EEA Technical report | No 1/2012

Air pollution by ozone across Europe during summer 2011

Overview of exceedances of EC ozone threshold values for April–September 2011

ISSN 1725-2237

European Environment Agency

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Design: EEA
Layout: EEA/Henriette Nilsson
Cover photo: EEA

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Luxembourg: Publications Office of the European Union, 2012

ISBN 978-92-9213-276-7
ISSN 1725-2237
doi:10.2800/95368

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Contents

Acknowledgements 6

Executive summary 7

1 Introduction 11

2 Ozone air pollution in summer 2011 and comparison with recent years 12

2.1 Summary of reported hourly exceedances 12

2.2 Overview of exceedances of the long-term objective, target value threshold and '2009 target value' for the protection of human health 14

2.3 Geographical distribution of ozone air pollution and estimation of affected population 21

2.4 Main ozone episode 24

3 Evolution and trends of summer ozone air pollution in Europe 28

4 Ozone-related policies 33

5 References 34

Annex 1 Legal requirements on data provision 37

Annex 2 Data reporting over summer 2011 38

Annex 3 Near real-time ozone data exchange 41

Acknowledgements

This report was prepared by the European Environment Agency (EEA), the European Topic Centre for Air Pollution and Climate Change Mitigation (ETC/ACM) and the Czech Hydrometeorological Institute (CHMI).

Libor Černikovský of CHMI Ostrava was the main author. Blanka Krejčí of CHMI Ostrava contributed the chapter entitled 'Evolution and trends of summer ozone air pollution in Europe'; Jaume Targa of 4sfera Innova contributed the annex entitled 'Near real-time ozone data exchange'; Pavel Kurfürst of CHMI Prague and Vladimíra Volná of CHMI Ostrava contributed the maps.

The EEA project managers were Peder Gabrielsen and Alberto González Ortiz, and the ETC/ACM task manager was Libor Černikovský.

The authors appreciate the advice and comments of Frank de Leeuw of the ETC/ACM and the Netherlands National Institute for Public Health and the Environment, Bilthoven (RIVM).

Finally, the EEA gratefully acknowledges the efforts made by national focal points and national reference centres in collecting data of the requested quality and reporting these on time.

Executive summary

Despite efforts to mitigate ozone pollution, the number of exceedances of EU ground-level ozone concentration standards for protecting human health (Directive 2008/50/EC) remained at serious levels during summer 2011 ([1]).

In the summer of 2011, the threshold of 120 micrograms per cubic meter air (µg/m^3) maximum daily eight-hour mean was exceeded on more than 25 days in a significant part of Europe. This is the threshold that will be used to assess whether countries meet the target value (TV) for protecting human health ([2]).

Exceedances of the target value threshold occurred in 17 EU Member States (Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia and Spain) and in five other countries (Croatia, Liechtenstein, the former Yugoslav Republic of Macedonia, Serbia and Switzerland). As in previous years, the most widespread concentrations occurred in the Mediterranean area.

In view of the maintained high surface ozone levels in Europe in the last four years, it seems likely that many EU Member States will face a significant challenge in meeting the TV as of 2010.

As in previous years, the long-term objective (LTO) for the protection of human health (maximum daily eight-hour mean concentration of 120 µg/m^3) was exceeded in all EU Member States.

The information threshold (a one-hour average ozone concentration of 180 µg/m^3) was exceeded at approximately 18 % of all operational stations — the lowest share since 1997.

The alert threshold (a one-hour average ozone concentration of 240 µg/m^3) was exceeded 41 times.

Europe-wide, summer 2011 was characterised by short regional ozone episodes of only two to three days followed by days with none or only a few exceedances; there were no widespread multi-day episodes.

In the summer of 2011, the occurrence of the exceedances of the information threshold and the LTO for the protection of human health was the lowest since comprehensive Europe-wide data reporting commenced in 1997. This was principally due to unusually low temperatures and increased rainfall during the summer months.

Independent of the episodic nature of ozone pollution and the strong influence of meteorological conditions, emissions of ozone precursor gases are sustaining a baseline number of exceedances of the information and alert thresholds, the TV threshold and the LTO. Decreased anthropogenic emissions of some ozone precursors (nitrogen oxides (NO_x), carbon monoxide (CO) and some volatile organic compounds (VOCs)) in the past two decades did not manifest in significant reductions in the number of such exceedances. The ozone pollution problem therefore requires further mitigation efforts.

([1]) Ozone levels in summer 2011 were compared with the summer ozone concentrations from 1997 to 2010. Summer ozone concentrations from 1997 to 2009 are validated and stored in the EEA's public air quality database (AirBase). Summer ozone concentrations for 2010 and 2011 are provisional at the time of preparation of this report. Differences between provisional and validated summer ozone data for the same year tend to be minimal.

([2]) Directive 2008/50/EC on ambient air quality and cleaner air for Europe sets out the 'target value for the protection of human health'. Specifically, the maximum daily eight-hour mean concentration of ozone should not, as of 2010, exceed 120 µg/m^3 on more than 25 days per calendar year, averaged over three years. It further specifies that the TV will first be calculated using validated data from 2010 and the following years. As such, it will not be possible to fully assess exceedance of the TV until data for 2010, 2011 and 2012 have been compiled and validated. References in this report to the 'target value threshold' pertain only to provisional ozone concentrations in 2011 (i.e. not more than 25 days with an eight-hour average exceeding 120 µg/m^3), rather than to the three-year validated data average used in assessing exceedance of the TV.

Ozone is a 'secondary' pollutant formed in the lower part of the atmosphere, the troposphere, from complex photochemical reactions following emissions of precursor gases such as nitrogen oxides (NO_X) and VOCs (Royal Society, 2008; US EPA, 2010). Ozone, one of the air pollutants giving rise to the greatest concern in Europe, is a powerful oxidising agent.

Ozone concentrations in Europe are also influenced by emissions in other northern hemispheric countries and by poorly regulated sectors such as international shipping and aviation. Thus, ozone pollution can no longer be considered a local air quality (AQ) issue — it is a hemispheric and global problem.

Ozone levels become particularly high in regions where considerable ozone precursor emissions combine with stagnant meteorological conditions during the summer, when high insolation and temperatures occur. In 2011, levels continued to exceed the long-term objective (LTO) established in EU legislation to protect human health.

This report provides an evaluation of ground-level ozone pollution in Europe for April–September 2011, based on information submitted to the European Commission under Article 10(2)(a) in Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air (EC, 2002), replaced by Directive 2008/50/EC (EC, 2008). Since EU Members States have not yet finally validated the submitted data, the conclusions drawn in this report should be considered as preliminary.

Directive 2002/3/EC requires EU Member States to report exceedances of the information threshold and alert threshold values (set out in Table 1.1) to the European Commission before the end of the month following an occurrence. Furthermore, by 31 October, EU Member States must provide additional information for the summer period. This should include data on exceedances of the LTO for the protection of human health (a maximum daily eight-hour average concentration of 120 $\mu g/m^3$).

In order to make information available as promptly as possible, an overview of the monthly data provided by the countries is presented by the ETC/ACM on the EEA website (EEA, 2012c). In addition, EEA's near real-time ozone website (EEA, 2012a) shows provisional ground-level ozone levels across Europe and provides up-to-date information (see Annex 3).

Overview of ozone air pollution in summer 2011

All 27 EU Member States provided information to the European Commission on observed one-hour and LTO exceedances. In addition, 12 other countries (Albania, Bosnia and Herzegovina, Croatia, Iceland, Kosovo under UNSC Resolution 1244/99, Liechtenstein, Montenegro, Norway, Serbia, Switzerland, the former Yugoslav Republic of Macedonia and Turkey) supplied information to the EEA upon request.

Main findings

In total, 2 186 ozone-monitoring sites, 2 122 of which were located in EU Member States, reported data. The following preliminary conclusions can be drawn from the April-to-September period of 2011.

Exceedance of the information threshold

- The percentage of ozone-monitoring stations reporting exceedances of the information threshold (a one-hour ozone concentration of 180 $\mu g/m^3$) is the lowest since comprehensive Europe-wide data reporting commenced in 1997. Ozone concentrations higher than the information threshold were reported from monitoring sites in 16 EU Member States and four non-member countries. The information threshold was exceeded at approximately 18 % of all operational stations — the lowest share since 1997.

- The spatial extent of the exceedances observed in the summer of 2011 is smaller than that of the summer of 2010, and similar to the situation during the summers of 2008 and 2009. No exceedances were reported from the Baltic states, Iceland, Ireland, Scandinavia (excluding Denmark) and the United Kingdom in summer 2011. Only northern Italy and several more isolated locations reported a substantial number of exceedances.

Exceedance of the alert threshold

- Ozone concentrations higher than the alert threshold (a one-hour ozone concentration of 240 $\mu g/m^3$) were reported on 41 occasions. They occurred in only six EU Member States (Bulgaria, France, Greece, Italy, Portugal and Spain) and in Switzerland and Turkey.

Exceedances of the alert threshold were observed at 28 locations, mainly in northern Italy and at other locations where the information threshold was most often exceeded. Most stations (22 in total, i.e. 79 %) reporting an exceedance of the alert threshold did so on just one day; only one station (Cebeci in Ankara, Turkey) reported the maximum number of seven days.

Maximum concentrations

- Three concentrations higher than or equal to 300 µg/m^3 were reported: AMS Rakovsky-Dimitrovgrad in Bulgaria, at 512 µg/m^3 on 9 June; Campo de Fútbol, Puertollano in Spain, at 301 µg/m^3 on 2 July; and Erba — Via Battisti, in the Lombardy region in Italy, at 300 µg/m^3 on 28 June.

Exceedance of the long-term objective (LTO) for the protection of human health

- As in all previous years, exceedances of the LTO for the protection of human health, i.e. maximum daily eight-hour average concentrations higher than 120 µg/m^3, were observed in every EU Member State and in most of the other reporting countries, in every summer month and at most of the stations during summer 2011. Approximately 84 % of all stations reported one or more exceedances.

- The number of exceedance days per country ranged from zero to 182 (in Italy) out of a maximum of 183 days. More than 150 exceedance days were reported by Greece, Italy and Spain . On every single day during summer 2011, at least one of the 2 186 operational stations in Europe reported an exceedance of the LTO. On average, those stations observing at least one LTO exceedance reported a total of 22 days of exceedance. The maximum number of 132 exceedance days was observed at the Fontechiari station in the Lazio region in Italy.

Exceedance of the target value (TV) for the protection of human health

- The TV is exceeded when the LTO (120 µg/m^3) has been exceeded at a particular station more than 25 times per calendar year, averaged over 3 years. The year 2010 was the first in a rolling sequence of three years which will be used in determining whether countries are meeting the TV requirement. As the first legally binding TV will not be calculated before 2012, the report lists the cases where LTO was exceeded more than 25 times during summer 2011 alone. Nevertheless, it also provides an estimate of exceedances of the 2009 TV (that is, only for the summer values in years 2009-2011, to be known as the '2009 target value') in order to get a first approximation of what might be expected in coming years.

- During summer 2011, more than 25 LTO exceedances occurred at stations in 17 EU Member States (Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia and Spain) and in five other countries (Croatia, Liechtenstein, the former Yugoslav Republic of Macedonia, Serbia and Switzerland).

- More than 25 LTO exceedances occurred at 24 % of all monitoring stations providing reports. This corresponded to approximately 20 % of the area assessed, affecting approximately 14 % of the total population ([3]).

- During the six months of summer, exceedances of the 2009 target value have been found for 17 EU Member States (Austria, Bulgaria, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and three of the other countries which fulfilled the criteria established for this calculation exercise (Croatia, the former Yugoslav Republic of Macedonia and Switzerland).

([3]) The figures for percentages of area and population affected are not exactly comparable with those published in the reports for the summers until 2009 because a different methodology for preparing the spatial distribution maps was applied.

- Exceedances of the 2009 TV were calculated in almost 26 % of the stations fulfilling the criteria for this exercise.

Main ozone episodes ([4])

- Summer 2011 was characterised by only short regional ozone episodes of two to three days followed by days with few or no exceedances; there were no widespread multi-day episodes. Typical episodes usually contained approximately 2 % to 8 % of the total number of exceedances of the information threshold experienced during the summer.

- The largest episode in terms of length occurred between 19 and 26 August. This accounted for approximately 23 % of the total number of exceedances of the information threshold, 17 % of the exceedances of the alert threshold, and about 8 % of the exceedances of the LTO.

- The largest episode in terms of area occurred in a single day of 28 June. This accounted for approximately 12 % of the total number of exceedances of the information threshold, 24 % of the exceedances of the alert threshold and about 2 % of the exceedances of the LTO.

Comparison with previous years

Differences in the distribution of ozone precursor emission sources, the chemical composition of the air, and climatic conditions along the north-south and east-west gradients in Europe result in considerable regional differences in summer ozone concentrations. At the current level of precursor emissions, the year-to-year differences in the occurrence of ozone threshold exceedances are induced substantially by meteorological variations.

The highest number of exceedances occurs frequently in the Mediterranean region, the lowest in northern Europe. The number of occurrences in southern Europe was lower between 1999 and 2002 than in the extreme summer of 2003, which saw a very large number of occurrences. This was also the case in more northern parts of Europe. Ozone levels decreased in 2004 and 2005 to previous levels, but in 2006 there was a further increase, not only in southern Europe. According to several indicators, ozone levels during the summers of 2007, 2008 and 2009 rank among the lowest in the past decade. After a slight increase in the number of exceedances in 2010, there was a decline in 2011. In the summer of 2011, the occurrence of the exceedances of the information threshold and the LTO for the protection of human health was the lowest since comprehensive Europe-wide data reporting commenced in 1997. This was principally due to unusually low temperatures and increased rainfall during the summer months.

Disclaimer

The preliminary analysis contains summary information based on data delivered before 20 December 2011.

The information describing the situation during summer 2011 is based on non-validated monitoring data and should therefore be considered preliminary.

([4]) An 'ozone episode' is defined as follows: 'A period of usually a few days up to 2–3 weeks with high ozone concentrations, characterised by daily exceedances of the thresholds set to protect human health. Ozone episodes occur under specific meteorological conditions characterised by large stagnant areas of high pressure. Since the formation of ozone requires sunlight, ozone episodes mainly occur during summer' (EEA, 2010b).

1 Introduction

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

In view of the harmful effects of photochemical pollution of the lower levels of the atmosphere, the European Council adopted Directive 92/72/EEC of 21 September 1992 on air pollution by ozone. That directive was succeeded by Directive 2002/3/EC. Directive 2002/3/EC is also known as the third daughter directive to the Air Quality Framework Directive (Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management). It set LTOs and TVs, and an alert threshold and information threshold for ozone (Table 1.1) for the purpose of avoiding, preventing or reducing the harmful effects on human health and environment. It provided common methods and criteria for assessing ozone concentrations in ambient air, and ensured that adequate information was made available to the public on the basis of this assessment. It also promoted cooperation between Member States in reducing ozone levels.

On 14 June 2008, the Directive 2008/50/EC (EC, 2008) on ambient air quality and cleaner air for Europe came into force. The provisions of earlier AQ directives (Directive 96/62/EC; Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air; Directive 2000/69/EC of the European Parliament and of the Council of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air; and Directive 2002/3/EC) remained in force until 11 June 2010, when they were repealed by Directive 2008/50/EC ([5]). The new directive does not change the levels of the existing TVs, LTOs, alert threshold or information threshold for ozone.

This report gives an overview of reported ground-level ozone concentrations regarding exceedances of regulated objectives between April and September 2011, and sets out their evolution and trends from 1997. The EEA has prepared similar overviews since 1997 ([6]).

The legal requirements for reporting provisional data on exceedances of the LTO and the target and threshold values for ozone during the summer, which form the basis of this report, are summarised in Annex 1.

Table 1.1 Ozone threshold values, long-term objective and target value for the protection of human health, as set out in Directives 2002/3/EC and 2008/50/EC

Objective	Level (µg/m³)	Averaging time
Information threshold (IT)	180	One-hour
Alert threshold (AT)	240	One-hour
Long-term objective (LTO)	120	8-hour average, maximum daily
Target value (TV)	120 (*)	8-hour average, maximum daily

Note: (*) Not to be exceeded on more than 25 days per calendar year, averaged over 3 years; 2010 will be the first year for which the data are used in calculating compliance over the following 3 years.

([5]) It should be noted, however, that the 'transmission of information and reports' of Article 10 of Directive 2002/3/EC has remained in force. This article addresses the reporting requirements concerning ambient ozone. The article will be repealed two years after entry into force of the upcoming implementing measures of Directive 2008/50/EC.

([6]) Previous reports are available from the EEA website (EEA, 2012d).

2 Ozone air pollution in summer 2011 and comparison with recent years

This chapter provides detailed country-by-country, month-by-month and day-by-day tabular, graphic and geographical information on threshold exceedances during summer 2011. The largest threshold exceedance episode is also described. Details on reported data and ozone-monitoring networks are provided in Annex 2.

2.1 Summary of reported hourly exceedances

Reports and information on ozone during summer 2011, as required by EU legislation, were submitted by all 27 EU Member States and 12 other European countries. Ozone concentrations in excess of the information threshold were reported from monitoring sites in 16 EU Member States and 4 other countries (Table 2.1).

The percentage of stations that recorded exceedances of the information threshold is the lowest since comprehensive Europe-wide data reporting commenced in 1997. No exceedances were observed in northern Europe, only several days with exceedances occurred in central Europe, and the highest percentage of stations with more than two exceedances of the information threshold was observed in Greece, Italy, Portugal, southern France, Spain and Turkey.

Table 2.2, Figure 2.1 and Figure 2.6 present the distribution of hourly exceedances during summer 2011. The highest number of exceedances occurred during August and June, which accounted for approximately 32 % and 25 % respectively of all observed information threshold exceedances, and about 24 % and 37 % respectively of alert threshold exceedances ([7]). The lowest share of exceedances of the information threshold for July since 2003 relates to the meteorological conditions, i.e. to unusually low temperatures and more rain (Figure 2.5). For the summer as a whole, the occurrence of information threshold exceedances was the lowest on record; the occurrence of alert threshold is among the lowest too. The number of days on which the information threshold and alert threshold were exceeded is also among the lowest (Table 3.1).

Figure 2.2 presents the frequency distribution of hourly ozone concentrations that exceeded the information threshold. For each country that submitted data, the graph uses box plots to indicate the minimum and maximum exceedance values and the 25^{th} and 75^{th} percentile values.

In Europe as a whole, 25 % of exceedances were below 184 μg/m^3 (compared to 207 μg/m^3 in 2003; 185 μg/m^3 in 2004, 2008, 2009 and 2010; and 186 μg/m^3 in 2005, 2006 and 2007). The 75th percentile values were all below 200 μg/m^3 — the lowest since 2003 (compared to 305 μg/m^3 in 2003; 203 μg/m^3 in 2004 and 2010; 206 μg/m^3 in 2005, 2006, 2007 and 2008; and 202 μg/m^3 in 2009).

([7]) In this report, one-hour exceedances are counted on a daily basis, i.e. each day on which a station records ozone levels above the information or alert threshold for at least one hour is counted as one exceedance.

Table 2.1 Overview of exceedances of one-hour thresholds during summer 2011, by country ([a])

Country	Number of stations ([b])	Stations with exceedances ([c])					Number of days with exceedances ([d])		Maximum observed one-hour concentration (µg/m³)	Occurrence of exceedances ([e])				Average duration of exceedances (hour)	
		(number)		(%)		(%)									
Austria	112	17	0	15	–	–	7	–	213	0.3	1.7	–	–	1.8	–
Belgium	41	13	0	32	–	–	1	–	220	0.3	1	–	–	2.6	–
Bulgaria	18	3	3	17	17	100	6	2	512	0.6	3.3	0.2	1	2.8	2
Cyprus	2	0	0	–	–	–	–	–	154	–	–	–	–	–	–
Czech Republic	61	1	0	2	–	–	1	–	181	0	1	–	–	1	–
Denmark	9	0	0	–	–	–	–	–	169	–	–	–	–	–	–
Estonia	9	0	0	–	–	–	–	–	175	–	–	–	–	–	–
Finland	18	0	0	–	–	–	–	–	178	–	–	–	–	–	–
France	417	79	5	19	1	6	34	2	282	0.4	1.9	0	1.2	2	1.3
Germany	252	16	0	6	–	–	9	–	226	0.1	1.2	–	–	1.5	–
Greece	22	13	3	59	14	23	42	3	270	4	6.8	0.2	1.3	1.8	1.8
Hungary	17	2	0	12	–	–	1	–	187	0.1	1	–	–	1	–
Ireland	12	0	0	–	–	–	–	–	149	–	–	–	–	–	–
Italy	343	149	11	43	3	7	81	6	300	2.2	5	0	1.2	2.9	3.1
Latvia	8	0	0	–	–	–	–	–	161	–	–	–	–	–	–
Lithuania	12	0	0	–	–	–	–	–	162	–	–	–	–	–	–
Luxembourg	6	2	0	33	–	–	1	–	190	0.3	1	–	–	1	–
Malta	5	1	0	20	–	–	4	–	200	0.8	4	–	–	3.5	–
Netherlands	39	25	0	64	–	–	1	–	229	0.6	1	–	–	2.7	–
Poland	67	0	0	–	–	–	–	–	177	–	–	–	–	–	–
Portugal	38	14	1	37	3	7	16	1	243	0.8	2.1	0	1	2.1	1
Romania	82	0	0	–	–	–	–	–	164	–	–	–	–	–	–
Slovakia	15	1	0	7	–	–	2	–	202	0.1	2	–	–	1.5	–
Slovenia	12	3	0	25	–	–	3	–	199	0.3	1	–	–	2.3	–
Spain	411	34	2	8	0	6	32	4	301	0.2	2.1	0	2.5	1.7	1
Sweden	12	0	0	–	–	–	–	–	162	–	–	–	–	–	–
United Kingdom	82	0	0	–	–	–	–	–	180	–	–	–	–	–	–
EU area	**2 122**	**373**	**25**	**18**	**1**	**7**	**128**	**18**	**512**	**0.6**	**3.2**	**0**	**1.3**	**2.5**	**2.1**
Albania	3	0	0	–	–	–	–	–	< 180	–	–	–	–	–	–
Bosnia and Herzegovina	1	0	0	–	–	–	–	–	113	–	–	–	–	–	–
Croatia	2	0	0	–	–	–	–	–	167	–	–	–	–	–	–
former Yugoslav Republic of Macedonia	11	1	0	9	–	–	10	–	206	0.9	10	–	–	4.7	–
Iceland	1	0	0	–	–	–	–	–	121	–	–	–	–	–	–
Kosovo under UNSC Resolution 1244/99	1	0	0	–	–	–	–	–	175	–	–	–	–	–	–
Liechtenstein	1	0	0	–	–	–	–	–	169	–	–	–	–	–	–
Montenegro	2	0	0	–	–	–	–	–	169	–	–	–	–	–	–
Norway	7	0	0	–	–	–	–	–	168	–	–	–	–	–	–
Serbia	5	1	0	20	–	–	3	–	216	0.6	3	–	–	2	–
Switzerland	27	9	2	33	7	22	13	1	282	0.9	2.7	0.1	1	2.7	3.5
Turkey	3	3	1	100	33	33	20	7	278	7	7	2.3	7	3.9	2.4
Whole area	**2 186**	**387**	**28**	**18**	**1**	**7**	**134**	**25**	**512**	**0.6**	**3.2**	**0**	**1.5**	**2.6**	**2.2**

Notes:

([a]) Unless otherwise stated, all tables and graphs have been compiled using data submitted by countries to EEA.
White columns refer to exceedances of the information threshold, grey to exceedances of the alert threshold.
'–' indicates 'not applicable'.
Data are provisional.

([b]) Total number of stations measuring ozone levels.

([c]) 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.

([d]) The number of calendar days on which at least one exceedance of thresholds was observed.

([e]) Occurrence of exceedance is calculated as the average number of exceedances observed per station in a country.
Left column: averaged over all implemented stations (total number of stations).
Right column: averaged over all stations that reported at least one exceedance.

Table 2.2 Overview of exceedances of one-hour thresholds in Europe during summer 2011, by month

Month	Stations with exceedances ([b])					Number of days with exceedances ([c])		Maximum observed one-hour concentration (μg/m³)	Occurrence of exceedances ([d])				Average duration of exceedances (hour)	
	(number)		(%)		(%)									
April	24	1	1	0	4	14	1	276	0	0.1	0	0	1.7	1
May	134	0	6	–	–	23	–	224	0.1	0.6	–	–	2.7	–
June	213	14	10	1	7	23	6	512	0.1	0.8	0	0.5	3.1	2.9
July	109	10	5	0	9	30	12	301	0.1	0.5	0	0.5	2.3	1.9
August	174	9	8	0	5	27	6	293	0.2	1	0	0.4	2.3	1.9
September	37	0	2	–	–	17	–	227	0	0.2	–	–	1.7	–

Note: Data are provisional.

([b])–([d]): see footnotes to Table 2.1.

2.2 Overview of exceedances of the long-term objective, target value threshold and '2009 target value' for the protection of human health

As in all previous years, at least one maximum daily eight-hour average concentration of ozone over 120 μg/m³ (the LTO) was observed in every EU Member State and in most of the other countries, in every summer month and most of the stations during summer 2011 (Table 2.3).

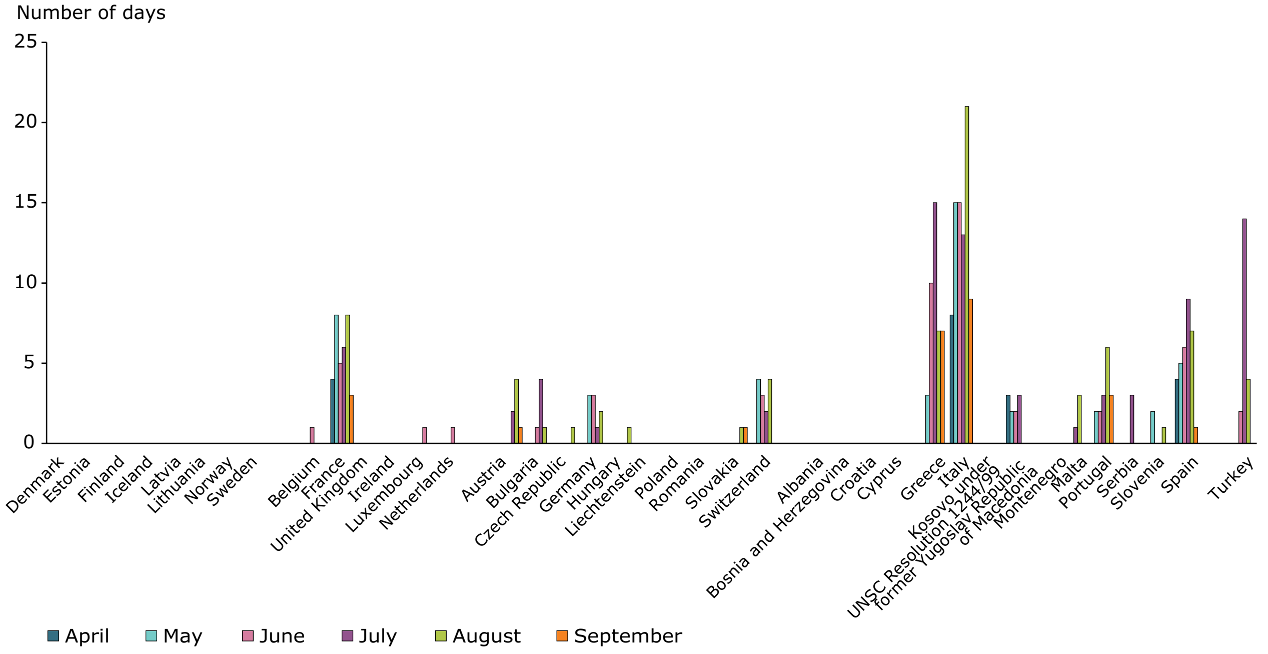
Table 2.4 presents the LTO exceedances on a monthly basis, and Figure 2.6 shows them on a day-by-day and country basis. Approximately 84 % of all stations reported at least one exceedance of the LTO. There was not a single day without a LTO exceedance in Europe in summer 2011.

The highest number of exceedances occurred during May (26 % of all observed exceedances), the lowest in September (8 %). The figures for May and April are exceptionally high compared with most of the previous years (21 % and 26 % respectively). Contrastingly, the figures of 13 % for June and 15 % for July are among the lowest on record (Table 2.4 and Figure 2.3). The distribution of exceedances is due to the meteorological conditions, i.e. longer-lasting favourable meteorological conditions for ozone creation in spring, and unfavourable conditions in summer months (Figure 2.5).

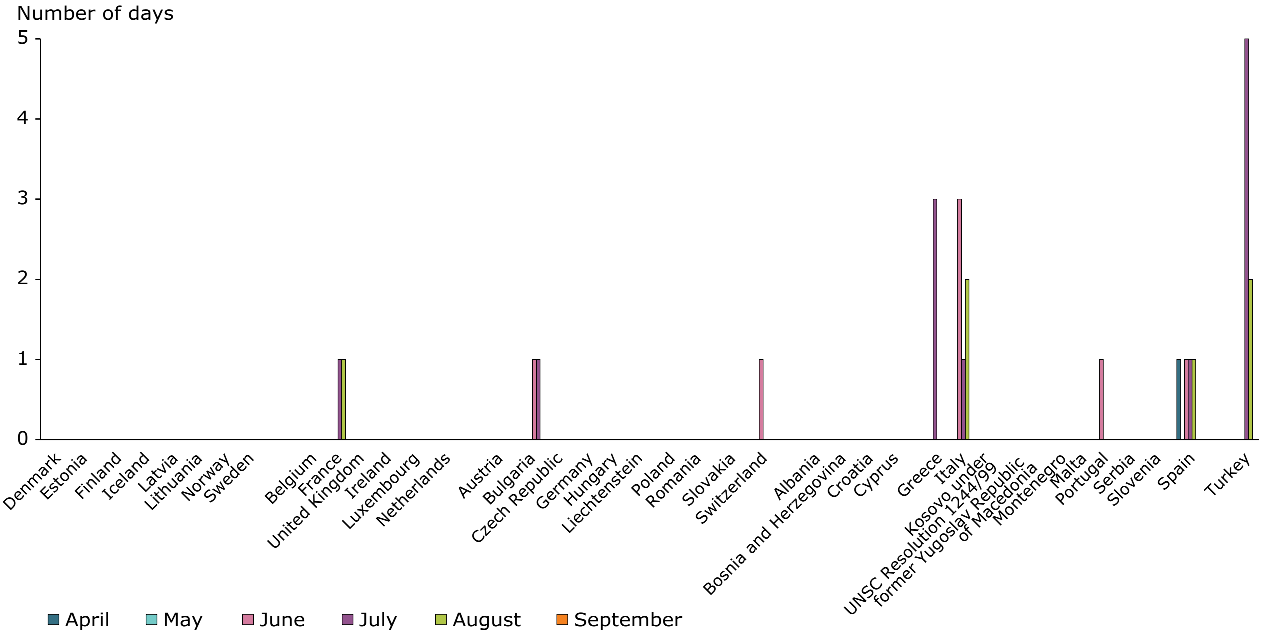
The frequency distribution of maximum daily eight-hour mean ozone concentrations exceeding the LTO level is shown in Figure 2.4. In Europe as a whole, 25 % of maximum daily eight-hour mean concentrations of all the observed exceedances was

Figure 2.1 Number of days on which at least one exceedance of the one-hour threshold value was observed during summer 2011, per country and per month (only countries that submitted data are shown)

a) Information threshold exceedances



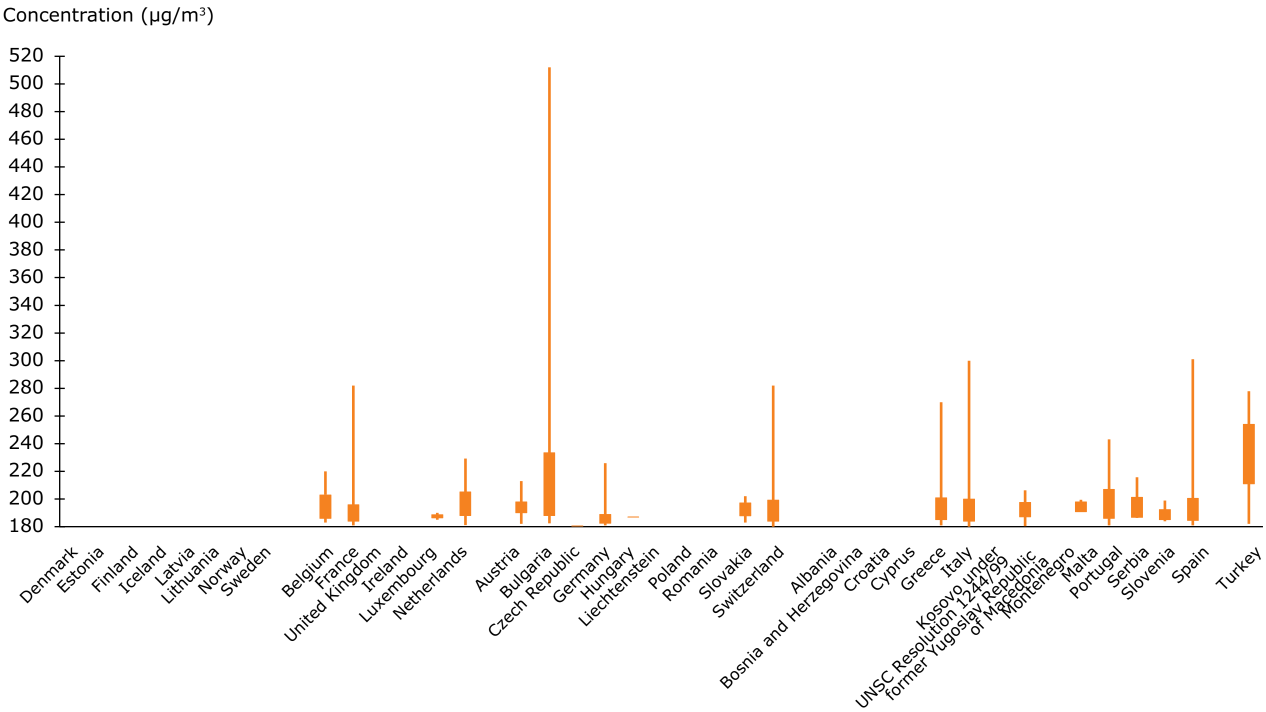
b) Alert threshold exceedances



Notes: Data are provisional.

The countries were divided into four regions in the figures to show ozone level variations due to climatic differences (see Chapter 3). This was an attempt to account for the geographical differences in weather patterns over the European continent.

Figure 2.2 Frequency distribution of concentrations in excess of the one-hour information threshold during summer 2011 (only countries that submitted data are shown)



Note: Data are provisional.

The box plots indicate the minimum value, the 25th percentile, the 75th percentile and the maximum value.

below 125 µg/m³ (125 µg/m³ in 2008, 2007, 2005 and 2004; 127 µg/m³ in 2006; 124 µg/m³ in 2009; and 126 µg/m³ in 2010). Moreover, 75 % were below 139 µg/m³ (143 µg/m³ in 2004 and 2010; 144 µg/m³ in 2005; 148 µg/m³ in 2006; 140 µg/m³ in 2007; 138 µg/m³ in 2008; and 139 µg/m³ in 2009).

In total, the occurrence of LTO exceedances was the lowest since reporting of Europe-wide data commenced in 1997, excluding summer 2010 (Table 3.1).

The TV will be exceeded when the LTO has been exceeded at a particular station more than 25 times per calendar year, averaged over three years, as of 2010. So 2010 was the first year in a rolling sequence of three years which will be used to determine whether countries are meeting the TV. The LTO was exceeded in 2011 for more than 25 days in a significant part of Europe comprising the following countries: 17 EU Member States (Austria, Belgium, Bulgaria, the Czech Republic, Cyprus, Germany, Greece, France, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Slovenia and Slovakia and Spain) and five other countries (Croatia, the former Yugoslav Republic of Macedonia, Liechtenstein, Serbia and Switzerland). As in previous years, the highest widespread concentrations occurred in the Mediterranean area, but also affected western and central Europe.

Table 2.3 Overview of exceedances of the long-term objective and target value threshold for the protection of human health during summer 2011, by country

Country	Number of stations ([a])	Stations with LTO exceedances ([b])		Stations with LTO exceedances above 25 days		Number of days with LTO exceedances ([c])	Maximum observed 8-hour mean concentration (µg/m³)	Occurrence of LTO exceedances ([d])	
		(number)	(%)	(number)	(%)				
Austria	112	111	99	48	43	112	191	24.1	24.3
Belgium	41	41	100	1	2	34	180	12.2	12.2
Bulgaria	18	15	83	2	11	121	233	15.4	18.5
Cyprus	2	1	50	1	50	63	146	31.5	63.0
Czech Republic	61	58	95	13	21	76	163	16.8	17.7
Denmark	9	7	78	–	–	24	188	6.1	7.9
Estonia	9	9	100	–	–	8	155	2.2	2.2
Finland	18	7	39	–	–	10	142	0.8	2.1
France	417	384	92	85	20	149	216	18.2	19.8
Germany	252	240	95	34	13	86	188	16.0	16.8
Greece	22	19	86	13	59	168	241	38.3	44.3
Hungary	17	17	100	8	47	92	161	24.2	24.2
Ireland	12	4	33	–	–	3	136	0.4	1.3
Italy	343	309	90	193	56	182	259	39.2	43.5
Latvia	8	2	25	–	–	20	151	3.8	15.0
Lithuania	12	10	83	–	–	15	146	2.8	3.4
Luxembourg	6	5	83	1	17	37	172	15.7	18.8
Malta	5	3	60	3	60	115	185	38.6	64.3
Netherlands	39	37	95	–	–	24	193	9.8	10.3
Poland	67	60	90	4	6	80	161	10.7	12.0
Portugal	38	30	79	3	8	76	192	10.9	13.8
Romania	82	12	15	–	–	45	143	0.9	6.1
Slovakia	15	14	93	6	40	89	153	25.3	27.1
Slovenia	12	11	92	9	75	110	177	41.0	44.7
Spain	411	336	82	63	15	177	189	12.5	15.3
Sweden	12	10	83	–	–	20	150	4.5	5.4
United Kingdom	82	39	48	–	–	21	167	0.9	1.9
EU area	**2 122**	**1 791**	**84**	**487**	**23**	**183**	**259**	**18.4**	**21.8**
Albania	3	0	–	–	–	–	–	–	–
Bosnia and Herzegovina	1	0	–	–	–	–	–	–	–
Croatia	2	2	100	2	100	62	147	37.5	37.5
former Yugoslav Republic of Macedonia	11	8	73	5	45	123	197	22.0	30.3
Iceland	1	0	–	–	–	–	–	–	–
Kosovo under the UNSC Resolution 1244/99	1	0	–	–	–	–	–	–	–
Liechtenstein	1	1	100	1	100	39	169	39.0	39.0
Montenegro	2	2	100	–	–	10	144	6.0	6.0
Norway	7	6	86	–	–	12	149	4.0	4.7
Serbia	5	5	100	3	60	63	159	21.2	21.2
Switzerland	27	27	100	16	59	102	242	33.1	33.1
Turkey	3	2	67	–	–	16	188	6.0	9.0
Europe	**2 186**	**1 844**	**84**	**514**	**24**	**183**	**259**	**18.5**	**21.9**

Notes: ([a]) Total number of stations measuring ozone levels.

([b]) The number and percentage of stations at which at least one exceedance was observed.

([c]) The number of calendar days on which at least one exceedance was observed.

([d]) Left column: averaged over all implemented stations. Right column: averaged over all stations that reported at least one exceedance.

'–' indicates 'not applicable'.

Data are provisonal.

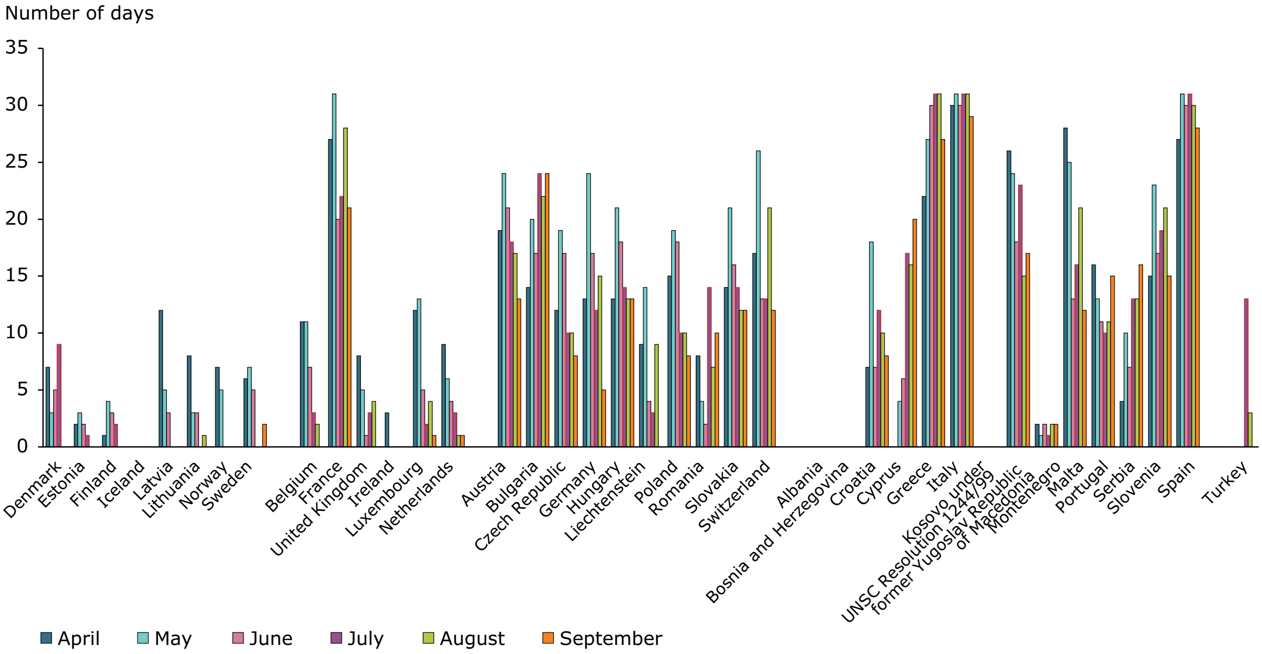
Table 2.4 Overview of exceedances of the long-term objective for the protection of human health in Europe during summer 2011, by month

Month	Stations with LTO exceedances (b)		No. of days with LTO exceedances (c)	Maximum observed 8-hour concentration (µg/m³)	Occurrence of LTO exceedances (d)	
	(number)	(%)				
April	1 537	70	30	181	3.9	4.6
May	1 479	68	31	209	4.9	5.8
June	1 385	63	30	259	2.4	2.9
July	1 356	62	31	241	2.8	3.4
August	1 143	52	31	256	3.1	3.6
September	706	32	30	197	1.5	1.8

Note: Data are provisional.

(b)–(d) see notes to Table 2.3.

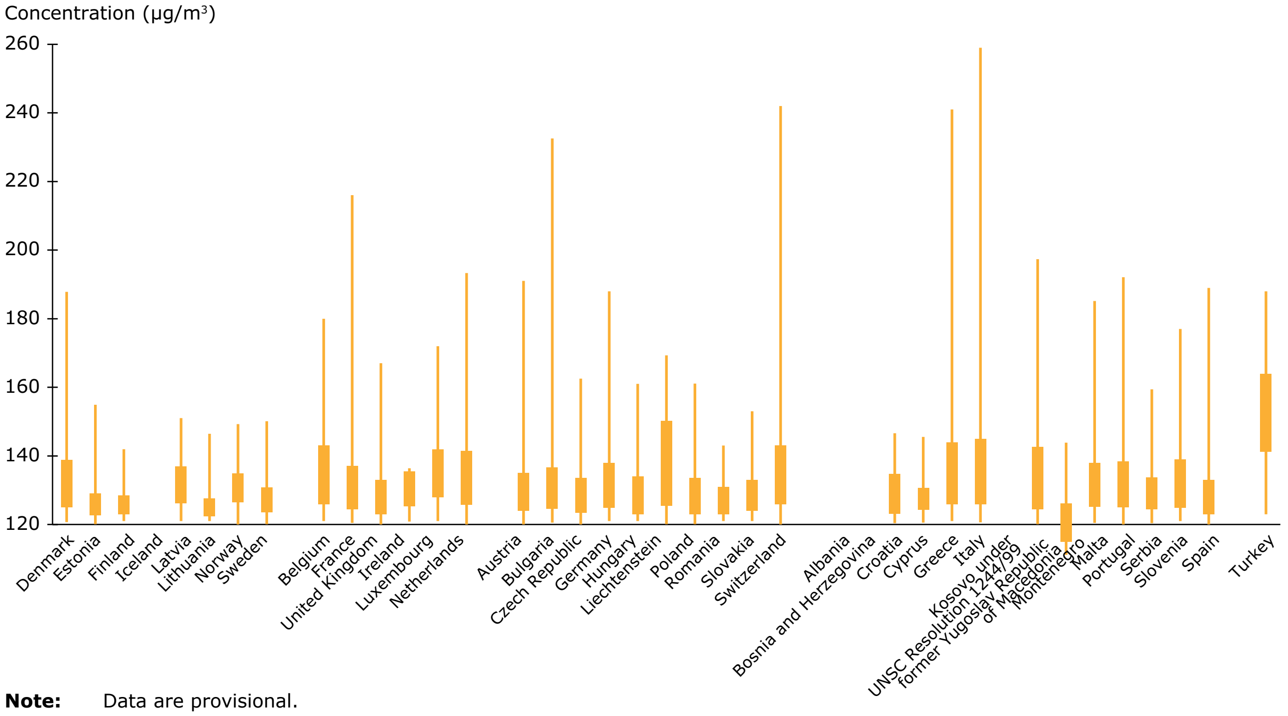
Figure 2.3 Number of days on which at least one exceedance of the long-term objective for the protection of human health was observed during summer 2011, per country and per month (only countries that submitted data are shown)



Note: Data are provisional.

The countries were divided into four regions in the figures to show ozone level variations due to climatic differences (see Chapter 3). This was an attempt to account for the geographical differences in weather patterns over the European continent.

Figure 2.4 Frequency distribution of concentrations in excess of the long-term objective for the protection of human health during summer 2011 (only countries that submitted data are shown)



Note: Data are provisional.

The box plots indicate the minimum value, the 25th percentile, the 75th percentile and the maximum value.

Finally, and for the first time, the so called '2009 target value' (2009 TV) was calculated to get a first approximation of what might be expected in coming years regarding exceedances of the TV. The assumptions when calculating this 'indicative' level were as follows:

- the three year average was obtained for the years 2009, 2010 and 2011, so it would be the TV for 2009, and has no legally binding value at all;
- only the six summer months were used, so this would be an underestimation of the 2009 TV, as exceedances of the maximum daily eight-hour average of 120 µg/m³ could occur also in the rest of the months (mainly in March and October);
- validated data were used only for 2009 while provisional data were used for 2010 and 2011;
- no time coverage criterion was applied;
- only stations for which the number of LTO exceedances is available for all three summers of 2009–2011 are involved in the summary per country (Table 2.5) and in the connected map (Map 2.3).

From a total of 3 148 stations reporting data from at least one year in 2009, 2010 and 2011, 1 924 (61 %) could be used for the exercise, as data from all the three years were reported for them. In the whole area of calculation, 496 stations out of the total 1 924 fulfilling the criteria of calculation (almost 26 %) had exceedances of the 2009 TV. This percentage is similar in the EU-27 area.

The '2009 target value' was exceeded (Table 2.5) in at least one station in 17 EU Member States (Austria, Bulgaria, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and in three of the other countries which fulfilled the criteria established for this calculation exercise (Croatia, the former Yugoslav Republic of Macedonia and Switzerland).

In five of the EU MS and in one other country the number of percentage of stations fulfilling the criteria for the calculation exercise and with levels exceeding the 2009 TV was above 50 %. Four of them were in the Mediterranean area.

Regarding the maximum number of days on which the 2009 TV was exceeded (Table 2.5 and Map 2.3),

Table 2.5 Overview of exceedances of the 2009 target value for the protection of human health (summer 2009, 2010 and 2011), by country

Country	Number of stations	Number of stations with TV exceedances	Percentage of stations with TV exceedances	Maximum number of days on which the TV was exceeded
Austria	104	44	42.3	68
Belgium	40	0	0.0	19
Bulgaria	16	2	12.5	106
Cyprus	1	1	100.0	61
Czech Republic	58	8	13.8	46
Denmark	8	0	0.0	6
Estonia	9	0	0.0	6
Finland	18	0	0.0	4
France	387	79	20.4	76
Germany	236	28	11.9	58
Greece	19	10	52.6	110
Hungary	17	10	58.8	42
Ireland	10	0	0.0	3
Italy	297	186	62.6	119
Latvia	7	0	0.0	8
Lithuania	12	0	0.0	10
Luxembourg	6	1	16.7	38
Malta	4	1	25.0	55
Netherlands	34	0	0.0	14
Poland	47	4	8.5	46
Portugal	27	7	25.9	59
Romania	58	4	6.9	43
Slovakia	14	6	42.9	62
Slovenia	12	8	66.7	80
Spain	345	77	22.3	92
Sweden	12	0	0.0	8
United Kingdom	79	0	0.0	8
EU area	**1 877**	**476**	**25.4**	
Albania	0	–	–	–
Bosnia and Herzegovina	1	0	0.0	1
Croatia	2	1	50.0	38
former Yugoslav Republic of Macedonia	11	4	36.4	114
Iceland	0	–	–	–
Kosovo under the UNSC Resolution 1244/99	0	–	–	–
Liechtenstein	1	0	0.0	24
Montenegro	0	–	–	–
Norway	7	0	0.0	3
Serbia	1	0	0.0	19
Switzerland	24	15	62.5	75
Turkey	0	–	–	–
Whole area	**1 924**	**496**	**25.8**	

Notes: Data from 2009 are validated, while data from 2010 and 2011 are provisional.

White rows refer to countries with exceedances of the 2009 TV; green rows to countries with no exceedances.

in at least four countries this maximum was above 100 days, in four more it was between 75 and 99, in six it was between 50 and 74 and in the rest six it was between 26 and 49.

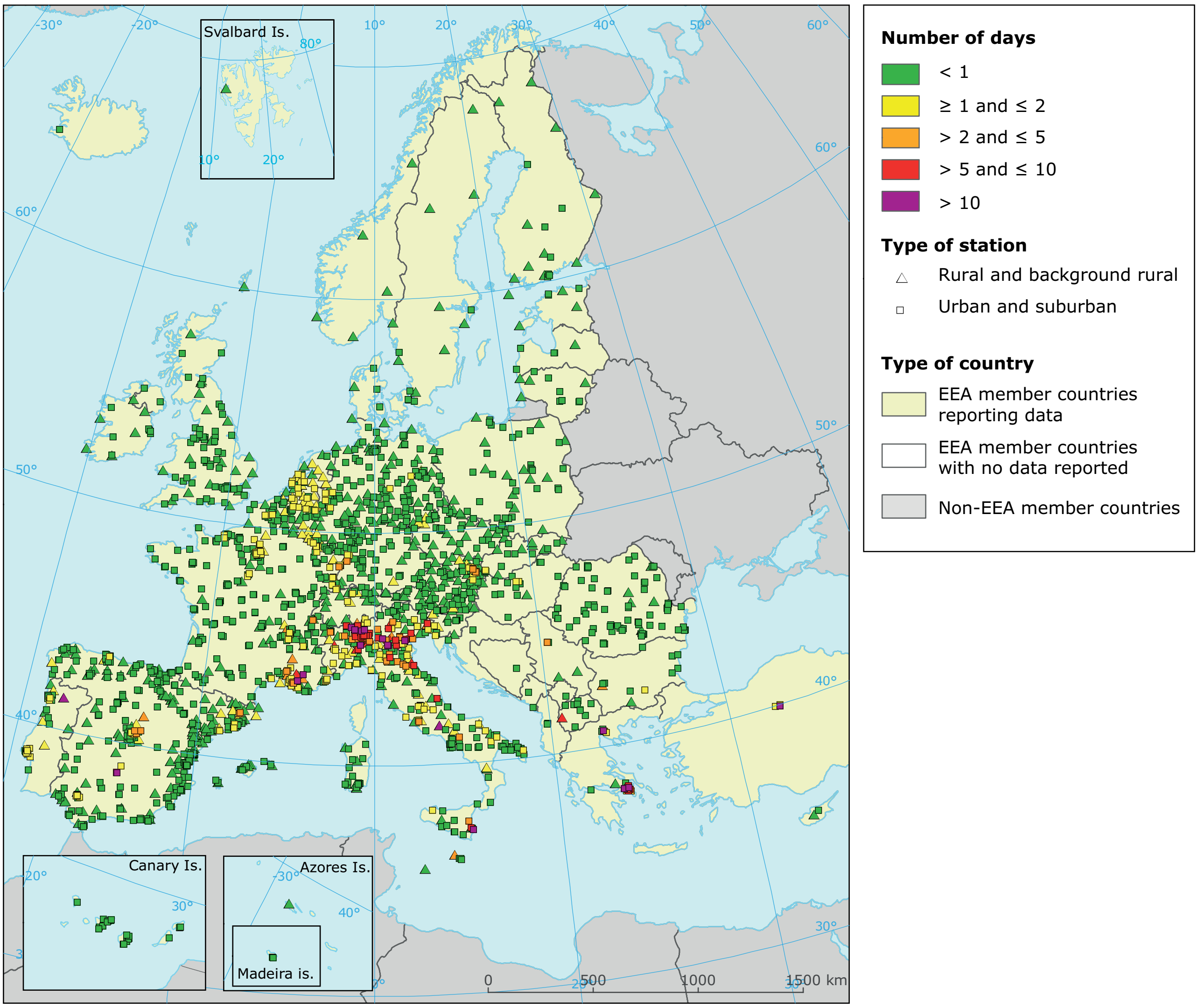
2.3 Geographical distribution of ozone air pollution and estimation of affected population

The spatial distribution of ozone exceedances throughout Europe is generally similar from year to year. In 2011, the highest ozone levels were found in northern Italy and also in several more isolated locations in Europe, where the highest number of information threshold exceedances were found. As in previous summers, north-western and northern Europe were not affected. The highest widespread exceedances of the LTO for the protection of human health and the '2009 target value' (2009 TV) occurred mostly in the Mediterranean area, but also affected western and central Europe.

In summer 2011, Baltic States, Iceland, Ireland, Scandinavia and United Kingdom reported the fewest exceedances of the information threshold and the fewest exceedances of the LTO and, together with Belgium and Netherlands, no exceedances of the 2009 TV. For the rest of Europe, the highest numbers of days with exceedances of the information threshold were reported in northern Italy and several more isolated locations. Finally, the Mediterranean areas and south-central Europe reported the highest numbers of exceedances of the LTO and the 2009 TV.

Map 2.1 depicts the number of days on which the one-hour information threshold was exceeded across Europe for rural and background rural, and urban and suburban sites. The spatial extent of

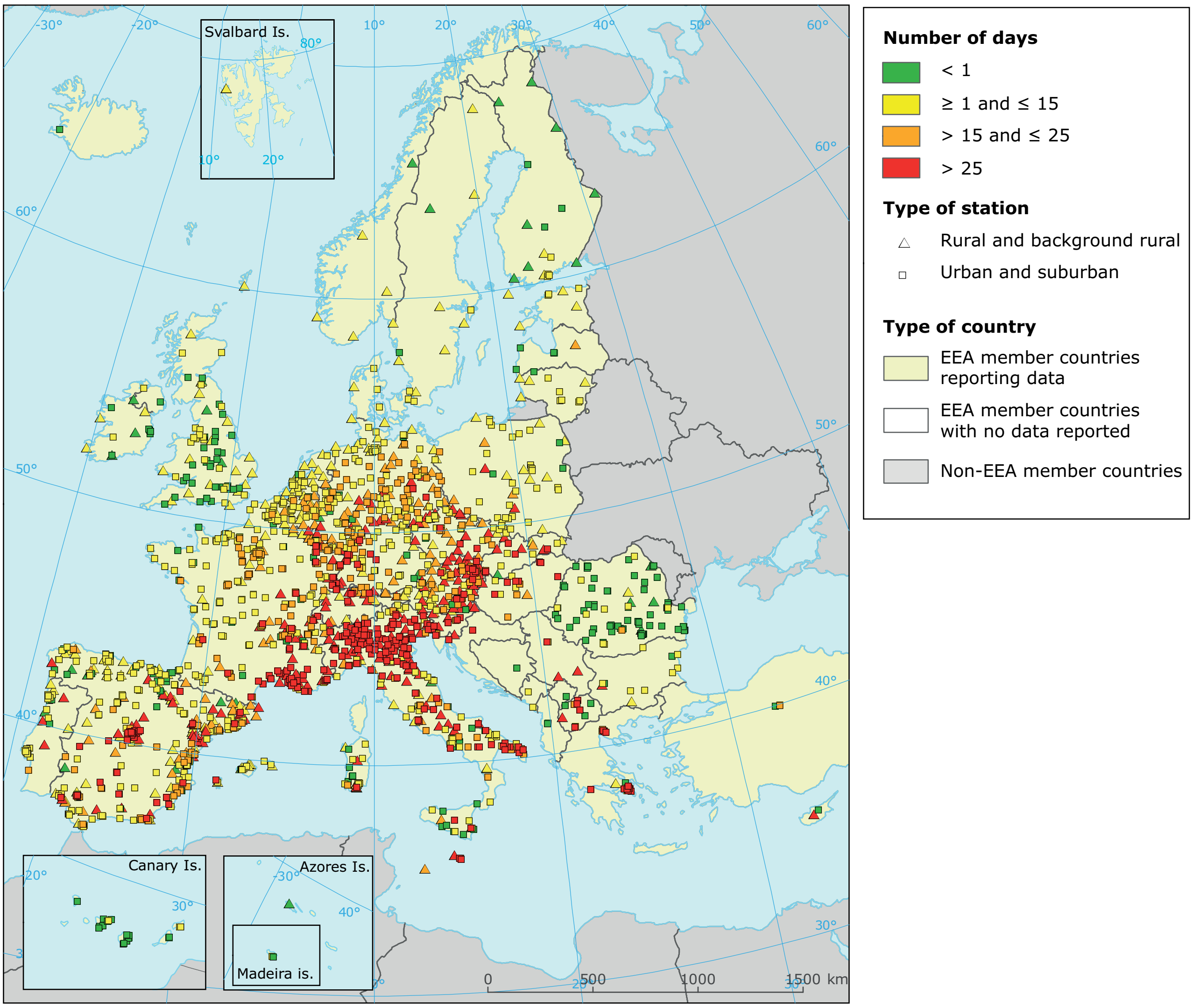
Map 2.1 Number of days on which ozone concentrations exceeded the information threshold during summer 2011 (provisional data)



the exceedances observed in the summer of 2011 is smaller than it was in the summer of 2010, and is similar to that in the summers of 2008 and 2009.

Map 2.2 displays the number of days on which the LTO was exceeded across Europe for rural and background rural, and urban and suburban sites. The areas that reported more than 25 days of LTO exceedance (relevant for determining exceedance of the TV) were slightly smaller in 2011 in comparison to 2010, and slightly larger than in the 2008 and 2009 summers, but smaller than in 2007, and more than twice smaller than in 2006. More than 25 LTO exceedances were recorded in approximately 20 % of the assessed area and affected approximately 14 % of the total population in the assessed territory. Most of the countries that registered exceedances recorded significant changes in the share of area and population affected in comparison with the summers of 2009 and 2010 (Table 2.6) ([8]).

Map 2.2 Number of days on which ozone concentrations exceeded the long-term objective for the protection of human health during summer 2011 (provisional data)



([8]) Due to an improved methodology used since 2010, the shares of affected area and population are not exactly comparable with those published in the reports for the summers until 2009. For more details, see ETC/ACM (2012).

Map 2.3 shows, for rural and background rural, and urban and suburban sites, the number of days on which the 2009 TV was exceeded across Europe. A widespread exceedance situation all over Europe can be observed, with the only exceptions of the Baltic States, Belgium, Ireland, Netherlands, Scandinavia and the United Kingdom and some poorly covered Balkan countries.

Map 2.3 Number of days on which the '2009 target value' for the protection of human health (summers of 2009, 2010 and 2011) was exceeded (data from 2009 are validated, while data from 2010 and 2011 are provisional)

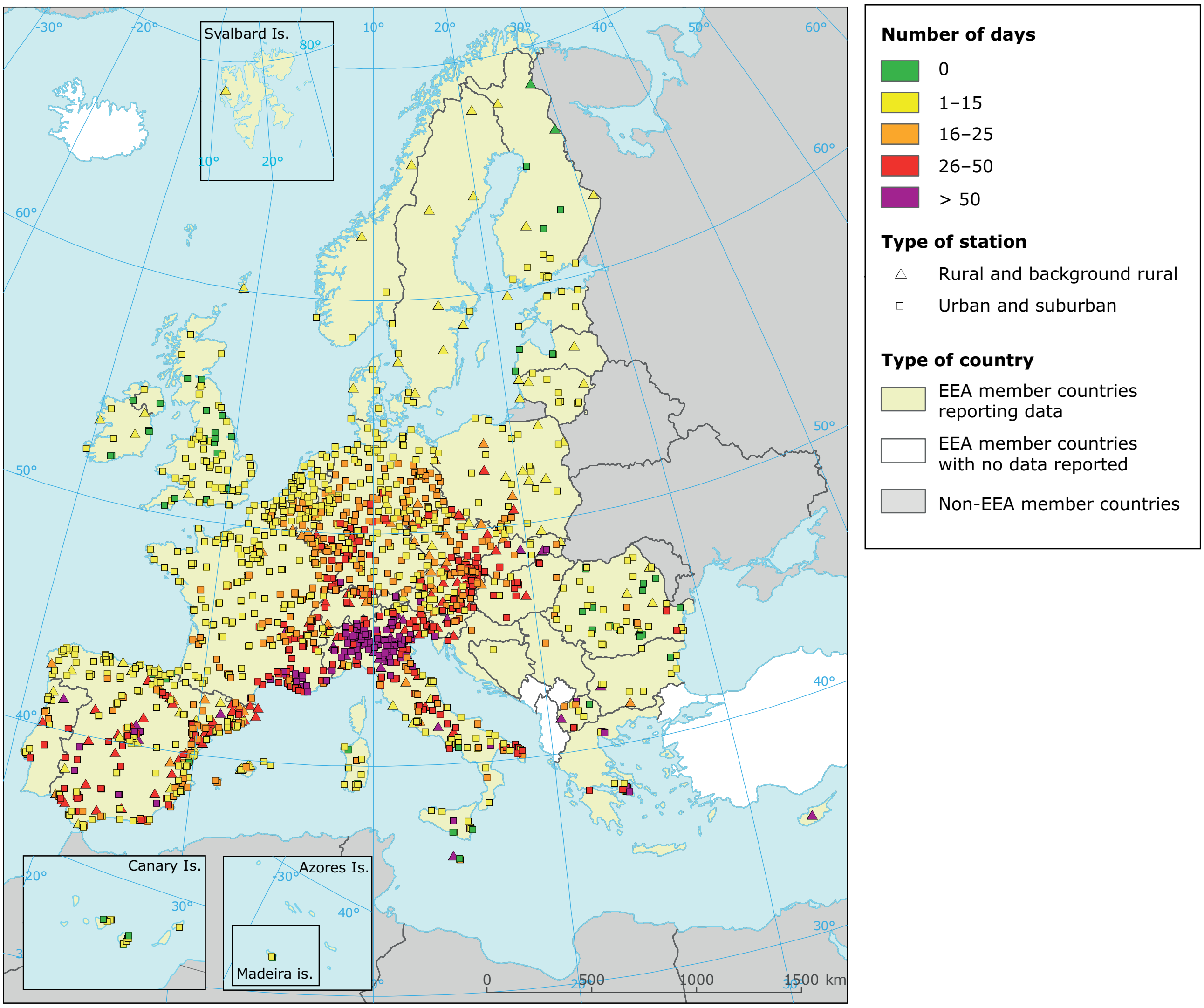


Table 2.6 Overview of estimated percentage of total area and population ([a]) resident in areas with more than 25 days of LTO exceedance during summers of 2006–2011, by country (only countries with spatial interpolation in Map 2.2 are shown) ([b])

Country	Area with more than 25 days of LTO exceedances (% of total area)						Population affected by more than 25 days of LTO exceedances (% of the total)					
	2006	2007	2008	2009	2010	2011	2006	2007	2008	2009	2010	2011
Austria	94.4	96.7	15	56.8	70.6	71.8	72	65.8	3.3	13.2	18.1	21.3
Belgium	69.7	0	0	0	0	0	41.9	0	0	0	0	0
Czech Republic	99.8	95.9	45.6	18.7	19.9	48.3	98.4	51	11.4	10.1	4.5	13.4
Denmark	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0	0	0	0
France	42.8	24.8	10.9	18.5	32.4	31.4	31.5	14.2	5.2	12.5	21.6	16
Germany	84.3	50.2	24.2	16.3	30.9	17.5	76.6	11.7	4.9	2.6	9.9	2.9
Hungary	95.9	99.5	77.7	99.4	25.9	59.9	46.5	93.9	23.2	94.4	17	22.3
Iceland	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0
Italy	75.8	76	41.9	49	47.8	85.6	45.8	61.3	46.7	48.5	51.2	61.1
Latvia	0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	–	0	0	0	19.9	0	–	0	0	0	4.3	0
Malta	49.3	49	0	0	0	56.5	2	1.9	0	0	0	3.6
Netherlands	15.4	0	0	0	0	0	11.5	0	0	0	0	0
Norway	0	0	0	0	0	0	0	0	0	0	0	0
Poland	77.6	27.2	3.5	2.8	0	10.4	41.5	21.8	1.1	2.8	0	2.7
Portugal	72.4	33	0.1	31.6	50.6	0	21.1	10.3	0.4	8	15.1	0
Romania	–	–	–	25.7	0	0	–	–	–	12.3	0	0
Slovakia	96.2	99.8	72.9	99.8	0	74	59.4	98.2	30.3	98.8	0	33.3
Slovenia	100	98.2	76.4	94.7	95.8	97.7	99.8	77.3	26.4	40.1	50.7	73.7
Spain	81.4	40.2	41.9	23.2	70.1	24.3	32	16.1	17.3	10.2	28.1	8.8
Sweden	0	0	0	0	0	0	0	0	0	0	0	0
Switzerland	100	92.5	10.2	81.6	99.1	95.9	100	45	3.8	19.3	90	69.9
United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0
Total	**43.5**	**28.4**	**15.6**	**17.2**	**21.8**	**19.7**	**39.8**	**22.1**	**10.5**	**13.8**	**15.7**	**13.7**

Notes: Data from 2010 and 2011 are provisional.

([a]) The Joint Research Centre (JRC) population data set CLC2000 has been used to estimate the affected population (EEA, 2012c). The Oak Ridge National Laboratory (ORNL) Global Population Dataset, version 2008 (ORNL, 2012) has been used in areas not covered by the JRC data set (the area related to calculations in this report covers Iceland, Norway and Switzerland). These data sets are incomparable in some respects, but can be used together for the calculation of percentage of affected population because only the spatial distribution of the population is used.

([b]) The data on affected area and population are indicative because of the different density of the monitoring network in different countries, the number and proportion between urban and rural stations, and the methodology of interpolation used.

2.4 Main ozone episode

Ozone formation in the atmosphere is a complicated, non-linear photochemical process. In the troposphere (the lower part of the atmosphere), ozone formation results from a chain of mechanisms involving photochemical reactions of NO_X, chained with oxidative decomposition of VOCs, CO and methane (CH_4), initiated by hydroxyl radicals.

Episodes of elevated ozone levels occur during periods of warm, sunny weather. The ozone concentration depends not only on precursor emissions but also on meteorological conditions and hemispheric background and transport. The largest ozone episodes with the highest ozone concentrations occur in areas of high air pressure (anticyclones). Within such areas, the prevailing stagnant conditions mean that emissions of ozone precursors are only dispersed into the atmosphere slowly, and chemical reactions leading to ozone formation take place.

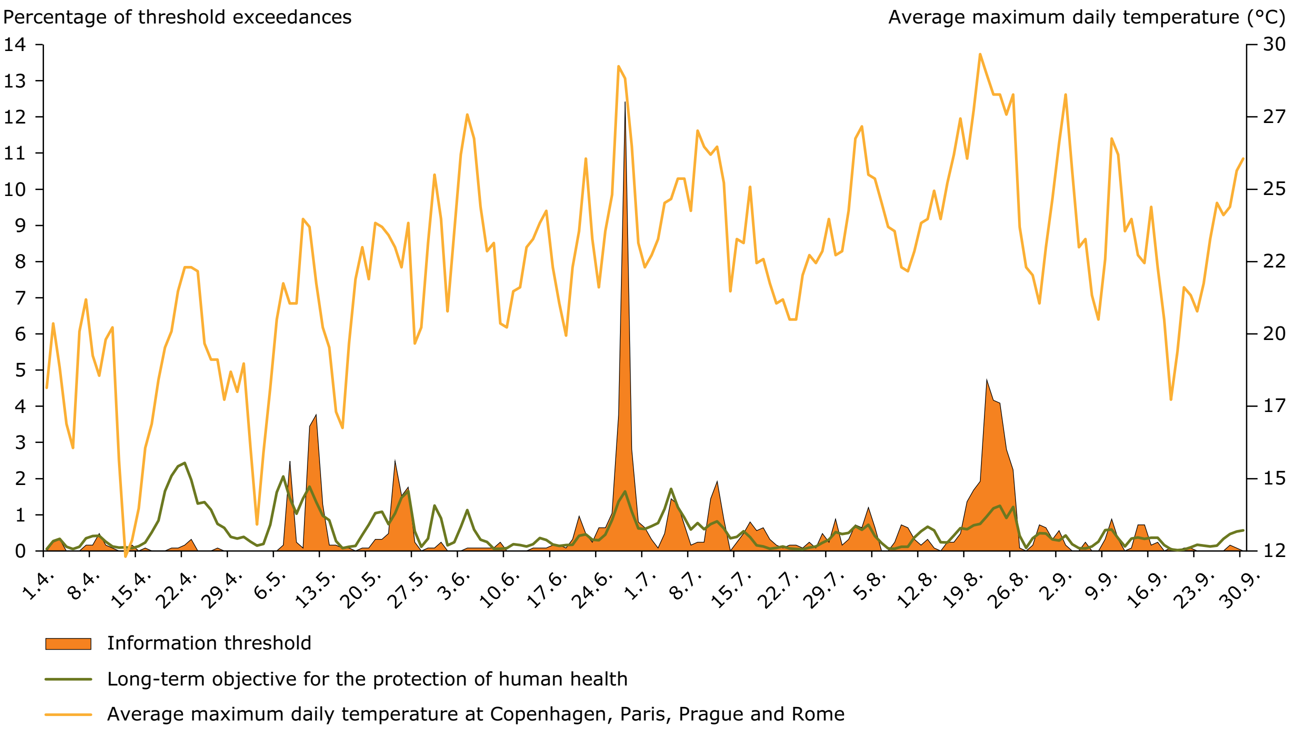
Summer 2011 was characterised by short regional ozone episodes of only two to three days followed by days with few or no exceedances; there were no widespread multi-day episodes. Typical episodes usually contained approximately 2 % to 8 % of the total number of exceedances of the information threshold experienced during the summer.

The largest episode in terms of length occurred between 19 and 26 August. This accounted for approximately 23 % of the total number of exceedances of the information threshold, 17 % of the exceedances of the alert threshold and about 8 % of the exceedances of the LTO.

The largest episode in terms of the area occurred in a single day (28 June) and accounted for approximately 12 % of the total number of exceedances of the information threshold, 24 % of the exceedances of the alert threshold and about 2 % of the exceedances of the LTO.

Figure 2.5 shows the distribution of daily exceedances for the entire continent of Europe and the averaged maximum temperatures observed in four European capital cities (Copenhagen (Denmark), Paris, (France) Prague (the Czech Republic) and Rome (Italy) ([9]). The distribution of exceedances per day and per country during summer 2011 is shown in Figure 2.6. Map 2.4 shows the coincidence of areas in Belgium, Luxembourg, Netherlands and northern Italy with elevated ozone concentrations and the highest temperatures.

Figure 2.5 Distribution of exceedances during summer 2011, by day



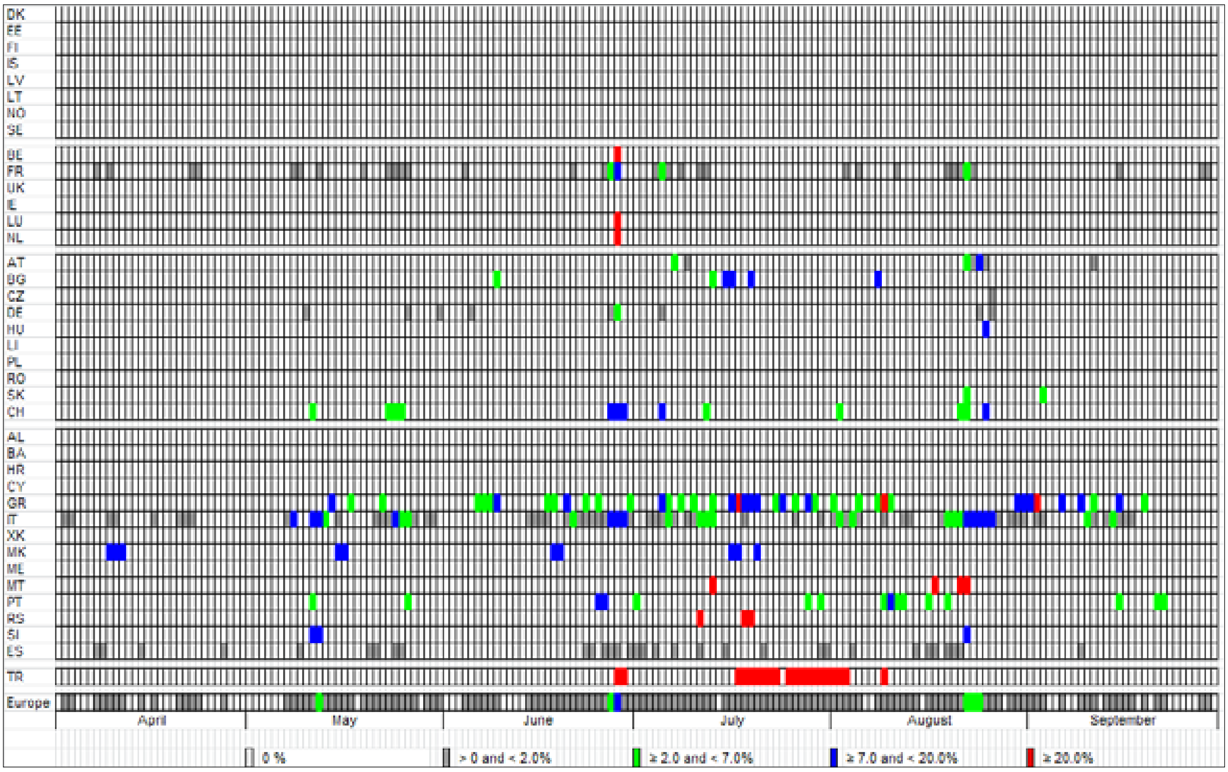
Note: Data are provisional.

The left y-axis represents the percentage of exceedances observed during a particular day. As such, the exceedances of the information threshold and the LTO depicted each total 100 % between 1 April and 30 September. Source of maximum temperature data: Weather Underground, 2012.

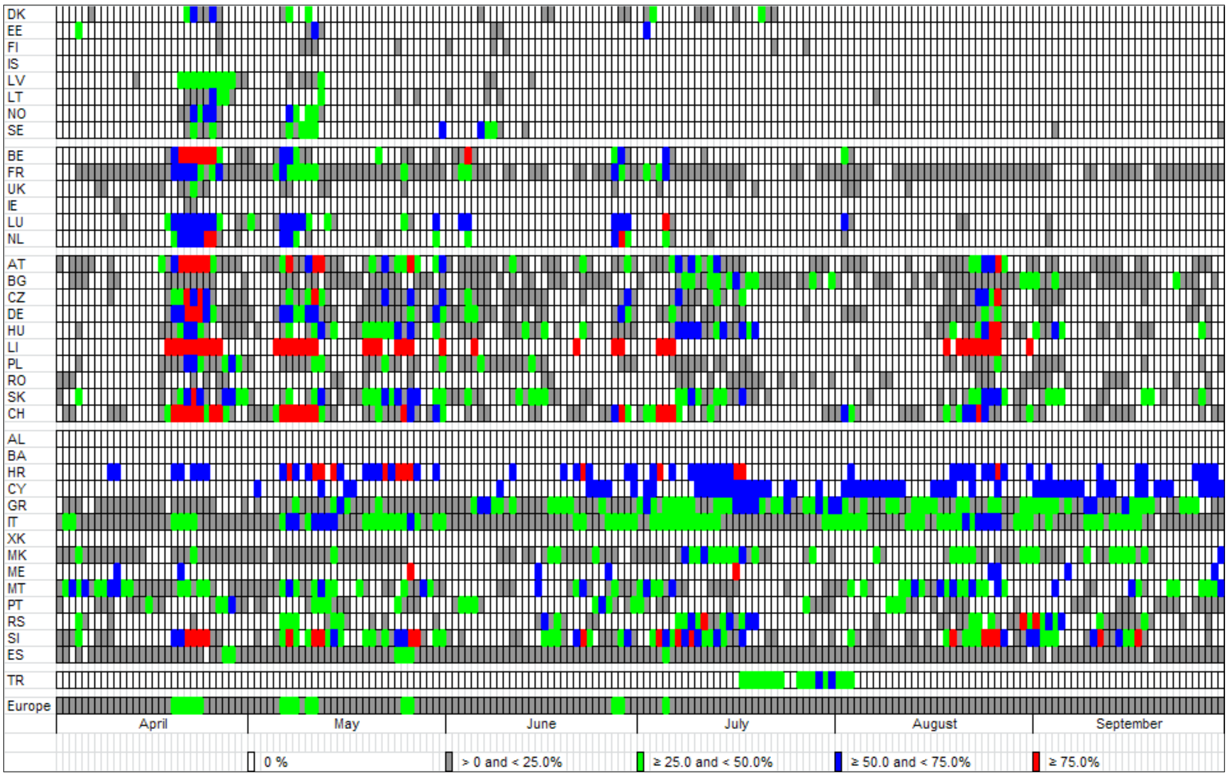
([9]) Europe was divided into four regions to analyse inter-annual variations in the trend of ozone levels due to climatic differences; four capital cities in the regions were selected to demonstrate the relation between the number of exceedances and the meteorological situation (see Chapter 3).

Figure 2.6 Distribution of exceedances during summer 2011: percentage of stations reporting exceedances on a daily basis per country ([a])

a) Information threshold exceedances



b) Long-term objective for the protection of human health exceedances



Notes: Data are provisional.

([a]) Distribution of exceedances is indicative for countries without proportioned stations' coverage, i.e. a small number of stations (West Balkan countries, except the former Yugoslav Republic of Macedonia, and Turkey).

The colours represent the percentage of a country's total number of stations that observe exceedances during a particular day.

MK and XK are provisional codes for the former Yugoslav Republic of Macedonia, and Kosovo under UNSC Resolution 1244/99, respectively.

Map 2.4 Selected days during the largest summer 2011 ozone episode in terms of area: observed maximum one-hour ozone concentrations and meteorological situation

27 June 2011

Maximal hourly value (µg/m⁻³)

- ≤ 180
- > 180 and ≤ 240
- > 240

Type of country

- Countries reporting data
- Non-EEA member countries

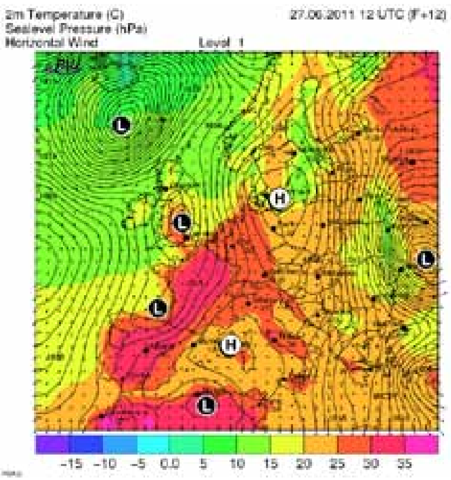
28 June 2011

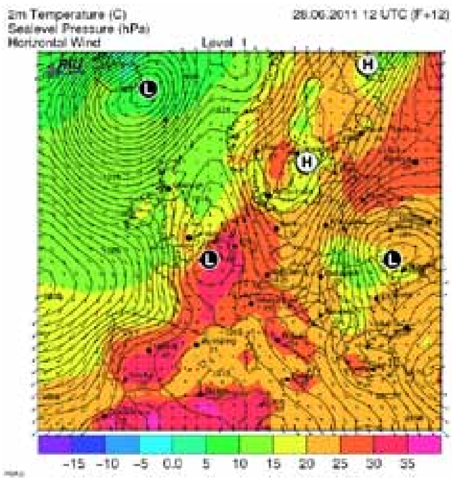
Maximal hourly value (µg/m⁻³)

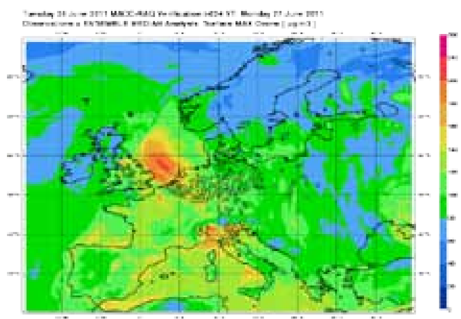
- ≤ 180
- > 180 and ≤ 240
- > 240

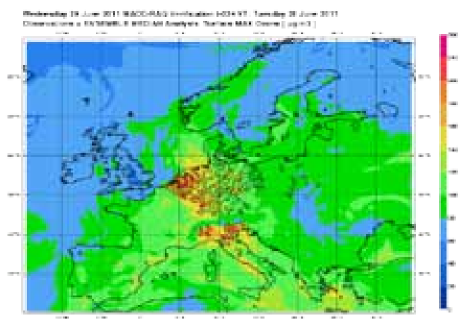
Type of country

- Countries reporting data
- Non-EEA member countries









Source: EEA; Rhenish Institute for Environmental Research (ground-level pressure, temperature and horizontal wind); Monitoring Atmospheric Composition and Climate (MACC) project-modelled ground-level ozone maximum one-hour concentrations).

3 Evolution and trends of summer ozone air pollution in Europe

To see the evolution through the years, ozone levels in summer 2011 were compared with the summer ozone concentrations from 1997 to 2010. Summer ozone concentrations from 1997 to 2009 are validated and stored in the EEA's public air quality database (AirBase). Before 1997, the number of ozone stations reporting to AirBase is too low to provide a representative picture for each of the four regions. However, the number of monitoring stations at the beginning of the considered period was less than half compared to the last years. Even in the period since 1997, some of the observed changes may have been caused by changes in the location of stations and the density of the monitoring networks. Only summer time-series that included more than 90 % of measured data during the summers from 1997 to 2009 were selected for comparison. Summer ozone concentrations for 2010 and 2011 are provisional and no time coverage criterion was applied.

Differences in the distribution of ozone precursors emission sources, the chemical composition of the air, and climatic conditions along the north-south and east-west gradients in Europe result in considerable regional differences in summer ozone concentrations. At the current level of precursor emissions, the year-to-year differences in the occurrence of ozone threshold exceedances are induced substantially by meteorological variations (EMEP, 2005). Based on experience from previous years, stations were divided into four groups (regions) according to the impact of climatic conditions on ozone concentrations (see key for Figure 3.1). To illustrate climatic differences and their relation to the number of exceedances among the groups of countries as well as the inter-annual variations, the graphs included the maximum daily temperatures averaged for the period from April to September of a particular year observed in four capital cities in selected regions (Paris (France), Prague (the Czech Republic), Rome (Italy) and Copenhagen (Denmark)) ([10]). Hot, dry summers with long-lasting periods of high air pressure over large parts of Europe lead to elevated ozone concentrations and many exceedances of ozone threshold values. The exceptionally warm summer of 2003 illustrated the link (see Figure 3.1). In the first half of August 2003, the weather conditions were almost unchanged and were characterised by a long period of high air pressure above south-western Europe, accompanied by exceptionally high temperatures covering large parts of southern, western and central Europe. Ozone concentrations were high for the entire period.

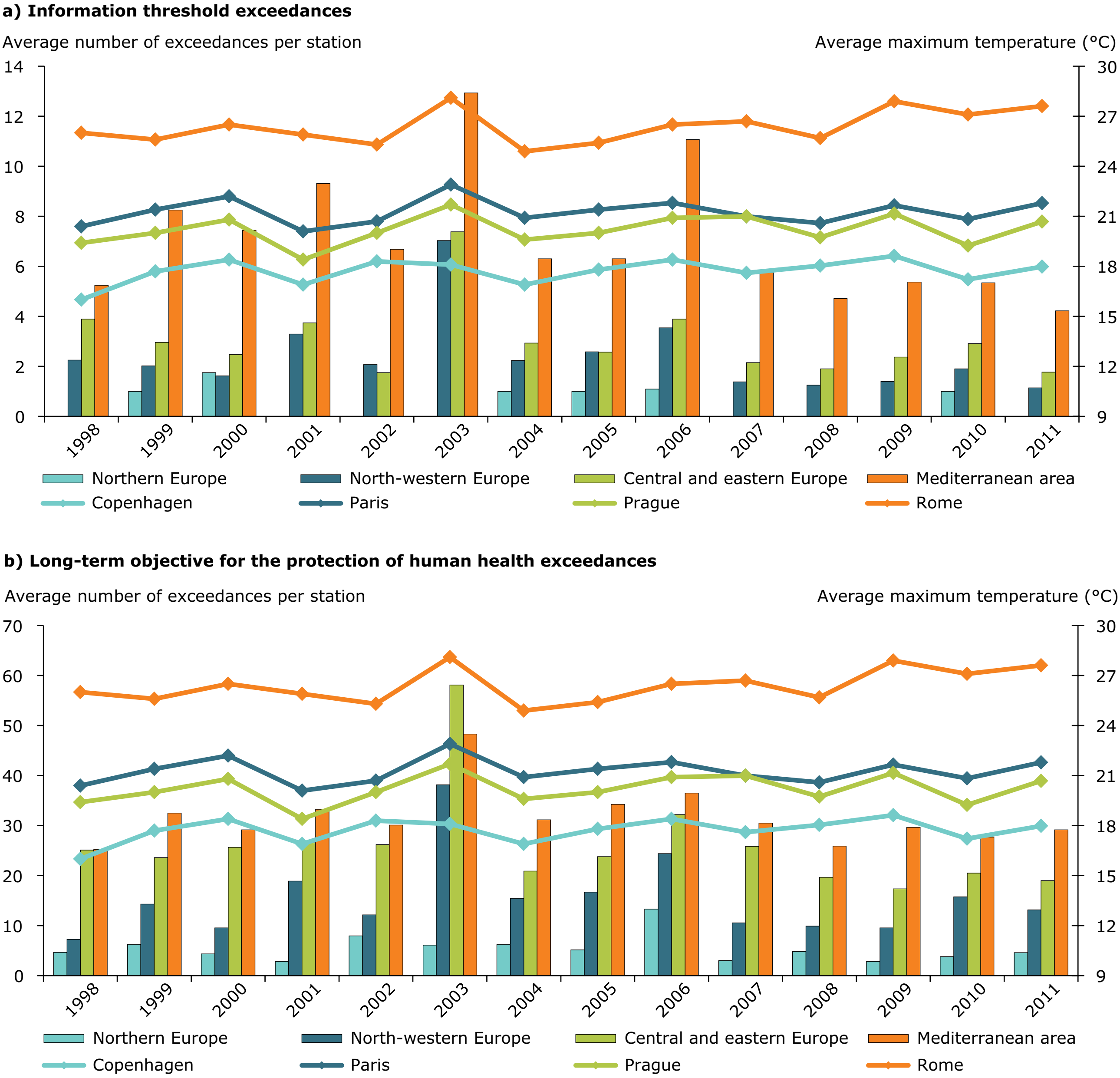
The highest number of exceedances occurs frequently in the Mediterranean region, and the lowest in northern Europe (Figure 3.1). The number of occurrences in southern Europe was lower between 1999 and 2002 than in the extreme summer of 2003 (EEA, 2003) which saw a very large number of occurrences. This was also the case in more northern parts of Europe. Ozone levels in 2004 and 2005 decreased to previous levels (EEA, 2005; EEA, 2006), but in 2006 there was a further increase, not only in southern Europe (EEA, 2007a). Since 2007, the situation has stabilised (EEA, 2011a). After a slight increase of the number of exceedances in 2010, there was a decline in 2011: the number of exceedances decreased and a general downward trend is also confirmed in 2011. It is worth noting that the summer temperatures have not fluctuated in recent years either. Within the last five-year period, the information threshold was exceeded in northern Europe only in 2010 (see Table 3.1 for detailed annual information).

In several countries with ozone-monitoring networks operating since at least the mid 1990s, it is possible to observe longer trends of the information threshold exceedances and the LTO for the protection of human health exceedances. There are selected stations with altitudes of up to 600 m above sea level, representing the densely populated areas as seen in Figure 3.2. AQ trends can vary from one area to another, but in charts there are noticeable downward trends of the number of exceedances in the period from 1990 to 2011. The number of stations meeting the criteria (time series of at least 15 years and data capture over 90 %) varies between countries due to the differing land areas of each country (see the numbers of stations in parentheses in the graph legends in Figure 3.2). These countries with long time-series represent three of the four geographical parts of Europe, according to the impact of climatic conditions on ozone concentrations; all of them

([10]) These cities were only selected in order to demonstrate the relation between the number of exceedances and meteorological situation. The selection was not based on the statistical evaluation of the meteorological representativeness of these cities for the regions.

have a visible steeper or moderate downward trend. This downward trend is seen in the number of exceedances, without this necessarily meaning that the exposure is reduced in the same way (many exceedances are in the range of 180 µg/m^3 to 185 µg/m^3; a small decrease in concentration will result in a large decrease in the number of exceedances ([11]).

Figure 3.1 Regional average number of exceedances during summer, per station for stations that reported at least one exceedance and average maximum daily temperature in selected cities

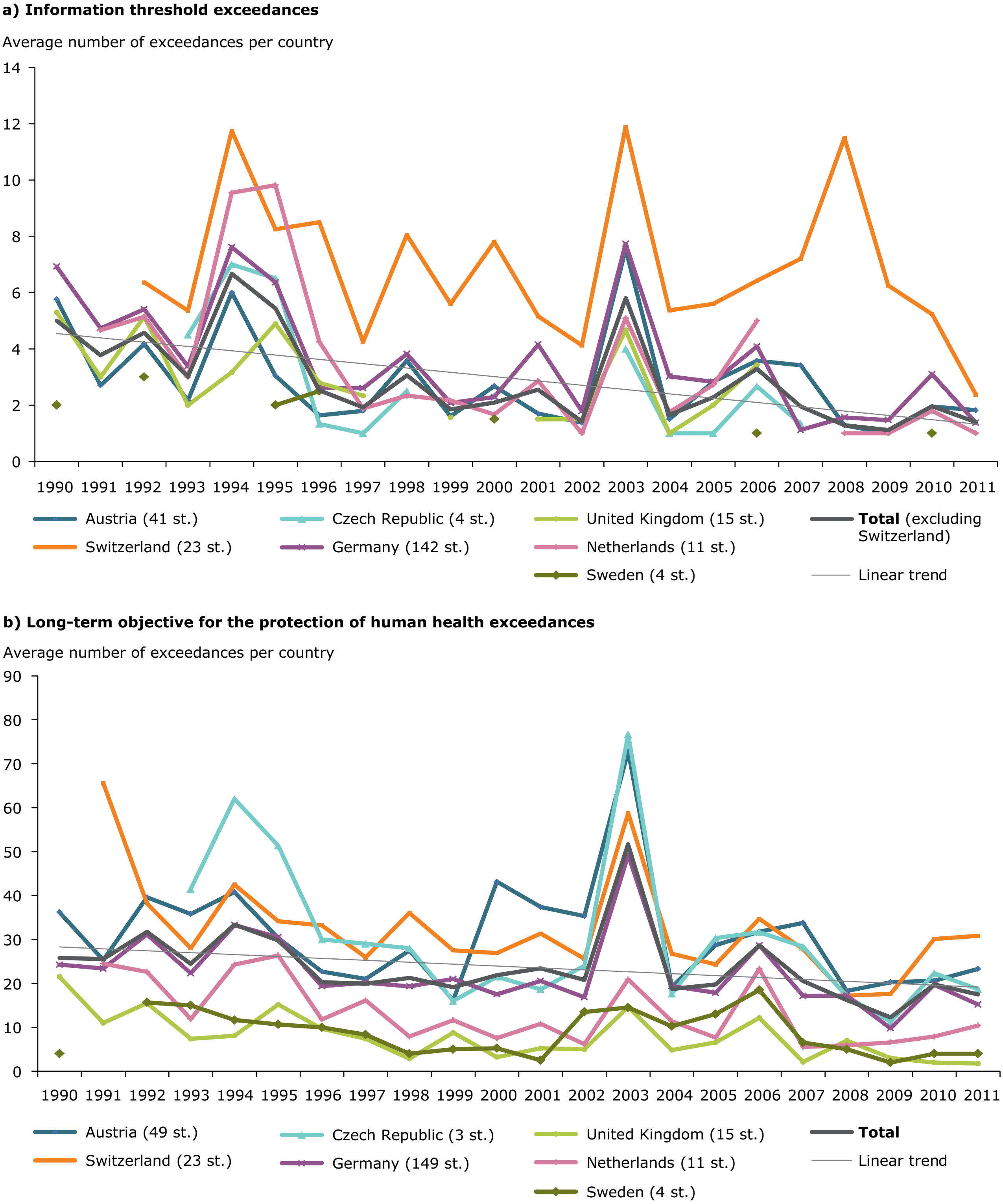


Notes: Data from 2010 and 2011 are provisional.
Northern Europe: Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway and Sweden.
North-western Europe: Belgium, Ireland, France (north of 45 ° latitude), Luxembourg, Netherlands and the United Kingdom.
Central and eastern Europe: Austria, Bulgaria, the Czech Republic, Germany, Hungary, Liechtenstein, Poland, Romania, Slovakia and Switzerland.
Mediterranean area: Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, France south of 45 ° latitude, Greece, Italy, Kosovo under UNSC Resolution 1244/99, Malta, Monaco, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain and the former Yugoslav Republic of Macedonia.

Source: Temperature data: Weather Underground, 2012.

([11]) Although there is no visible (or increasing) trend as for the annual average concentrations of ozone in Europe, for the number of exceedances and the episodic peak ozone levels in some European areas, a decreasing trend is observed (compare EEA, 2009b and EEA, 2010c). A similar downward trend also appears in the United States (US EPA, 2011).

Figure 3.2 Average number of exceedances per station during summer for stations that reported at least one exceedance (selected countries)



Notes: Data from 2010 and 2011 are provisional.

Only stations with altitudes of up to 600 m above sea level and with data spanning at least 15 years were included; the number of measuring stations is shown in parentheses following the countries.

Table 3.1 Overview of exceedances observed during summer in Europe (1997–2011) ([a])

a) Information threshold exceedances

Summer season	Number of stations ([b])	Stations with exceedances ([c])					Number of days with exceedances ([d])		Maximum observed one-hour con-centration (µg/m³)	Occurrence of exceedances ([e])				Average duration of exceedances (hour)	
		(number)		(%)		(%)									
1997	731	312	13	43	2	4	131	21	383	1.2	2.8	0.0	1.4	2.7	1.6
1998	778	450	62	58	8	14	134	59	421	2.2	3.8	0.1	1.6	3.3	2.0
1999	1 090	361	38	33	3	11	162	100	829	1.3	4.1	0.1	3.9	3.1	4.1
2000	1 173	524	32	45	3	6	132	54	471	1.5	3.3	0.0	1.8	2.9	1.9
2001	1 348	668	73	50	5	11	147	82	470	2.5	5.1	0.1	2.5	3.0	2.0
2002	1 405	511	55	36	4	11	136	41	391	1.2	3.3	0.1	2.1	2.8	2.0
2003	1 476	1 096	280	74	19	26	171	88	417	6.5	8.7	0.5	2.4	3.9	2.1
2004	1 518	553	37	36	2	7	137	44	385	1.5	4.0	0.0	1.8	3.1	2.0
2005	1 643	771	59	47	4	8	163	61	361	1.8	3.9	0.1	2.2	3.1	2.4
2006	1 732	1 090	101	63	6	9	181	138	447	3.6	5.7	0.4	7.7	4.3	5.2
2007	1 762	515	62	29	4	12	152	46	479	1.1	3.9	0.1	1.7	3.2	2.0
2008	1 878	380	20	20	1	5	135	27	399	0.7	3.6	0.0	2.2	2.9	2.6
2009	1 885	399	28	21	1	7	148	35	298	0.8	3.9	0.0	1.4	2.9	1.8
2010	2 193	756	32	34	1	4	111	23	332	1.3	3.7	0.0	1.4	3.0	1.9
2011	2 186	387	28	18	1	7	134	25	512	0.6	3.2	0.0	1.5	2.6	2.2

Notes: ([a]) Ozone levels in summer 2011 were compared with the summer ozone concentrations from 1997 to 2009 stored in the EEA AirBase, and the summer 2010 data submitted under directives in force. Data stored in AirBase are validated; 2010 and 2011 summer data are provisional and only partly validated, and no time coverage criterion was applied.

The increase in the number of stations is mainly attributable to an increasing number of reporting countries during the years. The difference between the number of stations in 2009, 2010 and 2011 is due to the use of different time coverage criteria.

([b]) Total number of stations measuring ozone levels.

([c]) 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 exceedances were also observed.

([d]) The number of calendar days on which at least one exceedance of thresholds was observed.

([e]) Occurrence of exceedances is calculated as the average number of exceedances observed per station in a country.
Left column: averaged over all implemented stations (total number of stations).
Right column: averaged over all stations that reported at least one exceedance.

Data from 2010 and 2011 are provisional.

White columns refer to exceedances of the information threshold, grey ones to exceedances of the alert threshold.

Table 3.1 Overview of exceedances observed during summer in Europe (1997–2011) ([a]) (cont.)

b) Long-term objective for the protection of human health exceedances

Summer season	Number of stations ([b])	Stations with LTO exceedances ([c])		Stations with LTO exceedances above 25 days ([c])		Number of days with LTO exceedances ([d])	Maximum observed 8-hour concentration (μg/m³)	Occurrence of LTO exceedances ([e])	
		(number)	(%)	(number)	(%)				
1997	756	698	92	208	28	183	243	19.5	21.2
1998	811	736	91	249	31	178	263	20.3	22.3
1999	1 138	1 060	93	340	30	183	537	20.7	22.2
2000	1 206	1 108	92	352	29	181	242	19.7	21.5
2001	1 368	1 259	92	534	39	183	269	23.8	25.8
2002	1 421	1 263	89	425	30	183	310	20.2	22.8
2003	1 510	1 437	95	1 025	68	183	296	45.6	47.9
2004	1 545	1 411	91	411	27	183	256	20.1	22
2005	1 667	1 527	92	562	34	183	291	22.7	24.7
2006	1 764	1 674	95	941	53	183	399	29.2	30.8
2007	1 795	1 567	87	556	31	183	277	20.5	23.5
2008	1 905	1 705	90	426	22	183	399	17.1	19.1
2009	1 921	1 703	89	444	23	183	244	17.9	20.2
2010	2 193	1 875	85	588	27	183	262	19.1	22.3
2011	2 186	1 844	84	514	24	183	259	18.5	21.9

Notes: ([a]) Ozone levels in summer 2011 were compared with the summer ozone concentrations from 1997 to 2009 stored in the EEA AirBase, and the summer 2010 data submitted under directives in force. Data stored in AirBase are validated; 2010 and 2011 summer data are provisional and only partly validated, and no time coverage criterion was applied.

The increase in the number of stations is mainly attributable to an increasing number of reporting countries during the years. The difference between the number of stations in 2009, 2010 and 2011 is due to the use of different time coverage criteria.

([b]) Total number of stations measuring ozone levels.

([c]) The number and percentage of stations at which at least one exceedance was observed.

([d]) The number of calendar days on which at least one exceedance was observed.

([e]) Left column: averaged over all implemented stations.
Right column: averaged over all stations that reported at least one exceedance.

Data from 2010 and 2011 are provisional.

4 Ozone-related policies

Photochemical ozone formation depends mainly on meteorological factors and on the concentrations of NO_X and VOCs. Ozone concentrations in urban areas with high NO_X emissions are generally lower than in the countryside. For ozone, there is a significant contribution in terms of intercontinental transport of air pollution. Other factors counteracting the possible positive effects of European measures to reduce ozone precursor emissions from anthropogenic sources are biogenic non-methane volatile organic compound (NMVOC) emissions, fire plumes from forest and other biomass fires (EEA, 2010c).

Ozone pollution as a global or hemispheric problem is addressed by the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP) (UNECE, 2010). The Gothenburg Protocol to the LRTAP Convention (UNECE, 1999) contains emission ceilings for the pollutant NO_X, NMVOCs, sulphur oxides (SO_X) and ammonia (NH_3) that parties to the protocol must meet by 2010.

In addition to the ceilings for individual countries, the protocol also specifies ceilings for the European Union, which is itself a party to the protocol. Member States report data on emissions of air pollutants annually to the European Commission (with copies to EEA) under Directive 2001/81/EC of 23 October 2001 of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants (EC, 2001). This NEC Directive contains national emission ceilings that, for the EU Member States, are either equal to or slightly more ambitious than those in the Gothenburg Protocol. The ceiling applies to the EU-15 grouping of Member States that constituted the European Community at the time the Gothenburg Protocol was agreed.

Emissions of three air pollutants primarily responsible for the formation of harmful ground-level ozone in the atmosphere fell significantly in the period from 1990 to 2009: CO (62 % reduction), NMVOCs (55 % reduction) and NO_X (44 % reduction). Emission reductions have been achieved from the road transport sector for all three pollutants, primarily through legislative measures requiring abatement of vehicle tailpipe emissions (EEA, 2011c). On the other hand, for another ozone precursor, CH_4, concentrations increased continuously during the 20th century, before growth slowed after 1990 and eventually stabilised between 1999 and 2007. Since 2007, however, measurements suggest that concentrations have started to rise again. CH_4 is a well-mixed pollutant globally, carried across long distances. Isolated local and regional abatement of CH_4 emissions may therefore have limited impact on local ozone concentrations (EEA, 2011f).

Formation of tropospheric ozone from increased concentrations of CH_4 may contribute to the sustained ozone levels in Europe.

European countries have significantly reduced anthropogenic emissions of ozone precursor gases since 1990, albeit briefly. In general, however, ambient air measurements in urban and rural areas of Europe do not show any downward trends in ground-level ozone (EEA, 2009b; EEA, 2011f).

These discrepancies might be the effect of:

- inefficient reductions of the ozone precursor emissions (for instance, under certain conditions, reductions of NO_X would lead to increased ozone concentrations);
- increasing intercontinental transport of ozone and its precursors in the northern hemisphere;
- climate change/variability;
- tropospheric ozone from increased concentrations of CH_4.

There is a need for more research to ascertain and quantify these possible contributions. At the time of writing this report, this quantification is lacking.

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Annex 1 Legal requirements on data provision

Directive 2002/3/EC ([12]) requires Member States to provide the following data to the European Commission and to the EEA:

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

For each month from April to September each year, data 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 before the end of the following month. 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 (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 eight-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. The annual data flow is included in the questionnaire to be used for annual reporting on air quality assessment in the scheme of the Air Quality Framework Directive (96/62/EC), its daughter directives, and Directive 2008/50/EC — for details, see Commission Decision 2004/461/EC of 29 April 2004 laying down a questionnaire to be used for annual reporting on ambient air quality assessment under Council Directives 96/62/EC and 1999/30/EC and under Directives 2000/69/EC and 2002/3/EC of the European Parliament and of the Council (EC, 2004).

Countries followed these requirements during the summer of 2011 to produce the data used in this report.

([12]) Although this directive has been replaced by Directive 2008/50/EC, these reporting obligations shall remain in force until the end of 2013.

Annex 2 Data reporting over summer 2011

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

Ozone-monitoring stations were operated throughout the whole period from April to September 2011. It is possible, however, that some exceedances were not reported due to temporary maintenance work or malfunction. Nevertheless, experience with current, continuously operated ozone monitors shows that such situations rarely occur.

Countries reported information on the validity of one-hour measurements at 1 549 stations (equal to 71 % of all of 2 186 operational stations). Of those, 1 311 (85 %) provided valid one-hour measurements at least 90 % of the time as requested by Directive 2008/50/EC (see Table A2.1). The proportions were similar to those of the 2007–2010 period.

An overview of monthly reported data is presented by the ETC/ACM and regularly updated on the EEA website (EEA, 2012e).

The ozone-monitoring network in 2011

Map A.1 presents the location of all ozone-monitoring stations assumed to be operational in the reporting countries during summer 2011. In total, 2 186 ozone-monitoring sites were operational in summer 2011, 2 122 of which were located in the EU.

The number of operational stations is similar to that in 2011 (Table 3.1). Most countries did not significantly change the number of ozone-monitoring stations compared to the preceding year.

The minimum number of sampling points for fixed continuous measurements, to assess compliance with target values, long-term objectives and information and alert thresholds where such measurements are the sole source of information, is set out in Directive 2008/50/EC; these sampling points should be situated away from the influence of local emissions. When there are more stations than the requested minimum, other locations might be selected as well. Station meta-information reveals that 431 (approximately 20 %) traffic or industrial stations are used for summer ozone assessment in the various countries. These stations were included in 2011 summer reporting and the current analysis to match the practice in previous years. The share of the traffic and industrial stations remains similar over the past years.

Most of the countries transmitted sufficient or complete information about all operational stations. To fill the gaps in station meta-information, i.e. geographical coordinates, information was extracted from AirBase. Nevertheless, for approximately 8 % of stations, the type of station was not known.

Table A.2.1 Overview of validity of one-hour measurements during summer 2011, by country

Country	Stations with available information ([a]) (%)	Stations with at least 90 % of valid one-hour data ([b]) (%)	Industrial and traffic stations ([c]) (%)
Austria	100	87	15
Belgium	100	100	22
Bulgaria	100	89	17
Cyprus	100	100	50
Czech Republic	100	98	10
Denmark	89	50	22
Estonia	100	100	33
Finland	100	83	6
France	94	93	3
Germany	0	–	16
Greece	100	73	55
Hungary	100	88	18
Ireland	100	75	8
Italy	0	–	0
Latvia	100	88	38
Lithuania	100	100	50
Luxembourg	100	83	17
Malta	100	80	40
Netherlands	100	74	15
Poland	100	69	3
Portugal	95	92	11
Romania	100	29	45
Slovakia	100	80	0
Slovenia	100	92	17
Spain	100	86	54
Sweden	100	92	0
United Kingdom	100	89	9
Albania	0	–	67
Bosnia and Herzegovina	100	100	100
Croatia	100	0	100
former Yugoslav Republic of Macedonia	0	–	91
Iceland	100	100	100
Kosovo under the UNSC Resolution 1244/99	100	0	0
Liechtenstein	100	100	100
Montenegro	100	50	0
Norway	100	86	0
Serbia	100	100	20
Switzerland	100	100	26
Turkey	100	33	33
Total	**71**	**85**	**20**

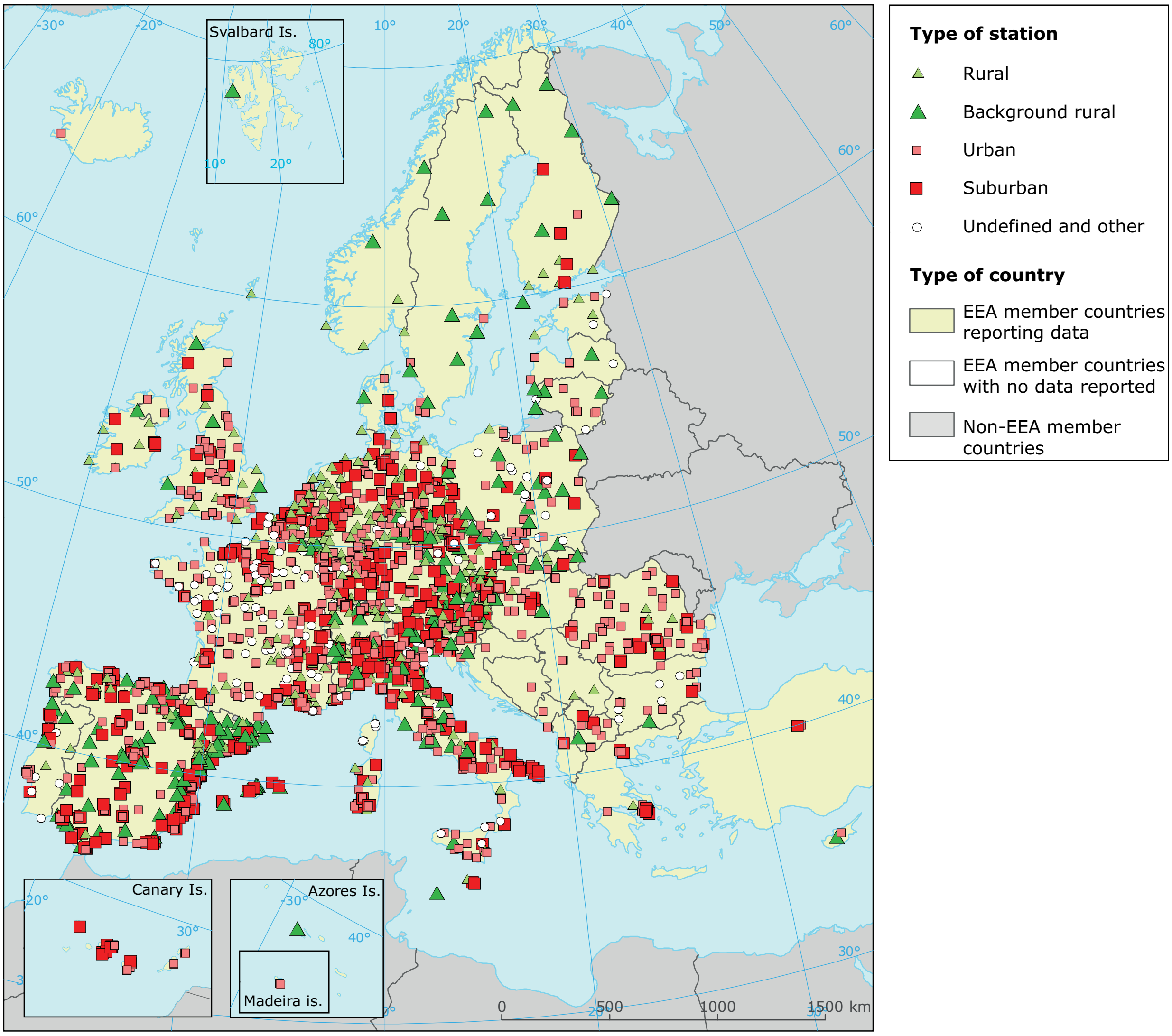
Notes: ([a]) The percentage of stations for which the country provided information on the validity of one-hour measurements.

([b]) The percentage of stations for which the country provided information, which provided valid one-hour measurements at least 90 % of the time during summer 2011.

([c]) The percentage of stations with the location classification of 'traffic' or 'industrial' (EC, 1997).

'–' indicates 'not applicable'. Data are provisional.

Map A.2.1 Location of ozone-monitoring stations in summer 2011 as reported by Member States and other European countries



Annex 3 Near real-time ozone data exchange

The information on ozone exceedances summarised in this report is provided through monthly reporting by EU Member States. This practice can be streamlined and updated by adopting a near real-time (NRT) air quality (AQ) data exchange.

EEA's work on NRT AQ data exchange is carried out in the context of the EEA's coordination role in Global Monitoring for Environment and Security (GMES) in situ coordination (GISC) and Shared Environmental Information Systems (SEIS). The EEA's NRT AQ data exchange serves several purposes within the AQ and environmental community within Europe. Initially, the EEA's NRT AQ data exchange aims to serve the general public, technical experts and European research projects/pre-operational GMES Atmospheric Services (e.g. the MACC project). The requirements for such services are broad and EEA attempts to fulfil as many as possible, streamlining European data exchange for NRT AQ information.

In the last couple of years, the NRT data exchange of ozone has matured and EEA has piloted the use of provisional NRT AQ data for calculating summer ozone exceedances. This has been provided on monthly basis historically using MS Excel files through the Eionet Central Data Repository (CDR). The provisional data consist of data submitted both as NRT, but also those resubmitted with extra verification. The piloting carried out in 2011 has shown an improved agreement between official summer ozone reporting (SOR) and calculated exceedances using provisional hourly NRT AQ data.

The NRT AQ data exchange focuses on both timely submission of AQ data (useful for data assimilation) but also the resubmission of data that has gone through further QA/QC checks. The resubmission of data is important for several issues, including the following:

- consistency between EEA's AQ web portals and local information;
- timely assessment of episodes at the European level;
- medium-term model re-verification;
- SOR exceedances calculations;
- reassurance to data providers concerning the deletion of erroneous data.

The operational EEA NRT data exchange programme for ozone across Europe is also in place for following common AQ components: nitrogen dioxide (NO_2), particulate matter (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometer (PM_{10}) and 2.5 micrometer ($PM_{2.5}$)), CO, and sulphur dioxide (SO_2). Currently, the Ozone Web (EEA, 2012a) provides NRT ambient ozone levels across Europe.

NRT hourly ozone data from more than 1 700 stations across Europe are exchanged with the EEA. The information is provided by national and regional organisations. Since the data must be as 'real time' as possible, they are displayed as soon as possible after the end of each hour. The AQ data displayed via Ozone Web are preliminary and may change upon validation, and are not used for legal policy compliance reporting. Data providers can resubmit AQ data whenever these have undergone a more rigorous validation/verification process.

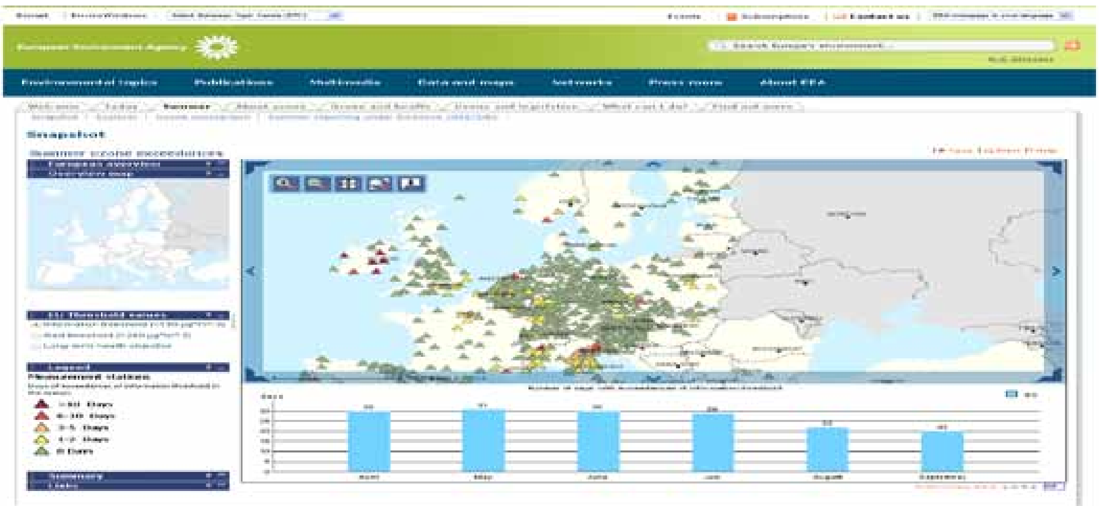
The EEA Ozone Web page consists of different sections with static information, maps and tabular data. During summer 2011, EEA launched a new map viewer for faster and more user-friendly viewing (Map A3.1). Ozone web continues to offer the Snapshot and Explorer (EEA, 2012b) modules, which can be used for display and download of the same statistics as described in this report, but which are based on delivered NRT data (Map A3.2).

During 2011, a monthly comparison was carried out between monthly SOR submission and exceedances calculated using NRT ozone data submitted during the summer. Discrepancies between both submissions have been used to inform data providers in order to improve data resubmission under NRT. This exercise, led by ETC/ACM, has achieved improvements in data communication.

Comparisons of the threshold exceedances calculated from the NRT data and summer data were presented at the last Eionet Workshops on Air Quality Management and Assessment. An improved alignment between NRT exceedances and SOR, with nearly 75 % matching maximum monthly exceedances and nearly 75 % matching monthly

Map A3.1 New Ozone Web map viewer

Map A3.2 Screenshot of Ozone Web



number of exceedances, was shown. Moreover, the number of data provider dropouts has fallen, as has the number of long persistent dropouts. Stability between the EEA and data providers, and communication between providers and the ETC/ACM have both improved.

A comparison between SOR submission and NRT is shown in Tables A3.1 and A3.2. The number of stations incorporated in the NRT was lower than officially reported during summer 2011. However, most of the exceeding stations are part of the current data exchange. The number of threshold exceedances recorded by NRT and the maximum observed one-hour concentrations were often higher for individual countries; this was due to poor resubmission of the validated data by some data providers, i.e. incorrect values persisted in the NRT database (Table A3.1). Compared to comparisons carried out in 2009 and 2010, the match between NRT-calculated exceedances and those presented via the monthly submission is much improved.

If maximum monthly exceedances are compared between April and September (see Table A3.2),

Table A.3.1 Comparison of the summer reporting (SOR) with near real-time reporting in summer 2011

Country	Summer ozone reporting						Near real-time ozone reporting					
	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed one-hour concentration (µg/m⁻³)	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed one-hour concentration (µg/m⁻³)
		Info	Alert	Info	Alert			Info	Alert	Info	Alert	
Austria	112	17	0	7	–	213	106	17	0	7	0	213
Belgium	41	13	0	1	–	220	40	12	0	1	0	220
Bulgaria	18	3	3	6	2	512	2	0	0	0	0	–
Cyprus	2	0	0	–	–	154	2	0	0	0	0	0
Czech Republic	61	1	0	1	–	181	61	1	0	1	0	180
Denmark	9	0	0	–	–	169	6	2	0	4	0	219
Estonia	9	0	0	–	–	175	2	0	0	0	0	0
Finland	18	0	0	–	–	178	17	2	0	3	0	219
France	424	79	5	34	2	282	377	53	2	21	2	392
Germany	252	16	0	9	–	226	272	21	0	9	0	226
Greece	24	13	3	42	3	270	x	x	x	x	x	x
Hungary	17	2	0	1	–	187	17	2	1	3	1	241
Ireland	12	0	0	–	–	268	13	1	1	1	1	249
Italy	343	149	11	81	6	300	133	88	25	128	48	400
Latvia	8	0	0	–	–	161	1	0	0	0	0	–
Lithuania	12	0	0	–	–	162	7	0	0	0	0	–
Luxembourg	6	2	0	1	–	190	6	3	0	2	0	190
Malta	5	1	0	4	–	200	3	1	1	7	1	290
Netherlands	39	25	0	1	–	229	32	20	0	2	0	229
Poland	78	0	0	–	–	177	45	5	3	7	4	337
Portugal	38	14	1	16	1	243	43	14	2	16	2	326
Romania	82	0	0	–	–	164	31	0	0	0	0	–
Slovakia	15	1	0	2	–	202	15	2	1	2	1	329
Slovenia	12	3	0	3	–	199	12	3	0	3	0	199
Spain	411	34	2	32	4	301	265	52	20	84	36	395
Sweden	12	0	0	–	–	162	9	0	0	0	0	–
United Kingdom	82	0	0	–	–	180	82	0	0	0	0	180
EU area	**2 142**	**373**	**25**	**128**	**18**	**512**	**1 599**	**299**	**56**	**156**	**84**	**400**
Albania	3	0	0	–	–	x	x	x	x	x	x	x
Bosnia and Herzegovina	1	0	0	–	–	113	x	x	x	x	x	x
Croatia	2	0	0	–	–	167	2	0	0	0	0	–
former Yugoslav Republic of Macedonia	11	1	0	10	–	206	x	x	x	x	x	x
Iceland	2	0	0	–	–	x	0	0	0	0	0	–
Kosovo under the UNSC Resolution 1244/99	1	0	0	–	–	175	x	x	x	x	x	x
Liechtenstein	1	0	0	–	–	169	1	0	0	0	0	–
Montenegro	2	0	0	–	–	169	x	x	x	x	x	x
Norway	7	0	0	–	–	168	9	3	2	13	10	383
Serbia	5	1	0	3	–	216	x	x	x	x	x	x
Switzerland	27	9	2	13	1	282	31	9	2	13	1	282
Turkey	3	2	1	41	23	520	3	3	1	46	29	520

Note: White columns refer to exceedances of the information threshold, grey to exceedances of the alert threshold. Orange cells refer to NRT > SOR, yellow cells to NRT < SOR, and green cells to NRT = SOR.

Table A.3.2 Comparison of the summer monthly exceedance reported under SOR with NRT reporting in summer 2011

Country	SOR						NRT					
	Max concentrations						Max concentrations					
	April	May	June	July	Aug.	Sep.	April	May	June	July	Aug.	Sep.
Austria	0	0	0	201	213	197	–	–	–	201	213	197
Belgium	0	0	220	0	0	0	–	–	220	–	–	–
Bulgaria	0	0	512	268	194	0	–	–	–	–	–	–
Cyprus	0	0	0	0	0	0	–	–	–	–	–	–
Czech Republic	0	0	0	0	181	0	–	–	–	–	180	–
Denmark	0	0	0	201	0	0	–	187	219	–	–	–
Estonia	0	0	0	0	0	0	–	–	–	–	–	–
Finland	0	0	0	0	0	0	–	–	–	207	219	–
France	189	206	218	282	282	195	392	206	218	282	198	186
Germany	0	189	226	185	192	0	–	188	226	185	221	–
Greece	0	185	198	270	223	222	x	x	x	x	x	x
Hungary	0	0	0	0	187	0	–	–	–	241	187	191
Ireland	0	0	0	0	0	0	–	–	–	–	–	249
Italy	203	224	300	278	293	227	383	398	362	384	294	400
Latvia	0	0	0	0	0	0	–	–	–	–	–	–
Lithuania	0	0	0	0	0	0	–	–	–	–	–	–
Luxembourg	0	0	190	0	0	0	–	–	190	–	–	186
Malta	0	0	0	191	200	0	–	180	184	190	200	290
Netherlands	0	0	229	0	0	0	193	–	229	–	–	–
Poland	0	0	0	0	0	0	228	337	–	324	–	262
Portugal	0	207	243	238	205	223	–	207	243	238	205	326
Romania	0	0	0	0	0	0	–	–	–	–	–	–
Slovakia	0	0	0	0	183	202	–	329	–	–	–	201
Slovenia	0	199	0	0	186	0	–	199	–	–	186	–
Spain	276	211	280	301	243	191	358	226	316	323	362	395
Sweden	0	0	0	0	0	0	–	–	–	–	–	–
United Kingdom	0	0	0	0	0	0	180	–	–	–	–	–
Albania	0	0	0	0	0	0	x	x	x	x	x	x
Bosnia and Herzegovina	0	0	0	0	0	0	x	x	x	x	x	x
Croatia	0	0	0	0	0	0	–	–	–	–	–	–
former Yugoslav Republic of Macedonia	189	204	198	206	0	0	x	x	x	x	x	x
Iceland	0	0	0	0	0	0	–	–	–	–	–	–
Kosovo under the UNSC Resolution 1244/99	0	0	0	0	0	0	x	x	x	x	x	x
Liechtenstein	0	0	0	0	0	0	–	–	–	–	–	–
Montenegro	0	0	0	0	0	0	x	x	x	x	x	x
Norway	0	0	0	0	0	0	–	–	195	383	286	336
Serbia	0	0	0	216	0	0	x	x	x	x	x	x
Switzerland	0	188	282	188	203	0	–	188	282	188	203	–
Turkey	0	0	206	278	520	0	–	–	211	278	520	341

Note: Orange cells refer to NRT > SOR, yellow cells to NRT < SOR, and green cells to NRT = SOR.

a better alignment can be observed. With the exception of some providers with a great number of stations and a degree of regionalisation like France, Italy and Spain, the match of the monthly exceedances is greater. For Spain, in particular, the match for most regions is 1 to 1 and the overall figures show data resubmission issues by particular data providers.

Previous presentations comparing SOR and NRT were made by Berkhout (2007), Cernikovsky (2008 and 2009) and Targa (2010).

Further details and documents on the progress of the EEA NRT data exchange and the pilot to replace the summer ozone report are provided by Eionet (2012).

Present-day plans on data flows were discussed during workshop session 6; presentations are available online (Gabrielsen, 2009).

The summer ozone report uses NRT AQ data to align with Directive 2008/50/EC and the new Implementing Rules (IPR) 2011/850/EC (EC, 2011). In the very near future, SOR exceedance calculations will only be produced using NRT AQ data delivered to the EEA. The EEA is already preparing for this, and is assessing the current data flow against its Central Data Repository (CDR) uploads. This approach will be tested throughout Europe as the forthcoming AQ e-reporting system is developed.

In addition to Ozone Web, EEA has expanded its Eye on Earth portal to include AirWatch, which provides AQ information to the citizens of Europe. Launched in November 2009, the site provides interactive information from street level to continental scales. The NRT information derives from AQ measurement stations and chemical transport modelling provided by the GMES Atmosphere Service (outputs from the MACC project) (Eye on Earth, 2012).

European Environment Agency

Air pollution by ozone across Europe during summer 2011

2012 — 46 pp. — 21 x 29.7 cm

ISBN 978-92-9213-276-7
doi:10.2800/95368

TH-AK-12-001-EN-N
doi:10.2800/95368

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ISBN 978-92-9213-276-7

Publications Office

European Environment Agency