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Temperature-Salinity Relationships in the Tasman Sea

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TEMPERATURE-SALINITY RELATIONSHIPS IN THE TASMAN SEA

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Abstract

Mean temperature-salinity curves are presented for four 5° latitude bands between 25° and 45°S in the Tasman Sea. The general shape of the curves is discussed in terms of the water masses in the Tasman Sea (briefly reviewed from the literature) and latitudinal differences are examined. Tables of the mean salinity, sigma-t and thermosteric anomaly as functions of temperature are given, and standard deviation tables are appended for use in quality control of hydrology data.

INTRODUCTION

With the increasing use of XBTs (Expendable Bathythermographs) in the Tasman Sea, it is desirable to be able to compute the dynamic height (and hence the geostrophic flow) from the temperature profiles.

One method of doing this is to use mean T-S (temperature-salinity) relationships to estimate the dynamic height anomalies in the XBT range (surface to about 480 m for T-4 probes), and then some regression relationship to calculate the dynamic height below this level down to the "reference depth", as a function of (say) the temperature at 450 m. Stommel (1947) examined T-S relationships in the North Atlantic Ocean and concluded that the method is suitable for approximate dynamic calculations in some areas but unsatisfactory in other regions. A detailed study of mean T-S curves in the North Pacific Ocean (Emery 1975); Emery and Wert 1976*a*,*b*) found the method to be useful in areas where the T-S relationship is sufficiently close. In regions where the T-S method is less satisfactory, use of mean salinity-depth curves has been suggested (Emery and O'Brien 1978), and Flierl (1978) found that further improvements would result from using a few observed salinities to estimate the mean T-S curve at fixed pressure levels.

This report derives mean T-S relationships in the Tasman Sea, and presents tables of the mean salinity, sigma-t and thermosteric anomaly (i.e., $10^5\ \Delta_{st}$) as functions of temperature at 0.1°C intervals. Best-fit polynomials are approximated to the mean salinity curves.

DATA ANALYSIS

Data Source

The data were taken from the CSIRO hydrology data store. The stations (Fig. 1) were grouped into four 5° latitude bands between 25° and 45°S; for convenience in later discussion the bands are designated A, B, C, D (Table 1). Only stations in water deeper than 300 m have been selected (to avoid possible bias by low-salinity water on the continental shelf), and all salinities outside the range 34‰ to 36‰ were rejected as a first stage of quality control. Stations situated exactly on a latitude boundary have been incorporated into each of the two adjacent bands.

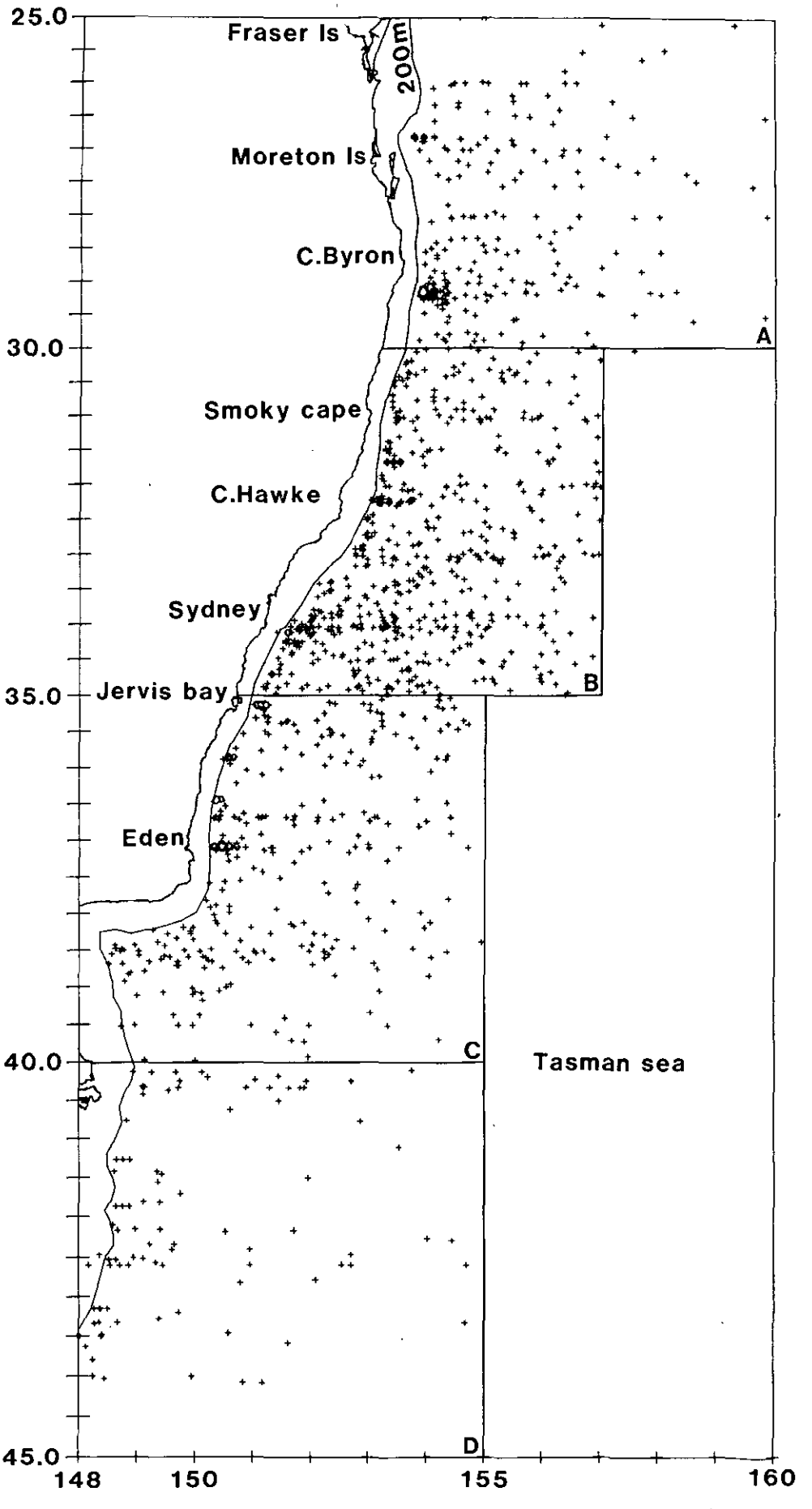

Fig. 1. Chart showing the stations used in this study, divided into the four latitude bands A, B, C and D. The 200 m isobath is indicated.

Table 1. Latitude and longitude limits of the data

Area	Latitude range (°S)	Longitude range (°E)	Number of stations	Number of T-S pairs
A	25°-30°	300m*-160°	311	4818
B	30°-35°	300m*-157°	611	7776
C	35°-40°	300m*-155°	585	5898
D	40°-45°	300m*-155°	108	1188
Total	25°-45°		1615	19680

*Minimum water depth

Analysis Procedure

The method of analysis for each area is basically that of Emery and Wert (1976*a*) and is summarized below:

(1) Find the mean salinity and standard deviation for all salinities in each 1°C interval.

(2) Any salinities falling outside the range [mean ± 2 x standard deviation] are excluded from further analysis — this is to eliminate grossly deviant values. (For the four areas A-D, the proportions of points eliminated at this stage were 4.0%, 4.2%, 4.4% and 3.7% respectively; for a normal distribution, 4.55% of values would be outside the range).

(3) For the remaining "good" T-S pairs, re-calculate the mean salinity in each 0.1°C interval; edit in any gaps (i.e. 0.1°C bands containing no observations) by linear interpolation. To reduce loss of data at each end of the curves in the subsequent smoothing procedure (see below), extend the series by setting a constant salinity of 34.72‰ below the lowest observed temperature (1°C), and a subjectively-assessed "mean" salinity from the highest observed temperature up to 30°C; these upper mean values for the four areas were chosen as 35.27‰, 35.39‰, 35.55‰ and 35.65‰ from north to south.

(4) Smooth the mean salinities by a 9-point moving-average filter.

(5) Calculate the standard deviation of the individual salinities in each 0.1°C interval; edit in missing and end values as in step (3) above, and smooth the resulting standard deviation curve using the same 9-point filter.

(6) At this stage, Emery and Wert (1976*a*) smoothed the mean salinity and standard deviation curves three more times using the 9-point filter "to reduce the small irregularities without changing any major features". In the present case it was found that the successive smoothing procedure noticeably distorted the T-S curve at the intermediate salinity minimum, so only the once-smoothed values are used in this report. As the absolute shape of the standard deviation curves is less important, and because they were still very irregular after only one smoothing operation, they have been smoothed four times.

(7) Compute sigma-t and the thermosteric anomaly from the once-smoothed salinities.

(8) As an alternative to the tabulated mean salinities, least-squares best-fit polynomials have been fitted to the once-smoothed mean salinities.

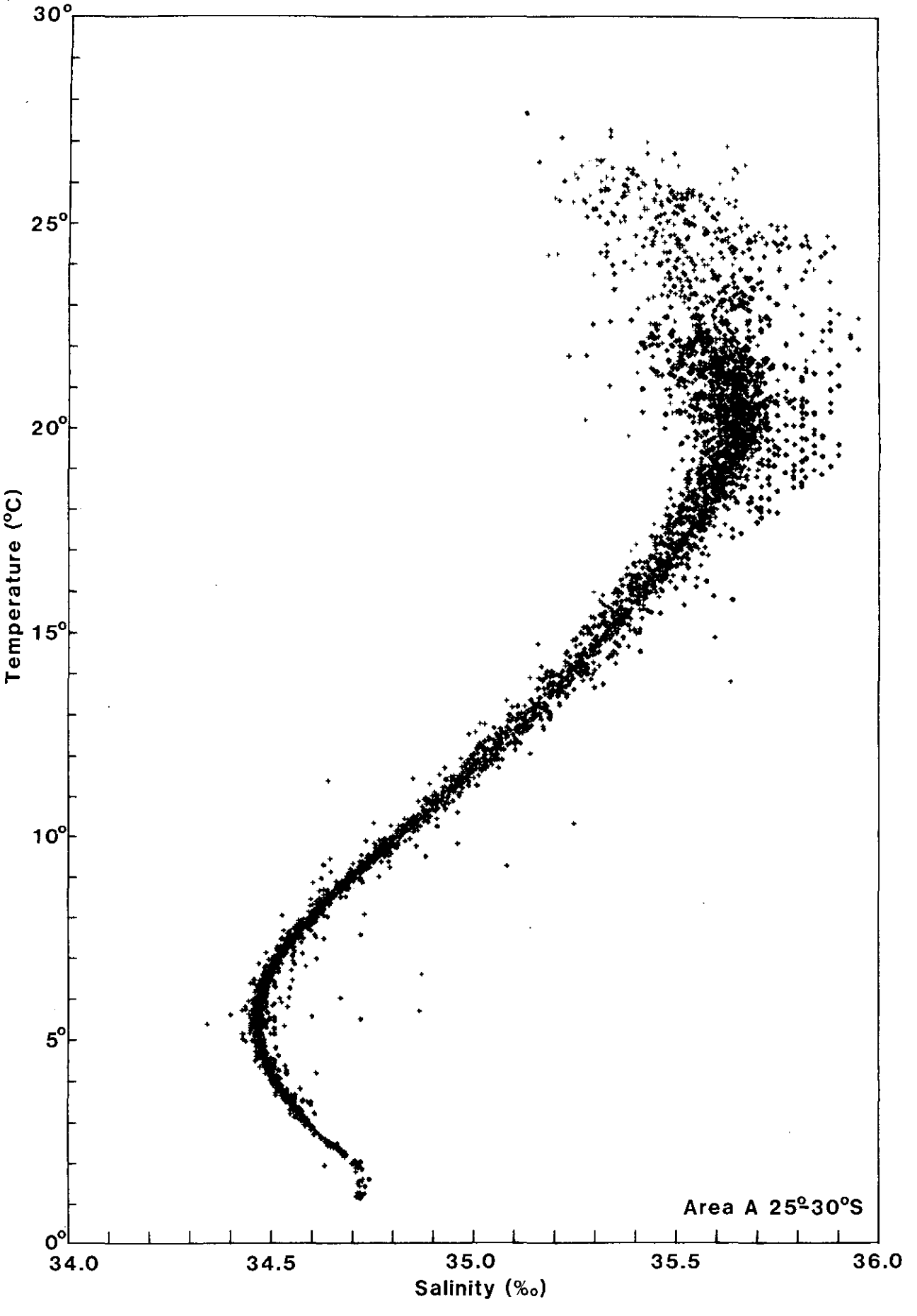

Fig. 2(*a*). T-S scatter plot for area A (25°-30°S). The number of points is 4818.

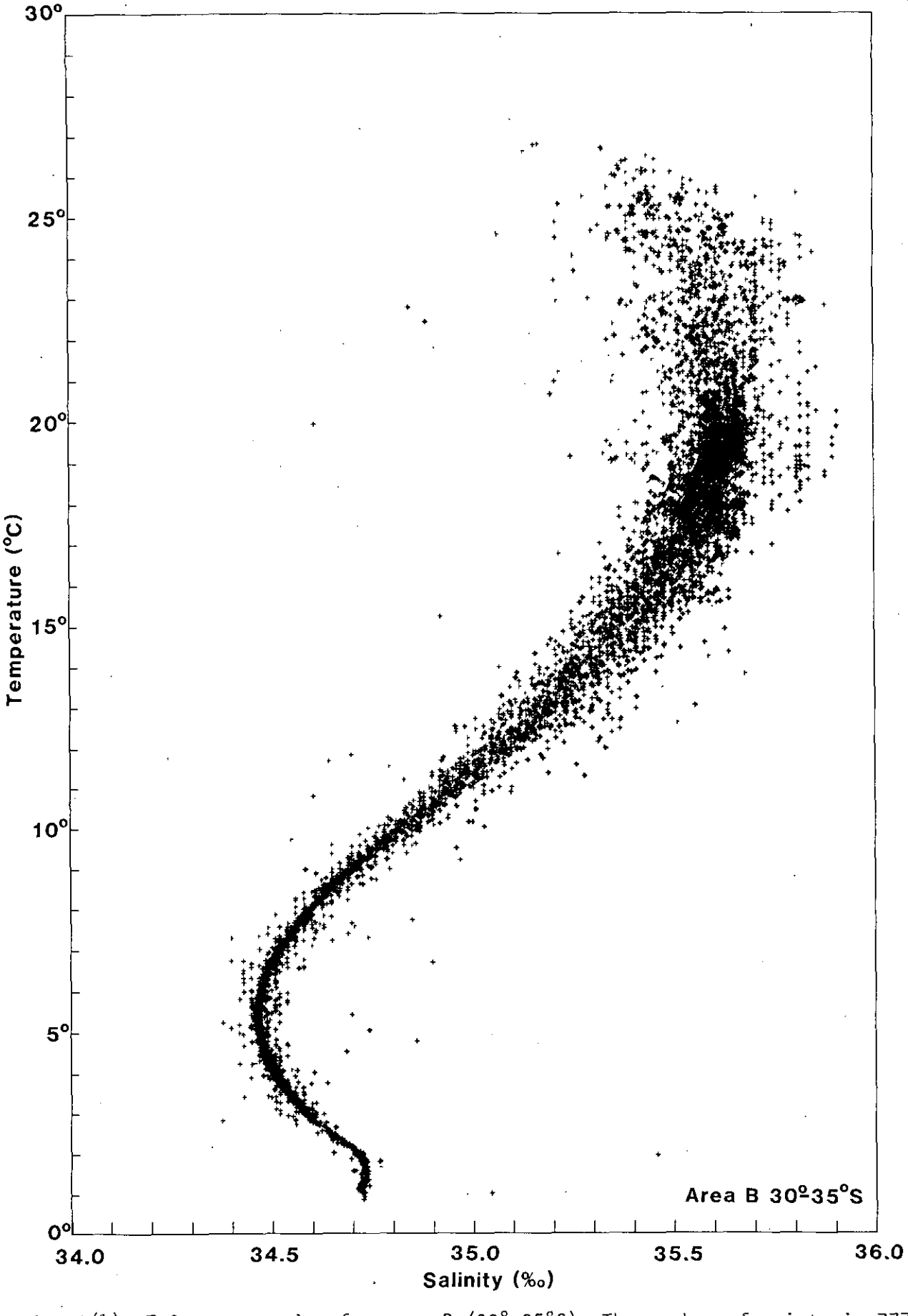

Fig. 2(*b*). T-S scatter plot for area B (30°-35°S). The number of points is 7776.

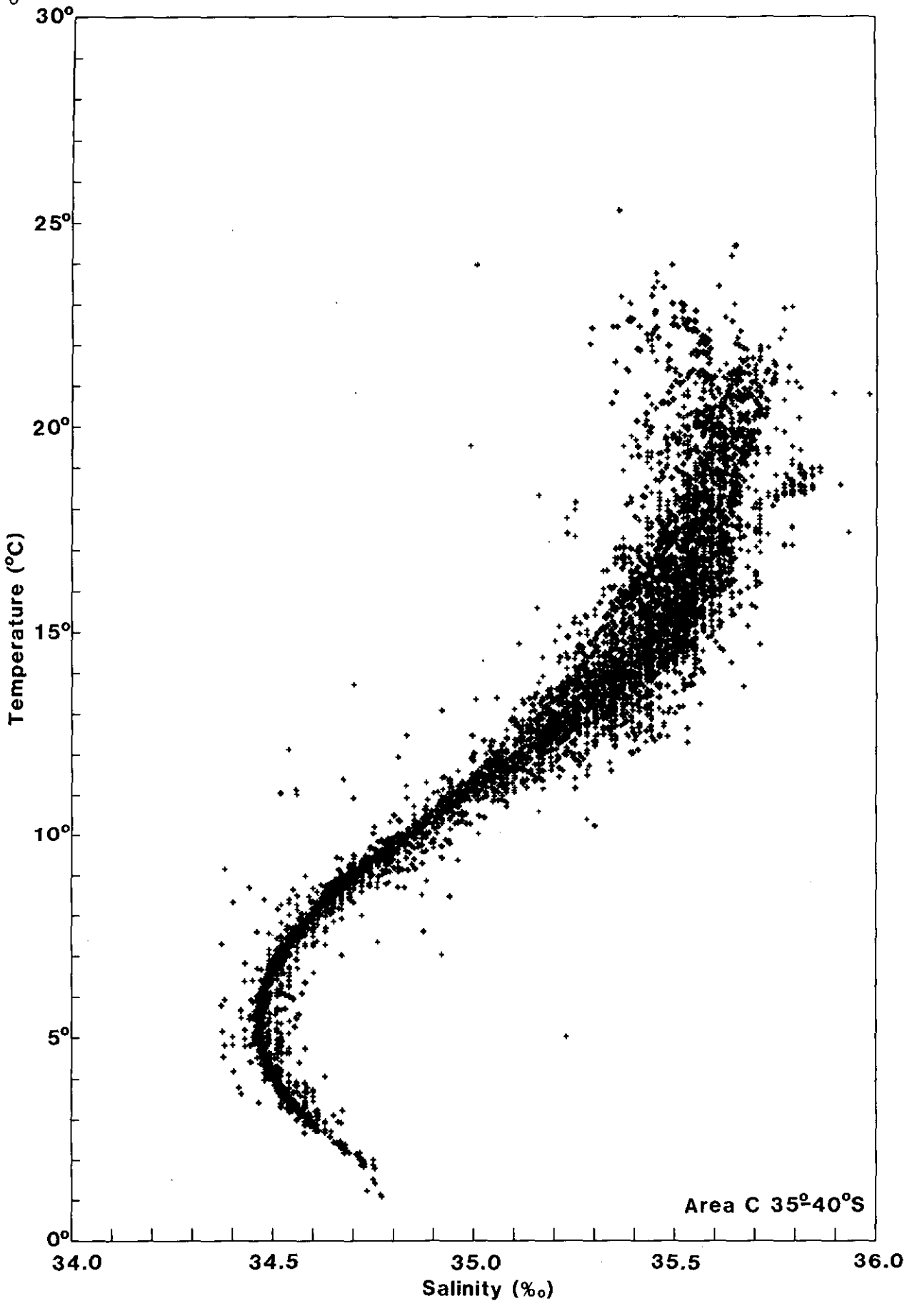

Fig. 2(*c*). T-S scatter plot for area C (35°-40°S). The number of points is 5898.

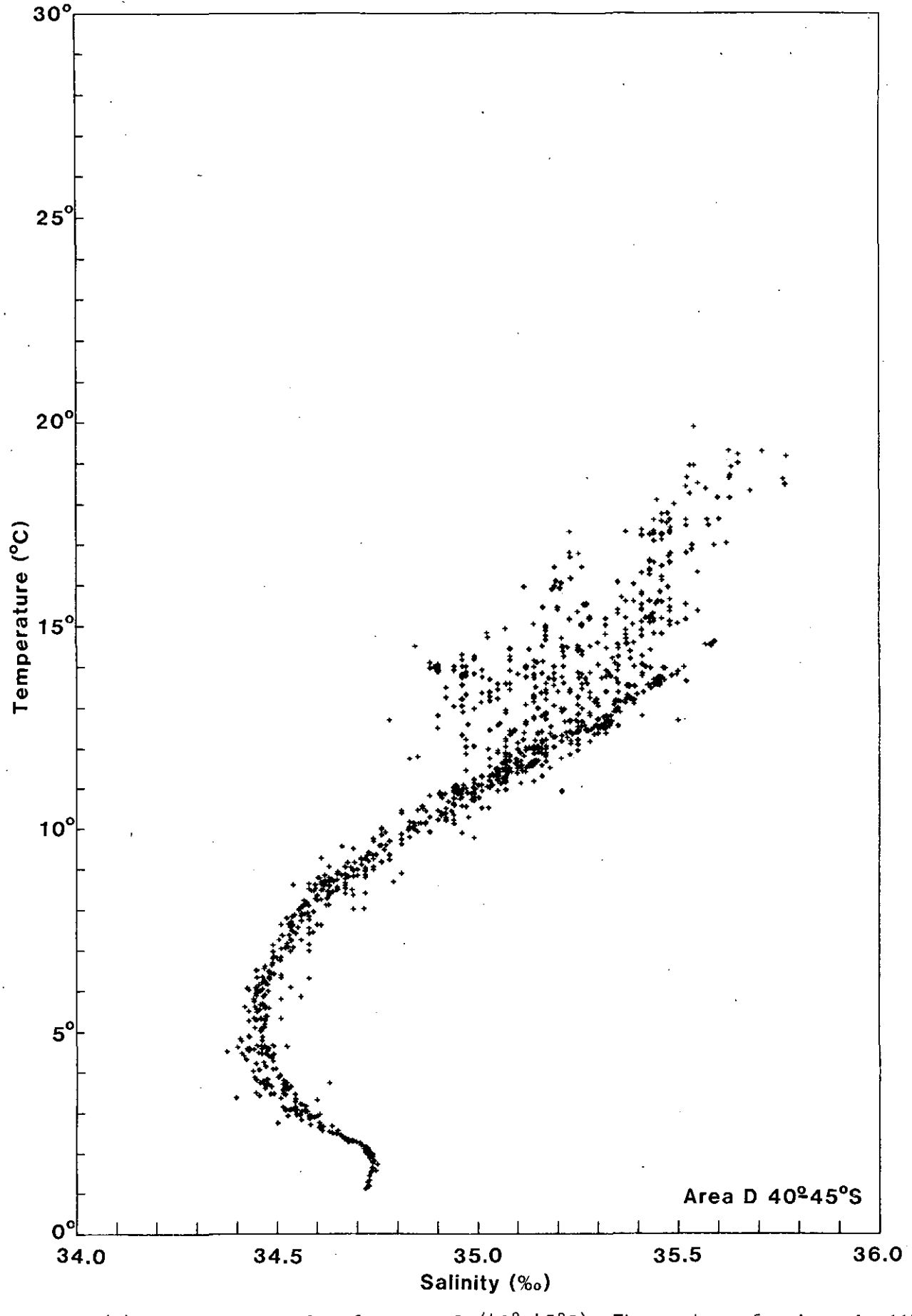

Fig. 2(*d*). T-S scatter plot for area D (40°-45°S). The number of points is 1188.

RESULTS AND DISCUSSION

Data Quality

The only "quality control" exercised during the analysis was the omission of T-S pairs whose salinity was outside the range 34‰ to 36‰, and then the rejection of those pairs whose salinity was more than 2 standard deviations from the mean in the appropriate 1°C interval.

While some scatter is to be expected in the surface and near-surface regions due to seasonal variability and localized dilution/evaporation processes, the number of points lying many standard deviations from the mean at greater depths is disturbing (Fig. 2). It is suspected that some of these values are erroneous (see, for example, the water masses in Fig. 3); it is not the object of this study to examine such discrepancies in detail, but it is recommended that users of the data store check any data which they use. It is also suggested that, as a form of quality control, new data be compared with the 3-standard deviation limits given in Appendix Tables 16-20 — any points falling outside the ± 3x standard deviation range should be carefully checked.

T-S Curves and Water Masses

The T-S scatter plots for the four areas are presented in Figs 2*a-d*. In the warmer upper layers, there is the expected scatter due to surface effects, but below about 15°C the general trend is very well defined.

The mean T-S curves are shown in Fig.4 to illustrate differences between the four areas, while overlay Fig. 3 shows diagrammatically the water masses of the Tasman Sea. There is no generally accepted nomenclature or definition of the various water masses, and it is beyond the scope of this report to undertake a critical review of the literature, so the T-S characteristics of the main water masses as used by various authors have simply been inserted onto Fig. 3 as a basis for interpretation of the T-S curves. (Part of the difficulty in identifying the water masses uniquely is that temperature and salinity alone are insufficient for characterising them, and other properties such as oxygen and phosphorus content must also be considered (Rochford 1958, 1968; Wyrtki 1962)).

Rochford (1959) defined the three major external surface water masses as South Equatorial Water, West Central South Pacific Water, and Sub-Antarctic Water, while three external surface water masses of less importance are Arafura Water and Tropical and Temperate high salinity waters (Table 2). The other (derived) surface water masses in Fig. 3 are formed as the main water masses interleave and mix *en route* to (as well as in) the Tasman Sea (Table 3; Rochford 1957). Water types at intermediate depths as defined by Rochford (1962) are listed in Table 4, and the subsurface water masses of Wyrtki (1962) are given in Table 5. It is evident from Fig. 3 that some of the confusion about the water masses lies in calling the same (or very similar) masses different names, while mixtures of water masses have different T-S characteristics depending on the amount of mixing that has occurred — perhaps these mixtures should not be given specific T-S limits except in broadest terms.

From Figs 3 and 4, it is evident that the T-S curves lie well in the water mass blocks of Rochford's Coral Sea, Subtropical Lower, Central Tasman, South-West Tasman and East-West Tasmanian Waters (all surface waters), Wyrtki's Sub-Antarctic Intermediate, Antarctic Intermediate, Deep Oxygen Minimum and Deep Waters, and trend towards the Antarctic Bottom Water at the lowest temperatures. East Central New Zealand Water is not represented in the present data as it occurs in only the eastern Tasman Sea; the effect of North Bass Strait Water is discussed in the next section. It seems that there is a need for a definitive study of the water masses of the Tasman Sea using the accumulating body of data now available.

Table 2. External surface water masses (after Rochford 1959)

Water mass	Temperature range (°C)	Salinity (‰)*
Major:		
South Equatorial	28-29	34.7
West Central South Pacific	26	36.5
Sub-Antarctic	9-12	34.7
Minor:		
Arafura	28-29	≤34.1
Tropical high-salinity	29-30	35.6
Temperate high-salinity	20-21	≥36.5

*Converted from chlorinity using S=1.80655 Cl, and rounded to the nearest 0.1‰

Table 3. Derived surface water masses in the Tasman Sea (after Rochford 1957)

Water mass	Temperature range (°C)	Salinity range (‰)*
Coral Sea	20-26	35.40-35.60
South Equatorial	24-26	35.25-35.40
Sub-Antarctic	10-14	34.60-34.85
Central Tasman	15-20	35.50-35.70
South-West Tasman	12-15	35.25-35.40
North Bass Strait	12-17	35.50-35.70
East Central New Zealand	15-20	34.50-34.85
East-West Tasmanian	10-14	35.05-35.25

*Converted from chlorinity using S=1.80655 Cl, and rounded to the nearest 0.5‰

Table 4. Intermediate water masses (after Rochford 1962)

Water mass	Temperature range (°C)	Salinity range (‰)
Upper Equatorial Intermediate[1]	10.0	34.80
Subtropical[1]	11.8-12.6	35.20-35.40
Upper Antarctic Intermediate[1]	4.5- 6.0	33.80-34.00
Pacific Equatorial Intermediate[2]	6.4	34.60
South West Pacific Intermediate[2]	7.0	34.70
Antarctic Intermediate[2]	2.1	34.02

[1]Temperatures derived from the sigma-t of 26.80
[2]Temperatures derived from the sigma-t of 27.20

Table 5. Subsurface water masses (after Wyrtki 1962)

Water mass	Temperature range (°C)	Salinity range (‰)	Depth range (m)
Subtropical Lower[1]	18-25	35.50-35.95	0- 250
Upper Oxygen Minimum[2]	12-24	34.9 -35.9	150- 500
Sub-Antarctic Intermediate	8-14	34.6 -35.2	200- 500
Antarctic Intermediate[3]	4.2-6.0	34.37-34.53	700-1100
Deep Oxygen Minimum	1.9-3.9	34.58-34.65	1200-2400
Deep Water	1.4-1.9	34.74	2500-3000
Bottom Water	Lowest	<34.70	>3000

[1]Comprises northern and southern components of slightly different T-S limits.
[2]Not plotted on Fig. 3.
[3]Temperature, salinity and depth values are for the "salinity minimum" component; the "oxygen maximum" component is not relevant here.

Latitudinal Variation in T-S Properties

Although the four mean T-S curves in Fig. 4 have the same general shape, there are three temperature ranges where they differ in detail: warmest water (>22°C); intermediate waters (9-18°C); and at the salinity minimum (3-7°C). There is probably little significance in the fact that the four curves coincide at 22°C and 18°C, but good agreement in the greatest depths is expected (the deflection of the southernmost curve is an interesting feature, discussed later).

Above 22°C, the curves are rather irregular, reflecting high variability of properties in the near-surface waters. The reduced salinities may be interpreted as due both to local surface dilution by rain (or runoff from major rivers) and to varying proportions of South Equatorial water. There is no obvious latitudinal dependence here. The salinity maximum of 35.60-35.65‰ is at 19-22°C and is remarkably well defined.

The most interesting section of the curves is between 9°C and 18°C, where the mean salinity at a constant temperature progressively increases with increasing latitude. Ignoring for the moment the southernmost curve, the meridional salinity gradient is about 0.013‰ per degree latitude. Due to the initial rejection of some data and the smoothing of the mean salinity and standard deviation curves, it is not easy to assess the statistical significance of the latitudinal increase in salinity; a crude analysis indicates that the difference between the once-smoothed salinities is significant at well over the 99% confidence interval. According to Tomczak (in press), this latitudinal variation reflects the intrusion of Bass Strait water into the Tasman Sea, as can be seen in Figs 3 and 4. Boland (1971) and Godfrey *et al.* (1980) have clearly shown the presence of Bass Strait water in the Tasman Sea.

The kink in the curve for area D at the salinity 35.2‰ is a puzzle. The individual T-S values in Fig. 2*d* show that the main aggregation of points extends smoothly to higher salinities as in the adjacent area C (Fig. 2*c*), but there is a lot of scatter towards higher temperatures and/or lower salinities. It is only beyond 35.2‰ that these scattered points are sufficient to deflect the mean curve sharply upwards. Surprisingly, this trend is supported by surface observations from merchant ships, which gave the following temperature ranges for 0.1‰ intervals in the area 42-44°S, 148-149°E:

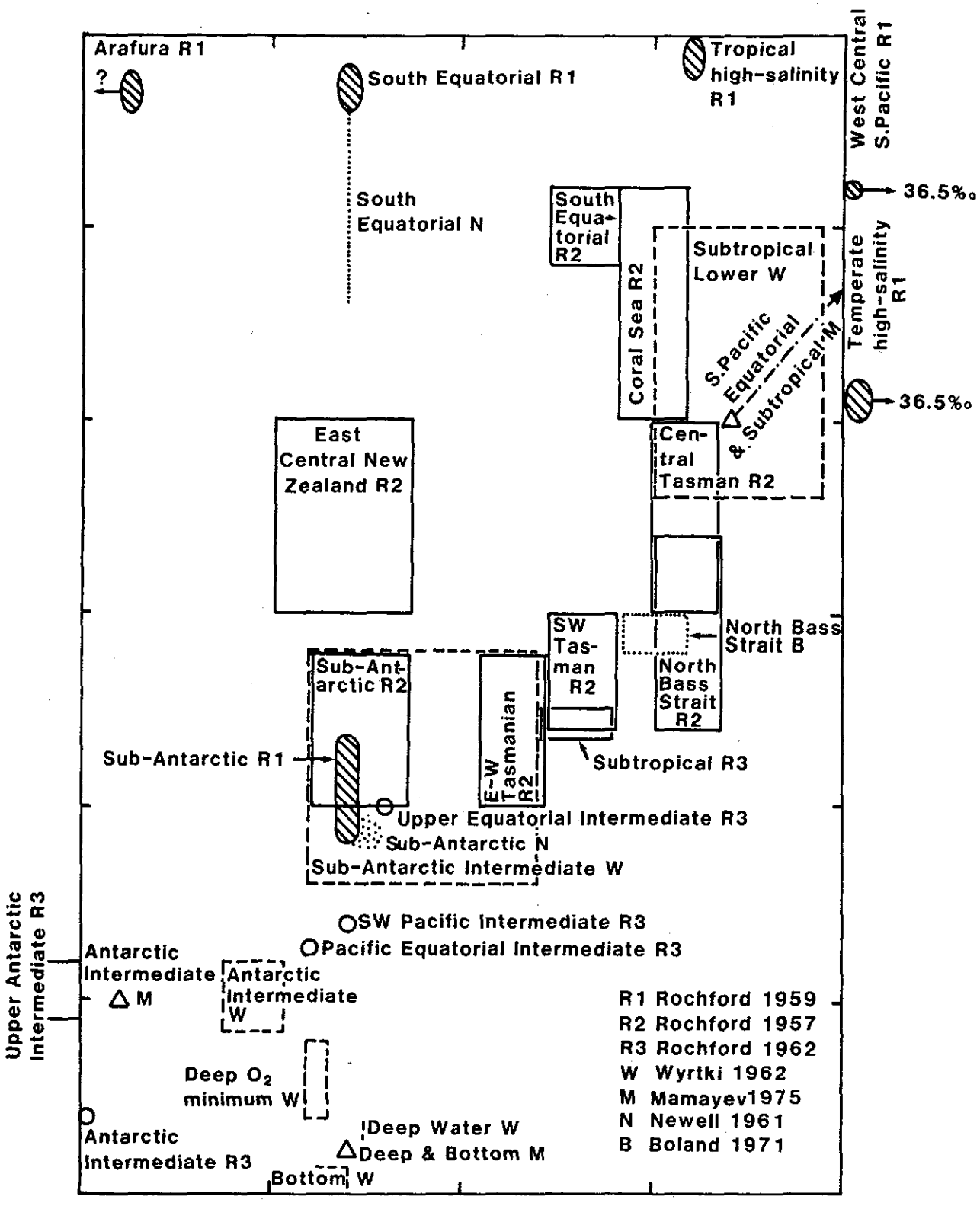

Fig. 3. T-S relationships in the Tasman Sea in diagrammatic form, after Rochford (1957-R2), Rochford (1959-R1), Rochford (1962-R3), Wyrtki (1962), Mamayev (1957), and Boland (1971, after Newell 1961). This figure overlays Fig. 4.

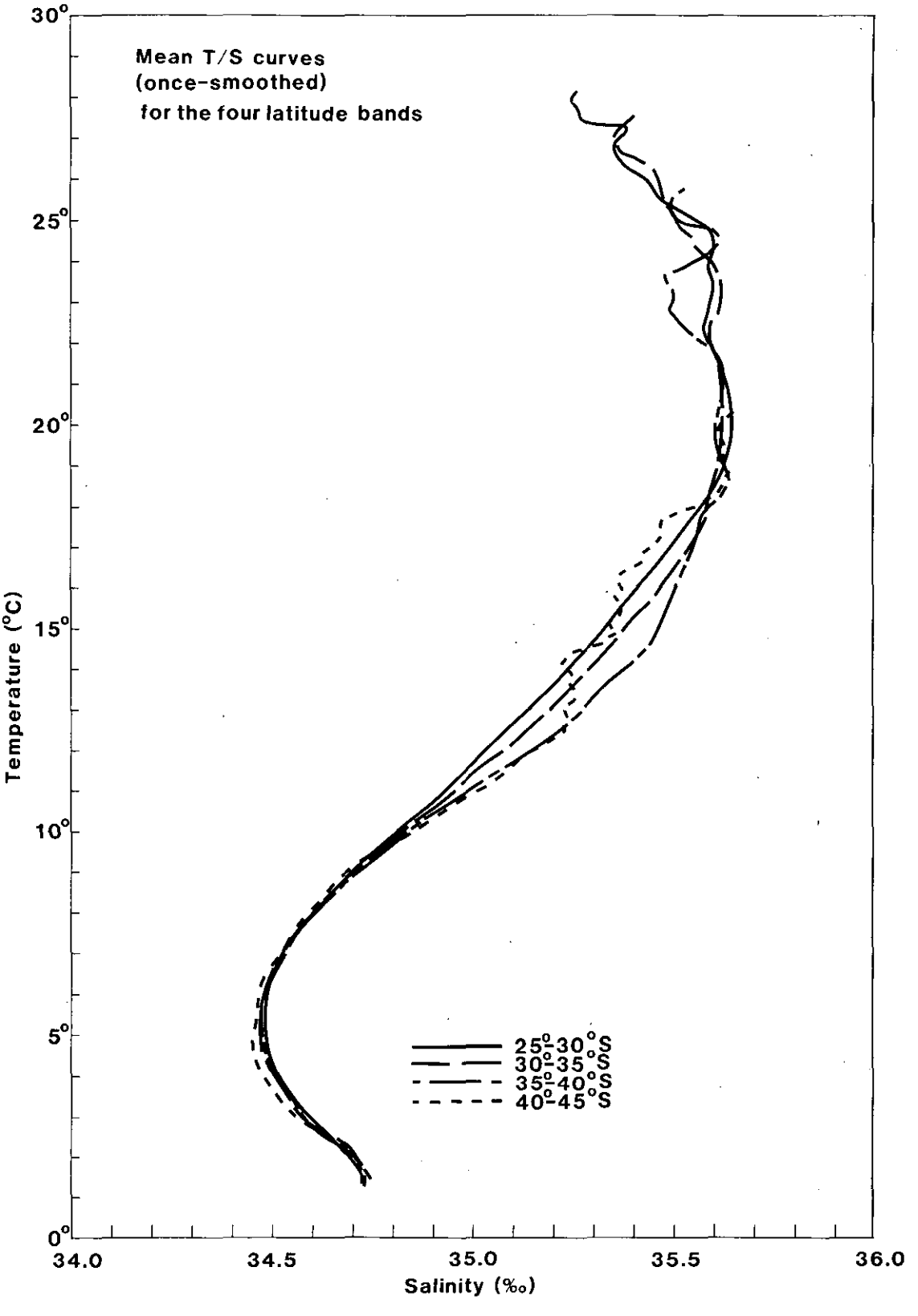

Fig. 4. Mean T-S curves (once-smoothed) for the four latitude bands.

Salinity range (‰)	Temperature range (°C)
35.0-35.1	12.5-13.0 = 0.5
35.1-35.2	12.3-16.4 = 4.1
35.2-35.3	12.5-17.1 = 4.6
35.3-35.4	15.8-17.6 = 1.8
35.4-35.5	17.2-17.8 = 0.6

(Data analyzed by R.J. Edwards from 1365 observations). Note the jump from 12.5 to 15.8°C in the temperature minimum between salinities of 35.3 and 35.4‰. Clearly this feature is observed at the surface, but it is not purely a local surface effect: the mean T-S analysis for area D was re-run omitting all data shallower than 5 m (this could not be set any deeper because of further depleting an already sparse data set) and the resulting mean T-S curve was almost identical with the previous one based on the complete data.

It is possible that this kink is in some way associated with the Subtropical Convergence which generally lies near 44°S east of Tasmania. The Subtropical Convergence separates Tasman Sea waters to the north from Subantarctic water to the south, and as is evident from Figs 3 and 4 the kink in the mean T-S curve is close to the boundary between the T-S characteristics of these water masses.

A further possibility is that the kink may be related to the vertical sampling distribution, i.e. to the sudden decrease in the number of observations available below 500 m depth (Tomczak, pers. comm.). However, both unpublished data and oceanographic atlases indicate that the average temperature and salinity at 500 m depth in area D are 8-9°C and 34.6-34.7‰ respectively, and the kink is in much warmer, more saline water nearer the surface.

Finally, the T-S curves for the 3 areas north of 40°S all coincide at the salinity minimum, but that for the region south of 40°S has a markedly lower salinity. This is almost certainly due to the two paths of entry of the Antarctic Intermediate Water into the Tasman Sea (Wyrtki 1962), as described in the next section.

The Intermediate Salinity Minimum

The salinity minimum at 5-6°C represents Antarctic Intermediate Water (Wyrtki 1962). Table 6 lists the mean salinities and temperatures of the minimum for the four areas, and T-S scatter plots are given in Fig. 5. The curves are well defined for the three northerly areas, but south of 40°S the small number of points are too scattered to show a neat curve.

Table 6. Temperatures and salinities of the salinity minimum

Area (°S)	Temp. (°C)	S min. (‰)[1]	S min. (‰)[2]	S min. (‰)[3]	S.D. (‰)[4]
25-30	5.45	34.469(53)	34.471	34.476	0.0128
30-35	5.45	34.471(73)	34.471	34.476	0.0125
35-40	5.40	34.465(15)	34.472	34.476	0.0236
40-45	4.80	34.412 (1)	34.450	34.455	0.0281

Note: [1]Unsmoothed minimum salinity (with number of values in 0.1°C interval).
[2]Once-smoothed minimum salinity.
[3]Four-smoothed minimum salinity.
[4]Four-smoothed standard deviation.

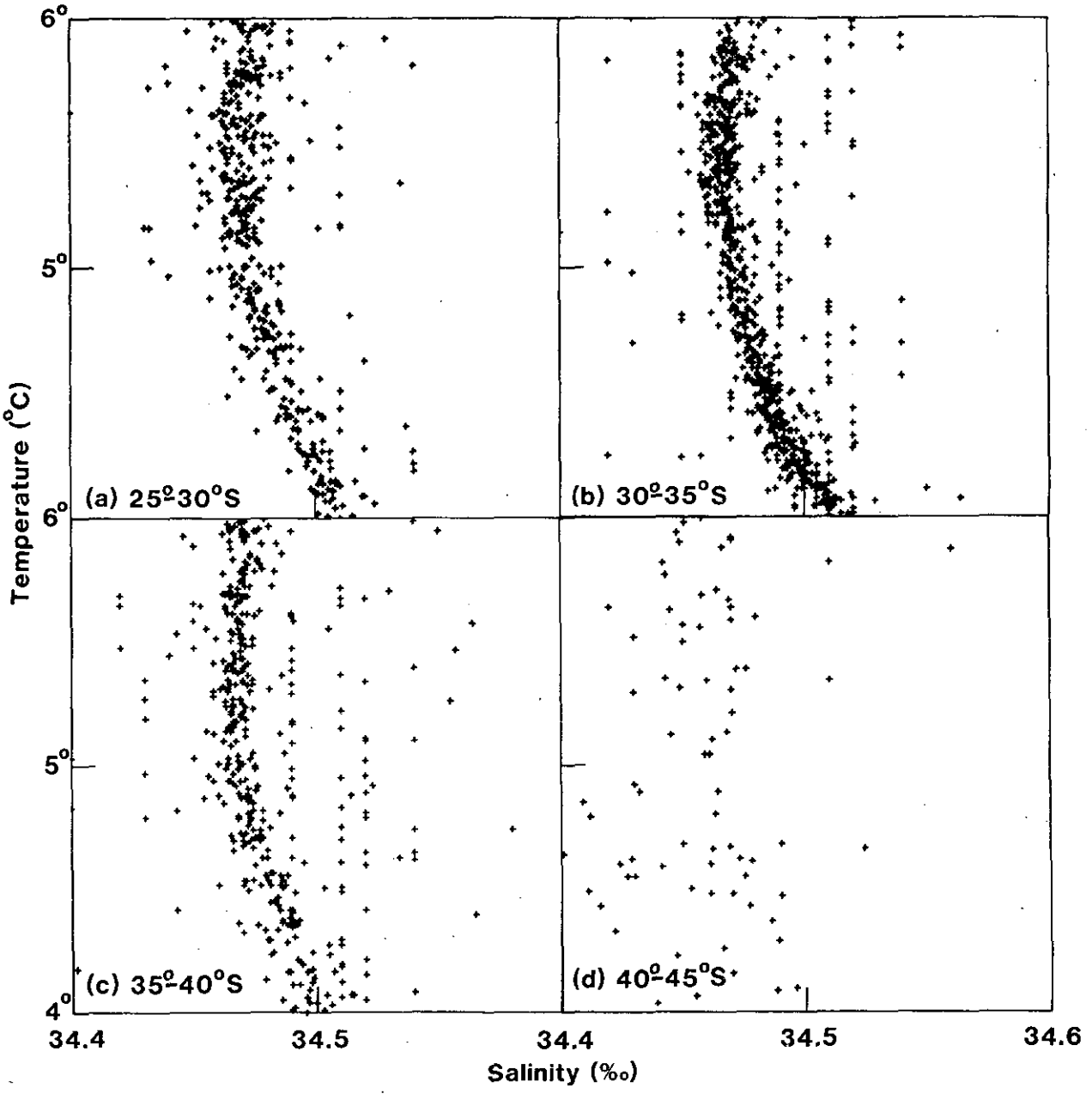

Fig. 5. T-S scatter plots in the region of the intermediate salinity minimum, for the four areas.

In the three areas north of 40°S, the mean (once-smoothed) minimum salinity is very uniform at 34.471‰ for a temperature of 5.4-5.5°C; Wyrtki (1962) quotes ranges of 34.37-34.53‰ at 4.2-6.0°C, so the present values fall well within Wyrtki's limits. Lockwood (1970) reported values of 34.468‰ and 34.463‰ for two cruises in 1965 in latitudes of 30-36°S and 28-36°S respectively, with standard deviation of 0.004-0.014‰. These mean values are in fair agreement with the unsmoothed means found here (third column of Table 6), but the once-smoothed means are significantly higher than Lockwood's data, and it is clear from the table that the four-fold smoothing has considerably biased the means. For this reason, the once-smoothed values are used in this report. An approximate estimate of the bias that would be introduced at the salinity minimum after 3 applications of a 9-point moving average filter is +0.005‰, which agrees well with the discrepancy in Table 6.

The mean (smoothed) salinity of 34.450‰ for the southernmost area is 0.02‰ below that for the other three areas. As mentioned earlier, this is probably due to Antarctic Intermediate Water entering the Tasman Sea by two routes: a direct path from the south between Tasmania and New Zealand where the low salinity core maintains its character (it reaches only to 40°S (Wyrtki 1962)); and a more circuitous path east of New Zealand and into the Tasman Sea from the east, during which the salinity minimum is gradually eroded by mixing processes.

The Deep Salinity Maximum

The mean statistics for the deep salinity maximum, which represents "a last trace of the North Atlantic Deep Water" moving into the Tasman Sea from the south (Wyrtki 1961), are tabulated in Table 7, and the T-S scatter plots are shown in Fig. 6.

Three of the areas exhibit a fairly well-defined "knee" in the T-S curve (Fig. 6) and a mean unsmoothed salinity maximum of 34.73-34.74‰, which agrees well with Wyrtki's (1962) value of 34.74‰ at 1.4-1.9°C. The smoothing process, however, has reduced this to a lower value of 34.72-34.73‰.

For the area 35-40°S, the "knee" is not well defined and there is a scatter (of the admittedly few values available) towards higher salinities, as reflected in the mean salinity of 34.75‰ in Table 7. The reason for this is not clear.

Table 7. Temperature and salinities of the deep salinity maximum

Area (°S)	Temp. (°C)	S max. (‰)[1]	S max. (‰)[2]	S.D. (‰)[3]
25-30	1.30	34.737 (2)	34.722	0.0135
30-35	1.55	34.732 (19)	34.725	0.0100
35-40	1.35	34.754 (1)	34.749	0.0186
40-45	1.60	34.739 (2)	34.732	0.0154

Note: [1]Unsmoothed maximum salinity (with number of values in 0.1°C temp. interval).
[2]Once-smoothed maximum salinity.
[3]Four-smoothed standard deviation.

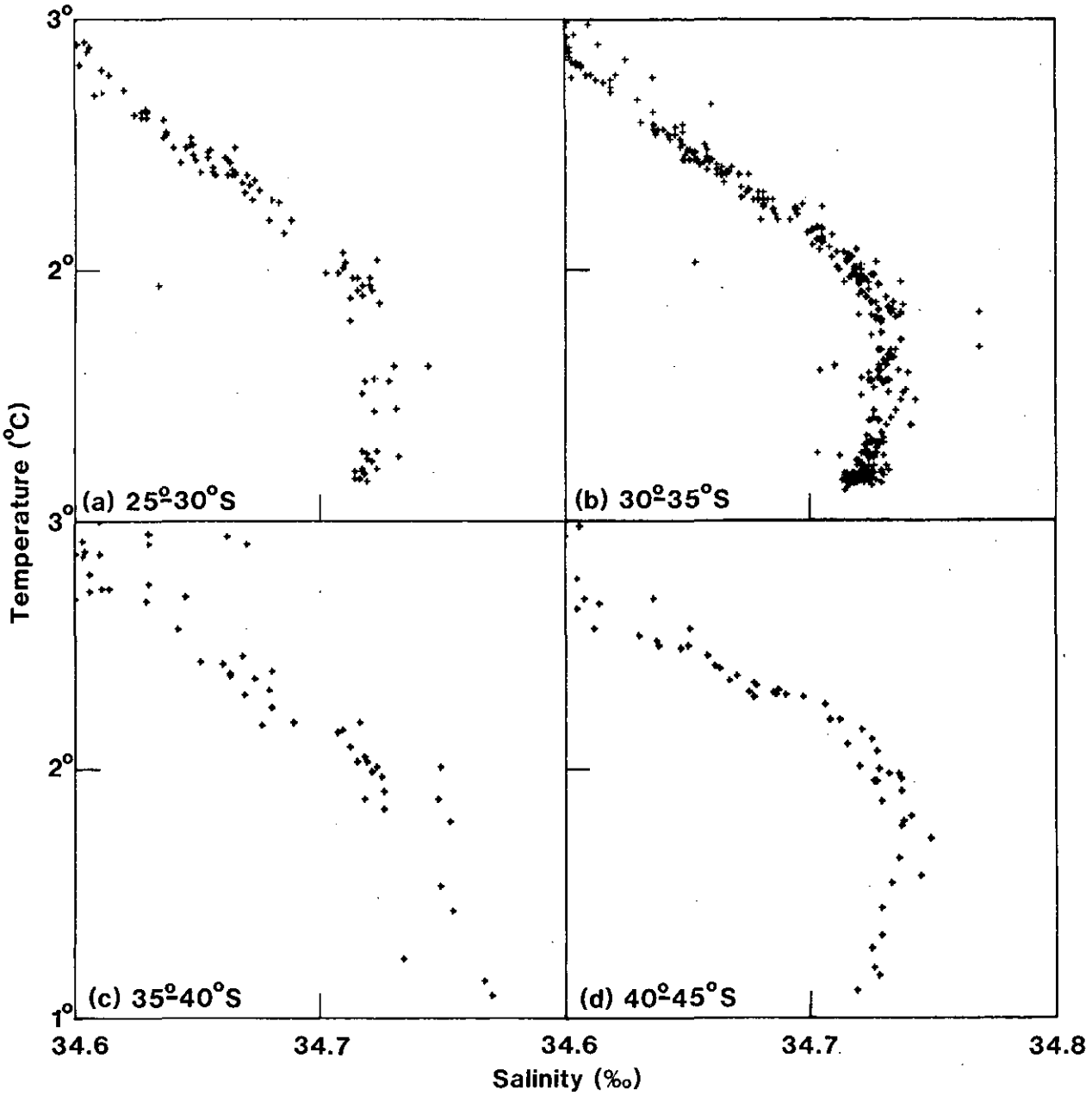

Fig. 6. T-S scatter plots in the region of the deep salinity maximum, for the four areas.

Table 8. Coefficients of 4th degree polynomials fitted to mean salinities (after one smoothing) at 0.1°C intervals. The right-hand column gives the RMS difference between the mean values in each 0.1°C interval and the fitted values.

Salinity $S = C_0 + C_1T + C_2T^2 + C_3T^3 + C_4T^4$ (‰)

Latitude band (°S)	C_0	C_1	C_2	C_3	C_4	Applicable temperature range (°C)	RMS difference (‰)
25-30	35.1583	-2.99800×10^{-1}	4.03824×10^{-2}	-1.59698×10^{-3}	1.93343×10^{-5}	2.5-27.8	0.020
30-35	35.2692	-3.57427×10^{-1}	4.92220×10^{-2}	-2.08012×10^{-3}	2.79178×10^{-5}	2.5-26.9	0.015
35-40	35.5719	-5.10475×10^{-1}	7.28711×10^{-2}	-3.41785×10^{-3}	5.27338×10^{-5}	2.5-25.1	0.027
40-45	35.7054	-6.12866×10^{-1}	9.46367×10^{-2}	-5.16169×10^{-3}	9.79726×10^{-5}	2.5-20.0	0.037
25-45	35.2670	-3.61225×10^{-1}	5.03699×10^{-2}	-2.15048×10^{-3}	2.91048×10^{-5}	2.5-28.0	0.023

Seasonal Variability

The seasonal changes in the T-S characteristics of the four regions have not been analysed. A preliminary study for part of the area showed virtually no change in the shape of the mean T-S curve or in the standard deviations below 19°C; above this, summer temperatures reach 28°C compared with about 23°C in winter, but the salinity is not greatly affected by season. Tomczak (in press) found little difference between the summer and winter characteristics in the northern Tasman Sea; further south there was some evidence of more of the higher salinity Bass Strait water in winter but no clear seasonal variation could be discerned.

Tabulated Results — Mean Salinity, Sigma-t, and Thermosteric Anomaly

Appendix Tables 1-5 list the mean salinities for the 5° latitude bands as well as the whole area (25-45°S) in 0.1°C intervals. Appendix Tables 6-10 contain the corresponding sigma-t values, and Appendix Tables 11-15 the thermosteric anomaly ($10^5\ \Delta_{st}$), which can be used for estimating dynamic heights directly from temperature profiles.

A summary of the mean T-S data is given in Appendix Tables 16-20, which show the mean salinity and standard deviation for quality control purposes. For a normal population, over 99% of the data points should lie within 3 standard deviations of the mean.

Curve-Fitting by Polynomials

For some purposes, it may be more convenient to use a polynomial expression for the mean T-S curve rather than tabulated values. Polynomials of degree 3, 4 and 5 were fitted, using a simple least-squares method, to the once-smoothed mean salinity curves for each 5° area as well as the entire 25-45° area. It was found that the functions were badly distorted by the sharp inflection in the curves at the deep salinity maximum, so the curves have been cut off below 2.5°C.

Fig. 7 shows the 3rd, 4th and 5th degree polynomials for the large area (25-45°). The 3rd degree curve is clearly inadequate, but the 4th and 5th degree appear to be equally good in approximating the mean data — in fact, the 4th degree is perhaps better at the endpoints, so the 4th degree curves have been selected here. The results for the four 5° latitude areas are plotted in Fig. 8, and the polynomial coefficients are listed in Table 8. RMS differences between the salinity computed from the polynomial and the original (once-smoothed) mean salinities are seen to be 0.02-0.04‰, with the southernmost area having the worst errors due to the kinky curve.

SUMMARY AND CONCLUSIONS

Apart from the mean salinity curves and tables (which were the original objectives of this study), the following conclusions have been reached:
(1) A small percentage of the data in the CSIRO hydrology store may be suspect.
(2) The mean T-S curves for the four areas (25-30°, 30-35°, 35-40° and 40-45°S) are very similar in shape, indicating overall similarity of the water mass properties.
(3) The important water masses seem to be South Equatorial, Subtropical, Sub-Antarctic, Antarctic Intermediate, Deep Water, and Antarctic Bottom Water, with a contribution from Bass Strait giving a small latitudinal progression in T-S characteristics.
(4) The T-S properties of Antarctic Intermediate Water (a salinity minimum) and Deep Water (a salinity maximum) agree well with previous work.
(5) Seasonal variability of the T-S curves has not been studied specifically, but is restricted to the warm upper layer (as would be expected).
(6) It is desirable that a definitive study of the nomenclature and T-S characteristics of the water masses in the Tasman Sea be undertaken, to clarify some of the ambiguities and differences of opinion existing in the literature at present.

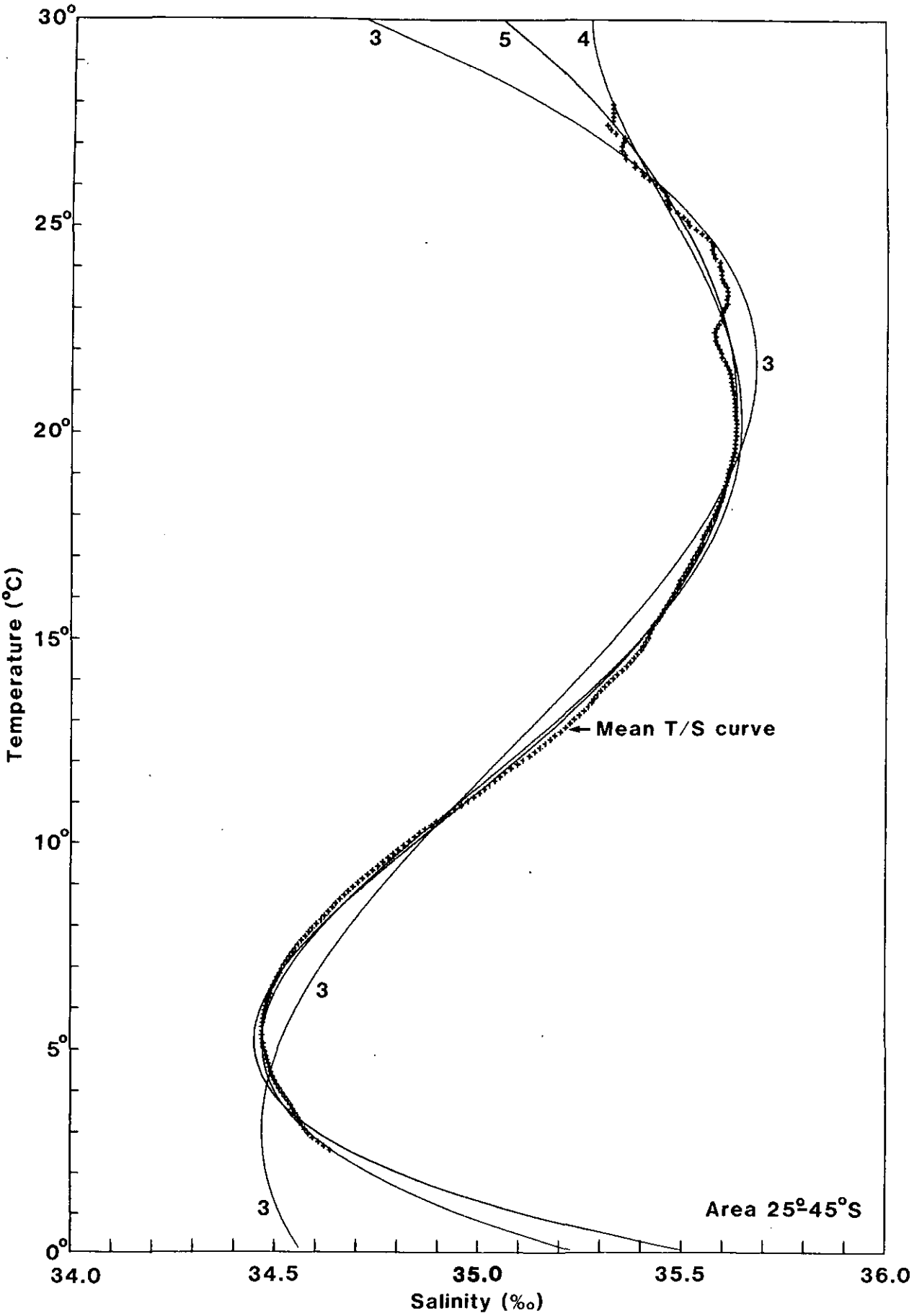

Fig. 7. Mean T-S curve (once-smoothed) for the areas 25°-45°, shown by crosses; and the best-fit polynomial of degrees 3, 4 and 5.

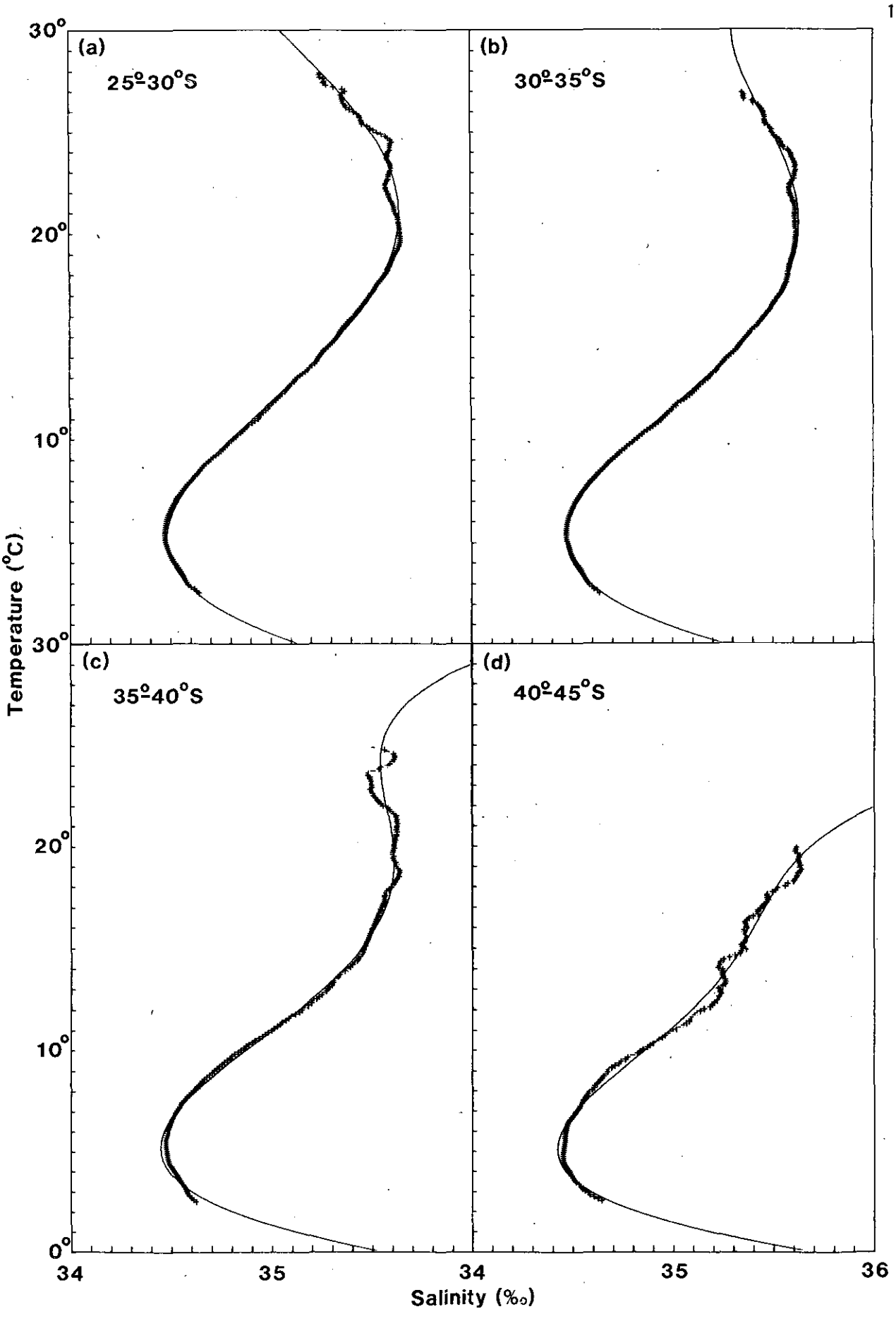

Fig. 8. Mean T-S curves (once-smoothed) for the four latitude areas, with the best-fit fourth degree polynomial.

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APPENDIX TABLES 1-20

Table A1. Mean salinity (‰) at 0.1 C intervals.

Latitude band 25°-30°S.

TEMp	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	34.72	34.72	34.72	34.72	34.72	34.72	34.72	34.72	34.71	34.70
2	34.69	34.68	34.67	34.67	34.66	34.65	34.63	34.62	34.61	34.59
3	34.58	34.57	34.57	34.56	34.56	34.55	34.55	34.54	34.53	34.52
4	34.52	34.51	34.50	34.50	34.49	34.49	34.49	34.48	34.48	34.48
5	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.48	34.48
6	34.48	34.48	34.48	34.49	34.49	34.49	34.50	34.50	34.51	34.52
7	34.52	34.53	34.53	34.54	34.55	34.56	34.56	34.57	34.58	34.59
8	34.60	34.61	34.62	34.63	34.64	34.64	34.65	34.66	34.67	34.68
9	34.70	34.71	34.72	34.73	34.75	34.76	34.77	34.78	34.79	34.80
10	34.81	34.82	34.83	34.84	34.85	34.86	34.87	34.88	34.90	34.91
11	34.93	34.94	34.95	34.95	34.97	34.98	34.99	35.00	35.01	35.02
12	35.03	35.04	35.05	35.06	35.08	35.08	35.09	35.10	35.11	35.12
13	35.13	35.14	35.15	35.17	35.18	35.19	35.20	35.21	35.23	35.23
14	35.24	35.25	35.25	35.26	35.27	35.28	35.29	35.30	35.31	35.32
15	35.33	35.34	35.34	35.35	35.36	35.36	35.37	35.38	35.39	35.40
16	35.41	35.42	35.43	35.44	35.44	35.45	35.46	35.47	35.48	35.48
17	35.49	35.50	35.51	35.52	35.52	35.53	35.53	35.54	35.55	35.56
18	35.56	35.57	35.58	35.59	35.59	35.60	35.60	35.61	35.61	35.61
19	35.62	35.62	35.63	35.64	35.64	35.64	35.65	35.65	35.65	35.65
20	35.65	35.65	35.65	35.65	35.64	35.64	35.64	35.64	35.64	35.64
21	35.63	35.62	35.62	35.62	35.62	35.61	35.61	35.60	35.60	35.59
22	35.59	35.59	35.58	35.58	35.57	35.57	35.58	35.58	35.59	35.59
23	35.59	35.60	35.60	35.60	35.60	35.60	35.59	35.58	35.58	35.58
24	35.59	35.59	35.60	35.60	35.60	35.60	35.60	35.59	35.58	35.56
25	35.54	35.52	35.51	35.49	35.47	35.46	35.46	35.45	35.45	35.44
26	35.43	35.41	35.39	35.38	35.37	35.36	35.36	35.36	35.36	35.36
27	35.37	35.37	35.34	35.30	35.27	35.27	35.27	35.26	35.25	35.25

Table A2. Mean salinity (‰) at 0.1°C intervals.

Latitude band 30°-35°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	34.72	34.72	34.72	34.72	34.72	34.72	34.72	34.72	34.72	34.72
2	34.71	34.70	34.69	34.68	34.67	34.65	34.63	34.61	34.60	34.59
3	34.58	34.57	34.56	34.56	34.55	34.55	34.54	34.54	34.53	34.52
4	34.51	34.51	34.50	34.50	34.49	34.49	34.49	34.48	34.48	34.48
5	34.48	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.48
6	34.48	34.48	34.48	34.49	34.49	34.50	34.50	34.50	34.51	34.51
7	34.52	34.53	34.53	34.54	34.55	34.55	34.56	34.57	34.58	34.59
8	34.60	34.61	34.62	34.62	34.63	34.65	34.66	34.67	34.68	34.68
9	34.70	34.71	34.72	34.73	34.74	34.75	34.77	34.78	34.79	34.80
10	34.82	34.83	34.84	34.85	34.87	34.88	34.89	34.91	34.92	34.94
11	34.95	34.96	34.97	34.98	34.99	35.00	35.01	35.02	35.04	35.05
12	35.07	35.08	35.10	35.11	35.12	35.13	35.14	35.15	35.16	35.17
13	35.18	35.19	35.20	35.21	35.22	35.23	35.24	35.25	35.26	35.27
14	35.28	35.29	35.30	35.31	35.32	35.33	35.34	35.35	35.36	35.36
15	35.37	35.38	35.39	35.40	35.41	35.42	35.43	35.44	35.45	35.45
16	35.46	35.47	35.48	35.49	35.49	35.50	35.50	35.51	35.52	35.53
17	35.53	35.54	35.55	35.56	35.56	35.56	35.57	35.57	35.58	35.58
18	35.58	35.58	35.58	35.59	35.59	35.59	35.60	35.60	35.60	35.60
19	35.61	35.61	35.61	35.61	35.62	35.62	35.62	35.62	35.62	35.62
20	35.62	35.62	35.62	35.62	35.62	35.62	35.62	35.62	35.62	35.62
21	35.62	35.62	35.62	35.62	35.62	35.61	35.61	35.61	35.60	35.60
22	35.59	35.59	35.59	35.59	35.59	35.59	35.60	35.61	35.61	35.61
23	35.62	35.62	35.62	35.62	35.62	35.61	35.61	35.60	35.60	35.60
24	35.59	35.58	35.57	35.56	35.55	35.55	35.54	35.53	35.52	35.51
25	35.50	35.50	35.50	35.49	35.48	35.47	35.47	35.47	35.47	35.46
26	35.46	35.46	35.45	35.44	35.42	35.41	35.38	35.36	35.36	35.36

Table A3. Mean salinity (‰) at 0.1°C intervals.

Latitude band 35°-40°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	34.74	34.74	34.74	34.75	34.75	34.74	34.74	34.73	34.72	34.72
2	34.71	34.70	34.69	34.68	34.66	34.64	34.62	34.60	34.59	34.59
3	34.58	34.57	34.57	34.56	34.56	34.55	34.54	34.54	34.53	34.52
4	34.52	34.51	34.50	34.50	34.49	34.49	34.48	34.48	34.48	34.48
5	34.48	34.48	34.47	34.47	34.47	34.47	34.47	34.47	34.48	34.48
6	34.48	34.48	34.49	34.49	34.49	34.50	34.50	34.51	34.51	34.52
7	34.52	34.53	34.54	34.54	34.55	34.55	34.56	34.57	34.58	34.59
8	34.60	34.61	34.62	34.63	34.64	34.65	34.66	34.67	34.68	34.70
9	34.71	34.72	34.73	34.74	34.76	34.77	34.78	34.80	34.81	34.82
10	34.84	34.85	34.87	34.88	34.89	34.91	34.93	34.94	34.96	34.97
11	34.99	35.00	35.02	35.03	35.04	35.06	35.08	35.09	35.11	35.12
12	35.14	35.15	35.17	35.19	35.20	35.21	35.23	35.24	35.25	35.26
13	35.27	35.28	35.29	35.30	35.31	35.32	35.32	35.33	35.34	35.36
14	35.37	35.38	35.40	35.41	35.42	35.43	35.43	35.44	35.45	35.46
15	35.46	35.47	35.47	35.47	35.48	35.48	35.49	35.49	35.49	35.50
16	35.50	35.51	35.51	35.52	35.52	35.52	35.53	35.53	35.54	35.54
17	35.55	35.55	35.55	35.56	35.56	35.56	35.56	35.57	35.57	35.58
18	35.59	35.60	35.61	35.61	35.62	35.63	35.63	35.64	35.64	35.63
19	35.62	35.62	35.62	35.61	35.60	35.60	35.60	35.60	35.60	35.61
20	35.61	35.61	35.61	35.61	35.61	35.62	35.62	35.62	35.62	35.62
21	35.62	35.62	35.62	35.62	35.62	35.62	35.61	35.60	35.59	35.58
22	35.57	35.55	35.54	35.53	35.52	35.51	35.51	35.50	35.49	35.49
23	35.50	35.50	35.50	35.49	35.49	35.48	35.48	35.49	35.52	35.54
24	35.56	35.58	35.60	35.61	35.61	35.61	35.61	35.60	35.57	35.53
25	35.51	35.50	35.49	35.49	35.49	35.50	35.51	35.52	35.54	35.55

Table A4. Mean salinity (‰) at 0.1°C intervals.

Latitude band 40°-45°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	34.72	34.72	34.73	34.73	34.73	34.73	34.73	34.73	34.73	34.72
2	34.71	34.70	34.69	34.68	34.67	34.65	34.63	34.61	34.59	34.58
3	34.57	34.55	34.54	34.53	34.52	34.51	34.50	34.50	34.49	34.49
4	34.48	34.47	34.47	34.46	34.46	34.45	34.45	34.45	34.45	34.45
5	34.45	34.45	34.46	34.46	34.46	34.46	34.46	34.46	34.46	34.46
6	34.46	34.47	34.47	34.47	34.47	34.48	34.49	34.50	34.50	34.51
7	34.52	34.53	34.53	34.54	34.54	34.55	34.55	34.56	34.57	34.58
8	34.59	34.60	34.61	34.61	34.62	34.63	34.64	34.65	34.66	34.67
9	34.67	34.68	34.70	34.72	34.73	34.75	34.77	34.78	34.81	34.83
10	34.84	34.86	34.87	34.89	34.91	34.92	34.94	34.95	34.97	34.98
11	35.00	35.02	35.04	35.06	35.07	35.08	35.09	35.10	35.11	35.12
12	35.14	35.17	35.19	35.20	35.21	35.22	35.23	35.23	35.24	35.23
13	35.23	35.23	35.25	35.26	35.26	35.26	35.25	35.24	35.24	35.24
14	35.23	35.22	35.23	35.23	35.24	35.26	35.29	35.32	35.33	35.35
15	35.35	35.34	35.35	35.36	35.36	35.37	35.37	35.36	35.35	35.36
16	35.37	35.36	35.36	35.36	35.37	35.39	35.41	35.42	35.42	35.43
17	35.44	35.45	35.46	35.47	35.47	35.47	35.47	35.48	35.50	35.51
18	35.54	35.56	35.58	35.60	35.61	35.62	35.62	35.62	35.64	35.63
19	35.63	35.63	35.63	35.62	35.62	35.63	35.62	35.61	35.61	35.61
20	35.62	35.62	35.63	35.64	35.65	35.65	35.65	35.65	35.65	35.65

Table A5. Mean salinity (‰) at 0.1°C intervals.

Latitude band 25°-45°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	34.72	34.72	34.72	34.72	34.73	34.73	34.72	34.72	34.72	34.71
2	34.70	34.69	34.69	34.68	34.67	34.65	34.63	34.61	34.60	34.59
3	34.58	34.57	34.56	34.56	34.55	34.55	34.54	34.54	34.53	34.52
4	34.51	34.51	34.50	34.50	34.49	34.49	34.49	34.48	34.48	34.48
5	34.48	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.47	34.48
6	34.48	34.48	34.48	34.49	34.49	34.50	34.50	34.50	34.51	34.52
7	34.52	34.53	34.53	34.54	34.55	34.55	34.56	34.57	34.58	34.59
8	34.60	34.61	34.62	34.63	34.64	34.65	34.66	34.67	34.68	34.69
9	34.70	34.71	34.72	34.73	34.75	34.76	34.77	34.78	34.80	34.81
10	34.82	34.84	34.85	34.86	34.88	34.89	34.90	34.92	34.94	34.95
11	34.97	34.98	35.00	35.01	35.02	35.03	35.05	35.06	35.07	35.09
12	35.10	35.12	35.13	35.14	35.16	35.17	35.18	35.19	35.21	35.22
13	35.23	35.24	35.25	35.26	35.27	35.28	35.29	35.30	35.30	35.31
14	35.32	35.33	35.35	35.36	35.37	35.38	35.38	35.39	35.40	35.41
15	35.41	35.42	35.42	35.43	35.43	35.44	35.45	35.45	35.46	35.47
16	35.47	35.48	35.48	35.49	35.49	35.50	35.51	35.51	35.52	35.52
17	35.53	35.53	35.54	35.55	35.55	35.55	35.56	35.56	35.57	35.57
18	35.58	35.58	35.59	35.59	35.59	35.60	35.60	35.60	35.60	35.61
19	35.61	35.61	35.62	35.62	35.62	35.62	35.63	35.63	35.63	35.63
20	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.63	35.62
21	35.62	35.62	35.62	35.62	35.62	35.61	35.61	35.60	35.60	35.59
22	35.59	35.58	35.58	35.58	35.58	35.58	35.58	35.59	35.59	35.59
23	35.60	35.60	35.60	35.61	35.61	35.60	35.60	35.59	35.59	35.59
24	35.59	35.59	35.58	35.57	35.57	35.57	35.57	35.56	35.55	35.54
25	35.52	35.51	35.50	35.49	35.47	35.46	35.46	35.46	35.46	35.45
26	35.44	35.42	35.41	35.40	35.39	35.38	35.37	35.35	35.35	35.35
27	35.35	35.35	35.34	35.33	35.32	35.32	35.33	35.33	35.33	35.33

Table A6. Sigma-t (computed from the mean salinity) at 0.1°C intervals.

Latitude band 25°-30°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	27.84	27.83	27.83	27.82	27.81	27.81	27.80	27.79	27.78	27.76
2	27.74	27.73	27.71	27.70	27.69	27.67	27.65	27.63	27.61	27.59
3	27.57	27.56	27.54	27.53	27.52	27.50	27.49	27.47	27.45	27.44
4	27.42	27.41	27.39	27.38	27.36	27.35	27.33	27.32	27.31	27.29
5	27.28	27.27	27.25	27.24	27.23	27.22	27.21	27.19	27.18	27.17
6	27.16	27.15	27.14	27.13	27.12	27.11	27.10	27.09	27.08	27.07
7	27.06	27.05	27.04	27.03	27.03	27.02	27.01	27.00	26.99	26.99
8	26.98	26.97	26.96	26.95	26.95	26.94	26.93	26.92	26.91	26.90
9	26.90	26.89	26.88	26.88	26.87	26.86	26.86	26.85	26.84	26.83
10	26.82	26.81	26.80	26.79	26.79	26.78	26.77	26.76	26.75	26.74
11	26.74	26.73	26.71	26.70	26.69	26.68	26.67	26.66	26.65	26.64
12	26.63	26.62	26.61	26.60	26.59	26.57	26.56	26.55	26.54	26.52
13	26.51	26.50	26.49	26.48	26.47	26.45	26.44	26.43	26.42	26.40
14	26.39	26.37	26.36	26.34	26.33	26.31	26.30	26.29	26.27	26.26
15	26.24	26.23	26.21	26.19	26.17	26.16	26.14	26.13	26.11	26.09
16	26.08	26.06	26.05	26.03	26.01	25.99	25.98	25.96	25.94	25.93
17	25.91	25.89	25.87	25.85	25.83	25.81	25.79	25.78	25.76	25.74
18	25.72	25.70	25.68	25.66	25.64	25.62	25.60	25.58	25.55	25.53
19	25.51	25.49	25.47	25.45	25.42	25.40	25.38	25.35	25.33	25.30
20	25.27	25.24	25.22	25.19	25.16	25.13	25.11	25.08	25.05	25.02
21	24.99	24.96	24.93	24.90	24.87	24.84	24.81	24.78	24.74	24.71
22	24.68	24.65	24.62	24.59	24.56	24.53	24.51	24.48	24.45	24.43
23	24.40	24.38	24.35	24.32	24.29	24.26	24.22	24.19	24.16	24.13
24	24.10	24.08	24.05	24.02	23.99	23.97	23.94	23.90	23.86	23.82
25	23.77	23.73	23.68	23.64	23.60	23.55	23.52	23.49	23.45	23.42
26	23.37	23.33	23.28	23.24	23.21	23.17	23.14	23.10	23.07	23.04
27	23.02	22.98	22.93	22.87	22.82	22.78	22.75	22.71	22.67	22.63

Table A7. Sigma-t (computed from the mean salinity) at 0.1°C intervals.
Latitude band 30°-35°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	27.84	27.84	27.83	27.82	27.82	27.81	27.80	27.79	27.78	27.77
2	27.76	27.74	27.73	27.71	27.69	27.67	27.64	27.62	27.61	27.59
3	27.57	27.55	27.54	27.53	27.51	27.50	27.48	27.47	27.45	27.44
4	27.42	27.40	27.39	27.38	27.36	27.35	27.33	27.32	27.31	27.29
5	27.28	27.27	27.25	27.24	27.23	27.22	27.21	27.19	27.18	27.17
6	27.16	27.15	27.14	27.13	27.12	27.11	27.10	27.09	27.08	27.07
7	27.06	27.05	27.04	27.03	27.02	27.02	27.01	27.00	26.99	26.98
8	26.98	26.97	26.96	26.95	26.95	26.94	26.93	26.92	26.91	26.91
9	26.90	26.89	26.88	26.88	26.87	26.86	26.86	26.85	26.84	26.83
10	26.83	26.82	26.81	26.80	26.80	26.79	26.78	26.78	26.77	26.76
11	26.75	26.74	26.73	26.72	26.71	26.70	26.69	26.68	26.67	26.67
12	26.66	26.65	26.64	26.63	26.62	26.61	26.60	26.58	26.57	26.56
13	26.55	26.54	26.52	26.51	26.50	26.49	26.47	26.46	26.44	26.43
14	26.42	26.41	26.39	26.38	26.37	26.35	26.34	26.32	26.31	26.29
15	26.28	26.26	26.24	26.23	26.21	26.20	26.19	26.17	26.15	26.14
16	26.12	26.10	26.08	26.07	26.05	26.03	26.01	25.99	25.98	25.96
17	25.94	25.92	25.90	25.88	25.86	25.84	25.82	25.80	25.78	25.76
18	25.73	25.71	25.68	25.66	25.64	25.62	25.59	25.57	25.55	25.53
19	25.50	25.48	25.45	25.43	25.40	25.38	25.36	25.33	25.30	25.28
20	25.25	25.23	25.20	25.17	25.14	25.12	25.09	25.06	25.03	25.01
21	24.98	24.95	24.93	24.90	24.87	24.84	24.81	24.78	24.75	24.72
22	24.68	24.65	24.62	24.60	24.57	24.54	24.52	24.50	24.47	24.44
23	24.42	24.39	24.36	24.33	24.30	24.27	24.24	24.20	24.17	24.14
24	24.11	24.07	24.03	23.99	23.96	23.92	23.89	23.85	23.81	23.77
25	23.74	23.71	23.68	23.64	23.60	23.56	23.53	23.50	23.47	23.43
26	23.40	23.36	23.33	23.29	23.24	23.20	23.15	23.10	23.07	23.04

Table A8. Sigma-t (computed from the mean salinity) at 0.1°C intervals.

Latitude band 35°-40°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	27.85	27.85	27.85	27.84	27.84	27.82	27.81	27.80	27.79	27.77
2	27.76	27.74	27.73	27.71	27.69	27.66	27.64	27.62	27.60	27.58
3	27.57	27.56	27.54	27.53	27.51	27.50	27.48	27.47	27.45	27.44
4	27.42	27.41	27.39	27.38	27.36	27.35	27.33	27.32	27.31	27.29
5	27.28	27.27	27.26	27.24	27.23	27.22	27.21	27.20	27.18	27.17
6	27.16	27.15	27.14	27.13	27.12	27.11	27.10	27.09	27.08	27.07
7	27.06	27.05	27.05	27.04	27.03	27.02	27.01	27.00	26.99	26.99
8	26.98	26.97	26.97	26.96	26.95	26.94	26.93	26.93	26.92	26.91
9	26.91	26.90	26.89	26.89	26.88	26.88	26.87	26.86	26.85	26.85
10	26.84	26.84	26.83	26.82	26.82	26.81	26.81	26.80	26.80	26.79
11	26.78	26.78	26.77	26.76	26.75	26.75	26.74	26.73	26.73	26.72
12	26.72	26.71	26.70	26.69	26.68	26.67	26.67	26.66	26.65	26.63
13	26.62	26.61	26.59	26.58	26.57	26.55	26.54	26.52	26.51	26.50
14	26.49	26.48	26.47	26.45	26.44	26.43	26.41	26.39	26.38	26.36
15	26.34	26.33	26.31	26.29	26.27	26.25	26.23	26.21	26.19	26.17
16	26.15	26.13	26.11	26.09	26.07	26.05	26.03	26.01	25.99	25.97
17	25.95	25.93	25.91	25.89	25.86	25.84	25.82	25.80	25.77	25.75
18	25.74	25.72	25.70	25.68	25.66	25.65	25.62	25.60	25.58	25.55
19	25.51	25.48	25.46	25.43	25.40	25.37	25.34	25.32	25.29	25.27
20	25.24	25.22	25.19	25.17	25.14	25.11	25.09	25.06	25.04	25.01
21	24.98	24.96	24.93	24.90	24.87	24.84	24.81	24.78	24.74	24.71
22	24.67	24.62	24.59	24.55	24.52	24.48	24.45	24.42	24.38	24.36
23	24.33	24.30	24.27	24.24	24.21	24.17	24.14	24.12	24.11	24.10
24	24.08	24.07	24.05	24.03	24.00	23.97	23.94	23.90	23.85	23.79
25	23.74	23.71	23.67	23.64	23.61	23.58	23.56	23.54	23.52	23.50

Table A9. Sigma-t (computed from the mean salinity) at 0.1°C intervals. Latitude band 40°-45°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	27.84	27.84	27.83	27.83	27.82	27.81	27.81	27.80	27.79	27.77
2	27.76	27.74	27.73	27.71	27.70	27.67	27.65	27.62	27.60	27.58
3	27.56	27.54	27.52	27.51	27.49	27.47	27.45	27.44	27.42	27.41
4	27.40	27.38	27.36	27.35	27.33	27.32	27.31	27.29	27.28	27.27
5	27.26	27.25	27.24	27.23	27.22	27.21	27.20	27.18	27.17	27.16
6	27.15	27.14	27.13	27.12	27.11	27.10	27.09	27.08	27.08	27.07
7	27.06	27.05	27.04	27.03	27.02	27.01	27.00	26.99	26.99	26.98
8	26.97	26.96	26.95	26.94	26.94	26.93	26.92	26.91	26.90	26.89
9	26.88	26.87	26.87	26.87	26.86	26.86	26.85	26.85	26.85	26.85
10	26.84	26.84	26.84	26.83	26.83	26.82	26.82	26.81	26.80	26.80
11	26.80	26.79	26.79	26.78	26.77	26.76	26.75	26.74	26.73	26.72
12	26.72	26.72	26.71	26.70	26.69	26.68	26.67	26.65	26.63	26.61
13	26.59	26.57	26.56	26.55	26.53	26.51	26.48	26.45	26.43	26.41
14	26.38	26.36	26.34	26.32	26.31	26.30	26.30	26.30	26.29	26.28
15	26.26	26.23	26.21	26.20	26.18	26.16	26.14	26.11	26.08	26.06
16	26.05	26.02	25.99	25.97	25.96	25.95	25.94	25.93	25.90	25.88
17	25.87	25.85	25.83	25.82	25.79	25.77	25.74	25.73	25.72	25.71
18	25.70	25.69	25.69	25.67	25.66	25.63	25.61	25.59	25.57	25.55
19	25.52	25.49	25.46	25.44	25.41	25.39	25.36	25.32	25.29	25.27
20	25.25	25.23	25.21	25.19	25.17	25.14	25.11	25.09	25.06	25.03

Table A10. Sigma-t (computed from the mean salinity) at 0.1°C intervals.

Latitude band 25°-45°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	27.84	27.84	27.83	27.82	27.82	27.81	27.80	27.79	27.78	27.77
2	27.75	27.74	27.73	27.71	27.69	27.67	27.64	27.62	27.60	27.59
3	27.57	27.55	27.54	27.53	27.51	27.50	27.48	27.47	27.45	27.44
4	27.42	27.40	27.39	27.37	27.36	27.35	27.33	27.32	27.31	27.29
5	27.28	27.27	27.25	27.24	27.23	27.22	27.21	27.19	27.18	27.17
6	27.16	27.15	27.14	27.13	27.12	27.11	27.10	27.09	27.08	27.07
7	27.06	27.05	27.04	27.03	27.03	27.02	27.01	27.00	26.99	26.98
8	26.98	26.97	26.96	26.95	26.95	26.94	26.93	26.92	26.92	26.91
9	26.90	26.89	26.89	26.88	26.87	26.87	26.86	26.85	26.84	26.84
10	26.83	26.82	26.82	26.81	26.80	26.80	26.79	26.79	26.78	26.77
11	26.77	26.76	26.75	26.74	26.74	26.73	26.72	26.71	26.70	26.69
12	26.69	26.68	26.67	26.66	26.65	26.64	26.63	26.62	26.61	26.60
13	26.59	26.58	26.56	26.55	26.54	26.52	26.51	26.49	26.48	26.47
14	26.45	26.44	26.43	26.41	26.40	26.39	26.37	26.36	26.34	26.32
15	26.31	26.29	26.27	26.25	26.23	26.22	26.20	26.18	26.16	26.14
16	26.13	26.11	26.09	26.07	26.05	26.03	26.01	25.99	25.97	25.95
17	25.93	25.92	25.90	25.88	25.85	25.83	25.81	25.79	25.77	25.75
18	25.73	25.71	25.69	25.67	25.64	25.62	25.60	25.57	25.55	25.53
19	25.50	25.48	25.46	25.43	25.41	25.39	25.36	25.34	25.31	25.28
20	25.26	25.23	25.21	25.18	25.15	25.12	25.10	25.07	25.04	25.01
21	24.98	24.96	24.93	24.90	24.87	24.84	24.81	24.78	24.74	24.71
22	24.68	24.65	24.62	24.59	24.56	24.53	24.51	24.48	24.46	24.43
23	24.40	24.38	24.35	24.32	24.30	24.26	24.23	24.20	24.17	24.14
24	24.10	24.07	24.04	24.00	23.97	23.94	23.91	23.87	23.84	23.79
25	23.75	23.72	23.68	23.64	23.60	23.56	23.52	23.49	23.46	23.42
26	23.38	23.34	23.30	23.26	23.22	23.18	23.14	23.10	23.06	23.03
27	23.00	22.97	22.93	22.89	22.85	22.82	22.79	22.76	22.72	22.69

Table A11. Thermosteric anomaly ($10^5 \Delta_{st}$; computed from the mean salinity) at 0.1°C intervals. Latitude band 25°-30°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	27	27	28	28	29	30	31	31	32	34
2	36	37	38	40	41	43	45	46	48	50
3	52	53	55	56	57	59	60	62	63	65
4	66	68	69	70	72	73	75	76	77	79
5	80	81	82	83	84	86	87	88	89	90
6	91	92	93	94	95	96	97	98	99	100
7	100	101	102	103	104	104	105	106	107	108
8	108	109	110	111	111	112	113	114	115	115
9	116	117	117	118	118	119	120	121	122	122
10	123	124	125	126	126	127	128	129	130	131
11	131	132	133	134	135	136	137	138	139	140
12	141	142	143	144	145	147	148	149	150	151
13	153	154	155	156	157	158	159	160	161	163
14	164	166	167	169	170	171	172	174	175	177
15	178	180	181	183	185	186	188	189	191	192
16	194	195	197	198	200	202	203	205	206	208
17	210	212	213	215	217	219	221	222	224	226
18	228	230	231	233	235	237	239	241	243	246
19	248	250	252	254	256	258	260	263	265	268
20	270	273	275	278	281	283	286	289	291	294
21	297	300	303	306	309	312	315	318	321	324
22	326	329	333	335	338	341	343	346	348	351
23	353	356	358	361	364	367	370	373	376	379
24	382	384	387	389	392	395	398	401	405	409
25	413	418	422	426	430	434	437	440	444	447
26	451	455	460	464	467	471	474	477	480	483
27	485	489	494	500	505	508	511	515	519	522

Table A12. Thermosteric anomaly (10^5 Δ_{st}; computed from the mean salinity) at 0.1°C intervals. Latitude band 30°-35°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	26	27	28	28	29	29	30	31	32	33
2	34	36	37	38	40	43	45	47	49	51
3	52	54	55	56	58	59	60	62	63	65
4	66	68	69	71	72	73	74	76	77	78
5	80	81	82	83	84	86	87	88	89	90
6	91	92	93	94	95	96	97	98	99	100
7	101	101	102	103	104	105	105	106	107	108
8	109	109	110	111	111	112	113	113	114	115
9	116	116	117	118	119	119	120	120	121	122
10	123	123	124	125	126	126	127	127	128	129
11	130	131	132	133	134	135	135	136	137	138
12	139	139	140	141	142	143	145	146	147	148
13	149	150	151	152	154	155	156	158	159	160
14	161	163	164	165	166	167	169	171	172	174
15	175	176	178	180	181	182	183	185	187	188
16	190	191	193	195	196	198	200	202	203	205
17	207	208	210	212	214	216	218	220	222	224
18	227	229	231	233	235	238	240	242	244	246
19	248	251	253	255	258	260	262	265	267	270
20	272	275	277	280	282	285	288	290	293	296
21	298	301	303	306	309	311	314	317	320	323
22	326	329	332	335	337	340	342	344	346	349
23	352	354	357	360	363	366	369	372	375	378
24	381	385	389	392	396	399	402	406	409	413
25	416	419	422	426	430	433	436	439	442	446

Table A13. Thermosteric anomaly ($10^5 \Delta_{st}$; computed from the mean salinity) at 0.1°C intervals. Latitude band 35°-40°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	25	26	26	26	27	28	29	31	32	33
2	35	36	37	39	41	44	46	48	49	51
3	52	54	55	56	58	59	60	62	63	65
4	66	68	69	71	72	73	75	76	77	78
5	80	81	82	83	84	86	87	88	89	90
6	91	92	93	94	95	96	97	98	98	99
7	100	101	102	103	104	105	105	106	107	107
8	108	109	109	110	111	112	112	113	114	114
9	115	116	116	117	117	118	119	119	120	121
10	121	122	122	123	124	124	124	125	125	126
11	127	127	128	129	130	130	131	131	132	133
12	133	134	135	135	136	137	138	139	140	141
13	142	143	145	146	147	149	150	151	153	154
14	155	156	157	158	159	161	162	164	165	167
15	168	170	172	174	176	178	179	181	183	185
16	187	189	191	192	194	196	198	200	202	204
17	206	208	210	212	214	216	219	221	223	224
18	226	227	229	231	233	235	237	239	241	244
19	247	250	253	255	258	261	263	266	269	271
20	273	276	278	280	283	285	288	290	293	295
21	298	300	303	306	308	311	314	317	321	324
22	328	332	335	339	342	345	349	352	355	358
23	360	363	366	369	372	375	378	380	381	382
24	383	385	387	389	391	394	397	401	405	411
25	416	420	423	426	429	431	434	436	437	439

Table A14. Thermosteric anomaly (10^5 Δ_{st}; computed from the mean salinity) at 0.1°C intervals. Latitude band 40°-45°S.

TEMP	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	26	27	27	28	28	29	30	30	31	33
2	34	36	37	39	40	42	45	47	49	51
3	53	55	57	58	60	62	63	65	66	67
4	69	70	72	73	75	76	77	78	79	80
5	81	82	83	84	85	86	88	89	90	91
6	92	93	94	95	96	97	98	98	99	100
7	101	101	102	103	104	105	106	107	108	108
8	109	110	111	112	112	113	114	115	116	116
9	117	118	119	119	119	120	120	120	120	120
10	121	121	122	122	123	123	124	124	125	125
11	126	126	126	127	128	129	130	131	132	133
12	133	133	133	134	135	136	138	139	141	143
13	145	147	148	149	151	153	156	158	160	162
14	165	167	169	171	172	172	173	173	174	175
15	176	179	181	182	184	186	188	191	193	195
16	197	199	202	204	205	206	207	208	210	212
17	214	215	217	218	221	223	225	227	228	229
18	230	230	231	232	234	236	238	240	242	244
19	247	249	252	255	257	259	262	265	268	271
20	273	275	276	278	280	283	285	288	290	293

Table A15. Thermosteric anomaly (10^5 Δ_{st}; computed from the mean salinity) at 0.1°C intervals. Latitude band 25°-45°S.

TEMP	Ø.Ø	Ø.1	Ø.2	Ø.3	Ø.4	Ø.5	Ø.6	Ø.7	Ø.8	Ø.9
1	26	27	28	28	29	29	30	31	32	33
2	35	36	37	39	41	43	45	47	49	51
3	52	54	55	56	58	59	60	62	63	65
4	66	68	69	71	72	73	75	76	77	78
5	80	81	82	83	84	86	87	88	89	90
6	91	92	93	94	95	96	97	98	99	99
7	100	101	102	103	104	105	105	106	107	108
8	108	109	110	110	111	112	113	114	114	115
9	116	116	117	118	118	119	120	120	121	122
10	122	123	123	124	125	125	126	127	127	128
11	128	129	130	130	131	132	133	134	135	135
12	136	137	138	138	139	140	141	142	143	144
13	145	146	148	149	150	151	153	154	155	157
14	158	159	161	162	163	164	166	167	169	170
15	172	174	176	177	179	181	182	184	186	187
16	189	191	193	194	196	198	200	202	204	205
17	207	209	211	213	215	217	219	221	223	225
18	227	229	231	233	235	237	239	242	244	246
19	248	251	253	255	257	260	262	264	267	269
20	272	274	277	279	282	284	287	290	292	295
21	298	300	303	306	309	311	314	317	320	323
22	326	329	332	335	338	341	343	345	348	350
23	353	355	358	361	363	366	369	373	376	378
24	381	384	388	391	394	397	400	403	407	411
25	415	419	422	426	430	434	437	440	443	447
26	450	454	459	462	466	470	473	477	481	484
27	487	490	493	498	502	504	507	510	513	516

Table A16. Mean salinity, standard deviation, and 3x range, at 1°C intervals. Latitude band 25°-30°S.

TEMP	SALNTY	STDEV	3*STDEV RANGE
1.	34.720	0.013	34.680-34.759
2.	34.689	0.015	34.644-34.734
3.	34.582	0.010	34.553-34.610
4.	34.517	0.010	34.488-34.546
5.	34.474	0.011	34.441-34.508
6.	34.478	0.013	34.438-34.518
7.	34.521	0.012	34.484-34.558
8.	34.598	0.012	34.562-34.635
9.	34.695	0.016	34.647-34.744
10.	34.809	0.018	34.755-34.862
11.	34.928	0.023	34.861-34.996
12.	35.034	0.027	34.953-35.114
13.	35.129	0.032	35.033-35.225
14.	35.237	0.032	35.140-35.334
15.	35.329	0.035	35.224-35.434
16.	35.410	0.035	35.306-35.515
17.	35.492	0.032	35.394-35.589
18.	35.564	0.042	35.438-35.690
19.	35.619	0.044	35.487-35.752
20.	35.647	0.046	35.509-35.786
21.	35.629	0.057	35.459-35.799
22.	35.590	0.068	35.385-35.795
23.	35.592	0.082	35.345-35.839
24.	35.585	0.119	35.228-35.942
25.	35.544	0.119	35.187-35.900
26.	35.426	0.097	35.134-35.719
27.	35.369	0.093	35.090-35.649

Table A17. Mean salinity, standard deviation, and 3x range, at 1°C intervals. Latitude band 30°-35°S.

TEMP	SALNTY	STDEV	3*STDEV RANGE
1.	34.722	0.009	34.696-34.748
2.	34.707	0.012	34.671-34.743
3.	34.579	0.015	34.535-34.622
4.	34.515	0.012	34.480-34.549
5.	34.476	0.012	34.441-34.511
6.	34.478	0.013	34.438-34.518
7.	34.519	0.014	34.479-34.560
8.	34.596	0.018	34.543-34.648
9.	34.696	0.021	34.634-34.758
10.	34.817	0.029	34.730-34.903
11.	34.947	0.036	34.839-35.055
12.	35.068	0.046	34.929-35.206
13.	35.184	0.057	35.014-35.354
14.	35.278	0.060	35.098-35.459
15.	35.373	0.062	35.186-35.559
16.	35.462	0.061	35.279-35.645
17.	35.535	0.058	35.360-35.710
18.	35.580	0.052	35.424-35.735
19.	35.608	0.048	35.463-35.753
20.	35.623	0.049	35.477-35.769
21.	35.617	0.058	35.441-35.792
22.	35.592	0.083	35.344-35.840
23.	35.616	0.097	35.324-35.908
24.	35.590	0.101	35.288-35.891
25.	35.504	0.097	35.214-35.793
26.	35.461	0.078	35.226-35.696

Table A18. Mean salinity, standard deviation, and 3x range, at 1°C intervals. Latitude band 35°-40°S.

TEMP	SALNTY	STDEV	3*STDEV RANGE
1.	34.737	0.019	34.681-34.793
2.	34.705	0.018	34.650-34.760
3.	34.579	0.020	34.518-34.639
4.	34.516	0.019	34.460-34.572
5.	34.477	0.022	34.409-34.544
6.	34.479	0.022	34.413-34.546
7.	34.523	0.020	34.464-34.582
8.	34.602	0.028	34.517-34.686
9.	34.708	0.036	34.601-34.815
10.	34.839	0.041	34.716-34.962
11.	34.990	0.054	34.827-35.152
12.	35.141	0.072	34.925-35.358
13.	35.274	0.079	35.037-35.511
14.	35.370	0.075	35.146-35.594
15.	35.462	0.070	35.250-35.673
16.	35.502	0.069	35.295-35.708
17.	35.545	0.072	35.328-35.762
18.	35.590	0.080	35.348-35.831
19.	35.624	0.096	35.337-35.911
20.	35.609	0.073	35.390-35.827
21.	35.622	0.077	35.390-35.854
22.	35.567	0.089	35.299-35.834
23.	35.500	0.087	35.237-35.762
24.	35.561	0.083	35.311-35.811
25.	35.505	0.084	35.253-35.757

Table A19. Mean salinity, standard deviation, and 3x range, at 1°C intervals. Latitude band 40°-45°S.

TEMP	SALNTY	STDEV	3*STDEV RANGE
1.	34.723	0.015	34.678-34.768
2.	34.708	0.018	34.655-34.761
3.	34.567	0.025	34.492-34.641
4.	34.483	0.031	34.390-34.575
5.	34.453	0.023	34.384-34.523
6.	34.464	0.022	34.397-34.531
7.	34.517	0.027	34.437-34.597
8.	34.586	0.035	34.480-34.692
9.	34.675	0.040	34.553-34.796
10.	34.840	0.044	34.708-34.971
11.	35.004	0.043	34.876-35.132
12.	35.143	0.061	34.960-35.325
13.	35.229	0.129	34.842-35.615
14.	35.233	0.181	34.688-35.777
15.	35.353	0.148	34.909-35.797
16.	35.368	0.127	34.987-35.748
17.	35.439	0.099	35.142-35.736
18.	35.539	0.072	35.323-35.754
19.	35.630	0.088	35.367-35.893
20.	35.615	0.080	35.374-35.856

Table A20. Mean salinity, standard deviation, and 3x range, at 1°C intervals. Latitude band 25°-45°S.

TEMP	SALNTY	STDEV	3*STDEV RANGE
1.	34.722	0.011	34.689-34.756
2.	34.703	0.014	34.661-34.745
3.	34.578	0.015	34.533-34.623
4.	34.515	0.014	34.471-34.558
5.	34.475	0.015	34.430-34.520
6.	34.478	0.016	34.430-34.526
7.	34.521	0.016	34.472-34.569
8.	34.598	0.022	34.532-34.664
9.	34.698	0.028	34.614-34.782
10.	34.823	0.036	34.716-34.929
11.	34.967	0.049	34.821-35.113
12.	35.103	0.072	34.889-35.318
13.	35.229	0.089	34.962-35.496
14.	35.324	0.093	35.046-35.601
15.	35.413	0.087	35.152-35.673
16.	35.472	0.073	35.254-35.689
17.	35.528	0.064	35.336-35.719
18.	35.577	0.059	35.401-35.753
19.	35.610	0.056	35.442-35.778
20.	35.630	0.054	35.469-35.790
21.	35.623	0.061	35.439-35.806
22.	35.590	0.079	35.354-35.825
23.	35.597	0.097	35.307-35.888
24.	35.589	0.109	35.263-35.914
25.	35.521	0.106	35.202-35.840
26.	35.437	0.090	35.168-35.706
27.	35.349	0.101	35.047-35.651

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