European Community Respiratory Health Survey II

Final Report of Work Package 5: Historic Data of Ambient Air Pollution in 37 European Cities of ECRHS I and II

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Abstract

Starting in 2000, the adult population of 29 of the original 41 (mostly) European centres of the former ECRHS I cross-sectional study (1989-92) is being re- investigated in a cohort study. The primary goal of the ECRHS II project is the assessment of the natural course of respiratory diseases, paying particular attention to asthma and the change in pulmonary function. The influence of long-term effects of outdoor air pollution on respiratory health will be investigated. Air pollution exposure data, however, is currently not available routinely in Europe. Thus, the aim of this Work Package is the collection of existing local or regional air pollution data from these centres.

In collaboration with the WHO European Centre for Environment and Health, Bilthoven, we collected historic air pollution data from the ECRHS study centres. Because there is no complete standardised European air pollution monitoring network operational yet, local and national agencies had to be approached. Air quality data (SO_2, CO, NO_2, NO, TSP, Black smoke, PM_{10} and O_3) from 127 stations, partly dating back to 1980 from 37 ECRHS cities in 17 different countries was received. From this data we calculated different means for each city. The current 3-year mean (1997-99) for SO_2 ranges from 1 $\mu g/m^3$ (in Umea) to 33 $\mu g/m^3$ (in Oviedo). For PM_{10} a range between 13 $\mu g/m^3$ (in Goteborg) and 47 $\mu g/m^3$ (in Dublin) was found. Concentrations of SO_2 has decreased significantly over 15 years, whereas NO_2, TSP, PM_{10} and O_3 have stayed more or less stable over the same period.

We conclude that:

1) historic air pollution data is incomplete across Europe
2) several indicators of air pollution will be available for a large number of ECRHS centres
3) there is a wide range of concentrations across these centres.

Therefore we expect to be able to assess the associations between the different measurements of respiratory health and of air pollution in both cross-sectional and cohort study data in the ECRHS.

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1 Introduction

The follow-up of the European Community Respiratory Health Survey (ECRHS I) population ten years after the first cross-sectional assessment, offers a unique opportunity to study the effect of cumulative long-term environmental exposure on disease incidence and development. The associations of short-term exposure to ambient air pollution and acute health effects (e.g., symptoms, decline in lung function, hospital admissions, daily mortality rates) has been extensively investigated in the last 10-20 years, particularly in the US and Europe (Holgate et al, 2000; Katsouyanni et al, 1997), including the specific assessment of effects amongst the diseased (Sunyer et al, 2000). There are, however, only a few studies which investigate the long-term late effects of cumulative, lifetime exposure to air pollution. Such studies are expensive and, ideally, require the follow-up of the same subjects, over their lifetime. So far there are only three cohort studies published which have been all conducted in the US with the major emphasis on air pollution and life expectancy (Dockery et al, 1993; Pope et al, 1995; Abbey et al 1999),. The late effects of air pollution on morbidity is poorly studied so far and most of the evidence relies on cross-sectional comparison (Sunyer, 2001), such as the Swiss Study on Air Pollution and Lung Diseases in Adults, SAPALDIA, which is one of the few projects initiated specifically to assess long-term effects of ambient air pollution (Ackermann-Liebrich et al, 1997; Zemp et al, 2000; Martin et al, 1994). Both studies, SAPALDIA and ECRHS, have been conducted during the same years, using identical protocols. Whereas ECRHS I had no environmental exposure module, SAPALDIA had a strongly extended protocol with regard to the environment.

The ECRHS II follow-up offers the chance to also consider ambient air pollution as an influencing factor on disease development. The large number of study centres is an advantage for handling confounding problems efficiently. The major problem, however, stems from the fact that, so far, Europe has no common, standardised, publicly available, air pollution monitoring network. Knowledge of ambient concentrations is however a prerequisite to investigate the long-term effect of ambient air pollution. The ECRHS II protocol, thus, has had to include Work Packages to derive indicators of ‘long-term exposure’ across Europe. These modules followed the strategy to collect fixed site monitoring data of the past 20 years (WP5) and to measure a current annual mean of fine particles (PM2.5) which are currently not measured routinely at all but are of high regulatory and health interest (Wilson and Spengler, 1996).

The advantage of air pollution epidemiology is the independence of exposure from subjects, conditional on residential history. Thus, ‘exposure’ may be reconstructed objectively, back in time. The concept, however, assumes, that concentrations measured at one monitoring site reflect, with appropriate accuracy, exposure of people living around this site. This approach is useful for the assessment of those characteristics of air pollution, which are homogeneously distributed across a city. Particulate matter, mainly inhaleable particles (PM_{10} or smaller) fulfil this criterion rather well, thus, the annual mean concentration at one site well reflects average population exposure (Künzli and Tager, 1997). The approach however fails to assess the health effect of exposures to specific pollutants with high spatial variability, e.g. proximity to traffic exhaust.

Accordingly, ECRHS II implemented Work Package 5 to assemble valid information on ambient pollutant concentrations in all of the ECRHS centres. The ECRHS I centres which do not participate in ECRHS II have been included in this module because exposure data may also be used in further analyses of the cross-sectional data set. This Report describes the historic air pollution data, which has been assembled from a variety of agencies and institutions, in all of the ECRHS centres.

2 Objectives

According to the EU grant, Work Package 5 has the following objectives:

- To assemble for each fieldwork centre a statistical summary of air pollutants, measured over the past years, by local authorities
- To assemble for each fieldwork centre a statistical summary of meteorological parameters, measured in the past years, by local authorities
- To describe the measurement methods used at the local fixed site monitors
- To assess the level of quality and comparability of the historic monitoring data across these centres
- To create a database containing, for each centre, the air quality and meteorological summary statistics and information about the measurement stations.

3 Methods

3.1 Procedure

In collaboration with the WHO European Centre for Environment and Health (WHO-ECEH), we carried out a screening of the available air quality data in different European databases (AIRBASE, DEM, NATIONAL WEBSITES, WHO-ECEH DATABASES (www.etcaq.rivm.nl)). WHO-ECEH uses these databases on a routine basis as a source for the time-series and historical air pollution data needed to estimate the health impacts of air pollution on population. Data sets for some ECRHS II cities were already available from other ongoing studies at WHO-ECEH or were collected simultaneously and shared with other studies (Xhillari et al, 2001, Hoek, 2001). Moreover, using the well-established network of WHO-ECEH collaborators facilitated the process of contacting air pollution data managers or air quality professionals.

As expected, we realised that the information contained in those databases is for the time being not directly applicable to air pollution epidemiology. In the existing records, there are a lot of gaps, and information about the measurement stations is often not complete. Meteorological data is lacking almost completely. We decided to use this data for cross checking the quality of the collected data, described below.

We developed a questionnaire addressed to the responsible local air quality monitoring authorities to collect the air quality data in a format needed in ECRHS II. Local sources are most likely to provide meaningful data for health impact assessment, because:

- More detailed information about the location of the monitoring stations and air quality time series is available.
- Part of this information often does not reach the national databases.
- Network managers have local knowledge and can judge how representative the air quality data is for the area and the quality of the data being collected within these areas

We created the questionnaire according to the criteria of EUROAIRNET and the collection procedure of Airbase. The questionnaire was reviewed by experienced air quality experts from different European Countries and also by epidemiological experts. At the same time, we built up a network of responsible air quality monitoring people from all ECRHS centres. In most cases, the ECRHS health person gave us the contact details of the responsible local air quality person. In some cases we had other sources, like Airbase, WHO or national web sites. We aimed to have a motivated counterpart from the local air quality monitoring in every ECRHS city.

After the consultations, we sent out a last draft of the questionnaire to all the health representatives in the ECRHS centres, to get a last feedback. The final questionnaire was sent out to the responsible people for air quality monitoring in the cities. We had phone conversations with most of them in order to explain more details of the project and clarify

technical issues. The programme targets were the monitoring stations which are representative of the areas where people live or were background stations (defined as stations not classified as traffic, rural, remote, or located in industrial zone). In some cases a limited number of other types of exposure-relevant stations (industrial or traffic) have been included in the study. Only air quality data, validated through well-documented quality assurance and control plans, has been considered. For the classification of the quality level of air quality data, the system used by EUROAIRNET has been adopted.
All data received from the agencies were entered into an Excel database.
The summary statistics (all tables and figures) were distributed with a draft version of this report, to the ECRHS local responsible partners and to each contact person of the agencies that provided the data. All feed backs of this step have been integrated in the final version of this report.

3.2 The Questionnaire

A sample of the original questionnaire is attached in the Annex.

Five areas of information were considered:

1. Contact details
2. Air quality summary data from representative stations, in particular arithmetic annual means and annual 95th percentile or 98th percentile for eight pollutants (SO_2, CO, NO_2, NO, TSP, PM_{10}, Black smoke) if available and some more information about ozone
3. A short description of the monitoring station
4. Few meteorological data
5. A map of the city, showing the location of the monitoring stations.

The questionnaire was kept as simple as possible to fulfil the needs of ECRHS and optimise compliance. The ECRHS cities were asked to report the arithmetic annual mean back to 1980, the annual mean of the 95th or the 98th percentile also back to 1980. Additionally the current and previous measurement principle was asked to be reported. For ozone the cities were asked to report the annual mean, the summer mean (April 1 to September 30), the value of the highest monthly mean of each year, the number of 8 hour exceedances of 110 and 120 $\mu g/m^3$ and the number of hourly exceedances of 180 $\mu g/m^3$. Additionally, the current and the old measurement principle for every reported pollutant had to be given.

The questionnaire about the station description was created according to the classification criteria for monitoring stations of Euroairnet (Technical Report No 12: Criteria for EUROAIRNET, the EEA Air Quality Monitoring and Information Network / Technical Report No 16: EUROAIRNET, site selection 1998). The station information was restricted to information about the station classification, the major emission sources within 500 meters, the traffic within 100 meters and the quality assurance/quality control procedures.
An appropriate way to check the quality was found in the Technical Report No. 12 of the European Environment Agency (Criteria for EUROAIRNET, the EEA Air Quality Monitoring and Information Network). This system was chosen because it is standardised, simple and officially required by the European Environment Agency in Copenhagen, and fulfils the needs of this study.
The criteria to classify stations according to the Quality Assurance / Quality Control level, are given in the table below. Each level is a combination of a type of network or station and a type of QA/QC procedure. According to the criteria presented in the table below, it is proposed that stations classified, as level 1,2,3 or 4 should be accepted in this study. Those are stations from national or local networks or affiliated stations, having at least a

minimum documented QA/QC plan (level 4). In terms of QA/QC, the stations for ECRHS can be divided into 4 categories:

Level 1 and 2a

Stations that are part of the national air quality monitoring network. Such stations may belong directly to the national network or a national sub-network. A complete QA/QC plan implemented on national level is the key feature that differentiates the first two levels from the rest. This is usually adopted by national sub-networks, based on a central laboratory (accredited or not), providing nation-wide comparability.

Level 2b and 3

Stations that are part of a local air quality monitoring network. In this case the complete QA/QC plan is implemented on a local basis without systematic connection to the national QA/QC plan

Level 4

Individually operated networks or stations (or even a national network) implementing a minimum QA/QC plan (Data quality objectives are set regarding only: 1. Accuracy and precision, 2. Data capture 3. Time coverage)

Level 5

Networks and stations with no documented QA/QC plan

With the following information the responsible air quality agency could easily find out which level their stations have.

	Criteria						
	Type of network/station			Type of QA/QC procedure			
	National		Local/regional	Accredited	Centralised	Minimum	No QA/QC
Level 1	yes			yes			
Level 2a	yes				yes		
Level 2b			yes	yes			
Level 3			yes		yes		
Level 4	yes	or	yes			yes	
Level 5							yes

QA/QC criteria for classification of stations

To get basic information about the meteorological conditions in the ECRHS city, it was asked for the average altitude (m) above sea level of the city, the annual mean of the temperature, the maximum and the minimum monthly mean for each year, the precipitation, the number of raining days and the global radiation.
The ECRHS cities were also asked to send us a map of the city (area) showing the location of the reported monitoring stations. These maps are presented in the Annex of this report.
Additional information on how to fill in these forms was given in annex 1 of the questionnaires Annex 2 of the questionnaires listed all the contact addresses for each ECRHS city for ease of contact between the centres.

3.3 Summary statistics

Table 4 to 11 show different statistical indices to characterise long-term concentration. For the time being there is no agreement as to what is the time period that best characterises the health-relevant aspects of long-term exposure. Therefore, we derive mean values across time windows of varying length. However, long-term averages usually could only be derived for a limited number of cities.
The averages over one, two, three and ten year periods were adopted as optimal statistical indices. The calculations concerned only data reported for the period from 1990 to 1999. Overall, data older than 1990 were sparse, thus, we decided not to include statistics from the period from 1980 to 1989 in these summary tables. However, the complete data set is given in the annex for all years. Furthermore, data from 1980 to 1990 was included in the graphical representations of the time-series.
The statistical indices for each city are calculated separately for background and traffic stations. Cities that reported data for both types of station are represented in the table with two different values for the same statistical index, one for background monitoring and the other for traffic monitoring. Indices calculated from background stations in the table are shaded in grey.
The following parameters have been calculated:

- Average of the 10-year period 1990-1999
- Average of the present 3-year period 1997-1999
- Average of the past 3-year period 1990-1992
- Average of the current 2-year mean 1998-1999
- Current annual mean 1999
- 98^{th} (or 95^{th}) percentile of 1999 (or 1998)
- 98^{th} (or 95^{th}) percentile of 1990 (or 1991)
- Coefficient of variability (C.V.) of 10-year period

In the following paragraphs a detailed description of the calculation methodology is given for each of the statistical indices.

<u>Current 1-year mean</u>
This index serves to describe the last-available-year mean outdoor concentration across all cities available.
It represents the city annual mean of 1999, calculated over all the stations of the same type, which have reported data for that particular year. If the 1999 annual mean is missing, the 1998 value is used instead (where available). This is a good approximation, in general, because consecutive values of annual averages have changed fairly little.
For O_3, unlike the other pollutants, the calculations are made for the summer mean.

Current 2-year mean

These indices serve to describe the average outdoor concentration during the last two years in all cities available.

The current 2-year mean represents the pollutant's average concentration in the city over the 1998-99 period, calculated according to the station's annual averages. First, the 2-year mean for each available station is calculated. Availability of values for both years was required, for each station. The current 2-year mean of a city is calculated as an average of all available local 2-year means.

Again, for O_3 the index only represents the period average of summer means.

Current 3-year mean

These indices serve to describe the outdoor concentration during the last three years, in all cities available.

The current 3-year means represent the pollutant's average concentration in the city over the 1997-99 period, based on the station's annual averages. First, the 3-year mean for each available station is calculated. Data for at least 2 out of 3 years of the period was required. The current 3-year mean of a city is calculated as an average of all available local 3-year means.

For O_3 only two "Current 3-year mean" indices are calculated: one gives the period average of summer means and the other the period average of maximum monthly means.

Past 3-year mean

These indices describe the outdoor concentration in all available cities during the period of the first study (ECRHS I). The aim of choosing 3-year periods at the beginning and at the end of the decade is to roughly describe the general trend of concentrations and to have exposure indices which closely reflect concentrations during the cross-sectional study (past 3-year mean) and shortly before the ECRHS II follow-up (current 3-year mean).

The past 3-year mean represents the pollutant's average concentration in the city over the 1990-92 period, calculated according to the station's annual averages. First, the 3-year mean for each available station is calculated. Data for at least 2 out of 3 years of the period was required. The past 3-year mean of a city is calculated as an average of all available local past 3-year means.

For O_3 only two "Past 3-year mean" indices are calculated: one gives the period average of summer means and the other the period average of maximum monthly means.

98^{th} (or 95^{th}) percentile for 1999 and 1990

These indices give a rough description for the short-term variability of concentrations within stations and cities. The values reflect both the level and frequency of peak exposure.

They represent the city mean of 98^{th} or 95^{th} percentiles for 1999 and 1990, calculated according to the station's annual percentiles. If a city has reported both 98th and 95th percentiles, only the first ones have been considered. If in those cases the 1999 and/or 1990 values are missing, values of 1998 and/or 1991 (if available) are used instead (for either 98th or 95th percentiles). The 98^{th} percentile is written in italic, the 95 percentile is written in cursive. Whenever the cities reported the 95^{th} percentile instead of the 98^{th} percentile, it is underlined. No percentile data has been collected for O_3.

Last 10-year period

Represents the pollutant's average concentration in the city over the 1990-99 period, calculated according to the station's annual averages. First, each station's average is calculated over this period. Values are only calculated if the annual station averages of at

least 7 out of ten years were available. Then, the city mean over the period is calculated as an average of all available stations that fulfil the condition.
For O_3 only two “Last 10-year period” indices are calculated: one gives the period average of summer means and the other the period average of annual means.
To reflect concentration variation over this 10-year period, we also provide the coefficient of variation (C.V.) of the annual means over this period. The C.V. is calculated as:

$$\text{C.V.} = \frac{\text{Standard deviation}}{\text{Average concentration over the 10-year period}}$$

C.V. gives a measure of the fluctuations of the annual means during last ten years. This may prove useful when comparing two cities that represent similar 10-year period averages that have different time-series patterns. We put no specific condition for the calculation of C.V., which means that the city annual averages are calculated out of all available stations (traffic and background separately) that have reported data for that particular year. The values of C.V. should be interpreted carefully because the temporal variation of the annual averages of a city over a long period could sometimes be affected by the different number of stations reported from each city (different length of the time-series reported from different stations). This problem does not arise in cities, which only have one data set, i.e. data from only one monitoring station.

Number of stations
Shows the total number of stations (traffic or background) that have reported data in general and the number of stations that have been used for the calculation of the values for that specific pollutant.

3.4 Presentation of time-series

For the time-series figures for every single year a city average from all available stations was made. For every pollutant two time-series figures are presented, one for background monitoring and one for traffic monitoring. Due to the fact that cities sometimes reported differing numbers of stations for each year, sudden changes in the time-series may occur. It was decided not to extrapolate the reported time-series for the missing values, but to take only the reported values. For ozone the time-series of the summer mean is given instead of the annual average.

3.5 Description of within-city variability

The figures give a comparison of the variability of pollution levels of a certain pollutant within a city in 1990 and 1999. If data from 1990 and/or 1999 is missing, data from 1991 and/or 1998 (if available) is used instead.
For each city the following values were presented: the highest and lowest reported annual average within a city as well as the calculated mean value across all available monitors. The number of stations contributing to the calculations is reported in brackets after the city name.
In order to evaluate the influence of the traffic stations, usually reporting higher pollution levels, two within-city variability indices have been derived: one which includes both traffic and background stations, and the other based on background stations only. The figures of within-city variability include only cities that have reported data from at least two stations. For ozone the within-city variability of the summer mean is given instead of the annual mean.

3.6 Meteorological data

The average over a three-year period from 1997 to 1999 of air temperature, the number of raining days and the precipitation is calculated and presented in table 15.

3.7 Maps

In the questionnaire it was asked for a map of the ECRHS city, showing the location of the monitoring stations the centres reported data from. One can find these maps in Annex.

3.8 Database of ECRHS II - WP5

The database is organised in the following way:
One folder called **ECRHS II WORK PACKAGE 5**, containing 6 subfolders and the word-file of the final report. The 6 subfolders are:

- Original database
- Summary statistics
- Within city variability
- Completed questionnaires
- Additional tables & figures
- Report Annex

The database should generally be self-explanatory. Wherever one may find a shortcut that is not clear, one can find the solution in the file “code list” in the folder “Report Annex”.

<u>Original database</u>
Containing 12 files, one file for each pollutant, the meteorological data, the station information and a file called XX_SUMMARY DATABASE, where one can find a summary of the whole original database.
Each pollutant file contains 9 Excel-sheets called:
“Background &Traffic”, where all the reported annual means for each station can be found, “Background only”, where the annual means from background stations can be found and “Traffic only”, where the annual means from traffic stations can be found. The next 6 sheets show the same for the 95th (95%) and the 98th (98%) percentile, 3 sheets in all for each percentile.

<u>Summary statistics, tables & figures</u>
Containing 10 files, one file for each pollutant, a file called XX_SUMMARY OF SUMMARY STATISTICS, giving a quick overview of all summary statistics and a file about the collected time-series (X_SUMMARY TIME-SERIES).
Each pollutant file contains the summary statistic table, several figures and the time-series reported for this specific pollutant.

<u>Within city variability, tables & figures</u>
Containing 9 files, one file for each pollutant and a file called “Average within-city (all pollutant)”, giving some general information about the within-city variability.
Each pollutant file contains pollutant specific information and figures about the within-city variability:

Filled out questionnaires

Containing the filled out questionnaires and maps, which were received electronically. All the original completed questionnaires are contained in a paper archive at the Institute of Social & Preventative Medicine, Basel

Some more tables & figures

Containing 3 files, a power point file with the map of Europe, including all ECRHS cities, a word file with summary tables about the station description and the measurement methods and an excel file with some general information about data completeness in Europe.

Report Annex

Containing the annex of the report. The complete time-series of the annual mean and the percentile reported for all stations, the code list, the questionnaire and the member list of the ECRHS air pollution working group.

4 Results

4.1 Participation

The questionnaire was sent out to 37 cities in 17 different European countries and to Christchurch in New Zealand. 12 of the 38 cities participated only in the first part of the ECRHS study in 1989-1992 (Aarhus participates only with screening data in the health assessment of ECRHS II). ECRHS I and ECRHS II cities are shown in figure 1. All of the cities answered the request. There was no historic air pollution data available from Reykjavik (Iceland) because there are no continuous monitoring stations, only a mobile trailer measuring PM_{10} at an extreme traffic site. Some other cities only reported air quality data from one or two stations and sometimes only for one pollutant, in the main NO_2. Other cities have no continues monitoring at all, only passive sampling. Mostly the gaseous pollutants were reported (SO_2: 32 cities, CO: 24 cities, NO_2: 36 cities, NO: 26 cities and O_3: 27 cities). The reported data for particles was very limited (TSP: 14 cities, Black smoke: 9, PM_{10}: 18 cities and PM2.5 in only one city). At the end of the data collection process the air quality database contained data from 37 cities and 127 monitoring stations. All in all there were 454 time-series reported for all pollutants. Despite the extensive number of time-series reported, they often presented remarkable gaps in terms of temporal completeness. Table 15 shows that the average length of the time-series collected is approximately 7 years.

4.2 Data availability:

Air quality data has been reported from 127 stations of which 81 are background stations. After a careful estimation of all parameters and a new consultation, for the calculations and figures all of the reported industrial stations could be classified as background stations (most of them) and traffic stations.

As shown in table 1, cities reported between one and nine stations. In table 2 one can find that 6 cities reported air quality data for one or two pollutants back to 1980, but in the main only data after 1990 has been reported. Air quality data for SO_2, NO_2, NO and O_3 has been reported from almost all ECRHS cities, whereas data for CO, TSP, PM_{10} and particularly for Black smoke was rarely available. Altogether, 70% of the cities were able to report some meteorological summary statistics.
With the exception of Tartu, Oviedo, Reykjavik and Ipswich, all ECRHS centres were able to report air quality data of at least level 4 standard. Due to the fact that only one station reported PM2.5 data (Basel-Binningen) the decision was taken not to include this data. Standardised measurement of PM2.5 is the aim of Work Package 6 of ECRHS II. It was not possible to collect data about the exceedances of ozone. The air quality agencies were asked to report the number of 8-hour exceedances of 110 and 120 $\mu g/m^3$ and the number of hourly exceedances of 180 $\mu g/m^3$ for ozone. However, some reported the number of daily exceedances instead of either 8 hour or hourly exceedances. It was not possible to distinguish between the two different ways of reporting.

4.3 Description of measurement stations:

Table 2 describes the characteristics of each measurement station, including the name of the station, the station-code, the station environment, the traffic volume next to the measurement station, the quality level of each station and the year in which the measurement of each pollutant started. At the end of table 2 one can find the explanation for the different indicators. If cells are empty this means either the data was not available or was not reported.

4.4 Measurement methods, data comparability:

In Table 3 the number of cities, the number of stations and the measurement methods for every pollutant are listed. For each pollutant we have one major prevalent measurement method, but there are a few exceptions. For SO_2, NO_2, NO, CO and O_3 over 80% (78.4% for NO_2) of the stations are measuring with the same method, referred to as "standard method" in this report. For TSP, PM_{10} and Black smoke we found more than one common principle. Some cities use uncommon measurement principles. Some cities use different measurement principles for one pollutant, within the city. Together with the quality level this table gives a good impression about the comparability of the collected air quality data between ECHRS cities. In the last column one can find the cities, which used alternative methods to the standard method. In brackets, after the city name, the measurement principle is listed. At the bottom of the table the different shortcuts of the measurement methods are explained.

4.5 Air Quality data completeness:

The annual completeness of the air quality data was not included in the questionnaire. Taking into account that the data completeness may be important for the validity of the values, we decided to use as an indicator the air quality data completeness calculated based on the data collected by the project "Health Impact Assessment of Air Pollution in the WHO European Region" of the WHO-European Centre for Environment and Health, Bilthoven Division, carried out during the period 1999-2000. This study calculates the annual completeness of the air quality data collected from 141 cities across WHO European Region. For most cities completeness is given for year 1998 or 1999.

Based on this data, we were able to retrieve the completeness for 18 out of 38 ECRHS cities. This data show the annual completeness in those cities for one particular year of the period 1996-1999. The completeness in each city for each pollutant is shown in Table 13.

For the missing cities we used calculated average completeness based on data from other cities of the respective country. The basic assumption was that, in principle, the completeness from the missing city should not be so much different from that of the other cities. Most of the ECRHS II cities, for which completeness data is missing in the WHO-ECEH study, report data from stations belonging to national or regional networks with quality level 1 or 2 has been used. Such that, they monitor according to the same QA/QC plans which insure a comparable levels of completeness throughout the network. Based on this assumption we may use the completeness at national scale as an indicator for the completeness in the selected ECRHS city. Together with the information about the quality level of each station reported, the table shows that lack of data may not be of concern for our study.

4.6 Summary statistics

Table 4 to 11 shows summary statistics of all pollutant concentrations. For each pollutant, data from background stations and traffic stations are shown separately. The background stations are shaded in grey. In column 4 one can find the total number of either background or traffic sites reported from the cities and in column 5 the number of stations is shown which reported this specific pollutant. The current one year mean from 1999 (or 1998 if the 1999 was not available), the current two year mean from 1998 to 1999 and the current three year mean from 1997 to 1999 is shown in column 6 to 10. In column 10 the past 3-year mean from 1990 to 1992 is shown. The next two columns show the 98 (or the 95) percentile from 1999 (1998) and 1990 (1991). The 98 percentile is written in italic, the 95 percentile is written in cursive. Whenever the cities reported the 95 percentile instead of the 98 percentile, it is underlined. In the second last column one can find the ten-year mean from 1990 to 1999. In the last column the temporal variability of the ten-year period is expressed as coefficient of variation (C.V.). Wherever cells are empty this means that cities haven't reported anything or the reported data did not fulfil our criteria explained in the method capture. The ECHRS cities are marked with a circle at the end of the city name.

4.7 Current and Past 3-year means

Figures 2 to 10 show the current and the past 3-year mean of city annual averages, except for ozone where the current and past 3-year summer mean and the current and past 3-year monthly maximum mean of city annual averages are shown. The presented values are from background monitoring stations only. All values are given in $\mu g/m^3$, except for CO (in mg/m^3). The values are ordered according to the current 3-year mean from the highest to the lowest value.

4.8 Comparison between annual mean and percentile

Figures 11 to 18 show the comparison between the annual mean and the 98th (or 95th) percentile for the year 1999 (or 1998) for background monitoring stations ordered according to the annual mean of 1999 (or 1998).

4.9 Time series

Figures 19 to 34 present the time-series reported from the ECRHS cities. For each pollutant, two figures are shown one for background monitoring only and the other for traffic monitoring only. For every year a city average was calculated out of all stations, which reported data for this specific year, again segregated into traffic and background stations. These figures visualise both the trends and the data. For ozone the summer mean is shown. Table 14 shows the total number and the average length of time-series reported. The number and the length is given for the annual average, the 98th percentile (98%) and the 95th (95%) percentile. For ozone the summer mean is given instead of the 98th percentile and the maximum monthly mean is given instead of the 95th percentile. Figure 34 shows the total number of stations reporting air quality data for each year of the period from 1980 to 1999.

4.10 Within city variability

Figures 36 to 50 shows the within-city spatial variability of the annual mean for the year 1990 (or 1991) and for the year 1999 (or 1998). The variability is illustrated as the reported minimum and maximum annual mean of the stations within each city. The cities are ordered by the annual mean. Each figure is divided into two parts. The left side panel includes both traffic and background stations; the right hand side shows only background stations. In brackets (after the city name) the number of stations contributing to the calculation is given. As in all tables and figures "ECRHS I only" cities are marked with a circle at the end of the city-name. For ozone the minimum, the maximum and the mean of the summer mean is given. Whenever cities reported a specific pollutant from traffic stations only, the respective values in the left part of the figure are marked with a rectangle.
In Table 12 the number of cities per pollutant is shown according to the number of stations included in the calculation of the traffic & background within-city variability. The number of cities is given for the year 1990 (or 1991) and the year 1999 (1998).

4.11 Spatial correlation between pollutants and temporal correlation for each pollutant

Due to common sources, many pollutants are highly correlated in time or space. Table 15 shows the Pearson correlation coefficients for 'current 3-year mean' of all available pollutants across Europe. The correlation coefficients were calculated for the background and traffic stations separately. Table 16 presents the same cross-pollutant correlations for the ‘past 3-year mean’ concentrations. Figures 51 and 52 show the corresponding correlation plots between all pollutants for the 'current 3-year mean' and the figures 53 and 54 for the 'past 3-year mean'.Table 17 presents, for each pollutant, the Pearson correlation coefficients of the ‘current 3-year mean’ versus the ‘past 3-year mean’ and the corresponding correlation plots are shown in Figures 55.

4.12 Meteorological data

Table 18 shows the summary meteorological data reported. The three-year average (1997-1999) of the annual mean, the minimum monthly mean, the maximum monthly mean of the air temperature, the number of raining days and the precipitation is presented. Also the average altitude above see level is given. Additionally, some cities also reported data for global radiation. Due to the fact that many cities reported this parameter in different, not clearly described units, it was decided not to include this data in the study.

4.13 Maps

All maps provided by the agencies are given in the annex. Although very different kinds of maps were available, the information may facilitate a further judgement about monitoring locations.

5 Discussion and Conclusion

5.1 Measurement situation in general

Air Quality monitoring represents remarkable variations in terms of institutional responsibilities, air monitoring objectives, equipment, quality assurance and quality control procedures and geographical distribution across Europe. These differences depend on the economical development of the countries and sub-regions but also on policies of air quality management and air pollution control strategies. Most of the air monitoring activity in Europe is devoted to monitoring the human exposure to air pollution, followed by those more specific to ecosystem and material exposure. Differences exist in philosophy of networks with respect to selection of sites for measuring air quality. Especially in southern Europe, measurements are preferentially conducted at “hotspots” such as major roads in cities. As a result few urban and rural background sites are available, which are more useful for estimating average population exposure. The use of traffic sites for estimating exposure may result in a substantial bias. Therefore in most of the tables and figures traffic and background measurements are shown separately. We found a difference in the terminology between the ECRHS cities. Sometimes even within the same country, terms like *urban background* do not have the same meaning. Therefore it is always useful to have additional information about the station environment as shown in table 2. Air quality monitoring in Europe is mostly decentralised and the responsibility of network management lies mostly at the regional or local level. This pattern is more remarkable in bigger countries or countries with regional or federal political structure, such as Germany, France, Italy and Spain. Data from these networks are mostly used at local level and usually not all of them reach the national air quality databases. Collection, processing and validation of air quality data is being carried out by the regional agencies of city councils which report them to the regional or central government. Smaller countries tend to organise their monitoring in a more centralised way. In those countries most of the monitoring is carried out by a national agency that belongs to the Ministry of Environment or National Environmental Agency. Air Quality data is mostly collected processed and validated centrally. The exception in this second group is Greece, where monitoring is carried out at local level only but the data management is still carried out centrally by the Ministry of Environment. Given this structure in Europe, it was sometimes difficult to collect the data. Especially in countries like Spain, Portugal and Italy, where air quality monitoring is the responsibility of local and regional organisations, it was difficult to find the responsible person. Some of the ECRHS cities have no air quality measurement at all, only one or two stations or only passive tube measurements.

However, problems with data availability, accessibility and quality were encountered during the course of the project. In the annex “City-specific comments” we describe, where needed, these comments regarding the data collection.

5.2 Data availability and accessibility

Availability of validated air quality data has been increasingly improved during past years with the setup of EUROAIRNET and development of AIRBASE. However, the efforts of this Work Package 5 were still needed to collect the respective data. Before 1993, the existing European databases GIRAFE and APIS contained extensive data only from 4 EU Member States. An important progress was made with creation of AIRBASE that receives air quality data from all EU Member States as well as from some non-EU countries.

Despite the improvement, there are still gaps in AIRBASE for some countries. For France and Italy, the last available time-series are for the year 1989. There are some statistics for Italy for the period 1990-1998 whereas for France no data exist for the last ten years. For Ireland, Portugal and Greece the set of time-series available is very limited indeed. The difficulties increased when more detailed data was required for some countries and cities.

Although substantially developed last years, there are still many cases in AIRBASE when information about the station environment (meta data) on networks and stations is not updated, is not correct or, even sometimes, missing. Often there is discrepancy between meta information and AQ data supplied by the same station. For many stations that have complete meta description there is no corresponding AQ data , which restricts the choice for AQ data selection. We also tried to use National AQ databases for AQ sources. These web sites give generally detailed information on organisation and extent of air quality monitoring in the countries, but access to downloadable AQ data is difficult and sometimes not possible. It was particularly difficult to retrieve free downloadable yearly time-series thus restricting the usefulness of these national databases for HIA studies. In some cases the data does exist but the users are required to pay a fee for the information. The only national database that provided full set of meta data and meaningful time-series for the study was the UK national database. In most cases we contacted directly local air quality agencies to get the AQ data. Besides language problems, some organisations that were contacted had difficulties to take part actively in the project due to lack of time, lack of financial resources and/or lack of manpower. General advice from the agencies was that, it was better to contact them in the beginning of the year when they could devote some resources to the participation in the project thus avoiding these problems. Some other agencies never responded to repeated letters or e-mails or promised to cooperate but never replied.

Limited air quality data were available for important pollutants, especially TSP, PM_{10} and PM2.5 in some of the ECRHS cities. Generally one can say that before 1990 much less air quality data is available in the ECRHS cities than after 1990. A systematic air quality monitoring network will greatly facilitate the use of this important data in future health studies.

5.3 Measurement methods and data comparability

A lot of attention has been paid last year to standardisation of air pollution measuring devices across Europe. This process has been also supported by extensive programmes of inter-calibration exercises organised by Joint Research Centre in Ispra, Italy.

Generally the data comparability across the study centres is good with only some of the ECRHS II cities still measuring some pollutants with alternative measurement methods (see Table 3). However difficulties may rise in some cases due to specific problems related to some of the methods or devices in use. For gaseous pollutants differences in measurement methodologies are probably small compared to other sources of variability but the comparability of the measurements of particles carried out with different methodologies may represent problems.

The difficulties are more remarkable for PM_{10} measurements with automatic monitors (TEOM) which result in underestimation of the determined particle concentration compared to the reference gravimetric method. The literature suggests for TEOM monitors the utilisation of a factor, which would correct the determined concentration for the loss of mass in the inlet of the device (normally 1.3). However, in Europe this is not yet a common practice to do so. For example, in Netherlands the bias is corrected in the reported values by multiplying the measured values by 1.33. In Germany only two federal states use correction factors. No correction is done to PM_{10} values monitored with TEOM in UK and other countries. The estimations of health impacts of PM_{10} based on TEOM measurements thus result in underestimation in the countries, which don’t use correcting factors.

Attention also should be paid to the Black smoke and TSP measured through gravimetric methods. Although standardised, these methods might give different results if the devices are not used with the same type of filter as described in the methodology.

5.4 Data quality and completeness

The quality of the air pollution data collected from the cities depends on the design, completeness and proper implementation of the QA/QC plans. Asking the cities about their detailed QA/QC plans was beyond the scope of the Working Package 5 of ECRHS. In order to get an idea about the quality and the completeness of the air pollution data we asked about the quality level of the station. The system used for quantifying the quality level for each city is described in the methodology chapter. The basic assumption was that wherever a station had quality level 1 to 4, 1 being the highest and 4 the lowest, the air quality data was useful for our study. This was an easy way to get standardised information about the quality of the reported data. Generally the air quality data reported represents good level of quality. From 127 stations supplying data for the study, 65 or 51% of all stations, report quality levels 1 and 2. Only 19 stations from three cities (Oviedo, Ipswich and Caerphilly) reported quality level 5. These cities did not have any documented QA/QC plan, which raised some doubt about the quality of the data reported by them. This does not mean necessarily that this data is not useful at all for the study's purpose but only that there is no information available regarding the quality level. Based on this consideration a decision was made to include the data reported from these stations into the main database. In the health studies, attention must be given to these cities. Detailed information on the quality levels of each station can be retrieved from Table 2.

The data completeness is an important element of the QA/QC plan. Table 13 gives some indications of the completeness of the air quality data in the ECRHS cities during the period from 1996 to 1999. One can see that for the last years there is generally a high level of completeness of the air quality measurements in almost all ECRHS II centres. There are missing values in the table for some cities and pollutants but we may assume at a good extent that we would expect these values to be at comparable level with the presented values of completeness. This assumption is based on the fact that the level of completeness of a network/monitoring station is strictly related to the quality level insured through the QA/QC plan. It must be kept in mind that ECRHS II needs long-term averages, which are not heavily influenced by the completeness.

5.5 Annual means across ECRHS cities

The gaps in the air quality database were the main limiting factor in the processing of the data. The aim was to generate city averages over long periods of time. It was not possible to average over the whole period of time (1980-1999) because there was generally very little data at the beginning of this period. The analysis of the time-series showed that there is a remarkable increase of the air quality data reported after 1990 (Figure 35).

The most important statistical indices were considered the past and current 3-year means. The main reason for selecting these indices was to have a comparison of the air pollution exposure between ECRHS I and ECRHS II studies. This fact was considered to be particularly significant for those cities that participate in both studies. 3-year means also allows for a wide range of comparison between cities because most of them have supplied data that meets the criteria for the calculation of these indices. The main observation is the decline in concentrations for most pollutants. The gaseous pollutants represent a bigger reduction than the particulates with SO_2 showing the biggest reduction over all. O_3 and PM_{10} behave differently and show almost no reduction over the 10-year period. It is noticeable that the 98th or 95th percentiles in the ECRHS cities have decreased at a faster rate than the annual averages. This corresponds to the general pattern that air pollution abatement strategies usually have a stronger effect on peaks than on means.

One major exposure issue in the epidemiological analyses will be the range of concentrations across the cities. This range differs across pollutants and is in general, rather large, reaching factors of 18 for SO_2, 16 for NO_2, 3.8 for TSP and 2.8 for PM_{10} for the current 3-year mean (background monitoring only). In general, the range across the cities declined over the last 10 years. For the epidemiological health analyses, this means a reduction in the range of current exposure; thus a decline in statistical power for health effects considered to be mostly related to "current" levels.

Two main conclusions can be drawn by analysing the summary statistic tables: First, the values of current 3-year mean, current 2-year mean and 1999 annual average generally do not differ much from each other. If the current 3-year mean for a city is missing, the current 2-year mean can be used instead for health studies. If even the latest one is missing the 1999 annual mean can be used instead. Obviously, in this last case the uncertainties do increase.

Second, the current 3-year mean may not be substituted for the 10-year mean. The tables show that due to general decrease of the air pollution levels there is remarkable difference between the two indices. The only exception may be in case of PM_{10} and the ozone summer mean for which the values of the 10-year means are comparable to the current 3-year means.

In order to describe the temporal variation over the last 10-year period we provided the coefficient of variation (C.V.). On average the annual averages of SO_2 show the highest temporal variation whereas NO_2 and O_3 the lowest. The other pollutants represent similar temporal variation.

5.6 Short-term temporal variability of concentrations

The annual mean represents the average exposure of the population to a certain pollutant but it does not capture temporal variation in the exposure, over the year. These characteristics are reflected in the upper percentile values.

The figures show that the ratio of peak versus mean concentrations largely vary across cities, except in case of ozone, which shows that the cities have different patterns of high pollution episodes. E.g. while the SO_2 98th percentile value was in 1998 more than six times higher than the annual mean in Barcelona, peaks were less than twice the mean in Galdakao. These differences can be explained with the influence of different factors. First of all the different patterns and density of the traffic fluxes in each of the cities. An argument to that is the fact that the traffic-related pollutants, i.e. NO_2, NO, CO, show the biggest difference between the 98th (or 95th) percentile and annual mean.

Other factors influencing the high pollution episodes are the geographic location and the size of the cities. Generally a higher difference between the annual mean and percentiles is noticed in the big cities located in the southern region of Europe.

The summer mean and maximum monthly mean of ozone show relatively little difference due to the fact that the summer represents the period of the year with the highest pollution level.

5.7 Long-term trends of concentrations

There is an increasing trend of the number of stations reporting data in ECRHS cities through the period 1980-1999. The most remarkable increase for all pollutants can be seen after 1990. Attention has been mostly paid to PM_{10}, which presents an increase of about 40 times (no data before 1990 collected), and NO_2 with about 25 times increase from 1980. For TSP and particularly for Black smoke, we see a decreasing trend in monitoring over the last years. This shows the tendency to pay more attention to PM_{10} while limiting TSP and Black smoke monitoring. In general the ECRHS cities reported more background station time-series than traffic station time-series and much more time-series from gaseous pollutants than particles. As expected the concentrations reported from traffic stations are higher than from background stations, except for the summer mean of ozone, where concentrations were, as expected, higher at background stations. Time-series figures are built based on the city annual means calculated out of all stations that have provided data. It has to be emphasised that in some cities the changing number of monitoring stations, across years, influenced some annual means, leading to abrupt changes in the curves from one year to another.

As a general pattern, the figures indicate that SO_2 and, less consistently, CO concentrations, decreased over the decade, particularly in cities with very high concentrations back in time. For the other pollutants, this trend is less consistent or rather small with a few cities reporting a decrease in air quality.

The time-series figures show that the range of the gaseous pollutants across cities is getting smaller from 1980 to 1999, whereas the range of the particles across cities stays more or less the same. Generally the range of traffic time-series is wider than for the background time-series.

5.8 Within city variability

The within-city variability of the pollutant's concentration is a parameter that allows us to describe the distribution of outdoor exposure within the city. Although the exposure to air pollutants is also determined by lifestyle and mobility of the individuals, the general long-term distribution of the pollutant's at the place of living remains a crucial determinant of personal exposure. The error in this "exposure" term will be larger if the within-city variability is high. Thus, more homogeneously distributed measures of exposure are more powerful to detect associations with health. The within-city variability gives a helpful parameter for evaluating the spatial heterogeneity of the air quality data in the ECRHS cities.

The background monitor data is the most important for the interpretation of the results because these are the concentrations that mostly characterise the exposure where most of the populations live.

The general within-city variability, including both background and traffic stations, serves mostly to detect the hot spot situations in the city. The influence of these hot spots to exposure is characteristic for a rather limited area around the station and may exaggerate exposure for most of the people. It is, however, a useful indicator of the 'worst case' scenario that can occur in one area.

It is to emphasise that spatial variability data could be calculated only for cities that provided data for more than one monitoring station per pollutant. Among these cities, in 47%, the variability is based on only 2 stations. Nevertheless the information is useful to distinguish cities with very high within-city homogeneity from a few cities with highly heterogeneous concentrations within the city. These latter concentrations may have a large random error if assigned to the whole ECRHS II population, from the city. Based on further personal information (residential local) and quantitative measures of the within-city variability, this error may be reduced and implemented in the statistical analyses on air pollution and health.

Generally the within-city variability of mixed stations is as expected higher than at background stations. The cities that generally present high variability are Athens, Porto, Paris, Barcelona, Galdakao and Hamburg. Galdakao has to be considered as an area rather than one city. The within-city variability of background monitoring shows generally similar values across the cities. There are few cities that present high variability of background stations only in specific cases, which may be influenced by one of the following factors:

- there is not a proper definition of the type of the stations taken into consideration for the within-city variability, i.e. a station strongly influenced by traffic emissions but reported as background may result in high variability
- there are very few stations for a meaningful within-city variability, i.e. there are only two stations one of which may be characteristic for a high pollution area.
- selection of the stations, i.e. some of the stations reported by the cities are not located in the inner city but in the greater area or the region

- the location and the topography of the city may be particular
- particular atmospheric conditions during the reported year

The importance of the location characteristics will be further investigated together with the work package 6 (PM2.5) and work package 7 (elemental analyses) data.

5.9 Spatial correlation between pollutants and temporal correlation for each pollutant

The correlation across the "current 3-year mean" of the pollutants show high values for SO_2 with both NO_2 and CO. TSP was highly correlated with NO and SO_2 across the available (< 10) cities. The PM_{10} pattern shows a negative association with NO (values from 8 cities only). Correlations across pollutants were similar in the "past 3-year mean" data.
From an epidemiology perspective the question of the correlation between current and past concentrations are highly relevant. For pollutants with similar ranking over time it cannot be assessed which exposure period may be of major health relevance. However, as an advantage, past exposure may be inferred from current measures and, therefore, long-term exposure may be available, in approximation, among all centres with at least current data. High correlations over 10 years were observed for NO_2, NO and - based on limited data - CO, O_3, TSP, PM_{10} and black smoke. The cross-time correlation was much smaller for SO_2, thus, the change (improvements) in SO_2 concentrations happened rather differently across Europe.

5.10 Pollutant-specific comments

<u>SO_2</u>

SO_2 is the pollutant representing the most significant reduction during the period 1980-1999. From the data collected from ECRHS II cities emerges that, when comparing the past and current 3-year periods, the most remarkable reduction has taken place in Erfurt, Turin, Grenoble and Hamburg. Particularly impressive is the reduction in Erfurt where the period average has dropped from 65 $\mu g/m^3$ in 1990-1992 to only 7 $\mu g/m^3$ during the period 1997-1999. This reduction may be at a large extent attributed to the drastic reduction of the use of brown coal, reach in sulphurs, in the former East Germany.
The cross-city range of annual averages (or the difference between cities with highest and lowest annual averages reported) has also narrowed remarkably during the last ten year period. So, if in 1990 the difference of annual averages between the cities with highest and lowest reported values was 63 $\mu g/m^3$, in 1999 this difference drops to 17 $\mu g/m^3$. Thus we see a general levelling off of the SO_2 concentrations across ECRHS II cities. Therefore, for health effects which may be considered to be mostly associated with SO_2 (or correlated pollutants), the cross-sectional data of ECHRS have a larger exposure range, thus higher power, whereas for effects which one may associate with the more recent pollution, the range across the ECRHS II cities has decreased, leading to a loss of statistical power.
SO_2 time-series show generally little fluctuation in time. An exception to this is the time-series of traffic monitoring only reported from Porto and Athens which show sharp kinks in the curve. This is due to the effect of averaging over stations with different time-series length. For both cities the year of kink coincides with exceptionally high values reported by one single station. This station reported values for only one year, which strongly influenced the cross-city mean value, thus leading to the observed sudden changes in the series of annual means.
Athens for traffic and background monitoring and Porto for both background only and traffic and background together show a high within-city variability. For Athens this is due to the fact that the traffic site *Pattission* is a site with an extremely high traffic intensity. The

effect of this site in the calculations is clearly seen when only background stations are considered. In this case the within-city variability is much lower. The high within-city variability for background monitoring only in Porto may be explained with the fact that the stations reporting data are located not only in the city but also in other towns of the agglomeration where the background concentrations are generally lower than those reported by the sites within the inner city.

CO

CO is a traffic-related pollutant so the influence of the local traffic emissions on CO levels is strong. This effect can be clearly seen by comparing the within-city variability of background monitoring with that of traffic and background together, which is, in all cases, clearly larger. The low within-city variability of the background monitoring suggests that the city averages calculated upon the reported time-series characterise tot a good extent the exposure of the whole city population.

The data shows that the values of the 98 percentiles generally don’t follow the order of the annual averages. This irregular pattern may also be explained by the fact that CO is strongly connected to the traffic fluxes in the cities. Some cities represent quite high values of 98 percentiles although their annual averages are lower compared to other cities with low 98 percentiles. This increased number of high CO level episodes occurs mainly in the cities with high traffic density. An influence may also have the selection of the stations reported to the project. For instance, Athens represent a high within-city variability when the extreme traffic site Pattission is included in the calculations. On the other hand, from the meta information retrieved we are not able to explain why Christchurch, reporting only one background station, represents particularly elevated values of 98 percentile and also relatively high average for the period 1990-1992.

It should be noted the remarkable reduction of CO in Turin. Thus, from an average of 5.9 mg/m^3 during the period 1990-1992, the concentration drops to 2.9 mg/m^3 during the current 3-year period. But, this trend is represented by only one traffic station although it maybe reasonable to assume that the background concentrations have also followed this trend, though at a slower rate.

NO_2

The data reveals a slight downward trend of NO_2 concentrations, in all the ECRHS II cities, during last ten years. The only exception to this, is Athens where, although at a slow rate, the measured concentrations rise steadily.

The within-city variability of background monitoring is generally low, except in a few cases where the calculations included background stations sub-urban or rural areas around the cities. The background concentrations reported by those stations are usually lower than those reported by the stations located in the cities.

For instance Paris represents an unusually high within-city variability of NO_2 background concentrations in 1999. This is due to the fact that one out of the five background stations reporting NO_2 data, reports extremely low values for that year. This station is located outside the city, in the Rambouillet Forest, which one may surmise as being unrepresentative for most of the population.

In Galdakao also we see high within-city variability of NO_2 background concentrations because one of the stations, Mundaka, represents the pollution at a remote rural site. The values reported from this site are quite low compared to the other stations located in urban type of zone.

The relatively high within-city variability in Hamburg is due to low values reported by station Tatenberg which is located in a suburb. The concentrations reported by the other background stations in Hamburg show comparability between them.

In Dundee the increase of within-city variability is due to the station Bernem Place which is also located in a sub-urban area.
In Turin NO_2 follows the trend of the other traffic-related pollutants such as CO and NO. So, in the last ten year, the reduction in background concentrations is noticeable. Decrease can also be noticed in the values reported by the traffic sites, although at a lower rate.

<u>NO</u>

The rate of reduction of NO annual averages follows the one of NO_2. They constantly decrease through the last ten year period, for all ECRHSII cities reporting NO data.
Being a traffic-related pollutant, NO follows the dynamics of the traffic emissions in the city. The data reported reveal that the high pollution episodes of NO are more visible compared to the other pollutants under scrutiny. When plotted besides the annual averages from the respective cities, the values of 98 percentiles show quite high levels of NO pollution episodes.
Within-city variability of NO background values are quite low for all cities except Bordeaux where we have higher variability because of the two stations Bastide and Floriac, respectively, reporting values out of the average range from the other stations. Bastide station is located in the inner city reporting high background values whereas Floriac, which is located in a suburb, reports low values.
The curve of the traffic monitoring time-series for Porto shows a sharp rise in the last reported year, 1998. This is due to the fact that out of four traffic stations reporting NO from Porto, two reported values only for year 1998. One of them, Villa Nova de Gaia station, reports very high annual average for 1998 which makes the city annual average curve to tilt sharply upwards in 1998. This station is not located in the city of Porto itself but in a small town in the Porto area, close to a very busy road. The inclusion of this station in the calculations explains also the extremely high within-city variability of NO annual averages for both background and traffic stations in Porto.

<u>TSP</u>

The time-series of TSP annual averages, both background and combined traffic and background , show a slight but steady decrease in all the ECRHS II cities throughout the period.
The range of the annual average concentrations is quite wide, Barcelona reporting the highest concentrations, in average four times higher than the lowest ones reported by Uppsala. On the other hand, Barcelona, alongside Turin, shows the most significant reduction in TSP level during last 10-year period.
Barcelona and Galdakao report for 1999 (or 1998) background concentrations with high within-city variability. In Barcelona, the high within-city variability in 1998 is due to the low annual average reported that year by one of the stations, while the values reported by the other three stations are higher and comparable with each-other. This is indeed an exception because the within-city variability calculated from these four stations for each of the three previous years is substantially lower than the 1998 value.
The high within-city variability of background concentrations in Galdakao is due to the high concentration reported in 1999 by one of the stations. Again the concentrations reported by the other three stations are comparable to each other.
The base of comparison between cities is rather weak due to the relatively small amount of data reported for TSP. One should be careful when extending conclusions about trends and patterns of reported TSP values across all ECRHS II cities.

Black smoke

BS concentrations generally follow the trend of the other particle matter fractions. Although the cities reported very little data about BS, we can still see a general trend of slow decrease of BS concentrations through the period. More visible is this trend for concentrations measured at traffic sites.

Exceptions to the general trend are Athens and Galdakao where the current 3-year mean concentrations are higher than the past ones.

The Black Smoke data should be interpreted with care because:

- there is rather weak base of cross-city comparison due to lack of data
- there is poor comparability of the reported data due to the lack of evidence on the type of filters used for carrying out the measurements.

PM_{10}

The time-series of PM_{10} reported by the cities cover the period 1990-1999. The plotted time-series curves indicate a slight decrease in the last years of the period. To a certain extent this trend is confirmed by the comparison of the past and current 3-year means. Anyway, one should be cautious in generalising this conclusion as we only have data for both 3-year periods from three cities.

The within-city variability of PM_{10} background concentrations is generally low for all cities, with Grenoble, Porto and Bordeaux showing a higher variation in 1999 compared to other cities. The highest variability being 15 $\mu g/m^3$. For Grenoble the higher variability may be explained by the fact that from two background stations reporting in 1999, one of them reports only a single value for 1999 whereas the other reports a 10-year time-series. We have no data to judge about the within-city variability in the past.

The curve of background concentration time-series of Vienna shows a kink for the year 1992. This is due to the overlapping of two time-series of different length. For year 1991 we have one value reported from only one background station whereas in 1992 another station starts reporting. The values of both stations for year 1992 are comparable but the value reported by the first station in 1991 is considerably higher than those reported in 1992. Thus it is not clear whether concentrations have truly dropped.

In Huelva there is also a sudden drop of the background concentrations in 1999. The curve of the time-series decreases at a steady rate until 1997, undergoes a sudden increase in 1998 and falling sharply again in 1999. This trend is confirmed by all six stations reporting PM_{10} data. The pattern of unusual high annual average concentration in 1998 in Huelva is common also to other pollutants such as SO_2 and CO.

In Christchurch there is unusual high number of high PM_{10} pollution episodes, represented by the high values of 98 percentile, compared to the other cities. In order to give a satisfactory answer to this phenomenon further investigation concerning particle emission sources and environmental information around the station may be of help.

As shown in Table 3, Grenoble, Paris, Christchurch, Bergen, Goteborg, and Norwich used TEOM devices whereas PM_{10} were gravimetrically measured in Basel and Cambridge. It is well known that results of these two measurement technologies may differ. However, it is not clear whether the difference may depend on the total concentration, humidity, temperature, and other local characteristics. Thus, we do not use any fixed correction factor but rather present the raw data. Further comparative analyses may clarify this issue in the future.

O_3

O_3 constitutes an exception to the general decreasing trend characterising the other pollutants under consideration during the last ten years. The data reported by the cities show that the current 3-year summer means and maximum monthly means are higher than the past 3-year summer means and maximum monthly means for all the cities reporting data for both periods. The sole exceptions are Erfurt that presents decrease of the 3-year period summer means and Athens that reports lower current 3-year maximum monthly mean. Despite the small reduction, Athens remains the ECRHS II city with highest summer means and maximum monthly means.

The general trend of increase in O_3 levels is also confirmed by the plotted curves of background concentration time-series.

The sharpest increase of O_3 levels is recorded in Huelva where from 1996 to 1998 the summer means almost double. Despite a slight decrease in 1999, the summer mean remains quite high, compared to the levels recorded in Athens. The peak of the O_3 time-series curves in 1998 confirm further that 1998 in Huelva recorded higher pollution levels for most of the pollutants.

The within-city variability of the background monitoring summer means is generally low across all cities, with exception of Galdakao and Athens. The high variability in 1999 is due mainly to the fact that one of the stations, where the time-series consists only of a single value in 1999, report a very high value. In the previous years when data from this station was missing. Else, the within-city variability is much lower.

For Athens and Porto one can notice very high within-city variability for the combined traffic and background stations . This is due to the effect of the extreme traffic sites included in the calculations which report quite low O_3 levels.

5.11 Conclusion

The aim of WP5 could be successfully accomplished. We were able to collect several measures of long-term and past air pollution mean concentrations. Although we don't have, for any single pollutant, data from all cities and all years, the data set is rich to rank the ECRHS centres with regard to ambient air pollution. The data confirms that the range of exposure across cities is rather large, which is a major advantage in the application of this data to epidemiologic effect assessment. Although the ranking across cities may not have substantially changed over time, the data clearly suggest that exposures were usually higher during ECRHS I and before as compared to the current situation; given that improvements were mostly made in high pollution areas, this change over time also brings a reduction in the range of exposure across cities. In the epidemiologic analyses, this observation must be taken into account. Health effects hypothesised to be associated with past exposure (e.g. 1990 and older) will be more likely to be observed with statistical significance then outcomes which may be due to more current exposure. Nevertheless, even for current exposure distributions, the range is rather large and in general broader then in cross-city air pollution studies such as the Harvard Six City study (Dockery et al, 1997) or SAPALDIA (Ackermann-Liebrich et al, 1997).

The heterogeneity in lack of collaboration across European air monitoring agencies is a major difficulty to efficiently conduct research. Despite major efforts, the data collected within this study are incomplete and may not even include all data that have been collected locally. In the future, it will be very important to have standardised and collaborative networks across Europe and to guarantee free access for research teams to these data, which should be available in a standard electronic format.

A further assessment of the correlations of different exposure measures, across cities, may lead to a valid scaling of all cities, based on some ‚pollution index', taking into account some or all pollutants from all cities. Such an ‚exposure index' would resolve the inherent problem that health analyses which may include different surrogates of air pollution may be based on different subsets of cities, depending on the availability of specific pollutant data.

The observed within-city variability, although incomplete, gives an important indication for the locations and the extent of potential within-city variability. This information can be taken into account in the epidemiological health analyses. In cities with large spatial variability, the random error in the assigned population mean exposure is larger then in those cities where we observed very little spatial variability. The latter cities are those, where one may assume that the fixed site monitor values are an excellent representation of the personal exposure to ambient air pollution.

It will be of interest to apply the WP5 data information also to the results and interpretation of workpackage 6, which consists in the measurement of an annual mean value of PM2.5.

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8 Tables

Table 1: Overview of reported measurement stations and pollutants per city

Country	City	Number of stations			Number of time-series for each pollutant								Quality level	Meteo data
		Backg.	Traff.	Indust.	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3		
Austria	**Vienna**	2	2		2	2	2	2			2	2	3	YES
Belgium	**Antwerp**		1		1		1	1	1	1	1	1	2a	YES
Denmark	**Arhus**		1		1		1	1					1	NO
Estonia	**Tartu**		1				1						5	YES
France	**Bordeaux**	5	2		4	3	5	5			5	4	2a	YES
	Grenoble	3			3		3	3			2	3	1	YES
	Montpellier	2			2		2	2			1	2	2a	YES
	Paris	5	1		4	1	6	6		2	1	4	<4	YES
Germany	**Erfurt**	1			1		1	1	1			1	1	NO
	Hamburg	5	1		5	3	5	5	5			2	2a	YES
Greece	**Athens**	2	1		3	3	3	3		2		3	3	YES
Ireland	**Dublin**	2	2	1	4	1	1			4	1		4	YES
	Wexford	1			1				1				1	NO
Italy	**Pavia**	1			1	1	1	1	1			1	4	YES
	Turin	1	1		2	2	2	2	2			1	4	YES
	Verona	1	1		2	2	2	2	2			1	4	YES
Nether-lands	**Bergen op Zoom**	1			1	1	1	1		1		1	1	NO

Country	City	Number of stations			Number of time-series for each pollutant								Quality level	Meteo data
		Backg.	Traff.	Indust.	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3		
	Geleen	1		2	3		3				1		3	YES
	Groningen	1	1		2	2	2	2				1	1	NO
New Zealand	Christchurch	1			1	1	1	1	1		1		3	YES
Norway	Bergen	1					1				1		2a	YES
Portugal	Coimbra		1		1	1	1	1				1	2b	YES
	Porto	3	4	1	7	5	7	7			4	7	4	NO
Spain	Albacete	1			1	1	1	1			1	1	3	YES
	Barcelona	2	3		4	5	5		4			4	2b	YES
	Galdakao	1		7	7	1	4	4	5	3		4	2a	YES
	Huelva	3	3		5	4	6	6			6	3	1	YES
	Oviedo		3		3	3	3		3			3	5	YES
Sweden	Goteborg	2			2	1	2	2		1	1	2	2b	YES
	Umea	3			2		2			1		1	<4	YES
	Uppsala	2	1		1	1	2	1	1		1	1	1	YES
Switzerland	Basel	2			2	2	2	2	1		2	2	<3	YES
UK	Cearphilly	9	9				9	1					5	NO
	Cambridge	1	4		1	1	5	4			4	1	1	NO
	Dundee	4	4				8						<2b	NO
	Ipswich		6				6						5	NO
	Norwich	2	1		2	1	2			1	1	1	1	NO

Station type: B = Background, T = Traffic, I = Industrial, U = Unknown / Air quality data only for 1989 from Airbase

Table 2: Summary of the description of the measurement stations

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
Austria	**Vienna**	Hohe Warte	auvi1	B	S	R	TC	M	L	W	3	88		88	88			91	91
Austria	**Vienna**	Stephansplatz	auvi2	B	U	RC	TC	S	L	W	3	88		90	90			92	92
Austria	**Vienna**	Taborstrasse	auvi3	T	U	RC	TC	M	H	W	3		88						
Austria	**Vienna**	Gaudenzdorf	auvi4	T	U	RC	TC	M	H	W	3		88						
Belgium	**Antwerp**	Borgerhout	bean1	T	U	C	TC	M	H	W	2a	80		80	80	80	95	95	80
Denmark	**Arhus**	Aboulevarden	deaa1	T	U	RC					1	89		89	89	89			
Estonia	**Tartu**	Riia-Turu	esta1	T	U	RC	PTC	M	H	W	5			93					
France	**Bordeaux (Talence)**	Talence	frbo1	B	U	R	TC	S	L	W	2a	98		98	98			98	98
France	**Bordeaux**	Bordeaux-Bastide	frbo2	IB	U	RI	TCI	M	H	W	2a	98	98	98	98			98	
France	**Bordeaux (Floirac)**	Floirac	frbo3	B	S	R	C	NO			2a	98		98	98			98	98
France	**Bordeaux**	Bordeaux-Gambetta	frbo4	T	U	RC	TC	S	H	C	2a		98	98	98			98	
France	**Bordeaux (Merignac)**	Merignac	frbo5	T	U	RC	TC	M	H	W	2a		98	98	98			98	
France	**Bordeaux**	Bordeaux-grand parc	frbo6	B	U	R	PTC	NO			2a	98		98	98			98	98
France	**Bordeaux (Bassens)**	Bassens	frbo7	B	S	RI	CI	S	L	W	2a	98		98				98	98
France	**Grenoble**	Villeneuve	frgr1	B	U	R	NO	NO			1	85		85	85		92	92	92
France	**Grenoble**	Fontaine	frgr2	B	U	R	NO	M	M	W	1	85		94	94				94
France	**Grenoble**	Saint Martin d'Heres	frgr3	B	U	R	NO	S	M	W	1	99		99	99			99	99
France	**Montpellier**	Cevennes	frmo1	B	U	R	NO	N	L	W	2a	98		96	96				96
France	**Montpellier**	Pres d'Arenes	frmo2	B	U	R	NO	N	L	W	2a	99		99	99			99	99
France	**Paris**	Aubervilliers	frpa1	B	U	R	TC	M	U		>4	92		92	92				92
France	**Paris**	Neuilly-sur/Seine	frpa2	B	U	R	TC	M	U		>4	92		92	92				92

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
France	**Paris**	Paris 12eme	frpa3	B	U	R	TC	S			>4	92		92	92		92	97	
France	**Paris**	Paris 13eme	frpa4	B	U	RC	TC	M	U		>4	92		92	92		92		92
France	**Paris**	Foret de Rambouillet	frpa5	B	R	natural	NO	NO			>4			94	93				92
France	**Paris**	Champs Elysees	frpa6	T	U	RC	TC	M	H	W	>4		92	92	92				
Germany	**Erfurt**	Kraempferstrasse	geer1	B	U	R	TC	M	H		1	91		92	91	91			91
Germany	**Hamburg**	Sternschanze	geha1	B	U	R	C	M	M	W	2a	84	84	84	84	84			84
Germany	**Hamburg**	Veddel	geha2	B	U	I	PTCI	M	H	W	2a	85	85	85	85	85			
Germany	**Hamburg**	Billbrook	geha3	B	U	C	CI	S	M	W	2a	85		85	85	85			
Germany	**Hamburg**	Tatenberg	geha4	B	S	R	TC	S	L	W	2a	85		85	85	85			92
Germany	**Hamburg**	Stresemannstr.	geha5	T	U	R	TC	M	H	C	2a	93	92	92	92	92			
Greece	**Athens**	Maroussi	grat1	B	S	RC	TC	S	L	W	3	90	90	90	90				90
Greece	**Athens**	Patission	grat2	T	U	C	TC	M	H	W	3	84	84	84	87		84		87
Greece	**Athens**	Smirni	grat3	B	S	RC	TC	S	L	W	3	84	84	84	87		88		87
Iceland	**Reykjavik**																		
Ireland	**Dublin**	College Street	irdu1	T	U	C	TC	M	H	W	4		96	88				96	
Ireland	**Dublin**	Brunswick Steet	irdu2	B	S	RC	T	M	H		4	93					93		
Ireland	**Dublin**	Ballsbridge	irdu3	T	S	RC	T	M	H	W	4	93					93		
Ireland	**Dublin**	Ringsend	irdu4	I	S	C	I	S	M	W	4	93					93		
Ireland	**Dublin**	Herbert Street	irdu5	B	S	C	TC	S	H		4	93					93		
Ireland	**Wexford**	St. Aidans Shopping Centre Wexford	irwe1	B	U	RC	TC	S	L	C	1	97				97			
Italy	**Pavia**	Folperti	itpa1	TB	U	R	TCI	M	M	W	4	94	94	94	94	94			94
Italy	**Turin**	Consolata	ittu1	T	U	C	TC	M	M	W	4	91	91	91	91	91			
Italy	**Turin**	Lingotto	ittu2	B	U	R	TC	S	M	W	4	91	92	91	91	91			93
Italy	**Verona**	Corso Milano	itve1	T	U	R	PT	M	M	W	4	96	96	96	96	96			96
Italy	**Verona**	Torricelle	itve2	B			NO		L	W	4	96	96	96	96	96			

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
Netherlands	**Bergen op Zoom**	Huijbergen	nebe1	B	R						1	87	87	87	87		87-93		87
Netherlands	**Geleen**	Heuvelstraat (Stein-Meers)	nege1	B		R		S	L		3	87		87					
Netherlands	**Geleen**	Vouershof	nege2	I	S	CI	TI	S	L		3	87		87					
Netherlands	**Geleen**	Asterstraat	nege3	I	S	I	TI	S	M		3	92		92				93	
Netherlands	**Groningen**	Kollumerwaard	negr1	B	R						1	90	94	90	90				90
Netherlands	**Groningen**	Groningen-Centrum	negr2								1	80-85	80-85	80-85	80-85				
New Zealand	**Christchurch**	St. Albans	nech1	B	U	R	TC	S	M	W	3	89	89	89	89	89		91	
Norway	**Bergen**	Raadhuset	nobe1	B	U	RC	TC	MS	M	W	2a			95				95	
Portugal	**Coimbra**	Coimbra	poco1	T	U	RC	T	M	H	W	2a	93	97	93	93				93
Portugal	**Porto**	Rua Formosa	popo1	T	U	RC	T	M		C	4	94	94	94	94				94
Portugal	**Porto**	Faculdade de Engenharia	popo2	T	U	RC	T	M		C	4	93	93	93	93				97
Portugal	**Porto**	Paranhos	popo3	T	U	R	T	M		W	4	99	99	99	99			99	
Portugal	**Porto (Matosinhos)**	Custoias	popo4	I	S	R	TI	N			4	99		99	99			99	99
Portugal	**Porto (Maia)**	Vila Nova Da Telha	popo5	B	S	R		N			4	99	99	99	99			99	99
Portugal	**Porto (Volongo)**	Ermesinde	popo6	B	S	R	T	S			4	99						99	99
Portugal	**Porto (Gondomar)**	Baguim	popo7	B	S	R	T	M		W	4		99	99	99				99
Portugal	**Porto (Vila Nova de Gaia)**	Villa Nova de Gaia	popo8	T	U	RC	T	M		W	4	98	98	98	99				99
Spain	**Albacete**	Albacete	spal1	B	U	R	C	S			3	99	99	99	99			99	99
Spain	**Barcelona**	S. Geruasi	spba1	T		C	T	MS	H	W	2b	86	86	86		87			86
Spain	**Barcelona**	Poble Nou	spba2	T	S	R	T	S	H	W	2b	86	86	86		87			86

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
Spain	**Barcelona**	Sagrera	spba3	B	S	R	C	S	H	W	2b	92	92	93		95			84
Spain	**Barcelona**	Sants	spba4	B	U	RC	T	S	H	W	2b	92	95	95		95			
Spain	**Barcelona**	Eixample	spba5	T	U	RC	T	M	H	W	2b		96	97					96
Spain	**Galdakao (Basauri1)**	C. Lope de Vega	spga1	I	U	RCI	TCI	S	M		2a	80					80		
Spain	**Galdakao (Basauri2)**	Barrio San Miguel	spga2	I	US	RCI	TCI	S	M		2a					91			
Spain	**Galdakao (Etxebarri)**	Ayto de Etxebarri	spga3	I	U	RCI	TCI	S	H		2a	80					80		
Spain	**Galdakao (Usansolo)**	Colegio Pena Lemona	spga4	I	U	RCI	TCI	S	M		2a	80					83		
Spain	**Galdakao (Basuri3)**	C. Calderon de la Barca	spga5	I	U	RCI	TI	S	M		2a	92		92	92	90			88
Spain	**Galdakao (Arrigorriaga)**	Polideportivo Municipal	spga6	I	U	RCI	TI	S	M		2a	95	95	95	95	95			95
Spain	**Galdakao (Durango)**	Durango	spga7	I	U	RCI	TI	S	M		2a	97		97	97	97			97
Spain	**Galdakao (Mundaka)**	Mundaka	spga8	B	R	R	no	S	L		2a	98		98	99	98			98
Spain	**Huelva**	La Orden	sphu1	TB	U	C	T	M	M	W	1	95		95	95			95	98
Spain	**Huelva**	Manuel Lois	sphu2	TB	U	R	T	M	L	W	1	95		96	96			95	95
Spain	**Huelva**	Los Rosales	sphu3	TI	U	RI	T	M	H		1	95	95	95	95			95	
Spain	**Huelva**	El Estadio	sphu4	T	U	RC	T	MS	M		1	95	95	95	95			95	
Spain	**Huelva**	Marimas del Titan	sphu5	B	S	R	T	S	L		1	96	96	96	96			96	
Spain	**Huelva**	Pozo Dulce	sphu6	TI	U	RI	T	M	H		1	95	95	95	95			95	95
Spain	**Oviedo**	Palacio de los Deportes	spov1	T	U	R	TC	M	H	W	5	93	93	93		93			94
Spain	**Oviedo**	General Elorza	spov2	T	U	R	TC	M	H	C	5	93	93	93		93			97
Spain	**Oviedo**	Plaza de Toros	spov3	T	U	R	PTC	M	H	W	5	93	93	93		93			95

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
Sweden	**Goteborg**	Femman	swgo1	B	U	C	T	M	H	W	2b	80	87	80	80		80	91	80
Sweden	**Goteborg**	Jarntorget	swgo2	B	U	C	PTI	H	H	W	2b	90		90	92				91
Sweden	**Umea**	Radhusesplanaden 8	swum1	B	U	RC	T	S	M		4	88		88					
Sweden	**Umea (Lycksele)**	Lycksele	swum2	B	U	RC	TC	M	M		3	86		86			86		
Sweden	**Umea (Vindeln)**	Vindeln	swum3	B	R	U			L		3								86
Sweden	**Uppsala**	Town Library	swup1	B	U	R	T	M	H	W	1	86		96			86		
Sweden	**Uppsala**	Marsta	swup2	B							1								98
Sweden	**Uppsala**	Kungsgatan	swup3	T	U	R	T	M	H	W	1		98	98	98	98		98	
Switzerland	**Basel**	St.Johannplatz	swba1	TB	U	R	T	S	M		3	80	88	86	86			97	88
Switzerland	**Basel**	Basel-Binningen	swba2	B	S	R	TC	NO			1	88	88	87	87	82		97	88
UK	**Caerphilly**	Mobile Trailer	ukce1	B	R	R	TI	MS	U		5			97	97				97
UK	**Caerphilly**	Croespenmaen/Oakdale	ukce2	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	Blackwood Library	ukce3	B	R	R	TI	MS	U		5	99		96					
UK	**Caerphilly**	High St. , Blackwood	ukce4	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	Ludlow St., Caerphilly	ukce5	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	Tony Felin, Caerphilly	ukce6	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	Upper Capel, Bargoed	ukce7	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	John St., Cwmcarn	ukce8	B	R	R	TI	MS	U		5			96					
UK	**Caerphilly**	Heol y Ddol, Caerphilly	ukce9	B	R	R	TI	MS	U		5			96					
UK	**Cambridge**	Silver street	ukca1	T	U	C	TC	MS	H	C	1			99	99			99	
UK	**Cambridge**	Gonville place	ukca2	T	U	C	TC	MS	H	C	1			99	99			99	
UK	**Cambridge**	Parmer street	ukca3	T	U	C	TC	MS	L	C	1	99		99	99			99	
UK	**Cambridge**	Regent street	ukca4	T	U	C	TC	MS	M	C	1		96	96	96			96	96
UK	**Cambridge**	Latham Road	ukca5	B	U	R			L	W				93					
UK	**Dundee**	Abertay	ukdu1	T	U	C	TC	MS	H		2b			95					
UK	**Dundee**	Balgavies Place	ukdu2	B	S	R	TC	MS	M	W	1			95					

Country	City	Name of the station	ECRHS Stationcode	Station Type	Type of Zone	Charact. of Zone	Emissionsource	Street within 100m	Traffic Volume	Wide/Can	Quality Level	SO_2	CO	NO_2	NO	TSP	BS	PM_{10}	O_3
UK	**Dundee**	Bank St. / Reform St.	ukdu3	B	U	C	TC	MS	M	C	2b			95					
UK	**Dundee**	Birnam Place	ukdu4	B	S	R	TC	MS	M	W	1			95					
UK	**Dundee**	Commercial St.	ukdu5	T	U	C	TC	MS	M	C	2b			95					
UK	**Dundee**	Seagate	ukdu6	T	U	C	TC	MS	M	C	2b			95					
UK	**Dundee**	Union Street	ukdu7	T	U	C	TC	MS	H	C	1			97					
UK	**Dundee**	Woodside Avenue	ukdu8	B	S	R	TCI	MS	H	W	1			95					
UK	**Ipswich**	Civic Drive	ukip1								5			96					
UK	**Ipswich**	Chevallier St	ukip2								5			96					
UK	**Ipswich**	Kings Av	ukip3								5			96					
UK	**Ipswich**	Wherstead Rd	ukip4								5			96					
UK	**Ipswich**	Landseer Rd	ukip5								5			97					
UK	**Ipswich**	Tavern St	ukip6								5			96					
UK	**Norwich**	Churchill Road	ukno1	B	U	R	TC	S	L	C	1	80					80		
UK	**Norwich**	Norwich Roadside	ukno2	T	U		TC	MH	M	W	1			97					
UK	**Norwich**	Norwich Centre	ukno3	B	U	R	TC	S	L	W	1	97	97	97				97	97

Explanation for table 2:

ECRHS Stationcode: Made out of the first two letters from the country name and the two first letters from the city name and the number of the station

Station Type:

T: Traffic (Station used for monitoring traffic induced air pollution)

I: Industrial (Station used for monitoring industrial air pollution)

B: Background (Station used for monitoring background air pollution levels. These stations can be located inside (urban/background) as well as outside (rural/background) cities.

U: Unknown (Station type is not known)

Type of Zone:
U: Urban (Station is located within the city)
S: Suburban (Station is located in the outskirts (fringe) of a city, or in small residential areas outside the main city)
R: Rural (Station is located outside the city)
U: Unknown (Location of the station is not known)

Charact. of Zone:
The major activity in the representative area is given. More than one is possible.
R: Residential
C: Commercial
I: Industrial

Emission source (Major emission source in station environment within 500 meters):
P: Public power, co-generation and district heating
T: Traffic
C: Commercial, institutional and residential combustion
I: Industrial activities
NO: No emission source within 500 meters)

Street within 100 m (Street type within 100 meter radius):
M: Main street
S: Side street
H: Highway
U: Unknown
NO: No street

Traffic Volume (Estimated traffic volume of the street with the highest traffic volume within 100 meters radius):
H: High traffic (More than 10'000 vehicles/day)
M: Medium traffic (Between 2'000 and 10'000 vehicles/day)
L: Low traffic (Less than 2'000 vehicles/day)
U: Unknown

Wide/Can:
W: D/H>1.5 (D = Distance between axis street and buildings)
C: D/H<1.5

Quality Level:
1, 2a: Stations that are part of the national air quality-monitoring network. Such stations may belong directly to the national network or a national sub-network. A complete QA/QC (Quality assurance/Quality control) plan implemented on national level is the key feature that differentiates the first two levels from the rest. This is usually adopted by national sub-networks, based on a central laboratory (accredited or not), providing nation-wide comparability.
2b, 3: Stations that are part of a local air quality-monitoring network. In this case the complete QA/QC plan is implemented on local basis and does not have systematic relation with the national QA/QC plan
4: Individually operated networks or stations (or even a national network) implementing a minimum QA/CQ plan (Data quality objectives are set on a minimum basis regarding only: Accuracy and precision, 2. Data capture 3. Time coverage)
5: Networks and stations with no documented QA/QC plan.

Years: Reported is the year when the station started to measure the specific pollutant

Table 3: Description of the measurement methods

Pollutant	# of cities	# of sites	standard method	# of sites with standard method (%)	Cities with other methods
SO_2	30	82	UVF	68(82,9%)	Dublin(Titration) Wexford(Hydrogen Peroxide Method) Galdakao(3 of the 8 stations from 80 to 93: Thorina) Goteborg(1 of the 2 stations: DOAS-4 path-average) Umea(Ion Chromatography) Norwich (1 of the 2 stations: Wet Chemistry Titration)
CO	22	47	IR	42(89,4%)	Dublin(Chemiluminescence) Bergen op Zoom, Groningen(Gas filter correlation spectrometry) Cambridge(NDIR) Uppsala (chemical absorption)
NO_2	36	111	CHL	87(78,4%)	Tartu (Griss-Ilosvi Colourimetry) Goteborg (1 of the 2 stations: DOAS-4 path average) Umea (Spectrophotometric) Dundee, Ipswich, One station in Cambridge(Diffusion Tube)
NO	26	66	CHL	65(98,5%)	Goteborg (DOAS-1 Path)
TSP	14	29	BAB	17(58,6%)	Aarhus, Turin, Barcelona, Basel(GRAV) Antwerp(Nephelometry) Wexford (REFL) Christchurch(scaled down version of Hi Volume Sampler 7 day average) Galdakao (1 of the 2 stations: Alto Volumen Gravimetrico)
BS	7	13	REF	9(64,3%)	Athens (1 station without information) Dublin (3 stations without information) Uppsala (without information)
PM_{10}	16	34	BAB	17(51,5%)	Grenoble, Paris, Christchurch, Bergen, Goteborg, Norwich (TEOM) Basel, Cambridge(1 of the 2 stations in Cambridge: GRAV)
O_3	27	56	UVA	52(94,5%)	Bergen op Zoom, Groningen (Chemiluminescent reaction of ozone and Rhodamine B) Goteborg (1 of the 2 stations: DOAS-3path average) Cambridge(UVP)

Standard methods:
UVF: UV Fluorescence / CHL: Chemiluminescence / IR: IR Absorption / BAB: Beta absorption / REF: Reflectrometry / UVA: UV Absorption

Table 4: SO_2 summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (µg/m3)		Current 2 year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	SO2	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	2	-	6	7	9	19	*16*	*60*	14	0.35
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	15	19	21	35	41	81	30	0.29
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	5	-	9	9	9	-	34	-	-	-
	Bordeaux	T	2	0	-	-	-	-	-	-	-	-	-
	Grenoble	B	3	2	-	6	7	8	31	26	125	17	0.64
	Montpellier	B	2	1	-	6	5	5	-	16	-	-	-
	Paris	B	5	4	-	12	13	15	-	38	-	17	0.18
	Paris	T	1	0	-	-	-	-	-	-	-	-	-
Germany	Erfurt	B	1	1	-	4	5	7	65	-	-	33	0.81
	Hamburg	B	4	4	-	9	9	10	26	41	150	17	0.43
	Hamburg	T	1	1	-	10	12	13	-	37	-	19	0.35
Greece	Athens	B	2	2	-	17	17	18	26	54	48	24	0.23
	Athens	T	1	1	-	21	29	31	78	78	177	53	0.40
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	3	-	12	14	17	-	-	-	20	0.25
	Dublin	T	2	1	-	32	28	30	-	-	-	33	0.39
	Wexford	B	1	0	16	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	8	8	9	-	27	-	-	-
	Turin	B	1	0	13	-	-	12	32	40	102	22	0.41
	Turin	T	1	1	-	10	14	14	49	37	158	27	0.53
	Verona	B	1	1	-	3	4	4	-	14	-	-	-
	Verona	T	1	1	-	4	4	4	-	13	-	-	-
Netherlands	Bergen op Zoom	B	1	0	9	-	-	-	-	32	63	-	-
	Geleen	B	3	3	-	5	7	8	19	*25*	*38*	14	0.37
	Groningen	B	1	0	1	-	-	2	5	5	26	4	0.45
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	0	-	6	-	7	13	21	56	8	0.41
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	1	-	11	10	11	-	23	-	9	0.29
	Porto	B	4	0	-	29	-	-	-	67	-	-	-
	Porto	T	4	0	-	21	-	18	-	64	-	-	-
Spain	Albacete	B	1	0	-	5	-	-	-	-	-	-	-
	Barcelona	B	2	0	10	-	-	12	-	66	-	12	0.38
	Barcelona	T	3	0	15	-	-	13	29	67	64	21	0.36
	Galdakao	B	8	7	-	9	9	9	12	17	36	13	0.31
	Huelva	B	3	3	-	10	11	10	-	58	-	-	-
	Huelva	T	3	3	-	14	17	16	-	87	-	-	-
	Oviedo	T	3	0	33	-	-	33	-	-	-	-	-
Sweden	Goteborg	B	2	2	-	4	4	4	8	17	30	6	0.30
	Umea	B	3	0	1	-	-	1	3	-	-	3	0.36
	Uppsala	B	2	0	-	-	-	-	2	-	-	-	-
	Uppsala	T	1	0	-	-	-	-	-	-	-	-	-
Switzerland	Basel	B	2	2	-	7	7	8	14	*18*	*42*	10	0.27
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	0	-	17	-	-	-	*43*	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	0	4	-	-	5	-	11	36	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 5: CO summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (mg/m3)		Current 2 year mean (mg/m3)	Current 3-year mean (mg/m3)	Past 3-year mean (mg/m3)	98 (or 95) percentile (mg/m3)		Last 10 year period (90-99)	
			Total	CO	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (mg/m3)	C.V.
Austria	Vienna	B	2	0	-	-	-	-	-	-	-	-	-
	Vienna	T	2	2	-	0.6	0.6	0.6	1.1	1.3	3.4	0.8	0.27
Belgium	Antwerp	T	1	0	-	-	-	-	-	-	-	-	-
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	1	-	0.8	0.8	0.8	-	2.9	-	-	-
	Bordeaux	T	2	2	-	0.9	1.0	1.0	-	2.8	-	-	-
	Grenoble	B	3	0	-	-	-	-	-	-	-	-	-
	Montpellier	B	2	0	-	-	-	-	-	-	-	-	-
	Paris	B	5	0	-	-	-	-	-	-	-	-	-
	Paris	T	1	1	-	1.9	2.1	2.1	-	5.0	-	2.7	0.23
Germany	Erfurt	B	1	0	-	-	-	-	-	-	-	-	-
	Hamburg	B	4	2	-	0.5	0.5	0.6	0.8	1.0	1.9	0.7	0.16
	Hamburg	T	1	1	-	0.9	1.0	1.1	-	2.6	-	1.4	0.24
Greece	Athens	B	2	2	-	1.8	1.8	1.9	2.1	6.5	7.7	1.9	0.16
	Athens	T	1	1	-	5.0	5.3	5.3	6.6	11.8	19.7	5.6	0.15
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	-	-	-	-
	Dublin	T	2	1	-	1.2	1.5	1.5	-	-	-	-	-
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	1.1	1.2	1.2	-	3.4	-	-	-
	Turin	B	1	1	-	1.1	1.2	1.2	-	4.3	-	1.9	0.49
	Turin	T	1	1	-	2.7	2.8	2.9	5.9	7.4	15.2	4.0	0.39
	Verona	B	1	1	-	1.3	1.3	1.3	-	2.7	-	-	-
	Verona	T	1	1	-	1.8	1.8	1.9	-	5.5	-	-	-
Netherlands	Bergen op Zoom	B	1	0	-	-	-	-	-	-	1.2	-	-
	Geleen	B	3	0	-	-	-	-	-	-	-	-	-
	Groningen	B	1	1	0.3	-	-	0.3	-	0.6	-	-	-
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	1	-	1.0	0.9	0.9	1.6	8.0	9.0	1.2	0.30
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	1	-	1.2	1.2	1.1	-	3.4	-	-	-
	Porto	B	4	2	-	0.5	-	-	-	2.1	-	-	-
	Porto	T	4	2	-	0.8	0.6	0.6	-	2.4	-	1.5	0.57
Spain	Albacete	B	1	1	-	0.3	-	-	-	-	-	-	-
	Barcelona	B	2	2	-	1.0	0.8	0.8	-	-	-	1.0	0.26
	Barcelona	T	3	3	-	1.5	1.7	1.6	1.9	-	-	1.8	0.10
	Galdakao	B	8	1	-	0.8	0.8	0.9	-	-	-	-	-
	Huelva	B	3	1	-	1.3	1.4	1.0	-	3.0	-	-	-
	Huelva	T	3	3	-	1.7	1.9	1.6	-	3.2	-	-	-
	Oviedo	T	3	3	1.3	-	-	1.3	-	-	-	-	-
Sweden	Goteborg	B	2	1	-	0.4	0.4	0.4	1.0	1.1	2.8	0.7	0.39
	Umea	B	3	0	-	-	-	-	-	-	-	-	-
	Uppsala	B	2	0	-	-	-	-	-	-	-	-	-
	Uppsala	T	1	1	-	0.7	0.6	-	-	-	-	-	-
Switzerland	Basel	B	2	1	-	0.4	0.4	0.4	0.6	0.8	1.7	0.5	0.19
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	1	-	2.1	1.7	1.5	-	3.5	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	1	0.4	-	-	0.4	-	-	-	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 6: NO_2 summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (µg/m3)		Current 2 year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	NO2	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	2	-	28	32	34	34	*66*	*99*	35	0.11
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	50	51	52	50	95	127	50	0.07
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	1	-	25	25	27	-	-	-	-	-
France	Bordeaux	B	5	5	-	27	27	27	-	75	-	-	-
	Bordeaux	T	2	2	-	45	47	47	-	95	-	-	-
	Grenoble	B	3	2	-	36	36	34	41	88	111	38	0.14
	Montpellier	B	2	1	-	23	20	22	-	74	-	-	-
	Paris	B	5	5	-	46	48	48	-	103	-	56	0.05
	Paris	T	1	1	-	72	72	72	-	140	-	72	0.08
Germany	Erfurt	B	1	1	-	32	33	35	-	-	-	37	0.19
	Hamburg	B	4	4	-	32	32	32	39	71	87	34	0.09
	Hamburg	T	1	1	-	56	55	56	-	121	-	60	0.09
Greece	Athens	B	2	2	-	42	44	44	38	121	121	40	0.08
	Athens	T	1	1	-	91	95	95	116	165	169	103	0.10
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	-	-	-	-
	Dublin	T	2	1	-	66	-	75	48	209	162	67	0.25
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	35	40	41	-	93	-	-	-
	Turin	B	1	1	-	50	49	48	66	125	188	55	0.18
	Turin	T	1	1	-	78	78	78	91	155	-	84	0.09
	Verona	B	1	1	-	21	22	22	-	67	-	-	-
	Verona	T	1	1	-	56	54	57	-	113	-	-	-
Netherlands	Bergen op Zoom	B	1	1	27	-	-	-	-	64	62	-	-
	Geleen	B	3	3	-	33	35	35	46	81	105	39	0.13
	Groningen	B	1	1	13	-	-	14	16	47	55	15	0.08
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	1	-	14	14	14	25	42	95	18	0.31
Norway	Bergen	B	1	1	-	34	36	37	-	-	-	-	-
Portugal	Coimbra	T	1	1	-	50	56	51	-	124	-	-	-
	Porto	B	4	3	-	25	-	-	-	78	-	-	-
	Porto	T	4	1	-	50	-	28	-	112	-	-	-
Spain	Albacete	B	1	1	-	17	-	-	-	55	-	-	-
	Barcelona	B	2	2	-	27	33	35	-	91	-	43	0.17
	Barcelona	T	3	3	-	67	65	62	55	145	139	56	0.10
	Galdakao	B	8	4	-	28	31	32	-	60	-	41	0.13
	Huelva	B	3	3	-	21	21	21	-	68	-	-	-
	Huelva	T	3	3	-	34	38	36	-	88	-	-	-
	Oviedo	T	3	3	50	-	-	48	-	-	-	-	-
Sweden	Goteborg	B	2	2	-	27	26	27	30	79	86	28	0.07
	Umea	B	3	1	22	-	-	23	27	-	-	30	0.12
	Uppsala	B	2	1	-	14	15	15	21	-	-	18	0.16
	Uppsala	T	1	1	-	29	28	-	-	-	-	-	-
Switzerland	Basel	B	2	2	-	31	31	33	42	*63*	*82*	38	0.11
UK	Caerphilly	B	9	9	-	25	26	24	-	-	-	-	-
	Cambridge	B	1	1	-	30	32	31	-	-	-	28	0.16
	Cambridge	T	4	1	-	44	43	46	-	-	-	-	-
	Dundee	B	3	3	-	25	22	20	-	-	-	-	-
	Dundee	T	5	5	-	36	34	33	-	-	-	-	-
	Ipswich	T	6	6	-	29	29	29	-	-	-	-	-
	Norwich	B	2	1	25	-	-	26	-	67	-	-	-
	Norwich	T	1	1	32	-	-	36	-	-	-	-	-

Table 7: NO summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (µg/m3)		Current 2 year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	NO	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	2	-	10	11	12	19	-	-	15	0.25
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	27	30	32	51	152	253	41	0.22
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	4	-	21	21	21	-	140	-	-	-
	Bordeaux	T	2	2	-	47	54	54	-	220	-	-	-
	Grenoble	B	3	2	-	23	21	22	32	183	221	28	0.18
	Montpellier	B	2	1	-	10	7	8	-	63	-	-	-
	Paris	B	5	5	-	19	22	24	-	113	-	26	0.18
	Paris	T	1	1	-	107	111	111	-	347	-	137	0.19
Germany	Erfurt	B	1	1	-	15	17	20	30	-	-	26	0.21
	Hamburg	B	4	4	-	15	16	17	22	97	118	20	0.16
	Hamburg	T	1	1	-	73	74	79	-	320	-	91	0.14
Greece	Athens	B	2	2	-	30	30	30	38	222	285	33	0.17
	Athens	T	1	1	-	126	128	130	191	411	641	160	0.18
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	-	-	-	-
	Dublin	T	2	0	-	-	-	-	-	-	-	-	-
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	35	38	39	-	149	-	-	-
	Turin	B	1	1	-	46	49	48	85	288	271	62	0.31
	Turin	T	1	1	-	72	75	75	129	327	444	95	0.29
	Verona	B	1	1	-	15	13	13	-	113	-	-	-
	Verona	T	1	1	-	93	85	89	-	407	-	-	-
Netherlands	Bergen op Zoom	B	1	1	7	-	-	-	-	47	82	-	-
	Geleen	B	3	0	-	-	-	-	-	-	-	-	-
	Groningen	B	1	1	2	-	-	3	7	18	51	4	0.61
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	1	-	27	24	26	38	276	485	29	0.30
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	1	-	70	74	71	-	265	-	-	-
	Porto	B	4	3	-	21	-	-	-	146	-	-	-
	Porto	T	4	2	-	122	-	20	-	401	-	-	-
Spain	Albacete	B	1	1	-	8	-	-	-	-	-	-	-
	Barcelona	B	2	0	-	-	-	-	-	-	-	-	-
	Barcelona	T	3	0	-	-	-	-	-	-	-	-	-
	Galdakao	B	8	1	-	14	26	31	-	78	-	33	0.34
	Huelva	B	3	3	-	7	8	8	-	48	-	-	-
	Huelva	T	3	3	-	15	16	17	-	80	-	-	-
	Oviedo	T	3	0	-	-	-	-	-	-	-	-	-
Sweden	Goteborg	B	2	2	-	22	20	20	28	115	321	25	0.26
	Umea	B	3	0	-	-	-	-	-	-	-	-	-
	Uppsala	B	2	0	-	-	-	-	-	-	-	-	-
	Uppsala	T	1	1	-	30	31	-	-	-	-	-	-
Switzerland	Basel	B	2	2	-	13	14	16	22	*62*	*106*	19	0.18
UK	Caerphilly	B	9	1	-	29	29	30	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	1	-	58	46	49	-	*154*	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	0	-	-	-	-	-	-	-	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 8: TSP summary statistics

Country	City	Station type	Number of stations		Current 1-year mean		Current 2 year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	TSP	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	0	-	-	-	-	-	-	-	-	-
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	-	-	-	75	-	163	71	0.21
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	0	-	-	-	-	-	-	-	-	-
	Bordeaux	T	2	0	-	-	-	-	-	-	-	-	-
	Grenoble	B	3	0	-	-	-	-	-	-	-	-	-
	Montpellier	B	2	0	-	-	-	-	-	-	-	-	-
	Paris	B	5	0	-	-	-	-	-	-	-	-	-
	Paris	T	1	0	-	-	-	-	-	-	-	-	-
Germany	Erfurt	B	1	1	-	40	42	43	72	-	-	59	0.23
	Hamburg	B	4	4	-	36	36	37	47	99	163	43	0.11
	Hamburg	T	1	0	-	-	-	-	-	-	-	-	-
Greece	Athens	B	2	0	-	-	-	-	-	-	-	-	-
	Athens	T	1	0	-	-	-	-	-	-	-	-	-
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	-	-	-	-
	Dublin	T	2	0	-	-	-	-	-	-	-	-	-
	Wexford	B	1	0	42	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	56	63	54	-	173	-	-	-
	Turin	B	1	1	-	79	87	91	121	181	277	101	0.13
	Turin	T	1	1	-	95	106	115	166	208	364	129	0.21
	Verona	B	1	1	-	30	31	29	-	69	-	-	-
	Verona	T	1	1	-	35	41	44	-	91	-	-	-
Netherlands	Bergen op Zoom	B	1	0	-	-	-	-	-	-	-	-	-
	Geleen	B	3	0	-	-	-	-	-	-	-	-	-
	Groningen	B	1	0	-	-	-	-	-	-	-	-	-
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	1	-	34	32	33	34	-	-	34	0.12
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	0	-	-	-	-	-	-	-	-	-
	Porto	B	4	0	-	-	-	-	-	-	-	-	-
	Porto	T	4	0	-	-	-	-	-	-	-	-	-
Spain	Albacete	B	1	0	-	-	-	-	-	-	-	-	-
	Barcelona	B	2	2	116	-	-	109	-	-	-	-	-
	Barcelona	T	3	1	-	149	140	140	173	-	-	147	0.14
	Galdakao	B	8	4	-	46	48	53	67	194	-	71	0.26
	Huelva	B	3	0	-	-	-	-	-	-	-	-	-
	Huelva	T	3	0	-	-	-	-	-	-	-	-	-
	Oviedo	T	3	3	68	-	-	67	-	*102*	-	-	-
Sweden	Goteborg	B	2	0	-	-	-	-	-	-	-	-	-
	Umea	B	3	0	-	-	-	-	-	-	-	-	-
	Uppsala	B	2	0	-	-	-	-	-	-	-	-	-
	Uppsala	T	1	1	-	22	20	-	-	-	-	-	-
Switzerland	Basel	B	2	1	30	-	-	32	38	*65*	*81*	35	0.11
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	0	-	-	-	-	-	-	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	0	-	-	-	-	-	-	-	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 9: Black smoke summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (µg/m3)		Current 2-year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	BS	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	0	-	-	-	-	-	-	-	-	-
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	21	22	-	-	55	-	-	-
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	0	-	-	-	-	-	-	-	-	-
	Bordeaux	T	2	0	-	-	-	-	-	-	-	-	-
	Grenoble	B	3	1	-	15	18	20	-	67	-	23	0.24
	Montpellier	B	2	0	-	-	-	-	-	-	-	-	-
	Paris	B	5	1	-	17	20	21	-	46	-	23	0.23
	Paris	T	1	0	-	-	-	-	-	-	-	-	-
Germany	Erfurt	B	1	0	-	-	-	-	-	-	-	-	-
	Hamburg	B	4	0	-	-	-	-	-	-	-	-	-
	Hamburg	T	1	0	-	-	-	-	-	-	-	-	-
Greece	Athens	B	2	1	-	28	26	26	21	75	81	24	0.15
	Athens	T	1	1	-	105	111	108	91	205	239	102	0.12
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	3	-	10	9	10	-	-	-	11	0.21
	Dublin	T	2	1	-	12	11	12	-	-	-	11	0.25
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	0	-	-	-	-	-	-	-	-	-
	Turin	B	1	0	-	-	-	-	-	-	-	-	-
	Turin	T	1	0	-	-	-	-	-	-	-	-	-
	Verona	B	1	0	-	-	-	-	-	-	-	-	-
	Verona	T	1	0	-	-	-	-	-	-	-	-	-
Netherlands	Bergen op Zoom	B	1	0	-	-	-	-	-	-	76	-	-
	Geleen	B	3	0	-	-	-	-	-	-	-	-	-
	Groningen	B	1	0	-	-	-	-	-	-	-	-	-
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	0	-	-	-	-	-	-	-	-	-
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	0	-	-	-	-	-	-	-	-	-
	Porto	B	4	0	-	-	-	-	-	-	-	-	-
	Porto	T	4	0	-	-	-	-	-	-	-	-	-
Spain	Albacete	B	1	0	-	-	-	-	-	-	-	-	-
	Barcelona	B	2	0	-	-	-	-	-	-	-	-	-
	Barcelona	T	3	0	-	-	-	-	-	-	-	-	-
	Galdakao	B	8	3	-	34	33	34	27	72	69	32	0.19
	Huelva	B	3	0	-	-	-	-	-	-	-	-	-
	Huelva	T	3	0	-	-	-	-	-	-	-	-	-
	Oviedo	T	3	0	-	-	-	-	-	-	-	-	-
Sweden	Goteborg	B	2	1	-	4	4	4	6	17	35	5	0.23
	Umea	B	3	0	6	-	-	7	-	-	-	-	-
	Uppsala	B	1	0	-	-	-	-	2	-	-	-	-
	Uppsala	T	1	0	-	-	-	-	-	-	-	-	-
Switzerland	Basel	B	2	0	-	-	-	-	-	-	-	-	-
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	0	-	-	-	-	-	-	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	1	-	-	-	-	-	-	40	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 10: PM_{10} summary statistics

Country	City	Station type	Number of stations		Current 1-year mean (µg/m3)		Current 2 year mean (µg/m3)	Current 3-year mean (µg/m3)	Past 3-year mean (µg/m3)	98 *(or 95)* percentile (µg/m3)		Last 10 year period (90-99)	
			Total	PM10	1998	1999	(98-99)	(97-99)	(90-92)	1999 (or 98)	1990 (or 91)	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	2	-	29	29	29	44	67	*138*	34	0.20
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	25	28	30	-	54	-	-	-
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	5	-	23	23	23	-	51	-	-	-
	Bordeaux	T	2	2	-	27	28	28	-	60	-	-	-
	Grenoble	B	3	1	-	24	18	20	-	70	-	23	0.19
	Montpellier	B	2	1	-	23	-	-	-	52	-	-	-
	Paris	B	5	1	-	22	23	24	-	46	-	-	-
	Paris	T	1	0	-	-	-	-	-	-	-	-	-
Germany	Erfurt	B	1	0	-	-	-	-	-	-	-	-	-
	Hamburg	B	4	0	-	-	-	-	-	-	-	-	-
	Hamburg	T	1	0	-	-	-	-	-	-	-	-	-
Greece	Athens	B	2	0	-	-	-	-	-	-	-	-	-
	Athens	T	1	0	-	-	-	-	-	-	-	-	-
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	94	-	-	-
	Dublin	T	2	1	-	49	49	47	-	94	-	-	-
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	0	-	-	-	-	-	-	-	-	-
	Turin	B	1	0	-	-	-	-	-	-	-	-	-
	Turin	T	1	0	-	-	-	-	-	-	-	-	-
	Verona	B	1	0	-	-	-	-	-	-	-	-	-
	Verona	T	1	0	-	-	-	-	-	-	-	-	-
Netherlands	Bergen op Zoom	B	1	0	-	-	-	-	-	-	-	-	-
	Geleen	B	3	1	-	28	29	32	-	-	-	37	0.17
	Groningen	B	1	0	-	-	-	-	-	61	-	-	-
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	1	-	22	23	23	30	115	109	25	0.23
Norway	Bergen	B	1	1	-	16	17	18	-	-	-	-	-
Portugal	Coimbra	T	1	0	-	-	-	-	-	-	-	-	-
	Porto	B	4	3	-	42	-	-	-	*90*	-	-	-
	Porto	T	4	1	-	47	-	-	-	-	-	-	-
Spain	Albacete	B	1	1	-	43	-	-	-	-	-	-	-
	Barcelona	B	2	0	-	-	-	-	-	-	-	-	-
	Barcelona	T	3	0	-	-	-	-	-	-	-	-	-
	Galdakao	B	8	0	-	-	-	-	-	-	-	-	-
	Huelva	B	3	3	-	27	35	36	-	82	-	-	-
	Huelva	T	3	3	-	38	41	38	-	106	-	-	-
	Oviedo	T	3	0	-	-	-	-	-	-	-	-	-
Sweden	Goteborg	B	2	1	-	13	13	13	15	50	52	14	0.10
	Umea	B	3	0	-	-	-	-	-	-	-	-	-
	Uppsala	B	2	0	-	-	-	-	-	-	-	-	-
	Uppsala	T	1	1	-	21	20	-	-	-	-	-	-
Switzerland	Basel	B	2	2	-	22	23	25	-	*49*	-	-	-
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	1	-	21	19	21	-	-	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-
	Norwich	B	2	1	20	-	-	21	-	-	-	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-

Table 11: O_3 summary statistics

Country	City	Station type	Number of stations		Current 1-year summer mean (µg/m3)		Current 2 year summer mean (µg/m3)	Current 3-year summer mean (µg/m3)	Past 3-year summer mean (µg/m3)	Current 3-year monthly max. mean (µg/m3)	Past 3-year monthly maximum mean (µg/m3)	Last 10 year period summer mean (90-99)		Last 10 year period annual mean (90-99)	
			Total	O3	1998	1999	(98-99)	(97-99)	(90-92)	(97-99)	(90-92)	Mean (µg/m3)	C.V.	Mean (µg/m3)	C.V.
Austria	Vienna	B	2	2	-	64	66	66	58	74	71	63	0.08	44	0.10
	Vienna	T	2	0	-	-	-	-	-	-	-	-	-	-	-
Belgium	Antwerp	T	1	1	-	43	39	39	-	52	-	-	-	-	-
Denmark	Aarhus	T	1	0	-	-	-	-	-	-	-	-	-	-	-
Estonia	Tartu	T	1	0	-	-	-	-	-	-	-	-	-	-	-
France	Bordeaux	B	5	4	-	67	68	68	-	81	-	-	-	-	-
	Bordeaux	T	2	0	-	-	-	-	-	-	-	-	-	-	-
	Grenoble	B	3	2	-	55	59	58	-	70	-	54	0.09	36	0.10
	Montpellier	B	2	1	-	75	80	78	-	87	-	-	-	-	-
	Paris	B	5	0	-	-	-	-	-	-	-	-	-	32	0.15
	Paris	T	1	0	-	-	-	-	-	-	-	-	-	-	-
Germany	Erfurt	B	1	1	-	57	54	51	65	60	80	53	0.18	40	0.16
	Hamburg	B	4	0	-	-	-	-	-	59	55	-	-	35	0.12
	Hamburg	T	1	0	-	-	-	-	-	-	-	-	-	-	-
Greece	Athens	B	2	2	-	82	83	82	74	96	103	77	0.10	59	0.08
	Athens	T	1	1	-	18	26	27	40	41	63	34	0.24	28	0.17
Iceland	Reykjavik	B	1	0	-	-	-	-	-	-	-	-	-	-	-
Ireland	Dublin	B	3	0	-	-	-	-	-	-	-	-	-	-	-
	Dublin	T	2	0	-	-	-	-	-	-	-	-	-	-	-
	Wexford	B	1	0	-	-	-	-	-	-	-	-	-	-	-
Italy	Pavia	B	1	1	-	65	66	61	-	81	-	-	-	-	-
	Turin	B	1	1	-	68	66	66	-	84	-	-	-	-	-
	Turin	T	1	0	-	-	-	-	-	-	-	-	-	-	-
	Verona	B	1	0	-	-	-	-	-	-	-	-	-	-	-
	Verona	T	1	1	-	60	64	65	-	218	-	-	-	-	-
Netherlands	Bergen op Zoom	B	1	0	-	-	-	-	-	-	-	-	-	38	0.06
	Geleen	B	3	0	-	-	-	-	-	-	-	-	-	-	-
	Groningen	B	1	0	-	-	-	-	-	-	-	-	-	46	0.08
	Groningen	T	1	0	-	-	-	-	-	-	-	-	-	-	-
New Zealand	Christchurch	B	1	0	-	-	-	-	-	-	-	-	-	-	-
Norway	Bergen	B	1	0	-	-	-	-	-	-	-	-	-	-	-
Portugal	Coimbra	T	1	1	-	32	23	23	-	36	-	-	-	-	-
	Porto	B	4	4	-	47	-	-	-	-	-	-	-	-	-
	Porto	T	4	1	-	7	-	39	-	49	-	-	-	-	-
Spain	Albacete	B	1	0	-	-	-	-	-	-	-	-	-	-	-
	Barcelona	B	2	0	-	-	-	-	-	-	-	-	-	-	-
	Barcelona	T	3	0	-	-	-	-	-	-	-	-	-	-	-
	Galdakao	B	8	3	-	48	39	38	31	-	-	34	0.21	27	0.22
	Huelva	B	3	2	-	74	78	77	-	87	-	-	-	-	-
	Huelva	T	3	1	89	-	-	82	-	83	-	-	-	-	-
	Oviedo	T	3	3	24	-	-	29	-	35	-	-	-	-	-
Sweden	Goteborg	B	2	2	-	54	56	58	55	67	63	57	0.08	47	0.09
	Umea	B	3	1	-	59	57	58	56	83	74	57	0.04	55	0.05
	Uppsala	B	2	1	-	61	55	55	-	70	-	-	-	-	-
	Uppsala	T	1	0	-	-	-	-	-	-	-	-	-	-	-
Switzerland	Basel	B	2	2	-	53	57	55	49	39	31	51	0.08	35	0.10
UK	Caerphilly	B	9	0	-	-	-	-	-	-	-	-	-	-	-
	Cambridge	B	1	0	-	-	-	-	-	-	-	-	-	-	-
	Cambridge	T	4	1	-	34	39	38	-	45	-	-	-	-	-
	Dundee	B	3	0	-	-	-	-	-	-	-	-	-	-	-
	Dundee	T	5	0	-	-	-	-	-	-	-	-	-	-	-
	Ipswich	T	6	0	-	-	-	-	-	-	-	-	-	-	-
	Norwich	B	2	0	-	-	-	-	-	-	-	-	-	-	-
	Norwich	T	1	0	-	-	-	-	-	-	-	-	-	-	-

Table 12: Distribution of cities according to the number of stations included in the calculation of the traffic & background within-city variability

Pollutant	Year	Number of cities								Total number of cities
		with 2 stations	with 3 stations	with 4 stations	with 5 stations	with 6 stations	with 7 stations	with 8 stations	with 9 stations	
SO2	1990(91)	8	2	1						11
	1999(98)	5	4	4	2	1	1			17
CO	1990(91)	4	1							5
	1999(98)	3	4	1	2					10
NO2	1990(91)	7	1	1						9
	1999(98)	7	4	2	3	3	1	1	1	22
NO	1990(91)	3	1	1						5
	1999(98)	7	2	1	2	3				15
TSP	1990(91)	2		1						3
	1999(98)	2	1	2						5
BS	1990(91)	1	1							2
	1999(98)	2	1	1						4
PM10	1990(91)									0
	1999(98)	3		2		1	1			7
O3	1990(91)	1	1							2
	1999(98)	5	3	2	1					11

Table 13: Completeness of air quality data in Europe

Country	City	station #	station #	Year	Completeness in % for each pollutant							
		background	traffic		PM10	TSP	BS	SO2	NO2	CO	O3	PM2,5
AUSTRIA	**Vienna**	11		1998		100		100	100	100	100	
BELGIUM	**Antwerp**	2		1998			72					
DENMARK	**(national)**	3	3	1998		96		97	92	87	96	
ESTONIA	**(national)**	1	1	1998				98	94		88	
FRANCE	**Bordeaux**	7		1999								
	Grenoble	2		1999								
	Monpellier	1		1999								
	Paris	1		1999								
GERMANY	**Erfurt**	1	2	1998		100		100	100		100	
	Hamburg	9		1998		100		100	75		99	
GREECE	**Athens**	1	4	1997			100	100	100		100	
IRELAND	**Dublin**	1	2	1996			100					
ITALY	**Pavia**	1		1999								
	Torino		1	1998		98						
	Verona	1		1999								
NETHERLANDS	**(national)**	6	11	1998	99		97	98	96	99	99	
PORTUGAL	**(national)**	3	3	1997					100	98	93	
SPAIN	**Barcelona**		3	1998		95		79	95	90	89	
	Huelva		1	1998	100			100	99	91		
	Oviedo		1	1998		85		86	73	81	93	
SWEDEN	**Gothenburg**	1		1998	88			85	100		100	
SWITZERLAND	**Basel**	1		1998					94	98	100	
UNITED KINGDOM	**(national)**	37		1999	97			97	96	97	99	82

Note: For the calculation of the completeness at country scale were used data from the following cities:
Denmark: Aalborg, Copenhagen, Odense Estonia: Tallinn
Netherlands: Amsterdam, Apeldoorn, The Hague, Dordrecht, Eindhoven, Haarlem, Rotterdam, Utrecht
UK: Belfast, Birmingham, Bristol, Carrdiff, Edinburgh, Glasgow, Liverpool, London, Manchester, Newcastle, Norwich, Oxford

Table 14: Summary time-series statistics per pollutant

Pollutant	**Total number of time-series reported**			**Pollutant**	**Average length of time-series reported [Number of Years]**		
	Annual Avg.	98 Percentile	95 Percentile		Annual Avg.	98 Percentile	95 Percentile
SO2	83	64	9	SO2	8	7	9
CO	49	31	5	CO	7	6	9
NO2	111	71	9	NO2	6	7	6
NO	68	56	7	NO	6	6	5
TSP	29	16	5	TSP	8	8	7
BS	17	13	0	BS	11	12	0
PM10	38	22	12	PM10	4	4	3
O3	59	44	43	O3	6	6	6
Total all pollutants	*454*	*317*	*90*	*Average all pollutants*	*7*	*7*	*6*

O_3: 98 percentile = summer mean, 95 percentile = maximum monthly mean

Table 15: Spatial Pearson correlation of the 'current 3-year annual mean' pollutant concentrations across Europe

Background stations only	bNO2curr	bNO_curr	bCO_curr	bSO2curr	bO3_curr	bBS_curr	bTSPcurr		**Traffic stations only**	tNO2curr	tNO_curr	tCO_curr	tSO2curr	tO3_curr
bNO_curr	0.6261								tNO_curr	0.8819				
p	0.0054								p	0.0003				
N	18								N	11				
bCO_curr	0.4947	0.5127							tCO_curr	0.814	0.711			
p	0.0722	0.0883							p	0.0007	0.0211			
N	14	12							N	13	10			
bSO2curr	0.7426	0.507	0.7013						tSO2curr	0.3142	0.1865	0.3395		
p	0.0001	0.0378	0.0052						p	0.3467	0.6584	0.3373		
N	21	17	14						N	11	8	10		
bO3_curr	0.0602	-0.2375	0.5921	0.4069					tO3_curr	-0.346	-0.3822	-0.1774	-0.4909	
p	0.8381	0.4573	0.1220	0.1676					p	0.4012	0.3975	0.7036	0.2633	
N	14	12	8	13					N	8	7	7	7	
bBS_curr	0.5481	0.8865	0.5426	0.448	-0.1625									
p	0.2601	0.0451	0.6349	0.3135	0.7941									
N	6	5	3	7	5									
bTSPcurr	0.588	0.9001	0.2165	0.8404	0.4897				tTSPcurr	0.5764		0.2927	-0.0345	
p	0.0959	0.0023	0.6066	0.0046	0.4023				p	0.4236		0.7073	0.9655	
N	9	8	8	9	5	0			N	4	2	4	4	2
bPM10_curr	-0.0521	-0.7196	0.6875	0.5016	0.7698	0.9464			tPM10_curr	0.5786	-0.8292	0.341	0.6458	0.8709
p	0.8792	0.0442	0.1312	0.1396	0.0734	0.2094			p	0.3068	0.1708	0.659	0.553	0.3271
N	11	8	6	10	6	3	2		N	5	4	4	3	3

p is the significance and N is the number of centres involved

Table 16: Spatial Pearson correlation of the ‘past 3-year annual mean’ pollutant concentrations across Europe

Background stations only	bNO2past	bNO_past	bCO_past	bSO2past	bO3_past	bBS_past	bTSPpast		**Traffic stations only**	tNO2past	tNO_past	tCO_past	tSO2past
bNO_past	0.8195								tNO_past	0.997			
p	0.0069								p	0.0495			
N	9								N	3			
bCO_past	-0.3555	0.9486							tCO_past	0.9617			
p	0.5571	0.0139							p	0.1768			
N	5	5							N	3	2		
bSO2past	0.8014	0.3105	0.3147						tSO2past	0.9527	0.9635	0.8789	
p	0.0017	0.3825	0.606						p	0.0473	0.1725	0.3165	
N	12	10	5						N	4	3	3	
bO3_past	0.0143	0.8196	0.9998	0.4495									
p	0.9818	0.0894	0.0134	0.3116									
N	5	5	3	7									
bBS_past	0.9248			0.6876	-0.3355								
p	0.2485			0.3124	0.7822								
N	3	2	2	4	3								
bTSPpast	0.9299	0.8758	-0.6585	0.404	0.1124				tTSPpast	0.5411			0.1556
p	0.0701	0.0515	0.5424	0.427	0.9283				p	0.636			0.9006
N	4	5	3	6	3	0			N	3	2	2	3
bPM10_past	0.4329	-0.4387		0.9953									
p	0.7149	0.7109		0.0619									
N	3	3	2	3	2	0	0						

p is the significance and N is the number of centres involved

Table 17: Pearson correlation between 'current' and 'past 3-year mean' concentrations across Europe

Background stations only	corr. coef.	p	N		**Traffic stations only**	corr. coef.	p	N
NO_2	0.8922	0.0001	12		NO_2	0.8464	0.0706	5
NO	0.9738	0.0000	10		NO	0.9911	0.0849	3
CO	0.9338	0.0202	5		CO	0.9122	0.0878	4
SO_2	0.3952	0.1814	13		SO_2	0.8248	0.1752	4
O_3	0.8341	0.0196	7		O_3			0
BS	1	0.005	3		BS			0
TSP	0.9666	0.0017	6		TSP			2
PM_{10}	0.995	0.0638	3		PM_{10}			0

p is the significance and N is the number of centres involved

Table 18: Summary meteorological statistics (3-year means 97-99)

Country	City	m.a.s.	avg. Temp.	max. month. Mean	min. month. Mean	# of raining days	precipitation
Austria	Vienna	180	11.9	22.2	0.2	95	717.7
Belgium	Antwerp	5	11.7	20.2	3.0	141	826.6
Denmark	Aarhus						
Estonia	Tartu	68	5.9	17.9	-4.9	110	569.0
France	Bordeaux	50	14.3	22.4	7.0		
	Grenoble	210	12.5	22.1	2.1	83	815.0
	Montpellier	8	13.7	23.5	6.2	53	
	Paris	75	12.8	16.6	9.0	115	694.7
Germany	Erfurt						
	Hamburg		9.8	19.5	0.3	130	813.6
Greece	Athens	107	18.7	29.3	9.9	38	
Ireland	Dublin	71	9.9	15.6	4.8	143	757.0
	Wexford		11.1	15.9	6.7		
Iceland	Reykjavik						
Italy	Pavia	70	11.1	21.4	1.3	83	755.0
	Turin	210	14.7	24.6	4.7	59	
	Verona	65	12.5	18.0	7.1	78	575.3
Netherlands	Bergen op Zoom						
	Geleen		12.6	20.8	4.8		
	Groningen						
New Zealand	Christchurch	37	11.8	18.2	5.9	82	585.3
Norway	Bergen	10	8.1	15.7	2.1	216	2706.3
Portugal	Coimbra		15.7	21.8	11.2	101	948.7
	Porto						
Spain	Albacete		17.9	26.7	6.2		
	Barcelona	8	16.5	19.3	13.8	38	382.0
	Galdakao		14.9	19.7	10.1	167	1078.6
	Huelva	50	20.8	28.4	13.2		
	Oviedo	336	13.7	17.8	9.5	122	901.0
Sweden	Goteborg	10	8.7	18.7	-0.2	134	1084.3
	Umea	20	3.4	16.4	-6.7		650.3
	Uppsala	25	6.8	18.3	-2.0	109	596.3
Switzerland	Basel	316	10.6	20.1	0.6	122	925.0
UK	Caerphilly						
	Cambridge						
	Dundee						
	Ipswich						
	Norwich						

m.a.s.: meters above sealevel / **avg. Temp.:** average temperature (3-year mean 97-99) / **max. month. Mean:** maximum monthly mean (3-year mean 97-99) / **min. month. Mean:** minimum monthly mean (3-year mean 97-99) / **# of raining days:** number of raining days (3-year mean 97-99) / **precipitation:** precipitation in mm (3-year mean 97-99)

9 Figures

Figure 1: Map of Europe including the ECRHS cities

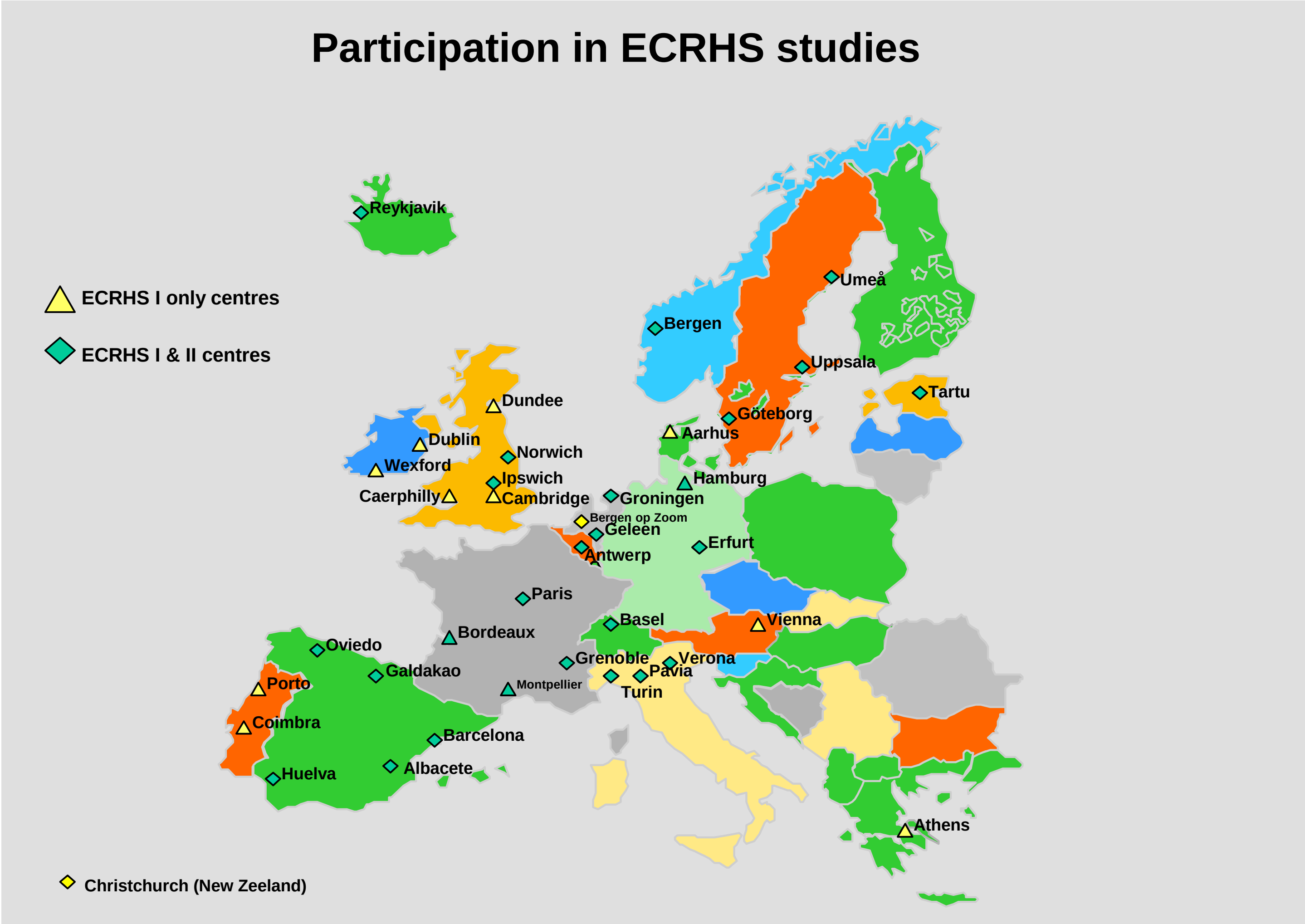


Figure 2: SO_2 comparison past & present

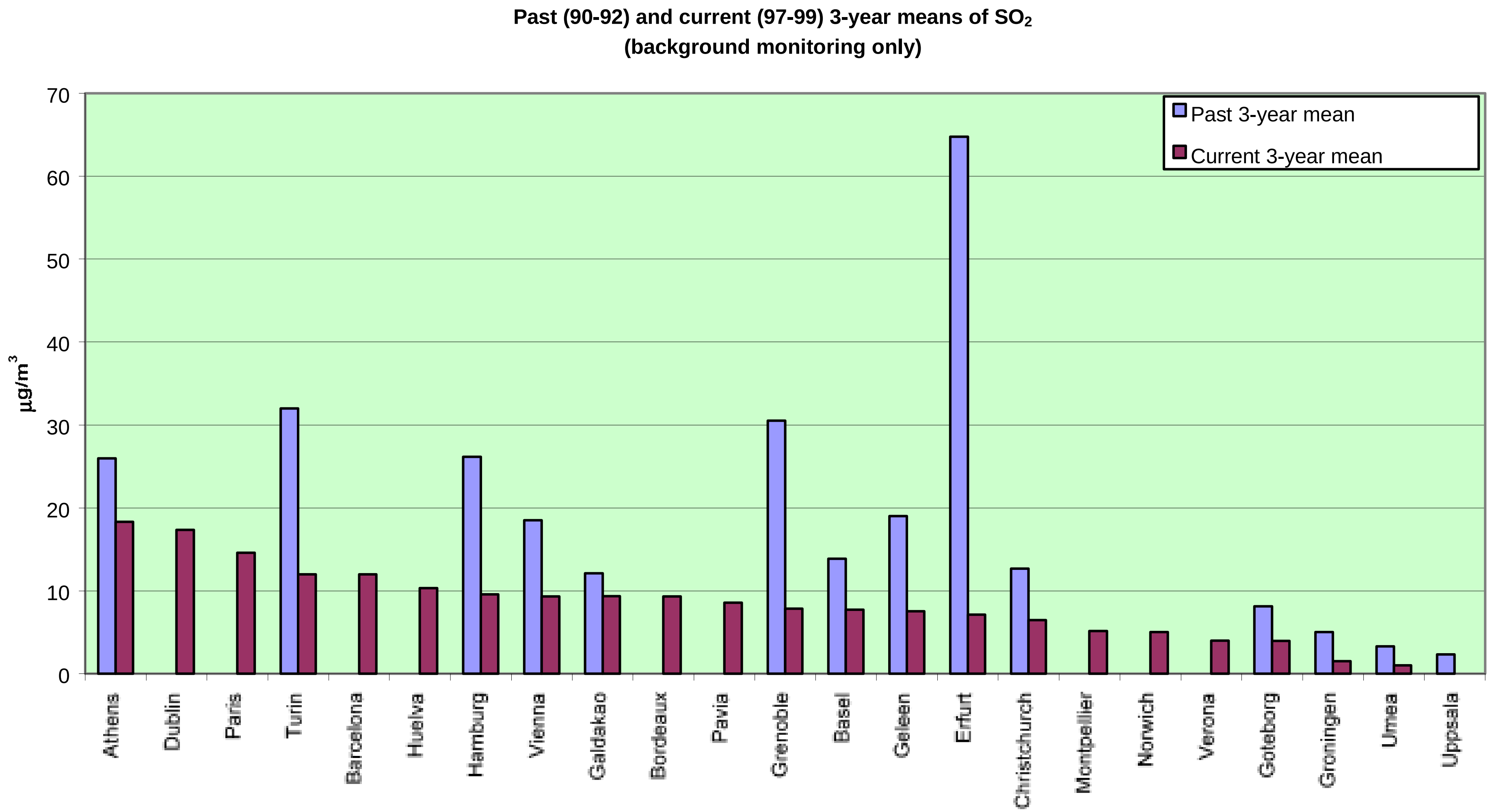


Figure 3: CO comparison past & present

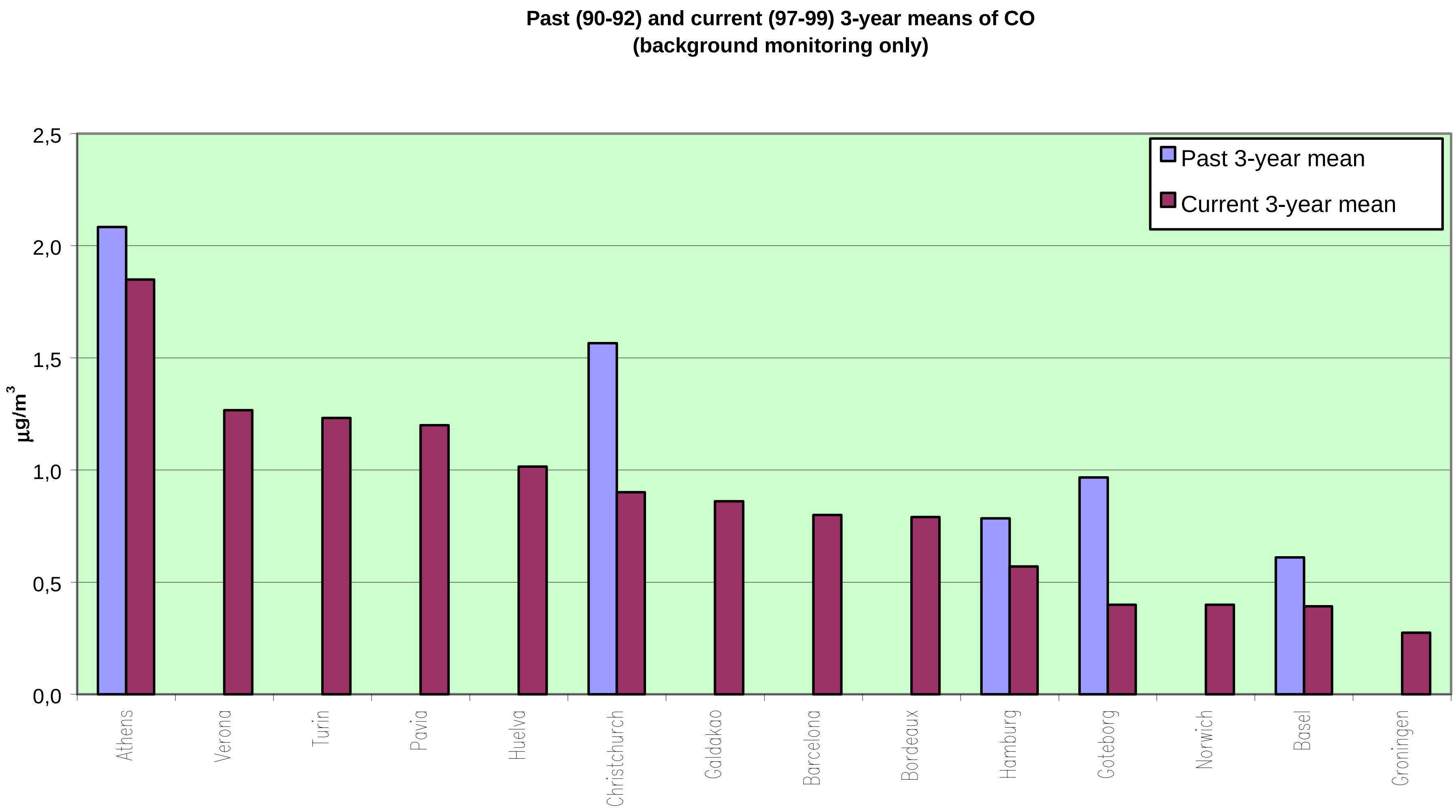


Figure 4: NO_2 comparison past & present

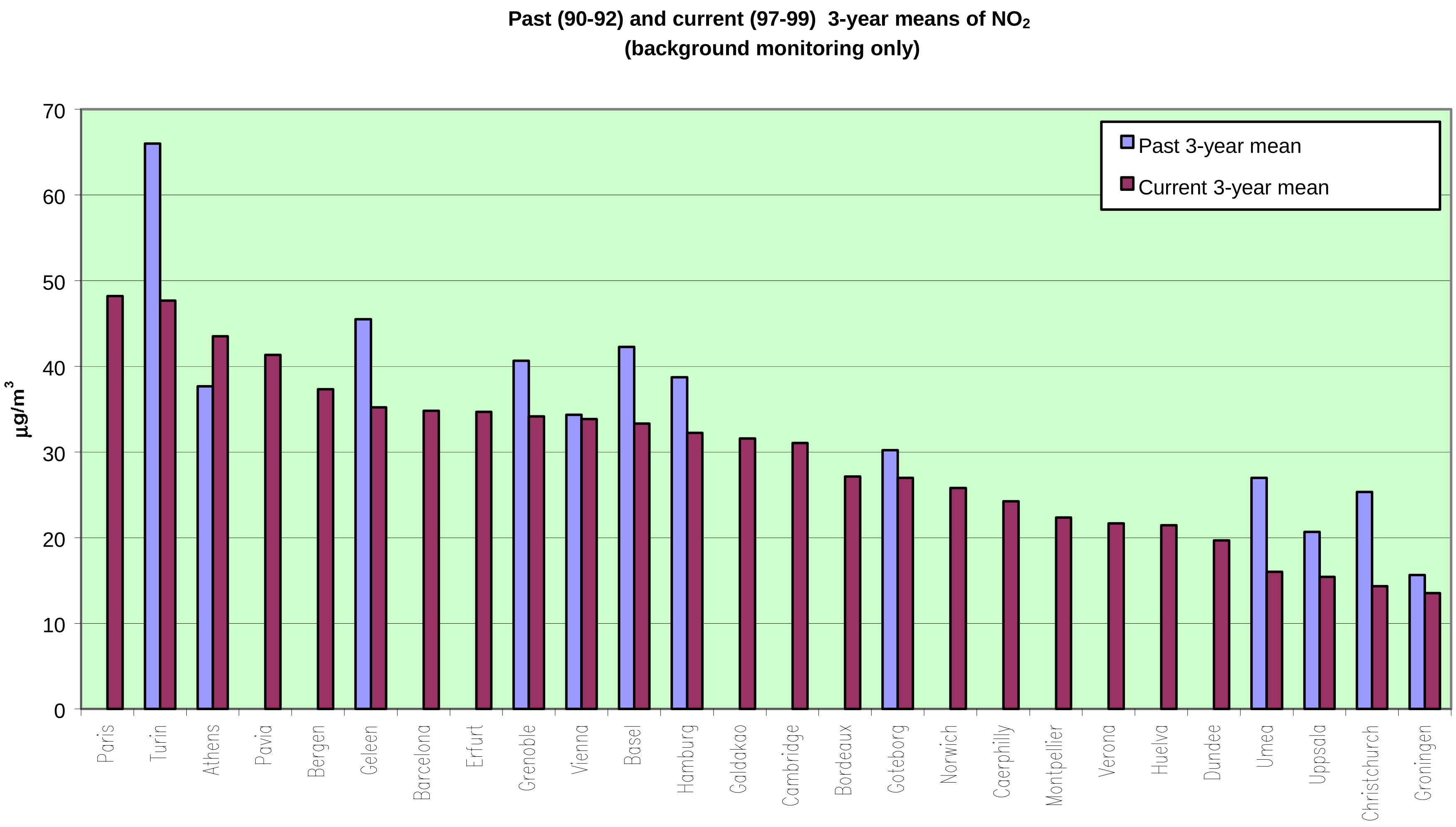


Figure 5: NO comparison past & present

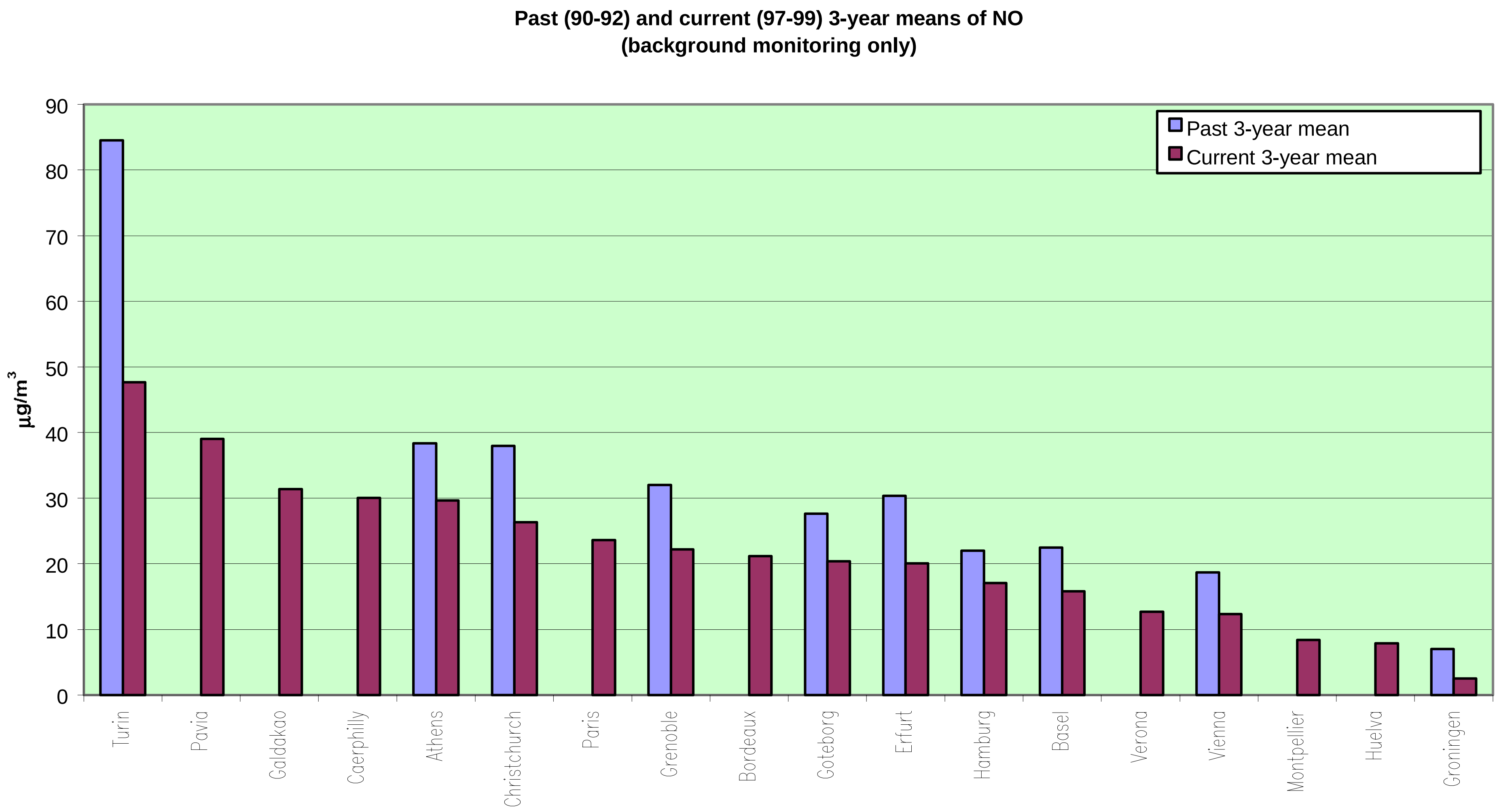


Figure 6: TSP comparison past & present

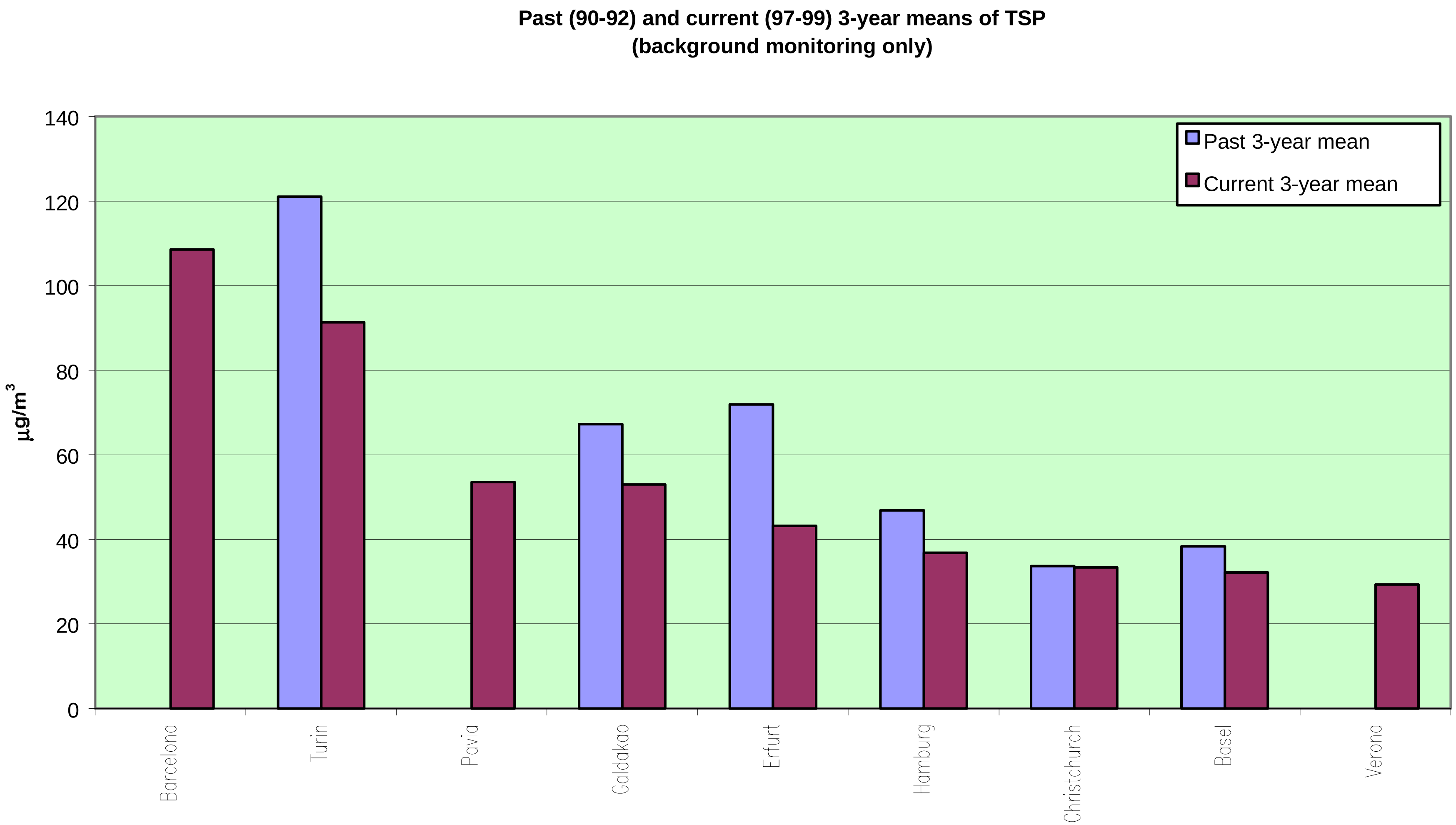


Figure 7: Black smoke comparison past & present

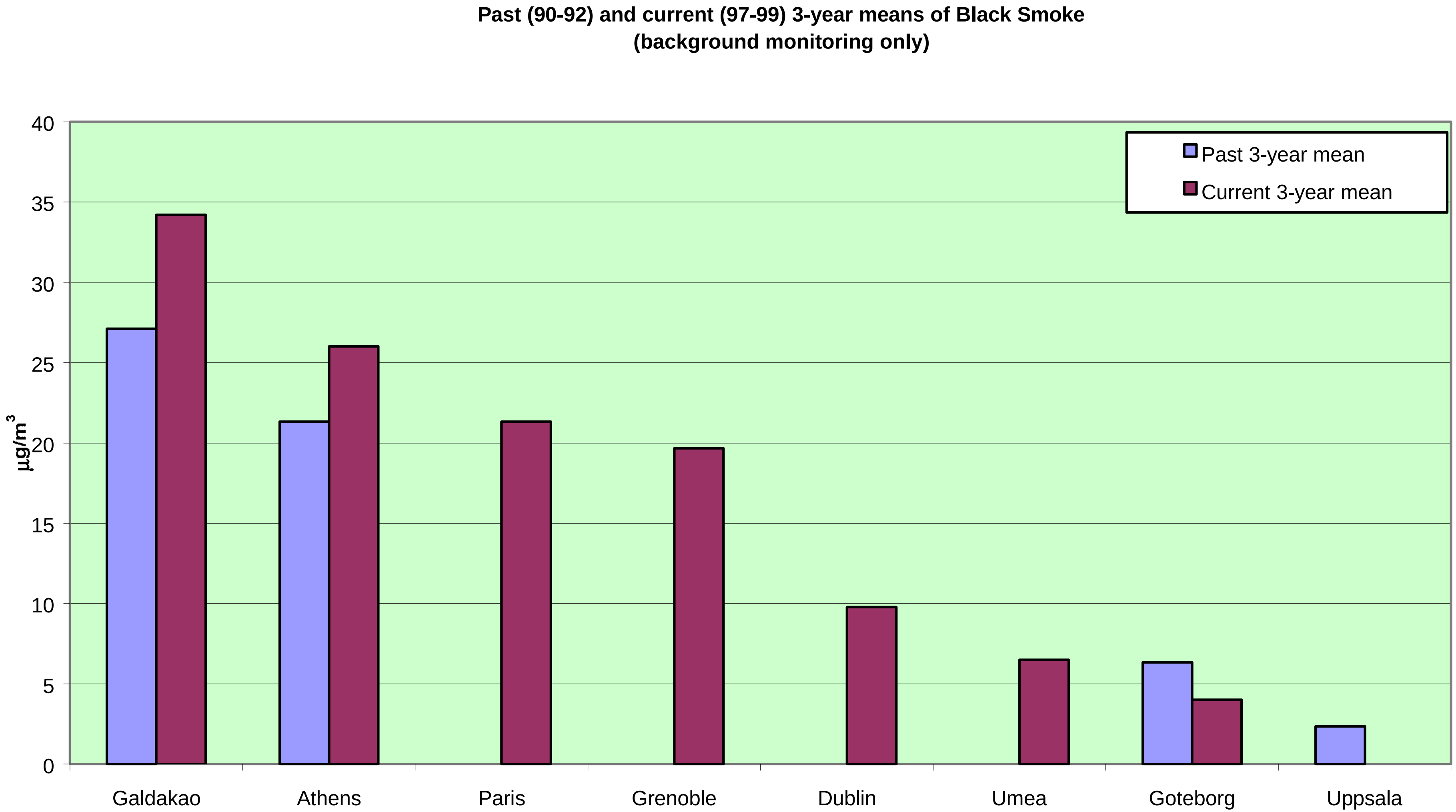


Figure 8: PM_{10} comparison past & present

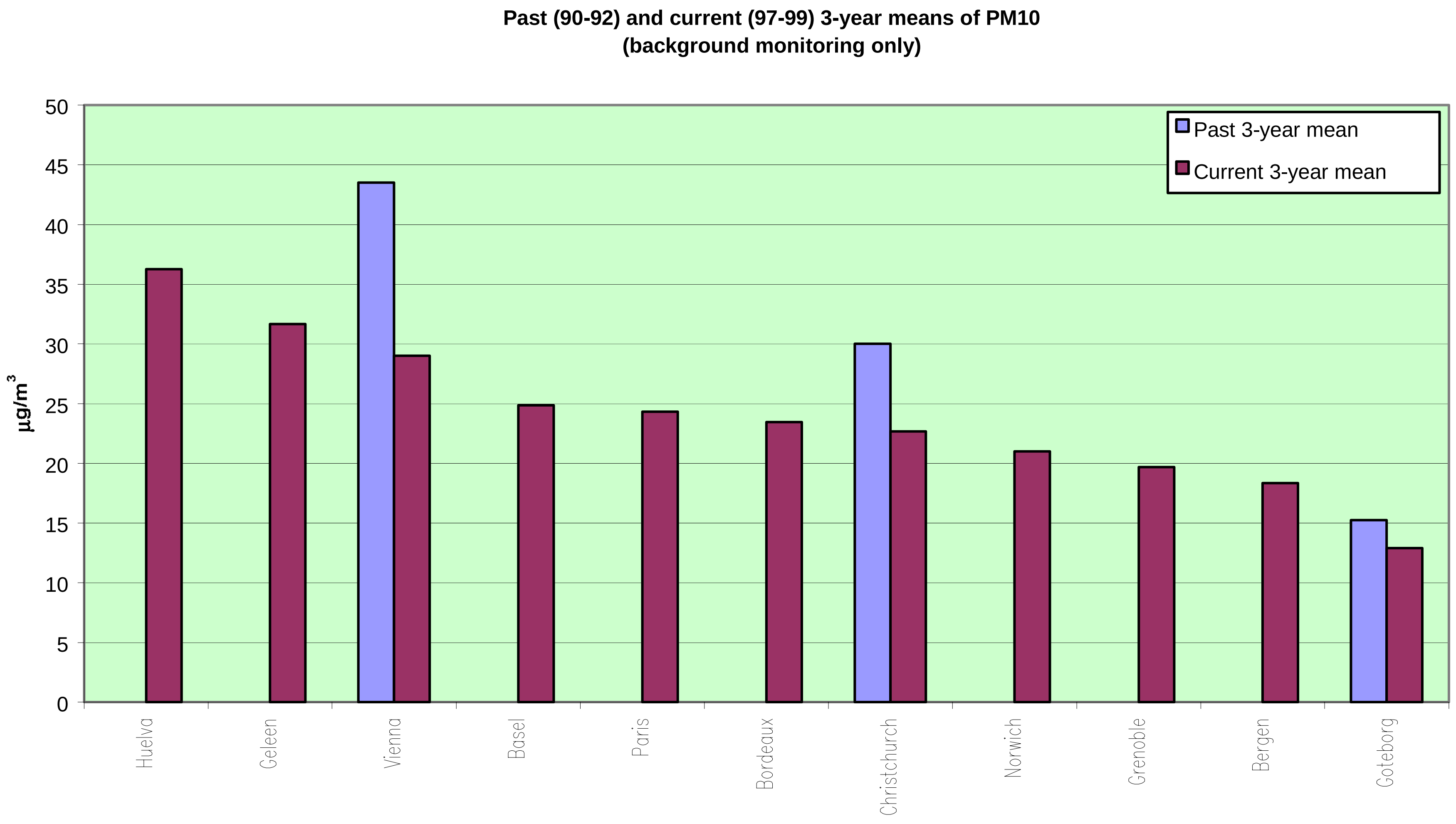


Figure 9: O_3 summer mean comparison past & present

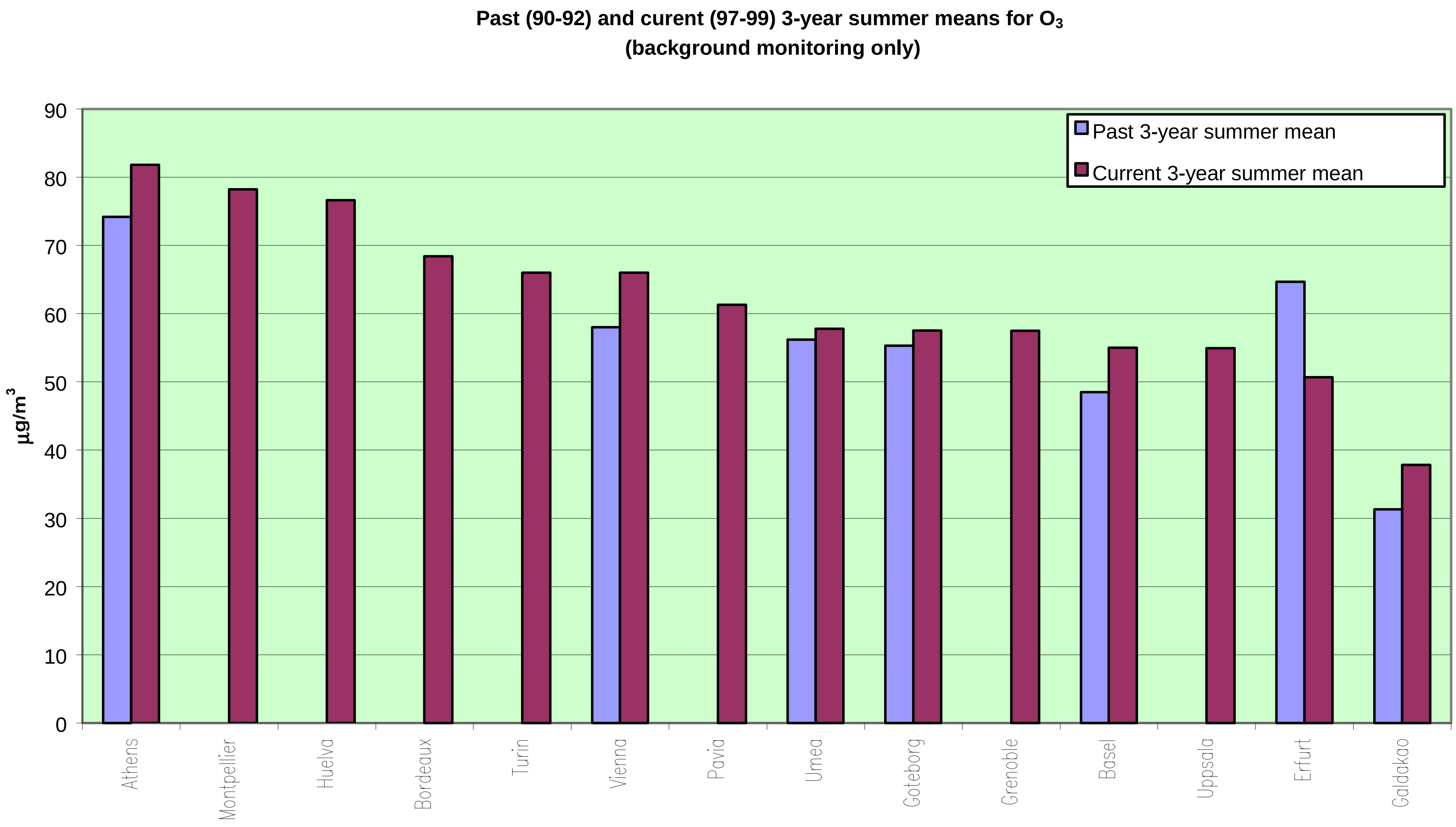


Figure 10: O_3 monthly maximum mean comparison past & present

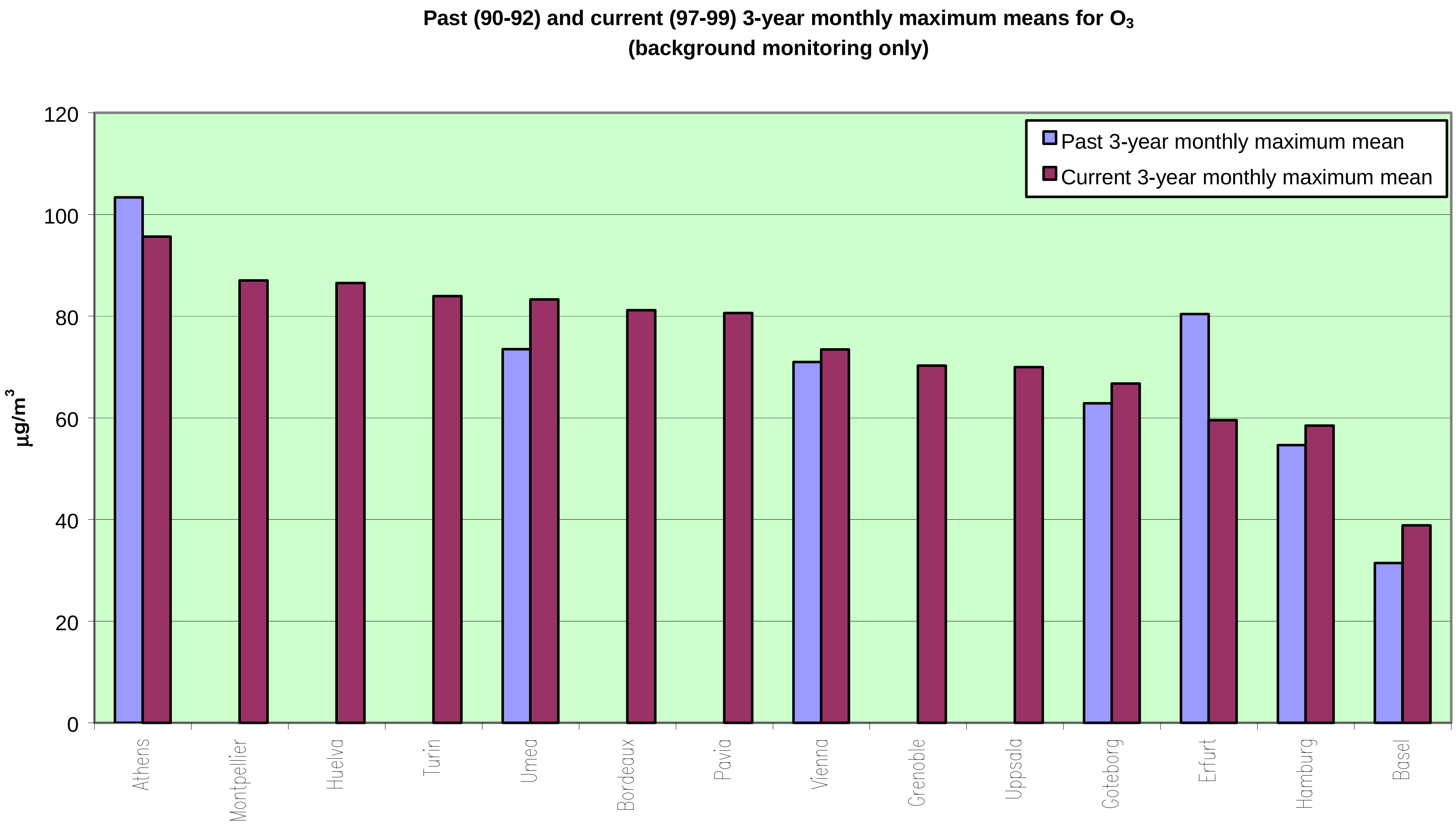


Figure 11: SO_2 annual mean & percentile

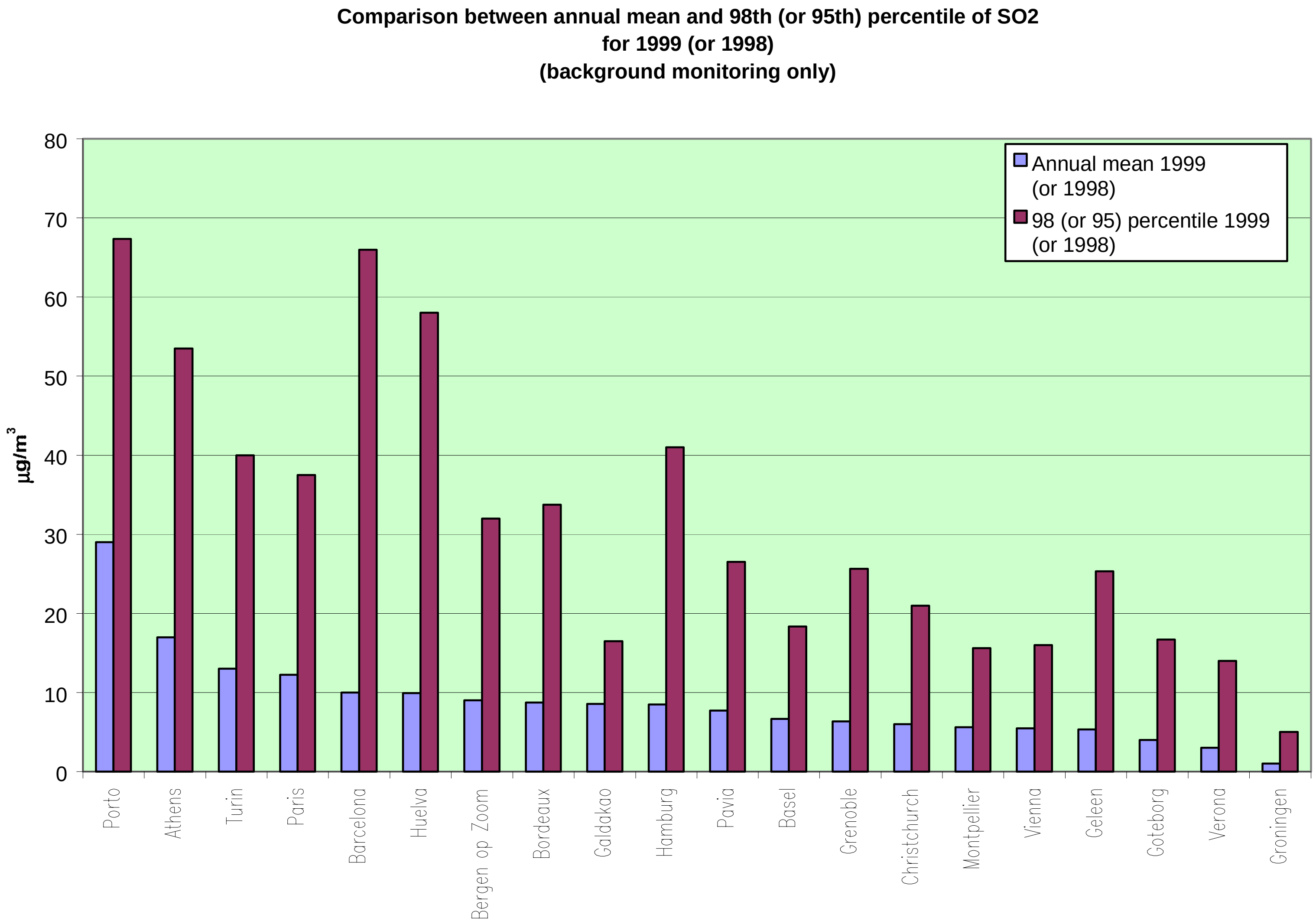


Figure 12: CO annual mean & percentile

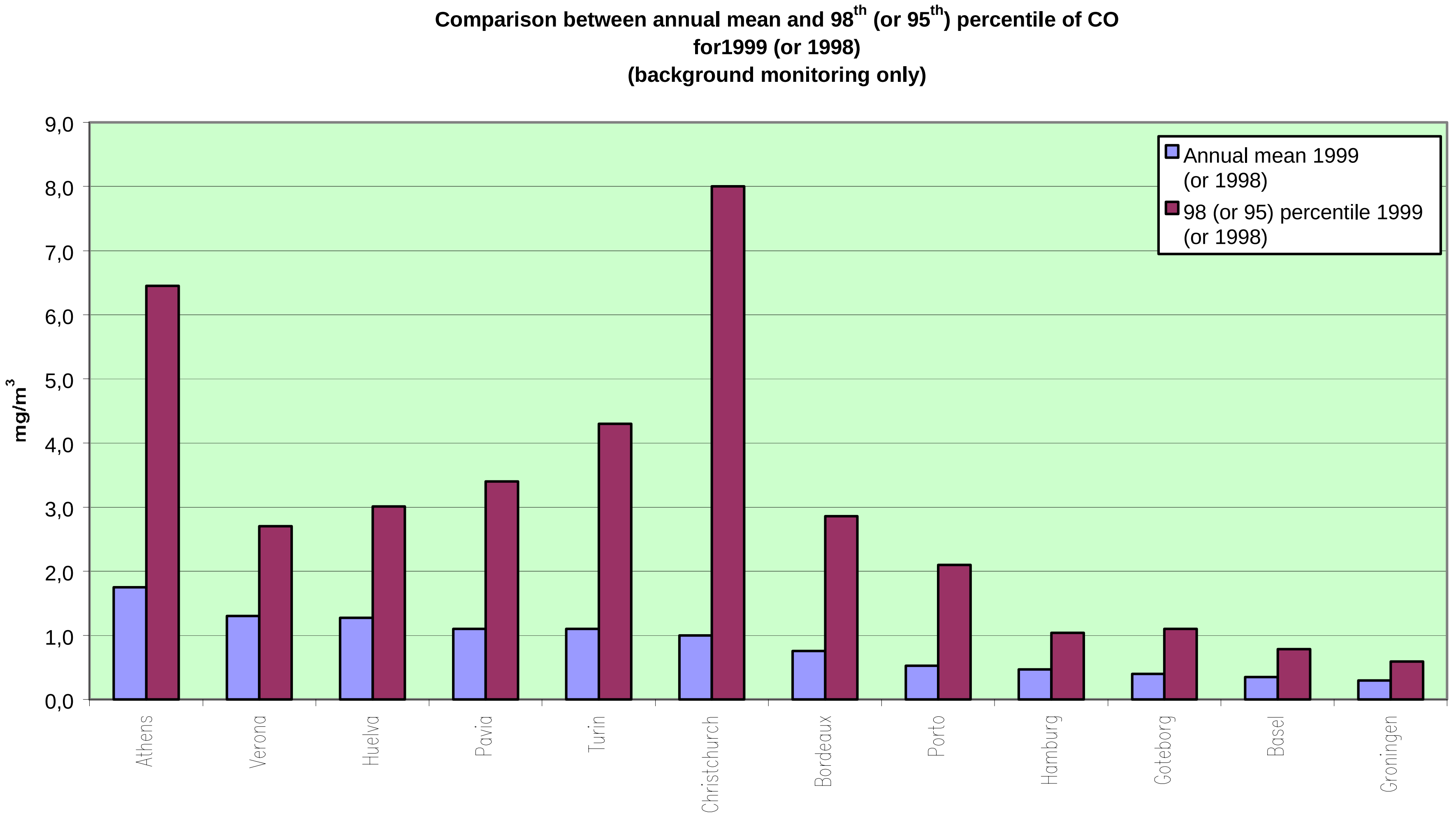


Figure 13: NO_2 annual mean & percentile

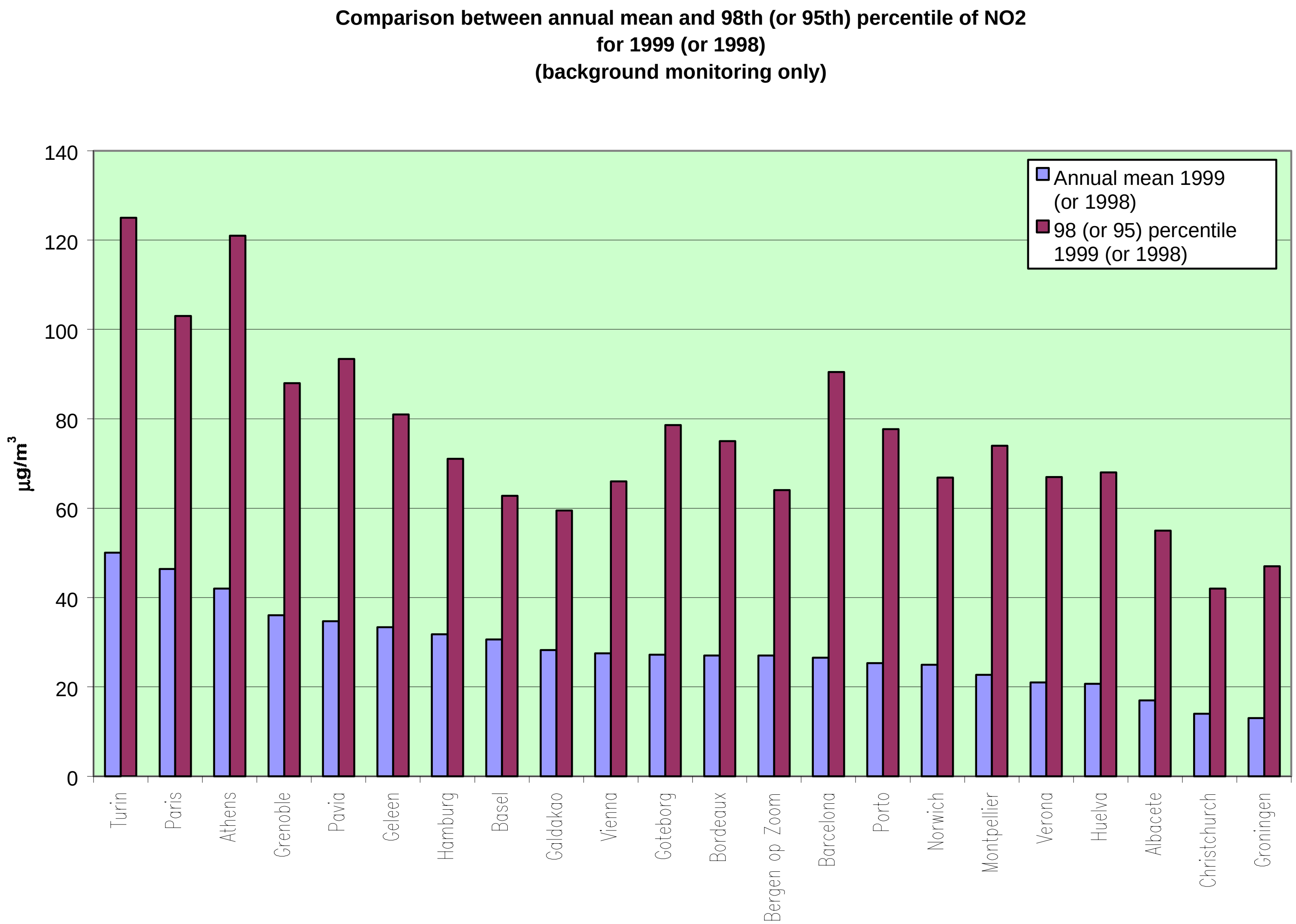


Figure 14: NO annual mean & percentile

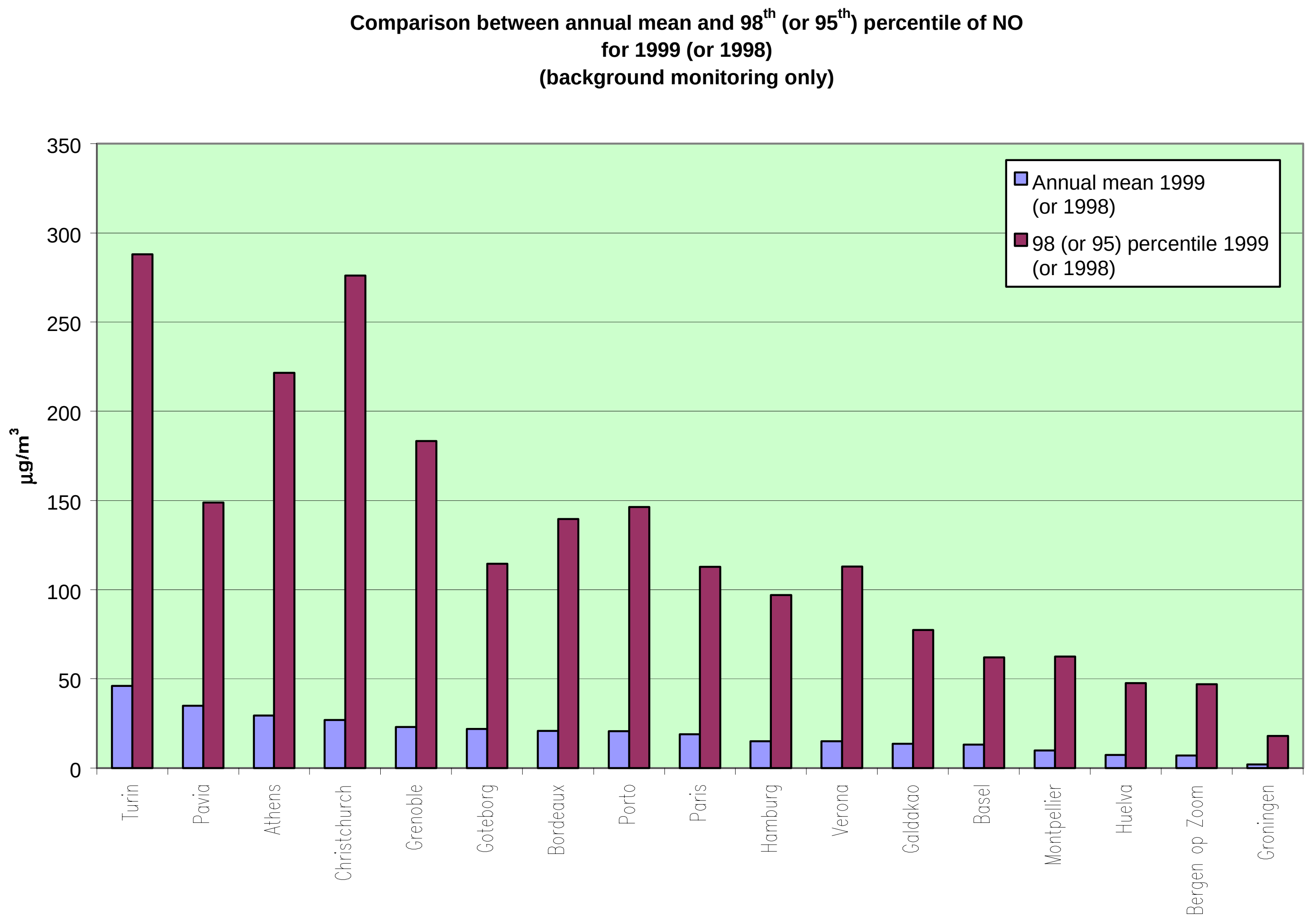


Figure 15: TSP annual mean & percentile

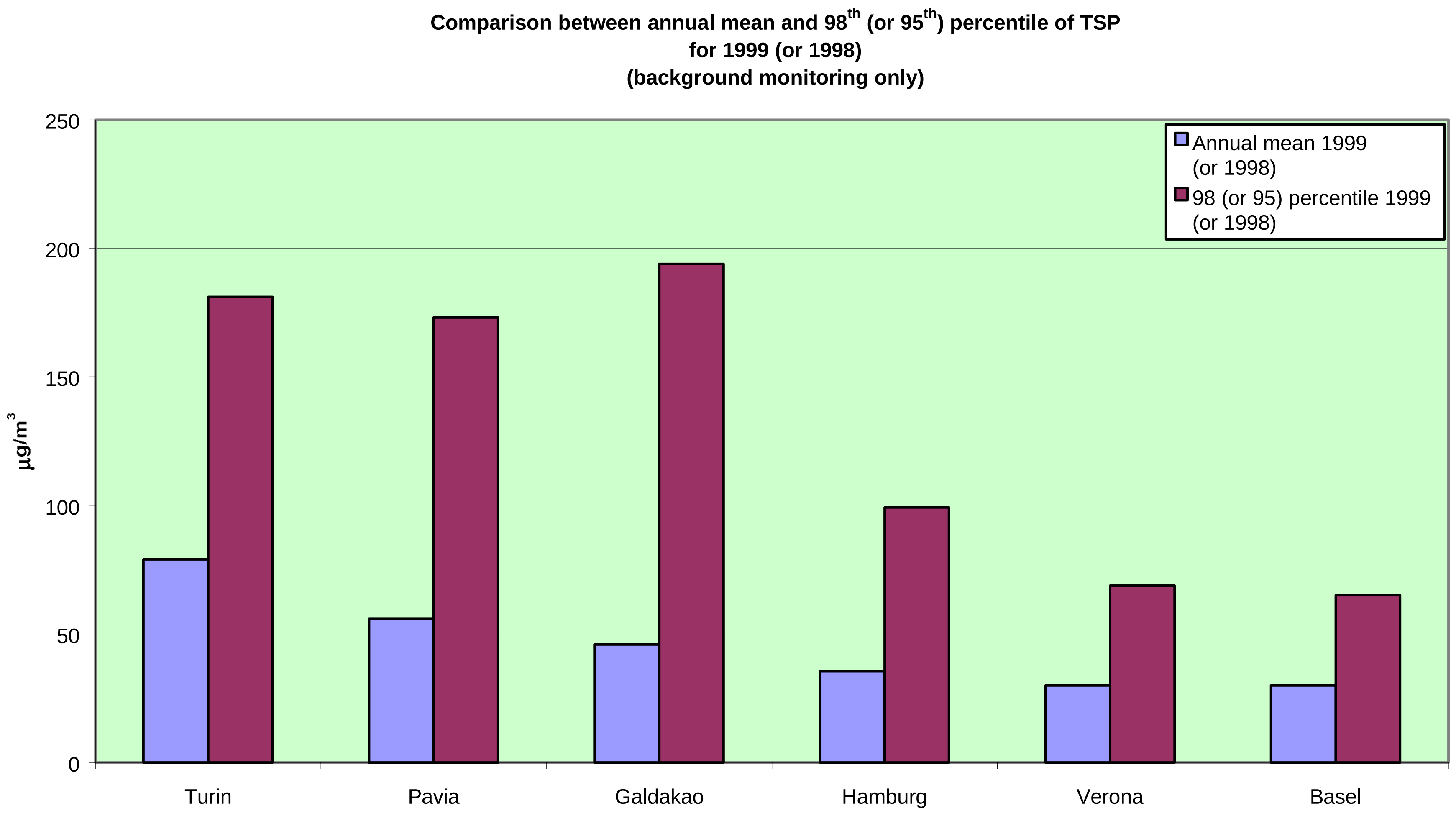


Figure 16: Black smoke annual mean & percentile

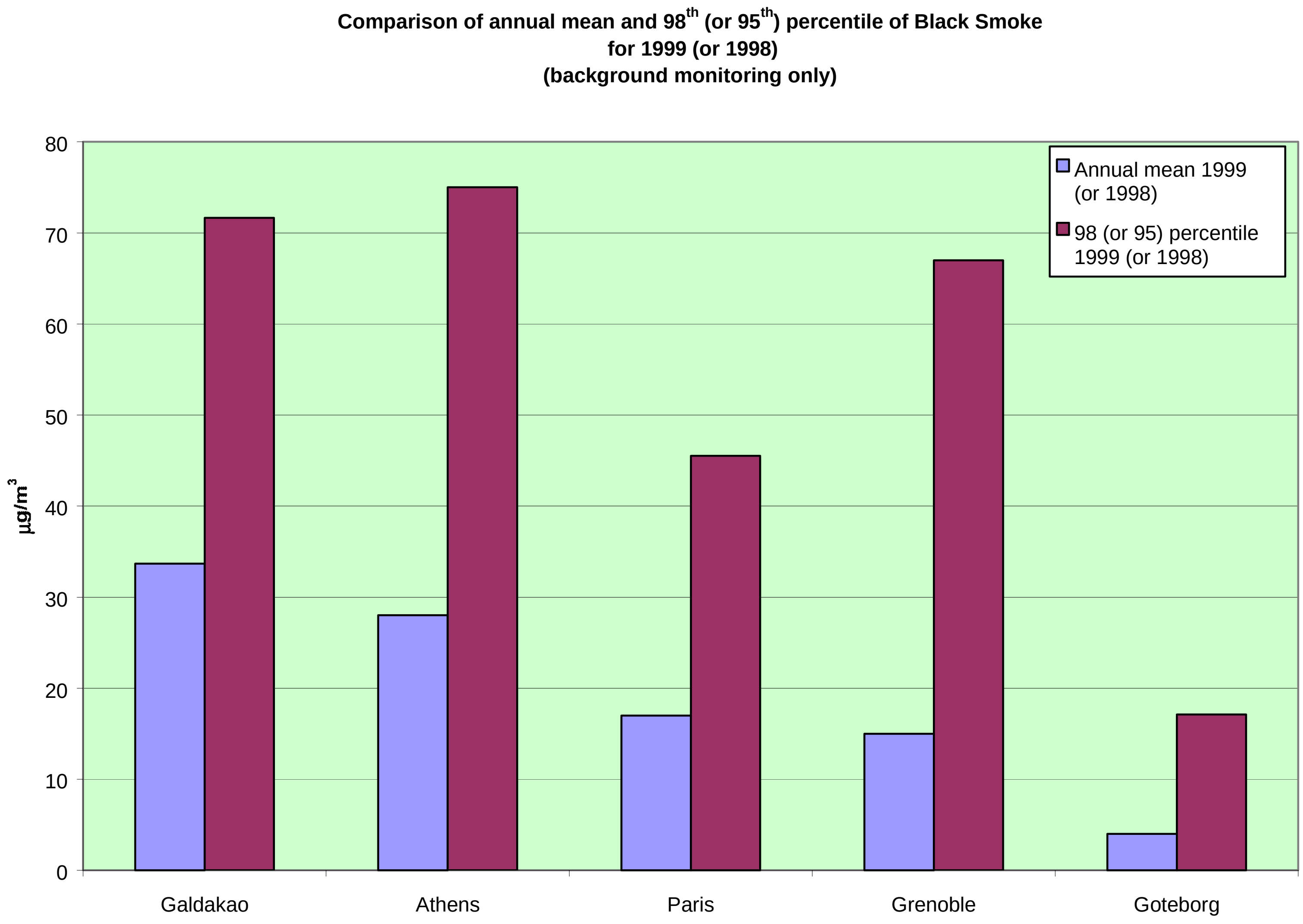


Figure 17: PM_{10} annual mean & percentile

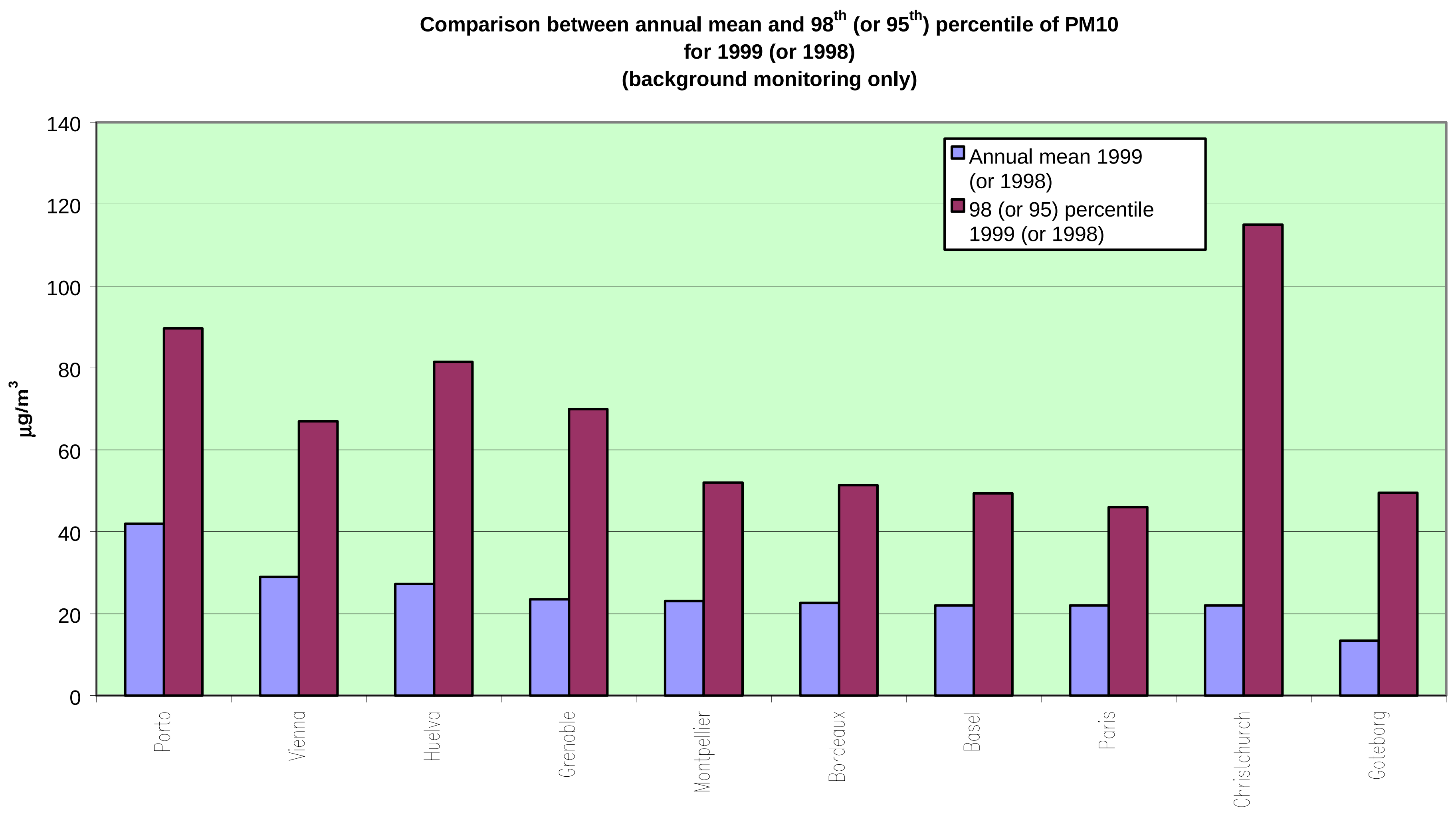


Figure 18: O_3 summer mean & maximum monthly mean

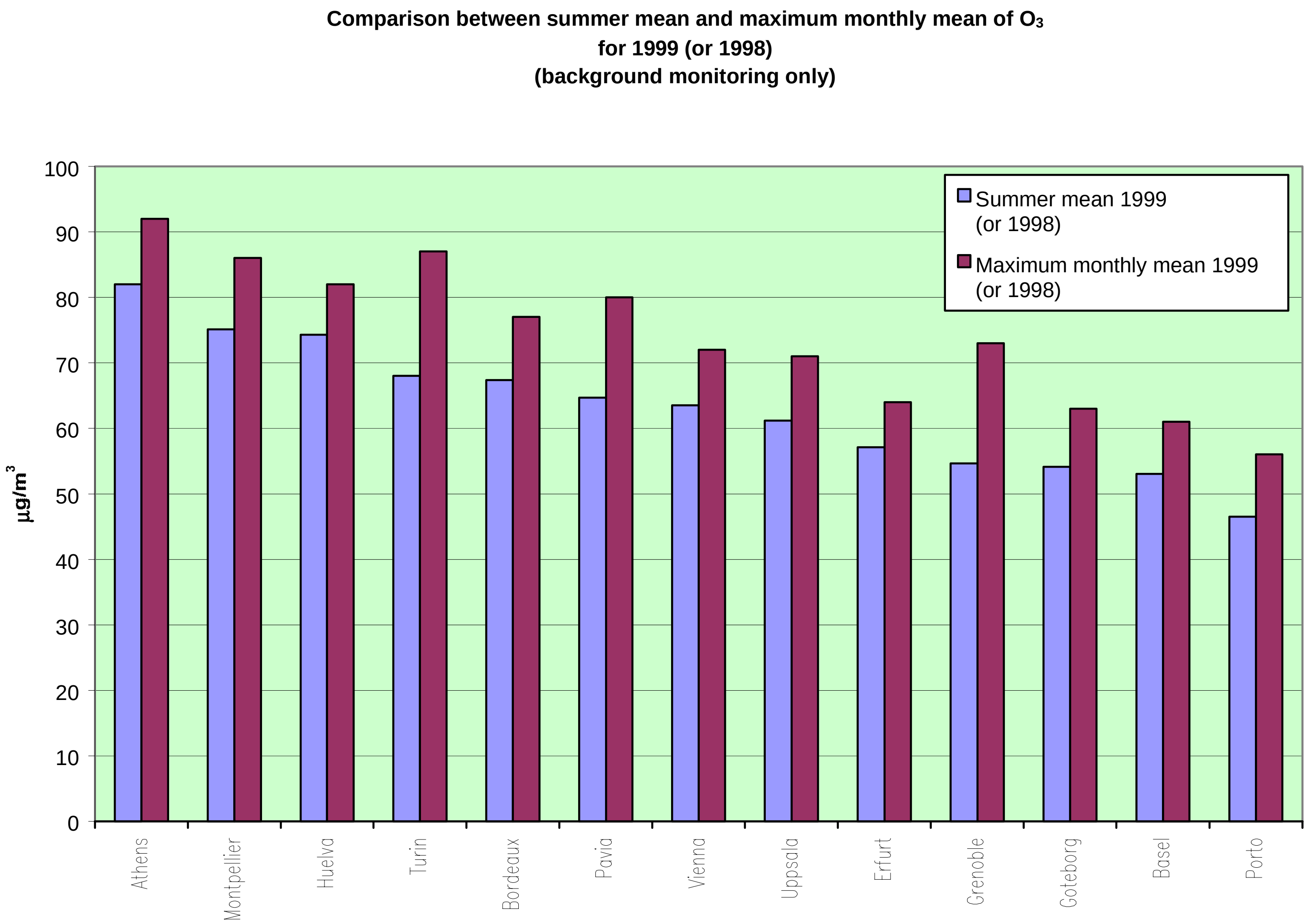


Figure 19: SO_2 background time-series

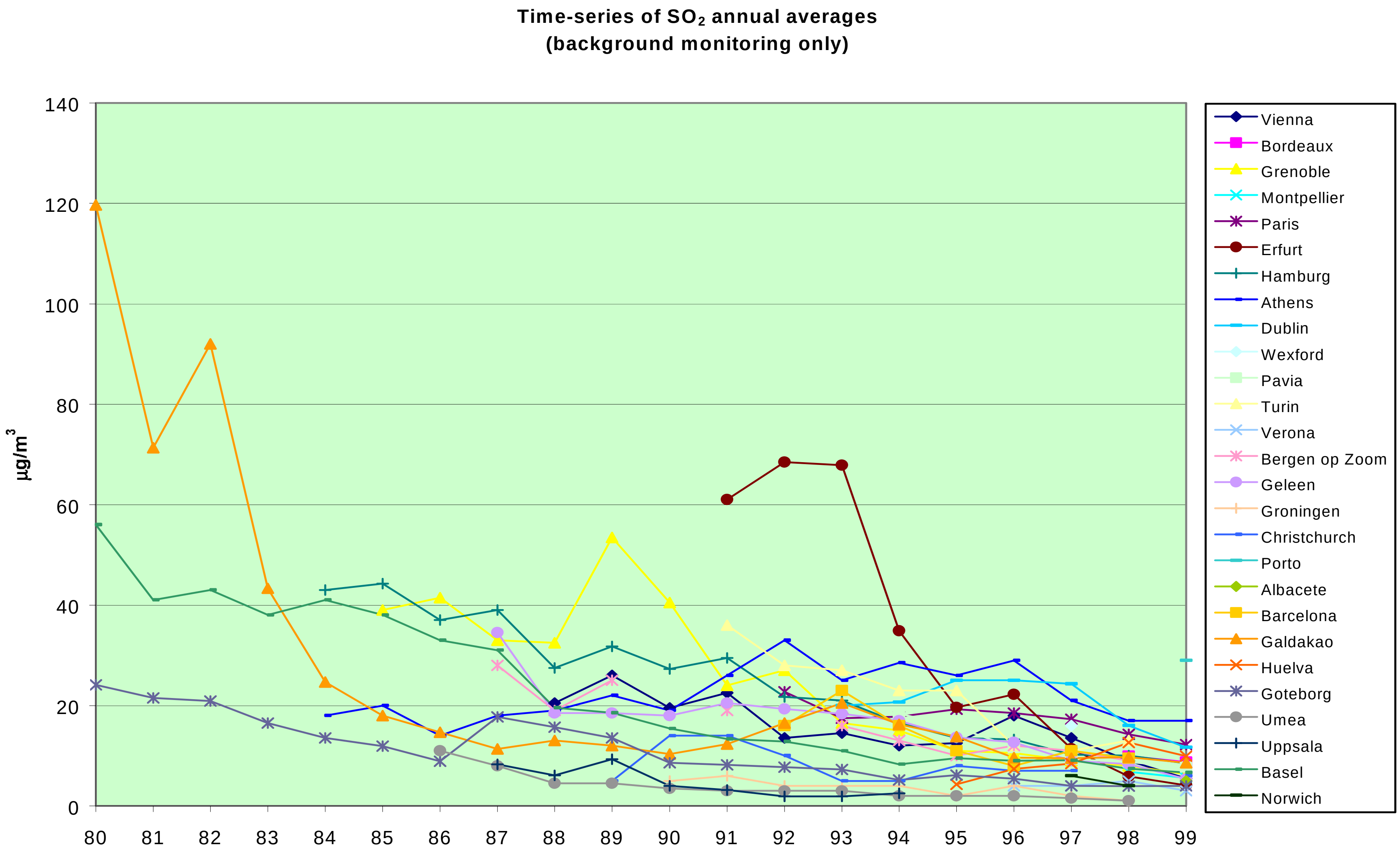


Figure 20: SO_2 traffic time-series

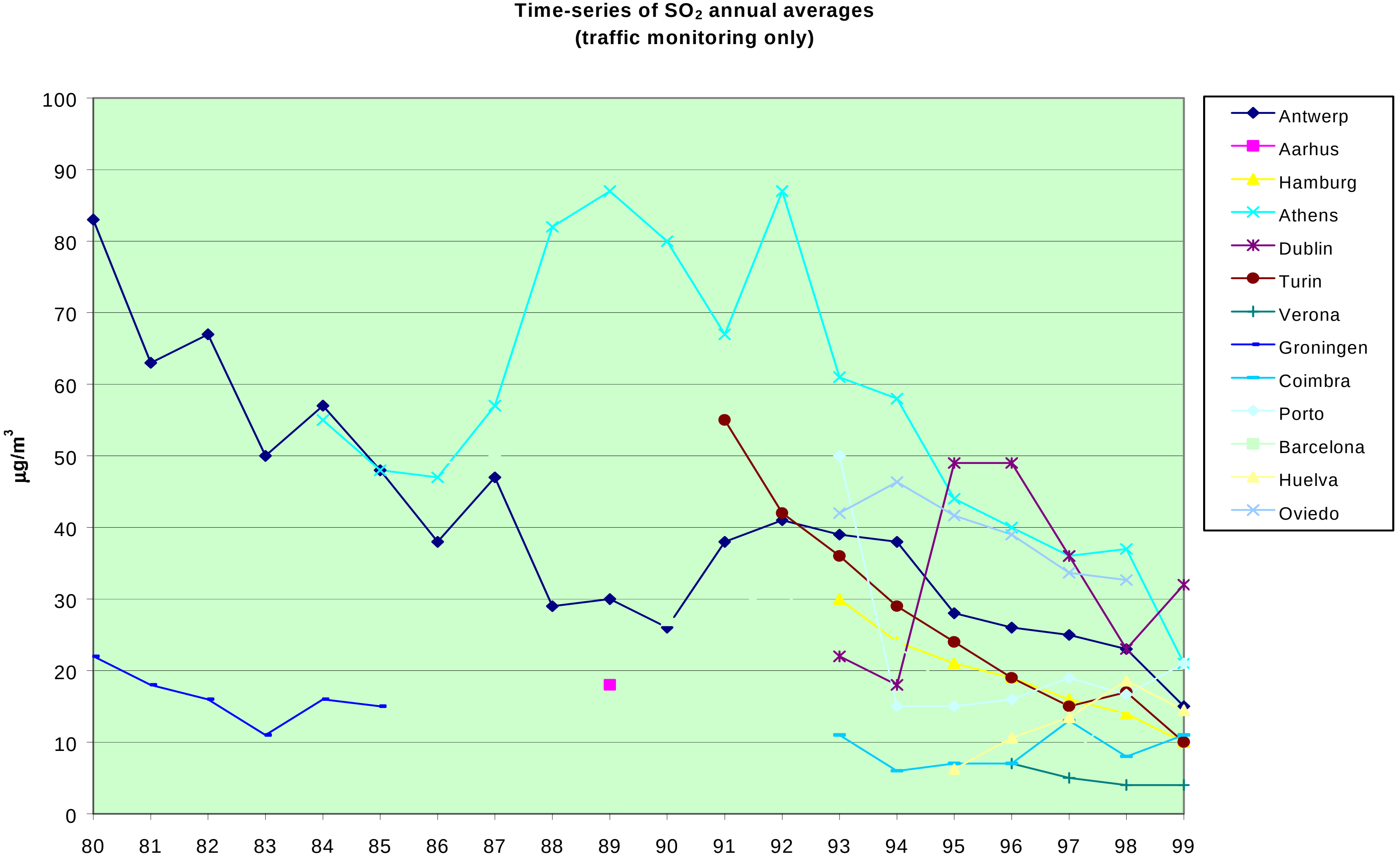


Figure 21: CO background time-series

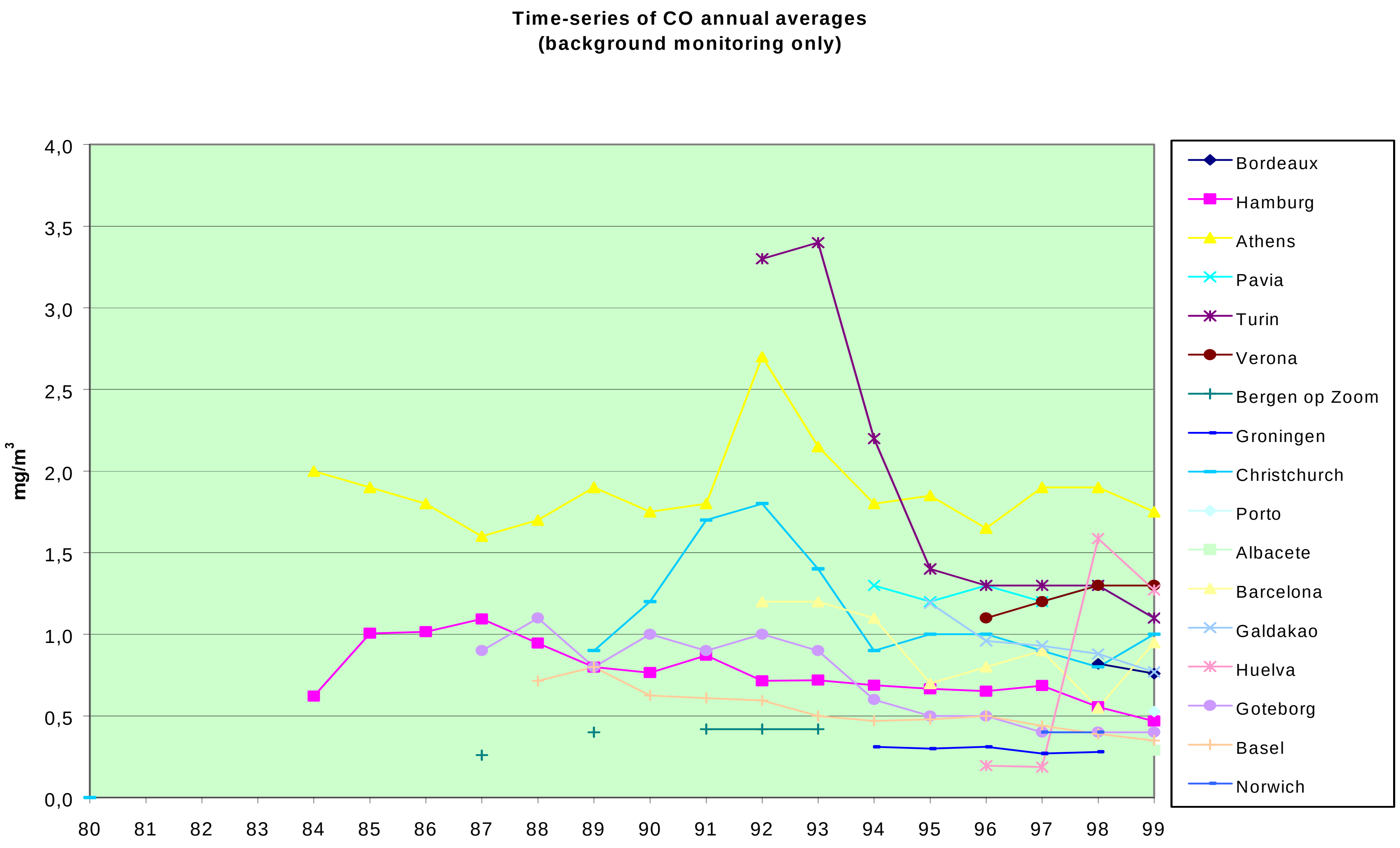


Figure 22: CO traffic time-series

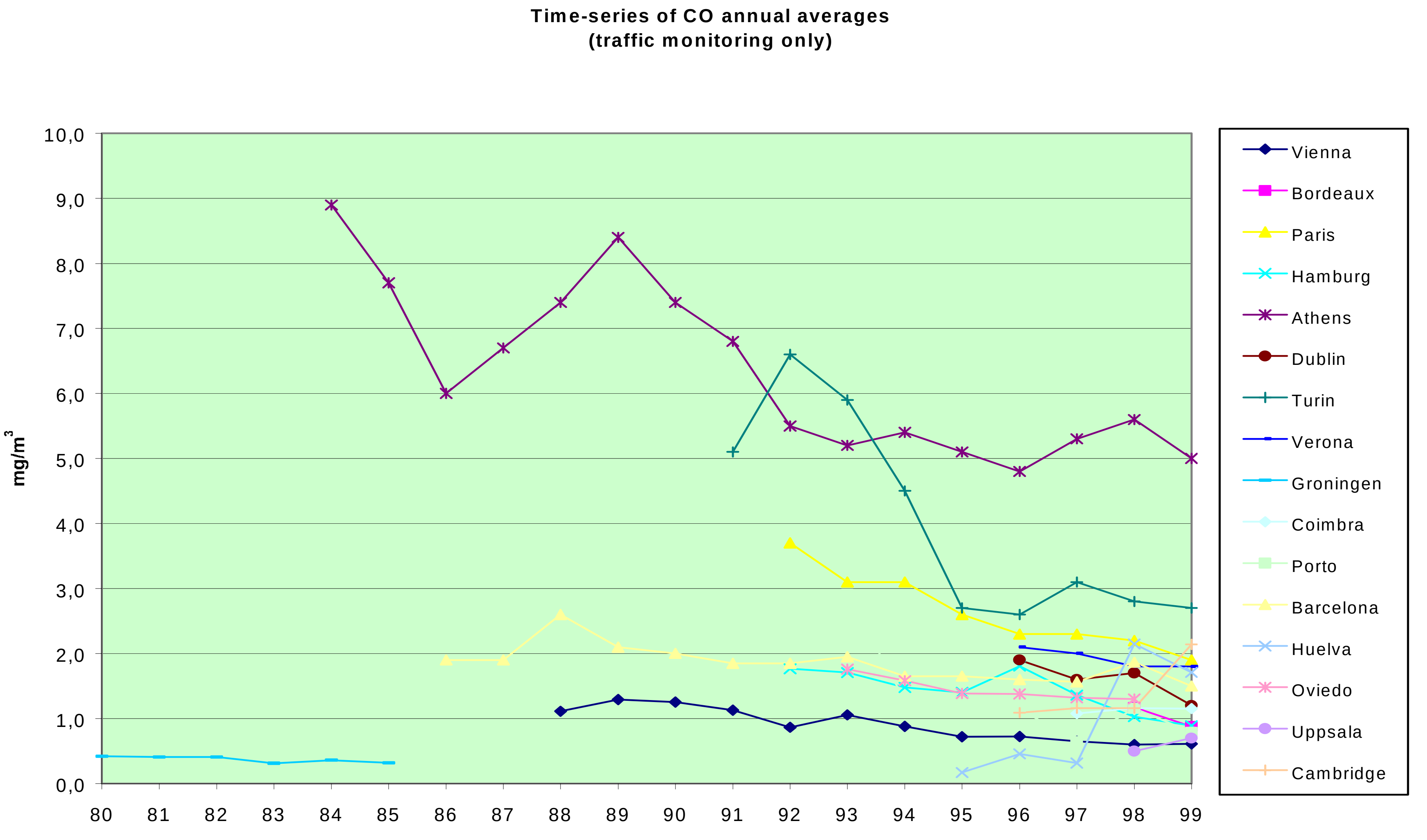


Figure 23: NO_2 background time-series

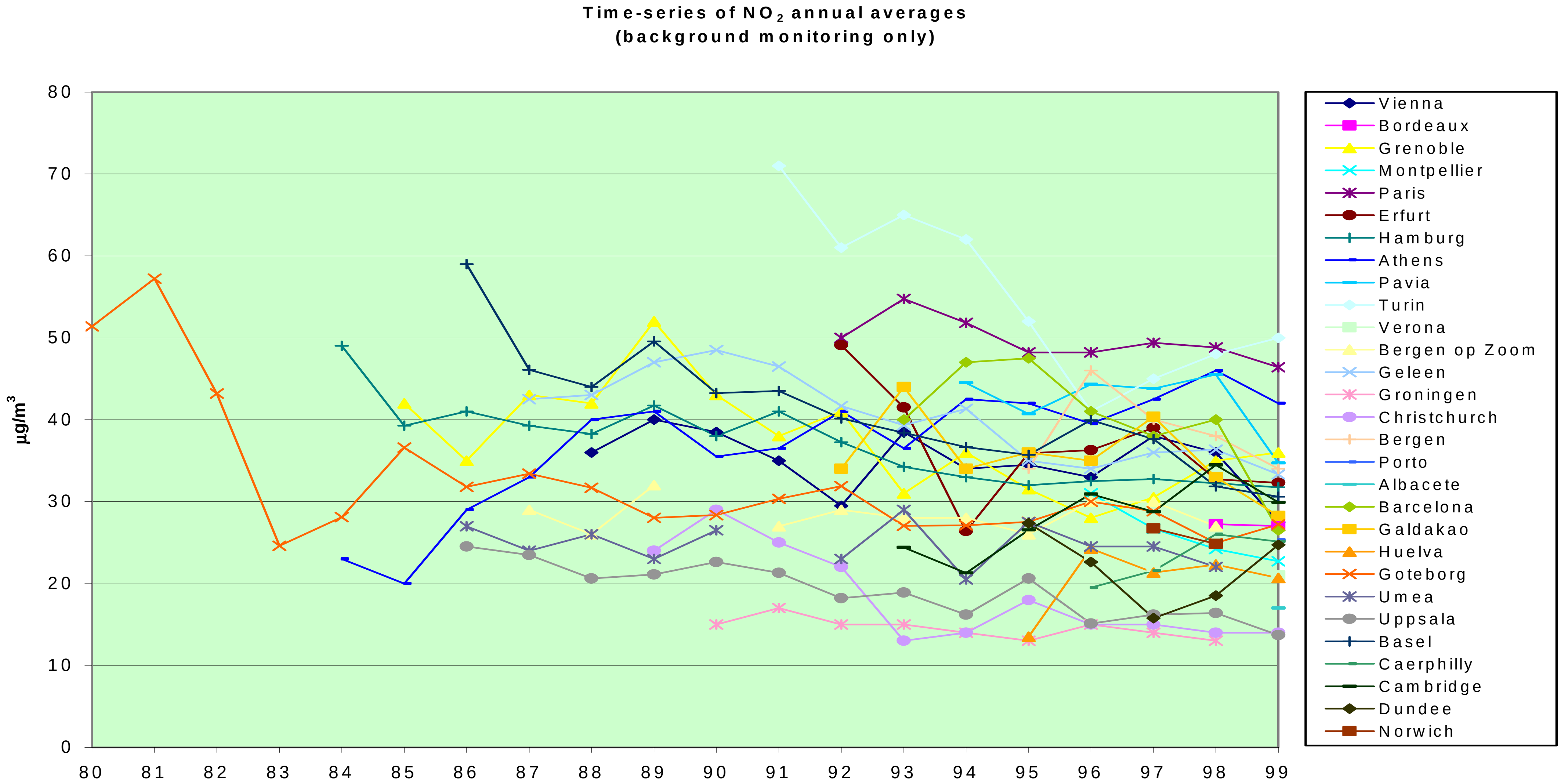


Figure 24: NO_2 traffic time-series

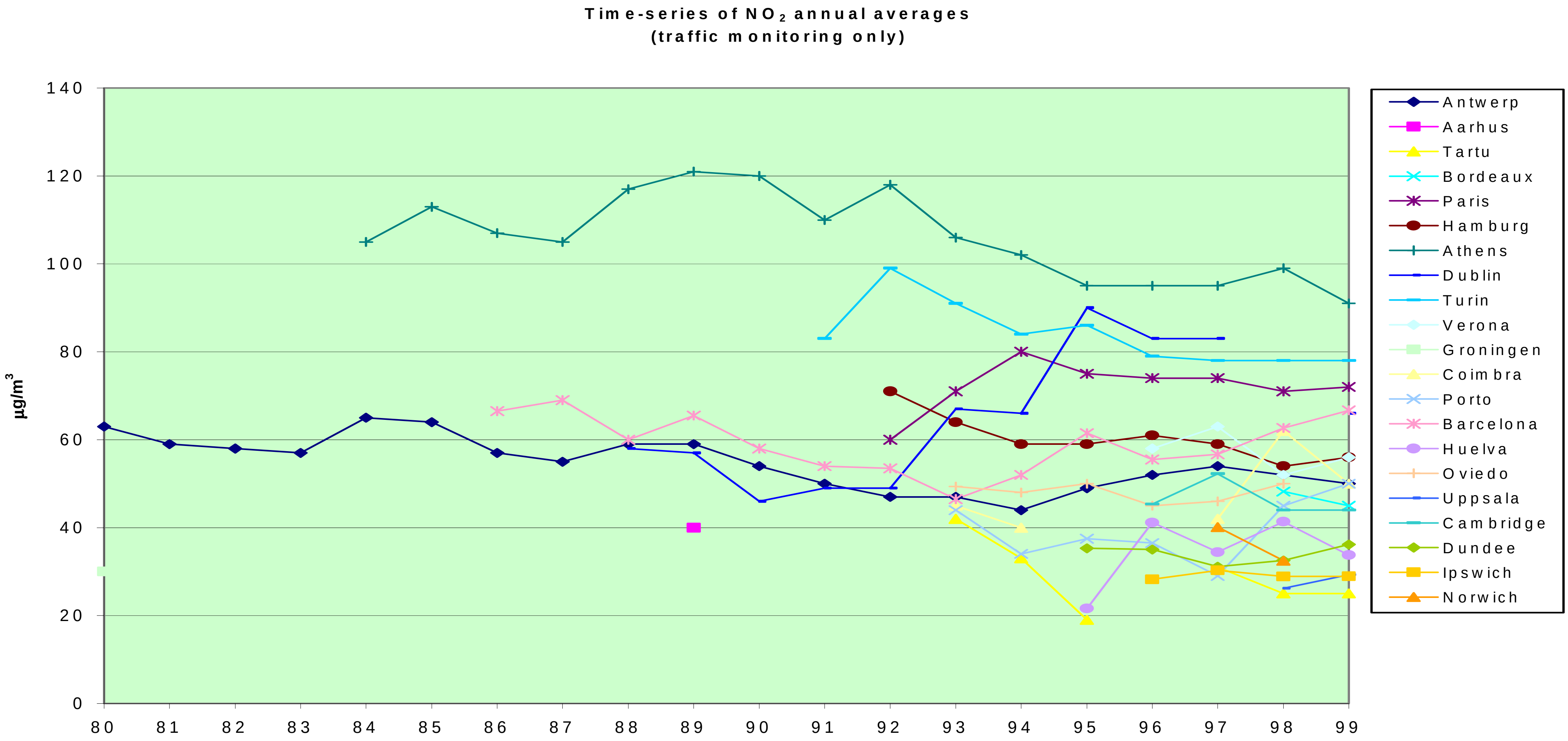


Figure 25: NO background time-series

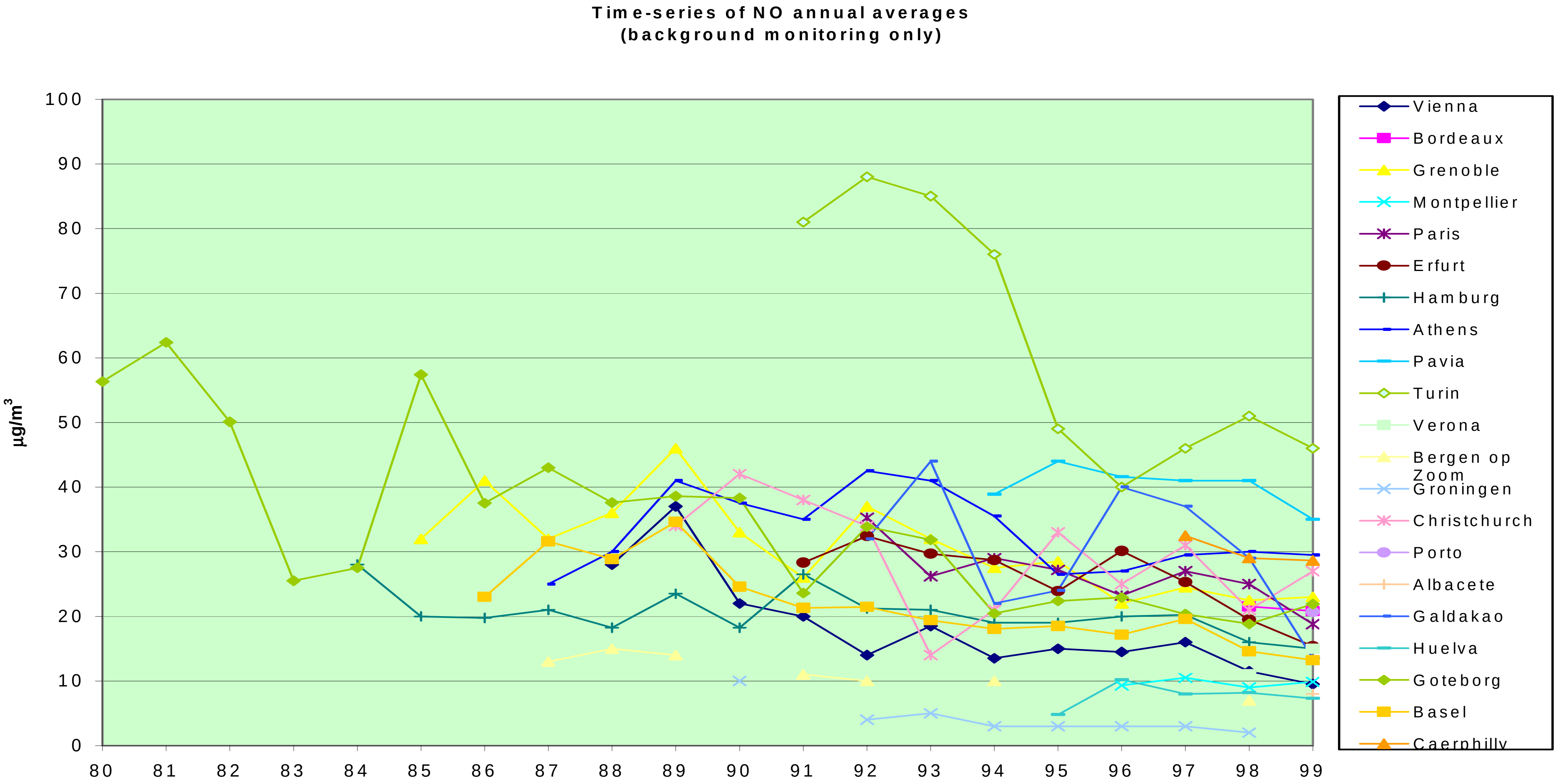


Figure 26: NO traffic time-series

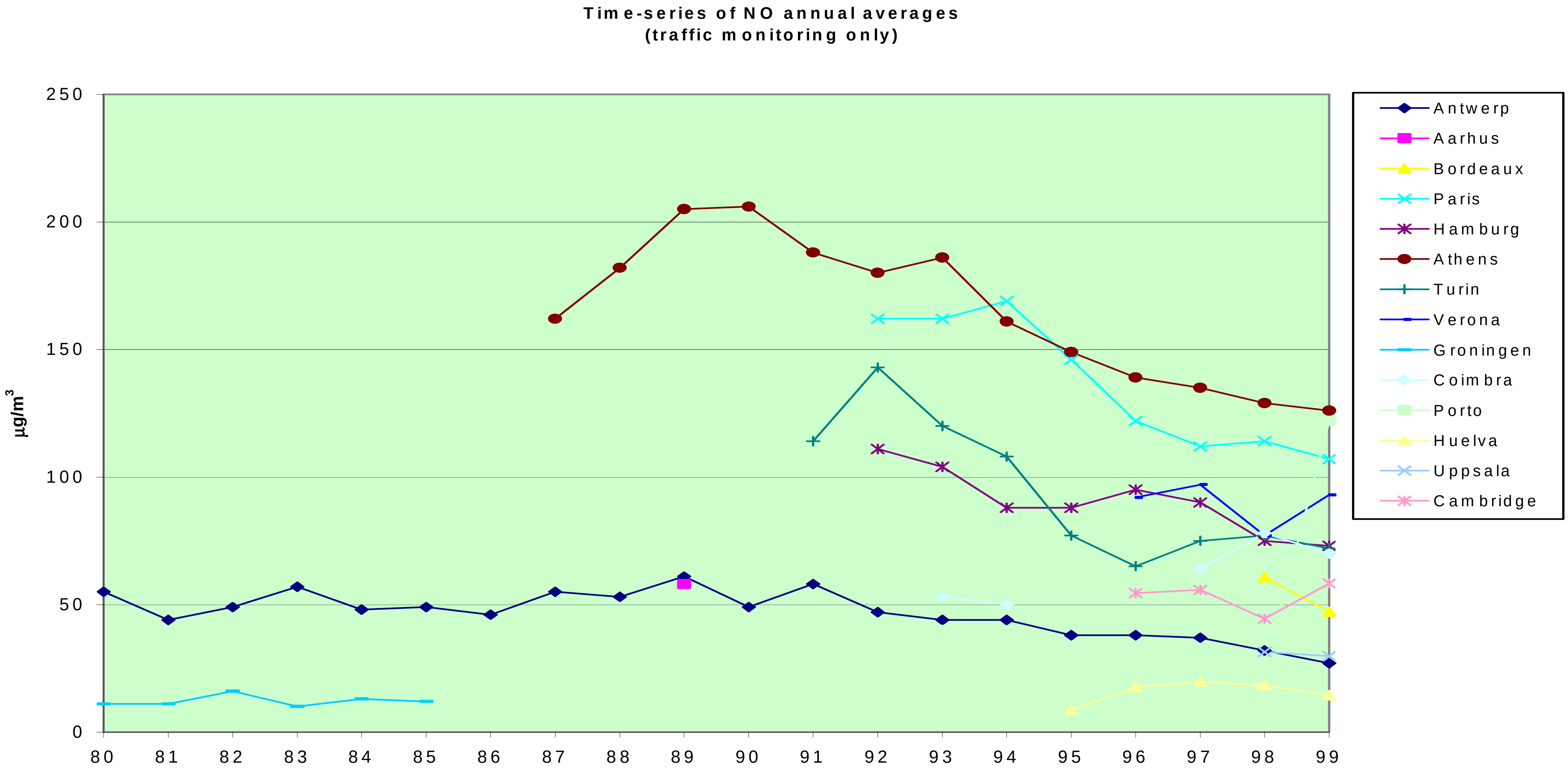


Figure 27: TSP background time-series

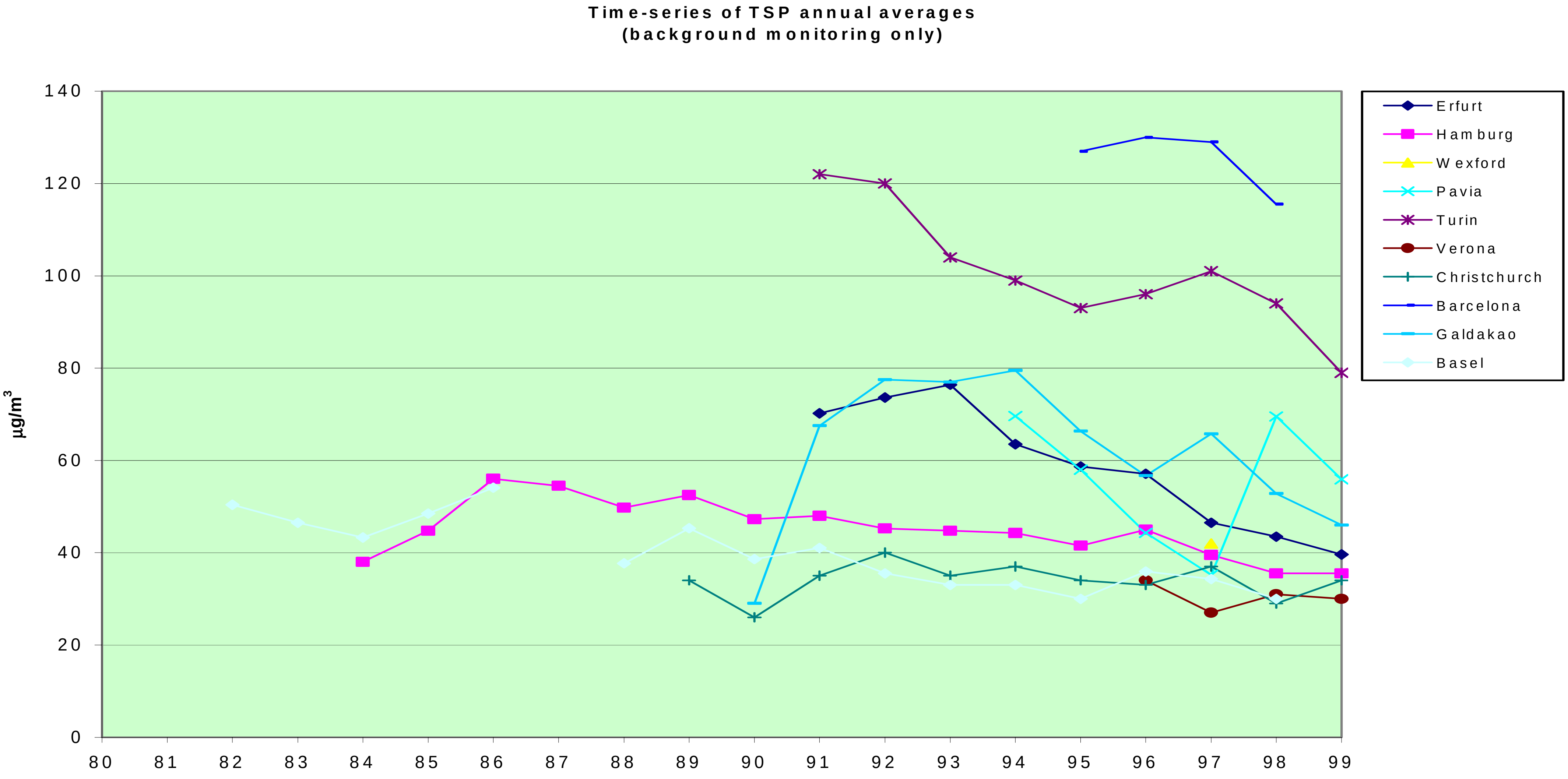


Figure 28: TSP traffic time-series

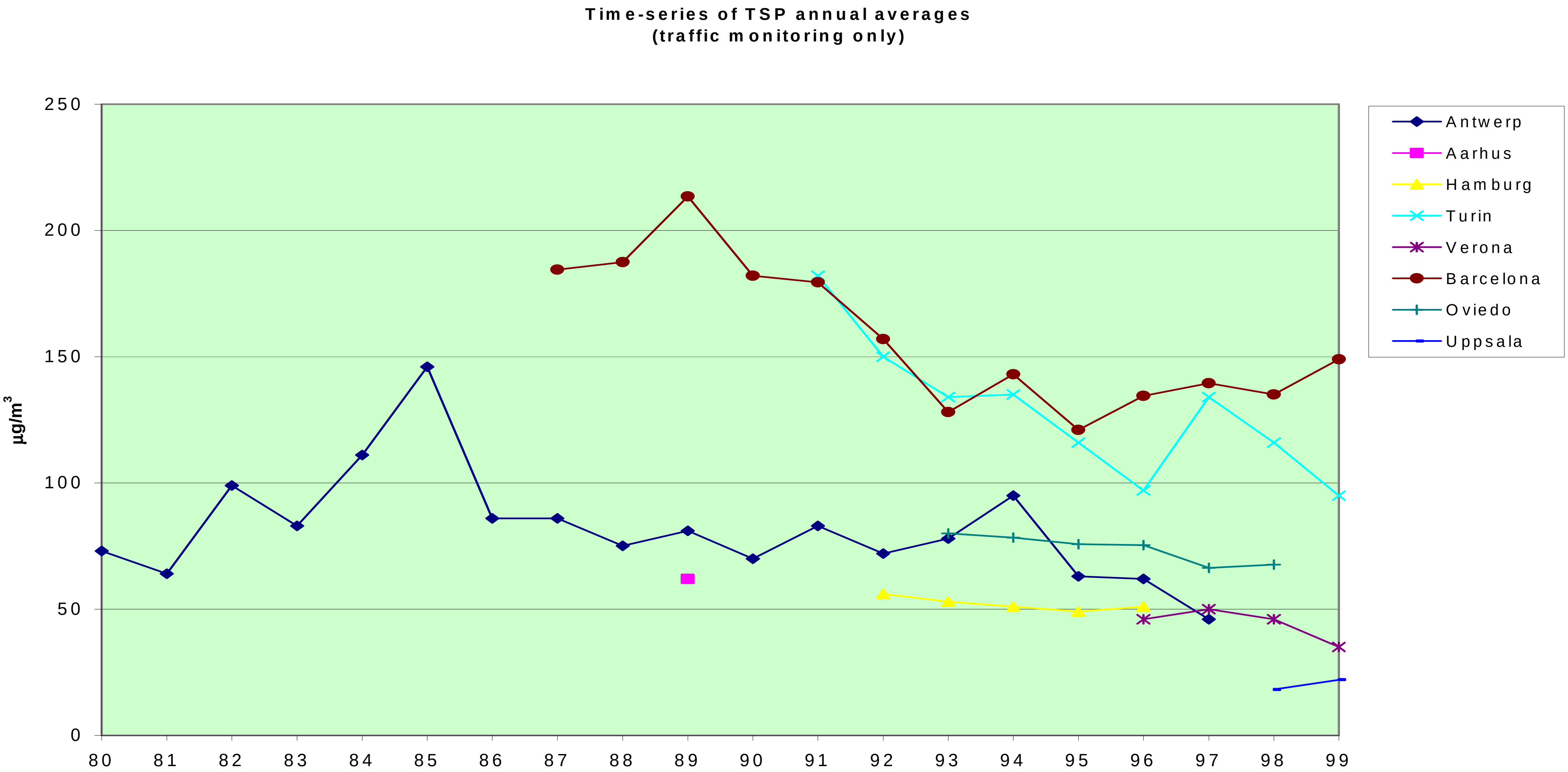


Figure 29: Black smoke background time-series

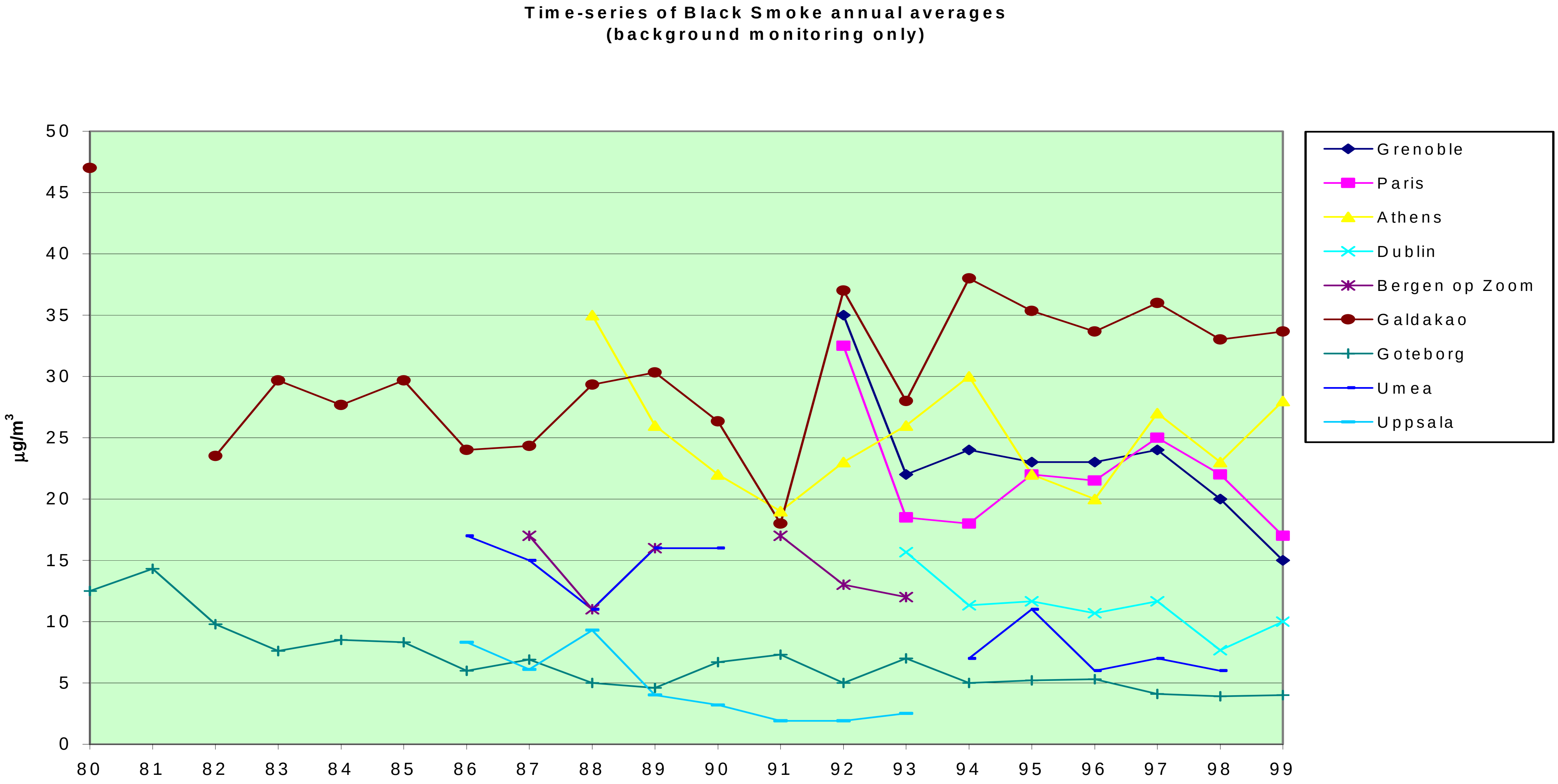


Figure 30: Black smoke traffic time-series

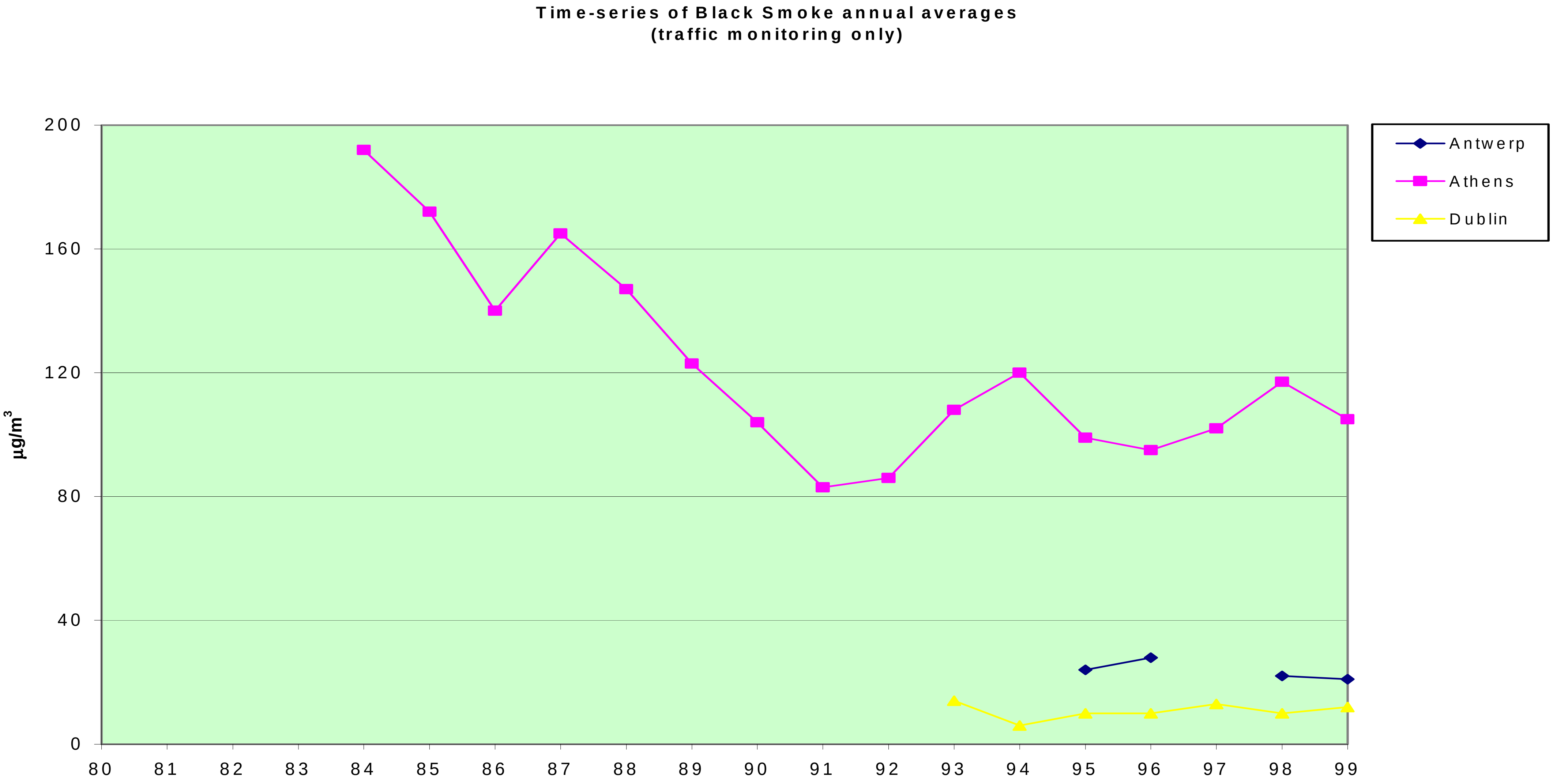


Figure 31: PM$_{10}$ background time-series

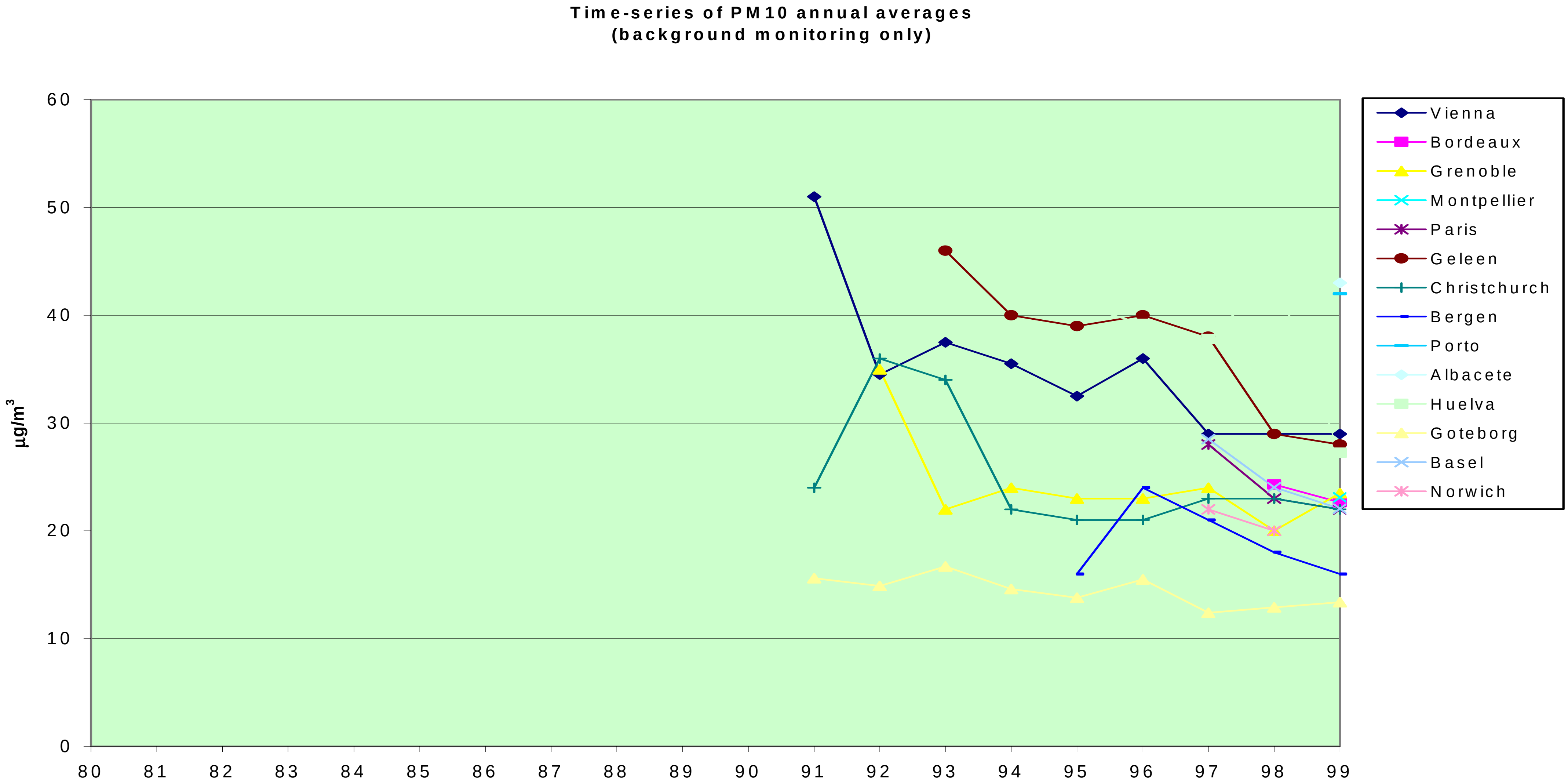


Figure 32: PM_{10} traffic time-series

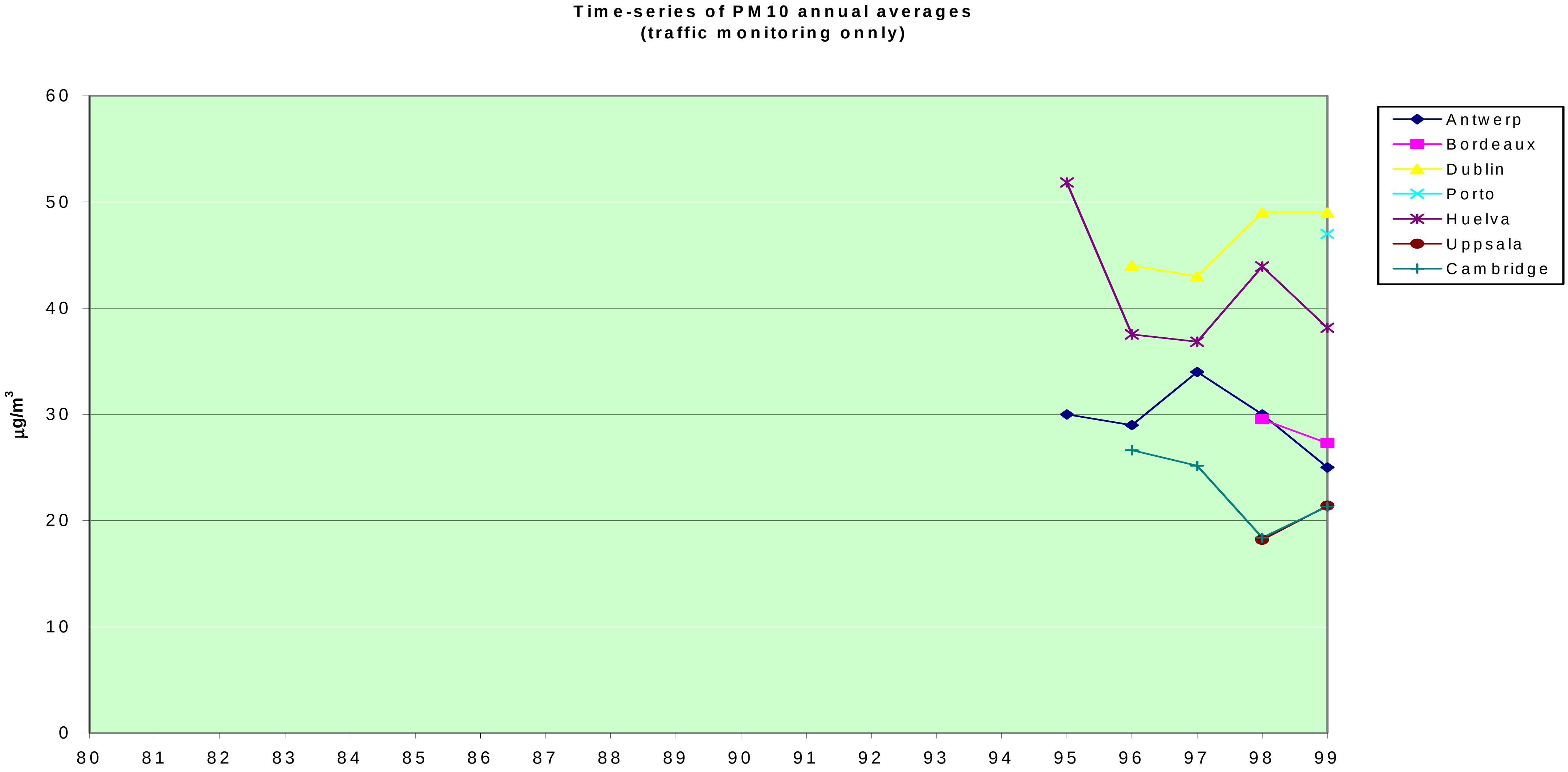


Figure 33: O_3 background time-series

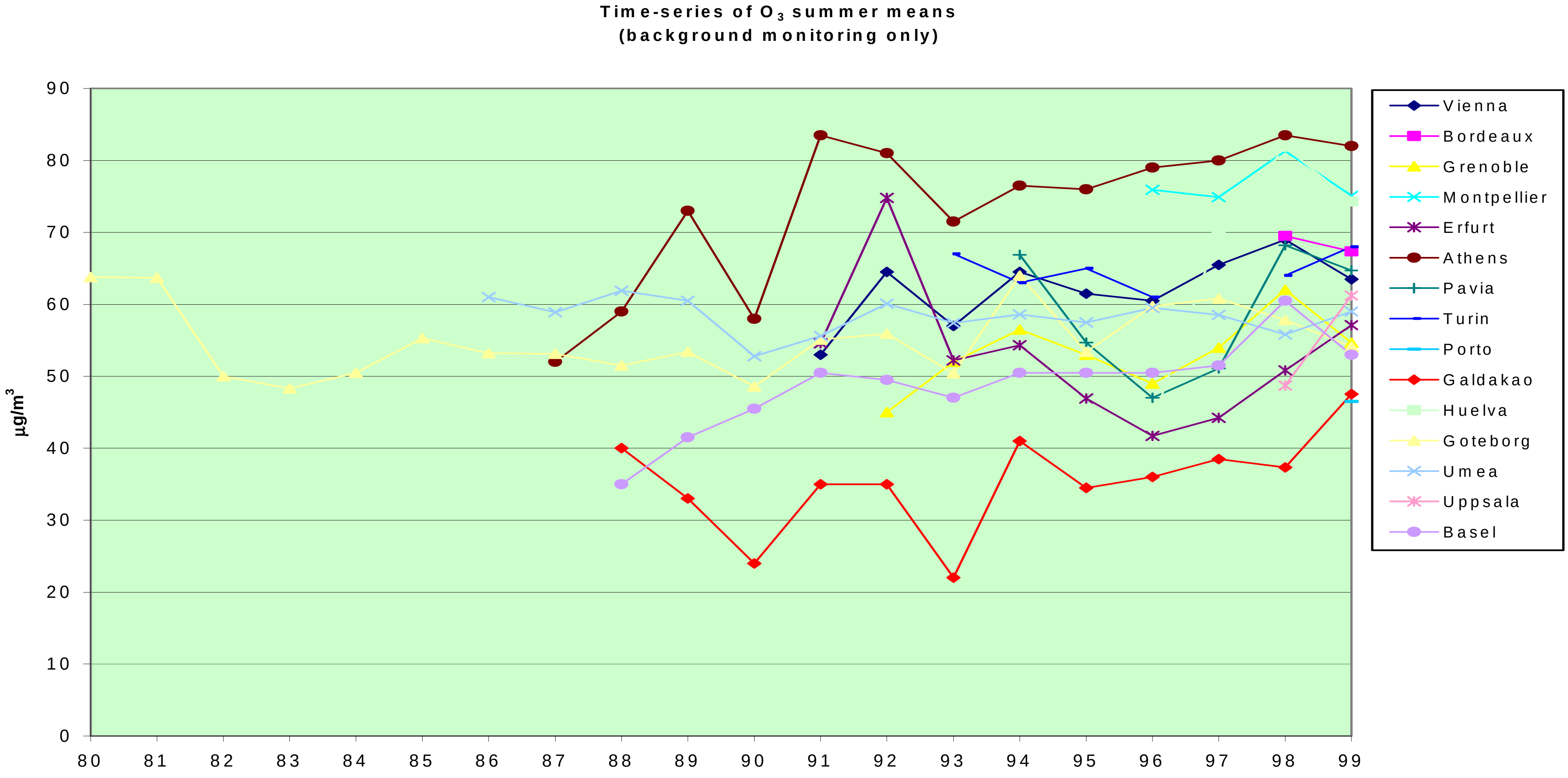


Figure 34: O_3 traffic time-series

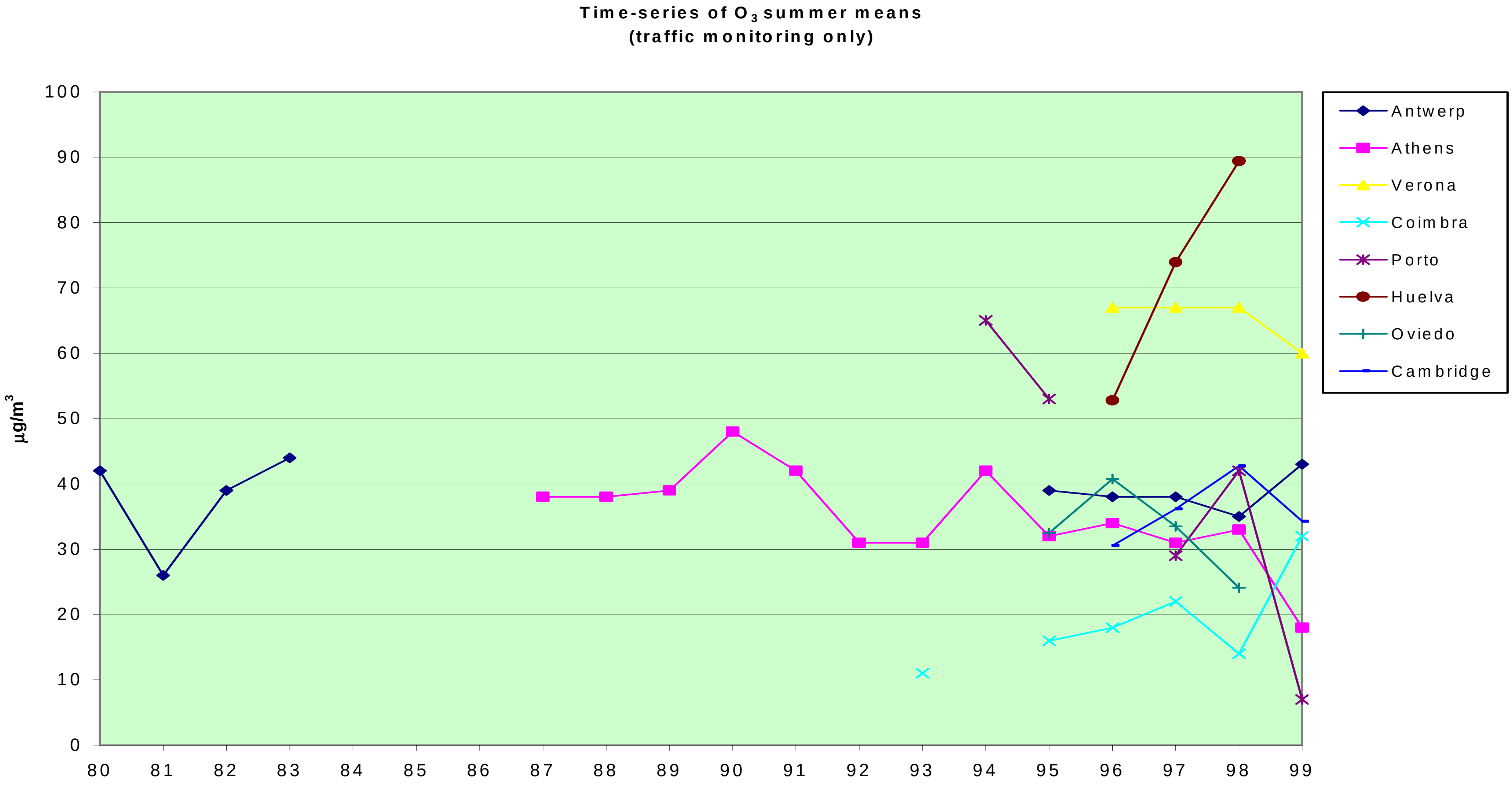


Figure 35: Summary time-series per pollutant

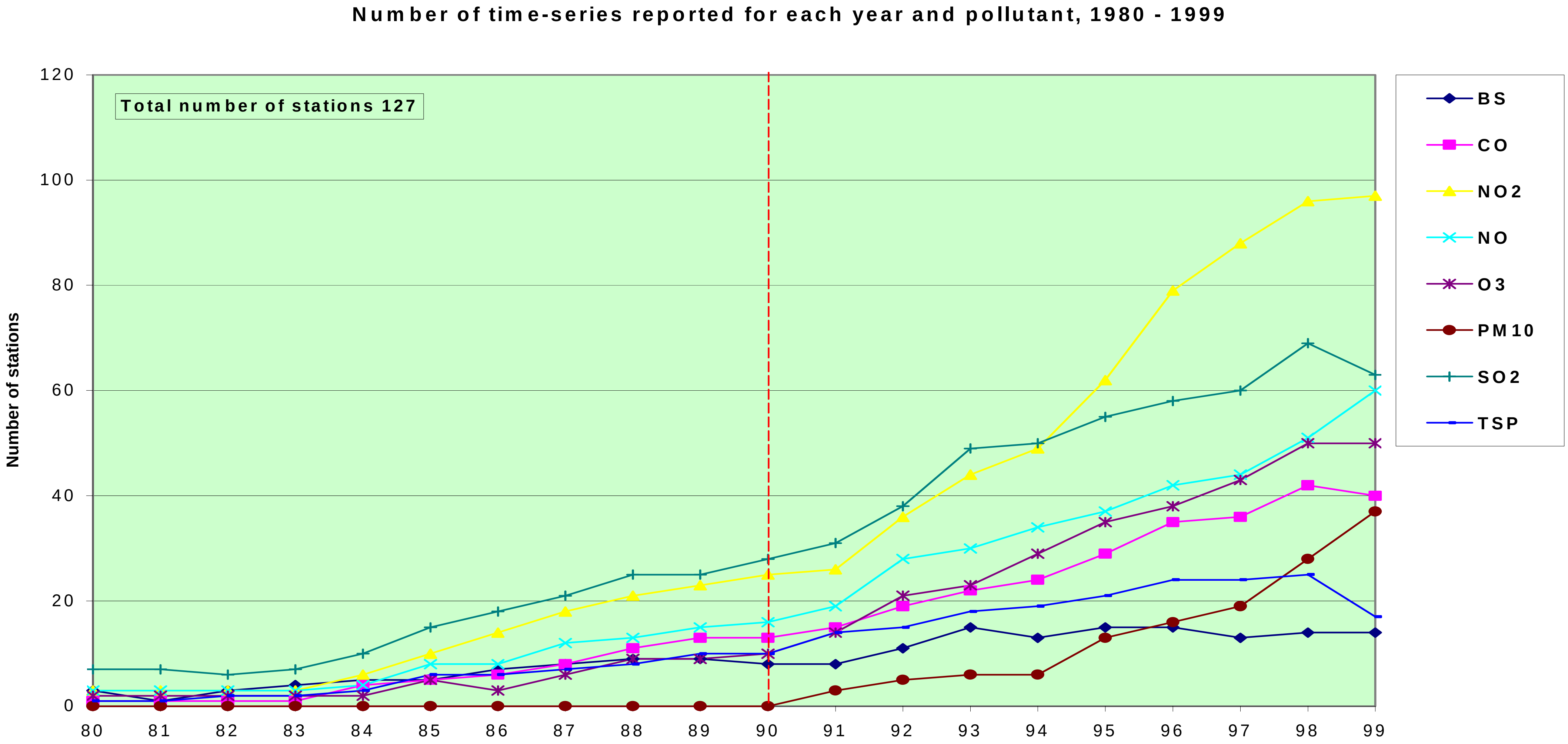


Figure 36: SO_2 lowest and highest annual mean monitor values within cities 1990

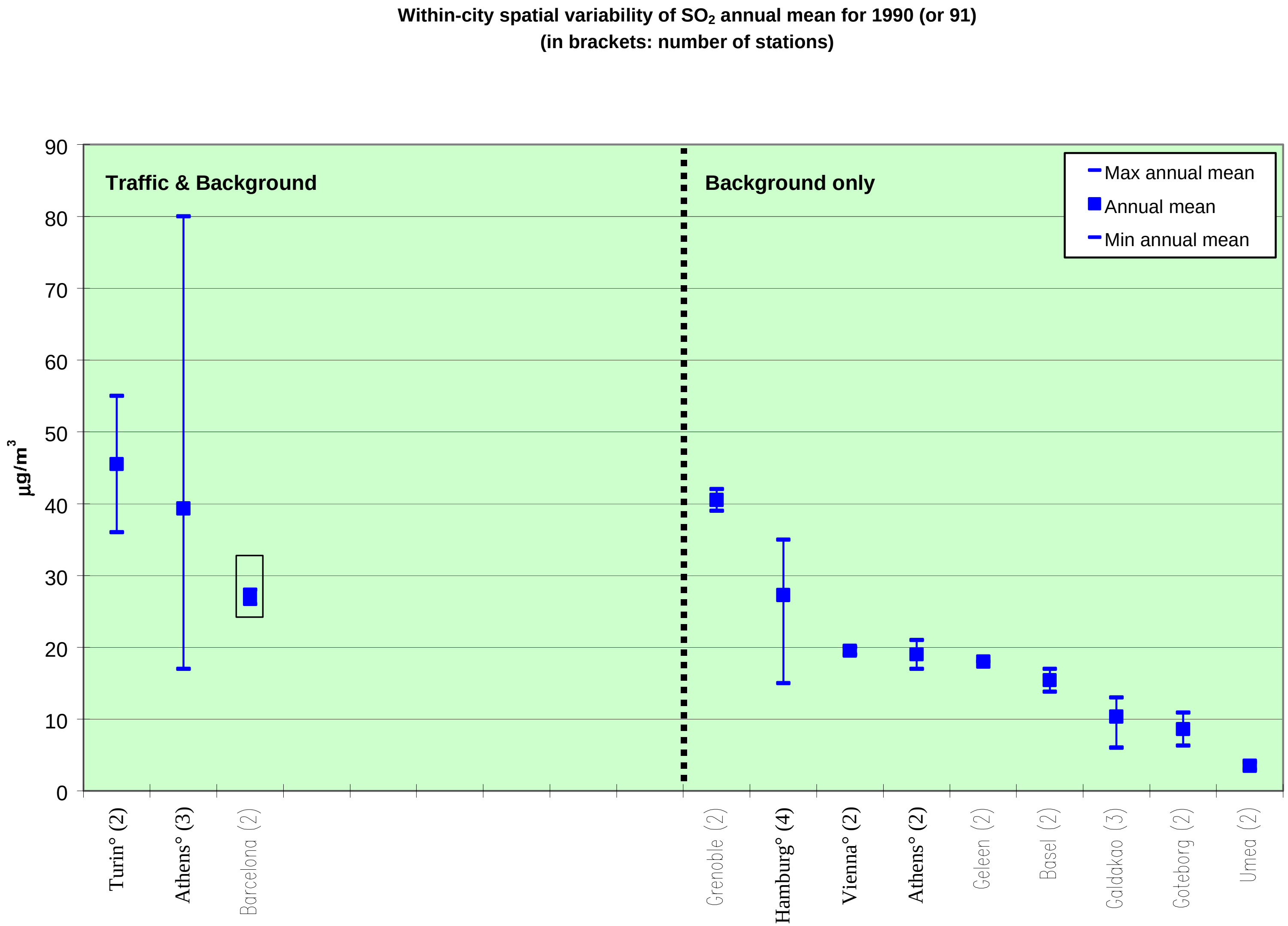


Figure 37: SO_2 lowest and highest annual mean monitor values within cities 1999

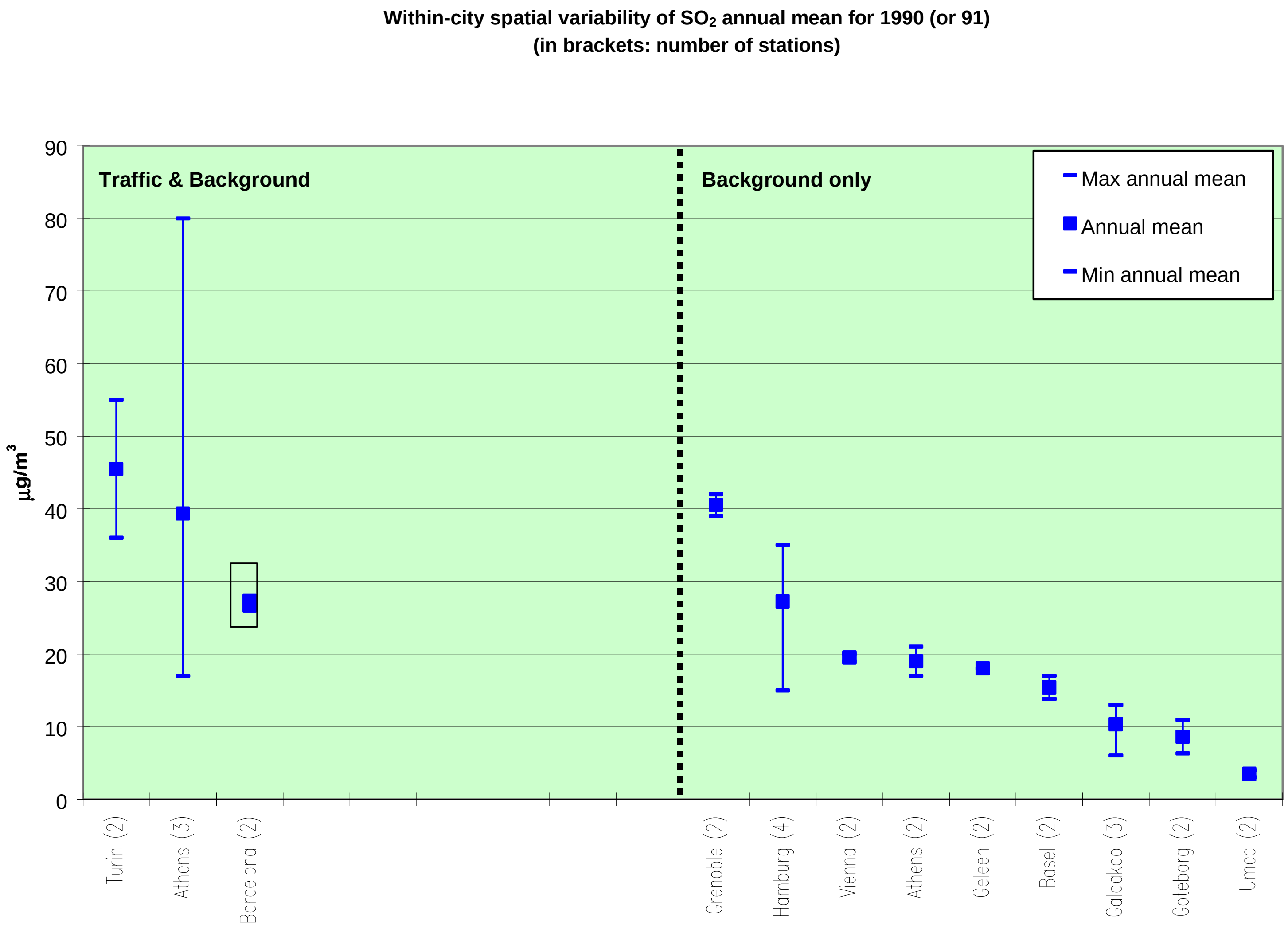


Figure 38: CO lowest and highest annual mean monitor values within cities 1990

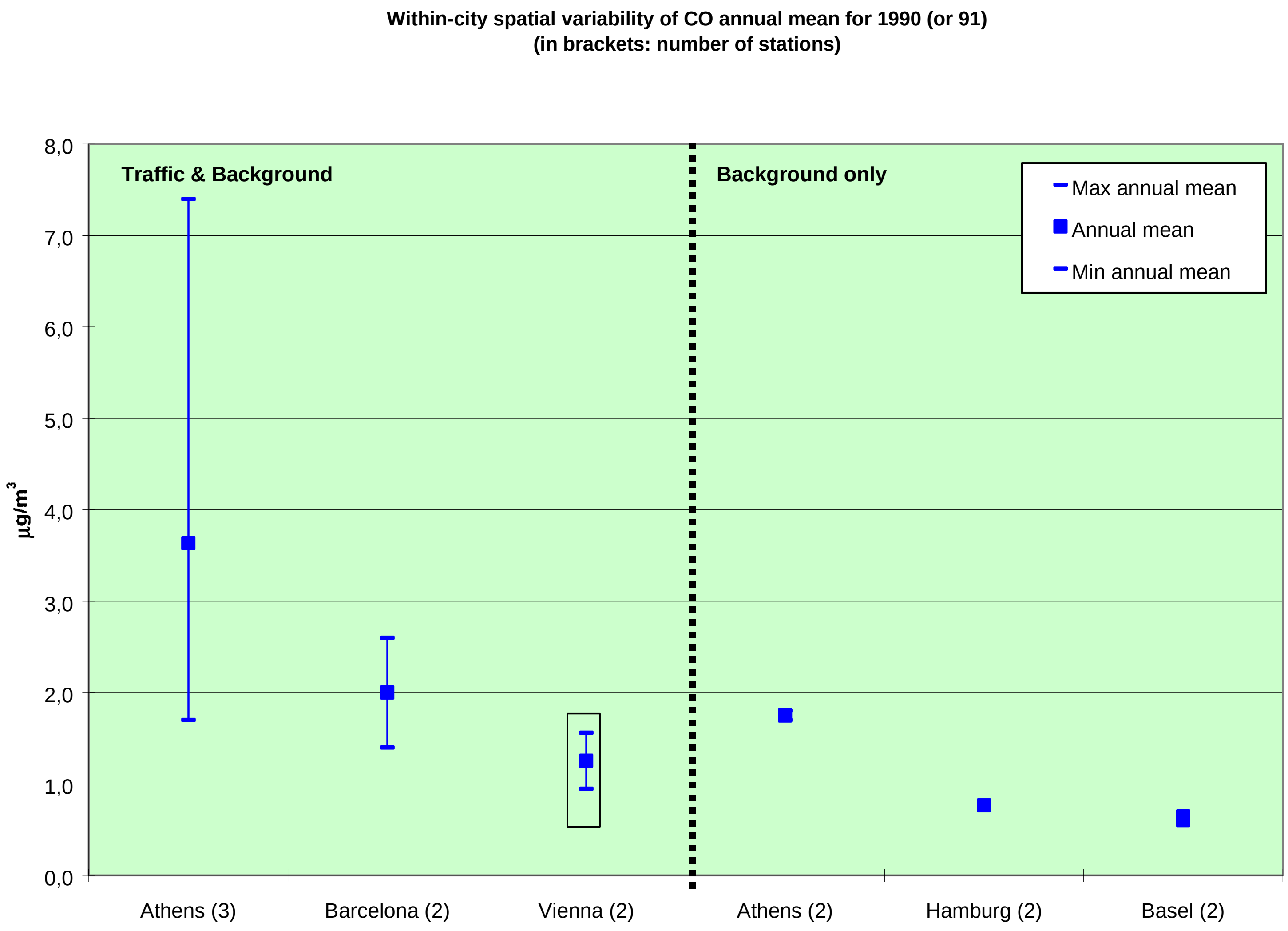


Figure 39: CO lowest and highest annual mean monitor values within cities 1999

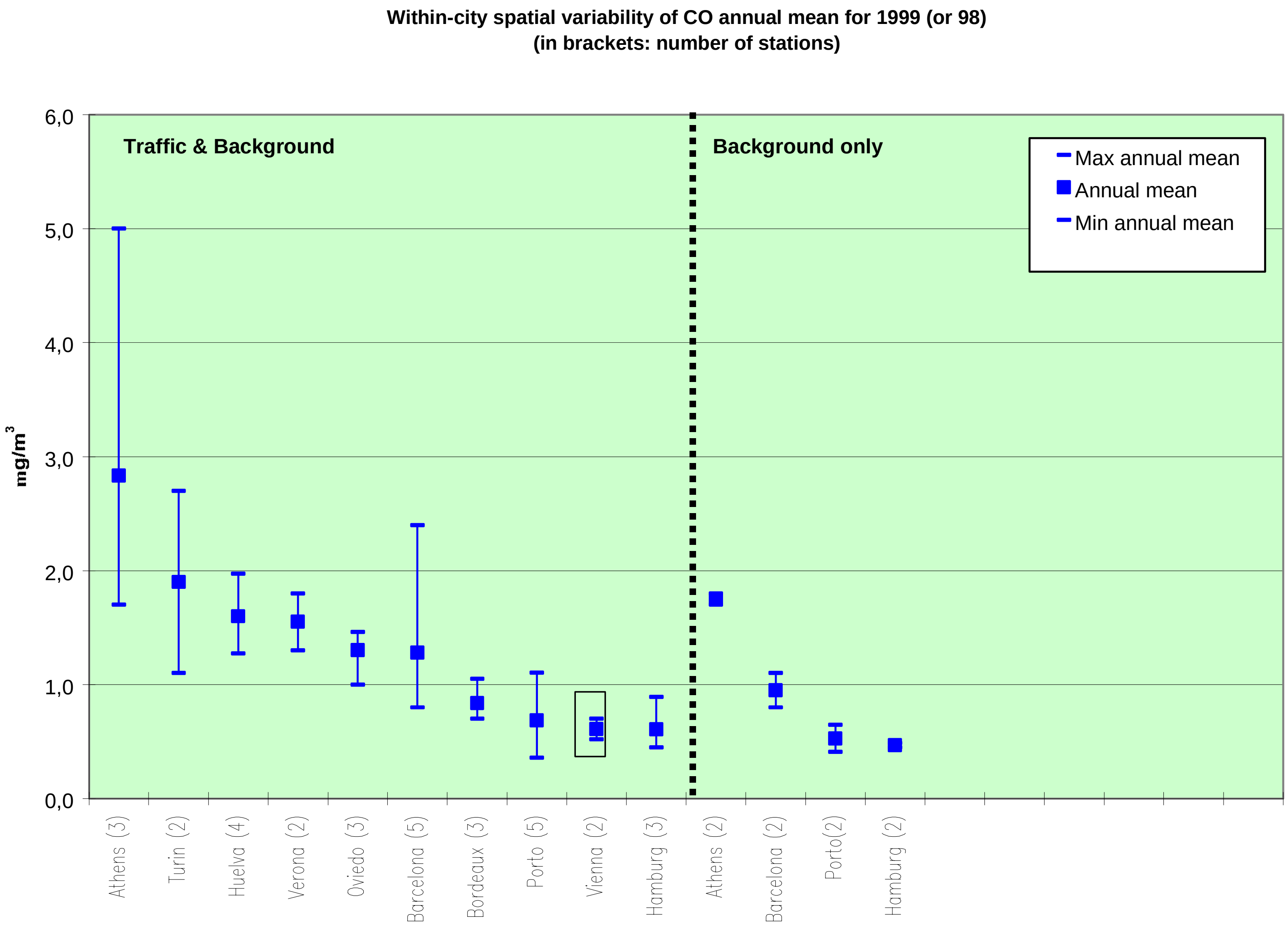


Figure 40: NO_2 lowest and highest annual mean monitor values within cities 1990

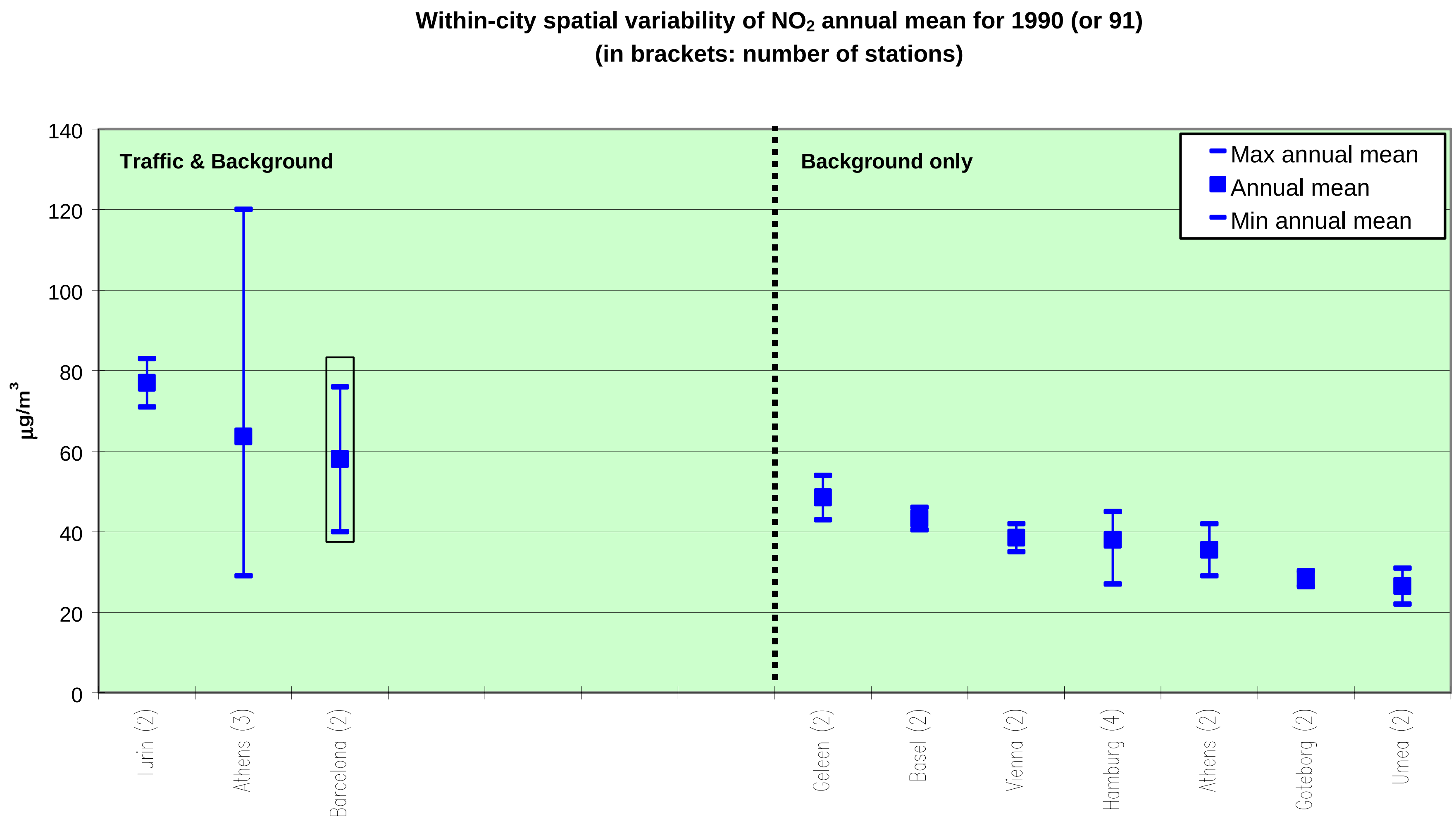


Figure 41: NO_2 lowest and highest annual mean monitor values within cities 1999

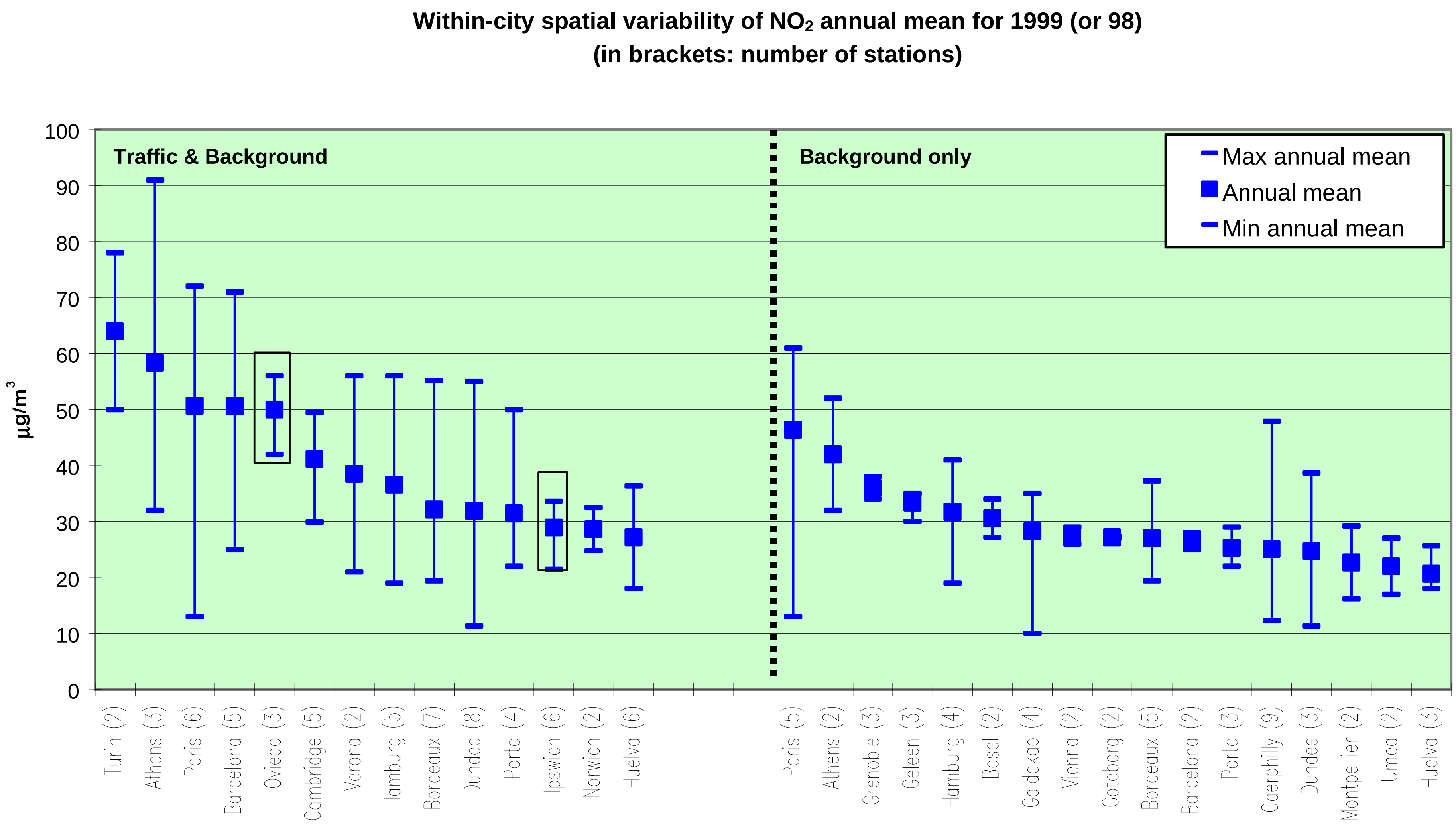


Figure 42: NO lowest and highest annual mean monitor values within cities 1990

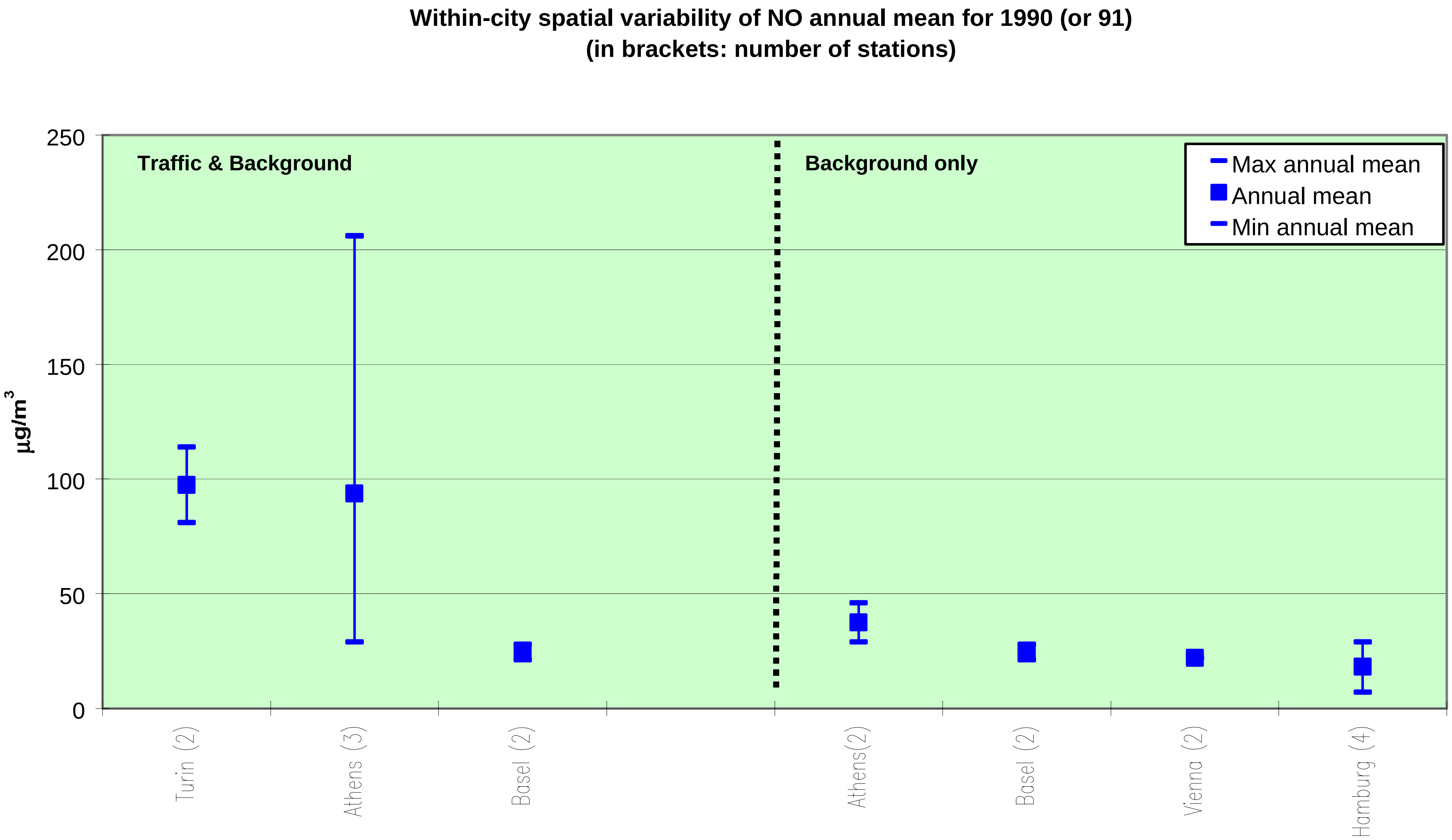


Figure 43: NO lowest and highest annual mean monitor values within cities 1999

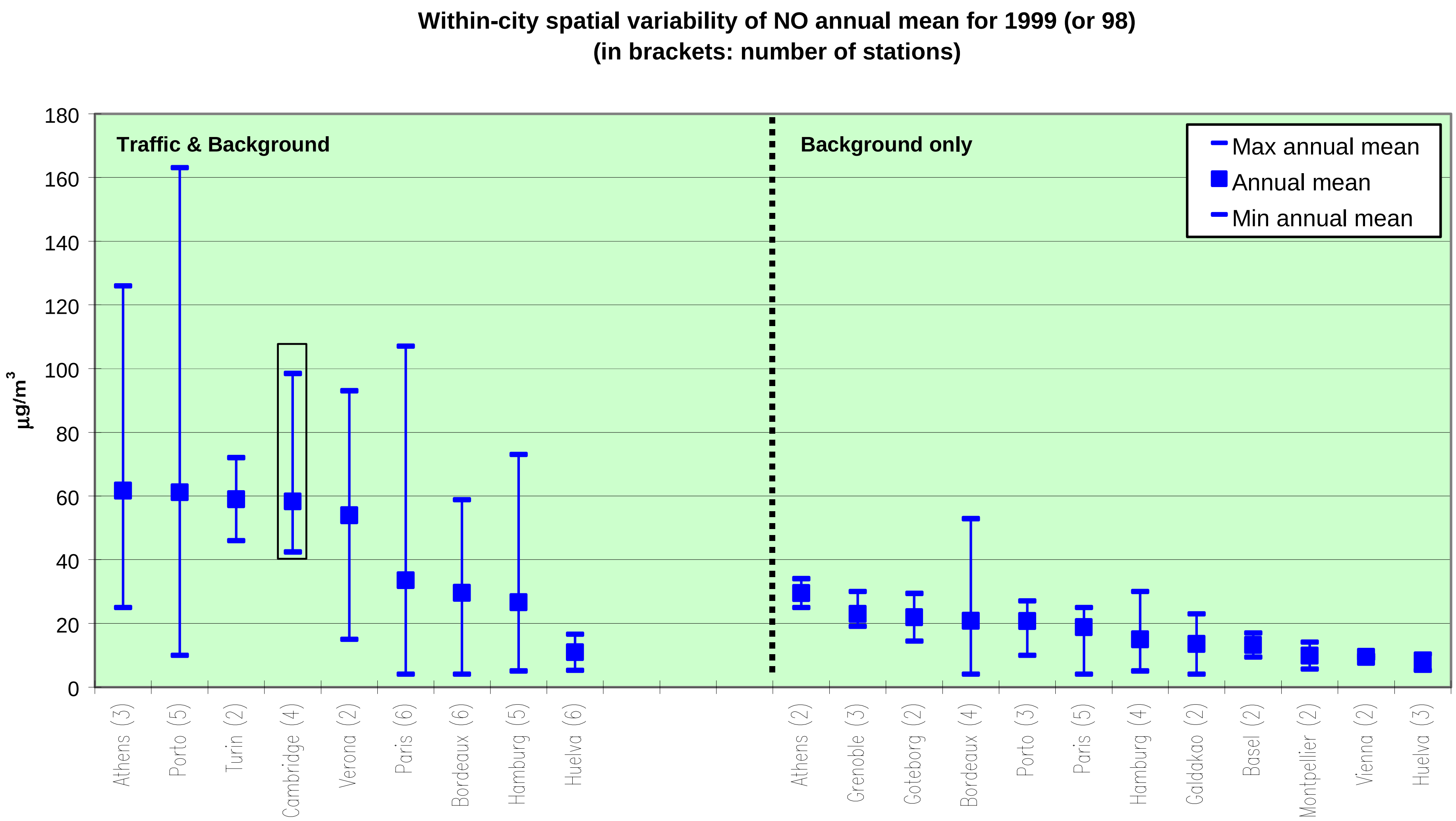


Figure 44: TSP lowest and highest annual mean monitor values within cities 1990

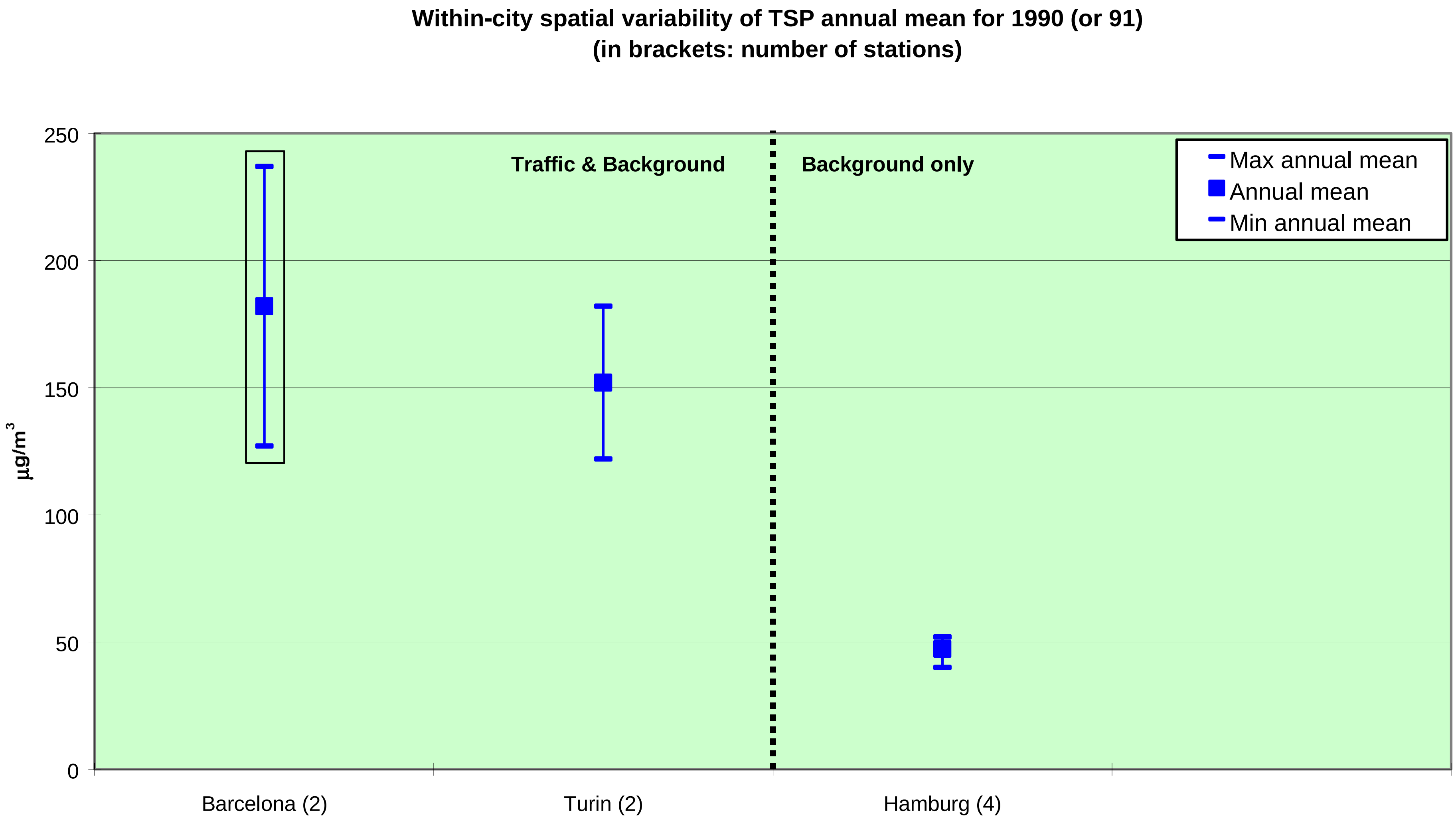


Figure 45: TSP lowest and highest annual mean monitor values within cities 1999

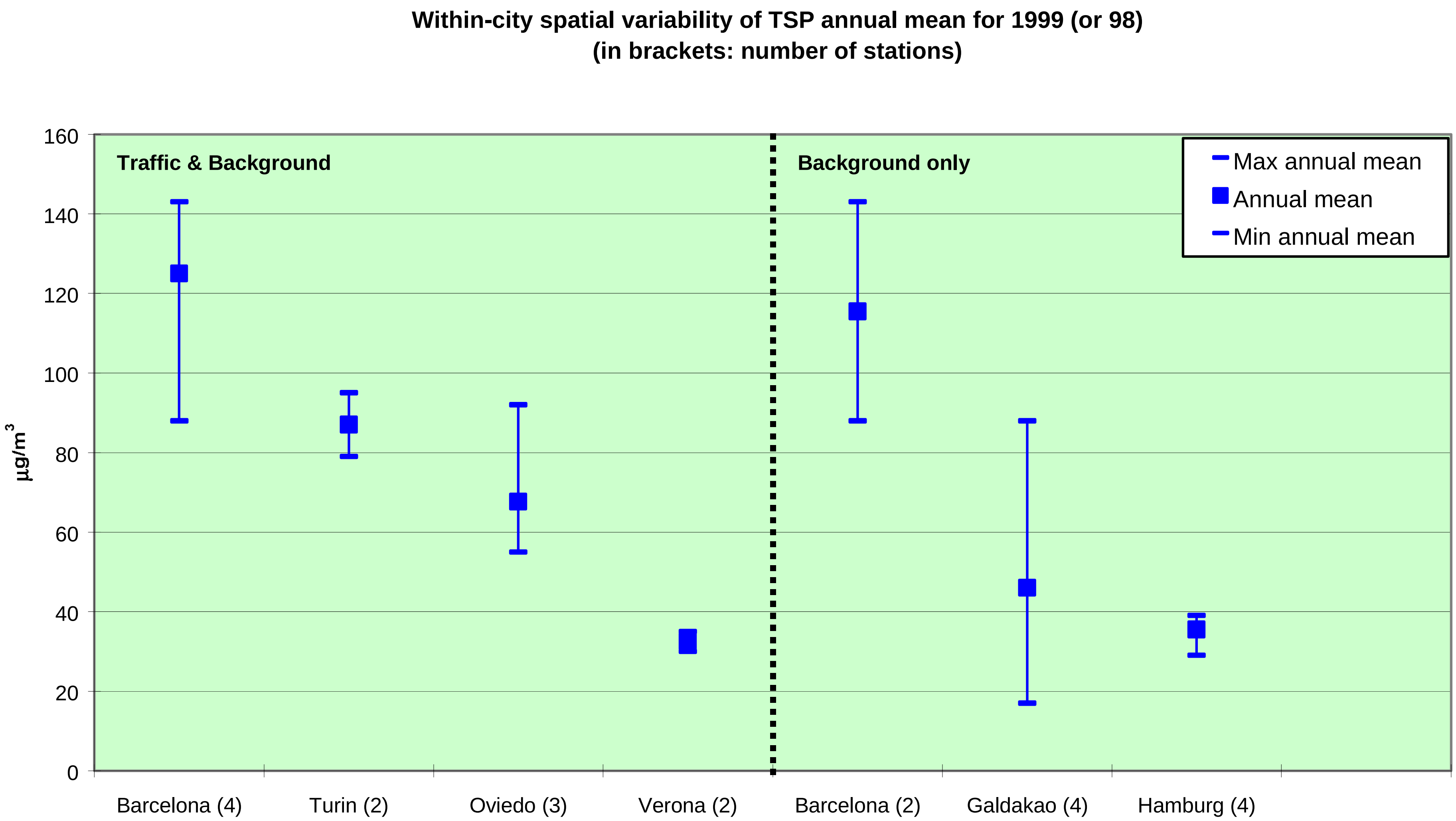


Figure 46: Black smoke lowest and highest annual mean monitor values within cities 1990

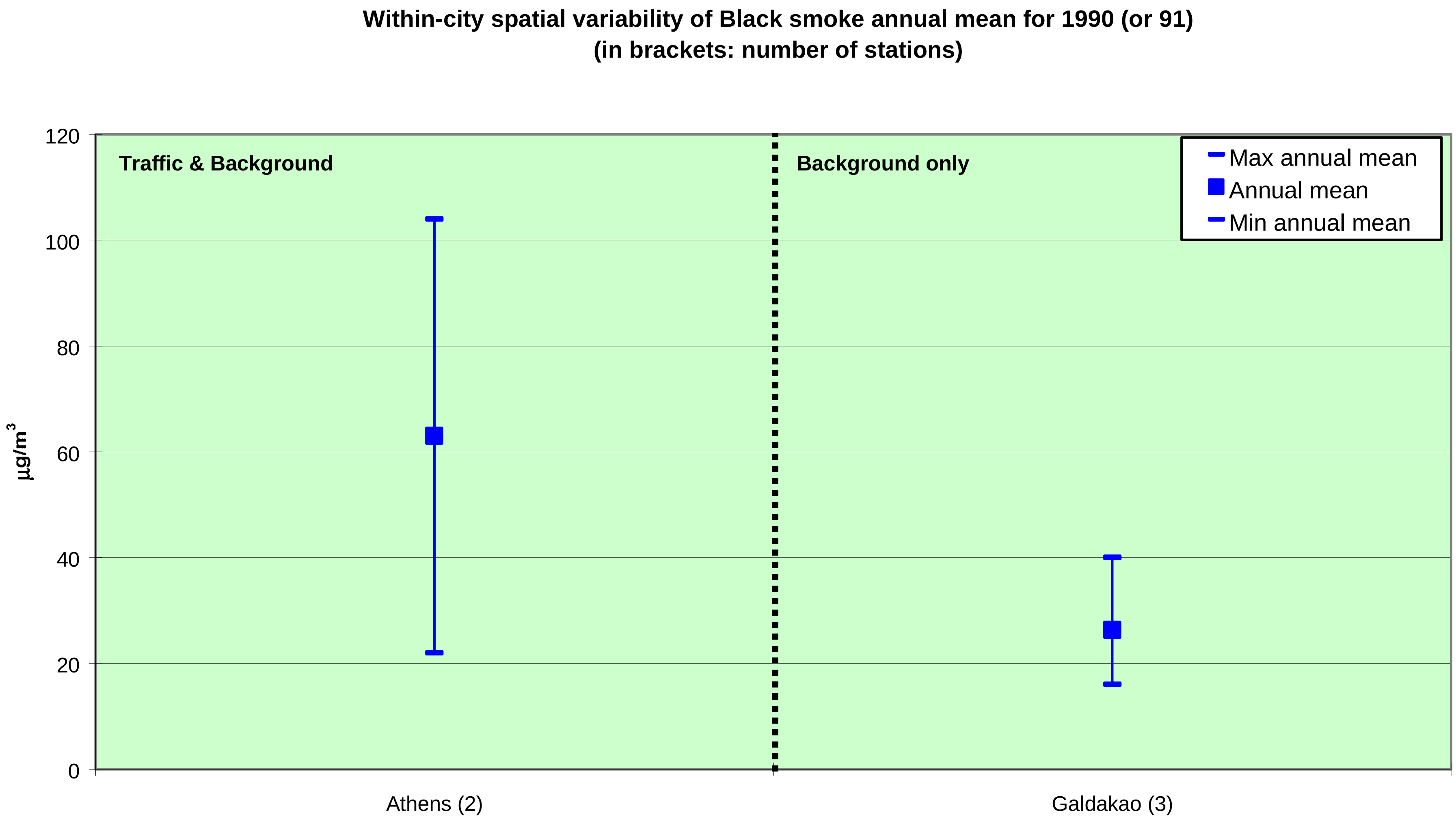


Figure 47: Black smoke lowest and highest annual mean monitor values within cities 1999

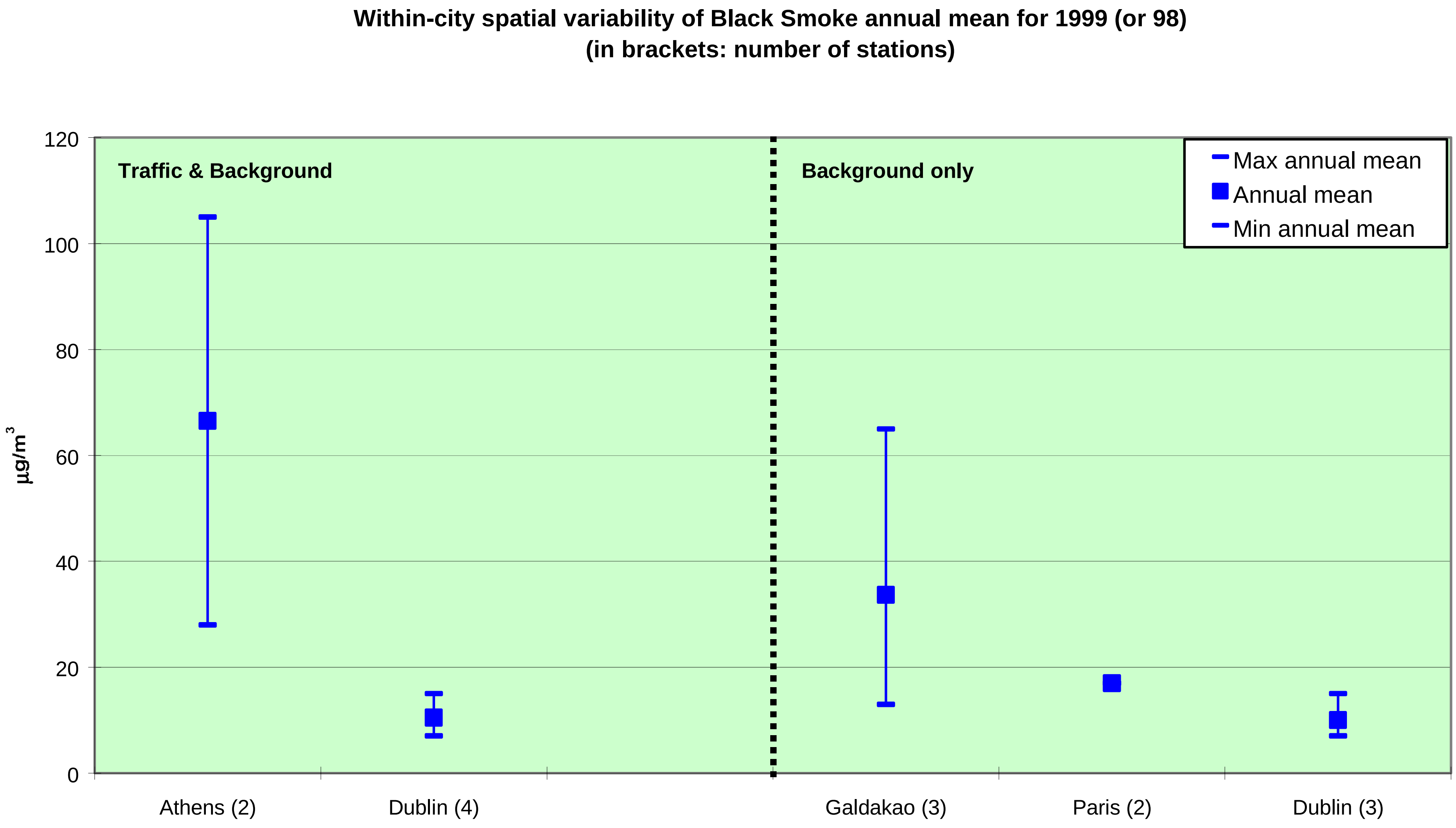


Figure 48: PM_{10} lowest and highest annual mean monitor values within cities 1999

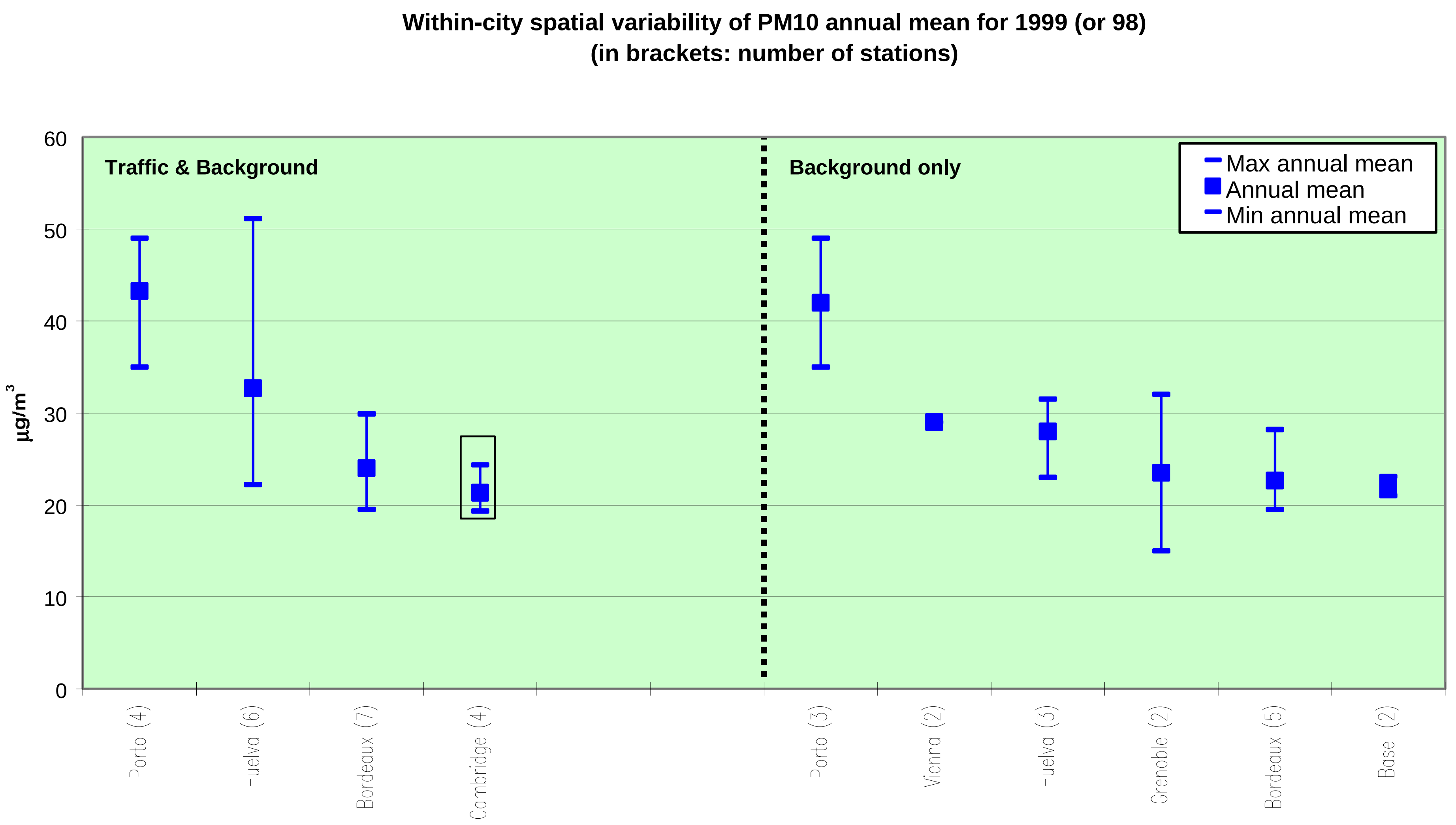
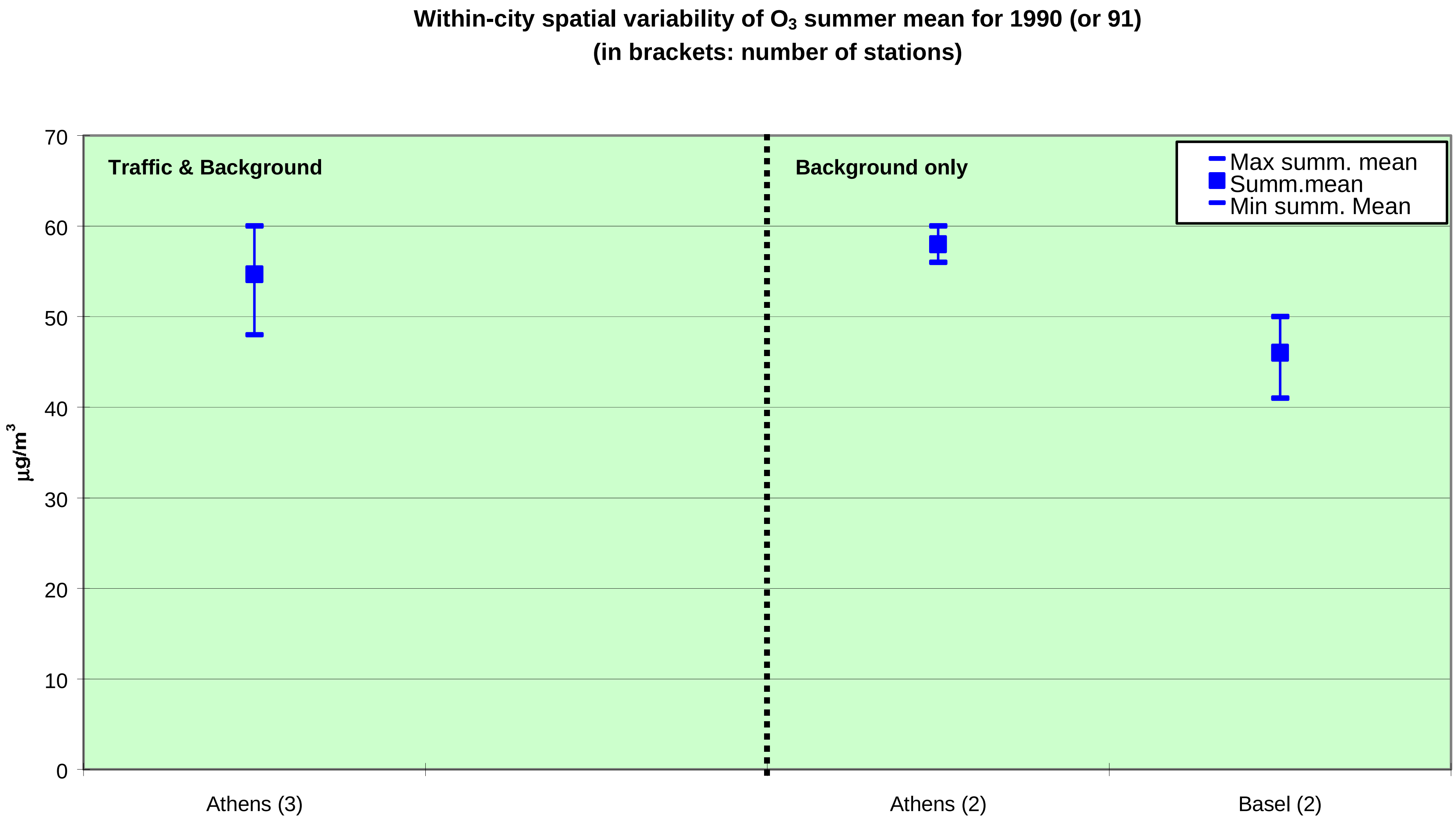


Figure 49: O_3 within-city summer mean variability 1990



a

Figure 50: O_3 within-city summer mean variability 1999

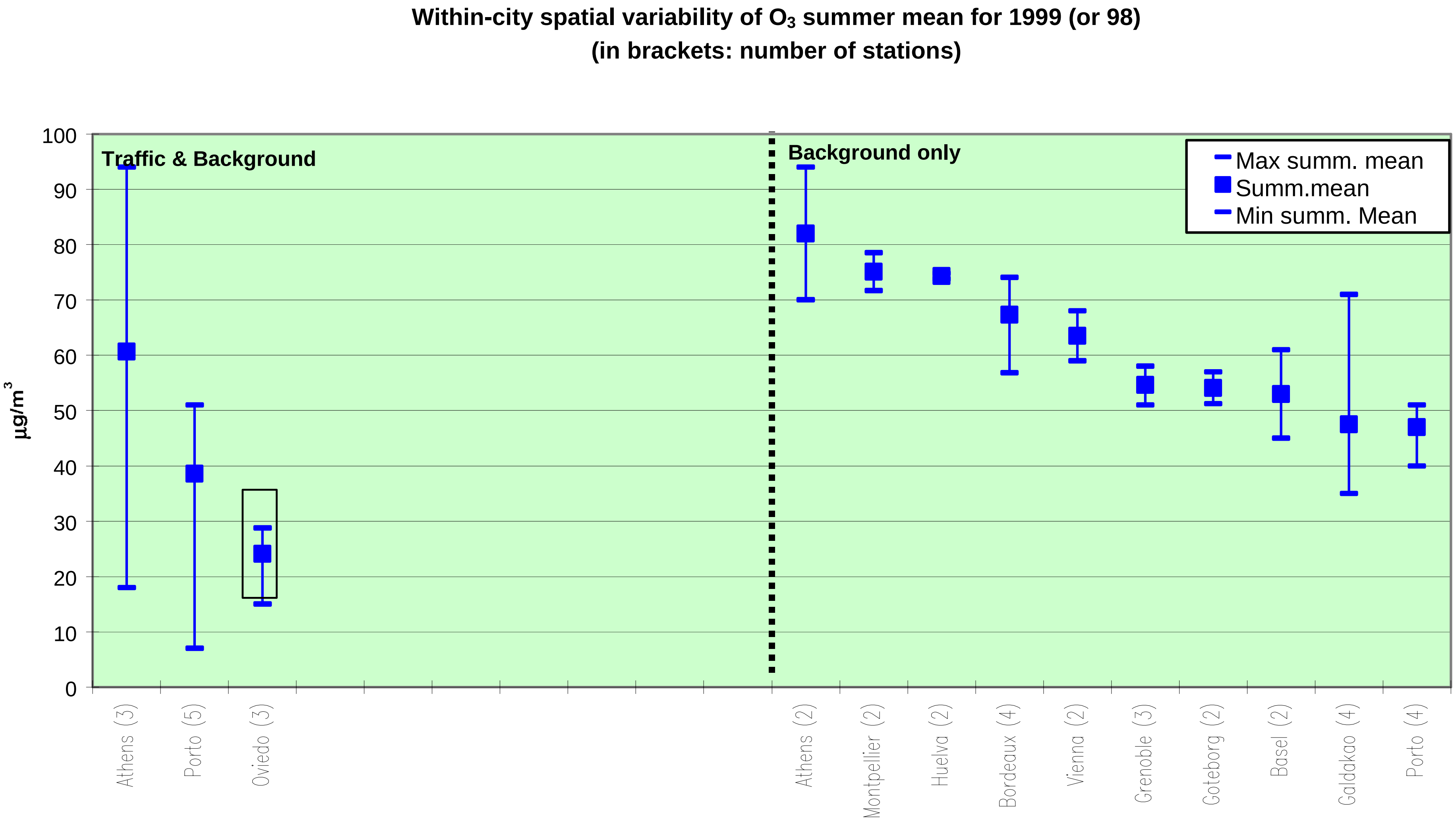
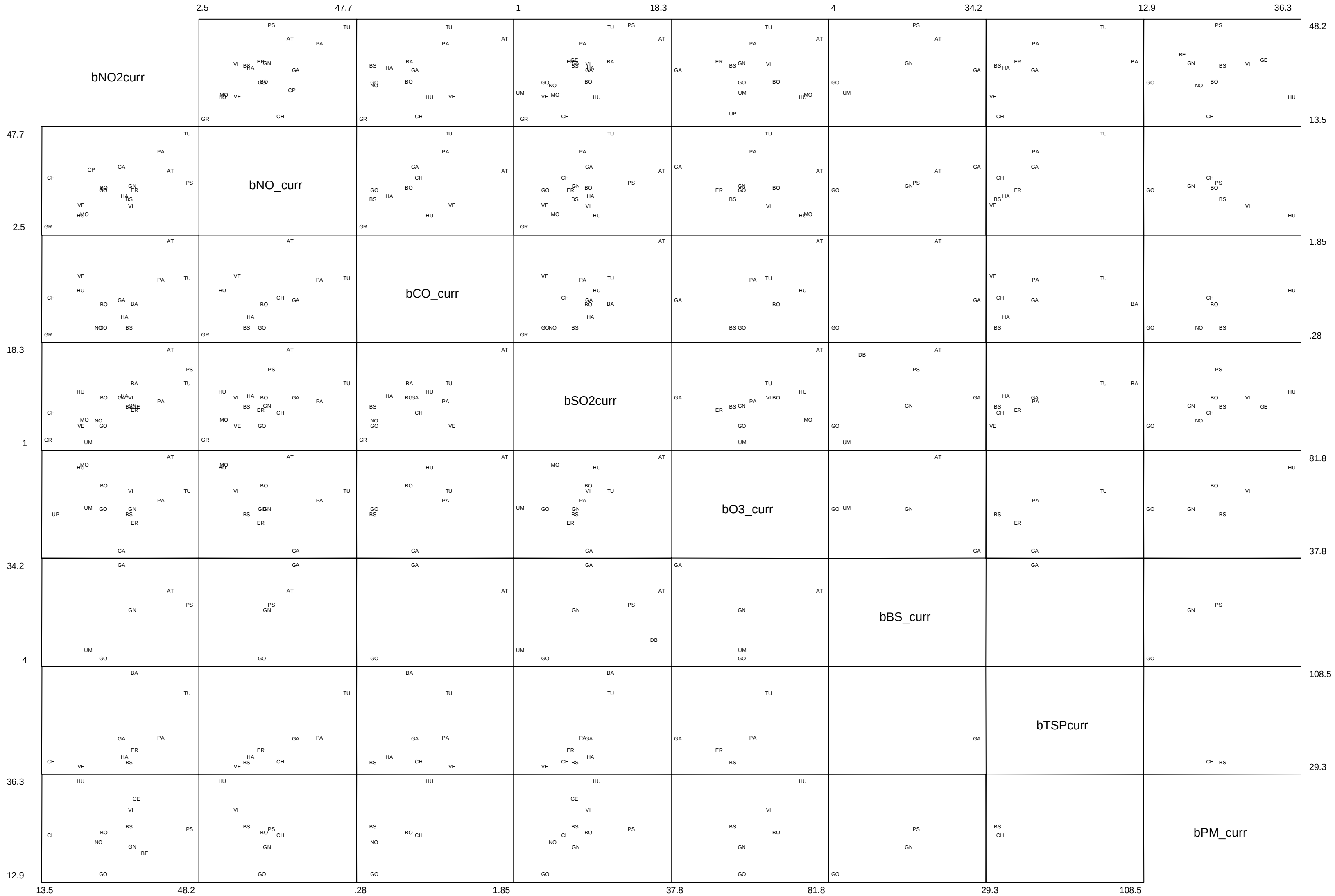


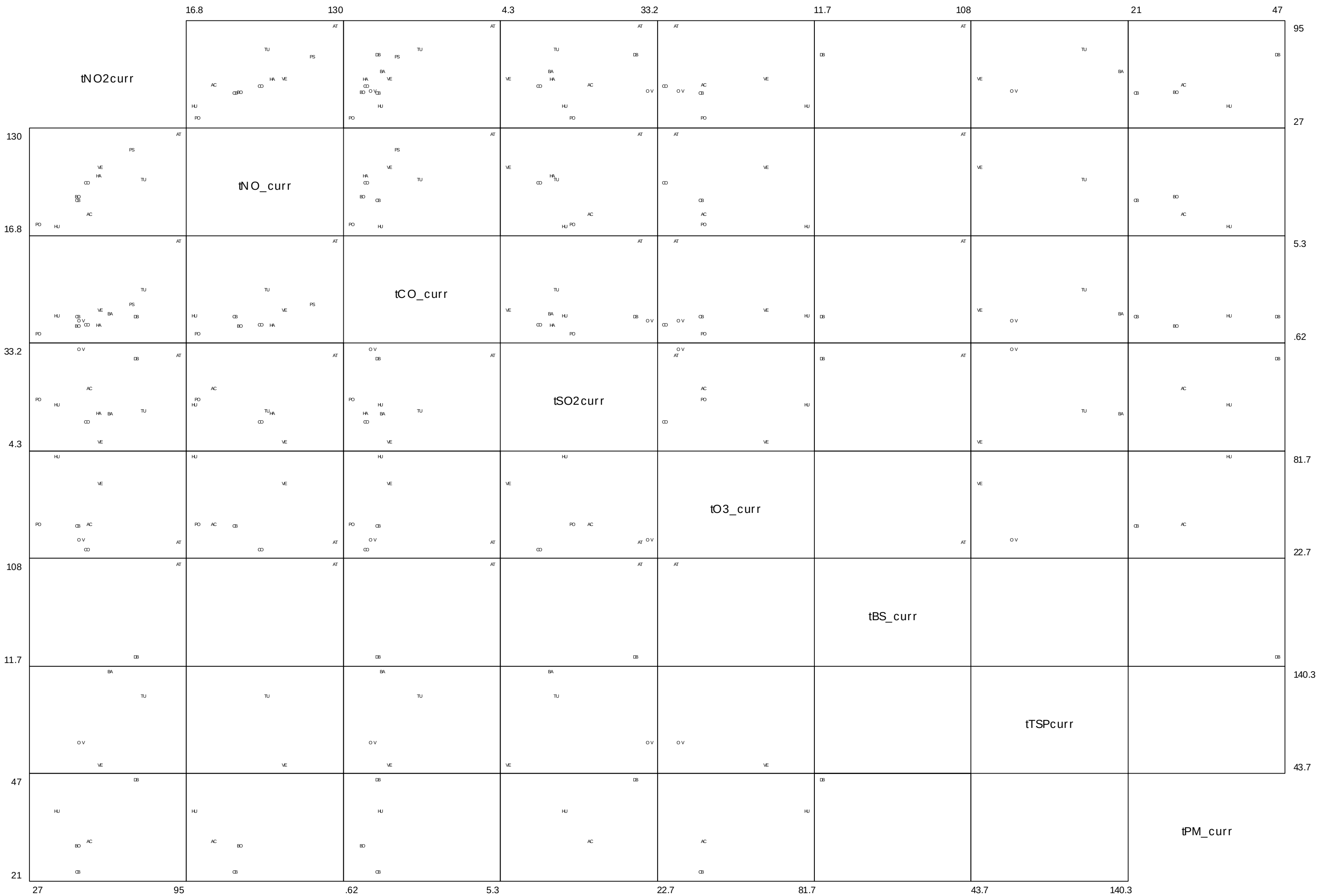
Figure 51: Correlation plots of all 'current 3-year annual mean' pollutant concentrations across Europe, BACKGROUND stations only



Centre	Code
Albacete	AL
Antwerp City	AC
Athens	AT
Barcelona	BA
Basel	BS
Bergen	BE
Bergen op Zoom	BZ
Bordeaux	BO
Cambridge	CB
Cearphilly	CP
Christchurch	CH
Coimbra	CO
Dublin	DB
Dundee	DD
Erfurt	ER
Galdakao	GA
Geleen	GE
Goteborg	GO
Grenoble	GN
Groningen	GR
Hamburg	HA
Huelva	HU
Ipswich	IP
Montpellier	MO
Norwich	NO
Oviedo	OV
Paris	PS
Pavia	PA
Porto	PO
Reyjkavik	RE
Tartu	TA
Turin	TU
Umea	UM
Uppsala	UP
Verona	VE
Vienna	VI

Concentrations in µg/m³
Except CO in mg/m³

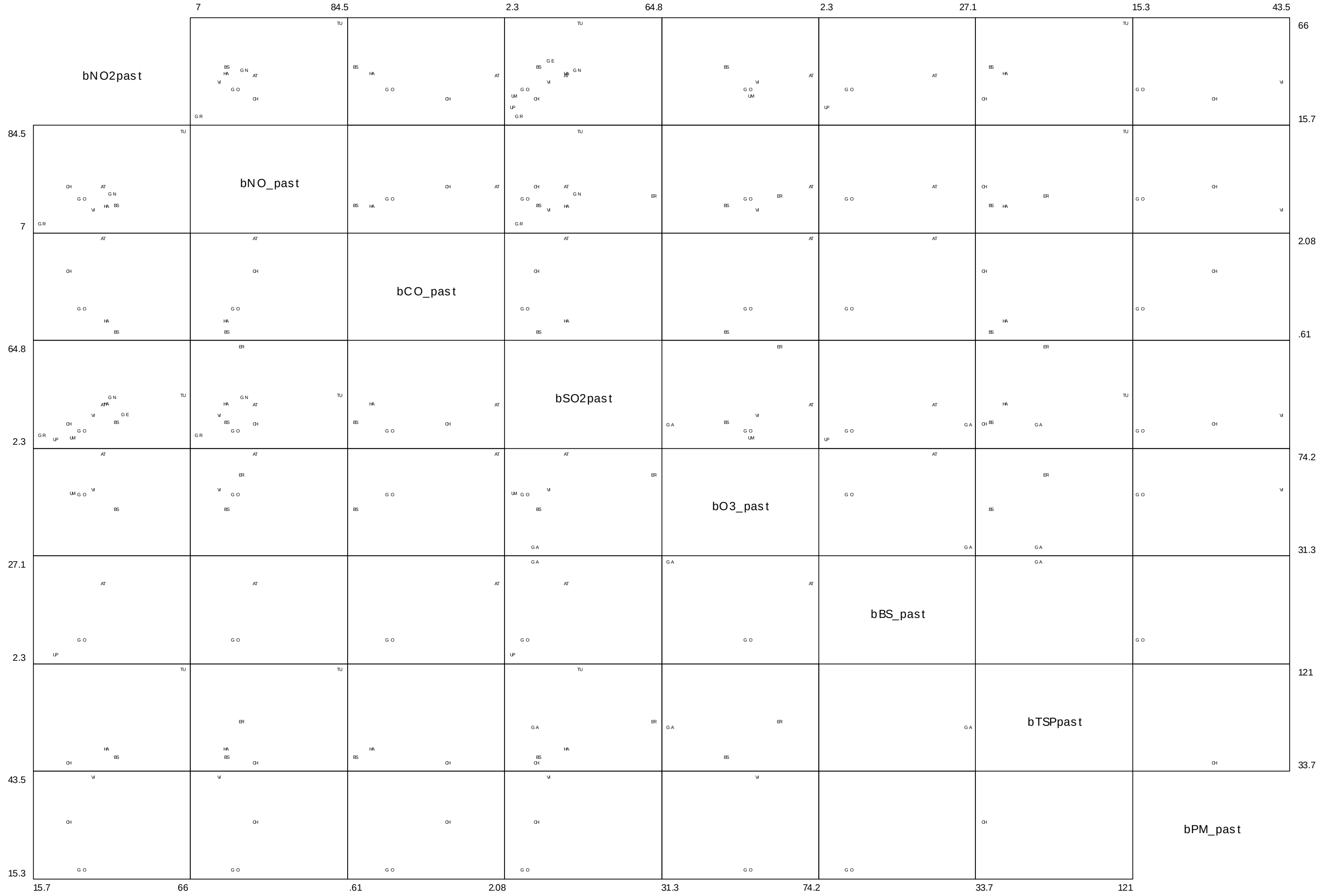
Figure 52: Correlation plots of all 'current 3-year annual mean' pollutant concentrations across Europe, TRAFFIC stations only



Centre	Code
Albacete	AL
Antwerp City	AC
Athens	AT
Barcelona	BA
Basel	BS
Bergen	BE
Bergen op Zoom	BZ
Bordeaux	BO
Cambridge	CB
Cearphilly	CP
Christchurch	CH
Coimbra	CO
Dublin	DB
Dundee	DD
Erfurt	ER
Galdakao	GA
Geleen	GE
Goteborg	GO
Grenoble	GN
Groningen	GR
Hamburg	HA
Huelva	HU
Ipswich	IP
Montpellier	MO
Norwich	NO
Oviedo	OV
Paris	PS
Pavia	PA
Porto	PO
Reyjkavik	RE
Tartu	TA
Turin	TU
Umea	UM
Uppsala	UP
Verona	VE
Vienna	VI

Concentrations in µg/m³
Except CO in mg/m³

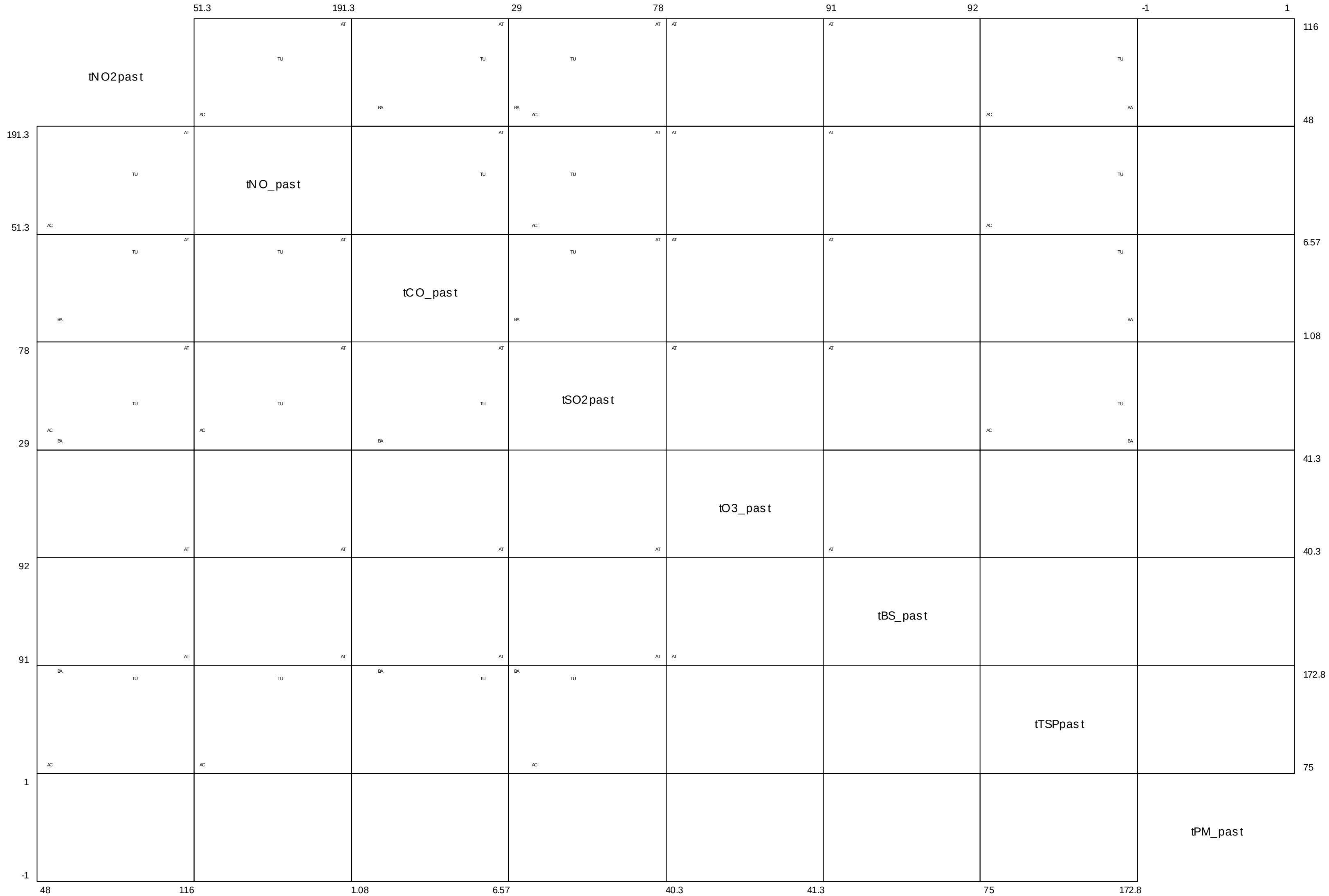
Figure 53: Correlation plots of all 'past 3-year annual mean' pollutant concentrations across Europe, BACKGROUND stations only



Centre	Code
Albacete	AL
Antwerp City	AC
Athens	AT
Barcelona	BA
Basel	BS
Bergen	BE
Bergen op Zoom	BZ
Bordeaux	BO
Cambridge	CB
Cearphilly	CP
Christchurch	CH
Coimbra	CO
Dublin	DB
Dundee	DD
Erfurt	ER
Galdakao	GA
Geleen	GE
Goteborg	GO
Grenoble	GN
Groningen	GR
Hamburg	HA
Huelva	HU
Ipswich	IP
Montpellier	MO
Norwich	NO
Oviedo	OV
Paris	PS
Pavia	PA
Porto	PO
Reyjkavik	RE
Tartu	TA
Turin	TU
Umea	UM
Uppsala	UP
Verona	VE
Vienna	VI

Concentrations in µg/m³
Except CO in mg/m³

Figure 54: Correlation plots of all ‘past 3-year annual mean’ pollutant concentrations across Europe, TRAFFIC stations only

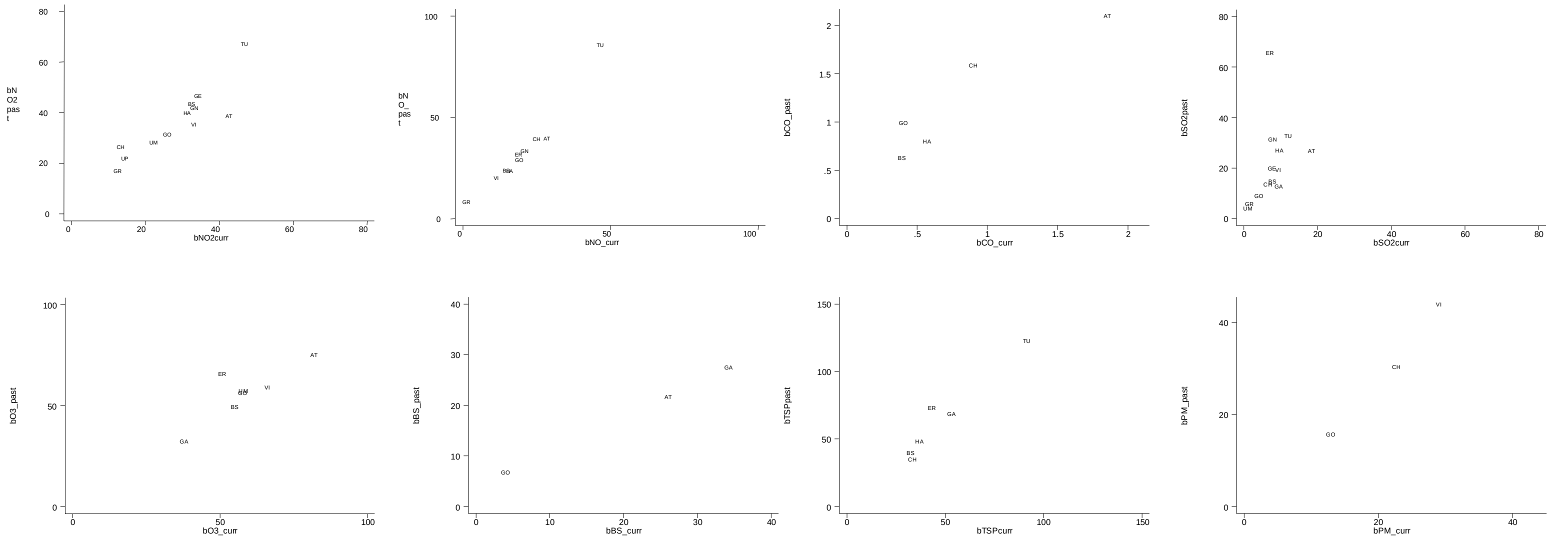


Centre	Code
Albacete	AL
Antwerp City	AC
Athens	AT
Barcelona	BA
Basel	BS
Bergen	BE
Bergen op Zoom	BZ
Bordeaux	BO
Cambridge	CB
Cearphilly	CP
Christchurch	CH
Coimbra	CO
Dublin	DB
Dundee	DD
Erfurt	ER
Galdakao	GA
Geleen	GE
Goteborg	GO
Grenoble	GN
Groningen	GR
Hamburg	HA
Huelva	HU
Ipswich	IP
Montpellier	MO
Norwich	NO
Oviedo	OV
Paris	PS
Pavia	PA
Porto	PO
Reyjkavik	RE
Tartu	TA
Turin	TU
Umea	UM
Uppsala	UP
Verona	VE
Vienna	VI

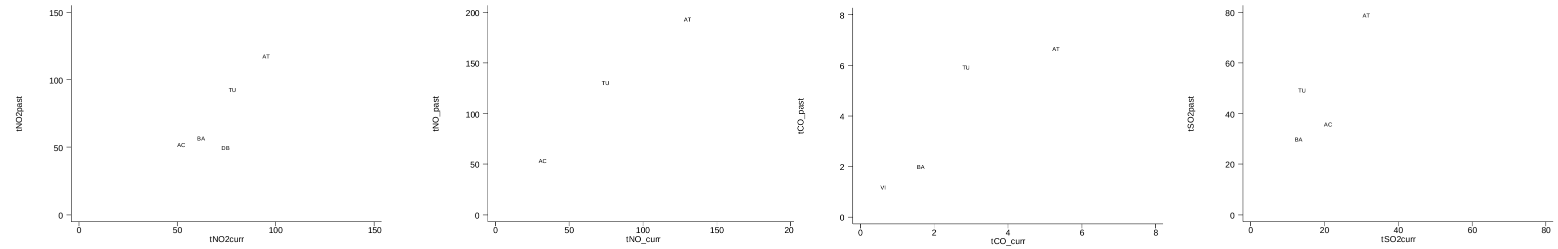
Concentrations in µg/m³
Except CO in mg/m³

Figure 55: Correlation plots of the 'current' and 'past 3-year mean' concentrations across Europe

BACKGROUND stations only



TRAFFIC stations only



Centre	Code
Albacete	AL
Antwerp City	AC
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Barcelona	BA
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Bergen	BE
Bergen op Zoom	BZ
Bordeaux	BO
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Goteborg	GO
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Oviedo	OV
Paris	PS
Pavia	PA
Porto	PO
Reyjkavik	RE
Tartu	TA
Turin	TU
Umea	UM
Uppsala	UP
Verona	VE
Vienna	VI

Concentrations in μg/m³
Except CO in mg/m³

10 Annex

10.1 City-specific comments

Denmark/Aarhus: There were no data available except from the year 1989 from Airbase. A local epidemiological expert told us, that they stopped measuring air pollution after 1989 because the pollution levels were to low. Aarhus has only participated in the national air pollution monitoring program in 1989. The local authorities have planned to resume the measurement in summer 2000.

Estonia/Tartu: December 31. 1999 all the measurements were stopped in Tartu because there were no more financial resources anymore. Only NO_2 from one traffic site was reported from Tartu. In November 98 the station was moved (300m) from hillside (70m.a.s.l.) Riia street to the crossing of Riia street and Turu street.

Greece/Athens: The station Marussi is the one in Athens with the highest pollution levels for secondary pollutants. The station Patission is the one in Athens with the highest pollution level for primary pollutants.

Germany/Hamburg: A public power station influenced the station “Sternenschanze” until the end of 1987. Since 1991 the influences due to traffic at the station “Veddel” is stronger due to a change in the direction of a nearby road.

Italy/Pavia: The station Folperti was classified as background station for this study, but according to the local authorities the station is rather a traffic station.

Island/Reykjavik: There is no urban background station. They only have a mobile trailer which is situated 2/3 to 3/ 4 of the year at one of the most trafficked location in Reykjavik and does not fulfil the requirements of the study.

Ireland/Dublin: The station College Street is not a “valid” site, as it is located in the centre of three heavily trafficked roads. We included this station as a normal traffic site.

Ireland/Wexford: We only have SO_2 and TSP data from 1.4.97 to 31.3.98. Air quality data further back is stored away somewhere due to lack of space for storage and is not available anymore. The only station in Wexford was ceased in June 1998. It is intended that monitoring shall recommence in the autumn 2000.

Netherlands/Bergen op Zoom: We only have data from a rural station outside of Bergen op Zoom from the National Air Quality Monitoring Network.

Netherlands/Groningen: We have data from a background station outside of Groningen. This is the nearest station from the National Air Quality Monitoring. The second station we have is a very old one in the centre of Groningen, which was shot down in 1985.

New Zealand/Christchurch: PM_{10} is measured after 1994 with TEOM. Therefore we see lower values after 1994 because they didn’t use a correction factor. Monitoring started in Christchurch after 1988 at this site, but there is no documented QA/QC info from the period 1988 to 1993. We do therefore not know what the measurement instruments/techniques were used prior to 1994. TSP is measured as a 7-day average.

Portugal/Coimbra: There is only one station in Coimbra, a traffic site. No background data available at all.

Portugal/Porto: The reported data is from a network called RMQA-AMP air pollution network, which is being installed, in the Metropolitan area of Porto. Besides Porto city the network concerns a larger area, which was already defined as one of the four agglomerations (Council Directive 96/62/CE of 27 September 1996) that exist in the north of Portugal. 5 of the 8 reported stations are in this agglomeration in the north of Portugal. We see a huge increase for NO from 1998 to 1999 due to the fact that villa nova de gaia is an extreme traffic site and only reported data for 1999.

Spain/Albacete: There is only one station in Albacete installed in May 1999. All values from Albacete are calculated with data from June 1999 to December 1999.

Spain/Galdakao: The study area is not a city but a quite extensive area. It has rural and urban areas and it goes from the cost to the interior. We received air quality data from 8 stations, 6 of them near Galdakao, the stations “Durango” and “Mundaka” are far away from Galdakao, but still in the study area. 4 of the stations are manual stations and 4 are automatic stations, but all of them have quality level 2a. The station “C.Lope de Vega” was before 1990 in another less contaminated area located. Also the station “Colegio Pena Lemona).

Spain/Huelva: It is not possible to get air quality data further back then 1995 because all the data acquisition system was changed in 1995. Older data is stored in old diskettes (most of them unrecoverable) and the management database used is different of the one they use now. All stations located in Huelva are mixed type stations, they can be considered as traffic and background stations with industrial influence depending on the meteorological conditions. We tried to put them either into the traffic or the background category.

Spain/Oviedo: In stead of reporting the annual average of NO_2 they reported only the 50 percentile. That means, that all the NO_2 values you find are not annual average but 50 percentile. The annual average for SO_2 and TSP is always calculated from April to March 31 of the following year. In practice the quality level of the three reported stations is 4, because they are applying some minimum rules to get a good working of equipment, a minimum number of data and a minimum precision in these data (the data are validated everyday in their office, and after they are validated again in the Environment Department of Spain in Madrid. But at the moment there is no written QA/QC plan that’s why Oviedo has quality level 5.

Sweden/Goteborg: One of the two stations is measuring with DOAS. DOAS is a measuring principle using a light beam and analysing is possible of several parameters simultaneously. The station Jaerntorget has a total of 5 light sources and of them 3,4 or all 5 measure NO_2, SO_2 or O_3. More information about this measurement principle you’ll find at www.opsis.se.
The station “Femman” moved to the present location in 1986 from a site 500 meters to the sea. Some changes in the traffic structure have been made during the last years near the station “Jarntorget”.

Sweden/Umea: The study area is not a city but a quite extends area called Södra Västerbotten. It has rural and urban areas. The values we received are only from the winter half-year (October to March). The ozone station in Vindeln is a rural station 50 km NW of Umea, located in the forest several kilometres outside a small municipality.

Sweden/Uppsala: The station Town Library is only measuring during the winter season from October to March.

Switzerland/Basel: Before 1987 the station St. Johannsplatz was somewhere else, near the institute for physics in Basel.

UK/Caerphilly: ukca1 is not a fixed monitoring site, it's a mobile trailer. The trailer has been sited at four different locations within the County Borough within a three year period. There are some gaps in the data due to equipment failure and communication problems. The QA/QC procedures have to be considered as level 5.

UK/Cambridge: At the station Latham Road they only measure NO_2 with diffusion tubes. There are 42 diffusion tubes sites for NO_2 in Cambridge, but Latham Road is the only background site.

UK/Dundee: The data from Dundee is limited to information from diffusion tube monitoring and limited real time monitoring via a mobile lab. The 8 stations are all NO_2 diffusion tubes sites. The data from the mobile lab did not fulfil the criteria for the selection of the stations.

UK/Ipswich: Ipswich Borough Council does not have any continuous monitors. They have a passive diffusion tube net. The quality assurance of these results can not be guaranteed. NO_2 data were reported as ppb. Because they don't use $\mu g/m^3$ at all we converted the data with the EU Standard factor of 1.91. All the NO_2 values you find for Ipswich are in $\mu g/m^3$.

UK/Norwich: NO_2 data was reported as ppb. Because they don't use $\mu g/m^3$ at all we converted the data with the EU Standard factor of 1.91. All the NO_2 values you find for Norwich are in $\mu g/m^3$.

10.2 Questionnaire and contact addresses

University of Basel
Institute for Social and Preventive Medicine
Department of Environment and Health
Steinengraben 49
4051 Basel
Switzerland

WHO World Health Organisation
European Centre for Environment and Health
Bilthoven Division
P.O. Box 10
3730 AA De Bilt
Netherlands

Regards: **EUROPEAN COMMUNITY RESPIRATORY HEALTH SURVEY (ECRHS)**
needs historic air pollution data

Dear Colleagues

I am writing to you on behalf of the European Community Respiratory Health Survey II (ECRHS). Starting in 2000 the adult population of 24 European cities will be investigated in a research project funded by the European Commission to determine causes and risk factors for respiratory diseases, in particular asthma (Principal Investigator: **Prof. Peter Burney**, London). The influence of environmental factors, including outdoor air pollution, on respiratory health will be investigated. The ECRHS II Air Pollution Unit (Head: **N. Künzli, MD PhD**, University Basel, Switzerland) co-ordinates two main activities in this field:
a) PM2.5 will be monitored in all participating centres to estimate the annual mean.
b) Historic air pollution data will be assembled and described.
I am responsible for this second component. This work is conducted in close collaboration with the WHO European Centre for Environment and Health, in Bilthoven (Head: **Dr. Michal Krzyzanowski**). The objective is to describe the long-term mean concentrations of available air pollutants, and compare the data over time and across cities. We will describe to what extent this database can be used to assess the health relevance of these pollutants. The monitoring methods, summary statistics of air pollutant concentrations, meteorological parameters, and variables describing the characteristics of the monitoring location will all be described and summarized in our report. Therefore we would very much appreciate your assistance in collecting these data. We particularly need five kinds of information from your city/area:

1. **The address / contact information**
   of the persons that may provide the air pollution summary data and the meteorological data (Quest. 1)

2. **Air quality summary data from representative stations in your city,**
   particularly, arithmetic annual means and annual 95% or 98% for eight pollutants, if available (SO2, NO2, NO, CO, TSP, PM10, PM2.5, Black smoke) and some more information about Ozone. (See questionnaire 4). If you can not give us the data from all stations in your city, please choose representative stations. (**urban background** stations, i.e., stations used to monitor the average air pollution levels in urban areas resulting from transport of air pollutants from outside the urban area and from emissions in the city itself. The stations are, however, not strongly dominated by emission sources like extreme traffic or industry in the very near distant of the monitor). Please send us only validated data.

3. **Short description of the monitoring station(s) in your city**
   (type of station and zone, local emission sources etc. See questionnaire 2)

4. **Few meteorological data from one monitor**
   (See Questionnaire 5)

5. **A map of your city, showing the location of the monitoring stations**
   this will help us to better evaluate the information of your stations

If you have some local reports about air quality, local databases or other useful information, please send it to us as well. We tried to make our questionnaire as simple as possible to fulfill the needs of ECRHS. The Explanation Sheet gives further detailed information on how to fill out the questionnaire. To submit data for all the stations you have selected form your city, you can **copy the sheets** in as many copies as you need.

Your Benefit

- You will receive our Report showing trends of exposure, across all participating centres. The study offers an opportunity to the professionals of air quality monitoring networks, to compare exposure as well as methodologies across the centres. The ECRHS activities will further strengthen the collaboration of health professionals and air pollution monitoring professionals, which have a long-standing contribution in collecting data of high public health relevance.

- From my colleague Dritan Xhillari here at WHO, you will also receive an easy-to-use software program, which will allow you to estimate the health impact of air pollution (AirQ, developed by WHO). This is a policy relevant tool that will be to the benefit of the community for pollution reduction policies.

- As mentioned above, ECRHS II also measures PM2.5 in 25 centres; you will receive the results of this study as soon as possible. It will be the first cross-European PM2.5 data set, assessed with one common standardised protocol and equipment.

I would like to thank you in advance for your help and support.

Best regards,

Roger Naef, MSc, currently at WHO

Please send the questionnaire back per mail, fax or e-mail within four weeks.

Address:

Roger Naef, MSc
WHO European Centre for Environment and Health
A. van Leeuwenhoeklaan 9
P.O. Box 10
3730 AA De Bilt
The Netherlands
Tel: +31 30 2295 304
Fax: +3130 2294 120/252
E-mail: RNA@WHO.nl

Important addresses: Questionnaire 1

(Please type or write in capital letters)

Responsible person for air quality data in your city/area:

Centre/City:	
First Name:	Family Name:
Profession:	Current Function:
Work Address:	Zip code: City: Country:
Phone:	Fax:
E-mail:	

Responsible person for meteorological parameters in your city/area:

Centre/City:	
First Name:	Family Name:
Profession:	Current Function:
Work Address:	Zip code: City: Country:
Phone:	Fax:
E-mail:	

If there is more than one responsible person for air quality monitoring in your city, please send the detailed information for all of them.

Roger Naef
Fax: +31 30 2294 120/252 / E-mail: rna@who.nl / Phone: +31 30 2295 304

Station information

Questionnaire 2

(Please type or write in capital letters)

Country: ____ **City:** ____

Station name: ____ **Network name:** ____

Station code: ____ **Sampling height (m) above ground:** ____

Altitude (m) a.s.l.: ____ **Pollutants measured:** ____

Station classification:

Station type: Traffic ☐ Industrial ☐ Background ☐ Unknown ☐

Type of zone: Urban ☐ Suburban ☐ Rural ☐ Unknown ☐

Characterisation of zone Residential ☐ Commercial ☐ Industrial ☐ Unknown ☐

Major emission sources in station environment within 500 meters:

	yes	no		yes	no
Public power, co-generation and district heating	☐	☐	Traffic	☐	☐
Commercial, institutional and residential combustion	☐	☐	Industrial activities	☐	☐

Other (specify) ____

Remarkable changes in station environment (type and year) during the data reporting period: ____

Street type within 100 meters radius
(More than one is possible)

Main street ☐
Side street ☐
Highway ☐
Unknown ☐
No street ☐

Estimated traffic volume
(Street with highest traffic volume within 100 meters)

High (>10'000 vehicles/day) ☐
Medium (2'000 - 10'000 vehicles/day) ☐
Low (< 2'000 vehicles/day) ☐
Unknown ☐

Wide (D/H>1.5) ☐
Canyon (D/H<1.5) ☐

Other (specify) ____

Quality Assurance/Quality Control (QA/QC) Procedures[1]

Level 1 ☐ Level 2a ☐ Level 2b ☐ Level 3 ☐ Level 4 ☐ Level 5 ☐

Remarkable changes of QA/QC Procedures (type and year) during the data reporting period ____

Conversion ppm (ppb) - µg/m³

Used temperature for conversion: ____ Used air pressure for conversion: ____

[1]***Refer to Annex 1 for detailed information on QA/QC levels***

Air quality data

Questionnaire 3

(Please type or write in capital letters)

Station name:

SO2(µg/m3)

Current principle:[1]		**From:**		**To:**	
Principle before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

CO(mg/m3)

Current principle:		**From:**		**To:**	
Principle before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

NO2(µg/m3)

Current principle:		**From:**		**To:**	
Principle before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

NO(µg/m3)

Current principle:		**From:**		**To:**	
Principle before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

TSP(µg/m3)

Current principle:		**From:**		**To:**	
Principle before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

Black smoke

(µg/m3)

Current type of reflectometer and filter type:		**From:**		**To:**	
Type fo reflectometer and filter before:		**From:**		**To:**	

	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
Avg																				
%																				

PM10 (µg/m^3) **Principle:**

	99	98	97	96	95	94	93	92	91
Avg									
%									

PM2.5 (µg/m3) **Principle:**

	99	98	97	96	95	94	93	92	91
Avg									
%									

Comments:

1: Principle: for example: UV Fluorescence, Chemiluminescence, UV Absorption, Beta absorption, TEOM, GRAVimetric, REFLectometry,

%: Choose either the 95 percentile or the 98 percentile, but please fill in which one you choose.

NO2, NO, CO: Based on hourly averages / SO2, TSP, PM10, PM2.5, Black smoke: Based on daily averages

Ozone (O3) Questionnaire 4

(Please type or write in capital letters)

Station name:

Current principle: **From:** **To:**

Principle before: **From:** **To:**

	Annual mean	Summer mean (01apr.-30sep)	Max. monthly mean[1]	Number of 8 hour exceedances of			Number of hourly exceedances of	
	(µg/m3)	(µg/m3)	(µg/m3)	110 µg/m3	120 µg/m3	µg/m3	180 µg/m3	µg/m3
1999								
1998								
1997								
1996								
1995								
1994								
1993								
1992								
1991								
1990								
1989								
1988								
1987								
1986								
1985								
1984								
1983								
1982								
1981								
1980								

Comments:

[1]: Give the value of the highest monthly mean of the year

You don't have to make calculations, just give us the readily available data. If no data are available for the exceedance limits of 110, 120 and 180 mg/m3, please, give the exceedances available for any other limits in the blank columns

Meteorological Parameters Questionnaire 5

(Please type or write in capital letters)

Country:

City:

Average Altitude (m) a.s.l. of the city:

	Station	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Air temperature (annual mean)											
Air temperature (maximum monthly mean)											
Air temperature (minimum monthly mean)											
Precipitation (annual mean in mm)											
Number of raining days (>/=1mm)											
Global radiation (annual mean in W/m2)											

	Station name
1:	
2:	
3:	
4:	
5:	

Comments:

If not all the required meteorological parameters are measured at the same station, please fill the missing parameters with data from other stations. Give the names of the stations from which the parameters are taken and indicate them with the respective numbers in the station column.

Annex 1: Explanations

Here some detailed information on how to fill out certain requested fields in the questionnaire:
Mark the correct answer in the questionnaire with a (X) or a (+).

Station classification:

Station type:

Traffic:	Station used for monitoring traffic induced air pollution
Industrial:	Station used for monitoring industrial air pollution
Background:	Station used for monitoring background air pollution levels. These stations can be located inside (urban/background) as well outside (rural/background) cities
Unknown:	Station type is not known

Type of zone:

Urban:	Station is located within the city
Suburban:	Station is located in the outskirts (fringe) of a city, or in small residential areas outside the main city
Rural:	Station is located outside the city
Unknown:	Location of the station is not known

Characterisation of zone:
Please give us the **major** activity in the representative area of the station (residential, commercial, industrial or other). If there is more than one major activity in the area, please mark each of them with a cross or a plus.

Street type and traffic volume within 100 meters radius:
D = Distance between axis street and buildings
H = Height of buildings
Highway = average speed vehicles > 80 km/h

Pollutants:

We are only interested in **SO2** (sulphur dioxide), **TSP** (total suspended particulate), **PM10** (suspended particulate < 10µm), **PM2.5** (suspended particulate < 2.5µm), **Black smoke**, **NO2** (nitrogen dioxide), **NO** (nitrogen monoxide, **CO** (Carbon monoxide), **O3** (Ozone)

Quality Assurance / Quality Control (QA/QC)

The criteria for classifying stations according to QA/QC level, are given in the table below. Each level is a combination of a type of network or station and a type of QA/QC procedure. According to the criteria presented in the table below, it is proposed that stations classified as level 1,2,3 or 4 should be accepted in this study. Those are stations from national or local networks or affiliated stations, having at least a minimum documented QA/QC plan (level 4). In terms of QA/QC, the stations for ECRHS can be divided into 3 categories:

Level 1 and 2a
Stations that are part of the national air quality-monitoring network. Such stations may belong directly to the national network or a national sub-network. A complete QA/QC plan implemented on national level is the key feature that differentiates the first two levels from the rest. This is usually adopted by national sub-networks, based on a central laboratory (accredited or not), providing nation-wide comparability.

Level 2b and 3
Stations that are part of a local air quality-monitoring network. In this case the complete QA/QC plan is implemented on local basis and does not have systematic relation with the national QA/QC plan

Level 4
Individually operated networks or stations (or even a national network) implementing a minimum QA/QC plan (Data quality objectives are set on a minimum basis regarding only: 1. Accuracy and precision, 2. Data capture, 3. Time coverage)

Level 5
Networks and stations with no documented QA/QC plan

With the following table you can easy find out which level your stations have.

	Criteria						
	Type of network/station			**Type of QA/QC procedure**			
	National		**Local/regional**	**Accredited**	**Centralised**	**Minimum**	**No QA/QC**
Level 1	yes			yes			
Level 2a	yes				yes		
Level 2b			yes	yes			
Level 3			yes		yes		
Level 4	yes	or	yes			yes	
Level 5							yes

QA/QC criteria for classification of stations

Remarkable changes of Quality Assurance/Quality Control (QA/QC) Procedures during the data reporting period: Either changes in organisational settings of the network or changes in technique/principle (i.e. from manual to semi-automatic to automatic or vice versa etc)

………

Air quality data:

Principle: We don't need the name of the measurement devices, but the name of the current measurement technique/principle and the name of the measurement principle before the current one. We also need the time span that each principle has been in use. Examples for measurement principles are: SO2: **UV Fluorescence (UVF)**, NO2: **Chemiluminescence (CHL)**, O3: **UV Absorption (UVA)**, CO: **IR Absorption (IR)**, PM10: **Beta absorption, TEOM, GRAVimetric**. For Black smoke we need the type of reflectometer and the filter type.

NO, NO2 and CO:
Arithmetic annual mean (avg.) and the 95 or the 98 percentile based on **hourly averages** and measured in µg/m^3 (CO in mg/m^3)

SO2, TSP, PM10, PM2.5 and Black smoke:
Arithmetic annual mean (avg.) and the 95 or the 98 percentile based on **daily averages** and measured in µg/m^3)

O3:
Annual mean and maximal monthly mean in µg/m3
Number of 8 hour exceedances of 110µg/m3 and/or 120µg/m3 and the number of hourly exceedances of 180µg/m3. (Or number of exceedances of alternative limits)

Annex 2: ECRHS Addresses

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10.4 Complete time-series for all stations

10.5 Code list

Councode	**Country Code**
Citycode	**City Code**
ECRHI/II	**ECRHS I or ECRHS II**
Statname	**Station name**
Statcode	**Station code**
ECRHcode	**ECRHS code (auvi1: austriaviennafirststation)**
Netwname	**Network name**
Altitude	**Altitude (m) a.s.l.**
Sampheig	**Sampling height (m) above ground**
Pollutan	**Pollutants measured**
A	**SO2**
B	**CO**
C	**NO2**
D	**NO**
E	**TSP**
F	**Black smoke**
G	**PM10**
H	**PM2.5**
I	**Ozon**

Measurement principles	
A_cuprin	**SO2 current principle**
A_custar	**SO2 current principle starting year**
A_oldpri	**SO2 principle before**
B_cuprin	**CO current principle**
B_custar	**CO current principle starting year**
B_oldpri	**CO principle before**
C_cuprin	**NO2 current principle**
C_custar	**NO2 current principle starting year**
C_oldpri	**NO2 principle before**
D_cuprin	**NO current principle**
D_custar	**NO current principle starting year**
D_oldpri	**NO principle before**
E_cuprin	**TSP current principle**
E_custar	**TSP current principle starting year**
E_oldpri	**TSP principle before**
F_curefl	**Black Smoke current type of reflectometer**
F_cufilt	**Black Smoke current type of filter**
F_oldref	**Black Smoke type of reflectometer before**
F_oldfil	**Black Smoke type of filter before**
F_custar	**Black Smoke current principle starting year**
G_cuprin	**PM10 current principle**
G_custar	**PM10 current principle starting year**
G_oldpri	**PM10 principle before**
H_cuprin	**PM2.5 current principle**
H_custar	**PM2.5 current principle starting year**
H_oldpri	**PM2.5 principle before**
I_cuprin	**O3 current principle**
I_custar	**O3 current principle starting year**
I_oldpri	**O3 principle before**

Measurement methods

UVF	UV Fluorescence
WCM	Wet chemical methods
CHL	Chemiluminesce
UVA	UV Absorption
IR	IR Absorbtion
BAB	Beta absorption
TEOM	TEOM
GRAV	GRAVimetric

Description of the measurement stations

Stattype	Station type
T	traffic
I	industrial
B	background
U	unknown
Zonetype	Type of zone
U	urban
S	suburban
R	rural
U	unknown
Zonechar	Characterisation of zone
R	residential
C	commercial
I	industrial
U	unknown
Majoremi	Major emission source within 500 meters
P	Public power, co-generation and district heating
T	Traffic
C	Commercial, institutional and residential
I	Industrial activities
PT/PC/PI/TC/TI/CI	Combinations of major emission source
Otheremi	Other emission source in station environment
envchang	Remarkable changes in station environment
Str100m	Street type within 100 meters radius
M	Main street
S	Side street
H	Highway
U	Unknown
N	No street
Otherstr	Other street type within 100 meters
Trafficv	Estimated traffic volume
H	High (more than 10000 vehicles/day)
M	Medium (2000-10000 vehicles/day)
L	Low (less than 2000 vehicles/day)
U	unknown
Wide/Can	Sreet within 100 meters radius (wide / canyon)
W	Wide
C	Canyon
Qualleve	Quality Level of the station
1	Level 1
2a	Level 2a
2b	Level 2b
3	Level 3
4	Level 4
5	Level 5
Qualchan	Remarkable changes of QA/QC Procedures
Convtemp	Used temperature for conversion
Convpres	Used pressure for conversion
Comments	Comments

Reported time-series	
A_avg_XX	**SO2 arithmetic annual mean in 19XX**
A_95p_XX	**SO2 95 percentile 19XX**
A_98p_XX	**SO2 98 percentile 19XX**
B_avg_XX	**CO arithmetic annual mean in 19XX**
B_95p_XX	**CO 95 percentile 19XX**
B_98p_XX	**CO 98 percentile 19XX**
C_avg_XX	**NO2 arithmetic annual mean in 19XX**
C_95p_XX	**NO2 95 percentile 19XX**
C_98p_XX	**NO2 98 percentile 19XX**
D_avg_XX	**NO arithmetic annual mean in 19XX**
D_95p_XX	**NO 95 percentile 19XX**
D_98p_XX	**NO 98 percentile 19XX**
E_avg_XX	**TSP arithmetic annual mean in 19XX**
E_95p_XX	**TSP 95 percentile 19XX**
E_98p_XX	**TSP 98 percentile 19XX**
F_avg_XX	**Black smoke arithmetic annual mean in 19XX**
F_95p_XX	**Black smoke 95 percentile 19XX**
F_98p_XX	**Black smoke 98 percentile 19XX**
G_avg_XX	**PM10 arithmetic annual mean in 19XX**
G_95p_XX	**PM10 95 percentile 19XX**
G_98p_XX	**PM10 98 percentile 19XX**
H_avg_XX	**PM2.5 arithmetic annual mean in 19XX**
H_95p_XX	**PM2.5 95 percentile 19XX**
H_98p_XX	**PM2.5 98 percentile 19XX**
I_avg_XX	**O3 arithmetic annual mean in 19XX**
I_sme_XX	**O3 summer mean (1.April-30. September) in 19XX**
I_mmm_XX	**O3 value of the highest monthly mean in 19XX**
I_110_XX	**O3 number of 8 hour exceedances of 110 in 19XX**
I_120_XX	**O3 number of 8 hour exceedances of 120 in 19XX**
I_8hX_XX	**O3 number of 8 hour exceedances of X in 19XX**
I_180_XX	**O3 number of hourly exceedances of 180 in 19XX**
I_1hX_XX	**O3 number of hourly exceedances of X in 19XX**

Meteorological data	
tempavXX	**Air temperature annual mean**
tempmaXX	**Air temperature maximum monthly mean**
tempmiXX	**Air temperature minimum monthly mean**
precipXX	**Precipitation annual mean**
raindaXX	**Numbers of raining days**
globraXX	**Global radiation**

10.6 Maps

Maps are not available electronically but there are paper copies. Please contact:

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Please ask for WP5 ECRHS Annex-Maps