RAPPORTSERIE

Nr. 18 - Oslo 1984

TORGNY VINJE:

The Fram Strait Cruise with M/S 'Lance'
17 - 31 August 1984

NORSK
POLARINSTITUTT

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Part reports

THE FRAM STRAIT CRUISE

Background and objectives

The oceanographic conditions in the Arctic are dominated by the negative radiation balance which require a heat transport from lower latitudes towards the Arctic Ocean. The oceanographic part of this heat transport constitutes of the inflow of warm Atlantic water and the outflow of ice and colder water through the Fram Strait. The other passages between the Arctic Ocean and the surrounding seas are far too narrow and shallow to be of importance in this connection. The Fram Strait therefore becomes a key area for the study of climatic variations both regional and global as well as for the study of the spreading of particular matters and contamination between the world oceans.

The annual cycle of the radiation and the fresh water discharge, mainly by the large Russian rivers, constitute the large variations in this connection. The exchanges of ice and water through the Fram Strait also vary from year to year, and it is therefore necessary with measuring programmes which extend over a period of years to catch the effect of these variations.

Since 1981 Norsk Polarinstitutt has organized annual cruises in the Fram Strait to observe the magnitude and variation of the exchange from year to year of ice, water and suspended matter. The 1984-cruise was accomplished some weeks after a cross-section was made by POLARSTERN from the Alfred-Wegener-Institut, Bremerhaven. The observations made by LANCE will therefore this year also add to the knowledge of the change in conditions in the Strait over a period of some weeks.

A close co-operation has been established with several groups of specialists interested in the Arctic Ocean heat budget, then particularely at the University of Bergen, the University of Washington, Seattle, and the Alfred-Wegener-Institut, Bremerhaven.

Cruise plan and accomplishment

This cruise plan comprised of a series of part projects which will be reported on below (p. 13).

We started out from Longyearbyen the 17 August at 0115 GMT with altogether 19 expedition members on board. The ships crew consisted of 15 members and was headed by captain Jan Jansen.

The two bottom pressure gauges deployed from LANCE last year NW of Spitsbergen were released the same afternoon and two new ones deployed (Fig. 1). We then continued towards one of the northernmost islands in the archipelago and landed two persons for inspection and service of an automatic weather station. Meanwhile LANCE deployed a current meter mooring at about $81^{0}04.8'N$ - $17^{0}45.68'E$ and made CTD-casts in the NE-ward running branch of the West-Spitsbergen Current. Having collected the people from land, LANCE headed NW-wards performing a CTD-section across the mentioned warm current branch.

Having reached the ice edge, LANCE was anchored to an ice floe for a 24 hours drift (drift track in Fig. 4). During the drift full ice and oceanographic programmes were performed. After that we steamed SW-wards along the ice edge taking oceanographic as well as ice stations at certain intervals (Fig. 1 and Table 1).

The ice conditions were particulare favourable this year and we menaged to cross the East-Greenland Ice Drift Stream, taking frequent CTD, ice and optic measurements, as far north as $80^{0}22'N$. The main core of the ice drift stream was only about 50 nm broad and consisted of small to medium multiyear ice floes with average concentration of 60%. (Cf Ice Chart in Fig. 2).

Having visited an ice barrier, extending from Nordostrundingen (described below under special observations), we headed southwards in open water to start a cross-section with full oceanographic and ice programme on the way back towards Ny-Ålesund along $78^{0}55'N$. Two more drift stations were carried through during this retour.

We arrived in Longyearbyen in the evening of 30 August and all expedition members left with plain at 0200 GMT the following day.

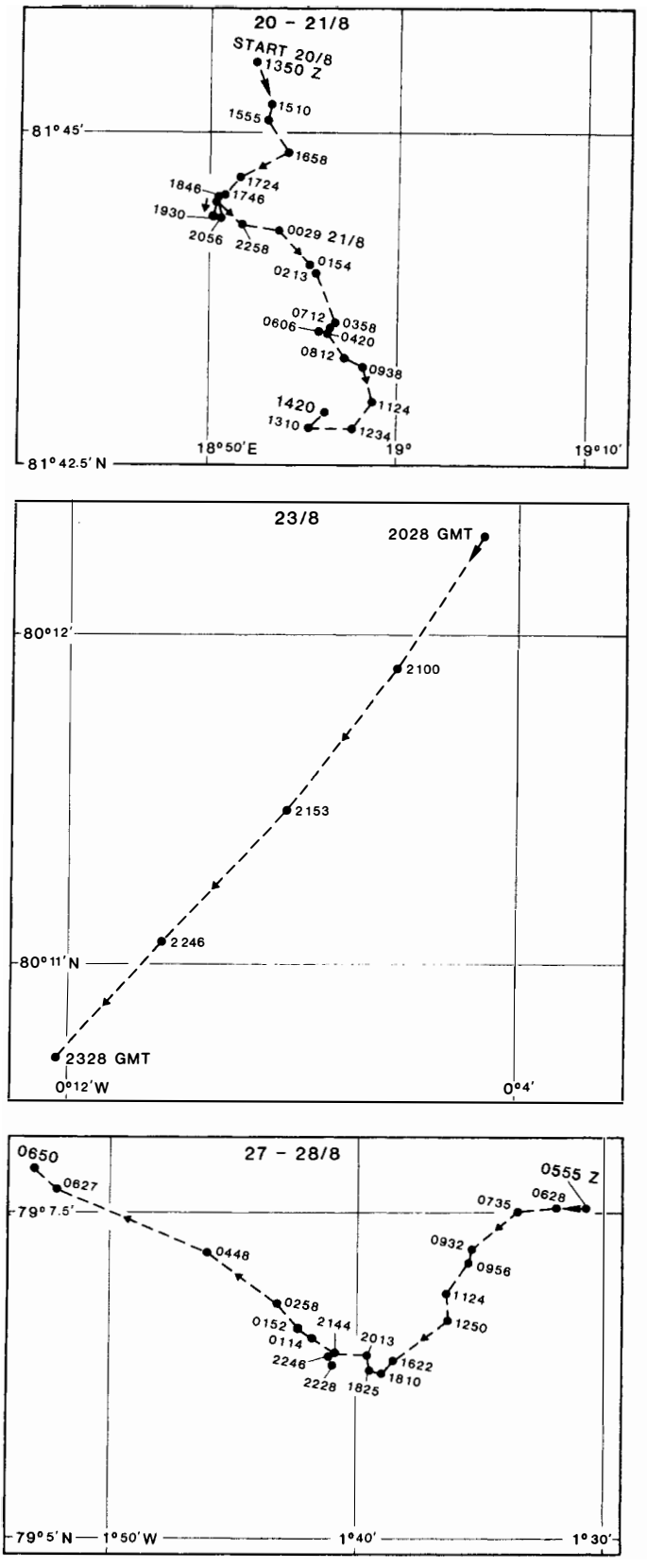


Fig.2

Drift tracks when anchored to ice floes.

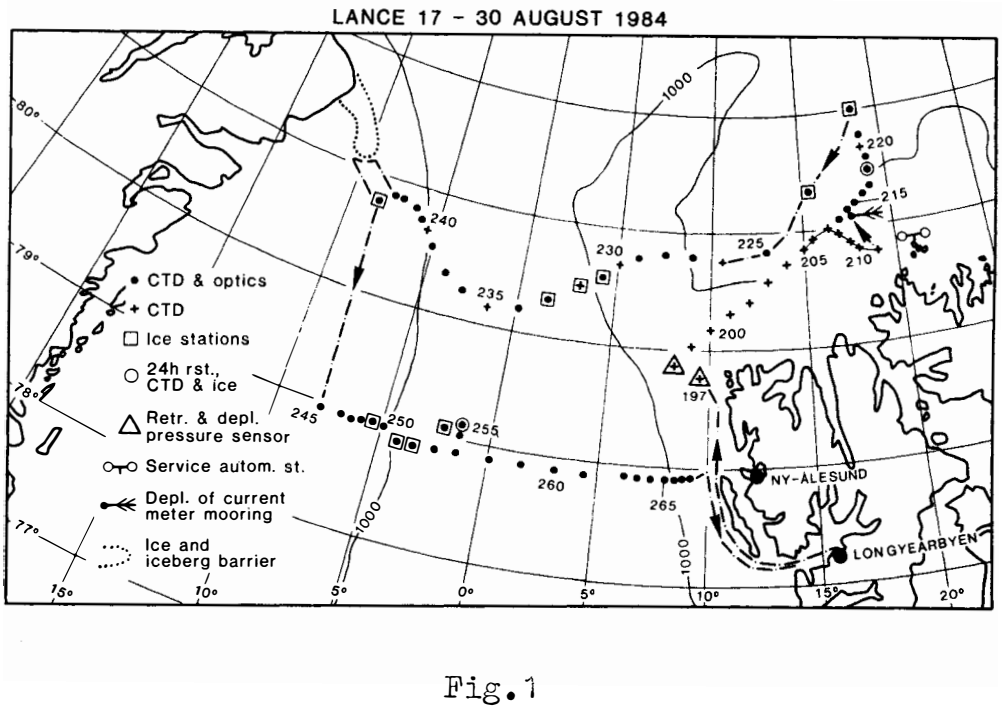


Fig.1

Sailing route and station numbers

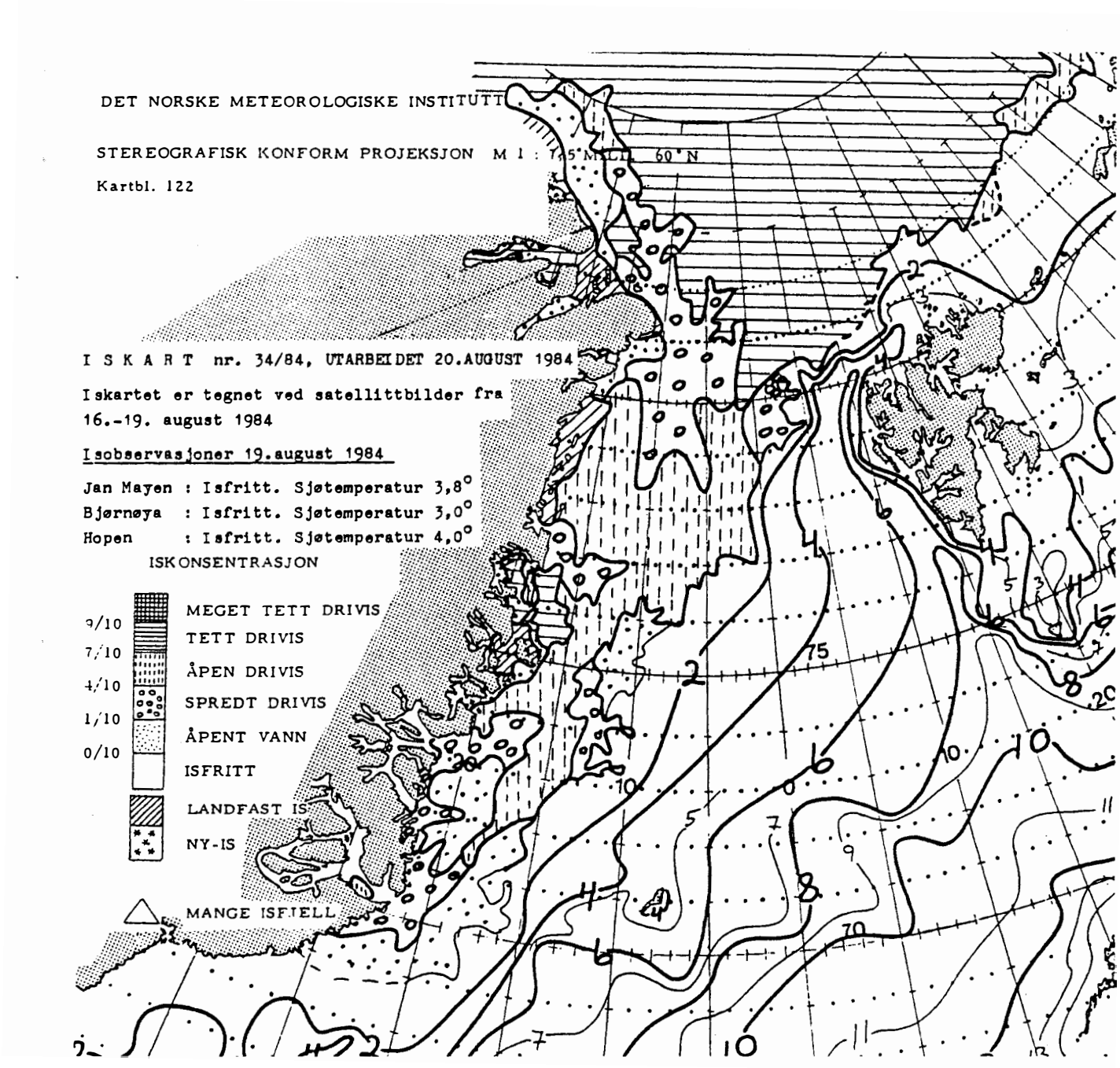


Fig. 2
Ice Chart

Position of stations

Table 1

Abbreviations:

CTD: Conductivity, temperature and depth (xx chemical sampling)
ICE: Ice specification, thickness, mini-CTD around ice floes, ice-water friction, ice keels
ICE 24: ICE + ablation + radiation + oceanographic development
SP: Special mixing processes
OPC: Optics + chlorophyll a

Station no	Lat.	Long.	N S E W	DATE Yr	Mo	Day	Time GMT	Depth to bottom	Observation CTD	ICE	ICE 24	SP	OPC
197	79 46.50	09 23.20		84	08	17	1715	378	x				
198	79 52.00	08 07.30		84	08	17	2130	560	xx				
199	80 02.50	09 00.00		84	08	17	2310	490	x				
200	80 10.50	10 00.00		84	08	18	0055	584	xx				
201	80 18.80	11 00.00		84	08	18	0235	342	x				
202	80 26.70	12 00.00		84	08	18	0405	498	x				
203	80 34.00	13 00.00		84	08	18	0535	785	xx				
204	80 42.00	14 00.00		84	08	18	0715	297	x				
205	80 49.50	15 00.00		84	08	18	0830	1735	xx				
206	80 53.20	15 30.00		84	08	18	1030	1980	x				
207	81 00.00	16 25.00		84	08	18	1245	1570	xx				
208	80 57.50	17 00.00		84	08	18	1415	680	x				
209	80 55.50	17 30.00		84	08	18	1520	370	x				
210	80 53.50	18 00.00		84	08	18	1605	174	xx				
211	80 49.30	19 00.00		84	08	18	1720	161	xx				
212	81 05.90	17 44.40		84	08	19	0900	499	x				x
213	81 04.00	17 00.00		84	08	19	1115	801	xx				x
214	81 08.00	17 30.00		84	08	19	1315	615	x				x
215	81 11.50	18 00.00		84	08	19	1425	460	xx				x
216	81 15.20	18 35.00		84	08	19	1535	495	x				x
217	81 19.00	19 05.00		84	08	19	1615	550	xx				x
218	81 28.00	18 59.00		84	08	20	0545	890	x				x
219	81 35.00	19 00.00		84	08	20	0725	1250	xx				x
220	81 39.60	18 40.00		84	08	20	0940	2880	x				
221	81 45.90	18 50.00		84	08	20	1330	3220	xx	x	x	x	x
222	81 42.80	18 56.00		84	08	21	1330	3200	x				x
223	82 00.00	18 22.00		84	08	21	1720	3340	xx	x		x	x
224	81 21.08	15 27.12		84	08	22	0525	2310	x	x		x	x
225	80 47.90	12 54.40		84	08	22	1600	1420	xx				x

Station no	Lat.	Long.	N S E W	DATE Yr Mo Day	Time GMT	Depth to bottom	Observation CTD	ICE	ICE	24	SP	OPC
226	80 42.00	10 30.00		84 08 22	2030	1348	x					
227	80 48.90	8 59.70		84 08 22	2235	719	x					x
228	80 47.00	7 30.00		84 08 23	0050	958	x					x
229	80 41.70	6 00.00		84 08 23	0245	750	x					x
230	80 39.00	4 52.00		84 08 25	0505	640	xx					
231	80 36.52	4 10.95		84 08 23	0645	810	x	x			x	x
232	80 29.70	2 57.30		84 08 23	1285	1507	xx	x			x	
233	80 22.60	1 28.10	E	84 08 23	1550	2770	xx	x			x	x
234	80 12.52	0 03.26	E	84 08 23	2015	3130	x					x
235	80 08.50	1 30.40	W	84 08 24	0200	2960	xx					
236	80 14.82	3 00.89	W	84 08 24	0520	2782	x					x
237	80 21.80	4 00.80	W	84 08 24	0840	2680	xx					x
238	80 31.00	5 01.00	W	84 08 24	1150	2060	xx					x
239	80 37.47	5 36.03	W	84 08 24	1440	1780	x					
240	80 42.70	6 01.30	W	84 08 24	1630	1310	xx					x
241	80 08.24	6 32.70	W	84 08 24	1810	975	x					x
242	80 49.20	7 21.00	W	84 08 24	2000	560	xx					x
243	80 52.60	7 40.00	W	84 08 24	2105	265	x					x
244	80 49.90	8 47.00	W	84 08 25	1120	71	x	x			x	x
245	78 57.00	7.58.00	W	84 08 26	0050	188	x					x
246	78 53.00	6 59.00	W	84 08 26	0240	260	x					x
247	78 51.00	6 30.00	W	84 08 26	0350	288	x					x
248	78 56.70	6 00.00	W	84 08 26	0455	432	x					x
249	78 55.70	5 30.00	W	84 08 26	0615	750	xx	x			x	x
250	78 56.60	4 54.00	W	84 08 26	1105	1260	xx					x
251	78 51.00	4 09.00	W	84 08 26	1340	1820	xx	x			x	x
252	78 51.20	3 27.30	W	84 08 26	1740	2325	xx	x			x	x
253	78 54.60	2 38.80	W	84 08 26	2155	2610	xx					x
254	78 53.00	1 30.00	W	84 08 27	0130	2690	x					x
255	79 07.04	1 36.28	W	84 08 27	1100	2640	xx	x	x		x	x
256	79 07.80	1 53.10	W	84 08 28	0700	2640	x					
257	79 02.80	2 05.60	W	84 08 28	0900	2600	xx	x				x
258	78 54.70	0 00.00		84 08 28	1425	2520	xx					x
259	78 54.50	1 29.50	E	84 08 28	1735	2540	x					x
260	78 54.80	2 59.70	E	84 08 28	2050	2380	x					x
261	78 51.10	4 29.80	E	84 08 29	0000	2790	xx					x
262	78 54.90	6 11.00	E	84 08 29	0340	2120	xx					x
263	78 55.40	6 38.10	E	84 08 29	0540	1565	xx					x
264	78 55.30	7 17.40	E	84 08 29	0735	1202	xx					x
265	78 55.00	8 15.00	E	84 08 29	0930	836	xx					x
266	78 55.00	8 26.70	E	84 08 29	1100	485	xx					x
267	78 55.00	8 59.00	E	84 08 29	1235	225	x					x

Special observations

Since 1980 an ice barrier has been observed, extending from Nordostrundingen SE-wards over the fairly shallow (37 m) Ob bank. Such an accumulation of ice have not been observed in this area since the advent of satellites in 1967. The new feature seems to have existed in somewhat modified and variable shape since 1980 until today. (Vinje 1982 and 1984 in Polar Record 21(131) and 21(135) resp.)

We arrived at this barrier 25 August at 81°18´N - 09°34´W. It turned out to consist of a mixture of fairly large, tabular icebergs and heavily ridged drift ice with a relatively high freeboard, between 1-5 metres. The extension of this barrier as observed from satellites in August 1983 and 1984 together with a picture illustrating the dimension of the icebergs and the drift ice are given in Fig. 3.

Altogether 60 tabular icebergs and two capsized ones were observed at 80°04´N - 10°13´W. Most of these icebergs, which were observed south of the main barrier, seemed to be stranded.

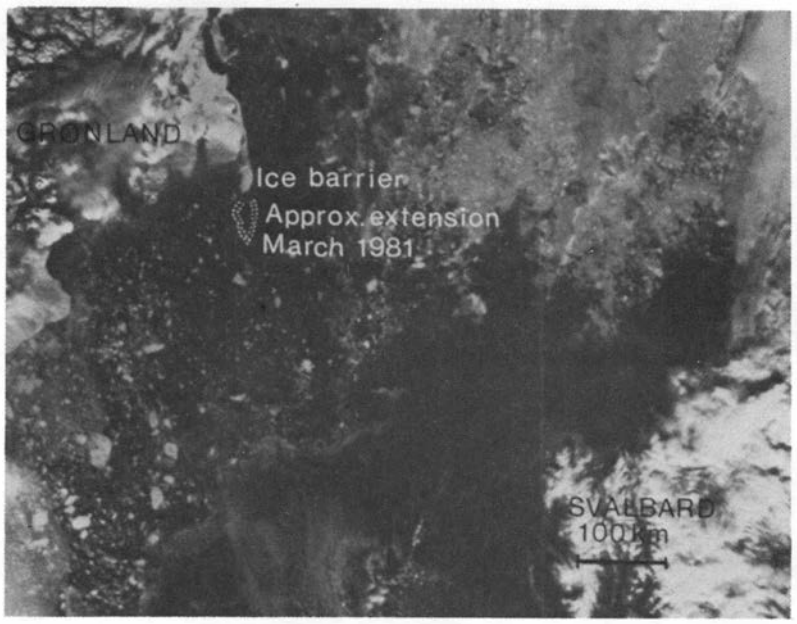
With the aid of radar and a sextant captain Jansen made the following observations:

Table 2

Dimensions given in metres

Lat N	Long W	Freeboard	Remark	Length	Width	Water depth
81°18´	9°34´	4	Tabular	330	100	120
81°16´	9°48´	8	"			100
81°15´	10°03´	32	Capsized	618	315	73
81°13´	10°04´	18	Tabular	105	70	73
81°08´	10°18´	18	"	85	60	78
81°05´	10°17´	10	"	370	320	66
81°04´	10°20´	18	"	100	70	60
81°03´	10°21´	12	"	100	80	56
81°06´	10°05´	10	"	400	200	55
81°06´	10°07´	18	"	80	80	55
81°06´	10°09´	9	"	150	70	53
81°06´	10°09´	8	"	80	60	53
81°06´	10°09´	9	"	200	150	53
81°05´	10°15´	23	Three" in a row	150	100 total	56
81°04´	10°17´	6	Four " in a row	880	300 total	54
81°03´	10°30´	21	"	320	150	54

A



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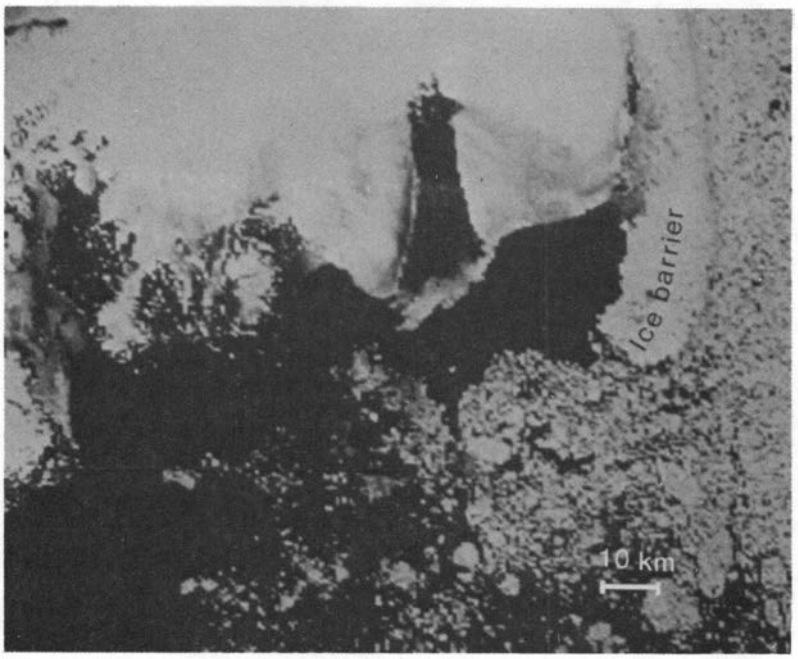

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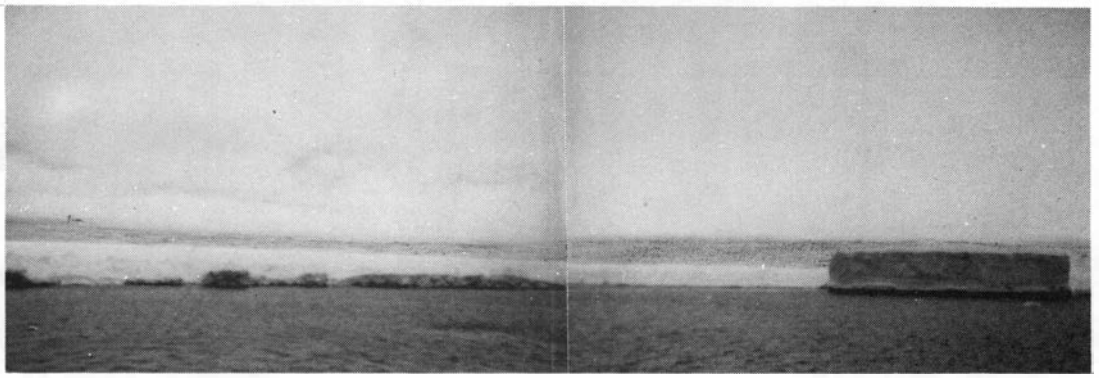

Fig. 3. The ice barrier extending from Nordostrundingen.
A. NOAA-7 image received in Tromsø 24 August 1984.
B. LANDSAT-4 image received in Kiruna 20 July 1983.
C. The ice barrier seen towards the north at 81°13'N, 10°04'W 25 August 1984. Iceberg freeboard 18 m, water depth 73 m. Note the water sky in the background.

Name and addresses of participants

Torgny Vinje	chief scientist meteorologist	Norsk Polarinstitutt (NP) Boks 158 N-1330 Oslo Lufthavn
Bert Rudels	oceanographer	"
Monica Kristensen	glaciologist	"
Øyvind Finnekåsa	data specialist	"
Niels Nergaard	engineer	"
Svein Østerhus	oceanographer	University of Bergen Geofysisk institutt, Avd. A N-5014 Bergen-Universitetet
Anne-Marie Larsson	oceanographer	University og Gothenburg (UG) Oceanografiska institutionen Boks 4038, S-400 40 Göteborg
Per Ingvar Sehlstedt	engineer	"
Earl Krause	engineer	University of Washington Applied Physics Laboratory 4057 Roosevelt Way N.E. Seattle, WA 98105
Henning Hundal	engineer	Institutt for fysisk oceanografi University of Copenhagen Haraldsgd 6, DK-2200 København
Siobhan O'Farrell	oceanographer	Scott Polar Research Institute Cambridge CB2 1ER, UK
Steven Lovell	glaciologist	"
Rob Massom	engineer	"
Peter Sloth	oceanographer	Grønlands fiskeri- og miljøundersøgelser Tagensvej 135 1. sal DK-2200 København K
Rune Dietz	biologist	"
Bjørn Erlingsson	oceanographer/ sea ice	Institutt for geofysikk University of Oslo Boks 1022, Blindern N-0315 Oslo 3
Lasse Petterson	oceanographer/ sea ice	"
Bengt Bjarne Larsen	marine geologist	Institutt for geologi Boks 1047, Blindern N-0316 Oslo 3
Fridtjof Austlid	meteorologist	Det norske meteorologiske institutt (DNMI) Boks 320, Blindern N-0314 Oslo 3

Comments

M/S LANCE is a practical, comfortable and well fitted platform for geophysical work in ice infested waters. The co-operation with the ship crew was as usual specially good and this contributed highly to increase the efficiency of the expeditionary work.

Part reports

OCEANOGRAPHY

Participants

Bert Rudels NP (responsible), Anne-Marie Larsson GU and
Per-Ingvar Sehlstedt NP/GU

Background and objectives

The polar ice covers play an important part in the global radiation balance. Changes especially in the Arctic sea ice cover may, due to its low mass, come about quite suddenly. Since the extent of the ice covered areas have important climatological effects it is of interest to study and monitor the different components of the Arctic heat balance.

The dominant terms in that balance are the incoming solar radiation and the reflected short and outgoing long wave radiation. The meridionally advected heat fluxes in the atmosphere and in the ocean are substantially smaller, but due to the importance of the ice cover in the radiation balance changes even in these small contributions may be of importance.

The by far largest oceanic heatflux takes place in Fram Strait, where warm Atlantic water enters the Polar Ocean in the West-Spitsbergen Current and cold water and ice are exported by the East-Greenland Current.

In addition, because of the cooling conditions which prevail in winter both north and south of Fram Strait, in the Polar Ocean and in the Greenland Sea respectively, deep water formation takes place. The transformed water masses meet and mix in the Fram Strait, adding to the complexity of the current field in the strait.

A study of the hydrographic condition in the region of Fram Strait thus not only gives important information on the Polar Ocean heat balance, but may also shed some light upon the deep water formation which occurs in the above mentioned areas. In addition, the strong vertical and horizontal gradients in heat and salt give rise to strong and interesting mixing effects.

Performance

The oceanographic work consisted almost exslusively of CTD observations supplemented by a study of basic chemical parameters such as phosphate, silica and oxygen to help to identify the different water masses.

Two east-west sections were occupied. The northerly one, roughly along $80^0 20'$ was quite long and extended from the Svalbard shelf at 20^0E over the Sofia Deep and the Nansen Ridge across Fram Strait to the Greenland shelf. The southern section went east-west along $^0 78\ 55'$N between Greenland and Svalbard. A north-south section was taken along 19^0E from the Svalbard shelf into the Polar Ocean. Some additional stations were taken on the eastern part of the Svalbard shelf and in the Sofia Deep. In all 70 CTD stations were occupied.

A current meter mooring was deployed on the northern Svalbard slope at 490 m at 17^0E. The system consisted of 3 Aanderaa current meters and with a 100 m long thermistorchain added close to the surface and will, hopefully, register part of the Atlantic inflow along the northern continental slope of Svalbard as well as the interaction between Atlantic and Polar water especially during winter.

The mooring also act as a complement to the more extensive current meter programme run by the University of Washington and Universitetet i Bergen in Fram Strait.

Preliminary results

Perhaps the most striking feature was the high temperatures and salinities found in the Atlantic water. These were higher than those observed in 1980, and perhaps even higher than what was found in 1983. The Atlantic layer, especially on the southern section was more extensive than in previous years, mainly towards the west.

Another conspicuous feature was the thin low saline surface layer, which on the northeastern stations almost exclusively seemed to be the result of ice melt, due to radiative and atmospheric heating rather than to a heatflux from the Atlantic layer below. Polar water proper was only encountered towards the west and did not coesist of a thick layer even there. This may be related to the anomalous ice situation. Over the Yearmak Plateau, however, a region of low saline water was found. This has been encountered in previous years and may be the cause - or the effect - of the observed splitting of the West-Spitsbergen Current in that area.

In the deeper layers Greenland Sea Deep Water was observed close to the bottom at almost all stations taken in the central part of the strait on the southern section. It may have been more conspicuous west of the 0 meridian. To comment upon the deep water circulation do however require a much closer look at the observations than that, which has been done so far.

Publication

The oceanographic programme was a joint effort between NP and GU and report will be compiled. If the results so warrant, a more extensive work will be prepared.

SEA ICE INVESTIGATIONS

Participants

Torgny Vinje NP (responsible), Monica Kristensen NP, Niels Nergaard NP/CMI and Øyvind Finnekåsa NP

Objectives

The objectives of this project was to obtain: a) A thickness distribution of the sea ice passing through the Fram Strait. The study is a subproject of the Arctic Ocean heat budget study. b) Statistics on salt and nutrient profiles under a comparative study of the ice in the Barents Sea, the Eastern Arctic and the Weddell Sea (MK is responsible). c) Statistics on the sea ice field, drift speeds, radiation, melt rates and thermohaline conditions underneath the ice floes.

Field investigations

Ice thickness distribution

Altogether 105 drillings were made at various places across the Fram Strait. These add to a number of 280 drillings from previous years. The thickness measurements will be combined with drift rates from automatic stations to obtain the volume transport of sea ice through the Fram Strait. Fig. 4 shows the ralationship between freeboard and ice thickness measurements in 1984.

Ice cores

Fourteen ice cores were collected across the Fram Strait. The cores were drilled with a SIPRE corer with a diameter of 8 cm, and were divided into 20 cm long segments. The total length of each ice corer varied between approx. 2 m (first-year ice) and up to over 6 m (multi-year ice). Salinity profiles were obtained on board the ship using a Watnable salinometer, and samples were taken from each segment for further analysis of nutrient contents. Crystal structure and the presence of sediments and biological material was noted for some of the cores.

Melt rates and drift

During two 24 hour stations, LANCE was anchored to an ice floe while studies of the drift and melting of the ice were conducted. Melting from the bottom of the floes was measured with an inverted echo sounder. In an area with 6/10 ice coverage, a melt rate of about 0.3 cm $hour^{-1}$ was found. The thermohaline conditions were measured repeatedly and the albedo was measured over different surfaces. Drift data were obtained through the satellite navigation system on board LANCE and is reproduced in Fig. 2.

General

The ice fields were described every three hours using the WMO code ICEOBS.

Publication of results

The results obtained for objectives a) and c) will be published as part of a study "On the sea ice transport through the Fram Strait" in Skrifter or Polar Research of NP. Results from the studies of salinity and nutrient profiles will be published in Journal of Geophysical Research.

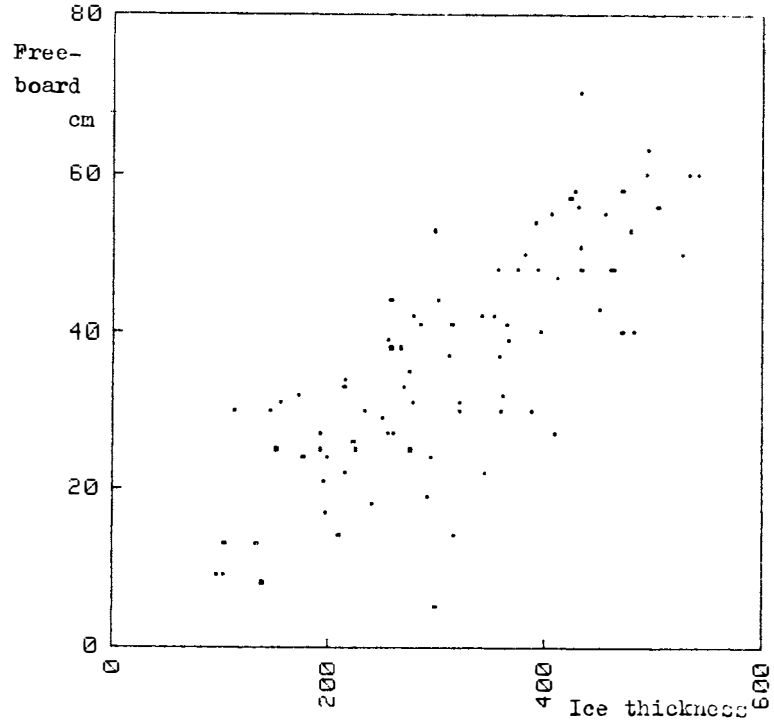

Fig. 4
Corresponding freeboards and ice thicknesses in cm

METEOROLOGY

Responsible

Fridtjof Austlid DNMI

Weather conditions

The cruise started with foggy, relatively calm weather conditions. A temperature drop occurred on the 21 August and the first snow fall was then observed. The temperature was slightly below zero after this date, and our operations were no longer hampered by poor visibility. The winds were light and variable with a predominant flow from west-northwesterly directions.

Meteorological services

The fax-receiver was not very cooperative at the actual latitude, and the few maps we received were generally useless. We established therefore a contact with the meteorological office in Longyearbyen Airport for retransmission of weather maps via a document-fax. This service was highly effective and generally we received weather maps once a day (on working days) consisting of analysis 0600 Z prepared at the Airport, 24 h prognosis 0600+24 h prepared at the Norwegian Meteorological Institute, and subjective 48 and 72 h prognosis prepared at Bracknell. Once a week we got ice charts which turned out to be very useful for our planning of the route through the East-Greenland Ice Drift Stream.

Based on the weather maps and the prognosis, a forecast could be suggested. Of particular interest was the probability for a wind increase which was of special interest for the operation in the polar pack.

Observations on board LANCE

Meteorological observations are taken on board LANCE on a regular basis every three hour. Whenever there is ice, an abbreviated information is given at the end of the obs, prefixed ICE. This ice information adds to the more specified observation made in accordance with the WMO ICEOB-code.

ICE-CURRENT FRICTION

Participants

Members of the field project was Lasse Petterson and Bjørn Erlingsson as responsible. Both from the University of Oslo, Institute of Geophysics, Department of Oceanography

Objective

The objective of the programme was to measure the turbulence field in the sublayer under a drifting iceflow for various external conditions.

Field work

The field procedure was to hang an ultrasonic current meter (SIMRAD UCM-10) in a position 2-3 metre from the bottom of an iceflow. The iceflow was to be typical for the ice conditions in roughness and size. To find a proper position in the developed turbulent sublayer there was a possibility for on-line readout of the measured values (three components of current, compass, temperature and pressure) with a readout unit (UCM-RD). The data was then recorded on a cassette for later prosessing. The wind (strength and direction) was measured instantly under the recordings. As far as is possible to say at this moment registrations were obtained. Those registrations of various burst intervals (15 sec., 5 sec., 2 sec.) record the mean and turbulent fields generated by the tide, wind and the swells. There were made at least two 15 min. series at each depth, at various depths on 16 ice-stations. As the temperature was registrated, there is a possibility to determine the turbulent transport of heat, which is used for ice melting.

Publications

The results of this field work will at first be published as institutional report from the Institute of Geophysics, University of Oslo. The final and most interesting results will be submitted to Polar Research.

Comments

The crew on LANCE gets special thanks for various suport on carrying out this field work. The Norwegian Polar Research Institute has given financial suport for the extra costs.Simrad Optronics has provided extensive instrumentation for small compensation. The preparation work was done while B. Erlingsson was holding a fellowship from Nordic Council for Physical Oceanography. Lasse Pettersson has been a very special help on this field work. This valuable support has made this work possible.

A) THE MELTWATER INFLUENCE ON THE OCEAN MIXED LAYER IN NON-COMPACT ICE (SIOBHAN O'FARRELL)

B) MULTI-YEAR PRESSURE RIDGES IN THE MARGINAL ICE ZONE

Participants

Siobhan O'Farrell, Stephen Lovell, Robert Massom (responsible)
(all from Scott Polar Research Institute, Cambridge, England)

Objectives and short description of field work

The Meltwater Influence on the ocean mixed layer in non-compact ice
- Siobhan O'Farell

During the LANCE cruise of 17-30 August a programme of profiles of the upper ocean was obtained using a small Conductivity, Temperature, Depth instrument designed and built at the Scott Polar Research Institute.

The instrument was suspended from a pulley system and positioned on an icefloe during most of the ice stations. On the first 24 hour stations the instrumentation was suspended from the ship's pick up boat enabling a survey of the lateral variation in mixed layer properties to be measured in the adjacent polynya. An intercalibration was carried out alongside the Neil Brown CTD run by B. Rudels on the evening of the 24 from the ships ladder.

The objective of the field programme was to obtain profiles of the upper ocean where the buoyancy input into the mixed layer is from ice meltwater and mixing is governed by keel stirring of the drifting ice floes. At this stage in the season, the dominating input is from melt pool drainage rather than direct bottom or side ablation of the floes. thoug during the survey across the East Greenland Current in Fram Strait most of the meltwater on the floes had refrozen.

The data logged by the mini-CTD has now been transferred to micro-computer discs for more extensive processing. This has not been possible to carry out on board due to heavy workload and instrumentation problems. The data will eventually be used along with data obtained on board KVITBJØRN during MIZEX-84 as a comparison with numerical model of mixed layer and frontal development, as part of my PhD studies.

I am grateful for the help of N. Nergaard and E. Krause in overcoming some of the instrumentation problems, to B. Rudels for co-operation with CTD stations in the ice and to the captain and the ships crew for use of the small pick up boat enabling stations to be obtained in polynyas.

Multi-year pressure ridges in the marginal ice zone

- Stephen Lovell

The scientific objective of the cruise was to obtain underwater sonor profiles of typical pressure ridges encountered during the voyage. It was also hoped that the internal structure (if any) of these ridges could be revealed by chainsawing the ridge sails and photographing the result.

Most of the ridges surveyed were in fact consolidated multi-year structures and chain sawing revealed that internally the ice was completely homogeneous and devoid of any noticable internal structure.

The keels were surveyed using a Ratheon model 200t5HAD transducer mounted on aluminimum extension rods over the ice through a hole drilled there in. The profile was recorded on a Ratheon model DE-719C depth sounder. The recorder and sonar were both on loan from Austin Kovacs of CRREL,US.

At first profiles were obtained in the 50-105 feet range due to a malfunction of the short range mode. However, this fault was rectified and towards the end of the cruise data was obtained at the closer range.

These data will be used as a comparison with submarine upward looking sonar profiles held at SPRI and also as part of a programme to model the mechanics of presuure ridge formation and evolution.

I wish to thank the Norsk Polarinstitutt for the opportunity to conduct this fieldwork and also to the captain and crew of LANCE for their help and co-operation. I am also grateful to the Norsk Polarinstitutt for the loan of the portable generator.

We all wish to thank the people of Norsk Polarinstitutt and the members of the LANCE crew for making our work so enjoyable. The co-operation and facilities have been superb. We are indebted to Niels Nergaard, Earl Krause and Øyvind Finnekåsa for their constant help. Last but not least, we would like to thank Monica Kristensen and Torgny Vinje for creating such a genial atmosphere and running the cruise so smoothly.

PRESSURE MEASUREMENTS IN THE WEST SPITSBERGEN CURRENT AN NSF FUNDED PROGRAMME

Participants

Dr. James Morison is the project leader and chief scientist. Earl Krause is responsible for instrument preparation and field work. Both are at the Applied Physics Lab., University of Washington in Seattle

Objective

The project objective is to monitor the barotropic component of the West Spitsbergen Current using bottom mounted pressure gauges. The 1984 work is a continuation of a mooring programme which started in July of 1982. The first year measurements were made concurrent with Canadian pressure measurements west of Greenland and current meter arrays west of Spitsbergen. The data will provide new and fundamental information about the variability of the current system and its associated pressure signal and about the potential usefulness of ocean pressure measurements in experiments to study the heat balance of the Arctic Ocean.

Field work

Instruments deployed in the summer of 1983 were recovered from $79^{0}52'N$, $08^{0}01'E$ at 570 m depth and $79^{0}47'N$, $10^{0}24'E$ at 115 m depth. New moorings were deployed in approximately the same locations.

Each mooring package consists of a pressure gauge rigidly attached to a flat plate anchor via an Acoustic Release. Floatation is provided by a glass-ball bouy.

The pressure sensors are capable of measuring pressure signals of a fraction of a millibar for periods of a year or more at depths to 600 metres. The pressure data, along with temperature and time, is stored on magnetic tape.

Results

The 1982-1983 data set has been processed and is of high quality. Plots of the de-tided, corrected (for temp. and drift) pressure record have been made. Interpretation is pending. Within the ability to determine aboard ship, the 1983-1984 data set is also of high quality. Preliminary analysis of both sets should be complete by December of 1984. There are no plans to deploy equipment in 1985.

DOUBLE-DIFFUSIVE MIXING PROCESSES

Responsible

Svein Østerhus, Geophysical Institute, Avd. A, University of Bergen

Background

In Fram Strait warm Atlantic water from the south meets colder fresher water masses, formed, or transformed inside the Polar Ocean and returning south into the Greenland Sea. The differences in T-S characteristics are favourable for double-diffusive mixing processes to take place. Essentially we may expect double-diffusive convection to occur both between the low density cold polar surface water, which passes over warm Atlantic water, and deeper down in the water column, where intense frontal mixing activity causes the water masses to interleave and thus transforms the horizontal gradients into large vertical variations in temperature and salinity. The upper configuration gives rise to "diffusive interfaces", which may enhance the heatloss from the warm Atlantic layer to the surface, while the deeper intrusions will be rapidly removed both by "saltfingers" and by fluxes through "diffusive interfaces".

Performance

To observe these a CTD augmented by an acoustic current meter was allowed to slide slowly along a vertical wire. The instrument thus measured temperature, conductivity, pressure and the horizontal velocity vectors. The low descent rate allowed for the registration of changes in the observed parameters over a short vertical distance. The instrument is best suited to study the conditions at the diffusive interfaces where the strong temperature-salinity gradients are vertical and the horizontal motions are conceivable. In the finger case the motions are primarily vertical, while the temperature and salinity gradients are mainly horizontal on the scale of the "fingers".

A total of 16 successful "drops" with the instrument was performed. All measurements were made in the northern Fram Strait. On the last 24 hour ice station at $79^{0}6'N$, $1^{0}40'W$ an 8 hour jojo station was taken with the ordinary Neil Brown CTD.

Primary results

Since the signals are recorded internally and only a control that the instrument had registered the different parameters could be made on board no results of the observation can be given at the present stage. The measurements will be processed at the Geophysical Institute after the cruise.

OPTICAL MEASUREMENTS

Participants

Henning Hundahl, Peter Sloth (field work) and Professor Gunnar Kullenberg, University of Copenhagen (responsible)

Background and objectives

The project is a continuation of a similar project carried out in the same area in 1981 also on LANCE.

It's the purpose of the project through optical measurements in connection with the CTD-measurements to make an analysis of the movements and the mixing of the different watermasses in the area. Conditions at the fronts and the slope areas are of special interest.

Field work

The most important measurements are these of the scatterance function ($\beta(16^0)$). These have been made at about 40 stations following two sections along approximately 81^0N and 79^0N between Greenland and Svalbard.

In addition to these, chlorophyll-a fluoroscence measurements were made on all stations. In a few stations quanta irradiance and colour index were measured as well. The colour index is defined as the relation between the radiance (L) at two wavelengths (450 nm, 520 nm). All measurements were performed with instruments constructed at Dept. of Physical Oceanography and with the exception of the colour index instrument all instruments are of the in-situ profiling type.

Preliminary results

Generally it can be said that the scatterance had its maximum in whe surface layer. In a rather deep intermediate layer the scatterance was at a minimum and in the deep layers the particle content was rising towards the bottom or 1060 m which was the maximum depth of measure. The scattering were generally lower at the northern section than at the southern. At the western stations near Greenland the scatterance was very large. The clorophyll-a fluoroscence had as expected

its maximum values in the upper tenth of metres. At the stations west of 2^{0}W at the 79^{0}N section the chlorophyll-a maximum was very distinct and situated in a very thin layer at about 20 to 30 m depth. More results will have to wait on further analysis.

Publication

When and where the publications of the results of the optical investigations will be, is to be decided on by professor Gunnar Kullenberg later.

Comments

We are very satisfied with the data material collected at the two sections, which are of a unique character.

We thank the Norwegian Polar Research Institute for letting us participate and the crew on LANCE for good assistance and help through the cruise.

STUDIES OF DISTRIBUTION AND PRESENCE OF MARINE MAMMALS IN THE GREENLAND SEA

Participants

Rune Dietz (field work) Greenland Fisheries Environment Research Institute and Thor Larsen NP (responsible)

Objectives

The main objective is, through ship based "line transect" study to map the relative and absolute presence of seals, whales and polar bears. Observations from the northwest Greenland Sea is very sparse. Possible connections to the nutrient is to be elucidated.

Short description of field work and preliminary results

Since there was only one participant in this study it has not been possible to make a complete coverage of the sailed route. When off duty, observations from the crew have been noted to a certain extent. The observations have mainly been carried out while sailing and during acceptable weather conditions.

General comments

Animal life (marine mammals and birds) were extremely scarse in the loose pack ice between $00^{0}00'$ - $08^{0}30'$W on the latitude $80^{0}30'$ - $81^{0}00'$N. A similar lack of life was recorded on $00^{0}45'$ - $05^{0}30'$W further south at $79^{0}00'$N.

Following number of animals were added to Norsk Polarinstitutts data base on marine mammals:

Ringed seal	41
Hooded seal	39
Harp seal	1
Bearded seal	41
Walrus	2
Polar bear	1
White nosed dolphin	158-212
Killer whale	6-8
Beluga	50-100
Minke whale	4
Fin whale	2

Ringed seal

This species had a scattered distribution through most of the investigated area. Ringed seals seemed sparse west of and close to the north of Svalbard. This was probably due to the little ice in the area.

Hooded seal

Most of the recorded specimens of hooded seals had an assimilated distribution to the loose pack ice edge and the great depths in the central Greenlandic Sea ($03^{0}00'W$ - $03^{0}00'E$). Primarily young animals were seen.

Harp seal

Only one specimen was recorded northwest of Svalbard not far from a drifting ice floe ($80^{0}46'N$ - $14^{0}28'E$).

Bearded seal

Bearded seals are, as counts for the walrus, limited to the north by the close ice, since none of them are able to maintain breathing holes through more than 20-30 cm ice. On this cruise bearded seals were recorded up to $82^{0}00'N$ north of Svalbard ($18^{0}21'E$) on depths more than 2500 m. This position was the farthest north where the ship went. Numerous bearded seals were recorded more than 70 N M of the Greenland west coast (ca. $09^{0}W$) from $81^{0}00'$ - $79^{-}30'N$. The depths were less than 100 m, which deals with the bottom feeding habit of the bearded seals.

Walrus

Two specimens were recorded on an ice floe 25.8 ($80^0 46'$N - $08^0 32'$W) 56 N M out of the Amdrup Land. The depth was 70 m situated west of continental shelf well below the 200 m bathymetric zone that seems to be preferred by the walrus. The age of the two animals was estimated to 8 years due to the length of the tusks (ca. 15 cm). Only one animal has previously been recorded further north ($81^0 10'$) close to the east coast of Greenland. This animal was seen during the Denmark Expedition 6.6.1907 (Johansen 1910).

Polar bear

Tracks were recorded twice (ca. $80^0 10'$N - $00^0 00'$), and one specimen, probably a young adult male, was recorded 25.8 on $80^0 22'$N - $09^0 00'$E.

White nosed dolphin

This species were seen three times during the cruise. Due to information from the crew a school of 50-100 "Springere" was spotted 29.8 on ca. $78^0 56'$N - $06^0 00'$E. On the same day a smaller school (8-10 animals) was seen fouraging in the upper water layers on $78^0 58'$N - $08^0 45'$E. The water in this area had an obviously light green colour, probably due to primary production.

More than 100 individuals were recorded 30.8 north of Prince Karls Forland ($78^0 56'$N - $10^0 27'$E). These animals seemed to be fouraging as well.

Killer whale

A school of 6-8 animals were spotted from a distance of more than one nautical mile at $78^0 56'$N - $08^0 45'$E on 29.8. The typical sideward way of jumping out of the water made the observation confident.

Beluga/White whale

After the arrival at Longyearbyen on 31.8, 50-100 belugas were seen in the fjord (information from bridge).

Minke whale

Twice during this cruise a single individual was seen in the loose pack ice. On 26.8 at $78^{0}51'N - 03^{0}26'E$ a minke whale was recorded 9 nautical miles from the ice edge. The following day a similar observation was made at $79^{0}07'N - 01^{0}37'E$, 3 N M from the ice edge. On 29.8 one specimen was seen in open water at $78^{0}55'N - 07^{0}49'E$. The final observation of this species was done on 30.9 near Ny-Ålesund.

Fin whale

Two specimen were seen north of Prins Karls Forland ($78^{0}57'N - 10^{0}27'E$) on 30.8.

Birds were recorded with a secondary priority, because birds were beyond the scope of the project.

Indication of where to be published

Norsk Polarinstitutt Skrifter together with other information gathered on NP data base.

Recommendation and critics

Further knowledge about seals, whales and polar bears in the Greenland Sea is desirable to get an overwiev on the distribution pattern. Minimum 3 observers are needed to give a complete coverage during ship cruise. Aerial surveys and tagging could comprise a valuable supplement to the ship based information.

Finally I wish to thank NP and the crew of LANCE for the help and interest shown to my biological work during the cruise.

DANISH ENVIRONMENTAL INVESTIGATIONS AT THE EAST COAST OF GREENLAND

Participants

Peter Sloth (field work) and lic. scient. Erik Buch, Greenland Fishery and Environmental Research Institute (responsible)

Background and objectives

A literature study on sea ice, oceanography and meteorology of the areas around Jameson Land at the east coast of Greenland is being worked on as a preparation to an environmental research programme planned to be running for some years. The project is caused by a coming exploration of oil in the area. The study will primarly deal with work already done in the area 67^0 - 74^0N, 15^0 - 30^0W. Secondly it will deal with methods and instrumentations used in projects in similar areas (MIZEX, NORSEX etc.).

To give the project member a first hand impression of working conditions and methods in sea ice coated areas, the participation of the project member in the cruise of LANCE was arranged through an agreement between Norwegian Polar Research Institute and Greenland Fishery and Environmental Research Institute.

Publication

A report on the literature study and the LANCE cruise is expected to be finished in December this year.

Comments

I wish to thank the expedition members for a good cooperation.

CONCENTRATION, CONTENT AND ORIGIN OF PARTICULATE MATERIAL IN THE SEA ICE

Participants

Bengt Bjarne Larsen (field work) with Dr. Anders Elverhøi (NP) and 1st Amm. Dr. Per Aagaard (University of Oslo) as supervisers

Objectives

The intention on this cruise was to collect material for my University Degree in Geology at the University of Oslo.

One of the subjects of interest is to deduce the origin of the dirty material in the sea ice by analyzing the chemical and mineralogical contents. I will also try to use chemical analysis of ice to examine the effect of industrial pollution transported from the continents into the Arctic area.

Field work

I have sampled 6 ice-cores, of which 2 are clean ice and the rest "dirty" ice. I have also tried to quantify the dirty zones across the Fram Strait, but it was rather difficult because of a recent snow cover. One ice block was collected for chemical examinations of possible pollution in the area. Also during the cruise I have filtered sea water from 10 CTD stations, at 5 depths, to obtain background values of suspended sediment concentration.

I have no preliminary results to publish at this stage, but I can mention that the theory of the origin of this dirty ice is that it is formed on the shelves which surround the Arctic Ocean, especially on the Siberian Shelf. It then moves across the Arctic Ocean within the Trans Polar Ice Drift Stream and exits through the Fram Strait.

Publication

The project shall be published for my University Degree late 1985 or early 1986.

Comments

My thanks are due to the Norwegian Polar Research Institute (NP), Dr. Anders Elverhøi (NP) and 1st. Amm. Dr. Per Aagaard (U of Oslo) who made it possible for me to join this cruise.