Correlation of TOC variations and the spatiotemporal features of the global atmospheric circulation

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The monthly average TOC values calculated from the satellite data are used. The lag of the annual behavior of ozone for three months in the eastern part of the northern hemisphere with respect to the western one is revealed, which demonstrates the connection of variations of ozone layer parameters and generalized groups of global atmosphere circulation and confirms the available results.

It may be considered as an established fact to date, that the ozone distribution as well as its annual, day-to-day and other variations cannot be explained without the account of the atmospheric circulation. The purpose of our research is revealing the connection of these variations with spatiotemporal peculiarities of the global circulation of the atmosphere.

The types of the atmospheric circulation separated by G.Ya. Vangengeim are the most convenient for investigations, because they are the results of generalizing of various circulation mechanisms and make it possible to reveal the most essential climate changes during many-year periods. Three main groups were selected based on the principle of prevalent transfer in the mid-latitude troposphere they are called macroprocesses of westward (W), eastward (E) and meridional (C) forms of the atmospheric circulation. The small-amplitude waves are observed in the troposphere for the W form, which quickly move from west to east, and the high-amplitude stationary waves are observed for C and E forms. Their principal difference is that the high trough is formed over European territory, Ural and the part of Siberia (to 80°E) under C-type circulation, and the ridge is observed over this territory under E-type circulation.[1]

Development of the methods for long-term forecast of the TOC variations in the atmosphere is necessary for prompt preparation of research and experiments, as well as for timely preventing the undesirable consequences of the extremely low TOC values on the biosphere and human beings.

Both forecast of the ozone dynamics and the data on some hard to observe peculiarities of the atmospheric circulation are necessary here the ozone state can be an indicator of them.

Hence, the ozone content is connected with the conditions of the atmospheric circulation and the relevant macro-synoptic situations.

The following generalized groups of the atmospheric circulation exist, according to classification by B.L. Dzerdeevskii's: latitudinal westward (LatW), longitudinal northward (LonN), longitudinal southward (LonS), latitudinal westward and longitudinal southward (LatWLonS), latitudinal westward and stationary position (LatWSP), longitudinal northward and stationary position (LonNSP), Longitudinal northward and latitudinal westward (LonNLatW), longitudinal northward and longitudinal southward (LonNLonS), longitudinal southward and stationary position (LonSSP). As was revealed by I.E. Basmanov from the data of correlation analysis, the groups LatW and LonN, which coincide with the annual behavior of ozone ahead of it by three month, have the greatest positive effect on TOC.

The first groups of atmospheric circulation (LatW, LonN, LonNSP, called ozone-active) transfer air masses enriched with ozone and favor the increase of its total content, and the second groups (LatWSP, LonSSP, LonNLatW, LatWLonS – deozonizing), poor of ozone, favor the decrease of its content in the region of observations, i.e. interaction of these two types of generalized groups of circulation results in the geographical distribution of ozone.

The calculated many-year monthly mean difference between ozone-active and groups related to reduced TOC gives a clear idea of the ozone activity of atmospheric circulation in each specific month. The annual behavior of ozone asynchronously coincides with the annual behavior of this difference.

According to the preliminary estimates, the many-year mean meridional velocity of the ozone transfer in Arctic latitudes is equal to 0.06–0.08 m/s. In mid-latitudes it increases up to 2.3–2.8 m/s, and in low latitudes it again decreases to 0.48 in subtropics and 0.25 m/s in the tropics. The mean velocity of ozone transfer from Arctic latitudes to tropic is 0.39 m/s in climatic scale.[1]

We took the monthly mean TOC values from satellite data for the northern hemisphere averaged over latitude and longitude. The data were averaged over longitude for all northern hemisphere and separately for two areas, from 90°W to 89°E and from 90°E to 89°W, respectively. The difference was calculated between two time series for the first and second areas. It was revealed that the correlation coefficient between the time series of TOC for all northern hemisphere and the difference series reaches maximum of $R = 0.71$ at the shift of the difference series by 3 months forward (see Fig. 1).

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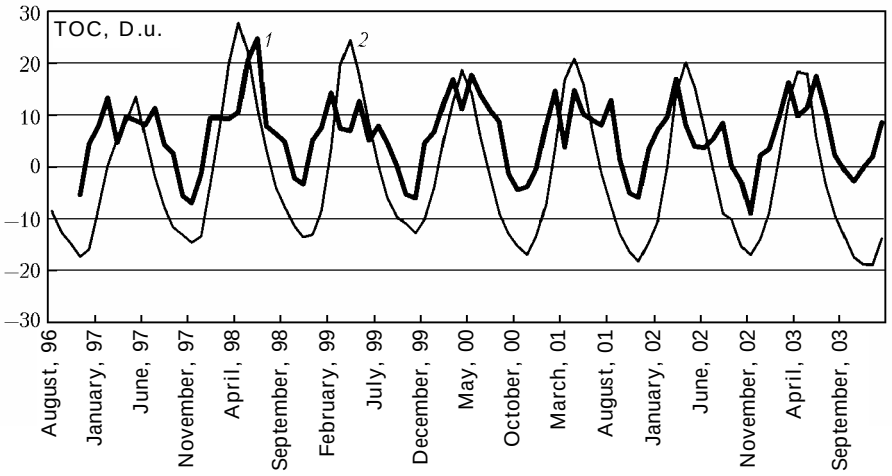

Fig. 1. Series of difference between the time series of TOC in eastern and western areas (*1*) (shift to 3 months) and for the northern hemisphere (*2*).

It is seen in the figure that the delay of the ozone annual behavior to three months occurs in the eastern part of the northern hemisphere with respect to the western part, that confirms the relation between variations of the ozone layer parameters and the generalized groups of the global circulation of the atmosphere and confirms the results presented in Ref. 1.

References

1. I.E. Basmanov, Meteorol. Gidrol. No. 9, 58–63 (1983).