RESEARCH OF THE VARIATIONS OF THE ATMOSPHERIC OZONE AND CHANGE OF THE ULTRAVIOLET SUN RADIATION OVER NORTHEASTERN BULGARIA

Garo MARDIROSSIAN, Stiliyan STOYANOV and Margarita PHILIPOVA

Space Research Institute - Bulgarian Academy of Sciences, BULGARIA, Sofia 1000, 6 Moskovska St, e-mail: mardirossian@space.bas.bg
Space Research Institute - Bulgarian Academy of Sciences, BULGARIA, Sofia 1000, 6 Moskovska St, e-mail: zhekovz@yahoo.com
National Military University « V. Levski », Department Natural and Math Sciences, Veliko Tarnovo, 76, Bulgaria Blvd, BULGARIA, e-mail: magi.vt@abv.bg

Key words:
total ozone content.

SYNOPSIS

Abstract The atmospheric total ozone content variations over the North-eastern region of Bulgaria have been observed during the period May-August 2008. The measurements are conducted above the hydro-meteorological station in the Kaliakra peninsula using a ground-based ozonometer M-124. The experimental data for the total ozone content distribution have undergone processing and the mean month values have been calculated.

INTRODUCTION

The problem of the periodic variations of the total ozone content is a question of present interest. (Филипова, 2007; Филипова & Димитрова, 2007; Филипова et al., 2007) The results of the interpretation of these data for the northern hemisphere show decreasing of the ozone layer with 30-50 Dobson units (Фиолетов,1989).

In 1986 a spring negative anomaly of the ozone trend has been detected in Greece (Хригиан, 1989). In 1987 a considerable decrease of total ozone content was detected in the town of Belsk, Poland (Хригиан, 1989).

The anomalies of the ozone trend are similar (the coefficient of the correlation is +0,44) in Europe: from 1982-1983 in Moscow (Хригиан, 1989); from 1984-1985 in Southern Europe – Vina del Vale and Lisbon (Хригиан, 1989). From 1986-1987 in Northern Europe (Хригиан, 1989). These data are received from ground ozonometric stations and their processing shows a negative linear trend of the total ozone content in the Northern hemisphere – 1,4% and respectively there is a considerable variation of the average total ozone content (Хригиан, 1989).

The goal of the research is to study the variations of the total ozone content in Northeastern Bulgaria for the period May – August 2008, which were measured by means of a ground ozonemeter in the hydro meteorological station in Kaliakra.

Kaliakra station is situated at 59,12 m altitude. Its geographic coordinates are 28°28’ eastern longitude and 43°22’ northern latitude. Having in mind the conservative meridional stratospheric circulation at altitude 20-22 km in northeastern Bulgaria and the comparative remoteness of Kaliakra from big industrial contaminators, it can be considered that the received experimental results are representative for a larger equable zonal structure, such as Northeastern Bulgaria.

The total ozone content is being researched by 4-month results: May, June, July and August. The data are in table 1. The days with unfavourable weather are less than 4 per month and they are not taken into consideration because they are within the limits of for the determination of the total ozone content variations.

The goal of the research is to check whether the values of the total ozone content X for the four months are commensurable and to examine for possible variations. Since the number of the days, in which the experimental value X is received, is different for the single months, the Barlet criterion is used (Худсон, 1970).

Table 1: Average values of the total ozone content X in Dobson units, Kaliakra, 09 May – 18 August 2008.

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
May									437			365	345	360	388
June	340	400	490	348	375				390	394	359	383	360	421	454
July	385	331	341	384	360	369	337	343	349	356	342	339	302	302	333
August	236	256	297	243	242	181	220	199	227	273	260	176	179	223	191

Month	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
May	388	304	341	335	402	384			414	437	412	414	397	380	408	384
June	383	344	428	403	389		385	389	395	324	376	364	341	330	334	
July	372	349	368	317	350	305	305	326	185	231	264	232	223	222	236	246
August	196	211	201													

The evaluations for every dispersion are calculated $S_1^2, S_2^2, S_3^2, S_4^2$:

(1) $$S_1^2 = \frac{1}{n_i - 1} \sum_{j=1}^{n_i} \left(X_{ij} - \overline{X} \right)^2$$

and the formula:

(2) $$\overline{X_i} = \frac{1}{n_i} \sum_{j=1}^{n_i} X_{ij}$$

is used to get the average values for the total ozone content for the separate months:

$\overline{X_1}$ =384 Dobson units, $\overline{X_2}$ =375 Dobson units, $\overline{X_3}$ =313 Dobson units, $\overline{X_4}$ =223 Dobson units

The dispersions are as follows:

$$S_1^2 = 1245{,}94; \; S_2^2 = 1153{,}96; \; S_3^2 = 3060{,}37; \; S_4^2 = 1191{,}47.$$

The zero hypothesis H_0 is checked that $S_1^2 = S_2^2 = S_3^2 = S_4^2$ as an assumption that the number of degrees of freedom is:

$$Y_1 = 19 - 1 = 18; \; Y_2 = 27 - 1 = 26; \; Y_3 = 31 - 3 = 30; \; Y_4 = 18 - 1 = 17$$

In this case

(3) $$Y = \sum_{i=4}^{4} Y_i = 91.$$

On the other hand,

(4) $$S^2 = \frac{1}{Y}\sum_{i=4}^{4} Y_i S_i^2 = \frac{1}{91} 164\ 495{,}98 = 1807{,}5$$

To calculate the value χ^2, the following values are determined:

(5) $$C = 1 + \frac{1}{3(n-1)}\left(\sum_{i=1}^{n}\frac{1}{Y_i} - \frac{1}{Y}\right) = 1{,}0158,$$

$$Y_1 = \ln\frac{S_1^2}{S^2} = -0{,}3722,$$

$$Y_2 = \ln\frac{S_2^2}{S} = -0{,}4488,$$

$$Y_3 = \ln\frac{S_3^2}{S} = 0{,}5265,$$

$$Y_4 = \ln\frac{S_4^2}{S} = 0{,}4168,$$

In this case:

$$(6)\quad \chi^2 = \frac{1}{C}\sum_{i=1}^{4} \ln \frac{S_i^2}{S^2} = 9{,}659,$$

At a level of importance $\chi^2 = \frac{1}{C}\sum_{i=1}^{4} \ln \frac{S_i^2}{S^2} = 9{,}659,$ from the tables of χ^2 the distribution of the degrees of freedom 4-1=3 is given: (0,05; 3)=7,815.

Because χ^2=9,659>7,815=χ^2 (0,05; 3), the conclusion is that there are reasons to reject the zero hypothesis, which means that the four dispersions are different. Since they cannot be considered equal, there are distinct variations of the examined values of total ozone content for the given months. Since the dispersion S_3^2=3060,37 is maximum, the conclusion should be that the observed anomaly in the total ozone contents values is the biggest in July when the trend is negative during the second half of the month and the total ozone content reaches 185 Dobson units. Similar explanation can be given for the maximum values within the range 176-181 Dobson units in the beginning of August. A registered sudden transition towards anomalous values of the total ozone content can be observed at the end of July.

REFERENCES:

Филипова, М. 2007: Екология и опазване на околната среда. - Издат. Комплекс НВУ „В. Левски”, В. Търново, pp. 131-133.

Филипова, М. & Димитрова, С. 2007: Екологичната криза и нейните икономически аспекти. - Издат. Комплекс НВУ „В. Левски”, В. Търново, pp. 22-24.

Филипова, М., Статев, С. & Мирчева, З. 2007: Екологична защита. - Издат. Комплекс НВУ „В. Левски”, В. Търново, pp. 25-26.

Фиолетов, В.Э. 1989: Метеорология и гидрология, №7. - Издательский центр «Метеорология и гидрология», Москва, pp. 27-31.

Хригиан, А.Х. 1989: Метеорология и гидрология, №7-Издательский центр «Метеорология и гидрология», Москва, pp. 24-27.

Худсон, Д. 1970: Статистика для физиков – Мир, Москва, 289 pp.

Original research article
Received: 31 July 2010