Oceanographic Condition of the Bering Sea in BASIS

Gennady V. Khen and **Eugeny O. Basyuk**
Pacific Scientific Research Fisheries Centre (TINRO-Centre),
4, Shevchenko Alley, Vladivostok 690950, Russia

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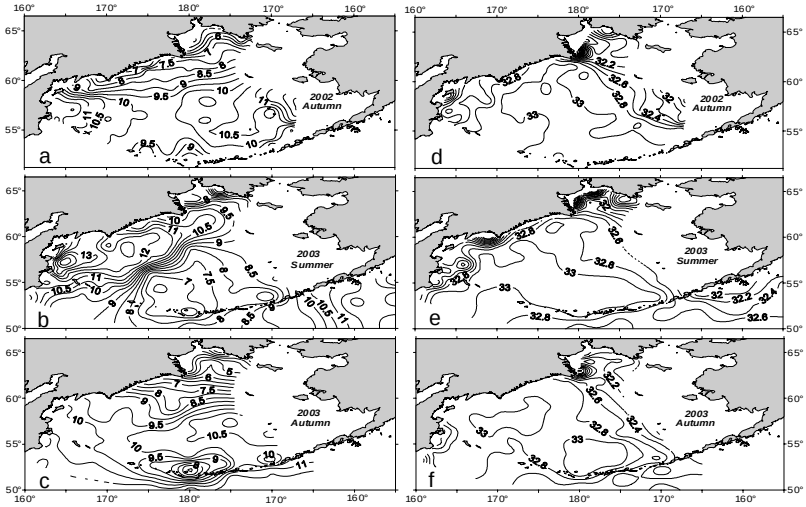
Several interdecadal changes have taken place in atmosphere and hydrosphere of the northern Pacific in the past three decades. The most important change was in late 1970s (Minobe 1997). It is known as "climate shift". Some scientist (Krovnin et al. 2001; Minobe 2002) considered that the cooling in 1998 was a "climate shift".

From 2002 both air temperature in spring and sea surface temperature in summer changed to warming in the Bering Sea again and 2003 was one of the warmest since 1950. Thus the start of BASIS coincided with a warming in the Bering Sea.

Fig. 1. Surface Temperature (a, b, c) and salinity (d, e, f) in the Bering Sea.

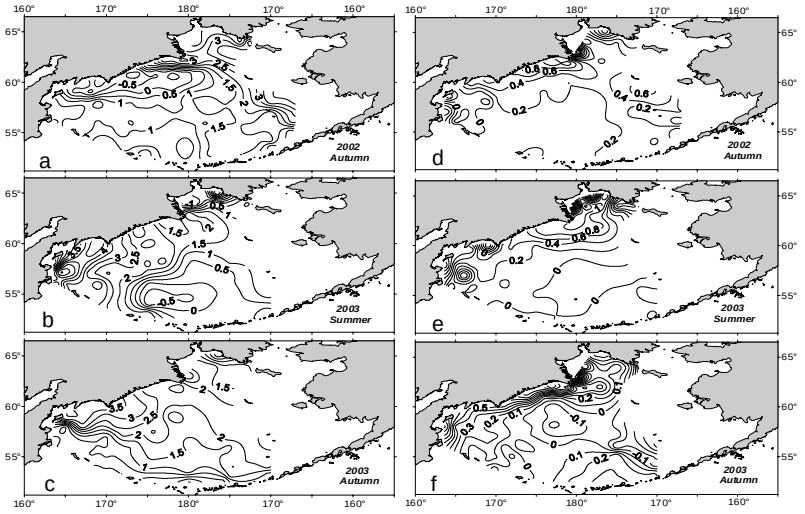


Intensification a water exchange between the Pacific and Bering Sea occurred during the last five years. From 1999 to 2003, the transport of the Kamchatka Current grew from 3.37 to 6.05 Sv in summer, and from 3.67 to 9.01 Sv in autumn. During BASIS years, the Kamchatka Current has increased approximately 15%.

The analyzed oceanographic data were obtained by two research vessels: the Russian R/V *TINRO* in Russian Economic Zone and the Japanese R/V *Kaiyo maru* in the southeastern. The surveys were conducted in autumn 2002, summer and autumn 2003. Dynamic topography and spatial distributions of temperature, salinity and there anomalies were investigated virtually throughout the whole Bering Sea, excluding the costal region of Alaska.

In first years of BASIS the warmest areas on the sea surface were found in the western and in the eastern parts of the Bering Sea (Fig. 1a, b, c). Surface layer in these areas was shallow: to 10 m in summer and to 20 m in autumn. The stability was high because of low salinity (< 32.5 psu) at the surface (Fig. 1d, e, f). In the Deep Basin, the surface salinity was higher (32.8–33.0 psu), and the upper layer was deepened beneath 20 m in summer and beneath 30 m in autumn.

Fig. 2. Anomalies of surface temperature (a, b, c) and salinity (d, e, f) in the Bering Sea.



Positive anomalies of temperature dominated at the sea surface (Fig. 2a, b, c). The highest values of the positive anomalies (2.0–2.5°C) were found in the east of the Sea and in the Gulf of Anadyr in autumn 2002. In 2003, the region of the highest anomalies (3.5–4.5°C) shifted to the opposite side of the sea—to the Kamchatka Basin. The anomalies lowered in autumn to 2.5–3.5°C. In the eastern part of the sea the anomalies did not exceed 1–2°C.

The high positive salinity anomalies (> 0.5 psu) in the Gulf of Anadyr and the eastern part of the Sea

All correspondence should be addressed to G. Khen.
e-mail: kheng@tinro.ru

in 2002 (Fig. 2d) were probably related with the small input of the fresh water. The salinity in the western part of the Sea was about average.

In the next year the distribution of salinity anomalies changed (Fig. 2e, f). In the east, salinity was noticeable lower the average, especially in autumn. The differences of salinity between 2003 and 2002 corresponded to the differences in river runoff affecting the region. In 2003 the freshwater influence extends over the continental shelf, its trace could be seen even in the Aleutian basin. In contrast to the east and west, positive salinity anomalies were observed along Korjak coast in both BASIS years. In general, geostrophic circulation in the BASIS years corresponded to the well known pattern of currents in the Bering Sea (Arsenev 1967; Stabeno and Reed 1994). Cyclonic circulation dominated in the Deep Basin, with the Bering Slope Current (BSC) and Kamchatka Current along the continental slope. An extraordinary situation occurred in the southeastern side of the Deep Basin in 2002 (Fig. 3a). Firstly BSC was not expressed along the eastern shelf break, but there were five anticyclonic and two cyclonic eddies in this area. Secondly, strong current was observed from the Amchitka Pass, it flowed northward as the eastern boundary of the Bering Sea cyclonic gyre, like BSC has been in another years. We inferred that BSC shifted westward as far as Bowers. In 2003, the BSC flowed northwestward along the eastern continental slope as usual (Fig. 3b, c).

Beneath the seasonal pycnocline which was found at the depth 5–25 m in summer (Fig. 4b) and 20–45 m in autumn (Fig. 4a, c), the temperature and salinity anomalies had other distribution than at the sea surface. The negative temperature anomalies were observed at the depth 50 m in the Deep Basin. The lowest negative anomalies (-0.5; -1.0°C) were observed at the cyclonic eddies. High positive anomalies (1.0–2.5°C) could be seen in the north around Navarin Cape. The salinity anomalies at 100 m reflected an autumn intensification of the Pacific water inflow through the central Aleutian passes. High positive anomalies (0.1–0.2 psu) were observed at the northern side of the Aleutian Islands in autumn of 2002 and 2003. In the central part of the Deep Basin, the salinity was about average both in summer and in autumn.

The beginning of BASIS investigations (2002–2003) coincided with warming and intensification of water exchange between the Pacific and the Bering Sea. During two BASIS years the warmest areas on the sea surface were found in the west and in the east of the Sea. Positive anomalies of temperature and salinity were dominated at the sea surface in 2002 and 2003. In autumn 2002, the highest positive salinity anomalies were observed in the eastern part of the Sea and in its western part in autumn 2003. In 2002, the Bering Slope Current was not expressed the eastern shelf breaks it shifted westward as far as Bowers Ridge. Beneath the seasonal pycnocline negative temperature anomalies were observed in the Deep Basin and high positive salinity anomalies at the northern side of the Aleutian Islands in autumn of 2002 and 2003.

Fig. 3. Dynamic topography of the surface of the Bering Sea basin relative 1000 db.

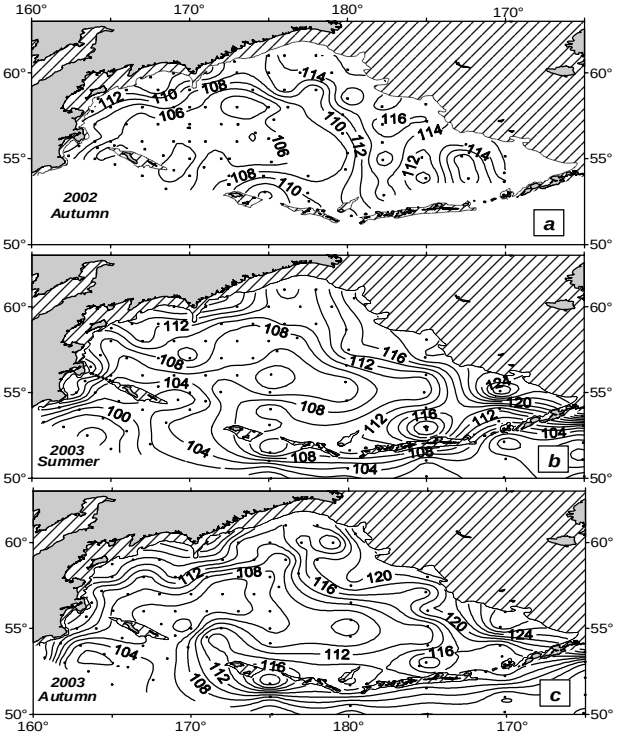
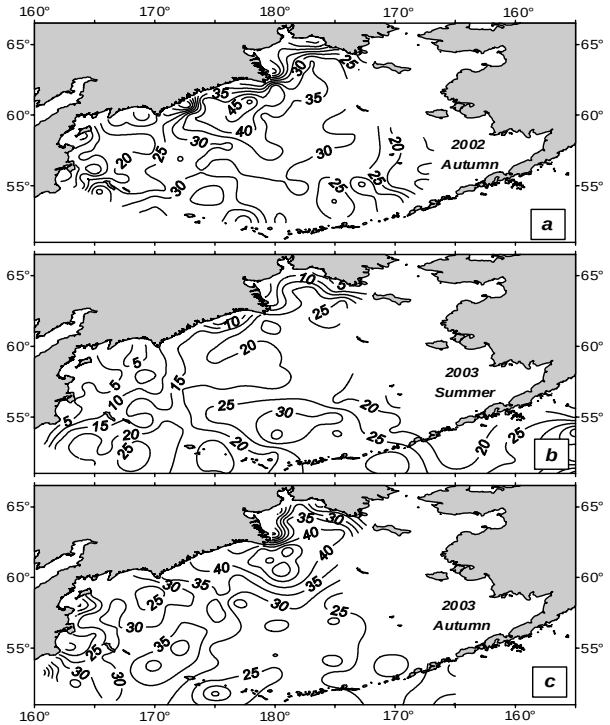


Fig. 4. Depth of the lower boundary of the surface layer in the Bering Sea.



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