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Hydrography Committee

On the Use of a Current Meter Mooring as a Drift Marker

by

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Introduction

On the 11th January 1971 F.R.S. "Explorer" laid two current meter moorings at positions A and B, shown in Figure 1. After returning to the area nine days later neither mooring could be found despite an extensive search. There was no indication of what had happened to the moorings until a float with the Aanderaa current meter, originally moored at position B, attached to it was found on the 31st March by a fishing boat on Bergen Bank, 120 miles ENE of its original position. The record from this current meter, which covers all but eight days of the period of drifting reveals exactly how the mooring came to be lost as well as providing some information on near surface drift currents and the behaviour of drifting objects under the action of wind.

In order to facilitate explanation of the fate of this mooring it should be mentioned that the mooring was of a typical U-shaped double anchor configuration with a surface spar buoy tethered to one anchor, the instrument line and subsurface float being attached to the other anchor. The subsurface float was a 1.2 x 0.6 m fibreglass cylinder weighing about 68 Kg. Whilst drifting in the sea it was half submerged with the current meter suspended 18 m below it.

The Record

The mooring was on station until 1345 on the 14th January. Up to this time a net flow of 15 cm/s towards 190° was present, in qualitative agreement with the results described at this meeting last year (Document C.M. 1970/C:3). Then a dramatic change in current pattern occurred. Figure 2 shows a vector displacement of the record for the 3½-hour period subsequent to 1345. Clearly the mooring had become involved with a trawler and the figure shows the preliminary trawl period, the actual tow which appeared on the record as a constant current speed of 180 cm/sec toward 250°, and then the final period of the tow when the trawler altered course to get the wind and tide astern of him.

Figure 3 shows the north and east components of the hourly means of current for the period of record after this incident. It can be seen that over the subsequent two days the current meter and subsurface float were still attached to its anchor and this part of the record is providing a measure of current at a position approximately 9 miles 070 degrees of the moored position. Since the buoy and instrument were returned to us completely undamaged it seems that the trawler may have become entangled with the surface buoy and anchor only, freeing his nets by cutting the surface buoy adrift. This is consistent with the fact that the mooring was initially laid out from east to west, normal to the direction of the initial part of the towing sequence.

The final part of the record covered the period 16th January to 23rd March, the instrument being recovered eight days after this. From the 14th to 16 January the record showed a net southerly drift of 6 cm/sec at its new position. Then, at 0630 on the 16th the record lost its tidal characteristics suggesting that at this time the instrument and subsurface float had broken adrift. Judging from the state of the equipment returned to us it seems that another fisherman (presumably a seine netter or drifter) had become entangled with the mooring as the lower end of the current meter support arm had been dismantled, thus parting the instrument from the anchor. The rest of this record is therefore a measure of the difference in velocity between the surface and 18 m, or of the velocity of the float relative to the water, assuming no gradient.

Figure 4 shows the vector displacement of the current meter record for the whole of the final period. The relative positions of the Orkney and Shetland Islands are superimposed. Also shown on this diagram is the reciprocal vector displacement of 4% of the wind recorded at Lerwick during this period and the close agreement between the two trajectories is evident. In order to compare the relative displacement of the current meter with respect to its position of recovery the final eight days have been interpolated from the wind record. This displacement is 170 nautical miles in a direction of 020°. The discrepancy between these two positions may be a consequence of the velocity shear between 0 and 18 m and of the movement of the buoy/current meter assembly in the frame of reference of the water, assuming no shear.

The most satisfactory explanation arises from assuming that the float was moving relative to the surface waters to the extent of 4% of the wind velocity under the action of wind and waves. In this way the discrepancy between the vector displacement and the position of recovery can be explained by the moving frame of reference of the buoy/current meter assembly. The effects of this moving frame of reference can be seen in the apparent path of the vector displacement through the Shetlands between the 22nd January and the 8th February.

Based on the current observations between the 11th and 16th a mean flow of at least 5 mpd towards 190° must be superimposed on this trajectory. Thus the float must have remained close to its release position until at least the 10th February when sustained south-westerly winds would have blown it far offshore outwith this area of strong current flow. Over this 26-day period, therefore, in the absence of wind, the assembly would have been transported some 130 nautical miles towards 190°. The remaining 40 nautical miles discrepancy between the apparent and actual finishing positions can be explained by the lagrangian drift due to the tide, which, if a mean tide propagation of 30 m/sec and tidal current of 1 knot over the area of drift is assumed, would contribute to a further southerly drift of 23 nautical miles. The final position of recovery can therefore be deduced from the apparent recovery position by taking these factors into account.

It is not at all clear if pure wind-driven currents played any part in the movement of the buoy. It has already been pointed out that the relative current at 20 m depth is approximately 4% of the wind speed and 180° to the direction of the wind. This figure of 4% may, of course, arise in a number of ways, e.g. there may be a surface movement of 2% with the wind and an 18 m movement of 2% against the wind or alternatively a surface and 20 m movement with the wind of speeds of say 5% and 1% respectively of the wind velocity. Neither of these possibilities are in agreement, however, with the acknowledged theories of wind-driven currents. It seems therefore that the most reasonable explanation is that both the float and current meter moved through the water at 4% of the wind speed and in the direction of the wind under the action only of windage and waves on the buoy. On the other hand, a most interesting conclusion can be reached if the current meter record is ignored and compare the resultant buoy path with the resultant wind vector. The former is 1.9% of the wind at an angle of deflection of 25° to the wind direction which fits in very well with theoretical surface drift currents!

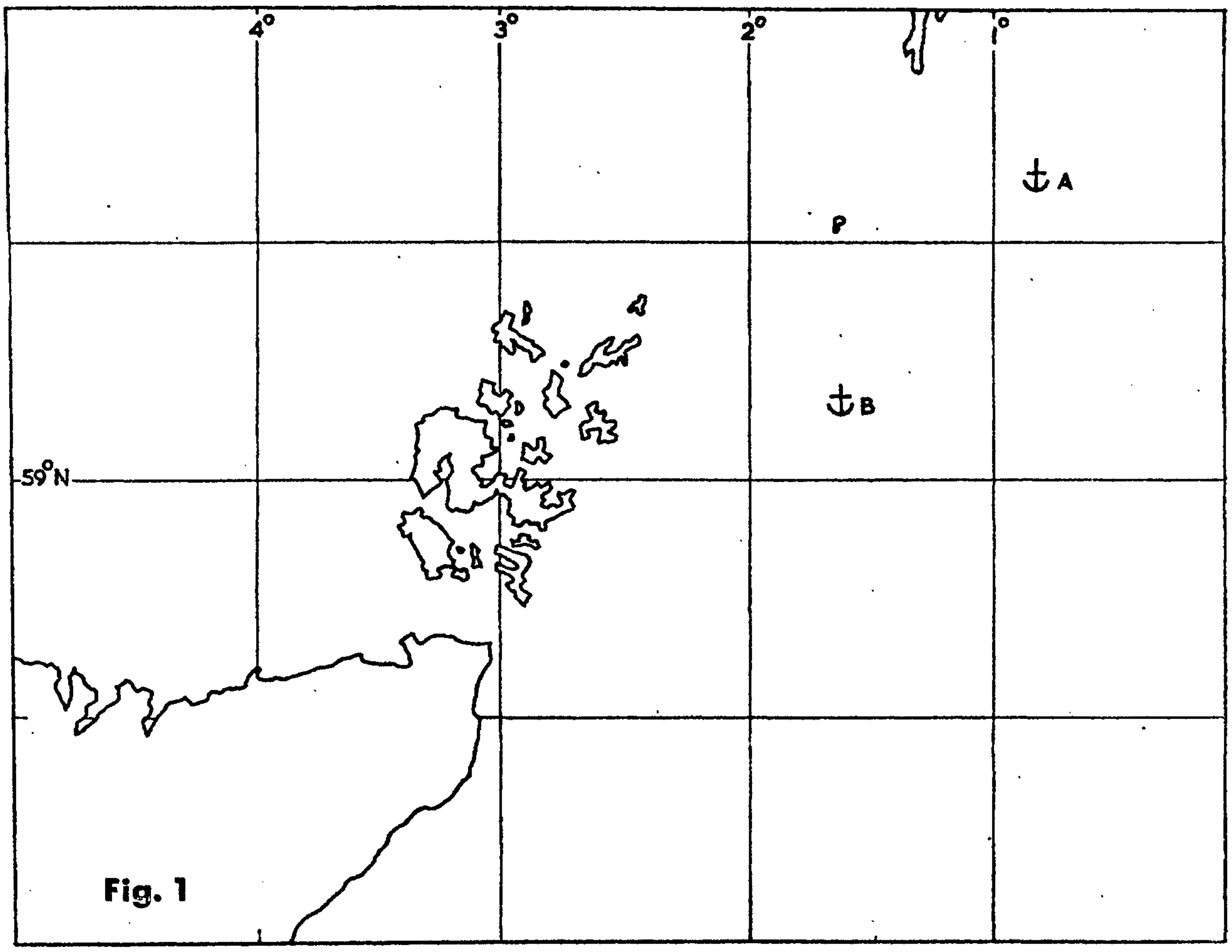


Fig. 1

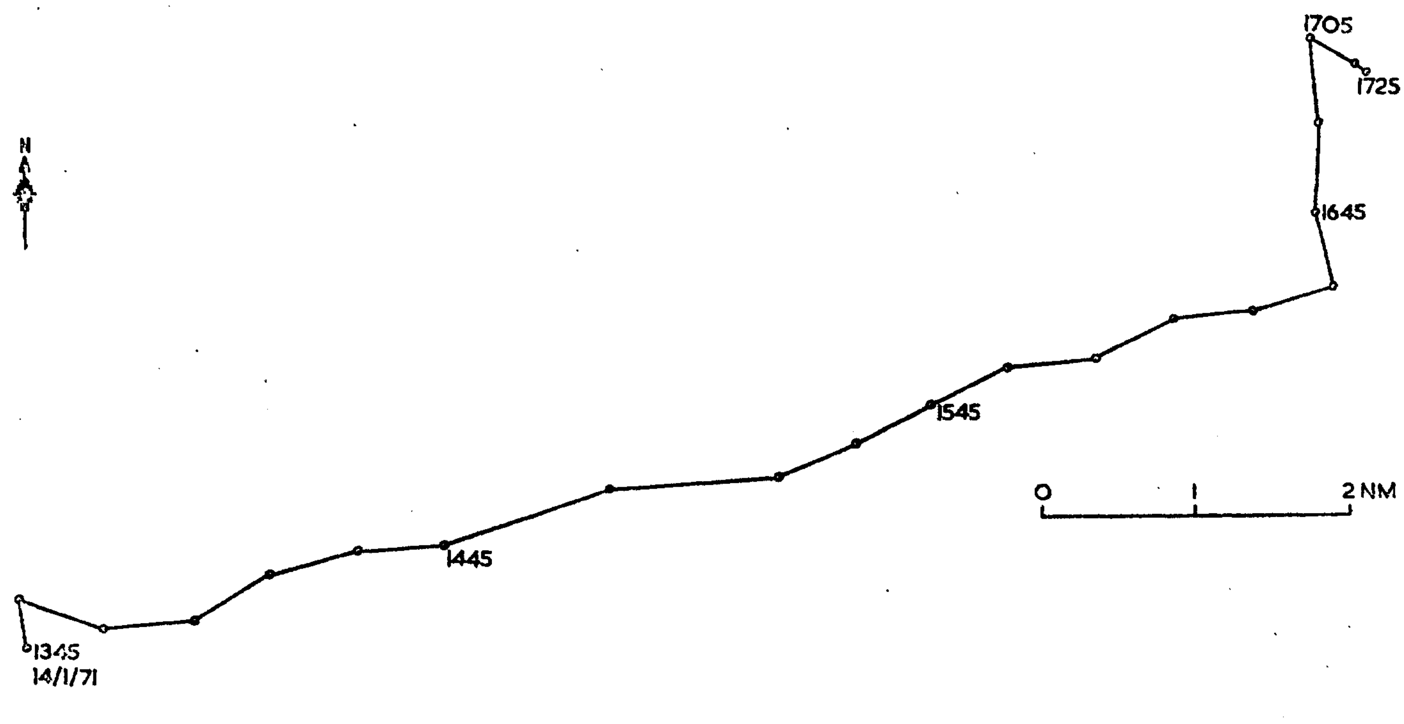
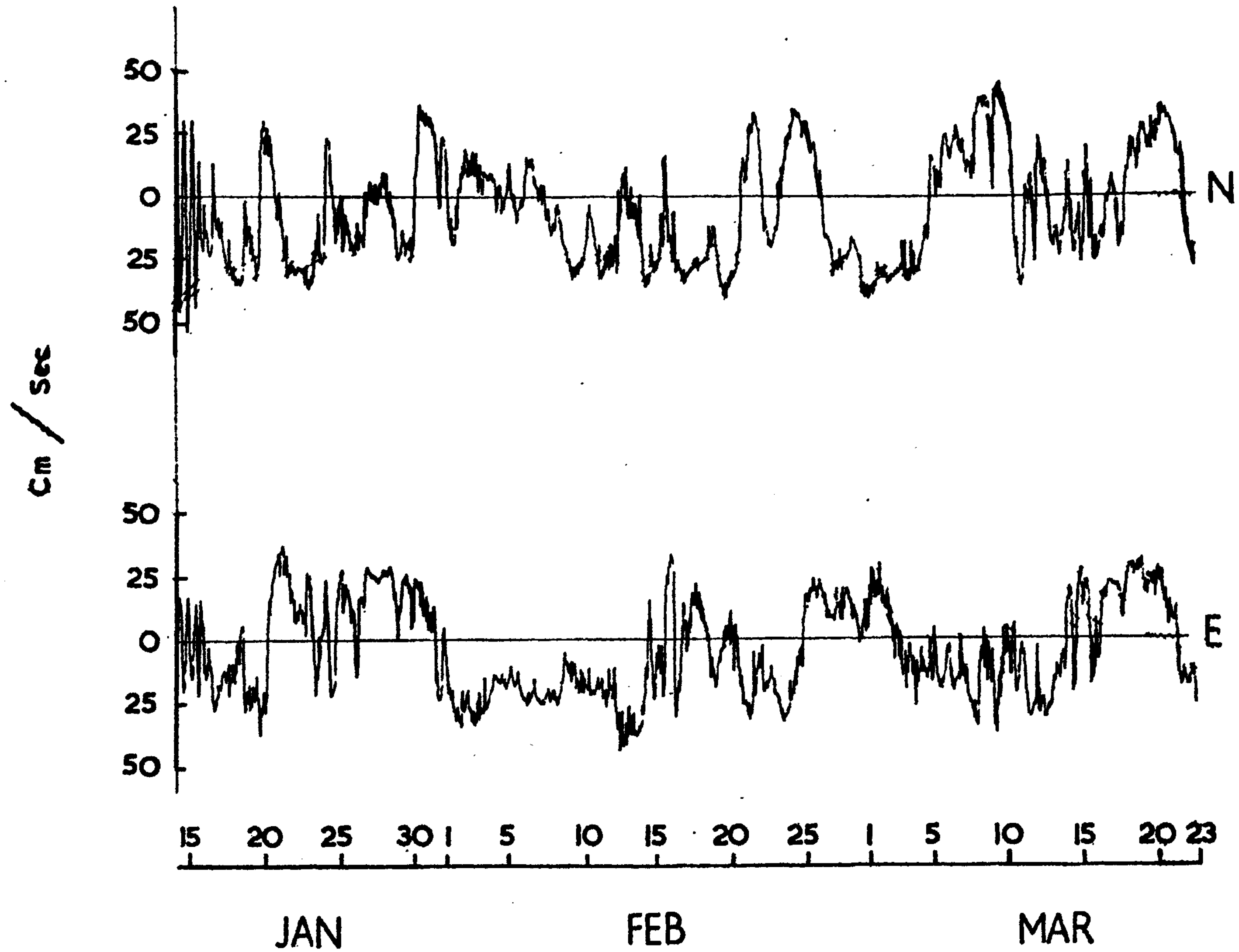


Fig. 2


Cm / sec
50
25
0
25
50
N
50
25
0
25
50
E
15
20
25
30
1
5
10
15
20
25
1
5
10
15
20
23
JAN
FEB
MAR
Fig. 3

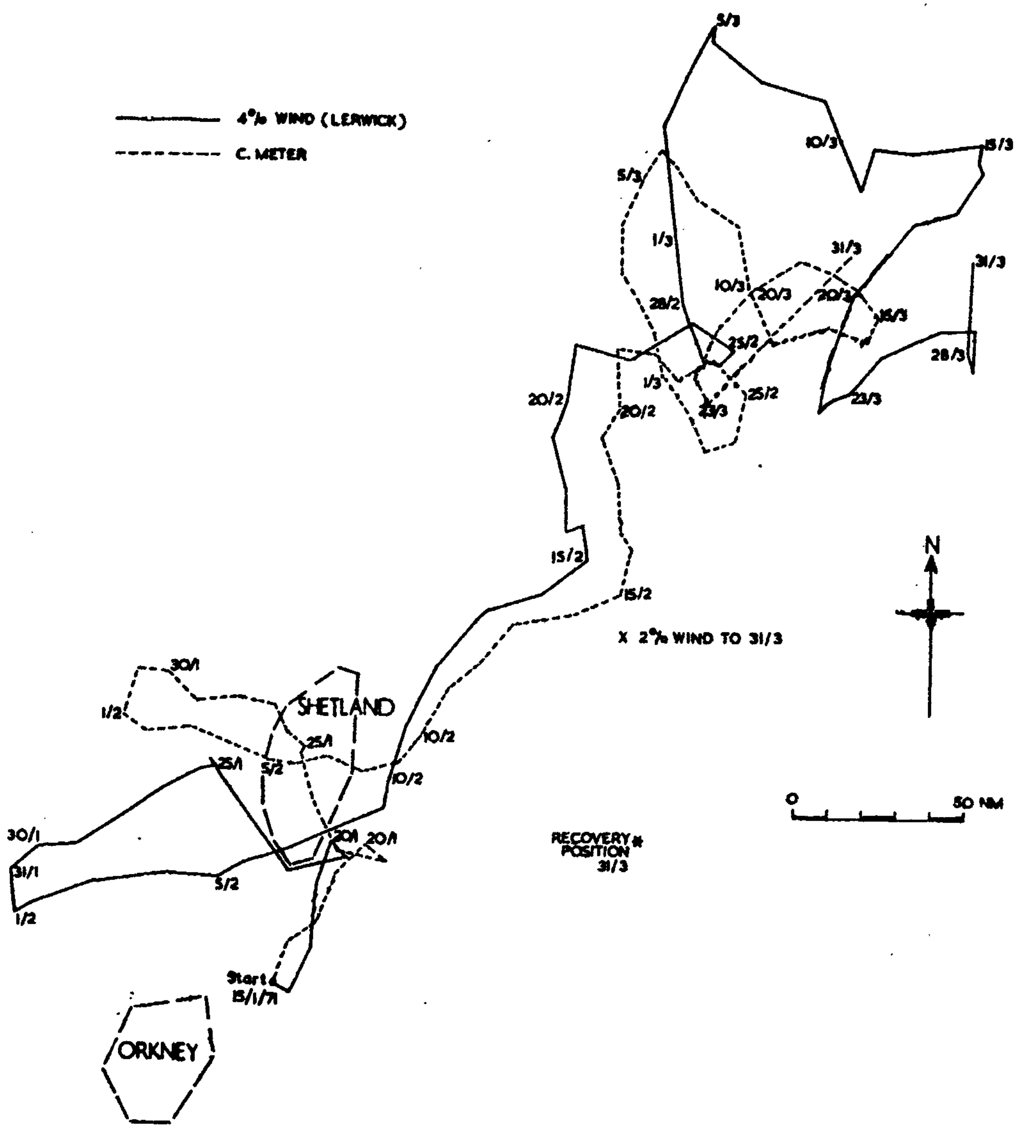

4% WIND (LERWICK)
C. METER
X 2% WIND TO 31/3
N
0
50 NM
SHETLAND
ORKNEY
RECOVERY POSITION 31/3
Start 15/1/71
5/3
10/3
15/3
31/3
28/3
23/3
20/3
1/3
28/2
25/2
20/2
15/2
10/2
5/2
1/2
31/1
30/1
25/1
20/1

Fig. 4