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GATE

Oceanographic activities on F. R. G. research vessels

by

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Kiel
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Die „Berichte aus dem Institut für Meereskunde" erscheinen in unregelmäßiger Folge und sind gedacht als Arbeitsunterlagen für den sich mit dem jeweiligen Thema befassenden Personenkreis. Die Hefte werden fortlaufend numeriert. Sie sind unredigierte Beiträge und geben allein die Meinung des Verfassers wieder.

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G A T E

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Contents

1. Scientific objectives

Activities were mainly aimed at a study of the Equatorial Undercurrent and at a study of mixed layer and thermocline variability in the C-Scale. In addition measurements were taken to aid the B-area experiments.

In the equatorial experiment it was intended to study the local transfers of vertical and lateral momentum, heat and mass from the equatorial undercurrent. Simultaneously a study of vertical momentum, heat and mass transfers in the atmospheric and oceanic boundary layer was carried out.

The investigations in the C-Scale were aimed at studying the detailed response of the ocean to local atmospheric disturbances. Work on F.R.G. vessels concentrated on (a) surface wave measurements to test numerical methods of wave prediction needed for an improved parameterization of air-sea momentum transfer, (b) measurements for a study of the coupling of internal gravity waves in the thermocline to the mixed layer and the wind field at the ocean surface and (c) measurements to correlate changes in the mixed layer with variations of the atmospheric forcing.

F.F.S. "Anton Dohrn" participated in the equatorial experiment during phase II of GATE. F.S. "Meteor" was positioned in the C-Scale during phases I - III, and W.F.S. "Planet" joined the C-Scale vessels for phase III.

2. F.F.S. "Anton Dohrn"

2.1. Oceanographic personnel

J. Meincke, principal investigator (IfM) +)

K.-H. Prien (IfM)

2.2. Ship and buoy operations

Equatorial Undercurrent: Moored instruments were used according to table 2.3.B). In addition 4-hourly current profiles and STDs from surface to 600 m were taken from August 10 to August 15 at position M2 (see table 2.3.A).

Air-sea interaction: Since the meteorological buoy of F.F.S. "Anton Dohrn" could not be tethered to radar buoy P11 (which broke loose on August 1, 74), the vessel carried out a drift station with the free-drifting meteorological buoy as a reference from August 1 to 8. The drift began at 0°N, 29°W and terminated at approximately 0°50'N, 35°W. 3-hourly current profiles and STDs from surface to 100 m were taken (see table 2.3.A). The meteorological buoy was equipped for wind, temperature and humidity measurements at 4 levels above sea surface and 11 levels of temperature below sea surface. Furthermore, turbulent temperature and turbulent wind fluctuations were measured at one level above sea surface.

a) STDs and XBTs at irregular intervals from Dakar to 0°N, 29°W (in accordance with net trawls).
b) Section from 0°N, 34°W to 0°N, 29°W with XBTs at half-hourly intervals (see table 2.).
c) XBTs at 12-hourly intervals on route from 1°N, 29°W to GATE position 4.

2.3. Lists of measurements

2.3.1. Remarks on nonstandard instruments

(Short description also referred to in other parts of this report).

A) CTD-equipment

a) Bathysonde.

"Bathysonde T 87/3" manufactured by Howaldtswerke AG., Kiel, FRG. The following specifications are taken from the manufacturers manual:

+) A list of participating institutions is given in chapter 5.

Sampling rate: 1 sec

Sensors:

Temperature: precision: ± o.o1 °C
resolution: o.o1 °C
time constant: 6o ms

Conductivity: precision: ± o.o12 mmho/cm
resolution: 1o µmho/cm

Pressure: precision: ± o.25 % of total range
resolution: 1 dbar ("Meteor" + "Anton Dohrn")
better than 1 dbar ("Planet")
range: 6ooo dbar ("Meteor" + "Anton Dohrn")
8oo dbar ("Planet")

The system used on "Anton Dohrn" and "Planet" was equipped with a crystal clock and a remote control Nansen bottle.

b) Multisonde:

Prototype instrument of the Institut für Angewandte Physik, Kiel University, described by W. Kroebel in "Meteor-Forsch. Ergebnisse" A 12, p. 53-67 (1973).

Sampling rate: ≥1 s

Sensors:

Temperature: precision: ± o.o1 °C
time constant: 1oo ms

Conductivity: precision: ± o.o1 m mho/cm

Pressure: precision: ± 2.5 %o of total range
range: 8ooo dbar

Sound velocity: precision: ± 1 cm/s

Light attenuation: precision: ± o.oo1 m^{-1}

B) Current Profiler:

The device sinks at a rate of about 5 m/min down the hydrographic wire. It consists of a frame with buoyancy spheres, a vane and a Bergen-type current meter turned upside-down and switched to a sampling rate of 3o sec. Some of the used profilers carried a (low precision) conductivity sensor, while temperature, pressure and current velocity were standard parameters.

2.3.2. List of measurements

A) Profiling with CTD, XBT and current profiler

date	instrument	observation interval (hours)	maximum depth (m)	number of observations	quality of data +)	remarks
1-8-74 to 8-8-74 and 1o-8-74 to 15-8-74	Bathysonde (CTD)	3	1oo	57	A	Drift from 29°W to 35°W along Equator
		4	6oo	27	A	Stationary at Pos. oo°o1'S, 28°52'W
1-8-74 to 8-8-74 and 1o-8-74 to 15-8-74	current profiler	3	1oo	57	A	Drift from 29°W to 35°W along Equator
		4	6oo	27	B	Stationary at Pos. oo°o1'S, 28°52'W
17-7-74 to 25-7-74 and 9-8-74 to 1o-8-74 and 16-8-74 to 18-8-74	XBT	24	45o	9		IGOSS
		o.5	45o	66		IGOSS Section from 34°W to 29°W along Equator
		12	45	8		IGOSS

+) Quality of data: A - good
B - some poor data
C - bad
D - not yet known

B) Moored instruments

mooring position	type of instrument	measured parametors	number of instruments	depths (m)	sampling rate (min)	date of Launch	date of recovery	quality of data	remarks
M1 (IfM mooring No. 1o2) φ = oo°25'N λ = 29°o4'W	Bergen current meter and thermistor chain	current temperature (pressure)	7	18 19-69 75,96 127,3o8 499	5/1o	27-7-74	15-8-74	A	instruments at 75,96, 127,3o8 and 499 m lost
M2 (IfM no.1o3) φ = oo°o1'S λ = 28°52'W	Bergen wind recorder, current-meter and thermistor chain	wind current temperature (pressure)	8	-2 18 19-69 75,96, 127,3o8, 499	5/1o	27-7-74	15-8-74	A (wind: C)	
M3 (IfM no. 1o4) φ = oo°49.5'S λ = 29°o6'W	Bergen current meter and thermistor chain	current temperature (pressure)	7	18 19-69 75,96, 127,3o8, 499	5/1o	28-7-74	15-8-74	A	

all moorings were surface buoy moorings

3. F.S. "Meteor"

3.1. Oceanographic personnel

Phase I: C. Brockmann, principal investigator (IfM)
P. Diehl (IAP)
E. Schulz (IAP)
H.J. Rubach (DHI)

Phase II: H. Peters, principal investigator (IfM)
W. Bartel (IAP)
W. Behrend (IfM)
H.J. Rubach (DHI)

Phase III: W. Zenk, principal investigator (IfM)
H. Carlson (DHI)
U. Huenninghaus (IfM)
R. Siara (IAP)

3.2. Ship and buoy operations.

3.2.1. Phase I

XBT profiles were obtained every 5 nm on the way from Dakar to GATE position 4 and back to port according to the Operations Plan

Profiling with Multisonde and current profiler was carried out from 28 to 3o June 1974 and from 16 to 17 June 1974 according to the Operations Plan. The schedule for the other profiling activities had to be changed due to the requirements posed by using the meteorological buoy for the boundary layer program. To avoid hazardous towing of this buoy which was tethered to the ship, "Meteor" had to be anchored.
The mooring cable prevented a lowering of the Multisonde to 5oo m or an even greater depth. The schedule was therefore changed to hourly Multisonde profiling to 15o m and hourly current profiling to 13o m.

In addition a moored waverider buoy was used, with recording on board for half an hour every 6 hours.

3.2.2. Phase II

During Phase II F.S. "Meteor", occupying station 4, had to be moored again so that no deep CTD-observations could be made. The hourly observation scheme of phase I was slightly altered, now running the CTD down to 18o m and making additional XBT casts every 6 hours down to 45o m. As the casts were made immediately after taking a CTD-profile, the XBT-profiles can be calibrated by the corresponding CTD temperatures. Whether it will be possible to deduce the density field down to 45o m by using the stable TS-relationship predicted for the region remains to be seen.
The scheme of wave observations corresponded to the scheme

of phase I, using the same wave rider mooring. The device worked excellently all the time till the recovery at the end of phase II.
The standard sensors of the Multisonde worked properly nearly all the time so that the time series show only a few and short gaps. In some profiles a small amount of data will be lost due to encoder malfunction. The sound velocity sensor worked properly except for two days. The light attenuation sensor operated properly until 6 August 1974, with instrument malfunction and calibration problems occuring afterwards.
Current profiling was done successfully, only one day and a half are lost due to system malfunction.
During Intercomparison II A and II B only CTD measurements were carried out taking deep profiles while the ship was now drifting freely.

3.2.3. Phase III

According to the GATE Ship Operations Plan two XBT-sections were taken on the vessel's track to and from the anchor station (position 1). The first section began after crossing 2o°W meridian, the second section was finished in the area of Intercomparison III B. In all cases surface water samples for later determination of salinity and reference temperatures were taken. Prior to the anchor station five additional waverider buoys were moored on a circle with an approx. radius of 5o km around pos.1. Together with a waverider anchored in phase I the wave heights could be recorded for 3o minutes every 3 hours. Problems appeared on Sept.5 and 7 when buoy G 4 broke loose and buoy G 2 transmitted weak signals only. The observation of wave parameters by means of a pitch-and-roll buoy near the ship, i.e. in the center of the waverider array, was not possible due to technical problems. However, similar data could be obtained by the tethered meteorological buoy supplied by the Hamburg University group. (The approximate position of the buoys G 1 to G 6 are shown in fig.1).

3.3. Lists of measurements

Gate phase	date	instrument	observation interval (hours)	maximum depth (m)	number of observations	quality of data	remarks
I	28-6-74 to 3o-6-74	Multi-sonde (CTD)	3 24	5oo 15oo	342	B	hysteresis in temperature sensor
	1-7-74 to 16-7-74		1	15o			one deep profile to the bottom (42oo m)
	16-7-74 to 17-7-74		3 24	5oo 15oo			
		Bathysonde (CTD)			34	B	used during malfunction of the Multisonde. No depth resolution between o and 1o m.
	as for CTD	current profiler	as for CTD	12o	345	B	number of usable profiles reduced due to malfunction during approximately 1 day.
	28-6-74 to 17-7-74	waverider	6		~ 8o	D	length of each record: 3o min
	26 to 27-6-74 and 17 to 18-7-74	XBT	o.5 (equiv. to 5 n.m.)	45o	88	B	trackline operations prior to and after phase I

Gate phase	date	instrument	observation interval (hours)	maximum depth (m)	number of observations	quality of data	remarks
II	27-7-74 to 15-8-74	Multisonde (CTD)	1	18o	446	D	quality supposed to be usually A and to be C in approx. 1o profiles.Light attenuation sensor broke down on 6-8-74 .
	as for CTD	current profiler	1	13o	441	D	number of usable profiles is less due to malfunction during approx. 36 hours.
	as for CTD	waverider	6		82	D	length of each record 3o min
	as for CTD	XBT	6	45o	73	B	XBT cast immediately after taking a CTD profile
	16 to 2o-8-74	Multisonde (CTD)	1 to 3	18o to 25oo	97	D	measurements during intercomparison II A and II B

Gate phase	date	instrument	observation interval (hours)	maximal depth (m)	number of observations	quality of data	remarks
III	31-8-74 to 17-9-74	Multisonde (CTD)	1	2oo	383	D	several yoyo measurements included. Comparision with Bissett-Berman STD from R/V "Hecla" on 16-9-1974. One deep profile to the bottom (48oo m).
	as for CTD	current profiler	1	15o	391	D	
	as for CTD	waveriders G 1 to G 6	3		~ 65o	D	Waverider G 4 broke down on 4-9-74. Signals from G 2 were disturbed after 7-9-74.
	27 to 29-8-74 and 19 to 21-9-74	XBT	o.5 (equiv. to 5 n.m.)	45o	11o	B	trackline operations prior to and after phase3
	31-8-74 appr. three weeks	thermistor chain	5 min sampling interval	o to ~ 5o		D	11 thermistors ,length 5o m,suspended from meteorological buoy tethered to the ship

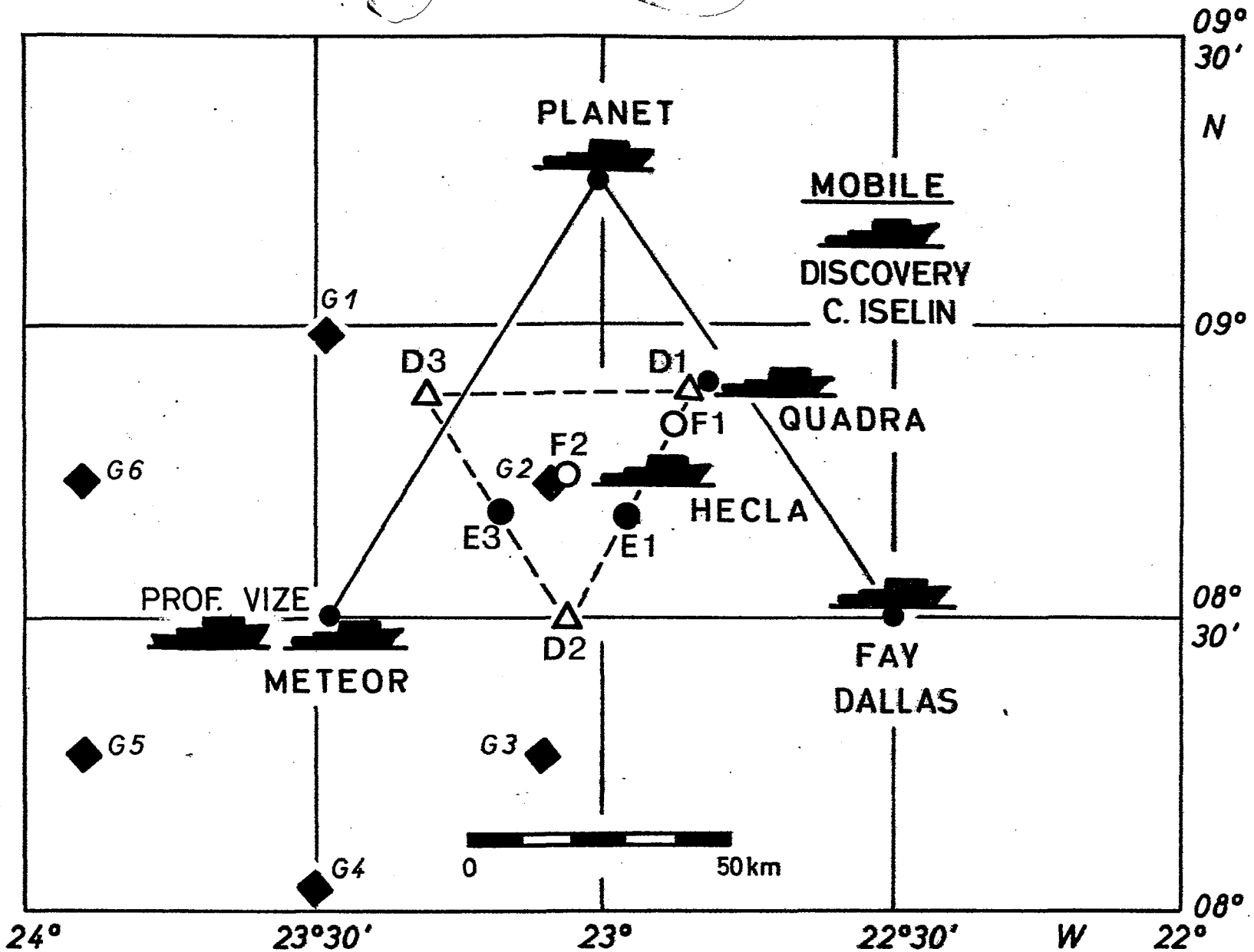

09° 30' N
09°
08°
30'
08°
24°
23°30'
23°
22°30'
W
22°
PLANET
MOBILE
DISCOVERY
C. ISELIN
QUADRA
HECLA
FAY
DALLAS
METEOR
PROF. VIZE
G1
G2
G3
G4
G5
G6
D1
D2
D3
E1
E3
F1
F2
0
50km

FIGURE: 1

Similar to phases I and II the Multisonde was used regularly every hour down to a maximum depth of 2oo m. In addition yoyo-type measurements were obtained from the upper 5o meters during the evening of Sept. 4 on the request of RRV "Discovery". The work at pos.1 was completed by one deep Multisonde station. The Multisonde sensors designed for sound velocity and light attenuation were in operation for four days only after which a technical problem arouse which could not be solved on board.

A nearly complete time series could be obtained from the hourly current profiling. Only a few profiles are missing for the periods when the ship had to be reanchored. This was necessary after the anchor cable parted late in the evening of Sept. 6.
In addition a thermistor chain with eleven equidistant sensors was suspended from the already mentioned meteorological buoy for monitoring temperature fluctuations within the upper 5o m.

4. W. F. S. "Planet"

4.1. Oceanographic personnel

G. Siedler, principal investigator (IfM)
D. Carlsen (IfM)
G. Hatje (IfM)

4.2. Ship and buoy operations

After arriving in the C-Scale area on 27 August 1974 a navigational buoy (IfM no.1o9) was set to aid the following mooring operations. During the night from 27 to 28 August, an echo sounder survey was carried out in the area selected

for the two-leg mooring F 1 (IfM no. 1o6, see fig.1,2)
In the morning of August 28 we started to set mooring F 1. The first leg, the horizontal instrumented line and the two surface buoys were launched according to plan. When lowering the second anchor with the ship's deep-sea winch - which was necessary for a precise positioning of this anchor - the winch brake failed with a load of approximately one third of the theoretically permitted maximum value. It was found on the next morning that the mooring cable connected to the ship's cable apparently broke during the winch failure.

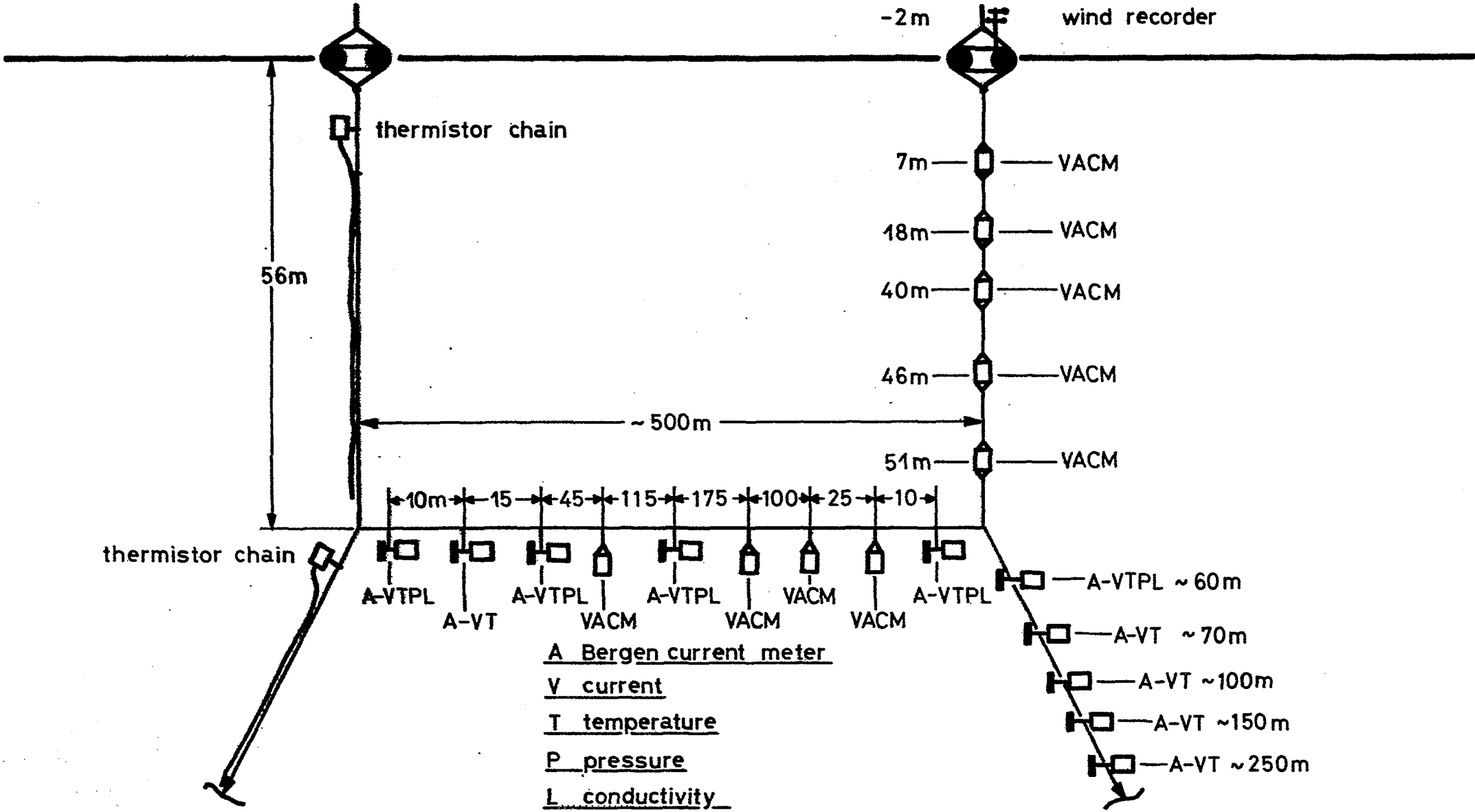
Fortunately the "Meteor" was close to the "Planet" on August 29. Spare cables and anchors were transferred to the "Meteor" by boat, and a second attempt was undertaken to set the second anchor of F 1 with "Meteor's" deep-sea winch. This time we were successful, and the two-leg mooring was set completely in the evening of August 29.
When obtaining a satellite position for our buoys from H.M.S. "Hecla" we found that the mooring had been set about 11 n.m. to the east of its supposed position (fig. 1).
During the night to August 3o an echo sounder survey was carried out in the center of the C-scale triangle, and the single-point mooring F 2 (IfM no. 1o5, see fig.1,3) was launched on August 3o. The master of H.M.S. "Hecla" kindly agreed to monitor our buoys with radar during phase III. Another echo sounder survey was done during the following night in the area of GATE position 27, and a navigational buoy (IfM no.11o) was set there on August 31. An additional thermistor cable was suspended from a float that was attached to this buoy on September 2.

The repeated fixed position profiling on position 27 started on August 31, first with three-hourly XBT soundings only. CTD and current profilers could first not be used due to handling problems because the deck was needed for the big meteorological buoy. Three-hourly current profiler measurements down to 14o m started on September 1, and three-hourly Bathysonde measurements to 5oo m were begun on September 3. A daily deep hydrocast was added beginning on September 6. These profiling measurements lasted until September 17.

On September 13 we received a mes-age from the "Hecla" indicating that our single-point mooring F 2 appeared to be adrift. To avoid hurting the fixed position program of GATE by leaving our position 27 for a recovery of our mooring F 2, we asked our colleagues on the "Discovery" whether they could assist in this matter. "Discovery" started to monitor the drift of our buoy on September 13 and recovered it successfully on September 14. It turned out that the mooring had been(presumably)accidently released by "Discovery" when she fired the release of her mooring E 3.

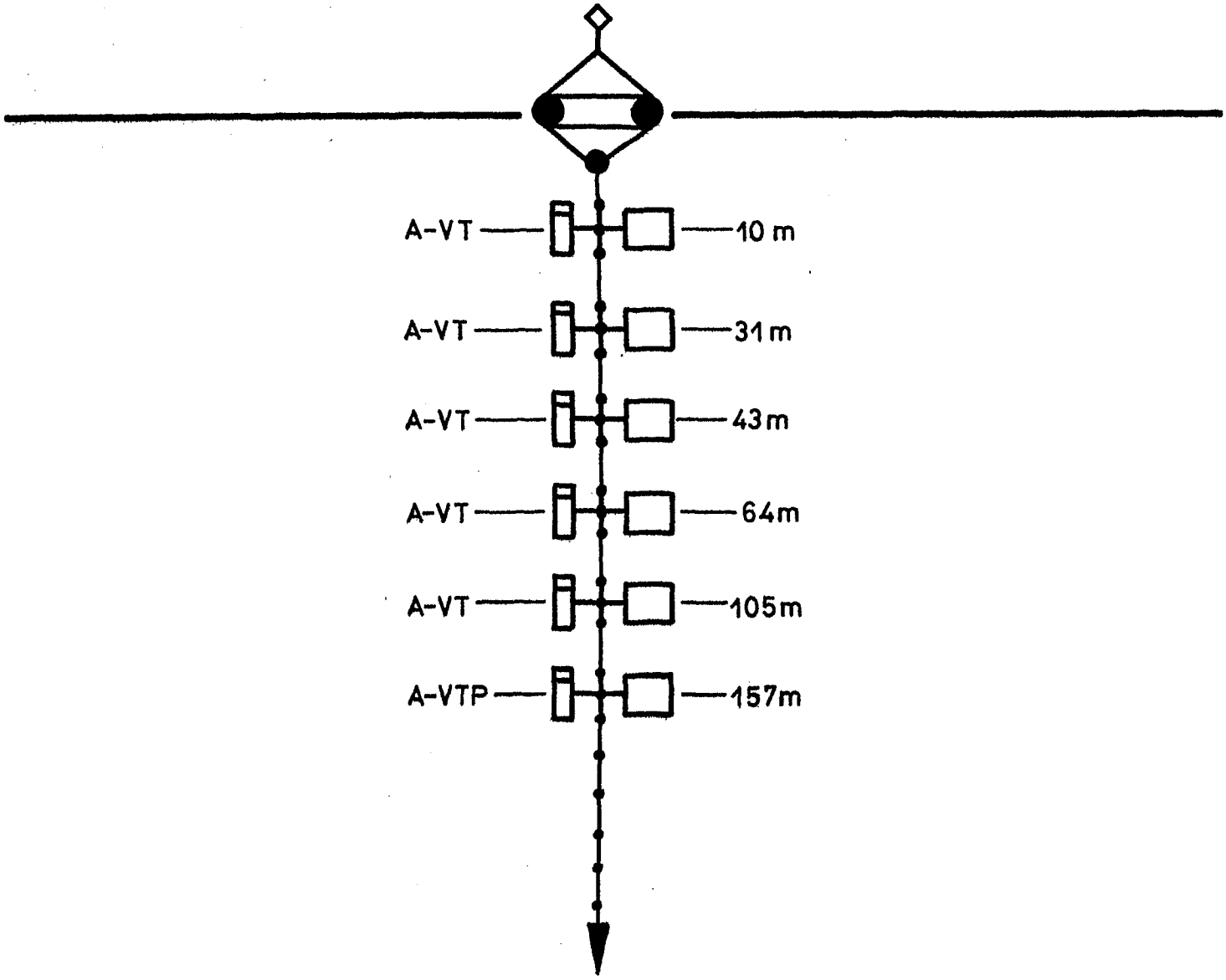
After finishing our fixed position profiling, we recovered the navigational buoy (IfM no. 11o) on September 17 and the two-leg mooring on September 18 without any unexpected problems. An attempt was made on September 19 to recover one release that had been lost by the winch failure on August 28. The release fired, but did not surface. Probably the broken mooring line and the lost deep-sea cable of the ship were entangled. The search for the release was aided by a GATE airplane. The navigational buoy no. 1o9 was recovered on the same day.

Trackline XBT measurements were carried out according to the GATE Operational Plan on our way from the C-Scale area to the Intercomparison Station III A.



SCHEMATIC DIAGRAM OF THE RECORDING INSTRUMENTS OF MOORING F1

FIGURE: 2



SCHEMATIC DIAGRAM OF THE RECORDING INSTRUMENTS OF MOORING F 2

FIGURE: 3

4.3. List of measurements

A) Profiling with CTD, XBT and current profiler

date	instrument	observation interval (hours)	maximum depth (m)	number of observations	quality of data	remarks
3-9-74 to 17-9-74	Bathysonde	3	5oo	1o8	B	occasional jumps in last digit of conductivity record
1-9-74 to 17-9-74	current profiler	3	14o	125	D	
31-8-74 to 3-9-74 and	XBT	3	45o	27	A	1 XBT cast during malfunction of the Bathysonde included
19 to 2o-9-74		o.5 (equiv. to 5 n.m.)	45o	38	A	trackline operation after phase III
6-9-74 to 17-9-74	cast	24	usually 6oo/8oo/ 1ooo/15oo	12	D	

mooring position	type of instruments	measured parameters	number of instruments	depths (m)	sampling rate (m)	date of launch	date of recovery	quality of data	remarks
F 2 (IfM-mooring no.1o5) φ = 8°44.76'N λ =23° 4.24'W	Aanderaa current-meter	current temperature	5	1o,31,43, 64,1o5 +)	5	3o-8-74	14-9-74	D	single-point mooring
		current temperature pressure	1	157	5			D	
IfM-mooring no.11o φ = 9°14.9'N λ =23° o.15'W	Aanderaa thermistor chain	temperature	1	o-5o	1o	31-8-74	2-9-74	D	11 thermistors length 5o m chain suspended from float that was tethered to navigational buoy at station 27

+) see fig. 3

B) Moored instruments

mooring position	type of instruments	measured parameters	number of instruments	depths +) (m)	sampling rate (m)	date of launch	date of recovery	quality of data	remarks
F 1 (IfM-mooring no.1o6) φ = 8° 49.9'N λ =22° 52.6'W	Aanderaa current-meter	current temperature	5	56,75, 1o5,155,255	5	28-8-74	18-9-74	D	two-leg mooring
		current temperature pressure conductivi-ty	5	56,65	5			D	
	VACM	current temperature	9	7,18,4o,46 51,56	3.75			A	
	thermistor chain Aanderaa	temperature	2	o-5o 6o-11o	1o			D	11 thermistors length 5o m
	Aanderaa wind recorder	wind speed, direction	1	-2	5			D	mounted on easterly sur-face buoy

+) see fig. 2

5. List of participating institutions.

DHI Deutsches Hydrographisches Institut
Bernhard-Nocht-Strasse 78
D 2 H a m b u r g

IfM Institut für Meereskunde
Universität Kiel
Düsternbrooker Weg 2o
D 23 K i e l

IAP Institut für Angewandte Physik
Universität Kiel
Olshausenstrasse 4o-6o
D 23 K i e l