Convention on Long-range Transboundary Air Pollution

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Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

EMEP/CCC report 2/2025

Ozone measurements 2023

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Short summary (English)
This report gives an overview of annual statistics and results from the monitoring programme of ozone in EMEP 2023.

Short summary (Norwegian)
Denne rapporten gir en oversikt over årsstatistikk og resultater fra EMEPs overvåkningsprogram for ozon 2023.

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1 Introduction

Ozone is a natural constituent of the atmosphere and plays a vital role in many atmospheric processes. However, man-made emissions of volatile organic compounds and nitrogen oxides have increased the photochemical formation of ozone in the troposphere. Until the end of the 1960s, the problem was basically believed to be one of the big cities and their immediate surroundings. In the 1970s, however, it was found that the problem of photochemical oxidant formation is much more widespread. The ongoing monitoring of ozone at rural sites throughout Europe shows that episodes of high concentrations of ground-level ozone occur over most parts of the continent every summer. During such episodes, the ozone concentrations can reach values above ambient air quality standards over large regions and lead to adverse effects for human health and vegetation. Historical records of ozone measurements in Europe and North America indicate that in the last part of the nineteenth century, the values were only about half of the average surface ozone concentrations measured in the same regions during the last 10-15 years (Bojkov, 1986; Volz and Kley, 1988).

The formation of ozone is due to a large number of photochemical reactions taking place in the atmosphere and depends on the temperature, humidity and solar radiation as well as the emissions of nitrogen oxides and volatile organic compounds. Together with the non-linear relationships between the primary emissions and the ozone formation, these effects complicate the abatement strategies for ground-level ozone and makes photochemical models crucial in addition to the monitoring data.

The EMEP ozone data from 2023 is presented in this report, which aims to give a short summary of the measurement data. A complete set of data can be downloaded from the web at https://ebas.nilu.no/data-access.

2 Limit values

Ozone concentrations vary widely from region to region, with the time of year, and with time of day. Typically, high concentrations of ozone are observed in periods with anticyclonic conditions. Such episodes may lead to adverse environmental effects such as impact on human health, agricultural crops, forests and materials. National authorities and international organisations have therefore defined limit values for ozone. Within the World Health Organization (WHO), these are called “air quality guidelines”, within EU “target value”, “long-term objective” etc. and within The United Nations Economic Commission for Europe (UNECE) “critical levels”. The values of the various threshold levels vary among these organisations. Additionally, the health-based indicators are normally based on concentration (µg m^{-3}), whereas those related to vegetation are based on mixing ratio (ppb). The conversion between these two units is, however, defined to be a factor 2 (i.e. 2 µg m^{-3} = 1 ppb) both by EU and WHO and should not be calculated based on the real temperature and pressure through the year. An overview of various limit values relevant for vegetation and human health is given in Table 1 and Table 2, respectively.

Table 1: Limit values for the protection of vegetation.

AOT40 (ppb hours)	Period	Reference	Comment
3000	3 months	CLRTAP (2011)	Critical level for crops and natural vegetation 1)
5000	1 April - 1 Oct	CLRTAP (2011)	Critical level for forest 1)
6000	3.5 months	CLRTAP (2011)	Critical level for horticultural crops
9000	1 May – 1 Aug	EU (2008)	EU's target value for vegetation 2,3)
3000	1 May - 1 Aug	EU (2008)	EU's long-term objective for vegetation 2,3)

1) ECE's AOT values should be based on the hours with global incoming radiation > 50 W/m^2
2) EU's AOT values should be based on the period 08-20 CET
3) The EU directive uses $\mu g/m^3$ and a factor 2 $\mu g/m^3$ = 1 ppb

Table 2: Limit values for the protection of human health.

Value ($\mu g/m^3$)	Averaging time (hours)	Ref	Description
180	1	EU (2008)	EU's information threshold
240	1	EU (2008)	EU's alert threshold
120	8 1)	EU (2008)	EU's target value. 8-hour mean value not to be exceeded on more than 25 days per year averaged over 3 years.
120	8 1)	EU (2008)	EU's long-term objective.
100	8 1)	WHO (2021)	WHO's short-term air quality guideline 2)
60	Peak season 3)	WHO (2021)	WHO's long-term air quality guideline

1) The highest 8-hour running mean value for each day through the year calculated such that the 8-hour periods are assigned to the day on which the period ends.
2) Defined as the 99th percentile of the annual distribution of daily maximum 8-hour average concentrations
3) Average of daily maximum 8-hour mean ozone concentration in the six consecutive months with the highest six-month running-average ozone concentration.

Within UNECE, scientific evidence has suggested that AOT40 based critical levels for vegetation (Gothenburg Protocol of 1999) should be replaced by stomatal flux-based critical levels. Flux-based critical levels have been developed to reflect that the real impacts depend on the amount of the pollutant transported into the leaves, whereas AOT40 is only based on the concentration of ozone in the atmosphere at the top of the plant canopy (Mills et al., 2011). Concentration-based critical levels (AOTx) for estimating the risk of damage to vegetation are, however, still included where climatic data or suitable flux models are not available.

The concentration-based critical level is 3000 ppbh (3-months period) for agricultural crops and (semi-)natural vegetation and 5000 ppbh (6-months period) for forest trees. The "Modelling and mapping manual" strongly recommends that the critical levels should be based on the concentrations at the canopy-height, whereas the measurements normally are taken at 2 m height above ground. When meteorological measurements are not available, it is recommended to adjust the measured data to values relevant for the canopy-height by applying a given vertical profile depending on the type of vegetation.

Furthermore, the period for calculation of AOT40 should reflect the true growing season and should thus be adapted to the climate of the various regions in Europe, as specified in the Mapping Manual (CLRTAP, 2011). This leads to large differences in the applied period, from March-May in East Mediterranean to June-August in North Europe, which in turn has major consequences for the calculated AOT values. Since the aim of the present report is to document the general status of the ozone levels and not to provide any effect-based calculations, the same 3-months period (May-July) is used for all stations. This also corresponds to the period stated in the EU directive. Moreover, no adjustment of the measured values to take the canopy-height into account is done in this report. The measurement data are used directly.

In October 2024 the EU adopted the revised Directive on ambient air quality for cleaner air for Europe (AAQD) (EU, 2024). The Directive builds upon the previous ozone directive (2002/3/EC) and the ambient air quality directive (2008/50/EC). The new AAQD defines a number of target values and long-term objectives for the protection of vegetation and human health. The target value for human health is 120 $\mu g/m^3$ (8h mean), which is not to be exceeded on more than 18 days per year averaged over 3 years. EU's long-term objective, to be attained by 2050, is 120 $\mu g/m^3$ (8h mean) not to be exceeded on more than more than 4 days per year.

For protection of vegetation, AOT40 (May-July) should not exceed 18 000 $\mu g/m^3h$ averaged over five years. The long-term objective for the protection of vegetation is defined as an AOT40-value of 6000 $\mu g/m^3h$ for the period May-July. In addition, information should be given to the population when hourly means exceed 180 $\mu g/m^3$ and an alert warning should be issued if hourly means exceed 240 $\mu g/m^3$.

WHO has also defined air quality guidelines for the protection of human health and provided a guideline for ground-level ozone in 2005 (WHO, 2006), revised in 2021 (WHO, 2021). The new guideline for long-term ozone exposure is 60 ug/m^3 as an average of the daily maximum 8h mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration (Table 2). WHO also defined a as indicated in Table 2 along with interim short-term target values.

Additionally, within both WHO and UN-ECE the parameter SOMO35, defined as the sum of maximum 8-hour ozone levels over 35 ppb, is used as an indicator for health effects without any specified threshold level (UNECE/WHO, 2004; WHO, 2008).

Flux-based critical levels for various types of vegetation have been approved for inclusion in the LRTAP Convention's modelling and mapping manual (CLRTAP, 2011). The DO3SE -model is used to estimate the stomatal ozone flux as a function of the ozone concentration at the leaf boundary layer, the transfer of ozone across this boundary layer, the stomatal conductance to ozone and the ozone deposition to the leaf cuticle. The accumulated stomatal flux over a specified time interval is estimated by the parameter PODY (the Phytotoxic Ozone Dose over a threshold flux of Y nmol m-2 PLA s-1|). In this context, Y represents a detoxification threshold, below which it is assumed that any ozone absorbed by the plant will be detoxified. Thus, PODY can be described as the "effective dose" or "effective flux". PODY is the flux-based analogy to the concentration-based AOT.

3 Measurement network

Surface ozone measurements have been a part of the EMEP extended (voluntary) measurement activities since the third phase (1 January 1984–31 December 1986). The systematic collection and checking of data within EMEP, did not start until 1 January 1987. The measurement of ozone data within the EMEP region was a continuation of the OECD's oxidant data collection programme OXIDATE. Ozone data from the OXIDATE-project have been reported in three reports (Grennfelt and Schjoldager, 1984; Grennfelt et al., 1988 and 1989).

This report presents surface ozone data measured at rural background EMEP-sites during 2023, with emphasis on statistical summaries and geographical distributions. Earlier reports are listed in Annex 5.

Table 3 and Figure 1 show the location of the monitoring stations reporting data from whole or part of 2023. In total, 143 stations from 25 different countries reported data. One of these sites (Ispra) is operated by the Commission of the European communities in Italy.

Table 3: List of EMEP ozone monitoring stations in operation 2023.

Code	Station name	Latitude	Longitude	Altitude
AT0002R	Illmitz	47°46'00"N	16°46'00"E	117
AT0005R	Vorhegg	46°40'40"N	12°58'20"E	1020
AT0030R	Pillersdorf bei Retz	48°43'16"N	15°56'32"E	315
AT0032R	Sulzberg	47°31'45"N	09°55'36"E	1020
AT0034G	Sonnblick	47°03'15"N	12°57'29"E	3106
AT0038R	Gerlitzen	46°41'37"N	13°54'54"E	1895
AT0040R	Masenberg	47°20'53"N	15°52'56"E	1170
AT0041R	Haunsberg	47°58'23"N	13°00'58"E	730
AT0042R	Heidenreichstein	48°52'43"N	15°02'48"E	570
AT0043R	Forsthof	48°06'22"N	15°55'10"E	581
AT0045R	Dunkelsteinerwald	48°22'16"N	15°32'48"E	320
AT0046R	Gänserndorf	48°20'05"N	16°43'50"E	161
AT0047R	Stixneusiedl	48°03'03"N	16°40'36"E	240
AT0048R	Zoebelboden	47°50'19"N	14°26'29"E	899
AT0049R	Grebenzen bei St. Lamprecht	47°02'25"N	14°19'48"E	1648
AT0050R	Graz Lustbuehel	47°04'01"N	15°29'37"E	481
BE0001R	Offagne	49°52'40"N	05°12'13"E	430
BE0007R	TMNT Vielsalm	50°18'14"N	06°00'05"E	496
BE0032R	Eupen	50°37'46"N	06°00'04"E	295
BE0035R	Vezin	50°30'12"N	04°59'22"E	160
BG0053R	Rojen peak	41°41'45"N	24°44'19"E	1750
CH0001G	Jungfraujoch	46°32'51"N	07°59'06"E	3578
CH0002R	Payerne	46°48'47"N	06°56'41"E	489
CH0003R	Tänikon	47°28'47"N	08°54'17"E	539
CH0004R	Chaumont	47°02'59"N	06°58'46"E	1137
CH0005R	Rigi	47°04'03"N	08°27'50"E	1031

Code	Station name	Latitude	Longitude	Altitude
CH0053R	Beromünster	47°11'23"N	08°10'32"E	797
CY0002R	Agia Marina Xyliatou / Cyprus Atmospheric Observatory	35°02'17"N	33°03'28"E	532
CZ0001R	Svratouch	49°44'06"N	16°02'03"E	735
CZ0003R	Košetice (NOAK)	49°34'24"N	15°04'49"E	534
CZ0005R	Churanov	49°04'00"N	13°36'00"E	1118
DE0001R	Westerland	54°55'32"N	08°18'35"E	12
DE0002R	Waldhof	52°48'08"N	10°45'34"E	74
DE0003R	Schauinsland	47°54'53"N	07°54'31"E	1205
DE0007R	Neuglobsow	53°08'29"N	13°01'54"E	62
DE0008R	Schmücke	50°39'00"N	10°46'00"E	937
DE0009R	Zingst	54°26'12"N	12°43'30"E	1
DE0054R	Zugspitze-Schneefernhaus	47°24'59"N	10°58'47"E	2671
DK0005R	Keldsnor	54°44'47"N	10°44'10"E	10
DK0010G	Villum Research Station, Station Nord	81°36'00"N	16°40'12"W	20
DK0012R	Risoe	55°41'38"N	12°05'19"E	3
DK0031R	Ulborg	56°17'26"N	08°25'39"E	10
EE0009R	Lahemaa	59°30'00"N	25°54'00"E	32
EE0011R	Vilsandi	58°23'00"N	21°49'00"E	6
ES0001R	San Pablo de los Montes	39°32'49"N	04°21'02"W	923
ES0005R	Noia	42°43'41"N	05°55'25"W	683
ES0006R	Mahón	39°52'31"N	04°18'59"E	78
ES0007R	Víznar	37°14'14"N	03°32'03"W	1258
ES0008R	Niembro	43°26'21"N	04°51'00"W	132
ES0009R	Campisábalos	41°16'27"N	03°08'33"W	1368
ES0010R	Cabo de Creus	42°19'09"N	03°18'57"E	23
ES0011R	Barcarrota	38°28'22"N	06°55'25"W	393
ES0012R	Zarra	39°04'58"N	01°06'04"W	885
ES0013R	Penausende	41°14'20"N	05°53'51"W	985
ES0014R	Els Torms	41°23'38"N	00°44'05"E	488
ES0016R	O Saviñao	42°38'05"N	07°42'17"W	506
ES0017R	Doñana	37°03'07"N	06°33'19"W	5
FI0009R	Utö	59°46'45"N	21°22'38"E	7
FI0018R	Virolahti III	60°31'48"N	27°40'03"E	4
FI0022R	Oulanka	66°19'13"N	29°24'06"E	310
FI0050R	Hyytiälä	61°51'00"N	24°17'00"E	181
FI0096G	Pallas (Sammaltunturi)	67°58'24"N	24°06'58"E	340
FR0008R	Donon	48°30'00"N	07°08'00"E	775
FR0009R	Revin	49°54'00"N	04°38'00"E	390
FR0010R	Morvan	47°16'00"N	04°05'00"E	620
FR0013R	Peyrusse Vieille	43°37'00"N	00°11'00"E	200
FR0014R	Montandon	47°18'00"N	06°50'00"E	836
FR0015R	La Tardière	46°39'00"N	00°45'00"W	133
FR0016R	Le Casset	45°00'00"N	06°28'00"E	1750

Code	Station name	Latitude	Longitude	Altitude
FR0017R	Montfranc	45°48'00"N	02°04'00"E	810
FR0018R	La Coulonche	48°38'00"N	00°27'00"W	309
FR0020R	SIRTA Atmospheric Research Observatory	48°42'32"N	02°08'55"E	162
FR0023R	Saint-Nazaire-le-Désert	44°34'10"N	05°16'44"E	605
FR0025R	Verneuil	46°48'53"N	02°36'36"E	182
FR0028R	Kergoff	48°15'43"N	02°56'38"W	307
FR0030R	Puy de Dôme	45°46'20"N	02°57'54"E	1465
GB0002R	Eskdalemuir	55°18'47"N	03°12'15"W	243
GB0006R	Lough Navar	54°26'35"N	07°52'12"W	126
GB0013R	Yarner Wood	50°35'47"N	03°42'47"W	119
GB0014R	High Muffles	54°20'04"N	00°48'27"W	267
GB0015R	Strath Vaich Dam	57°44'04"N	04°46'28"W	270
GB0031R	Aston Hill	52°30'14"N	03°01'59"W	370
GB0033R	Bush	55°51'44"N	03°12'21"W	180
GB0037R	Ladybower Res.	53°23'56"N	01°45'12"W	420
GB0038R	Lullington Heath	50°47'34"N	00°10'46"E	120
GB0039R	Sibton	52°17'38"N	01°27'47"E	46
GB0043R	Narberth	51°46'54"N	04°41'29"W	160
GB0045R	Wicken Fen	52°17'54"N	00°17'34"W	5
GB0048R	Auchencorth Moss	55°47'32"N	03°14'34"W	260
GB0049R	Weybourne	52°57'02"N	01°07'19"E	16
GB0050R	St. Osyth	51°46'41"N	01°04'56"E	8
GB0052R	Lerwick	60°08'21"N	01°11'07"W	85
GB0053R	Charlton Mackrell	51°03'23"N	02°41'00"W	54
GB1055R	Chilbolton Observatory	51°08'59"N	01°26'18"W	78
GR0001R	Aliartos	38°22'00"N	23°05'00"E	110
GR0002R	Finokalia	35°20'16"N	25°40'10"E	250
HU0002R	K-puszta	46°57'55"N	19°32'42"E	125
HU0017R	Nyirjes	47°53'59"N	19°56'48"E	670
IE0001R	Valentia Observatory	51°56'23"N	10°14'40"W	11
IE0031R	Mace Head	53°19'33"N	09°53'58"W	15
IT0004R	Ispra	45°48'52"N	08°38'09"E	209
IT0009R	Mt Cimone	44°11'36"N	10°42'05"E	2165
IT0014R	Capo Granitola	37°34'16"N	12°39'35"E	5
IT0018R	Lampedusa	35°31'06"N	12°37'50"E	45
IT0019R	Monte Martano	42°48'20"N	12°33'56"E	1090
LT0015R	Preila	55°22'34"N	21°01'50"E	5
LV0010R	Rucava	56°09'43"N	21°10'23"E	18
LV0016R	Zoseni	57°08'07"N	25°54'20"E	188
MK0007R	Lazaropole	41°32'10"N	20°41'38"E	1332
MT0001R	Giordan lighthouse	36°04'20"N	14°13'06"E	167
NL0007R	Eibergen	52°05'00"N	06°34'00"E	20
NL0009R	Kollumerwaard	53°20'02"N	06°16'38"E	1

Code	Station name	Latitude	Longitude	Altitude
NL0010R	Vredepeel	51°32'28"N	05°51'13"E	28
NL0091R	De Zilk	52°18'00"N	04°30'00"E	4
NL0644R	Cabauw Wielsekade	51°58'28"N	04°55'25"E	1
NO0002R	Birkenes II	58°23'19"N	08°15'07"E	219
NO0015R	Tustervatn	65°50'00"N	13°55'00"E	439
NO0039R	Kårvatn	62°47'00"N	08°53'00"E	210
NO0042G	Zeppelin mountain (Ny-Ålesund)	78°54'26"N	11°53'12"E	474
NO0043R	Prestebakke	59°00'00"N	11°32'00"E	160
NO0052R	Sandve	59°12'00"N	05°12'00"E	15
NO0056R	Hurdal	60°22'21"N	11°04'41"E	300
PL0002R	Jarczew	51°48'52"N	21°58'21"E	180
PL0003R	Sniezka	50°44'11"N	15°44'22"E	1603
PL0004R	Leba	54°45'14"N	17°32'03"E	2
PL0005R	Diabla Gora	54°09'00"N	22°04'00"E	157
SE0005R	Bredkälen	63°51'00"N	15°20'00"E	404
SE0013R	Esrange	67°53'00"N	21°04'00"E	475
SE0014R	Råö	57°23'38"N	11°54'50"E	5
SE0018R	Asa	57°09'52"N	14°46'57"E	180
SE0019R	Östad	57°57'09"N	12°24'11"E	65
SE0020R	Hallahus	56°02'34"N	13°08'53"N	190
SE0022R	Norunda Stenen	60°05'09"N	17°30'19"E	45
SE0032R	Norra-Kvill	57°49'00"N	15°34'00"E	261
SE0035R	Vindeln	64°15'00"N	19°46'00"E	225
SE0039R	Grimsö	59°43'41"N	15°28'19"E	132
SI0008R	Iskrba	45°34'00"N	14°52'00"E	520
SI0031R	Zarodnje	46°25'43"N	15°00'12"E	770
SI0032R	Krvavec	46°17'58"N	14°32'19"E	1740
SK0002R	Chopok	48°56'00"N	19°35'00"E	2008
SK0004R	Stará Lesná	49°09'00"N	20°17'00"E	808
SK0006R	Starina	49°03'00"N	22°16'00"E	345
SK0007R	Topolniky	47°57'36"N	17°51'38"E	113

The UV absorption method is the only measurement method in use in 2023. The monitors measure the mixing ratio (in nmol/mol), whereas all data presented in this report are given in µg/m³. The CCC accepts data submissions in both nmol/mol and µg/m³, however, if submitting in µg/m³ the temperature and pressure used to convert from nmol/mol to µg/m³ should be provided in the meta data. The only site not using the standard conditions of 20 C and 1013 hPa is the high-altitude site Jungfraujoch, where annual mean conditions (-8°C, 653 hPa) are used. For sites reporting in mixing ratio, data are converted to ug/m³ using standard conditions, corresponding to a conversion factor of 2.0.

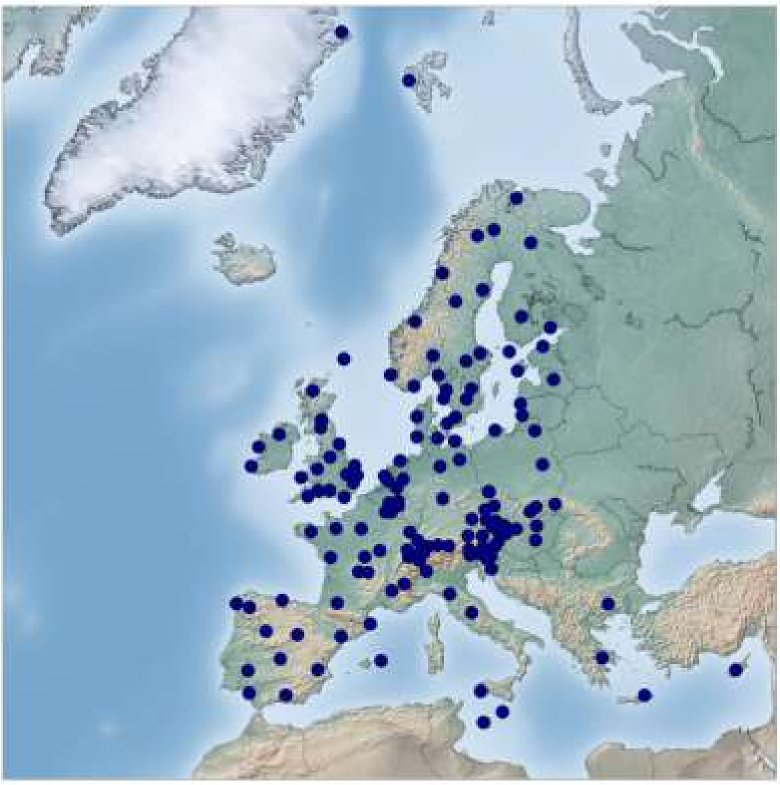

Figure 1: Location of the monitoring stations in 2023

4 Data completeness

The annual means and data capture (number of valid measurements in percent of the total number of measurements) for each station is given in Table A.1, Annex 1. The data capture is in general good, 128 stations have a data capture above 90%.

Missing data in the measurement series may be critical when calculating aggregated ozone metrics, especially in summer when the highest ozone concentrations occur. In particular, calculations of AOT40 values may be strongly affected by missing data, and a correction is necessary in order to obtain comparable calculations. In the mapping of AOT40, a data capture of 85% is required and an adjustment proportional to the number of missing data is applied, i.e. exposure index divided by the fraction of data available. This correction gives a good approximation when the missing data are randomly scattered throughout the dataset, but a better correction is needed for larger gaps in the dataset. Calculations of percentiles are less sensitive to missing data, and a data capture of 75% is regarded as sufficient for the mapping.

5 Concentration summaries and episodes

Ozone episodes are clearly linked to high pressure conditions: high temperatures, increased sunlight and stagnant conditions lead to increased concentrations of ozone precursors (NO_x and VOCs) and higher ozone production.

During 2023, there were two heatwaves in the UK (June and September), leading to values above 180 µg/m^3 at three British sites: Sibton on Sept 9 and Lullington Heath and St. Osyth on June 10-11 (Davison, 2023). A total of 11 sites in UK and Central Europe exceeded EU's information threshold of 180 ug/m3 (Table 4, Figure 2). At two sites, De Zilk in the Netherlands and Ispra in Italy, the number of days exceeding this limit was four. This is far less than previous years, in 2022 26 sites exceeded the EU information threshold (Figure 3), most during the major ozone episode following the European heatwave in mid-July.

Table 4: Maximum concentrations above 180 µg/m^3 and number of days above 180 µg/m^3 2023.

Code	**Station name**	**Maximum µg/m^3**	**Date**	**Number of days > 180 µg/m^3**
NL0091R	De Zilk	198.4	2023-07-08	4
IT0019R	Monte Martano	196.3	2023-07-19	2
AT0046R	Gänserndorf	189.3	2023-08-22	1
IT0004R	Ispra	188.5	2023-07-11	4
FR0020R	SIRTA Atmospheric Research Observatory	188.0	2023-06-16	3
GB0039R	Sibton	185.8	2023-09-09	1
GB0050R	St. Osyth	184.1	2023-06-11	2
GB0038R	Lullington Heath	181.4	2023-06-10	1
IT0009R	Monte Cimone	180.8	2023-06-23	1
AT0005R	Vorhegg	180.4	2023-06-22	1
ES0001R	San Pablo de los Montes	180.1	2023-06-28	1

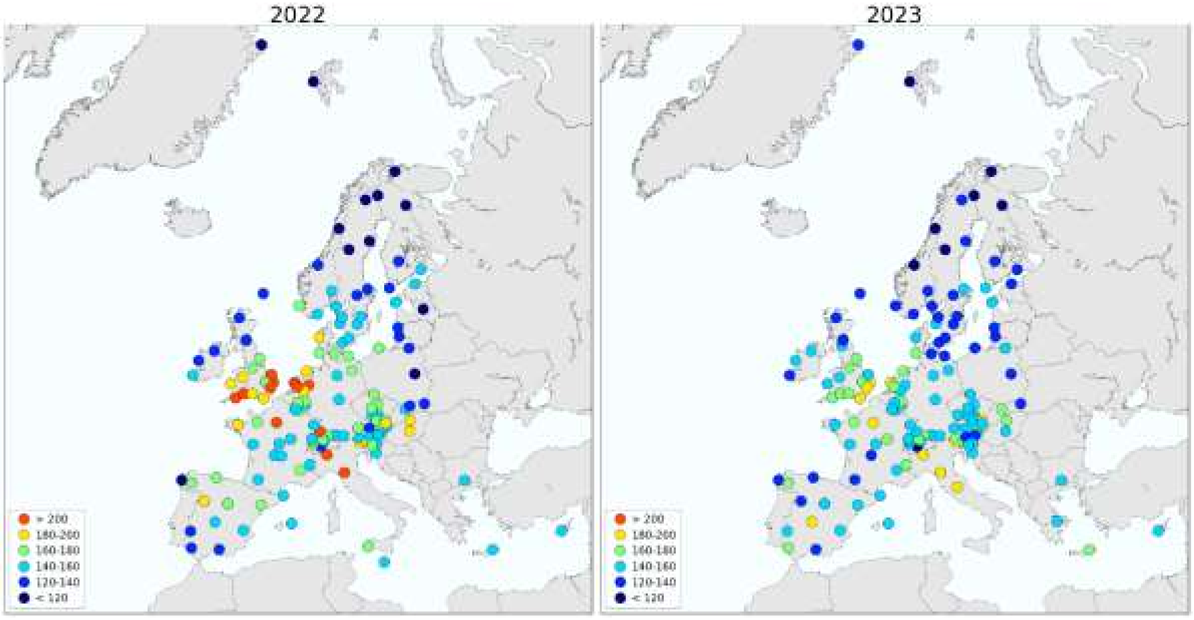

Figure 2: Maximum concentration 2022 (left) and 2023 (right). Unit µg/m³.

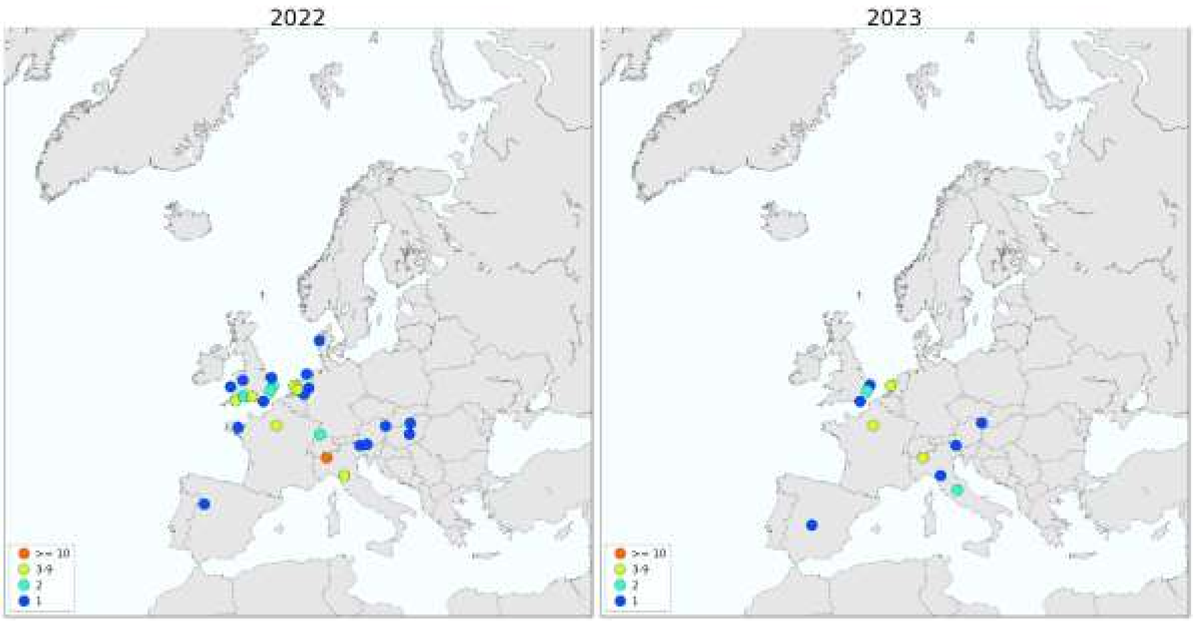

Figure 3: Number of days with maximum ozone concentration exceeding 180 µg/m³ *2022 (left) and 2023 (right). Unit: days.*

Graphical distributions of the 95- and 99-percentile for stations with data capture higher than 75% are shown in Figure 4. The lowest values are found in Scandinavia, Ireland and the UK, where the 95-percentiles are below 90 µg/m³. The concentrations are higher in France, Poland and the Baltics, where the 95-percentiles generally ranges from 100-120 µg/m³, and at its highest in the Southeastern parts of Europe and around the Mediterranean, where the 95-percentile values are above 120 µg/m³.

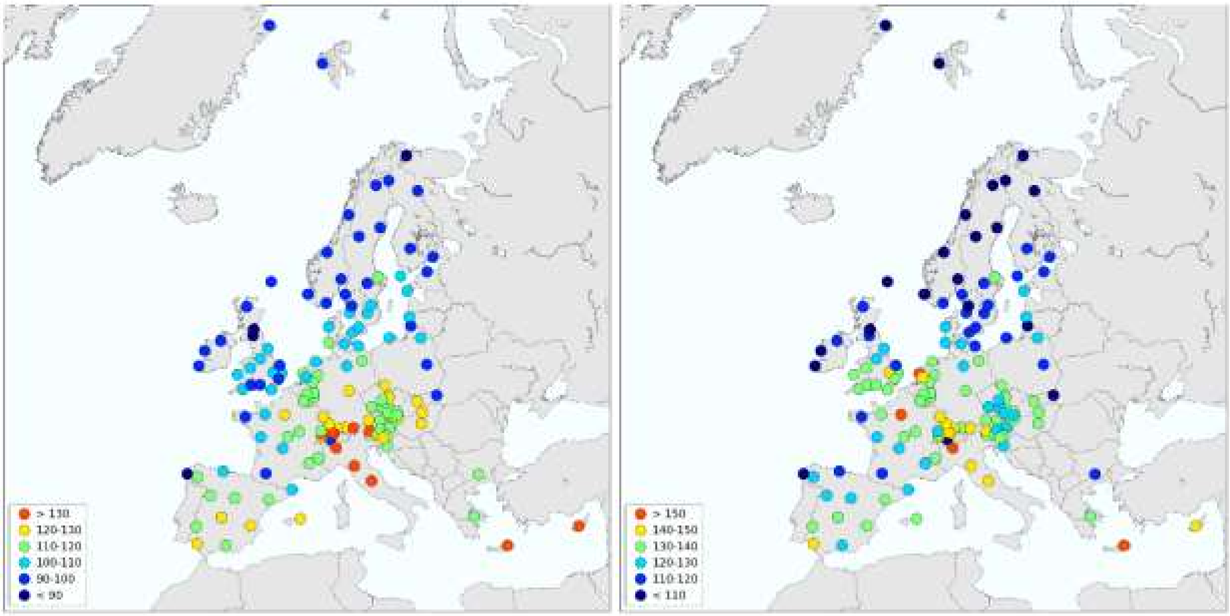

Figure 4: Hourly 95-percentile (left) and 99-percentile (right) April-September 2023. Unit µg/m³.

6 Calculation of AOT40

AOT40 is calculated as the accumulated sum of ozone over the threshold value of 40 ppb during sunlight hours (08-20 CET) for two periods, May-July and April-September (Table A.1, Annex 1).

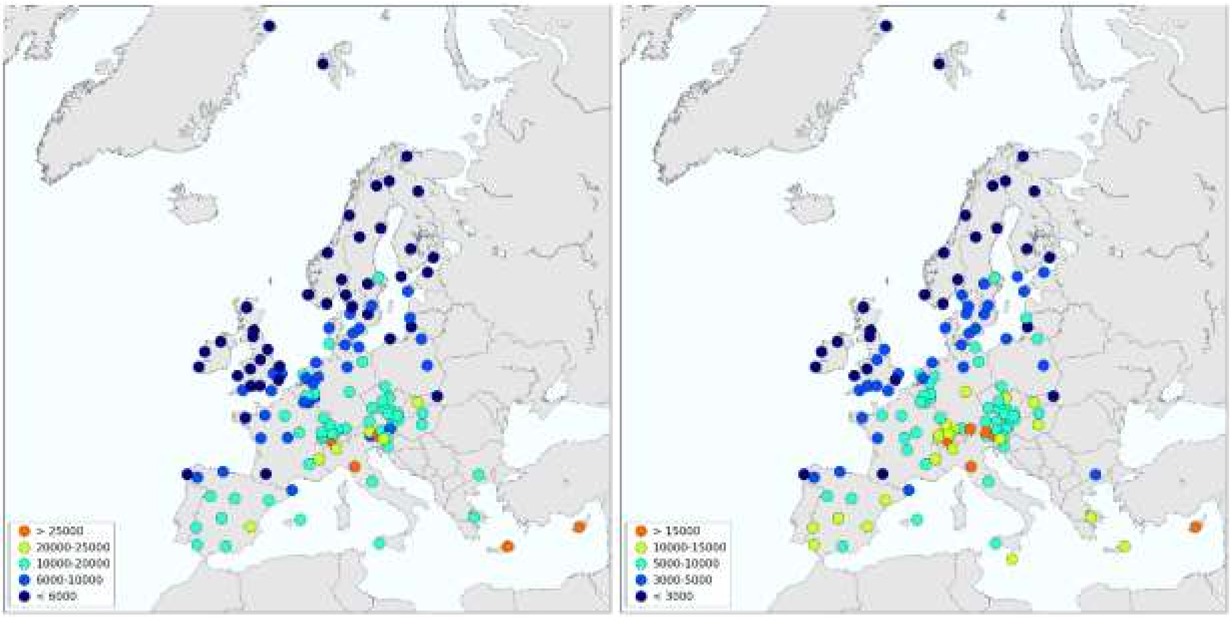

Figure 5: AOT40 2023 08-20 CET; April-September (left) and May-July (right). Unit: ppb hours.

The maps of AOT40 (Figure 5) show an increasing gradient from north to south and west to east with low values in Northern Europe and the highest values in Central Europe and the Mediterranean. The critical level for forest of 5000 ppbh for 6-months AOT is exceeded at most sites except Northern Europe, and several sites in the Mediterranean and Central Europe exceed 25 000 ppbh. The 3-month AOT40 shows the same pattern of exceedances, and the critical level for crops (3000 ppbh) reaches as high as 15000 ppbh at some sites.

7 Update

The data compiled in this report represent the quality assured and quality-controlled data at present. If errors are detected in the future, the data will be corrected in the database. It is important that users make certain they have access to the most recent version of the data. For the data presented here, the latest alteration was August 2025.

All EMEP measurement data can be downloaded at http://ebas.nilu.no/data-access or sent upon request to ebas@nilu.no. Information on EMEP and the measurement network are available at http://www.emep.int and http://www.nilu.no/projects/ccc.

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9 Acknowledgements

A large number of co-workers in participating countries have been involved in the many steps of collection of EMEP's measurement data. A list of participating institutes can be seen below. The staff at CCC wishes to express their gratitude and appreciation for continued good co-operation and efforts.

10 List of participating institutions

Country	Institution
Austria	Umweltbundesamt Provincial Government of Tyrol Provincial Government of Carinthia Environment Institute Vorarlberg Provincial Government Styria Provincial Government Salzburg Provincial Government Lower Austria
Belgium	Belgian Interregional Environment Agency (IRCEL – CELINE) Institut Scientifique de Service Public (ISSeP)
Bulgaria	Executive Environment Agency of Bulgaria
Commission of the European Communities	Joint Research Centre (EC-JRC)
Cyprus	Ministry of Labour and Social Insurance
Czech Republic	Czech Hydrometeorological Institute
Denmark	Department of Environmental Science, Aarhus University
Estonia	Estonian Environmental Research Centre
Finland	Finnish Meteorological Institute (FMI)
France	Institut Mines Telecom Lille Douai Laboratoire des Sciences du Climat et de l'Environnement (IPSL-CEA-CNRS) Laboratoire de Meteorologie Physique (CNRS-LaMP)
Germany	Umweltbundesamt
Greece	University of Crete Ministry of the Environment and Energy
Hungary	Hungarian Meteorological Service
Ireland	Environmental Protection Agency (EPA) Ricardo
Italy	Institute of Atmospheric Sciences and Climate (ISAC-CNR) Arpa Umbria
Latvia	Latvian Environment Geology and Meteorology Agency (LEGMC)

Country	Institution
Lithuania	SRI Center for Physical Sciences and Technology (CPST)
Macedonia	Ministry of Environment and Physical Planning
Malta	Department of Geoscience, University of Malta
Netherlands	National Institute for Public Health and the Environment (RIVM)
Norway	The climate and environmental research institute NILU
Poland	Institute of Meteorology and Water Management Institute of Environmental Protection
Slovakia	Slovak Hydrometeorological Institute
Slovenia	Slovenian Environment Agency
Spain	Ministerio de Medio Ambiente
Sweden	Swedish Environmental Research Institute (IVL)
Switzerland	Swiss Federal Laboratory of Materials Science and Technology (EMPA)
United Kingdom	Ricardo

Annex 1 Statistical summary 2023

Table A.1: Statistical summary of ozone data 2023.

		Annual mean ug/m³	Data capture %	95-perc Apr-Sep ug/m³	99-perc Apr-Sep ug/m³	Capture Apr-Sep %	Max ug/m³	Date for maximum	AOT40 crops ppbh	Capture AOT40c %	AOT40c corr ppbh	AOT40 forest ppbh	Capture AOT40f %	AOT40f corr ppbh
AT0002R	Illmitz	64.2	94.1	120.6	138.3	95.2	164.7	2023-08-21	9276	95.0	9763	15710	94.8	16578
AT0005R	Vorhegg	70.3	91.8	112.6	136.4	88.6	180.4	2023-06-22	5439	94.4	5762	7971	88.4	9013
AT0030R	Pillersdorf bei Retz	67.6	94.0	118.2	132.4	92.7	158.8	2023-06-20	7287	89.3	8159	12906	92.2	13996
AT0032R	Sulzberg	78.2	95.0	126.9	139.3	95.0	153.6	2023-06-17	9482	98.7	9603	13209	98.8	13373
AT0034G	Sonnblick	97.8	94.4	131.0	146.6	94.4	168.5	2023-09-05	14179	92.6	15317	23380	93.9	24888
AT0038R	Gerlitzen	95.4	90.2	128.5	139.9	91.1	165.0	2023-07-12	15001	98.6	15222	24742	98.1	25225
AT0040R	Masenberg	79.8	94.9	119.2	130.2	94.9	146.5	2023-06-19	7779	93.9	8282	13063	94.9	13765
AT0041R	Haunsberg	75.1	95.8	122.7	138.8	95.8	158.5	2023-08-22	9019	95.9	9402	12874	95.5	13482
AT0042R	Heidenreichstein	62.8	95.4	115.7	127.3	95.4	141.6	2023-06-22	7577	95.2	7959	12043	95.2	12648
AT0043R	Forsthof	70.4	92.9	120.0	133.0	90.6	172.4	2023-09-12	5804	85.3	6803	11095	90.0	12330
AT0045R	Dunkelsteinerwald	59.5	95.5	114.8	128.6	95.5	141.1	2023-06-22	6716	95.4	7041	11275	95.4	11819
AT0046R	Gänserndorf	60.4	95.4	119.7	134.1	95.5	189.3	2023-08-22	8690	95.4	9111	14446	95.4	15142
AT0047R	Stixneusiedl	62.5	94.3	114.6	129.5	93.1	146.0	2023-06-19	6008	89.9	6680	11177	92.7	12061
AT0048R	Zoebelboden	73.7	82.5	114.1	131.7	77.7	147.0	2023-06-18	5904	95.7	6173	6843	77.6	8819
AT0049R	Grebenzen bei St. Lamprecht	85.2	93.3	116.4	127.2	91.7	139.9	2023-06-18	7408	94.0	7879	11357	91.1	12464
AT0050R	Graz Lustbuehel	58.6	95.5	111.1	123.3	95.4	139.0	2023-08-21	5025	94.8	5298	8395	95.2	8820
BE0001R	Offagne	59.1	96.3	111.5	130.1	97.4	150.0	2023-06-17	6407	97.1	6598	8005	96.9	8257
BE0007R	TMNT09 Vielsalm	54.2	95.9	111.0	130.5	96.8	151.5	2023-06-17	5998	95.8	6259	7675	96.3	7969
BE0032R	Eupen	57.2	96.0	117.5	137.7	96.9	167.0	2023-06-17	6924	97.5	7105	9965	96.6	10317
BE0035R	Vezin	56.4	94.3	114.0	138.6	96.5	159.0	2023-06-12	7161	97.4	7354	10294	96.4	10673
BG0053R	Rojen peak	80.5	94.9	110.7	118.5	95.2	147.8	2023-08-05	4663	99.0	4710	10579	99.1	10676
CH0001G	Jungfraujoch	72.9	96.9	99.6	105.8	97.1	118.7	2023-07-15	19120	96.6	19783	32239	96.5	33410
CH0002R	Payerne	58.9	99.1	124.4	138.2	99.1	149.7	2023-06-25	9889	98.3	10062	15232	98.3	15500
CH0003R	Tänikon	59.4	99.5	125.2	142.9	99.3	171.8	2023-06-17	10711	99.4	10779	14912	98.9	15084
CH0004R	Chaumont	82.6	99.4	133.1	141.2	99.4	149.5	2023-06-14	11262	98.7	11407	18395	98.7	18633
CH0005R	Rigi	80.5	98.8	132.4	143.5	99.2	155.0	2023-06-08	11458	98.4	11648	17606	98.4	17891
CH0053R	Beromünster	74.4	99.5	132.9	146.0	99.5	173.3	2023-08-24	11322	99.1	11425	17782	99.1	17945
CY0002R	Agia Marina Xyliatou / Cyprus Atmospheric Observatory	98.8	97.5	135.3	143.5	98.0	157.2	2023-06-27	16951	97.6	17360	30983	97.6	31750
CZ0001R	Svratouch	71.8	93.7	122.5	134.1	94.3	145.8	2023-06-20	9881	97.6	10120	16181	98.2	16473
CZ0003R	Kosetice (NAOK)	66.4	93.9	113.7	125.9	92.8	145.8	2023-06-19	7551	94.3	8008	12472	95.9	13012
CZ0005R	Churanov	74.8	95.1	119.7	129.3	95.2	149.0	2023-06-26	9559	98.6	9691	14185	99.0	14335
DE0001R	Westerland	69.9	95.6	111.2	129.9	91.6	168.8	2023-09-09	4945	83.5	5921	9295	91.0	10216
DE0002R	Waldhof	55.5	95.1	104.2	125.4	94.6	150.7	2023-09-10	3004	93.6	3210	7086	94.0	7536
DE0003R	Schauinsland	82.0	93.6	129.0	142.0	93.8	158.4	2023-06-17	10253	95.4	10750	15278	94.4	16193
DE0007R	Neuglobsow	56.8	99.1	110.4	130.0	98.6	156.0	2023-09-10	6884	96.9	7103	11104	98.0	11336
DE0008R	Schmücke	75.5	94.9	125.0	134.7	94.5	151.2	2023-06-19	10847	92.0	11786	15830	93.9	16859
DE0009R	Zingst	63.8	95.0	105.4	119.9	95.0	136.5	2023-07-15	4974	94.7	5254	8386	94.1	8910
DE0054R	Zugspitze-Schneefernerhaus	96.6	90.9	133.1	143.2	82.7	156.6	2023-06-17	15705	100.0	15705	21525	83.1	25900

		Annual mean ug/m^3	Data capture %	95-perc Apr-Sep ug/m^3	99-perc Apr-Sep ug/m^3	Capture Apr-Sep %	Max ug/m^3	Date for maximum	AOT40 crops ppbh	Capture AOT40c %	AOT40c corr ppbh	AOT40 forest ppbh	Capture AOT40f %	AOT40f corr ppbh
DK0005R	Keldsnor	67.1	90.6	104.3	120.8	91.2	133.3	2023-07-15	4117	99.4	4143	6737	99.4	6780
DK0010G	Villum Research Station	64.6	90.3	95.0	109.6	90.3	133.3	2023-07-15	1181	97.0	1217	2846	98.2	2897
DK0012R	Risø	64.6	91.3	104.6	117.4	91.3	127.3	2023-05-12	4603	99.2	4641	7375	99.4	7418
DK0031R	Ulborg	66.7	89.9	104.6	120.2	88.4	154.6	2023-09-09	3725	99.5	3745	6595	96.2	6854
EE0009R	Lahemaa	53.1	99.1	99.3	119.9	99.8	129.3	2023-08-08	3094	99.9	3096	4873	99.6	4893
EE0011R	Vilsandi	67.8	99.6	106.6	122.4	99.7	147.8	2023-09-12	4066	98.9	4111	6396	99.4	6434
ES0001R	San Pablo de los Montes	84.6	98.6	122.1	131.7	98.6	180.1	2023-06-28	11266	100.0	11266	19821	100.0	19821
ES0005R	Noia	59.3	98.6	81.7	102.9	99.3	139.3	2023-08-23	50	100.0	50	523	100.0	523
ES0006R	Mahón	86.1	93.6	121.0	131.1	93.6	146.9	2023-06-18	8909	100.0	8909	16666	100.0	16666
ES0007R	Víznar	73.7	98.3	110.9	125.0	98.5	137.8	2023-08-11	6721	100.0	6721	12233	100.0	12233
ES0008R	Niembro	72.9	97.9	106.7	116.6	97.9	131.9	2023-03-29	3081	100.0	3081	7031	100.0	7031
ES0009R	Campisabalos	69.9	97.5	110.1	125.5	97.3	150.1	2023-07-17	6401	100.0	6401	11987	100.0	11987
ES0010R	Cabo de Creus	74.3	94.4	105.7	121.2	98.0	147.4	2023-06-16	3082	100.0	3082	6898	100.0	6898
ES0011R	Barcarrota	66.4	98.6	119.3	131.9	98.3	157.8	2023-06-28	10508	100.0	10508	18557	100.0	18557
ES0012R	Zarra	80.7	97.3	122.4	136.0	98.9	148.3	2023-06-27	12117	100.0	12117	20408	100.0	20408
ES0013R	Penausende	73.3	98.0	111.7	122.8	98.2	132.7	2023-06-24	6698	100.0	6698	11389	100.0	11389
ES0014R	Els Torms	78.1	98.7	119.1	130.6	98.9	141.4	2023-08-23	10053	100.0	10053	19132	100.0	19132
ES0016R	O Saviñao	69.4	97.5	110.6	125.6	98.0	168.5	2023-08-23	4842	100.0	4842	8235	100.0	8235
ES0017R	Doñana	65.1	95.1	125.4	142.1	96.9	161.9	2023-04-28	12070	100.0	12070	18484	100.0	18484
FI0009R	Utö	68.3	96.7	102.8	117.0	98.1	149.1	2023-06-17	3886	98.2	3958	5817	97.4	5975
FI0018R	Virolahti III	53.8	99.7	96.1	113.5	99.6	125.3	2023-05-12	2366	99.1	2388	4072	99.2	4106
FI0022R	Oulanka	58.1	99.8	94.2	104.2	99.8	115.2	2023-05-10	1178	99.6	1182	2875	99.7	2882
FI0050R	Hyytiälä	60.4	93.7	97.2	110.0	94.5	120.0	2023-05-15	1838	97.3	1890	3254	94.7	3437
FI0096G	Pallas (Sammaltunturi)	66.7	99.7	97.7	106.3	99.6	119.7	2023-05-16	1598	99.6	1603	3370	99.5	3386
FR0008R	Donon	69.8	96.9	124.9	140.9	96.4	159.0	2023-06-16	8394	98.1	8556	11469	97.8	11725
FR0009R	Revin	62.3	99.5	112.9	134.9	99.5	155.0	2023-06-16	6538	98.4	6646	8304	98.9	8396
FR0010R	Morvan	69.7	97.9	119.5	138.9	98.5	172.0	2023-06-15	8758	98.8	8862	12889	98.2	13122
FR0013R	Peyrusse Vieille	64.6	98.7	99.0	111.9	98.2	138.9	2023-06-16	1985	97.0	2046	4357	98.4	4429
FR0014R	Montandon	60.2	94.8	115.9	128.9	90.1	140.9	2023-06-07	5690	84.6	6726	9107	90.3	10080
FR0015R	La Tardière	58.1	94.3	105.0	121.1	97.6	147.9	2023-06-14	4341	99.1	4381	6203	97.4	6371
FR0016R	Le Casset	90.9	90.8	119.9	133.7	91.4	169.0	2023-06-12	10800	90.1	11983	19573	91.5	21394
FR0017R	Montfranc	74.3	89.0	108.0	120.9	83.3	131.9	2023-09-10	3074	71.4	4307	6648	84.2	7891
FR0018R	La Coulonche	68.2	98.3	108.0	132.9	98.4	173.0	2023-06-15	5144	97.7	5263	7366	97.8	7534
FR0020R	SIRTA Atmospheric Research Observatory	68.1	95.4	122.6	154.9	98.8	188.0	2023-06-16	9298	97.6	9531	13800	98.5	14011
FR0023R	Saint-Nazaire-le-Désert	59.3	90.9	110.9	127.9	98.9	157.0	2023-07-11	5943	99.8	5954	11266	99.8	11286
FR0025R	Verneuil	59.6	99.1	110.9	130.6	98.7	140.9	2023-06-14	5866	97.3	6030	9203	98.0	9391
FR0028R	Kergoff	63.8	93.4	100.0	116.4	94.6	159.0	2023-06-14	2928	91.8	3187	4508	94.4	4773
FR0030R	Puy de Dôme	83.9	74.7	129.1	142.0	58.2	152.6	2023-06-15	7054	85.7	8232	8708	57.1	15261
GB0002R	Eskdalemuir	58.2	96.8	89.3	119.1	94.0	141.7	2023-06-12	2145	89.8	2390	2670	94.1	2837
GB0006R	Lough Navar	50.5	99.7	94.9	114.9	99.7	150.1	2023-06-16	2072	100.0	2072	3706	99.6	3721
GB0013R	Yarner Wood	67.8	98.8	108.0	136.8	98.9	168.3	2023-06-15	4932	98.8	4991	7700	98.5	7814
GB0014R	High Muffles	62.7	99.2	105.0	129.7	99.2	176.4	2023-06-12	3048	99.6	3059	5303	99.0	5355
GB0015R	Strath Vaich Dam	68.5	88.5	99.2	115.1	89.0	138.7	2023-06-14	2551	99.1	2575	4575	88.7	5158

		Annual mean ug/m³	Data capture %	95-perc Apr-Sep ug/m³	99-perc Apr-Sep ug/m³	Capture Apr-Sep %	Max ug/m³	Date for maximum	AOT40 crops ppbh	Capture AOT40c %	AOT40c corr ppbh	AOT40 forest ppbh	Capture AOT40f %	AOT40f corr ppbh
GB0031R	Aston Hill	65.1	79.2	102.2	134.2	99.0	154.3	2023-06-12	2765	99.9	2768	4717	98.7	4777
GB0033R	Bush	60.4	99.7	89.8	105.7	99.7	126.6	2023-09-08	1387	99.8	1390	2495	99.5	2508
GB0037R	Ladybower Res.	61.9	99.4	100.3	128.5	99.7	164.5	2023-06-12	3439	100.0	3439	5446	99.5	5471
GB0038R	Lullington Heath	65.2	99.2	103.8	139.6	99.8	181.4	2023-06-10	3365	99.8	3371	6103	99.7	6122
GB0039R	Sibton	59.7	99.2	100.8	137.7	99.5	185.8	2023-09-09	3352	99.7	3361	6676	99.5	6707
GB0043R	Narberth	70.3	97.7	102.4	130.9	99.2	158.1	2023-06-15	2967	99.8	2972	5322	99.1	5371
GB0045R	Wicken Fen	57.5	93.9	106.0	147.1	89.3	161.9	2023-06-12	5602	80.0	7004	8795	88.9	9889
GB0048R	Auchencorth Moss	58.6	99.4	88.0	105.0	99.0	129.6	2023-06-13	1357	99.9	1359	2099	98.8	2125
GB0049R	Weybourne	61.8	94.5	97.6	115.0	89.2	144.5	2023-06-11	2022	80.4	2514	3398	88.8	3827
GB0050R	St. Osyth	58.6	96.9	97.6	131.4	96.8	184.1	2023-06-11	2964	99.5	2977	5423	96.9	5599
GB0052R	Lerwick	70.1	85.6	97.4	106.2	78.4	126.3	2023-07-08	1036	58.7	1765	3216	78.1	4121
GB0053R	Charlton Mackrell	60.5	96.0	97.1	133.7	96.5	172.1	2023-06-14	3058	97.3	3144	4312	95.1	4535
GB1055R	Chilbolton Observatory	57.2	98.6	97.9	137.9	99.6	164.9	2023-06-14	3415	99.1	3446	5240	99.3	5276
GR0001R	Aliartos	58.5	94.0	118.0	130.0	96.2	152.0	2023-08-29	10262	93.6	10967	17467	95.4	18309
GR0002R	Finokalia	95.7	83.0	137.4	150.0	90.9	172.2	2023-07-15	12123	85.8	14133	24340	89.8	27119
HU0002R	K-puszta	55.3	97.2	123.8	135.7	95.5	156.5	2023-08-24	9841	91.3	10778	18097	95.4	18969
HU0017R	Nyirjes	81.8	94.5	125.3	134.3	92.5	173.5	2023-08-22	9357	98.1	9538	16626	92.0	18066
IE0001R	Valentia Observatory	68.3	99.9	94.3	107.4	99.8	124.7	2023-06-08	803	100.0	803	2356	99.7	2363
IE0031R	Mace Head	72.7	99.7	95.5	102.9	99.6	141.2	2023-01-11	1331	99.8	1334	3062	99.7	3072
IT0004R	Ispra	50.8	97.9	137.0	156.9	100.0	188.5	2023-07-11	13916	100.0	13916	23048	100.0	23048
IT0009R	Monte Cimone	99.3	97.6	134.1	143.9	98.2	180.8	2023-06-23	14887	98.5	15120	29376	98.1	29949
IT0014R	Capo Granitola	80.3	53.5	113.3	129.2	57.9	144.9	2023-06-18	7492	88.6	8454	11211	91.6	12240
IT0018R	Lampedusa	88.7	58.0	113.3	124.5	66.6	166.8	2023-08-27	2887	44.7	6452	10649	66.5	16006
IT0019R	Monte Martano	63.2	91.7	130.3	143.8	96.0	196.3	2023-07-19	8386	93.7	8954	17959	95.5	18798
LT0015R	Preila	56.5	99.2	94.5	105.7	100.0	125.3	2023-06-21	1567	100.0	1567	2569	100.0	2569
LV0010R	Rucava	64.1	87.8	108.4	122.0	89.0	134.9	2023-06-21	5085	98.8	5146	7990	99.0	8075
LV0016R	Zoseni	43.4	23.2	-	-	0.0	77.6	2023-12-12	-	-	-	-	-	-
MT0001R	Giordan Lighthouse	95.5	53.4	121.5	133.5	58.2	157.0	2023-06-18	11511	89.6	12849	15376	58.7	26196
NL0007R	Eibergen	49.9	97.6	111.7	139.1	96.6	159.9	2023-06-18	6016	97.6	6161	8300	97.2	8537
NL0009R	Kollumerwaard	60.8	98.3	103.3	136.7	98.8	166.9	2023-09-09	3770	99.6	3783	6817	99.6	6842
NL0010R	Vredepeel	52.2	98.4	110.7	139.4	98.2	150.2	2023-06-09	6102	98.4	6203	8568	98.8	8671
NL0091R	De Zilk	62.1	97.5	113.7	150.7	96.3	198.4	2023-07-08	5946	97.9	6072	10223	96.9	10554
NL0644R	Cabauw Wielsekade	50.8	97.4	105.2	140.7	96.8	174.0	2023-09-08	4582	95.6	4795	6818	97.7	6980
NO0002R	Birkenes II	62.7	98.0	95.5	110.7	97.4	125.0	2023-05-14	2884	99.5	2897	4173	97.1	4298
NO0015R	Tustervatn	65.6	99.3	94.4	100.5	99.3	115.8	2023-09-10	805	99.2	811	2573	99.2	2594
NO0039R	Kårvatn	54.7	98.2	97.3	105.6	99.2	118.6	2023-05-14	1922	99.4	1935	3897	99.0	3939
NO0042G	Zeppelin mountain (Ny-Ålesund)	70.2	99.2	93.9	104.2	99.2	111.8	2023-04-14	478	99.0	482	1765	98.6	1791
NO0043R	Prestebakke	60.5	98.2	98.6	115.1	98.9	132.6	2023-05-13	3915	98.9	3958	5111	98.9	5170
NO0047R	Svanvik	55.1	95.8	89.0	98.8	95.5	111.1	2023-05-16	669	96.7	691	1614	95.5	1689
NO0052R	Sandve	63.6	99.3	92.8	105.0	99.4	134.9	2023-09-11	1396	99.1	1409	2810	98.9	2843
NO0056R	Hurdal	58.2	99.0	95.2	108.3	99.3	122.9	2023-06-14	2737	99.1	2762	3625	99.0	3663

		Annual mean ug/m³	Data capture %	95-perc Apr-Sep ug/m³	99-perc Apr-Sep ug/m³	Capture Apr-Sep %	Max ug/m³	Date for maximum	AOT40 crops ppbh	Capture AOT40c %	AOT40c corr ppbh	AOT40 forest ppbh	Capture AOT40f %	AOT40f corr ppbh
PL0002R	Jarczew	49.4	98.7	99.4	114.9	99.3	136.6	2023-09-13	3742	99.8	3749	6078	99.4	6117
PL0003R	Sniezka	79.0	97.7	124.6	136.1	97.4	147.4	2023-05-23	7121	99.6	7147	12949	97.8	13244
PL0004R	Leba	57.9	99.9	100.5	115.3	100.0	133.8	2023-09-11	3306	100.0	3306	5391	99.9	5396
PL0005R	Diabla Gora	56.0	98.8	107.8	123.5	99.2	211.5	2023-03-04	5083	99.0	5134	9376	99.1	9462
SE0005R	Bredkälen	63.3	97.0	98.0	107.9	99.1	117.7	2023-05-11	2265	99.5	2277	4092	99.6	4107
SE0013R	Esrange	65.4	99.5	98.2	105.8	99.6	120.9	2023-05-15	1748	99.7	1753	3820	99.8	3829
SE0014R	Råö	64.9	99.7	103.5	118.7	99.7	140.5	2023-07-15	4225	99.7	4237	6798	99.5	6835
SE0018R	Asa	54.9	99.1	101.3	115.3	98.6	136.1	2023-09-10	4006	97.3	4117	5801	98.3	5900
SE0019R	Östad	53.0	99.4	97.6	109.9	99.6	124.7	2023-05-12	3329	99.7	3338	4639	99.8	4650
SE0020R	Hallahus	62.2	99.2	106.3	119.4	98.6	136.7	2023-07-15	4800	99.8	4809	7612	98.3	7742
SE0022R	Norunda Stenen	60.7	97.2	116.9	139.0	100.0	149.5	2023-05-12	7988	100.0	7988	11269	100.0	11269
SE0032R	Norra-Kvill	63.1	98.8	105.7	118.3	99.8	133.7	2023-09-10	4337	99.9	4340	6620	99.6	6647
SE0035R	Vindeln	58.0	98.3	96.7	108.4	97.2	123.8	2023-05-14	2268	96.2	2357	4001	97.4	4107
SE0039R	Grimsö	55.6	98.3	96.8	112.9	98.5	123.3	2023-05-11	3355	99.7	3364	4361	99.5	4381
SI0008R	Iskrba	52.0	99.9	115.7	127.9	100.0	142.1	2023-07-11	8201	100.0	8201	14888	100.0	14888
SI0031R	Zarodnje	75.7	93.6	118.9	132.1	92.4	153.6	2023-07-11	6646	89.0	7464	11700	89.9	13016
SI0032R	Krvavec	92.2	100.0	126.9	138.5	100.0	159.6	2023-08-24	12921	100.0	12921	22280	100.0	22280
SK0002R	Chopok	88.9	93.1	126.0	134.0	90.7	164.0	2023-09-13	11936	98.7	12089	20495	95.0	21576
SK0004R	Stará Lesná	48.4	61.4	95.5	105.0	32.5	122.0	2023-04-06	-	-	-	1345	33.7	3997
SK0006R	Starina	53.1	94.4	96.0	108.0	93.5	131.0	2023-07-09	2749	93.9	2927	4646	93.4	4972
SK0007R	Topolniky	40.4	45.9	95.0	121.4	16.3	136.0	2023-09-12	-	-	-	850	16.4	5185

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https://doi.org/10.48597/HUCZ-EMDN Ozone at Sonnblick
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https://doi.org/10.48597/8X4G-6SVJ Ozone at Masenberg
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https://doi.org/10.48597/CNJU-9PX7 Ozone at Forsthof
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https://doi.org/10.48597/ACAB-UK2U   Ozone at Verneuil
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https://doi.org/10.48597/8E8E-W724   Ozone at Weybourne
https://doi.org/10.48597/6CBV-4V4K   Ozone at St. Osyth
https://doi.org/10.48597/VZEP-8CY7   Ozone at Lerwick
https://doi.org/10.48597/6FE3-MNQZ   Ozone at Charlton Mackrell
https://doi.org/10.48597/7NWT-EK9G   Ozone at Chilbolton Observatory
https://doi.org/10.48597/MR3T-A56S   Ozone at Aliartos
https://doi.org/10.48597/PYM7-CHMW   Ozone at Finokalia
https://doi.org/10.48597/RRX2-V6QP   Ozone at K-puszta
https://doi.org/10.48597/SK2Z-MGDM   Ozone at Nyirjes
https://doi.org/10.48597/ZGPT-VV3Q   Ozone at Valentia Observatory
https://doi.org/10.48597/X7E7-QAZQ   Ozone at Mace Head
https://doi.org/10.48597/D6BA-FVPE   Ozone at Ispra
https://doi.org/10.48597/9VSD-426S   Ozone at Monte Cimone
https://doi.org/10.48597/5AW4-TBK6   Ozone at Capo Granitola
https://doi.org/10.48597/R965-5ME3   Ozone at Lampedusa
https://doi.org/10.48597/6MEX-EB7E   Ozone at Monte Martano
https://doi.org/10.48597/JH8P-V4UY   Ozone at Preila
https://doi.org/10.48597/2U42-A4MJ   Ozone at Rucava
https://doi.org/10.48597/5SPN-VN9R   Ozone at Zoseni
https://doi.org/10.48597/MUSD-B7H4   Ozone at Giordan Lighthouse
https://doi.org/10.48597/9D2E-6CQ9   Ozone at Eibergen
https://doi.org/10.48597/YN7X-SMNS   Ozone at Kollumerwaard
https://doi.org/10.48597/NRX7-53CP   Ozone at Vredepeel
https://doi.org/10.48597/SAAH-DKGQ   Ozone at De Zilk
https://doi.org/10.48597/PGCE-RP59   Ozone at Cabauw Wielsekade

https://doi.org/10.48597/SU2S-3VZX	Ozone at Birkenes II
https://doi.org/10.48597/BEP9-P763	Ozone at Tustervatn
https://doi.org/10.48597/24HS-WKVA	Ozone at Kårvatn
https://doi.org/10.48597/87NH-HWSM	Ozone at Zeppelin mountain (Ny-Ålesund)
https://doi.org/10.48597/MSTZ-92NC	Ozone at Prestebakke
https://doi.org/10.48597/69RE-B5FQ	Ozone at Svanvik
https://doi.org/10.48597/EVNS-V44V	Ozone at Sandve
https://doi.org/10.48597/R4HH-JVTP	Ozone at Hurdal
https://doi.org/10.48597/RB5H-2XA5	Ozone at Jarczew
https://doi.org/10.48597/PA5C-P7RC	Ozone at Sniezka
https://doi.org/10.48597/ZRU6-SDDG	Ozone at Leba
https://doi.org/10.48597/DVTU-KPK5	Ozone at Diabla Gora
https://doi.org/10.48597/UMP7-2AVB	Ozone at Bredkälen
https://doi.org/10.48597/9U9X-3AHW	Ozone at Esrange
https://doi.org/10.48597/3AH6-2WFR	Ozone at Råö
https://doi.org/10.48597/G84G-CUW4	Ozone at Asa
https://doi.org/10.48597/5X6Y-ZT56	Ozone at Östad
https://doi.org/10.48597/QUBN-AJTU	Ozone at Hallahus
https://doi.org/10.48597/PYEC-VDUJ	Ozone at Norunda Stenen
https://doi.org/10.48597/JGXK-QKUK	Ozone at Norra-Kvill
https://doi.org/10.48597/E6F8-AMKC	Ozone at Vindeln
https://doi.org/10.48597/Y6AU-C8UR	Ozone at Grimsö
https://doi.org/10.48597/8MFZ-TB96	Ozone at Iskrba
https://doi.org/10.48597/GXVM-B9D4	Ozone at Zarodnje
https://doi.org/10.48597/X48X-9C39	Ozone at Krvavec
https://doi.org/10.48597/A52T-U484	Ozone at Chopok
https://doi.org/10.48597/H52W-BK7H	Ozone at Stará Lesná
https://doi.org/10.48597/NVA9-55JZ	Ozone at Starina
https://doi.org/10.48597/BF5M-XZTZ	Ozone at Topolniky

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