Prof. Woods

Dr Ulrich

Fahrtbericht

POSEIDON 31

JASIN 1978

(59° N 12°30' W)

14 August 1978 - 9 September 1978

1. Introduction

Poseidon cruise 31 was a contribution to the international JASIN expedition (Royal Society 1978), the principal field activity in the Air-Sea Interaction sub-programme of the Global Atmospheric Research Programme (managed jointly by the World Meteorological Organization and the International Council of Scientific Unions). Poseidon joined the other ships (Discovery, Shackleton, Challenger, John Murray, Guardline Endurer, Atlantis II, Endeavor, Tydeman, Meteor, Planet, Hecla, Scotia, Vernadsky) and aircraft (UK C-130, NASA C-130, Mystère, Electra) for phase 2 of the expedition, which included a special period for intensive oceanographic work.

The JASIN series of expeditions is centred around exploration of a theme of central importance to the first and second objectives of GARP (improving weather prediction and understanding the weather, respectively). This theme is the transfer of momentum, heat and moisture between the atmosphere and ocean on time scales up to a month and horizontal scales of up to 100 km. It was recognized at an early stage of planning JASIN, that there would be little hope of making measurements that could lead directly to improved parameterization of air-sea interaction in a form suitable for use in numerical models of weather or climate change. The aim was directed more towards the collection of a wide range of measurements that would contribute to the improved physical understanding of the exchange processes acting in the lower atmosphere and upper ocean, and at the surface between them.

A major part of the JASIN oceanographic programme was directed towards measuring vertical profiles of temperature, salinity and horizontal velocity, using instruments lowered from ships or attached to moorings or drifting buoys. The cruise programme for JASIN included only a modest contribution to such work. Our plan was to spend most of the time towing an undulating fish, in which was housed a Neil Brown

CTD, fluorometer and water pump. The idea was to collect water for batch analysis of Radon concentration while executing a series of surveys of dye spreading from a point injection below the wind-mixed layer. Thus Poseidon's contribution to JASIN was planned to concentrate on the determination of transport rates in the largely unexplored zone between surface entrainment layer, on the one hand, and seasonal thermocline, on the other, by direct observation of tracers both natural (radon) and artificial (rhodamine), taking account of the horizontal distribution of vertical thermohaline structure on scales up to 30 km.

In the event, Poseidon's programme had to be changed after the failure of the towing winch cable. Water collection for radon analysis was carried out with a pipe lowered on the hydrowinch wire while the ship drifted; using this method we collected high resolution profiles once or twice a day throughout the expedition. We carried out four dye experiments; sufficient to demonstrate that the new technique designed for JASIN worked well (until the winch cable failed), but terminated too soon in each case to permit mapping as planned. The parachute drogues laid in support of these dye experiments were tracked over several days, giving valuable information about the currents in the vicinity of the JASIN Fixed Intensive Array of moorings. Over one hundred CTD profiles were made to 500 metres (five to 1000 m); also several days work of yo-yo CTD profiles to 100 metres. These latter measurements, parachute tracking and CTD profiles, were not originally planned as part of the scientific programme for Poseidon 31, but were decided upon in consultation with principal scientists of other ships after the towing winch cable began to fail. In this way Poseidon continued to make a central contribution to the oceanographic programme of JASIN 1978.

2. Cruise Diary

Poseidon left the Institut für Meereskunde pier, Kieler Förde, at 0700* on Monday 14 August 1978. The passage out to the JASIN area (approximately 59° N 12°30' W) was interrupted for system trials, firstly in the Baltic (Eckernförde Bucht) then, after passing through the Nord-Ostsee Kanal (night of 14/15 August), in the North Sea and on the Shetland Shelf. In making these trials we were making up for lost cruises in May and early August, when Poseidon was laid up for engine modifications. The passage out enjoyed calm sunny weather with an excellent view of Fair Isle (we had taken the northern route to avoid risk with the virtually untested engines in the Pentland Firth). But as we passed over the shelf into the deep Atlantic (18 August) the wind changed to force 6 for the next week.

Our first pre-occupation, on arrival in the JASIN area was to test the undulating fish with its new water pump, fluorometer and Neil Brown CTD. The tests were hindered by Poseidon's strong pitching motion when motoring into the Atlantic swell, so we restricted the heading to lie along the swell crests (roll being virtually eliminated by the stabilizers at speeds above 5 knots). On the 19th August we completed the first four hour radon profile, with the fish towed at a series of constant depths. With this initial success we attempted the first run with the fluorometer, passing back and forth through a small quantity of rhodamine dye injected into the actively mixing surface layer. All started well, with clear dye signals showing through the periodic daylight signal. The new relative navigation system (e.m. log interfaced to the HP 9825A calculator) gave clear plots of the ship track as it passed repeatedly through the dye; systematic apparent drift was attributed to an offset in the thwartship component and non-linearity in the compass signal. The promising trial was abruptly ended when the protective circuit breaker in the power lines to the fluoro-

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*all times of day are GMT

meter and pump broke. The fish was recovered for investigation, and the opportunity was taken to complete calibration of the relative navigation system by tracking a parachute drogue over the next 34 hours.

We made a 24-hour time series of XBTs starting after breakfast on Sunday 20 August. There was evidence of sharp inversions suggestive of frontal interleaving in one XBT to the NE of the JASIN Fixed Intensive Array; this was reported to JASIN HQ with a request for an ART survey. The next day Discovery made a Batfish tow through the area and confirmed our report. (It later became clear that the region to the NE of the FIA was to exhibit strong microstructure below the mixed layer, with noticeable fluctuations of temperature and salinity on the surface thermosalinograph record, throughout the JASIN period.)

Next morning (21/8) we tested the fish, which seemed O.K., although no fault had been discovered and no alteration made. So after lunch, dye was pumped into the sea at 40 m, the bottom of the previous day's entrainment layer, which now extended to a depth of only about 20 metres. This is precisely the condition that we had planned to study: mixing in a layer between the thermocline and the active entrainment layer after a decrease in the wind. This was the first dye experiment. All started well with a number of good encounters with the dye during successive passes plotted on the HP 9872A using the e.m. log. We became confident that the experimental concept was satisfactory: it was indeed possible to map dye in relation to the temperature-salinity distribution using the towed undulating fish. But after five hours of excellent mapping the circuit breaker again broke, so we recovered the fish and continued with a standby fluorometer lowered by winch while the ship motored very slowly. This was the method that Prof. Kullenberg had used in earlier experiments. The contrast with the new method using the undulating fish was striking; there is no doubt that the new method is a major step forward.

In the evening (21/8) we tried out collecting water for a radon profile using a hose attached to the hydrowire and lowered on the starboard hydrowinch, the ship drifting. The method worked, but was far less satisfactory than the towed fish system we had planned to use. All radon profiles on Poseidon 31 were henceforth made using this technique. On only two days (20/8 and 25/8) was there no radon profiling; on all other days we collected at least one profile on the hydrowire; a total of 34. The times are listed elsewhere in this report and will not be mentioned again in the diary.

Next day (22/8) after further drogue tracking while the fish was repaired (the fault was identified as being a broken conductor in the towing cable) we started the second dye experiment. This continued until 1800 next day (23/8) with occasional interruptions to repair the fish as other conductor cables broke, to be replaced by spare lines. By the end of this second dye experiment it had become clear that the towing cable had a major fault and we could expect only a few more hours towing before all the conductor cables had broken. This was rather frustrating, since the weather was ideal for the dye experiments, and all other instruments were performing perfectly. I decided that the remaining conductor cables should be kept for a joint experiment with the other oceanographic ships scheduled (after several hours of conference calls on VHF over the past few days) for the 29th August. This meant that we had to prepare ourselves for other work. The obvious decision was to extract the Neil Brown CTD from the fish and configure it for standard profiling. We had not brought the sensor guard with us, but the ship's workshop rapidly made a steel frame in which the CTD was hammocked by nylon lines. Instantly named the "gorilla cage", this ungainly construction served faultlessly for the 119 CTD stations made during the remainder of the cruise, gaining a degree of amused affection amongst crew and scientists.

Next morning (24/8) we rendez-voused with Meteor for an intercomparison of the Heidelberg radon systems operating on the two ships and an ad hoc comparison of the meteorological systems. After lunch we tested the CTD in its new cage and then embarked on a series of profiles made to 500 metres at 1/2 n.mile spacing on a box around the Fixed Intensive Array of moorings. This work continued through the 25th and to 0930 on the 26th August. By then the most urgent task was to reconnoitre likely sites for the joint shipwork on the 29th. Discovery had reported spar buoy drift to the W and N on the NW side of the FIA, so the best bet seemed to be NW or SE, on the path of the water flowing through the moorings, but safely away from them. Poseidon being unrestricted as to area, and lying handily in the SE corner, I decided to concentrate our efforts on measuring currents (with parachute drogues) and thermohaline structure (by CTD profiling). This was what we did for the next 48 hours, breaking at intervals for radon profiles. By midday on the 28th we had established that the water in and above the thermocline was drifting S-SE at about 10 km/day with little vertical shear (drogues at different depths), but periodic modulation, apparently tidal. During the 27th, Discovery came down to the same area and confirmed our results with their drogues (after some earlier scepticism based on the quite different progress of their spar buoy further N during the previous days). So the decision was made to locate the joint shipwork on the 29th at the SE of the FIA.

Reviewing the joint plan that had evolved in VHF discussions between the chief scientists on the ships due to participate in this joint work, it became clear that there would be an advantage if Poseidon started her dye experiment the evening before, so that the initial stages of mapping (in which the ship manoeuvres are somewhat irregular) would be completed before the other ships moved into adjacent positions. The weather which had been ideal for the experiment (still calm after the previous week's gale) was forecast to change on the 29th; a second factor in starting early. And the third factor was our uncertainty as to the lifetime of the towing cable. We did not want to have to change our experimental measurement scheme in the middle of a closely spaced ship array during the joint work. Better to face up to that before if it was going to happen. So we recovered the drogues, which had by noon on the 28th had drifted nearly 20 miles SE of the site for our joint work, and motored back towards the FIA towing the fish, undulating with the CTD working. This gave an excellent three hour section, with no interruptions or cable breaks.

After a radon profile, we began the third dye experiment at 1600 on the 28th August, continuing until 0600 the next day. Again the experiment came frustratingly close to success, with excellent dye mapping during survey legs, interrupted by cable breaks, fish recovery, substitution of spare lines, relaunching (achieved with great efficiency and speed by Dr. Hansen, Herr Petersen and Herr Bock). Eventually we ran out of spare lines and the experiment had to be abandoned. The data collected will contain parts that are well worth analysis, although it will be impossible to follow the spread of the dye in successive maps, as we had planned. Again, all systems apart from the cable functioned well.

There was just time to complete a radon profile and get on station for CTD yo-yo profiling in the fixed ship array of the joint experiment starting at noon on the 29th and continuing until 0300 on the 1st September, with breaks for radon profiling. In this way we made a useful contribution to the intensive oceanographic work of the 29th and continued to support the work of Discovery and Planet at the drifting P2 spar buoy in the days that followed.

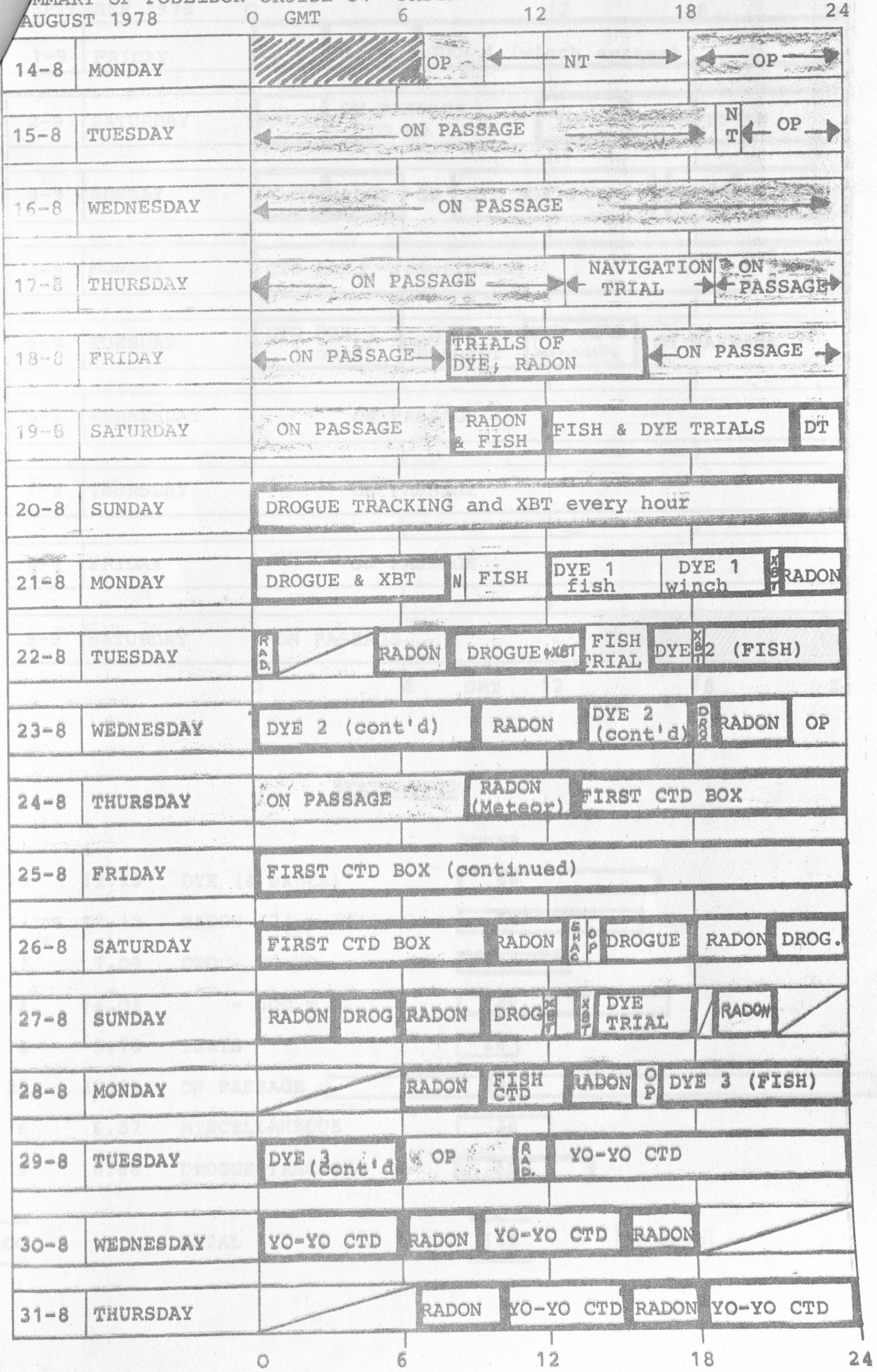
On the afternoon and evening of the 1st September we used the winch lowered fluorometer for a fourth dye experiment under Prof Kullenberg's direction. Afterwards Poseidon motored North to the H2 mooring (20 miles North of the FIA) to participate in the second joint ship day, making yo-yo CTD dips 4 cables from Meteor from 1130 on the 2nd to 0300 on the 3rd September, with two breaks for radon profiles, the sea being flat calm throughout. The remaining days in the JASIN area were devoted to a second CTD box around the FIA (again 1/2 n.mile spacing between dips to 500 m), in association with CTD work on Planet at a fixed station near the K3 mooring. With breaks for radon profiling, this work ran from 0800 on the 3rd to 1300 on the 5th September. The Academic Vernadsky joined Poseidon for a CTD intercomparison from 1030-1230 on the 5th September, after we had rendez-voused with Guardline Endurer to transfer Prof Roether, who was planning to attend meetings in the UK later in the week.

The weather, which had been embarrassingly calm for most of the second phase of JASIN (when Poseidon was in the area) had finally broken on the night of the 4/5 September, giving a strong SE wind. We motored home at reduced speed into rough seas from 1300 on the 5th, increasing speed slowly as the wind moderated during our crossing of the North Sea and past Skagen.

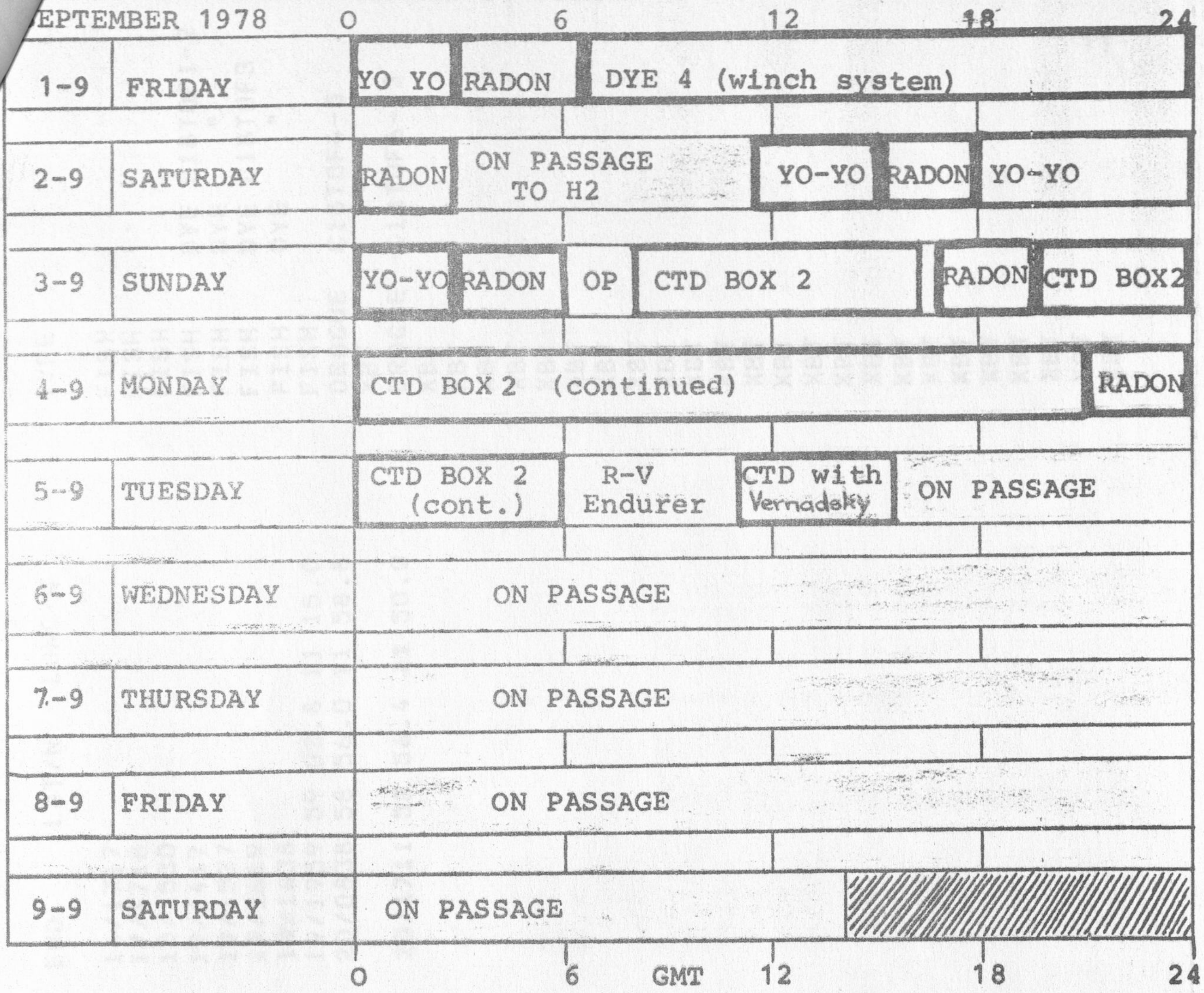
Poseidon was secured at the Institut für Meereskunde pier at 1510 (CET) on Saturday 9th September. The cruise was completed without instrument loss or accidental damage (the cable failure being counted as the result of wear and tear on earlier cruises). There was no case of accident or ill health amongst either scientific or ship's crew.

(J. D. Woods)

MMARY OF POSEIDON CRUISE 31 JASIN



14-8	MONDAY	OP ← NT → ← OP →
15-8	TUESDAY	← ON PASSAGE → NT ← OP →
16-8	WEDNESDAY	← ON PASSAGE →
17-8	THURSDAY	← ON PASSAGE → ← NAVIGATION TRIAL → ← ON PASSAGE →
18-8	FRIDAY	← ON PASSAGE → TRIALS OF DYE, RADON ← ON PASSAGE →
19-8	SATURDAY	ON PASSAGE RADON & FISH FISH & DYE TRIALS DT
20-8	SUNDAY	DROGUE TRACKING and XBT every hour
21-8	MONDAY	DROGUE & XBT N FISH DYE 1 fish DYE 1 winch XBT RADON
22-8	TUESDAY	RAD. RADON DROGUE +XBT FISH TRIAL DYE XBT 2 (FISH)
23-8	WEDNESDAY	DYE 2 (cont'd) RADON DYE 2 (cont'd) DRO RADON OP
24-8	THURSDAY	ON PASSAGE RADON (Meteor) FIRST CTD BOX
25-8	FRIDAY	FIRST CTD BOX (continued)
26-8	SATURDAY	FIRST CTD BOX RADON SHAC OP DROGUE RADON DROG.
27-8	SUNDAY	RADON DROG RADON DROG XBT XBT DYE TRIAL RADON
28-8	MONDAY	RADON FISH CTD RADON OP DYE 3 (FISH)
29-8	TUESDAY	DYE 3 (cont'd) OP RAD. YO-YO CTD
30-8	WEDNESDAY	YO-YO CTD RADON YO-YO CTD RADON
31-8	THURSDAY	RADON YO-YO CTD RADON YO-YO CTD



STATISTICS

	%		hours
13	13.25	DYE (4 expts)	84
12	12.13	RADON (24 profiles)	77
7	7.09	CTD - YO-YO	45
14	14.02	- 500 m	89
4	3.78	TESTS	24
35	35.43	ON PASSAGE	225
6	6.57	MISCELLANEOUS	36
9	8.66	DROGUE TRACKING	55
100		TOTAL	635 [27 days]

STATION LIST (1)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W	TYPE	
P1394	JCTDF001	14/1535	54 29.9	10 02.8E	14/1717			FISH	
	JCTDF002	17/1548	59 23.0	03 56.1	17/1718			FISH	
	JCTDF003	18/1507	59 19.0	08 20.0	18/1530			FISH	
	JCTDF004	19/1358	59 00.0	12 03.0	19/1417			FISH	DYE C18TOF1-2
	JCTDF005	19/1424	59 00.0	12 03.0	19/1527			FISH	DYE "
	JCTDF006	19/1551	58 59.5	11 57.0	19/1619			FISH	DYE C18TOF3
	JCTDF007	19/1625	58 59.5	11 57.0	19/1638			FISH	DYE "
	JCTDF008	19/1945	59 02.5	11 19.0	19/1959	59 02.8	11 15.0	FISH	
		20/0710	58 56.1	12 00.7	20/0838	58 56.0	11 58.8	DROGUE	C18TOF4-5
JX001		20/0900	58 57.0	12 00.0				XBT	
		20/0904	58 56.1	11 58.4	20/1711	58 56.4	11 50.0	DROGUE	C18TOF6-13
JX002		20/1000	58 58.0	11 56.8				XBT	
JX003		20/1100	58 58.2	11 57.8				XBT	
JX004		20/1200	58 58.1	11 58.0				XBT	
JX006		20/1300	58 58.4	11 54.0				XBT	
JX007		20/1400	58 58.2	11 56.6				XBT	
JX008		20/1500	58 58.2	11 55.8				XBT	
JX010		20/1600	58 58.1	11 55.1				XBT	
JX011		20/1700	58 57.8	11 50.6				XBT	
JX012		20/1800	59 01.0	11 53.4				XBT	
JX013		20/1900	59 00.0	11 48.9				XBT	
JX014		20/2000	58 54.8	11 39.0				XBT	
JX015		20/2100	58 55.0	11 37.8				XBT	
JX016		20/2200	59 00.0	11 46.0				XBT	
JX017A		20/2300	59 01.0	11 46.0				XBT	
JX017B		21/0000	58 56.8	11 37.0				XBT	
JX018		21/0100	58 55.9	11 35.6				XBT	
JX019		21/0200	59 01.8	11 43.1				XBT	
JX020		21/0300	59 02.0	11 43.4				XBT	
JX021		21/0400	58 57.0	11 32.6				XBT	
JX022		21/0500	58 57.0	11 31.0				XBT	
JX023		21/0600	59 02.0	11 37.0				XBT	
JX024		21/0700	59 04.8	11 43.0				XBT	
JX025		21/0800	59 02.9	11 44.5				XBT	
JX026		21/0900	58 58.8	11 37.0				XBT	

STATION LIST (2)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W	TYPE	
	JCTDF009	21/0948	58 56.0	11 33.0	21/1156	58 57.7	11 38.0	FISH	
100101	JCTDF010	21/1256	58 57.7	11 38.0	21/1359	58 59.0	11 34.7	FISH	DYE C18T1F1-2
100102	JCTDF011	21/1416	58 59.0	11 39.7	21/1444			FISH	DYE C18T1F3
100103		21/1445			21/2139	58 55.8	11 39.7	DYE	C18T1F4-9
JX027		21/2200	58 55.6	11 39.5				XBT	
JX028		22/0800	59 02.3	11 49.4				XBT	
		22/0823	59 02.1	11 50.0	22/1118	59 03.0	11 50.3	DROGUE	C18T1F10-12
JX029		22/0900	59 02.0	11 51.2				XBT	
JX030		22/1000	59 02.9	11 47.8				XBT	
JX031		22/1100	58 57.2	11 23.3				XBT	
JX032		22/1200	59 06.0	11 55.7				XBT	
	JCTDF013	22/1239	59 03.1	11 49.3	22/1257	59 03.9	11 48.1	FISH	
JX033		22/1400	59 04.9	11 48.0				XBT	
	JCTDF014	22/1432	59 02.2	11 50.0	22/1534			FISH	
JX034		22/1810	59 02.5	11 48.0				XBT	
200101	JCTDF015	22/1833	59 02.5	11 48.0	22/1904			FISH	DYE C18T1F19-2
200102	JCTDF016	22/2005	59 02.5	11 48.0	22/2025			FISH	DYE C18T1F21-2
200103	JCTDF017	22/2057	59 02.5	11 48.0	22/2153			FISH	DYE "
200104	JCTDF018	22/2339	59 02.5	11 48.0	-------			FISH	DYE C18T1F23-2
200201	JCTDF018	23/0035	-------	--------	23/0118			FISH	DYE "
200201	JCTDF019	23/0132	59 02.5	11 47.0	23/0139	59 02.6	11 47.5	FISH	DYE " 1
200301	JCTDF020	23/1445	59 01.2	11 43.4	23/1603	59 02.7	11 42.4	FISH	C24TOF12-15
P1415	JCTD0001	24/1337	58 55.4	12 37.8	24/1405	58 55.4	12 27.1	CTD	
P1416	JCTD0002	24/1554	58 55.4	12 26.5	24/1625	58 55.4	12 26.0	CTD	
P1417	JCTD0003	24/1648	58 55.9	12 26.8	24/1716	58 56.0	12 27.0	CTD	
P1418	JCTD0004	24/1732	58 56.4	12 26.6	24/1801	58 56.5	12 26.8	CTD	
P1419	JCTD0005	24/1816	58 56.9	12 26.6	24/1845	58 57.0	12 26.8	CTD	
P1420	JCTD0006	24/1859	58 57.3	12 26.4	24/1929	58 57.5	12 26.8	CTD	
P1421	JCTD0007	24/1941	58 58.0	12 26.4	24/2011	58 58.1	12 26.6	CTD	
P1422	JCTD0008	24/2024	58 58.5	12 26.8	24/2051	58 58.8	12 26.7	CTD	
P1423	JCTD0009	24/2101	58 58.9	12 26.5	24/2132	58 59.2	12 26.7	CTD	
P1424	JCTD0010	24/2146	58 59.4	12 26.7	24/2216	59 00.2	12 26.6 P	CTD	
P1425	JCTD0011	24/2231	58 59.9	12 26.5	24/2301	59 00.0	12 26.2 P	CTD	
P1426	JCTD0012	24/2322	59 00.8	12 26.2	24/2350	59 00.7	12 26.5 P	CTD	
P1427	JCTD0013	25/0037	59 01.6	12 25.7	25/0123			CTD	1000M

STATION LIST (3)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W		TYPE	
P1428	JCTD0014	25/0318	59 02.9	12 26.7	25/0352	59 01.6	12 27.0	P	CTD	
P1429	JCTD0015	25/0406	59 02.4	12 26.5	25/0437	59 02.2	12 27.1	P	CTD	
P1430	JCTD0016	25/0452	59 02.4	12 27.6	25/0523	59 02.0	12 28.5	P	CTD	
P1431	JCTD0017	25/0530	59 02.4	12 28.5	25/0605	59 02.3	12 29.5	P	CTD	
P1432	JCTD0018	25/0621	59 02.4	12 29.7	25/0649	59 02.4	12 31.1	P	CTD	
P1433	JCTD0019	25/0659	59 02.4	12 31.4	25/0729	59 02.6	12 31.8	P	CTD	
P1434	JCTD0020	25/0738	59 02.5	12 31.4	25/0808	59 02.6	12 32.6	P	CTD	
P1435	JCTD0021	25/0825	59 02.4	12 32.4	25/0854	28 02.7	12 33.3	P	CTD	
P1436	JCTD0022	25/0926	59 02.5	12 33.4	25/0955	59 03.0	12 33.2		CTD	
P1437	JCTD0023	25/1015	59 02.5	12 34.1	25/1043	59 02.8	12 34.3		CTD	
P1438	JCTD0024	25/1105	59 02.5	12 35.4	25/1134	59 02.7	12 34.3		CTD	
P1439	JCTD0025	25/1148	59 02.4	12 36.3	25/1248	59 02.3	12 37.1		CTD	1000M
P1440	JCTD0026	25/1305	59 01.9	12 36.3	25/1335	59 01.6	12 36.9		CTD	
P1441	JCTD0027	25/1352	59 01.4	12 36.3	25/1422	59 00.9	12 36.6		CTD	
P1442	JCTD0028	25/1438	59 00.9	12 36.3	25/1507	59 00.3	12 36.8		CTD	
P1443	JCTD0029	25/1521	59 00.4	12 36.4	25/1552	59 00.0	12 37.1		CTD	
P1444	JCTD0030	25/1608	58 59.9	12 36.4	25/1639	58 59.5	12 37.4		CTD	
P1445	JCTD0031	25/1656	58 59.4	12 36.4	25/1726	58 59.1	12 37.3		CTD	
P1446	JCTD0032	25/1743	58 58.9	12 36.4	25/1811	58 58.4	12 37.7		CTD	
P1447	JCTD0033	25/1833	58 58.5	12 36.4	25/1903	58 58.2	12 37.1		CTD	
P1448	JCTD0034	25/1919	58 57.9	12 36.5	25/1947	58 57.9	12 36.5		CTD	
P1449	JCTD0035	25/2004	58 57.4	12 36.2	25/2033	58 57.5	12 36.1		CTD	
P1450	JCTD0036	25/2058	58 56.9	12 36.4	25/2128	58 57.1	12 36.1		CTD	1000M
P1451	JCTD0037	25/2150	58 56.4	12 36.3	25/2246	58 56.5	12 35.2		CTD	
P1452	JCTD0038	25/2305	58 56.2	12 34.9	25/2334	58 56.2	12 34.2		CTD	
P1453	JCTD0039	25/2353	58 56.0	12 34.3	26/0023	58 55.5	12 32.3	P	CTD	
P1454	JCTD0040	26/0040	58 55.8	12 33.9	26/0111	58 55.6	12 31.6	P	CTD	
P1455	JCTD0041	26/0121	58 55.6	12 32.5	26/0151				CTD	
P1456	JCTD0042	26/0207	58 55.4	12 31.5	26/0238				CTD	
P1457	JCTD0043	26/0255	58 55.3	12 30.6	26/0326				CTD	
P1458	JCTD0044	26/0342	58 55.1	12 29.7	26/0413				CTD	
P1459	JCTD0045	26/0429	58 55.0	12 28.9	26/0457				CTD	
P1460	JCTD0046	26/0517	58 54.8	12 27.9	26/0546				CTD	1000M
P1461	JCTD0047	26/0601	58 54.6	12 26.9	26/0655	58 54.7	12 26.4		CTD	CF P1416
P1462	JCTD0048	26/0730	58 55.4	12 26.5	26/0758	58 55.4	12 26.4		CTD	

STATION LIST (4)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W	TYPE	
P1463	JCTD0049	26/0814	58 55.9	12 26.5	26/0843	58 55.9	12 26.2	CTD	CF P1417
P1464	JCTD0050	26/0900	58 56.4	12 26.6	26/0929	58 56.4	12 26.2	CTD	CF P1418
(1)		26/1440	58 53.2	12 20.5	27/1053	58 51.6	12 17.9	DROGUE	C20TOF1-6
P1474	JCTD0051	27/1055	58 51.5	12 17.9	27/1131	58 51.4	12 17.2	CTD	
P1475		27/1337	58 50.7	12 16.6	27/1602	58 50.6	12 16.8	DROGUE	DYE C20TOF7-9
JX035		27/1345	58 51.2	12 16.0				XBT	
P1478	JCTDF021	28/0910	58 50.6	12 14.3	28/1225			FISH	
300101	JCTDF022	28/1648	58 56.9	12 24.5	28/1853			FISH	DYE)
300201	JCTDF023	28/1951	58 57.1	12 54.7	29/0040	58 58.5	12 24.8	FISH	DYE) C21TOF1-
300202	JCTDF024	29/0044	58 57.8	12 24.0	29/0201	58 52.2	12 16.4	FISH	) OVERWRIT
300301	JCTDF025	29/0336	58 54.0	12 19.5	29/0538			FISH	)
P1482	JCTD0052	29/1155	58 53.8	12 20.4	29/1746	58 53.3	12 20.1	YOYO	
P1482	JCTD0053	29/1748	58 53.3	12 20.1	29/2359	58 53.3	12 22.2	YOYO	
P1482	JCTD0054	30/0006	58 53.3	12 22.3	30/0611	58 55.1	12 22.6	YOYO	
P1485	JCTD0055	30/0949	58 53.9	12 20.7	30/1430	58 53.7	12 18.7	YOYO	
P1488	JCTD0056	31/1000	58 51.1	12 11.6	31/1500	58 50.6	12 07.8	YOYO	
P1490	JCT00057	31/1825	58 48.9	12 05.7	01/0252	58 48.7	12 07.7	YOYO	
(2)		01/0725	58 47.0	12 04.1	01/2300	58 46.0	12 02.9	DROGUE	DYE C21TOF1-14
P1492	JCTD0058	01/1647	58 47.1	12 04.0	01/1719	58 47.2	12 04.0	YOYO	
P1497	JCTD0059	02/1123	59 26.0	12 27.5	02/1503	59 26.5	12 27.8	YOYO	
P1499	JCTD0060	02/1844	58 45.6	12 02.5	02/2350	59 26.1	12 27.6	YOYO	
P1499	JCTD0061	02/2354	59 26.1	12 27.6	03/0259	59 26.8	12 28.6	YOYO	
P1501	JCTD0062	03/0828	59 02.4	12 24.1	03/0851			CTD	
P1502	JCTD0063	03/0910	59 01.9	12 24.1	03/0933	59 01.7	12 24.3	CTD	
P1503	JCTD0064	03/0950	59 01.4	12 24.1	03/1013			CTD	
P1504	JCTD0065	03/1029	59 00.9	12 24.0	03/1052			CTD	
P1505	JCTD0066	03/1103	59 00.4	12 24.1	03/1126			CTD	
P1506	JCTD0067	03/1142	58 59.8	12 24.0	03/1207	58 59.7	12 24.0	CTD	
P1507	JCTD0068	03/1221	58 59.3	12 24.1	03/1247			CTD	
P1508	JCTD0069	03/1301	58 58.8	12 24.0	03/1325	58 58.5	12 24.1	CTD	
P1509	JCTD0070	03/1340	58 58.2	12 24.0	03/1406	58 58.0	12 24.0	CTD	
P1510	JCTD0071	03/1417	58 57.6	12 24.1	03/1440	58 57.5	12 24.1	CTD	
P1511	JCTD0072	03/1457	58 57.6	12 25.0	03/1521	58 57.7	12 25.3	CTD	
P1513	JCTD0073	03/2205	58 57.6	12 25.0	03/2227	58 57.6	12 24.9	CTD	CF P1511
P1514	JCTD0074	03/2249	58 57.6	12 25.9	03/2313	58 57.6	12 25.8	CTD	

STATION LIST (5)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W	TYPE	
P1515	JCTD0075	03/2332	58 57.6	12 26.9	03/2355	58 57.4	12 27.0	CTD	
P1516	JCTD0076	04/0010	58 57.6	12 27.9	04/0031	58 57.4	12 27.9	CTD	
P1517	JCTD0077	04/0049	58 57.6	12 28.9	04/0110	58 57.4	12 29.3	CTD	
P1518	JCTD0078	04/0123	58 57.6	12 29.8	04/0144	58 57.4	12 30.1	CTD	
P1519	JCTD0079	04/0204	58 57.6	12 30.8	04/0228	58 57.6	12 31.2	CTD	
P1520	JCTD0080	04/0242	58 57.6	12 31.8	04/0303	58 57.5	12 32.3	CTD	
P1521	JCTD0081	04/0315	58 57.6	12 32.7	04/0338	58 57.8	12 33.3	CTD	
P1522	JCTD0082	04/0355	58 57.6	12 33.7	04/0416	58 57.6	12 34.1	CTD	
P1523	JCTD0083	04/0433	58 57.6	12 34.7	04/0456	58 57.8	12 35.0	CTD	
P1524	JCTD0084	04/0516	58 57.6	12 35.7	04/0539	58 57.8	12 36.3	CTD	
P1525	JCTD0085	04/0553	58 58.1	12 35.8	04/0617	58 58.1	12 35.9	CTD	
P1526	JCTD0086	04/0641	58 58.6	12 35.8	04/0704			CTD	
P1527	JCTD0087	04/0720	58 59.1	12 35.8	04/0742	58 59.2	12 35.9	CTD	
P1528	JCTD0088	04/0755	58 59.6	12 35.8	04/0819	58 59.2	12 35.9	CTD	
P1529	JCTD0089	04/0838	59 00.2	12 35.7	04/0900	59 00.2	13 25.7	CTD	
P1530	JCTD0090	04/0919	59 00.6	12 35.6	04/0943	59 00.7	12 35.6	CTD	
P1531	JCTD0091	04/1003	59 01.2	12 35.8	04/1025	59 01.2	12 35.8	CTD	
P1532	JCTD0092	04/1044	59 01.6	12 35.9	04/1106	59 01.5	12 35.9	CTD	
P1533	JCTD0093	04/1128	59 02.4	12 35.7	04/1152	59 02.3	12 35.9	CTD	
P1534	JCTD0094	04/1213	59 02.3	12 34.7	04/1235	59 02.0	12 34.6	CTD	
P1535	JCTD0095	04/1258	59 02.4	12 33.9	04/1319	59 02.3	12 34.0	CTD	
P1536	JCTD0096	04/1340	59 02.4	12 32.9	04/1403	59 02.1	12 33.2	CTD	
P1537	JCTD0097	04/1427	59 02.4	12 31.9	04/1450	59 02.2	12 32.4	CTD	
P1538	JCTD0098	04/1511	59 02.4	12 31.0	04/1532	59 02.2	12 31.4	CTD	
P1539	JCTD0099	04/1606	59 02.4	12 30.0	04/1629	59 02.3	12 30.2	CTD	
P1540	JCTD0100	04/1645	59 02.4	12 29.1	04/1707	59 02.3	12 29.2	CTD	
P1541	JCTD0101	04/1721	59 02.4	12 28.1	04/1744	59 02.3	12 28.3	CTD	
P1542	JCTD0102	04/1807	59 02.4	12 27.2	04/1830	59 02.3	12 27.2	CTD	
P1543	JCTD0103	04/1846	59 02.4	12 26.2	04/1940	59 02.3	12 26.1	CTD	
P1544	JCTD0104	04/1921	59 02.4	12 25.3	04/1944	59 02.4	12 25.0	CTD	
P1545	JCTD0105	04/1956	59 02.4	12 24.1	04/2020	59 02.5	12 24.0	CTD	CF P1501
P1547	JCTD0106	05/0038	59 02.4	12 35.7	05/0102	59 02.0	12 35.6	CTD	CF P1533
P1548	JCTD0107	05/0129	59 02.4	12 34.8	05/0153	59 02.0	12 34.6	CTD	CF P1534
P1549	JCTD0108	05/0209	59 02.4	12 33.8	05/0227	59 01.9	12 33.6	CTD	CF P1535
P1550	JCTD0109	05/0249	59 02.4	12 31.8	05/0312	59 02.0	12 31.6	CTD	CF P1537

STATION LIST (6)

STN NO	DP NO	START	LAT/N	LONG/W	END	LAT/N	LONG/W	TYPE	
P1551	JCTD0110	05/0328	59 02.4	12 30.8	05/0351	59 02.2	12 30.3	CTD	CF P1538
P1552	JCTD0111	05/0402	59 02.4	12 29.8	05/0425	59 02.0	12 29.8	CTD	CF P1539
P1553	JCTD0112	05/0455	59 02.8	12 28.8	05/0517	59 02.7	12 28.9	CTD	
P1554	JCTD0113	05/0535	59 02.4	12 28.0	05/0559	59 02.3	12 27.9	CTD	CF P1541
P1555	JCTD0114	05/1047	59 02.3	12 27.4	05/1115	59 02.1	12 27.2	CTD	CF P1554 & P15
P1556	JCTD0115	05/1137	59 02.4	12 26.8	05/1219	59 01.8	12 26.2	CTD	1000M CF P15
P1557	JCTD0116	05/1235	59 02.4	12 25.9	05/1257	59 02.0	12 25.5	CTD	CF P1543
P1558	JCTD0117	05/1310	59 02.3	12 24.8	05/1333	59 01.9	12 24.6	CTD	CF P1544
P1559	JCTD0118	05/1345	59 02.3	12 24.1	05/1408	59 02.0	12 24.0	CTD	CF P1501 & P15
P1560	JCTD0119	05/1424	59 02.3	12 23.1	05/1447	59 02.1	12 23.1	CTD	

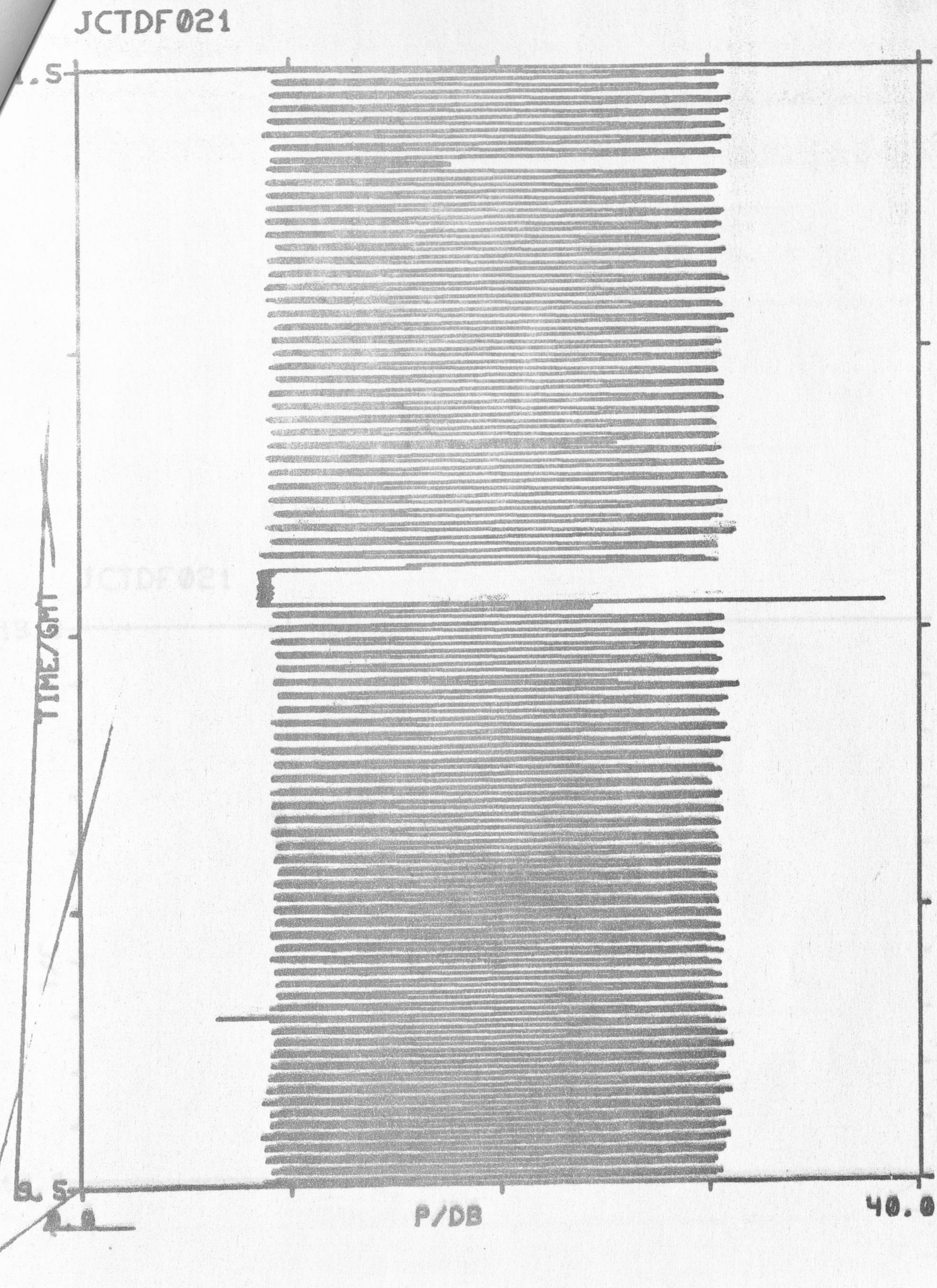
KEY

Column 1. P ≡ Poseidon Station Number. (1) ≡ Stations P1466, P1468, P1471 and P1473.
(2) ≡ Stations P1492, P1494 and P1495.

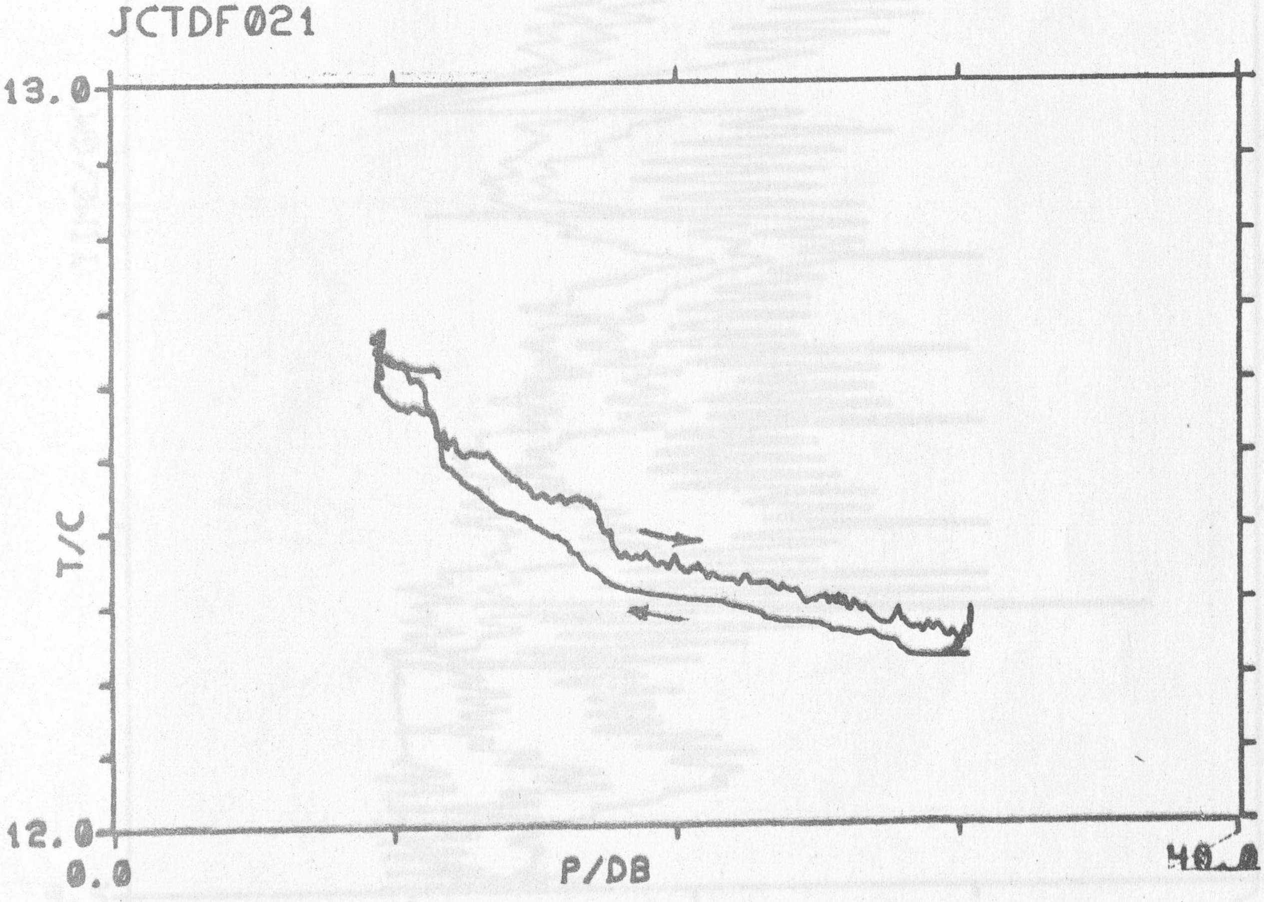
Column 2. DP No ≡ Name of magnetic tape file on which the data is held.

Columns 3&6. Start and end times in form Date (14≡14th August→5≡5th September)/Time (GMT)
P ≡ poor position fix.

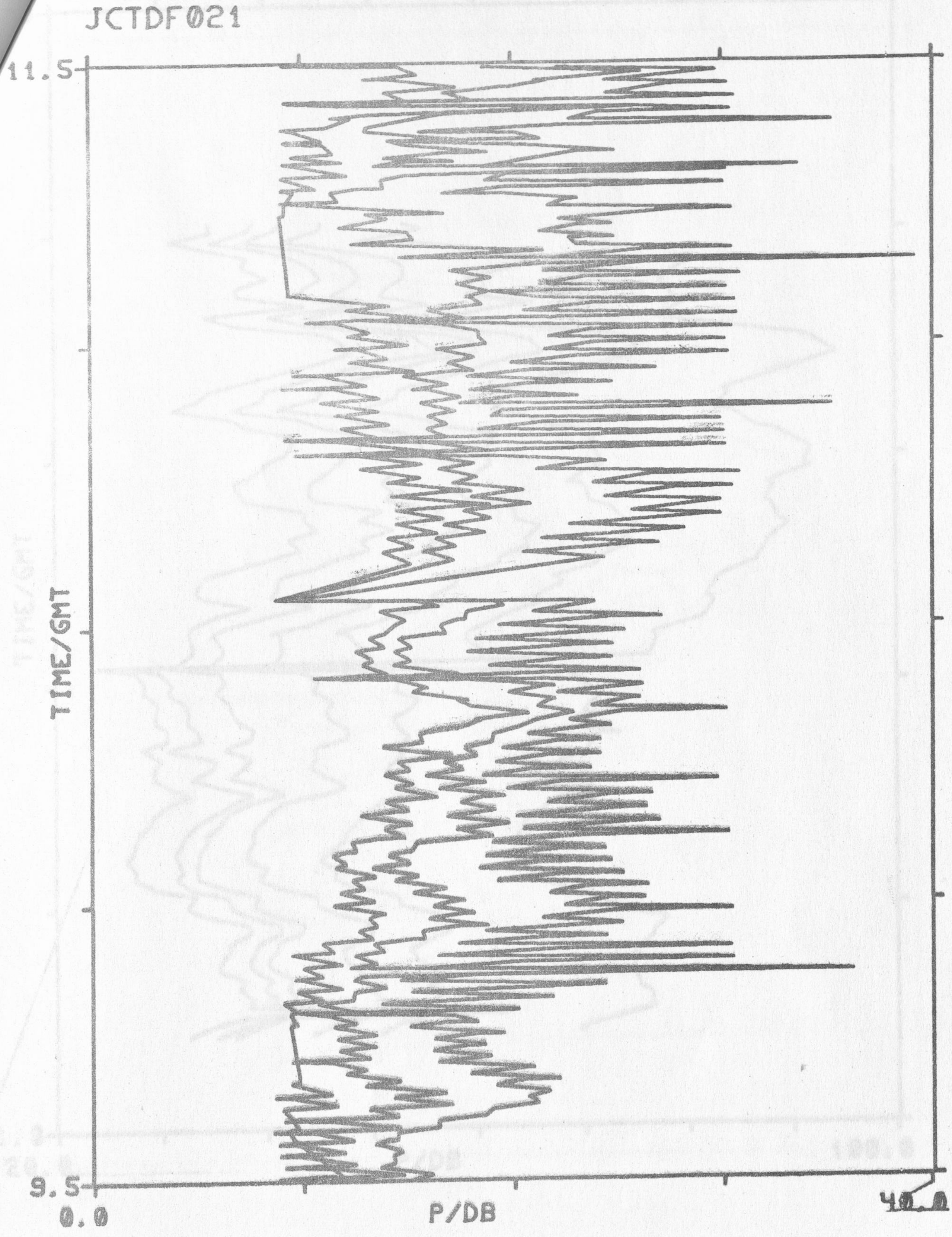
Column 9. Type of station. Earlier stations with the same nominal position are given. Where appropriate the location of the navigation data recorded by the Hewlett-Packard calculator is given in the form C (Cassette number) T(Track number) F (File number



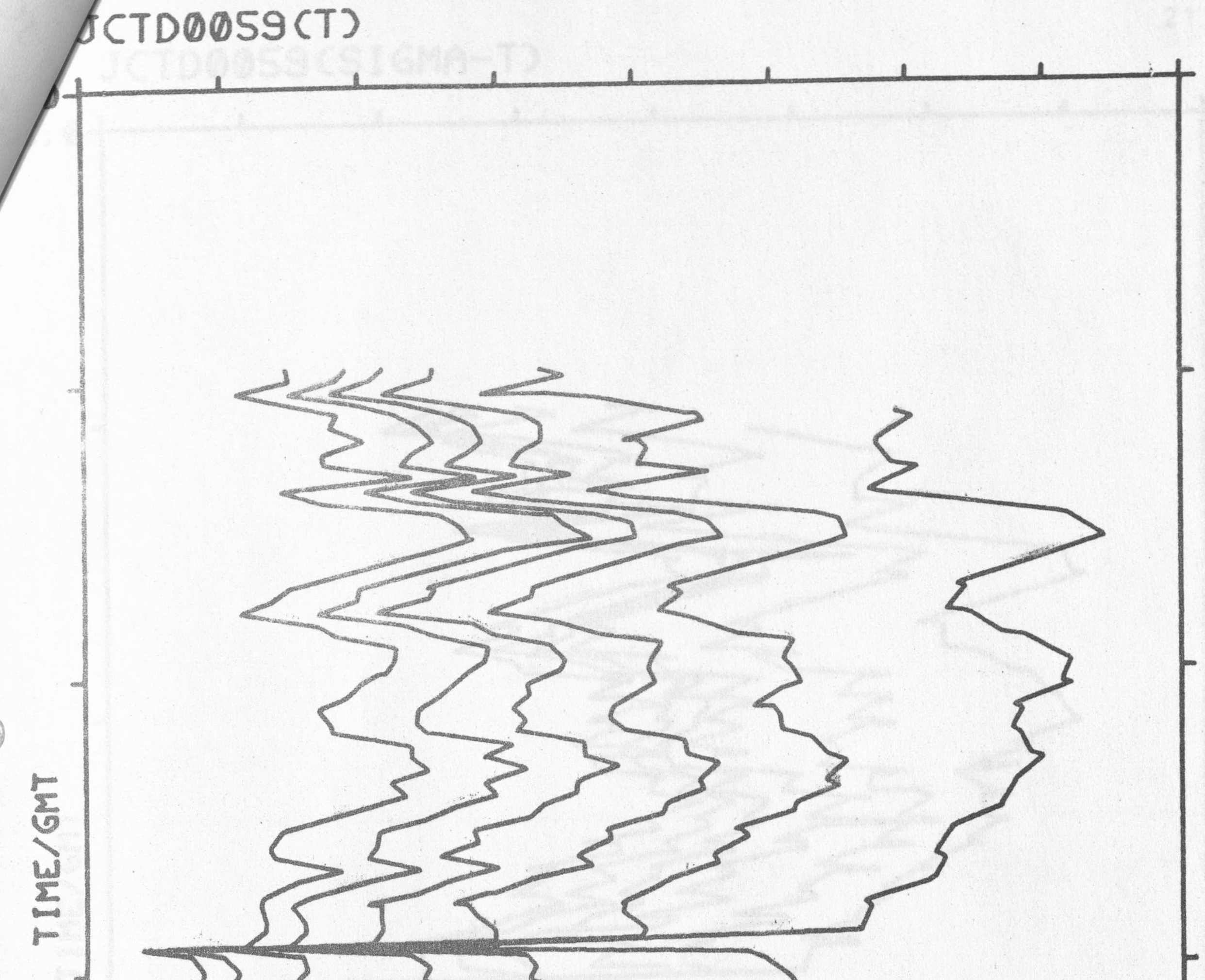
1. JCTDF021 28.8.78 P vs. t, ie Fish depth



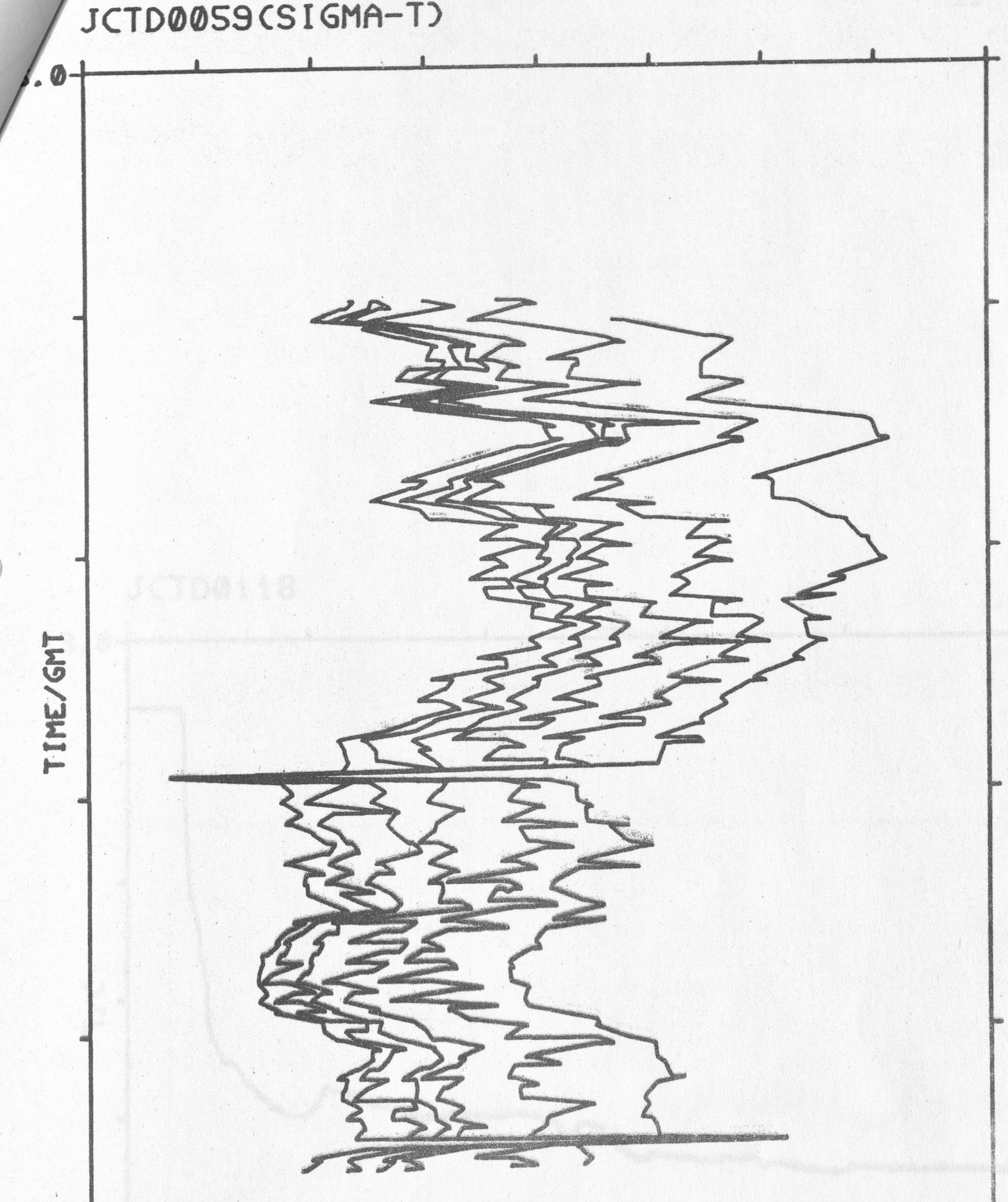
2. JCTDF021 28. 8. 78 sample T vs. P profile.



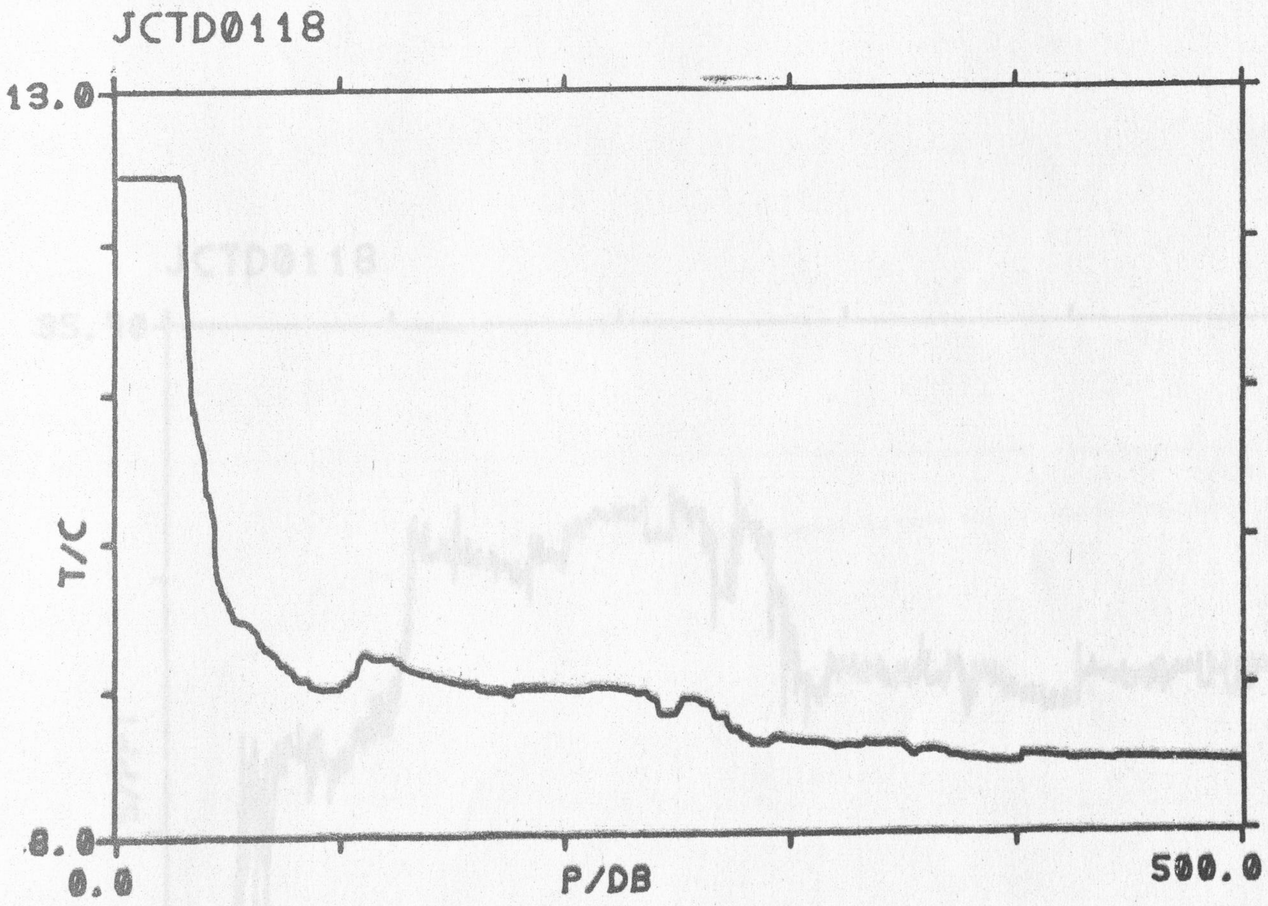
3. JCTDF021 28.8.78 T=12.2, 12.3 & 12.4C isotherms.



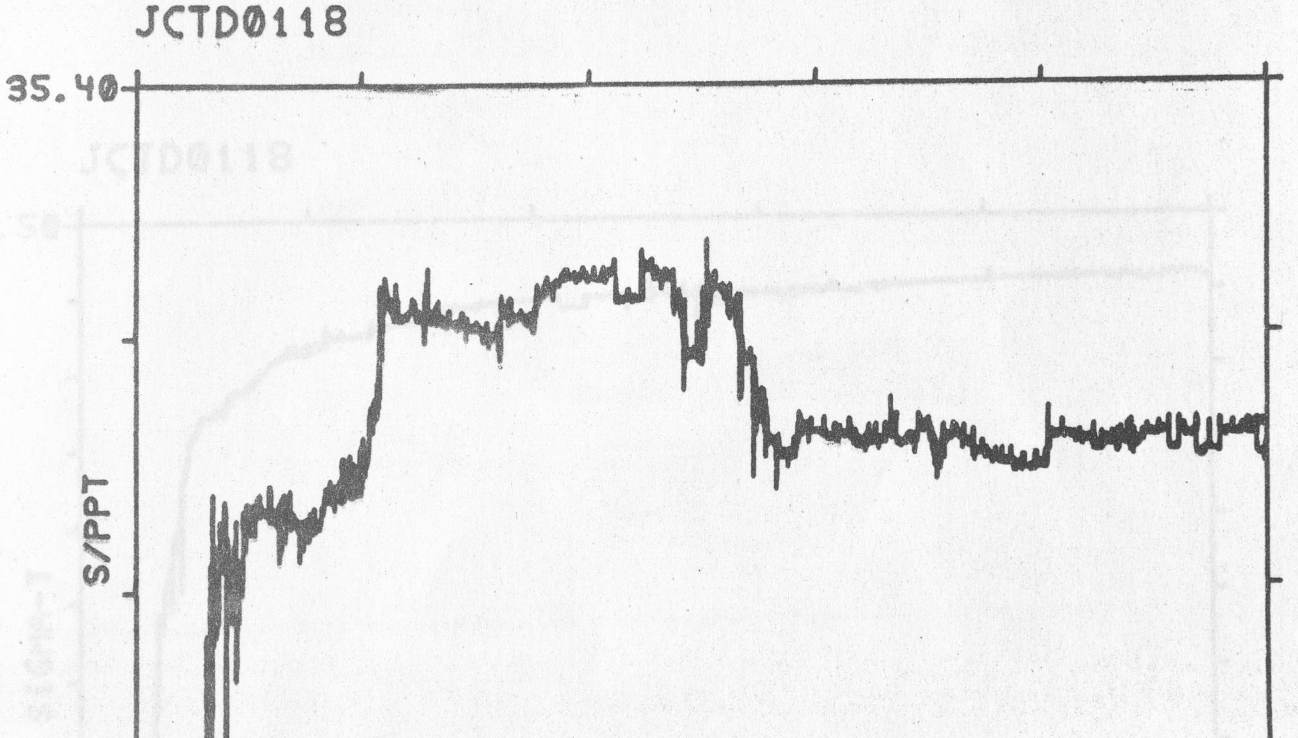
4. YO YO CTD time section 2.9.78, T=9.5,12.5,0.5 C isothe



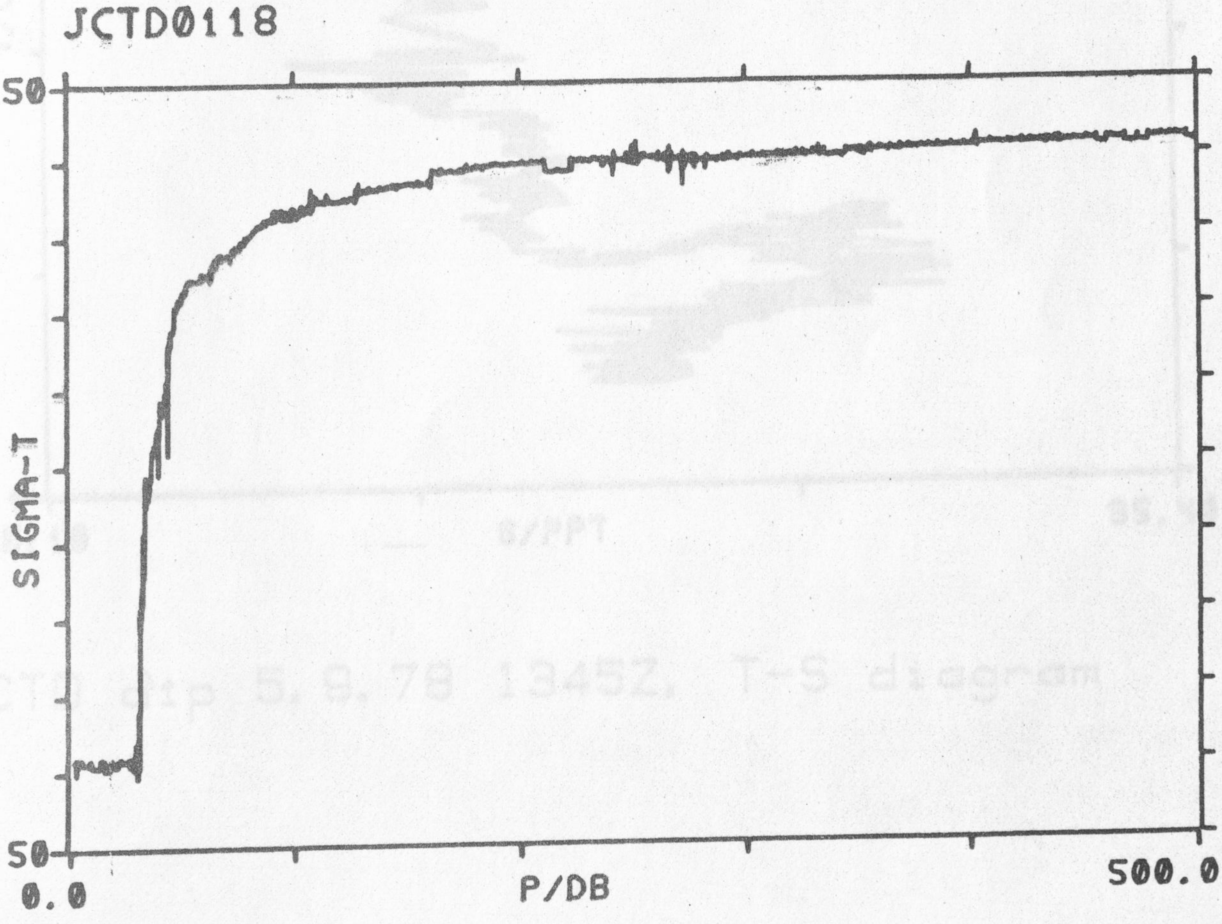
5. YD YD CTD 2.9.78, sigma-T=27.00, 27.25, 0.05 isopycnals



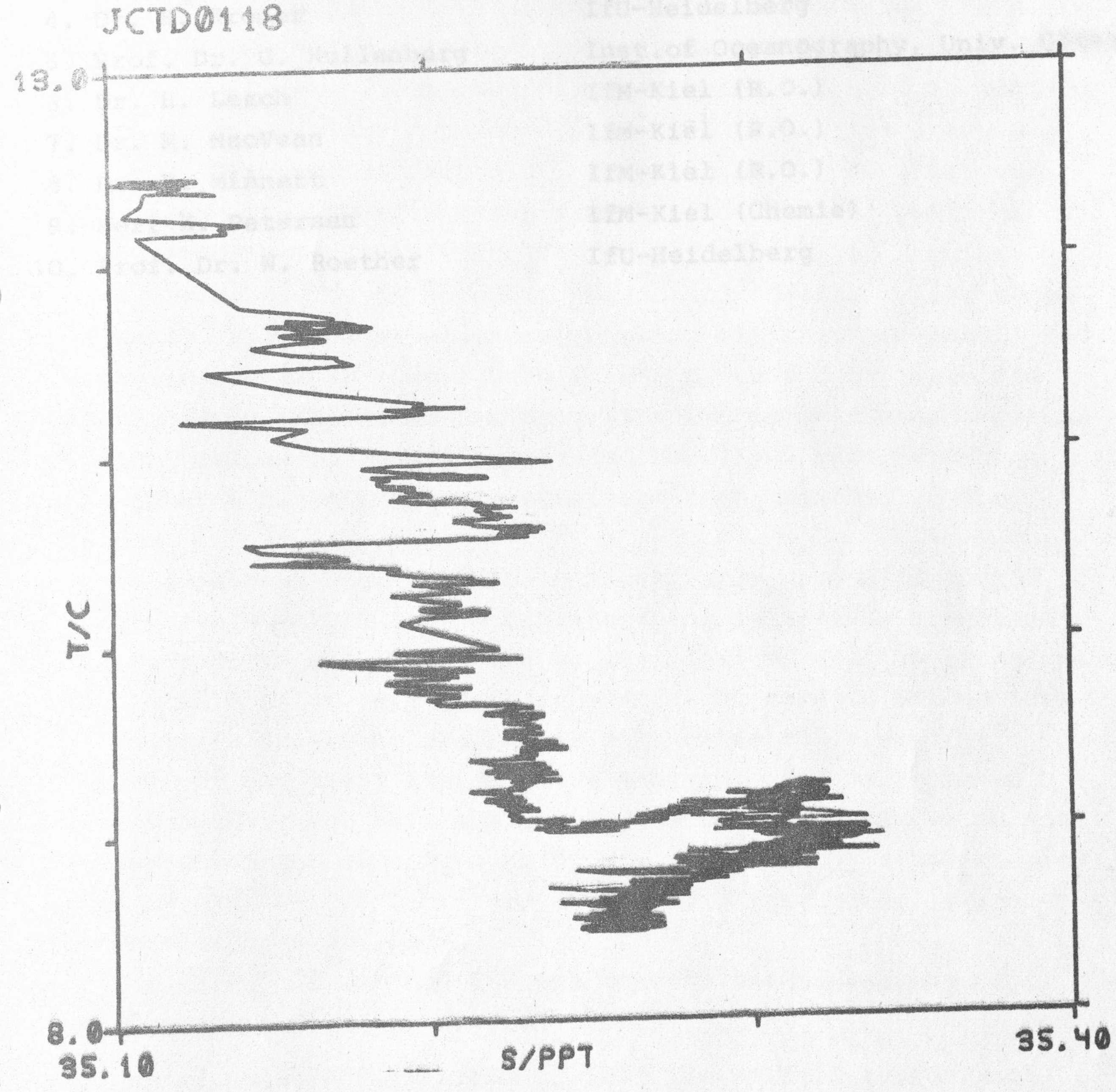
6. CTD dip 5. 9. 78 1345Z. T vs. P



7. CTD dip 5.9.78 1345Z, S vs. P



CTD dip 5.9.78 1345Z, sigma-T vs. P



1. CTD dip 5.9.78 1345Z, T-S diagram

4. Scientific personnel

1. Prof. Dr. J. D. Woods	IfM-Kiel (R.O.) Fahrtleiter
2. Herr R. Bock	IfM-Kiel (R.O.)
3. Dr. H.-P. Hansen	IfM-Kiel (Chemie)
4. Dr. B. Kromer	IfU-Heidelberg
5. Prof. Dr. G. Kullenberg	Inst.of Oceanography, Univ. Göteborg
6. Dr. H. Leach	IfM-Kiel (R.O.)
7. Dr. M. MacVean	IfM-Kiel (R.O.)
8. Dr. P. Minnett	IfM-Kiel (R.O.)
9. Herr H. Petersen	IfM-Kiel (Chemie)
10. Prof. Dr. W. Roether	IfU-Heidelberg

5. Recommendations for future cruises

The JASIN cruise (31) provided a valuable test of Poseidon's ability to support a strenuous scientific programme lasting nearly a month (14 August to 9 September) without intervening port calls. Operating closely with other ships around moorings and drifting buoys kept the bridge very busy, and the transition from towing to station work increased the load on the bosun and his deck crew above that planned. While the need to produce fresh water at every opportunity (even during brief intervals between CTD stations) added to the workload on the chief and his engine room team, already preoccupied with the performance of Poseidon's engines, which had only just emerged from extensive overhaul. The ship came through this testing cruise exceptionally well. The excellent support of all ship personnel, led enthusiastically by Capt. Schmickler, ensured that there was no instant when the scientific programme had to be changed because of limitations of ship performance. The first recommendation is, therefore, to keep this excellent team together in the future.

This success was, however, achieved only as the result of considerable effort and on occasions the scientific programme may have taken the ship close to the limit of what is practical with such a relatively small crew (18). We carried out no less strenuous a programme than ships with twice the crew. The success of the JASIN cruise shows that this can be achieved with Poseidon, but before embarking on a similar cruise in the future attention should be paid to a number of possible changes and improvements. This is the spirit in which the following recommendations are made.

The first two recommendations concern the management of similar cruises in the future.

(1) It is necessary to remember that the ship is a two-watch ship. The scientific programme should not require intense work around the clock for an extended period; there must be rest periods of lower intensity. This is difficult to

achieve if the scientific team includes a number of separate groups each keen to use all available ship time. It is, therefore, recommended that the scientific work should consist of one single experimental programme under the personal direction of the principal scientist. Poseidon is an exceptionally well-equipped single project small ship, not a miniature ocean-going multi-group large ship.

(2) In future every effort should be made to increase the scientific accommodation to the design specification of twelve berths. Only ten scientific berths were available for the JASIN cruise; after two were allocated to guest scientists from Heidelberg, the Kiel team was too small for the continuous round-the-clock operation originally planned.

(3) Every effort should be made to minimize messages sent by HF radio. Not only do the transmissions interfere with scientific, meteorological and navigation measurements, but also place an undue burden on the ship's officers.

(4) The fourth recommendation concerns the routine maintenance and calibration of scientific apparatus installed on Poseidon, including the meteorological and thermosalinograph systems, the winch-sliprings, etc. The IfM ship committee should recommend a management policy for these and other items that are not looked after as part of the ship's equipment.

(5) The power supply on the ship fluctuates wildly with manoeuvres, especially when operating on one engine. The fluctuations involve voltage drops below the level accommodated by the scientific power line regulators, which then fail, leaving instruments unprotected. Future users wishing to bring calculators and other sensitive equipment onto the ship should be prepared for failures and possible damage.

(6) Power supply fluctuations during the JASIN cruise were observed to cause jumps in the scientific clock (7 seconds at one instant during manoeuvres to get the ship on station for a CTD profile). The clock should be checked regularly.

(7) The meteorological system is not suitable for a research ship and should be replaced by one capable of meeting minimum WMO specification for recognized ships. (see the meteorological report)

(8) (a) The data circuit linking laboratories is not suitable for the transmission of analogue signals. It is recommended that digital encoders-decoders be installed in each laboratory and on the bridge.

(b) All instruments should transmit their measurements digitally over distances of more than one metre; large errors were detected in analogue signals due to radio frequency induction.

(9) The integrated scientific navigation system planned for Poseidon should be installed with high priority to minimize errors and the workload on both crew and scientists.

(10) The geological echosounding equipment at present permanently installed on the bridge should be reconfigured for easy removal on non-geological cruises when the rack space it occupies is needed for other instruments.

(11) The ship's acoustic log is not suitable for scientific measurement and an additional log should be installed, preferably on a towed fish to reduce errors due to flow irregularities under the hull.

Recommended books for Poseidon library

1. World Ocean Atlas Vol 2 Atlantic Ocean,
   Pergamon, Oxford 1978
   (Translation of Moscow edition)
2. CRC Handbook of Marine Science Vol I and Vol II
3. UNESCO Oceanographic Tables
4. Oceanographic Atlas of Baltic Sea hydrography
5. Atlas of monthly temperatures and of salinity distribution
   in the North Atlantic Ocean
   USN Special Publication 1978

5. Acknowledgements

The ambitious cruise 31 was completed successfully thanks to the excellent support of Capt. Schmickler and his crew, who enabled us to maintain a full scientific programme, under difficult circumstances, involving major changes after the towing winch cable failed. All departments of the ship contributed; we thank every member.

We also wish to record our thanks to Arthur Fisher at the Glasgow ship base who made arrangements for collection of an essential spare part flown over from the USA, to the Master and Chief Scientist of RV Shackleton for delivering it to us (and Shackleton's radio officer for his help with our communications), and to the Master and Chief Scientist of Guardline Endurer for their help in taking Prof. Roether to Aberdeen. We wish to thank the Natural Environment Research Council and Prof. K. Bowden of the Department of Oceanography, University of Liverpool, U.K., for the loan of a Neil Brown Mk III CTD and Prof. H. Charnock of the Department of Oceanography, University of Southampton, U.K., for the use of a Colnbrook electromagnetic current meter.

A1 - NAVIGATION (MacVean)

1. Absolute navigation

During the whole period that the ship was in the JASIN area Loran and Decca fixes were made every half an hour by the ship's officers. These were supplemented by additional Decca and Loran fixes as required in support of the experimental programme. The Loran transmitters SL3-W Faeroes-Iceland (Slave 1) and SL3-Y Faeroes-Sylt (Slave 2) and the Green (AC) lanes of the Decca Hebridean chain were used. Slave 2 was subject to frequent fading and therefore all position fixing was carried out using the readings from Slave 1 and the Decca Navigator. Fading of Slave 1 and of the Decca was also experienced on occasions, particularly at night, and so when possible radar fixes on fixed buoys were made; particular use was made of the radar buoy laid by Meteor for the express purpose of determining her own position.

2. Relative navigation

Navigation relative to the water was carried out as required by the experimental programme. To this end, during certain experiments, buoyed drogues were set and the ship's position relative to the drogues determined either visually or by radar.

Relative navigation was also carried out during the experiments using an automatic relative navigation system, being tried for the first time. The system consists of the ship's gyro-compass and a Colnebrook two-component electromagnetic current meter interfaced to a Hewlett-Packard 9825A desk-top calculator which integrates the current meter signals to give the ship's displacement through the water. The current meter sensor was retractably mounted slightly to port of the ship's fore- and aft line at the forward end of the working deck. When lowered, the current meter head projected about 60 cm below the hull. The basic program used for the integration was written before the cruise by Berndt Kassler, a student in the Regional Oceanography department.

One of the major tasks on the first day of the cruise

(14th August) was to attempt to calibrate the navigation system, which had not previously been run under operational conditions. During this calibration trial which was carried out in the vicinity of the measured miles in the Eckernförde Bucht the calculator, Colnebrook deck unit and the interface were located in the computer laboratory. The aims were:

(a) the calibration of the signal from the ship's gyro-compass

(b) to determine the apparent misalignment of the current meter to the ship's head and the variation of this with speed.

(c) the calibration of the signal giving the fore- and aft component of the ship's speed through the water

(d) the calibration of the signal giving the athwartships component of the ship's speed through the water

(e) to determine the average time interval between successive calculated displacements relative to the water. (This was necessary as no real-time clock signal was available in the system.)

(f) to investigate the behaviour of the system during turns.

As to be expected with a previously untried system the calibration was hampered by hardware and software problems and the trial was in fact restricted to consideration of (a) and (c). To calibrate the compass signal, the ship was steered on fixed headings of 0^o, 45^o, 90^o, 135^o, 180^o, 225^o, 270^o and 315^o for periods of between 2 and 5 mins, with constant engine revolutions, while the compass signals were monitored. The compass signals were within 5^o of the actual heading in each case, except for when the ship was steering 0^o, on which course totally unrealistic headings were logged. This was at first thought to be a software problem but eventually turned out to be a hardware problem: the potentiometer monitoring the gyro-compass does not have a full 360^o range and leaves an open circuit on headings within a few degrees of 0^o; it was not possible to remedy this shortcoming and so courses close to due North were avoided as far as possible during integrations.

For the second part of the calibration trial the ship was run along the measured mile repeatedly, in alternate directions (to eliminate the effect of any possible current), noting the times at which the transits were crossed and the distances from the buoys situated on the transits. In processing the results from these runs it became evident that there was a serious error somewhere in the navigation system, the displacements calculated being at an angle of 60-70° to port of the actual displacement. This behaviour was due to a programming error (not discovered until the 15th August) which resulted in a digital value of 0, corresponding to a current meter signal of -10 volts, being logged instead of the actual thwartships signal from the electromagnetic log. Because of this error it was not possible to calibrate the current meter signals from the data collected during this trial.

At speeds above about 7 knots an unacceptable level of vibration of the current meter assembly was noticed. This was thought to be due to the shedding of vortices behind the spar to which the current meter was clamped. To alleviate this problem the assembly was dismantled during the evening of 15th August to permit the welding on to the spar of a helical strip to inhibit vortex shedding. The unit was then reassembled (it was not possible to ensure that the alignment was exactly the same as previously) and lowered back into the water. No further vibration of the assembly was noted.

On the 17th August the navigation system was run while on passage at 10 knots on a steady heading. Decca fixes were taken at the beginning and end of each of two runs. From these relatively long runs (15 mins and 30 mins) a good estimate of (e) was made. After allowing for the tidal set using tidal charts, it was also possible to make an approximate calibration of the current meter signal for the fore- and aft direction (both runs yielded the sensitivity 1.03 volts $(ms^{-1})^{-1}$). A further error in the integration program was brought to light on the 17th August by a trial in which the ship was moved sideways to port and then to starboard using the bow thruster. This showed that the thwartships current meter signal is positive motion to port and vice-versa - in the program the opposite s assumed. The compass calibration was also repeated on the 7th August; it was determined that on all the courses steered between 45° and 315° the compass signal being logged was on average 3.7° too low (with a scatter from $3.3^{\circ}$to 4.1°).

At midday on 18th August the calculator, together with the deck unit and the interface were moved to a more convenient position on the bridge. A check on the compass signals logged by the calculator showed that these were now up to 15° too low and moreover that the signals varied while on a fixed heading. This variation appeared to be correlated with variations in the engine revolutions, which was thought to be a consequence of the long analogue signal cables running through the ship. From this point on, no reliable global calibration for the compass signal could be assumed and various corrections, based on short comparisons between the actual heading and the logged compass signal on the desired courses, were used on different runs.

No practical scheme could be devised to calibrate the thwartships component of the current meter signal so it was decided to follow the manufacturer's advice and assume the ratio of the sensitivity in the fore- and aft direction to that in the thwartships direction to be 1.3 : 2.0. It was felt that there was an offset in the thwartships component of the current meter signal; to test this a trial was carried out during which the ship made 3 pairs of 2 hour runs at constant engine revolutions with the wind (Beaufort force 7-8) alternately on the port and starboard beams. In processing the data obtained it had to be assumed that there was no current and that the effect of windage was constant throughout. The data from two of the pairs of legs was consistent with an offset equivalent to 0.22 ms^{-1} while the other data were inconsistent with such an offset; this correction was nevertheless applied in subsequent integrations. A new estimate of the sensitivity 1.0 volts (ms^{-1})$^{-1}$ was also obtained from this trial. Other than various ad-hoc corrections to the compass signal no other attempts at calibrations were made.

The relative navigation system was used operationally during the fish towing and dye experiments and generally functioned satisfactorily considering the inadequacy of the calibration procedure and the various shortcomings for which no remedy could be found. Buoyed drogues were often set for these experiments; differences between the ships actual position relative to the buoy and the integrated position relative to the buoy could not be attributed with certainty to shortcomings in the navigation system, since the effects of wind and current on the buoyed drogue were not necessarily the same as their effects on the ship.

The relative navigation system failed on three occasions during the cruise, once when the constant voltage power supply cut out after the voltage of the ship's power supply fell below a threshhold value and twice due to moisture in the signal cable. This second problem occurred because the cable was not initially sufficiently protected against chafe.

In summary, there now exists the basis of a good relative navigation system, but it is clear that a great deal more time must be devoted to calibration than was available on this cruise before the results can be relied on. Urgent consideration must be given to the provision of a real-time clock for the Hewlett-Packard calculator and the difficulty with the compass signal when heading due North must be overcome. The transmission of relatively low voltage analogue signals over long distances through the ship must also be avoided.

A2 - METEOROLOGY (MacVean)

It was not possible to make the full three-hourly meteorological observations for submission on JASIN forms 8 and 9 due to lack of trained observers and to the inadequacies in the ship's automatic meteorological station mentioned below. The only variable which is available for virtually all the required times is the barometric pressure noted by the ship's officers. No reliable values of the ship's speed are available; the other meteorological parameters which could be supplied are sometimes spot values and sometimes averages over 10 secs, 15 secs or 2 mins. For sixteen occasions between 0000Z on 19th August and 0000Z on 5th September no meteorological parameters other than the pressure are currently available. It may be possible to fill these gaps later from the meteorological data automatically recorded on cassette.

The ship's automatic meteorological station (Type: Digi-Tefrimet; Manufacturer Th. Friedrichs, Hamburg) continuously monitors the following parameters:

(1) dry bulb temperature
(2) wet bulb temperature
(3) dew point temperature
(4) sea surface temperature
(5) sea surface salinity
(6) downward radiation
(7) wind direction (relative to the ship's head)
(8) relative wind speed
(9) atmospheric pressure
(10) ship's head.

It should be noted that the ship's speed through the water is not routinely monitored. Spot values of each of the above variables except salinity are recorded cyclically on a chart recorder, one cycle taking about 50 secs to complete; the salinity is recorded continuously on a separate chart recorder. A Memodyne Series 200 cassette recording system is provided to record on tape a spot value of each variable at fixed intervals. The values monitored are also available to the NOVA computer for continuous logging on magnetic tape.

During this cruise, from 1501Z on 15th August onwards, the spot values were recorded on cassette at 1 min intervals. Between approximately 0000Z and 1209Z on 23rd August no data were recorded on cassette; otherwise the record should have no gaps. The chart recorders were in constant operation throughout the cruise apart from short periods when adjustment and maintanence were being carried out. The parameters were logged on magnetic tape using the NOVA computer when this was not required for other purposes. The values logged were either 10 sec, 15 sec or 2 min averages of the parameters when the computer was exclusively devoted to meteorological logging but only spot values when data from the CTD were also being logged.

The spot values logged by the NOVA computer were contaminated with high frequency noise, the amplitude of which was equivalent to about 0.1° C in temperature and about 0.5 mb in pressure; the averaging performed by the NOVA computer reduced this noise to an insignificant level. From the chart records there appears to be a correlation between variations in some of the meteorological parameters and changes in the ship's speed and direction. This correlation is attributed partly to the varying exposures of the sensors on different headings and partly to electrical noise induced in the long cables running through the ship, carrying the low voltage analogue signals to the recording system. During periods when HF radio transmissions were being made from the ship, particularly bad interference on all meteorological channels was experienced, rendering the signals unusable.

There now follows a more detailed summary of the performance of each sensor:

Dry_bulb_and_wet_bulb_temperatures

These are measured by an electrically ventilated psychrometer with platinum resistance thermometers situated above the bridge.

The location of this instrument is not ideal, its exposure being different for different apparent wind directions; a large exhaust vent is situated about 3 m forward of the psychrometer. A marked correlation between changes in the wet and dry bulb temperatures and changes in the ship's speed and heading was noticed on several occasions. On 26th August, for a period of 9 hours, the wet bulb temperature recorded was 0.5° C warmer than the dry bulb temperature; the same behaviour, although less marked, was also noted on other occasions.

The accuracy of the measured values has been estimated by the manufacturer to be ±0.2° C, but no adequate calibration has been carried out. On eight occasions the measured wet and dry bulb temperatures were compared with values obtained using an Assmann aspiration psychrometer. The results (Table 1) indicate that the dry bulb thermometer under-reads by 0.4° C on average, while the wet bulb thermometer over-reads by 0.2° C (ignoring the anomalous values obtained on 29th August). On 24th August at 1030, 1045Z and 1100Z comparisons were made between the temperatures recorded on board and those recorded at the meteorological buoys S1, S2 and S3 (attached to moorings B1, B2 and B3 respectively). According to this comparison the ship's dry bulb temperature is on average correct, while the ship's wet bulb temperature over-reads on average by 0.3° C. The discrepancy between these two groups of comparisons is probably attributable to the inherently different nature of the two groups - the first being a comparison between two instruments located in the same place and the second between instruments operating under rather different conditions.

Dew point temperature

This was measured from 1200Z on 23rd August onwards, using a hydrochemical hygrometer containing Lithium Chloride. The instrument is located next to the electrically ventilated psychrometer and thus the comments previously made about the suitability of the location of that instrument apply here also.

The accuracy of the measured values has been estimated by the manufacturer to be ±0.5° C but no adequate calibration has been made. Ten comparisons were made between the indicated dew point temperature and that calculated from the Assmann psychrometer or meteorological buoys wet and dry bulb temperatures; the results are given in Table 1 but the scatter is too great to permit any statement to be made about the accuracy of the dew point temperatures recorded.

Table 1

Date	Time (GMT)	T_{dry} (°C) Ship's System	Assmann Psychrometer / Met.Buoy	T_{wet} (°C) Ship's System	Assmann Psychrometer / Met.Buoy	T_{dew} (°C) Ship's System	Calculated from columns 3 and 5
23/08	1350	12.4	12.8	11.7	11.3	9.9	10.1
24/08	0859	12.7	13.3	11.6	11.5	9.6	10.1
28/08	0920	12.7	13.2	12.7	12.6	10.9	12.2
29/08	1850	11.9	12.7	10.7	11.7	8.8	10.9
30/08	1850	13.6	14.0	13.1	13.1	-	12.5
31/08	1115	12.0	12.3	9.6	9.4	7.6	6.7
03/09	1635	13.6	13.9	12.7	12.6	10.9	11.7
24/09	1705	12.5	12.8	12.1	11.9	10.5	11.2
Preliminary results from meteorological buoy intercomparison							
24/08	1030	12.5	12.4	11.3	11.0	9.1	9.9
24/08	1045	12.5	12.4	11.4	11.1	9.0	10.1
24/08	1100	12.4	12.5	11.5	11.2	9.1	10.2

Sea surface temperature

This is measured by two instruments - a Plessey Thermosalinograph Model 6600T, the temperature sensing elements of which are thermistors and a separately installed platinum resistance thermometer. The thermistors are mounted in the inlet pipe from a water chest, forward on the starboard side of the ship, to the thermosalinograph salinity unit. The other sensor is mounted in a water chest on the opposite side of the ship, but there is no pumped flow of water past it as is the case with the thermosalinograph. Both thermometers are situated about 2.5 m below the water-line. The thermosalinograph temperature is recorded on a chart recorder - the signals are not available for digital logging.

The accuracy of the temperatures measured by the platinum resistance thermometer is estimated by the manufacturers to be ±0.2° C, while the accuracy of the thermosalinograph temperatures is quoted as ±0.1° C; neither of the sensors has however been adequately calibrated. A large number of bucket sea surface temperatures were obtained during the cruise, mostly in connection with CTD stations, and these have been compared with the temperatures measured by the above-mentioned instruments. Only values obtained on days with a wind of Beaufort force 4 or above or at times for which the CTD profiles showed a vertically mixed surface layer of depth 5 m or more have been included in this comparison in an attempt to minimize the scatter due to differences in the environmental temperature between the depths at which the measurements were made. The comparison between bucket temperatures and thermosalinograph temperatures is shown in Figure 1. The scatter about the regression line, the slope of which is 0.94 rather than unity, is less than 0.1° C. According to the regression the thermosalinograph under-reads by 0.02° C at 12° C and by 0.08° C at 13° C.

Figure 2 shows a comparison between bucket temperatures and the computer-logged sea surface temperatures. Various outlying points were excluded from the linear regression calculation; with two exceptions the excluded data points were all obtained on 20th August. On this date the bucket samples were taken from aft on the starboard side, while on all the other occasions they were taken from the forward end of the working deck on the port side, but it is not possible to attribute these anomalous values with certainty to this difference. The scatter of the data points about the regression line is $\pm 0.2^{\circ}$ C, the slope is not unity but 0.91 and there is an offset of about 0.4° C at 12° C and 0.3° C at 13° C, the logged temperatures being too high; no statement can be made about the accuracy of temperatures measured by the platinum resistance thermometer outside this very limited range. The comparison of logged values from sensors 2.5 m below the surface with surface bucket samples is not a sound calibration procedure because of possible real differences between the values of the temperature or salinity at the two measurement locations. On Poseidon this problem is particularly acute since the surface samples can only conveniently be taken from the working deck on the port side, which is where the ship's various pumps discharge or from aft on the starboard side where the disturbance of the water by the ship is greatest.

Sea_surface_salinity

This is continuously measured by the thermosalinograph with a quoted accuracy of ± 0.01 °/oo; the instrument has not, however, been properly calibrated. The performance of the instrument during the cruise was not always satisfactory: the chart recorder trace was perfectly straight (and the digital values logged were constant) for periods of up to several hours on occasions and at other times it exhibited regular step-like variations in salinity. On the 2nd September the instrument was dismantled and thoroughly cleaned, which partially alleviated the problems. It is felt that the flow rate past the sensor may not have been high enough or that the conductivity cell may have become fouled on occasions. Figure 3 compares the salinities measured by the thermosalinograph with the salinity of surface water samples taken at the same time. The latter salinities were determined by a Guildline Autosal salinometer. Separate regression lines were drawn through the data points collected before and after the thermosalinograph was cleaned, after excluding outlying points. One group of outlying data points was collected at the same time as the surface temperature data points excluded from the regression shown in Figure 2; one possible explanation for the other group of outlying points is that the conductivity sensor may have become fouled. The scatter about the regression line is ±0.01 °/oo in each case but the slope of the regression line before cleaning the thermosalinograph was 1.07 while after cleaning the slope was reduced to 0.61. In view of this behaviour, for which no explanation can be given, it is not possible to say anything about the accuracy of the salinities logged other than that they were taken between 0.05 °/oo and 0.15 °/oo too low.

Downward radiation

The radiometer was inoperative for the whole of the cruise.

Relative wind direction

This is measured by a wind vane mounted on top of the bridge mast. Immediately before the cruise an attempt at calibrating the vane was made by fixing a cardboard disc underneath it with respect to which the angle of the vane could be measured. The vane was then held steady at angles of 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° measured on this disc and the results compared with a series of 10 sec average values logged by the NOVA computer. It was not possible to accurately determine the fore- and aft line of the ship from the mast top and a constant offset between the angle measured relative to the disc and that relative to the ship's head is possible. The calibration procedure was repeated three times; on the first two occasions difficulty was experienced in holding the vane in the desired position but on the third occasion weather conditions were very favourable and little difficulty was experienced. The results are given in Table 2; the large scatter in the results for 0° and 180° is probably attributed to the above-mentioned difficulties but no explanation can be offered for the relatively large scatter in the results for 90°.

Table 2

Angle relative to calibration disc	Computer-logged angle		
	Attempt 1	Attempt 2	Attempt 3
000	349	001	350
045	039	043	049
090	088	090	095
135	136	–	138
180	170	175	180
225	217	220	217
270	270	272	271
315	309	306	306

Relative wind speed

This is measured by an anemometer mounted on top of the bridge mast. A bad contact in the Digi-Tefrimet control unit resulted in a loss of the anemometer signal from 1832Z on 30th August until 0820Z on the 31st August. The anemometer has not been calibrated and the captain's subjective opinion is that it over-reads at wind force Beaufort 5 and above. A serious problem was noticed during the cruise: when the relative wind direction is between approximately 270° and 300° the anemometer grossly under-reads; at such times visual observation confirmed that the anemometer was indeed only rotating very slowly. The problem appears to be that under these circumstances the anemometer is sheltered from the true wind by the presence, about 70 cm upwind, of a navigation light.

Atmospheric pressure

This is measured by an aneroid barometer mounted on the wall in the air-conditioned computer laboratory at about 3 m above the water-line. The instrument has not been adequately calibrated, but on seven occasions comparisons were made between the logged values and the readings of a standard Deutsches Hydrographisches Institut-issue aneroid barometer (corrected to read sea-level pressure) mounted on the bridge. The results, given in Table 3, indicate that the meteorological system logs values which are, on average, 1.3 mb lower than the pressure indicated on the brige. However, neither of these instruments necessarily measures the true ambient pressure, since they are subject to variable errors due to the dynamic pressure caused by the ship's motion and by the pressure due to the air conditioning. Thus no statement can be made about the absolute accuracy of the values obtained.

The pressure indicated by the barometer on the bridge was recorded by the ship's officers every three hours and Figure 4 shows, a comparison between these pressures and those recorded by the ship's meteorological system: It should, however, be noted that the bridge pressure was only read off to the nearest 0.5 mb (and often of necessity very hurriedly) while on many occasions only spot values from the ship's meteorological system, which are subject to noise of ±0.5 mb, were available. The regression line has a slope of 0.994, while the scatter about the regression line is ± 1mb. According to the regression the pressure logged by the meteorological system is lower than that indicated on the bridge by 1.3 mb at 995 mb and by 1.5 mb at 1035 mb.

Table 3

Date	Time (GMT)	Met.System Pressure (mb)	Bridge Pressure (mb)
24/08	0838	1022.9	1024.0
28/08	0930	1022.0	1023.0
29/08	0836	1025.6	1026.8
30/08	1445	1022.3	1024.0
31/08	1120	1018.6	1019.9
03/09	1458	1011.6	1013.1
04/09	1625	1007.6	1009.0

Ship's head

The ship's gyro-compass is monitored, using a potentiometer, to give a record of the ship's head. On 14th August from 0930Z to 1015Z various steady courses were steered and the actual ship's head compared with the values logged by the NOVA computer. The results are given in Table 4; the errors in the logged values were all between 1° and 3°. It was discovered that incorrect values of the ship's head were logged on headings close to zero. This was due to the fact that the potentiometer used to monitor the gyro-compass does not have a full 360° range and thus leaves an open circuit when the compass reading is between about 358° and 000°.

Table 4

Actual ship's head	010	044	090	135	180	225	270	314
Computer logged ship's head	008	043	087	132	177	223	268	312

Recommendations for future cruises

As mentioned in previous cruise reports, the locations of the air temperature sensors and the aneroid barometer are far from ideal and these should be repositioned. It is now clear that the anemometer should also be repositioned at least 30 cm higher than it is now in order to avoid the sheltering effect noticed on this cruise. The problem with the signal from the compass when on headings close to 0° must be given high priority. The fault in the radiometer must be corrected and a thorough inspection of the thermosalinograph should be carried out. At sometime between the 7th September and the end of the cruise the water reservoir for the psychrometer disappeared. An inspection showed that the mounting of the reservoir is not secure enough for the unfavourable conditions encountered on board; extra measures should be taken in future to prevent a repetition of this.

A more fundamental reconsideration of the future of the meteorological station on Poseidon is also desirable. Assuming that the above mentioned shortcomings are removed and that an adequate calibration is carried out, the accuracy of the logged values provided by the present system is not high. Since the signals are sent from sensor to data logger as relatively low analogue voltages over large distances through a ship which is electrically very noisy, they are very vulnerable to interference. If serious scientific use is to be made of the meteorological data, it is necessary to upgrade the system, digitizing the signals as close to source as feasible and possibly replacing some of the sensors.

Another fundamental problem is posed by the logging of the data by the NOVA computer - it would be highly desirable to have the meteorological data-logging program running constantly as a background job if this is at all possible. Otherwise, as on this cruise, there will inevitably be large gaps in the meteorological record when the computer is busy with other tasks.

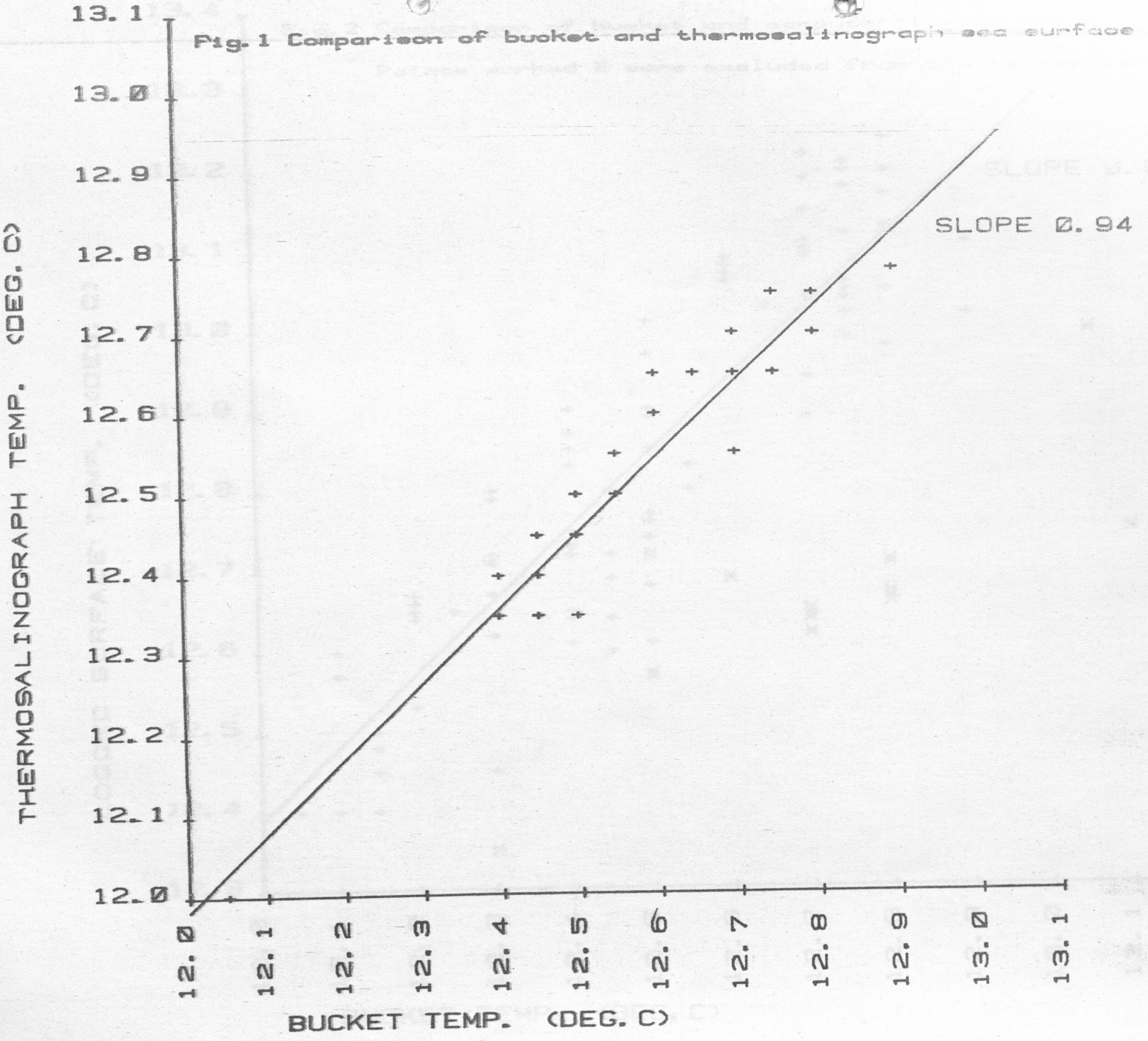
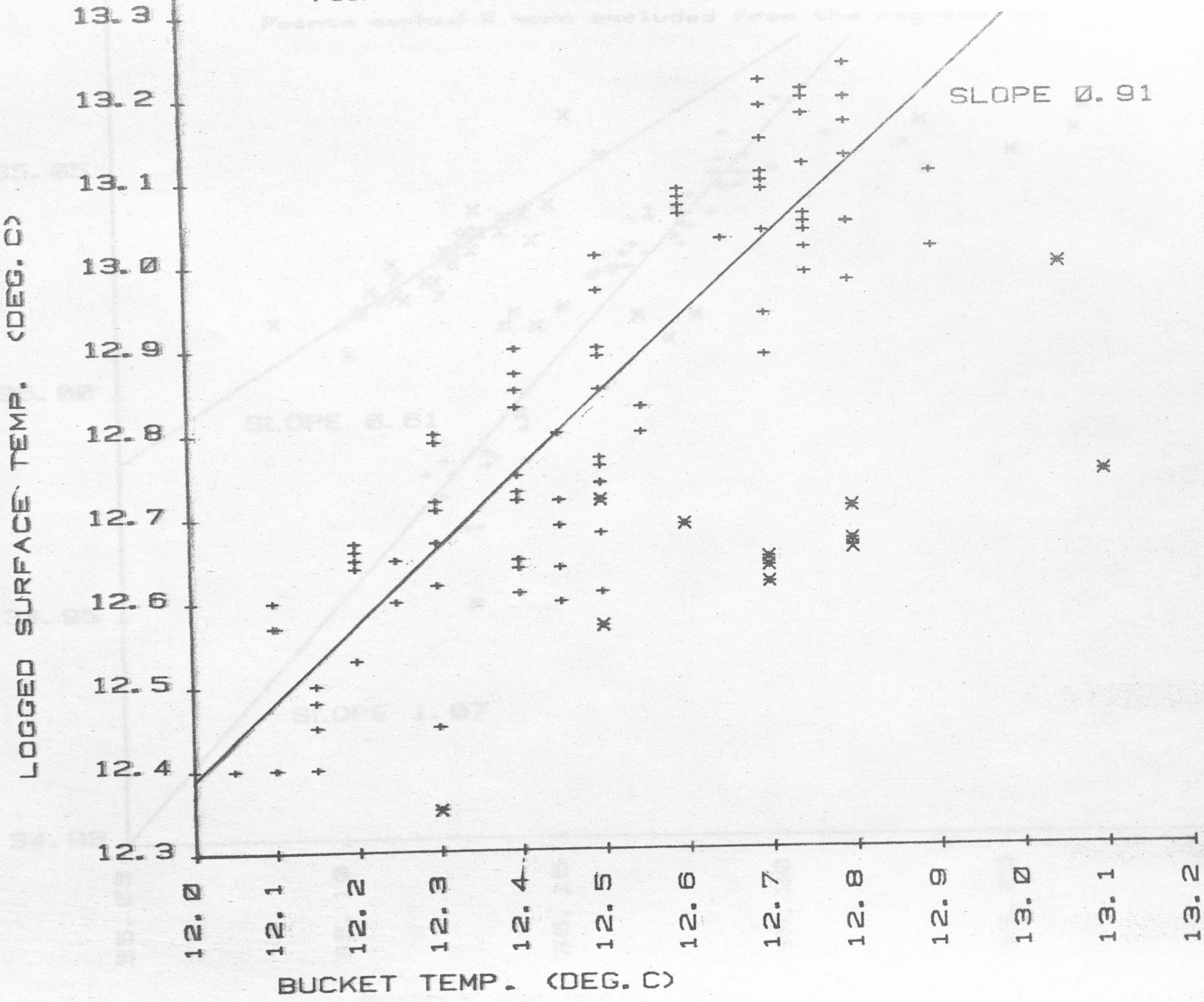


Fig. 1 Comparison of bucket and thermosalinograph sea surface temper

Fig. 2 Comparison of bucket and computer-logged sea surface te

Points marked ✱ were excluded from the regression.



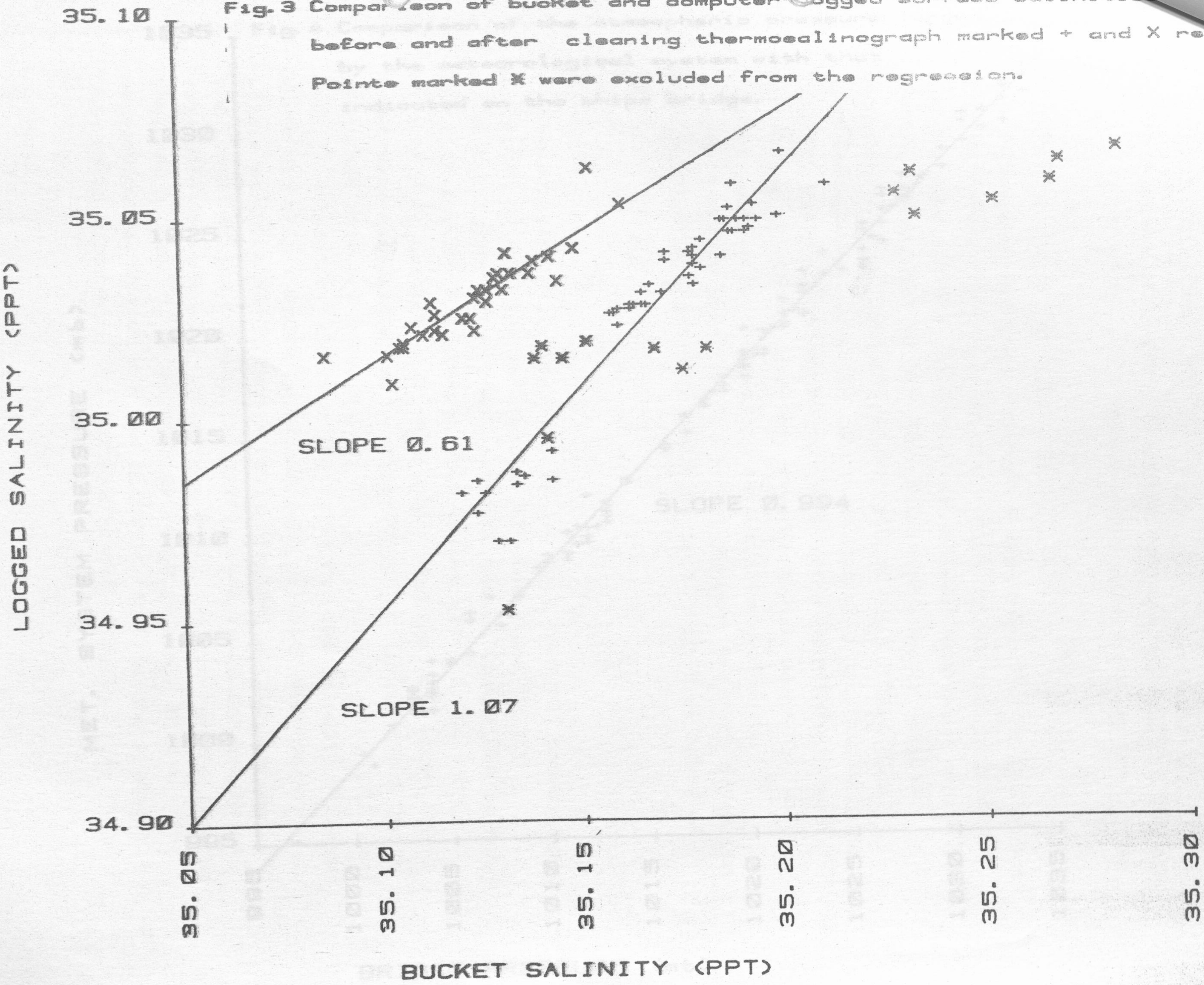


Fig. 3 Comparison of bucket and computer-logged surface salinitie
before and after cleaning thermosalinograph marked + and X resp
Points marked ⋇ were excluded from the regression.

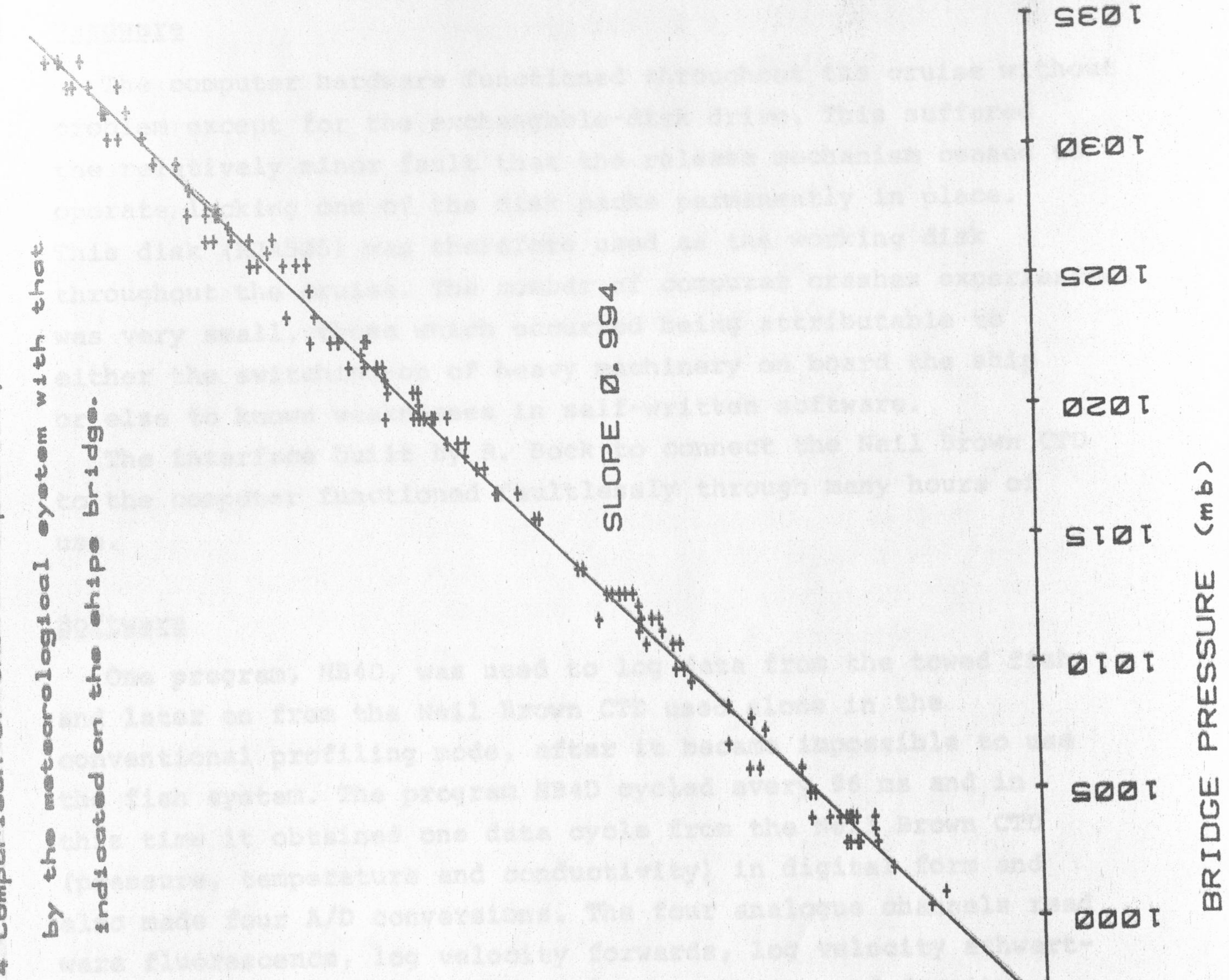


Fig. 4 Comparison of the atmospheric pressure logged by the meteorological system with that indicated on the ships bridge.

A3 - DATA MANAGEMENT (Leach)

The Poseidon NOVA 1200 shipboard computer was used to log and process oceanographic and meteorological data during the cruise.

Hardware

The computer hardware functioned throughout the cruise without problem except for the exchangable-disk drive. This suffered the relatively minor fault that the release mechanism ceased to operate, locking one of the disk packs permanently in place. This disk (RJA505) was therefore used as the working disk throughout the cruise. The number of computer crashes experienced was very small, those which occurred being attributable to either the switching-on of heavy machinery on board the ship or else to known weaknesses in self-written software.

The interface built by R. Bock to connect the Neil Brown CTD to the computer functioned faultlessly through many hours of use.

Software

One program, HB4D, was used to log data from the towed fish and later on from the Neil Brown CTD used alone in the conventional profiling mode, after it became impossible to use the fish system. The program HB4D cycled every 96 ms and in this time it obtained one data cycle from the Neil Brown CTD (pressure, temperature and conductivity) in digital form and also made four A/D conversions. The four analogue channels read were fluorescence, log velocity forwards, log velocity athwartships and ship's heading. In addition, salinity and density values were looked-up from a table prepared during the initiation phase of the program and similarly a value for rhodamine concentration was also looked-up. Every two minutes the program obtained a cycle of meteorological data from the ship's meteorological system via the analogue input to the computer. This cycle, along with the current sample of p, T, C, S, σ and F, was written to the line printer. All the data read in to the computer by the program were stored on magnetic tape.

To support the meteorological activities of the experiment two programs were used. The first, HBWE2, was used to log two-minute averages of data from the ship's meteorological system on magnetic tape. The second, HBWE3, was used to produce, at first ten-second but later fifteen-second, averages of meteorological data on the line printer for use during calibration tests. The logging of meteorological data onto magnetic tape was used as a background activity for the computer when it was not required for either logging oceanographic data or plotting. It was felt, however, that the support given to the meteorological activities was insufficient since the data obtained were neither continuous nor of consistant quality (i.e. not always two-minute averages, as during oceanographic logging for example).

The real-time plotting of data was not attempted during the cruise; no time was available for development of logging programs also capable of plotting prior to the cruise and limitations of core-store in the computer would also make such programs impracticable. However, plotting and processing of data in preparation for plotting was very effectively carried out using programs written by P.J. Minnett. The plotting program PPL01 was capable of plotting any one variable against any other variable on the Houston Instruments Complot digital plotter. This program was used to produce plots of P (t), T (P), S (P), σ_t (P), C (P) and so on from the archived data. The sorting program, PSRT1, was used to interpolate the archived data onto surfaces of P, T or σ_t prior to plotting time sections of the isolines with PPL01. The interpolation program PSRT2 was used to calculate the separation between any two specified isopleths in a space or time series of undulation data.

Late in the cruise the program HB4D2 was created from HB4D to log data solely from the Neil Brown CTD more efficiently by ignoring the, by then, redundant analogue input channels. This program was capable of cycling at 64 ms, i.e. logging every second cycle from the CTD instead of every third like its forebear. HB4D2 was used during the second CTD survey.

In order to enable the logging program HB4D to fit into core store, a slimmed-down version of the Data General operating system RDOS5, called OS7, was generated prior to the cruise and used exclusively whilst at sea.

Some examples of the at-sea plots are included after the station list in the cruise report (pp 17 to 25).

Details of programs, magnetic tape formats and so on are recorded in a document called "Forschungsschiff Poseidon, Nova 1200 Bordrechner Software Beschreibung", edited by H. Leach at the IfM-Kiel.

Summary of Data Collected

Data Set	File names	Program	Dates
1. Early Fish Tows	JCTDF001-JCTDF020	HB4D	14.8.-23.8.78
2. First CTD Survey	JCTD0001-JCTD0051	HB4D	24.8.-27.8.78
3. Late Fish Tows	JCTDF021-JCTDF025	HB4D	28.8.-29.8.78
4. CTD yo-yos	JCTD0052-JCTD0061	HB4D	29.8.- 3.9.78
5. Second CTD Survey	JCTD0062-JCTD0119	HB4D2	3.9.- 5.9.78
6. Met. Data	JMET001 -JMET026	HBWE2	14.8.- 6.9.78

Summary of Programms Used

Name	Author	Purpose
HB4D	H.Leach	Logging of CTD and Fluorometer signal from fish, raw data for relative navigation and meteorological data.
HB4D2	H.Leach	Logging of CTD and meteorological data only.
HBWE2	H.Leach	Logging of two-minute averages of meteorological data.
HBWE3	H.Leach	Printing of 15-second averages of meteorological data on line printer.
PPL01	P.J.Minnett	Plotting one variable against another.
PSRT1	P.J.Minnett	Interpretation of raw data onto up to 10 specified isopleths.
PSRT2	P.J.Minnett	Calculation of spacing of any two specified isopleths.

A4 - THE CTD SYSTEM (Minnett)

The Neil Brown Mark III CTD unit and the CTD-Nova interface (built by R. Bock) functioned reliably throughout the cruise.

On the manufacturer's recommendations a new conductivity cell was fitted. This was done on the 15th August after the first trial tow of the fish. A new fast response thermistor was installed on 26th August, so the temperature data collected before this date were done so with the use of only the platinum resistance thermometer. The replacement of the sensors invalidated the pre-cruise calibration and inadequate facilities on board prevented any reliable recalibration at sea. Comparison between CTD temperatures in the top few metres and bucket samples showed no detectable error when the thermistor was absent, and an error requiring a correction of about +25 mK when the thermistor was in use. The computed CTD salinities are about 0.02 $^{o}/oo$ too high, compared with bucket samples worked up with a Guildline "Autosal" salinometer when the thermistor was not in use, and about 0.02 $^{o}/oo$ too low after the thermistor had been replaced. It is anticipated that a recalibration of the CTD will take place upon our return to IfM.

Even with the fast thermistor in use, an apparent discrepancy in the time constants of the thermometer and the conductivity cell produced noise in the derived salinity and, to a lesser extent, in the derived density.

Data from the CTD were logged on the Nova computer for 108 hours 33 minutes during the cruise, of which time the CTD was mounted in the towed fish for some 28 hours. Considerable hysteresis of the temperature signal was experienced as the fish undulated, resulting in displacements of the apparent depth of isotherms of up to 10 m.

After the demise of the fish towing cable a protective frame was built for the CTD to enable it to be used from the "Einleiterwinde" to make vertical profiles. The effect of temperature hysteresis was much reduced when the CTD was used in this mode although winch speeds comparable to and greater than the vertical speed of the fish were employed. This suggests that part of the problem experienced when the CTD was mounted in the fish was caused by inadequate flushing of sea-water through the fish casing and past the sensors.

Two surveys were undertaken with the CTD in the profiling mode. Each took the form of a closed box around the FIA, with stations separated by 0.5 n.miles along sections of between 4 and 5 n.miles. The profiles were to 500 m, except those at the corners of the box of the first survey, which were to 1000 m. The first survey, which was made from 1559Z, 24.8.78 to 0929Z, 26.8.78 (Poseidon stations 1416 to 1464; tape files JCTD0002 to JCTD0051), was without the fast thermistor. The second survey, from 0828Z, 3.9.78 to 1447Z, 5.9.78 (Poseidon stations 1501 to 1560; tape files JCTD0062 to JCTD0119) included a single lowering to 1000 m, which was made at the same time as a similar CTD profile from the Academic Vernadski about 1 mile distant.

Between these two surveys a series of 100 m yo-yo stations were made in the period 1155Z, 29.8.78 to 0259Z, 3.9.78 (Poseidon stations 1482 to 1499; tape files JCTD0052 to JCTD0061). The yo-yos were started at five minute intervals in synchronization with similar profiles being made from other ships in the area.

Computer generated plots of the data occasionally show unrealistic spikes which are presumed to have been caused by telemetry failure. On the basis of these plots the data loss is estimated to be less than 0.1 %.

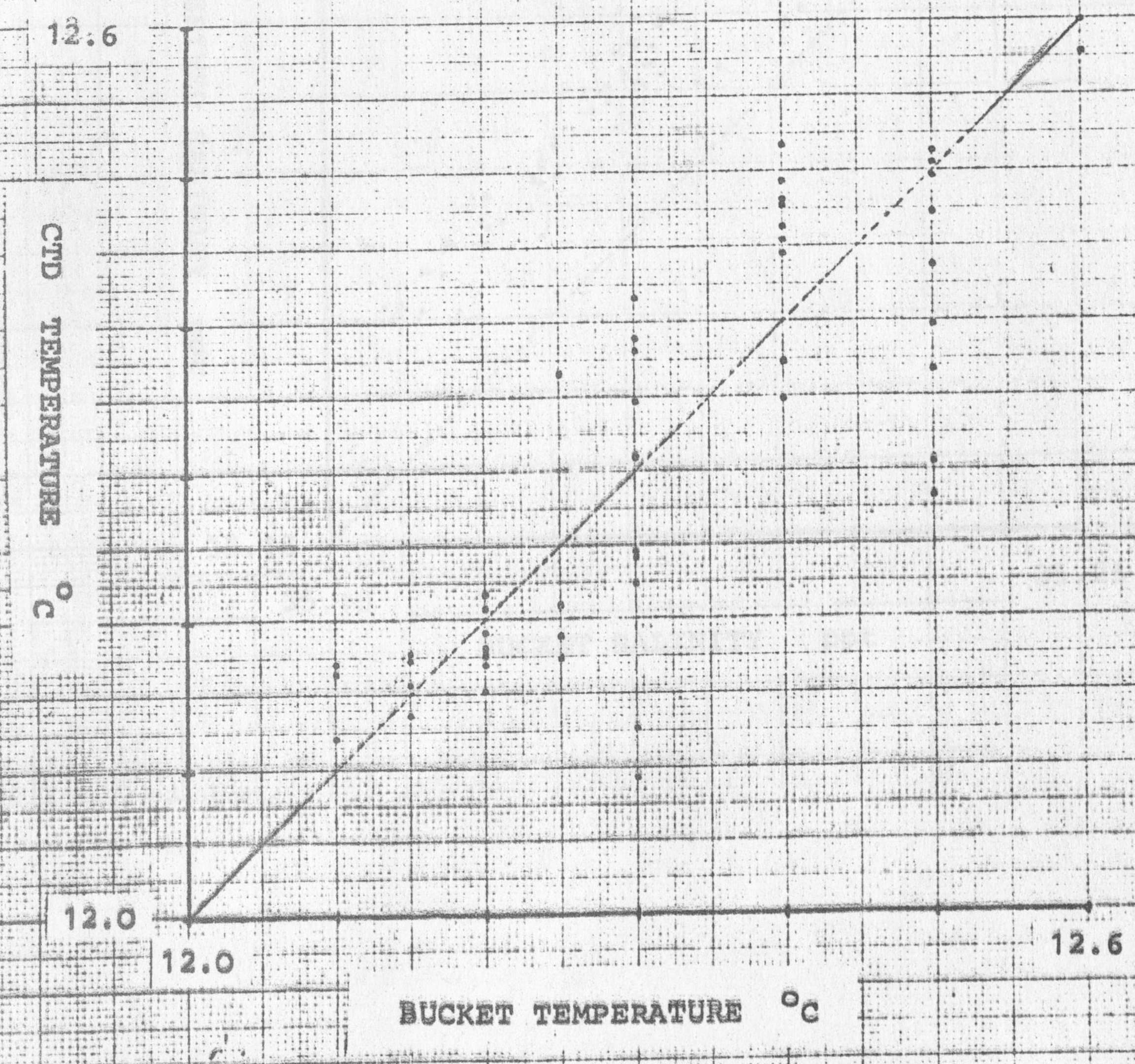
In addition to the strong diurnal thermocline, which is to be expected given such calm weather conditions as were experienced, and internal waves with peak to peak amplitudes of order 10 m, the plots of the raw data show much variability in the thermocline. Stable temperature inversions, sometimes up to 0.2° C for over 10 m, were frequently observed between 100 m and 300 m, and during the second survey around the FIA such an intrusion was associated with a depth change of the 9° C isotherm of about 100 m.

Assuming that the fish towing cable can be made reliable for future cruises, it is desirable to improve the water flow past the sensors to overcome the problem of hysteresis.

CTD SURFACE TEMPERATURE (without thermistor)

v SEA SURFACE TEMPERATURE (bucket)

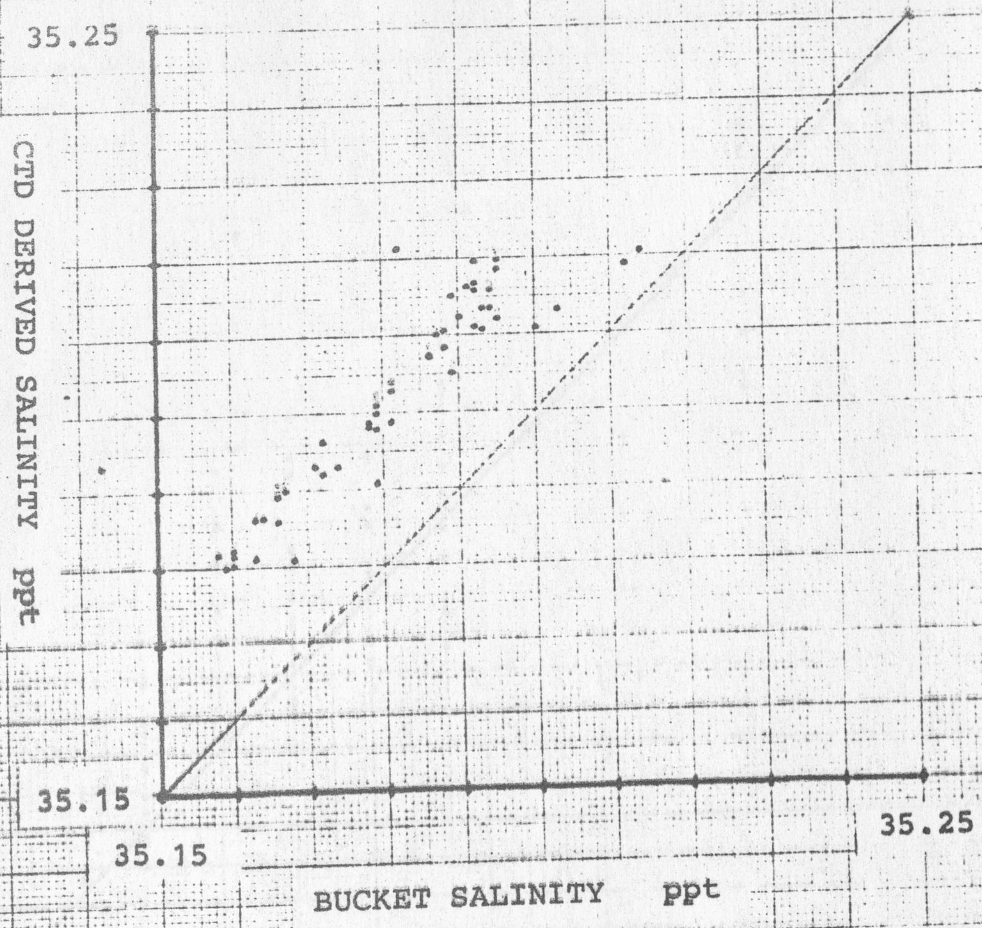
Stations 1416 to 1464 & 1474



CTD SURFACE SALINITY (without thermistor)

v SEA SURFACE SALINITY (bucket)

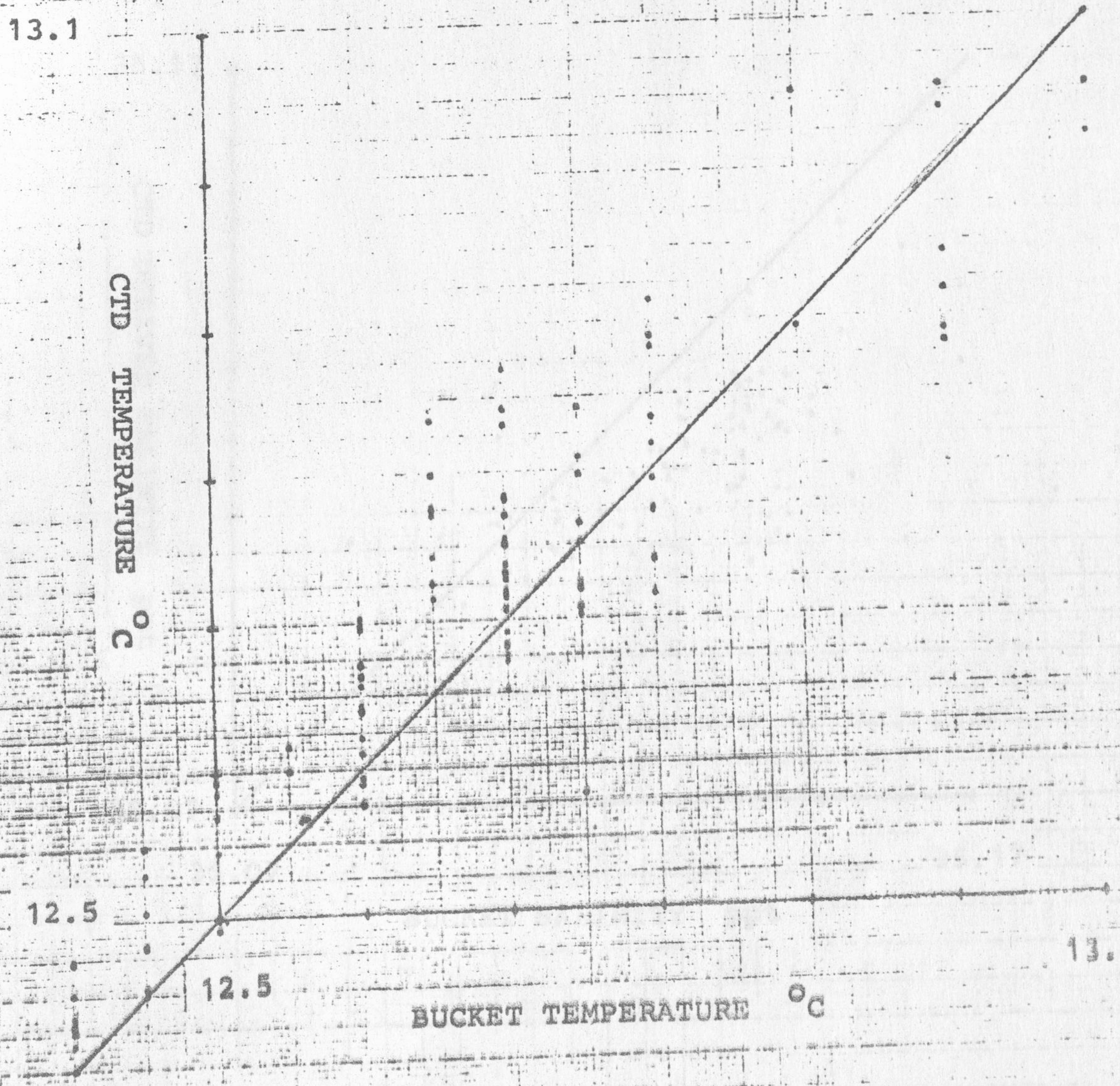
Stations 1416 to 1464



CTD SURFACE TEMPERATURE (with thermistor)

v SEA SURFACE TEMPERATURE (bucket).

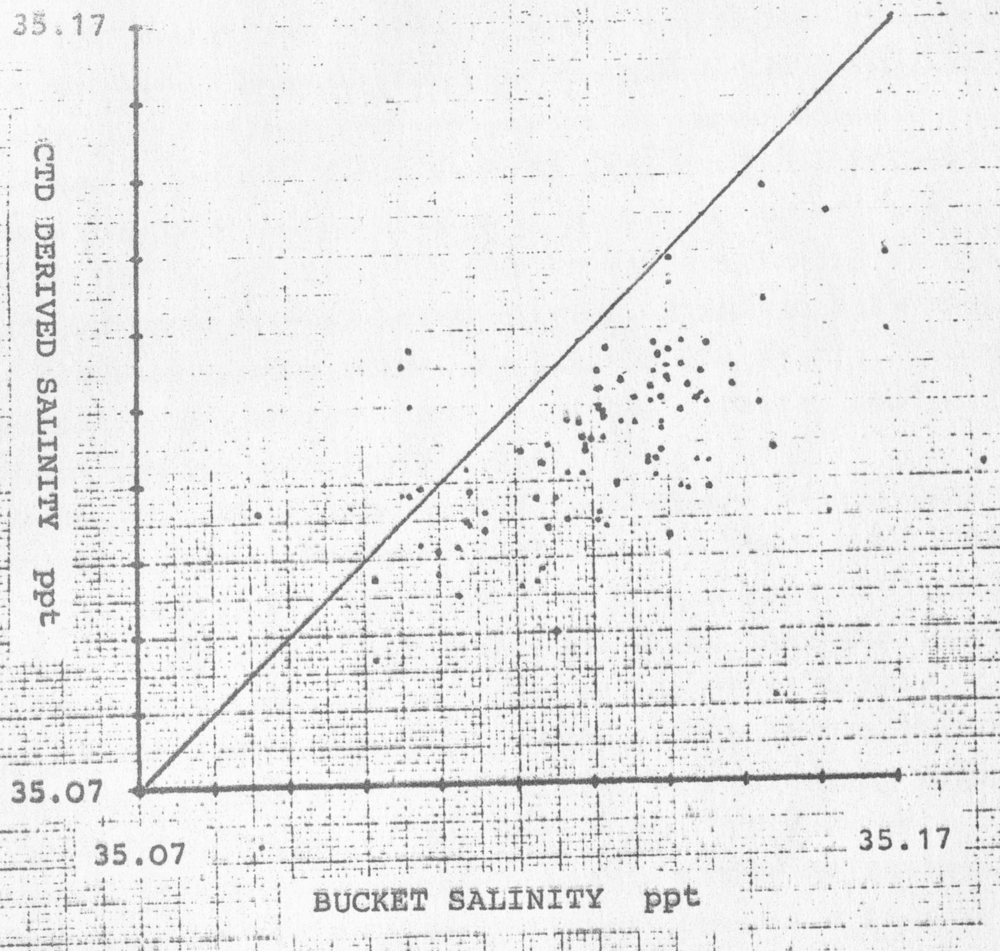
Stations 1501 to 1560



CTD SURFACE SALINITY (with thermistor)

v SEA SURFACE SALINITY (bucket)

Stations 1501 to 1560



A5 - XBT (Leach)

A hand-held XBT launcher and recorder were borrowed from the DHI. In total 36 XBT's were used, most of them in an hourly time series starting at 0900Z on 20th August 1978 at about $58^{o}58'$ N, $11^{o}57'$ W while tracking a drogue. The XBT system functioned faultlessly. The results will be sent to DHI.

A6 - CHEMICAL PROFILER (Hansen)

Description of the system

A fish containing a system of electrical sensors, a pump and a fluorometer is towed by the ship at speeds between 2 and 6 kn. The towing cable consists of a central hose (nylon 9 mm ID) surrounded by 20 electrical lines and a stainless steel shield.

To reduce the hydrodynamic drag the cable is armoured with nylon fairings of droplike cross section. By means of a microprocessor controlled hydraulic winch system the fish can be towed at depths between the surface and 100 m in either discrete steps or any desired form of continuous undulation.

Sensor signals, in the form of frequency multiplexed telegram signals and additional frequency modulated lines, and water are sent to the ship's lab. The system was originally designed to be connected to a chemical autoanalyzer. Standard parameters measured are: pressure, temperature, oxygen (in the fish), fluorescence, alkalinity, pH, conductivity, nitrate, nitrite, phosphate, silicate and ammonia (ship's lab).

During the JASIN experiments no chemical measurements were performed and the chemistry fish was replaced by another of identical design but equipped with a Neil Brown CTD (MK3). In addition an in situ fluorometer was built into the fish. All sensors were positioned as close to the water inlet, at the front of the fish above the centre line, to reduce the influence of the fish itself in causing mixing and turbulent effects.

The digital output of the Neil Brown CTD deck-unit was connected to the main computer (Nova) while the analogue output of pressure was fed back to the winch control system.

The profiler control processor was programmed to undulate the fish between two preset depth limits with 6.5 s delay at the turning points. The winch speeds for lowering and raising were set individually to the maximum possible for the particular sea state.

Aims

1.) Test of the profiler system:
The processor control system, some parts of the winch mechanics and the fish recovery unit were newly designed and therefore had to be tested.

2.) In combination with a navigation system the profiler - undulating between two depths - was to give a high resolution new data set of the hydrographic structure of the JASIN area and selected sections.

3.) Using the fluorometer in connection with 2.) a dye (rhodamine) patch was to be traced to obtain data on currents and mixing effects.

4.) As a separate experiment or in combination with 2.) and 3.) radon concentrations in the water delivered by the fish's pump were to be measured to yield information about gas exchange in the air-sea interface and surface layer (10 to 100 m).

Cruise_diary

11.08-13.08

Winch and lab electronics were installed. The fish was connected to the cable and all signal lines; CTD deck-unit, Nova, and winch control unit, were tested. On a test cruise in the Kiel Bay all functions seemed to be O.K.

The recovery unit seemed to need some more balance weight, so additional weights were ordered and delivered at Holtenau Lock on the Monday evening.

14.08-18.08

On our way to the JASIN area the fish was balanced with additional lead, the connection ball (cable to fish) appeared not to be turning sufficiently freely. The carrier clamps were replaced by those from the original (chemistry fish). The remaining time was spent on preparation work on the profiler processor system for the Mediterranean cruise (November 1978).

19.08

0950 GMT The radon-extractor (Roether, Heidelberg) was connected to the fish. With 15 min time steps, depths of 25-35-45-65-85 and 98 m were run. The fluorometer was switched on to be tested. This experiment was finished 1200 GMT.

1300 GMT Some rhodamine was put into the surface. The fish was towed at 10 m depth. A considerable fluorometers signal due to daylight nearly obscured the small dye signals.

1539 GMT Start of undulation between 30 and 50 m. During turns of the ship the fish was held at constant depth (normally 40 m).

1620 GMT Undulation extended 20-50 m.

1640 GMT Fuse of one power line (fluorometer) was blown. The fish was recovered. A system check showed that three lines of the faired cable were short-circuiting to ground (steel armour of the cable). During the next day (20.08) the line connections were changed to spare lines. The system was tested in a water tank on board.

21.08

0945 GMT Some new dye was injected and traced by undulating the fish at 5.3 kn from 20 to 50 m. As the ship turned the fish was kept at 40 m. The pump was disconnected.

1200 GMT Again one fuse blew. The fish was recovered and other spare lines connected.

1245 GMT Undulating again 30-50 m. The dye was found twice, then the power line failed again (1330 GMT). The fish was recovered. There was evidence for a fault in the cable which caused line after line to be short-circuited to the armour. The connection blocks in the fish were broken up and reconnected so that in case of another line failure a quick change to spare lines was possible.

22.08
After a test run starting at 1200 GMT a new dye experiment was started. In varying intervals the lines went off and were replaced by spare lines (about every 2 hours). Thus the system was kept going until on the 29th 0530 GMT the last of the 20 lines short-circuited.

Results

The fish system has been towed (most of the time undulating) for about 28 hours. One radon profile was completed. Three dye experiments were started but weren't finished because of breakdown of the cable lines. Neil Brown CTD data have been taken most of the time the fish was towed.

Except for the electrical cable the profiler system operated satisfactorily. Some modifications made on the recovery system allowed launching - undulating and recovering of the fish even under rough sea conditions.

The control processor never lost control of the fish. A few faults, stops before the given depth, were due to telegram errors of the Neil Brown system which could have been caused by the towing cable.

As far as the electrical system including sensors is concerned, the only modification should be a different way of power supply for the fluorometer. In these experiments the fluorometer was connected to one phase of the pump's power supply which is in the unstabilized ship's power circuit. This caused a considerable noise level on the fluorometer signal synchronous with the ship's thyristor regulation. The noise was low upto engine speeds of 90 rpm and increased rapidly above that.

The investigation of the cable showed one fault at 35 to 45 m. We suspect that there may be more. A complete inspection requires the total disconnection of the cable which was impossible on the ship. The Institute was informed and contact with the cable manufacturer was recommended.

A7 - DYE AND DROGUES (Kullenberg)

Fluorometer

The fluorometer unit, consisting of three separate housings, was mounted in the fish so as to ensure as efficient a flow passing the measuring volume as possible. A hole was made in the front of the fish and the flow was forced to pass the fluorometer.

The fluorometer consists of a lamp unit with a Phillips HKP 125 W Hg lamp, 220 VAC, and glass filters for separating the green 546 µm line. The photomultiplier detector with a log-amplifier is mounted in a separate housing at right angles to the light beam with a filter combination to separate out the rhodamine fluorescence, peaked around 575 µm. Power supplies and other necessary electronics are mounted in a third housing, from which the signal is also passed on to the transmission unit in the fish.

The fluorometer was calibrated in a laboratory tank (Fig. 1). The output range is from about 20 mV to about 10^3 mV for a concentration range of $5 \cdot 10^{-11}$ to $1 \cdot 10^{-7}$.

In the present system the effect of the daylight cannot be eliminated. A daylight signal around 15 mV was noticeable at about 30 m depth during mid-day overcast conditions.

The signal from the fluorometer is passed as an fm signal along the cable and disturbances were noticeable when the 220 V power supply fluctuated e.g. by change in the ship's engine revolutions. During the dye experiments the signals were recorded in the computer lab and displayed (C, T, fluor.) in analogue form on a strip chart recorder on the bridge. This was an experimental requirement for navigational purposes.

The fluorometer functioned well during the experiments and no problems were encountered. On the basis of the experiments a number of improvements for the system can nevertheless be suggested.

i) the power supply should be stabilized and possibly also the power requirements reduced;

ii) the signal should be digitized before transmission, as is the case with the CTD signals

iii) the measuring volume should preferably be outside the fish; otherwise the correct dye profile will not be obtained

iv) the daylight influence could be eliminated by introducing a chopped light source which, however, would increase the complexity and influence the reliability of the instrument

v) it is necessary to display the signals on the bridge and the signal lines for this purpose should preferably be a permanent part of the ship.

Experimental technique

Before injection of the dye the vertical density structure is observed This includes taking water samples at certain levels and measuring the density in σ_t units with a hydrometer. The same hydrometer is used for adjusting the density of the dye solution to that at the selected depth of injection. The acetic acid rhodamine solution is diluted with methanol to about the desired density and then surface water is added. By adding small amounts of methanol the correct density is obtained to within about 0.1 σ_t unit. A certain amount of care must be exercised in this process since otherwise the salt water addition will cause flocculation of the dye solution. The methanol should be added before the salt water, but slightly less than is required.

The density adjusted dye solution of about 100 litres is pumped into a metal container. This is connected to a second similar water filled container which in turn is connected to a high pressure air cylinder. The dye is injected through a high pressure 1 inch diameter hose connected to a 2 m vertical diffusor. The injection is forced by the high pressure air applying the required pressure.

The diffusor is tied to the hydrographic wire and lowered with the hose to the desired depth. With a weight of 70 kg on the wire it is easily kept vertical during injection, at least for depths less than 60 m. The injection lasts about 5 minutes.

Before the injection a parachute drogue of 20-30 m^2 area is released with the centre at the depth of injection. The drogue is connected to a surface buoy by a wire and from the parachute top a line goes up to a small float. This is used when recovering the parachute. The purpose of the drogue is to act as a relative navigation fix during the initial stages of the dye tracing. The dye is injected about 200 m from the drogue, taking bearing and distance (optically) to the buoy during the injection. After the injection the fish is launched and the ship is manoeuvrered to pass through the injection area relative to the drogue. In this way a number of passes through the dye are made to establish the position of the dye horizontally and vertically. The fish is operated in the cycling mode and the ship moves relatively slowly, at about 3 knots.

After the initial period lasting a couple of hours a more systematic small scale mapping is started. Legs with a length of about 5 nautical miles are run on a suitable course with a spacing of about 1 km. During the present cruise we did not go beyond this stage. Only a few legs were obtained on the first mapping stage before the fish cable gave trouble.

Account of individual trials and experiments

Trial no 1, 19th August: In order to test the fluorometer and through-flow in the fish a trial was made in the mixed layer, injecting a small amount of dye around 6 m depth. The fish was towed through the patch of a depth of 10-12 m. The dye was detected and the system worked satisfactorily.

Following the trial the fish was towed in the cycling mode around 30 m depth and after a while the fluorometer signal disappeared. Dismounting the instrument from the fish and checking proved that there was nothing wrong with the fluorometer. The instrument was remounted and all worked on deck. The fault was eventually found to be in the fish cable.

Experiment no 1, 21 August: 8 kg of dye was injected at 40 m depth on top of a well-developed thermocline. The fish was cycled in the interval 25/55 m and the dye was found from the top to slightly inside of the thermocline (Fig. 2). The injection had clearly been successful. After two passes through the dye the fluorometer signal disappeared due to failure in the fish cable. Although the fault was temporarily fixed the fish was brought on board when the fault reappeared.

A spare fluorometer of similar kind but with separate cable and daylight compensation was rigged for towing over the stern. With this instrument the dye was found again. However, it was not be possible to carry out the desired systematic mapping without the fish and hence the experiment was ended. Details of the drift of the dye and drogue are given in Table 1.

Experiment no 2, 22 August: During the morning of 22 August the fish was repaired and a new dye solution prepared for injection in the top of the thermocline around 40 m. The fish was tested for about one hour before the dye injection and worked satisfactorily. It was recovered before the dye injection. At 1545 injection was started but had to be interrupted due to a blockage in the hose. This was cleaned and at 1820 all 10 kg dye was injected at 38 m depth. The drogue had been released at 0800 at 40 m depth.

The fish was launched and the first pass through the dye was made 1855-1859 when the dye was found in the thermocline. The fish worked well till 2140 when the fuses started to blow again. The dye was encountered several times during this period and the regular mapping pattern on the small scale started at 2030.

Two legs had been completed and a third started by 2140.

The fish was brought on deck and the lines were shifted so that it could work again, at least temporarily. At 2338Z the mapping was re-started and a number of passes through the dye were made until 0145 23 August when the experiment was terminated due to loss of the CTD signals.

The fish was repaired during the first half of the day and the search pattern was taken up again in the period 1425-1630, without finding the dye. Then the experiment was ended and the drogue was recovered at 1805. Some details are given in Table 2, and the track plot is shown in Fig. 5.

Experiment no 3, 28-29 August: This was planned to be an extended experiment and hence 20 kg of dye was injected in the top of the thermocline layer at 20 m. The drogue was released at 1608 and the dye at 1635. The first pass through the dye with the fish was made 1702 and subsequently a number of passes were made establishing the position of the dye in the top of the thermocline layer (Fig. 3). Around 1900 the signal line gave trouble which was fixed with the fish on deck. At 2018 the small scale mapping started and 2.5 legs were completed before the signal line again became faulty. The mapping was continued despite this but had to be terminated at 2130. This ended the experiment; particulars are given in Table 3.

Experiment no 4, 1 September: This experiment was carried out with the separate fluorometer being towed from the geological or coring boom. Two drogues were released, at 26 m 0620 and at 42 m 0635. At 0730, 10 kg of dye was injected at 25 m in the bottom of the mixed layer. At 0830 a fairly large surface patch was observed implying that at least part of the dye was injected in the mixed layer. The dye was traced between 20-25 m and the surface till 2300. Towards the end only the surface dye layer, 0-8 m, was followed; particulars are given in Table 4. The wind during the experiment was around N-WNW at 7-4 m/s. The drogue at 26 m was picked up at 1800 and that at 42 m was recovered at 2340.

Separate dye trial

On the 27 August a trial dye experiment was performed injecting the dye in the thermocline layer at 20 m depth. The dye was traced with the separate fluorometer towed over the geological boom, and was found at depths from 15 to 20 m. The layer at 20 m was trapped in the thermocline (Fig. 4). The tracing was carried out relative to the 40 m drogue released the day before. At 1730 the experiment had to be terminated due to dense fog making it impossible to see the drogue buoy.

Drogue tracking

Separate drogue tracking was carried out on the 18 August for testing the relative navigation system (see section A1), and on 26-27 August for studying the currents at 40 and 60 m simultaneously. The drogues were released 26 August at 1400 (40 m level) and at 1415 (60 m level) and tracked to the following day, taking fixes relative to the radar buoy in the central JASIN area (Fig. 6). In Table 5 the resulting currents are given.

Table 1. Experiment no 1, injection at 39/41 m at 1250; drogue release at 40/42 m at 1242, wind WSW about 8 m/s.

Time interval 21 August GMT	type	drifting		conc $\cdot 10^{11}$ ton/m^3
		speed km/h	direction towards	
1308-1904	dye	0.45	150°	
1318-1904	dye	0.41	140°	
1308-1339	dye	0.45	125°	
1300-1555	drogue	0.30	110°	
1555-1642	drogue	0.75	150°	
1642-2048	drogue	0.40	135°	
1308	dye pass	-	-	1000
1318	dye pass	-	-	1400
1339	dye pass	-	-	25

Table 2. Dye experiment no 2, injection 1825, drogue release 0800 on 22 August

Time interval 22-23 August GMT	type	drifting		conc · 10^{11} ton/m^3
		speed km/h	direction towards	
2055-2100	-"-			12-650
2125	-"-			600
0041-0048	-"-			5-40
0121-0125	-"-			40
1900-2100	dye	0.37	210°	-
2125-0125	-"-	0.56	030°	-
1600-1900	drogue	0.60	135°	-
23 August				
0934-1023	drogue	0.84	330°	-
1023-1123	drogue	0.76	012°	-
1123-1350	drogue	0.69	045°	
1350-1553	drogue	1.03	083°	
1553-1637	drogue	0.64	130°	
1637-1806	drogue	1.00	130°	

Table 3. Dye experiment no 3, injection 1635, drogue release 1608 at 20 m

Time interval 28 August GMT	type	drifting		conc · 10^{11} ton/m^3
		speed km/h	direction towards	
1702	dye pass	-		420
1745	dye pass	-		440
1803-05	dye pass	-		90-460
1824	dye pass	-		60-100
1843-45	dye pass	-		16-400
2033-39	dye pass (leg 2)	0.21	165°	10-600
1608-0605	drogue	0.27	165°	-
0605-1850	drogue	0.225	165°	-

Table 4. Experiment no 4, injection 0730, drogue at 26 m at 0620 and drogue at 42 m at 0635.

Time interval 1 September GMT	type	drifting speed km/h	drifting direction towards
0730-0912	dye, surface	0.53	200°
0912-1000	-"-	0.66	270°
1000-1430	-"-	0.15	330°
1430-1930	-"-	0.60	105°
1600-1930	-"-	0.64	115°
0912-1330	dye, 20 m	0.33	275°
1330-1500	-"-	0.45	065°
1500-1600	-"-	0.45	069°
0620-1000	drogue, 26 m	0.425	210°
1000-1430	-"-	0.17	350°
1430-1630	-"-	0.525	070°
1630-1800	-"-	0.80	085°
0635-1600	drogue, 42 m	0.18	125°
1600-2340	-"-	0.30	100°
1800-2340	-"-	0.175	110°
0635-2340	-"-	0.23	110°

Table 5. Results of drogue tracking 26-27 August.

Time interval GMT	drifting speed km/h	drifting direction towards
40 m		
1400-1602	0.74	148°
1757-2124	0.30	108°
2124-2310	0.49	108°
2310-0310	0.52	140°
0502-1053	0.65	107°
60 m		
1545-1749	0.41	135°
1749-2136	0.415	118°
2136-2323	0.535	110°
2323-0325	0.46	140°
0325-0930	0.58	092°

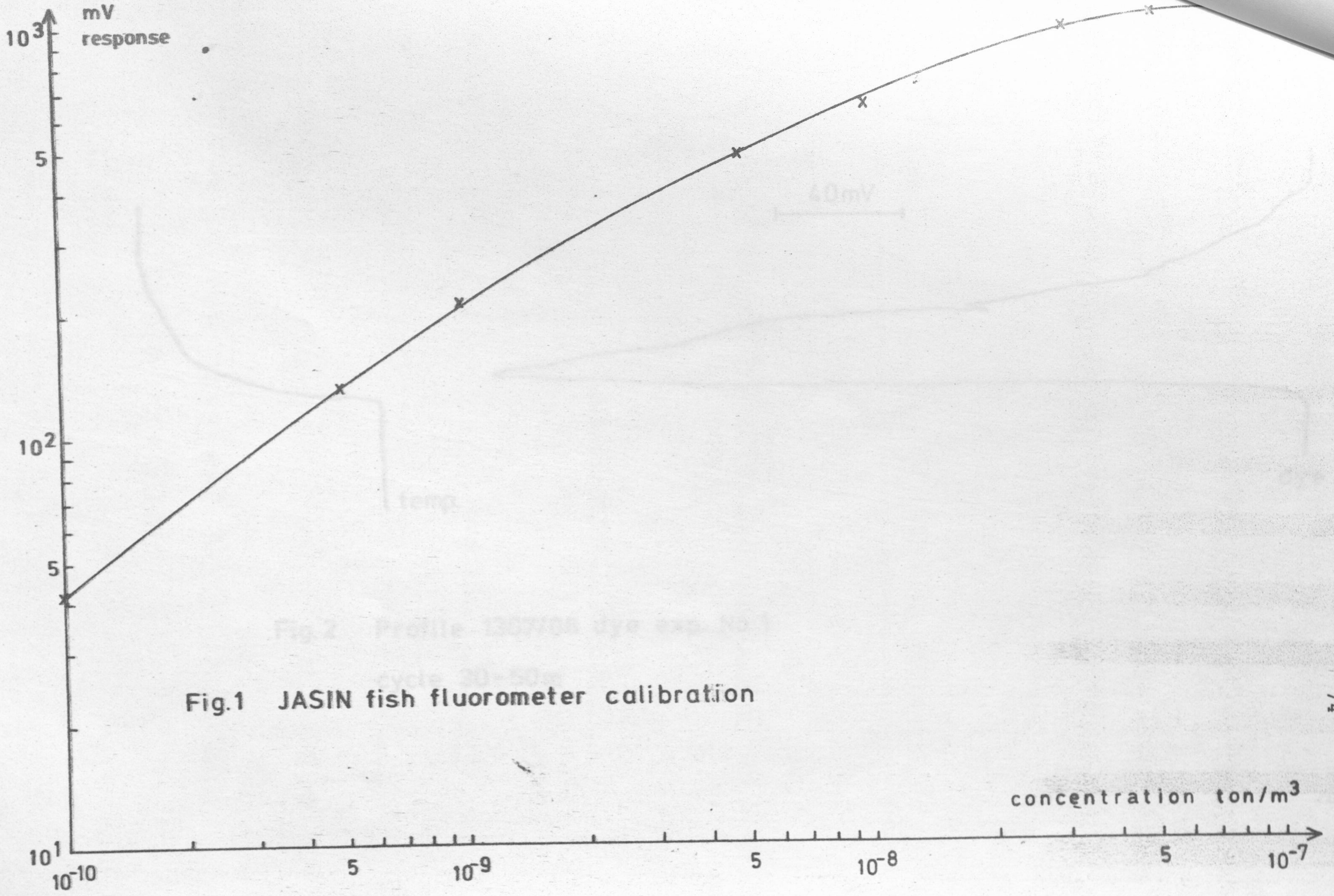


Fig.1 JASIN fish fluorometer calibration

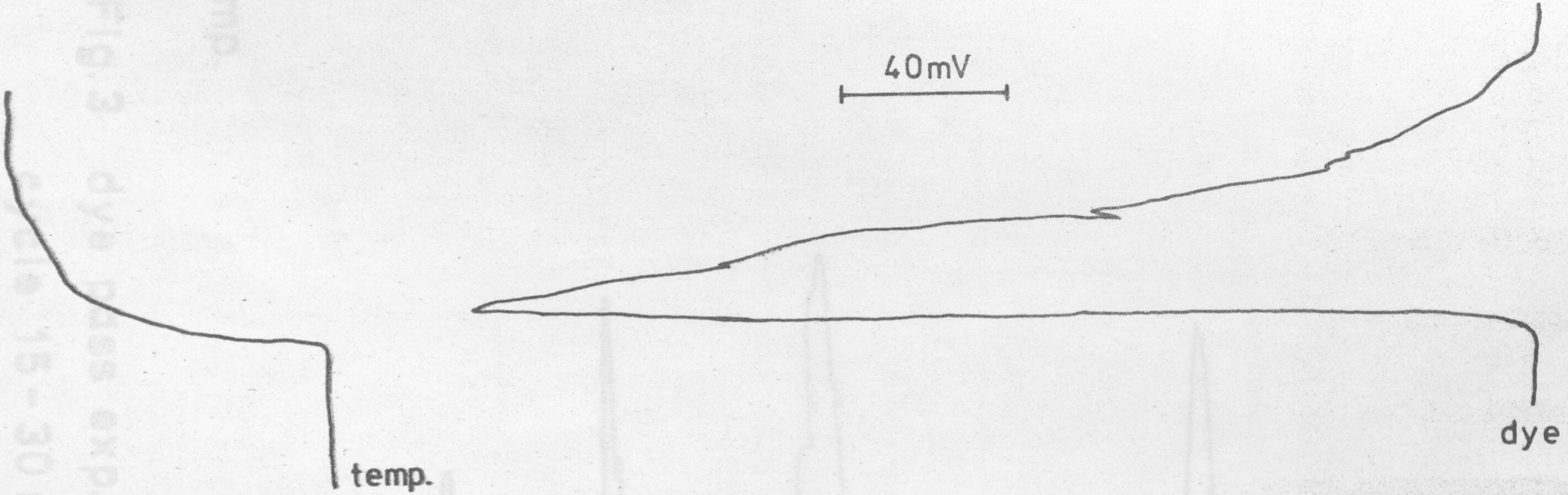


Fig. 2 Profile 1307/08 dye exp. No. 1
cycle 30-50m

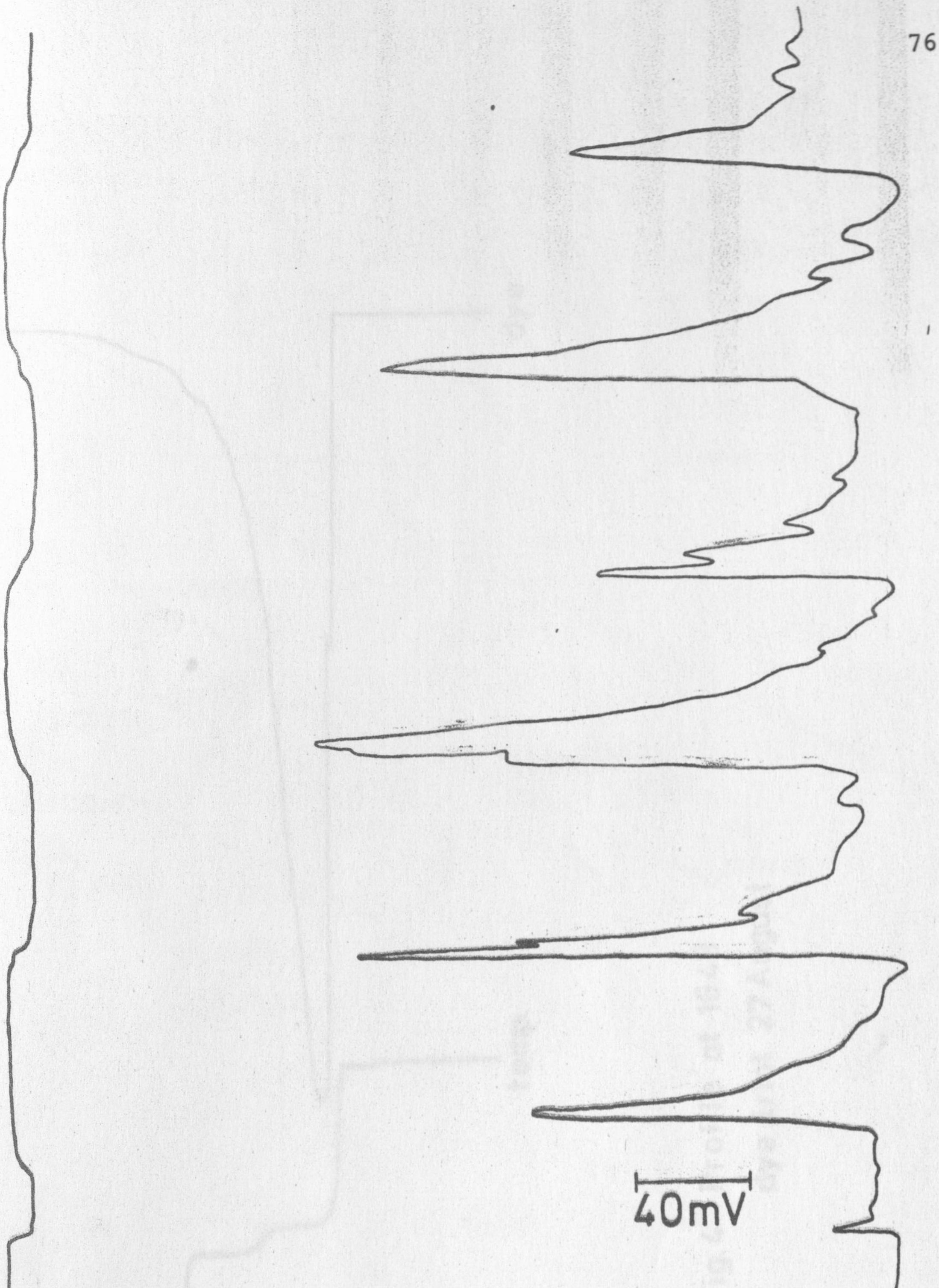


Fig. 3 dye pass exp. No. 3 at 2030
cycle 15 - 30 m

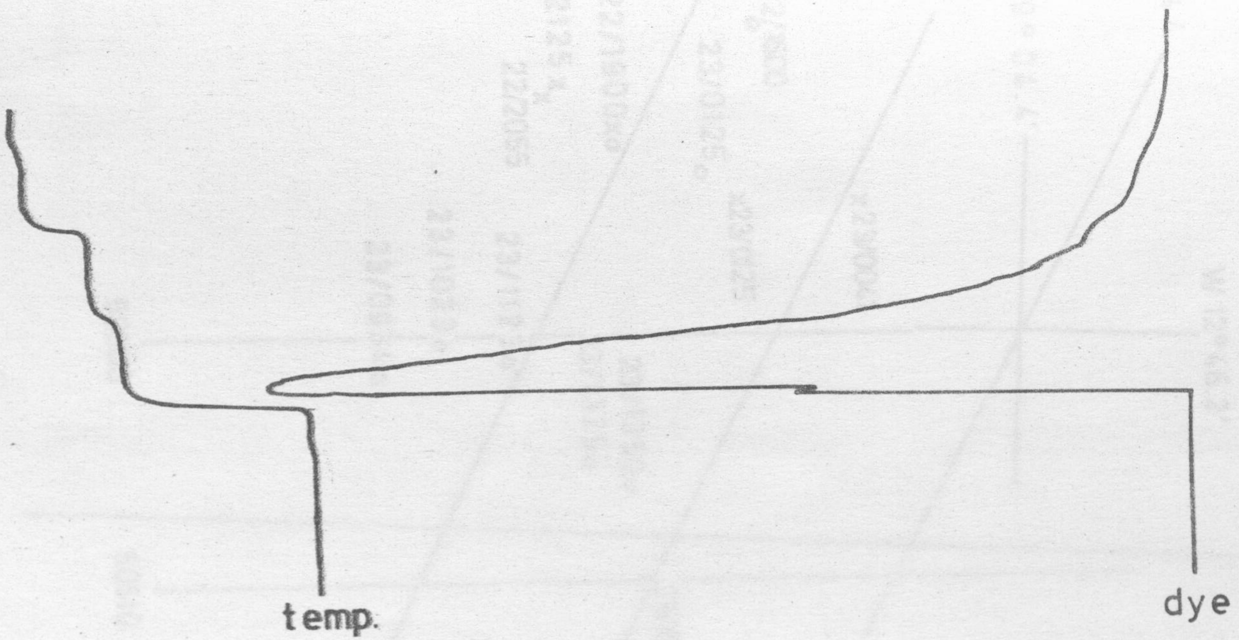


Fig. 4 Profile at 1643
dye trial 27 August

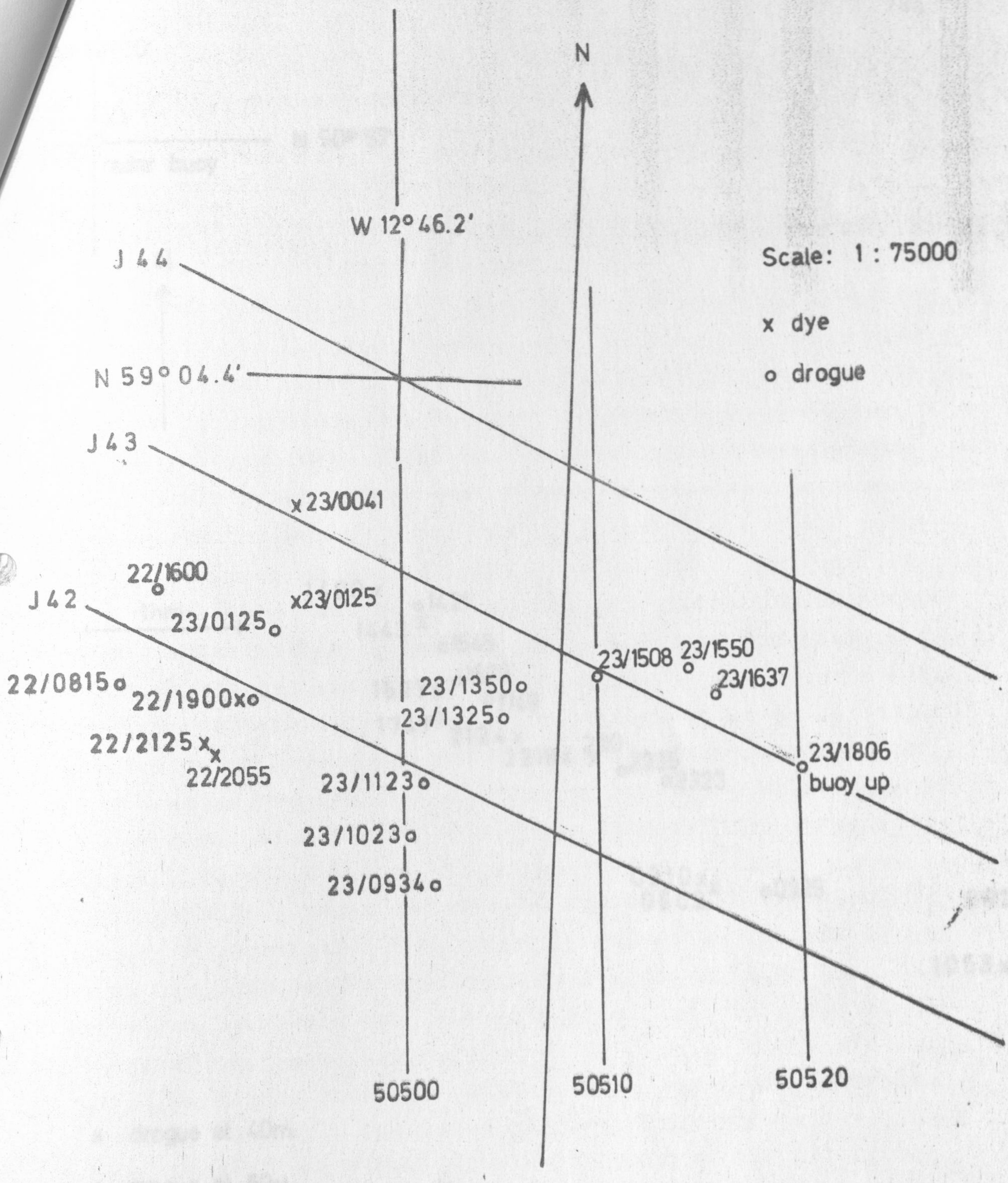


Fig.5 Drogue and dye positions in Loran/Decca exp.2, 22-23/8/1978

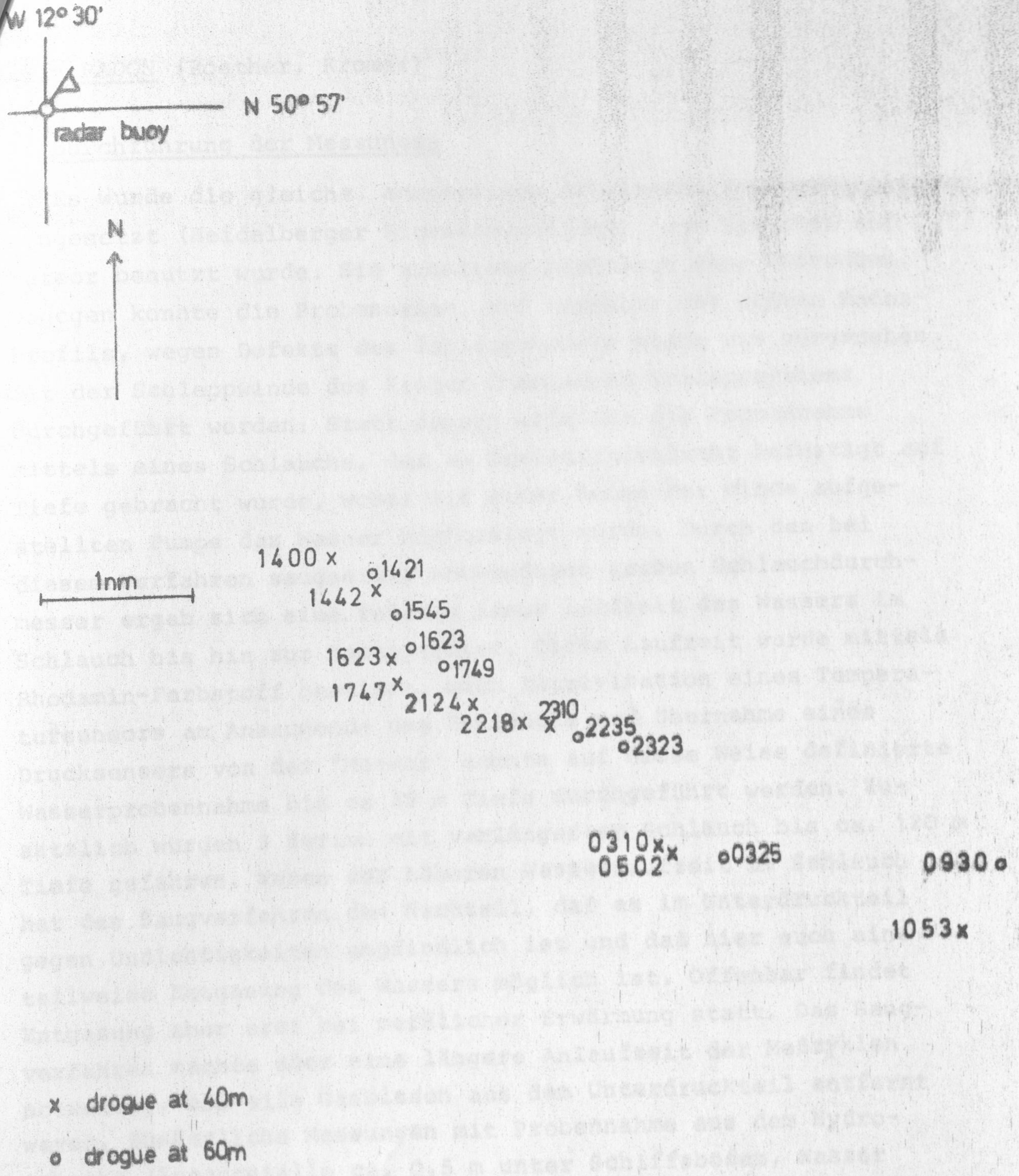


Fig. 6 Drogue tracking 26 - 27 August 1978

A8 - RADON (Roether, Kromer)

1. Durchführung der Messungen

Es wurde die gleiche, automatisch arbeitende Radonmeßapparatur eingesetzt (Heidelberger Eigenentwicklung), wie sie auch auf Meteor benutzt wurde. Sie arbeitete praktisch ohne Störungen. Dagegen konnte die Probennahme, mit Ausnahme des ersten Radon-Profils, wegen Defekts des Schlauchkabels nicht wie vorgesehen mit der Schleppwinde des Kieler Chemischen Schleppsystems durchgeführt werden: Statt dessen erfolgte die Probennahme mittels eines Schlauchs, der am Serienwindendraht befestigt auf Tiefe gebracht wurde, wobei mit einer neben der Winde aufgestellten Pumpe das Wasser hochgesaugt wurde. Durch den bei diesem Verfahren saugseitig notwendigen großen Schlauchdurchmesser ergab sich eine relativ lange Laufzeit des Wassers im Schlauch bis hin zur Meßapparatur. Diese Laufzeit wurde mittels Rhodamin-Farbstoff bestimmt. Nach Improvisation eines Temperatursensors am Ansaugende des Schlauchs und Übernahme eines Drucksensors von der "Meteor" konnte auf diese Weise definierte Wasserprobennahme bis ca 85 m Tiefe durchgeführt werden. Zusätzlich wurden 3 Serien mit verlängertem Schlauch bis ca. 120 m Tiefe gefahren. Neben der höheren Wasserlaufzeit im Schlauch hat das Saugverfahren den Nachteil, daß es im Unterdruckteil gegen Undichtigkeiten empfindlich ist und daß hier auch eine teilweise Entgasung des Wassers möglich ist. Offenbar findet Entgasung aber erst bei merklicher Erwärmung statt. Das Saugverfahren machte aber eine längere Anlaufzeit der Meßzyklen notwendig, bis alle Gasblasen aus dem Unterdruckteil entfernt waren. Zusätzliche Messungen mit Probennahme aus dem Hydroschacht (Ansaugstelle ca. 0.5 m unter Schiffsboden, Wasser von der Apparatur aus direkt angesaugt) ergaben gleiche Werte wie die mit Schlauch aus entsprechend flacher Tiefe genommenen.

Insgesamt wurden 24 Radon-Profile gemessen. Nach Übernahme von geeigneten Plastikbehältern von der "Planet" wurden außerdem 10 Radium-Proben genommen zur Messung in Heidelberg.

Neben den eigentlichen Messungen erfolgten verschiedene Tests der Apparatur: Wie auf Meteor wurde der Wasserdurchsatz auf 5 l/min begrenzt, nachdem klar wurde, daß andernfalls in der Gas-Extraktionskolonne mehr Permanentgas anfällt, als der nachgeschaltete Gaskompressor quantitativ absaugen kann. Die theoretische Radon-Ausbeuteänderung der Kolonne von ca. 1.1 % pro mb Druckanstieg in der Kolonne wurde durch Reduktion der Kompressorpumpleistung qualitativ bestätigt. Eichung der Meßkammern ergab interne Übereinstimmung der Radon-Meßempfindlichkeiten auf ± 1 %; bei einem der beiden Vierer-Sets wurden jedoch wegen Übersprechens zwischen den Kammern die Diskriminatorschwellen um 50 % angehoben, was eine um ca. 4 % reduzierte Ansprechwahrscheinlichkeit ergibt. Die Eichung erfolgte durch Einbringen von je 5 ml Eichgas aus einem Volumen mit emanierendem Präparat (2 nCi) mittels einer Gasspritze. Messungen des Radon-Gehalts der Luft (nach 100-facher Anreicherung mit Aktivkohle, drei Messungen) ergaben Werte zwischen 3 und 10 % des Lösungsgleichgewichts mit Oberflächenwasser; Rücklösung von Radon aus der Atmosphäre ist damit von geringem Einfluß. In einem weiteren Experiment wurde die Spülung der Kammern bei Zufuhr von neuem Füllgas durch Ausspülen des Eichstandards bestimmt. Die Ergebnisse stimmen mit den aufgrund der Volumenverhältnisse unter Annahme schneller Mischung in der Kammer berechneten Werten überein. Nulleffektmessungen der Kammern bestätigten die im Labor gefundenen Werte; diese Nulleffekte betragen ohnehin nur max. 5 % der Radon-Zählraten.

Diese Tests, und die Konsistenz sowohl der Meßergebnisse als auch der Kontrollgrößen der Apparatur (u.a. Gasausbeute, Druck in der Extraktionskolonne) zeigen, daß die Genauigkeit des Meßverfahrens bis zum ± 1 % Niveau nur durch den statistischen Zählfehler begrenzt wird. Der Nachweis der Radon-Zerfallsereignisse ist noch in geringem Maß empfindlich gegenüber Störimpulsen beim Einschalten induktiver Verbraucher. Solche Störungen werden aber als koinzidente Zählereignisse zwischen den Kammern sicher erkannt.

2. Ergebnisse und vorläufige Interpretation

Abb. 1 bis 4 zeigen der insgesamt 24 gemessenen Profile. In der mixed-layer findet sich ein klar ausgeprägtes Radon-Defizit gegenüber den Werten in größerer Tiefe. Im mixed-layer-Bereich wurden 3 verschiedene Typen von Profilen beobachtet: Abb. 1 zeigt konstante Konzentrationen bis zur Unterkante der mixed-layer und ein rasches Ansteigen der Radon-Konzentration über die Sprungschicht. In Abb. 2 findet sich ein abgestuftes Konzentrationsprofil. Diese Abstufung findet sich auch im Temperaturprofil wieder, wobei die obere Temperaturstufe bis ca. 15 m Tiefe einer in einer Periode geringer Windstärken entstandenen, temporären mixed-layer entspricht: Abb. 3 zeigt ein Profil, bei dem innerhalb der Meßfehler die Konzentration von der Oberfläche her graduell zunimmt, auch hier in Entsprechung zum Temperaturprofil. Abb. 4 zeigt zwei der Profile, die im Tiefenbereich 50-120 m aufgenommen wurden. Hier wird ein leichtes Ansteigen der Konzentration mit der Tiefe beobachtet. Dies entspricht der Beobachtung zeitvariabler Werte der 90 m-Konzentration auf der Meteor während Phase 1. Bei allen Meßpunkten der Abb. 1 - 4 liegt der Meßfehler bei ca. ±28 % - ein Wert, der die Genauigkeit der in der Literatur vorliegenden Daten bei weitem übertrifft.

Die Tatsache, daß laut Abb. 4 unterhalb der Sprungschicht keine tiefenkonstanten Radon-Konzentrationen gefunden werden, ist unerwartet. Sie bedeutet nämlich, daß entweder Radon aus diesem Tiefenbereich in die mixed-layer überführt wird was Mischung über die Sprungschicht beinhaltet, oder daß der Radiumgehalt mit der Tiefe variiert. Beides ist überraschend: Zwar ist Mischung mit der mixed-layer möglich, wenn die entsprechenden Isothermen *lateral* bis in die Deckschicht aufsteigen. Hierbei ist jedoch zu bedenken, daß das Radon nur ca. 5 Tage "Gedächtnis" aufweist, weil es mit einer Zeitkonstante von ca. 5 Tagen (= radioaktive Lebensdauer) ins radioaktive Gleichgewicht mit dem Radium nachwächst. Falls der vertikale Radon-Gradient unterhalb ca. 50 m Tiefe durch die genannte Mischung verursacht wird, müßte es sich demnach um recht massive Effekte handeln. Der Erklärung durch einen variierenden Radiumgehalt steht entgegen, daß man annehmen muß, daß der Radiumgehalt in jedem Winter durch konvektive Mischung homogenisiert wird und sich über die Zeit der Sommerstagnation nur geringe Radiumgradienten aufbauen sollten. Um diese Frage, die auch für die Planung künftiger Radon-Messungen wichtig ist, zu entscheiden, wurden Radiumproben aus dem infrage stehenden Tiefenbereich genommen, die in Heidelberg gemessen werden sollen. Für die Bestimmungen des vertikal integrierten Radon-Defizits - der Meßgröße für die Gasaustauschbestimmungen - ergibt das genannte Problem vorerst eine Unsicherheit von ca. ±5 % in den Gleichgewichtswerten.

Trotz dieser Unsicherheit kann das vertikal integrierte Radon-Defizit (gegenüber Gleichgewicht mit dem Radium, vgl. [1]) wegen der Qualität der Meßdaten sehr viel genauer bestimmt werden als bei früheren Untersuchungen. Vielleicht erst aufgrund der verbesserten Meßgenauigkeit liegt die Hauptfehlerursache jetzt in der Variabilität der mixed-layer-Tiefe infolge innerer Wellen. Durch Auswertung der gleichzeitig aufgenommenen Temperaturprofile und Hinzunahme von hydrographischen JASIN-Daten sollten sich diese Unsicherheiten aber stark reduzieren lassen. Bei den gleichzeitig auf Meteor durchgeführten Messungen wurde außerdem bei einem großen Teil der Profile ein Tiefenbereich, der den Bereich der Sprungschicht mit allen seinen Zeitvariationen überdeckte, im Jojo durchfahren (15 Minuten Periode), was eine unmittelbare Mittelung über die Effekte innerer Wellen ergibt. Ein weiteres handicap waren die relativ niedrigen Windstärken während JASIN, die zur Folge haben, daß in dem besonders interessanten Bereich hoher Windstärken praktisch keine Beobachtungen erhalten wurden. Schließlich war auch die Meßfolge nicht so hoch, wie das Verfahren es leisten kann. Dies lag primär an fehlender Stationszeit; jedoch war im gegenwärtigen Entwicklungsstadium des Meßverfahrens auch die software des Prozeßrechners einem durchgehenden Betrieb noch nicht ganz gewachsen. Trotzdem werden die JASIN-Daten, die die erste über eine längere Zeit und an praktisch festem Ort durchlaufende Radon-Meßserie guter Genauigkeit beinhalten, gegenüber Literaturwerten deutlich verbesserte Aussagen über den Gasaustausch ergeben. Eine sehr vorläufige Auswertung scheint zu zeigen, daß im Bereich bis hinauf zu etwa 12 m/sec Windgeschwindigkeit die Literaturwerte nach oben korrigiert werden müssen.

[1] W. Roether und B. Kromer: Field determination of air-sea gas exchange by continuous measurement of radon-222, Pure appl. Geophys. 116 (1978) 476-485.

Abb. 1: Radon-Tiefenprofile Nr. 1 (59.1° N, 11.3° W) und 3 (59.1° N, 11.8° W), 19. und 22.8.1978. Der schraffierte Bereich gibt die (vorläufige) Unsicherheit der Radon-Gleichgewichtswerte wieder, vgl. Text. Die Fehler sind der einfache statistische Zählfehler. Profil 1 ist das einzige mit der Schleppwinde gewonnene Profil. Das Temperaturprofil ist das bei Profil 1 mit der Neil-Brown-Sonde im Fisch gemessene.

Abb. 2: Radon-Tiefenprofil Nr. 11, 27.8.1978, 58.9° N, 12.3° W. Das Temperaturprofil gibt Mittelwerte am Ansaugstutzen des Schlauchs während der jeweiligen Sammelzeit der Proben.

Abb. 3: Radon-Tiefenprofil Nr. 7, 26.8.1978, 58.9° N, 12.5° W.

Abb. 4: Radon-Tiefenprofile, 50 bis 120 m Tiefe, in gespreizter Skala mit unterdrücktem Nullpunkt, Nr. 16, 58.9° N, 12.3° W, 30.8.1978, und Nr. 23, 2.9.1978, 59.4° N, 12.5° W. Für diese Profile konnten keine Temperaturen gemessen werden. Die niedrigeren Werte bei Profil 23 sind plausibel, da nach den Sondenmessungen die Isothermen zu dieser Zeit besonders tief lagen (9°-Isotherme in 200 anstatt typisch 100 m Tiefe).

Fig.1

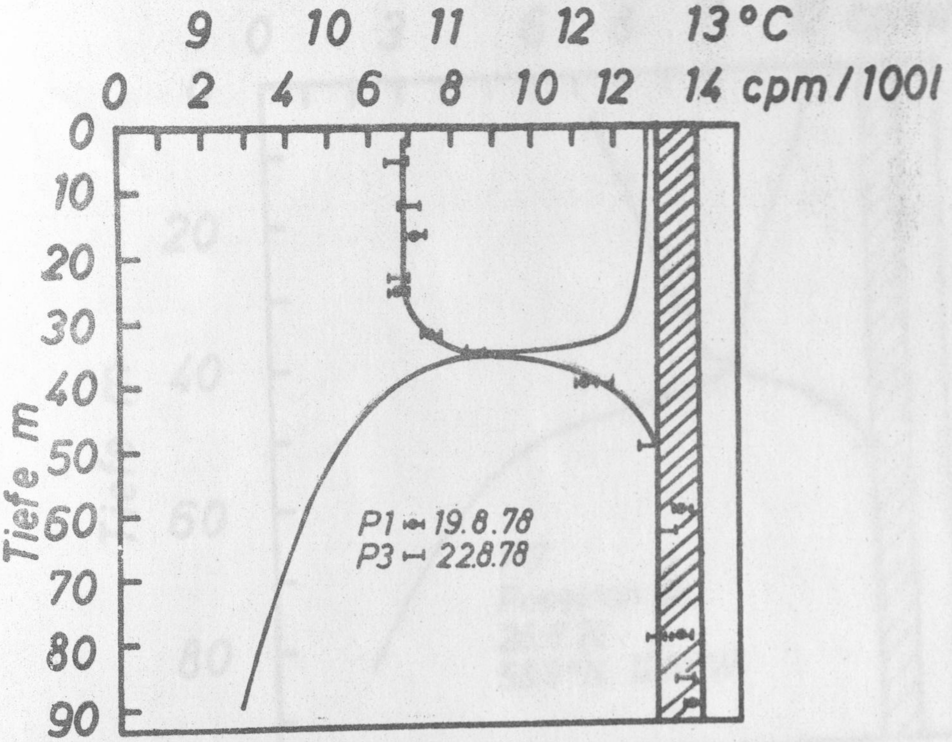

9
10
11
12
13 °C
0
2
4
6
8
10
12
14 cpm/100l
0
10
20
30
40
50
60
70
80
90
Tiefe m
P1 ⊷ 19.8.78
P3 ⊢ 22.8.78

Fig. 2

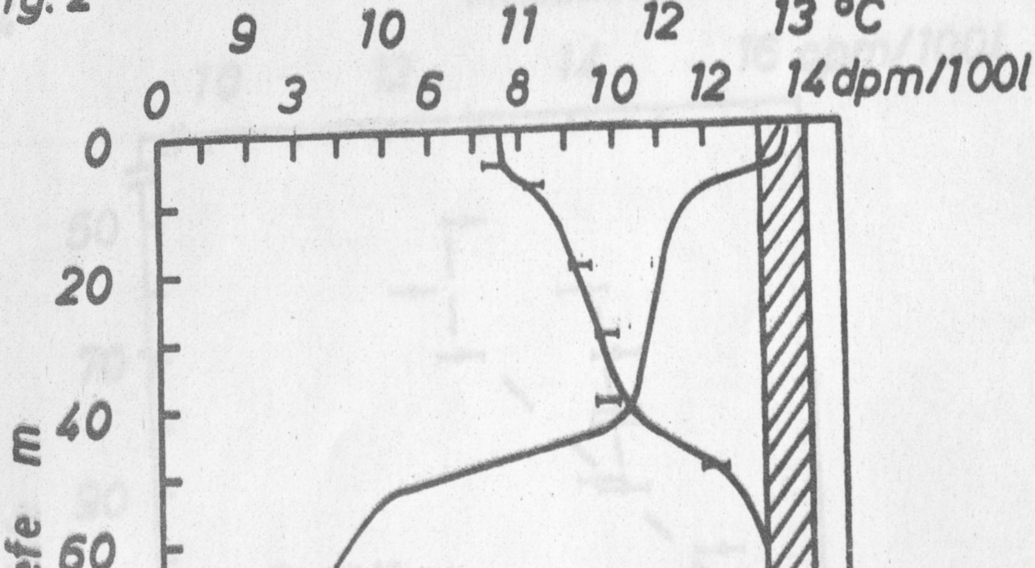

9
10
11
12
13 °C
0
3
6
8
10
12
14dpm/100l
0
20
40
60
80
Tiefe m
P 11
Poseidon 31
27. 8. 78

Fig. 3

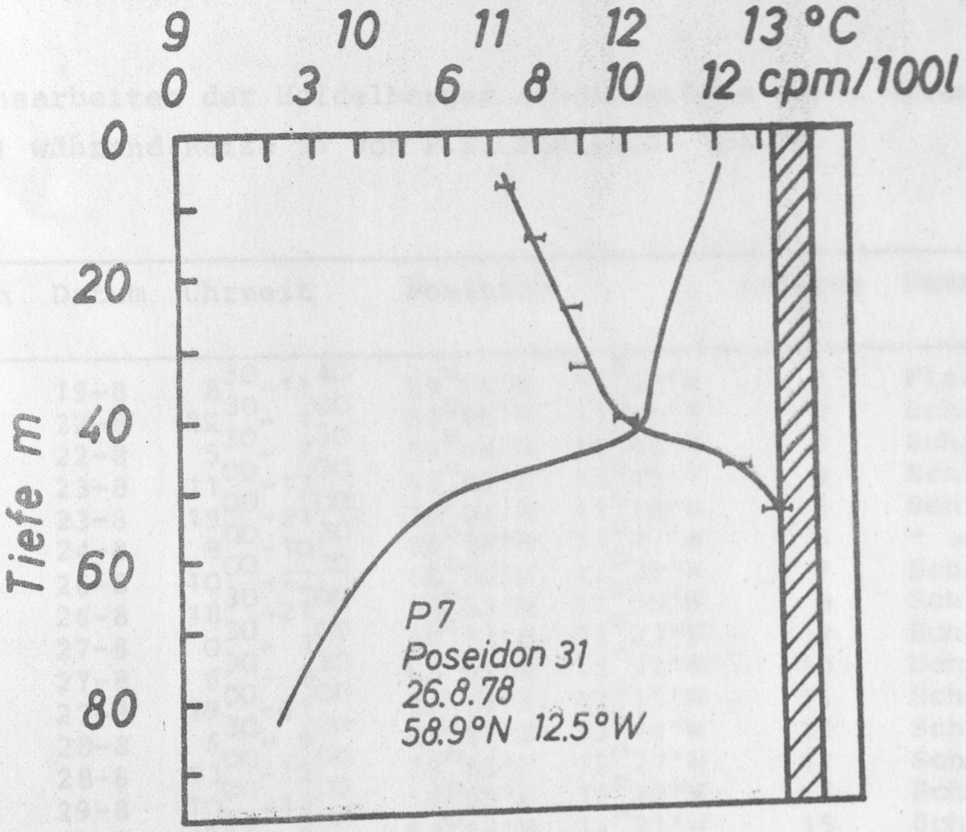
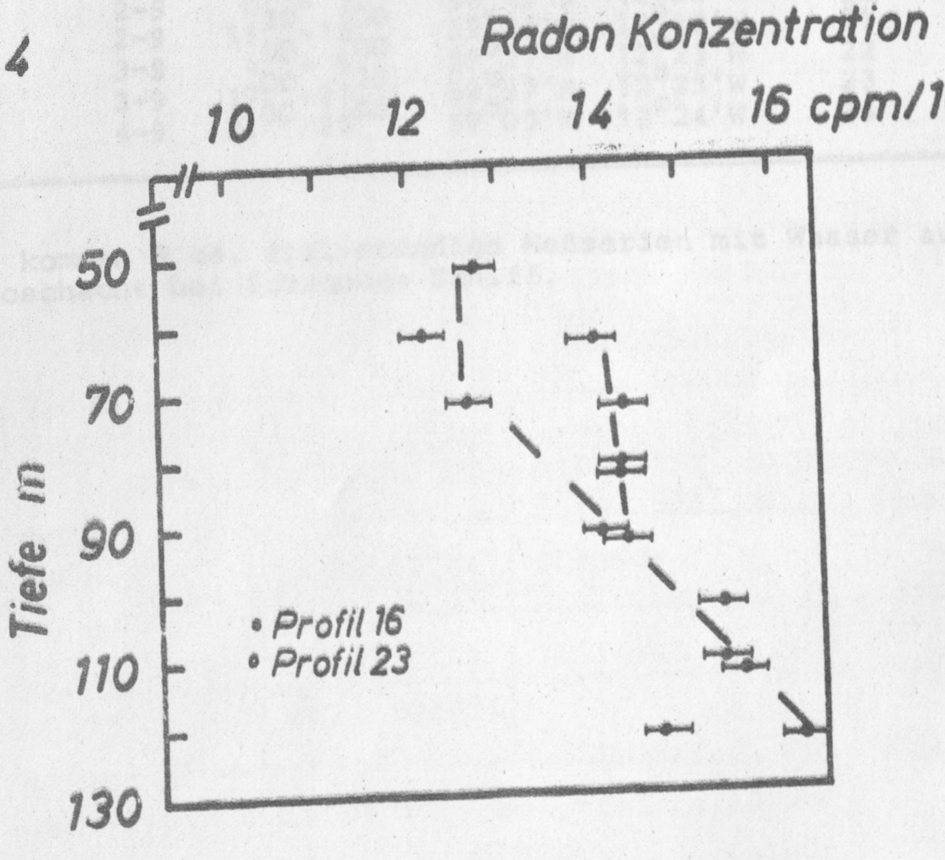

9
10
11
12
13 °C
0
3
6
8
10
12 cpm/100l
0
20
40
60
80
Tiefe m
P7
Poseidon 31
26.8.78
58.9°N 12.5°W

Fig. 4


Radon Konzentration
10
12
14
16 cpm/100l
50
70
90
110
130
Tiefe m
• Profil 16
∘ Profil 23

Stationsarbeiten der Heidelberger Arbeitsgruppe (tP7, Gasaustausch) während Reise 51 von F.S. POSEIDON (JASIN)

Station	Datum	Uhrzeit	Position		interne #	Bemerkungen
1396	19-8	$8^{30}-11^{40}$	59°04'N	11°20'W	1	Fisch
1406	22-8	$22^{30}-1^{00}$	58°55'N	11°31'W	2	Schlauch
1406	22-8	$5^{30}-7^{30}$	59°04'N	11°46'W	3	Schlauch
1413	23-8	$11^{00}-13^{00}$	59°02'N	11°45'W	4	Schlauch
1413	23-8	$19^{00}-21^{00}$	59°01'N	11°38'W	5	Schlauch
1414	24-8	$8^{00}-10^{30}$	58°58'N	12°27'W	6	" vgl.m.Meteor
1465	26-8	$10^{00}-12^{30}$	58°56'N	12°26'W	7	Schlauch
1467	26-8	$18^{30}-21^{00}$	58°52'N	12°30'W	8	Schlauch
1469	27-8	$0^{30}-3^{00}$	58°53'N	12°23'W	9	Schlauch
1472	27-8	$6^{30}-8^{30}$	58°52'N	12°22'W	10	Schlauch
1476	27-8	$19^{00}-21^{00}$	58°51'N	12°15'W	11	Schlauch
1477	28-8	$6^{30}-9^{00}$	58°51'N	12°14'W	12	Schlauch
1479	28-8	$13^{00}-15^{00}$	58°55'N	12°27'W	13	Schlauch
1481	29-8	$10^{00}-12^{00}$	58°55'N	12°22'W	14	Schlauch
1484	30-8	$7^{00}-9^{00}$	58°54'N	12°21'W	15	Schlauch
1486	30-8	$15^{30}-17^{30}$	58°54'N	12°21'W	16	62-122 m
1487	31-8	$6^{30}-9^{00}$	58°51'N	12°08'W	17	Schlauch
1489	31-8	$15^{00}-18^{00}$	58°50'N	12°07'W	18	Schlauch
1491	1-9	$3^{30}-6^{00}$	58°48'N	12°08'W	19	Schlauch
1496	2-9	$0^{00}-3^{00}$	58°49'N	12°00'W	20	Schlauch
1498	2-9	$15^{30}-18^{00}$	59°26'N	12°28'W	21	Schlauch
1500	3-9	$4^{00}-6^{00}$	59°27'N	12°23'W	22	Schlauch
1512	3-9	$17^{00}-21^{30}$	58°57'N	12°25'W	23	52-122m Schlauch
1546	4-9	$21^{00}-23^{00}$	59°03'N	12°24'W	24	62-122m Schlauch

Dazu kommen 8 ca. drei-stündige Meßserien mit Wasser aus dem Hydroschacht bei fahrendem Schiff.

JASIN FORM 5: CRUISE SUMMARY

(to be completed during each cruise leg)

Ship F.S. POSEIDON Principal Scientist J.D. WOODS Phase 2

2. Period covered by this form 19 August - 5 September 1978

3. Instrumentation

Instrument	Individual responsible	Institute	Principal Investigator
TOWED UNDULATING FISH	Dr. H-P. HANSEN	INSTITUT FÜR MEERESKUNDE, KIEL FRG	Prof. J.D. WOODS
NEIL BROWN CTD	Dr. P.J. MINNETT	„	„
XBT	Dr. H. LEACH	„	„
FLUOROMETER	Prof. G. KULLENBERG	OCEANOGRAFISKA INSTITUTIONEN, GÖTEBORG SWEDEN	Prof. J.D. WOODS & Prof. G. KULLENBERG
RADON PROFILER	Prof. W. ROETHER	INSTITUT FÜR UMWELTPHYSIK, HEIDELBERG FRG	Prof. W. ROETHER

4. Interactive work with other platforms

Date	Time start	Time finish	Lat.	Long.	Platforms involved	Nature of work
24.08	0800	1200	58°58′	12°27′	METEOR	COMPARISON OF RADON PROFILERS & MET SYSTEMS
29.08 01.09	1200	0300	58°54′ 58°49′	12°20′ 12°08′	PLANET, SHACKLETON, TYDEMAN, DISCOVERY, ATLANTIS, ENDEAVOR, P2	SYNCHRONIZED CTD YO-YO TO 100m. §
02.09 03.09	1130	0300	59°26′ 59°27′	12°28′ 12°27′	METEOR, PLANET, H2, DISCOVERY, ENDEAVOR, ATLANTIS.	SYNCHRONIZED CTD YO-YO TO 100m. §
03.09 05.09	0830	0530	59°02′ 59°02′	12°24′ 12°28′	PLANET	500m CTD PROFILES AROUND FIA. §
05.09	1130	1230	59°02′	12°27′	AKADEMIK VERNADSKY	1000m CTD
§ WITH BREAKS FOR RADON PROFILES.						

For all work within 1 nm of met. buoy fill in Form 6.

P.T.

Narrative (see also activity-time diagram).

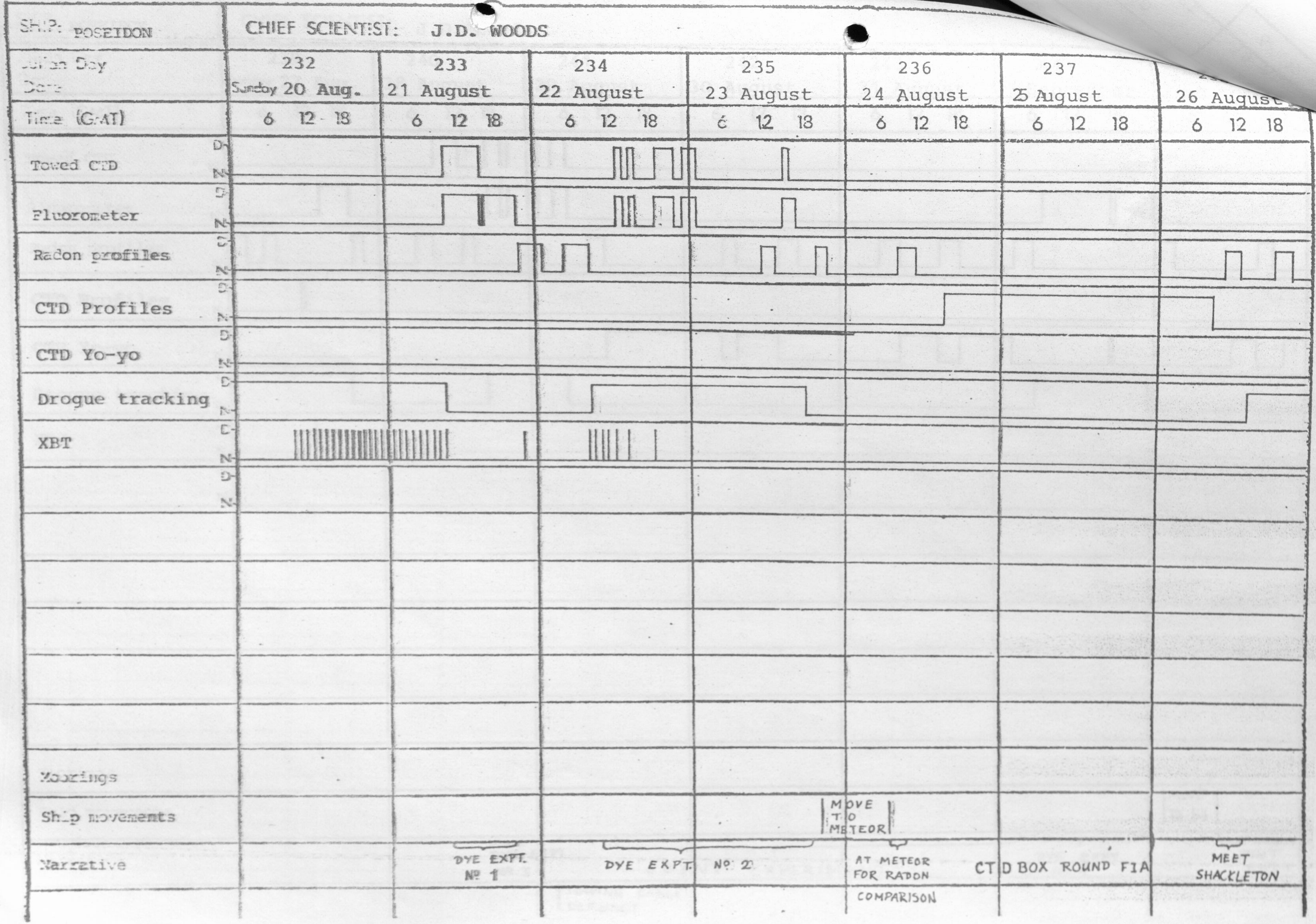
F.S. POSEIDON arrived in the JASIN area at 0700 on 19.8.78. After a 4 hour radon profile using the towed fish an experiment was made to investigate the mixing of a dye patch, using the CTD and fluorometer also mounted in the fish. During this experiment the electrical conductors in the cable began to break, but some 28 hours of CTD and fluorometer data were collected before the towing cable became useless at 0530 on 29.8.78. Vertical CTD profiles were made from 1559 on 24.8.78 to 0929 on 26.8.78 to a depth of 500m about 0.5n.miles apart along sections 4 to 5n.miles in length forming a closed box around the FIA. Corner stations were to 1000m. This procedure was repeated between 0828 on 3.9.78 and 1447 on 5.9.78. Between these two surveys a series of 100m CTD yo-yo stations were made in the period from 1155 on 29.8.78 to 0259 on 3.9.78. The yo-yos were started at 5 min. intervals in synchronization with those from other ships. A further dye experiment was made on 1.9.78 using a fluorometer towed at slow speed. Parachute drogues were released, in conjunction with the dye experiments and on other occasions, to monitor the near-surface flow. A further 23 radon profiles from the drifting ship were made during Phase 2, including a comparison station with METEOR on 24.8.78, and about 24 hours of surface radon samples were collected with the ship underway. 36 XBTs were released in the area. F.S. POSEIDON left the JASIN area at 1500 on 5.9.78 after a 1000m CTD comparison station with the AKADEMIK VERNADSKY earlier that day.

6. Moorings.

Mooring no.	Position set	Posn.recovered	Type/depths of sensors

SHIP: POSEIDON CHIEF SCIENTIST: J.D. WOODS

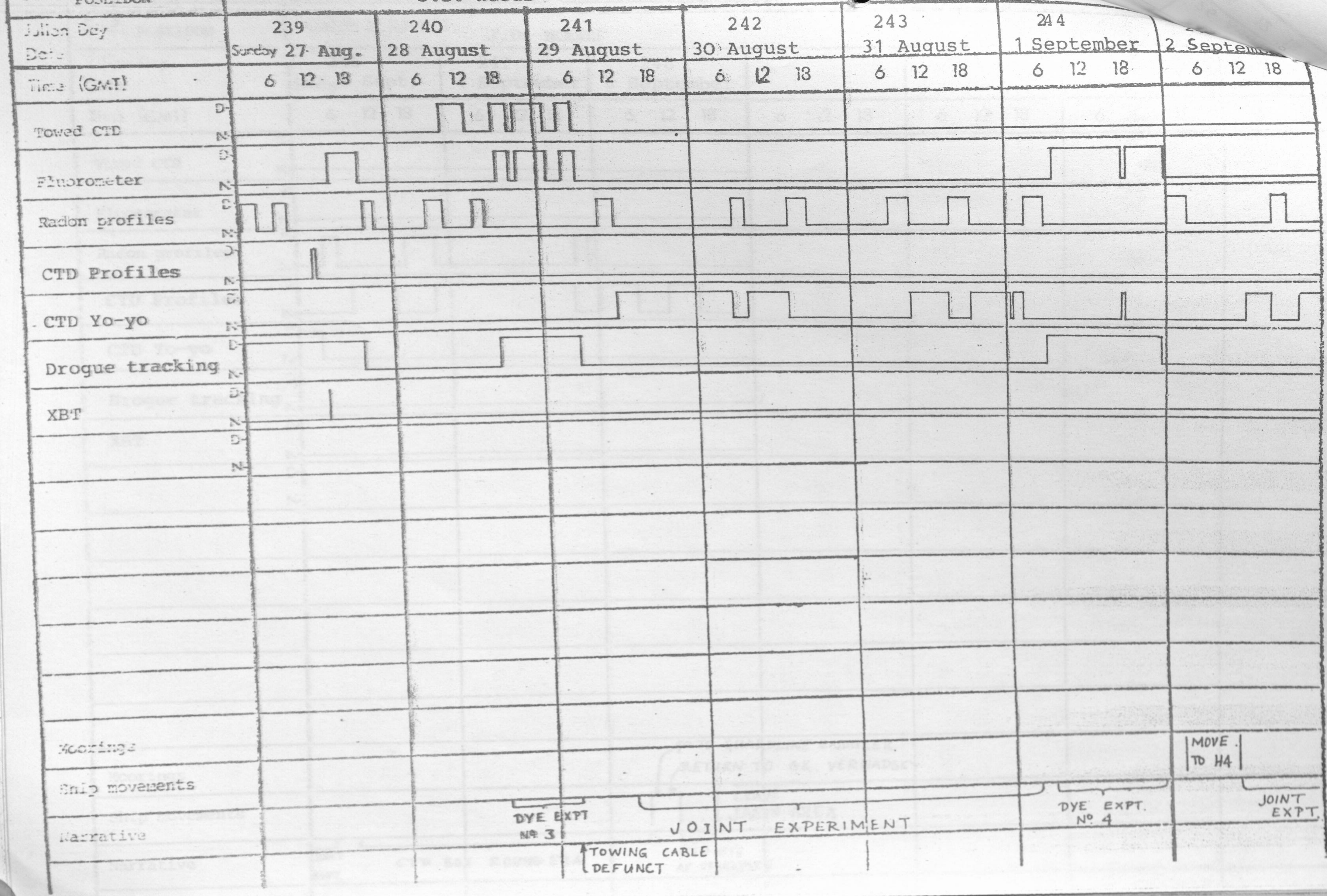
Julian Day		225	226	227	228	229	230	231
Date		Sunday 13 Aug.	14 August	15 August	16 August	17 August	18 August	19 August
Time (GMT)		6 12 18	6 12 18	6 12 18	6 ?2 18	6 12 18	6 12 18	6 12 18
Towed CTD	D N							
Fluorometer	D N							
Radon profiles	D N							
CTD Profiles	D N							
CTD Yo-yo	D N							
Drogue tracking	D N							
XBT	D N							
	D N							
Moorings								
Ship movements			DEPART KIEL					ARRIVE JASIN AREA
Narrative			ON	PASSAGE	— NAVIGATION T	RIALS & INST	RUMENT TESTS	



SHIP: POSEIDON	CHIEF SCIENTIST: J.D. WOODS						
Julian Day	232	233	234	235	236	237	
Date	Sunday 20 Aug.	21 August	22 August	23 August	24 August	25 August	26 August
Time (GMT)	6 12 18	6 12 18	6 12 18	6 12 18	6 12 18	6 12 18	6 12 18
Towed CTD							
Fluorometer							
Radon profiles							
CTD Profiles							
CTD Yo-yo							
Drogue tracking							
XBT							
Moorings							
Ship movements				MOVE TO METEOR			
Narrative		DYE EXPT. Nº 1	DYE EXPT. Nº 2		AT METEOR FOR RADON COMPARISON	CTD BOX ROUND FIA	MEET SHACKLETON

SHIP: POSEIDON

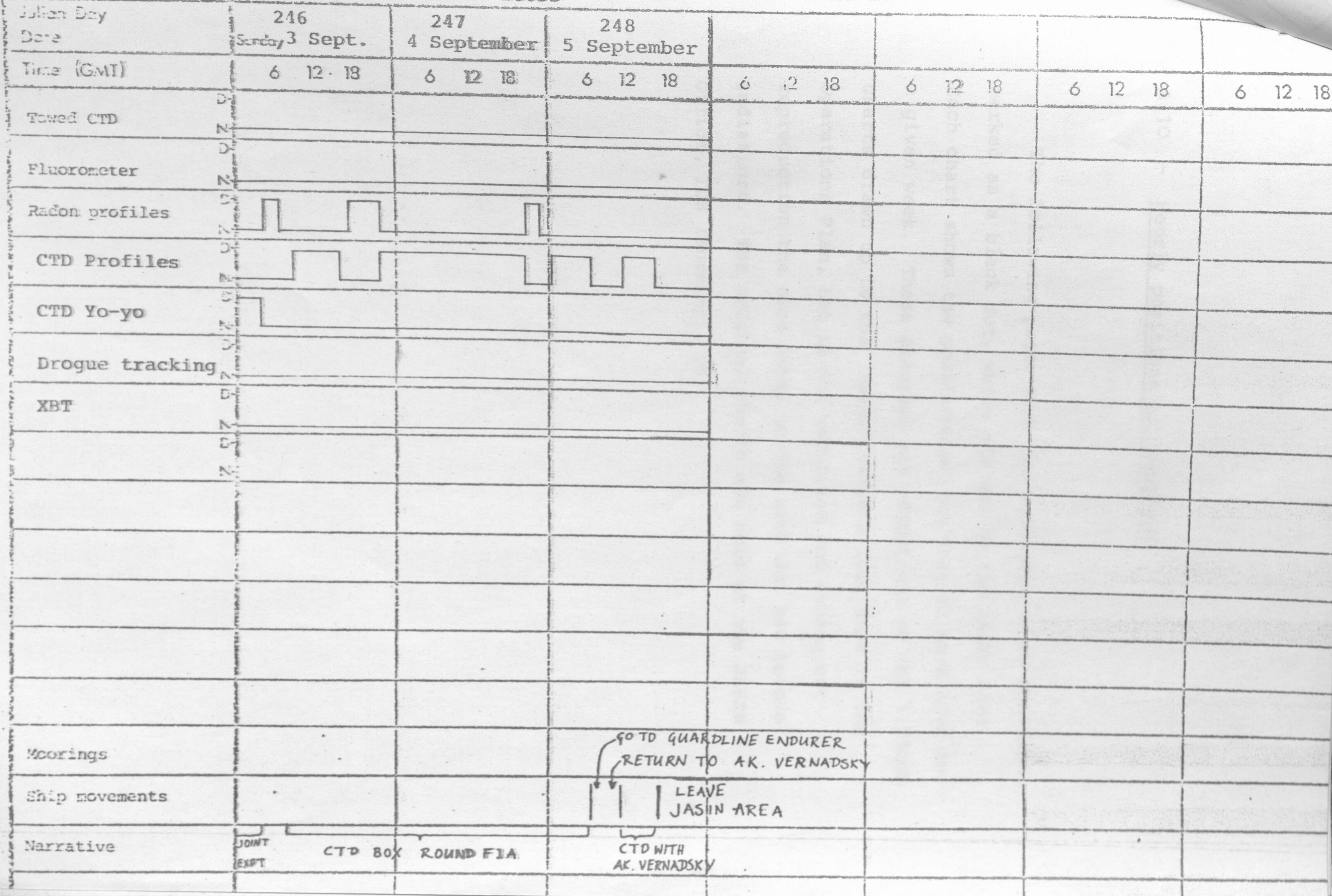
CHIEF SCIENTIST: J.D. Woods



SHIPBOARD ACTIVITY DI[illegible]AM

SHIP: POSEIDON

CHIEF SCIENTIST: J.D. WOODS

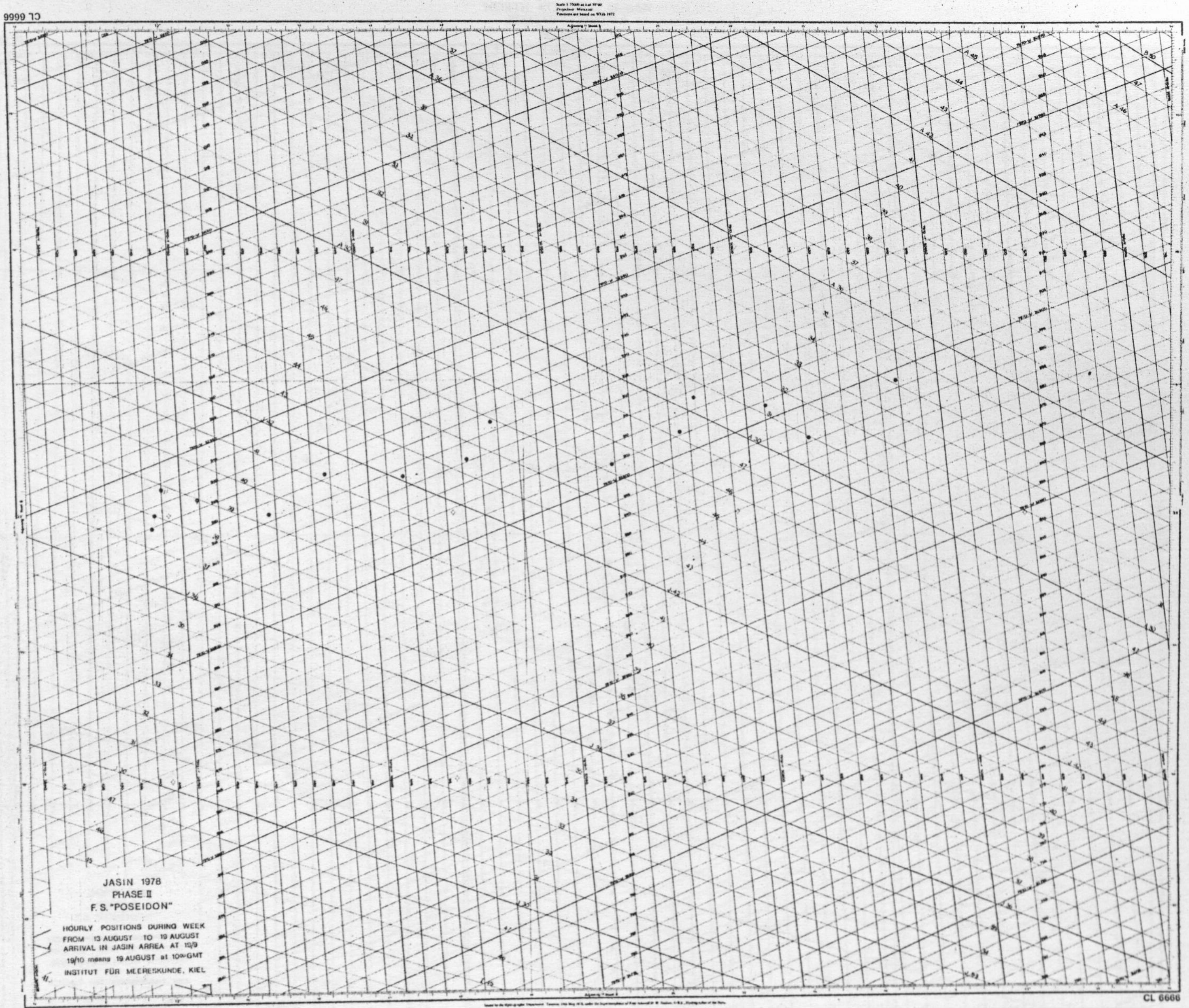


A 10 - Hourly positions of POSEIDON

The following pages show the positions of FS POSEIDON, marked as a black dot, while she was in the JASIN area. Each chart shows the positions at the turn of each hour for a given week. These diagrams are reductions of the 1:75000 charts drawn up to the specifications laid down in the Operations Plan, but in the reduction and subsequent reproduction the time label beside each dot has become indistinct. The original charts are held at the JASIN Office, IOS (Wormley), UK.

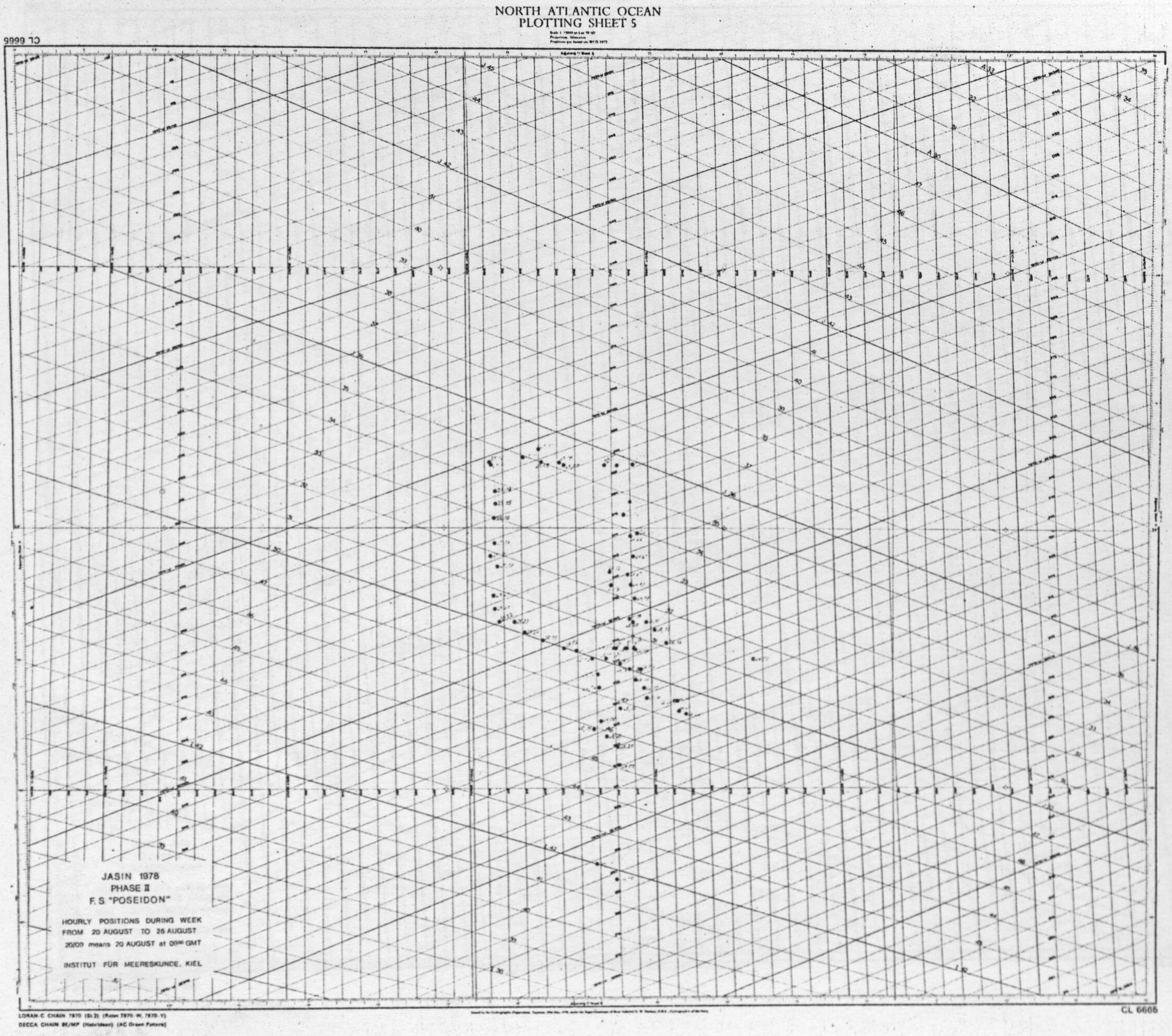
NORTH ATLANTIC OCEAN
PLOTTING SHEET 6

Scale 1:[illegible] at Lat [illegible]
Projection Mercator
Positions are based on WGS 1972

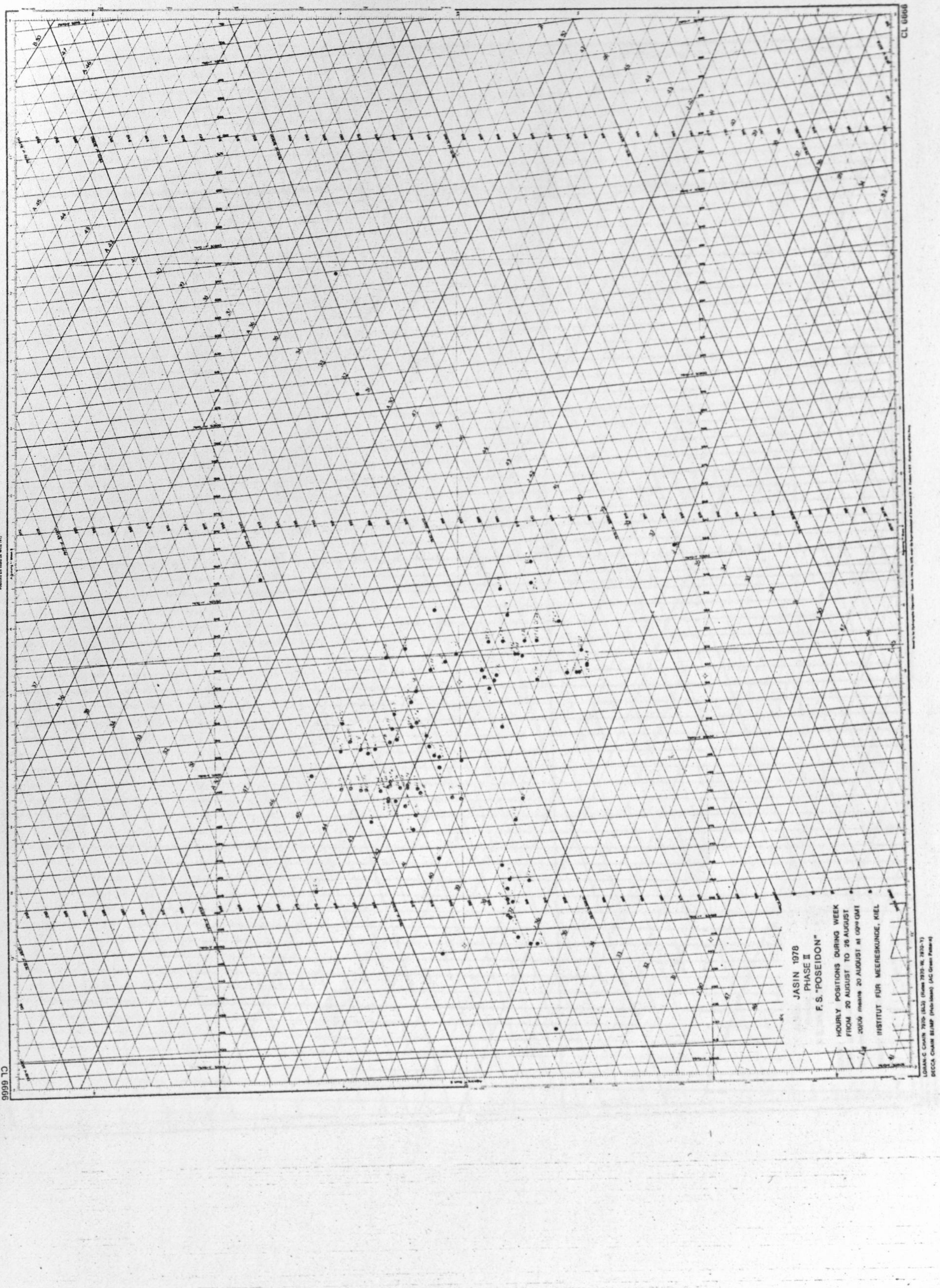


JASIN 1978
PHASE II
F. S. "POSEIDON"

HOURLY POSITIONS DURING WEEK
FROM 13 AUGUST TO 19 AUGUST
ARRIVAL IN JASIN ARREA AT 19/9
19/10 means 19 AUGUST at 10⁰⁰GMT
INSTITUT FÜR MEERESKUNDE, KIEL


NORTH ATLANTIC OCEAN
PLOTTING SHEET 5
CL 6666
CL 6665
JASIN 1978
PHASE II
F. S "POSEIDON"
HOURLY POSITIONS DURING WEEK
FROM 20 AUGUST TO 26 AUGUST
20/00 means 20 AUGUST at 00⁰⁰ GMT
INSTITUT FÜR MEERESKUNDE, KIEL
LORAN-C CHAIN 7970 (SL3) (Rates 7970-W, 7970-Y)
DECCA CHAIN 8E/MP (Hebridean) (AC Green Pattern)

NORTH ATLANTIC OCEAN
PLOTTING SHEET 6

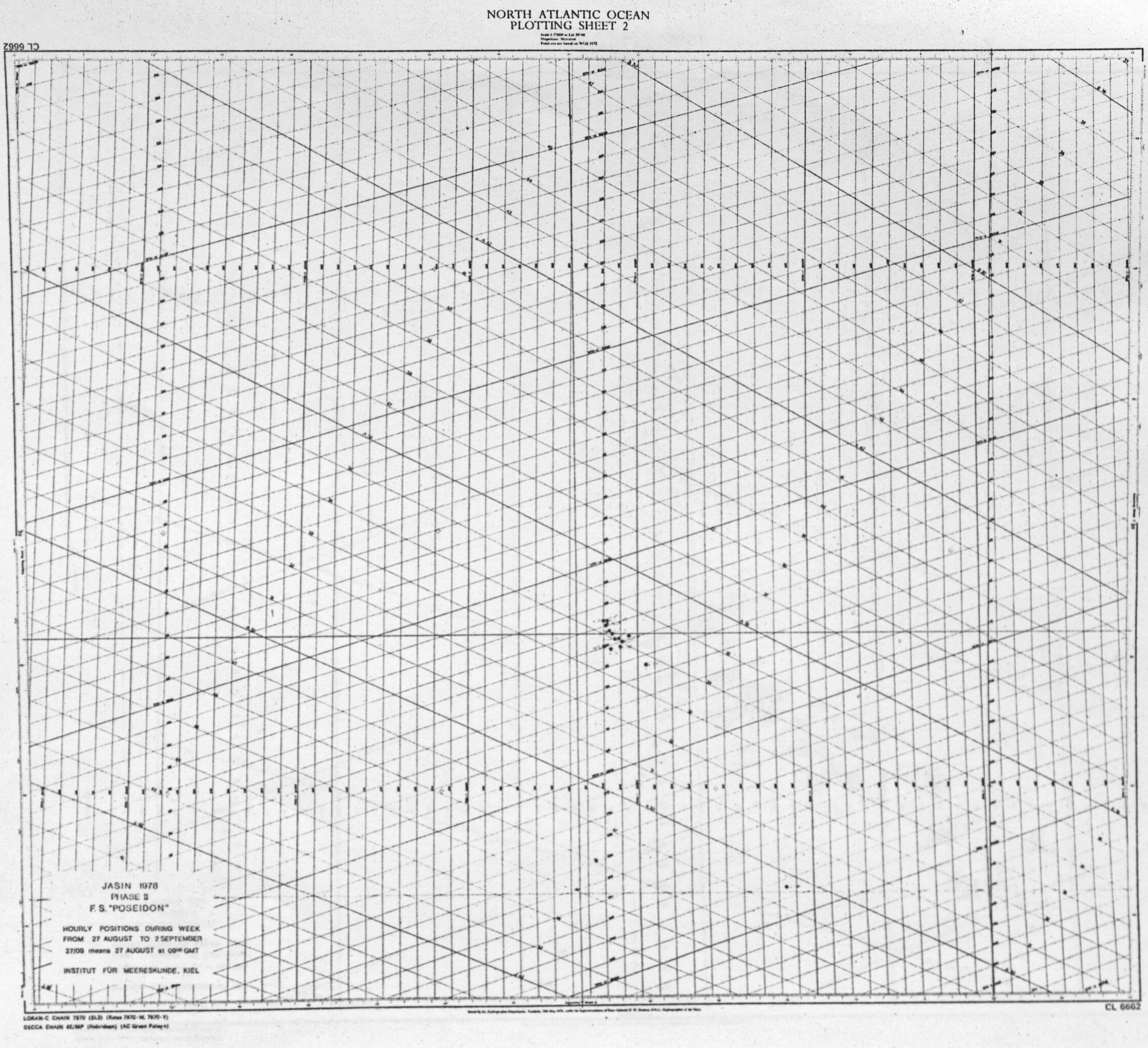


JASIN 1978
PHASE II
F.S. "POSEIDON"

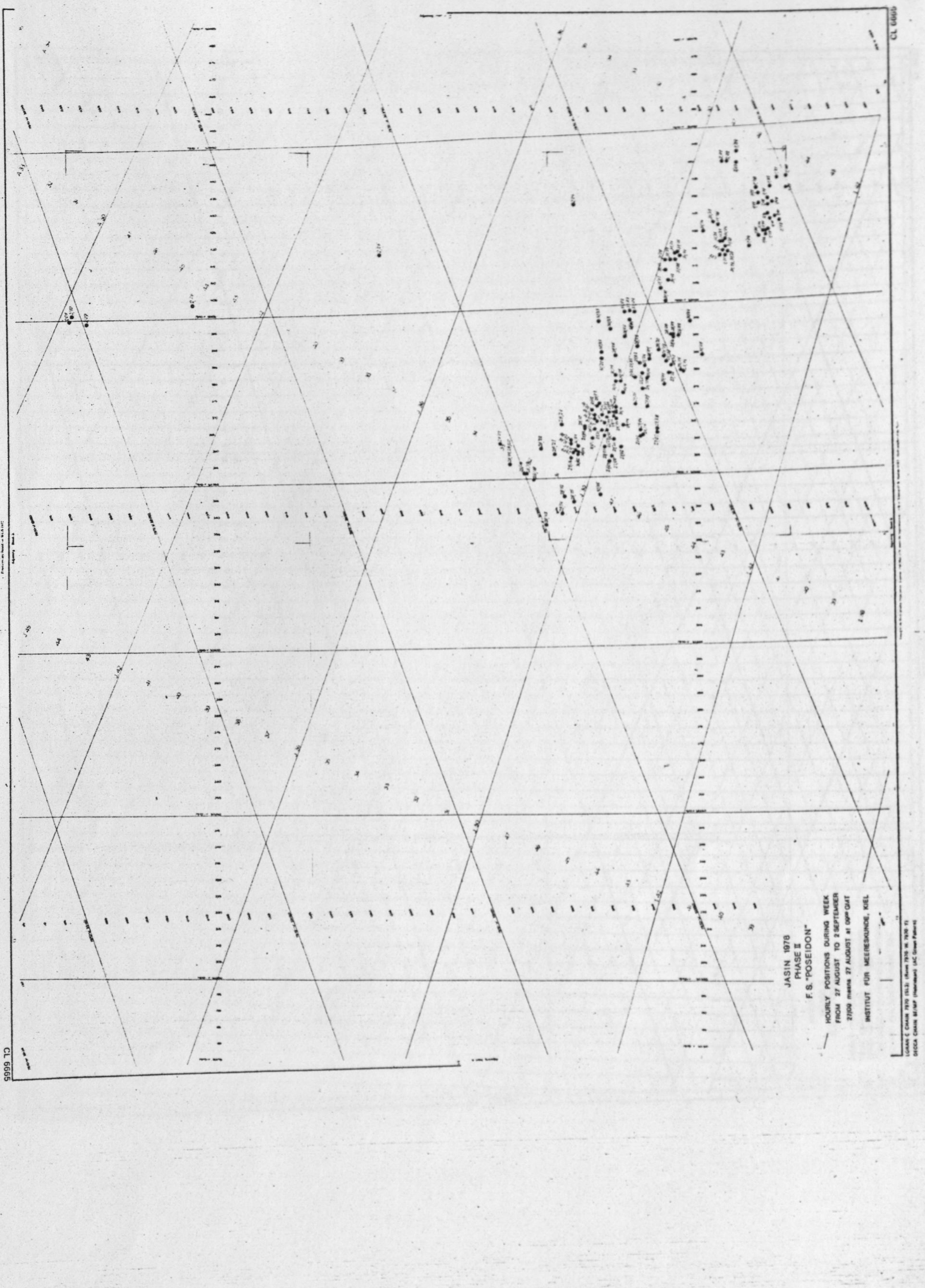
HOURLY POSITIONS DURING WEEK
FROM 20 AUGUST TO 26 AUGUST
20/00 means 20 AUGUST at 00^00 GMT

INSTITUT FÜR MEERESKUNDE, KIEL

LORAN-C CHAIN 7970- (SL3) (Rates 7970-W, 7970-Y)
DECCA CHAIN 8E/MP (Hebridean) (AC Green Pattern)


NORTH ATLANTIC OCEAN
PLOTTING SHEET 2
Scale 1:75000 at Lat 59°00'
Projection: Mercator
Positions are based on WGS 1972
CL 6662
JASIN 1978
PHASE II
F. S. "POSEIDON"
HOURLY POSITIONS DURING WEEK
FROM 27 AUGUST TO 2 SEPTEMBER
27/09 means 27 AUGUST at 09⁰⁰ GMT
INSTITUT FÜR MEERESKUNDE, KIEL
CL 6662
LORAN-C CHAIN 7970 (SL3) (Rates 7970-W, 7970-Y)
DECCA CHAIN 8E/MP (Hebridean) (AC Green Pattern)

NORTH ATLANTIC OCEAN
PLOTTING SHEET 5



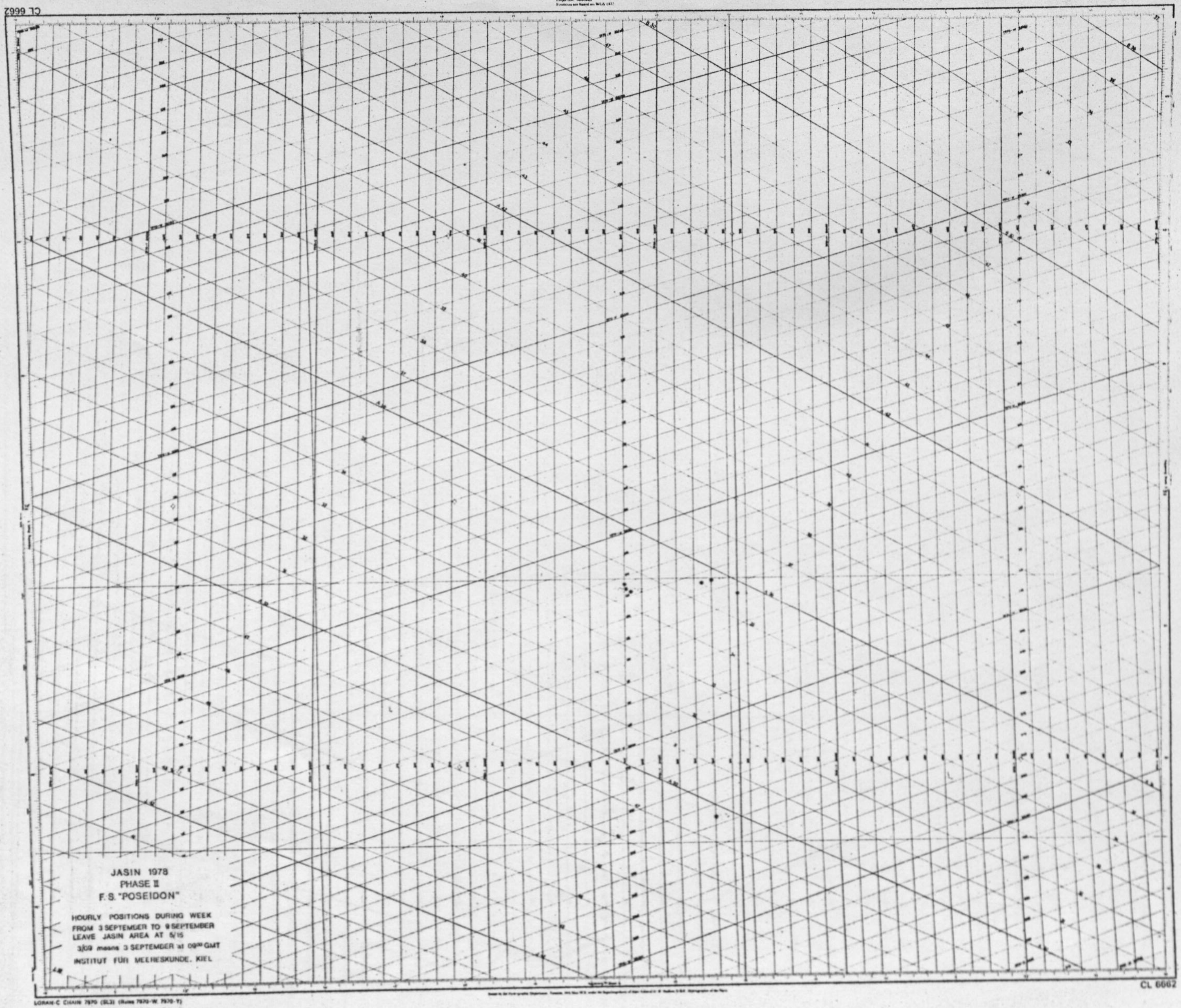
JASIN 1978
PHASE II
F.S. "POSEIDON"

HOURLY POSITIONS DURING WEEK
FROM 27 AUGUST TO 2 SEPTEMBER
27/09 means 27 AUGUST at 09^{00} GMT

INSTITUT FÜR MEERESKUNDE, KIEL

NORTH ATLANTIC OCEAN
PLOTTING SHEET 2

Scale 1:75000 at Lat 59°00'
Projection: Mercator
Positions are based on WGS 1972

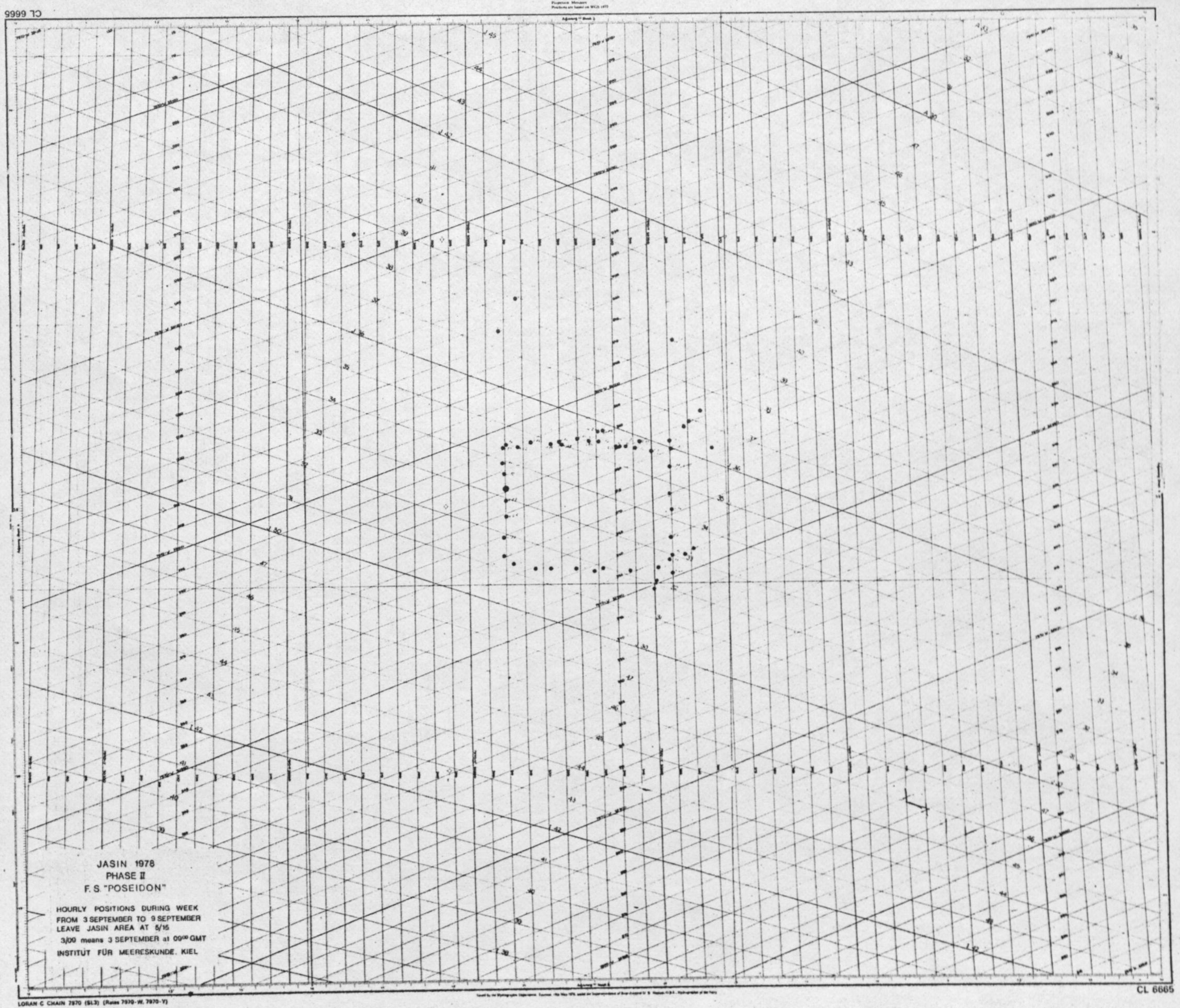


JASIN 1978
PHASE II
F.S. "POSEIDON"

HOURLY POSITIONS DURING WEEK
FROM 3 SEPTEMBER TO 9 SEPTEMBER
LEAVE JASIN AREA AT 5/15
3/09 means 3 SEPTEMBER at 09^00 GMT
INSTITUT FÜR MEERESKUNDE, KIEL

LORAN-C CHAIN 7970 (SL3) (Rates 7970-W. 7970-Y)
DECCA CHAIN 8E/MP (Hebridean) (AC Green Pattern)

NORTH ATLANTIC OCEAN
PLOTTING SHEET 5



JASIN 1978
PHASE II
F. S. "POSEIDON"

HOURLY POSITIONS DURING WEEK
FROM 3 SEPTEMBER TO 9 SEPTEMBER
LEAVE JASIN AREA AT 5/15
3/00 means 3 SEPTEMBER at 09^{00} GMT
INSTITUT FÜR MEERESKUNDE, KIEL

LORAN C CHAIN 7970 (SL3) (Rates 7970-W, 7970-Y)
DECCA CHAIN 8E/MP (Hebridean) (AC Green Pattern)