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Air pollution by ozone across Europe during summer 2013

Overview of exceedances of EC ozone threshold values: April–September 2013

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European Environment Agency

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Acronyms and symbols

AQ	Air quality
CH_4	Methane
CHMI	Czech Hydrometeorological Institute
EEA	European Environment Agency
EoI	Exchange of Information
ETC/ACM	European Topic Centre for Air Pollution and Climate Change Mitigation
EU	European Union
JRC	Joint Research Centre
LRTAP	Long-range Transboundary Air Pollution
LTO	Long-term objective
NEC	National emission ceilings
NH_3	Ammonia
NMVOC	Non-methane VOC
NO_X	Nitrogen oxides
NW	North-western
ORNL	Oak Ridge National Laboratory
PM	Particulate matter
PM_{10}	Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometres
$PM_{2.5}$	Particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometres
SO_2	Sulphur dioxide
SOR	Summer ozone reporting
SO_X	Sulphur oxides
TV	Target value
UNECE	United Nations Economic Commission for Europe
UTD	Up-to-date
VOC	Volatile organic compound

Executive summary

Key messages

During summer 2013 ([1]), concentrations of ground-level ozone significantly exceeded a number of European Union (EU) standards for protecting human health (see Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe). However, the number of exceedances was lower than in many previous years, continuing the long-term downward trend observed over the last 24 years.

- As in previous years, in summer ([2]) 2013, the threshold of 120 µg/m3 maximum daily 8-hour mean was again exceeded on more than 25 days, across a significant part of Europe. This is the threshold that will be used in future to assess whether countries meet the EU target value (TV) for protecting human health ([3]). Exceedances of this threshold occurred in 19 EU Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and 5 other countries or territories (the former Yugoslav Republic of Macedonia, Kosovo (under UNSCR 1244/99), Montenegro, Serbia and Switzerland). As in previous years, the most widespread exceedances occurred in the Mediterranean area.

- The long-term objective (LTO) for the protection of human health (a maximum daily 8-hour mean concentration of 120 µg/m^3) was exceeded in all Member States. It was exceeded in 83 % of all reporting stations, but this is the lowest percentage since reporting started in 1997.

- The so-called information threshold (a 1-hour average ozone concentration of 180 µg/m^3) was exceeded at approximately 26 % of all operational stations, one of the lowest percentages since 1997. In northern Europe, there were no exceedances of the information threshold in 2013.

- The alert threshold (a 1-hour average ozone concentration of 240 µg/m^3) was exceeded 27 times, again one of the lowest number of exceedances on record.

- Overall, summer 2013 was characterised by a very low incidence of exceedances prior to mid June and after 8 August, but with a period of frequent incidences during July and the first days of August. The period between 7 July and 6 August accounted for approximately 73 % of the total number of exceedances of the information threshold, 59 % of exceedances of the alert threshold, and 50 % of the LTO exceedances experienced during the summer.

([1]) Ozone levels in summer 2013 were compared with the summer ozone concentrations from 1997 to 2012. Summer ozone concentrations from 1997 to 2011 are validated and stored in the EEA's public air quality database (AirBase). Summer ozone concentrations for 2012 and 2013 are provisional at the time of writing. Differences between provisional and validated summer ozone data for the same year tend to be minimal.

([2]) Following Directives 2002/3/EC (EC, 2002) and 2008/50/EC (EC, 2008), 'summer' in this report refers to the period from April to September, i.e. the warm part of the year.

([3]) Directive 2008/50/EC sets the 'target value for the protection of human health' (TV). Specifically, as of 2010, the maximum daily 8-hour mean concentration of ozone should not exceed 120 µg/m^3 on more than 25 days per calendar year, averaged over 3 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 in 2011 until data for 2011, 2012 and 2013 have been compiled and validated. References in this report to the 'target value threshold' pertain only to provisional ozone concentrations in 2013 (i.e. not more than 25 days with a maximum 8-hour average exceeding 120 µg/m^3), rather than to the 3-year validated data average used in assessing exceedance of the TV.

Background

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 (VOCs) (Royal Society, 2008; US EPA, 2010 and 2013). It is a powerful oxidising agent, and in elevated concentrations causes serious health problems, especially of a respiratory (asthma, reduced lung function and other lung diseases) and cardiovascular nature, and can lead to premature mortality (WHO, 2006 and 2013). It also causes damage to materials and vegetation such as agricultural crops.

Ozone concentrations in Europe are also influenced by emissions of precursor pollutants in other northern hemispheric countries and from international sources such as international shipping and aviation. Thus, ozone pollution can no longer exclusively be considered a local air quality (AQ) issue — it also constitutes a hemispheric and global problem.

Ozone levels typically become particularly high in regions where considerable ozone precursor emissions combine with stagnant meteorological conditions during the summer, i.e. the periods when high incoming solar radiation and temperatures occur.

This report provides an evaluation of ground-level ozone pollution in Europe during the period from April to September 2013, based on information officially submitted by EU Member States and other reporting countries to the European Commission under Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air (EC, 2002), and Directive 2008/50/EC (EC, 2008). Since reporting countries have not yet validated submitted data for 2013, the conclusions drawn in this report should be considered preliminary.

Directive 2002/3/EC requires Member States to report exceedances of the information threshold and alert threshold values (Table 1.1) to the European Commission before the end of the month following an ozone occurrence. Furthermore, by 31 October of each year, Member States must provide certain additional information for the summer period (see Annex 1). This includes data on exceedances of the LTO for the protection of human health (a maximum daily 8-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 officially reported by the countries is presented by the European Topic Centre for Air Pollution and Climate Change Mitigation (ETC/ACM) on the European Environment Agency (EEA) website ([4]). In addition, the EEA's up-to-date (UTD) 'Air quality levels in Europe' website ([5]) shows provisional ground-level ozone levels across Europe and provides UTD information (see Annex 3).

The proposed Clean Air Policy Package

In 2011, the European Commission initiated a review of European air policy legislation. After a broad consultation and research process, in December 2013 the Commission adopted a proposal for a Clean Air Policy Package (EC, 2013); one of its objectives is to further reduce emissions, including those of ozone precursors. It refers, among others, to the following.

- A new Clean Air Programme for Europe with measures to ensure that existing targets are met in the short term, and introducing new objectives for the period up to 2030. The package also includes support measures to help cut air pollution, with a focus on improving air quality in cities, supporting research and innovation, and promoting international cooperation.
- A proposal for a revised NEC directive that would introduce national emission reduction commitments for 2020 and 2030, and address the four pollutants originally covered under the directive (SO_2, NO_X, non-methane VOCs, and NH_3), plus two new ones (primary $PM_{2.5}$ and CH_4)
- A proposal for a new directive to reduce pollution from medium-sized combustion installations, such as energy plants for commercial and institutional buildings, and small industrial installations. It aims at further reducing pollution of NO_X, SO_2 and PM through appropriate limit values for new and existing installations, together with a simple installation registration scheme.

([4]) http://www.eea.europa.eu/highlights/themes/air/air-quality/compare/summer-reporting-under-directive-2002-3-ec.
([5]) http://www.eea.europa.eu/themes/air/air-quality.

Overview of ozone air pollution in summer 2013: main findings

All 28 Member States provided information to the European Commission on observed 1-hour and LTO exceedances. In addition, nine other countries or territories (Albania, the former Yugoslav Republic of Macedonia, Iceland, Kosovo (under UNSCR 1244/99), Montenegro, Norway, Serbia, Switzerland and Turkey) supplied information to the EEA upon request.

In total, 2 110 ozone-monitoring sites reported data (only 2 105 for the maximum daily 8-hour mean values); of these, 2 038 were located in Member States. The following preliminary conclusions can be drawn for the period from April to September 2013.

Exceedance of the information threshold

- The percentage of ozone monitoring stations reporting exceedances of the information threshold (a 1-hour ozone concentration of 180 μg/m^3) is one of the lowest since comprehensive Europe-wide data reporting commenced in 1997. Ozone concentrations higher than the information threshold were reported from monitoring sites in 18 Member States and in 5 other countries or territories. The information threshold was exceeded at approximately 26 % of all operational stations.

- The spatial extent of the exceedances observed in the summer of 2013 was largely similar to that of the summer of 2012. No exceedances were reported from Scandinavia and the Baltic states, Albania, Bulgaria, Cyprus, Iceland, Ireland, Malta and Montenegro in summer 2013. Only northern Italy and several more isolated locations reported more than five days with exceedances of the information threshold.

Exceedance of the alert threshold

- Ozone concentrations higher than the alert threshold (a 1-hour ozone concentration of 240 μg/m^3) were reported on 27 occasions, which is one of the lowest numbers on record. They occurred in only four Member States (Austria, Belgium, Italy and Portugal) and in Kosovo (under UNSCR 1244/99). Exceedances of the alert threshold were observed at 20 locations, mainly in northern Italy and at other locations where the information threshold was most often exceeded. Most stations (15 in total, i.e. 75 %) reporting an exceedance of the alert threshold did so on just 1 day; only 2 stations (S. Giustina in Colle in Italy and Dardhishtë-Primary school in Kosovo (under UNSCR 1244/99)) reported the maximum number of 3 days.

Maximum concentrations

- The maximum 1-hour ozone concentration of 267 μg/m^3 was reported from Bergamo, Italy, on 2 August.

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

- A maximum daily 8-hour average concentration of ozone over 120 μg/m^3 (the LTO) was observed in all EU Member States. Approximately 83 % of all stations reported at least one exceedance during the summer period.

- The number of exceedance days per country ranged from 0 (in Iceland) to 167 (in Italy and Spain) out of a maximum of 183 days. On every single day except 2 (18 and 30 September), at least one of the 2 105 operational stations in Europe reported an exceedance of the LTO. On average, those stations where at least 1 LTO exceedance was observed reported 20 days of exceedance. The maximum number of 142 exceedance days was observed at the station Lazaropole, in the former Yugoslav Republic of Macedonia.

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 report lists the cases where the LTO was exceeded more than 25 times during summer 2013, and also provides an indicative calculation of the 2011 TV, for the 3-year period from 2011 to 2013.

- During summer 2013, more than 25 LTO exceedances occurred at stations in 19 Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and in five other reporting countries or territories (the former Yugoslav Republic of Macedonia, Kosovo (under UNSCR 1244/99), Montenegro, Serbia and Switzerland).

- More than 25 LTO exceedances occurred at 23 % of all monitoring stations providing reports. This corresponds to approximately 7.2 % of the area assessed, affecting approximately 10 % of the total population.

- The 2011 TV (averaged for the 2011-to-2013 period) was exceeded in 18 Member States (Austria, Bulgaria, Croatia, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and in 3 of the other reporting countries having sufficient data over the 3-year period (the former Yugoslav Republic of Macedonia, Serbia and Switzerland). It was exceeded a maximum of 122 days in Greece.

Main ozone episodes ([6])

- Summer 2013 was characterised by very low incidence of exceedances prior to mid June and after 8 August, but also by a period of frequent incidences during July and the first days of August. The period between 7 July and 6 August accounted for approximately 73 % of the total number of exceedances of the information threshold, 59 % of exceedances of the alert threshold, and 50 % of LTO exceedances experienced during the summer.

Comparison with previous years

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

The highest number of exceedances often occurs in the warmer Mediterranean region, while the lowest

Tenth anniversary of the 2003 ozone episode in Europe

An exceptionally long-lasting period of high ozone concentrations was reported in the first half of August 2003 by all countries, excepting those in northern Europe. During this episode, hourly ozone concentrations exceeded as much as 240 µg/m^3 at a large number of sites in northern-western and central Europe. The most affected areas were those with a high density of ozone precursor emissions from traffic and industrial production.

The ozone episode was caused by stagnant meteorological conditions combined with exceptionally high temperatures (even at nights) across large parts of southern, western and central Europe. The meteorological situation was characterised by a long-lasting, high air-pressure area above south-western Europe; the axis of the high pressure ridge was located above France, western Germany, Switzerland and northern Italy. These meteorological conditions remained almost unchanged for the whole first half of August.

A number of scientific papers (e.g. the ECDC's (2005) and the EPI's (2006)) have studied the adverse impact on public health of the 2003 heat wave. Up to 52 000 excess deaths were attributed to the heat wave, and even if high temperatures appear to have been the main cause, it is clear that exposure to elevated air concentrations of particulate matter (PM), and especially ozone, were also associated. The mortality impact of the heat wave was greatest on the elderly (over 75 years of age) and, among the elderly, rates were higher in females.

([6]) 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, 2014).

number is often in northern Europe. Nevertheless, there were no exceedances of the information threshold in certain Mediterranean countries in summer 2013 (Albania, Cyprus, Malta and Montenegro), nor in northern Europe.

The number of exceedances in both southern and northern Europe was lower between 1999 and 2002 than in the extreme summer of 2003, which saw a very large number of occurrences. Ozone levels in 2004 and 2005 subsequently decreased to pre 2003 levels, with 2006 exhibiting a second peak in exceedances across Europe. Since 2007, ozone levels have returned to their lower and more usual levels. The year 2013 was no exception. In 2013, both the information value threshold exceedances and the LTO exceedances decreased slightly in comparison with 2012 (28 % to 26 % and 85 % to 83 % of the total stations, respectively).

Disclaimer

The preliminary analysis contains summary information based on data delivered before 27 January 2014.

The information describing the situation during summer 2013 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), also known as the third daughter directive to the Air Quality Framework Directive (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 be 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, Directive 2008/50/EC (EC, 2008) came into force. The provisions of earlier AQ directives remained in force until 11 June 2010, when they were repealed by Directive 2008/50/EC ([7]). The new directive did not change the levels of the existing TVs, LTOs, alert threshold or information threshold for ozone.

This report gives an overview of reported groundlevel ozone concentrations between April and September 2013, and sets out the evolution and trends in these exceedances from 1997. The EEA has prepared similar overviews since 1997 ([8]).

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.

The updated World Health Organization Air Quality Guideline for O_3 is 100 μg/m^3 for an 8-hour average concentration; this is stricter than the EU limit (WHO, 2006).

Table 1.1 Ozone threshold values, LTO and TV for the protection of human health, as set out in Directives 2002/3/EC and 2008/50/EC

Objective	Level (μg/m^3)	Averaging time
Information threshold (IT)	180	1-hour
Alert threshold (AT)	240	1-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 was the first year for which the data are used in calculating compliance over the following 3 years.

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

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

2 Ozone air pollution in summer 2013

This chapter provides detailed country-by-country, month-by-month and day-by-day tabular, graphic and geographical information on threshold exceedances during summer 2013. 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

As required by the EU legislation, reports and information on ozone during summer 2013 were submitted by all 28 Member States and 9 other European countries or territories. Ozone concentrations in excess of the information threshold were reported from monitoring sites in 18 Member States and 5 other countries or territories (see Table 2.1).

The percentage of stations that recorded exceedances of the information threshold is one of the lowest since comprehensive Europe-wide data reporting commenced in 1997. No exceedance was observed in northern Europe (Scandinavia, the Baltic states, Ireland and Iceland), and several days with exceedances occurred in north-western and central Europe. The highest percentage of stations that recorded more than five exceedances of the information threshold was observed in northern Italy, in isolated stations in the rest of Italy, and in several other countries.

Table 2.2, Figure 2.1 and Figure 2.7 present the distribution of hourly exceedances during summer 2013. Most exceedances occurred during June, July and August, which respectively accounted for approximately 14 %, 51 % and 31 % of all observed information threshold exceedances and about 11 %, 11 % and 63 % of alert threshold exceedances ([9]). For the summer as a whole, the number of 1-hour thresholds exceedances belongs to the lowest on record. The number of days on which the information threshold was exceeded was the lowest ever recorded, at 111; the alert threshold was the lowest one recorded, together with that of summer 2012, at 15 days (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 exceedances were below 185 $\mu g/m^3$ (compared to 207 $\mu g/m^3$ in 2003, 186 $\mu g/m^3$ from 2005 to 2007, 185 $\mu g/m^3$ in 2004 and from 2008 to 2012). Also, 75 % of exceedances were below 202 $\mu g/m^3$, one of the lowest numbers since 2003 (305 $\mu g/m^3$ in 2003, 203 $\mu g/m^3$ in 2004 and 2010, 206 $\mu g/m^3$ from 2005 to 2008, 202 $\mu g/m^3$ in 2009 and 200 $\mu g/m^3$ in 2011 and 2012).

([9]) In this report, 1-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 1 hour is counted as one exceedance.

Table 2.1 Overview of exceedances of 1-hour thresholds during summer 2013, by country ([a])

Country	Number of stations ([b])	Stations with exceedances ([c])					Number of days with exceed-ances ([d])		Maximum observed 1-hour con-centration (µg/m³)	Occurrence of exceedances ([e])				Average duration of exceedances (hour)	
		(number)		(%)		(%)									
Austria	105	32	2	30	2	6	14	2	250	0.6	2.1	0.0	1.0	2.2	1.0
Belgium	41	30	2	73	5	7	3	2	259	1.0	1.4	0.0	1.0	4.0	1.0
Bulgaria	19	0	0	–	–	–	–	–	177	–	–	–	–	–	–
Croatia	2	2	0	100	–	–	1	–	207	1.0	1.0	–	–	2.0	–
Cyprus	2	0	0	–	–	–	–	–	151	–	–	–	–	–	–
Czech Republic	55	18	0	33	–	–	11	–	214	0.5	1.7	–	–	3.2	–
Denmark	9	0	0	–	–	–	–	–	169	–	–	–	–	–	–
Estonia	9	0	0	–	–	–	–	–	140	–	–	–	–	–	–
Finland	20	0	0	–	–	–	–	–	156	–	–	–	–	–	–
France	367	93	0	25	–	–	34	–	235	0.5	1.9	–	–	2.2	–
Germany	259	88	0	34	–	–	15	–	231	0.6	1.7	–	–	2.1	–
Greece	22	9	0	41	–	–	18	–	238	1.4	3.4	–	–	1.9	–
Hungary	17	2	0	12	–	–	3	–	218	0.2	1.5	–	–	2.3	–
Ireland	11	0	0	–	–	–	–	–	143	–	–	–	–	–	–
Italy	297	134	12	45	4	9	63	8	267	3.8	8.5	0.1	1.3	3.4	1.9
Latvia	8	0	0	–	–	–	–	–	145	–	–	–	–	–	–
Lithuania	14	0	0	–	–	–	–	–	130	–	–	–	–	–	–
Luxembourg	5	1	0	20	–	–	1	–	184	0.2	1.0	–	–	2.0	–
Malta	5	0	0	–	–	–	–	–	164	–	–	–	–	–	–
Netherlands	35	21	0	60	–	–	3	–	214	0.9	1.6	–	–	3.2	–
Poland	80	9	0	11	–	–	8	–	195	0.2	1.3	–	–	1.8	–
Portugal	40	26	1	65	3	4	26	1	250	2.2	3.3	0.0	1.0	1.9	1.0
Romania	104	1	0	1	–	–	1	–	189	0.0	1.0	–	–	1.0	–
Slovakia	15	2	0	13	–	–	3	–	217	0.2	1.5	–	–	2.0	–
Slovenia	12	6	0	50	–	–	11	–	210	2.1	4.2	–	–	3.3	–
Spain	392	60	0	15	–	–	38	–	226	0.3	2.1	–	–	2.0	–
Sweden	12	0	0	–	–	–	–	–	147	–	–	–	–	–	–
United Kingdom	81	2	0	2	–	–	1	–	194	0.0	1.0	–	–	1.5	–
EU area	**2 038**	**536**	**17**	**26**	**1**	**3**	**108**	**15**	**267**	**0.9**	**3.6**	**0.0**	**1.2**	**3.0**	**1.7**
Albania	1	0	0	–	–	–	–	–	153	–	–	–	–	–	–
Bosnia and Herzegovina	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
former Yugoslav Republic of Macedonia, the	14	1	0	7	–	–	9	–	196	0.6	9.0	–	–	4.1	–
Iceland	2	0	0	–	–	–	–	–	124	–	–	–	–	–	–
Kosovo (under UNSCR 1244/99)	7	3	3	43	43	100	19	4	262	3.4	8.0	0.9	2.0	2.8	2.2
Liechtenstein	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Montenegro	2	0	0	–	–	–	–	–	157	–	–	–	–	–	–
Norway	7	0	0	–	–	–	–	–	124	–	–	–	–	–	–
Serbia	4	2	0	50	–	–	2	–	212	0.8	1.5	–	–	2.0	–
Switzerland	30	8	0	27	–	–	20	–	215	1.4	5.3	–	–	3.1	–
Turkey	5	1	0	20	–	–	1	–	182	0.2	1.0	–	–	1.0	–
Whole area	**2 110**	**551**	**20**	**26**	**1**	**4**	**111**	**15**	**267**	**0.9**	**3.6**	**0.0**	**1.4**	**3.0**	**1.8**

Notes: 'x' indicates that no data were delivered from Bosnia and Herzegovina and Liechtenstein.
'–' indicates 'not applicable'.
White columns refer to exceedances of the information threshold, and grey 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 1-hour thresholds in Europe during summer 2013, by month

Month	Stations with exceedances (c)					Number of days with exceedances (d)		Maximum observed 1-hour concentration (µg/m³)	Occurrence of exceedances (e)				Average duration of exceedances (hour)	
	(number)		(%)		(%)									
April	19	2	1	0	11	10	1	246	0.0	0.0	0.0	0.1	4.0	2.0
May	3	1	0	0	33	11	1	262	0.0	0.0	0.0	0.1	2.6	5.0
June	141	3	7	0	2	21	2	255	0.1	0.5	0.0	0.2	2.7	1.3
July	409	3	19	0	1	30	3	259	0.5	1.8	0.0	0.2	2.9	1.0
August	271	15	13	1	6	30	7	267	0.3	1.1	0.0	0.9	3.3	1.8
September	51	1	2	0	2	9	1	250	0.0	0.1	0.0	0.1	2.0	1.0

Notes: White columns refer to exceedances of the information threshold, and grey to exceedances of the alert threshold. (c)–(e) see notes to Table 2.1.

2.2 Overview of exceedances of the LTO, TV threshold and TV for the protection of human health

A maximum daily 8-hour average concentration of ozone over 120 µg/m³ (the LTO) was observed in every Member State at least once (Table 2.3).

Table 2.4 presents the LTO exceedances on a monthly basis; Figure 2.7 shows them on a day-by-day and country basis. Approximately 83 % of all stations reported at least one exceedance of the LTO. There were two days without a LTO exceedance in Europe in summer 2013 (18 and 30 September). With the exception of 2012 (where there was one day with no exceedance), there have been exceedances of the LTO every day of every summer since 2001.

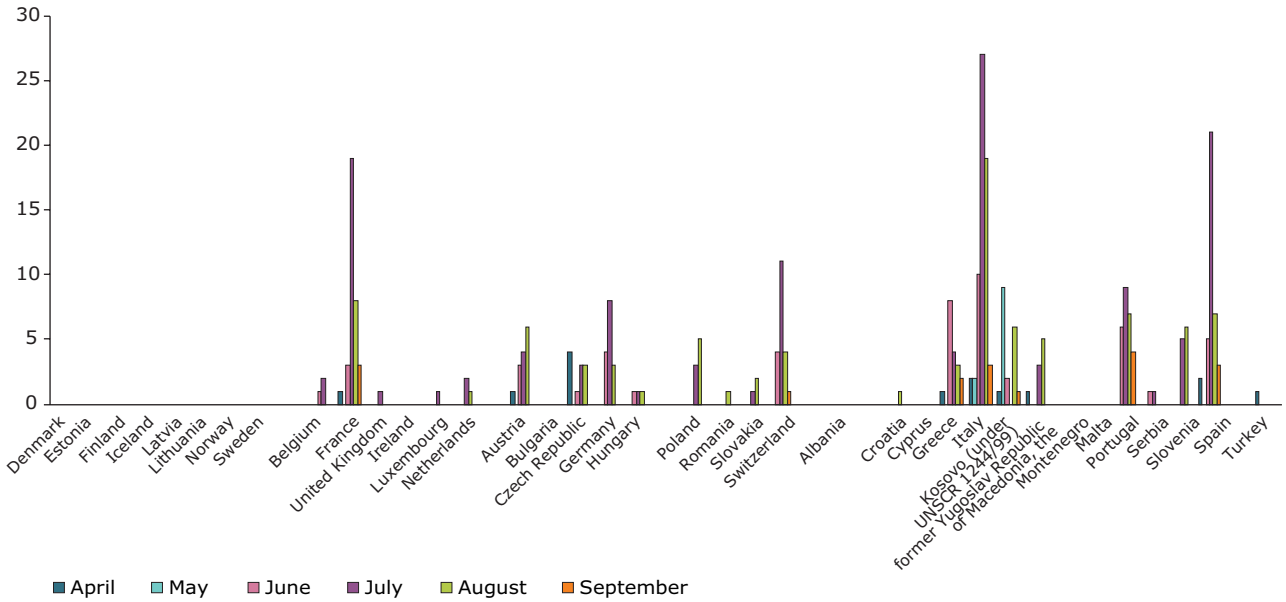
The highest number of exceedances occurred during July and August (45 % and 25 % of all observed exceedances), and the lowest in May (3 %). The figure for May is the lowest on record; the figure for July belongs to the highest (Table 2.4, Figure 2.3). The distribution of exceedances is due to the meteorological conditions (Figure 2.5, Chapter 2.3).

The frequency distribution of maximum daily 8-hour mean ozone concentrations exceeding the LTO is shown in Figure 2.4. In Europe as a whole, 25 % of maximum daily 8-hour mean concentrations of all the observed exceedances were below 125 µg/m³ (125 µg/m³ in 2012, 2011, 2008, 2007, 2005 and 2004, 127 µg/m³ in 2006, 124 µg/m³ in 2009, and 126 µg/m³ in 2010). A total of 75 % were below 142 µg/m³ (143 µg/m³ in 2004 and 2010, 144 µg/m³ in 2005, 148 µg/m³ in 2006 and 140 µg/m³ in 2007 and 2012, 138 µg/m³ in 2008, 139 µg/m³ in 2011 and 2009).

Figure 2.1 Number of days on which at least one exceedance of the 1-hour threshold value was observed during summer 2013, per country and per month (only countries that submitted data are shown)

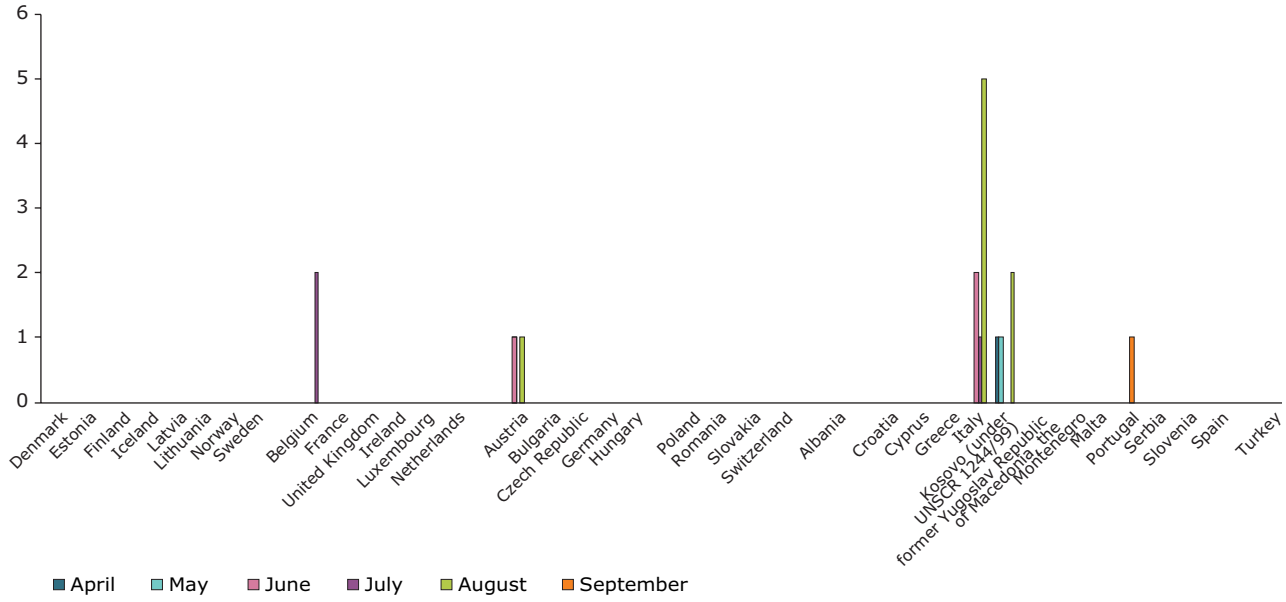
a) Information threshold exceedances

Number of days



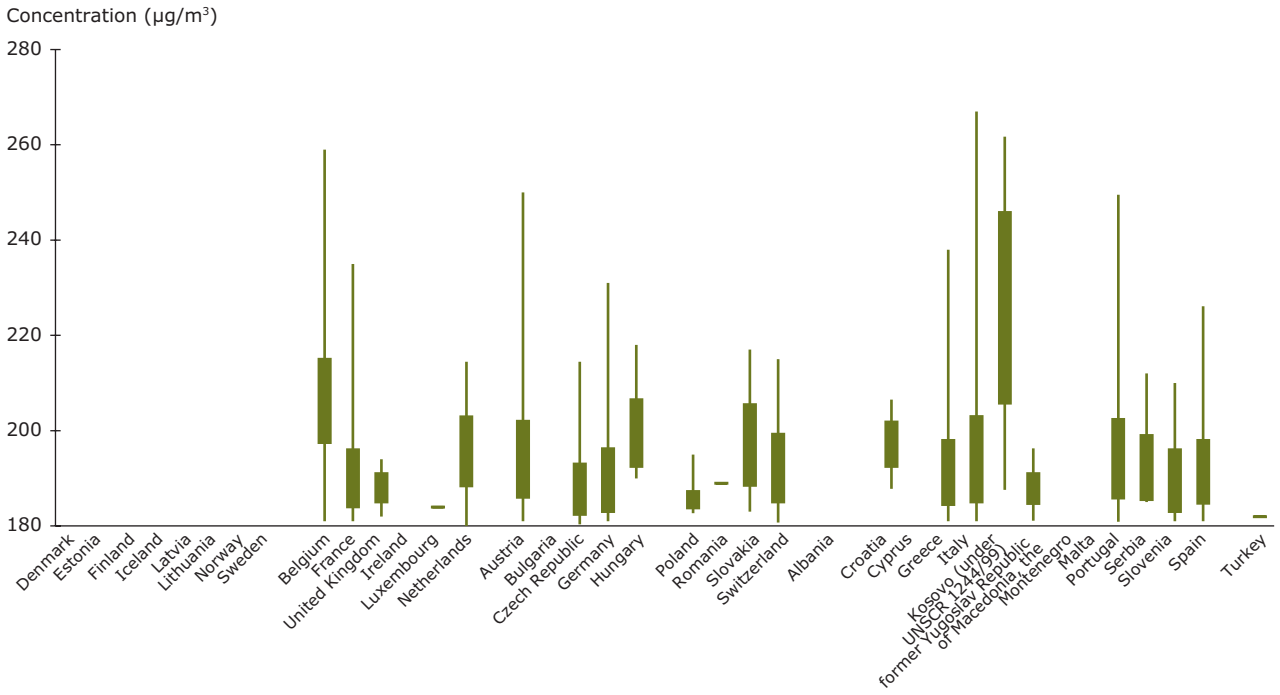
b) Alert threshold exceedances

Number of days



Notes: 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 1-hour information threshold during summer 2013 (only countries that submitted data are shown)



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

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

The TV is exceeded when the LTO has been exceeded at a particular station more than 25 times per calendar year, averaged over 3 years. 2010 was the first year in a rolling sequence of three years which will be used in determining whether countries are meeting the TV. The TV threshold (120 µg/m^3, maximum over 8 hours, for more than 25 days) was exceeded in a significant part of Europe in 2013: 19 Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and five other countries or territories (the former Yugoslav Republic of Macedonia, Kosovo (under UNSCR 1244/99), Montenegro, Serbia and Switzerland). As with previous years, the largest number of exceedances occurred in the Mediterranean area and, to a lesser extent, in western and central Europe.

Table 2.3 Overview of exceedances of the LTO and TV threshold for the protection of human health during summer 2013, 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	105	105	100	52	50	99	200	26.1	26.1
Belgium	41	41	100	1	2	37	200	10.4	10.4
Bulgaria	19	15	79	1	5	88	163	9.1	11.5
Croatia	2	2	100	1	50	39	175	30.0	30.0
Cyprus	2	2	100	1	50	79	143	40.5	40.5
Czech Republic	55	54	98	7	13	73	198	19.4	19.8
Denmark	9	5	56	0	–	10	143	2.0	3.6
Estonia	9	1	11	0	–	1	121	0.1	1.0
Finland	20	8	40	0	–	19	151	1.3	3.1
France	367	350	95	75	20	130	206	18.1	19.0
Germany	259	249	96	29	11	88	205	14.2	14.8
Greece	22	19	86	10	45	142	178	33.2	38.5
Hungary	17	15	88	7	41	75	177	20.9	23.7
Ireland	11	6	55	0	–	5	130	0.6	1.2
Italy	297	261	88	132	44	167	234	23.7	27.0
Latvia	8	2	25	0	–	6	132	0.9	3.5
Lithuania	14	3	21	0	–	1	123	0.2	1.0
Luxembourg	5	5	100	1	20	42	164	20.4	20.4
Malta	5	1	20	1	20	40	143	8.0	40.0
Netherlands	35	29	83	0	–	22	192	4.9	5.9
Poland	80	63	79	3	4	80	173	9.1	11.5
Portugal	40	37	93	14	35	85	195	19.9	21.5
Romania	104	18	17	4	4	104	163	2.2	12.6
Slovakia	15	15	100	7	47	75	166	23.0	23.0
Slovenia	12	12	100	7	58	118	199	38.6	38.6
Spain	392	342	87	100	26	167	205	16.7	19.2
Sweden	12	6	50	0	–	10	136	1.3	2.5
United Kingdom	81	27	33	0	–	19	160	0.7	2.0
EU area	**2 038**	**1 693**	**83**	**453**	**22**	**181**	**234**	**16.0**	**19.2**
Albania	1	1	100	0	–	10	146	10.0	10.0
Bosnia and Herzegovina	x	x	x	x	x	x	x	x	x
former Yugoslav Republic of Macedonia, the	14	8	57	4	29	147	187	20.5	35.9
Iceland	2	0	–	0	–	0	–	–	–
Kosovo (under UNSCR 1244/99)	7	7	100	4	57	76	248	24.0	24.0
Liechtenstein	x	x	x	x	x	x	x	x	x
Montenegro	2	2	100	2	100	41	147	27.5	27.5
Norway	7	1	14	0	–	2	123	0.3	2.0
Serbia	4	4	100	2	50	70	172	28.8	28.8
Switzerland	30	30	100	16	53	77	197	30.5	30.5
Turkey	x	x	x	x	x	x	x	x	x
Europe	**2 105**	**1 746**	**83**	**481**	**23**	**181**	**248**	**16.2**	**19.5**

Notes: 'x' indicates that no data were delivered from Bosnia and Herzegovina, Liechtenstein and Turkey.

'–' indicates 'not applicable'.

([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.

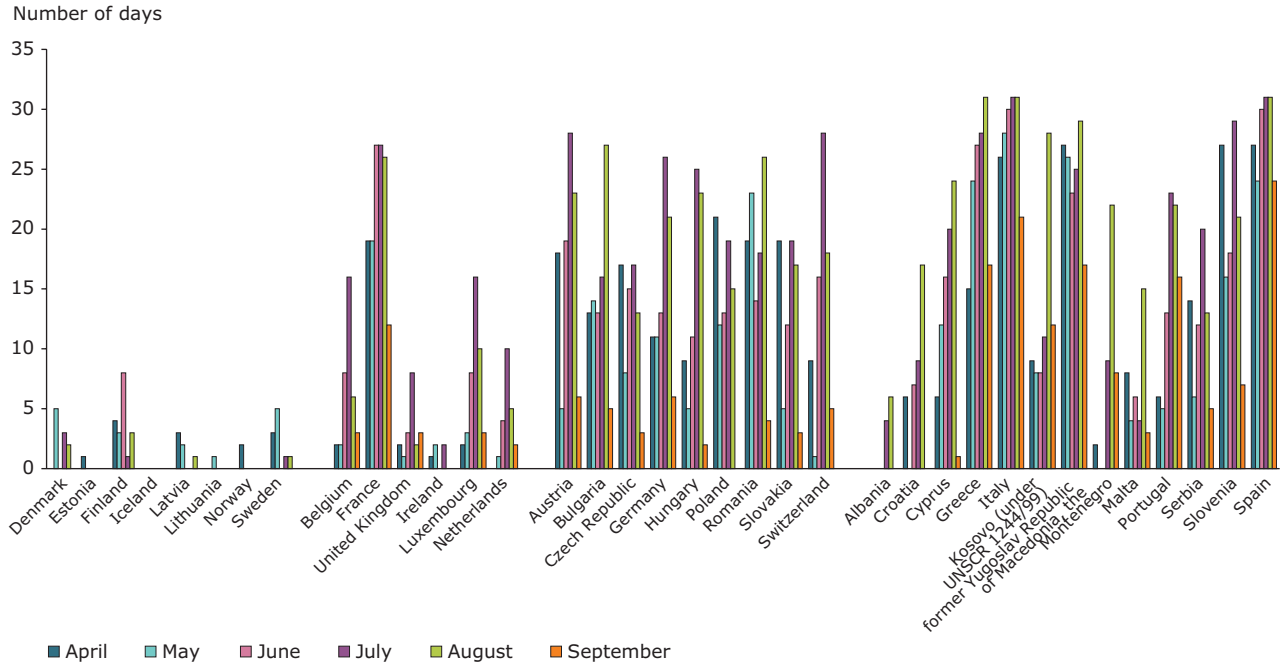
([d]) Left column: averaged over all implemented stations.
Right column: averaged over all stations which reported at least one exceedance.

Table 2.4 Overview of exceedances of the LTO for the protection of human health in Europe during summer 2013, 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	863	41	30	246	1.1	1.3
May	374	18	31	246	0.5	0.6
June	1 202	57	30	216	2.4	2.9
July	1 605	76	31	227	7.2	8.7
August	1 448	69	31	248	4.0	4.8
September	812	39	28	206	0.9	1.1

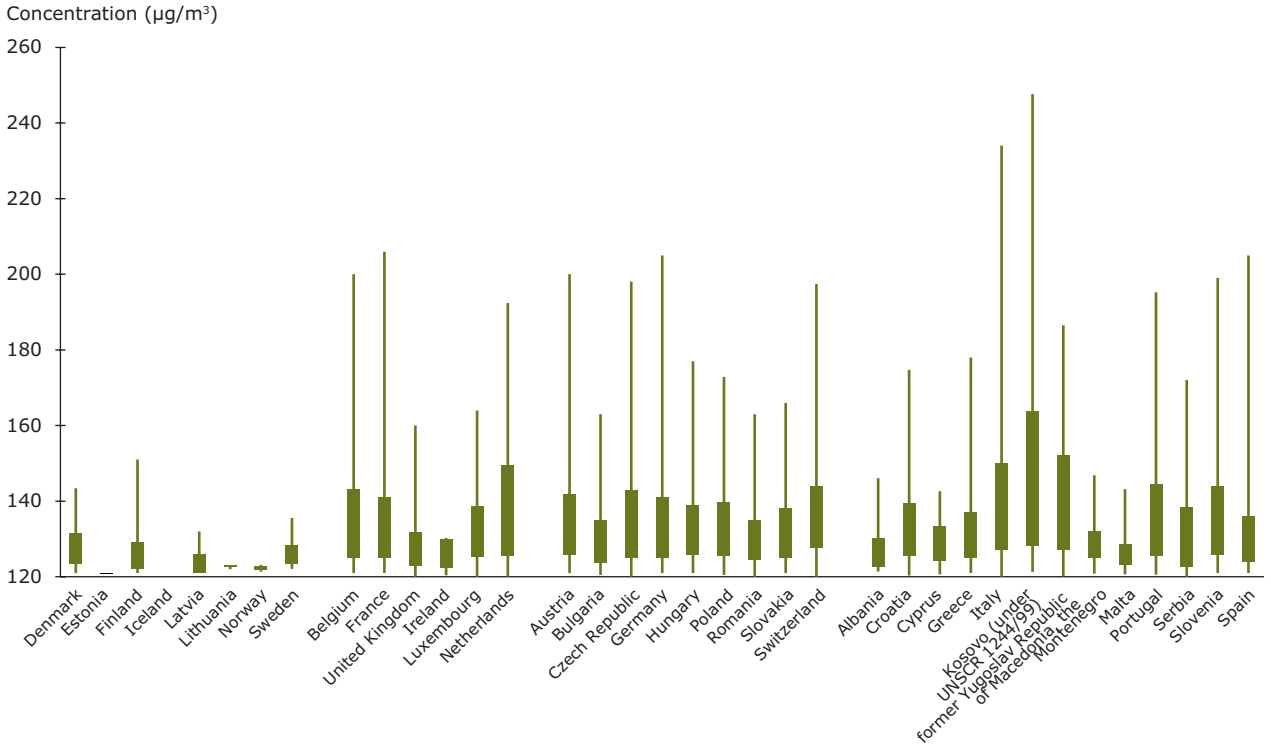
Notes: ([b])–([d]) see notes to Table 2.3.

Figure 2.3 Number of days on which at least one exceedance of the LTO for the protection of human health was observed during summer 2013, per country and per month (only countries that submitted data are shown)



Notes: 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 LTO for the protection of human health during summer 2013 (only countries that submitted data are shown)



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

Finally, the 2011 TV (for the period from 2011 to 2013) 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 2011 TV value that will be reported in 2014;
- the TV was calculated for all 28 Member States, plus 5 other countries or territories;
- only the 6 summer months were used, so this would be an underestimation of the TV, as exceedances of the maximum daily 8-hour average of 120 µg/m3 could also occur in other months (mainly in March and October);
- validated data were used only for 2011, while provisional data were used for 2012 and 2013;
- 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 from 2011 to 2013 are included in the summary per country (Table 2.5) and in the related map (Map 2.3).

From a total of 2 298 stations reporting data from at least 1 year in 2011, 2012 and 2013, only 1 862 (81 %) could be used for the exercise, having reported data from all the 3 years. Of these 1 862, 444 stations (23.8 %) had exceedances of the TV. This percentage is similar in the EU-28 area. The TV was exceeded (Table 2.5) in at least 1 station in 18 Member States (Austria, Bulgaria, Croatia, 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 that fulfilled the criteria established for this calculation exercise (the former Yugoslav Republic of Macedonia, Serbia and Switzerland).

Table 2.5 Overview of exceedances of the 2011 TV for the protection of human health (summer 2011, 2012 and 2013), 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	103	53	51.5	64.0
Belgium	39	0	0.0	19.0
Bulgaria	17	4	23.5	100.0
Croatia	2	2	100.0	42.0
Cyprus	2	1	50.0	73.0
Czech Republic	55	10	18.2	51.0
Denmark	7	0	0.0	5.0
Estonia	9	0	0.0	3.0
Finland	19	0	0.0	4.0
France	346	61	17.6	76.0
Germany	241	17	7.1	37.0
Greece	19	13	68.4	122.0
Hungary	17	10	58.8	61.0
Ireland	10	0	0.0	2.0
Italy	248	155	62.5	111.0
Latvia	8	0	0.0	12.0
Lithuania	12	0	0.0	9.0
Luxembourg	5	1	20.0	35.0
Malta	5	1	20.0	60.0
Netherlands	33	0	0.0	14.0
Poland	60	5	8.3	52.0
Portugal	32	4	12.5	33.0
Romania	54	1	1.9	31.0
Slovakia	14	8	57.1	60.0
Slovenia	11	9	81.8	89.0
Spain	363	72	19.8	92.0
Sweden	12	0	0.0	7.0
United Kingdom	79	0	0.0	10.0
EU area	**1 822**	**427**	**23.4**	
Albania	1	0	0.0	5.0
Bosnia and Herzegovina	0	–	–	–
former Yugoslav Republic of Macedonia, the	7	1	14.3	76.0
Iceland	0	–	–	–
Kosovo (under UNSCR 1244/99)	0	–	–	–
Liechtenstein	0	–	–	–
Montenegro	0	–	–	–
Norway	7	0	0.0	3.0
Serbia	2	2	100.0	53.0
Switzerland	23	14	60.9	77.0
Turkey	0	–	–	–
Whole area	**1 862**	**444**	**23.8**	

Notes: Data from 2011 are validated, while data from 2012 and 2013 are provisional.
White rows refer to countries with exceedances of the 2011 TV, and grey rows to countries with no exceedances.

In seven of the Member States, and in two other countries, the percentage of the total stations fulfilling the criteria for the calculation exercise and with levels exceeding the 2011 TV was above 50 %. Five of these 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 3 years. In 2 countries in 2013, 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 6 more countries, the averaged LTO was exceeded between 75 and 100 days. In 8 countries, the averaged LTO was exceeded between 50 and 74 days, and in the other 5 countries that reached the TV threshold, the LTO was exceeded between 26 and 49 days.

2.3 Geographical distribution of ozone air pollution

The spatial distribution of ozone exceedances throughout Europe is generally similar from year to year. In 2013, 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 occurred. As in previous summers, north-western and northern Europe were almost unaffected. 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.

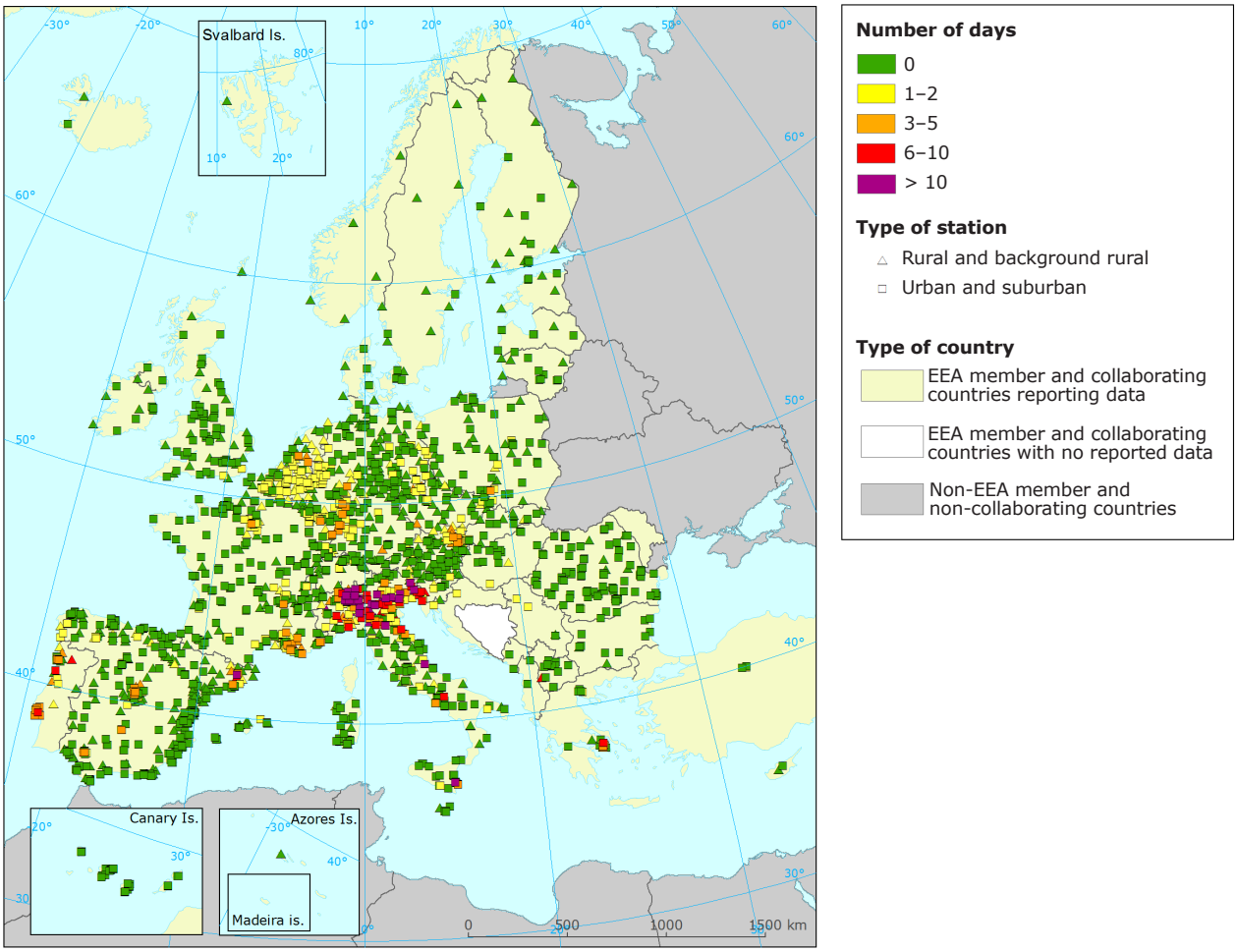
Only northern Italy and several more isolated locations reported exceedances of the information threshold on more than five days during the summer of 2013. No exceedances of the information threshold were reported from Scandinavia and the Baltic states, Albania, Bulgaria, Cyprus, Iceland, Ireland, Malta and Montenegro in summer 2013. The fewest exceedances of the LTO were reported from Scandinavia, the United Kingdom, Ireland and the Baltic states.

Map 2.1 depicts the number of days on which the 1-hour information threshold was exceeded across Europe. The spatial extent of the exceedances observed in the summer of 2013 is similar to that of summer 2012.

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 smaller in 2013 than in 2012. More than 25 LTO exceedances were recorded in approximately 7 % of the assessed area, and affected approximately 10 % 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 the last years (Table 2.6).

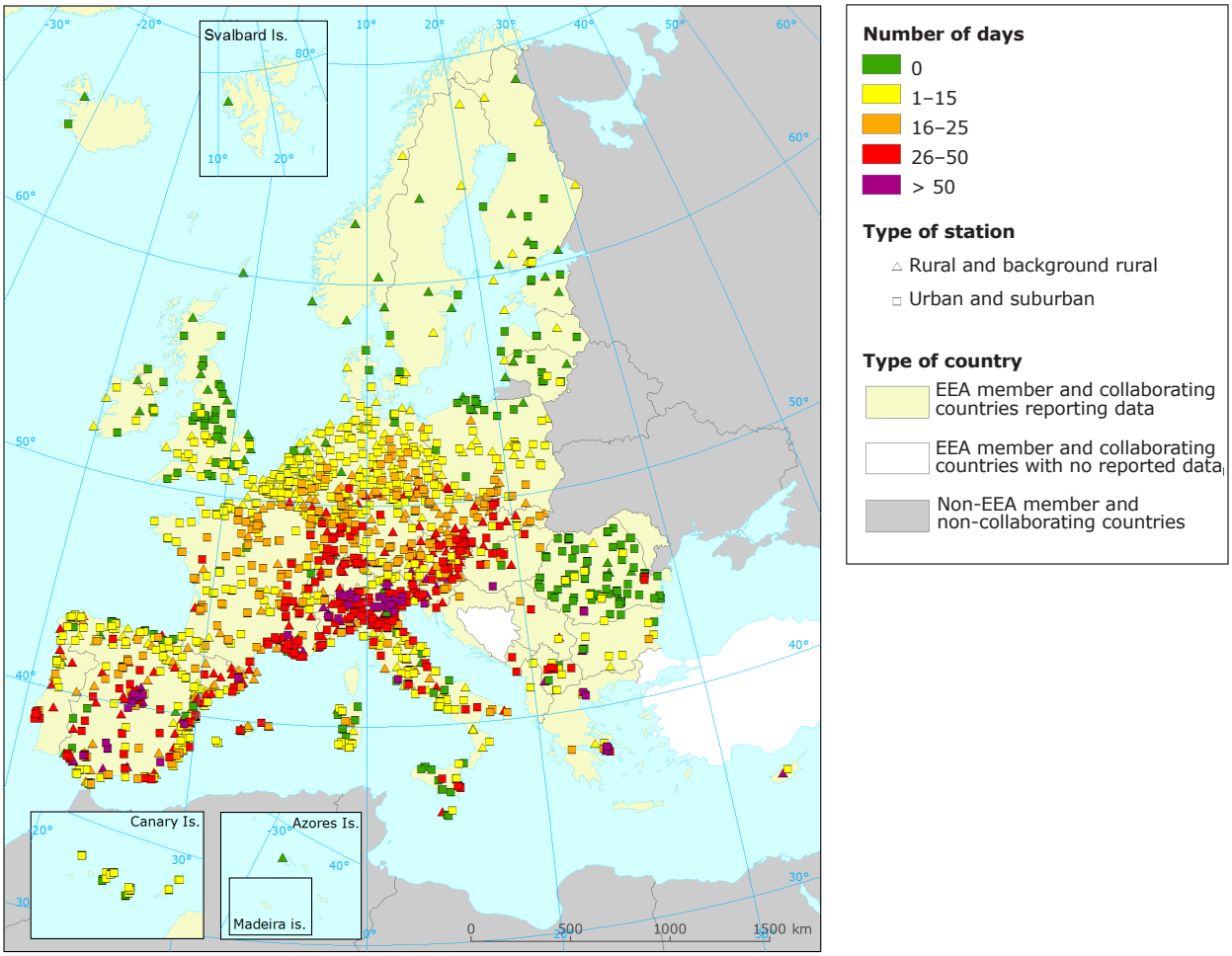
Map 2.3 shows the number of days on which the 2011 TV was exceeded across Europe for rural and background rural, and for urban and suburban sites. The area with exceedances of the TV (number of days > 25) covers a great part of Europe. The regions without exceedances of the TV were the Baltic States, northwestern Europe and some poorly covered Balkan countries. On the other hand, the greatest number 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 summer 2013 (provisional data)



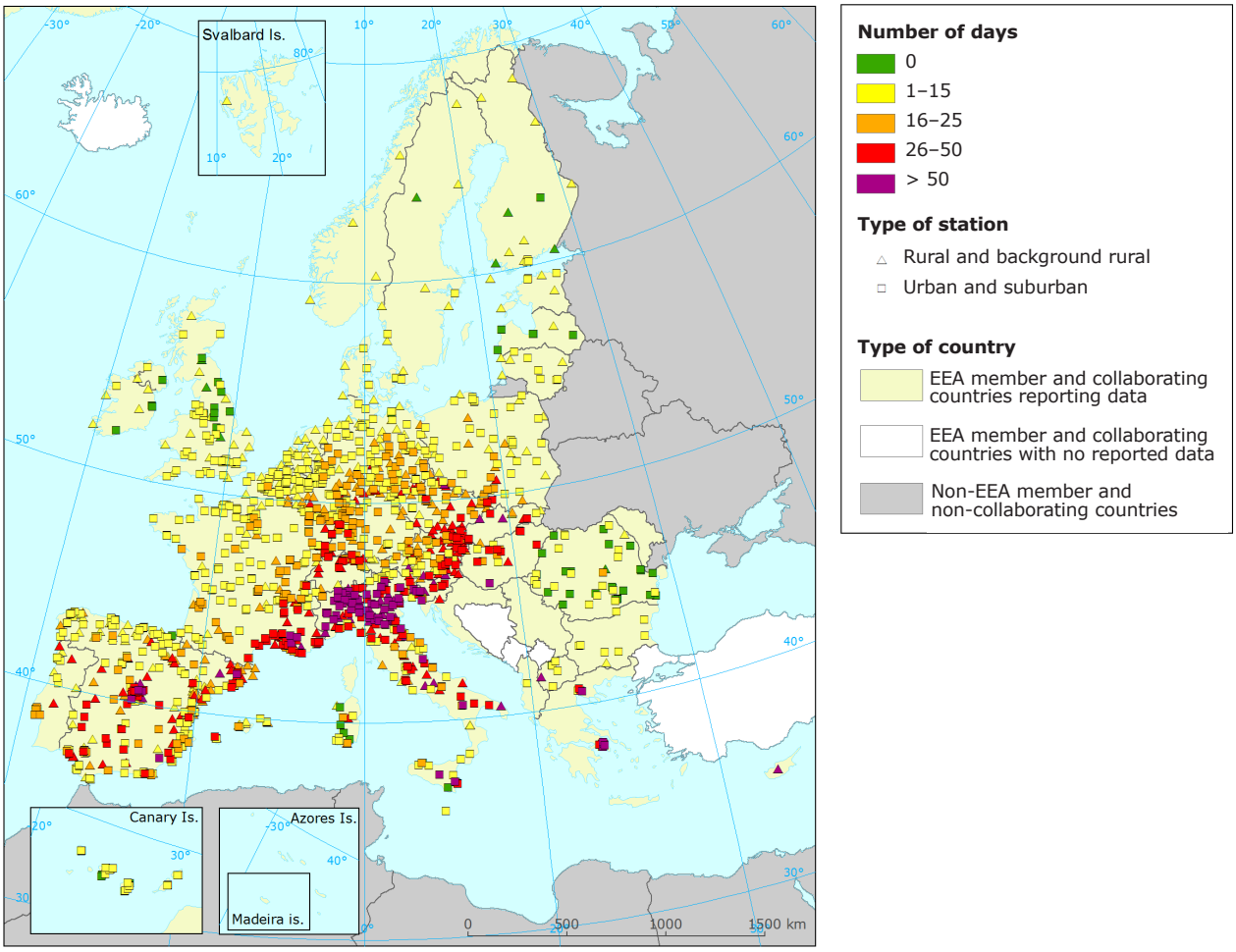
Note: Only stations with known metadata relating to the ozone type of station are depicted.

Map 2.2 Number of days on which ozone concentrations exceeded the LTO for the protection of human health during summer 2013 (provisional data)



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

Map 2.3 Number of days on which the 2011 TV for the protection of human health (summers of 2011, 2012 and 2013) was exceeded (data from 2011 are validated, while data from 2012 and 2013 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 summers of 2006–2013, by country ([a])

Country	Area with the exceedances over TV threshold (% of total area)								Population affected by the exceedances over TV threshold (% of the total) ([b])							
	2006	2007	2008	2009	2010	2011	2012	2013	2006	2007	2008	2009	2010	2011	2012	2013
Austria	94.4	96.7	15.0	56.8	70.6	71.8	57.4	6.7	84.8	67.3	13.7	14.5	26.8	45.2	42.0	28.7
Belgium	69.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech Republic	99.8	95.9	45.6	18.7	19.9	48.3	37.5	0.0	95.6	59.1	6.8	6.6	0.9	11.1	24.3	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	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	0.0	0.0	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	7.8	61.4	14.2	5.6	9.6	22.0	14.0	4.1	8.7
Germany	84.3	50.2	24.2	16.3	30.9	17.5	0.7	0.7	88.0	13.1	10.6	2.0	13.0	3.8	0.1	0.9
Hungary	95.9	99.5	77.7	99.4	25.9	59.9	95.5	20.9	69.3	85.9	28.6	85.6	3.5	24.3	83.7	13.8
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy	75.8	76.0	41.9	49.0	47.8	85.6	77.1	32.4	88.8	71.6	55.2	57.3	48.8	69.0	69.1	41.5
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luxembourg	–	0.0	0.0	0.0	19.9	0.0	0.0	0.0	100.0	0.0	0.0	0.0	2.9	1.8	0.0	0.0
Malta	49.3	49.0	0.0	0.0	0.0	56.5	54.8	0.0	4.9	2.7	1.6	0.0	0.7	4.0	3.0	0.0
Netherlands	15.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Norway	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Poland	77.6	27.2	3.5	2.8	0.0	10.4	9.9	0.0	53.0	12.3	1.9	0.4	0.0	2.4	5.5	0.0
Portugal	72.4	33.0	0.1	31.6	50.6	0.0	0.0	0.7	46.5	5.0	0.0	18.5	23.3	5.7	0.0	2.4
Romania	–	–	–	25.7	0.0	0.0	41.5	0.0	0.6	36.7	3.1	8.0	0.0	0.7	15.5	0.0
Slovakia	96.2	99.8	72.9	99.8	0.0	74.0	77.8	2.0	66.5	69.2	24.0	88.3	1.1	28.7	82.1	9.9
Slovenia	100.0	98.2	76.4	94.7	95.8	97.7	98.9	52.9	100.0	99.9	22.7	38.2	56.5	99.5	85.3	34.5
Spain	81.4	40.2	41.9	23.2	70.1	24.3	26.5	24.1	42.5	24.6	16.8	18.1	30.7	7.5	7.5	26.4
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Switzerland	100.0	92.5	10.2	81.6	99.1	95.9	58.4	59.1	100.0	53.6	11.1	15.4	99.5	40.6	16.4	58.2
United Kingdom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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**	**7.2**	**51.4**	**27.1**	**15.0**	**16.0**	**16.3**	**16.5**	**15.2**	**10.4**

Notes: Data from 2012 and 2013 are provisional from the summer reporting. Data for percentage of exposed area are provisional. Population exposure data from 2006 to2011 are based on validated data and the percentage is borrowed from the ETC/ACC report (ETC/ACM, 2013).

([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 between urban and rural stations, and the methodology of interpolation used. Due to different data used the shares of affected area and population from 2006 to 2010 and from 2011 to 2013 are not exactly comparable.

([b]) The Joint Research Centre (JRC) population data set CLC2000 has been used to estimate the affected population (EEA, 2012a). The Oak Ridge National Laboratory (ORNL) Global Population Data Set, 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.

2.4 Main ozone episode

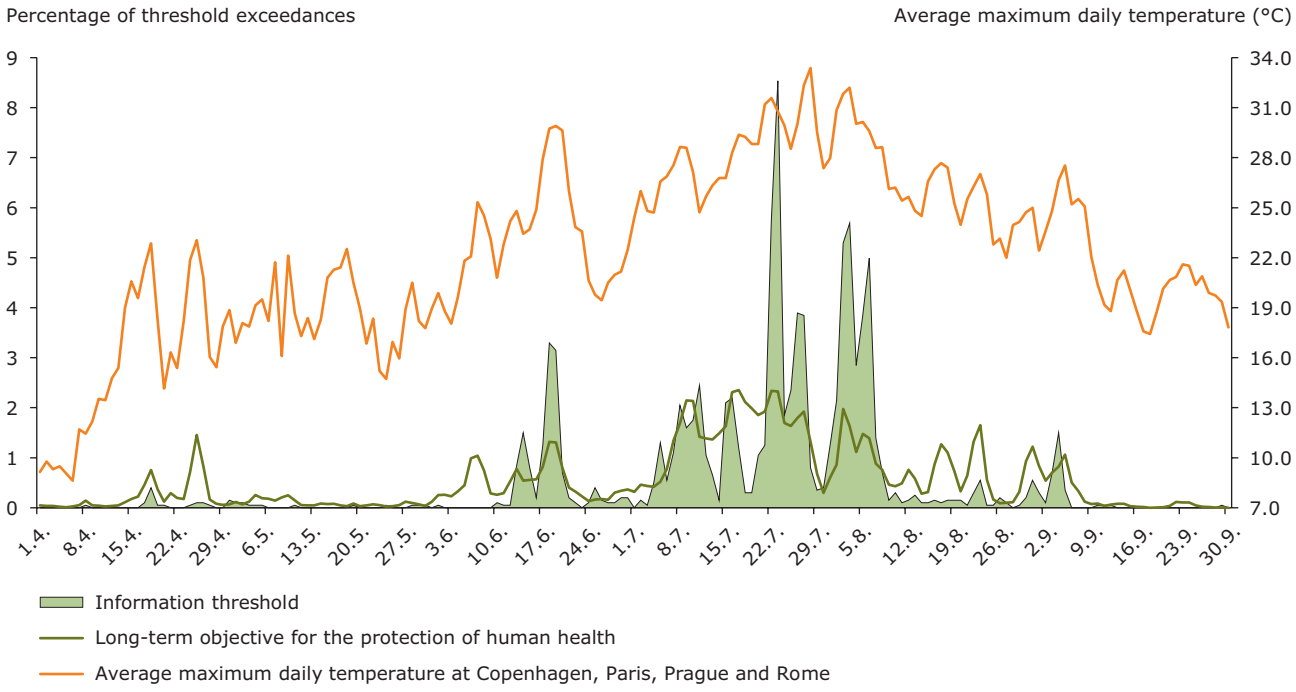
Ozone formation in the atmosphere is a complicated, non-linear, photochemical process. In the troposphere (the lower part of the atmosphere), ozone formation results from a chain of mechanisms involving photochemical reactions of NO_X, chained with oxidative decomposition of VOCs, carbon monoxide (CO) and methane, initiated by hydroxyl radicals. Episodes of elevated ozone levels typically 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 2013 was characterised by a very low incidence of exceedances prior to mid June and after 8 August, but also by a period of high incidences during July and the first days of August. The period between 7 July and 6 August accounted for approximately 73 % of the total number of exceedances of the information threshold, 59 % of exceedances of the alert threshold, and 50 % of LTO exceedances experienced during the summer. In the second 10 days of June, most of July and the beginning of August 2013, the average temperatures in Rome (Italy), Prague (the Czech Republic), Paris (France) and Copenhagen (Denmark) were higher than usual. These temperatures may have contributed to increased ozone levels (Figures 2.5 and 2.6). In the first half of July, concentrations exceeding the information threshold occurred mainly in northern Italy, Spain and southern France, but by the second half of the month, similarly high pollutant concentrations were also found in parts of northern Europe. Ozone exceeded these limits in the Paris area and in the Netherlands, Belgium and western Germany. At the end of July and the beginning of August, most of the exceedances were registered in northern Italy, with high values occasionally occurring also in the central European region. The highest 1-hour ozone concentration of summer 2013 was reported from Bergamo, northern Italy: 267 $\mu g/m^3$ on 2 August.

Figure 2.5 shows the distribution of daily exceedances for Europe and the averaged maximum temperatures observed in four European capital cities (Copenhagen, Paris, Prague and Rome ([10])). The distribution of exceedances per day and per country during summer 2013 is shown in Figure 2.7. Map 2.4 shows the coincidence of areas with elevated ozone concentrations and the highest temperatures on selected days.

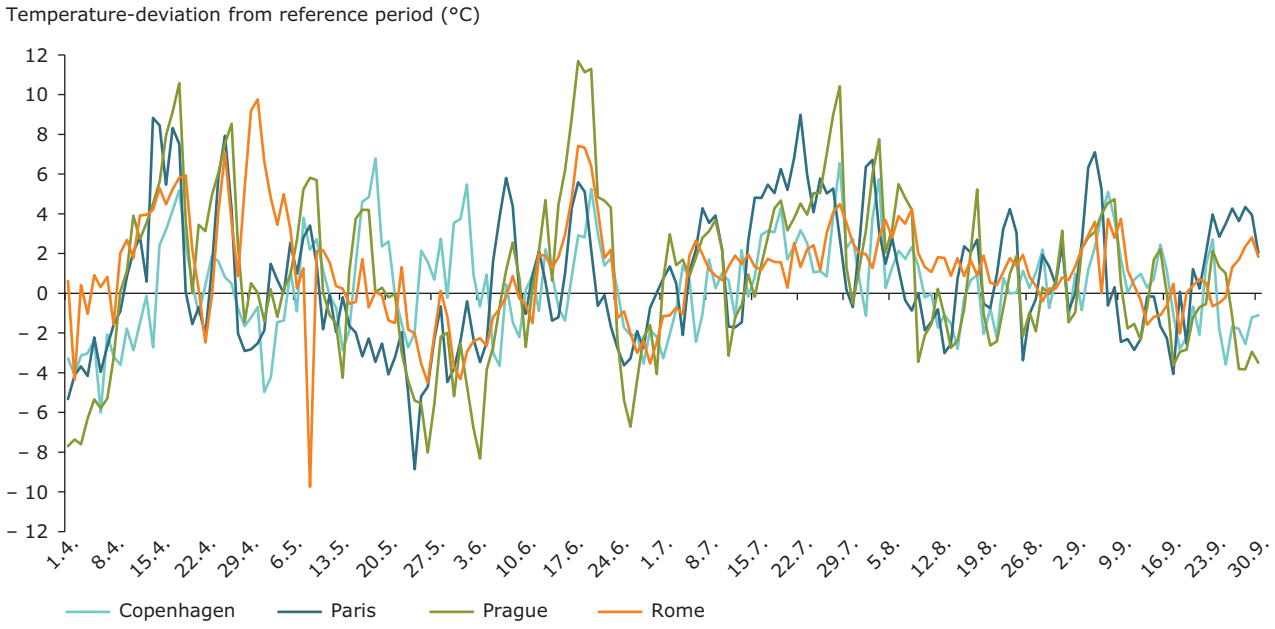
([10]) Europe was divided into four regions in order to analyse inter-annual variations in the trend of ozone levels due to climatic differences; four capital cities in the regions were selected to demonstrate the relation between the number of exceedances and the meteorological situation (see Chapter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

Figure 2.5 Distribution of exceedances during summer 2013, by day



Notes: 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: European Climate Assessment & Dataset, 2013.

Figure 2.6 Temperature anomaly relative to the reference period from 1971 to 2000, in selected cities for each day during summer 2013

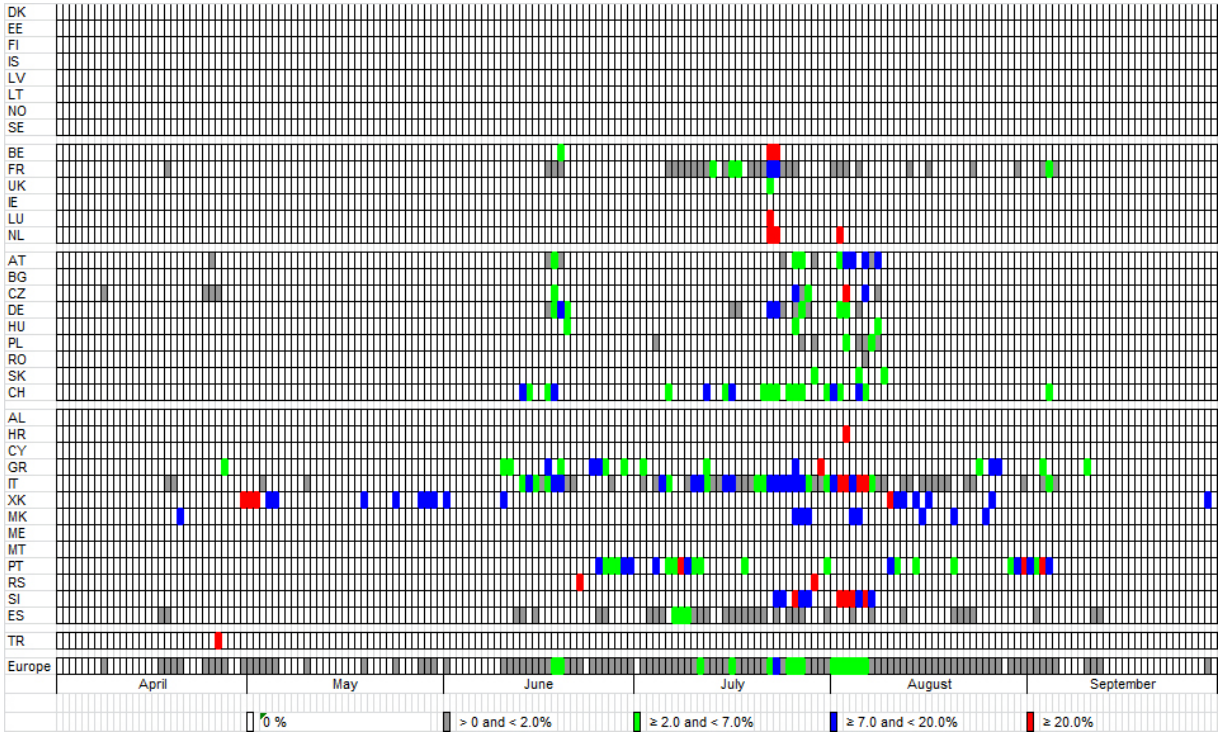


Notes: Temperature reference period: 1971–2000.

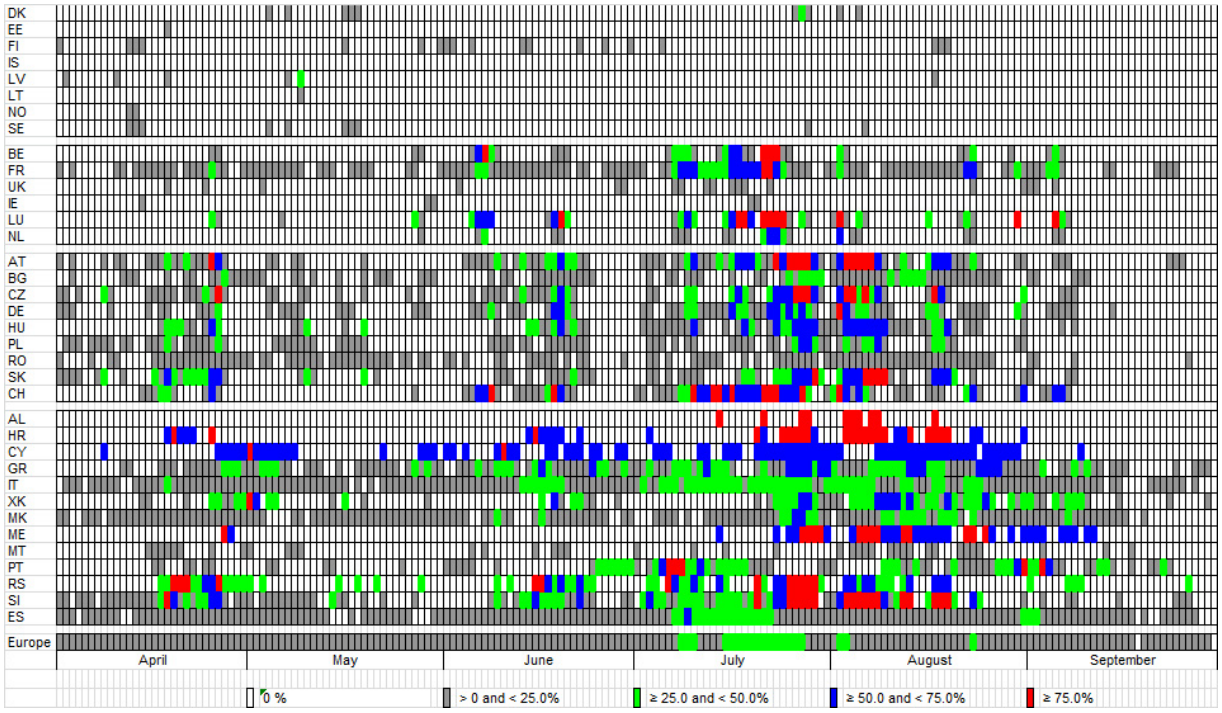
Source: Source of temperature data: European Climate Assessment & Dataset, 2013.

Figure 2.7 Distribution of exceedances during summer 2013: percentage of stations reporting exceedances on a daily basis per country ([a])

a) Information threshold exceedances



b) LTO for the protection of human health exceedances



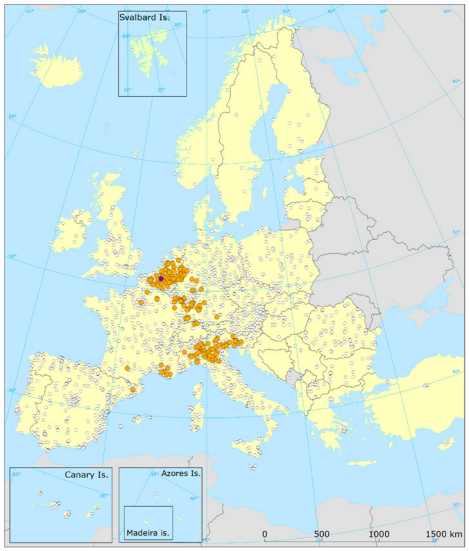
Notes: Two-letter country codes are explained in Table A.2.1 (see Annex 2).

([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).

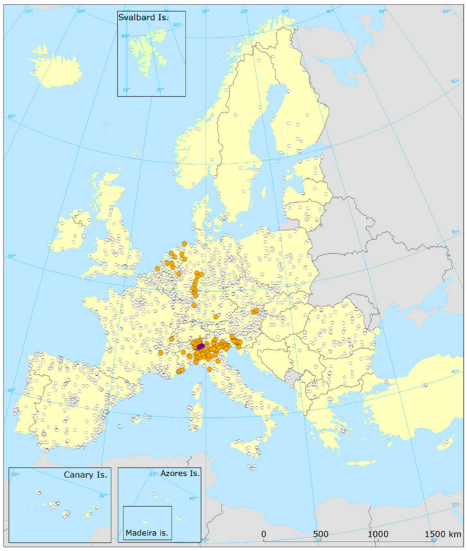
The colours represent the percentage of a country's total number of stations that observe exceedances during a particular day.

Map 2.4 Selected days during summer 2013 ozone episodes: observed maximum 1-hour ozone concentrations and meteorological situation

23 July 2013



2 August 2013

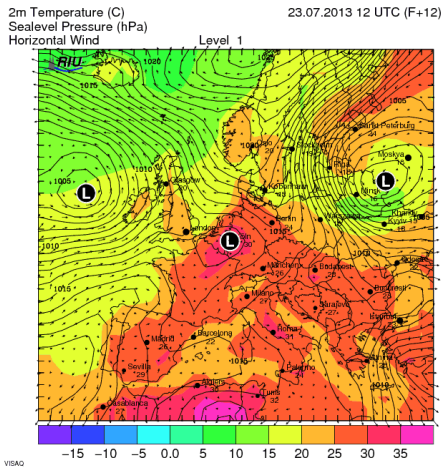


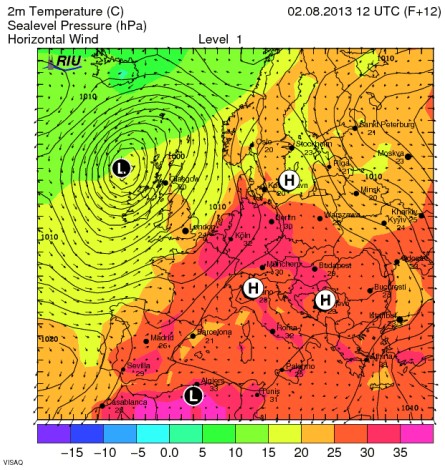
Maximal hourly value (µg/m^{-3})

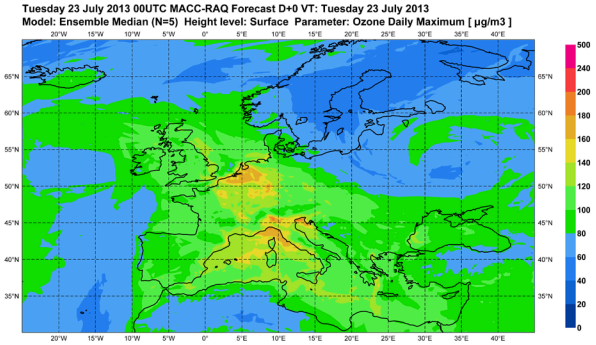
- ≤ 180
- > 180 and ≤ 240
- > 240

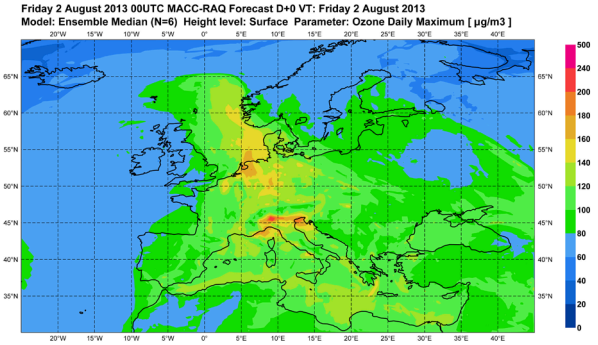
Type of country

- 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 project (modelled ground-level ozone maximum 1-hour concentrations).

3 Evolution and trends of summer ozone air pollution in Europe

For a comparison of pollution levels over a longer period, the 2013 summer ozone levels were compared with the summer ozone concentrations from 1997 to 2011 stored in the EEA AQ database AirBase, and with the summer 2012 data submitted under Directive 2008/50/EC. Only time series that included more than 75 % of valid, measured data during the summers from 1997 to 2011 were selected for comparison. Data stored in AirBase are validated, whereas the 2012 and 2013 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 traditionally divided into four regions, in order to analyse inter-annual variations in the trend of ozone levels due to climatic differences affecting ozone formation over Europe, based on the 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 4 regions. To illustrate climatic differences and their relation to the number of exceedances among the groups of countries, as well as the inter-annual variations, graphs included the maximum daily temperatures averaged for the April-to-September period of a particular year, as observed in four capital cities in selected regions (Paris, Prague, Rome and Copenhagen ([11]).

Long-lasting episodes with high ozone concentrations over large parts of the European continent occurred in 2003 and 2006. There have not been any of these similar long-lasting episodes in more recent years. It is worth noting that the situation in 2003 was entirely exceptional. Throughout the first half of August 2003, 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 (Table 3.1 and Maps 3.1 and 3.2).

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, which saw a very large number of occurrences. Ozone levels in 2004 and 2005 decreased to previous levels, but in 2006 there was a further increase across Europe. Since 2007, ozone levels have returned to their lower and more usual levels.

In recent years, beginning with the warm period in 2008, numbers of exceedances remain low. The year 2013 was no exception. The information value threshold exceedances were not significantly different from those in 2012 (however, there were no exceedances in 2013 in northern Europe). The LTO exceedances in 2013 decreased slightly in comparison with 2012. Summer temperatures do not fluctuate in recent years, either (Figure 3.1).

Using a more detailed division of stations (based on the Exchange of Information (EoI) type station classification (EC, 1997), different ozone concentrations are found at background, traffic, and industrial stations with an altitude lower than 600 m, where the majority of the European population live. In general, in all four European regions, the highest number of exceedances is measured at background stations. In some years, higher numbers of exceedances occur at industrial sites in central Europe and in the Mediterranean region (Figure 3.2).

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

Long-term trends in the information threshold exceedances and the LTO exceedances can be evaluated for areas or stations with comparably long time-series of measurements (Figure 3.3). In the case of the long-term trend, countries with long time-series represent three of the four climatic regions of Europe (see Section 2.4). Average values for these regions display a visible downward trend in the number of exceedances during the last 24 years, with visible deviations in the extreme years 2003 and 2006. The trend since 2001 is more representative (with stations from 27 countries, evenly spread across Europe in the trend period from 2001 to 2011), and it confirms the long-term trend in previous years. It is, however, important to note that this downward trend in the number of exceedances does not necessarily mean that the exposure is likewise reduced. For example, many exceedances are in the range of 180 $\mu g/m^3$ to 185 $\mu g/m^3$, so a small decrease in concentration will result in a large decrease in the number of exceedances (Figure 3.3).

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

Table 3.1 Overview of exceedances observed during summer season in Europe (1997–2013) ([a])

a) 1-hour threshold exceedances

Summer season	Number of stations ([b])	Stations with exceedance ([c])					Number of days with exceedance ([d])		Occurrence of exceedances ([e])				Average duration of exceedances (hour)	
		(number)		(%)		(%)								
1997	862	369	18	43	2	5	131	21	1.2	2.8	0.0	1.6	2.7	1.8
1998	881	508	73	58	8	14	134	59	2.3	3.9	0.2	2.1	3.4	2.2
1999	1 258	427	46	34	4	11	162	100	1.5	4.4	0.1	3.8	3.1	3.8
2000	1 327	591	44	45	3	7	132	52	1.6	3.5	0.1	2.0	2.9	2.1
2001	1 488	737	92	50	6	12	147	82	2.6	5.3	0.2	2.5	3.1	2.0
2002	1 549	565	66	36	4	12	136	41	1.3	3.4	0.1	2.0	2.8	2.0
2003	1 644	1 213	321	74	20	26	171	88	6.6	8.9	0.5	2.4	3.9	2.2
2004	1 714	628	43	37	3	7	137	44	1.5	4.0	0.0	1.9	3.1	1.9
2005	1 845	854	68	46	4	8	162	61	1.8	4.0	0.1	2.1	3.2	2.3
2006	1 916	1 188	113	62	6	10	181	138	3.6	5.8	0.4	7.4	4.3	5.1
2007	1 941	589	71	30	4	12	152	46	1.2	4.0	0.1	1.7	3.3	2.0
2008	2 085	439	28	21	1	6	135	27	0.8	3.8	0.0	2.0	2.9	2.3
2009	2 104	438	32	21	2	7	148	35	0.8	3.9	0.0	1.6	2.8	1.7
2010	2 109	769	32	36	2	4	112	24	1.3	3.7	0.0	1.3	3.1	1.9
2011	2 092	381	24	18	1	6	130	16	0.5	3.0	0.0	1.3	2.6	1.9
2012	2 107	597	17	28	1	3	115	15	0.9	3.2	0.0	1.5	2.9	1.7
2013	2 110	551	20	26	1	4	111	15	0.9	3.6	0.0	1.4	3.0	1.8

Notes: ([a]) Ozone levels in summer 2013 were compared with the summer ozone concentrations from 1997 to 2011 stored in the EEA AirBase, and with the summer 2012 data submitted under the directives in force. Data stored in AirBase are validated; 2012 and 2013 summer data are provisional and only partly validated, and no time coverage criterion was applied. This fact is also reflected in the number of measuring stations. Nevertheless, the increase in number of stations in the years from 1997 to 2010 is mainly attributable to an increasing number of reporting countries during this period.

Data from 2012 and 2013 are provisional.

White columns refer to exceedances of the information threshold, and grey 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 exceedances 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 which reported at least one exceedance.

Table 3.1 Overview of exceedances observed during summer season in Europe (1997–2013) ([a]) (cont.)

b) LTO and TV 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])	Occurrence of LTO exceedances ([e])	
		(number)	(%)	(number)	(%)			
1997	861	791	92	234	27	183	19.2	20.9
1998	881	796	90	268	30	178	20.2	22.4
1999	1 263	1 167	92	379	30	183	20.9	22.6
2000	1 328	1 205	91	381	29	181	19.5	21.5
2001	1 488	1 363	92	584	39	183	24.1	26.3
2002	1 548	1 375	89	450	29	183	20.0	22.5
2003	1 648	1 568	95	1 113	68	183	45.3	47.6
2004	1 714	1 551	90	450	26	183	19.9	22.0
2005	1 851	1 683	91	628	34	183	22.6	24.9
2006	1 919	1 807	94	1 000	52	183	28.8	30.6
2007	1 938	1 693	87	605	31	183	20.7	23.7
2008	2 084	1 849	89	485	23	183	17.5	19.7
2009	2 104	1 856	88	483	23	183	17.6	19.9
2010	2 114	1 881	89	613	29	183	20.5	23.0
2011	2 092	1 857	89	523	25	183	19.8	22.3
2012	2 107	1 793	85	437	21	182	16.4	19.2
2013	2 105	1 746	83	481	23	181	16.2	19.5

Notes: ([a]) Ozone levels in summer 2013 were compared with the summer ozone concentrations from 1997 to 2011 stored in the EEA AirBase, and with the summer 2012 data submitted under the directives in force. Data stored in AirBase are validated; 2012 and 2013 summer data are provisional and only partly validated, and no time coverage criterion was applied.

The increase in number of stations is mainly attributable to an increasing number of reporting countries during these years. The difference between the number of stations in 2011, 2012 and 2013 is due to the use of different time coverage criteria.

Data from 2012 and 2013 are provisional.

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

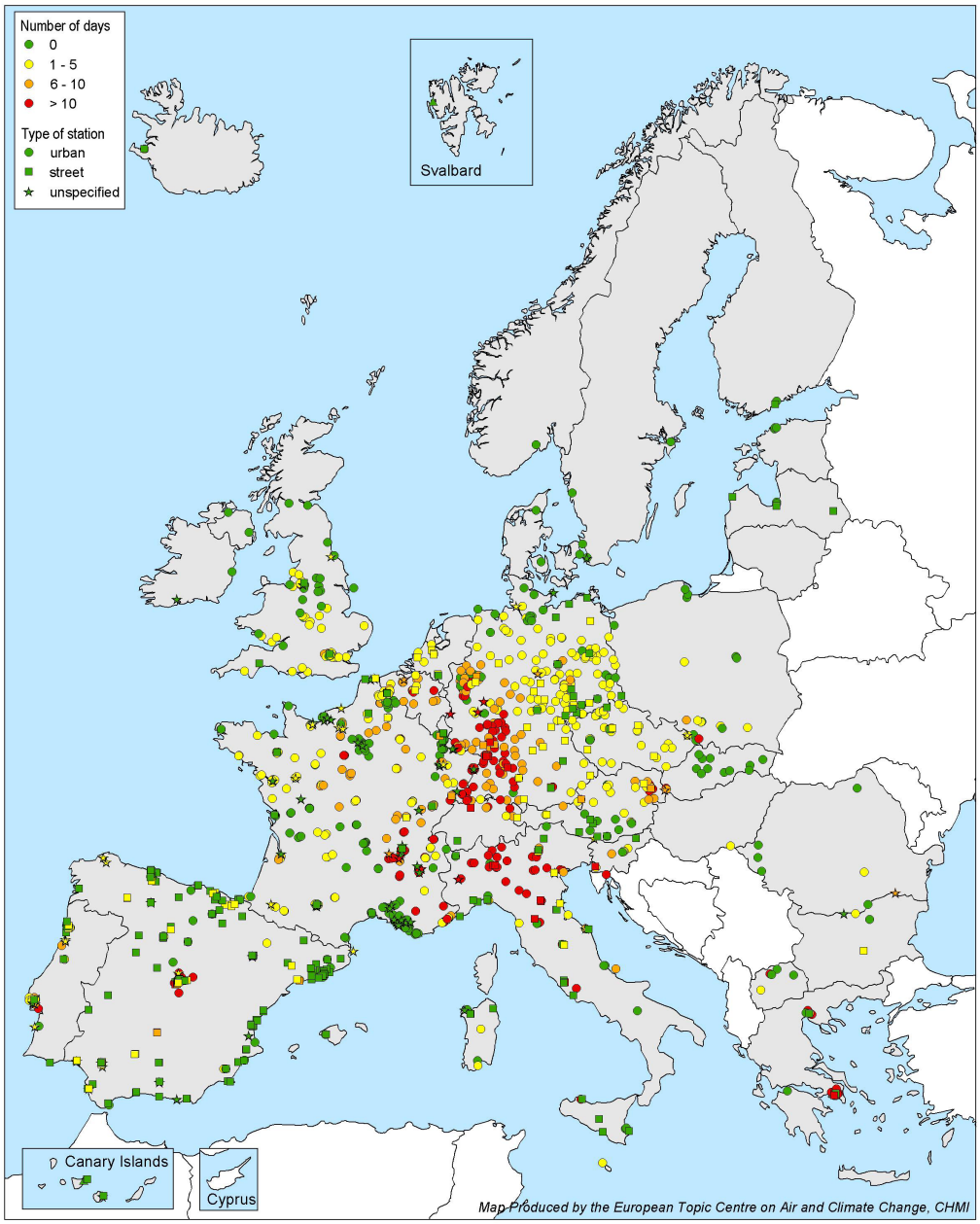
([c]) The number and percentage of stations at which at least one exceedance was observed.

([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.

Map 3.1 Number of days on which ozone concentrations exceeded the information threshold during summer 2003 (April–August)

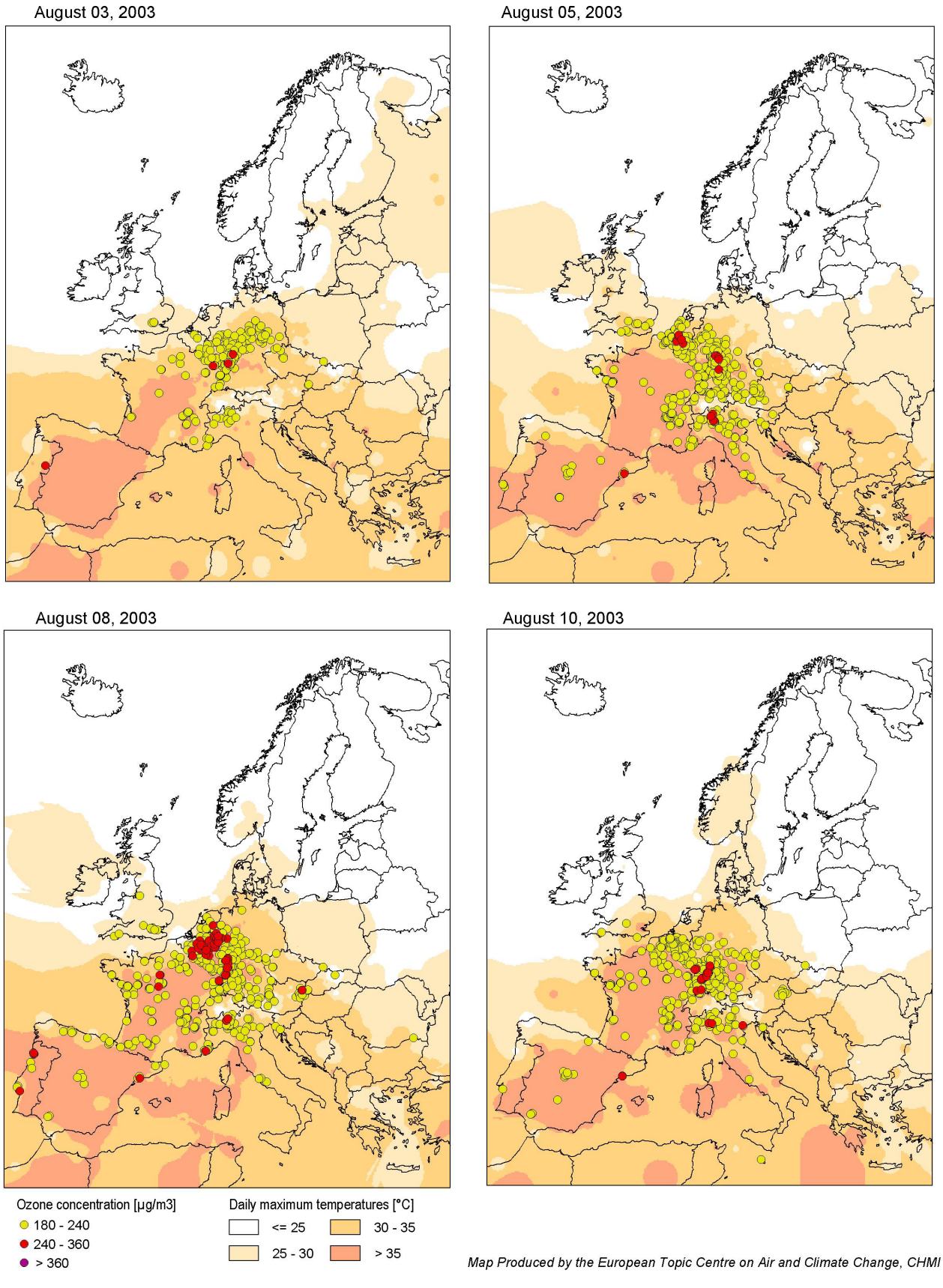


Notes: Only the period from April to August was assessed as a summer season in 2003.

Compare the spatial extent of information threshold exceedances in 2003 and 2013 (Map 2.1), and also the density of the ozone-monitoring network and its spatial coverage in summer 2003 and summer 2013 (Map A.2.1). Please note the difference between the maps' legends.

Source: EEA, 2003.

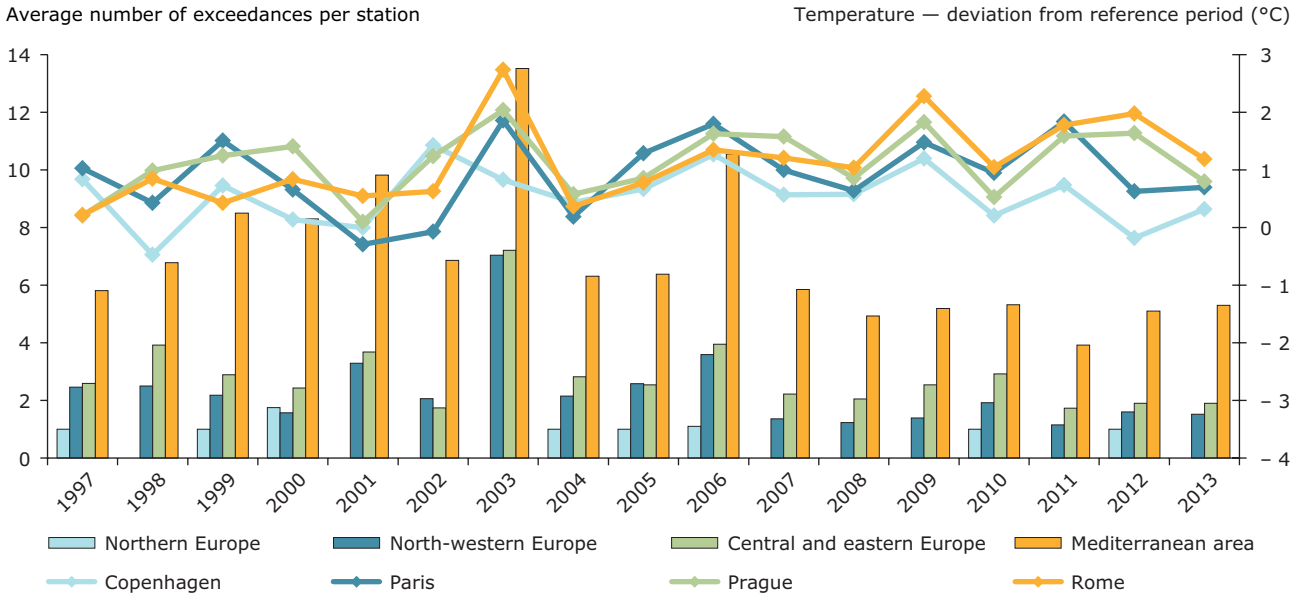
Map 3.2 Selected days during the summer 2003 ozone episode: observed maximum 1-hour ozone concentrations and meteorological situation



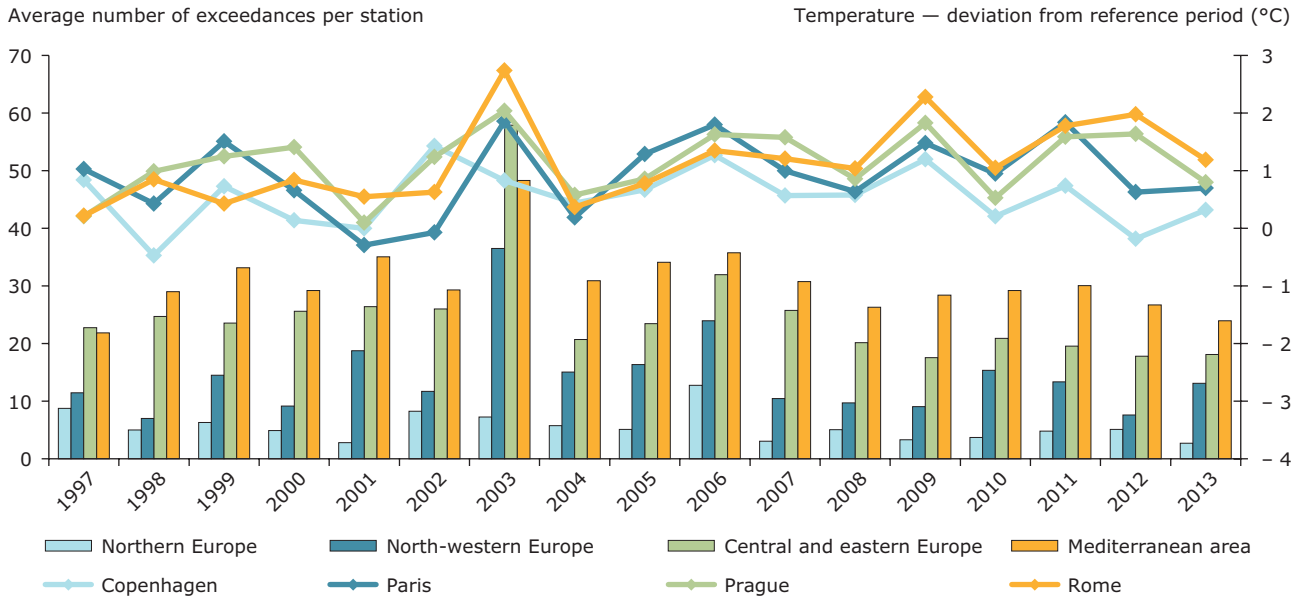
Note: Compare the spatial extent of episode in 2003 and 2013 (Map 2.4). Please note the difference between legends.
Source: EEA, 2003.

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

a) Information threshold exceedances



b) LTO for the protection of human health exceedances



Notes: Data from 2012 and 2013 are provisional.

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

North-western Europe: Belgium, France (north of 45 ° latitude), Ireland, Luxembourg, the Netherlands, the 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, the former Yugoslav Republic of Macedonia, France south of 45 ° latitude, Greece, Italy, Kosovo (under UNSCR 1244/99), Malta, Monaco, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain.

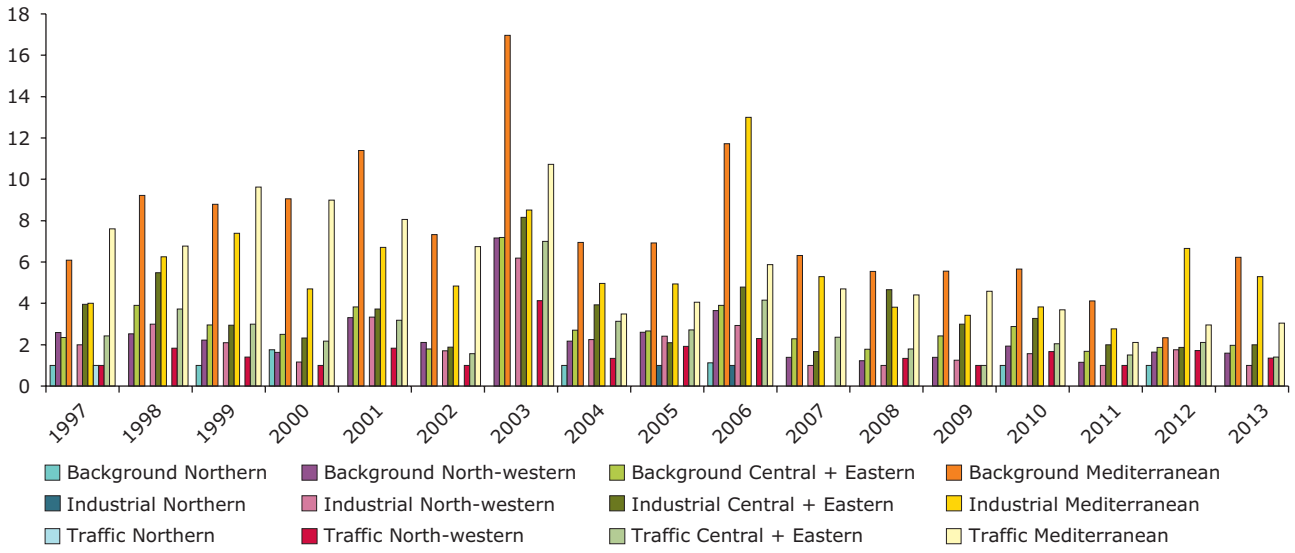
Temperature reference period: 1971–2000.

Temperature data: European Climate Assessment & Dataset, 2013.

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

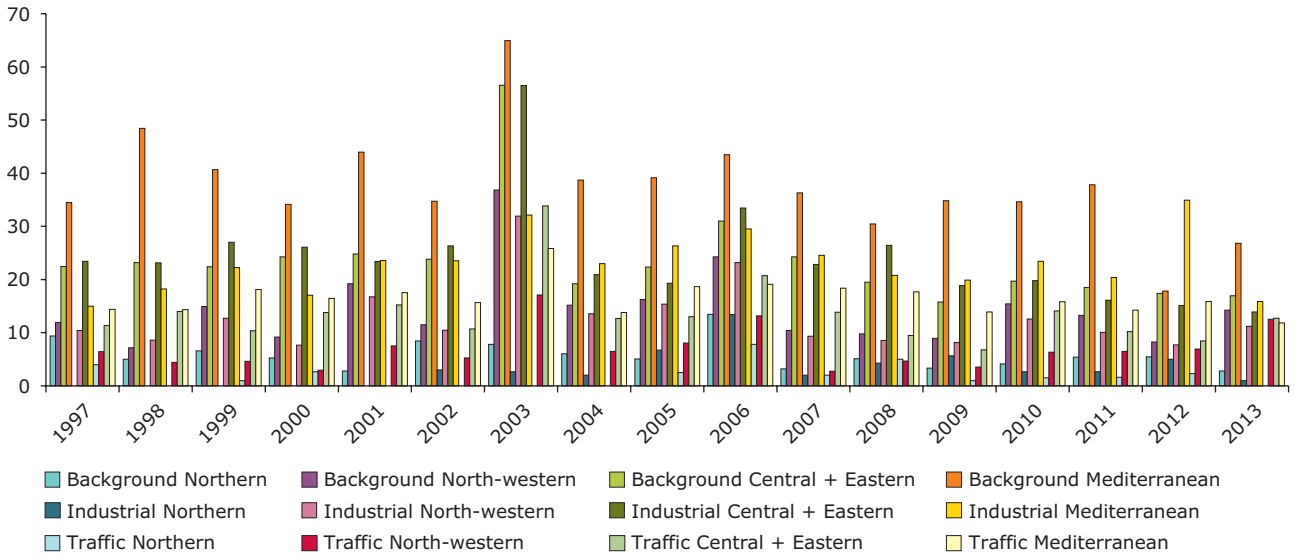
a) Information threshold exceedances

Average number of exceedances per station



b) LTO for the protection of human health exceedances

Average number of exceedances per station



Notes: Data from 2012 and 2013 are provisional.

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

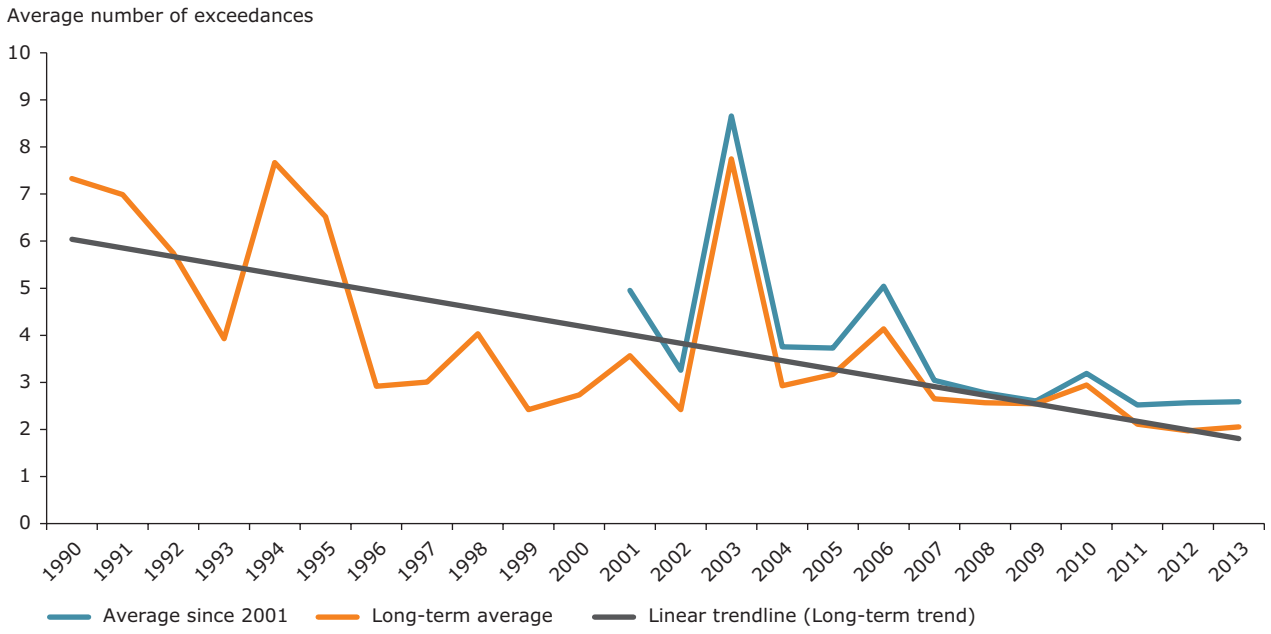
North-western Europe: Belgium, France (north of 45 ° latitude), Ireland, Luxembourg, the Netherlands, the United Kingdom.

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

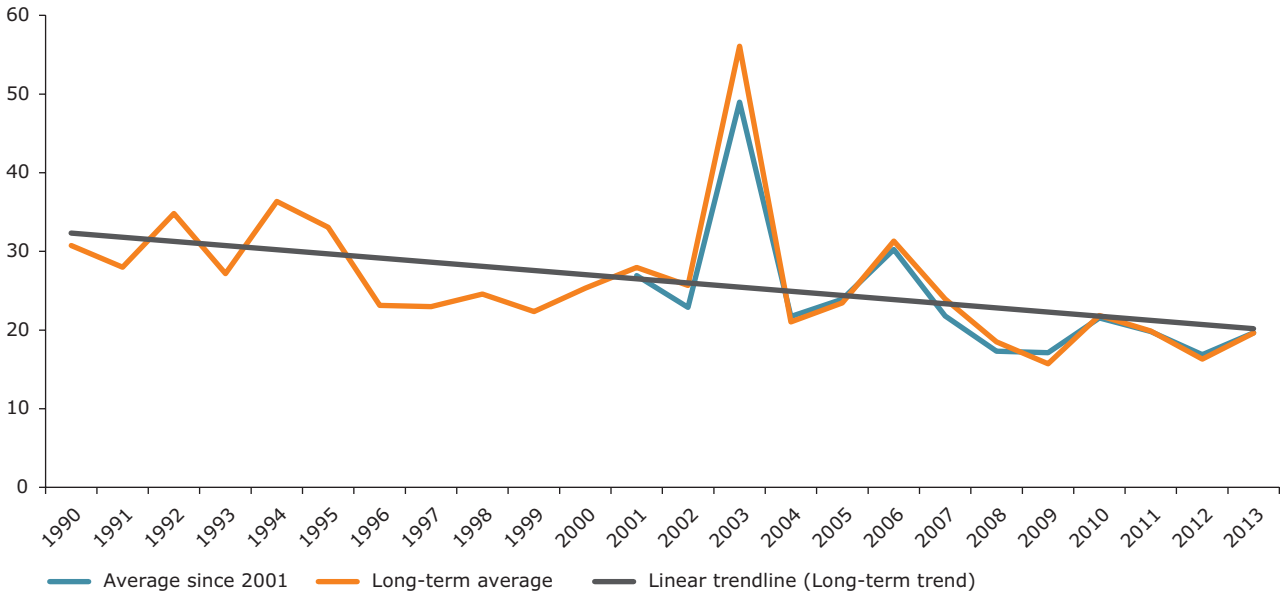
Mediterranean area: Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, the former Yugoslav Republic of Macedonia, France south of 45 ° latitude, Greece, Italy, Kosovo (under UNSCR 1244/99), Malta, Monaco, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain.

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) LTO for the protection of human health exceedances



Notes: Data from 2012 and 2013 are provisional.

Criteria for selecting stations: 75 % of valid years in the corresponding period.

Long-term average: countries where ozone-monitoring networks have operated since at least the mid 1990s: Austria (79 stations), Belgium (13 stations), Czech Republic (13 stations), Finland (5 stations), Germany (163 stations), Netherlands (14 stations), Sweden (4 stations), Switzerland (27 stations), the United Kingdom (20 stations); 341 stations in the period from 1990 to 2011.

Average since 2001: 1 423 stations of 27 countries, evenly spread across Europe in the period from 2001 to 2011.

4 Ozone-related policies

Ozone pollution as a global or hemispheric problem is addressed by the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP) (UNECE, 2010). The 1999 Gothenburg Protocol to the LRTAP Convention, amended in 2012 (UNECE, 2012), contains emission ceilings for the pollutants NO_X, non-methane VOCs (NMVOCs), sulphur oxides (SO_X), and ammonia (NH_3), that parties to the protocol must meet by 2010. It also contains further emission reduction commitments for those pollutants and for particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometres ($PM_{2.5}$) for 2020 and beyond.

In addition to the ceilings for individual countries, the protocol also specifies ceilings for the EU, which itself is a party to the protocol. Member States also report data on emissions of air pollutants annually to the European Commission and the EEA under the NEC Directive (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). For the Member States, the NEC Directive's national emission ceilings for 2010 are either equal to or slightly more ambitious than those in the Gothenburg Protocol. New national emission reduction commitments are proposed for 2020 and 2030 in a 'revised NEC directive' as part of the Clean Air Policy Package published by the European Commission in December 2013 (EC, 2013).

While reductions in emissions of O_3 precursor gases over the past decades have been substantial in Europe, ozone concentrations (in relation to the TV for the protection of health) have generally decreased slowly, but have increased in places between 2002 and 2011. Concentrations in the 2002-to-2011 period do not strongly reflect the general European reductions in emissions of O_3 precursors in the same period. Ozone precursor gas emissions decreased considerably between 2002 and 2011. In the EU, NO_X emissions decreased by 27 %, NMVOCs by 28 %, CO by 32 % and CH_4 by 15 %.

Ozone in Europe also results from precursor gases emitted elsewhere. For example, increased global emissions of CH_4 lead to higher concentrations of CH_4 in Europe, which in turn contribute to the formation of O_3. This increasing intercontinental transport of O_3 and its precursors in the northern hemisphere is likely to mask the effects of European measures to reduce O_3 precursor emissions. Moreover, the relationship of O_3 concentrations in Europe to the emitted precursors in Europe is not linear (EEA, 2013).

5 References

EC, 1992, Council Directive 92/72/EEC of 21 September 1992 on air pollution by ozone (OJ L 297, 13.10.1992 P. 0001–0007) (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1992:297:0001:0007:EN:PDF) accessed 30 January 2014.

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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 (1-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–September), as defined in Annex III to the directive, must be reported by 31 October. This includes information on exceedances of alert and information thresholds, exceedances of the health protection LTO, the daily maximum of 8-hour average ozone concentration higher than 120 μg/m^3, related NO_2 values when required, and for each month, 1-hour maximum ozone concentrations.

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 AQ 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 2013 to produce the data used in this report.

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

Annex 2 Data reporting over summer 2013

To manage the monthly and summer data flows, Member States and the other reporting countries and territories are required to use a set of reporting forms, i.e. templates for reporting (EEA, 2012b). Ozone-monitoring stations were operated throughout the whole period from April to September 2013. It is possible, of course, 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 1-hour measurements at 1 476 stations (equal to 70 % of all of 2 110 operational stations). Of those, 1 255 (85 %) provided valid 1-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-to-2012 period.

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

The ozone-monitoring network in 2013

Map A.2.1 presents the location of all ozone-monitoring stations assumed to be operational in the reporting countries during summer 2013. In total, 2 110 ozone-monitoring sites were operational in summer 2013 (2 105 reported data for the maximum daily 8-hour mean values), 2 038 of which were located in the EU.

The number of operational stations is similar to that in 2012 (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 TVs, LTOs 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 495 (approximately 23 %) traffic or industrial stations are used for summer ozone assessment in the various countries. These stations were included in 2013 summer reporting and in the current analysis, to match the practice in previous years. The share of traffic and industrial stations is thus higher than in previous years. Traffic and industrial stations might not be representative due to NO_x titration.

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 8.3 % of stations, the type of station was not known.

Table A.2.1 Overview of validity of 1-hour measurements, and share of industrial and traffic stations during summer 2013, by country

Country	Country code	Stations with available information (a) (%)	Stations with at least 90 % of valid 1-hour data (b) (%)	Industrial and traffic stations (c) (%)
Austria	AT	100	94	13
Belgium	BE	100	98	22
Bulgaria	BG	100	95	11
Croatia	HR	100	0	100
Cyprus	CY	100	100	50
Czech Republic	CZ	100	98	5
Denmark	DK	89	50	22
Estonia	EE	89	100	33
Finland	FI	100	90	10
France	FR	92	94	3
Germany	DE	0	–	15
Greece	EL	100	82	55
Hungary	HU	100	76	18
Ireland	IE	100	91	9
Italy	IT	0	–	30
Latvia	LV	100	88	38
Lithuania	LT	100	71	50
Luxembourg	LU	100	100	20
Malta	MT	100	40	40
Netherlands	NL	100	91	14
Poland	PL	80	69	4
Portugal	PT	100	93	8
Romania	RO	78	37	47
Slovakia	SK	100	53	0
Slovenia	SI	100	83	8
Spain	ES	100	84	50
Sweden	SE	92	91	0
United Kingdom	UK	100	94	9
Albania	AL	100	0	100
Bosnia and Herzegovina	BA	–	–	–
former Yugoslav Republic of Macedonia, the	MK	86	67	79
Iceland	IS	100	0	50
Kosovo (under UNSCR 1244/99)	XK	100	43	29
Liechtenstein	LI	–	–	–
Montenegro	ME	100	0	0
Norway	NO	100	100	0
Serbia	RS	100	50	0
Switzerland	CH	100	100	27
Turkey	TR	0	–	20
Total		**70**	**85**	**23**

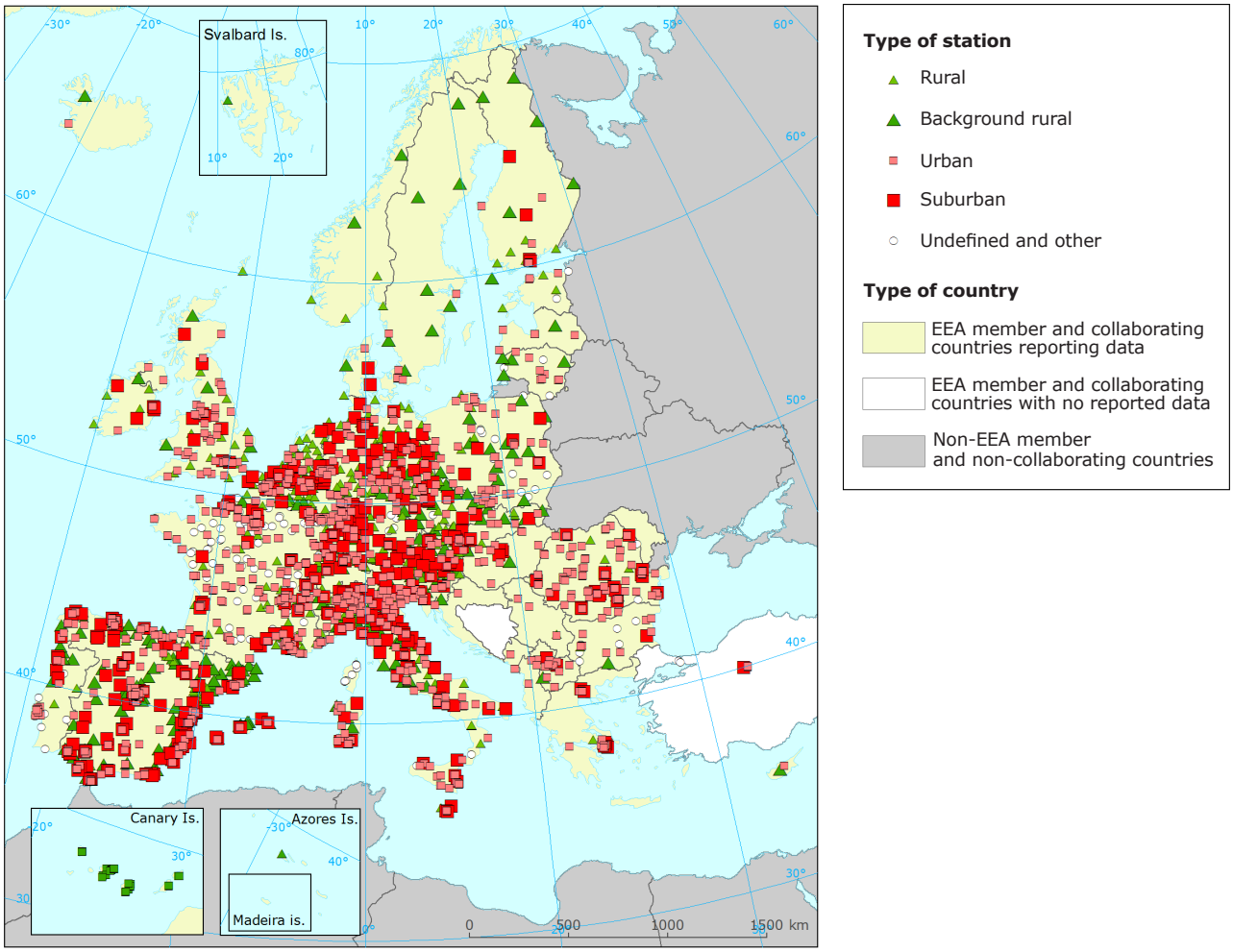
Notes: '–' indicates 'not applicable'.

(a) The percentage of stations for which the country provided information on the validity of 1-hour measurements.

(b) The percentage of stations for which the country provided information that provided valid 1-hour measurements at least 90 % of the time during summer 2013.

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

Map A.2.1 Location of ozone-monitoring stations in summer 2013, as reported by Member States and other European countries and territories



Annex 3 Up-to-date ozone data exchange

The information on ozone exceedances summarised in this report has been provided through official summer ozone reporting (SOR) by Member States and other voluntary reporting countries. The official AQ data exchange and reporting has been streamlined by the adoption of Decision 2011/850/EU (EC, 2011), which also considers the UTD AQ data exchange.

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. The provisional data consist of data submitted as UTD, but also those resubmitted with extra verification. The piloting carried out from 2011 to 2013 has shown an improved agreement between official SOR and calculated exceedances, using provisional hourly UTD AQ data. Discrepancies have been used to inform data providers in order to improve data resubmission under UTD.

The UTD AQ data exchange continues its focus both on timely submission of AQ data (useful for data assimilation) and on resubmission of data that have gone through further QA/QC checks.

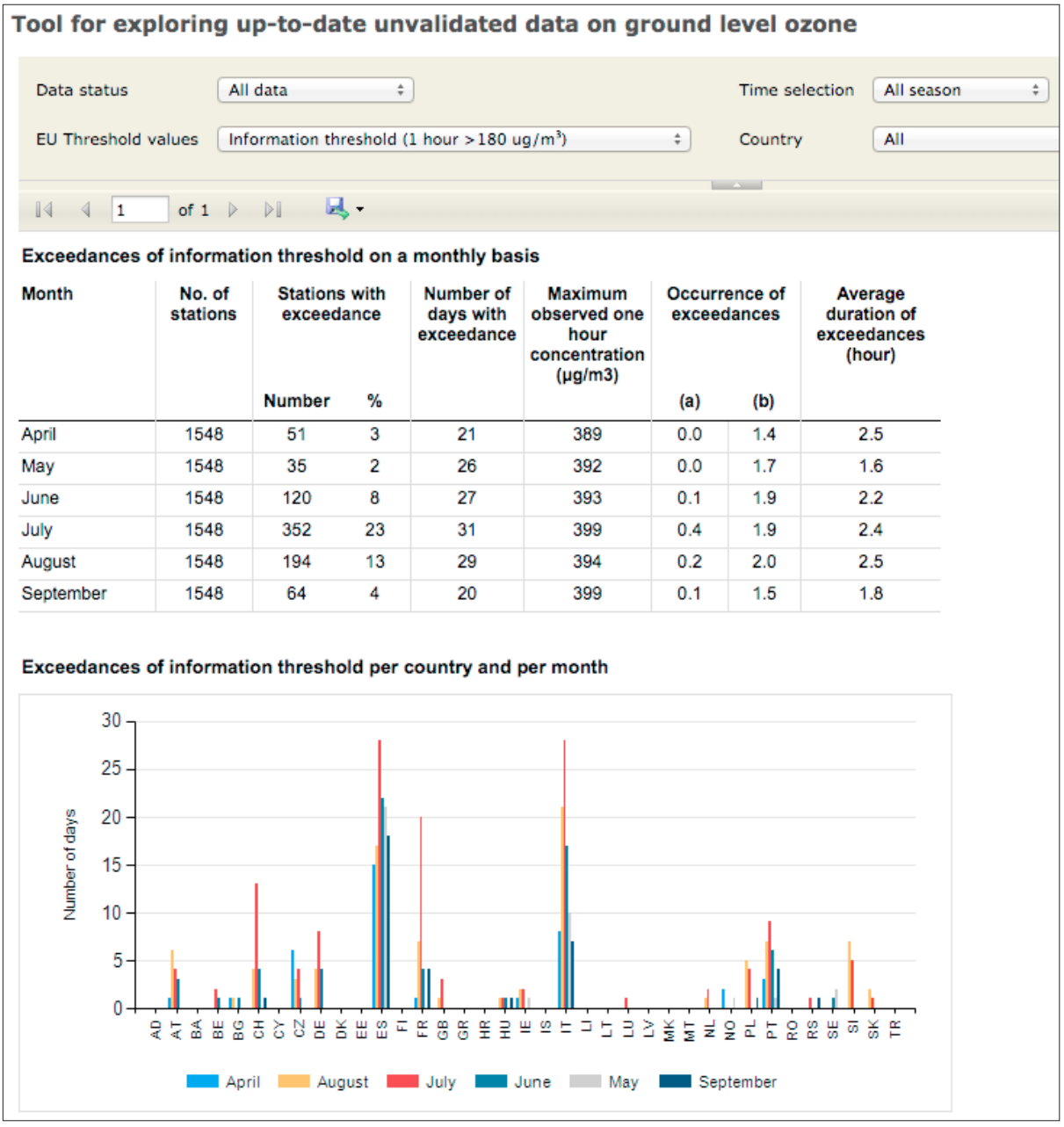
The comparison between SOR submission and UTD is shown in Tables A.3.1 and A.3.2. The number of stations incorporated in the UTD continued to be lower than officially reported during summer 2013. However, most of the exceeding stations are part of the current data exchange. The number of threshold exceedances, and the maximum observed 1-hour concentrations recorded by UTD were often higher for the individual country, because of poor resubmission of validated data by some data providers, i.e. incorrect values continued to exist in the UTD database (see Table A.3.1). Compared to comparisons carried out from 2009 to 2012, the match between UTD-calculated exceedances and those presented via the monthly submission is much better.

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), particles with an aerodynamic diameter less than or equal to a nominal 10 micrometres (PM_{10}) and sulphur dioxide (SO_2). Currently, O_3, PM_{10}, NO_2 and SO_2 UTD concentrations are provided via the 'Up-to-date air quality maps for Europe (provisional data including O_3, PM_{10}, NO_2, SO_2)' section ([13]). The pollutants episodes can easily be recognised with the map viewer (Map A3.2).

For ozone, UTD hourly data from more than 1 700 stations across Europe are exchanged with the EEA. The data are displayed as soon as possible after the end of each hour via the 'Explore unvalidated ground level ozone statistics' ([14]) section of the relevant EEA´s webpage. These data are preliminary, 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. Finally, the same statistics from data as described in detail in this report, but based on delivered unvalidated UTD data (Figure A.3.1), can be displayed and downloaded.

([13]) UTD AQ maps for Europe: http://www.eea.europa.eu/themes/air/air-quality/map/real-time-map.
([14]) http://www.eea.europa.eu/themes/air/air-quality/compare/explorer.

Figure A.3.1 Screenshot of UTD 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	1548	51	3	21	389	0.0	1.4	2.5
May	1548	35	2	26	392	0.0	1.7	1.6
June	1548	120	8	27	393	0.1	1.9	2.2
July	1548	352	23	31	399	0.4	1.9	2.4
August	1548	194	13	29	394	0.2	2.0	2.5
September	1548	64	4	20	399	0.1	1.5	1.8

Table A.3.1 Comparison of SOR with UTD reporting during summer 2013

Country	SOR						UPD					
	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed 1-hour con-centration (µg/m³)	Number of stations	Stations with exceedances		Number of days with exceedances		Maximum observed 1-hour con-centration (µg/m³)
		Info	Alert	Info	Alert			Info	Alert	Info	Alert	
Austria	105	32	2	14	2	250	105	32	0	14	0	250
Belgium	41	30	2	3	2	259	41	30	2	3	1	259
Bulgaria	19	0	0	0	0	< 180	18	2	2	3	3	238
Croatia	2	2	0	1	0	207	2	0	0	0	0	< 180
Cyprus	2	0	0	0	0	< 180	2	0	0	0	0	< 180
Czech Republic	55	18	0	11	0	214	51	20	1	14	1	219
Denmark	9	0	0	0	0	< 180	6	0	0	0	0	< 180
Estonia	9	0	0	0	0	< 180	2	0	0	0	0	< 180
Finland	20	0	0	0	0	< 180	17	0	0	0	0	< 180
France	367	93	0	34	0	235	341	88	4	36	5	340
Germany	259	88	0	15	0	231	266	92	1	16	1	231
Greece	22	9	0	18	0	238	–	–	–	–	–	–
Hungary	17	2	0	3	0	218	17	3	2	4	4	218
Ireland	11	0	0	0	0	< 180	10	4	0	6	0	295
Italy	297	134	12	63	8	267	90	69	22	91	46	399
Latvia	8	0	0	0	0	< 180	1	0	0	0	0	< 180
Lithuania	14	0	0	0	0	< 180	18	0	0	0	0	< 180
Luxembourg	5	1	0	1	0	184	5	1	0	1	0	184
Malta	5	0	0	0	0	< 180	–	–	–	–	–	–
Netherlands	35	21	0	3	0	214	33	20	0	3	0	214
Poland	80	9	0	8	0	195	41	7	1	10	1	261
Portugal	40	26	1	26	1	250	43	26	1	30	1	353
Romania	104	1	0	1	0	189	33	0	1	0	1	< 180
Slovakia	15	2	0	3	0	217	15	2	1	3	1	217
Slovenia	12	6	0	11	0	210	12	5	0	12	0	210
Spain	392	60	0	38	0	226	244	85	18	121	36	393
Sweden	12	0	0	0	0	< 180	9	2	2	3	4	216
United Kingdom	81	2	0	1	0	194	80	4	0	4	0	187
EU area	**2 038**	**536**	**17**	**108**	**15**	**267**	**1 500**	**492**	**58**	**153**	**86**	**399**
Albania	1	0	0	0	0	< 180	–	–	–	–	–	–
Bosnia and Herzegovina	0	–	–	–	–	–	–	–	–	–	–	–
former Yugoslav Republic of Macedonia, the	14	1	0	9	0	196	–	–	–	–	–	–
Iceland	2	0	0	0	0	< 180	–	–	–	–	–	–
Kosovo (under UNSCR 1244/99)	7	3	3	19	4	262	–	–	–	–	–	–
Liechtenstein	0	–	–	–	–	–	1	–	–	–	–	–
Montenegro	2	0	0	0	0	< 180	–	–	–	–	–	–
Norway	7	0	0	0	0	< 180	9	2	0	3	0	357
Serbia	4	2	0	2	0	212	4	1	0	2	0	274
Switzerland	30	8	0	20	0	215	30	10	0	22	0	382
Turkey	5	1	0	1	0	182	–	–	–	–	–	–
Whole area	**2 110**	**551**	**20**	**111**	**15**	**267**	**1 548**	**505**	**58**	**154**	**86**	**399**

Notes: '–' indicates 'not applicable'.
White columns refer to exceedances of the information threshold, and grey to exceedances of the alert threshold.
Orange cells refer 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 2013

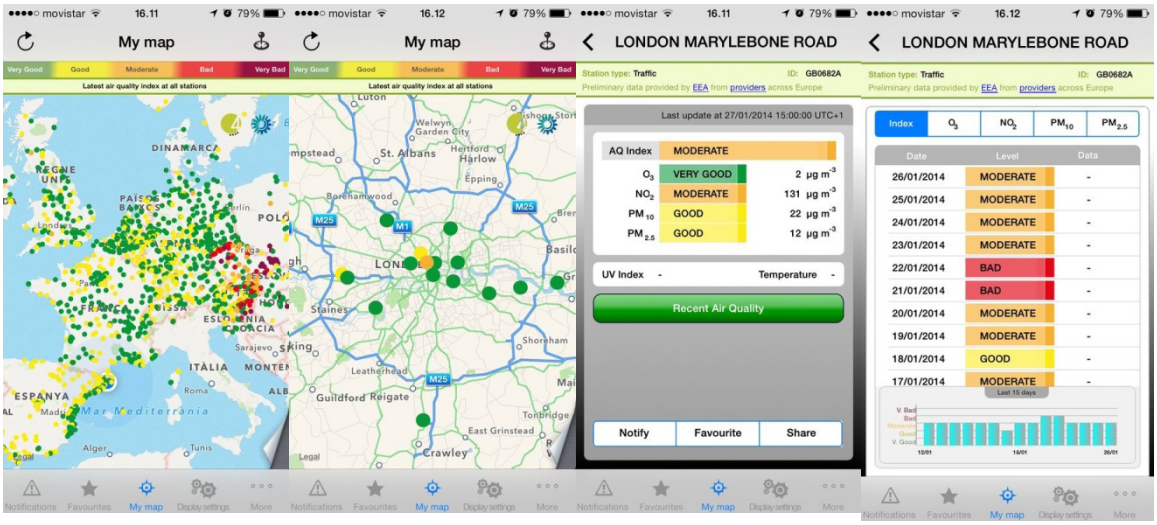
Country	SOR						UPD					
	Max concentrations						Max concentrations					
	April	May	June	July	Aug.	Sep.	April	May	June	July	Aug.	Sep.
Austria	183	x	245	202	250	x	183	x	245	202	250	x
Belgium	x	x	197	259	x	x	x	x	197	259	x	x
Bulgaria	x	x	x	x	x	x	221	x	212	x	238	x
Croatia	x	x	x	x	207	x	x	x	x	x	x	x
Cyprus	x	x	x	x	x	x	x	x	x	x	x	x
Czech Republic	214	x	193	189	213	x	219	x	193	189	213	x
Denmark	x	x	x	x	x	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	x	x	x
France	187	x	235	233	204	217	187	x	235	340	204	260
Germany	x	x	225	218	231	x	x	x	223	218	231	x
Greece	186	x	208	238	197	198	–	–	–	–	–	–
Hungary	x	x	195	190	218	x	x	x	195	190	218	x
Ireland	x	x	x	x	x	x	207	237	x	295	232	x
Italy	198	203	255	241	267	212	376	384	389	399	394	399
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	184	x	x	x	x	x	184	x	x
Malta	x	x	x	x	x	x	–	–	–	–	–	–
Netherlands	x	x	x	214	192	x	x	x	x	214	192	x
Poland	x	x	x	185	195	x	x	x	x	210	261	250
Portugal	x	x	209	236	218	250	264	353	209	236	218	249
Romania	x	x	x	x	189	x	x	x	x	x	x	x
Slovakia	x	x	x	183	217	x	x	x	x	183	217	x
Slovenia	x	x	x	199	210	x	x	x	x	199	210	x
Spain	205	x	205	226	198	190	389	392	393	385	371	364
Sweden	x	x	x	x	x	x	x	216	194	x	x	x
United Kingdom	x	x	x	194	x	x	x	x	x	187	x	x
EU area	**214**	**203**	**255**	**259**	**267**	**250**	**389**	**392**	**393**	**399**	**394**	**399**
Albania	x	x	x	x	x	x	–	–	–	–	–	–
Bosnia and Herzegovina	–	–	–	–	–	–	–	–	–	–	–	–
former Yugoslav Republic of Macedonia, the	188	x	x	196	196	x	–	–	–	–	–	–
Iceland	x	x	x	x	x	x	–	–	–	–	–	–
Kosovo (under UNSCR 1244/99)	246	262	204	x	248	206	–	–	–	–	–	–
Liechtenstein	–	–	–	–	–	–	x	x	x	x	x	x
Montenegro	x	x	x	x	x	x	–	–	–	–	–	–
Norway	x	x	x	x	x	x	357	220	x	x	x	x
Serbia	x	x	186	212	x	x	x	x	x	223	x	274
Switzerland	x	x	206	207	215	191	x	x	206	382	255	191
Turkey	182	x	x	x	x	x	–	–	–	–	–	–
Whole area	**246**	**262**	**255**	**259**	**267**	**250**	**389**	**392**	**393**	**399**	**394**	**399**

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

Map A.3.2 Screenshot of UTD AQ maps for Europe, showing AQ data results

In 2013, a new mobile application was launched in collaboration with the EEA. EuropeAir ([15]) has been developed to display UTD AQ data across Europe. It gets data from around 3 500 monitoring stations in more than 30 countries on the major components of air pollution: ozone (O_3), nitrogen dioxide (NO_2) and airborne particulate matter (PM_{10} and $PM_{2.5}$).

Map A.3.3 Screenshot of EuropeAir's mobile application



([15]) The mobile applications are available as follows: (a) EEA: http://www.eea.europa.eu/mobile; (b) Apple store: https://itunes.apple.com/en/app/europeair/id725509115; and (c) Google Play: https://play.google.com/store/apps/details?id=com.sfera.europeair&hl=en_419.

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