NORSK POLARINSTITUTT

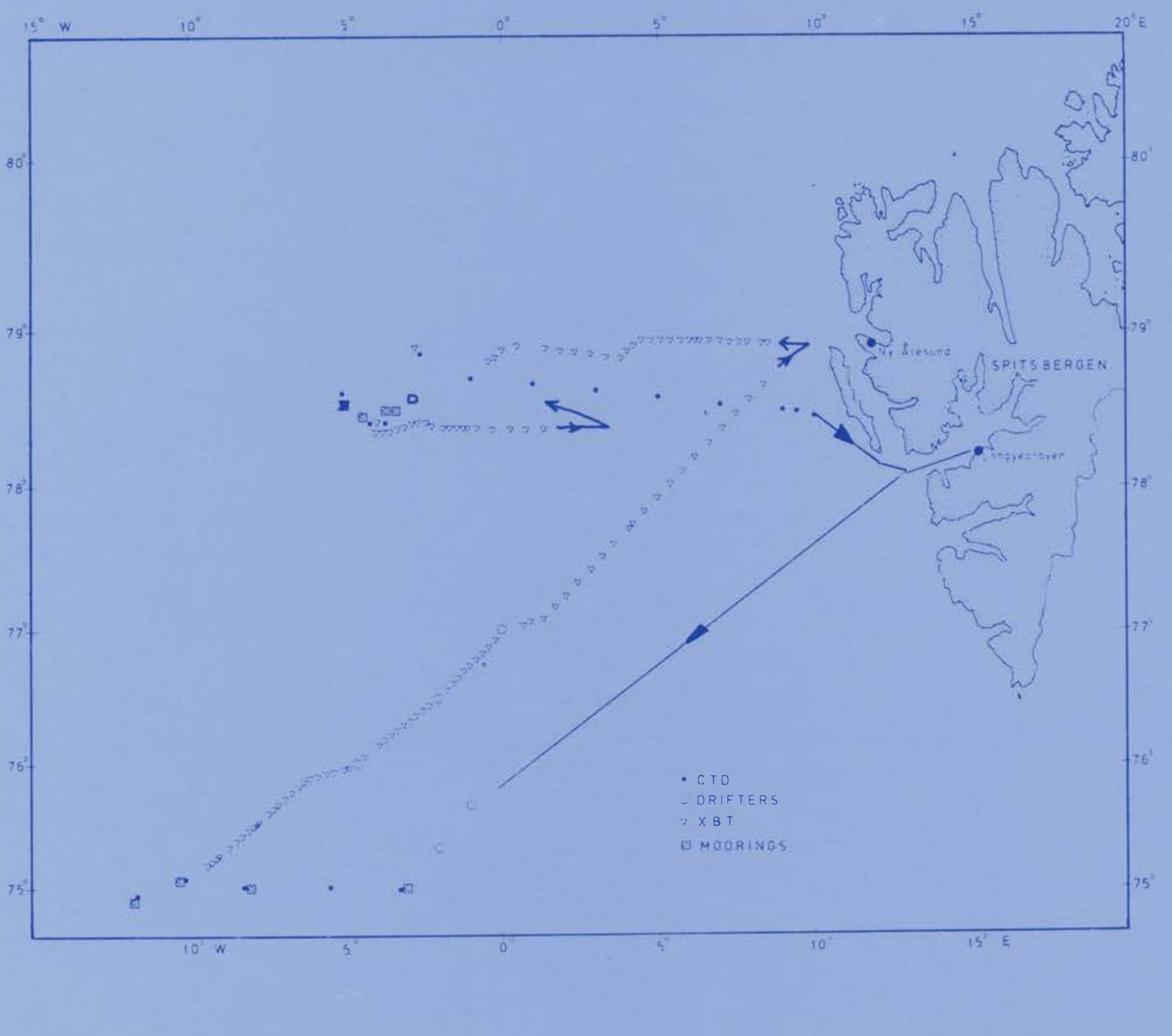
RAPPORTSERIE

NR. 82 - OSLO 1993

Svein Østerhus (Ed.)

CRUISE REPORT 1992

R/V Lance
Greenland Sea and Fram Strait



NORSK POLARINSTITUTT

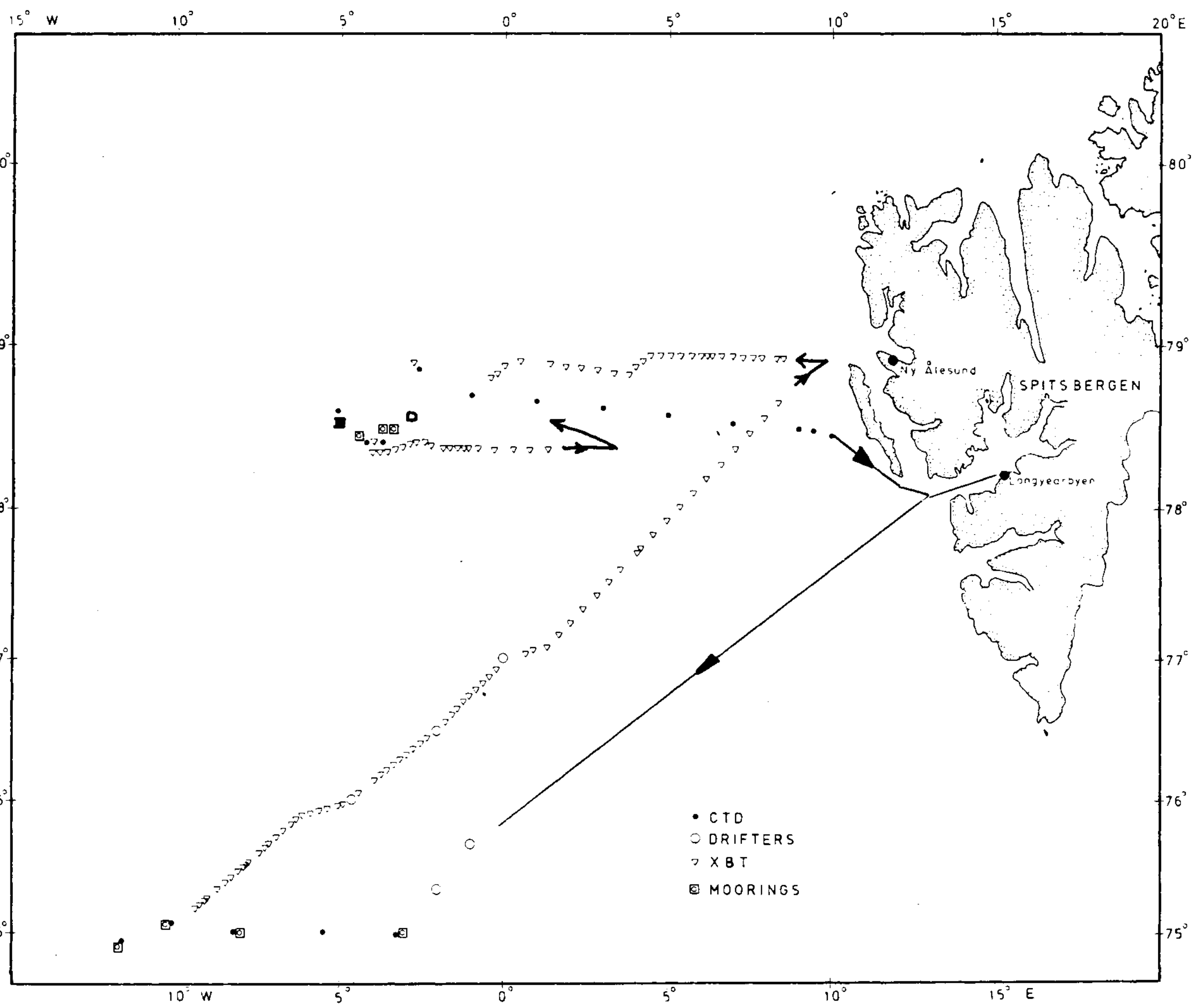
RAPPORTSERIE

NR. 82 - OSLO 1993

Svein Østerhus (Ed.)

CRUISE REPORT 1992

R/V Lance
Greenland Sea and Fram Strait



ISBN 82-7666-053-3
Printed August 1993

CRUISE NARRATIVE

Highlights

Expedition Designation

R/V Lance
Greenland Sea and Fram Strait
1992

Chief Scientists:	Svein Østerhus
Ship:	R/V Lance
Ports of Call:	Longyearbyen, Spitsbergen
Cruise Dates:	August 17 to August 31, 1992

CRUISE SUMMARY

The main task for the Lance 1992 cruise was to recover and deploy moorings for WMO Arctic Ice Thickness Monitoring Project (AITMP) in the Fram Strait and the Greenland Sea. AITMP is an international programme under the World Climatic Research Programme. The European Programme on Climatology and Natural Hazards (EPOCH) has funded four upward-looking sonars and SAR coverage in the Greenland Sea.

The cruise track and station locations are shown in figure 1.

A total of 17 CTD/rosette stations were occupied using EG&G Mark III B CTD, and a General Oceanic Rosette equips with 2.5 l Niskin water sampling bottles, figure 1.

Four drifters were deployed, figure 1.

Over 160 XBT were deployed, figure 1.

Nine instrument moorings were deployed and three moorings were recovered, figure 1.

Problems

The ice conditions were difficult and prevented us from reaching all the mooring positions. One scientist was injured and sent to the hospital in Longyearbyen by helicopter.

LIST OF CRUISE PARTICIPANTS

S. Østerhus	Norwegian Polar Institute
T. Løyning	
R. Korsnes	
J. Høkedal	
U. Druebbish	University of Hamburg
F. Schott	Alfred Wegener Institute for Polar and Marine Research
M. Visbeck	University of Kiel
T. Lothe	Geophysical Institute, University of Bergen
E. Nygaard	
S. Wells	Scott Polar Research Institute
M. Huddleston	
C. Darnall	NOAA Pacific Marine Env. Lab.
A. Roach	
A. Cresswell	
H.H. Shen	Clarkson University, New York
S. Ushio	National Institute for Polar Research, Japan
A. Honda	

Pilot and engineer from Lufttransport for helicopter operations.

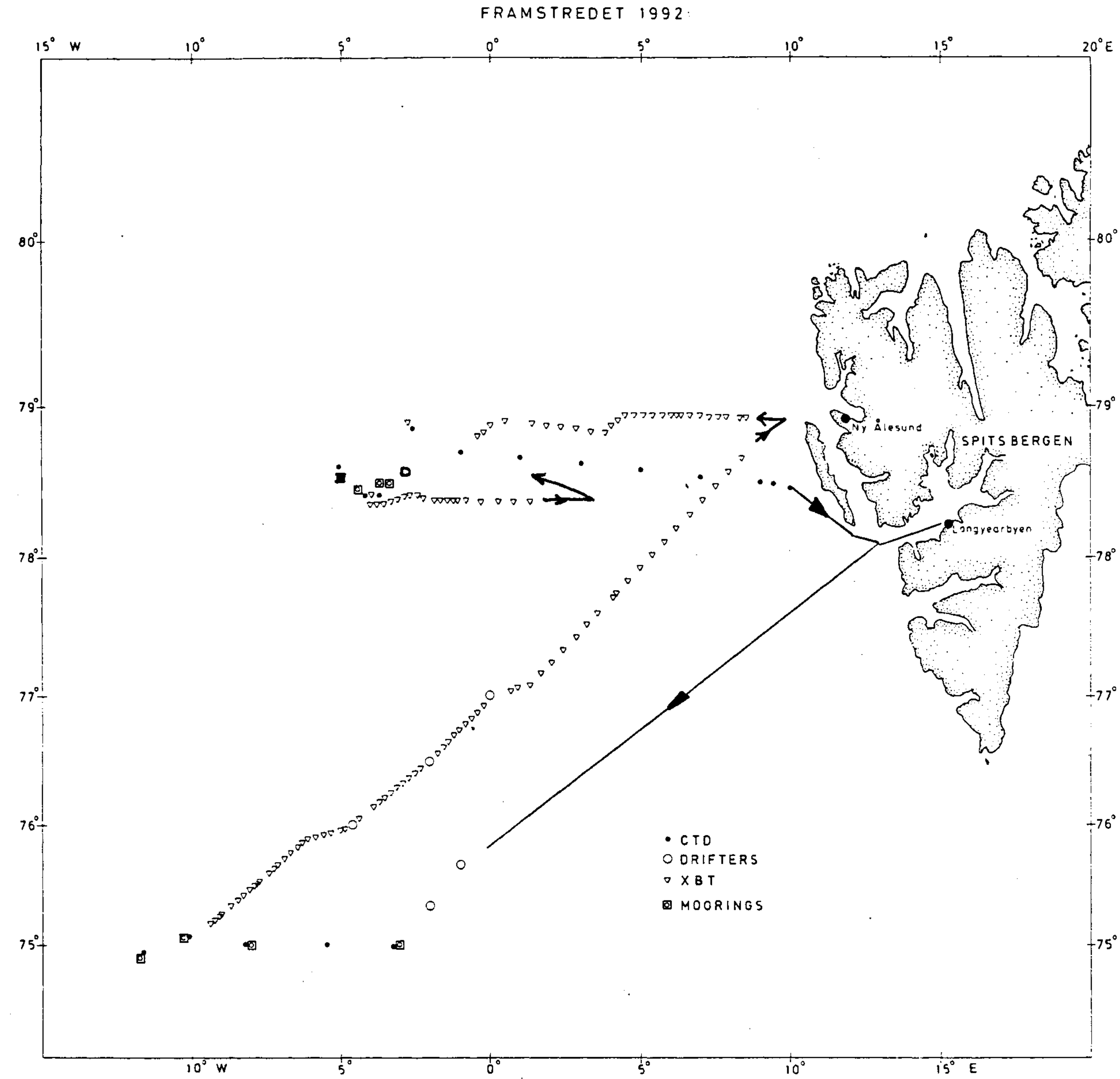


Fig.1

Cruise track and type of work of R/V LANCE 17-31 August 1992

INSTRUMENT MOORINGS

SVEIN ØSTERHUS

Mooring retrieval

During the Lance cruise 1991 we deployed four moorings at N75° from W10°15' to W13°35.5' (Østerhus and Finnekåsa, 1992). The moorings AWI-412 and AWI-413 deployed in 1991 were recovered. Because of the difficult ice condition we were not able to recover the other moorings.

Because of the ice conditions none of the Arctic Ice Thickness Monitoring Project (AITMP) moorings at the N79° were recovered.

Mooring deployment

Four moorings were deployed along N75° from W03° to W11°30'. One was a part of the Greenland Sea Monitoring Mooring Program (Visbeck, this issue); the three others were part of the Arctic Ice Thickness Monitoring Project (AITMP).

Five moorings were deployed in the Fram Strait as part of the AITMP and study of the fresh water budget. All the moorings carry upward looking sonars (CMR, APL) and current meters (Aanderaa).

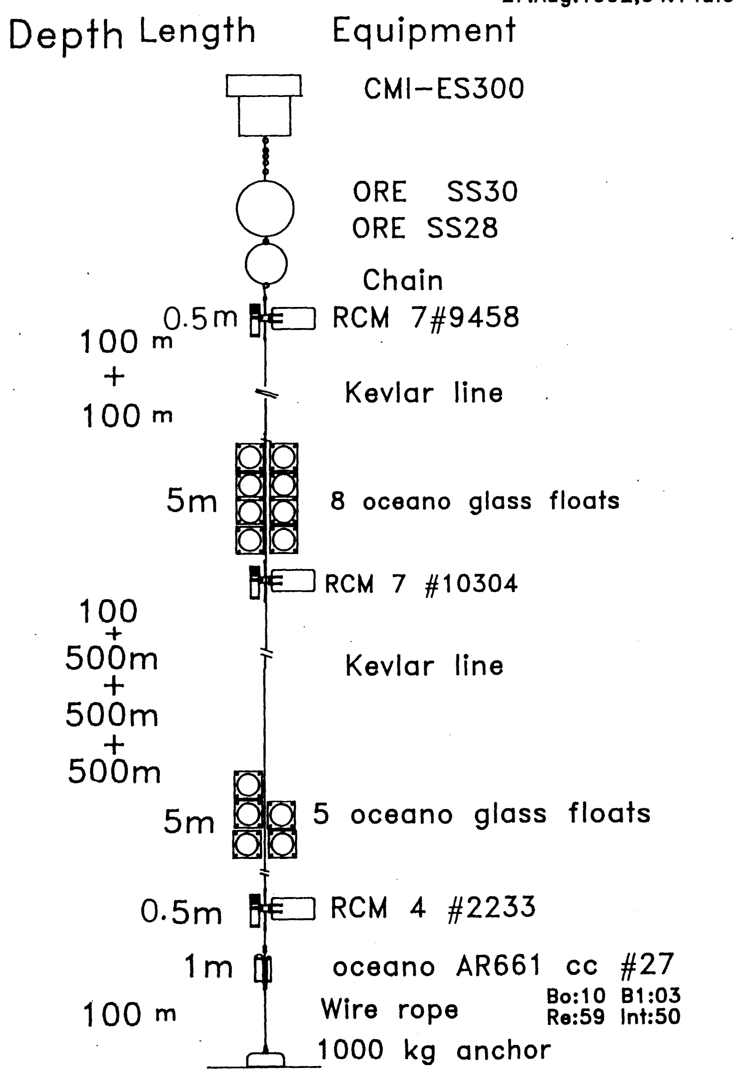
Latitude	*Longitude*	*Owner*
N 78°26.0'	W 06°00.0'	Meincke, 1 ULS Vinje
N 78°30.0'	W 03°11.8'	Aagaard
N 78°24.9'	W 04°04.1'	Aagaard
N 78°29.7'	W 03°41.8'	Vinje
N 78°27.5'	W 04°24.3'	Vinje

N P/ 92 / V 1.

Location: Fram Strait

Position: N78° 29.69′ W 03° 41.75′

Depth: 2076m (1500 m/s) Mooring in position 27.Aug.1992,04:14utc

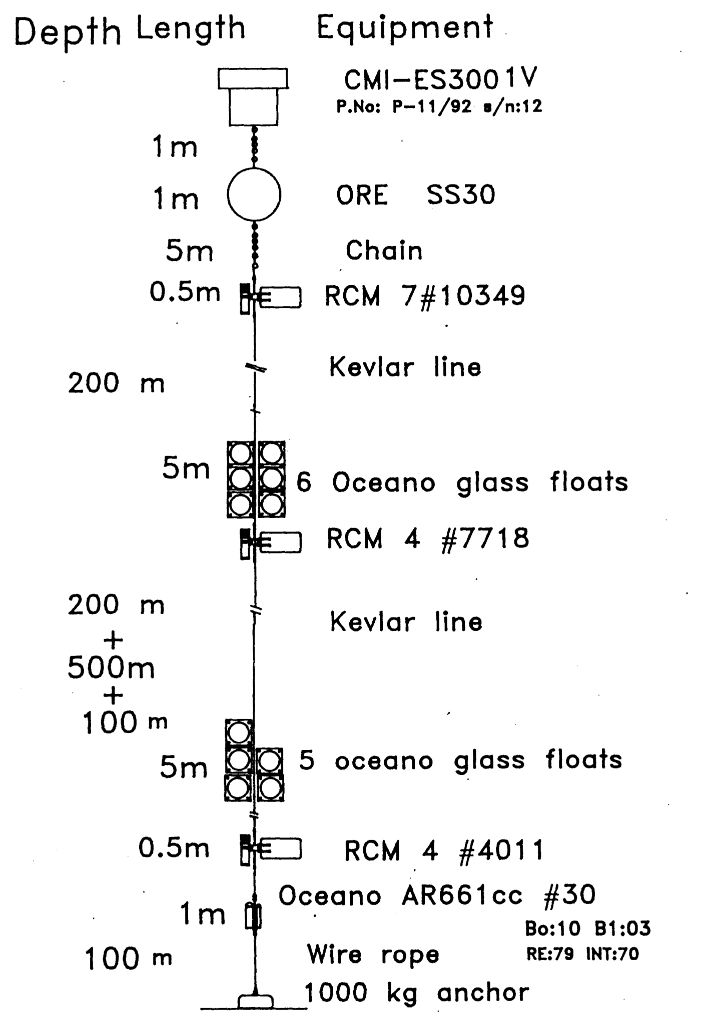


N P / 92 / V 2.

Location: Fram Strait

Position: N78° 27.54′ W04° 24.27′

Depth: 1236m (1500 m/s) Mooring in position 27.Aug.1992,11:16UTC



DEPLOYMENT OF SURFACE DRIFTERS

TERJE B. LØYNING

Six surface drifters were received from SACLANTCEN for deployment in the Greenland Sea. The drifters were packed in an inner an outer carton. The outer carton was removed, the inner carton was sealed with soluble tape, before the drifters were deployed. All the drifters were deployed in the deployment box (the inner carton). The ID number of the drifters, the time and position of deployment are given in the table below.

ID #	Date	Time (UT)	Latitude	Longitude
15889	19 August	13:15	N76°59.89'	W0°00.19'
15891	19 August	15:36	N75°40.15'	W0°59.47
15892	19 August	18:05	N75°19.71'	W2°00.79'
15894	19 August	20:39	N74°59.94'	W3°00.1'
15898	22 August	17:19	N75°59.98'	W4°36.22'
15908	22 August	19:51	N76°29.95'	W2°00.26'

CTD MEASUREMENTS

SVEIN ØSTERHUS

Vertical profiles of temperature and salinity were obtained using a Neil Brown Instrument System, EG&G, Mark III B CTD. A PC and the NPI CTD Data Acquisition System were used to log data in real time on disk. The CTD was combined with a General Oceanic Rosette sampler with twelve 2.5 litre bottles, for water sampling.

A total of 17 CTD cast was obtained using a Neil Brown MK III B CTD. Water samples were obtained for ashore analysis of salinity, radioactive carbon, tritium and helium.

CTD Calibration

A laboratory calibration was carried out after the cruise.

Two SIS reversing thermometers were used to check the CTD temperature in field. A total of 24 SIS thermometers was carried out in field. No disagreement between the laboratory calibration and the readings from the SIS reversing thermometers was discovered.

The CTD pressure sensor was checked against one SIS reversing pressure meter and compared with results from previous cruises.

143 water samples were collected for salinity analysis. The analysis was done at Geophysical Institute, Bergen shortly after the cruise. A Guildeline Instruments Portasal model 8410 salinometer was used for the salinity analysis. The Portasal salinometer was regularly calibrated against IAPSO Standard Sea water batch P114.

GREENLAND SEA MONITORING MOORING PROGRAM AT N 75° W 3°

PI: F. Schott, M. Visbeck and J. Fischer
Institut für Meerekunde Kiel, Germany

MARTIN VISBECK

The objectives of the Greenland Sea Monitoring mooring program are threefold:

- To understand the dynamics and statistics of convection events. These events can be detected by the vertical velocity profiles from the Acoustic Doppler Current Profile (ADCP) if their downwelling speeds exceed 1-2 cm/s. And also by changes in stratification and mixed layer depth as seen in the thermistor string and self contained CT (SEACAT) registrations.

- To archive a better understanding of the environmental conditions involved during the preconditioning and the active convection phase. Therefore we analyse the surface returned signal from the ADCP pulses in terms of wind and sea ice effects. Additionally meteorological information will be provided by the ECMWF weather forecast model and the overall ice conditions by satellite images.

- To monitor the year to year changes of the convection activity.

During the winter 1988-89 we had five ADCPs deployed in the central Greenland Sea during the extensive fieldwork phase within the framework of the Greenland Sea Project (GSP, 1990). This dataset shows convection events down to 1400m depth at the beginning of March 1989 within the ice free water bay formed in late January (Schott et al., 1992). In summer 1989 the first Monitoring mooring GSM01 was deployed but the ADCP failed. During the winter season 1989-90 the thermistor string records from that mooring show that the mixed layer depth never exceeded 250m until late April when the recording stopped and convection events are not likely anymore. The SSMI ice concentration data (L. Toudal, personal communication) also show a significant change between 1989 and 1990 with less ice during January-March in 1990. The followup mooring GSM02 was deployed in the summer 1990. It contained two ADCPs, four SEACATS (self contained temperature and salinity recorder) and two thermistor strings but could not be recovered in the summer of 1991, although during this time three cruises were scheduled to find the mooring.

During the LANCE 92 cruise the GSM03 mooring was deployed, in conjunction with the IFM Hamburg (J. Meincke) group, on the monitoring position N 75° W 3° at 01:20 UTC August 20, figure 1. The mooring is equipped with a radio beacon for the recovery on the top float, followed by a SEACAT. Further below a temperature measuring device is located every 20m down to 380m depth and from there on with 40m spacing down to 780m. The ADCP is looking upward from 580m depth and is measuring the horizontal and vertical velocities with 16m long depth cells upwards to about 250m depth with an accuracy of 1 cm/s for the vertical velocity and 2-3 cm/s for the horizontal components. The surface return signal is also stored and can be used for measuring the wind direction and estimating the windspeed (Schott, 1989). If the station is ice covered the ice drift is measured and a the ice thickness can be estimated (Visbeck and Fischer in prep.). The horizontal velocity profile is complemented by rotor current meter in 70m, 334m, 1100m, and 2460m depth. Since the stability of the water column in the cold water regions is controlled by salinity rather than temperature we distributed 4 SEACAT recorders throughout the water column to monitor changes in the salinity profile.

This work is sponsored by the Bundesminister für Forschung und Technologie (BMFT) under contract MFG 0071-8.

References:

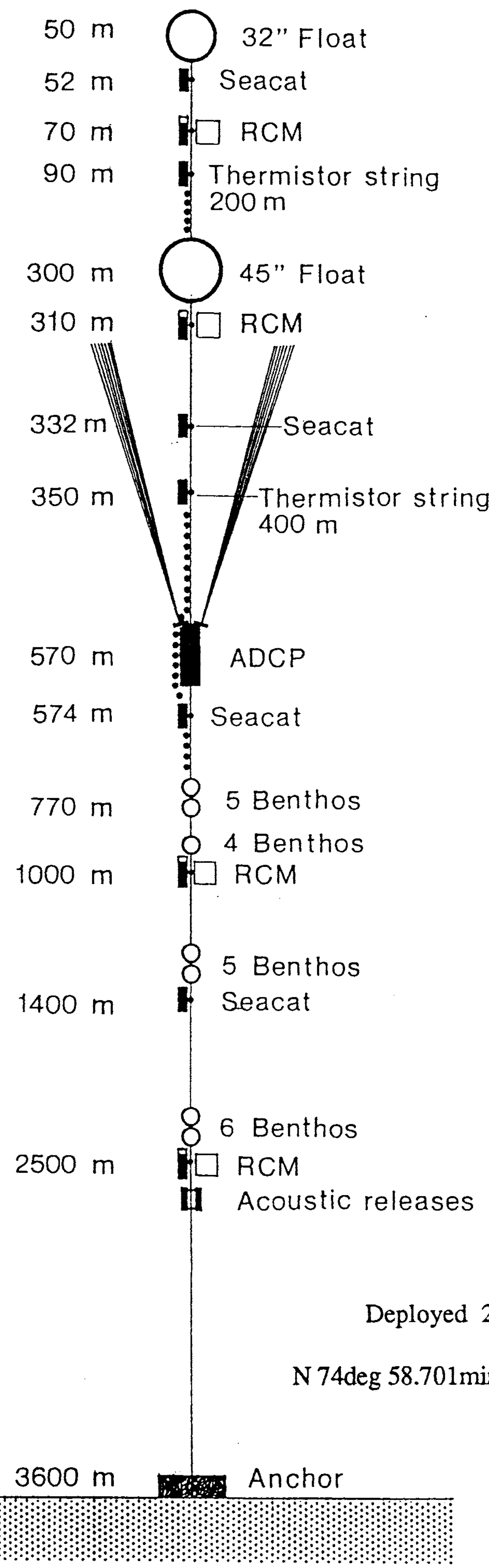
GSP group, 1990: Greenland Sea project: a venture toward improved understanding of the ocean's role in climate. *EOS, 71 (24)*, 750-755.

Schott, F., 1989: Measuring winds from underneath the ocean surface by upwardlooking acoustic Doppler current profilers. *J. Geophys. Res.*, *94*, 8313-8321.

Schott, F., Visbeck, M. and Fischer, J., 1992: Observations of vertical currents and convection in the Greenland Sea during the winter of 1988/89. Submitted to *J. Geophys. Res.*

Visbeck, M. and Fischer, J., 1992: Sea Ice observations by upward looking Acoustic Doppler Current Profilers. In preparation.

GSM03



Deployed 20 August 1992 at

N 74deg 58.701min - W 003deg 05.734min

SCOTT POLAR RESEARCH INSTITUTE PARTICIPATION, M/S LANCE CRUISE, GREENLAND SEA, AUGUST 1992

With the emphasis on the cruise on the recovery and deployment of buoys at N75° and N79°, and with much of Scott Polar Research Institute's equipment already committed to the Antarctic, our principal aim was to gain as much experience and knowledge of the conditions in the Greenland Sea area and ship based fieldwork as possible. This was done within the constraints of a very short preparation time and tight budget.

Our main scientific aims were two fold - to obtain detailed temperature profiles across the major current systems in the area using expendable bathy-thermographs (XBT's) and, whilst in the ice, to conduct simple ground truthing experiments for the ERS-1 SAR imagery now becoming available.

Over 160 XBT's were deployed from the ship in three sections. The first section ran from N75° W10' to N79° E10' with XBT's deployed every 20' of longitude until 0 longitude and thereafter at 40' intervals. This section ran parallel to the ice edge for a considerable time whilst west of the prime meridian. The second section ran from N79° E10' westwards to N79° E2', just inside the eastern limit of the ice, and the third, and most detailed, ran eastwards out of the ice from N78° W04' to N78° E01'. A detailed meteorological record was kept for these periods.

The datasets obtained will be used in comparison with the Atlantic Isopycnic Model (AIM) being developed at the James Rennell Centre for Ocean Circulation (a part of the Institute of Oceanographic Science) in Southampton. Models of this area are generally very poorly forced due to the lack of observations. The meteorological data will also be compared to AIM and ERS-1 scatterometer data.

At several ice stations a 3m x 1m grid was defined and the following information about the snow cover recorded: depth, temperature, density and inclination of the surface. A photographic record of the surface structure was also taken. An attempt was made to estimate the volume water content of the snow cover using a variation of Bader's method (freezing point depression). These observations will be compared with available SAR images.

Acknowledgements

The Scott Polar Research Institute and the Institute of Oceanographic Science provided funding and equipment. The XBT's were supplied by the Hydrographic Office, London; the Defence Research Agency (formerly the Admirality Research Establishment), Portland and the Institute of Oceanographic Science. We are grateful for the advice and assistance we received from all the staff of these institutes. We are especially grateful to the staff of the Norsk Polarinstitutt and the crew of M/S Lance for their help both before and during the cruise.

XBT LAUNCH DATA

NUMBER	DATE	TIME	LAT.	LONG.
001	FAIL			
002	FAIL			
003	FAIL			
004	08-22-92	06:57:51	75 10.9N	09 23.1W
005	08-22-92	07:14:06	75 12.8N	09 14.8W
006	08-22-92	07:27:18	75 14.5N	09 07.2W
007	08-22-92	07:34:14	75 15.4N	09 03.2W
008	08-22-92	07:39:47	75 15.9N	09 00.9W
009	FAIL			
010	08-22-92	08:13:29	75 19.9N	08 42.4W
011	08-22-92	08:38:46	75 22.9N	08 29.0W
012	08-22-92	08:58:56	75 25.3N	08 18.4W
013	08-22-92	09:19:38	75 28.0N	08 06.3W
014	08-22-92	09:38:11	75 29.8N	07 57.1W
015	08-22-92	09:45:54	75 30.7N	07 52.9W
016	08-22-92	09:59:01	75 32.2N	07 45.9W
017	08-22-92	10:32:52	75 36.3N	07 27.7W
018	08-22-92	10:53:45	75 38.7N	07 16.6W
019	08-22-92	11:08:56	75 40.4N	07 08.7W
020	08-22-92	11:33:58	75 43.4N	06 55.7W
021	08-22-92	11:57:07	75 46.1N	06 43.3W
022	08-22-92	12:22:05	75 49.1N	06 29.9W
023	08-22-92	12:42:33	75 51.5N	06 18.8W
024	08-22-92	13:00:00	75 53.1N	06 08.5W
025	08-22-92	13:24:14	75 54.2N	05 52.2W
026	08-22-92	13:47:08	75 55.2N	05 36.4W
027	08-22-92	14:08:15	75 56.1N	05 21.7W
028	FAIL			
029	08-22-92	14:36:01	75 57.2N	05 02.3W
030	08-22-92	14:51:07	75 57.8N	04 52.4W
031	08-22-92	15:11:26	75 59.1N	04 39.5W
032	FAIL			
033	08-22-92	15:37:13	76 01.5N	04 30.5W
034	08-22-92	15:50:33	76 02.*N	04 22.3W
035	08-22-92	16:39:39	76 08.5N	03 53.8W
036	FAIL			
037	08-22-92	17:01:23	76 10.9N	03 41.5W
038	08-22-92	17:18:31	76 12.9N	03 31.2W
039	08-22-92	17:39:32	76 15.2N	03 19.0W
040	08-22-92	18:00:12	76 17.5N	03 06.9W
041	08-22-92	18:20:43	76 19.7N	02 54.8W
042	08-22-92	18:41:14	76 22.0N	02 42.9W
043	08-22-92	19:01:06	76 24.2N	02 31.1W
044	08-22-92	19:21:16	76 26.5N	02 19.1W
045	08-22-92	19:41:08	76 28.7N	02 07.3W
046	08-22-92	19:59:46	76 30.6N	01 57.1W
047	08-22-92	20:21:00	76 33.5N	01 45.2W
048	08-22-92	20:44:09	76 36.6N	01 32.7W
049	08-22-92	21:00:51	76 38.9N	01 23.7W
050	08-22-92	21:22:21	76 41.9N	01 13.4W

NUMBER	DATE	TIME-UTC	LAT.	LONG.
051	08-22-92	21:41:49	76 44.3N	01 02.2W
052	08-22-92	22:00:15	76 46.9N	00 48.8W
053	08-22-92	22:21:07	76 49.7N	00 36.4W
054	08-22-92	22:40:23	76 52.2N	00 24.7W
055	08-22-92	23:01:31	76 55.5N	00 12.5W
056	08-22-92	23:22:49	76 58.0N	00 00.0
057	FAIL			
058	08-23-92	00:21:14	77 02.0N	00 41.9E
059	08-23-92	00:39:22	77 03.7N	00 56.0E
060	08-23-92	01:20:26	77 04.5N	01 21.4E
061	08-23-92	02:05:00	77 09.8N	01 43.0E
062	08-23-92	02:37:55	77 14.6N	02 03.0E
063	08-23-92	03:19:26	77 20.2N	02 26.4E
064	08-23-92	04:05:30	77 25.4N	02 52.9E
065	08-23-92	04:39:38	77 31.1N	03 13.2E
066	08-23-92	05:17:52	77 36.1N	03 35.0E
067	08-23-92	06:08:05	77 42.7N	04 04.3E
068	08-23-92	06:21:28	77 44.5N	04 12.0E
069	08-23-92	06:59:09	77 49.7N	04 34.4E
070	08-23-92	07:39:12	77 55.1N	04 58.5E
071	08-23-92	08:19:40	78 00.6N	05 23.2E
072	08-23-92	08:58:40	78 06.0N	05 46.8E
073	08-23-92	09:38:14	78 11.3N	06 11.3E
074	08-23-92	10:19:03	78 17.0N	06 37.7E
075	08-23-92	11:00:59	78 22.8N	07 03.6E
076	08-23-92	11:40:51	78 28.4N	07 29.0E
077	08-23-92	12:20:25	78 34.0N	07 55.8E
078	08-23-92	12:58:29	78 39.4N	08 21.3E
079	FAIL			
080	08-23-92	17:23:55	78 55.3N	08 29.8E
081	08-23-92	17:36:00	78 55.5N	08 18.5E
082	08-23-92	18:05:34	78 55.6N	07 50.7E
083	08-23-92	18:21:26	78 55.8N	07 35.3E
084	08-23-92	18:40:07	78 55.9N	07 16.8E
085	08-23-92	18:58:26	78 56.0N	06 58.0E
086	08-23-92	19:21:54	78 56.2N	06 38.0E
087	08-23-92	19:40:47	78 56.3N	06 19.8E
088	08-23-92	19:49:27	78 56.3N	06 10.5E
089	08-23-92	20:00:59	78 56.0N	06 00.0E
090	08-23-92	20:19:05	78 56.1N	05 42.5E
091	08-23-92	20:39:42	78 56.1N	05 23.0E
092	08-23-92	20:58:44	78 56.3N	05 05.3E
093	08-23-92	21:19:59	78 56.0N	04 45.8E
094	08-23-92	21:40:02	78 56.1N	04 27.5E
095	08-23-92	21:59:19	78 54.2N	04 13.8E
096	08-23-92	22:20:28	78 52.1N	04 00.5E
097	08-23-92	22:39:33	78 50.9N	03 52.7E
098	08-23-92	22:59:46	78 49.6N	03 47.7E
099	08-23-92	23:29:50	78 50.2N	03 21.3E
100	08-24-92	00:01:17	78 51.1N	02 51.0E

NUMBER	DATE	TIME-UTC	LAT.	LONG.
101	08-24-92	00:32:06	78 51.9N	02 21.0E
102	08-24-92	01:00:46	78 52.5N	01 53.2E
103	08-24-92	01:32:36	78 53.3N	01 23.6E
104	FAIL			
105	FAIL			
106	08-24-92	02:31:45	78 54.4N	00 29.9E
107	08-24-92	03:04:19	78 52.6N	00 00.9E
108	08-24-92	03:29:04	78 49.8N	00 11.9W
109	08-27-92	03:57:59	78 48.5N	00 24.2W
110	08-24-92	04:27:34	78 48.2N	00 22.2W
111	08-24-92	12:50:32	78 51.5N	02 36.1W
112	08-24-92	12:59:11	78 51.5N	02 36.1W
113	FAIL			
114	FAIL			
115	FAIL			
116	08-26-92	06:56:57	78 29.9N	04 26.3W
117	08-26-92	12:47:02	78 24.6N	04 13.3W
118	08-26-92	16:03:09	78 22.0N	03 48.3W
119	08-26-92	17:24:57	78 28.3N	04 03.2W
120	08-26-92	20:29:25	78 23.3N	03 31.1W
121	08-27-92	06:33:42	78 24.6N	03 43.8W
122	08-27-92	08:49:25	78 25.5N	03 57.3W
123	08-27-92	09:01:43	78 26.1N	03 58.1W
124	08-27-92	09:25:20	78 26.1N	04 01.3W
125	08-27-92	12:10:50	78 23.6N	04 04.7W
126	08-27-92	12:20:50	78 23.6N	04 04.9W
127	08-27-92	13:25:58	78 21.3N	03 59.6W
128	08-27-92	13:41:39	78 21.3N	03 50.6W
129	08-27-92	13:47:24	78 21.4N	03 45.0W
130	FAIL			
131	08-27-92	13:59:02	78 21.5N	03 34.0W
132	08-27-92	14:03:43	78 21.7N	03 29.3W
133	08-27-92	14:16:03	78 22.4N	03 18.8W
134	08-27-92	14:21:51	78 22.7N	03 14.3W
135	08-27-92	14:33:07	78 23.4N	03 04.5W
136	08-27-92	14:49:33	78 24.5N	02 50.0W
137	08-27-92	15:01:59	78 24.8N	02 40.0W
138	08-27-92	15:20:37	78 25.3N	02 23.3W
139	08-27-92	15:34:10	78 24.2N	02 13.0W
140	08-27-92	16:00:35	78 23.1N	01 52.5W
141	08-27-92	16:14:34	78 23.0N	01 39.5W
142	08-27-92	16:28:15	78 23.0N	01 25.1W
143	08-27-92	16:42:06	78 23.0N	01 13.0W
144	08-27-92	16:51:37	78 23.0N	01 04.5W
145	08-27-92	17:10:15	78 23.0N	00 47.2W
146	08-27-92	17:43:47	78 22.4N	00 17.8W
147	08-27-92	18:20:01	78 22.6N	00 18.0E
148	08-27-92	18:49:12	78 22.4N	00 47.4E
149	08-27-92	19:25:31	78 22.6N	01 21.3E
150				

MEASUREMENT OF WATER TEMPERATURE PROFILES, WATER AND AIR SAMPLING, AND PRELIMINARY OBSERVATION OF SEA SURFACE WITH AN INFRARED CAMERA

[1]) National Institute of Polar Research, Tokyo, Japan
[2]) Inst. of Low Temp. Sci., Hokkaido Univ., Sapporo,Japan

SHUKI USHIO [1]), AKIHARU HONDA [2]), HAJIME ITO [1])

XBT observations were carried out in the Greenland Sea and in the Fram Strait. Figure 1 shows positions of the XBT stations. We obtained 54 temperature profiles down to about 1000m in depth. Temperature sections are shown in figs. 2 and 3. Thermocline formed in 50m depth and temperatures of surface layer were high near Spitsbergen. From the thermal structure of upper layer nearby 0 degree in longitude, It is suggested that interleaving and mixing occured in the sea-ice edge region. Near the fjord region, temperature profiles were very complicated. Thermal structure was also influenced by land water influx in the fjord region.

Water samples were taken to measure the amount of total inorganic carbon, $\delta\,^{13}C$ and $\delta\,^{18}O$. The sampling sites are shown in table 1. We also took samples of air, which is equilibrated with surface water, to decide the partial pressure of carbon dioxide (pCO_2). Air sampling sites are listed in table 2. These analyses are in progress at present. The data are very useful for the understanding of a process of carbon exchange between ocean and atmosphere.

An infrared camera (Inframetrics model-760) detected the distribution of sea surface temperature. In comparison with the visible images, melt-water ponds on sea ice and cold melt water are distinguishable on the infrared images. These data are very useful for study on remote sensing of pack ice regions in the summer season.

Table 1. Sampling sites of water.

No.	Date	Latitude	Longitude
1	Aug. 20	75°00.0' N	05°30.0' W
2	Aug. 20	74°59.9' N	07°59.0' W
3	Aug. 21	74°55.3' N	11°36.4' W
4	Aug. 24	78°51.5' N	02°35.3' W
5	Aug. 25	78°36.5' N	05°05.6' W
6	Aug. 26	78°25.0' N	04°11.7' W
7	Aug. 27	78°24.8' N	03°42.8' W
8	Aug. 28	78°53.7' N	02°44.9' W
9	Aug. 29	79°00.6' N	03°23.7' W

Table 2. Sampling sites of air.

No.	Date	Latitude	Longitude
1	Aug. 19	75°00.0' N	03°00.0' W
2	Aug. 20	75°00.0' N	05°30.0' W
3	Aug. 20	74°59.9' N	07°59.0' W
4	Aug. 21	74°54.0' N	11°04.0' W
5	Aug. 24	78°51.4' N	02°36.0' W
6	Aug. 25	78°34.4' N	04°57.6' W
7	Aug. 26	78°24.5' N	04°12.8' W
8	Aug. 28	78°52.2' N	02°46.1' W
9	Aug. 30	78°30.2' N	09°00.7' E

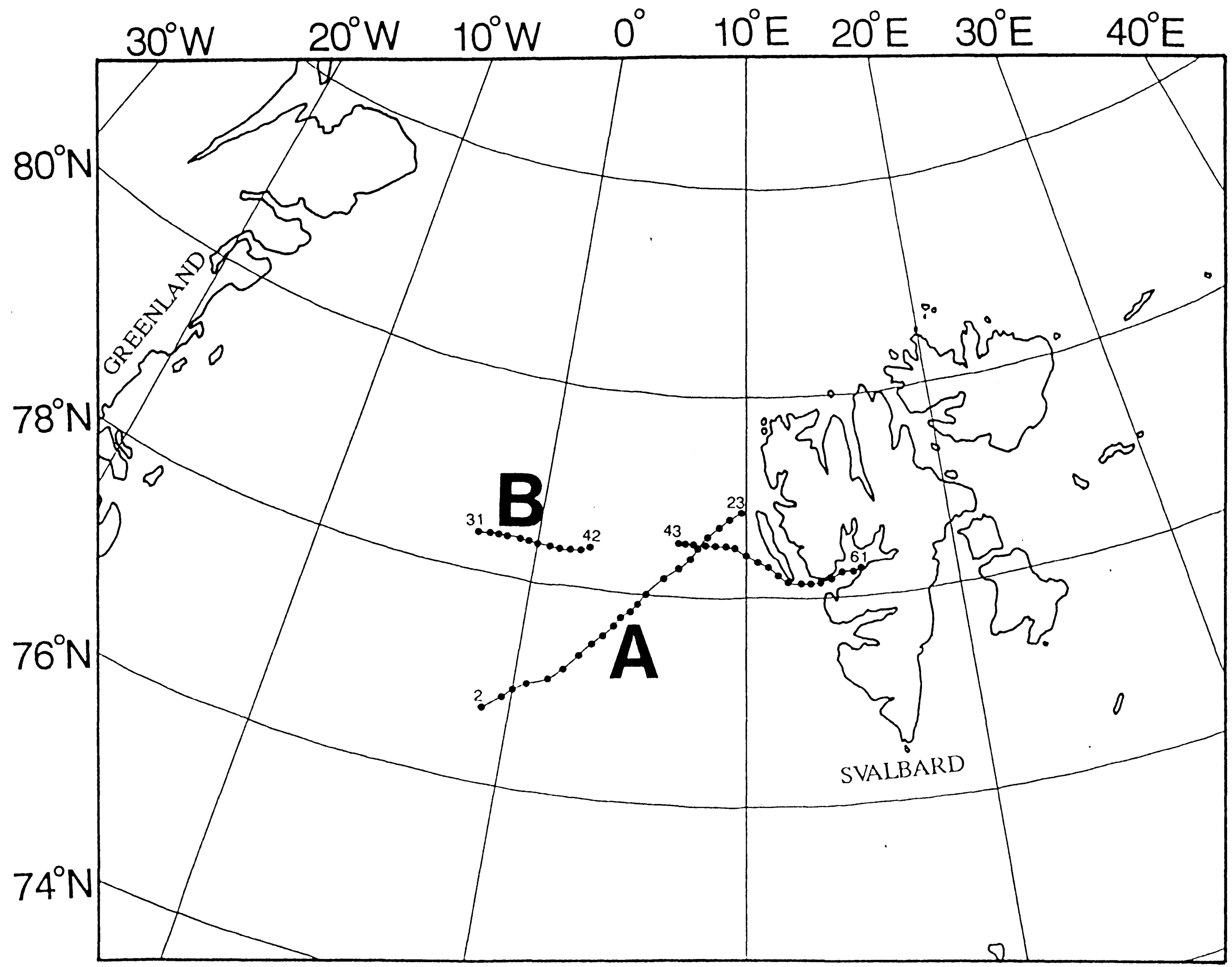


Fig. 1. Locations of the XBT observation stations in August 1992.

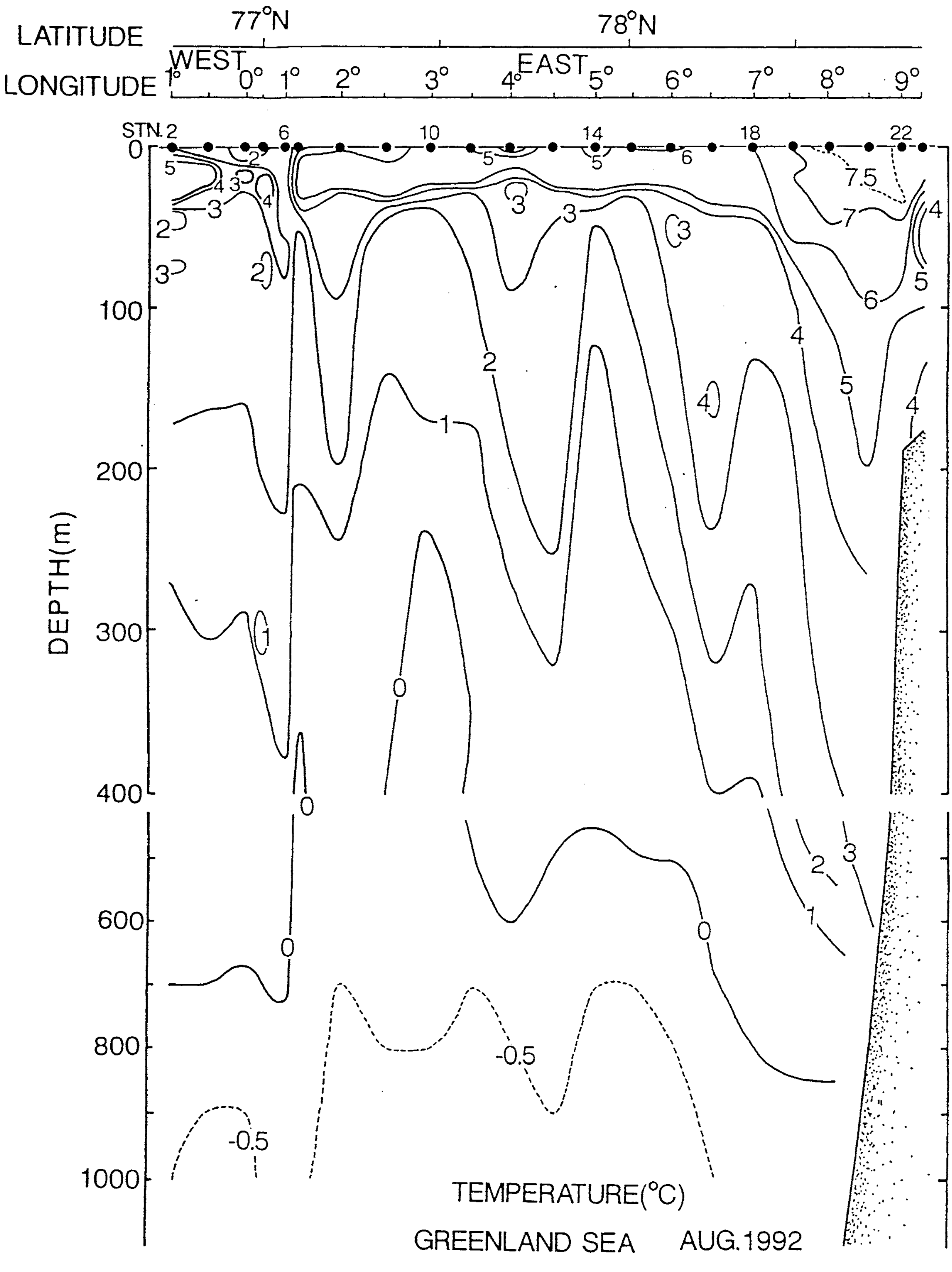


Fig. 2. Temperature section through the Greenland Sea (section-A).

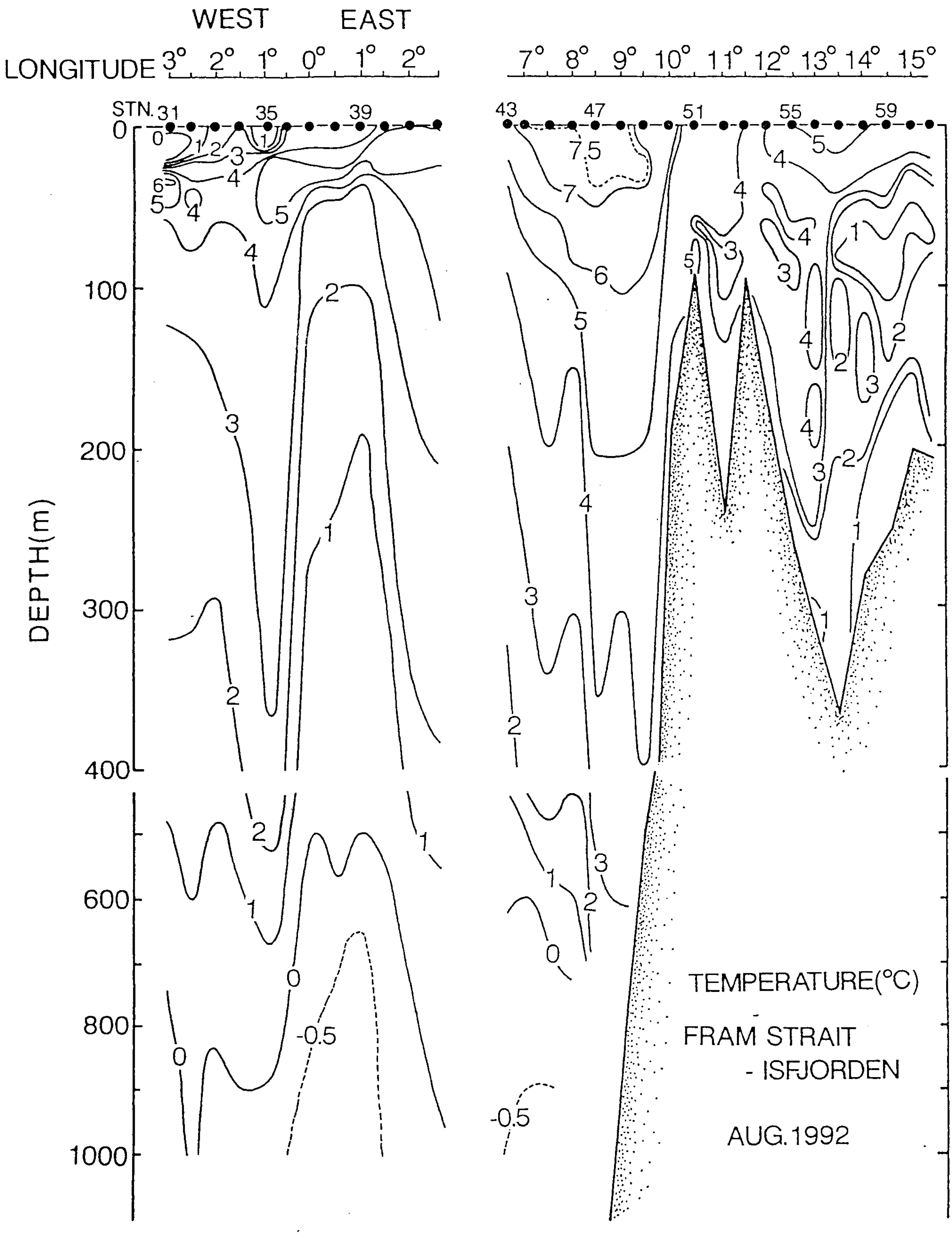


Fig. 3. Temperature section through the Fram Strait at 78°30'N (section-B).

SEA ICE OBSERVATION IN THE FRAME STRAIT - AUGUST 24 TO 29, 1992

Hayley H. Shen*, Reinert Korsnes†

April 27, 1993

Abstract

The observation given below is made in the period of Aug. 24-29, 1992, as the ship 'LANCE' entered the ice zone at 78:50N and 3:57E and left at 78:44N and 2:01W. A map of the area covered is given elsewhere in the report. The purpose for this sea ice observation is two-fold. First, to gain field experience, and second, to obtain data for ERS-1 SAR image analysis. Both of the investigators in this project have been doing modeling and mathematical analysis of the dynamic behavior of sea ice in the marginal ice zone. This trip provided necessary practical input to their future theoretical work. This report begins with a general description of the region, followed by the method of observation, the raw data, summary of the results, and concluded by suggestions for future work.

1 General Description of the Conditions in the Region of Observation

In the melting season, ice floes in the Greenland Sea and the Fram Strait drift with the wind and the current while they melt. These ice floes have been estimated to have a drift speed of $10 - 30cm/s$, in the general direction of SSW (along the coast of East Greenland).

Throughout the main part of this field trip, the floes consisted of mainly multiyear ice with worn ridges, covered by old snow. Figure 1 is a photo taken from the ship. A majority of the large floes had frozen melt pond on them. There were also a lot of frozen cracks on these old floes. In a few occasions, when we were able to walk on the floes, it was found that on the top part of many frozen melt pond and the cracks, there were many layers of thin ice sheet. Horizontal needle crystals were obvious on these sheets. These layers were about several mm thick, separated by mm thick air layers. These melt ponds were of the order of $1m$ thick. The cracks were in the order of several dm. In one occasion, a crack formation was observed in action while we walked on the floe. Audible noise with apparent variation in amplitude was generated during the cracking. The period of variation in the noise amplitude was estimated at $12sec$, which was in the order of the estimated period of the gravity waves in this area. No waves were however discernible in the ice zone. The open water adjacent to the ice zone had less than $1m$ wave. The weather condition in the region covered was mainly cloudy, with two half-day of partially sunshine, and two occasions of slight snow. The wind was calm or very mild. Figure 2 gives estimates for the wind August 1992 (the month before the observations).

The observation has been planned to include two parts. The first part is a time series of ice conditions observed from the ship, made along the route of the ship for the entire duration of the trip. The second part is a spatial series of the ice concentration and size distribution made from a video camera mounted on a helicopter. The helicopter's flight coincides with the ERS-1's coverage. The second part was however cancelled because of a minor accident which required the helicopter's service just before the scheduled observation. Nevertheless, details of the plan is given in the report.

2 Observation Method of the Ice Conditions from the Ship

The observation of the ice conditions from the ship included the ice type, size, and surface topography, the type of snow cover, interstitial water, thickness of both the ice floe and the snow cover, and meteorological

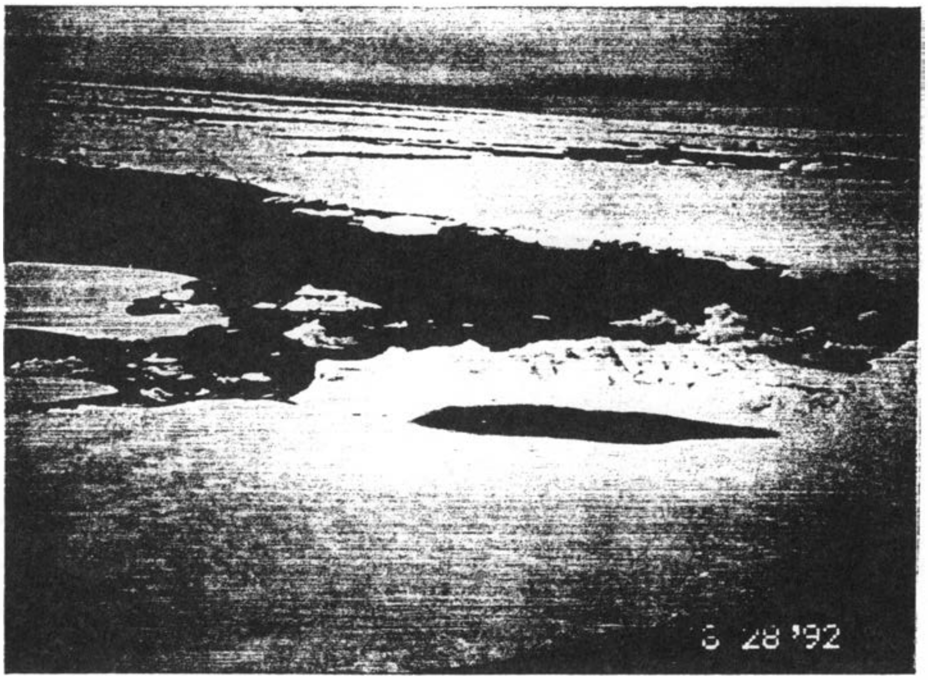


Figure 1: Ice floe in the Fram Strait August 28 1992.

conditions. These data are given in Table 2, with list of codes at the beginning of the table. Due to its size, Table 2 is given at the end of this report.

The interstitial water condition includes both the size of the opening and the water depth. The latter might be useful in estimating the strength of the underneath current. The meteorological conditions include the water and air temperature, the ship and wind speed and their directions, and visibility. All of these data except the open water area are available from the ship's instruments, hence the accuracy is dependable.

The data related to ice are from visual estimates. The low observation angle from the ship's bridge limited the areal extent of the observation. It also severely limited the resolution towards the horizon. The ship's operation biased towards the lower ice concentration region. The record of the ice concentration as well as the open water distribution is therefore not statistically representative. It however gives a general idea of the spatial variation of the ice condition along the route of the ship. The thickness of the ice floes and the snow cover were also made from visual observations from the ship's bridge. The ship moored three times during the trip. In those three times, the snow cover thickness was measured by the participants from SPRI. These measurements helped our subsequent estimates in the snow cover thickness. These estimates were made based on the whiteness of the snow cover and the visible part of the snow layer on floes close to the ship. The ice thickness was estimated by the amount above the water, and its average specific weight of 0.9. Occasionally, floes that turned sideways by the ship's motion exposed their thickness. These cases were utilized to verify the above estimates. The ship has a length of $60m$ and a width of $12m$. These dimensions were used as references for estimating the floe size and thickness.

The original recording chart suggested that in each observation, the ice condition should be categorized into three groups, from the thickest to the thinnest. Soon after the observation started, it was however felt that such classification reduced the certainty of estimates. This was partly due to the lack of variation at a given location of the ice cover. A reduction to two categories was therefore made, except in the first one, and one towards the end, in which the ice floe distribution was clearly much more complex than all the previous cases. Some data were missing from the record. This is because they were not included initially, unavailable at the time, or the condition prevented a reliable estimate.

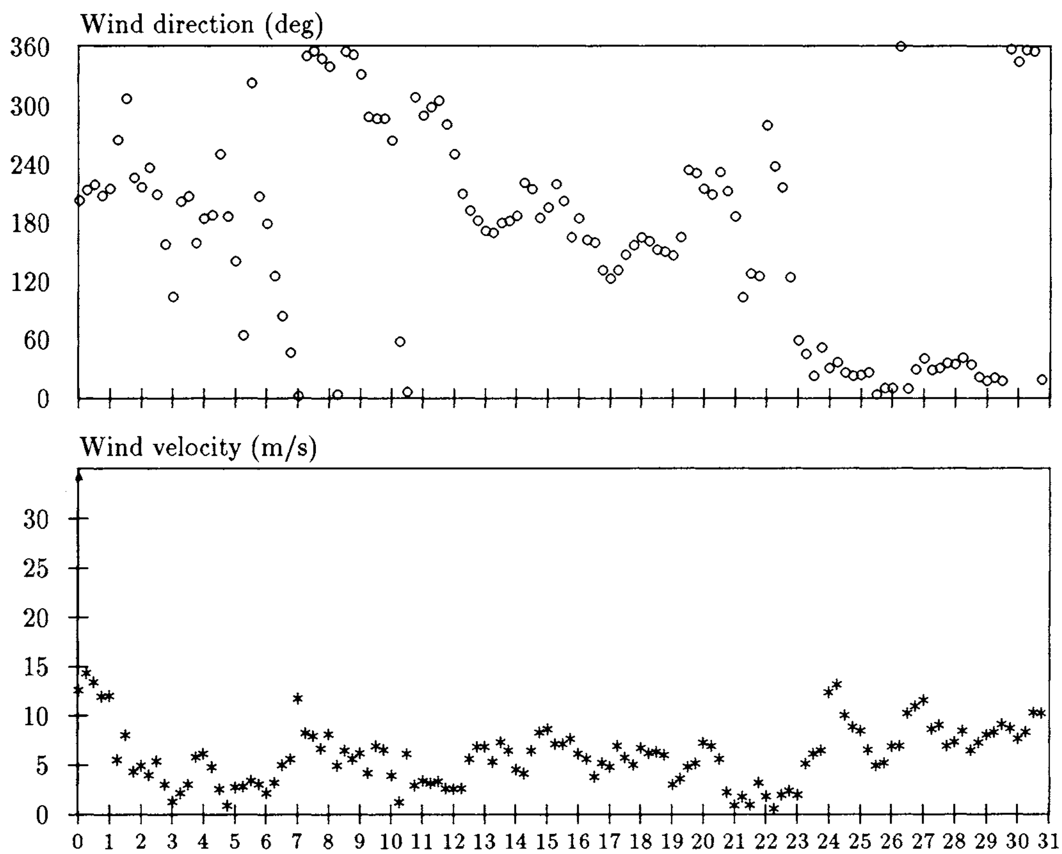


Figure 2: Hindcast wind data from August, 1992 at 78.7° N 5.4° W

3 Summary of the Results

The ice map as supplied by the Norwegian Meteorological Institute for the duration of the observation is given in Figures 3 and 4.

We summarize the ice condition in Figures 5 and 6. Figure 5 gives the ice floe concentration vs distance from the ice edge. Figure 6 gives the ice floe concentration size vs water depth. There seems to be a strong correlation between the ice concentration and the water depth.

4 Ice Observation from the Helicopter

The objective was to give a video photo coverage of the ice cover as close in time as possible of a study pair of ERS-1 SAR scenes in the Fram Strait on 30 August and 2 September. The idea was to give an example of the disintegration of the ice field in the East Greenland ice stream in the melting season as the ice fast approaches open water and where there is little mixing.

The experiment is related to work on possible quantitative generic techniques for the identification of different 'controlling regimes' related to gravity waves and stress in the ice field. However, due to an accident on the ship, the helicopter was not available for the experiment.

5 Coring

We made salinity samples from 3 ice floes here referred to as Floe #1 - #3. Table 1 gives the respective positions and size which were estimated from ship radar with the exception of Floe #2 in which case the floes outline could not be identified on the radar. We took 5 random samples at 10-15 cm depth from Floe # 1. These showed no salinity on our salinity meter. One and three salinity profiles were sampled from Floe #2 and Floe #3 respectively. Tables 2 and 3 show the results.

Table 1: Salinity sampling overview

Floe #	Time (August)	Position N W	Approx size (m)
1	24 17:00	78:49.9 2:42.6	500×400
2	25 17:25	78:35.8 5:08.7	$\approx 500 \times 500$
3	2? 10:45	78:51.4 2:47.6	550×425

Table 2: Salinity profile from Floe # 2

Depth (cm)	Salinity (ppt)
10	0.5
20	0.5
30	1.2
40	0.75
50	0.4
60	0.5

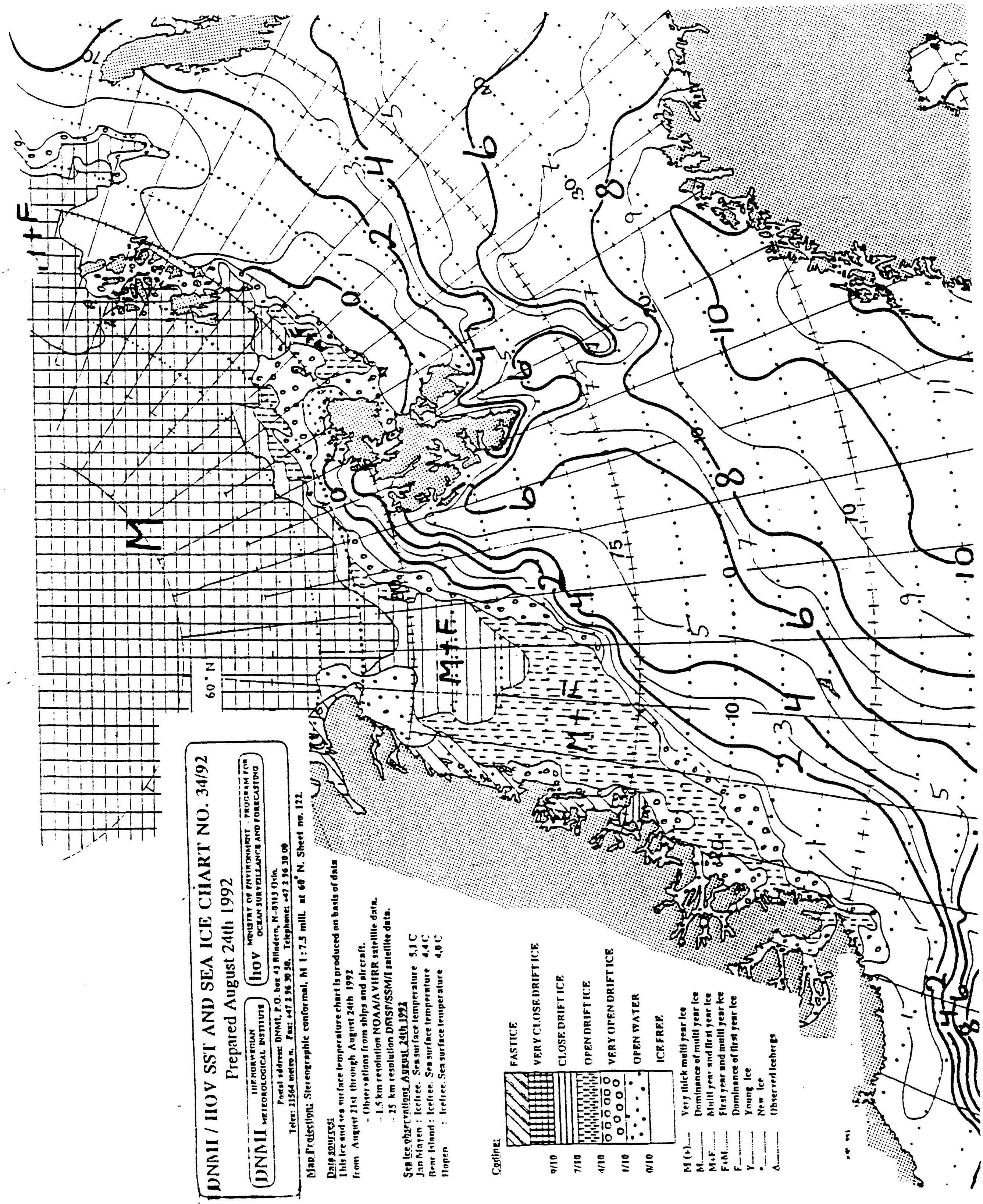


Figure 3: Ice map 24 August 1992

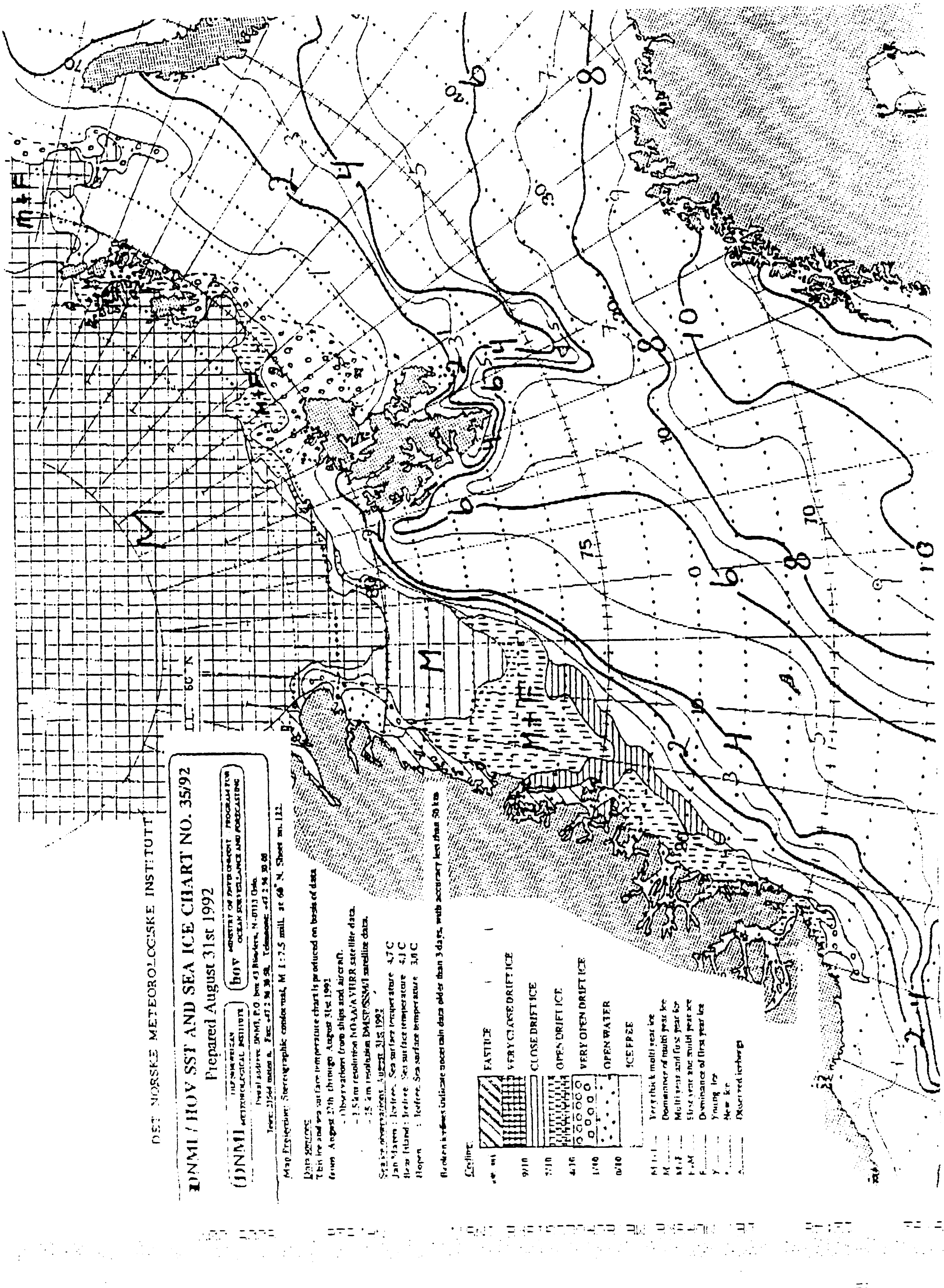


Figure 4: Ice map 31 August 1992

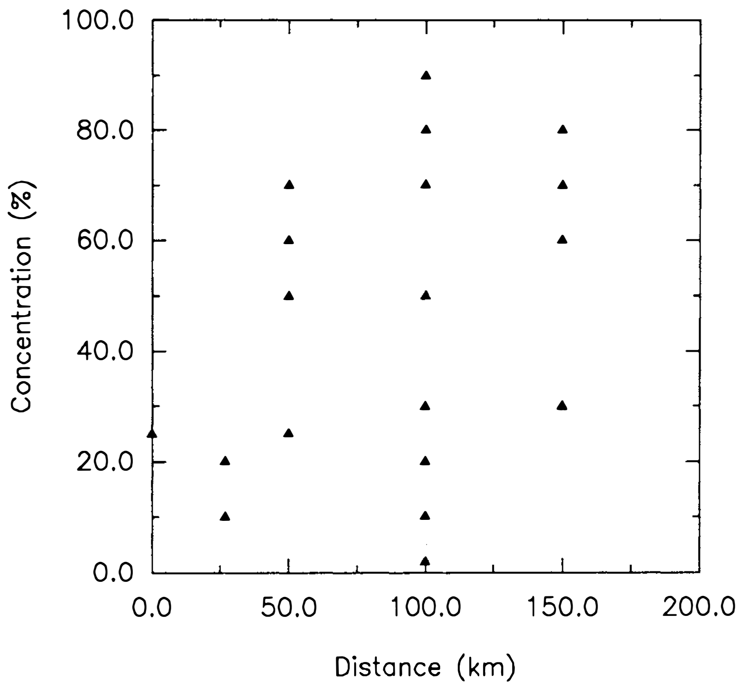


Figure 5: Floe concentration vs distance from ice edge

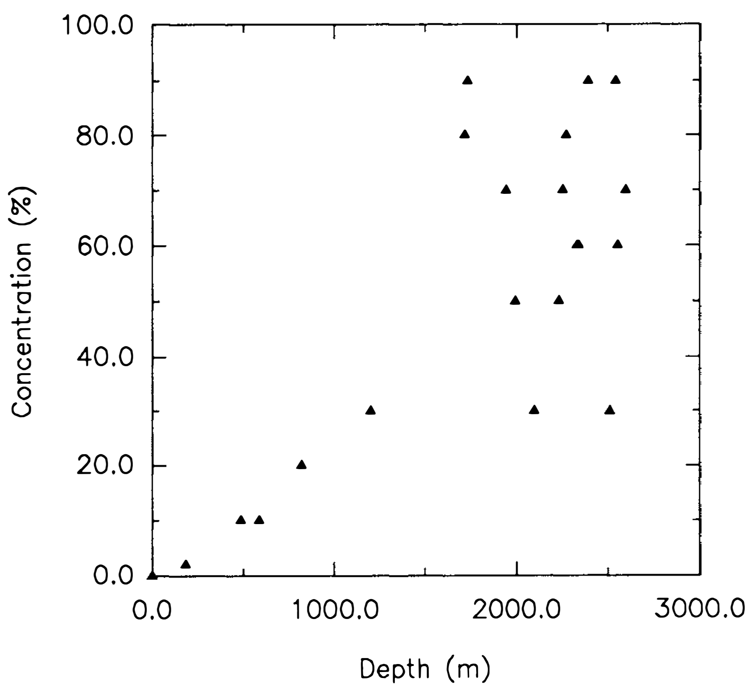


Figure 6: Floe concentration vs depth of water

Table 3: Salinity profile from Floe # 3

Depth	Salinity (ppt)		
(cm)	H1	H2	H3
10	< 0.5	< 0.5	< 0.5
20	¡ 0.5	0.5	< 0.5
30	1.0	1.0	< 0.5
40	2.0	1.0	< 0.5
50	1.0	3.5	0.5
60		1.5	1.4
70		1.0	1.2
80		2.0	

6 Discussions and Conclusion

The observation of ice conditions from the ship cannot be very accurate. The ship must be navigated through open water, and thus tends to avoid places with high floe concentration. The low observation angle limited the areal coverage of the observation. Both of the above two factors become more significant when the floe size and thickness increase. In cases where floes are small in comparison to the ship, navigation through them and observation coverage will not be as much a problem. The best method to collect ground truth for SAR image analysis is by helicopter flights, with which the data collection is fast and accurate. The coverage area is also much larger. Observation from a ship will still be necessary in the future for SAR image interpretation. Because details such as the surface roughness at the scale of *cm* or lower, the snow thickness and type, are not collectible from video recordings made from a helicopter. These data however can affect the brightness of the SAR image and thus can be of significance. To fully develop the SAR image technique for analyzing sea ice conditions and its dynamics, image analysis is a very important field that will require a great deal of future work. This work must be done in collaboration with knowledge in physical mechanisms.

7 *Acknowledgements*

This study has been supported by the US Army Cold Regions Research and Engineering Laboratory, grant #DACA 89-92-K-004, us National Science Foundation, grant #DPP9219165 and the Norwegian Polar Institute. The cooperation of the participating scientists and the hospitality from the crews of LANCE are both highly appreciated.

Table 2: Ice observation Aug. 24-29, 1992, Part I

Aug	Position	Sea Ice														
1992		concentration(%) and type											thickness			
Date/Time	la(N)/lo(E)	total	primary					secondary					ice(m)		snow(cm)	
		c(%)	c1	ty1	f1	t1	s1	c2	ty2	f2	t2	s2	z1	z2	sz1	sz2
24																
0,27	78:50/3:57	25	10	6	4	1	5	15	5	3	1	5	2	1	.5	.5
7,41	78:45/-0:24	20	20	7	4	1/3							3		.5	
8,59	78:44/-0:57	10	9	7	5	1/3	5	1	6	4	1	2	3	2	.5	.5
11,09	78:43/-1:59	25	15	8	5	4	2	10	6	5	1	2	10	3	1	1
13,00	78:50/-2:28	70	60	8	6	4	2	10	8	5	4	2	10	5	2-3	2-3
15,01	78:51/-2:36	60	55	8	6	4	2	5	8	4	4	2	8	5	3	3
21,36	78:46/-3:03	50	45	8	6	4	2	5	8	4	4	2	8	8	3	3
23,36	78:42/-3:35	50	40	8	6	4	2	10	8	4	4	2	8	8	3	3
25																
7,57	78:40/-4:25	80	70	8	7	4	2	10	8	4	2	2	10	5	0-3	3
13,07	78:37/-4:49	20	15	8	6	4	2	5	5	3	1	2	10	5	1	3
14,45	78:37/-5:03	10	8	8	6	4	2	2	5	3	1	2	5	4	3	3
20,50	78:34/-4:57	10	9	8	6	4	2	1	8	3	4	2	10	10	3	3
26																
11,00	78:28/-4:26	2	1	8	6	4	2	1	8	4	4	2	10	5	3	3
14,06	78:25/-4:12	50	45	8	6	4	2	5	8	4	4	2	5	2	3	3
16,14	78:25/-4:24	30	25	8	6	4	2	5	8	4	4	2	5	3	3	3
18,58	78:25/-3:46	50	40	8	6	4	2	10	7	5	1	2	5	3	3	3
22,05	78:22/-3:37	50	40	8	5	4	2	10	6	4	1	2	8	5	3	3
27																
7,38	78:26/-3:42	30	20	8	4	3	2	10	6	4	1	2	3	2	2	2
11,27	78:26/-4:01	90	70	8	7	3	2	20	8	5	1	2	3	3	2	2
14,10	78:23/-4:04	80	70	7	6	4	2	10	8	5/6	6	2	5	1	0-3	1
15,24	78:21/-3:59	70	60	7	5	1	2	10	7	5	4	2	5	5	3	3

Table 2: Ice observation Aug. 24-29, 1992, Part I (continued)

Aug 1992 Date/Time	Position	Sea Ice														
		concentration(%) and type											thickness			
	la(N)/lo(E)	total	primary					secondary					ice(m)		snow(cm)	
		c(%)	c1	ty1	f1	t1	s1	c2	ty2	f2	t2	s2	z1	z2	sz1	sz2
28																
6,50	78:50/-2:30	70	60	8	6	4	2	10	8	5	4	2	3	2	3	3
19,00	78:51/-2:55	30	25	8	6	3	2	5	8	4	3	2	6	2	0-2	0-2
20,03	78:58/-3:01	60	55	8	8	3	2	5	8	3	3	2	6	3	0-2	0-2
21,54	79:00/-3:11	60	50	8	7	3	2	10	8	5	3	2	6	3	0-2	0-2
29																
6,23	79:00/-3:23	70	60	8	6	3	2	10	8	5	3	2	6	3	0-2	0-2
8,54	78:58/-3:24	80	75	8	7	4	2	5	7	4	1	2	8	3	3	3
11,19	78:57/-3:10	90	40	8	7	4	2	50	7	4	1	2	8	3	3	3
13,01	78:55/-2:39	90	40	8	7	3	1	50	6	3	3	1	6	3	0-3	0-3
15,00	78:52/-2:44	60	45	8	5	4	2	15	8	4	3	2	6	3	0-3	0-3
16,00	78:49/-2:30	50	40	8	5	4	2	10	6	4	1	2	3	1	3	3
17,00	78:44/-2:01	<1														

Table 2: Ice observation Aug. 24-29, 1992, Part II

Aug 1992 Date/Time	Water w/depth(m)	Metereology temerature (^{0}c)	velocity (knots)	visibility v/humidity	direction ship/wind
24					
0,27	4	-0.8/-2.3	?/0.1	9	?/?
7,41	4	-1/-1.6	?/8	1	?/?
8,59	4	-1/-2.2	?/6	0	?/?
11,09	4	-1.1/-2.2	3.6/13	0	270/90
13,00	3	-1.2/-1.3	3.1/11	0	270/90
15,01	3/4	-1.4/-0.6	0/10	0	135/250
21,36	4	-1.4/0.3	8.6/17	9	180/240
23,36	4	-1.4/-1.8	5.1/25	9	280/90
25					
7,57	3/4	-1.5/-1.5	0.9/16	9/92.1	0/0
13,07	4/5/823	-1.5/-0.9	11.2/17	0/92.9	
14,45	5/488	-1.5/-0.5	6.0/11	0/92.0	220/130
20,50	4/5/590	-1.5/-2.5	0.4/14	3/91.9	347/30
26					
11,00	5/189	-1.5/-5.4	0.8/5	2/94.7	140/260
14,06	4/stop	-1.6/-3.4	0.9/4	3/94.6	135/250
16,14	5/1202	-1.5/-3.8	11.6/0	3/92.3	210/150
18,58	4/1994	-1.1/-3.0	10/12	9/91.8	315/60
22,05	4/2234	-0.9/-1.4	6.5/11	9/91.3	90/320
27					
7,38	3/2098	-1.5/-1.7	6.2/4	9/90.6	133/220
11,27	2/1734	-1.5/-0.9	2.1/13	3/93.9	270/90
14,10	3/1717	-1.6/-0.7	2.3/13	3/85.7	115/265
15,24	4/1944	-1.5/-1.1	4.5/17	3/?	120/260

Table 2: Ice observation Aug. 24-29, 1992, Part II (continued)

Aug 1992 Date/Time	Water w/depth(m)	Meteorology temerature (^{0}c)	velocity (knots)	visibility v/humidity	direction ship/wind
28					
6,50	3/2601	-0.3/-2.6	4.7/21	3/93.5	320/60
19,00	3/2510	-1.6/-2.6	10.4/16	9/88.1	308/30
20,03	2/2435	-1.5/-2.5	1.4/4	9/88.4	360/360
21,54	2/2332	-1.6/-2.4	0/4	9/90.9	60/300
29					
6,23	3/2256	-1.5/-2.0	0.4/12	9/85.5	160/180
8,54	3/2273	-1.6/-2.8	3.1/5	9/91.3	170/170
11,19	2/2396	-1.6/-1.5	5.4/17	9/90.5	30/330
13,01	3/2544	-1.3/-2.4	2.1/15	1/92.4	280/80
15,00	3/2556	-1.4/-2.0	4.2/11	3/91.6	126/270
16,00	3/?	-1.3/-1.7	4.9/13	9/90.8	100/290
17,00	open/2923	+0.8/-1.5	7.1/14	3/91.2	96/300

Ice type (ty)

0 open water
1 new ice, frazil, slush, grease
2 <0.1m
3 young ice, grey, 0.1-0.15m
4 young ice, grey-white, 0.15-0.3m
5 first year, 0.3-0.7m
6 first year, 0.7-1.2m
7 first year, >1.2m
8 old ice

Floe size (f)

0 open water
1 pancakes<3m
2 new sheet ice
3 brash, broken, <3m
4 cake ice, <20M
5 small floes, 20-100m
6 medium, 100-500m
7 large, 500m-2km
8 >2km
9 fast ice

topography(t)

0 no secondary topography
1 level ice
2 hummocked
3 ridged
4 worn ridges
5 old or merged ridges
6 raised floes

Snow type (s)

0 no snow
1 cold new snow(<1 day)
2 cold old snow
3 cold windspread snow
4 new melting snow
5 old melting snow
6 glaze
7 melt slush
8 melt puddles

water (w)

0 no openings
1 small cracks
2 very narrow break<50m
3 narrow, 50-200m
4 wide, 200-500m
5 very wide>500m
6 lead, coastal lead
7 polynya, coastal polynya

Visibility (v):

0 0-100m
1 300m-1km
2 2km
3 3km
9 horizon

Note:

1. Primary sea ice is ice of the greatest thickness. Hence ty1>ty2>ty3
2. Express ice concentration in tenths. c1 is concentration of thickest ice type, etc..
3. thickness is estimated thickness of each ice type (z1,z2,z3) and of the snow cover on each ice type (sz1,sz2,sz3).