Report of the Kagoshima-maru IGY Cruise, 1958

by

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Abstract

The general informations obtained from the Kagoshima-maru IGY cruise, 1958, in the western Equatorial Pacific are presented. A cold water of 10°C climbs up to ca 250 m depth at ca 5°N. Temperature of the core of salinity maximum of higher than 35‰ extending to the north from the southern latitudes in a layer around 150 m depth is ca 23°C. Low salinity is found around 5°N. Oxygen content in a layer above 100 m is ca 4cc/l and below the layer the vertical gradient is strong to the north of 3°N. The South Equatorial Current is found in a region to the south of 2°N and below the Current an eastward flow exists. It is difficult to distinguish the Equatorial Undercurrent from the Equatorial Countercurrent flowing eastwards in a region to the north of the South Equatorial Current. The amount of the eastward volume transport above a depth of 400 m, based on direct measurement, is ca 93 million m^3/sec and that of westward is ca 25 million m^3/sec.

1. Observations

The Kagoshima-maru cruise for the International Geophysical Year of 1957–58 in the western Equatorial Pacific was made during the period from March 24 to April 28, 1958. In the original schedule, which was obliged to be converted into the above-mentioned because of many difficulties, Kagoshima-maru was to participate in a multiple ship survey with Takuyo and Satsuma in February of 1958. Therefore, informations as to the variations of the Equatorial Currents in a few months after the multiple ship survey were obtained, though the multiple ship survey itself, the results of which is reported by S. Yoshida, H. Nitani, and N. Suzuki (1959), found somewhat less detailed structures of the Currents than the expected. In the present paper, the general informations obtained from the Kagoshima-maru cruise are presented, and not the discussion as to the variation with progressive months. Temperature, salinity, and oxygen content are observed at 25 stations by the usual method and BT observations are made at 27 stations. Direct measurements of relative current referred to a depth of 700 m are carried out at 16 stations by means of two current meters of Ekman-Mertz type. The observing points are shown in Fig. 1 and the observed data will be published by Japan Meteorological Agency.

2. Results

Distribution of temperature in the vertical sections along the meridians of 151° and 153° E is shown in Fig. 2, which is based on the observations with protected and unprotected reversible thermometers and BT observations. In the central part of these sections, isotherms in a layer between depths of ca 150 and 500 m climb up from south to north; from 2°N to 7°N and to 5°N above and below 200 m depth respectively on 151°E and from 2°N to 4°N on 153°E. Thus, the depth of cold water of 10°C is minimum at 5° and 4°N on 151° and 153°E respectively (250 m and 265 m). At these sites, the thickness of a layer bounded by two isotherms of 20° and 25°C is so small as ca 30 m; whereas the thickness becomes larger to the south of 3°N and amounts to 75 m or more around the Equator, and the large thickness at 1°S and 2°N on 153°E is especially notable. Another notable fact as to temperature distribution is the minimum depths of thermocline at 0°30′N, 3°N, and 7°N on 151°E and 2°N on 153°E, which is discussed elswhere (T. Takahashi, 1959).

Distribution of salinity in the vertical sections is shown in Fig. 3. A tanguelike protuberance of salinity maximum of higher than 35‰ extending to the north from the southern latitudes, where the numerical value of salinity is higher than 35.6‰, is found in a layer around 150 m depth in both sections. The upward diffusion from the core of the maximum salinity seems to approach to the sea surface at ca 3°N, which is especially obvious on 153°E. On 151°E, a latitudinal variation towards 3°N

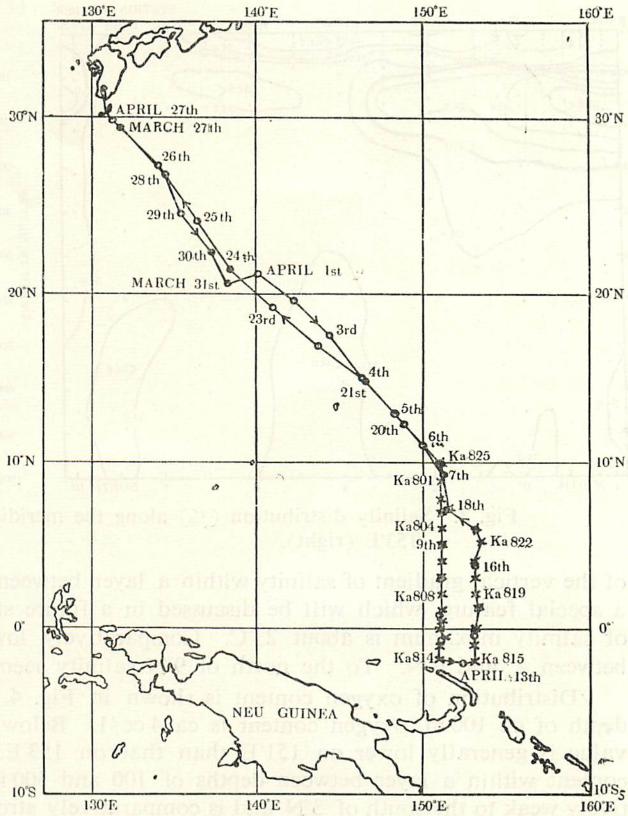

Fig. 1. Map showing the track and the observing points indicated by crosses. Circles indicate the positions at noon of everyday.

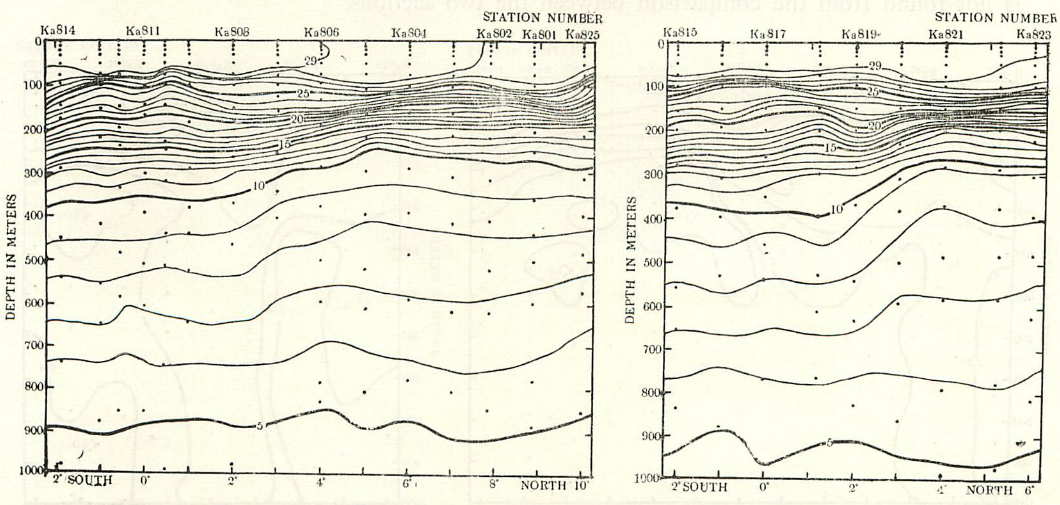

Fig. 2. Temperature distribution (°C) along the meridians of 151°E (left) and 153°E (right).

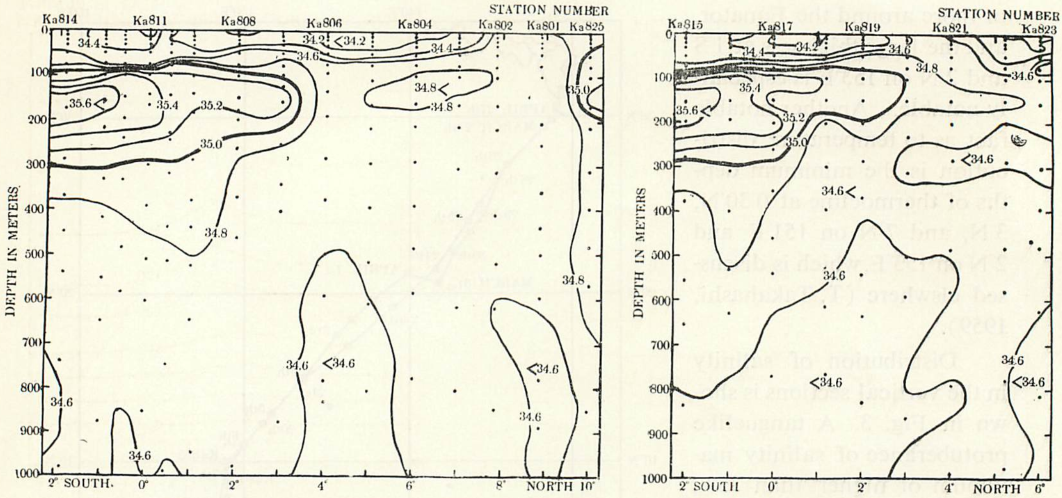

Fig. 3. Salinity distribution (‰) along the meridians of 151°E (left) and 153°E (right).

of the vertical gradient of salinity within a layer between depths of 50 and 100 m have a special feature, which will be discussed in a future study. Temperature of the core of salinity maximum is about 23°C. Comparatively low salinity is found in a region between 4° and 6°N. To the north of 9°N salinity seems to increase again.

Distribution of oxygen content is shown in Fig. 4. In the surface layer above a depth of ca 100 m, oxygen content is ca 4 cc/1. Below the surface layer, its numerical value is generally lower on 151°E than that on 153°E. Vertical gradient of oxygen content within a layer between depths of 100 and 300 m in both sections is comparatively weak to the south of 3°N and is comparatively strong to the north of the latitude; numerical values of oxygen content at 100 and 300 m depths are ca 3 cc/1 and more than 2.5 cc/1 respectively at 1°S, whereas they are ca 4 cc/1 and less than 2 cc/1 respectively at 5°N. A well defined zonal distribution in the region under consideration is not found from the comparison between the two sections.

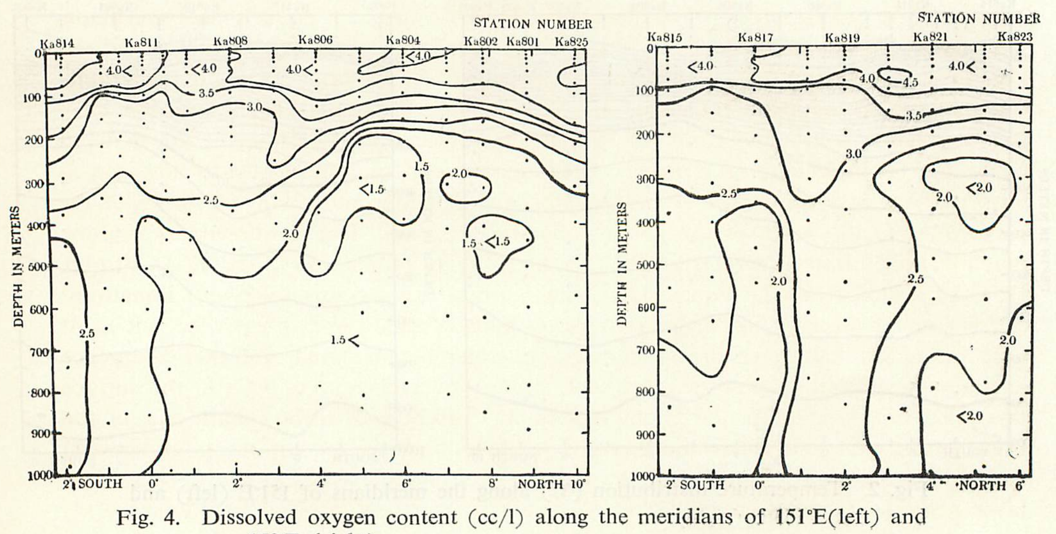

Fig. 4. Dissolved oxygen content (cc/l) along the meridians of 151°E(left) and 153°E (right).

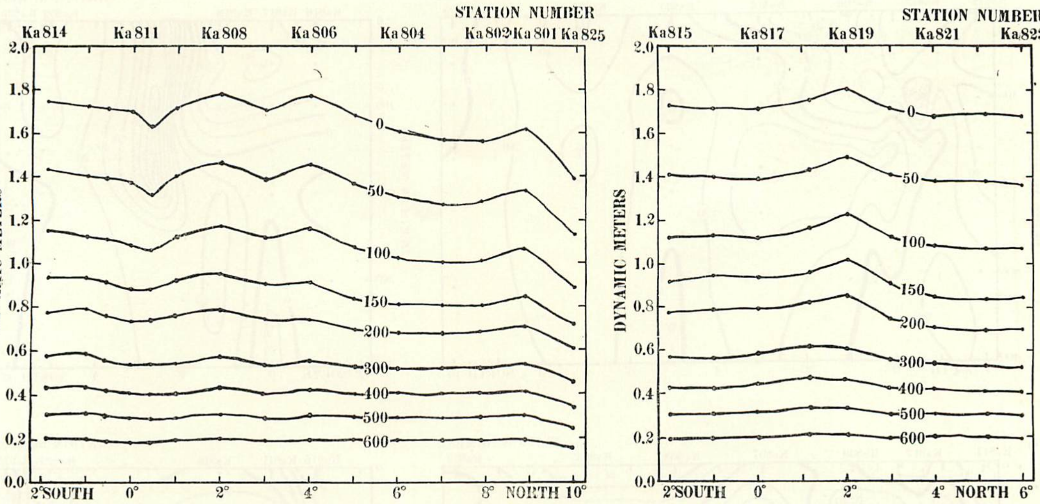

Fig. 5. Dynamic topography (dyn. m.), referred to 800 decibar surface, along the meridians of 151°E (left) and 153°E (right).

Dynamic topography referred to 800 decibar surface is shown in Fig. 5, from which it is deduced that the South Equatorial Current exists to the south of 2°N and the Equatorial Countercurrent to the north of the latitude. It is also deduced from the figure on 151°E that an eastward flow exists in the South Equatorial Current, between the Equator and the latitude of 0°30′N, and that two bands of westward flow exist in the region of the Equatorial Countercurrent, between 3° and 4°N and between 8° and 9°N. Computed relative currents are discussed elswhere (Takahashi, loc. cit.).

Eastward- and northward-components of the relative currents observed directly by two current meters along the two meridians are shown in Fig. 6, in which some computed values of eastward component of the relative current are conveniently employed between 2° and 4°N on 153°E because of so large distance where no direct measurement was made. The major feature as to the boundary between the South Equatorial Current and the Equatorial Countercurrent agrees with the deduced feature from dynamic topography stated above, though many inconsistencies between them are found (Takahashi, loc. cit.). It is a notable fact found from Fig. 6 that an eastward flow exists at ca 200 m depth below the South Equatorial Current at the Equator and that the eastward flow constitutes itself a submerged part of the Equatorial Countercurrent flowing eastwards at the sea surface to the north of the South Equatorial Current. It is questionable, therefore, that the Equatorial Undercurrent (T. Cromwell, R. B. Montgomery, and E. D. Stroup, 1954) separated from the Equatorial Countercurrent exists below the South Equatorial Current at the Equator, as suggested already by S. Yoshida and others (loc. cit.). It must be added that the north-south flow has considerable magnitude and that divergence and convergence are seen in the north-south flow. Divergence takes place in the surface layer near the Equator in the South Equatorial Current and in the middle part of the Equatorial Countercurrent, while convergence takes place in the surface layer between the South Equatorial Current and the Equatorial Contercurrent and in the subsurface layer near the Equator on 151°E.

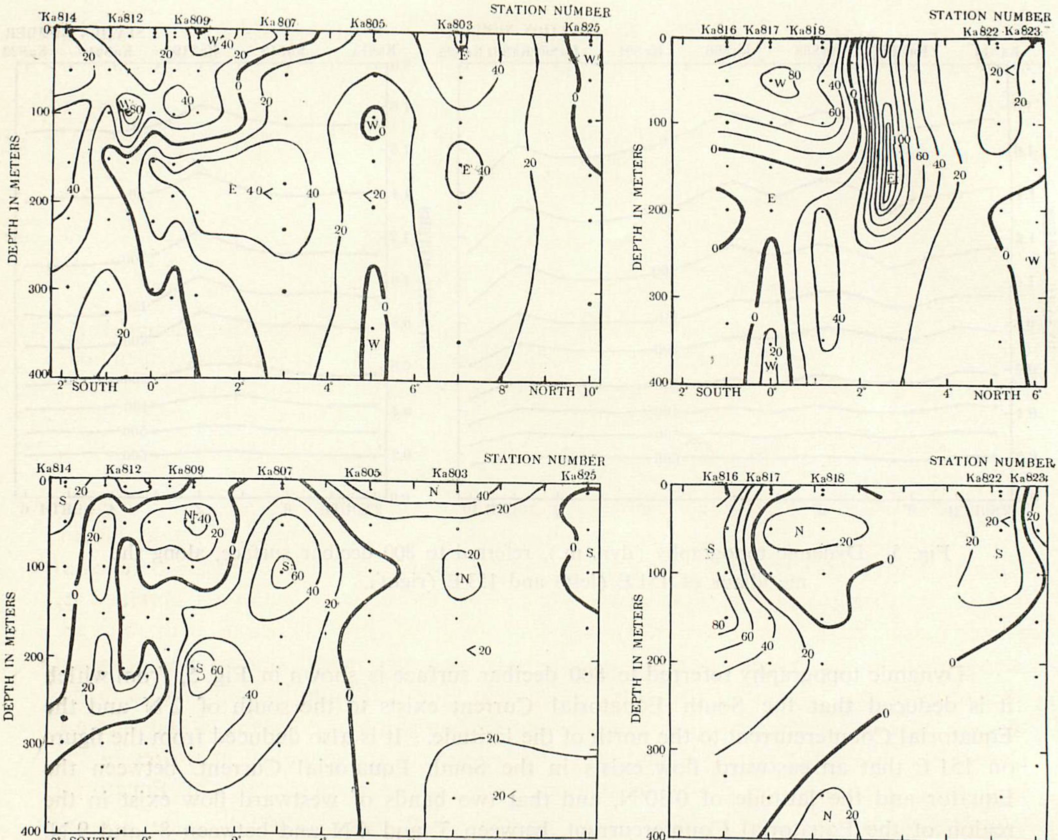

Fig. 6. East-west flow (upper figures) and north-south flow (lower figures) in cm/sec along the meridians of 151°E (left) and 153°E (right). E, W, N, and S show flows to the east, west, north, and south respectively. See text.

Eastward and westward volume transports above a depth of 400 m across the meridians, between latitudes covered with the observations, are obtained from Fig. 6 and the results are as follows:

	Eastward	Westward
151°E	93.0×10^6 m^3/sec	24.0×10^6 m^3/sec
153°E	67.2 〃	25.6 〃

The eastward volume transport obtained here includes that of the eastward flow existing below the South Equatorial Current. It is difficult to determine the transported volume of the Equatorial Countercurrent, because it is impossible to distinguish the Undercurrent from the Equatorial Countercurrent, as stated above. The low value of the eastward volume transport across 153°E is due to the fact that the northern limit of the observing range on the meridian is 6°N.

References

Cromwell, T., R. B. Montgomery, and E. D. Stroup, 1954: Equatorial Undercurrent in Pacific Ocean revealed by new method, Science 119, 648.

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