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Cruises into the Western Coral Sea by R.V. 'Sprightly' 1980/81 A Data Report

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CRUISES INTO THE WESTERN CORAL SEA
BY R.V. 'SPRIGHTLY' 1980/81
A DATA REPORT

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Abstract

This report presents data from a series of cruises into the Western Coral Sea during 1980/81. Data presented are contours of T_{250}, temperature sections adjacent to the Great Barrier Reef, and the recordings of current meters, tide gauges and a meteorology station. An appendix gives a preliminary analysis of TS characteristics in the area.

Introduction

During 1980/81, the Division of Oceanography completed ten cruises into the western Coral Sea area. It was proposed to occupy standard sections as often as possible on each cruise to assess the meridional and the seasonal variability of the circulation along the outer edge of the Great Barrier Reef as well as the contribution the area makes to the East Australian Current. Current meters, tide gauges and a wind recorder were deployed during the cruises. Current meters were also regularly deployed and recovered inside the reef lagoon for Dr Jason Middleton of the University of New South Wales.

Fig. 1 shows the area of the study and depicts the standard sections which the Division hoped to occupy on the cruises, as well as the sites of the meters. This data report presents some of the data collected during the cruises. Not all of the cruises occupied the nominated sections and Table 1 gives the details for each cruise.

Table 1. Cruise details - for section positions see Fig. 1.

Cruise	Date	Sections Occupied 1	2	3	4	5	6	7	CH*	155°E †	Other
6/80	11/04-30/04 1980		x	x	x	x	x		x	x	1(a),1(b)
8/80	27/05-13/06 1980		x	x	x	x	x	x	x	x	
9/80	14/06-18/06 1980					x					
10/80	20/06-24/06 1980					x					
14/80	4/09-18/09 1980		x	x	x	x				x	6(a)
15/80	19/09- 4/10 1980					x	x	x	x		1(a)
16/80	5/11-19/11 1980	x	x	x	x	x	x		x		
17/80	20/11- 5/12 1980	x	x			x	x	x	x	x	
2/81	3/02-17/02 1981	x	x	x	x	x	x	x	x	x	
3/81	18/02- 2/03 1981	x				x	x		x	x	

*Refers to the Cape Hawke section (Pearce 1981).
†Refers to the section along 155°E between 32°S and 22°S.

Data Presentation

Bathymetry

Fig. 2 shows the bathymetry of each of the sections shown in Fig. 1. The data was digitised half hourly from a Raytheon PDR. Only the standard sections *1-7* are shown.

T_{250}

Fig. 3 gives the contours of temperature at 250 m (T_{250}) superimposed on the track-chart for each cruise. The tracks were often determined by the need to recover or deploy the current meters inside the lagoon.

T_{250} has traditionally been used as an index of surface geostrophic flow in the Tasman Sea (Hamon 1968). The correlation coefficient between T_{250} and the surface dynamic height is not as high in the Coral Sea as in the Tasman Sea (see appendix), and the usefulness of T_{250} as a surface flow indicator over the present latitude range is thereby lessened. However, ship's drift observations confirmed many of the major features shown on these charts.

Temperature Profiles

Figs 4-13 are the temperature profiles, to a depth of 540 m, of the sections shown in Fig. 3. Contours are given every 1°C and were drawn by computer from XBT, Niskin bottle and, occasionally, bathysonde data. Note that different horizontal scales have been used for the sections. They generally started at about the 200 m isobath which was close to the outer edge of the Great Barrier Reef.

Current Meter and Tide Gauge Data

Figs 14-16. During the series of cruises, current meter measurements were made on the shelf slope near Townsville (19°10'S, 147°23'E, Fig. 1) and inside the lagoon. Only the Townsville data is shown here. There were either one or two moorings each with two current meters. The shallower mooring was on the 300 m isobath with one meter 25 m from the bottom and the other 160 m above the bottom. The deeper mooring was on the 500 m isobath with one meter 25 m above the bottom and the other 200 m above the bottom. The moorings were slightly north of Section *5* and the projection of their offshore positions onto Section *5* are given on Fig. 2(e). The mooring recovery rate was high with only one current meter being lost when a swivel failed. However, the data return was poor. This was due mainly to the fact that a number of the older current meters leaked. A bar graph indicating when good data was obtained and giving meter serial numbers and reasons for meter failure is given in Fig. 14. All meters were Aanderaa RCM4 current meters.

The raw data contains a strong semi-diurnal tidal signal as well as the low frequency signal presented here. The raw data were smoothed with a low pass filter (half-power point at 0.3 cpd) to form hourly values and then Munk's filter (Hamon 1977) used to remove frequencies greater than 1 cpd. The resultant signal was decimated to one value every twelve hours and plotted as sticks indicating the low passed velocity (Fig. 15).

Tide gauges were maintained on the offshore reefs (Bougainville Reef (15°29.4'S, 147°05.8'E) and Flinders Reef (17°32.8'S, 148°32.7'E) (Fig. 1) as well as a joint CSIRO/AIMS* tide gauge at Myrmidon Reef (18°16'S, 147°23'E). The data from the offshore gauges was similarly low passed to form hourly and twelve hourly values. The record from the Flinders Reef gauge was complete but the Bougainville Reef tide gauge failed after approximately 100 days. The twelve-hourly depth and temperature signal from both of these gauges are presented in Fig. 16.

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*Australian Institute of Marine Science

Wind Data

Fig. 17 is stick diagrams of raw hourly wind data from the wind recorder located at Carter Reef near Lizard Island (14°32'S, 145°34'E) (see Fig. 1). The recorder was an Aanderaa DL-1 datalogger with wind direction and speed sensors. The speed sensor logged both the average wind speed and maximum gust during the one hourly sampling interval. The maximum gusts are shown above the stick diagrams. The data are presented in roughly two month segments. However, the recorder was serviced at varying intervals and a total of four records were obtained. The recorder failed finally on 5 April 1981. (Note the cyclone recorded between 10-14 February).

Acknowledgments

We gratefully acknowledge the assistance of the Captain and crew of R.V. 'Sprightly', the cruise leaders who collected the data and Dr B. Goldman of the Lizard Island Research Station who serviced the datalogger on the Station's platform at Carter Reef.

References

Hamon, B.V. (1968). Temperature structure in the upper 250 metres in the East Australian Current area. *Australian Journal of Marine and Freshwater Research* **19**, 91-99.

Hamon, B.V. (1977). The spectrum of sea level at Sydney. *CSIRO Division of Fisheries and Oceanography Report* **80**.

Pearce, A. (1981). Temperature-salinity relationships in the Tasman Sea. *CSIRO Division of Fisheries and Oceanography Report* **135**.

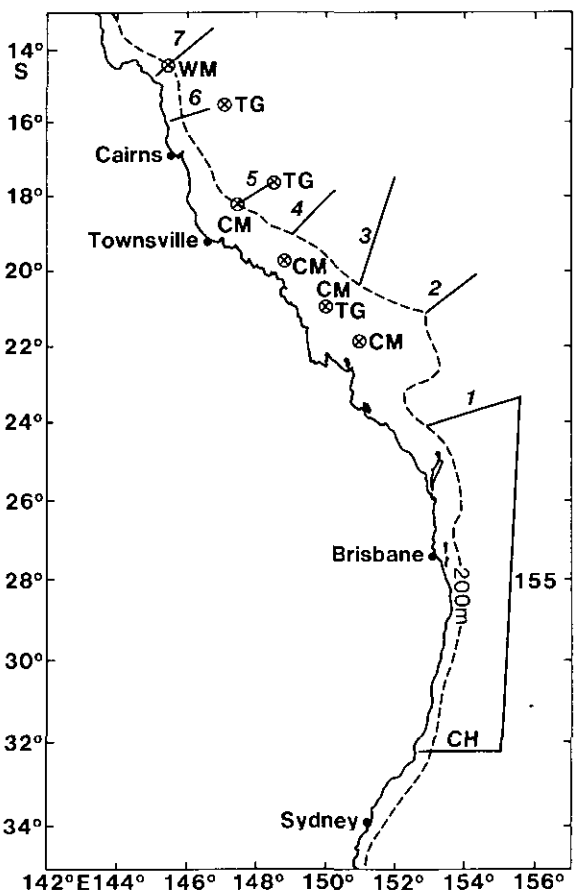


Fig. 1. The locations of the major Sections *1-7*, Cape Hawke (CH) and 155°E occupied during the Western Coral Sea cruises. CM is the location of the current meters. WM is the location of the meteorological data logger. TG shows the location of the tide gauges.

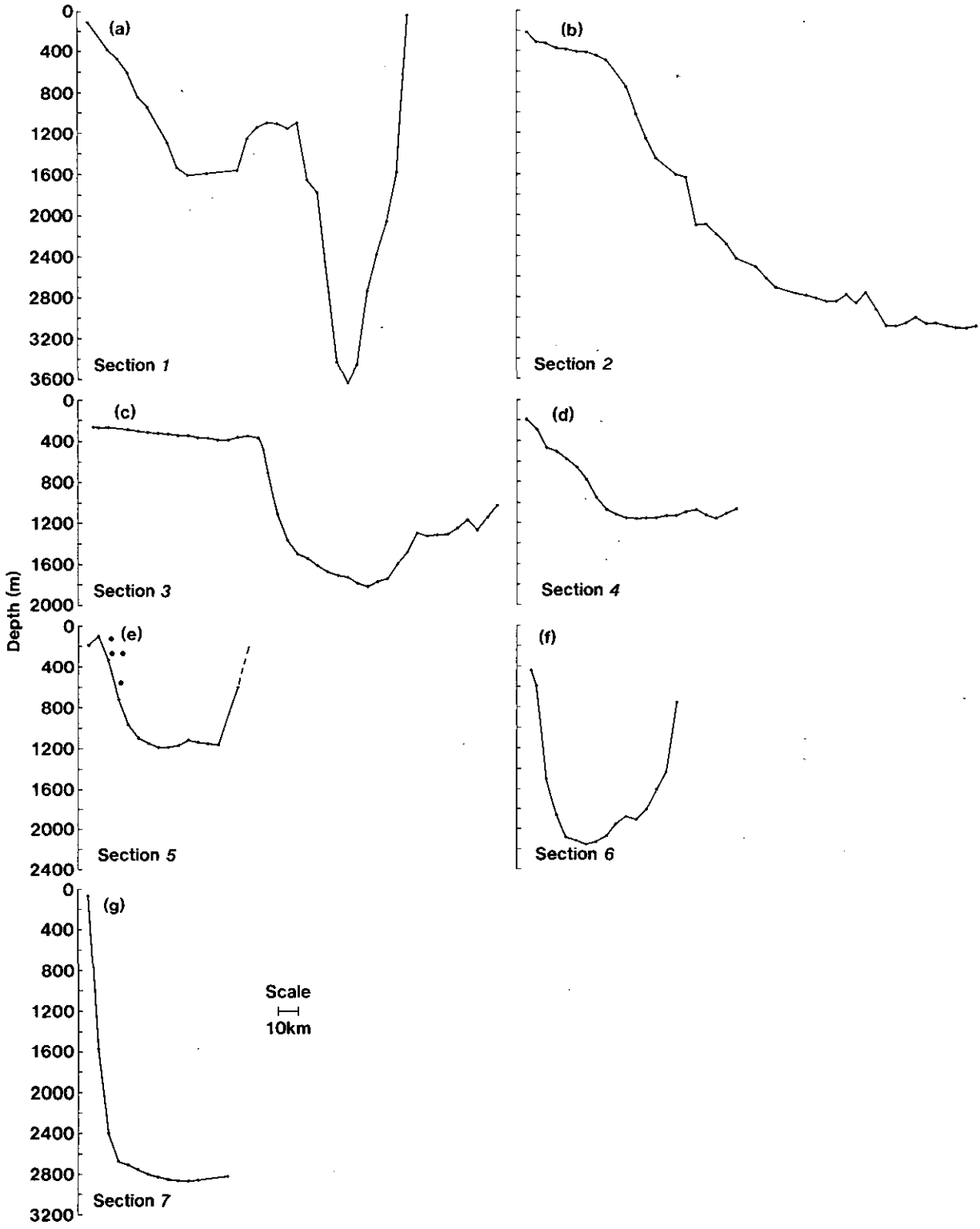


Fig. 2. The bathymetry of Sections *1-7* (a to g respectively) starting from the shelf break (approx 200 m). The positions of the current meters are shown on 2 (e).

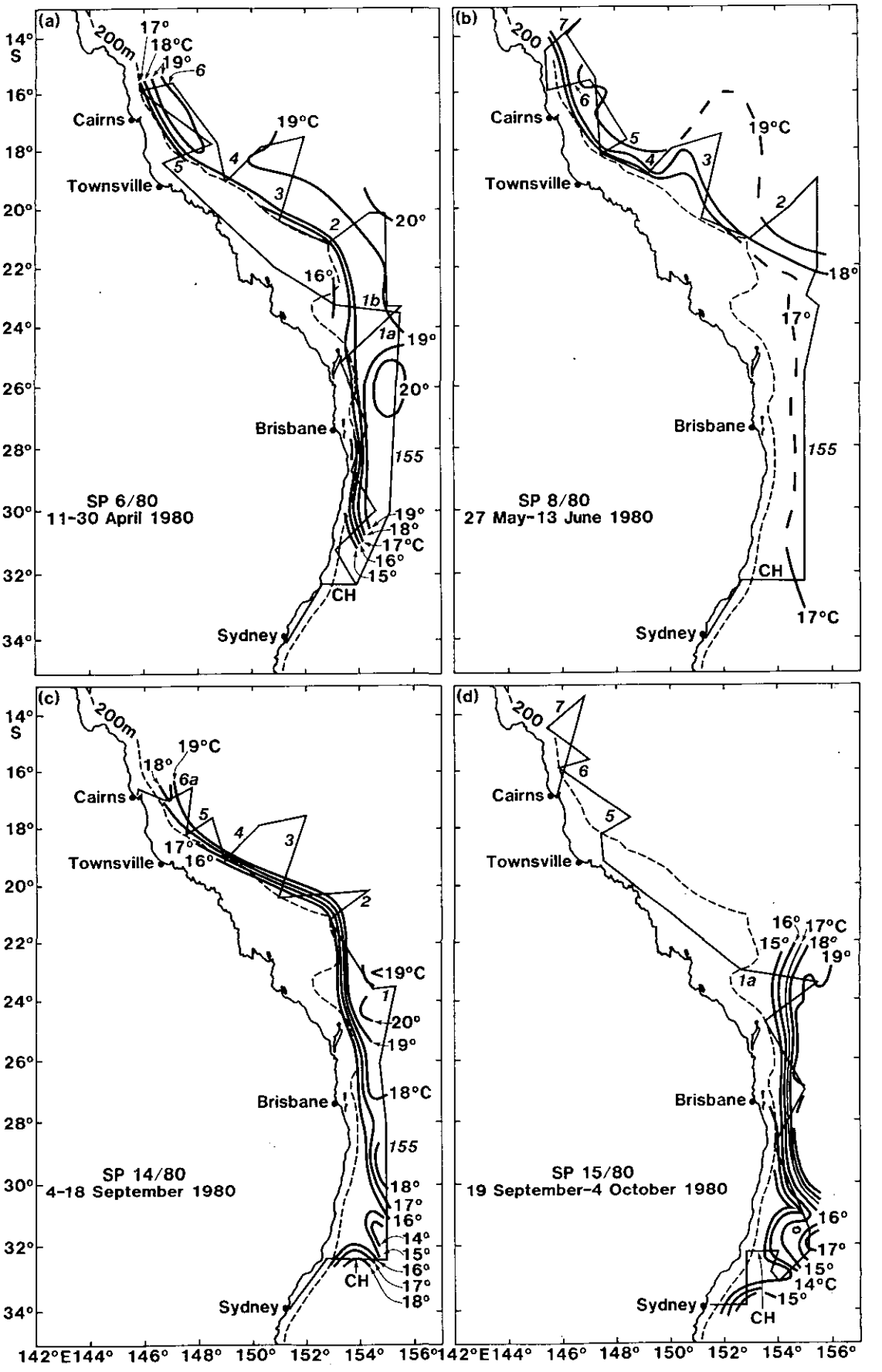
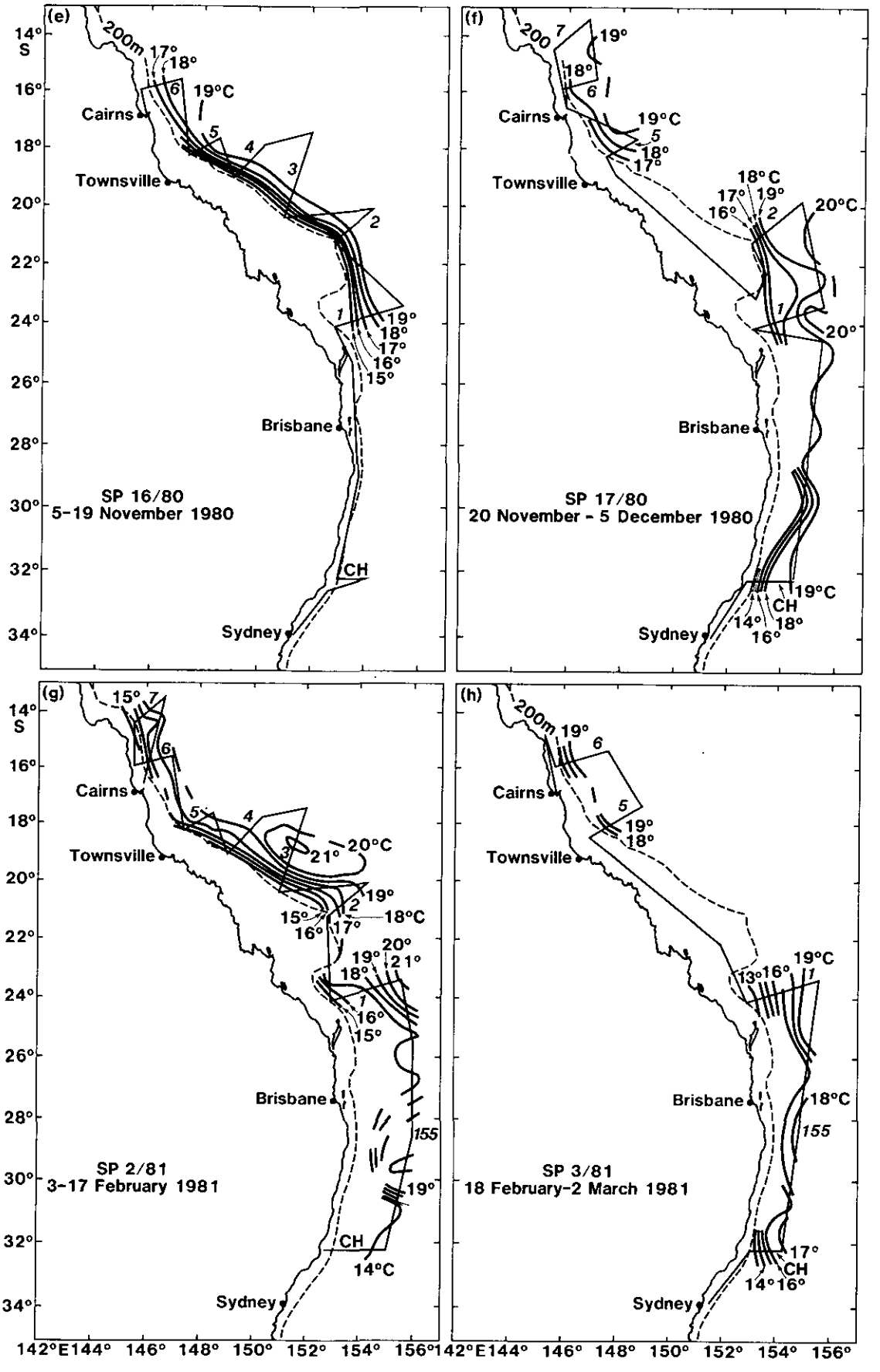


Fig. 3(a)-(h). Cruise tracks and T_{250} contours for cruises (a) SP6/80, (b) SP8/80, (c) SP14/80, (d) SP15/80, (e) SP16/80, (f) SP17/80, (g) SP2/81, (h) SP3/81. Sections occupied are marked according to the convention used in Table 1.


(e)
200m
17°
18°
19°C
Cairns
Townsville
Brisbane
Sydney
CH
SP 16/80
5-19 November 1980
(f)
200
19°
18°
19°C
17°
18°C
16°
20°C
20°
SP 17/80
20 November - 5 December 1980
14°
18°
(g)
15°
21°
20°C
18°C
155
14°C
SP 2/81
3-17 February 1981
(h)
13°
SP 3/81
18 February-2 March 1981
14°S
16°
18°
20°
22°
24°
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30°
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142°E
144°
146°
148°
150°
152°
154°
156°

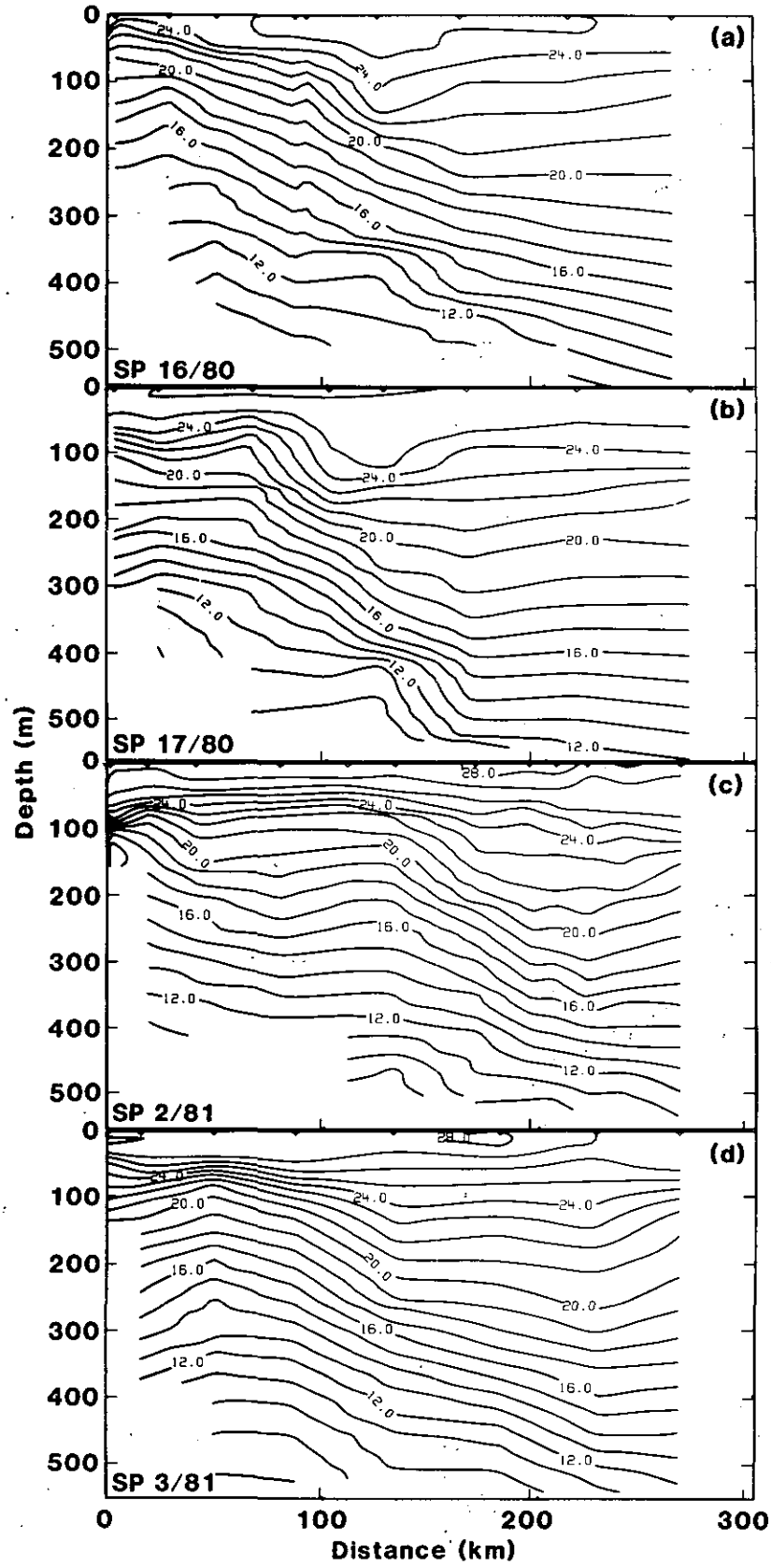


Fig. 4(a)-(d). Temperature sections (°C) for Section *1* occupied during cruises (a) SP16/80, (b) SP17/80, (c) SP2/81, (d) SP3/81.

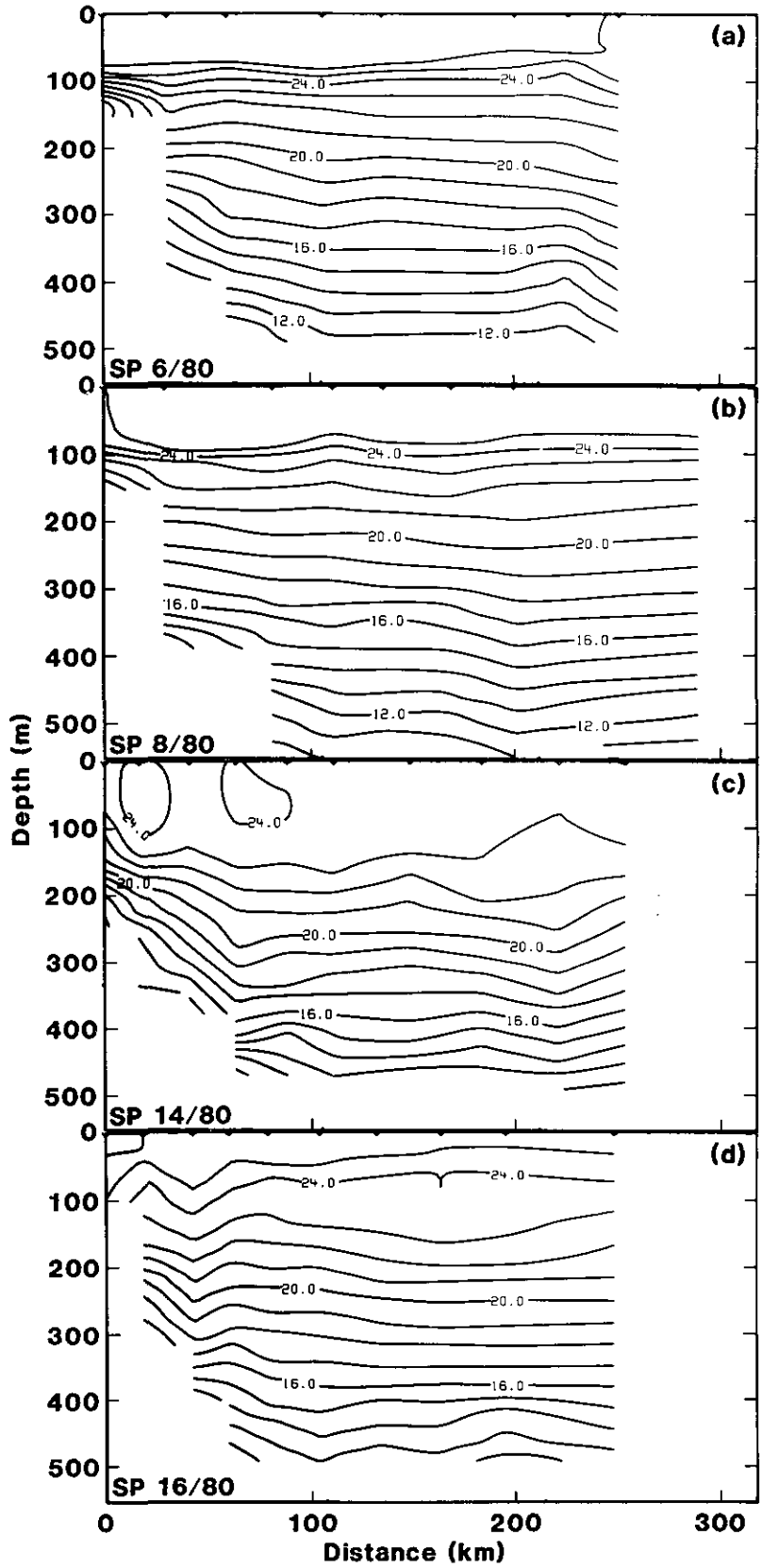


Fig. 5(a)-(f). Temperature sections (°C) for Section *2* occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP14/80, (d) SP16/80, (e) SP17/80, (f) SP2/81.

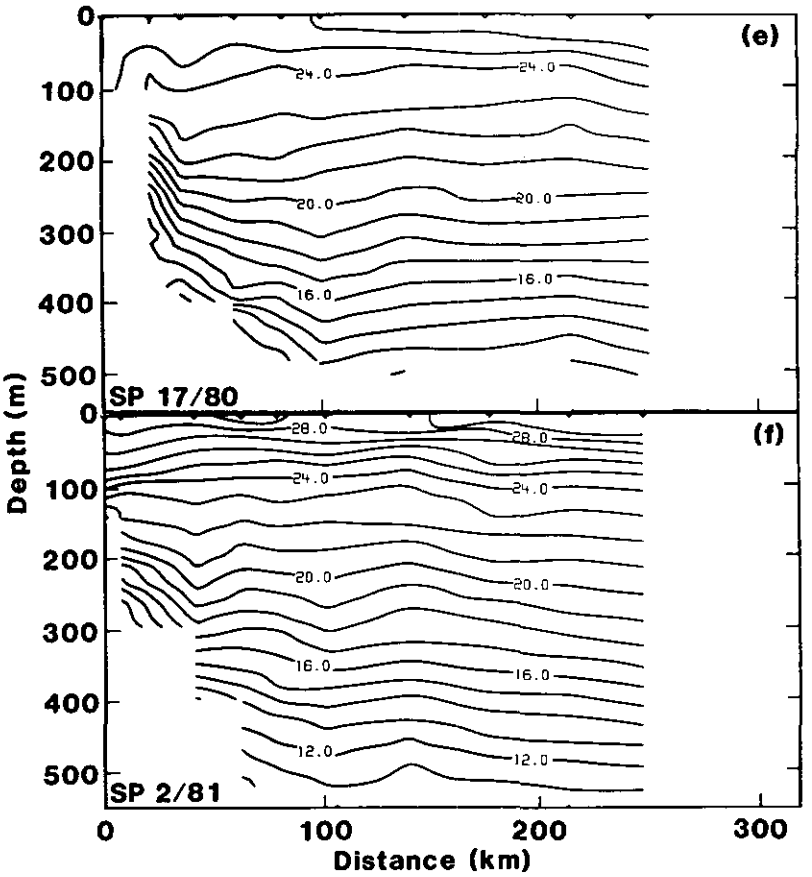


Fig. 5 (continued).

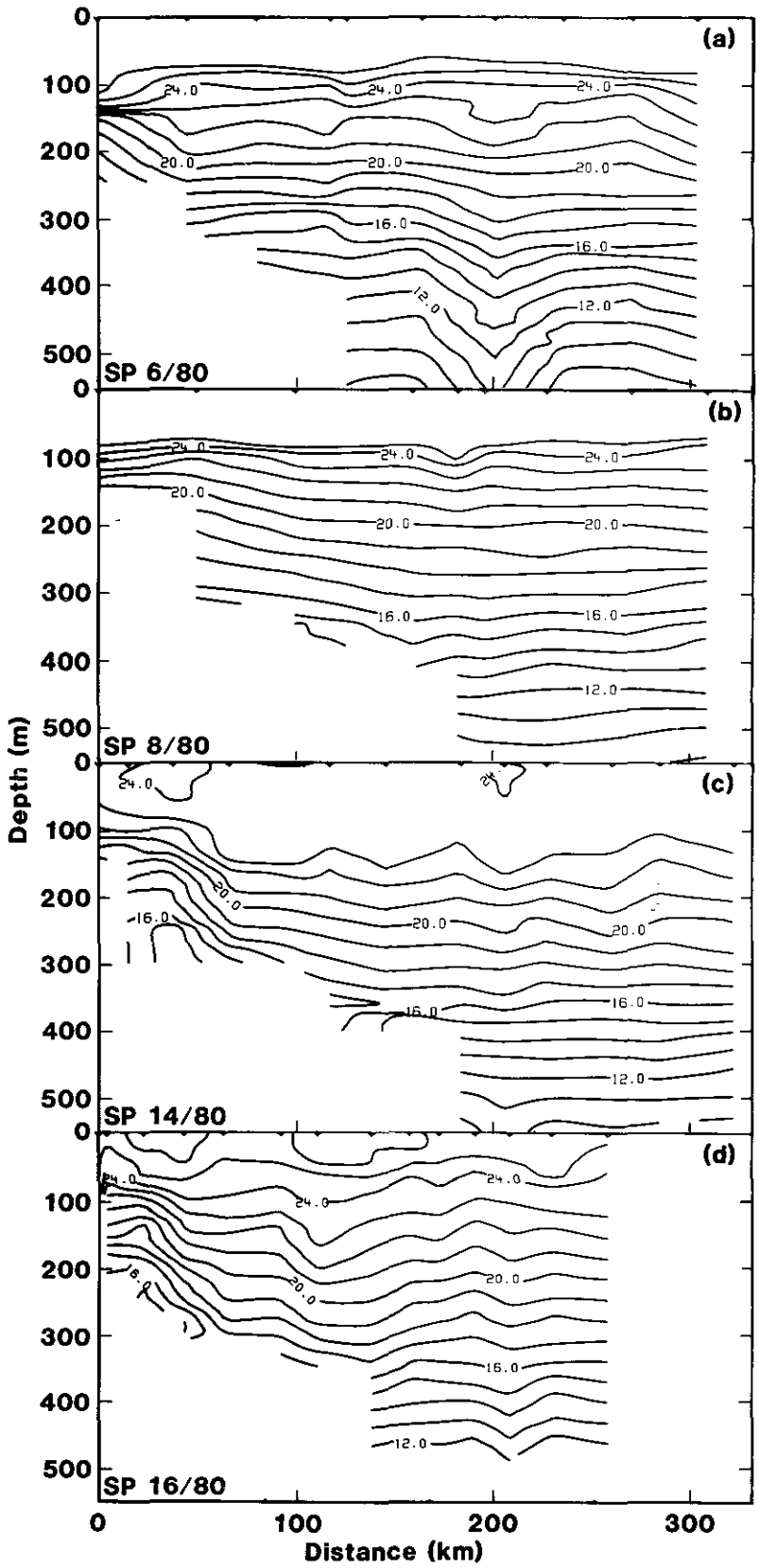


Fig. 6(a)-(e). Temperature sections (°C) for Section 3 occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP14/80, (d) SP16/80, (e) SP2/81.

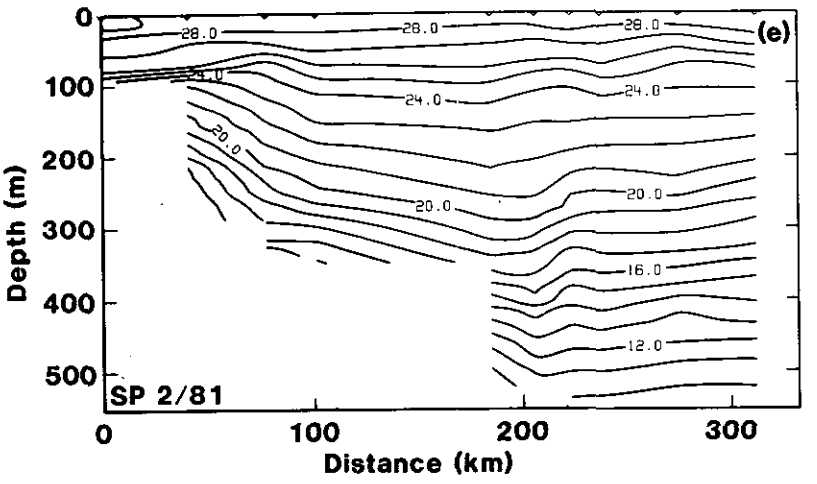


Fig. 6 (continued).

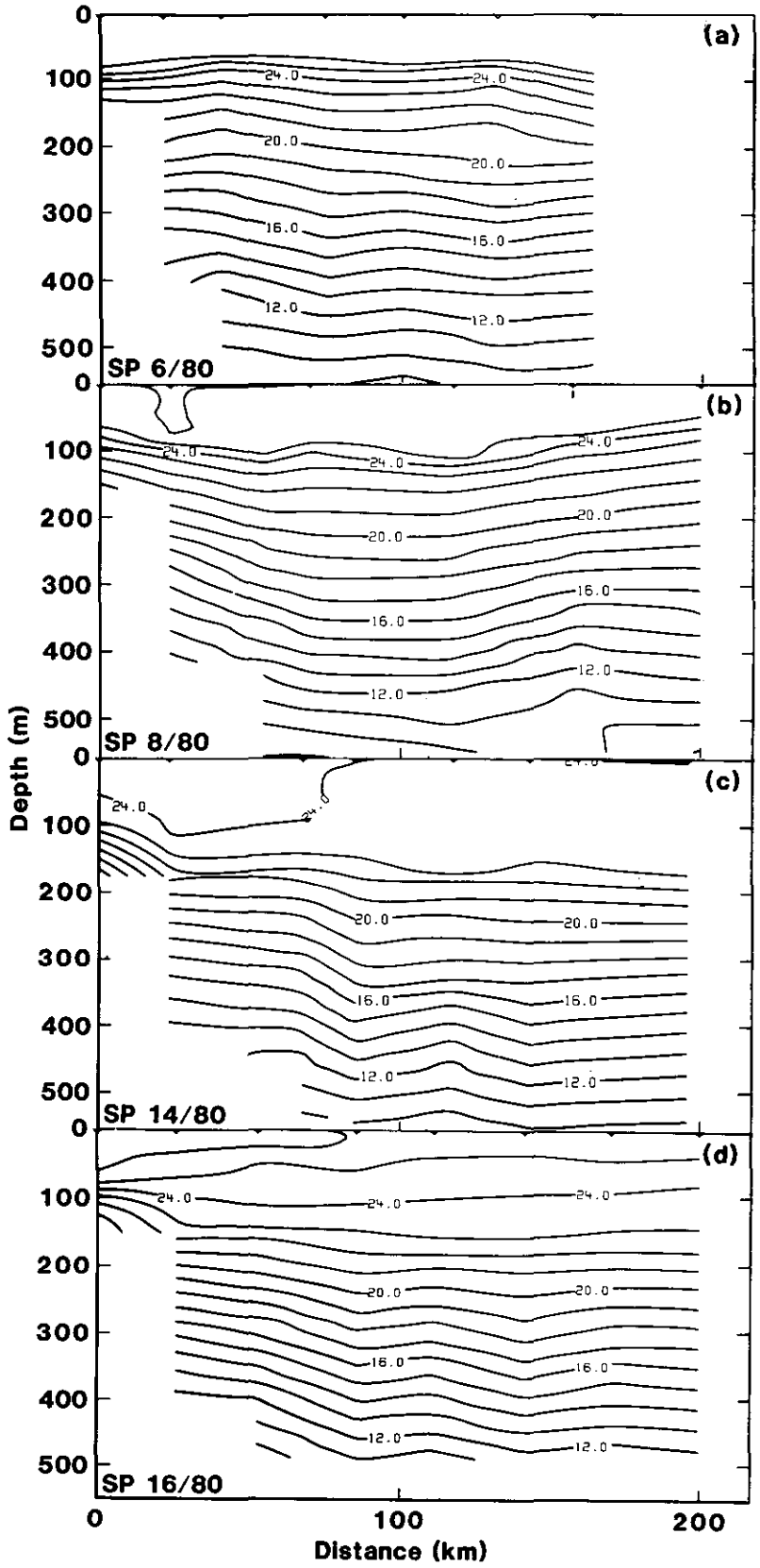


Fig. 7(a)-(e). Temperature sections (°C) for Section *4* occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP14/80, (d) SP16/80, (e) SP2/81.

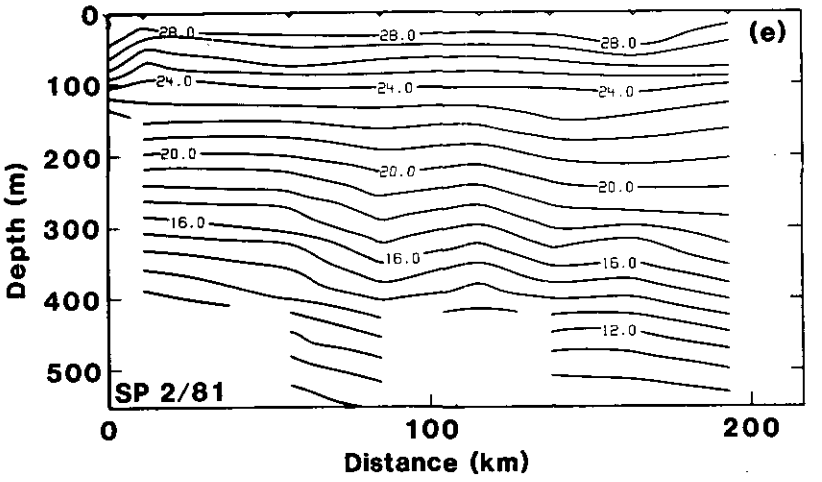


Fig. 7 (continued).

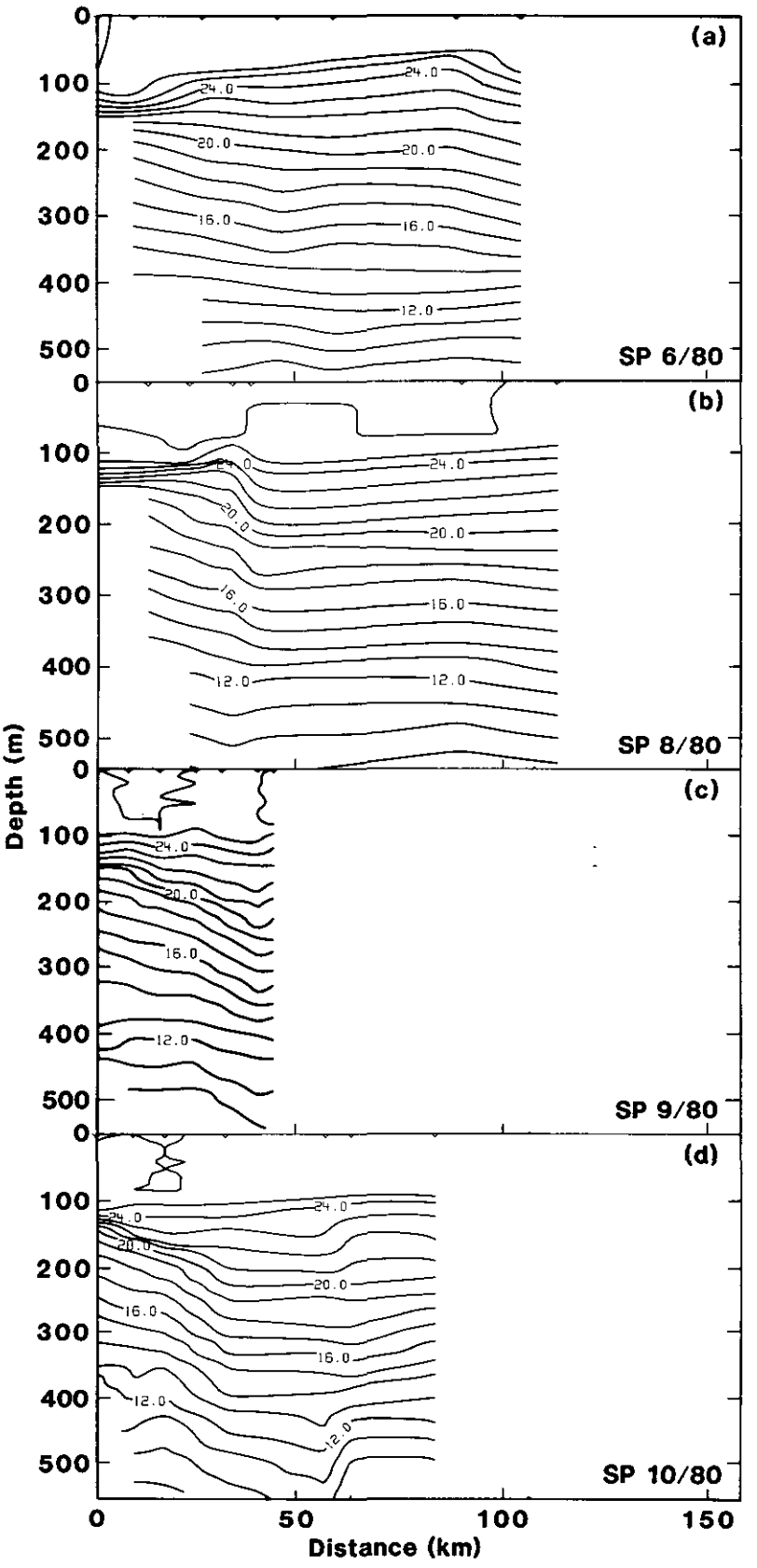


Fig. 8(a)-(j). Temperature sections (°C) for Section 5 occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP9/80, (d) SP10/80, (e) SP14/80, (f) SP15/80, (g) SP16/80, (h) SP17/80, (i) SP2/81, (j) SP3/81.

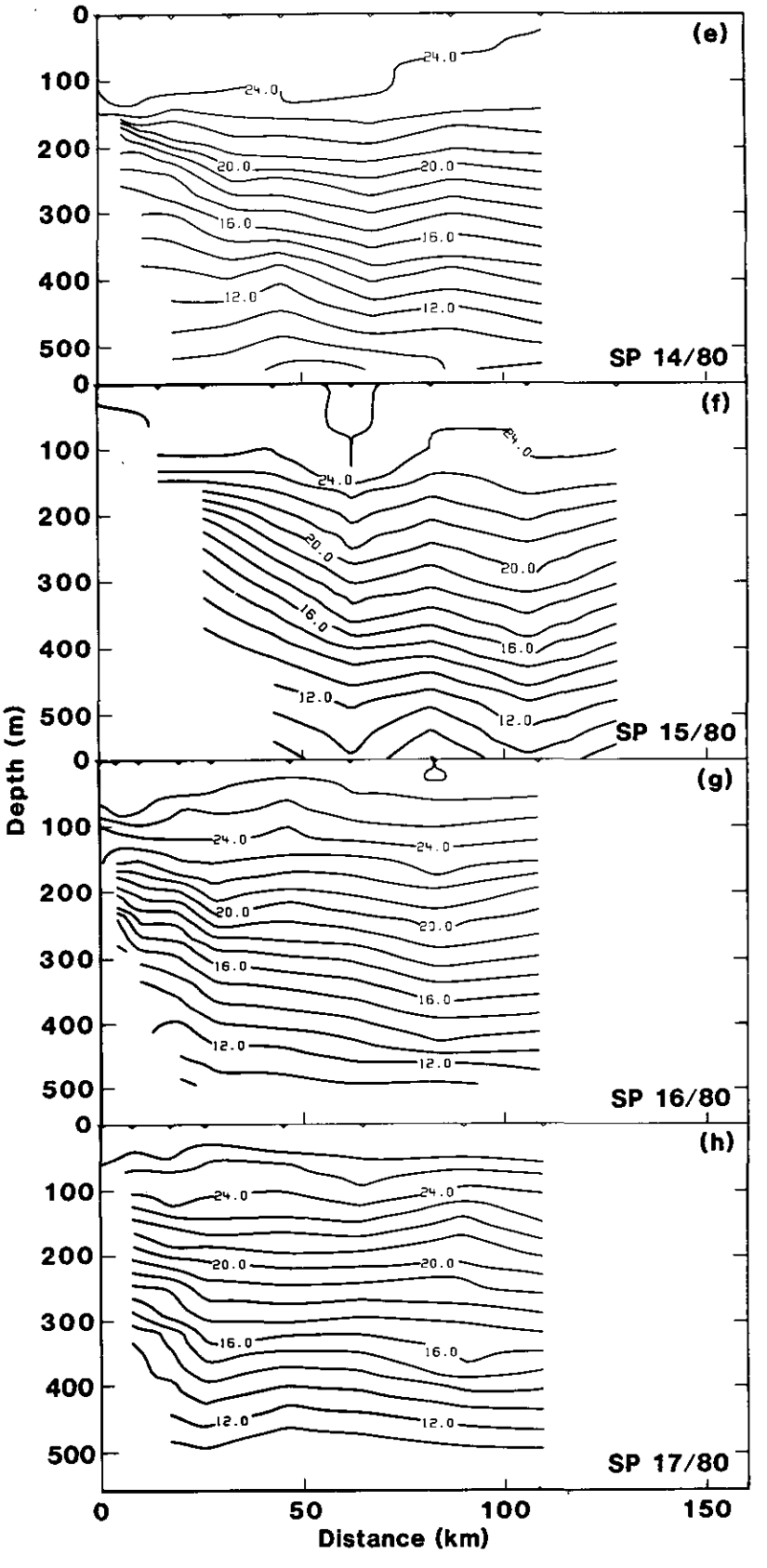


Fig. 8 (continued).

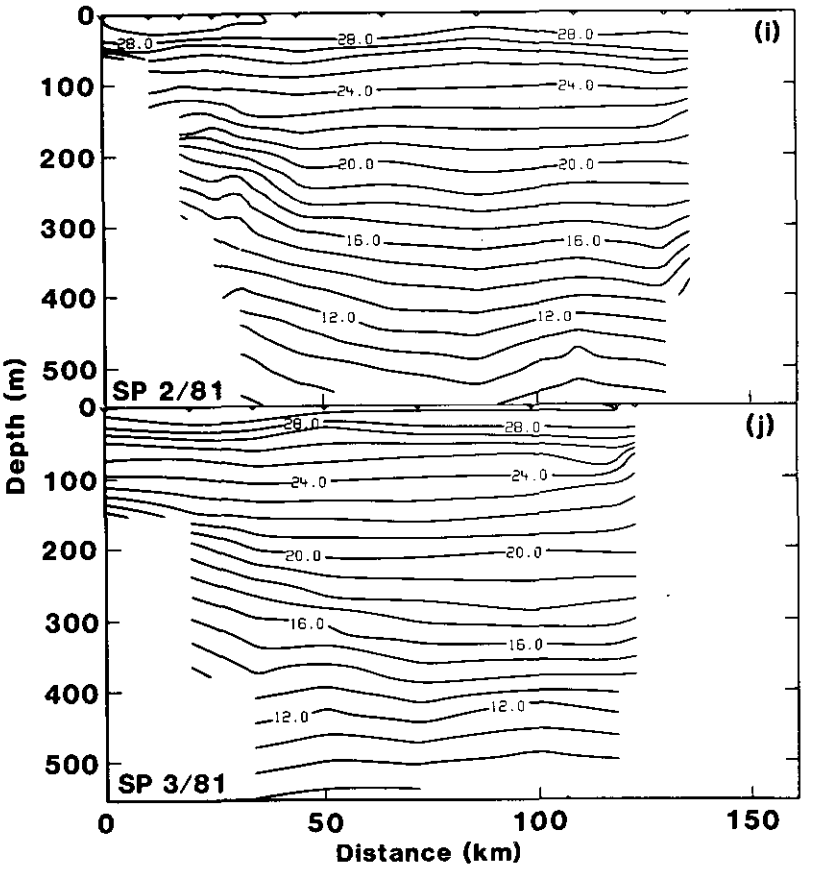


Fig. 8 (continued).

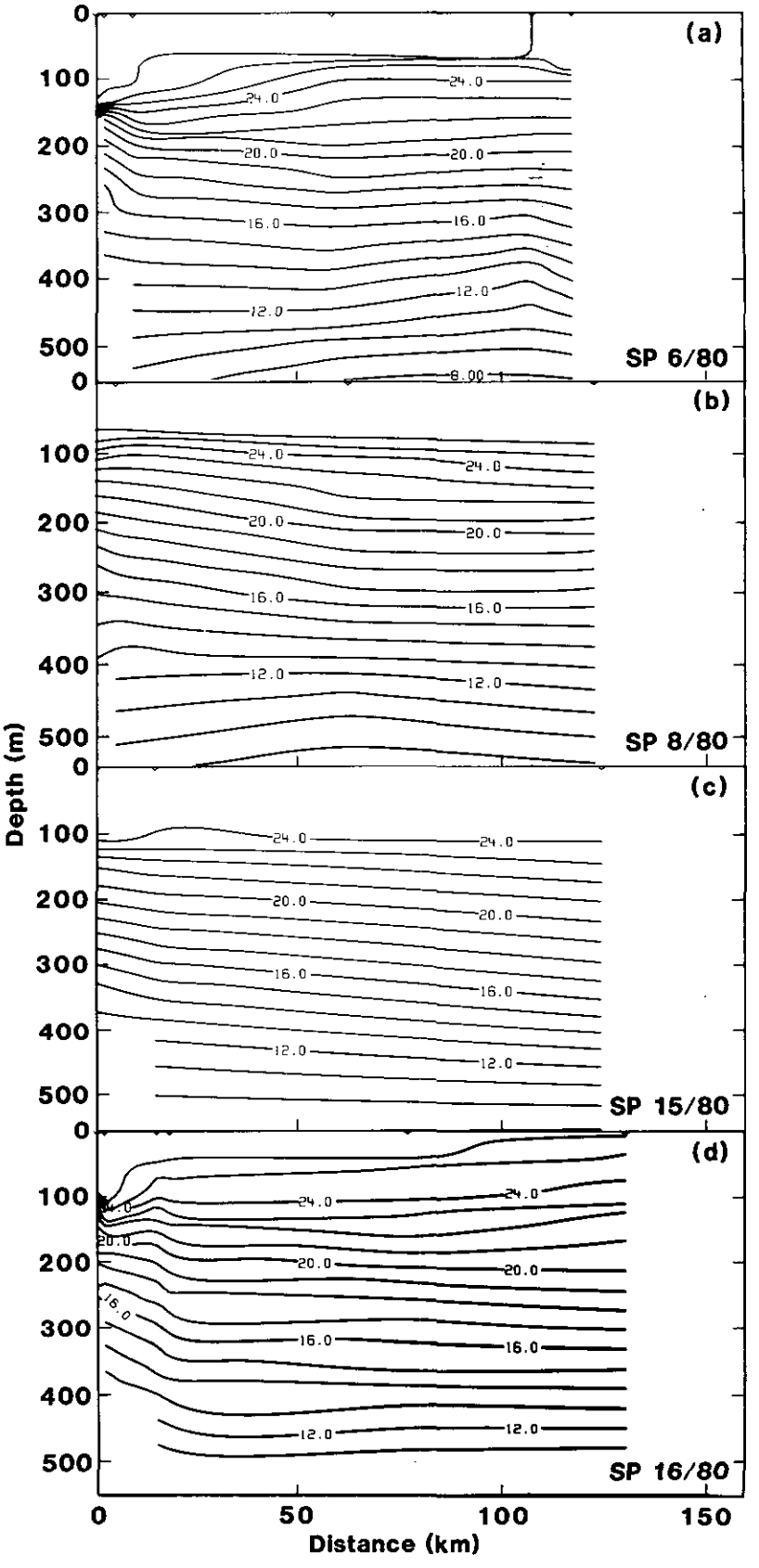
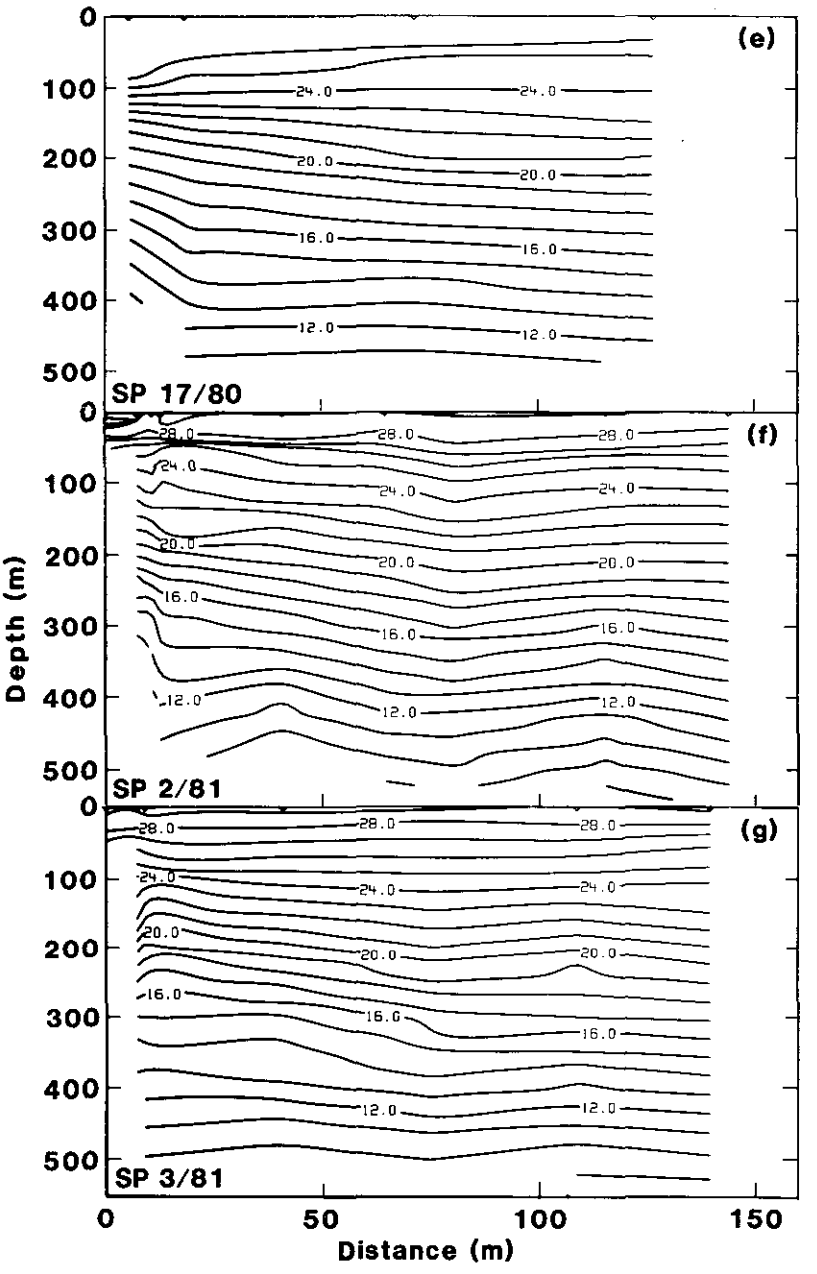


Fig. 9(a)-(g). Temperature sections (°C) for Section *6* occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP15/80, (d) SP16/80, (e) SP17/80, (f) SP2/81, (g) SP3/81.


(e)
(f)
(g)
SP 17/80
SP 2/81
SP 3/81
Depth (m)
Distance (m)
0
100
200
300
400
500
50
150
24.0
20.0
16.0
12.0
28.0

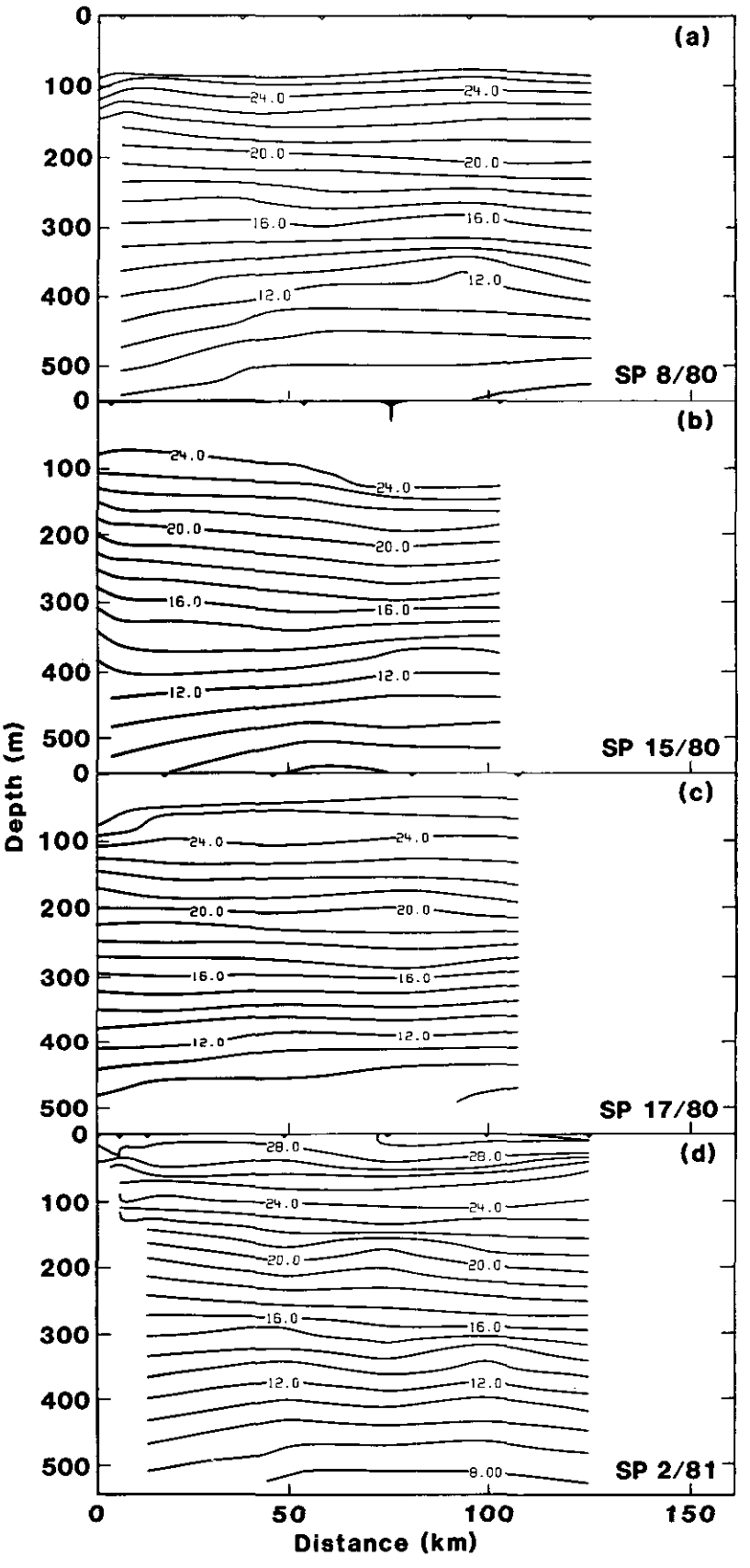


Fig. 10(a)-(d). Temperature sections (°C) for Section 7 occupied during cruises (a) SP8/80, (b) SP15/80, (c) SP17/80, (d) SP2/81.

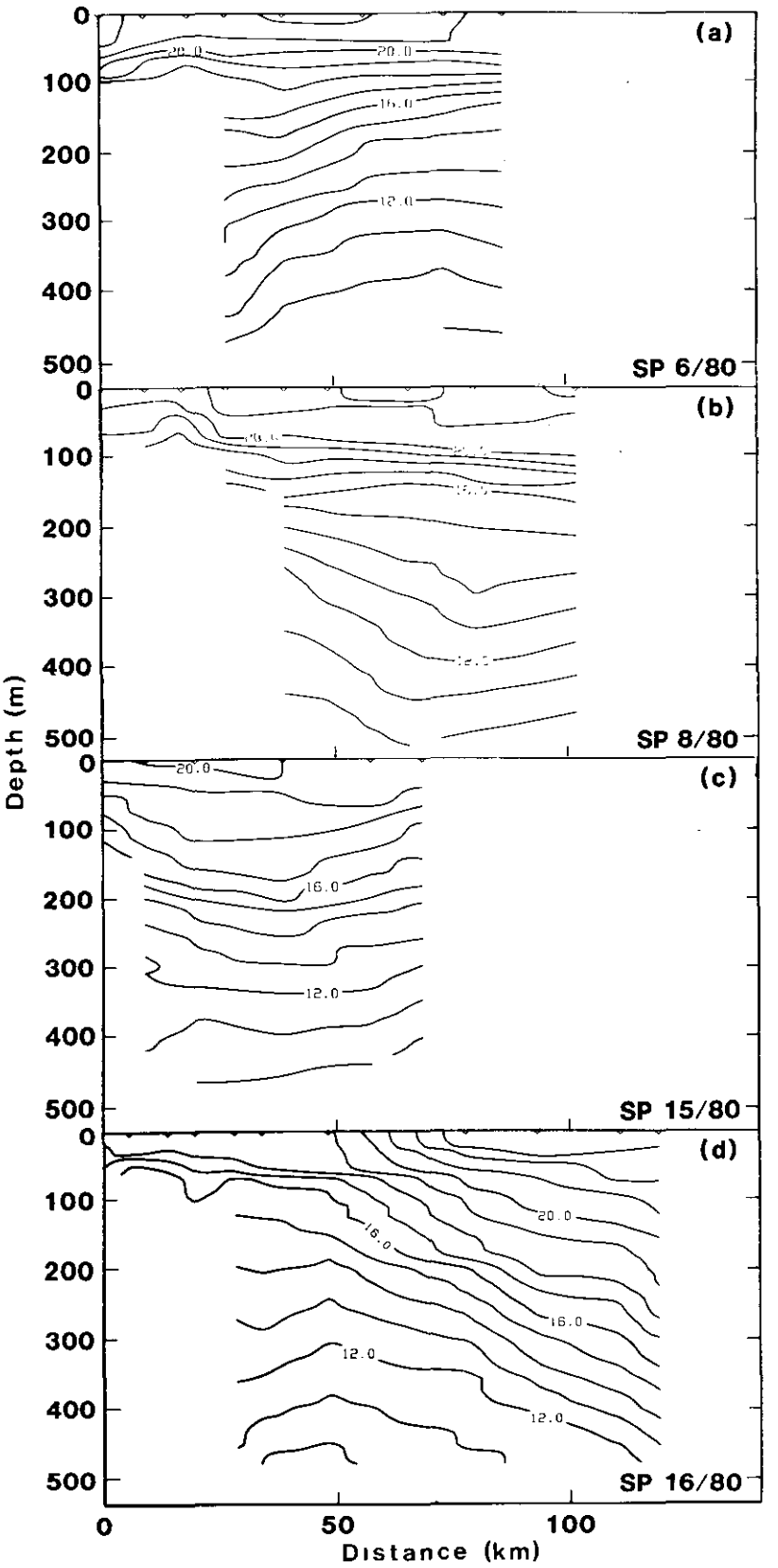


Fig. 11(a)-(g). Temperature sections (°C) for Cape Hawke section occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP15/80, (d) SP16/80, (e) SP17/80, (f) SP2/81, (g) SP3/81.

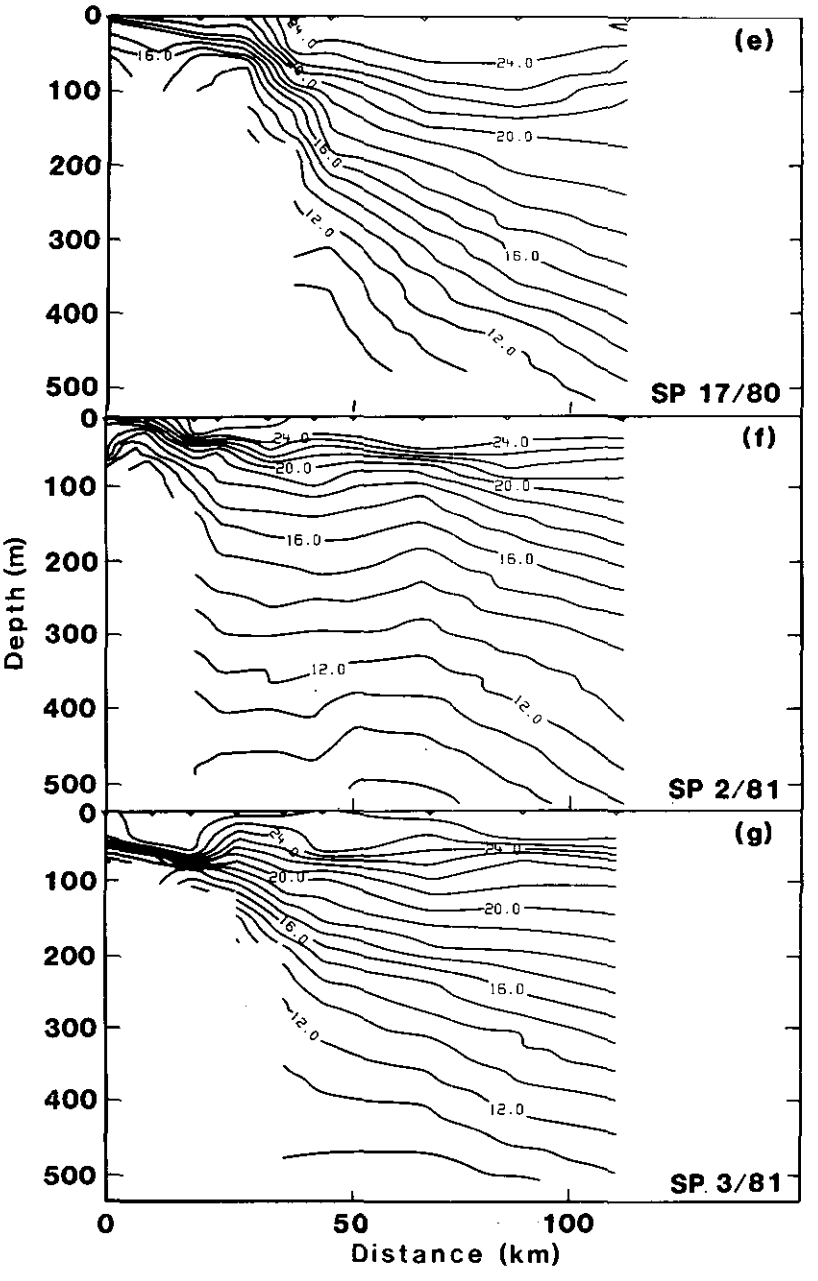


Fig. 11 (continued).

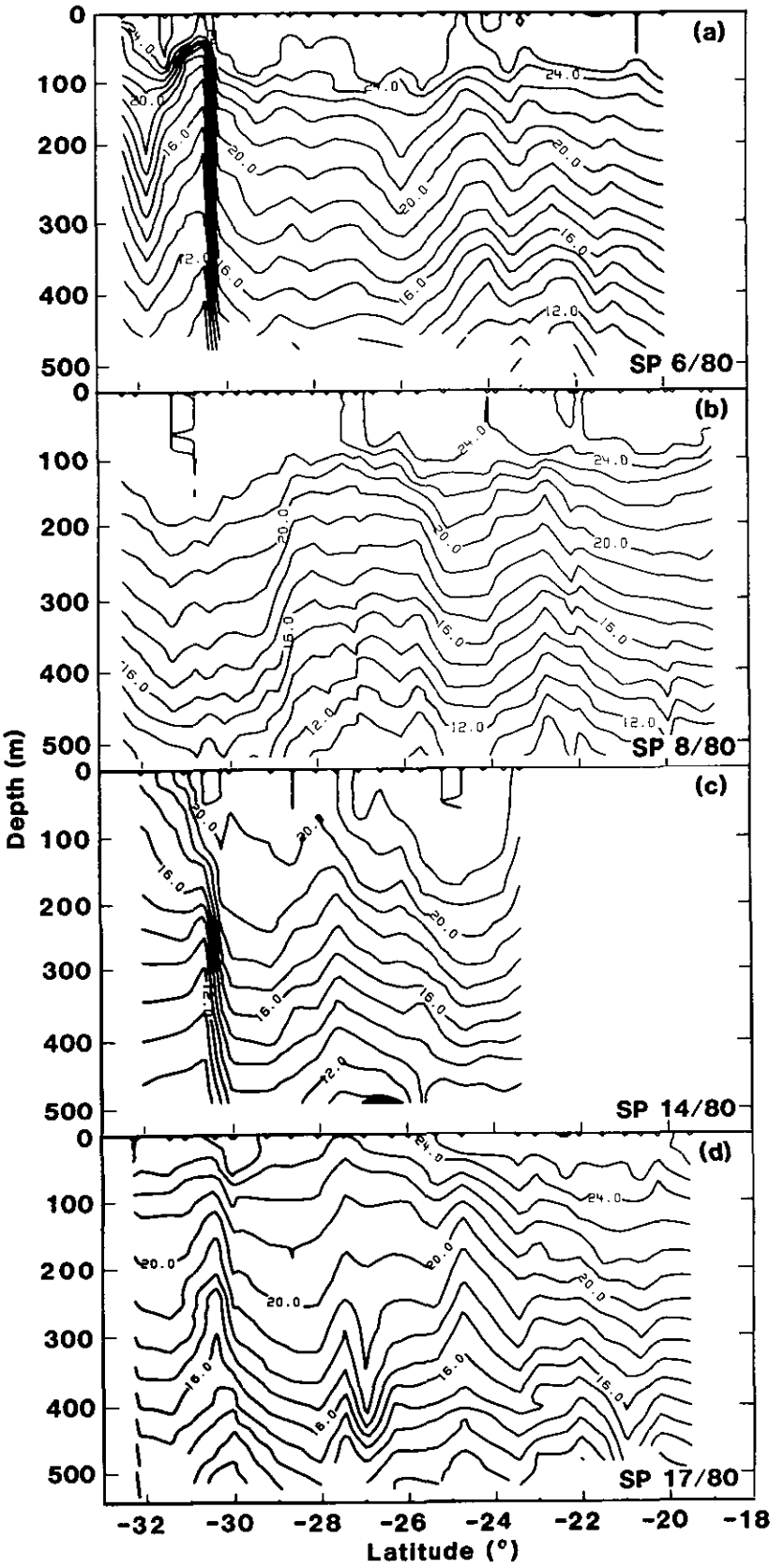


Fig. 12(a)-(f). Temperature sections (°C) for 155°E section occupied during cruises (a) SP6/80, (b) SP8/80, (c) SP14/80, (d) SP17/80, (e) SP2/81, (f) SP3/81.

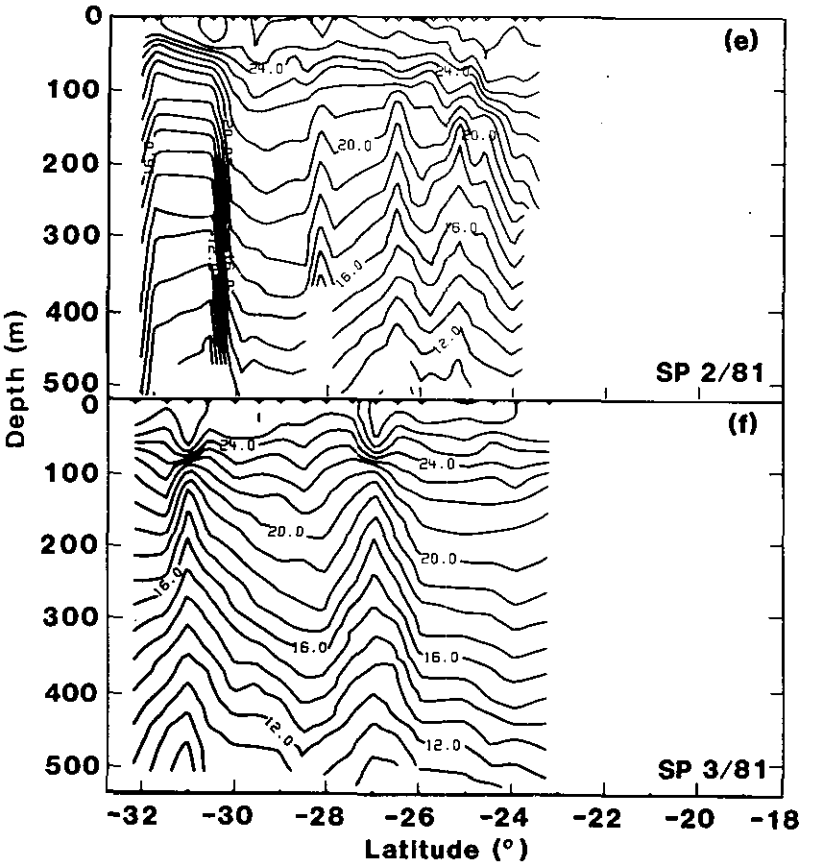


Fig. 12 (continued).

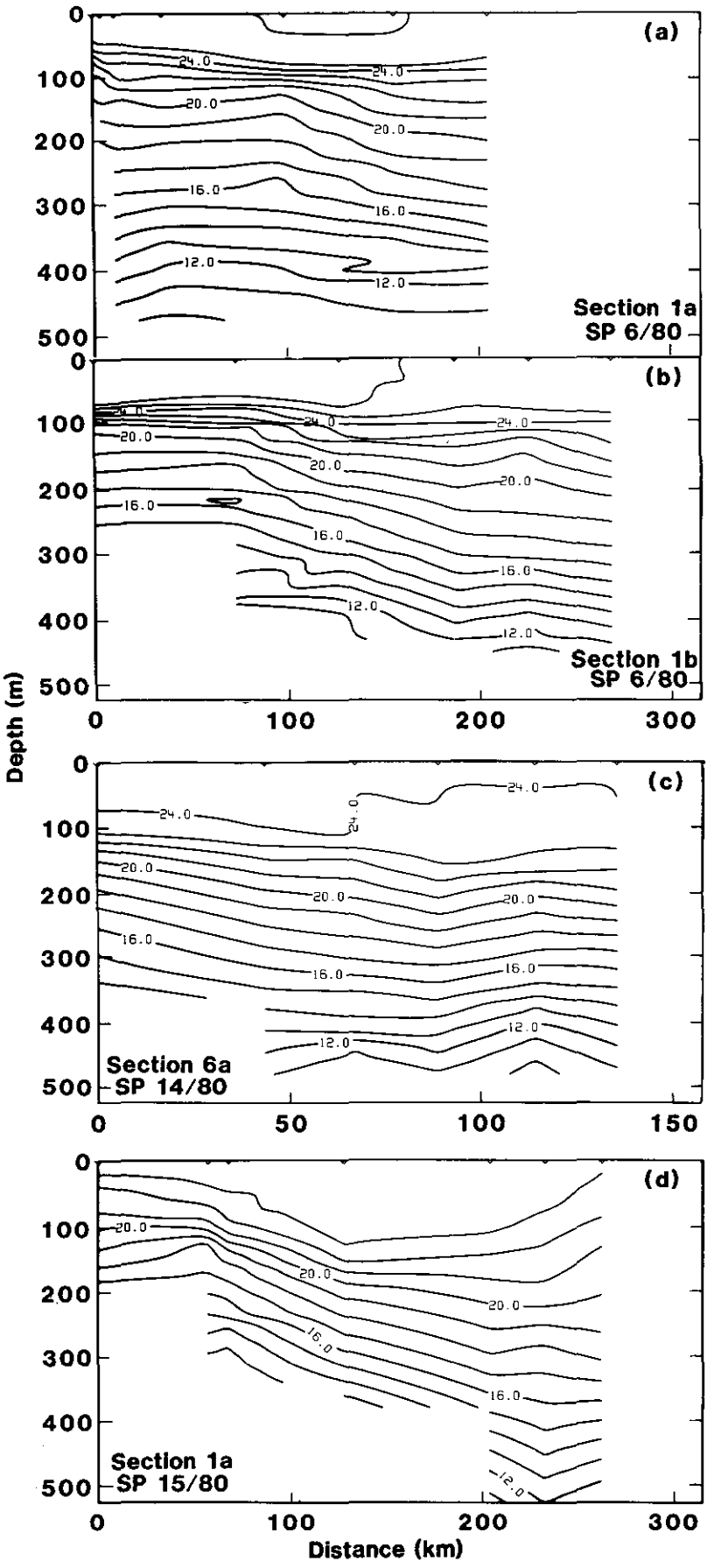


Fig. 13(a)-(d). Temperature sections (°C) for (a) Section *1(a)* occupied during cruise SP6/80, (b) Section *1(b)* occupied during cruise SP6/80, (c) Section *6(a)* occupied during cruise SP14/80, (d) Section *1(a)* occupied during cruise SP15/80.

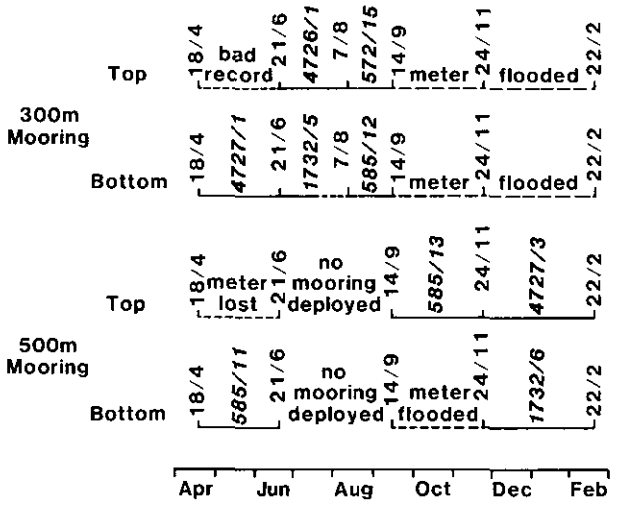


Fig. 14. Bar graph for current meter records. A solid line indicates a good record while a dotted line represents a meter deployed but no data obtained. The reasons for failure to acquire a record and the meter serial numbers are also given.

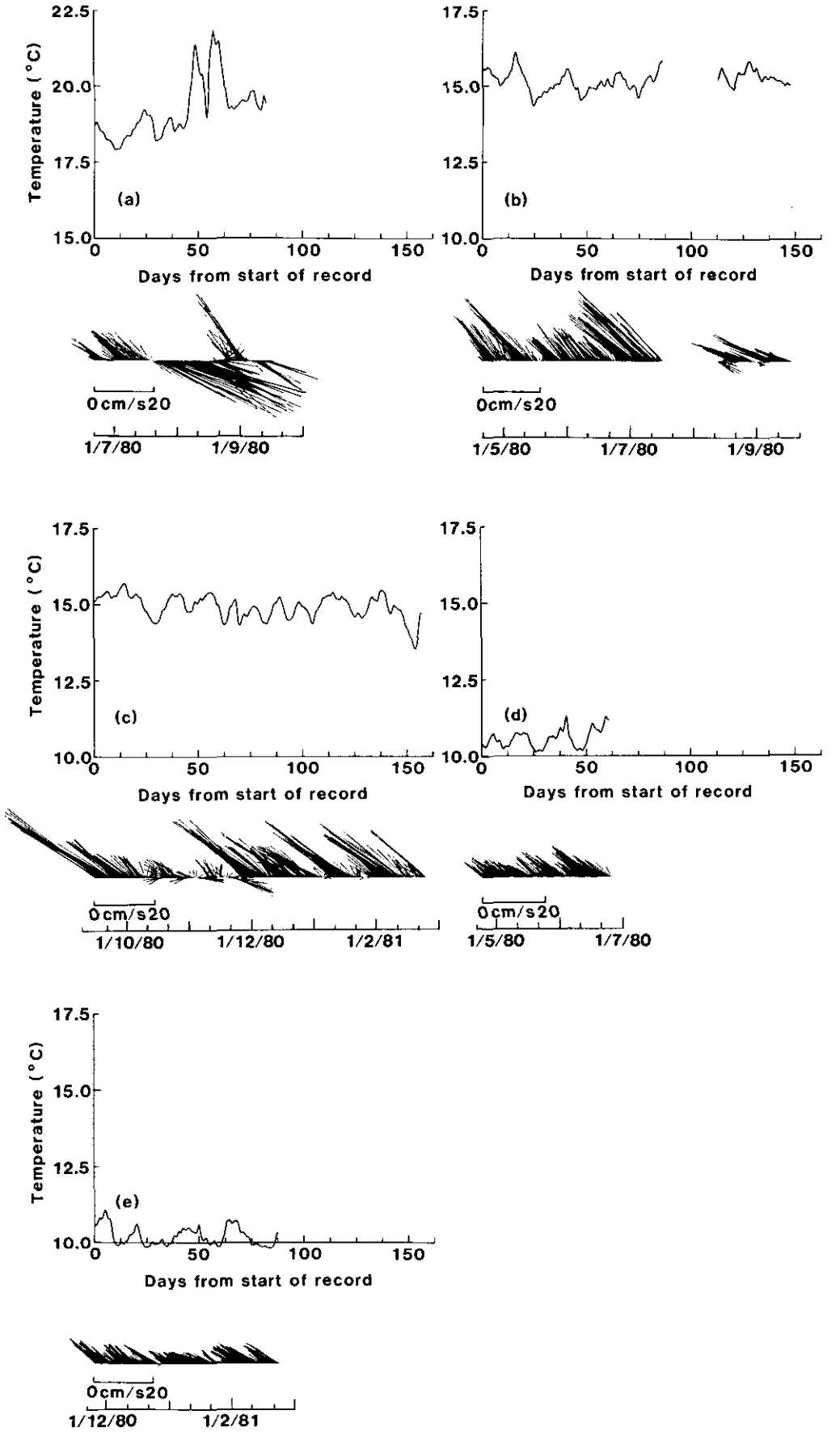


Fig. 15. Low passed currents and temperatures for (a) the 300 m mooring and top current meter, (b) the 300 m mooring and bottom current meter, (c) the 500 m mooring top current meter, (d) the 500 m mooring bottom current meter (No. 585/11), (e) the 500 m mooring bottom current meter (No. 1732/6).

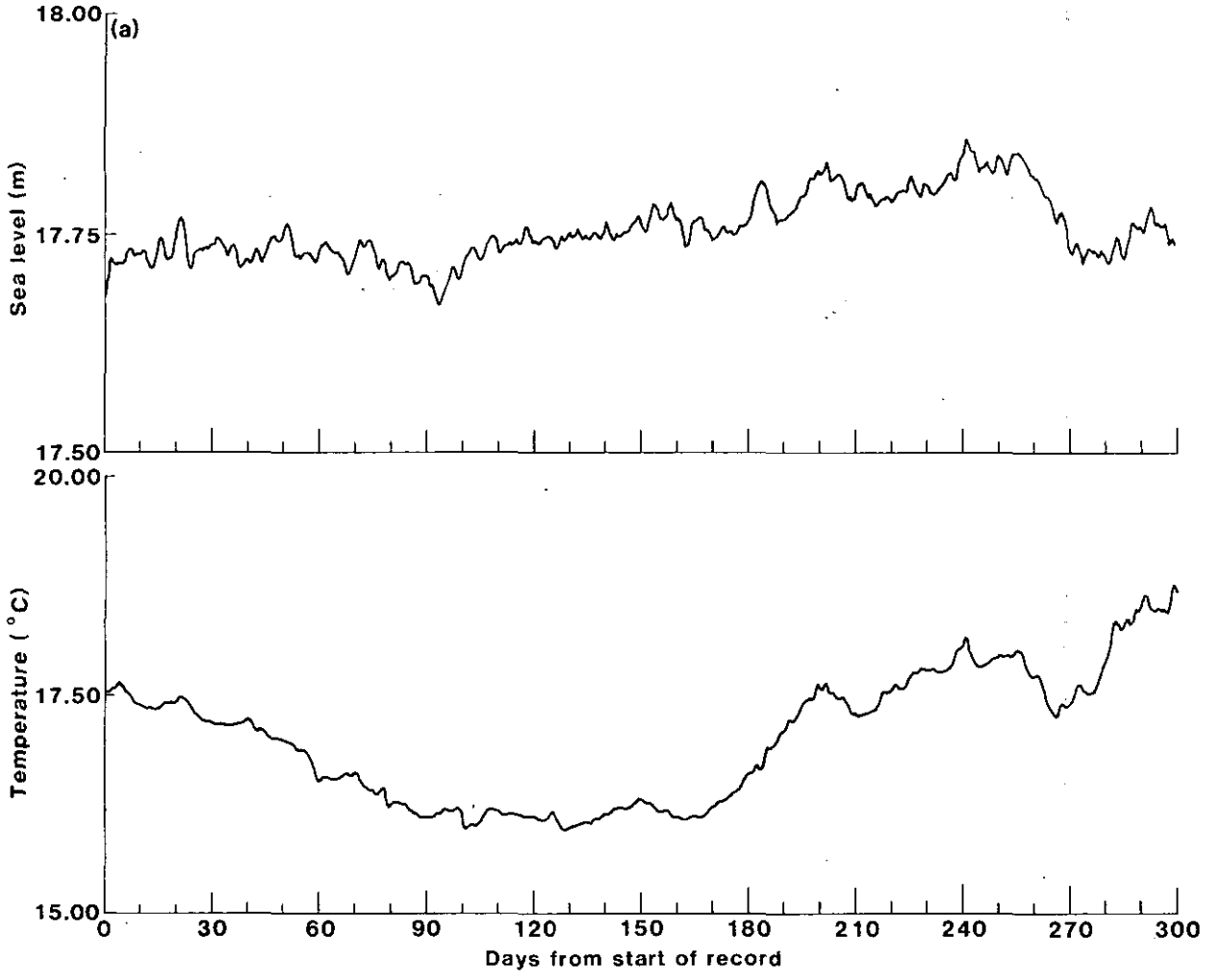


Fig. 16(a). Low passed sea level and temperature recorded by the Flinders Reef (17°32.8'S, 148°32.7'E) tide gauge, commencing 23 April 1981.

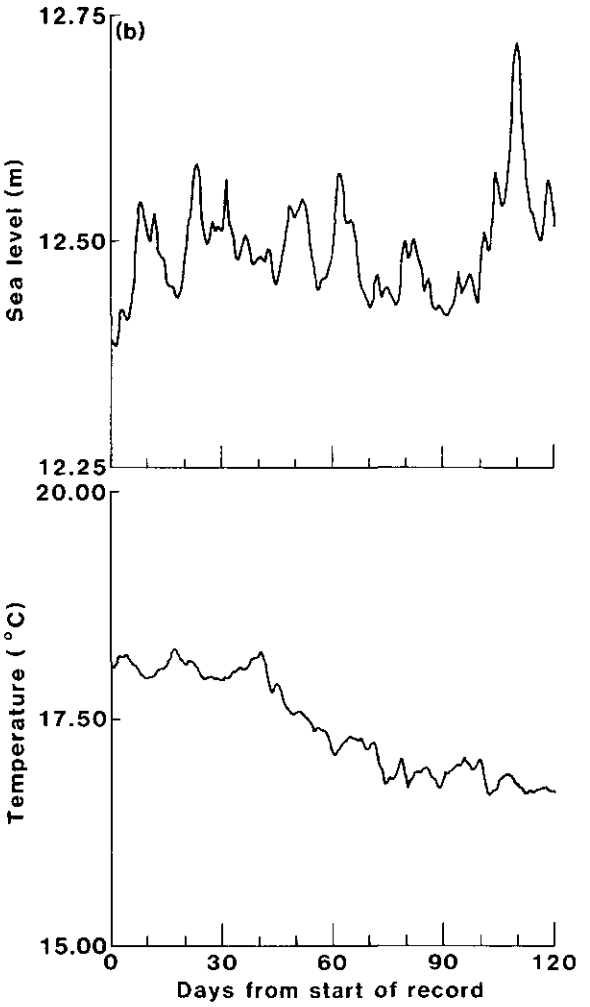


Fig. 16(b). Low passed sea level and temperature recorded by the Bougainville Reef (15°29.4'S, 147°05.8'E) tide gauge, commencing 22 April 1981.

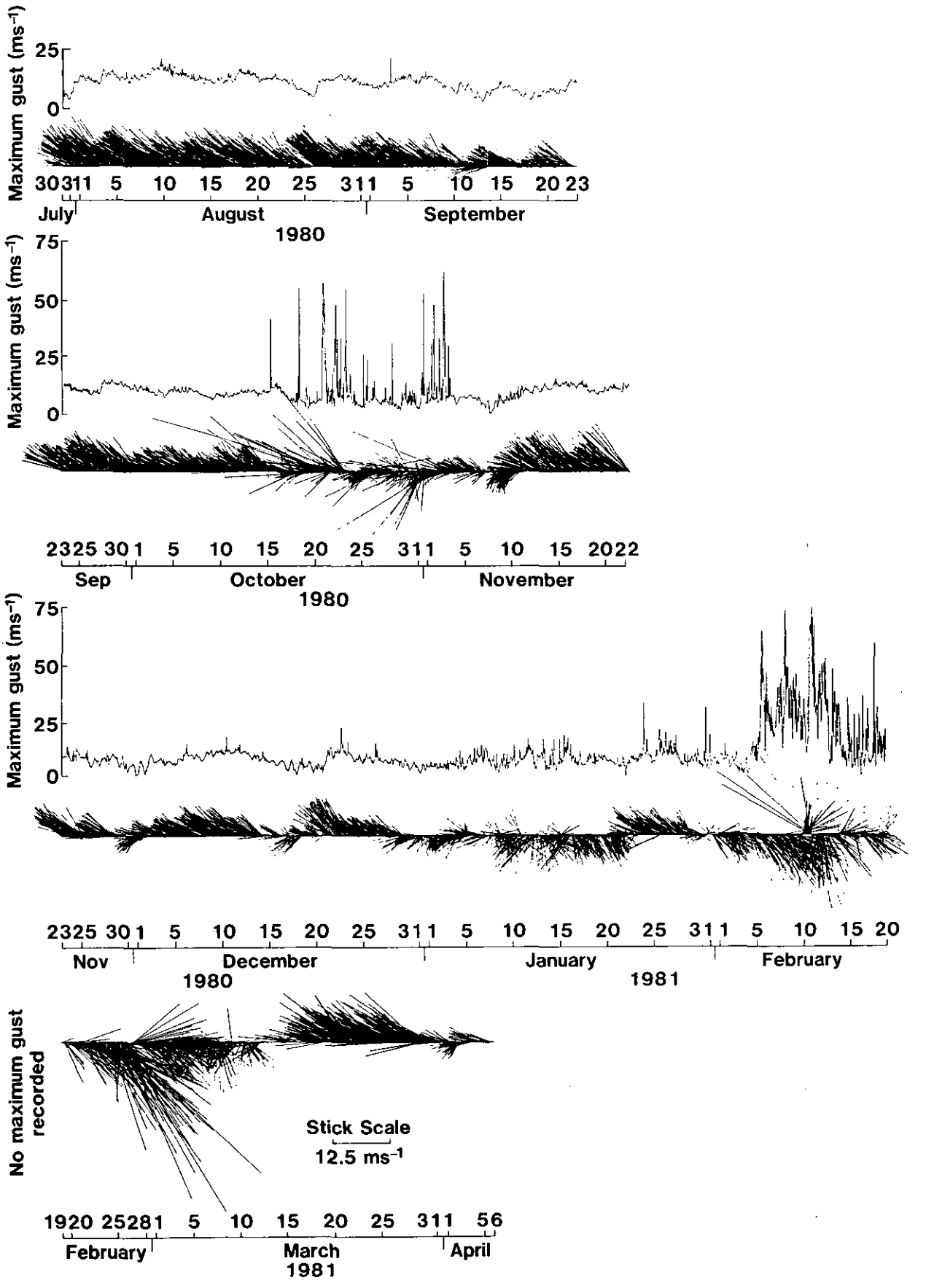


Fig. 17. Raw hourly wind data recorded at Carter Reef. Note that the scale for the maximum gust is different from the scale used for the vectors. (The vectors are in oceanographic convention).

APPENDIX

TS Relation in the Western Coral Sea

This is a preliminary analysis of TS characteristics in the Western Coral Sea. Data collected in this region must be considered sparse relative to that accumulated in the higher latitudes of the Tasman Sea. It is presented here because it could be useful in quickly computing approximate dynamic heights when temperature data alone are available. An analysis was done on all TS data points in the latitude range 13-25°S and longitude range 144-156°E, which are held in the CSIRO data bank. The basic techniques described by Pearce (1981) were used.

A total of 8265 data points were available (representing about 800 stations). No seasonal analysis was attempted but sub-sets of the data were used for latitude band analyses. However, it is felt that the significant features of the TS relation are provided by the results of the analysis on the total set and only these are presented.

TS Curve

The once-smoothed TS curves (see Pearce 1981) is given in Fig. A1 for the temperature range 2-29°C. (Below 2°C the salinity is not presented but appeared to remain constant at 34.710‰). For comparison the data points at every 1°C from the Tasman Sea (latitudes 25-45°S) are also shown.

Polynomial Fittings

A fifth order polynomial was fitted to this curve for data between 2° and 29°C. The coefficients defined by $S = C_0+C_1T+C_2T^2+C_3T^3+C_4T^4+C_5T^5$ are

$C_0 = 35.155$
$C_1 = -0.300$
$C_2 = +4.148 \times 10^{-2}$
$C_3 = -1.965 \times 10^{-3}$
$C_4 = +4.547 \times 10^{-5}$
$C_5 = -5.301 \times 10^{-7}$

Data points every 1°C calculated from this equation are also shown on Fig. A1. Generally, the fit is extremely good with the RMS difference being 0.037‰ (calculated for every 0.1°C step). The equation therefore should be a useful algorithm in the first stage of computing dynamic heights where only temperature data is available.

Temperature/Dynamic Height Correlations

Regressions of temperature at selected depths and selected dynamic heights were done for stations deeper than 1300 m and 900 m. The correlation coefficients compare unfavourably with that for Tasman Sea data. Depths 1300 m and 900 m were chosen for the analysis because of the variable bathymetry, but we do not intend to suggest that these represent levels of no motion. The variables defined by

$D(z \text{ rel. to } z) = M T_z + C$

are shown in the following table.

z	z	z	M	C	I*	II*	III*	IV*
0	1300	450	0.044	1.630	0.69	0.076	222	54
450	1300	450	0.035	0.449	0.72	0.055	222	88
0	900	450	0.036	1.412	0.61	0.067	320	56
0	1300	250	0.049	1.240	0.64	0.081	222	56
0	900	250	0.045	1.005	0.65	0.065	320	66
0	1300	250	0.095	0.421	0.96		375	†

† Tasman Sea data (Pearce, personal communication).

* Column I is the correlation coefficient between D (z relative to z_3) and T_{z_3}.

* Column II is the RMS difference between observed and calculated D in dynamic metres.

* Column III is the total number of data points.

* Column IV is the number of stations where the difference between the observed and calculated values < 5 dyn cm. The number is expressed as a percentage of the total.

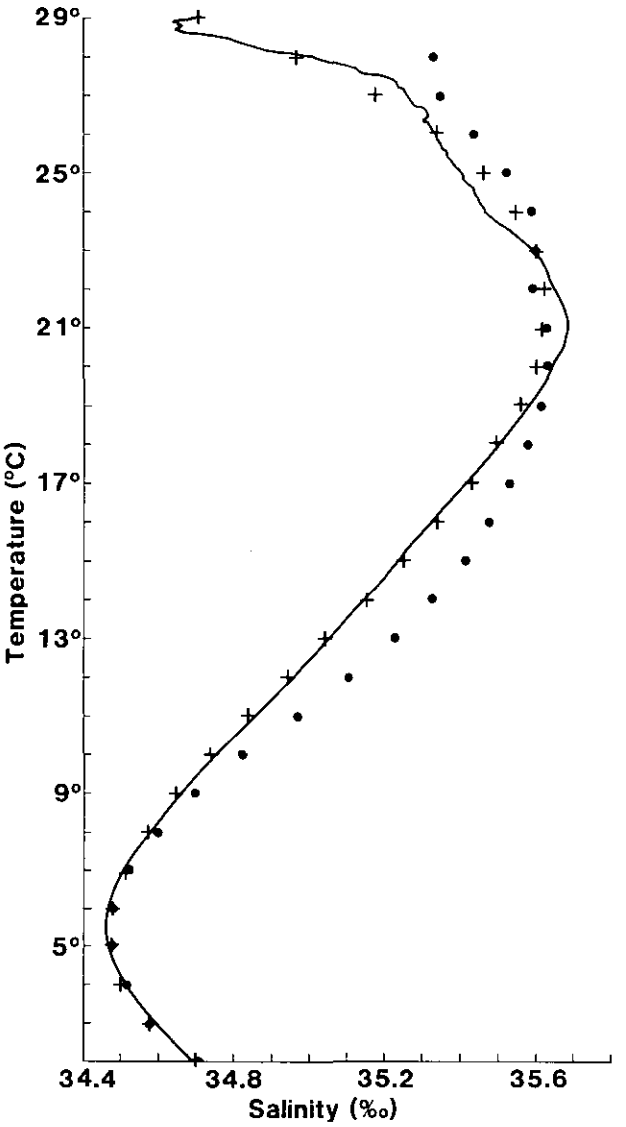


Fig. A1. The smoothed TS curve for the Western Coral Sea. + are the data points computed from the fitted polynomial (see text); • are the data points from the Tasman Sea between 25-45°S (Pearce 1981).

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