CRUISE REPORT

GIN SEA 86
HLNMS TYDEMAN A906

26 May - 30 June 1986

## 1. Introduction

In accordance with the SACLANTCEN GIN Sea Cruise Test Plan of 8 May 1986, the cruise, GIN Sea'86 has been conducted on board the HLNMS TYDEMAN. The cruise consisted of two legs: a mooring leg from 28 May - 6 June and a hydrography leg from 8 to 29 June. The survey area was centered in the Faeroe-Shetland channel but also extended south to the Wyville-Thompson ridge and north to 65° in the Norwegian Sea. In the following paragraphs we report on the tasks performed, personnel involved, and a summary of scientific and technical results. Greater detail will be available in the forthcoming Data Report.

## 2. Schedule of Tasks

### 2.1 Load Phase, 23-28 May

23 May, Containers arrived, processed through customs for disposition alongside TYDEMAN

26-28 May, Embark contents of containers and begin equipment installation

### 2.2 Installation Phase, 27-30 May

27-28 May, Installation dockside Den Helder

28 May, 1900 underway for Aberdeen, continue preparation

30 May, at Aberdeen load IOS equipment and embark Phillips and Waddington of IOS. Disembark Duarte

## 2.3 Leg I

| | |
|---|---|
| 30 May, | 1500 underway, for Faeroe-Shetland Channel |
| 31 May, | Deployed Mooring 1, XBT survey |
| 1 June, | Deployed Moorings 2 and 3 |
| 2 June, | Deployed and recovered OED float |
| | Deployed Met buoy |
| | Began CTD casts |
| 3 June, | Deployed IOS Moorings 1, 2, 3 |
| 4 June, | Deployed WEBB and OED floats |
| 5 June, | Continued CTD casts |
| 6 June, | CTD, Steamed for Lerwick |
| 7,8 June, | Lerwick, Disembarked Mulder, Gualdesi, D'Agostino, Della Maggiora, Phillips |

## 2.4 Leg 2

| | |
|---|---|
| 8 June | Embark Nacini, Povero, Menelli, Ribera, Vogel |
| 9 June | 1300 underway for Faeroe-Shetland Channel |
| | 1900 commence CTD track, St. 1 |
| 16 June | 0900 complete St. 65, underway for Unst, Faeroe Islands for dental emergency |
| | 2000 St. 66, resume CTD track |
| 22 June | Recover IOS mooring 1 between Sts. 110 and 111 |
| | Recover IOS moorings 3 and 2 between Sts. 111 and 112 |
| 24 June | Complete ST. 130 |
| | Recover OED float |
| | Recover SACLANTCEN mooring 1 |
| | Commence time series |
| 25 June | Complete time series (Sts. 131-144) |
| | Recover SACLANTCEN moorings 2 and 3 |
| 26 June | Recover Met Buoy |
| | 0500 underway for Aberdeen |
| 27 June | 0700 moored in Aberdeen |
| | Offload IOS equipment |
| | 1000 underway for Den Helder |
| 28 June | 1600 moored in Den Helder |

2.5 Unload Phase 29-30 June

| | |
|---|---|
| 29 June | Load containers |
| 30 June | Cruise personnel disembark |
| 3 July | Containers depart Den Helder under supervision of Della Maggiora |

3. Personnel

3.1 Load Phase

| Name | Organization |
|---|---|
| Della Maggiora, R. | OED |
| Duarte, V. | COM |
| Paoli, M. | OED |
| Ribera D'Alcala, M. | Stazione Zoologica, Napoli |
| Tavernelli, M. | OED |

3.2 Leg I

| | |
|---|---|
| Cavanna, A. | COM |
| D'Agostino A. | OED |
| Della Maggiora, R. | OED |
| Duarte, V. | COM (until Aberdeen) |
| Giannecchini, P. | AOG |
| Gualdesi, L. | OED |
| Hopkins, T.S. | AOG |
| Maddaluno, G. | OED |
| Montanari, C. | OED |
| Mulder, H.G. | AOG |
| Orsini, G. | COM |
| Phillips, G. | IOS (from Aberdeen to Lerwick) |
| Sisti, C. | OED |
| Tonarelli, B. | OED |
| Waddington, I. | IOS (from/to Aberdeen) |
| Zanasca, P. | AOG |

3.3 Leg II

| | | | |
|---|---|---|---|
| Cavanna, A. | COM | | |
| Giannecchini, P. | AOG | | |
| Hopkins, T.S. | AOG | | |
| Maddaluno, G. | OED | | |
| Montanari, C. | OED | | |
| Menelli, M. | OED | | |
| Nacini, E. | AOG | | |
| Orsini, G. | COM | | |
| Povero, P. | Stat. Zool. Napoli (University of Genoa) | | |
| Ribera D'Alcala, M. | (disembark in Aberdeen) | | |
| Sisti, C. | OED | | |
| Tonarelli, B. | OED | | |
| Vogel, Z. | DHI | Waddington, I. | IOS |
| Zanasca, P. | AOG | | |

3.4 Unload Phase

| | |
|---|---|
| Paoli, M. | OED |
| Della Maggiora, R. | OED |

4. Positions of Moorings, Floats, and CTD Stations

The positions of the moorings and floats are given below and illustrated in Figure 1. The release point of the Webb Float was shifted slightly to the southwest and that of the Met Buoy more to the north in the middle of the Faeroe-Shetland Channel.

| Mooring | Time (MODA GMT) | Water Depth(m) | Lat. (N) | Long. (W) |
|---|---|---|---|---|
| SACLANT 1 | 0531 1420 to 0624 1115 | 806 | 60°58.00' | 03°12.60' |
| SACLANT 2 | 0601 0813 to 0625 0820 | 800 | 61°29.90' | 04°30.75' |
| SACLANT 3 | 0601 1724 to 0625 1642 | 797 | 61°26.45' | 01°53.75' |
| Met Buoy | 0602 1818 to 0626 0415 | 1448 | 61°30.46' | 03°08.82' |
| IOS 1 | 0603 1054 to 0622 1100 | 2012 | 63°30.07' | 05°35.06' |
| IOS 3 | 0603 1527 to 0622 1630 | 2357 | 63°10.45' | 04°59.93' |
| IOS 2 | 0603 2010 to 0622 1820 | 1002 | 62°50.05' | 05°11.74' |
| WEBB FLoat | 0604 0753 | 1212 | 61°42.76' | 03°42.58' |
| OED Float | 0604 1543 to 0624 1000 | 1245 | 61°25.71' | 02°25.49' |

The positions of the CTD casts are indicated in Figures 1 and 2. The track deviated some what from that proposed in the Test Plan: a) The order was reversed to accomodate the recovery of the IOS moorings, b) More stations were taken on the Wyville-Thompson Ridge, in the hope of observing intermediate water overflow and in favor of those planned to the south of it where little spatial variability was expected, c) Additional stations were added in the Norwegian Trench area to increase the spatial resolution of the North Sea Inflow and Outflow, d) About ten deep water stations north of the Faeroes were sacrificed in order to increase the resolution over the Faeroes Slope and to make time for the Time Series sequence, e) A Time Series was added at the location of Sts. 6,50,125 (in the Faeroe-Shetland Channel) to explore higher frequency variability.

## 5. Methods

An array of three moorings was desployed in order to a) provide a triangular configuration for the subsurface floats and to observe the flow. Two moorings were located on the eastern side of the Faeroe-Shetland Channel where the major inflow (of North Atalntic Water) occurs. Mooring depths were all about 800 m, a depth chosen as a compromise between the hazard of bottom trawlers, which operate shallower than 600 m, and the necessity to be positioned over the steep bathymetric gradient of the continental slope where the stronger flows are commonly found.

The morning instrumentation is summarized as follows:

| Mooring | Instruments | Depth | Sampling | Variables |
|---|---|---|---|---|
| SACLANTCEN 1 | Aanderaa | 110 | 5 min | Spd,Dir,T,S,P |
| | VACM | 131 | 3 min 45 s | Spd,Dir,T |
| | NBIS | 236 | 4 min | Spd,Dir,T |
| | Aanderaa | 695 | 5 min | T,S,P |
| | Listening St. | 593 | 1 hr | Float |
| SACLANTCEN 2 | VACM | 127 | 3 min 45 s | Spd,Dir,T |
| | NBIS | 232 | 4 min | Spd,Dir,T |
| | Listening St. | 590 | 1 hr | Float |
| SACLANTCEN 3 | VACM | 125 | 3 min 45 s | Spd,Dir,T |
| | Weller | 230 | 4 min | Spd,Dir,T |
| | Listening St. | 585 | 1 hr | Float |

| | | | | |
|---|---|---|---|---|
| IOS 1 | Aanderaa | 265 | 10 min | P,T,Spd,Dir |
| | Aanderaa | 514 | 10 min | T,Spd,Dir |
| | Aanderaa | 1012 | 10 min | T,Spd,Dir |
| | Aanderaa | 1961 | 10 min | T,Spd,Dir |
| IOS 3 | Aanderaa | 260 | 10 min | P,T,Spd,Dir |
| | Aanderaa | 509 | 10 min | T,Spd,Dir |
| | Aanderaa | 1007 | 10 min | T,Spd,Dir |
| | Aanderaa | 1956 | 10 min | T,Spd,Dir |
| IOS 2 | Aanderaa | 253 | 10 min | P,T,Spd,Dir |
| | Aanderaa | 502 | 10 min | T,Spd,Dir |
| | Aanderaa | 951 | 10 min | T,Spd,Dir |

The two floats released were of Webb and Ocean Engineering Department (OED) manufacture. Both seek a level of constant density. The OED float settled at the intended 600-m depth while the Webb continued to 950 m because it failed to follow its compressibility characteristics. Both transponded pulses every 2 hrs for positioning.

The meteorological buoy (Met Buoy) was constructed by Polar Research Laboratory under the supervision of the National Data Buoy Center Bay Saint Louis, Mississippi. It had 16 water temperature sensors (down to 300 m) on a thermistor chain, two water pressure sensors, two air temperature sensors, and a wind speed and direction sensor. It transmitted running 8-min averages every 1 min to TIROS satellite. Data and the buoy positions were available through receiving stations, e.g. Service Argos, Toulouse, France.

The CTD (conductivity, temperature, depth) sensor was of Neil Brown manufacture. It included an oxygen sensor (Beckman) and a transmissometer sensor (Sea Tech).
The CTD was used in conjunction with a General Oceanics Rosette Sampler (with 12 5-l Niskin bottles). A continous down cast was made followed by an intermittant up-cast in which 1 min recordings were made prior to closing a Niskin bottle. Sample depths generally were standard in the surface layer at 3, 15, 30, 50 m and then varied depending on the total depth to obtain a reasonable vertical distribution. Sampling in the intermediate water layer (400 to 600 m) has a priority. At critical locations, such as over steep bathymetry, a pinger was utilized to obtain near-bottom ( 15 m) samples.

At least two salinity and two or more oxygen samples were drawn from every cast for calibration control. Oxygen samples were run on board with the Winkler method using an automated burette (Dosimat). Nutrient samples (nitrate/nitrite and silicate) were drawn from every sample and analyzed on an Alpkem Rapid Flow Analyzer. Chlorophyll samples were drawn from the top 4 to 5 bottles and analyzed on board with a Turner fluorometer for chlorophyll-a and phaeophytin. At more than half of the stations samples were drawn for particulate organic carbon, carbohydrates, and heavy metal analysis, for which only the filtration was done on board. At selected stations samples were drawn for phytoplankton counts, silicate, oxygen-18, and tritium, the analysis of which is to be done at collaborating institutions.

The CTD data was recorded on a Hewlett-Packard System (HO-1000/computer 21A-21-MX/Mag.Tape 7970B/Disc 7906). On-line plots of temperature and salinity were created from the down-casts, and on-line listings of the down-and-up casts were printed. The ships position, water depth, sea surface temperature and salinity, the wet and dry temperatures, and the wind speed and direction (corrected) were recorded on magnetic tape every minute and printed out every 5 min.

An additional Hewlett-Packard 21MX computer together with a receiver for NOAA6 and NOAA9 was used to receive remote sensed images in the infrared and visible windows. This capability was used to modify sampling in frontal areas and to assist in the meteorological prognoses.

6. Operational Comments

The technical problems which potentially could have diminished the observational objectives of the cruise are outlined below. Nearly all of these were resolved or circumvented.

6.1 The first OED float deployed on 2 June tested flawlessly before launch but as it sank to depth its transmissions were intolerably weak. It was successfully recovered and the problem diagnosed as a faulty transducer. The second radio locator system installed on the OED float proved critical in its surface relocation, even during Force 4 winds. The TYDEMAN uses a tethered-swimmer technique to recover equipment, which proved very quick and secure. Recovery of the second OED float (24 June) was realized within one hour due to good positioning and a low sea state.

6.2 The WEBB float deployed on 4 June displayed an erratic sinking pattern, which could not be explained by any prescribed compression characteristic, and eventually by 6 June arrived at a depth 300 m in excess of that programmed which could not be explained by a miscalculation in density (normally an error of 10 m in depth). This experience demonstrates the need for thorough pre-launch pressure testing of all purchased, off-the-shelf floats.

6.3 The Met-Buoy deployment proceeded easily as planned with the salt-pellet release system functioning according to schedule. Data results prior to launch, received via radio-telephone, indicated all sensors were operating. In fact, on board calibration data were taken while the Met-Buoy was strapped vertically on the aft helicopter deck. However, the data received within a day of launch indicated a malfunction in half (eight) of the underwater thermistors. For this reason the Met-Buoy was recovered for return to manufacturer. Final positions were obtained via radio from the Norwegian Meteorological Office.

6.4 The power supply unit on our main HP 2117 broke after 3 days. A spare unit was used and a new one ordered from HP via SACLANTCEN for delivery in Lerwick.

6.5 The new MICROVAX software system for recording, on-line display, and data formatting of the CTD casts was never utilized or tested due to remaining software difficulties. The back-up HP system was used instead. Several modifications and corrections to the HP software were made during Leg 1 to adapt it to the requirements of the Leg 2, i.e. correction of algorithms, elimination of double precision, on-line temperature and salinity plots, and adaptation to up-cast recording.

6.6 The new ALPKEM Rapid Flow Analyzer developed a number of mechanical and electronic problems. Most of these were resolved with the exception of those connected with the pump and bubble gate feature, which had the net effect of slowing down the analyses and decreasing the sensitivity.

Despite filtration of the samples, frequent spurious spikes and baseline shifts were caused by impurities in the samples.

6.7 The on-lines salinometer functioned erratically. The inductive cell was cleaned and several electronic adjustements made. A number of calibration samples were taken in an attempt to render useful the data.

6.8 The CTD unit failed regularly (about every 15 casts), during the first portions of the hydrographic tract, from what appeared to electrical shorting. This was finally identified as a short caused by the contraction of the pressure case against the main cable harness. For about ten stations prior to St. 94, the second CTD unit (without oxygen and Transmissometer sensors) was used.

## 7. Scientific Comments

Initial prognosis of the water structure indicates that the deployment positions were well planned. The floats are located in an important intermediate water mass that originates from the Iceland current. The current meter positions, including those of IOS, and the Met-Buoy data will allow comment on the coherence and forcing of this intermediate water. The CTD casts in support of the deployment were designed to map this water about the float positions in the Channel.

The rationale for re-occupying the primary Faeroe-Shetland Transect seemed well justified, i.e. to provide some indication of the several-day variability of that section relative to sections to the north and south of it. The addition of the Time Series on that transect on the western side allowed an evaluation of variations of internal wave and tidal periodicities. Additional identification of cross-channel seiches and other these time-dependent phenomena will be done in conjunction with currentmeter and pressure analyses.

The Atlantic inflowing water was anomalously low in salinity and temperature at the onset of the cruise, probably due to the preceeding easterly and northerly winds. This was collaborated by the initial movements of the floats and of the Met Buoy. As more typical weather returned (e.g. moderate southwesterlies) the flow and water structure returned to more normal patterns (e.g. strong inflow intensifying on the eastern side of the Channel).

The salinity-minimum depth (intermediate water), which separates the surface Atlantic water and the deep Norwegian Sea water, decreased from

450 m in the northern sections of the Channel to about 700 m at the Faeroe-Bank sill. The outflow over this sill was confined to the northern side (from 600-800 m) and appeared to consist of an intermediate and deep water mixture.

The northernmost transect (Sts. 94 to 108) showed the anticipated large amplitude (about 200 m) oscillations in the Atlantic water interface. Very significantly a large Soviet fishery fleet was situated over the most extreme vertical rise of this interface, presumably finding there an enriched fishing ground driven by upwelling. The Arctic Front (defined as the surface outcrop of the 35 isohaline) was found between Sts. 107 and 108. The surface temperature distribution oscillated on the order of a ½°C over the western half of the transect over 20 km, before dropping by about 2° (from 9° to 7°) at the front.

The Met Buoy eventually found itself in the stronger portions of the Atlantic Inflow and moved along the 1000 m isobath. On this portion of its track (Figure 3) it attained speeds on the order of 20 cm/sec which were not well correlated with the local wind vector. Variations in the sub-surface temperature structure indicated differential movement between it and the waters around it. At the terminus of its track (JD176-7 in Figure 3) it was moving into the field of one of the large interfacial oscillations characteristics of the Atlantic inflow.

## 8. General Comments

8.1 The HNLMS TYDEMAN proved to be an outstanding platform for our mooring deployment/recovery and hydrographic requirements. In addition, the support services and manpower assistance were excellent.

8.2 The cruise was greatly assisted and augmented by the participation of collaborative Institutes, summarized as follows:

| | |
|---|---|
| Institute of Oceanographic Sciences | Participants, Phillips and Waddington. Mooring deployment IOS 1-3<br>2 Aanderaa pressure sensors. |
| Deutsches Hydrographisches Institut | Participant, Vogel<br>Tritium analysis |

| | |
|---|---|
| Stazione Zoologica | Participant, Ribera<br>Nutrient, chlorophyll analyses |
| University of Genoa | Participant, Povero<br>POC and metal analysis |
| Hydrographic Office | Participant, Scheffers<br>Administrative support |
| Norwegian Meteorological Office | Met-Buoy positions and data |
| Nederlands Instituut voor Onderzoek de Zee | Silicate analysis |

8.3 The cruise is evaluated as highly successful having accomplished all of its planned objectives. Both the engineering and oceanographic results will be utilized to proper advantage in planning the SACLANTCEN 1987 field program southern Norwegian Sea.

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(attached)

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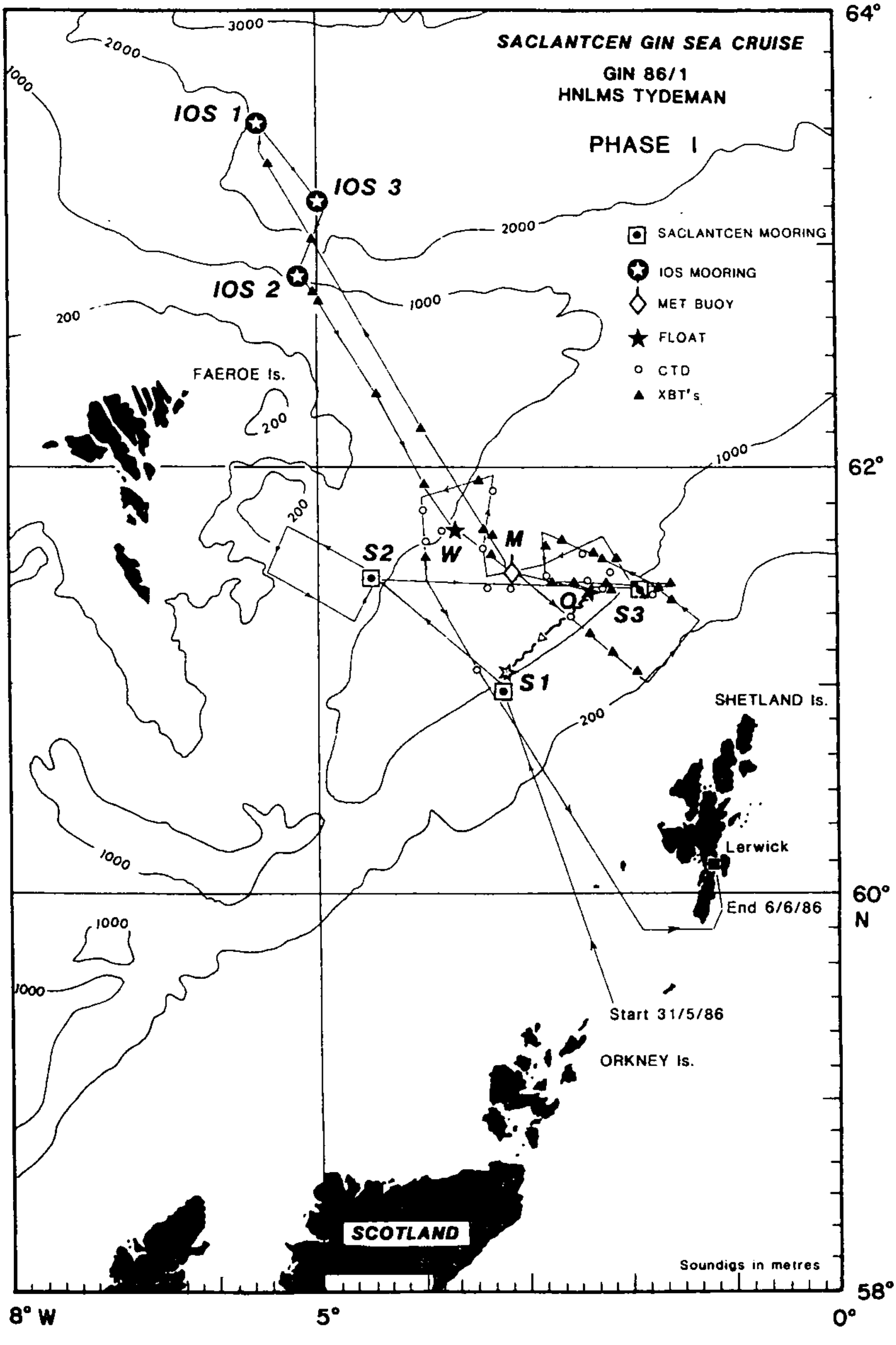


Fig. 1 Cruise track and moorings for Leg 1 of the TYDEMAN cruise.

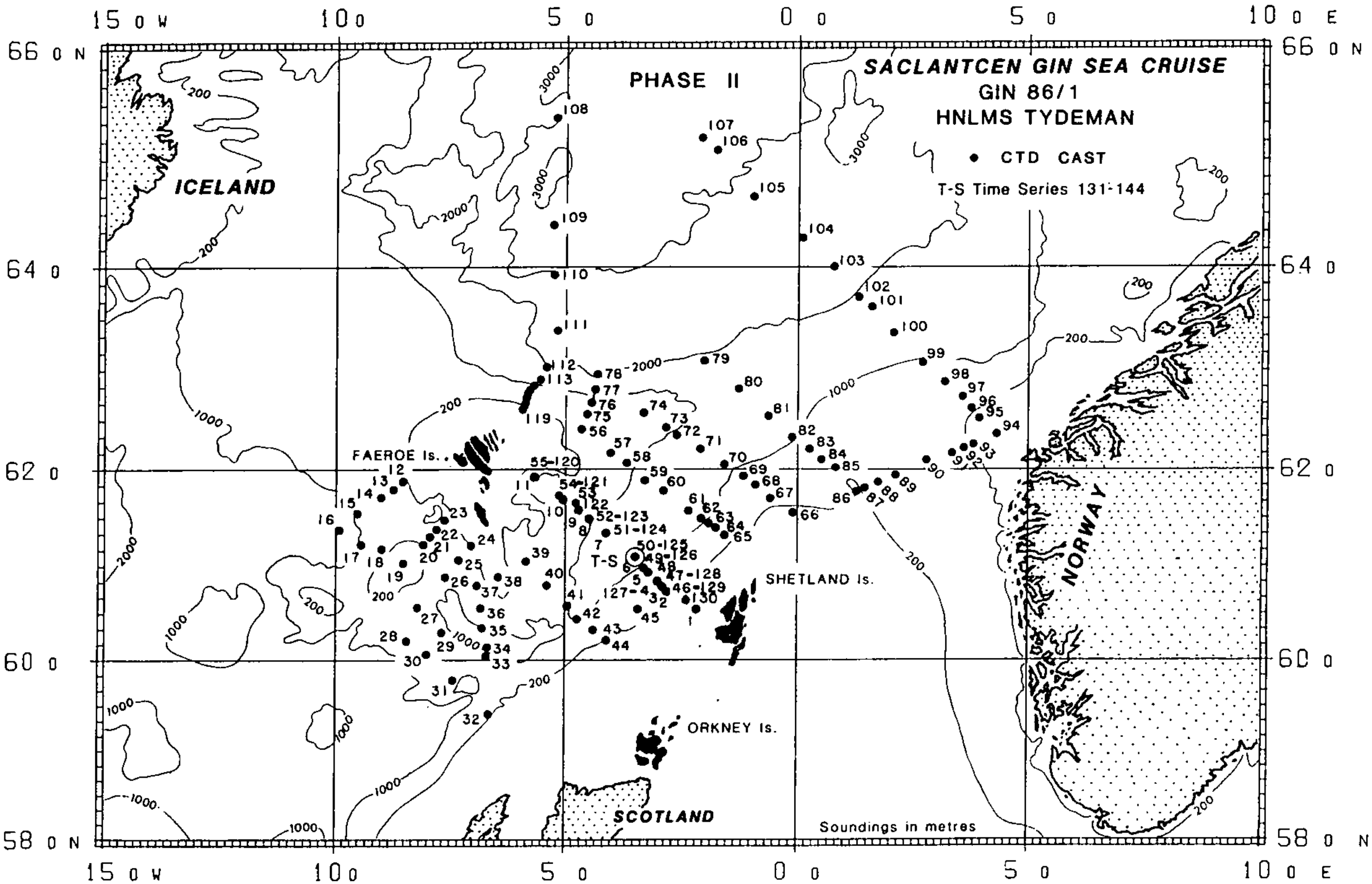


Fig. 2 CTD stations Leg 2.

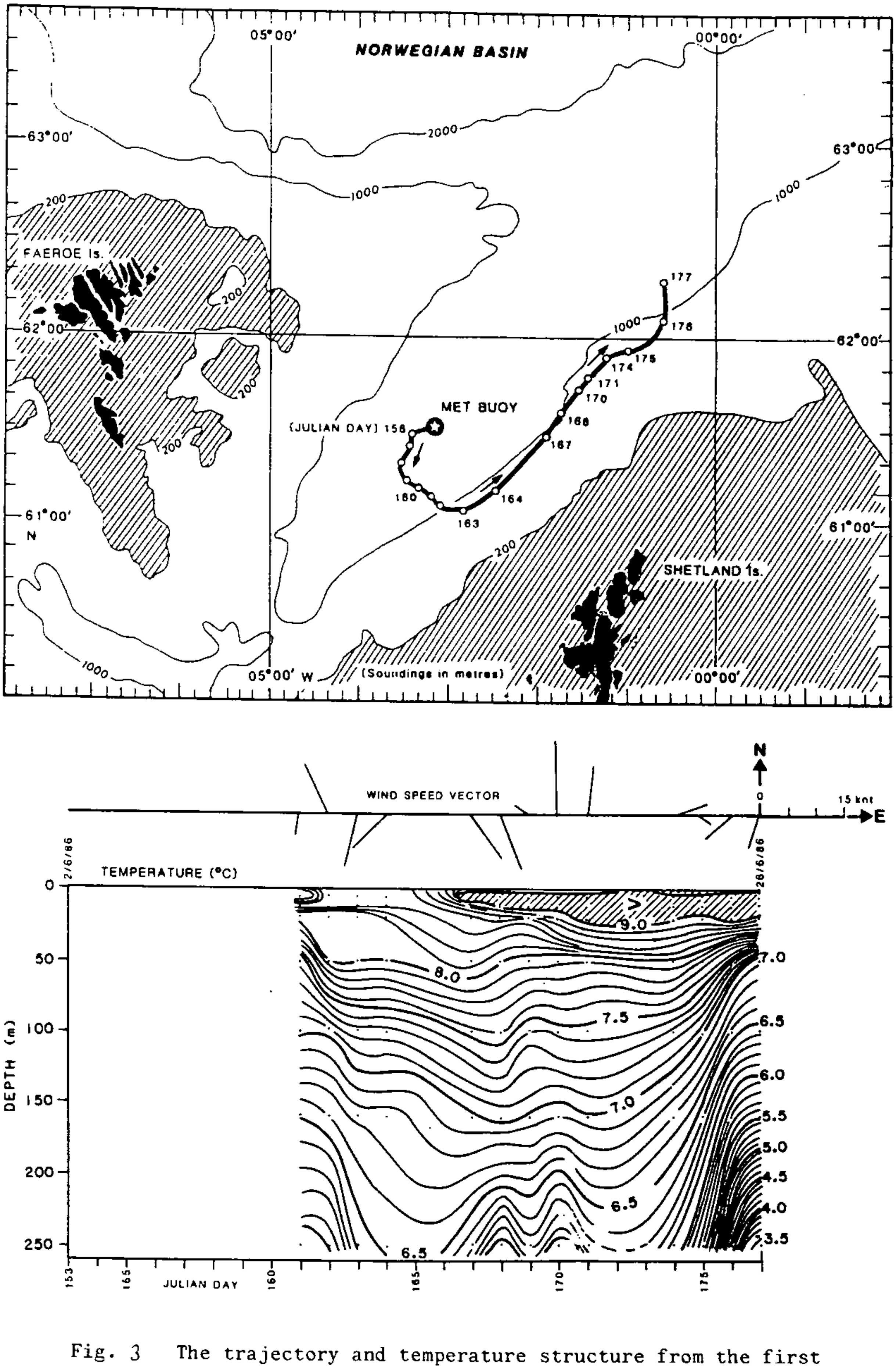


Fig. 3 The trajectory and temperature structure from the first available data of the Met-Buoy, TYDEMAN cruise.