Eionet Report – ETC/ATNI 2021/7

Status report of air quality in Europe for year 2019,
using validated data

August 2021

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Data may refer to submissions carried out prior to the United Kingdom's withdrawal from the European Union. The withdrawal of the UK from the EU did not affect the data presented in this document. Data relating to the UK will generally be explained by using terminology such as: "EU-27 and the UK" or "EEA-38 and the UK". Exceptions to this approach will be clarified in the context of their use.

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Contents

1 Summary

The *2019 Status report of air quality in Europe* presents summarized information on the status of air quality in Europe for the protection of health. It is based on 2019 validated data reported under the 2020 September reporting cycle. It also offers a comparison with the situation in the previous three years.

Data included in this report was received by 27 April 2021 from the reporting countries. By that date the reporting status of 2019 validated data is summarized in Figure 1. Please see editorial notes at the end of this Chapter on additional information on the data used. The number of stations by country reporting each pollutant is summarized in Table 3.

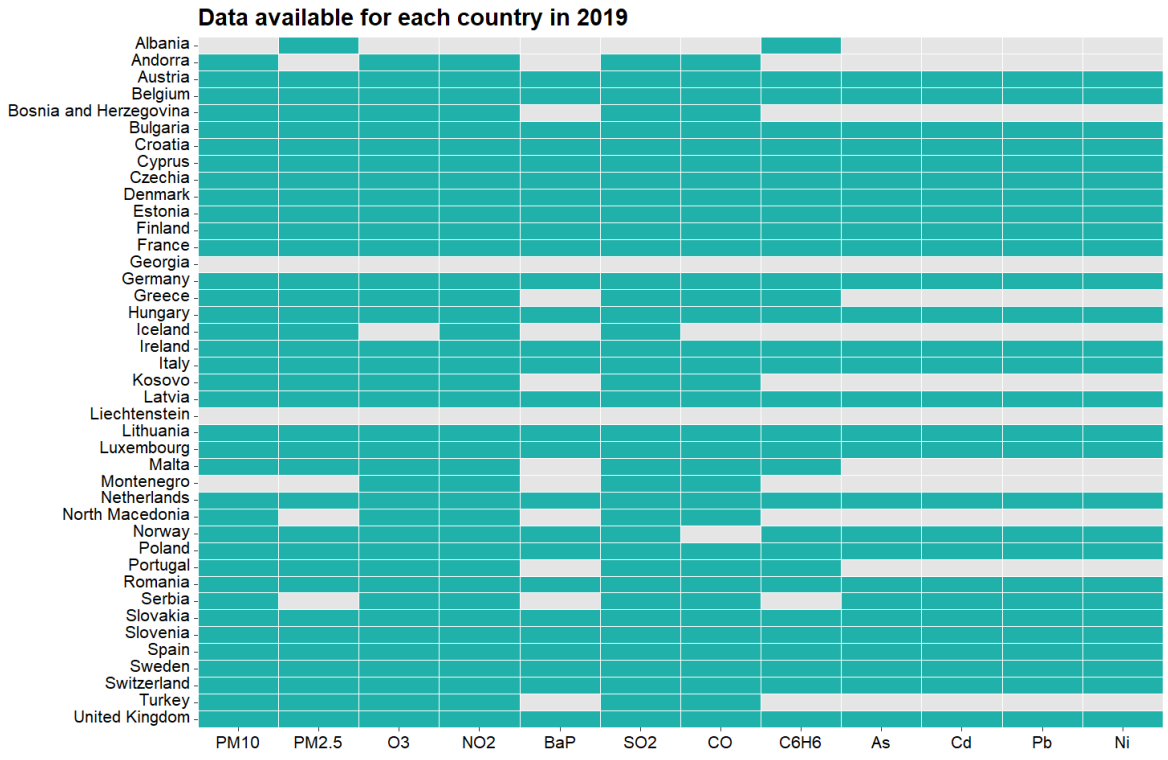


Figure 1: Reporting status of 2019 air quality data by 27 April 2021

The countries included in Figure 1 are the EU-27 (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden) and the United Kingdom ([1]); the five other member countries of the EEA

[1]The United Kingdom left the European Union on 31 January 2020. Data reported by the United Kingdom are included in all analyses and assessments contained herein, unless otherwise indicated. The former "EU-28",

(Iceland, Liechtenstein, Norway, Switzerland and Turkey) that, together with the EU-27 form the EEA-32; the six EEA's cooperating countries from the Western Balkans (Albania, Bosnia and Herzegovina, Kosovo under UN Security Council Resolution 1244/99, Montenegro, North Macedonia and Serbia) that, together with the EEA-32 form the EEA-38; and the voluntary reporting country of Andorra.

The air quality data are stored at the EEA's e-reporting database ([2]). Therefore, this is the source for all maps and figures in the report.

1.1 Particulate matter

For PM with a diameter of 10 µm or less (PM_{10}), concentrations above the EU daily limit value were registered at 14 % of the reporting stations in 16 countries in EU-27 and the UK and in five other reporting countries. For $PM_{2.5}$, concentrations above the annual limit value were registered at 2 % of the reporting stations in four countries in EU-27 and the UK and three other reporting countries.

The long-term WHO AQG for PM_{10} was exceeded at 43 % of the stations in 24 countries of the EU-27 and the UK and 7 other reporting countries. The long-term WHO AQG for $PM_{2.5}$ was exceeded at 59 % of the stations located in 24 countries of the EU-27 and the UK and 4 other reporting countries.

Despite the decreasing values in exposure to $PM_{2.5}$, two Member States had not yet met the exposure concentration obligation that was set under the Ambient Air Quality Directive to be attained as of 2015. The exposure concentration obligation reflects exposure of the population to fine particles and required that by 2015 exposure of the general population to $PM_{2.5}$ averaged over the previous 3-year period should not exceed 20 µg/m^3.

1.2 Ozone

29 % of stations registered concentrations above the EU ozone (O_3) target value for the protection of human health. These stations were located in 19 countries of the EU-27 and the UK and five other reporting European countries. The long-term objective was met in only 12 % of the stations. The WHO AQG for O_3 was exceeded in 97 % of all the reporting stations.

"EEA-33" and "EEA-39" are referred to in this report, unless otherwise indicated, as "EU-27 and the UK", "EEA-32 and the UK" and "EEA-38 and the UK".

[2] https://discomap.eea.europa.eu/map/fme/AirQualityExport.htm

1.3 Nitrogen dioxide

Around 6 % of all the reporting stations recorded concentrations above the annual limit value for nitrogen dioxide (NO_2), which is the same as the WHO AQG. These stations were located in 18 countries of the EU-27 and the UK and four other reporting countries. 87 % of concentrations above this limit value were observed at traffic stations.

1.4 Benzo[a]pyrene, an indicator for polycyclic aromatic hydrocarbons

Sixteen per cent of the reported benzo[a]pyrene (BaP) measurement stations reported annual mean concentrations above 1.0 ng/m^3. They were located in 14 countries in EU-27 and the UK and zero other reporting countries.

1.5 Sulphur dioxide, carbon monoxide, benzene and toxic metals

Only 19 stations (out of more than 1631) in two countries of the EU-27 and the UK and four other reporting countries measured values for sulphur dioxide (SO_2) above the EU daily limit value. However, 31 % of all SO_2 stations, located in 30 reporting countries, measured SO_2 concentrations above the daily WHO AQG.

Only 4 stations located in 3 countries (out of the 36 reporting countries) registered concentrations above the EU limit value for carbon monoxide (CO), which is the same as the WHO AQG.

Concentrations above the limit value for benzene (C_6H_6) were observed at only 2 stations (located in 2 countries out of 31 reporting countries).

Concentrations above the arsenic (As) target value were registered at 5 stations, located in 3 out of 28 reporting countries. For cadmium (Cd), there were 1 stations (located in 1 out of 28 reporting countries) measuring concentrations above the target value, and for nickel (Ni), 3 stations (in 3 out of 28 reporting countries) measured annual concentrations above the target value. Lead (Pb) concentrations above the limit value were measured in 1 stations, located in 1 out of 28 reporting countries.

1.6 Editorial note

According to feedback provided by the Italian authorities, BaP data from station SR-Via Gela (1.03 ng/m^3) is wrong, but no corrected data has been submitted yet.

2 Introduction

The *2019 Status report of air quality in Europe* presents summarized information on the air quality data reported as measurements data under the 2020 September reporting cycle (validated assessment data for 2019, deadline of submission 30 September 2020). It aims at informing on the 2019 status of ambient air quality in Europe and on progress towards meeting the air quality standards established for the protection of health in the Ambient Air Quality Directive (EU 2008) (Table 1) and the World Health Organization (WHO) air quality guidelines (WHO 2000, 2006) (Table 2).

This report builds on the former EEA "Air quality in Europe report" (EEA 2020) content, figures and maps regarding the status of monitored air quality in Europe. It provides for each pollutant:

- a European overview of the 2019 monitoring stations reported, and of their concentrations in relation to the EU legal standards and WHO AQGs;
- a map with the 2019 concentrations at station level;
- a boxplot graph summarizing for each country the range of concentrations (highlighting the lowest, highest, average and the 25 and 75 percentiles) for PM_{10}, $PM_{2.5}$, NO_2,O_3 and BaP.

Furthermore, it provides:

- maps with the situation at station level for the previous three years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed;
- heatmaps with the evolution of the mean and the maximum measured concentrations at country level since 2000.

Table 1: Air quality standards for the protection of health, as given in the EU Ambient Air Quality Directives

Pollutant	Averaging period	Legal nature and concentration	Comments
PM_{10}	1 day	Limit value: 50 µg/m^3	Not to be exceeded on more than 35 days per year
	Calendar year	Limit value: 40 µg/m^3	
$PM_{2.5}$	Calendar year	Limit value: 25 µg/m^3	Stage 1
		Indicative limit value: 20 µg/m^3	Stage 2: indicative limit value to be reviewed by the Commission in 2013. It remained unchanged after that revision
		Exposure concentration obligation: 20 µg/m^3	Average Exposure Indicator (AEI) ([a]) in 2015 (2013-2015 average)
		National Exposure reduction target: 0-20 percentage reduction in exposure	AEI ([a]) in 2020, the percentage reduction depends on the initial AEI
O_3	Maximum daily 8-hour mean	Target value: 120 µg/m^3	Not to be exceeded on more than 25 days/year, averaged over 3 years ([b])
		Long term objective: 120 µg/m^3	
	1 hour	Information threshold: 180 µg/m^3 Alert threshold: 240 µg/m^3	
NO_2	1 hour	Limit value: 200 µg/m^3	Not to be exceeded on more than 18 hours per year
		Alert threshold: 400 µg/m^3	To be measured over 3 consecutive hours over 100 km^2 or an entire zone
	Calendar year	Limit value: 40 µg/m^3	
BaP	Calendar year	Target value: 1 ng/m^3	Measured as content in PM_{10}
SO_2	1 hour	Limit value: 350 µg/m^3	Not to be exceeded on more than 24 hours per year
		Alert threshold: 500 µg/m^3	To be measured over 3 consecutive hours over 100 km^2 or an entire zone
	1 day	Limit value: 125 µg/m^3	Not to be exceeded on more than 3 days per year
CO	Maximum daily 8-hour mean	Limit value: 10 mg/m^3	
C_6H_6	Calendar year	Limit value: 5 µg/m^3	
Pb	Calendar year	Limit value: 0.5 µg/m^3	Measured as content in PM_{10}
As	Calendar year	Target value: 6 ng/m^3	Measured as content in PM_{10}
Cd	Calendar year	Target value: 5 ng/m^3	Measured as content in PM_{10}
Ni	Calendar year	Target value: 20 ng/m^3	Measured as content in PM_{10}

Notes:

[a] AEI: based upon measurements in urban background locations established for this purpose by the Member States, assessed as a 3-year running annual mean.

[b] In the context of this report, only the maximum daily 8-hour means in 2019 are considered, so no average over the period 2017 - 2019 is presented.

Sources:

EU (2004, 2008).

Table 2: WHO air quality guidelines (AQG) and estimated reference levels (RL) (a)

Pollutant	Averaging period	AQG	RL	Comments
PM_{10}	1 day	50 µg/m^3		99th percentile (3 days per year)
	Calendar year	20 µg/m^3		
$PM_{2.5}$	1 day	25 µg/m^3		99th percentile (3 days per year)
	Calendar year	10 µg/m^3		
O_3	Maximum daily 8-hour mean	100 µg/m^3		
NO_2	1 hour	200 µg/m^3		
	Calendar year	40 µg/m^3		
BaP	Calendar year		0.12 ng/m^3	
SO_2	10 minutes	500 µg/m^3		
	1 day	20 µg/m^3		
CO	1 hour	30 mg/m^3		
	Maximum daily 8-hour mean	10 mg/m^3		
C_6H_6	Calendar year		1.7 µg/m^3	
Pb	Calendar year	0.5 µg/m^3		
As	Calendar year		6.6 ng/m^3	
Cd	Calendar year	5 ng/m^3[b]		
Ni	Calendar year		25 ng/m^3	

Notes:

[a] As WHO has not set an AQG for BaP, C6H6, As and Ni, the RL was estimated assuming an acceptable risk of additional lifetime cancer risk of approximately 1 in 100 000.

[b] AQG set to prevent any further increase of Cd in agricultural soil, likely to increase the dietary intake of future generations.

Sources:

WHO (2000, 2006a).

Box 1.1 Classification of monitoring stations

Fixed sampling points in Europe are situated at different types of stations following rules for macro- and micro-scale siting. Briefly, depending on the predominant emission sources, stations are classified as follows:

- traffic stations: located in close proximity to a single major road;
- industrial stations: located in close proximity to an industrial area or an industrial source;
- background stations: where pollution levels are representative of the average exposure of the general population or vegetation.

Depending on the distribution/density of building, the area surrounding the station is classified as follows:

- urban: continuously built-up urban area;
- suburban: largely built-up urban area;
- rural: all other areas.

For most of the pollutants, monitoring stations have to fulfil the criterion of reporting more than 75 % of valid data out of all the possible data in a year to be included in this assessment. The Ambient Air Quality Directive sets, for compliance purposes, the objective of a minimum data capture of 90 % for monitoring stations, but, for assessment purposes, a coverage of 75 % allows more stations to be taken into account without a significant increase in monitoring uncertainties. For benzene, the required amount of valid data for the analysis is 50 %. For toxic metals (As, Cd, Ni, Pb) and BaP, it is 14 % (according to the air quality objectives for indicative measurements).

Measurement data are rounded following the general recommendations under (EU 2011). The number of considered decimals are indicated in the legend of the corresponding maps.

The assessments, in the cases of PM and SO_2, do not account for the fact that the Ambient Air Quality Directive (EU 2008) provides Member States with the possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting under specific circumstances.

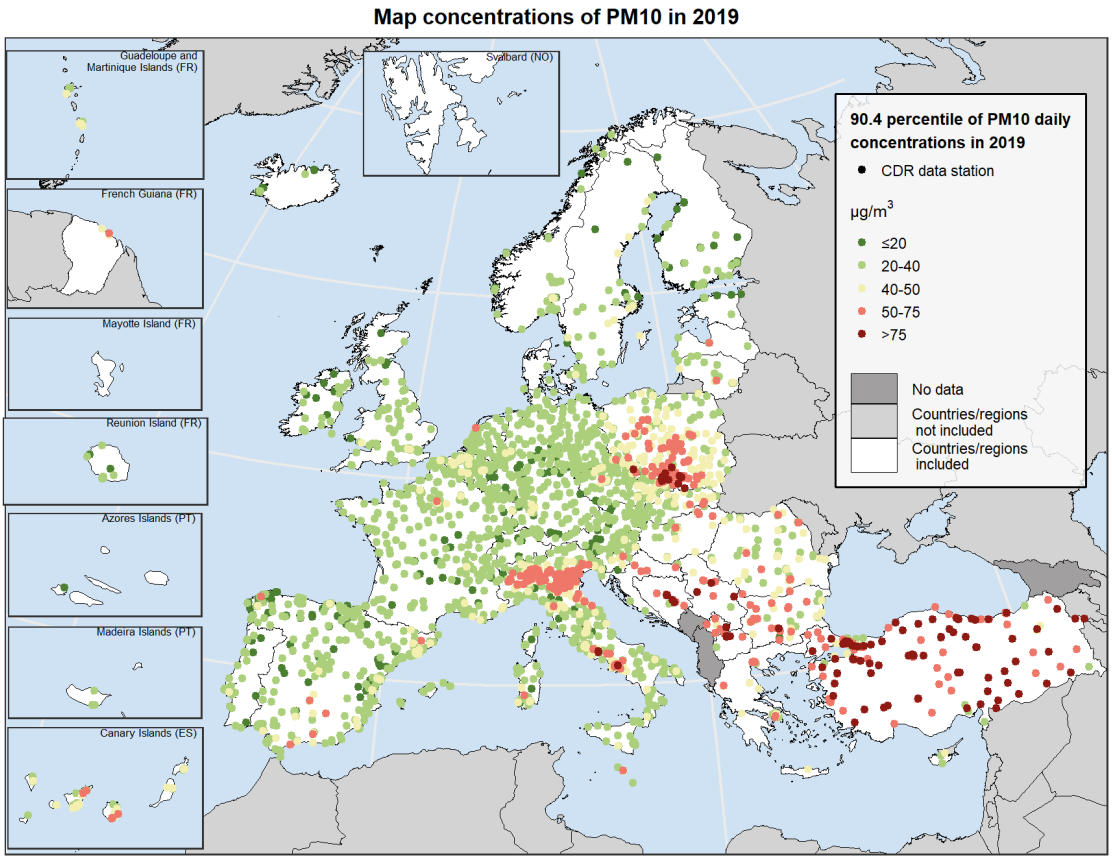
3 Status of particulate matter ambient air concentrations

3.1 Status of PM_{10} concentrations

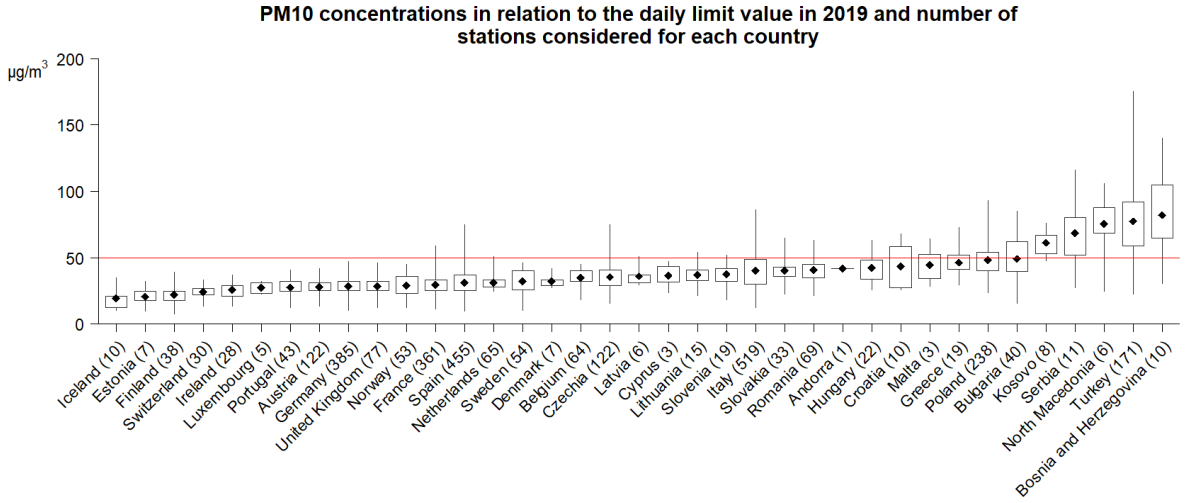
The EEA received PM_{10} data for 2019, with sufficient valid measurements (a minimum coverage of 75 %) from 3163 stations for the calculation of annual mean concentrations and from 3129 stations in relation to the daily limit value. The stations were located in all the reporting countries shown in Figure 1.

Sixteen countries in EU-27 and the UK, and five other reporting countries reported PM_{10} concentrations above the EU daily limit value (Figure 2). This was the case for 14 % (427) of reporting stations. In total, 97 % of those stations were either urban (87 %) or suburban (10 %).

Concentrations above the PM_{10} annual limit value (40 µg/m^3) were monitored in 4 % (125 stations) of all the reporting stations, located in 7 countries in EU-27 and the UK, and 4 other reporting countries. The stricter value of the WHO AQG for PM_{10} annual mean (20 µg/m^3) was exceeded at 43 % (1375) of the stations in all the reporting countries, except in Estonia, Finland, Iceland, Ireland, Luxembourg and Switzerland (Figure 5).



Note: Observed concentrations of PM10 in 2019. The possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting has not been considered. The map shows the 90.4 percentile of the PM10 daily mean concentrations, representing the 36th highest value in a complete series. It is related to the PM10 daily limit value, allowing 35 exceedances of the 50 $\mu g/m^3$ threshold over 1 year. The last two colour categories indicate stations with concentrations above this daily limit value. Only stations with more than 75 % of valid data have been included in the map.



Note: The graph is based, for each country, on the 90.4 percentile of daily mean concentration values corresponding to the 36th highest daily mean. For each country, the number of stations considered (in brackets) and the lowest, highest and average 90.4 percentile values (in $\mu g/m^3$) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The daily limit value set by EU legislation is marked by the horizontal line. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered.

Figure 2: Map and boxplot of PM10 concentrations in 2019 - daily limit value

The highest value in the boxplot, Turkey (250.1 µg/m³), has not been included in the graph for representation purposes.

Figure 3 shows the maps of the 90.4 percentile of PM_{10} daily mean concentrations (equivalent to the PM_{10} daily limit value) for four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

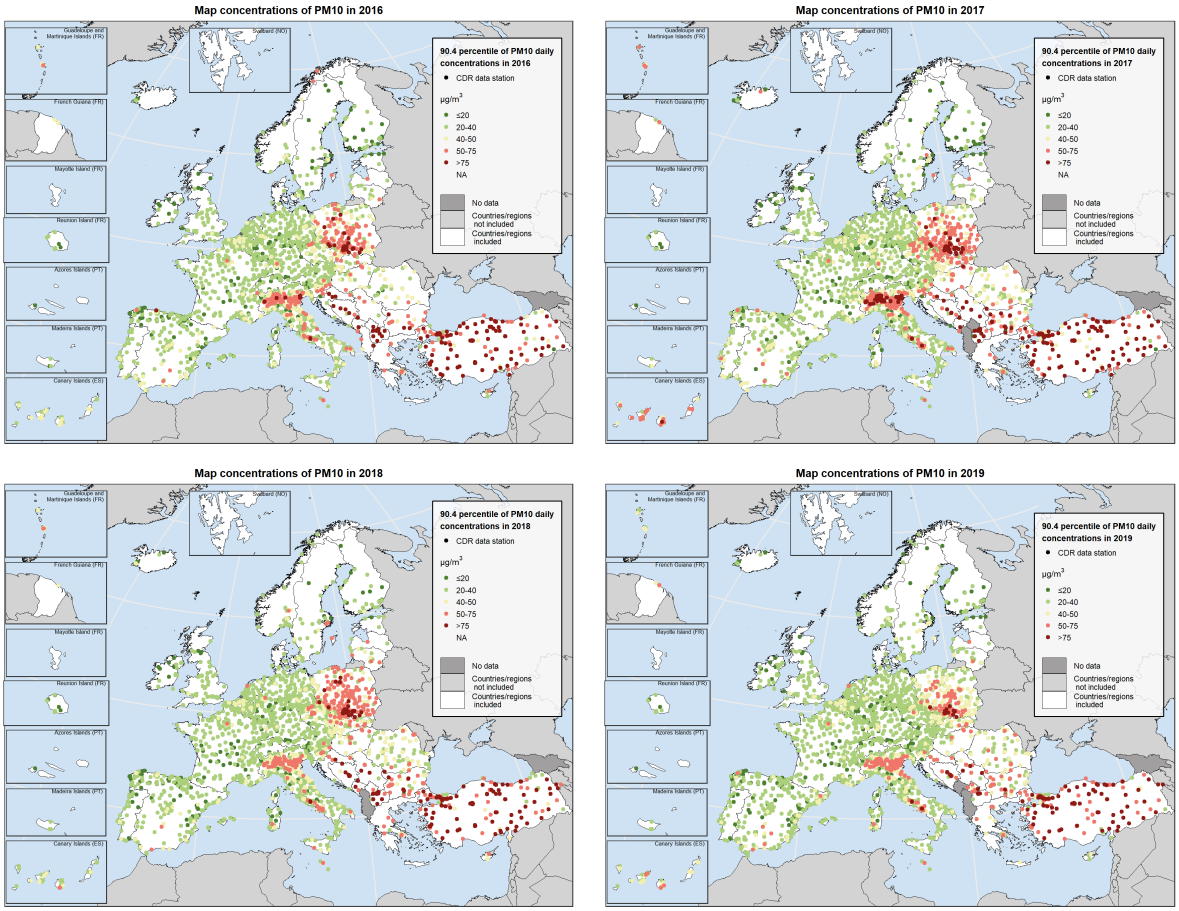
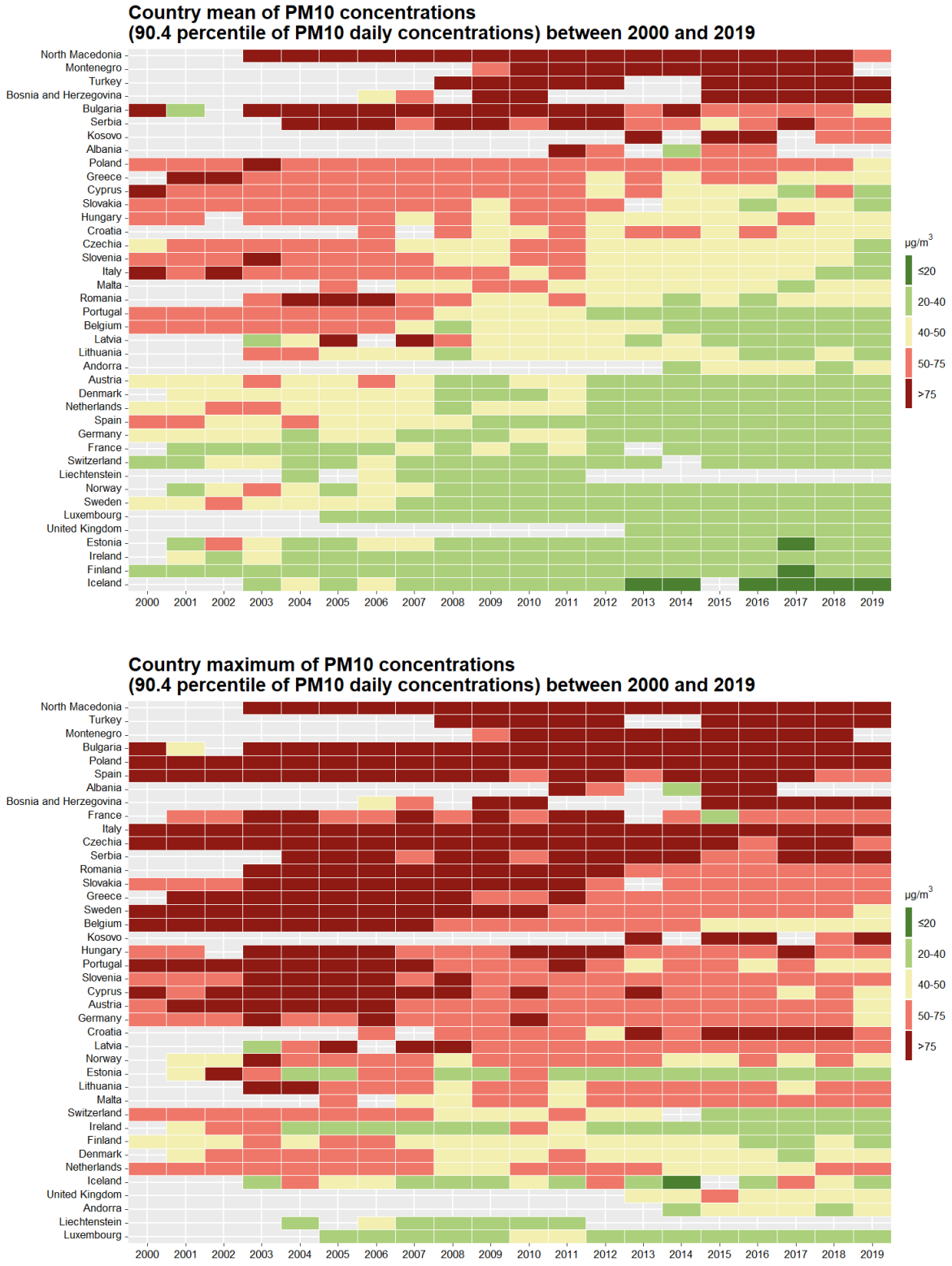


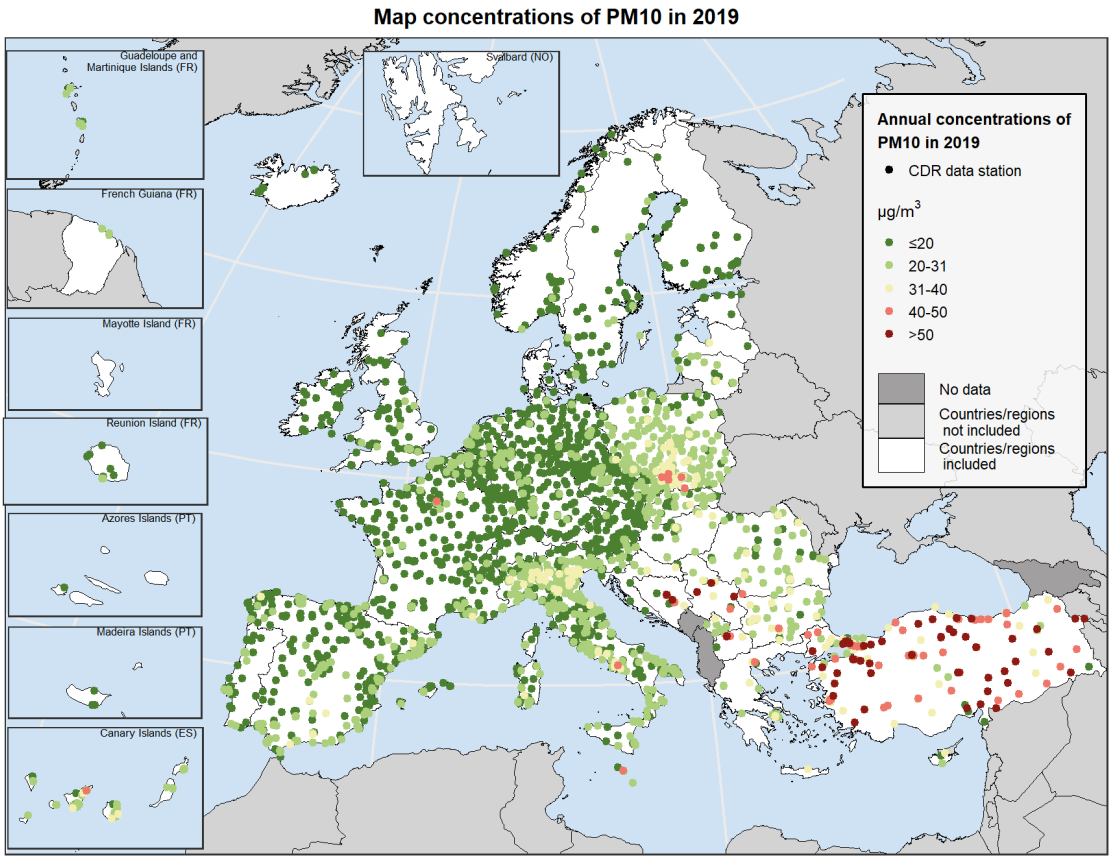
Figure 3: Maps of PM10 concentrations (daily limit value) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) 90.4 percentile of PM_{10} daily mean concentrations at country level are shown in figure 4. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).

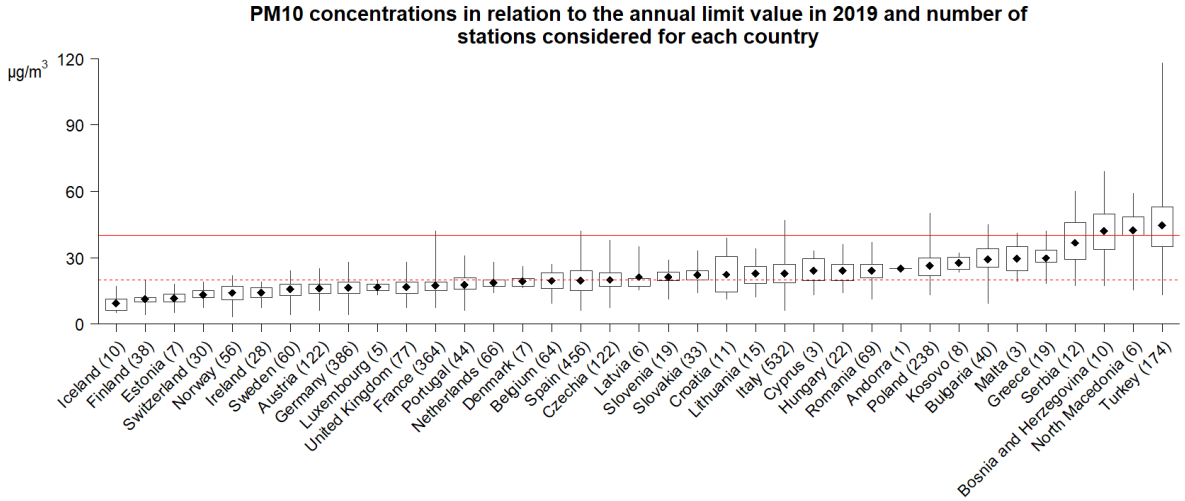


Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 4: Evolution of mean (top) and maximum (bottom) 90.4 percentile of PM10 daily mean concentrations (daily limit value) per country from 2000



Note: Observed concentrations of PM10 in 2019. The possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting has not been considered. The last two colour categories indicate stations reporting concentrations above the EU annual limit value (40 $\mu g/m^3$). The first colour category indicate stations reporting values below the WHO AQG for PM10 (20 $\mu g/m^3$). Only stations with more than 75 % of valid data have been included in the map.



Note: The graph is based on annual mean concentration values. For each country, the number of stations considered (in brackets) and the lowest, highest and average values (in $\mu g/m^3$) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The annual limit value set by EU legislation is marked by the upper continuous horizontal line. The WHO AQG is marked by the lower dashed horizontal line. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered.

Figure 5: Map and boxplot of PM10 concentrations in 2019 - annual limit value

The highest value in the boxplot, Turkey (135.2 µg/m³), has not been included in the graph for representation purposes.

Figure 6 shows the maps of PM_{10} annual mean concentrations at station level for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

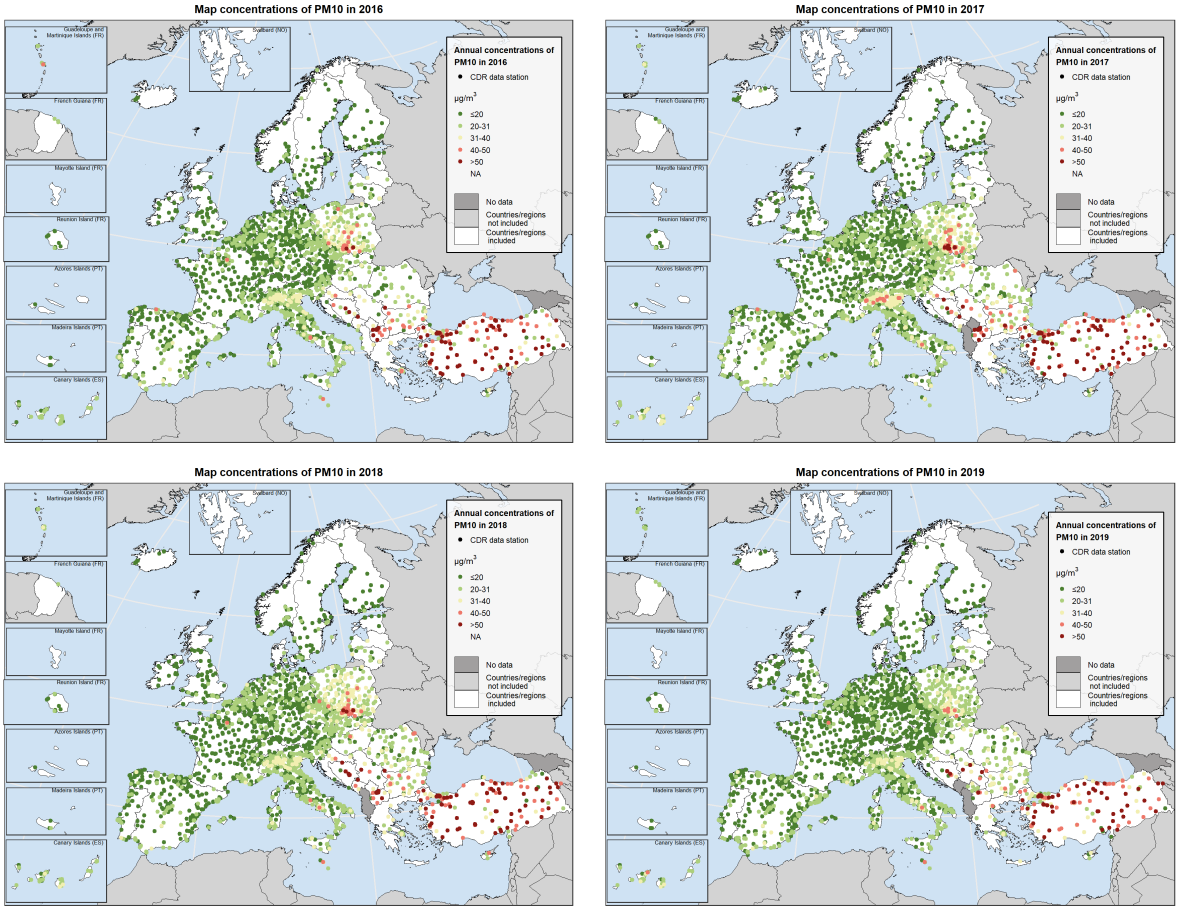
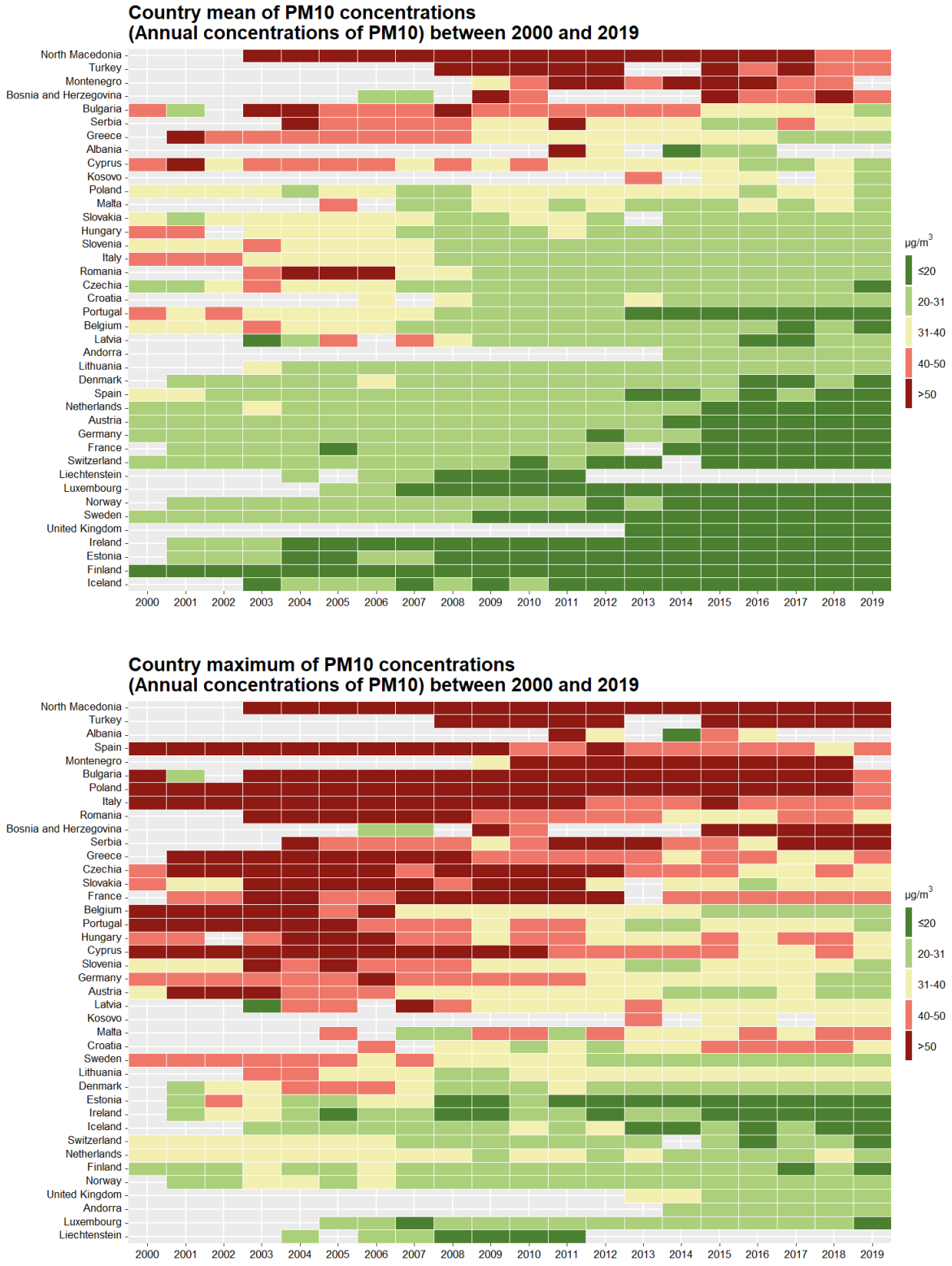


Figure 6: Maps of PM10 concentrations (annual limit value) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) annual mean PM_{10} concentrations at country level are shown in figure 7. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

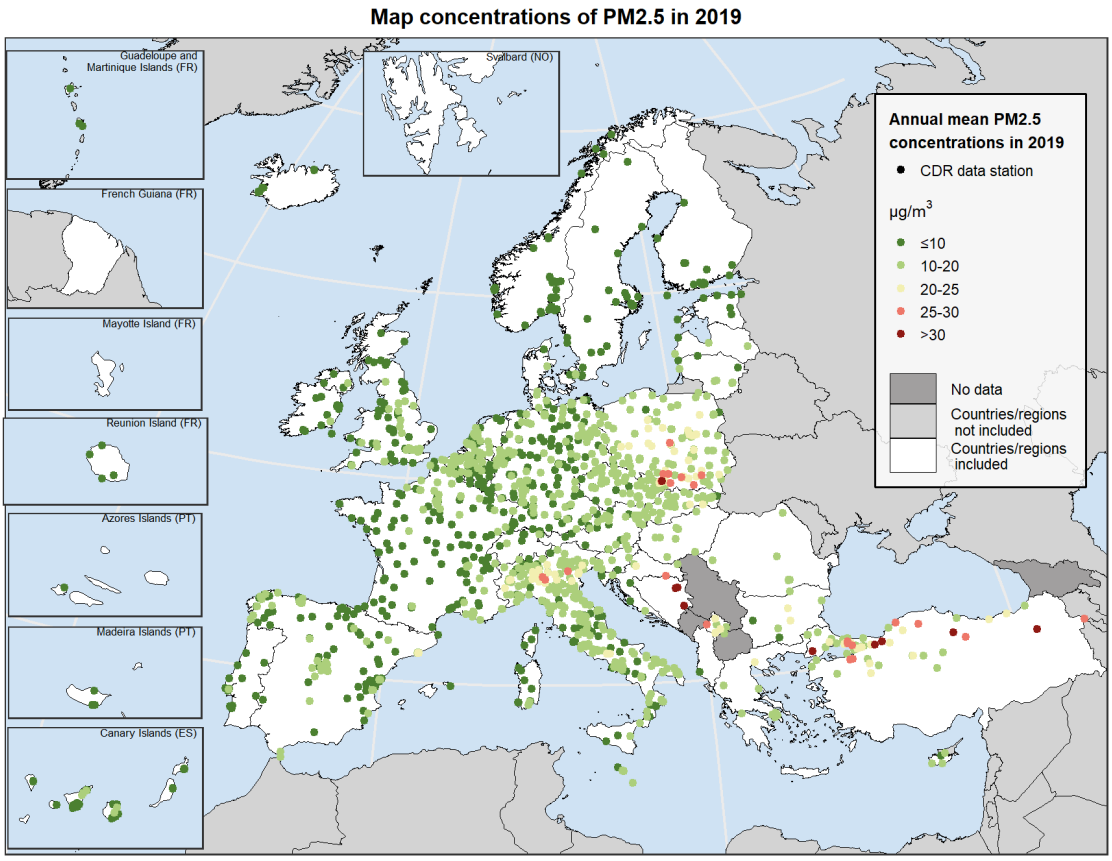
Figure 7: Evolution of mean (top) and maximum (bottom) PM10 annual mean concentrations (annual limit value) per country from 2000

3.2 Status of $PM_{2.5}$ concentrations

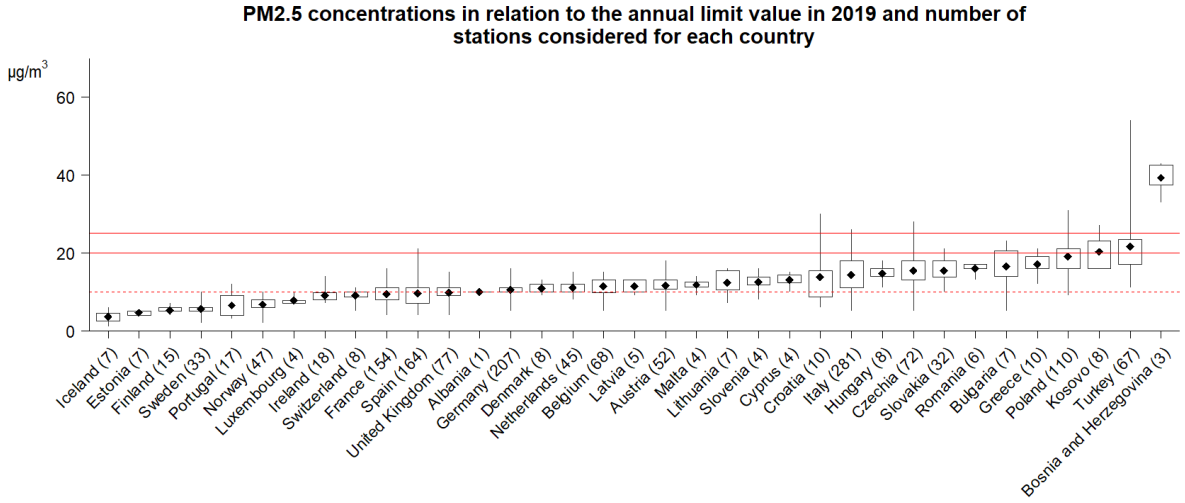
Regarding $PM_{2.5}$, data with a minimum coverage of 75 % of valid data were received from 1570 stations located in all the reporting countries shown in Figure 1.

The $PM_{2.5}$ concentrations were higher than the annual limit value in four countries in EU-27 and the UK and three other reporting countries (Figure 8). These concentrations above the limit value were registered in 2 % of all the reporting stations and occurred primarily (90 % of cases) in urban (77 %) or suburban (13 %) areas.

The WHO guideline for $PM_{2.5}$ annual mean (10 µg/m^3) was exceeded at 59 % of the stations, located in 28 of the 35 countries reporting $PM_{2.5}$ data (Figure 8). Albania, Estonia, Finland, Iceland, Luxembourg, Norway and Sweden did not report any concentrations above the WHO AQG for $PM_{2.5}$.



Note: Observed concentrations of PM2.5 in 2019. The possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting has not been considered. The last two colour categories indicate stations reporting concentrations above the EU annual limit value (25 $\mu g/m^3$). The first colour category indicate stations reporting values below the WHO AQG for PM2.5 (10 $\mu g/m^3$). Only stations with more than 75 % of valid data have been included in the map.



Note: The graph is based on annual mean concentration values. For each country, the number of stations considered (in brackets) and the lowest, highest and average values (in $\mu g/m^3$) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The annual limit value and the indicative annual limit value set by EU legislation are marked by the upper continuous horizontal lines at 25 and 20, respectively. The WHO AQG is marked by the lower dashed horizontal line. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered. Source: EEA, 2019.

Figure 8: Map and boxplot of PM2.5 concentrations in 2019 - annual limit value

Figure 9 shows the maps of measured $PM_{2.5}$ annual mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

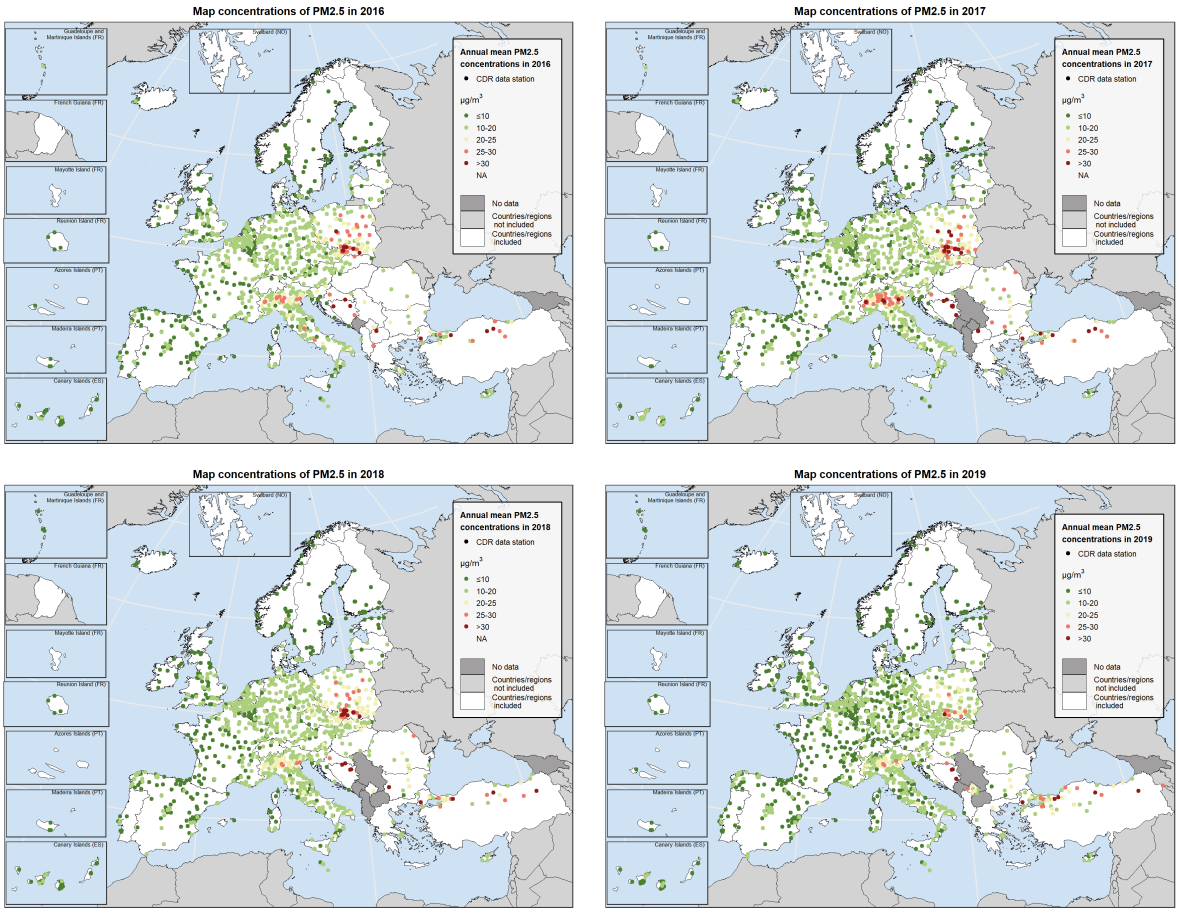
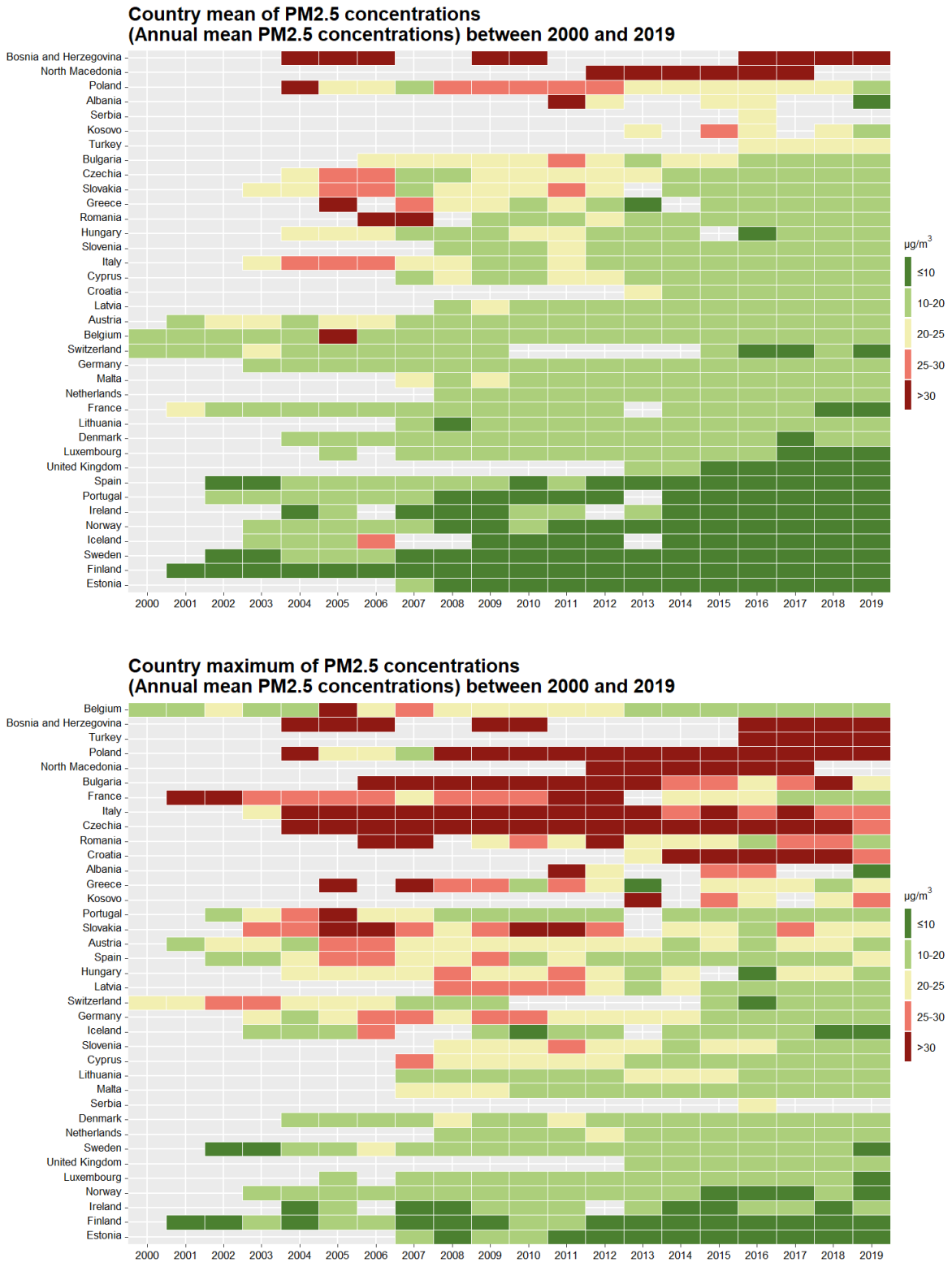


Figure 9: Maps of PM2.5 concentrations (annual limit value) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) $PM_{2.5}$ annual mean concentrations at country level are shown in figure 10. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

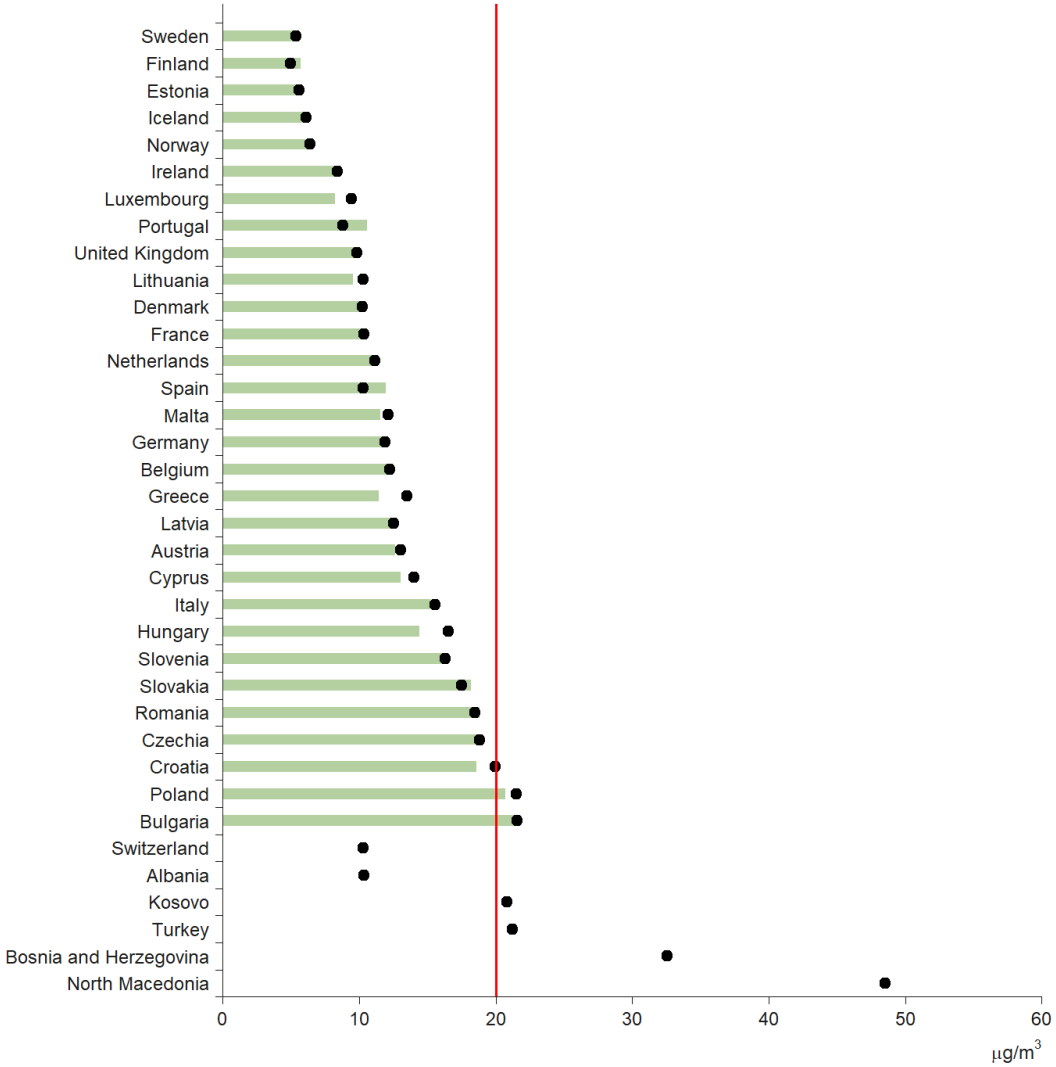
Figure 10: Evolution of mean (top) and maximum (bottom) PM2.5 annual mean concentrations (annual limit value) per country from 2000

3.3 $PM_{2.5}$ average exposure indicator

The Ambient Air Quality Directive (EU 2008) also sets two additional targets for $PM_{2.5}$, the exposure concentration obligation (ECO) and the national exposure reduction target (NERT) (Table 1). Both targets are based on the average exposure indicator (AEI), calculated at national level. The AEI is an average of concentration levels (over a 3-year period) measured at urban background stations (representative of general urban population exposure) selected for this purpose by every national authority. The reference year for the AEI is 2010 (average 2008-2010), but the Ambient Air Quality Directive offered two additional alternatives where data are not available for 2008: (1) an alternative AEI 2010, with a 2-year average (2009 and 2010) instead of the 3-year average; or (2) the AEI 2011 (average 2009-2011). For comparability purposes, the data presented here are analysed with reference to the AEI 2011, independently of the reference year chosen by each Member State. The exception is Croatia for which 2015 is the AEI reference year (average 2013-2015).

Figure 11 shows the AEI calculated for 2019 (average 2017-2019) and the situation in relation to the ECO. The bars show the AEI 2019 using the stations designated for this purpose by the reporting countries (if the bars are not shown it means that the AEI 2019 could not be calculated), while the dots show instead the 3-year (2017-2019) average concentrations from measurements at all urban and suburban background stations with 75 % data coverage. This calculation, covering the urban and suburban background stations, has been used in previous *Air quality in Europe* reports as an approximation of the AEI and is presented here for comparison with the information presented in those reports. The calculation using reported urban and suburban background stations is also made for the rest of the non-EU countries.

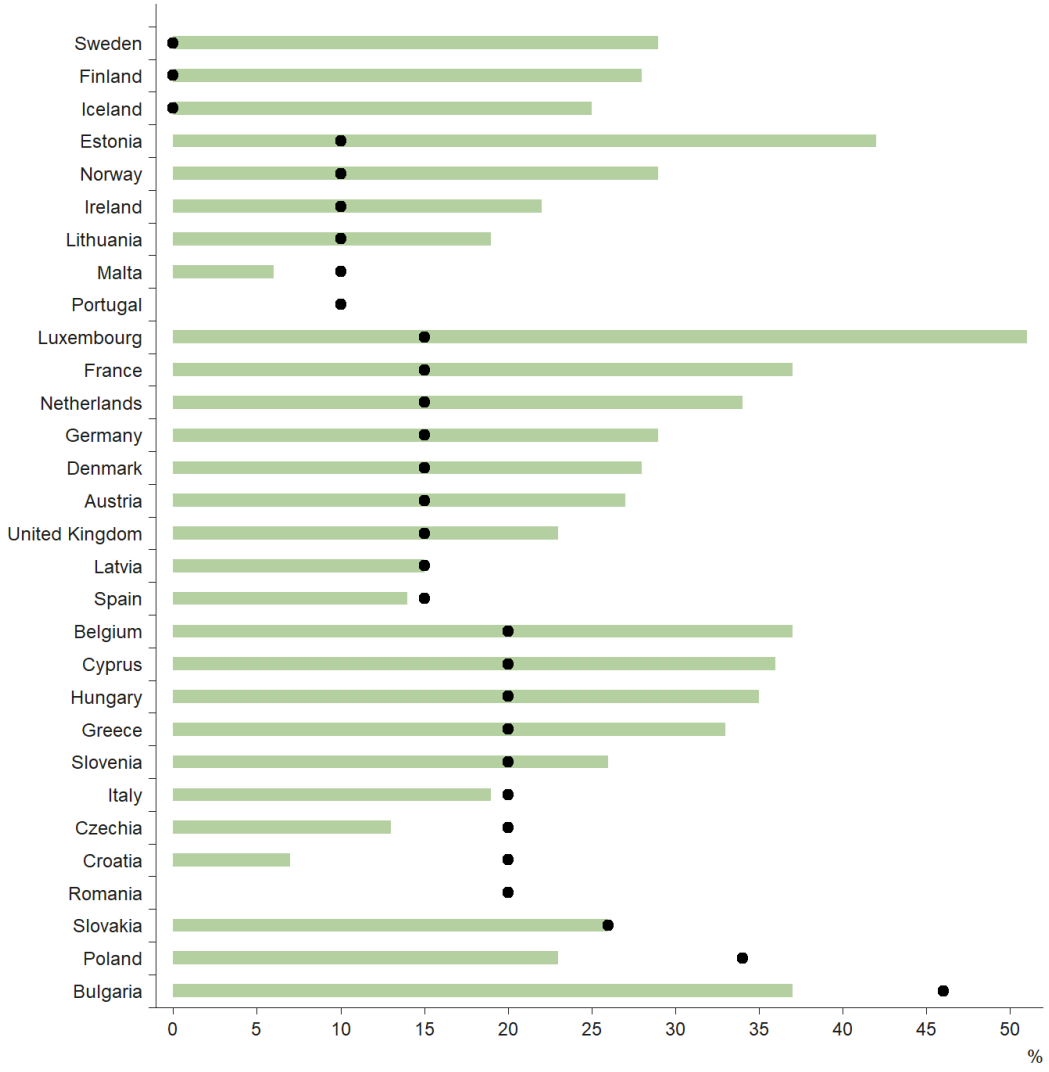
In Figure 11, those countries whose bars are to the right of the vertical line are countries for which the AEI is above the ECO. Those countries whose dots are to the right of the vertical line are countries for which the urban and suburban background concentration is above the ECO.



Note: The bars show the average exposure indicator (AEI) calculated in 2019 (averages 2017–2019) using the stations designated for this purpose by the reporting countries.
The dots show all urban and suburban background PM2.5 concentrations (for stations with at least 75 % of data coverage) in all reporting countries presented as 3–year (2017–2019) averages, as an approximation of the AEI in 2019 and to facilitate comparison with information provided in previous Air quality in Europe reports.
The vertical line represents the exposure concentration obligation for the countries in EU–27 and the UK, set at 20 $\mu g/m^3$, to be achieved as of 2015.

Figure 11: Average exposure indicator in 2019 and exposure concentration obligation

Figure 12 shows the situation per country, for those countries with AEI designated stations, in relation to the NERT. This reduction target is expressed as a percentage of the initial AEI 2010 (here, as stated above, AEI 2011 has been used for comparison). The dots indicate the percentage reduction to be attained in AEI 2020 (average 2018-2020) and the bars indicate the reduction in the AEI 2019 as a percentage of the AEI 2011 (AEI 2015 for Croatia). Figure 12 shows those countries that have reduced their AEI below their corresponding NERT values (those whose bar is to the right of the dot) and those that did not (the rest).



Note: Bars indicate the reduction in the AEI 2019 as a percentage of the AEI 2011 (AEI 2015 in the case of Croatia, see the main text). Dots indicate the reduction to be obtained in the AEI 2020 as a percentage of the AEI 2011 (AEI 2015 in the case of Croatia). If the end of the bar is to the right of the dot or in the same spot, the NERT was already achieved in 2019.

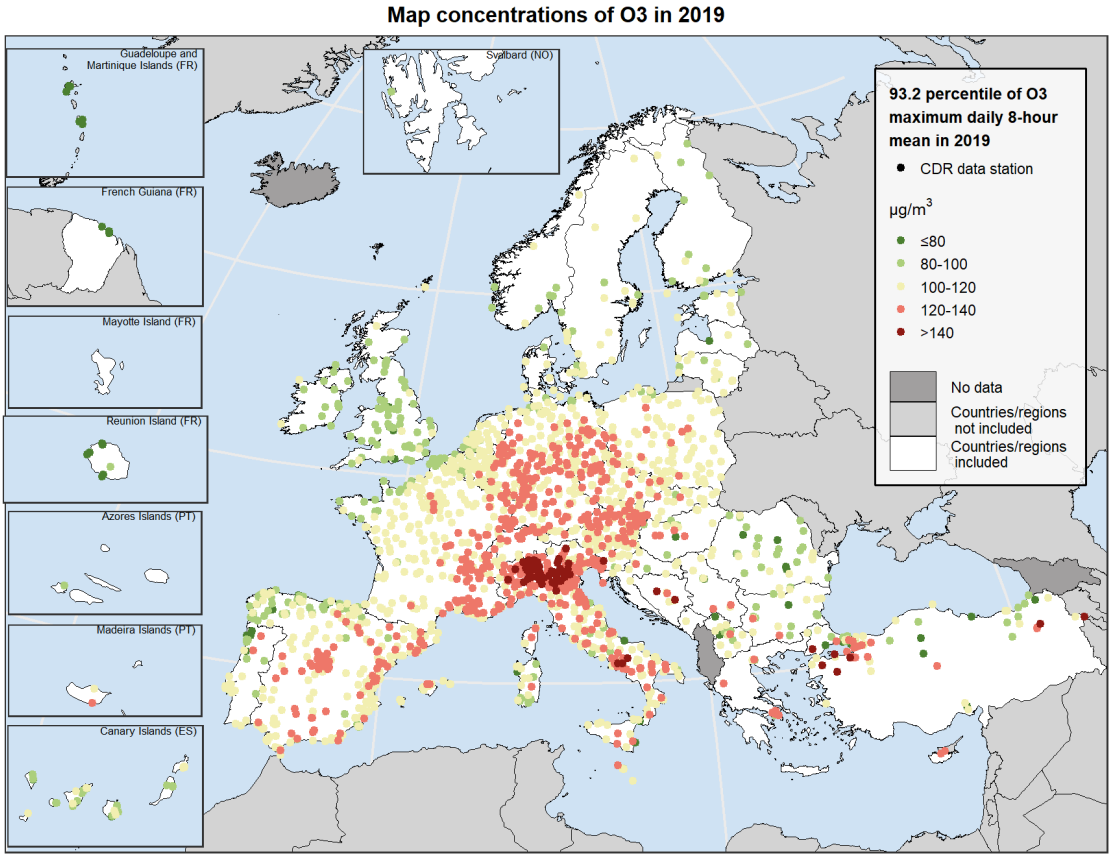
Figure 12: Percentage of reduction in AEI 2019 in relation to AEI 2011 and distance to the national exposure reduction target

4 Status of ozone ambient air concentrations

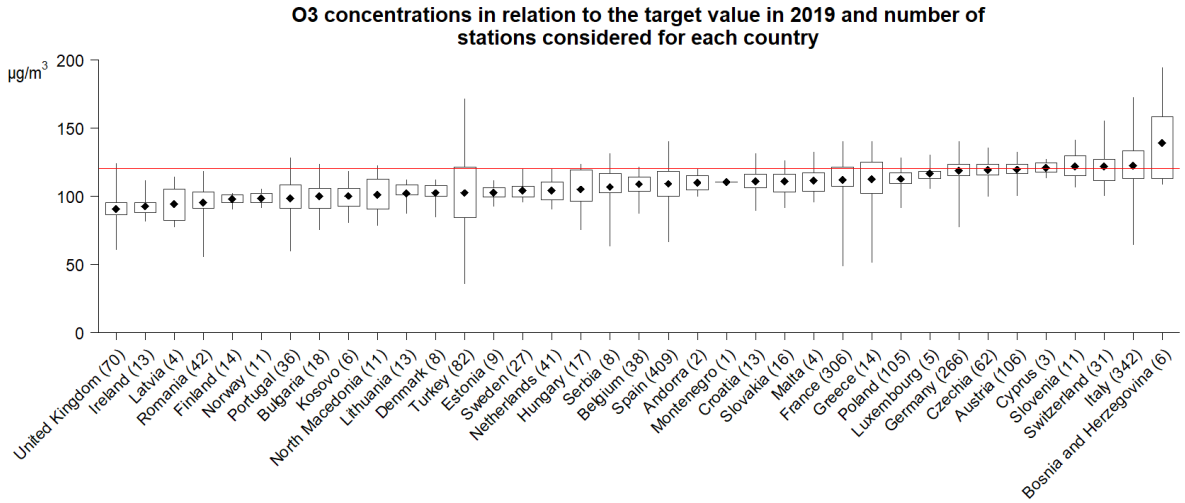
Data for O_3 were reported from 2170 stations in the reporting countries shown in Figure 1.

19 countries in EU-27 and the UK and 5 other reporting countries registered concentrations above the O_3 target value more than 25 times (Figure 13). In total, 29 % of all stations reporting O_3 showed concentrations above the target value for the protection of human health. In addition, only 12 % (258) of all stations fulfilled the long-term objective. 86 % of the stations with values above the long-term objective were background stations.

3 % (66) of all stations and only 1 of the 555 reported rural background stations had values below the WHO AQG value for O_3 (8-hour mean of 100 µg/m^3), set for the protection of human health.



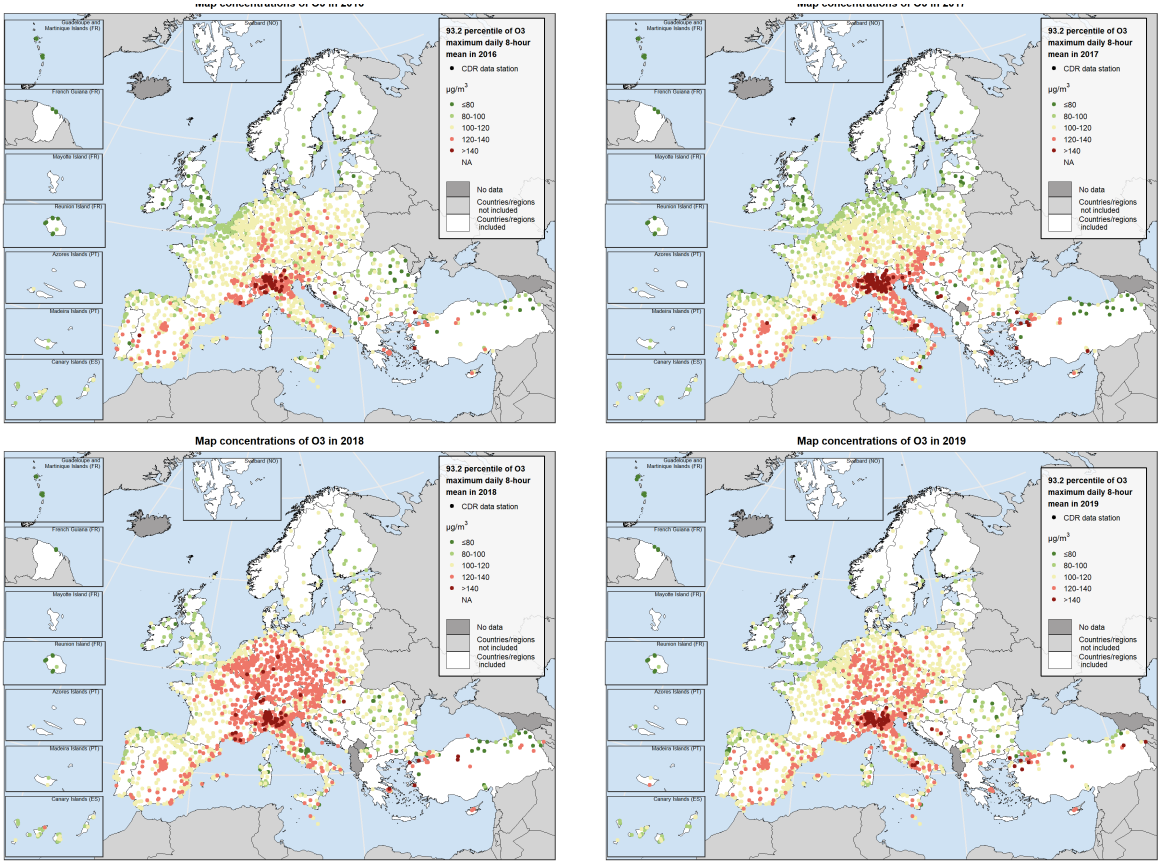
Note: Observed concentrations of O3 in 2019. The map shows the 93.2 percentile of the O3 maximum daily 8–hour mean, representing the 26th highest value in a complete series. It is related to the O3 target value. At sites marked with the last two colour categories, the 26th highest daily O3 concentrations were above the 120 $\mu g/m^3$ threshold, implying an exceedance of the target value threshold. Please note that the legal definition of the target value considers not only 1 year but the average over 3 years. Only stations with more than 75 % of valid data have been included in the map.



Note: The graph is based, for each country, on the 93.2 percentile of the maximum daily 8–hour mean concentration values, corresponding to the 26th highest daily maximum of the running 8–hour mean. For each country, the number of stations considered (in brackets), and the lowest, highest and average values (in $\mu g/m^3$) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The target value threshold set by the EU legislation is marked by the horizontal line. Please note that the legal definition of the target value considers not only 1 year but the average over 3 years. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered.

Figure 13: Map and boxplot of O3 concentrations in 2019

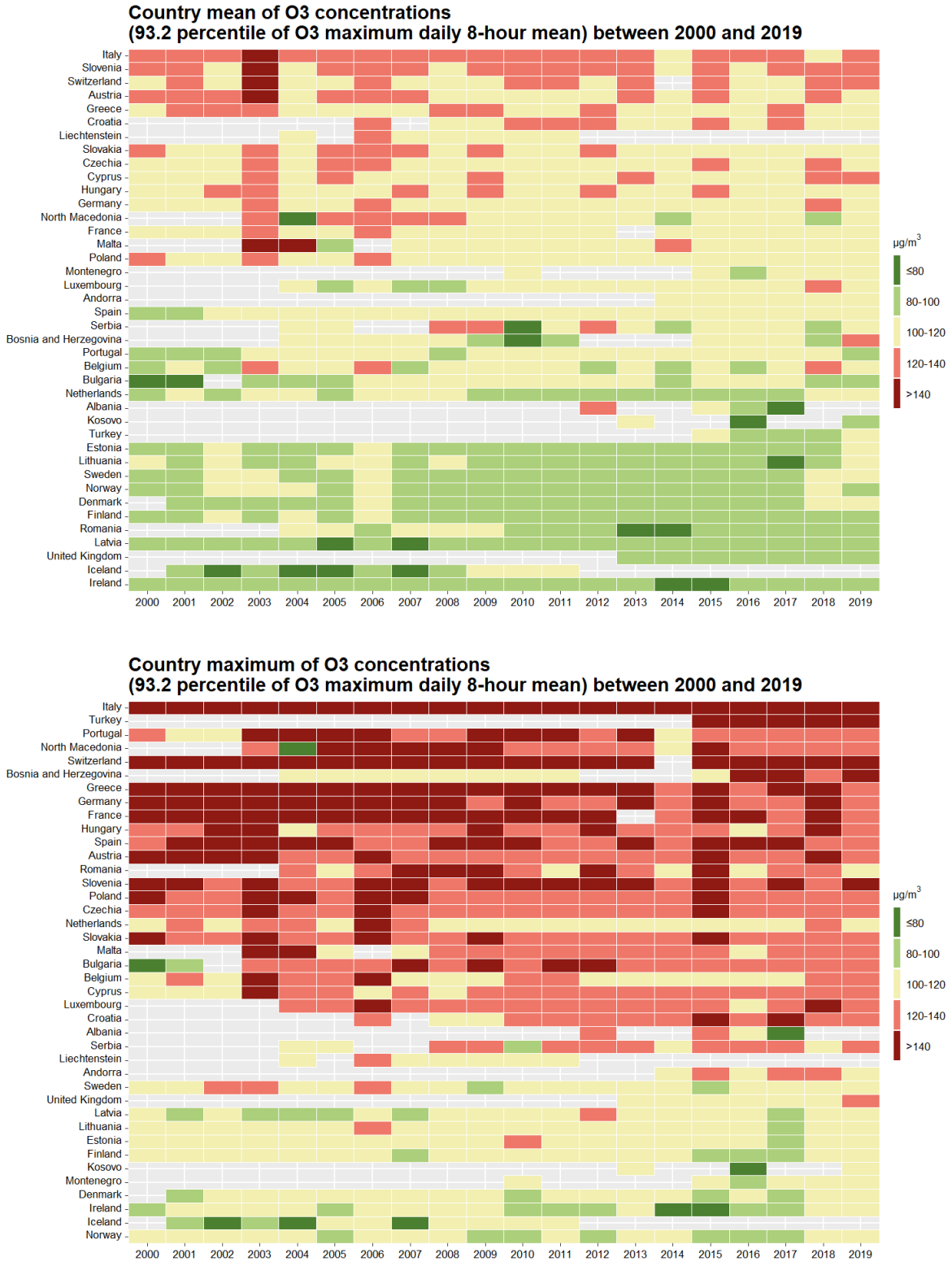
Figure 14 shows the maps of the observed 93.2 percentile of the O_3 maximum daily 8-hour mean concentrations (O_3 target value) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).



Note: Please be aware that the TV considers the average over 3 years and the maps only show the situation for one specific year.

Figure 14: Maps of O3 concentrations (related to the target value) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) O_3 concentrations (93.2 percentile of the maximum daily 8-hour mean concentration, target value) at country level are shown in figure 15. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020), especially for O_3 as higher atmospheric temperature leads to enhanced photochemical reactions and O_3 formation.



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 15: Evolution of mean (top) and maximum (bottom) O3 concentrations (93.2 percentile of the maximum daily 8-hour mean concentration, related to the target value) per country from 2000

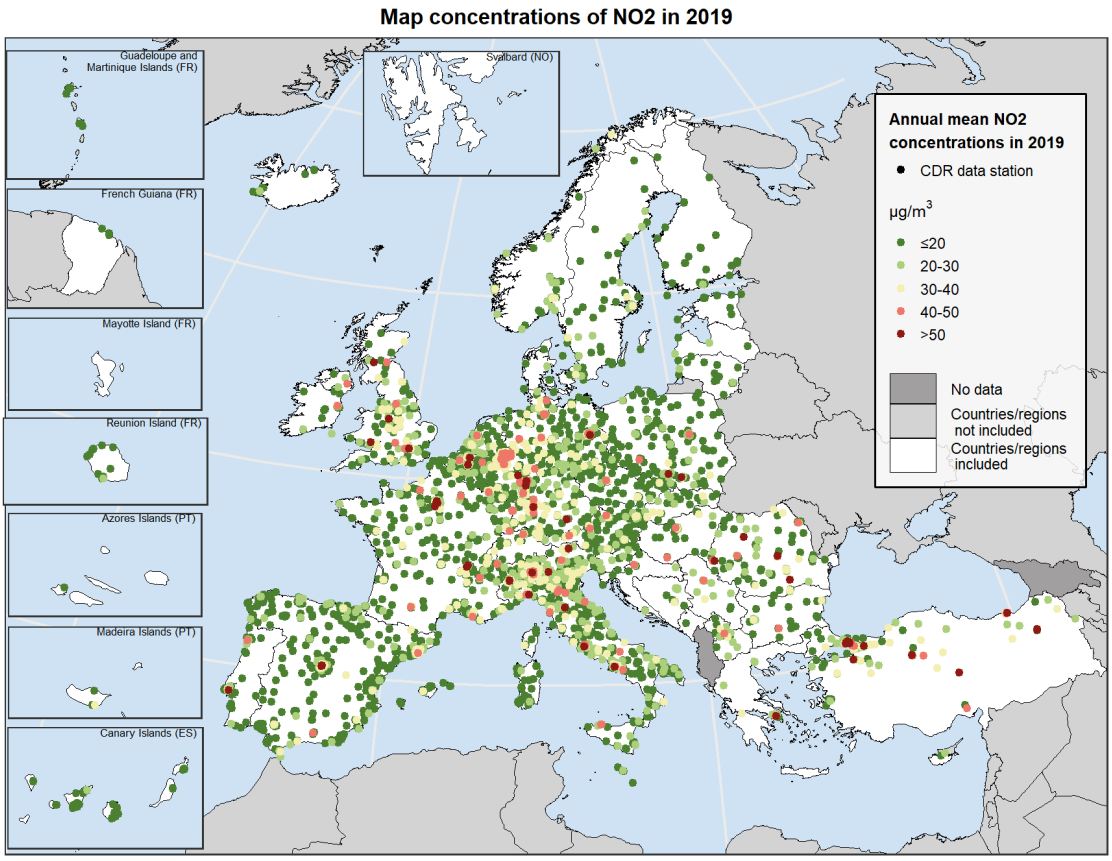
5 Status of nitrogen dioxide ambient air concentrations

The reporting countries shown in Figure 1 submitted NO_2 data from 3463 stations (for the annual limit value) and 3182 (for the hourly limit value).

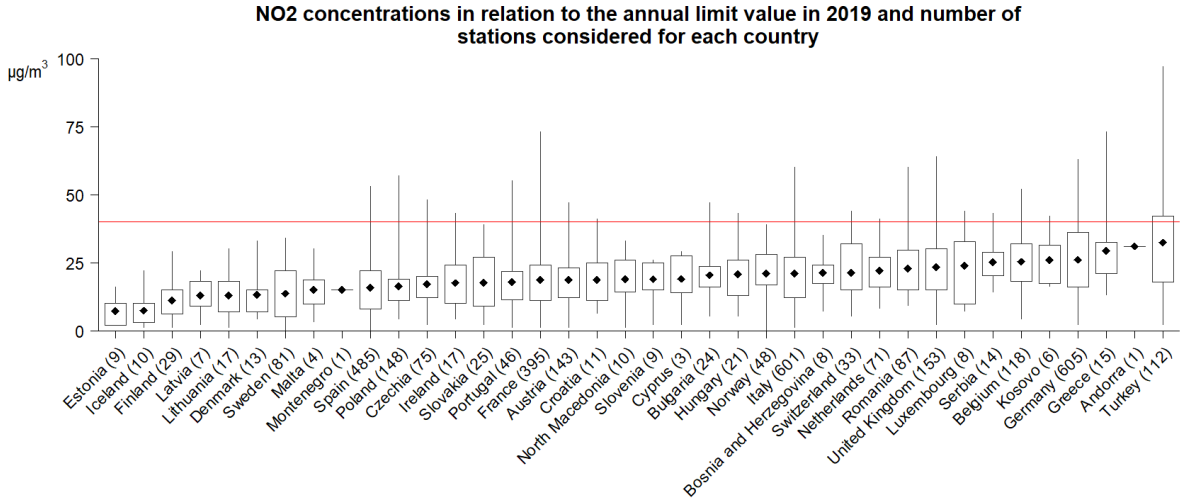
18 of the countries in EU-27 and the UK and 4 other reporting countries (Figure 16) recorded concentrations above the annual limit value (and the equal WHO AQ guideline). This happened in 6 % of all the stations measuring NO_2. Figure 16 shows the measured annual mean NO_2 concentrations.

87 % of all values above the annual limit value were observed at traffic stations. Furthermore, 99 % of the stations with concentrations above the annual limit value were located in urban or suburban areas.

Concentrations above the hourly limit value were observed in 0.3 % (11 stations) of all reporting stations, mostly at urban traffic stations. They were observed in five countries (number stations): Turkey (seven), Bosnia and Herzegovina (one), Kosovo (one), Spain (one) and United Kingdom (one).



Note: Observed concentrations of NO2 in 2019. The last two colour categories correspond to values above the EU annual limit value and the identical WHO AQG (40 $\mu g/m^3$). Only stations with more than 75 % of valid data have been included in the map.



Note: The graph is based on the annual mean concentration values. For each country, the number of stations considered (in brackets) and the lowest, highest and average values (in $\mu g/m^3$) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The limit value set by EU legislation (which is equal to that set by the WHO AQG) is marked by the horizontal line. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered.

Figure 16: Map and boxplot of NO2 concentrations in 2019

Figure 17 shows the maps of the observed NO_2 annual mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

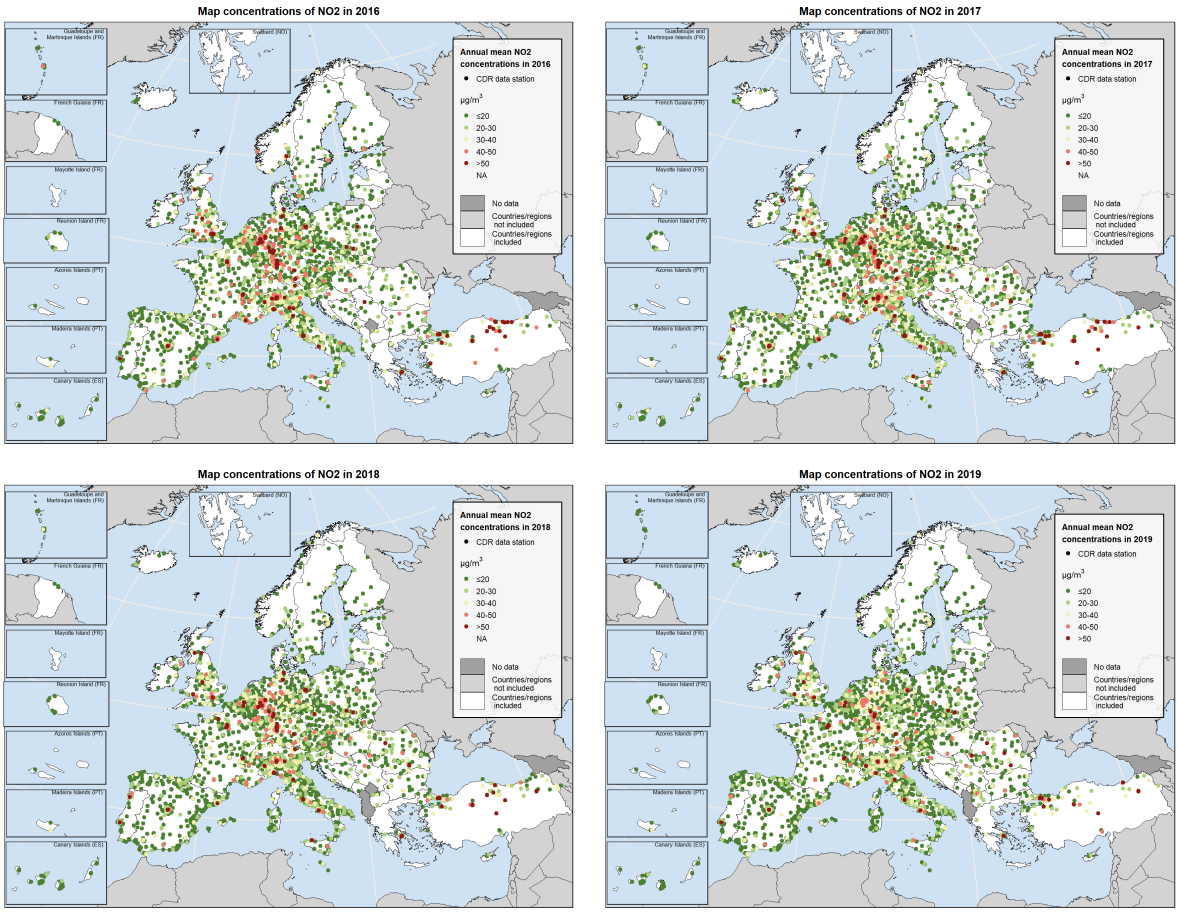
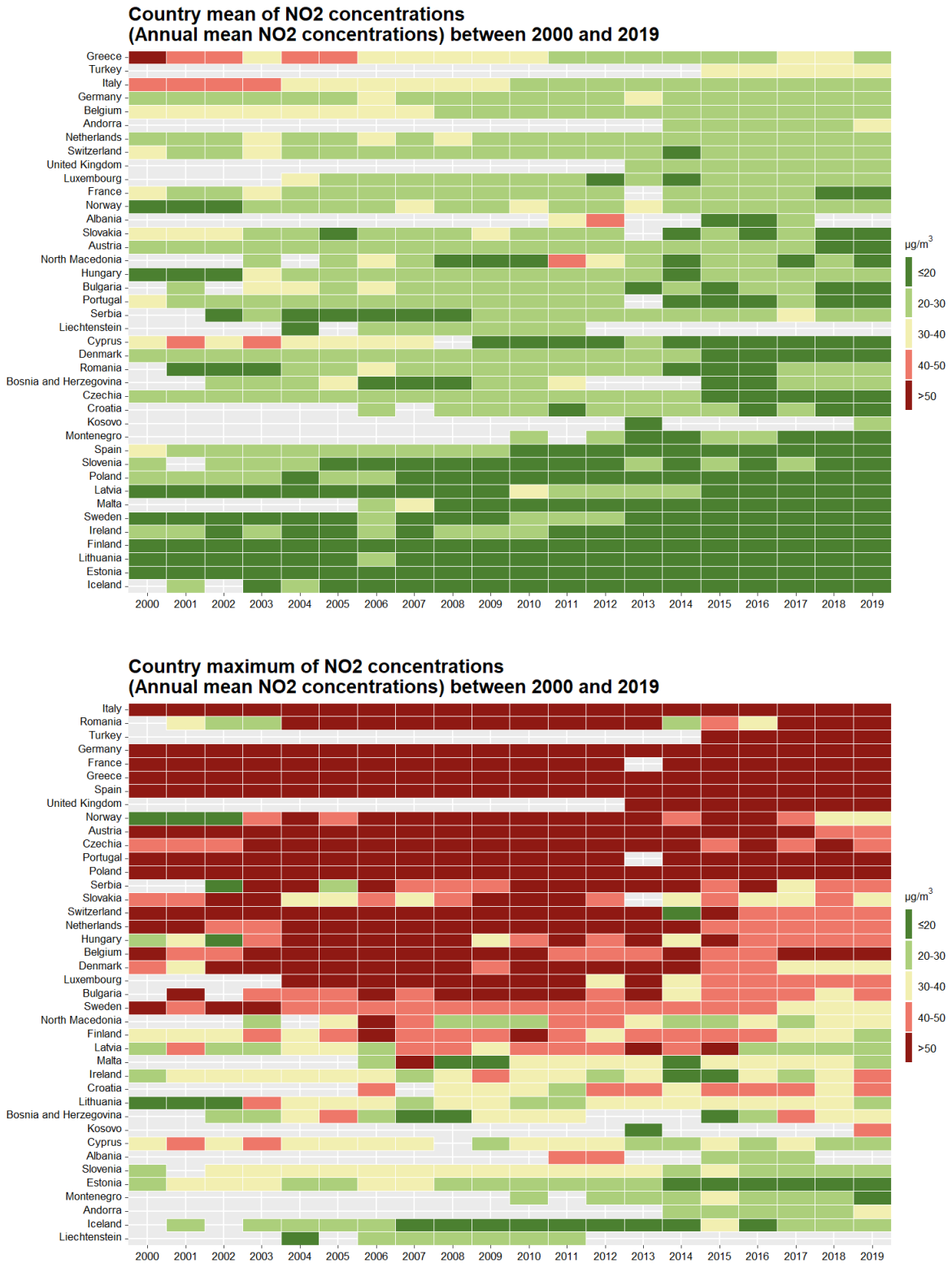


Figure 17: Maps of NO2 concentrations (annual mean) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) NO_2 annual mean concentrations at country level are shown in figure 18. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

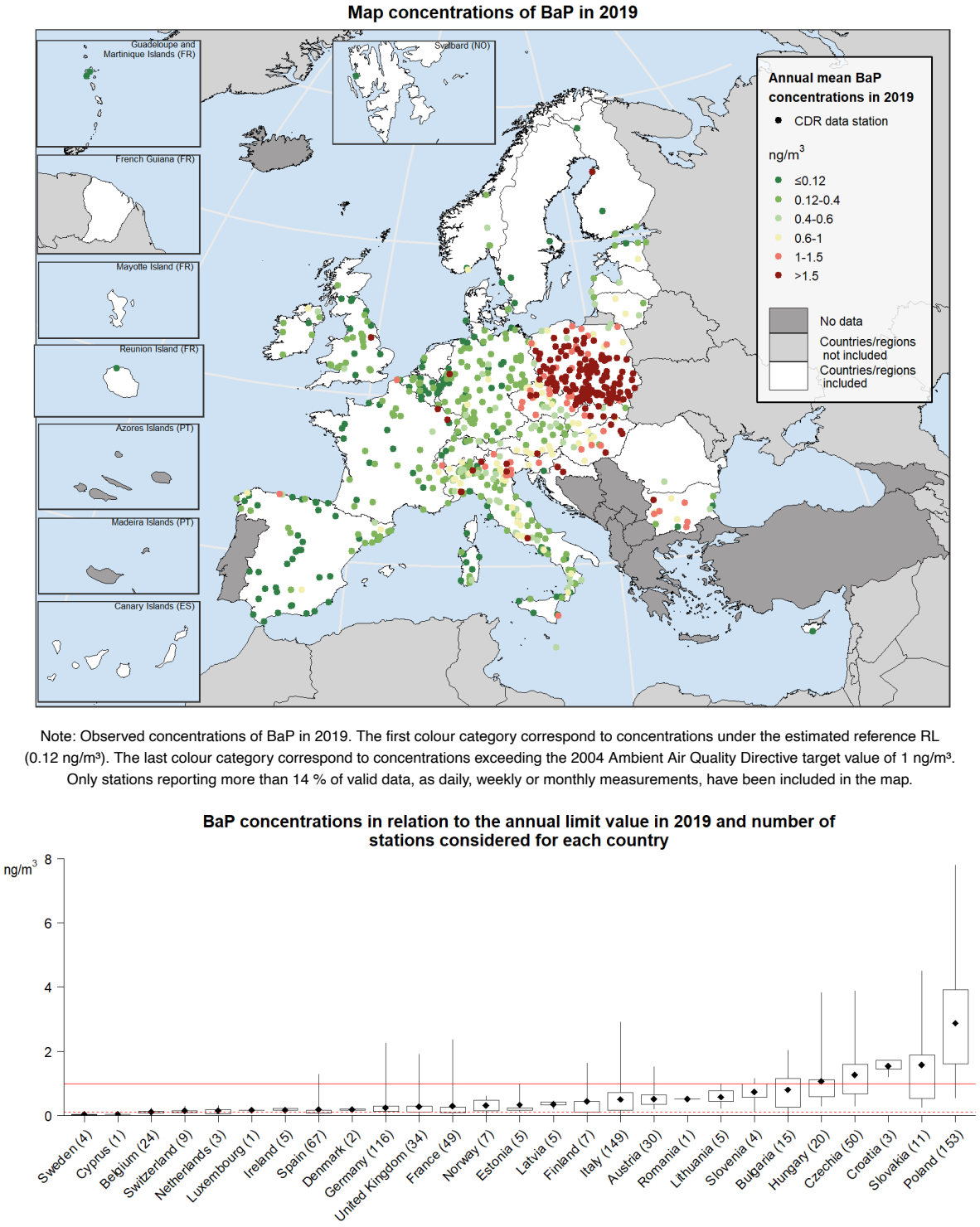
Figure 18: Evolution of mean (top) and maximum (bottom) NO2 annual mean concentrations (annual limit value) per country from 2000

6 Status of benzo[a]pyrene ambient air concentrations

A total of 780 stations in the reporting countries shown in Figure 1 reported BaP data with sufficient data coverage.

14 countries measured concentrations above 1.0 ng/m^3 (Figure 19). These were measured at 27 % of the reported BaP measurement stations (Figure 19), mainly at urban (77 % of all stations with values above 1.0 ng/m^3) and suburban (17 %) stations.

Regarding the reference level, all reporting countries, except for Cyprus and Sweden have at least one station with concentrations above 0.12 ng/m^3. Only 19 % of the reported stations had annual concentrations below the reference level.



Note: Observed concentrations of BaP in 2019. The first colour category correspond to concentrations under the estimated reference RL (0.12 ng/m³). The last colour category correspond to concentrations exceeding the 2004 Ambient Air Quality Directive target value of 1 ng/m³. Only stations reporting more than 14 % of valid data, as daily, weekly or monthly measurements, have been included in the map.

Note: The graph is based on the annual mean concentration values. For each country, the number of stations considered (in brackets), and the lowest, highest and average values (in ng/m³) recorded at its stations are given. The rectangles mark the 25th and 75th percentiles. At 25 % of the stations, levels are below the lower percentile; at 25 % of the stations, concentrations are above the upper percentile. The upper horizontal line marks the concentration of 1.0 ng/m³. The lower horizontal line marks the estimated air quality RL. The graph should be read in relation to the above map, as a country's situation depends on the number of stations considered.

Figure 19: Map and boxplot of BaP concentrations in 2019

The highest value in the boxplot, Poland (9.8 ng/m^3), has not been included in the graph for representation purposes.

Figure 20 shows the maps of the observed BaP annual mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

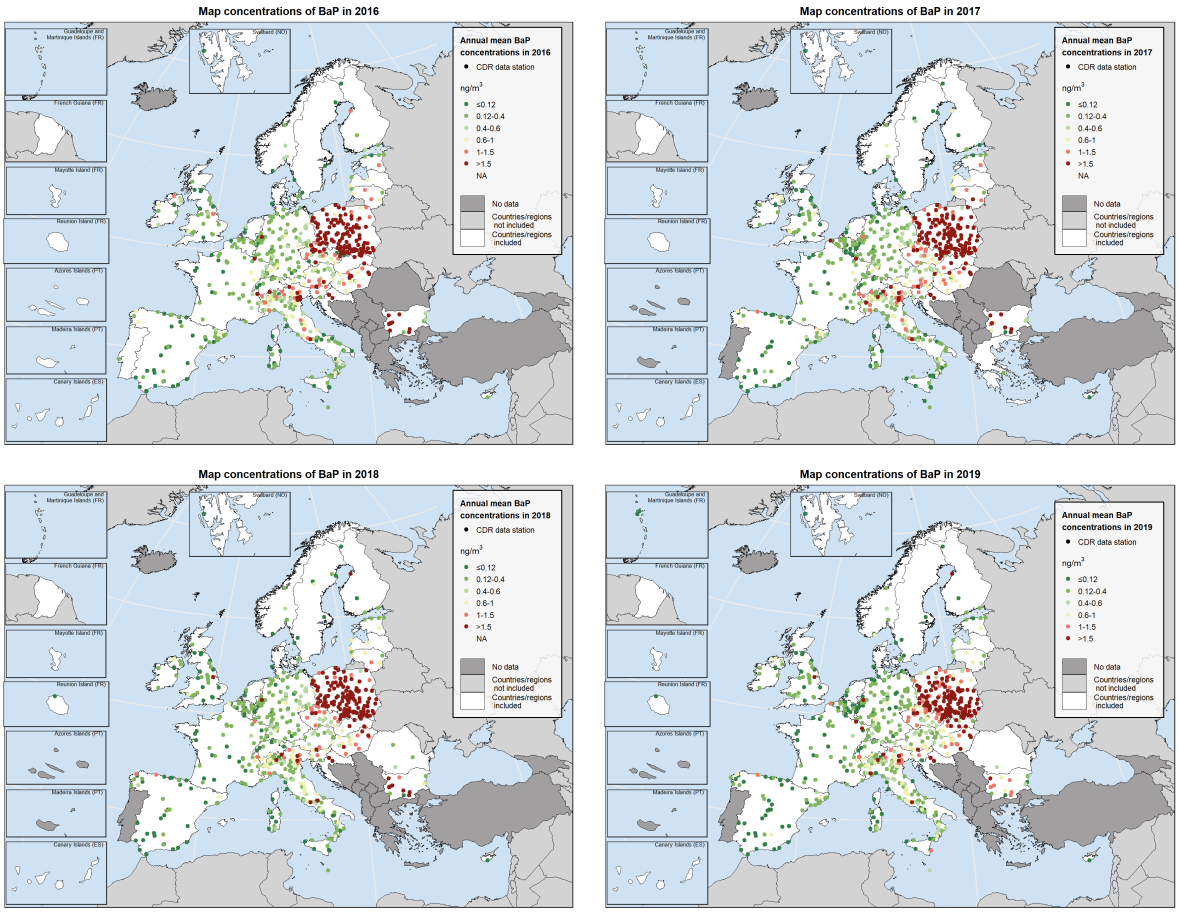
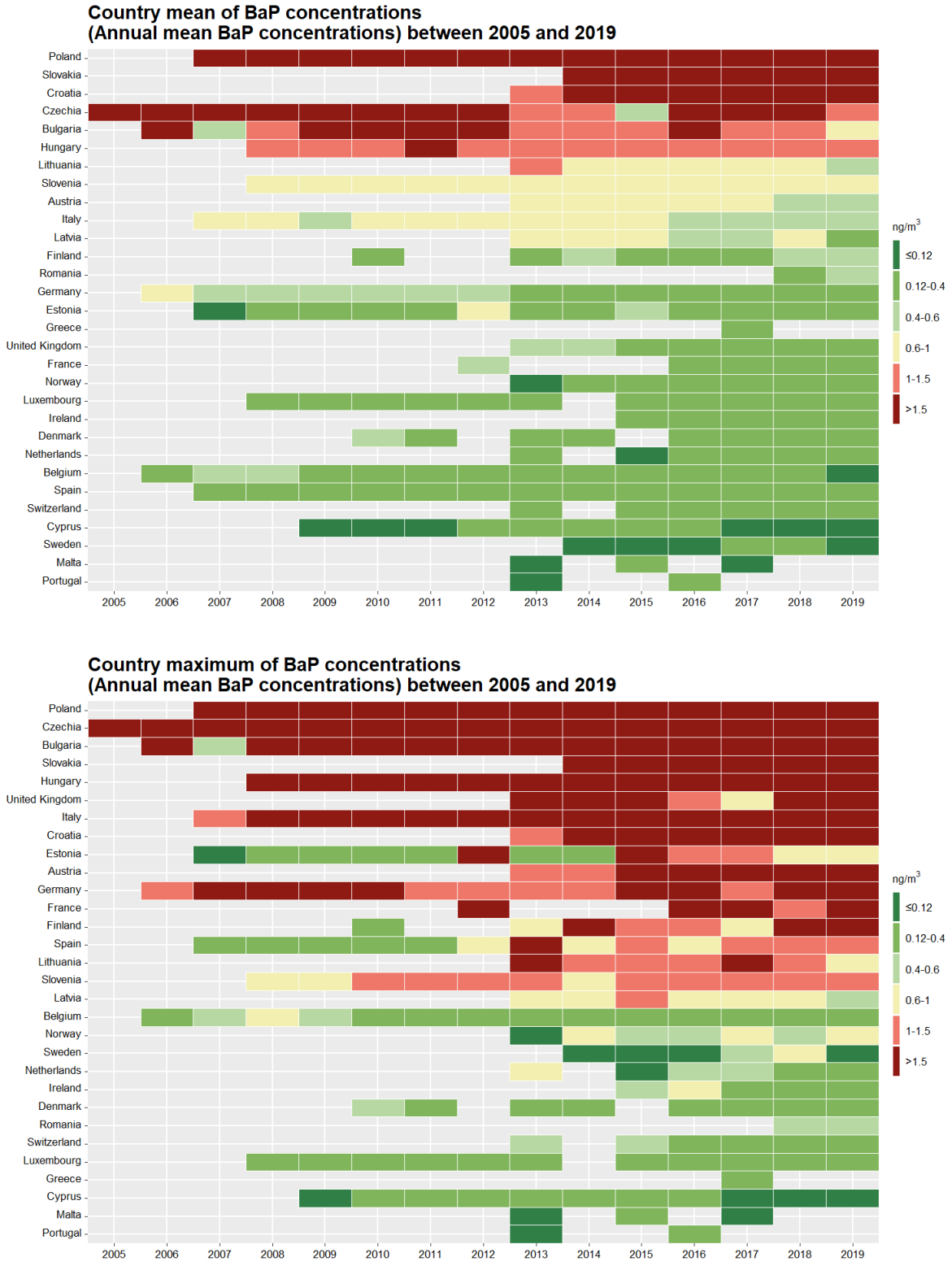


Figure 20: Maps of BaP concentrations (annual mean) for the last 4 years

Heatmaps with the evolution from 2005 of the mean (top) and the maximum (bottom) BaP annual mean concentrations at country level are shown in figure 21. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 21: Evolution of mean (top) and maximum (bottom) BaP annual mean concentrations (targe value) per country from 2005

7 Status of sulphur dioxide, carbon monoxide, benzene and toxic metals ambient air concentrations

7.1 Sulphur dioxide

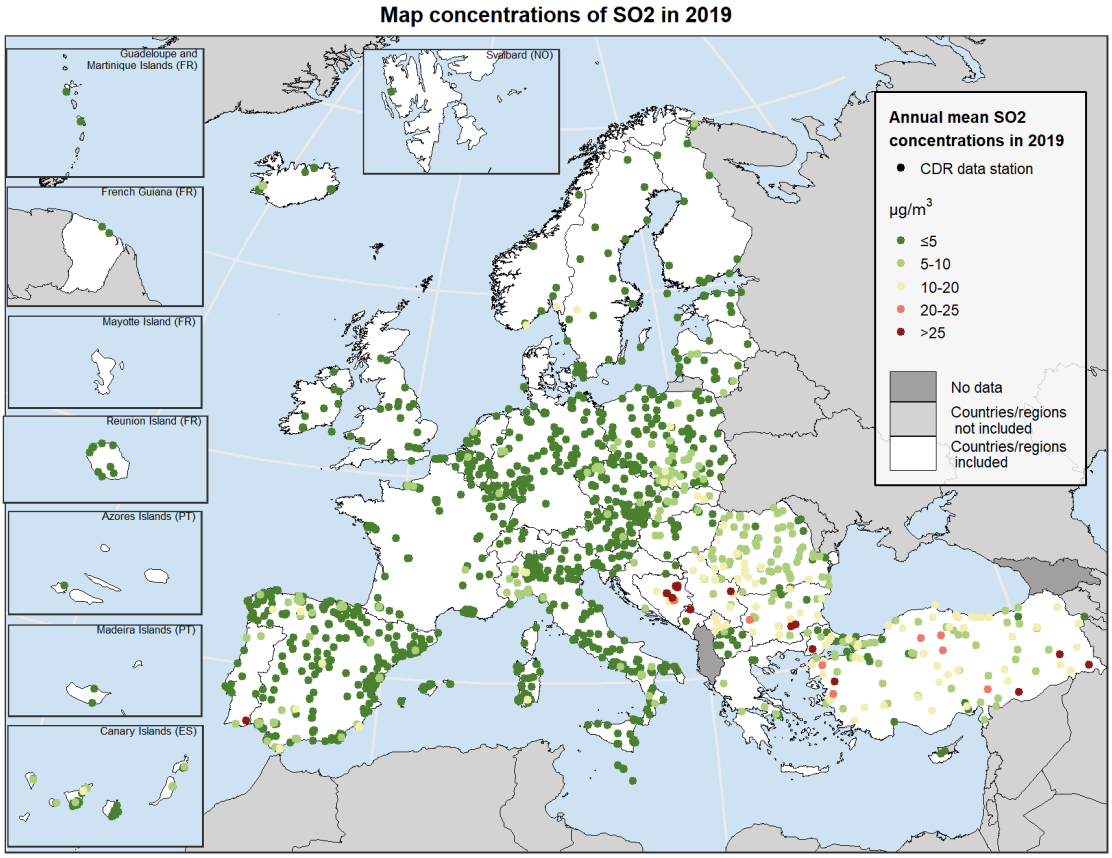
The reporting countries shown in Figure 1 reported measurements of SO_2 from 1631 stations for the hourly limit value and 1631 stations for the daily limit value.

15 stations ([3]) registered concentrations above the hourly limit value; and 19 stations ([4]) registered concentrations above the daily limit value for SO_2.

On the contrary, 511 (31 %) of all the stations reporting SO_2 levels, located in 30 reporting countries ([5]), measured SO_2 concentrations above the WHO AQG of 20 µg/m^3 for daily mean concentrations.

Figure 22 shows annual mean SO_2 concentrations. Though the annual mean is not linked to the limit values for the protection of human health, it is linked to the vegetation critical level (20 µg/m^3 as an annual mean) and provides a comparison of the situation across Europe.

[3] Turkey (seven), Bosnia and Herzegovina (five), Serbia (two) and Bulgaria (one)
[4] Turkey (eight), Bosnia and Herzegovina (six), Serbia (two), Bulgaria (one), Italy (one) and Montenegro (one).
[5] All reporting countries except Andorra, Cyprus, Denmark, Latvia, Luxembourg, Malta, Slovenia and Switzerland.



Note: Observed concentrations of SO2 in 2019. The map shows the SO2 annual mean, which relates to the vegetation critical level (20 $\mu g/m^3$). Only stations with more than 75 % of valid data have been included in the map.

Figure 22: Map of SO2 concentrations in 2019

Figure 23 shows the maps of the observed SO_2 annual mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

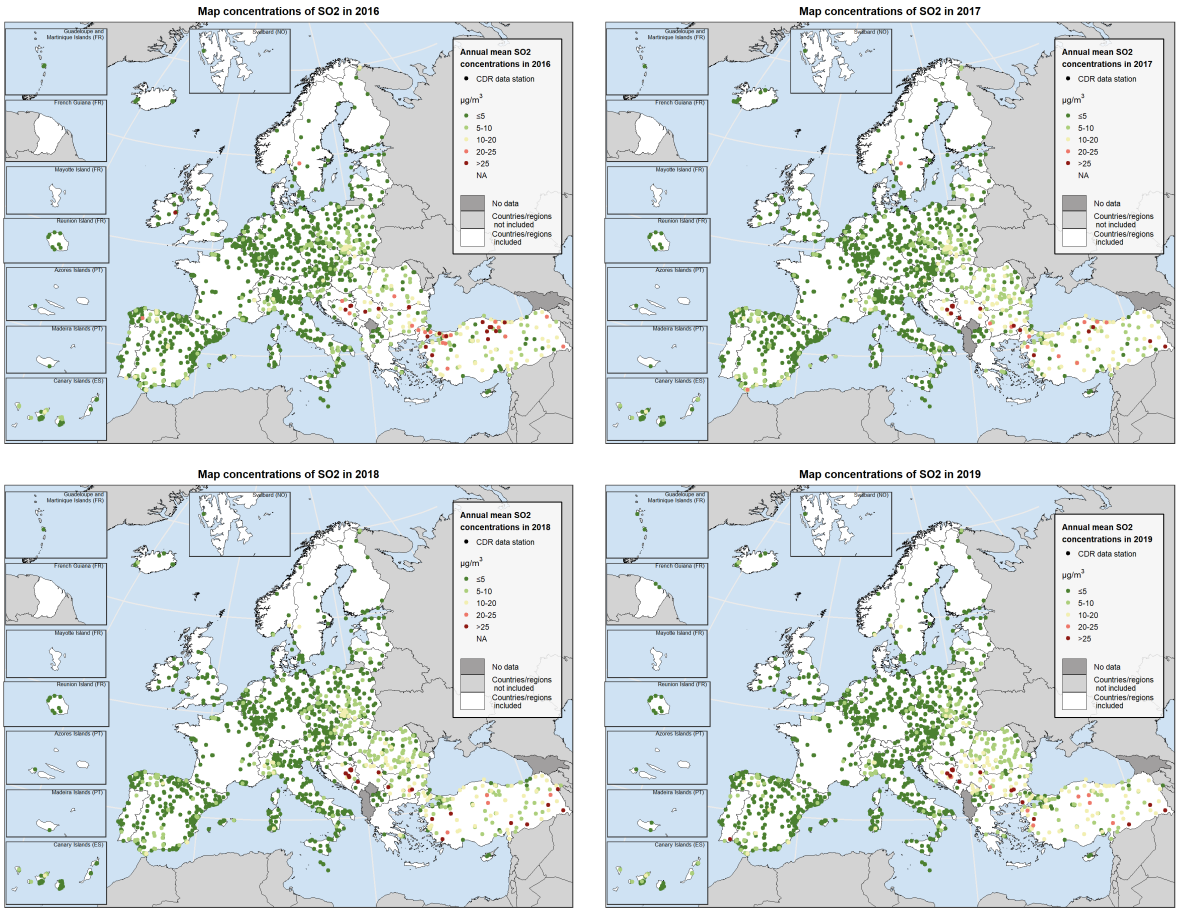
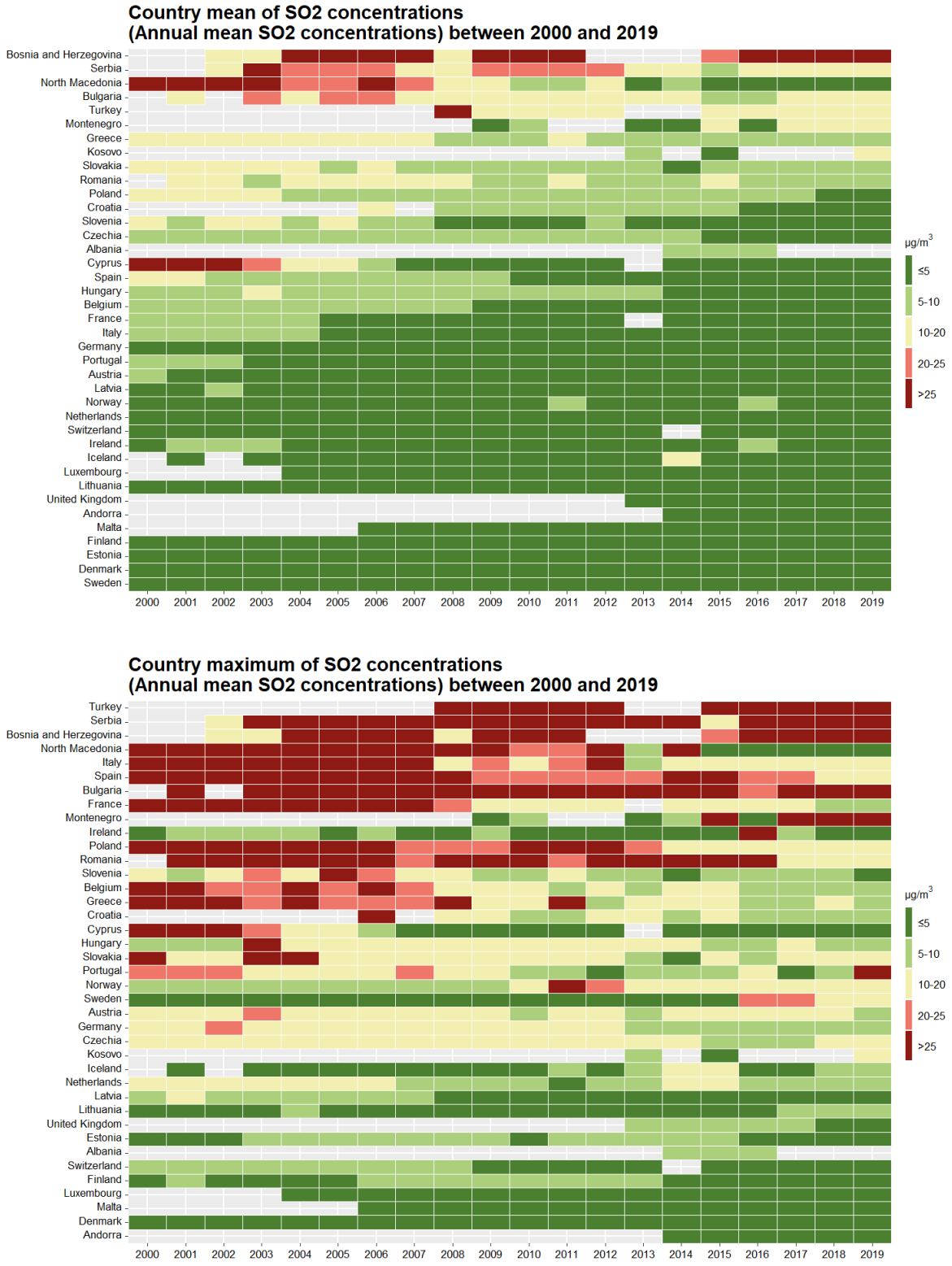


Figure 23: Maps of SO2 concentrations (annual mean) for the last 4 years

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) SO_2 annual mean concentrations at country level are shown in figure 24. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).

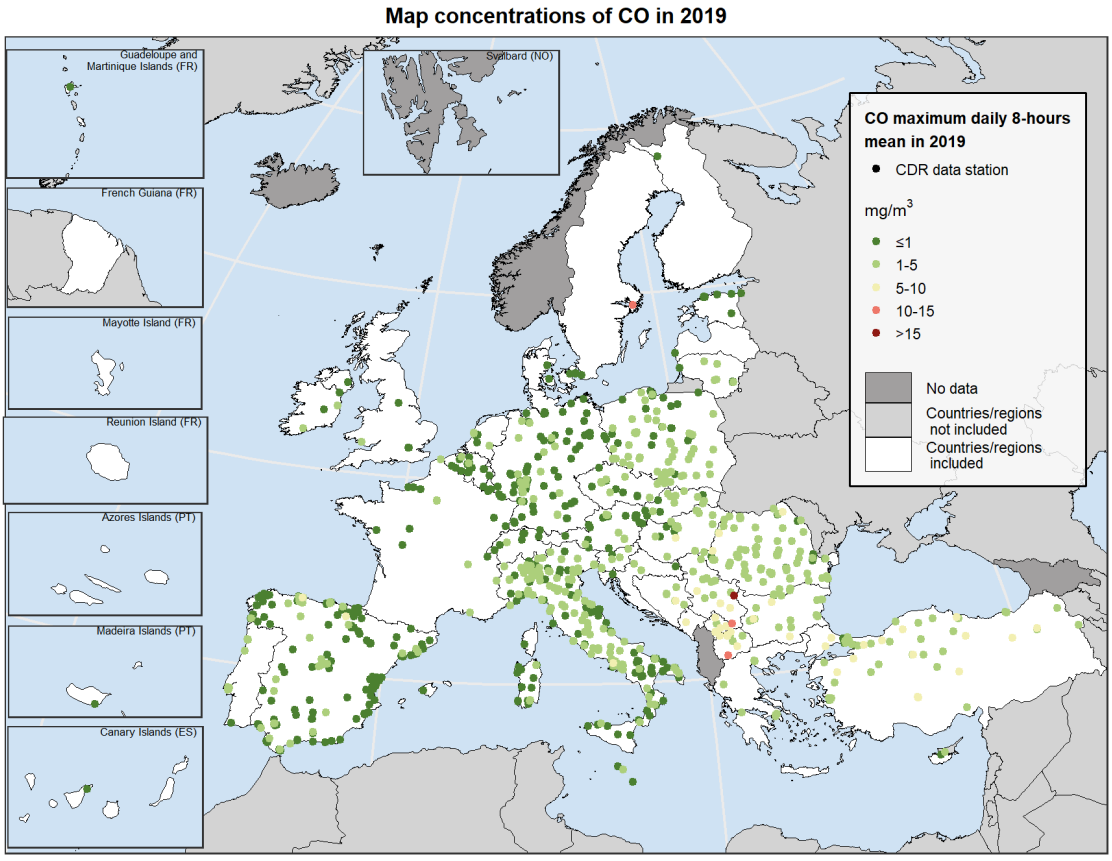


Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 24: Evolution of mean (top) and maximum (bottom) SO2 annual mean concentrations (vegetation critical level (20 µg/m³) per country from 2000

7.2 Carbon monoxide

All reporting countries shown in Figure 1 measured CO data from 963 operational stations. Only 4 stations registered concentrations above the CO limit value and the WHO AQG value: Serbia (two), North Macedonia (one) and Sweden (one).

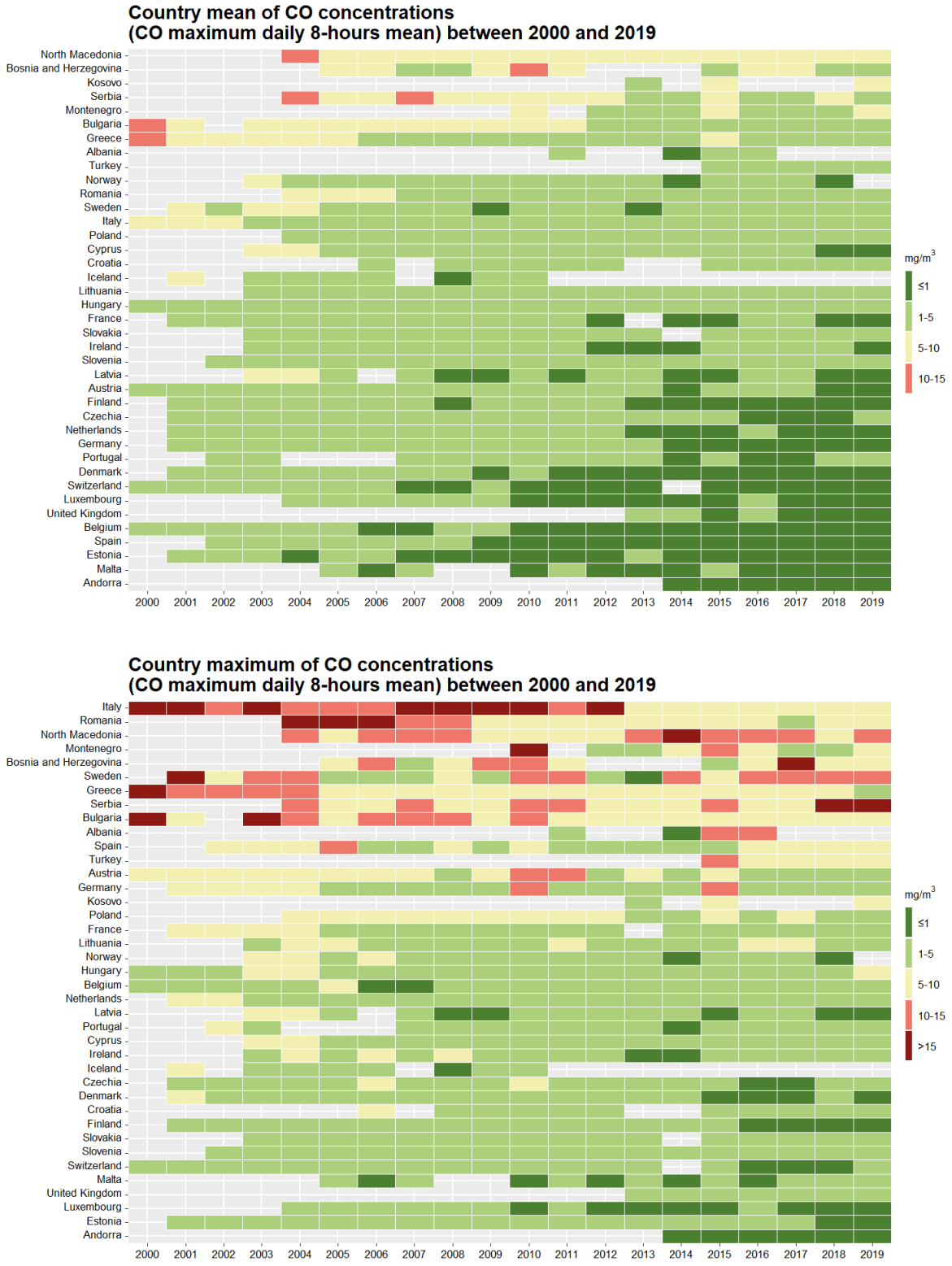


Note: Observed concentrations of CO in 2019. The map shows the CO maximum daily 8–hour mean. The last two colour categories correspond the values above the EU annual limit value and the WHO AQG (10 mg/m³). Only stations with more than 75 % of valid data have been included in the map.

Figure 25: Map of CO concentrations in 2019

When concentrations are below the 'lower assessment threshold' (LAT), air quality can be assessed by means of only modelling or objective estimates. At 919 stations (95 % of locations), maximum daily 8-hour mean concentrations of CO were below the LAT of 5 mg/m^3 (first two colour categories in Figure 25).

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) CO maximum daily 8-hour mean concentrations at country level are shown in Figure 26. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

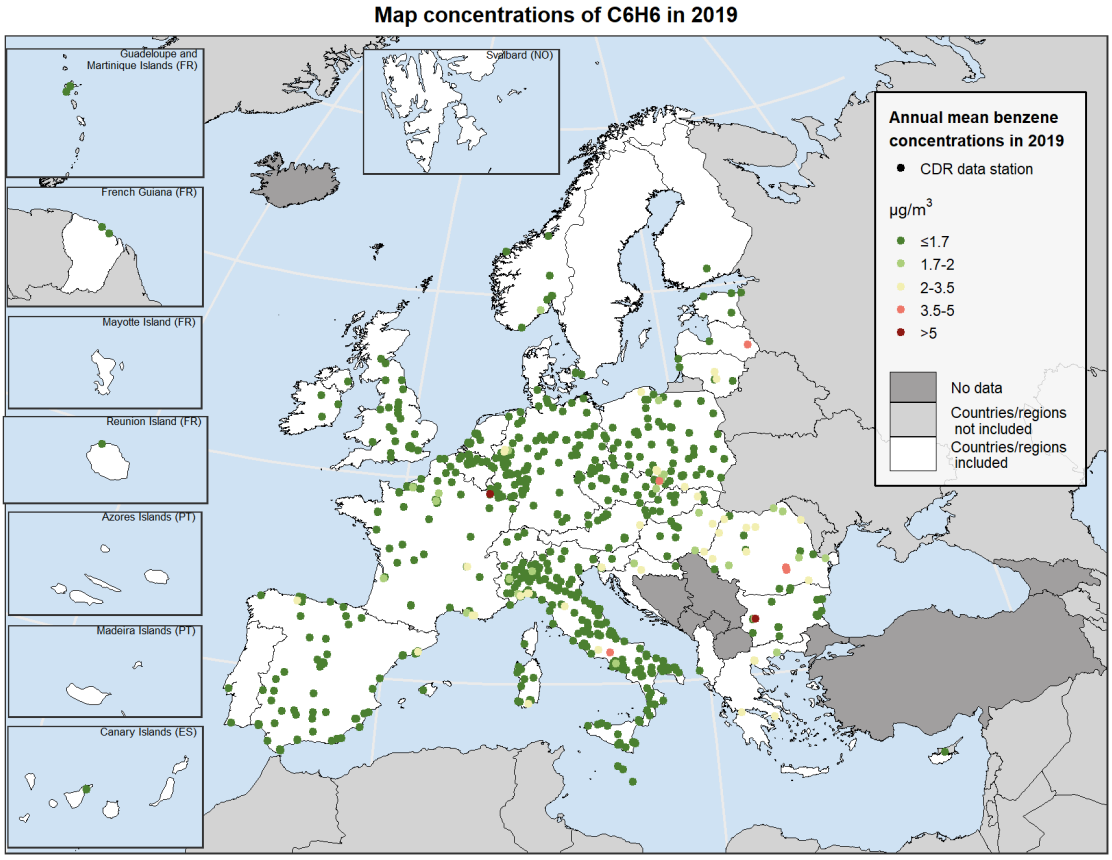
Figure 26: Evolution of mean (top) and maximum (bottom) CO maximum daily 8-hour mean concentrations (limit value) per country from 2000

7.3 Benzene

C_6H_6 measurements were reported from a total of 749 stations in the reporting countries shown in Figure 1.

Only 2 stations measured concentrations above 5.0 µg/m^3 located in: Bulgaria (one) and France (one). At 93 % of locations, annual mean concentrations of C_6H_6 were below the LAT of 2 µg/m^3 (first two colour categories in Figure 27).

Regarding the estimated WHO reference level, 11 % of all stations reported concentrations above this reference level, distributed across 15 European countries ([6]) (Figure 27).

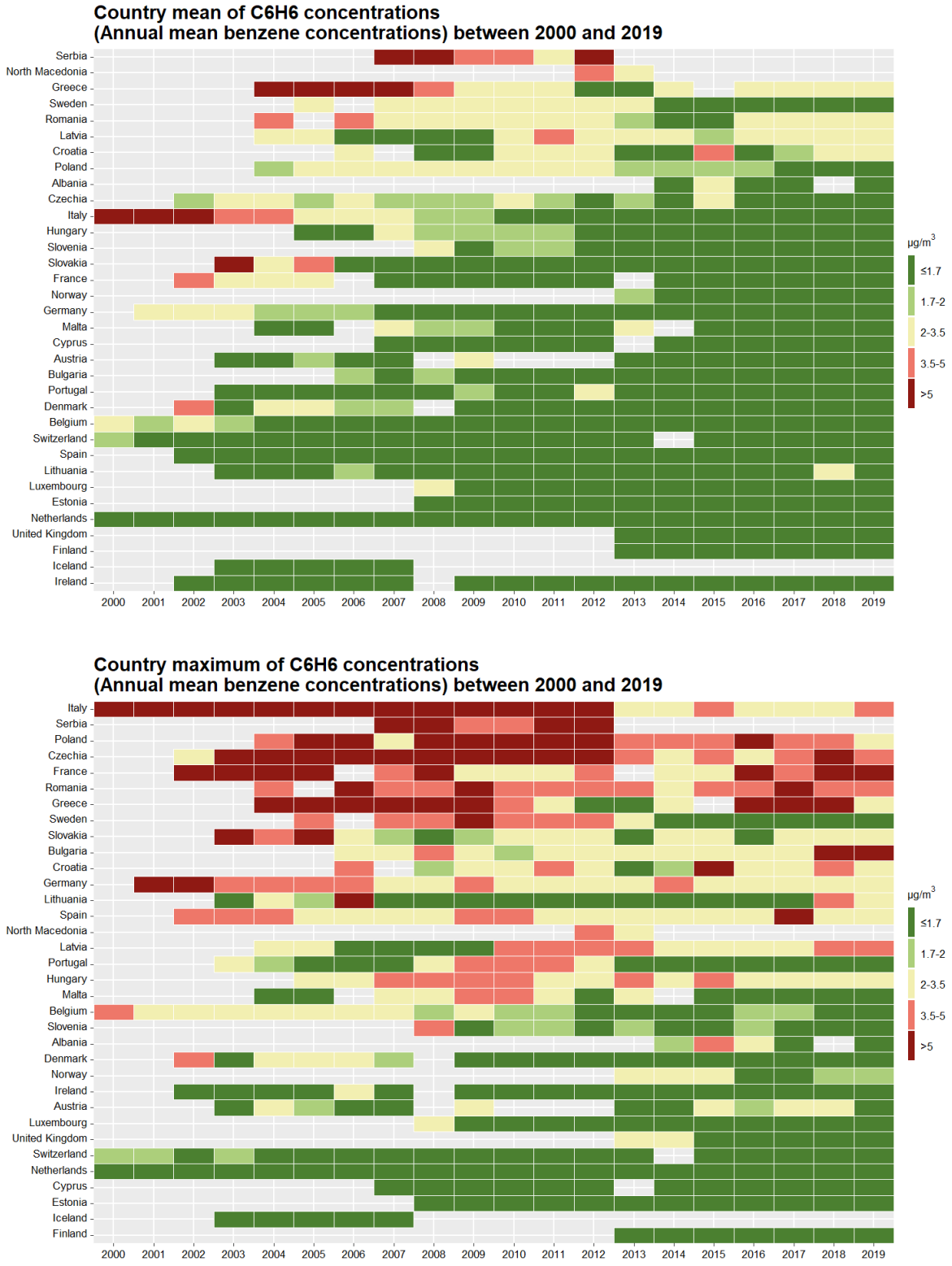


Note: Observed concentrations of C6H6 in 2019. The last colour category correspond to concentrations above the limit value of 5 µg/m³. The first colour category correspond to concentrations under the estimated WHO RL (1.7 µg/m³). Only stations reporting more than 50 % of valid data have been included in the map.

Figure 27: Map of C6H6 concentrations in 2019

[6] Bulgaria, Croatia, Czechia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Romania, Slovakia and Spain

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) C_6H_6 annual mean concentrations at country level are shown in Figure 28. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).

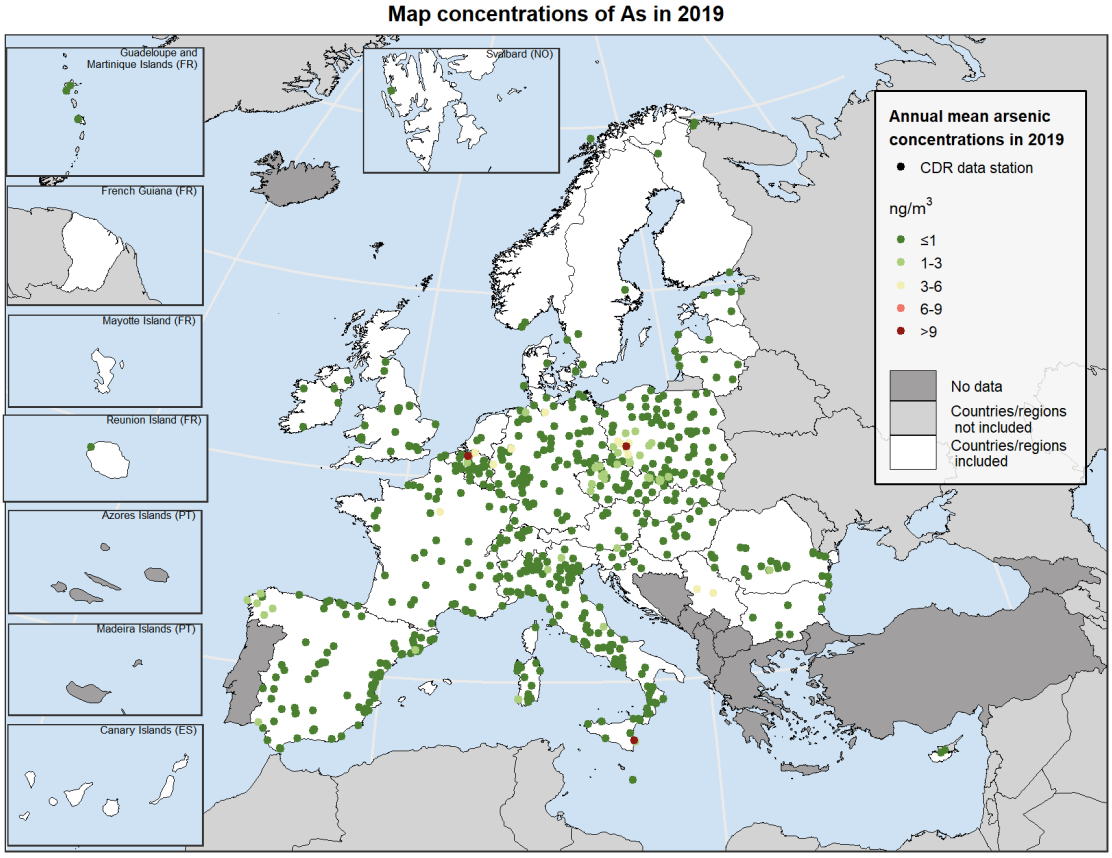


Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 28: Evolution of mean (top) and maximum (bottom) C6H6 annual mean concentrations (limit value) per country from 2000

7.4 Toxic metals

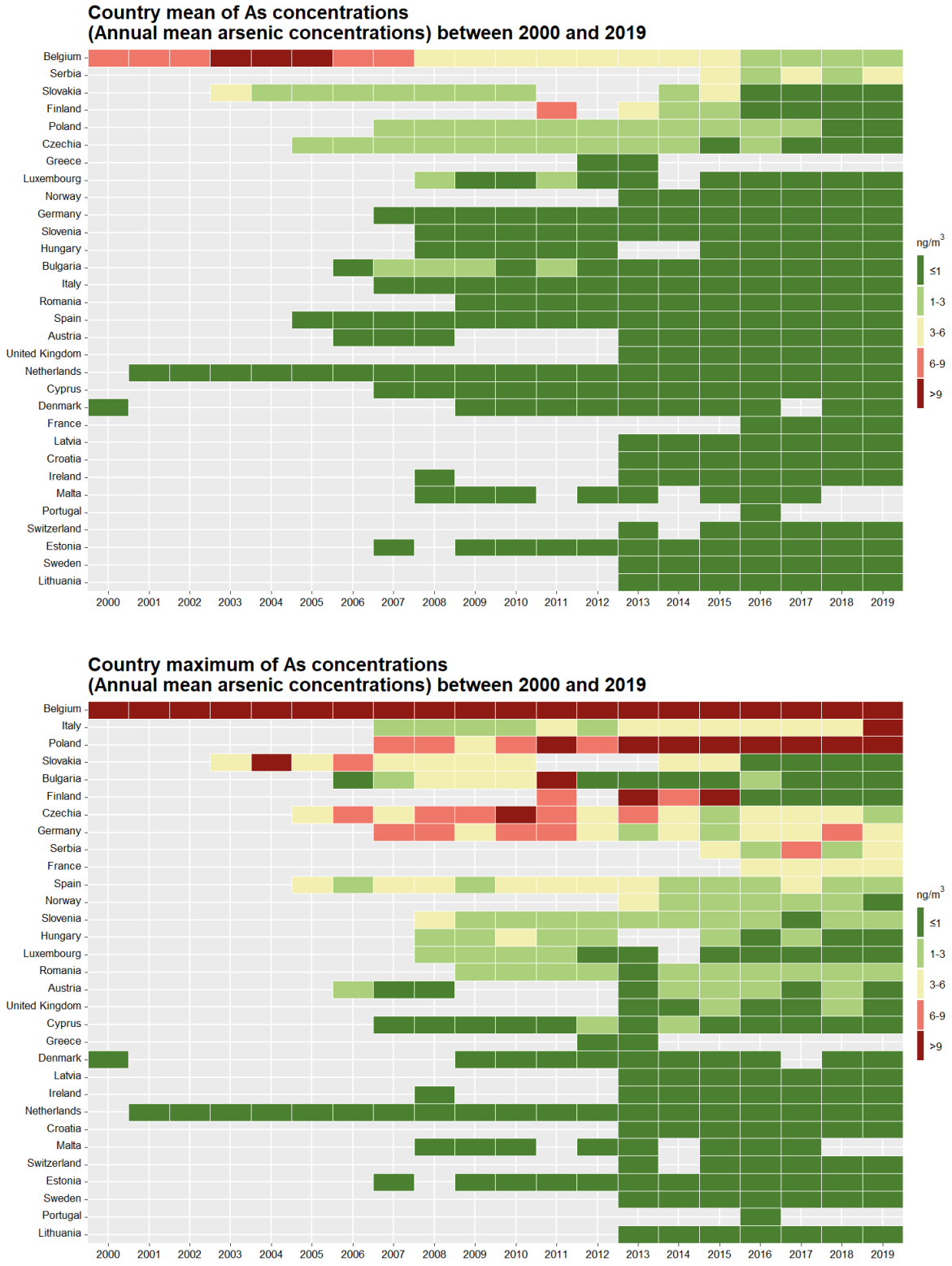
Data for **Arsenic** (As) were reported from 699 stations in the reporting countries shown in Figure 1. 5 stations measured concentrations above the target value (6 ng/m^3), located in: Belgium (three), Italy (one) and Poland (one), and 2 of these were industrial. Concentrations of As below the LAT (2.4 ng/m^3) were reported at 96 % of the stations (Figure 29).



Note: Observed concentrations of As in 2019. The last two colour categories correspond to concentrations above the EU target value. Only stations reporting more than 14 % of valid data have been included in the map.

Figure 29: Map of As concentrations in 2019

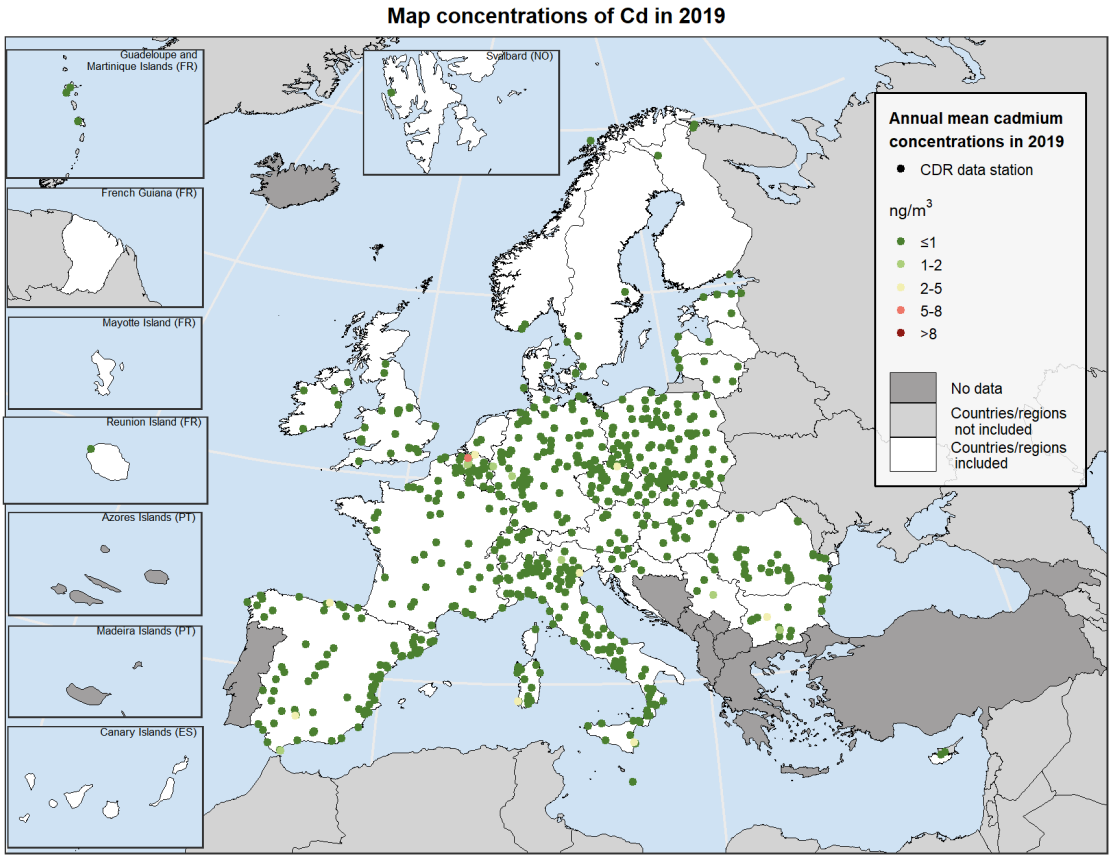
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) As annual mean concentrations at country level are shown in Figure 30. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 30: Evolution of mean (top) and maximum (bottom) As annual mean concentrations (target value) per country from 2000

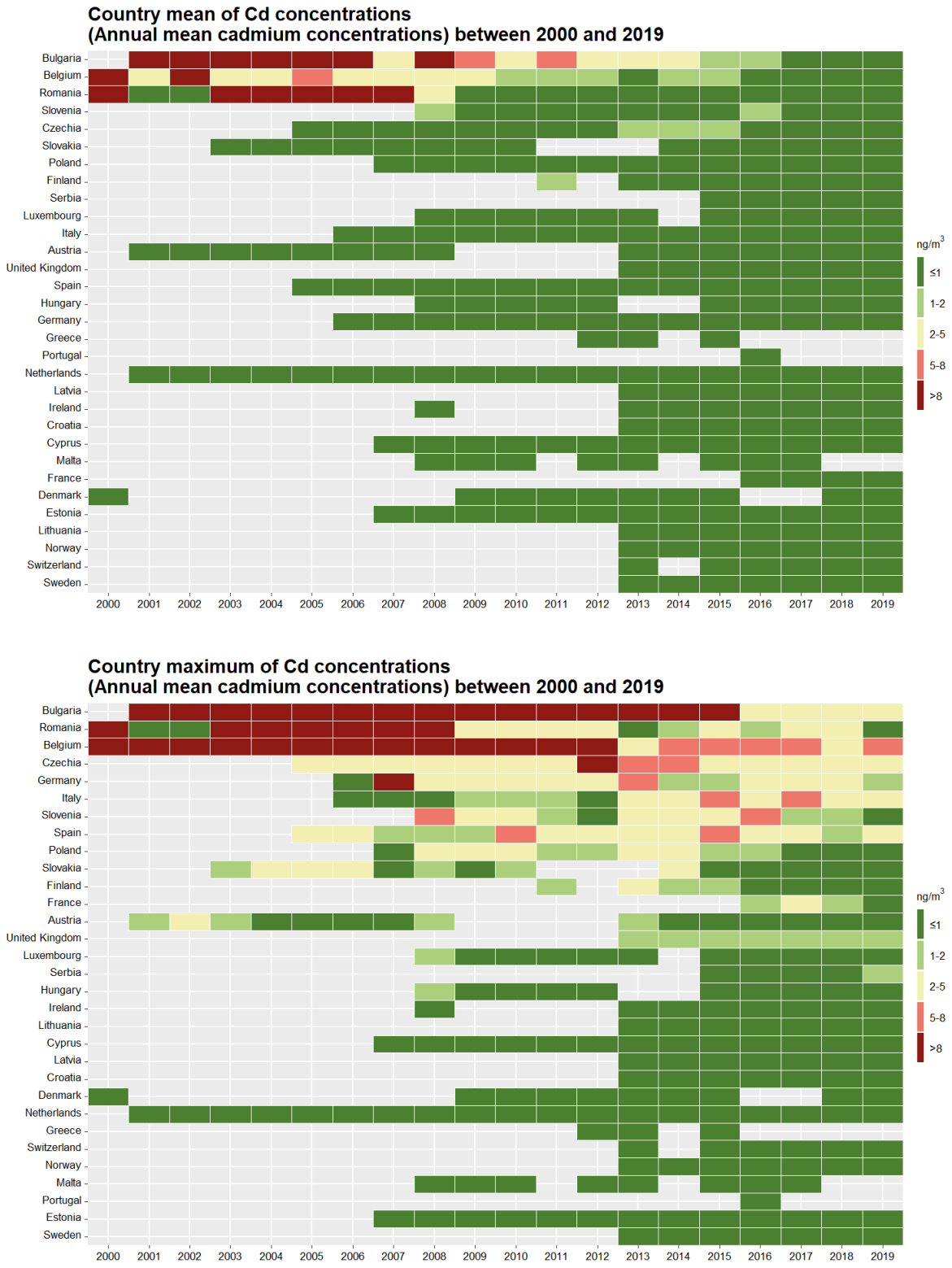
Cadmium (Cd) data were reported from 728 stations in the reporting countries shown in Figure 1. Concentrations above the target value (5 ng/m^3) were measured at 1 station located in: Belgium (one). At the great majority of stations (98 %), Cd concentrations were below the LAT (2 ng/m^3).



Note: Observed concentrations of Cd in 2019. The last two colour categories correspond to concentrations above the target value. Only stations reporting more than 14 % of valid data have been included in the map.

Figure 31: Map of Cd concentrations in 2019

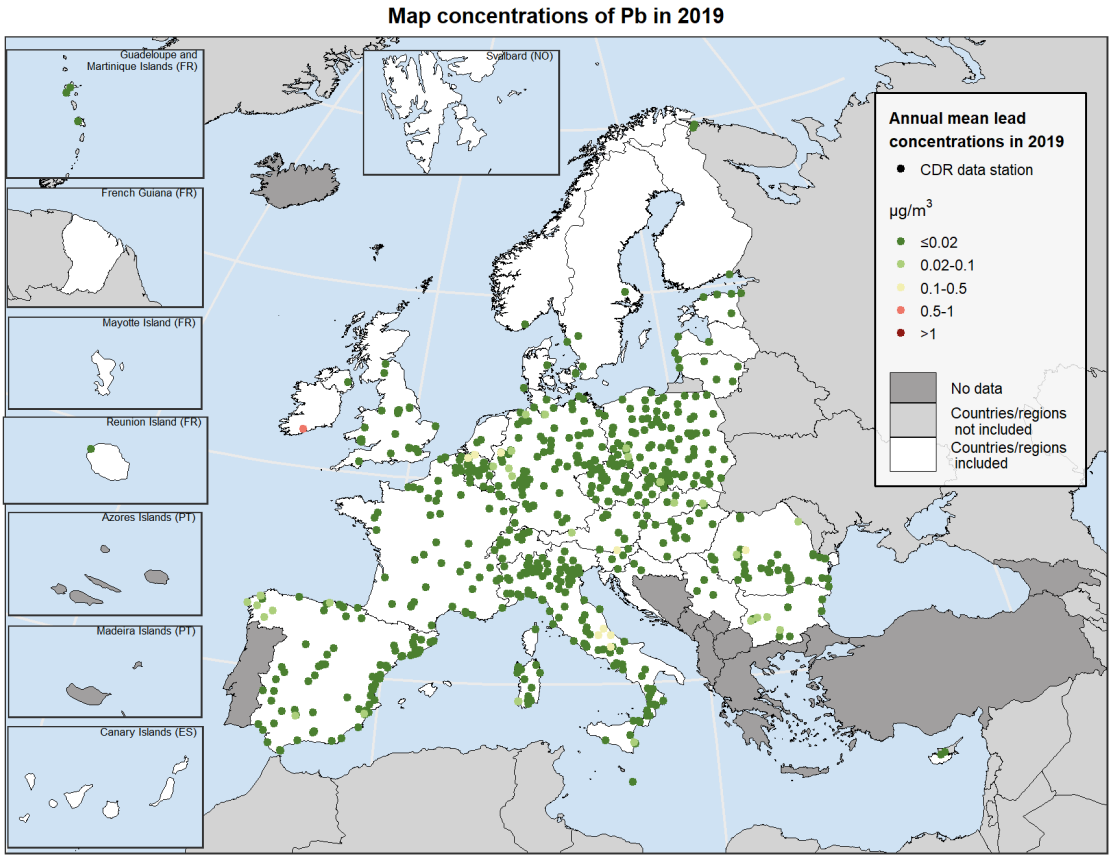
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) Cd annual mean concentrations at country level are shown in Figure 32. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 32: Evolution of mean (top) and maximum (bottom) Cd annual mean concentrations (target value) per country from 2000

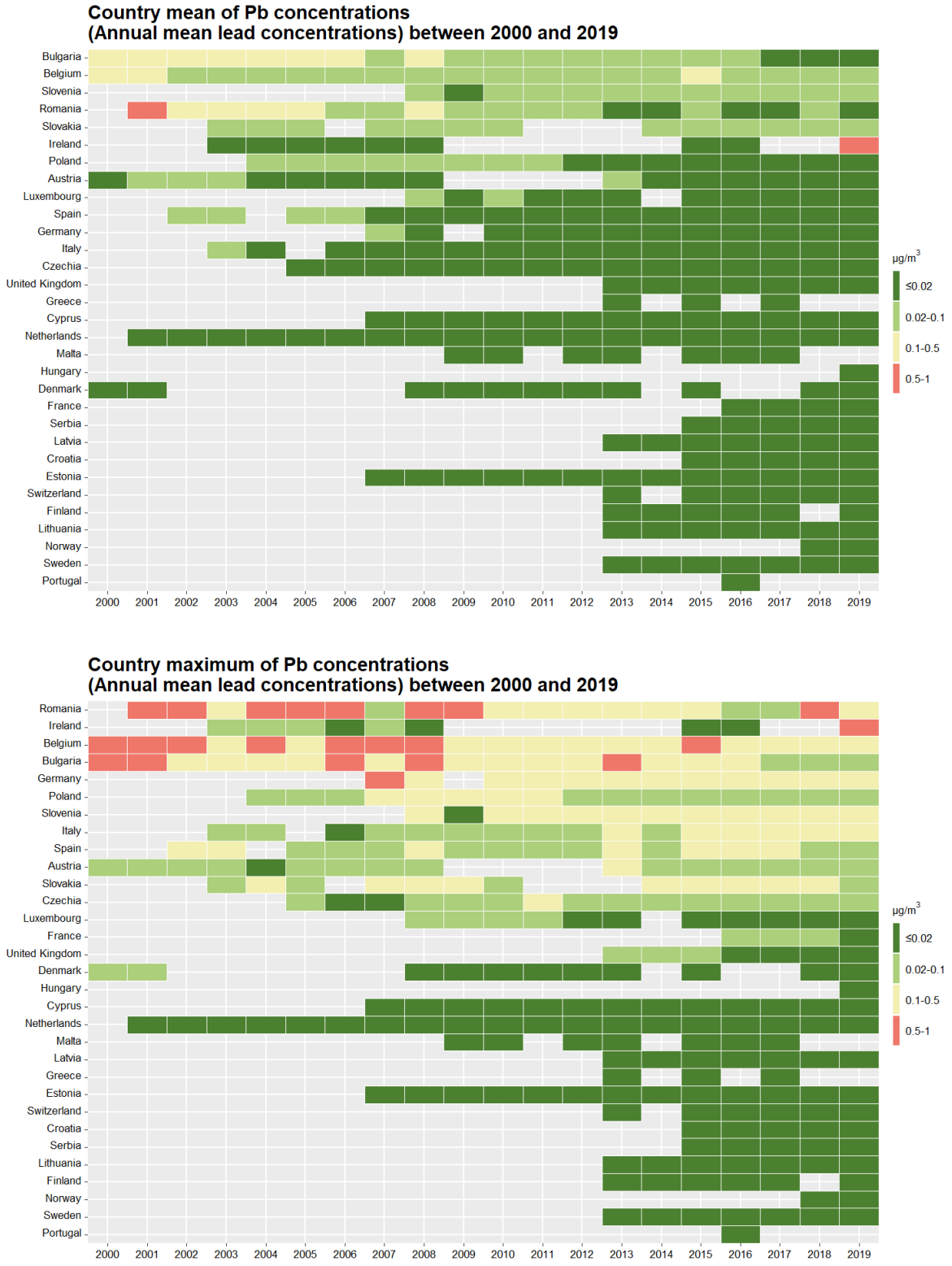
Lead (Pb) data were reported from 723 stations in the reporting countries shown in Figure 1. 1 station located in: Ireland (one) reported Pb concentrations above the 0.5 µg/m^3 limit value. 717 stations (99 % of the total) reported Pb concentrations below the LAT of 0.25 µg/m^3.



Note: Observed concentrations of Pb in 2019. The last two colour categories correspond to concentrations above the EU annual limit value. Only stations reporting more than 14 % of valid data have been included in the map. Source: EEA, 2019.

Figure 33: Map of Pb concentrations in 2019

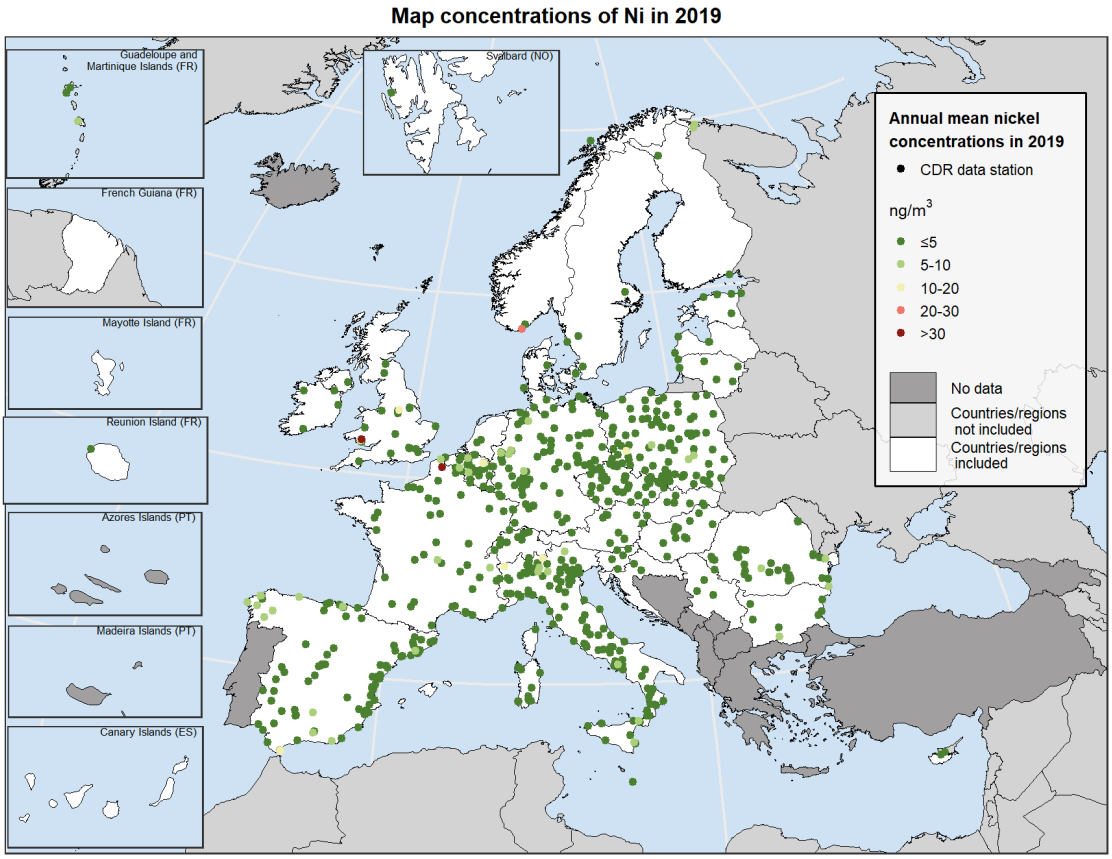
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) Pb annual mean concentrations at country level are shown in Figure 34. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 34: Evolution of mean (top) and maximum (bottom) Pb annual mean concentrations (limit value) per country from 2000

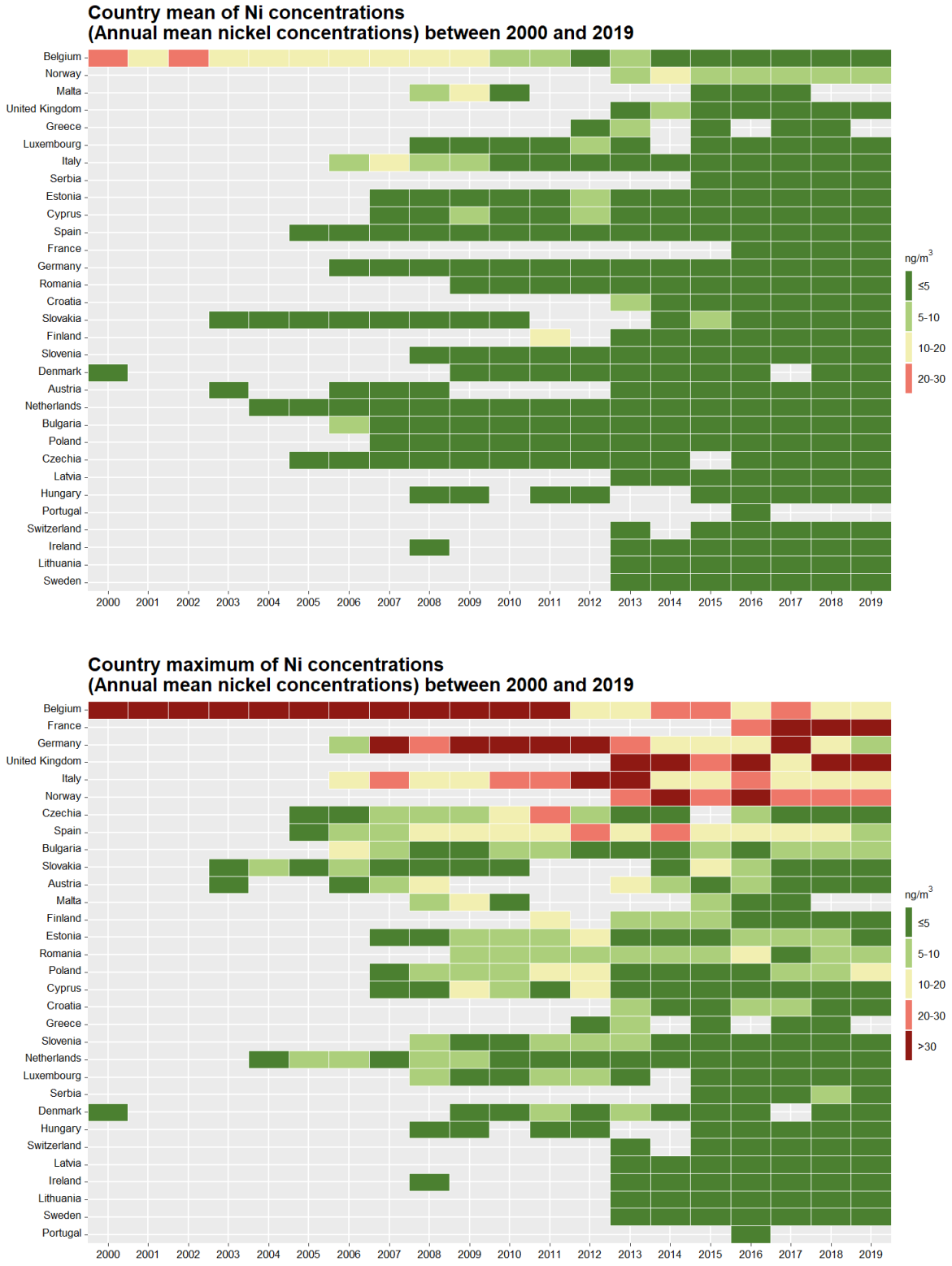
Nickel (Ni) data were reported from 704 stations in the reporting countries shown in Figure 1. Concentrations were above the target value of 20 ng/m^3 at 3 stations in: France (one), Norway (one) and United Kingdom (one), 3 of which were industrial. About 98 % of the stations reported Ni concentrations below the LAT of 10 ng/m^3.



Note: Observed concentrations of Ni in 2019. The last two colour categories correspond to concentrations above the target value. Only stations reporting more than 14 % of valid data have been included in the map.

Figure 35: Map of Ni concentrations in 2019

Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) Ni annual mean concentrations at country level are shown in Figure 36. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA 2020).



Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

Figure 36: Evolution of mean (top) and maximum (bottom) Ni annual mean concentrations (target value) per country from 2000

8 Abbreviations, units and symbols

µg/m^3: microgram(s) per cubic metre

AEI: Average exposure indicator for PM2.5 concentrations

AQG: Air quality guideline

As: Arsenic

BaP: Benzo[a]pyrene

C6H6: Benzene

Cd: Cadmium

CDR data stations: stations that sent the data to the Central Data Repository

CO: Carbon monoxide

ECO: Exposure concentration obligation

EEA: European Environment Agency

ETC/ATNI: European Topic Centre on Air pollution, Noise, Transport and Industrial Pollution

EU: European Union

LAT: Lower assessment threshold

mg/m^3: milligram(s) per cubic metre

NERT: National exposure reduction target

ng/m^3: nanogram(s) per cubic metre

Ni: Nickel

NO_2: Nitrogen dioxide

O_3: Ozone

Pb: Lead

PM: Particulate matter

$PM_{2.5}$: Particulate matter with a diameter of 2.5 µm or less

PM_{10}: Particulate matter with a diameter of 10 µm or less

RL: Reference level

SO_2: Sulphur dioxide

9 Annex

Data included in this report was received by 27 April 2021 from the reporting countries. By that date the number of stations by country reporting each pollutant is summarized in Table 3:

Table 3: Reporting status of 2019 air quality data by 27 April 2021

Country	PM10	PM2.5	O3	NO2	BaP	SO2	CO	C6H6	As	Cd	Pb	Ni
Albania	0	1	0	0	0	0	0	1	0	0	0	0
Andorra	1	0	2	1	0	1	1	0	0	0	0	0
Austria	122	52	106	143	30	68	27	16	12	13	12	12
Belgium	64	68	38	118	24	35	19	18	30	30	30	30
Bosnia and Herzegovina	10	3	6	8	0	11	6	0	0	0	0	0
Bulgaria	40	7	18	24	15	26	17	18	7	12	11	7
Croatia	11	10	13	11	3	7	4	3	2	2	2	2
Cyprus	3	4	3	3	1	3	3	1	2	2	2	2
Czechia	122	72	62	75	50	44	15	32	55	55	55	55
Denmark	7	8	8	13	2	1	5	3	3	3	3	3
Estonia	7	7	9	9	5	9	7	4	5	5	5	5
Finland	38	15	14	29	7	12	1	1	2	2	1	2
France	364	154	306	395	49	112	16	69	48	49	49	48
Georgia	0	0	0	0	0	0	0	0	0	0	0	0
Germany	386	207	266	605	116	110	87	109	97	97	97	96
Greece	19	10	14	15	0	8	8	5	0	0	0	0
Hungary	22	8	17	21	20	21	18	12	14	15	15	12
Iceland	10	7	0	10	0	14	0	0	0	0	0	0
Ireland	28	18	13	17	5	8	4	3	4	4	1	4
Italy	532	281	342	601	149	223	214	225	134	134	128	127
Kosovo	8	8	6	6	0	7	7	0	0	0	0	0
Latvia	6	5	4	7	5	4	1	3	5	5	5	5

Table 3: Reporting status of 2019 air quality data by 27 April 2021 (continued)

Country	PM10	PM2.5	O3	NO2	BaP	SO2	CO	C6H6	As	Cd	Pb	Ni
Liechtenstein	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	15	7	13	17	5	14	9	5	5	5	5	5
Luxembourg	5	4	5	8	1	3	3	1	1	1	1	1
Malta	3	4	4	4	0	3	2	2	0	0	0	0
Montenegro	0	0	1	1	0	2	1	0	0	0	0	0
Netherlands	66	45	41	71	3	14	8	9	2	2	2	2
North Macedonia	6	0	11	10	0	12	11	0	0	0	0	0
Norway	56	47	11	48	7	11	0	9	6	6	3	6
Poland	238	110	105	148	153	128	73	56	86	86	88	86
Portugal	44	17	36	46	0	20	12	2	0	0	0	0
Romania	69	6	42	87	1	95	92	28	30	49	54	44
Serbia	12	0	8	14	0	14	17	0	2	3	3	3
Slovakia	33	32	16	25	11	14	13	11	6	6	6	6
Slovenia	19	4	11	9	4	5	4	1	5	5	5	5
Spain	456	164	409	485	67	385	175	68	96	96	99	96
Sweden	60	33	27	81	4	25	8	1	4	4	4	4
Switzerland	30	8	31	33	9	9	9	3	12	13	13	12
Turkey	174	67	82	112	0	161	64	0	0	0	0	0
United Kingdom	77	77	70	153	34	23	6	30	24	24	24	24
EU-27 and the UK	2856	1429	2012	3220	764	1420	851	736	679	706	704	683
Total	3163	1570	2170	3463	780	1662	967	749	699	728	723	704

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