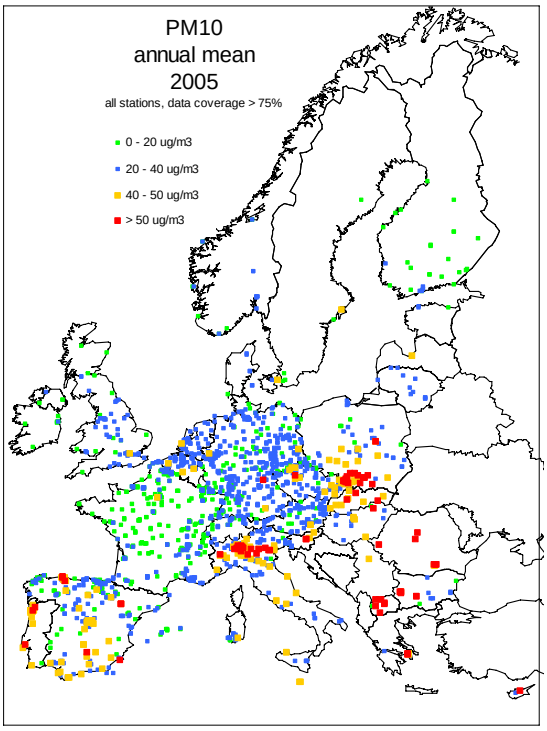
# European exchange of monitoring information and state of the air quality in 2005

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# SUMMARY

Current air quality legislation of the European Union, Council Decision (97/101/EC), requires the Commission to prepare yearly a technical report on the meta information and air quality data flows that have been exchanged among the European Union Member States and the Commission. Besides the EU Member States, other member and collaborating countries of the European Environment Agency, which include EU Acceding Countries and EFTA states, have agreed to follow this reporting procedure as well. All this information is made available in the AIRBASE database, accessible at "airbase.eionet.europa.eu". The results of the reporting cycle presented in this particular technical report cover data for 2005.

A total of 33 countries, including 26 EU Member States, have provided air quality data for 2005. Luxembourg is the only EU Member State not providing information. As in preceding years, a large number of time series have been transmitted, covering, for example, sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), nitrogen oxides ($NO_x$), particulate matter ($PM_{10}$, $PM_{2.5}$), ozone ($O_3$), carbon monoxide (CO) and benzene ($C_6H_6$). In an increasing degree also Volatile Organic Compounds (VOCs), Heavy Metals (HM's) and Polycyclic Aromatic Hydrocarbons (PAHs) have been transmitted. Nearly all the countries that have updated their meta information have used the Air Quality Data Exchange Module (AQ-DEM), made available for this purpose by the European Topic Centre on Air and Climate Change (ETC/ACC).

The previous Technical Reports were focused on the meta information and the quality of the measurement data. In addition to the more technical aspects of the data submission process, this report will briefly describe the state of the air quality for some selected pollutants.

Pollution by $SO_2$ shows a decreasing trend both in emissions as well as in ambient concentrations. Exceedances of the health related $SO_2$ limit values are observed at a limited number of stations only. The emission of $NO_x$ decreases but $NO_2$ concentrations in urban and traffic areas are decreasing at a much lower rate. Compliance with the $NO_2$ limit value for annual mean values is a serious problem in many urban and traffic areas. During the last five years emissions of primary $PM_{10}$ and its precursor gasses are reducing slowly but in the observed concentrations no clear European-wide trend is seen. The $PM_{10}$-limit value for daily values is exceeded frequently at urban and traffic stations. The ambient levels of CO are below the limit value; some incidental exceedances are observed but in these cases measuring artefacts can not be excluded. The benzene concentrations are in compliance with the limit values except for a limited number of traffic hotspot situations. Ozone precursor emissions are decreasing; the ozone concentrations, however, do not show a decreasing trend. On the contrary, the health related and the annual mean values show an increasing tendency. Both the health and the ecosystem related target values are exceeded frequently and widely over Europe

The regular QA/QC checks applied to the delivered EoI data were extended to include checks for missing data and for questionable station coordinates. This year countries were also asked to verify the information on the administrative units in which stations are located.

The methodology for calculating statistics and exceedances from the reported EoI data has also been reviewed and improved this year.

# CONTENTS

# 1. INTRODUCTION

Countries of the European Union have a long tradition of exchanging air quality data. The reciprocal exchange among countries and the Commission is based on a series of Council Decisions. The latest Decision (97/101/EC) 'establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States', the so-called Exchange of Information (EoI), was adopted by the European Council in 1997 (EU 1997). The annexes to the Decision have been amended to adapt the list of pollutants covered to changes and requirements on additional information, validation and aggregation (EU 2001a, EU 2001b). Data submission followed the Guidance on the revised Annexes of the Decision (Garber *et al.* 2001).

Parallel to dataflow under the EoI, the EU Member States provide information on air quality in the context of the Air Quality Framework (FWD; EU 1996) and related daughter directives (EU 1999, EU 2000, EU 2002, EU 2004). This information mainly focuses on compliance checking with obligations under the air quality directives, such as limit values. To avoid duplicate reporting by the Member States, some of the meta data that is needed for evaluating the reports under the FWD (in particular the meta-information on stations and networks) is only sent under the EoI.

The EoI requires a large set of meta information and air quality data to be delivered to the Commission. Part of this information is mandatory and the other items are to be delivered to the Commission 'to the extent possible' and 'as much information as feasible should be supplied'[1].

According to the EoI Decision, the Commission will, each year, prepare a technical report on meta information and air quality data exchanged, and make the information available to EU Member States. The decision states that the Commission will call on the European Environment Agency (EEA) with regard to the operation and practical implementation of the information system. The European Topic Centre on Air and Climate Change (ETC/ACC), under contract to EEA, manages the database system, AIRBASE (see Mol *et al.* 2005a). The information submitted under the EoI is stored in AIRBASE and made available to the public on Internet via the ETC/ACC website[2].

Efforts have been made to load meta-information for all stations sending information on near real time (NRT) ozone to EEA[3] into AIRBASE. AIRBASE has become more and more the central database for the air quality meta information for the different air quality data flows: EoI, FWD (questionnaire, summer ozone reporting) and the NRT ozone Web site.

This report shows information provided by EU-27 Member States, including Bulgaria and Romania. Note that these two countries joined the European Union at 01-01-2007 and that this report is handling 2005-data provided in 2006. In addition it contains information from the other 5 EEA member countries and from the 5 cooperating countries[4], which have agreed to follow the data exchange procedures in the framework of Euroairnet.

This report also reports on the QA/QC aspects of the data in AIRBASE. The procedures and the first QA/QC checks are described in a report (see Mol *et al.* 2005b). A check for missing data has been added to the yearly QA/QC checks on the delivered EoI-data (outliers, missing essential meta data, possible overwriting of data already stored in AIRBASE, possible deletion

[1] See Annex A for an overview.
[2] http://airbase.eionet.europa.eu/
[3] http://www.eea.europa.eu/maps/ozone/welcome
[4] EU27 Member States: Austria, Belgium, Bulgaria (since 01-01-2007), Denmark, Finland, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Sweden, United Kingdom, Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania (since 01-01-2007), Slovenia, Slovakia. EU 25 Member States: EU27 Member States minus Bulgaria and Romania. Next to the 27 EU Member States the four EFTA Countries (Iceland, Liechtenstein, Norway and Switzerland) and Turkey are EEA member countries (EEA 32 member countries). EEA collaborating countries are: Albania, Bosnia and Herzegovina, FYROM, Croatia and Serbia-Montenegro.

of stations and measurement configurations with data). In addition to these standard checks also QA/QC checks are performed on questionable station coordinates.

This year information on the administrative unit has been added to descriptive information of each monitoring station in AIRBASE. Besides the NUTS/LAU information also the EuroBoundaryMap[1] (formerly known as SABE - Seamless Administrative Boundaries of Europe) information has been loaded in AIRBASE. The member states have been asked to check the linkage between stations and the NUTS/LAU and SABE administrative information.

At the end of 2006 and the beginning of 2007 the EEA performed several checks on the generated statistics derived from the reported data in AirBase. These checks resulted in:

- improvements on the applications for specific cases (very low number of raw data within a year, wrongly reported datasets, duplicate datasets)
- detection of suspicious historical data wrongly marked as valid.

Although the impact of the detected inconsistencies was low, these checks resulted in a further improvement of the AirBase information system.

In addition to the more technical aspects of the data submission process, this report will briefly describe the state of the air quality for some selected pollutants. The current (2005) air quality status will be described together with the changes in concentrations during the last 10 and 5 years.

[1] http://www.eurogeographics.org/eng/04_sabe.asp

# 2. EXCHANGE OF INFORMATION 2006 (DATA FOR 2005)

## 2.1. Data delivery

Thirty three countries, including all EU-27 Member States except Luxembourg, provided air quality data for the reporting year 2005 (see the status table in http://air-climate.eionet.europa.eu/country_tools/aq/eoi_to_airbase_status/index_html)

The delivery of data was facilitated by the Air Quality Data Exchange Module (AQ-DEM), developed by the ETC/ACC. This tool was used by most of the countries. Some countries provided their data in files in the EoI specified formats (DEM and ISO-7168-1: 1999 (extended) format). All data delivered for the reporting year 2005 was loaded into AIRBASE. All statistics and exceedances relevant in the Daughter Directives have been calculated and were also loaded into AIRBASE.

## 2.2. QA/QC feedback actions

Several quality checks have been performed on delivered data and the already available information in AIRBASE. The procedures and the first QA/QC checks are described in a report (see Mol *et al.* 2005b). A check on missing data has been added to the yearly QA/QC checks on the delivered EoI-data (outliers, missing essential meta data, possible overwriting of data already stored in AIRBASE, possible deletion of stations and measurement configurations with data). In addition to these standard checks also QA/QC checks are performed on questionable station coordinates.

This year also extra administrative unit information has been added to AIRBASE. Besides the NUTS/LAU information[1] also the EuroBoundaryMap[2] (formerly known as SABE - Seamless Administrative Boundaries of Europe) information has been loaded in AIRBASE. The member states have been asked to check that stations are located in the correct administrative units.

Intensive feedback took place with the data suppliers on these items. The country feedbacks sent to the member states resulted for 22 EoI reports in one or more updates of their original report like:

- revalidation of suspicious data, originally reported as valid;
- resubmission of time series in which suspicious data were detected;
- updating (essential) meta information.

And as result of the new check, missing data, we detected in 12 EoI reports one or more missing time series. For 10 countries these reports resulted in additional submissions and/or meta information (end date of measurement). More detailed information on the country feedbacks can be found in Annex B.

## 2.3. Results

Transmitted data cover pollutants including mainly sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), nitrogen oxides ($NO_x$), ozone ($O_3$), carbon monoxide (CO), particulate matter ($PM_{10}$, $PM_{2.5}$), benzene ($C_6H_6$) and lead (Pb). Fewer time series were submitted for less commonly monitored components. Although this report includes the available information up to April 2007, data processing is an ongoing process, so please refer to the AIRBASE website [3] for the most recent overview of the progress in processing the data.

[1] http://ec.europa.eu/comm/eurostat/ramon/nuts/home_regions_en.html
[2] http://www.eurogeographics.org/eng/04_sabe.asp
[3] http://airbase.eionet.europa.eu

The number of reporting countries varied per component (*Table 1*). For completeness we have also added the number of stations with $NO_x$ data (or if no $NO_x$ data are available with $NO_2$ + NO data). We added also the number of stations providing data for one or more ozone precursors (VOC's; excluding benzene which is listed separately) and for the 4th Daughter Directive the number of stations with data for one ore more Heavy Metals (As, Cd, Hg, Ni, excluding Pb which is listed separately) and one or more PAH's ((benzo(a)pyrene, benzo(a)anthracen, benzo(b)fluoranthen, benzo(j)fluoranthen, benzo(k)fluoranthen, indeno (1,2,3-cd)pyren en dibenzo(a,h)anthracene).
The number of countries ranged from 4 for one or more PAHs to all 33 for nitrogen dioxide and ozone. The number of stations varied accordingly, being 49 for one or more PAHs and 2753 for nitrogen dioxide.

More detailed information on the number and type of stations per pollutant and per country in 2005 can be found in table A "number of stations per pollutant and station type and country in 2005" in http://air-climate.eionet.europa.eu/databases/airbase/aqtables/eoi2006/index_html.

Consequently, the distribution and density of stations throughout Europe shows differences (*Figures 2 through 9)*. This holds as well for the number of stations per country (*Table 2*).

All stations with primary data (raw data with averages varying from hour to year) are taken into account in this chapter, regardless of the data coverage at that station. *Figure 1* compares the number of stations from *Table 1* with the number of stations with >=75% and >=90% data coverage[1]. For $O_3$ and CO only hourly concentration data have been delivered and for Pb only daily values. For the components $SO_2$, $NO_2$, $PM_{10}$, $PM_{2.5}$ and benzene hourly as well as daily concentration data are available; $SO_2$ and $NO_2$ data are delivered mainly as hourly values. Also measurement data with other averaging times than hour and day have been delivered: weekly, 4-weekly, monthly, 3-monthly and yearly. These measurement data are related to the 4th DD pollutants (Heavy Metals and PAH's).

Stations which have delivered only statistics are not included in this report. However, the meta information of these stations and the statistics are available in AIRBASE. This evaluation focus on components defined under the Framework Directive (and the first three daughter directives). Most countries delivered data for more pollutants than the mandatory list of pollutants defined under the EoI. See table B "number of stations with HMs, VOCs, PAHs and other non-Directive components" in http://air-climate.eionet.europa.eu/databases/airbase/aqtables/eoi2006/index_html for a summary of these supplementary components.

The same number of countries (33) as in 2004 has delivered data in the framework of the EoI2006. The number of stations for which data are reported has increased for the components $SO_2$ (+228), $NO_2$ (+318), $PM_{10}$ (+405), $PM_{2.5}$ (+109), Pb (+118), CO(+175), benzene (+195) and $O_3$ (+112). The number of stations for which $NO_x$ or NO +$NO_2$ has been reported has decreased (-209). Fewer countries have reported NO in addition to $NO_2$. There is a large difference between the number of stations for which $NO_2$ has been reported and the number of stations for which NO (or $NO_x$) has been reported. This is surprising as most automated monitors measure both pollutants simultaneously. See table C "number of stations with $NO_2$, $NO_x$ and/or NO" in http://air-climate.eionet.europa.eu/databases/airbase/aqtables/eoi2006/index_html for an overview per country.

[1] The data quality objectives as laid down in the Daughter Directives require, in general, a data coverage of 90%. For continuous measurements in the assessments presented here (chapter3) a criterion of 75% data coverage is applied.

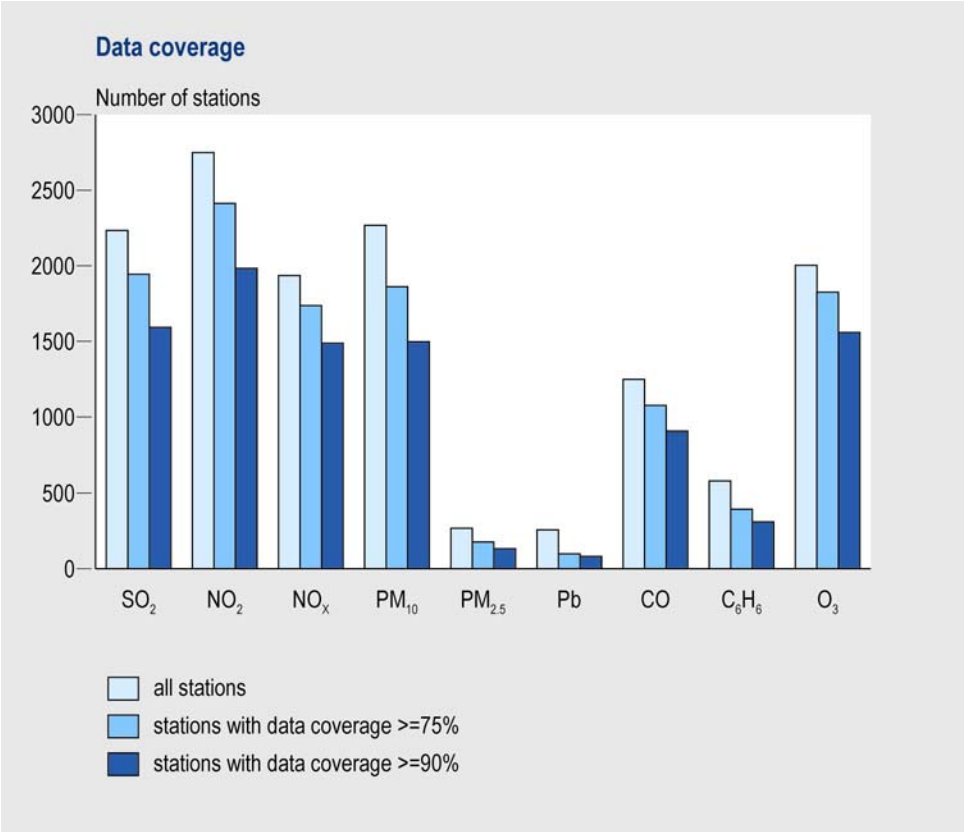
*Table 1 Number of stations for which 2005 data have been delivered for Daughter Directives components, specified per station type.*

| | Daughter Directive | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| | SO2 | NO2 | NOx/NO | PM10 | PM2.5 | Pb | CO | C6H6 | O3 | VOC | HM | PAH |
| Reporting EU countries | 26 | 26 | 24 | 26 | 15 | 14 | 26 | 20 | 26 | 10 | 11 | 4 |
| Total number of stations | 2152 | 2663 | 1878 | 2229 | 257 | 257 | 1219 | 566 | 1948 | 149 | 263 | 49 |
| Of which | | | | | | | | | | | | |
| Traffic | 466 | 766 | 643 | 648 | 77 | 62 | 627 | 269 | 326 | 87 | 63 | 7 |
| Urban background | 847 | 1088 | 647 | 948 | 104 | 97 | 409 | 197 | 911 | 45 | 85 | 30 |
| Industrial | 506 | 423 | 307 | 359 | 21 | 55 | 117 | 65 | 217 | 10 | 55 | 5 |
| Regional background | 293 | 339 | 275 | 236 | 48 | 43 | 46 | 29 | 446 | 7 | 60 | 7 |
| Other (total) | 40 | 47 | 6 | 38 | 7 | 0 | 20 | 6 | 48 | 0 | 0 | 0 |
| | | | | | | | | | | | | |
| Reporting non-EU countries | 6 | 7 | 7 | 6 | 3 | | 6 | 5 | 7 | 2 | | |
| Total number of stations | 84 | 90 | 59 | 60 | 12 | | 32 | 16 | 56 | 6 | | |
| Of which | | | | | | | | | | | | |
| Traffic | 27 | 34 | 26 | 25 | 9 | | 20 | 12 | 17 | 1 | | |
| Urban background | 30 | 30 | 17 | 19 | 3 | | 4 | 3 | 14 | 3 | | |
| Industrial | 15 | 12 | 7 | 7 | | | 6 | | 7 | | | |
| Regional background | 12 | 14 | 9 | 9 | | | 2 | 1 | 18 | 2 | | |
| Other (total) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | |
| Total reporting countries | 32 | 33 | 31 | 32 | 18 | 14 | 32 | 25 | 33 | 12 | 11 | 4 |
| Total number of stations | 2236 | 2753 | 1937 | 2289 | 269 | 257 | 1251 | 582 | 2004 | 155 | 263 | 49 |

*Table 2 Number of stations for which 2005 data have been delivered for Daughter Directives components, specified per country.*

| | Daughter Directive | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| | SO2 | NO2 | NOx/NO | PM10 | PM2.5 | Pb | CO | C6H6 | O3 | VOC | HM | PAH |
| **EU-27 countries** | | | | | | | | | | | | |
| AUSTRIA | 118 | 148 | 148 | 107 | 7 | 15 | 41 | 20 | 115 | 1 | 11 | 3 |
| BELGIUM | 66 | 63 | 63 | 47 | 9 | 37 | 18 | 34 | 39 | | 36 | |
| BULGARIA | 30 | 30 | 14 | 28 | | 11 | 12 | | 13 | 12 | 3 | |
| CYPRUS | 1 | 1 | 1 | 2 | | | 1 | | 2 | | | |
| CZECH REPUBLIC | 89 | 92 | 92 | 120 | 32 | 25 | 32 | 26 | 61 | | 25 | 20 |
| DENMARK | 5 | 12 | 12 | 10 | 3 | | 7 | 1 | 9 | 1 | | |
| ESTONIA | 7 | 7 | 7 | 4 | | | 5 | | 7 | | | |
| FINLAND | 11 | 28 | 28 | 32 | 6 | | 8 | | 16 | | | |
| FRANCE | 402 | 520 | | 358 | 59 | | 107 | 33 | 467 | | | |
| GERMANY | 270 | 441 | 435 | 428 | 24 | | 227 | 177 | 314 | 69 | 103 | |
| GREECE | 8 | 17 | 17 | 10 | 2 | | 10 | 1 | 20 | | | |
| HUNGARY | 24 | 24 | 23 | 19 | | | 16 | 7 | 16 | | | |
| IRELAND | 10 | 10 | 10 | 14 | | 10 | 5 | 5 | 8 | | | |
| ITALY | 265 | 355 | 235 | 235 | 12 | 6 | 265 | 90 | 198 | 33 | | |
| LATVIA | 6 | 6 | | 3 | | 4 | 1 | 1 | 5 | | 4 | 2 |
| LITHUANIA | 12 | 13 | 8 | 12 | | 7 | 7 | 5 | 11 | | | |
| MALTA | 2 | 2 | 2 | 2 | | | 2 | 1 | 3 | 1 | | |
| NETHERLANDS | 37 | 45 | 45 | 40 | | 4 | 22 | 8 | 39 | 8 | 4 | |
| POLAND | 132 | 135 | 71 | 150 | 2 | 29 | 48 | 17 | 54 | 4 | | |
| PORTUGAL | 46 | 63 | 63 | 54 | 17 | | 41 | 5 | 46 | | | |
| ROMANIA | 39 | 32 | 16 | 15 | | 16 | 12 | | 16 | 5 | 7 | |
| SLOVAKIA (Slovak Republic) | 27 | 28 | 28 | 28 | 3 | 21 | 11 | 14 | 22 | | 21 | |
| SLOVENIA | 22 | 10 | 10 | 10 | | | 5 | | 11 | | | |
| SPAIN | 436 | 443 | 434 | 403 | 70 | 44 | 234 | 65 | 352 | | 22 | |
| SWEDEN | 11 | 27 | 5 | 27 | 7 | | 3 | 15 | 16 | | | |
| UNITED KINGDOM | 76 | 111 | 111 | 71 | 4 | 28 | 79 | 41 | 88 | 15 | 27 | 24 |
| Total EU-27 countries | 2152 | 2663 | 1878 | 2229 | 257 | 257 | 1219 | 566 | 1948 | 149 | 263 | 49 |
| **non-EU-27 countries** | | | | | | | | | | | | |
| BOSNIA - HERZEGOVINA | 3 | 3 | 1 | | 2 | | 3 | | 2 | | | |
| ICELAND | 1 | 2 | 2 | 2 | 2 | | 1 | 1 | 4 | 1 | | |
| LIECHTENSTEIN | | 2 | 2 | 2 | | | | | 2 | | | |
| MACEDONIA;FORMER Y | 36 | 14 | 14 | 14 | | | 13 | 1 | 13 | | | |
| NORWAY | 6 | 19 | 14 | 19 | 8 | | 4 | 10 | 9 | | | |
| SERBIA AND MONTENEG | 25 | 24 | 3 | 1 | | | 1 | 1 | 1 | | | |
| SWITZERLAND | 13 | 26 | 23 | 22 | | | 10 | 3 | 25 | 5 | | |
| Total non-EU-27 countries | 84 | 90 | 59 | 60 | 12 | 0 | 32 | 16 | 56 | 6 | 0 | 0 |
| Total all countries | 2236 | 2753 | 1937 | 2289 | 269 | 257 | 1251 | 582 | 2004 | 155 | 263 | 49 |

*Figure 1 Number of stations with 2005 data coverage >0% (with data), >=75% and >=90%*



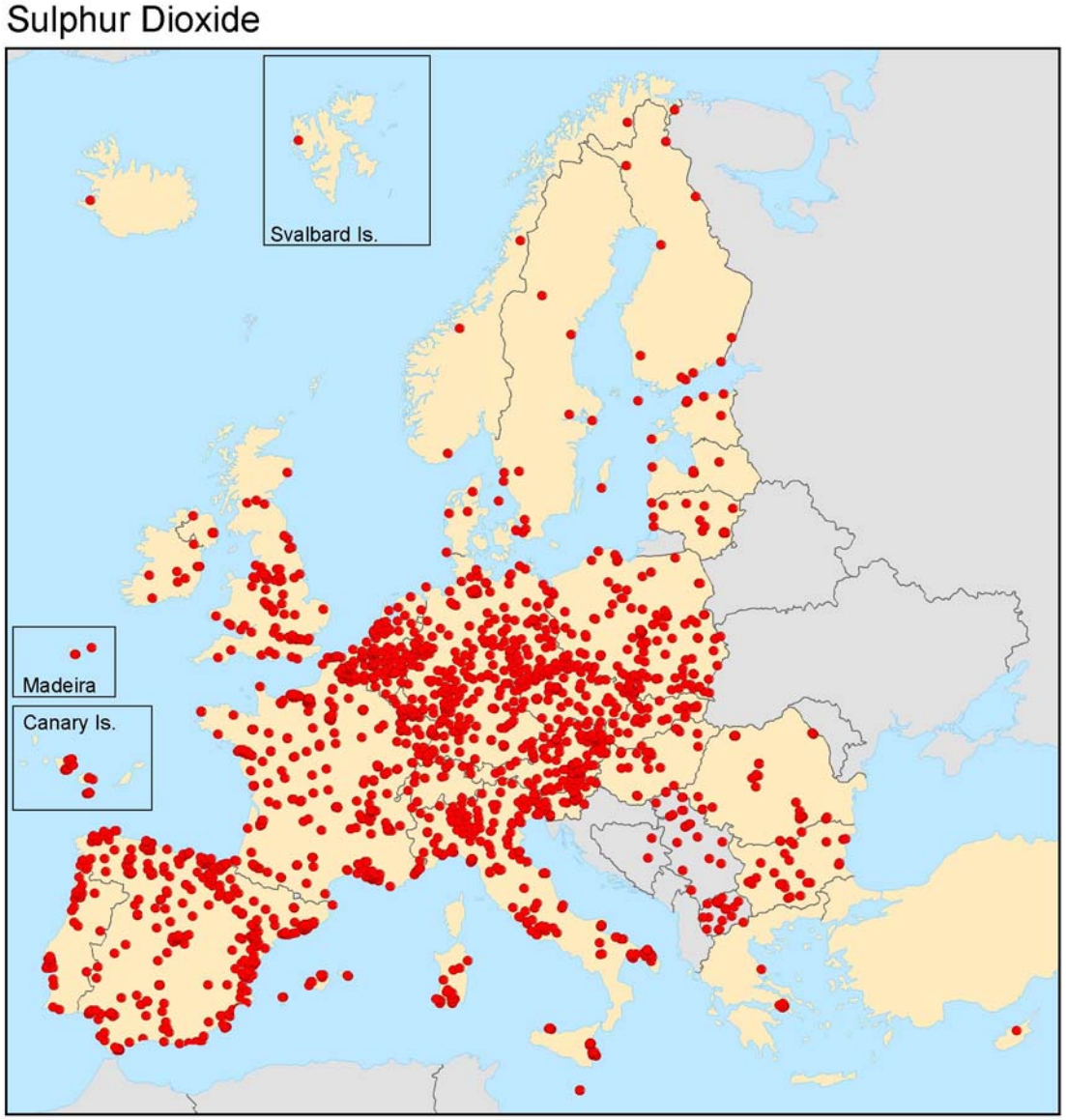



*Figure 2 Location of stations for which 2005 air quality data for sulphur dioxide ($SO_2$) have been reported.*

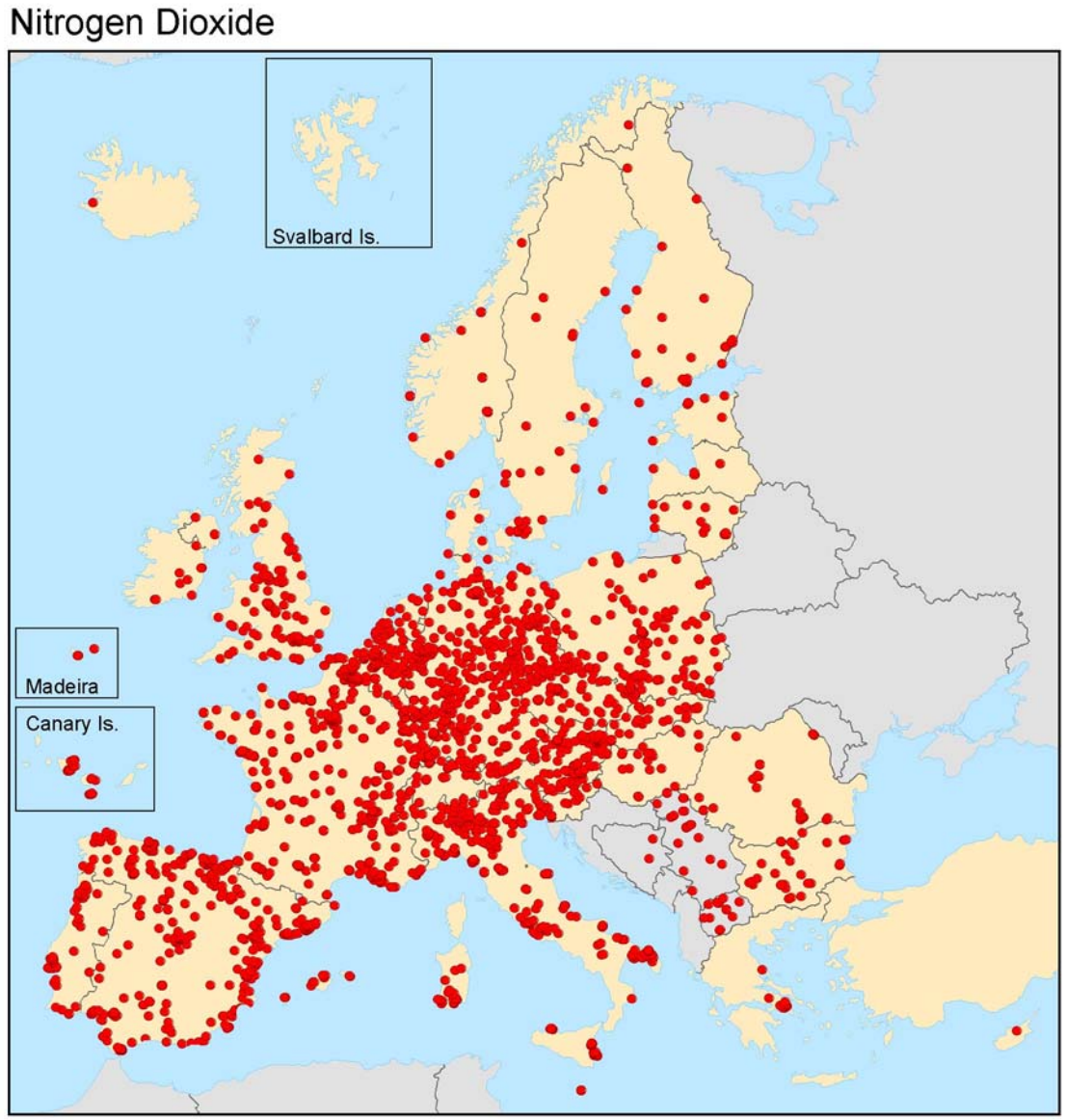



*Figure 3 Location of stations for which 2005 air quality data for nitrogen dioxide ($NO_2$) have been reported.*

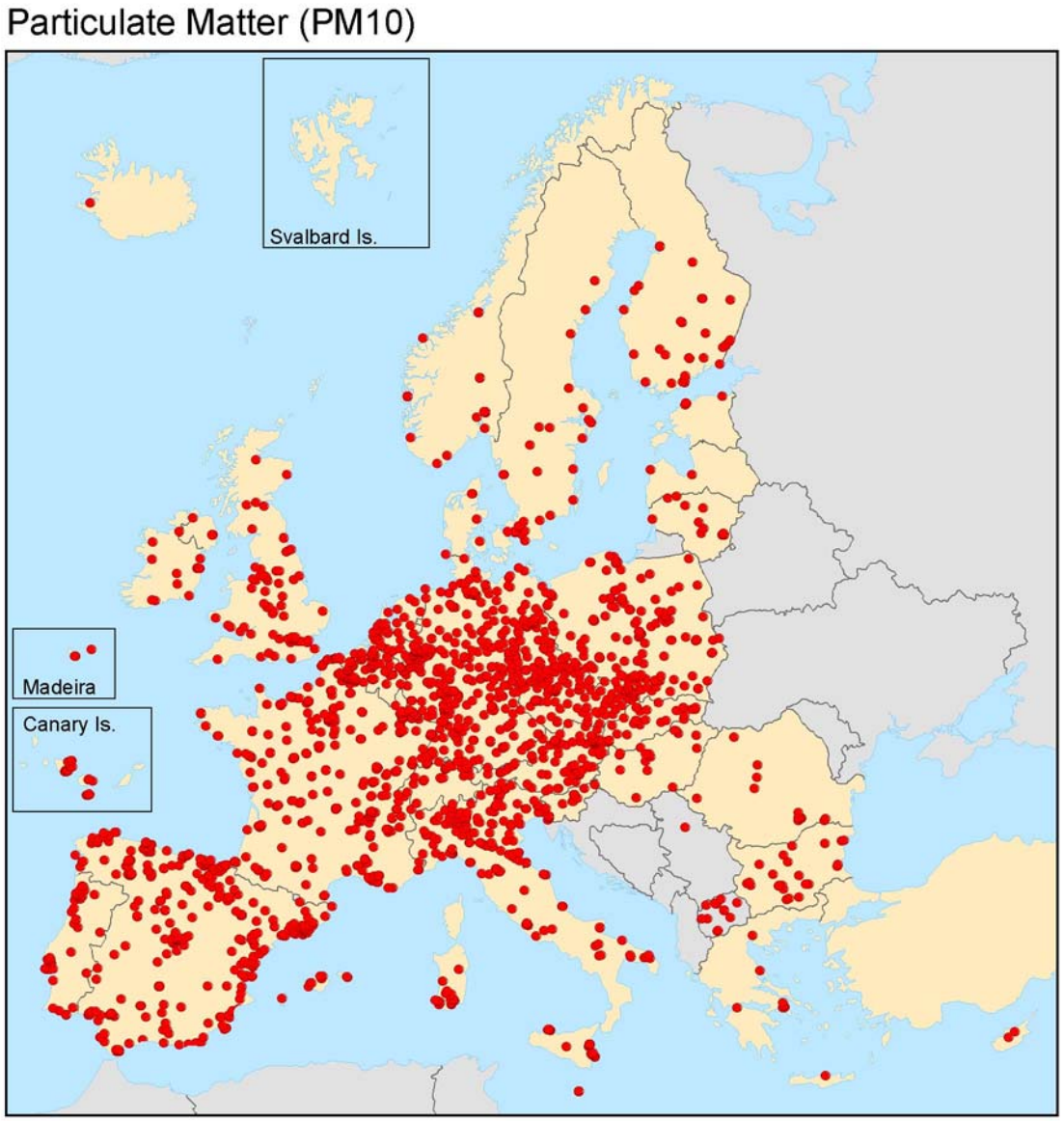



*Figure 4 Location of stations for which 2005 air quality data for particulate matter ($PM_{10}$) have been reported.*

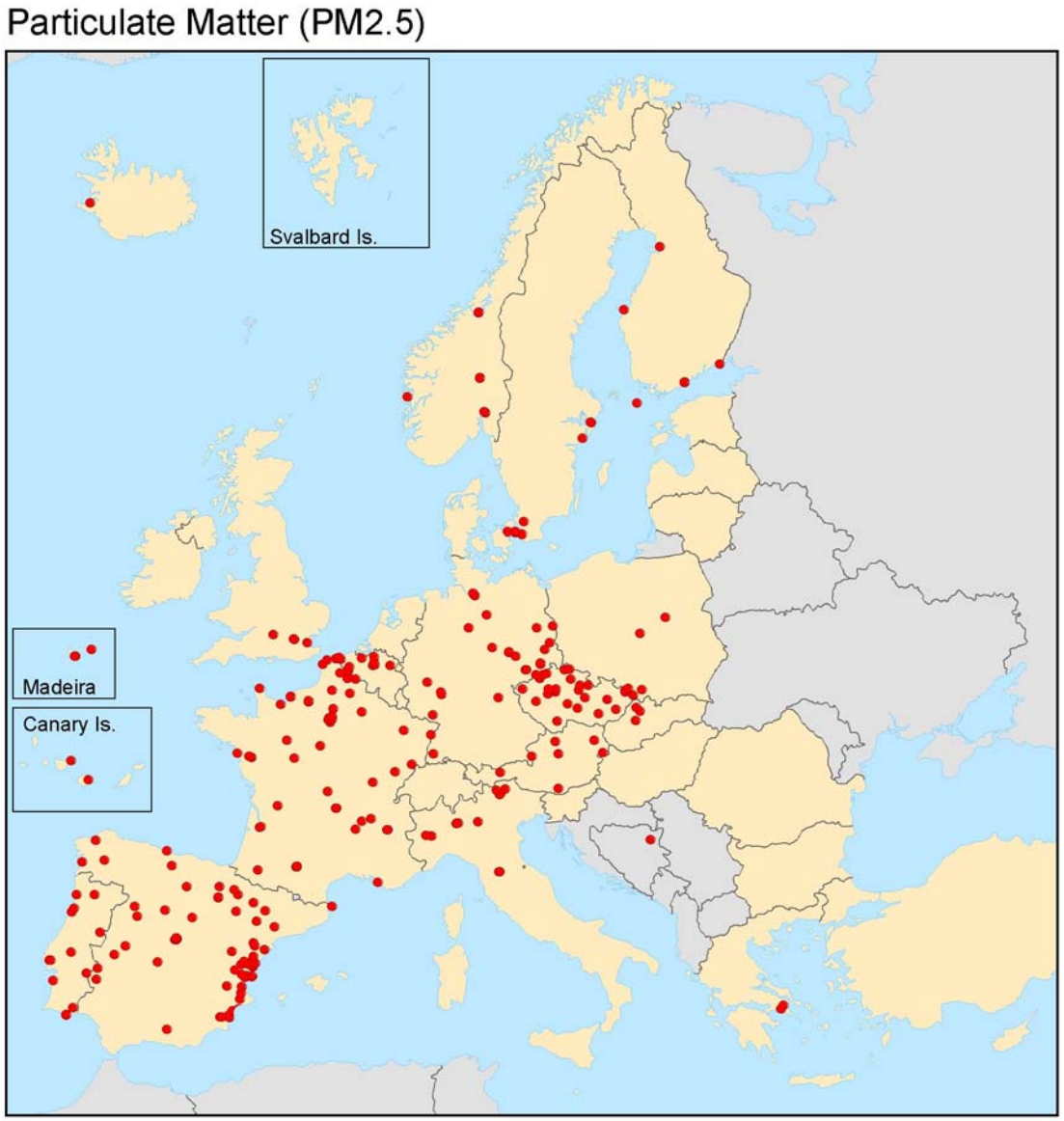



*Figure 5 Location of stations for which 2005 air quality data for particulate matter ($PM_{2.5}$) have been reported.*

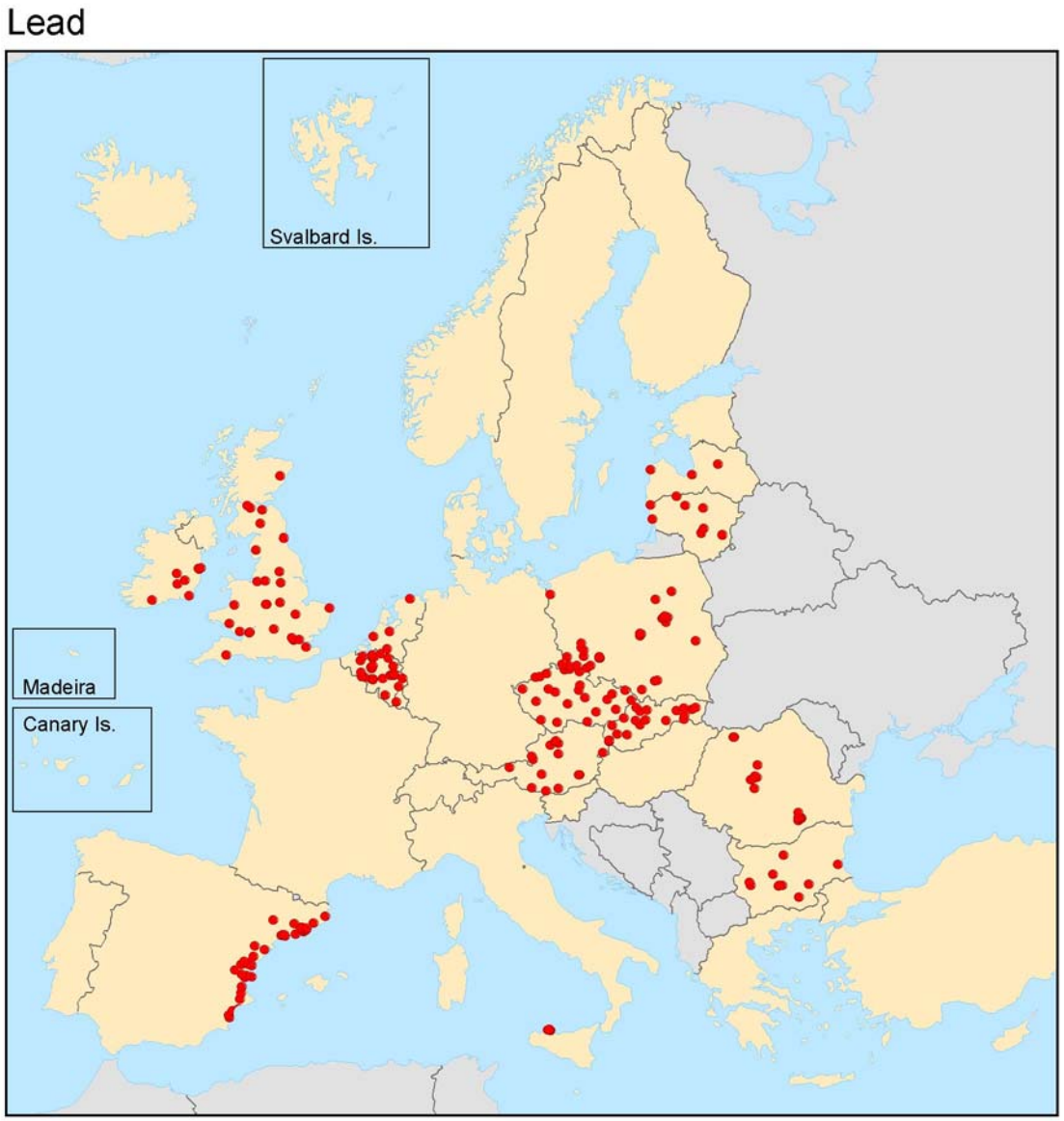



*Figure 6 Location of stations for which 2005 air quality data for lead (Pb) have been reported.*

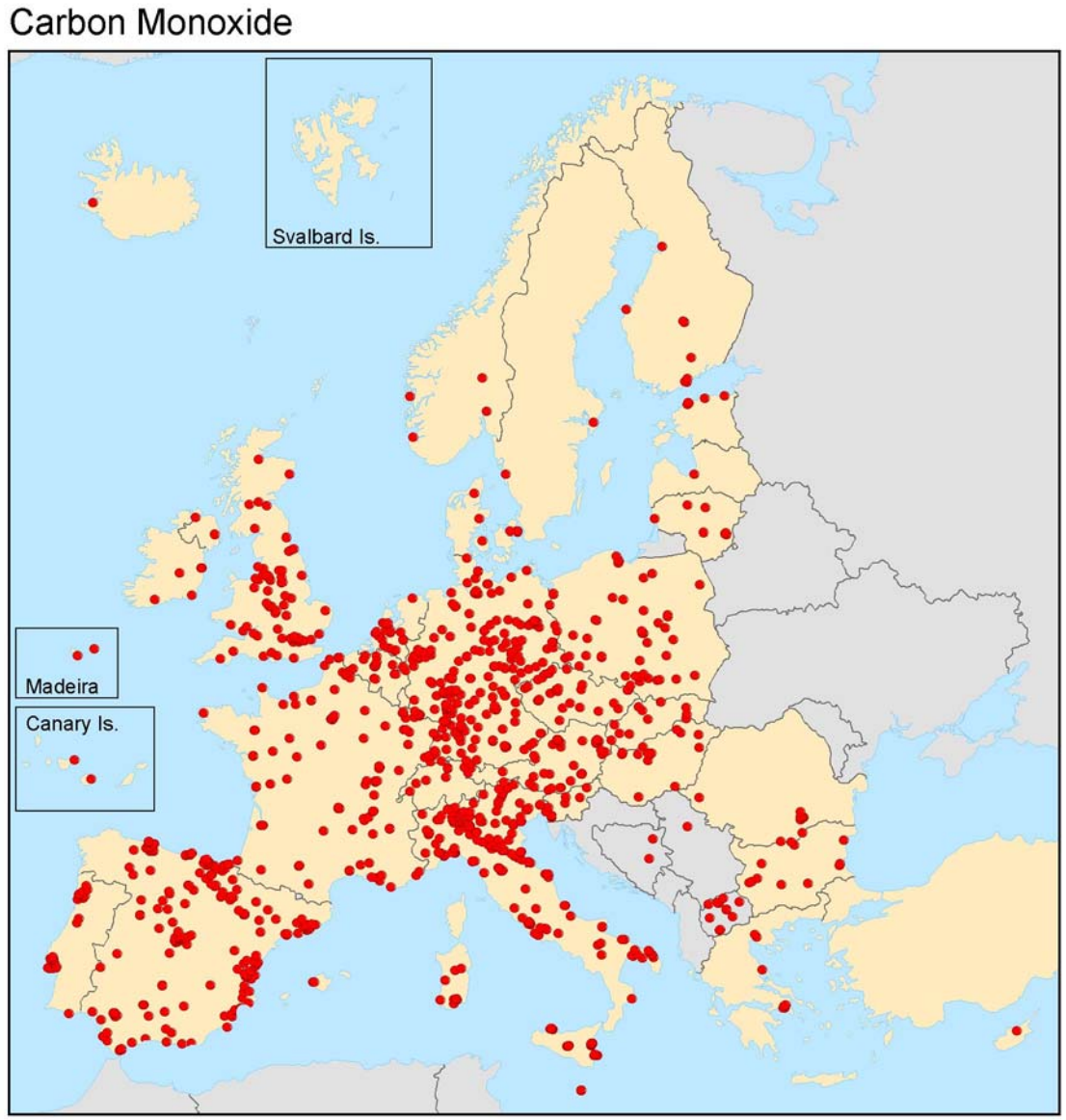



*Figure 7 Location of stations for which 2005 air quality data for carbon monoxide (CO) have been reported.*

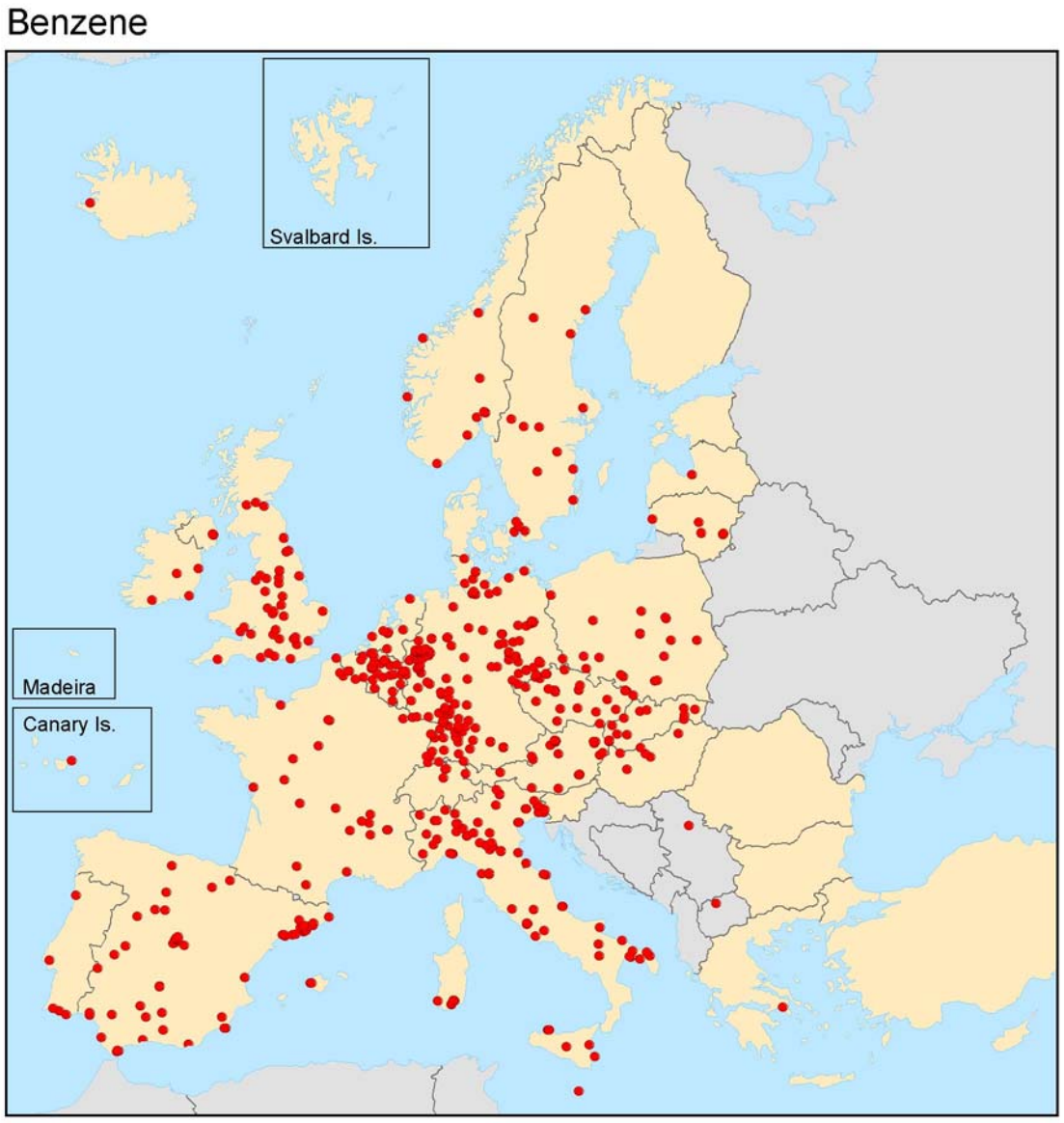



*Figure 8 Location of stations for which 2005 air quality data for benzene ($C_6H_6$) have been reported.*

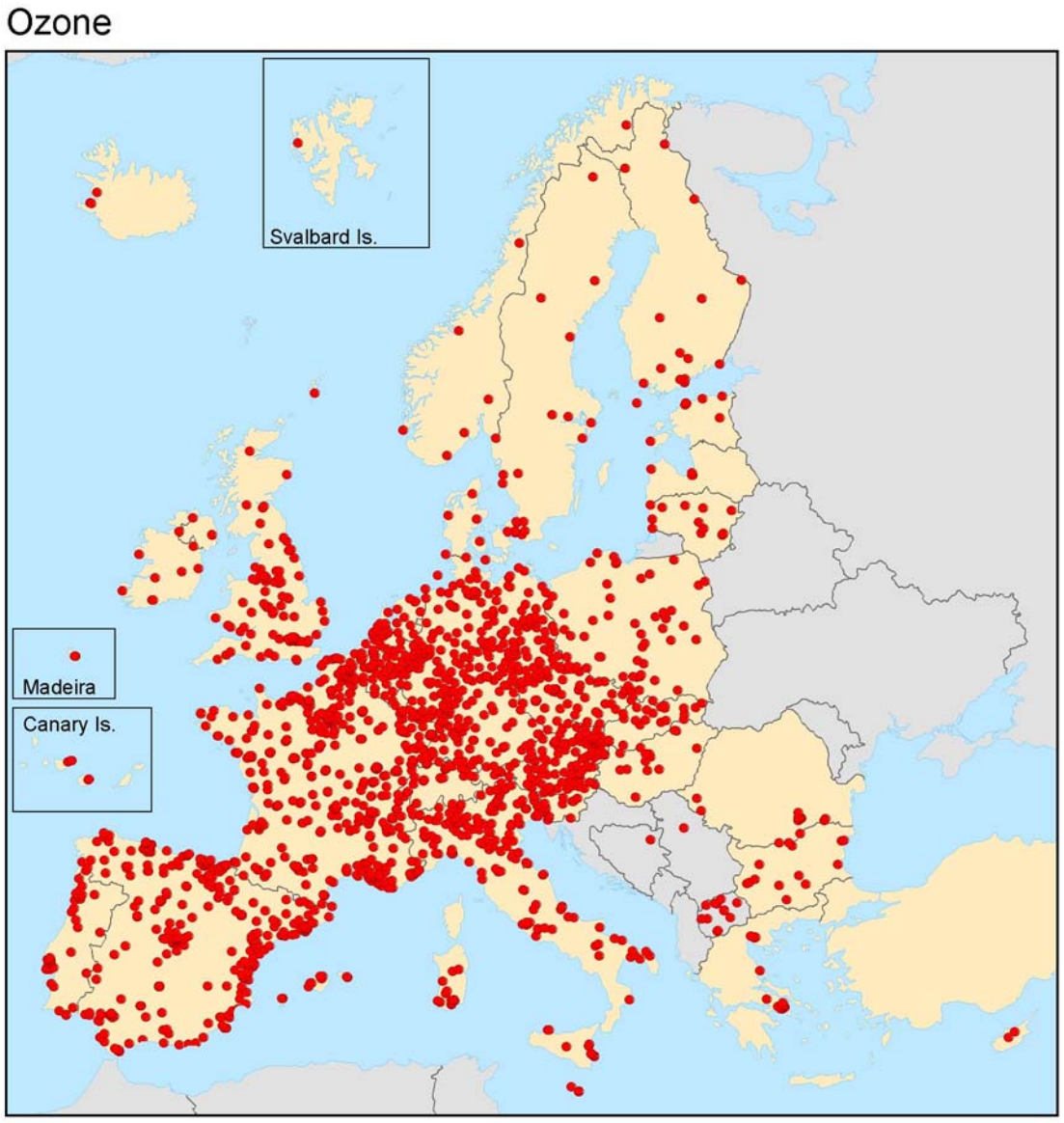



*Figure 9 Location of stations for which 2005 air quality data for ozone ($O_3$) have been reported.*

## 2.4. Time series

The total number of stations with raw data which are operational in 2005 is 3852 (see *Table 3*).

Long-term measurement series provide valuable information for determining, for example, the effect of abatement measures and trend analysis. Since AIRBASE became operational in 1997, the average length of the time series in AIRBASE is relatively short (see *Table 4*). The number of countries and stations with continuous time series with length 10, 5 or 1 year and ending in 2005, is visualized in *Figure 10*. However, as one of the long-term objectives is to expand the time series in AIRBASE, further improvement can be expected. More information about time series can be found in table D "Information on time series in AirBase" in http://air-climate.eionet.europa.eu/databases/airbase/aqtables/eoi2006/index_html.

Note that the length of the time series in years in *Table 4* and table "Information on time series in AirBase" are calculated regardless of the data capture in a year. If there is a gap of one or more years, the maximum length of time series is taken. For the average length of time series all stations available in AIRBASE have been included.

*Table 3 Summary of periods and number of stations for which 2005 data have been delivered*

Summary of periods and number of stations for which 2005 data have been delivered

| Country | Air quality reporting Start/end year | Number of stations for which 2005 data have been delivered [1)] |
|---|---|---|
| **EU-27 countries** | | |
| AUSTRIA | 1990-2005 | 185 |
| BELGIUM | 1985-2005 | 179 |
| BULGARIA | 1998-2005 | 32 |
| CYPRUS | 2003-2005 | 2 |
| CZECH REPUBLIC | 1992-2005 | 129 |
| DENMARK | 1976-2005 | 14 |
| ESTONIA | 1997-2005 | 7 |
| FINLAND | 1990-2005 | 56 |
| FRANCE | 1973-2005 | 734 |
| GERMANY | 1976-2005 | 510 |
| GREECE | 1983-2005 | 24 |
| HUNGARY | 1997-2005 | 24 |
| IRELAND | 1973-2005 | 24 |
| ITALY | 1976-2005 | 432 |
| LATVIA | 1997-2005 | 9 |
| LITHUANIA | 1997-2005 | 15 |
| LUXEMBOURG | 1976-1993 | - |
| MALTA | 2002-2005 | 3 |
| NETHERLANDS | 1976-2005 | 58 |
| POLAND | 1997-2005 | 209 |
| PORTUGAL | 1986-2005 | 67 |
| ROMANIA | 2001-2005 | 40 |
| SLOVAKIA (Slovak Republic) | 1995-2005 | 38 |
| SLOVENIA | 1997-2005 | 25 |
| SPAIN | 1986-2005 | 517 |
| SWEDEN | 1993-2005 | 43 |
| UNITED KINGDOM | 1969-2005 | 346 |
| *Total* | | *3722* |
| **Non-EU-27 countries** | | |
| ALBANIA | | - |
| BOSNIA - HERZEGOVINA | 2002-2005 | 3 |
| CROATIA | | - |
| ICELAND | 1993-2005 | 4 |
| LIECHTENSTEIN | 2004-2005 | 2 |
| FYROM [2)] | 1997-2005 | 40 |
| NORWAY | 1994-2005 | 30 |
| SERBIA AND MONTENEGRO | 2002-2005 | 25 |
| SWITZERLAND | 1992-2005 | 26 |
| TURKEY | | - |
| *Total* | | *130* |
| *Total EU-27 + non-EU-27 countries* | | *3852* |

1) Irrespective of the component(s) measured
2) Former Yugoslavian Republic of Macedonia

*Table 4 All (primary) AIRBASE data (raw data, not the derived data as statistics) of all 33 countries have been taken into account in calculating the average length of time series regardless of the starting year.*

| Component | Average length of time series | | Component | Average length of time series |
|---|---|---|---|---|
| | *Year* | | | *Year* |
| Sulphur dioxide | 5.4 | | Lead | 2.9 |
| Nitrogen dioxide | 5.2 | | Ozone | 5.8 |
| Particulate matter < 10 µm | 3.6 | | Carbon monoxide | 4.6 |
| Particulate matter < 2.5 µm | 2.2 | | Benzene | 2.8 |

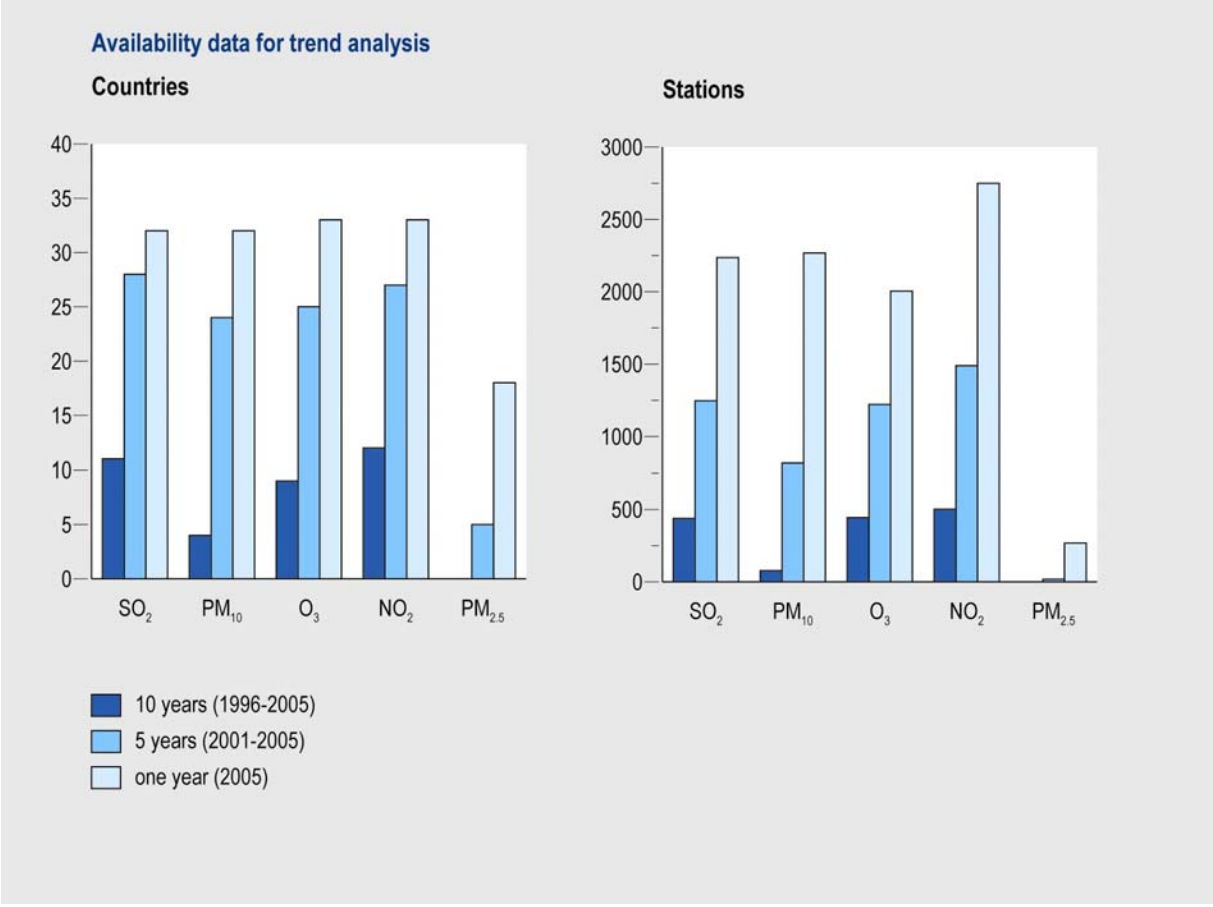



*Figure 10 Number of countries and stations with time series of 10, 5 and one year ending in 2005 for $SO_2$, $PM_{10}$, $O_3$, $NO_2$ and $PM_{2.5}$*

## 2.5. Total number of stations in AIRBASE

Since its introduction in 1997 AIRBASE has grown into a database which nowadays contains air quality data from 34 European countries for the years ranging from 1969 (United Kingdom) to 2005 for many pollutants. The total number of stations in AIRBASE is 6011, from which 5523 stations have measurement data. The 488 stations without data are partially stations for which meta information has been delivered but no measurement data (Germany) and partially stations for which measurement data will be delivered (e.g. United Kingdom). But also reporting near real time ozone to EEA which have not yet delivered for the EoI are included. In spite of the EoI obligation to send only raw data or raw data combined with statistics, there are still 241 stations with only statistics in AIRBASE. Summarized, in AIRBASE we have:

| | |
|---|---|
| 5282 | stations with raw data |
| 241 | stations with only statistics |
| 5523 | stations with data |
| 488 | stations without data |
| 6011 | stations in total |

Information on stations with missing essential information[1], see table E "number of stations with/without data and with missing essential meta information" in http://air-climate.eionet.europa.eu/databases/airbase/aqtables/eoi2006/index_html.

[1] From a user perspective the meta information essential for an adequate assessment of the air quality data consist of: station characteristics in terms of type of station and are, geographical co-ordinates and altitude, station name (see Mol and van Hooydonk 2005c for further discussion)

# 3. State of the air quality for selected pollutants

## 3.1. Introduction

In addition to the more technical aspects of the 2006-data submission process, this section will present a preliminary evaluation of the 2005 air quality data. A more extensive discussion on the state of the European ambient air will be provided in the air pollution reports prepared by EEA (see for example Larsen et al. 2007).
This section will briefly describe the current (2005) air quality status and the changes in concentrations during the last 10 and 5 years are discussed. Focus will be on the pollutants listed in the first three Daughter Directives, that is, sulphur dioxide, nitrogen dioxide, $PM_{10}$ and $PM_{2.5}$, carbon monoxide, and benzene. The concentrations measured in 2005 will be compared with the limit and target values as set in the Daughter Directives, see *Table 5*. Lead will not be discussed further. In general the annual averaged concentration of lead is far below the limit value of 0.5 μg/m³. High concentrations, up to a factor 5-8 higher than the limit values are observed at a number of stations in Romania. Information is lacking whether the lead has been measured on the $PM_{10}$-fraction (as described in the directive) or on total suspended particles.
Estimating a European wide trend in air quality is hampered by the fact that number and type of stations may differ widely between the European countries. To get an impression of the representativity of a trend line for the whole of Europe, a map is added to each trend figure that shows the density of the stations used in the analysis, see *Figure 11* for the colour coding. A "reference density", that is, the minimal density for estimating a trend in air quality representative for the whole country, cannot easily be defined. It will depend a.o. on the representativity of the stations and on the concentration gradients. Following the EMEP monitoring strategy (EMEP 2004) a minimum station density of one station per 50,000 km² is recommended; the trend line will not be representative for the white and gray-shaded countries (less than 0.2 stations per 10.000 km²). Please note that the minimum density refers to rural stations; in this analysis all stations type (including urban and hot spot stations) are included.
The emission data have been taken from the Annual European Community LRTAP Convention Emission Inventory 1990-2004 (EEA 2006). The current air quality in relation to the limit or target values is presented in so-called distance-to-target graphs. In these graphs for each station type (rural background, (sub)urban background and traffic stations) the concentration averaged over all stations, the average concentration calculated only for stations where the limit value (LV) is exceeded and the maximum observed value is presented. The number of stations in each category is given above the bars. The graphs are scaled in such a way that the concentration axis runs from zero to three times the limit or target value.
In the maps, distance-to-target graphs and in the trend graphs only stations having a data coverage of more than 75% have been included. The trend analyses are further restricted to stations having 8 (5) valid data points in the 10 (5) year period.

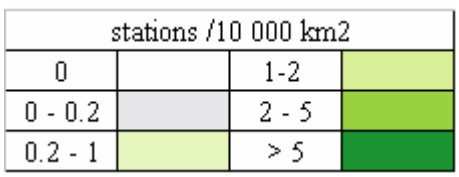


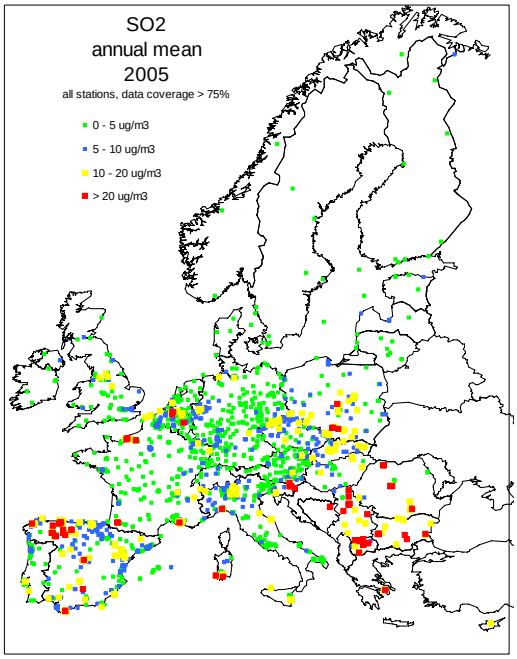

*Figure 11. Colour coding of monitoring station densities*

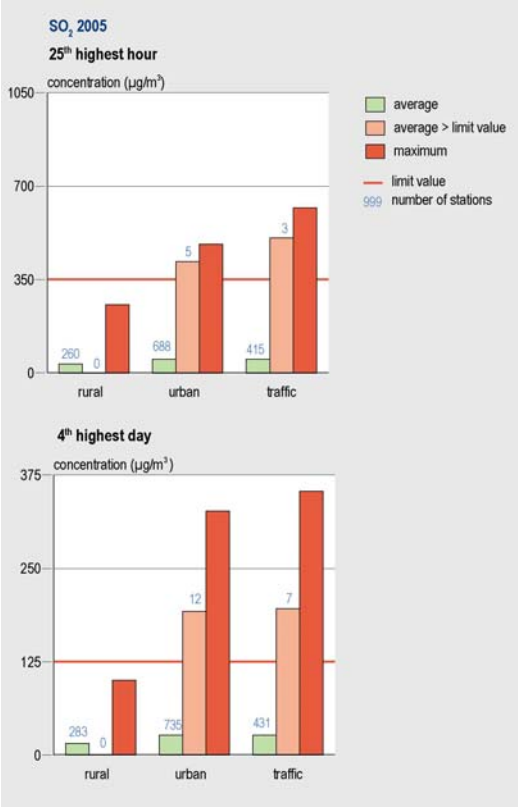
*Table 5 Limit and target values defined by the European Union for $SO_2$, $NO_2$, $PM_{10}$, Benzene, CO and $O_3$*

| Parameter | period | Limit and target values (µg/m3) | No of allowed exceedances | Target data |
|---|---|---|---|---|
| $SO_2$ (1999/30/EC) | | | | |
| Human health protection | Hourly average | 350 | 24 hours/yr | |
| Human health protection | Daily average | 125 | 3 days/yr | |
| Vegetation protection | Annual average | 20 | | |
| Vegetation protection | winter average | 20 | | |
| | | | | |
| $NO_2$ (1999/30/EC) | | | | |
| Human health protection | Hourly average | 200 | 18 hours/yr | 1 Jan 2010 |
| Human health protection | Annual average | 40 | | 1 Jan 2010 |
| | | | | |
| $PM_{10}$ (1999/30/EC) | | | | |
| Human health protection | Daily average | 50 | 35 days/yr | |
| Human health protection | Annual average | 40 | | |
| | | | | |
| Pb (1999/30/EC) | | | | |
| Human health protection | Annual average | 0.5 | | |
| | | | | |
| CO (2000/69/EC) | | | | |
| Human health protection | 8h running average[a] | 10 [b] | | |
| | | | | |
| Benzene (2000/69/EC) | | | | |
| Human health protection | Annual average | 5 | | 1 Jan 2010 |
| | | | | |
| Ozone (2002/3/EC) | | | | |
| Human health protection | 8h running average[a] | 120 | 25 days/yr | 1 Jan 2010 |
| Vegetation protection | Hourly averaged (growing season) | 18 [c] | | 1 Jan 2010 |

(a) daily maximum of 8h running averaged concentrations
(b) in mg/m3
(c) in (mg/m3).h

## 3.2. Sulphur dioxide ($SO_2$)




### Sources & effects

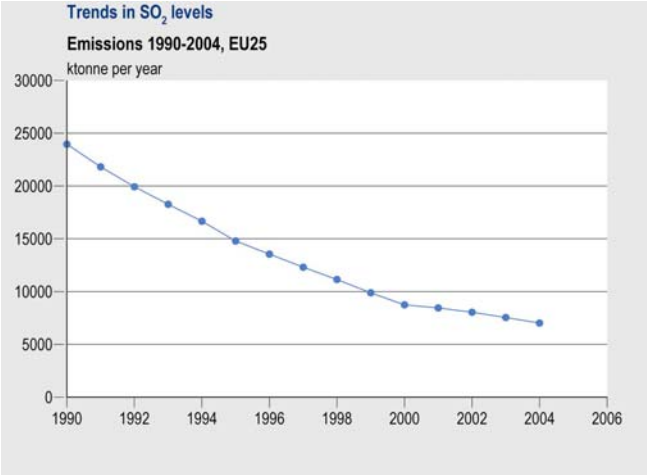
Man-made contributions to ambient $SO_2$ includes mainly the use of sulphur-containing fossil fuels and bio-fuels used for domestic heating, stationary power generation and for transport. Volcanoes are the most important natural sources. Epidemiological studies published in the recent past provide suggestive evidence on the human health effects of sulphur dioxide. $SO_2$ is a major precursor to particulate matter ($PM_{2.5}$) which is associated with significant health effects. Sulphur dioxide and its oxidation products contribute to acid deposition.

### Status

At 1933 stations $SO_2$ monitoring data fulfil the data coverage criteria of 75%. At half of them the annual mean is below 5 µg/m³. At about 100 stations, in Spain and the Balkan and a few other countries, the annual mean is above 20 µg/m³. As none of these stations has been classified as “rural background”, this suggests that the limit value for the annual average for protection of vegetation was probably not exceeded in 2005.

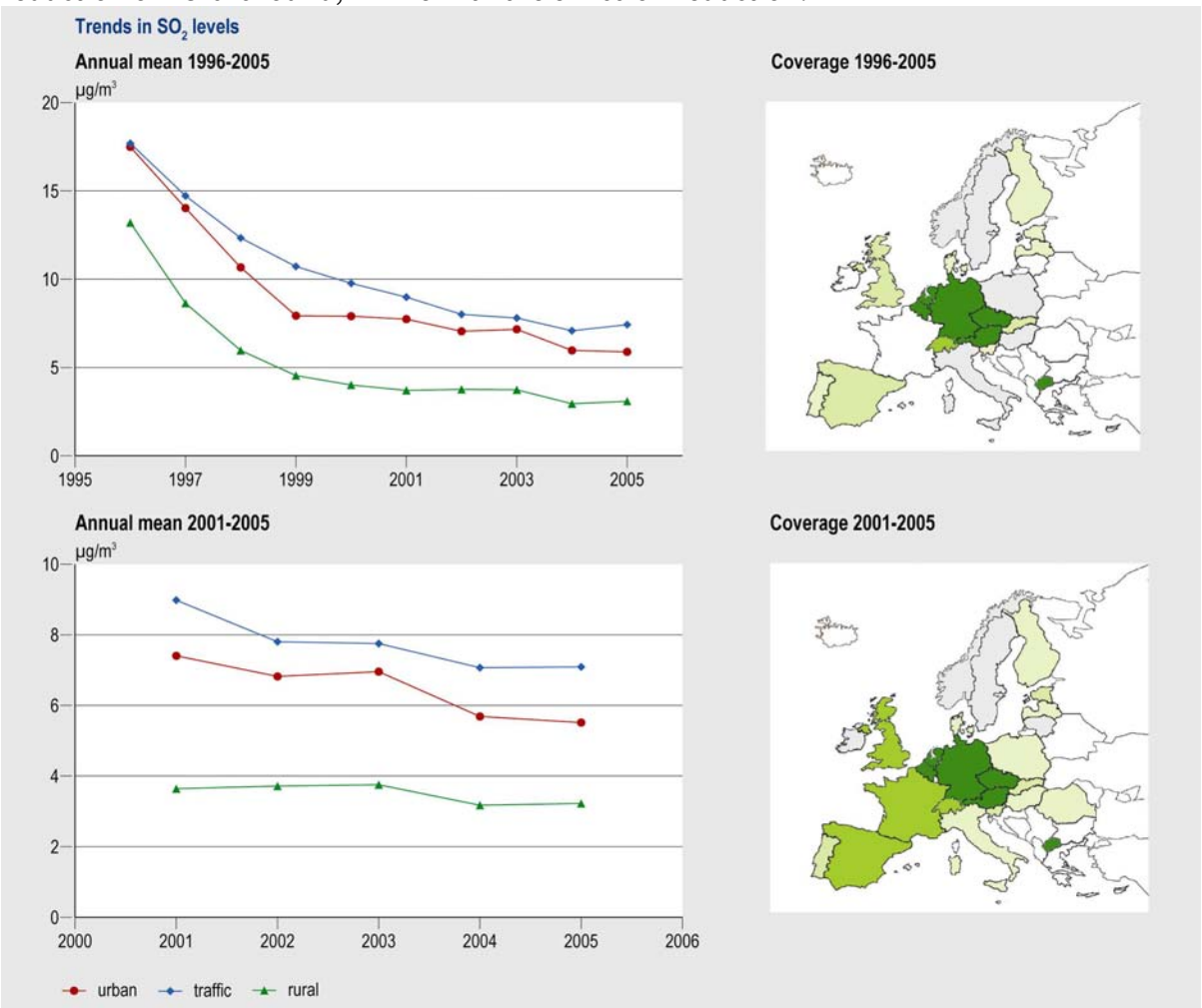
In the first daughter directive the EU has set limit values for the protection of human health (a daily average of 125 µg/m³ not to be exceeded on more than 3 days per year and an hourly average of 350 µg/m³ not to be exceeded on more than 24 days per year). The extent of exceedance of the $SO_2$ limit values is displayed in the figures on the left. Comparing the figures for the two limit values it is clear that the daily limit value is exceeded more than the hourly limit value. At rural stations no exceedance is observed for either of the two limit values. For both urban background and traffic hotspot stations an exceedance is observed at less then 1.5% of all stations. Concentrations at traffic hotspots tend to be higher than in the urban background; the difference is, however, not significant. Note that the number of stations differs in both graphs as a limited number of stations report only daily values.

## Trends in $SO_2$ levels



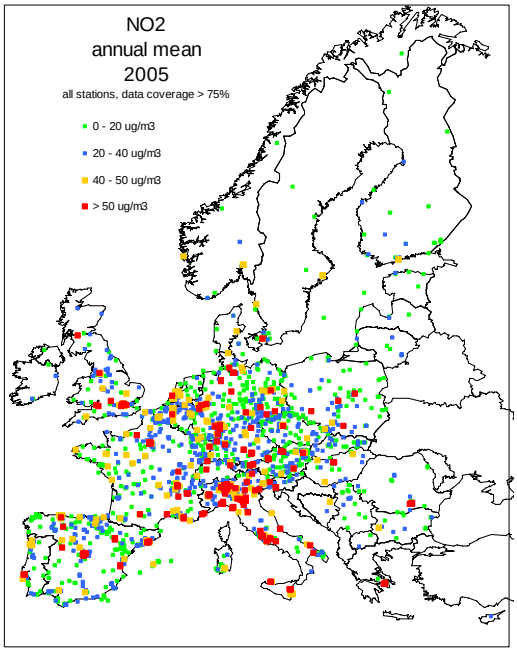

*$SO_2$ emission changes in the EU25 Member States*

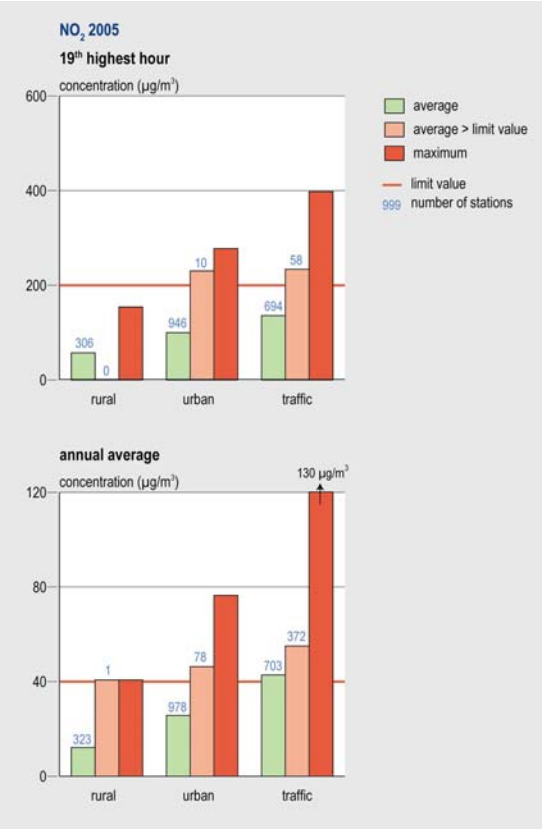
The $SO_2$ emissions have been reduced over the period 1990-2004 with 70% in the EU25 Member States. Over the periods 1996-2004 and 2001-2004 the decrease in emissions is 50% and 17% respectively. The changes in ambient concentrations are in agreement with this. On average the $SO_2$ concentrations (annual mean) have decreased by 65% from 1996 to 2005. This is slightly more than the EU25 emission reduction. However, as the map shows, the 1996-2005 trend is biased towards the situation in countries in NW Europe. The emission reduction in this region was larger then in the EU25 as a whole. Over the last five years (2001-2005) a concentration reduction of 20% is found, in line with the emission reduction.




*Changes in $SO_2$ air quality (based on annual mean concentrations) over the period 1996-2005 (based on 629 stations) and over 2001-2005 (based on 995 stations). The maps show the geographical coverage of the stations.*

## 3.3. Nitrogen dioxide ($NO_2$)



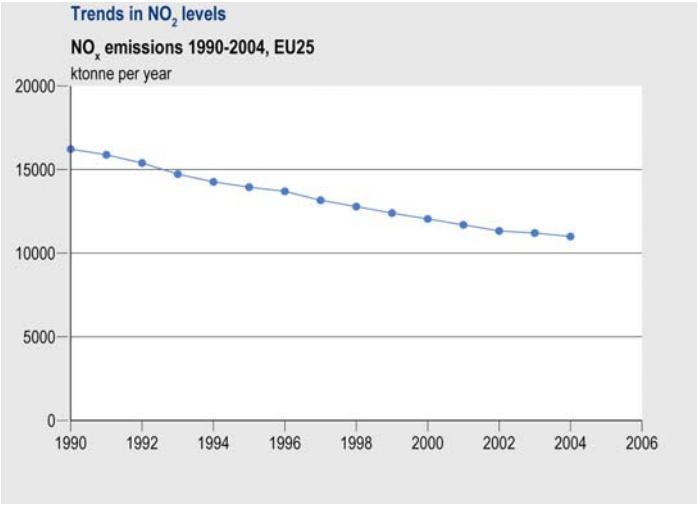

### Sources & effects

Nitrogen dioxide is a reactive gas that is mainly formed in the ambient air by oxidation of nitric oxide (NO). High temperature combustion processes (such as those occurring in car engines and power plants) are the major sources of nitrogen oxides, the term used to describe the sum of NO and $NO_2$. Nitrogen monoxide is the main component of the NOx emission. A small part is directly emitted as $NO_2$. There are clear indications that for traffic emissions the direct $NO_2$ fraction is increasing. Due to increased penetration of diesel vehicles, especially those with particle filter. This may lead to more frequent breeching of the $NO_2$ limit values in traffic hotspot situations. Health effects of nitrogen dioxide are seen both during short term exposures (changes in lung function in susceptible groups) and long-term exposure (increased susceptibility to respiratory infection). It should be noted that as $NO_2$ is highly correlated with other pollutants (in particular PM) it is very difficult to differentiate the effects of nitrogen dioxide from those of other pollutants in epidemiological studies. Nitrogen oxides play a major role in the formation of ozone and secondary aerosol contributing to $PM_{10}$ and $PM_{2.5}$ concentration. They further contribute to acidification and eutrophication.

### Status

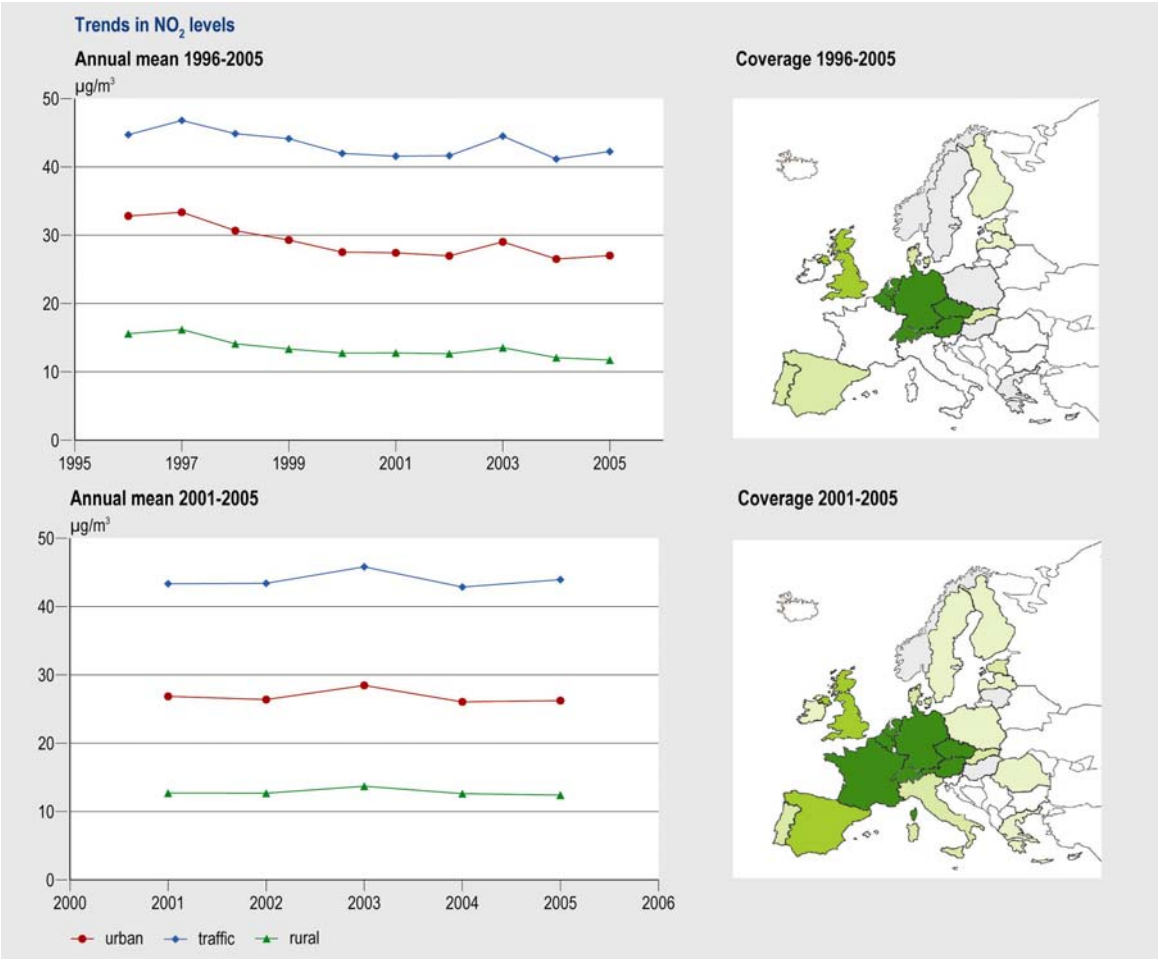
At 2404 stations the $NO_2$ daily values fulfil the data coverage criteria of 75%; for hourly values the criteria is fulfilled for 2335 stations.
In the first daughter directive the EU has set limit values for the protection of human health (an annual average of 40 µg/m3 and an hourly average of 200 µg/m3 not to be exceeded on more then 18 hours per year). The extent of exceedance of the $NO_2$ limit values is displayed in the figures on the left side. Comparing the figures it is clear that the annual limit value is exceeded to a larger extent than the hourly limit value. At rural station no exceedance of the hourly limit value is observed. For urban background and traffic hotspot stations exceedances are observed at 1% and 8% of the stations, respectively. Exceedance of the annual limit value is not only more frequent (at 8% and 53% of the urban and traffic stations, respectively) but also more severe: the concentration at traffic hotspots where an exceedance is observed is on the average 17% above the hourly limit value but 38% above the annual limit value.

## Trends in $NO_2$ levels



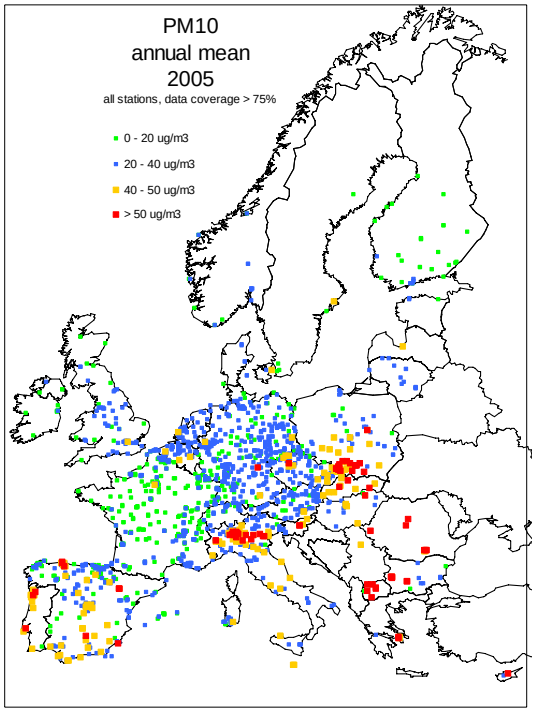

*NOx emission changes in the EU25 Member States*

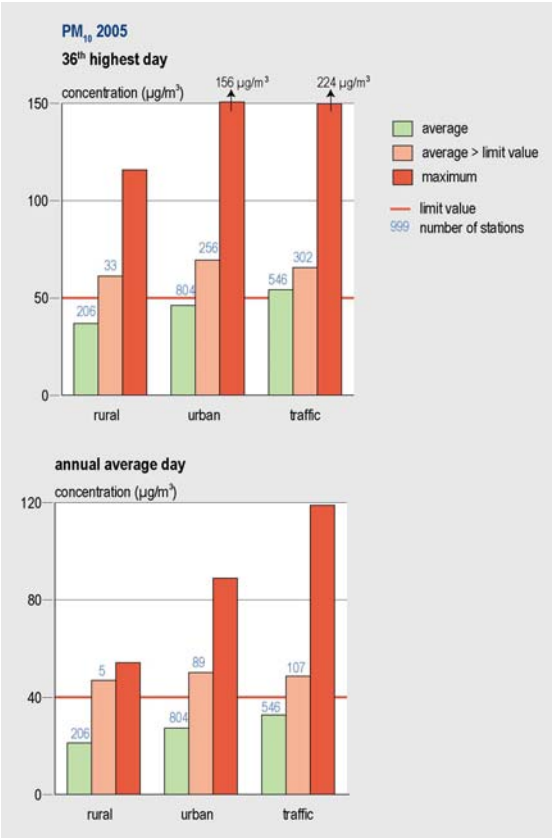
The NOx emissions have been reduced over the period 1990-2004 with 32% in the EU25 Member States. Over the periods 1996-2004 and 2001-2004 the decrease in emissions is 20% and 6% respectively. The changes in ambient $NO_2$ concentrations depend on the type of station. At rural stations, the 1996-2005 concentration change (-25%) is in line with the emission change. At more polluted stations the decrease in $NO_2$ is less: 18% and 5% reduction at urban background and traffic hotspots, respectively. Close to NOx sources a similar reduction in NOx emissions and corresponding NOx concentrations is not seen in the $NO_2$ concentrations as the $NO_2$/NOx ratio increase due to ozone oxidation of the available NO. In rural situations NO concentrations are very low and NOx and $NO_2$ concentrations changes are more parallel. A second reason of the small $NO_2$ reduction at traffic sites is the increase of direct emission of $NO_2$ by diesel cars. Over the last five years (2001-2005) the annual averaged $NO_2$ concentrations do not show a distinct trend.




*Changes in $NO_2$ air quality (based on annual mean concentrations) over the period 1996-2005 (based on 680 stations) and over 2001-2005 (based on 1211 stations). The maps show the geographical coverage of the stations.*

## 3.4. Particulate Matter ($PM_{10}$ and $PM_{2.5}$)




### Sources & effects

Particulate matter is the general term used for a mixture of solid particles and liquid droplets with a wide range in size and chemical composition. $PM_{2.5}$ refers to fine particle that have a diameter of 2.5 micrometer or less. $PM_{10}$ refers to the particles with a diameter of 10 micrometer or less. PM is either emitted directly (primary particles) or formed in the atmosphere from primary gaseous emissions (secondary particles, most important precursors are sulphur dioxide, nitrogen oxides, ammonia and organic compounds). PM is from natural (e.g. sea salt, Sahara dust, pollen, volcanic emissions) or anthropogenic origin such as thermal power generation, incineration and vehicles. In cities vehicle exhaust and road dust are important sources. Epidemiological studies indicate that the most severe health effects from exposure to air pollution must be attributed to the particulate matter and, in a lesser extent, to ozone (see section 3.7). It is suggested that for both pollutants there is no safe level: even at concentrations below current air quality guidelines they may pose a health risk (WHO, 2006).

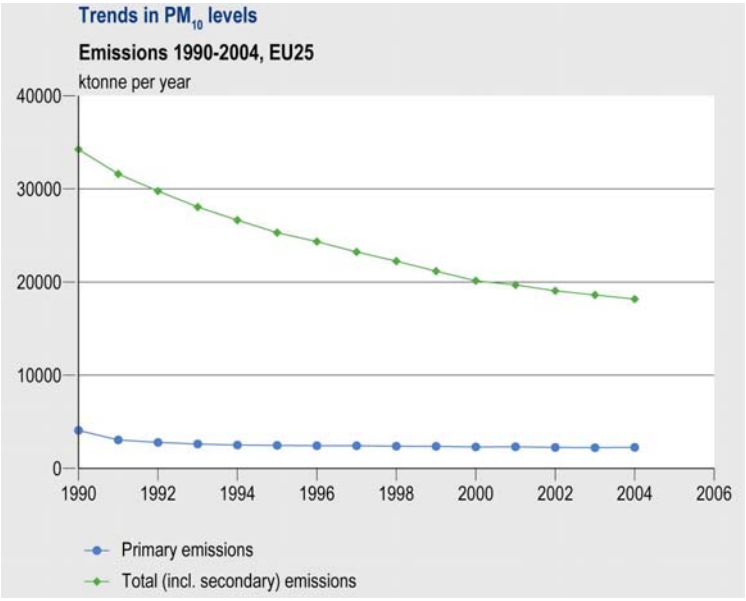
Health effects of fine particulate matter (PM) are caused by their inhalation and penetration into the lungs. Both chemical and physical interactions with lung tissues can induce irritation or damage. Since finer PM are more able to penetrate the lungs, the size of the particles is of significance. The current scientific understanding is that mortality effects of PM are mainly associated with the $PM_{2.5}$ fraction which represents 40 – 80% of the $PM_{10}$-mass (Larssen and de Leeuw 2007). However, health effects are seen with both the finer sub-2.5µm and the coarser 2.5-10µm fractions of $PM_{10}$. Whilst evidence is growing that finer size fractions are perhaps most important, ambient air quality measurements and emission data at present are often only available for $PM_{10}$. Different methods are in use from the routine monitoring of $PM_{10}$. Some of these methods are very sensitive for sampling artefacts. The first daughter directive states that when a non-reference method is applied, equivalence with the reference method has to be ensured, if necessary, by applying a correction factor. However, it can not be excluded that incidentally the data obtained by a non-reference method has not been or is not properly corrected prior to submission to

AirBase. This may lead to a systematic underestimation for the stations concerned. Overview of PM measuring methods and correction factors are available from the ETC/ACC web site (Buijsman and de Leeuw 2004, de Leeuw 2005).

### Status

At 1838 stations the $PM_{10}$ daily values fulfil the data coverage criteria of 75%.
In the first daughter directive the EU has set limit values for the protection of human health (an annual average of 40 µg/m³ and a daily average of 50 µg/m³ not to be exceeded on more than 35 days per year). The extent of exceedance of the $PM_{10}$ limit values is displayed in the distance-to-target graphs. Comparing the figures it is clear that the daily limit value is exceeded to a larger extent than the annual limit value. Exceedance of both limit values is observed at all types of stations with increasing numbers from rural to urban to traffic hotspot. The daily limit value is frequently exceeded at urban stations (more than 30%) and at traffic stations (more than 55%).

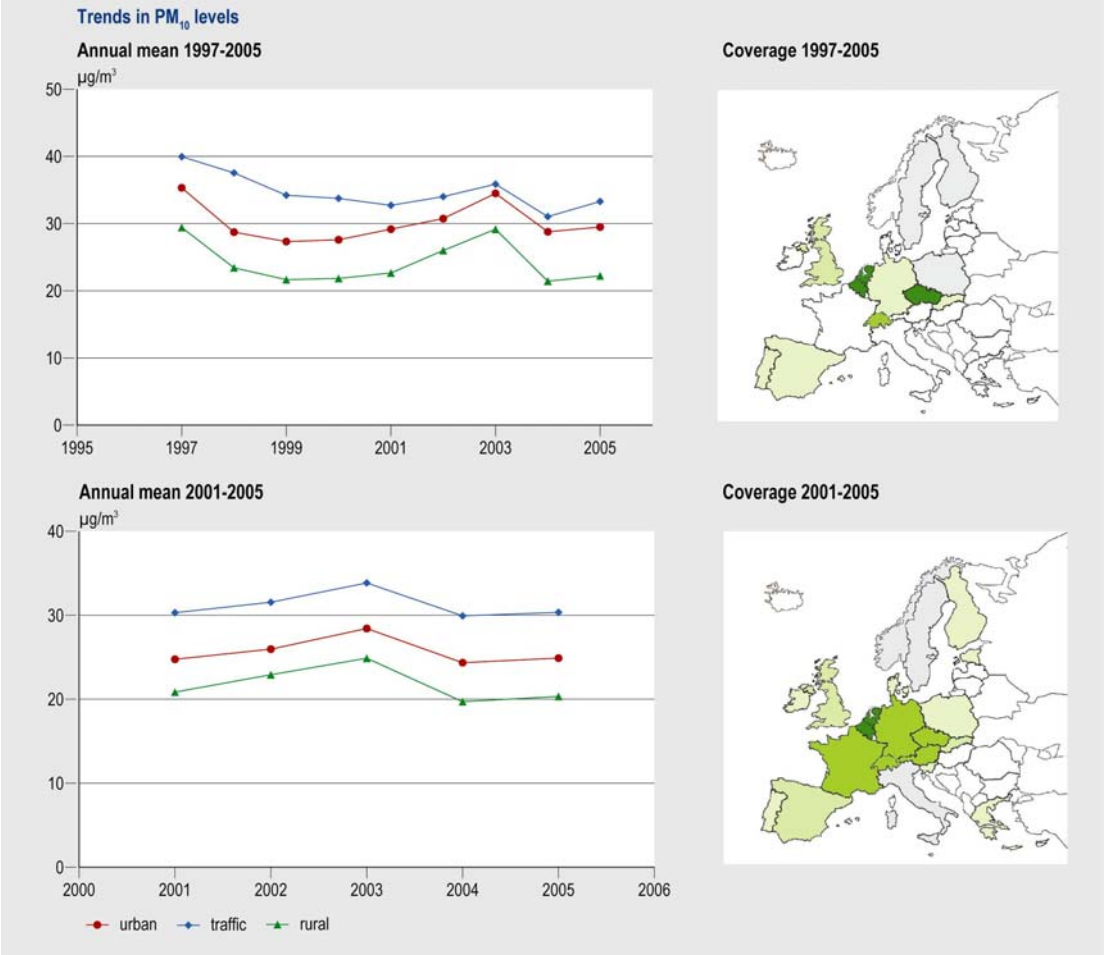
### Trends in $PM_{10}$ levels



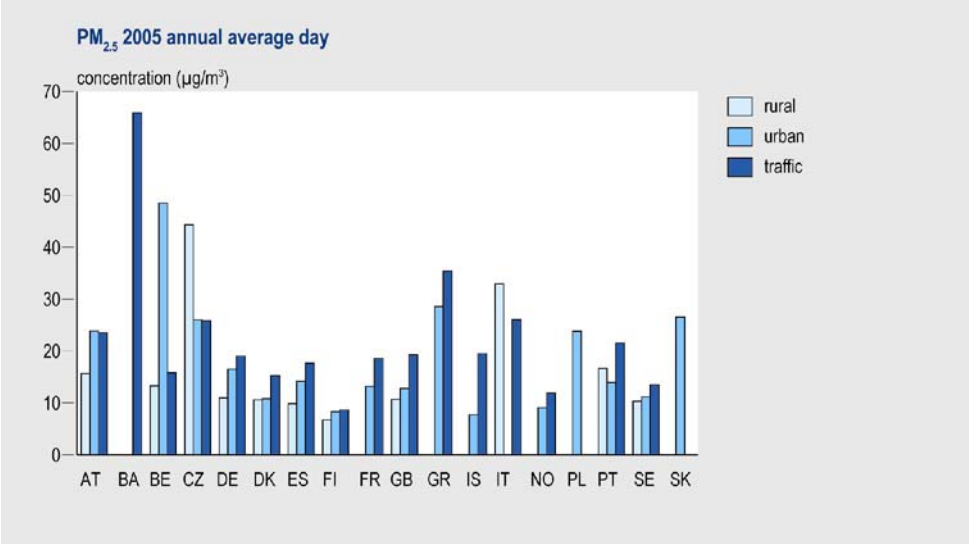

*Changes in emissions of primary $PM_{10}$ and total emissions (primary plus secondary) in the EU25 Member States*

The total $PM_{10}$ emissions have been reduced over the period 1990-2004 with 47% in the EU25 Member States. The secondary PM-precursor emissions are calculated as a weighted sum of the emissions of PM-precursors $SO_2$, $NO_x$ and $NH_3$ (see de Leeuw 2002).This reduction is largely due to a reduction in $SO_2$ emissions. The primary $PM_{10}$ emissions have been reduced by 45% over this period. Over the period 1997-2004 and 2001-2004 the decrease in total emissions is 22% and 8%, respectively. The limited number of stations operational during the period 1997-2005 and the large meteorologically induced inter-year variations over the entire period precludes any firm conclusion about a possible trend. Although the number of stations providing data during the last five year period has been more than doubled, a clear European-wide trend is not observed.

The number of operational $PM_{2.5}$ stations is growing but still limited. For 2005 there are 175 stations fulfilling the criteria of more than 75% data coverage. Although the spatial coverage of monitoring stations is presently insufficient to assess variations across Europe, some comparison is possible between observations at the increasing numbers of monitoring stations reporting $PM_{2.5}$ and the 25 µg/m³ 'cap' value of the proposed Air Quality Directive (EU 2005). Information is unfortunately too limited to compare against the expected concentration reduction trends of the proposed PM2.5 exposure reduction target (EU 2005). As many current $PM_{2.5}$ monitor types significantly underestimate concentrations mass loss during sampling, real $PM_{2.5}$ concentrations would be higher than those shown.
The indication is that hot-spot (traffic-related) locations may well exceed the cap value, although most $PM_{2.5}$ observations are below the proposed limit. Concentrations generally increase from rural-to-urban-to-traffic locations, in accordance with increasing proximity to PM sources.

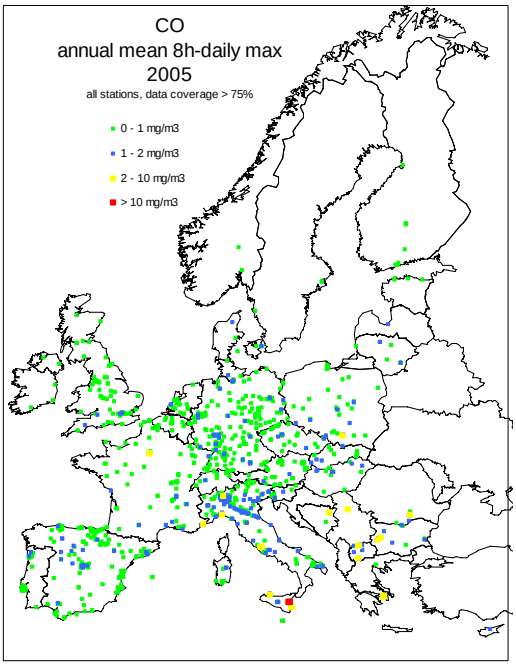


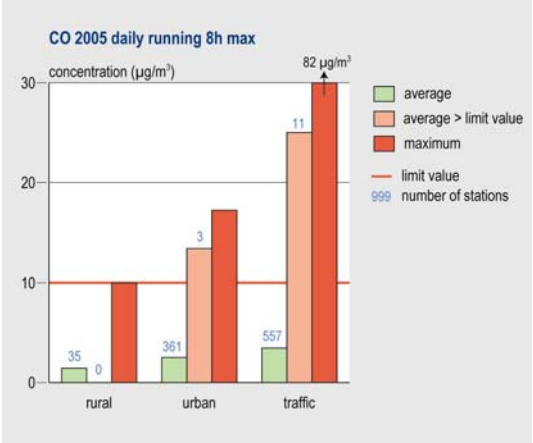

*Changes in $PM_{10}$ air quality (based on annual mean concentrations) over the period 1997-2005 (based on 202 stations) and over 2001-2005 (based on 565 stations).*




*Measured $PM_{2.5}$ concentrations, 2005 ($\mu g/m^3$, annual average) for several countries. Each bar represents the average concentrations for each station type*

## 3.5. Carbon monoxide (CO)



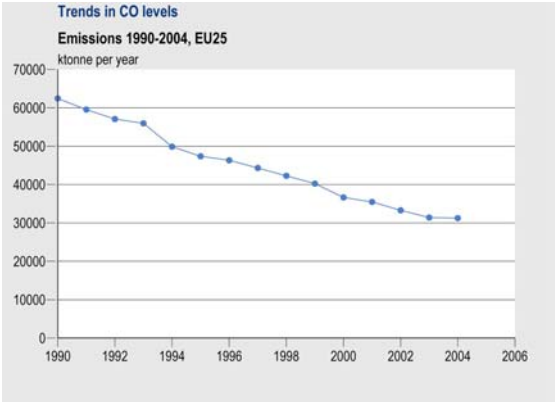




### Sources & effects

Carbon monoxide (CO) is a colourless, odourless gas that is formed during the incomplete combustion of fossil fuels and biofuels. The contribution of road transport to the CO emissions decreases from 56% in 1990 to 41% in 2003; the remaining is mainly emitted during energy production. The CO concentrations tend to vary with the traffic patterns during the day; the highest CO levels are found in urban areas, typically during rush hours at traffic locations. The atmospheric lifetime of CO is about 3 months. It is slowly oxidized to carbon dioxide. During this oxidation process ozone is formed and CO contributes to the hemispheric ozone background concentrations. Carbon monoxide enters the body through the lungs. In the blood it is strongly bound to hemoglobin and thereby it reduces the oxygen delivery to the body's organs and tissues. Those who suffer from cardiovascular disease are the most sensitive towards CO exposure.

### Status

At 1063 stations the CO daily maximum 8-hour mean values fulfil the data coverage criteria of 75%.
In the second daughter directive the EU has set limit values for the protection of human health: the CO daily maximum 8-hour mean values may not exceed 10 mg/m³. This level is not exceeded at the few operational rural stations. Exceedances are observed at less then 1% and at 2% of the urban and traffic stations, respectively. Most of these exceedances are observed in one Italian region; measurement artefacts can not be excluded.

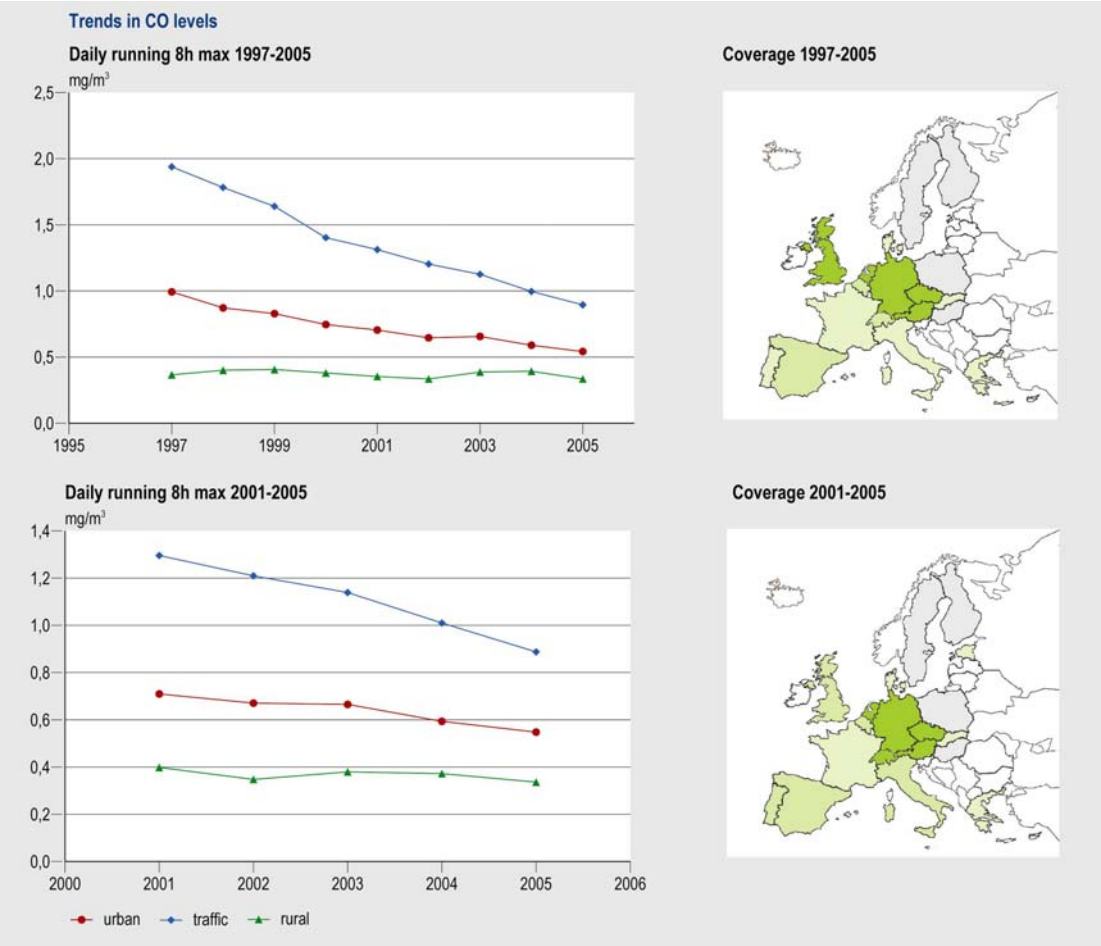



*CO emission changes in the EU25 Member States*

### Trends in CO levels

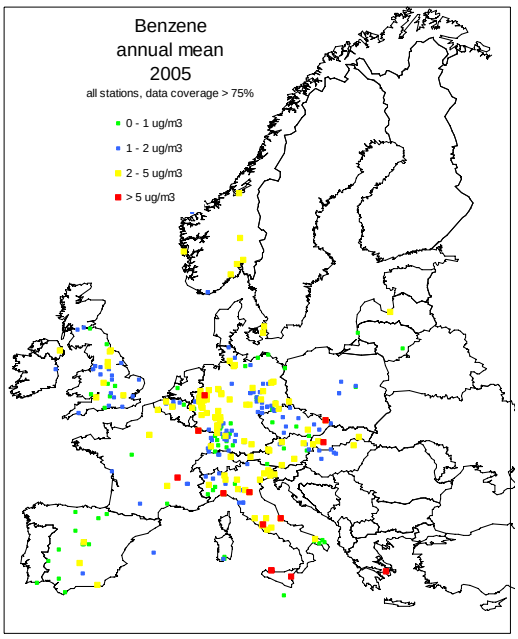
The CO emissions have been halved over the period 1990-2004 in the EU25 Member States. Over the periods 1997-2004 and 2001-2004 the decrease in emissions is 29% and 12% respectively. The changes in ambient concentrations are in agreement with this. On average the CO concentrations (annual mean of 8h daily maximum values) have decreased at traffic and urban stations, relatively close to the sources, with 50% from 1997-2005. At rural stations the decrease is about 10%. With an atmospheric reference time of about 3 months the

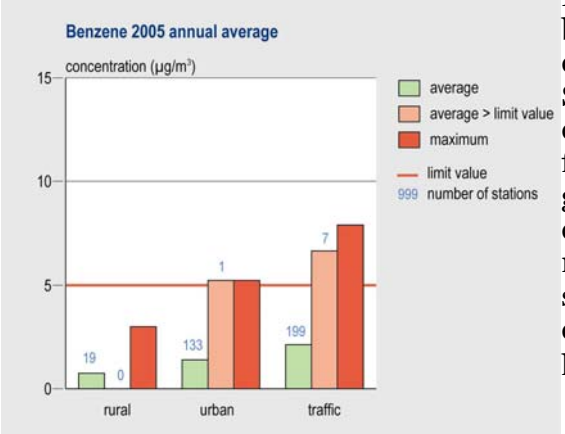
rural concentrations will to a large extent be determined by sources outside the EU25. Over the last five years (2001-2005) a 30% reduction is observed at traffic stations; in the urban background the reduction is about 23%. .




*Changes in CO air quality (based on annual mean concentrations) over the period 1997-2005 (based on 390 stations) and over 2001-2005 (based on 455 stations). The maps show the geographical coverage of the stations*

## 3.6. Benzene




### Sources & effects

Benzene is a volatile, colourless liquid with a sweet smell. Incomplete burning from combustion is the most significant source. Benzene is an additive to petrol with a maximum concentration of 1% v/v. At the European scale, 80-85% of benzene emissions are due to vehicular traffic. In general the contributions of domestic heating are small (about 5%) but with sharp geographic patterns. In Sweden the domestic contribution reaches over 50%. Removal of benzene from the atmosphere is mainly by reaction with the hydroxyl (OH) radical. Photo-oxidation does contribute to ozone formation, although benzene reactivity is relatively low. A lifetime of several days at representative tropospheric OH-concentrations is sufficient for benzene to be transported over long distances. Inhalation is the dominant pathway for benzene exposure in humans, food and water consumption being only a minor source. Smoking is a large source of personal exposure. The most significant adverse effects from prolonged exposure are haematotoxicity, genotoxicity and carcinogenicity. Chronic exposure to benzene can depress bone marrow, and cause haematological effects such as decreased red and white blood cell count in workers occupationally exposed to high concentrations.

### Status

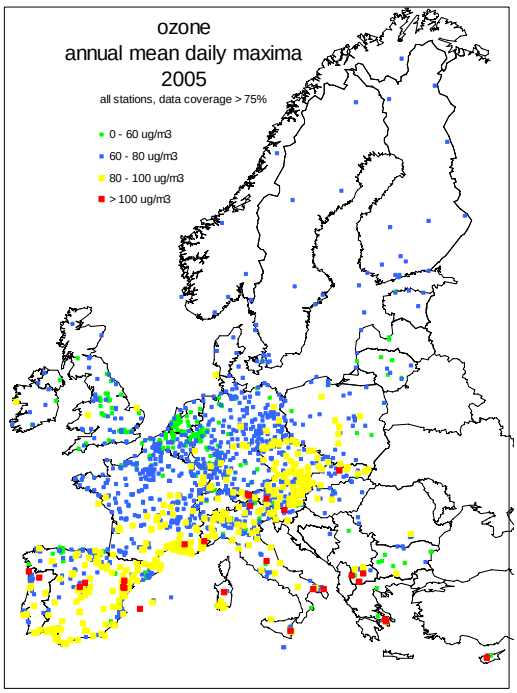
At 383 stations the benzene daily values fulfil the data coverage criteria of better than 75%. The second Daughter Directive (2000/69/EC) set an annual average concentration limit value of 5µg/m³ for benzene in ambient air, to be met by 2010. Including the margin of tolerance, the annual mean concentrations may not exceed 10 µg/m³ in 2005. At rural stations no exceedance of the limit value is observed. Exceedance of the limit value is observed at one urban station and at 7 traffic hotspot stations. Exceedances of the limit value plus margin of tolerance have not been reported.

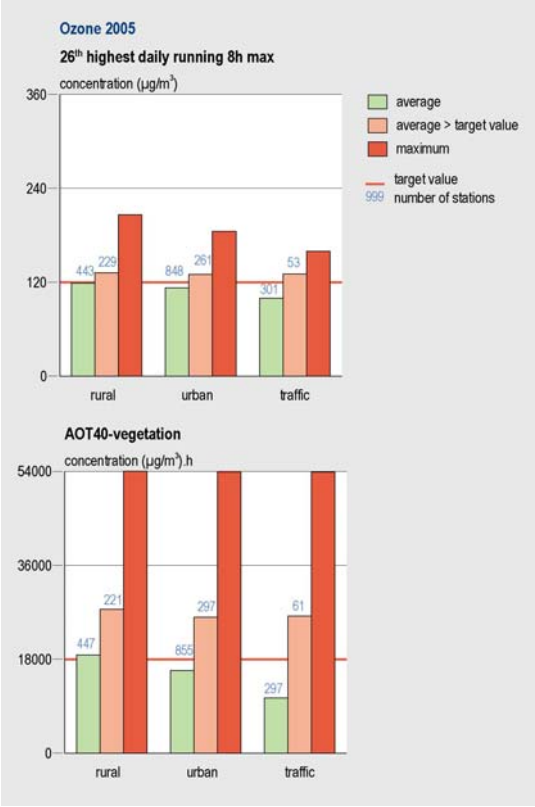
### Trends in benzene levels

Recent summaries of the benzene emissions in the EU25 countries do not exist. For a limited number of countries emission data representative for the last decade of the previous century is presented in the position paper on benzene in support to the preparation of the second

daughter directive. More recent, expert-based emission data have been prepared for the Auto Oil Programme (EEA, 2001). These studies indicate decreasing benzene emissions but a further quantification is not possible. Most important control methods to reduce benzene emissions include the reduction of benzene content of petrol to 1% in 2000, the introduction of catalytic converters and vapour recovery of petrol deliveries.
Up to 2001 benzene monitoring data has been submitted for less then 100 stations. Since 2001 onwards the number of stations annually reporting data might be as large as 500 although at a large number of the stations the data coverage criteria of 75% have not been met. For only 44 traffic stations a complete time series has been reported over the period 2001 – 2005. On the average these traffic station show a reduction by one third in these five years.

## 3.7. Ozone ($O_3$)



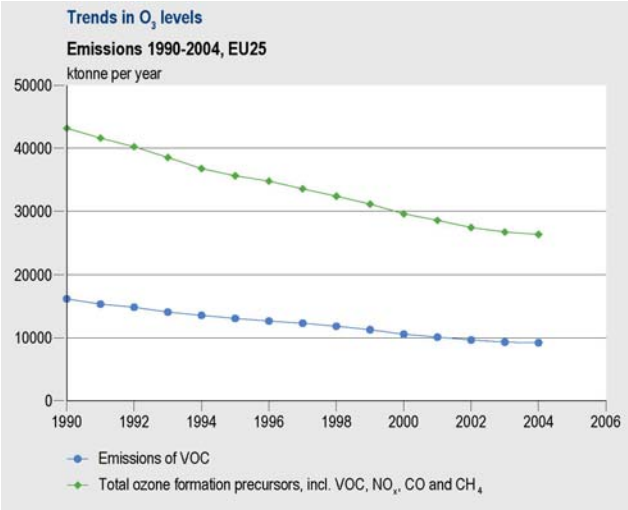

### Sources & effects

Ozone is not directly emitted into the atmosphere but formed by photochemical reactions of volatile organic compounds (VOC) and nitrogen oxides. Sunlight and high temperature favours ozone formation. NOx play a complex role in the ozone chemistry: close to NOx sources it will deplete ozone due to the scavenging reaction between the freshly emitted nitrogen monoxide and ozone. Farther away from sources, NOx is indispensable in the regeneration of the OH-radical, the key species in the oxidation chain process.
Evaporation losses are the main source of VOC emissions. Traffic, solvent usage and refineries are the largest anthropogenic sources.
Short-term studies show that $O_3$ has adverse health effects, especially in the summer, on pulmonary function, lung inflammation, lung permeability, respiratory symptoms, increased medication usage, morbidity and mortality. Long-term effects are less clear but evidence for the chronic effects of ozone is supported by human and experimental information. Epidemiological evidence of chronic effects is less conclusive, owing mostly to an absence of studies designed specifically to address this question and inherent limitations in characterizing exposure. The studies with the most efficient approaches and more individual assignment of exposure provide new evidence for chronic effects of ozone on small airway function and possibly on asthma.

### Status

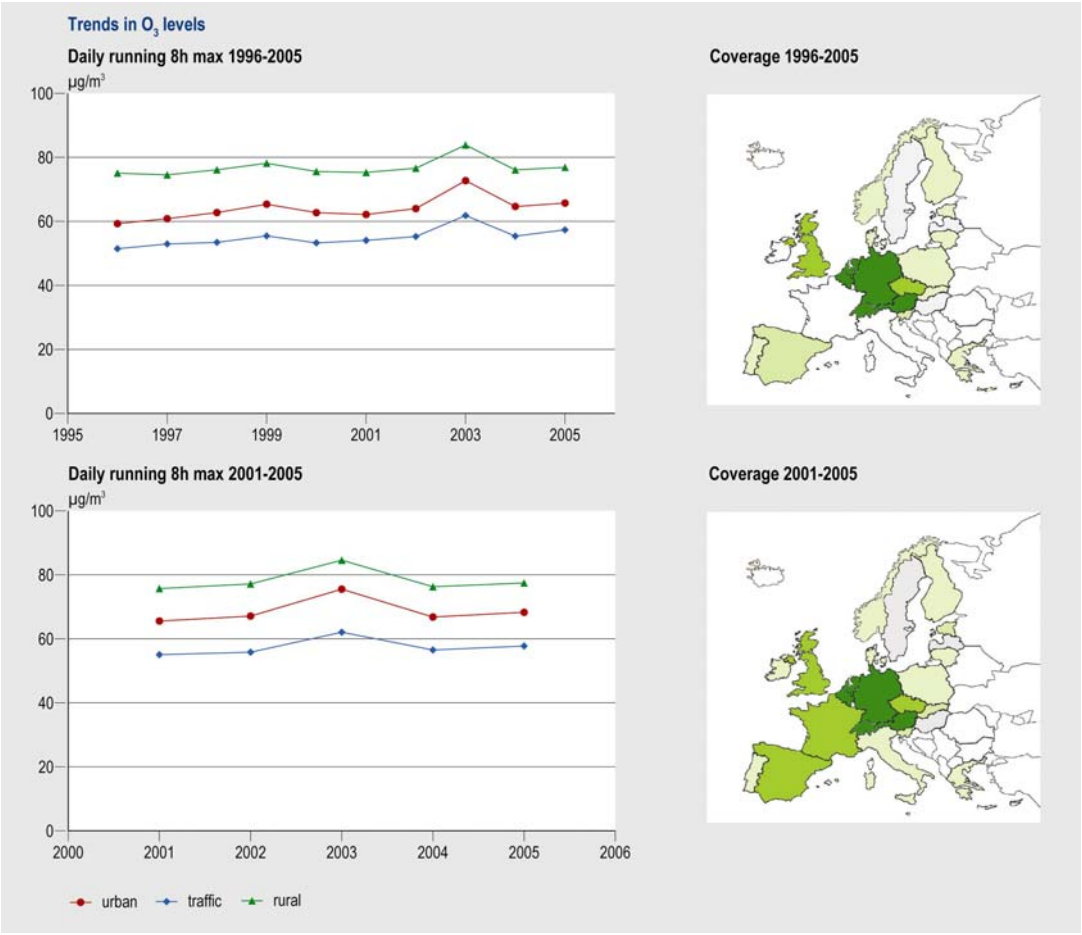
At 1808 stations the ozone daily values fulfil the data coverage criteria of 75%.
In the third daughter directive the EU has set target values for the protection of human health (the daily maximum of the running 8-hour mean values may not exceed 120 µg/m³ on more than 25 days per year) and for vegetation (18000 (µg/m³).h as AOT40 value).
The health related target is widely exceeded on more then half of the rural background stations. In urban area about 30% of the station is not in compliance with the target. The AOT40 value averaged over all rural background stations is just above the target. On half of the rural station the target is exceeded, on average concentrations are 50% above target. Even at one third of the urban stations and one fifth of the traffic station the AOT40-target is exceeded. The maximum observed AOT40 levels are more than three times

higher than the target value: 89000, 54800 and 54800 (µg/m³).h at rural, urban and traffic stations, respectively.




## Trends in ozone levels

The emissions of ozone precursors, weighted according to their contribution in ozone formation (de Leeuw 2002) have been reduced over the period 1990-2004 with about 40% in the EU25 Member States; the 32% NOx reduction is less than the 44% reduction in VOC emissions. Over the periods 1996-2004 and 2001-2004 the decrease in total emissions is 24% and 8% respectively. The development of the ozone concentrations during the last decade are not in line with these emission changes. Neglecting the high concentrations in 2003, caused by the extremely favourable conditions for ozone formation in that year in most of Europe, the rural data show no trend at all while the traffic and urban stations suggest some increasing tendency. This increase can be explained by less ozone depletion due to decreasing NOx emissions. The constant background levels are the net result of a number of possible processes: the increase in hemispheric background




*Changes in ozone air quality (based on annual mean concentrations) over the period 1996-2005 (based on 629 stations) and over 2001-2005 (based on 995 stations). The maps show the geographical coverage of the station.*

concentrations, less ozone deposition during the (more frequent) dry periods during the summer, increased ozone formation due to higher temperatures, less ozone formation due to emissions reduction. Climatologic changes in the large-scale circulation patterns over Europe might also play a role.

## 3.8. Further reading.

Air Quality Framework Directive and related Daughter Directive:

See EU (1996), EU (1999), EU (2000), EU (2002)

Health effects of air pollution:
See WHO (2006)

EEA and ETC/ACC publications on air pollution:
See Larssen S. *et al.* (2007)
See EEA (2006)

# 4. CONCLUSIONS

The EoI2006 data cycle was very successful. A total of 33 countries, including 26 EU Member States, have provided air quality data for 2005. Measurement data from 3852 stations have been delivered, about 300 stations more than in the EoI2005. The spatial station coverage of $PM_{2.5}$ has been increased but is still insufficient. $PM_{2.5}$ measurement data have been reported from only 269 stations. There is also a difference between the number of stations for which $NO_2$ has been reported and the number of stations for which NO (or $NO_x$) has been reported. This is surprising as most automated monitors measure both pollutants simultaneously. 11 countries have reported one or more VOCs except Benzene (ozone precursors 3DD) and Heavy Metals except Lead (4DD) and 4 countries have reported PAHs (4DD).
Nearly all countries have delivered the data in time before 1st of October 2005. ETC/ACC has produced QA/QC country feedback reports. The response on these reports was very good. The quality of the meta information, measurement data but also the derived information (statistics, exceedances) in AIRBASE has been improved considerably.
Concerning the air quality state for the selected pollutants we can conclude the following. Pollution by SO2 shows a decreasing trend both in emissions as well as in ambient concentrations. Exceedances of the health related limit values are observed at a limited number of stations only. The emission of NOx decreases but concentrations in urban and traffic areas are decreasing at a much lower rate. Compliance with the $NO_2$ limit value for annual mean values is a serious problem in many urban and traffic areas. During the last five years emissions of primary PM10 and its precursor gasses are reducing slowly but in the observed concentrations no clear European-wide trend is seen. The $PM_{10}$-limit value for daily values is exceeded frequently at urban and traffic stations. The ambient levels of CO are below the limit value; some incidental exceedances are observed but in these cases measuring artifacts can not be excluded. The benzene concentrations are in compliance with the limit values except for a limited number of traffic hotspot situations. Ozone precursor emissions are decreasing; the ozone concentrations, however, do not show a decreasing trend. On the contrary, the health related and the annual mean values show an increasing tendency. Both the health and the ecosystem related target values are exceeded frequently and widely over Europe.

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Air quality in larger cities in the European Union - A contribution to the Auto-Oil II programme
EEA Topic report No 3/2001

# Annex A Exchange of Information requirements

The Member States of the European Union should, according to Annex II of the Council Decision on the reciprocal exchange of information, report certain types of meta information (EU, 2001a). Part of the information, as mentioned in Annex II, is mandatory (*Table A1*). The other information should be delivered 'to the extent possible' and 'as much as feasible' (*Table A2)*.

*Table A.1 Overview of mandatory meta information to be delivered under the Exchange of Information (EoI)*

| Item [a] | Description |
|---|---|
| I.1. | Name of the network |
| I.4.1. | Name of the body responsible for network management |
| I.4.2. | Name of person responsible |
| I.4.3. | Address |
| I.4.4. | Telephone and fax numbers |
| I.5. | Time reference basis |
| II.1.1. | Name of the station |
| II.1.4. | Station code given under the present decision and to be provided by the Commission |
| II.1.8. | Geographical co-ordinates |
| II.1.10. | Pollutants measured |
| II.1.11. | Meteorological parameters measured |
| II.2.1. | Type of area |

(a) Numbers according to Annex II of the EoI (EU, 2001a)

*Table A.2. Overview of non-mandatory meta information to be delivered under the Exchange of Information (EoI)*

| Item [a] | Description |
|---|---|
| I.2. | Abbreviation (of the network) |
| I.3. | Type of networks |
| I.4.5. | E-mail (of the body responsible for the network) |
| I.4.6. | Website address |
| II.1.2. | Name of the town/city of location (of the station) |
| II.1.3. | National and/or local reference number or code |
| II.1.5. | Name of technical body responsible for the station |
| II.1.6. | Bodies or programmes to which data are reported |
| II.1.7. | Monitoring objectives |
| II.1.9. | NUTS level IV |
| II.1.12 | Other relevant information |
| II.2.2. | Type of station in relation to dominant emission sources |
| II.2.3. | Additional information about the station |
| III.1.1. | Name (of measurement equipment) |
| III.1.2. | Analytical principle or measurement method |
| III.2.1. | Location of sampling point |
| III.2.2 | Height of sampling point |
| III.2.3 | Result-integrating time |
| III.2.4 | Sampling time |

(a) Numbers according to the Annex II of the Exchange of Information (EU, 2001a).

*Table A.3 Overview of mandatory pollutants to be delivered under the Exchange of Information (EoI)*

| EoI nr. | Formula | Name of pollutant | Units of measurement | Average over |
|---|---|---|---|---|
| 1 | $SO_2$ | Sulphur dioxide | µg/m³ | 1 h |
| 2 | $NO_2$ | Nitrogen dioxide | µg/m³ | 1 h |
| 3 | $PM_{10}$ | Particulate matter < 10 µm | µg/m³ | 24 h |
| 4 | $PM_{2.5}$ | Particulate matter < 2.5 µm | µg/m³ | 24 h |
| 5 | SPM | Total suspended particulates | µg/m³ | 24 h |
| 6 | Pb | Lead | µg/m³ | 24 h |
| 7 | $O_3$ | Ozone | µg/m³ | 1 h |
| 8 | $C_6H_6$ | Benzene | µg/m³ | 24 h |
| 9 | CO | Carbon monoxide | mg/m³ | 1 h |
| 10 | Cd | Cadmium | ng/m³ | 24 h |
| 11 | As | Arsenic | ng/m³ | 24 h |
| 12 | Ni | Nickel | ng/m³ | 24 h |
| 13 | Hg | Mercury | ng/m³ | 24 h |
| 14 | BS | Black smoke | µg/m³ | 24 h |
| 15 | $NO_X$ | Nitrogen oxides | µg $NO_2$/m³ | 1 h |

*Table A.4 Overview of other pollutants to be delivered under the Exchange of Information (EoI) if available*

| EoI nr. | Formula | Name of pollutant | Units of measurement | Average over |
|---|---|---|---|---|
| 16 | $C2H_6$ | Ethane | µg/m³ | 24 h |
| 17 | $H_2C=CH_2$ | Ethene (Ethylene) | µg/m³ | 24 h |
| 18 | HC=CH | Ethyne (Acetylene) | µg/m³ | 24 h |
| 19 | $H_3C-CH_2-CH_3$ | Propane | µg/m³ | 24 h |
| 20 | $CH_2=CH-CH_3$ | Propene | µg/m³ | 24 h |
| 21 | $H_3C-CH_2-CH_2-CH_3$ | n-Butane | µg/m³ | 24 h |
| 22 | $H_3C-CH(CH_3)_2$ | i-Butane | µg/m³ | 24 h |
| 23 | $H_2C=CH-CH_2-CH_3$ | 1-Butene | µg/m³ | 24 h |
| 24 | $H_3C-CH=CH-CH_3$ | trans-2-Butene | µg/m³ | 24 h |
| 25 | $H_3C-CH=CH-CH_3$ | cis-2-Butene | µg/m³ | 24 h |
| 26 | $CH_2=CH-CH=CH_2$ | 1.3 Butadiene | µg/m³ | 24 h |
| 27 | $H_3C-(CH_2)_3-CH_3$ | n-Pentane | µg/m³ | 24 h |
| 28 | $H_3C-CH_2-CH(CH_3)_2$ | i-Pentane | µg/m³ | 24 h |
| 29 | $H_2C=CH-CH_2-CH_2-CH_3$ | 1-Pentene | µg/m³ | 24 h |
| 30 | $H_3C-HC=CH-CH_2-CH_3$ | 2-Pentenes | µg/m³ | 24 h |
| 31 | $CH_2=CH-C(CH_3)=CH_2$ | Isoprene | µg/m³ | 24 h |
| 32 | $C_{36}H_{14}$ | n-Hexane | µg/m³ | 24 h |
| 33 | $(CH_3)_2-CH-CH_2-CH_2-CH_3$ | i-Hexane | µg/m³ | 24 h |
| 34 | $C_7H_{16}$ | n-Heptane | µg/m³ | 24 h |
| 35 | $C_8H_{18}$ | n-Octane | µg/m³ | 24 h |
| 36 | $(CH_3)_3-C-CH_2-CH-(CH_3)_2$ | i-Octane | µg/m³ | 24 h |
| 37 | $C_6H_5-CH_3$ | Toluene | µg/m³ | 24 h |
| 38 | $C_6H_5-C_2H_5$ | Ethyl benzene | µg/m³ | 24 h |
| 39 | $m,p-C_6H_4(CH_3)_2$ | m,p-Xylene | µg/m³ | 24 h |
| 40 | $o-C_6H_4-(CH_3)_2$ | o-Xylene | µg/m³ | 24 h |
| 41 | $C_6H_3-(CH_3)_3$ | 1,2,4-Trimethylbenzene | µg/m³ | 24 h |
| 42 | $C_6H_3(CH_3)_3$ | 1,2,3-Trimethylbenzene | µg/m³ | 24 h |
| 43 | $C_6H_3(CH_3)_3$ | 1,3,5-Trimethylbenzene | µg/m³ | 24 h |
| 44 | HCHO | Formaldehyde | µg/m³ | 1 h |
| 45 | THC (NM) | Total non-methane hydrocarbons | µg C/m³ | 24 h |
| 46 | SA | Strong acidity | µg $SO_2$/m³ | 24 h |
| 47 | PM1 | Particulate matter < 1 µm | µg/m³ | 24 h |
| 48 | $CH_4$ | Methane | µg/m³ | 24 h |
| 49 | Cr | Chromium | ng/m3 | 24 h |
| 50 | Mn | Manganese | ng/m3 | 24 h |
| 51 | $H_2S$ | Hydrogen sulphide | µg/m³ | 24 h |
| 52 | $CS_2$ | Carbon disulphide | µg/m³ | 1 h |
| 53 | $C_6H_5-CH=CH_2$ | Styrene | µg/m³ | 24 h |
| 54 | $CH_2=CH-CN$ | Acrylonitrile | µg/m³ | 24 h |
| 55 | $CHCl=CCl_2$ | Trichloroethylene | µg/m³ | 24 h |
| 56 | $C_2Cl_4$ | Tetrachloroethylene | µg/m³ | 24 h |
| 57 | $CH_2Cl_2$ | Dichloromethane | µg/m³ | 24 h |
| 58 | BaP | Benzo(a)pyrene | µg/m³ | 24 h |
| 59 | VC | Vinyl chloride | µg/m³ | 24 h |
| 60 | PAN | Peroxyacetyl nitrate | µg/m³ | 1 h |
| 61 | $NH_3$ | Ammonia | µg/m³ | 24 h |
| 62 | N-DEP | Wet nitrogen deposition | mg N/($m^2$*month) | 1 month |
| 63 | S-DEP | Wet sulphur deposition | mg S/($m^2$*month) | 1 month |

# Annex B. QA/QC feedback actions

Overview of the QA/QC activities undertaken by the data suppliers and ETC/ACC during the EoI2005 reporting cycle is given in *Table B1*; some additional QA/QC feedback actions are described in *Table B2*. The QA/QC checks are described "QA/QC checks on air quality data in AirBase and on the EoI2004 data – Procedures and results" (see Mol *et al.* 2005b).

*Table B1. QA/QC actions on EoI2005 data in 2006 and 2007*

| Date | Processes by data supplier | Processes by ETC/ACC |
|---|---|---|
| 1 June 2006 | | Release of the DEMv9 |
| | Modifying meta data in the DEM<br>Checking meta data in the DEM<br>Import raw data into the DEM<br>Checking raw data in the DEM<br>Submit to Central Data Repository (CDR) | Help desk |
| 1 Oct to 15 Jan | | Upload DEM into AIRBASE<br>Checks on outliers, missing essential meta data, resubmission old data, deletion stations/measurement configurations with data.<br>Send feedback reports to the data suppliers |
| | Replies on the feedback reports add response rate(s) | |
| | | Processing of the (non) replies |
| 15 Jan | | Calculation of statistics and exceedances |
| 31 Jan to 10 Aug 2007 | | Release of AIRBASE with EoI2005 data (see airbase history page) |

*Table B2. QA/QC follow up on data supplied in earlier EoI cycles in 2007*

| Date | Processes by data supplier | Processes by ETC/ACC |
|---|---|---|
| 20 March | | Feedback reports on negative outliers before 2002 |
| | Replies on feedback reports | |
| 15 April | | Processing of the (non) replies |

33 countries have delivered EoI2005 data (see the status table in Annex C).
The response on the feedback reports was very good.

Results of the feedback actions are available at Circa EIONET Air and Climate Change interest group:

http://eea.eionet.europa.eu/Members/irc/eionet-circle/airclimate/library?l=/qaqc_country_feedback/eoi_2006_2005_data&vm=detailed&sb=Title

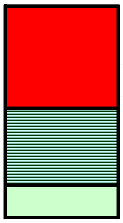
This information is not public. For access to this information a CIRCA user account and password is needed.

*Table B3. Status overview of QA/QC feedback actions on the EoI-2005 reporting cycle*

| Status | Country feedback | | | | | | |
|---|---|---|---|---|---|---|---|
| **Country** | | **outliers (extreme/ suspicious)** | **missing data** | **missing essential meta inform.** | **resub mitted data** | **deletion stations/ meas.conf. with data** | **reply received** |
| AL | Albania | | | | | | |
| AT | Austria | | | | | | |
| BA | Bosnia-Herzegovina | | | | | | |
| BE | Belgium | | | | | | |
| BG | Bulgaria | | | | | | |
| CH | Switzerland | | | | | | |
| CS | Serbia and Montenegro | | | | | | |
| CY | Cyprus | | | | | | |
| CZ | Czech Republic | | | | | | |
| DE | Germany | | | | | | |
| DK | Denmark | | | | | | |
| EE | Estonia | | | | | | |
| ES | Spain | | | | | | |
| FI | Finland | | | | | | |
| FR | France | | | | | | |
| GB | United Kingdom | | | | | | |
| GR | Greece | | | | | | |
| HR | Croatia | | | | | | |
| HU | Hungary | | | | | | |
| IE | Ireland | | | | | | |
| IS | Iceland | | | | | | |
| IT | Italy | | | | | | |
| LI | Liechtenstein | | | | | | |
| LT | Lithuania | | | | | | |
| LU | Luxembourg | | | | | | |
| LV | Latvia | | | | | | |
| MK | FYR of Macedonia | | | | | | |
| MT | Malta | | | | | | |
| NL | Netherlands | | | | | | |
| NO | Norway | | | | | | |
| PL | Poland | | | | | | |
| PT | Portugal | | | | | | |
| RO | Romania | | | | | | |
| SE | Sweden | | | | | | |
| SI | Slovenia | | | | | | |
| SK | Slovak Republic | | | | | | |
| TR | Turkey | | | | | | |

**Outliers (green, yellow, red). For definition see Mol *et all* , 2005b.**

**green outliers: outside ETC/ACC outlier limit values, but seems to be ok.**
**yellow outliers: outside ETC/ACC outlier limit values, but looks suspicious**
**red outliers: outside ETC/ACC outlier limit values, but looks extreme**



unknown status outliers (outliers reported, but no reply; green outliers are demarked in AirBase, so they are supposed to be correct; the yellow and red outliers remain marked in AirBase as incorrect, so they are not visible in AirBase

one or more real outliers detected; reply from MS; corrected data are delivered or the data are marked in AirBase (not visible in AirBase)

The detected data are no outliers. The data remain unchanged in AirBase.

**Missing data**

detected in feedback report, no reply received

missing data explained and data/meta data submitted

missing data explained

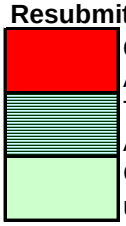
**Missing essential meta information**

detected in feedback report, no reply received

missing Information explained and (partly) submitted

missing Information explained

**Resubmitted data**

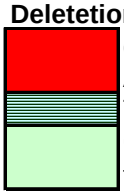


detected in feedback report, no reply received. The resubmitted data remain unchanged in AirBase

The resubmission has been removed and the old overwritten data has been restored in AirBase

Confirmation that the resubmission was intended, so the resubmitted data remain unchanged in AirBase

**Deletetion of stations or measurement configurations with data**

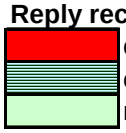


detected in feedback report, no reply received; the meta information has been kept in AirBase

The MS wants to keep this meta information in AirBase

Confirmation to delete. The stations or measurement configurations have been removed from AirBase

**Reply received on the country feedback report**



expected reply NOT received

expected reply received: report-modifications

no reply received: no report-modifications

# Annex C Status overview of the EoI 2005 EoI Reporting

ETC/ACC provides a regularly updated progress report for the annual EoI data cycle on: http://air-climate.eionet.europa.eu/country_tools/aq/eoi_to_airbase_status/index_html

**Overview 2006 EoI Reporting (Air Quality data of 2005)**

**Status since: 6-2-2007**

| Country (#) | | Date EoI data arrived at ETC/ACC | Initial upload to AirBase for QA/QC checking | Date QA/QC report sent to country | Date country reply to QA/QC report | End date processing data and statistics into AirBase | Remark |
|---|---|---|---|---|---|---|---|
| Alpha-2 | Short name | | | | | (***) | |
| AL | Albania | 27-02-06 | | | | | yearly statistics |
| AT | Austria * | 14-09-06 | 22-09-06 | 04-10-06 | 06-10-06 | 31-01-07 | |
| BA | Bosnia-Herzegovina | 29-09-06 | 18-10-06 | 24-10-06 | 24-10-06 | 31-01-07 | |
| BE | Belgium * | 20-09-06 | 13-10-06 | 16-10-06 | 17-11-06 | 31-01-07 | |
| BG | Bulgaria * | 28-09-06 | 17-10-06 | 24-10-06 | 20-11-06 | 31-01-07 | |
| CH | Switzerland ** | 10-10-06 | 25-10-06 | 02-11-06 | 01-02-07 | 31-01-07 | |
| CS | Serbia & Montenegro | 27-09-06 | 17-10-06 | 24-10-06 | 07-12-06 | 31-01-07 | |
| CY | Cyprus * | 09-10-06 | 25-10-06 | 02-11-06 | 14-11-06 | 31-01-07 | |
| CZ | Czech Republic * | 26-09-06 | 13-10-06 | 16-10-06 | 14-11-06 | 31-01-07 | |
| DE | Germany * | 28-09-06 | 30-11-06 | 07-12-06 | 11-12-06 | 31-01-07 | |
| DK | Denmark * | 29-09-06 | 18-10-06 | 24-10-06 | 20-12-06 | 31-01-07 | |
| EE | Estonia * | 21-09-06 | 13-10-06 | 16-10-06 | 01-12-06 | 31-01-07 | |
| ES | Spain * | 29-09-06 | 20-11-06 | 22-11-06 | 18-01-07 | 31-01-07 | |
| FI | Finland * | 13-10-06 | 25-10-06 | 02-11-06 | 01-12-06 | 31-01-07 | |
| FR | France * | 06-03-06 | 20-10-06 | 24-10-06 | 15-12-06 | 31-01-07 | |
| GB | United Kingdom * | 28-09-06 | 18-10-06 | 07-12-06 | 12-01-07 | 31-01-07 | |
| GR | Greece * | 22-09-06 | 13-10-06 | 16-10-06 | 31-10-06 | 31-01-07 | |
| HR | Croatia | | | | | | |
| HU | Hungary * | 28-09-06 | 17-10-06 | 24-10-06 | 27-11-06 | 31-01-07 | |
| IE | Ireland * | 27-09-06 | 17-10-06 | 24-10-06 | 20-11-06 | 31-01-07 | |
| IS | Iceland ** | 01-11-06 | 17-11-06 | 22-11-06 | 16-01-07 | 31-01-07 | |
| IT | Italy * | 23-10-06 | 01-12-06 | 06-12-06 | 10-01-07 | 31-01-07 | meta info + Sabe: february |
| LI | Liechtenstein ** | 15-09-06 | 13-10-06 | 16-10-06 | | 31-01-07 | no answer expected |
| LT | Lithuania * | 26-09-06 | 13-10-06 | 16-10-06 | 30-11-06 | 31-01-07 | |
| LU | Luxembourg * | | | | | | |
| LV | Latvia * | 18-09-06 | 13-10-06 | 16-10-06 | 14-11-06 | 31-01-07 | |
| MK | FYR of Macedonia | 29-09-06 | 18-10-06 | 24-10-06 | 08-11-06 | 31-01-07 | |
| MT | Malta * | 28-09-06 | 17-10-06 | 24-10-06 | 05-12-06 | 31-01-07 | |
| NL | Netherlands * | 29-09-06 | 18-10-06 | 24-10-06 | 15-01-07 | 31-01-07 | |
| NO | Norway ** | 28-09-06 | 17-10-06 | 24-10-06 | 11-12-06 | 31-01-07 | |
| PL | Poland * | 28-09-06 | 17-10-06 | 24-10-06 | 27-11-06 | 31-01-07 | |
| PT | Portugal * | 02-10-06 | 23-10-06 | 24-10-06 | 25-11-06 | 31-01-07 | |
| RO | Romania * | 12-10-06 | 25-10-06 | 02-11-06 | 17-01-07 | 31-01-07 | |
| SE | Sweden * | 29-09-06 | 18-10-06 | 24-10-06 | 09-11-06 | 31-01-07 | |
| SI | Slovenia * | 29-09-06 | 18-10-06 | 24-10-06 | 24-11-06 | 31-01-07 | |
| SK | Slovak Republic * | 29-09-06 | 06-11-06 | 07-11-06 | 05-12-06 | 31-01-07 | |
| TR | Turkey ** | | | | | | |

| | |
|---|---|
| * | EU 27 country |
| ** | Non EU27 country, EEA 32 country |
| (***) | Data not yet available via website (AirView) |
| (#) | ISO3166-1 codes: Alpha-2 element and Short Name |