

Europe's air quality status 2023

Briefing | Published 24 Apr 2023

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Air pollution is the largest environmental health risk in Europe, causing cardiovascular and respiratory diseases that lead to the loss of healthy years of life and, in the worst cases, to preventable deaths. This briefing presents the status of concentrations of pollutants in ambient air in 2021 and 2022 for regulated pollutants, in relation to both EU air quality standards and the 2021 WHO guideline levels. The assessment shows that, in spite of constant improvements, exceedances of air quality standards are common across the EU, with concentrations well above the latest WHO recommendations.

Key messages

- ➔ Despite ongoing overall improvements in air quality, levels of air pollutants above EU standards are seen across Europe and air pollution remains a major health concern for Europeans.
- ➔ In 2021, 97% of the urban population was exposed to concentrations of fine particulate matter above the health-based guideline level set by the World Health Organization.
- ➔ Central-eastern Europe and Italy reported the highest concentrations of particulate matter, primarily due to the burning of solid fuels for domestic heating and their use in industry.
- ➔ All countries reported levels of ozone and nitrogen dioxide above the health-based guideline levels set by the World Health Organization.
- ➔ The highest ozone levels were seen in the Mediterranean region and central Europe.

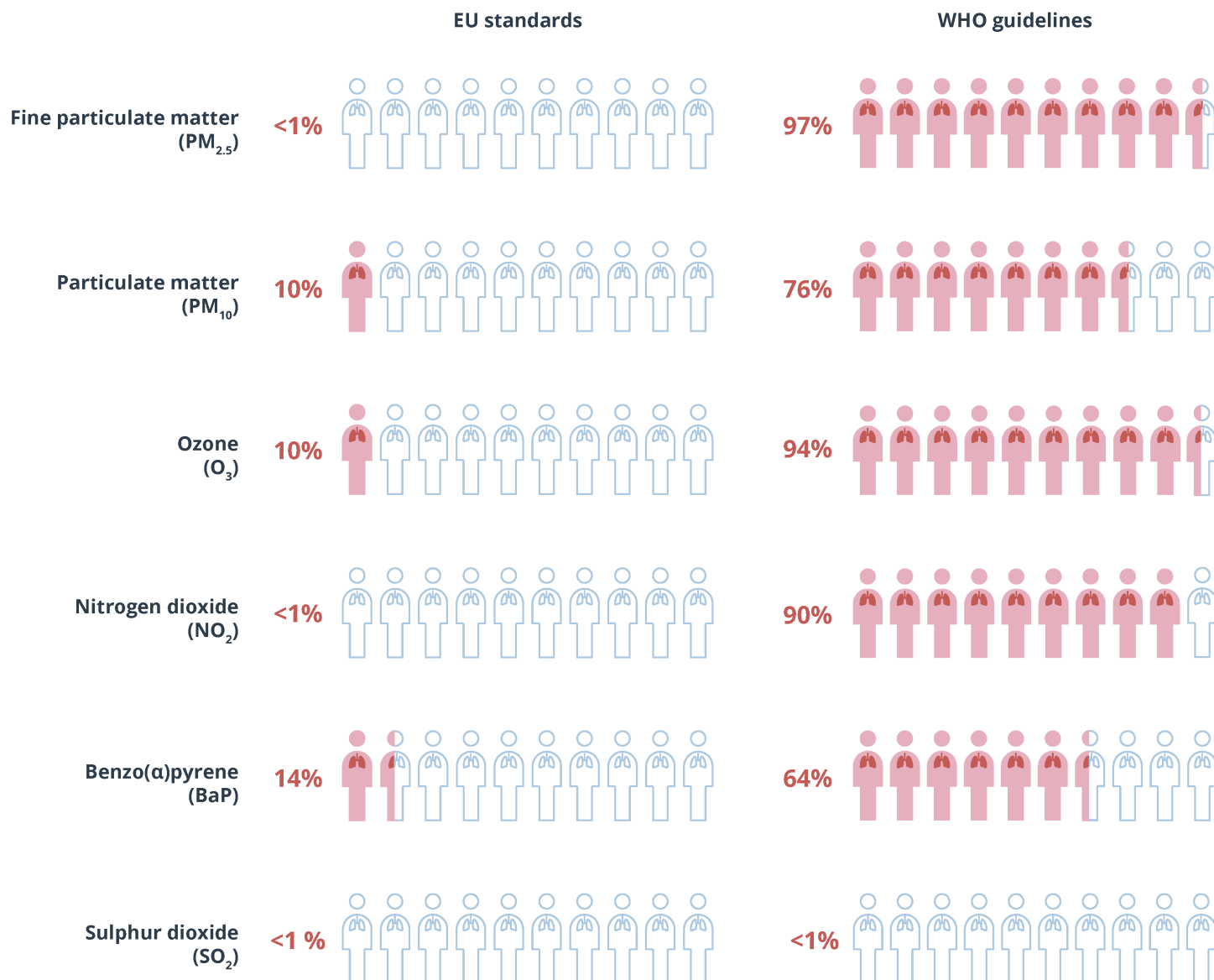
Europe's air quality status 2023 is one of a series to be published by the EEA as part of the **Air**

This briefing assesses levels of air pollutants in ambient air across Europe and compares them against both European Union (EU) standards as set out in the [ambient air quality directives](#) and the [2021 World Health Organization \(WHO\) global air quality guidelines](#). The EU air quality standards are less strict for all pollutants than the WHO [air quality guideline levels](#).

Under the European Green Deal's [Zero Pollution Action Plan](#), the European Commission set the 2030 goal of reducing the number of premature deaths caused by fine particulate matter (PM_{2.5}, a key air pollutant), by at least 55% compared with 2005 levels. To this end, the European Commission published in 2022 a [proposal to review the ambient air quality directives](#), aiming, among other things, to align the air quality standards more closely with WHO recommendations.

Despite reductions in emissions, in 2021 most of the EU's urban population was exposed to levels of key air pollutants that are damaging to health (see **Figure 1**). In particular, 97% of the urban population was exposed to concentrations of fine particulate matter (PM_{2.5}) above the 2021 WHO annual guideline of 5 µg/m³.

Figure 1. Share of the EU urban population exposed to air pollutant concentrations above certain EU standards and WHO guidelines in 2021



This analysis highlights those pollutants deemed to be most harmful to human health or that exceed the EU air quality standards and WHO guideline levels most frequently. The concentrations are obtained from measurements in monitoring stations that are officially reported to the EEA by its member and other collaborating countries. The **classification** of the monitoring stations and the criteria used to determine their inclusion in the analysis are described [here](#). The number of countries that submitted data and the number of monitoring stations with the minimum data coverage required vary for each pollutant and are summarised in [Table 1](#) for 2021, and [Table 2](#) for 2022. When referring to countries reporting data above certain levels, it means that they reported at least one station with concentrations above those levels.

The 2021 data were extracted from the EEA's reporting system on 13 February 2023 and the 2022 data on 20 March 2023.

The analysis for 2021 is based on officially validated data reported by countries. The analysis for 2022 is based on provisional up-to-date (UTD) data, and may therefore be subject to change once

the set of fully validated data is received by the EEA, and more countries are considered. Validated data for 2022 will only be available later in 2023 and presented in the 2024 briefing.

Additional information and further analysis can be found in the Eionet status reports [ETC/HE 2023/1](#) and [ETC/HE 2023/2](#), prepared by the [European Topic Centre on Human health and the environment \(ETC HE\)](#).

Further information on the concentrations of air pollutants, including those for previous years, can be found at the EEA's [statistics viewer](#), and data can be downloaded [here](#).

Apart from the measurements from monitoring stations, some countries also reported 2021 official data from modelling applications, that are available at <https://eeadmz1-cws-wp-air02.azurewebsites.net/index.php/users-corner/modeling-results-viewer/>. The results from these modelling applications have been included in this analysis when they implied concentrations above the EU standards.

Navigate the tabs for information on each pollutant:

PM₁₀

PM₁₀ stands for particulate matter with a diameter of 10 µm or less. PM₁₀ are emitted mainly by the combustion of solid fuels for domestic heating, while industrial activities, agriculture and road transport are also important sources. Some also come from natural sources such as sea salt, Saharan dust or volcanos, and some (called secondary PM) are formed in the atmosphere from the combination of different gases (as for instance, ammonia and nitrogen dioxide).

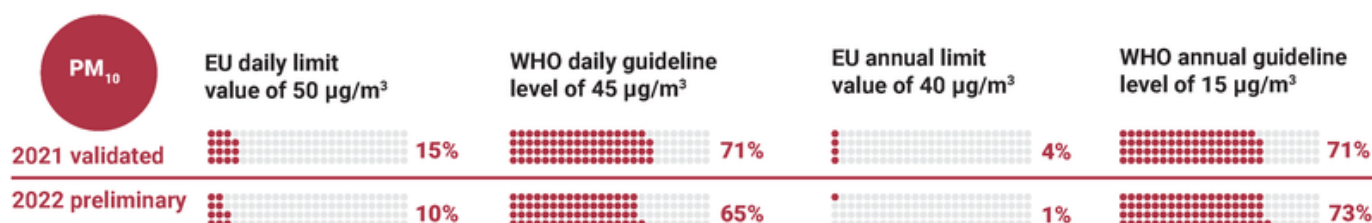
Concentrations above the EU daily limit value for PM₁₀ are seen mainly in **Italy and some eastern European countries** (Figures 2 and 4). In most central and eastern European countries, solid fuels such as coal are widely used for heating households and in some industrial facilities and power plants. The Po Valley, in northern Italy, is a densely populated and industrialised area with specific meteorological and geographical conditions that favour the accumulation of air pollutants in the atmosphere.

Figure 2. Concentrations of PM₁₀ in 2021 and 2022 in relation to the EU daily limit value

Concentrations of PM₁₀ in 2021:

- 21 reporting countries, including 15 EU Member States, registered concentrations above the EU daily limit value of 50 µg/m³
- 11 reporting countries, including 6 EU Member States, registered concentrations above the EU annual limit value of 40 µg/m³
- All 37 reporting countries registered concentrations above the WHO daily guideline level of 45 µg/m³
- All reporting countries except Iceland registered concentrations above the WHO annual guideline level of 15 µg/m³

Figure 3. Percentage of reporting monitoring stations registering PM₁₀ concentrations above the EU limit values and the WHO guideline levels in 2021 and 2022



Concentrations of PM₁₀ above the EU daily limit value were measured at 15% of monitoring stations (Figure 3), 86% of which were urban and 10% suburban.

Furthermore, Italy and Poland reported exceedances of the PM₁₀ daily limit value based on [assessment models](#) for 7 and 24 air quality zones, respectively.

Figure 4. PM₁₀ concentrations in 2021 by country in relation to the EU daily limit value

Concentrations of PM₁₀ in 2022:

- 20 reporting countries, including 15 EU Member States, reported concentrations above the daily limit value
- 4 reporting countries, including 2 EU Member States, reported concentrations above the annual limit value
- All 34 reporting countries reported concentrations above the WHO daily guideline level
- All reporting countries reported concentrations above the WHO annual guideline level

PM_{2.5}

PM_{2.5} stands for particulate matter with a diameter of 2.5 µm or less. These particles are emitted mainly from the combustion of solid fuels for domestic heating, industrial activities and road transport. As with PM₁₀, they can also come from natural sources and can be formed in the atmosphere. Agricultural emissions of ammonia make a significant contribution to the formation of fine particulate matter in the atmosphere.

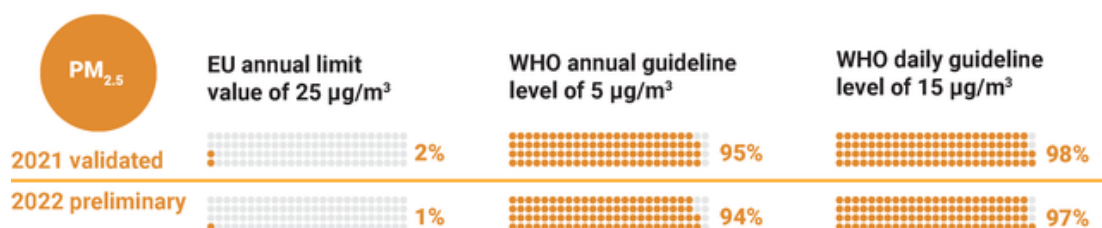
The highest PM_{2.5} concentrations were seen in **northern Italy and some eastern European countries** (Figures 5 and 7). As for PM₁₀, the use of solid fuels is the main reason for the situation in central and eastern Europe, together with an older vehicle fleet. In northern Italy, the high concentrations are due to the combination of a high density of anthropogenic emissions and meteorological and geographical conditions that favour the accumulation of air pollutants in the atmosphere and the formation of secondary particles.

Figure 5. Concentrations of PM_{2.5} in 2021 and 2022 in relation to the EU annual limit value and the WHO annual guideline level

Concentrations of PM_{2.5} in 2021:

- 8 reporting countries, including 4 EU Member States, registered concentrations above the EU annual limit value of 25 µg/m³
- All 37 reporting countries registered concentrations above the WHO annual guideline level of 5 µg/m³
- All reporting countries registered concentrations above the WHO daily guideline level of 15 µg/m³

Figure 6. Percentage of reporting monitoring stations registering PM_{2.5} concentrations above the EU annual limit value and the WHO guideline levels in 2021 and 2022



Concentrations of PM_{2.5} above the EU annual limit value were registered at 2% of monitoring stations (Figure 6), 72% of which were urban and 23% suburban.

Furthermore, Italy and Poland reported exceedances of the PM_{2.5} annual limit value based on [assessment models](#) for 5 and 46 air quality zones, respectively.

In 2021, all EU Member States continued to meet the exposure concentration obligation of 20 µg/m³, based on a 3-year average (2019-2021) measured at urban background stations, that was to be attained as of 2015 under the [Ambient Air Quality Directive](#). Furthermore, only Romania did

not meet the national exposure reduction target set for 2020. This indicator assesses the long-term exposure of the general population in urban areas.

Figure 7. PM_{2.5} concentrations in 2021 by country in relation to the EU annual limit value and the WHO annual guideline level

Concentrations of PM_{2.5} in 2022:

- 5 reporting countries, including 2 EU Member States, registered concentrations above the EU annual limit value
- All 33 reporting countries, except Iceland, registered concentrations above the WHO annual guideline level
- All 32 reporting countries^[1] registered concentrations above the WHO daily guideline level

An increase in PM levels could be expected in 2022 from the expected increase in the use of wood and coal as fuel, as a result of the energy crisis and higher gas prices seen in that period.

Nevertheless, the data presented here are 2022 annual averages, and the beginning of the winter 2022-2023 was milder than usual in Europe.

Ozone

Ozone (O₃) is a pollutant formed in the atmosphere when heat and light cause chemical reactions between nitrogen oxides and volatile organic compounds (VOCs), including methane. Emissions of these gases occur from anthropogenic sources and, in the case of VOCs, also biogenic. Ozone also is transported to Europe from other parts of the northern hemisphere and from the upper atmosphere. Meteorology plays an important role in the formation and dispersion of air pollution and in interannual variation in concentrations, and this effect is especially significant for ozone.

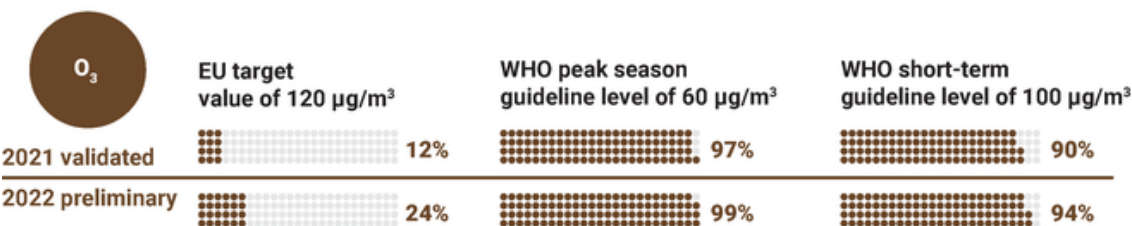
Figure 8. Concentrations of O₃ in 2021 and 2022 in relation to the EU target value

The highest concentrations in 2021 were found in some Mediterranean and Eastern countries (Figures 8 and 10).

Concentrations of O₃ in 2021:

- 22 reporting countries, including 16 EU Member States, registered levels above the EU target value threshold of 120 µg/m³
- All 35 reporting countries^[2] registered levels above the WHO peak season guideline level of 60 µg/m³
- All 35 reporting countries^[2] registered levels above the WHO guideline level of 100 µg/m³

Figure 9. Percentage of reporting monitoring stations registering O₃ concentrations above the EU target value and the WHO guideline levels in 2021 and 2022



The long-term EU objective for ozone of 120 µg/m³ was met at 21% of monitoring stations in 2021, with all reporting countries reporting stations with concentrations above the long-term objective.

Italy reported exceedances of the O₃ target value for the protection of health based on [assessment models](#) for 2 air quality zones. Italy and Poland reported exceedances of the O₃ long-term objective for the protection of health for 5 and 42 air quality zones, respectively.

Figure 10. O₃ concentrations in 2021 by country in relation to the EU target value

Concentrations of O₃ in 2022:

- 20 reporting countries, including 18 EU Member States, registered concentrations above the EU target value threshold
- All 31 reporting countries registered levels above the WHO short-term guideline level
- All 30 reporting countries^[3] registered levels above the WHO peak season guideline level

In 2022, the long-term EU objective for ozone was met at 12% of monitoring stations, with all 31 reporting countries registering concentrations above the long-term objective.

NO₂

The main source of **nitrogen dioxide (NO₂)** is road transport, which emits NO₂ close to the ground, mostly in densely populated areas, contributing to population exposure. Other important sources are combustion processes in industry and energy supply.

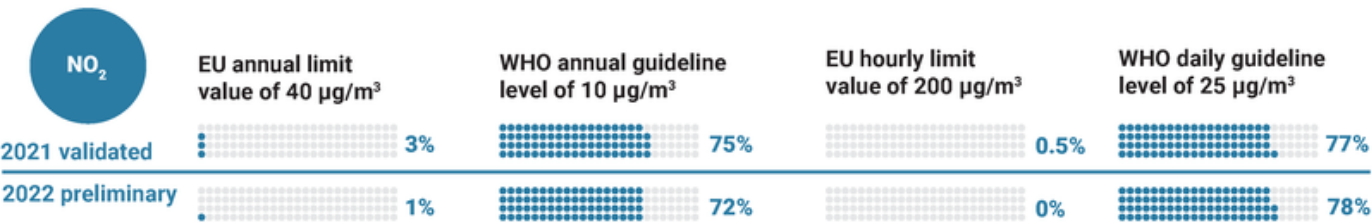
The highest concentrations were found **in some big cities with a high volume of traffic** (Figures 11 and 13). In general, maximum annual concentrations of NO₂ continued to fall in 2021 and 2022. In areas where maximum values have increased, they have not reached the levels observed before COVID-19.

Figure 11. Concentrations of NO₂ in 2021 and 2022 in relation to the EU annual limit value and the WHO annual guideline level

Concentrations of NO₂ in 2021:

- 11 reporting countries, including 9 EU Member States, registered concentrations above the EU annual limit value of 40 µg/m³
- All 37 reporting countries registered concentrations above the WHO annual guideline level of 10 µg/m³
- All 37 reporting countries registered concentrations above the WHO daily guideline level of 25 µg/m³

Figure 12. Percentage of reporting monitoring stations registering NO₂ concentrations above the EU limit values and the WHO guideline levels in 2021 and 2022



Concentrations of NO₂ above the EU annual limit value were registered at 3% of all monitoring stations (Figure 12), 75% of which were traffic stations.

Belgium, Italy and Poland reported exceedances of the NO₂ annual limit value based on [assessment models](#) for 2, 1 and 4 air quality zones, respectively.

Figure 13. NO₂ concentrations in 2021 by country and in relation to the EU annual limit value and the WHO annual guideline level

Concentrations of NO₂ in 2022

- 9 reporting countries, all of them EU Member States, registered values above the annual limit value
- All 35 reporting countries registered values above the WHO annual guideline level
- All 34 reporting countries^[1] registered values above the WHO daily guideline level

Concentrations of NO₂ above the annual limit value were registered at 1% of monitoring stations, all of which were traffic stations.

BaP

Benzo[a]pyrene (BaP) is a carcinogenic pollutant emitted mainly from the combustion of coal and wood for heating and, to a lesser extent, from the combustion of agricultural waste, and industrial installations.

The highest concentrations were found in **eastern Europe** (Figures 14 and 15), where the use of coal and other solid fuels for residential heating is widespread.

Figure 14. Concentrations of BaP in 2021

Concentrations of Benzo[a]pyrene in 2021:

- 13 out of 28 reporting countries, all of which were EU Member States, registered values above 1.0 ng/m³

Concentrations above 1.0 ng/m³ were registered at 27% of the reported monitoring stations, the majority of which were urban (78%) or suburban (17%).

Greece and Poland reported exceedances of the BaP target value based on [assessment models](#) for 3 and 38 air quality zones, respectively.

Figure 15. BaP concentrations in 2021 by country

Other pollutants

Concentrations of **sulphur dioxide (SO₂)** in 2021:

- 5 out of 37 reporting countries^[4], including one EU Member State, registered levels above the EU daily limit value of 125 µg/m³

- 19 countries, including 12 EU Member States, registered values above the WHO daily guideline level of 40 µg/m³^[5]

In 2021, concentrations above the EU daily limit value were registered at 1% of reporting monitoring stations.

Poland reported exceedances of the SO₂ daily limit value based on [assessment models](#) for 1 air quality zone.

In 2022, concentrations of SO₂ above the EU daily limit value were registered in only one reporting station outside the EU (in Serbia). In the same year, concentrations above the WHO daily guideline level were registered in 10 countries (including 7 EU Member States), out of 33 reporting countries.

Concentrations above EU limit/target values, were registered in 2021 for the following:

- Carbon monoxide in four stations located in one EU Member State (Italy, two stations) and two non-EU Member States (Serbia and Türkiye, one station each), out of 34 reporting countries.
- Benzene in one station in a EU Member State (Romania), out of 28 reporting countries. (Italy reported exceedances of the benzene annual limit value based on [assessment models](#) for 1 air quality zone).
- Lead in one station in a EU Member State (Slovenia), out of 30 reporting countries.
- Arsenic in five stations located in three EU Member States (Belgium, Poland and Finland), out of 30 reporting countries. (Poland reported exceedances of the arsenic annual target value based on [assessment models](#) for 1 air quality zone).
- Cadmium in one station located in a EU Member State (Italy), out of 29 reporting countries.
- Nickel in three stations located in three countries (two EU Member States, Finland and France; plus Norway), out of 30 reporting countries.

Identifiers

Briefing no. 05/2023

Title: **Europe's air quality status 2023**

EN HTML: TH-AM-23-006-EN-Q - ISBN: ISBN: 978-92-9480-554-6 - ISSN: 2467-3196 -

doi: 10.2800/59526

Notes

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1. Stations from Bosnia and Herzegovina did not get the minimum data coverage to estimate the percentile 99 of daily mean concentrations.
[a](#) [b](#)
 2. The station from Montenegro was excluded out of the analysis due to suspicion of wrong units.
[a](#) [b](#)
 3. The 2022 peak season O3 concentrations for Slovakia are not shown due to a processing problem.
[↩](#)
 4. Bosnia and Herzegovina, Türkiye, Serbia, North Macedonia and Poland.
[↩](#)
 5. The 99.18th percentile of the daily values has been considered, 3 days of exceedance per year.
[↩](#)

Related content:

- [Air pollution levels across Europe still not safe, especially for children](#)