

**REPORT OF THE REPUBLIC OF LITHUANIA
PURSUANT TO ARTICLE 9
“RESEARCH, DEVELOPMENT, PUBLIC AWARENESS AND EXCHANGE OF
INFORMATION’ OF THE MONTREAL PROTOCOL
ON SUBSTANCES THAT DEplete THE OZONE LAYER
For the years 2020–2021**

In accordance with the Parties' obligations under Article 9 'Research, development, public awareness and exchange of information' of the Montreal Protocol, the Republic of Lithuania has prepared a report on activities performed in 2020–2021 pursuant to this Article.

This report contains information on:

- Observational and research activities related to stratospheric ozone and UV monitoring;
- Promoting public awareness.

1. OBSERVATIONAL AND RESEARCH ACTIVITIES RELATED TO STRATOSPHERIC OZONE AND UV MONITORING

Lithuania ratified the Vienna Convention on the Protection of Ozone Layer and Montreal’s Protocol on Substances that Deplete the Ozone Layer on December 19, 1994. The London, Copenhagen, and Montreal Amendments were ratified on December 9, 1997. The Montreal and Beijing Amendments to the Montreal Protocol were ratified on January 15, 2004. The Göteborg Protocol to Abate Acidification, Eutrophication, and Ground-level Ozone was ratified on February 5, 2004.

In Lithuania total column ozone and ultraviolet solar radiation (UV) monitoring is conducted mainly by the Lithuanian Hydrometeorological Service under the Ministry of Environment of the Republic of Lithuania (LHMS). Following the State Monitoring Programme for 2018-2023, the being implemented objectives of the program regarding monitoring of total column ozone content and UVA and UVB allow to assess the condition of the natural environment (air, climate, ozone layer, radiological condition, water, soil, wildlife, conditionally natural forest ecosystems, landscape) in Lithuania, manage and forecast both nationally and internationally, provide all levels of environmental protection properly. Total column ozone and UV monitoring are being conducted using the standard observation program recommended by the World Meteorological Organization for National meteorological services.

Table 1. Total column ozone and UV measurement sites in Lithuania during 2020-2021

<i>Meteorological station</i>	<i>Location</i>	<i>UV-A</i>	<i>UV-B</i>	<i>UV-E</i>	<i>Total column ozone</i>	<i>Period of UV measurements</i>
Kaunas	54°53'N, 23°50'E	x	x	x	x	2000-now
Vėžaičiai	55°43'N, 21°28'E		x	x		2020-now

The beginning of UV radiation measurements in Lithuania was in 2000 at Kaunas meteorological station (WIGOS ID 0-20000-0-26629). In 2020 February UV measuring started at Vėžaičiai automatic meteorological station (WIGOS ID 0-20000-0-26517) replacing measurements canceled at Palanga aeronautical meteorological station (WIGOS ID 0-20000-0-26502) due to changed station representativeness (the airport terminal was expanded, and site effected by new surroundings). UV radiation is being measured by the Kipp & Zonen equipment at both sites. The sensors were upgraded and fully installed in Vėžaičiai at the end of 2019. The UV-E element has been started to measure additionally at both stations (from January 2020 in Kaunas and from February 2020 in Vėžaičiai).

1.1 Column measurements of ozone and other gases/variables relevant to ozone loss

The state of the ozone layer is monitored at Kaunas meteorological station (WIGOS ID 0-20000-0-26629), which is located close to the geographical center of Lithuania. Total column ozone

measurements have been carried out since 1 January 1993 with the M-124 filter ozonometer installed according to its viewing requirements. Routine measurements of total column ozone were made manually (in the daytime) up to a maximum of nine times per day. Since 2014 Kaunas meteorological station was equipped with Brewer MK-III Spectrophotometer which is designed for continuous outdoor operation and contains two modified Ebert f/6 spectrometers. For some year period the comparison of measurements was carry out and since April 2018 measurements were fully automated. During 2020-2021 measurements were continued, the analysis of data accuracy and suitability were carried out by specialists in LHMS.

1.2 Profile measurements of ozone and other gasses/variables relevant to ozone loss

LHMS sites are not equipped with ozone sondes and ozone lidar to make measurements of ozone profile.

1.3 UV measurements

UV measurements have been carried out since 2000 at Kaunas meteorological station and from 2020 at Vėžaičiai automatic meteorological station. Mean and maximum daily radiation is being monitored using the Smart UV Radiometers made by Kipp & Zonen SUV Series (SUV-A, SUV-B, and SUV-E in Kaunas, also SUV-B and SUV-E in Vėžaičiai).

Kaunas UVA and UVB data for the period from 01-01-2020 to 31-05-2020 is used measured by the Solar light biometer 501-A, due to the results of the comparative analysis of the instruments. From 1 July 2020 UVA and UVB data measured with the Kipp & Zonen Smart UV device is used. Kaunas UVE radiation data measured by the Kipp & Zonen Smart UV instrument is used from 2020-01-17.

Vėžaičiai UVB and UVE data started to be measured with the Kipp & Zonen Smart UV instrument on 04-02-2020. Due to the analysis carried out after the installation of the instruments, the daily average and maximum values of these parameters are in operational use from 05-02-2020.

1.5 Calibration activities

The network instruments are calibrated against the working references (standards) of LHMS Metrological Laboratory at regular intervals, at least once every two years. The last calibration was performed in the year 2021. The working references were calibrated at their manufacturer's Kipp & Zonen laboratory, using traceable references.

The Brewer MK III spectrophotometer in the Kaunas meteorological station was once calibrated in 2017 by Kipp & Zonen. The results showed that Brewer #219 was in very good working condition when inspected. A dispersion test with external cadmium and an internal mercury lamp was done. The Brewer was calibrated for ozone against the reference Brewer #158.

2. RESULTS FROM OBSERVATIONS AND DATA ANALYSIS

The distribution of stratospheric ozone data for 2021 is similar to 2018 and 2019, which had exceptionally increased daily maximum values and in contrast to 2020, which had exceptionally decreased ozone values. In 2020, the absolute minimum of stratospheric ozone (224 DU) was observed on 26th January (in 2021 – 230 DU on 25th October) and the maximum (573 DU) was measured on 19th March (in 2020 – 480 DU on 14th March).

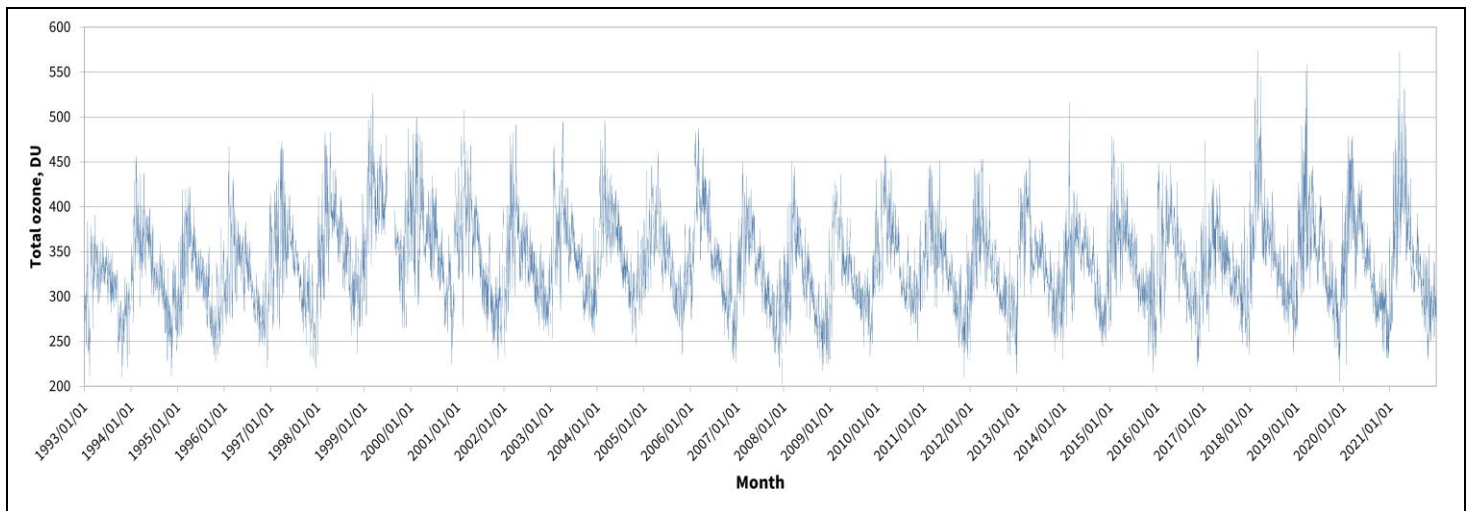


Fig. 1. Total column ozone daily fluctuations 1993–2021 (station N 312¹, Kaunas)

The 2021 daily maximum average value (573 DU) was 44% higher than the long-term maximum March average (1993-2020), and only 1 DU was measured lower than the all-time Lithuanian daily maximum ozone value of 574 DU measured on 3 March 2018. The mean annual amount of ozone in 2020 was 339 DU and in 2021 – 344 DU. Compared with the 2020 measurements, in 2021 the average amount of the stratospheric ozone increased by 1.5 % and was 2 % higher than the normal value (comparing 2020 annual mean with the 2019 measurements), the total amount of the stratospheric ozone decreased by 1.5 % and was only 1 % above normal value (multi-annual mean).

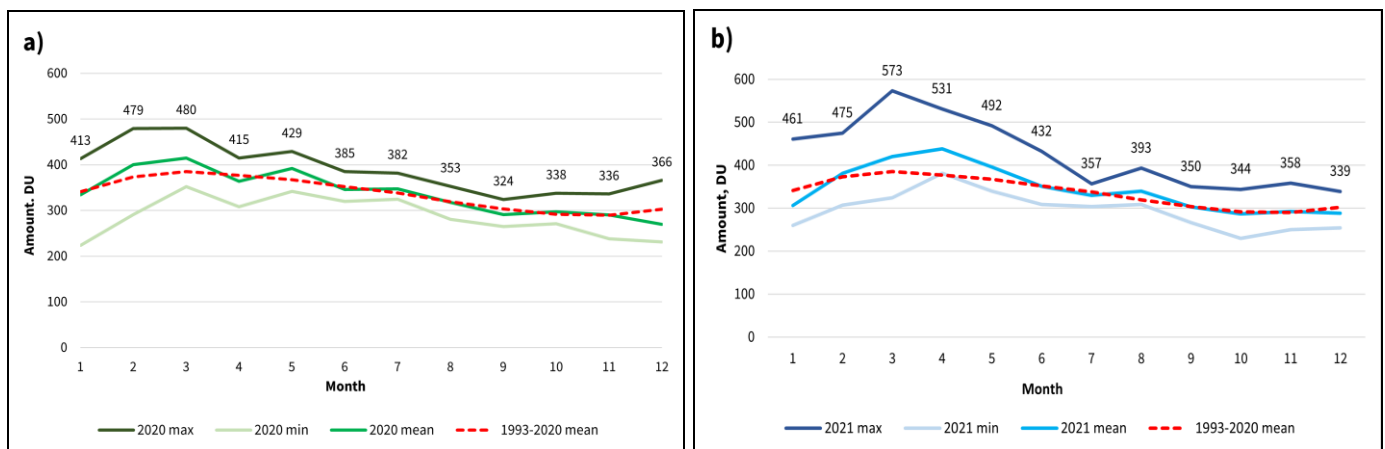


Fig. 2. Total column ozone mean annual cycle in 2020 (a) and 2021 (b)

All observational data is stored and processed regularly. In 2020, the LHMS carried out the ozone data analysis resulting in the establishment of the mean total column ozone values for the period of 1993–2020 that has since been used to assess the ozone layer depletion over Lithuania. It is also used in monitoring the total column ozone and assessment of its quantitative changes until now.

¹ 312 - WOUDC Station ID

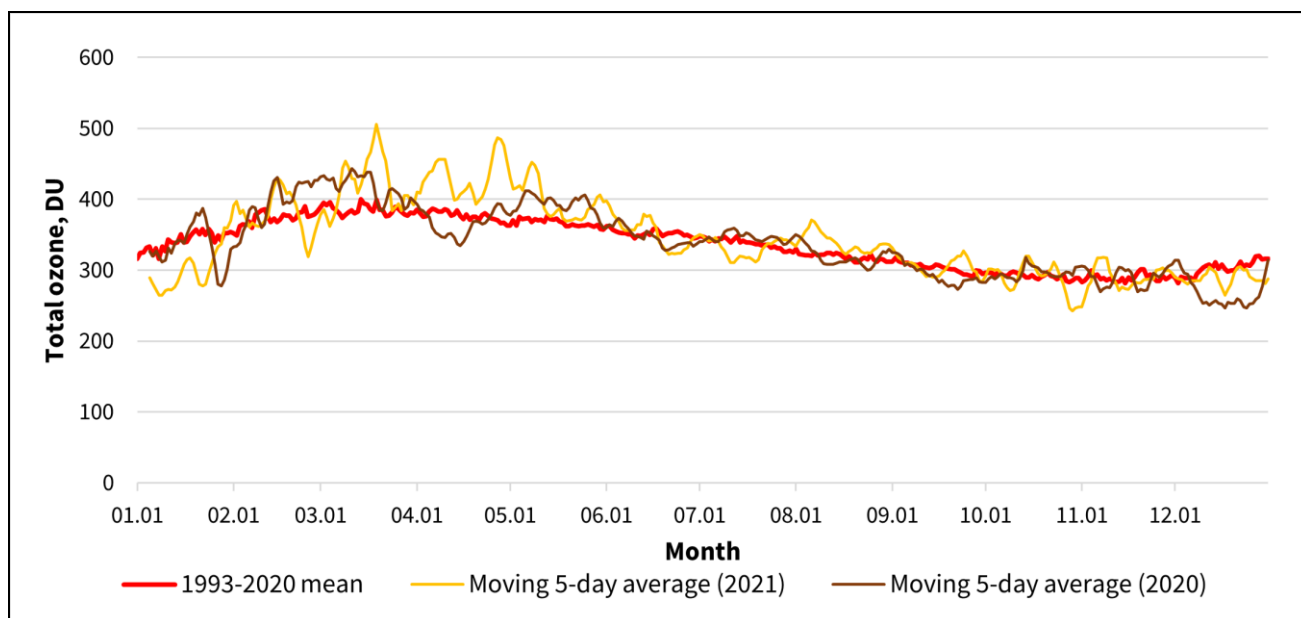


Fig. 3. Total column ozone daily fluctuations in 2020 and 2021

3. THEORY, MODELLING, AND OTHER ZONE RELATED RESEARCH

No research, analysis, or studies have been carried out on this initiative.

4. DISSEMINATION RESULTS

4.1 Data reporting

The ozone measurements data is sent on a regular basis to the World Ozone and Ultraviolet Data Centre (WOUDC) in Toronto, Canada. Since 2004, also the UV-B measurement data from the Kaunas station has been sent to WOUDC each month.

To forecast the UV Index, data from the Human Biometeorology Unit (GF MM) of the German Meteorology Service (DWD) are used with modifications depending on local cloudiness.

4.2 Information to the public

Being conscious that public awareness and exchange of information is important for the successful implementation of the Montreal Protocol, and relevant European and national legislation, the Government of the Republic of Lithuania considers awareness rising as one of the priorities.

The Ministry of Environment of the Republic of Lithuania provides interested parties with consultations and explanations on particular ozone-depleting substances (ODS) related issues, especially with regard to the legal interpretation of the particular provisions of Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer and national legal acts.

Lithuania's population is informed about the level of UV radiation in Lithuania and the risks related to it. In case of significant ozone layer depletion, LHMS originates warnings, which are disseminated through the mass media and via the Internet (www.meteo.lt). Such notices were published 7 times: on the 27th of January 2020, the 8th of April 2020, 20th of November 2020, 5th, 20-21st January 2021, and 25th of October 2021.

Since 2001, LHMS has been providing the UV index forecasts (UVI) for the period May-August. Since 2008, the forecasting period has been extended for the periods April – September. These forecasts continuously are disseminated through the mass media and via the Internet.

Ultraviolet solar radiation data and their analysis as an environmental and health indicator each year (as well as in 2020 and 2021) are presented to the Health Education and Disease Prevention Centre under the Ministry of Health of the Republic of Lithuania.

4.3 Relevant scientific papers

The following advisories and articles on the ozone were prepared in 2020-2021:

Articles on ozone depletion over Lithuania were published on the LHMS website in January, April and November 2020, and in January and October 2021, stating the reasons and providing recommendations.

The following scientific papers were published during the reporting period:

- I. Aukštakojytė Ž., Pociūtė A., Trinkūnienė V. (2020). Melanoma: rizikos veiksniai ir prevencinės priemonės. *Sveikatos mokslai/Health sciences*, 30(4), 81-85, DOI: <https://doi.org/10.35988/sm-hs.2020.101>.
- II. Bimbraitė-Survilienė K., Stankevičius M., Šuštauskaitė S., Gėgotek A., Maruška A., Skrzydlewska E., Barsteigienė Z., Akuneca I., Ragažinskienė O., Lukošius A. (2021). Evaluation of Chemical Composition, Radical Scavenging and Antitumor Activities of *Satureja hortensis* L. Herb Extracts. *Antioxidants*, 10(1), 53, DOI: 10.3390/antiox10010053.
- III. Kiznys D., Vencloviene J. (2021). Statistical Association between Space Weather and Meteorological Variables During Winter in the Baltic Sea Region. *Geomagnetism and Aeronomy*, 61, 117-127, DOI: 10.1134/S0016793221010072.
- IV. Kosaitė M. (2021). Changes of Total Ozone and Ultraviolet Radiation in Lithuania. Master thesis, Vilnius University.
- V. Sherin P., Vyšniauskas A., Lopez-Duarte I., Ogilby R. P., Kuimova K. M. (2021). Visualising UV-A light-induced damage to plasma membranes of eye lens. *Journal of Photochemistry and Photobiology B: Biology*, 225, DOI: 10.1016/j.jphotobiol.2021.112346.
- VI. Vasiliauskienė V., Pačiulienė M., Jasaitis D. (2021). Influence of Meteorological Parameters on the Dynamics of Ozone and Aerosol Particles Near a Road Transport Street. *Water, Air, & Soil Pollution*, 349, 232, DOI: 10.1007/s11270-021-05304-y.

5. PROJECTS, COLLABORATION, TWINNIG AND CAPACITY BUILDING

At present no international or national projects on the study of ozone are conducted