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Thermohaline structures in the Bering Sea basin in summer 2002

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Abstract

Thermohaline structure was examined in the Bering Sea basin from 29 June to 15 July 2002 on board the R/V *Kaiyo maru*, to clarify relationship between oceanographic structures and salmonid distribution. Here, we report results of hydrographic observations by EPCS and CTD. Surface temperature in the eastern the Bering Sea basin was 2 °C higher than that of in the western basin. Surface salinity less than 33.0 psu in the northeastern basin was observed and was lower than that of the western basin. There was an upper mixed layer about 30 m thick, temperature minimum centered around 100-150 m, and then halocline around 150-200m along the south-north transect at 180° and the east-west transect at 54°N. Distribution of the surface geopotential anomalies referred 1500db indicated that there was the inflow through the Amchitka Pass and the Amukta Strait and a cyclonic circulation pattern in the Bering Sea basin.

Introduction

The Bering Sea is one of major marginal seas of the North Pacific and thought to be the main habitat of salmon born in Japan. These salmon live and grow during major part of their life cycles in this area. Thus, the oceanographic structures including temperature, salinity, currents and primary production in the Bering Sea play important for the growth and survival of salmon in the ocean life.

The Bering Sea has the circulation pattern that much of the inflows derived from the Alaskan stream through the Near Strait and the Amchitka Pass, circulate with cyclonic loops in the Bering Sea basin, and outflow mainly through the Kamthatcka Strait (Favorite et al.1976). Roden (1995) reported that the Bering Sea basin in summer was composed of thin mixed layer in warm temperature and low salinity, thick temperature minimum layer due to a remnant of winter convection, and maximum temperature layer centered around 300 m depth. Many of these results, however, were derived from observations conducted in one transect line or composite data derived from observations conducted in different period. There were few observations conducted in wide regions, up to deep layers, and simultaneously in the Bering Sea basin. Thus, the purpose of this report is to describe the oceanographic structures, which was observed simultaneously in the Baring Sea basin in summer by R/V *Kaiyo maru*.

Materials and Methods

During *Kaiyo maru* cruise from 29 June to 15 July 2002, hydrographic observations at 32 stations were conducted in the Bering Sea basin using SBE9plus CTD (Conductivity-Temperature-Depth-meter) cast down to 3000db or near the bottom, and XCTD (eXpendable CTD) down to 1000 m, respectively (Fig. 1). At each station, vertical profiles of temperature and conductivity were obtained. Water samples for salinity, nutrients and chlorophyll were collected at 12 depths (10, 20, 30, 50, 75, 100, 125, 200, 250, 300, 400, 500 db) using 2.5 liter Niskin bottles during up-cast. Salinity was measured using an AUTOSAL Model 8400B (Guildline) with standard LAPSO seawater P133 (K=0.99993). Surface temperature and salinity were measured with EPCS (Electronic Plankton Counting and Sizing System) in every 1minute during the cruise. In this paper, CTD and EPCS observations data have been used to describe the oceanographic structures in the Bering Sea basin.

Results

Surface distributions of temperature and salinity in the Bering Sea basin

Surface distributions of temperature and salinity measured by the EPCS were shown in Fig. 2. Surface temperature in the eastern Bering Sea basin was about 2 ℃ higher than that in the western basin. Surface salinity less than 33.0 psu in the northeastern basin was lower than that in the western basin, and the salinity front was formed along a continental shelf edge in the northeastern Bering Sea. On the other hand, relatively low temperature and high salinity waters existed around the Amtitka Pass. These waters might be caused by a strong tidal mixing (Roden 1995).

Thermohaline structure of the south-north transect at 180° line

Figure 3 shows vertical sections of salinity and temperature along 180°. There was an upper mixed layer about 30m thick. The thickness of mixed layer was thinner than that in winter (Watanabe et .al 1999). Below the mixed layer, temperature minimum less than 3°C were observed around 100-150 m depth except for St.27 near the Amchitka Pass. There was halocline centered around 150-200 m under the temperature minimum layer. The temperature maximum more than 3°C occurred around 200-250 m depth, and temperature decreased toward the bottom. On the other hand, salinity isotherms dropped southward just above the sill around 53°N. This indicates that there were eastward baroclinic currents above the sill around 53°N, because the density mainly depends on salinity in the Subarctic regions.

Thermohaline structure of the east-west transect at 54°N line

Figure 4 shows the vertical sections of salinity and temperature along 54°N. The vertical distributions of temperature and salinity were similar to those along the 180°. Thermohaline structures were also consisted of an upper mixed layer with 30m thick and temperature minimum layer centered around 100-150 m along 54°N. A halocline occurred around 150-200 m. However, the thermohaline did not correspond to the thermocline. Salinity isotherms around 173°W and 168°W dropped eastward and those rose around 172°W, respectively. These indicate that there were northward baroclinic currents around 173°W and 168°W and southward one around 172°W, respectively.

Surface geopotential anomaly referred to 1500 decibars

To clarify the circulation pattern in the Baring Sea basin, a surface geopotential anomaly referred to 1500 decibars was estimated (Fig. 5). Geopotential anomalies in the center of the Bering basin were lower than that in areas along the Aleutian Islands and the eastern basin. Relatively high geopotential anomaly was found around the 54°N, 172°W. This indicates that there is a cyclonic circulation pattern in the Bering Sea basin with some meanders.

Summary

The characteristics of oceanographic structures in the Bering Sea basin in summer of 2002 are summarized as follows:

1. Surface temperature in the eastern Bering Sea basin was about 2°C higher than the western basin. In contrast, surface salinity in the western basin was about 0.2 psu higher than the eastern basin. On the other hand, lower temperature and higher salinity

water was observed around the Amchitka Pass.

2. Vertical thermohaline structures of south-north transect at 180° were almost similar to those of east-west transect at 54°N. Vertical thermohaline structures of both lines consisted of an upper mixed layer about 30m thick, temperature minimum layer centered around 100–150 m, and halocline around 150-200m.

3. The distributions of surface geopotential anomalies referred to 1500db showed that there was the cyclonic circulation pattern accompanying with some meanders and gyres.

Acknowledgments

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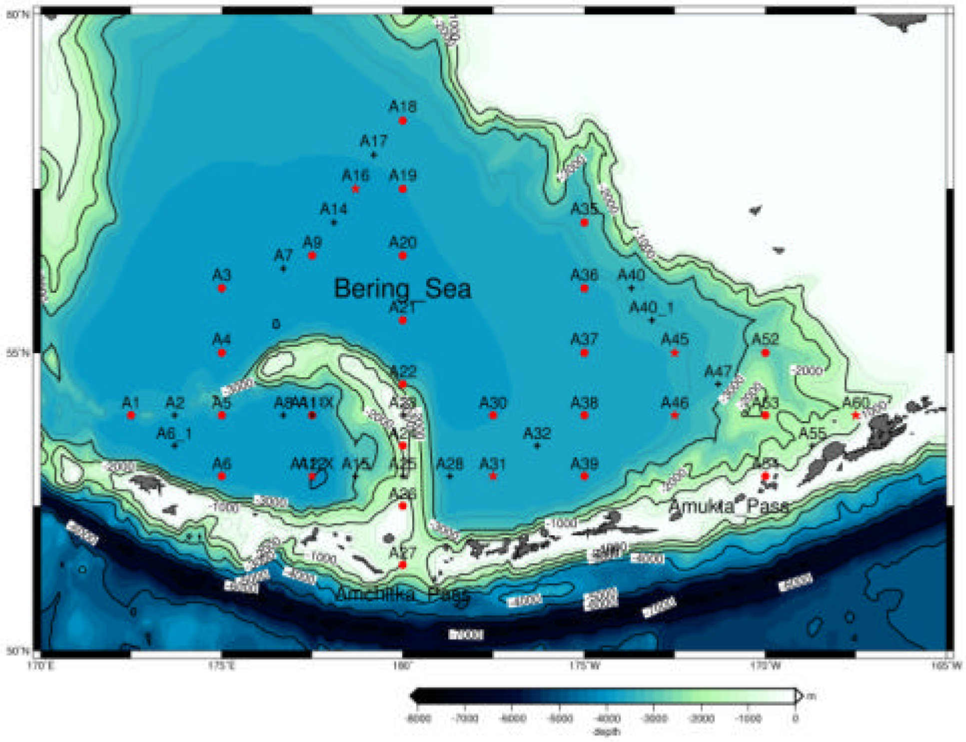

Figure 1. Stations locations conducted by the R/V *Kaiyo maru* 2002-summer cruise. Closed circles and cross symbols in this figure indicate CTD and XCTD observations points, respectively.

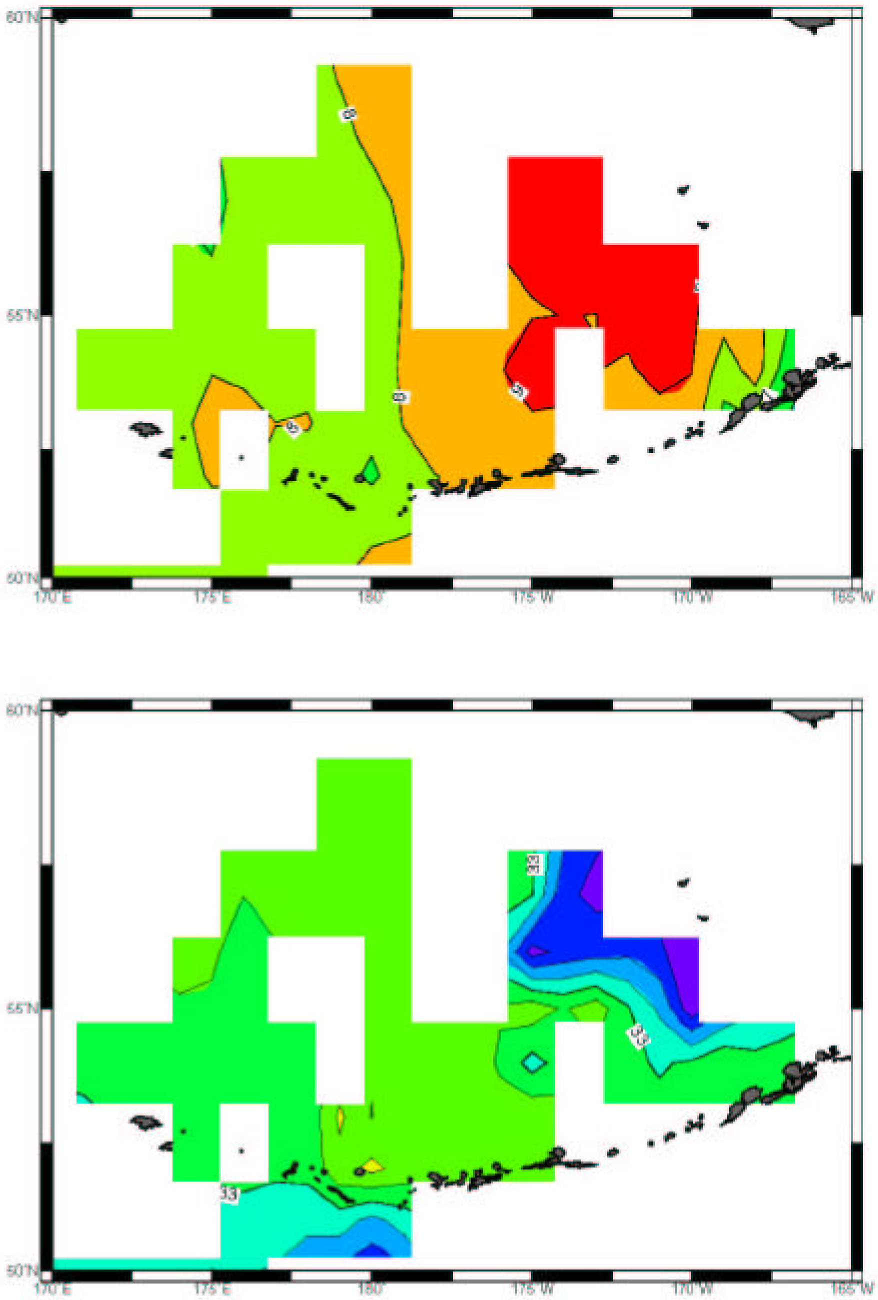

Figure 2. Surface temperature (upper panel) and salinity (lower panel) distributions measured by EPCS.

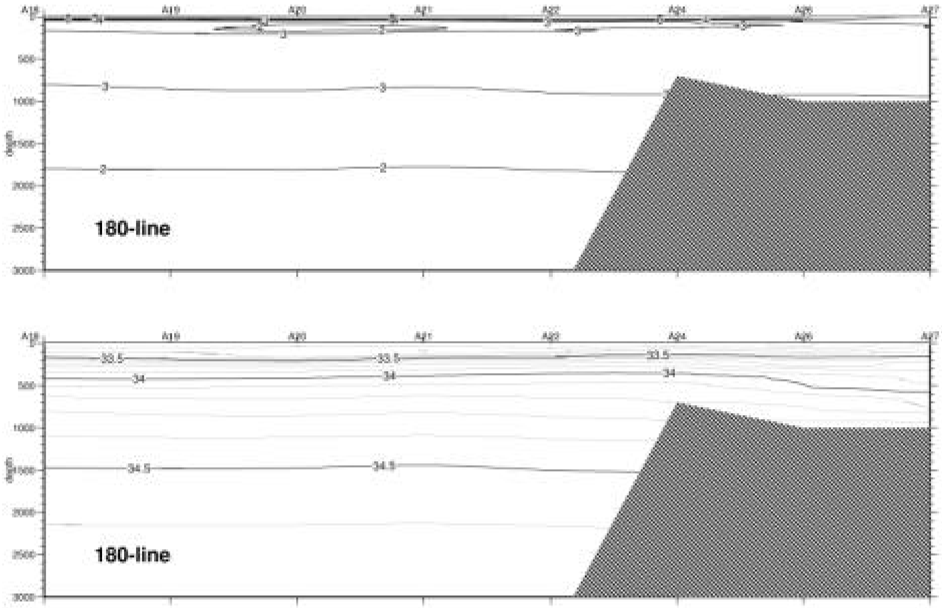

Figure 3. Vertical sections of temperature (upper panel) and salinity (lower panel) along 180°.

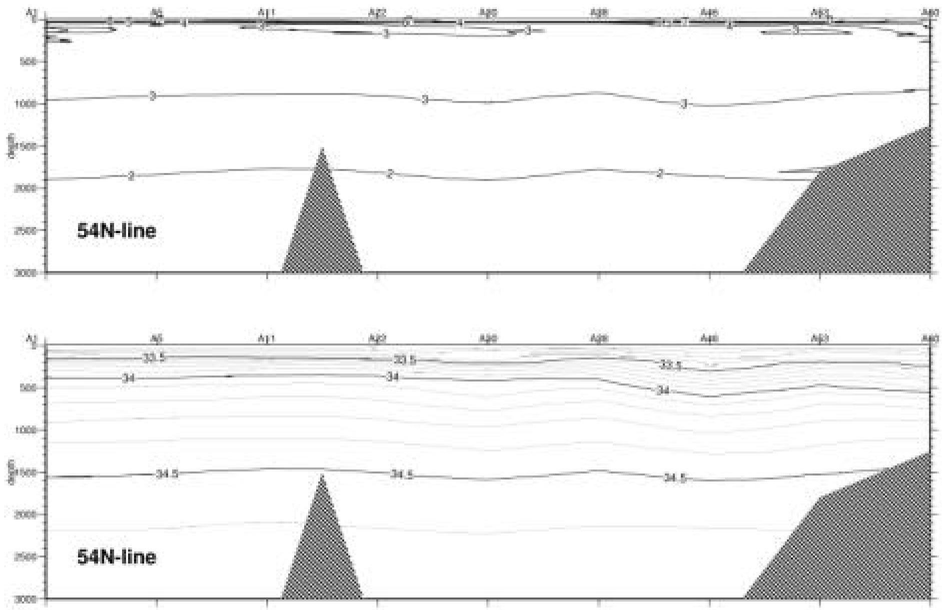

Figure 4. Vertical sections of temperature (upper panel) and salinity (lower panel) along 54°N.

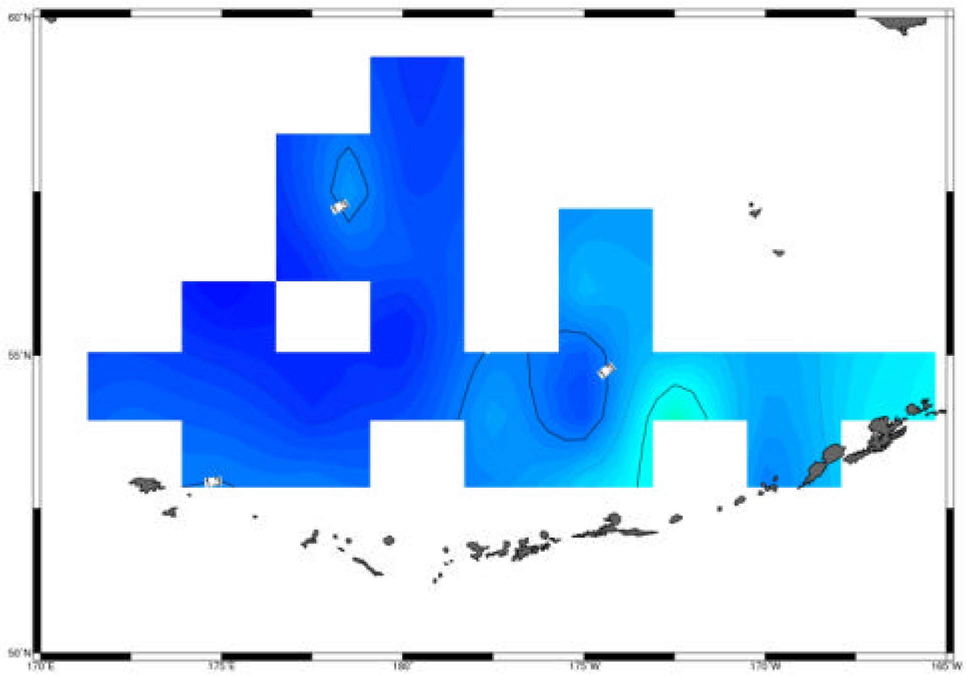

Figure 5. Horizontal distribution of dynamic topography referred to 1500db in the Bering Sea basin.