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Air pollution by ozone in Europe in summer 2005

Overview of exceedances of EC ozone threshold values for April–September 2005

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European Environment Agency

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Executive summary

In summer 2005, the levels of ground-level ozone were high in southern Europe with widespread exceedances of the information threshold value (180 µg/m^3, Directive 2002/3/EC). The frequency of these exceedances was comparable with those of previous years, though not as high as in the record year 2003. The highest one-hour ozone concentration in summer 2005 (361 µg/m^3) was observed in Portugal. Other high hourly ozone concentrations of between 300 and 360 µg/m^3 were reported in France, Greece, Italy, Romania and Spain. The directive's long-term objective to protect human health (maximum ozone concentration of 120 µg/m^3 over 8 hours) was extensively exceeded in the EU and other European countries. In many parts of Europe the target value to protect human health was also exceeded.

Although emissions of ozone precursors have been reduced over the last decade, ozone air pollution has not fallen correspondingly. In some cases a decrease of ozone pollution has been observed, such as peak values of ozone. However, this decrease has levelled off during most recent years.

Compared to summer 2004, the occurrence of exceedances in summer 2005 shows a slight increase in north-west and southern Europe. Nevertheless, it was significantly lower than the annual occurrence of exceedances during the period 1999–2003, particularly in southern Europe.

Ground-level ozone is one of the air pollutants of most concern in Europe. Ozone pollution is produced by photochemical processes involving nitrogen oxides and volatile organic compounds in the lower parts of the atmosphere. Ozone levels become particularly high in regions close to high ozone precursor emissions and during summer when stagnant meteorological conditions with high insolation and high temperatures persist. Levels continue to exceed both target values and the long-term objectives established in EU legislation to protect human health and prevent damage to ecosystems, agricultural crops and materials.

This report provides an evaluation of ground-level ozone pollution in Europe for April–September 2005 based on information submitted to the European Commission under Directive 2002/3/EC on ozone in ambient air. Since the submitted data have not yet been finally validated by the Member States, the conclusions drawn in this report should be considered as preliminary.

Directive 2002/3/EC requires the Member States to report exceedances of the information threshold and alert threshold values (see Table 1) to the Commission before the end of the month following an occurrence. Furthermore, by 31 October each year they must provide some additional information for the summer period. This information should include in particular exceedances of the long-term objective for the protection of human health (daily maximum 8-hour average concentrations of 120 µg/m^3).

Table 1 Ozone threshold values, long-term objective and target value for the protection of human health

Objective	Level (µg/m^3)	Average time
Information threshold (IT)	180	One-hour
Alert threshold (AT)	240	One-hour
Long-term objective (LTO)	120	8-hour average, daily maximum
Target value (TV)	120*	8-hour average, daily maximum

* Not to be exceeded on more than 25 days per calendar year, averaged over three years and to be achieved where possible by 2010.

In order to provide information as timely as possible, the summaries of the monthly data provided by the countries were made available on the European Topic Centre on Air and Climate Change website (http://etc-acc.eionet.eu.int/databases/o3excess) as they came in.

Overview of ozone air pollution in summer 2005

All 25 EU Member States either provided information to the European Commission on observed exceedances or indicated by the deadline that no exceedances had been observed. In addition, eight other countries (Bulgaria, Iceland, Liechtenstein, FYR of Macedonia, Norway, Romania, Switzerland and Turkey) supplied information upon request from the European Environment Agency.

In summer 2005, exceedances of the long-term objective for the protection of human health for ozone were observed in almost every country, in almost every summer month and at most of the stations. Exceedances of the target value to protect human health (more than 25 occurrences of daily maximum 8-hour average concentrations of ozone higher than 120 μg/m^3) were observed in 16 EU Member States (Austria, Belgium, Cyprus, Czech Republic, France, Germany, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovak Republic, Slovenia, Spain and Sweden) and in two other countries (Bulgaria and Switzerland).

Detailed findings

From a total of 1 931 ozone monitoring sites reporting data, 1 865 were located in EU Member States. The following preliminary conclusions can be drawn for the period April–September 2005:

Exceedance of the information threshold

- The number of exceedances of information threshold values (180 μg/m^3 of one-hour ozone concentration) was similar to previous years, but not as high as those in the record year 2003. Ozone concentrations higher than the information threshold were reported from monitoring sites in 18 EU Member States and four other countries. The information threshold was exceeded at about 42 % of all operational stations (68 % in 2003, 35 % in 2004).

- The spatial extent of the exceedances observed was larger than in 2004. The most frequent exceedances of the information threshold were observed in northern Italy, southern France and at several locations in Portugal, Spain, Greece and FYR of Macedonia. Most of western and southern Europe recorded at least one day with exceedance in summer 2005. Most of central Europe was without any recorded exceedance.

Exceedance of the alert threshold

- Ozone concentrations higher than the alert threshold of 240 μg/m^3 were reported on 127 occasions in nine EU Member States (Austria, Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal and Spain) and two other countries (Romania and Switzerland). In comparison, 13 of EU-15 Member States and two other countries reported exceedances of the alert threshold in 2003, and eight and four respectively in 2004.

- The exceedances were found largely in northern Portugal, southern France, northern Italy, Belgium, the Netherlands and Luxembourg. Generally, there were only one or two days with an exceedance of the alert threshold per station.

Maximum concentrations

- The highest one-hour ozone concentration of 361 μg/m^3 in summer 2005 was observed in northern Portugal (at rural-background station Lamas de Olo, altitude 1 086 m). Other high hourly ozone concentrations between 300 and 360 μg/m^3 were reported in Greece, Italy, France, Romania and Spain. In 2004 three exceedances of 360 μg/m^3 were recorded with a maximum ozone level of 419 μg/m^3. In 2003 four exceedances of 360 ug/m^3 were recorded with a maximum ozone level of 417 μg/m^3.

Exceedance of the long-term objective for the protection of human health

- Exceedances of the long-term objective (LTO) for the protection of human health for ozone, i.e. daily maximum 8-hour average concentrations higher than 120 μg/m^3, were observed every month in every country which reported data (except Iceland) and at most of the stations. About 86 % of all stations reported one or more exceedances (70 % in 2004).

- For those countries that reported exceedances, the number of exceedance days per country ranged from 1 (Ireland and Latvia) to 181

(Spain). There was no day without any exceedance in Europe in summer 2005. On average 23 days with exceedances were observed at stations that recorded at least one exceedance (21 in 2004).

Exceedance of the target value for the protection of human health

- The target value for protection of human health is exceeded if the LTO has been exceeded more than 25 times (averaged over three years). Exceedances of the target value occurred at 30 % of all monitoring stations providing reports (19 % in 2004).

- The target value was exceeded in approximately 42 % of the area for which data were reported (23 % in 2004).

Main ozone episodes

- The most important ozone episode occurred from 21–24 June. During this period, 24 % of the total number of exceedances of the information threshold, 22 % of exceedances of the alert threshold and 9 % of exceedances of the long-term objective were observed.

- The next strongest episodes occurred from 14–17 July and 25–28 May during which 14 (9) % of the total number of exceedances of the information threshold, 7 (9) % of exceedances of the alert threshold and 9 (8) % of exceedances of the long-term objective were observed.

Comparison with previous years

- Compared to summer 2004, the number of exceedances per station per region in summer 2005 indicates a slight increase in north-west and southern Europe. Nevertheless, the occurrence of exceedances was significantly lower in 2005 than the annual occurrence of exceedances during the period 1999–2003, particularly in southern Europe.

Disclaimer

The information describing the situation for summer 2005 is partly based on non-validated monitoring data and hence should be regarded as preliminary.

1 Introduction

Ozone is the main product of complex photochemical processes in the lower atmosphere involving oxides of nitrogen and volatile organic compounds as precursors. Ozone is a strong photochemical oxidant. In elevated concentrations it causes serious health problems and damage to ecosystems, agricultural crops and materials. The main sectors that emit ozone precursors are road transport, power and heat generation plants, households (heating), industry, and petrol storage and distribution.

In view of the harmful effects of photochemical pollution in the lower levels of the atmosphere, the Council adopted in 1992 Directive 92/72/EEC on air pollution by ozone (CEC, 1992). This directive has been succeeded by Directive 2002/3/EC of the European Parliament and of the Council relating to ozone in ambient air. Directive 2002/3/EC, also known as the third daughter directive to the Air Quality Framework Directive 96/62/EC, sets primarily long-term objectives, target values, an alert threshold and an information threshold (Table 1) for ozone to avoid, prevent or reduce harmful effects on human health and environment. It provides common methods and criteria for the assessment of ozone concentrations in ambient air, and ensures that on the basis of this assessment adequate information is made available to the public. It also promotes cooperation between the Member States in reducing ozone levels.

Directive 2002/3/EC requires the following data to be provided to the European Commission (and to the EEA):

Monthly data (Article 10(2)(a)(i))

Before the end of the following month, information collected on exceedances of the information and/or the alert thresholds (one-hour ozone concentration higher than 180 μg/m^3 and 240 μg/m^3) must be reported. Data submitted in the monthly reports are considered provisional and are updated, if necessary, in subsequent submissions.

Summer data (Article 10(2)(a)(ii))

Additional provisional data for the foregoing summer period (from April to September), as defined in Annex III to the directive (i.e. information on exceedances of alert and information thresholds, on exceedances of the health protection long-term objective, the daily maximum of 8-hour average ozone concentration higher than 120 μg/m^3, related NO_2 values when required and for each month one-hour maximum ozone concentrations) must be reported by 31 October.

Annual data (Article 10(2)(b))

Validated annual data for ozone and precursors (as defined in Annexes III and VI to the directive) of the previous year must be submitted by 30 September as well. The annual data flow is included in the questionnaire to be used for annual reporting on air quality assessment in the Framework of the Air Quality Framework Directive (96/62/EC) and its daughter directives — see Commission Decision 2004/461/EC for details (Commission of the European Communities, 2004).

The report gives an overview of the situation during April–September 2005, and provides a comparison with previous years over the last decade. The EEA has prepared similar overviews since 1994. Previous reports are available from EEA's website: http://www.eea.eu.int.

All EU Member States provided information of observed one-hour exceedances on time or indicated that no exceedances had been observed. They provided information on observed 8-hour exceedances and one-hour maximums for all stations. In addition, eight other countries (Bulgaria, Iceland, Liechtenstein, FYR of Macedonia, Norway, Romania, Switzerland and Turkey) supplied information upon request from the European Environment Agency. Details on reported data over summer 2005 and ozone monitoring networks are given in Annex 1.

The report contains summary information based on data delivered before 22 November 2005 (i.e. 22 days after the deadline set by the directive).

2 Ozone air pollution in summer 2005

Air pollution by ozone during summer 2005 was slightly higher than in summer 2004, but much lower than in summer 2003 (EEA, 2003). This corresponds to the fact that summer 2003 was one of the warmest and summer 2004 was one of the coolest in the past 10 years. Summer 2005 was slightly warmer compared to summer 2004.

2.1 Summary of hourly exceedances reported

Table 2.1 presents a general overview of the observed exceedances of the thresholds during the period for which data were available by country. Ozone concentrations higher than the information threshold were reported from monitoring sites in 18 EU Member States and four other countries.

Ozone concentrations higher than the alert threshold of 240 μg/m^3 were reported from monitoring sites in Austria, Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal and Spain and two other countries (Romania and Switzerland). An exceedance of the alert threshold was also observed at 8 % of the stations which reported an exceedance of the information threshold (27 % in 2003, 11 % in 2002 and 8 % in 2004). The ratio of the number of exceedances of the information threshold and the number of exceedances of the alert threshold varied widely across the reporting countries, and it is apparently higher for the southern European countries.

The highest concentrations were observed in Portugal, Greece, Italy, France and Romania. As in 2004, Estonia reported one exceedance of the information threshold in contrast to no threshold exceedances during the previous years. Finland reported no exceedances, as in previous years except for 2004.

The number and level of the highest concentrations were lower than in 2003 and 2004. In 2005 only one occurrence of an exceedance of 360 μg/m^3 over one hour (the warning threshold of the former ozone directive) with a maximum of 361 μg/m^3 was observed (northern Portugal, at rural-background station Lamas de Olo, altitude 1086 m) compared to three exceedances with maximum of 419 μg/m^3 in 2004. In 2003 four exceedances of 360 ug/m^3 were recorded with a maximum ozone level of 417 μg/m^3.

In the EU Member States, no exceedances of the information threshold were observed in Cyprus, Denmark, Finland, Ireland, Latvia, Lithuania and Sweden. Also Iceland, Liechtenstein, Norway and Turkey did not observe any exceedance of the information threshold in summer 2005. However, Turkey reported from one traffic station only.

Table 2.1 Overview of exceedances of the one-hour thresholds during summer 2005 on a country-by-country basis

Country	Number of station (1)	Stations with exceedance (2) Number		%		%	Total number of exceedances		Number of days with exceedance (3)		Max. observed conc. µg/m³	Occurence of exceeedances (4)				Average duration of exceedances (hour)	
Austria	120	36	1	30	1	3	79	1	18	1	270	0.7	2.2	0.0	1.0	1.8	2.0
Belgium	39	36	6	92	15	17	89	6	12	1	274	2.3	2.5	0.2	1.0	4.4	3.5
Cyprus	2	0	-	-	-	-	-	-	-	-	162	-	-	-	-	-	-
Czech Republic	69	16	-	23	-	-	21	-	8	-	235	0.3	1.3	-	-	2.2	-
Denmark	7	0	-	-	-	-	-	-	-	-	160	-	-	-	-	-	-
Estonia	7	1	-	14	-	-	1	-	1	-	182	0.1	1.0	-	-	1.0	-
Finland	16	0	-	-	-	-	-	-	-	-	173	-	-	-	-	-	-
France	455	233	19	51	4	8	797	22	54	12	313	1.8	3.4	0.0	1.2	2.7	1.5
Germany	310	177	2	57	1	1	462	3	27	3	257	1.5	2.6	0.0	1.5	2.9	1.0
Greece	21	12	5	57	24	42	131	12	56	7	350	6.2	10.9	0.6	2.4	2.2	1.8
Hungary	7	1	-	14	-	-	1	-	1	-	186	0.1	1.0	-	-	5.0	-
Ireland	7	0	-	-	-	-	-	-	-	-	130	-	-	-	-	-	-
Italy	177	102	15	58	8	15	844	38	86	18	327	4.8	8.3	0.2	2.5	3.7	2.3
Latvia	5	0	-	-	-	-	-	-	-	-	143	-	-	-	-	-	-
Lithuania	12	0	-	-	-	-	-	-	-	-	175	-	-	-	-	-	-
Luxembourg	3	3	-		-	-	9	-	5	-	209	3.0	3.0	-	-	3.8	-
Malta	3	1	-	33	-	-	1	-	1	-	224	0.3	1.0	-	-	1.0	-
Netherlands	40	30	1	75	3	3	74	1	7	1	252	1.9	2.5	0.0	1.0	4.1	1.0
Poland	65	11	-	17	-	-	13	-	7	-	217	0.2	1.2	-	-	2.0	-
Portugal	52	42	8	81	15	19	222	35	65	25	361	4.3	5.3	0.7	4.4	3.8	3.6
Slovak Republic	22	2	-	9	-	-	8	-	4	-	229	0.4	4.0	-	-	1.9	-
Slovenia	11	3	-	27	-	-	14	-	11	-	205	1.3	4.7	-	-	3.6	-
Spain	313	77	5	25	2	6	275	6	61	4	305	0.9	3.6	0.0	1.2	2.3	1.5
Sweden	12	0	-	-	-	-	-	-	-	-	175	-	-	-	-	-	-
United Kingdom	90	11	-	12	-	-	15	-	5	-	204	0.2	1.4	-	-	2.3	-
EU area	**1 865**	**794**	**62**	**43**	**3**	**8**	**3 056**	**124**	**143**	**54**	**361**	**1.6**	**3.8**	**0.1**	**2.0**	**3.1**	**2.4**
Bulgaria	11	1	-	9	-	-	1	-	1	-	199	0.1	1.0	-	-	1.0	-
Iceland	4	0	-	-	-	-	-	-	-	-	119	-	-	-	-	-	-
Liechtenstein	1	0	-	-	-	-	-	-	-	-	179	-	-	-	-	-	-
Macedonia, FYR of	11	2	-	18	-	-	32	-	31	-	226	2.9	16.0	-	-	10.2	-
Norway	8	0	-	-	-	-	-	-	-	-	144	-	-	-	-	-	-
Romania	17	7	1	41	6	14	16	1	15	1	328	0.9	2.3	0.1	1.0	1.1	1.0
Switzerland	13	11	1	85	8	9	78	2	28	2	255	6.0	7.1	0.2	2.0	3.9	2.0
Turkey	1	0	-	-	-	-	-	-	-	-	169	-	-	-	-	-	-
Whole area	**1 931**	**815**	**64**	**42**	**3**	**8**	**3 183**	**127**	**157**	**54**	**361**	**1.6**	**3.9**	**0.1**	**2.0**	**3.2**	**2.4**
Summer 2003	1 805	1 220	326	68	18	27	11 352	720	137	*	417	5.4	9.3	8.0	*	3.4	*
Summer 2004	1 852	654	52	35	3	8	2 527	95	128	46	419	1.4	3.9	0.1	1.8	2.8	2.1

Note: White columns refer to information threshold, grey to alert threshold.
- Not applicable.
* Not evaluated in 2003.

(1) Total number of stations with ozone measurement.
(2) The number and percentage of stations at which at least one threshold exceedance was observed; fifth column: percentage of stations with information threshold exceedance at which alert threshold exceedance were also observed.
(3) The number of calendar days on which at least one exceedance of thresholds was observed.
(4) Occurrence of exceedance is calculated as the average number of observed exceedances per country, i.e. the total number of exceedances for all stations divided by the total number of operational stations. Left column: averaged over all implemented stations, right figure: averaged over all stations which reported at least one exceedance.

For those countries that reported exceedances, the number of exceedance days per country ranged from one (Estonia, Hungary, Malta, Bulgaria) to 86 (Italy). For 157 days within the 183-day period between April–September, there was at least one station in all reporting countries where an exceedance was observed. About 42 % of all stations reported one or more exceedances. On average 3.9 exceedances were observed at stations which recorded at least one exceedance.

The largest number of exceedances occurred during June and July. Due to meteorological conditions the occurrence of exceedances was lower in August than in May. An exceedance of the information threshold was observed every day in July at least at one of the reporting stations, and also almost every day in June and August (see Table 2.2 and Figures 2.5 and 2.6).

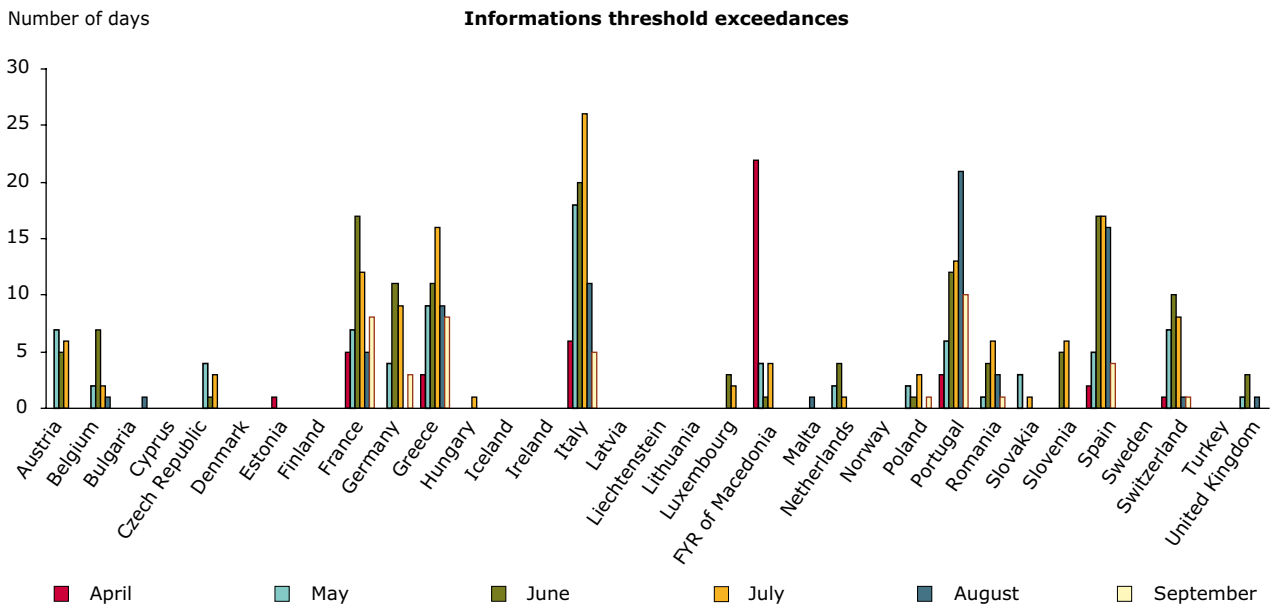
Table 2.2 Overview of exceedances of the one-hour thresholds during summer 2005 on a month-by-month basis

Month	Stations with exceedance (²) Number		%			Total number of exceed-ances		Number of days with exceedance (³)		Max. observed concen-tration µg/m³	Occurence of excedances (⁴)				Average duration of exceedan-ces (hour)	
April	46	7	2	0	15	82	7	25	2	313	0.0	0.1	0.0	0.1	4.9	1.7
May	263	10	14	1	4	447	15	24	8	327	0.2	0.5	0.0	0.2	2.9	2.2
June	557	31	29	2	6	1350	48	28	14	361	0.7	1.7	0.0	0.8	3.4	2.3
July	454	19	24	1	4	951	32	31	16	359	0.5	1.2	0.0	0.5	3.2	2.5
August	104	15	5	1	14	242	23	27	12	333	0.1	0.3	0.0	0.4	2.6	3.0
September	69	1	4	0	1	111	2	22	2	285	0.1	0.1	0.0	0.0	2.3	1.5

(²), (³) and (⁴) See notes on Table 2.1

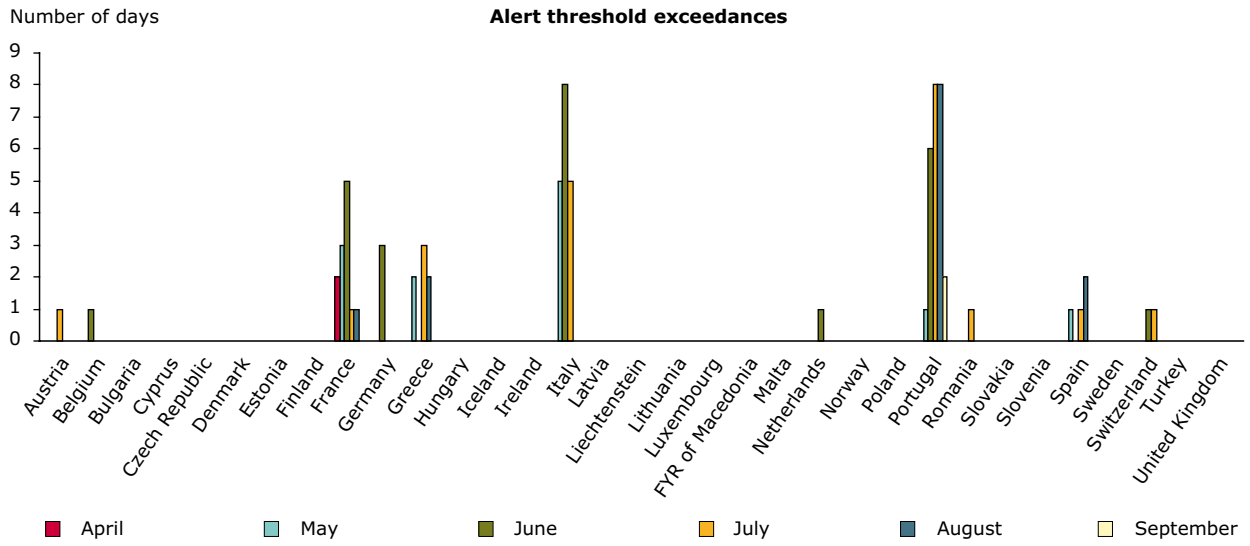
Figure 2.1 presents the number of days per month on which at least one station in a country recorded an exceedance. For most countries this figure reflects the seasonal behaviour seen in Table 2.2.

Figure 2.1.a Number of days on which at least one exceedance of the one-hour threshold value was observed per country and per month during summer 2005



Note: Only countries which delivered data are shown.

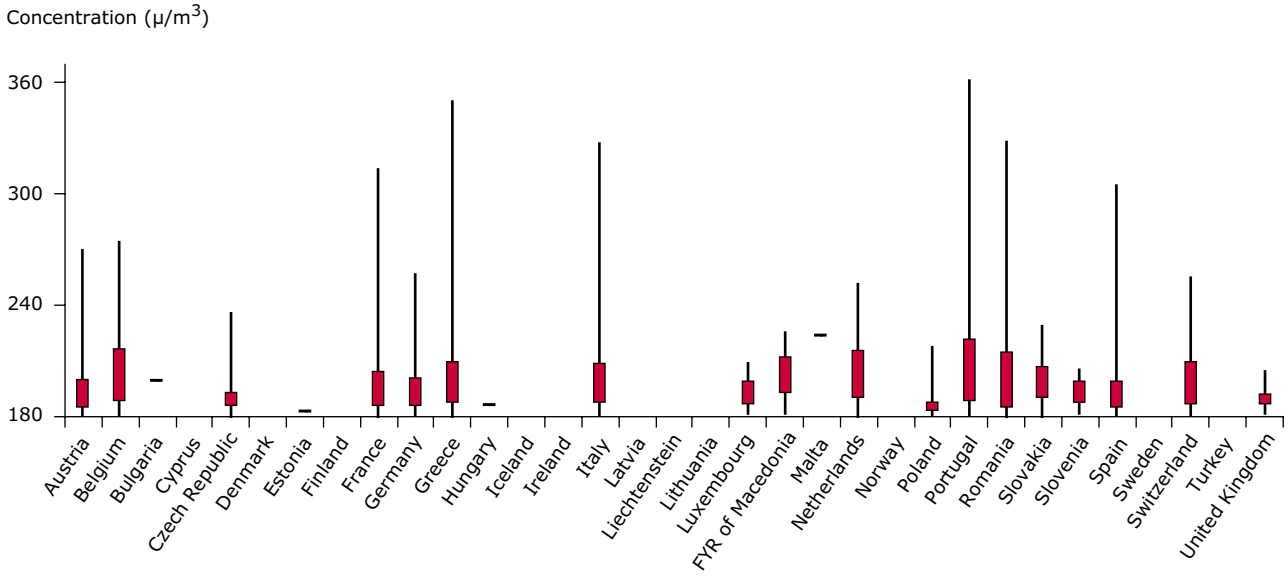
Figure 2.1.b Number of days on which at least one exceedance of the one-hour threshold value was observed per country and per month during summer 2005



Note: Only countries which delivered data are shown.

Figure 2.2 shows the frequency distribution of hourly ozone concentrations exceeding the information threshold. At European level, 25 % of the maximum hourly concentrations of all the observed exceedances were below 186 μg/m^3 (207 μg/m^3 in 2003, 185 μg/m^3 in 2004). The highest values of the 75th percentile of all maximum concentrations in a country during exceedances were below 206 μg/m^3 (305 μg/m^3 in 2003, 203 μg/m^3 in 2004), which is comparable with the maximum 75th percentile value during summers 2002 (219 μg/m^3) and 2001 (208 μg/m^3).

Figure 2.2 Frequency distribution of concentrations in excess of the one-hour information threshold



Note: Presented as Box-Jenkins plots indicating the minimum, the 25th percentile, the 75th percentile and the maximum value. Only countries which delivered data are shown.

2.2 Overview of exceedances of long-term objective and target value for the protection of human health

Table 2.3 presents a general overview of the observed exceedances of the long-term objective (LTO) and of the target value (TV) during summer 2005. (LTO is exceeded when the daily maximum 8-hour average concentration of ozone is higher than 120 μg/m^3, TV is exceeded when LTO has been exceeded at particular station more than 25 times) ([1]).

Exceedances of LTO were observed in every country which reported data — except for Iceland ([2]) — in every month and at most of the stations. About 86 % of all stations reported one or more exceedances (70 % in 2004). For those countries that reported exceedances, the number of exceedance days per country ranged from one (Ireland and Latvia) to 181 (Spain). There was no day without any exceedance in Europe in the summer 2005. On average 23 days with exceedances were observed at stations that recorded at least one exceedance (21 in 2004). TV was exceeded at 30 % of all stations (19 % in 2004).

Table 2.4 summarises the exceedances on a monthly basis. The largest number of exceedances of LTO occurred during June and July. Due to meteorological conditions the occurrences of exceedances was lower in August than in May.

Figure 2.3 presents the number of days per month on which at least one station in a country recorded an exceedance of LTO.

Figure 2.4 shows the frequency distribution of 8-hour ozone concentrations exceeding the long-term objective level. At European level, 25 % of maximum 8-hour concentrations of all the observed exceedances were below 125 μg/m^3 (same as in 2004). The highest values of the 75th percentile of all maximum concentrations in a country during exceedances were below 144 μg/m^3 (143 μg/m^3 in 2004).

([1]) Daily maximum 8-hour average concentrations were compared with the legally set objectives solely for indicative purposes to assess the current situation and its distance from objectives, and not for checking compliance with Directive 2002/3/EC. As reporting of maximum daily 8-hour average concentration of ozone started in 2004, exceedances of TVs presented in this report are counted for indicative purposes if LTO has been exceeded more than 25 times during the assessed summer period.

([2]) Turkey also not recorded an exceedance of LTO in summer 2005 as it reported only from one station of traffic type.

Table 2.3 Overview of exceedances of the long-term objective for the protection of human health during summer 2005 on a country-by-country basis

Country	Number stations (1)	Stations with LTO exceedance (2)		Stations with TV exceedance (2)		Total number of exceedances	Number of days with exceedance (3)	Max. observed concentration µg/m³	Occurence of LTO exceedances (4)	
		Number	%	Number	%					
Austria	120	114	95	61	51	3 234	108	193	27	28.4
Belgium	39	39	100	2	5	584	38	259	15	15
Cyprus	2	2	100	1	50	94	85	149	47	47
Czech Republic	69	69	100	34	49	1 803	78	204	26.1	26.1
Denmark	7	4	57	0	-	4	4	141	0.6	1
Estonia	7	6	86	0	-	23	15	159	3.3	3.8
Finland	16	10	63	0	-	39	21	164	2.4	3.9
France	455	438	96	141	31	9 871	153	246	21.7	22.5
Germany	310	296	95	77	25	5 788	107	214	18.7	19.6
Greece	21	13	62	10	48	762	157	233	36.3	58.6
Hungary	7	7	100	2	29	162	71	174	23.1	23.1
Ireland	7	1	14	0	-	1	1	121	0.1	1
Italy	177	158	89	97	55	6 263	177	286	35.4	39.6
Latvia	5	1	20	0	-	1	1	125	0.2	1
Lithuania	12	8	67	0	-	30	16	161	2.5	3.8
Luxembourg	3	x	x	x	x	x	x	x	x	x
Malta	3	3	100	1	33	93	87	157	31	31
Netherlands	40	38	95	0	-	231	23	222	5.8	6.1
Poland	65	51	78	12	18	869	86	190	13.4	17
Portugal	52	49	94	11	21	1 065	144	288	20.5	21.7
Slovak Republic	22	22	100	11	50	622	91	174	28.3	28.3
Slovenia	11	9	82	6	55	317	85	191	28.8	35.2
Spain	313	246	79	102	33	6 040	181	238	19.3	24.6
Sweden	12	9	75	1	8	55	29	164	4.6	6.1
United Kingdom	90	34	38	0	-	107	28	188	1.2	3.1
EU area	**1 862**	**1627**	**87**	**569**	**31**	**38 058**	**183**	**288**	**20.4**	**23.4**
Bulgaria	11	9	82	1	9	108	68	153	9.8	12
Iceland	4	0	-	0	-	-	-	-	-	-
Liechtenstein	1	1	100	0	-	22	22	164	22	22
FYR of Macedonia	11	x	x	x	x	x	x	x	x	x
Norway	8	3	38	0	-	4	3	129	0.5	1.3
Romania	17	x	x	x	x	x	x	x	x	x
Switzerland	13	13	100	11	85	542	100	231	41.7	41.7
Turkey	1	0	-	0	-	-	-	-	-	-
Whole area	**1 911**	**1 653**	**86**	**581**	**30**	**38 734**	**183**	**288**	**20.3**	**23.4**
Summer 2004	1 852	1 297	70	355	19	27 845	182	250	15	21.5

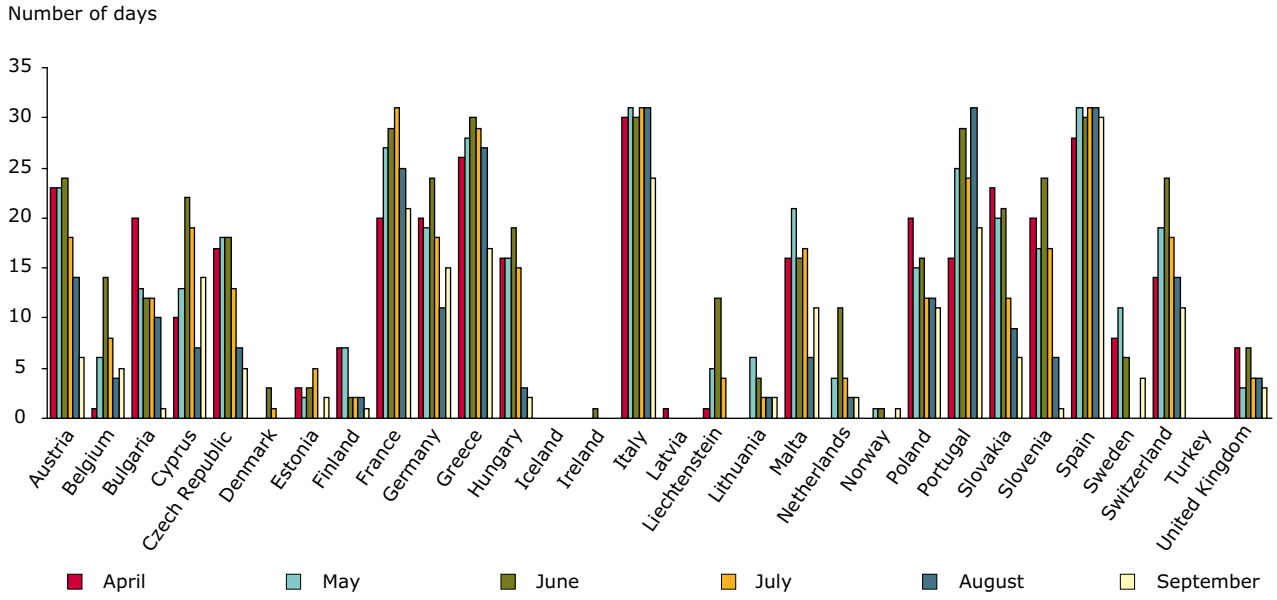
Note: x No data delivered from Luxembourg, Romania and FYR of Macedonia.
- Not applicable.
(1) Total number of stations with ozone measurement.
(2) The number and percentage of stations at which at least one exceedance was observed.
(3) The number of calendar days on which at least one exceedance was observed.
(4) Left column: averaged over all implemented stations, right figure: averaged over all stations which reported at least one exceedance.

Table 2.4 Overview of exceedances of the long-term objective for the protection of human health during summer 2005 on a month-by-month basis

Month	Stations with exceedance (2) Number	%	Total number of exceedances	Number of days with exceedance (3)	Max. observed concentration µg/m³	Occurrence of exceedances (4)	
April	845	44	3 571	30	246	1.9	2.2
May	1 385	72	7 236	31	286	3.8	4.4
June	1 484	78	11 682	30	275	6.1	7.1
July	1 436	75	9 647	31	280	5.1	5.9
August	1 084	57	4 055	31	288	2.1	2.5
September	864	45	2 543	30	224	1.3	1.5

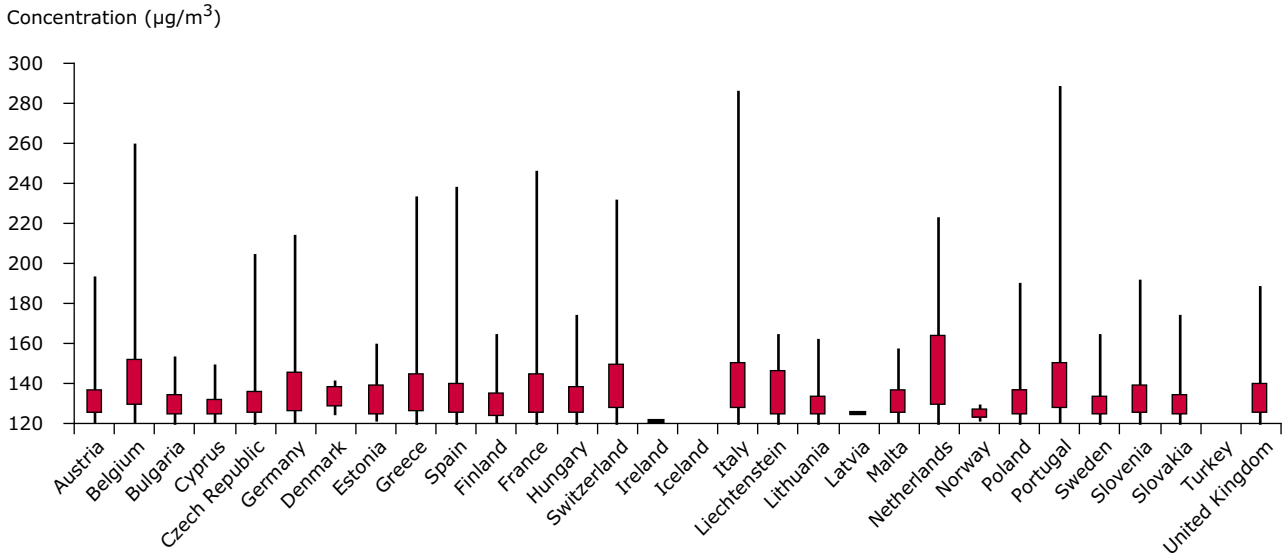
(2), (3) and (4) See notes on Table 2.3.

Figure 2.3 Number of days on which at least one exceedance of the long-term objective for the protection of human health was observed per country and per month during summer 2005



Note: Only countries which delivered data are shown.

Figure 2.4 Frequency distribution of concentrations in excess of the long-term objective for the protection of human health



Note: Presented as Box-Jenkins plots indicating the minimum, the 25th percentile, the 75th percentile and the maximum value. Only countries which delivered data are shown.

2.3 Geographical distribution

The calculated and measured values were interpolated using inverse distance weighting without distance limitation for rural stations and with an arbitrary radius representing 20 km for urban and suburban stations for map presentation. Combining rural and urban stations leads to rather homogeneous maps. The colour coding is common for station symbols as well as for interpolated maps. The density of ozone monitoring sites is too low to provide reliable estimates of the spatial distribution by interpolation for the south-eastern part of Europe, and so the data are presented with an arbitrary radius representing 100 km for rural stations ([3]).

The spatial distributions were similar between criteria, showing the highest ozone levels in the Mediterranean region. Higher ozone levels also occurred in Belgium, the Netherlands, eastern parts of France, and western parts of Germany. The lowest ozone levels occurred in the Baltic States and Scandinavia. Nevertheless, the long-term objective for the protection of human health was also often exceeded in these countries.

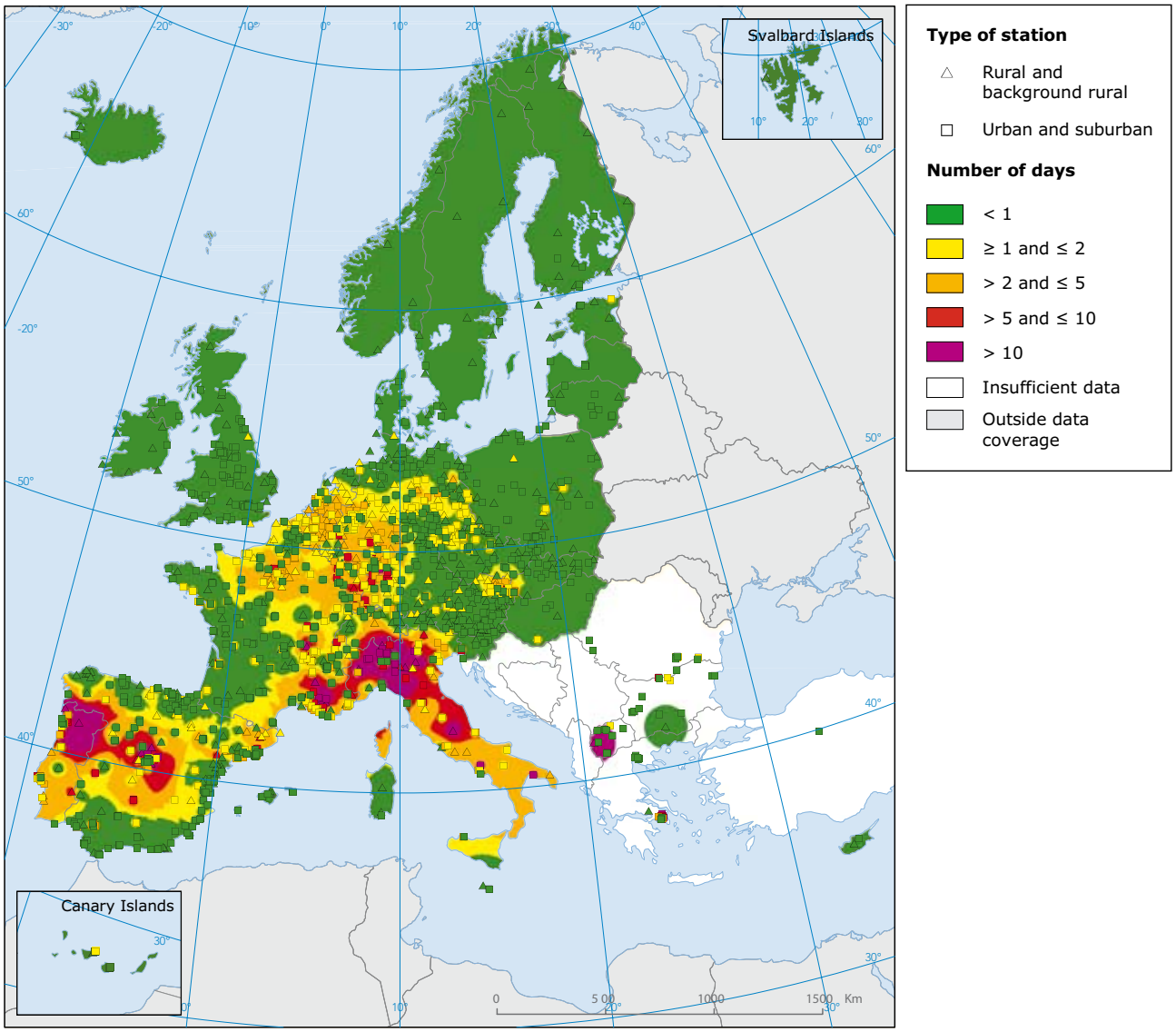
Map 2.1 shows the geographical distribution of the number of days on which the one-hour information threshold was exceeded. The spatial extent of the exceedances observed in summer 2005 was larger than 2004 but much smaller than in the hot summer of 2003. Notably a major part of central Europe was without any recorded exceedances in 2005. The area with more than 5 exceedance days in summer 2005 covered northern Italy, south-eastern France, northern Portugal and central Spain. The number of days with exceedance was significantly lower than in summer 2003, but about 25 % higher than in 2004. Scandinavia, Ireland, Cyprus and the Baltic States, except Estonia, had no days with exceeded levels of the information threshold.

Exceedances were found largely in Belgium, the Netherlands, northern Portugal, southern France and northern Italy. Generally, the alert threshold per station was exceeded on only one or two days.

Map 2.2 shows the geographical distribution of the number of days on which the long-term objective for the protection of human health level (LTO) was exceeded. The area with observed number of days with LTO exceedance higher than 25 (exceedance of TV) covered almost the whole Iberian peninsula, southern and central France and Germany, the Czech Republic, Southern Poland, Slovakia, Austria, Hungary, Switzerland, Slovenia and Italy. This area was continuous in rural areas with lower number of exceedances in cities. The area with exceedances of TV represented approximately 42 % (23 % in 2004) of the assessed territory and around 34 % (28 % in 2004) of the population of the total population on the assessed territory.

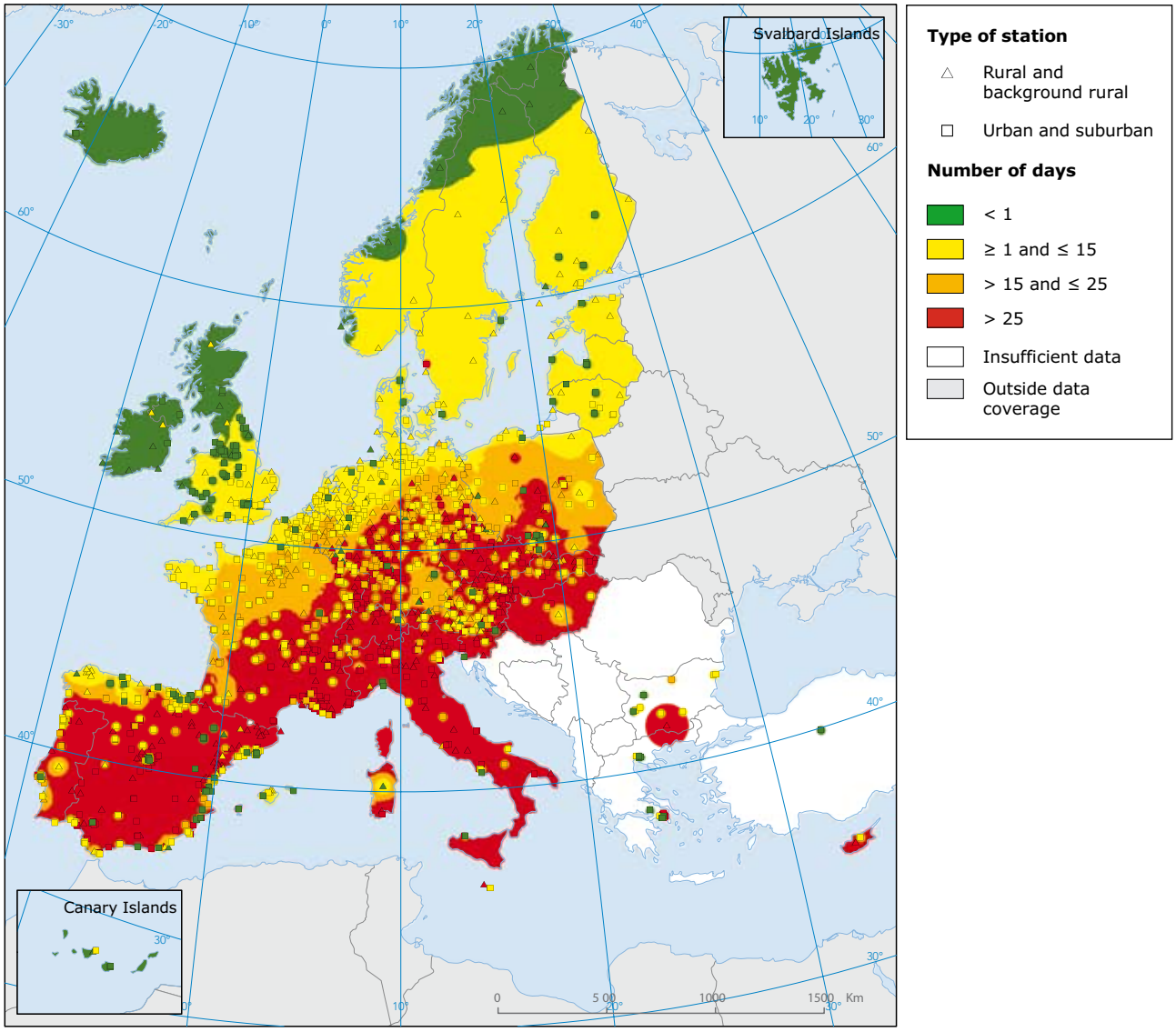
([3]) This radius might actually be different for the various regions in Europe.

Map 2.1 Number of days with exceedance of the information threshold



Source: Map produced by the European Topic Centre on Air and Climate Change, CHMI.

Map 2.2 Number of days with exceedance of the long-term objective for the protection of human health



Source: Map produced by the European Topic Centre on Air and Climate Change, CHMI.

2.4 Main ozone episodes

The occurrence of ozone exceedances varies during summer. A summary of exceedances on a monthly basis was shown in Tables 2.2 and 2.4. Figure 2.5 shows the distribution of exceedances on a daily basis for the whole of Europe during summer 2005. Figure 2.6 shows the distribution of exceedances per day and per country during summer 2005.

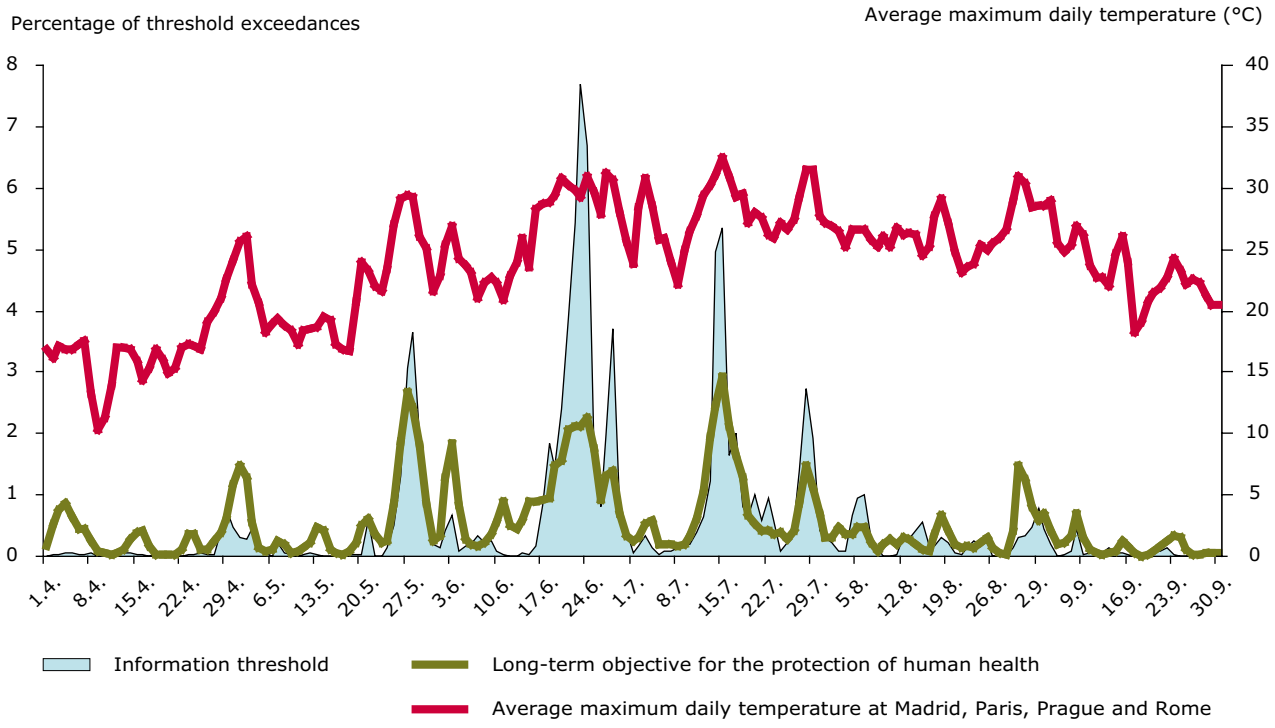
The level of ozone concentration depends on the meteorological situation and is closely correlated with air temperature. To show this correspondence, the average daily maximum temperature of maximum temperatures observed in four European capital cities (Madrid, Paris, Prague and Rome) is drawn in Figure 2.5 (source of the temperature data: http://www.wunderground.com).

The most important ozone episode occurred between 21–24 June. During this period, 24 % of the total number of exceedances of the information threshold, 22 % of exceedances of the alert threshold and 9 % of exceedances of the long-term objective were observed. The ozone episode in this period covered a large proportion of Europe comprising Austria (about 6 % of stations with exceedances of information threshold in this period), Belgium (about 77 % of stations), France (22 %), Germany (27 %), Greece (24 %), Italy (33 %), the Netherlands (75 %), Portugal (31 %), Romania (12 %), Slovenia (9 %) and Switzerland (77 %) (Figure 2.6).

The next strongest episodes occurred from 14–17 July and 25–28 May, during which 14 (9) % of the total number of exceedances of the information threshold, 7 (9) % of exceedances of the alert threshold and 9 (8) % of exceedances of the long-term objective were observed.

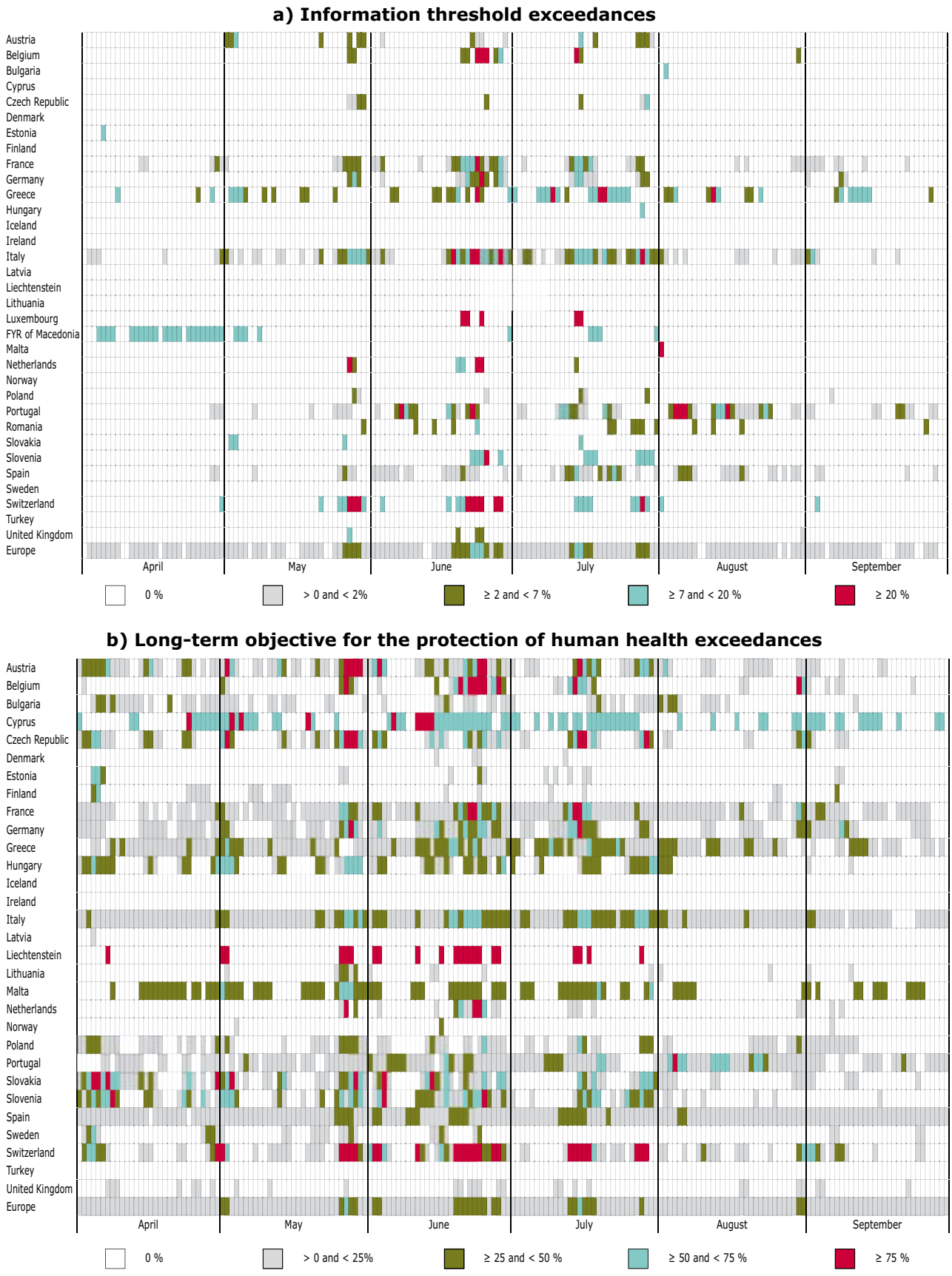
The meteorological conditions connected with the ozone episodes are characterised by a high-air-pressure area during anti-cyclone conditions, with stagnant air masses above a large part of Europe. This was the case during the ozone episodes in summer 2005 (http://www.wetterzentrale.de/topkarten/fsreaeur.html).

Figure 2.5 Distribution of exceedances during summer 2005 on day-by-day basis



Note: The left y-axis represents the percentage of exceedances observed during a particular day. Total number of exceedances of the information threshold and the long-term objective for protection of human health respectively is 100 %.

Figure 2.6 Distribution of exceedances during summer 2005 on day-by-day basis per country in percentage of stations with exceedances of:



Note: The colours represent the percentage of stations with observed exceedances during a particular day. Total number of stations (see Table 2.1) for any particular country is 100 %.

3 Comparison with previous years

The ozone levels in 2005 were compared to ozone concentrations since 1995. However, this should be done with caution for several reasons. The data over the period 1995–2002 were extracted from Airbase and therefore refer to a full calendar year; the 2003–2005 data were submitted under the ozone directive and refer to the summer months only. Also, they are only partly validated. Over the years the networks in Europe have changed. Some of the observed changes might be caused by the changes in location or density of the networks.

As described in the previous chapters, the ozone concentrations over Europe vary widely, partly as a result of the large variations in climate, such as the warm Mediterranean, the humid marine climate in the west and the cold and the polar-like climate in the north. In the more continental part, the predominantly western winds cause a gradual build-up of precursor emissions. To examine a possible variation in the trend of ozone levels over Europe, countries were divided into four regions for the purpose of this report, based on last year's experience and this summer's data (see the maps in previous chapter):

1. Northern Europe (Norway, Sweden, Finland, Estonia, Lithuania, Latvia, Denmark and Iceland);

2. North-western Europe (the United Kingdom, Ireland, the Netherlands, Belgium, Luxembourg and France north of 45 ° latitude (roughly corresponding to the line Bordeaux-Valence-Briancon));

3. Central and eastern Europe (Germany, Poland, the Czech Republic, Slovakia, Hungary, Austria and Switzerland);

4. Southern Europe (France south of 45 ° latitude, Portugal, Spain, Italy, Slovenia, Greece, Cyprus and Malta).

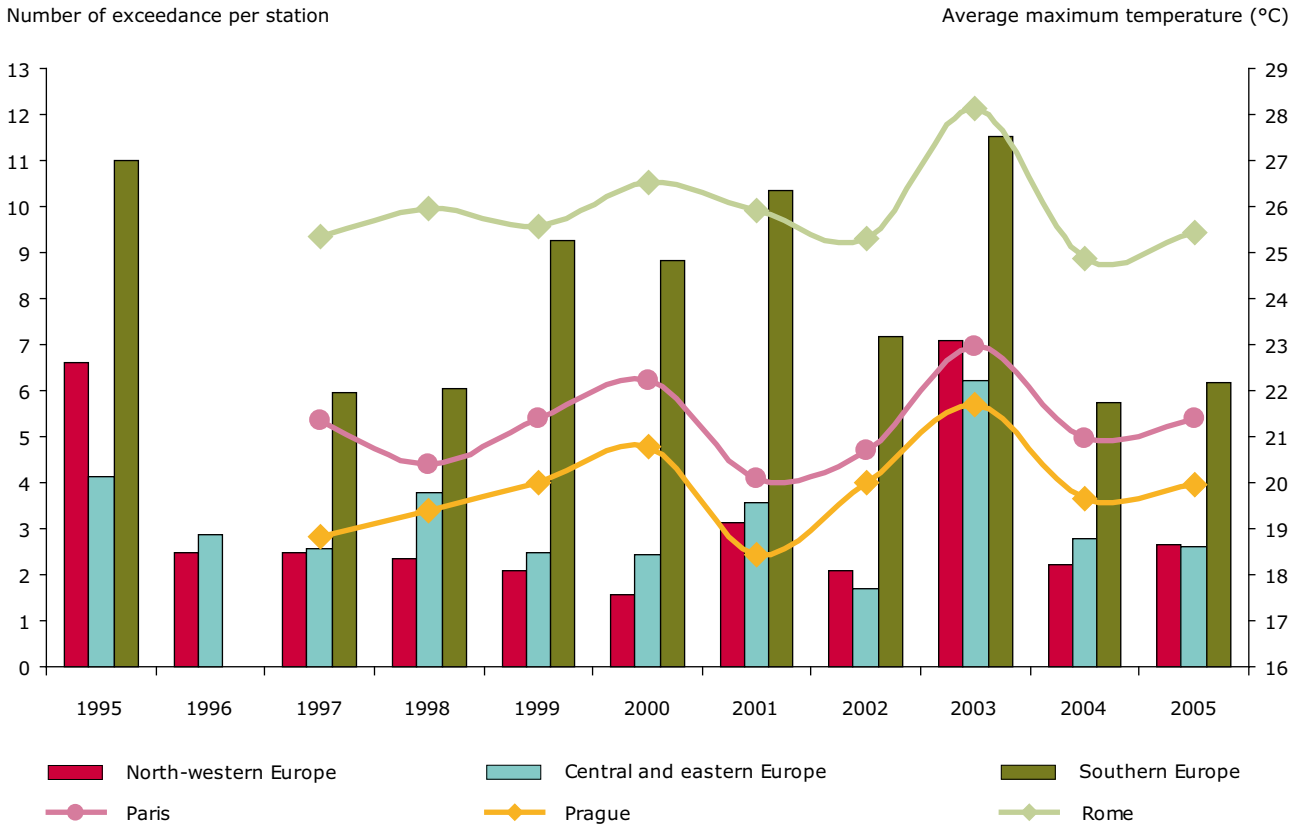
In region 1, northern Europe, exceedances of the information threshold are exceptional. This region is not further included in the trend analysis on exceedances.

Figure 3.1 clearly shows that frequent occurrence of exceedance was quite common in southern Europe. Between 1999 and 2001, the number of occurrences in southern Europe was only slightly lower than in the extreme summer of 2003 which saw a very large increase in occurrence. This was also the case in other parts of Europe. The situation during the summer of 2004 and 2005 returned to 'normal', as described in previous chapters. Daily maximum temperatures observed in four capital cities in regions (Paris (France) — region 2, Prague (Czech Republic) — region 3, Rome (Italy) — region 4) averaged for the period April to September of a particular year are drawn in Figure 3.1. This is to show correspondence between temperature and the occurrence of exceedances (source of the temperature data: http://www.wunderground.com).

Although the emissions of the ozone precursors have been reduced over the last decade ozone air pollution has not changed consistently. In some cases a decrease of ozone pollution has been observed, such as for the peak values of ozone. This decrease has levelled off during the most recent years. In other cases the data suggest an increase in ozone air pollution, by about one third of the urban and street monitoring stations. The average concentrations of ozone show an increasing trend for all station types. (EEA, 2005 and Simmonds P.G. *et al.*, 2004).

At the current level of precursor emissions, year-to-year variation of occurrence of ozone threshold exceedances is substantially induced by climatological changes from one year to another (CCC, 2005). Hot, dry summers lead to elevated ozone concentrations and the increased occurrence of exceedances of ozone threshold values. The hotter the summer the higher the number of exceedance was.

Figure 3.1 Average occurrence (the number of exceedances per station) per region for stations, which reported at least one exceedance, observed during the year and the summer average maximum daily temperature in selected cities



North-western Europe: the United Kingdom, Ireland, the Netherlands, Belgium, Luxembourg and France north of 45 ° latitude;

Central and eastern Europe: Germany, Poland, the Czech Republic, Slovakia, Hungary, Austria and Switzerland;

Southern Europe: France south of 45 ° latitude, Portugal, Spain, Italy, Slovenia, Greece, Cyprus and Malta;

Northern Europe has not been included in this figure because of the low number of exceedances.

Note: No station in region southern Europe has reported ozone data in 1996, only a few stations in Greece and Spain in 1995. No temperature data available for 1995 and 1996.

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Annex 1 Data reporting over summer 2005

To manage the monthly and summer data flows, the Member States are required to use a set of reporting forms as described in the Commission guideline 'Directive 2002/3/EC relating to ozone in ambient air: procedures and formats for the exchange' (ETC/ACC, 2004).

Ozone monitoring stations operated mostly throughout the whole period April–September 2005. However, it is possible that some exceedances were not reported if a monitoring station was temporarily out of operation due to maintenance or breakdown. Nevertheless, general experience with current, continuously operated ozone monitors indicate that such situations do not occur frequently.

In this report one-hour exceedances are counted on a daily basis, i.e. a day on which an information/alert threshold is exceeded during at least one hour is counted as one exceedance. The counting of 8-hour exceedances is done in the same way, i.e. a day on which at least one 8-hour average exceeded the long-term objective level is one exceedance.

A summary of monthly reported data has been presented and regularly updated on the ETC/ACC website http://etc-acc.eionet.eu.int/databases/o3excess.

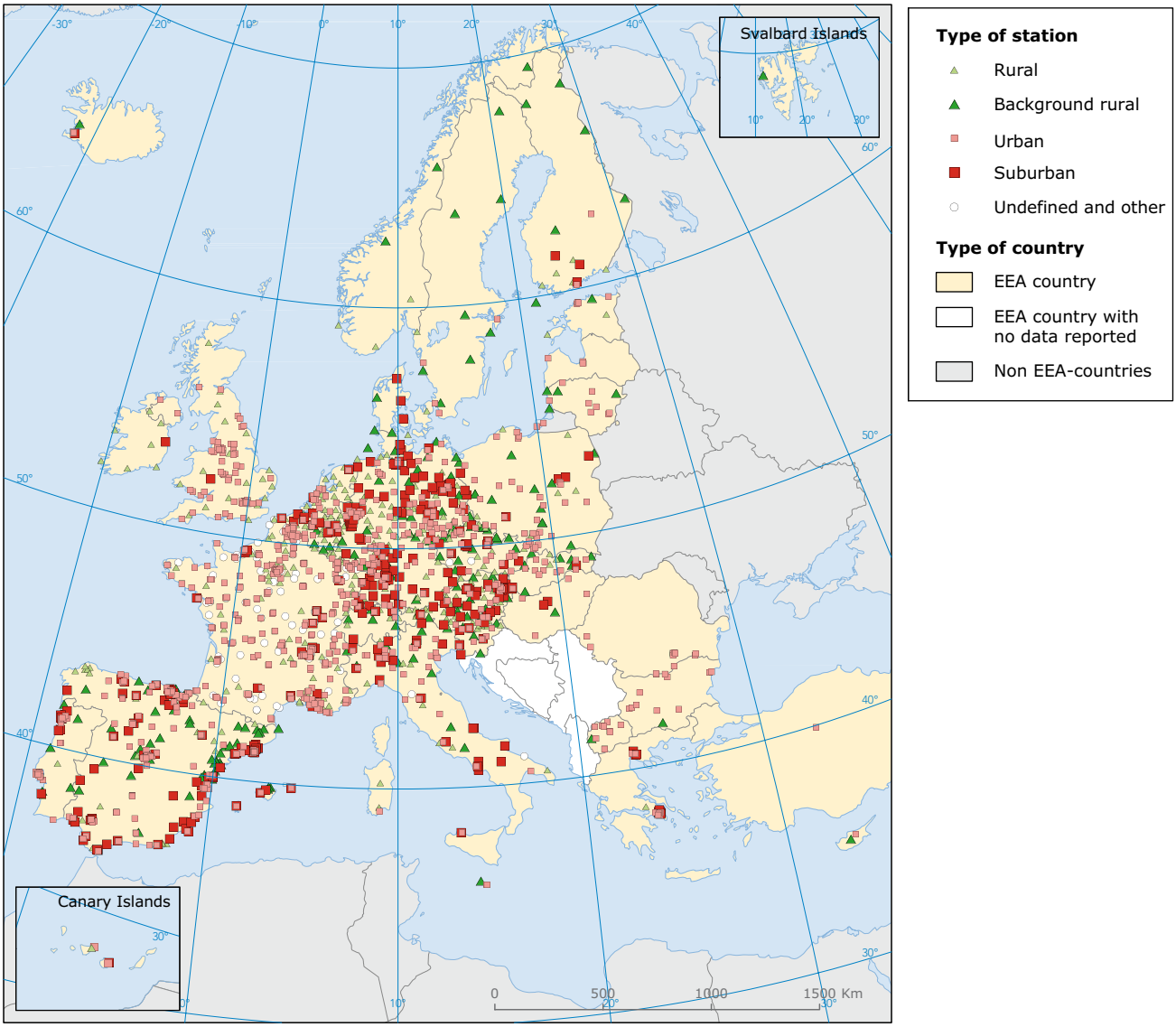
The ozone monitoring network in 2005

Map A.1 presents the location of all ozone-monitoring stations assumed to be operational in the reporting countries during the 2005 summer season. In total 1 931 ozone-monitoring sites were operational in summer 2005. Out of 1 931 stations, 1 865 are located within the EU area. The number of stations reporting during the 2005 summer increased only slightly compared to previous years (1 842 stations in 2001, 1 718 stations in 2002, 1 805 stations in 2003, 1 852 in 2004). There has been a significant increase in the number of stations in Poland (65 stations in 2005 in comparison with 21 in 2004).

According to the requirements in the ozone directive, the stations should be situated away from the influence of local emissions. When looking at the delivered station meta information, 328, i.e. about 17 %, are traffic or industrial stations (thus not fulfilling the requirements), and were included in 2005 summer reporting.

The problem with missing or unclear meta-information on monitoring stations was not as large as in previous years. Most of the countries transmitted complete information about all operational stations. To fill the gaps in station meta information, i.e. geographical coordinates, information was extracted from the summer 2005 reporting and from Airbase.

Map A.1 Location of ozone monitoring stations as reported by Member States and other European countries in the framework of the ozone directive for summer 2005



Source: Map produced by the European Topic Centre on Air and Climate Change, CHMI.

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