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THE TOTAL OZONE AMOUNT CHANGES OVER LITHUANIA AND NEIGHBOURING COUNTRIES

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Abstract. Changes in the total ozone amount (TOA) above Lithuania and neighbouring countries during the period 1993–2008 have been analysed. The present study focuses on the TOA seasonal variations over the aforementioned area. The statistical data of measurements were analysed. The detailed information of TOA was presented by the Lithuanian Hydrometeorological Service and the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). The net of stations measuring the TOA changes was set; it consisted of 16 meteorological stations. The coefficients of correlation of TOA changes between various stations were calculated basing upon the Pearson's Correlation Coefficient. It was established that the seasonal TOA variation tendencies were coincident between the stations and most linear correlation coefficients between Lithuania and neighbouring countries were 0.9 and 1.0. During the analysis of TOA data, it was established that the results of measurements performed in Lithuania from May 1999 to February 2000 and from May 2000 to January 2001 were insufficiently precise. To estimate TOA in Lithuania (at Kaunas Meteorological Station) without performing direct measurements, the linear function was calculated using the least squares method and the data obtained from the investigated net of meteorological stations. The difference between calculated and measured TOA results was up to 8%.

Keywords: total ozone amount, meteorological station, linear correlation coefficients, monitoring.

1. Introduction

Without ozone in the upper atmosphere, life on Earth would not have evolved and could not exist today. It serves as a protection system from harmful ultraviolet radiation. The problem of the changes in the ozone layer and formation of ozone holes not only above Antarctica but also above other continents is one of the most interesting and complicated (Smirnova *et al.* 2000). An ozone hole is an abnormality, the depletion of ozone in the atmosphere (rarefaction of the ozone layer), which is typical for the certain latitudes and seasons. Therefore, the main priority in the environmental protection of countries is public interest, i.e. to be protected from negative global phenomena including ozone holes.

The total ozone amount is used for evaluation of the changes in the stratospheric ozone layer. Currently, the total amount of atmospheric ozone is expressed in terms of Dobson units (DU).

The total ozone amount (TOA) variations are hard to control due to the anthropogenic influence (Stolarski *et al.* 1994). Pollution of the anthropogenic atmosphere reduces the ozone layer in the stratosphere. The changes of total ozone amount in stratosphere condition the changes of biologically active UV radiation at the Earth's surface (Palancar, Toselli 2004). Most importantly, in case of stratospheric ozone layer depletion, more solar UV radiation will reach the ground surface, harming life on Earth, as well as decreasing the thermal stability of the stratosphere. Of course, the decrease of the total ozone amount conditions the increase in intensity of UV radiation, even if all other factors remain stable. Stratospheric ozone is one of the environmental elements of utmost importance to humans. Although this fact has been known for many years, people started showing more interest only in the last few decades, as the stratospheric ozone layer started to decrease, thus increasing the risk of skin cancer (Chadyšienė, Girgždys 2009). Subsequently, it became necessary to provide people with more information on the total ozone amount changes, appearance of ozone holes and the impact of anthropogenic pollution on composition of ozone molecules.

In Lithuania, the TOA monitoring measurements have started since 1993. However, the TOA measurements can be performed only under congenial meteorological conditions (i.e. clear or slightly cloudy sky).

There are no possibilities to perform the continuous measurements of TOA data using measuring tools in latitudes of Lithuania. Therefore, it is relevant to find ways to widen possibilities of TOA measuring, using the information cumulated and the measured TOA data. Thus it would be possible to estimate TOA data in those countries, where the monitoring is not performed or due to meteorological conditions and other reasons there are no possibilities to carry out continuous measurements of TOA.

The seasonal variations of TOA show that in the northern hemisphere, ozone amounts are larger in winter and early spring, while smaller in summer and autumn (Hilsenrath *et al*. 1981). However, there were no investigations analysing whether the variations of TOA above Lithuania were the same as the changes above neighbouring countries during the same period of time as well as possible relationships between these changes. Besides, it needs to be clarified, the data of which neighbouring countries could be used for estimating TOA in latitudes of Lithuania.

Ground-based solar radiation monitoring stations are of a particular interest in obtaining exhaustive and reliable information about the radiation field on the Earth's surface, the column ozone content (Aculinin *et al.* 2005; Jonov *et al.* 1998; McPeters, Labow 1996). A Dobson ozone spectrophotometer is one of the primary instruments used for the ground-based measurement of the total column content of ozone (Evans *et al.* 2004; Santangelo *et al.* 1996). There are various pieces of equipment used to measure ozone, but some of disadvantages are related to high price, high costs for operation and maintenance as well as large size and weight, which are adverse to field campaigns. Well trained staff is absolutely necessary to achieve good results and to keep the instruments well calibrated over a long time of operation (Köhler 1999). There is very little scientific information on ozone analysis performed in Lithuania and no precise and methodically based investigations of TOA changes; however, there is a lot of scientific information on tropospheric ozone changes (Girgzdiene *et al*. 2007, 2009; Valuntaitė *et al*. 2009). Dynamics of TOA changes in Lithuania and neighbouring countries are insufficiently examined. Analyzing TOA changes in Lithuania, it is important to estimate long-term tendencies of variations both in Lithuania and neighbouring countries, to estimate the similarity criteria of these variations, and evaluate possibilities to adopt data of other countries for estimating TOA in Lithuania.

The aim of the study is to examine the relationship of TOA changes in latitudes of Lithuania and neighbouring countries, also to study the possibility to estimate TOA over Lithuania without direct measurements, using the TOA results of neighbouring countries.

2. Methodology of the Analysis

TOA changes over Lithuania and neighbouring countries

To evaluate TOA changes over Lithuania and neighbouring countries, the network of 16 meteorological stations was set, including Kaunas. All stations are in European cities (Fig. 1).

The distance method was used to measure TOA from ground level (R3-15). The detailed information of TOA was presented by the Lithuania Hydrometeorological Service and the World Ozone and Ultraviolet Radiation Data Centre (WOUDC).

Fig. 1. Scheme of the network of meteorological stations

Table 1. Geographical location data of the meteorological stations (MS) and TOA

No.	City	Coordinates of stations		TOA, DU
		East longitude, degrees, X	North latitude, degrees, Y	
1.	Riga (Latvia)	24.25	57.19	Z_1
2.	St. Petersburg (Russia)	30.30	59.96	Z_2
3.	Hohenpeissenberg (Germany)	11.02	47.80	Z_3
4.	Ukkel (Belgium)	4.35	50.80	Z_4
5.	Bielsk (Poland)	20.79	51.84	Z_5
6.	Hradec Králové (Czechia)	15.83	50.18	Z_6
7.	Kiev (Ukraine)	30.45	50.40	Z_7
8.	Minsk (Belarus)	27.46	53.83	Z_8
9.	Sodankyla (Finland)	26.6	67.40	Z_9
10.	Oslo (Norway)	10.72	59.91	Z_{10}
11.	Norrköping (Sweden)	16.15	58.58	Z_{11}
12.	Moscow (Russia)	37.57	55.75	Z_{12}
13.	Voronezh (Russia)	39.17	51.70	Z_{13}
14.	Poprad-Ganovce (Slovakia)	20.32	49.03	Z_{14}
15.	Lindenberg (Germany)	14.12	52.21	Z_{15}
16.	Kaunas (Lithuania)	23.55	54.52	Z_{16} (unknown)

The TOA variation is not a phenomenon of local importance (Basher 1994). It covers huge territories and the distances between the meteorological stations amount to hundreds of kilometres. Therefore, for simplification cities, not the meteorological stations are referred as to datum-points. Information about geographical location of the meteorological stations is presented in Table 1.

For the analysis of TOA data of the monitoring stations, equal time interval from 1 January 1993 to 31 December 2008 was chosen. The annual total ozone amount changes were established for each station and the tendencies of the annual changes during the examined period, quantitative and qualitative indicators were evaluated.

The monitoring of TOA data of all 16 cities during the period 1993–2008 was examined. The monthly average values of the results obtained during TOA monitoring measurements were estimated; the tendencies of seasonal variations were defined and the monthly distribution of TOA data was evaluated (having in mind the TOA dimension), using the standard deviation function.

Correlation analysis was applied using SPSS v. 17.0 statistical software. Correlation method of analysis reveals links between the values of the cause. It is only a quantitative measure of the connection strength. The TOA monthly average values were studied by Pearson's Correlation Coefficient *r*. This parameter is presented by formula (Hill, Lewicki 2007):

$$r = \frac{\frac{1}{n-1}\sum (x_i - \overline{x})(y_i - \overline{y})}{S_x S_y}, \tag{1}$$

where: r – linear correlation coefficient; x_i – Kaunas TOA value, DU; y_i – other city TOA value, DU; $\overline{x}$ – Kaunas TOA average value, DU; $\overline{y}$ – other city TOA average value, DU; S_x and S_y – standard deviation.

TOA measurement in Lithuania adopting the data of neighbouring countries

Using the data from the network of stations, the accuracy of TOA measurements performed in Lithuania during the period 1999–2001 was evaluated.

To measure TOA in Lithuania (Kaunas Meteorological Station) with the help of the least squares method, the data on geographical locations of the measuring stations and TOA measured by meteorological stations of neighbouring countries were used (Table 1).

The possibilities to adopt TOA data measured in other countries for latitudes of Lithuania were evaluated by attributing values of TOA data of the station network to a small range of surface. The optimal trend or the linear function has to reduce the square deflections from trend as much as possible (Kang-Tsung 2006; Bailey, Gatrell 1995). The solution is performed in the following matrix:

$$Z = aB, \tag{2}$$

where: Z – linear matrix of known values; a – column vector of known a coefficients; B – square matrix, received from known X and Y coordination values of the points of geographical places.

Thus the optimising solution is:

$$a = B^{-1}Z, \tag{3}$$

where B^{-1} – inverse B matrix.

The calculation of the first row surface, using the least squares method, is performed according to the following formula:

$$Z(x, y) = a_0 + a_1 X + a_2 Y, \tag{4}$$

Z(x, y) is calculated TOA; a_0, a_1, a_2 – coefficients of polynomial equation; and *X*, *Y* — coordinates of a station.

The following three normal equations were used to calculate these three unknown *a* for the *n* data point:

$$\sum_{i=1}^{n} Z_i(x,y) = n \times a_0 + a_1 \sum_{i=1}^{n} X_i + a_2 \sum_{i=1}^{n} Y_i \,, \tag{5}$$

$$\sum_{i=1}^{n} X_i Z_i(x,y) = a_0 \sum_{i=1}^{n} X_i + a_1 \sum_{i=1}^{n} X_i^2 + a_2 \sum_{i=1}^{n} X_i Y_i \,, \tag{6}$$

$$\sum_{i=1}^{n} Y_i Z_i(x,y) = a_0 \sum_{i=1}^{n} Y_i + a_1 \sum_{i=1}^{n} X_i Y_i + a_2 \sum_{i=1}^{n} Y_i^2 \,. \tag{7}$$

Having calculated this system, the best variant of the two-dimensional, first row (flat) surface was received, well defined by the least squares regression (Johnston 2003). It can be written in the form of a matrix:

$$\begin{bmatrix} n & \sum_{i=1}^{n} X_i & \sum_{i=1}^{n} Y_i \\ \sum_{i=1}^{n} X_i & \sum_{i=1}^{n} X_i^2 & \sum_{i=1}^{n} X_i Y_i \\ \sum_{i=1}^{n} Y_i & \sum_{i=1}^{n} X_i Y_i & \sum_{i=1}^{n} Y_i^2 \end{bmatrix} \times \begin{bmatrix} a_0 \\ a_1 \\ a_2 \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{n} Z_i \\ \sum_{i=1}^{n} X_i Z_i \\ \sum_{i=1}^{n} Y_i Z_i \end{bmatrix}. \tag{8}$$

The monthly average values of TOA during 1993–2008 were calculated and the data obtained from neighbouring countries were compared with Kaunas data. The difference between obtained TOA results by interpolation method and the TOA data measured at Kaunas Meteorological Station was calculated. Thus, the accuracy of obtained results was evaluated and the possibilities to estimate TOA above Lithuania were extended, despite of non-existent possibilities to take TOA measurements.

3. Results of the Analysis

TOA changes above Lithuania and neighbouring countries

While investigating seasonal variations of TOA at latitudes of Lithuania and 15 other chosen neighbouring countries (the Northern Hemisphere), it was revealed that the process of these seasonal variations is analogous: it decreases during April–October and increases during November–March. As an example, the estimated TOA data in investigated cities in 2005 is graphically shown in Fig. 2.

After processing the TOA data of all 16 meteorological stations comparing the same day results of the measurement and the monthly average values, and after calculating the linear correlation coefficients between TOA data of Lithuania and neighbouring countries, it was revealed that in general, the variation tendencies of measurement results taken at Kaunas Meteorological Station were similar to annual variation tendencies of the investigated neighbouring countries: many of 201 linear correlation coefficients had a strong correlation – more than 0.9; 43 coefficients are between 0.8–0.9 (strong); 10 coefficients were between 0.7–0.8 (strong) and only 2 coefficients were less than 0.7 (weak) (Table 2).

The seasonal variations of TOA during 1999–2001 were examined and linear correlation coefficients were defined without using data of that period, when the TOA estimated in Lithuania was significantly different from the data of neighbouring countries.

The TOA data of 2000 were not examined at all as the results of only two months corresponded to general variations of other countries and these data were not enough to evaluate correlation. The obtained results are shown in Table 3.

Having evaluated the process of seasonal TOA variations in 16 cities, it was established that the data of Kaunas Meteorological Station from May 1999 to February 2000 and from May 2000 to January 2001 inclusively, were significantly dissimilar (in some cases, the difference is more that 150 DU) with the data of neighbouring countries (Fig. 3).

Having summarised the obtained variations of linear correlation coefficients, it was revealed that the correlation coefficients between the data of Kaunas Meteorological Station and St. Petersburg, Lindenberg, Hradec

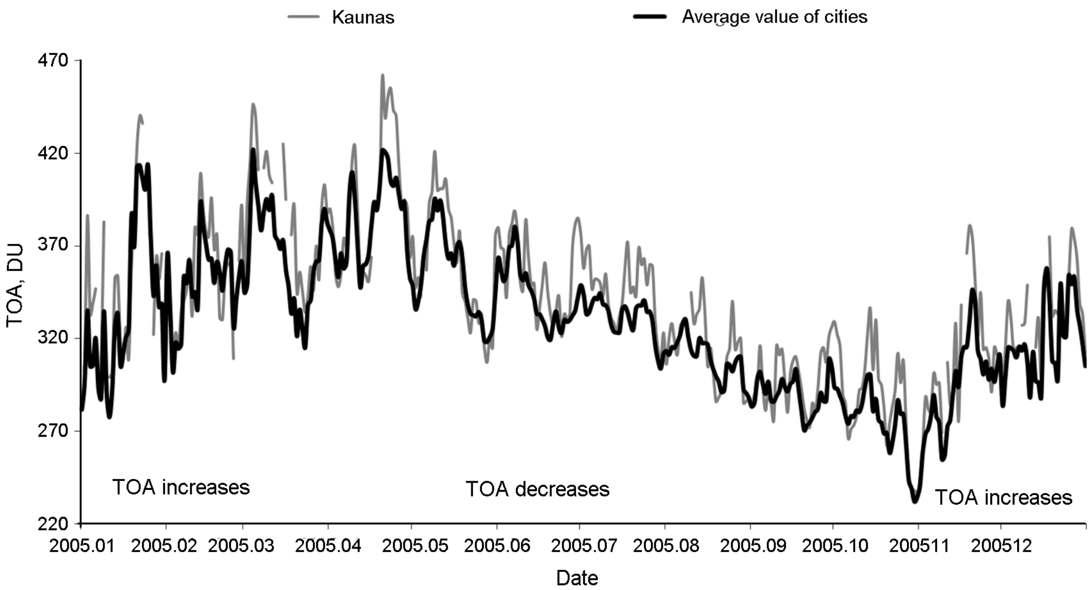

Fig. 2. Total ozone amount data of average value of 16 cities and data of Kaunas in 2005

Table 2. Linear correlation coefficients between the total ozone amount data of Lithuania and neighbouring countries

No.	City	Linear correlation coefficients															
		Year															
		1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1.	Riga	0.886	0.936	0.941	0.915	0.980	0.961	0.795	*	*	*	*	*	*	*	*	*
2.	Kaunas																
3.	St. Petersburg	0.958	0.987	0.949	0.883	0.978	0.969	0.829	0.910	0.961	0.968	0.974	0.960	0.885	0.969	0.980	*
4.	Lindenberg	0.833	0.982	0.964	0.944	0.891	0.970	0.864	0.943	0.957	0.970	0.958	0.992	0.962	0.986	0.970	0.960
5.	Ukkel	0.816	0.955	0.976	0.942	0.806	0.897	0.865	0.765	0.910	0.897	0.921	0.953	0.806	0.960	0.883	0.942
6.	Kiev	0.933	0.918	0.922	0.924	*	*	*	*	*	*	*	*	*	*	*	*
7.	Sodankyla	0.766	0.885	0.884	0.704	0.884	0.971	0.823	0.805	0.934	0.766	0.844	0.940	0.789	0.944	0.871	0.968
8.	Hradec Králové	0.956	0.966	0.945	0.960	0.927	0.947	0.853	0.893	0.963	0.946	0.926	0.988	0.952	0.977	0.972	*
9.	Minsk	*	*	*	*	0.976	0.910	0.711	0.893	0.825	0.929	*	0.944	0.922	*	*	*
10.	Oslo	0.882	0.931	0.931	0.729	0.943	0.929	0.820	0.943	0.965	0.836	0.894	0.959	0.893	0.975	0.970	0.532
11.	Voronezh	0.854	0.909	0.949	0.770	0.920	0.945	0.851	*	0.941	0.922	0.960	0.974	0.888	0.979	0.944	*
12.	Hohenpeissenberg	0.917	0.949	0.942	0.852	0.903	0.936	0.819	0.781	0.939	0.824	0.955	0.961	0.852	0.953	0.914	0.945
13.	Bielsk	0.953	0.994	0.958	0.902	0.979	0.983	0.884	0.911	0.916	0.972	0.930	0.994	0.977	0.985	0.988	*
14.	Moscow	0.855	0.947	0.941	0.947	0.944	0.979	0.900	0.933	0.932	0.944	*	0.984	*	*	*	*
15.	Poprad-Ganovce	0.636	0.977	0.946	0.951	0.935	0.941	0.865	0.921	0.918	0.943	0.925	0.967	0.934	0.973	0.953	0.947
16.	Norrköping	0.936	0.960	0.950	0.875	0.981	0.965	0.841	0.866	0.977	0.955	0.969	0.989	0.919	0.960	0.972	0.982

* – no or not enough TOA data;
– linear correlation coefficients between 0.8–0.9;
– linear correlation coefficients less than 0.8;
– year, when TOA variations above Lithuania and neighbouring countries were dissimilar.

Table 3. Comparison of the obtained linear correlation coefficients between the total ozone amount data of Lithuania and neighbouring countries, cities with (initial) and without (revised) data from May 1999 to February 2000 and from May 2000 to January 2001

No.	City	Linear correlation coefficients				
		Year				
		Initial values		Revised values		Article I
		1999	**2001**	**1999**	**2001**	**Average value of 1993–2008**
1.	Riga	0.795	*	*	*	0.946
2.	Kaunas					
3.	St. Petersburg	0.829	0.961	0.993	0.974	0.959
4.	Lindenberg	0.864	0.957	0.960	0.969	0.954
5.	Ukkel	0.865	0.910	0.763	0.949	0.898
6.	Kiev	*	*	*	*	0.924
7.	Sodankyla	0.823	0.934	0.716	0.938	0.858
8.	Hradec Králové	0.853	0.963	0.908	0.974	0.953
9.	Minsk	0.711	0.825	0.271	0.859	0.830
10.	Oslo	0.820	0.965	0.836	0.962	0.880
11.	Voronezh	0.851	0.941	0.981	0.968	0.926
12.	Hohenpeissenberg	0.819	0.939	0.849	0.954	0.914
13.	Bielsk	0.884	0.916	0.961	0.950	0.966
14.	Moscow	0.900	0.932	1.000	0.932	0.947
15.	Poprad-Ganovce	0.865	0.918	0.912	0.955	0.926
16.	Norrköping	0.841	0.977	0.950	0.988	0.957

* – no or not enough TOA data;
– increased linear correlation coefficients;
– decreased linear correlation coefficients;
– average value > 0.950 during the period 1993–2008.

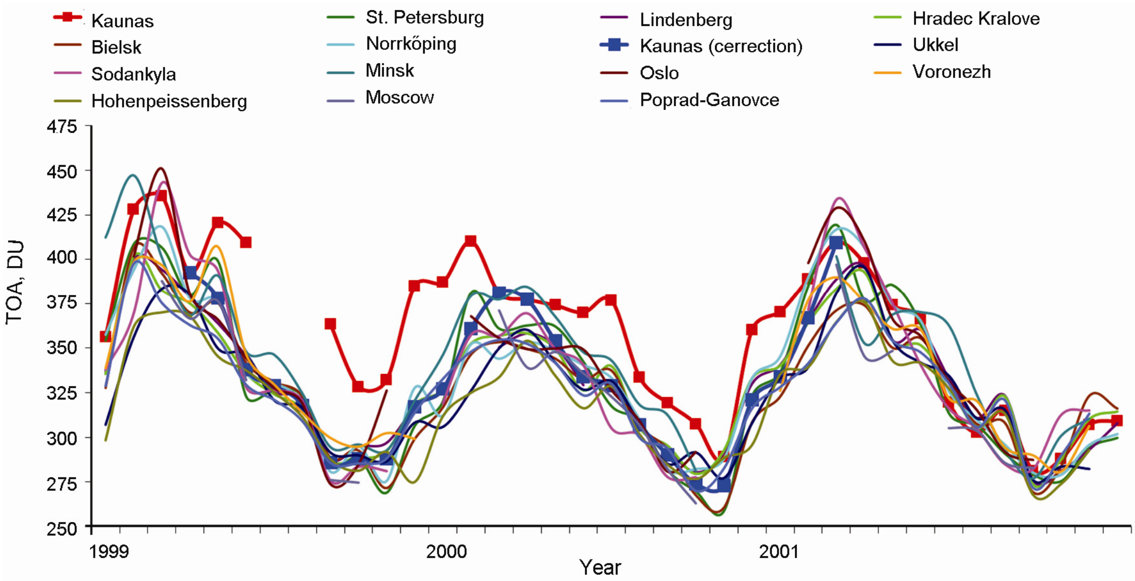

Fig. 3. Results obtained by the interpolation method (Kaunas correction)

Králové, Oslo, Voronezh, Hohenpeissenberg, Bielsk, Moscow, Poprad-Ganovce and Norrköping meteorological stations increased in 1999. It decreased between Ukkel, Sodankyla and Minsk (Table 3). The linear correlation coefficients of TOA variations increased between the data of Kaunas and St. Petersburg, Lindenberg, Ukkel, Sodankyla, Hradec Králové, Minsk, Voronezh, Hohenpeissenberg, Bielsk, Poprad-Ganovce and Norrköping meteorological stations in 2001. The linear correlation coefficient of 2001 was the same compared to the Moscow data. It decreased by 0.003 only between Kaunas and Oslo.

The obtained values of linear correlation coefficients between the data of Kaunas Meteorological Station and other countries can be adopted to define the total ozone amount during those periods when the measurements of the total ozone amount were not performed above Lithuania or the obtained results of the measurements are inaccurate. The difference in data of Kaunas Meteorological Station and other investigated countries can be explained as inaccuracy of measuring ozonometer, impact of meteorological conditions on performed measurements, mistakes of a worker performing measurements, and etc.

The largest average values of linear correlation coefficients during the period 1993–2008, which are more than 0.950, were defined between Kaunas and St. Petersburg, Lindenberg, Hradec Králové, Bielsk and Norrköping (Table 3). The TOA data of these cities are the most correspondent to the seasonal TOA variations and alteration tendencies of Lithuania. To define the TOA in Lithuania the interpolation of data must be performed. For interpolation only the results obtained during TOA measurements in neighbouring countries can be used.

TOA measurement in Lithuania adopting the data of neighbouring countries

The method of least squares was used. Number n was equal of the number of used stations. For calculation, the known processed data were inserted in Eq. 9.

For example, the following matrix was obtained using the average values of the total ozone amount in January 1997 (Table 4) (n = 14, because there were no TOA data of Minsk and Kaunas and data of these stations were not used).

Having changed the matrix and having calculated unknown a, the linear function was defined as follows:

$$Z(x,y) = 355.9885 + 1.0692X + 0.9961Y. \qquad (9)$$

Having inserted the coordinates of Kaunas Meteorological Station, the average value in Lithuania in January 1997 was calculated as 327 DU. Having compared the calculated result of 327 DU with the measured 336 DU, the data difference was found amounting to as little as 2.67%.

Table 4. Average values (DU) of the total ozone amount in January 1997

Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8
313	323	299	327	310	334	339	no
Z_9	Z_{10}	Z_{11}	Z_{12}	Z_{13}	Z_{14}	Z_{15}	Z_{16}
312	308	320	361	348	320	332	**336**

Having revised the monthly average values of the total ozone amount from May 1999 to February 2000 and from May 2000 to January 2001, we obtained TOA results, which differed from the measured ones. The calculated results are graphically presented in Fig. 3.

It was established that in case of the method of the interpolation calculations and the least squares method with a smaller amount of stations, the TOA data only from those countries, between which the linear correlation coefficients with Kaunas Meteorological Station were the largest (over 0.950), was suitable for calculation of one day TOA. As an example, the obtained results are presented in Table 5.

Having evaluated the obtained results and the TOA variation tendencies in Lithuania and neighbouring countries, having used the data of neighbouring countries and the data measured in Lithuania, the difference between calculated TOA values was up to 8%.

Table 5. Comparison of measured and calculated TOA data (DU)

City	Days in July 2007						
	10	11	12	13	14	15	16
St. Petersburg	327	295	318	322	373	350	336
Bielsk	333	371	351	344	307	318	306
Hradec Králové	295	359	364	348	319	308	308
Norrköping	344	354	360	316	308	335	309
Lindenberg	361	355	347	322	299	no	296
Kaunas (meas.)	317	328	330	350	330	305	316
Kaunas (calc.)	**336**	**336**	**339**	**336**	**331**	**308**	**318**
Data difference, %	5.99	2.44	2.73	4.00	0.30	0.98	0.63

4. Conclusions

1. Having evaluated the TOA variations in Lithuania and chosen neighbouring countries and having adopted the monitoring data of 1993–2008, it was confirmed that the seasonal variations of TOA have the same alteration tendencies. The largest average values of linear correlation coefficients during the period 1993–2008, which are more than 0.950, were defined between Kaunas and St. Petersburg, Lindenberg, Hradec Králové, Bielsk and Norrköping. The TOA data of these cities corresponded to the most with seasonal TOA changes and alteration tendencies in Lithuania.

2. It is possible to estimate the TOA data in Lithuania using the TOA data of neighbouring countries adopting the interpolation method and using the least squares method. The difference between such calculated TOA values is up to 8%.

3. In case there were no TOA data from all 16 meteorological stations, the TOA in Lithuania could be estimated by the least squares method, adopting the data only from those countries, between which TOA variations have a correlation over 0.950.

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BENDROJO OZONO KIEKIO POKYČIAI VIRŠ LIETUVOS IR KAIMYNINIŲ ŠALIŲ

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Santrauka

Remiantis 1993–2008 m. duomenimis, nagrinėjami bendrojo ozono kiekio (BOK) pokyčiai virš Lietuvos ir kaimyninių šalių. Įvertintos sezoninių šių BOK pokyčių sąsajos. Išsamiõs informacijos apie BOK pateikė Lietuvos hidrometeorologijos tarnyba bei Pasaulio ozono ir ultravioletinės spinduliuotės duomenų centras. Sudarytas bendrojo ozono kiekio matavimo stočių tinklas iš 16 meteorologinių stočių. Analizuojant BOK pokyčių tarp skirtingų stočių tiesinės sąsajos stiprumą taikyti Pirsono koreliacijos koeficientai. Nustatyta, kad BOK sezoninių pokyčių tendencijos tarp šių stočių sutampa, ir dauguma koreliacijos koeficientų (tarp Lietuvos ir kaimyninių šalių) yra 0,9–1,0. Analizuojant BOK duomenis, nustatyta, kad nuo 1999 m. gegužės iki 2000 m. vasario ir nuo 2000 m. gegužės iki 2001 m. sausio Lietuvoje atliktų matavimų rezultatai nėra pakankamai tikslūs. Mažiausiųjų kvadratų metodu apskaičiuota tiesinė funkcija BOK nustatyti Lietuvoje (Kauno meteorologijos stotyje) neatliekant tiesioginių matavimų. BOK skaičiavimo ir matavimo rezultatų skirtumas siekia iki 8 %.

Reikšminiai žodžiai: bendrasis ozono kiekis, meteorologijos stotis, tiesinės koreliacijos koeficientai, stebėsena.

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