P.O.L.

RRS CHALLENGER

CRUISE 123

LEG A:

SOUTHAMPTON

to

ARDROSSAN

15 NOVEMBER 1995

to

29 NOVEMBER 1995

Dr. J.M. HUTHNANCE

LOIS SHELF EDGE STUDY

CRUISE REPORT NO. 21

1995

Natural Environment Research Council

PROUDMAN OCEANOGRAPHIC LABORATORY

POL CRUISE REPORT NUMBER 21

RRS CHALLENGER CRUISE 123

LOIS SHELF EDGE STUDY

Leg A: Southampton to Ardrossan

Principal Scientist: Dr. J.M. Huthnance

DOCUMENT DATA SHEET

AUTHOR

HUTHNANCE, J.M.

PUBLICATION DATE 1995

TITLE

CRUISE REPORT *RRS CHALLENGER* 123A, 15 - 29 November 1995.
LOIS Shelf Edge Study.

REFERENCE

Proudman Oceanographic Laboratory, Cruise Report, No. 21

ABSTRACT

RRS *Challenger* cruise 123 was the fourth of seven at approximately 3-month intervals as part of the UK Land-Ocean Interaction Study (LOIS) Shelf Edge Study.

Leg A of the cruise was badly affected by weather; several days were spent hove to or sheltering. Only about three days' light (out of 10 potentially) was available for SES mooring recovery and deployment. In this time, of the south line moorings:

- those at S140 were all recovered and (re-) deployed as planned except that the wave-rider remained adrift and the meteorological buoy was not recovered;
- the S300 and S700 marker toroid moorings and the S300 sub-surface mooring were deployed, but not the S700 sub-surface mooring;
- the S400 ADCP was recovered but not redeployed.

The north line was not visited, no bottom pressure recorders were recovered or deployed and there was no dragging for previously-lost equipment, although two releases were contacted.

CTD stations were carried out in association with all the actual mooring recoveries and deployments, and at a few other stations of particular interest for water samples.

SeaSoar tracks were confined to 2½ nights after neap tides; tracks were run along the slope at approximate depths 1000 m, 500 m and 170 m as planned; two short tracks were run across the upper slope (above about 700 m) and adjacent shelf. On the last recovery, SeaSoar was found to have some external damage; apparently some unknown object had been struck.

Throughout the cruise, CO was estimated in the atmosphere, and in the water from the non-toxic supply (underway) but not from (CTD) bottle samples.

The POL 75 kHz ADCP was deployed for testing in 587 m water, but not recovered.

Three in-line acoustic releases were tested in 100 m water in the Sound of Jura.

ACKNOWLEDGEMENT. The scientific party extends warm thanks to the Master, G.M. Long, Officers and crew of RRS *Challenger* for their help and co-operation during the cruise, and to RVS for its support, all willingly given and making the scientific work possible.

ISSUING ORGANISATION

Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside L43 7RA
UK

Director: Dr B S McCartney

TELEPHONE
051 653 8633

TELEX
628591 OCEAN BG

TELEFAX
051 653 6269

KEYWORDS
HEBRIDES SEA, NWEURHEB, LOIS, HYDROGRAPHY, MOORINGS, EXCHANGE, CONTINENTAL SHELVES, CONTINENTAL SLOPE

CONTRACT

PROJECT MSH-11-6

PRICE £9.00

Copies of this report are available from:
The Library, Proudman Oceanographic Laboratory.

CONTENTS

1. OBJECTIVES

LOIS-Shelf Edge Study (SES) Objectives are:-

(a) to identify the time and space scales of ocean-shelf momentum transmission and to quantify the contributions to ocean-shelf water exchange by physical processes;

(b) to estimate fluxes of water, heat and certain dissolved and suspended constituents across a section of the shelf edge with special emphasis on net organic carbon export from, and nutrient import to, the shelf;

(c) to relate sediment properties and fluxes to the physical context;

(d) to quantify organic carbon cycling in shelf-edge sediments;

(e) to incorporate process understanding into models which will be tested by comparison with observations and provide a basis for estimation of fluxes integrated over time and the length of the shelf edge.

These SES objectives are being pursued by measurements at the shelf edge west of Scotland, and by the development of numerical models representing physical processes and microbiology. The overall plan for measurements includes an initial sea-bed survey, maintenance of moorings from spring 1995 to summer 1996, seasonal measurements of distributions, coring, tracking of drogued buoys and remote sensing. RRS *Challenger* cruise 123/95 is the fourth of a sequence of seven planned SES cruises at intervals ~ 3 months.

Specific Objectives for Leg A of *RRS Challenger* Cruise 123/95 were:

1.1 Recoveries and reployment of mooring array

	Latitude N	*Long.W / depth*	*Configuration*	*Instruments*
"South"	56°27.6′	(9°39′) 1500	BP	
section	56°27.6′ + 27.14′	(9°9.5′) 700	pop-up + 1-strand	3 × RCM, Tc; Tr
	56°27.6′	(9°5′) 400	ADCP	
	56°27.6′ + 27.14′	(9°4′) 300	pop-up + 1-strand	3 × RCM; Tr
	56°27.6′ + 27.14′	8°58′,57.5′ (145)	"U", toroid, 8′, BP/ADCP, wavebuoy	
"North"	56°42.6′ + 43.13′	(9°24.5′) 1500	pop-up (check), pop-up (CM), BP	
section	56°37.45′	(9°1.35′) 300	1-strand	3 × RCM
	56°36.3′ + 35.9′	(8°56.1′) (138)	marker buoy, BP	

(BP - bottom pressure recorder; RCM / CM - current meter; ADCP - acoustic doppler current profiler; Tc - thermistor chain; Tr - transmissometer). "Recoveries" includes searching and possibly grappling for BPs (S1500, N1500), mooring remnants (S700, S300, N300, N200, S140 at N140 and at locations ~60mi SE and 15mi S of S200) and a displaced wavebuoy.

1.2 CTD and water sampling at locations of mooring deployments, before recovery and after redeployment. The CTD should record C, T, DO, transmittance, fluorescence, irradiance. Samples should be analysed for S, nutrients (autoanalyser), stored for subsequent analysis of DOC, DON, and filtered for subsequent analyses of particulates and plankton. Some 12-hour stations in connection with CO sampling, and some dips for calibration purposes.

1.3 Under-way (SeaSoar) profiling of sections N, P, R, S across the slope from 140 to 1600m depth and along the slope from 56°18′N to 56°44′N in depths 170, 500, 1000 m, after neap tides and after spring tides. The intent was to repeat the 170 m section 3 to 4 times to span a tidal period.

1.4 Estimates of air-sea exchange (especially carbon monoxide).

1.5 Test deployment and recovery of POL 75kHz ADCP in 600-700 m water depth.

1.6 Test in-line acoustic releases.

2 SUMMARY

The cruise was badly affected by weather. In the limited time available:

2.1 The moorings at S140 were all recovered and (re-) deployed as planned except that the wave-rider remained adrift and the meteorological buoy was not recovered;

the S300 and S700 marker toroid moorings and the S300 sub-surface mooring were deployed, but not the S700 sub-surface mooring;

the S400 ADCP was recovered but not redeployed.

The north line was not visited, no bottom pressure recorders were recovered or deployed and there was no dragging for previously-lost equipment, although two releases were contacted.

2.2 CTD stations were carried out in association with all the actual mooring recoveries and deployments, and at a few other stations of particular interest for water samples.

2.3 SeaSoar tracks were confined to 2½ nights after neap tides; tracks were run along the slope at approximate depths 1000 m, 500 m and 170 m as planned; two short tracks were run across the upper slope (above about 700 m) and adjacent shelf. On the last recovery, SeaSoar was found to have some external damage; apparently some unknown object had been struck.

2.4 Throughout the cruise, CO was estimated in the atmosphere, and in the water from the non-toxic supply (underway) but not from (CTD) bottle samples.

2.5 The POL 75 kHz ADCP was deployed for testing in 587 m water depth, but not recovered.

2.6 Three in-line acoustic releases were successfully tested in 100 m water in the Sound of Jura.

B3. PERSONNEL ON BOARD

Scientists

J. M.	Huthnance (PS)	POL
N. G.	Ballard	POL
A. D.	Banaszek	POL
A. J.	Harrison	POL
R.I.R.	Palin	POL
D.A.	Neave	BODC
I. A.	Ezzi	DML
F.	Perez-Castillo	UWB
T.	Sjoberg	PML
H. C.	Anderson	RVS
A.	Taylor	RVS
P. G.	Taylor	RVS
S.	Watts	RVS
J.	Wynar	RVS

Officers and crew

G. M.	Long	Master
P. W.	Newton	C/O
D. H.	Thomas	2/O
J. C.	Holmes	3/O
B.	McDonald	C/E
J. R.	Crosbie	2/E
C. J.	Phillips	3/E
P. G.	Parker	ELEC
G. A.	Pook	CPO(D)
P. R.	Bennett	PO(D)
G.	Crabb	SG.1A
H. R.	Hebson	SG.1A
R.	Johnson	SG.1A
J. C.	Manning	SG.1A
R.	Bell	S.C.M.
G.	Welch	Chef
W. J.	Link	Steward
R.	Stephen	Steward
G.	Slater	MM.1A

4. NARRATIVE

(Note all times GMT). See Figs. 1 to 4 for general area map and cruise tracks.

15/11/95 RRS *Challenger* sailed from Southampton at 0800 as planned, taking a course around the eastern side of the Isle of Wight, so avoiding the Needles, owing to uncertainty about the engines. Course was then made down the Channel, around Cornwall (**16/11/95**) and through the Irish Sea (**17/11/95**) in generally light to moderate conditions but into the wind. The underway sampling and thermosalinograph were started about 1100 on 15/11/95, and the ship-borne ADCP also that day. Opportunity was taken for emergency drill (15/11/95 at 1615).

18/11/95 RRS *Challenger* passed through the North Channel in the early morning. As the SES mooring array would not be reached during daylight, it was decided to proceed to the last Argos-recorded position of S200, *en route*. Acoustic contact using an overside transducer was sought in the vicinity of 55°44.5′N, 7°41′W (1305-1315) but without success. Course was then made for a second search site. Near 56°14.8′N, 9°09.9′W, release #254 from S200 deployed on CD93 was contacted at a range of about 1350m, and release #260 from S200 deployed on Ch 121 at a range of about 2480m (1930-2000). Both were on their side. RRS *Challenger* then proceeded to the start of the night's SeaSoar runs. Two sets of acoustic release tests were carried out successfully on the hydrographic wire: nos. 6A and 4B to 50m; nos. 262 and 223 to 700m (2050-2200). Then CTD1 was carried out to 400m (2210-2250). SeaSoar was launched (2310) and all the faired cable paid out (2325). Tracks were run ~

northwards in depth ~ 1000m (to 0250 on **19/11/95**) and ~ southwards in depth ~ 500m between 56°20'N and 56°44'N (0320-0555).

19/11/95 SeaSoar was recovered (0555-0645) and RRS *Challenger* headed directly for the S140 area (no CTD) to enable mooring operations to commence and fully exploit the available daylight. In reasonable conditions the 8-foot marker toroid was deployed (0815-0915) and the ADCP and spooler contacted acoustically, released, sighted, grappled and hauled in (0940-1015). CTD2 was carried out (1030-1055).

Next, the S140 "U"-shaped mooring was recovered (1115-1315), protracted by several failed attempts to grapple and secure the spar buoy (pellet line missing, a line parted after the first successful attempt at grappling), trouble removing the first anchor clump from the line, twisted cable, tangled chain at the second anchor clump and unravelling of the 75m thermistor chain from the subsurface line. In the time prior to redeployment, contacts with other missing acoustics were attempted without success, and a calibration cast CTD3 was carried out (1440-1500) for transmissometers. Preparations continued for the eventual successful redeployment of the S140 "U"-shaped mooring (sub-surface buoy first, spar buoy last: 1645-1705).

RRS *Challenger* moved to position and the S140 ADCP was redeployed at 1724. CTD4 was carried out (1740-1800). RRS *Challenger* moved to S400 to check the status of the RDI ADCP there (in preparation for the following day's strategy); there seemed to be a response by the acoustic release at the right frequency but it was possibly already pinging - an unknown source was giving a rapid response masking the range recorded by the deck unit.

RRS *Challenger* proceeded to the 170m along-slope SeaSoar line. SeaSoar was deployed (1910-1930) on a short length (~ 160m) of faired cable and secured for the night's repeated traverses. Conditions had continued reasonable with slow improvement all day.

20/11/95 SeaSoar was hauled in (0630-0700) after covering the 170m line northwards (northern half), southwards, northwards and southwards again (northern half). CTD5 (0725-0740) was carried out; one Niskin bottle came back broken at its mounting, not thought to have been the result of any untoward knock during deployment. Wind and waves had been increasing and after this CTD RRS *Challenger* hove to for the rest of the day, during which winds reached 35-40 knots from the SE going S.

21/11/95 Winds decreased to 20 knots in the early morning and RRS *Challenger* proceeded back to the S140 area to assess conditions. These proved possible for CTDs but were judged too rough for recoveries. CTD6 to CTD9 were carried out in a line across the shelf edge at nominal locations S140, S160, S200, S300 (times 0940-1000; 1105-1120; 1145-1200; 1230-1305) to investigate the cross-slope structure of warmer fresher water overlying cooler saline water shown on the SeaSoar 170m transects. Meanwhile the S400 ADCP acoustic release was further investigated (near-instant signals continued to be received in contrast with S140) and the POL 75kHz ADCP was prepared for trial deployment.

This ADCP deployment was carried out at 1350 at nominal position S600. Further attempts to range on the S400 ADCP from S600 (apparently with successful contact), S500 (no consistent contact) and S400 (repeated contact but rather excessively varying range) were overall inconclusive; visibility was considered too poor by then (~1515) to risk an attempt at recovery. Course was made towards the S140 instrumented toroid, and an associated CTD10 was made (1607-1622) in anticipation of recovering the toroid. However, on approaching the toroid, no stray line was visible; in view of the marginal conditions and approaching darkness it was decided not to attempt recovery.

At 1650 approximately, RRS *Challenger* headed towards R700, the intended start point for SeaSoar through the night. Pause was made near 400m depth for another attempt at acoustic contact with S400 (about 3 miles to the south) and near 700m depth for wire tests of acoustic releases (1810-1905). Then SeaSoar was deployed (1935 in water - 1955 line paid out) and towed for three hours along the route R700, R140, P140, P700 across the upper slope (twice) and outer shelf until increased winds (to 40 knots) forced recovery (2300-2350). It was found that the front ballast weight had been lost and that its support and bottom outer panel had been knocked back, suggesting that SeaSoar had hit something in the water.

22/11/95 Conditions prevented any further work and RRS *Challenger* hove to in westerly winds and sea. At 1500 she proceeded to make for shelter from an approaching depression with forecast force 9 winds and 7-8 m swell.

23/11/95 Around dawn RRS *Challenger* reached shelter off Londonderry, and remained there while strong SW winds, and northerly winds further offshore and to the north, persisted around a slow-moving depression off NW Ireland.

24/11/95 After a forecast of force 4 for E Malin, RRS *Challenger* left (~1430) heading for the SES area. However, as soon as open water was reached (~1530), 40-45 knot winds on the west side of the depression were encountered. In view of their expected tracking eastwards, course was made to shelter east of Islay.

25/11/95 During the early morning hours of darkness, RRS *Challenger* stood by a fishing boat that was taking on water, until a coastguard helicopter and lifeboat arrived. The latter towed the fishing boat to a harbour on Jura.

In view of continued forecasts of winds to 45 knots in the SES area, and the swell already expected there, prolonged sheltering east of Islay was expected, and it was decided to make some use of this time. CTD11 (1120-1140) and CTD12 (1225-1240) were carried out in deeps in the Sound of Jura. Acoustic releases were wire-tested: Benthos (1320), Sonardyne numbers 2D (1340) and 70 (1400). They were subsequently deployed anchor-first on light moorings (each with anchor, short wire, release, ~ 10 m rope, package of buoyancy spheres and stray line): Benthos at 1436, Sonardyne 70 at 1451, Sonardyne 2D at 1507. Then RRS *Challenger* proceeded to the estimated location of the sill to the North Channel for CTD13 (1630-1645). RRS *Challenger* returned towards the acoustics moorings for successive attempts to range from ~ 10, 6, 4, 2 km with increasing success (1720-1925). Subsequent ranging tests were carried out as RRS *Challenger* proceeded northwards away from the moorings; from ~ 3 km, and 8.1 km for the Benthos, for which a new deck unit and monitoring on the Simrad hull transducer were also tested (2000-2145). CTD14 was carried out in the deepest known trough of the Sound of Jura (2225-2245).

26/11/95 The three acoustic moorings were recovered in order: Benthos (fired at first attempt at 0.55 km after ranging from 1.6 km; 0830-0845), Sonardyne 70 (fired, first attempt, 0.6 km; 0900-0910), Sonardyne 2D (fired, probably at first attempt judging from time seen at surface, but a second command was sent due to an ambiguous message on the Psion control, 0.41 km; 0925-0935). Then (0940) RRS *Challenger* made course for the SES area. CTD15 was carried out at S140 (2200-2220) anticipating recovery of the instrumented toroid there. Further ranging was then carried out to determine the position of the ADCP at S400.

27/11/95 The high-priority station at R1000 followed (CTD16: 0150-0255). Then RRS *Challenger* proceeded to S300. After some preparation on deck (0600-0625), the sub-surface mooring was deployed buoy first without any hold-ups (0625-0712). After daylight, the S400 ADCP position now confirmed to be as deployed, its release was fired (0850) and it was recovered without incident (0910). Course was made for the "S600" position of the 75kHz ADCP test; however, repeated executions of the firing sequence apparently failed to release the frame. After the same result with a new deck unit, the site was abandoned.

RRS *Challenger* proceeded to S140 and the instrumented toroid was recovered without incident (1120-1145). Returning to S300, CTD17 was carried out (1255-1330) for the morning's deployment and to calibrate a transmissometer for S700. Meanwhile, the marker toroid mooring for S300 was prepared on deck; it was deployed buoy first without any hold-ups bar a final tow to position (1350-1420). S140 was then revisited to calibrate the transmissometer (CTD18: 1510-1525) for the instrumented S140 toroid which was redeployed straightforwardly, buoy first (1535-1555).

Course was then made for S700 where the marker toroid mooring was rapidly deployed, buoy first (1655-1735). Subsequently RRS *Challenger* hove to while the S700 sub-surface instrumented mooring was prepared on deck. Attempts to range on the POL 75 kHz ADCP (1800-1830) were unsuccessful, leading to the conclusion that it had surfaced subsequent to the morning's attempted release. An acoustic release for the S400 ADCP was wire-tested (2000-2025). Then RRS *Challenger* returned to S140 for CTD19 (2130-2150) to calibrate the newly-deployed instruments on the toroid. The station at S700 (a priority site but also anticipating the instrumented mooring deployment) was carried out twice (CTD20, 2305-0010; CTD21, 0055-0135) owing to problems firing bottles.

Conditions had been reasonably good all the time, enabling a most productive day.

28/11/95 An intended deep CTD was not attempted owing to the constraint to return to S700 for a deployment at 0600. However, the wind increased to 30 knots from the east during the night, so that no mooring work was possible. In the conditions, the return to Ardrossan was expected to take all the remaining time, and (0625) this course was set. Progress was slowed by strong headwinds and waves, and in the evening the main propulsion motor failed.

29/11/95 From the early hours of the morning, propulsion was regained and gradually increased to near-normal levels. Adverse winds and weather continued but with some favourable tidal currents in the North Channel RRS *Challenger* eventually reached Ardrossan at 2030, about 12 hours later than originally scheduled.

5. TECHNICAL REPORTS

5.1 Moorings (A.J. Harrison)

Mooring activity was confined to the South section of the SES array due to bad weather, there being only three days in which mooring work was possible.

Of the *current meter* moorings:

- the "U" shaped current meter mooring at S140 was recovered and redeployed with two RCM current meters, the bottom one having a SeaTech transmissometer attached;
- the pop-up current meter mooring at S300 was deployed with three RCM current meters, a SeaTech transmissometer being fitted to the bottom one.

The *surface toroid* at S140 fitted with a fluorometer and transmissometer was recovered in good order but with much marine growth on the optical instruments. This was re-deployed with similar instruments attached.

Toroidal marker buoys were deployed at S140, S300 and S700.

ADCPs:

- the RDI ADCP at S140 was recovered successfully and re-deployed after down-loading the data successfully;
- the RDI ADCP at S400 was recovered after some delay in fixing its position due to lack of ranging capability from the release acoustics. Due to adverse weather, it was not re-deployed;
- A POL 75 KHz ADCP was deployed at S600 for a trial period. During recovery it failed to move off the sea bed immediately when the release was fired. However, it must have surfaced a short time later after the ship moved off-site, since when the position was re-occupied a few hours later there was no contact with the instrument.

5.2 Ship-borne ADCP (P.G. Taylor)

The RDI 150 KHz VM ADCP was run continuously and gave no problems. Data were recorded on the system PC using RDI *Transect* software. Water-tracking and bottom-tracking modes were automatically selected by the software. In good weather conditions, 500 m profiles were obtained and bottom tracking was maintained to depths greater than 400 m.

5.3 SeaSoar (S. Watts)

The system comprises: Chelsea Instruments SeaSoar vehicle; Neil Brown MkIII CTD; Chelsea Instruments MkIII Fluorometer; SeaSoar winch with 500 m faired cable; strain gauge. During the cruise, the SeaSoar was deployed three times. It generally performed very well and achieved a consistent yo-yo down to 350 m. This is a great improvement from its first cruise in which its flight path was very erratic.

The *first run* was parallel with the 1000 m contour and then back along the 500 m contour within the SES survey area. During most of the six-hour tow, the SeaSoar achieved 0 - 350 m easily without getting stuck at the surface or taking too long to turn at its deepest point. However, for the first few yo-yos the vehicle would not get closer than 25 m to the surface despite the *min* control being set to zero; this problem was resolved by a slight adjustment of the bias control.

The *second run* was along the 170 m contour. Initially it was decided to pay out 160m cable. A consistent yo-yo of 150 m was achieved; however the cable tension was generally quite high (1500 kg weight) at its deepest point. Moreover, the slack part of the sea cable had a tendency to wrap itself around the chain holding the carpenters stopper. To resolve this, an extra 30 m of cable was paid out and the towing position was altered so that the carpenters stopper was near the centre of the drum. After the alterations had been made the SeaSoar flew very well down to 150 m with cable tensions less than 1000 kg weight.

A number of problems were encountered during the *third run*. Firstly, the intended course went from deep water (1600 m) into shallow water (140 m); this meant that the full 500m wire had to be paid out, which could easily cause problems in the shallow water. Also at the time the weather was not good, which gave the added problem of maintaining ship speed. Just after SeaSoar had been deployed, it was noticed that the strain gauge was not working; while the problem was being investigated, good readings of normal magnitude began, then suddenly the strain rose above 1800 kg. It was suspected to be a bad connection causing an offset in the reading; however, SeaSoar was brought to the surface just in case the reading was correct. It was then held there until the strain gauge cable was re-terminated. After that, SeaSoar flew well in the deep section of the tow. The *max* depth was gradually adjusted while crossing the slope; an altitude > 30 m was maintained. On reaching 140 m the water depth levelled off and the SeaSoar was flown down to 115 m. During the first turn (90°) the SeaSoar started to go a few metres deeper; the controls were adjusted accordingly without any problems. However, during the second turn, the SeaSoar dived sharply; the *override* switch was turned on as the SeaSoar reached 120 m and the vehicle started to rise at 130 m. At this point the fluorometer started to give noisy data, solved by increasing the current slightly. The ship then headed back into deep water and the SeaSoar continued to fly well. However, shortly afterwards the captain ordered recovery of the vehicle as the weather had worsened.. The recovery was achieved without incident. However, when the vehicle was lifted out of the water, it was found that the balance weight had been lost and slight damage had been caused to the under-side of the body.

The most obvious explanation is that the vehicle hit the sea bed during the second turn, although it was thought that the closest approach was 10 m. Also, there were no scratches or marks that might have been expected on the under-side of the vehicle or on the tail plane. It is also possible that SeaSoar struck an object floating in the water.

The weather halted work for the next several days, during which time it was decided not to re-deploy SeaSoar; it was too difficult to repair while at sea. The damage should not affect future SeaSoar cruises.

5.4 Underway recording and sampling (J. Wynar)

The surface instruments, including transmissometer # 101D, fluorometer # 254 and thermosalinograph # TSG103, all worked well without any major faults. However, some spikes were detected in the collected data. This mainly occurred in poor weather, implying that the noise was caused by aeration in the instrument's housing.

5.5 CTD (J. Wynar)

The profiling instrumentation comprised CTD # 1195, fluorometer # 229, transmissometer # 79D, downwelling lightmeter # 8 and upwelling lightmeter # 10. In total, 21 casts were carried out during leg A of cruise CH123. The only significant occurrences were as follows.

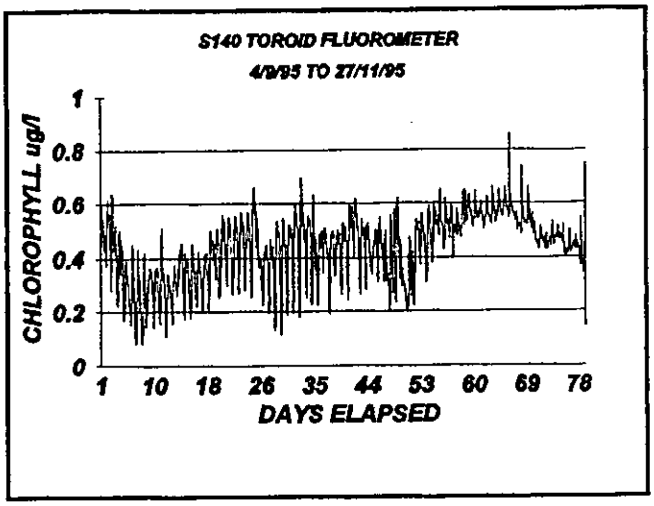
- One Niskin water bottle was damaged during recovery of the CTD in poor and deteriorating weather conditions.
- During cast 20, problems with the CTD deck unit caused the power supply to trip out. This was rectified by changing over to the alternative deck units. The fault occurred at the bottom of the cast when an attempt to fire a water bottle was being made. As there was some uncertainty about where the bottles were fired, and since it was too late to go to S1500 for a deep cast, this cast was repeated.

Generally, the CTD system worked reliably with only a very few misfires.

5.6 Chlorophyll (I. Ezzi)

Fluorometer calibration. Three fluorometers were used on or from the ship, one attached to the CTD, one on SeaSoar and one in the deck tank being fed by the non-toxic sea water supply for continuous underway sampling. In order to calibrate the CTD instrument, water samples were taken from 5 m and 30/60 m alternately from all CTD dips and filtered/ frozen for later extraction and measurement at DML. The deck tank fluorometer was calibrated using water samples taken from the tank at regular intervals. Due to difficulty of sampling, the SeaSoar instrument will be calibrated against the deck tank fluorometer.

In situ fluorometer. Aquatracka fluorometer 011 was recovered from the S140 toroid buoy on 27th November and data were successfully recovered. This instrument had been deployed on cruise Ch121C. After calibration against a range of concentrations of *Skeletonema costatum* cultured at DML, it was re-deployed at the same site.



The graph shows preliminary (uncalibrated) results from the recovered S140 fluorometer. Values are low, as might be expected for the time of year. The noise is due to diurnal changes in chlorophyll levels. Apart from the noise, there is a changing pattern through the month; the lessening of the diurnal difference after approximately 50 days may be due to the battery reaching the end of its life before finally failing after day 78.

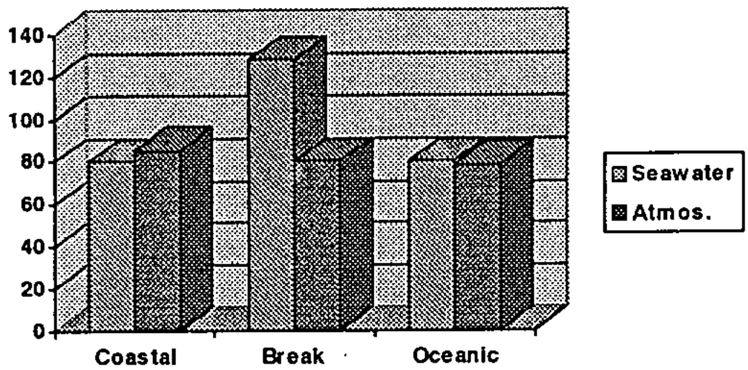
5.7 Water sampling for POC and PON (F. Perez-Castillo)

To complement the sediment trap experiment, seawater samples were taken for the analysis of particulate organic carbon (POC) and particulate organic nitrogen (PON). The samples were taken at several depths in selected CTD casts. 1000 ml was filtered for in pre-combusted GF/F filters. Afterwards, filters were frozen and taken to DML for further analysis. Five water-column profiles were so sampled during CTD casts on leg A (Table 7).

5.8 Carbon monoxide (CO) in seawater and atmosphere (T. Sjoberg)

Under-way measurements were taken continuously from the non-toxic supply and analysed directly by gas chromatography. Seawater was pumped in at a rate of 0.7 l/min to an equilibrator with a 4:1 proportion of water to gas (Oxygen-Free Nitrogen). Hopcalite was used to clean up the carrier gas. Equilibrium was reached in eight minutes. A 1 ml gas sample was then injected through a precolumn (Unibead, 60-80 mesh) and a 1 m Molecular-sieve 13X (80-100 mesh) column to a Reduction Gas Detector. In the detector CO is carried over a mercuric oxide bed which reacts on a mole-to-mole hasis to produce carbon dioxide and elemental mercury. An infrared lamp subsequently detects elemental mercury which is recorded on a Spectra-Physics integrator. Atmospheric samples were taken every four hours. A Capex 2DC air pump was used to pump in air from the front of the ship, hence eliminating the risk of contamination from the ship's exhaust fumes.

Preliminary results indicate a uniform but supersaturated level of CO in the coastal zone. CO has been reported in the literature to be globally supersaturated in the oceanic and coastal environment. The data obtained during this cruise substantiates that claim. The data gathered also indicates elevated levels of CO in the shelf-break zone; occasionally as much as a 70% increase. This may be attributed to elevated levels of DOC due either to upwelling of DOC-rich bottom water or to increased primary productivity. CO has been shown to be produced as a by-product from photodegradation of DOC, especially humic and fulvic acids and carbonyl compounds. Atmospheric samples showed a decreasing trend proportional to distance from shore; otherwise, they displayed no discernible variation.



5.9 Acoustic release trials (A.J. Harrison)
While the ship was sheltering in the Sound of Jura, three separate acoustic pop-up moorings were deployed in about 100 m water depth to evaluate the performance of one *Benthos* and two *Sonardyne* in-line release acoustics. Successful range and command tests were carried out on each unit; after 16 hours deployment all three units were successfully released and subsequently recovered at the surface.

Release	*N position*	*W*	*depth, m*
Benthos	55°43.71′	5°53.58′	98
Sonardyne 70	55°43.36′	5°53.78′	97
Sonardyne 2D	55°42.99′	5°53.99′	97

5.10 DGPS (A. Taylor)
Differential GPS navigation was used during the cruise, correction messages being received for the majority of the cruise from the Rhinns of Islay station. These corrections were fed to a Decca MK53 GPS receiver used by the bridge, and a Trimble 4000DS GPS receiver.

The Trimble was used as the primary source of navigation data; the Decca was used as the secondary source. The work area was on the working limit for this system of differential correction. Differential coverage while at the work area was intermittent with no more than 35% coverage. This is an estimate as, at present, there is no means of recording when the receivers are operating in differential mode.

5.11 Ship systems (P.G. Taylor)
All ship systems performed well. The EA500 echo sounder was used mainly in Transceiver-2 mode (38 KHz) with a hull transducer. Transceiver-1 mode (10 KHz) was occasionally used for release tracking and worked well with both hull and fish transducers.

5.12 Computing (H.C. Anderson)
Data were logged from the instruments into the Level A computers, which sample at regular intervals, time-stamp the data, provide rudimentary error checking and pass the data on to the Level B computer *via* RS232 serial lines. The Level B stores the data onto tape, provides a visual indication of the status of the data from each Level A and passes the data on to the Level C computer *via* an Ethernet network. The Level C computer is used to analyse and process the data, produce maps and plots, and to produce a data tape for distribution to the scientists. Level

A and instruments used were:

SOLI	- Kipp & Zonen Solar Integrator
TSG103	- Thermosalinograph
FLUTE	- Fluorometer & transmissometer in deck tank
BIN_GYRO	- Ship's gyro compass
LUMEN	- Luminescence
GPS_4000	- Trimble 4000DS GPS receiver
GPS_TRIM	- Trimble 4000AX GPS receiver
DECMK53G	- Decca MK53G GPS receiver
EA500D2	- Simrad EA500 echosounder (38 KHz hull transceiver)
CHF_NMEA	- Chernikeeff Electromagnetic speed log
SEA_SOAR	- Chelsea Instruments SeaSoar CTD profiler
RVS_CTDF	- Neil Brown MkIII CTD

Logging commenced at 1000 on 15th November 1995.

ADCP data from the *Transect* software were transferred to the Level C *via* the Translation PC. They were then compressed and archived with the rest of the Level C processed data. These transfers occurred at several points during the cruise, due to the insufficient space available on the ADCP PC's hard disk drive to store this volume of data.

The Trimble 4000DS GPS receiver (Differentially corrected) was used as the primary navigation fix source, with the Decca GPS receiver used as the secondary source. Processed navigation was stored in files called *bestnav* and *bestdrf*.

Bathymetry was sub-sampled to 30 s and Carter area corrected into a file *prodep*.

Plots of CTD downcast data, ship's track in various areas, mooring and CTD locations and contoured transects of SeaSoar runs were produced. At the end of the cruise, data were compressed using the Unix *Compress* program, and archived onto 150 megabyte 1/4" cartridge tapes. These tapes were passed on to BODC.

6. CONCLUSIONS

The cruise was badly affected by the weather, which should not be surprising at this time of year. It was possible to leave a certain amount of work as possibilities for the following leg, but the extent of this was limited by a complete change-over of personnel to enable the specialist science of SES 4B, and by the full programme of that cruise.

The position of deeper-deployed bottom-mounted instruments should be re-established by acoustic ranging from different directions before recovery; they may have drifted from the deployment position during descent. The release should be fired at a distance close enough that the rig is visible after surfacing (the expected distance and direction being known from the re-established position). If possible, ranging should be continued after release to confirm the rig's rise to the surface (also a requirement for firing the release close by). A system for ranging while the ship is underway (not available on this cruise) would help greatly, as would an Argos beacon on the rig.

SeaSoar could maintain regular yo-yo cycles in deep water under constant conditions. However, the character of shallower yo-yos proved very sensitive to the length of cable deployed, to ship speed and especially to changes of course, which slow the SeaSoar vehicle flight speed. The controls do not specify the depth of yo-yo directly. Hence care is required in water depths less than the length of tow cable, especially when changing course.

On this cruise, SeaSoar was deployed at night only, alternating with other work (especially mooring recoveries and deployments) during hours of daylight. This has the advantage that the SeaSoar watches are required to maintain the high level of concentration, necessary over shelf-edge topography, only for fairly short deployment periods. Disadvantages are less synoptic SeaSoar coverage and more frequent risk of damage during SeaSoar deployment and recovery. The faired cable tends to suffer damage in a few places each time.

Warm and relatively fresh water was found over the outer shelf and slope. Typically stratification between 60 and 120 m depth was 1°C in temperature and 0.1 psu. in salinity (warmer and fresher on top). However these depths, stratification thickness, temperature and salinity were also variable in space and time, with no apparent consistency; temperature and salinity were inversely correlated. The Irish Sea was yet warmer and fresher, but the salinity front with the Malin Shelf did not correspond with anything like the *pro rata* temperature change. Hence the temperature-salinity correlations elsewhere were not the result simply of varying admixtures of "coastal" water.

The amount of fresh water represented by 0.1 psu salinity deficit (in ~ 35.4 psu) over the top 100m is about 0.3 m or the total rainfall for the summer-stratified season. Although the warm surface waters may have persisted because of the long hot summer of 1995, it is not clear how such an extensive freshening accumulated; evaporation would be expected to remove most of the summer fresh water. Comparison should be made with adjacent Atlantic waters.

In the Sound of Jura reaching to the sill with the North Channel, respective CTDs showed:

	depth of *water* (m),	*thermocline*	T *top* (°C)	*bottom*	S *top* (psu)	*bottom*
CTD14	210	—	12.030	12.070	34.063	34.065
CTD12	159	85-90	12.223	12.173	34.067	34.070
CTD11	186	—	12.208	12.231	34.070	34.070
CTD13	93	—	12.287	12.266	34.027	34.044

It is interesting that there was homogenisation in the deepest parts of the Sound, with some temperature *increase* through depth, although this is rarely the case in the Clyde (more isolated from the North Channel; behind a shallow sill; subject to relatively large freshwater input and having surface salinities < 33 psu. on 29th November) and was not the case on the open outer Hebridean Shelf. Heat appears to be lost from the surface within the Sound and the salinity (and stratification at CTD12?) corresponds with exchange through the Sound of Islay rather than with the North Channel. However, these values are only on one day of the seasonal cycle. A detailed knowledge of the complex bathymetry (*via* swath bathymetric mapping?) is also needed for firmer interpretation.

CH123A Moorings							
Stn	Buoy Type	Event	Date & Time	Latitude	Longitude	Depth	Comments
S140	toroid marker	deploy	19951119 0911Z	56 26.71	008 59.50W		
S140	p/u ADCP	recover	19951119 0940Z	56 27.68N	008 58.25W	147m	CTD2
S140	U	recover	19951119 1210Z	56 27.75N	008 57.77W	146m	CTD3; spar deployed 56 27.72N 008 57.86W
S140	U	deploy	19951119 1659Z	56 27.18N	008 59.11W	148m	CTD4; clump 2 56 27.22N 008 59.27W
					008 58.9W in bridge log - scientific and BODC logs agree		
S140	p/u ADCP	deploy	19951119 1724Z	56 26.91N	008 59.03W	148m	
S600	p/u ADCP	deploy	19951121 1352Z	56 27.40N	009 07.79W	587m	
S300	straight	deploy	19951127 0712Z	56 27.73N	009 03.67W	302m	
S400	p/u ADCP	recover	19951127 0908Z	56 27.21N	009 04.92W		
S600	p/u ADCP	recover	19951127 0957Z				instrument ascended some time after releases fired - adrift at 19951127
S140	toroid	recover	19951127 1127Z	56 27.91N	008 57.62W	146m	
S300	toroid marker	deploy	19951127 1420	56 27.13N	009 04.00W	303m	
S140	toroid	deploy	19951127 1554Z	56 26.72N	008 58.55W	143m	CTD18
S700	toroid marker	deploy	19951127 1733	56 27.31N	009 09.63W		

Table 1. Moorings

CH123A Instrumentation								
Station	Rig	Instrument	Serial No.	Date & Time Started/Finished	In/Out Water	Sample Interval	Owner	Comments
S140 (recover)	pop up	ADCP RDI	1148	19951119	19951119 1008Z			CTD2
		WLR	444	19951119 103129Z	19951119 1008Z			
		Release	3B 4A					
S140 (recover)	U	Argos	11443					CTD3
		RCM 7	11608	19951119 083100Z	19951119 1305Z	30 min	UCNW	55 secs slow
		TC logger	1142				DRA	
		TC 76m	1185	19951119 173044Z			UCNW	
		RCM 7	11818	19951119 173102Z	19951119 1250Z			connector leaked
		SeaTech	638	19951119 173102Z	19951119 1250Z			
		Release	222					
S140 (deploy)	U	Argos	11443					
		RCM7	8240	19951119 1130Z	19951119 1645Z	30 min	RVS	CTD4
		RCM7	11814	19951119 1530Z	19951119 1654Z	30 min	POL	
		SeaTech	556	19951119 1530Z	19951119 1654Z	30 min	POL	CTD3 calibration
		Release	222					
S140 (deploy)	pop up	ADCP RDI	1149		19951119 1724Z	15 min	POL	
		WLR	1038	19951119 083045Z		15 min	POL	
		Releases	3B 4A				POL	
S600 (deploy)	pop up	ADCP POL	No. 1		19951121 1352	10 min	POL	Experimental
		Release	6A					not recoverable 19951127
S300 (deploy)	straight	Argos	24027		19951127 0630Z			
		RCM7	8249	19951126 123000Z	19951127 0631Z	30 min	RVS	
		RCM7	11053	19951126 130008Z	19951127 0645Z	30 min	POL	
		RCM7	11045	19951126 223000Z	19951127 0703Z	30 min	POL	
		SeaTech	555	19951126 223000Z	19951127 0703Z	30 min	POL	
		Release	161					
S400 (recover)	pop up	ADCP RDI	394		19951127 0908Z		RVS	
S140 (recover)	toroid	Argos	?					
		TRB2	1761		19951127 1127Z	1 min	POL	50l water sample (POL)
		Fluorometer	112/2530/011		19951127 1127Z	60 min	DML	
S140 (deploy)	toroid	Argos	?					
		TRB2	1761	19951127 122400Z	199511271537Z	1 min	POL	CTD18 calibration
		Fluorometer	112/2530/014		199511271537Z	60 min	DML	

Table 2. Instrumentation on moorings

CHALLENGER TSG SALINITY CALIBTRATION

Date	Time	Stsg PSU	Samp Bot	Bridge Sal	dSAL tsg/brdg
19:11:95	04:12	35.228	1	35.2646	-0.0366
19:11:95	12:10	35.276	2	35.3081	-0.0321
19:11:95	16:00	35.258	3	35.299	-0.0410
19:11:95	11:04	35.267	4	35.3049	-0.0379
20:11:95	03:52	35.225	6	35.2663	-0.0413
20:11:95	08:15	35.281	8	35.3169	-0.0359
20:11:95	18:21	35.211	9	35.2516	-0.0406
21:11:95	08:18	35.219	10	35.2674	-0.0484
21:11:95	13:10	35.269	11	35.3131	-0.0441
21:11:95	18:25	35.130	12	35.171	-0.0410
22:11:95	00:22	35.238	13	35.2798	-0.0418
22:11:95	08:16	35.211	14	35.2574	-0.0464
22:11:95	12:58	35.237	15	35.2826	-0.0456
23:11:95	11:32	33.815	16	33.8603	-0.0453
23:11:95	15:43	33.962	17	34.0063	-0.0443
23:11:95	19:53	33.98	18	34.02	-0.0400
24:11:95	09:01	33.972	19	34.0169	-0.0449
24:11:95	12:59	33.966	20	34.0161	-0.0501
24:11:95	16:49	34.028	21	34.0797	-0.0517
24:11:95	23:59	34.043	22	34.0898	-0.0468
25:11:95	08:36	34.046	23	34.0886	-0.0426
25:11:95	15:52	34.014	25	34.0569	-0.0429
25:11:95	20:16	34.042	26	34.0863	-0.0443
26:11:95	08:23	34.043	27	34.0941	-0.0511
25:11:95	12:24	34.027	29	34.0725	-0.0455
25:11:95	18:51	35.078	30	35.1228	-0.0448
25:11:95	21:43	35.252	31	35.2987	-0.0467
27:11:95	08:44	35.278	35	35.3225	-0.0445
25:11:95	15:20	35.206	36	35.255	-0.0490
25:11:95	18:53	35.225	37	35.2693	-0.0443

STDEV=	0.004466
Average=	-0.044

Table 3. Thermosalinograph salinity calibration against bottle samples

Challenger Cruise 123A CTD Thermosalinograph Calibration

CAST No	TSG TEMP	TSG SALINITY	CTD TEMP	CTD SALINITY	dTEMP	dSAL
1	11.784	35.283	11.782	35.296	-0.002	0.013
4	11.572	35.262	11.637	35.275	0.065	0.013
5	11.458	35.289	11.465	35.303	0.007	0.014
11	12.170	34.056	12.202	34.071	0.032	0.015
12	12.146	34.046	12.225	34.066	0.079	0.020
14	11.967	34.042	12.029	34.063	0.062	0.021
15	11.475	35.230	11.458	35.255	-0.017	0.025
16	11.177	35.275	11.140	35.292	-0.037	0.017
18	11.594	35.268	11.658	35.231	0.064	
19	11.549	35.212	11.629	35.232	0.080	0.020
20	11.354	35.266	11.353	35.282	-0.001	0.016
21	11.303	35.273	11.322	35.290	0.019	0.017

STD DEV	0.040041	0.003776
AVERAGE	0.029250	0.017364

Table 4. Thermosalinograph temperature and salinity calibration against CTD

Table 5. CTD salinity calibration against bottle samples

Challenger Cruise 123A CTD Salinity Calibration

CAST No	DEPTH m	CTD SAL PSU	SAMPLE BOTTLE No	BOTTLE SALINITY	dSAL
4	8	35.2739	5	35.3028	0.0289
5	8	35.3015	7	35.3260	0.0245
11	10	34.0699	24	34.0912	0.0213
14	5	34.0711	27	34.0941	0.0230
15	6	35.2550	32	35.2764	0.0214
16	994	35.1956	34	35.2194	0.0238
16	9	35.2902	33	35.3150	0.0248
19	8	35.2321	38	35.2572	0.0251

STD DEV	0.0024
AVERAGE	0.0241

CH123A CTD casts							
Cruise	**Cast**	**Start date&time**	**End date&time**	**Stn**	**Latitude**	**Longitude**	**Comments**
CH123A	CTD1	19951118 2210Z	19951118 2248		56 17.35N	009 20.51W	1st Seasoar deployment calibration; 1037m
CH123A	CTD2	19951119 1036Z			56 27.95N	008 58.50W	148m
CH123A	CTD3	19951119 1440Z		S140	56 30.30N	009 00.42W	Transmissometer calibration; 157m
CH123A	CTD4	19951119 1741Z			56 27.13N	008 59.92W	149m
CH123A	CTD5	19951120 0727Z			56 26.35N	008 58.93W	147m
CH123A	CTD6	19951121 0945Z	19951121 1000Z		56 26.25N	008 57.95W	142m
CH123A	CTD7	19951121 1106Z	19951121 1123Z		56 27.65N	009 01.60W	165m
CH123A	CTD8	19951121 1146Z		S200	56 27.22N	009 02.80W	195.5m
CH123A	CTD9	19951121 1245Z	19951121 1306Z	S300	56 27.27N	009 04.03W	308m
CH123A	CTD10	19951121 1608Z	19951121 1622Z		56 27.57N	008 57.37W	148m
CH123A	CTD11	19951125 1120Z		Islay	55 42.82N	005 51.37W	186m
CH123A	CTD12	19951125 1226Z		Islay	55 45.65N	005 51.62W	149m
CH123A	CTD13	19951125 1631Z		Islay	55 33.17N	005 57.98W	93.5m
CH123A	CTD14	19951125 2223Z	19951125 2245Z	Islay	55 50.00N	005 47.60W	214m
CH123A	CTD15	19951126 2202Z	19951126 2222Z	S140	56 25.10N	008 58.20W	145m
CH123A	CTD16	19951127 0146Z		R1000	56 30.98N	009 17.75W	1003m
CH123A	CTD17	19951127 1258Z		S300	56 27.08N	009 04.97W	Transmissometer calibration at 30m; 404m
CH123A	CTD18	19951127 1511Z		S140	56 26.07N	008 59.95W	148m
CH123A	CTD19	19951127 2133Z		S140	56 27.10N	008 57.75W	146m
CH123A	CTD20	19951127 2305Z		S700	56 27.23N	009 09.62W	640m
CH123A	CTD21	19951128 0055Z		S700	56 28.63N	009 08.28W	600m
							DAN 19951129

Table 6. CTD casts

Table 7. Water column bottle samples for POC, PON

Station No.	S140	S200	S300	R1000	S700
Date	19.11	21:11	21.11	27.11	28.11
time	10:36	11:46	12:45	01:46	00:55
water depth (metres)			**CTD No.**		
	02	08	09	16	21
5	X	X	X	X	X
15	X	X	X	X	X
30	X	X	X	X	X
60	X	X	X	X	X
100	X	X	X	X	X
200	140	183	X	X	X
300			320	X	X
400				X	X
500				X	X
600				X	592
800				X	
1000				994	

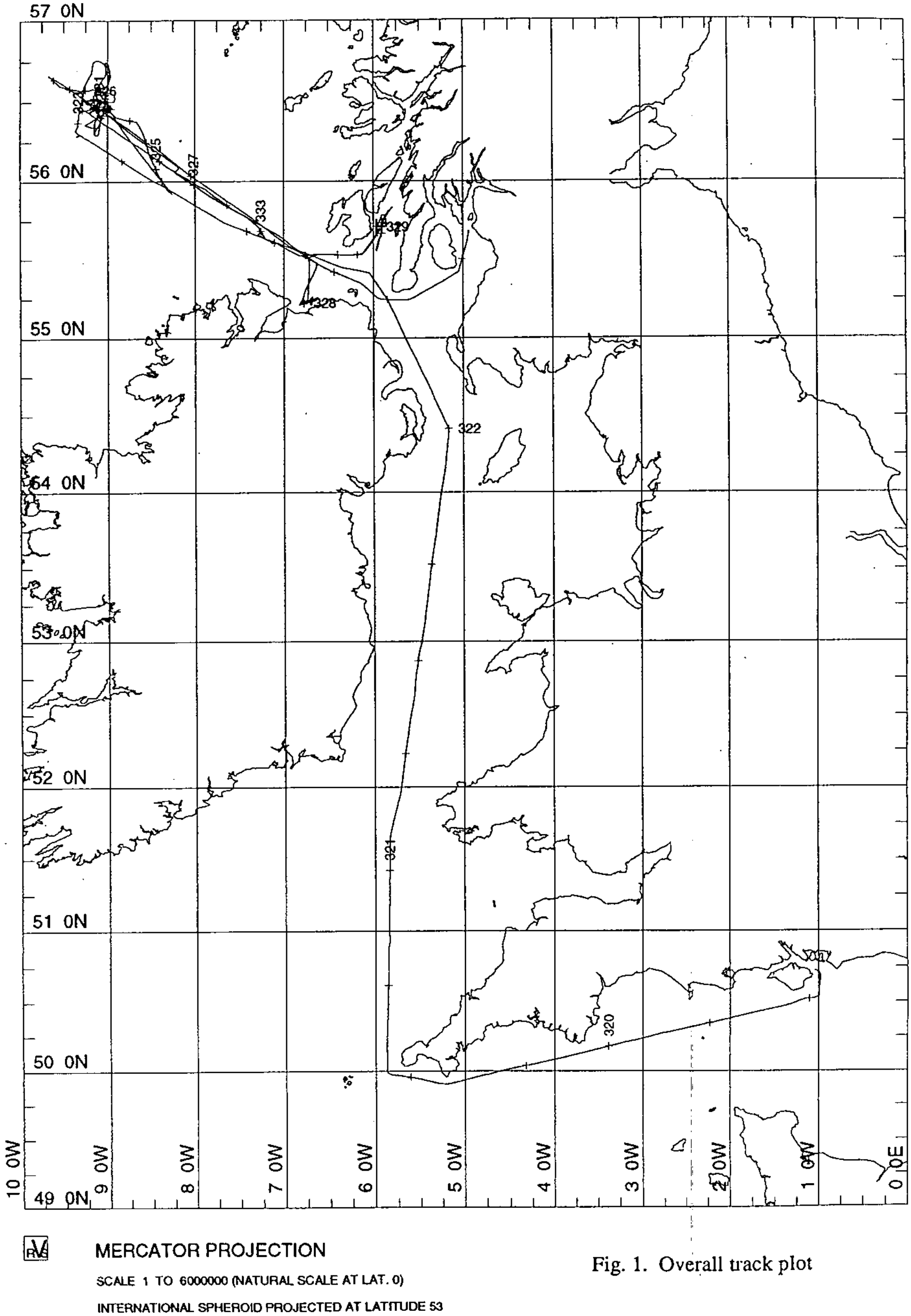


Fig. 1. Overall track plot

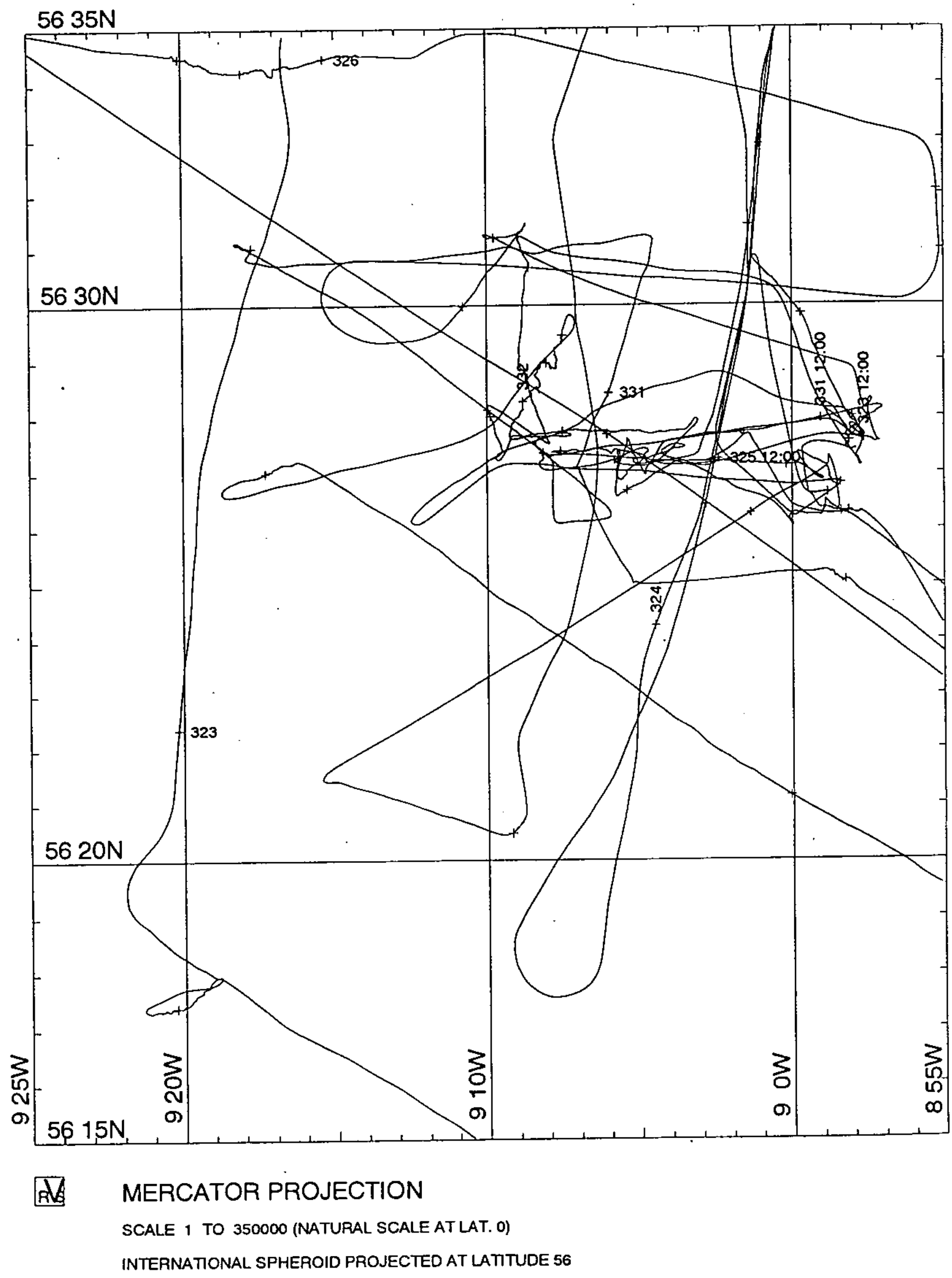


Fig. 2. Detailed track plot - SES area

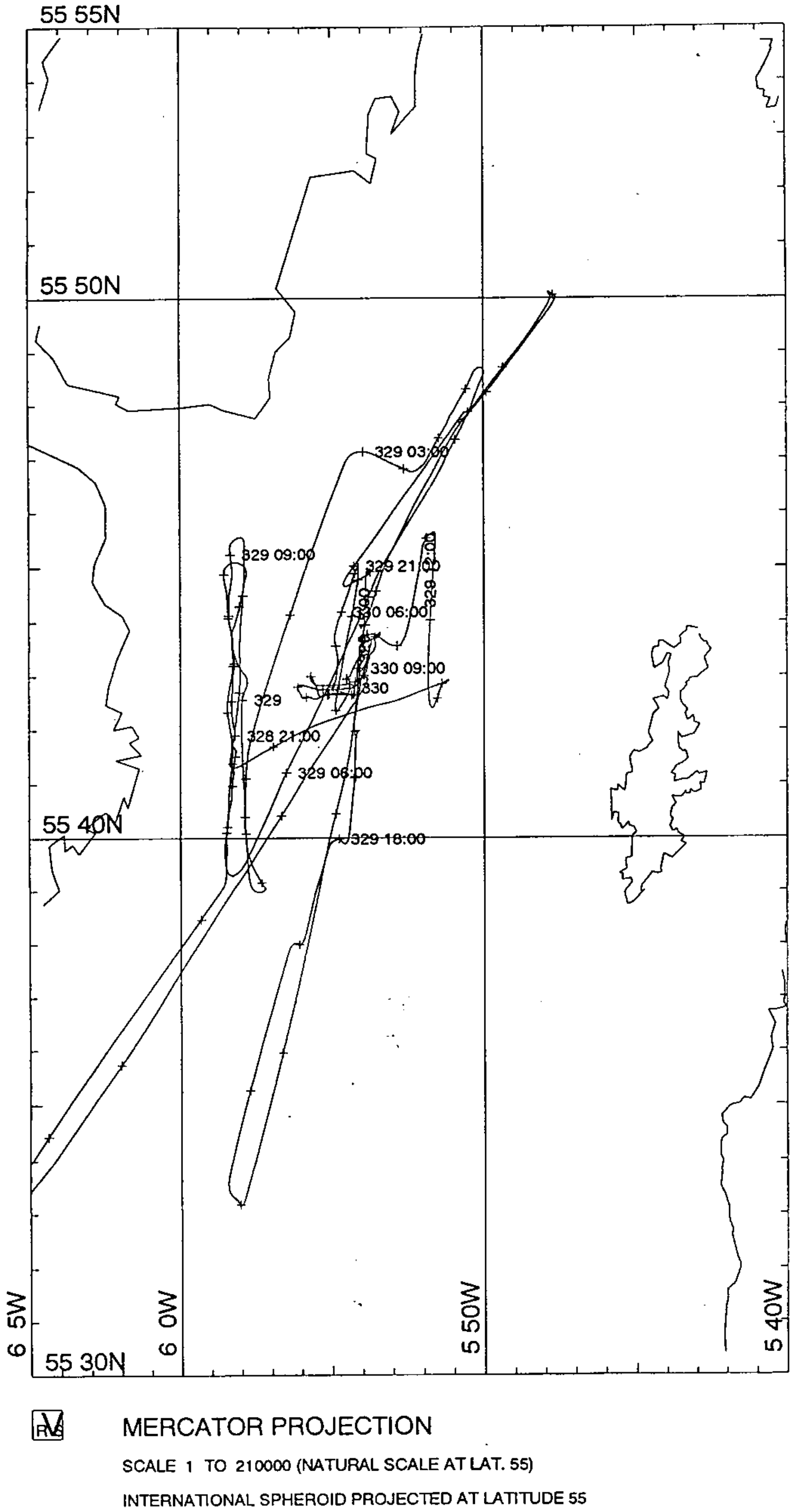


Fig. 3. Detailed track plot - Sound of Jura

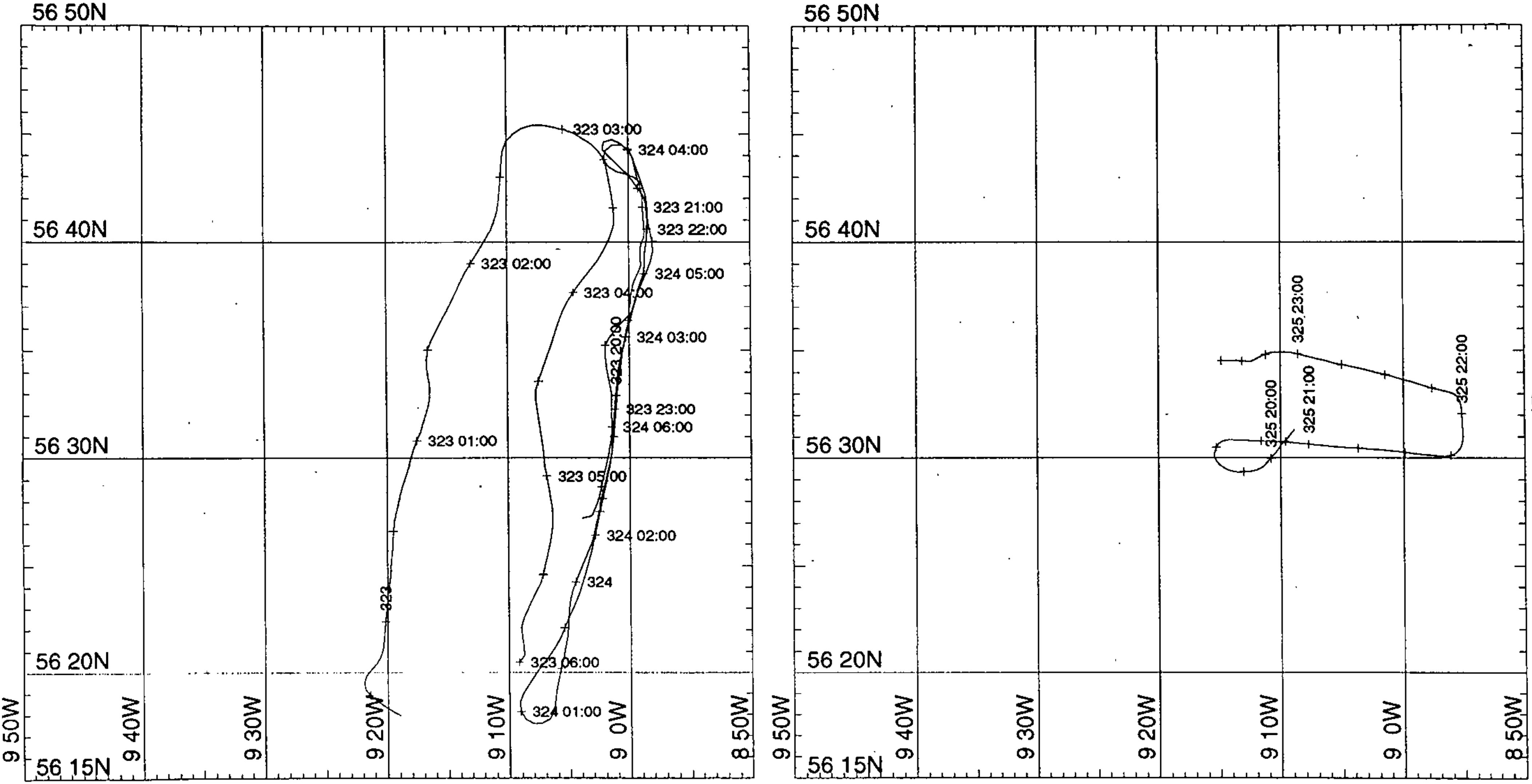


Fig. 4. SeaSoar tracks

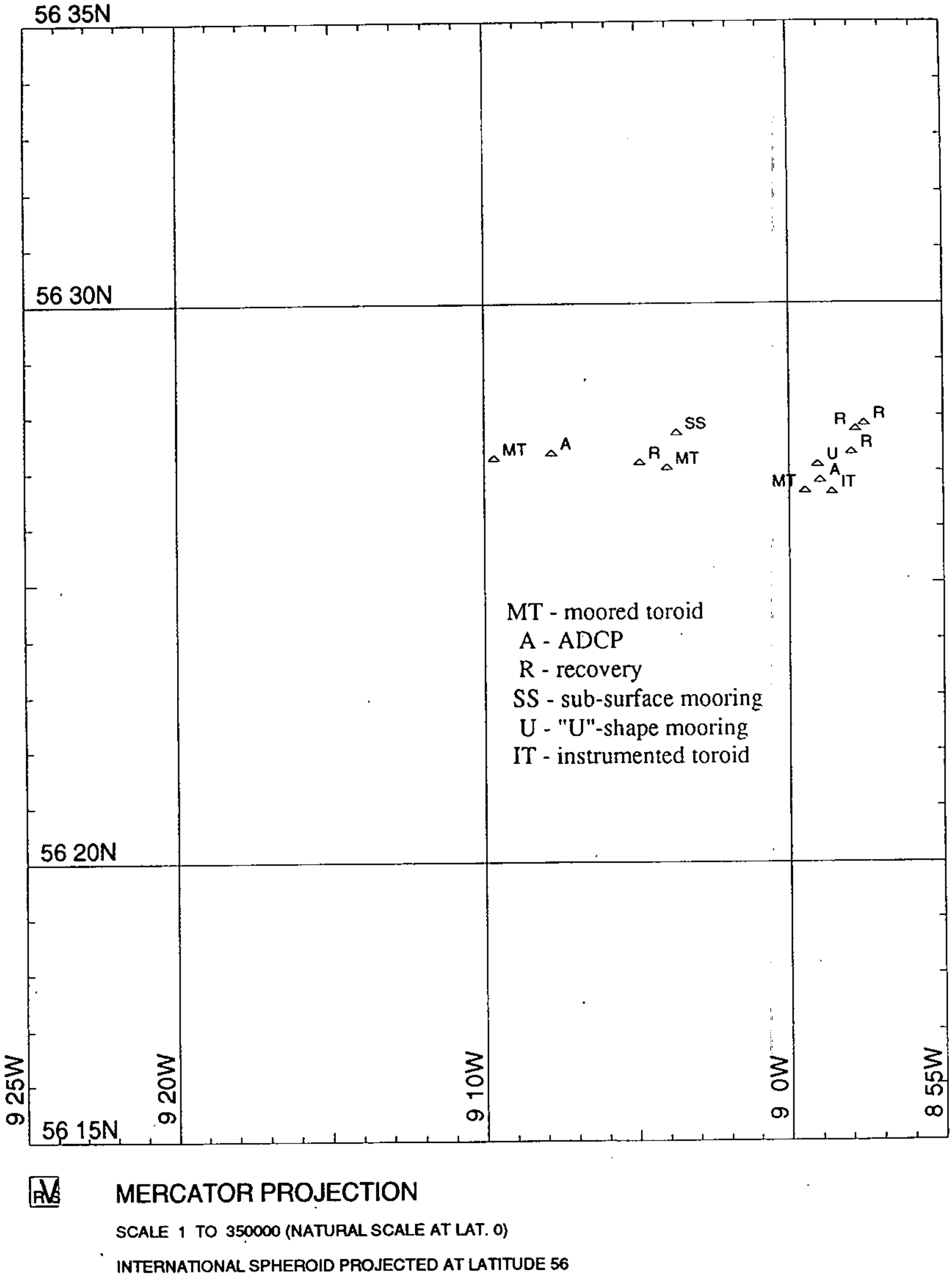


Fig. 5. SES area moorings

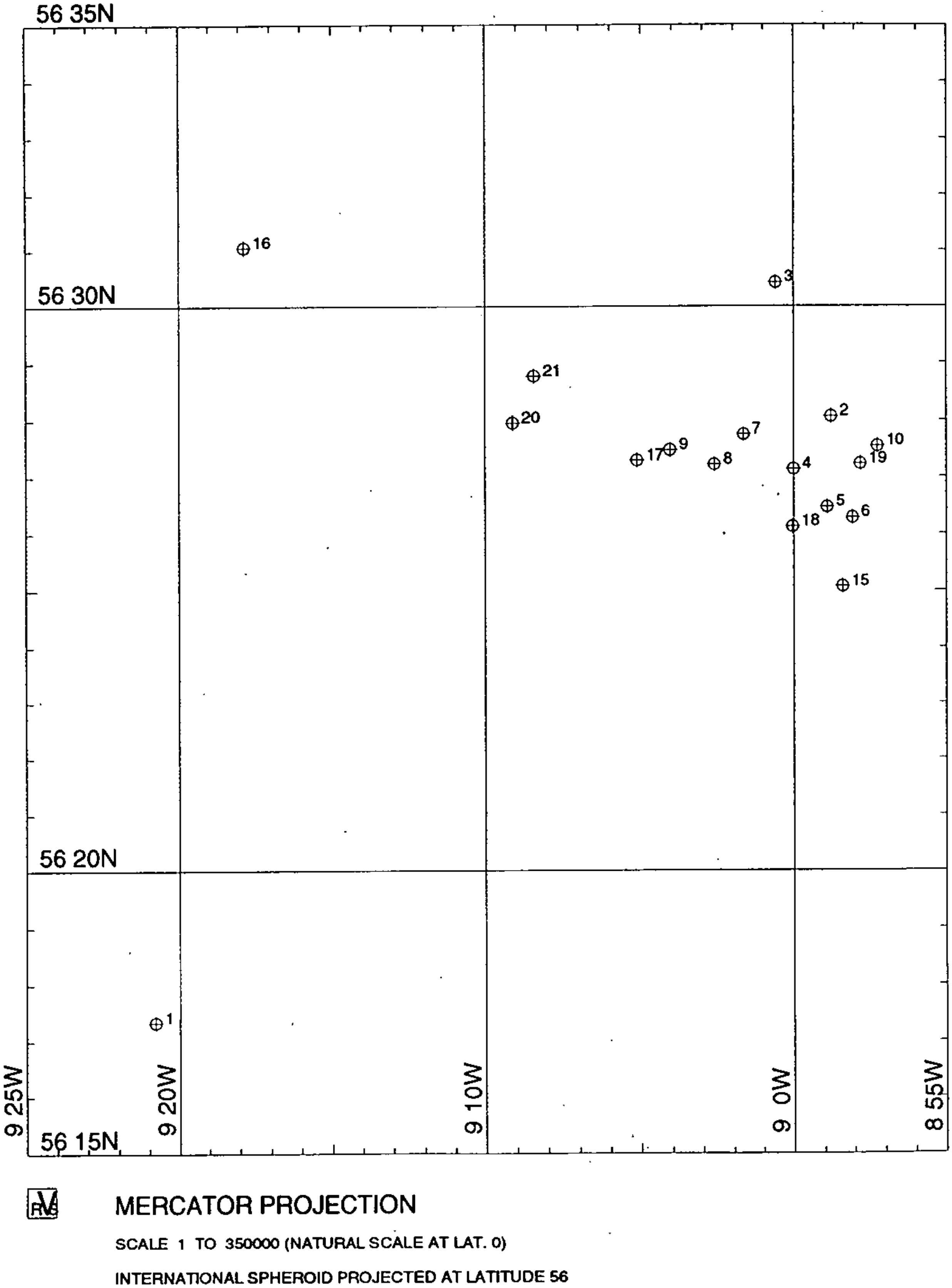


Fig. 6. SES area CTD stations

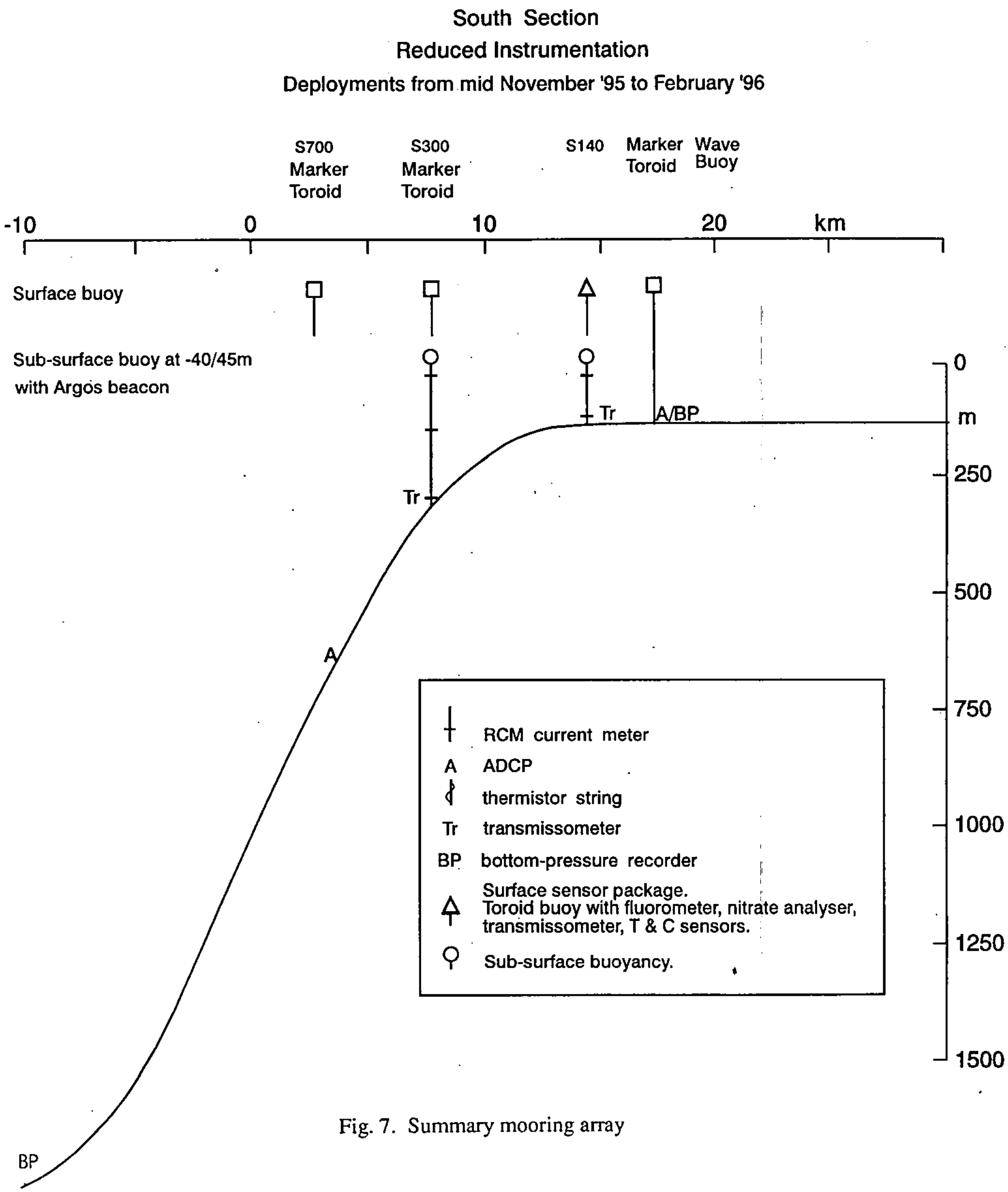


Fig. 7. Summary mooring array

Challenger Cruise SES 4

S 140 South section mooring

Deployment from mid November '95 to February '96

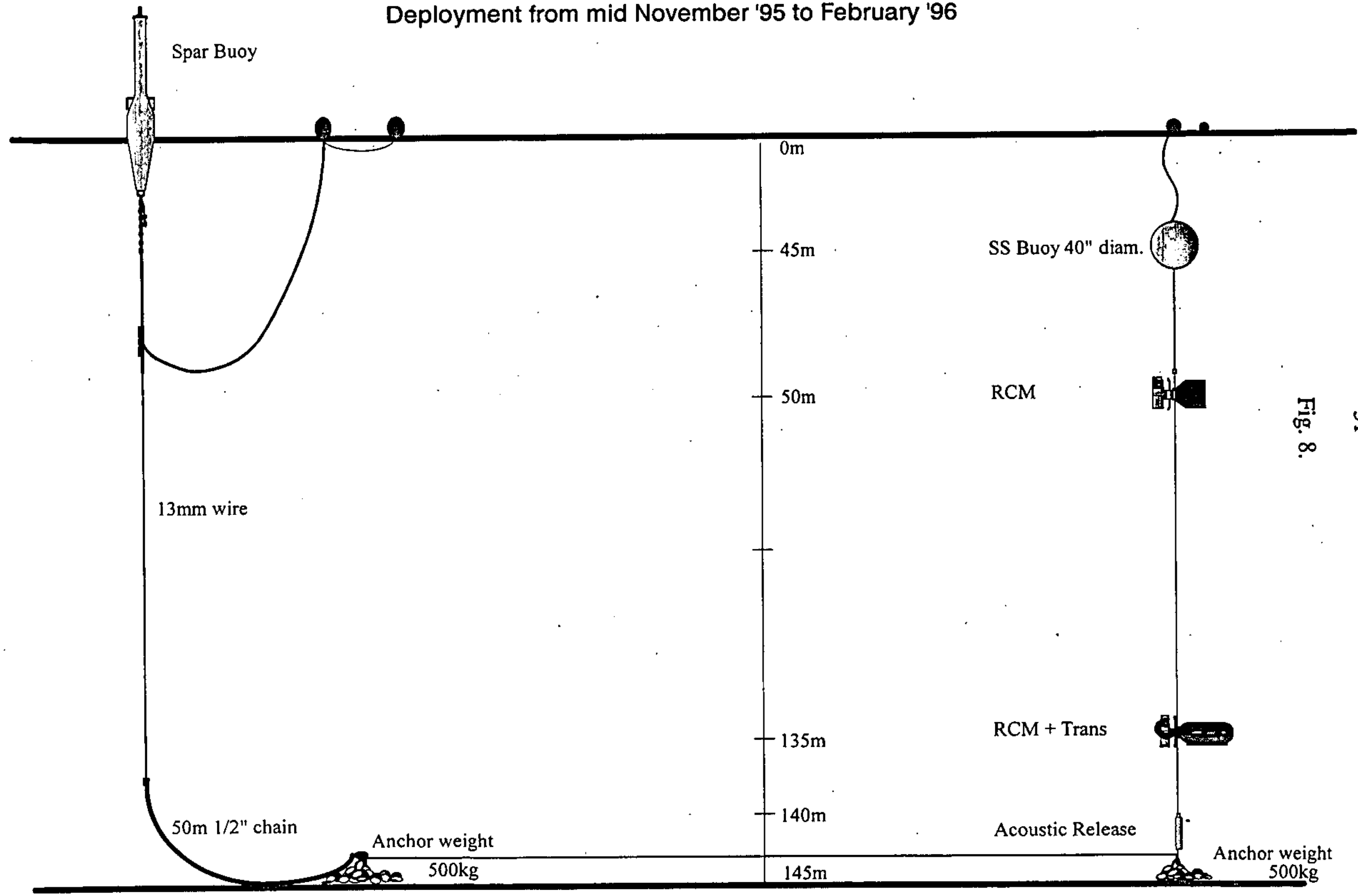


Fig. 8.

Fig. 9.

S 300 South section (sub-surface mooring)

Deployment from mid November '95 to February '96

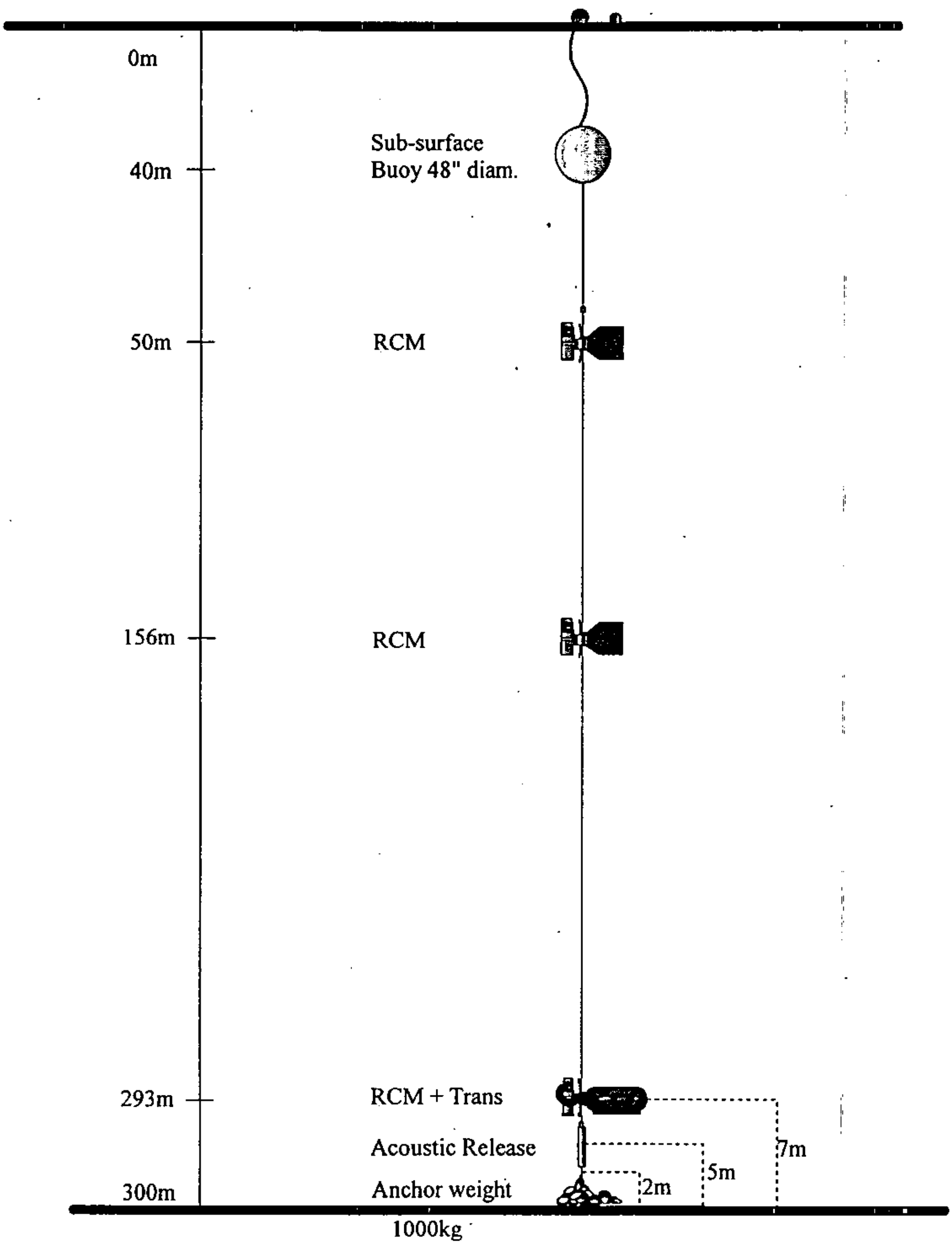


Fig. 10.

S 140 South section (surface buoy mooring)

Deployment from mid November '95 to February '96

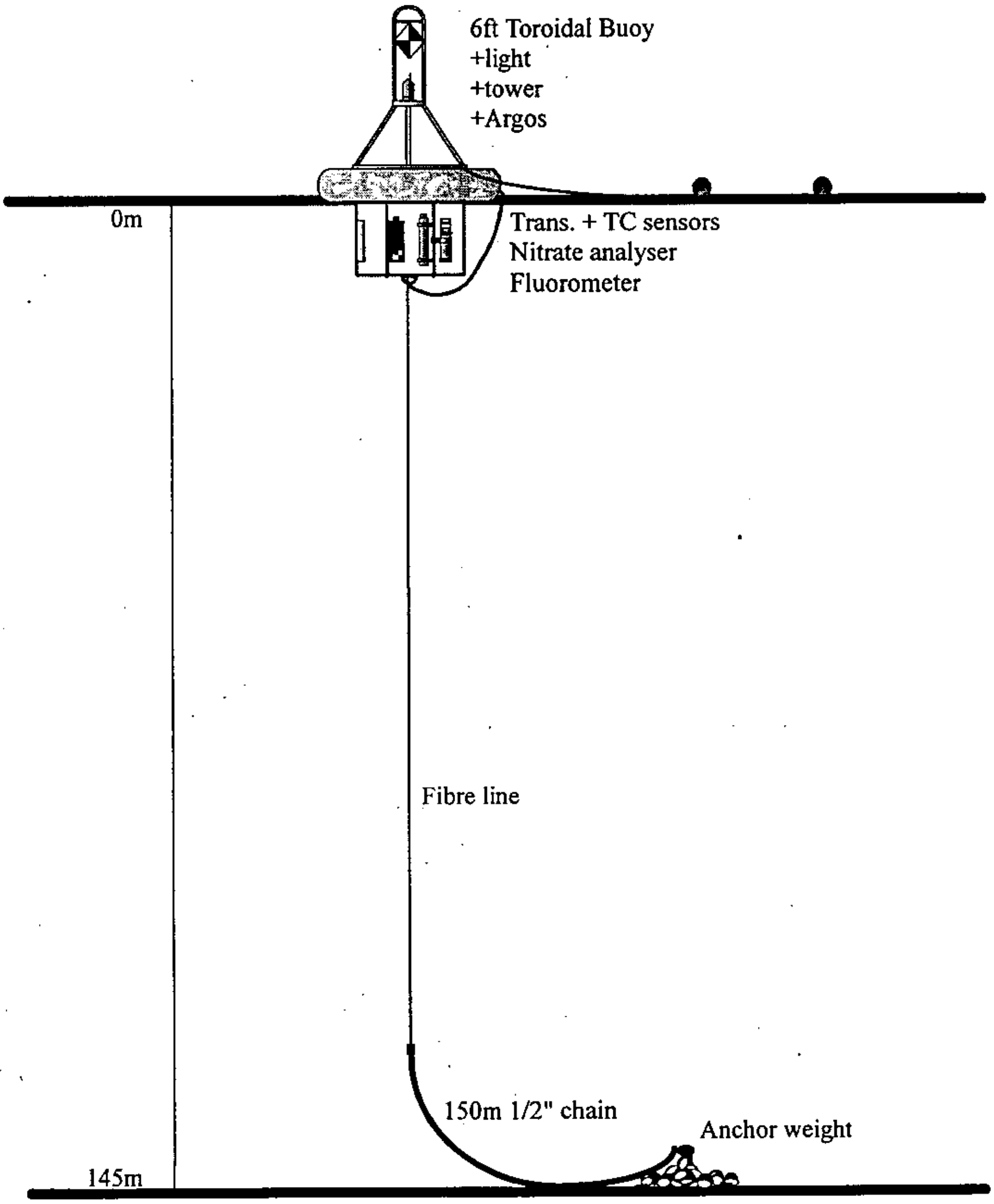


Fig. 11.

S 300 South section (surface buoy mooring)

Deployment from mid November '95 to February'96

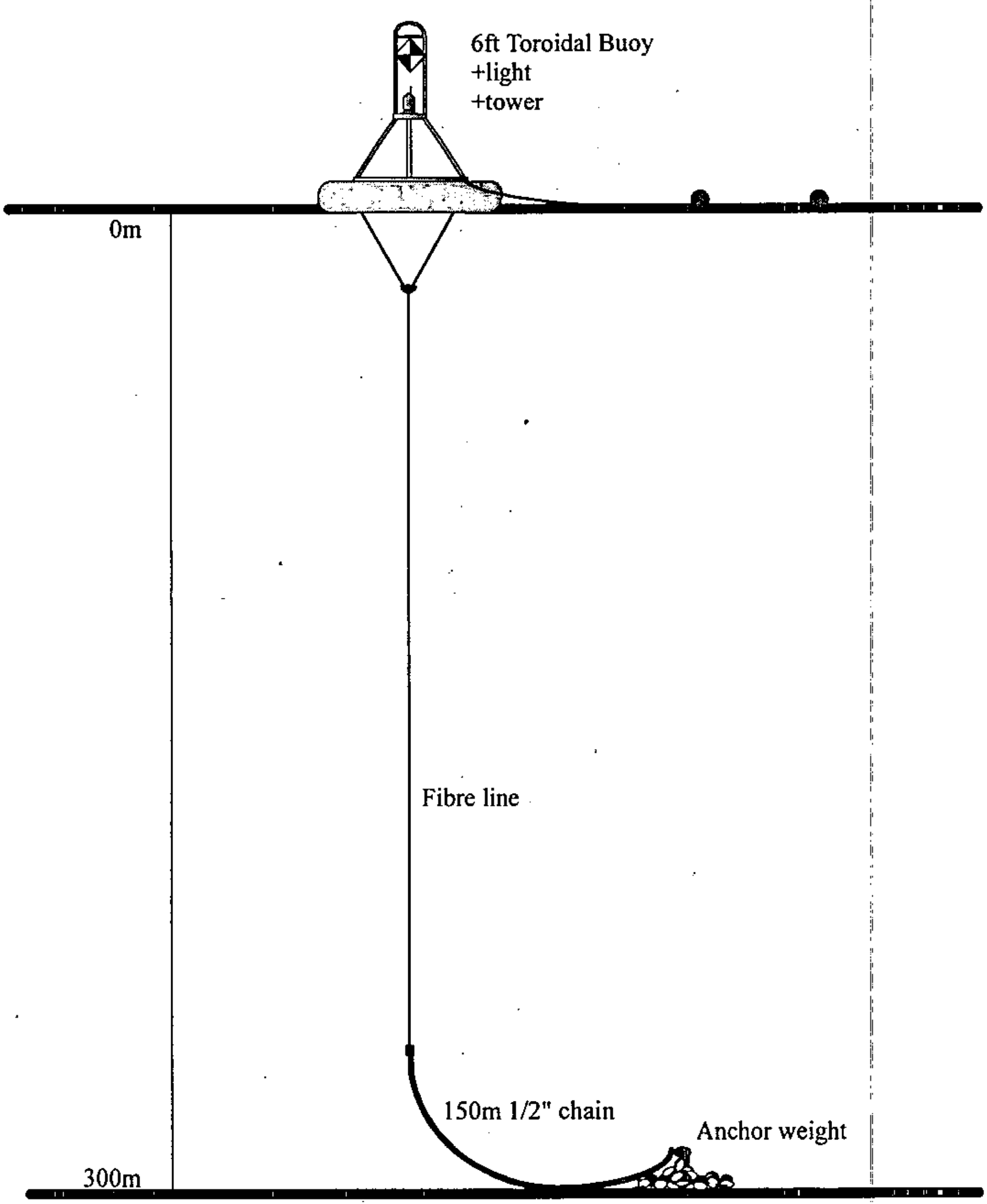
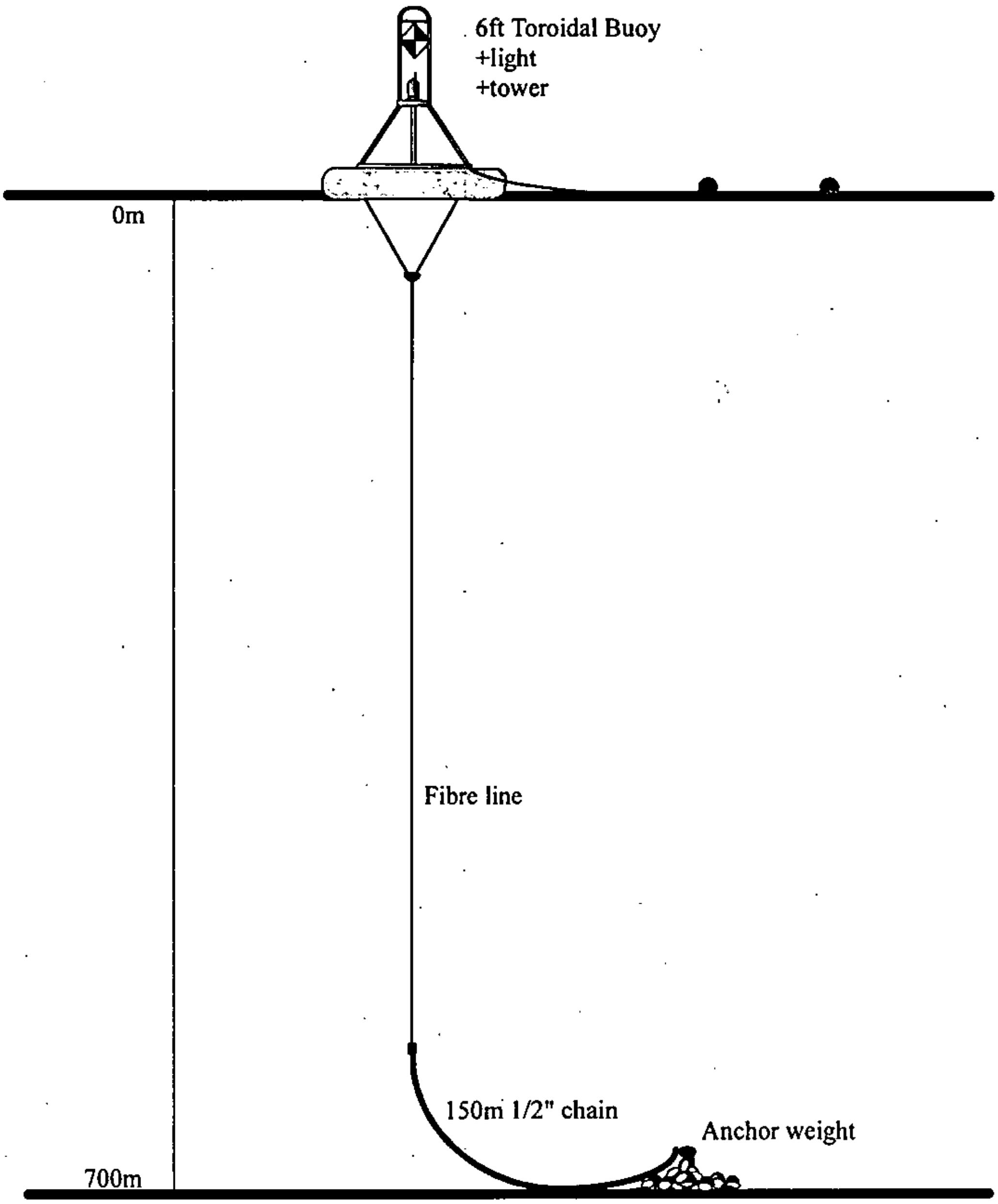


Fig. 12.

S 700 South section (surface marker buoy mooring)

Deployment from mid November '95 to February'96



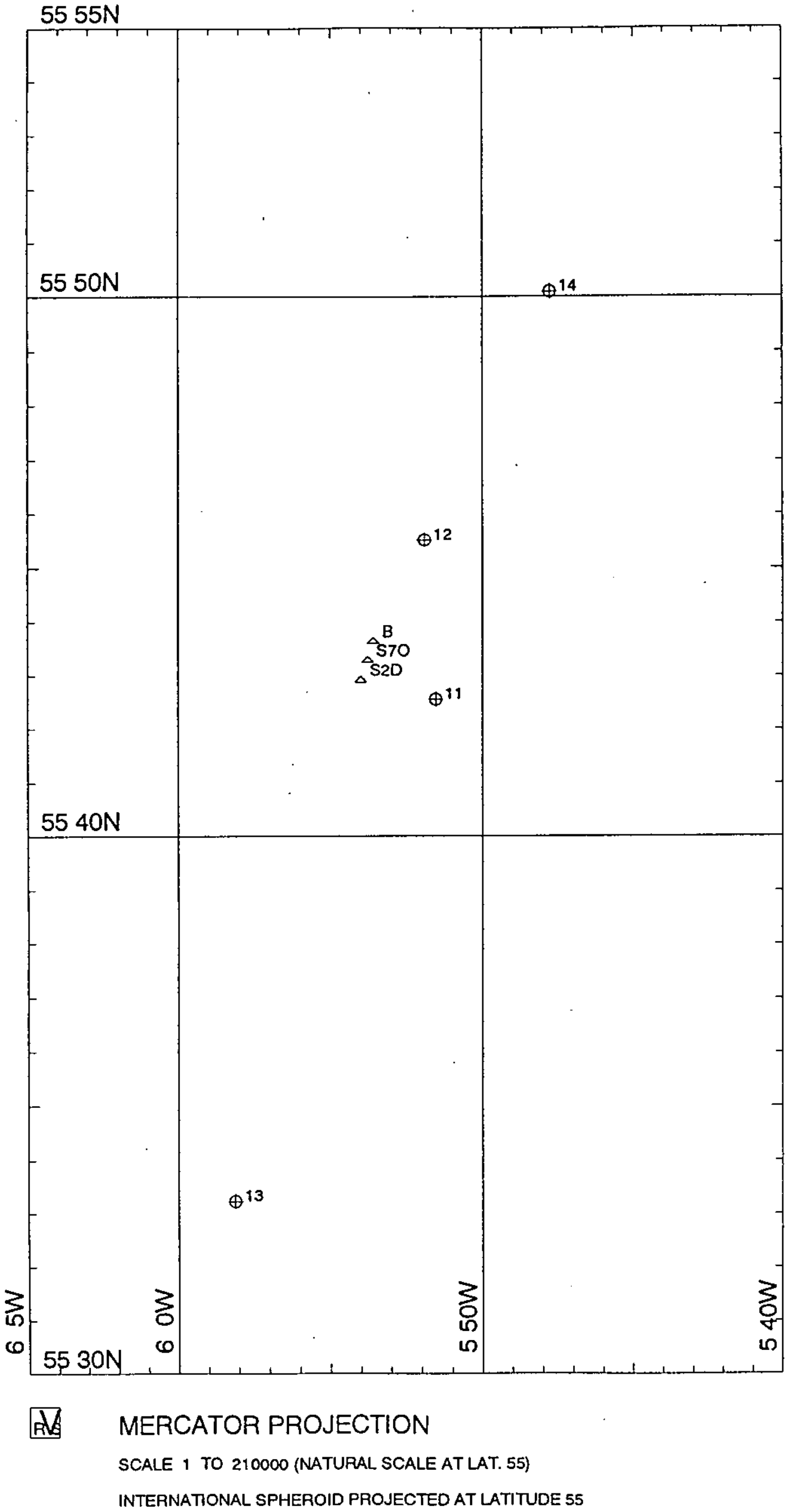


Fig. 13. Sound of Jura CTD stations and acoustic moorings