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International Council for the Exploration of the Sea

C.M. 1988/C:18
Hydrography Committee

"Report of the Working Group on Oceanic Hydrography, Copenhagen, 4-5 February, 1988"

OCEANIC HYDROGRAPHY WORKING GROUP

MEETING 4-5 FEBRUARY 1988

ICES HQ COPENHAGEN

Attendance

W J Gould (Chairman)
G Becker
V Birne
J Blindheim
E Buch
Y Camus
R A Clarke
T Dalzell
H Dooley - Representing ICES
C Druet - Representing GSP
E Gmitrowicz
B Hansen
C Maillard
S-A Malmberg
A Martin
J Meincke
S Osterhus
A Swansson
J H Swift - Representing GSP
H M van Aken
J van Bennekom

1. Chairman's opening remarks

The chairman welcomed the WG members and remarked that many of them had already been at ICES for 3 days for the NANSEN and GSP workshops. He reviewed local arrangements and introduced the Hydrographer (Dr Dooley) who could help with any particular problems.

The draft agenda for the meeting was presented.

2. Review of WG membership

The chairman remarked that there had been several changes in membership over the past year. Specifically there were now 3 members from

Poland, Mr Grelowski, Ms Pastuszak and Dr Piechura. Although they were not present at the meeting, Poland was represented by Professor Druet who had been attending the GSP meeting. Capt Romanov had replaced Capt Sedov, Mr Dalzell had replaced Lt Cdr McAndrew, Mr Gmitrowicz replaced Dr Dickson, Dr Osterhus replaced Dr Saelen. Although no replacement had yet been nominated, Dr Prangsma had resigned from the WG since he was now working entirely on meteorological problems.

3. Reports of NANSEN and GSP workshops (NANSEN Report is Appendix A)

3.1 Dr Gould briefly reviewed the proceedings of the NANSEN group. The aim of the project was to gain a better understanding of the exchanges of the water and heat between the N. Atlantic and Norwegian Sea. Many measurements had been made in 1987, mostly between May and September but the work had been largely uncoordinated and consisted of individual contributions from several laboratories.

The large amount of data which had been collected represented an important data set amounting to over 1700 CTD and water bottle stations, 140 current and temperature time series and over 400 XBT stations. Plans were in hand to create a NANSEN data archive. ICES had been directed to act as a data centre for NANSEN had procedures had been devised to create a CTD/WB data bank at ICES. It was thought appropriate that MIAS in the UK would be an appropriate place to archive the time series data and an inventory was already in course of preparation. XBT data were already archived in appropriate national data centres.

Although there was relatively little data fully worked up at this stage at least two points had appeared on which further work was deemed useful.

(a) CTD stations in the S. Norwegian Sea and in the Faroe Shetland channel in recent years had identified a minimum of salinity at about 34.900 and a temperature of 0^{o}C. This feature was not present in the Overflow '73 data and was thought to have appeared around 1980. This minimum layer was presently widely found in the Norwegian Sea as reported by Blindheim. It was thought useful to study recent high quality data from the area in order to identify when the feature had first appeared.

(b) The details of the surface circulation of the area were still far from clear - particularly in the areas NE of Faroe and over the Faroe Bank and Wyville Thomson ridge. The seasonal and interannual changes in both deep and surface circulation were largely unknown.

(c) Recent measurements by IOS using a combination of geostrophic computations from CTD data with shear measurements from a ship-mounted Acoustic Doppler Current Profiler had enabled transport measurements to be made in and around the Faroes. The NANSEN group had recognised this as a useful new method and recommended that a workshop should be held later in 1988 (perhaps in late September) to try to establish some common procedures and computer software for the reduction of ADCP data.

3.2 Prof Meincke reviewed the GSP workshop. The aim of this international project is to understand the water mass conversion in the Greenland Sea. This process involves local deep convection as well as surface and internal advective fluxes of heat and salt from and to adjacent seas. The project

is designed in a way that will lead to the kind of quantitative results that are needed before the thermohaline driving of the ocean circulation can be incorporated into the numerical modelling climate studies.

During the workshop the plans for field work in Phase 1 (June 88 to August 89) were finalised. Special attention was paid to the intercalibration problem since it is intended that the hydrographic data for the four seasonal surveys will be combined. These 100 stations in open and ice covered water will be used for a detailed water mass census. 34 moored arrays, including acoustic tomography, current meters and moored ADCPs will be deployed for 1 year.

Hydrographic data will be limited to CTD and O_2 observations. Nutrients will not be measured since the precision of this measurement falls short of GSP needs.

In addition, process oriented studies including biological, glaciological and meteorological projects will be carried out. GSP Phase-I will also involve remote sensing in preparation for the application of remote sensing techniques to GSP Phase II.

The GSP workshop had recommended that ICES would be the appropriate repository for GSP Phase I CTD data. This is reflected in Draft Resolution B. (See Section 9).

4. Water movements and mixing at the foot of the Porcupine Slope

4.1 Mr Gmitrowicz reviewed the recent work by the MAFF Fisheries Laboratory and other UK laboratories in the southern Rockall Trough and on the Porcupine Slope.

Long period ($\sim$100 day) motions on the rise at the entrance to the Rockall Channel are found to be polarized along isobath while motions at a period of 8 days, corresponding to Nα, (the cut-off frequency for topographic Rossby waves) are polarized across isobath.

In both cases the motions are bottom intensified and the 8 day motions show no significant vertical phase shifts below the main thermocline. Horizontal phase shifts for the 100 day motions indicate across isobath phase propagation, while phase shifts for the 8 day motions indicate along isobath phase propagation. The wavelength of the 8 day motions calculated from the horizontal phase shifts is $\sim$90 km, while that predicted from the degree of bottom trapping (Rhines (1970)) is $\sim$80 km.

Stations at the foot of the Porcupine Slope have been occupied by both Prof Thorpe and MAFF. The work of Prof Thorpe is more detailed though the moorings from his latest and more extensive current meter deployment will not be recovered until later this year.

Some results from Thorpe's earlier 3 mooring array the deployment of BERTHA (Benthic Resistance Thermistor Chain) and CTD measurements are:

a) Mean flows which are along isobath (northward) and veer to the right with increasing distance from the bottom.

b) Subtidal along isobath flows which are generally in geostrophic balance.

c) A strong baroclinic component in the m_2 tide, with phase propagation onshore.

d) Enhanced mixing on approaching the slope as indicated by density inversions in CTD profiles.

MAFF measurements from a 3 mooring array have only recently begun to be worked up. They differ from the Thorpe results in that mean flows do not generally veer to the right with increasing distance from the bed and along isobath subtidal motions are not found to be in geostrophic balance as found by Thorpe and as may be expected.

The mean flows from a full depth mooring show northward flows at all depths except at 1,600 m, where there is zero mean flow. Anomalous slope flows in the depth range 1500 - 2000 m have been seen in other MAFF measurements and have been noted by Prof Thorpe.

4.2 The Chairman noted that other groups were presently working on processes of mixing on continental slopes. In particular Drs Pingree and New at IOSDL had been for some years been studying the mixing and internal tide propagation on the slope west of Brittany. Dr Camus reported on French work in that area.

4.3 ONDINE 85 At the beginning of the eighties, R. Maze (Laboratoire d'Oceanographic Physique de L'Universite de Bretagne Occidentale) had developed a numerical model (2 D; 2 layers) describing the generation/propagation of the the baroclinic tide generated by the barotropic tide flowing onto the continental slope west of Brittany.

Taking into account the non-linearities due solely to the propagation of the internal tide above the shelf, he was able to develop an analytical formula which reproduced the thermocline oscillation at its generation point. This internal oscillation then propagates onto the shelf within the barotropic tide environment.

A. Pichon (Etablissement Principal du Service Hydrographique et Oceanographique de la Marine) applied that formula to ONDINE 85 data.

With the input of the barotropic current component normal to the slope and the initial temperature profile, she was able to reproduce the thermocline oscillation as shown by thermistor chain measurements on the shelf, close to the break.

She got good agreement between prediction and observations during spring tides, but poor agreement during neap tides.

4.4 It was remarked that poleward eastern boundary currents had received considerable attention in recent years. Many more measurements had been made since the Swallow, Gould and Saunders ICES paper had been published in 1979 and it was thought appropriate that a new review of such measurements should be made. The Chairman pointed out that there had recently been a workshop at Monterey on just this subject and that the proceedings would be published by Springer Verlag.

5. Current meter data quality. Preparation for the Statutory Meeting.

5.1 The Chairman reminded members that a special session would be held at the 1988 Statutory Meeting in Bergen on the subject of current meter data

quality (Chaired by J. Howarth). The idea for this session came from the success of the CTD session in London which had stimulated several activities including the intercomparison of salinometers and water sample bottles. Members were asked to suggest topics which would be appropriate for this session so that Mr Howarth could bear these in mind.

5.2 It was remarked that there had been a large number of current meter intercomparisons in recent years (Chairman agreed to try to list all of these by accessing the IOSDL and ASFIS information archives) but that problems still remained and there were now many new instruments which had still to be fully evaluated. A brief enquiry of the Working Group members revealed that there are about ten types of current meters in regular use by the members' laboratories. Such a diversity of instruments would certainly create problems of compatibility in certain physical situations.

5.3 Topics that were suggested as likely to be of interest in the Statutory meeting session were:

a) Mooring knockdown and displacement. How should records be treated when mooring knockdown is large? What is the degree of contamination of tidal/inertial signals when moorings are subject to significant horizontal displacements at these frequencies? Can new mooring designs and the use of new materials alleviate these problems?

b) Biological fouling. How can the effects of fouling be limited? How can long records be tested for the severity of biological fouling? (Tidal analyses have been used for such tests in the past). Can the biologists give guidance on the likely severity of fouling by location, depth or season?

c) How do some of the new generations of currents meters (e.g. RCM4) behave at low speeds? Are the instruments which measure east and north components directly likely to behave worse or better than those which measure speed and direction separately?

d) How do conventional meters compare with bottom mounted ADCPs in shelf seas?

e) What are the advantages of new techniques (e.g. H.F. radar) for measuring near surface currents? How good (or bad) are these new techniques?

f) What is our present capability in measuring other parameters on moorings? We can measure temperature pretty well, can we also measure salinity, oxygen and turbidity/transmittance to a useful accuracy?

5.4 It was suggested that a keynote speaker would help to set the subject in context and that Dr Dale Pillsbury of OSU who had worked for many years on this topic would be an appropriate person for this. ICES could not undertake to help with his travel costs but it was thought that a few laboratories might help with contributions to his travel in return for visits to those laboratories.

The Chairman undertook to report the discussions held in Copenhagen to Mr Howarth.

6. Reports of recent work and plans for future work

The Chairman invited members to describe briefly their past and future research and that of their colleagues. It was suggested that the reviews should not concentrate on NANSEN and GSP work since these topics had already been discussed in detail. The following are brief descriptions derived from contributions from members.

6.1 Gmitrowicz (MAFF Lowestoft)

Data from the first two years of the SOFAR float experiment at 2000 - 2500 m on the Iberia Abyssal Plain have been worked up, with a data return of 3,600 float days. The zonal dispersion coefficient calculated from the float data is 3.7×10^6 $cm^2 s^{-1}$ and the meridional dispersion coefficient is 2.5×10^6 cms^{-1}. Good agreement is found between the directly calculated diffusivity and that using Taylor's hypothesis.

The final deployment of the IOS ALS stations were recovered in July 1987. Only two of the three stations were recovered and hence data from WHOI ALS's which will be recovered in 1988 will be required to properly track the floats for the third and last year.

In 1988 it is planned to deploy an 8 mooring array on a section south of the Denmark Strait to measure the volume of overflow. Each mooring will carry 3 Aanderaa current meters, 3 of the moorings will carry thermistor chains and one mooring will carry a SEACAT conductivity-temperature sensor.

6.2 Swift (SIO)

During P.F.S. Polarstern cruise Arctis IV/3, 4 July - 3 September 1987, a section occupied was of 18 CTD/hydrographic/tracer stations with ~700 sampling depths across the Nansen Basin of the Arctic Ocean. This is the first section of reference-quality stations across an Arctic Ocean basin. The north-most station, at 86.2°N and 22°E surpasses the most northern portion of the drift of the Fram in 1896. The shipboard measurements (T, S, O_2, nutrients, freons, total carbonate) show a quiet interior basin, with signs of intrusions and narrow boundary current cores at both the northern and southern boundaries. There was an abrupt mid-basin transition in the upper and intermediate waters from a southern regime with a fresh melt water source and strong influences of the Barents Sea to a northern regime more nearly typical of the central Arctic with a runoff fresh water source and strong influences of the eastern arctic shelves. The bottom waters seemed quiet and isolated, and were freon-free in the central basin with detectable freons at all depths along the boundaries. The characteristics of the waters over the Nansen-Gakkel Ridge suggest that the Amundsen Basin - the basin north of the Nansen Basin - may be ventilated directly from Fram Strait by a route that does not include the Nansen Basin. The Nansen Basin waters cannot alone supply the Fram Strait outflows, which also must contain waters from the Canada Basin, and recirculated waters from the West Spitsbergen Current.

6.3 Clark (BIO, Canada)

A mooring array in Newfoundland Basin was recovered in Fall 1987 after 18 months and hydrographic/tracer survey plus Batfish mapping of North Atlantic current done for a third time (Spring 1986, Winter 1987, Fall 1987). Data have been analysed in terms of:

a) effect of Newfoundland seamounts on North Atlantic current,

b) effect of seasonal changes of freshwater content of inshore water on salinity gradients across the N.A. current and,

c) the depth and structure of the winter mixed layer of the Newfoundland Basin.

An example of the near real-time Batfish processing software capabilities with Microvax computers was shown with fully processed and objectively analysed T, S and - contours along the sections being produced within a few hours of the data collection.

An array of current meters/bottom pressure gauges will be recovered in Summer 1988 in the western side of the Labrador Sea. This array is looking for the western boundary transport of 30-40 Sverdrups in the Labrador Sea and its annual cycle that is predicted by an integration of the Sverdrup transport across the ocean basin.

The current meter array in the Labrador current will be replaced in Summer 1988 continuing this 10 year monitoring program.

An array of 5 moorings will be replaced in Davis Strait to determine the movement of water from West Greenland across to Baffin Island. This array will be maintained for a total of 3 years; it was first set in 1987.

A new Gulf Stream experiment will begin in April 1988. An array of 8 moorings will attempt to estimate the transport across 50^{o}W south of the Grand Banks; measuring both the slope water and the Gulf Stream. Hydrography, standard tracers and trace metals will form part of this work.

6. The XBT program from Halifax and Reykjavik on an Icelandic Steamship Company vessel has been suspended due to reassignment of the vessel. We hope to reestablish collection on replacement vessel.

6.4 Van Bennekom NIOZ

In September 1987 the Tydeman was involved in a cruise the main aim of which was to investigate the possible changes in the deep water masses around the Faroe Islands Southern Norwegian Basin.

Compared with 1981-3 the waters below 3000 m had slightly decreased in salinity and silica, whereas temperature and oxygen were the same. This indicates that the episode of quicker flushing of the deep Norwegian Sea water was not ended yet.

In the Northeast Iceland Basin a section from 63^{o}N, 17^{o}W to 60.5^{o}N, 14.5^{o}W showed at the northern side a thin bottom layer of low salinity, low temperature and low silica, first detected in 1933. This is presumably a new variety of ISOW. At the southern side the bottom layer was relatively high in silica, probably due to a small admixture of AABW.

6.5 Meincke IfM, Hamburg

Observational activities at the IfM Hamburg are focussing on processes relevant to the climatic role of the Greenland Sea and the Barents Sea. They comprise studies of the variability of fluxes of heat and mass across Fram Strait and the Barents shelf break, the intrusion of

dense winter shelf water into the deep basins west of Svalbard, the transfer of salt from the Spitzbergen current across the Arctic front into the Greenland Sea gyre and the convective overturning in the Greenland Sea.

A similar amount of effort is put into developing a set of models adequate to describe the observed processes. It consists of an Atlantic-Arctic Ocean circulation model, (resolution 100 km), embracing the Norwegian-Greenland-Iceland Seas model (resolution 2 km) on frontal exchanges.

6.6 Camus (EPSHOM)

Athena 88 is a SHOM study in cooperation with the Laboratoire de Meteorologie Dynamique, Groupe de Recherche et Geodesie Spatiale, Meteo Marine (IFREMER) and Harvard University (Robinson).

From mid-July to end August 1988 mesoscale variability processes will be studied in a 200 km sided square centred at 53°N 25°W. Three subsurface moorings (each with 5 VACMs at 200, 500, 1000, 1500 and 2500 m), one surface buoy with surface meteorological and thermistor chains to 175 m, will be deployed. Two drifting buoys with also be deployed and three hydrographic surveys of 37 stations carried out.

The surveys will coincide with GEOSAT satellite tracks and will involve CTD stations to 2000 m (some to 4000 m) and also XBT drops.

Numerical models from GRGS, Toulouse and from Harvard will be run during the cruise and will be used to assimilate the hydrographic data. The moorings and drifting buoys will be recovered at the end of the cruise. One subsurface mooring will be redeployed for a further 6 months.

The French Navy together with IFREMER have been involved in acoustic tomography since 1983. There is at present a small group of two technical experts and two theoreticians working on the problem.

Three prototype transceivers were constructed in 1987 and if funding permits four further units will be built in the next 2 years. A test of the system will be carried out during the BORD.EST IFREMER experiment.

The first experiment (EXTASE) is planned from November 1988 to June 1989 in conjunction with measurements by WHOI and BIO on the Gulf Stream extension south of Newfoundland. The main purpose will be measurements of potential vorticity. The array will consist of 8 devices, 5 from WHOI and 3 from IFREMER.

A Navy experiment will be carried out from late 1989 to mid 1990 in the Bay of Biscay to study mesoscale variability and its relationship to Mediterranean water intrusions. Six devices are planned to be used in that experiment.

6.7 Gould IOSDL

The NANSEN studies had already been described. Future plans included a cruise in May/June 1988 primarily to recover the moored array deployed in 1987 in the Faroe Bank channel and in conjunction with that work to carry out further tests of the long base line acoustic current meter (ATTOM). All this work would be carried out early in the cruise and would be followed by a detailed study of conditions in the Charlie-Gibbs Fracture

Zone, the aim of which was to examine the throughflow of overflow water from the eastern to western basin.

Other planned work particularly by Robin Pingree in the Biscay area was described as were UK plans for contributions to WOCE. The WOCE activities relevant to ICES include a long term commitment to NANSEN studies which are expected to amount to a cruise per year for 3 or 4 years. Further south detailed studies would be taking place in a "Control Volume" (1000 km sided triangle) west of the UK and coming in to the continental slope.

7. Hydrographer's comments

The ICES Hydrographer brought several matters to the attention of the Working Group.

a) ROSCOP forms ICES HQ held a computer based inventory of information derived from ROSCOP forms. It had been used during the meeting to identify cruises on which data useful for pursuing a variety of scientific questions had been collected. Several members remarked that they found the present form poorly laid out and difficult to use, particularly in respect of the categorisation of observations into Marsden squares and in the treatment of moored data. A draft revised form has been prepared by Hydrographer on behalf of IOC which takes into account the problems re Marsden square and time series data. This draft was made available to WG members to enable them to make further comments to Meirion Jones who is developing a new form based on these draft proposals.

b) JPOTS A note was circulated describing the work of the JPOTS panel charged with preparing a replacement for the LaFond oceanographic manual which was now so out of date. Hydrographer is a member of this panel and he reported that it was hoped that the planning work would be completed in late 1988. It was commented that this work would complement that of SCOR WG 51, the report from which was still urgently required. It was asked whether any formulae and algorithms would be produced in "floppy disk" format but it was thought that this would perhaps he inappropriate since the document would be circulated globally to many laboratories and organisations which did not have the ability to handle information in this format. That being the case it was hoped that all formulae would have a series of test values to ensure that they had been properly implemented. There was considerable discussion on the question of units for oceanographic variables. It was revealed that oceanographers were in general a "conservative" community and that they were often unhappy to see new units being introduced.

c) ICES Inventory The present version of the Inventory was tabled and members were asked to check their entries and to bring them up to date. Hydrographer stated that enteries that had not been amended for 5 years were now automatically deleted.

8. New Chairmanship The present Chairman stated that he had held the post now for almost 5 years and that due to increased commitments in his own laboratory he felt it was time for him to stand down in favour of a new Chairman. Prof. Meincke then reviewed the procedure which had been adopted. Members of the Hydrography Committee had been balloted to determine their preference for which member of the present OHWG should

assume the role of Chairman. The procedure was one instituted by Chairman of Hydrography Committee since there were no formal guidelines as to how the selection procedure should be carried out. The clear result of the ballot was that Mr Bogi Hansen was the favoured candidate and in view of this he had been approached and was , despite reservation concerning the amount of work involved and the difficulties of communication from his laboratory in the Faroes, willing to accept the nomination.

The present Chairman commented that he felt that Mr Hansen was an ideal choice for the post and he was confident that under his Chairmanship the OHWG would continue to prosper. There was unanimous agreement among the members.

9. Any other business

9.1 The Chairman reminded the members that during discussions in the meeting it was felt that two resolutions should be submitted to the Hydrography Committee from the WG. These are as follows:

A: Archiving of Oceanographic Data Set

The ICES Oceanic Hydrography WG is concerned that many oceanographic data sets (particularly CTD, water bottle and current meter data) were not archived in any data centre. Such data sets were costly to collect and their ready availability to the wider oceanographic community will be increasingly important as climate scale changes in oceanic conditions are studied in the World Climate Research Programme and the World Ocean Circulation Experiment. All efforts should be made by individual scientists, Laboratoires and University Institutes to ensure that Oceanographic data sets are maintained in a form that will facilitate their acquisition by National Data Centres and their distribution to the ICES community through the ICES Service Hydrographique.

B: Data banking for the Greenland Sea Project

Participants in the Greenland Sea Project are recommended to use the ICES Service Hydrographique as an archive for their data.

9.2 Chairman reminded members that Dr Dickson was updating his analysis of long current meter records (>9 months) from non-continental shelf areas and had requested that he be informed of any time series which should be included in the new analysis.

9.3 In connection with the archiving of data sets, Hydrographer reminded members of the possibility of using the IGOSS BATHY/TESAC reporting procedures to transmit station data either in real time or after the return of the vessel to port. All data from the Russian "Sections" programme is available in the IGOSS archive. While not an ideal way to provide a record of observations made (there is no substitute for the archiving of the original data sets the IGOSS route should be used to a greater extent.

10. Work and location of next meeting

10.1 Reports on progress in the GSP and in NANSEN would obviously be considered at the next meeting but two further topics were advanced as being of importance.

These were:

(a) A consideration of good CTD and water bottle operating procedures. There was a general need to improve the standard of CTD and chemical observations and a discussion of present practices as used by OHWG members would be worthwhile. In particular there was a real concern that dissolved oxygen determinations, although very important, were very difficult to carry out to a uniformly high standard. Dr Swift indicated that he agreed that the topic was important and would try to provide a written summary of PACODF procedures.

(b) The assembly and assessment of slope current transport measurements was thought to be important and could involve measurements from a range of latitude from west Africa to northern Norway.

10.2 It was suggested that the OHWG should meet for two days in April 1989 at the University of Goteborg, Sweden.

11. Concluding remarks The Chairman thanked the members for making the workshops and WG so successful. He also thanked the Hydrographer and ICES Secretariat for their assistance.

C/008/sh

Appendix A to ICES OHWG Report 1988

NANSEN Workshop Report

Workshop 1-3 February 1988 Ices Copenhagen

Attendance:

W J Gould IOSDL Chairman
J Blindheim IMR Norway
S-A Malmberg Iceland
L Rickards IOS MIAS Bidston
G Becker DHI Hamburg
A Lippert IfM Hamburg
K Jancke ICES
H Dooley ICES
P Lundberg Univ Gothenberg
S Osterhus Univ Bergen
B Hansen Faroes
A Martin DAFS
T Dalzell MOD
V Birne Inst Hydr Lisbon
A Van Bennekom NIOZ
Prof Druet Poland

I. Background

The Chairman opened the meeting and welcomed the attendees. He reviewed the background to the NANSEN project and reminded the meeting of the objective of gaining an improved understanding of the exchange processes between the North Atlantic and the Norwegian Sea.

He hoped that in the course of the Workshop the following topics would be covered:

(1) A review of data collected during 1987 in the NANSEN area (between Scotland and Greenland),

(2) A consideration of any scientific points that occurred immediately from the data presented at the meeting,

(3) The meeting needed to formulate a strategy for data banking and for dissemination of the combined data set to interested scientists,

(4) And, finally, the future strategy for measurements in the area needed to be formulated in the light of recent experience.

II. Reviews of observations from 1987

DAFS (Martin)

Tony Martin summarised the occupation of the Fair Isle-Munken and Nolso-Flugga sections. The former section was first occupied in July but problems with the bow thruster on "Scotia" had meant that data could only be obtained to 600 m. The full depth data from the two sections had revealed a minimum in salinity at about the 0 $^{\circ}$C temperature, a characteristic that had been noted in recent DAFS data.

Two current meter moorings had been deployed in 600 and 1,000 m on the Faroe side of the Faroe-Shetland Channel near 5°W. Each had two current meters that had been in place for approx. 2 months (July to September). The data showed an overall weak flow but dominated by fluctuations with periods as short as 4 days near the sea bed. There was considerable vertical coherence between the instruments 250 m apart.

The possible change in deep-water conditions was commented upon further as perhaps being an indicator of long-term changes. Such a minimum was not present in Overflow '73.

Records of salinity in the Atlantic water in the Faroe-Shetland Channel and of the Lamb index of westerly winds were shown. The records show a generally decreasing trend in both the Westerlies and in the salinity (from 5-year running means).

Gould (IOSDL)

Data for the 1987 "Challenger" Cruise 15 were presented. The work had focussed on two areas: (a) a SeaSoar survey of the Iceland-Faroes front from Iceland to the Scottish shelf and (b) multiple CTD sections in the Faroe Bank and Faroe-Shetland Channels. The SeaSoar data had been published in an IOS data report. The main features were briefly reviewed.

The data had been supplemented with ship-mounted ADCP observations (RDI, 150kHz). Errors in data arose from many possible sources:

1. Navigational errors (SatNav was used throughout).

2. Misalignment (observed to be less 0.3°).

3. A possible underestimate of the forward speed. There was no evidence of this frequently reported error in the "Challenger" 15/87 data.

The measurements were also contaminated by other factors which restricted their usefulness as a reference for geostrophic calculations:

(i) Inertial and internal tidal motions had a high vertical modal structure and could be minimized by taking as deep a reference level as possible (300 m was used in this analysis);

(ii) Barotropic tidal currents. Where these were known, corrections had been made to the data.

Temperature and computed velocity sections were shown which revealed large changes in the conditions in the Faroe Bank channel over a 10-day period (transports had dropped from 1.5 to 0.75 Sv of water below 0°C). Sections further downstream of the outflow showed the cold water much reduced in area and transport due to mixing. Observations on the Fair Isle-Munken section show the Atlantic inflow at ~5.5 Sv and a net outflow of 1.7 Sv colder than 0°C but with large error bars and with much of the cold water being recirculated in the bottom of the channel.

Other sections remained to be worked up but evidence seemed to point to the section north of the Faroes having been close to a frontal meander and hence perhaps not typical.

A section along the W-T ridge showed only a small overflow of cold water (0.75 Sv) and little vertical shear.

In summary, the data showed the promise of measuring transports without using current meters. It was suggested that the possibility of getting barotropic tide data from the area should be investigated in order to support future ADCP work.

In addition to these data, five current meter/thermistor chain moorings had been put in the Faroe Bank Channel for 1 year. Recovery would be attempted in May 1988.

Hansen (Faroes)

Three cruises had been carried out in May, June/July, and August. Not all data had yet been worked up but some analyses had been done on the middle cruise. The work was basically a continuation of the 1986 joint study with the Norwegians. Much work focused on the area NE of Faroes to see what was the fate of the water flowing to the east. Did it enter the Faroe-Shetland Channel or did it cross to the Norwegian side? The data analysis is not yet complete and the results are therefore at present inconclusive. Current measurements from 3 sites on the NE Faroe shelf and slope show a changing pattern but with a strong correlation between temperature and N-S flow.

The second part of the cruise was centred SW of Faroes to look at an area important to the spawning of halibut. The deep water (colder than zero) is discontinuous downstream of the exit from the Faroe Bank Channel. What are the dynamics of the flow of such cold water as it exists in the channel?

Gould pointed out that there was a pressure/temperature gauge N of Faroe Bank which might show evidence of intermittency in the flow of cold water.

SACLANT ("La Spezia")

Gould described the extensive surveys in May, August, and September worked by "La Spezia". The data should be freely available and would hopefully aid the interpretation of the observations NE of Faroes - the main focus of the SACLANT work had been the Atlantic inflow.

Osterhus (Bergen)

Joint work carried out in conjunction with the work previously described by Hansen was presented. As yet there are few results but data for 1986 on the 6°W line showed the variability of currents close to the Iceland-Faroes front and the degree of topographic control exerted on currents even far above the sea bed. A total of seven moorings had been deployed in 1986 and 5 distributed around the area NE of Faroes in 1987.

Blindheim (IMR Bergen)

Two CTD sections had been worked east and north of the Faroes and one further section running out north-westwards from the Norwegian coast at approximately 62°15'N. On the first two sections data processing had been delayed by the need to correct for a pressure-dependent conductivity sensor.

Two Argos buoys had been launched N of the Faroes in the spring. One had stopped after 4 days and was much later discovered in the Orkneys - probably having been trawled. The second moved generally eastward but then

was trapped in the middle of the F-S Channel between April and June. After leaving the anti-clockwise circulation the buoy proceeded northwards towards Norway. The buoy had been trapped close to sections worked by "Challenger" which had demonstrated a doming of isotherms in the centre of the Channel.

Malmberg (MRI Iceland)

Data from a multidisciplinary cruise to the north and west of Iceland in September 1987 were described in general terms. A data report was tabled, based on discrete samples. CTD data are still in course of preparation. The cruise included sections across the Denmark Strait. Two current meter moorings had also been deployed west and north of Iceland. In cooperation with Denmark five further moorings are to be deployed in September 1988.

Becker (DHI)

A wide-ranging CTD survey of the Iceland basin of the North Atlantic had been worked in July/August 1987. This was supplemented by a line of three current meter moorings on the slope south of Iceland. The CTD data revealed that the overflow water had at that position broken into at least 3 distinct streams at depths of about 1,000, 1,400 and 2,000 m, and it was in these streams that the moorings had been placed. The CTD data were still being processed. It is planned to repeat the same station pattern in the summer of 1988 when the moorings will be recovered.

Dickson (MAFF)

Two moorings each with 2 current meters have been deployed since Autumn 1986 on the Greenland Slope south of the exit from the Denmark Strait. They were recovered successfully in June 1987 and have been replaced by eight moorings for another year.

Lippert (IFM, Hamburg)

Numerical modelling studies of the exchanges between the North Atlantic and the Norwegian Sea were described. They form part of a hierarchy of models ranging from a large-scale process model of the North Atlantic to small-scale regional circulation models. The models will require data for validation, particularly in the form of time series of temperature, salinity, and currents over long periods (several months). The combination of the effects of meteorological forcing, high stratification and complex topography make the modelling of flows in the area very difficult. It was noted that Drs Peter Lundberg and K Borenas of Univ Goteborg were also involved in numerical studies of Channel flows, in particular as they affect the Faroe Bank Channel.

Van Bennekom (NIOZ)

III. General Discussion

A large mass of data had been collected in the past year, and this is summarized in Table I. Several points seem to emerge:

1. There is a problem with trying to measure the deep flows far away from the sills. This is because flows are not localized and move up- and down-slope as the energetics of the flow change. Secondly, the calculation of volume transports is made difficult by using

instruments at discrete levels since the position of the sharp interface cannot be accurately assessed. A long sensor that integrated temperature along its length would be a useful new tool.

2. The ADCP had emerged as a useful new device for the investigation of water circulation - either alone or in conjunction with geostrophic calculations. There was a need to disseminate the expertise gained by the labs who had experience and a perceived need to have a good understanding of the barotropic tides in our area of interest.

3. Some understanding was now available of where the serious measurement problems lie in assessing, particularly, the surface inflow to the Norwegian Sea. These seemed to be:

   (a) What is the mechanism by which transports in the slope current increase so drastically on crossing the W-T ridge?

   (b) What is the normal circulation pattern NE of the Faroes?

   (c) What are the seasonal and interannual variations in the strengths of the in- and outflows and, perhaps also, are there changes in circulation patterns from year to year?

   (d) What is the primary forcing mechanism for the seasonal and interannual variability - is it wind stress?

IV. Data Exchange and Banking (Dr L Rickards represented the MDM interests in place of Dr M T Jones).

The compilation of observations showed that there was a large volume - particularly of CTD data - and that in order to interpret this properly the data needed to be assembled in one location.

It was agreed in accordance with C. Res 1986/4.14 that CTD and nutrient data should be submitted to ICES Headquarters, and the Hydrographer agreed that this was appropriate. It would be preferable to submit data to the Hydrographer in ICES Blueprint format but GF3 was also acceptable. Where possible, if formats that were new to ICES were to be submitted, test tapes should be sent as soon as possible. It was thought that many of the data could be assembled in a common format at ICES by the end of 1988.

Current meter and thermistor chain data were a lesser problem! In view of the experience of handling such data by MIAS; it was suggested that if possible MIAS should act as the focus for this activity. Any input data format could be handled but it was requested that as much information on formats, data collection procedures, etc. should be provided to MIAS with the data. Time series relevant to NANSEN would be entered into the current meter inventory. Inventory information for observations during 1985, 1986 or 1987 were deemed relevant.

Very few XBT data had been collected, mostly by SACLANT, IOS and DHI, and it was believed that all of these had been, or would be, archived in the appropriate national data centres and could, therefore, be exchanged. SeaSoar data posed a more serious problem in the long term, but some had already been archived in MIAS (from JASIN).

It was thought that a restriction on distribution to non-NANSEN participants before 1992 of NANSEN data submitted to ICES and to MIAS was

appropriate, but this should be at the discretion of the originating institutes.

V. Future Work

(a) A review was made of cruise plans for 1988. These are summarized in Table II. The level of activity was lower than in 1987 but will be significant. It was agreed that detailed cruise plans, when available, should be distributed to NANSEN participants so that opportunities for intership research and calibration could be identified.

(b) A complete list of 1987 CTD and water bottle station positions would be compiled at IOS. Station lists giving:

(1) Station identifier
(2) Date/time
(3) Latitude and longitude (degrees, minutes to one decimal place)
(4) Water depth
(5) Maximum depth reached.
(6) Parameters measured.

should be sent to John Gould at IOS

(c) The possibility of arranging an ADCP workshop in early autumn 1988 would be investigated by IOS.

(d) It was noted that the (NKFO) had considered the question of the involvement of the Nordic nations in WOCE. The Chairman agreed to arrange a contact between the Chairman of the Nordic Council for Physical Oceanography and the Director of the WOCE Planning Office (Dr Needler).

(e) The Chairman drew the attention of members to the proposed update of eddy current statistics being carried out for WOCE by Dr Dickson. He requested members who had long-time series which had yet to be analyzed by Dr Dickson to notify Dr Dickson of their existence. Records longer than 9 months in deep water were appropriate.

(f) Chairman agreed to find and obtain cloud free satellite images of the area of the Iceland-Faroes front and distribute them to interested participants.

(g) Batch of Standard Sea Water to be recorded.

Table 1 Data collected in the NANSEN area in 1987 and reported at the meeting.

Name	Lab	Ship	Month	CTD	CM	XBT
Becker	DHI	Gauss	Jul/Aug	81	25	205
Malmberg	MRI	B Sæmundsson	Sep	88	4+20	?
Hopkins	SACLANT	Tydeman	May	123	20	200
Hopkins	SACLANT	Belgica	Sep	106		
Sherwin	UCNW	F Russell	Aug	71	10	
Dickson	MAFF	Cirolana	Jun	20	10	
Martin	DAFS	Scotia	Jul	9	4	
			Sep	21		
Osterhus	U Bergen	H.Mosby	Jun/Jul	167	15	
Blindheim	IMR	Eldjarn	Mar/Apr	62		
		G.O.Sars	Jul/Aug	200		
Ellett	SMBA	Challenger	Sep	66	5	
Gould	IOS	Challenger	May	90	35	73
Malmberg	MRI	B.S.	Feb	80*		
			May/Jun	80*		
			Aug	80*		
			Nov	80*		
Hansen	FRS	Magnus-H	Apr/May	102*	3	
			Jul	176		
			Aug/Sep	54*		
V Bennekom	NIOZ	Tydeman	Sep/Oct	17		?
				1,773	131	478

*Hydro-Biological investigations.

Table 2 1988 Cruises to the NANSEN area.

Contact	Ship	Dates	Area
Saunders	Discovery	19.V-12.VI	FBC - CGFE
Becker	Gauss	15.VI-15.VII	Iceland Basin
Dickson	Cirolana	19.VI-20.VII	E.Greenland to UK
Hansen	M.Heinason	20.IV-4.V	FBC + FSC
		18.V-1.VI	Around Faroes
		10.VIII-30.VIII	Norwegian Sea
		Feb	Seasonal and Standard Sections
Osterhus	H.Mosby	29.IV-25.V	I.F. Ridge
Henderson	Scotia	16.IX-4.X	FSC
Monstad/ Blindheim	G.O.Sars	Mar-Apr	W of UK + FSC
Blindheim	Eldjarn	Aug	Norwegian/Iceland Sea
Hopkins	Alliance?	Jun/Jul	I.F. Ridge