NORSK POLARINSTITUTT

RAPPORTSERIE

NR. 78 - OSLO 1992

TORGNY VINJE & VLADIMIR VOLKOV (Eds.)

CRUISE REPORTS 1991

R/V LANCE
Barents Sea and Greenland Sea

R/V PROFESSOR MULTANOVSKY
Barents Sea

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Programmes:

Soviet-Norwegian Oceanographic Programme (SNOP)
ERS-1 Sea Ice Climate Variables (ICECLIMA)
WMO Arctic Ice Thickness Monitoring Programme (AITMP)
Ice-ocean-atmospheric interaction study
CO_2 uptakes and tracers
Ice algae and kisel algae distributrion
Ocean UV-B and color index

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THE LANCE CRUISE

29 July - 24 August 1991

PROGRAMMES AND ORGANIZATION

T. Vinje

GENERAL

Multidiciplinary investigation programmes were carried out in the north-western Barents Sea from 29 July to 13 August (leg I) and in the northern Greenland Sea from 13-24 August (leg II). (Fig. 1 a and b.)

A helicopter supported our investigation programmes on the first leg, and a helicopter transfer of persons from/to LANCE took place in Ny-Ålesund 12 August.

There were 19 participants plus 2 helicopter crew members on the first leg and 14 participants on the second one.

FIELD PROGRAMMES

Field studies were carried out on special locations in conjunction with coverages by ERS-1 SAR, LANDSAT TM, and Russian satellite OKEAN, real aperture radar (RAR).

The field activities constituted multi-diciplinary programmes with participation from a number of national and foreign institutions with defined separate projects carried out on a cooperative basis.

Objectives, field and research programmes are given in separate individual reports.

Soviet-Norwegian Oceanographic Programme (SNOP)

From R/V Professor Multanovsky and R/V LANCE:

Joint ocean and ice programmes under the Soviet-Norwegian Oceanographic Programme (SNOP) in the northern Barents Sea. Norwegian and Soviet scientists took part in the investigation programmes on each others' ships. CTD programmes and deployment of moorings for recording of oceanic parameters and ice thickness distribution (AARI-NP-GI/UiB-HI).

ERS-1 Sea Ice Climatic Variables (ICECLIMA)

The Programme for International Polar Oceans Research (PIPOR) and the Seasonal Ice Zone Experiment (SIZEX) will execute a number of ERS-1 projects in the Greenland and Barents Sea rendering SAR coverage at different parts of the year over the locations where we have upward looking sonars in operation. This will increase the background data necessary for a number of research topics regarding ice field morphology at different times of the year (NP-NRS-NERSC).

Field observations from LANCE:

Ice extent, concentration, dynamics, floe size distribution, lead and ridge orientation, flexural patterns, and iceberg distribution with contemporary ERS-I SAR coverage.

Detailed survey of the above parameters by the use of video, stereophotograpy, ARGOS stations, and GPS from ship and helicopter (Fig. 1a).

Detailed survey of ice surface parameters such as snow cover distribution, water content in snow, salinity of upper surface, ice thickness distribution, surface topography and chrystallography over an area of at least two SAR pixels for characterization of the SAR return signals under melting conditions for a given snow cover.

WMO Arctic Ice Thickness Monitoring Project (AITMP)

An international programme under the World Climatic Research Programme. Retrieval/ deployment of three/seven upward looking sonars in the Greenland and Barents Seas. The European Programme on Climatology and Natural Hazards (EPOCH) have funded four upward looking sonars and SAR coverage in the Greenland Sea (NP-SPRI-AWI- PMEL).

Air-Ice-ocean-atmosphere interaction processes

One week full monitoring of atmospheric and oceanic forcing on a number of ice floes in the SAR-covered investigation area (GI/UiB-UiO-NP).

CO_2 uptakes and tracers

Measurements in the northern part of the Greenland Sea by LRD. This project started in 1990 in cooperation between LRD-GI/UiB-HI-and NP.

Ice algae and kisel algae

Investigations in the northern Barents Sea by UiTØ during the sea ice programmes.

Ocean UV-B and colour index

Measurements on leg I and leg II during sea ice programmes (UiO-NP).

LOGISTICS, INSTRUMENTS AND AFFILIATION

R/V LANCE with helicopter (NP)
Soviet spaceborne SLAR (AARI)
Upward looking sonars (NP-SPRI-AWI-PMEL)
Current meters (NP - AWI)
Stereophotography and video (NP)
Global Positioning System (NP-NSKV)
Scanning sonar (NP)
Ocean turbulent flux meters (UiO-NP)
Atmospheric turbulent fluxes and tether sounding equipment (GI/UiB)
Automatic weather stations (GI/UiB-NP)
Geodimeter (NP)
Accelerometer (NP)
Weather observations (NSKV)
Ocean carbondioxide and tracer measuring equipment (LRD)
Ocean UV-B and colour index measuring equipment (UiO)
Video (NP)
Underwater video camera (NP)

PARTICIPANTS

Affiliation-hired by		Name	Responsibility/ Dicipline	Research topic/ Programme
NP		T. Vinje	Cruise leader	ICECLIMA-SNOP-AITMP
GI/UiB	*	Y. Gjessing	Next in command	Atmos./ice transfers
NP		S. Østerhus	Oceanography	SNOP-ICECLIMA-AITMP
NP		Å.S. Kvambekk	Sea ice	SNOP-AITMP
NP		B. Erlingsson	Sea ice	Modelling
NP		T.B. Løyning	Oceanography, diver	Ocean/ice transfers
NP		R. Korsnes	Sea ice	ICECLIMA
NERSC		Ø. Frette	Scatterometer	SIZEX-ICECLIMA
NP		Ø. Finnekåsa	System operator	Ocean-sea ice
GI/UiB-NP	*	T. de Lange	Meteorology	Atm./ice transfers
Gi/UiB-NP	*	Gao Dengyi	Meteorology	Atm./ice transfers
UiO-NP		J. Høkedal	Ocean, sea ice	UV-b, colour index
NP	*	R.W. Hiorth	Secretary	Ice-ocean reports
AARI		A. Proshutinsky	Oceanography	SNOP-Modelling
AARI		V.A. Abramov	Sea ice	SNOP
NP		N. Doronin	Sea ice	SNOP-Modelling
LRD	**	R. Nydal	Chemistry	CO_2-Tracers
LRD	**	A. Nes	Chemistry	CO_2-Tracers
UiTØ	*	C. Hellum	Marine biology	Ice algae
BT	*	T. Sponga	Journalist	
BT	*	U. Sponga	Video	

Both legs participants, no asterix.
* First leg participants, 29 July Longyear-12 Aug. Ny-Ålesund
** Second leg participants, 12 Aug. Ny-Ålesund-24 Aug. Longyearbyen

LIST OF ACRONYMS

AARI	Arctic and Antarctic Research Institute, St. Petersburg
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred-Wegener-Institute for Polar and Ocean Research
BT	Bergens Tidende
GI/UiB	Geophysical Institute, University of Bergen
GPS	Global Positioning System
HI	Marine Research Institute, Bergen
LRD	Radiological Dating Laboratory, University of Trondheim
NERSC	Nansen Environmental and Remote Sensing Center, Bergen
NP	Norwegian Polar Research Institute
NSKV	Norwegian Hydrographic Service, Stavanger
PMEL	Pacific Marine Environmental Laboratory of NOAA, Seattle
SAR	Syntetic Aperture Radar
SPRI	Scott Polar Research Institute, University of Cambridge
UiO	University of Oslo
UiTØ	University of Tromsø

ICECLIMA RESEARCH TOPICS

Modelling application

Textural analysis of SAR images for validation of model on the relationship between internal and external stress which yield characteristic fracture patterns in the ice fields.

Verification of possible signal structuctures on SAR images with ocean wave patterns in the outer ice edge as recorded on the ships digital radar for studies of wave attenuation.

Ice field morphology

Development of statistically based algorithms for ice field roughness by comparison of SAR return signal structure with ULS recordings during freezing, melting and variable snow cover.

Ice thickness distribution

Development of algorithms for distinguising between ice of different thickness and age by comparing SAR return signal structures with recordings from ULS at different time of the year.

Ice mass transport

Calculation of the ice volume flux from the Arctic Ocean through the Fram Strait and in the ice fields of the Barents Sea combining SAR- and AVHRR-based dynamics and ice thickness series from ULS's.

Iceberg detection

Comparison of SAR return signals from ARGOS instrumented icebergs for development of algoritms for iceberg signal structure.

Iceberg production

SAR coverage of selected glaciers and outlet areas will be studied for estimation of iceberg production and potential surging features observed from previous field studies.

Comparative studies

Comparison of SAR products with products from AVHRR images as well as the Russian side looking spaceborne radar and, if funded, also from a Soviet airborne SAR.

Fig. 1a: Ship's route and helicopter flights (straight lines) under leg 1.

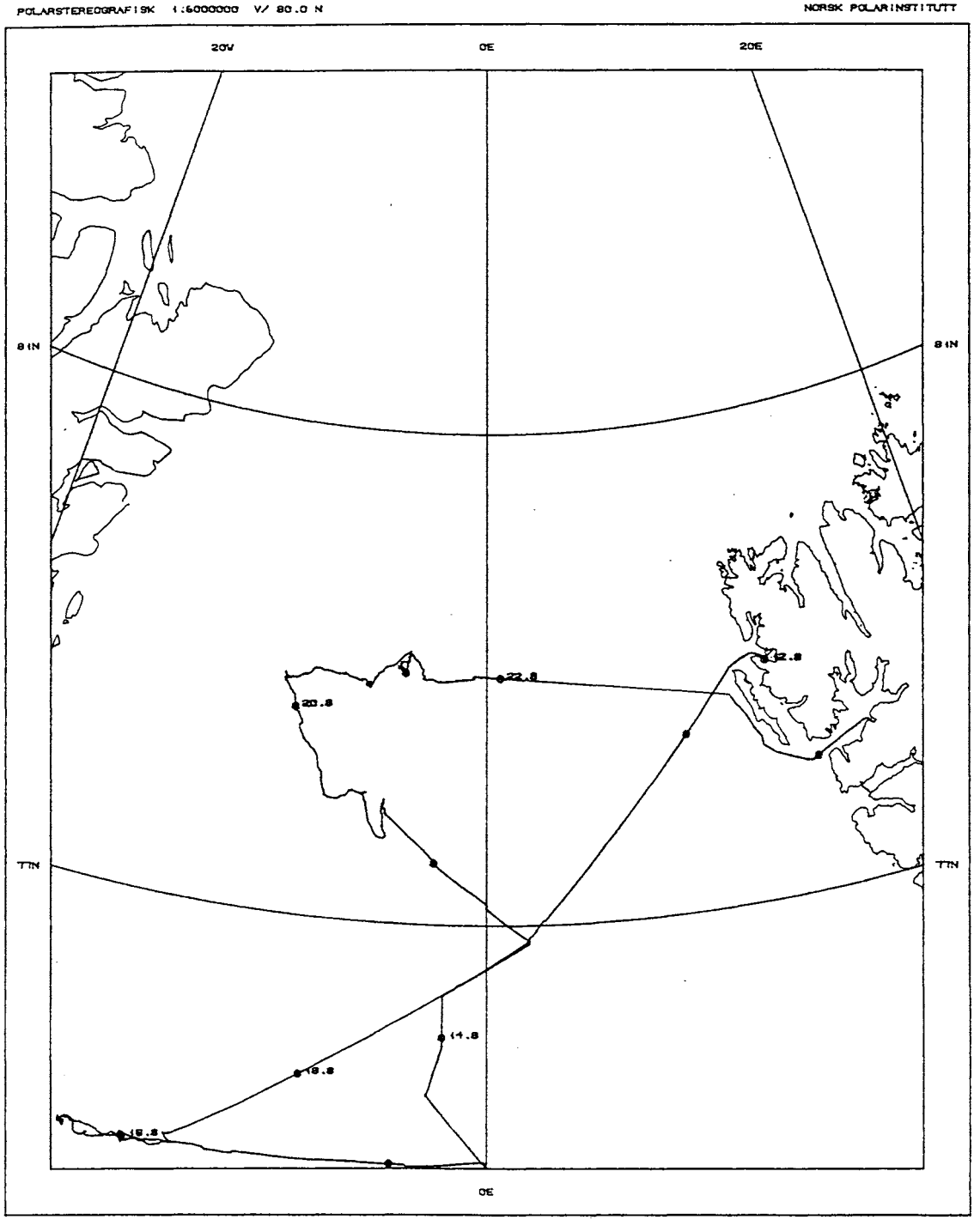


Fig. 1b: Ship's route under leg 2.

INSTRUMENTED MOORINGS AND CTD MEASUREMENTS

S. Østerhus and Ø. Finnekåsa

BARENTS SEA

Mooring deployment

One subsurface instrumented mooring, SNOP-91-01, was deployed in position N78°24.6', E26°59.5'. The SNOP-91-01 mooring carries two Aanderaa RCM-7 current meters and one Oceano AR661 acoustic release for recovery (Fig. SNOP/91/01).

One subsurface instrumented mooring, SNOP-91-02, was deployed in position N79°27.2', E30°15.6'. The SNOP-91-02 mooring carries one APL-ULS Mark-2 upward looking sonar, two Aanderaa RCM current meters, and one Oceano AR661 acoustic release (Fig. SNOP/91/02).

Mooring retrieval

An attempt to recover two instrumented moorings, SNOP-90-01 and SNOP-90-02, failed.

The SNOP-91-01 and SNOP-91-02 moorings were retrieved after only 10 days in the sea.

GREENLAND SEA / FRAM STRAIT

Mooring deployment

Altogether six instrumented moorings were deployed under the Arctic Ice Thickness Monitoring Project (AITMP). Four moorings were deployed in the Greenland Sea at N75°. These four moorings were prepared by AWI. Two moorings were deployed in the Fram Strait at N79°.

One mooring, AWI-410, was deployed in position N75°, W13°35.5' at 198 m depth. The AWI-410 carries two Aanderaa RCM current meters, and one Oceano AR161 acoustic release (Fig. AWI-410). One mooring, AWI-411, was deployed in position N74°56.1', W12°39.8' at 1002 m depth. The AWI-411 carries two Aanderaa RCM current meters, one APL-ULS Mark-2 upward looking sonar, and one Oceano AR161 acoustic release (Fig. AWI-411). One mooring, AWI-412, was deployed in position N74°56.5', W11°30.1 at

2389 m depth. The AWI-412 carries two Aanderaa RCM current meters, one CMI ES 400 upward looking sonar, and one Oceano AR161 acoustic release (Fig. AWI-412). One mooring, AWI-413, was deployed in position N75°3.3', W10°15.3 at 3146 m depth. The AWI-413 carries three Aanderaa RCM current meters, one CMI ES 400 upward looking sonar, and one Oceano AR161 acoustic release (Fig. AWI-413).

In the Fram Strait the mooring NP-91-V1 was deployed in position N79°04.7', W3°44.4' at 2053 m depth. The NP-91-V1 carries three Aanderaa RCM current meters, one CMI-ES 300 upward looking sonar, and one Oceano AR661 acoustic release (Fig. NP/91/V1). The mooring NP-91-V2 was deployed in position N78°54.1', W4°55.6 at 1235 m depth. The NP-91-V2 carries three Anderaa RCM current meters, one CMI-ES 300 upward looking sonar, and one Oceano AR661 acoustic release for recovery (Fig. NP/91/V2).

Mooring retrieval

The mooring, Klima-1-90, in position N76°52.2', E1°31.5 at 3270 m depth was successfully recovered. The Klima-1-90 mooring carries three Aanderaa RCM current meters, and one Oceano acoustic release. The Klima-1-90 mooring belongs to Geophysical Institute, Bergen. One mooring, NP-90-V1, in position N78°02.4', W4°46.5' at 1612 m depth was successfully recovered. The NP-90-V1 mooring was equipped with one CMI-ES 300 upward looking sonar, and one Oceano RT161 acoustic release. A third mooring, NP-90-V2, in position N79°12.8', W3°16.6' at 2030 m depth, was also successfully recovered. The NP-90-V2 was equipped with three Aanderaa RCM current meters, one CMI-ES 300 upward looking sonar, and one Oceano AR161 acoustic release. All instruments contained complete data series.

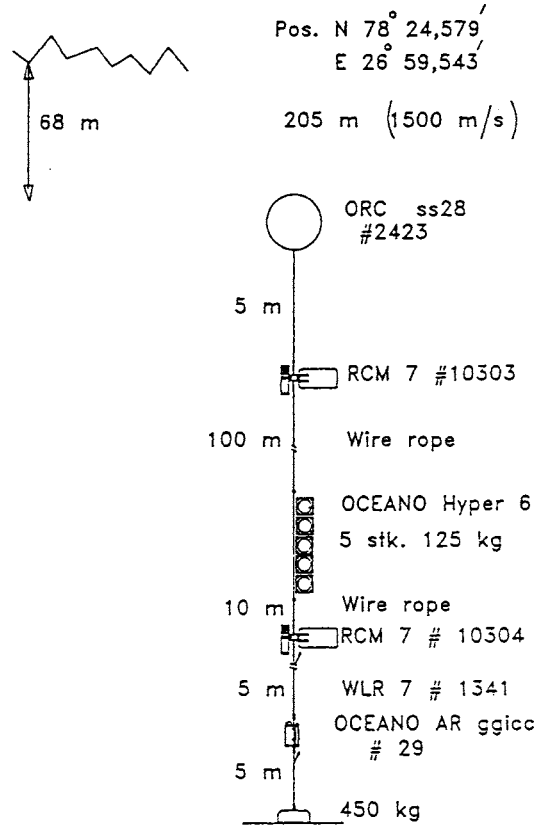
CTD measurements

Vertical profiles of temperature and conductivity (salinity) were obtained using a Neil Brown CTD Mark III (s.n. 01-1133). A 12 bottle remotely controlled General Oceanics rosette for water sampling was connected to the CTD.

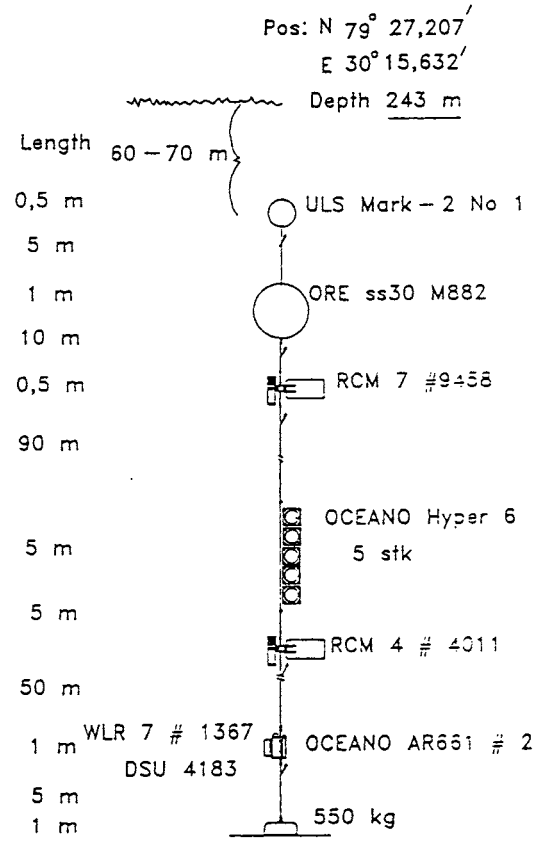
34 CTD casts were taken in the northwest Barents Sea and 19 CTD cast were taken in the Greenland Sea and Fram Strait (see attached figure).

The temperature sensor were calibrated before the cruise and five reversing mercury-in-glass thermometers were used for CTD temperature sensor control during the cruise. A small correction had to be done. 124 water samples were collected in the Greenland Sea and Fram Strait for calibration of the conductivity cell.

SNOP / 91 / 01

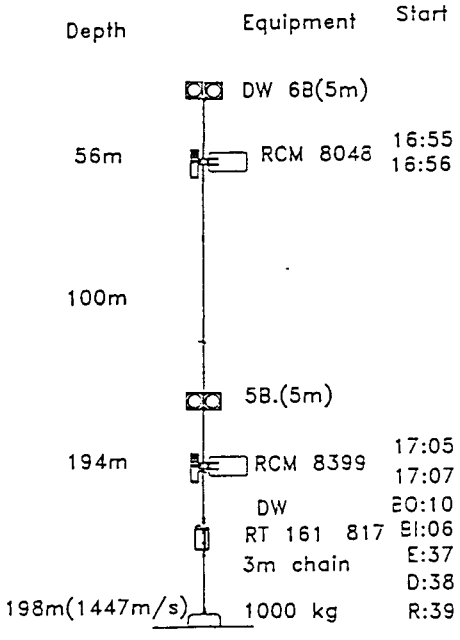


SNOP / 91 / 02



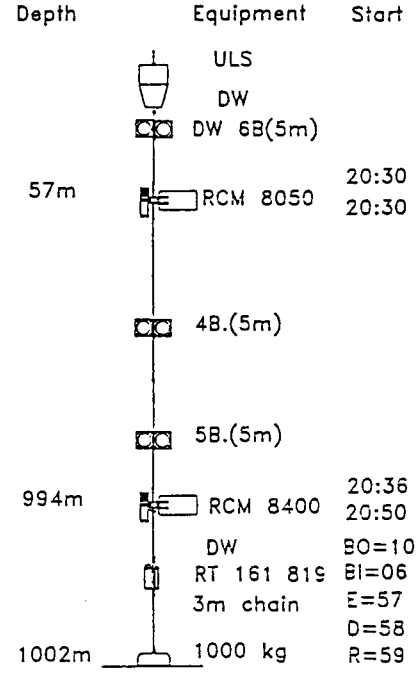
AWI 410

Pos: N75° 00′ W13° 30′
m/s LANCE-SNOP-16.08.91
Pos: N75° 00.084′ W13° 35.534′ Euro 50
GPB DOP= 1.8
Depth= 198m (1447m/s)197m (1550m/s)



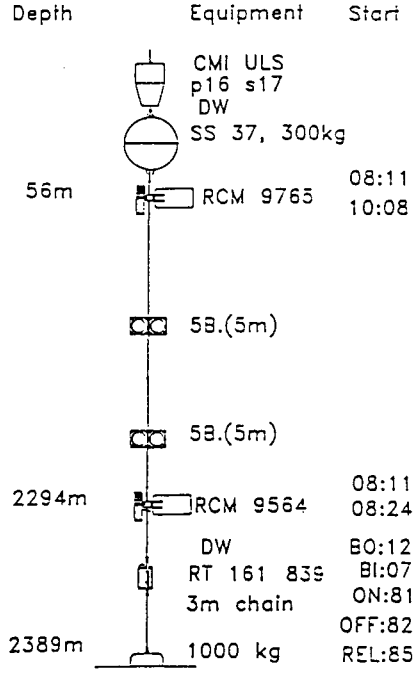
AWI 411

Pos:N75° 00′ W12° 30′
m/s LANCE-SNOP-16.08.91
Pos: N74° 56.085′ W12° 39.800′ Euro 50
GPS DOP=1.3
Depth=1002m (1461m/s)



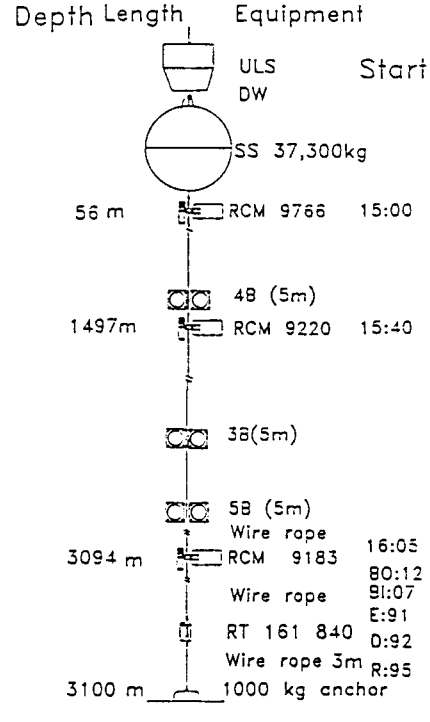
AWI 412

Pos:N75° 00′ W11° 30′
m/s LANCE-SNOP-17.08.91
Pos:N74° 56.475′ W11° 30.097′ Euro 50
G P S
Depth= 2389(1467m/s)



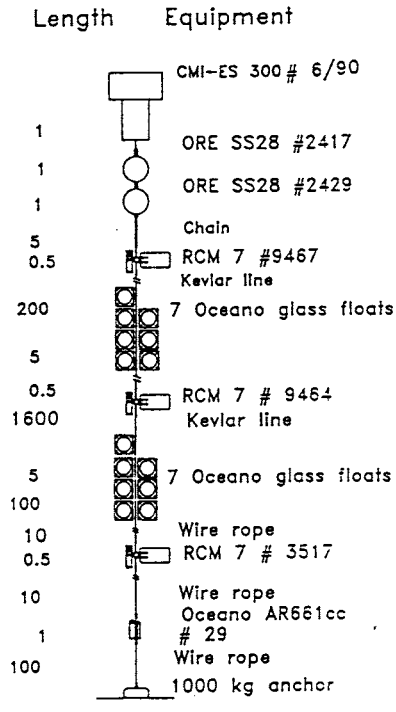
AWI 413

POS:N75° 03.263′ W10° 15.272′
G P S Euro 50
Depth= 3146(1500m/s)



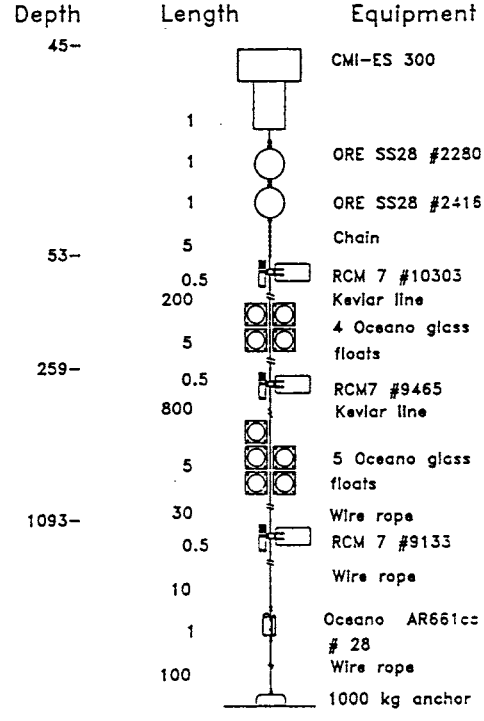
NP/91 /V1

Location: Fram Strait
Position: N 79° 04.692'
" W 3° 44.417'
Depth 2053 m (1469 m/s)



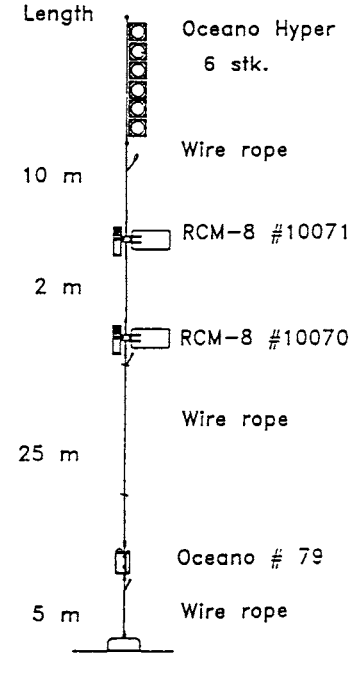
NP/91/V2

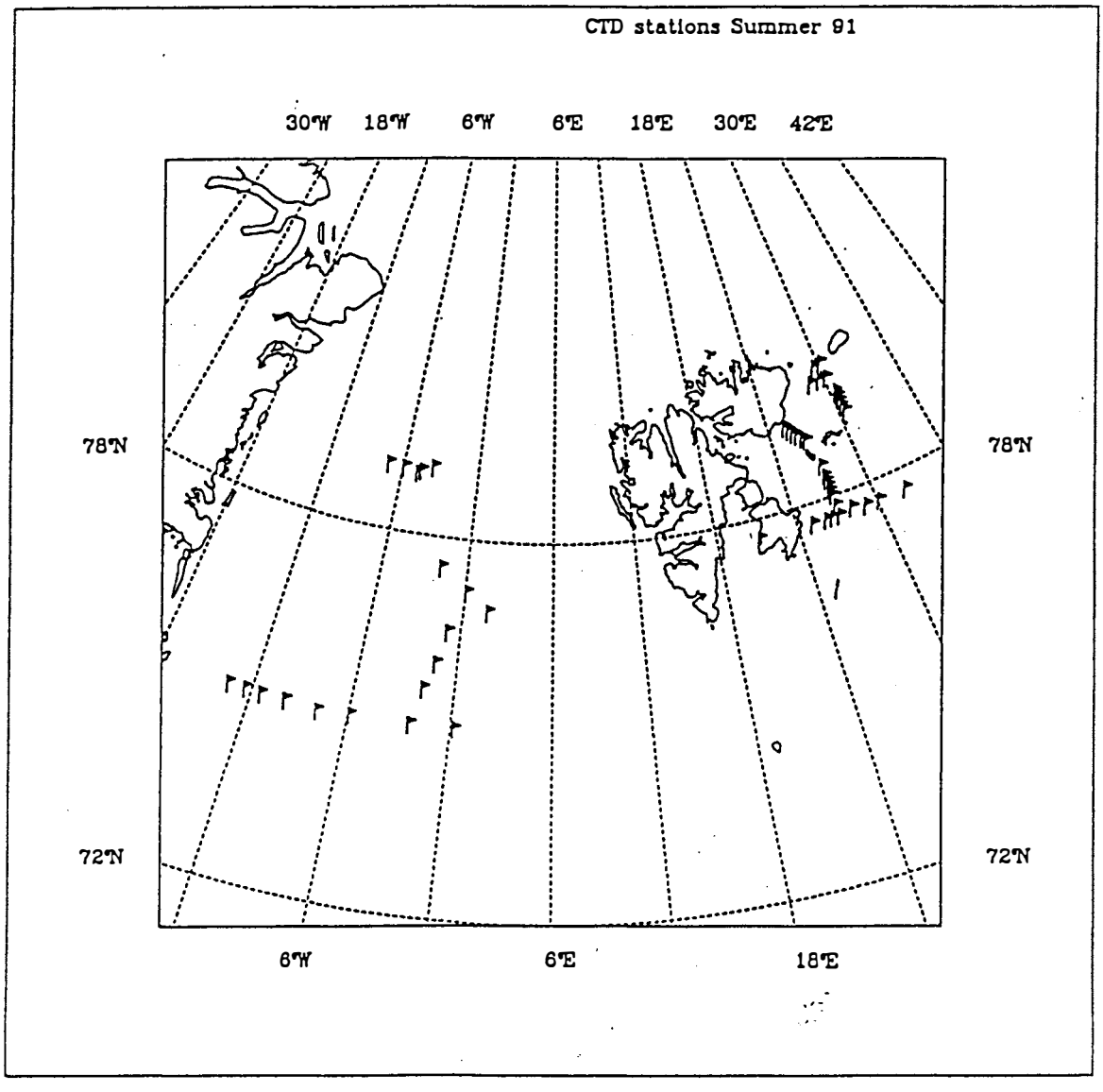
Location: Fram Strait
Position: N 78 54.099'
W 4 55.451
Depth: 1235m (1460m/s)



KLIMA – 1 – 90.

POS: N76° 52.248' } GPS Europe. 1950
" E01° 31.530'
Depth: 3270 m (1500 m/s)





Map of CTD-stations

ICE BOTTOM TOPOGRAPHY AT TWO ICE FLOES BETWEEN KVITØYA AND NORDAUSTLANDET

Ånund Sigurd Kvambekk

Very little is known about the ice thickness distribution in the Barents Sea. The ice thickness is a limiting factor for energy exchange between the sea and the air, and the form of the underside governs the momentum transport between the ice and the sea.

Two large ice floes were partly mapped 3-7 August 1991 using a scanning sonar Mesotech 971. The ice floes were located at 80°09'N, 30°01'E and 80°15'N, 29°50'E, but the positions changed due to drift during the measurements. They are referred to as icefloe 1 and 2 in this cruise report.

Measuring technique

The sonar was mounted at the end of a metal bar and lowered 18 m through a hole in the ice. It was then pulled to a horizontal position and the rotating head measured a profile of the ice underside. The metal bar was turned every 5 degrees to measure the bottom in a star shaped pattern. The ice topography was well resolved within a radius of 40 m from the centre hole. Several holes at one floe increased the accuracy and the area coverage. Deep ice ridges will impose shadow areas, so it is important to measure ridges from both sides to resolve its true form.

Data sampling

A cable from the vessel to the sonar supplied power and transmitted the data. A PC stored the viewing angle, sonar tilt and the time for the sound pulse to reach sea/ice interface and return.

Ice draft

The sound speed in the upper water layers was measured with a CTD. The sonar data was converted to ice draft data and interpolated into a grid net of 2 m resolution.

Ice floe 1

Three holes were drilled through the ice (Fig. 1) and an area of 13000 m^2 were mapped. The ice floe was a multi year floe with a mean ice draft of 2.16 m. The maximum ice draft was 4.8 m. The ice bottom was relatively smooth compared to ice floe 2, and only two ridged areas were seen within the measured area.

Ice floe 2

Six holes were drilled through the ice (Fig. 2) and an area of 26000 m^2 were mapped. The ice floe was a mixture of multi year ice and winter ice. Blocks of 1-1.5 m winter ice were pressed on top of the ice several places. Distinct features were also found at the underside. Most of the ridges seemed to have been formed in the previous winter. They were rather loose and difficult to climb. The mean ice draft was 3.42 m, and the maximum was 11.2 m.

Date 3/8/1991
Position N8009 E3001

STATION−1

Contour interval 1.0m
Grid distance 2.0m

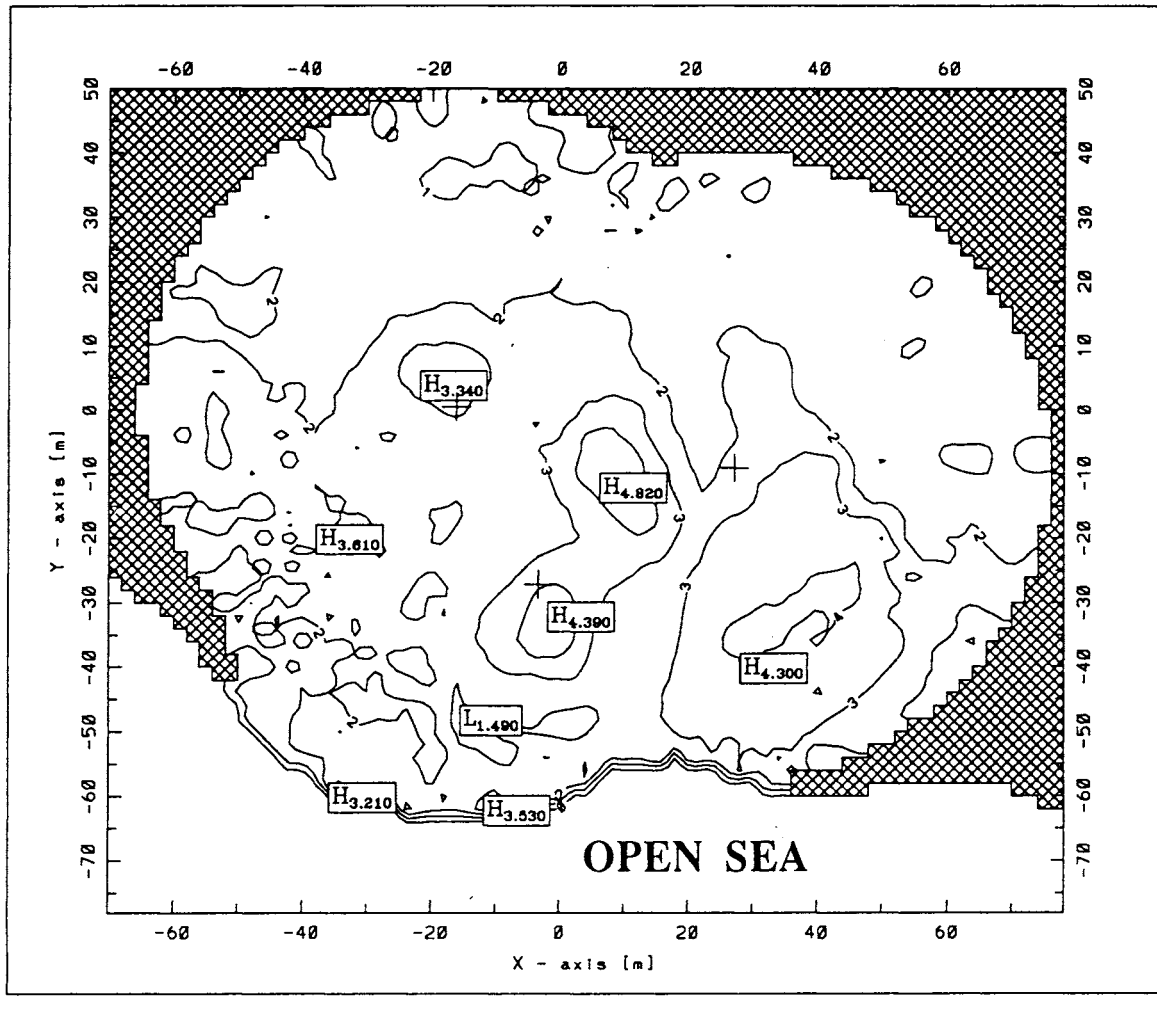


Fig. 1: *Map of ice floe 1 at 3 August 1991 located at approximately 80°09'N, 30°01'E. The contour interval is 1 m and the grid spacing is 2 m. The crosses mark the sonar holes. The edge of the ice floe is at the lower part of the plot. The cross-hatched areas are parts of the ice floe, but they were out of the sonar range.*

Date 4/8/1991
Position N8015 E2950

STATION-2

Contour interval 1.0m
Grid distance 2.0m

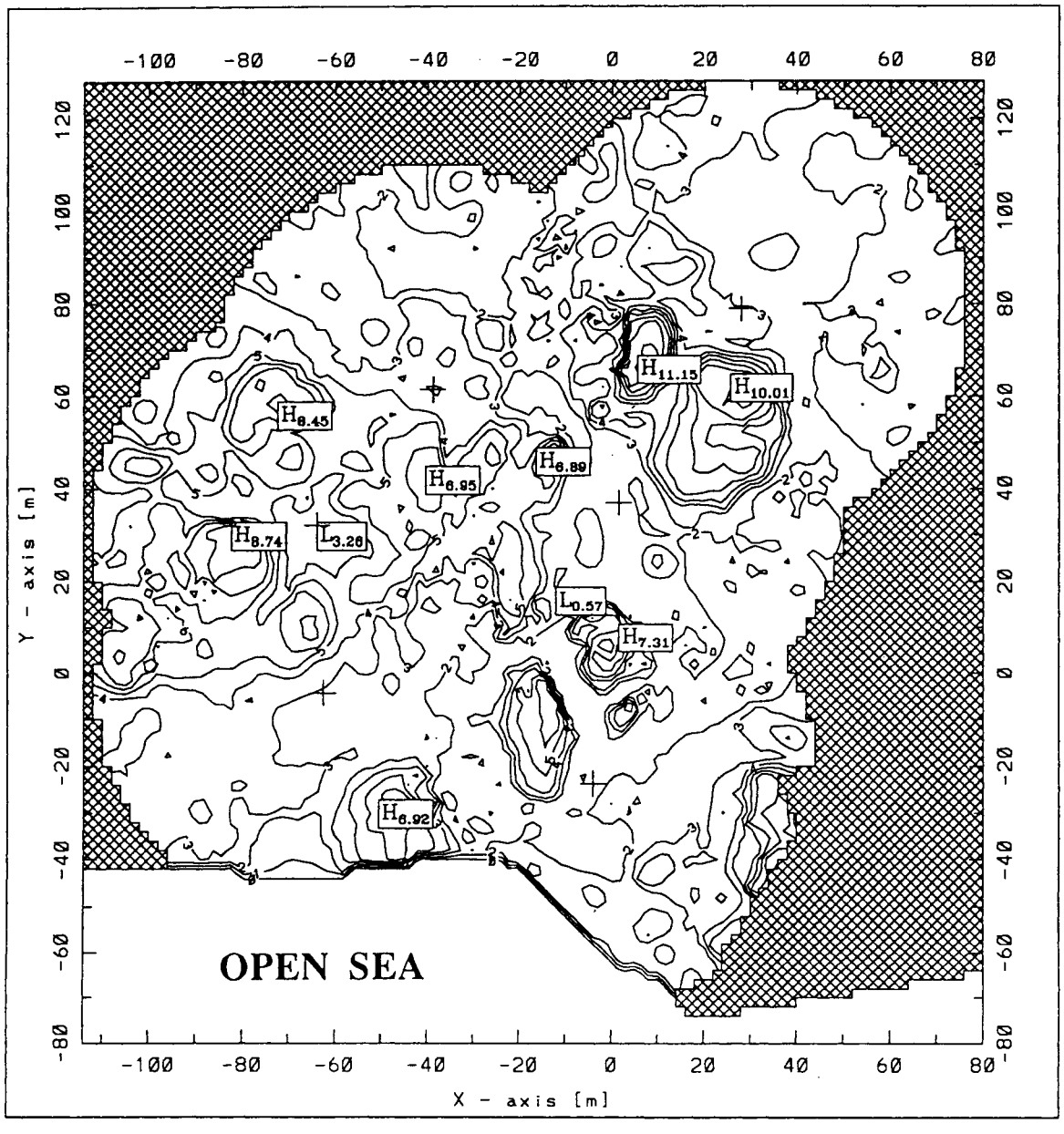


Fig. 2: *Map of ice floe 2 at 4-7 August 1991 located at approximately 80°15'N, 29°50'E. The contour interval is 1 m and the grid spacing is 2 m. The crosses mark the sonar holes. The edge of the ice floe is at the lower part of the plot. The cross-hatched areas are parts of the ice floe, but they were out of the sonar range.*

Ice draft distribution

Fig. 3 reveals the difference in the ice draft distribution between the two sites. There was almost a total lack of ridged ice at ice floe 1. Both floes had however a maximum in the distribution close to 2 m, so they may be of the same age.

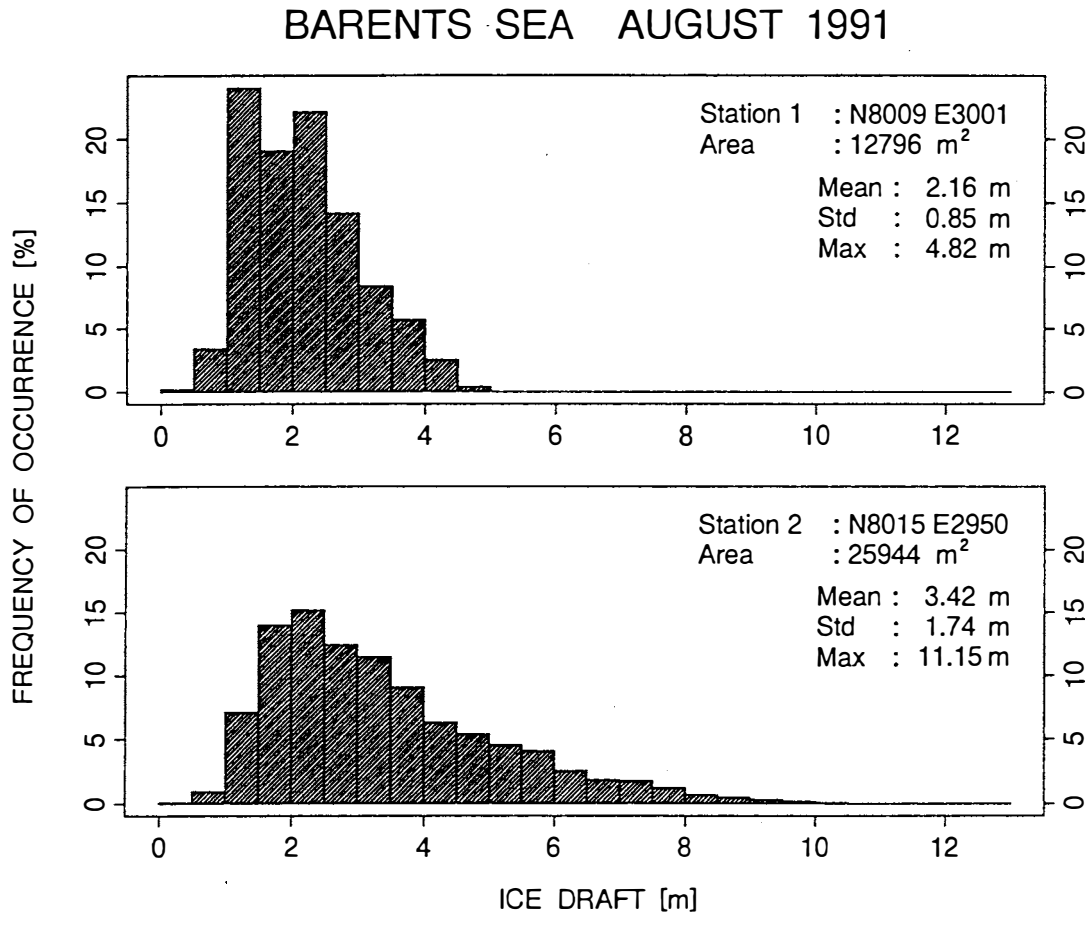


Fig. 3: Frequency of occurrence [%] of ice draft at ice floe 1 and 2. The distribution interval is 0.5 m.

AIR-ICE INTERACTION

Dengyi Gao, Yngvar Gjessing and Tor de Lange

The purpose of the studies were three fold:

1. Determine the aerodynamic skin roughness of different ice floes (winter ice, multiyear ice, heavily ridged ice floes etc.).

2. Determine the mean roughness (form roughness + skin roughness + sail roughness) for larger areas with a different ice cover.

3. Determine the heat exchange between the atmosphere and the ice floes.

The weather conditions during the experiments were very stable:

	Wind speed	Wind direct.	Cloud cover	Air temp.
Aug. 3.	7 - 12 kn.	150 - 180^G	9/8	0.5 - 2.7
4.	8 - 9 "	195 - 340	0/8 - 8/8	- 1.4 - 0.4
5.	7 - 9 "	120 - 300	7/8 - 9/8	- 1.7 - 0.5
6.	7 - 8 "	180 - 210	7/8 - 8/8	0.5 - 1.3
7.	7 - 12 "	200 - 250	6/8 - 8/8	0.1 - 0.5
8.	6 - 16 "	240 - 320	6/8 - 9/8	- 0.6 - 1.2
9.	3 - 9 "	250 - 350	8/8 - 9/8	- 0.3 - 1.0
10.	2 - 5 "	140 - 280	9/8	1.2 - 3.8
11.	0 - 11 "	80 - 130	5/8 - 9/8	0.7 - 3.7

The skin roughness was determined by profile measurements from meteorological masts of wind velocity and air temperatures at 0.40 m, 1.22 m and 3.68 m above the surface. The mean values were recorded every 5. min. on Aanderaa dataloggers.

The experiments were carried out on:

Ice floe 1. (multiyear ice) 3 Aug. 1100 - 6 Aug. 1400
2. (heavily ridged multiyear ice) in 4 different locations during the period 4 - 8 Aug.
3. (winter ice) 3 - 8 Aug.

The mean aerodynamic roughness for larger area was determined by Tether soundings. The wind speed, wind direction and air temperatures were recorded as a function of air pressure. These experiments were carried out from floe 2 during the following periods:

1. Aug. 6: 20h - 22h
   6 profiles up to 180 m max wind speed: 13 knots.

2. Aug. 7: 13h - 15h
   4 profiles up to 640 m max wind speed: 4 knots.

3. Aug. 8: 09h - 11h
   6 profiles up to 185 m max wind speed: 12 knots.

The energy exchange between the ice and the atmosphere (sum of radiation fluxes, turbulent fluxes and heat flow into the ice) were determined from temperature, wind speed and humidity profiles in the meteorological masts. The transport of latent heat was calculated under the assumption of water vapour saturation of the surface. The income shortwave and atmospheric radiation were determined by respectively Kipp & Zonen solarimeter and Eppley pyrgeometer. Integrated values were recorded every 5 min. The conductive heat fluxes in the ice were recorded by heat flux plates.

OCEAN - ICE INTERACTIONS

T. Brinck Løyning, V. Abramov, A. Proshutinsky

Ice floe I: Mooring system

A hole was drilled in the ice 50 m from the edge of the floe, wide enough to put through Aanderaa current meters with rudder. The drilling was mainly carried out with a melt water pump, i.e. the water was pumped into a heater, which after heating the water pumped it out again with high temperature and pressure.

The mooring with one ultra sonic current meter (UCM 40), three Aanderaa current meters, and a Gytre current meter SD 4, was deployed for two and a half day.

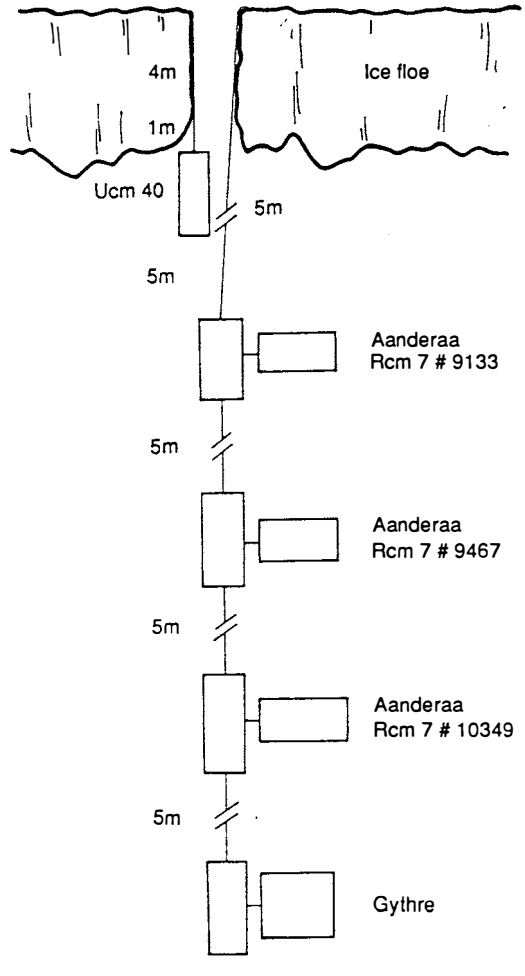


Fig. 1: Mooring arrangements at floe I.

Ice floe II

Five current profiles using the ultra sonic current meter were obtained by measuring at 4, 5, 6, 7, 8, 9 19, 15, 20 and 25 m over periods of 30 minutes at each depth. The holes were drilled with a melt water pump as on Ice floe I, but this time the holes were smaller in size. The instrument was lowered by hand, and fastened to a board of wood on the ice. The data was logged on a PC which was placed on the same board. (The PC and accumulators were sheltered against wind and precipitation.)

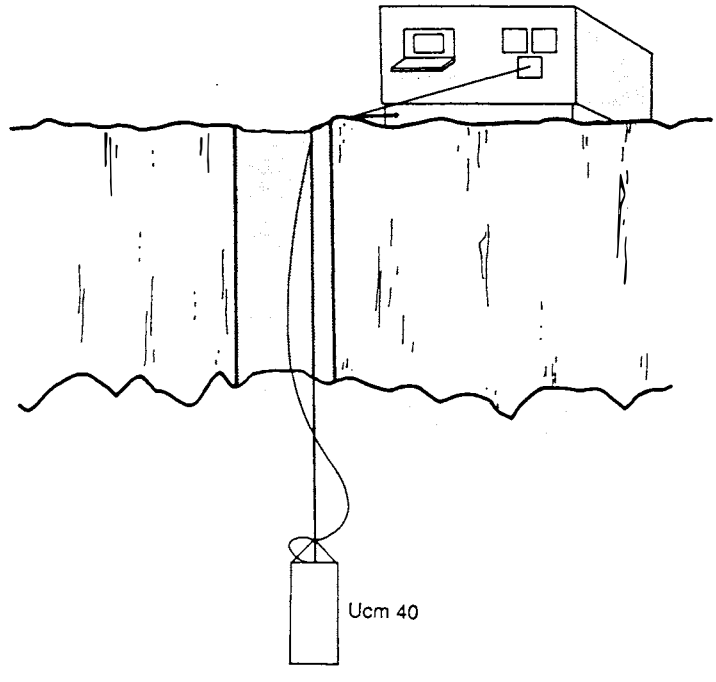


Fig. 2: Instrumental setup at floe II.

FIELD VERIFICATION FOR REMOTE SENSING (ICECLIMA)

1) Physical Properties of the Ice Surface

Reinert Korsnes, Bjørn Erlingsson and Øyvind Frette

OBJECTIVE: *To describe the ice conditions within the scheduled ERS-1 SAR coverage between Kvitøya and Storøya and in the Fram Strait during the Lance cruise.*

The Barents Sea leg

Two ice stations were made during the period of 3-8 August. The position of Floe #1 was N80°26.24 E30°06.303 August 3 at 8:55 and the position of Floe #2 August 6 at 23:40 was N80°26.24 E30°57.46.

The floes were about 500 metres across and both were classified as multiyear ice. They were about 10% covered by melt ponds. Measurements showed a mean conductivity of about 0.1 mS in these ponds.

Both floes were covered by video and photo from ground and air.

Respectively 10 and 6 spatially distributed core samples were taken from floe #1 and floe #2. Temperature and conductivity profiles were measured from these cores on depths 0, 10, ..., 40 cm. Table 1 shows a summary of these measurements.

Depth (cm)	Conductivity Floe #1 (mS)	Conductivity Floe #2 (mS)
0	0.112	0.050
10	0.082	0.087
20	0.213	0.262
30	0.471	0.488
40	0.783	0.687

Table 1. Average of measured conductivity of Floes #1 and #2.

Floe #1 had a highly variable snow layer. The grain size was increasing with depth (max 1 times 1 times 5 cm). Floe #2 had a similar, but slightly thicker snow cover (5 - 10 cm).

The 6 August several video image helicopter missions were carried out at a height of 4000 ft. The camera was mounted vertically below the helicopter.

The same day 12 ice floes were selected at random along a helicopter leg. Each floe was classified bye eye and an ice core sample was taken for salinity measurements at depths 0 and 20 cm. Each floe was covered by video and photography from ground and air.

The 7 August 13 ice floes were similarly investigated.

The Fram Strait leg

Helicopter services were not available during the Fram Strait leg and the ice investigations were restricted to two ice stations and video/photo coverage from Lance.

Floe #3 (first ice station of the Fram Strait leg) had position N74°59.97 W13°23.403 August 16 at 10:50.
Floe #4 (second ice station of the Fram Strait leg) had position N79°4.40 W3°42.85 August 21 at 12.46.

Both ice floes were classified by eye as multiyear ice.

Respectively 4 and 3 spatially distributed ice cores samples were taken from the floes. Table 2 shows a summary of these measurements.

Depth (cm)	Conductivity Floe #3 (mS)	Conductivity Floe #4 (mS)
0	0.037	0.080
10	0.110	0.157
20	0.777	0.550
30	1.915	0.640
40	2.600	1.280

Table 2. Average of measured conductivity of Floes #3 and #4.

Floe #3 had a firn layer of 3-6 cm. Floe #4 had very litte snow (0 - 4 cm).

2) Helicopter Ice Field Surveys

B. Erlingsson and R. Korsnes

VIDEO SECTION NNE - KONG KARLS LAND 02.08.91

OBJECTIVE: *Video photo of ice floes for measurements of ice floe size distribution, size distribution of ice types and ice concentration. Ice berg observations.*

Start at LANCE in position N 79°28.8' - E 30°16.8'.

			Observations:
LEG 1:	Start at:	N 79°23.7' - E 30°08.4'	Large ice floes 3-5 nm west of track at N 79°26'N - E 31°41.8'E
	Time on video:	13:44 - 14:01	
	End at:	N 79°27.9' - E 33°05.5'	
	Cruising speed 120 kn Altitude 2940 ft.		
LEG 2 :	Start at:	N 79°27.9' - E 33°05.5'	Large ice floes 3-5 nm at N 79°35.6'N - E 32°59.4'
	On track:	N 79°31.1' - E 33°08.0	
	Time on video:	14:01 - 14:05	
	End at:	N 79°36.1' - E 32°54.2'	
	Cruising speed 115 kn Altitude 2930 ft.		
LEG 3:	Start at:	N 79°31.6' - E 32°54.2'	Pinacular iceberg 35 nm 205° from N 79°31.6' - E 32°54.2'
	Time on video:	14:06 - 14:27	
	End at:	N 79°26.7'N - E 29°41.9'	l: 200 m h: 15-20 m.
	Cruising speed 100 kn Altitude 2940 ft.		Large ice floes at N 79°33.6' - E 32°00.5'

HELICOPTER FLIGHTS WEST OF KVITØYA 04.08.91

OBJECTIVE: *Video registrations on sections EN starting at the ice edge.*
Stereophotography over ice floe station #1.

LEG 1:	On track at	N 80°11.0'	E 29°27.8'	
	Video start	16:58	speed 115 kn	alt. 800 ft
	Off track at	N 80°11.26'	E 30°33.05	alt. gradually to 600 ft during LEG 1
LEG 2:	On track at	N 80°12.04'	E 30°17.55'	
	Video start	17:06	speed 103 kn	alt. 650 ft
	Off track at	N 80°14.64'	E 29°30.25'	
LEG 3:	On track at	N 80°14.94'	E29°35.00'	
	Video start	17:12	speed 110 kn	alt. 500 ft
	Off track at	N 80°17.48'	E 30°26.26'	
	Nice flat winter ice floe at N 80°15.92' - E 30°12.5'			
LEG 4:	On track at	N 80°15.14'	E 29°56.36'	
	Video start	17:21		
	Off track	N 80°14.26'N	E 29°49.03'	

End due to poor flying conditions. Additionally two short legs over LANCE (video 17:21) and ice floe station #1 (video 17:21) were taken.

After landing / take-off a stereo photographic sections at ice floe station #1 was conducted. Several sections were carried through in 800 ft, 500 ft and 300 ft respectively (Hasselblad Film 1). On the return pictures of the small icefloe and ice station #2 was taken (N 80°14.88' - E 29°47.4').

Participants: Bjørn Erlingsson, Reinert Korsnes

FLIGHT TO KVITØYA 05.08.91
PHOTO FLIGHT AT ICE STATION #2

OBJECTIVE: *Redeployment of ICEXAIR capsule and retrieval of old meteorological station on Kvitøya. The deployment was successfully carried through after inspection of the old mast on Andrè-neset. The remaining mast was successfully retrieved on later trip.*

OBSERVATIONS: Scattered winter ice floes at N 80°19.30' - E 30°03.07' and multiyear floes at N 80°10.9' - E 30°54.11'.

PHOTO FLIGHT: Couple of photographic sections were taken at floe #2. The conditions were good but it had to be carried through in low altitude, 200 ft. The photographic sections were taken on the end of film #1 and in the beginning of film #2.

DEPLOYMENT POLES ON ICE FLOES FOR DRIFT MEASUREMENTS.

OBJECTIVE: *Deployment of drifting poles on different ice floes on a one (1) nm long section elongated towards west from ice station #2. This to investigate how different the drift behaviour of different ice floes is in terms of size, draft and ice type.*

DEPLOYMENT: During 19:36 - 20:18 the 5.8.91
Position of floe #2 was: N 80°19.398' - E 29°55.855'

Time	*Position*	*No.*	*Flag*	*Description*
19:36	N 80°19.124' - E 29°50.776'	1	blue/o - o/o	400 m diameter multi year floe. Few pressure ridges
19:41	N 80°19.053' - E 29°50.220'	2	blue/orange - o/o	Multi year floe. Pressure ridges 1.2 - 1.5 m. Weathered pressure ridges.
19:55	N 80°18.946' - E 29°49.65'	3	blue/black - o/o	Thick winter ice. Ice floes in cluster 4 - 5. Relatively many pressure ridges 2/10. Second year ice - 3 year ice.

20:03	N 80°18.946' - E 29°49.65'	4	blue/o - o/o	Winter ice floe 50 x 40 m. Small with noe pressure ridges.
20:05	N 80°18.672' - E 29°47.304'	5	blue/o - blue/o	Thick multi year floe / old pressure ridge 5 - 6 m high. Ice floe 200 m in diameter.
20:18	N 80°18.256' - E 29°42.561	6	blue/black - blue/black	Open lead / rotten ice in between. Diameter 250 m, in cluster consisting of small ice floes. Many small ice floes in the lead. Relatively young pressure ridge.

Revisit: 1 The floes were revisited during the time 02:30 - 01:51 the 6.8.91.
All but one were found during that time.

The ice floe position N 80°18.17' - E 30°07.91'

No: 1 position N 80°18.14' - E 30°06.42'
2 position N 80°17.92' - E 30°04.51'
3 position N 80°18.01' - E 30°02.67'
4 position N 80°18.113' - E 30°01.08'
5 position N 80°17.81' - E 29°57.60'

Revisit: 2 The ice floes were revisited again during 15:21 - 15:50 the 6.8.91.
All but one were found. The whole system had turned around.

The floe at position N 80°19.992' - E 30°28.137'

No: 1 (4) position N 80°21.906' - E 30°30.33'
2 position N 80°21.60' - E 30°30.99'
3 position N 80°21.52' - E 30°28.25'
5 position N 80°20.709' - E 30°21.148'
6 position N 80°20.647' - E 30°18.557'

Revisit: 3 All floes were revisited during 15:10 - 15:20 the 8.8.91.
The ice station 2 was at position N 80°27.78' - E 31°32.06' (?)

No: 1 position N 80°31.61' - E 31°34.55'
2 position N 80°31.44' - E 31°35.12'
3 position N 80°31.14' - E 31°36.40'
4 position N 80°31.62' - E 31°37.86'
5 position N 80°31.67' - E 31°27.04'
6 position N 80°31.06' - E 31°22.26'

AROUND KVITØYA POSITIONING REEFS

OBJECTIVE: *Positioning of new land (reefs) north and SE of Kvitøya.*
Observation of walrus.
Photography and iceberg observations.

Comment:	Picture: frame/film	Position:
General overview over the ice field NW of Kvitøya.		N 80°18.6' - E 32°41'
Fracture zone at the shelf.	2/1	N 80°16.0' - E 33°15'
Walrus - 5 on the ice, 2 in the water.		N 80°13.5' - E 33°31.8'
Reef photographed in 200 ft altitude towards east and south. Approximate size 50 x 50 m.	7-13/1	N 80°11.104' - E 33°28.943' N 80°11.103' - E 33°28.940' N 80°11.098' - E 33°28.934'
The first of two adjacent reefs. Photo 200 ft. altitude towards east and south.	14-15/1	N 80°10.412' - E 33°27.658' N 80°10.411' - E 33°27.656' N 80°10.411' - E 33°27.653' N 80°10.412' - E 33°27.677'
The second of two adjacent reefs. Photo 200 ft. altitude towards east	16-17/1	N 80°10.247' - E 33°27.317' N 80°10.247' - E 33°27.318' N 80°10.246' - E 33°27.311' N 80°10.246' - E 33°27.316'
River running from the glacier on the rock a couple of meters in front of the glacier. We name it "Kvitåa".	22/1	River near the reefs.
Hornodden view from west.	23-24/1	At Hornodden.
Two stones / small reefs. Photo 200 ft. altitude from north	25-26/1	N 80°08.432' - E 33°21.479' N 80°08.431' - E 33°21.481' N 80°08.432' - E 33°21.479'
Iceberg grounded near Hornodden. W/L: 40/75 m H: 10 m	27/1	N 80°06.17' - E 32°30.06'
Iceberg grounded W/L: 100/150 m h: 12 m	27/1	N 80°04.7' - E 32°06.2'
Reef. Photo from 200 ft. towards east.	28-29/1	N 80°02.583' - E 31°44.733' N 80°02.583' - E 31°44.741' N 80°02.584' - E 31°44.746'

Seaweed and mainly sea angle washed up on the shelf melting its way in the glacier.	30-31/1 34-36/1	South of the reef along the ice shelf towards S and W
Reef. Photo 200 ft. altitude towards east.	32-33/1	N 80°02.500' - E 31°42.930' N 80°02.489' - E 31°42.919' N 80°02.497' - E 31°42.892'
	New film in camera	
Met. station at Kvitøya.	1-3/2	N 80°06.618' - E 31°28.429' N 80°06.618' - E 31°28.441' N 80°06.619' - E 31°28.468' N 80°06.619' - E 31°28.469'
Instrument "fish" washed on shore.	5-7/2	500 m north of met. station
Stone or small reef. Photo 200 ft. altitude towards west.	8-9/2	N 80°12.947' - E 31°53.002' N 80°12.947' - E 31°53.009' N 80°12.947' - E 31°53.004'
Reef 60 x 60 m^2. Photo 200 ft. altitude towards west.	9-10/2	N 80°13.132' - E 31°54.917' N 80°13.133' - E 31°54.921' N 80°13.135' - E 31°54.917'
4 walruses on the ice.		N 80°24.6' - E 31°51'

General comment: The observations of reefs took place during 16:30 to 17:00 the 08.08.91. The "Tremble Trans Pack" GPS was in an "European 1952"-projection mode.

VIDEO SECTIONS AT LANCE - STEREO PHOTO ICEFLOE 1 AND 2

OBJECTIVE: *Video sections for ice morphology and ice type. Measuring proportion of melting ponds. Stereophotography of ice floes for surface topography and ice freeboard. Panorama over ice field in the vicinity of LANCE.*

Start at LANCE N 80°26.67' - E 31°00.41'
Cruising speed 108 kn and altitude 4000 ft.on legs 1 - 5

			Observations:
LEG 1:	Start at:	N 80°32.86' - E 29°59.63'	Large brown algae at N 80°32.86' - E 29°59.63'E
	Video time:	01:22 - 01:31	
	End at:	N 80°33.14' - E 31°41.49'	
LEG 2:	Start at:	N 80°30.57' - E 31°29.23'	
	Video time:	01:33 - 01:42	
	End at:	N 80°26.94' - E 29°59.82'	
LEG 3:	Start at:	N 80°27.14' - E 30°04.43'	
	Video time:	01:43 - 01:50	
	End at:	N 80°27.09' - E 31°25.70	
LEG 4:	Start at:	N 80°27.68' - E 31°27.64'	
	Video time:	01:51 - 02:00	
	End at:	N 80°23.24' - E 29°59.76'	
LEG 5:	Start at:	N 80°23.16 - E 30°03.00'	
	Video time:	02:02 - 02:08	
	End at:	N 80°23.09' - E 31°17.56'	
LEG 6:	Start at:	N 80°21.9' - E 31°21.3'	
	Video time:	02:12 - 02:15	
	End at:	N 80°26.7' - E 31°00.2'	

Cruising speed 110 kn - altitude 7000 ft.

Stereophotography: Four sections over Ice Station 2 in altitudes 2000, 1000, 500 and 800 ft. respectively. Hasselblad film 2.
Four sections over Ice Station 1 in altitudes 2000, 1000, 800 and 500 ft. respectively. Hasselblad film 2.

Panorama: Panorama was taken at N 80°22' - E 31°20' in altitude 4000 ft. Hasselblad end of film 2 and continued on film 1.

ICE-REC. VIDEO AND PHOTO - LANCE - KVITØYA - STORØYA

OBJECTIVE: *Ice reconnaissance of mooring search area SW of Storøya.*
Video registrations of ice field and photography of large ice features.
Iceberg observations.

Start at LANCE at N 80°29.60' - E 31°15.7'

		Picture no. and position
Comment:	Photo showing THETRA sonde	5)
LEG 1:	Start at: N 80°29.41' - E 31°15.632'	
	Cruising speed: 105 kn	
	Altitude: 4500 ft.	
	Video time: 13:48 - 13:54	
	Photo: large ice-floe towards east.	6) N 80°26.91' - E 31°21.87'
	Iceberg l: 120 m h: 14 m, 4-5 m nm west	N 80°23.21' - E 31°32.59'
	Photo towards KVITØYA	7) " "
	End at: N 80°19.78' - E 31°43.29' over open water.	
LEG 2:	Start at: N 80°17.846' - E 31°31.037'	
	Cruising speed: 110 kn	
	Altitude: 4500 ft.	
	Video time: 13:56 - 14:15	
	Photo towards west:	9) N 80°14.34' - E 30°06.59'
	Photo opening open water	10) N 80°12.53' - E 30°06.59'
	Photo Storøya north coast	11)
	Photo two icebergs NNE off the NE coast	12)
	End at: N 80°09.40' - 28°20.10'	
LEG 3:	Start at: N 79°41.29' - E 29°16.81' at the tip of the "ice-odd"	
	Cruising speed: 109 kn	
	Altitude: 5000 ft.	
	Video time: 14:58 -- 15:18	
	Two icebergs - one grounded, l: 150 m h: 15-20 m, pinacular, the other tabular, drifting, passing the coast with speed > 2 kn.	
	Iceberg 5 nm NE off N 80°10.8' - E 27°26.18' Pinacular h: 20 m l: 150-200 m.	
	Tabular iceberg grounded 2-3 nm E of SE part of Storøya.	
	Photo west off the "ice-odd" towards east	16) and 17)
	Photo from the "ice-odd" towards Storøya	18)
	Photo in direction towards Storøya	19) N 79°54.7' - E 29°48.9'
	Photo towards Storøya	20) N 80°01.18' - E 30°05.1'
	Sequential photos in direction towards Storøya	21) - 25)

BE-tab 20.8.91

ICE OBSERVATION PHOTOGRAPHY, SNOW AND ICE SAMPLING 6.8.91 16:45 -

OBJECTIVE: *To collect data on ice type, roughness, floe size west of the working area.*
To take samples (0 cm and 20 cm depth) for conductivity measurements for verification of ice type observations.
To estimate snow thickness and grain size.
To collect iceberg observations.

OBSERVATIONS

No. Position Time	Ice type	Floe size m^2	Roughness characteristics	Photo no.	Conductivity 0 cm - 20 cm	Snow depth - Grain size
1. N 80°24.04' - E 30°11.05' 16:52	Old multiyear	1000 x 1100	Old weathered consolidated ridges.	1 - 4 200 ft. towards S.	120 - 60	
2. N 80°23.88' - E 30°17.24' 17:05	Multiyear	300 x 400 cluster (2000 x 2500)	Newly ridged ice. Encaptured in large cluster of floes.	6 - 10 200 ft. towards S.	60 - 80	
3. N 80°23.75' - E 30°19.63'	Old multiyear	200 x 200	One weathered ridge.	11 - 14 200 ft. towards S.	No data.	

4. N 80°23.82' E 30°26.88' 17:30	Thick winter ice coherent to second year ice	350 x 400	Few pressure ridges < 1/10.	15 - 22 200 ft. towards S.	930 - 151	
5. N 80°23.60' - E 30°32.82' 17:40	Old multiyear	50 x 70	Old and new ridges.	23 - 28	70 - 150	
6. N 80°23.72' - E 30°37.43' 17:50	Rotten winter ice	200 x 300	Few ridges.	29 - 34	250 - 2540	

ICE OBSERVATION PHOTOGRAPHY,
SNOW AND ICE SAMPLING 6.8 22:30 -

OBJECTIVE: See above. Sampling west of working area.

No. Position Time	Ice type	Floe size m^2	Roughness characteristics	Photo no.	Conductivity 0 cm - 20 cm	Snow depth - Grain size
1. N 80°25.48' - E 31°28.60 22:40	Winter ice	200 x 200	No ridges.	1 - 4 200 ft. towards W	150 - 1650	
2. N 80°25.32' - E 31°25.49 22:50	Multiyear ice encl. winter ice 2/10	1200 x 1300	Ridges 1 m 3 m max	5 - 10 200 ft. towards W	30 - 20	
3. N 80°25.98' E 31°20.13' 23:00	Old multiyear ice - some encl. winter ice	350 x 200	Old weathered pressure ridges 1,2 m - new ridges on the east side.	11 - 15 200 ft. towards W	20 - 50	

4. N 80°26.11' E 31°12.27' 23:07	Multiyear ice. Some encl. refrozen leads, winter ice.	300 x 400	Ridges 2-3/10 1,5 m max 2-2,5 m new ridges.	16 - 20 200 ft. towards W	20 - 80	
5. N 80°26.35' E 31°09.71' 23:17	Old multiyear ice.	200 x 300	Weathered pressure ridges.	21 - 26 200 ft. towards W	50 - 20	
6. N 80°26.41' E 31°04.07' 23:24	Second year ice with scattered multiyear ice and winter ice.	1300 x 700	Relatively new ridges 1,5 m - 3,0 m max. Ruble field at the edge.	27 - 31 200 ft. towards W	10 - 210	

ICE OBSERVATION PHOTOGRAPHY,
SNOW AND ICE SAMPLING 7.8.91

OBJECTIVE: *See above. Sampling on sections east, south and west of the working area. Algae filtering in leads.*

Number Postition Time	Ice type	Floe size m^2	Roughness characteristics	Photo no.	Conductivity 0 cm - 20 cm	Snow depth	Grain size mm^3
1. N 80°35.72' - E 31°14.10' 19:13	Second year ice. 1-2/10 encl. multi year ice.	1600 x 800	..... ridges 1,5-2 m max 5 m 1-2/10. Refrozen lead along the floe 20-30 m.	1 - 8 400 ft.	80 - 420	7 cm ± 2	3 x 10 x 40
2. N 80°40.45' - E 31°10.91' 19:25	Thick winter ice.	900 x 1700	Few ridges. Max height < 1 m. Less than 1/10 embedded with old multiyear.	9 - 17 400 ft.	20 - 320	12 cm ± 3	3 x 4 x 7
3. N 80°46.35' - E 31°12.20' 19:40	Three year old ice.	5000 x 10 000	Few ridges. Old weathered max height 1 m.	19 - 22 400 ft.	20 - 20	9 cm ± 2	3 x 7 x 50

4. N 80°45.62' - E 31°11.39'	Winter ice. Peel of icefloe 3.	4000 x 5000	Flat refrozen lead. Few ridges max height < 1 m.	Same as no. 3 400 ft.	40 - 80	6 cm ± 2	No data
5. N 80°41.65' - E 31°35.39'	Multiyear (4 yr) < 1/10 old multiyear ice 1-2/10 emb. winter ice.	500 x 700	Relative young ridges 1,5 m max 3 m.	23 - 27 - 30 400 ft.	60 - 220	10 cm ± 2	3 x 10 x 20
6. N 80°28.03' - E 32°14.73'	Multiyear 3/10, second year 3/10. Winter ice 3/10.	500 x 1000	Young ridges max 2 m. The multiyear ice is ..... 1,5 - 2 m max.	31 - 33			
7. N 80°31.24' - E 31°58.85' 20:45	Second year.	500 x 800	Young ridges 0,5 - 1 m 2 m max.	6 - 9 400 ft.	20 - 690	12 cm ± 3	2 x 3 x 5
8. N 80°22.40' - E 30°06.46' 21:10	Multiyear ice with brown algae spots (3).	400 x 800	Old weathered ridges 1 - 1,5 m 3 - 4 m max.	13 - 17	10 - 150	10 cm ± 2	3 x 5 x 7
9. N 80°16.25' - E 29°03.7' 21:30	Old multiyear ice.	1500 x 800	Young ridges 2 - 3 m.	23 - 27	0 - 0	12 cm ± 2	3 x 7 x 70

10. N 80°12.4' - E 28°35.9' 21:40	Thick winter ice / second year ice.	300 x 800	Few ridges 0,5 m, 1 m max.	28 - 36	30 - 120	9 cm ± 1	2 x 2 x 3
11. N 80°23.82' - E 27°34.3' 22:05	Multiyear ice. 50 x 50 m winter ice embedded.	1000 x 1500	Few ridges 0,5 m - 1 m max.	NEW FILM 5 - 9	0 - 20	10 cm ± 1	2 x 3 x 7
12. N 80°26.7' - E 28°52.3' 22:18	Multiyear. Small 50 m + 300 m long winter ice lead.	1000 x 1000	Young ridges 1,5 - 2 m, max 4 - 5 m.	13 - 16	20 - 50	8 cm ± 1	2 x 2 x 3
13. N 80°30.1' - E 29°44.0'	Composite ice floe. 5/10 winter ice, 3/10 second year ice, 2/10 multiyear ice.	1200 x 600	Ridges 0,5 - 1 m, max 2 m.	17 - 25	140 - 520	12 cm ± 2	3 x 5 x 30

N 80°45.78' -
E 31°11.80'
19:37

Second year ice floe with prominent winter ice peel in the middle. Same structure as floe station no. 3. Few ridges, some old and weathered with maximum height 1 m.
Photo no. 18 in 400 ft. Size 5000 x 10 000 m^2, where winter ice peel is 700 x 5 000 m^2.

OBSERVATIONS WITHOUT SAMPLES

N 80°33,87' - E 32°58.70'	Iceberg, two coherent pinacular, 50 m wide and 70 m and 100 m long respectively 13 m high. Photo 34 -> and new film no. 1 - 5. 200 ft.
N 80°27.29' - E 30°46.4'	Large multiyear ice floe with winter ice along the long side, 400 m wide and 1000 m long. Photo 10 - 12. 700 ft.
N 80°18.8' - E 29°31.6'	Composite ice floe. Photo 18 - 22.
N 80°15.5' - E 29°01.5'	Iceberg h: 5 m l x w: 30 x 25 m^2
N 80°21.7' - E 27°48.6'	Iceberg h: 12 m l x w: 40 x 20 m^2. Pinacular. Photo 1 - 4; new film.

GENERAL SEA ICE CONDITIONS

T. Vinje and V. Abramov

The general ice distribution in the expedition area are given in the attached Norwegian and Russian ice maps for different periods. Comparing with long term means it turns out that the ice edge in the sector 25-35°E has a normal position. Eastward from 35°E the ice edge is about 60 nm to the south of the mean one. This distribution may indicate that ice has been brought in from the Arctic Ocean through the strait between Kvitøya and Franz Josef Land.

One-year old ice cakes and small floes in a concentration of up to 3/10 were observed south of Kong Karls Land. LANCE passed through the strait between Kvitøya and Nordaustlandet 3 August. The ice conditions in that area as given in the figure below showed no marked changes during the ship's drift which ended 8 August.

Positions and dimensions of icebergs were determined both from the ship as well as from the numerous helicopter flights (Table 1). A total of 59 icebergs were observed of which 10 were estimated to be about, or more than 100 m across.

The most southern location of icebergs in the Western Barents Sea was at the end of July 77.7°N, which according to Russian observations is close to the long term mean propagation for this time of the year (Table 2).

The floe size distribution was estimated from visual observations along the ship's track (Table 3). The ice margins south of Kong Karls Land consisted of ice floes less than 50 m across. The relative occurrence of this category decreased to 77%, but was still the dominant form when passing into the margins of the Arctic Ocean between Kvitøya and Nordaustlandet. This ice form which generally characterizes the outer ice edge was during this cruise accordingly found over an extensive area.

At 75°N in the Greenland Sea we encountered only open ice that was composed of small to medium ice floes of multi-year ice. Very little remnants of the winter ice were observed in this area. Further north, at 79°N the concentration of multi-year ice was occasionally very high (see attached ice maps). The retrievals and deployments of moorings had to be carried out in openings that occasionally passed the mooring locations. A higher degree of remnants from the winter ice were observed at this latitude (10-20%).

DET NORSKE METEOROLOGISKE INSTITUTT

STEREOGRAFISK KONFORM PROJEKSJON M 1 : 7,5 MILL. 60°N

Kartbl. 122

I S K A R T nr. 31/91, UTARBEIDET 5.august 1991

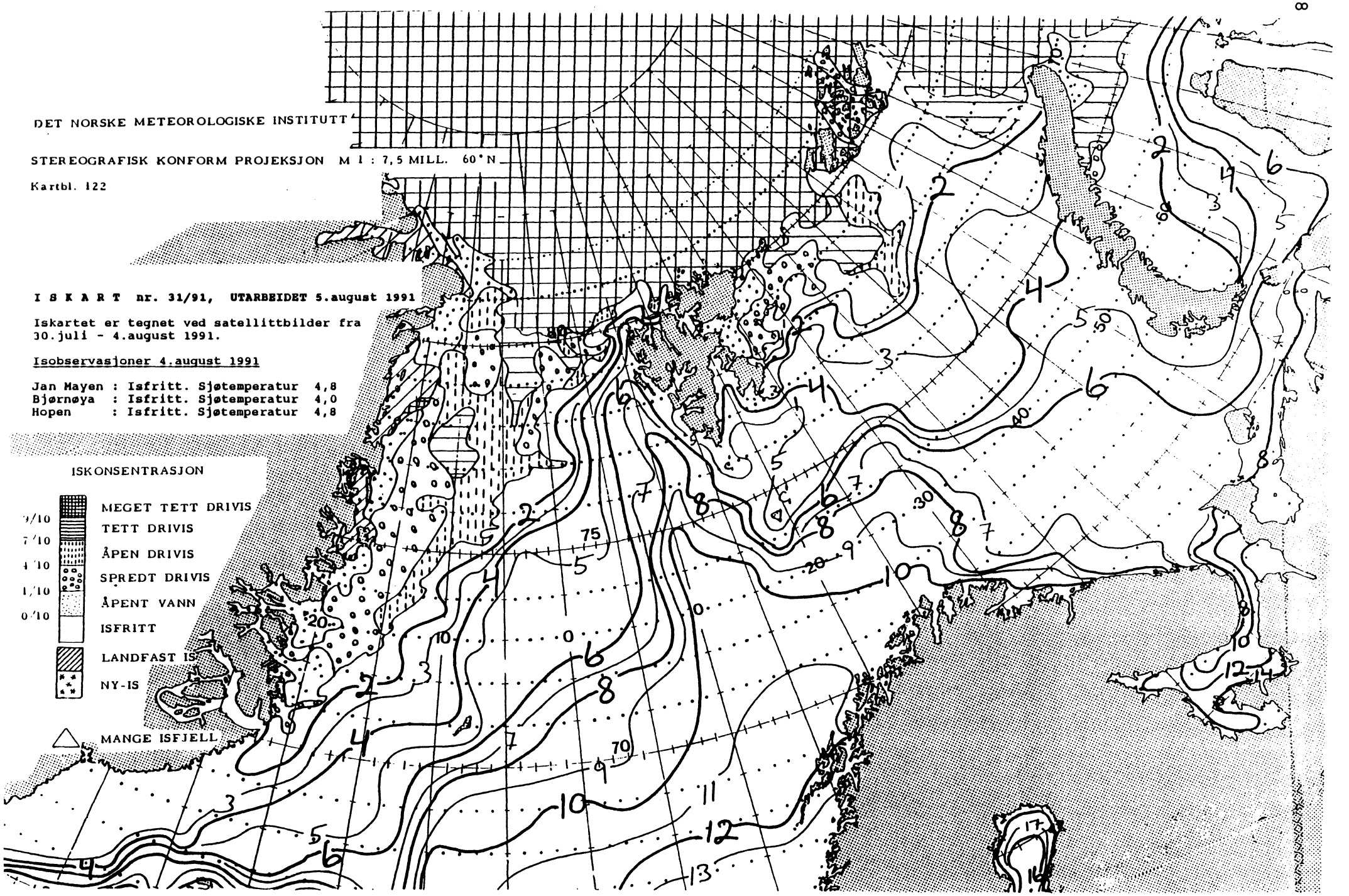
Iskartet er tegnet ved satellittbilder fra 30.juli - 4.august 1991.

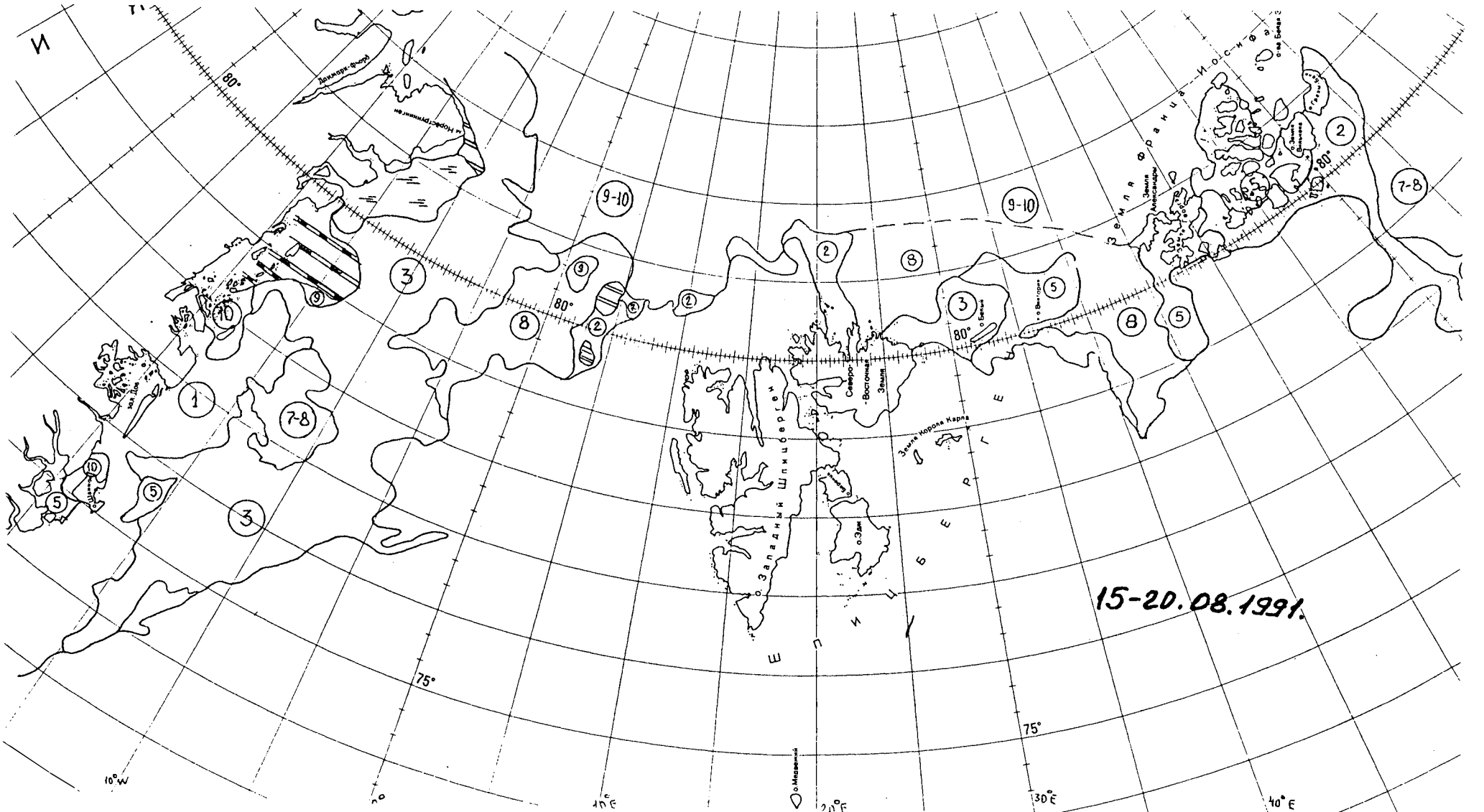
<u>Isobservasjoner 4.august 1991</u>

Jan Mayen : Isfritt. Sjøtemperatur 4,8
Bjørnøya : Isfritt. Sjøtemperatur 4,0
Hopen : Isfritt. Sjøtemperatur 4,8

ISKONSENTRASJON

9/10 MEGET TETT DRIVIS
7/10 TETT DRIVIS
4/10 ÅPEN DRIVIS
1/10 SPREDT DRIVIS
0/10 ÅPENT VANN
ISFRITT
LANDFAST IS
NY-IS
MANGE ISFJELL




15-20.08.1991.
Земля Франца-Иосифа
Земля Александры
Земля Короля Карла
Северо-Восточная Земля
Западный Шпицберген
о. Медвежий
о. Зап
о. Белый
о. Виктория
о. на Белом
Земля Вильчека
Земля Вальтера
Земля Зичи
Земля Норд-Остлянд
Земля Джиллис
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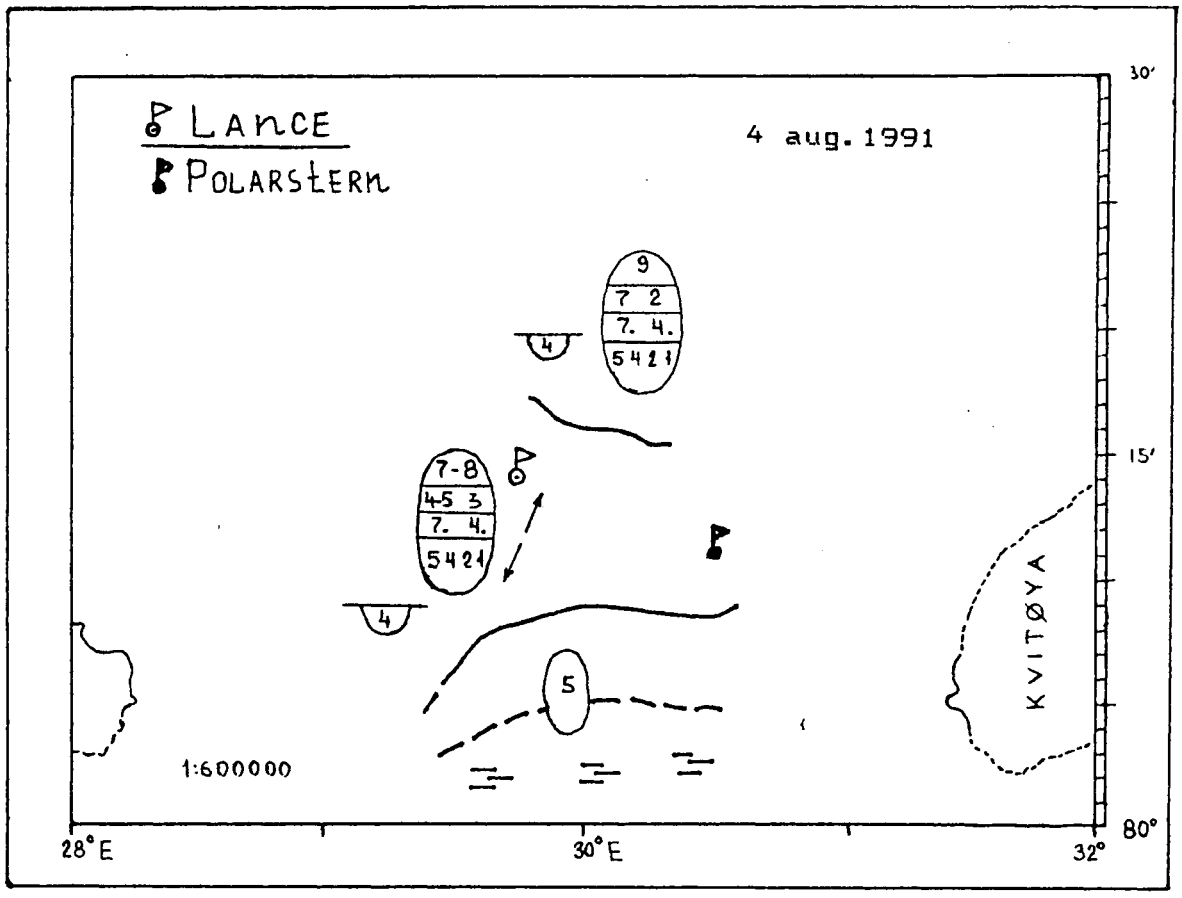


Ice conditions 4 August 1991 given by the egg code (below).

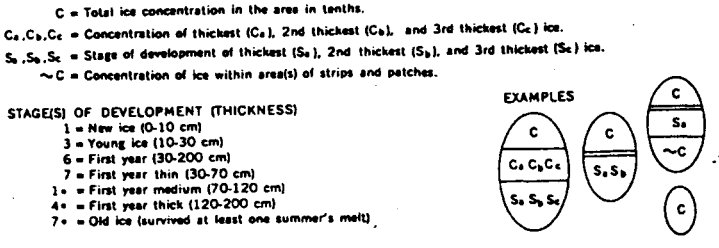


Table 1

The position of icebergs on 1991 (R/V LANCE).

	Date	Latitude	Longitude	Length	Width	Height
		N	E	m	m	m
1	91 07 31	77 40	27 58	25		5
2	91 07 31	77 41	27 58	50		8
3	91 08 01	77 40	25 40	100		11
4	91 08 01	77 40	25 39	40		5
5	91 08 01	77 53	27 00	50	50	9
6	91 08 01	77 59	26 57	60		10
7	91 08 01	78 05	26 55			
8	91 08 01	78 05	26 54			
9	91 08 01	78 05	26 53			
10	91 08 01	78 05	27 00	50	30	7
11	91 08 01	78 05	26 59	100		14
12	91 08 01	78 17	27 00	50	40	11
13	91 08 01	78 46	27 05	30	30	7
14	91 08 01	78 46	27 05	135		13
15	91 08 01	78 38	26 10	150	110	12
16	91 08 01	78 37	28 10	50		10
17	91 08 02	79 05	31 30	200		17
18	91 08 04	80 13	31 05	110	50	14
19	91 08 06	80 21	30 44			
20	91 08 07	80 28	31 06			
21	91 08 07	80 24	31 54	60	40	7
22	91 08 07	80 24	31 54	40	25	5
23	91 08 08	80 06	32 30	75	40	10
24	91 08 08	80 05	32 06	150	100	12
25	91 08 08	80 14	27 39	175		20
26	91 08 08	80 10	27 50			
27	91 08 08	80 34	32 59	85	50	13
28	91 08 08	80 16	29 02	30	25	5
29	91 08 08	80 22	27 49	40	20	12
30	91 08 08	80 08	30 36			
31	91 08 08	80 02	30 02			
32	91 08 08	80 02	29 58			
33	91 08 08	79 58	29 08			
34	91 08 08	79 59	29 31			
35	91 08 08	80 26	31 23	120	60	14
36	91 08 09	79 40	30 42	100		
37	91 08 09	79 42	29 32			
38	91 08 09	79 44	28 54			
39	91 08 09	79 27	30 10	50	30	12
40	91 08 09	79 27	30 10	80	50	14
41	91 08 10	78 33	27 09			
42	91 08 10	78 51	27 18	50	30	20
43	91 08 10	78 54	26 27	25	15	4
44	91 08 10	79 00	27 30			
45	91 08 11	79 10	23 47	60	40	7
46	91 08 11	79 11	23 44	30	25	4
47	91 08 11	79 11	23 44	30	25	4
48	91 08 11	79 11	23 44	30	25	4
49	91 08 11	79 11	23 44	30	25	4
50	91 08 11	79 11	23 44	30	25	4
51	91 08 11	79 11	23 44	30	25	4
52	91 08 11	79 11	23 44	30	25	4
53	91 08 11	79 11	23 44	30	25	4
54	91 08 11	79 11	23 44	30	25	4
55	91 08 11	79 11	23 44	30	25	4
56	91 08 11	79 10	23 10	60	40	7

cont.

57	91	08	11	79	10	23	18	50	30	5
58	91	08	11	79	10	23	18	50	30	6
59	91	08	11	79	10	23	18	50	30	6

Table 2

Long term mean latitude of iceberg appearance
in the Western Barents Sea (1936-1990)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Latitude	74.8	74.9	75.9	76.0	75.8	76.1	76.8	78.3	79.0	77.8	76.2	-

Table 3

Ice floe size distribution as visually estimated
from LANCE, August 1991.

	Southward from of Kong Karls Land	The area between Kvitoya and Svalbard.(Fig.2)
Diameter floes, m	Relative number,%	Relative number, %
5 - 50	100	77.0
51 - 100	-	12.0
101 - 250	-	5.0
251 - 500	-	2.5
501 - 1000	-	2.0
1001- 1500	-	1.0
1501- 2000	-	0.5

HYDROGRAPHICAL OBSERVATIONS ALONG THE 75°N CROSS-SECTION IN THE GREENLAND BASIN

N.Yu. Doronin, S. Østerhus and A.Yu. Proshutinsky

During the second leg of R/V "Lance" cruise in august 1991 a hydrographical cross-section 13.5° west to 0° along 75°N was fulfilled. The cross-section consisted of 8 hydrographical stations. The main goal of the observations was in continuation of data set collections for large-scale processes monitoring in the Greenland Sea.

The cross-section transects the Greenland Basin, where favorable conditions exist for winter deep convection and renewal of bottom water. Such events, expressed in water mixing from surface to bottom were observed several times by the vessels of Arctic and Antarctic Research Institute, Leningrad. Investigations carried out in this area during more than 10 years indicate that no deep convection has taken place during the last few years. So far there is no answer to which mecanisms are stirring that climatically important process.

The distribution of conventional density at depths more than 100 m is adduced in Fig. 1. In the central part of the Basin (long. 3-5°W) the characteristic dome-shaped elevation of water with the conventional density higher than 28.02 can be seen. It is caused by general cyclonic circulation. The dense water masses in the near-bottom layers at 11°W are connected with Arctic ocean deep waters outflow. The high gradients of density in the upper, western part of the section are caused by the interaction between recirculating Atlantic water and the East Greenland Current.

A nearly similar picture is indicated by the salinity distribution (Fig. 2), while the potential temperature distribution is quite different (Fig. 3). The temperature gradient is more sharp in the western part of the cross-section then the saline one, while in the deep layers the potential temperature is almost horizontally uniform.

The most important for the analysis is the temperature distribution in the upper 400 m (Fig. 4). There is a "lense" of cold (down to -1.46°C) winter water in the layer between 70 and 350 m above the dome of deep water. Such a structure is characteristic for the years when no deep convection occurred. The winter convective mixing does not penetrate deeper than 400 m and the subsequent summer surface heating, up to 5°C, forms a seasonal thermocline in the upper 50-70 m. Summer observations can therefore give information about the intensity of winter convection.

Fig. 1 SIGMA-THETA LAT.75N AUG.1991 r/v "LANCE"

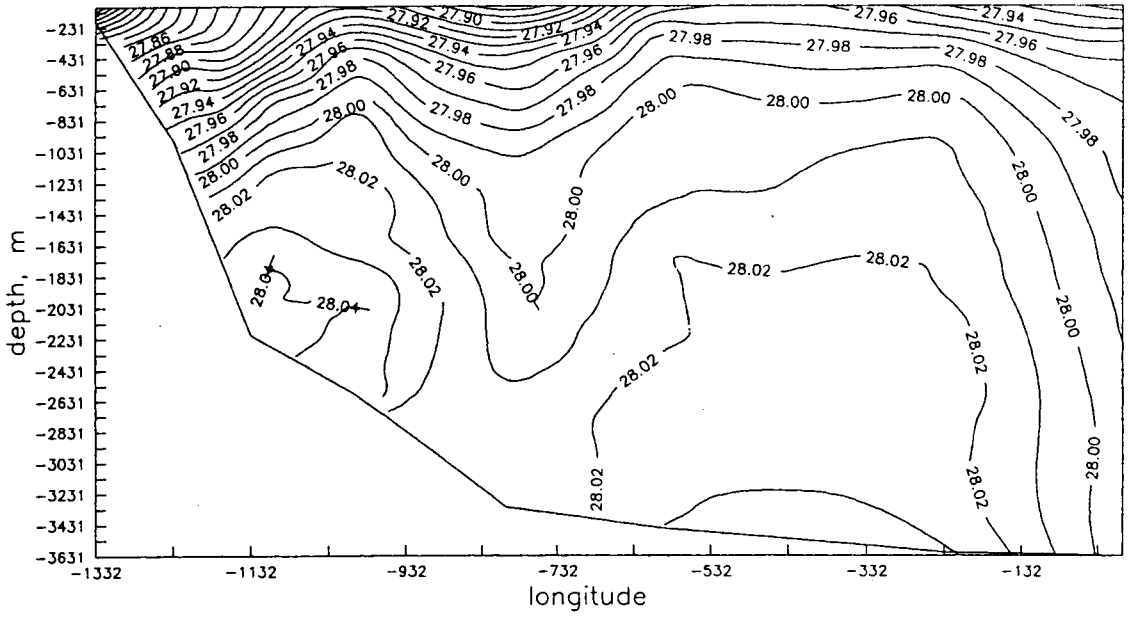


Fig. 2 SALINITY*LAT*75N*AUG*1991*R/V "LANCE"

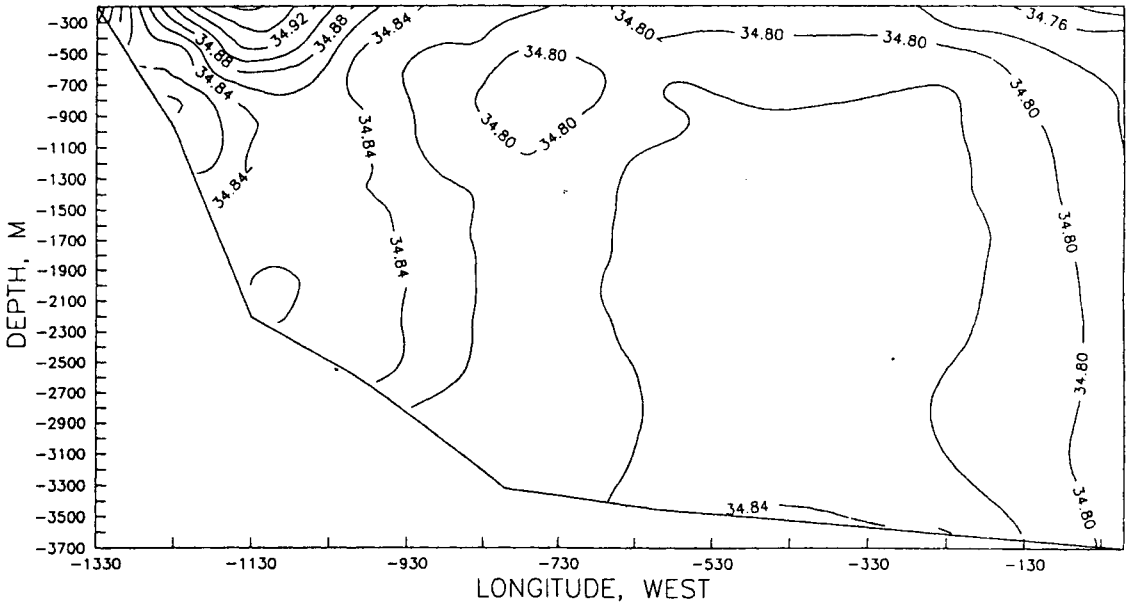


Fig. 3 POTENT*TEMP*LAT*75N*AUG*1991*"LANCE"

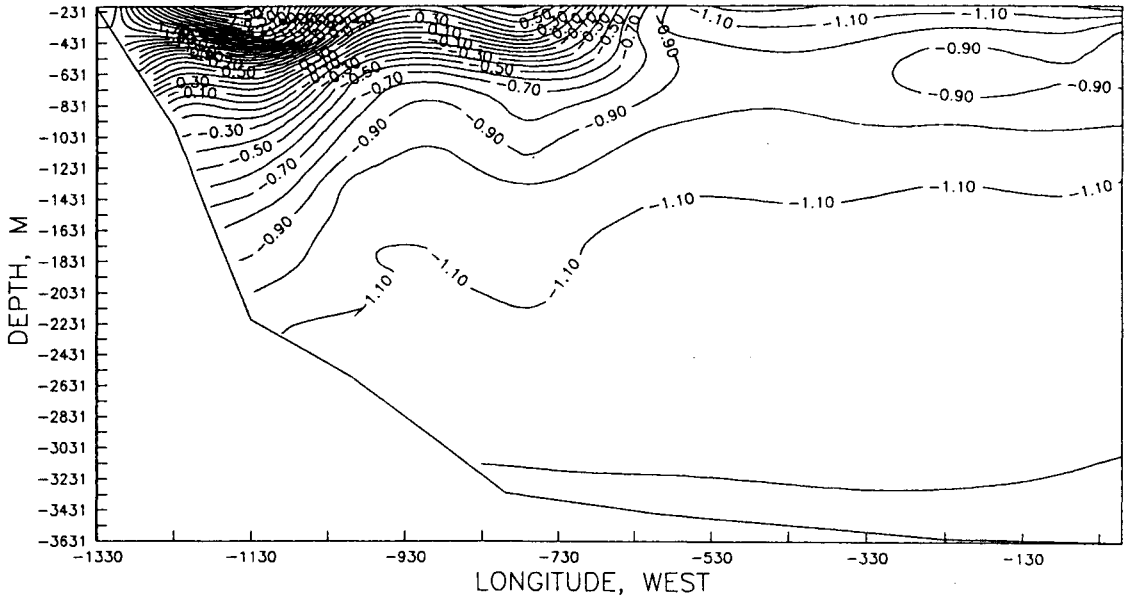
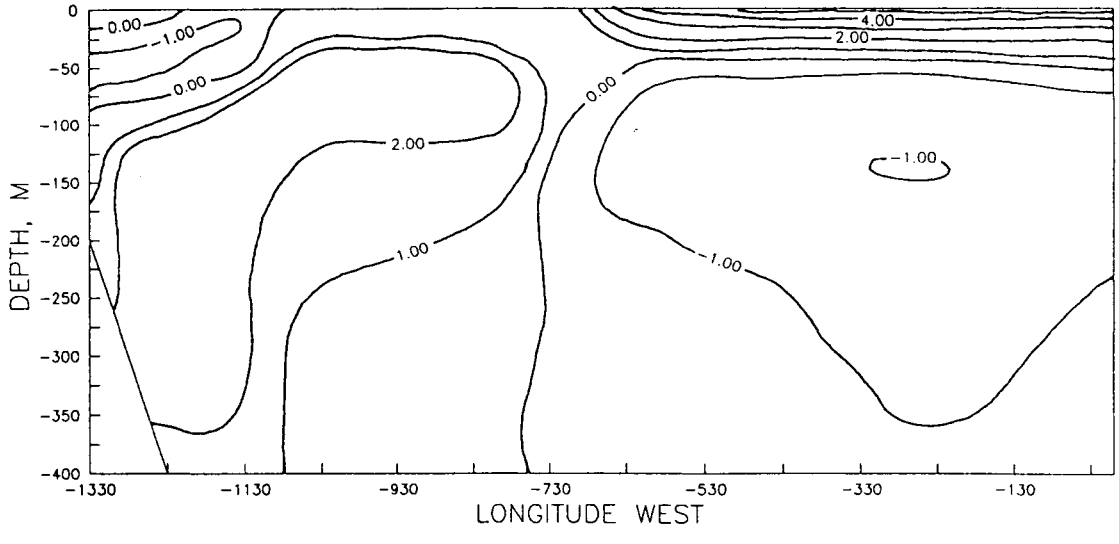


Fig. 4 POT*TEMP*UPPER LAYER*LAT*75N*AUG*1991



CO_2 UPTAKE IN THE NORDIC SEAS

Adelheid Nes and Reidar Nydal

CO_2 uptake in the oceans at higher latitudes is of main interest in order to map the climate development. In cooperation with the Norwegian Polar Research Institute (NP), our laboratory (Radiological Dating Laboratory, LRD) participated during the SNOP (Soviet Norwegian Oceanographic Programme) cruise summer 1991 in the Fram Strait and the Greenland Sea. Our participation consisted of Adelheid Nes and Reidar Nydal.

We tried to obtain deep sea profiles of $\delta^{13}C$, ^{14}C, dissolved inorganic carbon (DIC) and the CO_2 pressure (pCO_2). Measurement of the last quantity was the main task for Adelheid Nes, who had just finished her diploma thesis on this subject and received a scholarship from NP. Knowledge about pCO_2 in the atmosphere and the ocean surface is of main importance in order to study the CO_2 flux between the two reservoirs. In addition to the present measurements, several data, as salinity, temperature and pressure were obtained as a part of the SNOP programme.

Carbon Programme

The SNOP cruise followed the 0°W/E longitude through the Boreas and the Greenland Basins down to the 75°N. The course continued along this latitude westwards to ca 11°W, and further along this longitude until 79°N. The further programme along this last latitude back to Svalbard was disturbed by bad weather. The following programme was performed during the whole cruise:

In the Boreas Basin at 76°52'N, 01°31'E (Sta. no. 35) a complete profile of 20 samples for ^{13}C, ^{14}C and DIC measurements was performed down to 3270 m. Samples for pCO_2 measurements were also collected from the atmosphere and ocean surface.

In the Greenland Basin at 75°00'N, 00°08'W (Sta. no. 38) a profile of 20 samples, down to a depth of 3500 m, was performed in order to repeat the corresponding measurements from the preceeding year (1990), and also the earlier GEOSECS measurements from 1972. pCO_2 measurements down to 200 m were also performed at this station.

In the Greenland Current (75°00'N, 10°00'W - Sta. no. 42), collection was performed with 6 samples between 2000 m and 3200 m (each 250 m). This deep part of the profile was a supplement to the more shallow profile (2260 m) with 15 samples (74°59'N, 11°31'W - Sta. no. 43). Sampling for pCO_2 was also performed from the atmosphere and ocean at the latter station.

16 samples in a depth profile of 2000 m were further collected at the northernmost station (79°04'N, 03°45'W) in the Greenland Current. Also pCO2 was studied with samples from the atmosphere and ocean at three different locations in this area.

Conclusion

The present cruise is a continuation of the cruise performed in 1990, and has the purpose to obtain further central carbon profiles in the Nordic Seas. We have this time been able to obtain some satisfactory profiles in the Greenland Current. The work onboard the ship has mainly consisted of processing CO_2 samples from DIC for later treatment in the laboratory. The ^{14}C samples are going to be measured with AMS (Accelerator Mass Spectrometry) technique in Tucson, Arizona. A data report from the cruise will appear in spring 1992.

OPTICAL MEASUREMENTS

J. Høkedal and T. Brinck Løyning

Purposes

The purpose of this part of the cruise was to map and survey the water masses in the Barents and Greenland Seas by optical methods, i.e. by remote sensing and in situ measurements. Of particular interest was the determination of the depth of the layer were the photosynthesis occur, and a comparison study of Ultra-Violet B irradiance and Blue irradiance. The latter is to be carried out as a master thesis by J. Høkedal, University of Oslo.

Instruments and methods

The following parameters were measured during the cruise:

- UV-B irradiance
- Blue irradiance
- Irradiance without filter
- Transmission
- Secchi-depth
- Colour index

The first two radiative components were measured on nearly every station, the others were measured on several stations. (See table 1 and the maps of the stations.)

Water samples were taken at several stations for estimation of:

- Clorophyll A
- Suspended material
- Turbidity

The water samples will be analysed at Norsk Institutt for Vannforskning (NIVA), Oslo.

To measure at some distance from the shipside to minimize shading effects, the first four of the instruments were lowered from the great beam on the starboard side, which also was provided to be the "sunny" shipside. It may be more practical to use the winches on the CTD side of the deck next time optical measurements are carried out. According to our present experience the distance from the shipside to the instruments should be long enough. A discussion of the shadow effect of the ship is given by Aas (1969a) and by Aas & Berge (1976).

The Secchi disk and the Colour index meter were lowered by hand on the same shipside as the other optical measurements.

All water samples were taken from the surface in a steel bucket.

References

Aas, E. 1969a. On submarine irradiance measurements. Re. Inst. Fysisk Oceanogr., Univ. Copenhagen 6. 23 pp.

Aas, E. & Berge, G. Irradiance observations in the Norwegian and Barents Seas. Rep. No. 23, Inst. of Geophysics, Univ. Oslo.

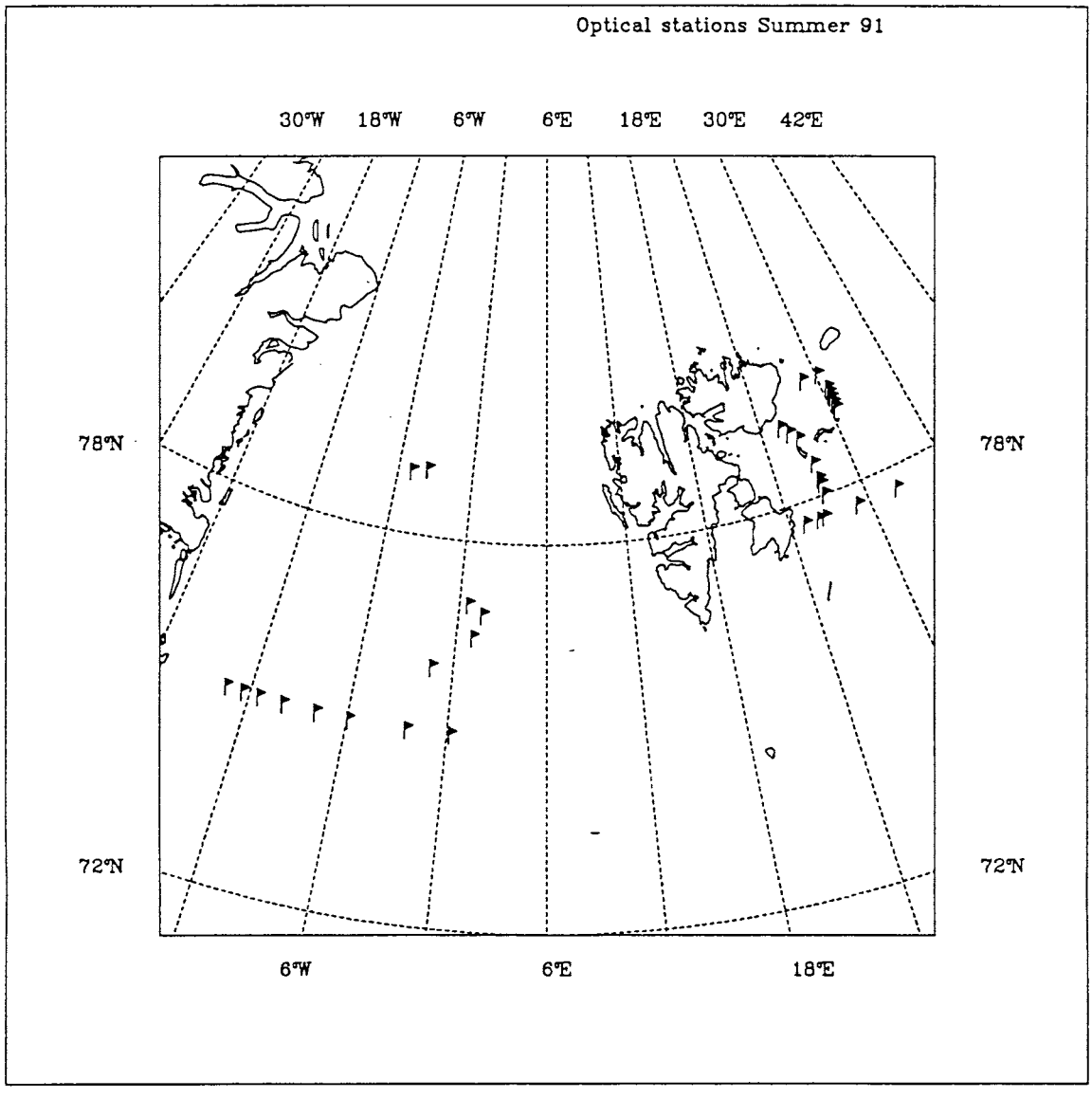


Figure 1: Overview of optical stations on the cruise with M/S Lance in August 1991.

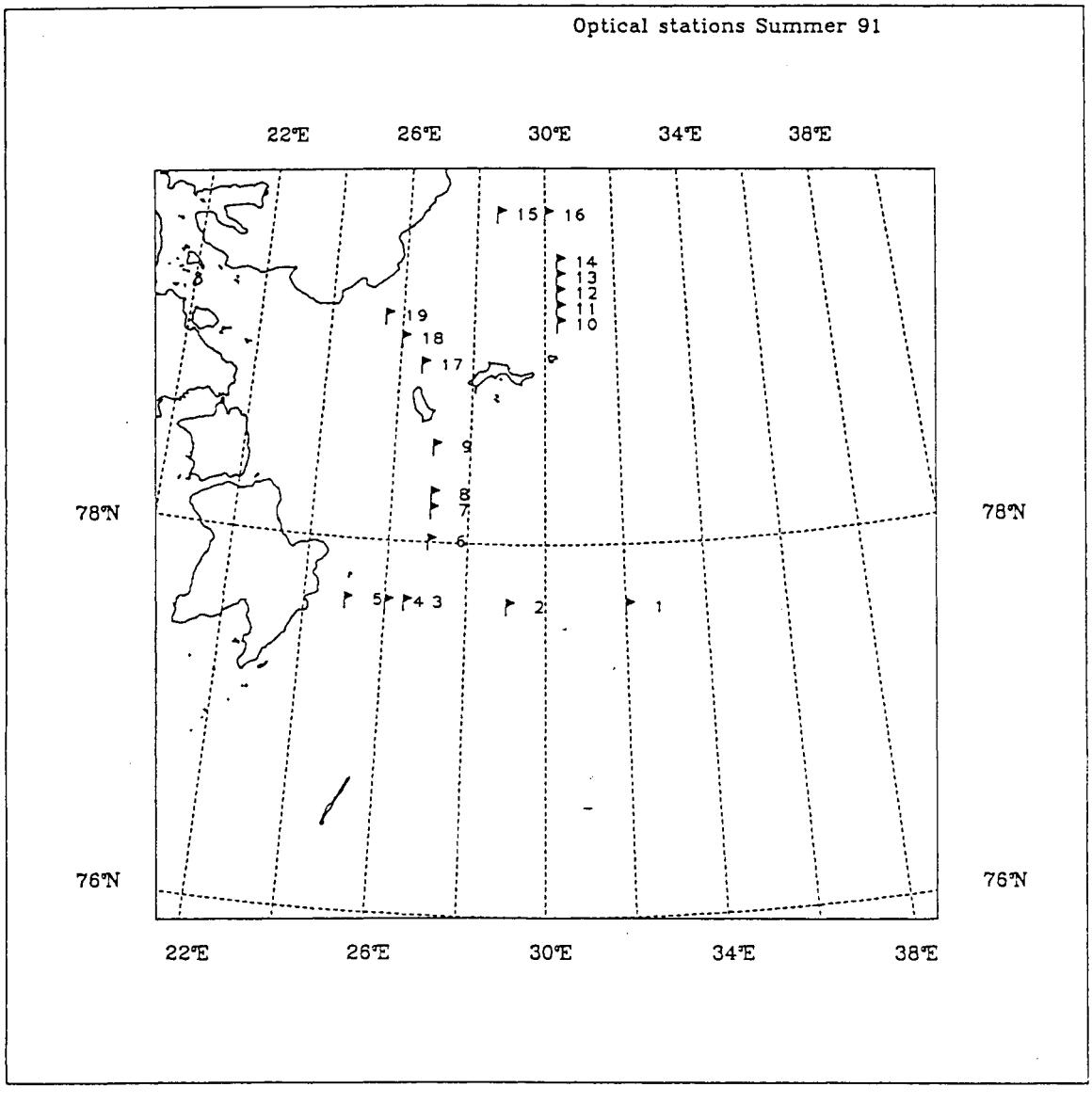


Figure 2: Optical stations in the Barents Sea in August 1991

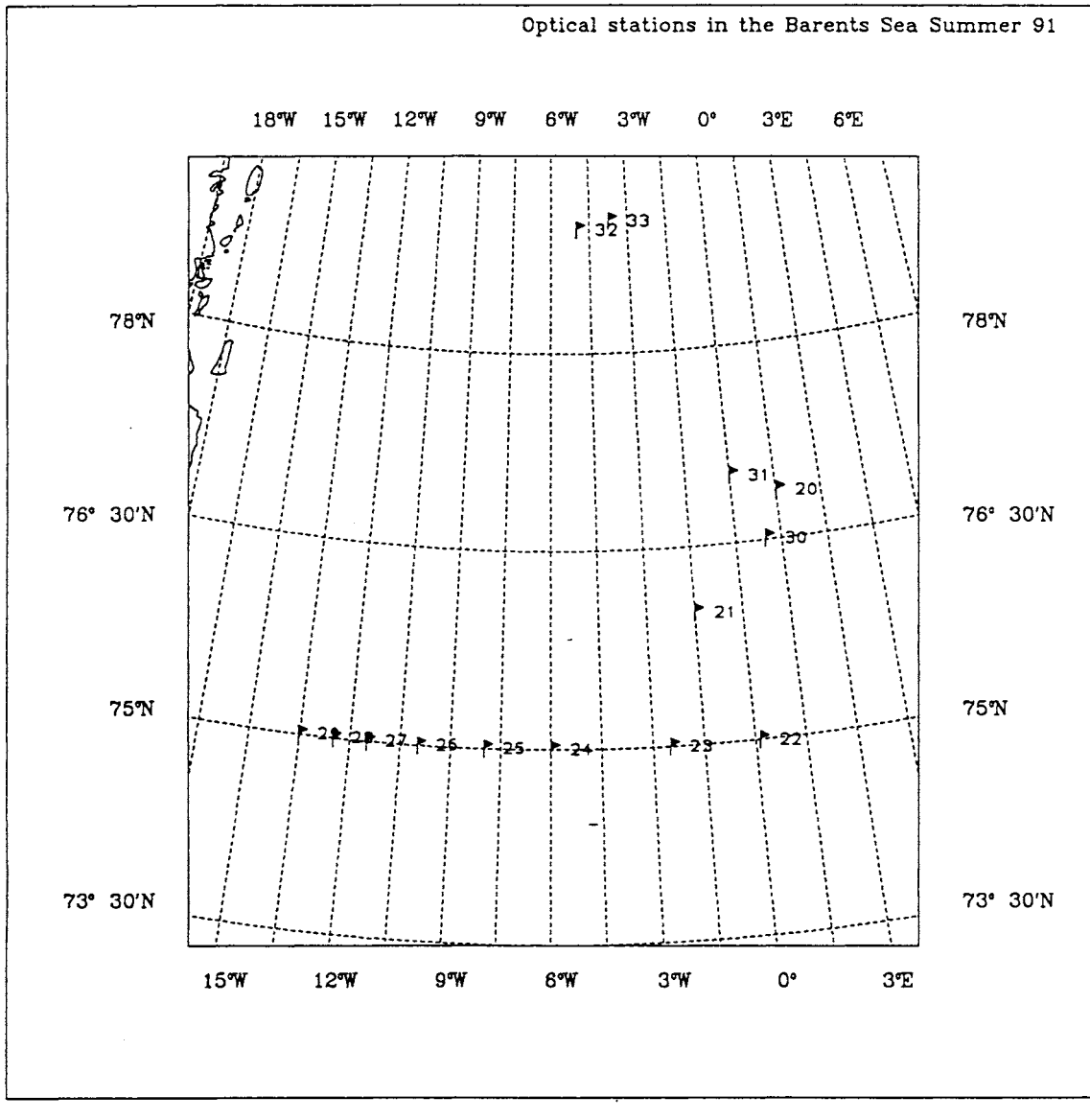


Figure 3: Optical stations in the Greenland Sea in August 1991

St.	Posistion		Irradiance			Trans-		Coulor	Water
#	Lat	Lon	UV-B	Blue	White	mission	Secchi	Index	samples
1	N77°40′	E32°	x				x		
2	N77°40′	E29°	x	x	x	x	x	x	x
3	N77°40′	E27°	x	x	x	x	x	x	x
4	N77°40′	E26°	x	x	x		x	x	
5	N77°40′	E25°	x	x	x	x	x	x	
6	N78°	E26°59′	x	x	x	x	x	x	x
7	N78°10′	E27°	x	x	x	x	x	x	x
8	N77°40′	E32°					x	x	
9	N78°30′	E27°	x	x	x	x	x		x
10	N79°10′	E30°20′	x	x	x	x	x	x	x
11	N77°40′	E32°					x	x	
12	N79°20′	E30°20′	x	x	x	x	x	x	x
13	N77°40′	E32°					x	x	
14	N79°30′	E30°20′	x	x	x	x		x	x
15	N79°45′	E28°35′	x	x			x		
16	N79°45′	E30°	x	x			x		
17	N78°56′	E26°35′	x	x	x	x	x	x	x
18	N79°04′	E26°	x	x		x	x	x	x
19	N79°11′	E25°30′	x	x		x	x		x
20	N76°52′	E1°32′	x	x	x	x	x	x	x
21	N76°	W1°30′	x	x			x		
22	N75°	E0°08′	x	x					
23	N75°	W2°30′	x	x					
24	N75°	W6°	x	x	x		x	x	x
25	N75°	W8°	x	x	x		x	x	
26	N75°	W10°	x	x	x		x	x	x
27	N75°	W11°30′	x	x			x		
28	N75°	W12°31′	x	x			x		
29	N75°	W13°32′	x	x	x		x	x	x
30	N76°31′	W0°59′	x	x	x				x
31	N77°08′	W0°00′	x	x			x		
32	N78°56′	W5°1′	x	x	x		x	x	x
33	N79°	W3°45′	x	x	x		x		x

Table 1: Optical measurements in August 1991

ICE ALGAE AND KISEL ALGAE DISTRIBUTION

Cecilie Hellum

Background and objectives

Ice algae live either within ice attached to ice crystals, in the interstitial water between ice crystals, or they may be associated with the undersurface of the ice as floating mats, lumps, or strands that extend downward into the water column (Horner et al. 1988).

The ice algal assemblages can be divided in different types of assemblages. Two different types were studied on this cruise, pool assemblages and sub-ice assemblages. The pool assemblages occur in pools formed on the ice surface. They may be formed by thawing of the ice, a combination of flooding and melting, or by flooding alone. Additional mechanisms leading to pool formation may include wave action and pressure ridge buildup and breakdown. There is still considerable confusion about surface assemblages because they have received so little attention. The sub-ice assemblages consist of algae floating directly beneath the ice or attached to the underside of the ice and forming strands that trail into the water column (Horner et al. 1988).

Ice algae are present in annual sea ice in all areas where sea ice is a regular feature of the environment. In higher latitudes, the ice community is well-developed and consists primarily of a spesial group of pennate diatoms that, in the northern hemispere, are widely distributed throughout the area. Organisms other than diatoms are also present in the ice, but these are not so well known and have been identified and studied in relatively few areas. Some of the organisms occur only in ice and are not found in the water coloumn or sediments at other times of the year, while some taxa, especially centric diatoms, are nearly always found in the water column when ice is present. Whether they depend on the ice during some part of their life cycle is not known, although spores of some centric diatoms are regularly found in the ice. The origin of the cells in the ice is often not known because few cells are present in the water column when the ice forms. Similarly, the fate of the ice algae is still not well known. The presence of these communities early in spring before the phytoplankton starts to grow suggests that they provide a valuable source of food for planktonic and bentic grazers, thereby lengthening the growing season and moderating the harsh seasonal variability found in polar regions. In some areas, the ice

algae may also seed the water column and initiate, or help initiate, the spring phytoplankton bloom (Horner 1985).

One of my main objectives is to increase the knowledge about the relationship between the ice and the water column near the ice with regard to the origin and fate of the cells in the ice.

Materials and methods

Long strands of ice algae were found floating at the water surface. These were possible to collect by hand-picking.

Algae from the pools on ice floe I and II were collected by a special piston.

Phytoplankton was collected for abundance estimates in two ways:

1. Water samples (provide estimates of absolute abundance).
2. Net samples (25 µm - provide material for relative abundance. Net samples also provide material for identification and aids for isolation of living material for related studies).

Vertical net hauls and water samples were taken in areas with ice, but also before we reached the ice.

The algae samples were preserved in a mixture of formaldehyde and acetic acid.

Preliminary results

More than 50 spp. have been identified from the material of collected ice algae and phytoplankton.

The pool assemblages were of 5 different types and all of them were quite different from the phytoplankton samples. The pool assemblages consisted mostly of pennate diatoms of the genus, *Nitzschia*, *Navicula*, etc. Most of the cells, including the diatoms, were dead (empty frustules) or only cell remnants making it difficult to determine whether the cells actually lived and grew in the pools or were incorporated into the ice as dead cells. Some of the diatoms were from fresh water.

A sub-ice assemblage consisting of the *Melosira arctica* community characterized by *M. arctica* and its associated epiphytes *Pseudogomphonema arcticum*, *Chaetoceros septentrionalis* and *Synedra hyperborea* was found near floe I. This probably because the moving of the boat made the alge loosen from the underside of the ice.

About 7 spp. were common in most of the phytoplankton samples. Diatoms, dinoflagellates and different types of small flagellates were recorded. Diatom were most abundant, and the most common species included several species of the genus *Thalassiosira* (*T. hispida*, *T. antarctica* var. *borealis*), *Chaetoceros* (*C. socialis*, *C. decipiens*, *C. wighamii*, *C. borealis*). A chrysophyce, *Dinobryon* sp., was common at some of the stations, but was found at several of the stations. The most abundant autothrophic flagellate in the phytoplankton samples, was the Prymnesiophyte, *Phaeocystis pouchetii*. Usually, the species composition showed a typical summer situation. Species that are typical at the ice edge in spring (*Nitzschia grunowii*, *Navicula vanhoeffenii*, *Thalassiosira hyalina*, *Bacteriosira fragilis*, *Achnantes taeniata* etc.), were common at one station north-east of Storøya (helicopter station). An undescribed species was also common here.

References

Horner, R. (1985). Ecology of sea ice microalgae. In Horner, R. (ed.): Sea ice biota. CRC Press, Inc., Boca Raton, Florida: 191-201.

Horner, R., Syvertsen, E.E., Thomas, D.P., Lange, C. (1988). Proposed terminology and reporting units of sea ice algal assemblages. Polar Biol. 8: 249-253.

TABLE 1

Stn. no.	Sampling date	Position	
1	31 July	77°40'N	32°00'E
2	31 July	77°43'N	27°59'E
3	31 July	77°40'N	26°27'E
4	1 August	77°40'N	25°00'E
5	1 August	78°40'N	26°59'E
6	1 Augus	78°10'N	27°01'E
7	2 August	79°10'N	30°23'E
8	2 August	79°20'N	30°19'E
9	2 August	79°30'N	30°17'E
10	2 August	79°45'N	28°35'E
11	2 August	79°45'N	30°00'E
12	3 August	80°00'N	30°02'E
13	5 August	80°15'N	30°30'E
14	7 August	80°23'N	30°39'E
15	8 August	80°46'N	31°12'E
16	8 August	80°41'N	31°35'E
17	8 August	80°22'N	30°06'E
18	8 August	79°56'N	29°12'E
19	10 August	78°57'N	26°32'E
20	10 August	79°04'N	26°00'E
21	10 August	79°11'N	25°30'E
22	11 August	80°32'N	17°39'E

Sampling stations, LANCE cruise 29 July - 13 August 1991

THE PROFESSOR MULTANOVSKY CRUISE

17 July - 27 July 1991

INTRODUCTION

V.A. Volkov

Arctic and Antarctic Research Institute was responsible for the Soviet contribution to the 1991 field program of the Soviet-Norwegian Oceanographic Programme (SNOP) carried out onboard "Professor Multanovsky".

The expedition started out from Murmansk on July 17 and terminated in Murmansk on July 27. It included participants from AARI (4) and UB (1) - see attached list of participants. V.A. Volkov (AARI) was the expedition leader.

Before the departure from Murmansk it was proposed to start investigations east of Svalbard which at that time was accessible. Afterwards we planned to pass via the Hinlopen Strait, and then we planned to approach the region of Frants Josef Land from south-east by passing to the south of the heavy ice fields.

These recommendations were made according to satellite data from 5-9 July as well as prognosis and satellite data from 11-15 July (Longyearbyen) and 22 July (telegram from Murmansk). The cruise route of "Professor Multanovsky" is presented in Fig. 1.

Ice field observations were taken along the route from July 22 to July 25.

CTD stations were performed using a Norwegian CTD-probe OTS-1500 winched over board from "Professor Multanovsky". Stations from 6 to 10 (Section A) and from 11 to 17 (Section B) are shown in Fig. 2 and 3 respectively.

Seven CTD stations were made near the glaciers in the Glazov Bay, Novaya Zemlya, to explore the influence of the glaciers edge on the water mass structure.

ICE CONDITIONS

N.E. Dmitriev and L.G. Pisarevskaya

Visual observations were taken of the distribution and characteristics of the sea ice and icebergs according to the "Mezdunarodnaya simvolika dlja morskich ledovych kart i nomenklatura morskich l'dov" (International symbolics for sea ice charts and nomenclature of sea ice) - Gidrometeoizdat, Leningrad, 1984, 65 pp.

A ship-borne locator was used to determine the dimensions of icebergs and the position of the ice edge, particularly in conditions of limited visibility. An ice chart was completed from the results of the observations (Fig. 4).

The first signs of the drifting ice (6/10) were met near the island of Moffen (north of Svalbard). While passing the strait of Hinlopen we met sea ice with a concentration of 1/10. The ice cover consisted of first-year ice of all categories. The thickness of the ice cover (from visual observations) due to melt processes was distinguised by a large non-uniformity, being within the 50 - 250 cm range. The degree of ice decay was 3-4 (in 5 grades scale).

On 23 July during conditions of limited visibility the ship navigated through an ice belt to the eastward side of the Abeløya, Kong Karls Land, with a concentration of 4 to 6/10 and on July 24 at 77°30'N 43°00'E, a vast area of drifting sea ice with a concentration of 4 to 5/10 was observed.

A big iceberg with the lateral dimentions of 150 x 100 m and a free board of about 8-10 m was met free drifting at 78°38'N 47°39'E.

On the whole the ice conditions were close to normal.

OCEANOGRAPHIC SURVEY NEAR A GLACIER

D.G. Kutin and T. Lossius

To study the glacier edge influence on the water mass modifications 7 CTD stations were made in Glazov Bay (Fig. 5). Dashed lines correspond to the flow of relatively diluted and turbid waters from the glaciers defined visually from the bridge.

Section C (Stations from 18 to 21) and Section D (Stations from 22 to 24) are shown in Fig. 6 and 7, respectively.

Fig. 8 depicts a well defined step-like structure at the Station 22.

On the whole this water mass structure disturbance reminds much of an estuary system. Further analysis will reveal the details.

T A B L E

List of time and position of the CTD-station during the cruise

STA	Position		Time	Depth
1	77.5980 N	13.0080 E	7:20:0113	151
2	78.0901 N	11.4020 E	7:20:2304	275
3	78.3720 N	10.3310 E	7:21:0150	116
4	78.5800 N	10.4030 E	7:21:0352	141
5	79.5899 N	13.2658 E	7:22:0202	151
6	79.0860 N	21.1830 E	7:22:2030	85
7	79.0850 N	24.0750 E	7:23:0100	77
8	79.0870 N	26.5150 E	7:23:0435	225
9	79.0700 N	29.3310 E	7:23:0820	131
10	79.0340 N	30.5690 E	7:23:1247	91
11	78.5260 N	30.5350 E	7:23:1558	103
12	78.4032 N	30.3965 E	7:23:1830	244
13	78.2090 N	33.1910 E	7:23:2228	172
14	78.2090 N	33.1910 E	7:23:2235	172
15	78.0390 N	35.4730 E	7:24:0127	101
16	77.5140 N	37.2360 E	7:24:0325	214
17	77.2710 N	43.1500 E	7:24:1135	249
18	75.0550 N	56.2750 E	7:25:0805	64
19	75.0780 N	56.3020 E	7:25:0856	94
20	75.1030 N	56.3390 E	7:25:0938	101
21	75.1480 N	56.4000 E	7:25:1032	82
22	75.1670 N	56.3400 E	7:25:1108	82
23	75.1420 N	56.2530 E	7:25:1140	124
24	75.1160 N	56.1820 E	7:25:1221	81

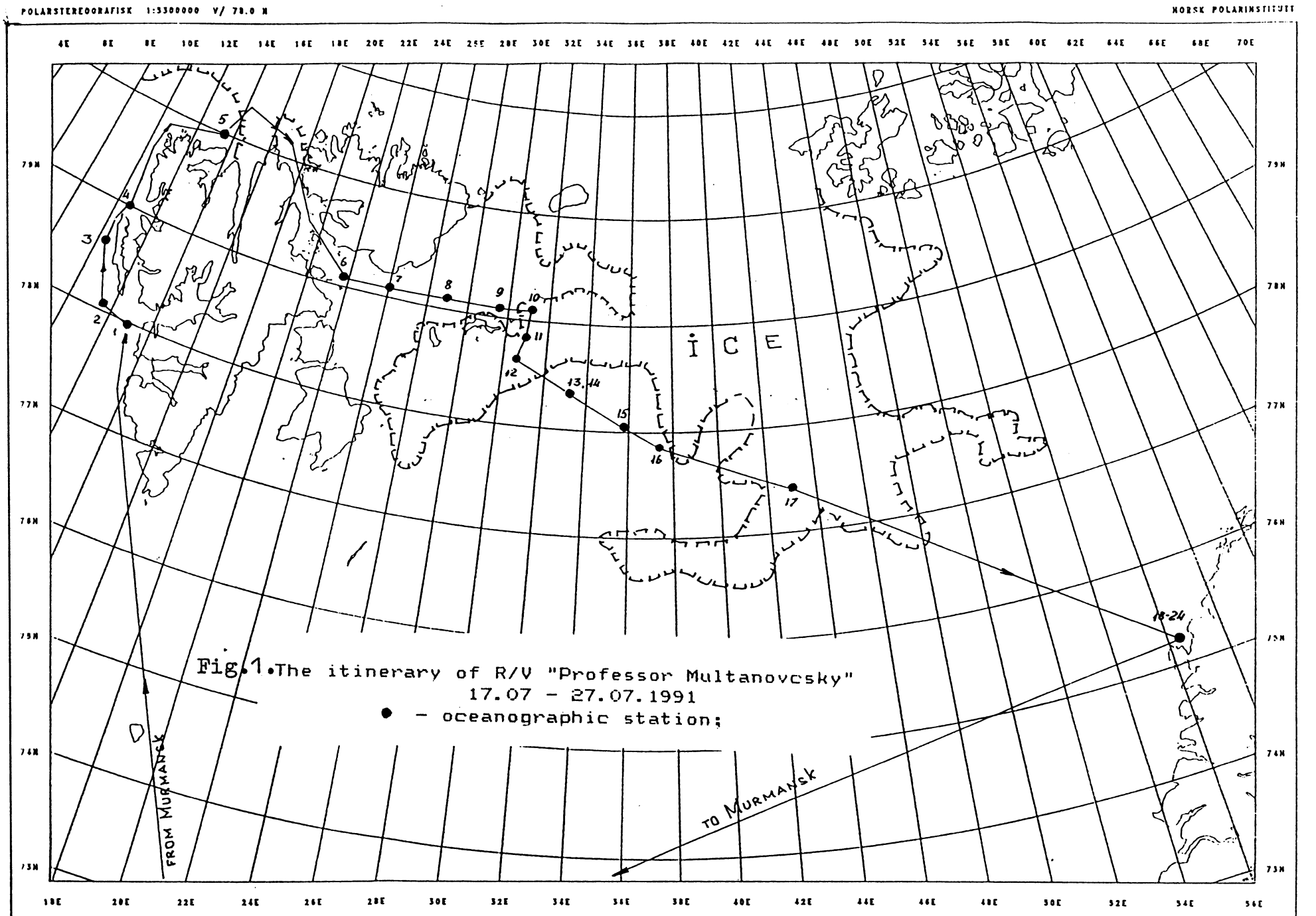
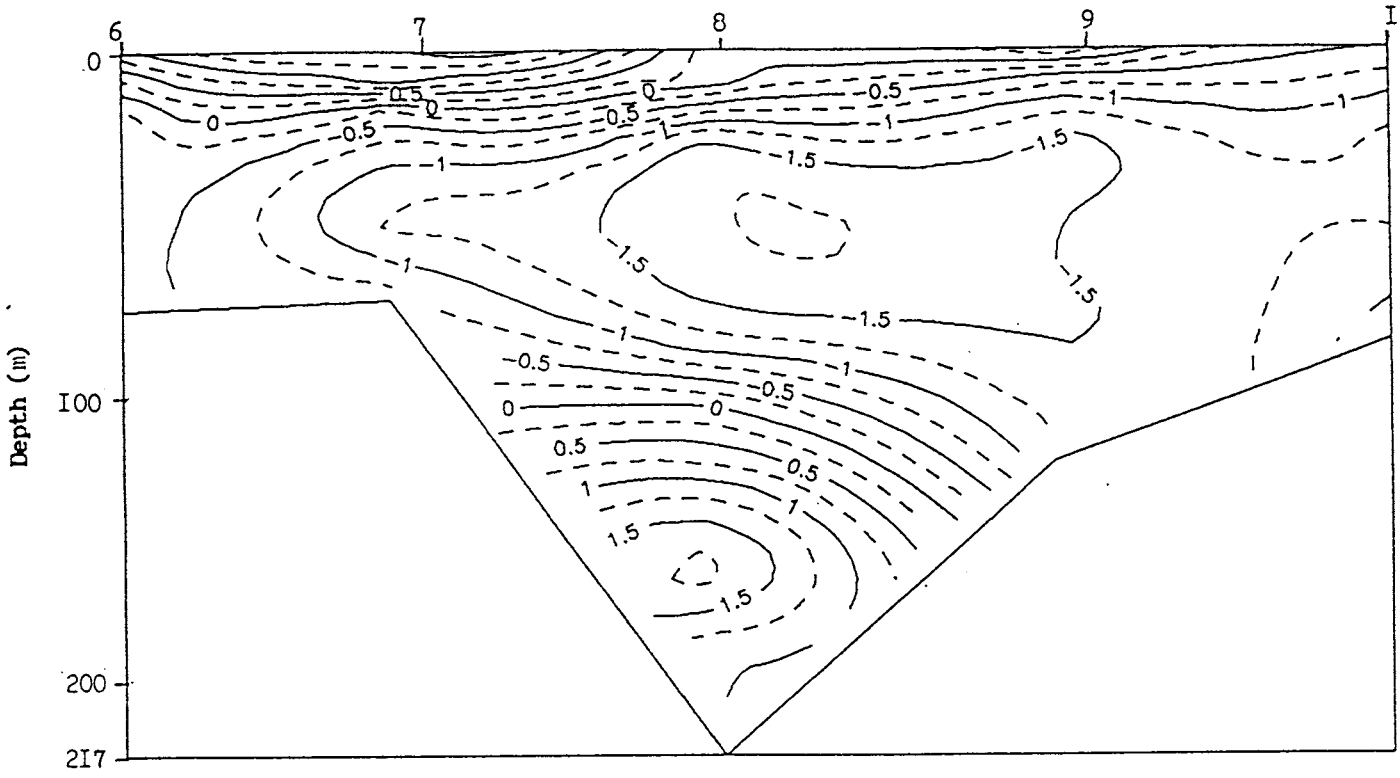


Fig.1. The itinerary of R/V "Professor Multanovcsky"
17.07 - 27.07.1991
● - oceanographic station;

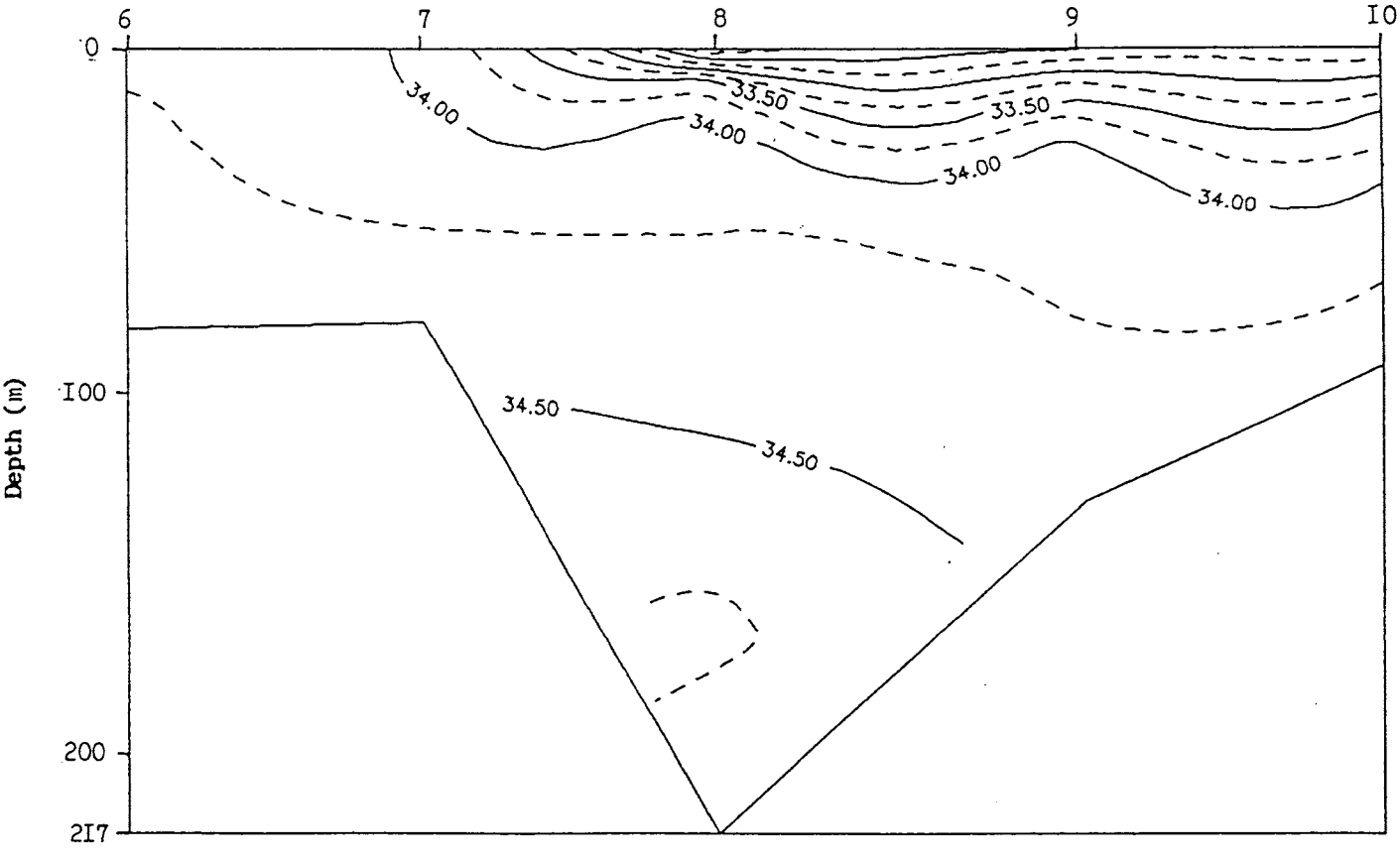
Fig. 2 (a) Number of Station



Section: TEMPERATURE (deg. Cel.)

A

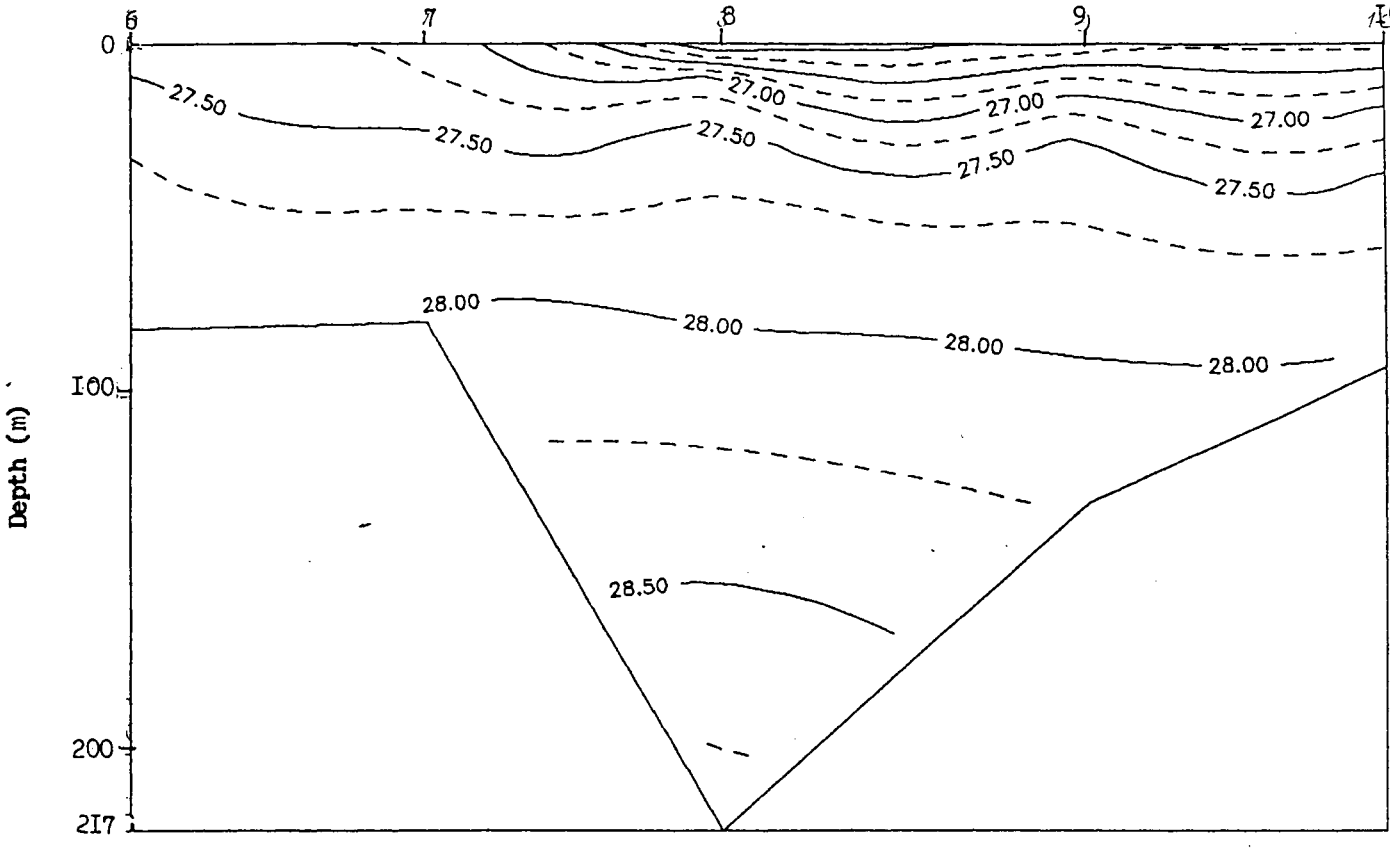
Fig. 2 (b) Number of Station



Section: SALINITY (PPS-78)

A

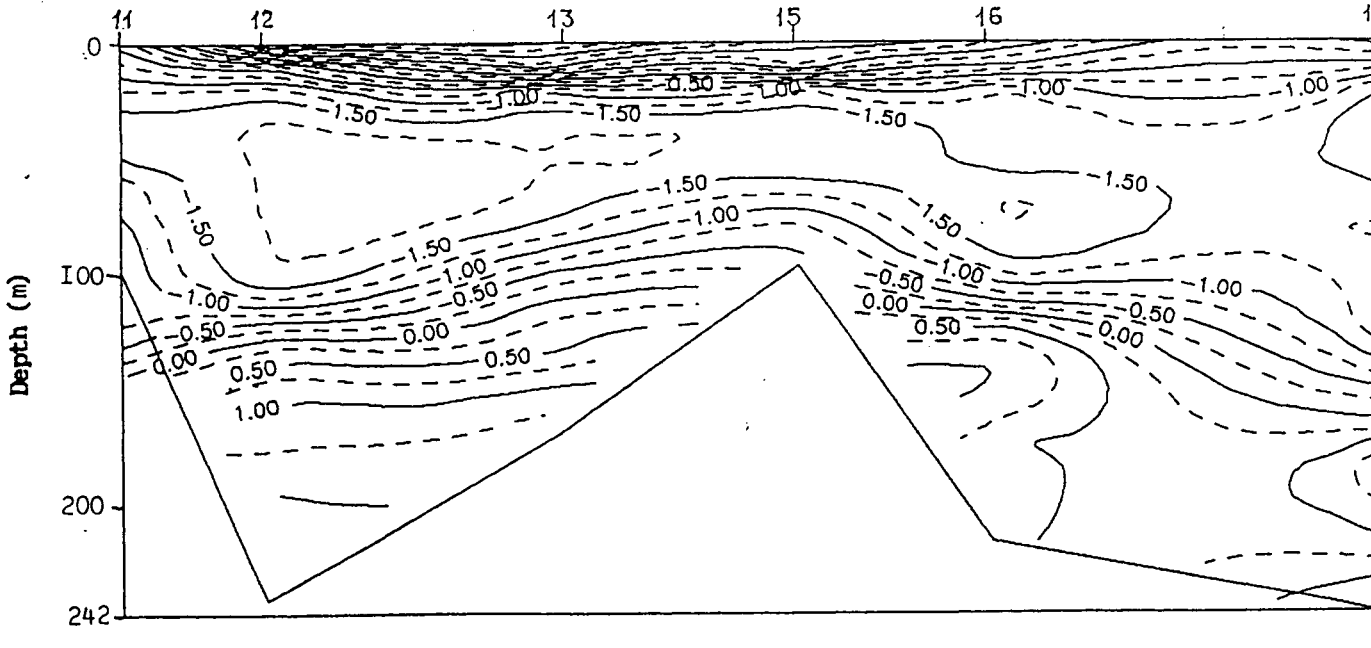
Fig. 2 (c) Number of Station



Section: SIGMA-T

A

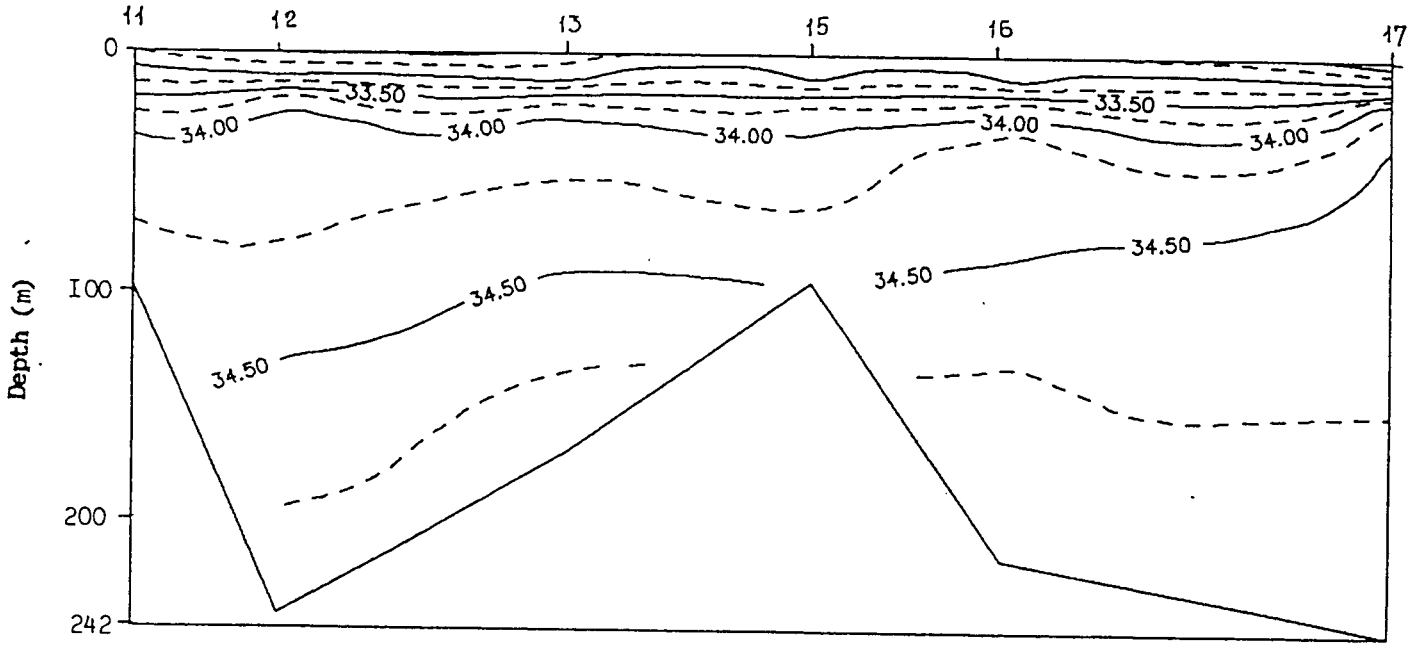
Fig. 3 (a) Number of Station



Section: TEMPERATURE (deg. Cel.)

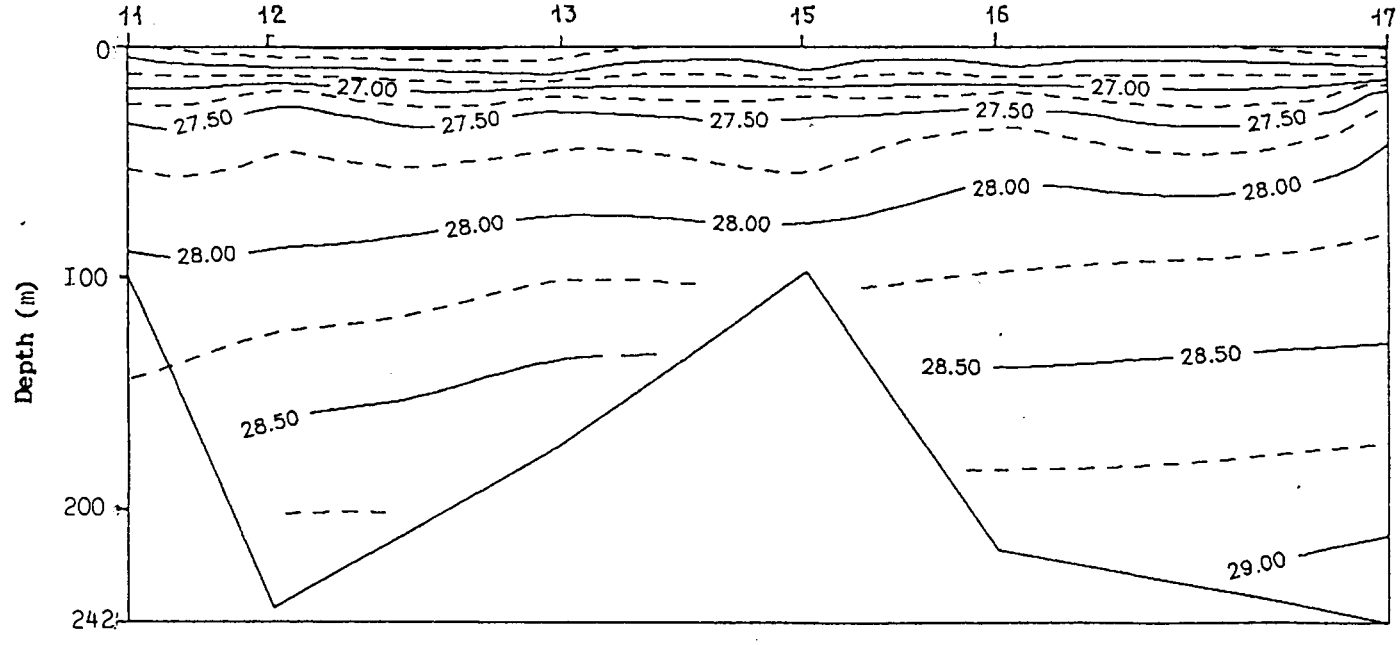
B

Fig. 3 (b) Number of Station



Section: SALINITY (PPS-78)
B

Fig. 3 (c) Number of Station



Section: SIGMA-T
B

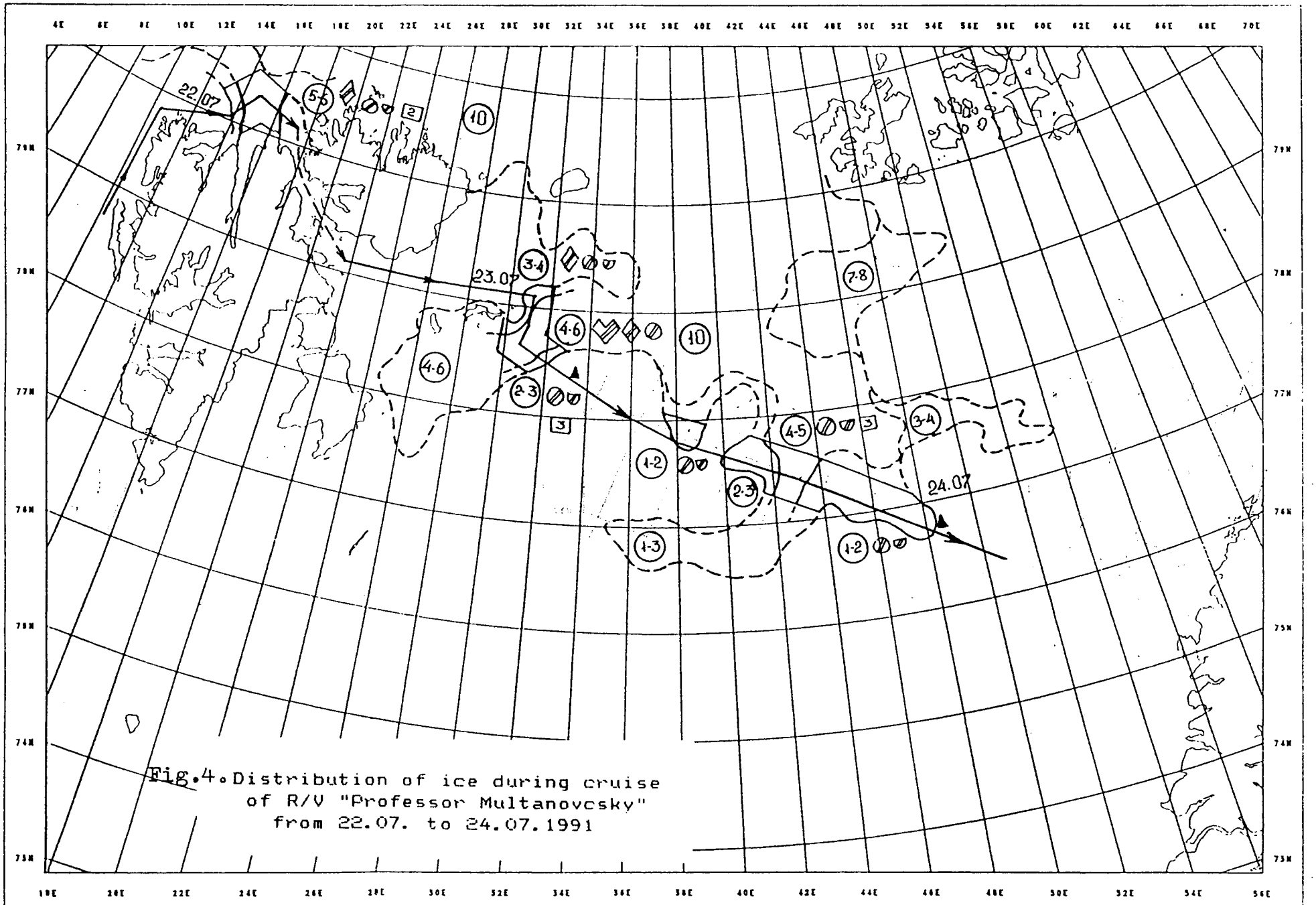


Fig.4. Distribution of ice during cruise of R/V "Professor Multanovcsky" from 22.07. to 24.07.1991

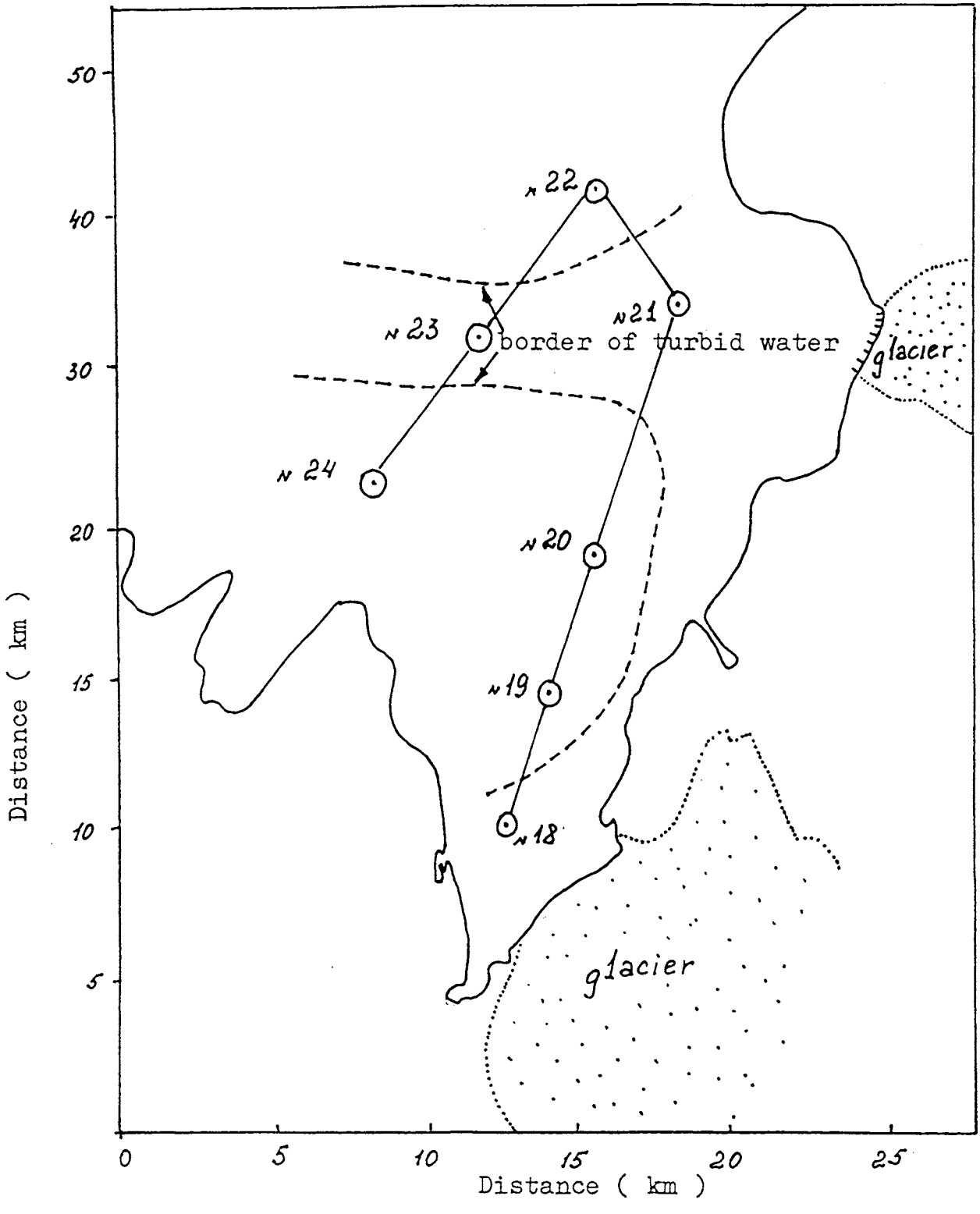


Fig. 5. Scheme of CTD-stations in Glazov Bay.

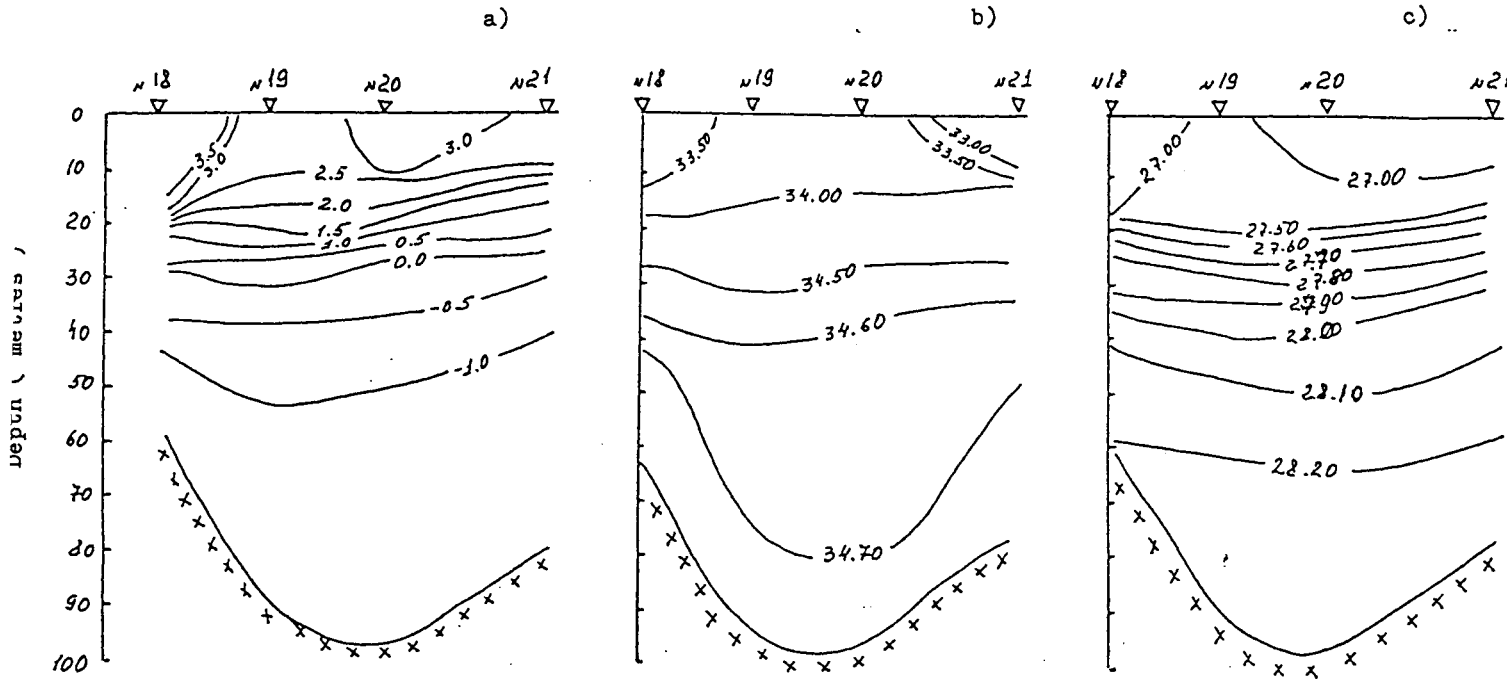


Fig. 6. Section C (stations 18 - 21),
a) Temperature (deg. Cel.),
b) Salinity (PPS - 78),
c) Sigma - T.

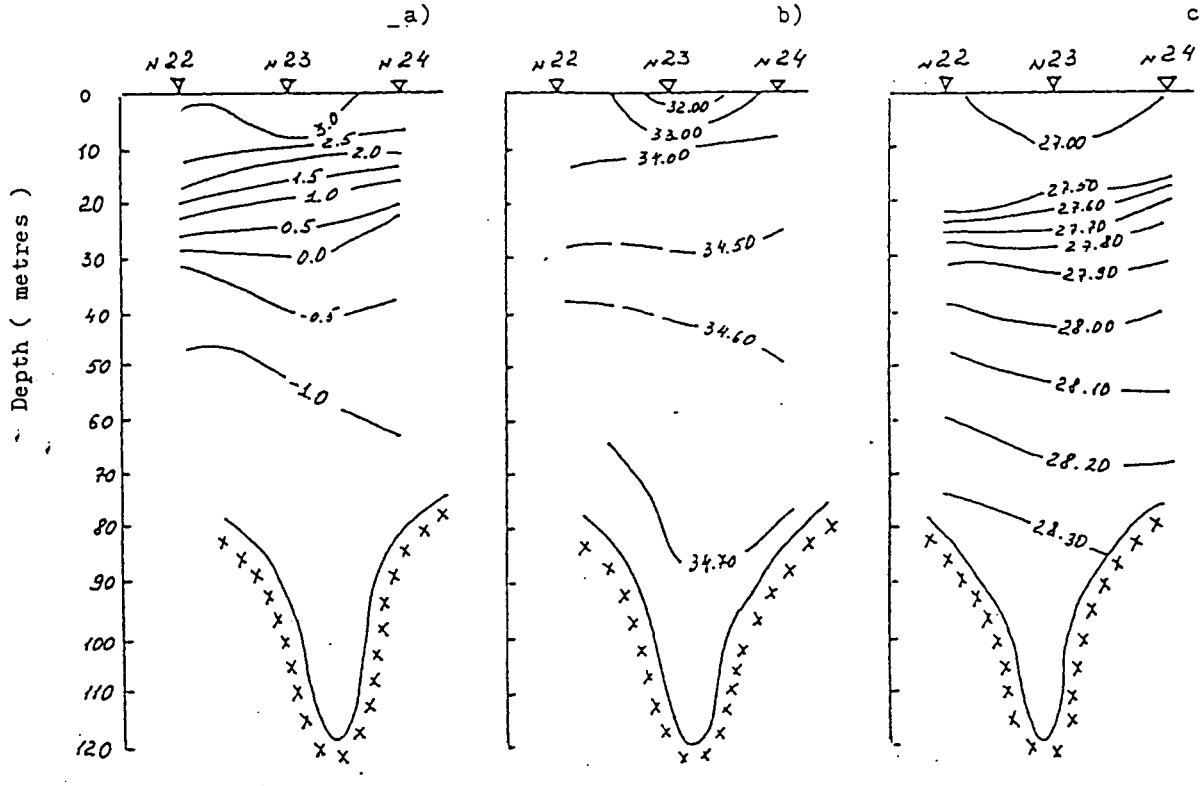
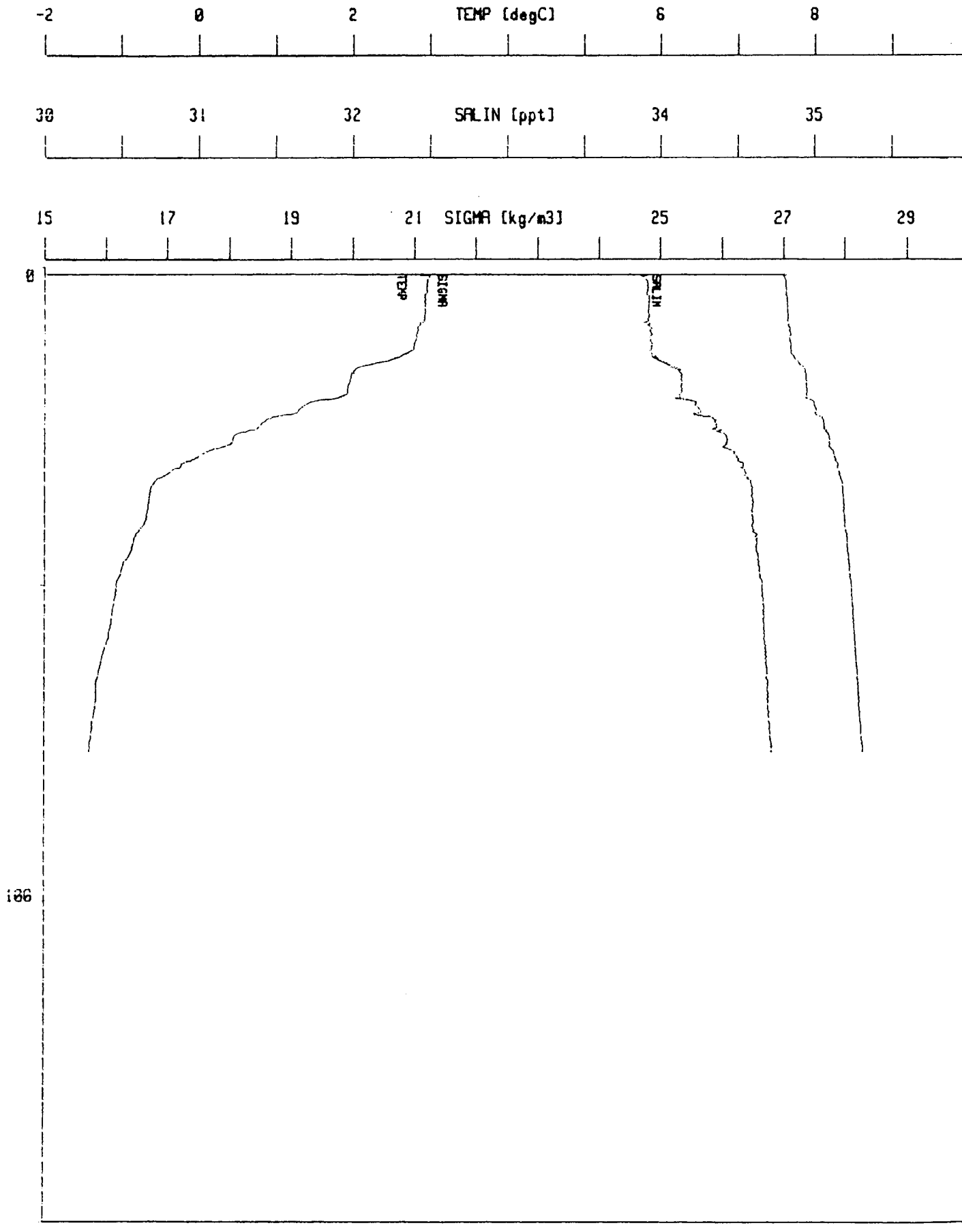


Fig. 7. Section D (stations 22 - 24),
a) Temoerature (deg. Cel.),
b) Salinity (PPS - 78),
c) Sigma - T.



ME Meerestechnik-Elektronik GmbH	C:\MULTIPAR\SNOP-CTD\91725110.mer plotted: Thu Jul 25 11:22:50 1991	Fig. 8 STATION 22

GCS A/S, Oslo