I.O.S.

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27 JANUARY — 20 FEBRUARY 1983

PHYSICAL OCEANOGRAPHY OF THE UPPER OCEAN IN WINTER IN THE EASTERN ATLANTIC OCEAN IN THE REGION 38-48 °N, 10-21 °W

CRUISE REPORT NO. 147
1983

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

RRS DISCOVERY

Cruise 132

27 January - 20 February 1983

Physical oceanography of the upper ocean in winter in the eastern Atlantic Ocean in the region 38-48°N, 10-21°W

Principal Scientist

R.T. Pollard

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CRUISE OBJECTIVES

Scientific

(1) To locate and survey possible upper ocean fronts in the northeast Atlantic Ocean.

(2) To examine the horizontal and vertical structure of the winter mixed layer over ten degrees of latitude.

(3) To establish the connection between surface temperatures derived from satellite infrared data and in situ mixed layer temperatures.

(4) To examine spatial variations of pressure, temperature, salinity, and oxygen on those thermocline density surfaces which may outcrop and ventilate to the north or east.

Technical

(5) To test the performance of Kevlar rope in a 4500m subsurface mooring.

(6) To test deploy a benthic current and temperature package (BENCAT) and a benthic thermistor string (BERTHA).

(7) To determine the quality of current and temperature data from instruments hung beneath drogued satellite tracked buoys.

(8) To test deploy a satellite tracked buoy for measuring the surface current.

NARRATIVE

After a six hour delay to dismantle, dry out, and replace the satellite navigation aerial with the aid of a shoreside crane, Discovery sailed from Falmouth at 1830/27th January 1983. After adjusting compasses and calibrating radio d/f, course was set for 47° N, 19° W at 2130. The PES fish was streamed at 1000/28th, and the sea surface temperature (SST) fish at noon, but progress was slow (7 kt) into a stiff (25-30 kt) headwind.

The shelf edge was passed at 0730/29th, and watches to monitor the echo sounder, SST fish and Plessey thermosalinograph were begun. XBTs were deployed hourly from 0830. Initially 450m probes donated by the Hydrographic Office were used, though these were known to be past their expiry date. Because of a high failure rate and mixed layer depth (MLD) over 300m, it was decided to switch to Deep Blue XBTs (900m) from 1530/29th.

On stopping to make a shallow CTD cast at 1730/29th, it was found that water had severely fouled the midship winch deck electronics, so passage was resumed during repairs. The electric winch was also in need of repair, as a fuse carrier was smashed in, and several metres of wire had to be cut and reterminated. The winches were repaired simultaneously, and a 600m CTD cast with the shallow CTD (station 10620) was begun at 2215/29th after testing the midship winch with Lucas weights. 40kt winds precluded a further CTD cast early on day 30, but XBTs were deployed every two hours.

After heaving to at 1030/30 to secure weights in the after-hold, it was decided at 1200/30 to alter course to the south in view of continuing bad weather and head winds. Passage south along 14° W continued until 1900/31, but was broken at 1700/30 for a 2000m CTD calibration cast (station 10621) with the new deep CTD, followed by release wire tests. The SST fish was twice recovered and restreamed to correct faults. Discovery altered course 254° at 1900/31 towards a likely mooring position, which was reached at 0650/32. After a site survey and further wire tests, a full depth subsurface experimental mooring was deployed at 44° 15.3'N, 16° 06.2'W in 4650m from 1200-1618/32. A Hermes buoy was launched with some difficulty 3 n.m. north of the mooring, carrying a thermistor chain and VAECM with an acoustic transponder 300m below the damping plate and window shade drogue.

The XBT section down 14° W had shown that the front we sought lay north of the mooring position, and the SeaSoar was deployed at 2000/32 to survey north and west. Control of the sawtooth yoyo pattern was poor on the northward run, necessitating recovery at 0807/33. The cable fairing was found to be twisted and seized against stoppers on the cable, and a bellows in the hydraulic unit needed replacing.

After a CTD cast (10624) to 1000m, the SeaSoar was redeployed at 1430/33 and the subsequent 44 hour survey (Run 2) continued until 1044/35. During the survey, the speed was slowed to 1kt every two hours for about 15 minutes. This enabled the SeaSoar to sink under its own weight to over 450m, compared with a maximum depth of only 250m during normal yoyos at 8-9 kts. Erratic behaviour on day 35 necessitated recovery a few hours earlier than planned, and the fairing was again found to be twisted and seized, so it was cut and seized pieces removed in a number of places.

The SeaSoar survey had crossed a front several times, terminating south of it (where CTD 10625 was done) so it was decided to deploy hourly XBTs along a 330° line, followed by a CTD section from 47° 30'N, 19° W down 20° W to about 40° 30'N. Casts 10626 (2035/35) to 10637 (2334/37) were made at intervals of 35' of latitude, with three Deep Blue XBTs deployed between each cast, yielding XBTs or CTDs every 9 n.m. Casts were to 1000 or 1200m, with salinity and usually oxygen samples taken at 200, 400, 600 and 800m and temperatures read from reversing thermometers at 800m. The CTD casts were plagued by noisy data in patches which appeared to correlate with the position of the traverse such that the wire was just touching one of the traverse guide rollers. Several casts were delayed as attempts were made to cure this and other problems (damp slip rings, faulty potentiometers on deck control panel).

A total power failure occurred at 2347/37, 13 minutes after CTD cast 10637 had ended, and lasted 33 minutes. Because of the time lost, the last planned CTD had to be replaced by an XBT to enable the site for several deployments to be reached by daybreak on day 38. The surface current buoy was launched with the aid of the rubber boat at 0900/38 with only a clump of chain for stability beneath it. The second Hermes buoy was then deployed (1000/38), again with some difficulty, followed by BENCAT deployment from the foredeck (1103-1131/38). A CTD station was attempted, but the brake on the midships winch seized. The Benthic thermistor array (BERTHA) was deployed from 1336/38 to 1406/38, and at 1406/38 course was set to recover the surface current buoy.

At 1430/38 the main engines were switched off when a burst pipe caused oil to flood over the main switch board. The vessel remained not under command until 0900/39, during which time it proved possible to clean and dry out the switchboard. The first task on regaining command was to search for the surface current buoy which, for its temporary deployment, had only its satellite signal to assist location. After steaming to its last known positon it was sighted at 1305/39 after a 40 minute search. Conditions were too rough to launch a boat, but it proved possible to grapple the buoy and partially retrieve it without damage to the VAECM sensor head. The drogue and transponder were attached and the system relaunched at 1520/39.

After a CTD cast (10638) at 40° 30'N, 20° 30'W, it was decided to launch the SeaSoar before the weather deteriorated further, to survey to the east in a zigzag pattern between 40 and 42° N. The launch was completed at 2157/39, but progress against a head wind and sea was barely fast enough to maintain control of the SeaSoar, and Run 3 was terminated at 0701/40 because of a cable termination failure. During repairs, the electric winch was tested to 2000m with Lucas weights, but it was eventually decided to replace the SeaSoar survey with a CTD section to the east following approximately the 41.5°N line surveyed by Discovery in 1977. Casts were 36 n.m. apart, with 450m XBT probes between them at 9 n.m. intervals.

CTD casts 10639 (1213/40) to 10644 (2255/41) were completed, but the following cast had to be replaced by XBT 118, as the vessel could not be held on station in 40-50 kt winds, and from 1200/42 the vessel was hove to. By that evening, the wind had moderated enough for cast 10645 to be completed (2218/42) though winds of 35 kt gusting to 45 kt were recorded. After 16 acceptable or nearly acceptable shallow XBTs with only one failure between 1326/40 and 2052/41, a succession of failures forced a switch back to Deep Blue XBTs from 0641/42. Conditions on the poop were difficult, and the watchkeeper launching the XBT wore both life jacket and safety harness.

Slow eastward progress continued, hindered by loss of engine suction caused by heavy rolling and faulty storm valves, but the final cast (10647) was completed at 1630/43. The SeaSoar was launched at 1644/43 for Run 4, but failed after less than 20 hours (cable termination failure) and was recovered at 1300/44. After a short search the Hermes buoy was located at 1700/44, but recovery was slow and difficult, and a VAECM head was broken during recovery. CTD 10648 to 5000m was done at the site of the drogue recovery, and after the mooring had been located, CTD 10649 was done near it to 4000m, ending at 0430/45.

Meteorological calibrations on eight headings relative to wind were made from 0500-0718/45, and the experimental mooring was then located and recovered by 1210/45.

Deteriorating weather conditions during the passage to the south west cluster of instruments made it advisable to recover the surface current buoy first. It was sighted at 1647/46 without a search, and recovered by 1834/46. Overnight, the final CTD (10650) of the 20°W section was completed, though it had to be done 5 n.m. south of the planned position in order to return to the BENCAT position to recover at first light.

In spite of 30-40 kt winds and a 15-20ft swell, superb seamanship by the master and officers enabled both BENCAT and BERTHA to be recovered without incident between 0803 and 1448/47.

Discovery then steamed towards the last known position of the second Hermes buoy, satellite fixes from which had ceased updating at 0345/45. The buoy carried an acoustic transponder, so an omni-directional dolphin was lowered to about 30m at 7 n.m. intervals. The search continued for 18 hours from 2000/47 until 1352/48 but had then to be abandoned to commence passage to Lisbon.

XBTs were launched at 20 n.m. intervals, until the SeaSoar was streamed for Run 5 at 0807/49. At 0857/49 the straingauge parted, but the wire was held by the safety stopper while the straingauge was quickly reconnected. The SeaSoar was yoyoing efficiently from 4 to 350m now that the fairing had been freed in many places, but at 1134/49 control was lost during radio transmission. Several offscale strains (over 2000 kg) were recorded and the SeaSoar appeared to be upsidedown thereafter, so was recovered by 1214/49, and the stainless steel wings found to be bent. This was the most serious incident caused by radio interference, but SeaSoar control was (and always has been) poor whenever the Radio Officer was transmitting.

The SeaSoar wings were replaced and it was restreamed at 1336/49 for Run 6, only to be recovered again at 2315/49 when its response to the command signal deteriorated severely. The bridle was found to be bent, and fouling the wings, and the SeaSoar was redeployed after straightening the bridle at 0124/50 for Run 7. Between 0934 and 1003/50 Discovery steamed in a large circle with the SeaSoar towed horizontally in manual during essential RO transmissions. Thus scientific time was lost but none of the west-east section.

The SeaSoar was finally recovered at 1746/50 at 11°W. The PES fish was recovered at the same time and watches ceased, but logging of the thermosalinograph data continued until 0600/51. Discovery berthed at Lisbon at 0845/51.

Surface meteorology (Guymer, Burnham, Lewis, Taylor)

The main object of the program was the calibration and evaluation of the automatic meteorological logging system following the removal of the IBM 1800 and the transfer of logging to the PDP 11/34. Sensors were connected via the RVS data transmission system (DTS) employing a new series of interface packages. The computer room had been completely rewired including new cables for the DTS interfaces. Several days were spent tracking down connector "teething" problems and checking that digital data were consistent with the output voltages of the various instruments. Additional problems were traced to errors in software resulting in incorrect application of calibration coefficients. These coefficients were derived from the old 1800 values except for the solarimeter, anemometer and wind vane, which were new instruments, where manufacturer's calibrations were used.

In order to assess the accuracy of the data a series of three-hourly WMO surface observations was maintained whenever possible. This incorporated the 00 and 06Z reports made by the bridge officers. Variables included wind, dry and wet bulb temperature, sea surface temperature, barometric pressure, cloud type and amount and visual estimates of wind-wave and swell conditions. A clockwork Assmann psychrometer was also operated to enable air temperatures to be measured at different locations. These time series (Fig. 2) also serve to provide a useful description of the weather during the cruise and, together with the facsimile charts received on the bridge, enabled forecasts to be made up to a few days ahead for the area in which Discovery was working. Such information assisted in day-to-day planning.

After a brief period of strong westerly winds a blocking situation developed in mid-Atlantic such that Discovery was in strong north or north-easterlies for much of the cruise. A cold, dry airstream resulted but showers also occurred which turned to hail on 11 February. As the high pressure declined and transferred to the UK winds decreased but a small low developing at an occlusion point just to the south of Discovery's position on 15 February resulted in gale-force easterlies before calmer conditions returned as the vessel headed to Lisbon. Average wind speed was 25 kt and the wave height was mostly greater than 10ft (visual estimates), exceeding 30ft on 11 February. The air temperature only rarely exceeded the sea temperature and the occurrence of westerly winds was very low.

Comparisons between the different instruments (Figs. 3-5) were generally very encouraging, particularly for air temperatures. Wicks occasionally dried out and from 10-13 February could not be moistened because rough weather prevented access to the wheelhouse top. Pressures were about 2.5 mb higher than those from the bridge precision aneroid barometer (after correction for height difference) and a revised calibration has now been incorporated. Winds from the logging anemometer were systematically lower than those from the WMO anemometer as read on the bridge but agreed to within 1 kt with the repeater of the bridge anemometer in the plot. Simultaneous readings of both dials confirmed that there was a difference of 5 kt in the WMO outputs which suggests a zeroing error in one of the dials.

On 14 February two experiments were conducted to investigate the effect of airflow over the vessel on winds, pressures and temperatures. In the first the vessel was placed on 8 different headings relative to the wind and at negligible speed through the water. The clearest effect was on the dry and wet bulb temperatures which were about 0.5°C higher when sensors were in the lee of the vessel. The second calibration excercise involved steaming into and downwind at various speeds thereby allowing a study of the effect of different relative wind speeds.

In conclusion, the Discovery meteorological system is capable of providing reliable 1-minute means of surface winds, air and sea temperatures, pressure and downwards solar radiation, which can be routinely logged. A useful feature of the system is the ability to hold up to 48 hours data on disk and to generate plots in near real-time so that the system can be easily monitored. It is suggested that the shipborne wave recorder (which was operated only twice near the end of the cruise) should be interfaced with the 11/34 to augment the surface data logging system.

<u>CTD Sections</u> (Smithers, Moorey, Pollard)

29 CTD casts were made (Table 1), all but one of which used the new IOS deep Neil Brown CTD (D2). Station 10620 was used to calibrate the old shallow NBIS CTD (S1), used thereafter in the SeaSoar. Salinity and usually oxygen samples were taken at 3 to 9 depths on all casts, using a 24 bottle Rosette multisample with Niskin bottles in alternate slots. Reversing thermometer readings were generally taken at only one level, but at two or three levels for deep casts and calibration casts. Samples were taken during the "up" cast. CTD salinities were taken from computer listings of data just before the multi-sampler was fired. Oxygen values were taken from the listings just before the winch was stopped.

After initial adjustment of the conductivity ratio, the mean difference between deep CTD salinities and bottle values for 129 samples was 0,0003 psu, with a standard deviation of 0,0028 psu. To calculate oxygens, the internal temperature of the oxygen sensor was ignored, and the CTD temperature lagged with a five minute time constant was used in the formula O%=C* (oxygen current)* exp(aT+bP). Taking C=0.00146, a=-0.036, b=0.000155 yielded a mean difference of 0.002 ml/l between deep CTD oxygens and bottle values for 111 samples, with a standard deviation of 0.087 ml/l.

While the calibrations were acceptable, the quality of the data logged by the computer was poor for reasons which are not yet fully understood. Noise on all channels introduced by the midships winch was not eliminated prior to the 1-second averaging that is standardly applied, resulting in sections of data with a high proportion of bad values, particularly in the top 100m and around 400 and 800m. Further noise was apparently introduced by bit-dropping, the cause of which has yet to be traced.

To make use of the data during the cruise, the magnetic tapes archived by the real time computer system (S1) were read back into the offline (USER) system. After passing through an interactive despiking option, the CTD cast data were of good enough quality to create 10 db averages, and then to contour the 20°W and 41°N sections with pressure or density as the vertical coordinate.

XBTs (Cherriman, Pollard, Cotterall)

Two kinds of probe were used. In addition to 91 Deep Blue XBTs (Table 2), 43 T4 probes were deployed from a large number donated by the Hydrographic Office. These were known to be past their expiry date (up to eight years old) but it was felt they might be scientifically useful. 16 of the T4 probes failed, with a further 6 of dubious quality. In view of these failures, and the deep mixed layers encountered in the north of the survey area, fewer T4 probes were used than had been anticipated.

The only method of logging was the Sippican analogue chart recorder. However, temperatures at 50m intervals were read off to maintain a running contour plot. Additionally, these values were entered into the USER computer and computer-contoured plots produced.

SeaSoar (Lawford, Smithers, Bonner)

In general the cruise was a disappointing one. All but the last of the seven runs (Table 3) had to be terminated prematurely. In all only about 113 hours of data were recorded. On each run the intention was to yoyo the vehicle from close to the surface to as deep as possible. Also a number of deep dives were made during the first four runs. This involved slowing the ship to less than 1 knot and allowing the vehicle to sink under its own weight. Depths in excess of 450m were attained. During the last two runs, after modifications to the fairing described below, it was found to be possible to yoyo the vehicle from the surface to a depth of 375m with a period of about 10 minutes. The ship's speed at the time being 9.5 to 10 knots.

Throughout the cruise the vehicle was fitted with a Neil Brown/Smithers CTD in its new shallow rated stainless steel case and a Chelsea Instruments Aquatracker fluorometer. The CTD was fitted with a roll sensor which was interfaced with the data stream. This showed that under normal conditions the vehicle rolled to about 20° either side; the rolls being in phase with the cable tension. From this it may be inferred that the towing cable in use is not entirely torque balanced. The rudder was lost from the vehicle during run 4 and the range of the roll more than doubled.

Initially the system included four new pieces of equipment, the desk control unit, a slip ring assembly on the capstan, a new 600m length of towing cable fitted with 550m of Fathom fairing and a pair of basically flat steel wings on the vehicle.

The desk control unit. Built in house by John Smithers, this replacement to the Hermes original performed well once the operators had mastered the intricacies of setting it up correctly. This was not achieved until the start of Run 4.

Slip rings. A set of slip rings was fitted to the capstan allowing full operation of the vehicle hydraulic unit and the CTD during launch and recovery. This meant that both systems could be monitored for correct operation during the entry into the water of the vehicle. Also the depth of the vehicle could to some extent be controlled during both manoeuvres.

It has been found that to reduce cable snatching during both launch and recovery it is best to keep the vehicle close to water surface thus reducing the cable angle and so reducing the effect of ship heave on the cable tension.

Faired cable. The new Fathom faired cable proved to be a considerable disappointment initially. There had recently been a change in the design of this fairing. The new fairing was continuous over its full length, spanning the support stops with a special section, not in discrete 3m sections as was the original design. The result of this change was the collection of twists or turns in the fairing around the cable which tended to propagate down the cable. This quickly increased the drag of the cable and so decreased the maximum depth attainable by the vehicle. This effect made it necessary to terminate both Run 1 and Run 2. On each occasion it was found that about 20 complete turns were spread down the top 30m of cable. In several places the special bridging section of fairing had twisted and jammed onto the cable. The remedy was found to be to cut out the individual 10cm long sections of fairing that span the support stops. This allows the individual lengths of fairing to rotate independently.

Steel wings. The flat stainless steel high aspect ratio wings were fitted for Runs 1 and 5. Though these performed very similarly to the original composite aerofoil wings there was an indication of some instability at the near surface turnover. During Run 5 RF interference from the ships' transmitter (see below) caused some severe changes to the vehicle flight path, several times cable tensions in excess of 2000 kg were recorded. This overloaded the wings to such an extent that both incurred permanent deflection downwards of some 10°. This was the reason for ending Run 5.

As well as the new pieces of equipment in the SeaSoar system, both the layout of the poop deck and the generation of hydraulic power were new.

Poop deck layout. The present arrangement of equipment on the poop deck makes handling the SeaSoar vehicle during launch and recovery a much more awkward and hazardous manoeuvre than in the past. The space between the Hiab crane and the Schat coring crane is so narrow that operation of the Hiab is severely restricted. Ideally the coring crane should be removed when gear is to be handled over the stern. Also for future SeaSoar cruises the large mushroom fairlead should be cleared from the deck.

Hydraulic power. The new power pack for the Hiab crane worked well though the crane itself was somewhat stiff after its refit. However control of the cable capstan, which is powered from the aft ring main system was far from satisfactory. The control of the capstan urgently needs alteration in three respects.

1. The whole system is so soft hydraulically that any fast movement of the controller causes the drum to oscillate up to 30°.

2. There is no centre off position on the controller. The position of the controller at which the drum is stationary is dependent upon the load on the drum. This makes operation of the capstan, when the ship is pitching, potentially hazardous.

3. The dynamic range of control is insufficient. If the range is set so that there is a great enough degree of sensitivity then there is not enough power, with the controller hard over, to handle the capstan at the higher cable loads.

Throughout the cruise considerable interference was experienced when the ships main transmitters were in use. Depending upon the frequencies being worked all the SeaSoar data channels, including the strain gauge, were effected. On one occasion the time make from the ships clock was corrupted. The interference was such that usually all control of the vehicle was lost for the period of the transmission.

Mooring (Cherriman)

Mooring 338 was set (Station 10622) on 1st February 1983 (Table 4) with two aims:-

(1) To measure temperature structure across the base of the deep winter mixed layer,

(2) To evaluate the performance of British Ropes 'Kevlar' rope with a view to using Kevlar's low stretch properties on some future moorings with the subsurface buoy near to the surface in deep water.

Due to heavy swell and hence large surges on the rope the original mooring was modified to the mooring shown in

Fig. 6, reducing the anchor load by 100 kg. The mooring was set smoothly and without mishap. First indications show that the Kevlar stretched by 6% with a 700 kg load. This was consistent on all 4x1000m lengths used.

Recovery took place on 14th February 1983 smoothly and without mishap. The first lengths of Kevlar recovered indicated that the original stretch was permanent, i.e. no 'recovery', the lengths measuring 1059m and 1066m, the last lengths' measurement being unreliable due to slippage of the meter wheel from lack of load.

All instrument tapes had run and more information on the Kevlar will hopefully be obtained from the pressure transducers on the two current meters set in the mooring.

<u>BENCAT</u> (Clayson)

The first operational trial of the new Mk2 version of BENCAT was made: the deployment lasted 9 days and was made in a depth of 4275m (Table 4). The instrument package comprised two 2-component electromagnetic current meters, a Savonius rotor and vane unit, 2 axis inclinometers and compass and a slow response thermistor. The equipment was deployed from the foredeck and sank at 0.71 m/s. After nearly 9 days on the sea bed the acoustic release was fired and the equipment rose at 0.60 m/s. Recovery was achieved in Force 8 winds with little difficulty thanks to the excellent ship handling.

<u>BERTHA</u> (Clayson)

A further trial of the benthic resistance thermometer array was carried out. The deployment of nearly 10 days duration was made in a depth of 4239m (Table 4). The five temperature sensors and the depth sensor were strapped together in an attempt to obtain intercalibration, stability and noise level information in deep sea conditions. The equipment was deployed buoyancy first in moderately rough conditions. This was found to be much more difficult than previous deployments from R.R.S. Challenger and put both equipment and personnel at some risk due to the obstructions on the poop, high rail, etc. After release of the anchor, the mooring sank at 2.2 m/s. After nearly 10 days, the acoustic release was fired and the mooring rose at 1.1 m/s. The mooring was recovered on the foredeck with no problems, again due to excellent ship handling, and it is clear that an anchor first deployment from the foredeck is to be preferred on R.R.S Discovery. This will, however, necessitate some redesign of the mooring hardware.

The assistance of the ship's officers and crew in these operations is gratefully acknowledged.

Hermes Buoys (Hunter, Cherriman)

Two buoys equipped with satellite transmitters for accessing the ARGOS system were launched (Table 4). The more northerly of the buoys was launched (Station 10623) at $44^{\circ}18.3'$N $16^{\circ}07.2'$W on 1st February (Day 32). This buoy was fitted with a $25m^2$ window shade drogue at about 100m depth. Just above the drogue was a Vector Averaging Electro-magnetic Current Meter (VAECM), and beneath the drogue an Aanderaa thermistor chain 120m in length was suspended. Beneath this was a further 120m of rope with an acoustic transponder at the end. In order to decouple the surface motion of the buoy, as far as possible, from the VAECM, the drogue was suspended from an elastic section of unstretched length approx. 55m below the buoy. A large damper plate was added to the top of the drogue giving a horizontal area of about $2m^2$. The VAECM was mounted on a bar between this elastic section and the damper plate of the drogue.

Launching of the system was carried out as on previous cruises, by releasing the buoy into the water first and paying out the tackle over the stern, whilst keeping a minimal amount of way on the ship so that the buoy and its tether fell away astern in an orderly fashion.

After paying out the rubber bungee this was stopped off at the rail and the transponder lowered over the side followed by its rope, and then by the thermistor chain. When all this had been paid out it was hanging suspended from a bridle beneath the drogue bottom bar. At the point when the drogue was ready to go over, it was held up at the rail on the crane hook and slipped using a no-load release and a strop bundled around this specially folded drogue. This method has worked well in the past with simpler drogues with less weight underneath, but the addition of thermistor chain and transponder contributed to larger drag forces which preloaded the no-load release and resulted in its non-operation, so the strop was cut instead.

When the second of the satellite tracked buoys was launched further south at 40° 23.4'N 20° 34.8'W on 7th February (Day 38) the procedure for launching was modifed in the light of experience. This buoy was not fitted with a thermistor chain, but it still had the transponder on 300 metres of rope. For this buoy we suspended the drogue from the recovery strop and cut it away to release it. The rope was then payed out until the transponder was reached, when it was lifted over manually and let go.

Relocation. The relocation of the first buoy was accomplished by heading to the last known positon of the buoy and listening for radio and acoustic signals, first capture being made on the VHF radio, closely followed by acoustic contact, which allowed us to home in the usual manner until visual contact was achieved. Had we had a Radio Direction Finder we would have obtained bearing information as well as range thus saving some time.

Recovery. This proved to be a long and difficult business conducted in adverse weather conditions and failing light. The presence of various structures on the deck and near the stern rail prevented adequate access and rendered the operation more difficult, and at times hazardous. The worst offender in this respect was the Schatt coring davit which constantly got in the way, and eventually damaged the drogue.

After lifting the buoy inboard by the recovery line, the rubber bungee cord was recovered in short sections, stopping off each time. The ship's capstan was used to haul in the sections which was also difficult because the control is so sited that the operator does not have a clear view of the operations and cannot hear either, if the crane motor is running. The recovery operation took nearly two hours, during which the VAECM was damaged when the support bar bent near the stern rail and pushed the head off its mounting.

The second buoy had headed off south easterly at a relatively high rate and then ceased to provide position data. Despite spending some time doing a box search for it, we failed to find it, and as the weather was worsening and our e.t.a. in Lisbon was threatened, the search was abandoned.

Surface current buoy (Collar, Hunter)

Opportunity was taken during the cruise to carry out some initial testing of a new design of satellite telemetering buoy incorporating a vector averaging electromagnetic current meter. Surface currents relative to the 1.5 metres diameter discus hull are measured at 1m depth, averaged over consecutive half-hour periods and are transmitted as a time series through the Argos system. When these are combined with the rate of change of buoy position over the earth's surface, improved estimates of near-surface current should result, independent of any wind forcing of the hull through the water.

The buoy was initially deployed undrogued at 0910 on 7th February close to one of the drogued Hermes buoys. It carried beneath it a length of chain intended to provide a righting moment in the event of capsize. The intention was to monitor the U.H.F. buoy transmissions on the ship in order to ascertain data quality and then to recover the buoy within a few hours on completion of some mooring work nearby. A pipe failure in the ship's engine room at 1430, with consequent loss of propulsion, led to a longer deployment than anticipated. However, the approximate position of the buoy was sufficiently predictable for it to be located and recovered by 1446 on the following day. The initial data having appeared to be satisfactory, the buoy was equipped with a drogue (80m depth) and an acoustic transponder and was redeployed at 1520 near 40° 11'N, 20° 34'W (Table 4). Bungee damper plate, drogue and tansponder were configured similarly to those of two Hermes buoys already deployed. For the current buoy, the drogue was launched before paying out the rope and transponder, which prevented fouling and proved more satisfactory. In addition the wire strops bypassing the bungee were replaced with rope, which proved simpler to handle on recovery.

The surface current buoy was finally recovered on 15th February at 1710 at 40° 14'N, 20° 26'W. Subsequent inspection showed that in the intervening stormy period water had entered the upper housing via the antenna sealing gasket and had flooded the compass and associated plugs and sockets, though without affecting the integrity of the main hull containing currrent meter and transmitter electronics and power supplies. Furthermore loads imposed either during the storm, or during recovery, had induced cracks in welded seams at the base of the hull.

The test deployment had thus usefully pinpointed two structural deficiencies: the data set acquired, also, should permit the validity of the technique to be assessed. First indications were encouraging. The slippage recorded showed the undrogued buoy being driven through the water by the wind at a speed of a few cm/s; attachment of the drogue reduced the drift of the buoy and produced a relative surface current approximately in the direction of the wind.

Overall, experience with the deployment, and especially with the recovery of the drifting buoys has demonstrated the need for a rapid communications link with the drifting buoy processing computer at Toulouse. It is to be hoped that future shipboard facilities will include a Marisat communications terminal, which will permit direct Telex access to Toulouse at any time. The present arrangement - via h.f. and m.f. radio links to the laboratory ashore and thence by Telex - introduces delays of several hours at the critical time prior to buoy retrieval. Moreover information can only be obtained during working hours ashore.

Electric and Midships Hydrographic Winches

(Clayson, Bonner, Hamlyn).

Cruise 132 presented the first opportunity to test some modifications in these winches and, after the extended period out of service in Falmouth, problems were expected and, indeed, experienced.

The traverse on the electric winch had been realigned and on a 2000m cast of the conductor cable with Lucas weights, spooling was excellent. The wire out counter electronics had been completely replaced at refit by a new design interfaced to the dynamometer displays throughout the ship. This worked well as did a new display in the deck controller. The portable controller had been removed since the original requirement for it was no longer valid and it had been subject to some abuse.

The midships winch electrical equipment in the deck console suffered a number of annoying faults due to ingress of water. These had been anticipated and work is in hand to fit a completely new console with improved weatherproofing during the 1983 refit. Another annoying problem was electrical interference on the CTD signals which only occurred when the traverse was in mid position so that the wire just scraped one of the traverse rollers. This was probably an earth loop problem but proved difficult to eradicate so that it was necessary to fit an insulating sleeve to each traverse roller.

A new interface to the dynamometer displays around the ship had been fitted in the refit and was satisfactory after initial teething troubles. The brake once again gave trouble, sometimes refusing to release and, once, refusing to be reapplied. It was necessary to renew the brake valve solenoid, strip down the brake actuating eccentric and to change the brake cylinder supply to the 1Q line. After these operations, the brake worked satisfactorily, if somewhat noisily.

VAECMs (Clayson)

It was intended to use VAECMs for measuring the slippage at the drogues of all three drifting buoys. It was however decided to omit the VAECM from the surface current buoy due to doubts about its sensor head. In the two Hermes buoy configurations, the VAECMs were mounted just above the drogue at a depth of approximately 80 metres. Three 20 metre lengths of waverider bungee, together with a damping plate on the drogue, decoupled the VAECM from the buoy's heave motion. This was necessary to prevent errors due to the wake of the VAECM housing. Only one Hermes buoy was recovered and although the sensor was broken in the process, a good record was apparently obtained.

A fourth VAECM was used in the surface current buoy itself: this was interfaced to the UHF satellite telemetry transmitter so as to transmit the preceding 8 half-hour vector averaged currents.

Computer Services (Burnham, Lewis, Potter)

During the refit in Falmouth, the IBM 1800 was finally removed from the ship after many, not uneventful years of service. The computer room was completely renovated. New air conditioning units were installed and all the myriad of cabling replaced. In its place two PDP-11/34 systems were installed to provide interim computer services until the full "Wells report" system arrives.

The two computers play two quite distinct roles. The first computer (colloquially known as the "S1" system) is used for real-time data acquisition, processing, archiving and data presentation. The second computer (known as the "USER system" is used for off-line processing and program development. Both share common peripherals via a new flexible patchboard system such that plotters, printers and terminals can be swapped from one computer to another in seconds.

The shipborne computer group objectives for this cruise were six-fold:-

1. To provide the standard SeaSoar computer services rendered as on previous cruises.
2. To prove that the new upgraded SeaSoar software worked.
3. To test out the new computer room wiring connections and cabling under full sea-going conditions.
4. To implement a new meteorological software package which improved upon the old IBM 1800 style capability.
5. To verify the sea-going ruggedness of the new 84 megabyte Winchester disc drive.
6. To provide a more comprehensive program development support service commensurate with the new hardware features offered.

Naturally, in a major change like this there were several frustrating problems which had to be overcome before the system was reliable. Several days were spent tracking down cabling connector faults which vibrated free under sea-going conditions.

By the mid point of the cruise, the new meteorological software and hardware interface package was working reliably. The success of the system was due, in no small part, to the dedicated efforts of Trevor Guymer and Duncan Collins.

The Winchester disc proved to be a very great success but was not severely tested for sea-worthiness and heavy work-load until towards the latter part of the cruise. Not only does it provide more capacity, it is significantly faster than the complementary RL01 disc drives. Such a drive installed on the "S1" computer would provide a real improvement to the throughput of the machine.

In late 1982, the various PDP-11/34 computer systems finally, after much hard work, arrived at a common RSX-11M operating system supporting common hardware features. For historical reasons and the legacy of CAMAC, they had formerly diverged. The effect of this was that certain features on the SeaSoar "S1" system had to be upgraded to the RSX-11M version 3.2 operating system. This upgrade was at the expense of memory space available to the scientific application tasks.

It quickly became apparent at the start of the cruise that the new "unified" system "S1" system running under a 16K 3.2 executive could not cope with the work load traditionally expected of it. The problem was not one of the lack of physical memory space on the machine as new FORTRAN memory resident libraries had mitigated this problem. Neither was it one of execution speed of the PDP-11 processor, rather it was the lack of executive dynamic storage region or POOL space. Simply put, the total virtual memory space sum of executive code plus pool space must be rounded up to the nearest 4K word chunk of address space. The present system was a 12.8K word executive plus 3.2K word pool allocation giving a 16K word total. Under the previous RSX-11M SeaSoar system, the equivalent executive code was less than 9K words with an accompanying pool space of 7K words. Although more pool space had been allocated elsewhere, albeit indirectly, the total amount was just not sufficient. The effect of this was that the computer "hung", the keyboard terminals failed to respond to prompts and a re-boot of the system became necessary. The system operated as an interim replacement was just not acceptable.

The outcome of this was that a new system generation was performed at sea which raised the executive code to a new 20K word size and providing more than 7K words of pool space. From then on, the operating system with all the new features worked perfectly and is, to date, "bomb proof".

One unfortunate side effect of the decision was that some privileged tasks cannot run under the 20K executive. They no longer have sufficient memory management registers to map the task code onto virtual address space. It is impossible to get round this problem with the programs constituted as they presently stand; it is a fundamental restriction of the PDP-11 UNIBUS architecture. In scientific terms, this means that the raw surface temperature and raw surface irradiance tasks cannot be supported. There is a way round the problem but this needs a completely new design approach to the programs which would use different executive programming techniques.

In conclusion, then, the interim IBM 1800 replacement system has been successfully installed and run at sea. The computer services offered at sea are enormously improved by the use of the two computers, and flexibile capability to switch hardware peripherals between the two.

PSTAR data processing (Pollard, Collins)

Cruise 132 was the first on which an offline (USER) computer was available for further processing of data being collected by the realtime (S1) system. A subset of PSTAR programs developed for the mainframe GEXEC system had been made interactive and implemented on the USER system. Data were transferred from the S1 system by two routes. Data on S1 archive tapes could be read back once the tape had been filled and changed on the S1 system, involving a delay of perhaps a day or two. Data could be transferred directly between the computers using the RVS COPYDAT program which copies data from a cyclic random S1 file into a sequential ASCII file, then TRAnsfers it across, after which it was converted back into a PSTAR binary random file. The technique was known to be temporary in the absence of fast transfer hardware, and proved too slow to handle 1-second CTD data. It was acceptable for 10-second or 1-minute data, but the TRA process failed occasionally, apparently when the Winchester disk receiving the data was busy.

PSTAR programs were used extensively to append all thermosalinogaph data into a few long files and produce running plots. PSTAR programs were also used to despike, average, plot, amalgamate, and contour CTD cast data and to amalgamate and contour XBT data.

The intention to contour SeaSoar data could not be achieved however. The S1 system had been used in the past to plot data in contourable fashion, but did not appear capable of handling the load when running under the RSX-11M version 3.2 operating system. The poor data quality precluded contouring in the USER system without considerable despiking, for which time was not available. Archive and retrieval programs were written and used to archive edited data.

Navigation (Collins, Burnham)

Navigational programs in the S1 computer use the same files as contain meteorological data. Processing was therefore hampered initially by the hardware problems discussed under Surface Meteorology. Once those had been overcome, the 1-second EMlog and gyro data were routinely reduced to 1-minute averages and calibrated. Satellite fixes were also obtained, and the EMlog dead reckoned values corrected to match pairs of satellite fixes by assuming a constant current. The final stage of allowing certain fixes to be rejected by the user before recalculating currents and updated 1-minute positions was not done in the S1 system. The relevant programs were converted to run as PSTAR programs in the USER system. This change allowed the final stage to be repeated as often as necessary to obtain the most consistent set of satellite fixes. It also allowed the 1-minute data for the whole cruise to be stored in a single file. These programs were perfected a few days before the end of the cruise, allowing the navigation data for the whole cruise to be corrected, and track plots produced by the USER computer on several scales.

TABLE 1

CTD Station List

Station No.	Day No.	Time z	Lat. N	Long W	Wire Out	CTD	Calibration Levels Sal	Oxy	Temp
10620	29	2214	48 18.9	12 52.6	600	S1	9	9	3
10621	30	1809	47 03.9	14 08.5	2000	D2	8	9	3
10624	33	1226	45 46.9	15 58.9	1000	D2	9	8	2
10625	35	1334	46 49.0	18 08.1	2000	D2	9	9	2
10626	35	2115	47 30.8	18 59.2	1000	D2	9	9	2
10627	36	0213	46 55.7	19 08.0	1000	D2	4	0	1
10628	36	0657	46 19.9	19 15.2	1000	D2	4	0	1
10629	36	1130	45 45.5	19 23.0	1200	D2	4	4	1
10630	36	1552	45 26.8	19 24.3	1200	D2	4	4	1
10631	36	1847	45 10.2	19 30.5	1200	D2	3	3	1
10632	37	0010	44 36.7	19 38.9	1000	D2	4	0	1
10633	37	0520	44 00.0	19 46.3	1200	D2	4	0	1
10634	37	0943	43 24.8	19 53.5	1000	D2	4	4	1
10635	37	1409	42 50.4	20 02.5	1000	D2	4	0	1
10636	37	1837	42 15.6	20 09.1	1000	D2	4	4	1
10637	37	2241	41 40.8	20 16.0	1000	D2	4	4	1
10638	38	1845	40 29.7	20 29.6	1000	D2	3	4	1
10639	39	1213	41 16.5	19 41.0	1500	D2	4	4	1
10640	40	1907	41 21.2	18 51.5	1200	D2	6	6	1
10641	41	0226	41 27.1	18 06.6	1200	D2	6	0	1
10642	41	0931	41 31.2	17 18.7	1200	D2	6	6	1
10643	41	1614	41 34.8	16 31.8	1200	D2	6	6	1
10644	41	2255	41 39.9	15 43.6	1200	D2	6	6	1
10645	42	2218	41 59.8	14 00.7	800	D2	6	6	1
10646	43	1043	42 14.9	12 59.8	1200	D2	5	5	1
10647	43	1557	42 14.5	12 20.1	1200	D2	6	6	1
10648	44	2057	43 56.9	15 53.1	5000	D2	7	7	3
10649	45	0253	44 17.7	16 08.0	4000	D2	7	7	3
10650	47	0007	40 59.1	20 25.4	1200	D2	4	4	1

TABLE 2

XBT Data

Seq. No.	Day No.	Time z	Lat. N	Long. W	Max. Depth (m)	Type	Comments
1	29	0830	48 47.1	10 43.4	500	T4	
2	29	0930	48 44.9	10 54.9	500	T4	
3	29	1030	48 42.1	11 08.0	320	T4	Dubious
4	29	1130	48 38.7	11 19.9	500	T4	
5	29	1231	- - -	- - -	---	--	Failed
6	29	1239	48 35.1	11 35.1	500	T4	
7	29	1330	48 32.8	11 45.8	450	T4	
8	29	1430	- - -	- - -	---	--	Failed
9	29	1434	- - -	- - -	---	--	Failed
10	29	1436	- - -	- - -	---	--	Failed
11	29	1441	48 29.3	12 00.2	500	T4	
12	29	1529	- - -	- - -	---	--	Failed
13	29	1532	- - -	- - -	---	--	Failed
14	29	1536	48 24.4	12 22.2	230	DB	
15	29	1630	- - -	- - -	---	--	Failed
16	29	1635	- - -	- - -	---	--	Failed
17	29	1953	48 18.5	12 51.4	890	DB	
18	30	0130	48 16.0	13 06.1	140	DB	Paper feed failure
19	39	9147	48 14.9	13 08.1	830	DB	
20	30	0330	48 10.6	13 21.3	890	DB	
21	30	0538	48 06.2	13 36.0	999	DB	Constant to 1000m?
22	30	0738	48 01.8	13 50.3	890	DB	
23	30	0930	47 58.0	14 04.9	670	DB	Dubious
24	30	1126	47 53.6	14 10.5	890	DB	Dubious
25	30	1330	47 37.9	14 12.8	920	DB	
26	30	1530	47 18.9	14 10.9	900	DB	
27	31	0031	46 50.3	14 03.4	900	DB	
28	31	0231	46 37.4	14 01.4	920	DB	
29	31	0431	46 25.0	13 59.3	890	DB	
30	31	0630	46 13.7	14 01.6	800	DB	
31	31	0830	45 57.4	14 03.8	900	DB	
32	31	1030	45 40.1	14 06.1	800	DB	
33	31	1230	45 24.3	14 07.8	800	DB	
34	31	1430	45 09.4	14 07.7	880	DB	
35	31	1630	44 52.5	14 11.1	890	DB	
36	31	1830	44 37.4	14 14.3	920	DB	
37	31	2030	44 33.6	14 30.3	900	DB	
38	31	2230	44 31.7	14 46.4	900	DB	
39	32	0030	44 28.9	15 02.6	890	DB	
40	32	0230	44 23.7	15 20.5	890	DB	
41	32	0430	44 19.4	15 38.4	920	DB	
42	32	0630	44 13.7	15 57.9	910	DB	
43	33	0930	45 49.3	15 59.9	910	DB	
44	35	1154	46 45.4	18 03.1	710	DB	
45	35	1215	46 47.9	18 06.6	810	DB	

TABLE 2 (XBT data cont.)

Seq. No.	Day No.	Time z	Lat. N	Long. W	Max. Depth (m)	Type	Comments
46	35	1530	46 53.8	18 15.1	890	DB	
47	35	1630	47 01.5	18 24.3	890	DB	
48	35	1830	47 08.8	18 32.8	890	DB	
49	35	1929	47 23.9	18 50.0	900	DB	
50	35	2250	47 23.7	18 59.1	900	DB	
51	35	2347	47 13.6	19 02.2	890	DB	
52	36	0039	47 05.7	19 05.1	750	DB	
53	36	0347	46 45.7	19 12.5	910	DB	
54	36	0438	46 37.3	19 14.3	910	DB	
55	36	0528	46 28.6	19 14.9	890	DB	
56	36	0828	46 10.8	19 17.6	890	DB	
57	36	0917	46 01.6	19 19.7	890	DB	
58	36	0947	45 55.8	19 20.9	540	T4	
59	36	1008	45 52.4	19 21.6	910	DB	
60	36	1300	45 35.7	19 22.3	890	DB	
61	36	1320	45 33.2	19 22.9	550	T4	
62	36	1336	45 30.9	19 23.2	515	T4	Dubious
63	36	1407	45 27.8	19 24.2	750	DB	
64	36	1730	45 17.8	19 28.2	770	DB	
65	36	2017	45 01.0	19 32.1	900	DB	
66	36	2108	44 57.7	19 34.3	880	DB	
67	36	2158	44 42.7	19 36.3	880	DB	
68	37	0140	44 27.7	19 41.2	890	DB	
69	37	0240	44 17.4	19 43.7	890	DB	
70	37	0319	44 10.3	19 45.4	900	DB	
71	37	0647	43 50.9	19 49.4	890	DB	
72	37	0743	43 41.4	19 50.9	900	DB	
73	37	0827	43 33.2	19 52.7	890	DB	
74	37	1106	43 16.1	19 55.6	900	DB	
75	37	1153	43 06.7	19 57.9	880	DB	
76	37	1245	42 58.9	20 00.8	840	DB	
77	37	1535	42 41.9	20 04.7	880	DB	
78	37	1630	42 32.5	20 06.6	890	DB	
79	37	1715	42 23.7	20 09.0	890	DB	
80	37	2000	42 06.6	20 10.9	890	DB	
81	37	2051	41 58.1	20 13.3	900	DB	
82	37	2145	41 48.8	20 15.0	890	DB	
83	38	0135	41 32.2	20 18.0	880	DB	
84	38	0240	41 21.8	20 20.7	910	DB	
85	38	0335	41 14.0	20 22.5	900	DB	
86	38	0429	40 04.7	20 23.9	900	DB	
87	38	0518	40 55.6	20 26.6	830	DB	
88	38	0610	40 46.5	20 28.5	900	DB	
89	38	0702	40 37.1	20 29.6	910	DB	
90	39	0946	40 02.0	20 48.7	900	DB	
91	39	1117	40 09.0	20 43.0	900	DB	
92	39	1530	40 11.2	20 34.3	910	DB	
93	39	1656	40 20.9	20 33.0	910	DB	
94	40	1326	41 17.3	19 29.3	540	T4	
95	40	1526	41 17.0	19 19.5	530	T4	

TABLE 2 (XBT data cont.)

Seq. No.	Day No.	Time z	Lat. N	Long. W	Max. Depth (m)	Type	Comments
96	40	1649	41 13.2	19 08.1	520	T4	
97	40	2130	41 23.1	18 37.3	500	T4	
98	40	2210	41 22.0	18 33.0	480	T4	
99	40	2301	41 22.8	18 26.5	500	T4	
100	41	0030	- - -	- - -	---	T4	Failed
101	41	0052	41 24.9	18 11.7	500	T4	Dubious
102	41	0435	41 28.2	17 53.0	500	T4	Dubious
103	41	0630	41 27.8	17 42.6	500	T4	
104	41	0730	41 28.4	17 29.3	500	T4	
105	41	1139	41 33.7	17 06.9	500	T4	
106	41	1308	41 35.4	16 54.5	490	T4	
107	41	1430	41 35.3	16 42.1	500	T4	Dubious
108	41	1812	41 37.5	16 21.2	460	T4	
109	41	1932	41 37.8	16 08.8	500	T4	
110	41	2052	41 38.9	15 56.5	560	T4	
111	42	0055	- - -	- - -	---	T4	Failed
112	42	0235	- - -	- - -	---	T4	Failed
113	42	0239	- - -	- - -	---	T4	Failed
114	42	0245	- - -	- - -	---	T4	Failed
115	42	0250	- - -	- - -	---	T4	Failed
116	42	0355	- - -	- - -	---	T4	Failed
117	42	0400	- - -	- - -	---	T4	Failed
118	42	0641	41 44.8	14 49.3	930	DB	
119	42	0847	41 46.2	14 32.8	510	T4	Dubious
120	42	1137	41 49.3	14 16.1	930	DB	
121	43	0118	42 03.5	13 47.3	900	DB	
122	43	0433	42 07.8	13 35.0	900	DB	
123	43	0705	42 11.3	13 22.1	830	DB	
124	43	0859	42 14.0	13 11.2	880	DB	
125	43	1250	42 14.4	12 45.1	840	DB	
126	43	1405	42 14.1	12 31.2	680	DB	
127	48	1415	39 45.9	19 45.4	920	DB	
128	48	1726	39 33.7	19 23.2	930	DB	
129	48	2024	39 22.5	18 59.1	890	DB	
130	48	2250	39 12.0	18 37.4	920	DB	
131	49	0120	39 00.4	18 13.8	850	DB	
132	49	0355	38 52.1	17 49.6	920	DB	
133	49	0610	38 49.2	17 24.0	830	DB	
134	50	0038	38 37.0	14 06.0	840	DB	

TABLE 3

SeaSoar Runs

Run	Start			Stop			Length (hr)	Depth range	Comments
	Day/time	Lat.N	Long.W	Day/time	Lat.N	Long.W			
1	32/2057	44 21.2	16 04.6	33/0807	45 45.9	15 59.8	11	yoyo 40-240m.	Recovered to change wings, found very twisted fairing.
2	33/1444	45 44.8	15 57.1	35/1044	46 46.5	17 59.2	44	yoyo 0-250m. Deep dives	Recovered because erratic depth signal; fairing very twisted again.
3	39/2157	40 37.2	20 25.2	46/0701	41 17.4	19 41.2	9	yoyo 50-305m. Deep dives	Recovery due to broken conductor where cable entered vehicle.
4	43/1710	42 16.9	12 16.8	44/1300	43 40.9	15 17.6	20	yoyo 30-330m. Deep dives	Recovery due to short in cable to plug joint within vehicle.
5	49/0838	38 46.1	16 58.5	49/1134	38 45.5	16 27.4	3	yoyo 20-330m.	Control lost during ship R/Tx; wings bent under high tension.
6	49/1336	38 45.2	16 11.6	49/2315	38 41.0	14 11.5	10	yoyo 0-380m.	Towing bridle bent.
7	50/0155	38 34.1	13 51.2	50/1746	38 31.7	11 00.3	16	yoyo 0-370m.	End of run.

TABLE 4

Mooring, Bencat, Bertha, surface buoy details

System	Lat.(N)	Long.(W)	Time/day set	Time/day recovered	Depth
Mooring 338	44° 15.3	16° 06.2	1618/32	0830/45	4650m
BENCAT	40° 23.7	20° 34.4	1131/38	0803/47	4275m
BERTHA	40° 22.1	20° 35.2	1406/38	1137/47	4239m
Hermes 1798					
set	44° 18.3	16° 07.2	1923/32		
recover	43° 56.4	15° 53.7		1720/44	
Hermes 1797					
set	40° 23.4	20° 34.8	1032/38		
recover				not recovered	
Surface current buoy 1800					
set	40° 10.9	20° 34.3	1520/39		
recover	40° 14.1	20° 26.0		1710/46	

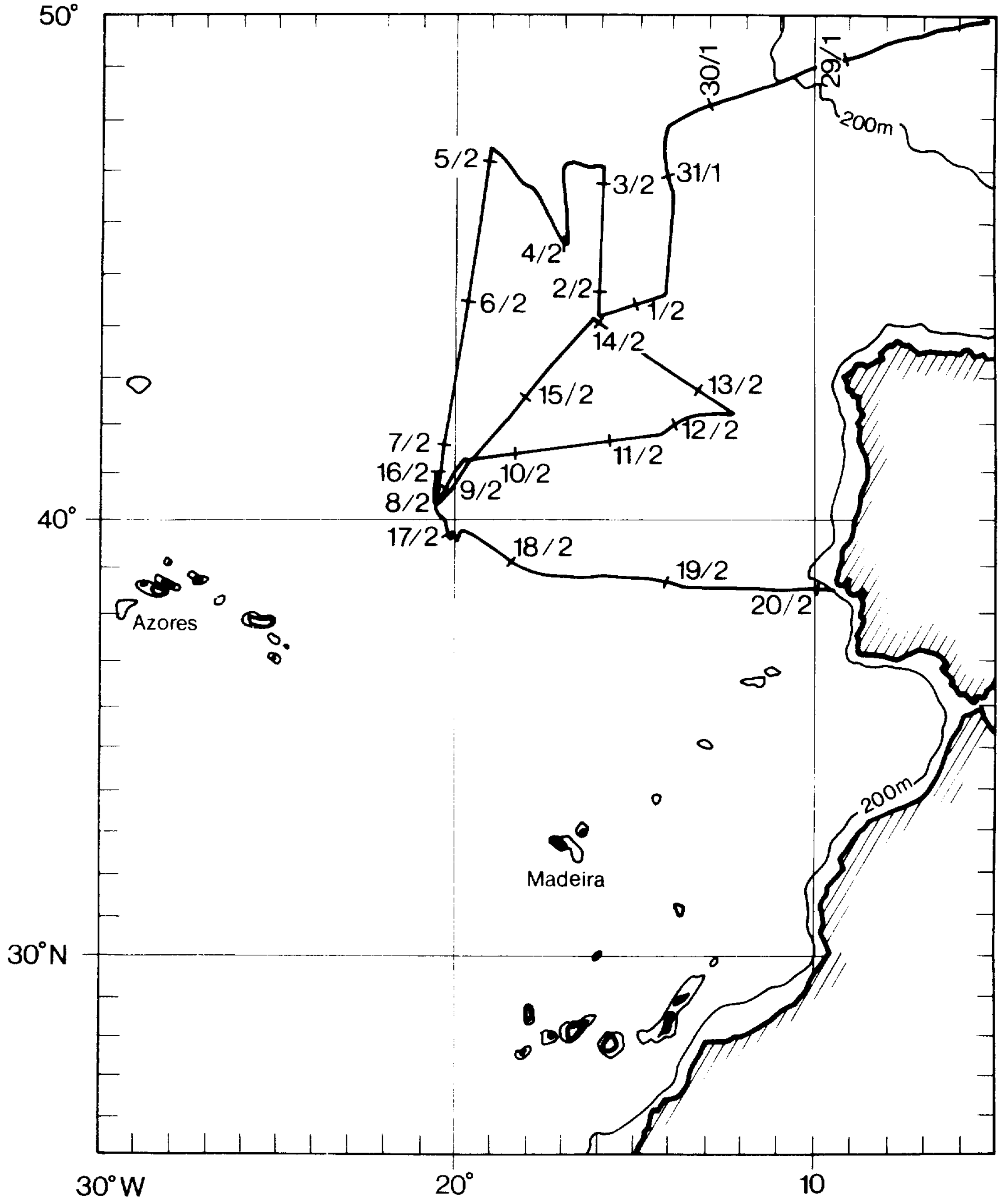

Fig.1 Track plot, Cruise 132

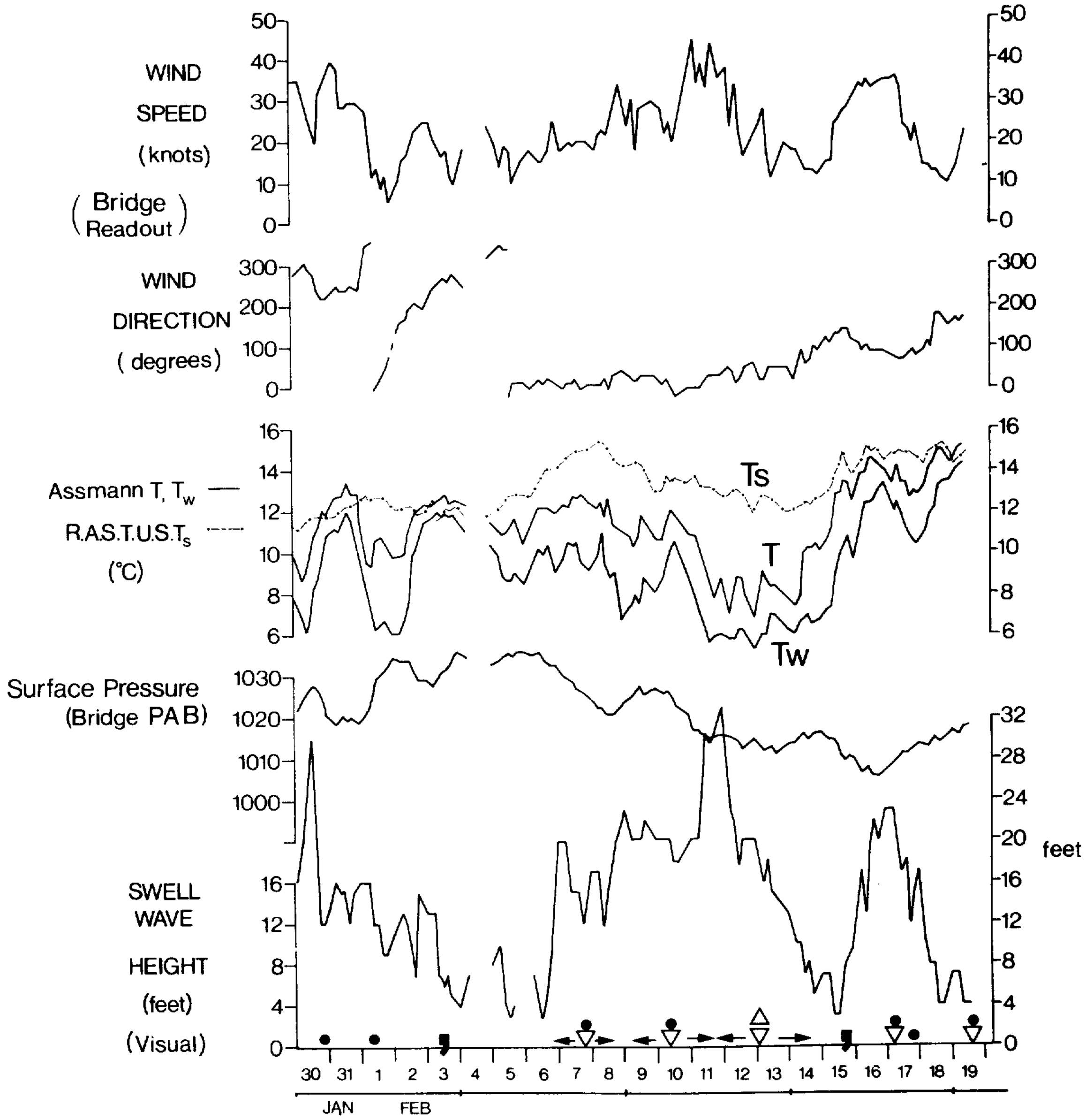

Fig. 2 Time series of 3-hourly meteorological observations

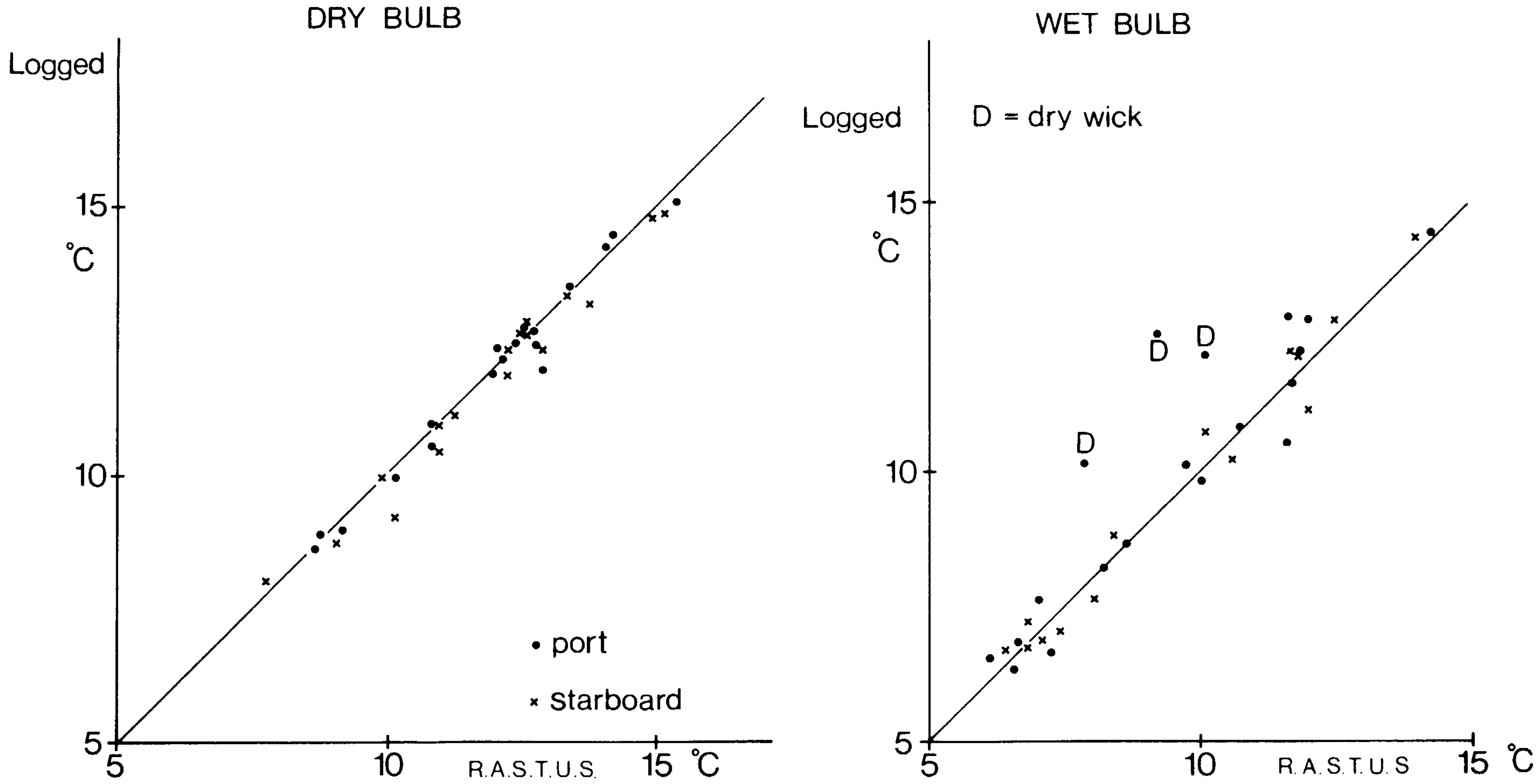

Fig. 3 Air temperature comparison

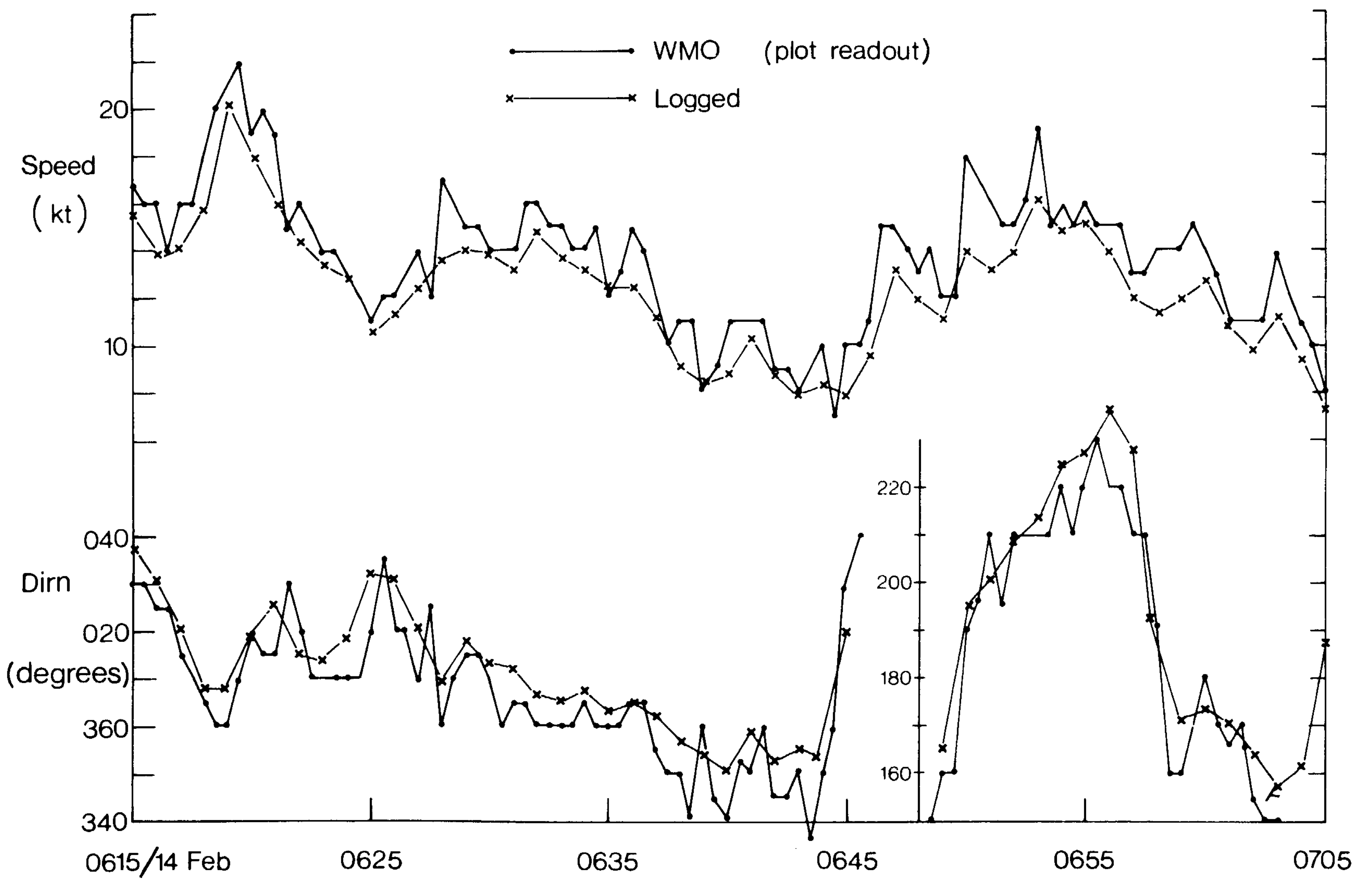

Fig. 4 Comparison of wind speed and direction

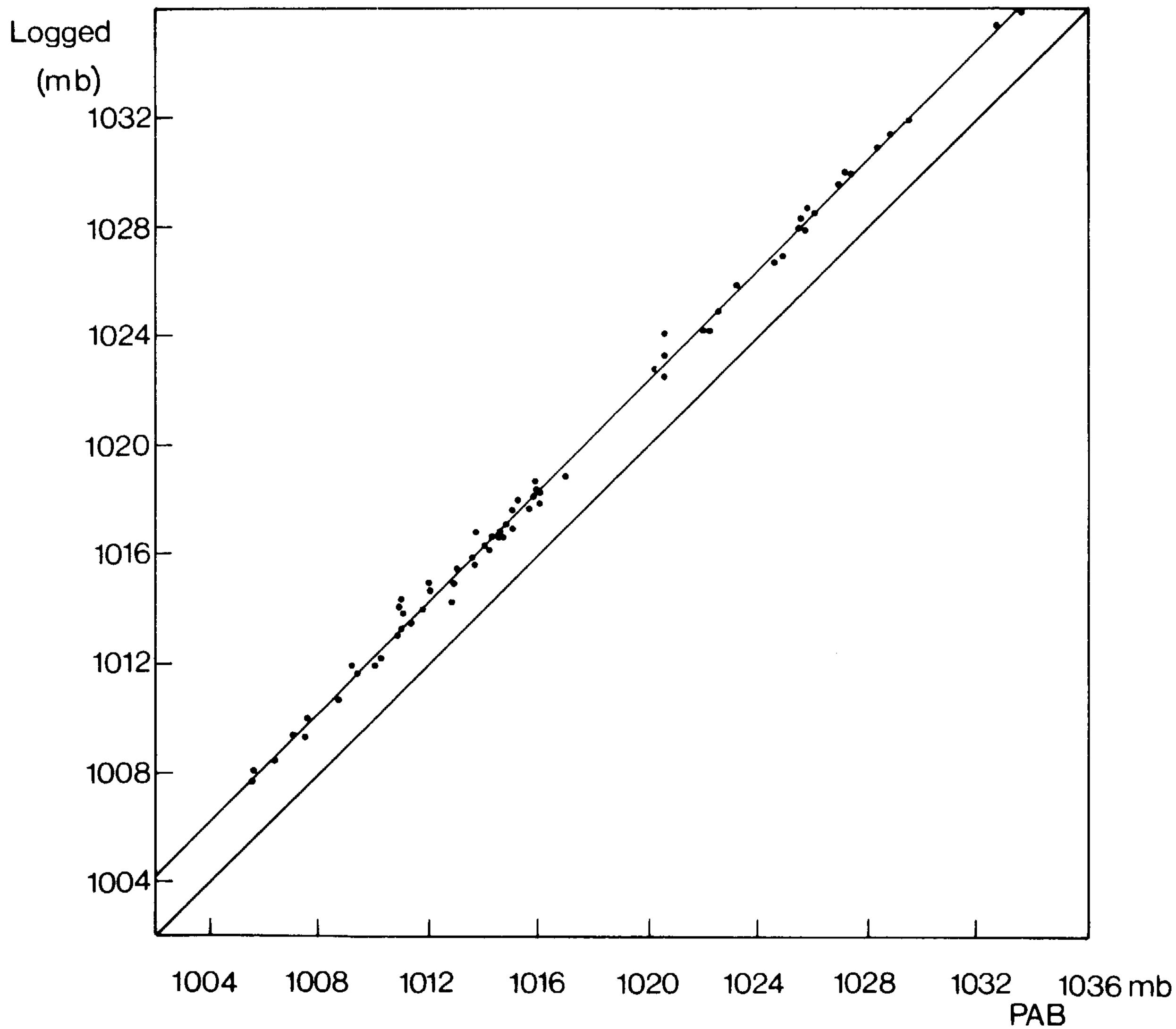

Fig.5 Comparison of height — corrected pressures

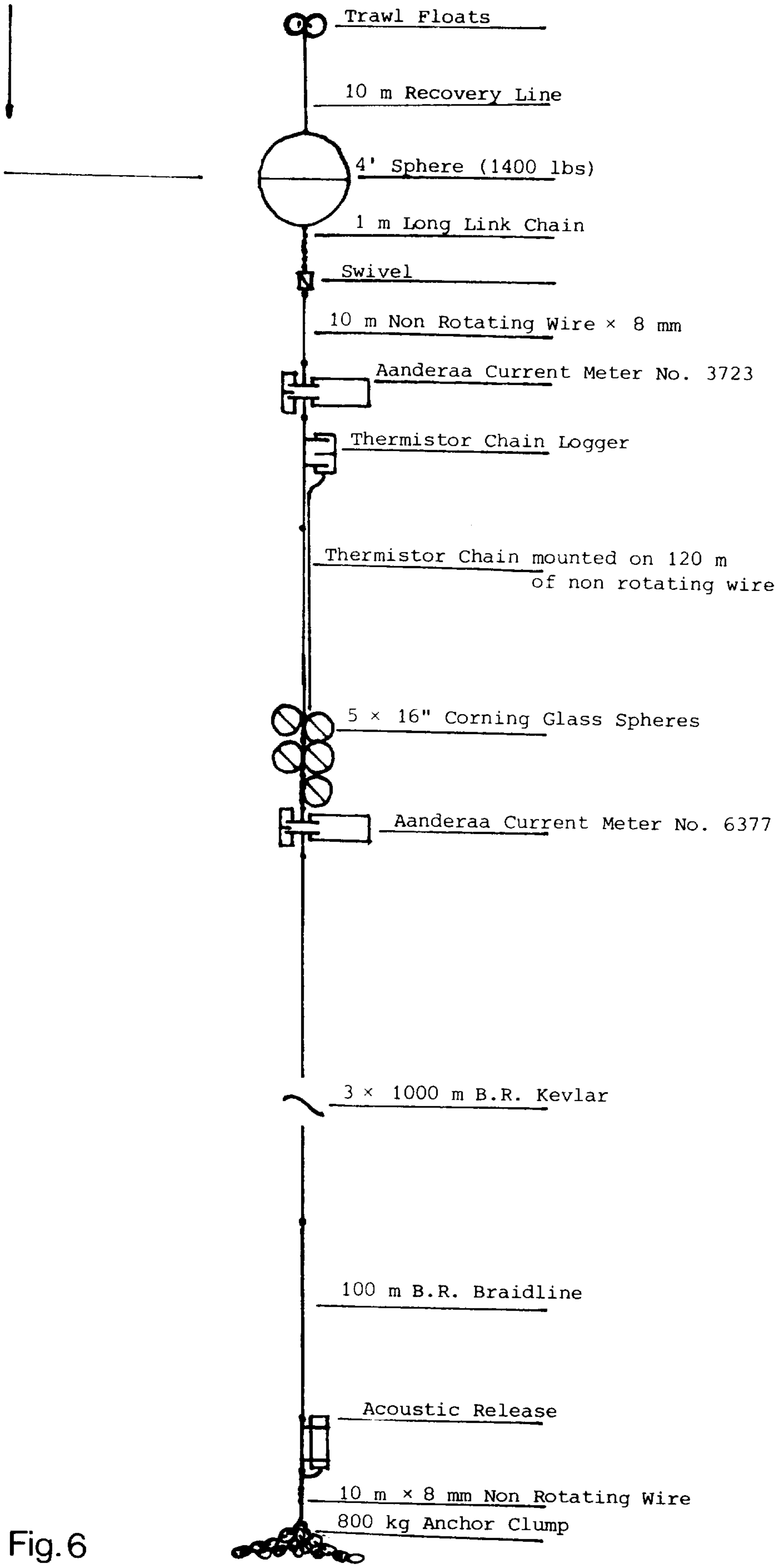
Trawl Floats
10 m Recovery Line
4' Sphere (1400 lbs)
1 m Long Link Chain
Swivel
10 m Non Rotating Wire × 8 mm
Aanderaa Current Meter No. 3723
Thermistor Chain Logger
Thermistor Chain mounted on 120 m of non rotating wire
5 × 16" Corning Glass Spheres
Aanderaa Current Meter No. 6377
3 × 1000 m B.R. Kevlar
100 m B.R. Braidline
Acoustic Release
10 m × 8 mm Non Rotating Wire
800 kg Anchor Clump

Fig. 6

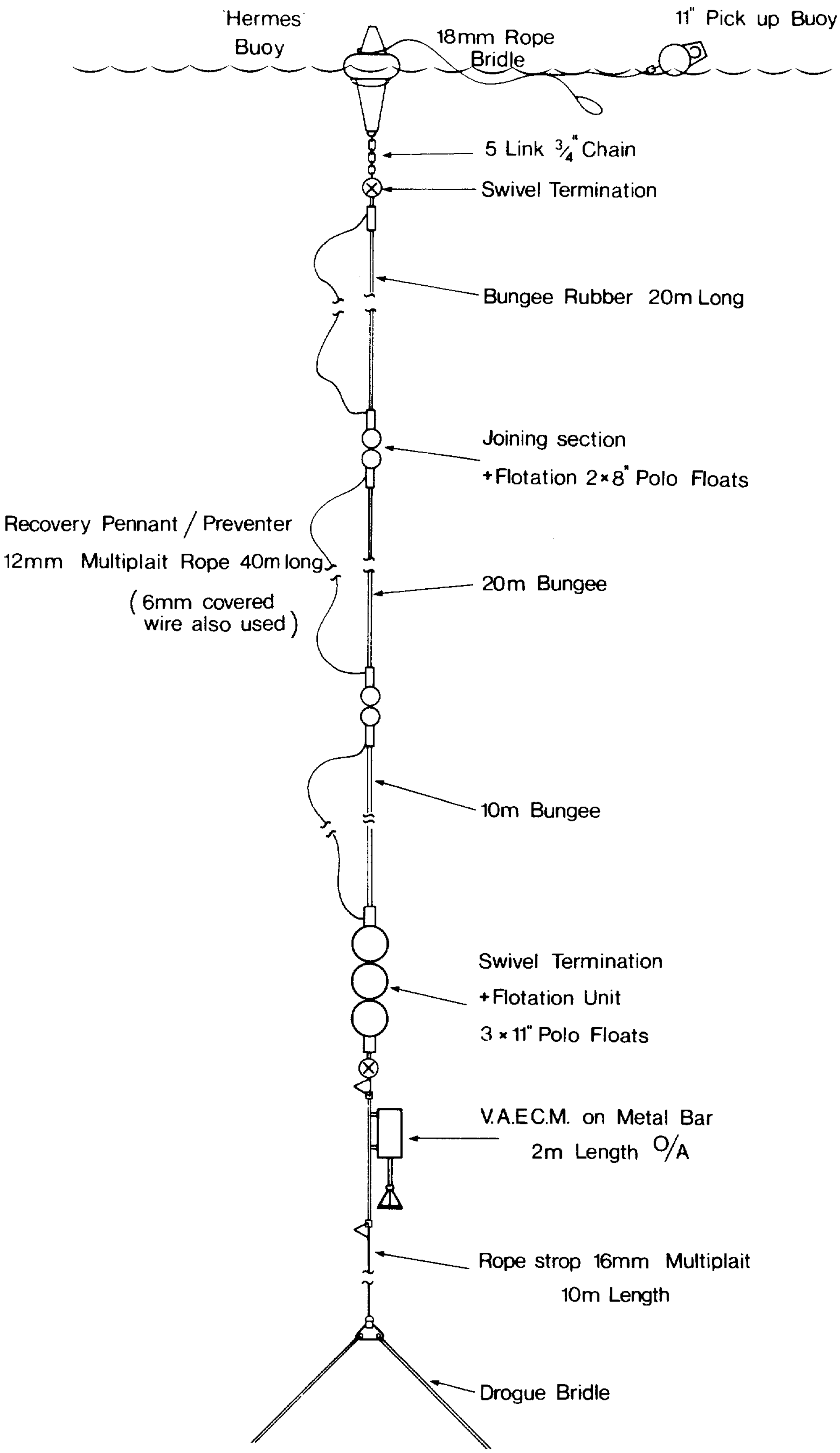

Fig. 7a Top Half of 1797 and 1798

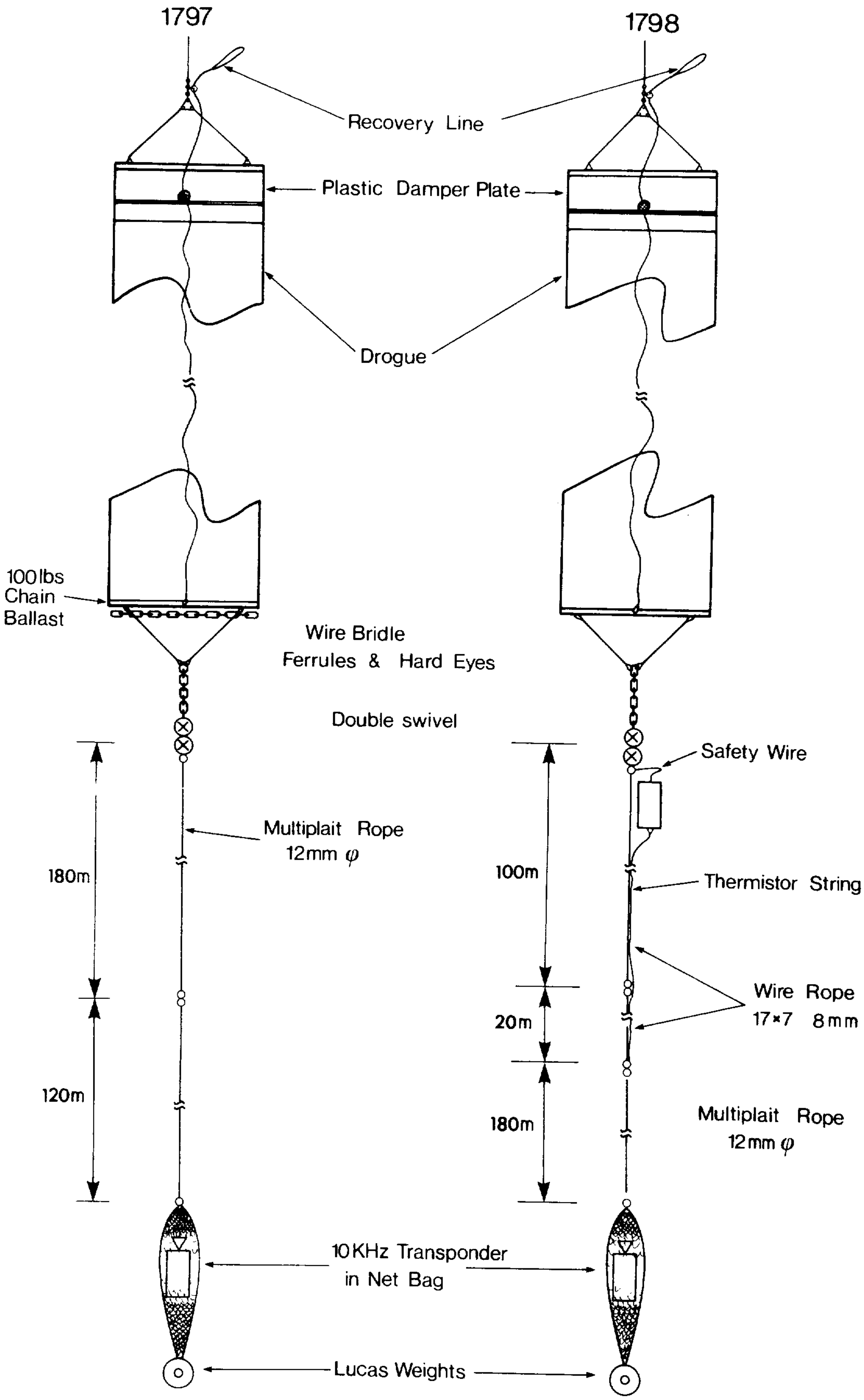

Fig.7 Lower Half of 1797 and 1798