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Air pollution by ozone across Europe during summer 2012

Overview of exceedances of EC ozone threshold values for April–September 2012

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European Environment Agency

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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 2012 ([1]).

In the summer of 2012, the threshold of 120 micrograms per cubic metre of air (μg/m^3) maximum daily eight-hour mean was exceeded on more than 25 days again across large parts 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 this threshold occurred 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 five other countries (Albania, Croatia, the former Yugoslav Republic of Macedonia, Serbia and Switzerland). As in previous years, the most widespread concentrations occurred in the Mediterranean area.

The long-term objective (LTO) for the protection of human health (a maximum daily eight-hour mean concentration of 120 μg/m^3) was exceeded in all EU Member States except Estonia. The average number of LTO exceedances in 2012 was comparable with 2009–2011 years.

The so-called 'information threshold' (a one-hour average ozone concentration of 180 μg/m^3) was exceeded at approximately 28 % of all operational stations at least once during the summer, one of the lowest percentages since 1997. After a slight increase in occurrence of exceedances in 2010, there was a reduction of the information threshold exceedances in the years 2011 and 2012 back to levels seen in the years 2008 or 2009 in most European regions. In northern Europe, there were no exceedances of the information threshold in 2012, except for one in Denmark.

The so-called 'alert threshold' (a one-hour average ozone concentration of 240 μg/m^3) was exceeded in the 3 % of stations (only 25 times) during the summer, which is the lowest number on record.

The largest ozone episode in terms of area affected occurred between 24 and 28 July, and accounted for approximately 33 % of the total number of exceedances of the information threshold, 32 % of the exceedances of the alert threshold, and about 12 % of the exceedances of the LTO.

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 volatile organic compounds (VOC) (Royal Society, 2008; US EPA, 2010 and 2011). 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

([1]) Ozone levels in summer 2012 were compared with the summer ozone concentrations from 1997 to 2011. Summer ozone concentrations from 1997 to 2010 are validated and stored in the EEA's public air quality database (AirBase). Summer ozone concentrations for 2011 and 2012 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' (TV). 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 2012 (i.e. not more than 25 days with a maximum eight-hour average exceeding 120 μg/m^3), rather than to the three-year validated data average used in assessing exceedance of the TV.

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 2012, 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 2012, 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 Member 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 (see Annex 1). 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, 2012d). In addition, the EEA's near-real-time 'Air quality levels in Europe' website (EEA, 2012b) shows provisional ground-level ozone levels across Europe, and provides up-to-date information (see Annex 3).

Overview of ozone air pollution in summer 2012

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 UNSCR 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, 2 107 ozone monitoring sites reported data, of which 2 040 were located in EU Member States. The following preliminary conclusions can be drawn from the period April–September 2012:

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 one of the lowest percentages since comprehensive Europe-wide data reporting commenced in 1997. Ozone concentrations higher than the information threshold were reported from monitoring sites in 18 EU Member States and six non-member countries. The information threshold was exceeded at approximately 28 % of all operational stations.

- The spatial extent of the exceedances observed in the summer of 2012 is slightly larger than in the summer of 2011 because of larger impacts in western Europe. No exceedances were reported from the Baltic States, Bosnia and Herzegovina, Cyprus, the former Yugoslav Republic of Macedonia, Ireland, Iceland, Liechtenstein, Malta, Montenegro, Scandinavia (excluding Denmark), and Slovakia in summer 2012. Only in northern Italy, southern France and several more isolated locations were exceedances of the information threshold reported on more than five days during each episode.

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 25 occasions which is the lowest number on record. They occurred in only seven EU Member States (Belgium, France, Germany, Greece, Italy, Portugal and Spain). Exceedances of the alert threshold were observed at all 17 locations, mainly in northern Italy and at other locations where the information threshold was most often exceeded. 12 of the 17 stations (or 71 %) that reported an exceedance of the alert threshold did so on just one day. The station that had the highest number of days where the alert threshold was exceeded was Lecco via Sora in

Italy, where the threshold was exceeded on four days.

Maximum concentrations

- Only one hourly concentration higher than 300 μg/m^3 was reported (Thrakomakedones, Greece, 343 μg/m^3, 16 July).

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

- LTO exceedances (a maximum daily 8-hour average concentration of ozone over 120 μg/m^3) were observed in every EU Member State this summer with the exception of Estonia. Exceedances of the LTO were also observed in most of the other reporting countries. Approximately 85 % of all stations reported one or more exceedances.

- The number of LTO exceedance days per country ranged from zero to 168 (in Spain) out of a maximum of 183 days. More than 150 exceedance days were reported by Spain, Italy and Greece. On every single day except one (21 September) during summer 2012, at least one of the 2 107 operational stations in Europe reported an exceedance of the LTO. On average, those stations observing at least one LTO exceedance reported a total of 19 days of exceedance. The maximum number of 143 exceedance days was observed at the station Panorama in Greece.

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 three years. 2010 was the first year in a rolling sequence of three years that will be used in determining whether countries are meeting the TV requirement. The report lists the cases where LTO was exceeded more than 25 times during summer 2012 and also an indicative calculation of the first TV (based on the years 2010–2012). This indicative calculation does not have any compliance purpose.

- During summer 2012, TV exceedances occurred at stations 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 five other countries (Albania, Croatia, the former Yugoslav Republic of Macedonia, Serbia and Switzerland).

- TV exceedances occurred at 21 % of all monitoring stations providing reports. This corresponded to approximately 18 % of the area assessed, affecting approximately 15 % of the total population.

Main ozone episodes ([3])

- Summer 2012 was characterised by short regional ozone episodes with few exceedances of thresholds between mid-June and the end of August. There were only three longer episodes this summer: a six-day episode in June, a five-day episode in August and a five-day episode in July. These episodes contained approximately 63 % of the total number of exceedances of the information threshold, 60 % of the total number of exceedances of the alert threshold, and 27 % of the total number of LTO exceedances experienced during the summer.

- The largest episode in terms of area affected occurred between 24 and 28 July, and accounted for approximately 33 % of the total number of exceedances of the information threshold, 32 % of the total number of exceedances of the alert threshold, and about 12 % of the number of 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.

([3]) 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).

The highest number of exceedances of all types is often in the Mediterranean region, while the lowest number of exceedances is often in northern Europe. The number of occurrences of exceedances of all types in southern Europe was lower between 1999 and 2002 than in the extreme summer of 2003, which saw a very large number of occurrences. More northern parts of Europe also saw a similar pattern. Ozone levels in 2004 and 2005 decreased to previous levels, but in 2006 there was a further increase across all of 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 occurrence of exceedances in 2010, there was a reduction in information threshold exceedances in the years 2011 and 2012 in most European regions to levels comparable to 2008 or 2009. In northern Europe, there were no exceedances of the information threshold in 2012, except for one in Denmark. The average number of LTO exceedances in 2012 was comparable with the years between 2009 and 2011.

Disclaimer

The preliminary analysis contains summary information based on data delivered before 21 December 2012.

The information describing the situation during summer 2012 is based on non-validated monitoring data and should therefore be regarded as preliminary.

1 Introduction

Ozone is the main product of complex photochemical processes in the lower atmosphere, involving NO_X and VOC 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 (EC, 1992). That directive was succeeded by Directive 2002/3/EC (EC, 2002). 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 (EC, 1996)). It set LTOs and TVs, and an 'alert' threshold and an 'information' threshold for ozone (Table 1.1) for the purpose of avoiding, preventing or reducing harmful effects on human health and the 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 (EC, 1999); 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 (EC, 2000); and Directive 2002/3/EC) remained in force until 11 June 2010, when they were repealed by Directive 2008/50/EC ([4]). 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 that regulated objectives between April and September 2012, and sets out the evolution and trends in these exceedances from 1997. The EEA has prepared similar overviews since 1997 ([5]).

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 values and target values 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 tree years; 2010 will be the first year for which the data are used in calculating compliance over the following three years.

([4]) 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 as from 1 January 2014, two years after entry into force of the implementing measures of Directive 2008/50/EC (EC, 2011).

([5]) Previous reports are available from the EEA website: http://www.eea.europa.eu/publications.

2 Ozone air pollution in summer 2012

This chapter provides detailed country-by-country, month-by-month and day-by-day tabular, graphic and geographical information on threshold exceedances during summer 2012. 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 2012, as required by the 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 18 EU Member States and six other countries (Table 2.1).

The percentage of stations that recorded exceedances of the information threshold is one of the lowest percentages since comprehensive Europe-wide data reporting commenced in 1997. Only one exceedance of the information threshold was observed in northern Europe (in Denmark), and only several days with exceedances occurred in north-western and central Europe. The highest percentage of stations with at least five exceedances of the information threshold was observed in northern Italy and southern France, and in isolated stations in several other countries.

Table 2.2, Figure 2.1 and Figure 2.6 present the distribution of hourly exceedances during summer 2012. The highest number of exceedances occurred during July and August, which respectively accounted for approximately 44 % and 30 % of all observed information threshold exceedances, and about 56 % and 32 % of alert threshold exceedances ([6]). The low share of exceedances of the information threshold for June is due to the meteorological conditions, i.e. lower temperatures in the first half of the month (Figure 2.5). For the summer as a whole, the number of information threshold exceedances is the second lowest on record, and the number of alert threshold exceedances was also the lowest ever recorded at 25 (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 lowest hourly ozone value that exceeded the information threshold, the highest hourly ozone value that exceeded the information threshold, and the 25th and 75th percentiles of all values that exceeded the hourly threshold.

In Europe as a whole, 25 % of information threshold exceedances in 2012 were below 185 μg/m^3 (compared to 207 μg/m^3 in 2003, 185 μg/m^3 in 2004, 2008, 2009, 2010 and 2011, and 186 μg/m^3 in 2005–2007); and 75 % of exceedances in 2012 were below 200 μg/m^3. This means that the summer of 2012 and the summer of 2011 saw the lowest 75th percentile recording of exceedances of the information threshold since 2003 (305 μg/m^3 in 2003, 203 μg/m^3 in 2004 and 2010, 206 μg/m^3 in 2005–2008 and 202 μg/m^3 in 2009).

([6]) 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 2012, by country ([a])

Country	Number of stations ([b])	Stations with exceedances ([c])					Number of days with exceed-ances ([d])		Maximum observed one-hour con-centration (μg/m³)	Occurrence of exceedances ([e])				Average duration of exceed-ances (hour)	
		(number)		(%)		(%)									
Austria	113	10	0	9	–	–	3	–	199	0.1	1.0	–	–	1.6	–
Belgium	41	37	2	90	5	5	4	1	269	1.9	2.1	0.0	1.0	4.2	2.0
Bulgaria	18	6	0	33	–	–	14	–	221	0.9	2.8	–	–	2.7	–
Cyprus	2	0	0	–	–	–	–	–	176	–	–	–	–	–	–
Czech Republic	59	5	0	8	–	–	2	–	203	0.1	1.0	–	–	3.4	–
Denmark	10	1	0	10	–	–	1	–	185	0.1	1.0	–	–	1.0	–
Estonia	9	0	0	–	–	–	–	–	132	–	–	–	–	–	–
Finland	20	0	0	–	–	–	–	–	137	–	–	–	–	–	–
France	375	133	1	35	0	1	31	3	272	0.7	1.9	0.0	3.0	2.7	1.0
Germany	260	126	1	48	0	1	8	1	245	0.9	1.8	0.0	1.0	2.9	2.0
Greece	20	12	3	60	15	25	43	1	343	4.4	7.3	0.2	1.0	2.4	3.3
Hungary	17	3	0	18	–	–	3	–	197	0.2	1.3	–	–	2.8	–
Ireland	11	0	0	–	–	–	–	–	158	–	–	–	–	–	–
Italy	287	154	8	54	3	5	71	8	269	3.5	6.5	0.0	1.6	3.1	1.6
Latvia	8	0	0	–	–	–	–	–	152	–	–	–	–	–	–
Lithuania	14	0	0	–	–	–	–	–	179	–	–	–	–	–	–
Luxembourg	5	4	0	80	–	–	3	–	204	1.4	1.8	–	–	4.9	–
Malta	5	0	0	–	–	–	–	–	178	–	–	–	–	–	–
Netherlands	37	21	0	57	–	–	4	–	213	0.8	1.5	–	–	2.1	–
Poland	79	3	0	4	–	–	2	–	212	0.0	1.0	–	–	1.3	–
Portugal	39	15	1	38	3	7	16	1	244	0.7	1.9	0.0	1.0	2.0	1.0
Romania	89	6	0	7	–	–	12	–	197	0.2	2.7	–	–	2.2	–
Slovakia	14	0	0	–	–	–	–	–	174	–	–	–	–	–	–
Slovenia	12	8	0	67	–	–	9	–	205	1.6	2.4	–	–	3.1	–
Spain	401	33	1	8	0	3	30	2	251	0.2	2.4	0.0	2.0	1.5	1.0
Sweden	12	0	0	–	–	–	–	–	169	–	–	–	–	–	–
United Kingdom	83	2	0	2	–	–	2	–	186	0.0	1.0	–	–	1.5	–
EU area	**2 040**	**579**	**17**	**28**	**1**	**3**	**111**	**15**	**343**	**0.9**	**3.2**	**0.0**	**1.5**	**2.9**	**1.7**
Albania	2	1	0	50	–	–	1	–	184	0.5	1.0	–	–	1.0	–
Bosnia and Herzegovina	1	0	0	–	–	–	–	–	118	–	–	–	–	–	–
Croatia	2	1	0	50	–	–	1	–	188	0.5	1.0	–	–	3.0	–
Iceland	1	0	0	–	–	–	–	–	< 180	–	–	–	–	–	–
Kosovo under UNSCR 1244/99	5	1	0	20	–	–	1	–	190	0.2	1.0	–	–	1.0	–
Liechtenstein	1	0	0	–	–	–	–	–	165	–	–	–	–	–	–
Macedonia, former Yugoslav Republic of	10	0	0	–	–	–	–	–	179	–	–	–	–	–	–
Montenegro	2	0	0	–	–	–	–	–	174	–	–	–	–	–	–
Norway	7	0	0	–	–	–	–	–	130	–	–	–	–	–	–
Serbia	5	5	0	100	–	–	8	–	222	3.0	3.0	–	–	2.5	–
Switzerland	26	8	0	31	–	–	18	–	221	1.7	5.4	–	–	2.2	–
Turkey	5	2	0	40	–	–	10	–	231	2.0	5.0	–	–	1.6	–
Whole area	**2 107**	**597**	**17**	**28**	**1**	**3**	**115**	**15**	**343**	**0.9**	**3.2**	**0.0**	**1.5**	**2.9**	**1.7**

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

Table 2.2 Overview of exceedances of one-hour thresholds in Europe during the summer of 2012, by month

Month	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)		(%)		(%)									
April	2	0	0	–	–	4	–	197	0.0	0.0	–	–	3.8	–
May	57	0	3	–	–	13	–	225	0.0	0.1	–	–	2.8	–
June	150	2	7	0	1	27	2	251	0.2	0.6	0.0	0.1	2.8	1.0
July	440	12	21	1	3	30	7	343	0.4	1.4	0.0	0.8	3.1	2.1
August	252	8	12	0	3	30	5	272	0.3	1.0	0.0	0.5	2.6	1.3
September	36	1	2	0	3	11	1	242	0.0	0.1	0.0	0.1	1.8	1.0

Notes: Data are provisional. '–' indicates 'not applicable'.
White columns refer to exceedances of the information threshold, blue to exceedances of the alert threshold.
(c)–(e) see notes to Table 2.1.

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

No maximum daily 8-hour average concentration of ozone over 120 µg/m³ (the LTO) was observed in Estonia this summer. All other EU Member States experienced exceedances of the LTO threshold (Table 2.3).

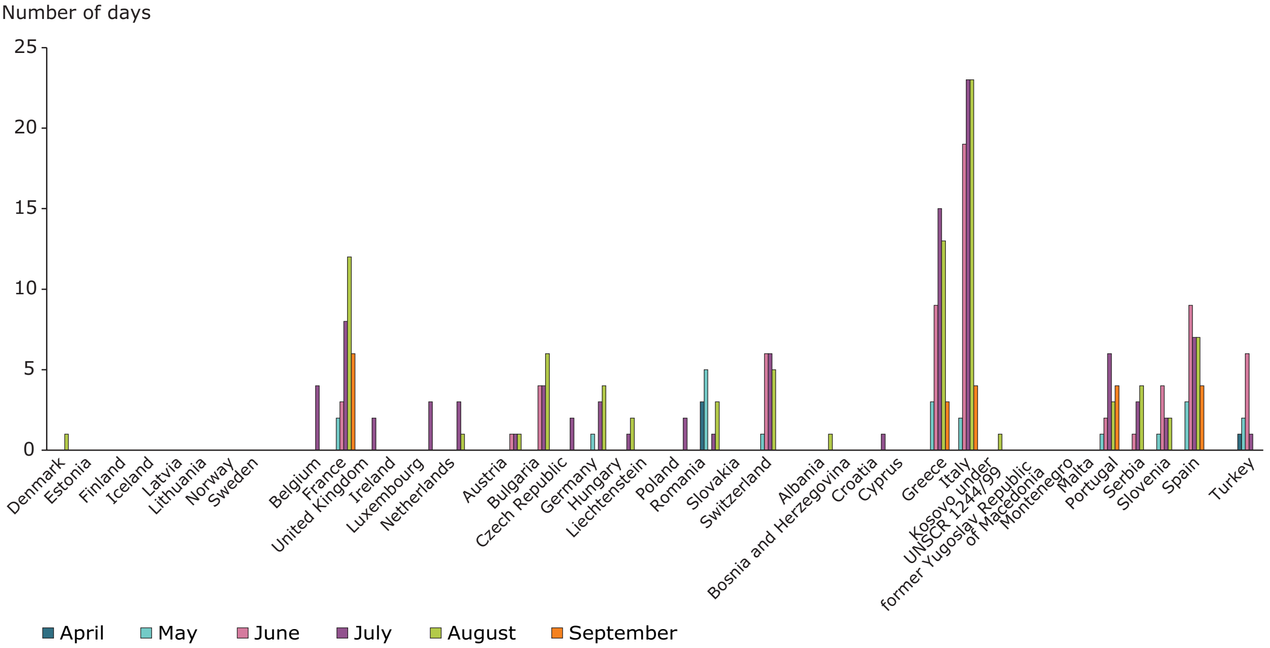
Table 2.4 presents the LTO exceedances on a monthly basis and Figure 2.6 shows them on a day-by-day and country basis. Approximately 85 % of all stations reported at least one exceedance of the LTO. There was one single day without an LTO-exceedance anywhere Europe in summer 2012 (21 September). With the other exception of 2008, there have been exceedances of the LTO threshold every day of every summer since 2001.

The highest number of LTO exceedances occurred during July and August 2012 (28 % and 27 % of all observed exceedances), and the lowest in April (4 %). The figure for April this year is the lowest on record for that month (Table 2.4, Figure 2.3). The distribution of exceedances is due to meteorological conditions, and there were more favourable meteorological conditions for ozone creation between mid June and the end of August (Figure 2.5).

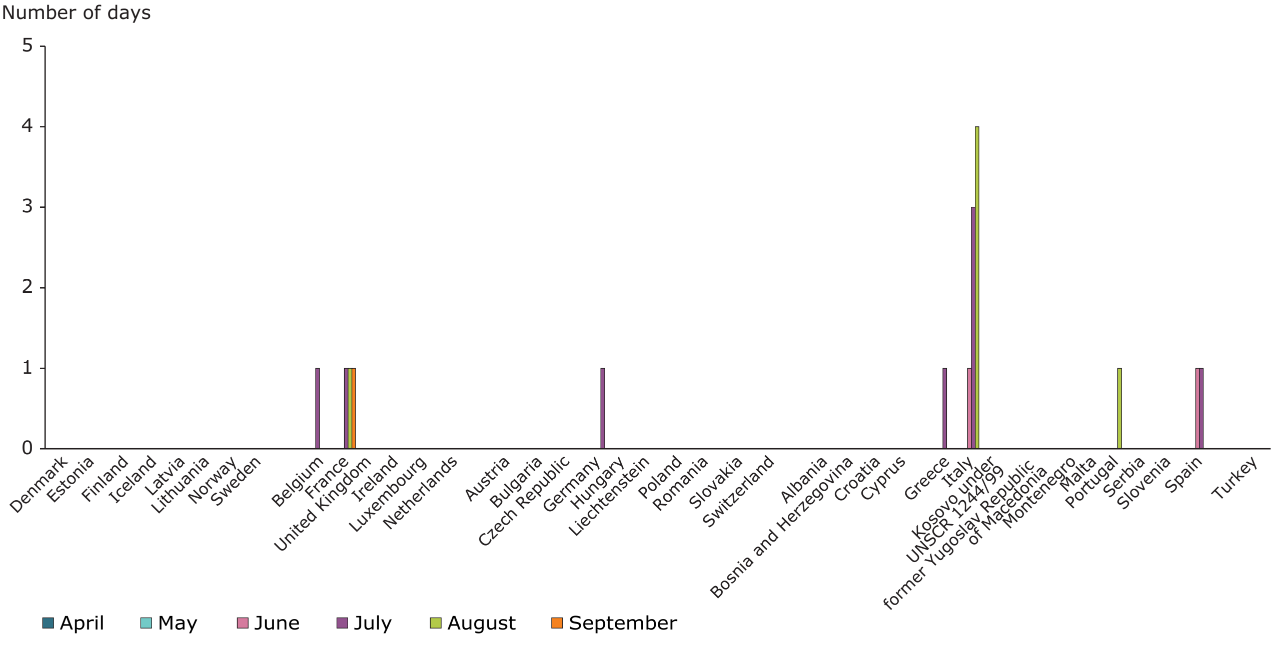
The frequency distribution of maximum daily 8-hour mean ozone concentrations exceeding the LTO of 120 µg/m³ is shown in Figure 2.4. In Europe as a whole, 25 % of maximum daily 8-hour mean

Figure 2.1 Number of days on which at least one exceedance of the one-hour threshold value was observed during summer 2012, per country and per month (only countries that submitted data are shown)

a) Information threshold exceedances



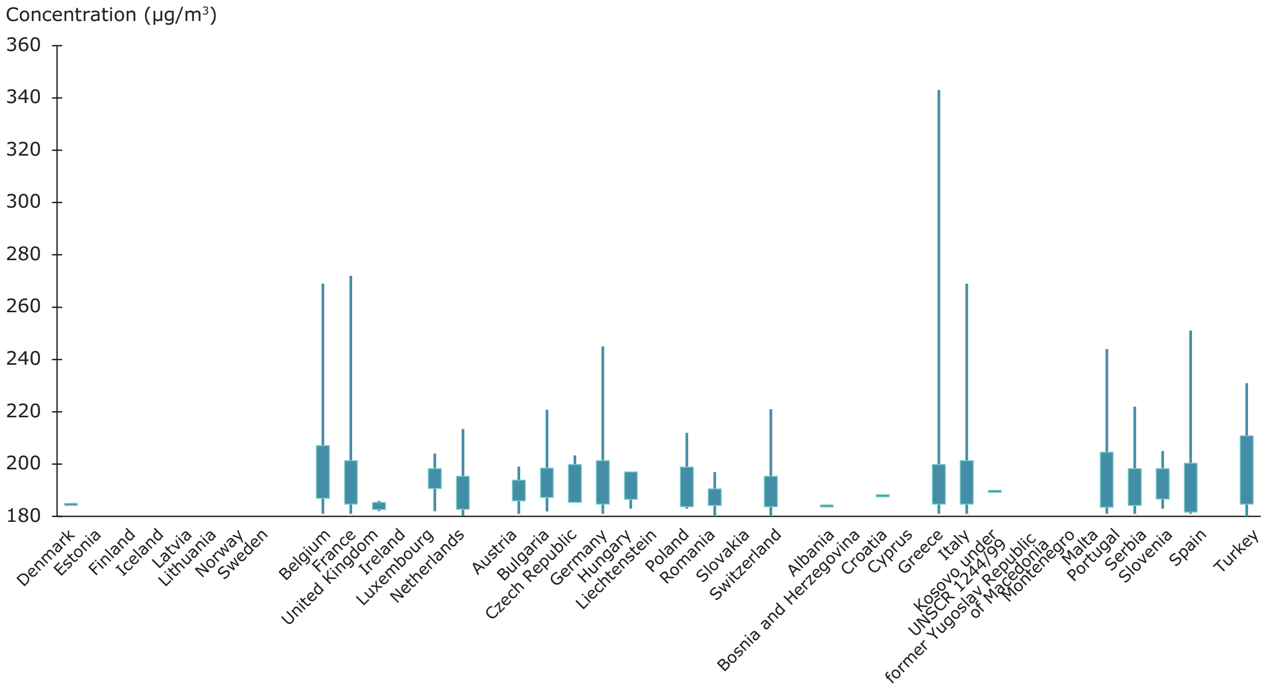
b) Alert threshold exceedances



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 2012 (only countries that submitted data are shown)



Notes: Data are provisional.

The box plots indicate the lowest hourly value that exceeded the threshold, the 25th percentile of all hourly values that exceeded the threshold, the 75th percentile of all hourly values that exceeded the threshold, and the highest hourly value that exceeded the threshold.

concentrations of all the observed exceedances were below 125 µg/m³ (this 25th percentile was 125 µg/m³ in 2011, 2008, 2007, 2005 and 2004; 127 µg/m³ in 2006; 124 µg/m³ in 2009; and 126 µg/m³ in 2010). 75 % were below 140 µg/m³ (this 75th percentile was 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 2011 and 2009).

The share of stations with an occurrence of LTO exceedances was the second lowest (after summer 2011) since reporting of Europe-wide data commenced in 1997 (Table 3.1).

The target value (TV) is exceeded when the LTO has been exceeded at a particular station more than 25 times per calendar year, averaged over three years. 2010 was the first year in a rolling sequence of three years that will be used in determining whether countries are meeting the TV. The TV threshold (120 µg/m³, maximum over eight hours, for more than 25 days) was exceeded in a significant part of Europe in 2012 comprising the following countries: 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 five other countries (Albania, Croatia, the former Yugoslav Republic of Macedonia, Serbia and Switzerland). The highest widespread concentrations occurred, as with previous years, in the Mediterranean area, but also affected western and central Europe.

Finally, and for the first time, the TV was estimated for indicative purposes. The assumptions when calculating it were as follows:

- the TV was calculated for information purposes and will not be used as the basis for the official TV value that will be reported in 2013
- the TV was calculated for all 27 members of the EU, plus 12 other countries
- only the six summer months were used, so this would be an underestimation of the TV, as exceedances of the maximum daily eight-hour average of 120 µg/m³ could occur also in the other months (mainly in March and October);

Table 2.3 Overview of exceedances of the long-term objective and target value threshold for the protection of human health during summer 2012, 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	113	111	98	45	40	118	177	22.4	22.8
Belgium	41	41	100	–	–	16	210	7.3	7.3
Bulgaria	18	17	94	9	50	135	208	28.4	30.1
Cyprus	2	2	100	1	50	74	165	38.0	38.0
Czech Republic	59	58	98	11	19	76	187	18.8	19.1
Denmark	10	7	70	–	–	11	158	2.6	3.7
Estonia	9	0	–	–	–	–	–	–	–
Finland	20	2	10	–	–	1	126	0.1	1.0
France	375	364	97	30	8	126	216	11.8	12.1
Germany	260	254	98	13	5	80	225	12.6	12.9
Greece	20	17	85	12	60	151	273	41.6	48.9
Hungary	17	16	94	12	71	102	176	34.2	36.3
Ireland	11	6	55	–	–	4	142	1.2	2.2
Italy	287	265	92	173	60	163	235	39.2	42.4
Latvia	8	2	25	–	–	24	147	3.5	14.0
Lithuania	14	9	64	–	–	27	168	4.3	6.7
Luxembourg	5	5	100	1	20	27	199	12.6	12.6
Malta	5	5	100	2	40	64	163	24.2	24.2
Netherlands	37	37	100	–	–	22	185	6.6	6.6
Poland	79	71	90	14	18	79	169	13.0	14.4
Portugal	39	34	87	1	3	52	189	7.9	9.1
Romania	89	30	34	5	6	147	180	5.5	16.2
Slovakia	14	14	100	8	57	97	159	29.9	29.9
Slovenia	12	12	100	9	75	113	191	44.3	44.3
Spain	401	325	81	73	18	168	179	12.3	15.2
Sweden	12	6	50	–	–	11	150	2.0	4.0
United Kingdom	83	37	45	–	–	14	165	0.8	1.7
EU area	**2 040**	**1 747**	**86**	**419**	**21**	**182**	**273**	**16.3**	**19.0**
Albania	2	2	100	1	50	72	157	38.0	38.0
Bosnia and Herzegovina	1	0	–	–	–	–	–	–	–
Croatia	2	2	100	2	100	63	170	46.5	46.5
Iceland	1	0	–	–	–	–	–	–	–
Kosovo under UNSCR 1244/99	5	3	60	–	–	33	148	7.2	12.0
Liechtenstein	1	1	100	–	–	15	166	15.0	15.0
Macedonia, former Yugoslav Republic of	10	3	30	2	20	65	166	10.2	34.0
Montenegro	2	2	100	–	–	23	149	12.0	12.0
Norway	7	2	29	–	–	2	125	0.4	1.5
Serbia	5	5	100	4	80	93	188	44.6	44.6
Switzerland	26	26	100	9	35	93	204	27.0	27.0
Turkey	5	0	–	–	–	–	–	–	–
Europe	**2 107**	**1 793**	**85**	**437**	**21**	**182**	**273**	**16.4**	**19.2**

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

No data delivered from Iceland and Turkey.

([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 which reported at least one exceedance.

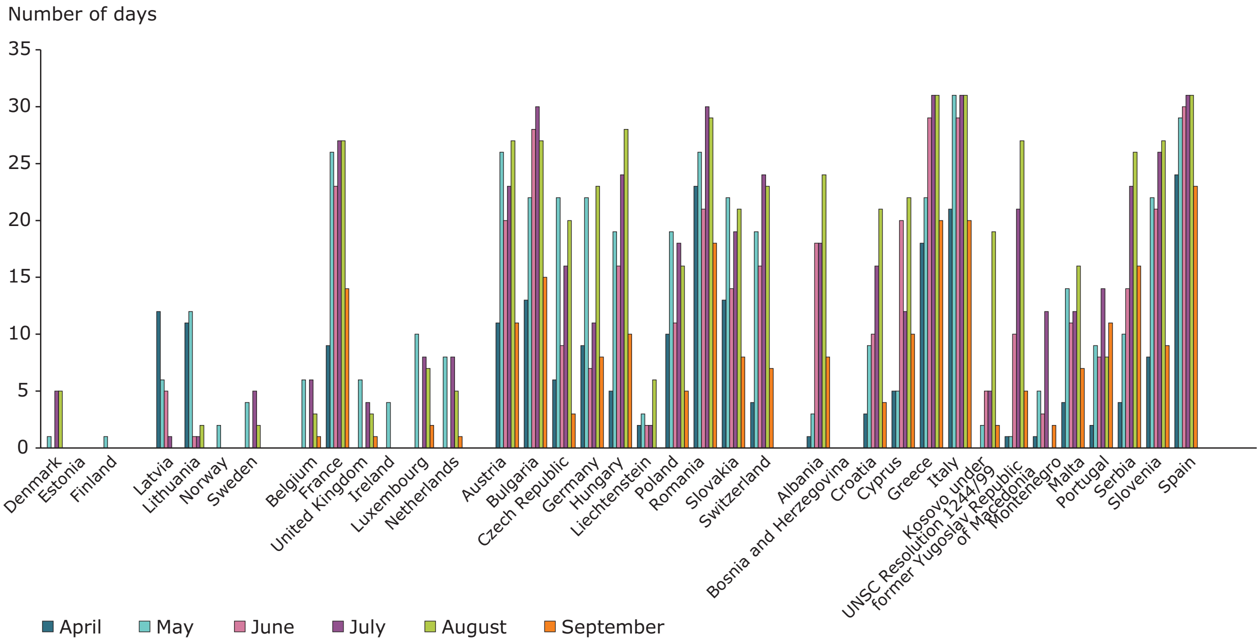
Table 2.4 Overview of exceedances of the long-term objective for the protection of human health in Europe during summer 2012, by month

Month	Stations with LTO exceedances (ᵇ)		Number of days with LTO exceedances (ᶜ)	Maximum observed 8-hour mean concentration (µg/m³)	Occurrence of LTO exceedances (ᵈ)	
	(number)	(%)				
April	605	29	30	171	0.7	0.8
May	1 345	64	31	208	2.9	3.4
June	996	47	30	215	2.5	3.0
July	1 565	74	31	273	4.5	5.3
August	1 357	64	31	226	4.4	5.2
September	906	43	29	184	1.3	1.5

Notes: Data are provisional.

(ᵇ)–(ᵈ) see notes to Table 2.3.

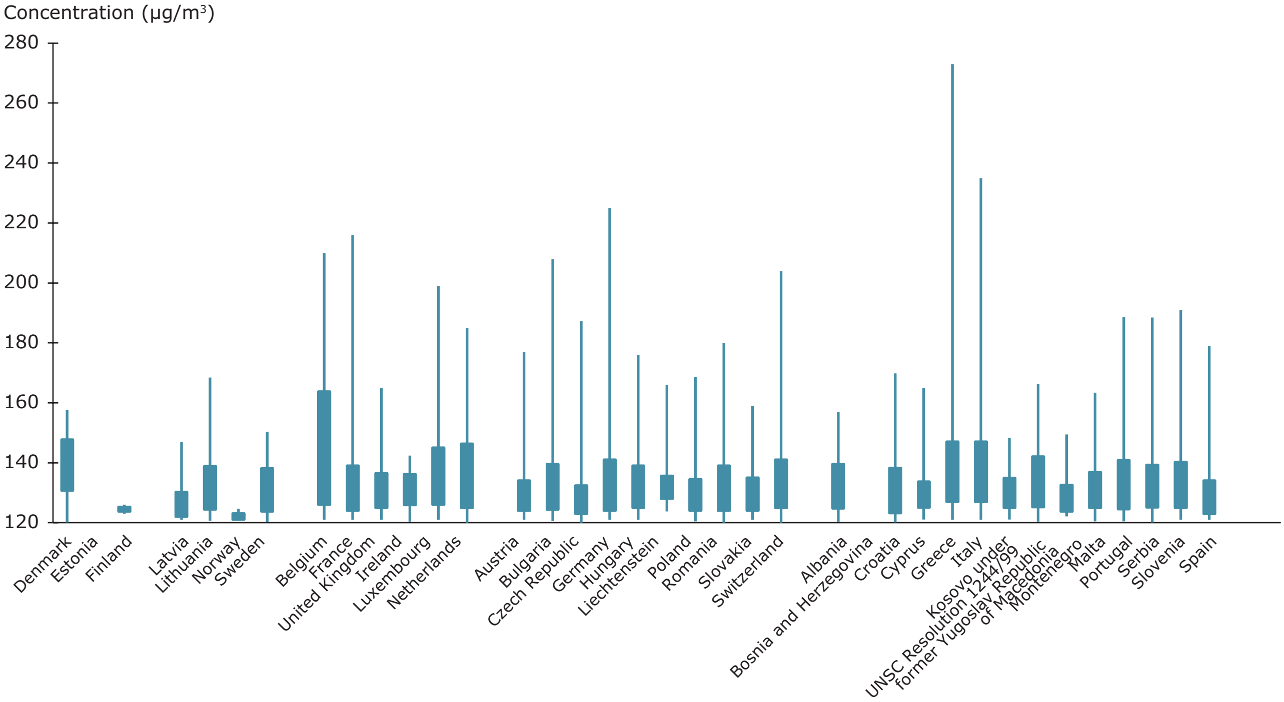
Figure 2.3 Number of days on which at least one exceedance of the long-term objective for the protection of human health was observed during summer 2012, per country and per month (only countries that submitted data are shown)



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 2.4 Frequency distribution of concentrations in excess of the long-term objective for the protection of human health during summer 2012 (only countries that submitted data are shown)



Notes: Data are provisional.

The box plots indicate the lowest value that exceeded the threshold, the 25th percentile of all values that exceeded the threshold, the 75th percentile of all values that exceeded the threshold, and the maximum value that exceeded the threshold.

- validated data were used only for 2010, while provisional data were used for 2011 and 2012;
- no time coverage criterion in relation to the Data Quality Objectives was applied;
- only stations for which the number of LTO exceedances is available for all three summers of 2010–2012 are involved in the country summary (Table 2.5) and in the related map (Map 2.3).

From a total of 2 322 stations reporting data from at least one year in 2010, 2011 and 2012, only 1 852 (80 % of the total) could be used for the exercise, as data from all the three years were reported only by these stations. Of these 1 852, 445 stations (24 %) had exceedances of the TV. This percentage is similar in the EU-27 area. The TV 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 four of the other countries that fulfilled the criteria established for this calculation exercise (Croatia, Liechtenstein, the former Yugoslav Republic of Macedonia and Switzerland).

In four of the EU Member States, and in three other countries, the percentage of stations fulfilling the criteria for the calculation exercise and with levels exceeding the 2010 TV was above 50 %. Four of these countries were in the Mediterranean area.

The TV is exceeded when the LTO has been exceeded at a particular station more than 25 times per calendar year averaged over the previous three years. In four countries in 2012, this averaged LTO was exceeded on more than 100 days, putting them at the highest end of the TV scale (Table 2.5 and Map 2.3). In three more countries, the averaged LTO was exceeded on between 75 and 99 days. In five countries the averaged LTO was exceeded on between 50 and 74 days, and in the other nine countries that reached the TV threshold, the LTO was exceeded on between 26 and 49 days.

Table 2.5 Overview of exceedances of the target value for the protection of human health (summer 2010, 2011 and 2012), 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 LTO was exceeded
Austria	106	49	46.2	66.0
Belgium	40	0	0.0	18.0
Bulgaria	18	4	22.2	105.0
Cyprus	2	1	50.0	58.0
Czech Republic	58	9	15.5	46.0
Denmark	9	0	0.0	7.0
Estonia	9	0	0.0	5.0
Finland	14	0	0.0	4.0
France	346	63	18.2	75.0
Germany	243	25	10.3	44.0
Greece	19	11	57.9	109.0
Hungary	17	9	52.9	46.0
Ireland	11	0	0.0	3.0
Italy	241	149	61.8	115.0
Latvia	7	0	0.0	10.0
Lithuania	12	0	0.0	13.0
Luxembourg	5	1	20.0	30.0
Malta	5	2	40.0	68.0
Netherlands	34	0	0.0	16.0
Poland	51	4	7.8	49.0
Portugal	29	4	13.8	40.0
Romania	64	1	1.6	31.0
Slovakia	14	7	50.0	55.0
Slovenia	12	9	75.0	82.0
Spain	350	75	21.4	108.0
Sweden	12	0	0.0	7.0
United Kingdom	79	0	0.0	9.0
EU area	**1 807**	**423**	**23.4**	
Albania	0	–	–	–
Bosnia and Herzegovina	1	0	0.0	3.0
Croatia	2	2	100.0	46.0
Iceland	0	–	–	–
Kosovo under UNSCR 1244/99	0	–	–	–
Liechtenstein	1	1	100.0	26.0
Macedonia, former Yugoslav Republic of	7	3	42.9	57.0
Montenegro	2	0	0.0	14.0
Norway	7	0	0.0	3.0
Serbia	1	0	0.0	21.0
Switzerland	24	16	66.7	75.0
Turkey	0	–	–	–
Whole area	**1 852**	**445**	**24.0**	

Notes: Data from 2010 are validated, while data from 2011 and 2012 are provisional.

White rows refer to countries with exceedances of the 2010 TV; blue rows to countries with no exceedances.

2.3 Geographical distribution of ozone air pollution

The spatial distribution of ozone exceedances throughout Europe is generally similar from year to year. In 2012, the highest ozone levels were found in northern Italy and southern France and also in several more isolated locations in Europe, where the highest number of information threshold exceedances was found. As in previous summers, northern and north-western Europe were almost not affected. The highest widespread exceedances of the TV for the protection of human health occurred mostly in the Mediterranean area, but also affected western and central Europe.

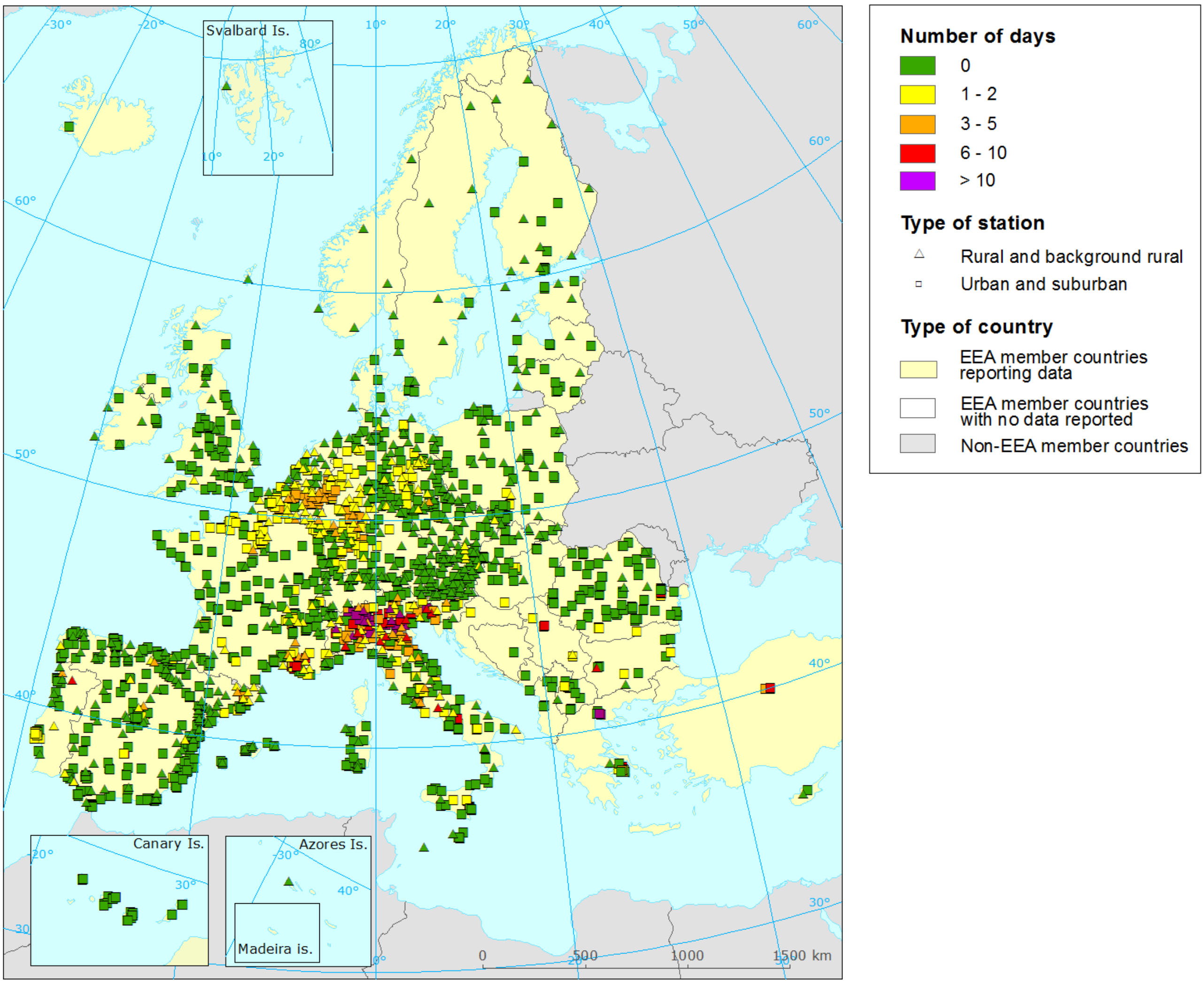
Only northern Italy, southern France and several more isolated locations reported exceedances of the information threshold on more than five days during each episode. No exceedances of the information threshold were reported from the Baltic states, Bosnia and Herzegovina, Cyprus, the former Yugoslav Republic of Macedonia, Iceland, Ireland, Liechtenstein, Malta, Montenegro, Scandinavia (excluding Denmark), Slovakia and Slovenia in summer 2012. The fewest exceedances of the LTO were reported from Scandinavia, United Kingdom, Ireland and the Baltic states.

Map 2.1 depicts the number of days on which the one-hour information threshold was exceeded across Europe. The spatial extent of the exceedances observed in the summer of 2012 is slightly larger than in the summer of 2011 because of a larger impact in western Europe.

Map 2.2 displays the number of days on which the LTO was exceeded across Europe. The areas that reported more than 25 days of LTO exceedance (relevant for determining exceedance of the TV) were in 2012 slightly larger in comparison to 2011. More than 25 LTO exceedances were recorded in approximately 18 % of the assessed area and affected approximately 15 % 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 during last years (Table 2.6).

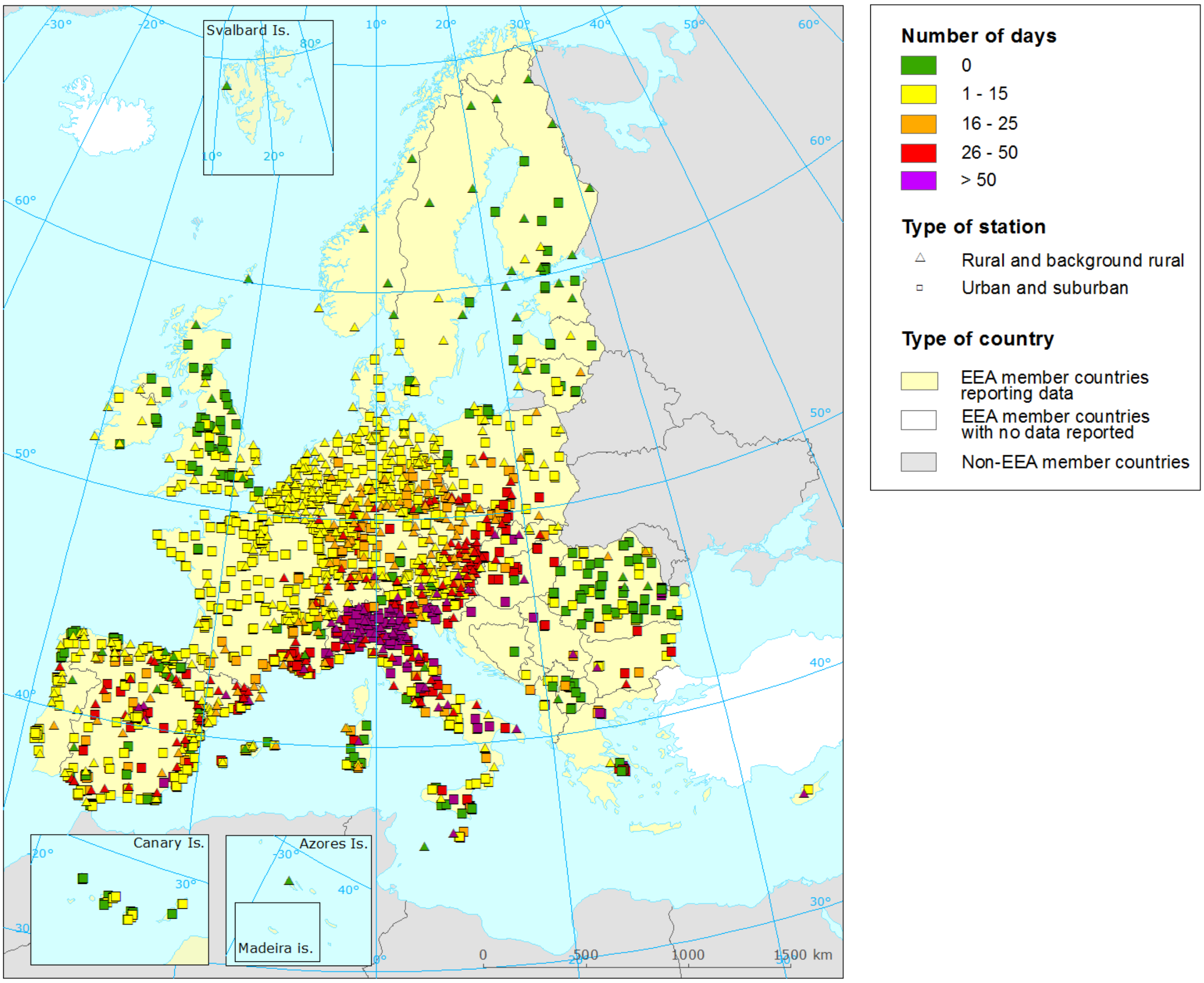
Map 2.3 shows, for rural and background rural, and for urban and suburban sites, the number of days on which the TV was exceeded across Europe. The area with exceedances of the TV (number of days > 25) covers a great part of Europe. The regions without exceedances of the TV were the Baltic States, north-western Europe and some poorly covered Balkan countries. On the other hand, the largest amount of exceedances is found in northern Italy, southern France and several more isolated locations, largely in the Mediterranean area.

Map 2.1 **Number of days on which ozone concentrations exceeded the information threshold during the summer of 2012 (provisional data)**



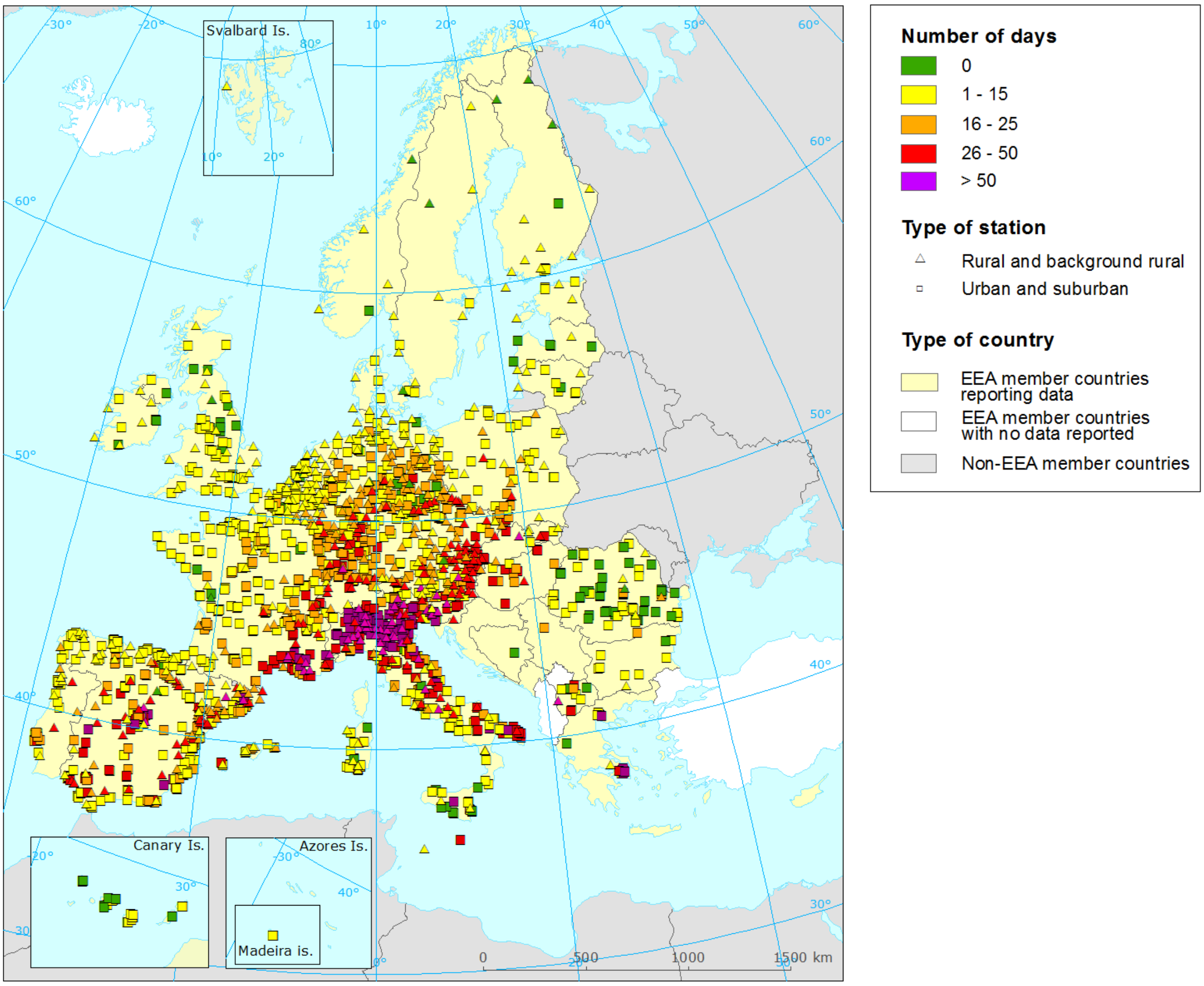
Note: Only stations with known metadata relating to the ozone type of station are depicted.

Map 2.2 Number of days on which ozone concentrations exceeded the long-term objective for the protection of human health during summer 2012 (provisional data)



Note: Only stations with known metadata relating to the ozone type of station are depicted.

Map 2.3 **TV calculation: three-year rolling average of summer days in which the LTO was exceeded (summers of 2010, 2011 and 2012) (data from 2010 are validated, while data from 2011 and 2012 are provisional)**



Note: Only stations with known metadata relating to the ozone type of station in AirBase are depicted.

Table 2.6 Overview of estimated percentage of total area and population resident in areas with more than 25 days of LTO exceedance during the summers of 2006–2012, by country ([a])

Country	Area with exceedances over Target Value threshold ([b]) (% of total area)							Population affected by exceedances over Target Value threshold (% of the total)						
	2006	2007	2008	2009	2010	2011	2012	2006	2007	2008	2009	2010	2011	2012
Austria	94.4	96.7	15	56.8	70.6	71.8	57.4	95.4	85.5	6.6	14.5	18.1	21.3	42
Belgium	69.7	0	0	0	0	0	0	95	0	0	0	0	0	0
Czech Republic	99.8	95.9	45.6	18.7	19.9	48.3	37.5	98.6	73.4	6.8	6.6	4.5	13.4	24.3
Denmark	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0
Estonia	0	0	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	0	0
France	42.8	24.8	10.9	18.5	32.4	31.4	11.2	64.4	16.1	5.6	9.6	21.6	16	4.1
Germany	84.3	50.2	24.2	16.3	30.9	17.5	0.7	89.8	23.4	10.6	2	9.9	2.9	0.1
Hungary	95.9	99.5	77.7	99.4	25.9	59.9	95.5	85.2	94.1	28.6	85.6	17	22.3	83.7
Iceland	0	0	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	0	0
Italy	75.8	76	41.9	49	47.8	85.6	77.1	94	79.2	55.2	57.3	51.2	61.1	69.1
Latvia	0	0	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	0	0
Luxembourg	-	0	0	0	19.9	0	0	100	0	0	0	4.3	0	0
Malta	49.3	49	0	0	0	56.5	54.8	14.2	7.9	1.6	0	0	3.6	3
Netherlands	15.4	0	0	0	0	0	0	38.3	0	0	0	0	0	0
Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	77.6	27.2	3.5	2.8	0	10.4	9.9	66	20.9	1.9	0.4	0	2.7	5.5
Portugal	72.4	33	0.1	31.6	50.6	0	0	58.1	6.4	0	18.5	15.1	0	0
Romania	-	-	-	25.7	0	0	41.5	1.3	52.6	3.1	8	0	0	15.5
Slovakia	96.2	99.8	72.9	99.8	0	74	77.8	86.4	77.8	24	88.3	0	33.3	82.1
Slovenia	100	98.2	76.4	94.7	95.8	97.7	98.9	99.8	100	22.7	38.2	50.7	73.7	85.3
Spain	81.4	40.2	41.9	23.2	70.1	24.3	26.5	50.1	26.7	16.8	18.1	28.1	8.8	7.5
Sweden	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0
Switzerland	100	92.5	10.2	81.6	99.1	95.9	58.4	100	58.7	11.1	15.5	90	69.9	16.4
United Kingdom	0	0	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**	**17.7**	**55.5**	**33.5**	**15**	**16**	**15.7**	**13.7**	**15.2**

Notes: Data from 2010, 2011 and 2012 are provisional. Data from 2006–2009 for percentage of exposed area is provisional. Population exposure data from 2006–2009 is based on validated data and the percentage is borrowed from the ETC/ACC reports (ETC/ACC, 2009a; ETC/ACC, 2009b; ETC/ACC, 2010; ETC/ACM, 2011)

([a]) 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 of urban and rural stations, and the methodology of interpolation used. Due to different data used the shares of affected area and population in 2006–2009 and 2010–2012 are not exactly comparable.

([b]) 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 the percentage of affected population because only the spatial distribution of the population is used.

2.4 Main ozone episodes

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 nitrogen oxides, chained with oxidative decomposition of volatile organic compounds, carbon monoxide (CO) and methane, initiated by hydroxyl radicals.

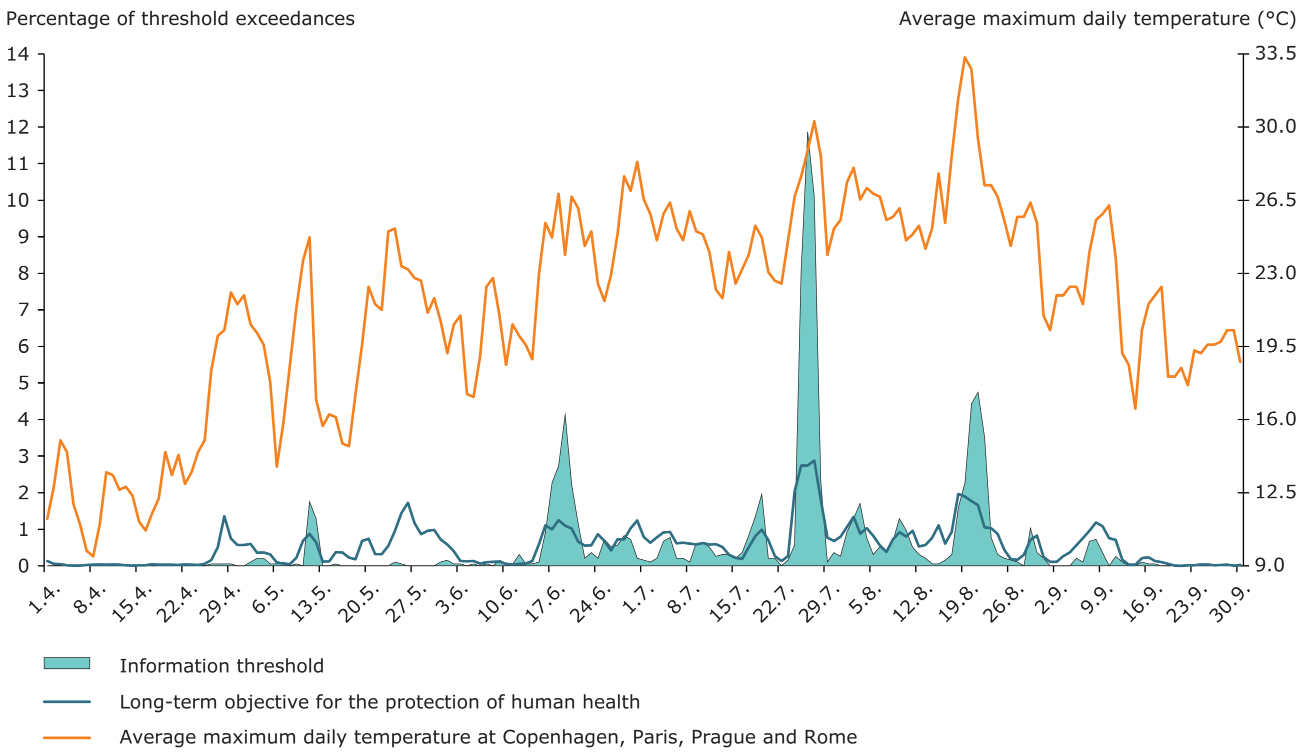
Episodes of elevated ozone levels occur during periods of warm, sunny weather. The ozone concentration depends not only on precursor emissions but also on meteorological conditions. The largest ozone episodes with the highest ozone concentrations occur in areas of high air pressure (anticyclones). Within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

Summer 2012 was characterised by short, regional ozone episodes with few exceedances of thresholds between mid-June and the end of August. There were only three larger episodes this summer: a six-day-long episode in June, a five-day-long one in August, and a five-day-long one in July. These episodes accounted for approximately 63 % of the total number of exceedances of the information threshold, 60 % of exceedances of the alert threshold, and 27 % of LTO exceedances experienced during the summer.

The largest episode in terms of area occurred between 24 and 28 July, when an area of high air pressure (anticyclone) lingered over western and central Europe, and temperatures exceeded 30 °C. The episode ended when colder oceanic air moved across the European continent. The episode accounted for approximately 33 % of the total number of exceedances of the information threshold, 32 % of exceedances of the alert threshold and about 12 % of 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) (7). The distribution of exceedances per day and per country during summer 2012 is shown in Figure 2.6. Map 2.4 shows the coincidence of areas with elevated ozone concentrations and the highest temperatures.

Figure 2.5 Distribution of exceedances during summer 2012, by day



Notes: Data are provisional.

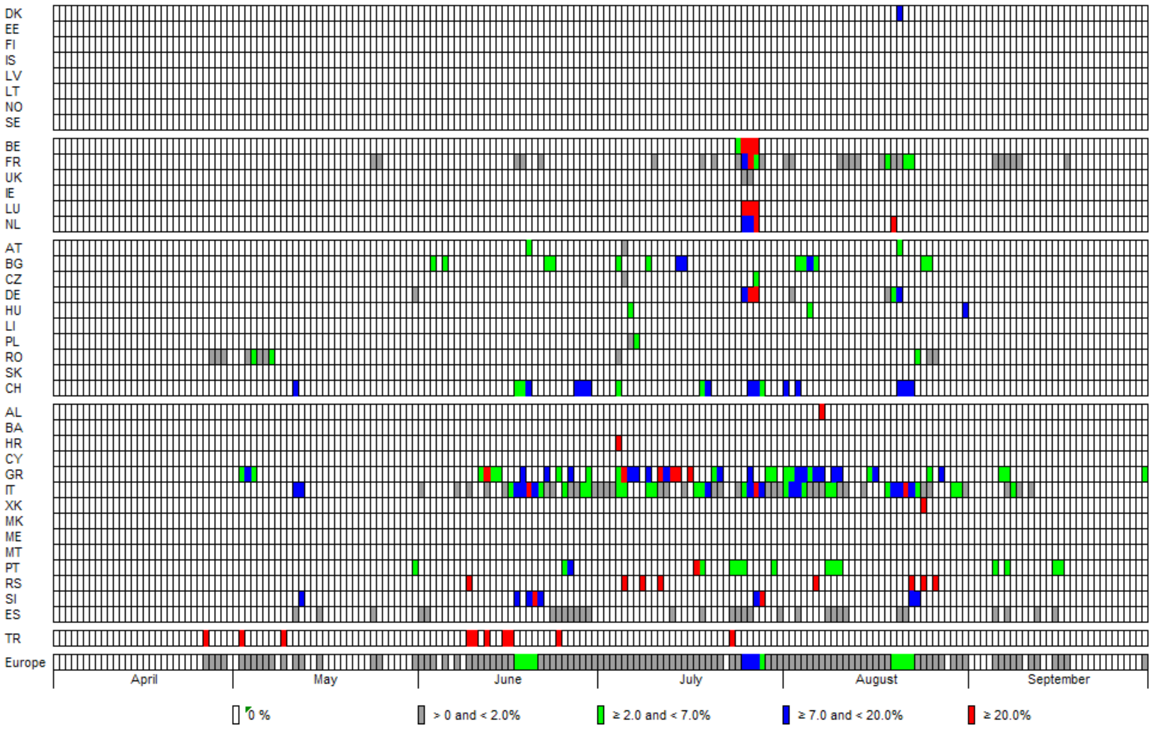
The left y-axis represents the percentage of exceedances observed during a particular day. As such, the exceedances of the information threshold and the LTO depicted each total 100 % between 1 April and 30 September.

Source: Maximum temperature data: Weather Underground, 2012.

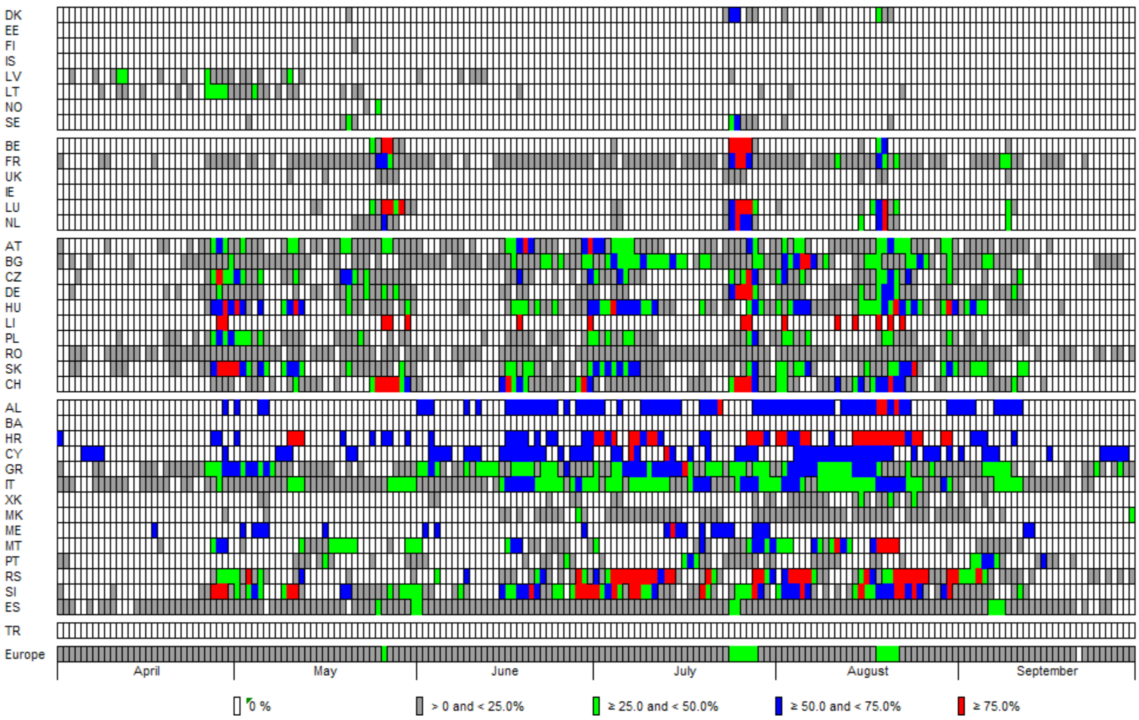
(7) Europe was divided into four regions to analyse inter-annual variations in the trend of ozone levels due to climatic differences; four capital cities in the regions were selected to demonstrate the relation between the number of exceedances and the meteorological situation (see Chapter 3).

Figure 2.6 Distribution of exceedances during summer 2012: 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.

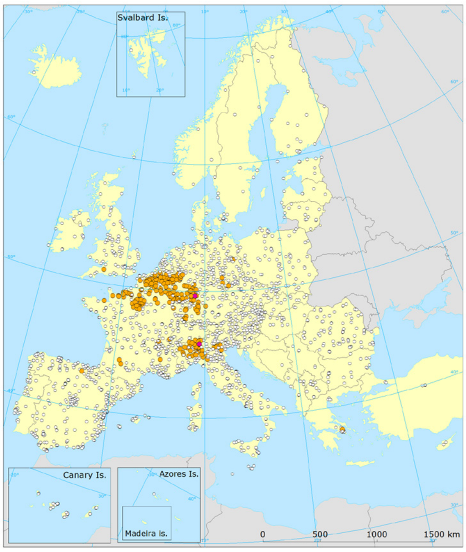
([a]) Distribution of exceedances is indicative for countries without proportioned station coverage, i.e. a small number of stations (Turkey, and all the West Balkan countries with the exception of the former Yugoslav Republic of Macedonia).

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

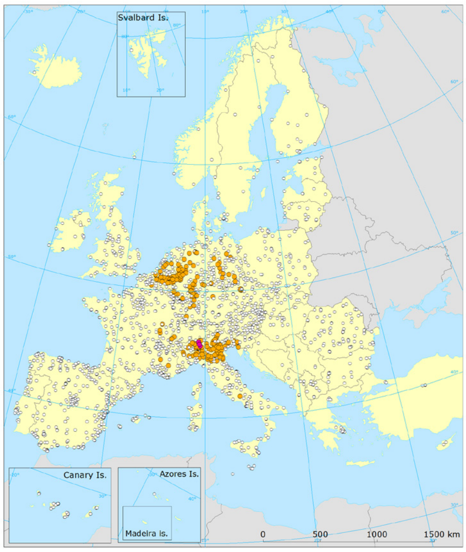
MK and XK are provisional codes for the former Yugoslav Republic of Macedonia, and Kosovo under UNSCR 1244/99, respectively.

Map 2.4 Selected days during the largest summer 2012 ozone episode in terms of area: observed maximum one-hour ozone concentrations and meteorological situation

26 July 2012



27 July 2012

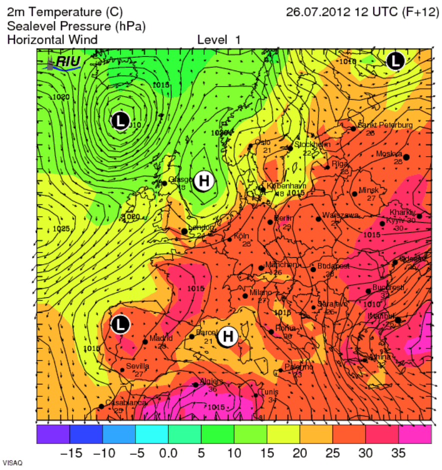


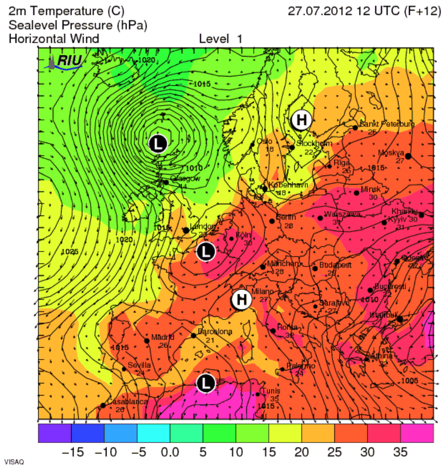
Maximal hourly value (µg/m-3)

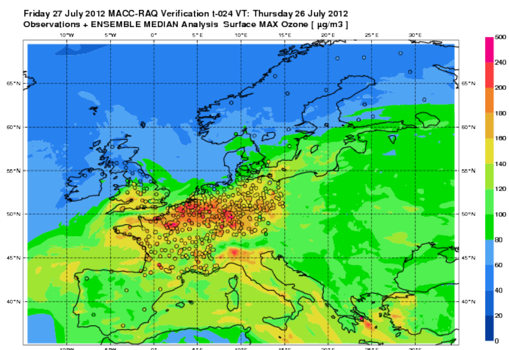
- ≤ 180
- > 180 and ≤ 240
- > 240

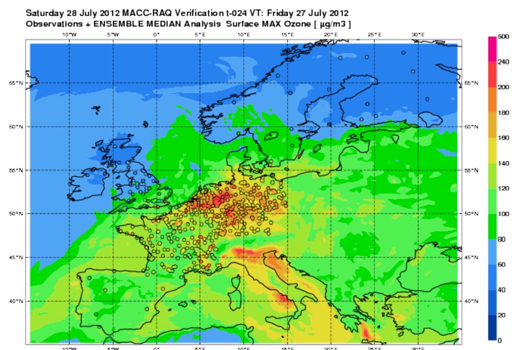
Type of country

- 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 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

For a comparison of pollution levels over a longer period, the 2012 summer ozone levels were compared with the summer ozone concentrations from 1997 to 2010 stored in the EEA air quality database AirBase, and with the summer 2011 data submitted under Directive 2008/50/EC. Only time series that included more than 90 % of valid, measured data during the summers of 1997–2010 were selected for comparison. Data stored in AirBase are validated, whereas the 2011 and 2012 summer data are provisional and only partly validated. Before 1997, ozone data collection in Europe was not comprehensive, so the data in AirBase are not comparable. 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.

The stations were divided into four regions to analyse inter-annual variations in the trend of ozone levels due to climatic differences affecting ozone formation over Europe, based on last years' experience (see key for Figure 3.1). The average occurrence of 1-hour and 8-hour exceedances (the number of exceedances per station and per regions) was calculated for these four regions. To illustrate climatic differences and their relation to the number of exceedances among the groups of countries and also the inter-annual variations, the graphs included the maximum daily temperatures averaged for the period April–September of a particular year observed in four capital cities in selected regions (Paris, Prague, Rome and Copenhagen ([8]).

Long-lasting episodes with high ozone concentrations over large parts of the European continent occurred in 2003 and 2006. In more recent years, there have not been any of these similar long-lasting episodes. It is worth noting that the situation in 2003 was entirely exceptional. Throughout the first half of August 2003, the weather conditions did not change, 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, while the lowest number is often to be found in northern Europe (Figures 3.1 and 3.2). The number of exceedances in both southern and northern Europe was lower between 1999 and 2002 than in the extreme summer of 2003 (EEA, 2003), which saw a very large number of occurrences. Ozone levels in 2004 and 2005 decreased to previous levels in 2003 (EEA, 2005; EEA, 2006), but in 2006 there was a further increase across Europe (EEA, 2007). Since 2007, ozone levels have returned to their lower and more usual levels (EEA, 2011a; EEA, 2012a).

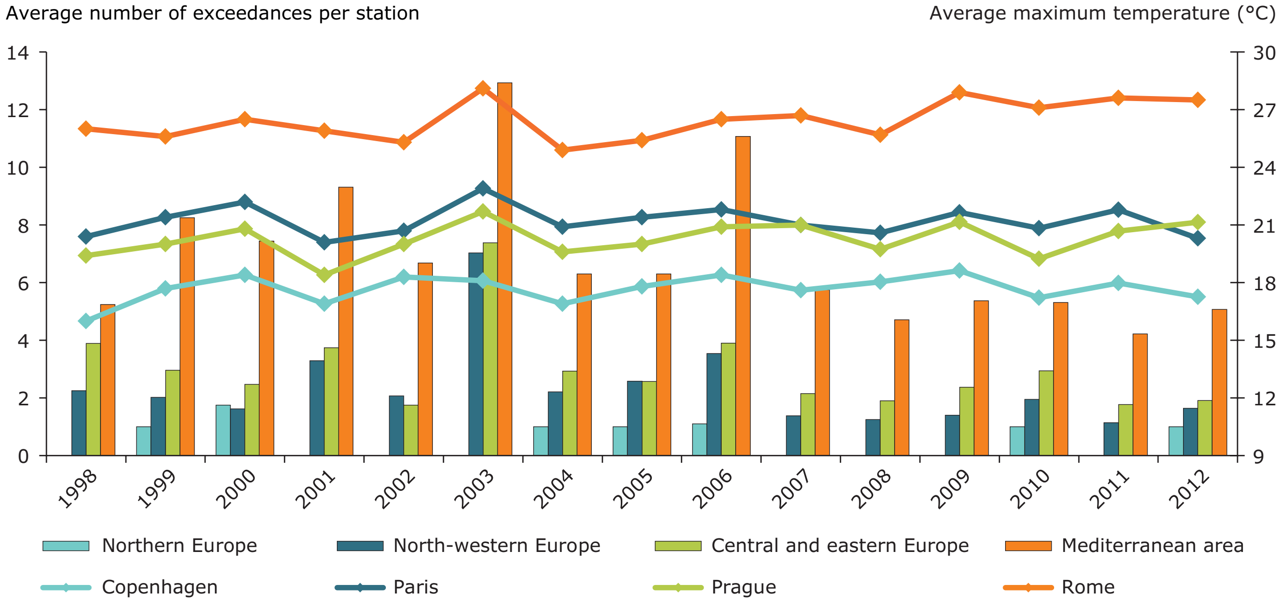
After a slight increase of occurrence of exceedances in 2010, there was a reduction of the information threshold exceedances in years 2011 and 2012 to the level comparable to the one in the years 2008 or 2009 in most European regions. In northern Europe, there were no exceedances of the information threshold in 2012 except for one in Denmark. The average number of LTO exceedances in 2012 was comparable with the years 2009–2011, while number of exceedances in 2008 was lower. The summer temperatures do not fluctuate in recent years either (Figure 3.1).

Using a more detailed division of stations (based on the EoI type station classification (EC, 1997)), different ozone concentrations are found at the background, traffic, and industrial stations with an altitude lower than 600 m, where a majority of the European population live. The highest number of exceedances is measured mostly at background stations, where the main thresholds being breached are the information and LTO thresholds. In central and eastern Europe, the highest numbers of exceedances are often measured at industrial stations (Figure 3.2).

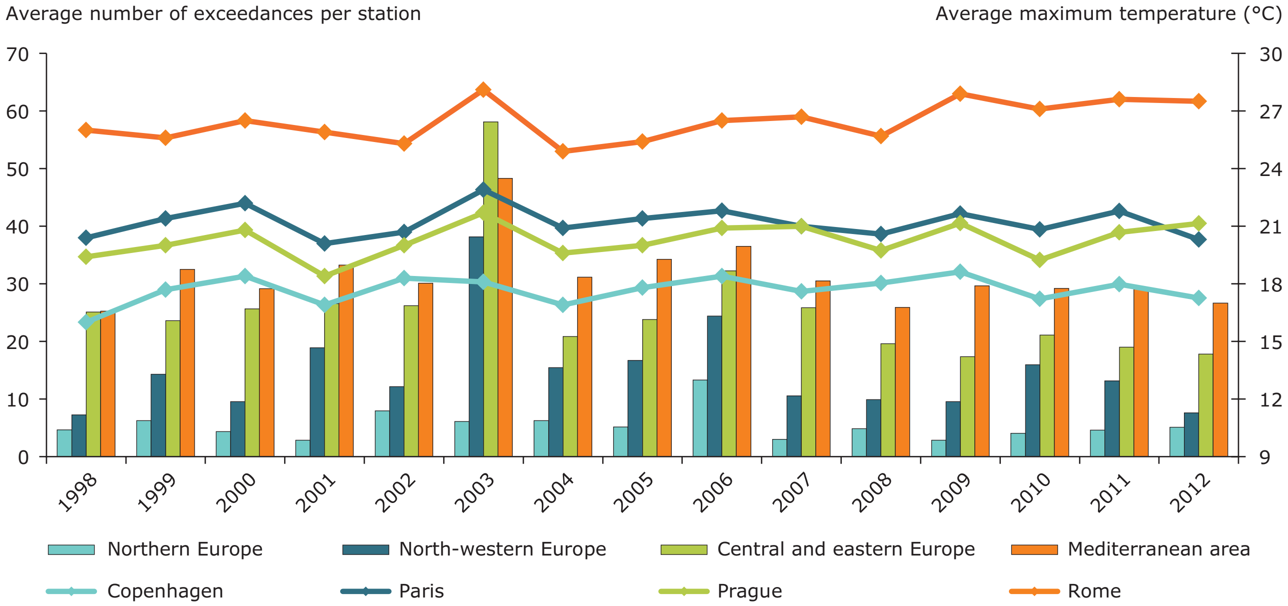
([8]) These cities were selected only for demonstration of the relation between the number of exceedances and meteorological situation. The selection was not based on the statistical evaluation of the meteorological representativeness of these cities for the regions.

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

a) Information threshold exceedances



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



Notes: Northern Europe: Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway, Sweden.

North-western Europe: Belgium, France (north of 45 ° latitude), Ireland, Luxembourg, the Netherlands, United Kingdom.

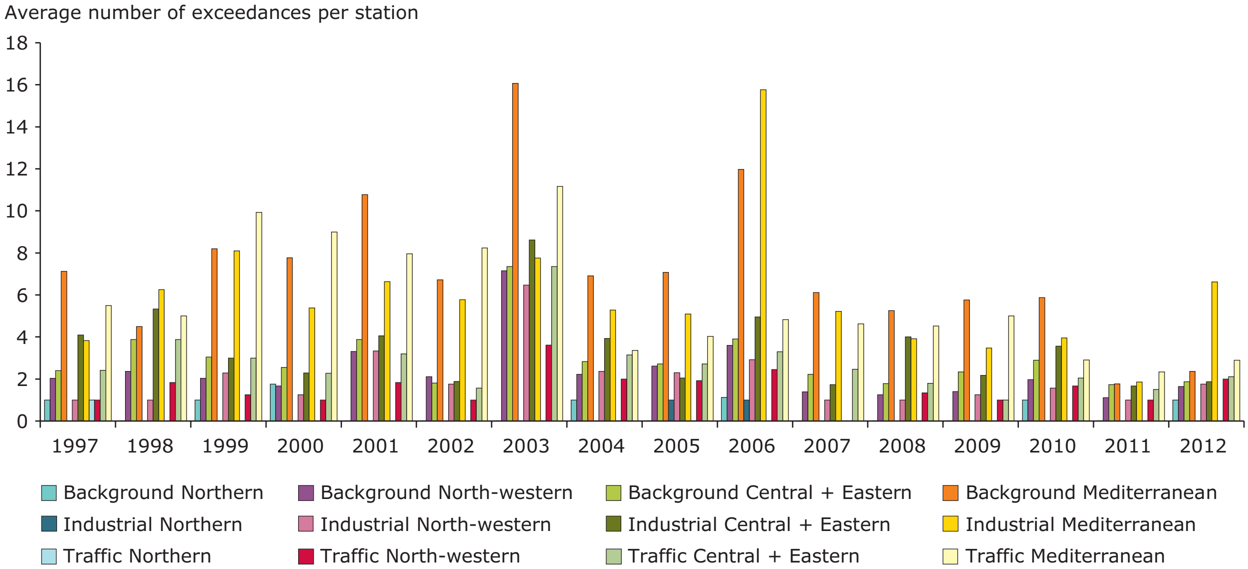
Central and eastern Europe: Austria, Bulgaria, Czech Republic, Germany, Hungary, Liechtenstein, Poland, Romania, Slovakia, Switzerland.

Mediterranean area: Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, France south of 45 ° latitude, Greece, Italy, Kosovo under UNSCR 1244/99, Malta, Monaco, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain, the former Yugoslav Republic of Macedonia.

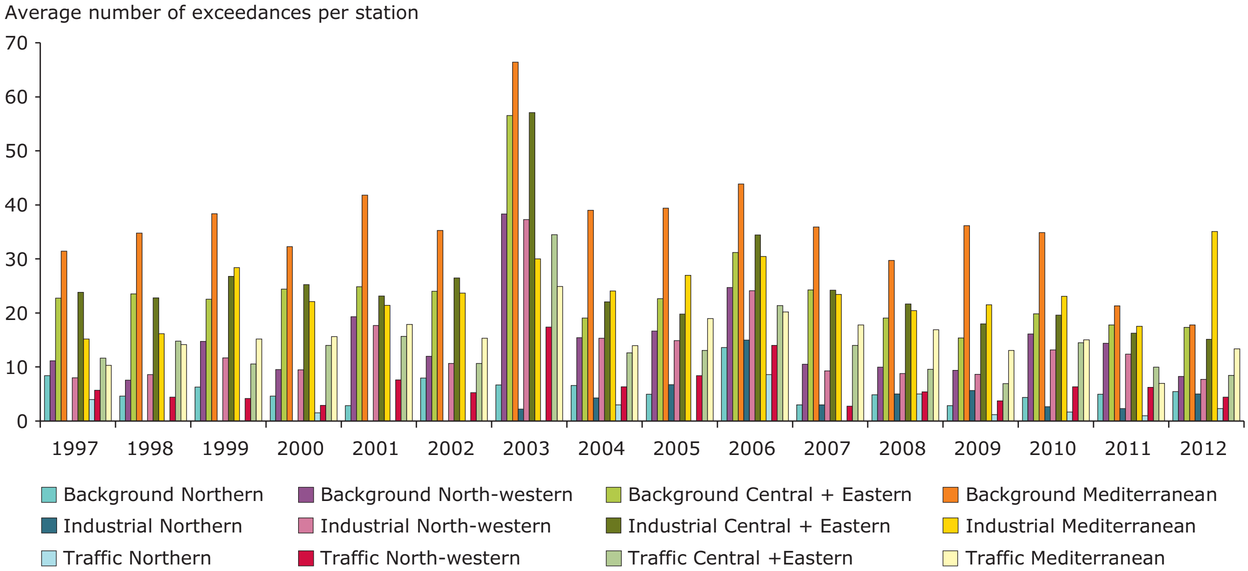
Source: Temperature data: Weather Underground, 2012.

Figure 3.2 Regional average number of exceedances during summer, per station type for stations that reported at least one exceedance

a) Information threshold exceedances



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



Notes: Northern Europe: Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway, Sweden.

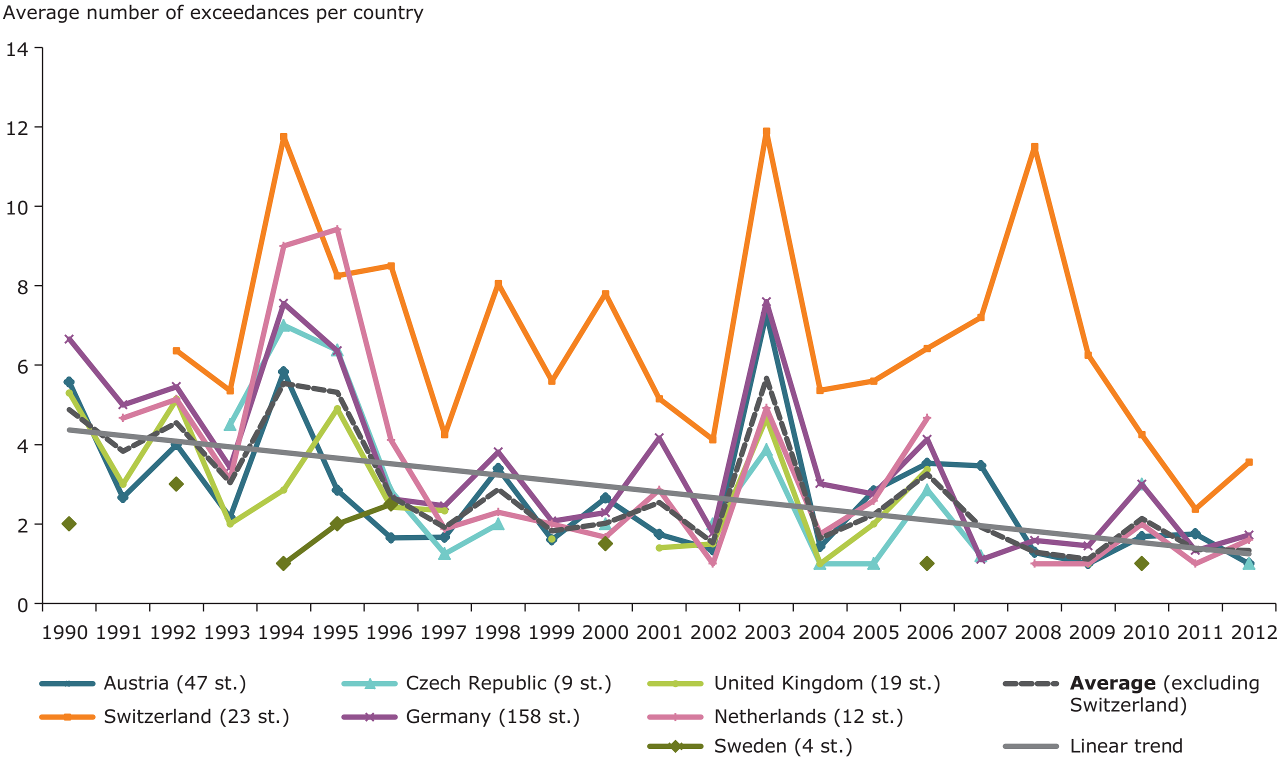
North-western Europe: Belgium, France (north of 45 ° latitude), Ireland, Luxembourg, the Netherlands, United Kingdom.

Central and eastern Europe: Austria, Bulgaria, Czech Republic, Germany, Hungary, Liechtenstein, Poland, Romania, Slovakia, Switzerland.

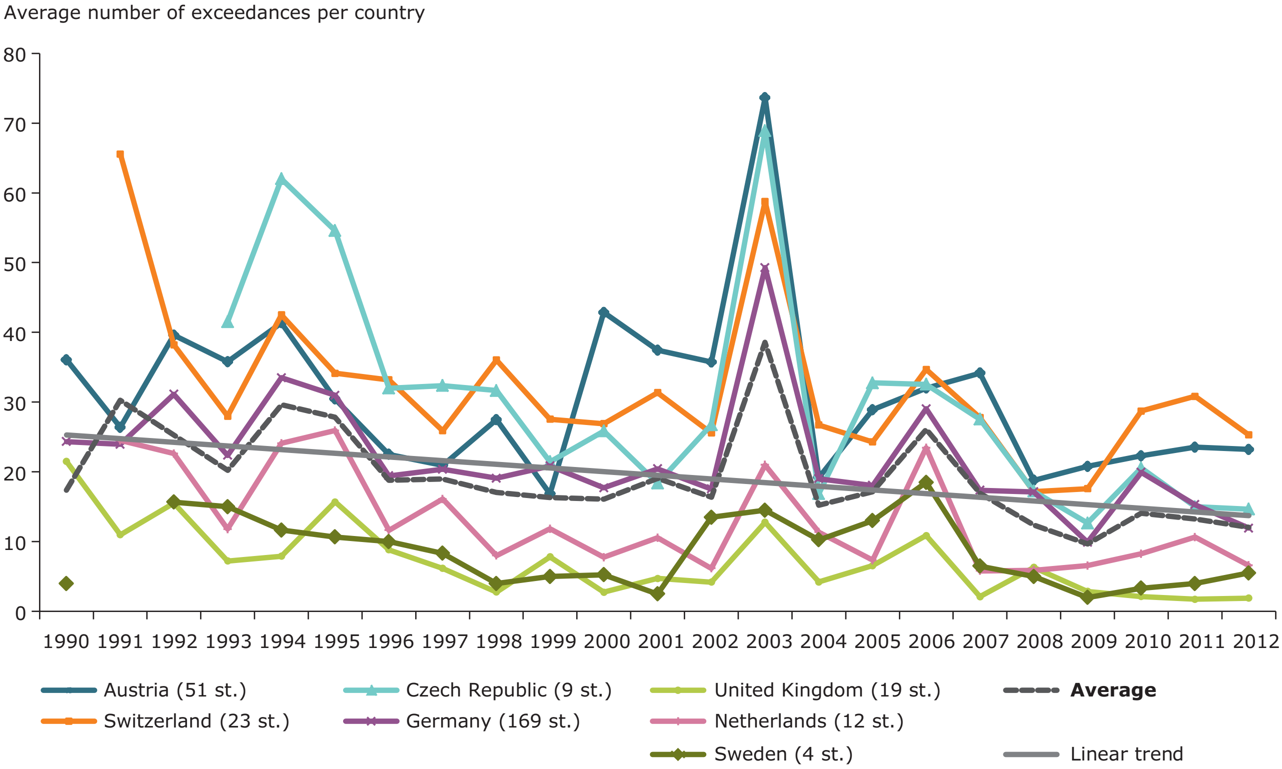
Mediterranean area: Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, France south of 45 ° latitude, Greece, Italy, Kosovo under UNSCR 1244/99, Malta, Monaco, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain, the former Yugoslav Republic of Macedonia.

Figure 3.3 Average number of exceedances per station during the summer for stations with long series that reported at least one exceedance (selected countries)

a) Information threshold exceedances



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



Notes: Data from 2011 and 2012 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.

In several countries where ozone monitoring networks have operated since at least the mid 1990s, it is possible to observe longer trends in the information threshold exceedances and the LTO exceedances. Figure 3.3 depicts selected stations with altitudes of up to 600 m above sea level, representing the most densely populated areas of Europe. Air quality trends can vary from one area to another, but the charts show that across all areas, there has been a noticeable downward trend in the number of exceedances in the period between 1990 and 2012. The number of stations meeting the criteria for inclusion in the figure (time series of at least 15 years and data capture over 90 %) varies between countries due to the different land area of each country (see numbers of stations in brackets in the graph legends). Those countries with long time series represent three of the four geographical parts of Europe according to the impact of climatic conditions on ozone concentrations, and all of them display a visible downward trend in the number of exceedances. It is important to note that this downward trend in the number of exceedances does not necessarily mean that the exposure is reduced in the same way. For example, a lot of exceedances are in the range 180–185 μg/m³, so a small decrease in concentration will result in a large decrease in the number of exceedances ([9]).

Detailed accounts of the relationship between ozone concentrations, meteorological situations and emissions during past years are presented in other reports (EEA, 2009a).

Table 3.1 Overview of exceedances observed during the summer season in Europe (1997–2012) ([a])

a) One-hour threshold exceedances

Summer season	Number of stations ([b])	Stations with exceedance ([c]) (number)		(%)		(%)	Number of days with exceedance ([d])		Maximum observed one-hour concentration (μg/m³)	Occurrence of exceedances ([e])				Average duration of exceedances (hour)	
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	52	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	1 475	1 096	280	74	19	26	171	88	417	6.5	8.7	0.5	2.4	3.9	2.1
2004	1 517	552	37	36	2	7	137	44	385	1.5	4.0	0.0	1.8	3.1	2.0
2005	1 642	771	59	47	4	8	163	61	361	1.8	3.9	0.1	2.2	3.1	2.4
2006	1 731	1 089	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	1 879	380	20	20	1	5	135	27	399	0.7	3.6	0.0	2.2	2.9	2.6
2009	1 884	399	28	21	1	7	148	35	298	0.8	3.9	0.0	1.4	2.9	1.8
2010	1 882	703	29	37	2	4	112	25	376	1.3	3.6	0.0	1.3	3.1	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
2012	2 107	597	17	28	1	3	115	15	343	0.9	3.2	0.0	1.5	2.9	1.7

Notes: ([a]) Ozone levels in summer 2012 were compared with the summer ozone concentrations from 1997 to 2010 stored in the EEA AirBase, and the summer 2011 data submitted under directives in force. Data stored in AirBase are validated; 2011 and 2012 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 2010, 2011 and 2012 is due to the use of different time coverage criteria.
Data from 2011 and 2012 are provisional.
White columns refer to exceedances of the information threshold, blue ones to exceedances of the alert threshold.

([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 which reported at least one exceedance.

([9]) There is no increasing trend for the annual average concentrations of ozone in Europe. However, a decreasing trend can be observed for the number of exceedances and for episodic peak ozone levels in some European areas (compare EEA, 2009a and EEA, 2010c). A similar downward trend is also evident in the United States (US EPA, 2011).

Table 3.1 Overview of exceedances observed during the summer season in Europe (1997–2012) ([a]) (cont.)

b) Long-term objective and target value threshold for the protection of human health exceedances

Summer season	Number of stations ([b])	Stations with LTO exceedance ([c])		Stations with LTO exceedance above 25 days ([c])		Number of days with LTO exceedance ([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	1 544	1 410	91	410	27	183	256	20.1	22.0
2005	1 666	1 527	92	562	34	183	291	22.7	24.7
2006	1 763	1 673	95	941	53	183	399	29.2	30.8
2007	1 795	1 567	87	556	31	183	277	20.5	23.5
2008	1 906	1 706	90	426	22	182	399	17.1	19.1
2009	1 920	1 704	89	444	23	183	244	17.9	20.2
2010	1 921	1 729	90	556	29	183	270	20.7	23.0
2011	2 186	1 844	84	514	24	183	259	18.5	21.9
2012	2 107	1 793	85	437	21	182	273	16.4	19.2

Notes: ([a]) Ozone levels in summer 2012 were compared with the summer ozone concentrations from 1997 to 2010 stored in the EEA AirBase, and the summer 2011 data submitted under directives in force. Data stored in AirBase are validated; 2011 and 2012 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 2010, 2011 and 2012 is due to the use of different time coverage criteria.
Data from 2011 and 2012 are provisional.

([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 which reported at least one exceedance.

4 Ozone-related policies

Ozone pollution as a global or hemispheric problem is addressed by the Task Force on Hemispheric Transport of Air Pollution (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 pollutants NO_X, non-methane volatile organic compounds (NMVOC), 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 itself is a Party to the protocol. Member States report data on emissions of air pollutants annually to the European Commission (with copies to the EEA) under Directive 2001/81/EC on national emission ceilings for certain pollutants (EC, 2001). The '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 the three air pollutants primarily responsible for the formation of harmful ground-level ozone in the atmosphere fell significantly in the period 1990–2009: CO (62 % reduction), NMVOC (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).

Photochemical ozone formation depends mainly on meteorological factors and on the concentrations of NO_X and VOC. Ozone concentrations in urban areas with high NO_X emissions are generally lower than in the countryside. Ozone concentrations are often increased by the inter-continental transport of air pollution from areas outside Europe. Other factors help mask the positive effects of European measures to reduce ozone precursor emissions from anthropogenic sources: biogenic NMVOC emissions, and fire plumes from forest and other biomass fires (EEA, 2010c).

European countries have significantly reduced anthropogenic emissions of ozone precursor gases since 1990. In general, however, ambient air measurements in urban and rural areas of Europe do not show any downward trends in ground-level ozone (EEA, 2009a; EEA, 2011b; EEA, 2011c; EEA, 2012e).

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Annex 1 Legal requirements on data provision

Directive 2002/3/EC ([10]) 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 respectively) 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–September), as defined in Annex III to the directive (i.e. information on exceedances of alert and information thresholds, on exceedances of the health protection long-term objective, the daily maximum of 8-hour average ozone concentration higher than 120 µg/m^3 threshold, 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 2012 to produce the data used in this report.

([10]) 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 2012

To manage the monthly and summer data flows, Member States and the other reporting countries are required to use a set of reporting forms (templates for reporting (EEA, 2012d)). Ozone-monitoring stations were operated throughout the whole period from April to September 2012. 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 1 547 stations (equal to 73 % of all of 2 107 operational stations). Of those, 1 276 (82 %) provided valid one-hour measurements at least 90 % of the time as requested by Directive 2008/50/EC (see Table A.2.1). The proportions were similar to those of the 2007–2011 period.

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

The ozone monitoring network in 2012

Map A.2.1 presents the location of all ozone monitoring stations assumed to be operational in the reporting countries during summer 2012. In total, 2 107 ozone-monitoring sites were operational in summer 2012, 2 040 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. In spite of these siting criteria, station meta-information reveals that 695 (approximately 33 %) traffic or industrial stations are used for summer ozone assessment in the various countries. These stations were included in 2012 summer reporting and the current analysis to match the practice in previous years. The share of traffic and industrial stations is thus higher than in previous 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 8.7 % of stations, the type of station was not known.

Table A.2.1 Overview of share of industrial and traffic stations and validity of one-hour measurements during summer 2012, by country

Country	Industrial and traffic stations ([a]) (%)	Stations with available information ([b]) (%)	Stations with at least 90 % of valid one–hour data ([c]) (%)
Austria	15	100	88
Belgium	22	100	98
Bulgaria	17	100	94
Cyprus	50	100	100
Czech Republic	8	100	100
Denmark	30	80	25
Estonia	33	100	100
Finland	10	90	89
France	3	100	93
Germany	15	0	–
Greece	50	100	75
Hungary	18	100	82
Ireland	9	100	73
Italy	99	0	–
Latvia	38	100	75
Lithuania	50	100	86
Luxembourg	20	100	80
Malta	40	100	40
Netherlands	14	100	95
Poland	3	100	65
Portugal	13	95	89
Romania	46	100	37
Slovakia	0	100	93
Slovenia	17	100	83
Spain	51	100	81
Sweden	0	100	92
United Kingdom	8	100	84
Albania	50	100	0
Bosnia and Herzegovina	100	100	100
Croatia	100	100	50
Iceland	100	0	–
Kosovo under UNSCR 1244/99	40	100	20
Liechtenstein	100	100	100
Macedonia, former Yugoslav Republic of	80	100	30
Montenegro	0	100	0
Norway	0	100	86
Serbia	0	100	80
Switzerland	19	100	100
Turkey	20	0	–
Total	**33**	**73**	**82**

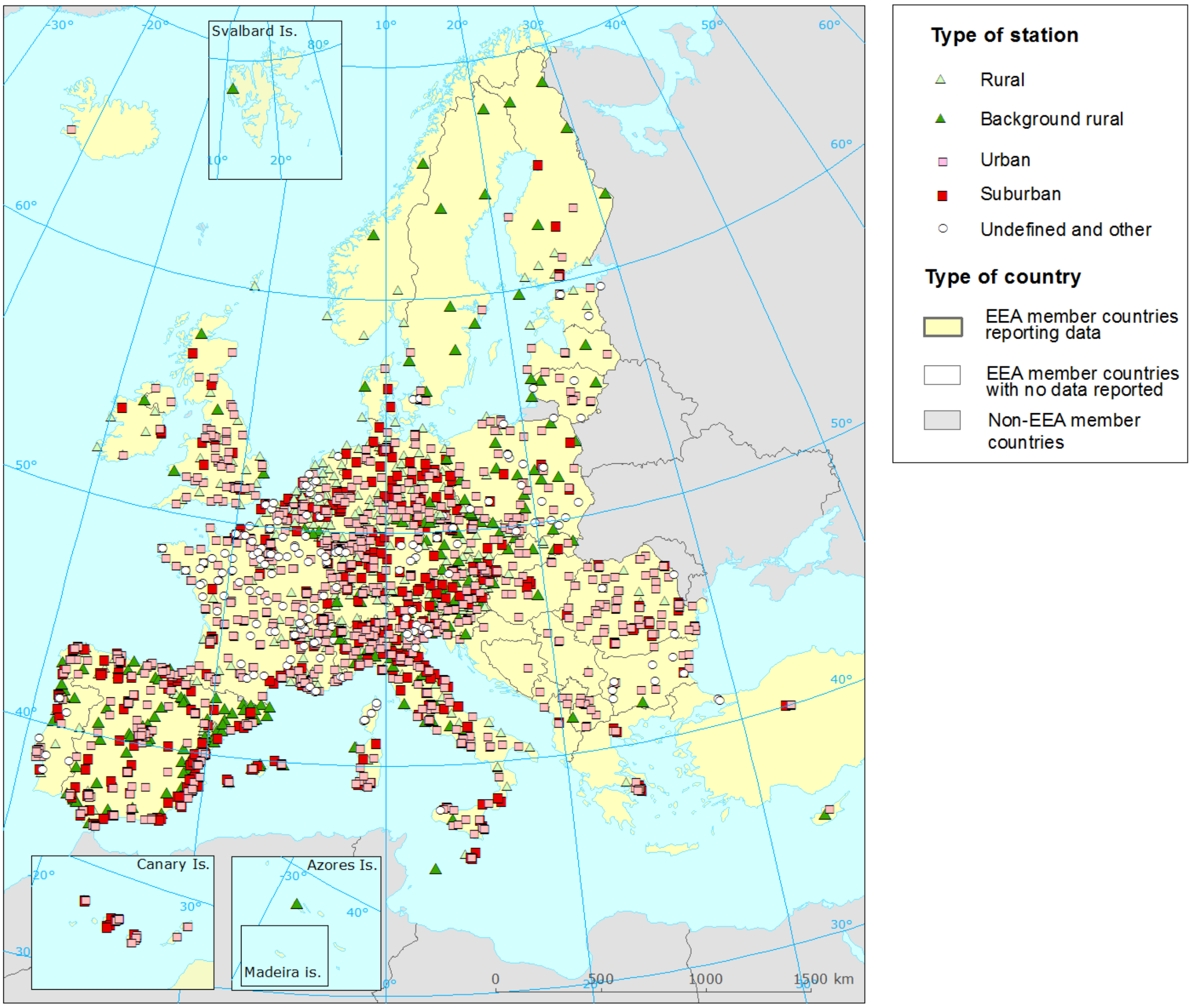
Notes: Data are provisional. '–' indicates 'not applicable'.

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

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

([c]) The percentage of stations for which the country provided information that provided valid one-hour measurements at least 90 % of the time during summer 2012.

Map A.2.1 Location of ozone monitoring stations in summer 2012 as reported by Member States and other European countries



Annex 3 Up-to-date 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 an up-to-date (UTD) air quality (AQ) data exchange.

The EEA's work on UTD 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 UTD AQ data exchange serves several purposes within the AQ and environmental community within Europe. Initially, the EEA's UTD 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 the EEA attempts to fulfil as many as possible, streamlining European data exchange for UTD AQ information.

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

The UTD AQ data exchange continues its focus 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 reasons, including the following:

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

The operational EEA UTD data exchange programme for ozone across Europe is also in place for the 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 ($PM_{2.5}$)), carbon monoxide (CO), and sulphur dioxide (SO_2). Currently, they are provided via the 'Air quality levels in Europe' Web (EEA, 2012b).

UTD 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 the Ozone component of the 'Air quality levels in Europe' 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.

During 2012, the EEA upgraded some sections of the UTD web pages, especially the explorer pages ([11]). On these pages, the same statistics from data as described in details in this report can be displayed and downloaded, but the statistics are based on delivered, unvalidated, up-to-date data (Map A.3.1). The pollutants episodes could be easily recognised by the map viewer (Map A.3.2).

During 2012, a monthly comparison was carried out between official monthly SOR submissions and exceedances calculated using UTD ozone data submitted during the summer. Discrepancies between both submissions have been used to inform data providers in order to improve data re-submission under a UTD system. This exercise led by ETC/ACM has achieved improvements in data communication.

The comparison between SOR submissions and UTD data is shown in Tables A.3.1 and A.3.2. The number of stations incorporated in the UTD was lower than officially reported during summer 2012. Most of the stations that registered exceedances are part of the current data exchange. The number of threshold exceedances recorded by UTD and the maximum observed one-hour concentrations as well were often higher for the individual country compared to the officially reported SOR submission because of the poor UTD resubmission of the validated data by some data providers, i.e. incorrect values persisted in the UTD database (Table A.3.1). Compared to comparisons carried out in 2009–2011, the match between UTD calculated exceedances and those presented via the monthly submission is now much better.

If maximum monthly exceedances are compared between April and September (see Table A.3.2), a better alignment can be observed. With the exception of some providers with a great number of stations and a degree of regionalisation (such as France, Italy and Spain), there is a much better match between monthly exceedances compiled with UTD systems and monthly exceedances compiled using SOR. For Spain, in particular, the match for most regions continue to be 1 to 1 and the overall figures show data resubmission issues by particular data providers.

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

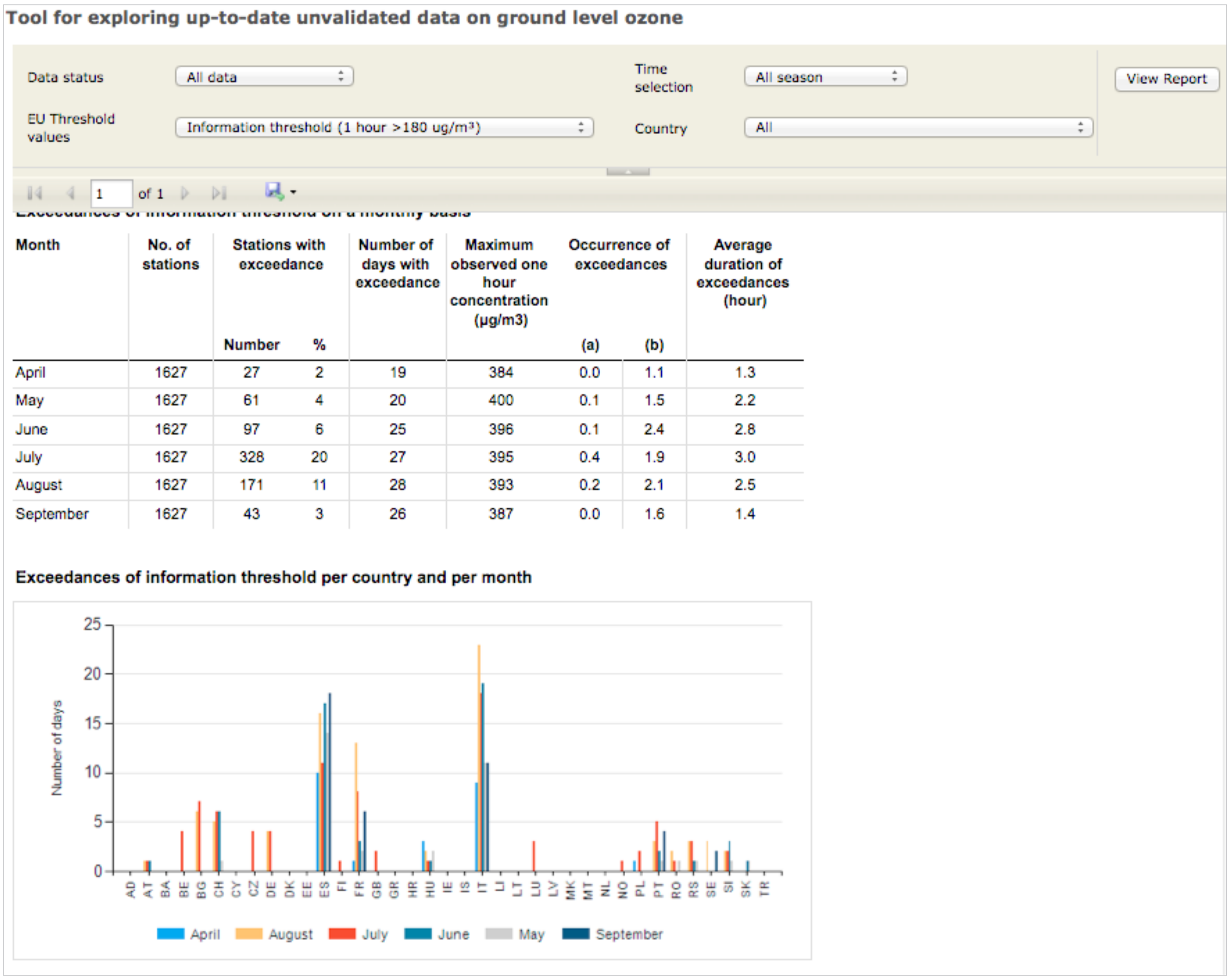
Further details and documents on the progress of the EEA UTD data exchange and the pilot to replace the summer ozone report are provided by Eionet (2012).

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

In addition to the EEA's Air Quality Web page, the EEA has upgraded its 'Eye on Earth' portal (Map A.3.3) to include a new application, 'AirWatch' (Eye on Earth, 2012), providing air quality information from member countries of the European Environment Agency (EEA), US EPA (AirNow) and Roshydromet (Russia). The EEA provides access to provisional, unvalidated, up-to-date air quality information on ambient air concentrations. These data are exchanged from different data providers and gathered centrally by the EEA. Depending on the provider, the EEA receives the air quality data within a number of hours of the measurement being taken. The data are harmonised, processed and stored at the EEA air quality database. Based on the air quality concentrations at each monitoring station, the EEA Air Quality Index is calculated and visualised in AirWatch. The EEA Air Quality Index is based on both health and legislative aspects (Map A.3.4).

([11]) Tool for exploring up-to-date unvalidated data on ground level ozone: http://www.eea.europa.eu/themes/air/air-quality/compare/explorer.

Map A.3.1 Screenshot of up-to-date data explorer



Month	No. of stations	Stations with exceedance		Number of days with exceedance	Maximum observed one hour concentration (µg/m3)	Occurrence of exceedances		Average duration of exceedances (hour)
		Number	%			(a)	(b)	
April	1627	27	2	19	384	0.0	1.1	1.3
May	1627	61	4	20	400	0.1	1.5	2.2
June	1627	97	6	25	396	0.1	2.4	2.8
July	1627	328	20	27	395	0.4	1.9	3.0
August	1627	171	11	28	393	0.2	2.1	2.5
September	1627	43	3	26	387	0.0	1.6	1.4

Map A.3.2 Screenshot of Ozone — ozone hourly concentrations on 26 July 2012 between 16:00 and 17:00 across Europe (see Map 2.4 for comparison with SOR)

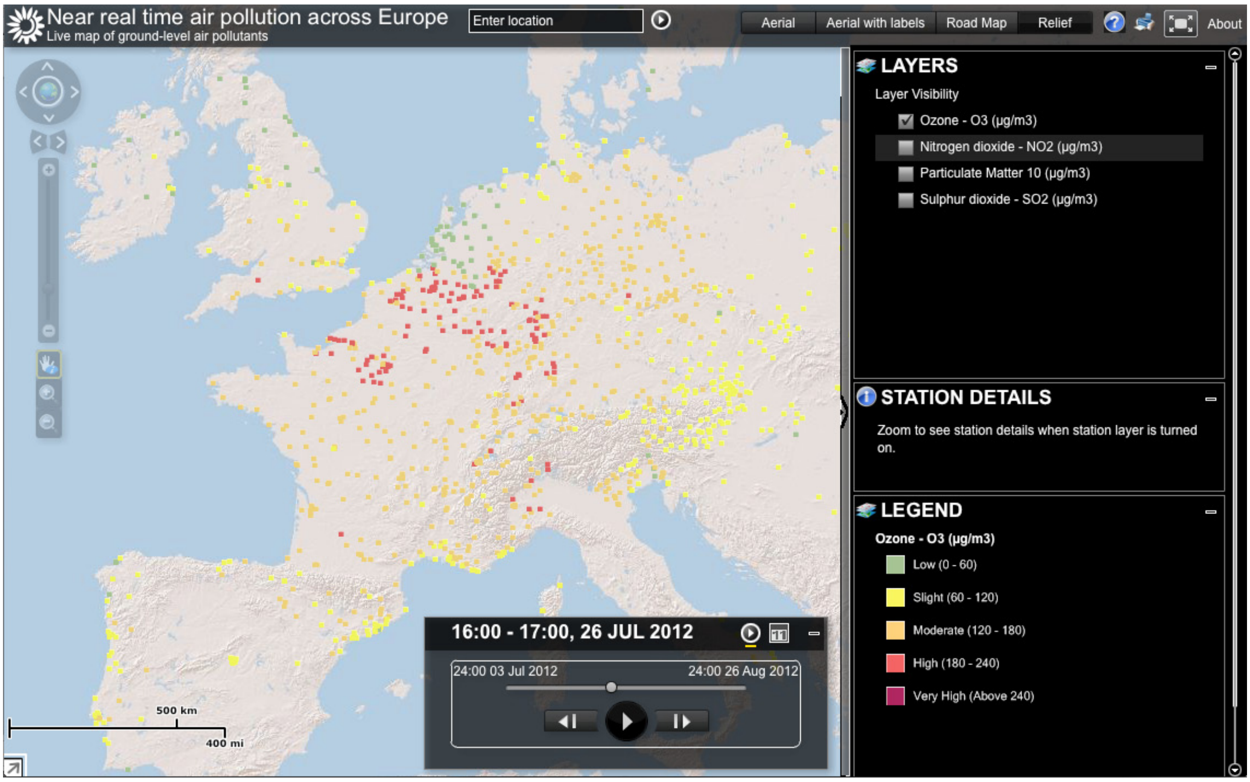


Table A.3.1 Comparison of the summer reporting (SOR) with up-to-date reporting (UTD) during summer 2012

Country	SOR						UTD					
	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed one-hour con-centration (µg/m³)	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed one-hour con-centration (µg/m³)
		Info	Alert	Info	Alert			Info	Alert	Info	Alert	
Austria	113	10	0	3	0	199	109	10	0	3	0	199
Belgium	41	37	2	4	1	269	41	37	2	4	1	269
Bulgaria	18	6	0	14	0	221	18	6	2	13	3	262
Cyprus	2	0	0	0	0	176	1	0	0	0	0	0
Czech Republic	59	5	0	2	0	203	56	6	1	4	1	255
Denmark	10	1	0	1	0	185	6	0	0	0	0	0
Estonia	9	0	0	0	0	132	2	0	0	0	0	0
Finland	20	0	0	0	0	137	15	1	0	1	0	182
France	375	133	1	31	3	272	349	112	4	33	5	393
Germany	260	126	1	8	1	245	262	127	1	8	1	245
Greece	20	12	3	43	1	343	–	–	–	–	–	–
Hungary	17	3	0	3	0	197	17	5	2	9	4	265
Ireland	11	0	0	0	0	158	12	0	0	0	0	0
Italy	287	154	8	71	8	269	124	72	22	91	46	396
Latvia	8	0	0	0	0	152	1	0	0	0	0	0
Lithuania	14	0	0	0	0	179	7	0	0	0	0	0
Luxembourg	5	4	0	3	0	204	5	4	0	3	0	204
Malta	5	0	0	0	0	178	1	0	0	0	0	0
Netherlands	37	21	0	4	0	213	36	–	–	–	–	–
Poland	79	3	0	2	0	212	45	3	1	3	1	257
Portugal	39	15	1	16	1	244	41	15	1	15	1	244
Romania	89	6	0	12	0	197	34	3	1	4	1	271
Slovakia	14	0	0	0	0	174	12	2	1	2	1	294
Slovenia	12	8	0	9	0	205	12	5	0	8	0	205
Spain	401	33	1	30	2	251	278	59	18	86	36	400
Sweden	12	0	0	0	0	169	9	2	2	5	4	280
United Kingdom	83	2	0	2	0	186	81	3	0	2	0	192
EU area	**2 040**	**579**	**17**	**111**	**15**	**343**	**1 574**	**472**	**58**	**144**	**86**	**400**
Albania	2	1	0	1	0	184	–	–	–	–	–	–
Bosnia and Herzegovina	1	0	0	0	0	118	–	–	–	–	–	–
Croatia	2	1	0	1	0	188	2	0	0	0	0	0
Iceland	1	0	0	0	0	< 180	0	0	0	0	0	0
Kosovo under UNSCR 1244/99	5	1	0	1	0	190	–	–	–	–	–	–
Liechtenstein	1	0	0	0	0	165	1	0	0	0	0	0
Macedonia, former Yugoslav Republic of	10	0	0	0	0	179	–	–	–	–	–	–
Montenegro	2	0	0	0	0	174	–	–	–	–	–	–
Norway	7	0	0	0	0	130	10	1	0	1	0	202
Serbia	5	5	0	8	0	222	4	4	0	8	0	239
Switzerland	26	8	0	18	0	221	31	9	0	18	0	221
Turkey	5	2	0	10	0	231	–	–	–	–	–	–
Whole area	**2 107**	**597**	**17**	**115**	**15**	**343**	**1 627**	**486**	**58**	**145**	**86**	**400**

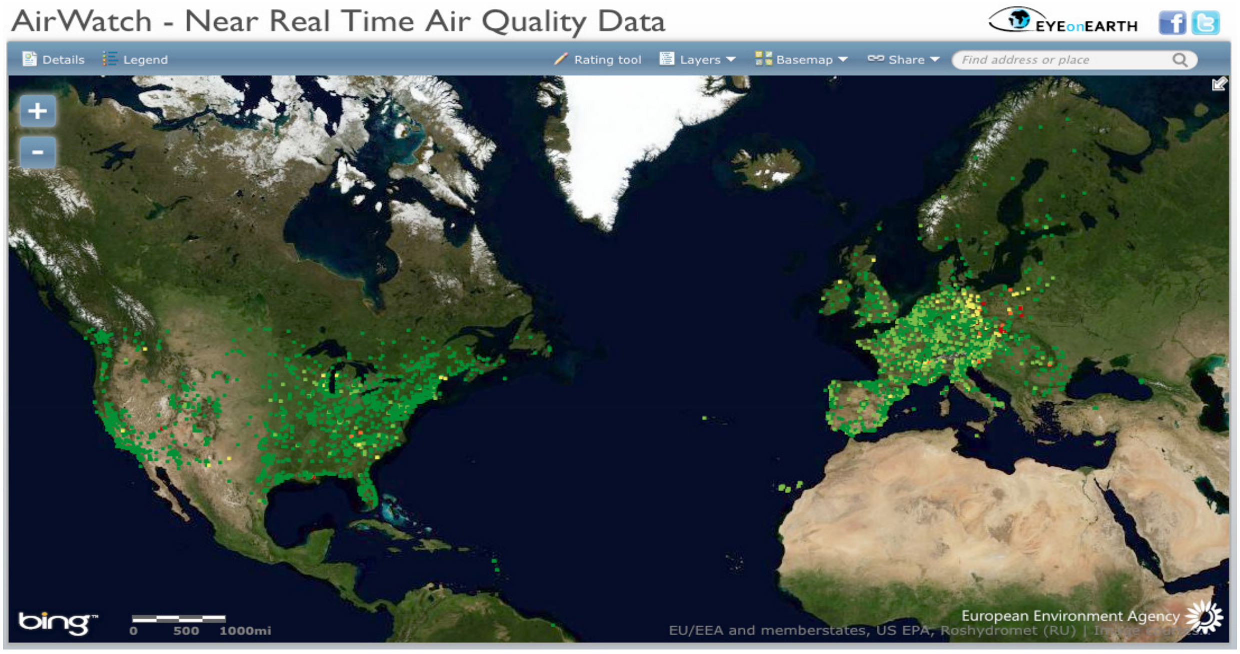
Notes: '–' indicates 'not applicable'.
White columns refer to exceedances of the information threshold, blue to exceedances of the alert threshold.
Orange cells refers to UTD > SOR, yellow cells to UTD < SOR, green cells to UTD = SOR.

Table A.3.2 Comparison of the summer monthly exceedance reported under SOR with up-to-date reporting (UTD) during summer 2012

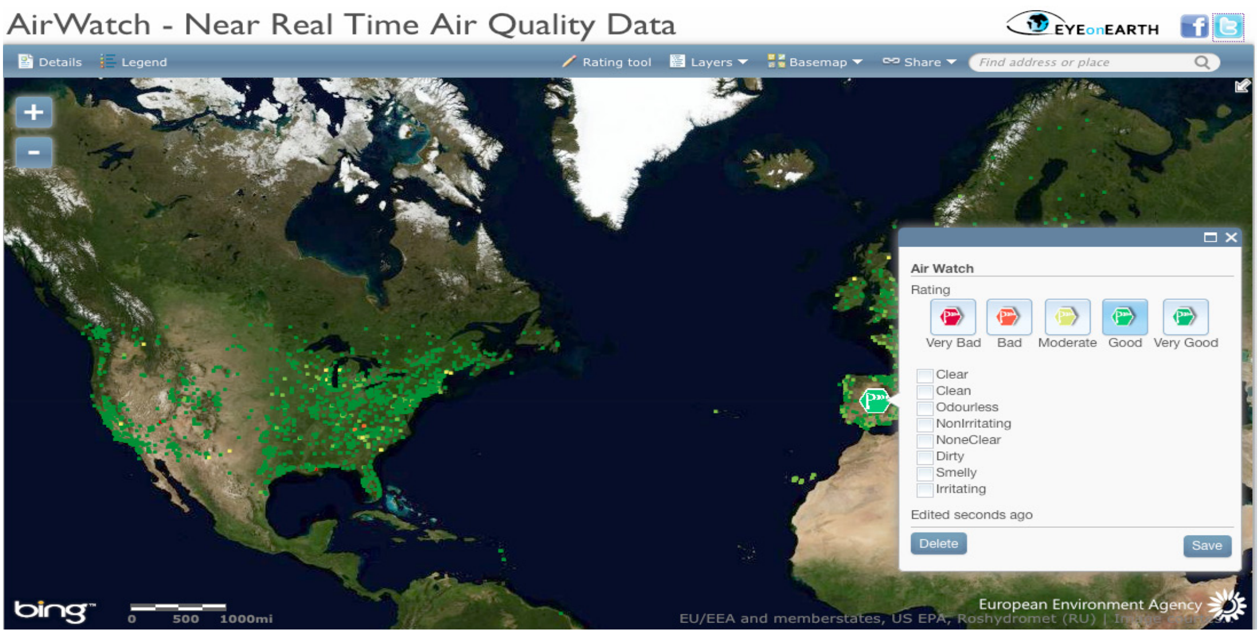
Country	SOR Max concentrations						UTD Max concentrations					
	April	May	June	July	Aug.	Sep.	April	May	June	July	Aug.	Sep.
Austria	x	x	192	192	199	x	x	x	192	192	199	x
Belgium	x	x	x	269	x	x	x	x	x	269	x	x
Bulgaria	x	x	204	221	194	x	x	x	x	262	194	x
Cyprus	x	x	x	x	x	x	x	x	x	x	x	x
Czech Republic	x	x	x	203	x	x	x	x	x	255	x	x
Denmark	x	x	x	x	185	x	x	x	x	x	x	x
Estonia	x	x	x	x	x	x	x	x	x	x	x	x
Finland	x	x	x	x	x	x	x	x	x	182	x	x
France	x	190	210	245	272	242	199	200	188	262	393	265
Germany	x	182	x	245	231	x	x	x	x	245	231	x
Greece	x	190	223	343	221	195	–	–	–	–	–	–
Hungary	x	x	x	197	197	x	241	265	265	197	197	x
Ireland	x	x	x	x	x	x	x	x	x	x	x	x
Italy	x	225	242	269	263	225	384	330	396	395	391	387
Latvia	x	x	x	x	x	x	x	x	x	x	x	x
Lithuania	x	x	x	x	x	x	x	x	x	x	x	x
Luxembourg	x	x	x	204	x	x	x	x	x	204	x	x
Malta	x	x	x	x	x	x	x	x	x	x	x	x
Netherlands	x	x	x	212	213	x	–	–	–	–	–	x
Poland	x	x	x	212	x	x	257	x	x	197	x	x
Portugal	x	185	233	232	244	195	x	185	233	232	244	195
Romania	197	197	x	180	191	x	x	187	x	180	271	x
Slovakia	x	x	x	x	x	x	x	294	197	x	x	x
Slovenia	x	191	205	203	203	x	x	191	205	203	197	x
Spain	x	205	251	247	214	227	373	400	315	338	358	364
Sweden	x	x	x	x	x	x	x	x	x	x	263	280
United Kingdom	x	x	x	186	x	x	x	180	x	192	x	x
EU area	**197**	**225**	**251**	**343**	**272**	**242**	**384**	**400**	**396**	**395**	**393**	**387**
Albania	x	x	x	x	184	x	–	–	–	–	–	–
Bosnia and Herzegovina	x	x	x	x	x	x	x	x	x	x	x	x
Croatia	x	x	x	188	x	x	x	x	x	x	x	x
Iceland	x	x	x	x	x	x	x	x	x	x	x	x
Kosovo under UNSCR 1244/99	x	x	x	x	190	x	–	–	–	–	–	–
Liechtenstein	x	x	x	x	x	x	x	x	x	x	x	x
Macedonia, former Yugoslav Republic of	x	x	x	x	x	x	–	–	–	–	–	–
Montenegro	x	x	x	x	x	x	–	–	–	–	–	–
Norway	x	x	x	x	x	x	x	x	x	202	x	x
Serbia	x	x	188	222	196	x	x	186	239	220	192	x
Switzerland	x	184	208	221	205	x	x	184	208	221	205	x
Turkey	191	193	231	215	x	x	–	–	–	–	–	–
Whole area	**197**	**225**	**251**	**343**	**272**	**242**	**384**	**400**	**396**	**395**	**393**	**387**

Notes: 'x' indicates 'no exceedances'. '–' indicates 'not applicable'.
Orange cells refers to UTD > SOR, yellow cells to UTD < SOR, green cells to UTD = SOR.

Map A.3.3 Screenshot of Eye on Earth — AirWatch showing the results of the air quality data



Map A.3.4 Screenshot of Eye on Earth — AirWatch showing how air quality is rated by users



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