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INTERNAL DOCUMENT 174

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INTERNATIONAL ASPECTS OF SOFAR FLOAT

STUDIES IN THE NE ATLANTIC

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The Department of Environment funded project (PECD7/9/023) "Dispersion in the Deep Waters of the Eastern North Atlantic" is one of a series of experiments to be conducted in the N.E. Atlantic basin and aimed at investigating the multi-year dispersion and advection of neutrally buoyant floats. All of the experiments will use the techniques developed over the past decade in the USA at the Woods Hole Oceanographic Institution and the University of Rhode Island for the acoustic-tracking of floats via sound transmissions in the SOFAR channel. This document will report the current status and known interactions of the various projects and will present an overview of the likely benefits to DOE to be achieved by the cooperative nature of these studies.

Review of the objectives and scope of DOE-funded IOS project.

The project PECD7/9/023 will permit IOS to make long term (of order 2 year) measurements of the dispersion of neutrally buoyant tracers (floats) in the deep ocean over horizontal scales of up to 1000 km. This capability will be achieved by the adoption and further enhancement of technology developed over the past decade in the USA. The major innovation in the IOS project will be the construction

of floats capable of working at much greater depths than have previously been used.

This advance will enable IOS to make the first measurements of dispersion over large time and space scales at subthermocline depths. (Previous measurements at these scales have been made in the Western N. Atlantic in the thermocline. The only subthermocline measurements have been at short length and time scales). The measurements will be made in the region around the presently favoured disposal areas and will complement the smaller scale near-bottom studies already made in the Madeira basin under project DGR 481/176. The IOS experiment is designed specifically with the near-sea-bed DOE interests in mind but it will benefit both logistically and scientifically from other SOFAR float measurements to be carried out simultaneously by US and European laboratories. Fig. 1. It will be seen in this document however that none of the other projects will make deep ocean measurements as planned in the IOS/DOE project.

The results of benefit to DOE will be

(a) the direct measurement of large scale dispersion at great depths in the ocean in the region of possible disposal sites

(b) the comparison of short term near-sea-bed dispersion measurements with the large scale measurements in the overlying subthermocline and thermocline layers

- (c) the identification of the degree of interaction of deep water (subthermocline) flow with bottom topography and its implications for mixing in the deep water column
- (d) confirmation of models of abyssal mean circulation patterns and energetics.

The IOS study concentrates on the measurement of dispersion well below the thermocline. To this end a float has been designed at IOS which uses glass spheres in place of aluminium tube for the pressure housing. This removes the mechanical limits on float operation. The Tillier design of listening stations will be used. It is planned to deploy 8 floats at a depth of 3500 m in an area around 31°N 24°W (fig. 4,5). The feasibility of receiving useable signals at ranges of up to 1000 km from this depth was demonstrated in trials in the summer of 1982*. A short (July - November) trial of a three ALS network and of the floats will be carried out in 1983 in the Madeira basin (fig. 2,3). After a full analysis of the data the first operational deployment of floats is scheduled for a cruise for which shiptime has been requested in August/September 1984.

International cooperation

The IOS/DOE project will benefit greatly from the work of other groups involved in SOFAR float work in the NE

* IOS Internal Document No. 167. "Long Range Propagation Trials June-July 1982".

Atlantic. It is useful to review three other projects and their interaction with the IOS work. The Institutions and scientists involved are listed in the Appendix.

1. Other projects.

The following paragraphs give a brief description of the scope of the research projects.

(a) The Woods Hole Oceanographic Institution is funded by the US National Science Foundation under a grant entitled "A study of advection and diffusion in the eastern North Atlantic". It aims to deploy a cluster of 20 floats (together with an outlying array of a further 8 floats) at a depth of about 1100 m (near the axis of the high temperature and salinity Mediterranean water which issues from the Straits of Gibraltar). The scientific goals are

- (1) To determine the mean flow close to the Mediterranean water salt tongue.
- (2) To determine the magnitude and isotropy of the horizontal eddy diffusion at that depth in the eastern basin of the N. Atlantic.
- (3) To determine the temporal and horizontal spatial scales of the mesoscale eddy motions.

The floats will be launched in an array centred at 31°N 24°W and will be tracked from four Autonomous Listening Stations*

* The ALS and TLS are self contained recording listening stations which will be anchored on deep sea moorings. They will be used to determine the positions of the neutrally buoyant floats.

(ALS) at 34° N 23° W, 29° N 19° W, 24° N 24° W and 28° N 28° W. The first deployment of floats and ALS moorings is scheduled for the early autumn 1984 and recoveries and redeployments of the ALS array are scheduled at yearly intervals until late 1987. The present proposal runs until late 1985.

The floats and listening stations are of the type used previously in the western N. Atlantic. The floats have a limited (~ 200 m) maximum depth capability and the ALS units are of the original "Bradley" design.

(b) L. Armi (Scripps) and T. Rossby (URI) are proposing to make a study of the dynamics of isolated, intense "blobs" of Mediterranean water by tagging them with SOFAR floats. The salt blobs will be located by a prior CTD survey. The floats tagging the blobs will be tracked by means of the WHOI ALS array described in (a).

(c) In addition to his involvement in the salt blob study Rossby will be funded to process the data from the WHOI ALS network. He has had responsibility for all ALS data processing in the USA since the use of Autonomous Listening Stations was commenced.

(d) The C.O.B. in France have been funded to carry out an experiment named "TOPOGULF" in which they will undertake to investigate the dynamics of the eastward extension of the Gulf Stream as it crosses the mid Atlantic ridge. This experiment is scheduled to commence in summer 1983 using standard Woods Hole designed floats and a listening station known as the Tillier Listening Station (TLS) jointly

developed by COB and Woods Hole. The experiment concentrates on the upper ocean (a cluster of 15 floats will be launched at 700 m) with the deployment made somewhat to the West of the mid-Atlantic ridge (near 35° N 40° W) in the belief that the cluster will move in a generally eastward direction. The listening station sites are widely spaced (fig 1) being at present planned for

$41^{\circ} 30'N$ $37^{\circ} 00'W$, $36^{\circ} 30'N$ $28^{\circ} 00'W$, $29^{\circ} 00'N$ $30^{\circ} 00'W$ and
 $25^{\circ} 00'N$ $38^{\circ} 30'W$.

The listening stations will be repositioned at yearly intervals.

(e) The MAFF laboratory at Lowestoft plan to purchase floats of the IOS design for deployment in the NE Atlantic in 1984. Negotiations for the commercial manufacture of the floats for the 1984 deployments are underway. MAFF will rely heavily on IOS expertise to carry out this experiment and there has been regular contact between IOS and MAFF during the planning stages. Mr. Mitson of MAFF participated in the 1982 Discovery cruise.

2. Interactions with IOS work.

The first IOS operational deployment will coincide with the Woods Hole float/ALS deployment and it is presently envisaged that the IOS floats at 3500 m will be laid immediately below the Woods Hole 1100 m cluster in position $31^{\circ} N$ $24^{\circ} W$ (fig. 4,5.).

The float signals will be received initially by the Woods Hole ALS array and will reveal the statistics of both

the float dispersion in the deeper parts of the water column and the mean circulation and eddy kinetic energy of motions in the NE Atlantic basin.

MAFF will not purchase or operate a listening station array and will rely on IOS/WHOI/COB tracking facilities. The present area of interest for MAFF is near 42° N 14° - 15° W in the general area of the low level dumpsite. In order to cover the dispersion/advection of floats from this site and others as they drift into range from other deployments, 3 IOS TLS moorings will be deployed in the Iberian basin in August/September 1984. Presently planned TLS positions are 45° N 15° W, $41^{\circ} 30'$ N 20° W and $37^{\circ} 30'$ N $16^{\circ} 30'$ W (figs. 4,5.) The TLS moorings will be recovered and redeployed at 6 monthly intervals during the first year of the experiment in order to maximise the probability of a high data return. MAFF will deploy a cluster of 6 floats probably at 3500 m and will add to this deployment single floats at 6 monthly intervals to form a "plume" experiment. MAFF will rely on IOS for initial data processing.

Summary of past and planned intergroup contacts

The following are the main lines of communication among these projects.

(a) At a technical level there is close contact (on a weekly basis) between IOS (Millard) and Tillier at COB and Webb and Bradley at WHOI regarding the purchase of components and the design and construction of IOS floats and ALS.

(b) Gould (IOS) is in contact with Rossby (URI) concerning the implementation of the float tracking and data analysis program, and with Colin de Verdiere (COB) and Richardson/Price (WHOI) over the experimental design and the interaction of the various projects.

(c) Tillier spent a considerable amount of time in the past year working at WHOI with Bradley and Webb. Millard spent six months working at WHOI with Bradley and Webb in 1980.

(d) There have been regular meetings between IOS and MAFF personnel at a technical and scientific level and MAFF have sent and will continue to send observers on relevant IOS cruises.

(e) A meeting at which all laboratories will be represented will be held at COB France in April 1983 and a further opportunity for direct contact will be presented by an international meeting in Germany in August 1983.

(f) COB, WHOI, URI and IOS are all linked by the Telemail electronic Mail system which has proved invaluable for rapid communication between groups.

Main points of agreement and overlap

Cruise schedules have as much as possible been planned to make the maximum use of the ships and to allow the projects to interact to the greatest possible extent.

All ALS will be capable of recording the signals from all floats. Two receiving channels will be used, one for

the US floats and another for the European ones.

Common data processing suites will be used to facilitate the interchange of data.

W.J. Gould

10-XII-82

Appendix

Institutions involved in the experiments

The following is a list of the scientists and institutions at present involved in the studies.

- (a) Institute of Oceanographic Sciences,
Brook Road, Wormley, Godalming, GU8 5UB
Principal Scientific investigator: Dr. W.J. Gould
Main technical support: Mr. N. Millard.
- (b) Woods Hole Oceanographic Institution, Woods Hole,
Massachusetts 02543, U.S.A.
Principal Scientific Investigations:
Dr. P. Richards, Dr. J. Price
Technical support: Mr. D. Webb, Mr. A. Bradley,
Mr. J. Valdes.
- (c) Scripps Institution of Oceanography, U.S.A.
Mail Code A030. La Jolla, CA 92093, U.S.A.
Principal scientific investigator: Dr. L. Armi
- (d) University of Rhode Island U.S.A.
Graduate School of Oceanography,
Narragansett Bay Campus,

Kingston, RI 02881, U.S.A.

Principal scientific investigator: Prof. T. Rossby.

(e) Centre Oceanologique de Bretagne, France.

Boite Postale 337,

29273 Brest Cedex, France.

Principal Scientific investigator: Dr. A. Colin de
Verdiere.

Main technical support: M. Pierre Tillier

(f) Ministry of Agriculture, Fisheries and Food,

Fisheries Laboratory,

Lowestoft, Suffolk NR33 0HT.

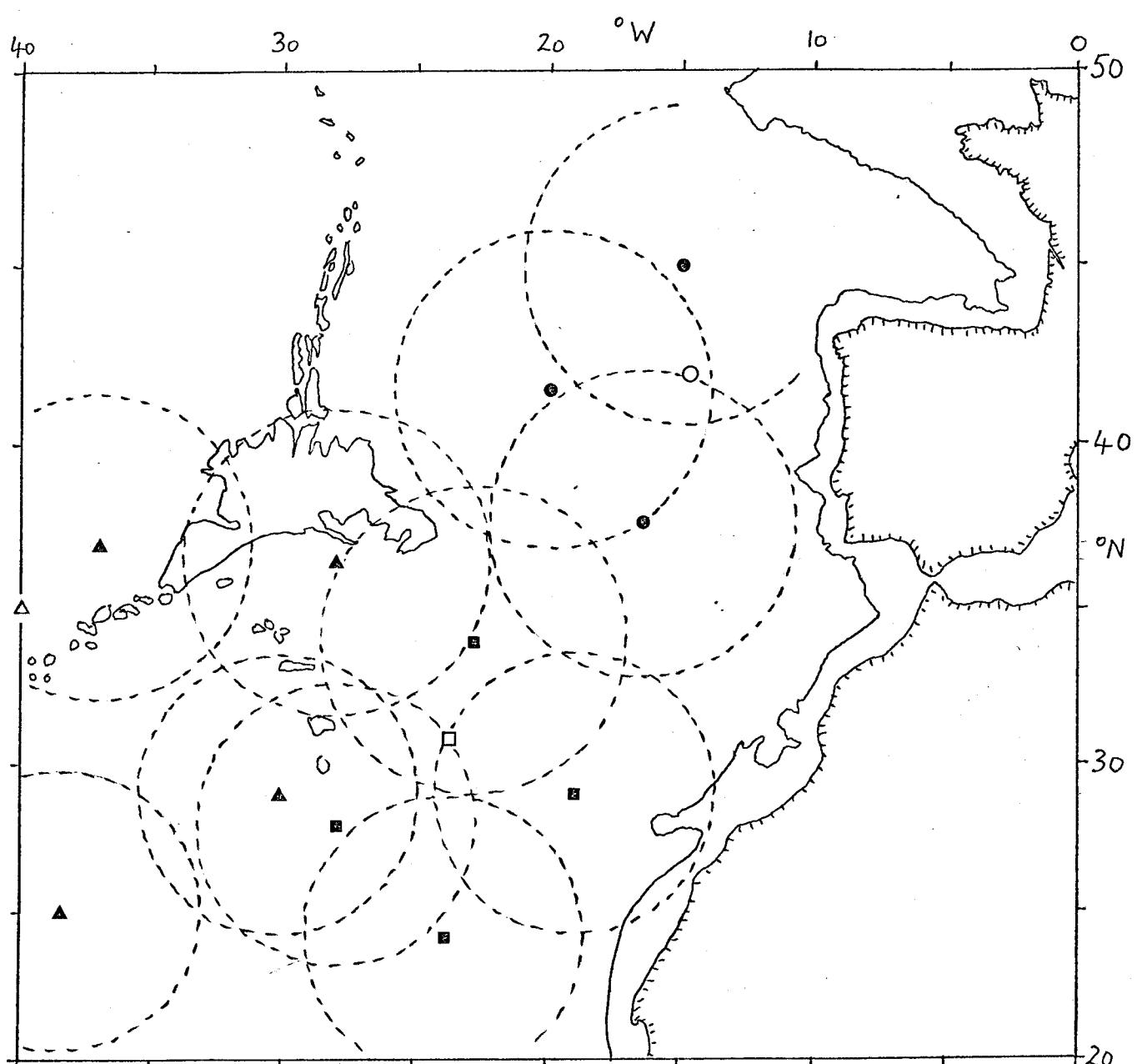
Principal scientific investigator: Dr. R. Dickson

Main technical support: Mr. R. Mitson + support from
IOS.

Figures

1. NE Atlantic SOFAR float experiments.
 - IOS listening stations (September 1984 onwards)
 - IOS and WHOI float launch position (Sept. 1984)
 - MAFF float launch position (Sept. 1984)
 - WHOI listening stations (Sept. 1984 onwards)
 - ▲ COB listening stations (July 1983 to July 1984)
 - △ COB float launch positions (July 1983).

(500 km radius circles are drawn around each listening station). (2000m depth contour is added to show extent of Continental slope and mid Atlantic ridge. Smaller seamounts and plateaux are omitted).
2. Coverage from IOS and COB listening stations during float trials (July-November 1983). Assuming 750 km ranges. Shaded areas are within range of 3 or more stations. (Symbols as for fig. 1).
3. As for figure 2 but assuming 1000 km ranges.
4. Coverage from IOS and WHOI listening stations from Sept. 1984 onwards. 750 km range circles are shown. Shaded areas are within range of 3 or more stations. (Symbols as for fig. 1). COB listening stations will be added but positions are not yet known.
5. As for figure 4 but assuming 1000 km ranges.



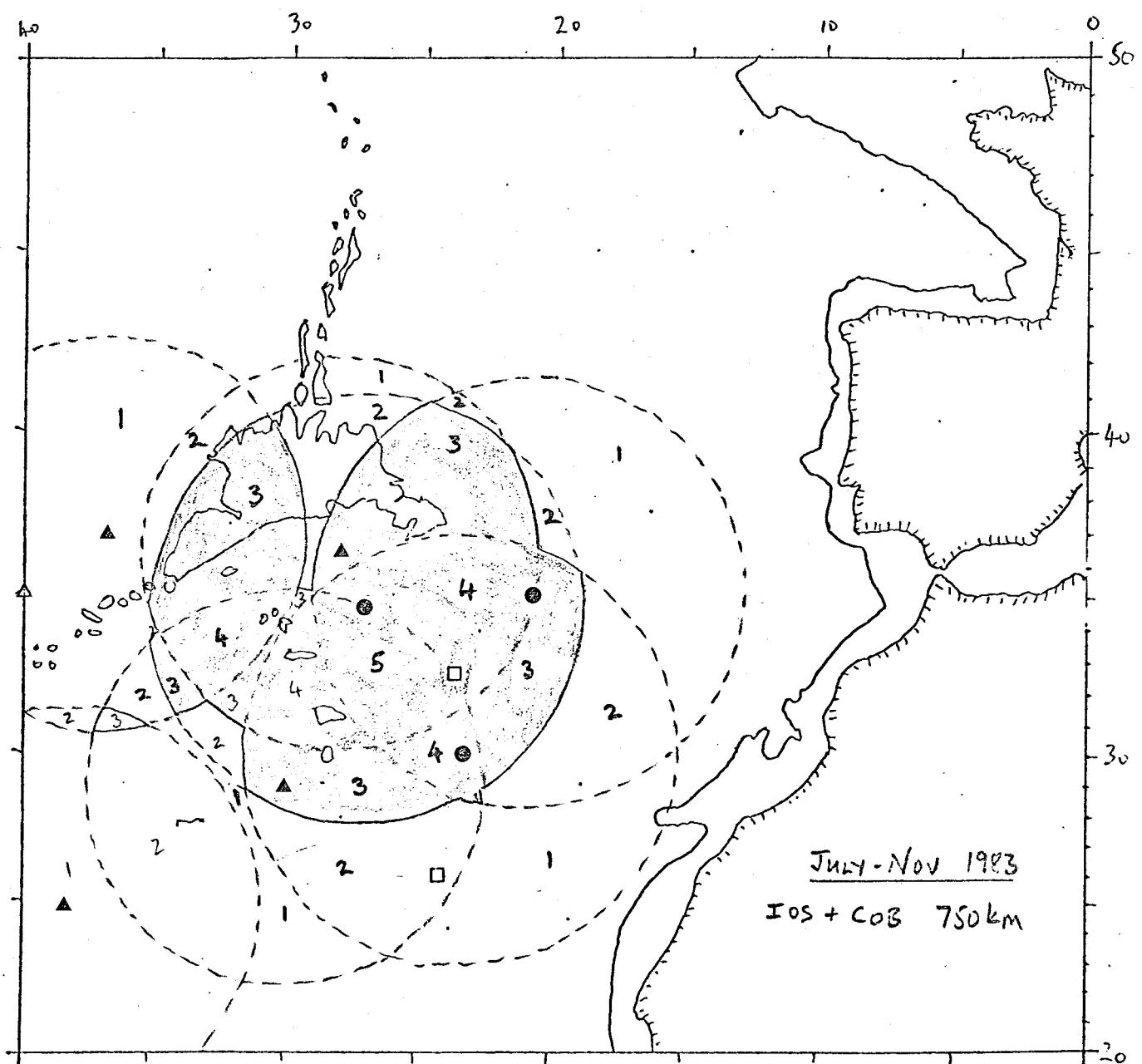
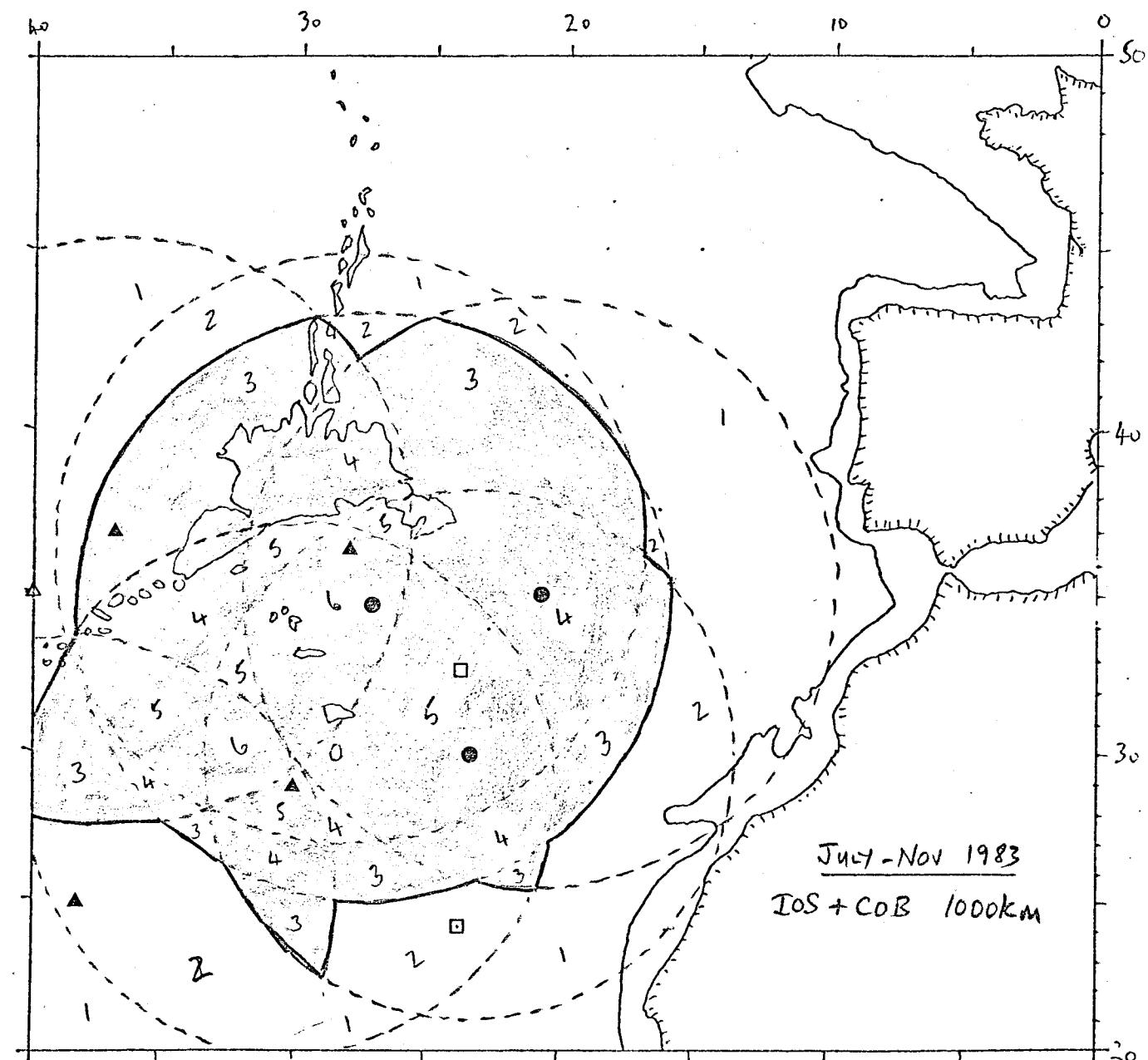


Fig 2



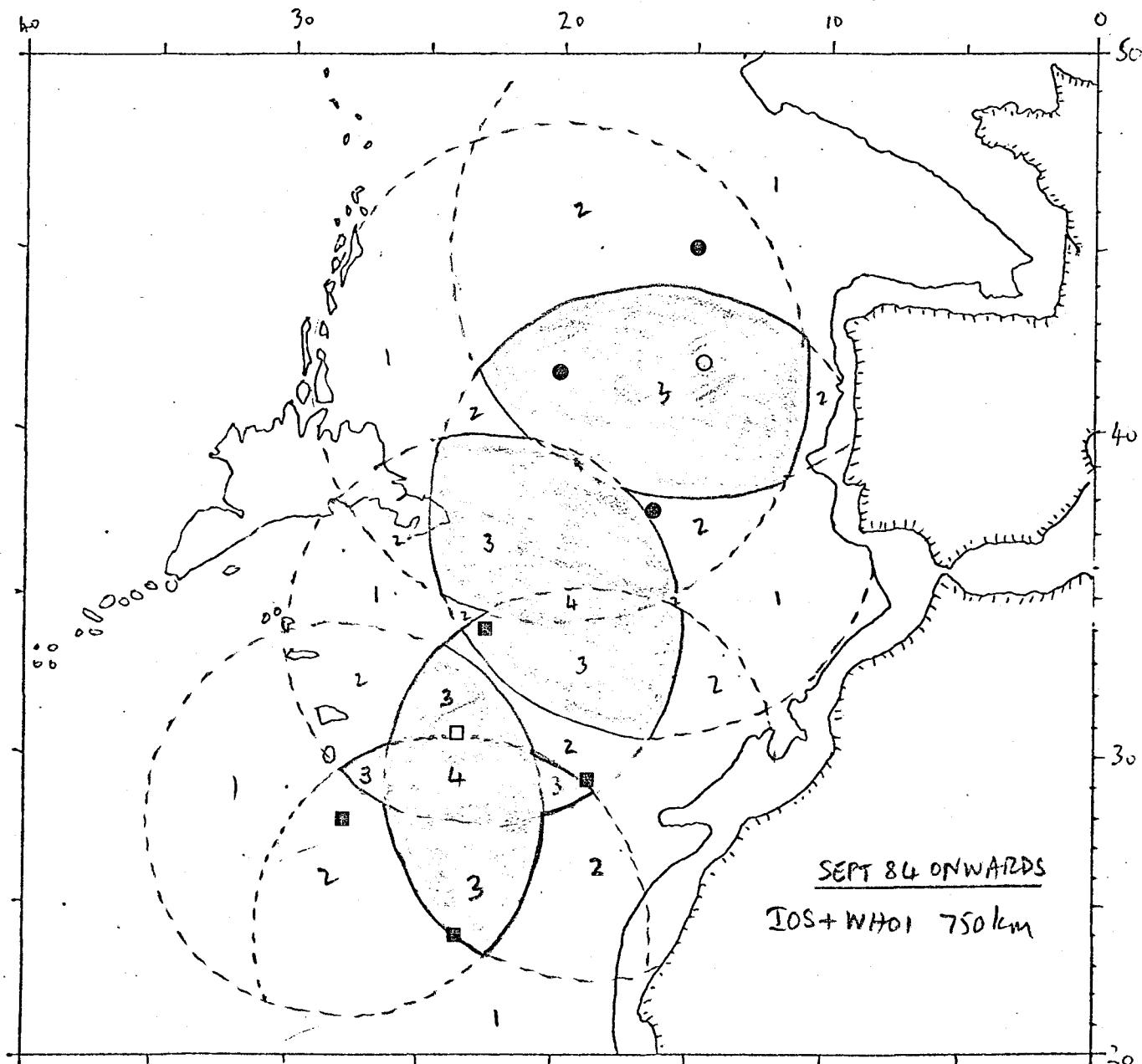


Fig 4

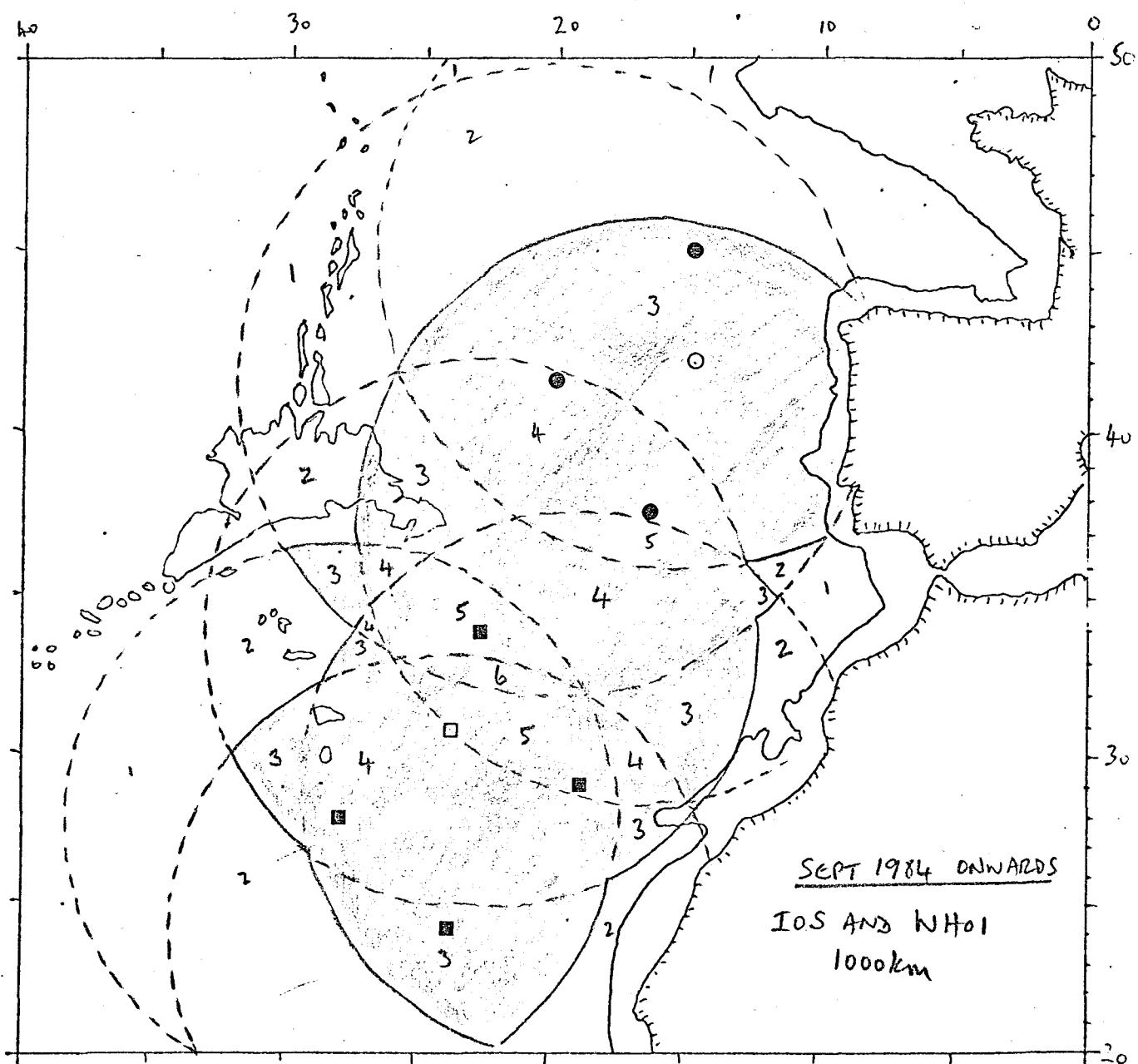


Fig 5

