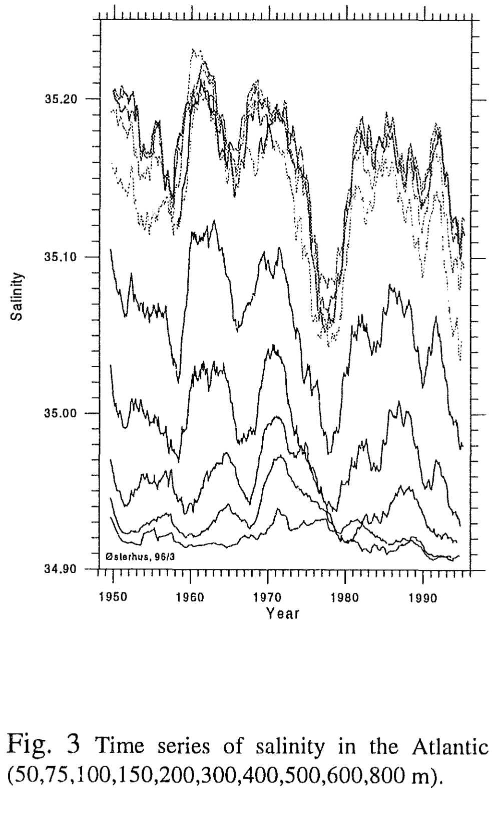

Fig. 3 Time series of salinity in the Atlantic Water (50,75,100,150,200,300,400,500,600,800 m).

Figure 2 and 3 show that the Atlantic water has become cooler and fresher since 1991. For depth below 200 m the temperature and salinity are down to the levels observed during the late 70's, when the so-called "Great Salinity Anomaly" passed through (Dickson et al.,1988). Independent observations (Hansen and Kristiansen, 1994) indicate that the inflow of Atlantic Water to the Nordic Seas has been reduced. The long term trends are a cooling and freshening of the upper layer consistence with a accumulating of Arctic Surface Water in the Nordic Seas (Blindheim et al.,1996).

Smoothed monthly mean temperatures for the 3 deepest standard depths (1200m, 1500m, 2000m) are shown in Figure 4 for the period 1948-1995. Notice that a recent warming has occurred, starting at 2000m in 1985, then gradually penetrating upwards through 1500m in 1987 and reaching the 1200m level in 1990. The temperature increase is about 0.07°C, and nearly constant with depth.

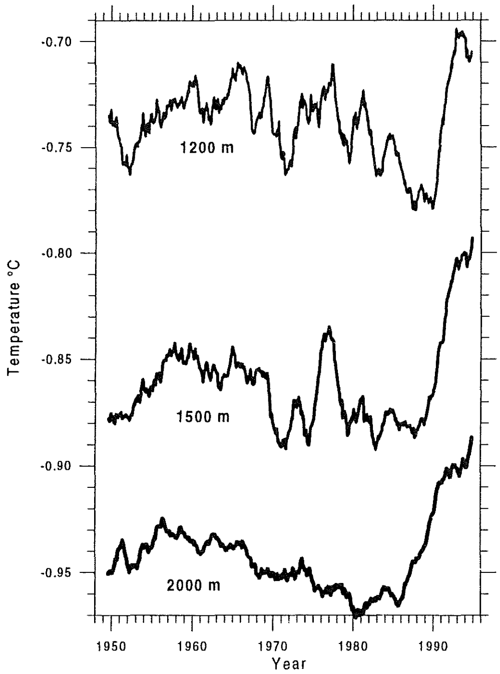

Fig. 4 Time series of smoothed monthly mean temperature at depth of 1200m, 1500m 2000m from the weather ship station Mike.

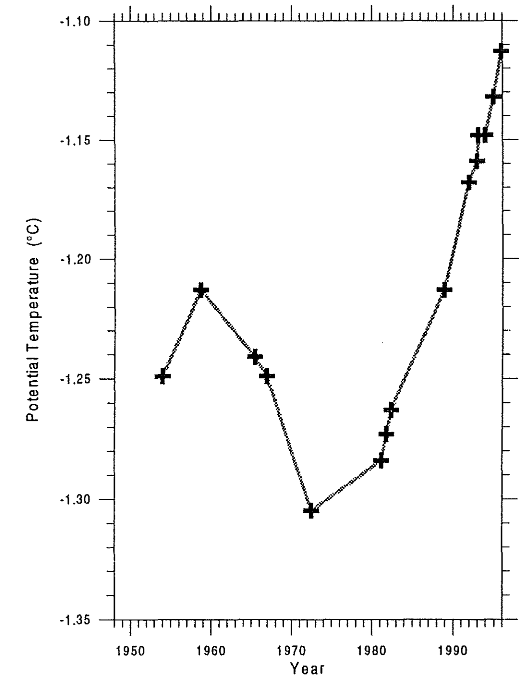

Fig. 5 Time series of the mean temperature below 2000m in the central Greenland Sea.

The low temperature of the Norwegian Sea Deep Water (NSDW) is maintained by the contribution of the Greenland Sea Deep Water (GSDW). The bottom water in the Greenland Sea is renewed locally by surface cooling of relative fresh water, resulting in the coldest bottom water found in the deep ocean. NSDW is formed by mixing GSDW and the deep water from the Arctic Ocean. The recent warming of the NSDW has its forerunner in an even more markedly warming of the GSDW, see figure 5, consonant with the idea that the deep water formation in the Greenland Sea has ceased. The Greenland Sea and the Norwegian Sea basins are separated by the Mohn Ridge (Figure 1), and the exchange of water masses between the two deep basins takes place through a channel which has a threshold depth of 2200 m and is situated just north of Jan Mayen. Since the warming of GSDW appears to have continued unchecked to date, (Figure 5) the cessation of warming observed in the NSDW since 1990 is certainly unexpected, (Figure 4) suggesting that as GSDW production has (virtually) ceased, the transport through the Jan Mayen Channel may have reduced or even reversed, see figure 6, cutting off the deep Norwegian Sea from the influence of the GSDW and its changes, see Østerhus and Gammelsrød, 1996.

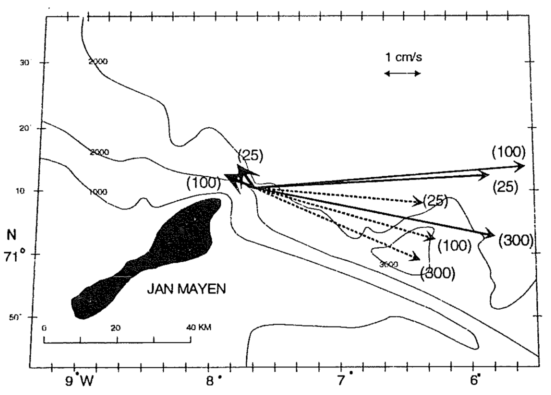

Fig. 6 Results from the current measurements in the Jan Mayen Channel from April to November 1991 (thin doted arrows), September 1983 to July 1984 (thin arrows) and from November 1992 to July 1993 (thick arrows). The numbers in parentheses indicate height of current meter above the bottom. The stability factor (defined as the absolute value of the average current vector divided by the average speed) was 0.91 in 83/84 and 0.18 in 92/93. The mean temperature was -1.01°C in 83/84, increasing to -0.94°C in 92/93.

Planned activity

The OSW M will continue its operation at least to the year 2000. A CD containing quality controlled hydrographic data (as stations data and time series) is planned for the 50 years anniversary in 1998. The history of OWS M is being written. It is proposed that Polarfront should be equipped with an Acoustic Doppler Current Profiler (ADCP). Twenty-four ADCP's and XBT's sections a year across the Norwegian Atlantic Current will be invaluable for monitoring the influx of Atlantic water to the Arctic. Plans for extending the hydrographic, biological and geochemical programmes exist. The future of M depends on us as researchers being able to convince the powers of the purse that these data are really necessary for climate research.

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Salinity of the NSDW

Introduction

The monitoring of the salinity of the Norwegian Sea Deep Water (NSDW) requires the ultimate accuracy in salinity measurement. During the last OHWG meeting changes in the salinity of the NSDW were reported by Bennekom and Østerhus. The working group therefore decided to ask Bennekom, Blindheim, Hansen, Turrell and Østerhus (chairman) to scrutinise salinity data from the Norwegian Sea and report back to the working group.

Data

The two main data sets used in this report are the hydrographic data from the CCS Hudson expedition in 1982 and the R/V Johan Hjort WOCE cruise in 1994, figure 1. In addition we use data from the Transient Tracer in the Ocean/North Atlantic Study (TTO/NAS), R/V Håkon Mosby hydrographic data from 1994, hydrographic data from OWS Mike (66°N, 2°E) and data provided by Bennekom.

The TTO/NSA expedition in 1981 reported a salinity of 34.907 to 34.912 for the NSDW in the Norwegian Basin (station 144), and a potential temperature in the adiabatic layer of -1.058 to -1.060°C.

In this study we have used stations 106 to 132 from the CCS Hudson 1982 cruise 82-001. As, for this section the salinity varied from 34.908 to 34.912 in the NSDW in the Norwegian Basin. The potential temperature in the adiabatic layer varied from -1.054 to -1.057°C.

The R/V Håkon Mosby bottle data from 1984 have a salinity from 34.908 to 34.912 and a potential temperature of -1.039°C in the adiabatic layer.

The R/V Johan Hjort data from 1994 have a salinity of 34.909 (bottle data from 34.908 to 34.911) and a potential temperature between -1.036 to -1.037°C in the adiabatic layer.

Bennekom reported salinities from 34.9086 to 34.9105 for the NSDW and a potential temperature from -1.036 to -1.037°C in the adiabatic layer in 1994.

Results

Figure 2 shows that the temperature in the adiabatic layer has increased by 15 to 20 mK between 1982 and 1994. This change is equal to a heat flux of 170 to 230 mW/m^2 for a 1000m thick layer. The thickness of the adiabatic layer has decreased by 200-300 metres between 1982 and 1994.

The CCS Hudson 1982 data have an average salinity between 34.910 and 34.911, figure 3, but the TTO/NAS data indicate an average salinity of 34.909 in the deep NSDW. The "Johan Hjort" data and Bennekom's data from 1994 accord very well with each other. The average salinity of these two data sets are between 34.909 and 34.910. The "Håkon Mosby" bottle data from 1994 have an average salinity of about 34.910. The 1994 salinity data are between 0.001 to 0.002 lower than the "Hudson" 1982 data.

Both data sets from 1994 show a salinity maximum about 1500 dbar, the same as the "Hudson" data from 1982 show, figure 3. The homohaline layer started at about 1000 dbar in 1982 and between 1400-1500 dbar in 1994. Salinity data from OWS Mike show that the reduction in the thickness of the homohaline layer started after 1982, figure 4.

Discussion

The adiabatic layer

The heat flow from the ocean floor in the Norwegian Basin is about 60 mW/m^2 (Vogt 1986, Sundvor, pers. com.). This can explain about one third of the observed warming. The remaining heat can be brought down by convection driven by the heat flow from the ocean floor. This can also explain the reduced thickness of the adiabatic layer. The reduced salinity, if any, can be explain by reduced production of NSDW, see below.

The homohaline layer

As a result of the reduced deep water production in the Greenland Sea after 1980 the NSDW above 2000 m is warming and the transport of new NSDW from the Greenland Sea to the Norwegian Sea is reduced (Østerhus and Gammelsrød, 1996). Mixing between the NSDW and the fresher water above will reduce the thickness and the salinity of the NSDW.

Conclusions

- The potential temperature in the adiabatic NSDW has increased by 20 mK between 1982 and 1994.
- The thickness of the adiabatic layer has decreased.
- The salinity of the homohaline layer is constant or reduced by 0.001 to 0.002 (psu).
- The thickness of the homohaline layer has decreased.

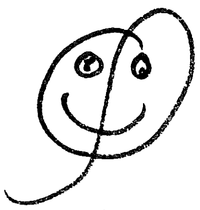

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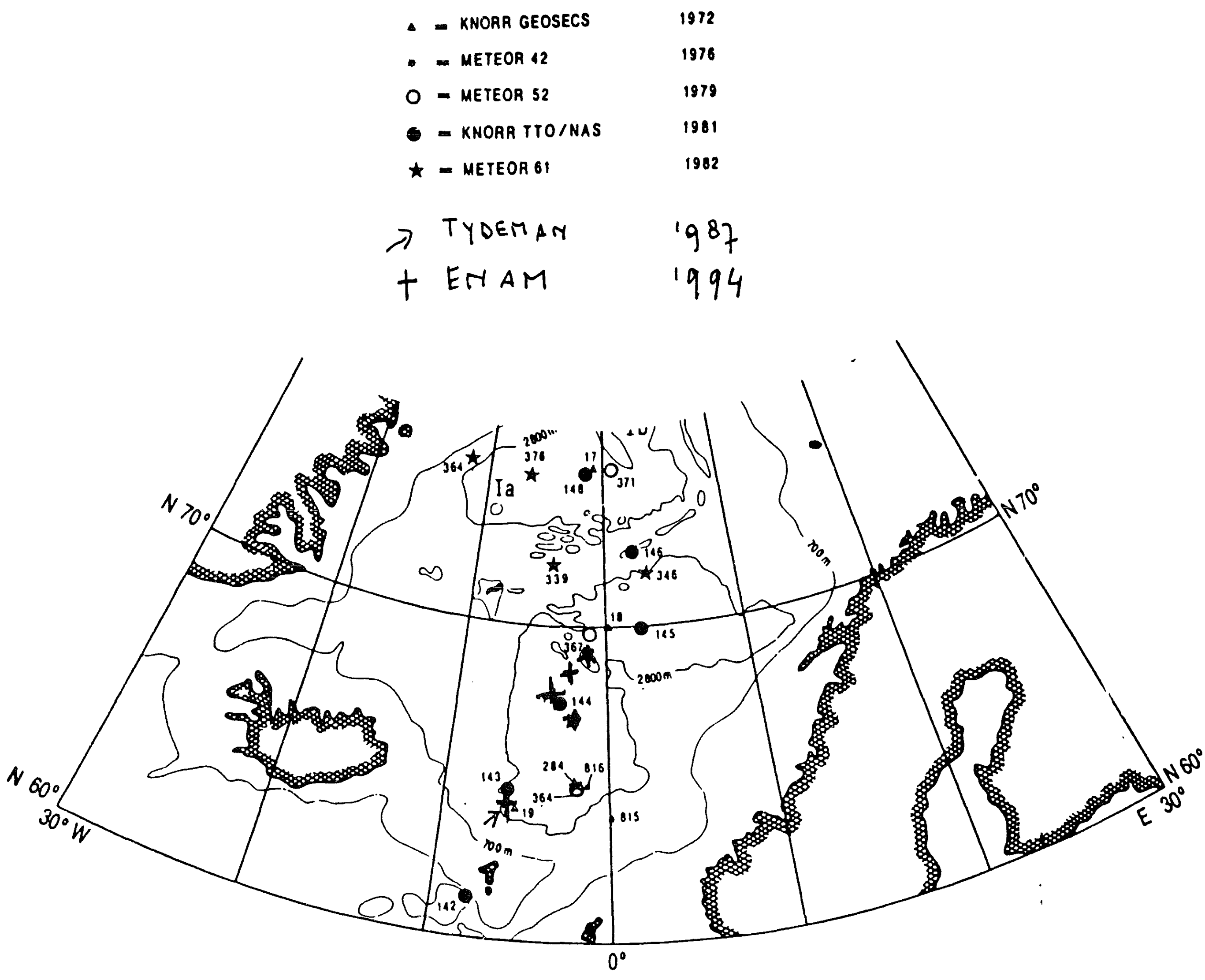
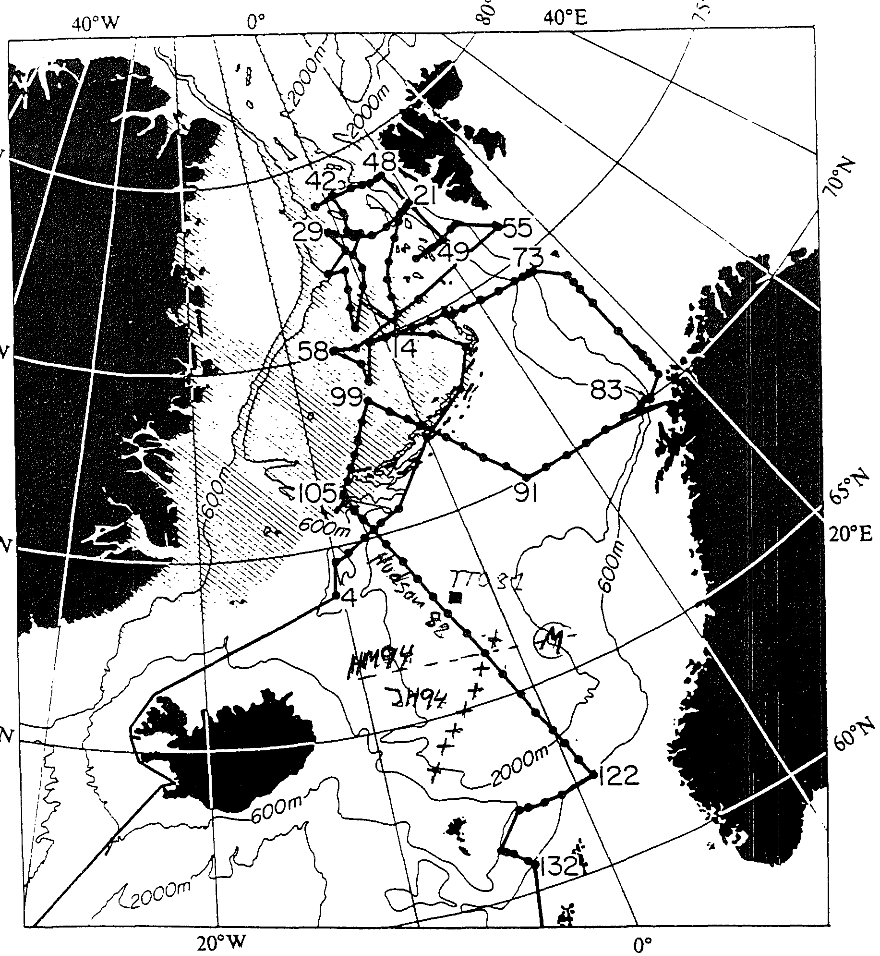
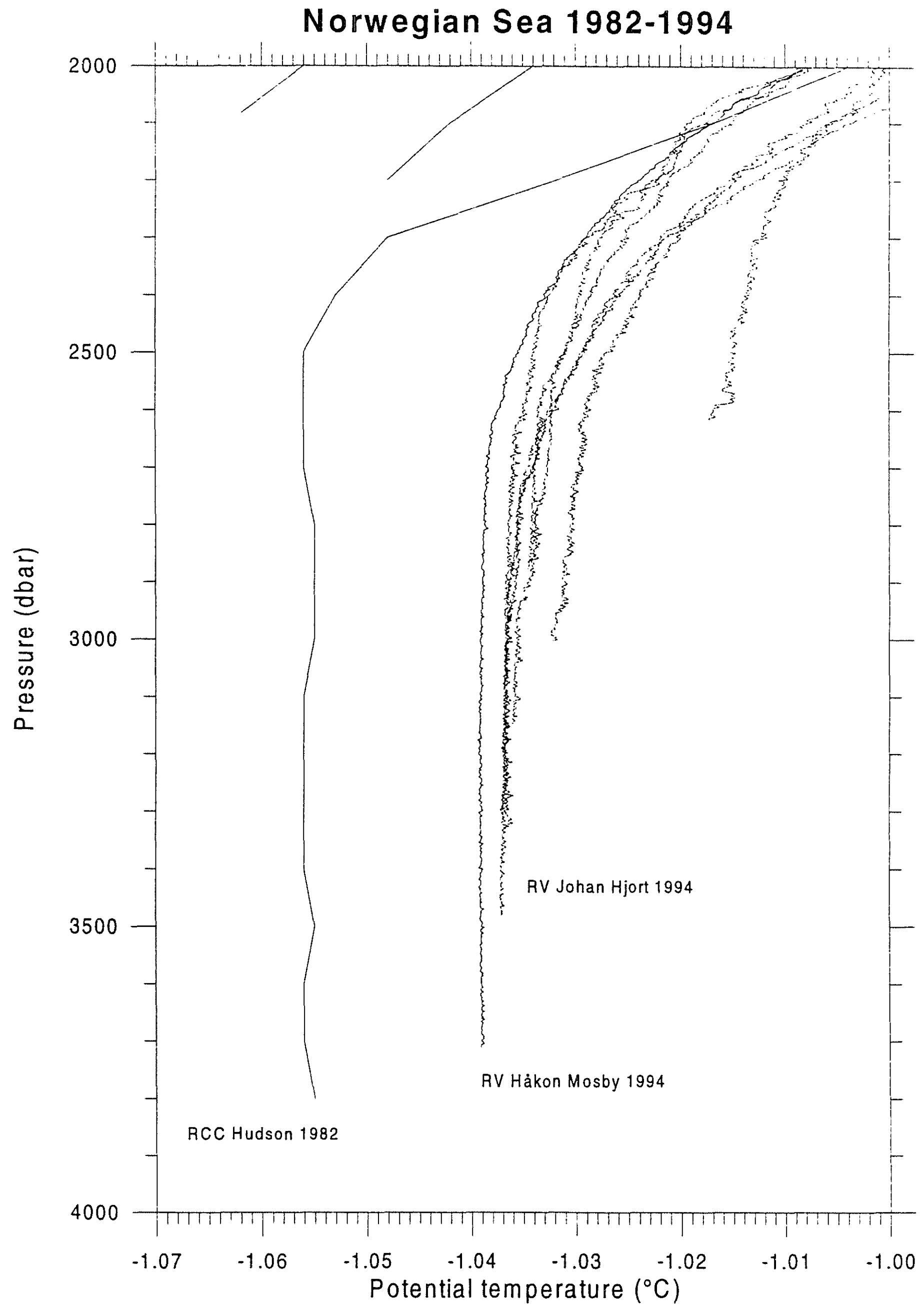
Figure 1, a, b, c.
Upcast salinity and potential temperature profiles with bottle data (•) in October 1994 in the Norwegian Basin, to 10 m from the bottom.
Positions a: Station 2: 68.0 ^{o}N, 3.0 ^{o}W
b: Station 3: 67.1 ^{o}N, 3.9 ^{o}W
c: Station 4: 64.5 ^{o}N, 5.7 ^{o}W

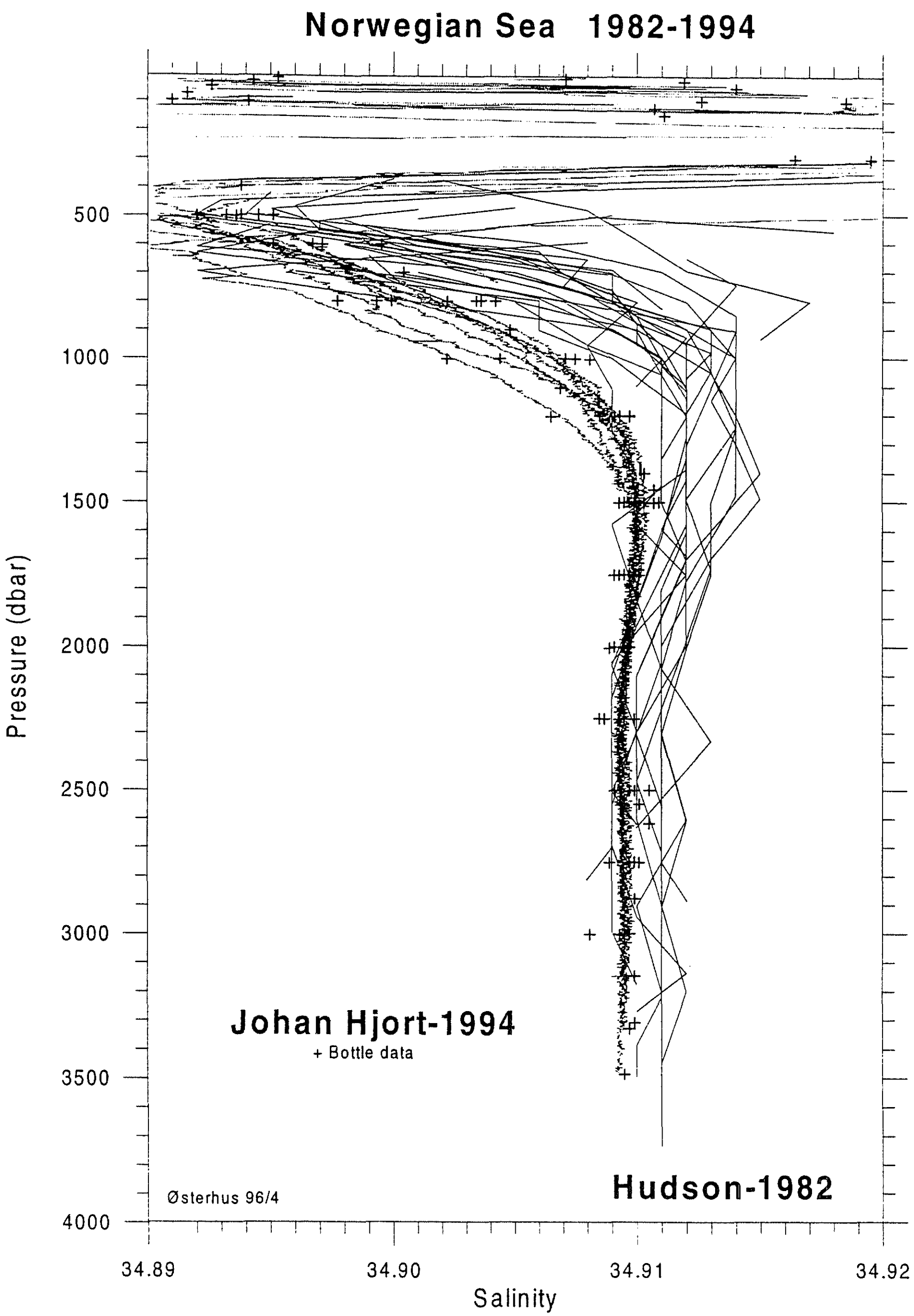
Figure 2.
Potential temperature-Salinity graphs for the deep part of the CTD profiles for the stations of Fig 1, with depth of extrema in dB.

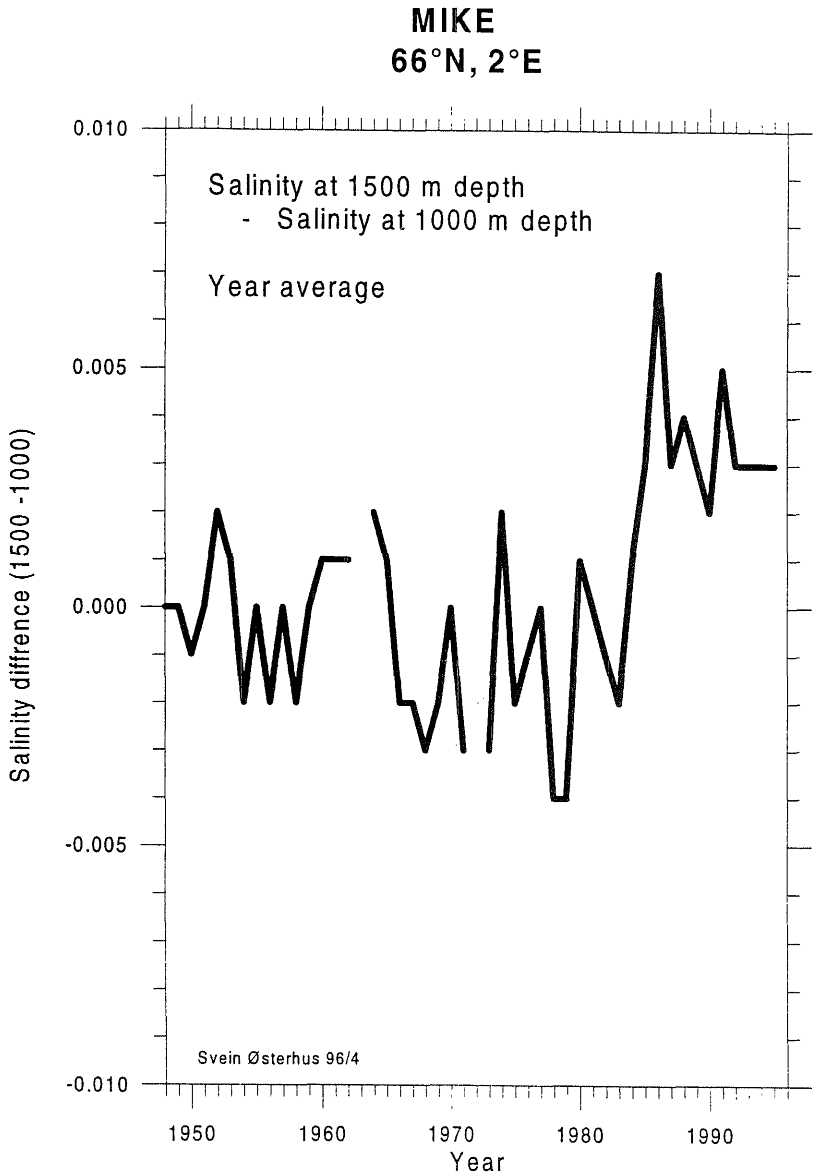



40°W
0°
80°N
40°E
75°N
70°N
65°N
60°N
20°E
20°W
0°
2000m
600m
42
48
21
29
55
49
73
58
14
83
99
105
91
4
122
132
Hudson 82
TTO 31
HM94
JH94
M


Norwegian Sea 1982-1994
Pressure (dbar)
2000
2500
3000
3500
4000
RV Johan Hjort 1994
RV Håkon Mosby 1994
RCC Hudson 1982
-1.07
-1.06
-1.05
-1.04
-1.03
-1.02
-1.01
-1.00
Potential temperature (°C)

1


Norwegian Sea 1982-1994
Pressure (dbar)
500
1000
1500
2000
2500
3000
3500
4000
Salinity
34.89
34.90
34.91
34.92
Johan Hjort-1994
+ Bottle data
Hudson-1982
Østerhus 96/4


MIKE
66°N, 2°E
Salinity at 1500 m depth
- Salinity at 1000 m depth
Year average
Salinity diffrence (1500 -1000)
0.010
0.005
0.000
-0.005
-0.010
Year
1950
1960
1970
1980
1990
Svein Østerhus 96/4

Salinity changes in the Norwegian Basin adiabatic layer
(Follow-up to a discussion during the 1995 OHWG meeting).

Note by A.J. van Bennekom and S. Ober
Netherlands Institute for Sea Research, POB 59, Texel, Holland

In October 1994 we carried out a few stations in the Norwegian Basin with a Seabird 911 plus CTD. The salinity was measured against batch P 119 with a Guildline 8400A salinometer. Samples (N=18) from the adiabatic layer gave 34.9097± 0.0005 (PSU scale). The 27 samples from >2000 m had 34.9096 ± 0.0004. Range was 34.9086 to 34.9105.

A figure of "near 34.910" is often cited in the literature for NSDW; most data from the early eighties are in the range 34.910 to 34.913, with uncertainties of about 0.002. Usually all values below 2000 m are averaged. During the last 15 years, the salinity decrease of NSDW has been only 0.001 to 0.002, not statistically significant in view of measurement accuracy. When slight salinity variations below 2000 m depth are taken into account, some evidence for a decrease exists.

Our 1994 CTD profiles (Figs 1 & 2) all show the same structure, slight salinity minima at about 2300 m depth, similar to the deepest connection between the Greenland and the Norwegian Basin. At this level the recently entered NSDW is expected. Swift and Koltermann (1988) mention that new NSDW, entering the Norwegian and Lofoten Basins in 1981/1982 was 0.001 to 0.002 fresher than the resident NSDW. In 1994, this feature was hardly resolved by bottle data, but it is compatible with a salinity decrease below 2000 m in the Greenland Basin, inferred by Clarke et al (1990, Fig 12). These authors report a maximum of > 34.912 at about 1500 m depth in the Norwegian Basin, which was absent in our profiles.

WOCE criteria, requiring 0.001 salinity precision and 0.002 accuracy are also hardly able to detect these differences. The most recent WOCE manual states that an accuracy of 0.001 is "expected".
Our experience has been that the accuracy of bottle salinities is not better than 0.001. Salinities from the CTD have a better precision, but offsets of the conductivity sensor has to be determined with many bottle values to attain the required accuracy.
It will be interesting to measure further changes in NSDW.

References

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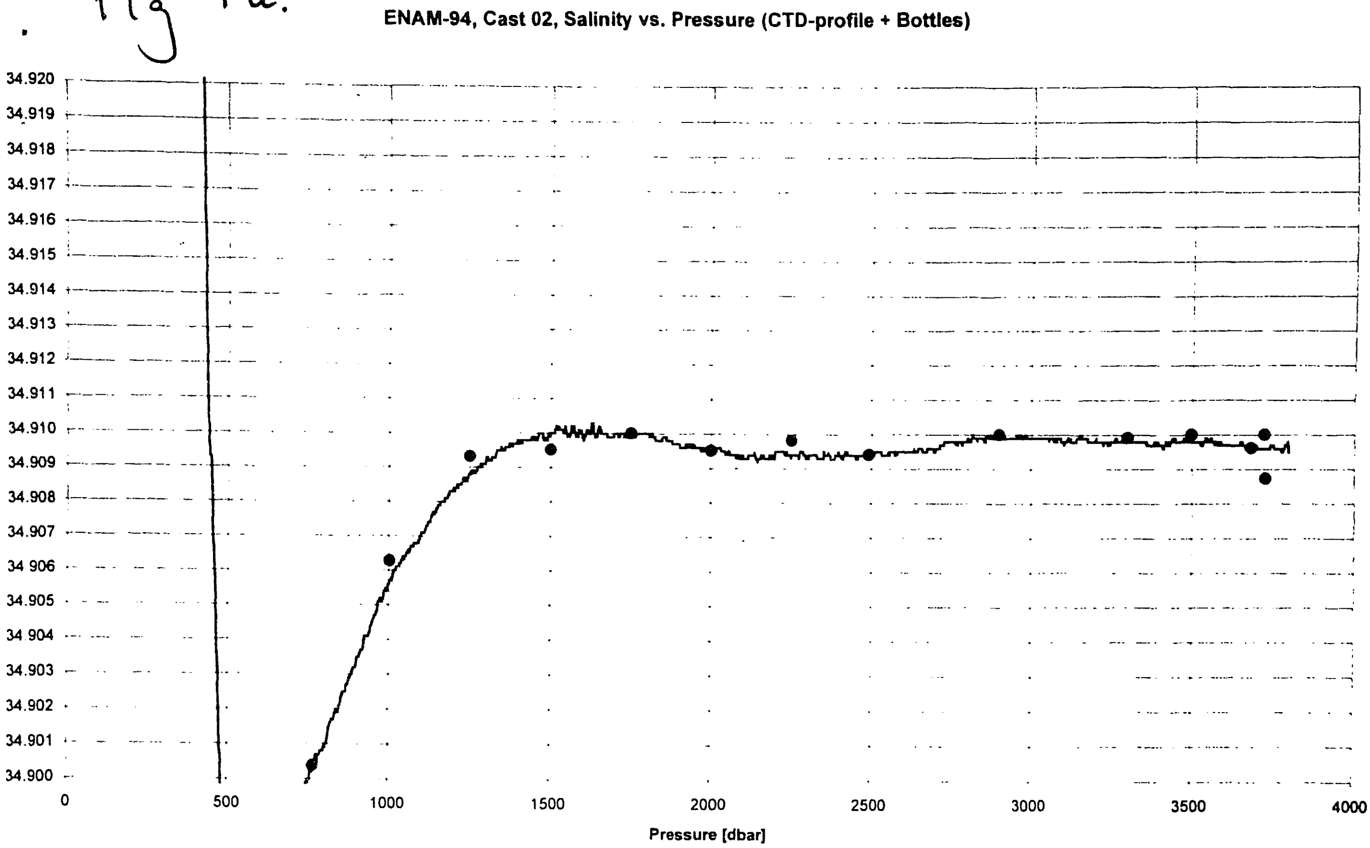
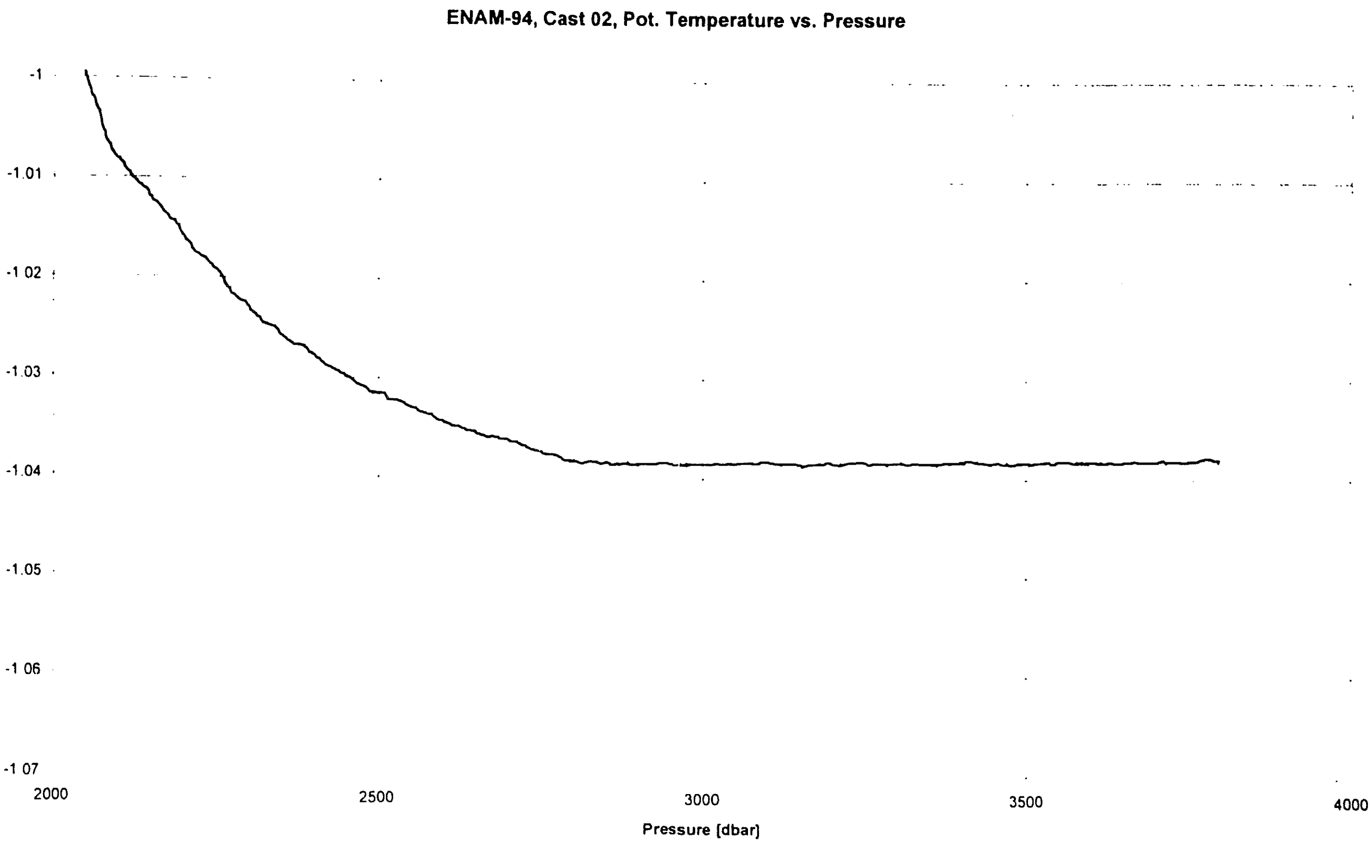
Fig 1a.

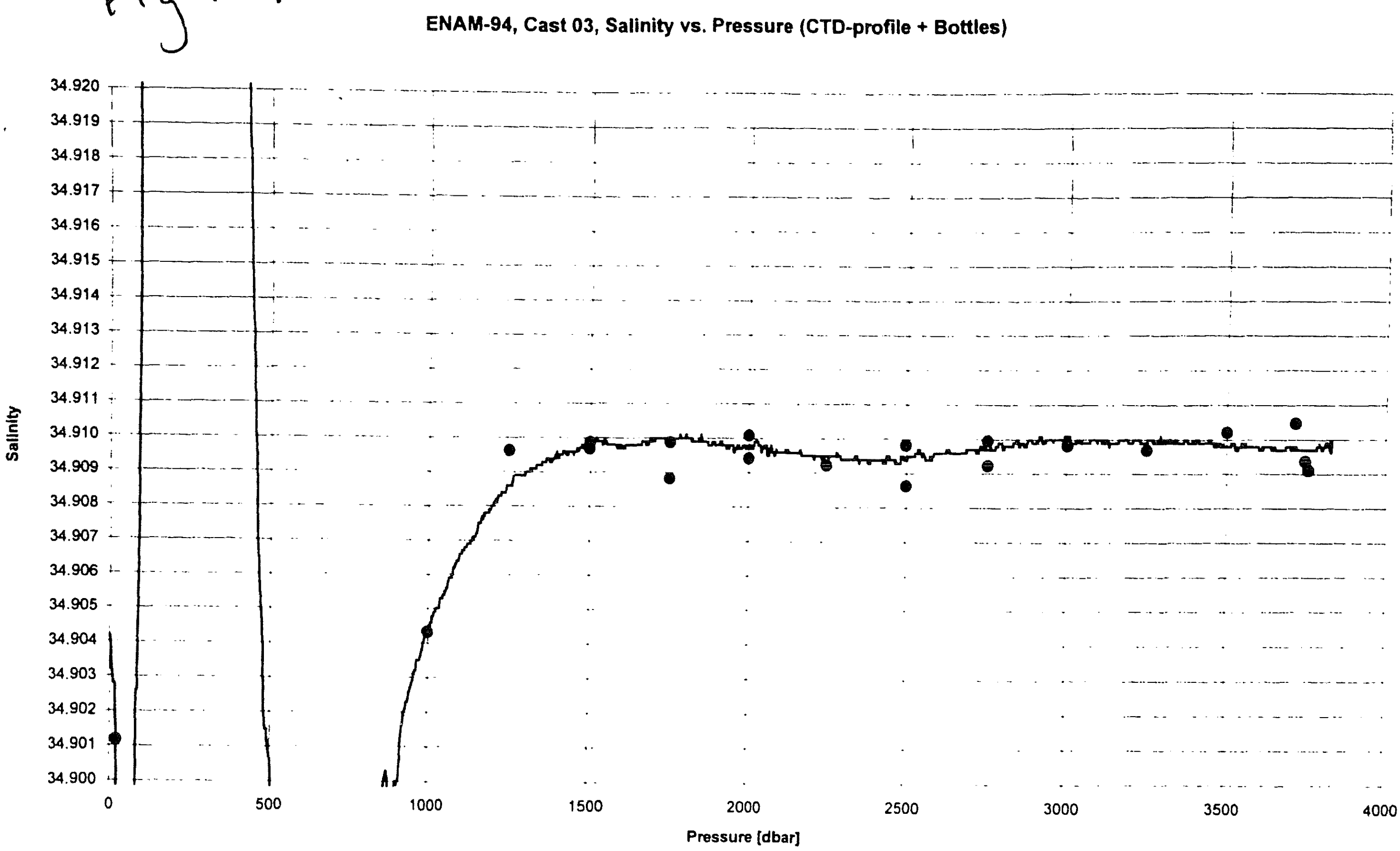


ENAM-94, Cast 02, Salinity vs. Pressure (CTD-profile + Bottles)
34.920
34.919
34.918
34.917
34.916
34.915
34.914
34.913
34.912
34.911
34.910
34.909
34.908
34.907
34.906
34.905
34.904
34.903
34.902
34.901
34.900
0
500
1000
1500
2000
2500
3000
3500
4000
Pressure [dbar]



ENAM-94, Cast 02, Pot. Temperature vs. Pressure
-1
-1.01
-1.02
-1.03
-1.04
-1.05
-1.06
-1.07
2000
2500
3000
3500
4000
Pressure [dbar]

Fig 10.


ENAM-94, Cast 03, Salinity vs. Pressure (CTD-profile + Bottles)
Salinity
34.920
34.919
34.918
34.917
34.916
34.915
34.914
34.913
34.912
34.911
34.910
34.909
34.908
34.907
34.906
34.905
34.904
34.903
34.902
34.901
34.900
0
500
1000
1500
2000
2500
3000
3500
4000
Pressure [dbar]

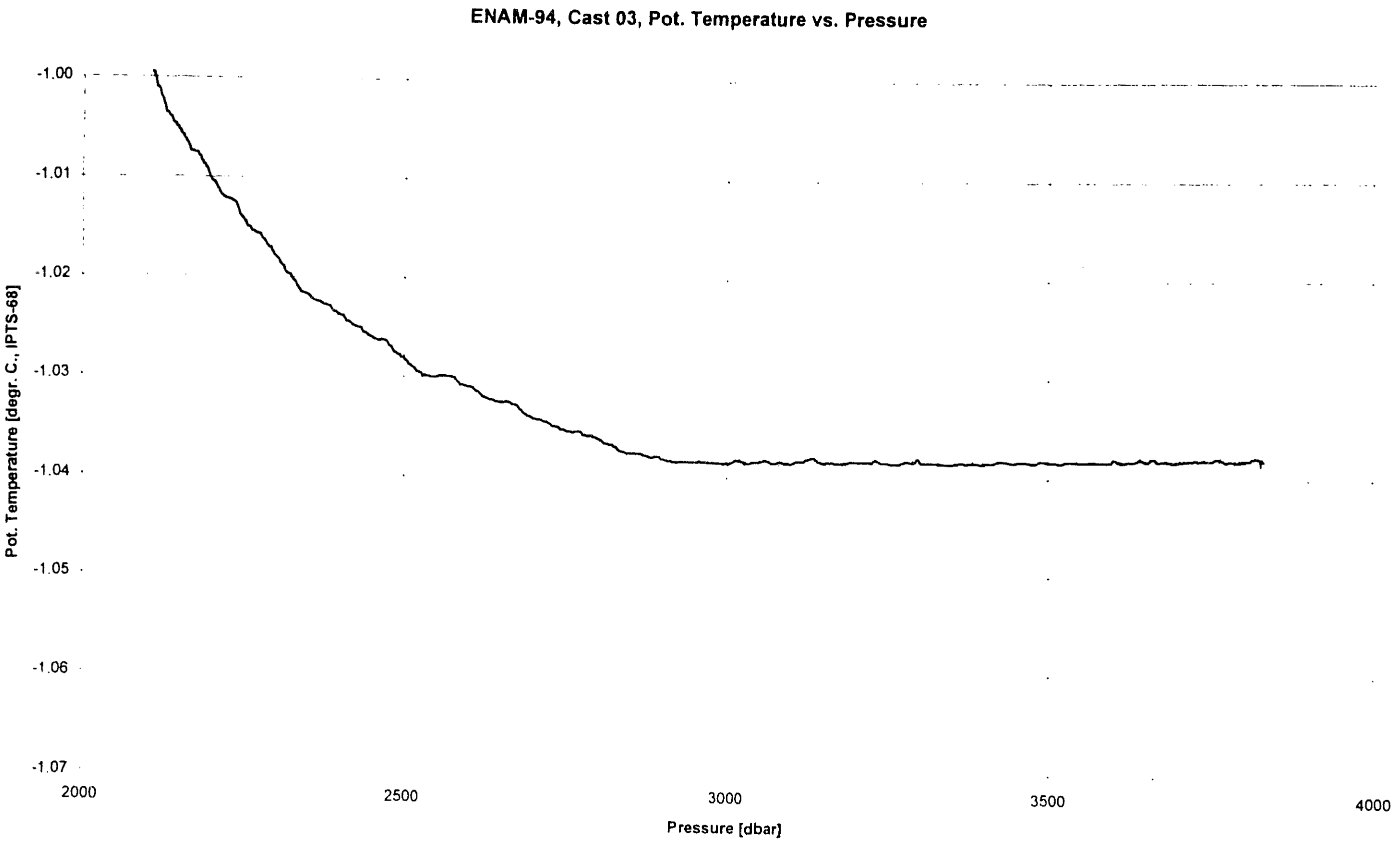
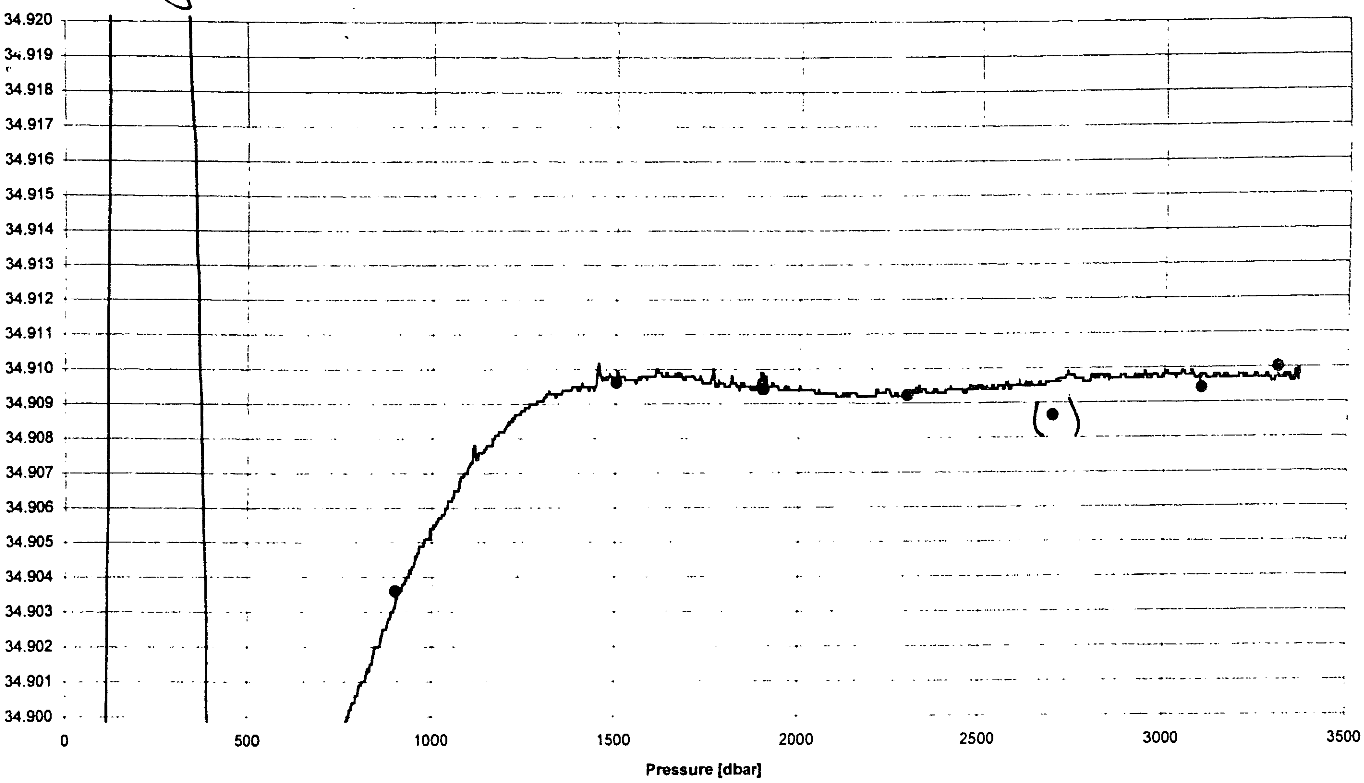
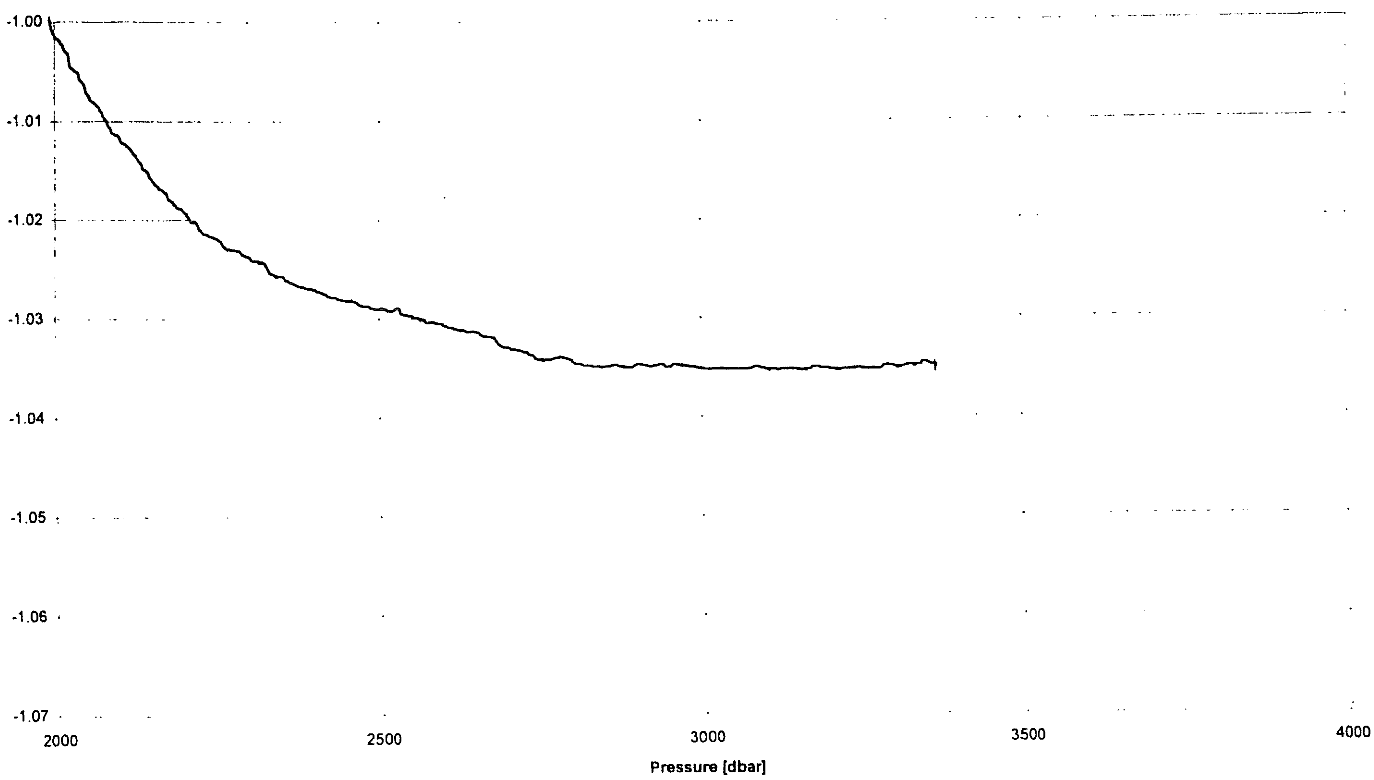

ENAM-94, Cast 03, Pot. Temperature vs. Pressure
Pot. Temperature [degr. C., IPTS-68]
-1.00
-1.01
-1.02
-1.03
-1.04
-1.05
-1.06
-1.07
2000
2500
3000
3500
4000
Pressure [dbar]

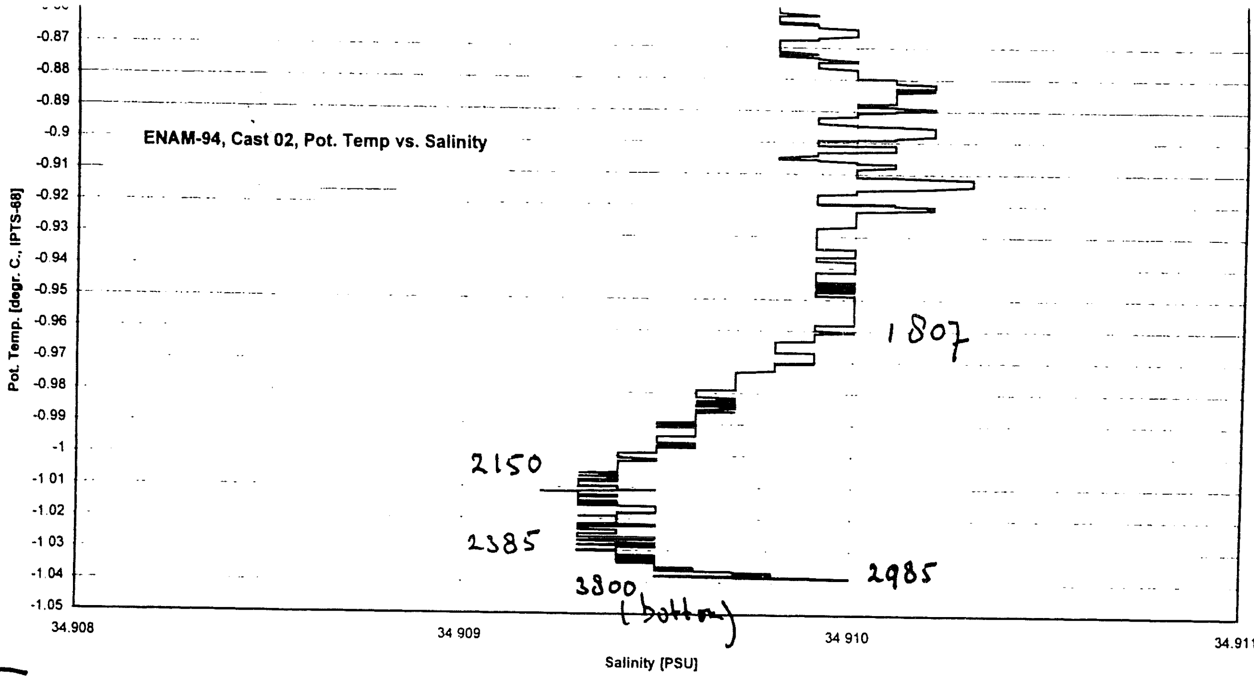
Fig 1c.

ENAM-94, Cast 04, Salinity vs. Pressure (CTD-profile + Bottles)

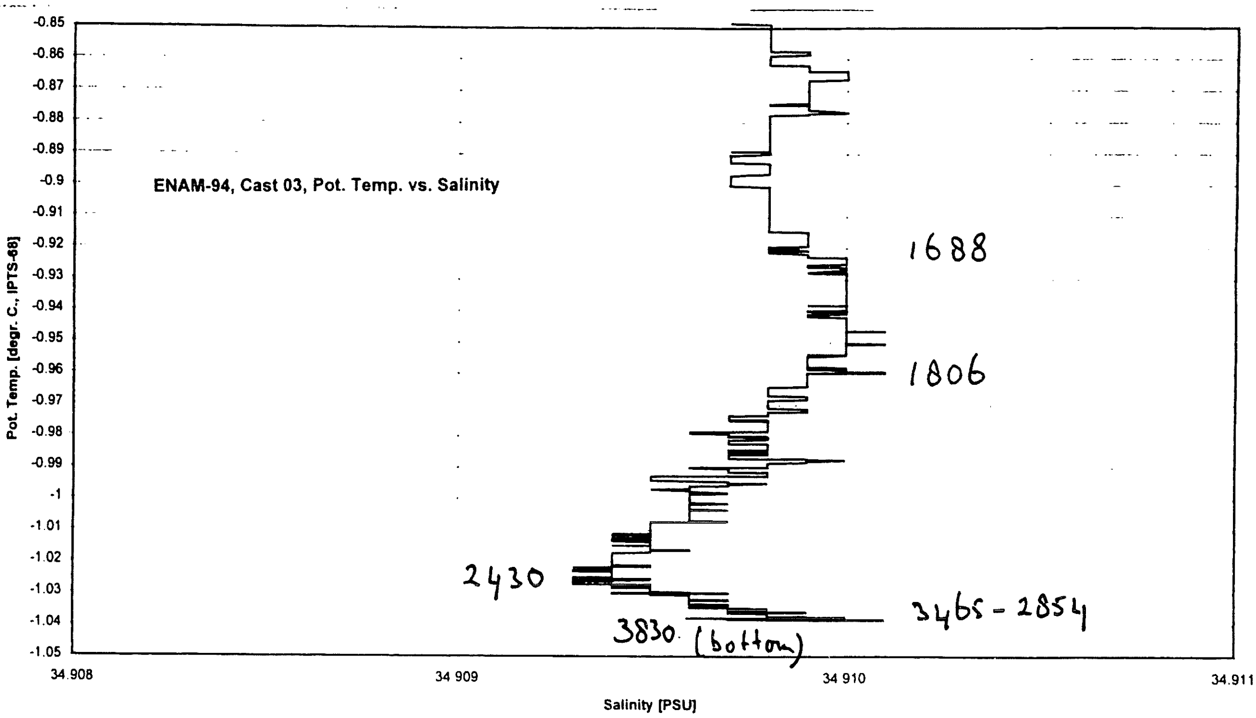


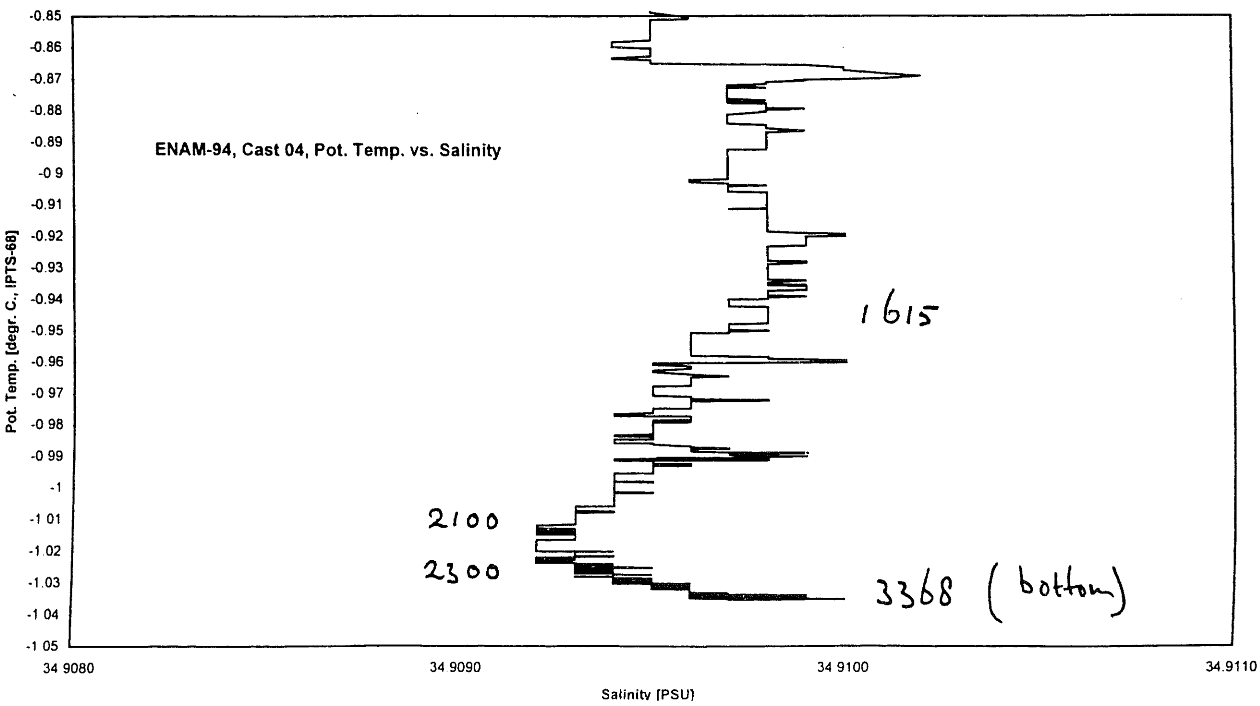
ENAM-94, Cast 04, Pot. Temperature vs. Pressure




ENAM-94, Cast 02, Pot. Temp vs. Salinity
Pot. Temp. [degr. C., IPTS-68]
-0.87
-0.88
-0.89
-0.9
-0.91
-0.92
-0.93
-0.94
-0.95
-0.96
-0.97
-0.98
-0.99
-1
-1.01
-1.02
-1.03
-1.04
-1.05
34.908
34 909
34 910
34.911
Salinity [PSU]
1807
2150
2385
2985
3800 (bottom)

ig2


ENAM-94, Cast 03, Pot. Temp. vs. Salinity
Pot. Temp. [degr. C., IPTS-68]
-0.85
-0.86
-0.87
-0.88
-0.89
-0.9
-0.91
-0.92
-0.93
-0.94
-0.95
-0.96
-0.97
-0.98
-0.99
-1
-1.01
-1.02
-1.03
-1.04
-1.05
34.908
34 909
34 910
34.911
Salinity [PSU]
1688
1806
2430
3465 - 2854
3830 (bottom)


ENAM-94, Cast 04, Pot. Temp. vs. Salinity
Pot. Temp. [degr. C., IPTS-68]
-0.85
-0.86
-0.87
-0.88
-0.89
-0.9
-0.91
-0.92
-0.93
-0.94
-0.95
-0.96
-0.97
-0.98
-0.99
-1
-1.01
-1.02
-1.03
-1.04
-1.05
34 9080
34 9090
34 9100
34.9110
Salinity [PSU]
1615
2100
2300
3368 (bottom)