

THE OZONE LAYER OVER BULGARIA IN THE PERIOD 1997-2018

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Abstract. A detailed analysis of the variations of the stratospheric and mesospheric ozone over Bulgaria, for the period 1997-2018, is presented in the article on the basis of ground and satellite measurements of the Total Ozone Content (TOC). The existing long-term trends of the move of the basic components of the seasonal course have been studied. In conclusion, it can be argued that the ozone layer over Bulgaria fully retains its protective functions.

Key words: total ozone content, seasonal course, long-term trends.

Introduction

The increased interest to the ozone layer condition of the Earth atmosphere over the last decades is due to the understanding that the protection of the whole biosphere from solar radiation UVB (280-315 nm) depends, to some extent, on this little atmospheric compound. Besides, the variations in its concentration have a substantial impact on the temperature regime and hence – on the whole dynamics of the middle atmosphere namely because of ozone's property to absorb solar energy (Georgieva et al. 2017). In relation to the task assigned to NIGGG by governmental organs to study the condition of the ozone layer over Bulgaria, a daily monitoring of the TOC was organized in 2008 with ground facilities working in Sofia also at present (Gadzhev and Ganev 2018a, 2018b). Since it is not possible to obtain a continuous data row (measurements with ground appliances are possible only by clear weather), the data was complemented with measurements from satellites (Kaleyana et al. 2013, Tcherkezova et al. 2013). The output row of daily values allowed tracking of the condition of the ozone layer in the atmosphere over Bulgaria for a sufficiently long period: from 1997 to 2018 and making some conclusions about the protective ability of the ozone layer.

Data of Total Ozone Content

The measurements of TOC in NIGGG were conducted with the sun photometer Microtops II, a product of Solar Light Company, USA, <http://www.solarlight.com>. The results were obtained completely automatically from the built-in microcomputer. The accuracy of the appliance, given by the manufacturer, was 1-2%. The error amounted to 6 DU by an average amount of the total content about 300 DU.

The measurements with Microtops II have been complemented with data from Ozone Monitoring Instrument (OMI) working on AURA Satellite which are available on <http://toms.gsfc.nasa.gov/>. The relation between the data obtained from Microtops II and OMI was for the period September 2009 to June 2009. There has been some systematic bias between the two types of measurements, about 11 DU, which has allowed recalculating the data from OMI and tying them to the data of Microtops II. The data row was extended to 1996 with the data from a Total Ozone Mapping Spectrometer (TOMS) aboard the Nimbus 7 polar-orbiting satellite. The simultaneous data from TOMS and OMI from October 2004 to December 2005 has allowed to calibrate the data of TOMS to OMI and then to the data of Microtops II. The resulting data row, notwithstanding that it has been obtained from different appliances, should be considered free of systematic bias (Kaleyva et al. 2013, Bojilova 2017).

Montly mean TOC

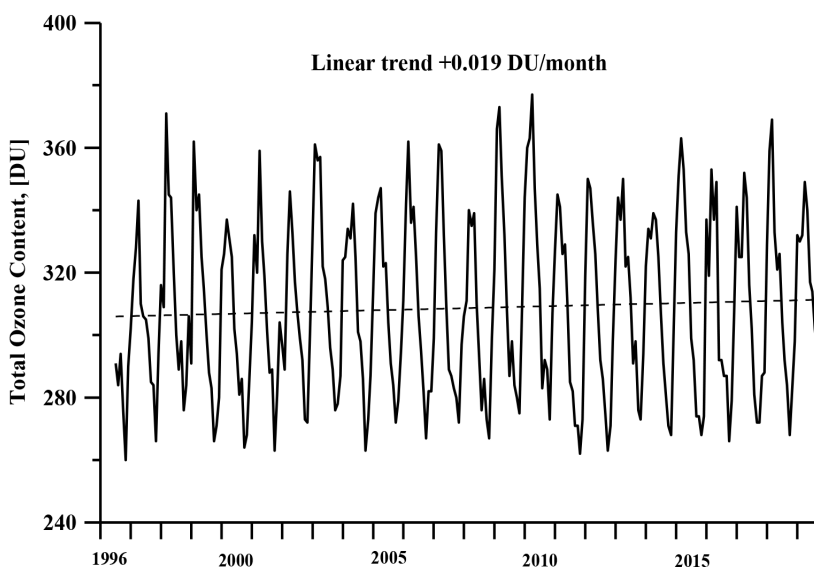


Fig. 1. Monthly averages of TOC over Bulgaria in the period 1996-2018.

The course of the annual monthly values of TOC over Bulgaria is displayed on Fig. 1. A certain seasonal cycle of the total ozone with a spring maximum and an autumn minimum may be readily seen. The linear approximation gives a positive trend of 0.019 DU/month, which allows making the conclusion that the ozone layer over Bulgaria was generally stable during the period.

Components of seasonal cycle.

A decomposition of the monthly mean values has been made with a sliding time segment of a year with a step of one month (Kaleyna et al. 2013). The course of yearly running mean values is displayed in Fig. 2. The value of the positive linear trend is 0.017 DU/month and practically coincides with the trend of monthly average values. Significant variations are observed over a period of about five years.

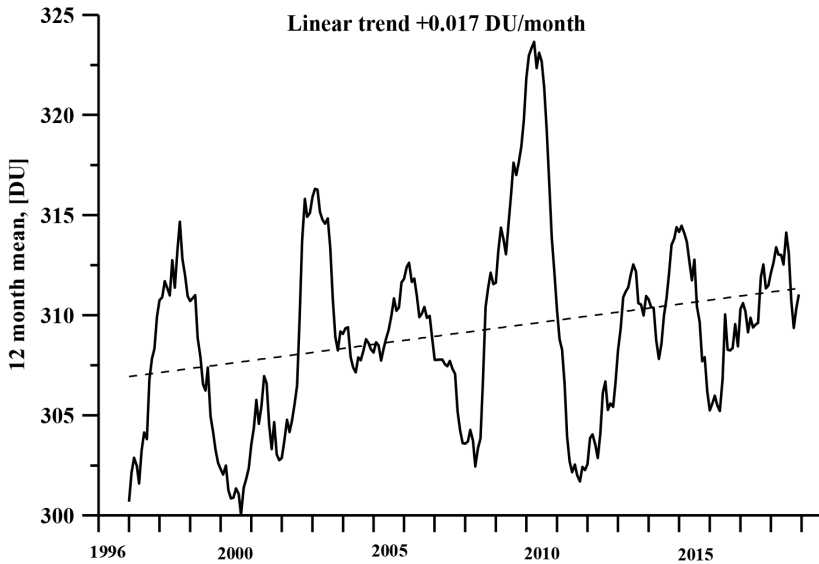


Fig. 2. Running yearly mean TOC.

The course of the annual amplitude shown in Figure 2 has a positive linear trend of 0.028 DU/month. This means that seasonal variation increases over time. The phase of the annual variation (the day of the year when TOC is maximal) is shown in Figure 4. Linear trend is negative- 0.055 days/month. At the beginning of the period the day of the maximum is at the end of March, at the end of the period it reaches the middle of the month.

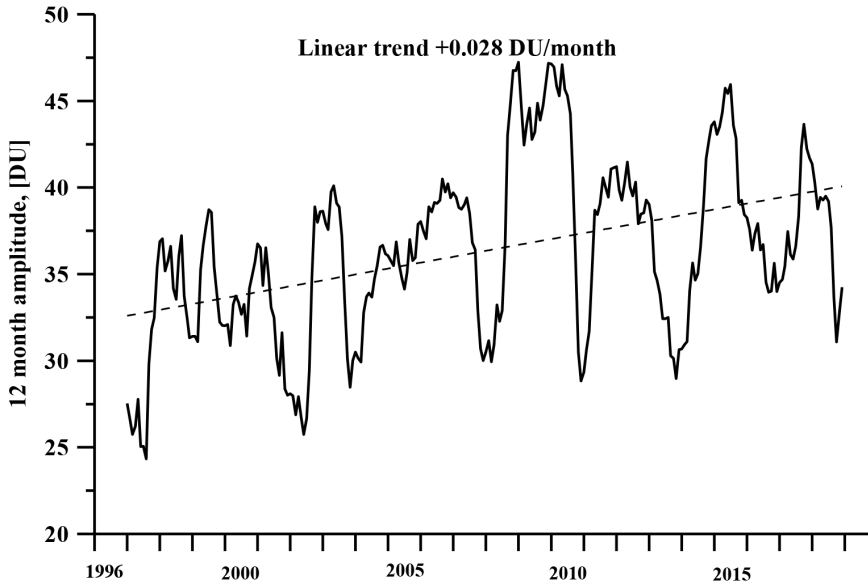


Fig. 3. 12-month amplitude.

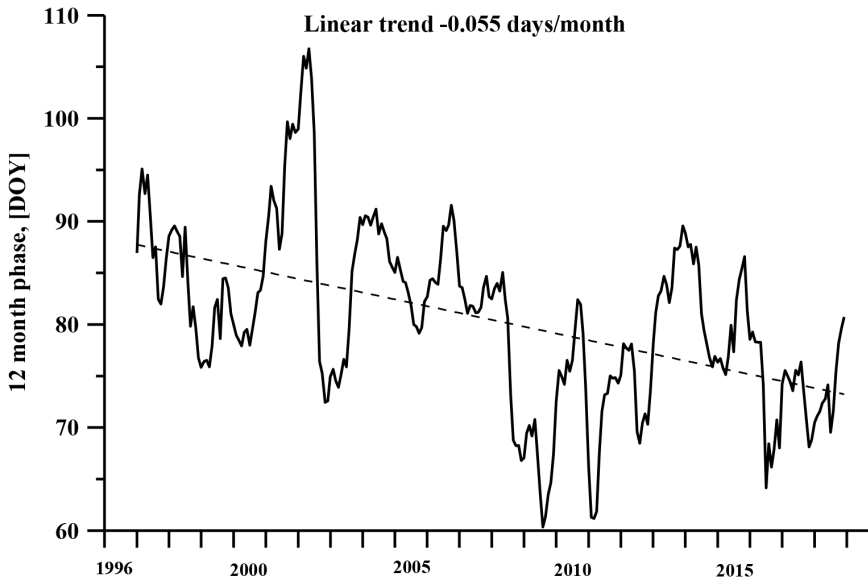


Fig. 4. 12-month phase.

Conclusions

The analysis of the seasonal cycle of the Total Ozone Content over Bulgaria made on the basis of assimilated dataset of daily values obtained by ground and satellite measurements and smoothed between each other with the use of regression fitting has shown that the condition of the stratospheric ozone which is the most important for the protection of the Earth's surface from the harmful impact of the ultraviolet solar radiation was stable during the studied period (1997-2018), and no trends towards its destruction have been observed. On the contrary, the total amount of ozone tends to increase slightly. Seasonal variations are also relatively persistent.

In conclusion, it can be argued that the ozone layer over Bulgaria fully retains its protective functions.

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Озоновият слой над България в периода 1997–2018 г.

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Резюме: Направен е детайлен анализ на вариациите на стратосферния и мезосферен озон над България за периода 1997–2018 г. на базата на наземни и спътникови измервания на тоталното озоново съдържание (ТОС). Изследвани са основните компоненти на сезонната изменчивост и съществуващите тенденции за изменението им. В заключение е направен извод, че озоновият слой над България напълно запазва своите защитни свойства.