



## **Coastal upwellings in 1941-2005 at Listvyanka settlement (Southern Baikal)**

Elena Troitskaya, Mikhail Shimaraev, Andrey Zhdanov, Rita Zhdanova, and Elena Salva

Limnological Institute SB RAS, Laboratory of hydrology and hydrophysics, Irkutsk, Russian Federation (troitca@lin.irk.ru, 7-395-2-42-54-05)

The first results of studies of coastal upwelling are presented in this paper based on long-term (1941-2005) measurements of surface water temperature in May-December at the pier of Limnological Institute (Listvyanka settlement, Southern Baikal). Listvyanka settlement is situated in Listvenichnoye Bay not far from the outlet of the Angara River. The flow of the Angara River is formed from the surface waters and ascending deep waters of Lake Baikal. Therefore, when the wind is of northwest direction, either surface waters are driven away along the northern shore or upwelling is formed if the wind blows for 2-3 days. Analyzing a temperature set, upwelling was considered in those cases when temperature dropped sharply by 2 or more degrees and it stayed for more than 3 days.

Coastal upwelling developed more often in July and August in the area studied (it was recorded in 41 and 46 cases from 65 years analyzed), more rarely in September (in 36 cases from 65), seldom in October (in 16 from 65), 3 times in June (in 1948, 1972 and 1994), and once in November (1969).

One-two upwellings were usually formed during a month. However, three-four upwellings were recorded in some years (July: 1949, 1974, 1976, 1994, 1996, 2003; August: 1942, 1955, 1972, 1973, 1975, 1976, 1978, 1982, 1990; and September: 1951, 2002).

The duration of upwelling varied from 3 days to 3 weeks. The most long-lasting upwellings were recorded in August-September due to the intensification of wind activity above Lake Baikal in late summer.

The temperature drop in the upwelling zone was 2.3-3.5°C in June, in July – 2.1-10.8 °C, in August – 2.2-11.9°C, in September – 2.5-11.2°C, in October – 2.1-7.5°C, and in November – 1.9°C. There were recorded some cases when the temperature decreased by more than 10°C (July 1949, August 1953, 1963, 1979, 1986, 1993, 2002, 2004, and September 1943, 1964, 1974).

In some years, upwelling occurred every month in July-October or July-September (1974, 1984, 1987, 1988, 1998, 2000, 2002, and 2004). In 1941 and 1954, upwellings did not develop at all. Upwelling developed on the average during two months: in July-August or August-September.

A tendency of increasing a number of upwellings during a month and during a year was observed beginning from 1970 when the temperature of surface waters of Lake Baikal began to rise till the end of the last century. This is likely to be caused by intensification of the surface currents due to activation of wind activity and rise of gradients of temperature/density of the water.

In October-December 1946, the coastal upwelling is likely to have been formed during winter temperature stratification of the water. The surface water temperature dropped almost to zero three times (0, 0.3 and 0 °C, respectively) from 29 October till 4 December (29.10-04.11, 09.11-14.11 and 19.11-04.12). Then the temperature rose to 4.8-5.5 °C on 4-9 November, 4.2-5.4 °C – on 14-19 November, and to 3.2 °C on 4 December. It is more likely that the upper water layer cooled down in windless or weak windy weather. After strong short-term stormy winds the waters ascended from large depths and there was no time for them to cool. On the other hand, there might have been an inflow of waters from the surface layers of the lake pelagic area which cooled longer than coastal waters under the influence of northeastern and eastern winds. To answer this question we have to analyze and compare these data with the data on wind.

This work was supported by the Program of the Fundamental Research of RAS Presidium (Project 17.11) and RFBR Grant 09-05-00222.