ETC-HE Report 2022/2

Status report of air quality in Europe for year 2020, using validated data

Authors:
Jaume Targa (4sfera Innova), Anna Ripoll (4sfera Innova), Lorena Banyuls (4sfera Innova), Alberto González Ortiz (EEA), Joana Soares (NILU)

European Environment Agency
European Topic Centre
Human health and the environment

Cover design: EEA
Cover image: © Jaume Targa
Layout: EEA-ETC HE

Publication Date: March 2022

ETC-HE coordinator: NILU - Stiftelsen Norsk institutt for luftforskning (NILU - Norwegian Institute for Air Research)

ETC-HE consortium partners: Federal Environment Agency/Umweltbundesamt (UBA), Aether Limited, Czech Hydrometeorological Institute (CHMI), Institut National de l'Environnement Industriel et des Risques (INERIS), Swiss Tropical and Public Health Institute (Swiss TPH), Universitat Autònoma de Barcelona (UAB), Vlaamse Instelling voor Technologisch Onderzoek (VITO), 4sfera Innova S.L.U., klar-FAKTe.U

ISBN 978-82-93970-01-9

How to cite this report:
Targa, J., Ripoll, A., Banyuls, L., González, A., Soares, J. (2022). Status report of air quality in Europe for year 2020, using validated data (Eionet Report – ETC/HE 2022/2).

European Topic Centre on
Human health and the environment (ETC-HE)
https://www.eionet.europa.eu/etcs/etc-he

Acknowledgements

This report has been produced by the European Topic Centre on Human health and the Environment (ETC HE) in close cooperation with the EEA.

Its content and automatisation were developed under two tasks: Task 3.2.1.2 (ETC manager: Jaume Targa (4sfera Innova) and EEA task manager: Luca Liberti) and Task 3.2.2.1 (ETC manager: Cristina Guerreiro (NILU) and EEA task manager: Alberto González Ortiz).

Additional EEA contributors were Artur Gsella. Additional ETC HE contributors were Michel Houssiau (under 4sfera Innova), Cristina Carnerero (4sfera Innova) and Rune Ødegård (NILU).

Thanks are due to the air quality data suppliers in the reporting countries for collecting and providing the data on which this report is based.

Contents

1 Summary

The *2020 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 2020 validated data officially reported under the Ambient Air Quality Directives in the 2021 September reporting cycle([1]). It provides information on the following pollutants, regulated by the Ambient Air Quality Directives:

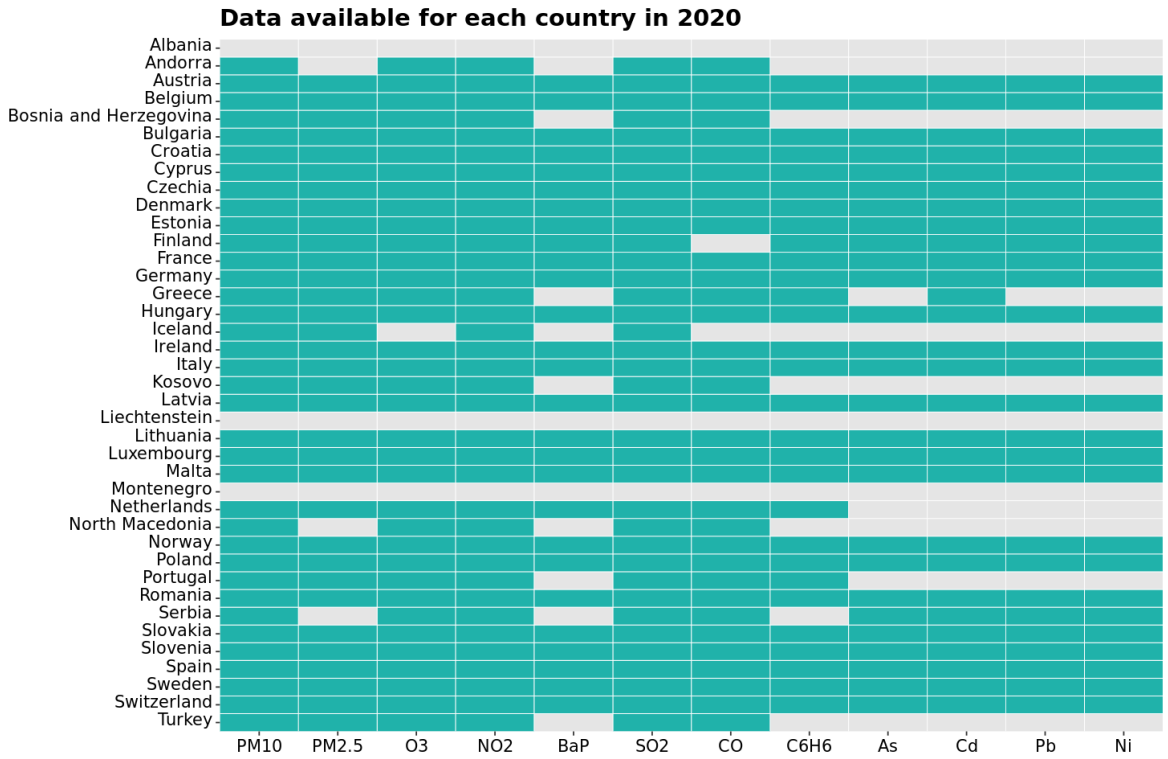
- PM_{10}: Particulate matter with a diameter of 10 µm or less
- $PM_{2.5}$: Particulate matter with a diameter of 2.5 µm or less
- O_3: Tropospheric ozone
- NO_2: Nitrogen dioxide
- BaP: Benzo[a]pyrene
- SO_2: Sulphur dioxide
- CO: Carbon monoxide
- C6H6: Benzene
- As: Arsenic
- Cd: Cadmium
- Pb: Lead
- Ni: Nickel

It also offers a comparison with the situation in the previous three years.

Data included in this report was received by 24 March 2022 from the reporting countries. By that date the reporting status of 2020 validated data is summarized in Figure 1, where a green box indicates that the referred pollutant was reported by the referred country and a grey box indicates the contrary (that the referred pollutant was not reported by the referred country). 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.

[1] https://aqportal.discomap.eea.europa.eu/index.php/reporters-corner/

Figure 1: Reporting status of 2020 air quality data by 24 March 2022



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); the five other member countries of the EEA (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_{10}, concentrations above the EU daily limit value (50 µg/m^3) were registered at 16 % of the reporting stations in 15 countries in EU-27 and in five other reporting countries. For $PM_{2.5}$,

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

concentrations above the annual limit value (25 µg/m^3) were registered at 2 % of the reporting stations in three countries in EU-27 and three other reporting countries.

The long-term world health organitzation air quality guidelines (WHO AQG) for PM_{10} (15 µg/m^3) was exceeded at 68 % of the stations in 27 countries of the EU-27 and 8 other reporting countries. The long-term WHO AQG for $PM_{2.5}$ (5 µg/m^3) was exceeded at 92 % of the stations located in 26 countries of the EU-27 and 6 other reporting countries.

All Member States had 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

14 % of stations registered concentrations above the EU O_3 target value (120 µg/m^3) for the protection of human health. These stations were located in 15 countries of the EU-27 and six other reporting European countries. The long-term EU objective (120 µg/m^3) was met in only 19 % of the stations. The short-term WHO AQG for O_3 (100 µg/m^3) was exceeded in 91 % of all the reporting stations, and 97 % of stations registered concentrations above the long-term WHO AQG for O_3 (60 µg/m^3).

1.3 Nitrogen dioxide

Around 2 % of all the reporting stations recorded concentrations above the annual limit value for NO_2 (40 µg/m^3). These stations were located in 7 countries of the EU-27 and one other reporting countries. 69 % of concentrations above this limit value were observed at traffic stations.

On the contrary, 73 % of stations, located in 27 countries of the EU-27 and nine other reporting countries reported concentrations above the WHO AQG level of 10 µg/m^3.

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

27 % of the reported BaP measurement stations reported annual mean concentrations above 1.0 ng/m^3. They were located in 11 countries in EU-27.

1.5 Sulphur dioxide, carbon monoxide, benzene and toxic metals

Only 23 stations (out of more than 1567) in two countries of the EU-27 and three other reporting countries measured values for SO_2 above the EU daily limit value (125 µg/m^3). However, 7 % of all SO_2 stations, located in 16 reporting countries, measured SO_2 concentrations above the daily WHO AQG (40 µg/m^3).

Only 2 stations located in 2 countries (out of the 34 reporting countries) registered concentrations above the EU limit value for CO, which is the same as the 8-hour WHO AQG (10 mg/m^3).

Concentrations above the limit value for C_6H_6 (5 µg/m^3) were not observed at any stations.

Concentrations above the As target value (6 ng/m^3) were registered at 7 stations, located in 3 out of 27 reporting countries. For Cd, there were 1 stations (located in 1 out of 28 reporting countries) measuring concentrations above the target value (5 ng/m^3), and for Ni, 2 stations (in 2 out of 27 reporting countries) measured annual concentrations above the target value (20 ng/m^3). Pb concentrations above the limit value (0.5 µg/m^3) were measured in 0 stations, located in 0 out of 27 reporting countries.

1.6 Editorial note

France informed that a measurement change for PM_{10} was introduced in 2007, and that the number of $PM_{2.5}$ stations before 2008 was low. Both issues could affect the comparability over the years shown in the heatmaps.

Greece also reported data for BaP, As, Ni and Pb from stations GR0038A and GR0039A, and for Cd from station GR0038A; they do not appear in this report for because, due to a mistake in the validation flag, they were wrongly reported as invalid data.

Italy informed that Pb data from stations IT2161A, IT1856A, IT1857A and IT2166A, in the Abruzzo region, are wrong.

2 Introduction

The *2020 Status report of air quality in Europe* presents summarized information on the air quality data reported as measurements data under the 2021 September reporting cycle (validated assessment data for 2020, deadline of submission 30 September 2021). It aims at informing on the 2020 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, 2021) (Table 2)([3]).

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:

- a European overview of the 2020 monitoring stations reported, and of their concentrations in relation to the EU legal standards and WHO AQGs for each pollutant;
- a map with the 2020 concentrations at station level for each pollutant;
- 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.

[3] Nevertheless, in this report the following standards and guidelines are not analysed: information and alert thresholds for O_3, alert threshold for NO_2, and alert threshold for SO_2 in Table 1; and hourly air quality guideline for NO_2, 10 minutes air quality guideline for SO_2, and hourly air quality guideline for CO in Table 2.

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 2020 are considered, so no average over the period 2018 - 2020 is presented.

Sources:

EU (2004, 2008).

Table 2: WHO air quality guidelines (AQGs) and estimated reference levels (RL) ([a])

Pollutant	Averaging period	AQG	RL	Comments
PM_{10}	1 day	45 µg/m^3		99th percentile (3-4 exceedance days per year). Updated 2021 guideline
	Calendar year	15 µg/m^3		Updated 2021 guideline
$PM_{2.5}$	1 day	15 µg/m^3		99th percentile (3-4 exceedance days per year). Updated 2021 guideline
	Calendar year	5 µg/m^3		Updated 2021 guideline
O_3	Maximum daily 8-hour mean	100 µg/m^3		99th percentile (3-4 exceedance days per year). New 2021 guideline
	Peak season ([b])	60 µg/m^3		New 2021 guideline
NO_2	1 hour	200 µg/m^3		
	1 day	25 µg/m^3		99th percentile (3-4 exceedance days per year). New 2021 guideline
	Calendar year	10 µg/m^3		Updated 2021 guideline
BaP	Calendar year		0.12 ng/m^3	
SO_2	10 minutes	500 µg/m^3		
	1 day	40 µg/m^3		99th percentile (3-4 exceedance days per year). New 2021 guideline
CO	1 hour	30 mg/m^3		
	Maximum daily 8-hour mean	10 mg/m^3		
	1 day	4 mg/m^3		99th percentile (3-4 exceedance days per year). New 2021 guideline
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 ([c])		
Ni	Calendar year		25 ng/m^3	

Notes:

[a] As WHO has not set an AQG for BaP, C_6H_6, As and Ni, the RL was estimated assuming an acceptable risk of additional lifetime cancer risk of approximately 1 in 100 000.

[b] Average of daily maximum 8-hour mean concentration in the six consecutive months with the highest six-month running average O_3 concentration.

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

Sources:

WHO (2000, 2006, 2021).

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 buildings, 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 PM random fixed measurements, toxic metals (As, Cd, Ni, Pb) and BaP, the required amount of valid data for the analysis is 14% (according to the air quality objectives for indicative measurements). For benzene, it is 50 %. Reporting stations not fulfilling the minimum data coverage could be found at the Annual AQ statistics table.

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

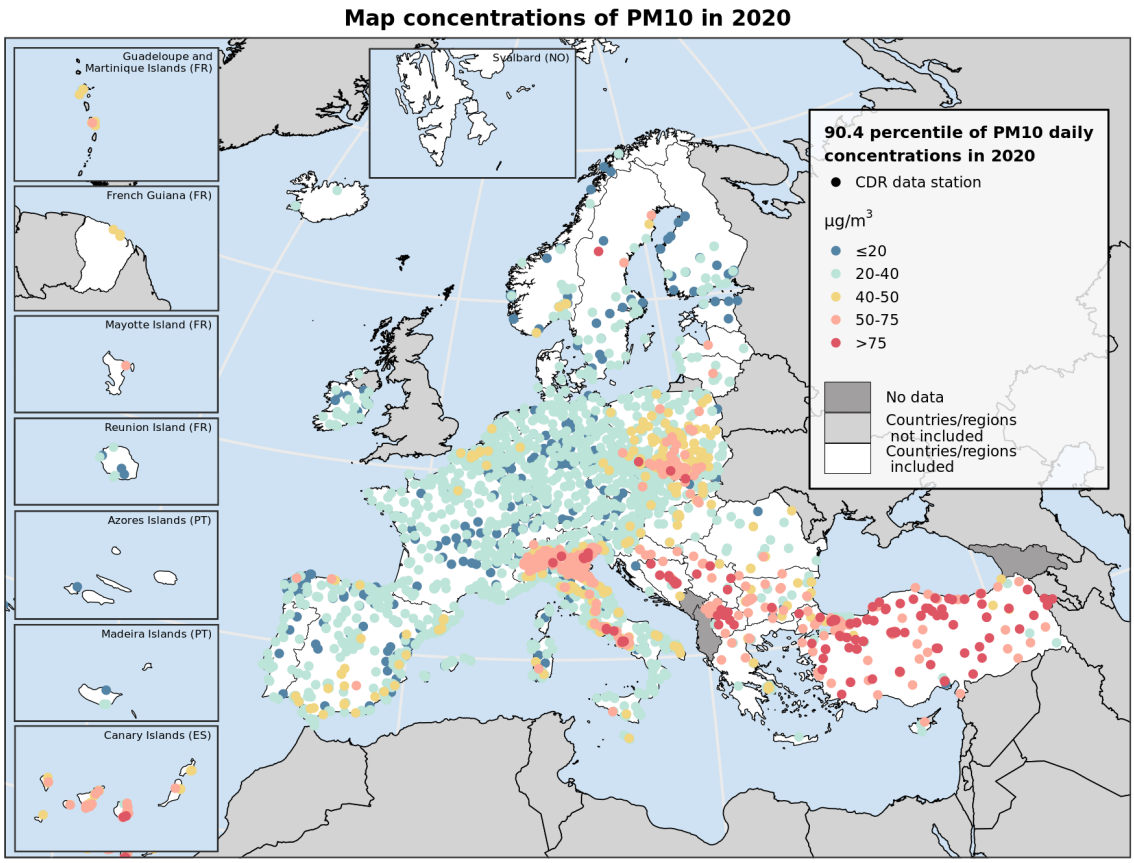
3.1 Status of PM_{10} concentrations

The EEA received PM_{10} data for 2020, with sufficient valid measurements (a general minimum coverage of 75 % and of 14 % for fixed random measurements) from 3101 stations for the calculation of annual mean concentrations and from 3092 stations in relation to the daily limit value. The stations were located in all the reporting countries shown in Figure 1.

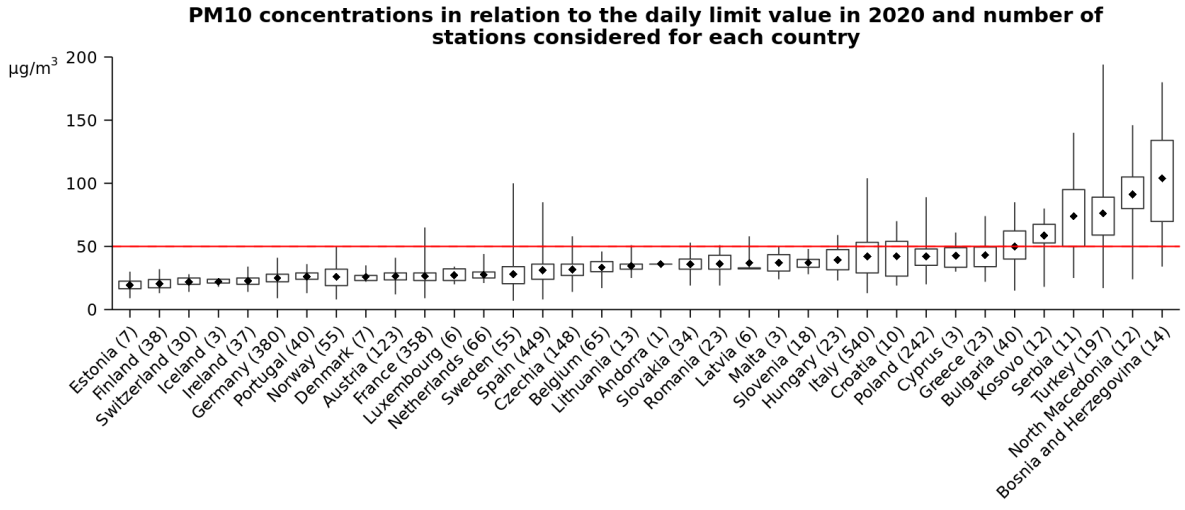
Fifteen countries in EU-27, and five other reporting countries reported PM_{10} concentrations above the EU daily limit value of 50 µg/m^3 (Figure 2). This was the case for 16 % (482) of reporting stations. In total, 95 % of those stations were either urban (84 %) or suburban (11 %). The stricter value of the WHO AQG for PM_{10} daily mean (45 µg/m^3) was exceeded at 61 % (1894) of the stations in all the reporting countries (Figure 8).

Concentrations above the PM_{10} annual limit value (40 µg/m^3) were monitored in 5 % (149 stations) of all the reporting stations, located in 6 countries in EU-27, and 4 other reporting countries. The stricter value of the WHO AQG for PM_{10} annual mean (15 µg/m^3) was exceeded at 68 % (2118) of the stations in all the reporting countries, except in Iceland (Figure 5).

Figure 2: Map and boxplot of PM_{10} concentrations in 2020 - daily limit value



Note: Observed concentrations of PM10 in 2020. 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 µg/m³ 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, and more than 14 % in the case of fixed random measurements, have been included in the map.

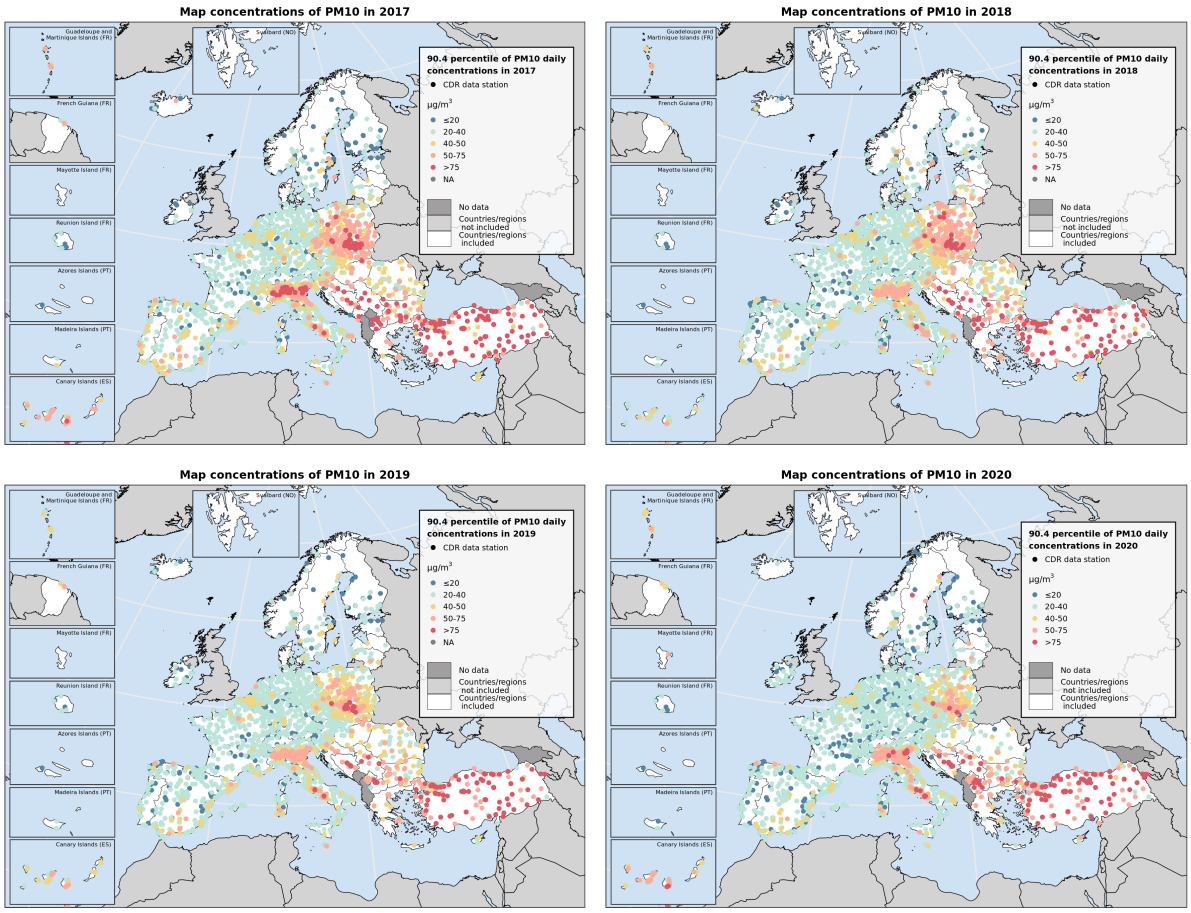


Note: The graph is based, for each country, on the 90.4 percentile of daily mean concentration values corresponding to the 36th highest daily mean. For each country, the number of stations considered (in brackets) and the lowest, highest and average 90.4 percentile values (in µg/m³) recorded at its stations 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 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.

The highest value in the boxplot, Turkey (205.1 µg/m^3), has not been included in the graph for representation purposes.

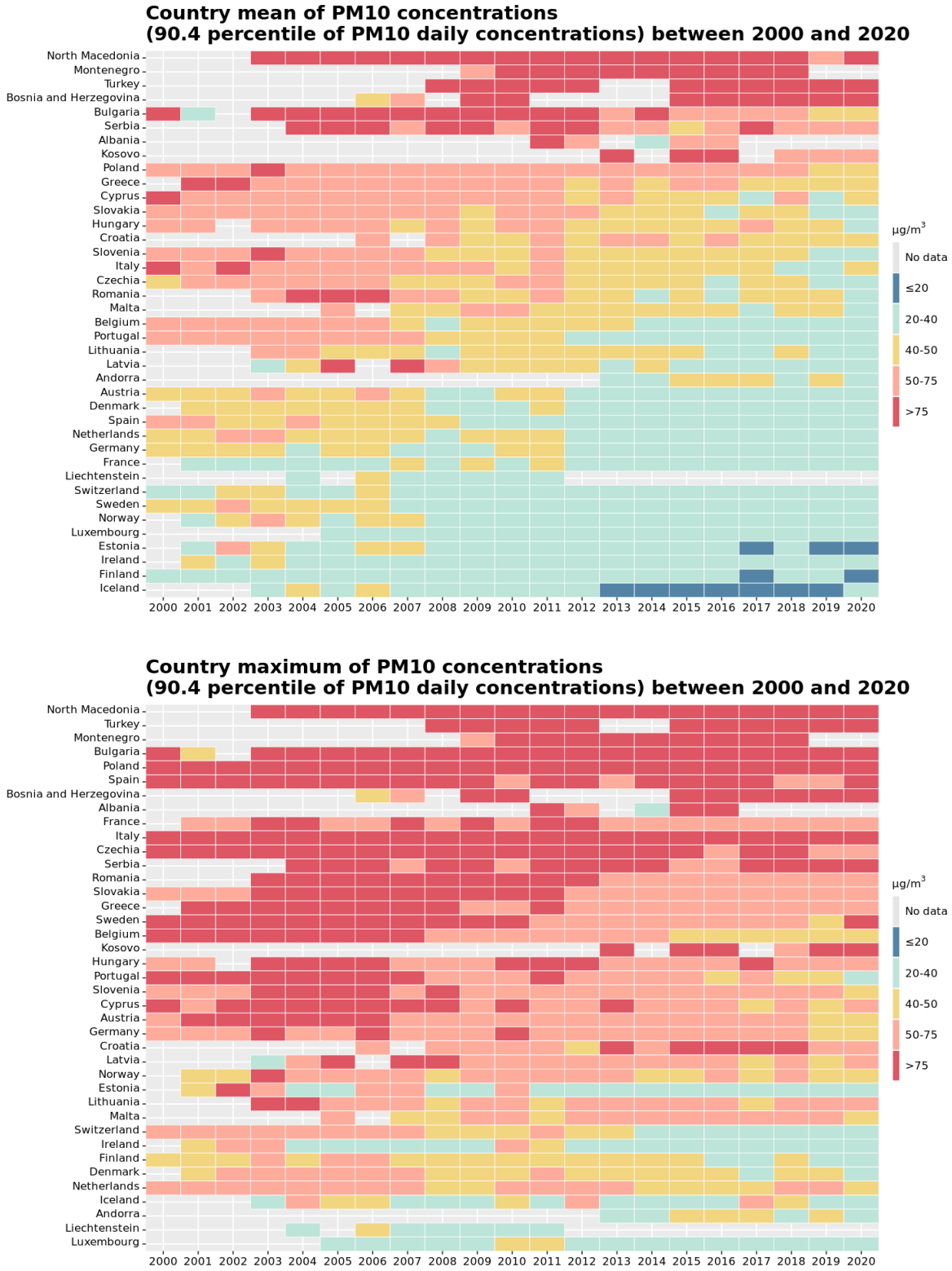
Figure 3 shows the maps of the 90.4 percentile of PM_{10} daily mean concentrations (equivalent to the PM_{10} daily limit value) for four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based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

Figure 3: Maps of PM_{10} concentrations (daily limit value) for the last 4 years



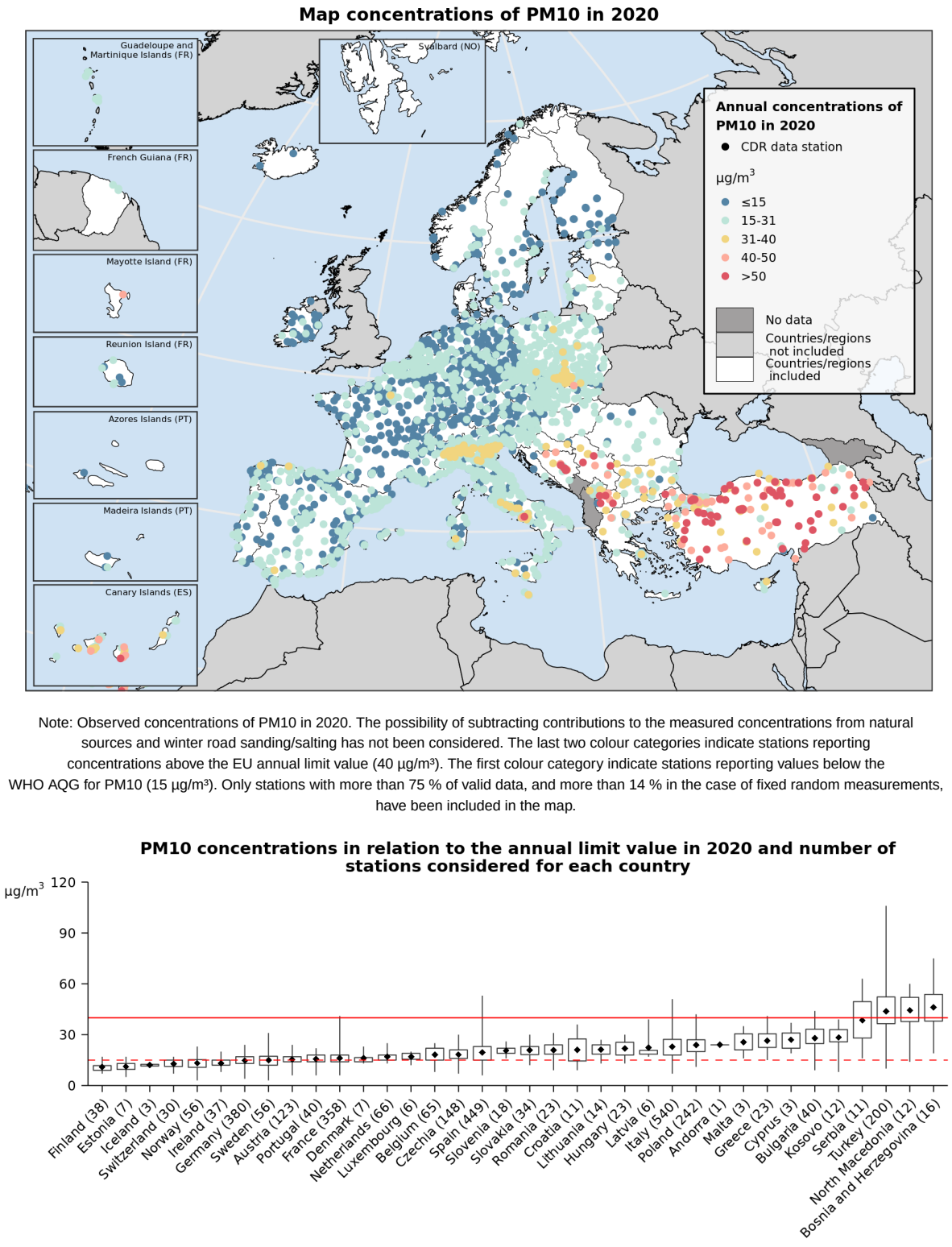
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) 90.4 percentile of PM_{10} daily mean concentrations at country level are shown in figure 4. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note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

Figure 4: Evolution of mean (top) and maximum (bottom) 90.4 percentile of PM_{10} daily mean concentrations (daily limit value) per country from 2000



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 5: Map and boxplot of PM_{10} concentrations in 2020 - annual limit value

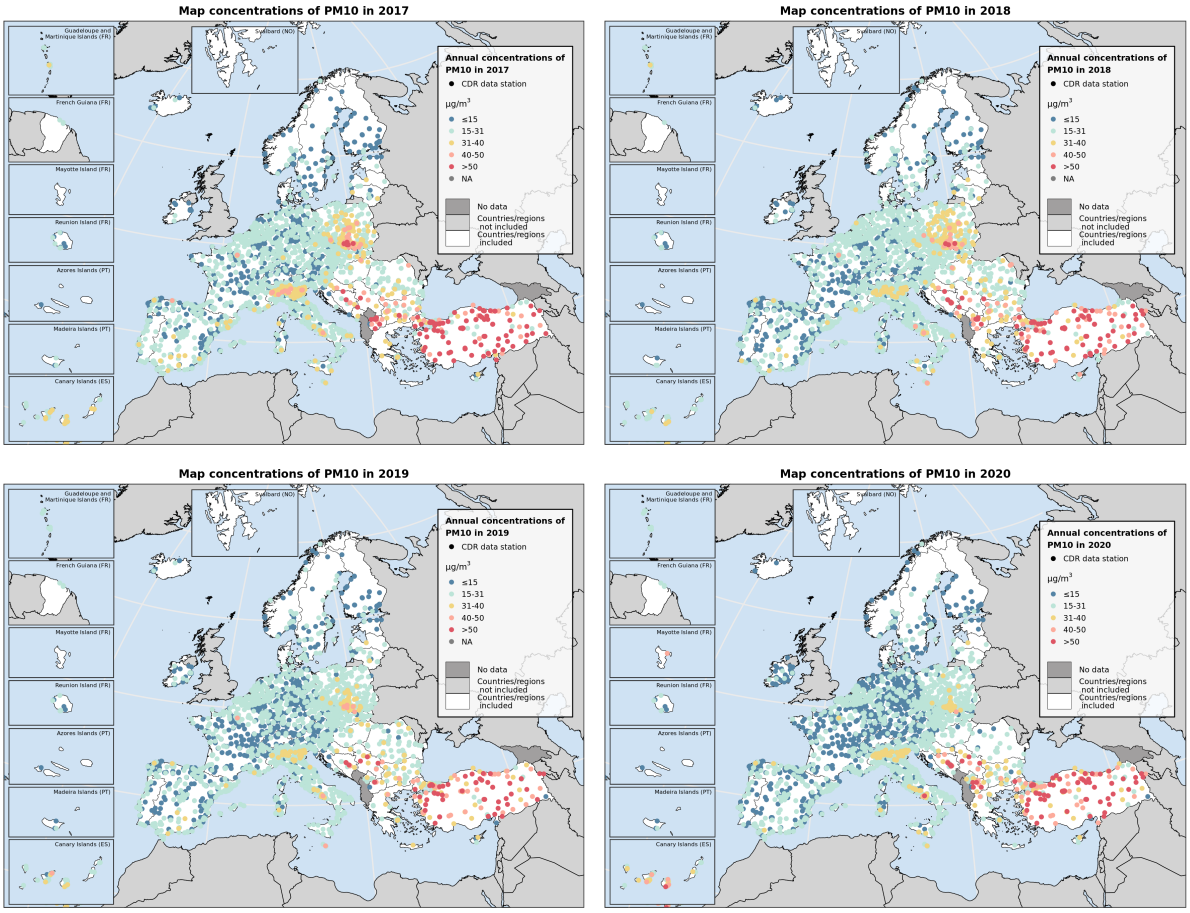


Note: Observed concentrations of PM10 in 2020. The possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting has not been considered. The last two colour categories indicate stations reporting concentrations above the EU annual limit value (40 µg/m³). The first colour category indicate stations reporting values below the WHO AQG for PM10 (15 µg/m³). Only stations with more than 75 % of valid data, and more than 14 % in the case of fixed random measurements, 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 µg/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 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 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).

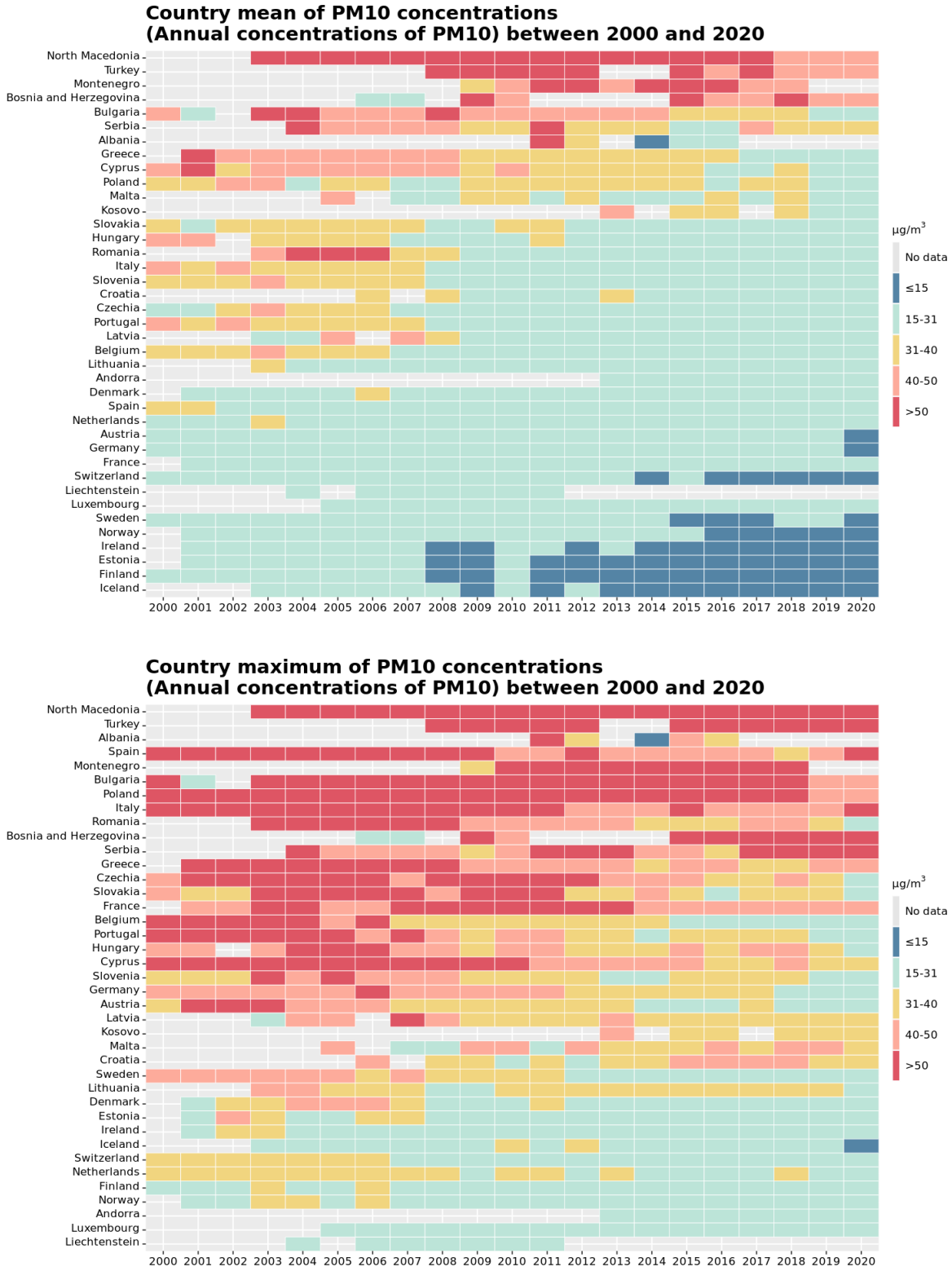
Figure 6: Maps of PM_{10} concentrations (annual limit value) for the last 4 years



Maps for years before 2020 are different to the ones published in previous reports because the bands in the legend have been modified to accomodate the 2021 WHO AQG level.

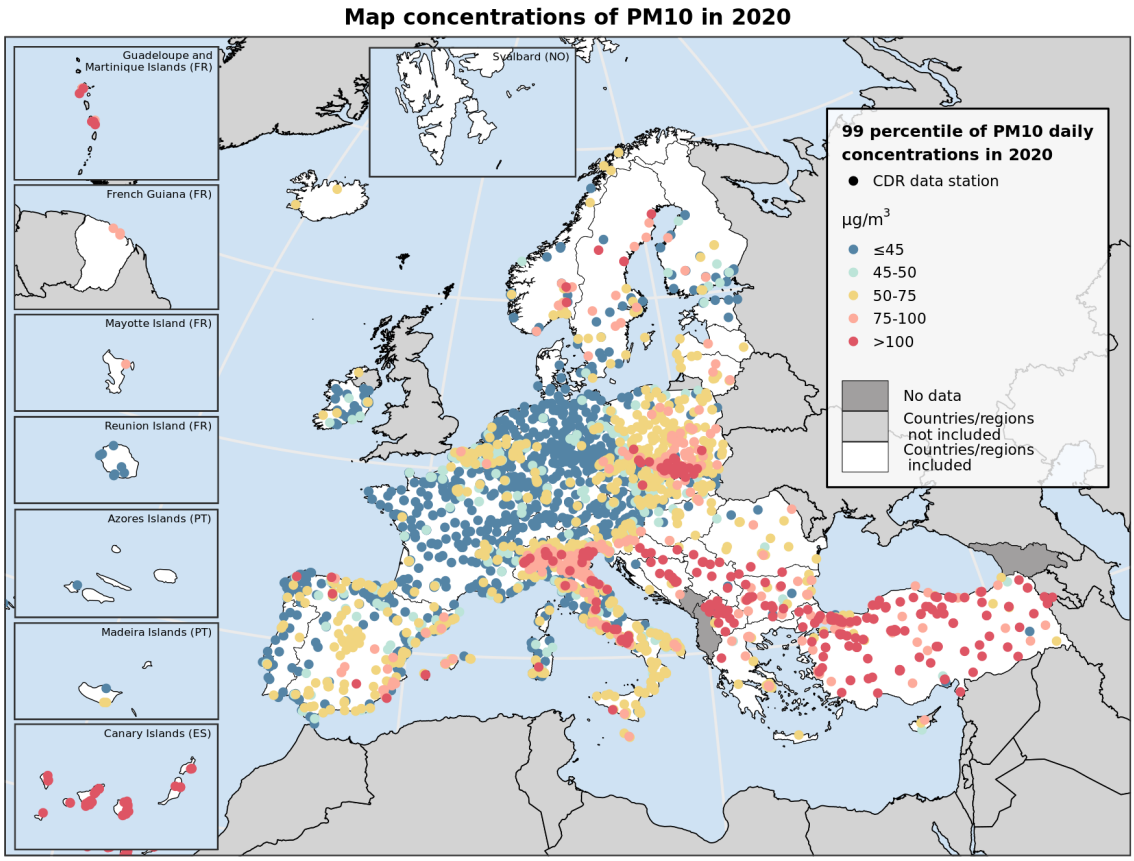
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) annual mean PM_{10} concentrations at country level are shown in figure 7. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological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

Figure 7: Evolution of mean (top) and maximum (bottom) PM_{10} annual mean concentrations (annual limit value) per country from 2000



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.

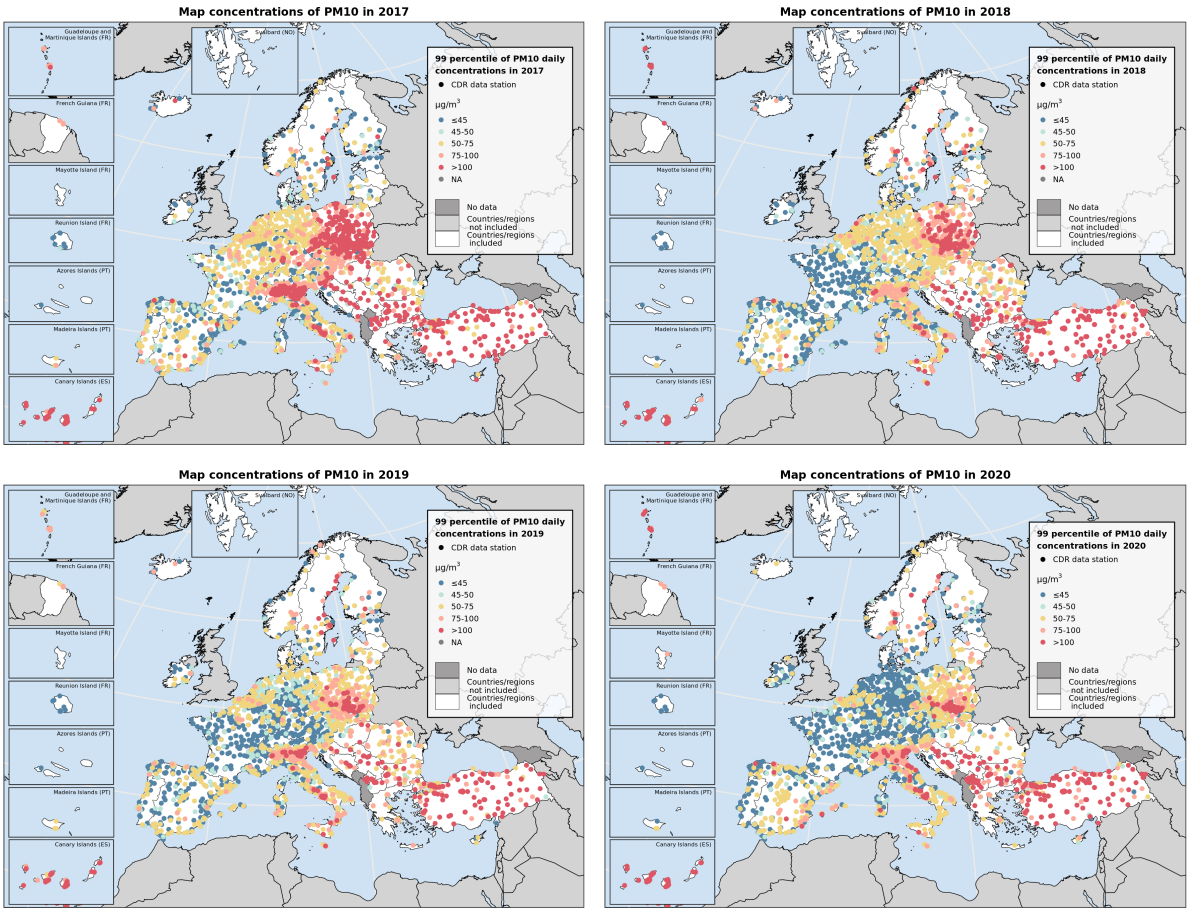
Figure 8: Map of PM_{10} concentrations in 2020 - daily WHO AQG level



Note: Observed concentrations of PM10 in 2020. The map shows the 99 percentile of the PM10 daily mean concentrations, equivalent to 3−4 exceedance days per year, according to the definition of the daily WHO AQG level (45 µg/m³). The first colour category indicates stations with concentrations below this AQG level. Only stations with more than 75 % of valid data, and more than 14 % in the case of fixed random measurements, have been included in the map.

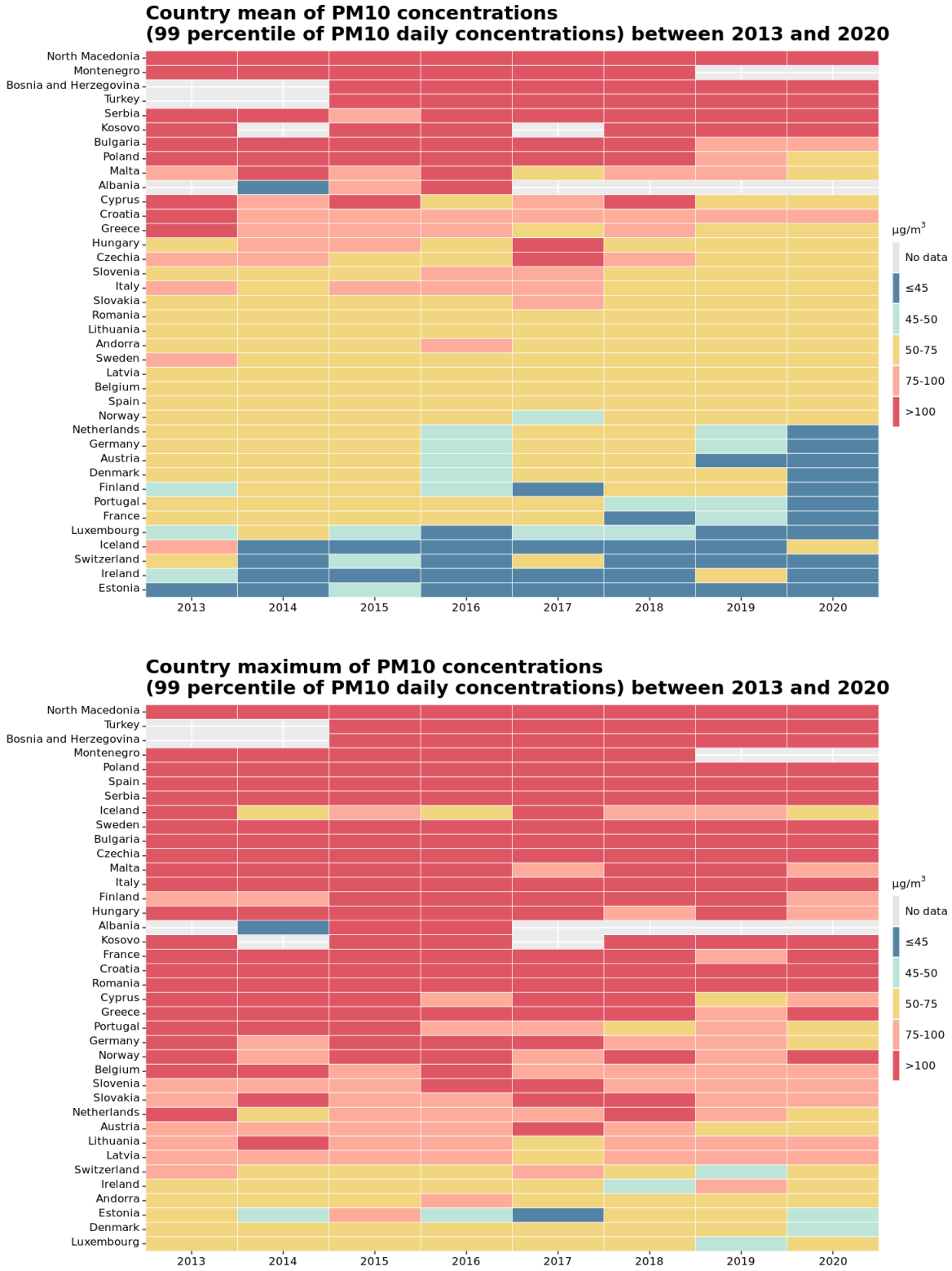
Figure 9 shows the maps of the 99 percentile of PM_{10} daily mean concentrations (equivalent to the WHO AQG for PM_{10} daily mean level) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 9: Maps of PM_{10} concentrations (daily WHO AQG level) for the last 4 years



Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) 99 percentile of PM_{10} daily 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).

Figure 10: Evolution of mean (top) and maximum (bottom) 99 percentile of PM_{10} daily mean concentrations (daily WHO AQG level) per country from 2013



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.

3.2 Status of $PM_{2.5}$ concentrations

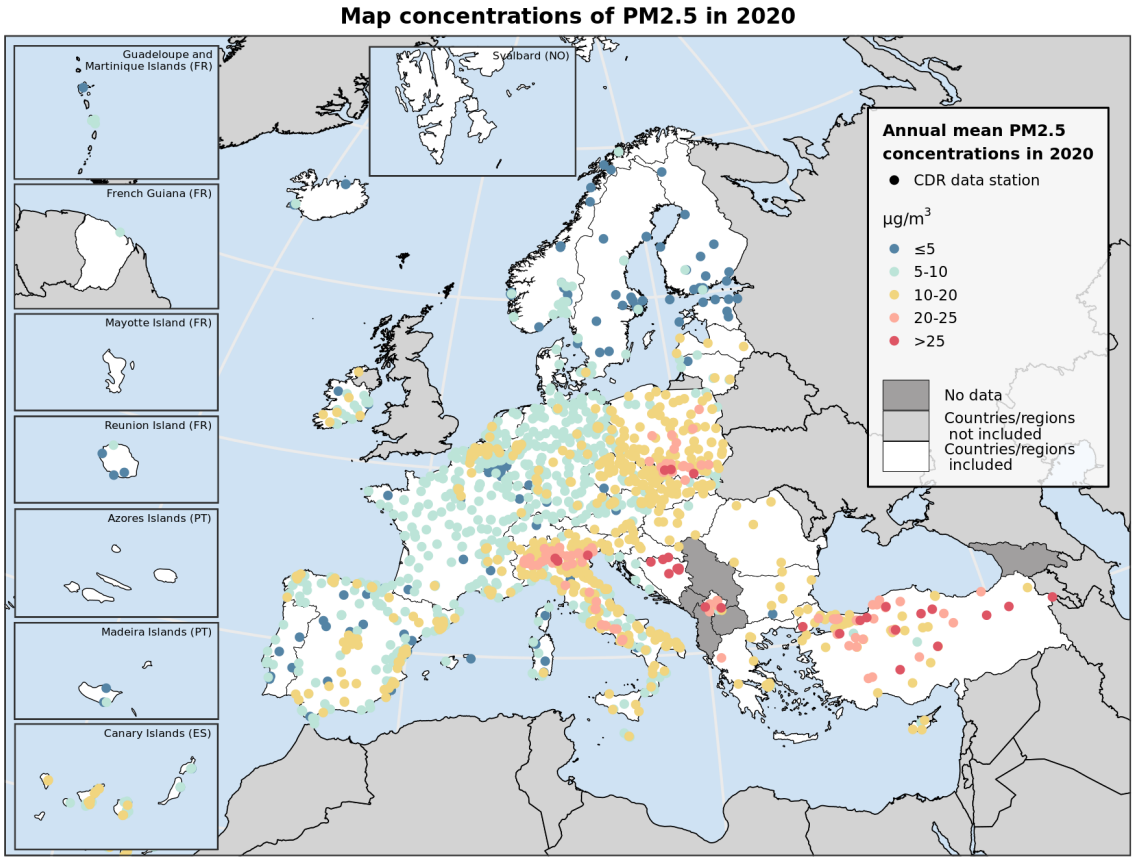
Regarding $PM_{2.5}$, data with a general minimum coverage of 75 %, and of 14 % for fixed random stations, of valid data were received from 1710 stations for the calculation of annual mean concentrations and from 1701 stations in relation to the short-term WHO AQG. These stations were located in all the reporting countries shown in Figure 1.

The $PM_{2.5}$ concentrations were higher than the annual limit value (25 µg/m^3) in three countries in EU-27 and three other reporting countries (Figure 11). These concentrations above the limit value were registered in 2 % of all the reporting stations and occurred primarily (90 % of cases) in urban (69 %) or suburban (21 %) areas.

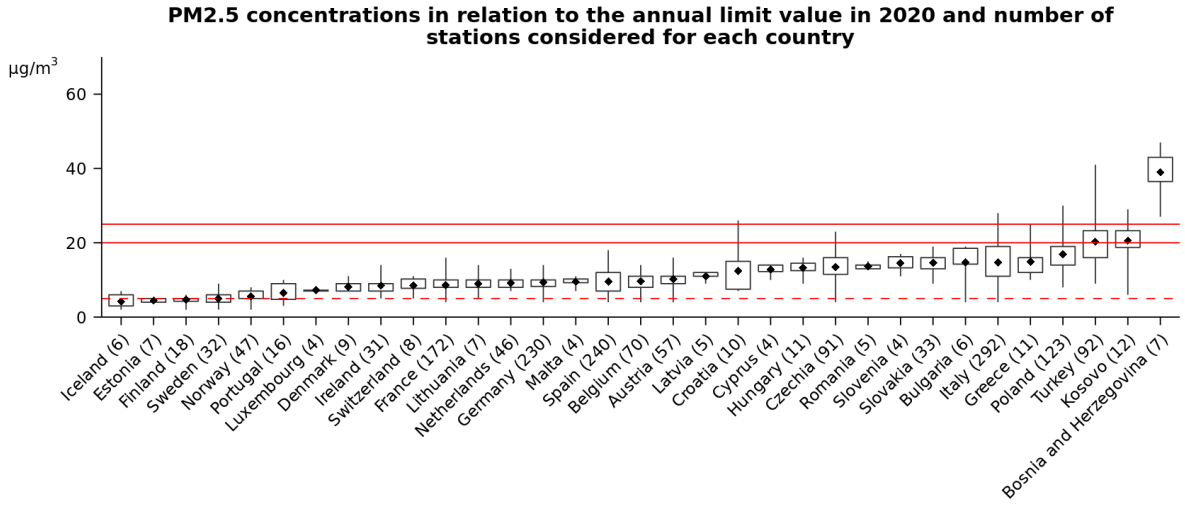
The WHO AQG for $PM_{2.5}$ annual mean (5 µg/m^3) was exceeded at 92 % of the stations, located in 32 of the 33 countries reporting $PM_{2.5}$ data (Figure 11).

Although the EU has not set any short-term standard for $PM_{2.5}$, the WHO defined in 2021 a daily AQG level of 15 µg/m^3, expresed as percentile 99. It was exceeded at 95 % (1616 stations) of the stations in all the reporting countries (Figure 14).

Figure 11: Map and boxplot of $PM_{2.5}$ concentrations in 2020 - annual limit value



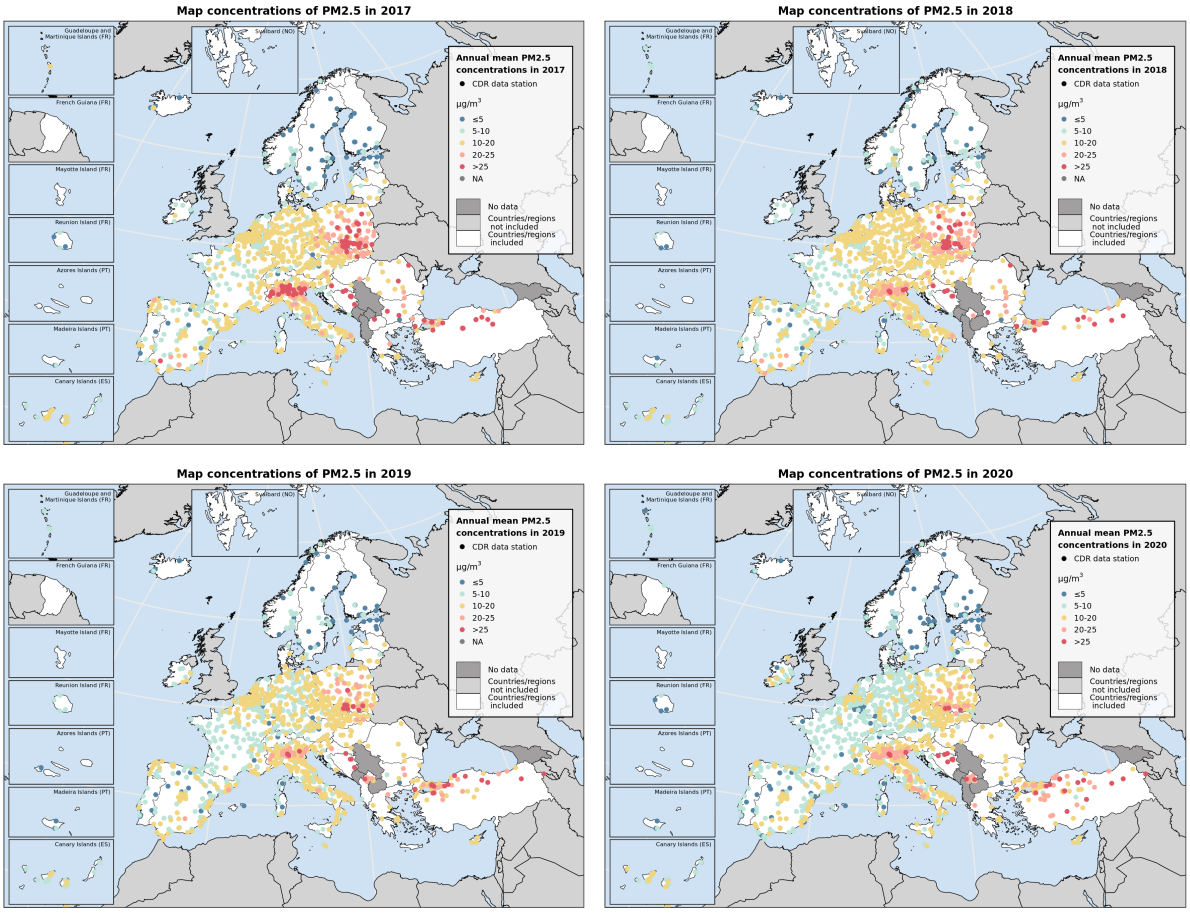
Note: Observed concentrations of PM2.5 in 2020. The possibility of subtracting contributions to the measured concentrations from natural sources and winter road sanding/salting has not been considered. The last two colour categories indicate stations reporting concentrations above the EU indicative annual limit value (20 µg/m³) or the EU annual limit value (25 µg/m³). The first colour category indicates stations reporting values below the WHO AQG for PM2.5 (5 µg/m³). Only stations with more than 75 % of valid data, and more than 14% in the case of fixed random measurements, 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 µg/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 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.

Figure 12 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).

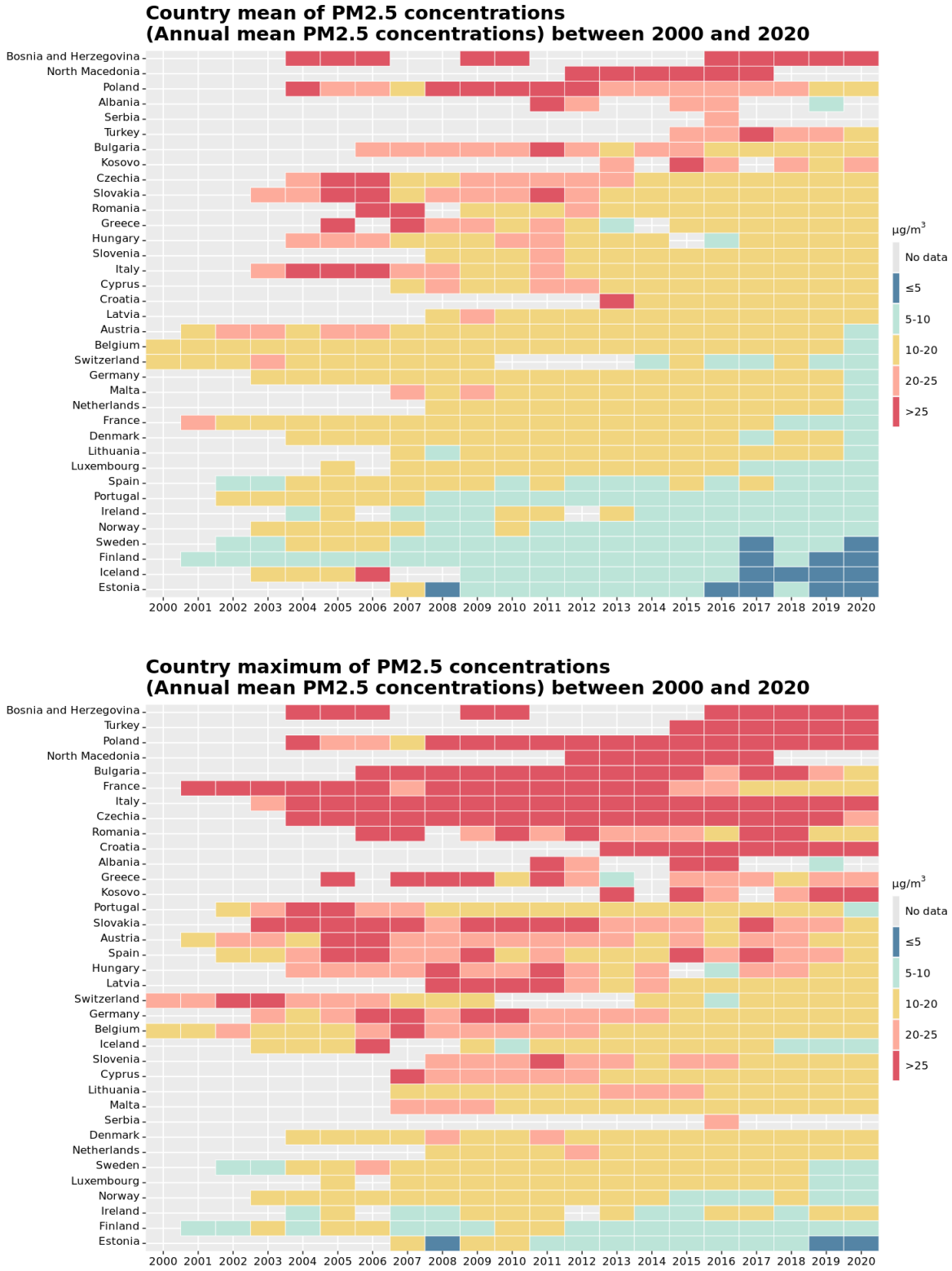
Figure 12: Maps of $PM_{2.5}$ concentrations (annual limit value) for the last 4 years



Maps for years before 2020 are different to the ones published in previous reports because the bands in the legend have been modified to accomodate the 2021 WHO AQG level.

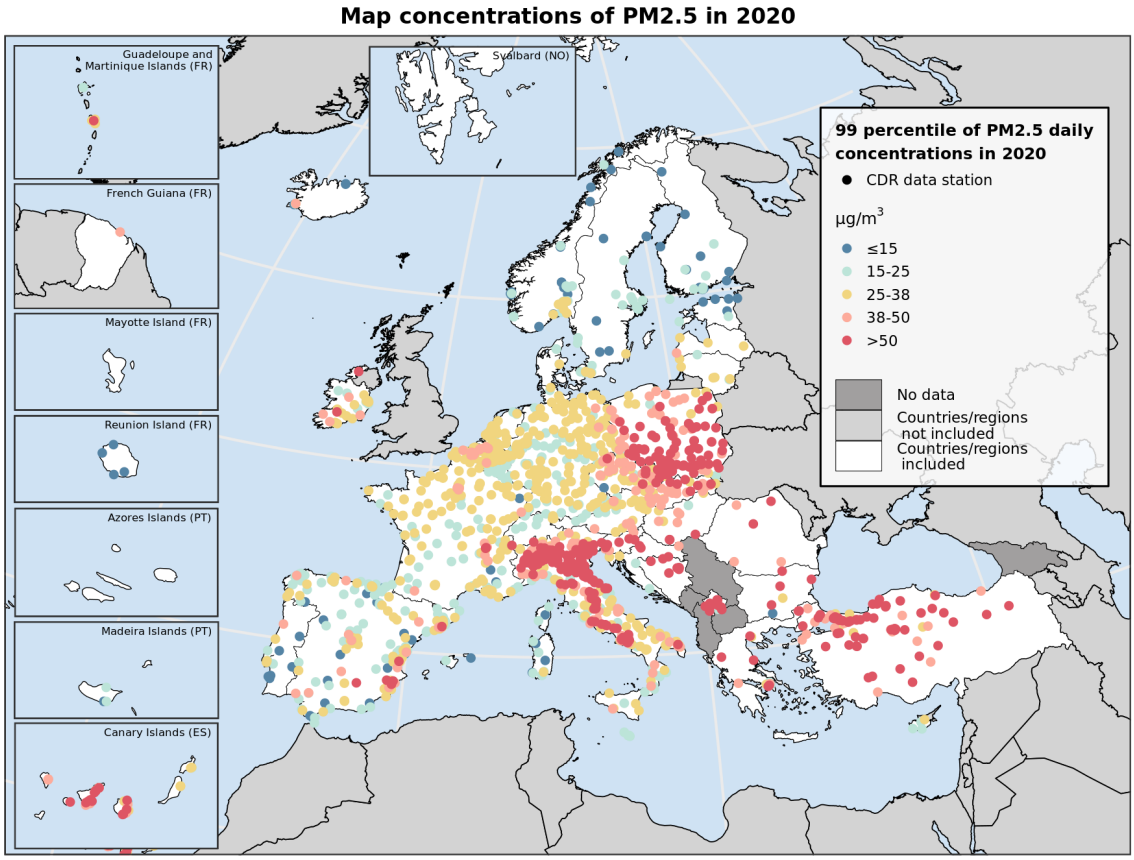
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) $PM_{2.5}$ annual mean concentrations at country level are shown in figure 13. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA, 2020).

Figure 13: Evolution of mean (top) and maximum (bottom) $PM_{2.5}$ annual mean concentrations (annual limit value) per country from 2000



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.

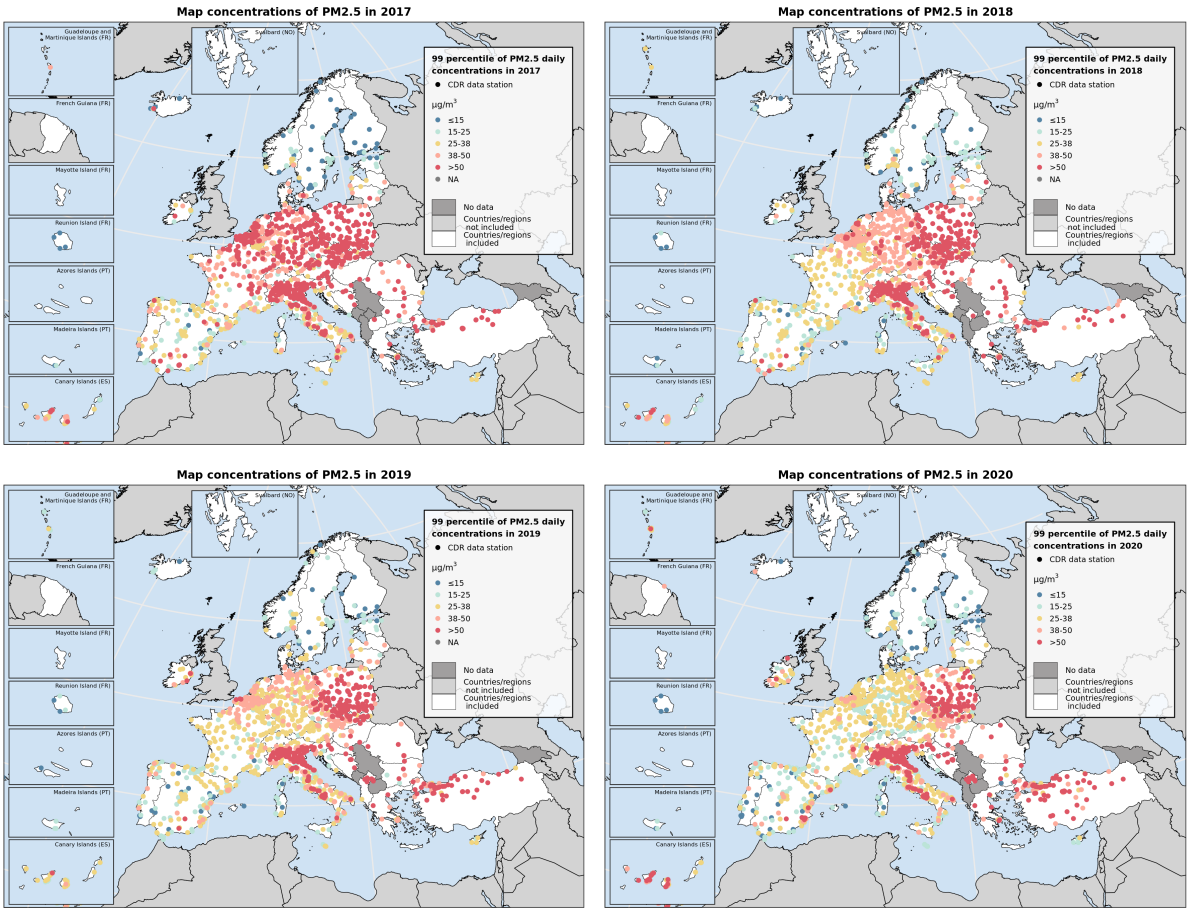
Figure 14: Map of $PM_{2.5}$ concentrations in 2020 - daily WHO AQG level



Note: Observed concentrations of PM2.5 in 2020. The map shows the 99 percentile of the PM2.5 daily mean concentrations, equivalent to 3−4 exceedance days per year, according to the definition of the daily WHO AQG level (15 µg/m³). The first colour category indicates stations with concentrations below this AQG level. Only stations with more than 75 % of valid data, and more than 14 % in the case of fixed random measurements, have been included in the map.

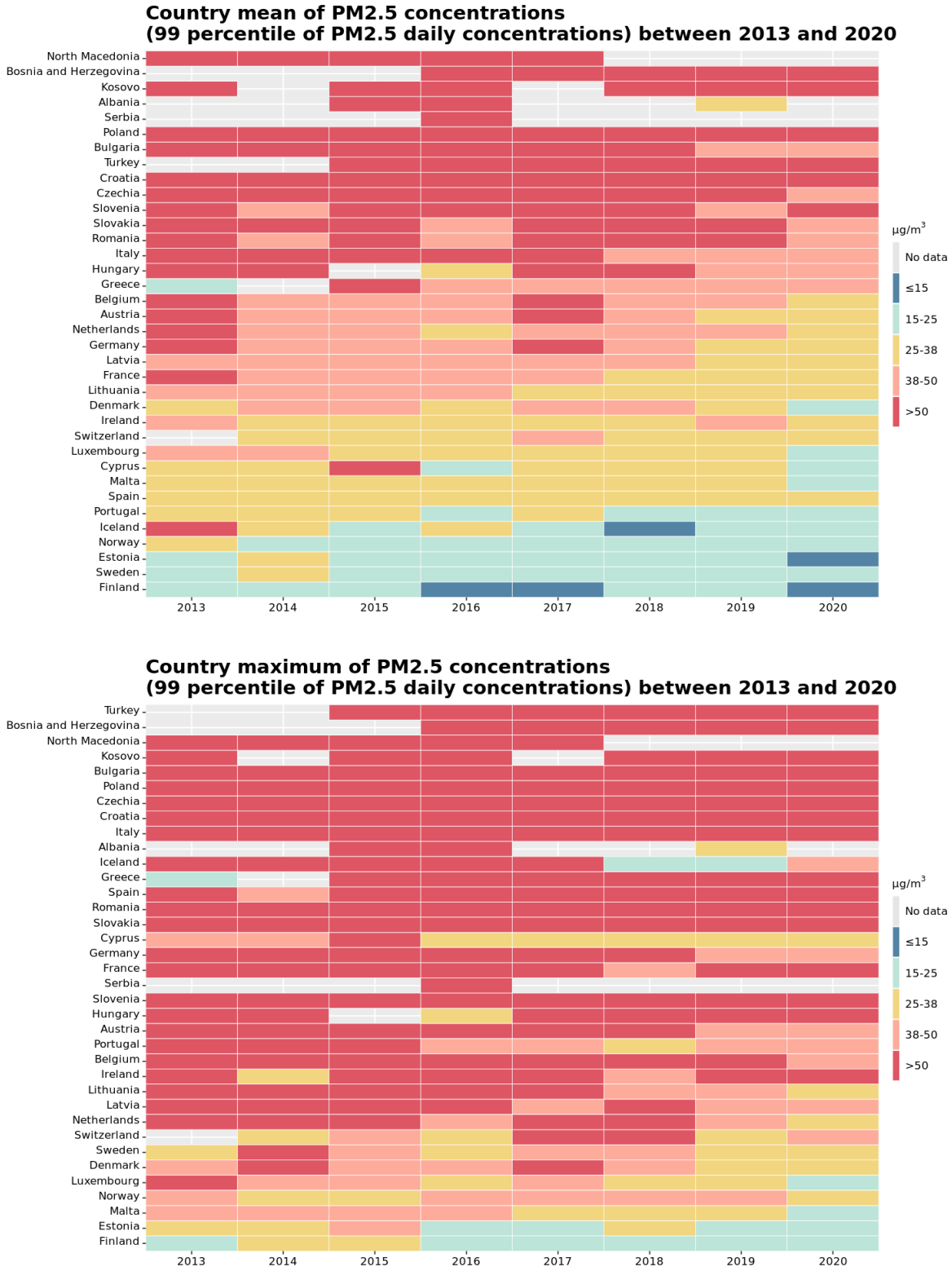
Figure 15 shows the maps of the 99 percentile of $PM_{2.5}$ daily mean concentrations (equivalent to the WHO AQG for $PM_{2.5}$ daily mean level) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 15: Maps of $PM_{2.5}$ concentrations (daily WHO AQG level) for the last 4 years



Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) 99 percentile of $PM_{2.5}$ daily mean concentrations at country level are shown in figure 16. 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).

Figure 16: Evolution of mean (top) and maximum (bottom) 99 percentile of $PM_{2.5}$ daily mean concentrations (daily WHO AQG level) per country from 2013



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.

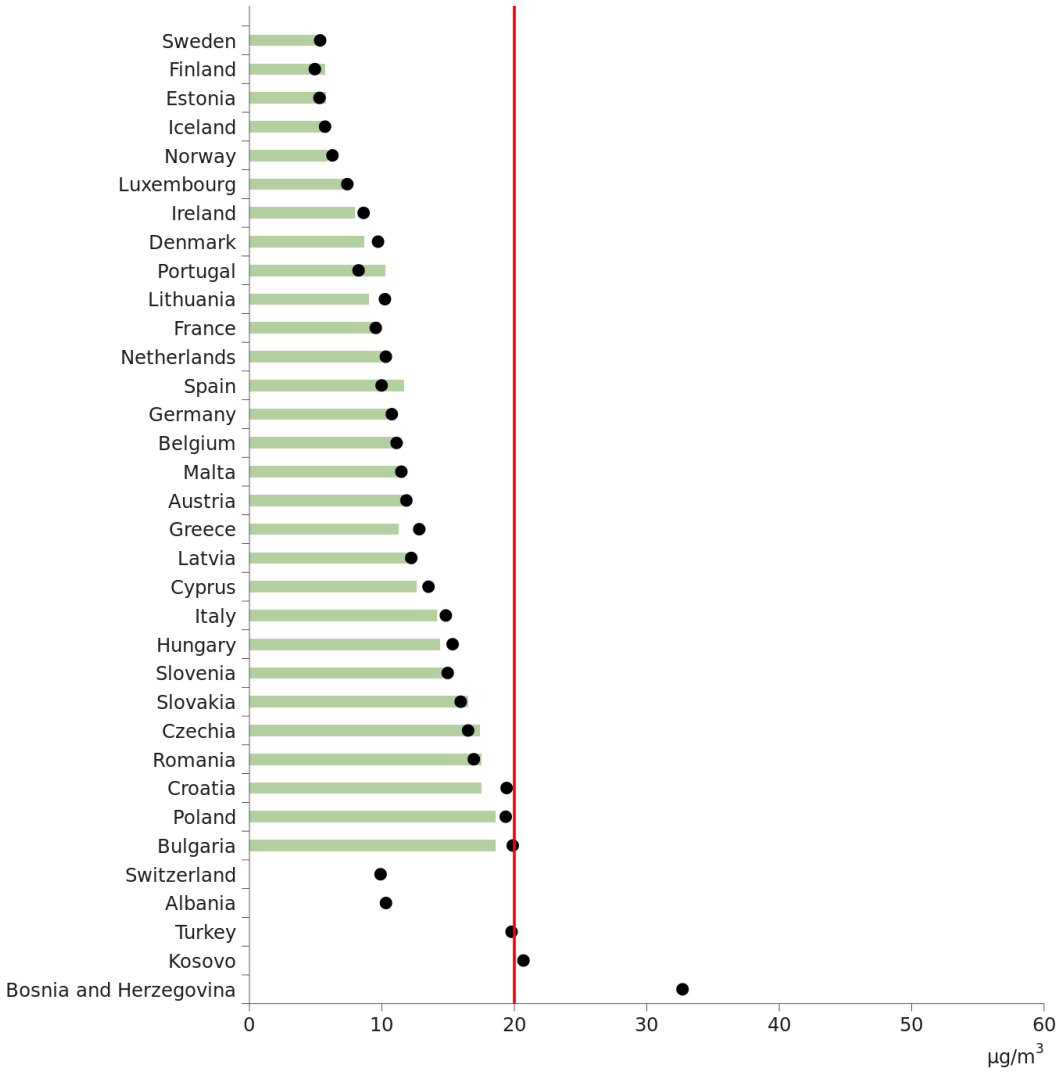
3.3 $PM_{2.5}$ average exposure indicator

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 when 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 17 shows the AEI calculated for 2020 (average 2018-2020) and the situation in relation to the ECO. The bars show the AEI 2020 using the stations designated for this purpose by the reporting countries (if the bars are not shown it means that the AEI 2020 could not be calculated), while the dots show the 3-year (2018-2020) 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 17, 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.

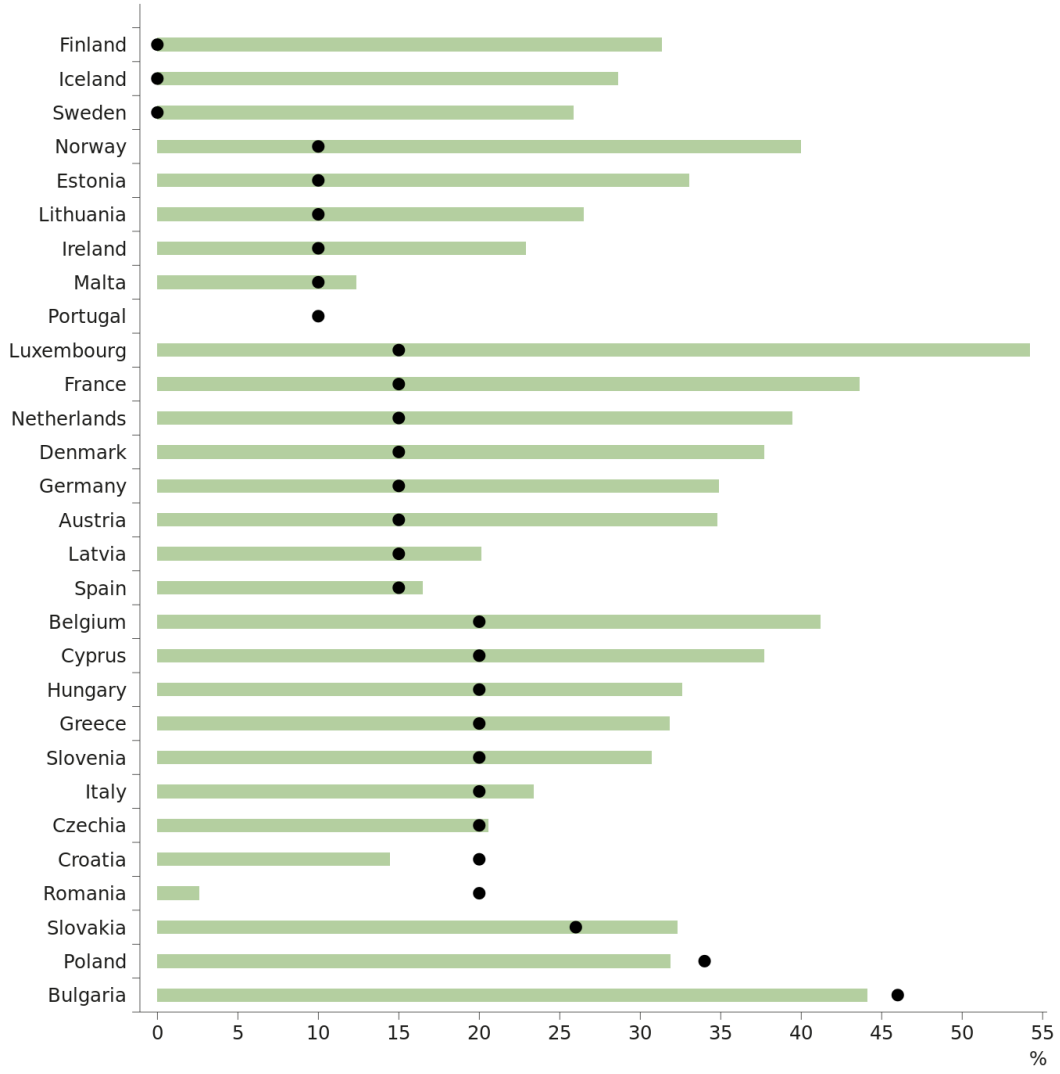
Figure 17: Average exposure indicator in 2020 and exposure concentration obligation



Note: The bars show the average exposure indicator (AEI) calculated in 2020 (averages 2018−2020) 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 (2018−2020) averages, as an approximation of the AEI in 2020 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, set at 20 µg/m³, to be achieved as of 2015.

Figure 18 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 2020 as a percentage of the AEI 2011 (AEI 2015 for Croatia). Figure 18 shows those countries that have reduced their AEI below their corresponding NERT values, estimated from their initial AEI2011, (those whose bar is to the right of the dot) and those that did not (the rest).

Figure 18: Percentage of reduction in AEI 2020 in relation to AEI 2011 and distance to the national exposure reduction target



Note: Bars indicate the reduction in the AEI 2020 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 2020.

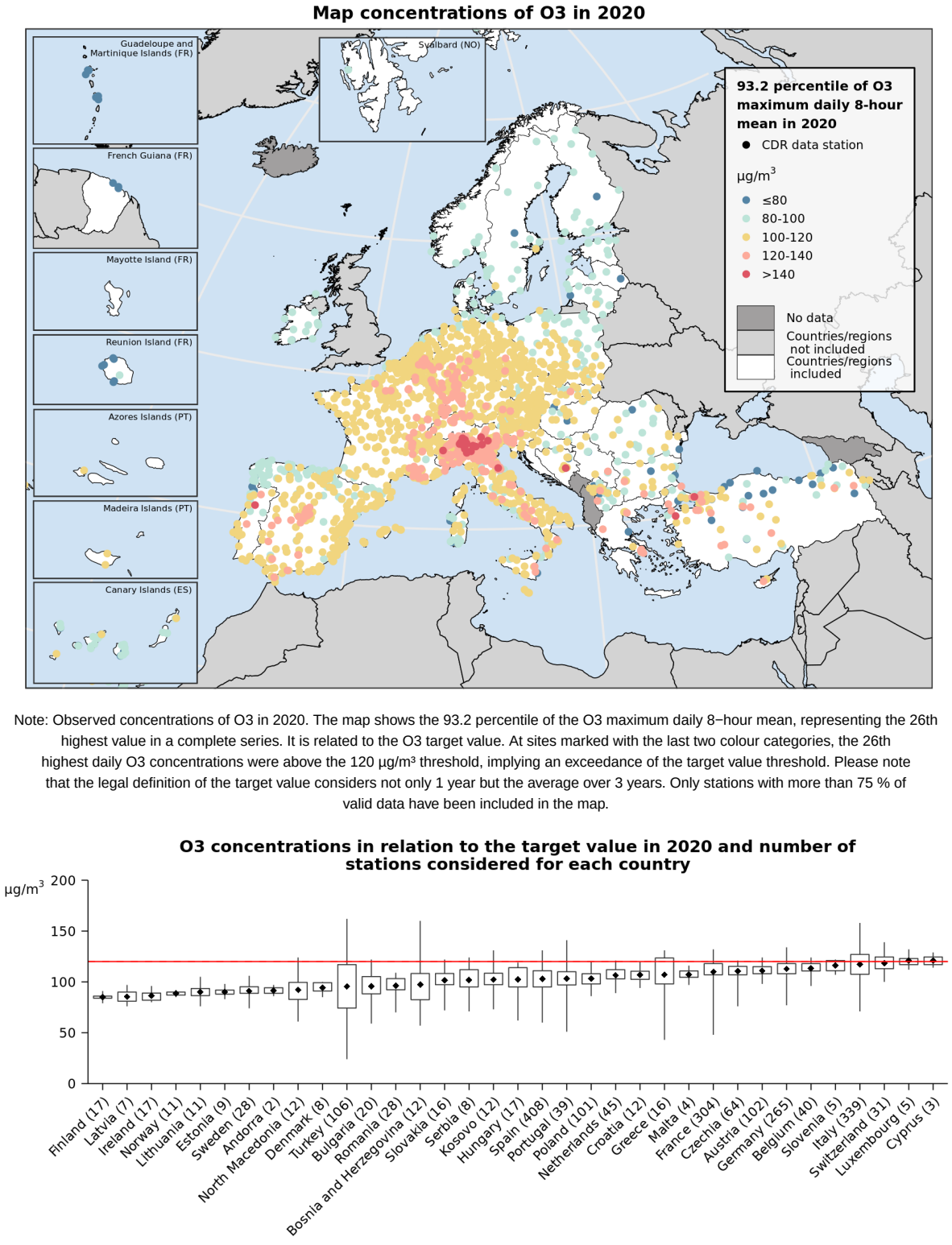
4 Status of ozone ambient air concentrations

Data for O_3 were reported from 2124 stations for the calculation of EU standards, from 2124 stations in relation to the short-term WHO AQG, and from 2008 stations for the long-term WHO AQG. These stations were located in all the reporting countries shown in Figure 1.

15 countries in EU-27 and 6 other reporting countries registered concentrations above the O_3 target value (120 µg/m^3) more than 25 times (Figure 19). In total, 14 % of all stations reporting O_3 showed concentrations above the target value for the protection of human health. In addition, only 19 % (410) of all stations fulfilled the long-term objective (120 µg/m^3). 87 % of the stations with values above the long-term objective were background stations.

9 % (200) of all stations and only 27 of the 539 reported rural background stations had values below the short-term WHO AQG value for O_3 (100 µg/m^3) (Figure 22), set for the protection of human health. The long-term (peak season) WHO AQG level (60 µg/m^3) was exceeded in 97 % (1950) of all stations located in 26 countries in EU-27 and 8 other reporting countries. Only 3 of the 524 reported rural background stations had values below this AQG level (Figure 25).

Figure 19: Map and boxplot of O_3 concentrations in 2020

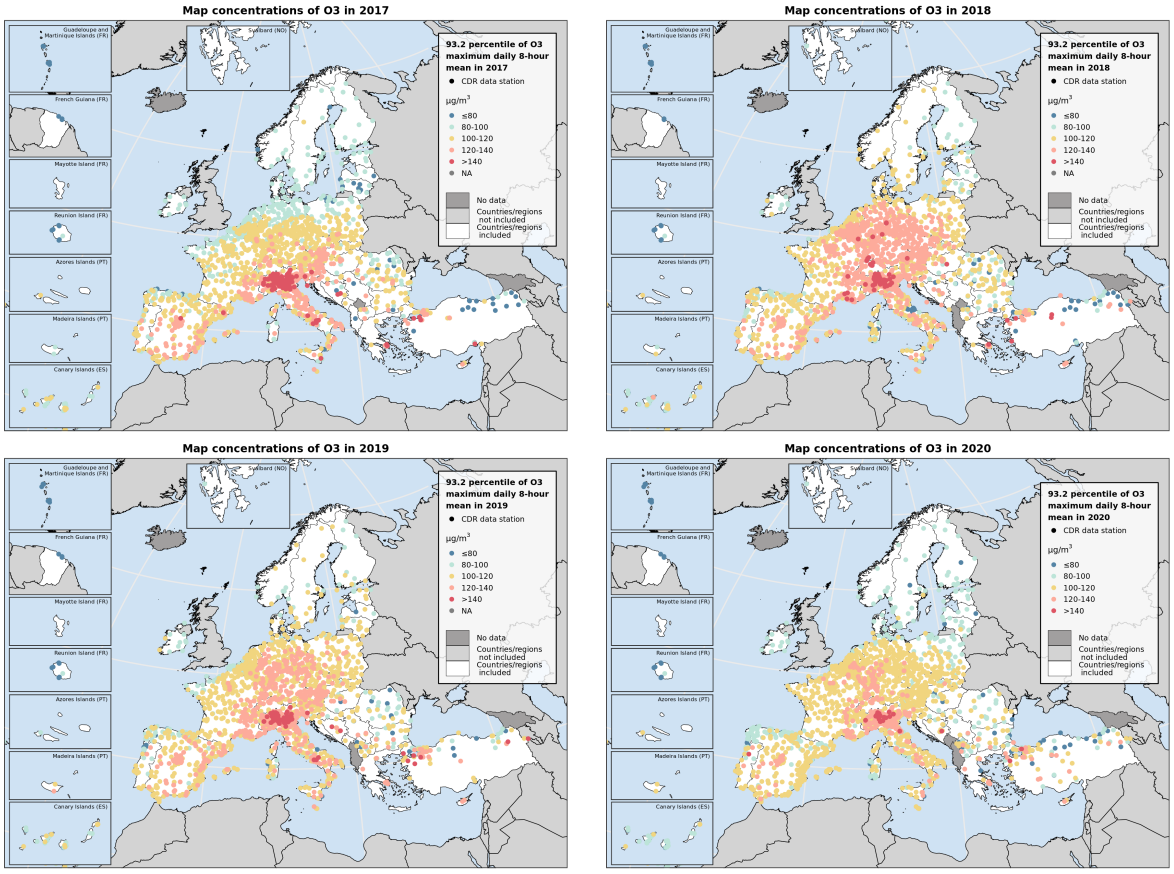


Note: Observed concentrations of O3 in 2020. The map shows the 93.2 percentile of the O3 maximum daily 8−hour mean, representing the 26th highest value in a complete series. It is related to the O3 target value. At sites marked with the last two colour categories, the 26th highest daily O3 concentrations were above the 120 µg/m³ 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 µg/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 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 20 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).

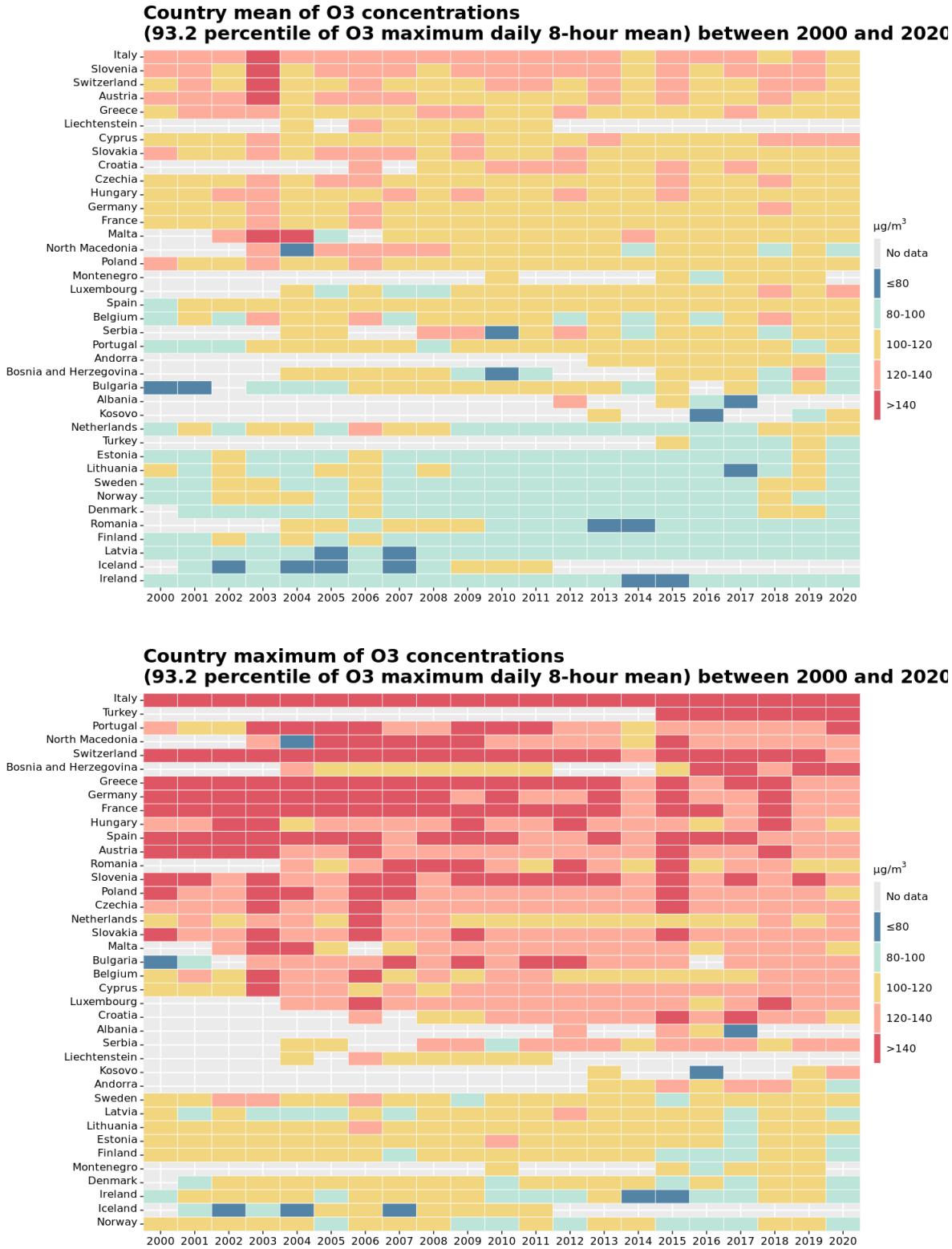
Figure 20: Maps of O_3 concentrations (related to the target value) for the last 4 years



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

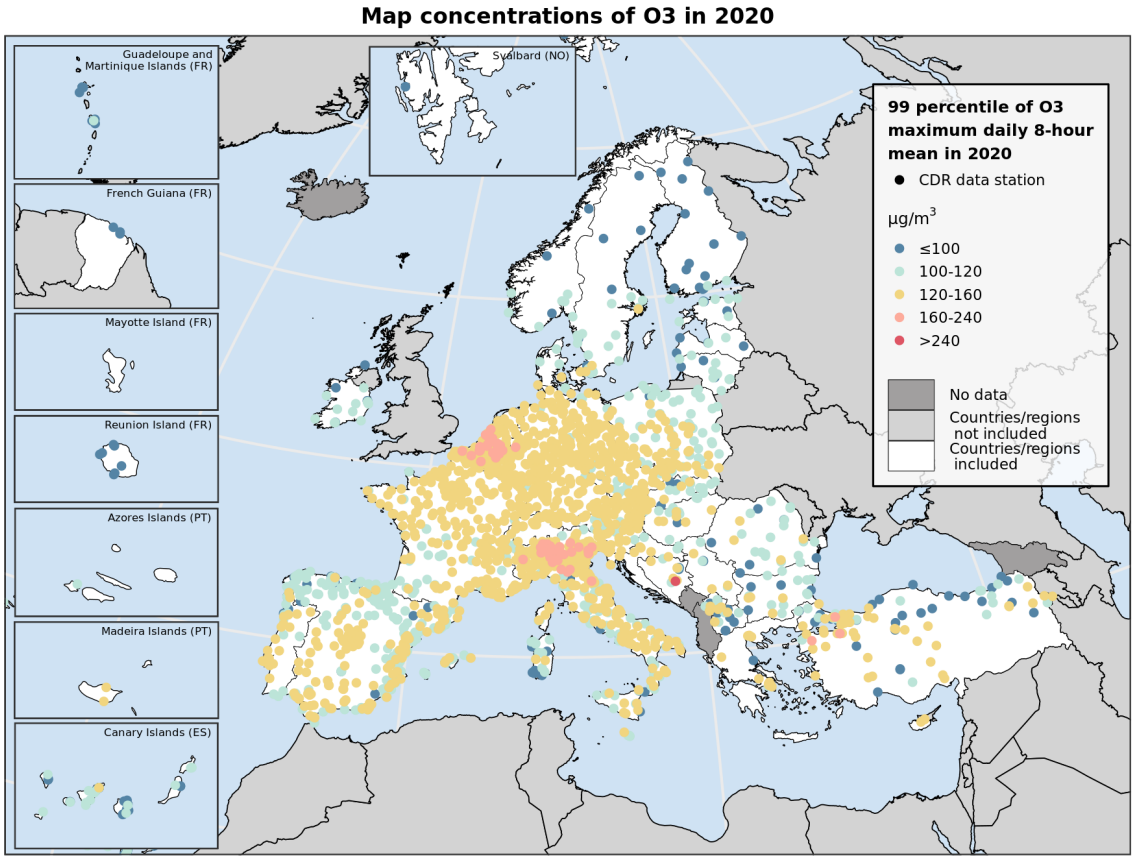
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) O_3 concentrations (93.2 percentile of the maximum daily 8-hour mean concentration, target value) at country level are shown in figure 21. In this way, the evolution along years of the average and maximum measured concentration 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), especially for O_3 as higher atmospheric temperature leads to enhanced photochemical reactions and O_3 formation.

Figure 21: Evolution of mean (top) and maximum (bottom) O_3 concentrations (93.2 percentile of the maximum daily 8-hour mean concentration, related to the target value) per country from 2000



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.

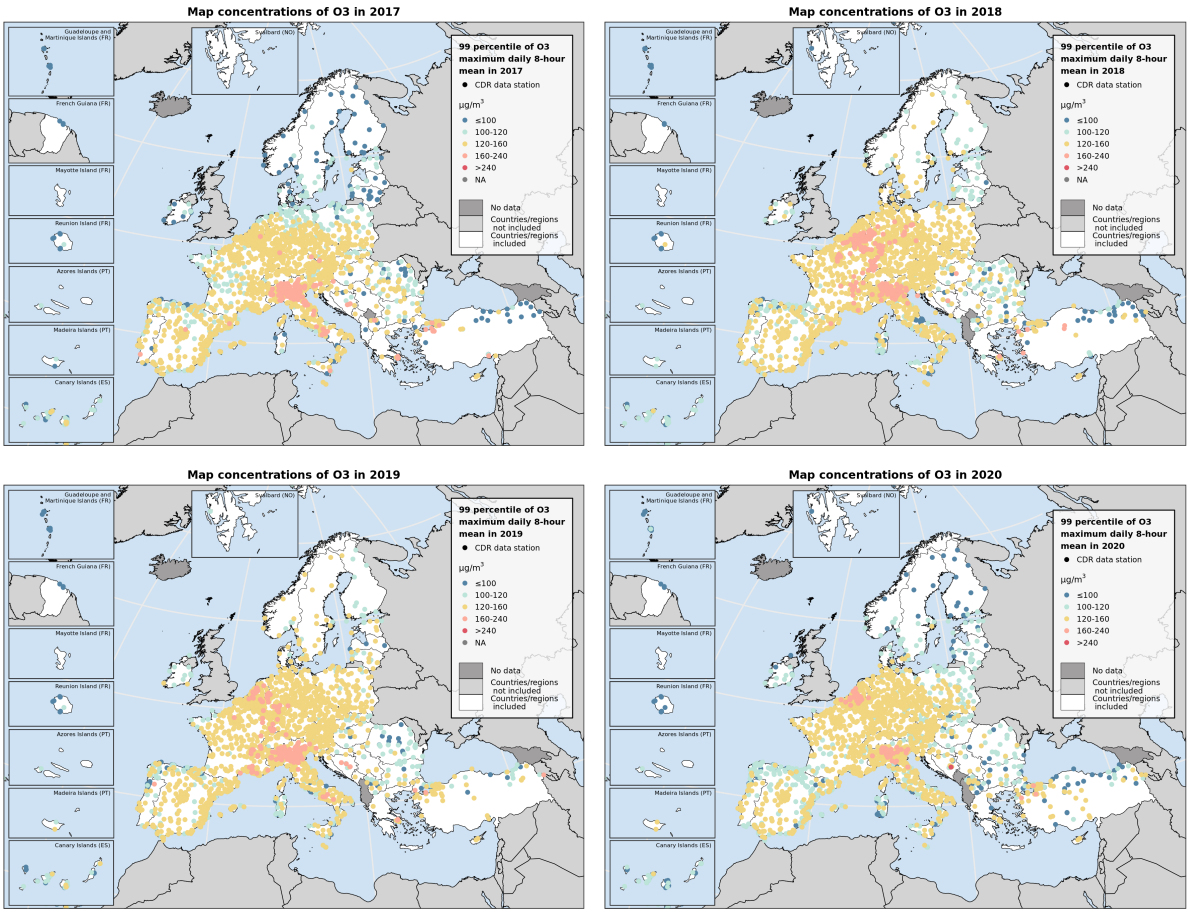
Figure 22: Map of O_3 concentrations in 2020 - short-term WHO AQG level



Note: Observed concentrations of O3 in 2020. The map shows the 99 percentile of the O3 maximum daily 8−hour mean concentrations, equivalent to 3−4 exceedance days per year, according to the definition of the short−term WHO AQG (100 µg/m³).
The first colour category indicates stations with concentrations below this AQG level.
Only stations with more than 75 % of valid data have been included in the map.

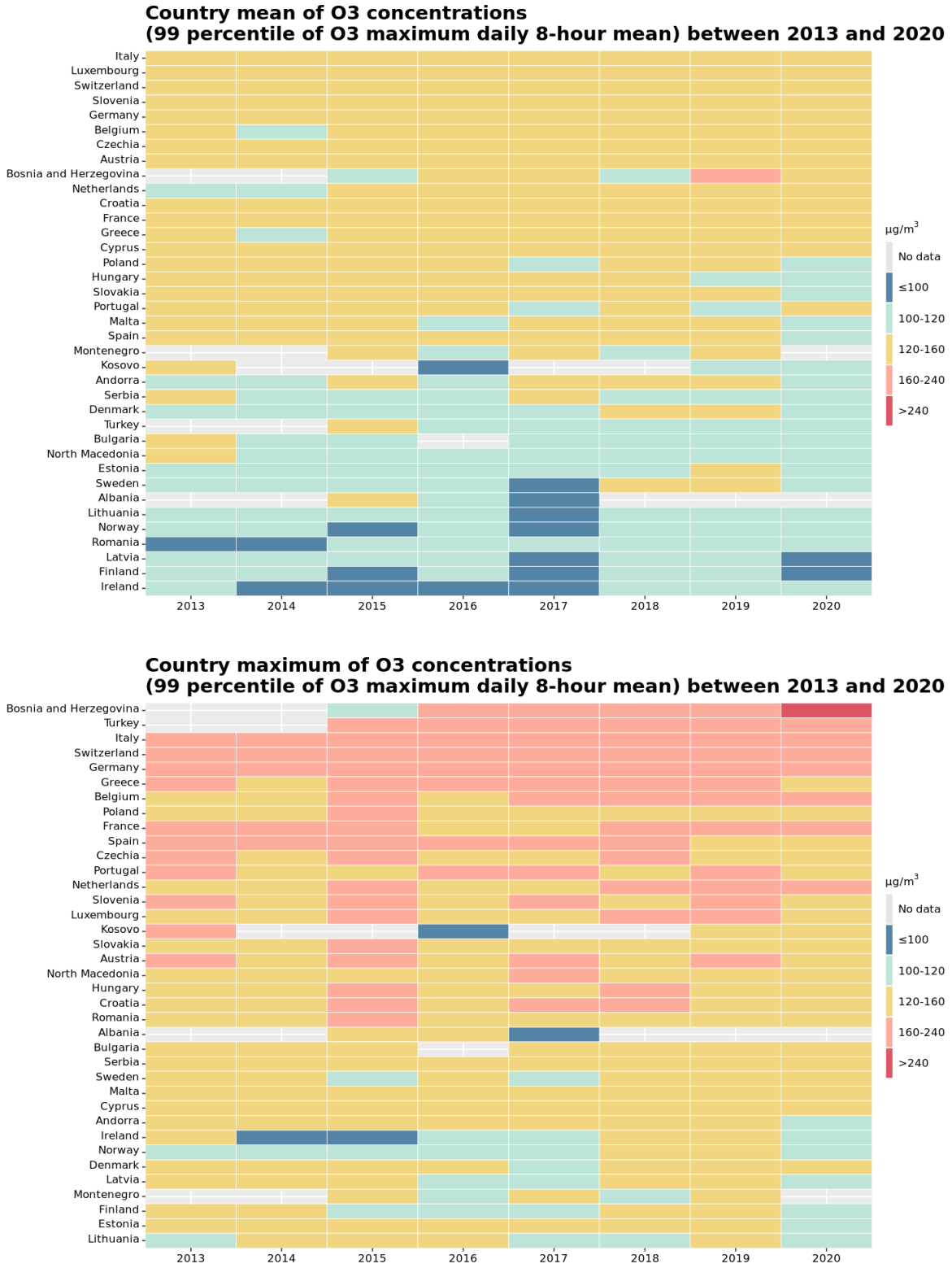
Figure 23 shows the maps of the 99 percentile of the O_3 maximum daily 8-hour mean concentrations (equivalent to the short-term WHO AQG level) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 23: Maps of O_3 concentrations (short-term WHO AQG level) for the last 4 years



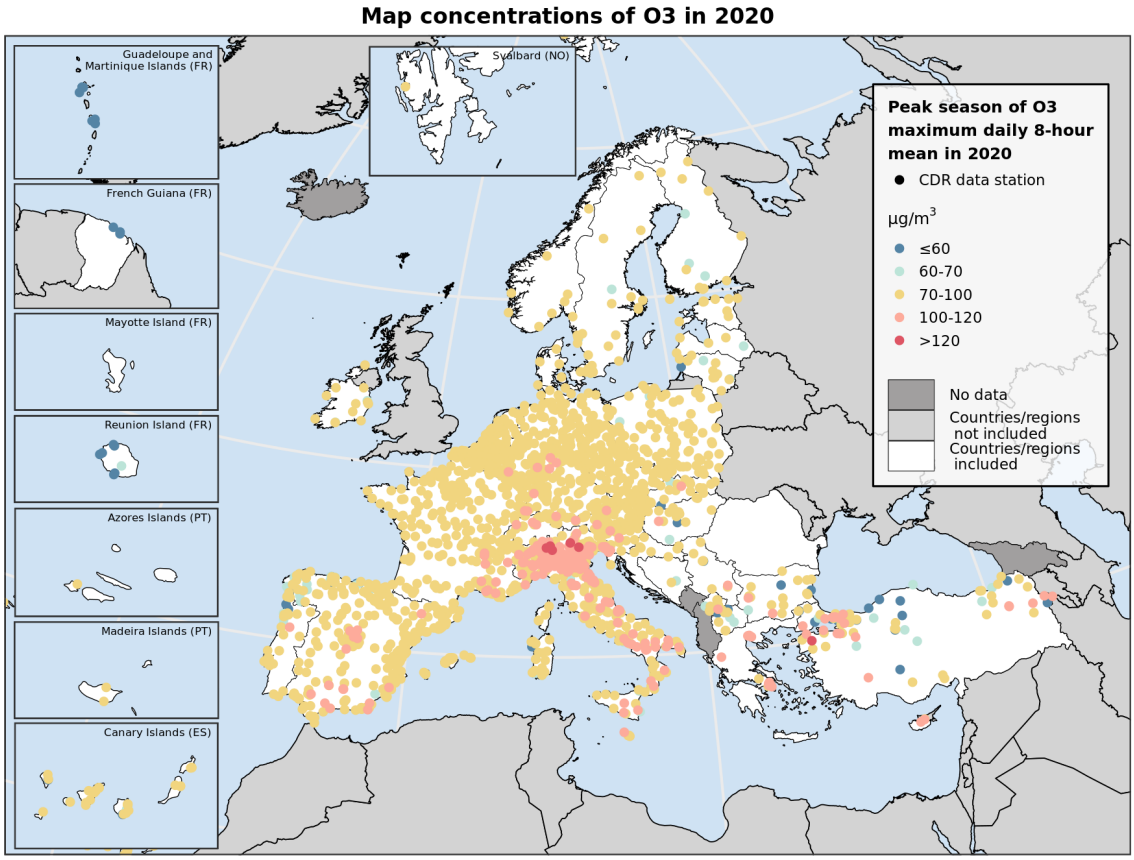
Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) 99 percentile of the O_3 maximum daily 8-hour mean concentrations at country level are shown in figure 24. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA, 2020).

Figure 24: Evolution of mean (top) and maximum (bottom) 99 percentile of the O_3 maximum daily 8-hour mean concentrations per country from 2013



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.

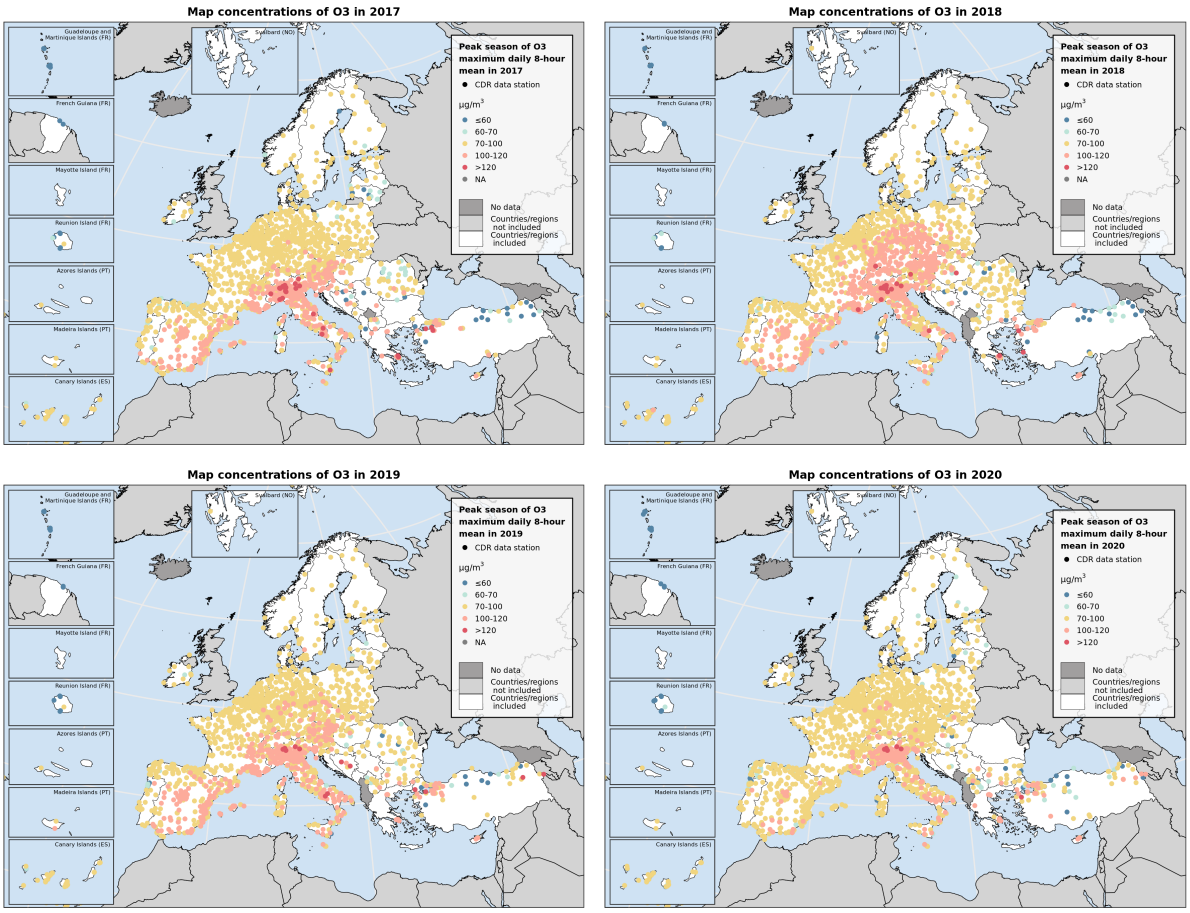
Figure 25: Map of peak season O_3 concentrations in 2020



Note: Observed concentrations of O3 in 2020. The map shows the average of the daily maximum 8−hour mean O3 concentration in the six consecutive months with the highest six−month running−average O3 concentration. The first colour category represents stations fulfilling the peak season O3 AQG level. Only stations with more than 75 % of valid data have been included in the map.

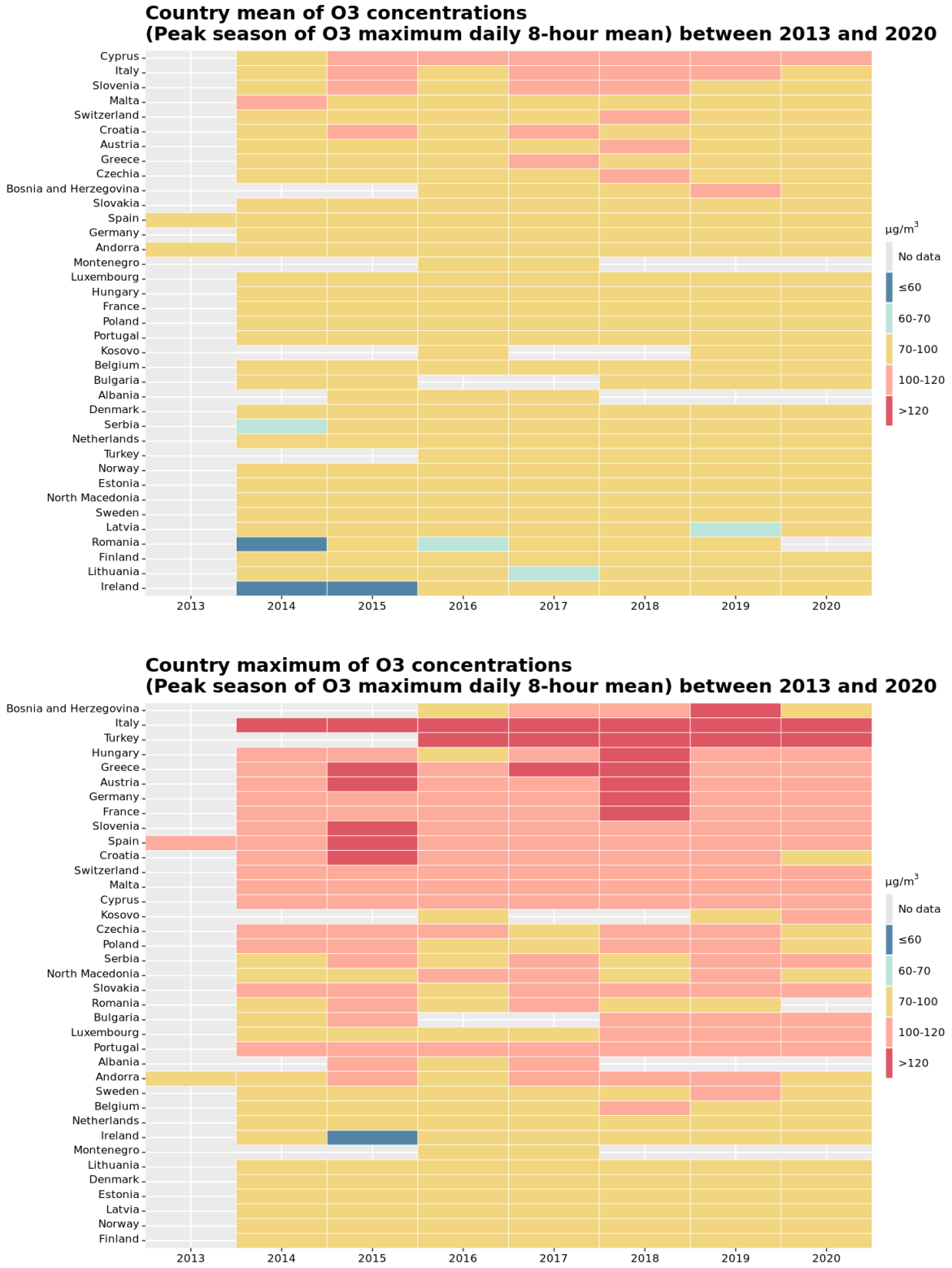
Figure 26 shows the maps of the peak season O_3 concentrations (equivalent to the long-term WHO AQG level) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 26: Maps of peak season O_3 concentrations for the last 4 years



Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) peak season O_3 concentrations at country level are shown in figure 27. 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).

Figure 27: Evolution of mean (top) and maximum (bottom) peak season O_3 concentrations per country from 2013



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.

5 Status of nitrogen dioxide ambient air concentrations

The reporting countries shown in Figure 1 submitted NO_2 data from 3333 stations for the annual limit value, 3019 stations for the hourly limit value, and 3329 stations for the daily WHO AQG level.

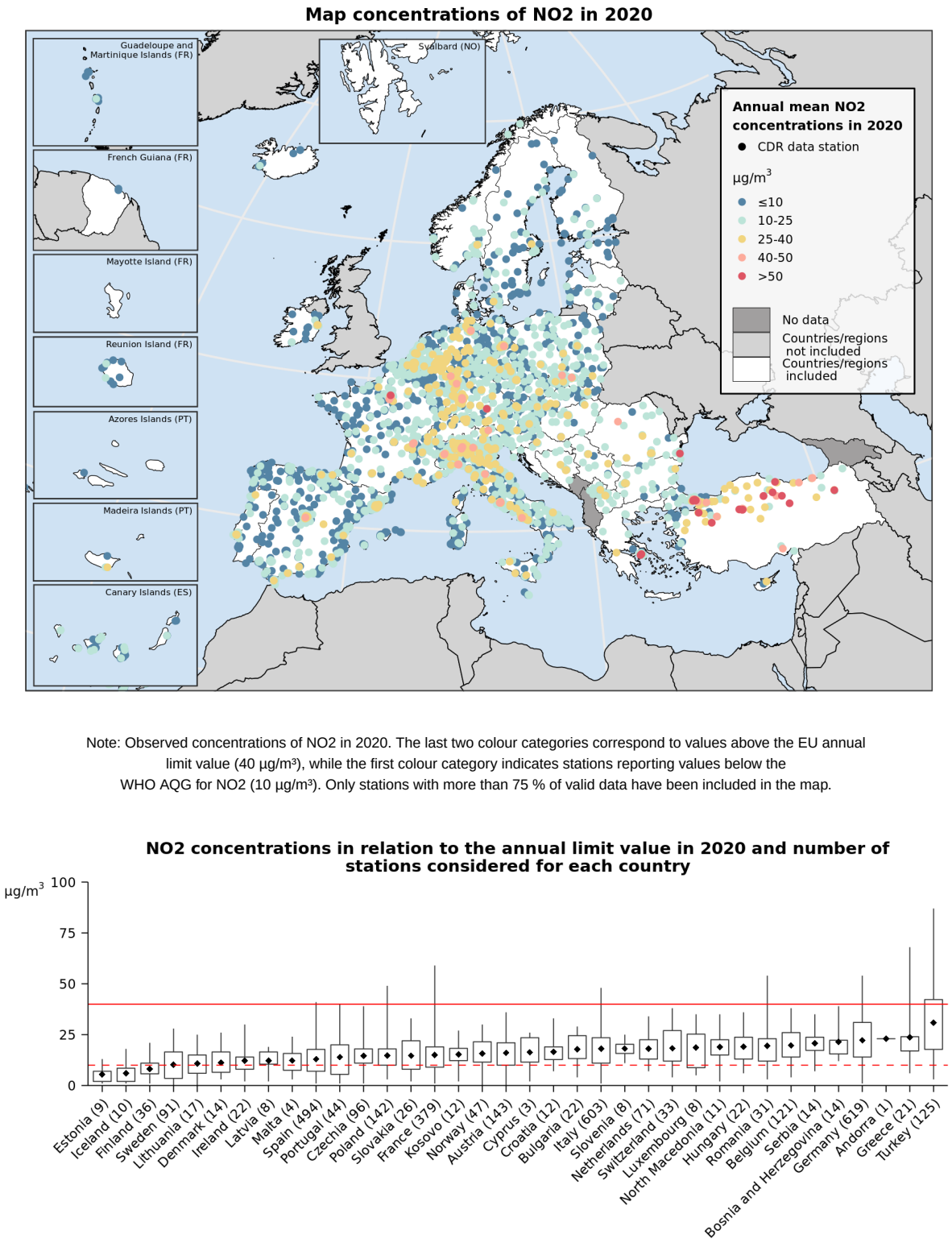
7 of the countries in EU-27 and 1 other reporting countries (Figure 28) recorded concentrations above the annual limit value (40 µg/m^3). This happened in 2 % of all the stations measuring NO_2. On the contrary, 73 % of stations, located in 27 of the countries in EU-27 and 9 other reporting countries reported concentrations above the WHO AQG level of 10 µg/m^3. Figure 28 shows the measured annual mean NO_2 concentrations.

69 % of all values above the annual limit value were observed at traffic stations. Furthermore, 100 % of the stations with concentrations above the annual limit value were located in urban or suburban areas.

Concentrations above the hourly limit value (200 µg/m^3) were observed in 0.3 % (10 stations) of all reporting stations, mostly at urban traffic stations. They were observed in one countries (number stations): Turkey (ten).

Finally, concentrations above the daily NO_2 WHO AQG level (25 µg/m^3) were registered in 78 % (2581 stations) of all the reporting stations in 27 of the countries in EU-27 and 9 other reporting countries (Figure 31).

Figure 28: Map and boxplot of NO_2 concentrations in 2020



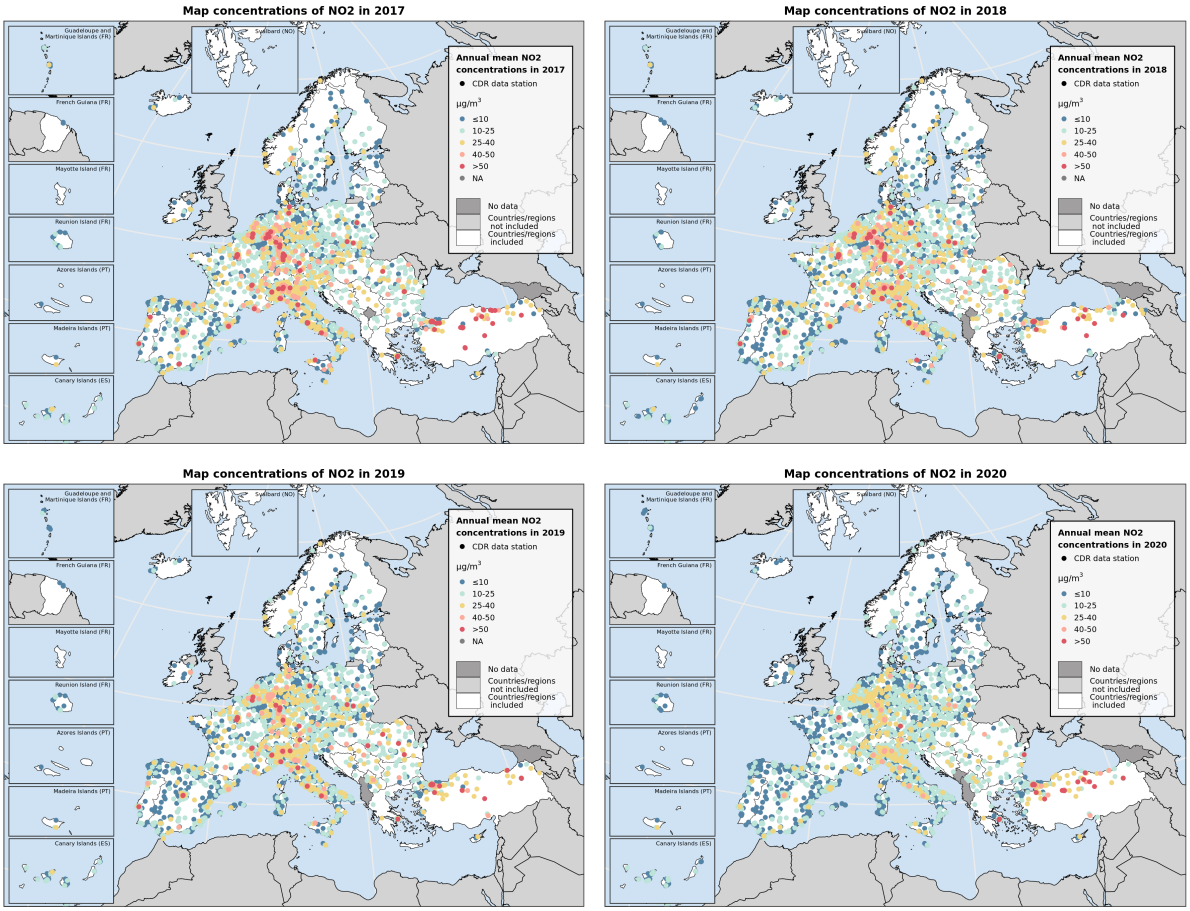
Note: Observed concentrations of NO2 in 2020. The last two colour categories correspond to values above the EU annual limit value (40 µg/m³), while the first colour category indicates stations reporting values below the WHO AQG for NO2 (10 µg/m³). Only stations with more than 75 % of valid data have 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 µg/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 limit value set by EU legislation is marked by the horizontal line. The WHO AQG level 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.

The highest value in the boxplot, Turkey (102.4 µg/m^3), has not been included in the graph for representation purposes.

Figure 29 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).

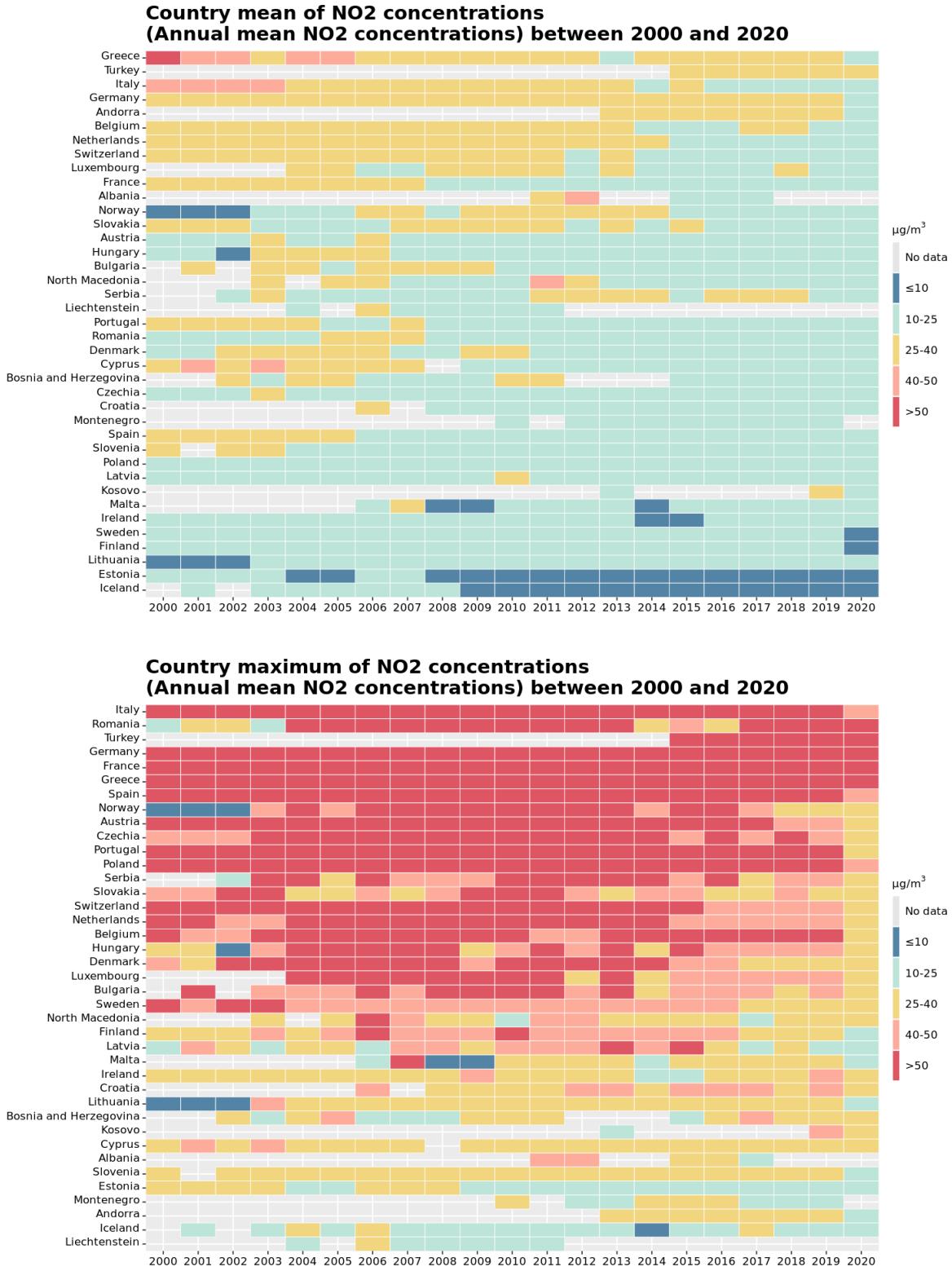
Figure 29: Map of NO_2 concentrations (annual mean) for the last 4 years



Maps for years before 2020 are different to the ones published in previous reports because the bands in the legend have been modified to accomodate the 2021 WHO AQG level.

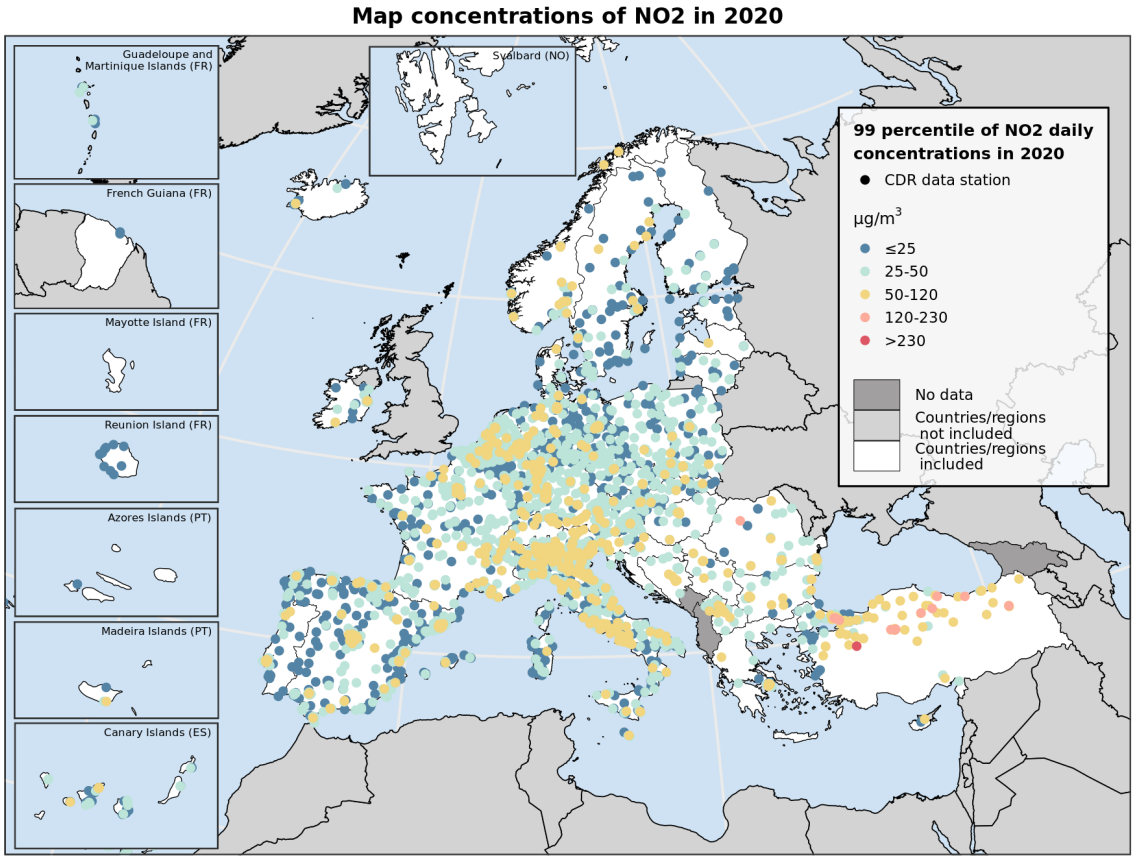
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) NO_2 annual mean concentrations at country level are shown in figure 30. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA, 2020).

Figure 30: Evolution of mean (top) and maximum (bottom) NO_2 annual mean concentrations (annual limit value) per country from 2000



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.

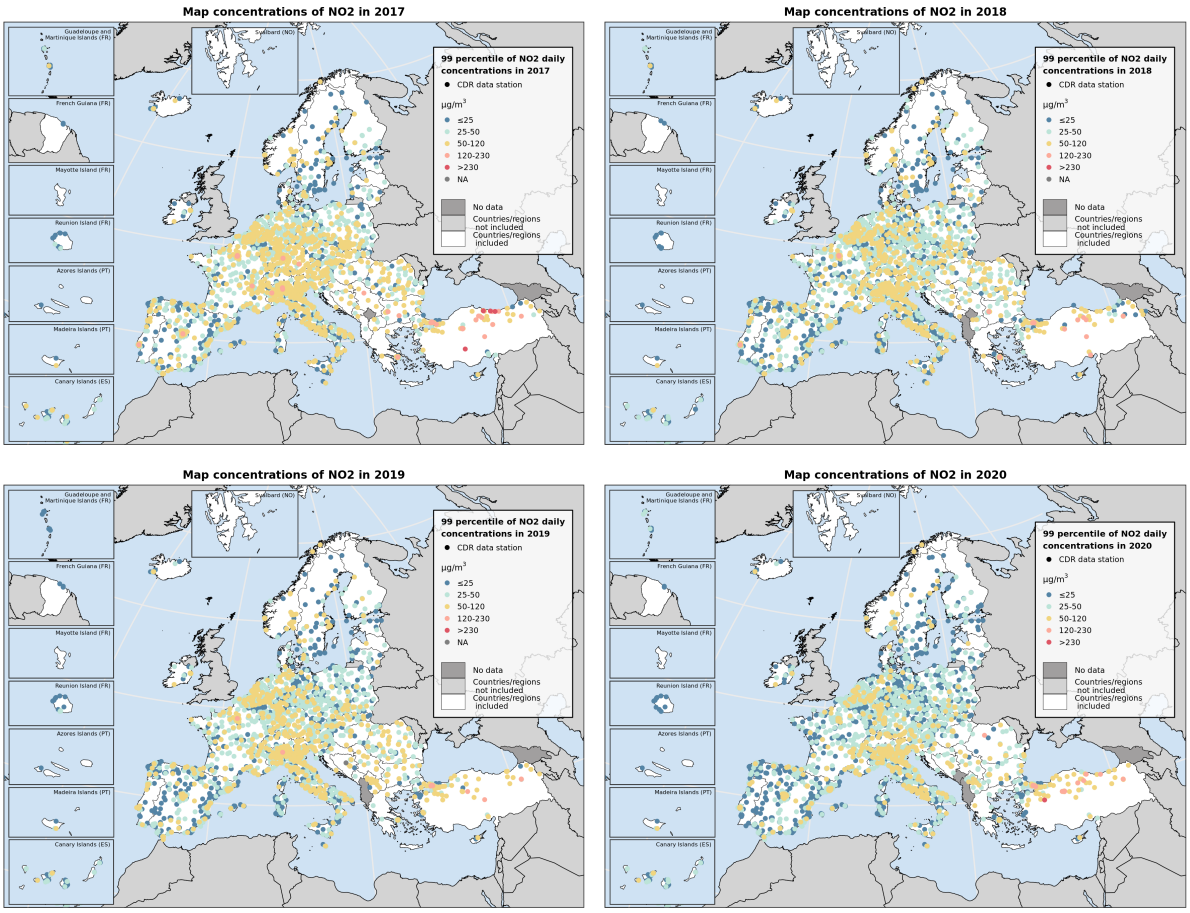
Figure 31: Map of NO_2 concentrations in 2020 - daily WHO AQG level



Note: Observed concentrations of NO2 in 2020. The map shows the 99 percentile of the NO2 daily mean concentrations, equivalent to 3−4 exceedance days per year, according to the definition of the daily WHO AQG level (25 µg/m³). The first colour category indicates stations with concentrations below this AQG level. Only stations with more than 75 % of valid data have been included in the map.

Figure 32 shows the maps of the 99 percentile of NO_2 daily mean concentrations (equivalent to the WHO AQG for NO_2 daily mean 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 32: Maps of NO_2 concentrations (daily WHO AQG level) for the last 4 years



Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) 99 percentile of NO_2 daily mean concentrations at country level are shown in figure 33. 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).

Figure 33: Evolution of mean (top) and maximum (bottom) 99 percentile of NO_2 daily mean concentrations (daily WHO AQG level) per country from 2013

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.

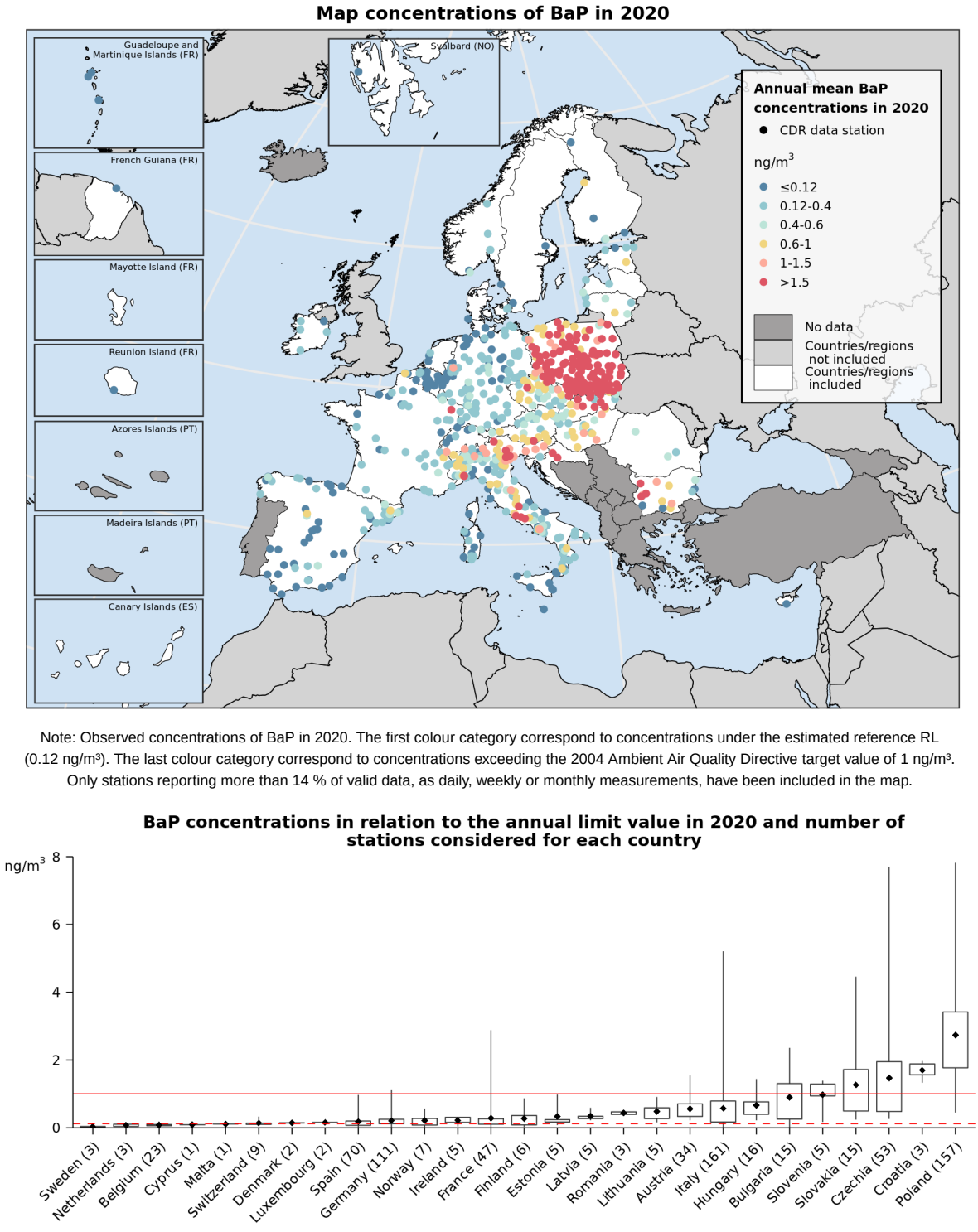
6 Status of benzo[a]pyrene ambient air concentrations

A total of 767 stations in the reporting countries shown in Figure 1 reported BaP data with sufficient data coverage.

11 countries measured concentrations above 1.0 ng/m^3 (Figure 34). These were measured at 27 % of the reported BaP measurement stations (Figure 34), mainly at urban (79 % of all stations with values above 1.0 ng/m^3) and suburban (15 %) stations.

Regarding the reference level, all reporting countries, except for Cyprus, Malta and Sweden have at least one station with concentrations above 0.12 ng/m^3. Only 20 % of the reported stations had annual concentrations below the reference level.

Figure 34: Map and boxplot of BaP concentrations in 2020



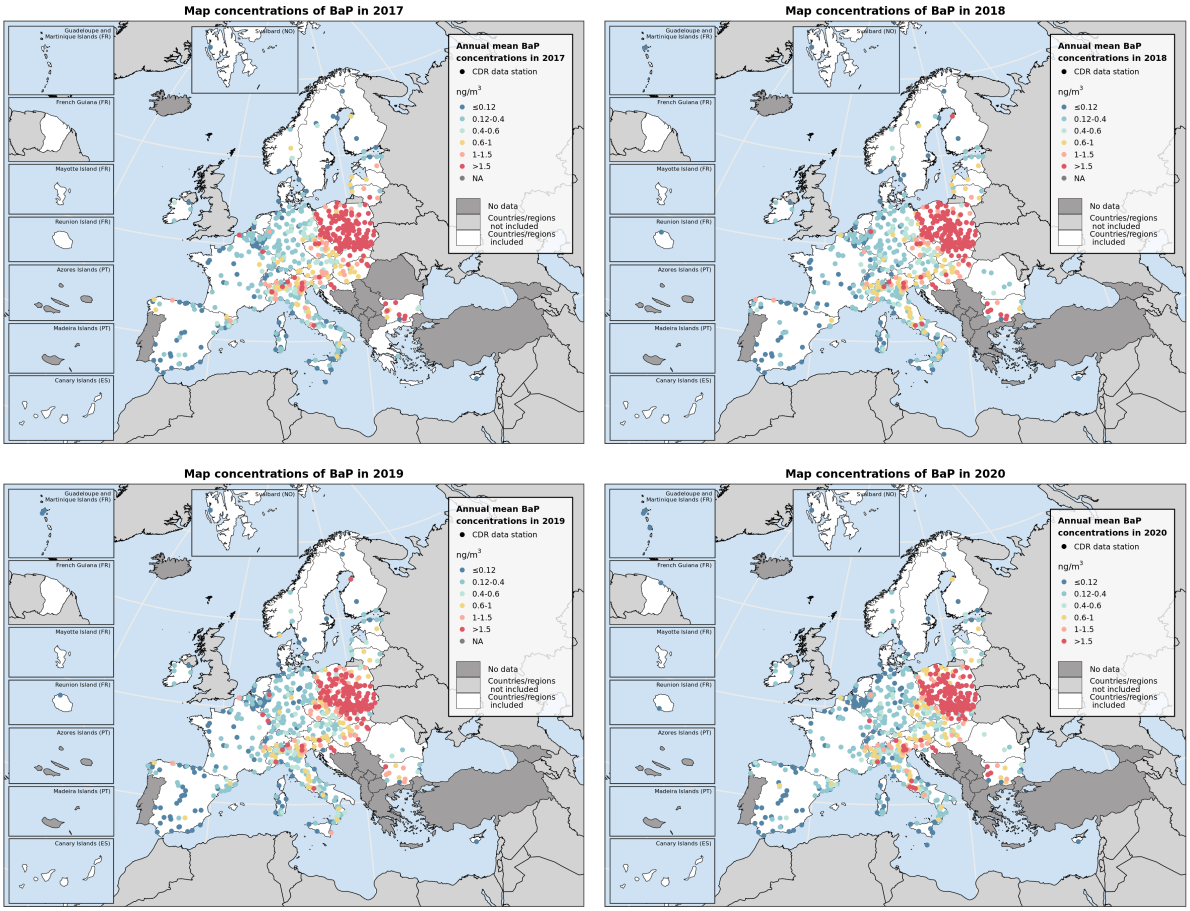
Note: Observed concentrations of BaP in 2020. The first colour category correspond to concentrations under the estimated reference RL (0.12 ng/m³). The last colour category correspond to concentrations exceeding the 2004 Ambient Air Quality Directive target value of 1 ng/m³. Only stations reporting more 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.

The highest value in the boxplot, Poland (18.4 ng/m^3), has not been included in the graph for representation purposes.

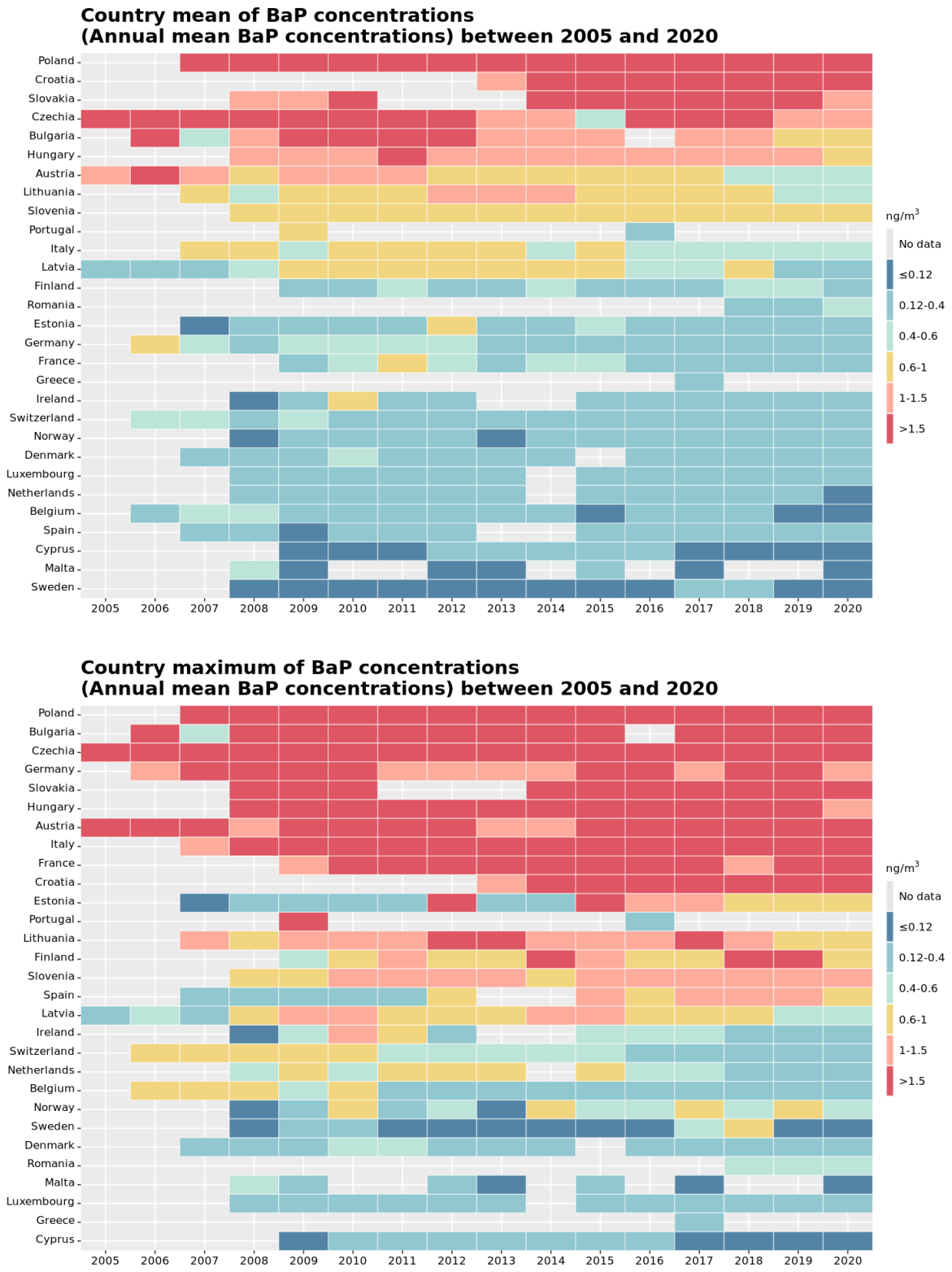
Figure 35 shows the maps of the observed BaP annual mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 35: 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 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).

Figure 36: Evolution of mean (top) and maximum (bottom) BaP annual mean concentrations (targe value) per country from 2005



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.

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 1537 stations for the hourly limit value and 1567 stations for the daily limit value.

19 stations ([4]) registered concentrations above the hourly limit value (350 µg/m^3); and 23 stations ([5]) registered concentrations above the daily limit of 125 µg/m^3 for SO_2 (Figure 37).

On the contrary, 105 (7 %) of all the stations reporting SO_2 levels, located in 16 reporting countries ([6]), measured SO_2 concentrations above the WHO AQG of 40 µg/m^3 for daily mean concentrations ([7]).

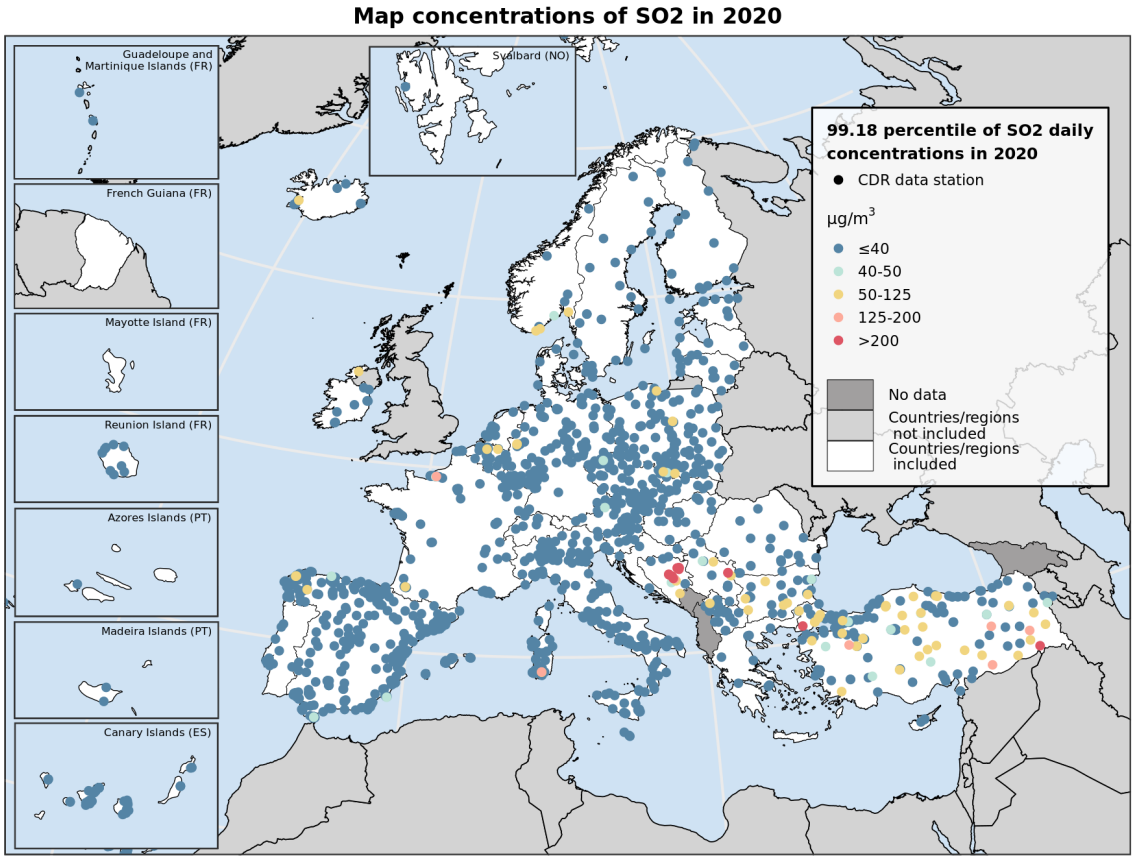
[4] Bosnia and Herzegovina (eleven), Turkey (five), Serbia (two) and Bulgaria (one)

[5] Bosnia and Herzegovina (twelve), Turkey (seven), Serbia (two), France (one) and Italy (one).

[6] All reporting countries except Andorra, Croatia, Cyprus, Denmark, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, Netherlands, North Macedonia, Portugal, Romania, Slovakia, Slovenia, Sweden and Switzerland.

[7] Although the WHO AQG level for daily means refers to the percentile 99 (3-4 exceedance days), here we have used the percentile 99.18 (3 exceedance days), so the daily WHO AQG level can be directly compared with the EU daily LV.

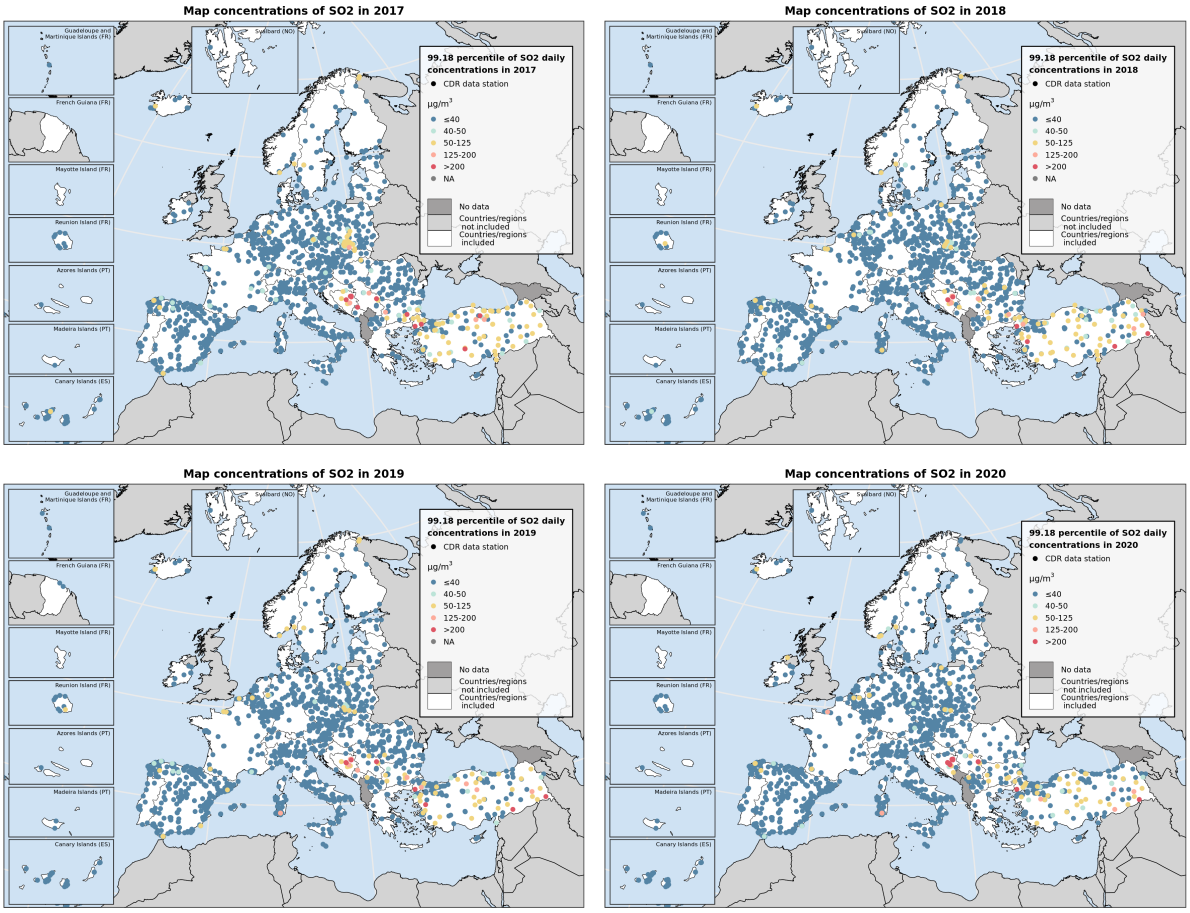
Figure 37: Map of SO_2 daily concentrations in 2020



Note: Observed concentrations of SO2 in 2020. The map shows the percentile 99 of SO2 daily means, indicating 3 exceedance days. It relates to the EU daily limit value (125 µg/m³) and to the WHO daily AQG level (40 µg/m³). Only stations with more than 75 % of valid data have been included in the map.

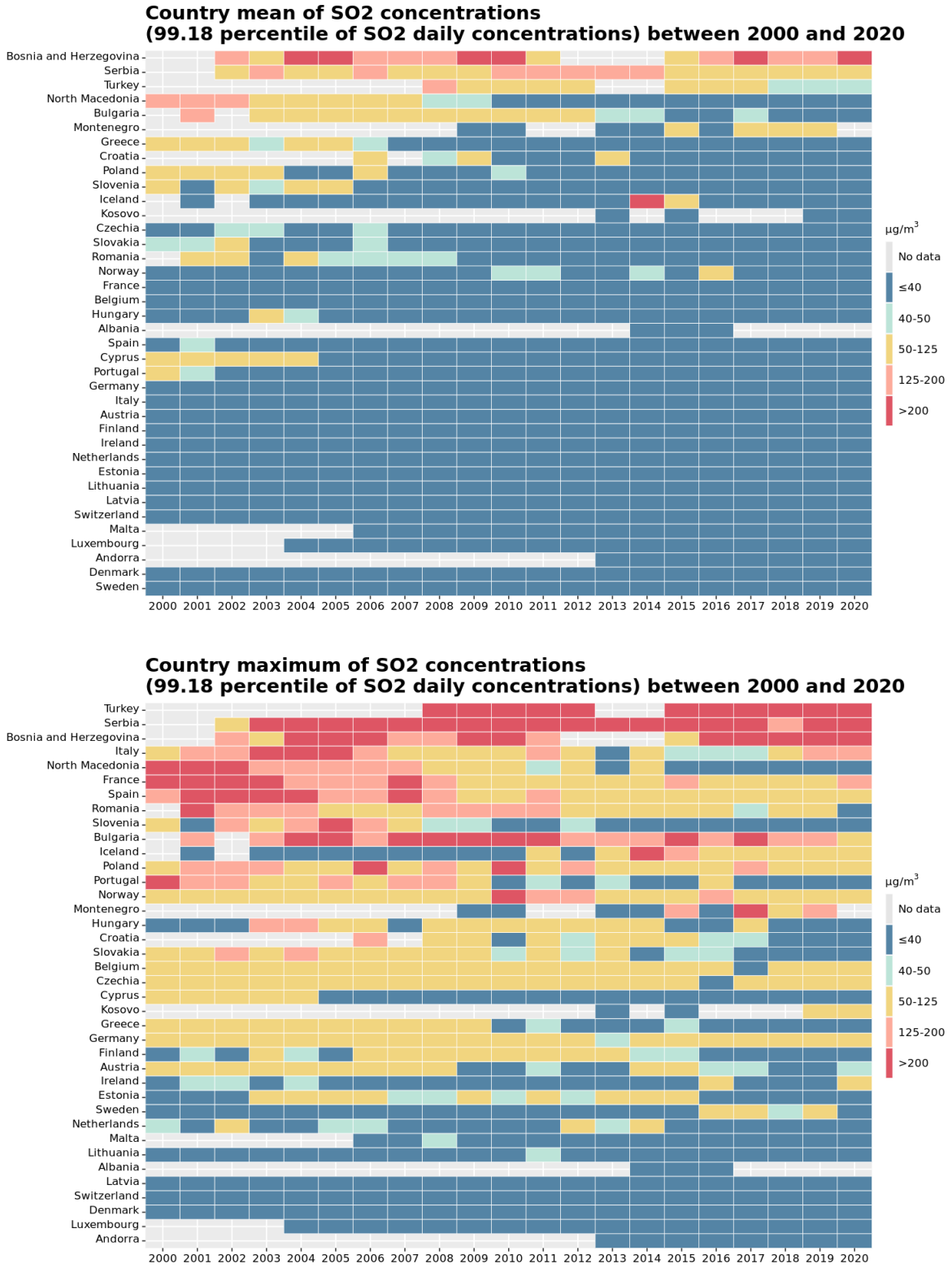
Figure 38 shows the maps of the observed SO_2 daily mean concentrations for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 38: Maps of SO_2 concentrations (daily mean) for the last 4 years



Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) SO_2 daily mean concentrations at country level are shown in figure 39. 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).

Figure 39: Evolution of mean (top) and maximum (bottom) SO_2 99.18 percentile of daily mean concentrations (EU LV (125 µg/m^3) and WHO AQG level (40 µg/m^3)) per country from 2000



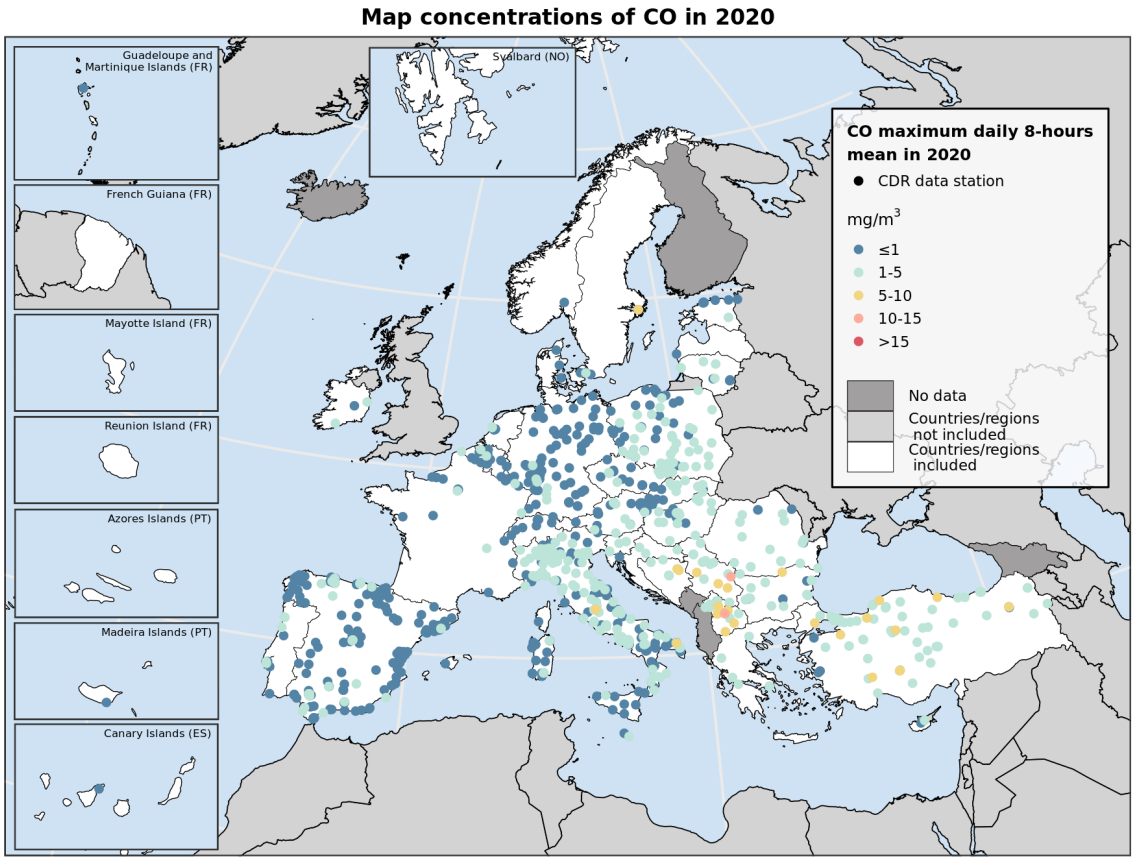
Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

7.2 Carbon monoxide

All reporting countries shown in Figure 1 measured CO data from 892 operational stations for the daily limit value and from 897 stations for the daily WHO AQG. Only 2 stations (Figure 40) registered concentrations above the CO limit daily value (10 mg/m^3) and the WHO AQG value for the maximum daily 8-hour mean: North Macedonia (one) and Serbia (one).

3 stations registered concentrations above the daily WHO AQG. They were located in Bosnia and Herzegovina (one), Kosovo (one) and North Macedonia (one) (Figure 42).

Figure 40: Map of CO concentrations in 2020

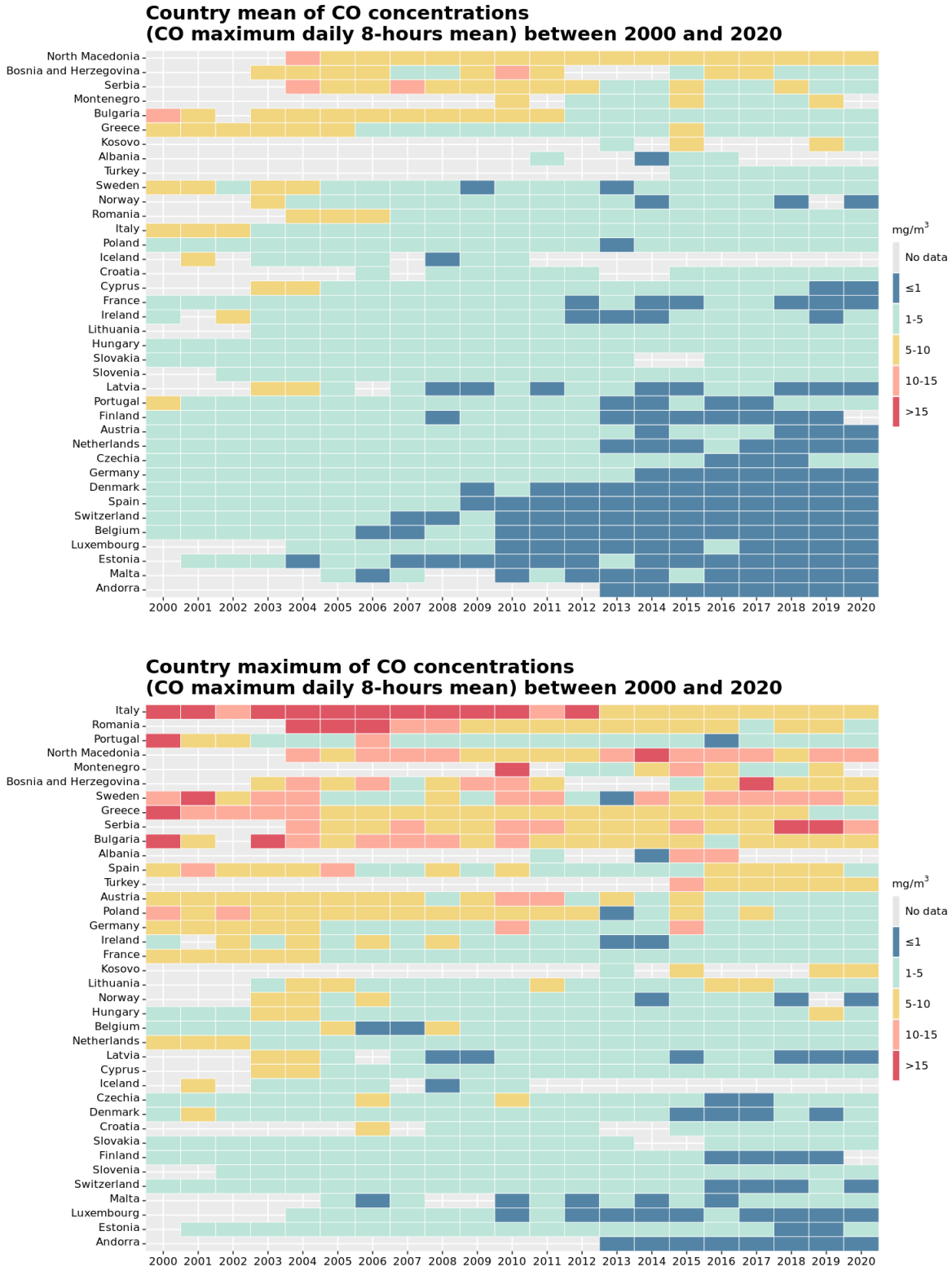


Note: Observed concentrations of CO in 2020. The map shows the CO maximum daily 8−hour mean. The last two colour categories correspond the values above the EU annual limit value and the WHO AQG (10 mg/m³). Only stations with more than 75 % of valid data have been included in the map.

When concentrations are below the 'lower assessment threshold' (LAT), air quality can be assessed by means of only modelling or objective estimates. At 862 stations (97 % 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 40).

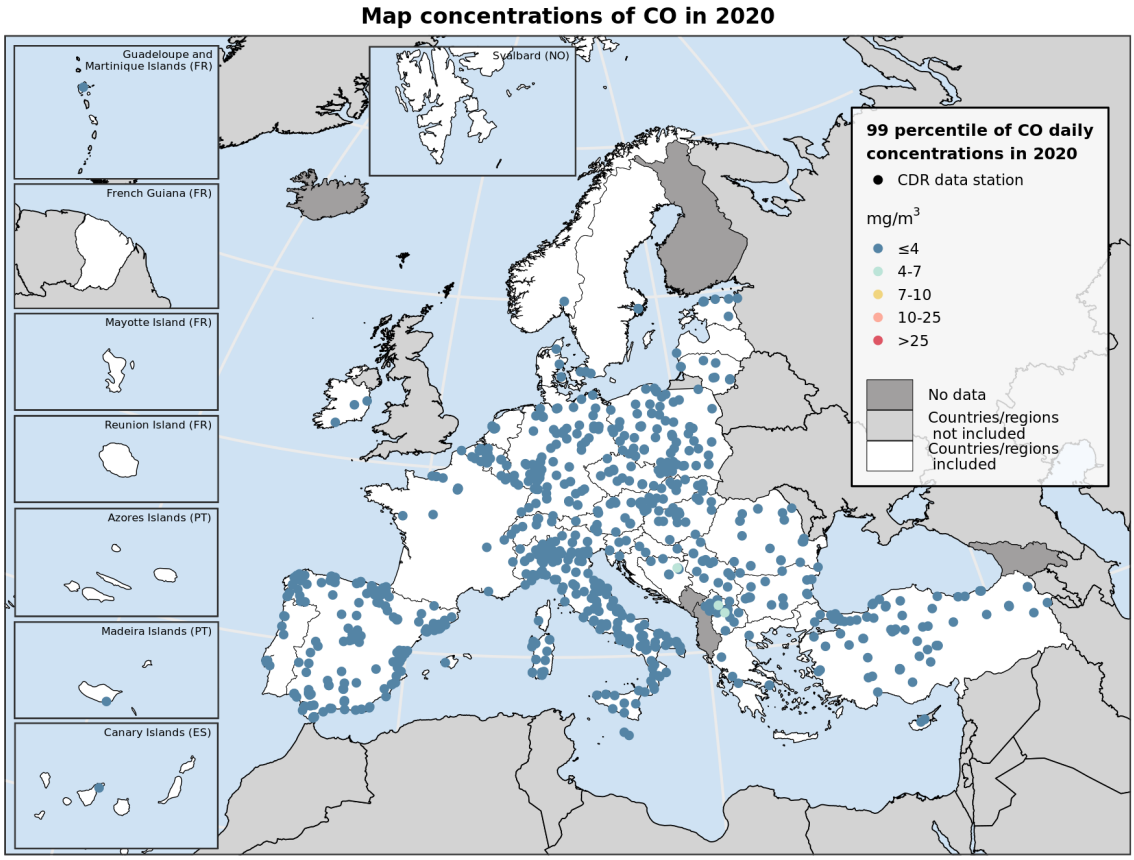
Heatmaps with the evolution from 2000 of the mean (top) and the maximum (bottom) CO maximum daily 8-hour mean concentrations at country level are shown in Figure 41. In this way, the evolution along years of the average and maximum measured concentration levels can be seen for each country. Note that meteorological variability has a considerable impact on year-to-year changes in ambient air concentrations of air pollutants (EEA, 2020).

Figure 41: Evolution of mean (top) and maximum (bottom) CO maximum daily 8-hour mean concentrations (limit value) per country from 2000



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.

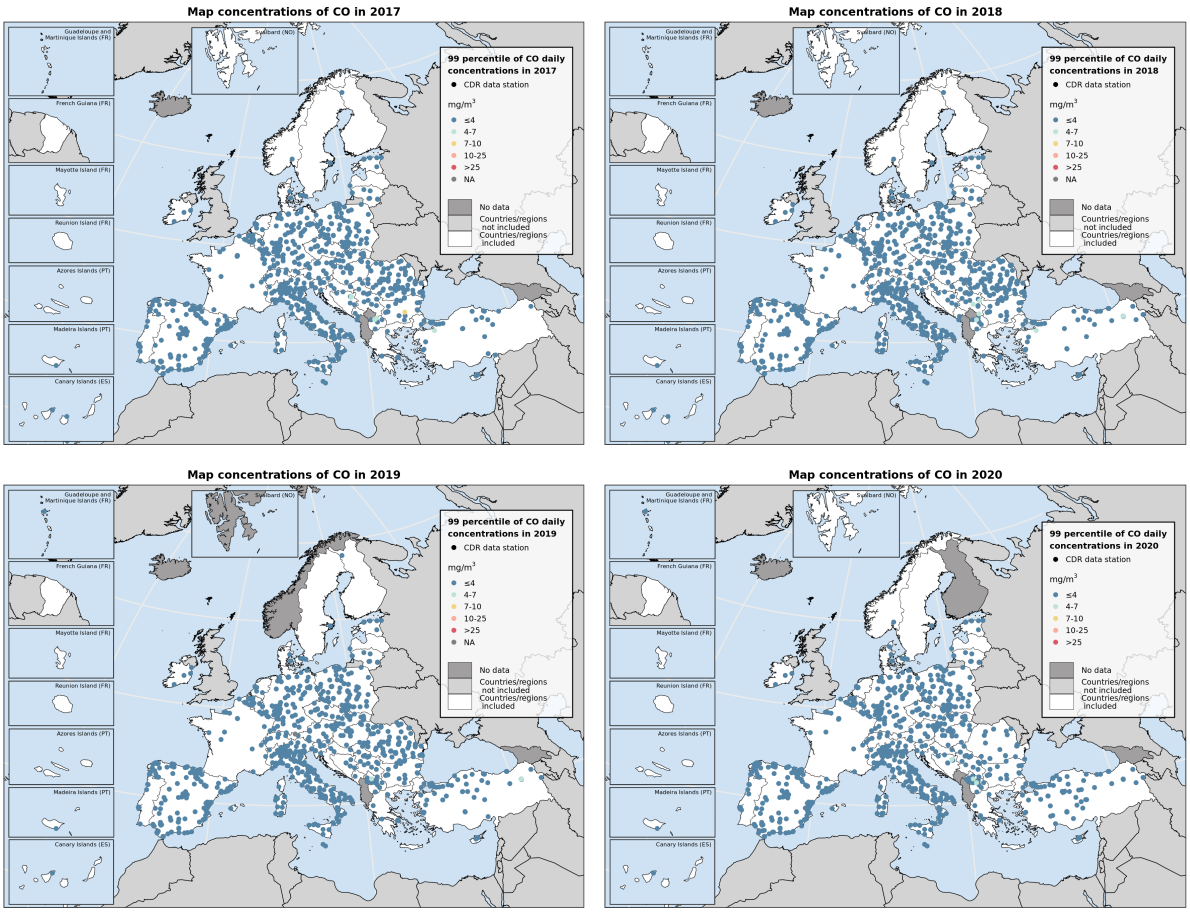
Figure 42: Map of daily CO concentrations in 2020



Note: Observed concentrations of CO in 2020. The map shows the 99 percentile of CO daily concentrations, meaning 3−4 exceedance days. The first colour category corresponds to values below the WHO AQG level (4 mg/m³). Only stations with more than 75 % of valid data have been included in the map.

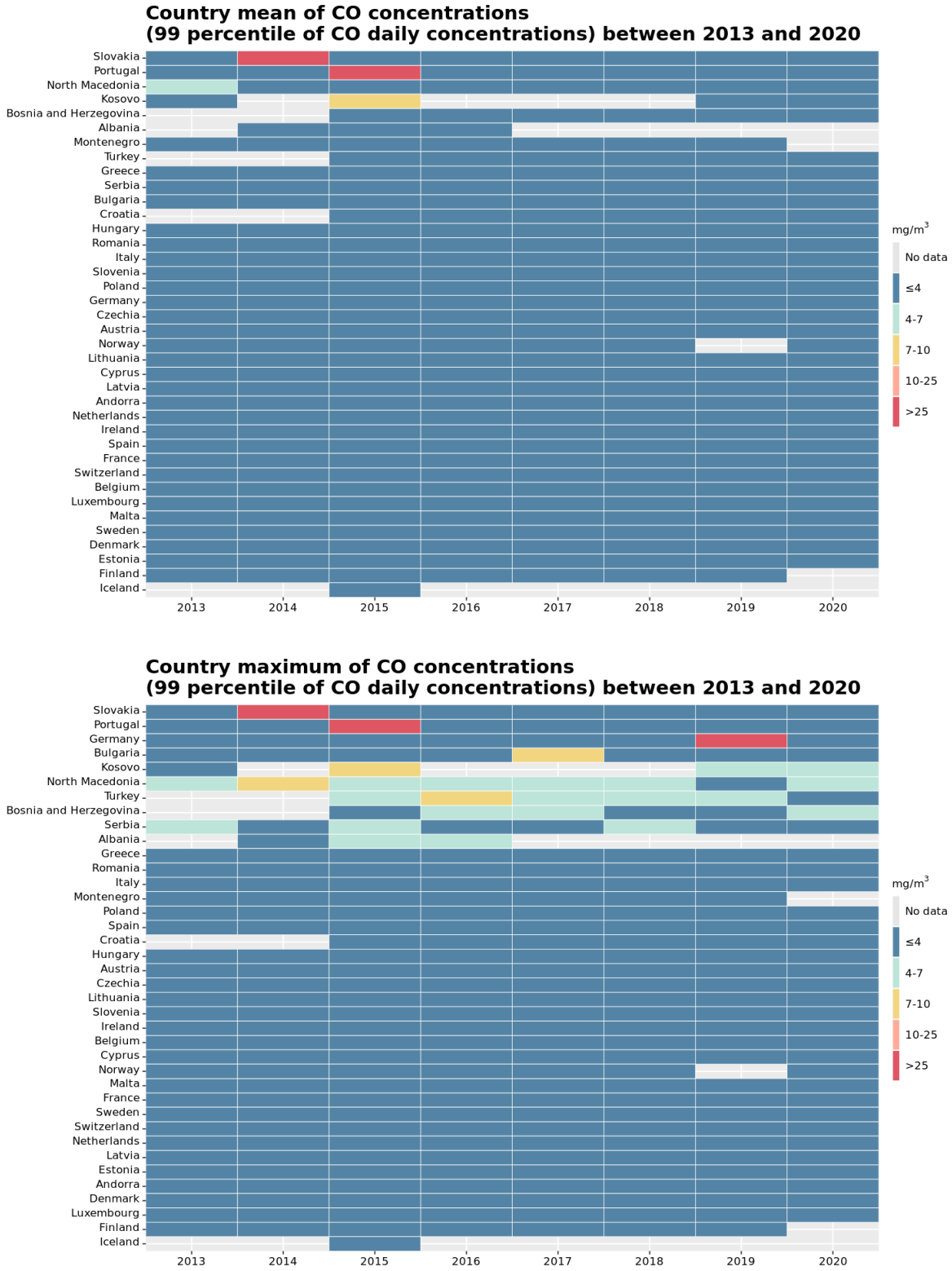
Figure 43 shows the maps of the 99 percentile of CO daily mean concentrations (equivalent to the WHO AQG for CO daily mean level) for the last four years. In this way, any significant change in the spatial distribution of the values above the set thresholds in the legends can be observed. These maps are based on officially reported validated data (CDR).

Figure 43: Maps of CO concentrations (daily WHO AQG level) for the last 4 years



Heatmaps with the evolution from 2013 of the mean (top) and the maximum (bottom) 99 percentile of CO daily mean concentrations at country level are shown in figure 44. 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).

Figure 44: Evolution of mean (top) and maximum (bottom) 99 percentile of CO daily mean concentrations (daily WHO AQG level) per country from 2013



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.

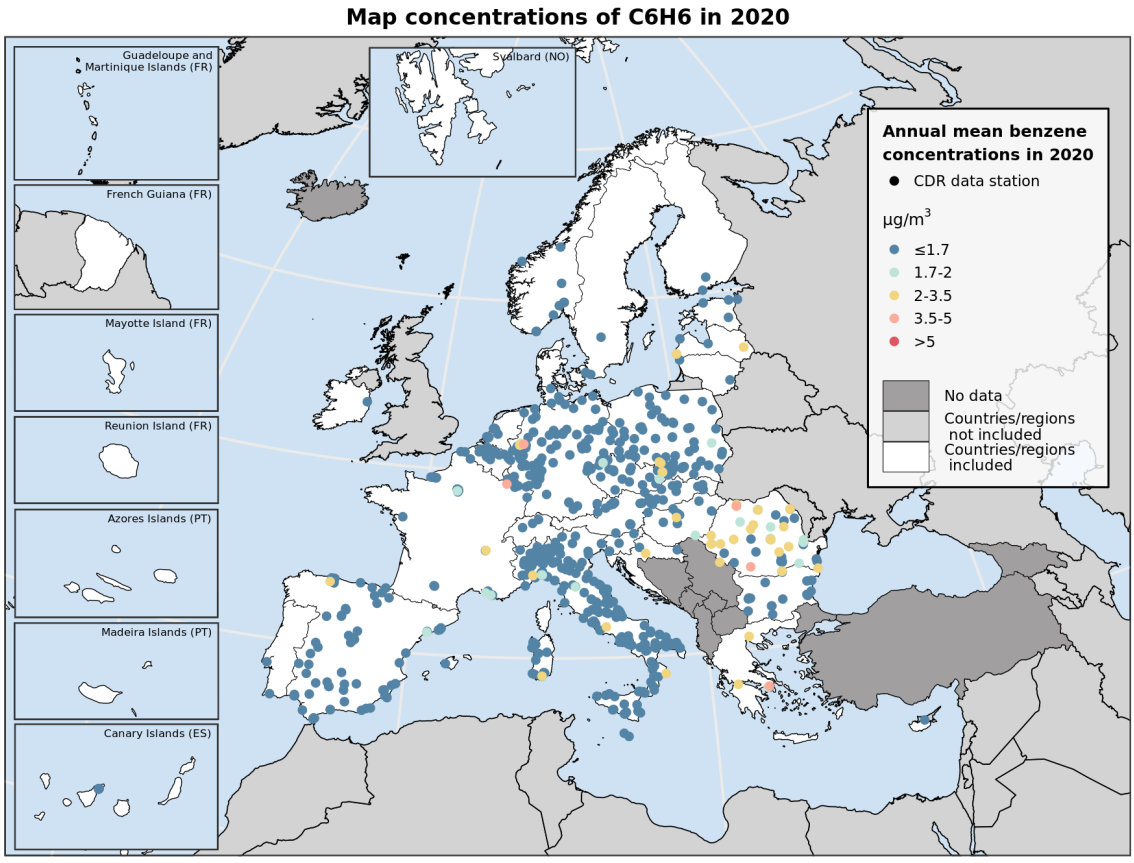
7.3 Benzene

C_6H_6 measurements were reported from a total of 718 stations in the reporting countries shown in Figure 1.

Concentrations above the limit value for C_6H_6 (5 µg/m^3) were not observed at any stations. At 94 % of locations, annual mean concentrations of C_6H_6 were below the LAT of 2 µg/m^3 (first two colour categories in Figure 45).

Regarding the estimated WHO reference level, 9 % of all stations reported concentrations above this reference level, distributed across 11 European countries ([8]) (Figure 45).

Figure 45: Map of C_6H_6 concentrations in 2020

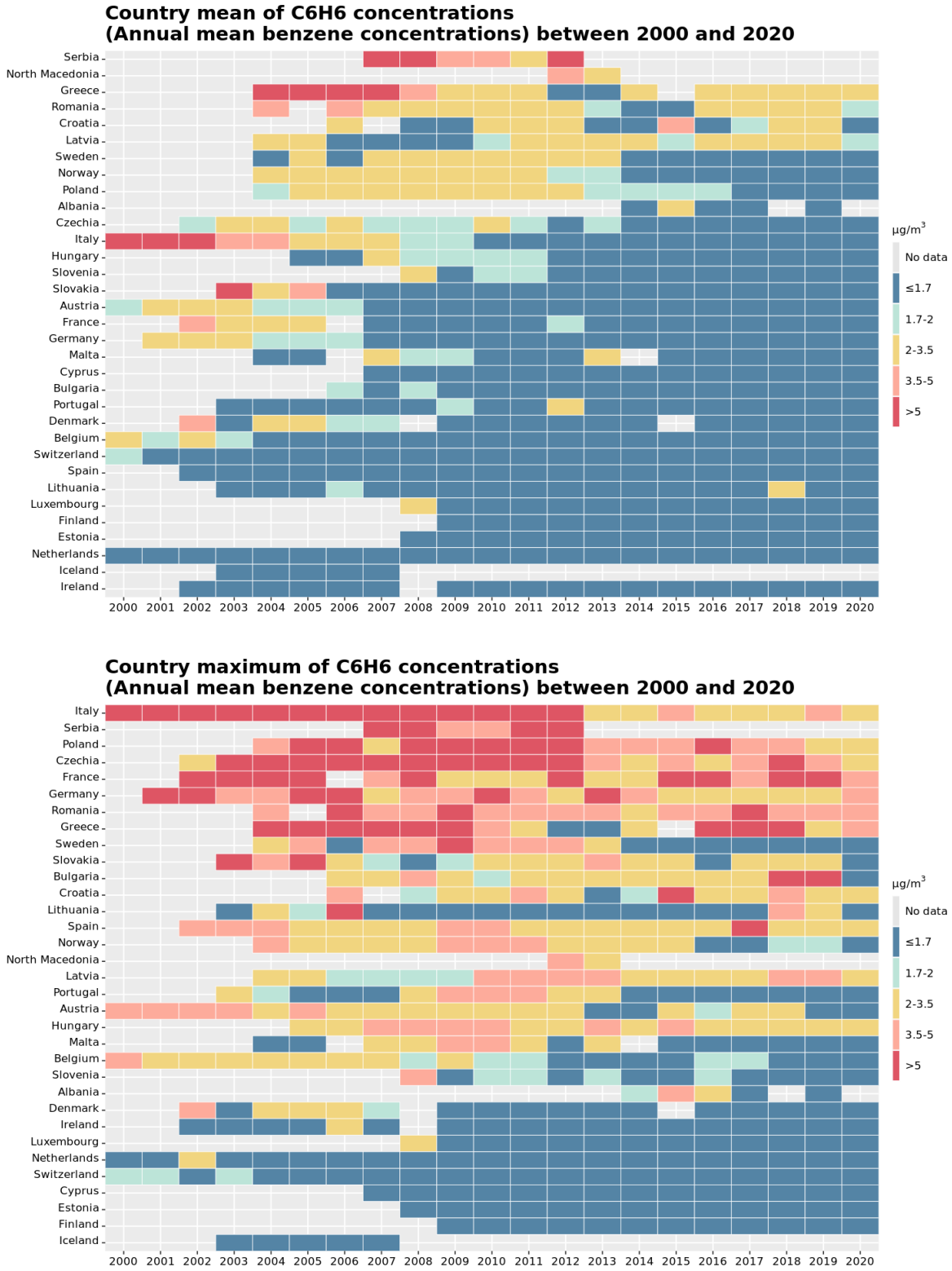


Note: Observed concentrations of C6H6 in 2020. The last colour category correspond to concentrations above the limit value of 5 µg/m³. The first colour category correspond to concentrations under the estimated WHO RL (1.7 µg/m³). Only stations reporting more than 50 % of valid data have been included in the map.

[8] Croatia, Czechia, France, Germany, Greece, Hungary, Italy, Latvia, Poland, Romania 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 46. 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).

Figure 46: Evolution of mean (top) and maximum (bottom) C_6H_6 annual mean concentrations (limit value) per country from 2000

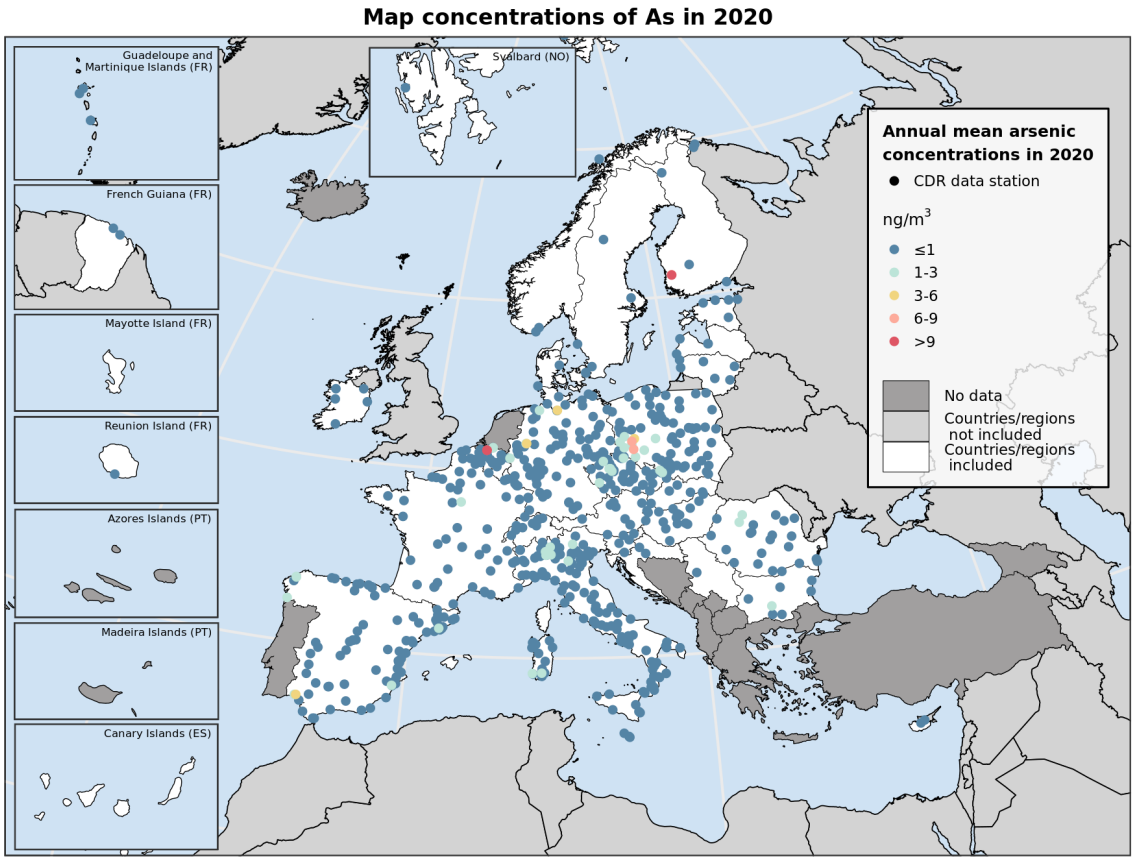


Note: It is important to note that the figure is not based on a consistent set of stations. The number, location and classification of the stations included may vary from year to year.

7.4 Toxic metals

Data for **Arsenic** (As) were reported from 661 stations in the reporting countries shown in Figure 1. 7 stations measured concentrations above the target value (6 ng/m^3), located in: Belgium (three), Finland (two) and Poland (two), and 4 of these were industrial. Concentrations of As below the LAT (2.4 ng/m^3) were reported at 97 % of the stations (Figure 47).

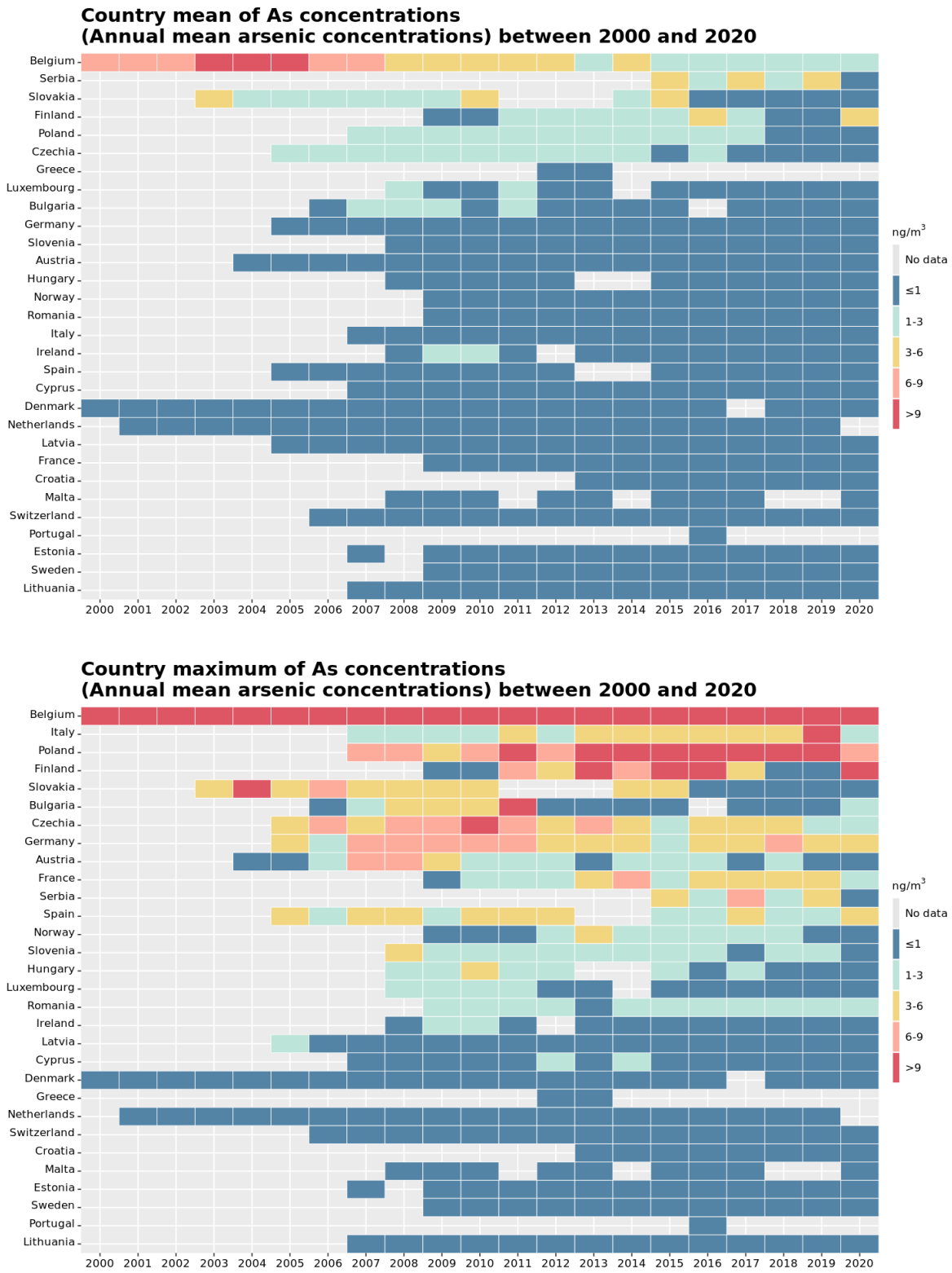
Figure 47: Map of As concentrations in 2020



Note: Observed concentrations of As in 2020. 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.

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 48. 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).

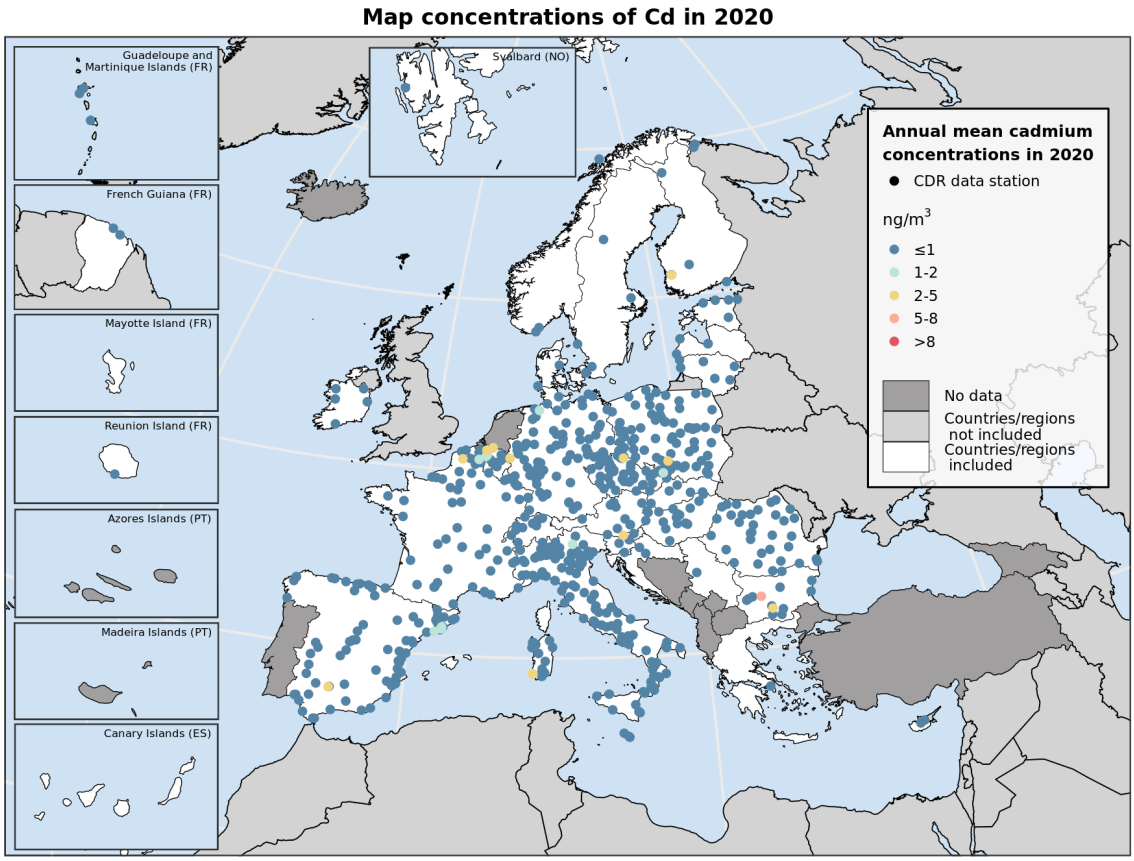
Figure 48: Evolution of mean (top) and maximum (bottom) As annual mean concentrations (target value) per country from 2000



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.

Cadmium (Cd) data were reported from 680 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: Bulgaria (one). At the great majority of stations (98 %), Cd concentrations were below the LAT (2 ng/m^3).

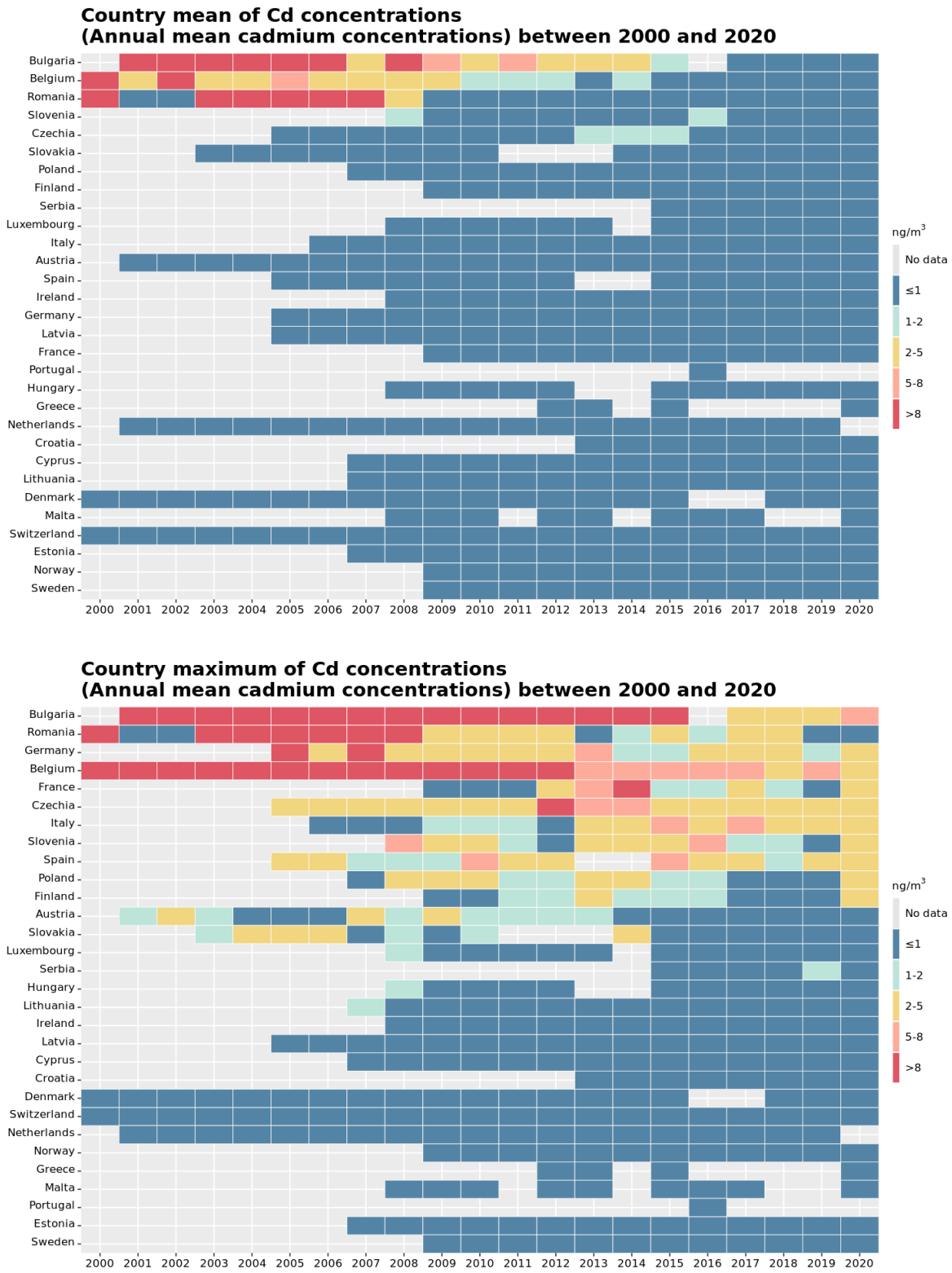
Figure 49: Map of Cd concentrations in 2020



Note: Observed concentrations of Cd in 2020. 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.

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 50. 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).

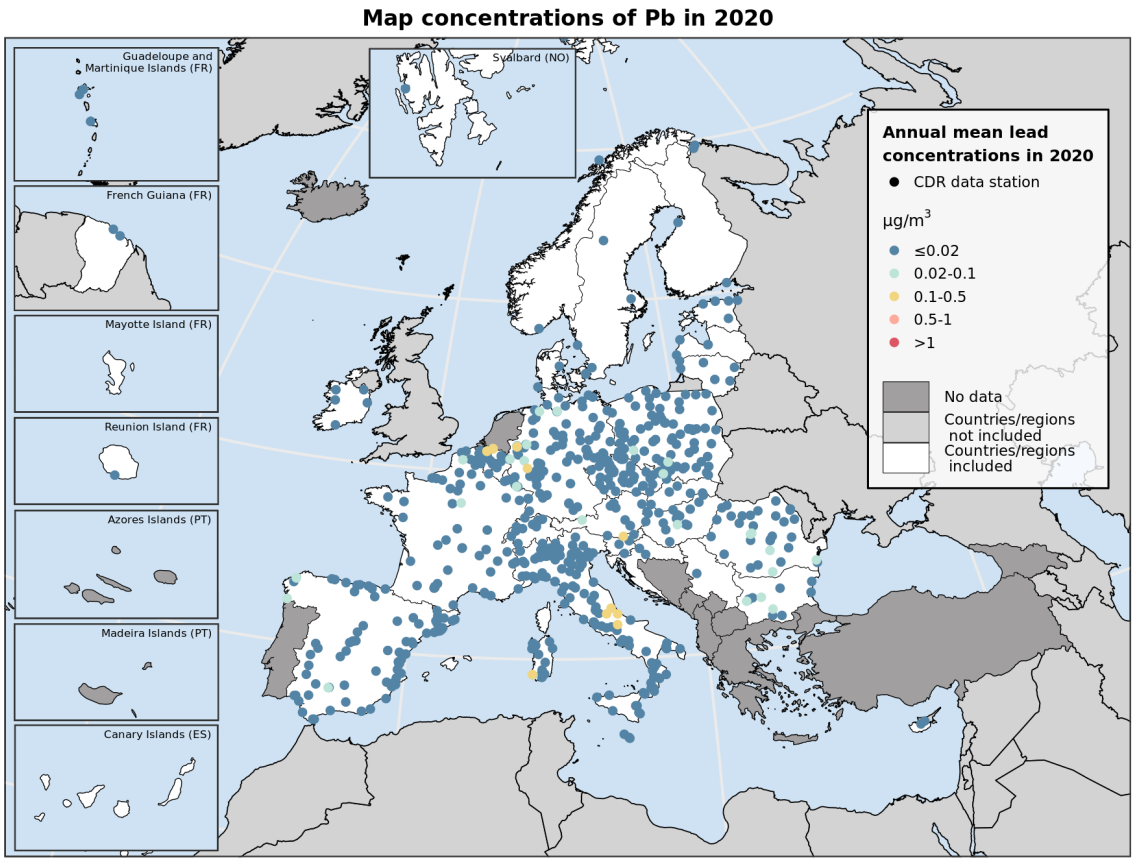
Figure 50: Evolution of mean (top) and maximum (bottom) Cd annual mean concentrations (target value) per country from 2000



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.

Lead (Pb) data were reported from 675 stations in the reporting countries shown in Figure 1. 0 stations located in: NO result reported Pb concentrations above the 0.5 µg/m^3 limit value. 670 stations (99 % of the total) reported Pb concentrations below the LAT of 0.25 µg/m^3.

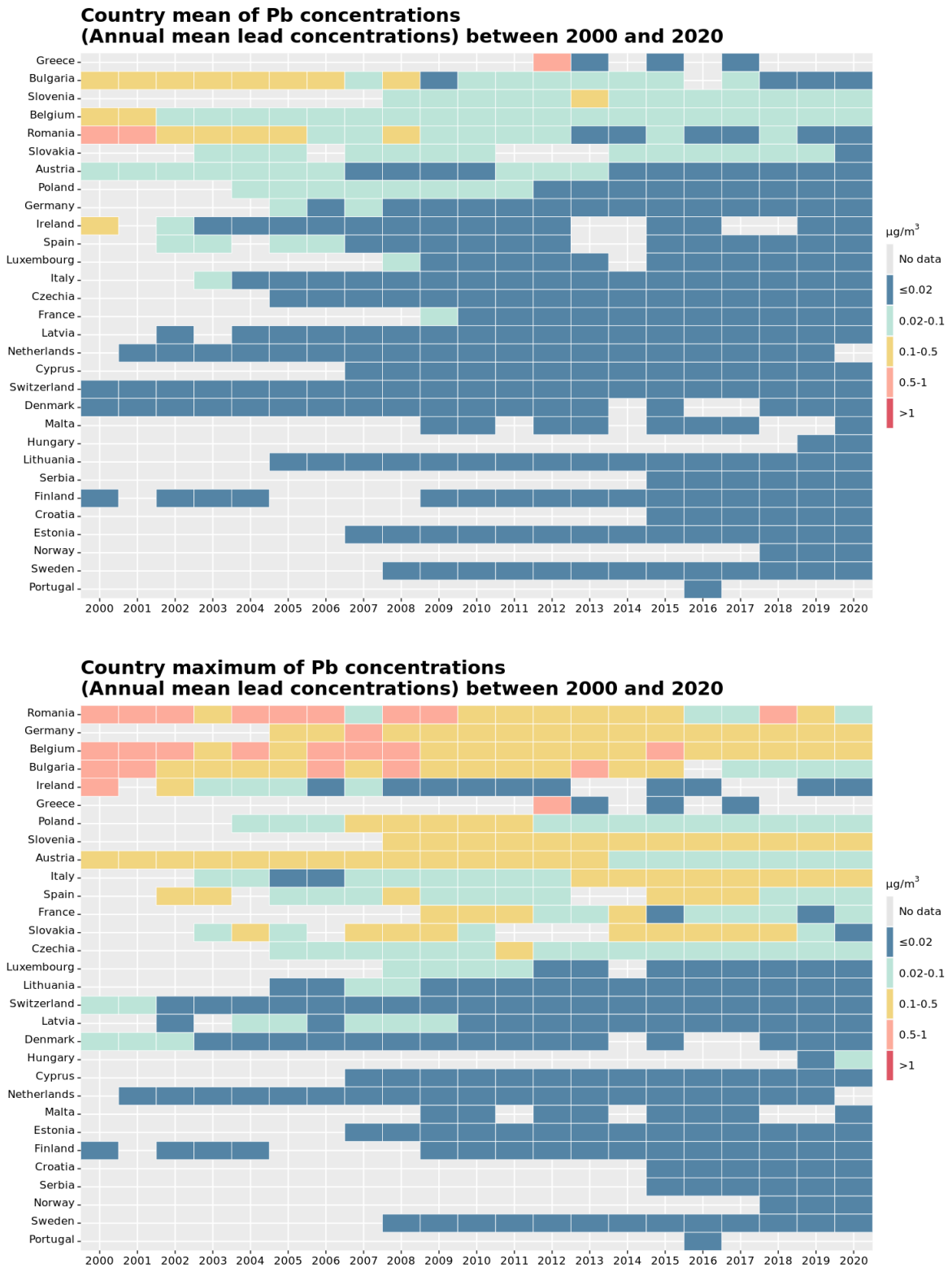
Figure 51: Map of Pb concentrations in 2020



Note: Observed concentrations of Pb in 2020. 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, 2020.

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 52. 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).

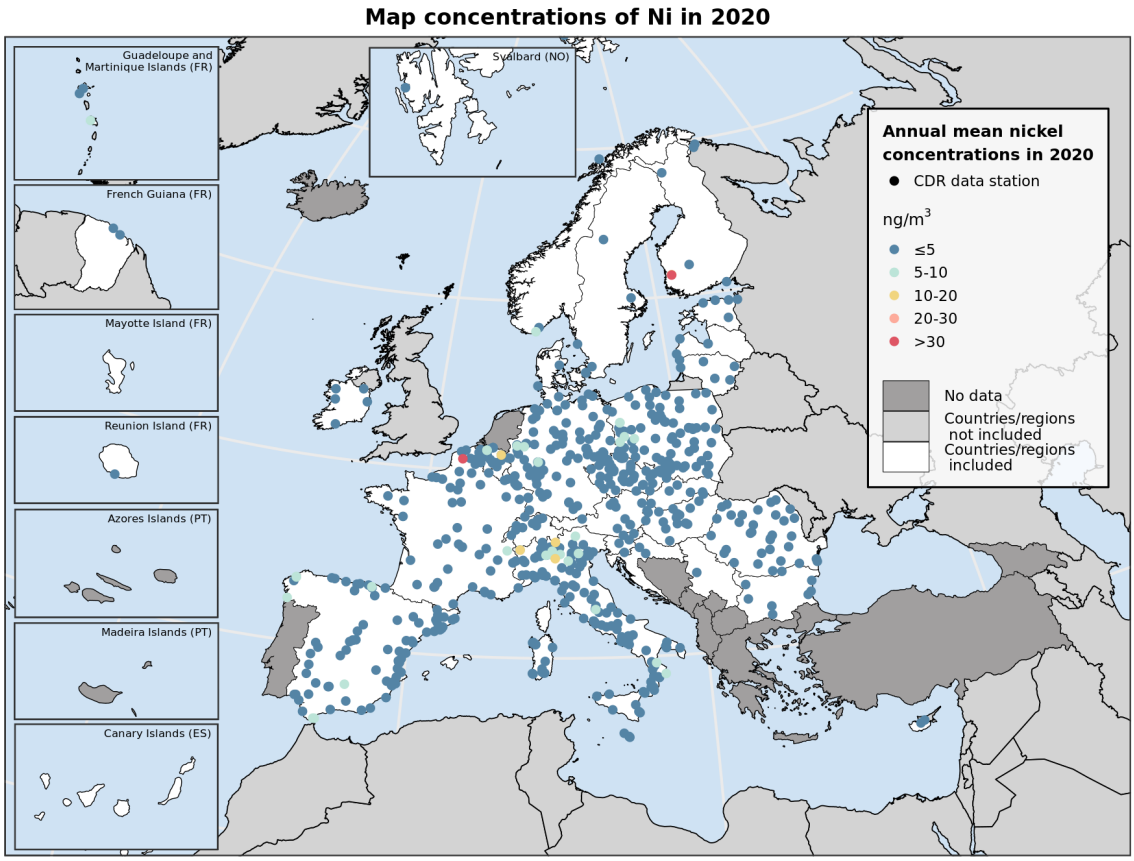
Figure 52: Evolution of mean (top) and maximum (bottom) Pb annual mean concentrations (limit value) per country from 2000



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.

Nickel (Ni) data were reported from 666 stations in the reporting countries shown in Figure 1. Concentrations were above the target value of 20 ng/m^3 at 2 stations in: Finland (one) and France (one), 2 of which were industrial. About 99 % of the stations reported Ni concentrations below the LAT of 10 ng/m^3.

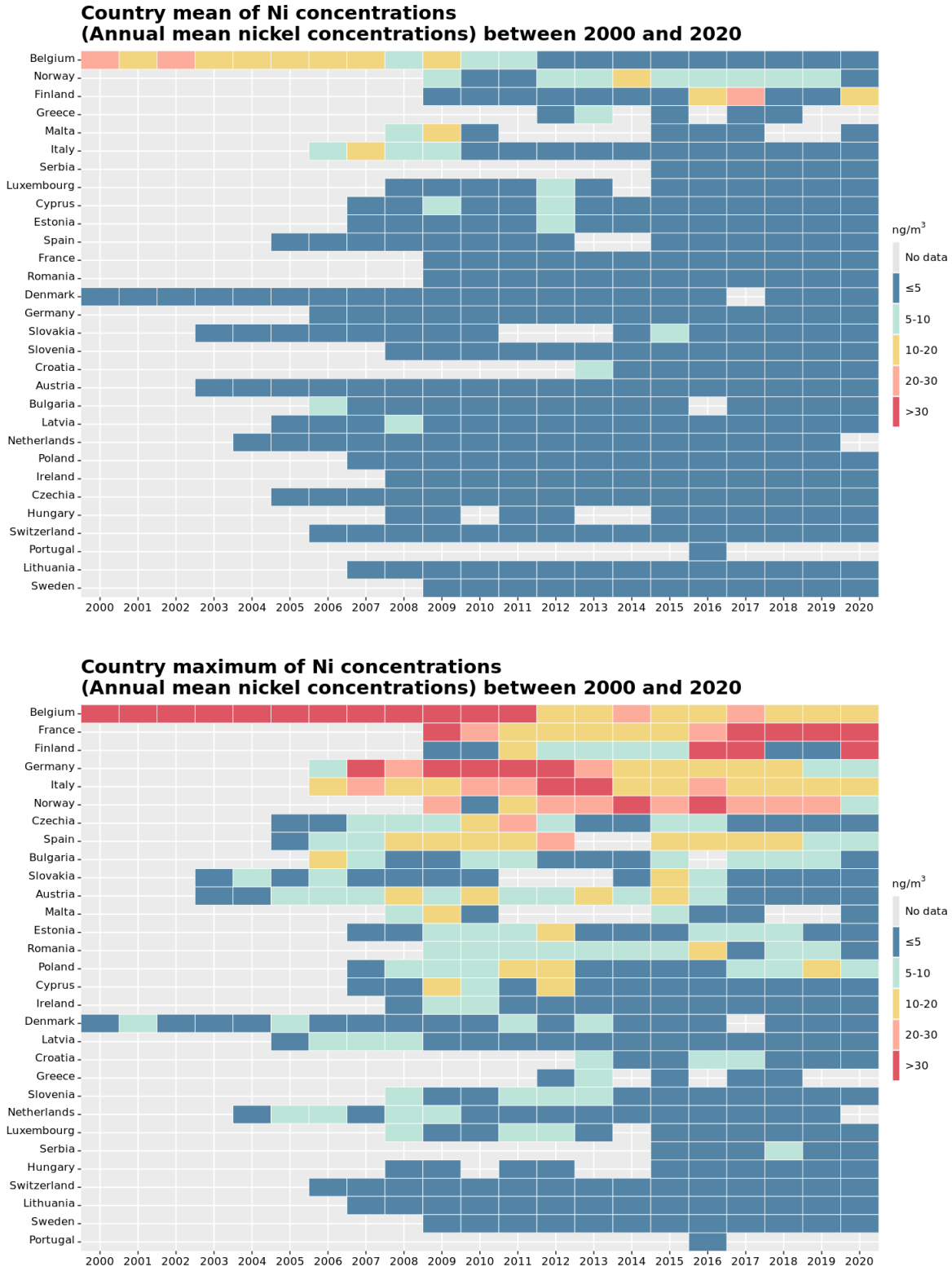
Figure 53: Map of Ni concentrations in 2020



Note: Observed concentrations of Ni in 2020. 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.

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 54. 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).

Figure 54: Evolution of mean (top) and maximum (bottom) Ni annual mean concentrations (target value) per country from 2000



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.

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: Central data repository

CO: Carbon monoxide

ECO: Exposure concentration obligation

EEA: European Environment Agency

ETC HE: European Topic Centre on Human health and the Environment

EU: European Union

LAT: Lower assessment threshold

LV: limit value

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

TV: target value

WHO: World Health Organization

9 Annex

Data included in this report was received by 24 March 2022 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 2020 air quality data by 24 March 2022

Country	PM10	PM2.5	O3	NO2	BaP	SO2	CO	C6H6	As	Cd	Pb	Ni
Albania	0	0	0	0	0	0	0	0	0	0	0	0
Andorra	1	0	2	1	0	1	1	0	0	0	0	0
Austria	123	57	102	143	34	65	27	18	12	13	12	12
Belgium	65	70	40	121	23	25	20	20	22	22	23	22
Bosnia and Herzegov-ina	16	7	12	14	0	18	7	0	0	0	0	0
Bulgaria	40	6	20	22	15	27	16	18	7	12	11	7
Croatia	11	10	12	12	3	7	4	3	2	2	2	2
Cyprus	3	4	3	3	1	3	3	1	2	2	2	2
Czechia	148	91	64	96	53	57	21	31	58	59	59	59
Denmark	7	9	8	14	2	4	6	3	3	3	3	3
Estonia	7	7	9	9	5	9	7	4	5	5	5	5
Finland	38	18	17	36	6	15	0	2	5	5	2	5
France	358	172	304	379	47	95	16	28	52	52	55	53
Germany	380	230	265	619	111	111	85	108	98	98	98	98
Greece	23	11	16	21	0	8	6	5	0	1	0	0
Hungary	23	11	18	22	16	23	21	12	16	16	16	16
Iceland	3	6	0	10	0	11	0	0	0	0	0	0
Ireland	37	31	17	22	5	10	3	1	5	5	5	5
Italy	540	293	339	603	161	223	204	226	140	140	135	133
Kosovo	12	12	12	12	0	12	11	0	0	0	0	0
Latvia	6	5	7	8	5	6	1	5	5	5	5	5
Liechtenstein	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Reporting status of 2020 air quality data by 24 March 2022 (continued)

Country	PM10	PM2.5	O3	NO2	BaP	SO2	CO	C6H6	As	Cd	Pb	Ni
Lithuania	14	7	12	17	5	14	9	1	5	5	5	5
Luxembourg	6	4	5	8	2	3	3	1	2	2	2	2
Malta	3	4	4	4	1	3	2	2	3	3	3	3
Montenegro	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	66	46	45	71	3	14	6	9	0	0	0	0
North Macedonia	12	0	12	11	0	12	11	0	0	0	0	0
Norway	56	47	11	47	7	12	1	9	6	6	5	6
Poland	242	123	101	142	157	102	68	61	72	71	73	71
Portugal	40	16	39	44	0	17	13	2	0	0	0	0
Romania	23	5	28	32	3	19	21	49	23	34	32	34
Serbia	11	0	8	14	0	15	16	0	1	1	1	1
Slovakia	34	33	16	26	15	16	14	12	5	5	5	5
Slovenia	18	4	5	8	5	4	2	2	5	5	5	5
Spain	450	240	410	494	70	389	176	80	91	91	94	91
Sweden	56	32	27	91	3	24	5	2	4	4	4	4
Switzerland	30	8	31	33	9	9	9	3	12	13	13	12
Turkey	200	92	107	125	0	191	88	0	0	0	0	0
EU27	2761	1539	1933	3067	751	1293	759	706	642	660	656	647
Total	3102	1711	2128	3334	767	1574	903	718	661	680	675	666

References

EEA (2020). Air quality in Europe–2020 report. *EEA Report No 9/2020*, https://www.eea.europa.eu/publications/air-quality-in-europe-2020.

EU (2008). Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. *OJ L 152, 11.6.2008, pp. 1–44*.

EU (2011). Commission Implementing Decision No 2011/850/EU of 12 December 2011 laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air quality. *OJ L 335, 17.12.2011, pp. 86–106*.

WHO (2000). Air quality guidelines for Europe, *World Health Organization, Regional Office for Europe, Copenhagen*.

WHO (2006). Air quality guidelines: Global update 2005 — Particulate matter, ozone, nitrogen dioxide and sulphur dioxide, *World Health Organization, Regional Office for Europe, Copenhagen*.

WHO (2021). WHO global air quality guidelines. Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. *World Health Organization, Geneva*.

European Topic Centre on
Human health and the environment
https://www.eionet.europa.eu/etcs/etc-he

The European Topic Centre on Human health and the environment (ETC-HE) is a consortium of European institutes under contract of the European Environment Agency.

European Environment Agency
European Topic Centre
Human health and the environment