Topic report | 6/2002

Air pollution by ozone in Europe in summer 2002

Overview of exceedances of EC ozone threshold values during the summer season April–August 2002

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The information describing the situation during summer 2002 is partly based on non-validated monitoring data and hence should be regarded as preliminary.

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Summary

According to Council Directive 92/72/EEC on air pollution by ozone, EU Member States have to provide information on ozone ambient air concentrations (statistical parameters, number and duration of exceedances of specified threshold values) on an annual basis before 1 July of the following year. Additionally, exceedances of the threshold values for population information and warning, as set in the directive, must be reported to the Commission within one month after occurrence. This report gives a first evaluation of the observed exceedances of the ozone public information and warning thresholds during summer 2002 (April–August).

The agreed deadline for transmitting data for this report was 16 September 2002. Most of the EU Member States provided information on the observed exceedances in time, or indicated that no exceedances had been observed. In addition, 12 other European countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Slovakia, Slovenia and Switzerland) provided information on observed exceedances upon request of the European Environment Agency.

From an evaluation of the exceedances, the following conclusions are drawn for the situation during summer 2002.

- Exceedances of the threshold value for providing information to the population (180 μg/m^3 for hourly values) have been reported by 11 EU Member States and by six other countries. About 33 % of all stations reported one or more exceedance. The average maximum hourly concentration during an exceedance was 201 μg/m^3.

- In the reporting period April–August 2002 exceedance of the threshold value for warning of the population (360 μg/m^3 for hourly values) occurred in Spain, France and Italy at five stations in total, all in June.

- Within the European Union and other reporting countries, 1 718 ozone monitoring stations were operational.

For early information of the Member States and the Commission a summary of monthly reported data has been presented and regularly updated on the ETC-ACC web page http://etc-acc.eionet.eu.int/databases/2002o3excess.html.

An updated analysis of information on ozone exceedances extended to data for 2000 confirms results obtained on data submitted in the period 1994–99. The analysis clearly shows a decreasing trend in the short-term peak (highest hourly) concentrations of ozone but an increasing trend in the long-term median concentrations. These findings suggest that Europe-wide reductions of ozone precursor emissions in the period 1994–2000 led to a reduction in high (peak) ozone concentrations and to a reduced short-term exposure to high ozone values. On the other hand, the increasing median concentrations have led to an increased long-term exposure of the population to ozone.

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 of ozone formation. Ozone is a strong photochemical oxidant. Its elevated concentrations cause serious health problems and damage to ecosystems, agricultural crops and materials.

In view of the harmful effects of photochemical pollution in the lower levels of the atmosphere, the European Council adopted Directive 92/72/EEC on air pollution by ozone (the ozone directive) in 1992. The directive came into force in March 1994. It established procedures for harmonised monitoring of ozone concentrations, for exchange of information, for communication with and alerting of the population regarding ozone and to optimise the action needed to reduce ozone formation.

Article 6 of the directive specifies how the information on monitoring results must be provided by the Member States to the European Commission. Regarding the time frame, two main types of reporting can be distinguished. Information on exceedances of the so-called information threshold (Article 6 paragraph 2) and warning threshold (Article 6 paragraph 3) for the ozone concentration is to be provided within one month after occurrence. Information on exceedances of all threshold values given in Article 6 must be provided within six months following the annual reference period (Article 6 paragraph 1). Article 7 of the directive stipulates that the Commission shall at least once a year evaluate the data collected under the directive. The present report gives an overview of the situation during summer 2002. Overviews for the period 1994–2001 have been prepared by the European Topic Centre on Air and Climate Change (previous reports are available from the Internet site of EEA: http://www.eea.eu.int/).

Harmful ozone concentrations are observed over the whole of Europe (Beck et al, 1998; de Leeuw et al., 1999; Hjellbrekke et al., 2002). Formation of ozone takes place at various space and time scales: the high emission density of reactive precursors in urban areas might lead to high ozone concentrations within the city or at short distances downwind. But ozone precursors may also be transported over distances of hundreds to thousands of kilometres, resulting in ozone formation far from the sources. To improve the insight in current ambient ozone concentrations over Europe, countries outside the European Union have been requested by the European Environment Agency (EEA) to provide information on ozone exceedances of the threshold values as specified in the ozone directive.

The data reported here does not cover all ozone monitoring stations in the European Union. To be included in this report, the data must satisfy certain criteria stipulated in the directive, concerning inter alia measuring methods, sampling methods, station siting, quality assurance and documentation.

On 9 March 2002, the new Directive 2002/3/EC of the European Parliament and of the Council relating to ozone in ambient air was published.

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 for ozone to avoid, prevent or reduce harmful effects on human health and the environment. It provides for common methods and criteria for the assessment of ozone concentrations in ambient air and on the basis of this assessment to ensure that adequate information is made available to the public, and to promote increased cooperation between the Member States in reducing ozone levels.

The current Directive 92/72/EEC shall be repealed from 9 September 2003. By this date Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with Directive 2002/3/EC. From 2004, the Member States will transfer provisional data on exceedances of

information and alert thresholds for ozone as required by Article 10 of Directive 2002/3/EC.

In the new Directive 2002/3/EC the information threshold is defined similar to the current Directive 92/72/EEC as 1h average values of 180 $\mu g/m^3$. Directive 2002/3/EC sets the alert threshold as 1-hour average 240 ug/m^3 and stipulates that for the implementation of short-term action plans (as described in Article 7) the exceedance of the threshold should be measured (or predicted) for three consecutive hours. Unless explicitly stated, in this report when a reference is made to the ozone directive this refers to Directive 92/72/EEC.

The available information, submitted under the current Directive 92/72/EEC, allows an evaluation of the occurrence of exceedance of the alert threshold but it is insufficient to evaluate whether ozone concentrations are above the alert threshold of the new directive during three consecutive hours.

2. Data reporting

2.1. Introduction

According to the Directive 92/72/EEC, EU Member States must inform the Commission on a monthly basis in case exceedances of the population information or warning threshold values for ozone are observed. In this report an assessment is made of the 2002 summer season, based on the exceedances of these thresholds for ozone, which were transmitted by the Member States after the end of each month.

In addition to this monthly-based reporting on exceedances of ozone thresholds in the current summer, Member States have to provide the following information for the annual reference period based on validated data for the previous year:

- maximum, median and 98 percentile value of 1h and 8h average ozone concentrations;
- location, date and duration of periods during which threshold values as presented in Table 2.1 are exceeded and the maximum concentrations recorded during each occurrence.

An evaluation of the data reported on an annual basis will be included in a forthcoming EEA report on air pollution in Europe, which additionally covers the information collected under the EU Exchange of Information Decision (97/101/EC).

The formats for information and data exchanges have been defined in Directive 92/72/EEC. Considering the increasing amount of data requiring processing, as well as the improvement in the transfer of data relating to the implementation of Directive 92/72/EEC, the Commission prepared an update in April 1996 of the required data exchange format. The major changes concern the transfer of additional information:

- type of station: definition of the location of stations as recommended in the decision on exchange of information;
- altitude of stations as recommended by the expert group;
- NO_x and VOC data, according to Annex 2.3 of the ozone directive;
- file names: it is recommended to define unique names for all files in order to improve the management and transfer of the data files.

After 1996, no further modifications in data requirements and data exchange formats have been made. Non-EU countries were requested to submit their data in agreement with these data exchange formats. Information submitted using the air quality DEM (date exchange module, a software tool developed by ETC/ACC (see for example, Sluyter and Schoorl, 1999) to facilitate data flows under the exchange of information decision) is also accepted.

2.2. Data reported over summer 2002

For this report on summer 2002, the deadline agreed for transmitting data was 16 September 2002. Data were reported timely by most of the Member States and in addition to the information from Member States, 12 other European countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Slovakia, Slovenia and Switzerland) reported on the summer ozone situation. As far as possible, any information received after the

Threshold values for ozone concentrations (in µg/m³; ref 92/72/EEC) Table 2.1.

Threshold for:	Concentration	Averaging period
Health protection	110	8 h
Vegetation protection	200	1 h
	65	24 h
Population information	180	1 h
Population warning	360	1 h

deadline was also included in this report. If during a month no exceedances have been observed, there is no obligation to inform the Commission on this. Almost all countries, however, confirm that no exceedances have been observed. It is greatly appreciated by the Commission and EEA that most countries were able to transmit August exceedance data before the formal deadline as set in the directive.

As in the last five years (1997–2001), Ireland and Finland confirmed no exceedance of the 180 µg/m^3 threshold in 2002. Also in Denmark, Sweden, Estonia, Latvia, Lithuania, Norway and Romania no exceedances were observed. Table 2.2 presents an overview of observed exceedances per country per month. Note that the information used in this report to describe the situation during summer 2002 is partly based on non-validated monitoring data and/or on incomplete information on monitoring networks; hence the results should be regarded as preliminary.

Since only exceedances of thresholds were reported, there is no evidence whether stations were operational continuously during summer (April–August) 2002. It is possible that ozone concentrations exceeded a threshold at a site but this was not reported because the monitoring station was temporarily out of operation.

In this report exceedances are counted on a daily basis, that is, a day on which a threshold is exceeded during at least one hour is counted as one exceedance.

A summary of monthly reported data has been presented and regularly updated on ETC-ACC web page http://etc-acc.eionet.eu.int/databases/2002o3excess.html.

Table 2.2. **Overview of observed exceedances per month per country in 2002**

	April	May	June	July	August
Austria	–	p	p	p	p
Belgium	–	–	–	p	p
Denmark	–	–	–	–	–
Finland	–	–	–	–	–
France	p	p	p	p	p
Germany	–	p	p	p	p
Greece	p	p	p	p	p
Ireland	–	–	–	–	–
Italy	p	p	p	p	p
Luxembourg	–	–	p	p	x
Netherlands	–	–	p	p	p
Portugal	p	–	–	p	p
Spain	p	p	p	p	p
Sweden	–	–	–	–	–
United Kingdom	–	–	p	p	p
Bulgaria	–	x	x	x	x
Czech Republic	–	–	p	p	p
Estonia	–	–	–	–	–
Hungary	–	–	p	–	–
Lithuania	–	–	–	–	–
Latvia	–	–	–	–	–
Norway	–	–	–	–	–
Poland	–	–	p	–	p
Romania	–	–	–	–	–
Slovakia	p	–	–	–	–
Slovenia	–	–	p	–	–
Switzerland	–	p	p	p	p

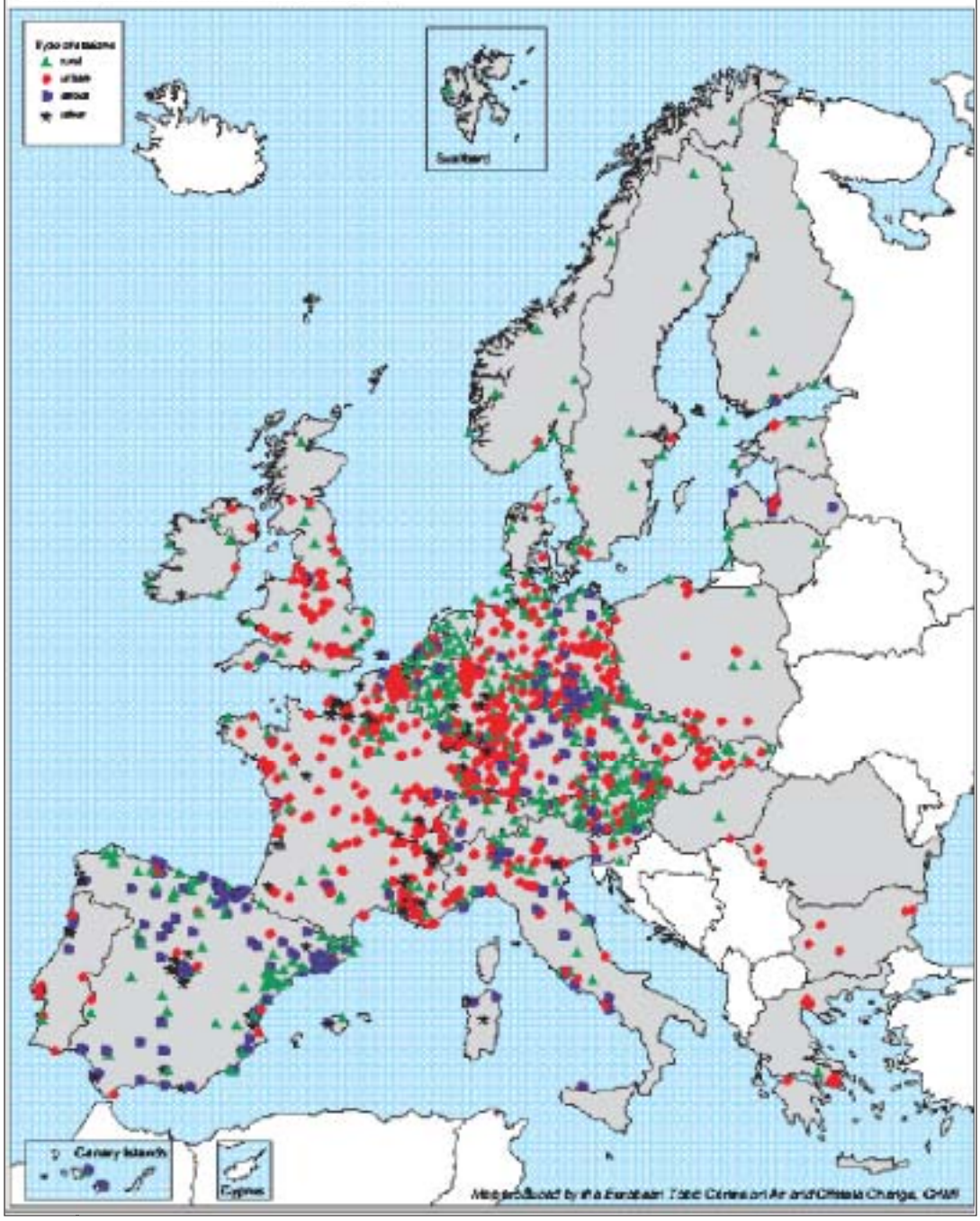
p: exceedance of the population information threshold reported, –: no exceedance reported;
x: no information delivered.

Location of ozone monitoring stations as reported by Member States and other European countries in the framework of the ozone directive for the reference period 2002

Map 2.1.

Location and type of ozone monitoring stations reporting data

Reference period: summer 2002 (April–August)



2.3. The ozone monitoring network in 2002

Most of the countries provided information on the operational ozone monitoring network in summer 2002 (number of monitoring stations, coordinates, station type, etc.) or reported that it was the same as in 2001. For the countries for which no actual information has been submitted, it has been assumed that the network configuration as found for the annual period 2001 was also in place during the summer of 2002.

Map 2.1. presents the location of all ozone monitoring stations assumed to be operational in the reporting countries during the 2002 summer season. In total 1 718

ozone monitoring sites are operational. From these stations 1 555 stations are located within the EU, 465 stations are situated in rural areas, 796 stations in urban environments, 322 are classified as street stations and 135 stations were characterised as industrial stations or the monitoring environment was not specified. The number of stations reporting during the 2002 summer is slightly less than the number of stations operational in previous years (1 842 stations in 2001). The difference is mainly due to the lower number of stations submitted by Italy.

3. Information for summer 2002

3.1. Summary of exceedances reported

The threshold value for warning the public (1h > 360 µg/m³) was exceeded in June in France (one station), in Italy (one station) and Spain (three stations) (Table 3.1). No further exceedances of the warning threshold have been reported for the European territory for the reporting period April–August 2002.

The number of exceedances of the warning level in 2002 is similar to the number found in previous years. In summer 2001, the threshold value 360 µg/m³ was exceeded in March at the French station Marignane Ville (maximum concentration 387 µg/m³). The annual 2001 reporting presented two additional exceedances of the warning threshold at one station in Italy (369 µg/m³ in August) and at one station in Spain (470 µg/m³ in November). In the annual reports for 2000, only Italy reports exceedances of this threshold on three occasions at two stations. In 1999, exceedances were observed in Spain (five stations), in Italy (one station) and in Bulgaria (two stations); however, both the Spanish and Bulgarian data shows extremely high values at unexpected times so that measuring artefact and/or interference with other chemicals cannot be excluded.

Table 3.2 presents a general overview of the observed exceedances of the threshold for informing the public (1h > 180 µg/m³) during the period April–August 2002 per country. Since the number of stations differs widely from country to country, the absolute number of exceedance days is not suitable for comparison of the situation in different countries. Therefore, the concept of 'occurrence of exceedance' has been introduced. Occurrence of exceedance is defined as the average number of observed exceedances per country, that is, the total number of exceedances for all stations divided by the total number of operational stations. Although this parameter is more comparable between countries, the differences in network, in particular, the ratio between street, urban and rural stations, limits the comparison.

With respect to EU Member States, in Denmark, Finland, Ireland and Sweden no exceedances of the 180 µg/m³ threshold value were observed. Ireland and Finland have not reported any exceedance during the last six summer seasons (1997–2002). The other countries, Estonia, Lithuania, Latvia, Norway and Romania, did not observe exceedance of the population information threshold in the summer season 2002.

For those countries that reported exceedances, the number of exceedance days ranged from one to 68. During 120 days within the April–August period of 153 days there was at least one station in all reporting countries where an exceedance was observed. About 33 % of all stations reported one or more exceedances. On average 3.3 exceedances were observed this summer at stations which recorded at least one exceedance. The average maximum hourly concentration during an exceedance of the threshold was 201 µg/m³.

Exceedances of threshold value for warning the public (1h > 360 µg/m³) in 2002 Table 3.1.

Country	Station	Date	Maximum concentration (µg/m³)
Spain	Puertollano-Institute	22 June	370
Spain	Puertollano-Barrio	22 June	391
Spain	Vila-Seca	13 June	384
France	Rognac les Brets	19 June	372
Italy	Meda	22 June	377

Table 3.2. **Summary of exceedances of the threshold for information of the public (1h ozone concentration > 180 µg/m³) during summer 2002 (April–August) on a country-by-country basis**

	No of stations [1])	No of stations with exceed-ance		No of days with excee-d-ance [2])	Maximum observed concentr. (µg/m³)	Averaged maximum concentr. (µg/m³) [3])	Occur-rence of exceed-ances [4])		Average duration of exceed-ances (hours)
Austria	114	26	23 %	13	265	192	0.3	1.3	1.4
Belgium	34	20	59 %	3	256	197	0.9	1.6	2.3
Denmark	7	0	0 %	0	<180	<180			
Finland	11	0	0 %	0	<180	<180			
France	432	187	43 %	56	372	200	1.6	3.7	2.4
Germany	362	151	42 %	27	292	199	0.7	1.6	2.5
Greece	23	16	70 %	68	316	205	8.8	12.6	2.4
Ireland	6	0	0 %	0	<180	<180			
Italy	106	60	57 %	52	377	206	4.1	7.2	3.4
Luxembourg [5])	5	3	60 %	3	212	194	1.0	1.7	2.4
Portugal	34	9	26 %	4	211	195	0.3	1.2	2.4
Spain	297	45	15 %	48	391	201	0.4	2.9	2.2
Sweden	11	0	0 %	0	<180	<180			
Netherlands	35	10	29 %	5	229	197	0.3	1.1	2.5
United Kingdom	78	11	14 %	4	271	195	0.2	1.5	1.6
EU area	1 555	538	35 %	118	391	201	1.2	3.3	2.6
Bulgaria [5])	5	0	0 %	0	<180	<180			
Czech Republic	59	12	20 %	5	207	191	0.2	1.2	1.6
Estonia	6	0	0 %	0	<180	<180			
Hungaria	2	1	50 %	1	181	181	0.5	1.0	1.0
Latvia	11	0	0 %	0	<180	<180			
Lithuania	3	0	0 %	0	<180	<180			
Norway	14	0	0 %	0	<180	<180			
Poland	22	4	18 %	4	203	188	0.3	1.5	2.2
Romania	2	0	0 %	0	<180	<180			
Slovakia	20	1	5 %	1	184	184	0.1	1.0	1.0
Slovenia	6	2	33 %	5	219	197	1.2	3.5	4.3
Switzerland	13	10	77 %	28	273	201	4.6	6.0	3.5
Whole area	1 718	568	33 %	120	391	201	1.1	3.3	2.6

[1]) Number of stations implemented in the framework of the ozone directive.
[2]) The number of calendar days on which at least one exceedance was observed.
[3]) Average of all maximum concentrations recorded during exceedances.
[4]) Left figure: averaged over all implemented stations, right figure: averaged over all stations which reported at least one exceedance.
[5]) Incomplete information delivered.

Summary of exceedances of the threshold for information of the public (1h ozone concentration > 180 µg/m³) during summer 2002 (April–August) on a month-by-month basis

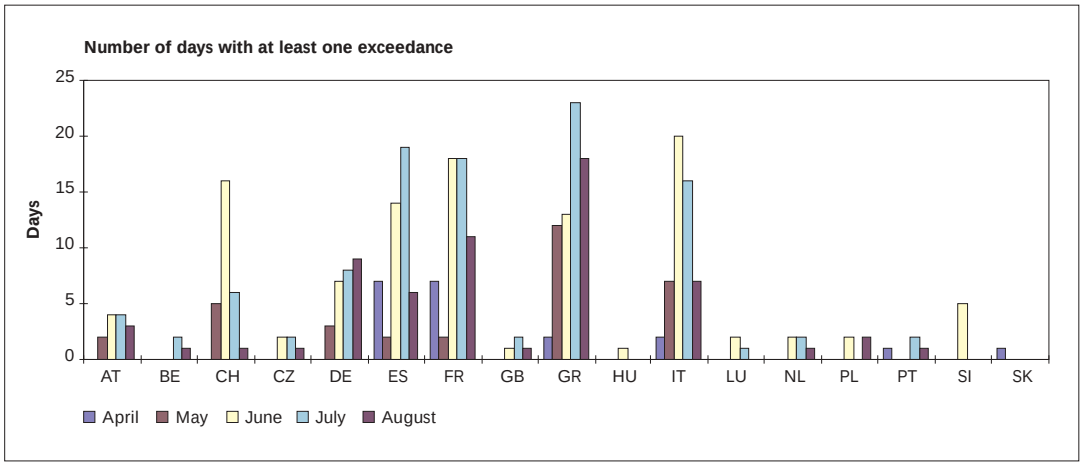
Table 3.3.

	No of stations with exceedance [1]	Maximum observed concentration (µg/m³)	Average maximum concentration (µg/m³) [2]	Occurrence of exceedances [3]		Average duration of exceedances (hr)
April	20	293	200	0.0	1.3	1.5
May	47	289	194	0.0	1.5	2.3
June	366	391	204	0.6	2.8	3.0
July	302	316	198	0.3	2.0	2.3
August	86	286	197	0.1	1.8	2.0

[1]) The theoretical maximum is 1 718 stations (all stations which are assumed to be operational in the reporting European countries during summer 2002); at 568 stations one or more exceedance has been observed.
[2]) Average of all maximum concentrations recorded during exceedances.
[3]) Left figure: averaged over all stations in operation, right figure: averaged over all stations which reported at least one exceedance.

Number of days on which at least one exceedance of the threshold value for information of the public (1h ozone concentration > 180 µg/m³) was observed per country ([1]) and per month during summer 2002

Figure 3.1.



Countries confirming that no exceedances were observed are not shown.

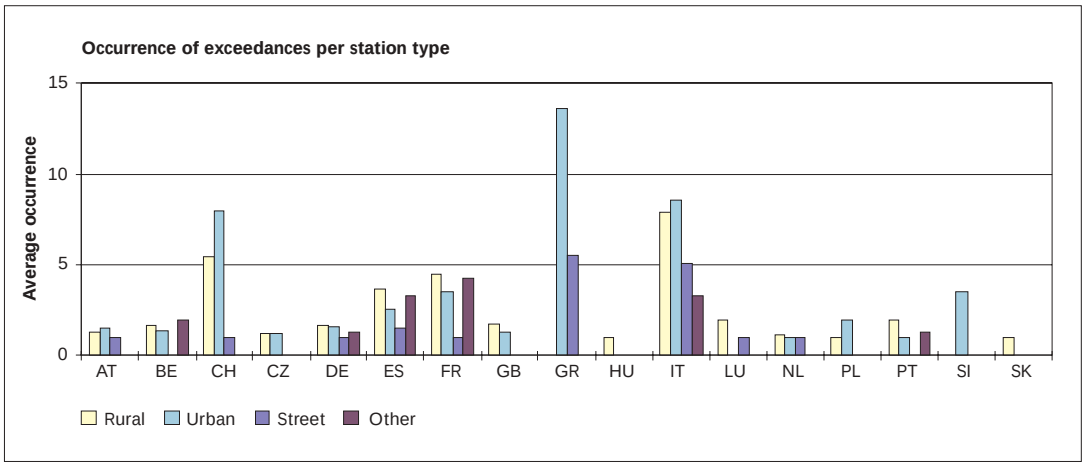
Table 3.3 summarises the exceedances on a monthly basis. The largest number of exceedances occurred during June and July in 2002; almost every day, an exceedance was observed at at least one of the reporting stations (see Section 3.3, Figure 3.6).

Figure 3.1 presents the number of days per month on which at least one station in a country recorded an exceedance. The seasonal behaviour seen in Table 3.3 is, in general terms, reflected in this figure, although for individual countries large year-to-year fluctuations occur.

The average occurrence of exceedances (in days) in each country of the threshold for information of the public by station type (rural, urban, street and other) is presented in Figure 3.2. According to ozone phenomenology, the average occurrence rate is expected to decrease in general in the order rural background — urban background — street. For some countries, this decrease is apparent. In other countries, this relation is not visible or even contradicted.

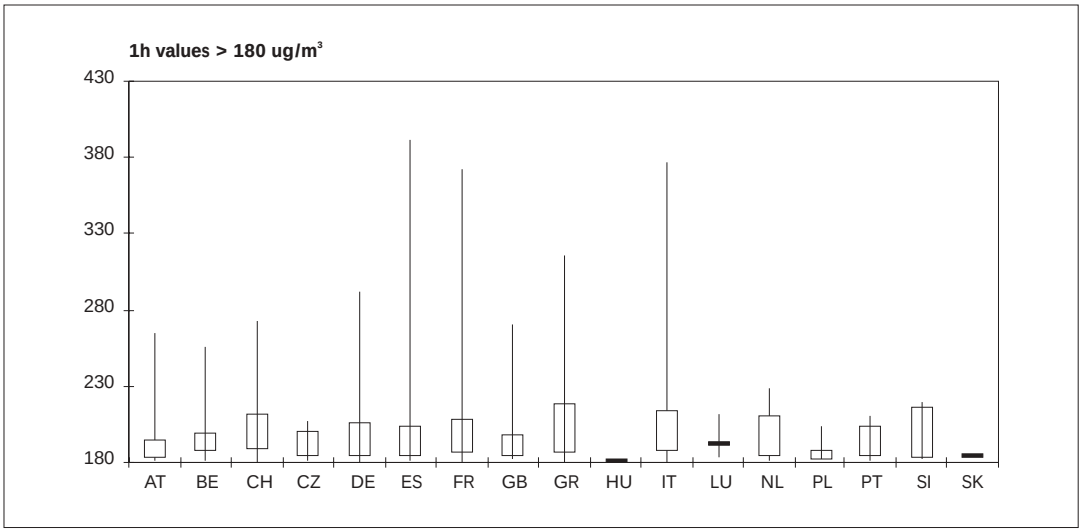
(1) In all figures the countries have been identified using the ISO 3166-1:1997 Alpha-2 code.

Figure 3.2. **Average occurrence of exceedances (in days) of the threshold for information of the public (1h ozone concentration > 180 µg/m³) by station type (rural background, urban background, street and other) and country during summer 2002**



Countries confirming that no exceedances were observed are not shown.

Figure 3.3. **Frequency distribution of ozone concentrations in excess of the 180 µg/m³ information threshold for hourly values (April–August 2002)**



	AT	BE	BG	CH	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HU
Ex	34	31		60	14	236			131		686	16	202	1
St	26	20		10	12	151			45		187	11	16	1

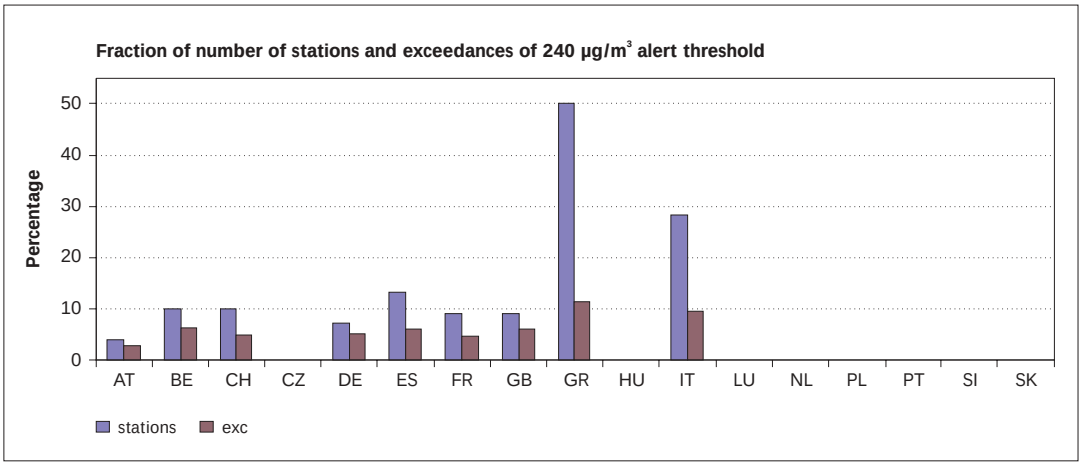
	IE	IT	LT	LU	LV	NL	NO	PL	PT	SE	SI	SK	RO
Ex		430		5		11		6	11		7	1	
St		60		3		10		4	9		2	1	

Frequency distributions are presented as Box-Jenkins plots indicating the minimum, the 25 percentile, the 75 percentile and the maximum value. Countries reporting no exceedances are not shown.
Bottom: total number of exceedances (Ex) and number of reporting stations (St) per country (ISO 3166-1:1997 Alpha-2 code).

Figure 3.3 shows the frequency distribution of hourly ozone concentrations in excess of the information threshold value using Box-Jenkins plots. For each country the Box-Jenkins plot indicates the minimum (here the minimum is 180 µg/m³), maximum, 25 percentile and 75 percentile value of the exceedances. The figure shows that during 25 % of all observed exceedances, the maximum hourly concentration recorded was just above the180 µg/m³ threshold. The highest value of the 75 percentile of all maximum concentrations in a country during exceedances were below 219 µg/m³,

Number of stations and number of reported exceedances of the alert threshold (Directive 2002/3/EC, 240 µg/m³) expressed as percentage of the number of stations and number of reported exceedances of the information threshold (180 µg/m³), respectively; summer 2002

Figure 3.4.



Countries reporting no exceedances of the 180 µg/m³ threshold are not shown.

which is higher than the maximum 75 percentile value during summer 2000 (207 µg/m³) and 2001 (208 µg/m³).

The reported data on exceedances of the information threshold was used to analyse the number of exceedances of the alert threshold (240 µg/m³) as set in the third daughter Directive 2002/3/EC and to be reported from 9 September 2003 onwards. On average at 11 % of the stations, which report an exceedance of the 180 µg/m³ threshold, an exceedance of the 240 µg/m³ alert threshold was observed. In total 124 exceedances of the alert threshold were counted, that is, during about 7 % of the reported exceedances the maximum concentration reached a level above 240 µg/m³. The ratio of the number of exceedances of the 180 µg/m³ level and the number of exceedances of 240 µg/m³ thresholds varied strongly across the reporting countries, see Figure 3.4. The situation in each country (number, location and type of stations, local meteorological conditions) is probably an important factor in determining this ratio; Figure 3.4 suggests a higher ratio for the southern European countries.

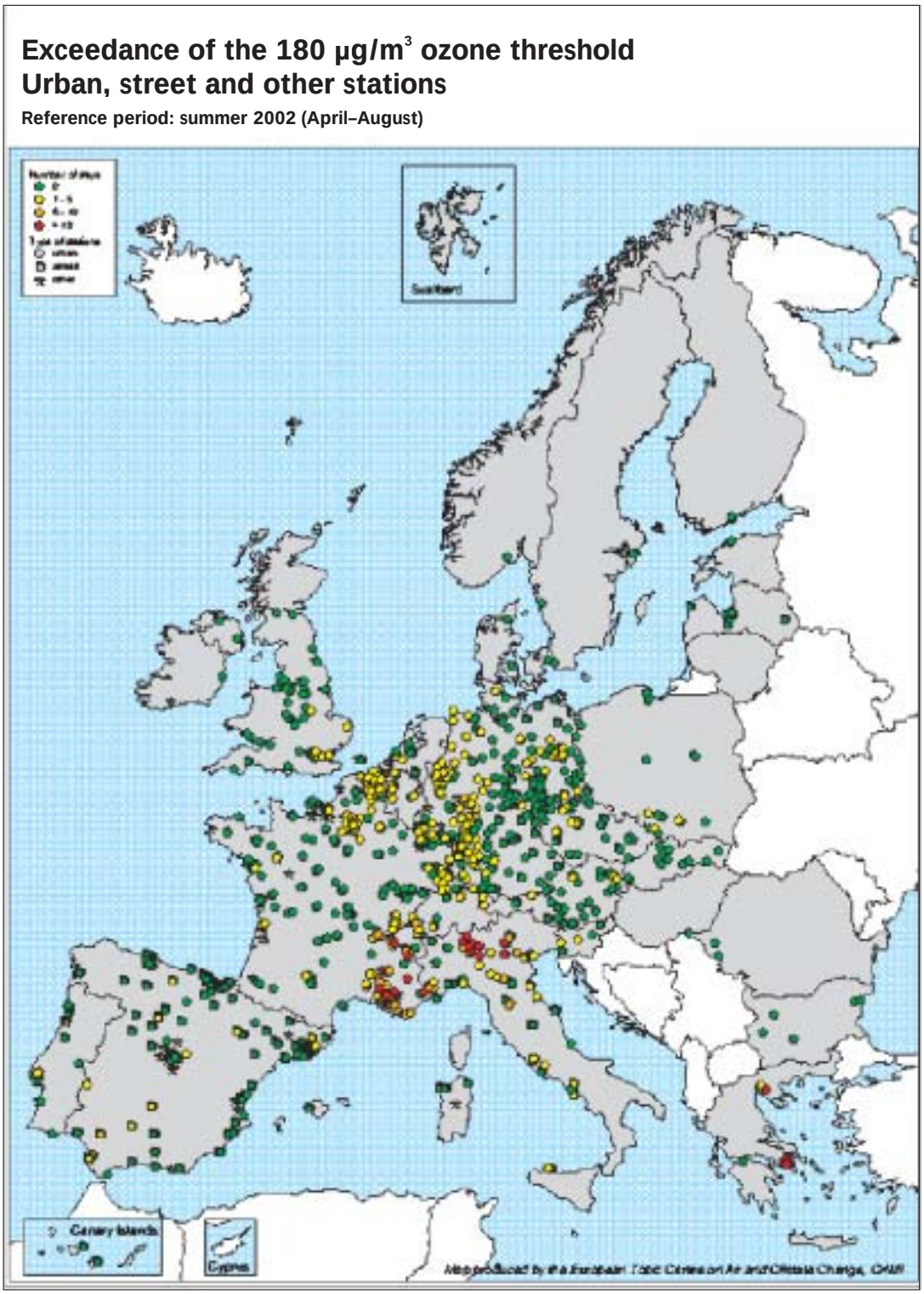
Maps 3.1 and 3.2 show the geographical distribution of the number of days on which the threshold value for information of the public was exceeded for urban (²) and rural stations, respectively (³). Exceedance data for urban stations are presented as dots. The exceedance data for rural stations are interpolated using simple inverse distance weighting and a tentatively estimated 'radius of representativeness' of 100 km. Note that this radius will depend on local conditions (meteorological, orography, distance from sources, etc) at the station. It will be different for the different regions in Europe.

The geographical distribution of exceedances observed in summer 2002 at urban stations and stations of unspecified type in northern and western Europe follows the pattern observed in most of the previous summer seasons. The number of exceedances rises from zero in the Scandinavian countries, Baltic States and Ireland to a maximum in southern Europe. No consistent spatial pattern is apparent in the Mediterranean region. Here, many stations did not report exceedances, while other stations reported more than 10 exceedances.

The spatial pattern of exceedances observed in summer 2002 at background stations (interpolated field), follows the pattern observed in most previous summer seasons. The highest number of exceedances is observed in southern France, the Po Valley and central Italy.

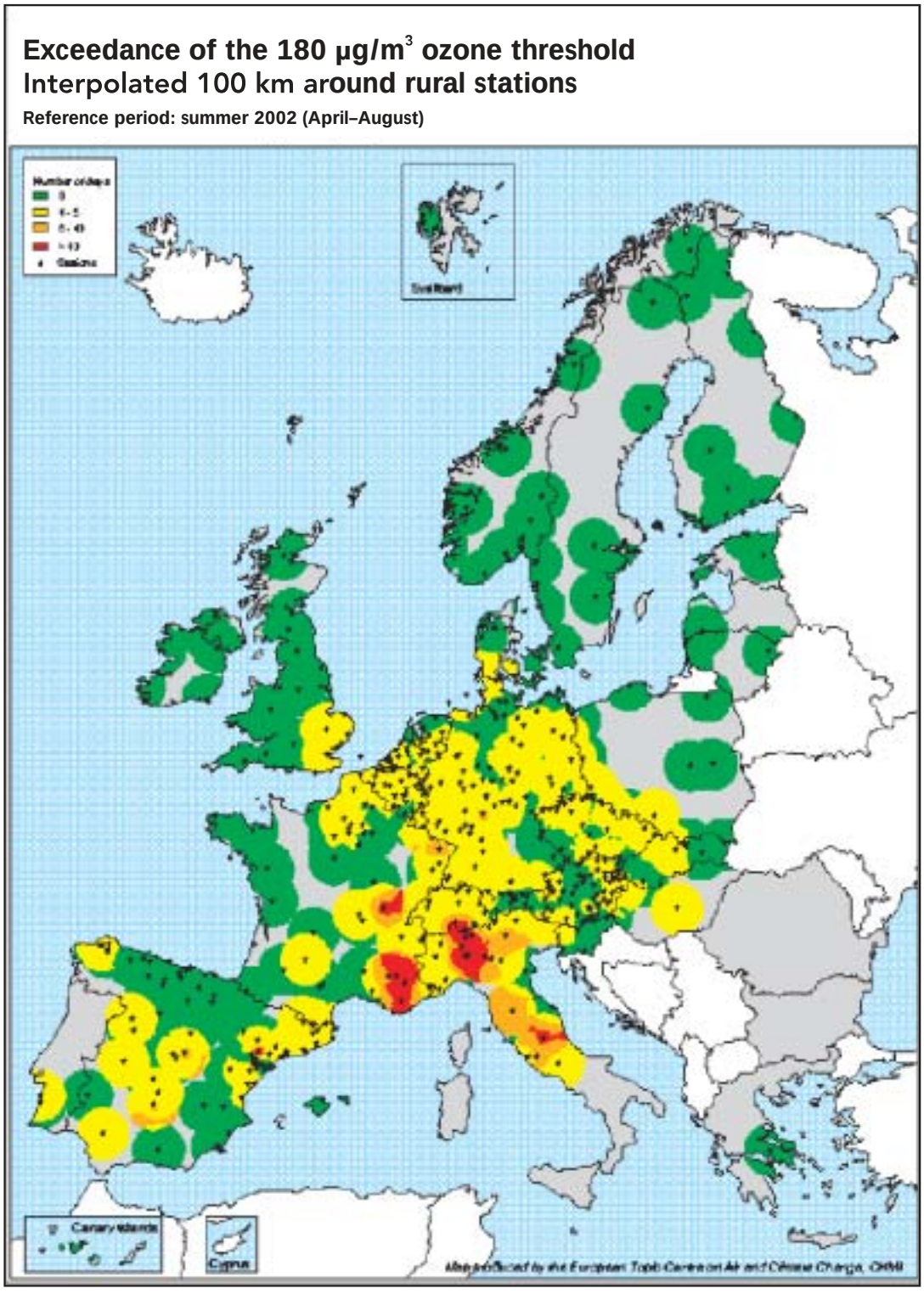
(2) Exceedances reported from stations of unspecified type are also plotted in this map.
(3) Stations assumed to be operational but for which no data were transmitted are drawn in the maps with 'zero exceedances observed'. For most countries/stations this will be true, but this cannot be guaranteed because it is possible that exceedances were observed but not yet communicated. As a result, the number of stations/area with no exceedances observed could be slightly over-estimated.

Map 3.1.	**Number of exceedances of the threshold value for public information (1h ozone concentration > 180 µg/m³) observed at urban/street stations and stations of unspecified type in the EU and other countries**



Number of exceedances of the threshold value for public information (1h ozone concentration > 180 µg/m³) observed at background station, interpolated using inverse distance weighting, cut-off distance of 100 km

Map 3.2.



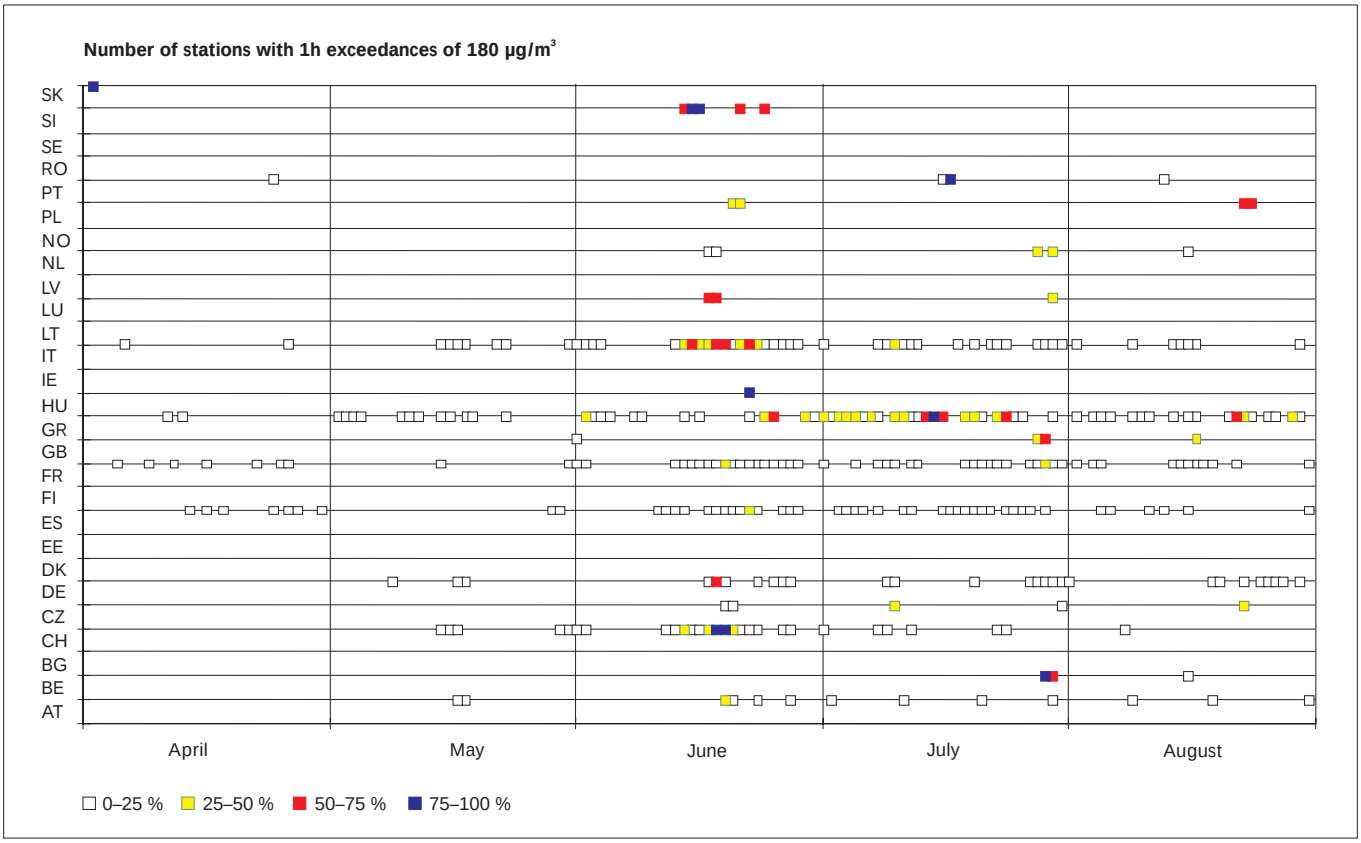
3.3. Main ozone episodes

Ozone formation and destruction is dependent on emissions, concentrations and ratios of precursors (mainly VOC, NO_X and CO), and on the amount and intensity of sunlight. Important in this respect is the role of nitrogen oxide emissions. In urban areas, ozone concentrations may be lower than the rural ('background') concentrations due to chemical scavenging by locally emitted nitrogen oxide.

Episodes, periods with elevated ozone levels, mainly occur during periods of warm sunny weather. In Mediterranean countries, with prolonged spells of hot and sunny weather during the summer, ozone can quickly be formed and high concentrations can occur on many days and in the vicinity of urban centres. In northern Europe, the build-up of ozone is slower due to the more moderate weather conditions. Here, the highest levels are usually found downwind of cities. Figure 3.6 presents a graphical representation of the percentage of stations that reported exceedances of the threshold value for population information (180 µg/m³ for hourly values) during the 2002 summer season ([4]).

In southern European countries exceedances are observed already in April and early May. In June, July and August exceedances are observed all over Europe except in the most northern countries. As mentioned before, weather conditions are important for the occurrence or non-occurrence of ozone episodes. The geographically most extended episode with the highest ozone concentrations occurred in the third week of June (17–22 June). An overview of the sites where exceedances were observed during period 17–19 and 22 June is presented in Map 3.3. There was a strong high air pressure area above Europe and the warm tropical air flew to the Europe from the south. Warm airflow was gradually changed by a low air pressure area coming from the Atlantic Ocean during the following days. The maximum daily temperatures are shown as a background layer of Map 3.3.

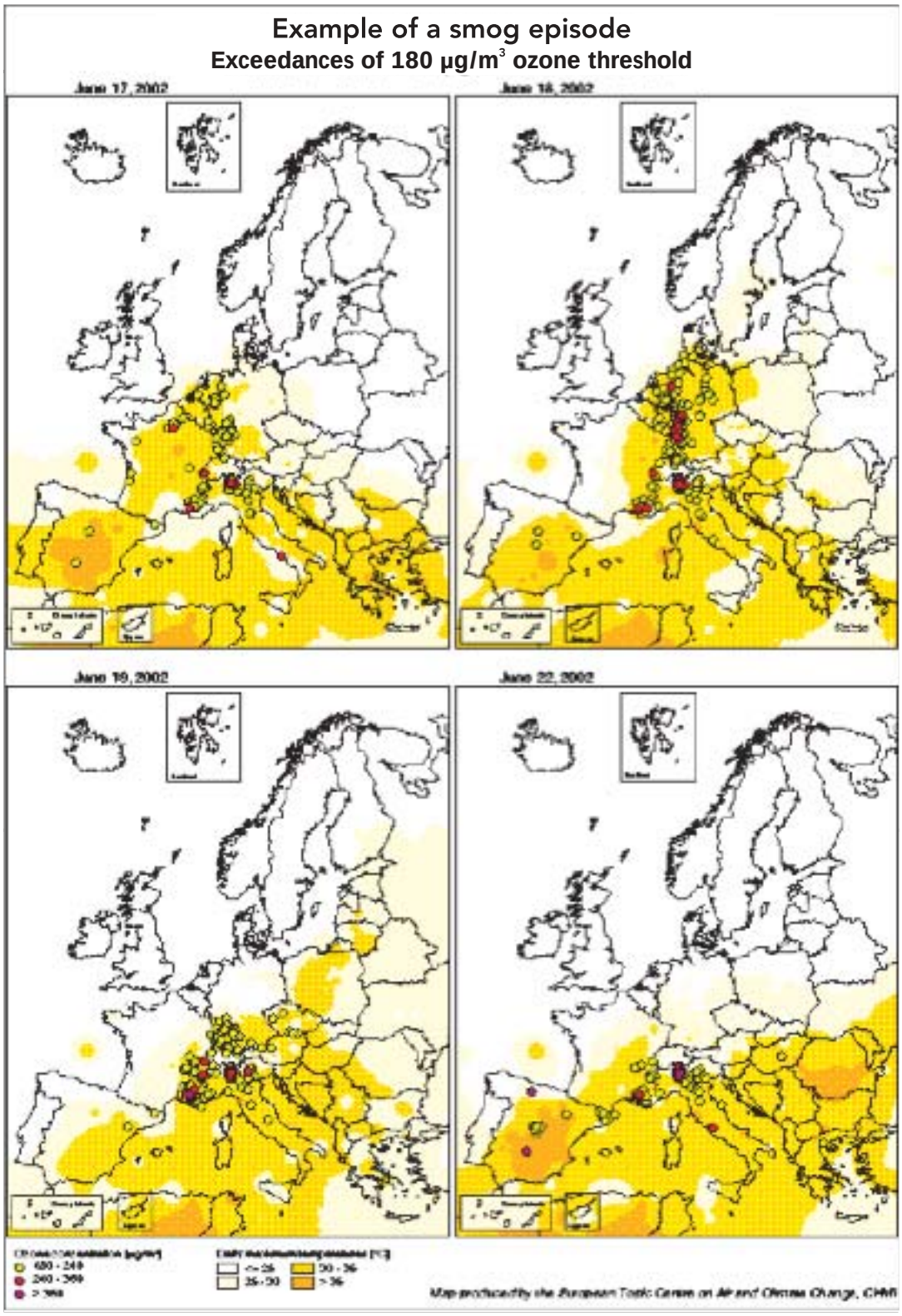
Figure 3.5. **Qualitative overview of exceedances of the 180 µg/m³ population information threshold value for ozone during the period April–August 2002**



The symbols represent the percentage of stations, which observed at least one exceedance of the threshold during a particular day.

(4) A table indicating per day and per country the number of stations where the information threshold has been exceeded is available upon request.

Example of a smog episode: stations which reported an hourly ozone concentration in excess of 180 µg/m³, 17–19 and 22 June 2002 (all station types) Map 3.3.



3.4. Comparison with previous years

In a recent study the data submitted under the ozone directive up to the annual period 1999 was re-analysed (de Leeuw, 2000). Applying the methodology described by de Leeuw on an extended data set covering the years 1994–2000, the data have been analysed for a possible trend in statistical parameters (50 and 98 percentiles) and the number and severity of exceedances of threshold values defined in the current ozone directive.

Time series are rather short but the data suggests that there might be a small increasing trend in the 50 percentile values. In contrast, the peak ozone concentrations, expressed as 98 percentiles or as number of exceedance days tend to decrease in the period 1994–2000 (Table 4.1.). However, these conclusions must be interpreted carefully since on the short time scales considered here meteorological interannual variations might play an important role. The decrease in peak ozone concentrations is most likely caused by the decrease in European ozone precursor emissions since 1990. Possible explanations for the increasing 50 percentile values are an increase in tropospheric ozone background values caused by a worldwide increase in CH_4, CO and NO_x emissions and a reduced ozone titration by reduced NO_x emissions at the local scale. However, the data submitted to date under the ozone directive is insufficient to provide firm conclusions on this point.

Exceedances observed in the EU during the 2002 summer period were compared to exceedances observed during 1995–2000. In Figure 4.1, a comparison of the average exceedance duration, the average occurrence and the average maximum concentrations during these years is presented. Note that for the period 1995–2000, information is available for 12 months per year whereas for 2001–02 data is available for only five months. However, it is not possible to draw any conclusion on a significant trend, duration and severity of exceedances. Average exceedance duration and the average occurrence detected in summer 2002 are lower whereas the average maximum concentration is higher in comparison with summer 2001.

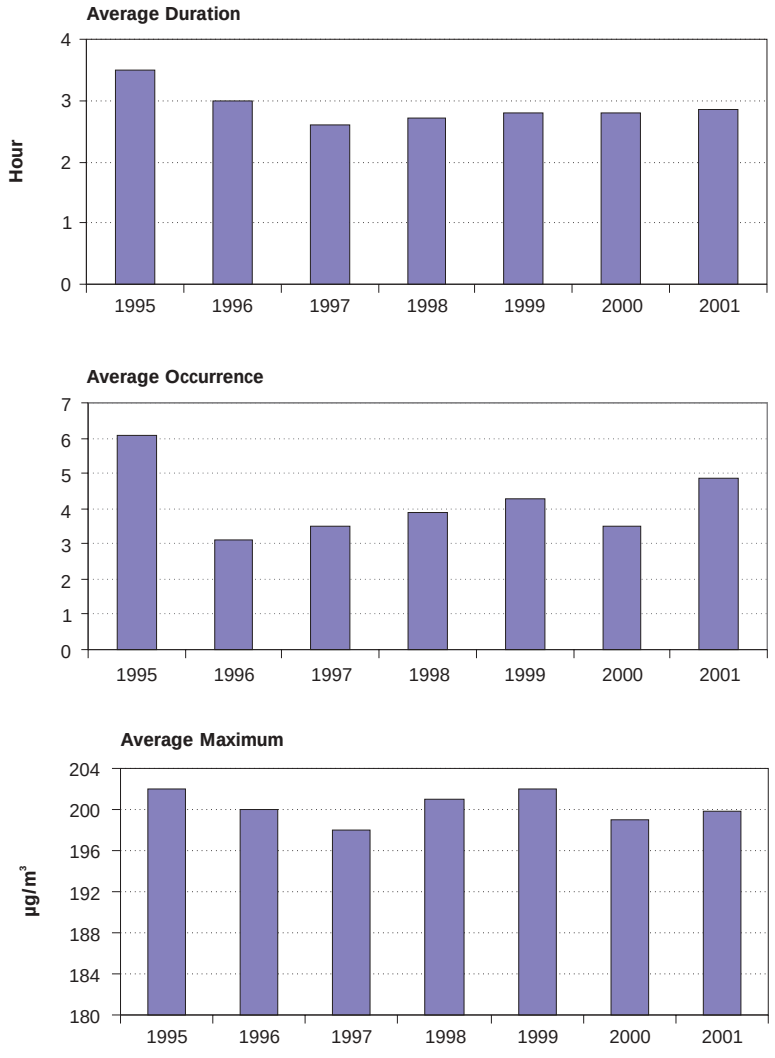
The year-to-year fluctuations reflect to a large extent the character of the European summer. Another factor concealing a possible trend is the variability in the underlying ozone monitoring network. Over the years the number of reporting stations and hence the territorial coverage has increased strongly. This increase is not consistent over all countries and a bias might be introduced here. In some years information from one or two large Member States is missing. Moreover, the ratio between the number of stations located in urban and rural areas has changed over the year; within a country, the configuration of monitoring network may show large variation in number and location of stations. Detection of possible ozone trends calls therefore for a more in-depth analysis using the information on a station-by-station basis.

Table 3.4. **Summary of trend evaluation of 50 and 98 percentiles of hourly average ozone concentrations and of number of exceedance days of the threshold levels of 180 µg/m³ (1h), 110 µg/m³ (8h) and 65 µg/m³ (24h); monitoring period 1994–2000**

	50 P	98 P	180 µg/m³ (1h)	110 µg/m³ (8h)	65 µg/m³ (24h)
Number of stations reporting over at least one year	1 585	1 787	1 868	1 804	1 745
Number of stations with five to seven monitoring years	644	644	664	586	593
Number of stations with significant upward trend	127	13	6	15	53
Number of stations with significant downward trend	11	164	131	131	83
Number of stations in compliance with threshold during the period 1994–2000			87	3	0

Average duration in hours of exceedances (top), average number of occurrences of exceedances at stations (middle) which reported at least one exceedance and average maximum ozone concentration (µg/m³) observed during exceedances (bottom); EU-15 stations only

Figure 3.6.



4. Conclusions

This report presents a first evaluation of the reported exceedances of the threshold values for information and warning of the public during summer 2002. Information is partly based on non-validated monitoring data and hence the conclusions drawn are preliminary.

- Information on air pollution by ozone has been received from all EU Member States; for Luxembourg information for one month is missing. In addition, information has been received from 12 non-EU countries. In total 1 718 monitoring stations were considered to be in operation during this summer in the reporting countries.

- The threshold value for warning the public (1h > 360 μg/m^3) was exceeded in June in France (one station), in Italy (one station) and Spain (three stations). No further exceedances of the warning threshold have been reported for the European territory for the reporting period April–August 2002.

- The threshold for information of the public (180 μg/m^3 1-h average) was exceeded in 17 out of the 27 countries reporting. One third of the stations (568 stations) reported one or more exceedance. In total, 1 882 exceedances (on average 1.1 exceedance per operational station or 3.3 exceedance per station where at least one exceedance is observed) have been reported. During exceedances, the average maximum hourly concentration was 201 μg/m^3. The most widespread ozone episode occurred on 17–22 June 2002.

- During summer 2002 the ozone concentrations were slightly higher in comparison to the situation in summer 2001. A comparison of 2002 data with the data submitted for previous summer periods does not reveal any significant trend in occurrence, duration and severity of exceedance events.

The changes in reporting networks from year to year and the highly aggregated level of the submitted data preclude further conclusions on trends. However, a more in-depth analysis of ozone data submitted under the ozone directive since 1994 suggests a decreasing trend in peak ozone concentrations (a.o. the number and severity of exceedances of the 180 μg/m^3 threshold value) but an increasing trend in median concentrations. These findings suggest that Europe-wide reductions of ozone precursor emissions in 1994–2000 led to a reduction in high ozone concentrations and to a reduced short-term exposure to high ozone values. However, median concentrations increased and have led to increased long-term exposure of the population to ozone.

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