NATURAL FACTORS OF FORMATION OF OZONE ANOMALIES OVER BAIKAL REGION

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Abstract. A long-term regime of anomalies in total ozone in Baikal region in 1987–2016 was studied. The typification of synoptic processes of the formation of positive and negative anomalies of the total ozone content is proposed, which reflects the contribution of natural circulation processes. It is established that at present in Baikal region negative ozone anomalies prevail over positive anomalies. This can have a negative impact on the ecology of the region. The decrease in ozone is accompanied by an increase in the proportion of ultraviolet radiation, which is dangerous for ecosystems and human health.

Key words: general ozone, Baikal region, synoptic processes

An important environmental problem of Baikal region is the reduction of total ozone. This problem can influence on quality of natural conditions for development of tourism in this territory. Currently, the troposphere contains about 8–10% ozone, in the stratosphere up to 80–85% and part of the ozone is contained in the mesosphere [1]. Degradation of ozone in the stratosphere leads to the fact that over the last 25–30 years, the stratosphere is cooling with an average velocity of about 0.4–0.8 ° K for 10 years [7]. With a decrease in ozone, ultraviolet radiation increases, which adversely affects human life and the ecological state of Baikal region.

The territory of Baikal region is an orographic region of Eastern Siberia where the distribution of ozone is greatly influenced by the relief. Under the influence of mountain systems, river valleys and reservoirs, isolines of the total ozone content take a different outline and “density”. The variability of the total ozone content is affected by anthropogenic and natural factors [2]. In the role of anthropogenic factors, photochemical processes are most often considered. The contribution of natural factors has been poorly studied. It is believed that significant variations in ozone content are directly related to circulation or horizontal movement of air masses [4]. At the beginning of the XXI century it was found that cyclones and anticyclones affect the change in ozone. In cyclones, the content of ozone increases, and in anticyclones – decreases [6].

The maps of average monthly values and deviations of the total ozone content (OC) according to the data of the Canadian Center for the period 1987–2016 are analyzed. (WOUDC - World Ozone and Ultraviolet Data Center, Canada). Also, fields of general content (e.D.) were used for each day, absolute deviations of the ozone content (from the climatic norm) per day, relative ozone deviations from the climatic norm (%), and standard deviation from the climatic norm (in e.D.) [5].

The long-term dynamics of the total ozone content in Baikal region for 1987–2016 has been studied. According to the synoptic charts, the effect of baric formations on the change in the total ozone content in Baikal region during the period under study was estimated. It turned out that negative ozone anomalies are noted more often than not. Since 2012, negative ozone anomalies are observed annually. The number of negative ozone anomalies exceeds the number of positive anomalies in all calendar seasons of the year. The interannual variability of the total ozone content in Baikal region reaches its highest values in April (32%) and January (30%).

One of the major negative anomalies in Baikal region in recent years was registered in January 2016 (Fig. 1). The deviation of the total ozone from the mean values reached 50%. The anomaly on January 27–31, 2016 is classified as an ozone "mini-hole". A "mini-hole" is understood as a situation where the total ozone content is less than 220 e.D. and persist for up to one week. Usually such anomalies form over the North Atlantic in...
October and November, move from west to east and fill over the Scandinavian Peninsula, but sometimes penetrate into the territory of Russia.

An analysis of the daily synoptic charts showed that 87% of the negative anomalies in the total ozone content in Baikal region in 2016 were noted in the presence of an anticyclone at the Earth's surface. A comparative analysis of surface and high-altitude baric fields for cases with positive and negative anomalies in total ozone in Baikal region in 2012–2016 is carried out. The influence of processes of the cyclonal type is clearly distinguished during the formation of positive anomalies of the total ozone and anticyclonic type in the formation of negative anomalies. The results obtained by us are in good agreement with earlier studies carried out by Gushin G.P. and Vinogradova N.N. [3], Syrovatkina O.A., Karol I.L., Shalamyansky A.M. and Klyagina L.P. [6].

In the territory of Baikal region in 1987–2016 the predominance of negative anomalies of the total ozone content over positive, especially in winter and in spring, was revealed. The minimum number of positive and negative anomalies in total ozone is in the summer months. It was found that the lack of total ozone in Baikal region is due to the influence of anticyclonic fields near the Earth's surface with long-term localization of the local air mass with weak meridional and zonal air exchange.

References
[1] Aleksandrov E L, Izrael Yu A, Karol I L, Khrgian A Kh 1992 Ozone shield of the Earth and its changes. SPb: Gidrometeoizdat, 288 p. (in Rus)
[2] Bioindication of stratospheric ozone 2006 (Ed. V V Zuev). Novosibirsk: Publishing house of the SB RAS, 228 p. (in Rus)
[3] Gushchin G P, Vinogradova N N 1983 Total ozone in the atmosphere. Leningrad, Gidrometeoizdat, 238 p. (in Rus)
[4] Matveev L T 2000 Physics of the atmosphere. Saint-Petersburg, Gidrometeoizdat, 751 p. (in Rus)
[5] Shalyaminsky A M, Karol I L, Klyagina L P, Romashkina K I 2004 The total ozone content over the territory of the Russian Federation. *Meteorology and hydrology* 8. pp. 24-35. (in Rus)
[6] Syrovatkina O A, Karol I L, Shalamyansky A M, Klyagina L P 2008 Interannual features of ozone formation in the high latitudes of the Northern Hemisphere in November-March 1998-2005. *Meteorology and hydrology* 8. pp. 47-57. (in Rus)
[7] Visheratin K N 2007 Interannual variations and trends of medium-zonal series of total ozone, temperature and zonal wind. *Izvestiya. Physics of the Atmosphere and Ocean*. V. 43, 4, pp. 67-85. (in Rus)

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