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RRS CHALLENGER CRUISE 9A/80

8th-17th JUNE 1980

NEAR SURFACE CURRENT AND WAVE INTERCOMPARISONS NEAR THE UK DATA BUOY POSITION (48°43'N, 08°58'W)

CRUISE REPORT NO. 113

1981

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Wormley, Godalming,
Surrey, GU8 5UB.
(0428 - 79 - 4141)

(Director: Dr. A.S. Laughton)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051 - 653 - 8633)

(Assistant Director: Dr. D.E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823 - 86211)

(Assistant Director: M.J. Tucker)

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Wormley, Godalming, Surrey GU8 5UB

SCIENTIFIC PARTICIPANTS

K.G. Birch

J.W. Cherriman

P.G. Collar (Principal Scientist)

C.H. Clayson

G. Griffiths

N.W. Millard

R.W. Pascal

All participants were from IOS (Wormley).

SHIP'S OFFICERS

G. Long	Master
A.L. Moore	Chief Officer
S. Jackson	2nd Officer
P. Pepler	3rd Officer
R. Anderson	Chief Engineer
I. McGill	2nd Engineer
D. Hornsby	3rd Engineer
P. March	4th Engineer

SCIENTIFIC OBJECTIVES

The aims of the experiment were:

(a) to test the assertion that mean currents in the uppermost few metres of the wave field can in principle be measured adequately using vector-averaging current sensors mounted on a moored, surface following buoy,

(b) to test an experimental mooring designed for this purpose, and to investigate its suitability for mooring arrays of pitch/roll wave buoys,

(c) to see whether the technique provides sufficient accuracy for current shear to be detected in the near surface region,

(d) to provide further testing for the vector averaging electromagnetic current meter recently developed at IOS,

(e) to provide independent measurements in the open sea against which the performance of the UK data buoy wave and current sensors can be assessed.

The objectives were identical to those of a cruise undertaken six months previously (RRS John Murray, Cruise 20/79, December 5th-17th), which was curtailed owing to severe weather.

Observations were to be made in an area on the continental shelf where surface currents of a few tens of cm/s are often less than wave orbital speeds. For this purpose two similar moorings were laid with a horizontal separation of approximately 500 m. Each consisted of an anchor, acoustic release, acoustic transponder, three different types of current meter (for details see fig. 2), subsurface buoyancy, compliant tether, and a surface following annular float containing two vector-averaging electromagnetic current meters (VAECMs). Comparisons were to be made between the outputs from the VAECMs and the displacement rates of drifting surface floats, tracked acoustically. Cruciform drogues, attached to the floats caused them to respond to local water movement at the depths of the moored current sensors. Determination of a float position was to be made using well established methods. Two stages were involved in this: first, ship position relative to the two moorings was obtained at each fix time by interrogating a transponder located in each of the two moorings, thus measuring the range to each from the ship. At the same time, the range of any drifting float transponder from the ship was also obtained. The distance between the two fixed transponders in the moorings, and the orientation of this baseline relative to true North, were obtainable from initial surveying-in. Secondly, an interrogator located in a third mooring, whose position was readily determined from the measurements, was activated remotely from the ship so as to provide a second range to any float transponder from the remote interrogator.

Ambiguities resulting from use of only two ranges for ship and float position determinations could be easily resolved by examining consistency in float displacements over a period of time - or, in the case of ship position, by taking into account the range from the remote interrogator.

The first of the VAECM-equipped buoys measured current at two depths (0.5, 1.5 metres, averaging interval 112.5 sec) with a view to detecting any shear in this depth range. One of these instruments sampled more frequently (1.758 sec interval) for 3 hours each day so as to extend the frequency response to include wave frequencies. The second buoy carried identical heads at the same depth, 50 cm, in order to test for the near unity coherence which should be obtained between the two outputs. The performance of surface following floats on a compliant single point mooring was of wider interest in view of a proposed experiment using an array of moored pitch/roll buoys to obtain improved wave directional resolution.

The opportunity was also taken to include on one mooring three different types of rotor-vane current meters (AMF Vector Averaging Current Meter Type 610C, Aanderaa Type RCM5 and Plessey Model 9021) with as little vertical separation as possible. This was partly to enable comparison to be made with the currents measured close to the surface, partly to afford a comparison between current meter responses and sampling schemes in a situation in which appreciable mooring motion might be encountered.

The second mooring also contained three current meters at similar depths, but in this case the Plessey current meter was replaced by an ultrasonic current meter type UCM2* in order to provide some basic testing of this new type of instrument.

The experiment took place in the vicinity of the UK Data Buoy, DB1. This offered advantages in that DB1 measures current at 3 m depth, thus making a valuable contribution to shear determination. Equally, the attachment of drogues to some floats at 3 m mean depth was planned, so as to facilitate comparison with the DB1 current sensor and so validate its output.

Furthermore, it was planned to make directional wave measurements, deploying the IOS pitch/roll buoy system from the ship, and to make regular meteorological observations, for later comparison with DB1 data. The aim of the pitch/roll

*Designed and supplied by Christian Michelsen's Institute, Bergen, Norway.

measurements was to provide information on the high frequency slope following performance of the UK Data Buoy, DB1, as well as comparisons of wave height. Pitch/roll buoy slope following performance is near perfect up to wave frequencies in excess of 0.3 Hz whereas the pitch and roll response of DB1 cuts off at about this frequency. By comparison of pitch/roll buoy and DB1 slope spectra it was hoped that it would be possible to derive the transfer function of DB1 in pitch and roll, under a range of tidal conditions, thereby enabling corrections to be made to DB1 data.

NARRATIVE

RRS Challenger left Ardrossan at 10 a.m. on 8th June, and after an easy passage the Data Buoy (DB1) site (48°43'N, 08°58'W) was reached shortly after midday on the 10th, a stop having been made near 49°N, 08°30'W in order to test acoustic releases on the hydrographic winch. Following an initial echo sounder survey round proposed mooring positions, the near-surface remote interrogator mooring with dhan buoy marker was laid NW of DB1 (DB1 range 0.5 nmiles at 144°) and the first current meter mooring was laid NE of DB1 (DB1 range 0.42 nm at 233°). During this operation some difficulty was experienced in obtaining good radar fixes on the dhan buoy which was equipped with a Lüneberg lens radar reflector. This was of some importance because a good radar fix on the dhan buoy gave an independent measure of the ship-remote interrogator baseline orientation. Accordingly a corner reflector was added to the dhan, which resulted in some improvement. Work now commenced on laying the second current meter mooring, CM2, (DB1 range 0.6 nm at 264°) and, notwithstanding some difficulty in stemming the tide to the degree required for precise location, was successfully completed by 1920 hrs. The dispositions of all moorings are shown in fig. 3.

At the time of laying each mooring the acoustic range to the remote interrogator had been determined, and the baseline distance CM1-CM2 likewise obtained. A further series of acoustic range measurements were now made to confirm these, and the orientation of the baseline with respect to true North was obtained at different phases of the tide during the next 12 hours by taking visual bearings on the surface buoys (equipped with flashing lights) with CM1 in transit with CM2. The Data Buoy, DB1, also was found to be a very useful aid to navigation in this and later phases of the experiment, although it was not used as a fixed beacon, in view of the unknown mooring scope. In fact, a later analysis of radar fixes taken on it throughout the experiment showed the total horizontal excursion of DB1 not to exceed a few tens of metres.

With the positions of CM1 and CM2 determined satisfactorily, float deployments and tracking commenced. Initially single floats were tracked at approximately half hour intervals to enable the system and propagation conditions to be tested and to gain familiarity with the procedures.

Shortly after daybreak on the 11th the surface buoy attached to CM1 was found to be partially capsized; this followed an earlier observation during the night that its flashing light was unusually diffuse. The ship's work boat was launched at 07.30 and additional buoyancy was attached to the surface end of the compliant tether. In view of the limited time available for the experiment and the fact that the near-surface current sensors appeared to be in good order it was decided not to recover and redeploy the mooring. The moorings had been designed using data gathered in the previous year by DB1 and assuming a uniformity of tidal current with depth. Subsequent analysis of the float data and data from the moored current sensors has shown DB1 measurements at 3 m depth to be correct during the period of the experiment, but that tidal currents at 50 m depth substantially exceed these - typically by 20%. This unexpected 40% increase in drag is believed to account for the tow-under problems encountered. A similar problem occurred with CM2 at the next peak in tidal current; this was quickly dealt with in a similar manner. Thereafter both moorings behaved satisfactorily until shortly before recovery at the end of the experiment.

Float tracking then recommenced in what had become very calm conditions. Although the first float fixes appeared to be quite satisfactory it was decided that the overall accuracy might be improved by siting the remote interrogator close to the sea bed rather than 10 m below the surface dhan buoy. The scope of this mooring would then be immaterial, and radar fixes on the dhan could be dispensed with, relying on a multiplicity of acoustic range measurements from the ship and CM1 and CM2 for determination of the mean position of the remote interrogator.

This was duly done in the evening of the 11th and float tracking continued throughout the night, floats being set and retrieved at, typically, 3-4 hour intervals. Cruciform drogues were attached and centred at any of three depths 0.5, 1.5, 3.0 metres so as to coincide with the depths of the VAECMs on the CM1 and CM2, and with the acoustic current meter on DB1. Up to 5 floats were deployed at a time. In some cases, particularly where drogues were centred at differing depths, these were deployed as a cluster. At other times floats were deployed with initial separations to test for spatial homogeneity in the current. With the necessity of fairly frequent retrieval, if floats were to be maintained in the water within a kilometre or two of the array, handling five floats proved costly in time and deployment of two or three floats at a time was found to be more efficient. At night a Xenon flashing light was attached to each float so as to aid recovery.

During the morning of the 12th June, close observation of DB1 revealed the radio telemetry aerial to be unusually skewed, and advantage was taken of the very calm conditions prevailing to board the buoy, inspect and carry out repairs to the aerial mounting bracket. At 14.40 the first of several pitch roll buoy deployments was made in order to effect directional wave spectrum comparisons with DB1. Again, this was done concurrently with float tracking.

Sea conditions became appreciably rougher in the early hours of the 13th as a weak front passed through. During this period floats drogued at 0.5 m moved downwind at about 2-3 cm/s relative to floats with deeper drogues, a tendency not observed previously. By mid morning, however, conditions were again calm and the apparent vertical shear had disappeared. The float tracking continued - interspersed with pitch/roll buoy deployments - until 11.00 on the 14th, when a second dhan buoy mooring with an acoustic transponder attached at the surface was laid to the south of DB1 in order to check the remote interrogator position. The position of this mooring was again determined relative to CM1 and CM2 by a combination of acoustic range measurements and visual transits with all other moorings and DB1. Float work was then resumed until 08.30 on 15th, when rapidly deteriorating weather necessitated retrieval of all moorings; this was achieved by midday. Both surface buoys were retrieved intact although the tethering arrangements on each were found to be badly worn and one had sustained remarkable damage.

Following an unsuccessful search for a mooring lost at the site six months previously, the pitch roll buoy was then deployed at 1400 hrs in order to make a comparison with DB1 in moderately rough sea conditions. Two hours later this was retrieved, whereupon course was set for N. Lundy. Scarweather Light Vessel in the Bristol Channel was passed at 21.15 on 16th June and a search initiated shortly after for a lost tide gauge belonging to IOS (Bidston) at 51°23'N 3°58'W. Acoustic contact was made twice with this instrument during the next three hours, but only with considerable difficulty, and the instrument failed to respond to release signals. The search was accordingly abandoned at 0030, and the ship docked at Barry at 07.30 hours on 17th June.

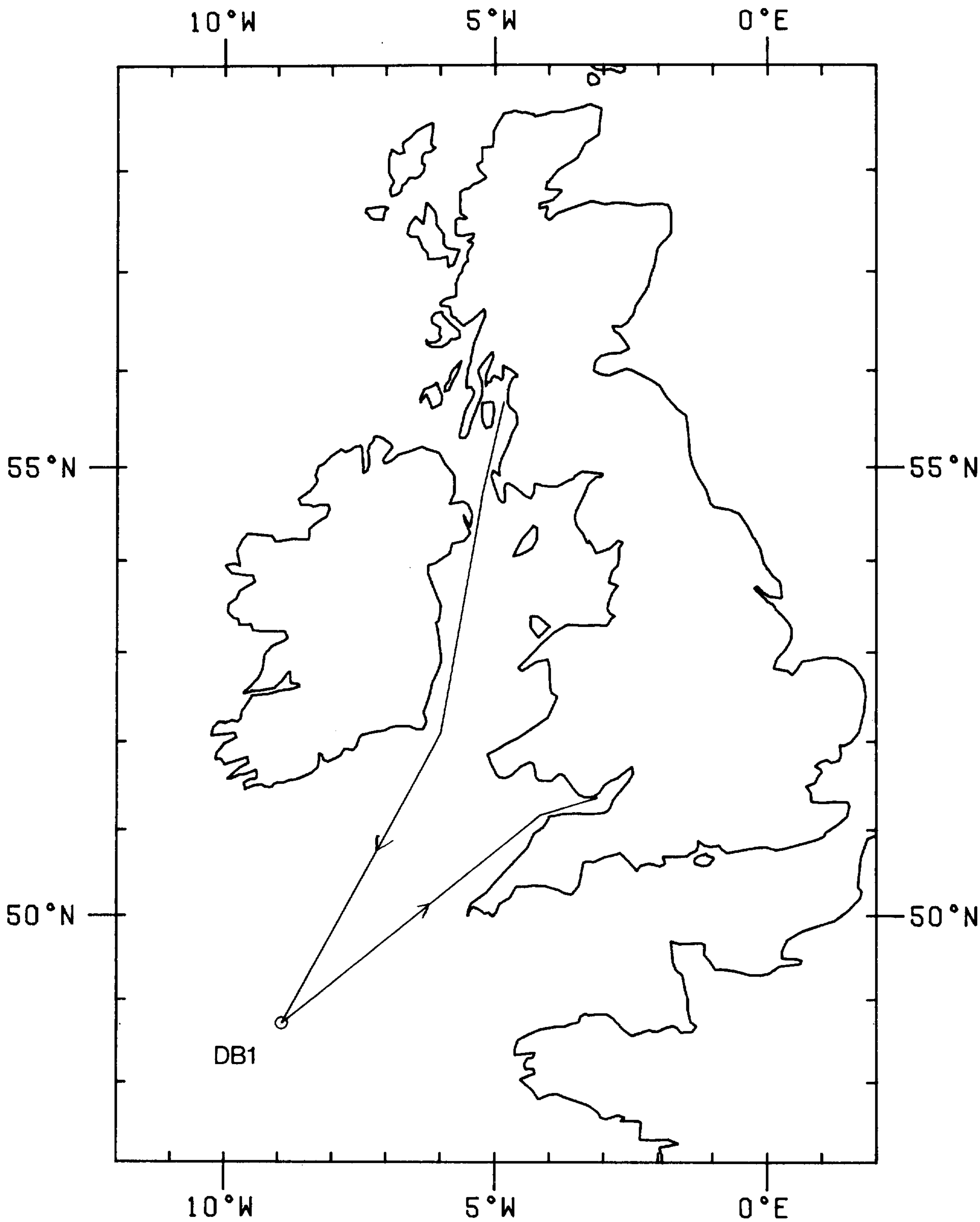
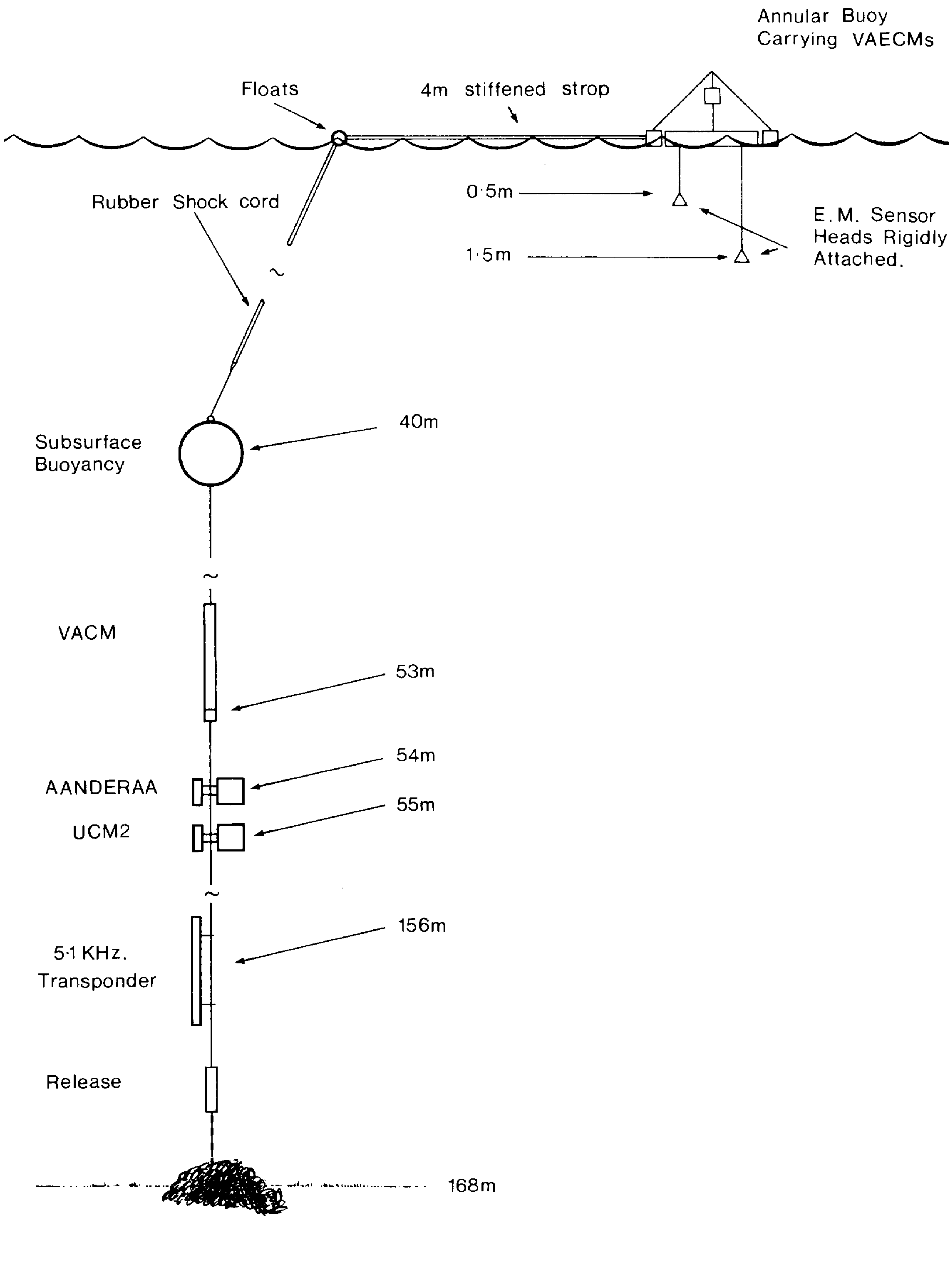


Fig.1



Annular Buoy
Carrying VAECMs
Floats
4m stiffened strop
Rubber Shock cord
0·5m
1·5m
E.M. Sensor
Heads Rigidly
Attached.
Subsurface
Buoyancy
40m
VACM
53m
AANDERAA
54m
UCM2
55m
5·1 KHz.
Transponder
156m
Release
168m

Fig. 2

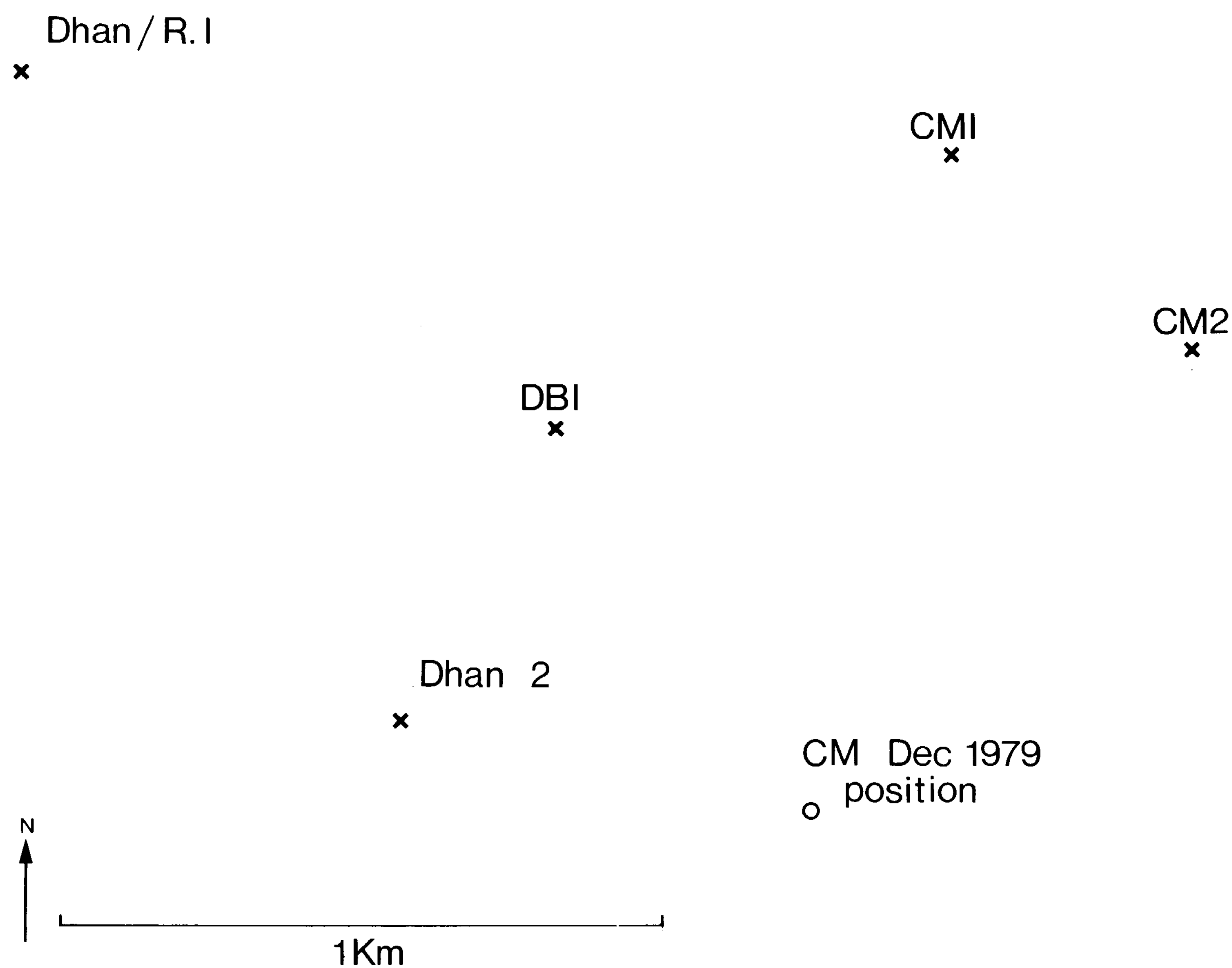


Fig. 3