

The oceanographic research in the Eastern North Pacific—VIII Oceanic conditions in the southwestern region of the Hawaiian Islands on May of 1986

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Abstract

The C. T. D observations were made of the longitudinal section in the southwestern region of the Hawaiian Islands on May, 1986, as a yearly oceanographic work of the Keiten Maru of the Kagoshima University.

In this report, the general oceanographic condition is presented on the bases of the water temperature, salinity and geostrophic sections.

1. Introduction

Since 1981, the Keiten Maru of the Kagoshima University took a oceanographic section along 20° N from 160° W to 170° W to investigate the tuna fishing ground in the southwestern region of the Hawaiian Islands in the North Equatorial Current. Those oceanographic results were presented in the previous papers (Yuwaki et al. 1982, 1983, 1984).

In 1986, the oceanographic observations were carried out in the same region on May 14th-27th. The general feature of the oceanographic condition were presented and we discussed the conditions included the last three years.

2. Materials and Methods

The oceanographic observations were carried out on board the Keiten Maru (G.T 860 tons), the fisheries training and research ship of Kagoshima University, along 19°-45'N from 160°W to 167°W on May 14th-27th, 1986, as a part of cadets training program.

The oceanographic data was obtained with the C. T. D systems (Neil Brown Model 1150). The sensor of C. T. D cast down from the surface to 1,200m in depth with lowering speed of ca. 60m/min.

The locations of observation stations are shown in Fig.1. The numerical values of temperature and salinity at each station are tabulated in the annexed table.

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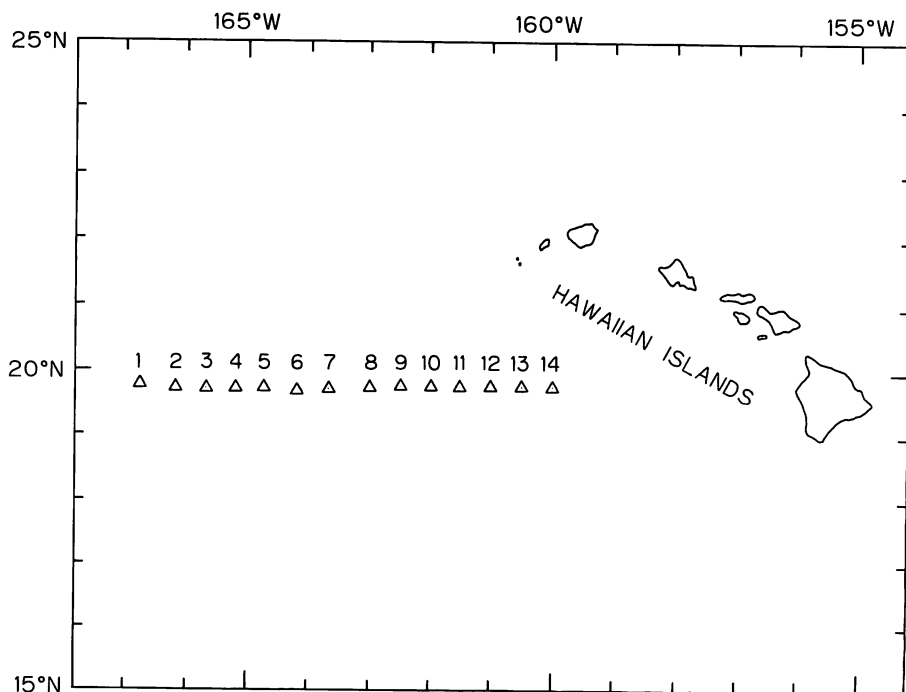


Fig. 1. Oceanographic stations of C. T. D observations in the southwestern region of the Hawaiian Islands.

3. Temperature and Salinity Distributions

Temperature and salinity section along the latitude of 19°-45'N from 160°W to 167°W are shown in Fig.2 and 3, respectively.

In the temperature section (Fig.2), the depth of surface mixed layer is ca. 50m around 166°W, and ca. 25m around 163°W where is the shallowest on the section. This fact suggests that some upwelling take place. The numerical value of temperature at the surface is ca. 26.0°C or more. This value is ca. 0.3°C higher than that of 1981 and 1982.

Below the surface mixed layer, the thermocline is seen in the layer at a depth of 60m to 360m. The temperature in the thermocline is from 26°C to 10°C and the vertical gradient of temperature in the thermocline is ca. 0.05°C/m. This gradient is almost equal to those in 1981 and 1982.

The isotherms below the thermocline undulate, which may indicate weak upwelling of lower water around 163°W.

In the salinity section (Fig.3), surface less saline water lower than 35.00‰ is seen in the top 50m layer. The value of salinity of surface mixed layer is ca. 0.20‰ lower than that of 1981 but ca. 0.40‰ higher than that of 1982. The surface less saline water is divided into two portions of the east and the west sides of 163°W, accompanied with the subsurface saline water. The surface salinity is maximum near 163°W, where the upwelling suspected to have take place on temperature section.

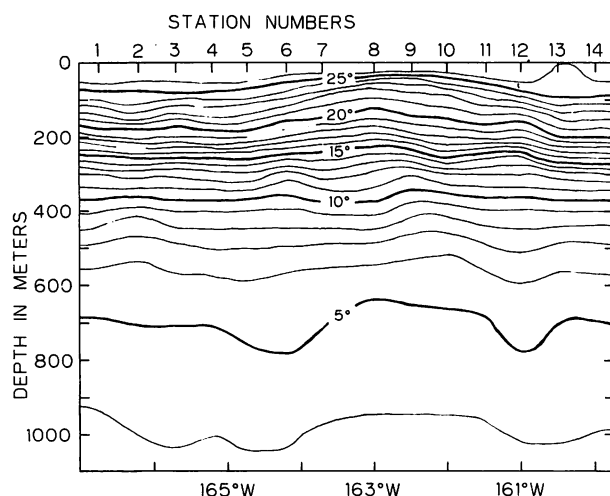


Fig. 2. Distribution of temperature ($^{\circ}\text{C}$) on the vertical section along $19^{\circ}\text{-}45'\text{N}$.

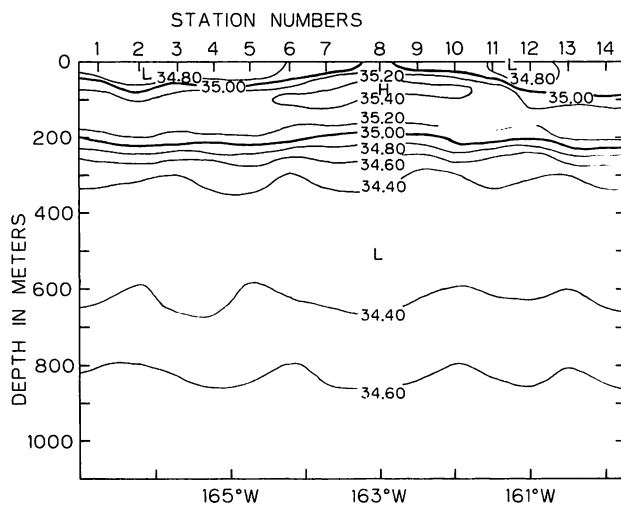


Fig. 3. Distribution of salinity (‰) on the vertical section along $19^{\circ}\text{-}45'\text{N}$.

A saline core higher than 35.20‰ is seen around 163°W . The depth of the center of that core is ca. 75m , corresponding to the shallowest part of the thermocline.

The general aspects of temperature and salinity distribution were almost the same as those in research in 1981 and 1982 (Yuwaki *et al.* 1981, 1982).

4. Temperature and Salinity Diagram

The representative temperature-salinity curves are shown in Fig. 4. The Eastern North

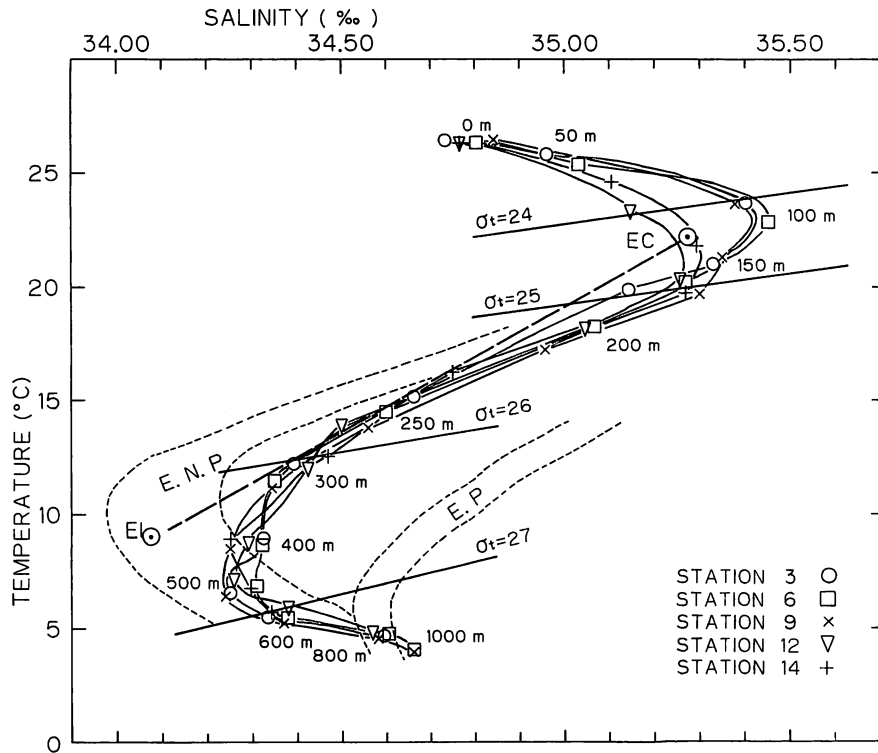


Fig. 4. The representative temperature-salinity curves in the southwestern region of the Hawaiian Islands.
Observing depths in meter are entered. E. N. P represents the Eastern North Pacific Central Water, and P. E. the Pacific Equatorial Water.

Pacific Central Water (E.N.P) and the Pacific Equatorial Water (E.P) defined by Sverdrup et al. (1942) are indicated by dotted bands and the subsurface saline water (EC-water) and the subarctic intermediate water (EI-water) determined by Yuwaki et al. (1981) are entered in the figure.

The temperature-salinity curves at each station are quite similar to each other, i. e., the curves have an inverted form of 'S' characterized with a salinity maximum at a depth of ca. 120m and a salinity minimum at a depth of ca. 450m. The salinity maximum water corresponds to the subtropical subsurface saline water and the salinity minimum water to the subarctic intermediate water.

The mean values of temperature and salinity of subsurface saline water are ca. 22.1°C and ca. 35.40‰, and those subarctic intermediate water are ca. 7.7°C and ca. 34.28‰, respectively. The mean values of salinity maximum and minimum are ca. 0.15‰ high compared with those for the last three years (Yuwaki et al. 1981-1983).

The cause in the differences of the mean values of salinity maximum and minimum is not clear. One possible explanation of this difference might be the inter annual variations of heating and evaporation in the Eastern North Pacific.

The saline water higher than 34.80‰ represents subtropical water that has originated from the central North Pacific with a surface salinity maximum of around 30°N (Montgomery 1962).

The less saline water lower than 34.35‰, associated with the North Pacific Intermediate Water, is found in the layer between 400 m and 500 m depth. The North Pacific Intermediate Water is formed at high latitude in the mixed layer in winter and sinks as it flows toward latitudes, either as an undercurrent along the western boundary or as a part of the general wind-driven circulation of the subtropical anticyclones (Reid, 1965).

The EC-Water is clearly seen at a depth of ca. 100 m-150 m, though the value of salinity is ca. 0.15‰ low. The temperature-salinity curves between 250 m-300 m coincide with a straight line passing through the EC-Water and the EI-Water, showing that the water in the layer, is a mixture of these two water masses. The water at a depth of ca. 250 m, showing ca. 15.0°C and ca. 34.67‰, is a mixture of the EC-Water and the EI-Water at a rate 1 : 1. The water at a depth of ca. 300 m, showing ca. 12.2°C and 34.43‰ is a mixture of the EC-Water and the EI-Water at a rate 1 : 2. The water of salinity minimum at a depth of ca. 450 m is a mixture of the EI-Water and some of lower water. The temperature-salinity curves below ca. 450 m depth coincide with that of the Eastern North Pacific Central Water.

5. Geostrophic Current

The vertical section of the north-south components of geostrophic current velocity referred to 1,200 db along the latitude of 19°-45'N from 160°W to 167°W is shown in Fig. 5. The volume of geostrophic transport are listed in Table 1.

As is seen in Fig. 5, the geostrophic current has the alternate distribution of direction ; north, south and north from east to west.

The northward flow, having a maximum velocity of 27 cm/sec, is located around 161°-15'W and the total volume transport is estimate to be $9.8 \times 10^6 \text{ m}^3/\text{sec}$.

The maximum velocity of northward flow was almost equal to that of 1981 but it was 6 cm/sec larger than that of 1982.

Table 1. The volume transport of north-south components estimated by geostrophic approximation with the reference level of 1,200 decibar on the section along 19°-45'N.

Current range (Long. West)	Transport (m^3/sec)	Total transport* (m^3/sec)
160°-162°	11.6×10^6 -1.8×10^6	9.8×10^6
162°-165°	0.3×10^6 -9.1×10^6	-8.8×10^6
165°-167°	7.2×10^6 -1.8×10^6	5.4×10^6

* Northward flow : positive.

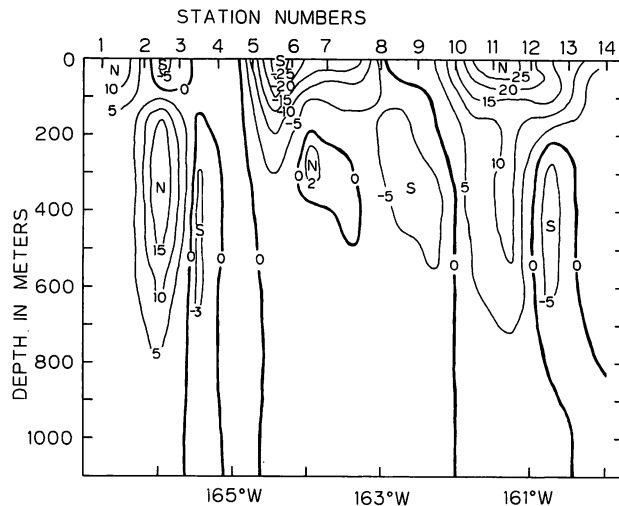


Fig. 5. Distribution of geostrophic current (cm/sec) on referred to 1,200 decibar level on the vertical section along 19°-45°N.

The southward flow, having a maximum velocity of 28cm/sec, occupied comparatively broad range and the main axis is located around 164°-30'W and the total volume transport is estimate to be $8.8 \times 10^6 \text{ m}^3/\text{sec}$. The maximum velocity of southward flow is 23cm/sec smaller than that of 1981 but it is 7cm/sec larger than that of 1982 and the main axis has shift to the west about 110 miles compared with that of 1981.

It is considered that these differences on the velocity and the axis of current are caused by the vicissitude of wind system excelling in the Eastern North Pacific or complicated oceanographic condition including some eddies in this region.

6. Summary

The oceanographic research was carried out in the southwestern region of the Hawaiian Islands on May, 1986. The results obtained are summarized as follows ;

- 1) The depth of surface mixed layer is ca. 50m around 166°W, and ca. 25m around 163°W. The numerical value of water temperature of surface is ca. 26.0°C or more, which is ca. 0.3°C higher than that of 1981 and 1982.
- 2) The thermocline is seen in depth range from 60m to 360m.
The temperature in the thermocline is from 26°C to 10°C and vertical gradient in the thermocline is ca. 0.05°C/m, being almost equal to ones in 1981 and 1982.
- 3) The surface less saline water lower than 35.00‰ is seen in the top 50m layer, which salinity is ca. 0.20‰ lower than that of 1981 but 0.40‰ higher than that of 1982.
- 4) A saline core higher than 35.20‰ is seen around 163°W at ca. 75m depth.
- 5) The less saline water lower than 34.35‰ is seen in the layer between 400m and 500m.
- 6) The salinity maximum of ca. 35.40‰ and the salinity minimum of ca. 34.28‰ are seen at a depth of ca. 120m and 450m.

- 7) The northward flow, having a maximum velocity of 27cm/sec, is located around 161°-15'W and the total volume transport is estimated to be $9.8 \times 10^6 \text{ m}^3/\text{sec}$.
- 8) The southward flow, having a maximum velocity of 28cm/sec, is located around 164°-30'W and the total volume transport is estimated to be $8.8 \times 10^6 \text{ m}^3/\text{sec}$.
- 9) The general aspects of water temperature and salinity distributions were almost the same as those in research in 1981 and 1982.

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Annexed table

Date	1986. 5. 14		1986. 5. 15		1986. 5. 16		1986. 5. 17		1986. 5. 18	
St'n	1		2		3		4		5	
Lat	19°-48.0N		19°-42.2N		19°-42.8N		19°-43.0N		19°-44.2N	
Long	166°-45.8W		166°-10.4W		165°-40.1W		165°-11.9°W		164°-43.5W	
	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰
0	26.62	34.72	26.22	34.53	26.46	34.73	26.36	34.71	26.14	34.72
10	26.51	34.72	26.22	34.53	26.45	34.74	26.33	34.72	26.12	34.72
20	26.47	34.73	26.08	34.67	26.30	34.73	26.34	34.71	26.12	34.73
30	26.46	34.74	26.08	34.69	26.27	34.74	26.32	34.72	26.12	34.73
50	26.06	35.09	26.03	34.72	25.88	34.96	26.11	34.74	26.07	34.86
75	24.80	35.18	25.44	34.93	25.14	35.14	24.91	35.20	25.23	35.19
100	23.68	35.43	24.69	35.24	23.71	35.41	23.71	35.37	23.65	35.34
150	21.17	35.41	22.24	35.35	21.02	35.33	21.65	35.44	21.51	35.38
200	18.38	35.08	19.35	35.20	18.83	35.14	19.00	35.16	19.13	35.18
250	14.86	34.68	15.62	34.74	15.10	34.66	15.36	34.66	15.64	34.75
300	12.18	34.46	12.57	34.42	12.19	34.39	12.58	34.44	12.85	34.46
400	9.03	34.29	8.17	34.27	8.99	34.32	8.93	34.33	8.91	34.32
500	6.60	34.25	6.30	34.28	6.64	34.25	7.11	34.31	7.23	34.35
600	5.40	34.35	5.38	34.43	5.63	34.34	5.61	34.35	5.93	34.42
700	4.87	34.51	5.03	34.54	5.05	34.46	4.98	34.50	5.20	34.52
800	4.53	34.60	4.61	34.60	4.76	34.59	4.60	34.56	4.77	34.58
900	4.14	34.64	4.33	34.65	4.42	34.64	4.37	34.64	4.46	34.63
1000	3.82	34.67	4.03	34.67	4.13	34.66	4.05	34.67	4.10	34.66
1200	3.26	34.70	3.42	34.71	3.52	34.70	3.42	34.71	3.48	34.70

Date	1986. 5. 19		1986. 5. 20		1986. 5. 26		1986. 5. 27		1986. 5. 27	
St'n	6		7		8		9		10	
Lat	19°-42.1N		19°-42.8N		19°-45.0N		19°-45.0N		19°-45.1N	
Long	164°-11.8W		163°-40.8W		163°-00.0W		162°-30.0W		162°-00.1W	
	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰
0	26.23	34.80	26.13	34.84	25.98	35.06	26.51	34.83	26.62	34.92
10	26.22	34.80	26.12	34.84	25.99	35.07	26.50	34.84	26.12	34.92
20	26.20	34.81	26.12	34.84	25.95	35.07	25.99	34.99	26.13	34.92
30	26.02	34.82	25.50	35.05	24.51	35.29	25.78	35.04	25.66	35.00
50	25.61	35.03	24.29	35.31	23.06	35.44	23.73	35.38	24.76	35.27
75	23.97	35.36	22.82	35.40	21.60	35.44	22.37	35.46	22.51	35.44
100	22.76	35.45	21.71	35.46	20.65	35.33	21.31	35.35	21.26	35.39
150	20.26	35.27	20.09	35.35	19.22	35.26	19.69	35.30	19.80	35.30
200	18.25	35.07	17.17	34.96	16.53	34.90	17.31	34.96	18.07	35.11
250	14.56	34.60	14.51	34.67	13.74	34.62	13.82	34.56	15.55	34.76
300	11.47	34.35	12.36	34.47	12.11	34.48	11.14	34.34	11.91	34.39
400	8.76	34.32	9.17	34.27	9.52	34.30	8.53	34.25	8.38	34.25
500	6.99	34.31	6.70	34.25	6.75	34.24	6.43	34.24	6.18	34.26
600	5.62	34.38	5.54	34.35	5.44	34.32	5.32	34.37	5.33	34.43
700	5.23	34.54	4.96	34.49	4.65	34.45	4.84	34.49	4.90	34.55
800	4.92	34.61	4.57	34.58	4.41	34.57	4.49	34.58	4.54	34.61
900	4.55	34.64	4.22	34.63	4.18	34.63	4.23	34.63	4.19	34.65
1000	4.09	34.67	3.89	34.66	3.94	34.66	3.93	34.67	3.86	34.67
1200	3.44	34.70	3.35	34.70	3.34	34.70	3.35	34.69	3.36	34.69

Annexed table

Date	1986. 5. 27		1986. 5. 27		1986. 5. 27		1986. 5. 27	
St'n	11		12		13		14	
Lat	19°-45. '0N		19°-45. 0N		19°-45. 0N		19°-45. '0N	
Long	161°-29. '9W		161°-00. 0W		160°-30. 0W		160°-00. '0W	
	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰	Temp℃	Sali‰
0	26. 39	34. 78	26. 49	34. 76	25. 95	34. 84	26. 48	34. 74
10	26. 38	34. 78	26. 42	34. 77	25. 95	34. 84	26. 48	34. 74
20	26. 23	34. 77	26. 42	34. 77	25. 93	34. 83	26. 41	34. 75
30	26. 22	34. 80	26. 42	34. 78	25. 88	34. 85	26. 31	34. 73
50	25. 39	35. 06	26. 01	34. 71	25. 69	34. 84	25. 89	34. 77
75	23. 64	35. 35	24. 98	34. 96	25. 44	34. 87	25. 55	34. 80
100	22. 64	35. 42	23. 43	35. 15	24. 61	35. 11	24. 60	35. 11
150	20. 77	35. 37	20. 21	35. 26	22. 21	35. 36	21. 78	35. 30
200	18. 33	35. 11	18. 18	35. 05	19. 78	35. 27	19. 83	35. 27
250	14. 54	34. 63	14. 01	34. 50	16. 24	34. 79	16. 40	34. 78
300	12. 15	34. 46	11. 99	34. 42	12. 52	34. 40	12. 75	34. 47
400	8. 79	34. 30	8. 80	34. 29	8. 92	34. 29	8. 82	34. 28
500	6. 82	34. 31	7. 23	34. 36	6. 73	34. 31	6. 82	34. 30
600	5. 50	34. 39	6. 06	34. 38	5. 58	34. 41	5. 65	34. 34
700	4. 89	34. 50	5. 40	34. 48	4. 99	34. 53	5. 02	34. 49
800	4. 61	34. 59	4. 90	34. 57	4. 66	34. 60	4. 65	34. 58
900	4. 22	34. 63	4. 40	34. 63	4. 41	34. 64	4. 35	34. 63
1000	3. 88	34. 65	4. 07	34. 66	4. 11	34. 66	4. 03	34. 66
1200	3. 29	34. 69	3. 37	34. 69	3. 55	34. 70	3. 45	34. 69