A Monitoring Section across the East Australian Current

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A MONITORING SECTION ACROSS THE EAST AUSTRALIAN CURRENT

By F. M. BOLAND*

Abstract

The results from 40 temperature sections across the East Australian Current are presented. The measurements were taken over a period of 2 years. The results confirm earlier work on the variability of the current and the time scales involved. An interesting feature is the appearance of north- and south-flowing currents to the east of those previously reported.

I. INTRODUCTION

In July 1969 CSIRO installed an Expendable Bathythermograph (XBT) system on the T.S.M.V. *Maheno*. This ship operates on a fortnightly schedule between Sydney and New Zealand ports. The aims of the experiment were twofold. Firstly, to provide information on the short time scale variations of the East Australian Current System. Secondly, to establish a long-term monitor on the System in order to establish seasonal changes and to check the existence of long-term secular events such as those observed in the Kuroshio Current (Uda 1964). This paper presents some of the results obtained in the first two years of observations.

II. METHODS

The Expendable Bathythermograph was developed by the Sippican Corporation in the U.S.A. and the components are supplied in Australia by Plessey Pacific Ltd. The expendable probes are released through a launching tube while the vessel is under way and an onboard chart recorder displays the temperature-depth profile. Temperature is measured by a thermistor and depth by elapsed time. The manufacturers list ±0.2°C and ±10 m as estimates of accuracy. The maximum depth reached is 450 m.

The probes are released by the ship's deck officers who also provide log sheets for each drop. The log sheets list ship's speed, depth, position, time, and the surface temperature measured at the engine room intake.

XBT drops are made at time intervals of 2 hours on each outbound trip from Sydney. This provides a station spacing of approximately 60 kilometres at the normal cruising speed of 18 knots. The starting point on each run is the 200-fathom line. The outbound trips were chosen for navigational reasons and because this leg runs almost along a latitude circle (Sydney to Auckland – approximately 34°S.). The return voyage is from Wellington to Sydney.

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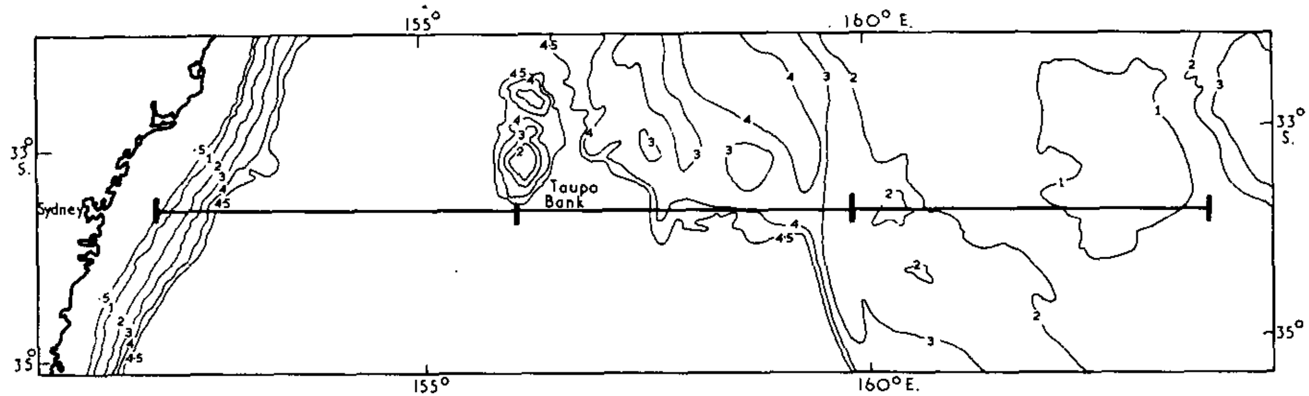

Fig. 1.–The bathymetry near the section. The marked positions refer to the ends of the short, intermediate, and long sections. Depth contours are in kilometres.

The geostrophic current is directly proportional to the gradient of the density and in the upper layers of the ocean the temperature field is closely related to the density field. Thus, from a single section showing the temperature field, the component of geostrophic current normal to the section can be deduced. Isotherms sloping downwards to the east imply a south-flowing current and to the west a north-flowing current. The strength of the current can be gauged from the steepness of the slope.

III. Results

Initially the sections consisted of seven drops each. This provided a section extending eastward from the coast to 156°E. as shown in Figure 1. Figure 2 shows one of these sections. There is a strong south-going current near the coast and an equally strong north-going return flow further offshore. These south and north current pairs seem to be a common feature in this latitude. A strong current flowing to the south is always accompanied by a strong counter-current flowing to the north.

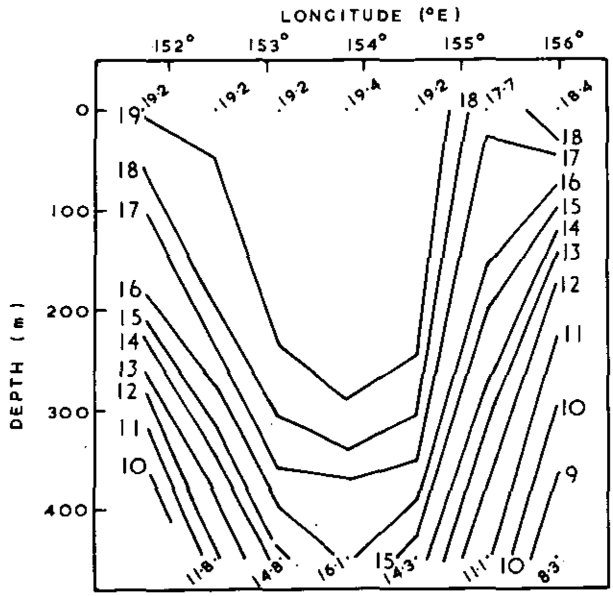

Fig. 2.—Temperature section, M.V. *Maheno*, 23 October 1969.

In March 1970, in order to check the existence of the counter-current when the southward current is far offshore, alternate sections were extended further east. These medium-length sections, each of 12 drops, reach to ~ 160°E. and have confirmed the existence of the counter-current. Figure 3 shows an example. However, as can be seen in the figure, these longer sections also showed another south-flowing current to the east of the near-shore features.

Accordingly in July 1971 these medium-length sections were further extended to 164°E. At this longitude, the sections have crossed the abyssal plain and the shallowest part of the Lord Howe Rise (Fig. 1). Figure 4 shows an example. On this run, two south-north current pairs were present with the outermost north-flowing current running on the western edge of the Lord Howe Rise. No more than two current pairs have been observed at any time, but it is not known whether more may exist.

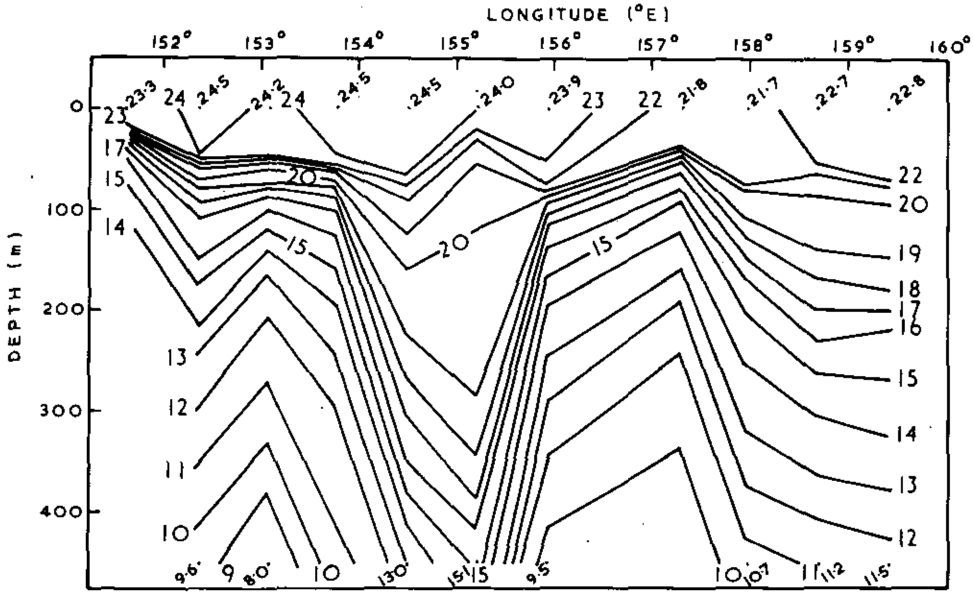

Fig. 3.–Temperature section, M.V. *Maheno*, 8 April 1971.

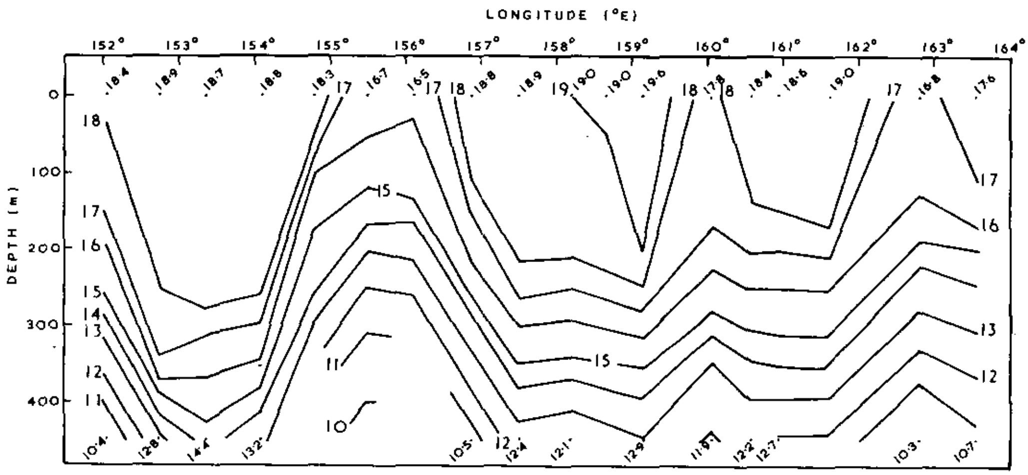

Fig. 4.–Temperature section, M.V. *Maheno*, 6 August 1971.

In the two years' operation, from July 1969 to June 1971, observations were made on 40 voyages. On 11 of these, sections reached to ~160°E.

No convenient way has been found to present all the data but Figure 5 shows a time sequence of the results. The figure is a plot of the temperature at 240 m depth against longitude and time. The hatched areas represent temperatures higher

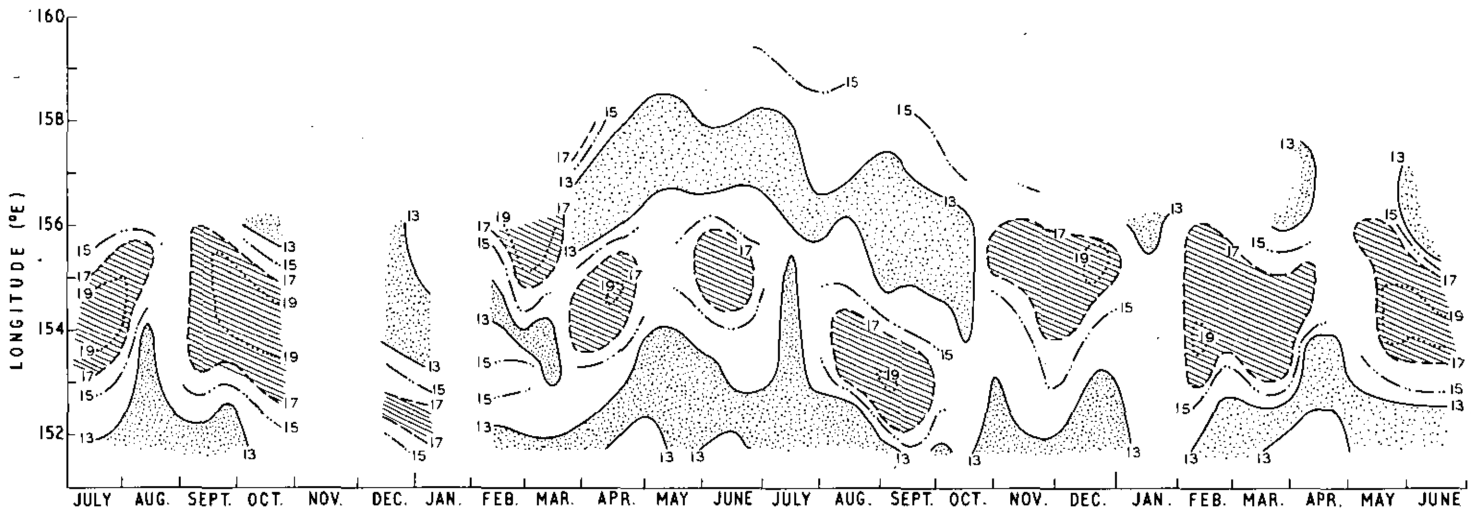

Fig. 5.–The temperature at 240 m depth. Hatched areas represent temperatures $>17°C$ and stippled $<13°C$.

than 17°C and the stippled areas are less than 13°C. In this part of the Tasman Sea there is a close relationship between the temperature at 240 m and the dynamic height (Hamon 1968). Thus a close spacing of isotherms represents a strong current and wide spacing a weak one.

The highest temperatures are on the left-hand side of the current looking downstream. The 15° isotherm has been chosen as representing the "core" of the current, i.e. the location of the fastest-flowing surface water (or the strongest temperature gradient). This isotherm has been drawn only where there are indications of a strong current crossing the section. The two large gaps in the record were caused by a shipping strike and equipment malfunction.

Two features are immediately clear from Figure 5. Firstly, the currents are transitory: a strong current may appear and disappear within a time span of approximately 6 weeks. These currents are indicated by the appearance of bodies of warm water (> 17°C) on the section.

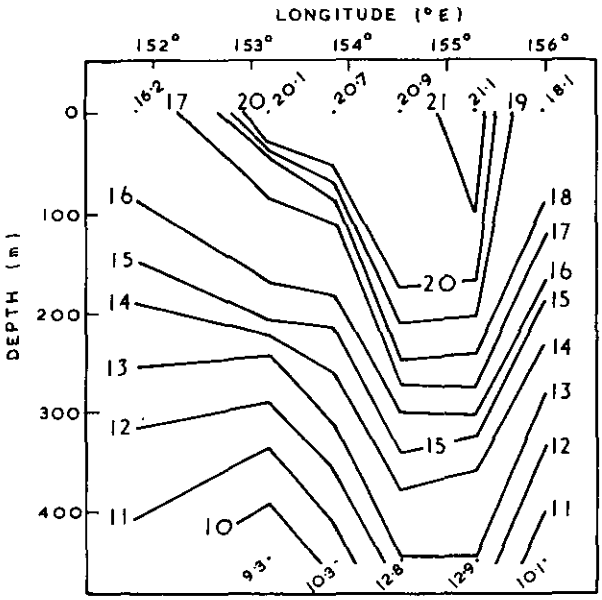

Fig. 6.–Temperature section, M.V. *Maheno*, 18 June 1970.

In the period February 1970 to July 1971 seven such warm water masses appeared. The average time between such events was 73 days.

Secondly, the east-west locations of the currents are variable. The axes can move longitudinally at speeds of 10 km per day. The average position of the axis of the inshore southerly current was 153°21′ and its average separation from the inshore northerly current was 1°54′ (175 km). The average distance to the next southerly current is 3° (275 km).

These data have failed to show any significant seasonal variations in the strength or position of the current system. However, the "warm core" reported by Ryan *et al.* (1968) appears to be a seasonal event. When there is a strong southward current it is almost always present in autumn and winter (March to August) and absent in spring and summer (September to February). Figure 6 shows an example of a section with a warm core. This can be compared with the section in Figure 2 which does not have a warm core.

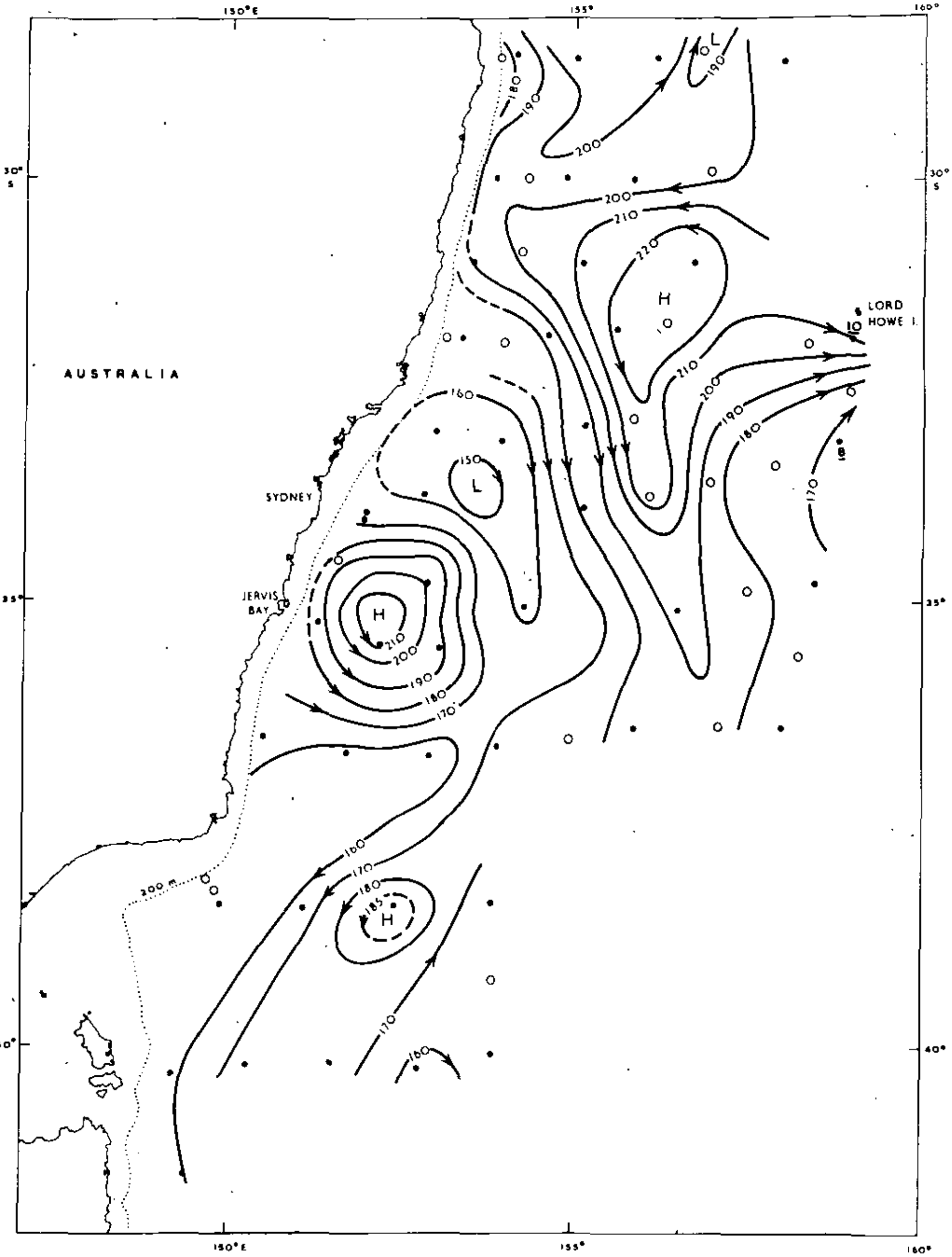

Fig. 7.–Dynamic height of the sea surface relative to 1300 db, Cruise G1/64.

IV. Discussion

Since a single east-west section provides information on only the north-south current components it is not possible to describe fully the observed south and north current pairs. Oceanographic cruises in the same latitudes (Hamon 1965; Boland and Hamon 1970) indicate that they may be either detached warm eddies or a part of a larger system. Figure 7 shows the only previous pattern from an oceanographic cruise that would appear on a single section as a double pair structure. The present observations indicate that this structure may be representative of the system.

There is now a fairly substantial body of evidence concerning time and space scales in the East Australian Current. Hamon (1965) gave 250 km as a typical eddy diameter and 5 km/day as their rate of drift to the south. Hamon (1968) gave time and length scales of the order of 70 days and 100 km respectively. If the time scale can be regarded as the interval between the passages of successive eddies, these estimates agree fairly well.

Hynd (1968, 1969) studied surface temperature charts in the area from 34°S. to 38°S. produced by equipping an aircraft with an infrared temperature sensor. He concluded that fortnightly charts were insufficient to follow water movements and implied a time scale of the order of 12 days.

The time scale of 73 days from the present data confirms the estimates made by Hamon. There is reasonably good coherence between sections made at fortnightly intervals. On no occasion has a current "pair" appeared only on a single section.

At present there is no clear explanation for the discrepancy between these two results. It is possible that the difference in time scale derived from observations of surface temperatures arises from the difficulty of interpreting the charts. Hamon (1965) has pointed out that, at least below 34°S., large eddies frequently cannot be identified from surface temperature patterns. Consequently attempts to derive a time scale relating to the geostrophic flow from such patterns may give ambiguous results.

Hamon and Cresswell (1972) have calculated a structure function using the present data. From this they estimate a space scale of 500 km. This agrees with the average distance between the two south-flowing currents found earlier to be 450 km, which could be regarded as being a wavelength for the system.

V. Acknowledgments

The author wishes to convey his appreciation to the captain and crew of the T.S.M.V. *Maheno* for their invaluable assistance in carrying out this programme.

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