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TASMAN AND CORAL SEA TEN YEAR MEAN TEMPERATURE AND SALINITY FIELDS, 1967-1976

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TASMAN AND CORAL SEA TEN YEAR MEAN TEMPERATURE AND SALINITY FIELDS - 1967-1976

R.J. Edwards

Abstract

Ten year mean temperature and salinity fields for the decade 1967-1976 are presented for the Tasman and Coral Seas. Data were collected using merchant vessels. The results provide better information for temperature than has previously been available due to the wide spatial and temporal coverage while the salinity fields are useful for analysis of the marine climate.

INTRODUCTION

In 1966, in response to the results of a pilot study, the CSIRO Division of Fisheries and Oceanography established a programme using ships of the merchant fleet to monitor the temperature and salinity fields of the Tasman and Coral Seas. The region in which coverage was attempted was 0-45°S, 140-180°E. At the programme's peak 28 ships were involved. However, due to the rationalisation of routes and the trend to automation in ships, numbers have declined in recent years.

The merchant ship programme

The programme has been fully described by Piip (1974). Briefly, selected ships are fitted with a thermograph and water sampling system operating through the engine room water intake. Each two hours the engine room staff take a water sample and annotate the thermograph chart. At the same time the bridge staff record the ship's position. When the ship returns to port the unit is serviced and the samples and charts returned to the laboratory.

The thermograph charts are digitised and the water samples analysed for salinity using a salinity-temperature meter (Hamon 1956). The values are collated and reduced using the CSIRO CDC 7600 computer. In general, temperatures are considered precise to about 0.2°C not taking into account bias effects described by Piip (1974) and Tabata (1977). Salinities are accurate to better than 0.05‰. Figure 1 shows the main routes of the vessels used in the programme.

Data

Though the data are used frequently and are checked on a monthly basis there has been no definitive editing till now. With ten years of records available there was sufficient information to provide a reliable picture of the temperature and salinity patterns over the whole area and to detect trends in long term changes which may have occurred.

The data were sorted into one degree squares on a monthly basis. Each set of records was again sorted according to ascending temperature and salinity values. The highest and lowest values, mean, standard deviation and number of

records in each square were printed out for examination. Each one degree square for each month for each parameter was then examined. Values were compared among themselves and to those of adjoining months and squares for anomalies. In all, some 180,000 records were examined.

The mean values for each month were plotted using those squares with ten or more readings. Figure 2 shows the average number of readings made in June - a typical month. All data are available from the World Oceanographic Data Centre.

The data were hand contoured using the contour which satisfied the greatest number of points. The temperature fields required very little smoothing due to abnormal values. Salinity fields also were able to be contoured with the minimum of subjective editing although there were more aberrant values. The temperature fields are contoured at an interval of 1 centigrade degree and the salinity at 0.1‰.

Figures 3 to 14 give the monthly temperature fields and Figures 15 to 26 the salinity. Where the contour is shown as a dashed line there are little data in the immediate area and the position of the contour has been interpolated.

RESULTS

Temperature

The normal picture which has been shown in various surface temperature atlases is apparent with more detail due to the better spatial and temporal coverage. The depression of the isotherms on the western edge of the area due to the East Australian Current system is more marked than is sometimes shown whilst the elevation on the southwest boundary due to the effect of the Sub-Antarctic Surface Water advected northward by the prevailing wind has not always been so apparent in previous works.

An interesting feature which emerges is the relative depression of the isotherms in the nearshore area at about 20° to 25°S during most of the year. This is quite some distance north of the area of influence of the East Australian Current system and is probably due to the wide continental shelf and barrier reef system acting as a source of warm water.

Though the data when reduced to ten year means contour smoothly, it must be emphasised that any individual year can show quite a different picture. An attempt to contour the standard deviations over the decade proved fruitless and Pickard (1977) showed that, especially in the tropical region, an individual isotherm can vary over a large area from year to year. A perusal of the monthly variation (Figs 27 to 34) will demonstrate this point.

Salinity

Rochford (1977) used the data to produce monthly charts in an oceanographic analysis of the salinity regime of the area. The figures presented here represent the long term climatic values since the data have been edited to the extent of only using those squares with ten or more values and using a smooth contour. Readers requiring a full explanation of the oceanographic processes taking place are referred to Rochford (1977) as only a resumé will be given here.

The area can be divided in three basic regions: tropical, subtropical and temperate: sub-antarctic. Each of these areas and their interaction is discussed below.

Tropical: In this area there is an excess of precipitation over evaporation. The greater part of the precipitation occurs during the north-west monsoon in the early months of the year which results in lower salinities which are enhanced near coastlines due to run off. This low salinity water is then advected south causing a depression of the isohalines together with a strong gradient near coastlines.

In the latter part of the year evaporation tends to exceed precipitation and this, together with the advection of higher salinity water from outside the area by the prevailing south-east tradewinds, causes the salinity to rise and the balance to be maintained.

Subtropical: This area is marked by an excess of evaporation over precipitation. A core of high salinity water (>35.7‰) extends over the central Tasman Sea from about 160°E. To the north the salinity drops under the influence of the tropical regime. To the west, along the coast of Australia, the salinity drops due to advection by the East Australian Current system and to the south due to mixing with low salinity Sub-Antarctic Surface Water.

Temperate: Sub-Antarctic: Here, though there is a slight excess of evaporation over precipitation, the area is marked by lower salinities due to the advection of lower salinity Sub-Antarctic Surface Water with convective overturning and mixing.

Yearly variations

To give some idea of the temporal changes in the area over the decade, the monthly values for eight one-degree squares are given in Figures 27 to 34. The squares were chosen both for their geographic position and for the number of observations available. The temperature charts are contoured at intervals of 2 centigrade degrees while on the salinity charts there is one contour which represents some convenient mean for that square. The contours are only intended as a guide, and the values should be consulted if anything more than the general trend is required.

Northern: 15°-16°S, 151°-152°E; 16°-17°S, 167°-168°E
Figures 27 and 28 give the data for these two squares. The temperature diagrams indicate that there has been a slight warming in the area. This warming has been more pronounced in the east and there is some oscillation in the winter temperatures in the west. The salinities for both areas show alternating high and low values which are roughly in phase on a yearly basis.

North-Central: 23°-24°S, 156°-157°E; 23°-24°S, 170°-171°E
The data in Figures 28 and 30 show that the warming trend is not so evident at this latitude. The alternating high and low salinity pattern is still evident in the east but in the west there has been a general lowering of salinity.

South-Central: 33°-34°S, 153°-154°E; 34°-35°S, 170°-171°E
Figures 31 and 32 show that though the warming trend continues in the east, the western areas are cooling after a period of warming. Salinities in the west show the same general pattern as to the north; however in the east, values have been much more consistent over the decade.

South: 40°-41°S, 149°-150°E; 39°-40°S, 170°-171°E

Figures 33 and 34 indicate that though a weak warming trend is evident in the east, there has been little change in the decade in the west. Salinities in the west have been quite stable but in the east there has been a general increase.

Temperature: salinity envelopes

Figures 35 and 36 give the average monthly change in the temperature: salinity relationship for each of the one degree squares chosen to illustrate yearly variations above. Though an individual year could be quite different from the picture shown, the figures give a good indication of the changes taking place.

CONCLUSIONS

The general features that have been shown in previous temperature atlases have been confirmed and enhanced. Long term monthly average salinity fields are presented which will be of assistance in marine climate analysis. An examination of the year to year changes shows that there has been a warming trend, particularly in the north of the area. Salinity is shown to be quite variable from year to year, but consistent from month to month in any one year.

ACKNOWLEDGEMENTS

Without the assistance of the officers and men of the merchant fleet, the data used in this report could not have been collected. I would also like to thank Miss D. Waddington for her assistance in editing and checking the data.

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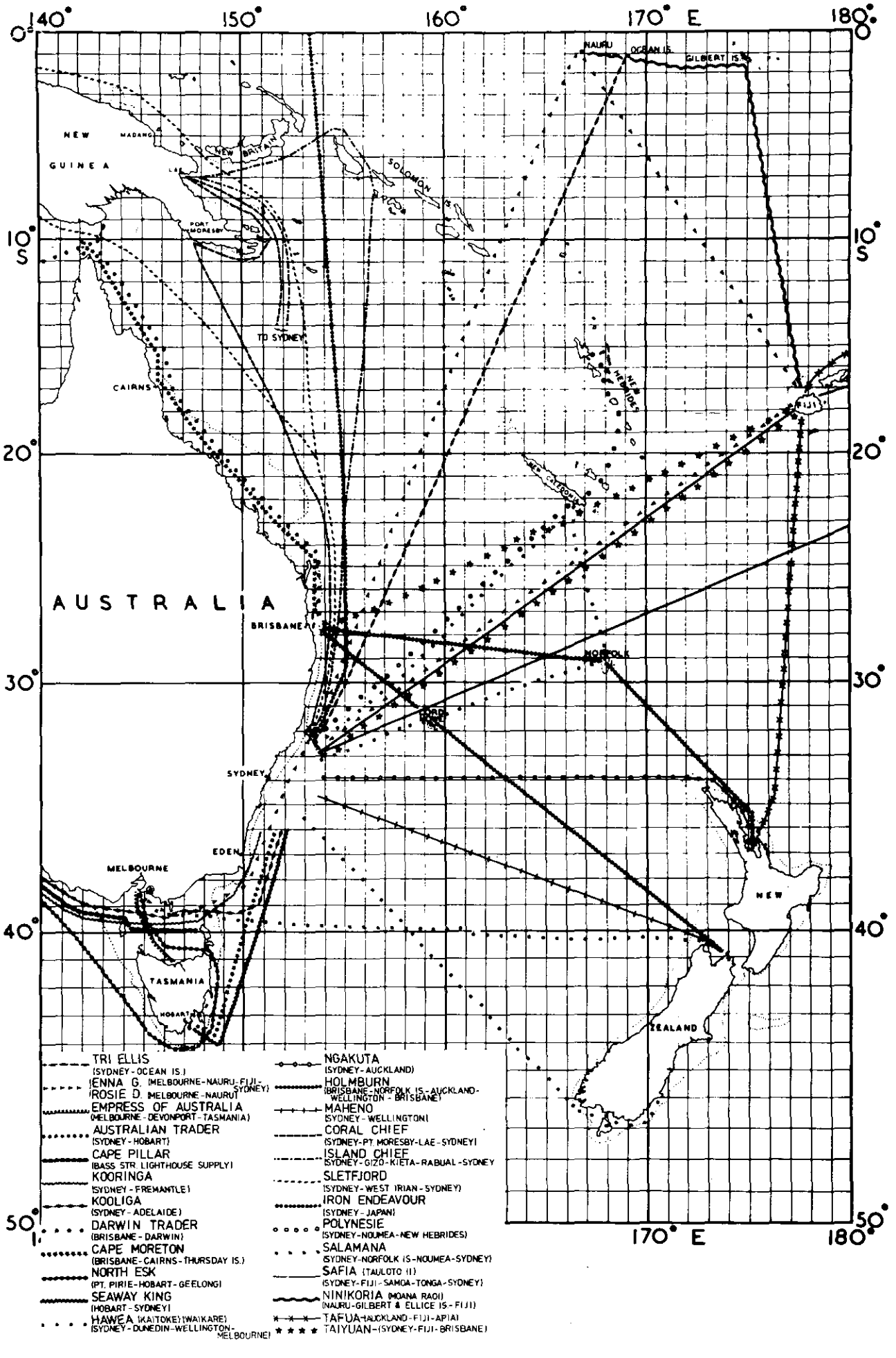

Fig. 1. Chart showing the principal routes of the merchant vessels which collected data used in this report.

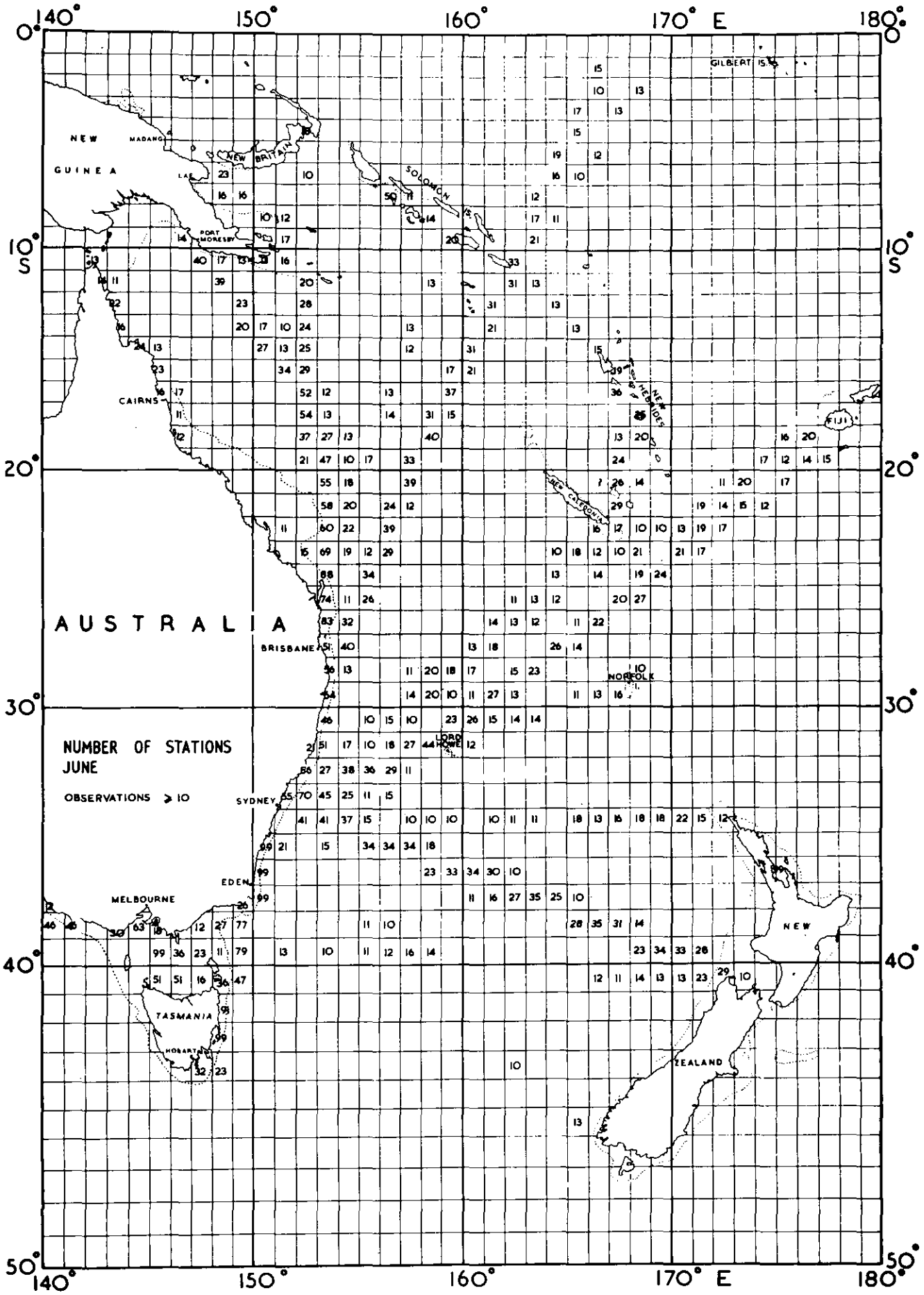

Fig. 2. Chart showing the number of stations (N ≥ 10) for the month of June used in the charts of this report.

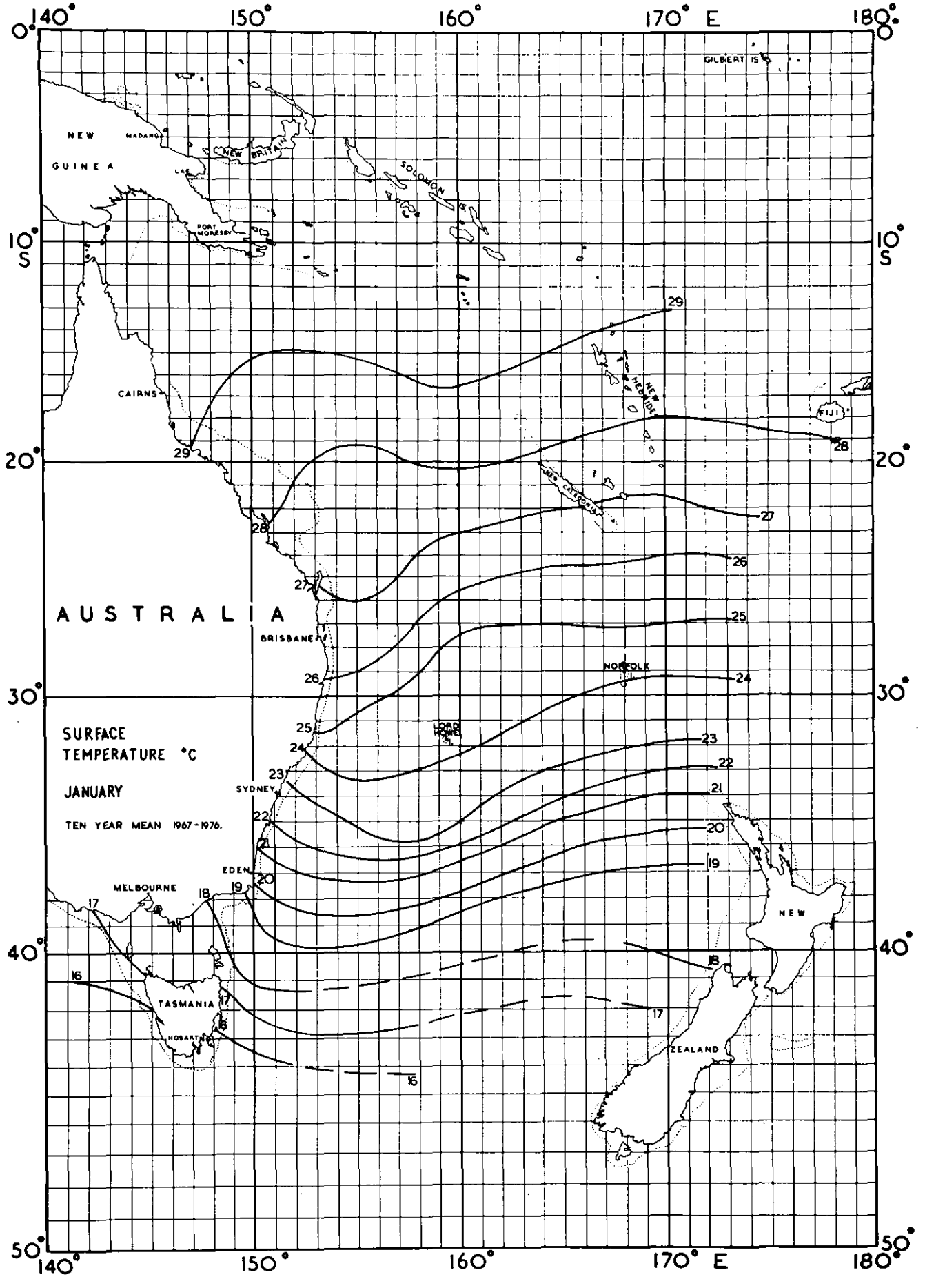

Fig. 3. Ten year average temperature field for the month of January. Contour interval is one centigrade degree.

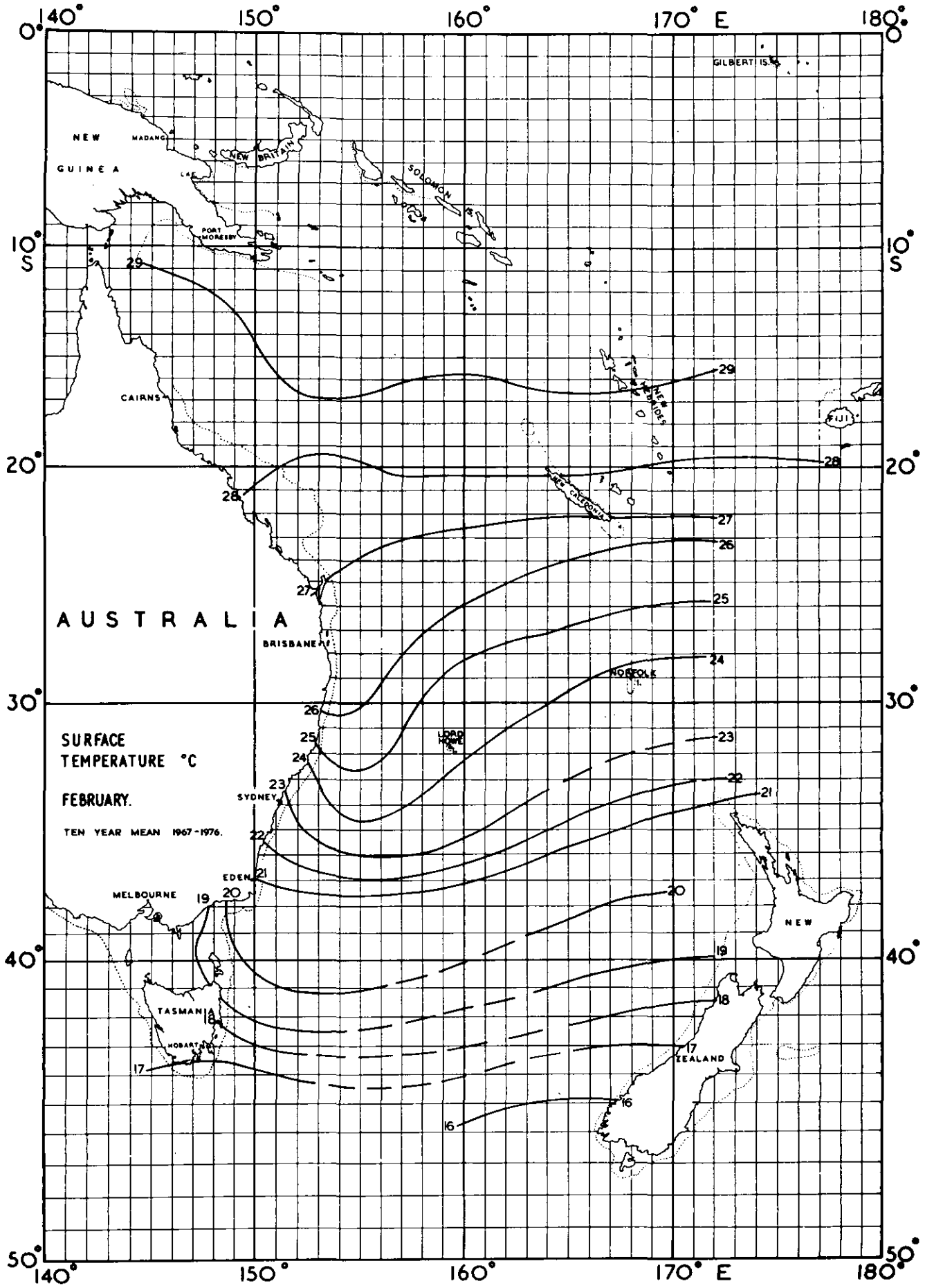

Fig. 4. Ten year average temperature field for the month of February. Contour interval is one centigrade degree.

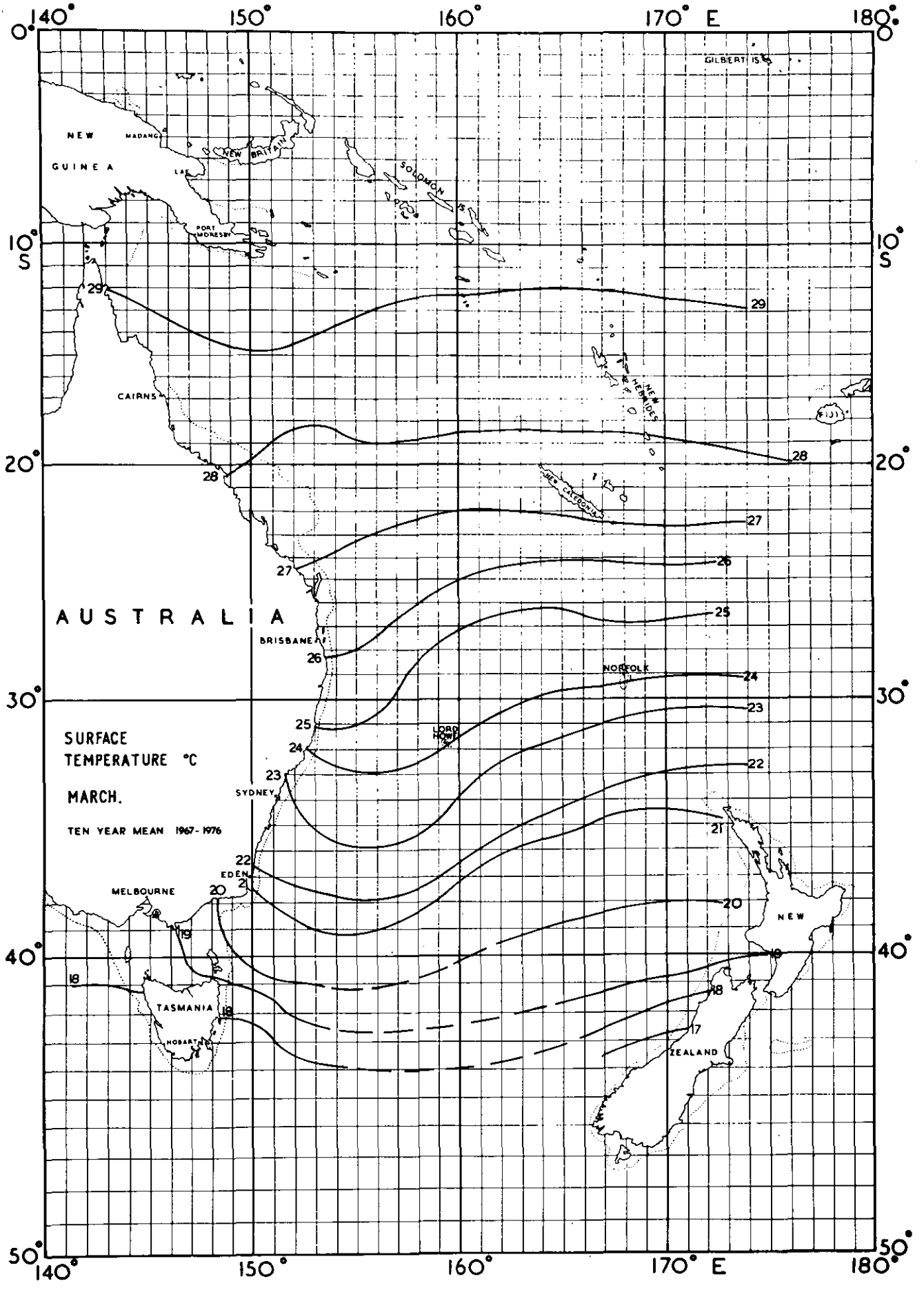

Fig. 5. Ten year average temperature field for the month of March. Contour interval is one centigrade degree.

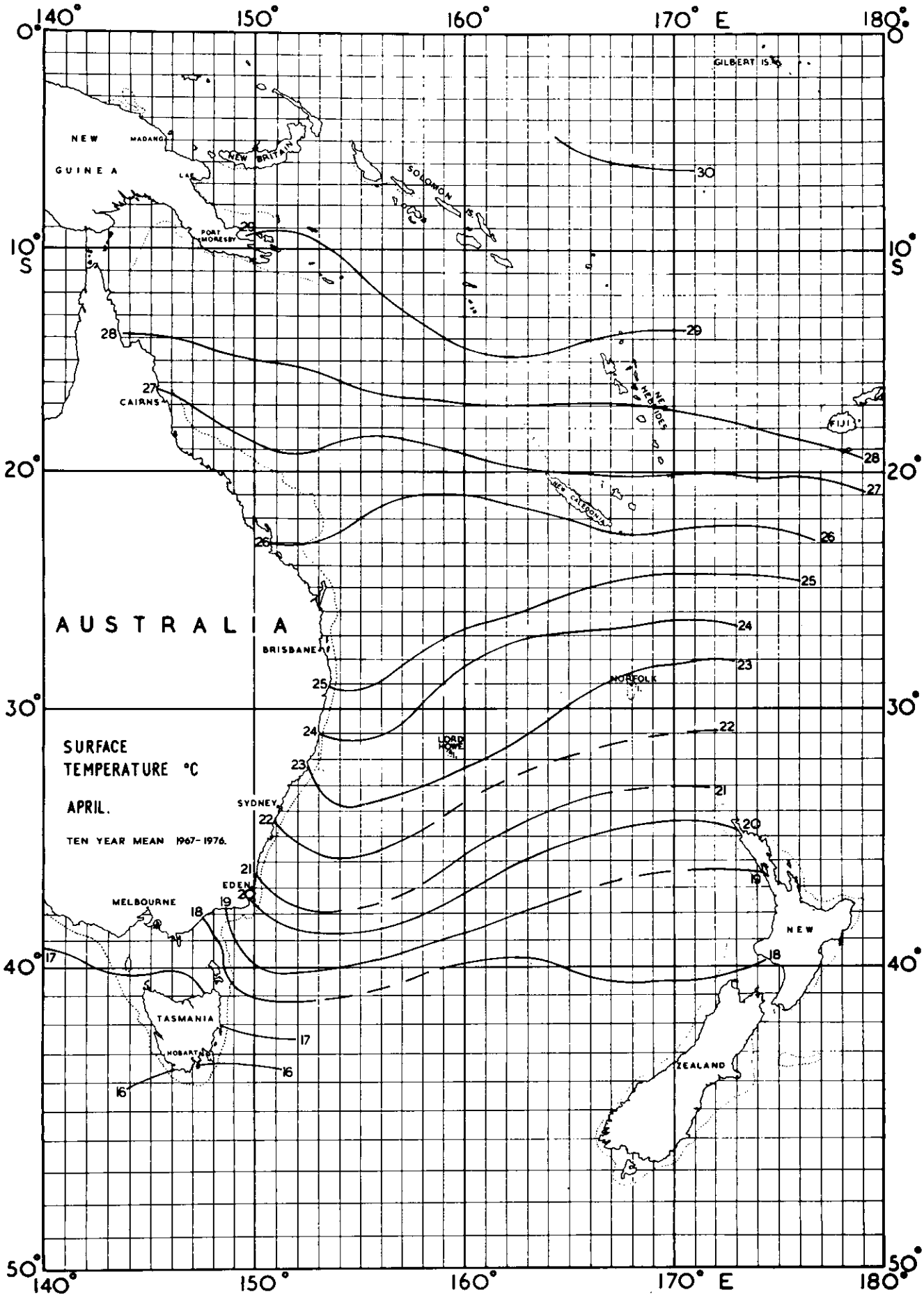

Fig. 6. Ten year average temperature field for the month of April. Contour interval is one centigrade degree.

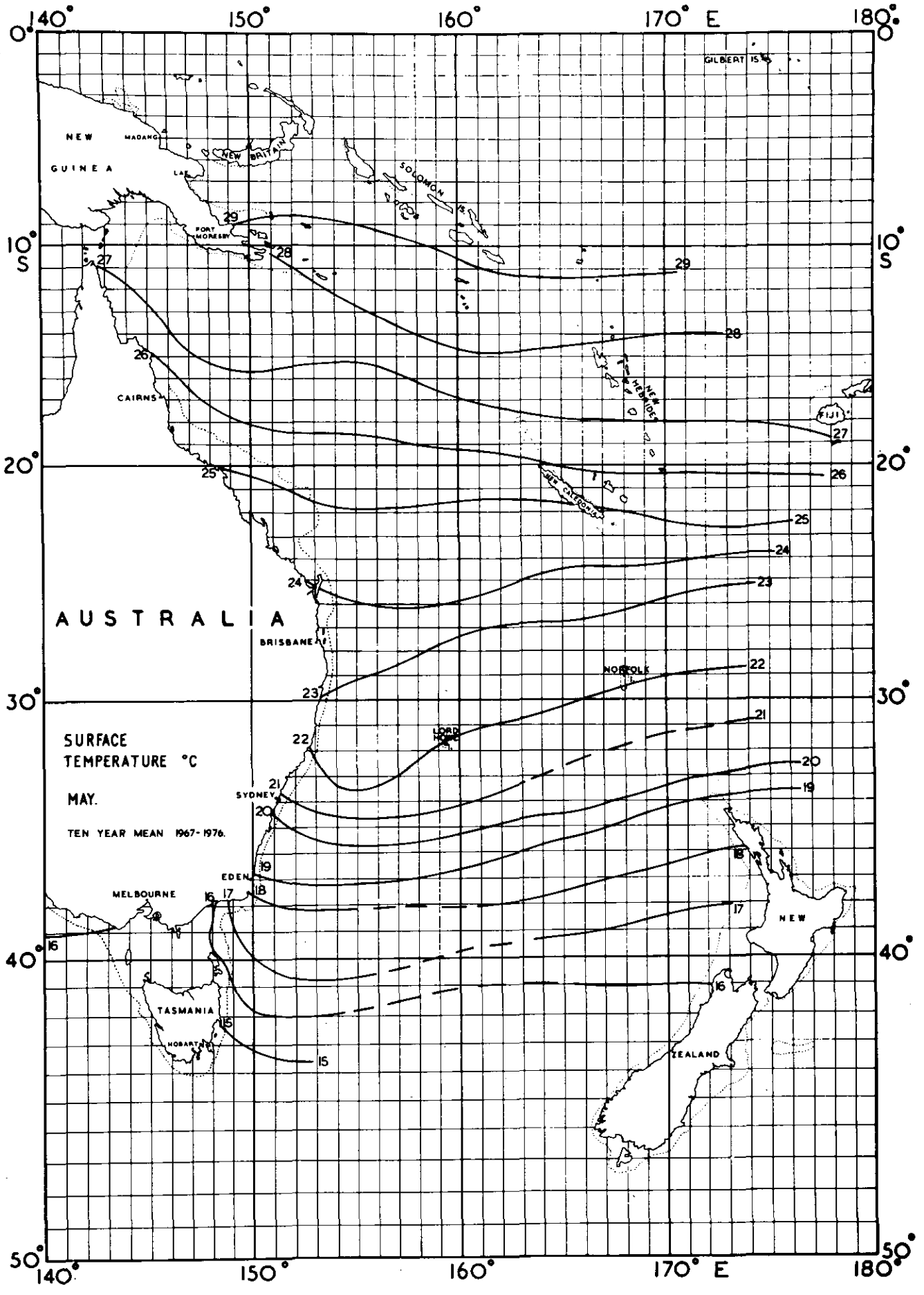

Fig. 7. Ten year average temperature field for the month of May. Contour interval is one centigrade degree.

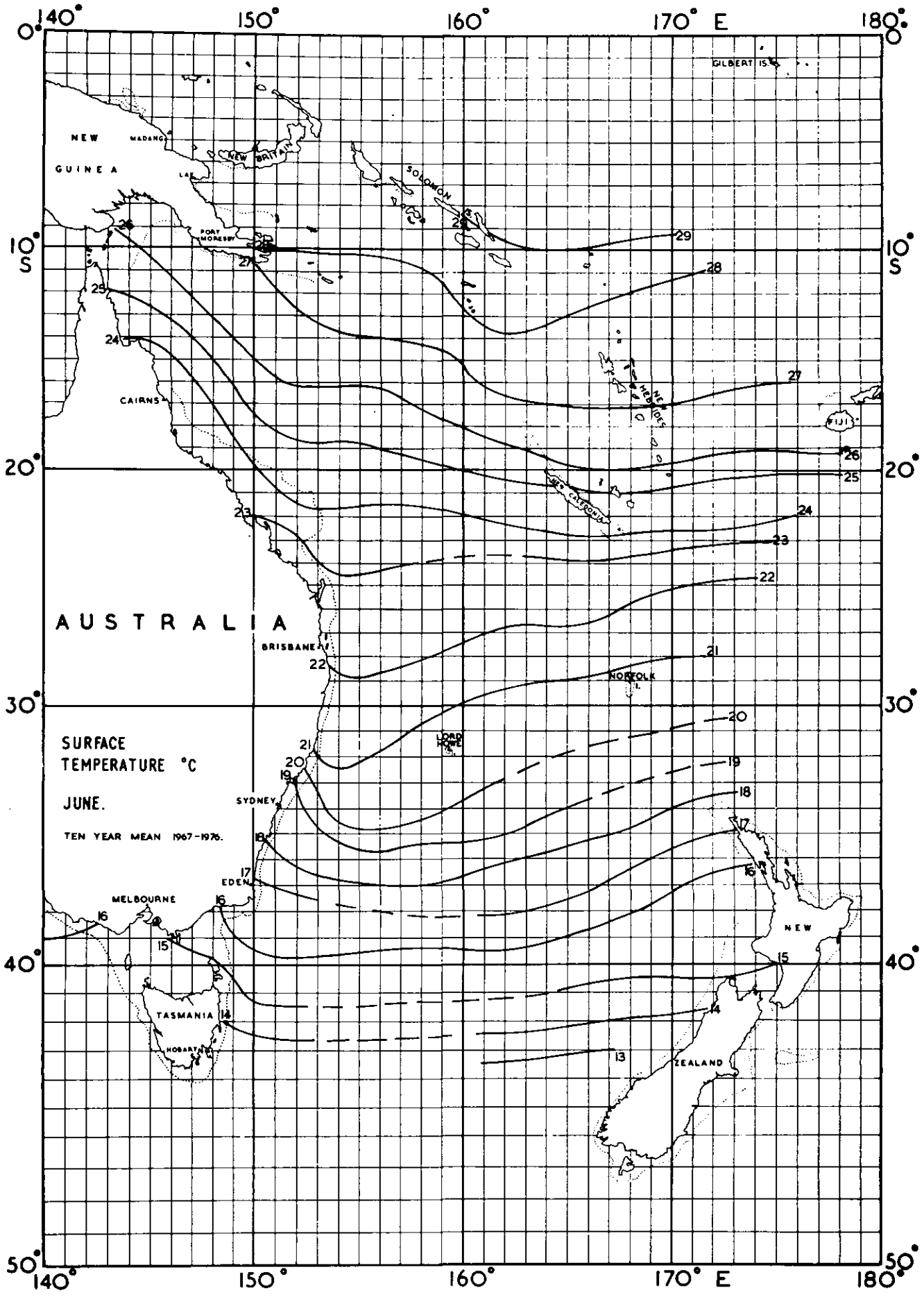

Fig. 8. Ten year average temperature field for the month of June. Contour interval is one centigrade degree.

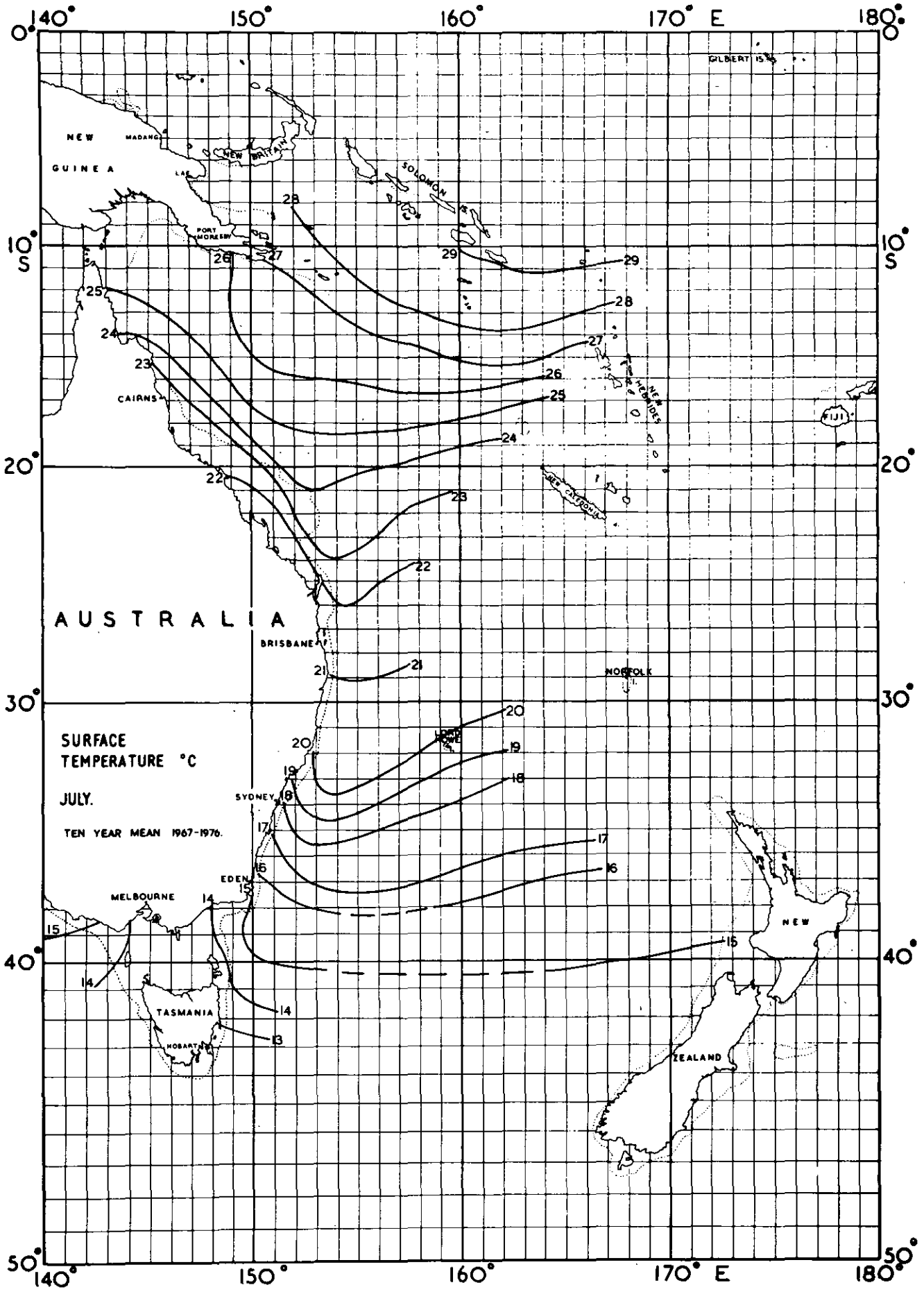

Fig. 9. Ten year average temperature field for the month of July. Contour interval is one centigrade degree.

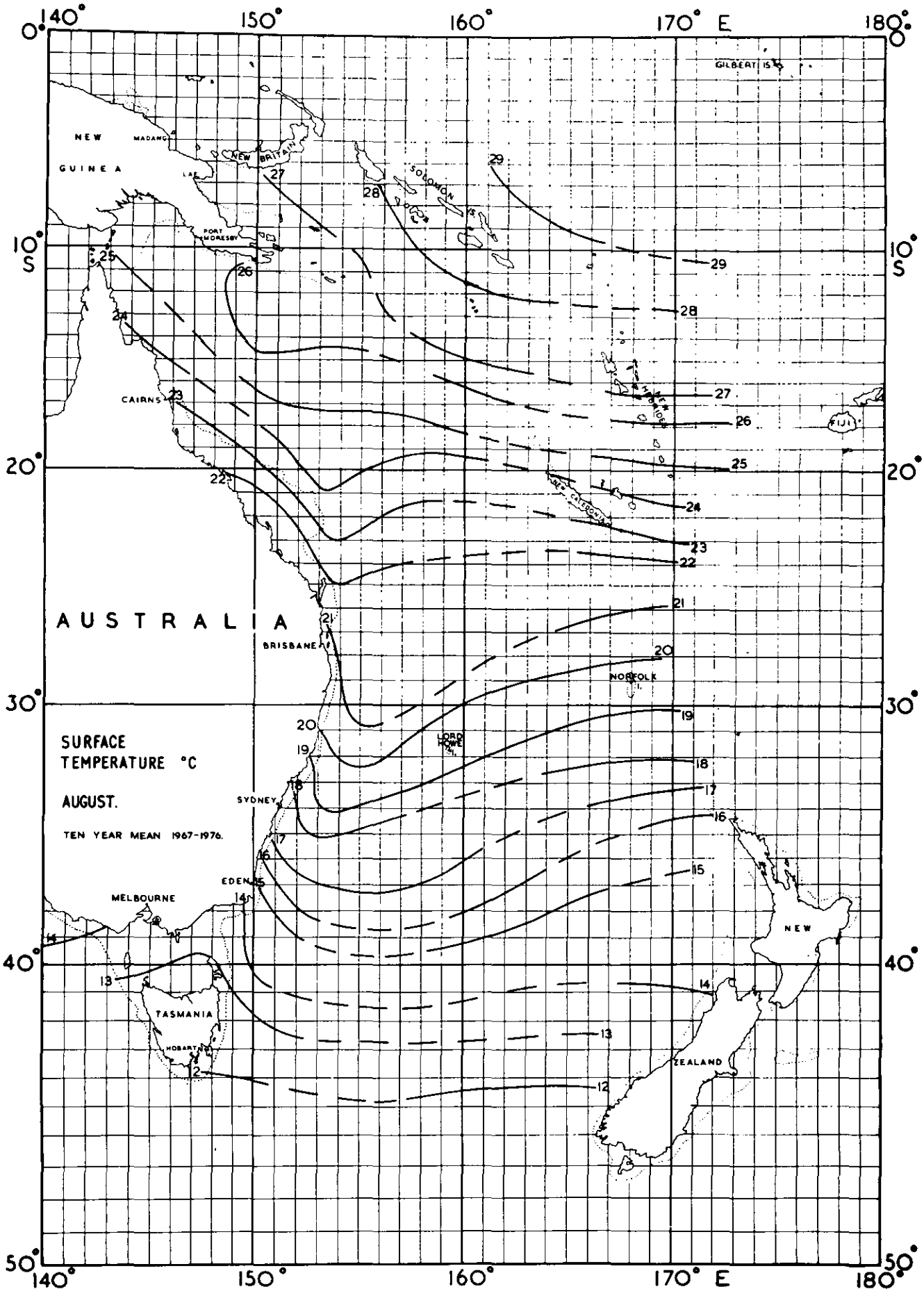

Fig. 10. Ten year average temperature field for the month of August. Contour interval is one centigrade degree.

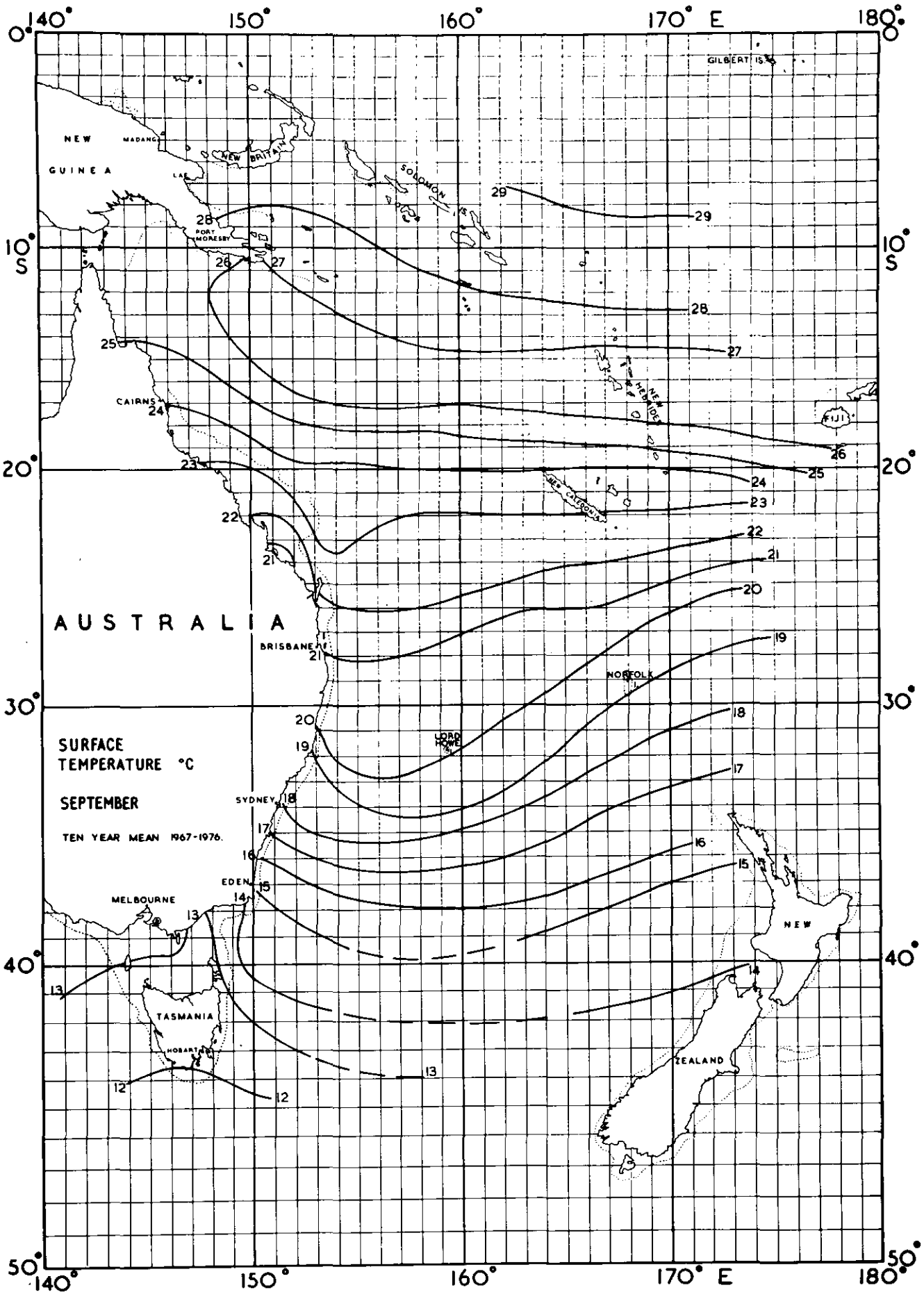

Fig. 11. Ten year average temperature field for the month of September. Contour interval is one centigrade degree.

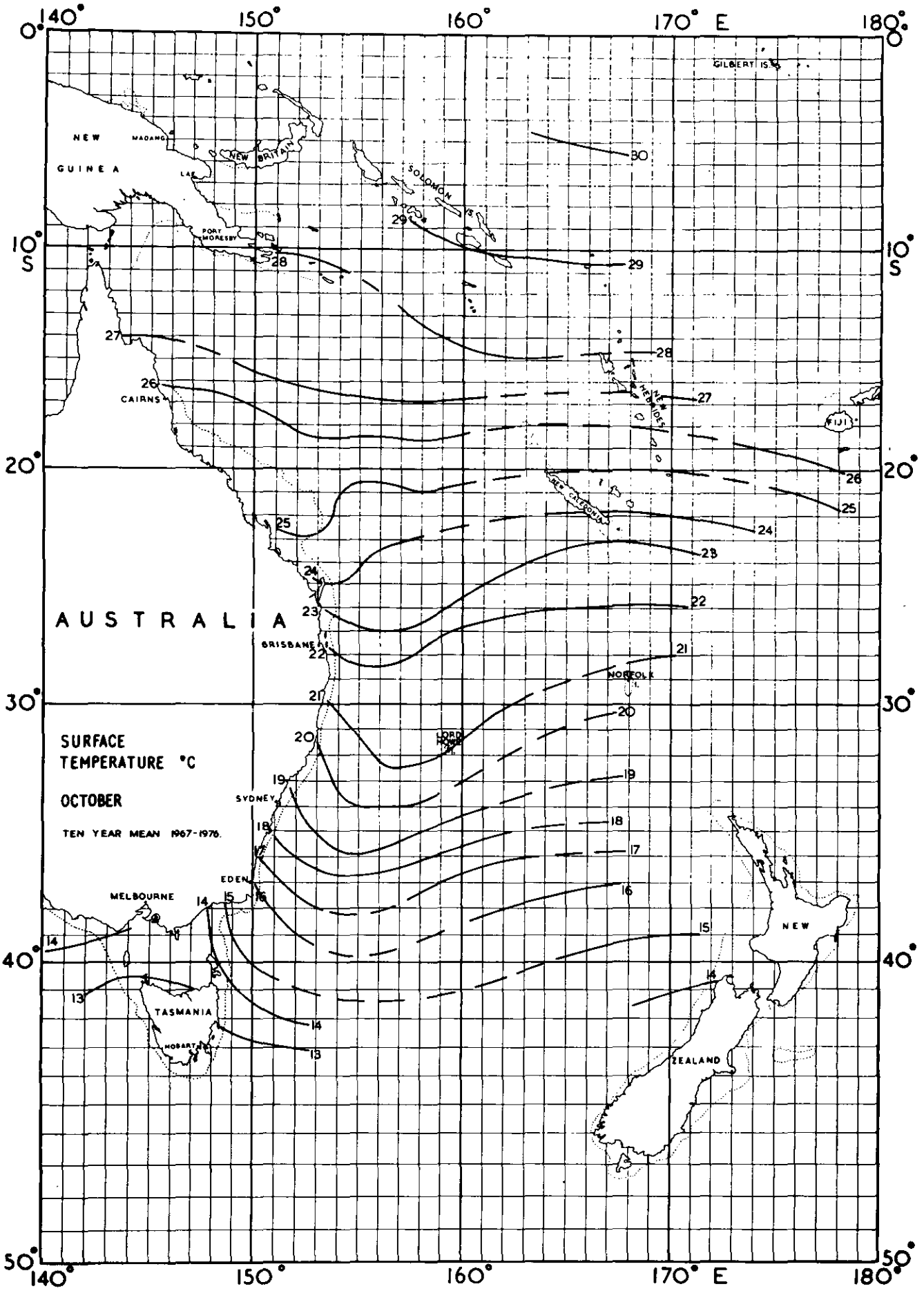

Fig. 12. Ten year average temperature field for the month of October. Contour interval is one centigrade degree.

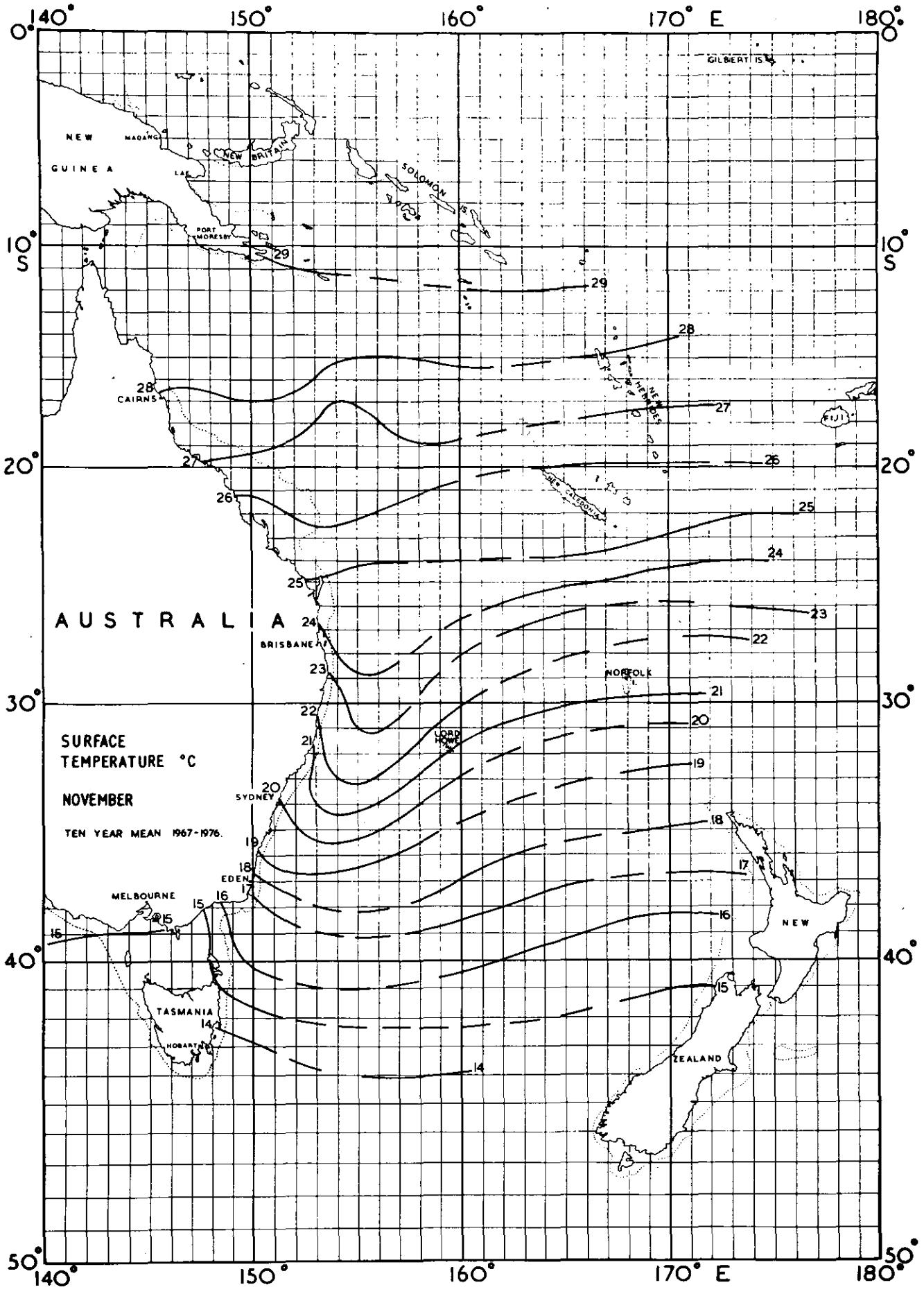

Fig. 13. Ten year average temperature field for the month of November. Contour interval is one centigrade degree.

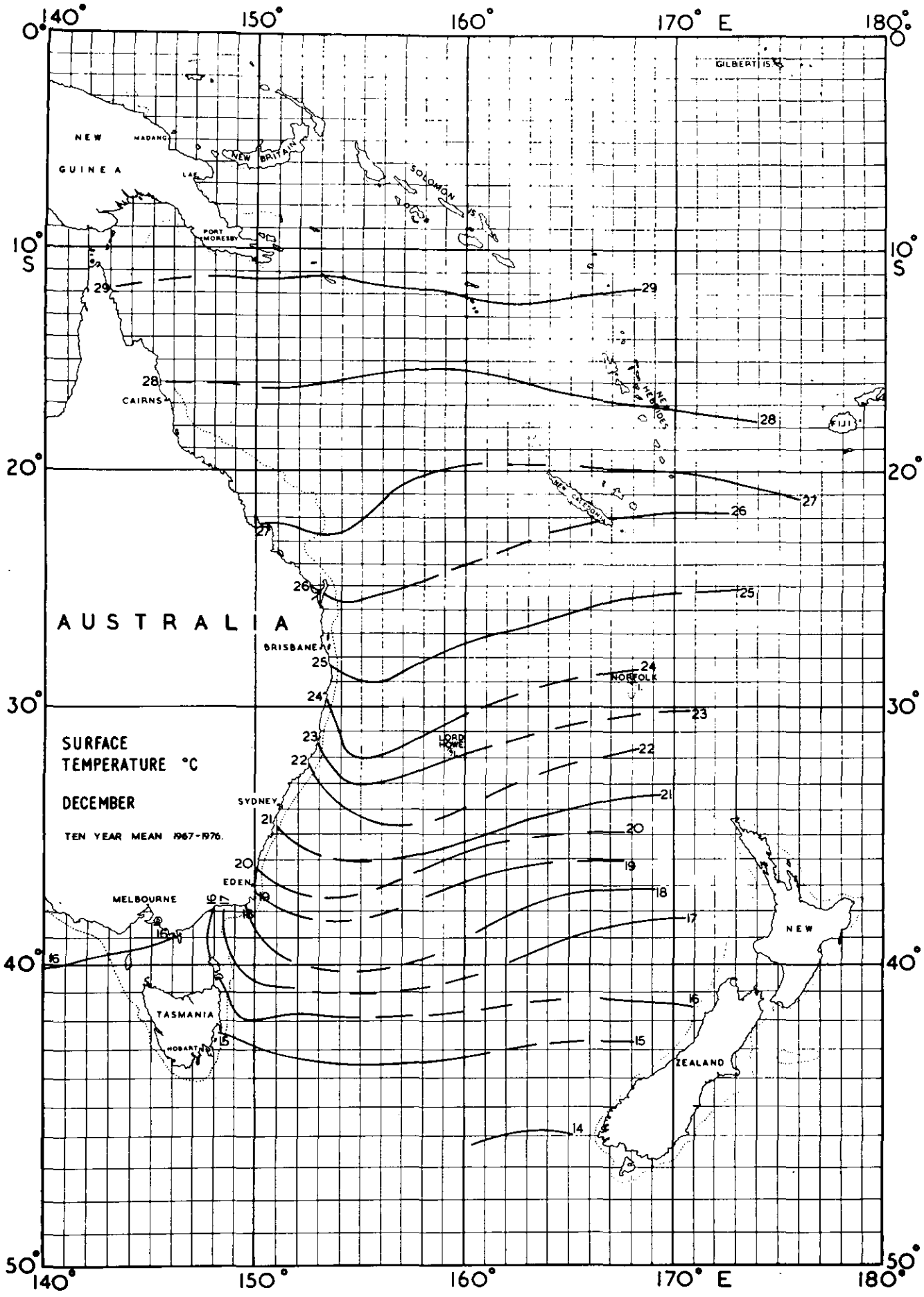

Fig. 14. Ten year average temperature field for the month of December. Contour interval is one centigrade degree.

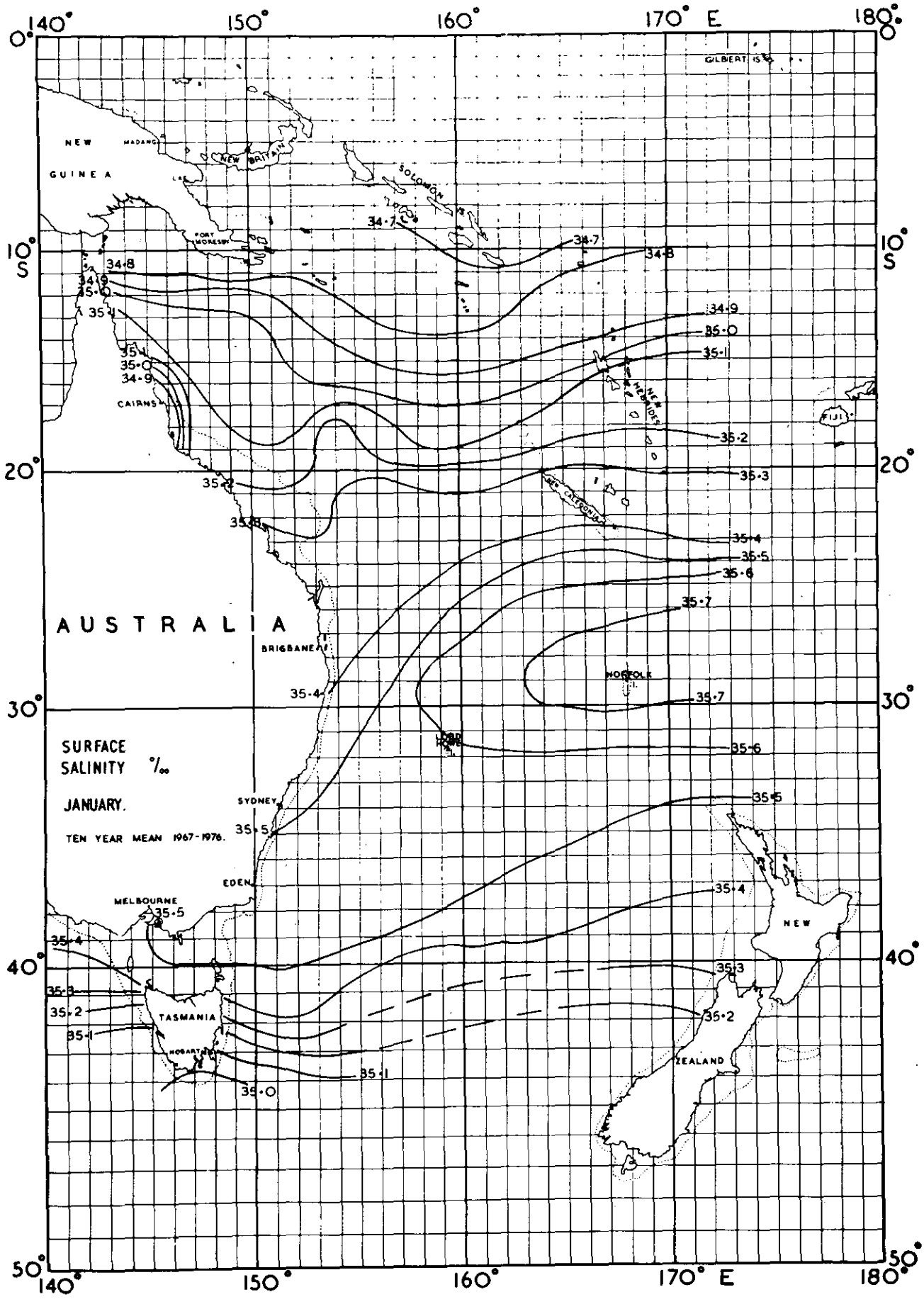

Fig. 15. Ten year average salinity field for the month of January. Contour interval is 0.1‰ (parts per thousand).

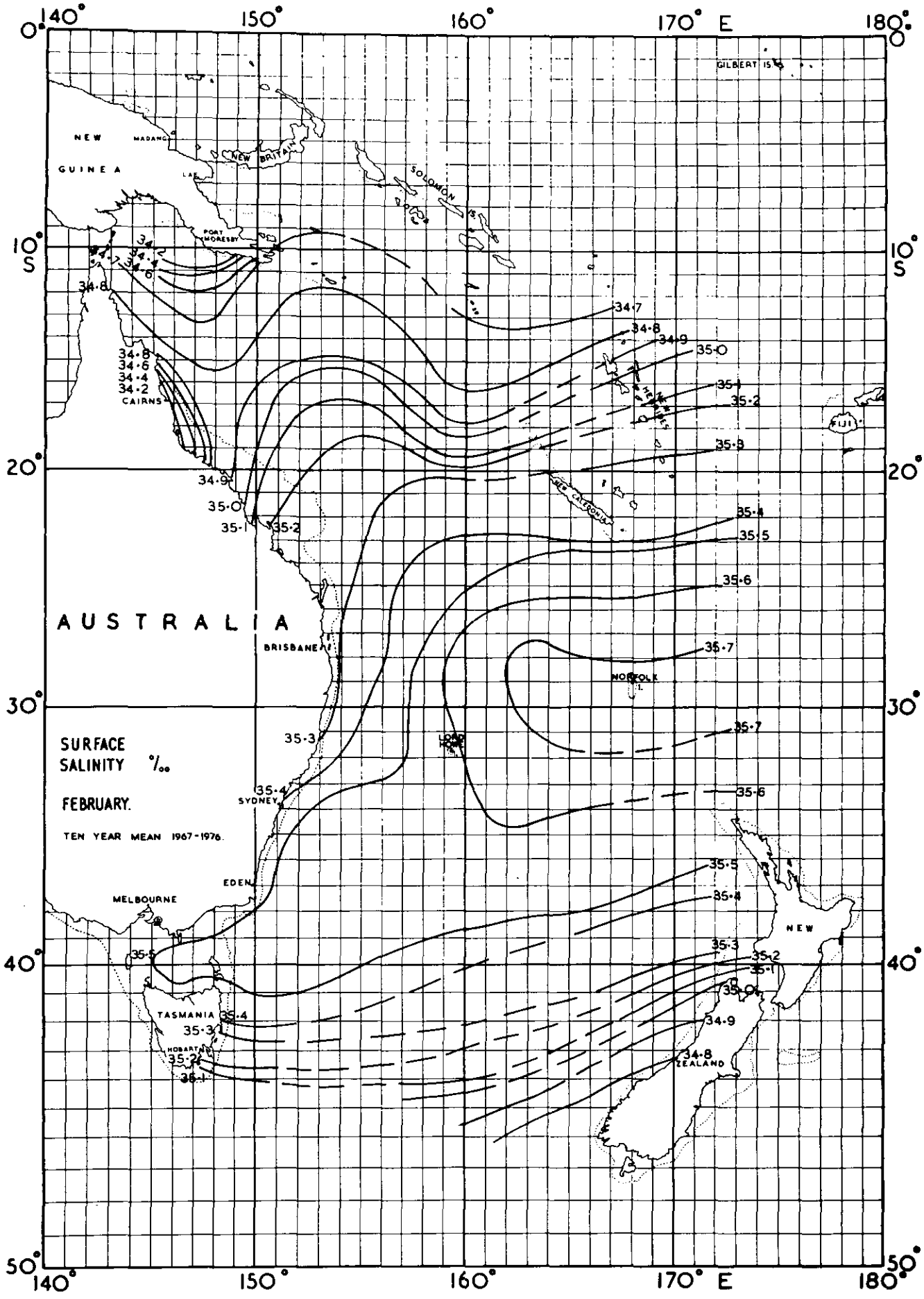

Fig. 16. Ten year average salinity field for the month of February. Contour interval is 0.1‰ (parts per thousand).

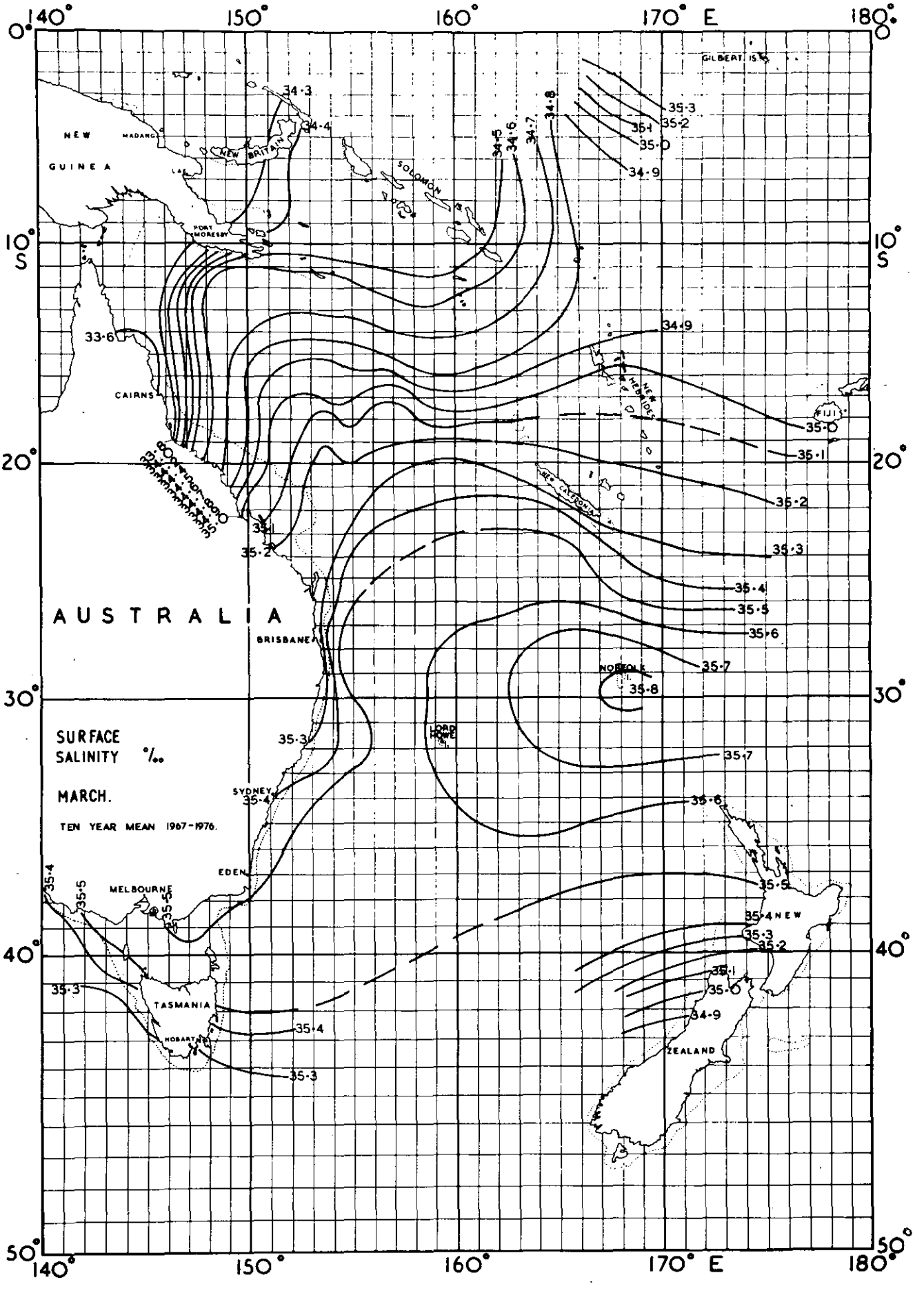

Fig. 17. Ten year average salinity field for the month of March. Contour interval is 0.1‰ (parts per thousand).

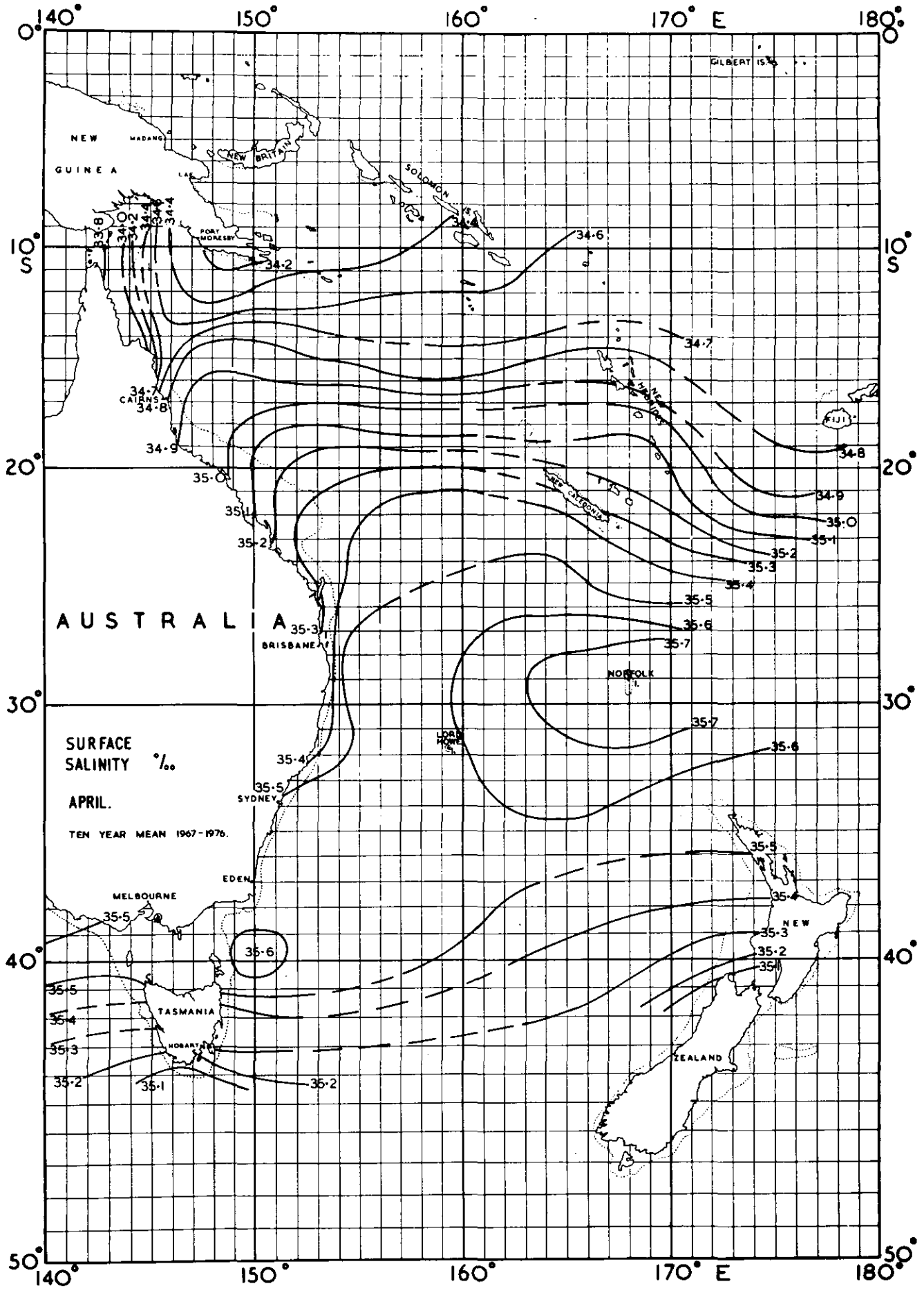

Fig. 18. Ten year average salinity field for the month of April. Contour interval is 0.1‰ (parts per thousand).

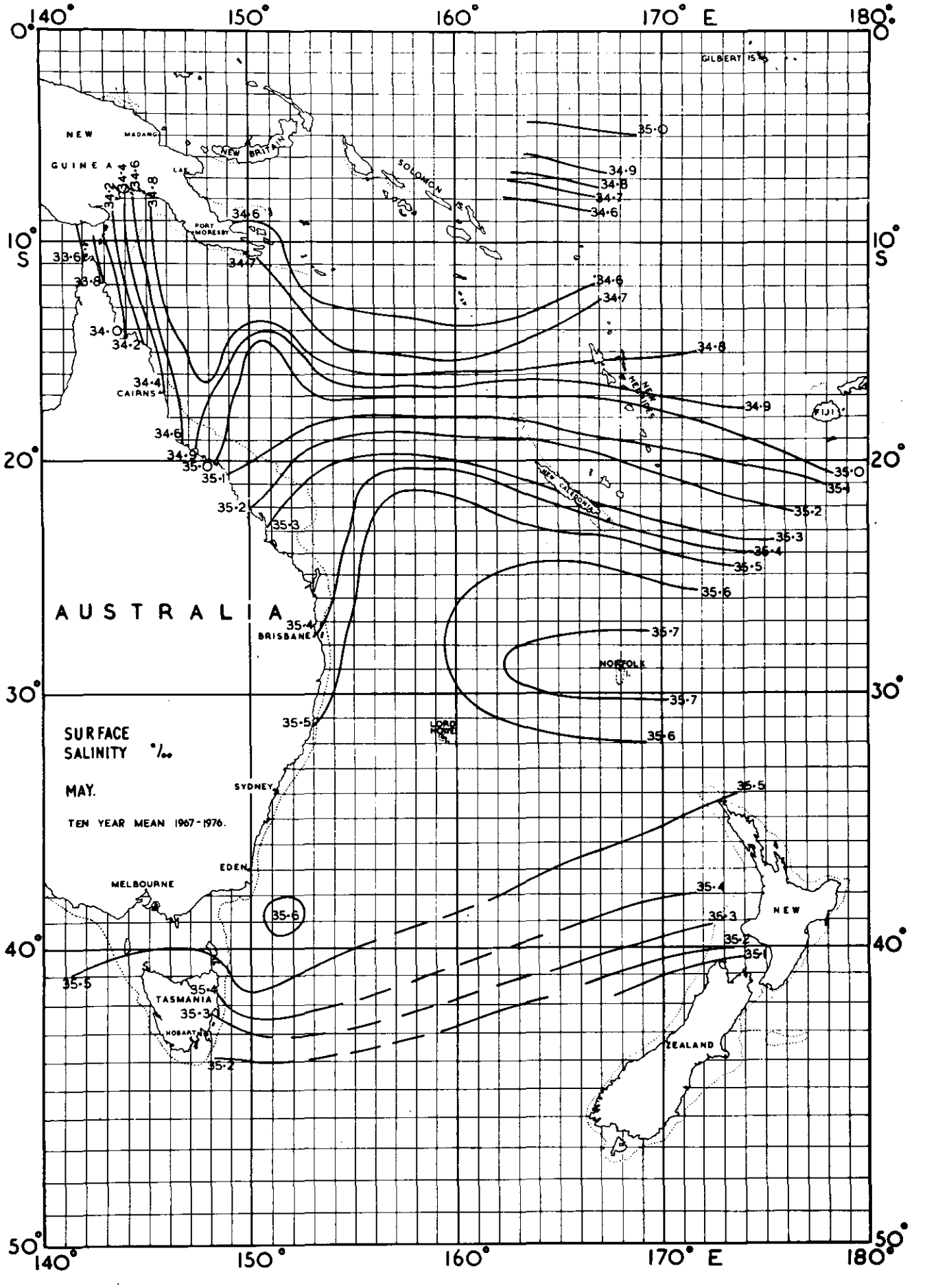

Fig. 19. Ten year average salinity field for the month of May. Contour interval is 0.1‰ (parts per thousand).

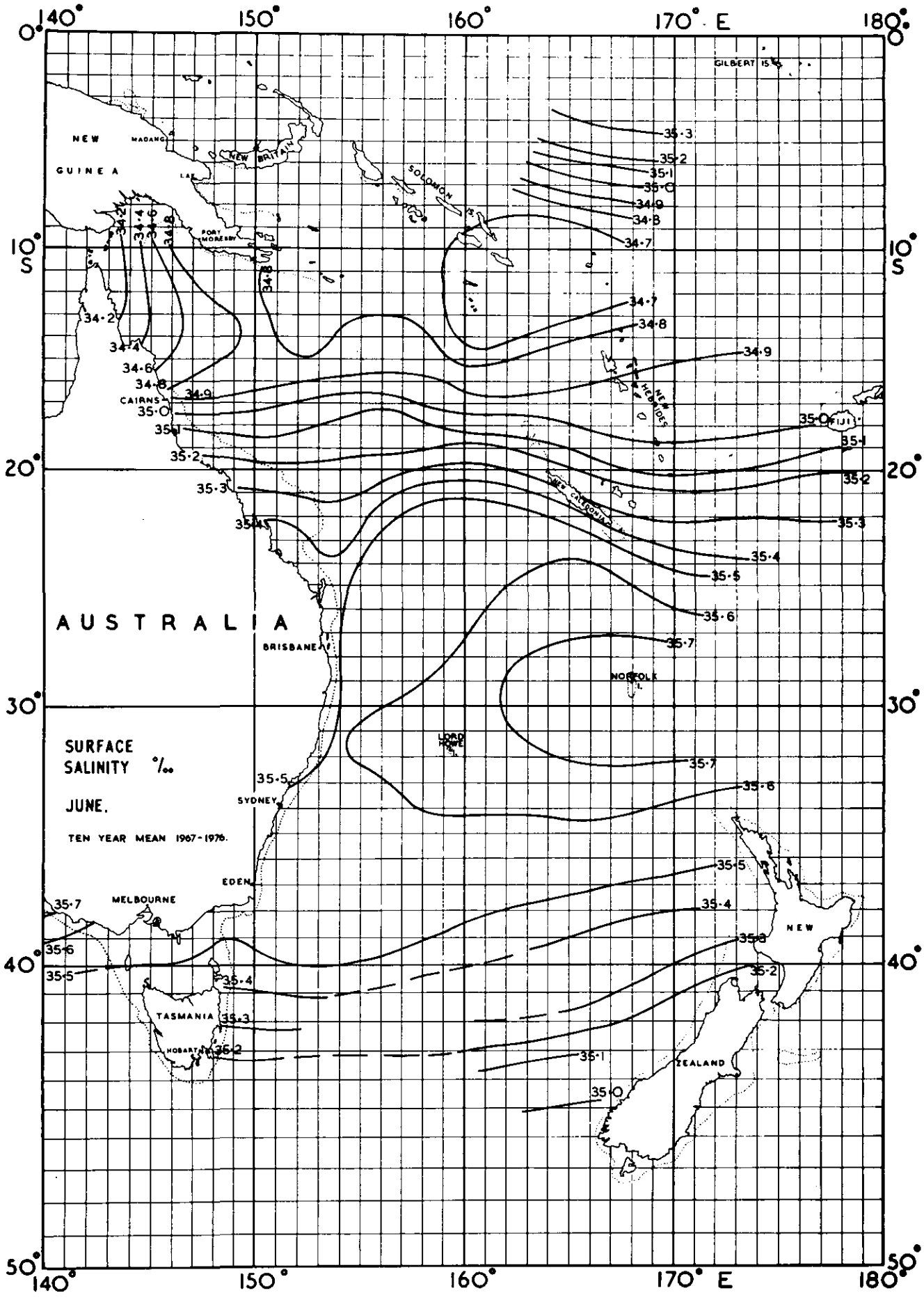

Fig. 20. Ten year average salinity field for the month of June. Contour interval is 0.1‰ (parts per thousand).

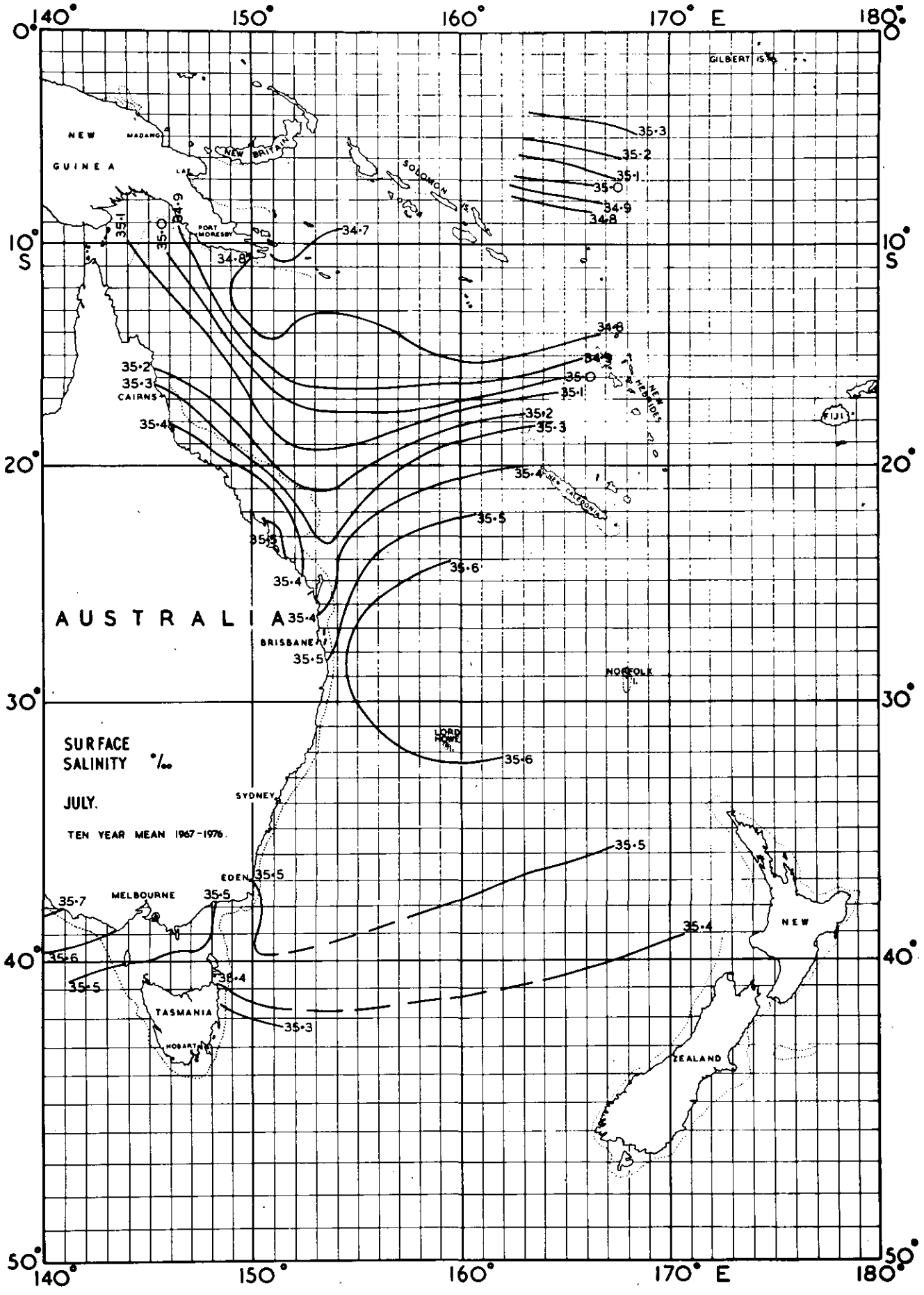

Fig. 21. Ten year average salinity field for the month of July. Contour interval is 0.1‰ (parts per thousand).

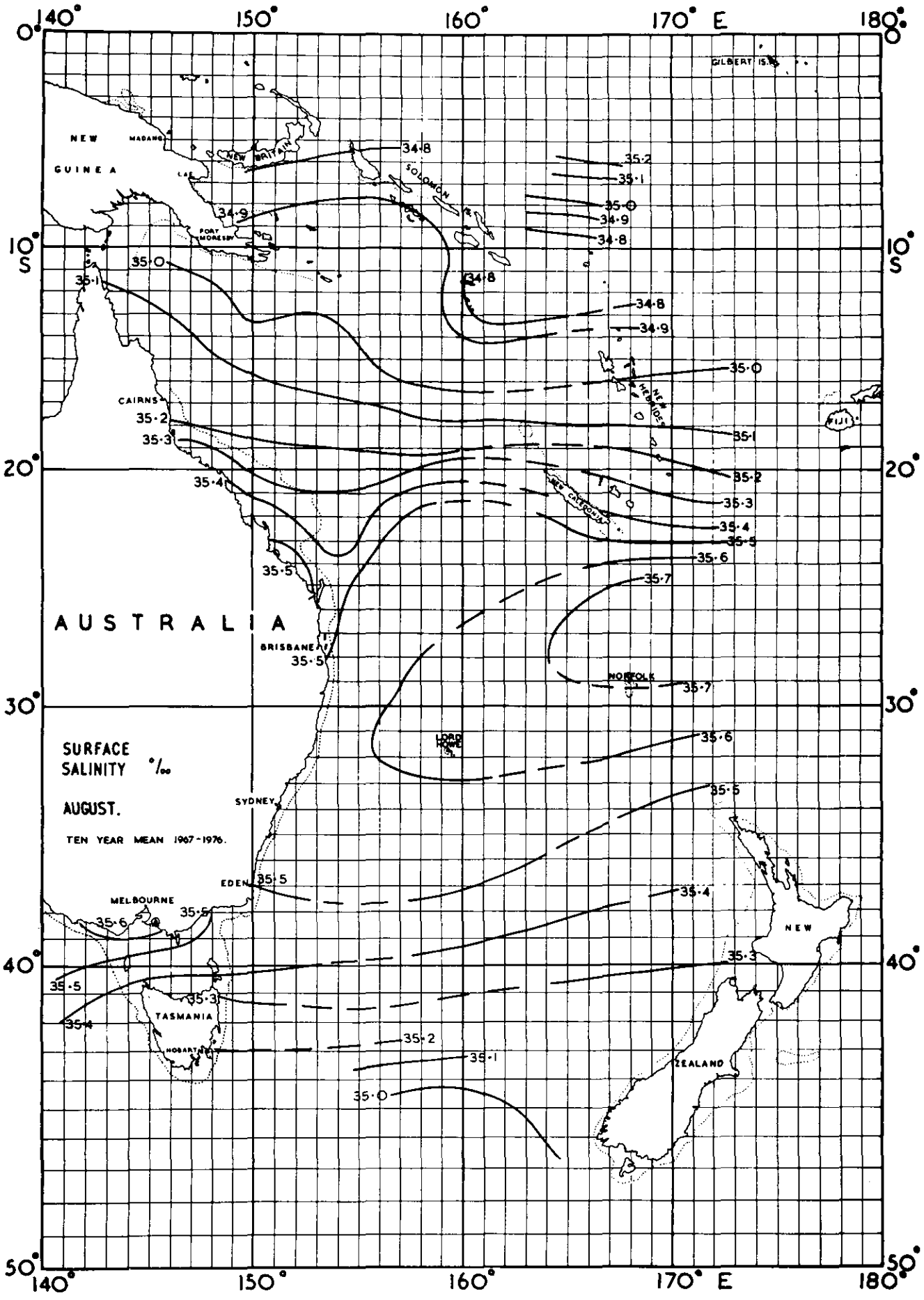

Fig. 22. Ten year average salinity field for the month of August. Contour interval is 0.1‰ (parts per thousand).

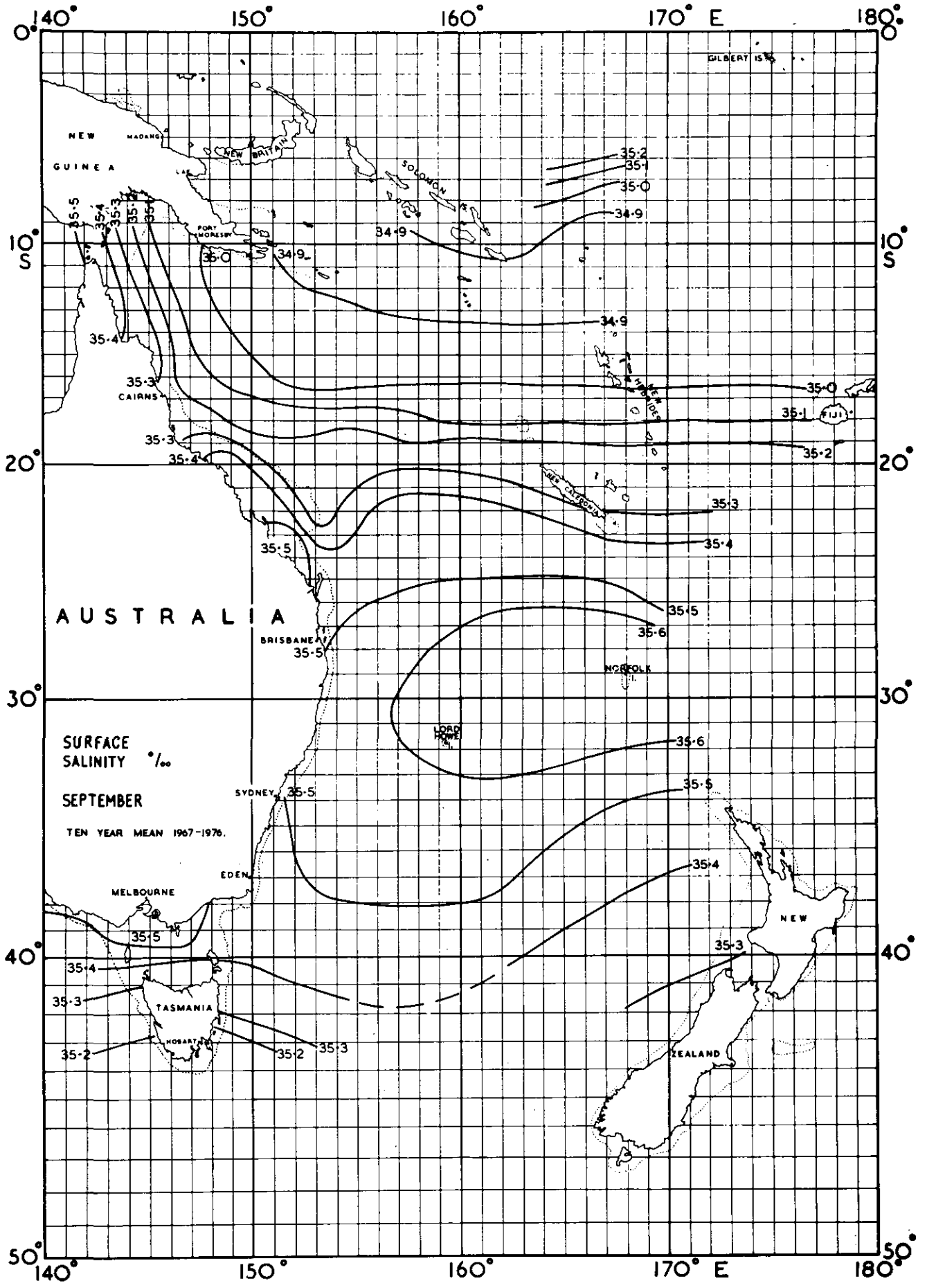

Fig. 23. Ten year average salinity field for the month of September. Contour interval is 0.1‰ (parts per thousand).

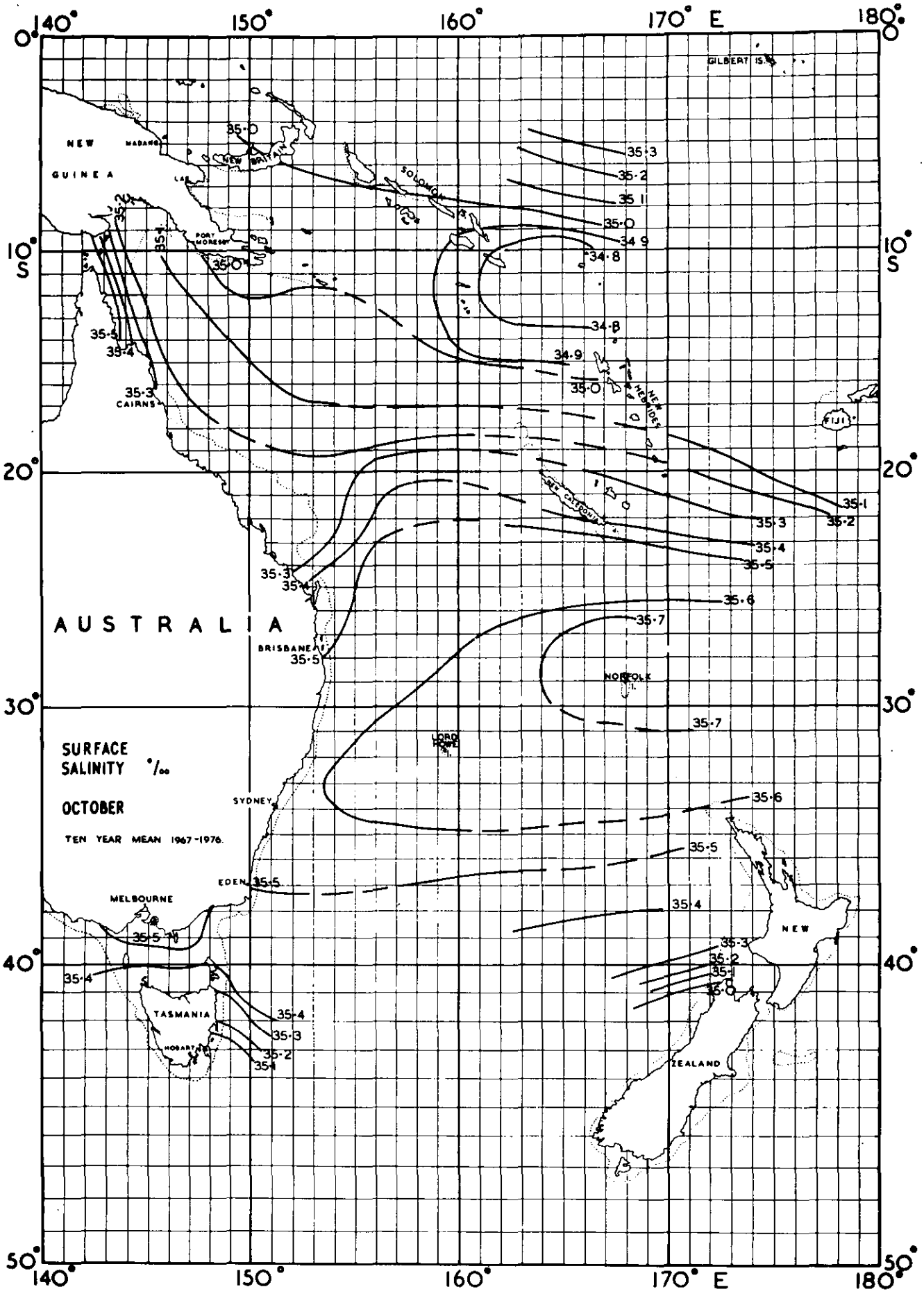

Fig. 24. Ten year average salinity field for the month of October. Contour interval is 0.1‰ (parts per thousand).

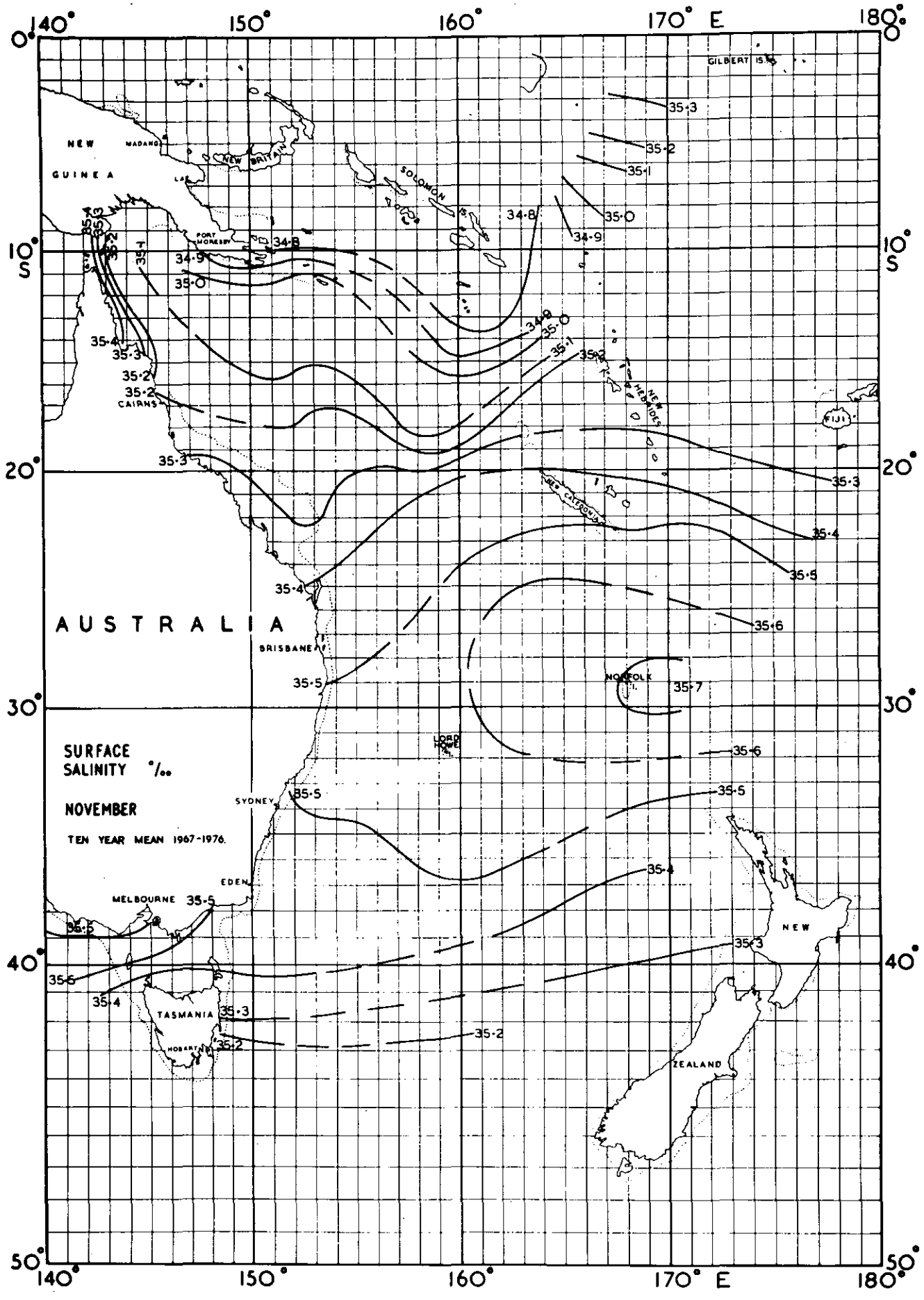

Fig. 25. Ten year average salinity field for the month of November. Contour interval is 0.1‰ (parts per thousand).

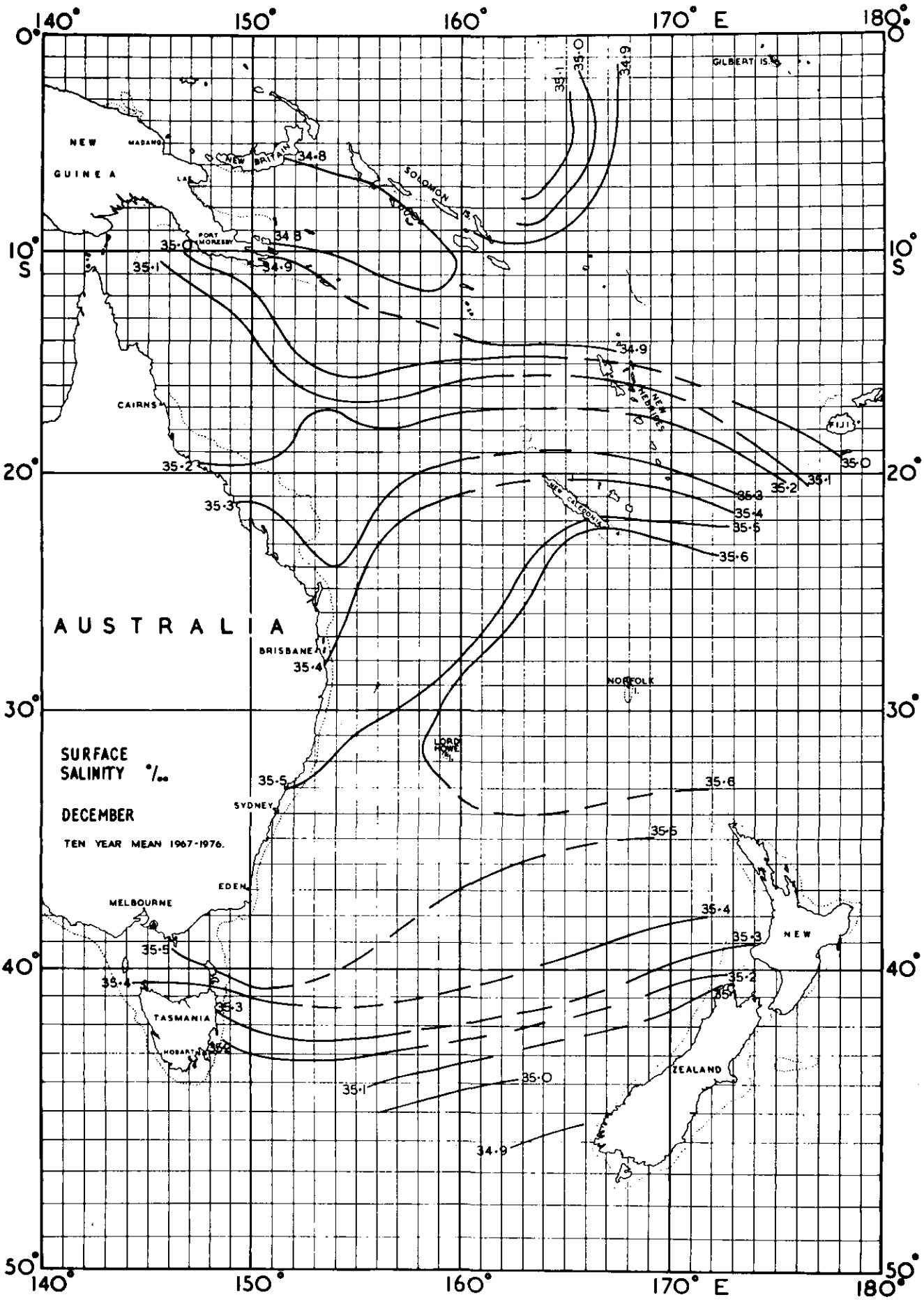

Fig. 26. Ten year average salinity field for the month of December. Contour interval is 0.1‰ (parts per thousand).

15°S:151°E

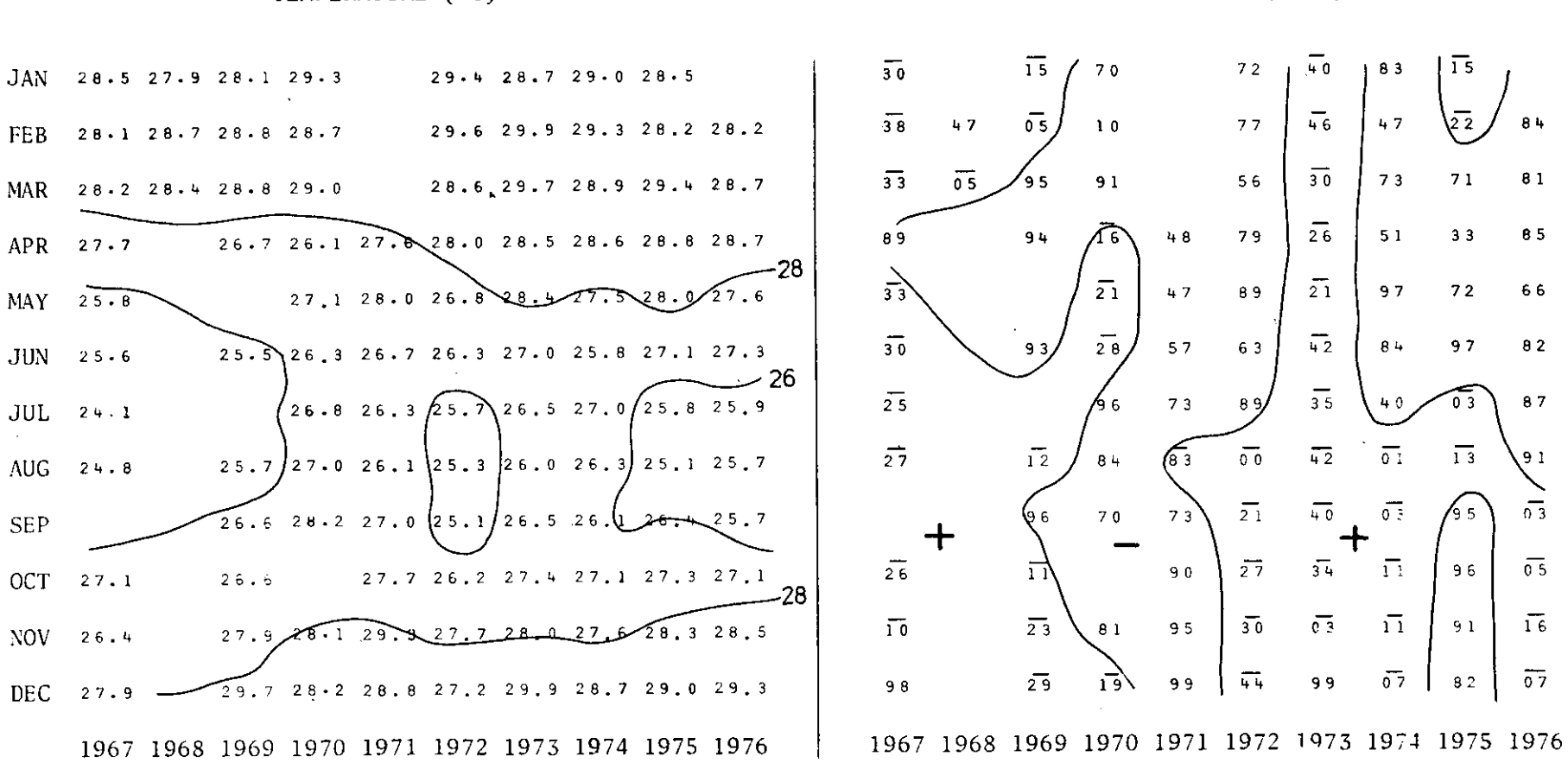

Fig. 27. Monthly average temperature and salinity values for the 1° square 15°-16°S; 151°-152°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.00‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

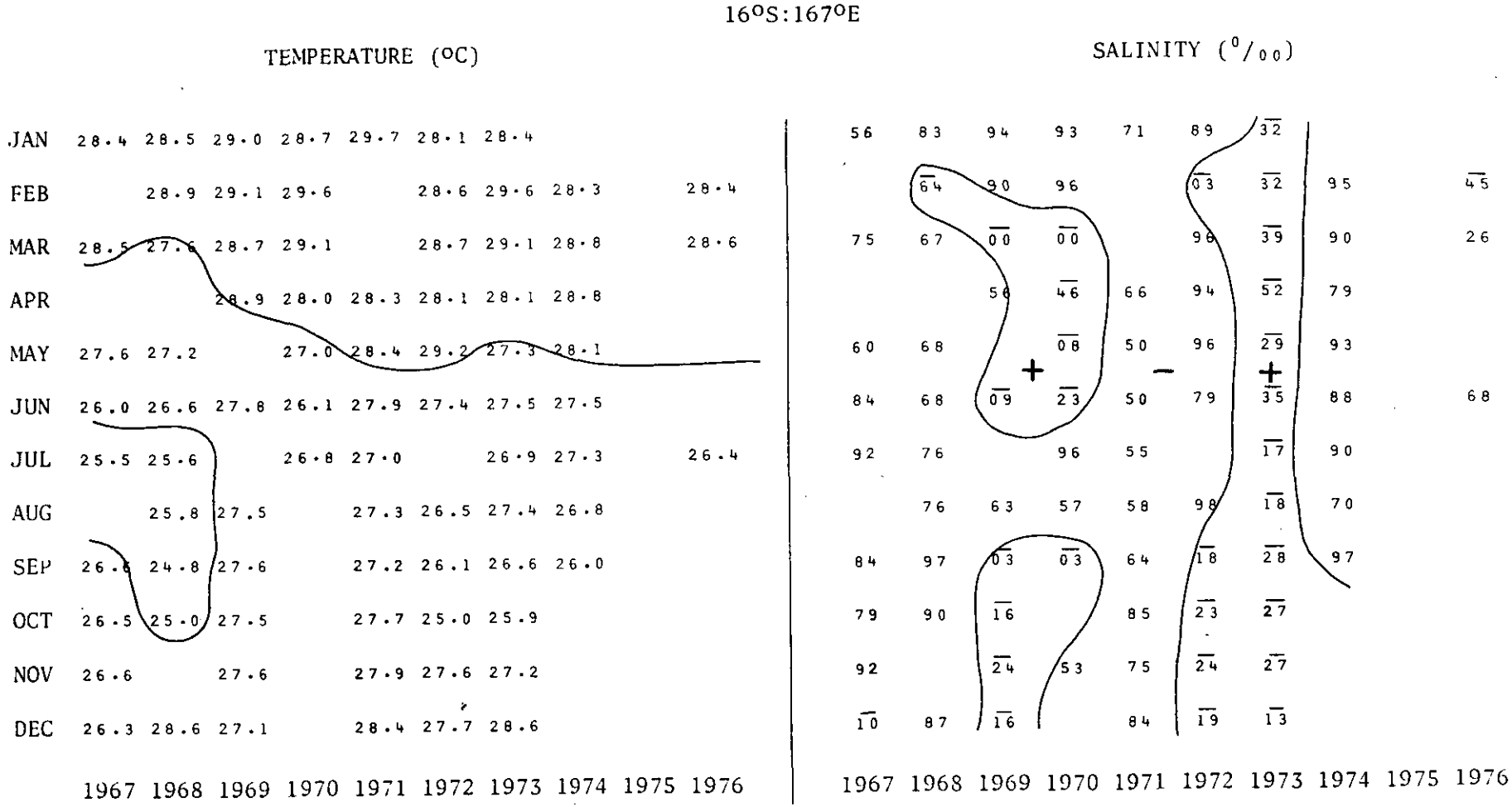

Fig. 28. Monthly average temperature and salinity values for the 1° square 16°-17°S; 167°-168°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.00‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

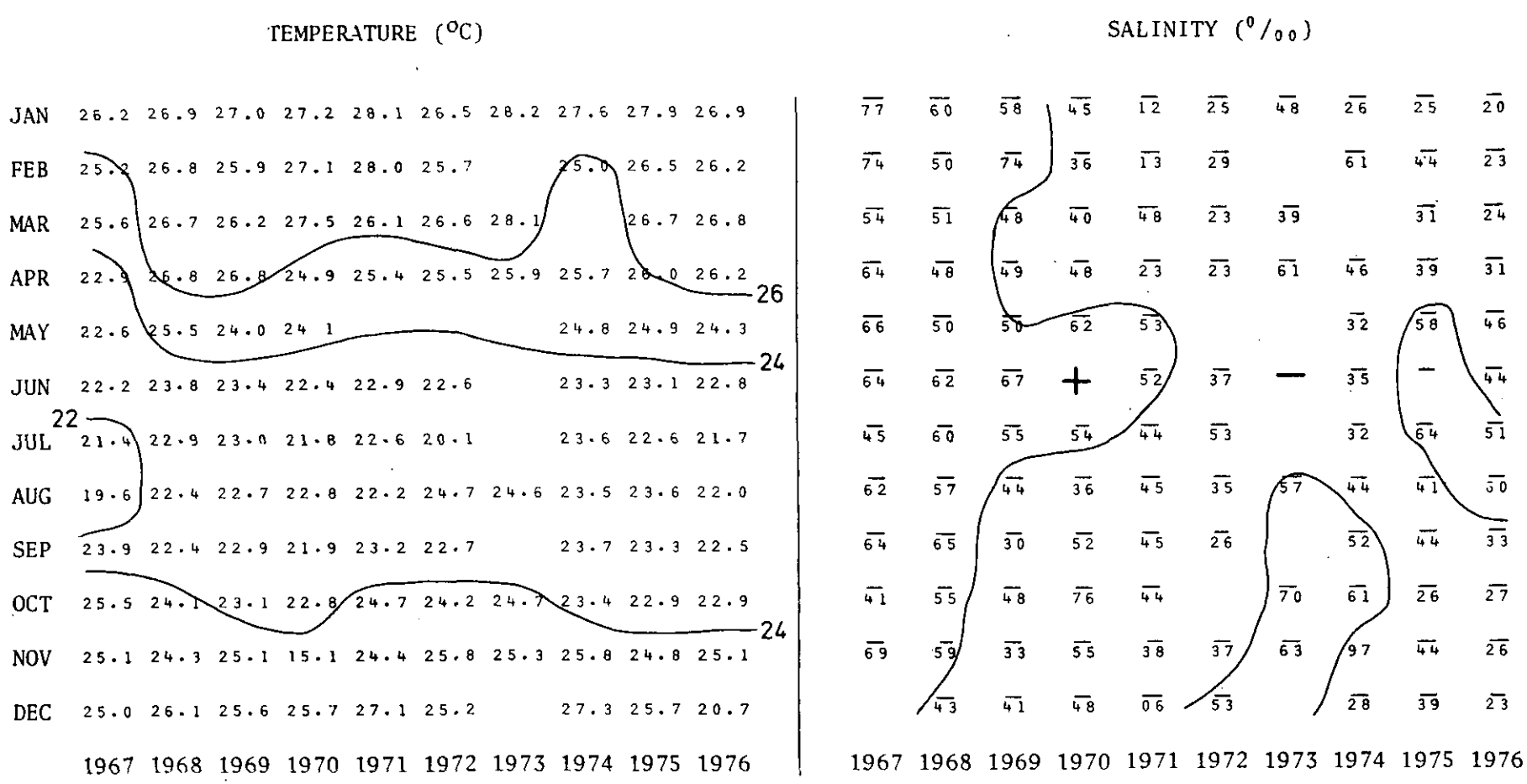

Fig. 29. Monthly average temperature and salinity values for the 1° square 23°-24°S; 156°-157°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.50‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

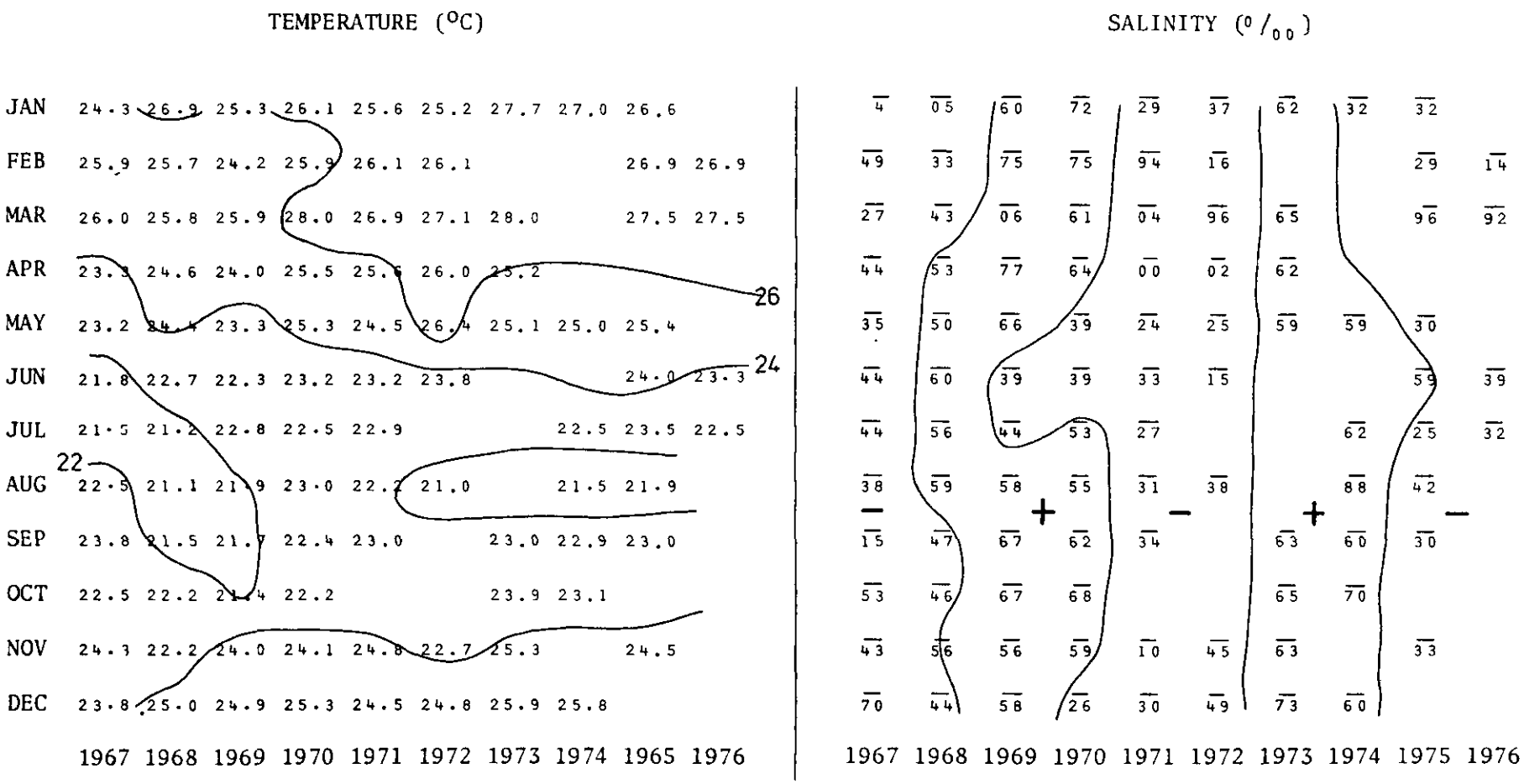

Fig. 30. Monthly average temperature and salinity values for the 1° square 23°-24°S; 170°-171°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.50‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

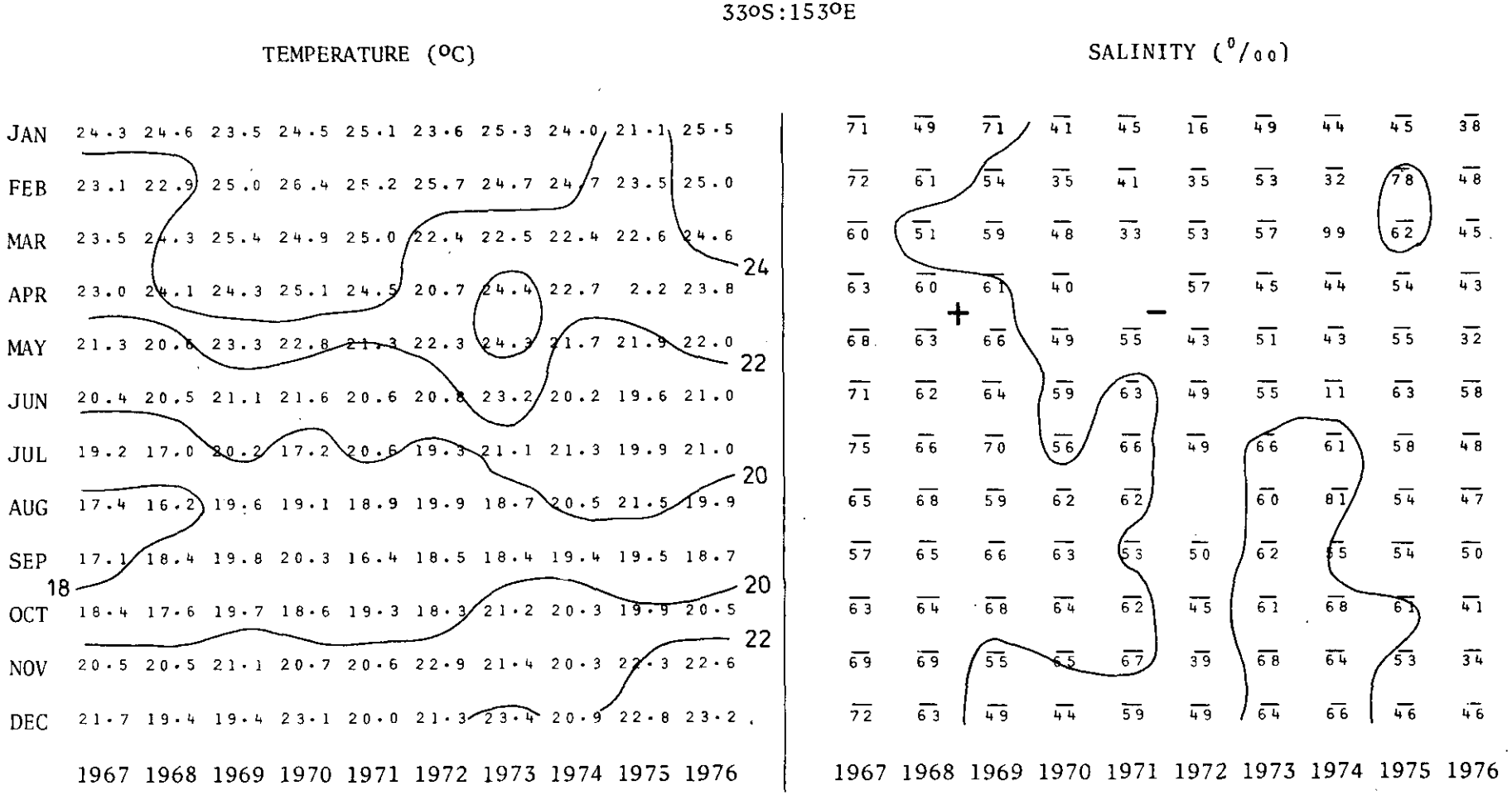

Fig. 31. Monthly average temperature and salinity values for the 1° square 33°-34°S; 153°-154°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.60‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

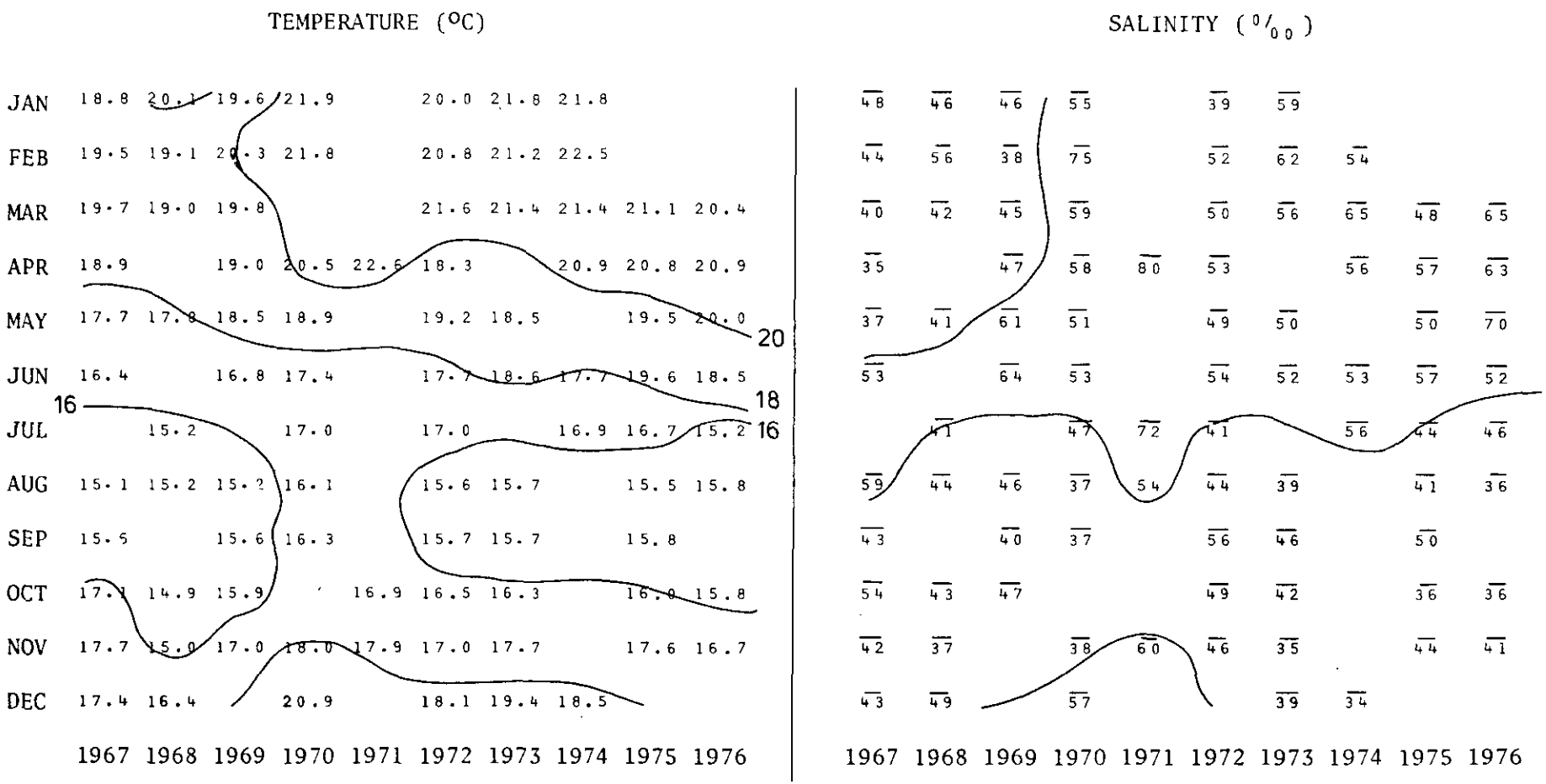

Fig. 32. Monthly average temperature and salinity values for the 1° square 34°-35°S; 170°-171°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.50‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

40°S:149°E

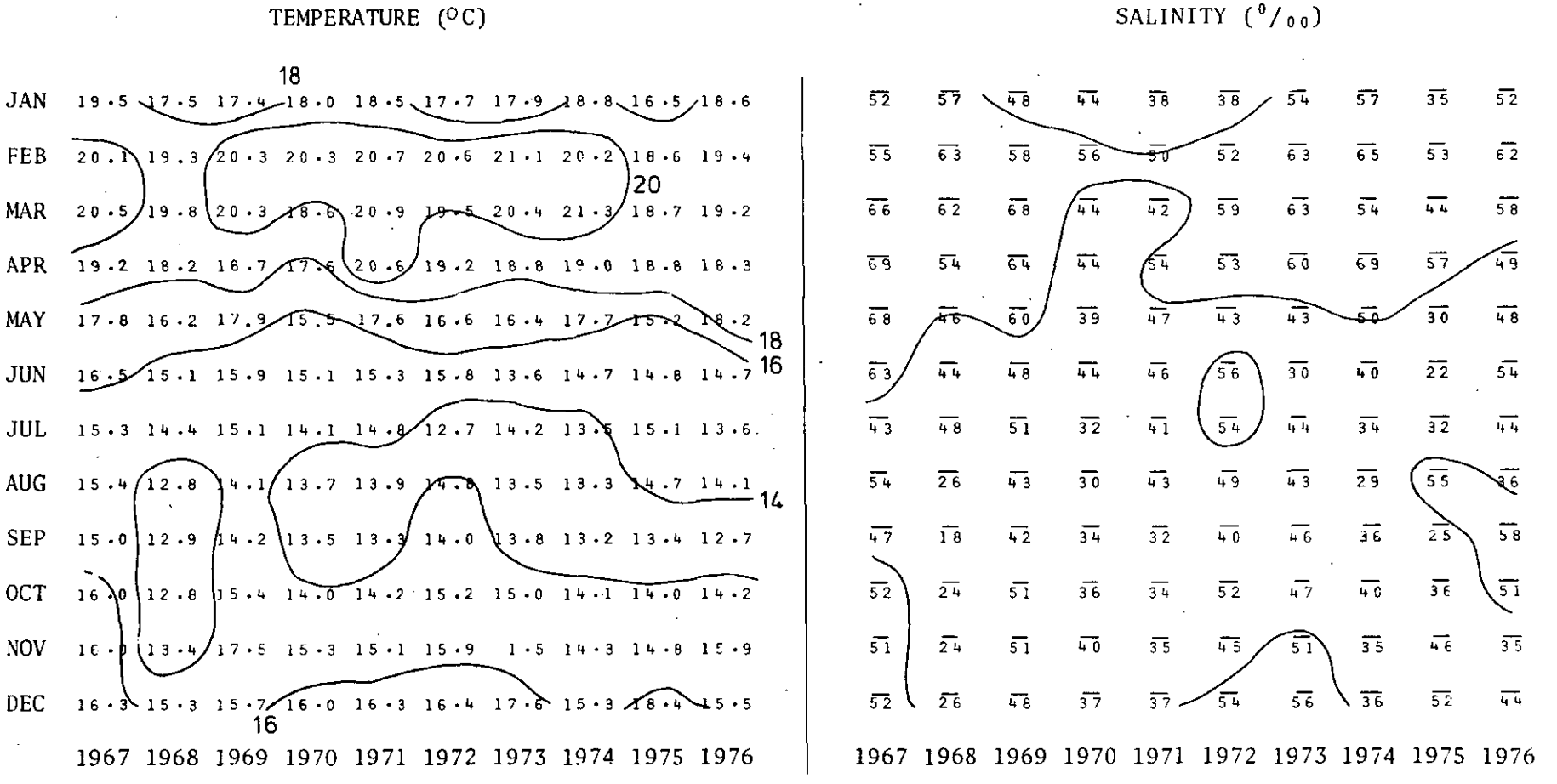

Fig. 33. Monthly average temperature and salinity values for the 1° square 40°-41°S; 149°-150°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.50‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

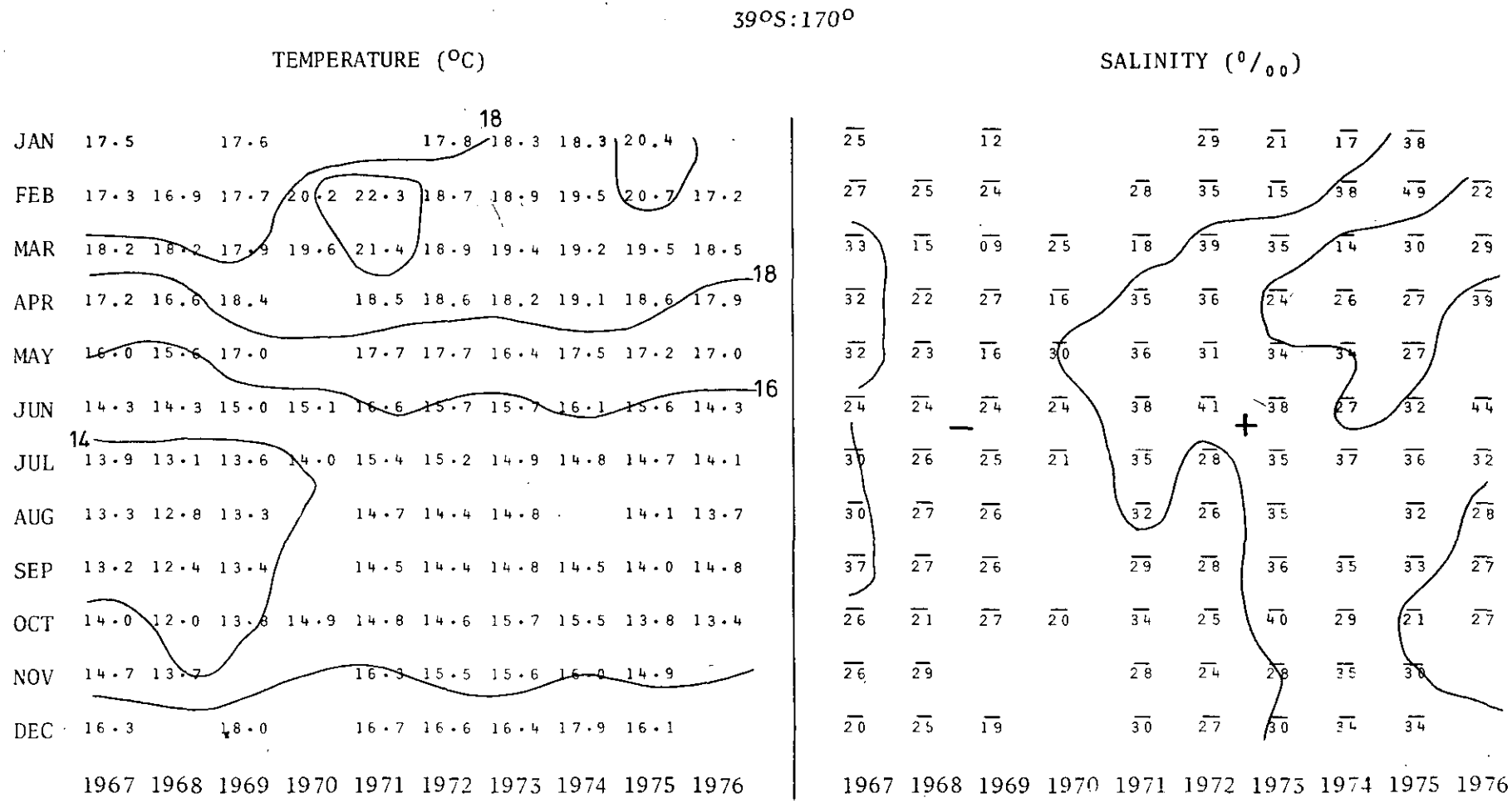

Fig. 34. Monthly average temperature and salinity values for the 1° square 39°-40°S; 170°-171°E for the decade 1967-1976. Temperatures are contoured at 2 centigrade degree intervals and the salinity contour is 35.30‰. Barred values have 35.00‰ added to them and 34.00‰ to the remainder.

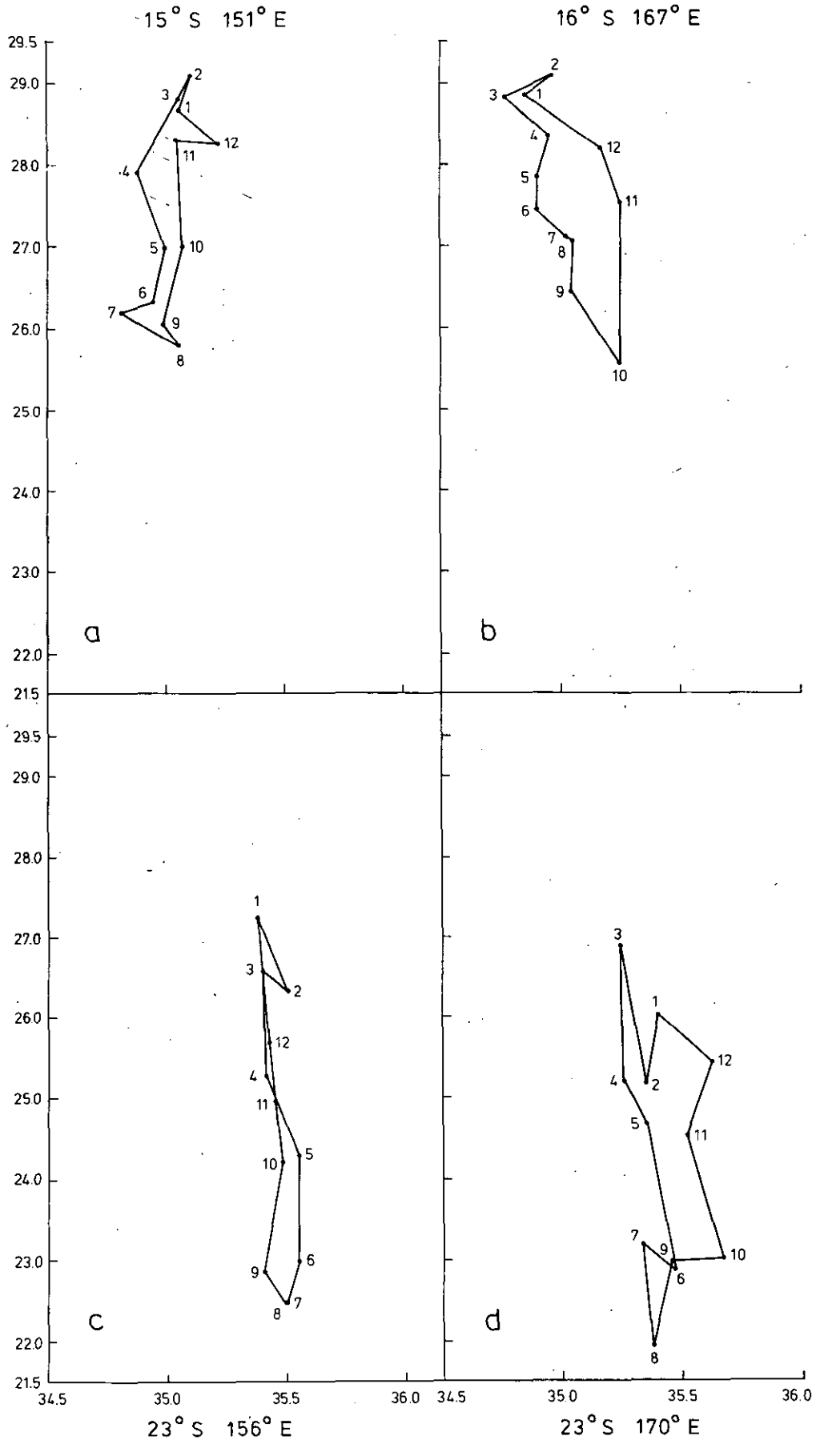

Fig. 35. Average yearly temperature salinity envelopes for the 1° squares a, 15°-16°S, 151°-152°E; b, 16°-17°S, 167°-168°E; c, 23°-24°S, 156°-157°E; d, 23°-24°S, 170°-171°E. Numbers 1-12 represent months of the year.

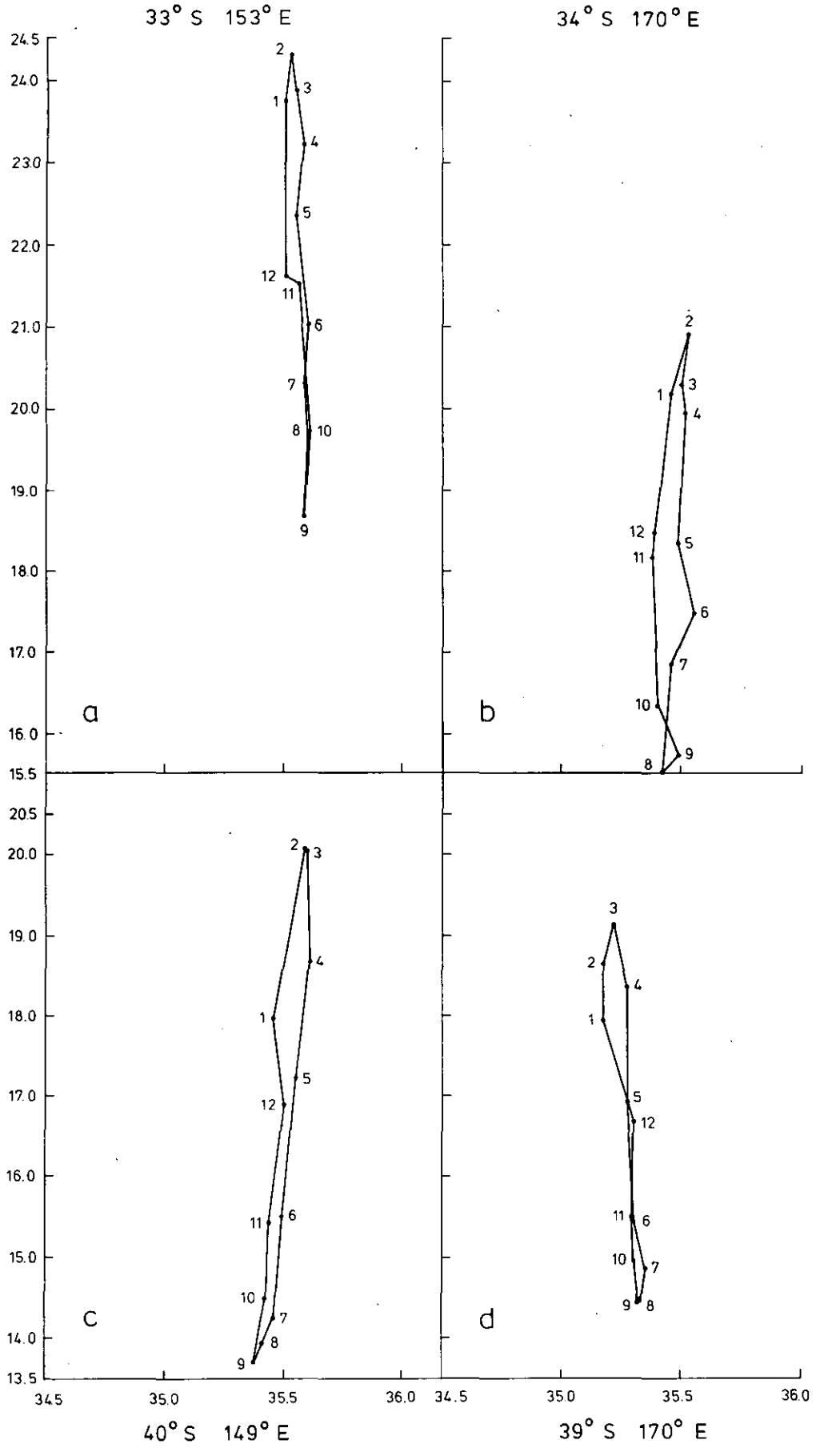

Fig. 36. Average yearly temperature salinity envelopes for the 1° squares a, 33°-34°S, 153°-154°E; b, 34°-35°S, 170°-171°E; c, 40°-41°S, 149°-150°E; d, 39°-40°S, 170°-171°E. Numbers 1-12 represent months of the year.