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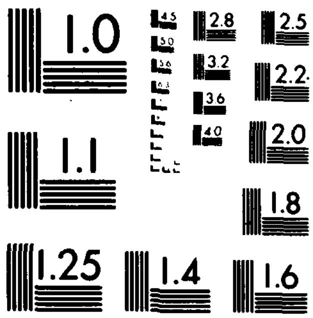

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A TIME SERIES OF OCEANOGRAPHIC SECTIONS ACROSS THE EQUATOR AT 92°E IN THE EASTERN INDIAN OCEAN

BY

P. J. MULHEARN, RANRL and R. J. EDWARDS, CSIRO Div of FISHERIES OCEANOGRAPHY

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RAN TECHNICAL NOTE 2/79

A TIME SERIES OF OCEANOGRAPHIC SECTIONS ACROSS THE EQUATOR AT 92°E IN THE EASTERN INDIAN OCEAN.

P.J. Mulhearn, RANRL and R.J. Edwards, CSIRO Div of Fisheries & Oceanography

S U M M A R Y

A series of oceanographic sections across the equator in May and June 1979 were carried out by RANRL and CSIRO at 92°E in the eastern Indian Ocean. Marked reversals in the surface currents were found which suggest the presence of either equatorially trapped waves or waves caused by the Ninety East Ridge. The XBT sections and dynamic height contours support the observed current reversals.

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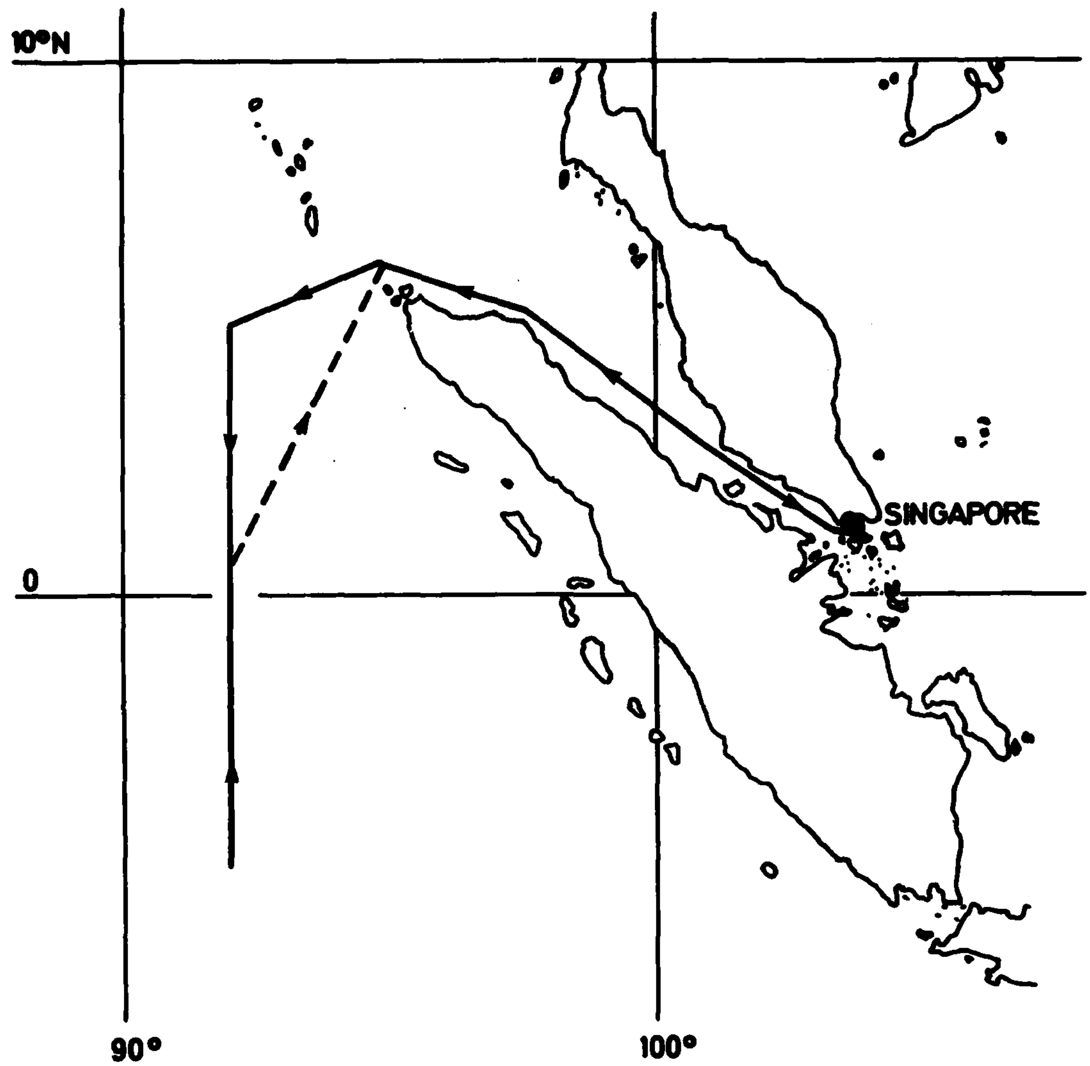

Fig. 1. Cruise tracks (Dashed line shows deviation from 92°E on RANRL's return leg).

1. Introduction

In May and June 1979 the R.A.N. Research Laboratory and the CSIRO Division of Fisheries and Oceanography carried out a series of North-South oceanographic sections across the equator at 92°E, in the eastern Indian Ocean. The experiments were part of the oceanographic programme of the First GARP Global Experiment (FGGE) and occurred in its Second Special Observing Period. (See GARP Newsletters). A primary aim of FGGE's oceanographic programme was to obtain a better understanding of equatorial current systems. In the Indian Ocean most interest was centred on the western half and the Somali Current, so that the results discussed here represent one of the few data sets for the eastern half of the Indian Ocean at that time. Other data was obtained from U.S.S. Wilkes and some may have been obtained by a polygon of five Russian ships which traversed along the equator before and after Special Observing Period II.

The coverage and dates of the RANRL and CSIRO cruises, all using HMAS Diamantina are set out below.

Dates	Latitude and Longitude	Institution
12-15 May	5°N, 92°E to 3°S, 92°E	RANRL
15-17 May	3°S, 92°E to ½°N. 92°E	RANRL
17-18 May	½°N, 92°E to 6°N, 95°E	RANRL
28 May - 1 June	5°N, 92°E to 5°S, 92°E	CSIRO
1-5 June	5°S, 92°E to 5°N, 92°E	CSIRO

RANRL only went as far south as 3°S because it was taking longer time-series measurements en-route. It also had to leave the 92°E line on 17 May and head for Singapore because of a fire on board. Cruise tracks are shown on Figure 1.

Some data were taken by RANRL which were not taken by CSIRO and vice-versa, because of the slightly different aims of the two cruises. The data presented here are those which were measured by both institutions and hence allow a time series development of certain oceanographic parameters to be presented. Data to be presented are

(1) Temperature cross-sections from XBT's

(2) Surface currents

(3) Dynamic heights

(4) Satellite-tracked buoy paths

Some previous work on the eastern equatorial Indian Ocean is contained in works by Wyrtki (1973), Taft and Knauss (1967), Eriksen (1979),O'Brien and Hurlburt (1974) and Philander (1973). From climatological data Wyrtki showed the existence of an eastward equatorial jet in the

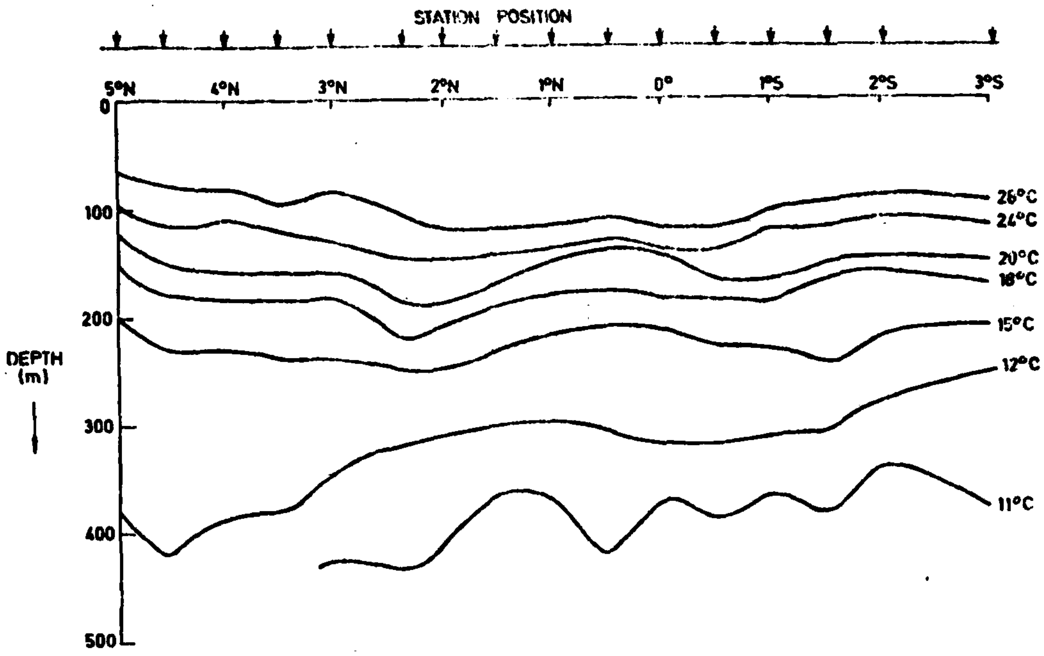

Fig. 2(a). XBT section on south-going RANRL leg 12/5/79–15/5/79.

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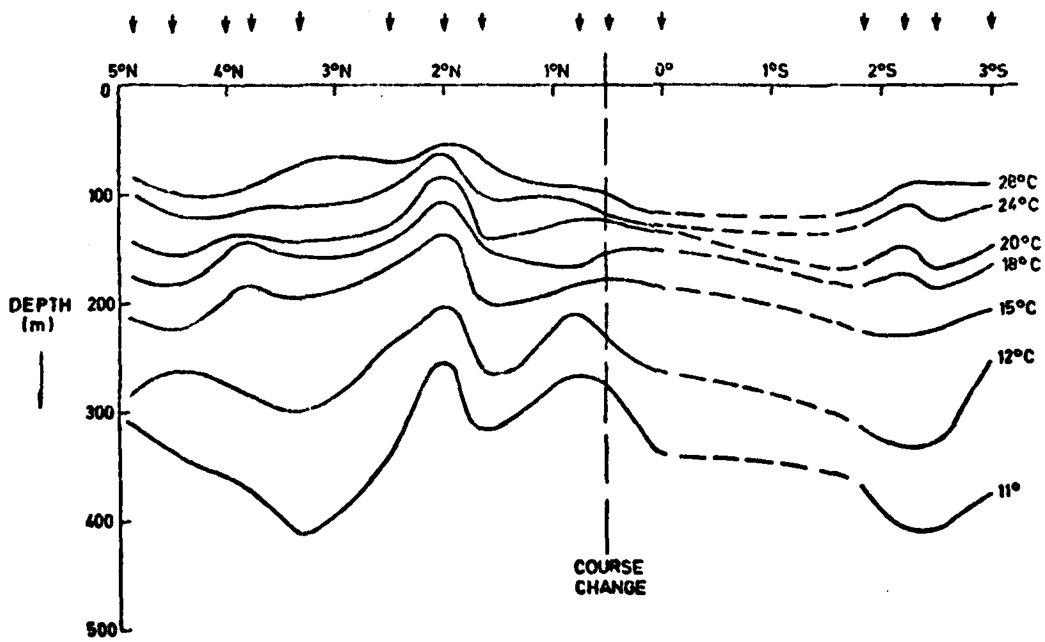

Fig. 2(b). XBT section on north-going RANRL leg 15/5/79–18/5/79.

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monsoon changeover months of May and October. O'Brien and Hurlburt obtained such a jet in a simple numerical model which imposed a uniform eastward wind over the ocean basin - such eastward winds being predominant in May and October. Taft and Knauss at 53°E, found a surface eastward equatorial current in May in the course of one of their cruises. Data from other times usually show a westward flow at the surface with a subsurface eastwards jet at the equator. Philander (1973) provides a broad review of the equatorial current systems.

2. Methods

The Temperature sections to be presented were all obtained with standard XBT equipment. The surface currents from RANRL's cruise were obtained when the ship was drifting on station and obtained four or more sat-nav fixes. Surface currents from CSIRO's cruise were obtained by the differences between dead-reckoning and sat-nav fixes.

For RANRL's cruise dynamic heights were obtained using temperatures from XBT's and salinities from shallow Niskin casts and XSTD probe data. (XSTD = expendable salinity - temperature depth). No reversing thermometers were attached to the Niskin bottles but the true depths of the salinity samples were obtained from the angle of the hydrographic wire and a comparison of the shapes of salinity profiles from the Niskin bottles and the XSTD probes. CSIRO obtained their dynamic heights from Nansen and Niskin cast data by standard means. All salinities were measured on board using an inductive salinometer (Brown and Hamon, 1961).

Satellite-tracked buoys were deployed by CSIRO on 1 June at 0° and 3 June at 1°N, both on 92°E. These were of the torpedo shape described in Cresswell and others (1978) and were drogued at 20 m.

3. Results

3.1 XBT Sections

The four XBT sections in Figures 2(a) to (d) are rather featureless, the isotherms in most cases being almost horizontal, except that for the RANRL sections there is a tendency for isotherms near the base of the mixed layer to converge near the equator. This convergence suggests that the surface flow is to the east relative to the water below the thermocline. The section of Fig 2(b) shows more features especially along the track from ½°N, 92°E to 5°N, 94°20'E. The time series at 0° shown in Fig 2(e) shows very little change over a ten hour period.

3.2 Surface Currents

Ship's sets are available at the positions shown on Figures 3(a) and (b). They are available for the southward leg of RANRL's cruise from 12-15 May and on 16 May at 0°, during the northwards leg. On CSIRO's cruise they are available only for the southward leg from 28 May to 1 June, because the sat-nav failed on the way back north.

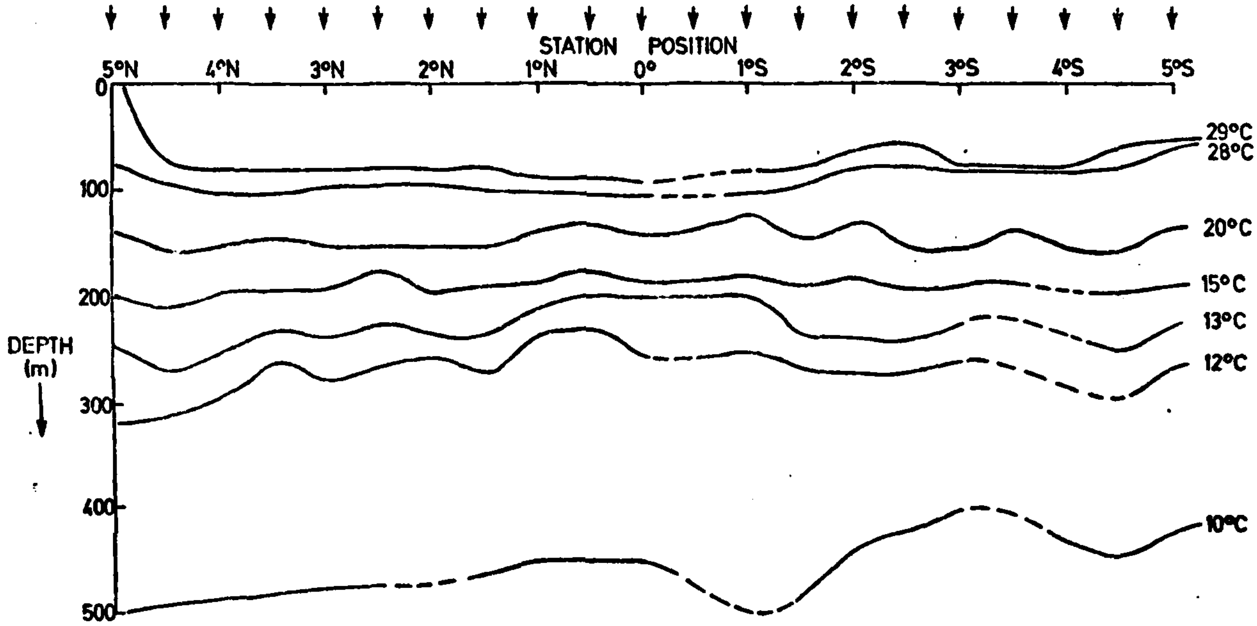

Fig. 2(c). XBT section on south-going CSIRO leg 28/5/79—1/6/79.

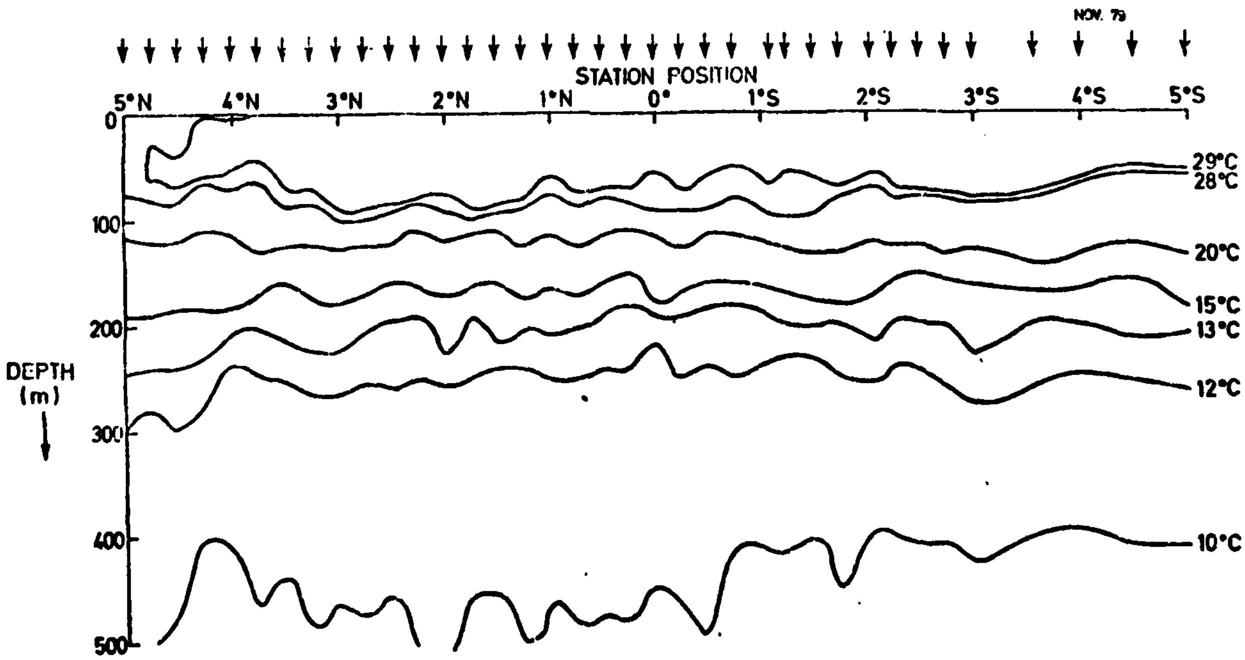

Fig. 2(d) XBT section on north-going CSIRO leg 1/6/79-5/6/79.

The reversal of the currents (some of up to 2 knots magnitude) in the two weeks between the cruises is a striking feature of these results. From 12-15 May currents were to the east while they went to the west in the 28 May - 1 June period. Winds were light and variable throughout this period and a calm prevailed for most of the RANRL legs.

3.3 Dynamic Heights

Profiles of dynamic height of the sea-surface relative to 300 m, taken for the 3 periods 12-15 May, 28 May - 1 June and 1-5 June are presented in Figs 4(a) to (c). Dynamic heights are larger and show more variation for the period 12-15 May than for the other two legs. Geostrophic currents calculated from these dynamic topographies appear to be of the correct order north of 1½°N and south of 1½°S but the amount of reliable data on currents available by this method is very limited. The change in slope of the dynamic height between 2°N and 4°N from RANRL's leg of 12-15 May and CSIRO's leg of 28 May - 1 June supports the surface current measurements. Overall there is a tendency for the range of dynamic height to decrease with time.

The dynamic height relative to 1000 dbars is shown in Fig 4(d) for the period 28 May - 1 June.

3.4 Satellite-tracked Buoys

Satellite-tracked buoys were deployed on 1 June at 0°N, 92°E and on 3 June at 1°N, 92°E. The tracks of these buoys follow each other closely for the next 80 days at least. Initially they drifted westwards for 12 to 14 days, supporting the ships set data, then turned back towards the east and continued towards the east, tending southwards for another 78 days before turning towards the west once more. The final journey to the west may be due to capture by the South Equatorial Current, but the earlier reversing motion revealed by both the buoy tracks and the ship's sets may be caused by equatorially trapped standing waves.

4. Conclusion

The data presented in this short report demonstrates that in the period May to June 1979 the area between 5°N and 5°S at 92°E was subject to oscillating currents with a magnitude of 1 to 2 knots and a horizontal space scale of several degrees of latitude (400-500 km). The time scale of the oscillations is harder to estimate but appears to have been less than 2 weeks.

5. Acknowledgements

Thanks are due to the officers and men of HMAS DIAMANTINA for their help in the conduct of these experiments. Mr D. Rochford is thanked for some useful discussions and Dr. C. Nilsson for the use of his computer programmes for the dynamic height calculations for the RANRL transect.

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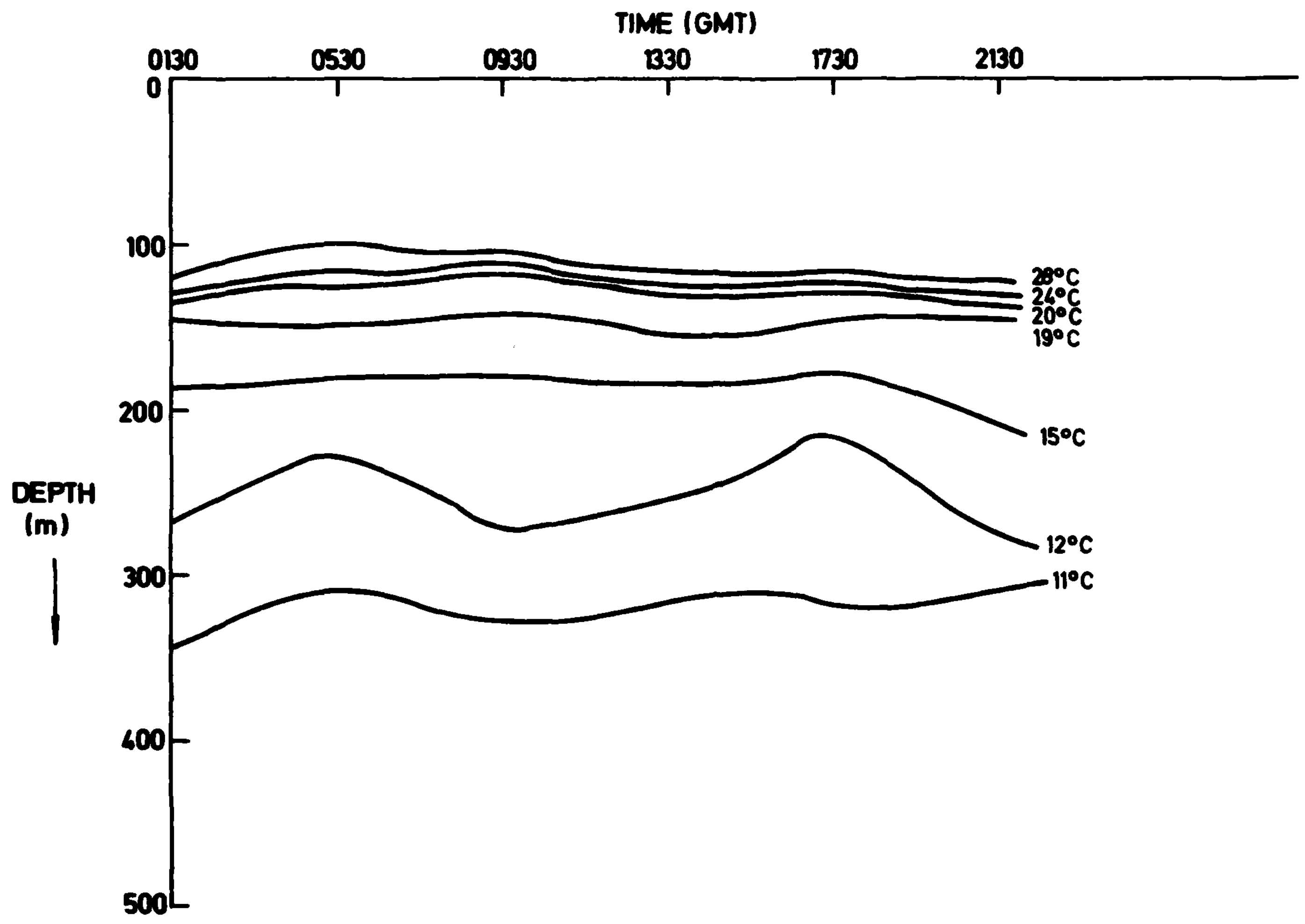

Fig. 2(e). Temperature time series at 0°; 92°E on 16/5/79.

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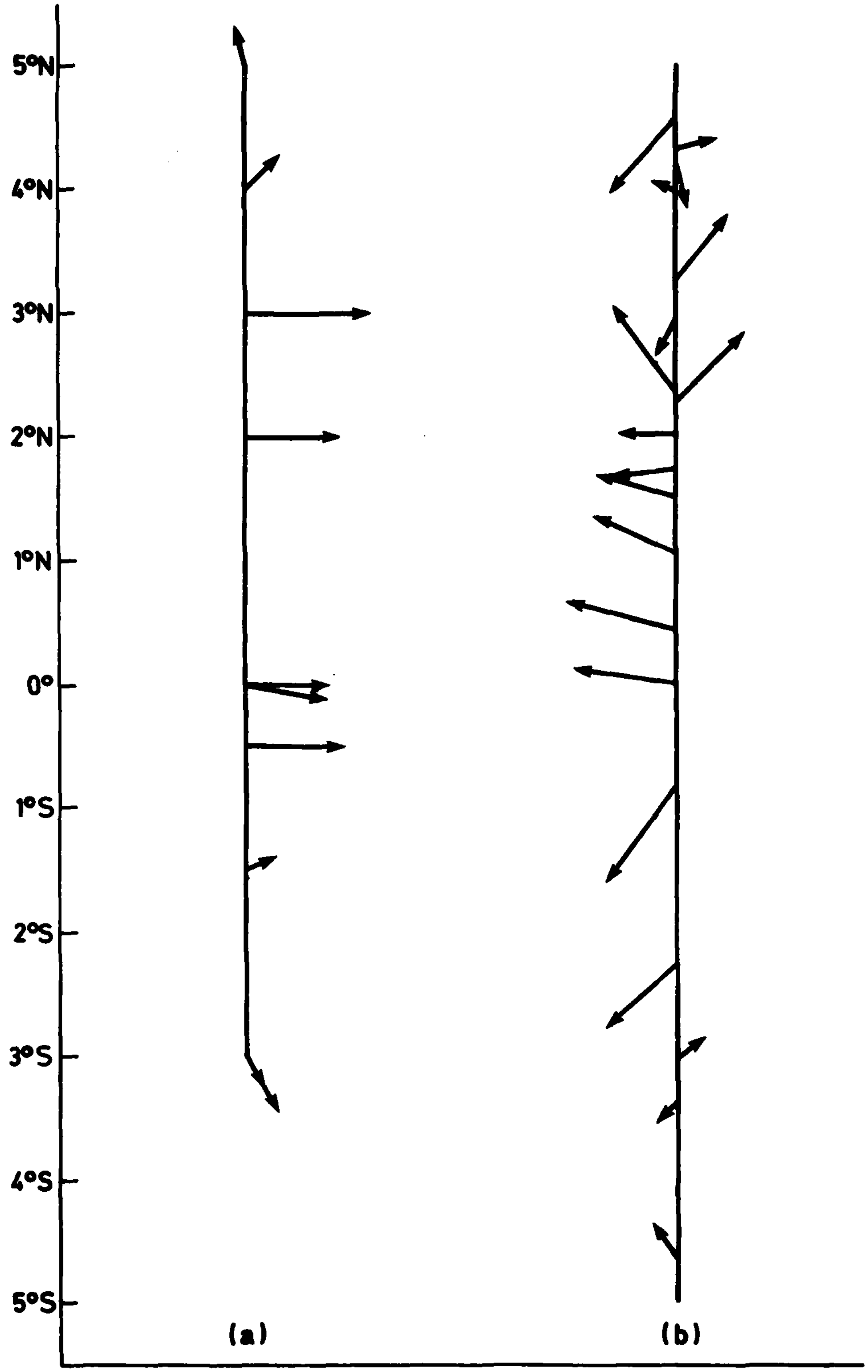

Fig. 3. Surface currents from ship's sets for (a) RANRL's south-going leg 12/5/79 – 15/5/79, with values at Equator on 16/5/79 and (b) CSIRO's south-going leg 28/5/79 – 1/6/79. (1cm ≡ 1 knot.)

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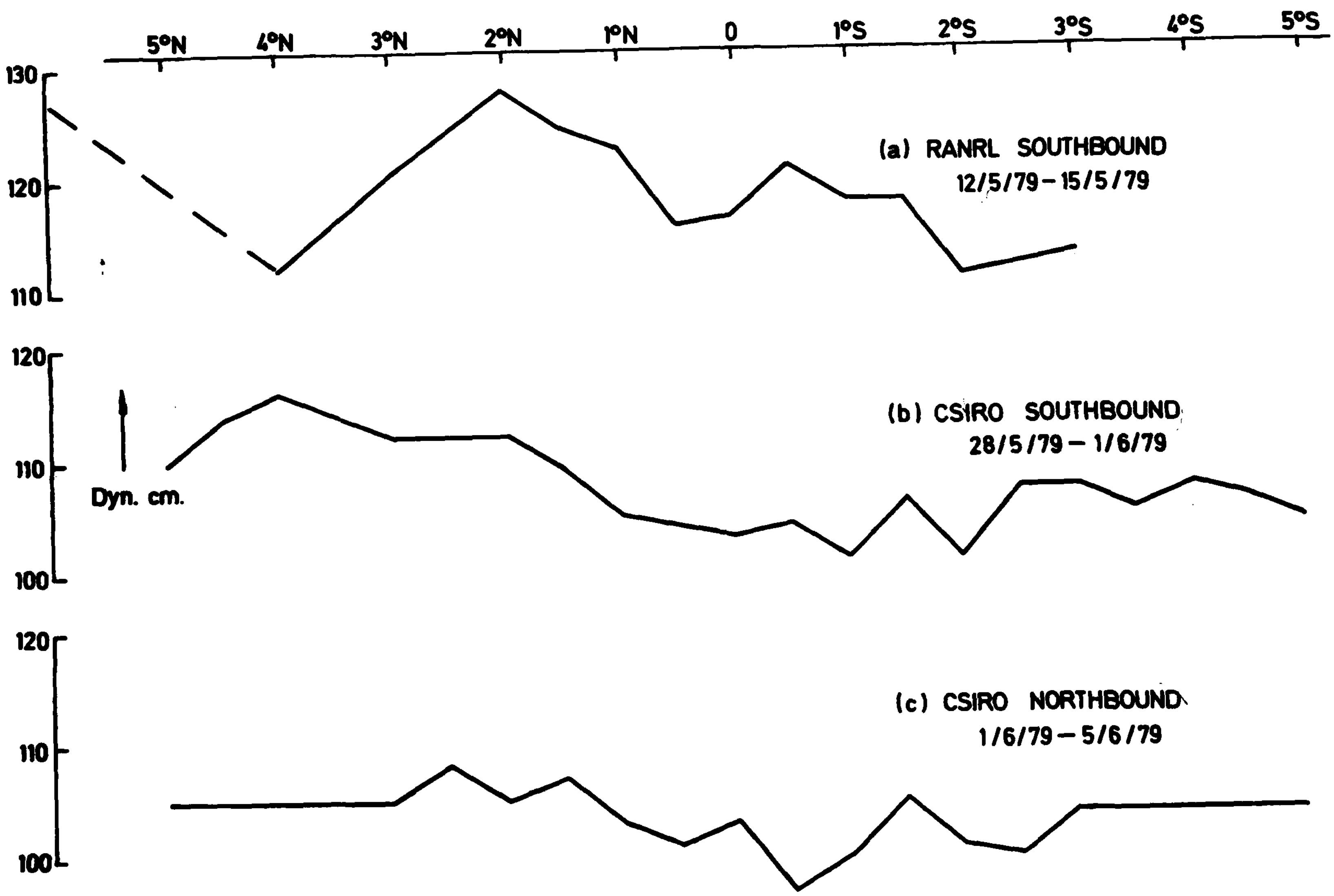

Fig. 4. Dynamic height of sea-surface relative to 300m.

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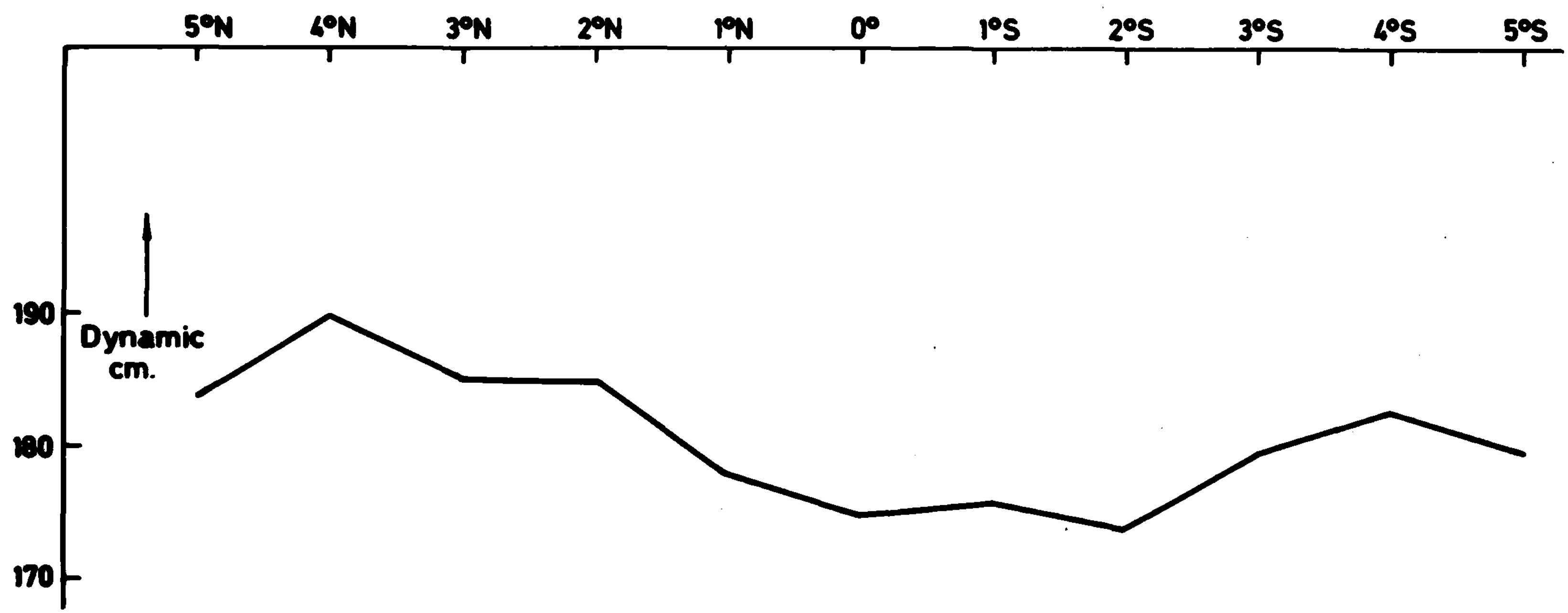

Fig. 4 (d). Dynamic height relative to 1000 db along 92°E.

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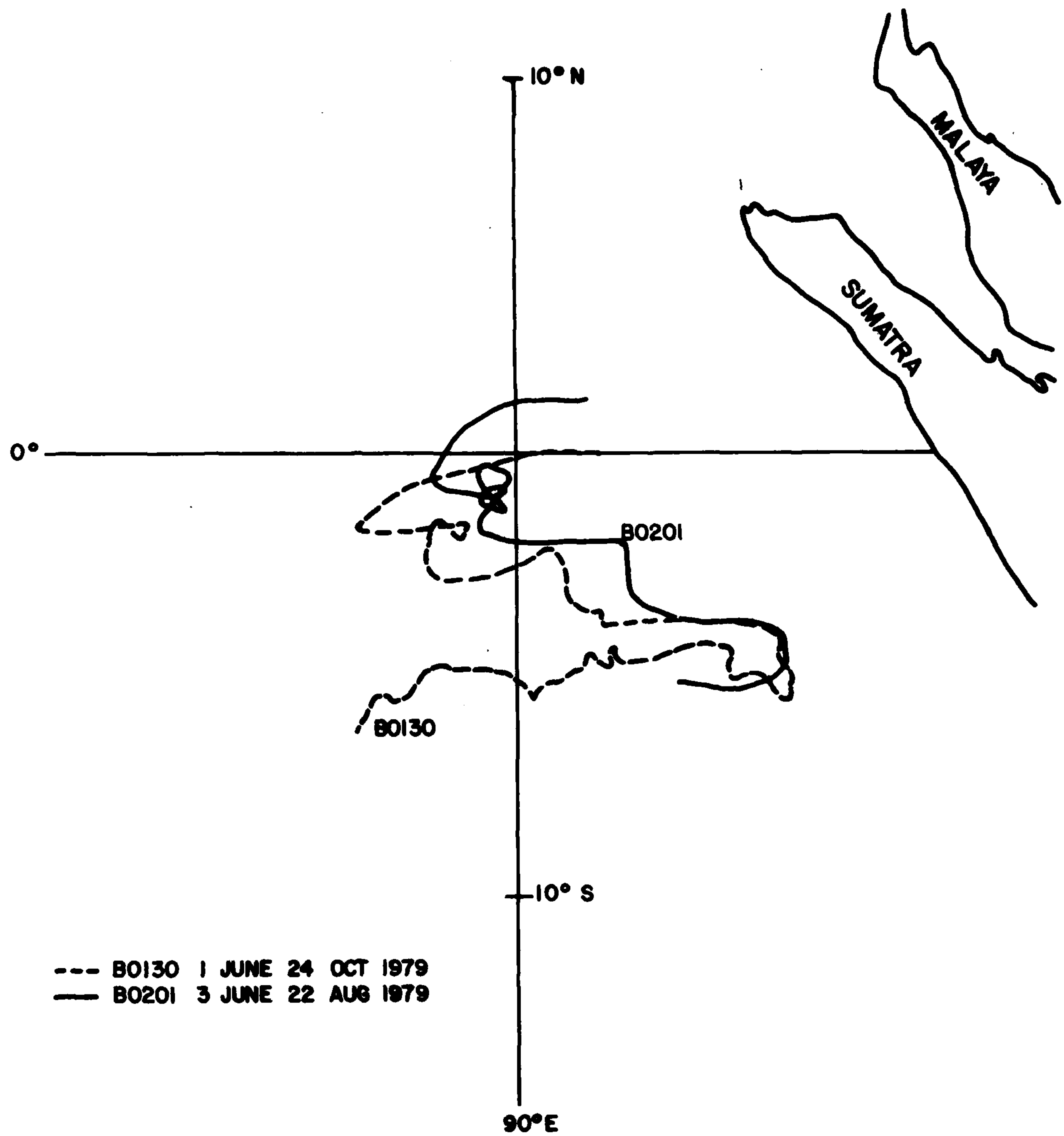

Fig.5 Path of satellite-tracked buoys.

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