Exper PF

Measurement campaigns in the Euro-region

2002 - 2004

Study realised with the help of the European program
INTERREG III

AREMA Lille Métropole
Air quality network around Lille

Vlaamse Milieumaatschappij
Flemish Environmental Agency

Universiteit Antwerpen
University of Antwerp

Contents

List of figures

List of tables

Aim of the study

Objective of this project :

The idea of this project is to develop and promote a tool for a better assessment of air quality in the euro-region defined by Nord-Pas-de-Calais for France and the province of West-Vlaanderen for Flanders. The project focus on suspended particles (PM), with a special effort on its fine fraction PM2.5. One part of the project consists in the development of an optical approach for measuring PM and thus enabling us to increase the spatial coverage of the PM monitoring by the use of satellite. Another part of the project is to build up a regional database which should contain PM data, meteorological data, some chemical information and satellite images. A third part is to realise some measurements of gaseous pollutants and PM on each side of the border to evaluate the dispersion of pollutants in rural areas at the north-east of the agglomeration Lilloise. This third objective is developed in this report.

These operations are included in an INTERREG project called "**EX**position des **P**opulations vivants au cœur de l'**E**uro-**R**égion aux polluants atmosphériques : le cas des **P**oussières **F**ines" whose abbreviation is EXPER/PF.

Description and partners of the study:

The additional measurements in situ were realised by AREMA Lille Metropole (AREMA LM), the flemish Environment Agency (VMM) and the University of Antwerp (UA).

AREMA LM and VMM used their mobile laboratories. To have a good temporal representation and several kinds of meteorological conditions, the laboratories were installed during the winter 2002-2003 and during the summer 2003. AREMA LM installed the first mobile station in Halluin and the second one in Wervicq. VMM installed his laboratory in Rollegem-Kortijk. The mobile stations are equipped to analyse gaseous pollutants (SO_2, NO_x, O_3 and CO) and suspended particles. Additionally particulate matter was collected on filters to analyse heavy metals in the PM2.5 and PM10 fraction and to analyse PAH (winter). During the winter campaign VMM installed also a mobile laboratory equipped with gas chromatography to analyse VOC.

To compare the capability of measurement of each organism, an evaluation of the PM monitors was done in December with a reference mass. In summer an intercomparison took place with the three mobile stations installed in Wervicq. The data obtained during these campaigns were compared with the fixed stations near the border of France and Flanders.

In Menen, VMM started supplementary measurements of PM2.5 and PM10. Supplementary measurements of heavy metals in PM10 were also started. PM2.5 was sampled on filters for the analysis of heavy metals (VMM and UA) and for the analysis of anions and cations (UA). UA, using passive samplers, determined at this location a certain number of gaseous pollutants (SO_2, NO_2, BTEX and NH_3) and analyzed a certain number of filters on PAH's.

In Kortrijk, VMM started supplementary measurements of PM2.5 and PM10.

Since 1995 VMM measures the deposition of dioxin in Flanders. In order to determine the influence of the northern part of France, VMM took measurements on different locations nearby the French border. Samples were collected in Moeskroen, Veurne, Wervicq, Kortrijk and Menen. Menen houses 5 measurement stations. However, high depositions measured in one particular station incited to put in use a sixth station. Two stations in Menen started with measurements on a monthly basis. Complementary samples were collected on the grounds of a local shredder company and in Halluin.

A pilot study was started in West-Vlaanderen by VMM and UA to map out in a detailed way the concentration levels of BTEX (benzene, toluene, ethylbenzene and the three xylene isomers) and NO_2.

1. The pollutants

I Description of the pollutants

A Sulphur dioxide (SO_2)

SO_2 is a gaseous pollutant, which is encountered around industrial areas. It originates from the combustion of fossil combustible (fuel, charcoal) by industry and domestic heating. It is responsible for respiratory damages in case of high concentrations. The ambient concentrations are decreasing for several years at the same time of improvement of industrial processes.

B Particulate matter (PM)

The term PM is equivalent to the term atmospheric aerosol and defines a suspension of air-borne solid particles and/or droplets of various sizes. A single particle usually contains a mixture of chemical and physical (solid, liquid) constituents.

The PM10 concentration is the mass per volume unit (µg/m^3) of particles with an aerodynamic diameter smaller than 10 micrometer (µm). When inhaled, the larger particles contained in the PM10 size fraction reach the upper part of the lung. The smaller particles of this size fraction (in particular PM2.5 and PM1) penetrate more deeply into the lung and reach the alveolar region.

Size and composition of ambient PM not only depend on the emission process, but also, particularly for the finer fractions, on the atmospheric processes that the particles go through after emission. The particle mass is usually found in two size-related modes. The finer mode, up to around 1 µm, generally originates from high temperature processes and/or gas-to-particle formation processes in the atmosphere; these particles carry inorganic compounds (such as sulphates, nitrates and elemental carbon) and organic compounds, including semi-volatile components. Mechanical processes such as erosion, corrosion and material abrasion give rise to coarser particles, usually larger than 1 µm. These particles carry e.g. soil components and sea spray. Another fraction, the ultrafine particles (UFP), in size below 0.1 µm, is better characterised by the number concentration (number of particles per cm^3), because despite their large number they contribute only little to the particulate mass. Large and very small particles have a limited atmospheric residence time due to deposition or coagulation. Particles in the size range between approximately 0.1 and a few µm remain much longer in the atmosphere (typically several days to a week) and can consequently be transported over long distances (1000 or more kilometres).

PM is emitted directly from ‘primary’ sources (primary PM) and is also formed in the atmosphere by reaction of precursor gases (secondary PM). The main precursor gases are SO_2, NO_x, VOC and NH_3. Other common distinctions are natural/anthropogenic sources and combustion/non-combustion sources.

A large body of scientific evidence has emerged that has strengthened the link between ambient PM exposure and health effects. New analyses have shown death being advanced by at least a few months on population average, at current PM concentrations in Europe, for causes such as cardiovascular and lung disease. Furthermore, there are robust associations between ambient PM and increases in lower respiratory symptoms and reduced lung function in children, and chronic obstructive pulmonary disease and reduced lung function in adults. There is no evidence for a threshold below which ambient PM has no effect on health. In its recent review, WHO has concluded that there is a causal relationship between PM exposure and health effects. It has however not been possible to establish a causal relationship between PM-related health effects and one single PM component. This is in spite of intensive research roughly over the last decade. Nevertheless there is strong evidence to conclude that fine particles – usually measured as PM2.5 in health effects studies – are more hazardous than larger ones. This does not imply that the coarse fraction of PM10 is innocuous. PM characteristics found to contribute to toxicity include:

metal content, presence of polycyclic aromatic hydrocarbons and other organic components, endotoxin content and small (less than 2.5 µm) and extremely small (less than 0.1 µm) size. Epidemiological studies suggest that a number of emissions sources are associated with health effects, especially motor vehicles and also coal combustion. Toxicological studies show that particles originating from internal combustion engines, coal burning, residual oil combustion and wood burning have strong inflammatory potential.

C Nitrogen monoxide (NO) and nitrogen dioxide (NO_2)

The nitrogen oxides are generated by all combustion sources (domestic heating, automobile traffic) because of the reaction between nitrogen and oxygen at high temperature and by industrial processes (chemical industry). So they have two different origins and they are encountered in all types of environment. The emitted nitrogen monoxide reacts quickly with air to transform itself in nitrogen dioxide. At high concentrations nitrogen dioxide can provoke respiratory damages.

D Ozone (O_3)

We call ozone a secondary pollutant because it does not come directly from human activity but results from a photochemical reaction between nitrogen oxides and volatile organic compounds (VOC) under the influence of sunlight. The reaction is more efficient when the temperature is high. Ozone results from the dissociation of NO_2 under the influence of sunlight. It reacts with NO emitted by human activities to build an equilibrium. It is the reason why the rural concentrations of ozone are a little bit higher than urban concentrations. This equilibrium is broken in the presence of VOC, which also reacts with NO. At this moment, O_3 isn't destroyed anymore and increases.

Ozone provokes respiratory damages and ocular problems. At high concentrations, it can provoke an asthmatic crisis by sensible persons.

E Ammonia (NH_3)

Ammonia mainly originates from agricultural activities. Cattle farming, depot and distribution of animal fertiliser, are the most important sources of ammonia in the atmosphere. Next to cattle farming, traffic is a growing source of ammonia emission, due to the increasing use of catalysators.

F Carbon monoxide (CO)

Carbon monoxide comes from incomplete combustion. Its principal source is the explosion engine of vehicles. It is a pollutant found in high concentrations near the important traffic roads or in places with bad dispersion (canyon streets or indoor). Carbon monoxide can lead to death if high doses are inspired.

G Heavy metals

Most of the heavy metals have a toxic or carcinogenic character. They are adsorbed on suspended particles, which is the principal way of entering the body. The industry and traffic mainly emit them.

H Volatile organic compounds (VOC)

The gaseous combinations of carbon and hydrogen occurring in nature and polluted air encompass a large spectrum of the organic chemistry. Carbon can form combinations with hydrogen, oxygen, sulphur, chlorine, fluorine and with carbon itself to form straight chains, branched chains, cyclic compounds and cyclic compounds with branching. So the number of organic compounds is practically unlimited.

The most important sources of volatile organic compounds are industrial processes and traffic.

I Poly-aromatic hydrocarbons (PAH)

The poly-aromatic hydrocarbons are composed of more than one aromatic ring. They occur in a large measure in complex mixtures as soot, oil products, smoke of cigarettes, the exhaust of cars and residues of the production of gas from coal. Exposure to each of these complex mixtures is associated to an elevated mortality by cancer. PAH are harmful because of their known carcinogenic and mutagenic properties.

PAH are products of incomplete combustion and pyrolysis of fossil fuels and other organic materials from natural and anthropogenic sources. The higher the temperature of formation of a PAH compound, the higher its risk to human health. In urban and industrial atmospheres, PAH are almost entirely from anthropogenic origin. PAH are present in the atmosphere both in the vapour and the condensed phase. The most hazardous representatives of these ubiquitous compounds have been found to be associated with suspended particulate matter.

The most important emissions are realised by domestic heating, traffic and industry, especially the wood and furniture industry.

J Dioxins and PCBs

1 Dioxins

The term "dioxins" covers a group of 75 polychlorinated dibenzo-p-dioxin (PCDDs) and 135 polychlorinated dibenzofurans (PCDFs). They became publicly known due to the Seveso accident. Dioxins have a flat molecular structure composed of two benzene rings linked by two oxygen atoms. Four chloride atoms are implanted on the benzene rings.

2,3,7,8-tetrachlorodibenzo-p-dioxin

2,3,7,8- tetrachlorodibenzofuran

Figure 1.1.: Structure of dioxins

Dioxins are formed essentially as **unintentional by-products** in a number of chemical processes as well as during any incomplete combustion process. They are extremely resistant to chemical and biological degradation and therefore persist in the environment. They have been shown to exert a number of toxic responses, including dermal toxicity, immunotoxicity, endocrine disruption and carcinogenicity. The most important route for human exposure to PCDDs and PCDFs is consumption of products of animal origin and fish. Contamination of food is primarily caused by deposition of emissions of various sources (e.g. waste incineration, production of chemicals, metal industry) on farmland and a subsequent accumulation in the food chain in which they are particularly associated with fat. Therefore investigations of deposition samples are able to indicate the pollution of the environment with PCDDs and PCDFs.

Among the family of dioxins only the 2,3,7,8- substituted congeners are toxicologically important. Hence, the analysis of deposition is focused on these 17 congeners.

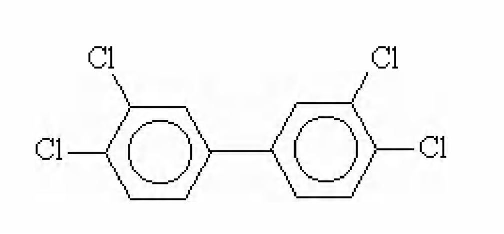
The toxicity of dioxins is evaluated by use of toxic equivalency factors "TEF". The TEFs relate the toxicity of a given 2,3,7,8- substituted dioxin to that of 2,3,7,8-TCDD, the most toxic congener (TEF=1). TEF values in combination with chemical residue data can be used to calculate toxic equivalent TEQ concentrations. Several TEF schemes have been developed. In the past, the International TEFs (I-TEFs) have been used; nowadays the TEFs calculated by the World Health Organisation (WHO) are internationally considered as the standard values.

Table 1.1.: WHO-TEF of PCDDs and PCDFs

Component Dibenzodioxins	WHO -TEF	Component Dibenzofurans	WHO-TEF
2,3,7,8-TCDD	1	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
OCDD	0.0001	2,3,4,6,7,8-HxCDF	0.1
		1,2,3,4,6,7,8-HpCDF	0.01
		1,2,3,4,7,8,9-HpCDF	0.01
		OCDF	0.0001

2 PCBs

Polychlorinated biphenyl`s "PCBs" are a group of 209 different congeners. The structural difference with dioxins is that PCBs have no oxygen atoms between their benzene rings.



3,3`, 4,4`-tetrachloro biphenyl

Figure 1.2.: Structure of PCBs

PCBs are **intentionally produced** chemicals manufactured in the past for a variety of industrial uses, notably as electrical insulators or dielectric fluids and specialised hydraulic fluids. Most countries banned the manufacture and use of PCBs in the 1970s. However, past improper handling of PCBs constitutes a continuing source of PCBs in the environment, and disposal of equipment now in use poses some risk of further contamination. The source of PCBs pollution depends on the type of uses. There are two types of uses of PCBs:

Closed uses: dielectric fluids in electrical equipment. From these uses, the main sources of releases are: leakage, fires, accidents, illegal dumping and inadequate disposal.
Open uses: as pesticide extenders, flame retardants, sealants, paints…From these uses the main sources of releases are: landfilling, migration, air emission from evaporation.

Other less significant sources are waste incineration, sewage sludge application to land, combustion of waste oils, as well as the evaporation from PCB reservoirs, such as marine and river sediments and harbour slugs.

PCBs can be divided into groups according to their toxicological properties: 12 congeners exhibit toxicological properties similar to dioxins and are therefore often termed "dioxin-like PCBs". Those 12 congeners have a flat molecular structure and are called "coplanar PCBs". The other PCBs do not exhibit dioxin-like toxicity and have a different toxicological profile. According to dioxins, the coplanar PCBs are extremely resistant to chemical and biological degradation and therefore persist in the environment and accumulate in the feed and food chain. The toxicity of coplanar PCBs is evaluated in the same way as dioxins, which means with TEF related to 2,3,7,8, -TCDD. Table 1.2. demonstrates that, among the coplanar PCBs, PCB126 is the most toxic congener. Although dioxins are far more toxic than PCBs, it has to be taken in account that the quantities of PCBs released to the environment are several times higher. Due to budgetary considerations, only the deposition of the most toxic PCB congener (PCB126) was measured.

Table 1.2.: WHO-TEFs of PCB

Non-ortho Coplanar PCB's	WHO-TEF	Mono-ortho Coplanar PCB's	WHO-TEF
3,3`,4,4`-TetraCB (77)	0.0001	2,3,3`,4,4`-PentaCB (105)	0.0001
3,4,4`,5-TetraCB (81)	0.0001	2,3,4,4`,5-PentaCB (114)	0.0005
3,3`,4`,4`,5-PentaCB (126)	0.1	2,3`,4,4`,5-PentaCB (118)	0.0001
3,3`,4,4`,5,5`-HexaCB (169)	0.01	2`,3,4,4`,5-PentaCB (123)	0.0001
		2,3,3`,4,4`,5-HexaCB (156)	0.0005
		2,3,3`,4,4`,5`-HexaCB (157)	0.0005
		2,3`,4,4`,5,5`-HexaCB (167)	0.00001
		2,3,3`,4,4`,5,5`-HptaCB (189)	0.0001

K Physical parameters

Next to the chemicals pollutants, several physical parameters relative to the atmosphere were recorded: pressure, temperature, relative humidity, wind speed and wind direction and rainfall. These parameters are very useful to know where the pollution comes from and where it goes to. It permits to explain the presence of ozone, the dispersion of the pollutants or the increase of particulate matter coming directly from the ground under the effect of the wind. The wind parameters are used to build a pollution rose. This analysis tool is obtained by classifying the concentration of a pollutant for each wind direction. The wind direction is expressed in degrees referred to the north. The north direction is expressed by the 0 value. The value 90 means that the wind comes from the east, the value 180 means that the wind is coming from the south and a value 270 indicates that wind coming from the west is blowing.

II Sampling, analysis method and data treatment of the compounds

A Automatic monitors

1 Sampling and measurement method

The mobile stations and fixed stations are equipped with an inoxydable sampling head situated on the roof. The manifold is constituted of a teflon or glass cylinder protected from the rain by a metallic cover. Several short lines are connected on the manifold until each monitor. The air is aspired in the principal line by a high volume pump. The analysed air is this situated around the station. The pumping of air is a continuous process. Each monitor has its own pump and samples the necessary volume of air from the manifold.

The particles are pumped through a special head, which selects those, whose diameter is less than 10 µm. The larger particles impact on the impaction plate and stop. The smaller ones are carried by the flow in the monitor. To determine particles of less than 2.5 µm a sharp cut cyclone is added to modify the flow pattern of the particles according to their size.

The pollutants measured with the automatic monitors in the mobile laboratories and the fixed stations are analysed with the method mentioned in the European legislation. They are indicated in table 1.3..

Table 1.3.: Table of measurement methods of the automatic monitors

Pollutant	Method	Directive reference
Sulphur dioxide	Ultra-violet fluorescence	1999/30/CE
Nitrogen oxides	Chemiluminescence	1999/30/CE
Particulate matter	Tapered Element Oscillating Microbalance (*) β-absorption (*)	1999/30/CE
Ozone	Ultra-violet Absorption	2002/3/CE
Carbon monoxide	Non-dispersive infra-red spectrometry	2000/69/CE

(*) TEOM or β-absorption is not the normative method but member's states can use other methods if they show its equivalence to the normative method.

2 Calibration of monitors

At the beginning and at the end of each campaign, the monitors measuring gaseous pollutants were calibrated using standardised operating procedures. Gas bottles filled with one pollutant at a well-known concentration are presented to the monitors. The concentration of the gas bottles is compared to the standards of the country. In France, they belong to Laboratoire National d'Essais. In Flanders the standards are ministered by the Interregional Cell for the Environment (IRCEL). The PM monitors are calibrated using filters with a well-known mass. The flow is regularly checked.

3 Data validation

At AREMA LM the data are validated using a method from 'Agence de l'Environnement et de la Maitrise de l'Energie' (*Règles et recommandations en matière de validation des données, critères d'agrégation, et paramètres statistiques, mars 2002*). These rules define the different steps of the validation with the necessary analysis tools and the required knowledge of the person who treats the data.

First, a value is calculated by the data logger system. If the monitor functions correctly for at least 12 minutes out of 15 minutes, the data logger uses all the elemental responses obtained (about one every ten seconds) to calculate a mean value. If the monitor has a problem (heating, problem of an element,…), it sends a fault code and the mean value is coded with this fault. If the monitor fails, there is no data. These 15 minutes values are the basic values.

Secondly, a person has to control the values. He considers technical points like regular auto-controls of the monitor, response of the monitor to a known sample of gas (the zero and span check), importance of the defaults, environmental points like the comparison with other monitors, the effect of meteorology and the chemical reaction between pollutants to validate or invalidate the values. When these basic values are validated, it is possible to calculate hourly values, daily values and so on.

To obtain an hourly value, it is necessary to have 3 quarter values out of 4 (75%). To obtain a daily value, 75% of hourly values on the period are needed, what corresponds to 18 hourly values per day.

The validation procedure at VMM is not imposed by external rules, but the followed procedure is very similar. The basis values are half hourly values. To obtain an hourly value, it is necessary to have the two half-hourly values. To obtain a daily value, 50% of the half-hourly values on the period are needed, what corresponds to 24 half-hourly values per day.

The temporal reference of a data is the moment of the end of the measurement. So the value indicated at 9:00 corresponds to the sampling between 8:00 and 9:00.

The time used is universal time (UT). We have to add one hour in winter (between end of October and end of March) and two hours in summer to obtain the local time.

4 Calculation of hourly and daily values

The rules of data treatment are universal. The arithmetic means are calculated with the formula:

$$Average = \frac{\sum_{i}^{N} C_i}{N}$$

where Ci is the ambient concentration at i (quarter, half hour, hour)
N is the number of correct data in the hour or in the day.

5 Concentration units

The gas analysers measure a number of molecules of a specified gas in a volume of air. So, we obtain concentration in micromole/mole (ppm) or nanomole/mole (ppb). To have a correspondence with the European Directives, it is necessary to express the results in mass by volume unit. To do this, we consider that air is a perfect gas in normal conditions of temperature (20°C) and pressure (101325 Pa). The concentrations are expressed in $\mu g/m^3$ or mg/m^3.

6 Uncertainty

The uncertainty on the value given by the monitor depends on a lot of parameters, which influence the measurements. They are:

-the environment such as the ambient temperature, the pressure, the humidity
-the sampling: length and cleanness of the line
-the monitor: its metrological properties (drift, linearity, repeatability…)
-the calibration.

This uncertainty is difficult to evaluate. The regular cleaning operations and the calibrations permit to have uncertainty as low as possible. The European Directive asks for an uncertainty of no more than 15% for SO_2, NO_2, NO_x, O_3 and CO and of no more than 25 % for PM and benzene.

B Heavy metals

For the metals AREMA LM used Partisol-Plus2025 Samplers equipped with a PM10 head. The flow is 1 m^3/h. Quartz filters (Whattman) were used. The filters were changed automatically every week.

Sampling at the VMM sites was carried out using Leckel (Leckel SEQ 47/50) PM10 and PM2.5 samplers. The flow is 2.3 m^3/h. Cellulose nitrate filters (Sartorius) were used. The filters were changed automatically every day.

AREMA LM works with the Institut Pasteur de Lille who obtained an accreditation for the analyses of heavy metals. The filters are mineralised with 5 ml of nitric acid in PTFE bomb under microwaves. The solutions are completed with 50 ml H_2O and are used for the analysis of metals. Depending on the sensitivity of the metal, the analyses are effected using Ion Coupled Plasma with Argon Emission Spectrometry or Ion Coupled Plasma with Mass Spectrometry.

For the determination of the heavy metal content in particulate matter in the VMM laboratory wavelength dispersive X-ray fluorescence technique (WD-XRF) is used. Standard filters for the XRF equipment are prepared by aerosol generation. For the calibration of the XRF methods VMM is using flame and graphite furnace atomic absorption spectrometry to determine the heavy metal content in the standard filters.

UA used a Tracor Spectrace 5000 EDXRF instrument for the determination of heavy metals in particulate matter. The equipment uses a low power Rh-anode X-ray tube (17.5 Watts). The characteristic X-ray radiation was detected by a Si(Li) detector. For determining high-Z (starting from K) elements, an accelerating voltage of 35 kV and a current of 0.35 mA were used. The acquisition time was set at 10000 seconds. The measured intensities were converted into elemental concentration by application of the AXIL program (B. Vekemans *et al.*, 1994).

The gravimetric determination of PM10 and PM2.5 mass collected on the filter is performed by the determination of the weight of blank and sampled filters with a microbalance.

C Volatile organic compounds (VOC)

VOC were measured with an automatic BTEX monitor. The monitor gives each half-hour the concentration of benzene, toluene, ethylbenzene, xylene isomers, C3-alkylbenzene isomers, C4-alkylbenzene isomers and naftalene.

The ambient air is sampled automatically over an adsorption tube that adsorbs the pollutants. By thermal desorption the substants are eluted and then transported on an analytical capillaire column. This column separates the components and after the separation the detection is done with a photo ionisation detector (PID). The detection limit for all the compounds is 0.1 $\mu g/m^3$.

D Sampling of gaseous compounds by means of diffusion tubes (NO_2, SO_2, BTEX and NH_3)

Radiello diffusion tubes were used by VMM and UA to sample various gaseous compounds. Depending on the compound to be detected, different types of tubes were used. The diffusion tubes of each type were exposed during 14 days subsequently, spread over one year. According to the manual provided by the manufacturer, the diffusion tubes were analysed by UA with appropriate analytical techniques. NO_2 and SO_2 were detected as nitrite, sulphite and sulphate by ionchromatography. NH_3 was measured as the blue coloured indophenol by means of visible spectrophotometry. Benzene, toluene, ethylbenzene, ortho-xylene and the sum of meta- and para- xylene were detected by means of coupled gaschromatography – mass spectrometry.

E Poly-aromatic hydrocarbons (PAH)

VMM collects the polycyclic aromatic hydrocarbons over a glass fibre filter. The flow is 54 m^3/h. After extraction with dichloromethane they are analysed with high performance liquid chromatography with fluorescense detection.

AREMA LM collects the PAH on quartz filters with a diameter of 150 mm using a high volume sampler of 30 m^3/h. The rythm of collect is 1 day out of 6. The analysis protocol is identical.

For PAH determination at UA filter samples were extracted using pressurised liquid extraction. The extracts were concentrated in a Turbo Vap 500 concentrator and the solvent was exchanged into 1 ml acetonitrile prior to their analysis for the presence of 16 PAH using HPLC in combination with programmed fluorescence detection. The HPLC system consisted of a liquid chromatography system and a fluorescence detector. Separation of the PAH was accomplished using a Vydac 201TP column (250 mm x 4.6 mm), with a gradient elution ranging from a 50/50 acetonitrile-water mixture to 100% acetonitrile in 20 min. The fluorescence of PAH was monitored with automatic adjustment of the wavelength for each compound according to the retention time. The excitation wavelengths ranged between 260 and 300 nm, the emission wavelengths between 380 and 465 nm.

F Dioxins and PCBs

The atmospheric emissions of dioxins are the main input into the environment and, as such, the key factor to human uptake via the food chain. The monitoring of the dioxin and "dioxin-like PCBs" deposition gives, besides the emission measurements, and control, an independent complementary assessment. Moreover, it allows the detection of important sources of dioxin and dioxin-like PCBs.

The samples are collected in Bergerhoff deposition gauges, as described in the German VDI 2090/1 Entwurf-standard of December 1999. A set of 3 glass jars with 9.5 cm inner diameter, 20 cm high is placed on a 1.5 m high pole for a period of 30 ± 3 days. The Bergerhoff gauge was chosen because it is made of glass and can be heated to 450°C, in order to obtain low blank values. In order to obtain an uniform collection efficiency during the whole sampling period 1 cm of water was added at the start.

The content of the 3 gauges is put together and analysed as one sample. The dioxins (17 congeners) are analysed by gas - chromatography linked with high-resolution mass-spectrometry (GC - HRMS). The detection limits of the congeners are below 1 $pg.m^{-2}.d^{-1}$ fulfilling the VDI 2090 standard. If a congener has a level below the detection limit, the half of the detection limit is taken for further calculation.

Measuring the dioxin pollution by deposition measurement has several advantages. The price of the collectors (Bergerhoff gauges) is rather low. Therefore, large-scale campaigns with low cost equipment may be performed. As the collectors are small and no electricity is needed, gauges can be placed on private ground. The duration of sampling time is rather long (1 month) implicating that performing a few analyses can cover a large period. The long sampling duration does enhance the risk of losing compounds due to degradation resulting in an underestimation of the dioxin deposition. Additionally, the vapour phase cannot be measured.

2. Legislation concerning atmospheric pollution

The EU-Framework Directive about Air Quality appeared on 27th September 1996. This Framework Directive established a list of 13 pollutants for which requirements should be described in subsequent Daughter Directives. The first Daughter Directive (1999/30/EC) gave air quality norms (limit values and alarm thresholds) for SO_2, NO_x, PM10 and lead. Margins of tolerance were in most of the cases associated with the limit values. The second Daughter Directive (2000/69/EC) gave limit values for carbon monoxide and benzene. The third Daughter Directive (2002/03/EC) proposed target values and thresholds for ozone. Since ozone does travel over borders and since it is a secondary pollutant whose production is highly influenced by meteorological parameters, no legal limit values were proposed by the EU-Commission. A proposal for the fourth Daughter Directive is being discussed on the moment. Non-mandatory target values are proposed for arsenic, cadmium, nickel and benzo(a)pyrene.

I Sulphur dioxide (SO_2)

Table 2.1. gives an overview of the future limit values and the alert threshold for SO_2 (1999/30/EC). The limit values (hourly and daily) for the protection of human health must be reached by 1st January 2005. The compliance date to the limit value for the protection of ecosystems (vegetation) was 19th July 19 2001. The margin of tolerance for SO_2 (hourly limit value for the protection of human health) was set at 43 % at the entry into force of that Directive (19th July 1999). The margin of tolerance decreases linearly from 1/1/2001 to 0% at the date where the limit value must be reached (1/1/2005). As far as the daily limit value for the protection of human health is concerned, no margin of tolerance was given.

Table 2.1.: Future limit values for the protection of health for SO_2 coming into force on 1/1/2005 and alert threshold for SO_2 in 2001 (1999/30/EC)

HOURLY LIMIT VALUE for the PROTECTION of HUMAN HEALTH	**350 µg/m³ not to be exceeded more than 24 times a calendar year**
DAILY LIMIT VALUE for the PROTECTION of HUMAN HEALTH	125 µg/m³ not to be exceeded more than 24 times a calendar year
ALERT THRESHOLD	500 µg/m³ over 3 consecutive hours

II PM10 and PM2.5

There were no EU-norms for PM10 until 1999. The Directive 1999/30/EC proposes 2 phases. The limit values in phase 1 must be reached by 1st January 2005 whereas those in phase 2 must be reached by 1st January 2010. The limit values of phase 2 are only indicative and have to be revised when more information is obtained about the effects on health and the environment, about technical feasibility and from the results of phase 1.

The limit values (daily and yearly) for the protection of human health from phase 1 must be reached by 1st January 2005. Margins of tolerance (MOT) were proposed together with the limit values. The margin of tolerance for PM10 in phase 1 at the entry into force of that Directive (19th July 1999) was set at 50% for the daily limit value and 20% for the yearly limit value. These margins of tolerance decrease linearly from 1/1/2001 to 0% at the date where the limit values must be reached (1/1/2005).

Table 2.2. gives an overview of the future limit values (phase 1) for PM10 (1999/30/EC).

Table 2.2.: Future limit values for PM10 (phase 1) coming into force on 1/1/2005

DAILY LIMIT VALUE for the PROTECTION of HUMAN HEALTH	50 µg/m³ PM10 not to be exceeded more than 35 times a calendar year
ANNUAL LIMIT VALUE for the PROTECTION of HUMAN HEALTH	40 µg/m³ PM10

So far there are no limit values for PM2.5 inside the European Union. The EU only requires member states to do measurements. The 2003/37/EC Decision gives a reference method for the sampling and analysis of PM2.5. The sole limit value that can be found at the present time is that of the American Environmental Protection Agency (EPA). The EU Working Group proposes 20 µg/m³ as the future yearly limit value. Table 2.3. gives an overview of the EPA limit values for PM2.5.

Table 2.3.: EPA limit values for PM2.5

DAILY LIMIT VALUE	65 µg/m³
ANNUAL LIMIT VALUE	15 µg/m³

The reference method for the measurement of PM10 is described in the European Standard EN12341. The reference measuring method consists of a PM10 sampling inlet, directly coupled with a filter substrate and a regulated flow device, followed by gravimetric determination of the PM10 mass collected on the filter. Other methods, e.g. attenuation of β-radiation or the oscillating mass balance method, can be used if their equivalence to the reference method can be demonstrated or if there is a consistent relationship with the reference method (European Directive 1990/30/EG). Automatic monitors for the measurement of PM10 usually give lower results due to the volatization of volatile materials, like volatile organic materials and components with ammonia. A reference method for PM2.5 is not yet determined.

In Flanders comparative measurements were executed in 2001 and 2002. A correction factor of 1.37 is used for the β-absorption monitors and a correction factor of 1.47 is used for the TEOM monitors. Corrected PM10-values in Flanders are named PM_{ref}-10 in this report. In France, a campaign took place in the summer 2001 and the winter 2001-2002 for 2 months in several towns (Marseille, Lille, Strasbourg, Rouen, Lyon, Toulouse, Grenoble) to compare TEOM and Partisol on daily sampling. The ratios obtained are about 1.1 in summer and 1.3 in winter with values reaching 1.8 in case of high concentration of PM. So, it was decided in France to avoid the use of a correction factor, also not to use the European suggested factor of 1.3.

III Nitrogen dioxide (NO_2)

Table 2.4. shows the future limit values for NO_2 and NO_x and the alarm threshold for NO_2 (1999/30/EC). The limit values (hourly and yearly) for the protection of human health must be reached by 1 January 2010.

Table 2.4.: Future limit values for NO_2 coming into force on 1/1/2010 and alert threshold for NO_2 in 2001 (1999/30/EC)

HOURLY LIMIT VALUE for the PROTECTION of HUMAN HEALTH	200 µg/m³ not to be exceeded more than 18 times a calendar year
ANNUAL LIMIT VALUE for the PROTECTION of HUMAN HEALTH	40 µg/m³

ALERT THRESHOLD	400 µg/m³ over 3 consecutive hours

IV Ozone (O_3)

The European Directive 92/72/EEC describes the threshold values for the ozone concentrations in ambient air that apply for the protection of human health and for the protection of the vegetation. Table 2.5. gives a summary of the ozone threshold values for the protection of human health and vegetation.

Table 2.5.: Ozone thresholds for the protection of human health and vegetation valid until 8/9/2003

INFORMATION THRESHOLD POPULATION	hourly average: 180 µg/m^3
ALARM THRESHOLD POPULATION	hourly average: 360 µg/m^3
HEALTH POPULATION	8-hours average: 110 µg/m^3 (*)
VEGETATION	hourly average : 200 µg/m^3
	daily average: 65 µg/m^3

Table 2.6. gives the target values and the long-term objectives for ozone not only for the protection of human health but also for the protection of vegetation.

Table 2.6.: Target values and long term objectives (LTO) ozone for the protection of human health and vegetation to be respected in 2010 and 2020

TARGET VALUE for the PROTECTION of HEALTH	Maximum daily 8-hour mean : 120 µg/m³ not to be exceeded on more than 25 days per calendar year averaged over three years
TARGET VALUE for the PROTECTION of VEGETATION	AOT40, calculated from 1h values from May to July : 18 000 µg/m³.h averaged over 5 years (*)
Long term objective for the PROTECTION of HUMAN HEALTH	Maximum daily 8-hour mean within a calendar year: 120 µg/m³ in 2020 (target date)
Long term objective for the PROTECTION of VEGETATION	AOT40: calculated from 1h values from May to July : 6 000 µg/m³.h in 2020 (target date) (*)

(*) AOT40 (expressed in (µg/m^3).hour means the sum of the difference between hourly concentrations greater than 80 µg/m^3 (=40 ppb) and 80 µg/m^3 over a given period using only the 1 hour values measured between 8:00 and 20:00 Central European Time each day.

Table 2.7. shows the information and alert thresholds for ozone.

Table 2.7.: Information and alert thresholds for ozone from 9/9/2003

INFORMATION THRESHOLD	Hourly average : 180 µg/m³
ALERT THRESHOLD	Hourly average : 240 µg/m³ (*)

(*) If the threshold value is exceeded during 3 consecutive hours short term actions should be developed

V Carbon monoxide (CO)

The second Daughter Directive 2000/69/EG gives a limit value for the protection of human health for CO. Table 2.8. shows the future limit value for CO. This limit value for the protection of human health needs to be reached by 1st January 2005. A margin of tolerance has also to be applied. It amounts to 6 mg/m³ from 13/12/2000 to 31/12/2002. It decreases linearly from 1st January 2003 in order to reach 0% by 1/1/2005.

Table 2.8.: Future limit value for CO coming into force on 01/01/2005 (2000/69/EC)

LIMIT VALUE for the PROTECTION of HUMAN HEALTH	10 mg/m³ as a maximum daily 8-hour mean

VI Heavy metals

The first Daughter Directive (1999/30/EC) gives a limit value for lead (Pb). The margin of tolerance for Pb was set at 100 % at the entry into force of that Directive (19th July 1999). The margin of tolerance decreases linearly from 1/1/2001 to 0% at the date where the limit value must be reached (1/1/2005). The fourth Daughter Directive has been approved and published recently. Non-mandatory target values are proposed for arsenic (As), cadmium (Cd) and Nickel (Ni). Table 2.9. shows the future limit value for Pb and the target values for As, Cd and Ni.

Table 2.9.: Future limit value for Pb coming into force on 01/01/2005 (1999/30/EC) and target values for As, Cd and Ni

Pb: LIMIT VALUE for the PROTECTION of HUMAN HEALTH	annual average: 500 ng/m³ (PM10 fraction)
As: TARGET VALUE	annual average: 6 ng/m³ (PM10 fraction)
Cd: TARGET VALUE	annual average: 5 ng/m³ (PM10 fraction)
Ni: TARGET VALUE	annual average: 20 ng/m³ (PM10 fraction)

VII Volatile organic compounds (VOC): Benzene

The second Daughter Directive 2000/69/EG gives a limit value for the protection of human health for benzene. Table 2.10. shows the future limit value for benzene. This limit value for the protection of human health needs to be reached by 1st January 2010. A margin of tolerance has also to be applied. It amounts to 5 µg/m³ from 13/12/2000 to 31/12/2005. It decreases linearly from 1st January 2006 in order to reach 0% by 1/1/2010. In Flanders the target date for respecting the limit value has been brought back to 1st January 2005.

Table 2.10.: Future limit value for benzene coming into force on 01/01/2010 (2000/69/EC)

LIMIT VALUE for the PROTECTION of HUMAN HEALTH	5 µg/m³

VIII Poly-aromatic hydrocarbons (PAH): Benzo(a)pyrene

The fourth Daughter Directive has been approved and published recently. A non-mandatory target value is also proposed for benzo(a)pyrene. Table 2.11. shows the target value.

Table 2.11.: Target value for benzo(a)pyrene

TARGET VALUE	annual average: 1 ng/m³ (PM10 fraction)

IX Dioxins and PCBs

The WHO proposes a tolerable daily intake (TDI) of 1 to 4 pg TEQ per kg bodyweight. A chain model was used to establish the relationship between the TDI and guide values for deposition. The proposed guide values for dioxin deposition are summarised in table 2.12..

Table 2.12.: WHO-TEF of PCDDs and PCDFs

Allowed deposition		
On a monthly basis	**Appreciation**	**On a yearly basis**
≤ 6 pg TEQ/m².d	Not increased	≤ 2 pg TEQ/m².d
> 6 pg TEQ/m².d	Moderately increased	> 2 pg TEQ/m².d
> 26 pg TEQ/m².d	Increased	> 10 pg TEQ/m².d

No guidelines for PCBs have been calculated. Meanwhile the target values for dioxin deposition are used to assess the deposition of PCB126 (table 2.12.).

3. Description of the studied area

The emphasis of the study lays on the border area between the cities of Roeselare and Kortrijk in the Flemish province of West-Vlaanderen and the cities of Lille and Tourcoing in France.

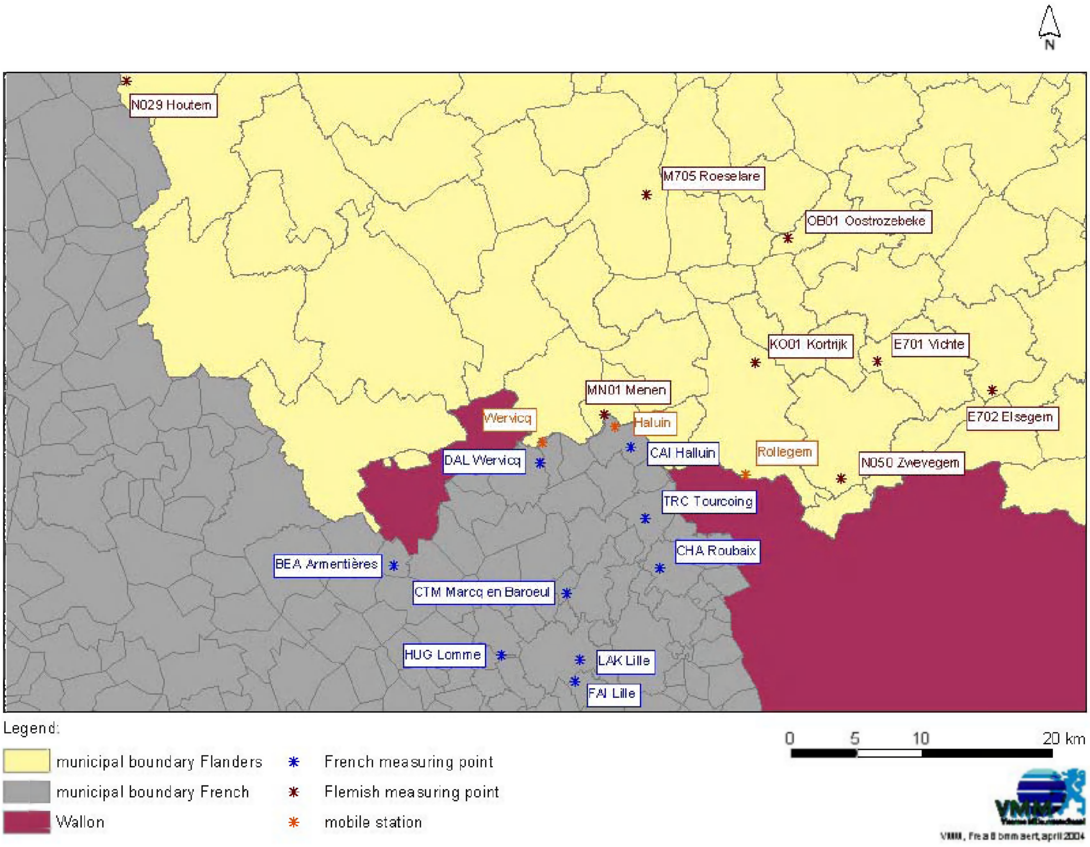


Figure 3.1.: Map of the agglomeration of Lille and nearer part of Flanders with situation of the fixed stations

4. Campaigns with mobile laboratories

I Technical means

AREMA LM and VMM used their mobile laboratories. The laboratories were installed during the winter 2002-2003 and during the summer 2003. AREMA LM installed the first mobile station in Halluin and the second one in Wervicq. VMM installed his laboratory in Rollegem-Kortrijk. The mobile stations are equipped to analyse gaseous pollutants (SO_2, NO_x, O_3 and CO) and suspended particles. Additionally particulate matter was collected on filters to analyse heavy metals in the PM2.5 and PM10 fraction and to analyse PAH (winter). During the winter campaign VMM also installed a mobile laboratory equipped with gas chromatography to analyse VOC.
To compare the capability of measurement of each organism an evaluation of the PM monitors was done in December with a reference mass. In summer an intercomparison took place with the three mobile stations installed in Wervicq. The data obtained during these campaigns are compared with the fixed stations near the border of France and Flanders. Table 4.1. shows the measurements at the different locations.

Table 4.1.: Equipment of the mobile laboratories

Location	**Code station**	**SO_2**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**O_3**	**heavy metals PM10**	**heavy metals PM2.5**	**VOC**	**PAH**
Rollegem_mob	L800	x	x	x	x	x	x	x	x	x(*)	x(*)
Halluin_mob	rem1	x	x	x		x	x	x			
Wervicq_mob	rem2 or U2	x	x		x	x	x	x			

(*) only during the winter campaign

II Locations

The sites were located near the border and their location was chosen to have a different influence from the Lille agglomeration taking into account the wind. It is necessary that the sites are free of buildings to permit a good circulation of air. Figure 4.1. gives the situation of the mobile stations during the measuring campaigns.

- Wervicq-Sud: the mobile station is located Avenue des Sports just near a football place and a sports room. This place is large enough to install the three laboratories for the intercomparison campaign.
- Halluin: During wintertime the mobile station is situated Rue des frères Martel prolognée near the musical school. The road just near has a low traffic. In summer, this site was not available and we installed the unit at stade Wancquet at the periphery of the city. It is closer to the RN17.
- Rollegem: the mobile station is situated at the Tombroekstraat at a small square.

The three points of study are situated on a line going from Wervicq (west side) to Rollegem (eastside) through the urban pole Halluin-Menen. The distance between the two sites is about 15 km. On each side, the density of population is not important. Wervicq has 4328 inhabitants and a density of 888 inhabitants/km^2). At the centre of this zone are situated the towns of Halluin (France) and Menen (Belgium) which have a population of respectively 17628 and 32 154 inhabitants. The density is a little bit higher with respectively 1114 inhabitants/km^2 and 973 inhabitants/km^2.

The area is situated at a distance of 8 km from Tourcoing in northern direction. The area between Tourcoing and Halluin can be classified as a suburban zone. The areas around Wervicq and Rollegem are more rural.

The studied zone is crossed by the highway A22-A14, coming from Lille and going to Gent. The highway runs 3 km south-east from Halluin and 3 km north-west from Rollegem. The number of vehicles running on the highway is 27 000 per day with 35% of lorries. Another axis exists (N17) going to Halluin and Menen with 5900 vehicles per day.

There is an important industrial emitter near Wervicq, which emits 1900 ton of SO_2 in 2003. Between Menen and Halluin two important shredders are situated on each side of the border. They work up metallic waste and have no industrial processes. They can be at the origin of diffuse dust emissions. 3 km in north-westerly direction of Rollegem an industrial emitter is situated which emits 341 ton of SO_2 (2002).

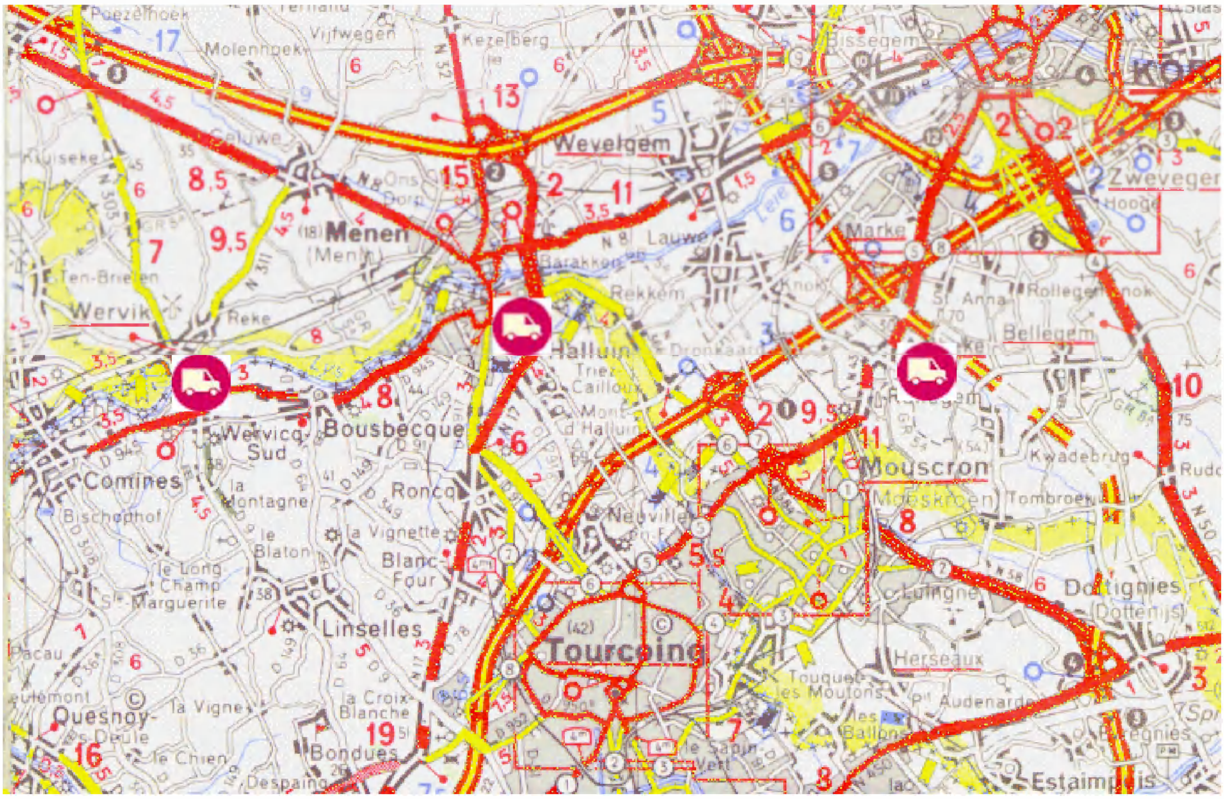


Figure 4.1.: Situation of the mobile stations during the measuring campaigns

III Measurement stations near the studied area

Figure 3.1. shows the location of the fixed measurement stations.

➢ Station of Houtem (N029)

The station of Houtem is situated in a rural area at a distance of 500 m from the French border.

➢ Station of Sint-Denijs (Zwevegem) (N050)

The station is located in the Rode Wilgenstraat near the library of Sint-Denijs.

➢ Station of Roeselare (M705)

The station is located near the canal Roeselare-Leie. Different industrial areas are situated in the neighbourhood. High concentrations of PM10 are measured at this location.

Station of Oostrozebeke (OB01)

The station is located in the Hulststraat at Oostrozebeke. Several wood chipboard factories are situated in the neighbourhood of the station. The closest factory is situated 870 m in south-western direction. The other factories are located in eastern direction at a distance of 3000 m. Also at this location high concentrations of PM10 are often measured.

Station of Kortrijk (KO01)

The station is located in the centre of Kortrijk at the school Pleinschool.

Station of Menen (MN01)

The station is located in the Wervikstraat just outside the town of Menen and near the border with France.

Station of Vichte (Anzegem) (E701)

The station E701 is located at the corner of the Otegemsestraat and the A. Rodenbachstraat near a container park. 200 m in eastern direction lies an import road, the N36. The station is situated in a rural and residential area.

Station of Elsegem (Wortegem-Petegem) (E702)

The station is located at a 50 m distance of the rather busy Kortrijkstraat (N453). A small nature reserve is situated in south-eastern direction. The station is situated in a rural area.

Station of Halluin (CAI)

It is situated in the periphery of the city and outdoor of the Lille agglomeration. For this reason, the measurements of nitrogen oxydes are lower than the urban stations but the ozone measurements are higher. First, it was installed to control the emissions of a waste incineration factory. The factory has been renewed a few years ago and the emissions are now less important. Depending on the wind, the station measure important levels of nitrogen oxydes coming from the highway.

Station of Wervicq (DAL)

It is an industrial station which survey an industry situated on the NW. Important values are often measured, but the norms are rarely exceeded.

Station of Tourcoing (TRC)

This is an urban station situated in the centre of Tourcoing which measure mean levels typical of the whole agglomeration. Under bad dispersion conditions, it can measure high levels of NO_2 which overlap the norms. The PM10 concentrations are equivalent to those obtained in others parts of the agglomeration.

Station of Armentières (BEA)

This station is situated in the centre of the town and it is outdoor the Lille agglomeration. The pollution levels are smaller than at the agglomeration.

Station of Lomme (HUG)

It is an urban station from the agglomeration with sometimes important levels of pollutants when the dispersion is bad. The PM levels are higher then the other measurements due to the presence of an emitter in the south.

Station of Roubaix (CHA)

It is an urban station from the north of the agglomeration with sometimes important levels of pollutants when the dispersion is bad. The SO_2 levels are higher than the other measurements due to the presence of a few industries in the town.

Station of Marcq en Baroeul (CTM)

It is an urban station from the agglomeration with sometimes important levels of pollutants when the dispersion is bad. It is situated close to the way RN17.

Station of Lille Faidherbe (FAI)

It is an urban station from the agglomeration situated near the highway A1 at the arrival on Lille. For this reason, the levels of NOx are quite important. It contains both measurements of PM10 and PM2.5.

Station of Lille Five (LAK)

It is an urban station from the agglomeration situated near the ring of Lille. The SO_2 measurements present a few higher concentrations due to the presence of a heating factory.

Table 4.2.: Equipment of the fixed stations

Town	Code station	SO_2	PM_{10}	$PM_{2.5}$	NO_x	O_3	CO
Houtem	N029	x	x		x	x	
Sint-Denijs (Zwevegem)	N050	x			x	x	
Roeselare	M705	x	x			x	
Oostrozebeke	OB01	x	x		x		
Menen	MN01		x(*2)	x(*2)			
Kortrijk	KO01		x(*1)	x(*1)			
Vichte	E701	x			x		
Elsegem	E702	x			x		
Halluin	CAI	x			x	x	
Wervicq	DAL	x					
Tourcoing	TRC	x	x		x	x	
Roubaix	CHA	x			x	x	
Marcq en Baroeul	CTM	x	x		x	x	
Lomme	HUG	x	x	x	x	x	
Lille Faidherbe	FAI	x(*3)	x	x	x(*3)		
Lille Five	LAK	x(*3)	x		x(*3)		
Armentières	BEA	x(*3)			x(*3)	x	

(*1) from 20th March 2003 on
(*2) from 6th February 2003 on
(*3) data not used for comparison with mobile stations

IV Results of the intercomparisons

A Control of TEOMs

In December, a first verification of the PM monitors took place. A common inert filter who's mass was well known was used. This filter was introduced in each microbalance and the answer of the monitor was observed. This test is used to control the good function of the monitor. The results are summarised in table 4.3.. The results show a good function of the apparatus. The limit value to detect a bad response is 3%.

Table 4.3.: Control of TEOM

Inert filter		Unit 1	Unit 2	VMM PM2.5	VMM PM10
Mass = 0.06096 g	Initial K_0	11991	16652	14577	12744
	New K_0	12015	16983	14792	12532
	Difference (%)	0.2 %	2 %	1.5 %	1.7 %

B Intercomparison mobile laboratories in Wervicq

The three mobile laboratories were located together at Wervicq from 12th to 20th June 2003. The mobile laboratory rem2 arrived only on 16th June 2003. The gaseous monitors were calibrated at the beginning of the intercomparison by the usual technicians from AREMA LM and VMM. Each technician used his own calibration gases.

The data obtained are compared in terms of mean value and maximum value. A statistical test is used to compare the mean values two by two. It will decide, with a confidence interval of 95%, if the samples are two different estimations of the same measure. The standard deviation for each series of data has been calculated. If the series are identical, the global deviation (sum of two deviations) must be inferior to the difference between the two mean values. If not, the series come from different populations and are not identical. Furthermore, the global deviation will give an idea of the uncertainty of the measurement at the level of the mean value.

First, we calculate the correlation coefficients for the data series 2 by 2 (table 4.4.). For SO_2, NO_2, O_3 and PM10, these coefficients are always better than 0.96. They are a little bit smaller for NO. This is due to the fact that the site is rural so the NO concentrations are not very high and a small deviation on one monitor has an important impact on the coefficient. This is more visible for CO. The coefficients are bad (inferior to 0.5). The mean values are very small and the monitors work in their limits of sensibility. In those conditions, their correlation cannot be good.

Table 4.4.: Correlation coefficients between the measurements

	SO2	NO	NO2	O3	CO	PM10
Rem1-VMM	0.964	0.940	0.974	0.998	0.384	0.978
Rem2-VMM	0.994	0.974	0.986	0.998	0.292	0.980
Rem1-rem2	0.967	0.930	0.988	0.998	0.427	0.985

Figure 4.2. shows the mean values. Table 4.5. gives the mean and maximum values.

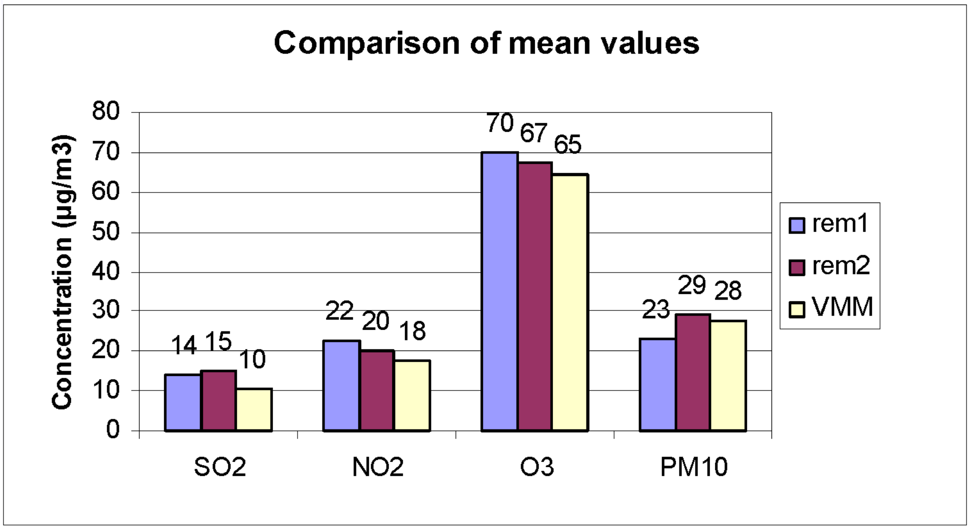


Figure 4.2.: Mean values of the different monitors

SO_2: There is an important difference given by VMM for the mean value, which underestimates the concentrations (5 µg/m^3 at a level of 15 µg/m^3). Statistically, the three measurements are identical.
NO: The results are good, but the ambient levels are very small and for the maximum there are no important differences. Statistically, there is a difference between rem2 and VMM.
NO_2: The VMM laboratory seems to underestimate the ambient concentrations especially for the maximum value. Its measurements are statistically different from rem1.
O_3: There are no important differences on the maximum value but the deviation on the mean value is relatively important. The measurements are identical.
CO: rem2 gives a higher mean value but a smaller maximum. The monitor seems to have a bad sensitivity and a positive offset (which explains the mean value). Compared by the mean values, the measurements of rem1 and VMM are identical, what means that the rem2 measurements are too high.
PM10: Results from rem2 and VMM are very good. Rem1 shows a problem in the measurement by underestimation. It might present a hole in the line which diminish the direct flow from ambient air. The statistical tests indicate that measurements from rem1 are different from the others.

Table 4.5.: Mean and maximum values for the measurements

	SO_2 (µg/m^3)		NO (µg/m^3)		NO_2 (µg/m^3)		O_3 (µg/m^3)		CO (mg/m^3)		PM10 (µg/m^3)	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Rem1	14	174	2.4	21	22	67	70	165	0.25	1.42	23	75
Rem2	15	161	3.3	28	20	67	67	163	0.36	0.6	29	84
VMM	10	154	2.2	24	18	59	65	161	0.29	3.63	28	84
Uncertainty	3.5		0.45		2.1		4.9		0.024		1.87	

This intercomparison shows two things:

-The VMM laboratory seems to underestimate the concentrations of gaseous pollutants for SO_2 and NOx
-The rem1 laboratory presents a too low measurement of PM10 of about 20%
-The CO measurement is very difficult to realise and give important deviations between the 3 stations.

C Intercomparison of heavy metals at Wervicq

From 14th to 19th June also an intercomparison for heavy metals took place at Wervicq. AREMA LM collected PM10 on quartz filters Whattman for two times 3 days with a flow of 1 m^3/h (Partisol Plus). VMM collected also PM10 during the same periods on quartz filters Whattman with a flow of 2.3 m^3/h (Leckel SEQ 47/50).

AREMA LM works with the Institut Pasteur de Lille who obtained an accreditation for the analyses of heavy metals. The analyses are effectuated using Ion Coupled Plasma with Argon Emission Spectrometry or Ion Coupled Plasma with Mass Spectrometry.

Normally wavelenght dispersive X-ray fluorescence technique (WD-XRF) is used in the VMM laboratory for the determination of the heavy metal content. For this intercomparison also flame and graphite furnace atomic absorption spectrometry was used.

(Large) differences in the results are seen, depending on the analyse method. Also between 2 filters, analysed by the same method (AREMA LM, 17th to 19th June), differences are measured for some pollutants. There`s no strict relationship between the different methods; this relationship is depending on the pollutant. Like for copper the method of AREMA LM measures every time a lot higher (factor 2 to 3), for other pollutants the results are more similar.

Table 4.6.: Heavy metals in PM10 at Wervicq during the intercomparison campaign

(ng/m^3)	14th to 16th June			17th to 19th June			
	VMM XRF	**VMM AAS**	**AREMA LM**	**VMM XRF**	**VMM AAS**	**AREMA LM**	**AREMA LM**
Pb	36	37	14	20	20	16	26
Zn	45	65	45	50	66	57	42
Cu	<5	8.9	24	<5	7.9	29	22
Ni	4.1	5.2	4.4	4.7	7.8	8.4	4.3
Sb	-	2.9	-	-	2.4	-	-
As	<3	1.4	<1	<3	1.2	1.0	1.2
Mn	9.8	13	-	11	14	-	-
Cd	-	0.55	0.2	-	0.31	0.2	0.4
Cr	2.8	3.4	-	5.2	3.9	-	

V Results of the measurement campaigns

A Number of data during the measurement campaigns

The table below lists the percentage of available data for each measurement and each mobile laboratory. It represents the number of hourly values, which are correct between the first and the last hour of measurement. The difference with 100% comes from failures of the monitors, failure of power supply and calibration of the monitors (SO_2, NO_x, CO).

Table 4.7.: Number of data during the measurement campaigns

	Winter campaign			Summer campaign		
	Halluin (rem1)	**Wervicq (rem2)**	**Rollegem (L800)**	**Halluin (rem1)**	**Wervicq (rem 2)**	**Rollegem (L800)**
	18/12/02 2:00 until 20/01/03 9:00	**18/12/02 1:00 until 21/01/03 6:00**	**4/12/02 1:00 until 3/2/03 24:00**	**20/06/03 11:00 until 16/07 6:00**	**16/06/03 15:00 until 15/07/03 8:00**	**21/6/03 1:00 until 23/07/03 24:00**
SO_2	93.2 %	99.9 %	89.3 %	99.5 %	99.5 %	90.3 %
PM10	94 %		97.6 %	99.8 %		98.5 %

PM2.5		96.8 %	97.2 %		66.6 %	99.9 %
NO	96.8 %	99.9 %	93.5 %	99.9 %	99.5 %	90.0 %
NO_2	96.8 %	99.9 %	93.4 %	99.9 %	99.5 %	90.0 %
O_3	11.7 %	100 %	93.8 %	99.9 %	99.8 %	95.2 %
CO	96.8 %	99.9 %	93.1 %	99.9 %	99.7 %	94.9 %

An important loss of ozone data occurred in Halluin during winter because of a failure on the monitor. Furthermore, a break of electricity occurred from 19th to 21st December 2002. In summer the data capture of PM2.5 in Wervicq was not very good. Data were lost because the monitor was still measuring PM10 instead of PM2.5 from 20th June 2003 10:00 UT until 23rd June 2003 10:00 UT (at the end of the intercomparison campaign).

For the further discussion, the data from 18th December 2002 until 20th January 2003 and from 21st June until 15th July are taken into account.

B Meteorological conditions

1 Wind roses

During the winter campaign the wind roses looked like those obtained for a whole year. Most of the winds came from the south-west and the second most important direction was north-east. In summer, we had a more important part of wind coming from north-west.

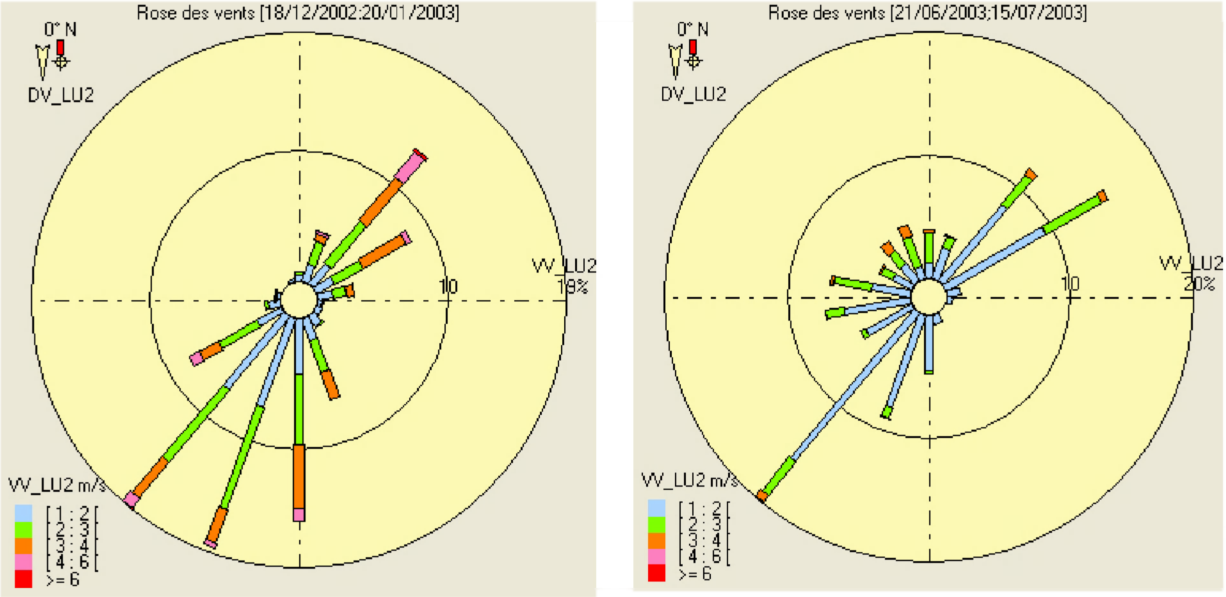


Figure 4.3.: Wind roses for the winter and the summer campaigns obtained in Wervicq

2 Other meteorological parameters

In December there were a few sunny days on 18th and 19th and then from 6th to 12th January. The temperatures were low and the hourly minimum reached -7.5°C. The rest of the campaign was cloudy with mild temperatures around 12°C. The pressure had important variations between 995 and 1035 hPa, which indicates the presence of a depression and an anticyclone.

In summer, there were fewer fluctuations of the meteorological parameters. The mean temperature was quite constant and the daily maximum varied from 19°C on 2nd and 3rd July to 32°C on 15th July. The maximum temperature exceeded 25°C on June 22nd, 26th and 29th. In July we had a warm period from 8th to 15th with temperatures superior to 25°C. Between these two periods we had only one short period with low pressure and cloudy sky in the beginning of July.

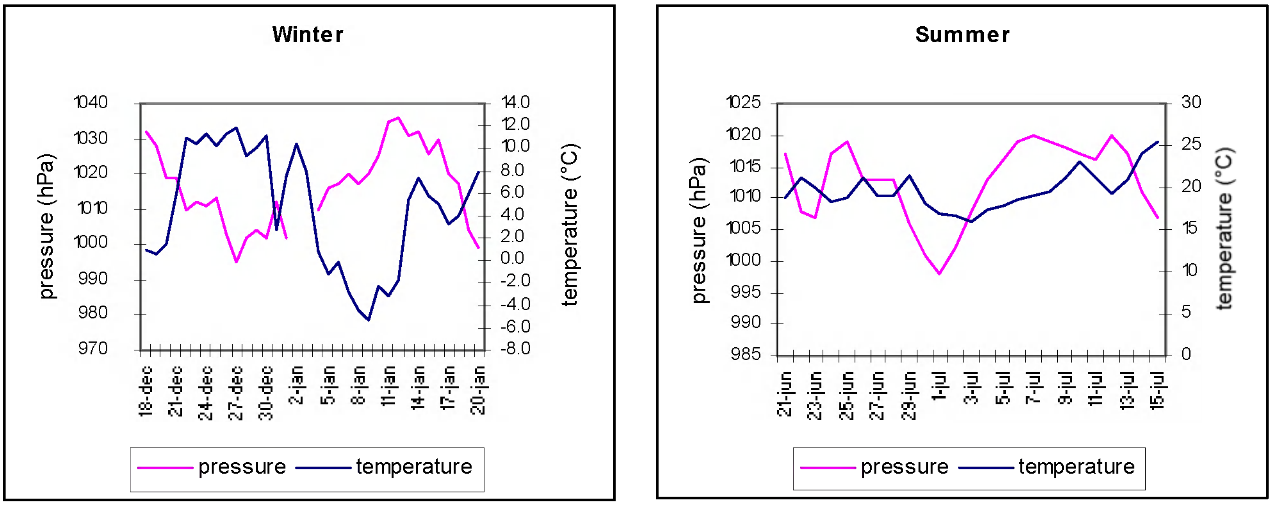


Figure 4.4.: Variation of mean temperature and pressure during the campaigns in winter and summer

C The measurements of pollutants

1 Sulphur dioxide (SO_2)

The results of 6 fixed stations of VMM and 6 fixed stations of AREMA LM are included, as well as the results of the 3 mobile laboratories.

Table 4.8.: Mean and maximum hourly values for SO_2

	Rollegem_mob	**Wervicq_mob**	**Halluin_mob**	**Houtem**	**Sint-Denijs**	**Roeselare**	**Oostrozebeke**	**Vichte**	**Elsegem**	**Halluin**	**Wervicq**	**Tourcoing**	**Roubaix**	**Marcq**	**Lomme**
mean winter	10	12	10	4	10	7	15	9	10	9	3	17	14	14	9
max winter	71 10/01	139 06/01	78 13/01	35 08/01	90 05/01	46 08/01	80 14/01	69 09/01	85 13/01	49 10/01	50 10/01	140 10/01	108 05/01	84 10/01	62 09/01
mean summer	5	16	7	5	6	5	11	2	4	7	11	7	7	6	4
max summer	48 26/06	208 27/06	57 04/07	42 11/07	62 15/07	28 11/07	34 23/06	16 29/06	38 21/06	56 21/06	264 08/07	52 04/07	41 08/07	48 24/06	33 12/07

The SO_2 measurements during the winter and summer campaign are low. During the wintertime the SO_2 concentrations are generally higher than during the summer time. Only at the fixed station of Wervicq and at the mobile laboratory in Wervicq clearly higher concentrations were measured in summer.

The highest mean value of 17 µg/m³ SO_2 is measured during the winter campaign in the French fixed station of Tourcoing. The highest mean value at a Flemish permanent station is measured at Oostrozebeke also during wintertime and is 15 µg/m³ SO_2. A mean value of 16 µg/m³ SO_2 is measured in the mobile laboratory at Wervicq during the summer campaign.

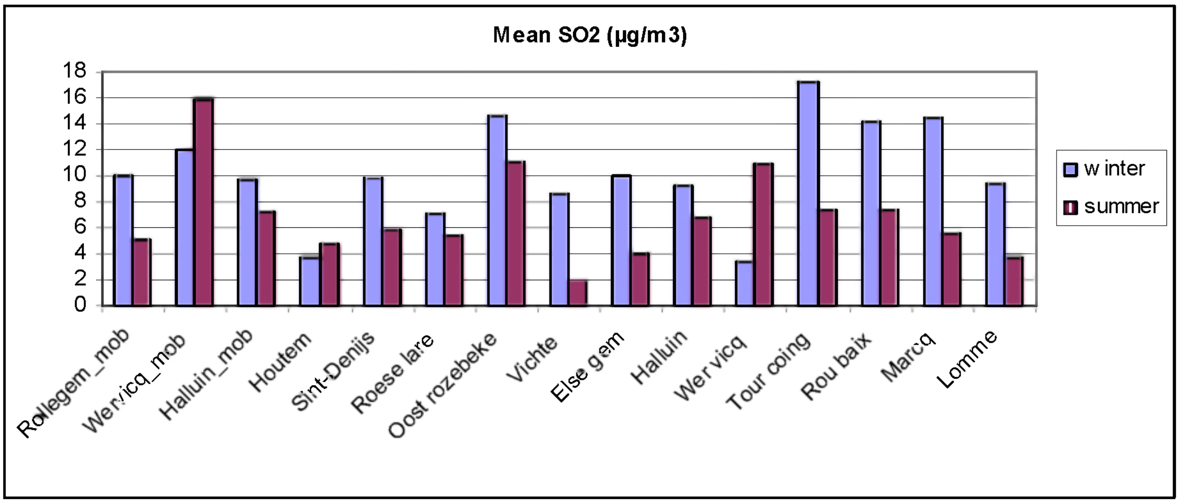


Figure 4.5.: Comparison of the mean values of SO_2

During wintertime the highest concentrations are measured from 18th to 22nd December and from 8th to 13th January. These days correspond to an accumulation of the pollutants under bad dispersion conditions. The wind mostly comes from the east with a low speed. During the other days the wind is stronger what permits a better dispersion. On the plots of the hourly values (annex 1) we see that the concentrations are higher in January than in December. During summer time the concentrations are often elevated in the mobile and fixed stations at Wervicq.

The graphic of the daily profile in winter (figure 4.6.) shows that in the morning the SO_2 concentrations are low in most of the stations. In the forenoon the concentrations increase slowly and in the afternoon they decrease again. The variation in the concentration is only a few µg/m³. In the station of Oostrozebeke the concentrations are also high during the nighttime.

During the summer the pattern of the daily profile shows for most of the stations a low SO_2 concentration during the whole day except from 6:00-11:00 UT. In the station of Oostrozebeke the concentrations stay higher during the whole day. At the station of Wervicq and the mobile laboratory Wervicq_mob we also see elevated concentrations during all day.

When we look at the pollution roses during winter time (annex 2) we see that the mobile laboratory of Rollegem and the fixed station of Sint-Denijs are influenced in north-eastern direction by the power-station of Ruien, situated in the Flemish municipality of Kluisbergen. At the station of Elsegem we also see the influence of the power station from the south-western direction. The wind is coming only rarely from the power station Ruien for the station of Vichte. At the station of Oostrozebeke, high concentrations are measured from the south-west direction where a wood chipboard factory is situated. Especially at the fixed stations of Tourcoing, Roubaix and Marcq and Lomme we see elevated SO_2 concentrations coming from the north-east. There are no special sources for this SO_2 but it is the result of the heating emissions from the town and a worse dispersion. We see also these phenomena looking at the mean values for winter which are higher in towns (figure 4.5.).

During summer time we also see the influence of the chipboard factory at the station of Oostrozebeke. The mobile laboratory at Wervicq and the fixed station of Wervicq are measuring the influence of an industrial source situated west of the fixed station, which produces colouring pigments containing sulphur.

The hourly value of 350 µg/m^3 and the daily value of 125 µg/m^3 of the future limit values for the protection of health (1999/30/EC) are not exceeded during the measurement campaigns.

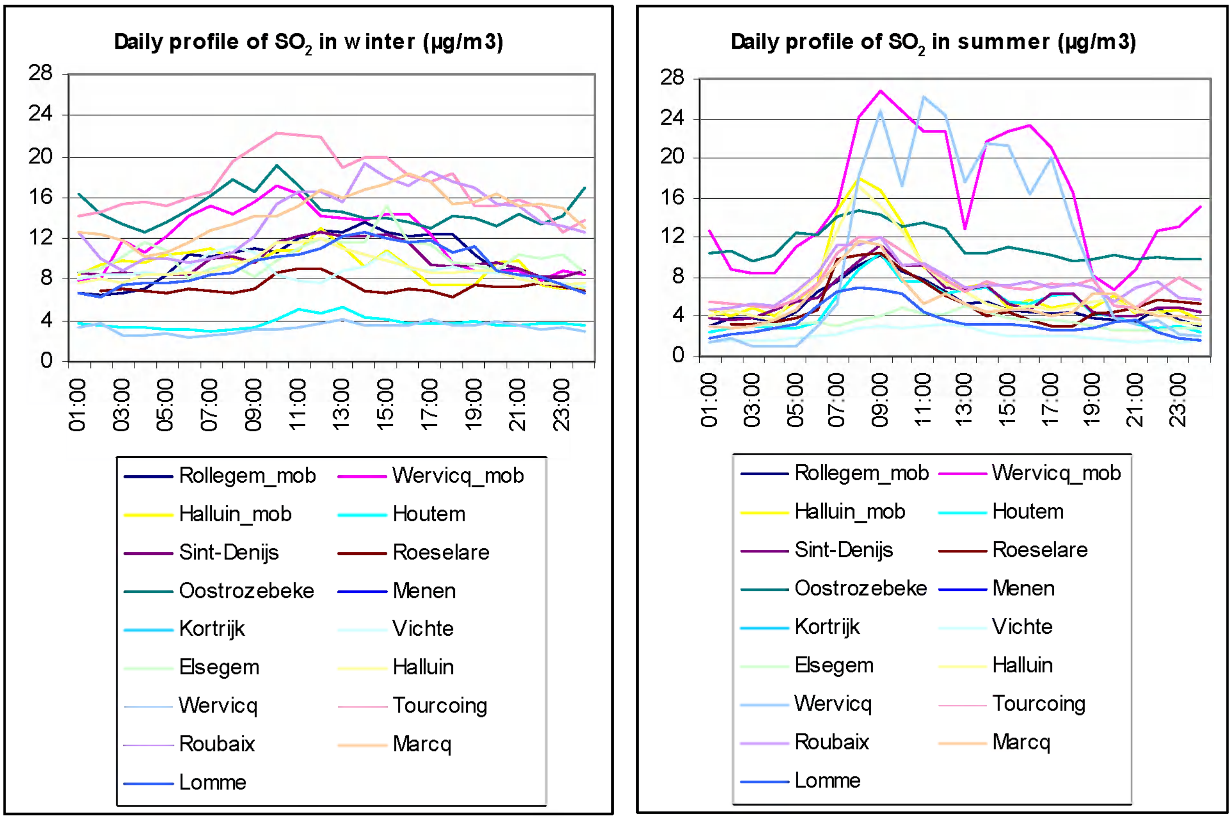


Figure 4.6.: Daily profiles of SO_2 during the winter and summer campaign

2 Particulate Matter

➢ PM$_{10}$

5 permanent stations are located in the neighbourhood of the agglomeration of Lille. In the province of West-Vlaanderen in Flanders 5 fixed stations are situated. The stations of Menen and Kortrijk started in spring 2003.

Table 4.9.: Mean and maximum values (daily averages) of PM10 (µg/m^3)

	Rollegem	**Halluin mob**	**Houtem**	**Roeselare**	**Oost rozebeke**	**Menen**	**Kortrijk**	**Tour coing**	**Marcq**	**Lomme**	**Lille Faidherbe**	**Lille Five**
mean winter	18	18	19	23	27	-	-	21	22	24	18	19
max winter	53 12/01	40 12/01	35 20/12	55 20/12	73 12/01	-	-	43 10/01	49 12/01	58 12/01	43 12/01	53 12/01
mean summer	25	21	24	32	24	25	25	22	26	26	24	27
max summer	38 15/07	32 21/06	43 15/07	65 15/07	41 27/06	32 15/07	35 27/06 and 15/07	36 15/07	43 15/07	38 15/07	36 15/07	39 15/07

During the winter campaign there were 2 periods with high PM10 concentrations namely 20th to 21st December and 10th to 12th January. During the summer campaign a period of higher concentrations started at 15th July, the last day of the campaign. The average PM10 concentrations are higher during the summer campaign except for Oostrozebeke. The highest concentrations during the winter campaign were measured in Oostrozebeke, Lomme, Roeselare and Marcq. During the summer campaign the highest concentrations were measured in Roeselare, Lille Five, Marcq and Lomme.

To evaluate the influence of the agglomeration of Lille on the mean values the different stations are plotted in the order of their geographic position on a south-north axis and on a west-east axis. No influence of the agglomeration of Lille on the measured values can be detected.

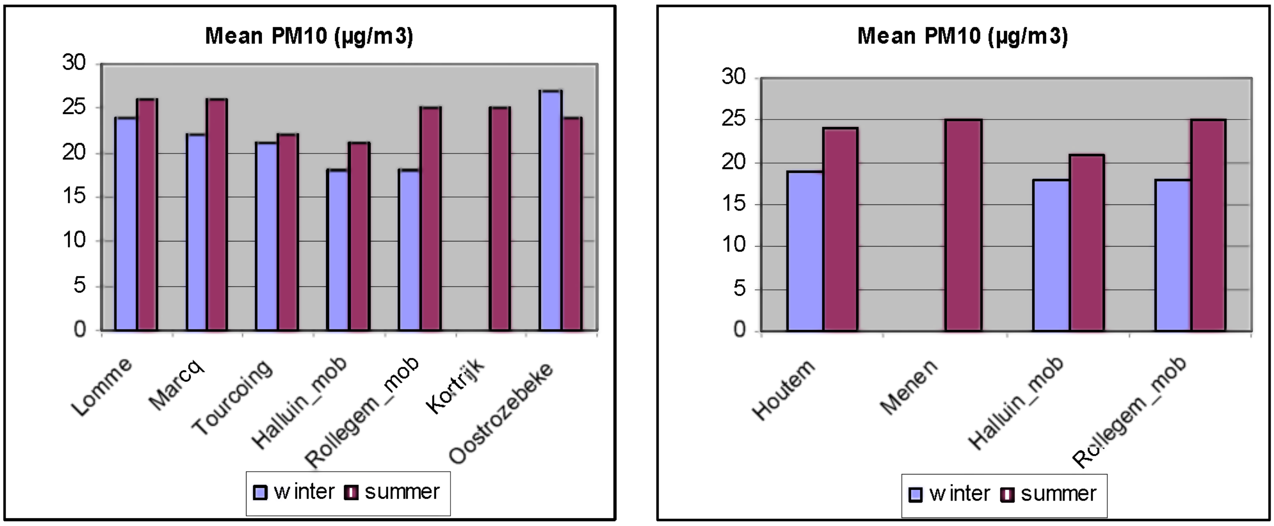


Figure 4.7.: Mean values of PM10 from south to north (left) and from west tot east (right)

During the winter campaign and summer campaign the PM10 concentrations stay fairly constant during the day. The lowest concentrations are generally measured during the night and early morning (figure 4.8.).

During the winter campaign the measurements are generally higher when to wind is coming from the north-east compared to the south-west. At Oostrozebeke (OB01) the highest concentrations are measured in the south-western direction where a wood chipboard factory is situated. (see annex 2)

During the summer campaign the measurements are more homogeneous over the different wind directions. At Oostrozebeke we see again higher concentrations when the wind is coming from the south-west. At Roeselare the concentrations are elevated when the wind is coming from the east. In eastern direction an industrial area is situated. (see annex 2)

The limit value of 40 µg/m^3 for the protection of health (1999/30/EC) is not exceeded during the measurement campaign in winter and summer. After correction with the factors used in Flanders this limit value is exceeded in the station of Roeselare during the summer campaign. The daily value of 50 µg/m^3 for the protection of health (1999/30/EC) is exceeded during winter and summer. During the winter campaign it was exceeded 1 time at Rollegem, Lomme and Lille Five, 2 times at Roeselare and 4 times at Oostrozebeke and during the summer campaign it was exceeded 2 times at Roeselare. After correction with the factors used in Flanders this daily value is exceeded during wintertime once at Lille-Faidherbe and Halluin_mob, 2 times at Rollegem and Lille-Five, 4 times at Tourcoing, 5 times at Lomme and Marcq, 7 times at Roeselare and 13 times at Oostrozebeke. During summer time 1 exceedance occurred at Tourcoing, Lomme, Lille-Faidherbe and Lille-Five, 2 exceedances at Rollegem, Houtem, Oostrozebeke, Kortrijk and Marcq and 3 exceedances at Roeselare. 35 exceedances of the daily value of 50 µg/m^3 are permitted on a yearly basis.

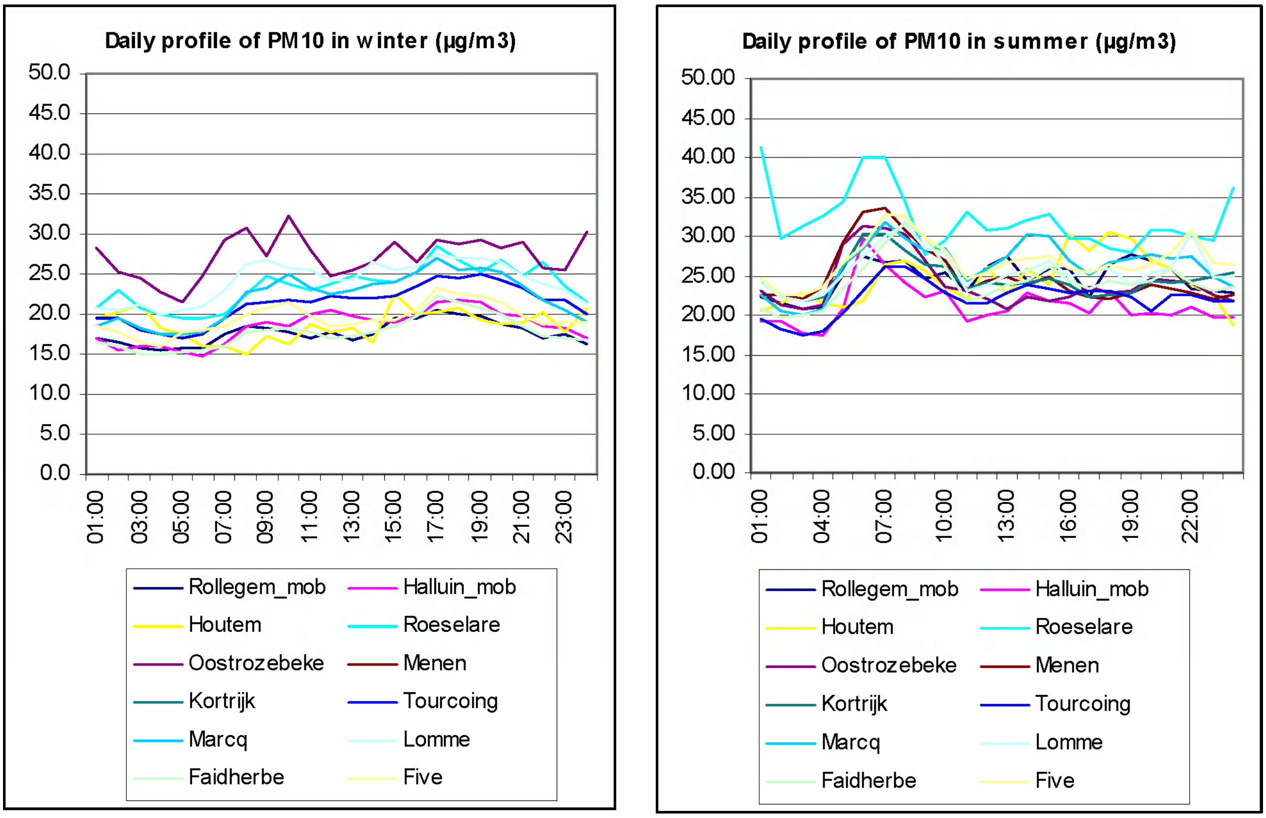


Figure 4.8.: Daily profile of PM10 during the winter and summer campaign

- PM2.5

The PM2.5 pollution in the neighbourhood of Lille is only monitored at 2 fixed locations in France and at 2 fixed locations in the province of West-Vlaanderen in Flanders. The stations of Menen and Kortrijk were started during spring 2003.

Table 4.10.: Mean and max values (daily averages) of PM2.5 (µg/m3)

	Rollegem_mob	**Wervicq_mob**	**Menen**	**Kortrijk**	**Lomme**	**Lille Faidherbe**
mean winter	16	16	-	-	17	14
max winter	53 12/01	35 12/01	-	-	49 12/01	38 12/01
mean summer	11	-	15	15	16	15
max summer	15 27/06	25 27/06	22 27/06	26 27/06	21 27/06 and 05/07	21 05/07

As for PM10 during the winter campaign there were 2 periods of high PM2.5 concentration during the winter campaign namely 20th to 21st December and 10th to 12th January. As for PM10 a period of higher concentrations started during the summer campaign at 15th July, the last day of the campaign.

The graphics of the daily profile for PM2.5 are comparable with those of PM10.

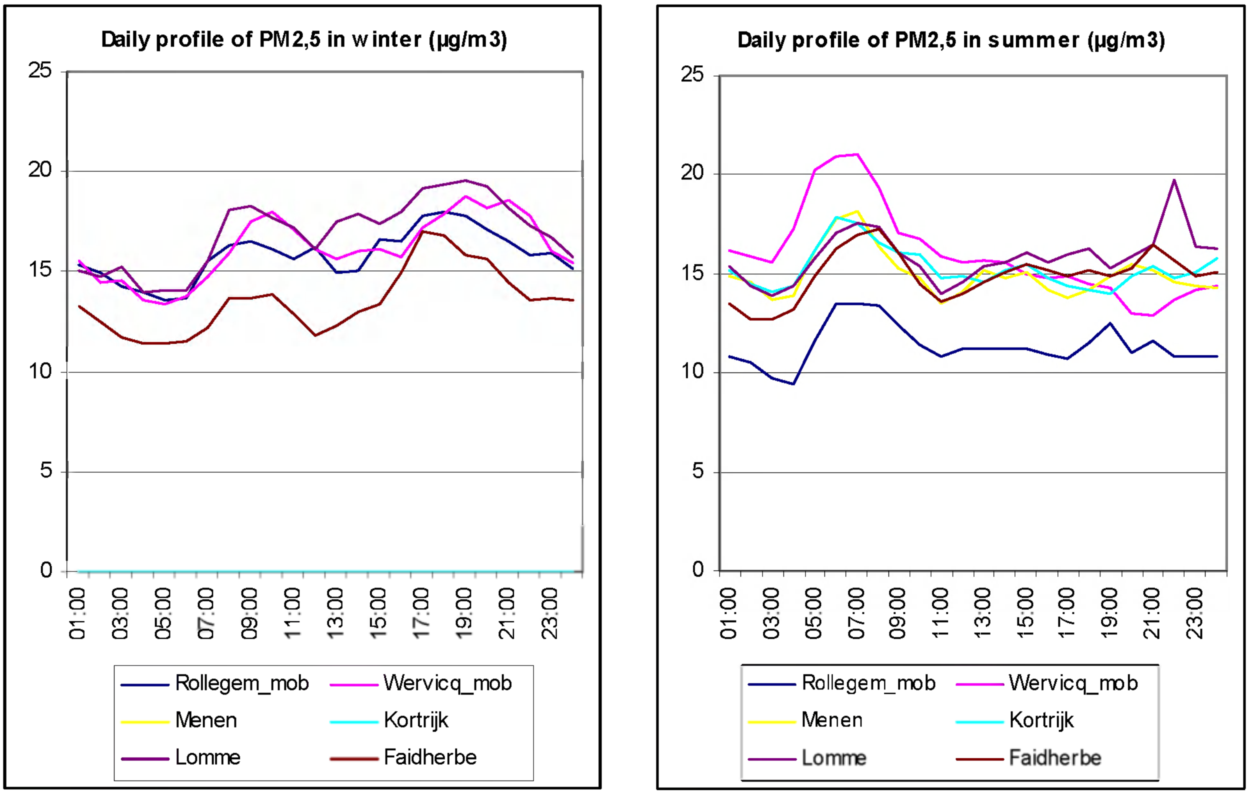


Figure 4.9.: Daily profile of PM2.5 during the winter and summer campaign

In the studied area in France and in Flanders there are only a few locations where both PM10 and PM2.5 are measured. In the winter the difference between PM10 and PM2.5 is smaller than in the summer. During the winter the PM10 at Rollegem exists for 89% of PM2.5. During the summer the fraction PM2.5 is only 44 % of the PM10 at Rollegem. At Lille-Faidherbe the fraction of PM2.5 in PM10 is 78% during the winter and 63% during the summer. At Lomme the fraction of PM2.5 in PM10 is 71% during the winter and 62% during the summer.

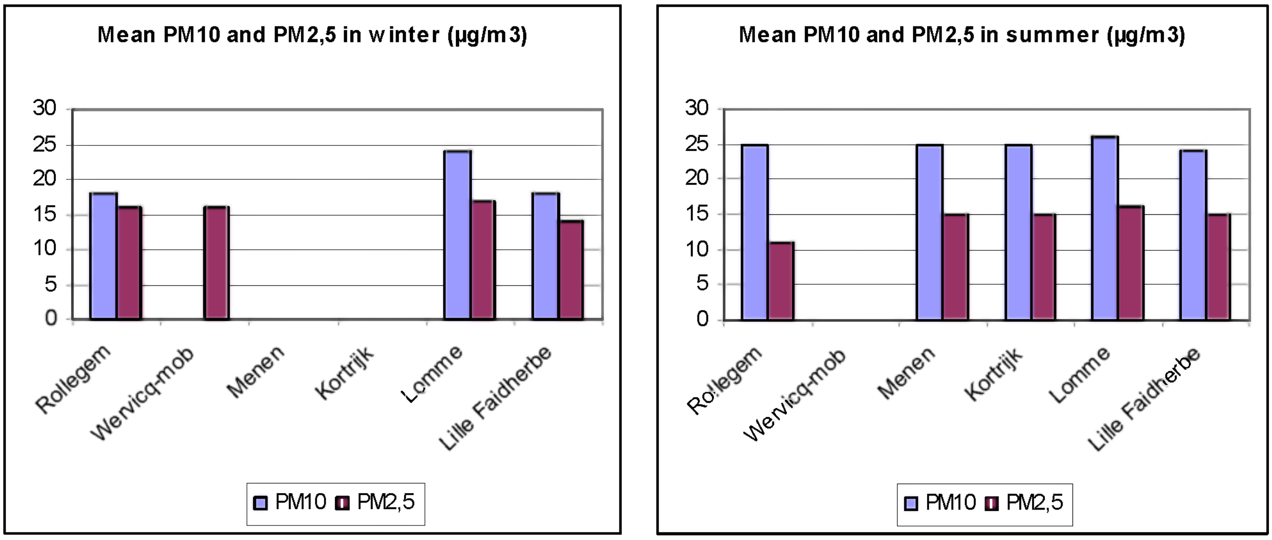


Figure 4.10.: Comparison of PM10 and PM2.5 during the winter and summer campaign

As for PM10 the measurements during the winter campaign are generally higher when the wind is coming from the north-east compared to the south-west. During the summer campaign the measurements are also more homogeneous over the different wind directions.

3 Nitrogen oxides (NO and NO_2)

From 18th December to 20th January 2002 the lowest mean values for NO are obtained in Flanders: 6 µg/m^3 in Elsegem, 7 µg/m^3 in Houtem and 9 µg/m^3 in Sint-Denijs. A more important mean value is measured in Oostrozebeke (16 µg/m^3). This value is the only one close to the values obtained in the agglomeration of Lille which vary from 16 to 24 µg/m^3 (table 4.11.).

In summer there are less differences: the mean values for NO vary from 1 to 5 µg/m^3. The dispersion in summer is more efficient and there is more ozone to consume NO.

When we have a look at the evolution of hourly data in December and January (annex 1), we distinguish two periods with higher concentrations: from 18th to 21st December and from 8th to 12th January. The most important values are obtained in the morning what points out the influence of traffic.

The maximum hourly values for NO are 295 µg/m^3 in Lomme on 21st December, 276 µg/m^3 in Marcq en Baroeul on 10th January and 241 µg/m^3 in Roubaix on 21st December. In summer, the maximum values for NO are less important and are comprised between 98 µg/m^3 in Marcq and 22 µg/m^3 in Houtem.

As for NO, we identify two periods with higher levels of NO_2 in winter: from 18th to 21th December and from 8th to 12th January. On the plot of the maximum daily NO_2 values we see that the levels are higher in January than in December. The maximum hourly concentrations overpasses 100 µg/m^3 on 10th January in Lomme, Marcq and Roubaix, which are the three most polluted sites. On 12th January the maximum hourly concentrations overpasses 100 µg/m^3 in Marcq and Lomme and on 16th January in Lomme. In summer, the levels are more regular and we have only a few single days with daily maximum hourly values close to 100 µg/m^3 on 30th June (Marcq and Lomme) and 10th July (Marcq). Most part of the daily maximum hourly values is between 40 and 60 µg/m^3 for urban stations and between 20 and 40 µg/m^3 for rural stations.

Table 4.11.: Mean and maximum hourly values for NO and NO_2

		Rollegem_mob	Wervicq_ mob	Halluin_ mob	Houtem	Sint-Denijs	Oostrozebeke	Vichte	Elsegem	Halluin	Tourcoing	Roubaix	Marcq	Lomme
NO	**mean winter**	13	14	18	7	9	16	-	6	16	19	22	23	24
	max winter	164 12/01	196 10/01	199 20/12	137 21/12	118 12/01	161 19/12	-	103 21/12	197 21/12	198 10/01	241 21/12	276 10/1	295 21/12
	mean summer	2	3	3	1	2	5	3	3	5	2	5	5	2
	max summer	49 10/07	33 15/07	58 10/07	22 11/07	47 9/07	75 10/07	29 15/07	43 07/07	58 10/07	29 09/07	61 09/07	98 10/07	94 10/07
NO_2	**mean winter**	30	33	35	19	28	33	-	23	36	34	41	44	46
	max winter	88 10/01	99 10/01	100 10/01	73 10/01	76 10/01	95 18/12	-	72 10/01	82 10/01	93 10/01	108 10/01	119 10/01	117 10/01
	mean summer	18	20	21	15	19	29	20	16	21	21	31	31	21
	max summer	76 15/07	74 30/06	92 15/07	40 20/06	67 15/07	67 30/06	71 15/07	50 10/07	72 15/07	69 15/07	79 30/06	101 10/07	101 30/06

Figure 4.11. and figure 4.12. shows the daily profile of NO and NO_2 during winter and summer for all the stations situated in the studied area. This gives an indication of the influence of the traffic on the immissions of nitrogen oxides. The presence of the NO maximum in winter during the morning (between 8:00 and 11:00 UT) and in the afternoon (17:00 and 18:00 UT) are characteristics for the peak of traffic that exists in and around important agglomerations. This is the reason why the higher profiles are those of the urban stations (Lomme, Marcq, Roubaix, Tourcoing). The Flemish station of Oostrozebeke has a traffic influence comparable to Tourcoing. The other stations are less influenced and Houtem and Elsegem, which are rural stations have almost no influence of traffic. The order of the profiles is the same for NO_2: the concentrations are the highest for urban stations.

In summer, we observe the same phenomena with lower levels for NO. The maximum morning concentration is about 20 µg/m^3 in Marcq and only a few µg/m^3 in the rural stations. This difference is due to a better dispersion of the pollutants and a consumption of NO by O_3 in the afternoon. Concerning NO_2, the differences between the two periods are not so big and the levels are quite the same. The first part of the profiles in the morning is quite identical but the second part is lower.

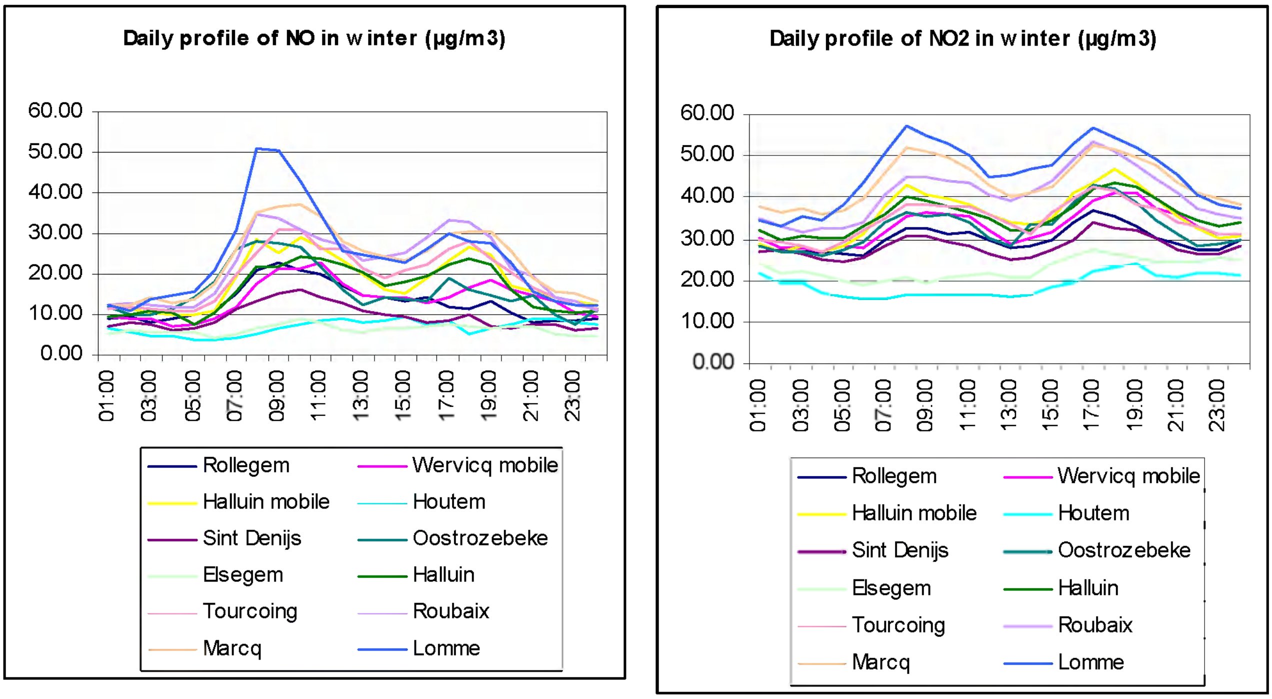


Figure 4.11.: Daily profiles of NO and NO_2 during the winter campaign

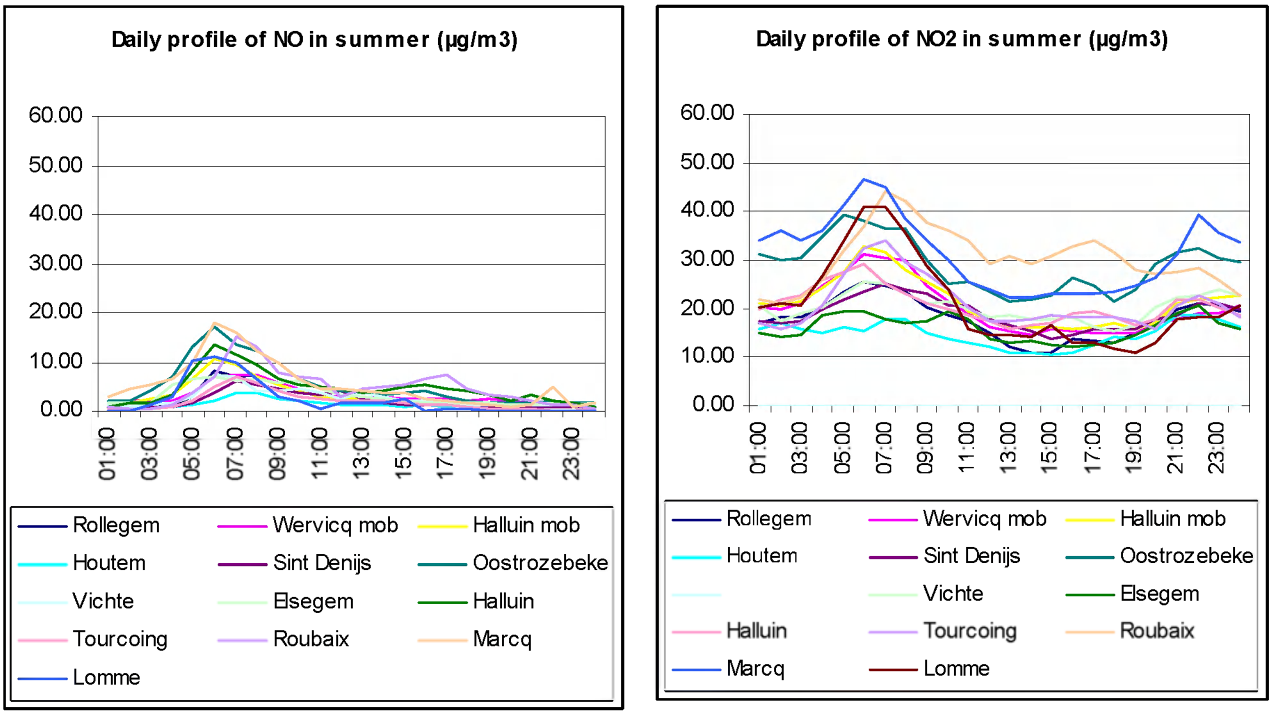


Figure 4.12.: Daily profiles of NO and NO_2 during the summer campaign

It is possible to evaluate the influence of the agglomeration of Lille by plotting the average values obtained on the different stations in order of their geographic position on a south-north axis and on a west-east axis.

In the direction of the dominant wind, the concentration of NO decreases with the distance from Lomme and the ambient concentration is divided by 2.5 (-60%) after 25 km in Sint-Denijs. This decrease is stopped near Oostrozebeke where the ambient concentrations of NO have a comparable level as in Halluin. In the other direction, we observe an increase of the concentrations approaching the agglomeration plume (near Halluin) and afterwards the concentrations trend towards their basic level in Elsegem. The levels in the rural part are 70% lower than in the urban part. These two plots show the influence of the agglomeration of Lille. The levels for the summer are not plotted because they are low (between 1 and 5 µg/m^3) compared to those of winter. For comparison, the levels of NO in suburban stations around Lille are 10 µg/m^3 in Salomé, situated 25 km in the SW of Lille. So the levels in Sint-Denijs are the ground levels in the wind direction and are a little bit higher than Elsegem.

Another way of seeing the distribution of NO is by plotting the pollution roses of each station (see in annex 2). The roses during winter for Rollegem and Sint-Denijs indicate the higher levels coming from the south-west. For Houtem, the direction is the east and south-east which corresponds to the agglomeration of Lille. In Oostrozebeke, the two main directions are south-west (it can indicate Lille) and north-east (others emissions). Elsegem shows a source at the south-east.

The same treatment is done for NO_2. On a parallel axis to the dominant wind, a decrease is observed in winter with levels going from 46 to 28 µg/m^3, what represents a decreasing of 40%. In summer, the profile is not the same. All the stations show mean concentrations close to one another (about 20 µg/m^3) except Marcq, Roubaix and Oostrozebeke, which present values of 30 µg/m^3. We can suppose that the better dispersion trends to equalise the levels over the whole region.

On the perpendicular axis, the winter levels of NO_2 look like those for NO with the highest values (35 µg/m^3) in the centre and the lowest (20 µg/m^3) on each side. In summer, we measure the same levels of 20 µg/m^3 in all places. This value seems to be the ground level in that region in summer. It is also the ground level in the Euro region because the station of Salomé, what is the least exposed station from the AREMA network, presents a mean measurement of 19 µg/m^3.

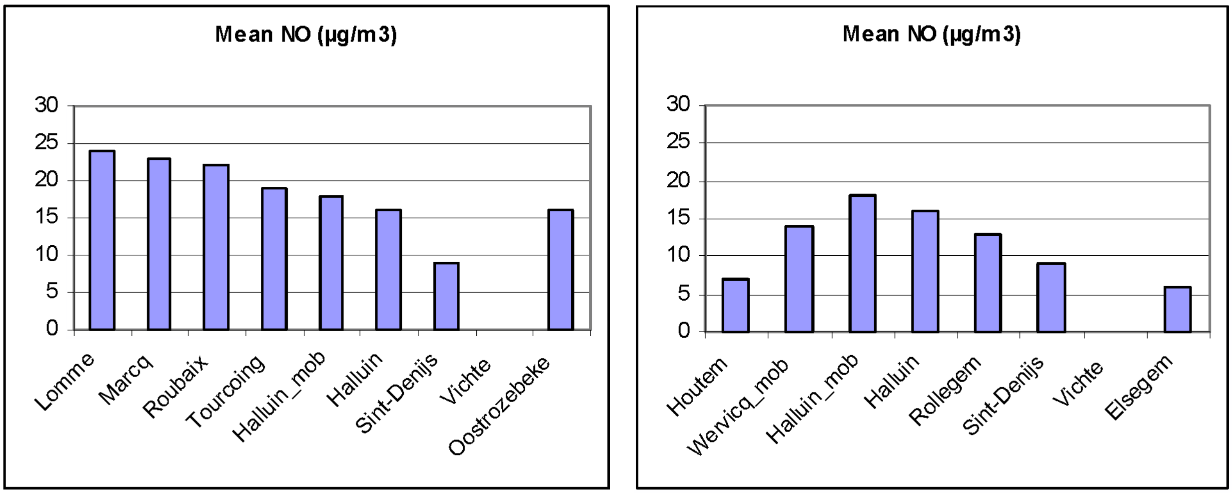


Figure 4.13.: Mean values of NO from south to north (left) and from west to east (right) in winter

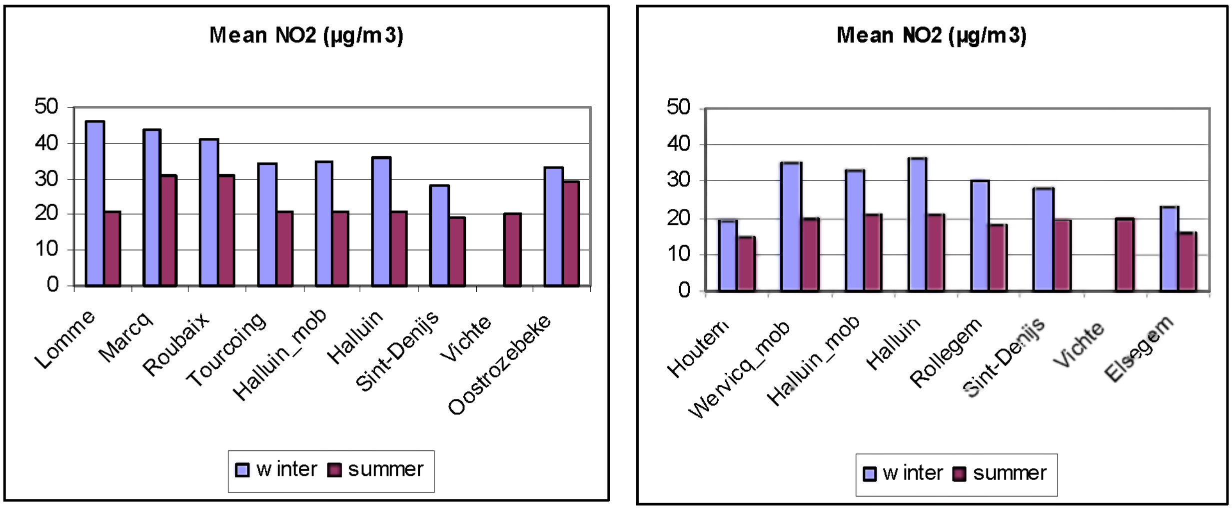


Figure 4.14.: Mean values of NO_2 from south to north (left) and from west to east (right) in winter

The future hourly limit value of 200 µg/m^3 for the protection of health (1999/30/EC) for NO_2 is not exceeded during the measurement campaign. The annual limit value for the protection of health (40 µg/m^3 for NO_2) is exceeded during the winter campaign in the urban stations of Roubaix, Marcq and Lomme.

4 Ozone (O_3)

The area around the agglomeration of Lille is monitored by 6 fixed stations. Four of them (Marcq, Roubaix, Lomme and Tourcoing) have an urban environment and two (Halluin and Armentières) have a suburban environment. In Flanders the nearest stations are situated in Sint-Denijs and Roeselare. One station is situated in Houtem in a rural area.

The plots of the hourly values (annex 1) in winter and summer show a good agreement between the curves of the different stations. We observe very well the daily rhythm of appearance and disappearance of ozone.

In winter, there are a few days without ozone (20th and 21st December) what correspond to high levels of nitrogen oxides. At these moments high atmospheric pressure and low winds prevail which limit the dispersion of pollutants. At the opposite, the levels of ozone can be as high as 80 µg/m^3 during days with important wind speed. In detail, we observe that high levels of ozone can occur during the night when the photochemical reactions do not exist. At that time, the ozone is stratospheric ozone, which arrives under the effect of the wind. This phenomenon can lead to the exceedance of the daily threshold of 65 µg/m^3. It is what happened on 2nd January in Houtem (70 µg/m^3). This is the only station where an exceedance in winter is observed. Ozone levels can be higher in rural areas than urban areas. We observe this also on the plot showing the daily maximum hourly values where the data from Houtem are often higher than the others.

In summer, the maximum levels reach 215 µg/m^3 in Armentières and 213 µg/m^3 in Roubaix on 15th July. In Flanders, we obtained 210 µg/m^3 in Houtem and 209 µg/m^3 in Sint-Denijs on the same day. This day the highest levels are obtained over the Euroregion. Most of the stations exceeded the hourly threshold (180 µg/m^3) on 15th July. The plot on figure 4.15. indicates that the maximum hourly values on this day are quite identical, except for Halluin_mob and Roeselare. This is difficult to explain. For this episode of pollution, we do not observe any difference between the urban stations and the rural stations.

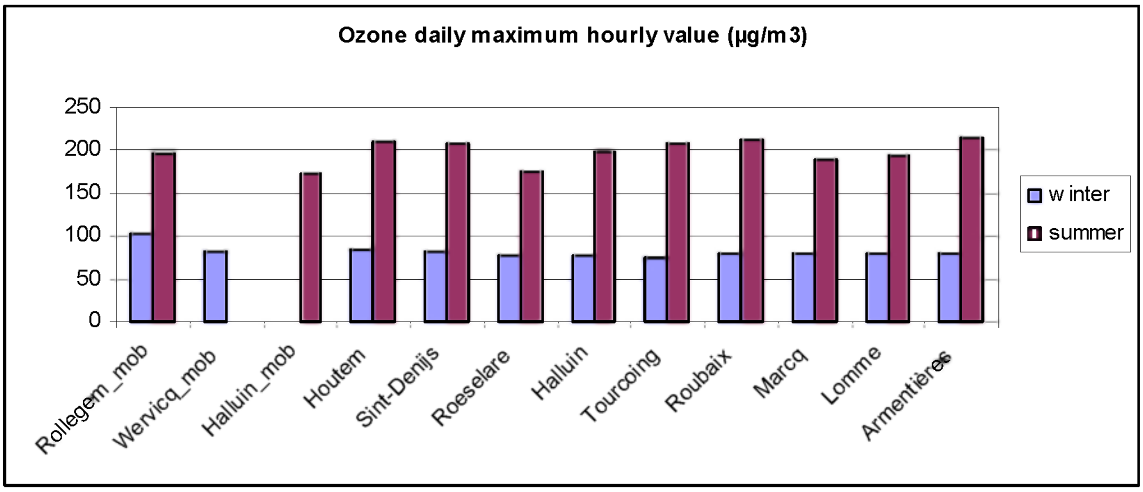


Figure 4.15.: Comparison of the daily maximum hourly values of ozone
(The value from Wervicq_mob for the summer campaign is not indicated on the plot because the mobile station has gone away on 15th July)

Table 4.12.: Mean and maximum hourly values for O_3

	Rollegem_mob	**Wervic_ob**	**Halluin_ob**	**Houtem**	**Sint-Denijs**	**Roeselare**	**Halluin**	**Tourcoing**	**Roubaix**	**Marcq**	**Lomme**	**Armentières**
mean winter	27	25	-	36	29	25	23	20	21	21	23	23
max winter	102 30/12	82 01/01	-	83 01/01	82 01/01	78 01/01	77 01/01	74 01/01 en 02/01	79 01/01 en 02/01	80 01/01 en 02/01	80 01/01	80 01/01
mean summer	62	72	64	63	70	59	60	69	-	58	70	64
max summer	197 15/07	167* 14/07	173 15/07	210 15/07	209 15/07	176 15/07	199 15/07	207 15/07	213 15/07	190 15/07	193 15/07	215 15/07

* The mobile station has gone away on 15th July which is the day where the highest values where recorded

To evaluate the dispersion of ozone and the influence of Lille agglomeration, we compare the mean value of the stations in winter and summer on figure 4.16. It indicates that they are about two groups of stations depending on the season.

In winter, the levels are higher on the more rural stations (Rollegem, Wervicq_mob, Houtem, Sint-Denijs, Roeselare, Halluin, Armentières) than on the urban stations. This is due to the fact that the concentrations of nitrogen oxides are more important in the urban area so more ozone is consumed. Houtem, which is farther from the agglomeration of Lille presents the highest mean value.

In summer, the highest mean values are obtained on the urban stations Lomme and Tourcoing and in Sint-Denijs and Wervicq.

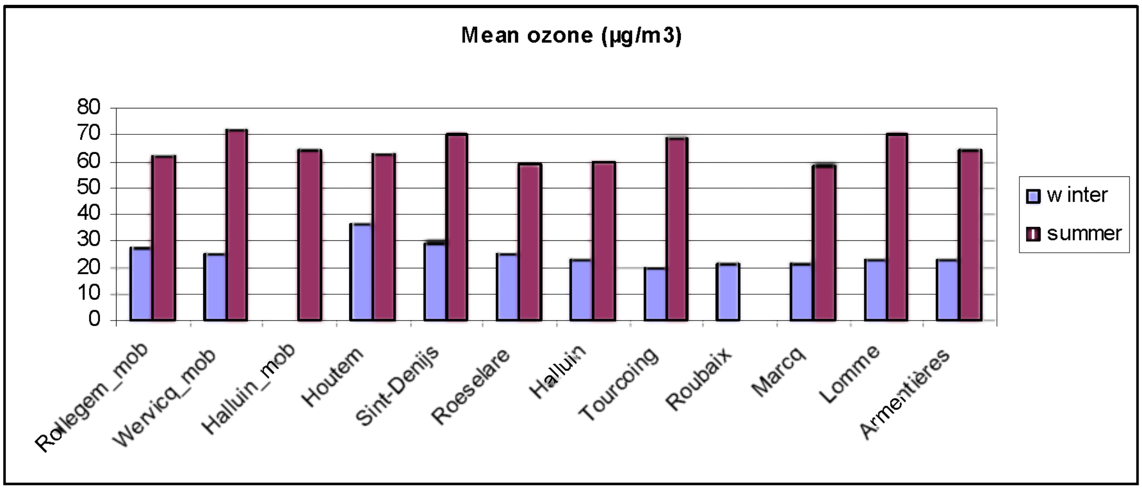


Figure 4.16.: Comparison of the mean values of ozone

When we have a look at the pollution roses of the summer campaign (annex 2), we observe that the higher concentrations are recorded when the wind comes from he north-east to east. This often corresponds to an anticyclonic period with high pressure and weak wind.

5 Carbon monoxide (CO)

CO is discussed for the mobile stations at Wervicq, Halluin and Rollegem. The CO concentration is higher in winter than in summer. In the winter the highest CO concentration is measured at Halluin. In summer the concentrations at Wervicq and Halluin are almost the same and higher than in Rollegem.

Table 4.13.: Mean and maximum hourly values for CO (mg/m^3)

	Rollegem_mob	Wervicq_mob	Halluin_mob
mean winter	0.48	0.61	0
max winter	2.39 12/01	2.24 21/12	3.38 12/01
mean summer	0.24	0.37	0.36
max summer	0.73 26/06	1.07 7/07	1.02 07/07

When we have a look at the evolution of the hourly data (annex 1) we distinguish again 2 periods with higher CO concentration: 20th December to 21st December and 10th January to 12th January.

Figure 4.17. shows the daily profile of CO during the winter and summer campaign. During the winter on the 3 locations the CO concentration increases from 6:00 UT due to the building heating and the morning traffic. In Halluin the morning peak is higher and wider. In the late afternoon the concentration increases again due to the evening traffic. This is also more dominant at Halluin. In the

nighttime the CO concentration stays high. In the summer the CO concentration is low. Only in the morning we see a slight increase due to the traffic. After the traffic peak in the morning the concentration decreases and stays low during the rest of the day.

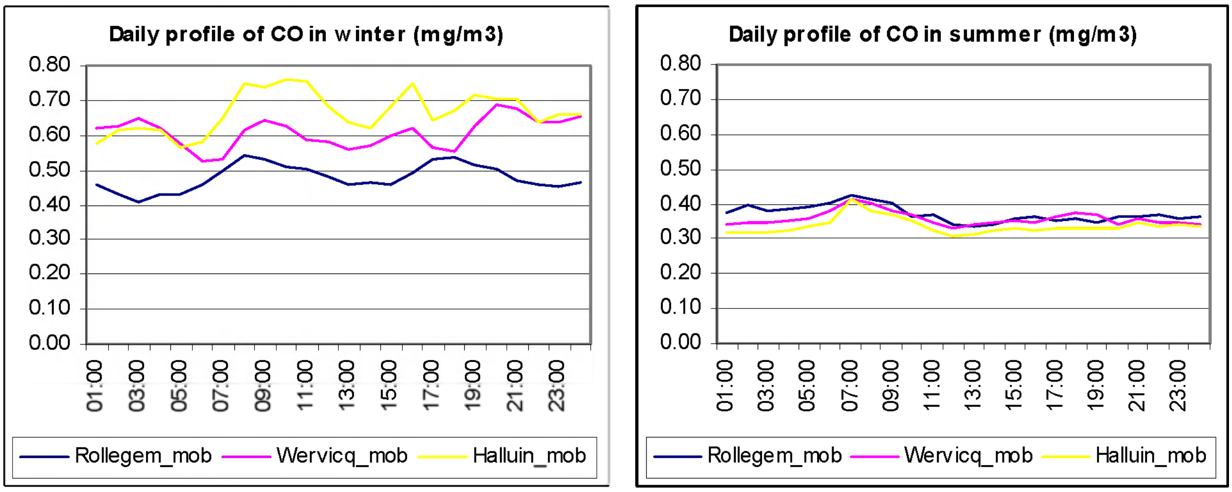


Figure 4.17.: Daily profile of CO during the winter and summer campaign

The future limit value for the protection of health of 10 mg/m^3 as a maximum daily 8-hour mean (1999/30/EC) is not exceeded during the measurement campaign.

6 Heavy metals

AREMA LM collected PM10 on quartz filters for one week each time with a flow of 1 m^3/h. The filters were exposed from 0:00 UT until 0:00 UT 7 days later. A sample of 168 m^3 passed through the filter. VMM collected both PM10 and PM2.5 on cellulosenitrate filters with a flow of 2.3 m^3/h. The filters were exposed from 0:00 UT until 0:00 UT the next day, so a sample of 55.2 m^3 passed through the filter.

During the winter campaign and more specifically during the weeks of 18th to 24th December 2002 and 8th to 14th January 2003, increased concentrations were measured in Wervicq and Halluin. Around this period, we also see an increase in the concentrations found in Rollegem and Menen both in PM10 and PM2.5. During the summer campaign there are no real periods of increased concentrations. Relative high values for arsenic were found on 3rd July 2003 at Rollegem, both in PM2.5 and PM10. A high value for cadmium was found on 22nd July 2003 at Rollegem also both in PM2.5 and PM10.

During the winter campaign the concentrations are higher in Wervicq than in Halluin, except for copper. During the summer campaign the concentrations are more similar between Wervicq and Halluin, except for nickel which is higher in Wervicq.

The concentrations measured in PM10 and PM2.5 in Menen during the winter campaign are higher than those measured in Rollegem, except for arsenic, cadmium, nickel, lead and antimony, which are very similar. For PM2.5 also the concentrations for zinc are similar. During the summer campaign concentrations in PM10 are also higher in Menen than in Rollegem, except for arsenic, copper and zinc which are very similar. Cadmium is higher in Rollegem. For PM2.5 only the concentration for manganese is higher in Menen. The concentrations for cadmium and zinc are higher in Rollegem.

Using different analysing methods the detection limits for VMM and AREMA LM differ. Therefore comparisons between the measurement locations in Flanders and France for the results for arsenic, cadmium and copper for the winter campaign and arsenic, cadmium and nickel for the summer campaign are difficult to make. During the winter campaign measurements for nickel, lead and zinc are higher in Menen and Rollegem than those measured in Wervicq and Halluin. During the summer campaign the same goes for lead and zinc, the measurements for copper are similar.

In table 4.24. an overview of the concentrations of heavy metals in PM10 and PM2.5 is given for Rollegem and Menen. For most heavy metals the ratio concentration in PM2.5 versus concentration in PM10 is lower or similar in summer compared to winter except for lead.

The mean values for lead in PM10 for the different measurement campaigns were lower than the limit value (500 ng/m^3 as a yearly average). The mean values for arsenic, cadmium and nickel in PM10 for the different measurement campaigns are also lower than the respective target values (6 ng/m^3 for arsenic, 5 ng/m^3 for cadmium and 20 ng/m^3 for nickel as a yearly average).

Table 4.14.: Heavy metals in PM10 at Wervicq and Halluin during the winter campaign

Period	Site	Pb ng/m^3	Zn ng/m^3	Cu ng/m^3	Ni ng/m^3	As ng/m^3	Cd ng/m^3
18/12 to 24/12	Wervicq	85	160	12	4.2	1.9	3.6
25/12 to 31/12		38	54	< 2	1.8	< 1	1.8
01/01 to 07/01		19	31	6.1	2.2	<1	0.3
08/01 to 14/01		66	130	9.2	5.7	1.6	1.1
15/01 to 21/01		30	58	2.3	5.0	< 1	1.1
18/12 to 24/12	Halluin	57	130	15	3.1	1.3	1.8
25/12 to 31/12		20	36	7.2	1.6	< 1	0.7
01/01 to 07/01		17	25	4.2	2	< 1	0.3
08/01 to 14/01		52	100	16	6.7	1.7	0.7
15/01 to 21/01		16	28	< 2	2.8	< 1	0.9

Table 4.15.: Heavy metals in PM2.5 at Rollegem during the winter campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
15/12/2002	11	58	7	2	1	5	5	1	3
16/12/2002	23	58	7	7	2	5	4	1	3
17/12/2002	29	68	7	10	2	5	5	1	3
18/12/2002	54	83	7	8	6	5	5	2	3
19/12/2002	42	155	7	9	3	5	14	1	7
20/12/2002	183	281	7	8	4	5	8	4	3
21/12/2002	55	66	7	6	3	5	4	2	3
22/12/2002	10	38	7	6	1	5	11	1	3
23/12/2002	29	52	7	6	2	5	6	1	3
24/12/2002	34	66	7	6	1	5	1	1	3
25/12/2002	12	29	7	7	1	5	1	1	3
26/12/2002	11	32	7	2	1	5	1	1	3
27/12/2002	36	41	7	6	2	5	1	1	3
28/12/2002	29	56	7	7	9	5	5	1	3
29/12/2002	11	32	7	6	1	5	1	1	3
30/12/2002	8	33	7	2	1	5	1	1	3
31/12/2002	4	28	7	6	2	5	1	1	3
01/01/2003	16	36	7	2	1	5	1	1	3
02/01/2003	4	38	7	2	1	5	1	1	3
03/01/2003	28	46	7	7	1	5	1	1	3
04/01/2003	16	36	7	8	1	5	1	1	3
05/01/2003	86	100	7	9	3	5	8	2	3
06/01/2003	35	61	7	7	2	5	1	1	3
07/01/2003	17	54	7	7	2	5	3	1	3
08/01/2003	34	99	7	9	3	5	12	1	3
09/01/2003	59	135	7	11	5	5	10	1	3
10/01/2003	131	224	7	13	5	5	20	1	10
11/01/2003	100	169	7	11	11	5	10	1	3
12/01/2003	233	239	21	13	12	5	8	3	6
13/01/2003	4	43	7	8	11	5	4	1	3
14/01/2003	27	56	7	7	6	5	3	1	3
15/01/2003	146	150	7	8	3	5	1	4	3
16/01/2003	22	71	7	9	2	5	11	1	6
17/01/2003	31	45	7	2	2	5	1	1	3
18/01/2003	49	63	7	6	2	5	1	1	3
19/01/2003	21	69	7	7	1	5	1	1	3
20/01/2003	9	42	7	2	1	5	1	1	3
21/01/2003	4	28	7	6	1	5	1	1	3

22/01/2003	51	75	7	6	3	5	4	4	3
23/01/2003	9	52	7	7	1	5	1	1	3
24/01/2003	52	108	7	6	4	5	5	2	6
25/01/2003	88	126	7	9	4	5	4	3	3
26/01/2003	18	43	7	8	2	5	6	1	3
27/01/2003	18	48	7	9	2	5	7	1	6
28/01/2003	37	54	7	2	4	5	5	1	3
29/01/2003	17	68	7	6	8	5	1	1	3
30/01/2003	19	51	7	2	1	5	4	1	3
31/01/2003	48	97	7	7	2	5	10	1	3
Mean	**42**	**77**	**7**	**7**	**3**	**5**	**5**	**1**	**3**
Minimum	**4**	**28**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**233**	**281**	**21**	**13**	**12**	**5**	**20**	**4**	**10**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 4.16.: Heavy metals in PM10 at Rollegem during the winter campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
15/12/2002	4	67	7	7	1	5	15	1	3
16/12/2002	25	67	7	9	3	5	10	1	3
17/12/2002	34	79	7	10	2	5	11	1	3
18/12/2002	63	102	7	9	7	5	11	1	3
19/12/2002	48	191	7	11	4	5	26	1	10
20/12/2002	271	386	17	9	6	5	16	5	7
21/12/2002	82	85	7	6	4	5	5	2	3
22/12/2002	9	44	7	2	2	5	16	1	3
23/12/2002	44	78	7	7	3	5	10	2	3
24/12/2002	55	106	7	7	2	5	3	2	3
25/12/2002	17	41	7	6	2	5	1	1	3
26/12/2002	26	54	7	6	1	5	1	1	3
27/12/2002	40	48	7	2	2	5	3	1	3
28/12/2002	29	64	7	7	9	5	8	1	3
29/12/2002	17	44	7	2	1	5	1	1	3
30/12/2002	13	37	7	2	1	5	1	1	3
31/12/2002	4	30	7	8	4	5	1	1	3
01/01/2003	33	62	7	6	1	5	1	1	3
02/01/2003	9	47	7	6	1	5	1	1	3
03/01/2003	31	55	7	8	2	5	9	1	3
04/01/2003	20	40	7	10	1	5	4	1	3
05/01/2003	103	127	7	12	4	5	25	3	3
06/01/2003	53	86	7	9	3	5	6	1	3
07/01/2003	22	63	7	9	3	5	7	1	3
08/01/2003	37	129	15	13	4	5	21	1	11
09/01/2003	69	168	28	14	6	5	22	1	7
10/01/2003	178	296	20	17	7	5	39	2	16
11/01/2003	110	196	21	13	12	5	23	1	7
12/01/2003	352	446	41	16	15	5	17	7	8
13/01/2003	12	54	7	10	11	5	8	1	6
14/01/2003	33	68	7	8	7	5	6	1	3
15/01/2003	295	307	7	6	4	5	6	8	3
16/01/2003	27	97	7	9	3	5	16	1	10
17/01/2003	47	65	7	7	2	5	1	1	3
18/01/2003	70	64	7	6	2	5	1	1	3
19/01/2003	41	92	7	2	1	5	1	1	3
20/01/2003	17	54	7	2	1	5	1	1	3
21/01/2003	4	31	7	2	1	5	1	1	3
22/01/2003	87	100	7	2	4	5	8	6	3
23/01/2003	14	59	7	7	2	5	5	1	3
24/01/2003	91	151	16	12	7	5	17	2	10
25/01/2003	166	183	7	7	9	5	9	7	3
26/01/2003	24	50	7	8	2	5	11	1	3
27/01/2003	23	60	7	11	3	5	18	1	7
28/01/2003	43	62	7	2	4	5	9	1	3
29/01/2003	22	72	7	2	8	5	6	1	3

30/01/2003	66	112	7	10	3	5	30	1	3
31/01/2003	27	57	7	7	1	5	13	1	3
Mean	**61**	**104**	**9**	**8**	**4**	**5**	**10**	**2**	**4**
Minimum	**4**	**30**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**352**	**446**	**41**	**17**	**15**	**5**	**39**	**8**	**16**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³

(Values below the detection limit (DL) are archived as DL/2)

Table 4.17.: Heavy metals in PM2.5 at Menen during the winter campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
15/12/2002	10	68	7	7	2	5	13	1	3
16/12/2002	18	49	7	7	2	5	9	1	3
17/12/2002	47	90	7	9	3	5	12	1	3
18/12/2002	85	126	19	10	9	5	22	1	8
19/12/2002	61	237	29	11	5	5	29	1	12
20/12/2002	187	271	22	13	7	5	29	4	10
21/12/2002	139	131	15	7	5	5	4	3	3
22/12/2002	4	24	15	6	2	5	10	1	3
23/12/2002	44	50	7	7	2	5	8	1	3
24/12/2002	48	91	7	7	2	5	1	1	3
25/12/2002	49	61	7	7	1	5	1	3	3
26/12/2002	17	36	7	7	1	5	1	1	3
27/12/2002	53	62	7	2	4	5	1	2	3
28/12/2002	10	32	7	2	1	5	4	1	3
29/12/2002	4	28	7	2	1	5	1	1	3
30/12/2002	4	24	7	7	1	5	1	1	3
31/12/2002	10	26	7	7	2	5	1	1	3
01/01/2003	16	33	7	2	1	5	1	1	3
02/01/2003	4	25	7	6	1	5	1	1	3
03/01/2003	11	34	7	7	1	5	1	1	3
04/01/2003	18	41	7	7	2	5	3	1	3
05/01/2003	36	53	7	8	2	5	5	1	3
06/01/2003	48	69	7	9	3	5	9	1	3
07/01/2003	33	60	7	7	2	5	6	1	3
08/01/2003	67	136	7	9	6	5	15	1	3
09/01/2003	88	113	7	13	4	5	17	1	3
10/01/2003	143	270	7	14	5	5	23	4	13
11/01/2003	82	115	7	12	5	5	11	1	3
12/01/2003	67	131	7	12	4	5	13	1	7
13/01/2003	4	69	7	9	7	5	7	1	3
14/01/2003	4	42	7	7	2	5	7	1	3
15/01/2003	23	130	16	8	2	5	50	1	3
16/01/2003	15	73	7	9	3	5	21	1	10
17/01/2003	153	130	7	8	4	5	6	4	3
18/01/2003	21	92	32	2	3	5	1	1	3
19/01/2003	4	37	7	2	1	5	7	1	3
20/01/2003	38	81	7	2	2	5	11	1	3
21/01/2003	34	80	7	7	1	5	1	2	3
22/01/2003	16	56	7	6	2	5	7	1	3
23/01/2003	4	28	7	6	1	5	3	1	3
24/01/2003	31	86	7	9	4	5	15	1	3
25/01/2003	45	94	7	8	3	5	6	1	3
26/01/2003	11	46	7	8	1	5	7	1	3
27/01/2003	40	44	7	9	1	5	8	1	3
28/01/2003	77	50	7	2	1	5	3	1	3
29/01/2003	24	33	7	2	1	5	1	1	3
Mean	**42**	**80**	**9**	**7**	**3**	**5**	**9**	**1**	**4**
Minimum	**4**	**24**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**187**	**271**	**32**	**14**	**9**	**5**	**50**	**4**	**13**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³

(Values below the detection limit (DL) are archived as DL/2)

Table 4.18.: Heavy metals in PM10 at Menen during the winter campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
15/12/2002	15	68	7	10	2	5	12	1	3
16/12/2002	21	58	7	7	2	5	11	1	3
17/12/2002	49	99	7	9	3	5	12	1	3
18/12/2002	94	131	21	11	9	5	23	1	10
19/12/2002	62	241	29	10	5	5	28	1	12
20/12/2002	227	327	41	13	4	5	35	1	13
21/12/2002	169	166	8	8	8	5	8	4	3
22/12/2002	10	33	7	7	2	5	13	1	3
23/12/2002	56	69	7	9	3	5	11	1	3
24/12/2002	63	161	7	6	3	5	4	2	3
25/12/2002	97	147	7	2	2	5	1	3	3
26/12/2002	31	61	7	7	1	5	1	1	3
27/12/2002	77	108	7	6	5	5	1	2	3
28/12/2002	9	40	7	7	2	5	7	1	3
29/12/2002	4	28	7	2	1	5	1	1	3
30/12/2002	4	26	7	7	1	5	1	1	3
31/12/2002	13	29	7	7	4	5	3	1	3
01/01/2003	27	50	7	6	1	5	1	1	3
02/01/2003	13	33	7	6	1	5	3	1	3
03/01/2003	9	39	7	6	2	5	9	1	3
04/01/2003	22	43	7	9	2	5	6	1	3
05/01/2003	44	57	7	9	3	5	9	1	3
06/01/2003	55	81	7	9	3	5	19	1	3
07/01/2003	36	78	7	9	3	5	14	1	3
08/01/2003	83	183	7	11	11	5	29	1	13
09/01/2003	152	141	7	18	6	5	38	1	8
10/01/2003	267	461	68	24	7	5	60	9	22
11/01/2003	84	133	7	12	8	5	20	1	6
12/01/2003	70	170	26	10	5	5	16	1	14
13/01/2003	11	77	7	10	9	5	13	1	3
14/01/2003	11	50	7	8	3	5	9	1	6
15/01/2003	188	658	132	14	3	5	351	1	14
16/01/2003	27	112	7	10	4	5	32	1	14
17/01/2003	278	255	24	9	5	5	16	6	8
18/01/2003	25	104	35	6	3	5	4	1	3
19/01/2003	13	46	7	2	1	5	9	1	3
20/01/2003	91	150	8	10	3	5	21	1	9
21/01/2003	107	208	25	12	2	5	11	2	10
22/01/2003	27	86	7	9	3	5	15	2	3
23/01/2003	4	35	7	8	1	5	6	1	3
24/01/2003	73	177	53	13	6	5	47	2	12
25/01/2003	63	121	7	8	4	5	14	1	6
26/01/2003	23	55	7	8	2	5	12	1	3
27/01/2003	46	51	7	9	2	5	23	1	3
28/01/2003	89	61	7	2	1	5	11	1	3
29/01/2003	24	35	7	2	1	5	1	1	3
Mean	**64**	**120**	**15**	**9**	**4**	**5**	**22**	**2**	**6**
Minimum	**4**	**26**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**278**	**658**	**132**	**24**	**11**	**5**	**351**	**9**	**22**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 4.19.: Heavy metals in PM10 at Wervicq and Halluin during the summer campaign

Period	Site	Pb ng/m^3	Zn ng/m^3	Cu ng/m^3	Ni ng/m^3	As ng/m^3	Cd ng/m^3
14/06 to 16/06	Wervicq	14	45	24	4.4	< 1	0.2
17/06 to 19/06		26	42	22	4.3	1.2	0.4
17/06 to 19/06		16	57	29	8.4	1.0	0.2
23/06 to 29/06		19	48	15	4.0	1.0	0.4
30/06 to 06/07		10	30	14	2.5	<1	0.3

07/07 to 13/07		20	45	13	4.9	1.0	0.2
23/06 to 29/06	Halluin	18	50	15	3.5	1.0	0.3
30/06 to 06/07		14	40	16	2.2	< 1	0.3
07/07 to 13/07		22	48	15	3.0	< 1	0.3

Table 4.20.: Heavy metals in PM2.5 at Rollegem during the summer campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
21/06/2003	29	59	7	2	1	5	4	1	3
22/06/2003	34	109	7	2	2	5	6	1	3
23/06/2003	21	50	7	2	1	5	4	1	3
24/06/2003	35	29	17	2	1	5	4	1	3
25/06/2003	20	29	7	2	2	5	1	1	3
26/06/2003	53	91	18	2	2	5	10	1	3
27/06/2003	32	37	7	5	2	5	1	1	3
28/06/2003	26	45	7	2	2	5	4	1	3
29/06/2003	26	46	7	2	2	5	3	1	3
30/06/2003	25	41	7	2	1	5	1	1	3
01/07/2003	16	22	7	2	1	5	1	1	3
02/07/2003	28	33	7	2	1	5	3	1	3
03/07/2003	51	100	7	2	3	12	8	1	3
04/07/2003	40	132	7	2	4	5	5	2	3
05/07/2003	19	25	7	2	1	5	1	1	3
06/07/2003	19	22	7	2	1	5	1	1	3
07/07/2003	39	61	7	2	2	5	3	1	5
08/07/2003	30	66	7	2	2	5	9	1	3
09/07/2003	38	45	7	2	2	5	9	1	3
10/07/2003	26	56	7	2	2	5	5	1	3
11/07/2003	29	57	7	2	1	5	5	1	3
12/07/2003	33	39	7	2	1	5	3	1	3
13/07/2003	22	34	7	2	1	5	1	1	3
14/07/2003	19	24	7	2	1	5	1	1	3
15/07/2003	35	113	7	2	2	5	8	1	3
16/07/2003	32	78	7	2	5	5	7	1	3
17/07/2003	14	14	7	2	1	5	1	1	3
18/07/2003	21	34	25	2	1	5	1	1	3
19/07/2003	19	32	7	2	1	5	3	1	3
20/07/2003	23	34	7	2	1	5	5	1	3
21/07/2003	23	60	7	2	1	5	1	1	3
22/07/2003	30	41	20	5	2	5	1	34	3
23/07/2003	43	95	17	2	3	5	1	1	3
Mean	**29**	**53**	**9**	**2**	**2**	**5**	**4**	**2**	**3**
Minimum	**14**	**14**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**53**	**132**	**25**	**5**	**5**	**12**	**10**	**34**	**5**

Detection limit: Pb: 7 ng/m^3 - Zn: 3 ng/m^3 - Cu: 14 ng/m^3 - Ni: 5 ng/m^3 - Sb: 1 ng/m^3 - As: 9 ng/m^3 - Mn: 3 ng/m^3 - Cd: 1 ng/m^3 - Cr: 5 ng/m^3

(Values below the detection limit (DL) are archived as DL/2)

Table 4.21.: Heavy metals in PM10 at Rollegem during the summer campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
21/06/2003	32	86	7	2	2	5	12	1	3
22/06/2003	38	154	7	5	3	5	15	1	7
23/06/2003	24	65	7	2	1	5	10	1	6
24/06/2003	35	40	23	2	1	5	14	1	5
25/06/2003	20	42	19	2	3	5	7	1	3
26/06/2003	53	118	28	2	3	5	33	1	7
27/06/2003	38	58	7	7	3	5	10	1	6
28/06/2003	31	67	7	5	2	5	12	1	7

29/06/2003	27	86	22	2	3	5	12	1	3
30/06/2003	28	58	15	2	3	5	9	1	6
01/07/2003	19	34	7	2	2	5	5	1	3
02/07/2003	36	47	15	2	2	5	12	1	3
03/07/2003	56	130	22	2	3	10	25	1	6
04/07/2003	51	162	21	2	6	5	15	3	7
05/07/2003	28	36	7	2	1	5	8	1	3
06/07/2003	25	27	7	2	2	5	4	1	3
07/07/2003	40	77	17	5	3	5	8	1	7
08/07/2003	40	91	7	5	2	5	33	1	8
09/07/2003	49	66	34	2	3	5	23	1	3
10/07/2003	30	86	23	2	3	5	14	1	6
11/07/2003	34	93	7	2	2	5	16	1	7
12/07/2003	47	50	7	2	2	5	8	1	3
13/07/2003	25	51	7	2	2	5	8	1	3
14/07/2003	22	39	16	2	2	5	12	1	7
15/07/2003	45	160	20	2	2	5	21	1	8
16/07/2003	49	131	40	2	5	5	26	1	7
17/07/2003	14	24	17	2	2	5	4	1	3
18/07/2003	21	54	16	2	2	5	8	1	3
19/07/2003	23	49	7	2	1	5	12	1	3
20/07/2003	20	46	7	2	1	5	15	1	3
21/07/2003	25	88	7	2	2	5	12	1	6
22/07/2003	32	43	16	2	2	5	5	35	3
23/07/2003	46	109	17	2	4	5	9	1	3
Mean	**33**	**75**	**15**	**3**	**2**	**5**	**13**	**2**	**5**
Minimum	**14**	**24**	**7**	**2**	**1**	**5**	**4**	**1**	**3**
Maximum	**56**	**162**	**40**	**7**	**6**	**10**	**33**	**35**	**8**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³

(Values below the detection limit (DL) are archived as DL/2)

Table 4.22.: Heavy metals in PM2.5 at Menen during the summer campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
21/06/2003	31	31	7	2	3	5	4	1	3
22/06/2003	37	98	15	2	2	5	6	1	3
23/06/2003	27	62	7	2	1	5	5	1	6
24/06/2003	19	18	7	2	1	5	3	1	3
25/06/2003	33	40	7	2	2	5	4	1	3
26/06/2003	31	49	7	2	2	5	9	1	3
27/06/2003	25	34	7	6	1	5	4	1	6
28/06/2003	19	23	7	2	1	5	4	1	3
29/06/2003	42	62	7	2	2	5	4	1	3
30/06/2003	29	45	7	2	2	5	5	1	3
01/07/2003	39	60	16	2	2	5	6	1	6
02/07/2003	20	20	7	2	1	5	4	1	3
03/07/2003	26	30	7	2	1	5	7	1	3
04/07/2003	31	36	7	5	2	5	5	1	3
05/07/2003	20	26	7	2	1	5	1	1	3
06/07/2003	26	21	7	2	1	5	1	1	3
07/07/2003	27	25	7	2	1	5	7	1	6
08/07/2003	27	28	7	2	1	5	5	1	3
09/07/2003	34	30	7	2	2	5	7	1	3
10/07/2003	28	44	7	2	3	5	8	1	3
11/07/2003	28	59	7	2	2	5	5	1	6
12/07/2003	48	62	7	2	2	5	4	1	3
13/07/2003	59	79	7	2	2	5	5	1	3
14/07/2003	26	36	7	2	1	5	4	1	3
15/07/2003									
16/07/2003	42	73	7	2	4	5	8	1	3
17/07/2003	20	20	7	2	1	5	5	1	3
18/07/2003	30	42	17	2	3	5	4	1	3

19/07/2003	25	41	7	2	2	5	4	1	3
20/07/2003	22	30	7	2	1	5	6	1	3
21/07/2003	22	37	7	2	1	5	3	1	3
22/07/2003	13	12	7	2	1	5	1	1	3
23/07/2003	18	16	7	2	1	5	1	1	3
Mean	**29**	**40**	**8**	**2**	**2**	**5**	**5**	**1**	**3**
Minimum	**13**	**12**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**59**	**98**	**17**	**6**	**4**	**5**	**9**	**1**	**6**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 4.23.: Heavy metals in PM10 at Menen during the summer campaign

Datum	Pb ng/m3	Zn ng/m3	Cu ng/m3	Ni ng/m3	Sb ng/m3	As ng/m3	Mn ng/m3	Cd ng/m3	Cr ng/m3
21/06/2003	39	61	30	2	5	5	9	1	3
22/06/2003	46	145	22	16	3	5	15	1	6
23/06/2003	43	129	17	2	2	5	14	1	8
24/06/2003	24	26	7	2	1	5	7	1	3
25/06/2003	42	57	20	6	4	5	12	1	3
26/06/2003	38	77	22	5	4	5	36	1	9
27/06/2003	28	65	7	8	2	5	10	1	9
28/06/2003	25	42	7	5	2	5	13	1	6
29/06/2003	55	93	18	5	3	5	14	1	6
30/06/2003	46	71	21	2	3	5	13	1	6
01/07/2003	86	182	51	7	3	5	24	1	10
02/07/2003	19	33	7	2	1	5	12	1	6
03/07/2003	22	46	7	2	2	5	21	1	5
04/07/2003	34	56	7	2	2	5	18	1	3
05/07/2003	27	36	7	2	2	5	6	1	6
06/07/2003	26	29	16	2	2	5	6	1	3
07/07/2003	36	42	7	5	2	5	24	1	6
08/07/2003	32	48	7	5	2	5	14	1	8
09/07/2003	49	69	19	5	3	5	19	1	6
10/07/2003	52	96	26	5	4	5	23	1	7
11/07/2003	30	96	7	5	2	5	17	1	8
12/07/2003	55	70	7	2	3	5	15	1	5
13/07/2003	66	100	7	2	3	5	14	1	3
14/07/2003	32	60	15	2	2	5	12	1	6
15/07/2003	-	-	-	-	-	-	-	-	-
16/07/2003	82	153	25	5	4	5	31	1	8
17/07/2003	31	38	7	2	2	5	7	1	3
18/07/2003	60	74	22	2	3	5	14	1	6
19/07/2003	29	67	15	2	3	5	12	1	3
20/07/2003	23	48	7	5	2	5	17	1	3
21/07/2003	35	67	7	2	2	5	10	1	6
22/07/2003	18	17	7	2	1	5	5	1	3
23/07/2003	28	25	7	2	1	5	7	1	3
Mean	**39**	**69**	**14**	**4**	**3**	**5**	**15**	**1**	**6**
Minimum	**4**	**17**	**7**	**2**	**1**	**5**	**1**	**1**	**3**
Maximum	**86**	**182**	**51**	**16**	**5**	**5**	**36**	**1**	**10**

Detection limit: Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 4.24.: Overview of the concentrations of heavy metals in PM10 and PM2.5

	Pb ng/m³	Zn ng/m³	Cu ng/m³	Ni ng/m³	Sb ng/m³	As ng/m³	Mn ng/m³	Cd ng/m³	Cr ng/m³
Rollegem 15-12-02 till 31-01-03									
Average PM10	61	104	9	8	4	5	10	2	4
Average PM2.5	42	77	7	7	3	5	5	1	3
% PM2.5/PM10	**68.9**	**74.0**	**77.8**	**87.5**	**75.0**	**100.0**	**50.0**	**50.0**	**75.0**

Menen 15-12-02 till 29-01-03									
Average PM10	64	120	15	9	4	5	22	2	6
Average PM2.5	42	80	9	7	3	5	9	1	4
% PM2.5/PM10	**65.6**	**66.7**	**60.0**	**77.8**	**75.0**	**100.0**	**40.9**	**50.0**	**66.7**
Rollegem 21-06-03 till 23-07-03									
Average PM10	33	75	15	3	2	5	13	2	5
Average PM2.5	29	53	9	2	2	5	4	2	3
% PM2.5/PM10	**87.9**	**70.7**	**60.0**	**66.7**	**100**	**100.0**	**30.8**	**100**	**60.0**
Menen21-06-03 till 23-07-03									
Average PM10	39	69	14	4	3	5	15	1	6
Average PM2.5	29	40	8	2	2	5	5	1	3
% PM2.5/PM10	**74.4**	**58.0**	**57.1**	**50.0**	**66.7**	**100.0**	**33.3**	**100**	**50.0**

7 VOC

The VMM only measured VOC at Rollegem during the winter campaign. VOC were measured with an automatic BTEX-monitor. The monitor gives each half-hour the concentration of benzene, toluene, ethylbenzene, xylene isomers, C3-alkylbenzene isomers, C4-alkylbenzene isomers and naftalene.

The daily averages are given in table 4.25.. To compare the results at Rollegem with other places the results for January for 8 other locations in Flanders are also given in table 4.26.. We see that the concentrations in Rollegem are comparable with the rest of Flanders. At the urban station of Borgerhout the concentration of benzene, toluene and C3-benzene is much higher. Higher concentrations are recorded when the wind comes form east to south-east. This is probably due to a local source.

Of all components measured only for benzene a regulation on European level is determined. The limit value for the yearly average in ambient air is determined at 5 µg/m^3. The limit value must be obtained by the member states in 2010 at the latest. In Flanders, this limit value comes into operation in 2005. This value, determined to protect public health, was not exceeded during this measurement campaign.

Table 4.25.: Daily averages of VOC from 17/12/02 to 31/01/03 at Rollegem

Date	**Benzene** (µg/m^3)	**Toluene** (µg/m^3)	**Ethyl-benzene** (µg/m^3)	**Meta- and para-xylene** (µg/m^3)	**Ortho-xylene µg/m^3** (µg/m^3)	**C3-alkyl benzene-isomers** (µg/m^3)	**C4-alkyl benzene-isomers** (µg/m^3)	**Naftalene** (µg/m^3)
17/12/2002	2.17	4.04	0.55	1.54	0.52	0.86	0.22	0.14
18/12/2002	1.74	3.44	0.60	1.60	0.56	1.46	0.24	0.13
19/12/2002	1.45	6.37	0.74	1.99	0.69	1.89	0.25	0.11
20/12/2002	2.75	8.83	1.62	5.05	1.65	3.15	0.51	0.15
21/12/2002	4.13	16.16	2.49	6.96	2.53	6.46	0.72	0.24
22/12/2002	0.52	2.12	0.30	0.86	0.30	0.37	0.22	0.04
23/12/2002	0.74	2.44	0.39	1.58	0.38	0.70	0.28	0.06
24/12/2002	0.66	2.81	0.36	1.02	0.36	0.49	0.13	0.04
25/12/2002	0.72	2.51	0.33	0.86	0.32	0.25	0.02	0.04
26/12/2002	0.45	1.65	0.24	0.66	0.23	0.30	0.04	0.03
27/12/2002	0.55	2.11	0.27	0.75	0.28	0.59	0.08	0.04
28/12/2002	0.74	3.30	0.38	1.09	0.39	0.39	0.07	0.03
29/12/2002	0.40	1.54	0.17	0.48	0.17	0.15	0.03	0.02
30/12/2002	0.49	1.82	0.28	0.76	0.29	0.33	0.05	0.03
31/12/2002	1.42	1.99	0.32	0.77	0.31	0.35	0.07	0.05
Mean December	*1.3*	*4.1*	*0.6*	*1.7*	*0.6*	*1.2*	*0.2*	*0.1*
Min. December	*0.40*	*1.54*	*0.17*	*0.48*	*0.17*	*0.15*	*0.02*	*0.02*
Max. December	*4.13*	*16.16*	*2.49*	*6.96*	*2.53*	*6.46*	*0.72*	*0.24*

01/01/2003	0.69	1.58	0.22	0.61	0.20	0.23	0.04	0.03
02/01/2003	0.33	1.47	0.25	0.65	0.25	0.34	0.06	0.03
03/01/2003	0.88	3.21	0.48	1.29	0.45	0.47	0.10	0.03
04/01/2003	1.10	1.57	0.29	0.57	0.23	0.21	0.09	0.05
05/01/2003	1.90	6.20	0.77	2.07	0.70	0.59	0.15	0.08
06/01/2003	1.10	4.89	0.26	0.95	0.26	0.25	0.06	0.06
07/01/2003	1.21	1.77	0.26	0.73	0.22	0.17	0.09	0.05
08/01/2003	1.60	2.95	0.26	1.46	0.22	0.29	0.08	0.07
09/01/2003	1.93	4.29	0.53	1.75	0.42	0.83	0.07	0.07
10/01/2003	2.42	9.83	1.20	3.53	1.14	2.19	0.20	0.11
11/01/2003	2.61	4.34	0.60	1.61	0.55	0.90	0.08	0.12
12/01/2003	4.73	14.49	1.89	5.45	1.95	2.32	0.40	0.21
13/01/2003	0.83	3.19	0.37	1.22	0.37	0.45	0.03	0.04
14/01/2003	0.87	3.93	0.49	1.76	0.51	0.47	0.03	0.04
15/01/2003	0.85	4.12	0.37	1.22	0.45	0.48	0.04	0.04
16/01/2003	1.08	5.15	0.65	2.19	0.68	0.83	0.11	0.05
17/01/2003	1.01	3.15	0.46	1.39	0.45	0.71	0.07	0.04
18/01/2003	1.04	2.74	0.34	1.01	0.33	0.57	0.07	0.03
19/01/2003	0.79	1.45	0.20	0.49	0.19	0.33	0.10	0.04
20/01/2003	0.51	1.09	0.13	0.37	0.13	0.27	0.09	0.03
21/01/2003	0.61	1.33	0.19	0.58	0.20	0.17	0.20	0.04
22/01/2003	0.72	3.15	0.39	1.31	0.42	0.57	0.24	0.04
23/01/2003	0.62	1.46	0.28	0.79	0.28	0.42	0.10	0.03
24/01/2003	2.27	10.02	1.44	4.30	1.58	3.22	0.32	0.10
25/01/2003	1.62	4.87	0.79	2.41	0.83	1.17	0.12	0.06
26/01/2003	0.88	2.89	0.38	1.15	0.38	0.65	0.07	0.04
27/01/2003	0.68	3.50	0.46	1.52	0.48	1.01	0.13	0.04
28/01/2003	0.43	1.12	0.17	0.51	0.17	0.32	0.17	0.03
29/01/2003	0.45	0.71	0.10	0.26	0.11	0.15	0.19	0.03
30/01/2003	0.60	1.19	0.17	0.48	0.18	0.25	0.24	0.03
31/01/2003	1.44	3.11	0.49	1.45	0.47	1.28	0.36	0.07
Mean January	*1.22*	*3.70*	*0.48*	*1.45*	*0.48*	*0.71*	*0.13*	*0.06*
Min. January	*0.33*	*0.71*	*0.10*	*0.26*	*0.11*	*0.15*	*0.03*	*0.03*
Max. January	*4.73*	*14.49*	*1.89*	*5.45*	*1.95*	*3.22*	*0.40*	*0.21*
Mean	**1.23**	**3.82**	**0.52**	**1.54**	**0.52**	**0.87**	**0.15**	**0.06**
Minimum	**0.33**	**0.71**	**0.10**	**0.26**	**0.11**	**0.15**	**0.02**	**0.02**
Maximum	**4.73**	**16.16**	**2.49**	**6.96**	**2.53**	**6.46**	**0.72**	**0.24**

Table 4.26.: Average concentration of VOC in January at several locations in Flanders

Location	**Benzene (µg/m³)**	**Toluene (µg/m³)**	**Ethylbenzene (µg/m³)**	**Meta- and para-xylene (µg/m³)**	**Ortho-xylene (µg/m³)**	**C3-alkyl benzene-isomers (µg/m³)**
Aarschot	1.5	2.1	0.3	0.9	0.3	1.2
Borgerhout	2.2	7.3	0.9	2.5	1.0	6.9
Doel	1.2	1.9	0.4	1.0	0.4	0.9
Maasmechelen	1.3	1.9	0.4	1.0	0.4	1.3
Stabroek	1.9	3.4	1.0	3.1	1.1	3.4
Tessenderlo Den	1.6	3.5	0.4	1.2	0.5	1.7
Tessenderlo Hof	1.0	1.8	0.2	0.6	0.3	1.6
Zelzate	1.3	2.5	0.4	1.2	0.5	1.5
Rollegem	*1.2*	*3.7*	*0.5*	*1.5*	*0.5*	*0.7*

8 PAH

The VMM only measured PAH during the winter campaign at Rollegem. The concentrations measured are part of the EPA-priority list for PAH. Benzo(a)pyrene is selected as indicator. On European level a target value of 1 ng/m³ as yearly mean for benzo(a)pyrene is decided. The average concentration for benzo(a)pyrene measured here is 0.31 ng/m³ thus finding itself beneath the proposed target value.

The concentrations measured can be compared with those measured on other locations in Flanders. A local source that has a perceptible influence cannot be determined.

Table 4.27.: Weekly concentrations of PAH during the winter campaign at Rollegem

PERIOD	**fluor-anthene (ng/m³)**	**pyrene (ng/m³)**	**benzo(a)-anthracene (ng/m³)**	**chrysene (ng/m³)**	**benzo(b)-fluor-anthene (ng/m³)**	**benzo(k)-fluor-anthene (ng/m³)**	**benzo(a)-pyrene (ng/m³)**	**dibenzo(a,h)-anthracene (ng/m³)**	**benzo(g,h,i)-perylene (ng/m³)**	**indeno (1,2,3-cd)-pyrene (ng/m³)**
week 51	0.34	0.59	0.26	1.12	1.15	0.43	0.44	0.34	1.46	0.53
week 52	0.06	0.03	0.04	0.13	0.18	0.05	0.03	0.06	0.27	0.03
week 1	0.12	0.35	0.2	0.79	1.07	0.42	0.29	0.26	0.96	0.35
week 2	0.7	1.5	0.72	3.12	2.4	0.98	0.89	0.57	1.92	1.03
week 3	0.05	0.07	0.13	0.35	0.48	0.17	0.07	0.1	0.4	0.15
week 4	0.06	0.07	0.12	0.38	0.5	0.15	0.05	0.07	0.29	0.11
week 5	0.23	0.3	0.19	0.82	1.03	0.41	0.38	0.3	1.05	0.52
Mean	**0.22**	**0.42**	**0.24**	**0.96**	**0.97**	**0.37**	**0.31**	**0.24**	**0.91**	**0.39**

In the same time, AREMA/LM realised daily measurements in Marcq with a high volume sampler (30 m³/h). The results are presented below (table 4.28.) for comparison.

Table 4.28.: Daily concentrations of PAH during equivalent periods at Marcq

PERIOD	**fluor-anthene (ng/m³)**	**pyrene (ng/m³)**	**benzo(a)-anthracene (ng/m³)**	**chrysene (ng/m³)**	**benzo(b)-fluor-anthene (ng/m³)**	**benzo(k)-fluor-anthene (ng/m³)**	**benzo(a)-pyrene (ng/m³)**	**dibenzo(a,h)-anthracene (ng/m³)**	**benzo(g,h,i)-perylene (ng/m³)**	**indeno (1,2,3-cd)-pyrene (ng/m³)**
18/12/02 (week 51)	2.8	1.8	1.8	4.4	2.1	1.2	1.9	0.2	2.2	1.7
24/12/02 (week 52)	0.9	0.4	0.4	1.1	0.9	0.4	0.6	< 0.1	1.0	0.5
30/12/02 (week 1)	< 0.1	0.2	0.2	0.5	0.6	0.3	0.4	<0.1	0.5	0.5
5/01/03 (week 1)	**5.7**	**3.2**	**2.9**	**5.5**	**5.5**	**2.2**	**3.7**	**0.1**	**2.9**	**3.2**
11/01/03 (week 2)	**14**	**12**	**10**	**17**	**7.6**	**4.3**	**9.6**	**0.8**	**5.1**	**7.0**
17/01/03 (week 3)	1.1	0.7	1.4	2.8	1.6	0.7	1.0	< 0.1	1.7	0.8
23/01/03 (week 4)	1.1	1.0	1.7	2.2	1.3	0.6	1.3	0.2	2.7	0.9
29/01/03 (week 5)	1.4	0.3	0.3	0.6	0.3	0.1	0.2	< 0.1	0.5	0.3
Mean	**3.4**	**2.5**	**2.3**	**4.3**	**2.5**	**1.2**	**2.3**	**0.2**	**2.1**	**1.9**

The mean values from Marcq are much more higher than Rollegem. This difference is due to the way of sampling (daily sampling leads to more concentrated samplers) and also due to more important emissions in Marcq than at Rollegem. An important source is the domestic heating and this is more important in urban area than in rural area. On the two sites, we observe the highest concentrations during week 1 and 2. This period corresponds as well to higher concentrations in heavy metals present in PM10. The anticyclonic conditions with worse dispersion is in part responsible of those concentrations.

During the winter campaign the target value for BaP is exceeded in Marcq and it is also exceeded on the whole calendar year with a mean concentration of 1.03 ng/m³ of BaP in 2003.

5. Measurements at Menen and Kortrijk

I General

In Menen, VMM started supplementary measurements of PM2.5 and PM10. Supplementary measurements of heavy metals in PM10 were also started. PM2.5 was sampled on filters for the analysis of heavy metals (VMM and UA) and for the analysis of anions and cations (UA). UA, using passive samplers, determined at this location a certain number of gaseous pollutants and analysed a certain number of filters on PAH's.

In Kortrijk, VMM started supplementary measurements of PM2.5 and PM10.

II PM measurements

A Gravimetric method versus automatic method

During the measurement campaigns in winter and summer PM10 and PM2.5 were determined both by gravimetric method and automatic method in Rollegem (winter and summer campaigns) and Menen (summer campaign). The reference method was the Low Volume Sampler Sequential Sampler SEQ 47/50 (Leckel). The automatic monitors were TEOM monitors. The difference between the gravimetric method and the automatic method comes from loss of particles by volatilisation.

A linear regression through the origin was calculated for PM10 and PM2.5 for both summer and winter and for both locations. To obtain a daily average with the TEOM, the average of 48 half-hour concentrations was made. Only if 38 half hours (80%) were available, a daily average was calculated.

The regression equations shown in table 5.1. indicate that in Rollegem for PM10 in summer a better agreement between the gravimetric method and the automatic method occurs. For PM2.5 the opposite is true. In winter the agreement between the gravimetric method and the automatic method is better for PM2.5 than for PM10, in summer the agreement is better for PM10 than for PM2.5.

For 2003 a average correction factor of 1.47 is used for TEOM monitors in Flanders. New comparison tests were performed in Flanders during 2004.

Table 5.1.: Summary linear regression through origin Leckel (x) - TEOM (y)

	number of pairs	average TEOM	average Leckel	number > 50 µg/m^3 TEOM	number > 50 µg/m^3 Leckel	regression	R^2
PM10							
Rollegem 15/12/2002-03/02/2003	50	17	27	1	5	y = 0.604x	0.91
Rollegem 21/06/2003-23/07/2003	32	24	29	0	0	y = 0.817x	0.56
Menen 21/06/2003-23/07/2003	29	23	28	0	0	y = 0.819x	0.80
PM2.5							
Rollegem 15/12/2002-03/02/2003	49	15	20	1	1	y = 0.679x	0.90
Rollegem 21/06/2003-23/07/2003	33	11	18	0	0	y = 0.548x	0.72
Menen 21/06/2003-23/07/2003	32	13	20	0	0	y = 0.666x	0.87

B PM measurements at Menen and Kortrijk

PM10 and PM2.5 measurements were started at Menen on 6th February 2003 and at Kortrijk on 20th March 2003. Figure 5.1. shows the daily averages for 2003 and 2004 (up to and including June). Table 5.2. shows the frequency distribution for 2003 and table 5.3. for 2004 (up to and including June). Both the non-corrected and corrected (PM_{ref}-10 = PM10*1.47) PM10 values are shown. The pollution roses for 2003 are shown in figure 5.2. and 5.3., those for 2004 (until June) in figure 5.4. and 5.5..

In figure 5.1. we can see that the PM2.5 measurements at Menen and Kortrijk are rather similar. The PM10 measurements are higher at Menen then at Kortrijk. This is seen again at the table with the frequency distribution. Using the correction factor 1.47 the limit value for the yearly average of 40 $\mu g/m^3$ for the protection of health (1999/30/EC) is exceeded in 2003 at Menen. The daily value of 50 $\mu g/m^3$ for the protection of health (1999/30/EC) is exceeded in 2003 both at Menen and Kortrijk. At Menen 79 exceedances are perceived and at Kortrijk 53 (with PM_{ref}-10). 35 exceedances of the daily value of 50 $\mu g/m^3$ are permitted on a yearly basis. For comparison we give in table 5.3. an overview of the yearly averages and the number of exceedances of the daily value of 50 $\mu g/m^3$ of the other PM10 stations in Flanders for 2003. The limit value for the daily values is exceeded in all the stations. The limit value for the yearly average is exceeded in 8 of the 19 stations. In the first six months of 2004 the limit value for the yearly average of 40 $\mu g/m^3$ is not exceeded at Menen or Kortrijk. The daily value of 50 $\mu g/m^3$ is exceeded during the first six months of 2004 21 times at Menen and 19 times at Kortrijk.

The pollution roses for PM10 and PM2.5 at Kortrijk are rather homogeneous. At Menen we see higher concentrations coming from the north to the east to the south. This is also true to a less extent for PM2.5.

The fraction PM2.5 in PM10 is 59 % at Menen and 61 % at Kortrijk.

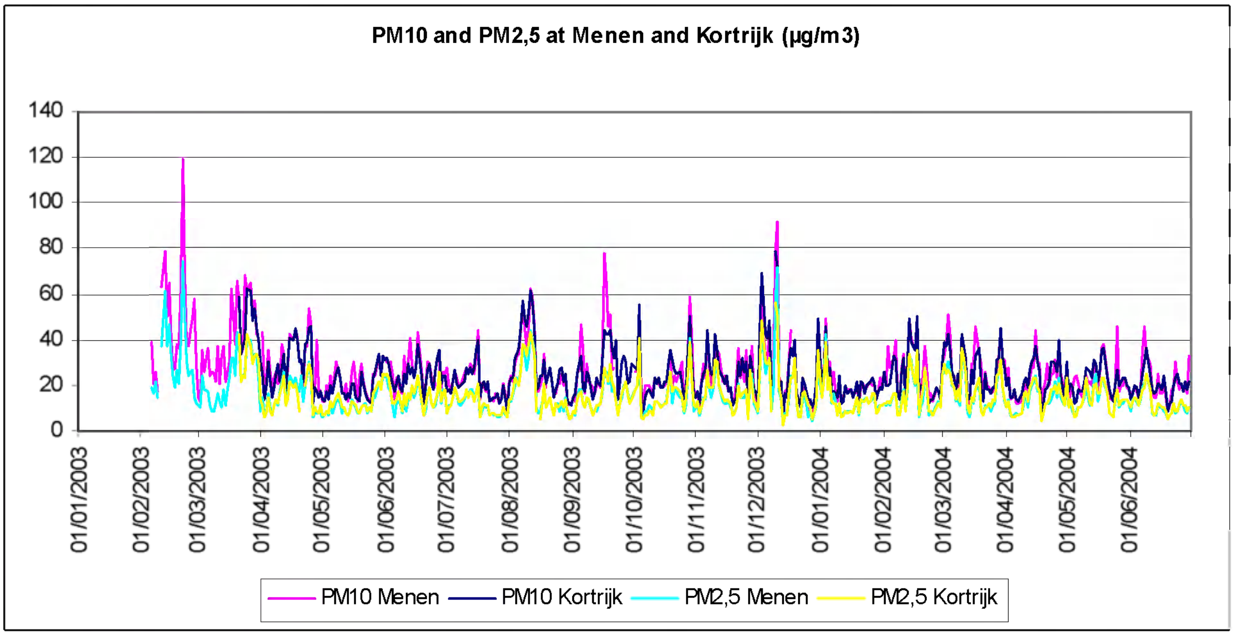


Figure 5.1.: Daily averages for PM10 and PM2.5 at Menen and Kortrijk for 2003 and 2004 (until June)

Table 5.2.: Frequency distribution for PM10 and PM2.5 at Menen and Kortrijk for 2003 (PM_{ref}-10 = PM10*1.47)

	PM10		PMref-10		PM2.5	
	Kortrijk	Menen	Kortrijk	Menen	Kortrijk	Menen
N	285	311	285	311	282	323
N%	78	85	78	85	77	88
Mean	26	29	38	42	16	17
Min	4	5	6	7	3	3
10P	14	14	21	21	7	8

20P	16	17	24	25	9	9
25P	17	19	25	27	10	10
30P	19	20	27	29	11	11
40P	21	22	31	32	12	12
50P	23	25	34	36	14	14
60P	26	28	38	41	16	16
70P	29	31	43	46	18	18
75P	31	34	45	51	20	21
80P	33	37	49	55	22	23
90P	42	47	63	69	28	30
95P	49	61	72	89	34	37
98P	59	68	86	101	41	47
99P	62	78	92	115	43	56
Max	79	119	117	175	56	74

Table 5.3.: Frequency distribution for PM10 and PM2.5 at Menen and Kortrijk for 01/01-30/06/2004 (PM_{ref}-10 = PM10*1.47)

	PM10		**PMref-10**		**PM2.5**	
	Kortrijk	**Menen**	**Kortrijk**	**Menen**	**Kortrijk**	**Menen**
N	179	182	179	182	182	182
N%	98	100	98	100	100	100
Mean	23	23	33	34	15	14
Min	5	5	7	7	4	4
10P	14	14	20	21	7	7
20P	16	16	24	23	9	9
25P	17	17	25	25	10	9
30P	18	17	26	26	10	10
40P	19	19	28	28	12	11
50P	21	20	31	30	13	12
60P	22	23	33	34	14	14
70P	25	26	37	39	16	15
75P	27	28	39	42	18	17
80P	29	30	43	44	19	19
90P	35	36	51	53	23	23
95P	37	42	55	62	27	28
98P	42	46	62	68	32	31
99P	46	49	67	72	35	31
Max	50	51	73	74	39	42

Table 5.4.: Overview of the yearly averages and the number of exceedances of the daily value of 50 µg/m^3 on the PM10 stations in Flanders for 2003

Town	**Station code**	**Yearly average**	**Number of exceedances**
Hasselt	**42N045**	35	52
Vilvoorde	**42R020**	35	50
Borgerhout	**42R801**	39	70
Ruisbroek	**42R832**	49	126
Mechelen-Technopolis	**42R841**	35	50
Roeselare	**44M705**	51	142
Houtem	**44N029**	34	50
Gent-Baudelo	**44R701**	44	93

Evergem	**44R731**	53	123
St. Kruis-Winkel	**44R740**	44	99
Zelzate	**44R750**	44	93
Herne	**40HR01**	37	70
Mechelen-Zuid	**40ML01**	38	67
Oostrozebeke	**40OB01**	42	101
Steenokkkerzeel	**40SZ02**	37	59
Tielrode	**40TR01**	35	44
Lommel	**40WZ01**	35	54
Antwerpen-Luchtbal	**42M802**	44	75
Gent-Krijgslaan	**00GN05**	32	40

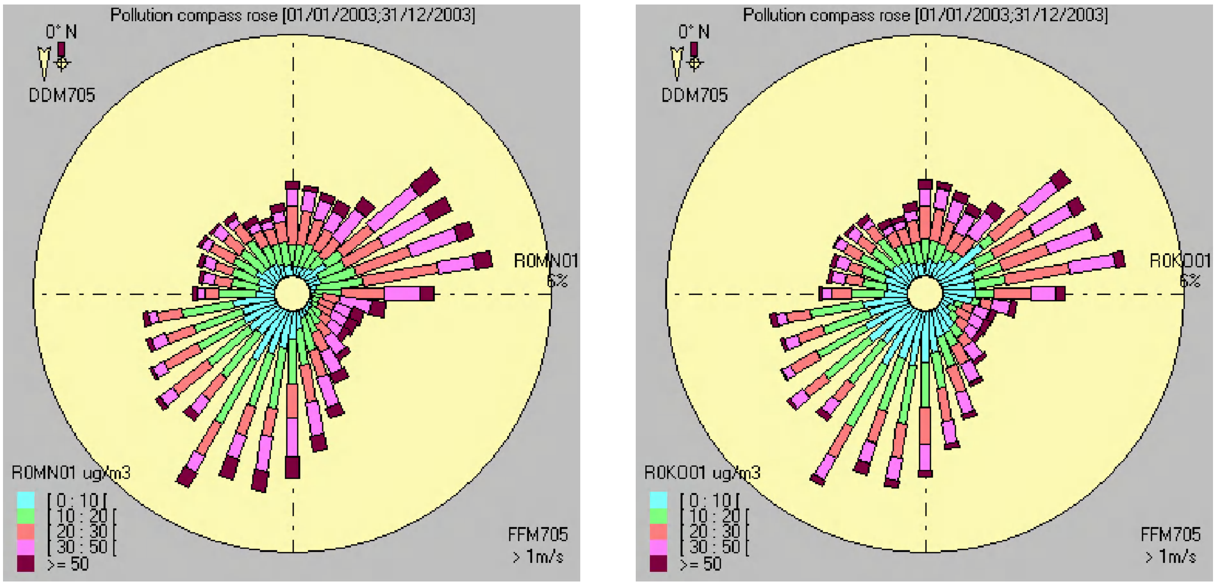


Figure 5.2.: Pollution roses for PM10 at Menen and Kortrijk for 2003

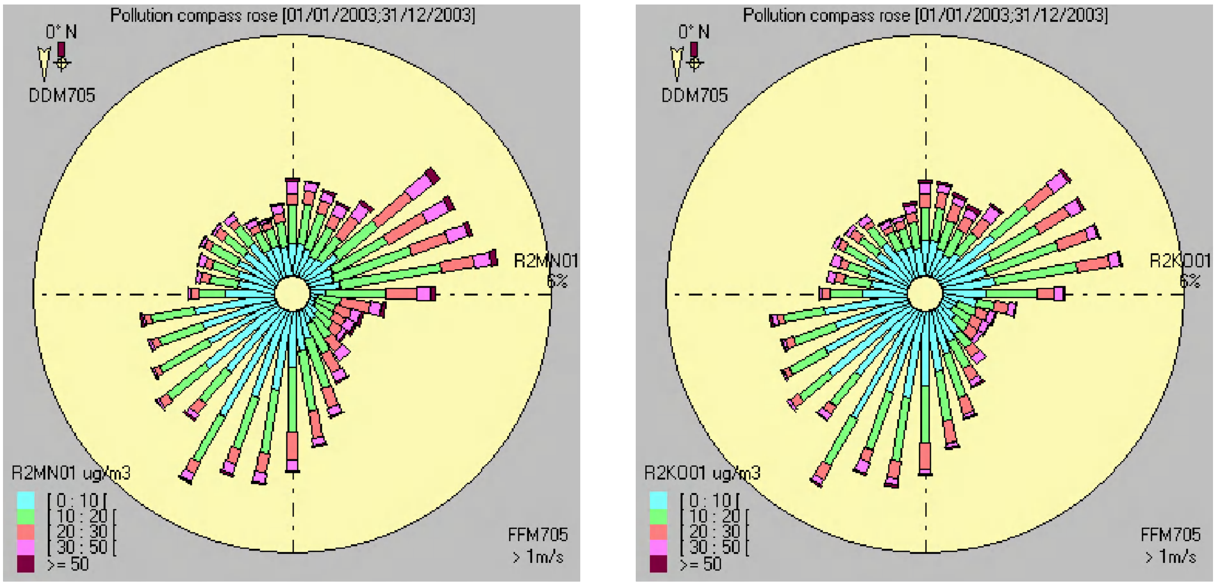


Figure 5.3.: Pollution roses for PM2.5 at Menen and Kortrijk for 2003

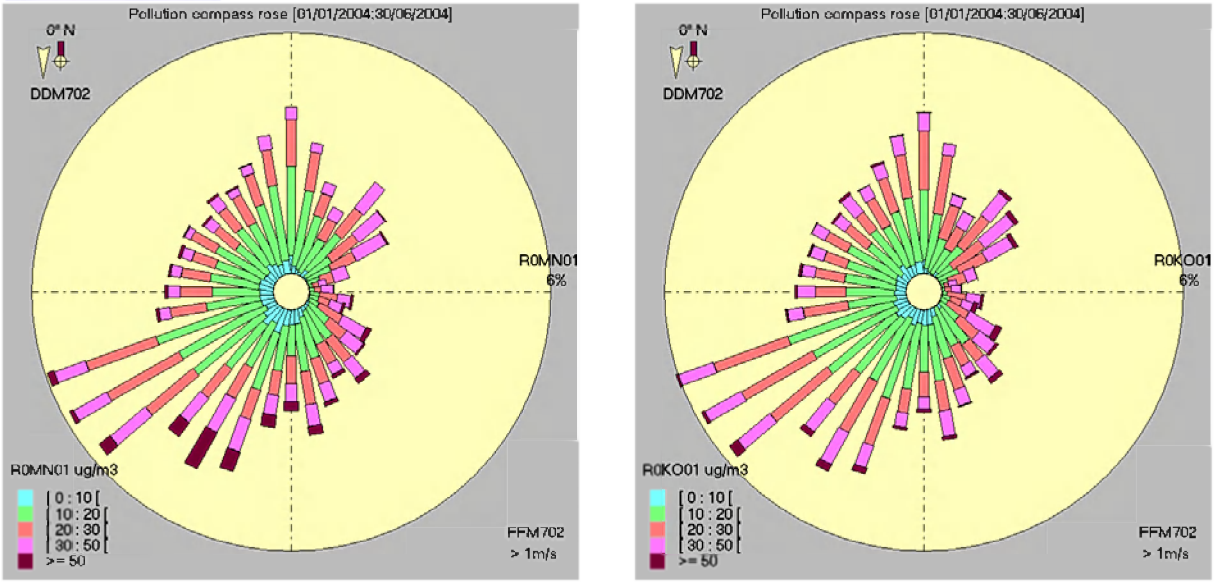


Figure 5.4.: Pollution roses for PM10 at Menen and Kortrijk for 2004 (01/01-30/06/2004)

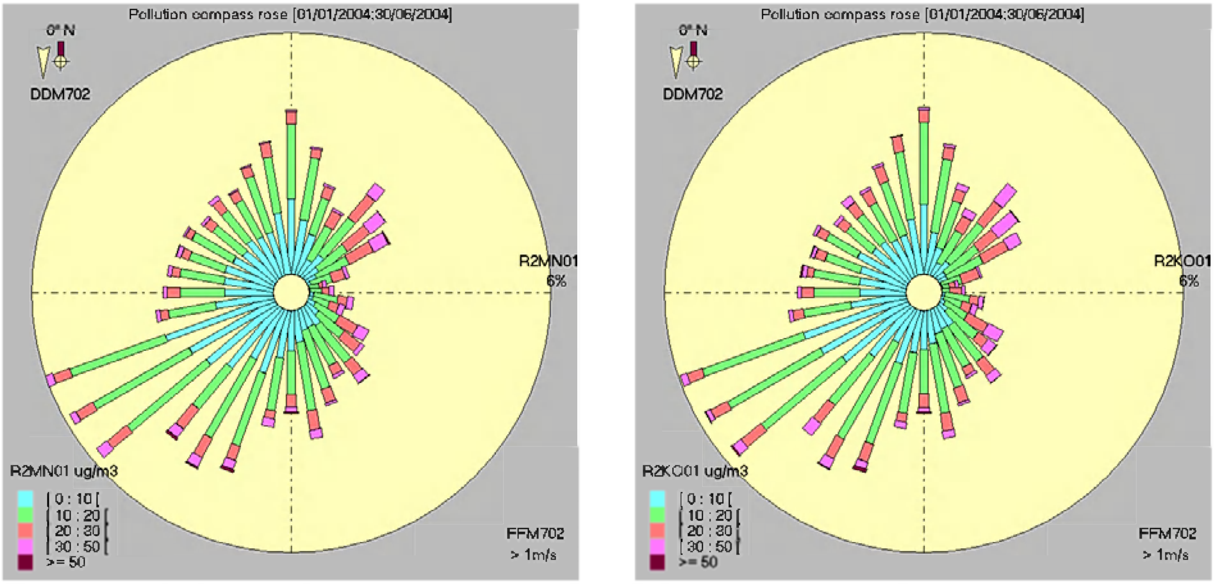


Figure 5.5.: Pollution roses for PM2.5 at Menen and Kortrijk for 2004 (01/01-30/06/2004)

III Heavy metals at Menen

During one year, heavy metals in the PM2.5 and PM10 aerosol fractions in Menen have been determined by VMM and UA. 24h samples were collected on cellulose nitrate filters, at a flow rate of 2.3 m^3/h. In total 55.2 m^3 of air passed through each filter. The data have been split up into seasons, in order to study the data not only on a yearly basis.

A Heavy metals in PM2.5

An overview of the heavy metal content of PM2.5 during the 4 seasons is shown in tables 5.5., 5.6., 5.7. and 5.8..

Since VMM and UA used different analytical techniques to determine heavy metals in the samples, each institute was able to determine a different set of heavy metals. VMM determined chromium, manganese, nickel, copper, zinc, antimony, arsenic, cadmium and lead. UA determined vanadium, chromium, manganese, nickel, copper, zinc and lead. Both techniques imply different detection limits for each heavy metal, which are specified under each table in italic writing for the samples analysed by VMM, and in non-italic writing for samples analysed by UA.

Zinc, lead and copper are the most abundant heavy metals in PM2.5, during all seasons. Vanadium, chromium, manganese, arsenic and nickel are present in each sample, although in smaller concentrations. Cadmium and antimony are only represented by very small amounts. Figure 5.6. shows an overview of the mean concentrations of each heavy metal during the 4 seasons. The average concentrations of vanadium, chromium, nickel, copper and arsenic all show the highest concentration during winter. Lead, zinc and manganese are characterised by a similar seasonal variability. All three heavy metals show higher concentrations during autumn and winter, more average concentrations during spring, and lowest concentrations in summer. The concentrations lead, zinc and manganese also show the largest difference between the highest and the lowest detected concentration, each season.

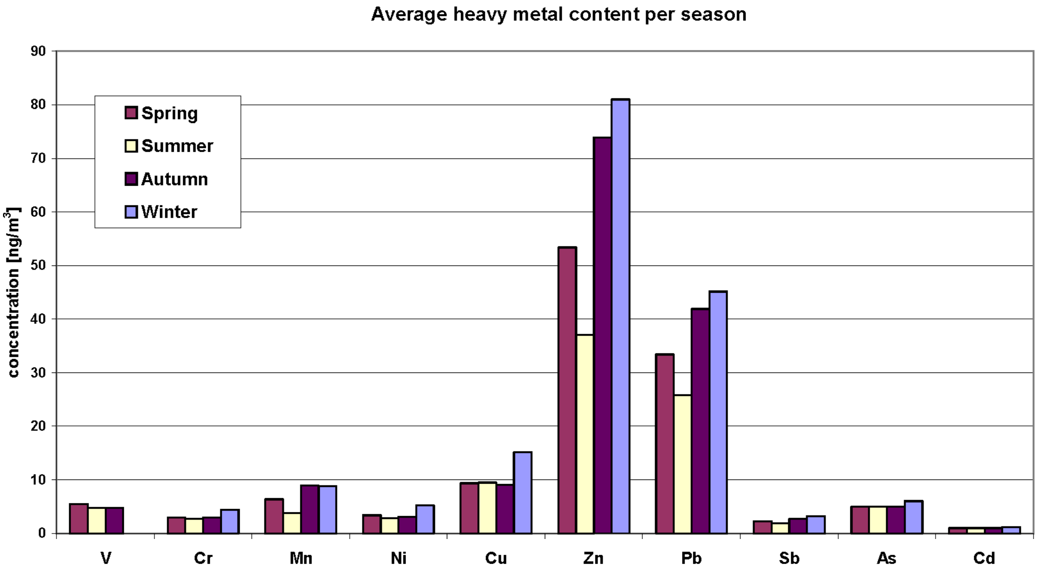


Figure 5.6.: Average heavy metal content in PM2.5 per season at Menen

Table 5.5.: Heavy metals in PM2.5 in Menen during winter [ng/m^3]

	V	Cr	Mn	Ni	Cu	Zn	Pb	Sb	As	Cd
15/12/2002	-	*5.4*	*12.7*	*6.5*	*14.5*	*67.6*	*9.6*	***2.0***	***9.1***	***2.0***
16/12/2002	-	*5.4*	*9.3*	*6.7*	*14.5*	*48.8*	*17.6*	***2.0***	***9.1***	***2.0***
17/12/2002	-	*5.4*	*11.6*	*9.1*	*14.5*	*90.0*	*46.8*	***2.7***	***9.1***	***2.7***
18/12/2002	-	*7.8*	*22.1*	*10.3*	*18.9*	*126.3*	*85.3*	***8.9***	***9.1***	***8.9***
19/12/2002	-	*12.3*	*28.8*	*10.9*	*29.0*	*236.6*	*60.8*	***5.4***	***9.1***	***5.4***
20/12/2002	-	*10.2*	*29.0*	*12.7*	*22.5*	*270.9*	*187.4*	***6.7***	***9.1***	***6.7***
21/12/2002	-	*5.4*	*4.2*	*7.3*	*14.5*	*131.0*	*139.3*	***5.3***	***9.1***	***5.3***
22/12/2002	-	*5.4*	*10.0*	*6.0*	*14.5*	*24.5*	*7.3*	***1.6***	***9.1***	***1.6***
23/12/2002	-	*5.4*	*8.3*	*7.3*	*14.5*	*49.5*	*43.9*	***2.4***	***9.1***	***2.4***
24/12/2002	-	*5.4*	*2.7*	*6.9*	*14.5*	*90.9*	*47.5*	***2.0***	***9.1***	***2.0***
25/12/2002	-	*5.4*	*2.7*	*7.1*	*14.5*	*60.8*	*48.6*	***1.3***	***9.1***	***1.3***
26/12/2002	-	*5.4*	*2.7*	*6.5*	*14.5*	*35.9*	*17.4*	***1.1***	***9.1***	***1.1***
27/12/2002	-	*5.4*	*2.7*	*5.1*	*14.5*	*62.0*	*53.2*	***3.8***	***9.1***	***3.8***
28/12/2002	-	*5.4*	*4.4*	*5.4*	*14.5*	*32.3*	*9.6*	***1.1***	***9.1***	***1.1***
29/12/2002	-	*5.4*	*2.7*	*5.3*	*14.5*	*27.8*	*7.3*	***1.1***	***9.1***	***1.1***
30/12/2002	-	*5.4*	*2.7*	*7.4*	*14.5*	*24.3*	*7.3*	***1.1***	***9.1***	***1.1***
31/12/2002	-	*5.4*	*2.7*	*7.4*	*14.5*	*26.3*	*9.6*	***2.2***	***9.1***	***2.2***

01/01/2003	-	3.0	1.0	5.3	7.0	32.7	15.8	**1.0**	**5.0**	**1.0**
02/01/2003	-	3.0	1.0	6.3	7.0	25.2	4.0	**1.0**	**5.0**	**1.0**
03/01/2003	-	3.0	1.0	6.7	7.0	34.3	10.9	**1.3**	**5.0**	**1.3**
04/01/2003	-	3.0	3.1	7.4	7.0	40.6	17.6	**1.6**	**5.0**	**1.6**
05/01/2003	-	3.0	4.9	8.2	7.0	53.0	35.6	**2.0**	**5.0**	**2.0**
06/01/2003	-	3.0	9.4	9.3	7.0	69.5	48.4	**2.5**	**5.0**	**2.5**
07/01/2003	-	3.0	6.0	7.3	7.0	60.4	33.0	**2.4**	**5.0**	**2.4**
08/01/2003	-	6.9	15.1	8.9	7.0	135.7	66.7	**6.2**	**5.0**	**6.2**
09/01/2003	-	3.0	16.9	12.7	7.0	112.6	88.2	**4.0**	**5.0**	**4.0**
10/01/2003	-	12.5	23.2	14.0	15.4	270.5	143.1	**4.5**	**5.0**	**4.5**
11/01/2003	-	3.0	10.7	12.2	7.0	115.4	82.2	**5.3**	**5.0**	**5.3**
12/01/2003		7.1	12.5	11.6	7.0	130.8	66.9	**4.0**	**5.0**	**4.0**
13/01/2003	-	3.0	7.4	8.7	7.0	68.6	4.0	**7.3**	**5.0**	**7.3**
14/01/2003	-	3.0	7.3	6.7	7.0	42.3	4.0	**2.4**	**5.0**	**2.4**
15/01/2003	-	3.0	50.5	8.2	15.6	130.1	23.0	**2.2**	**5.0**	**2.2**
16/01/2003	-	9.8	21.2	8.5	7.0	73.5	14.5	**2.7**	**5.0**	**2.7**
17/01/2003	-	3.0	6.3	8.2	7.0	130.2	152.7	**4.2**	**5.0**	**4.2**
18/01/2003	-	3.0	1.0	5.1	32.5	92.2	21.0	**2.7**	**5.0**	**2.7**
19/01/2003	-	3.0	6.5	4.7	7.0	36.6	4.0	**1.3**	**5.0**	**1.3**
20/01/2003	-	3.0	11.3	2.0	7.0	81.3	37.7	**1.6**	**5.0**	**1.6**
21/01/2003	-	3.0	1.0	6.9	7.0	80.0	33.6	**1.3**	**5.0**	**1.3**
22/01/2003	-	3.0	7.4	5.6	7.0	55.7	16.3	**1.8**	**5.0**	**1.8**
23/01/2003	-	3.0	3.1	6.3	7.0	27.6	4.0	**1.0**	**5.0**	**1.0**
24/01/2003	-	3.0	14.5	9.3	7.0	86.3	31.4	**4.2**	**5.0**	**4.2**
25/01/2003	-	3.0	5.6	8.3	7.0	94.0	45.0	**2.9**	**5.0**	**2.9**
26/01/2003	-	3.0	6.5	7.6	7.0	45.9	11.2	**1.5**	**5.0**	**1.5**
27/01/2003	-	3.0	7.6	8.5	7.0	43.7	39.7	**1.3**	**5.0**	**1.3**
28/01/2003	-	3.0	2.9	4.9	7.0	49.5	77.3	**1.0**	**5.0**	**1.0**
29/01/2003	-	3.0	1.0	2.0	7.0	33.0	23.6	**1.0**	**5.0**	**1.0**
30/01/2003	-	3.0	1.0	2.0	7.0	1.0	4.0	**1.3**	**5.0**	**1.3**
31/01/2003	-	3.0	1.0	2.0	7.0	1.0	4.0	**1.6**	**5.0**	**1.6**
01/02/2003	-	3.0	3.8	2.0	7.0	59.1	36.9	**2.8**	**5.0**	**2.8**
02/02/2003	-	3.0	2.8	2.0	7.0	24.4	19.7	**1.0**	**5.0**	**1.0**
03/02/2003	-	3.0	8.2	2.0	7.0	37.0	39.9	**1.5**	**5.0**	**1.5**
04/02/2003	-	3.0	5.2	2.0	7.0	39.5	38.8	**1.0**	**5.0**	**1.0**
05/02/2003	-	3.0	5.4	2.0	7.0	77.8	46.2	**1.3**	**5.0**	**1.3**
06/02/2003	-	3.0	9.1	5.3	14.7	80.5	45.2	**3.9**	**9.4**	**3.9**
07/02/2003	-	3.0	5.8	2.0	7.0	87.9	35.9	**2.0**	**5.0**	**2.0**
08/02/2003	-	3.0	3.1	2.0	7.0	61.0	30.3	**3.0**	**5.0**	**3.0**
09/02/2003	-	3.0	1.0	2.0	7.0	42.2	29.5	**2.2**	**5.0**	**2.2**
10/02/2003	-	3.0	8.6	2.0	15.6	105.0	45.0	**2.2**	**5.0**	**2.2**
11/02/2003	-	3.0	17.8	2.0	17.4	126.8	66.2	**3.7**	**5.0**	**3.7**
12/02/2003	-	7.9	15.3	2.0	23.0	193.8	89.9	**8.1**	**5.0**	**8.1**
13/02/2003	-									
14/02/2003	-	8.2	22.1	9.3	20.5	234.6	136.8	**8.4**	**10.6**	**8.4**
15/02/2003	-	3.0	7.0	2.0	7.0	104.4	61.4	**2.8**	**5.0**	**2.8**
16/02/2003	-	3.0	8.3	2.0	7.0	86.1	57.3	**6.2**	**5.0**	**6.2**
17/02/2003	-	3.0	5.0	2.0	7.0	58.8	47.4	**1.9**	**5.0**	**1.9**
18/02/2003	-	8.5	13.8	2.0	25.9	114.6	55.1	**5.5**	**5.0**	**5.5**
19/02/2003	-	6.9	12.0	2.0	21.1	137.2	54.4	**3.7**	**10.2**	**3.7**
20/02/2003	-	7.2	26.1	4.7	31.9	209.4	84.5	**6.0**	**9.2**	**6.0**
21/02/2003	-									
22/02/2003	-	8.7	20.4	2.0	50.7	165.1	87.7	**7.0**	**9.3**	**7.0**
23/02/2003	-	3.0	4.5	2.0	17.8	78.9	45.9	**3.4**	**5.0**	**3.4**
24/02/2003	-	7.5	9.9	2.0	28.8	99.2	52.4	**4.0**	**5.0**	**4.0**
25/02/2003	-	8.7	18.2	2.0	24.2	120.1	48.4	**3.4**	**5.0**	**3.4**
26/02/2003	-	5.8	21.3	6.0	36.7	125.8	58.8	**4.2**	**5.0**	**4.2**
27/02/2003	-	6.3	13.6	4.6	26.5	139.3	79.8	**6.3**	**5.0**	**6.3**
28/02/2003	-	3.0	3.5	2.0	19.8	81.4	36.2	**3.6**	**5.0**	**3.6**
01/03/2003	-	3.0	1.0	2.0	15.5	42.1	25.1	**1.6**	**5.0**	**1.6**
02/03/2003	-	3.0	1.0	2.0	20.6	25.8	21.0	**1.1**	**5.0**	**1.1**

03/03/2003	-	9.6	11.7	7.8	23.6	73.6	42.3	3.5	5.0	3.5
04/03/2003	-	3.0	18.5	2.0	16.0	80.4	46.1	2.7	5.0	2.7
05/03/2003	-	3.0	6.8	2.0	21.7	75.0	43.7	10.5	5.0	10.5
06/03/2003	-	3.0	8.7	2.0	21.7	52.3	29.4	1.5	5.0	1.5
07/03/2003	-	3.0	8.5	4.8	17.2	66.1	35.4	3.4	5.0	3.4
08/03/2003	-	3.0	1.0	2.0	15.9	29.4	18.7	6.8	5.0	6.8
09/03/2003	-	3.0	1.0	2.0	38.8	58.2	26.3	3.2	5.0	3.2
10/03/2003	-	3.0	7.3	2.0	34.9	56.0	31.7	20.2	5.0	20.2
11/03/2003	-	3.0	5.6	2.0	23.8	44.3	26.9	1.4	5.0	1.4
12/03/2003	-	3.0	1.0	2.0	7.0	17.7	23.9	1.0	5.0	1.0
13/03/2003	-	3.0	6.2	2.0	28.2	69.4	54.2	1.7	5.0	1.7
14/03/2003	-	3.0	8.4	2.0	20.6	74.9	56.1	2.9	5.0	2.9
15/03/2003	-	3.0	4.8	2.0	21.9	54.5	34.1	2.3	5.0	2.3
16/03/2003	-	3.0	5.2	2.0	39.1	59.6	42.4	2.1	9.6	2.1
17/03/2003	-	6.9	11.6	5.2	29.1	109.2	69.5	4.4	5.0	4.4
18/03/2003	-	3.0	9.9	7.5	14.6	119.6	88.9	3.3	5.0	3.3
19/03/2003	-	3.0	8.1	8.5	16.6	92.6	71.1	3.2	5.0	3.2
20/03/2003	-	3.0	8.6	8.4	15.0	60.7	64.2	2.9	5.0	2.9
Mean		4.4	8.9	5.3	15.2	81.0	45.1	3.3	6.0	1.2
Minimum		3.0	1.0	2.0	7.0	1.0	4.0	1.0	5.0	1.0
Maximum		12.5	50.5	14.0	50.7	270.9	187.4	20.2	10.6	4.4

Detection limit (VMM): Pb: 7 ng/m^3 - Zn: 3 ng/m^3 - Cu: 14 ng/m^3 - Ni: 5 ng/m^3 - Sb: 1 ng/m^3 - As: 9 ng/m^3 - Mn: 3 ng/m^3 - Cd: 1 ng/m^3 - Cr: 5 ng/m^3

Detection limit (UA): V: 0.3 ng/m^3 - Pb: 2.3 ng/m^3 - Zn: 0.7 ng/m^3 - Cu: 0.9 ng/m^3 - Ni: / ng/m^3 - Mn: 0.3 ng/m^3 - Cr: 1.5 ng/m^3

(Values below the detection limit (DL) are archived as DL/2)

Table 5.6.: Heavy metals in PM2.5 in Menen during spring [ng/m^3]

	V	Cr	Mn	Ni	Cu	Zn	Pb	Sb	As	Cd
21/03/2003	-	6.7	7.7	11.8	15.4	88.0	50.9	2.8	5.0	1.0
22/03/2003	-	5.5	6.7	2.0	18.8	112.6	54.2	3.3	5.0	1.0
23/03/2003	-	3.0	11.1	2.0	25.0	82.5	44.2	4.1	5.0	1.0
24/03/2003	-	5.8	9.7	2.0	21.9	88.1	54.3	2.8	5.0	1.0
25/03/2003	-	6.0	8.6	7.7	7.0	76.4	48.1	5.6	5.0	1.0
26/03/2003	-	6.5	17.0	7.9	28.0	171.4	126.4	5.7	5.0	1.0
27/03/2003	-	5.9	15.5	9.6	20.2	134.6	101.4	5.6	5.0	1.0
28/03/2003	-	6.2	14.8	8.6	24.5	146.3	107.4	7.0	5.0	1.0
29/03/2003	-	6.1	11.0	7.2	19.7	81.3	63.7	3.8	5.0	1.0
30/03/2003	-	3.0	4.4	10.0	15.0	38.1	29.9	1.3	5.0	1.0
31/03/2003	-	3.0	2.7	2.0	14.7	43.5	36.1	1.8	5.0	1.0
01/04/2003	-	3.0	7.0	2.0	17.0	304.0	45.8	2.4	5.0	1.0
02/04/2003	-	3.0	1.0	2.0	7.0	21.9	17.9	1.0	5.0	1.0
03/04/2003	-	3.0	1.0	2.0	7.0	15.5	15.9	1.0	5.0	1.0
04/04/2003	-	7.3	12.4	11.7	15.7	47.8	37.6	2.7	5.0	1.0
05/04/2003	-	3.0	1.0	2.0	7.0	13.8	21.2	1.0	5.0	1.0
06/04/2003	-	3.0	1.0	2.0	7.0	13.6	17.8	1.0	5.0	1.0
07/04/2003	-	3.0	6.5	2.0	7.0	69.0	61.4	1.9	5.0	1.0
08/04/2003	-	3.0	9.1	5.9	7.0	83.5	61.3	3.4	5.0	1.0
09/04/2003	-	3.0	3.7	2.0	7.0	41.9	32.9	1.7	5.0	1.0
10/04/2003	-	6.8	1.0	2.0	7.0	33.4	26.2	1.7	5.0	1.0
11/04/2003	-	3.0	6.8	2.0	21.6	106.8	43.8	5.4	5.0	1.0
12/04/2003	-	3.0	8.2	2.0	7.0	95.4	41.9	4.8	5.0	1.0
13/04/2003	-	3.0	10.1	2.0	7.0	53.9	27.7	2.1	5.0	1.0
14/04/2003	-	3.0	6.1	2.0	7.0	122.1	31.1	1.7	5.0	1.0
15/04/2003	-	3.0	10.4	2.0	16.8	128.3	117.3	3.0	5.0	1.5
16/04/2003	2.5	3.2	9.3	1.8	11.4	95.7	48.8	-	-	-
17/04/2003	3.2	2.3	10.5	3.0	8.9	83.2	36.7	-	-	-
18/04/2003	6.4	1.4	9.8	3.4	7.1	69.3	39.6	-	-	-

19/04/2003	3.9	0.7	4.1	2.1	2.3	34.4	25.7	-	-	-
20/04/2003	3.0	2.3	6.2	2.7	3.6	99.1	49.9	-	-	-
21/04/2003	4.8	0.9	11.8	2.1	3.9	45.6	16.0	-	-	-
22/04/2003	7.5	0.7	11.8	3.2	3.4	48.8	31.0	-	-	-
23/04/2003	13.7	0.7	8.0	7.1	4.6	57.2	40.8	-	-	-
24/04/2003	14.6	2.5	32.4	8.4	9.8	147.7	90.9	-	--	-
25/04/2003	11.2	0.9	20.0	5.7	8.2	69.7	43.5	-	-	-
26/04/2003	2.3	1.4	3.0	1.4	5.0	26.0	9.3	-	-	-
27/04/2003	2.3	0.7	1.6	1.4	2.7	10.9	7.1	-	-	-
28/04/2003	2.5	1.1	5.5	1.4	8.2	42.4	22.3	-	-	-
29/04/2003	2.5	0.7	4.8	1.4	6.8	15.7	6.4	-	-	-
30/04/2003	2.5	2.1	8.0	1.8	5.7	55.6	16.9	-	-	-
01/05/2003	-	0.7	0.9	0.5	1.1	7.7	4.1	-	-	-
02/05/2003	-	0.7	7.7	0.9	3.2	122.8	10.0	-	-	-
03/05/2003	3.2	0.7	1.1	1.1	3.9	7.5	4.8	-	-	-
04/05/2003	-	0.7	1.8	0.9	2.1	12.3	8.4	-	-	-
05/05/2003	2.5	0.9	4.3	2.1	4.8	21.2	14.4	-	-	-
06/05/2003	7.5	0.7	7.1	2.7	2.1	18.9	11.4	-	-	-
07/05/2003	4.3	0.7	3.9	3.0	9.8	28.0	21.6	-	-	-
08/05/2003	9.8	0.7	6.6	4.3	3.6	33.7	27.6	-	-	-
09/05/2003	12.3	0.9	5.9	6.2	3.2	46.9	32.8	-	-	-
10/05/2003	5.9	0.7	4.1	2.1	1.6	16.6	10.3	-	-	-
11/05/2003	2.5	1.4	2.5	1.1	4.1	16.2	7.3	-	-	-
12/05/2003	5.2	1.1	5.7	2.3	3.6	27.6	16.4	-	-	-
13/05/2003	2.3	0.7	6.8	1.4	0.9	11.4	10.7	-	-	-
14/05/2003	-	***3.0***	***3.8***	***2.0***	***7.0***	***19.6***	***21.7***	***1.0***	***5.0***	***1.0***
15/05/2003	-	***3.0***	***7.7***	***2.0***	***7.0***	***66.2***	***32.5***	***3.2***	***5.0***	***1.0***
16/05/2003	-	***3.0***	***8.9***	***2.0***	***7.0***	***100.9***	***40.3***	***2.3***	***5.0***	***1.0***
17/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***39.7***	***18.2***	***3.6***	***5.0***	***1.0***
18/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***11.4***	***18.0***	***1.0***	***5.0***	***1.0***
19/05/2003	-	***3.0***	***2.9***	***2.0***	***7.0***	***29.2***	***29.2***	***3.1***	***5.0***	***1.0***
20/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***27.6***	***16.8***	***1.0***	***5.0***	***1.0***
21/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***12.5***	***13.3***	***1.0***	***5.0***	***1.0***
22/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***11.1***	***17.6***	***1.0***	***5.0***	***1.0***
23/05/2003	-	***3.0***	***11.4***	***2.0***	***7.0***	***19.2***	***17.2***	***1.6***	***5.0***	***1.0***
24/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***23.5***	***18.5***	***1.4***	***5.0***	***1.0***
25/05/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***18.7***	***21.6***	***1.0***	***5.0***	***1.0***
26/05/2003	-	***6.0***	***7.7***	***6.6***	***7.0***	***29.8***	***29.0***	***1.3***	***5.0***	***1.0***
27/05/2003	-	***6.1***	***19.4***	***10.4***	***7.0***	***36.2***	***32.3***	***1.7***	***5.0***	***1.0***
28/05/2003	-	***3.0***	***5.3***	***7.9***	***19.0***	***60.1***	***43.5***	***2.3***	***5.0***	***1.0***
29/05/2003	-	***5.6***	***4.9***	***2.0***	***34.3***	***40.2***	***36.3***	***2.3***	***5.0***	***1.0***
30/05/2003	-	***3.0***	***1.0***	***6.5***	***34.6***	***25.6***	***25.7***	***1.3***	***5.0***	***1.0***
31/05/2003	-	***3.0***	***1.0***	***8.6***	***7.0***	***25.8***	***26.8***	***1.5***	***5.0***	***1.0***
01/06/2003	-	***3.0***	***2.8***	***2.0***	***16.2***	***50.0***	***26.0***	***1.5***	***5.0***	***1.0***
02/06/2003	-	***5.6***	***7.7***	***6.3***	***7.0***	***30.4***	***24.8***	***1.9***	***5.0***	***1.0***
03/06/2003	-	***3.0***	***11.2***	***2.0***	***7.0***	***70.2***	***35.7***	***2.3***	***5.0***	***1.0***
04/06/2003	-	***6.1***	***7.3***	***2.0***	***16.0***	***47.2***	***28.0***	***2.7***	***5.0***	***1.0***
05/06/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***18.2***	***16.6***	***1.0***	***5.0***	***1.0***
06/06/2003	-	***3.0***	***6.1***	***2.0***	***7.0***	***48.0***	***31.2***	***2.4***	***5.0***	***1.0***
07/06/2003	-	***3.0***	***2.9***	***2.0***	***7.0***	***25.1***	***25.4***	***1.6***	***5.0***	***1.0***
08/06/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***16.1***	***25.1***	***1.0***	***5.0***	***1.0***
09/06/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***8.5***	***14.1***	***1.0***	***5.0***	***1.0***
10/06/2003	-	***3.0***	***5.6***	***2.0***	***7.0***	***86.7***	***47.4***	***1.3***	***5.0***	***1.0***
11/06/2003	-	***3.0***	***3.8***	***2.0***	***7.0***	***18.7***	***20.8***	***1.0***	***5.0***	***1.0***
12/06/2003	-	***3.0***	***6.9***	***2.0***	***14.9***	***43.0***	***31.0***	***2.3***	***5.0***	***1.0***
13/06/2003	-	***3.0***	***9.7***	***7.4***	***7.0***	***74.3***	***47.7***	***1.9***	***5.0***	***1.0***
14/06/2003	-	***3.0***	***5.8***	***6.6***	***7.0***	***69.7***	***69.6***	***2.8***	***5.0***	***1.0***
15/06/2003	-	***3.0***	***3.9***	***2.0***	***7.0***	***35.9***	***38.6***	***1.7***	***5.0***	***1.0***
16/06/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***28.8***	***29.8***	***1.8***	***5.0***	***1.0***
17/06/2003	-	***6.0***	***7.0***	***5.5***	***18.5***	***104.1***	***63.9***	***2.9***	***5.0***	***1.0***
18/06/2003	-	***3.0***	***3.9***	***2.0***	***7.0***	***21.7***	***23.5***	***1.1***	***5.0***	***1.0***

19/06/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*13.1*	*14.3*	*1.0*	*5.0*	*1.0*
20/06/2003	-	*3.0*	*20.2*	*2.0*	*7.0*	*17.0*	*21.2*	*1.0*	*5.0*	*1.0*
Mean	5.5	3.0	6.4	3.4	9.4	53.4	33.4	2.3	5.0	1.0
Minimum	2.3	0.7	0.9	0.5	0.9	7.5	4.1	1.0	5.0	1.0
Maximum	14.6	7.3	32.4	11.8	34.6	304.0	126.4	7.0	5.0	1.5

Detection limit (VMM): Pb: 7 ng/m^3 - Zn: 3 ng/m^3 - Cu: 14 ng/m^3 - Ni: 5 ng/m^3 - Sb: 1 ng/m^3 - As: 9 ng/m^3 - Mn: 3 ng/m^3 - Cd: 1 ng/m^3 - Cr: 5 ng/m^3

Detection limit (UA): V: 0.3 ng/m^3 - Pb: 2.3 ng/m^3 - Zn: 0.7 ng/m^3 - Cu: 0.9 ng/m^3 - Ni: / ng/m^3 - Mn: 0.3 ng/m^3 - Cr: 1.5 ng/m^3

(Values below the detection limit (DL) are archived as DL/2)

Table 5.7.: Heavy metals in PM2.5 in Menen during summer [ng/m^3]

	V	**Cr**	**Mn**	**Ni**	**Cu**	**Zn**	**Pb**	**Sb**	**As**	**Cd**
21/06/2003	-	*3.0*	*3.9*	*2.0*	*7.0*	*31.4*	*30.7*	*3.3*	*5.0*	*1.0*
22/06/2003	-	*3.0*	*5.9*	*2.0*	*15.4*	*98.2*	*37.3*	*2.1*	*5.0*	*1.0*
23/06/2003	-	*5.6*	*5.2*	*2.0*	*7.0*	*62.4*	*27.4*	*1.3*	*5.0*	*1.0*
24/06/2003	-	*3.0*	*3.1*	*2.0*	*7.0*	*17.8*	*18.8*	*1.0*	*5.0*	*1.0*
25/06/2003	-	*3.0*	*4.4*	*2.0*	*7.0*	*40.0*	*32.8*	*1.7*	*5.0*	*1.0*
26/06/2003	-	*3.0*	*8.9*	*2.0*	*7.0*	*48.9*	*31.1*	*1.9*	*5.0*	*1.0*
27/06/2003	-	*5.8*	*4.0*	*6.5*	*7.0*	*34.1*	*24.6*	*1.0*	*5.0*	*1.0*
28/06/2003	-	*3.0*	*3.5*	*2.0*	*7.0*	*22.7*	*19.4*	*1.1*	*5.0*	*1.0*
29/06/2003	-	*3.0*	*3.7*	*2.0*	*7.0*	*62.1*	*42.2*	*2.1*	*5.0*	*1.0*
30/06/2003	-	*3.0*	*5.0*	*2.0*	*7.0*	*44.9*	*29.1*	*1.9*	*5.0*	*1.0*
01/07/2003	-	*5.6*	*5.9*	*2.0*	*15.5*	*59.7*	*38.7*	*2.2*	*5.0*	*1.0*
02/07/2003	-	*3.0*	*3.9*	*2.0*	*7.0*	*19.9*	*19.9*	*1.0*	*5.0*	*1.0*
03/07/2003	-	*3.0*	*7.4*	*2.0*	*7.0*	*29.6*	*25.7*	*1.5*	*5.0*	*1.0*
04/07/2003	-	*3.0*	*5.0*	*4.8*	*7.0*	*35.9*	*30.8*	*1.7*	*5.0*	*1.0*
05/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*26.2*	*19.7*	*1.0*	*5.0*	*1.0*
06/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*20.9*	*26.0*	*1.2*	*5.0*	*1.0*
07/07/2003	-	*5.6*	*6.8*	*2.0*	*7.0*	*24.7*	*26.6*	*1.1*	*5.0*	*1.0*
08/07/2003	-	*3.0*	*5.3*	*2.0*	*7.0*	*27.5*	*26.6*	*1.4*	*5.0*	*1.0*
09/07/2003	-	*3.0*	*7.4*	*2.0*	*7.0*	*29.8*	*34.1*	*2.2*	*5.0*	*1.0*
10/07/2003	-	*3.0*	*8.2*	*2.0*	*7.0*	*44.1*	*28.2*	*2.7*	*5.0*	*1.0*
11/07/2003	-	*6.3*	*5.2*	*2.0*	*7.0*	*59.1*	*28.2*	*1.7*	*5.0*	*1.0*
12/07/2003	-	*3.0*	*4.4*	*2.0*	*7.0*	*61.6*	*48.2*	*2.0*	*5.0*	*1.0*
13/07/2003	-	*3.0*	*5.1*	*2.0*	*7.0*	*79.1*	*58.9*	*2.2*	*5.0*	*1.0*
14/07/2003	-	*3.0*	*3.9*	*2.0*	*7.0*	*36.1*	*25.6*	*1.0*	*5.0*	*1.0*
15/07/2003	-	-	-	-	-	-	-	-	-	-
16/07/2003	-	*3.0*	*8.1*	*2.0*	*7.0*	*72.9*	*41.7*	*3.5*	*5.0*	*1.0*
17/07/2003	-	*3.0*	*4.8*	*2.0*	*7.0*	*20.3*	*19.7*	*1.2*	*5.0*	*1.0*
18/07/2003	-	*3.0*	*4.0*	*2.0*	*16.9*	*41.6*	*29.9*	*2.5*	*5.0*	*1.0*
19/07/2003	-	*3.0*	*4.0*	*2.0*	*7.0*	*40.9*	*25.2*	*1.9*	*5.0*	*1.0*
20/07/2003	-	*3.0*	*5.7*	*2.0*	*7.0*	*29.8*	*22.2*	*1.2*	*5.0*	*1.0*
21/07/2003	-	*3.0*	*3.2*	*2.0*	*7.0*	*37.3*	*22.0*	*1.3*	*5.0*	*1.0*
22/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*12.4*	*13.2*	*1.0*	*5.0*	*1.0*
23/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*16.3*	*18.1*	*1.0*	*5.0*	*1.0*
24/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*17.2*	*18.3*	*2.1*	*5.0*	*1.0*
25/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*20.1*	*26.1*	*1.7*	*5.0*	*1.0*
26/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*10.2*	*15.8*	*1.0*	*5.0*	*1.0*
27/07/2003	-	*3.0*	*1.0*	*2.0*	*24.8*	*7.0*	*11.7*	*1.0*	*5.0*	*1.0*
28/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*10.6*	*18.1*	*1.0*	*5.0*	*1.0*
29/07/2003	-	*3.0*	*3.4*	*2.0*	*18.6*	*32.2*	*25.3*	*4.6*	*5.0*	*1.0*
30/07/2003	-	*3.0*	*1.0*	*2.0*	*7.0*	*10.2*	*13.5*	*1.0*	*5.0*	*1.0*
31/07/2003	-	*3.0*	*2.9*	*2.0*	*7.0*	*29.5*	*25.3*	*1.7*	*5.0*	*1.0*
01/08/2003	-	*3.0*	*3.4*	*2.0*	*7.0*	*28.1*	*17.1*	*1.4*	*5.0*	*1.0*
02/08/2003	-	*3.0*	*5.6*	*2.0*	*7.0*	*16.0*	*19.1*	*1.3*	*5.0*	*1.0*
03/08/2003	-	*3.0*	*1.0*	*5.9*	*7.0*	*34.2*	*29.1*	*1.5*	*5.0*	*1.0*
04/08/2003	-	*3.0*	*1.0*	*5.2*	*7.0*	*46.0*	*30.9*	*1.9*	*5.0*	*1.0*

05/08/2003	-	***3.0***	***3.2***	***2.0***	***7.0***	***66.4***	***39.7***	***2.3***	***5.0***	***1.0***
06/08/2003	-	***3.0***	***7.6***	***2.0***	***7.0***	***60.6***	***26.8***	***1.8***	***5.0***	***1.0***
07/08/2003	-	***5.5***	***13.6***	***13.9***	***7.0***	***58.0***	***37.6***	***2.6***	***5.0***	***1.0***
08/08/2003	-	***3.0***	***2.8***	***6.9***	***7.0***	***19.6***	***13.7***	***1.2***	***5.0***	***1.0***
09/08/2003	-	***3.0***	***1.0***	***5.2***	***7.0***	***24.3***	***21.2***	***1.4***	***5.0***	***1.0***
10/08/2003	-	***3.0***	***4.3***	***2.0***	***7.0***	***44.2***	***30.5***	***2.4***	***5.0***	***1.0***
11/08/2003	-	***3.0***	***7.3***	***2.0***	***7.0***	***69.7***	***40.4***	***3.0***	***5.0***	***1.0***
12/08/2003	-	***7.3***	***8.6***	***10.6***	***7.0***	***43.4***	***26.6***	***2.4***	***5.0***	***1.0***
13/08/2003	-	***3.0***	***3.9***	***7.9***	***7.0***	***29.7***	***25.4***	***1.3***	***5.0***	***1.0***
14/08/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***13.9***	***17.8***	***1.0***	***5.0***	***1.0***
15/08/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***12.9***	***16.0***	***1.1***	***5.0***	***1.0***
16/08/2003	-	***3.0***	***1.0***	***2.0***	***7.0***	***22.4***	***27.8***	***1.0***	***5.0***	***1.0***
17/08/2003	-	***3.0***	***4.5***	***2.0***	***7.0***	***29.6***	***28.9***	***1.7***	***5.0***	***1.0***
18/08/2003	-	***3.0***	***4.4***	***2.0***	***22.5***	***50.5***	***41.4***	***1.8***	***5.0***	***1.0***
19/08/2003	-	***3.0***	***2.8***	***2.0***	***7.0***	***12.9***	***15.4***	***1.0***	***5.0***	***1.0***
20/08/2003	***Power cut-off***									
21/08/2003	***Power cut-off***									
22/08/2003	***Power cut-off***									
23/08/2003	7.7	0.7	2.3	3.0	1.1	14.1	9.6	-	-	-
24/08/2003	6.6	0.7	2.3	3.0	3.9	26.7	23.9	-	-	-
25/08/2003	3.4	0.7	2.3	2.3	6.8	15.5	14.4	-	-	-
26/08/2003	7.5	0.7	2.3	3.2	1.8	12.1	10.5	-	-	-
27/08/2003	3.6	0.7	2.3	2.1	1.8	8.2	4.8	-	-	-
28/08/2003	6.8	0.7	2.3	3.6	12.8	77.7	61.3	-	-	-
29/08/2003	3.9	0.7	2.3	2.1	4.8	13.9	10.7	-	-	-
30/08/2003	2.3	0.7	2.3	0.9	1.4	8.7	4.6	-	-	-
31/08/2003	1.8	0.7	2.3	0.9	2.3	19.6	25.5	-	-	-
01/09/2003	2.5	0.7	2.3	1.4	10.7	23.5	16.9	-	-	-
02/09/2003	3.4	0.7	2.3	1.4	25.1	8.7	5.5	-	-	-
03/09/2003	7.7	1.1	2.3	3.9	28.7	35.3	18.9	-	-	-
04/09/2003	6.2	2.1	2.3	3.6	67.0	85.7	36.0	-	-	-
05/09/2003	3.4	4.3	2.3	2.1	70.2	145.1	48.3	-	-	-
06/09/2003	3.0	1.4	2.3	2.7	5.2	60.8	21.6	-	-	-
07/09/2003	6.8	0.7	2.3	3.4	1.6	35.1	19.6	-	-	-
08/09/2003	8.2	1.1	2.3	4.1	4.1	61.7	57.4	-	-	-
09/09/2003	9.6	0.7	2.3	4.3	2.7	18.5	15.9	-	-	-
10/09/2003	3.2	0.9	2.3	2.3	3.9	39.4	18.0	-	-	-
11/09/2003	6.2	0.7	2.3	2.5	1.8	13.4	8.9	-	-	-
12/09/2003	3.9	0.9	2.3	2.7	5.7	17.1	8.7	-	-	-
13/09/2003	3.4	0.7	2.3	2.1	3.2	35.5	25.7	-	-	-
14/09/2003	2.1	0.7	2.3	0.7	2.7	23.7	17.8	-	-	-
15/09/2003	2.5	0.9	2.3	1.1	3.6	42.4	25.7	-	-	-
16/09/2003	-							-	-	-
17/09/2003	-	***7.0***	***10.7***	***4.7***	***18.4***	***104.6***	***59.9***	***7.7***	***5.0***	***1.0***
18/09/2003	-	***3.0***	***9.1***	***5.9***	***21.5***	***59.9***	***36.7***	***4.4***	***5.0***	***1.0***
19/09/2003	-	***6.2***	***12.9***	***9.2***	***22.5***	***76.7***	***37.4***	***5.4***	***5.0***	***1.0***
20/09/2003	-	***3.0***	***5.1***	***4.9***	***7.0***	***36.4***	***23.6***	***2.5***	***5.0***	***1.0***
Mean	**4.8**	**2.8**	**3.8**	**2.9**	**9.5**	**37.1**	**25.9**	**1.9**	**5.0**	**1.0**
Minimum	**1.8**	**0.7**	**1.0**	**0.7**	**1.1**	**7.0**	**4.6**	**1.0**	**5.0**	**1.0**
Maximum	**9.6**	**7.3**	**13.6**	**13.9**	**70.2**	**145.1**	**61.3**	**7.7**	**5.0**	**1.0**

Detection limit (VMM): Pb: 7 ng/m³ - Zn: 3 ng/m³ - Cu: 14 ng/m³ - Ni: 5 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Mn: 3 ng/m³ - Cd: 1 ng/m³ - Cr: 5 ng/m³

Detection limit (UA): V: 0.3 ng/m^3 - Pb: 2.3 ng/m³ - Zn: 0.7 ng/m³ - Cu: 0.9 ng/m³ - Ni: / ng/m³ - Mn: 0.3 ng/m³ - Cr: 1.5 ng/m³

(Values below the detection limit (DL) are archived as DL/2)

Table 5.8.: Heavy metals in PM2.5 in Menen during autumn [ng/m^3]

	V	Cr	Mn	Ni	Cu	Zn	Pb	Sb	As	Cd
21/09/2003	-	***3.0***	***1.0***	***2.0***	***14.8***	***37.3***	***26.6***	***2.5***	***5.0***	***1.0***
22/09/2003	-	***6.1***	***10.1***	***9.4***	***33.0***	***79.2***	***55.5***	***3.6***	***5.0***	***1.0***

23/09/2003	-	3.0	1.0	2.0	7.0	14.8	20.3	1.0	5.0	1.0
24/09/2003	-	3.0	7.9	2.0	7.0	41.7	33.0	2.6	5.0	1.0
25/09/2003	-	5.8	7.5	2.0	7.0	93.7	49.3	3.6	5.0	1.0
26/09/2003	-	7.2	17.8	11.7	7.0	73.8	40.4	4.3	5.0	1.0
27/09/2003	-	3.0	6.0	4.6	7.0	52.6	35.1	2.8	5.0	1.0
28/09/2003	-	8.4	5.8	2.0	7.0	51.0	37.9	2.6	5.0	1.0
29/09/2003	-	3.0	5.3	2.0	7.0	30.9	22.7	2.7	5.0	1.0
30/09/2003	-	3.0	9.0	2.0	7.0	84.7	37.9	2.8	5.0	1.0
01/10/2003	3.2	5.9	10.9	5.9	8.2	106.6	42.2	-	-	-
02/10/2003	2.5	2.3	6.6	1.8	5.5	50.8	27.1	-	-	-
03/10/2003	8.9	3.0	9.1	6.2	7.7	77.5	54.0	-	-	-
04/10/2003	1.4	0.7	5.0	0.9	2.3	33.9	11.2	-	-	-
05/10/2003	1.4	0.9	2.5	1.1	1.8	22.3	8.2	-	-	-
06/10/2003	1.4	4.6	12.5	8.2	21.0	29.6	17.8	-	-	-
07/10/2003	2.1	0.9	5.2	0.7	2.5	28.0	9.8	-	-	-
08/10/2003	3.6	1.4	7.3	2.3	2.5	34.0	16.2	-	-	-
09/10/2003	3.4	0.7	3.0	1.4	3.4	17.1	7.1	-	-	-
10/10/2003	3.9	4.1	4.6	1.8	1.4	87.5	7.5	-	-	-
11/10/2003	3.4	0.7	1.8	1.8	2.7	24.1	18.7	-	-	-
12/10/2003	3.4	1.1	3.4	2.3	3.4	31.7	20.7	-	-	-
13/10/2003	1.8	2.3	5.5	1.4	4.6	58.6	20.5	-	-	-
14/10/2003	2.5	1.8	6.2	2.3	5.0	41.7	14.6	-	-	-
15/10/2003	4.3	2.3	7.7	2.5	9.1	46.7	22.8	-	-	-
16/10/2003		2.7	8.9	2.7	7.3	65.0	31.5	-	-	-
17/10/2003	5.5	3.6	10.0	3.4	7.5	67.9	30.3	-	-	-
18/10/2003	6.2	3.6	14.4	4.6	10.9	154.7	112.3	-	-	-
19/10/2003	7.7	1.6	12.8	5.5	7.5	118.7	103.7	-	-	-
20/10/2003	5.7	0.7	4.3	2.7	6.8	39.9	28.9	-	-	-
21/10/2003	4.8	0.7	7.3	2.5	5.9	38.3	32.8	-	-	-
22/10/2003	3.6	1.1	7.7	2.7	7.1	63.6	24.4	-	-	-
23/10/2003	5.0	0.7	6.2	3.2	4.1	51.3	33.5	-	-	-
24/10/2003	3.9	1.8	5.7	2.5	5.9	60.6	45.6	-	-	-
25/10/2003	4.8	1.4	3.4	2.3	2.5	21.9	18.5	-	-	-
26/10/2003	3.0	0.7	2.5	1.4	4.3	26.2	18.9	-	-	-
27/10/2003	14.6	0.7	14.1	8.0	20.7	107.3	83.4	-	-	-
28/10/2003	4.6	3.2	32.6	4.6	18.2	162.5	89.1	-	-	-
29/10/2003	-	3.0	6.6	2.0	20.6	142.8	58.7	5.5	5.0	1.0
30/10/2003	-	3.0	8.3	2.0	16.2	94.8	40.2	3.1	5.0	1.0
31/10/2003	-	3.0	1.0	2.0	22.9	61.6	31.7	2.5	5.0	1.0
1/11/2003	-	3.0	2.7	2.0	7.0	37.1	22.2	1.4	5.0	1.0
2/11/2003	-	3.0	1.0	2.0	7.0	24.3	23.5	1.2	5.0	1.0
3/11/2003	-	3.0	3.8	2.0	7.0	31.2	18.3	1.0	5.0	1.0
4/11/2003	-	3.0	7.9	2.0	7.0	83.9	37.5	2.5	5.0	1.0
5/11/2003	-	6.0	23.7	2.0	7.0	68.1	34.4	2.0	5.0	1.0
6/11/2003	-	7.2	14.1	6.1	18.4	132.7	86.8	5.9	5.0	1.0
7/11/2003	-	6.3	8.4	2.0	23.4	138.6	80.6	3.9	5.0	1.0
8/11/2003	-	3.0	3.5	2.0	7.0	51.4	35.5	2.2	5.0	1.0
9/11/2003	-	3.0	7.4	2.0	7.0	115.3	38.8	2.7	5.0	1.0
10/11/2003	-	3.0	3.2	2.0	7.0	79.0	62.3	3.1	5.0	1.0
11/11/2003	-	3.0	8.7	4.6	7.0	93.6	69.4	3.9	5.0	1.0
12/11/2003	-	3.0	7.2	6.0	7.0	105.0	51.0	4.1	5.0	1.0
13/11/2003	-	3.0	10.4	2.0	7.0	35.2	28.3	2.6	5.0	1.0
14/11/2003	-	3.0	4.1	2.0	7.0	46.4	35.5	2.6	5.0	1.0
15/11/2003	-	3.0	1.0	2.0	7.0	33.0	26.8	2.5	5.0	1.0
16/11/2003	-	3.0	1.0	2.0	7.0	33.9	30.6	1.6	5.0	1.0
17/11/2003	-	5.7	8.3	2.0	7.0	74.7	34.2	1.8	5.0	1.0
18/11/2003	-	3.0	1.0	2.0	7.0	26.7	10.8	1.0	5.0	1.0
19/11/2003	-	3.0	2.9	2.0	7.0	26.4	18.2	1.0	5.0	1.0
20/11/2003	-	7.2	20.5	2.0	7.0	53.2	28.3	3.2	5.0	1.0
21/11/2003	-	3.0	12.4	2.0	7.0	73.5	39.5	4.4	5.0	1.0
22/11/2003	-	3.0	1.0	2.0	7.0	27.5	24.5	2.3	5.0	1.0
23/11/2003	-	3.0	4.1	2.0	7.0	41.7	37.3	1.9	5.0	1.0
24/11/2003	-	3.0	5.7	2.0	7.0	44.3	23.6	1.9	5.0	1.0
25/11/2003	-	6.5	25.5	2.0	7.0	87.8	44.2	3.9	5.0	1.0

26/11/2003	2.5	1.1	3.9	1.8	6.8	48.3	13.9	-	-	-
27/11/2003	5.2	3.2	9.6	4.8	24.4	89.1	62.2	-	-	-
28/11/2003	6.2	5.7	9.3	3.6	15.3	120.5	62.4	-	-	-
29/11/2003	4.1	0.7	1.8	2.1	2.5	20.3	13.7	-	-	-
30/11/2003	4.3	0.9	1.1	1.6	2.1	21.9	12.5	-	-	-
01/12/2003	2.1	1.6	3.0	1.1	3.2	41.2	19.8	-	-	-
02/12/2003	4.1	3.0	18.9	2.7	10.7	135.4	67.7	-	-	-
03/12/2003	15.0	3.9	17.1	10.0	11.4	155.4	97.3	-	-	-
04/12/2003	3.6	0.7	3.6	2.7	5.2	52.9	23.0	-	-	-
05/12/2003	5.2	0.9	5.7	3.2	4.6	72.7	46.5	-	-	-
06/12/2003	4.8	0.0	4.8	3.2	3.4	100.5	56.5	-	-	-
07/12/2003	3.4	1.8	5.5	2.7	4.1	68.4	36.0	-	-	-
08/12/2003	5.7	3.9	22.1	4.8	14.6	154.5	66.1	-	-	-
09/12/2003	8.7	7.3	43.1	8.0	25.5	359.6	179.6	-	-	-
10/12/2003	10.9	5.9	25.1	7.5	44.9	363.5	219.2	-	-	-
11/12/2003	8.4	0.7	7.1	4.8	9.3	57.6	34.6	-	-	-
12/12/2003	5.7	1.4	7.7	3.4	9.6	83.2	49.9	-	-	-
13/12/2003	2.1	0.5	1.8	1.1	3.6	19.1	5.2	-	-	-
14/12/2003	2.5	0.7	5.0	1.4	2.1	40.3	33.3	-	-	-
15/12/2003	2.1	0.7	1.1	0.9	8.7	16.6	8.2	-	-	-
16/12/2003	6.6	2.5	16.6	3.6	7.1	60.4	31.4	-	-	-
17/12/2003	6.4	4.8	36.7	5.0	18.9	155.4	93.2	-	-	-
18/12/2003	3.4	4.8	50.3	4.1	11.6	171.6	118.5	-	-	-
19/12/2003	5.0	4.6	14.1	5.0	18.7	181.2	62.7	-	-	-
20/12/2003	3.0	1.1	3.2	1.4	6.8	44.4	16.2	-	-	-
Mean	**4.8**	**2.8**	**3.8**	**2.9**	**9.5**	**37.1**	**25.9**	**2.7**	**5.0**	**1.0**
Minimum	**1.8**	**0.7**	**1.0**	**0.7**	**1.1**	**7.0**	**4.6**	**1.0**	**5.0**	**1.0**
Maximum	**9.6**	**7.3**	**13.6**	**13.9**	**70.2**	**145.1**	**61.3**	**5.9**	**5.0**	**1.0**

Detection limit (VMM): Pb: 7 ng/m^3 - Zn: 3 ng/m^3 - Cu: 14 ng/m^3 - Ni: 5 ng/m^3 - Sb: 1 ng/m^3 - As: 9 ng/m^3 - Mn: 3 ng/m^3 - Cd: 1 ng/m^3 - Cr: 5 ng/m^3

Detection limit (UA): V: 0.3 ng/m^3 - Pb: 2.3 ng/m^3 - Zn: 0.7 ng/m^3 - Cu: 0.9 ng/m^3 - Ni: / ng/m^3 - Mn: 0.3 ng/m^3 - Cr: 1.5 ng/m^3

(Values below the detection limit (DL) are archived as DL/2)

B Heavy metals in PM10

VMM determined the heavy metals in the PM10 fraction: chromium, manganese, nickel, copper, zinc, antimony, arsenic, cadmium and lead. Vanadium wasn't analysed. An overview of the heavy metal content of PM10 during the 4 seasons is shown in tables 5.9., 5.10., 5.11. and 5.12.. The detection limits for each heavy metal are specified under each table.

Zinc and lead are the most abundant heavy metals in PM10, followed by manganese and copper. Chromium, nickel, antimony and arsenic are present in each sample, although in smaller concentrations. Cadmium is only represented by very small amounts. Figure 5.7. shows an overview of the mean concentrations of each heavy metal during the 4 seasons. Depending on the heavy metal the highest concentration is measured in the winter (lead, nickel, arsenic, manganese and cadmium) or in autumn (zinc, copper, antimony and chromium). All heavy metals shows the lowest concentrations in the summer. Chromium, nickel, antimony, arsenic and cadmium show less seasonal variability then manganese and copper. Lead and zinc show the largest variability between the seasons. The concentrations lead, zinc, copper and manganese show the largest difference between the maximum and the minimum detected concentration, each season.

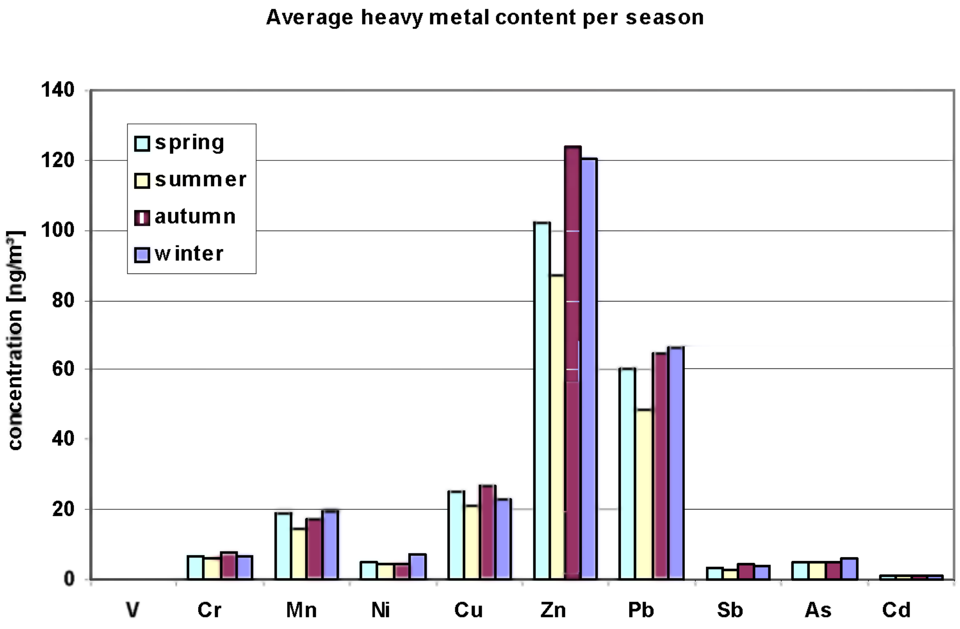


Figure 5.7.: Average heavy metal content in PM10 per season at Menen

Table 5.9.: Heavy metals in PM10 in Menen during winter [ng/m^3]

	V	Cr	Mn	Ni	Cu	Zn	Pb	Sb	As	Cd
15/12/2002	-	5.4	11.8	10.0	14.5	67.6	14.5	1.8	9.1	1.1
16/12/2002	-	5.4	11.4	6.9	14.5	57.7	20.9	2.0	9.1	1.1
17/12/2002	-	5.4	11.8	9.3	14.5	99.2	49.3	2.5	9.1	1.1
18/12/2002	-	9.6	22.7	11.4	21.4	131.0	93.8	9.4	9.1	1.1
19/12/2002	-	11.6	28.5	10.2	28.7	240.7	62.2	5.4	9.1	1.1
20/12/2002	-	13.2	34.6	12.9	41.2	327.0	226.9	4.0	9.1	1.1
21/12/2002	-	5.4	8.3	8.0	15.1	166.2	168.7	8.0	9.1	3.6
22/12/2002	-	5.4	13.1	6.7	14.5	33.2	10.2	2.0	9.1	1.1
23/12/2002	-	5.4	11.2	8.7	14.5	69.5	55.5	2.7	9.1	1.1
24/12/2002	-	5.4	3.8	5.6	14.5	161.4	63.5	2.5	9.1	2.0
25/12/2002	-	5.4	2.7	4.5	14.5	147.1	96.5	1.8	9.1	3.4
26/12/2002	-	5.4	2.7	6.7	14.5	61.3	30.8	1.5	9.1	1.1
27/12/2002	-	5.4	2.7	5.6	14.5	108.3	76.7	4.7	9.1	2.4
28/12/2002	-	5.4	7.1	7.4	14.5	39.9	9.3	1.6	9.1	1.1
29/12/2002	-	5.4	2.7	4.7	14.5	28.5	7.3	1.1	9.1	1.1
30/12/2002	-	5.4	2.7	6.5	14.5	26.3	7.3	1.1	9.1	1.1
31/12/2002	-	5.4	2.9	6.7	14.5	28.7	13.1	3.8	9.1	1.1
1/01/2003	-	3.0	1.0	5.6	7.0	49.9	27.2	1.3	5.0	1.0
2/01/2003	-	3.0	3.1	6.0	7.0	32.8	12.5	1.0	5.0	1.0
3/01/2003	-	3.0	9.3	6.3	7.0	39.0	9.4	1.8	5.0	1.0
4/01/2003	-	3.0	5.8	8.5	7.0	43.4	21.6	2.0	5.0	1.0
5/01/2003	-	3.0	9.4	9.4	7.0	57.1	44.3	2.5	5.0	1.0
6/01/2003	-	3.0	19.0	9.1	7.0	81.5	54.6	3.1	5.0	1.0
7/01/2003	-	3.0	13.6	9.4	7.0	77.6	35.9	3.1	5.0	1.0
8/01/2003	-	12.5	29.0	11.4	14.7	183.2	83.5	10.5	5.0	1.0
9/01/2003	-	7.8	38.5	17.6	7.0	141.3	151.6	5.6	5.0	1.0
10/01/2003	-	21.8	59.7	23.6	67.7	460.7	266.6	6.9	5.0	9.1
11/01/2003	-	6.2	20.1	12.3	7.0	133.3	83.6	8.0	5.0	1.0
12/01/2003	-	13.6	16.1	10.0	25.9	170.2	69.8	5.4	5.0	1.0
13/01/2003	-	3.0	12.7	9.8	7.0	77.1	10.7	8.7	5.0	1.0
14/01/2003	-	5.8	9.1	8.3	7.0	49.9	11.1	2.5	5.0	1.0

15/01/2003	-	14.1	351.0	14.3	132.1	657.5	187.7	3.1	5.0	1.5
16/01/2003	-	14.1	32.1	10.3	7.0	112.1	27.4	4.0	5.0	1.0
17/01/2003	-	7.6	16.3	9.3	24.5	254.5	278.3	4.9	5.0	5.8
18/01/2003	-	3.0	3.8	5.6	35.2	103.6	25.0	3.3	5.0	1.0
19/01/2003	-	3.0	9.1	5.1	7.0	46.3	12.7	1.5	5.0	1.0
20/01/2003	-	8.9	20.7	9.8	15.4	149.7	90.7	2.7	5.0	1.3
21/01/2003	-	9.8	11.4	12.0	25.0	207.5	107.0	2.2	5.0	1.8
22/01/2003	-	3.0	14.9	9.1	7.0	86.0	26.7	2.5	5.0	1.8
23/01/2003	-	3.0	5.8	8.0	7.0	35.2	4.0	1.5	5.0	1.0
24/01/2003	-	11.8	46.8	13.2	53.3	177.0	73.1	5.8	5.0	1.8
25/01/2003	-	6.3	13.8	8.2	7.0	121.0	63.5	4.4	5.0	1.0
26/01/2003	-	3.0	11.6	8.2	7.0	54.6	23.0	2.0	5.0	1.0
27/01/2003	-	3.0	22.7	9.3	7.0	51.0	46.3	1.8	5.0	1.0
28/01/2003	-	3.0	10.7	5.1	7.0	60.6	88.9	1.3	5.0	1.0
29/01/2003	-	3.0	1.0	4.9	7.0	35.0	23.6	1.0	5.0	1.0
30/01/2003	-	3.0	7.5	2.0	7.0	33.5	36.5	1.5	5.0	1.0
31/01/2003	-	3.0	8.1	2.0	7.0	59.2	44.5	2.2	5.0	1.0
1/02/2003	-	3.0	6.7	2.0	7.0	82.6	37.6	3.8	5.0	1.0
2/02/2003	-	6.5	4.0	2.0	7.0	31.0	21.0	1.0	5.0	1.0
3/02/2003	-	6.7	15.7	2.0	7.0	50.4	43.8	2.0	5.0	1.0
4/02/2003	-	3.0	10.3	2.0	7.0	46.8	39.9	1.7	5.0	1.0
5/02/2003	-	3.0	9.2	2.0	7.0	93.0	54.7	1.5	5.0	1.0
6/02/2003	-	9.3	24.2	8.1	46.3	163.3	97.1	4.5	5.0	1.0
7/02/2003	-	5.6	8.8	4.6	15.7	105.6	37.3	2.9	5.0	1.0
8/02/2003	-	6.7	6.1	2.0	16.1	100.9	36.7	4.2	5.0	1.0
9/02/2003	-	3.0	1.0	2.0	7.0	53.7	32.8	3.2	5.0	1.0
10/02/2003	-	8.2	22.8	5.0	36.0	188.3	110.1	3.8	5.0	1.0
11/02/2003	-	12.1	35.6	7.8	48.6	235.4	125.7	7.4	5.0	1.0
12/02/2003	-	15.8	31.6	7.6	47.4	283.5	109.6	13.5	5.0	1.0
13/02/2003	-									
14/02/2003	-	12.3	44.7	12.1	41.2	296.9	167.5	11.7	9.1	1.8
15/02/2003	-	3.0	14.7	2.0	7.0	116.2	69.0	3.3	5.0	1.0
16/02/2003	-	3.0	10.7	2.0	17.0	70.7	48.5	3.4	5.0	1.0
17/02/2003	-	7.7	20.2	7.4	21.1	109.7	71.4	8.1	5.0	1.0
18/02/2003	-	13.5	26.7	7.0	41.3	157.4	73.7	7.5	5.0	1.0
19/02/2003	-	-	-	-	-	-	-	-	-	-
20/02/2003	-	-	-	-	-	-	-	-	-	-
21/02/2003	-	-	-	-	-	-	-	-	-	-
22/02/2003	-	-	-	-	-	-	-	-	-	-
23/02/2003	-	-	-	-	-	-	-	-	-	-
24/02/2003	-	-	-	-	-	-	-	-	-	-
25/02/2003	-	-	-	-	-	-	-	-	-	-
26/02/2003	-	-	-	-	-	-	-	-	-	-
27/02/2003	-	-	-	-	-	-	-	-	-	-
28/02/2003	-	-	-	-	-	-	-	-	-	-
1/03/2003	-	-	-	-	-	-	-	-	-	-
2/03/2003	-	-	-	-	-	-	-	-	-	-
3/03/2003	-	-	-	-	-	-	-	-	-	-
4/03/2003	-	-	-	-	-	-	-	-	-	-
5/03/2003	-	9.5	19.0	5.8	39.1	150.1	99.8	11.7	5.0	1.0
6/03/2003	-	6.8	29.9	2.0	32.2	75.8	43.4	2.5	5.0	1.0
7/03/2003	-	8.8	21.3	8.8	37.6	209.4	129.7	4.9	5.0	1.0
8/03/2003	-	3.0	1.0	2.0	17.4	32.8	22.5	6.4	5.0	1.0
9/03/2003	-	3.0	1.0	2.0	36.0	71.5	28.8	4.0	5.0	1.0
10/03/2003	-	10.9	24.3	9.0	78.3	199.0	100.6	19.4	5.0	1.9
11/03/2003	-	9.0	14.0	2.0	42.4	106.9	51.6	2.4	5.0	1.0
12/03/2003	-	3.0	5.6	2.0	16.6	23.8	24.2	1.7	5.0	1.0
13/03/2003	-	5.6	15.3	2.0	33.1	84.0	61.4	2.1	5.0	1.0
14/03/2003	-	7.7	17.1	5.6	32.4	96.3	57.3	4.4	5.0	1.0
15/03/2003	-	6.9	9.2	2.0	30.1	70.9	34.8	3.5	5.0	1.0
16/03/2003	-	7.1	11.4	2.0	59.0	82.9	47.8	4.4	5.0	1.0
17/03/2003	-	18.1	48.6	16.5	110.9	375.7	216.3	7.5	5.0	5.1
18/03/2003	-	7.6	22.7	9.6	26.1	148.4	98.3	4.8	5.0	1.0
19/03/2003	-	9.3	25.4	11.0	26.7	116.9	79.1	6.0	5.0	1.1

20/03/2003	-	8.4	24.0	10.3	26.6	86.3	77.2	4.7	5.0	1.0
Mean		**6.8**	**19.7**	**7.2**	**23.1**	**120.4**	**66.6**	**4.2**	**5.9**	**1.4**
Minimum		**3.0**	**1.0**	**2.0**	**7.0**	**23.8**	**4.0**	**1.0**	**5.0**	**1.0**
Maximum		**21.8**	**351.0**	**23.6**	**132.1**	**657.5**	**278.3**	**19.4**	**9.1**	**9.1**

Detection limit (VMM): - Cr: 5 ng/m³ -Mn: 3 ng/m³ -Ni: 5 ng/m³ -Cu: 14 ng/m³ - Zn: 3 ng/m³ - Pb: 7 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Cd: 1 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 5.10.: Heavy metals in PM10 in Menen during spring [ng/m^3]

	V	Cr	Mn	Ni	Cu	Zn	Pb	Sb	As	Cd
21/03/2003	-	10.8	23.9	15.2	28.9	129.1	67.8	5.6	9.3	1.0
22/03/2003	-	10.3	20.9	2.0	30.3	139.5	64.5	5.6	5.0	1.0
23/03/2003	-	7.2	38.4	4.9	28.5	103.4	52.0	5.6	5.0	1.0
24/03/2003	-	17.2	46.7	11.6	69.5	370.1	279.2	5.3	5.0	1.6
25/03/2003	-	9.3	25.6	8.7	28.7	120.7	58.6	7.5	5.0	1.0
26/03/2003	-	12.6	44.9	11.0	44.5	210.7	133.5	9.1	9.7	1.0
27/03/2003	-	11.4	40.1	12.2	30.5	171.0	117.9	8.1	5.0	1.0
28/03/2003	-	12.4	37.0	12.1	45.2	217.4	142.2	9.8	5.0	1.3
29/03/2003	-	8.7	27.7	9.3	30.4	121.8	83.3	5.7	5.0	1.0
30/03/2003	-	6.2	9.0	11.5	19.8	47.1	32.1	2.5	5.0	1.0
31/03/2003	-	3.0	8.9	2.0	16.5	47.7	38.6	2.1	5.0	1.0
1/04/2003	-	12.2	32.8	9.4	52.1	491.5	127.3	3.2	5.0	2.6
2/04/2003	-	3.0	3.6	2.0	7.0	25.1	17.1	1.0	5.0	1.0
3/04/2003	-	3.0	1.0	2.0	7.0	20.7	17.6	1.0	5.0	1.0
4/04/2003	-	11.4	29.0	12.1	41.1	97.8	62.8	4.0	5.0	1.0
5/04/2003	-	3.0	1.0	2.0	7.0	15.2	17.1	1.0	5.0	1.0
6/04/2003	-	3.0	1.0	2.0	7.0	16.1	21.4	1.0	5.0	1.0
7/04/2003	-	3.0	15.0	2.0	7.0	75.8	60.4	2.7	5.0	1.0
8/04/2003	-	7.6	21.9	5.5	17.0	104.6	66.9	4.6	5.0	1.0
9/04/2003	-	3.0	12.0	2.0	7.0	56.7	38.1	2.4	5.0	1.0
10/04/2003	-	3.0	7.1	2.0	15.0	42.0	30.0	2.6	5.0	1.0
11/04/2003	-	15.0	22.0	7.1	48.9	256.0	125.2	7.3	5.0	1.0
12/04/2003	-	8.0	25.1	2.0	28.7	130.0	46.8	7.3	5.0	1.0
13/04/2003	-	3.0	42.2	2.0	7.0	73.6	29.5	2.4	5.0	1.0
14/04/2003	-	7.2	20.9	4.8	7.0	186.1	37.2	1.5	5.0	1.0
15/04/2003	-	10.5	38.2	2.0	33.1	188.6	150.8	3.7	5.0	1.0
16/04/2003	-	10.4	25.8	2.0	41.6	126.0	64.0	5.2	5.0	1.0
17/04/2003	-	10.9	31.8	5.8	26.2	114.2	53.3	4.6	5.0	1.6
18/04/2003	-	7.8	35.6	5.2	24.4	94.1	51.3	4.7	5.0	1.0
19/04/2003	-	3.0	12.8	2.0	7.0	48.6	36.8	2.1	5.0	1.0
20/04/2003	-	6.6	14.0	4.8	7.0	111.0	54.8	3.5	5.0	1.0
21/04/2003	-	3.0	22.0	2.0	7.0	68.6	30.2	1.9	5.0	1.0
22/04/2003	-	8.0	31.2	5.2	27.6	95.8	83.5	5.8	5.0	1.0
23/04/2003	-	6.7	18.4	7.9	16.0	74.8	55.0	5.9	5.0	1.0
24/04/2003	-	14.7	75.9	12.1	50.7	301.6	187.0	6.2	5.0	1.8
25/04/2003	-	9.1	47.0	8.6	37.9	148.9	90.2	5.4	5.0	1.0
26/04/2003	-	3.0	11.2	2.0	21.2	56.8	30.0	2.2	5.0	1.0
27/04/2003	-	3.0	1.0	2.0	7.0	18.7	18.5	1.2	5.0	1.0
28/04/2003	-	11.9	36.6	12.9	83.0	338.9	260.0	4.4	5.0	1.8
29/04/2003	-	6.0	8.9	2.0	15.8	40.8	33.4	1.8	5.0	1.0
30/04/2003	-	7.6	14.6	4.8	24.4	102.6	49.7	3.2	5.0	1.0
01/05/2003	-	3.0	1.0	2.0	7.0	17.1	15.0	1.3	5.0	1.0
02/05/2003	-	3.0	10.8	2.0	7.0	148.2	25.6	1.7	5.0	1.0
03/05/2003	-	3.0	1.0	2.0	17.8	21.0	17.6	1.2	5.0	1.0
04/05/2003	-	3.0	3.4	2.0	7.0	24.8	23.2	1.8	5.0	1.0
05/05/2003	-	7.4	17.0	2.0	33.7	89.7	48.6	2.8	5.0	1.0
06/05/2003	-	8.2	11.0	2.0	7.0	44.3	20.5	6.6	5.0	1.0
07/05/2003	-	7.9	14.5	2.0	125.3	128.9	94.3	9.2	14.9	1.0
08/05/2003	-	6.6	22.1	8.0	53.4	81.7	65.7	3.6	5.0	1.0
09/05/2003	-	6.3	11.9	8.3	18.4	76.0	46.3	3.7	5.0	1.0
10/05/2003	-	3.0	11.1	2.0	16.4	36.0	24.5	1.6	5.0	1.0

11/05/2003	-	5.5	4.5	2.0	7.0	34.4	21.9	3.0	5.0	1.0
12/05/2003	-	8.9	17.8	6.2	44.0	137.0	78.4	1.6	5.0	1.0
13/05/2003	-	3.0	13.4	2.0	7.0	22.2	17.7	1.6	5.0	1.0
14/05/2003	-	6.3	12.5	2.0	7.0	38.4	24.3	2.1	5.0	1.0
15/05/2003	-	7.3	18.9	2.0	47.5	132.5	73.1	3.7	5.0	1.0
16/05/2003	-	12.4	32.3	6.0	43.6	326.2	155.4	4.4	5.0	1.1
17/05/2003	-	7.0	12.7	2.0	22.6	225.6	102.0	5.0	5.0	1.0
18/05/2003	-	3.0	1.0	2.0	14.9	19.1	13.4	1.0	5.0	1.0
19/05/2003	-	9.3	18.4	6.7	37.1	237.7	135.2	4.3	5.0	1.0
20/05/2003	-	6.3	5.7	2.0	7.0	45.7	18.0	1.0	5.0	1.0
21/05/2003	-	3.0	6.0	2.0	7.0	22.5	18.8	1.2	5.0	1.0
22/05/2003	-	5.5	3.1	2.0	7.0	13.7	14.8	1.0	5.0	1.0
23/05/2003	-	6.7	18.5	2.0	7.0	34.4	25.6	1.9	5.0	1.0
24/05/2003	-	6.2	6.7	2.0	7.0	50.4	31.7	2.0	5.0	1.0
25/05/2003	-	3.0	7.6	4.9	7.0	29.4	17.4	1.0	5.0	1.0
26/05/2003	-	8.8	13.8	7.4	18.0	63.0	48.2	2.5	5.0	1.0
27/05/2003	-	6.0	39.1	10.6	15.3	54.4	29.8	2.5	5.0	1.0
28/05/2003	-	7.5	16.3	9.5	32.1	82.8	52.6	4.0	5.0	1.0
29/05/2003	-	3.0	11.6	6.2	50.7	54.2	42.3	3.7	5.0	1.0
30/05/2003	-	6.0	10.2	7.3	85.3	39.5	28.2	2.8	5.0	1.0
31/05/2003	-	3.0	5.6	8.7	7.0	34.9	29.9	2.5	5.0	1.0
1/06/2003	-	6.8	17.2	2.0	7.0	69.9	30.2	2.6	5.0	1.0
2/06/2003	-	8.0	22.4	5.8	21.5	68.2	44.3	2.9	5.0	1.0
3/06/2003	-	10.7	34.2	6.0	38.8	191.1	110.8	3.9	5.0	1.0
4/06/2003	-	12.0	29.1	2.0	37.2	164.8	100.4	4.4	5.0	1.0
5/06/2003	-	5.6	9.7	2.0	19.1	45.1	26.1	1.5	5.0	1.0
6/06/2003	-	9.3	42.0	2.0	28.9	157.4	92.8	4.3	5.0	1.0
7/06/2003	-	5.6	14.0	2.0	16.3	52.3	39.4	2.5	5.0	1.0
8/06/2003	-	3.0	6.6	2.0	7.0	22.6	28.9	1.6	5.0	1.0
9/06/2003	-	3.0	1.0	2.0	7.0	15.7	16.5	1.4	5.0	1.0
10/06/2003	-	10.1	22.2	5.4	41.3	220.1	125.0	2.6	5.0	1.0
11/06/2003	-	5.9	10.8	2.0	29.1	42.2	32.5	2.0	5.0	1.0
12/06/2003	-	6.5	20.5	5.2	31.3	77.6	48.3	4.1	5.0	1.0
13/06/2003	-	12.3	42.3	12.5	56.7	230.2	145.2	2.7	5.0	1.0
14/06/2003	-	5.9	12.7	6.8	21.4	83.7	76.0	4.7	5.0	1.0
15/06/2003	-	3.0	9.0	2.0	15.3	45.6	45.2	3.1	5.0	1.0
16/06/2003	-	3.0	10.4	4.7	20.0	40.7	28.3	3.5	5.0	1.0
17/06/2003	-	14.4	23.0	8.6	44.4	198.5	124.0	4.7	5.0	1.0
18/06/2003	-	6.9	13.4	2.0	7.0	37.3	27.3	1.6	5.0	1.0
19/06/2003	-	6.3	4.7	2.0	7.0	21.4	15.8	1.0	5.0	1.0
20/06/2003	-	3.0	36.4	2.0	19.2	24.2	21.1	1.9	5.0	1.0
Mean		**6.9**	**19.0**	**4.8**	**25.1**	**101.9**	**60.4**	**3.4**	**5.2**	**1.1**
Minimum		**3.0**	**1.0**	**2.0**	**7.0**	**13.7**	**13.4**	**1.0**	**5.0**	**1.0**
Maximum		**17.2**	**75.9**	**15.2**	**125.3**	**491.5**	**279.2**	**9.8**	**14.9**	**2.6**

Detection limit (VMM): - Cr: 5 ng/m³ -Mn: 3 ng/m³ -Ni: 5 ng/m³ -Cu: 14 ng/m³ - Zn: 3 ng/m³ - Pb: 7 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Cd: 1 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 5.11.: Heavy metals in PM10 in Menen during summer [ng/m^3]

	V	**Cr**	**Mn**	**Ni**	**Cu**	**Zn**	**Pb**	**Sb**	**As**	**Cd**
21/06/2003	-	3.0	9.2	2.0	29.8	60.7	39.5	4.5	5.0	1.0
22/06/2003	-	6.4	14.6	15.9	21.9	145.4	45.7	3.4	5.0	1.0
23/06/2003	-	8.3	14.3	2.0	16.6	128.9	43.2	1.9	5.0	1.0
24/06/2003	-	3.0	7.2	2.0	7.0	26.2	23.7	1.4	5.0	1.0
25/06/2003	-	3.0	11.7	6.0	19.9	57.3	42.0	3.5	5.0	1.0
26/06/2003	-	8.7	35.6	4.8	21.7	77.4	37.9	3.7	5.0	1.0
27/06/2003	-	8.8	10.1	7.7	7.0	64.6	28.0	2.1	5.0	1.0
28/06/2003	-	5.6	12.5	5.2	7.0	41.8	24.7	1.5	5.0	1.0
29/06/2003	-	6.1	14.5	4.6	17.9	93.4	55.2	3.1	5.0	1.0
30/06/2003	-	5.9	13.0	2.0	21.3	71.2	45.8	3.2	5.0	1.0
1/07/2003	-	10.0	23.9	7.1	51.4	181.8	85.6	3.1	5.0	1.1

2/07/2003	-	6.1	11.6	2.0	7.0	32.6	19.0	1.3	5.0	1.0
3/07/2003	-	5.5	21.2	2.0	7.0	46.4	21.9	1.8	5.0	1.0
4/07/2003	-	3.0	17.7	2.0	7.0	56.2	34.4	2.4	5.0	1.0
5/07/2003	-	6.5	6.1	2.0	7.0	35.6	26.5	1.9	5.0	1.0
6/07/2003	-	3.0	5.7	2.0	15.9	28.6	25.7	2.0	5.0	1.0
7/07/2003	-	6.4	24.4	5.0	7.0	42.1	36.1	1.5	5.0	1.0
8/07/2003	-	7.7	13.5	4.7	7.0	47.7	32.1	1.9	5.0	1.0
9/07/2003	-	5.8	18.5	4.8	19.0	69.2	49.1	2.9	5.0	1.0
10/07/2003	-	7.0	22.9	4.8	26.1	95.6	51.7	4.2	5.0	1.0
11/07/2003	-	8.0	17.3	4.6	7.0	95.6	30.2	2.2	5.0	1.0
12/07/2003	-	5.5	15.2	2.0	7.0	70.2	54.8	2.8	5.0	1.0
13/07/2003	-	3.0	14.2	2.0	7.0	99.8	66.5	3.0	5.0	1.0
14/07/2003	-	6.1	12.0	2.0	14.9	60.5	31.9	2.3	5.0	1.0
15/07/2003	-	-	-	-	-	-	-	-	-	-
16/07/2003	-	7.8	31.3	5.2	25.3	152.7	81.5	4.1	5.0	1.0
17/07/2003	-	3.0	7.4	2.0	7.0	37.5	31.2	1.7	5.0	1.0
18/07/2003	-	6.1	14.0	2.0	21.8	73.6	59.9	3.3	5.0	1.0
19/07/2003	-	3.0	11.6	2.0	14.6	67.4	28.9	3.0	5.0	1.0
20/07/2003	-	3.0	17.3	5.3	7.0	47.9	22.7	1.9	5.0	1.0
21/07/2003	-	6.1	10.1	2.0	7.0	66.7	35.3	2.3	5.0	1.0
22/07/2003	-	3.0	5.0	2.0	7.0	17.3	17.8	1.2	5.0	1.0
23/07/2003	-	3.0	7.3	2.0	7.0	25.4	27.7	1.4	5.0	1.0
24/07/2003	-	3.0	5.8	2.0	15.4	31.9	25.7	2.1	5.0	1.0
25/07/2003	-	3.0	8.6	2.0	18.3	52.8	47.7	2.2	5.0	1.0
26/07/2003	-	3.0	1.0	2.0	20.0	22.9	20.4	1.4	5.0	1.0
27/07/2003	-	3.0	3.3	2.0	33.1	13.6	13.9	1.0	5.0	1.0
28/07/2003	-	3.0	5.0	2.0	7.0	13.6	18.2	1.0	5.0	1.0
29/07/2003	-	5.8	9.2	2.0	22.0	70.4	46.9	4.9	5.0	1.0
30/07/2003	-	3.0	1.0	2.0	7.0	15.0	16.7	1.3	5.0	1.0
31/07/2003	-	3.0	10.0	2.0	7.0	49.8	40.6	2.5	5.0	1.0
1/08/2003	-	5.8	10.5	2.0	7.0	82.6	32.5	2.2	5.0	1.0
2/08/2003	-	3.0	14.7	2.0	7.0	22.2	18.3	2.1	5.0	1.0
3/08/2003	-	3.0	5.4	7.1	7.0	37.5	27.4	2.1	5.0	1.0
4/08/2003	-	5.9	7.9	2.0	23.5	61.6	33.9	3.4	5.0	1.0
5/08/2003	-	6.6	12.6	7.2	18.9	83.5	45.0	4.3	5.0	1.0
6/08/2003	-	7.3	23.4	5.7	19.8	80.0	38.3	3.5	5.0	1.0
7/08/2003	-	7.5	34.7	13.5	15.3	81.1	46.7	3.4	5.0	1.0
8/08/2003	-	5.7	6.1	8.0	7.0	30.0	22.1	1.9	5.0	1.0
9/08/2003	-	3.0	6.2	2.0	7.0	32.2	23.2	2.2	5.0	1.0
10/08/2003	-	6.1	15.6	2.0	20.9	65.8	50.3	4.1	5.0	1.0
11/08/2003	-	7.1	23.4	6.2	20.7	95.1	46.6	3.9	5.0	1.0
12/08/2003	-	11.4	30.4	15.1	20.4	82.3	39.6	3.4	5.0	1.0
13/08/2003	-	5.6	20.0	11.1	19.2	67.8	47.7	2.4	5.0	1.0
14/08/2003	-	3.0	4.7	2.0	7.0	22.8	17.4	1.3	5.0	1.0
15/08/2003	-	3.0	4.3	2.0	7.0	16.8	22.0	1.2	5.0	1.0
16/08/2003	-	3.0	9.4	2.0	7.0	28.7	27.6	1.3	5.0	1.0
17/08/2003	-	7.9	16.1	2.0	19.7	52.9	43.1	3.2	5.0	1.0
18/08/2003	-	12.4	26.2	7.7	49.1	130.8	73.2	3.1	5.0	1.9
19/08/2003	-	3.0	9.5	2.0	16.2	25.8	28.7	1.4	5.0	1.0
20/08/2003	Power cut-off									
21/08/2003	Power cut-off									
22/08/2003	Power cut-off									
23/08/2003	-	3.0	6.8	2.0	7.0	27.2	18.8	2.1	5.0	1.0
24/08/2003	-	3.0	9.3	5.2	7.0	37.5	38.2	1.5	5.0	1.0
25/08/2003	-	3.0	8.9	2.0	7.0	25.8	31.3	1.1	5.0	1.0
26/08/2003	-	3.0	8.5	2.0	17.5	28.0	26.8	2.2	5.0	1.0
27/08/2003	-	3.0	7.0	2.0	7.0	23.7	16.5	2.2	5.0	1.0
28/08/2003	-	6.9	17.3	5.5	19.5	96.7	83.9	3.6	5.0	1.0
29/08/2003	-	3.0	1.0	2.0	20.0	28.6	24.9	2.3	5.0	1.0
30/08/2003	-	3.0	1.0	2.0	7.0	19.0	16.2	1.6	5.0	1.0
31/08/2003	-	3.0	6.7	2.0	7.0	28.1	33.4	1.7	5.0	1.0
01/09/2003	-	3.0	10.6	2.0	27.4	42.9	31.3	2.5	5.0	1.0
02/09/2003	-	3.0	4.7	2.0	41.7	24.9	15.4	2.0	5.0	1.0
03/09/2003	-	7.3	12.9	2.0	57.5	62.8	33.8	4.3	5.0	1.0

04/09/2003	-	8.4	14.6	5.4	82.5	111.7	47.6	4.6	5.0	1.0
05/09/2003	-	23.5	47.8	11.3	129.6	617.0	227.4	9.8	5.0	1.0
06/09/2003	-	13.6	37.6	9.2	57.8	681.2	242.8	10.3	5.0	1.1
07/09/2003	-	3.0	16.1	2.0	7.0	52.9	26.1	2.1	5.0	1.0
08/09/2003	-	9.0	22.4	6.5	28.6	155.2	113.2	3.2	5.0	1.0
09/09/2003	-	7.5	13.8	2.0	18.7	45.3	34.4	3.2	5.0	1.0
10/09/2003	-	8.5	21.5	8.6	42.7	193.7	78.2	3.0	5.0	4.8
11/09/2003	-	3.0	10.7	2.0	15.4	26.7	24.0	1.8	5.0	1.0
12/09/2003	-	6.0	5.5	5.0	20.0	39.5	22.7	5.9	5.0	1.0
13/09/2003	-	3.0	6.7	2.0	16.6	48.7	40.1	3.8	5.0	1.0
14/09/2003	-	3.0	7.0	2.0	15.9	37.5	29.0	3.6	5.0	1.0
15/09/2003	-	8.3	20.1	2.0	21.6	82.4	53.1	5.3	5.0	1.0
16/09/2003	-	-	-	-	-	-	-	-	-	-
17/09/2003	-	29.1	72.0	16.7	122.9	835.9	406.4	13.9	5.0	3.8
18/09/2003	-	12.0	35.1	9.6	60.3	241.3	138.4	6.7	5.0	1.5
19/09/2003	-	15.5	41.8	14.4	66.9	275.4	155.9	7.7	5.0	1.2
20/09/2003	-	7.3	14.3	6.2	24.6	77.5	41.2	4.3	5.0	1.0
Mean		**6.0**	**14.7**	**4.3**	**21.2**	**86.8**	**48.5**	**3.0**	**5.0**	**1.1**
Minimum		**3.0**	**1.0**	**2.0**	**7.0**	**13.6**	**13.9**	**1.0**	**5.0**	**1.0**
Maximum		**29.1**	**72.0**	**16.7**	**129.6**	**835.9**	**406.4**	**13.9**	**5.0**	**4.8**

Detection limit (VMM): - Cr: 5 ng/m³ -Mn: 3 ng/m³ -Ni: 5 ng/m³ -Cu: 14 ng/m³ - Zn: 3 ng/m³ - Pb: 7 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Cd: 1 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

Table 5.12.: Heavy metals in PM10 in Menen during autumn [ng/m^3]

	V	**Cr**	**Mn**	**Ni**	**Cu**	**Zn**	**Pb**	**Sb**	**As**	**Cd**
21/09/2003	-	6.5	10.5	2.0	24.6	72.4	33.6	4.0	5.0	1.0
22/09/2003	-	22.4	72.9	22.5	117.6	598.5	391.0	3.9	5.0	4.8
23/09/2003	-	3.0	4.1	2.0	15.1	24.0	23.6	1.3	5.0	1.0
24/09/2003	-	8.8	23.1	2.0	43.0	129.7	69.0	4.3	5.0	1.0
25/09/2003	-	11.7	19.1	2.0	33.6	138.8	61.2	6.5	5.0	1.0
26/09/2003	-	15.3	46.0	13.8	33.7	218.0	75.2	5.9	5.0	1.0
27/09/2003	-	6.3	28.3	2.0	21.3	95.1	42.9	4.5	5.0	1.0
28/09/2003	-	15.0	18.6	2.0	18.9	93.8	39.9	3.4	5.0	1.0
29/09/2003	-	7.4	18.8	2.0	32.2	97.7	60.4	3.9	5.0	1.0
30/09/2003	-	8.8	17.5	2.0	19.2	127.8	54.1	4.5	5.0	1.0
01/10/2003	-	13.8	15.7	6.8	29.5	128.4	52.0	5.0	5.0	1.0
02/10/2003	-	7.1	9.4	2.0	20.6	62.5	39.0	3.0	5.0	1.0
03/10/2003	-	11.9	15.1	8.4	29.9	121.1	67.6	9.5	5.0	1.0
04/10/2003	-	3.0	12.0	2.0	7.0	43.6	22.3	2.0	5.0	1.0
05/10/2003	-	3.0	3.8	2.0	7.0	27.2	18.2	1.5	5.0	1.0
06/10/2003	-	9.9	25.4	11.0	38.2	95.2	37.4	2.1	5.0	1.1
07/10/2003	-	3.0	12.9	2.0	7.0	38.9	21.1	1.8	5.0	1.0
08/10/2003	-	6.1	13.1	2.0	7.0	55.3	24.9	2.2	5.0	1.0
09/10/2003	-	3.0	7.9	2.0	7.0	31.2	16.8	1.9	5.0	1.0
10/10/2003	-	9.7	7.8	2.0	7.0	123.5	22.8	1.0	5.0	1.0
11/10/2003	-	3.0	5.0	2.0	17.3	37.7	29.5	3.2	5.0	1.0
12/10/2003	-	3.0	4.9	2.0	15.7	42.4	32.4	3.8	5.0	1.0
13/10/2003	-	8.1	9.9	2.0	23.1	76.4	36.6	3.8	5.0	1.0
14/10/2003	-	8.4	11.8	2.0	23.4	63.9	28.1	4.2	5.0	1.0
15/10/2003	-	7.5	12.0	2.0	21.5	59.9	30.5	3.5	5.0	1.0
16/10/2003	-	10.7	14.6	2.0	19.3	90.3	45.3	3.2	5.0	1.0
17/10/2003	-	11.2	15.9	6.2	22.1	91.3	37.6	6.2	5.0	1.0
18/10/2003	-	11.6	24.9	7.1	25.0	182.5	119.2	7.3	10.9	1.0
19/10/2003	-	7.0	21.5	6.6	18.7	129.7	100.1	6.0	12.4	1.0
20/10/2003	-	5.6	8.9	4.9	21.3	55.9	40.4	4.6	5.0	1.0
21/10/2003	-	5.5	12.0	5.0	21.0	56.2	43.9	3.1	5.0	1.0
22/10/2003	-	3.0	10.9	2.0	28.5	88.1	32.3	2.7	5.0	1.0
23/10/2003	-	5.8	12.1	2.0	14.6	71.3	47.4	3.2	5.0	1.0
24/10/2003	-	9.5	15.7	7.1	27.8	130.8	78.6	5.2	5.0	1.0
25/10/2003	-	3.0	4.0	2.0	7.0	32.3	29.4	2.6	5.0	1.0

26/10/2003	-	3.0	3.9	2.0	7.0	34.5	34.4	2.2	5.0	1.0
27/10/2003	-	7.9	24.1	11.6	44.6	126.7	100.3	8.1	5.0	1.0
28/10/2003	-	14.5	48.1	9.0	75.1	333.5	161.3	11.0	5.0	1.8
29/10/2003	-	11.5	24.9	8.6	63.3	375.1	133.6	8.6	5.0	1.4
30/10/2003	-	7.3	16.3	4.7	31.4	152.6	71.6	3.5	5.0	1.0
31/10/2003	-	5.7	7.2	2.0	19.7	102.0	47.9	3.8	5.0	1.0
1/11/2003	-	7.3	7.2	2.0	7.0	58.5	26.9	1.9	5.0	1.0
2/11/2003	-	3.0	1.0	2.0	7.0	33.3	28.9	2.0	5.0	1.0
3/11/2003	-	3.0	6.0	2.0	7.0	40.5	19.8	1.0	5.0	1.0
4/11/2003	-	9.5	14.5	5.3	26.6	167.4	60.7	3.5	5.0	1.0
5/11/2003	-	9.8	42.8	2.0	18.5	110.5	49.6	3.1	5.0	1.0
6/11/2003	-	13.1	34.1	9.1	48.4	260.8	133.9	9.8	5.0	1.0
7/11/2003	-	12.4	18.4	5.7	27.9	172.6	82.5	6.4	5.0	1.0
8/11/2003	-	5.7	9.9	2.0	17.2	68.6	39.9	4.2	5.0	1.0
9/11/2003	-	6.3	33.6	2.0	15.6	156.0	44.7	3.6	5.0	1.0
10/11/2003	-	3.0	5.2	2.0	28.8	103.6	68.4	4.0	5.0	1.0
11/11/2003	-	3.0	12.6	6.5	14.8	101.5	81.2	5.5	5.0	1.0
12/11/2003	-	9.3	21.5	9.2	36.2	252.6	125.4	5.9	5.0	1.0
13/11/2003	-	7.7	16.3	6.1	23.1	87.7	51.3	4.1	5.0	1.0
14/11/2003	-	7.4	13.6	4.6	42.6	143.2	76.0	3.9	5.0	1.0
15/11/2003	-	3.0	3.8	2.0	7.0	45.9	26.4	3.5	5.0	1.0
16/11/2003	-	3.0	1.0	2.0	7.0	38.7	32.1	2.8	5.0	1.0
17/11/2003	-	9.5	14.9	2.0	35.0	150.3	48.6	3.0	5.0	1.1
18/11/2003	-	3.0	2.9	2.0	7.0	34.5	18.9	1.0	5.0	1.0
19/11/2003	-	6.1	6.0	2.0	7.0	42.8	26.7	1.0	5.0	1.0
20/11/2003	-	12.0	47.7	2.0	44.6	223.2	101.7	4.4	5.0	1.6
21/11/2003	-	9.7	26.3	6.3	35.3	175.3	93.5	6.5	5.0	1.0
22/11/2003	-	3.0	7.5	2.0	7.0	38.3	33.1	3.6	5.0	1.0
23/11/2003	-	5.8	11.7	2.0	7.0	55.0	43.1	2.7	5.0	1.0
24/11/2003	-	3.0	1.0	2.0	7.0	21.5	19.6	1.4	5.0	1.0
25/11/2003	-	13.3	45.9	11.3	102.8	349.7	157.7	7.1	5.0	1.4
26/11/2003	-	7.6	15.5	7.5	69.1	236.4	108.2	3.6	5.0	1.0
27/11/2003	-	9.9	9.2	5.7	37.6	71.5	73.9	8.3	5.0	1.0
28/11/2003	-	17.7	17.7	8.1	59.3	191.9	91.2	8.1	5.0	2.1
29/11/2003	-	3.0	3.2	4.6	7.0	35.7	32.1	2.3	5.0	1.0
30/11/2003	-	3.0	1.0	2.0	7.0	34.0	25.7	1.5	5.0	1.0
01/12/2003	-	3.0	5.0	2.0	7.0	54.3	34.1	3.0	5.0	1.0
02/12/2003	-	13.0	34.9	7.1	48.4	268.4	106.3	8.0	5.0	2.0
03/12/2003	-	13.5	28.3	11.4	38.8	212.6	105.6	9.9	5.0	1.0
04/12/2003	-	3.0	6.7	2.0	15.5	78.7	38.1	2.6	5.0	1.0
05/12/2003	-	3.0	11.5	2.0	17.2	93.8	49.8	3.5	5.0	1.0
06/12/2003	-	3.0	9.2	2.0	7.0	132.2	62.3	3.3	5.0	1.0
07/12/2003	-	6.8	10.0	2.0	15.1	85.4	49.4	2.8	5.0	1.0
08/12/2003	-	12.8	36.2	7.0	34.0	199.2	91.5	9.9	5.0	1.0
09/12/2003	-	20.0	69.1	11.9	73.7	456.7	163.3	16.4	18.4	1.0
10/12/2003	-	-	-	-	-	-	-	-	-	-
11/12/2003	-	7.2	15.2	8.5	32.3	120.9	97.6	5.4	5.0	1.0
12/12/2003	-	7.0	11.3	5.5	27.2	135.3	83.3	5.8	5.0	1.0
13/12/2003	-	3.0	1.0	2.0	7.0	27.6	17.3	1.0	5.0	1.0
14/12/2003	-	3.0	9.3	2.0	7.0	47.9	45.7	1.3	5.0	1.0
15/12/2003	-	3.0	1.0	2.0	7.0	19.0	16.6	1.8	5.0	1.0
16/12/2003	-	10.8	27.0	6.5	28.2	98.7	60.6	4.5	5.0	1.0
17/12/2003	-	18.0	69.0	12.5	101.7	403.8	279.6	18.5	5.0	2.1
18/12/2003	-	15.0	63.8	7.6	38.4	247.9	147.3	6.5	5.0	1.0
19/12/2003	-	17.0	26.3	12.0	57.3	276.7	111.2	11.7	5.0	1.8
20/12/2003	-	3.0	3.4	2.0	7.0	62.6	29.9	2.6	5.0	1.0
Mean		**7.8**	**17.5**	**4.7**	**26.7**	**123.7**	**64.9**	**4.6**	**5.3**	**1.1**
Minimum		**3.0**	**1.0**	**2.0**	**7.0**	**19.0**	**16.6**	**1.0**	**5.0**	**1.0**
Maximum		**22.4**	**72.9**	**22.5**	**117.6**	**598.5**	**391.0**	**18.5**	**18.4**	**4.8**

Detection limit (VMM): - Cr: 5 ng/m³ -Mn: 3 ng/m³ -Ni: 5 ng/m³ -Cu: 14 ng/m³ - Zn: 3 ng/m³ - Pb: 7 ng/m³ - Sb: 1 ng/m³ - As: 9 ng/m³ - Cd: 1 ng/m³
(Values below the detection limit (DL) are archived as DL/2)

IV Anions and cations at Menen

In every season one month from all 24h-samples of PM2.5 taken in Menen during 2003 has been selected for determination of anions and cations. After XRF-analysis, filter samples from these periods have been analysed on the water-soluble ion fraction by means of ion chromatography. The detected anions and cations are presented in tables 5.13., 5.14., 5.15. and 5.16..

Table 5.13.: Anions and cations in PM2.5 in Menen [µg/m^3] – Campaign 1 (spring)

Date	F^- µg/m^3	Cl^- µg/m^3	NO_3^- µg/m^3	SO_4^{2-} µg/m^3	NH_4^+ µg/m^3	K^+ µg/m^3	Mg^{2+} µg/m^3	Ca^{2+} µg/m^3
16/04/2003	0.01	0.15	6.1	5.6	2.7	0.17	0.04	0.28
17/04/2003	0.01	0.14	9.1	5.5	3.6	0.20	0.03	0.11
18/04/2003	0.01	0.20	12.9	5.9	4.8	0.17	0.03	0.12
19/04/2003	0.01	0.23	7.9	9.2	5.0	0.14	0.02	0.07
20/04/2003	0.02	0.32	12.6	9.8	24.1	0.27	0.03	0.07
21/04/2003	0.02	0.31	6.6	5.7	3.5	0.11	0.03	0.05
22/04/2003	0.02	0.43	11.5	9.6	5.9	0.18	0.02	0.13
23/04/2003	0.02	0.36	19.8	11.7	11.6	0.36	0.02	0.16
24/04/2003	0.02	0.32	37.3	14.1	14.7	0.32	0.02	0.18
25/04/2003	0.01	0.34	30.2	10.6	10.5	0.17	0.01	0.13
26/04/2003	0.01	0.25	4.2	2.4	1.8	0.06	0.01	0.03
27/04/2003	0.02	0.52	2.4	3.5	1.4	0.07	0.04	0.04
28/04/2003	0.01	0.11	1.6	1.8	1.3	0.05	0.01	0.05
29/04/2003	0.01	0.27	4.8	2.7	2.0	0.05	0.01	0.05
30/04/2003	0.02	0.29	6.3	1.8	1.9	0.09	0.02	0.08
1/05/2003	0.01	0.55	2.7	1.9	0.9	0.05	0.04	0.05
2/05/2003	0.02	0.25	2.7	1.7	1.1	0.04	0.02	0.04
3/05/2003	0.01	0.37	2.1	2.1	0.9	0.04	0.02	0.05
4/05/2003	0.01	0.17	4.0	1.4	1.3	0.06	0.01	0.05
5/05/2003	0.01	0.32	2.9	3.0	1.5	0.09	0.01	0.06
6/05/2003								
7/05/2003	0.01	0.26	8.4	2.9	2.9	0.10	0.01	0.07
8/05/2003	0.02	0.30	12.6	3.8	4.5	0.14	0.01	0.09
9/05/2003	0.01	0.21	5.9	4.4	5.4	0.11	0.02	0.04
10/05/2003	0.05	0.07	1.0	0.8	0.5	0.02	0.00	0.00
11/05/2003	0.01	0.12	1.6	2.8	1.9	0.05	0.01	0.02
12/05/2003	0.00	0.16	1.4	2.5	1.4	0.05	0.01	0.03
13/05/2003	0.01	0.16	1.4	1.7	1.0	0.08	0.01	0.02
Mean	**0.01**	**0.27**	**8.1**	**4.8**	**4.4**	**0.12**	**0.02**	**0.08**
Minimum	**0.00**	**0.07**	**1.0**	**0.8**	**0.5**	**0.02**	**0.00**	**0.00**
Maximum	**0.05**	**0.55**	**37.3**	**14.1**	**24.1**	**0.36**	**0.04**	**0.28**

Table 5.14.: Anions and cations in PM2.5 in Menen [µg/m^3] – Campaign 2 (Summer)

Date	F^- µg/m^3	Cl^- µg/m^3	NO_3^- µg/m^3	SO_4^{2-} µg/m^3	NH_4^+ µg/m^3	K^+ µg/m^3	Mg^{2+} µg/m^3	Ca^{2+} µg/m^3
20/08/2003	0.05	0.51	5.5	2.7	1.3	0.12	0.02	0.30
21/08/2003	0.31	1.67	28.1	6.8	2.0	0.59	0.02	0.07
22/08/2003	0.04	0.26	3.0	2.3	0.8	0.08	0.01	0.05
23/08/2003	0.01	0.09	1.7	4.4	2.7	0.09	0.01	0.03
24/08/2003	0.01	0.07	1.6	4.9	2.6	0.11	0.02	0.04
25/08/2003	0.01	0.18	2.2	3.1	1.3	0.09	0.02	0.05
26/08/2003	0.01	0.11	2.2	4.6	3.0	0.10	0.01	0.05
27/08/2003	0.01	0.18	2.1	3.2	2.2	0.08	0.01	0.05
28/08/2003	0.01	0.32	4.3	4.4	4.7	0.29	0.02	0.07
29/08/2003	0.02	0.14	3.1	2.4	2.6	0.07	0.01	0.03
30/08/2003	0.01	0.24	2.3	1.0	0.6	0.05	0.01	0.03
31/08/2003	0.01	0.20	2.6	1.4	0.9	0.08	0.01	0.03
1/09/2003	0.01	0.17	1.9	1.8	1.4	0.17	0.01	0.04
2/09/2003	0.01	0.29	2.9	1.4	0.7	0.07	0.02	0.04
3/09/2003	0.02	0.28	7.3	4.1	3.0	0.13	0.02	0.06
4/09/2003	0.01	0.13	6.3	4.8	6.2	0.14	0.01	0.06

5/09/2003	0.01	0.10	4.6	4.3	4.4	0.15	0.02	0.13
6/09/2003	0.02	0.21	5.5	3.8	1.9	0.09	0.02	0.13
7/09/2003	0.01	0.12	2.1	3.9	2.7	0.11	0.02	0.05
8/09/2003	0.01	0.15	3.2	3.6	3.4	0.18	0.02	0.07
9/09/2003	0.01	0.31	8.6	4.7	3.5	0.07	0.02	0.06
10/09/2003	0.01	0.14	0.9	1.8	0.9	0.07	0.02	0.04
11/09/2003	0.01	0.18	2.2	2.6	2.0	0.11	0.01	0.03
12/09/2003	0.01	0.27	1.6	1.9	1.2	0.07	0.03	0.04
13/09/2003	0.01	0.18	1.8	2.0	1.3	0.13	0.04	0.05
Mean	**0.03**	**0.26**	**4.30**	**3.28**	**2.29**	**0.13**	**0.02**	**0.06**
Minimum	**0.01**	**0.07**	**0.94**	**1.01**	**0.64**	**0.05**	**0.01**	**0.03**
Maximum	**0.31**	**1.67**	**28.10**	**6.82**	**6.16**	**0.59**	**0.04**	**0.30**

Table 5.15.: Anions and cations in PM2.5 in Menen [µg/m^3] – Campaign 3 (Autumn)

Date	F^- µg/m^3	Cl^- µg/m^3	NO_3^- µg/m^3	SO_4^{2-} µg/m^3	NH_4^+ µg/m^3	K^+ µg/m^3	Mg^{2+} µg/m^3	Ca^{2+} µg/m^3
2/10/2003	0.01	0.13	3.1	8.3	5.9	0.11	0.01	0.0
3/10/2003	0.01	0.32	6.8	15.6	14.8	0.22	0.02	0.1
4/10/2003	0.01	0.28	1.5	1.6	0.7	0.19	0.04	0.0
5/10/2003	0.01	0.15	1.1	1.0	0.5	0.17	0.02	0.0
6/10/2003	0.01	0.52	2.7	1.7	0.8	0.07	0.04	0.1
7/10/2003	0.02	1.26	2.3	1.5	0.5	0.32	0.08	0.1
8/10/2003	0.02	0.59	2.6	2.4	1.1	0.24	0.05	0.1
9/10/2003	0.01	0.26	1.0	3.9	0.9	0.17	0.05	0.0
10/10/2003	0.01	0.20	0.7	2.0	0.6	0.05	0.05	0.0
11/10/2003	0.01	0.28	1.5	2.5	1.3	0.09	0.05	0.0
12/10/2003	0.01	0.21	2.0	3.0	2.6	0.11	0.04	0.0
13/10/2003	0.01	0.16	1.6	1.9	2.3	0.10	0.03	0.1
14/10/2003	0.01	0.29	5.1	2.0	1.7	0.09	0.02	0.0
15/10/2003	0.01	0.27	6.5	3.0	2.4	0.10	0.02	0.1
16/10/2003	0.01	0.12	3.6	2.7	3.5	0.11	0.02	0.1
17/10/2003	0.01	0.12	3.4	2.6	3.3	0.10	0.02	0.1
18/10/2003	0.02	0.61	10.2	4.8	3.6	0.38	0.03	0.1
19/10/2003	0.02	0.55	11.1	5.3	4.3	0.34	0.10	0.1
20/10/2003	0.01	0.19	3.4	2.4	3.4	0.13	0.02	0.1
21/10/2003	0.01	0.26	4.1	5.8	5.5	0.15	0.01	0.0
22/10/2003	0.01	0.17	4.9	5.1	5.6	0.12	0.01	0.1
23/10/2003	0.01	0.21	4.2	4.7	5.1	0.16	0.01	0.1
24/10/2003	0.01	0.43	2.8	2.5	3.3	0.21	0.01	0.1
25/10/2003	0.01	0.15	1.7	1.5	2.1	0.39	0.01	0.0
26/10/2003	0.02	0.35	4.0	2.5	1.8	0.11	0.01	0.0
27/10/2003	0.03	0.96	9.1	4.0	3.2	0.43	0.03	0.1
28/10/2003	0.15	0.93	9.8	5.5	4.9	1.14	0.02	0.1
Mean	**0.02**	**0.37**	**4.10**	**3.70**	**3.18**	**0.21**	**0.03**	**0.05**
Minimum	**0.01**	**0.12**	**0.66**	**0.96**	**0.48**	**0.05**	**0.01**	**0.01**
Maximum	**0.15**	**1.26**	**11.07**	**15.58**	**14.79**	**1.14**	**0.10**	**0.14**

Table 5.16.: Anions and cations in PM2.5 in Menen [µg/m^3] – Campaign 4 (Winter)

Date	F^- µg/m^3	Cl^- µg/m^3	NO_3^- µg/m^3	SO_4^{2-} µg/m^3	NH_4^+ µg/m^3	K^+ µg/m^3	Mg^{2+} µg/m^3	Ca^{2+} µg/m^3
26/11/2003	0.22	0.22	2.7	1.4	0.28	0.22	0.00	0.002
27/11/2003	0.14	0.41	2.2	2.3	2.2	0.44	0.01	0.027
28/11/2003	0.11	1.28	8.2	4.3	5.4	0.21	0.01	0.071
29/11/2003	0.11	0.35	7.7	4.3	4.7	0.10	0.01	0.042
30/11/2003	0.16	0.37	3.6	2.9	2.4	0.08	0.01	0.033
1/12/2003	0.02	0.25	3.0	1.7	1.2	0.08	0.02	0.037
2/12/2003	0.15	0.65	5.5	2.4	2.6	0.68	0.02	0.098
3/12/2003	0.20	1.02	8.1	14.6	10.7	0.39	0.01	0.096
4/12/2003	0.02	0.34	7.6	15.7	10.4	0.10	0.01	0.055
5/12/2003								
6/12/2003	0.02	1.05	3.3	16.9	6.1	0.20	0.08	0.074
7/12/2003	0.02	0.60	6.1	2.2	1.9	0.18	0.02	9.297
8/12/2003	0.02	1.09	6.2	3.4	2.6	0.24	0.04	0.125
9/12/2003	0.15	2.35	11.4	8.5	6.4	0.68		0.187

10/12/2003	0.26	3.52	13.3	14.2	22.6	0.84	0.02	0.133
11/12/2003	0.11	0.56	5.9	4.5	4.3	0.18	0.01	0.051
12/12/2003	0.14	0.37	3.0	2.3	3.3	0.07	0.02	0.035
13/12/2003	0.12	0.27	1.8	1.9	0.8	0.07	0.01	0.023
14/12/2003	0.14	1.12	1.7	1.1	0.3	0.36	0.08	0.047
15/12/2003	0.02	0.97	1.8	1.1	0.4	0.06	0.06	0.037
16/12/2003	0.12	0.71	5.4	1.9	2.1	0.23	0.04	0.082
17/12/2003	0.02	1.21	5.8	3.6	2.5	0.22	0.04	0.129
18/12/2003	0.03	0.71	4.2	2.9	1.9	0.18	0.03	0.111
19/12/2003	0.03	1.29	8.6	5.7	4.2	0.35	0.02	0.097
20/12/2003								
21/12/2003	0.01	0.88	1.8	1.1	0.4	0.07	0.05	0.037
Mean	**0.10**	**0.90**	**5.4**	**5.0**	**4.2**	**0.26**	**0.03**	**0.46**
Minimum	**0.01**	**0.22**	**1.7**	**1.1**	**0.3**	**0.06**	**0.00**	**0.00**
Maximum	**0.26**	**3.52**	**13.3**	**16.9**	**22.6**	**0.84**	**0.08**	**9.30**

It has to be noted that the sodium content of these samples could not be determined due to a contamination in the stock Milli-Q water system.

During all seasons, most abundant ions in the PM2.5 fraction are nitrate, sulphate and ammonium. Fluoride, chloride, potassium, magnesium and calcium show less contribution to the total water-soluble ion content, with average concentrations smaller than 1 µg/m^3.

The mean nitrate-concentration is most elevated during spring and summer campaigns. Both sulphate and ammonium concentrations were lowest during summer campaigns.

V Elemental composition and water-soluble ion concentrations in PM2.5 in Menen

During the complete sampling campaign in Menen, PM2.5 samples of 4 periods were analysed for its elemental composition and water-soluble ion concentrations, as described in sections III and IV. This section describes the interpretation of these results by using backward trajectory models, obtained from 'Air Resources Laboratory' (http://www.arl.noaa.gov/ready/open/traj.html). The parameters selected for the backward trajectories were selected at a starting point of 20 meters and a backward counting time of 120h. (Figures: see annex 4)

The first campaign can be divided into 2 parts. For the first part the concentrations of the metals chromium, manganese copper, zinc and lead were most enriched when the air originated from the continent, where the trajectories started at Hungary and Slovakia, and especially when the air passed over Germany and Belgium in low air masses. Air that moved over the industrial areas in Lille and Dunkerque before reaching Menen did not show a distinct difference in composition of the compounds studied. On the other hand, air masses moving over the Southeastern part of the United Kingdom towards Menen, were characterised by increased amounts of vanadium, chromium, manganese, zinc, lead, sulphate and ammonium. During the second part of this campaign, air masses were originating mainly from the Atlantic Ocean. The concentrations of all compounds were very low during this period in comparison with the first part.

In the first part of the second campaign, air originating from the North and from the Atlantic Ocean moved towards Menen. During this period only low concentrations of all compounds have been detected. In case the air, originating from the North, passed over a part of the continent (Belgium, mainly Germany) before reaching Menen, increased concentrations of vanadium, chromium, manganese, copper, zinc and lead were registered in PM2.5 in Menen. The highest concentrations of vanadium, nickel, chloride, nitrate and sulphate were registered when the air passed slowly over the Southeastern part of United Kingdom.

Also during the third campaign the air, moving over the Atlantic Ocean towards Menen, was characterised by the lowest content of elements and water-soluble ions, especially when the air moved at high speed. This effect of speed can also be noted in the air masses moving over Germany. In case of air masses characterised by high speed, a reduced metal content is observed in Menen. On the other hand, in case the air moves slowly over Germany, elevated contents of manganese, zinc, lead, nitrate, ammonium, potassium and calcium were detected in PM2.5. In case the air passed (slowly) over the Netherlands before reaching Menen, elevated ammonium concentrations were measured. Moreover this campaign confirmed that in the air masses, which passed the southeastern part of United Kingdom, the highest concentrations of manganese, copper, zinc, lead, fluoride, chloride and nitrates were detected.

In the last campaign, air masses originating from the Atlantic Ocean, passing the North of France before reaching Menen, carried vanadium, chromium, copper, zinc, lead, chloride and ammonium. Air masses initiated in the same area but passing over other parts of France (often reaching the most southern parts), at low speed, contained mostly ammonium. In contrast, air passing slowly over Germany contained vanadium, chromium, nickel, zinc, lead, chloride, sulphate and ammonium, but in case of fast movements, it contained more ammonium and sulphates.

Overall, it can be concluded that the PM2.5 fraction, detected in Menen is highly dependable upon the backward trajectories of the air masses. The least heavy metal contaminated air in Menen is registered in case the air originated from the Atlantic Ocean. Most often, heavy metal polluted air was detected when the air masses passed Germany or the southeastern part of United Kingdom before reaching Menen. In the case of air masses passing Germany, elevated concentrations of the heavy metals chromium, manganese, copper, zinc, lead and vanadium were detected. Air masses passing the southeastern part of United Kingdom, mainly London and its surroundings, were characterised by elevated concentrations of the heavy metals vanadium, chromium, manganese, zinc, lead, and sulphates.

VI Gaseous pollutants at Menen

The gaseous compounds NO_2, SO_2, NH_3 and BTEX have been measured in Menen by means of radiello diffusion tubes. The diffusion tubes were exposed during 14 days, and analysed with suitable analytical techniques. The results indicate a 14-day average value, which permits to study seasonal variations, and allows to calculate a yearly average value of the different gaseous compounds.

The measured values are shown in tables 5.17. (NO_2, SO_2 and NH_3) and 5.18. (BTEX).

Table 5.17. : Detected concentrations of NO_2, SO_2 and NH_3 in Menen

Date	NO_2 [µg/m^3]	SO_2 [µg/m^3]	NH_3 [µg/m^3]
04/02/03 – 18/02/03	31.9	4.4	15.9
18/02/03 – 04/03/03	39.4	3.9	22.2
04/03/03 – 18/03/03	31.4	3.6	25.5
18/03/03 – 01/04/03	49.4	5.2	75.8
01/04/03 – 15/04/03	23.8	3.1	29.1
15/04/03 – 29/04/03	26.1	3.8	38.1
29/04/03 – 13/05/03	21.2	2.8	27.5
13/05/03 – 27/05/03	15.9	4.7	16.2
27/05/03 – 10/06/03	21.8	2.1	35.4
10/06/03 – 24/06/03	23.1	4.2	37.2
24/06/03 – 08/07/03	15.7	4.1	30.9
08/07/03 – 22/07/03	15.6	1.9	37.5
22/07/03 – 05/08/03	-	-	28.0
05/08/03 – 19/08/03	-	-	59.0
19/08/03 – 02/09/03	15.2	0.5	30.7
02/09/03 – 16/09/03	21.5	2.1	36.6
16/09/03 – 30/09/03	24.2	1.0	26.5
30/09/03 – 14/10/03	24.7	2.9	23.2
14/10/03 – 10/11/03	23.4	1.8	12.0
10/11/03 – 24/11/03	19.0	2.9	14.2

24/11/03 – 08/12/03	46.6	1.5	15.0
08/12/03 – 22/12/03	17.1	2.7	15.0
Mean	**25.4**	**3.0**	**29.6**
Standarddeviation	**9.9**	**1.3**	**15.0**
Minimum	**15.2**	**0.5**	**12.0**
Maximum	**49.4**	**5.2**	**75.8**

The annual mean NO_2 concentration of 25.4 ± 9.9 $\mu g/m^3$ did not exceed the annual limit value for the protection of health of 40 $\mu g/m^3$. Comparing all 14-day average NO_2 concentrations, only a small variation between the data was registered. During winter, the highest NO_2 levels were detected; maximum values of 49.4 $\mu g/m^3$ were reached.

Concerning SO_2, a very low annual mean level of 3.0 ±1.3 $\mu g/m^3$ was detected.

During the periods 18th March until 1st April and 5th August until 18th august, elevated ammonia concentrations were detected. Maximum concentrations of 75.8 $\mu g/m^3$ were registered. Yearly average concentrations of 29.6 ± 15.0 $\mu g/m^3$ are detected.

Table 5.18. : BTEX concentrations at Menen

Date	Benzene [$\mu g/m^3$]	Toluene [$\mu g/m^3$]	Ethylbenzene [$\mu g/m^3$]	o-xylene [$\mu g/m^3$]	m+p-xylene [$\mu g/m^3$]
04/02/03 – 18/02/03	1.57	4.60	0.84	0.82	2.57
18/02/03 – 04/03/03	1.88	7.14	1.40	1.47	4.35
04/03/03 – 18/03/03	1.03	3.83	0.84	0.88	2.97
18/03/03 – 01/04/04	1.36	4.47	0.84	0.80	2.50
01/04/03 – 15/04/03	0.75	2.28	0.33	0.29	0.95
15/04/03 – 29/04/03	0.74	2.99	0.53	0.49	1.53
29/04/03 – 13/05/03	0.43	2.44	0.46	0.45	1.44
13/05/03 – 27/05/03	0.35	2.03	0.41	0.47	1.33
27/05/03 – 10/06/03	0.46	1.87	0.45	0.45	1.30
10/06/03 – 24/06/03	0.40	2.69	0.43	0.37	1.30
24/06/03 – 08/07/03	0.38	2.00	0.44	0.25	0.79
08/07/03 – 22/07/03	0.37	2.39	0.52	0.37	1.27
22/07/03 – 05/08/03	0.42	2.14	0.56	0.34	1.12
05/08/03 – 19/08/03	0.55	2.72	0.57	0.33	1.02
19/08/03 – 02/09/03	0.37	1.63	0.52	0.30	0.97
02/09/03 – 16/09/03	0.64	3.41	1.03	0.73	2.84
16/09/03 – 30/09/03	0.82	5.25	1.20	1.10	3.57
30/09/03 – 14/10/03	0.63	2.19	0.56	0.42	1.33
14/10/03 – 10/11/03	-	-	-	-	-
10/11/03 – 24/11/03	-	-	-	-	-
24/11/03 – 08/12/03	1.78	7.74	1.96	1.92	5.81
08/12/03 – 22/12/03	2.10	9.03	2.01	2.05	6.04
Mean	**0.85**	**3.64**	**0.80**	**0.71**	**2.25**
Standarddeviation	**0.57**	**2.13**	**0.50**	**0.53**	**1.59**
Minimum	**0.35**	**1.63**	**0.33**	**0.25**	**0.79**
Maximum	**2.10**	**9.03**	**2.01**	**2.05**	**6.04**

Proportional concentrations of the different BTEX compounds (benzene, toluene, ethylbenzene, ortho-, meta- and para-xylene) are registered during each sampling period. The limit value for benzene for the protection of human health (5 $\mu g/m^3$) was not exceeded in Menen.

VII PAH at Menen

A Results of individual and total PAH

Sixteen US EPA criteria PAH were analysed at Menen because they are suspected to be more harmful than some of the others and exhibit adverse effects that are representative of the PAH.

PAH compounds are the most stable form of hydrocarbons with a low hydrogen/carbon ratio and are formed by combustion of hydrocarbons under oxygen deficient conditions. Because of their low vapor pressure, some PAH are present at ambient temperature in air, both as gases and associated with particles. The lighter PAH, such as phenanthrene, are found almost exclusively in gas phase, where as the heavier PAH, such as benzo(a)pyrene, are almost totally adsorbed onto particles.

Table 5.19. gives an overview of the detected PAH-concentrations in aerosol samples during 2003. Concentrations of lighter PAH (molecular weight <200) were found relatively low in filter samples in comparison to heavier PAH fractions at Menen. Naphthalene (0.15 ng/m^3) and phenanthrene (0.19 ng/m^3) dominates the lighter fraction of PAH. The high molecular weight species like fluoranthene (0.83 ng/m^3), chrysene (0.87 ng/m^3), benzo(b)fluoranthene (0.84 ng/m^3), benzo(a)pyrene (0.58 ng/m^3), benzo(ghi)perylene (0.73 ng/m^3) and indeno(123cd)pyrene (0.77 ng/m^3) dominates the PAH fraction of filter samples (Figure 5.8.). Further the concentration of benzo(a)pyrene (0.58 ng/m^3 as annual average) was found to be lower than its proposed target value (1 ng/m^3).

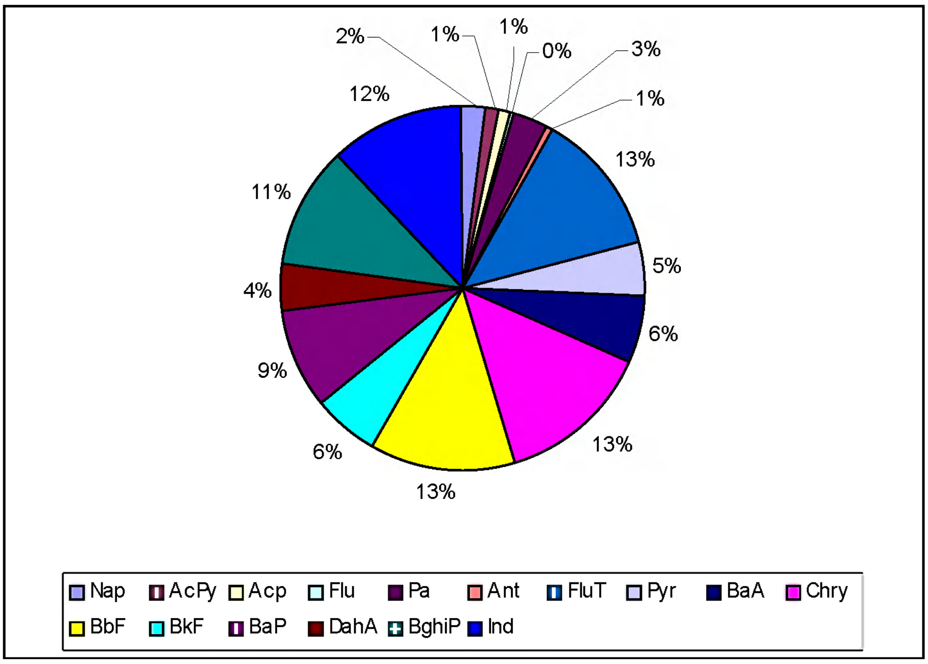


Figure 5.8.: Relative representation of individual annual average PAH concentration at Menen

The comparison of the daily total PAH concentration and the prevailing wind direction during sampling days, shows that the daily total PAH concentrations were relatively high when the prevailing wind direction was southwest at the sampling site.

Figure 5.9. shows the monthly average of ΣPAH concentrations. This figure shows that the PAH concentration were significantly high during the winter season in comparison to the summer at Menen. The annual average concentration of ΣPAH was 6.49 ng/m^3. The monthly average ΣPAH concentrations were 5-7 times higher in January, February and December, in comparison to the concentration in May, June and August. The possible reason of high concentration of ΣPAH during the winter season seems to

be related with the very low temperature during these period which made favourable conditions for the condensation/adsorption of these species on suspended particles in air.

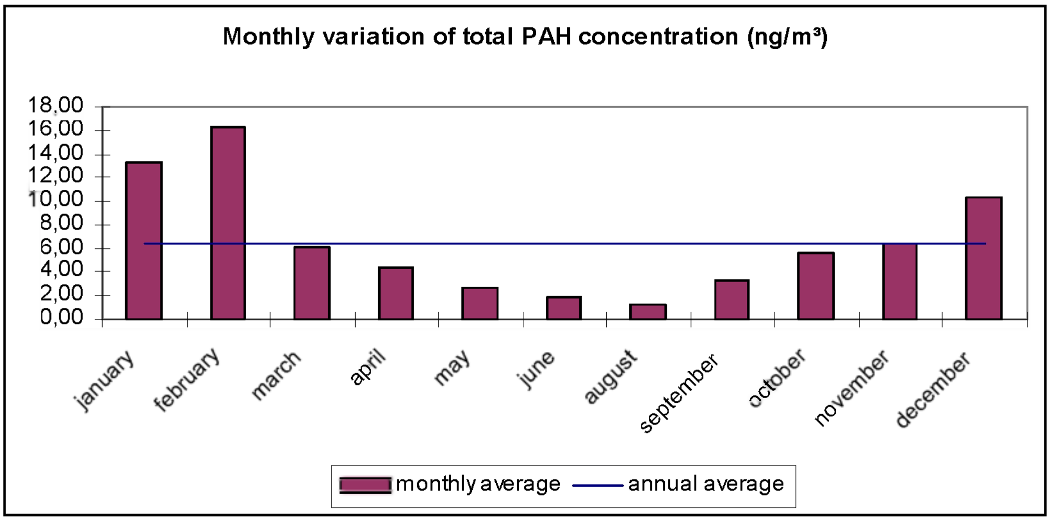


Figure 5.9.: Monthly variation of total PAH concentration (ng/m³) at Menen

Table 5.19.: Measured PAH-concentrations at Menen (ng/m^3)

Sampling Dates	Naphthalene	Acenapthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	**TOTAL PAH**
11/12-01-03	0.05	0.05	0.01	0.07	0.09	0.01	8.13	0.8	3.09	7.82	6.12	2.74	5.06	1.25	5.44	5.03	**45.8**
26/27-01-03							0.11	0.32	0.26	0.51	0.52	0.23	0.24	0.16	0.25	0.3	**2.90**
23/24-01-03	0.1	0.02	0.04	0.05	0.02	0.03	1.78	0.25	0.56	1.8	1.51	0.66	1.07	0.27	1.1	1.78	**11.0**
27/28-01-03	0.22	0.01	0.05	0.02	0.16	0.01	1.07	0.08	0.05	0.39	0.48	0.2	0.19	0.15	0.36	0.37	**3.81**
29/30-01-03	0.14	0.03	0.07	0.01	0.05	0	0.3	0.09	0.1	0.47	0.34	0.16	0.18	0.04	0.31	0.07	**2.36**
31/01-02-03	0.05	0.02	0.05	0.03	0.16	0.01	2.42	0.27	0.91	2.65	1.82	0.81	1.37	0.51	1.6	1.63	**14.3**
04/05-02-03	0.23	0.01	0.1	0.01	0.04	0.01	0.84	0.09	0.17	0.64	0.45	0.2	0.28	0.19	0.71	0.51	**4.48**
14/15-02-03	0.15	0.18	0.07	0.04	0.89	0.17	2.54	2.58	1.13	2.72	1.9	0.94	1.65	0.58	1.99	1.91	**19.4**
20/21-02-03	0.42	0.63	0.11	0.04	2.29	0.23	6.12	3.08	2.08	5.19	3.78	1.73	3.56	1.5	4.23	3.61	**38.6**
24/25-02-03	0.16	0.02	0.1	0.05	0.26	0.06	0.48	0.21	0.59	0.89	0.96	0.42	0.59	0.04	0.71	0.78	**6.32**
26/27-02-03							1.39	1.69	0.92	1.91	1.64	0.76	0.93	0.32	1.38	1.85	**12.8**
06/07-03-03	0.14	0.06	0.09	0.05	0.31	0.06	0.45	0.37	0.38	0.79	0.82	0.36	0.29	0.1	0.76	0.61	**5.64**
12/13-03-03	0.12	0.03	0.04	0.01	0.07	0.02	0.04	0.18	0.17	0.4	0.6	0.16	0.19	0.04	0.32	0.38	**2.77**
18/19-03-03	0.62	0.05	0.03	0.04	0.07	0.06	0.67	0.2	0.75	1.06	1.15	0.59	0.79	0.64	1.37	1.25	**9.34**
20/21-03-03	0.3	0.03	0.11	0.04	0.17	0.04	0.24	0.16	0.34	0.57	0.55	0.26	0.34	1.05	0.67	0.62	**5.49**
22/23-03-03	0.18	0.03	0.12	0.02	0.39	0.02	0.24	0.74	0.4	0.67	0.92	0.38	0.5	0.38	1.47	0.86	**7.32**
24/25-03-03	0.25	0.02	0.06	0.04	0.61	0.09	0.16	0.66	0.81	0.91	1.28	0.53	0.6	0.53	1.37	1.03	**8.95**
26/27-03-03	0.05	0.06	0.06	0.01	0.1	0.03	0.22	0.67	0.62	0.6	0.77	0.38	0.43	0.19	1.02	0.72	**5.93**
28/29-03-03							0.31	0.56	0.71	0.73	0.85	0.37	0.53	0.2	0.71	1.17	**6.14**
30/31-03-03	0.1	0.01	0.06	0.02	0.06	0.02	0.18	0.4	0.17	0.29	0.42	0.18	0.22	0.27	0.62	0.31	**3.33**
05/06-04-03	0.11	0.05	0	0.02	0.04	0.01	0.14	0.04	0.09	0.08	0.12	0.04	0.05	0.07	0.13	0.19	**1.18**
09/10-04-03	0.3	0.03	0.03	0.02	0.05	0.01	0.64	0.12	0.17	0.56	0.48	0.22	0.33	0.08	0.59	0.52	**4.15**
11/12-04-03							0.33	0.78	0.88	1.07	1.26	0.54	0.66	0.33	1.18	1.4	**8.43**
13/14-04-03	0.55	0.04	0.02	0.02	0.23	0.01	0.67	0.19	0.06	0.35	0.47	0.18	0.33	0.1	0.26	0.48	**3.96**
15/16-04-03	0.05	0.04	0.05	0.01	0.33	0.03	0.75	0.13	0.07	0.46	0.56	0.23	0.29	0.09	0.43	0.46	**3.98**

Table 5.16.: Measured PAH-concentrations at Menen (ng/m^3) *(continued)*

Sampling Dates	Naphthalene	Acenapthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	**TOTAL PAH**
19/20-04-03	0.09	0.01	0.04	0.03	0.11	0.01	0.79	0.06	0.07	0.29	0.44	0.16	0.19	0.03	0.23	0.42	**2.97**
21/22-04-03	0.05	0.01	0.06	0.03	0.56	0.06	0.65	0.11	0.16	0.66	0.62	0.25	0.41	0.04	0.51	0.64	**4.82**
23/24-04-03	0.08	0.01	0.01	0.03	0.35	0.06	0.74	0.08	0.16	0.53	0.58	0.23	0.28	0.06	0.36	0.56	**4.12**
25/26-04-03	0.32	0.01	0.03	0.09	0.67	0.17	0.92	0.18	0.3	0.68	0.64	0.29	0.36	0.09	0.23	0.63	**5.61**
05/06-05-03	0.19	0.02	0.09	0.02	0.05	0.03	0.21	0.13	0.49	0.28	0.36	0.16	0.12	0.06	0.37	0.41	**2.99**
07/08-05-03	0.16	0.32	0.18	0.02	0.12	0.05	0.09	0.07	0.31	0.28	0.31	0.14	0.19	0.05	0.13	0.08	**2.50**
15/16-05-03	0.14	0.04	0.06	0.03	0.14	0.05	0.46	0.38	0.34	0.35	0.47	0.23	0.26	0.27	0.53	0.56	**4.31**
30/31-05-03	0.07	0.01	0.02	0.01	0.04	0	0.07	0.04	0.07	0.08	0.07	0.03	0.03	0.03	0.08	0.01	**0.66**
01/02-06-03	0.08	0.01	0.15	0.01	0.06	0.02	0.16	0.04	0.03	0.2	0.22	0.08	0.11	0.08	0.12	0.26	**1.63**
05/06-06-03	0.11	0.02	0.05	0.03	0.22	0.08	0.18	0.04	0.03	0.25	0.31	0.13	0.13	0.07	0.2	0.15	**2.00**
20/21-08-03	0.05	0.03	0.19	0.04	0.2	0.02	0.22	0.09	0.03	0.16	0.18	0.07	0.08	0.06	0.04	0.08	**1.54**
23/24-08-03	0.08	0.01	0.07	0.01	0.04	0	0.01	0.04	0	0.05	0.04	0.02	0.02	0.07	0.06	0.03	**0.55**
25/26-08-03	0.06	0.03	0.12	0.02	0.04	0.01	0.17	0.09	0.03	0.15	0.3	0.1	0.11	0.08	0.09	0.16	**1.56**
29/30-08-03	0.13	0.02	0.05	0.01	0.01	0	0.64	0.04	0.01	0.08	0.08	0.04	0.04	0.02	0.02	0.05	**1.24**
03/04-09-03	0.03	0.02	0.06	0.01	0.05	0.01	0.08	0.12	0.01	0.11	0.16	0.07	0.06	0.01	0.13	0.13	**1.06**
05/06-09-03	0.04	0.01	0.01	0.05	0.46	0.11	0.37	0.25	0.34	0.44	0.55	0.26	0.21	0.32	0.62	0.54	**4.58**
07/08-09-03	0.09	0.03	0.07	0.02	0.11	0.03	0.1	0.13	0.16	0.19	0.23	0.1	0.1	0.03	0.25	0.14	**1.78**
09/10-09-03	0.18	0.01	0.06	0.02	0.04	0.03	0.31	0.06	0.17	0.2	0.19	0.09	0.11	0.1	0.16	0.07	**1.80**
15/16-09-03	0.32	0.01	0.06	0.03	0.41	0.18	0.35	0.17	0.51	0.6	0.64	0.31	0.4	0.54	0.56	0.64	**5.73**
19/20-09-03	0.45	0.02	0.01	0.03	0.27	0.07	0.29	0.29	0.31	0.39	0.42	0.18	0.2	0.06	0.39	0.38	**3.76**
21/22-09-03	0.32	0.02	0.1	0.04	0.27	0.05	0.18	0.11	0.25	0.28	0.32	0.15	0.14	0.11	0.33	0.33	**3.00**
23/24-09-03	0.11	0.11	0.1	0.03	0.08	0.02	0.17	0.1	0.22	0.17	0.23	0.11	0.1	0.16	0.2	0.25	**2.16**
25/26-09-03	0.24	0.02	0.09	0.02	0.06	0.03	0.68	0.16	0.43	0.44	0.59	0.25	0.35	0.16	0.55	0.56	**4.63**
29/30-09-03	0.21	0.01	0.12	0.04	0.03	0.02	0.4	0.09	0.36	0.35	0.49	0.23	0.28	0.21	0.52	0.55	**3.91**
01/02-10-03	0.14	0.02	0.08	0.03	0.05	0.01	0.13	0.08	0.23	0.24	0.39	0.18	0.25	0.55	0.39	0.34	**3.11**

Table 5.16.: Measured PAH-concentrations at Menen (ng/m^3) *(continued)*

Sampling Dates	Naphthalene	Acenapthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene	Indeno(1,2,3-c,d)pyrene	**TOTAL PAH**
17/18-10-03	0.05	0.01	0.06	0.01	0.05	0.02	0.47	0.16	0.33	0.54	0.65	0.31	0.48	0.18	0.5	0.56	**4.38**
19/20-10-03	0.1	0.28	0.17	0.05	0.32	0.02	1.47	0.52	0.28	0.86	1	0.47	0.76	0.33	1.07	1.14	**8.84**
23/24-10-03	0.09	0.17	0.06	0.04	0.26	0.02	0.96	0.29	0.38	1.07	0.93	0.43	0.76	0.2	0.77	0.88	**7.31**
25/26-10-03	0.06	0.1	0.13	0.01	0.03	0.01	1.05	0.14	0.13	0.44	0.53	0.25	0.42	0.2	0.51	0.56	**4.57**
11/12-11-03	0.09	0.05	0.08	0.01	0.08	0.05	0.86	0.16	0.2	0.82	1.01	0.44	0.67	0.35	0.7	1.04	**6.61**
25/26-11-03	0.11	0.01	0.02	0.02	0.03	0.04	0.45	0.18	0.18	0.9	1.08	0.47	0.56	0.25	0.85	1.07	**6.22**
09/10-12-03	0.29	0.04	0.07	0.06	0.11	0.18	5.88	1.51	3.23	6.61	5.78	2.67	6.06	2.88	5.75	5.48	**46.6**
11/12-12-03	0.17	0.01	0.06	0.02	0.16	0.05	0.85	0.19	0.25	0.96	1.09	0.47	0.82	0.22	0.78	1.21	**7.31**
13/14-12-03	0.03	0.03	0.08	0.01	0.01	0.01	0.08	0.03	0.01	0.09	0.15	0.05	0.05	0.06	0.1	0.07	**0.86**
21/22-12-03	0.06	0.21	0.15	0.03	0.06	0.01	0.43	0.31	0.34	1.09	0.89	0.39	0.5	0.17	0.2	0.53	**5.37**
23/24-12-03	0.64	0.04	0.08	0.01	0.04	0.04	0.83	0.11	0.41	0.97	1.32	0.63	1.04	0.38	1.08	1.13	**8.75**
25/26-12-03	0.14	0.02	0.02	0.01	0.02	0.01	0.28	0.07	0.03	0.22	0.32	0.13	0.18	0.07	0.19	0.29	**2.00**
27-28-12-03	0.03	0.03	0.03	0.01	0.02	0.01	0.55	0.08	0.07	0.23	0.27	0.11	0.13	0.07	0.12	0.16	**1.92**

Detection limits (ng/m^3): naphthalene (Nap): 0.005, acenapthylene (AcPy): 0.005, acenaphthene (Acp): 0.006, fluorene (Flu): 0.003, phenanthrene (Pa): 0.001, anthracene (Ant): 0.0005, fluoranthene (FluT): 0.003, pyrene (Pyr): 0.001, benzo(a)anthracene (BaA): 0.003, chrysene (Chr): 0.002, benzo(b)fluoranthene (BbF): 0.002, benzo(k)fluoranthene (BkF): 0.003, benzo(a)pyrene (BaP): 0.002, dibenzo(a,h)anthracene (DahA): 0.0004, benzo(g,h,i)perylene (BghiP): 0.0004 and indeno(1,2,3-c,d)pyrene (Ind): 0.001.

B Potential Sources of PAH

Correlation of Menen data was evaluated by regression analysis. The correlation coefficients (*r*) show that chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)-anthracene, benzo(g,h,i)perylene and indeno(1,2,3-c,d)pyrene have very strong correlation in between and hence one of these PAH can be used as an indication of other PAH concentration. There wasn't found a strong correlation between low molecular and high molecular weight PAH, which likely indicates towards their origin from different sources.

Principal component analysis (PCA) is the oldest and most widely used multivariate statistical technique in atmospheric sciences. The PCA results shows that three factors explain the main part of the data variance. Therefore, one element for each factor has been chosen as a tracer. Factor 1 has very high factor loading of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene and indeno(123, cd)pyrene; which are identified as maker of gasoline emissions. A relatively high factor loading for fluoranthene, phenanthrene, anthracene, and pyrene is an indicator of diesel emission. Hence, it can be suggested that vehicular emissions forms a major fraction of PAH at Menen, although gasoline emission may dominate this fraction. The high factor loading of chrysene, and benzo(b)fluoranthene indicates that stationary sources may also affect the PAH concentration at the sampling site in Menen.

For factor 2, acenapthylene, phenanthrene and anthracene had the loading factor >0.5, indicating them from other sources than identified in factor 1. These PAH have been identified in coal combustion, coke production and wood combustion by many studies.

The third factor is comprised of the lighter PAH (naphthalene and acenaphthene), which are prevalent in the vapor phase. Components related to the third factor are not attributed to 'identified sources'.

C Conclusion

Filter samples collected during this Inter Region project were analysed for 16 US EPA criteria PAH. The concentration of lighter PAH were found relatively very low and were dominated by naphthalene and phenanthrene , whereas heavier PAH fluoranthene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene and indeno(123cd)pyrene dominates the total PAH concentration in particulate matter.

Seasonal and meteorological parameters also influence the PAH concentration. Generally higher concentrations in the winter season were found. Further the reported daily PAH concentrations were relatively high when the prevailing wind direction was southwest at the sampling site in Menen.

The application of correlation coefficient calculation and PCA allowed to find the possible source of PAH which indicate towards vehicular emission as a major source although other sources like wood burning/ coke production etc. might also exist.

6. Dioxins and PCB126

I The deposition monitoring programme

Since 1993 the VMM organises twice a year, during spring and winter a campaign to measure the dioxin deposition. Since 2002 the deposition of the dioxin-like PCB126 was measured simultaneously. Samples are taken near:

-waste incinerators: municipal, medical and industrial
-industrial areas: Ferro and non-Ferro metallurgy
-rural sites
-urban sites
-traffic sites
-crematoria
-airports.

Extra measurements were performed in areas where repeatedly high depositions were found. Table A in annex 3 summarises the dioxin depositions measured in Flanders from 1993 to 2001. Table B gives an overview of the deposition of dioxins and PCB126 in 2002 and 2003. Table C summarises the evolution of the monthly dioxin and PCB126 depositions per measurement site from 2000 onwards. Table D gives an overview of the depositions of dioxins and PCB126 measured near shredder installations.

Since the first measurement in 1993 the deposition of dioxins has significantly decreased (figure 6.1.). This decrease can be related to the closure of several incinerators and to the installation of dioxin removal units to comply with the Flemish emission limit of 0.1 ngTEQ/m³. In certain periods there remain high depositions in problem areas. In spite of the fact that in Flanders the dioxin depositions decreased considerably, the depositions still remain high in Menen.

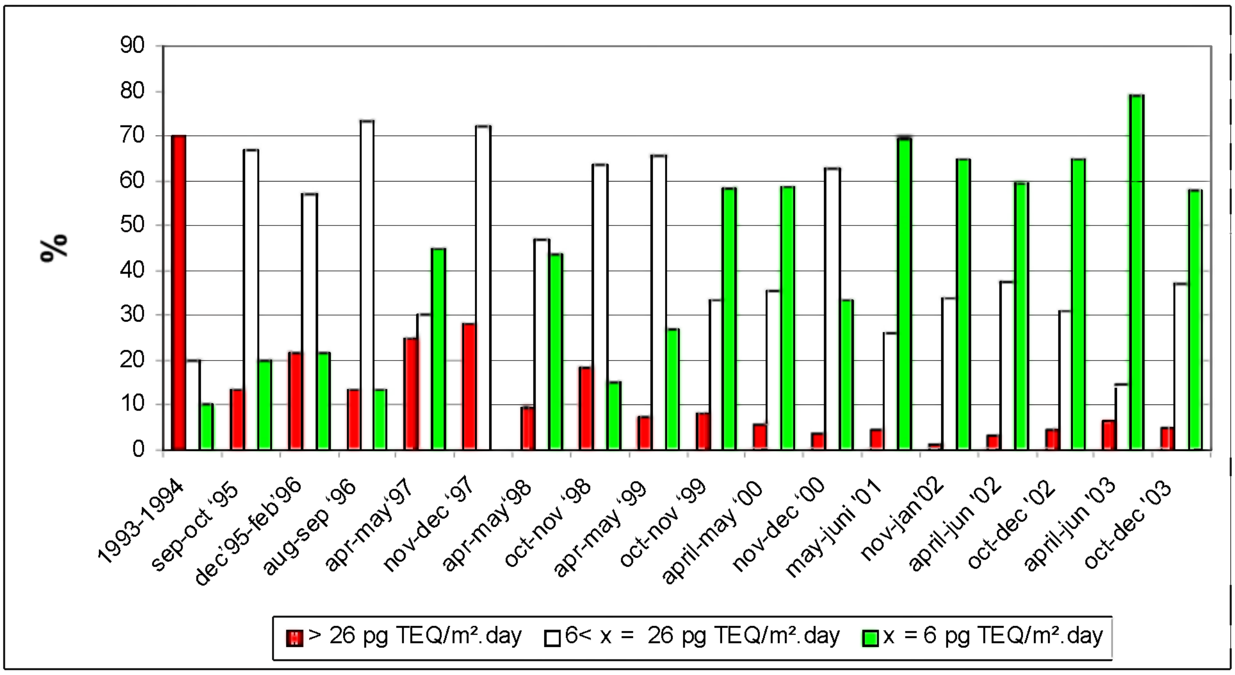


Figure 6.1.: Exceedance of guide values expressed as a percentage of the monthly values of allowed dioxin depositions (The bars represent the percentage of samples, which comply the guide values)

II Measurement campaigns at the French border

A Introduction

Measurement campaigns of dioxin and PCB126 deposition took place from October 2002 until December 2003.

-the winter-campaign of 2002 took place from October 2002 till April 2003.
-the spring-campaign of 2003 took place from April 2003 till June 2003.
-the winter-campaign of 2003 took place from October 2003 till December 2003.
-a yearly dioxin and PCB126 depositions measurement campaign of monthly measurements took place in 2002 and 2003. The purpose was to evaluate the monthly trend of deposition over a whole year. In this report the samples taken from October 2002 till March 2004 at Menen2 and Menen6 will be discussed.
-the "extra measuring" campaign took place in the period of April 2002 till February 2003. Extra samples were taken in Menen on the factory ground of the shredder plant Galloo and in Halluin (France). The plant is situated on the border between Belgium and France. A part of the plant is located in Belgium (Menen) while the other part is located in France (Halluin). Both sides have their own shredder installation.

B The winter - campaign 2002 and the spring- and winter- campaign 2003

1 Location of measuring points

The winter-campaign of 2002 took place from October 2002 till April 2003, the spring-campaign of 2003 from April till June 2003 and the winter-campaign of 2003 from October 2003 till December 2003. The sampling locations are shown on the map on figure 6.2..

Table 6.1.: Location of measuring point and potential sources

nr	**Location**	**Lambert co-ordinates**	**Sample**		
			Winter 2002	**Spring 2003**	**Winter 2003**
1	Menen (Rekkem) *Nachtegaalstraat*	N 164 986 O 64 255	X	X	X
2	Menen *Wervikstraat 236*	N 165 293 O 61 164	X	X	X
3	Menen (Ter Berken) *Volkslaan – rusthof"Ter Berken"*	N 166 993 O 62 111	X	X	X
4	Menen *Ropswalle 101*	N 164 089 O 60 637	X	X	X
5	Menen *Zwembad,Sluizenkaai 75*	N 165 641 O 61 645	X	X	X
6	Menen *Wervikstraat 221*	N 165 202 O 60 916		X	
7	Wervik *Menensesteenweg 279*	N 164 050 O 58 780	X	X	X
8	Moeskroen (Rollegem) *Moeskroensestraat 29*	N 161 431 O 71 557	X	X	X
9	Veurne *Westmoerstraat*	N 191 090 O 24 710	X	X	X
10	Kortrijk *Hoek Parkietlaan 26,Open veld*	N 171 432 O 73 015	X		

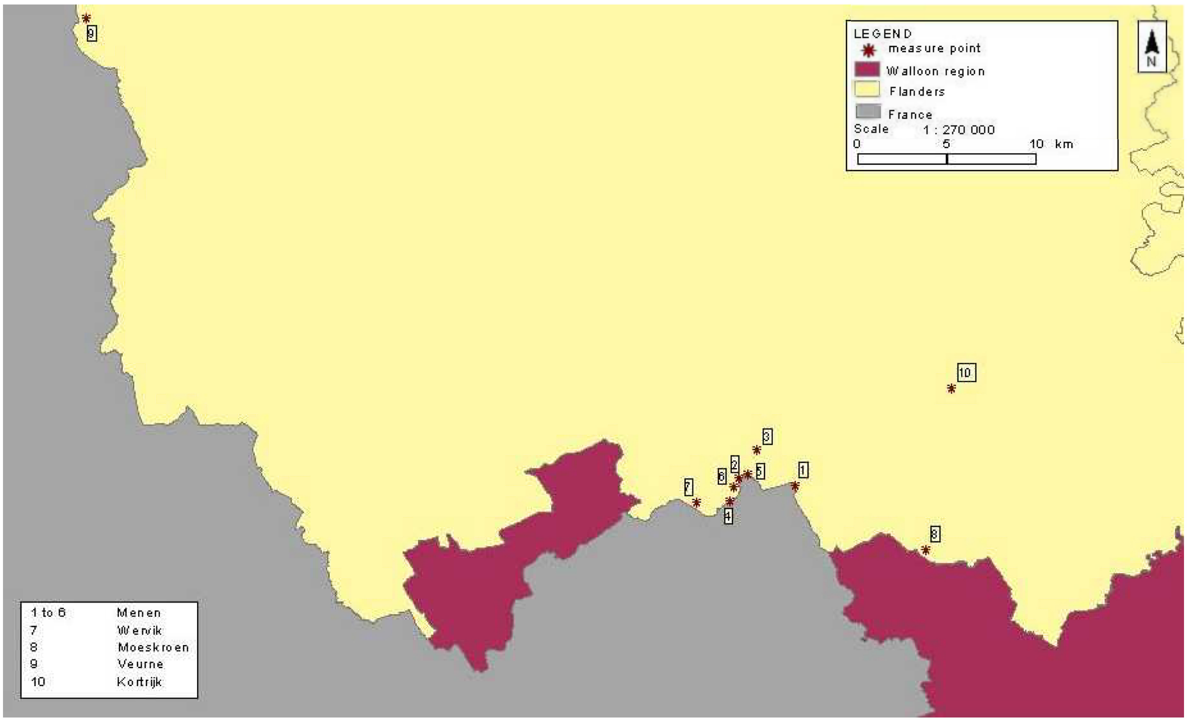


Figure 6.2. : Sampling locations of dioxin and PCB deposition

Potential sources in Menen include small industries, open fires, and municipal incineration. Veurne and Wervik have been installed to look for any influence coming from the North of France (for example the industrial complex of Duinkerken). In Moeskroen a possible source could be MEPREC etc.

2 Results of the dioxin deposition during winter 2002, spring 2003 and winter 2003

During the winter campaign of 2002, no increased dioxin deposition was measured at 6 of the 9 locations. Moderately increased dioxin depositions were measured at 3 of the 9 locations: Menen2, Menen5, and Veurne. The highest value was found at the location Menen2, Wervikstraat. This sampling point is located close to the shredder plant "Galloo".

During the spring campaign of 2003, an extra measuring point was placed closer to the shredder plant (Menen6). The highest dioxin deposition was found at Menen6. Moderately increased dioxin depositions were measured at 4 of the 9 locations: Menen2, Menen4, Menen6 and Wervik. No increased dioxin deposition was measured at 5 of the 9 locations.

During the winter campaign of 2003, no increased dioxin deposition was measured 4 of the 8 locations. Moderately increased dioxin depositions were measured at 3 of the 8 locations: Menen2, Menen3 and Menen4. The highest value was found at Veurne.

Table 6.2.: Results of the dioxin deposition measurements during winter 2002, spring 2003 and winter 2003 (TEQ/m².day (WHO-TEF))

Location	**Winter 2002**	**Spring 2003**	**Winter 2003**
Near municipal incinerator IVMO and Shredder plant Galloo			
Menen1, Nachtegaalstraat	2.5	2.3	2.8
Menen2, Wervikstraat	23.5	13.4	9.0
Menen3, Ter Berken	4.7	2.5	13
Menen4, Ropswalle	4.3	10.6	13
Menen5, Sluizenkaai	6.2	5.5	4.8
Menen6, (Galloo)	*	23	*

Near industrial areas MEPREC industry			
Moeskroen	5.2	2.9	5.9
Near the border of the North of France			
Veurne	18.1	2.5	27
Wervik	2.9	7.9	3.2
Measurements in municipal areas			
Kortrijk	4.5	*	*

* no measurement available

🟥 $x > 26$ pg TEQ/m^2.day (increased)

🟩 $x \leq 6$ pg TEQ/m^2.day (not increased)

⬜ $6 < x \leq 26$ pg TEQ/m^2.day (moderately increased)

Table 6.3.: Evaluation of the dioxin deposition during winter 2002, spring 2003 and winter 2003

# measuring points	**Winter 2002**	**Spring 2003**	**Winter 2003**
Increased > 26 pg TEQ/m^2.d	**Zero of nine**	**Zero of nine**	**One of eight:** Veurne
Moderately increased $6 < x \leq 26$ pg TEQ/m^2.d	**Three of nine:** Menen2, Menen5, Veurne	**Four of nine:** Menen2, Menen4, Menen6, Wervik	**Three of eight:** Menen2, Menen3, Menen4
Not increased ≤ 6 pg TEQ/m^2.d	**Six of nine:** Menen1, Menen3, Menen4, Moeskroen, Wervik, Kortrijk	**Five of nine :** Menen1, Menen3, Menen5, Moeskroen, Veurne	**Four of eight:** Menen1, Menen5, Moeskroen, Wervik

3 Results of the deposition of PCB126 during winter 2002, spring 2003 and winter 2003

During the winter campaign of 2002, a high deposition was found at one location, namely Menen2.

During the spring campaign of 2003, increased levels of PCB126 were measured at 3 locations near the river Leie namely Menen 2, 4 en 6. The highest value was measured at location Menen6, the nearest point to the shredder plant Galloo. A moderately increased PCB126 deposition was also measured at Menen5 (Sluizenkaai) situated approximately 800 m, northerly from the shredder plant. The PCB126 depositions were low in all other locations. It is noteworthy that repeatedly high PCB126 depositions were measured near other shredder installations (table D).

During the winter campaign of 2003, a high deposition was measured at Menen 4, moderately PCB126 depositions were found at Menen 2, Menen 3 and Veurne.

Table 6.4.: Results of the PCB126 deposition measurements during winter 2002, spring 2003 and winter 2003 (TEQ/m^2.day)

Location	**Winter 2002**	**Spring 2003**	**Winter 2003**
Near municipal incinerator IVMO and shredder plant Galloo			
Menen1, Nachtegaalstraat	<1	1.5	<1
Menen2, Wervikstraat	38	32	19
Menen3, Ter Berken	1.5	2.3	26
Menen4, Ropswalle	3.4	30	51
Menen5, Sluizenkaai	2.7	8.8	2.6
Menen6, (Galloo)	*	33	*
Near industrial areas and potential sources MEPREC industry			
Moeskroen	<1	2.0	<1
Near the border of the North of France			

Veurne	3.5	3.1	9.1
Wervik	<1	3.7	<1
Measurements in municipal areas			
Kortrijk	<1	*	*

* no measurement available

🟥 x > 26 pg TEQ/m^2.day (increased)
🟩 x ≤ 6 pg TEQ/m^2.day (not increased)
☐ 6 < x ≤ 26 pg TEQ/m^2.day (moderately increased)

Table 6.5.: Evaluation of the deposition of PCB126 during winter 2002, spring 2003 and winter 2003

# measuring points	**Winter 2002**	**Spring 2003**	**Winter 2003**
Increased > 26 pg TEQ/m^2.d	**One of nine:** Menen2	**Three of nine:** Menen2, Menen4, Menen6	**One of eight:** Menen4
Moderately increased 6< x ≤ 26 pg TEQ/m^2.d	**Zero of nine**	**One of nine:** Menen5	**Three of eight:** Menen2, Menen3, Veurne
Not increased ≤ 6 pg TEQ/m^2.d	**Eight of nine:** Menen1, Menen3, Menen4, Menen5, Moeskroen, Wervik, Veurne, Kortrijk	**Five of nine:** Menen1, Menen3, Moeskroen, Veurne, Wervik	**Four of eight:** Menen1, Menen5, Moeskroen, Wervik

C Monthly measurements over a whole year

1 Locations and measurements

High depositions of dioxins and PCB126 were repeatedly found at Menen2. In order to survey the air quality at this location in more detail, monthly deposition samples were taken at Menen2. From April 2003 to October 2003, additional samples were taken at Menen6, which is located nearby but closer to the shredder plant Galloo.

2 Results of the monthly dioxin and PCB126 deposition measurements at Menen2 and Menen6 during the period October 2002 -March 2004

The results (shown in table 6.6. and 6.7.) demonstrate that the levels of dioxins and PCB126 are increased in all the samples, the deposition of dioxins and PCB126 exceeding the level of 6 pg TEQ/m^2.day. Moreover, for PCB126 increased levels (>26 pg TEQ/m^2.day) were found in almost every sample. The levels of dioxin and PCB126 are mostly higher at Menen6. Menen6 is also situated in the Wervikstraat but closer to the shredder plant Galloo.

Deposition measurements on a monthly basis were also organised in three strongly industrialised areas namely Hoboken, Olen and Zelzate. Table C demonstrates that in these areas several not increased dioxin depositions were found and that almost no PCB126 was measured. These results are in strong contrast with the fluctuating dioxin level and high PCB126 depositions found in Menen.

Table 6.6.: Results of the monthly dioxin and PCB126 deposition at Menen2 and Menen6 (October 2002 - March 2004) (pg TEQ/m^2.day)

Sampling period	**Menen2**		**Menen6**	
	Dioxin	**PCB126**	**Dioxin**	**PCB126**
09-10/02	43	109	*	*
10-11/02	24	38	*	*

11-12/02	9.1	14	*	*
12-01/03	13	28	*	*
01-02/03	8.5	8.7	*	*
02-03/03	33	59	*	*
03-04/03	13	32	*	*
04-05/03	24	65	23	33
05-06/03	23	66	37	79
06-07/03	19	47	41	96
07-08/03	11	28	12	23
08-09/03	14	28	18	42
09-10/03	25	102	32	123
10-11/03	18	52	*	*
11-12/03	9.0	19	*	*
12-01/04	15	33	*	*
01-02/04	19	32	*	*
02-03/04	6.6	8.4	*	*

* no measurement available

🟥 $x > 26$ pg TEQ/m².day (increased)

🟩 $x \leq 6$ pg TEQ/m².day (not increased)

☐ $6 < x \leq 26$ pg TEQ/m².day (moderately increased)

Table 6.7.: Evaluation of the monthly dioxin and PCB126 deposition at Menen2 and Menen6 (October 2002 - March 2004)

Menen2: 18 samples *Menen6: 6 samples*	**Dioxin**		**PCB126**	
	Menen2	**Menen6**	**Menen2**	**Menen6**
Increased > 26 pg TEQ/m².d	2/18	3/6	14/18	5/6
Moderately Increased $6 < x \leq$ pg TEQ/m².d	16/18	3/6	4/18	1/6
Not increased ≤ 6 pg TEQ/m².d	0/18	0/6	0/18	0/6

D Extra measurement campaign

1 Locations of the measurements

In order to track down the pollution source in the area of the Wervikstraat in Menen, extra measurements were performed around the shredder plant Galloo Menen, and Halluin. The campaign took place in the period of October 2002 till February 2003 (included). Simultaneously with this campaign, samples were collected at Menen2. The measuring points are shown on the map on figure 6.3. (point A, B, C, D).

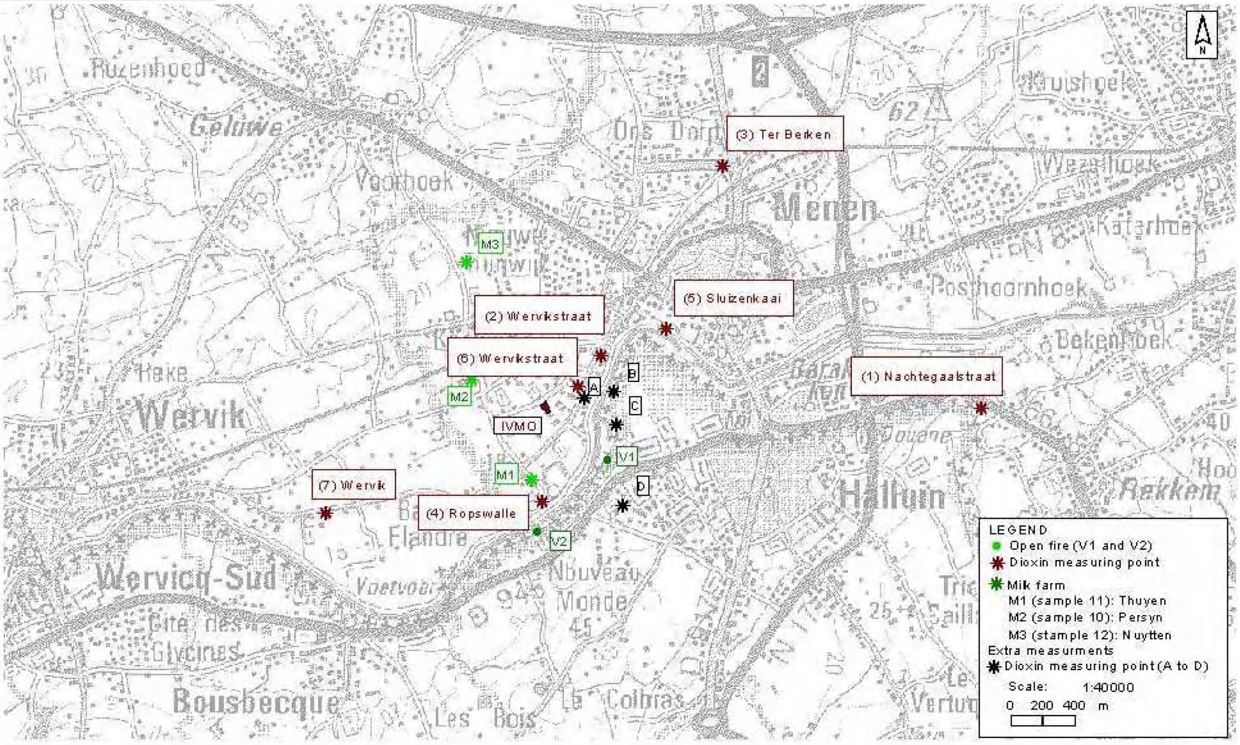


Figure 6.3. : Sampling locations of the extra measurement campaign (points A to D)

2 Results of dioxin and PCB126 deposition measurements around the shredder plant Galloo in Menen in the period October 2002 - February 2003

The campaign consisted of 3 measurement periods. Near the Flemish shredder installation (Galloo1) very high dioxin depositions (over the 100 pgTEQ/m².day) were measured during the whole campaign. A peak of 191 pgTEQ/m².day dioxin deposition was measured on that location and all 3 measurements were increased. The dioxin level was lower near the French shredder (Galloo2). Still, all 3 values were increased. The lowest dioxin deposition was measured at the border of the French plant (Galloo3): one on three samples was increased. In Halluin, low levels of dioxin deposition were measured.

Similar conclusions can be drawn for the PCB126 depositions: the highest values are measured near the Flemish shredder (over 250 pg TEQ/m².day). All PCB126 depositions are increased near the French shredder, but levels are halved compared to the values measured near the Flemish shredder. The lowest PCB126 deposition was measured at the border of the French plant (Galloo3) where only one of three samples was increased. In Halluin, low levels of PCB126 deposition were measured.

Table 6.8.: Results of extra measurements of dioxin and PCB126 deposition around the shredder plant Galloo in Menen. For congener deposition values below the detection limit, the value of 0.5*DL was given (pg TEQ/m².day)

	29/10-26/11/02		26/11-24/12/02		24/12/02-21/1/03		21/1-18/2/03	
	dioxins	***PCB126***	***dioxins***	***PCB126***	***dioxins***	***PCB126***	***dioxins***	***PCB126***
Menen2	24	38	9.1	14	13.3	28	8.5	8.7
	29/10-26/11/02		**26/11/02-21/1/03**				**21/1-18/2/03**	
	dioxins	***PCB126***	***dioxins***	*PCB126*			***dioxins***	***PCB126***
Galloo1 Entrance of Flemish shredder	156	174	131	258	*	*	191	194
Galloo 2 Near French shredder	38	69	46	101	*	*	73	100

Galloo 3 **End of French shredder**	18	23	12.5	21	*	*	40	32
Halluin **French city upwind of plant**	*	*	4.0	<1	*	*	7.5	3.4

Table 6.9.: Evaluation of the extra dioxin and PCB126 deposition measurement around the shredder plant Galloo in Menen from October 2002 till February 2003

11 measurements ***4 locations***	**Dioxin**	**PCB126**
Increased > 26 pg TEQ/m².d	Galloo1 - 3 of 3 Galloo2 - 3 of 3 Galloo3 - 1 of 3 **Total 7 of 11 measurements**	Galloo1 - 3 of 3 Galloo2 - 3 of 3 Galloo3 - 1 of 3 **Total 7 of 11 measurements**
Moderately increased 6 < x ≤ 26 pg TEQ/m².d	Halluin - 1 of 2 Galloo3 - 2 of 3 **Total 3 of 11 measurements**	Halluin - 1 of 2 Galloo3 - 2 of 3 **Total 3 of 11 measurements**
Not increased ≤ 6 pg TEQ/m².d	Halluin - 1 of 2 **Total 1 of 11 measurements**	Halluin - 1 of 2 **Total 1 of 11 measurements**

III General conclusions

During winter 2002, spring 2003 and winter 2003, a measurement campaign of dioxin and PCB126 deposition was organised in Flanders near the French border. The measurements were performed in the areas of Menen, Moeskroen, Veurne, Wervik, and Kortrijk.

The results show that high levels of dioxin and PCB126 deposition were repeatedly measured in the area of Menen. This observation is in contrast with the decreasing trend of dioxin deposition observed in Flanders. Moreover, the high levels of PCB126 deposition measured in Menen are not in accordance with the average PCB126 deposition of 2 pg TEQ/m².d, measured in most other places in Flanders. It is remarkable that the pollution is concentrated in a small area around the river Leie and is not extended to the rest of Menen. The highest dioxin and PCB126 levels were found in samples taken close to a shredder plant. This plant is situated near the Leie on the border between France and Belgium. Part of the plant is located in Belgium, the other part in France. Both parts have their own shredder installation. The highest dioxin and PCB126 levels were measured near the Flemish shredder installation. Since bulk materials are unloaded near this sampling point, it is not clear whether the clouds of blowing dust or emissions from the shredder installation provokes the high deposition.

For further assessment of the source:

-the Department of Environmental Inspection (AMI) has collected dust samples from the yard of the plant

-the plant manager sprinkles the factory grounds and cleans the factory roads to avoid the distribution of dust and shall order emission measurements

-the environmental inspection will continue to survey the plant and will insist that the French authorities do the same on the other side of the border

-the VMM shall continue the monitoring of the quality of the ambient air in the residential areas near the plant.

Menen remains a problem area characterised by high levels of dioxin and PCB126 depositions. The research programs that are carried out by order of the VMM, combined with initiatives from other official institutions have the purpose to assess the situation in Menen and to detect potential sources of dioxins and PCB126.

The case of Menen led to investigations in other areas around shredder plants. Similar high depositions of dioxin and PCB126 were found in areas around other shredder plants. It appears that this kind of industry is a source for dioxins and PCB126 emissions.

7. Benzene and NO_2 in West-Vlaanderen

I General

The most important goal of this project is to map out detailed information on the concentration levels of benzene and NO_2 through a pilot study in one of the Flemish provinces i.e. West-Vlaanderen. Special attention is paid to the south of this province: modelling showed that this region forms a possible problem for benzene. The most important organic pollutant in this project is benzene but also toluene, ethylbenzene and the three xylene isomers are taken into account.

In order to map out the total surface of the province of West-Vlaanderen in a representative way, the surface can be divided in 27 squares of 10*12 km each. Roughly in the middle of each square a measurement station is placed, so one can say that on an average base measurement stations are representative for **rural zones** near industry, rural residential areas or rural areas, villages and traffic and eventual important sources that come up.

Four representative **urban areas (agglomerations)** were selected: Oostende and Brugge, with each 3 measurement stations and Nieuwpoort and Roeselare with each 2 measurement stations. In each of these agglomerations measurements are taken on an urban background as well as nearby a hectic traffic-artery.

For the **southern part** of the province 13 measurement stations have been chosen. Measurements are taken nearby residential areas, traffic arteries and in areas having a representative urban background.

In totally, there were 50 measurement points.

In order to arrive at a representative value for the yearly average, 4 measurement periods of 4 weeks each are foreseen, one for each season. The first measuring campaign for NO_2 also lasted 4 weeks, but because of the noticed problems with humidity of the bodies, the next three campaigns only lasted 2 weeks each. Samples for the organic parameters are taken using the VOC diffusive sampler of the type Radiello (activated carbon). Samples for NO_2 are taken using the NO_2 diffusive sampler of the type Radiello (triethanolamine).

II Measurements of benzene in West-Vlaanderen

A Rural areas

In rural areas the highest BTEX-concentrations are measured in the villages, followed by the traffic roads. Industry as a source takes relatively low place in the list.

Table 7.1.: Yearly averages BTEX (µg/m³) in rural zones

	Benzene	Toluene	Ethylbenzene	m-+ p-Xylene	o-Xylene
Village	1.4	4.8	0.8	2.1	0.7
Traffic road	1.2	3.9	0.7	1.8	0.6
Residential area	1.1	3.1	0.6	1.4	0.4
Industry	1.0	2.2	0.6	1.5	0.5
Rural area	1.0	2.3	0.5	1.1	0.4

B Urban areas/Agglomerations

In urban areas concentrations are mostly higher in the neighbourhood of traffic arteries than those found in measurement stations with an urban background. Nieuwpoort forms an exception to this observation. The highest values are measured in Brugge and Roeselare. The agglomerations Oostende and Nieuwpoort near the sea have lower concentrations.

Table 7.2.: Yearly averages BTEX (µg/m³) in the agglomerations

		Benzene	**Toluene**	**Ethylbenzene**	**m-+ p-Xylene**	**o-Xylene**
Oostende	Traffic artery	2.0	7.8	1.4	3.7	1.4
	Urban background	1.7	7.0	1.2	3.0	1.1
	Average	1.8	7.3	1.3	3.2	1.2
Brugge	Traffic artery	2.7	12.8	2.0	4.9	1.7
	Urban background	1.9	8.2	1.5	3.6	1.3
	Average	2.2	9.8	1.6	4.0	1.4
Nieuwpoort	Traffic artery	1.3	3.8	0.7	1.7	0.6
	Urban background	1.4	4.8	0.8	2.0	0.7
	Average	1.3	4.3	0.7	1.8	0.7
Roeselare	Traffic artery	2.7	11.3	2.2	5.8	2.0
	Urban background	1.7	8.3	1.2	3.2	1.0
	Average	2.2	9.8	1.7	4.5	1.5

C Southern area

In the southern area the concentrations measured in Wielsbeke and Ieper are normal. In Kortrijk the xylene concentrations are higher than normal probably due to an industrial source. In Kuurne and Harelbeke the concentrations measured are unexpectedly high for respectively toluene and ortho-xylene probably also due to local industries. In Waregem concentrations are too high for all components except benzene taking into consideration that it is a rural traffic artery.

Table 7.3.: Yearly averages BTEX (µg/m³) of the southern area

		Benzene	Toluene	Ethylbenzene	m-+ p-Xylene	o-Xylene
Residential area	**Wielsbeke**	1.3	4.7	0.8	2.2	0.7
	Ieper	1.3	4.0	0.7	1.8	0.6
	Kuurne	1.5	6.2	1.0	2.5	0.8
	Harelbeke	1.4	5.4	1.0	2.6	2.5
Urban background	**Kortrijk**	1.6	6.9	1.1	2.9	3.0
Traffic road	**Waregem**	2.5	10.8	1.9	4.7	1.7

D Conclusion

There were no exceedances of the limit value for benzene (yearly average of 5 µg/m³) measured.

Figure 7.1. shows that the highest concentrations for benzene are measured at traffic arteries and urban background stations. But also household heating is, next to traffic, a major source for benzene. In general, the benzene values in the winter are higher then in the summer, but the winter/summer ratio varies from location to location. The higher values in the winter can be explained by more pollution due to heating of households in the winter. In rural areas the traffic (constant source) has a relatively smaller influence, so the winter-summer ratio changes the most.

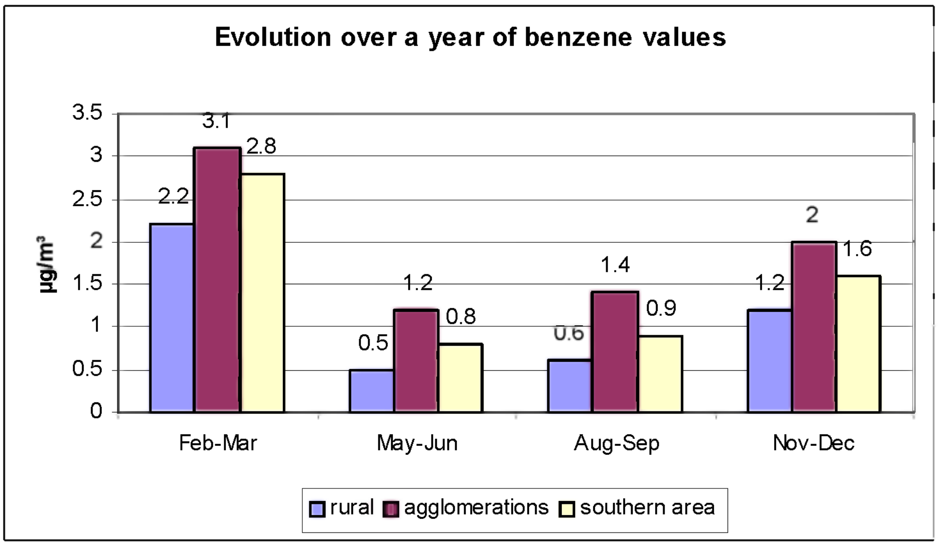


Figure 7.1.: Evolution over a year of benzene values

III Measurements of NO_2 in West-Vlaanderen

A Rural areas

The concentrations in the rural averages are clearly below the limit value of 40 µg/m³. The influence of traffic on the concentration of NO_2 is confirmed in the table: the highest values are measured in the villages and the traffic roads.

Table 7.4.: Yearly averages of NO_2 (µg/m³) in rural zones

	NO_2
Village	20.1
Traffic road	20.0
Rural area	18.3
Residential area	17.8
Industry	16.4

B Urban areas/Agglomerations

The ratio between detected concentrations on traffic arteries and urban backgrounds seems to vary, depending on the agglomeration. Brugge was the only agglomeration where the traffic arteries measured consequently higher values. In Oostende and Nieuwpoort the concentrations for both type of measuring points were more similar. But in Roeselare the highest concentrations were detected at urban background locations.

Comparing the average concentration for each agglomeration, you clearly see that the agglomerations near the sea (Oostende, Nieuwpoort) measure the lowest values.

Table 7.5. : Yearly averages of NO_2 (µg/m³) in agglomerations

		NO_2
Oostende	Traffic artery	31.4
	Urban background	31.2
	Average	31.3
Brugge	Traffic artery	54.1
	Urban background	30.3
	Average	38.2
Nieuwpoort	Traffic artery	26.4
	Urban background	23.1
	Average	24.7
Roeselare	Traffic artery	28.0
	Urban background	44.3
	Average	36.1

C Southern area

Wielsbeke, Ieper and Kuurne can be classified in the category 'rural villages', because of the similar measured concentrations. The results in Harelbeke are more similar with the average results of a traffic road. The measured NO_2 concentrations at Waregem are more related to urban background locations.

Table 7.6.: Yearly averages of NO_2 (µg/m³) of southern area

		NO_2
Residential area	**Wielsbeke**	23.5
	Ieper	16.1
	Kuurne	23
	Harelbeke	25
Urban background	**Kortrijk**	27.4
Traffic road	**Waregem**	32.9

D Conclusion

In the rural areas there's not one measuring point with an exceedance of the EU yearly average limit value. Also in agglomerations the yearly averages were below the limit value of 40 µg/m³, but in Brugge and Roeselare the yearly averages were approximating the limit value. At some traffic arteries in the agglomerations and and at some urban background locations, there were exceedances in some seasons (mainly spring and summer) up to 74 µg/m³.

Figure 7.2. shows that the highest concentrations are measured in agglomerations. At some traffic locations in the agglomerations and the southern area higher values in the spring and summer were measured. At locations were lot of NO is emitted through the traffic, the increase in the summer is due to the conversion of NO with ozone to NO_2 (conversion is related to sun intensity). In the rural areas, there is less traffic, what results in not much extra production of NO_2 in the summer due to conversion with O_3, so (almost) no annual variation.

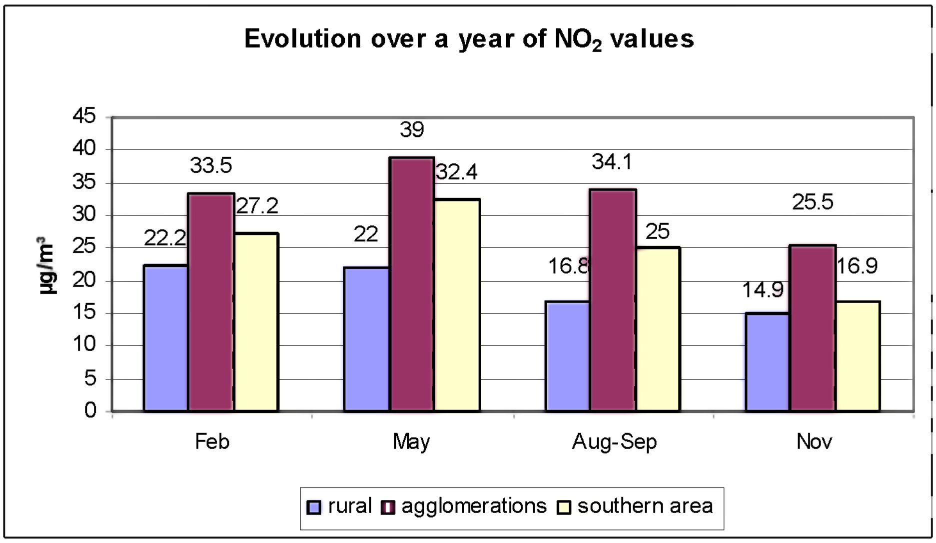


Figure 7.2.: Evolution over a year of NO_2 values

8. Summary

The idea of the Interreg project EXPER/PF is to develop and promote a tool for a better assessment of air quality in the Euro-region defined by Nord-Pas-de-Calais for France and the province of West-Vlaanderen for Flanders. The project focus on suspended particles (PM), with a special effort on its fine fraction PM2.5. One part of the project consists in the development of an optical approach for measuring PM and thus enabling us to increase the spatial coverage of the PM monitoring by the use of satellite. Another part of the project is to build up a regional database, which should contain PM data, meteorological data, some chemical information and satellite images. A third part is to realise some measurements of gaseous pollutants and PM on each side of the border to evaluate the dispersion of pollutants in rural areas at the north-east of the agglomeration Lilloise. This third objective is developed in this report.

The additional measurements in situ were realised by AREMA Lille Metropole (AREMA LM), the Flemish Environmental Agency (VMM) and the University of Antwerp (UA).

Campaigns with mobile laboratories

AREMA LM and VMM used their mobile laboratories. To have a good temporal representation and several kinds of meteorological conditions, the laboratories were installed during the winter 2002-2003 and during the summer 2003. AREMA LM installed the first mobile station in Halluin and the second one in Wervicq. VMM installed his laboratory in Rollegem-Kortijk. The mobile stations are equipped to analyse gaseous pollutants (SO_2, NO_x, O_3 and CO) and suspended particles. Additionally particulate matter was collected on filters to analyse heavy metals in the PM2.5 and PM10 fraction and to analyse PAH (winter). During the winter campaign VMM installed also a mobile laboratory equipped with gas chromatography to analyse VOC.

During the winter campaign the wind roses looked like those obtained for a whole year. Most of the winds came from the south-west and the second most important direction was north-east. In summer, we had a more important part of wind coming from north-west. In December there were a few sunny days on 18th and 19th and then from 6th to 12th January. The temperatures were low and the hourly minimum reached -7.5°C. The rest of the campaign was cloudy with mild temperatures around 12°C. The pressure had important variations between 995 and 1035 hPa, which indicates the presence of a depression and an anticyclone. In summer, there were fewer fluctuations of the meteorological parameters. The mean temperature was quite constant and the daily maximum varied from 19°C on 2nd and 3rd July to 32°C on 15th July. The maximum temperature exceeded 25°C on June 22nd, 26th and 29th. In July we had a warm period from 8th to 15th with temperatures superior to 25°C. Between these two periods we had only one short period with low pressure and cloudy sky in the beginning of July.

The SO_2 measurements during the winter and summer campaign are low. During wintertime the highest concentrations are measured from 18th to 22nd December and from 8th to 13th January. These days correspond to an accumulation of the pollutants under bad dispersion conditions. The wind mostly comes from the east with a low speed. During summer time the concentrations are often elevated in the mobile and fixed stations at Wervicq. The mobile laboratory of Rollegem and the fixed station of Sint-Denijs are influenced in north-eastern direction by the power-station of Ruien, situated in the Flemish municipality of Kluisbergen. At the station of Elsegem we also see the influence of the power station from the south-western direction. The wind is coming only rarely from the power station Ruien for the station of Vichte. At the station of Oostrozebeke, high concentrations are measured from the south-west direction where a wood chipboard factory is situated. Especially at the fixed stations of Tourcoing, Roubaix and Marcq and Lomme we see elevated SO_2 concentrations coming from the north-east. The source is the local heating whose emissions accumulate when the dispersion is less important. During summer time we also see the influence of the chipboard factory at the station of Oostrozebeke. The mobile laboratory at Wervicq and the fixed station of Wervicq are measuring the influence of an industrial source situated west of the fixed station and using some products containing sulphur.

The hourly value of 350 µg/m^3 and the daily value of 125 µg/m^3 of the future limit values for the protection of health (1999/30/EC) for SO_2 are not exceeded during the measurement campaigns.

During the winter campaign there were also 2 periods with high PM10 concentrations namely 20th to 21st December and 10th to 12th January. During the summer campaign a period of higher concentrations started at 15th July, the last day of the campaign. The average PM10 concentrations are higher during the summer campaign except for Oostrozebeke. During the winter campaign the measurements are generally higher when to wind is coming from the north-east compared to the south-west. At Oostrozebeke the highest concentrations are measured in the south-western direction where a wood chipboard factory is situated. During the summer campaign the measurements are more homogeneous over the different wind directions. At Oostrozebeke we see again higher concentrations when the wind is coming from the south-west. At Roeselare the concentrations are elevated when the wind is coming from the east. In eastern direction an industrial area is situated.

The limit value of 40 µg/m^3 for the protection of health for PM10 (1999/30/EC) is not exceeded during the measurement campaign in winter and summer. After correction with the factors used in Flanders this limit value is exceeded in the station of Roeselare during the summer campaign. The daily value of 50 µg/m^3 for the protection of health (1999/30/EC) is exceeded during winter and summer.

As for PM10 during the winter campaign there were 2 periods of high PM2.5 concentration and a period of higher concentrations started during the summer campaign at 15th July, the last day of the campaign. Comparable to PM10 the PM2.5 measurements during the winter campaign are generally higher when the wind is coming from the north-east compared to the south-west. During the summer campaign the measurements are also more homogeneous over the different wind directions.

In the studied area in France and in Flanders there are only a few locations where PM10 and PM2.5 are measured together. In the winter the difference between PM10 and PM2.5 is smaller than in the summer.

Two periods with higher concentrations can also be distinguished for NO and NO_2 namely from 18th to 21st December and from 8th to 12th January. In the winter period the lowest mean values for NO are obtained in Flanders: Elsegem, Houtem and Sint-Denijs. The NO value measured at Oostrozebeke is the only one close to the values obtained in the agglomeration of Lille which vary from 16 to 24 µg/m^3. In summer there are less differences: the mean values for NO vary from 1 to 5 µg/m^3. The dispersion in summer is more efficient and there is more ozone to consume NO. The levels of NO_2 are higher in January than in December. In summer, the levels are more regular. Most part of the daily maximum hourly values are between 40 and 60 µg/m^3 for urban stations and between 20 and 40 µg/m^3 for rural stations. The presence of the NO an NO_2 maximum during the morning and in the afternoon are characteristics for the peak of traffic that exists in and around important agglomerations. This is the reason why the higher profiles are those of the urban. In the direction of the dominant wind, the concentration of NO decreases with the distance from Lomme and the ambient concentration is divided by 2.5 (-60%) after 25 km in Sint-Denijs. This decrease is stopped near Oostrozebeke where the ambient concentrations of NO have a comparable level as in Halluin. In the west-east direction, we observe an increase of the concentrations approaching the agglomeration plume (near Halluin) and afterwards the concentrations trend towards their basic level in Elsegem. The levels in the rural part are 70% lower than in the urban part. On a parallel axis to the dominant wind, a decrease for NO_2 is observed in winter with levels going from 46 to 28 µg/m^3, what represents a decreasing of 40%. In summer, the profile is not the same. All the stations show mean concentrations close to one another (about 20 µg/m^3) except Marcq, Roubaix and Oostrozebeke, which present values of 30 µg/m^3. We can suppose that the better dispersion trends to equalise the levels over the whole region. On the west-east axis, the winter levels of NO_2 look like those for NO with the highest values (35 µg/m^3) in the centre and the lowest (20 µg/m^3) on each side.

The hourly value of 200 µg/m^3 of the future limit value for NO_2 for the protection of health (1999/30/EC) is not exceeded during the measurement campaign. The annual limit value for the protection of health (40 µg/m^3) is exceeded during the winter campaign in the urban stations of Roubaix, Marcq and Lomme.

The plots of the hourly values for O_3 in winter and summer show a good agreement between the curves of the different stations. We observe very well the daily rhythm of appearance and disappearance of ozone. In winter, there are a few days without ozone (20th and 21st December) what corresponds to high levels of nitrogen oxides. At these moments high atmospheric pressure and low winds prevail which limit the dispersion of pollutants. At the opposite, the levels of ozone can be as high as 80 µg/m^3 during days with important wind speed. Ozone levels can be higher in rural areas than urban areas. In summer, the maximum levels reach 215 µg/m^3 in Armentières and 213 µg/m^3 in Roubaix on 15th July. In Flanders, we obtained 210 µg/m^3 in Houtem and 209 µg/m^3 in Sint-Denijs on the same day. This day the highest levels are obtained over the Euro-region. Most of the stations exceeded the hourly threshold (180 µg/m^3) on 15th July.

For CO we distinguish again 2 periods with higher concentration: 20th December to 21st December and 10th January to 12th January. During the winter the CO concentration increases from 6:00 UT due to the building heating and the morning traffic. In the late afternoon the concentration increases again due to the evening traffic. In the nighttime the CO concentration stays high. In the summer the CO concentration is low. Only in the morning we see a slight increase due to the traffic. After the traffic peak in the morning the concentration decreases and stays low during the rest of the day.

The future limit value for the protection of health for CO of 10 mg/m^3 as a maximum daily 8-hour mean (1999/30/EC) is not exceeded during the measurement campaign.

The mean values for lead in PM10 for the different measurement campaigns were lower than the limit value (500 ng/m^3 as a yearly average). The mean values for arsenic, cadmium and nickel in PM10 for the different measurement campaigns are also lower than the respective target values (6 ng/m^3 for Arsenic, 5 ng/m^3 for Cadmium and 20 ng/m^3 for Nickel as a yearly average).

The concentrations for VOC in Rollegem are comparable with the rest of Flanders. Higher concentrations are recorded when the wind comes form east to south-east. This is probably due to a local source.

The limit value for benzene for the yearly average in ambient air is determined at 5 µg/m^3. This value was not exceeded during the measurement campaign.

The PAH concentrations measured are part of the EPA-priority list for PAH. Benzo(a)pyrene is selected as indicator. On European level a target value of 1 ng/m^3 as yearly mean for benzo(a)pyrene is under discussion. The average concentration for benzo(a)pyrene measured here is 0.31 ng/m^3 thus finding itself beneath the proposed limit value. A local source having a perceptible influence cannot be determined.

Measurements at Menen and Kortrijk

In Menen, VMM started supplementary measurements of PM2.5 and PM10. Supplementary measurements of heavy metals in PM10 were also started. PM2.5 was sampled on filters for the analysis of heavy metals (VMM and UA) and for the analysis of anions and cations (UA). UA, using passive samplers, determined at this location a certain number of gaseous pollutants and analysed a certain number of filters on PAH's. In Kortrijk, VMM started supplementary measurements of PM2.5 and PM10.

During the measurement campaigns in winter and summer PM10 and PM2.5 were determined both by gravimetric method (Leckel) and automatic method (TEOM) in Rollegem (winter and summer campaigns) and Menen (summer campaign). The regression equations indicate that in Rollegem for PM10 in summer a better agreement between the gravimetric method and the automatic method occurs then in the winter For PM2.5 the opposite is true. In winter the agreement between the gravimetric method and the automatic method is better for PM2.5 than for PM10, in summer the agreement is better for PM10 than for PM2.5.

PM2.5 measurements at Menen and Kortrijk are rather similar. The PM10 measurements are higher at Menen then at Kortrijk. Using the correction factor 1.47, the limit value for the yearly average of 40 µg/m^3 for the protection of health (1999/30/EC) is exceeded in 2003 at Menen (42 µg/m^3), but not at Kortrijk (38 µg/m^3). The daily value of 50 µg/m^3 for the protection of health (1999/30/EC) is exceeded in 2003 more then the permitted 35 exceedances both at Menen (79 exceedances) and Kortrijk (53 exceedances). For 2003, the limit value for the daily values is exceeded in all the other PM10-stations in Flanders. The limit value for the yearly average is exceeded in 8 of the 19 PM10-stations. In the first six months of 2004 the limit value for the yearly average of 40 µg/m^3 is not exceeded at Menen and Kortrijk and the daily value of 50 µg/m^3 is exceeded 21 times at Menen and 19 times at Kortrijk.

The pollution roses for PM10 and PM2.5 at Kortrijk are rather homogeneous. At Menen we see higher concentrations coming from the north to the east to the south. This is also true to a less extent for PM2.5.

The fraction PM2.5 in PM10 is 59 % at Menen and 61 % at Kortrijk.

Zinc, lead and copper are the most abundant heavy metals in PM2.5, during all seasons. Vanadium, chromium, manganese, arsenic and nickel are present in each sample, although in smaller concentrations. Cadmium and antimony are only represented by very small amounts. The average concentrations of vanadium, chromium, nickel, copper and arsenic all show the highest concentration during winter. Lead, zinc and manganese are characterised by a similar seasonal variability: all three heavy metals show higher concentrations during autumn and winter, more average concentrations during spring, and lowest concentrations in summer. The concentrations lead, zinc and manganese also show the largest difference between the highest and the lowest detected concentration, each season.

Zinc and lead are the most abundant heavy metals in PM10, followed by manganese and copper. Chromium, nickel, antimony and arsenic are present in each sample, although in smaller concentrations. Cadmium is only represented by very small amounts. Depending on the heavy metal the highest concentration is measured in the winter (lead, nickel, arsenic, manganese and cadmium) or in autumn (zinc, copper, antimony and chromium). All heavy metals show the lowest concentrations in the summer. Chromium, nickel, antimony, arsenic and cadmium show less seasonal variability then manganese and copper. Lead and zinc show the largest variability between the seasons. The concentrations lead, zinc, copper and manganese show the largest difference between the maximum and the minimum detected concentration, each season.

During all seasons, most abundant ions in the PM2.5 fraction are nitrate, sulphate and ammonium. Fluoride, chloride, potassium, magnesium and calcium show less contribution to the total water-soluble ion content, with average concentrations smaller than 1 $\mu g/m^3$. The mean nitrate concentration is most elevated during spring and summer campaigns. Both sulphate and ammonium concentrations were lowest during summer campaigns.

It can be concluded that the PM2.5 fraction, detected in Menen is highly dependable upon the backward trajectories of the air masses. The least heavy metal contaminated air in Menen is registered in case the air originated from the Atlantic Ocean. Most often, heavy metal polluted air was detected when the air masses passed Germany or the southeastern part of United Kingdom before reaching Menen. In the case of air masses passing Germany, elevated concentrations of the heavy metals chromium, manganese, copper, zinc, lead and vanadium were detected. Air masses passing the southeastern part of United Kingdom, mainly London and its surroundings, were characterised by elevated concentrations of the heavy metals vanadium, chromium, manganese, zinc, lead, and sulphates.

The gaseous compounds NO_2, SO_2, NH_3 and BTEX have been measured in Menen by means of radiello diffusion tubes. The annual mean NO_2 concentration of 25.4 $\mu g/m^3$ did not exceed the annual limit value for the protection of health of 40 $\mu g/m^3$. Only a small seasonal variation between the data was registered. During winter, the highest NO_2 levels were detected; maximum values of 49.4 $\mu g/m^3$ were reached. Concerning SO_2, a very low annual mean level of 3.0 $\mu g/m^3$ was detected. Yearly average concentrations of 29.6 $\mu g/m^3$ are detected for ammonia. During the periods 18th March until 1st April and 5th August until 18th august, elevated ammonia concentrations were detected. Maximum concentrations of 75.8 $\mu g/m^3$ were registered. Proportional concentrations of the different BTEX compounds are registered during each sampling period. The limit value for benzene for the protection of human health (5 $\mu g/m^3$) was not exceeded in Menen.

Filter samples collected during this Inter Region project were analysed for 16 US EPA criteria PAH. The concentration of lighter PAH were found relatively very low and were dominated by naphthalene and phenanthrene, whereas heavier PAH fluoranthene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene and indeno(123cd)pyrene dominates the total PAH concentration in particulate matter.

Seasonal and meteorological parameters also influence the PAH concentration. Generally higher concentrations in the winter season were found. Further the reported daily PAH concentrations were relatively high when the prevailing wind direction were SW in Menen at the sampling site.

The application of correlation coefficient calculation and PCA was applied to find the possible source of PAH which indicate towards vehicular emission as a major source although other sources like wood burning/ coke production etc. might also exist.

Dioxins and PCB126

Since 1995 VMM measures the deposition of dioxin in Flanders. Since 2002 the deposition of the dioxin-like PCB126 was measured simultaneously. In order to determine the influence of the northern part of France, VMM took measurements on different locations nearby the French border. Samples were collected in Moeskroen, Veurne, Wervik, Kortrijk and Menen. Menen houses 5 measurement stations. However, high depositions measured in one particular station incited to put in use a sixth station. Two stations in Menen started with measurements on a monthly basis. Complementary samples were collected on the grounds of a local shredder company and in Halluin.

The high levels of dioxin deposition repeatedly measured in the area of Menen are in contrast with the decreasing trend of dioxin deposition in Flanders. Moreover, the high levels of PCB126 deposition measured in Menen are not in accordance with the average PCB126 deposition of 2 pg TEQ/m².d measured in Flanders. The pollution is concentrated in a small area around the river Leie and is not extended to the rest of Menen. The highest dioxin and PCB126 levels were found in samples taken close to the Flemish shredder plant, situated near the Leie on the border between France and Belgium. Since bulk materials are unloaded near this sampling point, it is not clear whether the clouds of blowing dust or emissions from the shredder installation provokes the high deposition.

The case of Menen led to investigations in other areas around shredder plants. Similar high depositions of dioxin and PCB126 were found in areas around other shredder plants. It appears that this kind of industry is a source for dioxins and PCB126 emissions.

Benzene and NO_2 in West-Vlaanderen

A pilot study was started in West-Vlaanderen by VMM and UA to map out in a detailed way the concentration levels of BTEX (benzene, toluene, ethylbenzene and the tree xylene isomers) and NO_2.

There were no exceedances of the limit value for benzene (yearly average of 5 µg/m³) measured. The highest concentrations for benzene are measured at traffic arteries and urban background stations. But also household heating is, next to traffic, a major source for benzene. In general, the benzene values in the winter are higher then in the summer, but the winter/summer ratio varies from location to location. The higher values in the winter can be explained by more pollution due to heating of households in the winter. In rural areas the traffic (constant source) has a relatively smaller influence, so the winter-summer ratio changes the most.

In the rural areas there`s not one measuring point with an exceedance of the EU yearly average limit value for NO_2. Also in agglomerations the yearly averages were below the limit value of 40 µg/m³, but in Brugge and Roeselare the yearly averages were approximating the limit value. At some traffic arteries in the agglomerations and at some urban background locations, there were exceedances in some seasons (mainly spring and summer) up to 74 µg/m³. The highest concentrations are measured in agglomerations. At some traffic locations in the agglomerations and the southern area higher values in the spring and summer were measured. At locations were lot of NO is emitted through the traffic, the increase in the summer is due to the conversion of NO with ozone to NO_2 (conversion is related to sun intensity). In the rural areas, there is less traffic, what results in not much extra production of NO_2 in the summer due to conversion with O_3, so (almost) no annual variation.

9. Bibliography

CAFE Working Group on Particulate Matter (2004). Second Position Paper on Particulate Matter – final draft. http://europa.eu.int/comm/environment/air/cafe/pdf/working_groups/2nd_position_paper_pm.pdf

Spruyt M., Goelen E., Geyskens F., Maes F., Bormans R., Poelmans D., Verbeke L. (2003).Regiometingen benzeen eindrapport, studie uitgevoerd in opdracht van VMM, Vito rapport 2003/MIM/R/186.

Stranger M., Van Grieken R. (2004). Regiometingen stikstofdioxide, studie uitgevoerd in opdracht van VMM. UA, May 2004.

B. Vekemans, K. Janssens, L. Vincze, F. Adams, R. Van Grieken (1994). Analysis of X-ray spectra by iterative least squares (AXIL): New developments, X-Ray Spectrom. 23, 278-285.

10. ANNEXES

Annex 1 : Evolution of the pollutants during the campaigns with the mobile laboratories

Annex 2 : Pollution roses of the mobile laboratories and fixed stations in the studied area

Annex 3 : Dioxin and PCB depositions

Annex 4 : Backward trajectories at Menen

Annex 1 : Evolution of the pollutants during the campaigns with the mobile laboratories

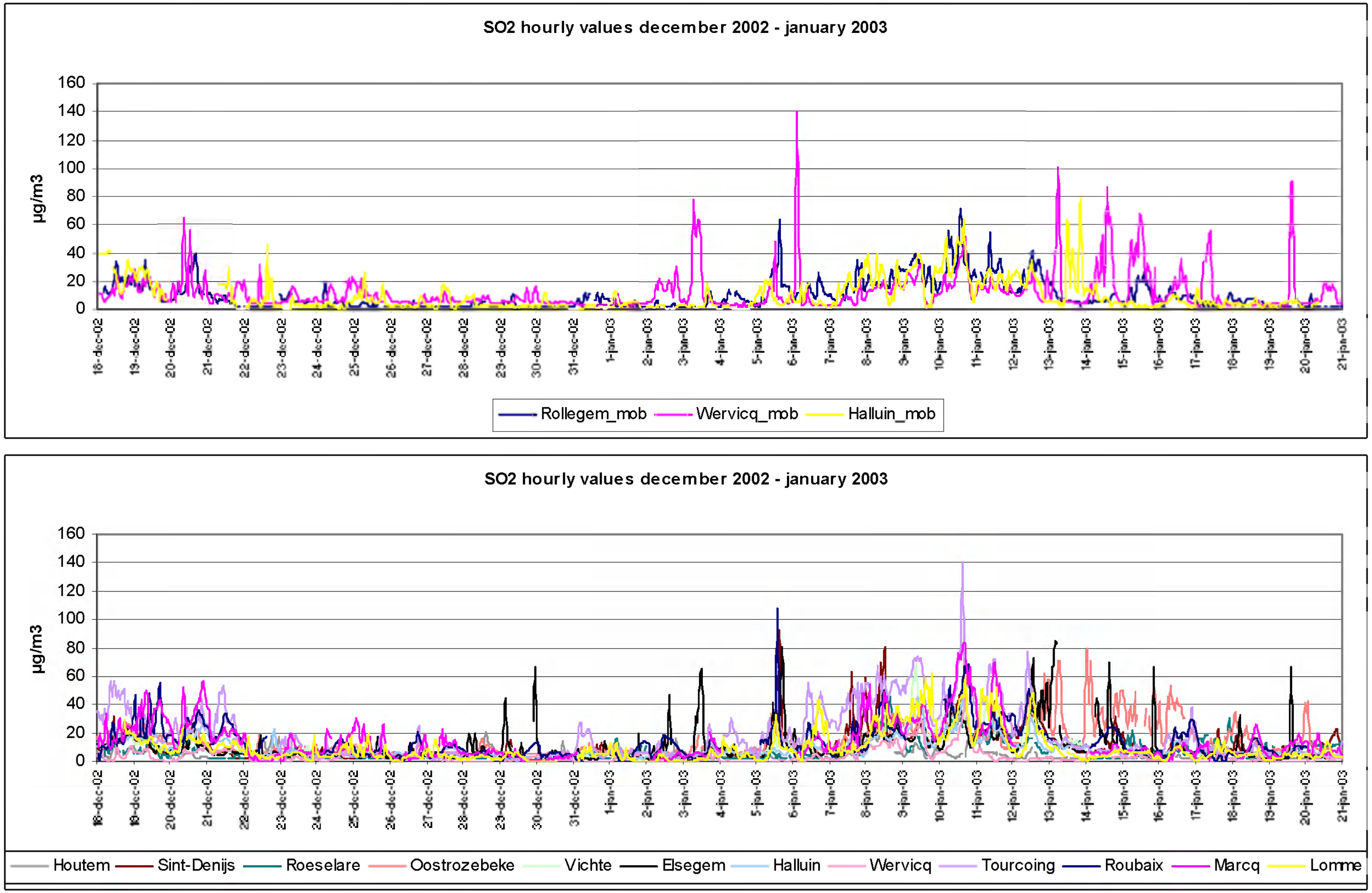


Figure A: SO2 hourly values

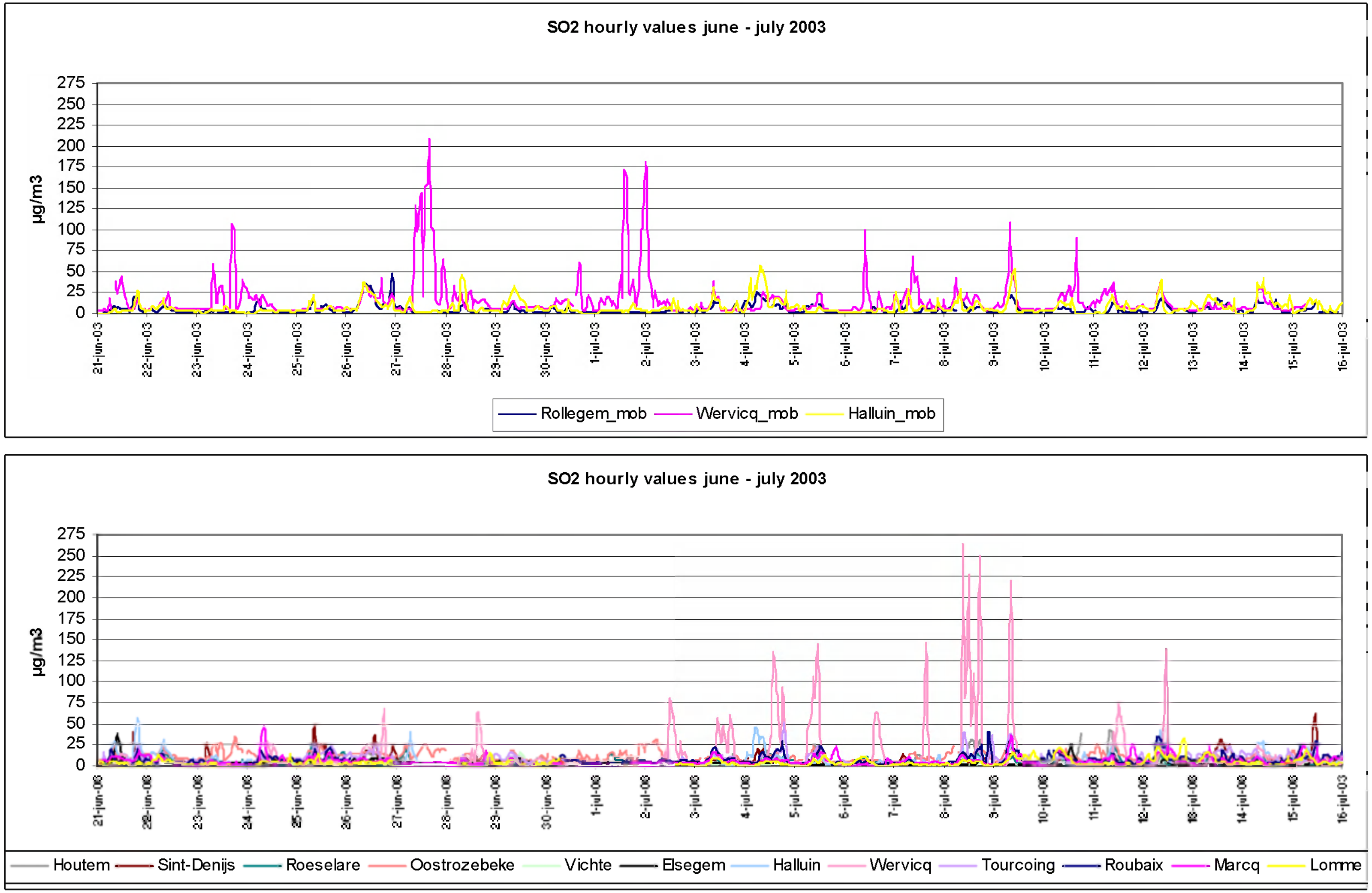


Figure A: SO2 hourly values (continued)

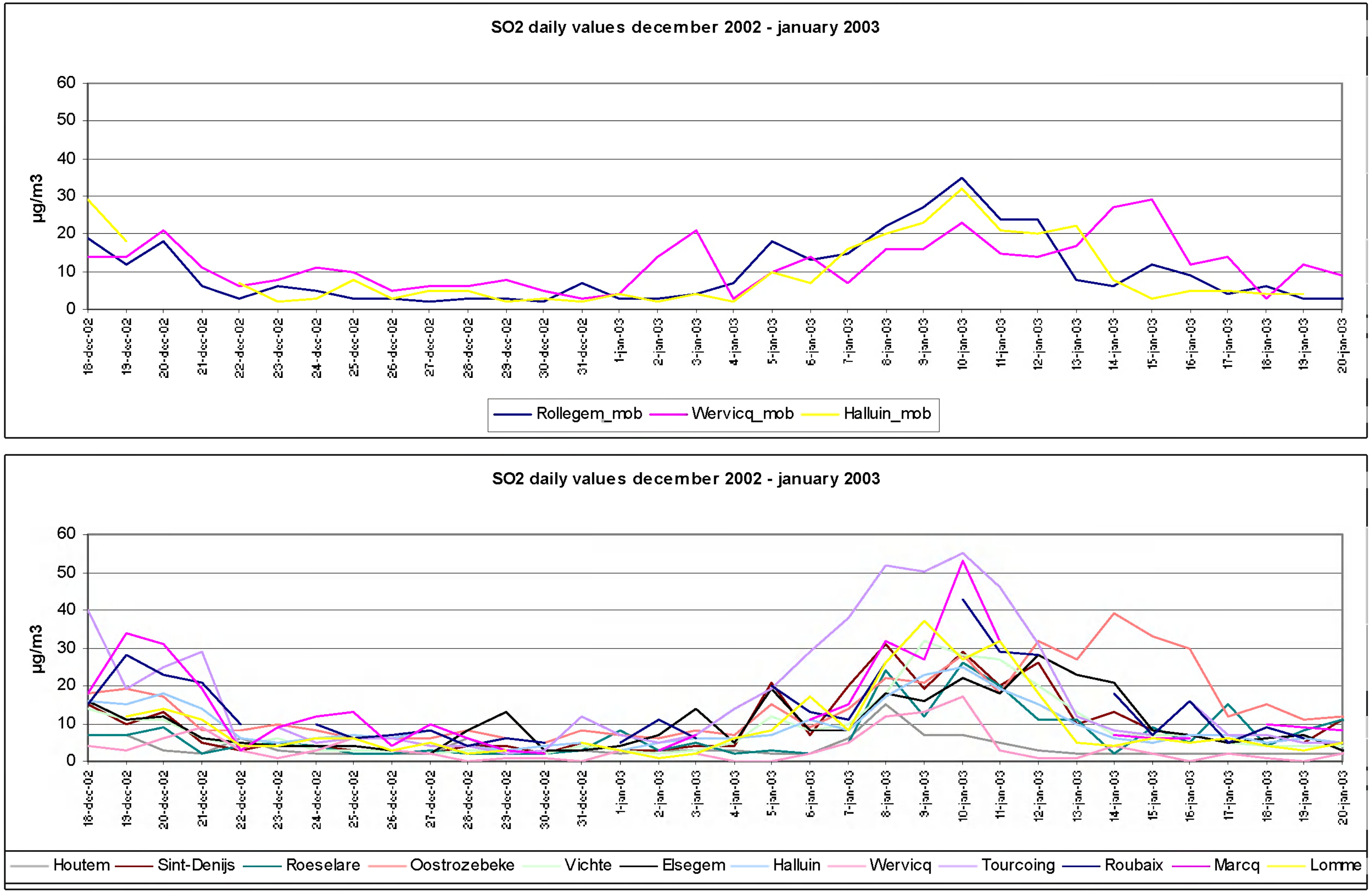


Figure B : SO2 daily values

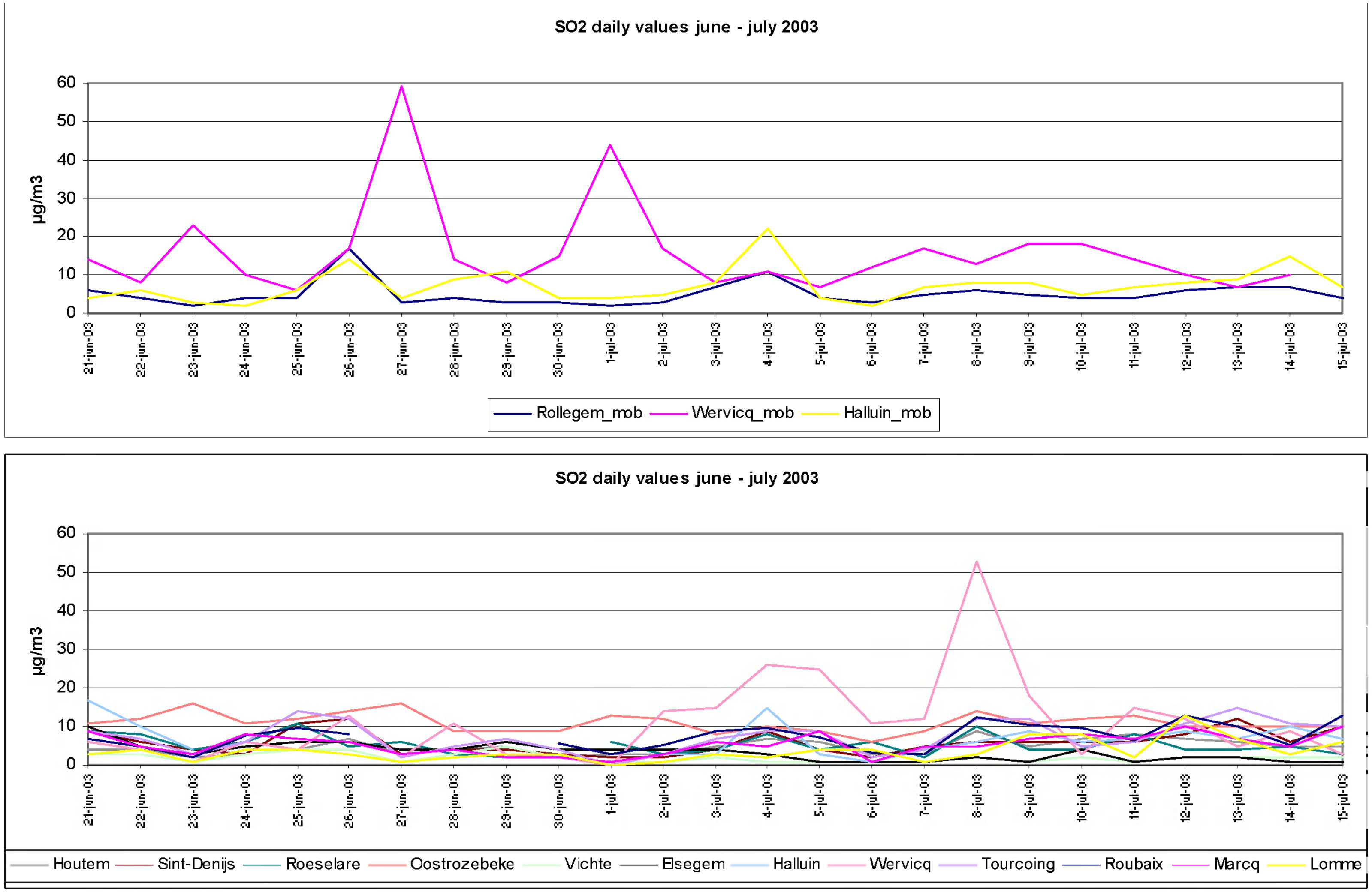
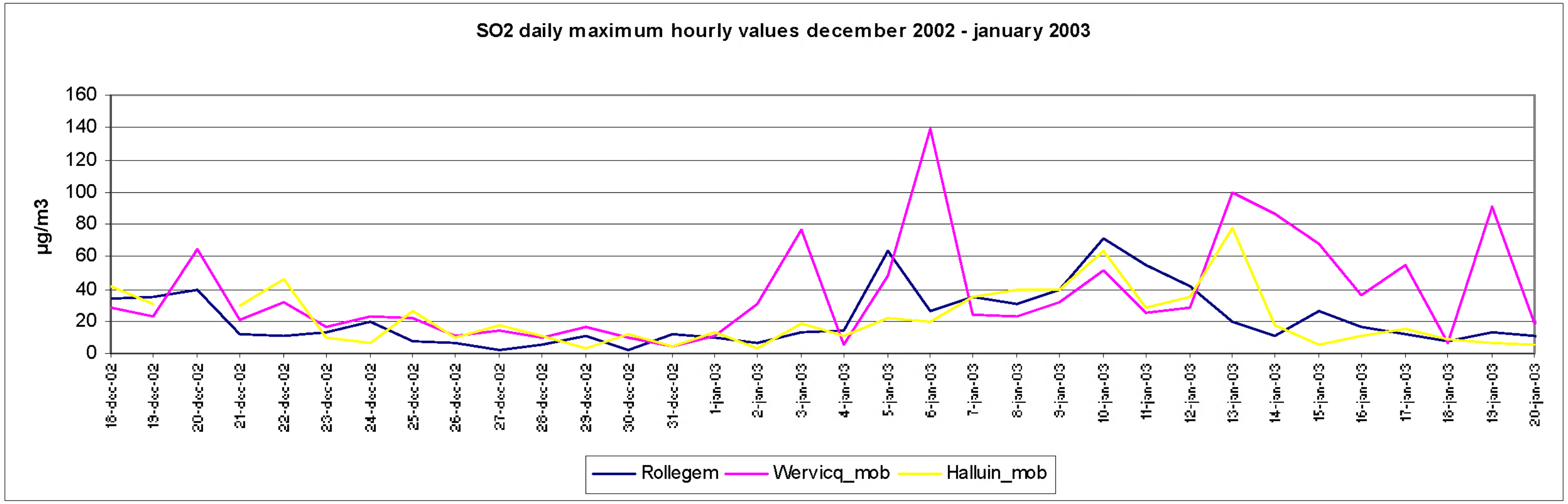


Figure B : SO2 daily values (continued)



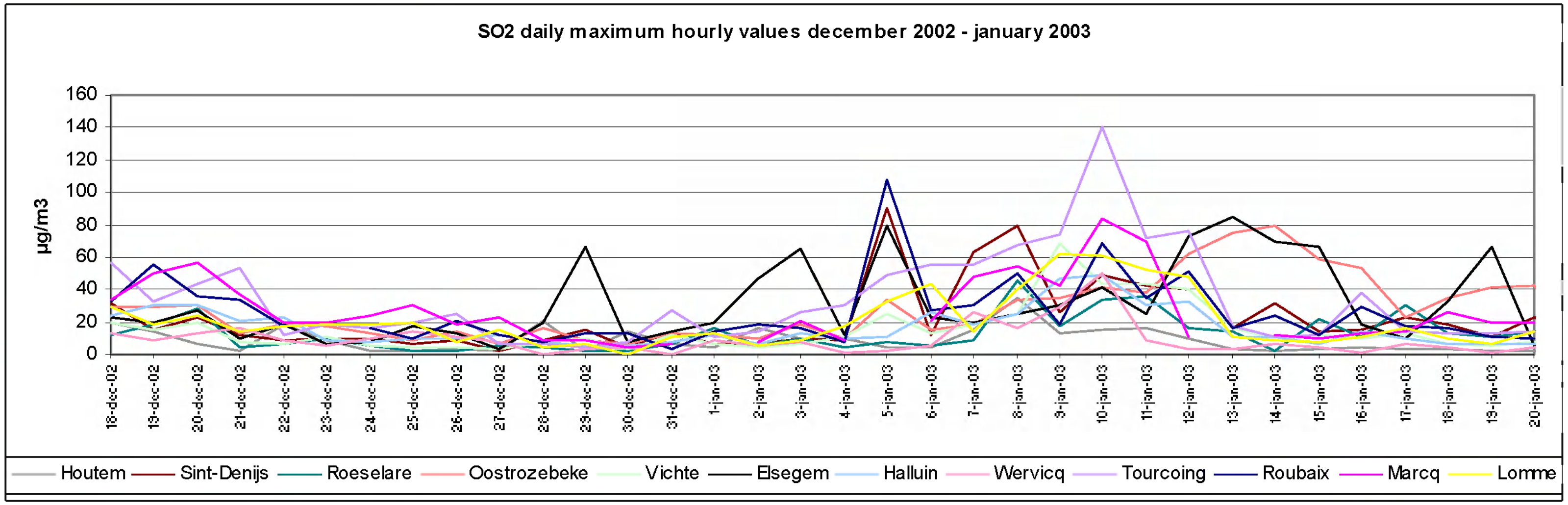


Figure C : SO2 daily maximum hourly values

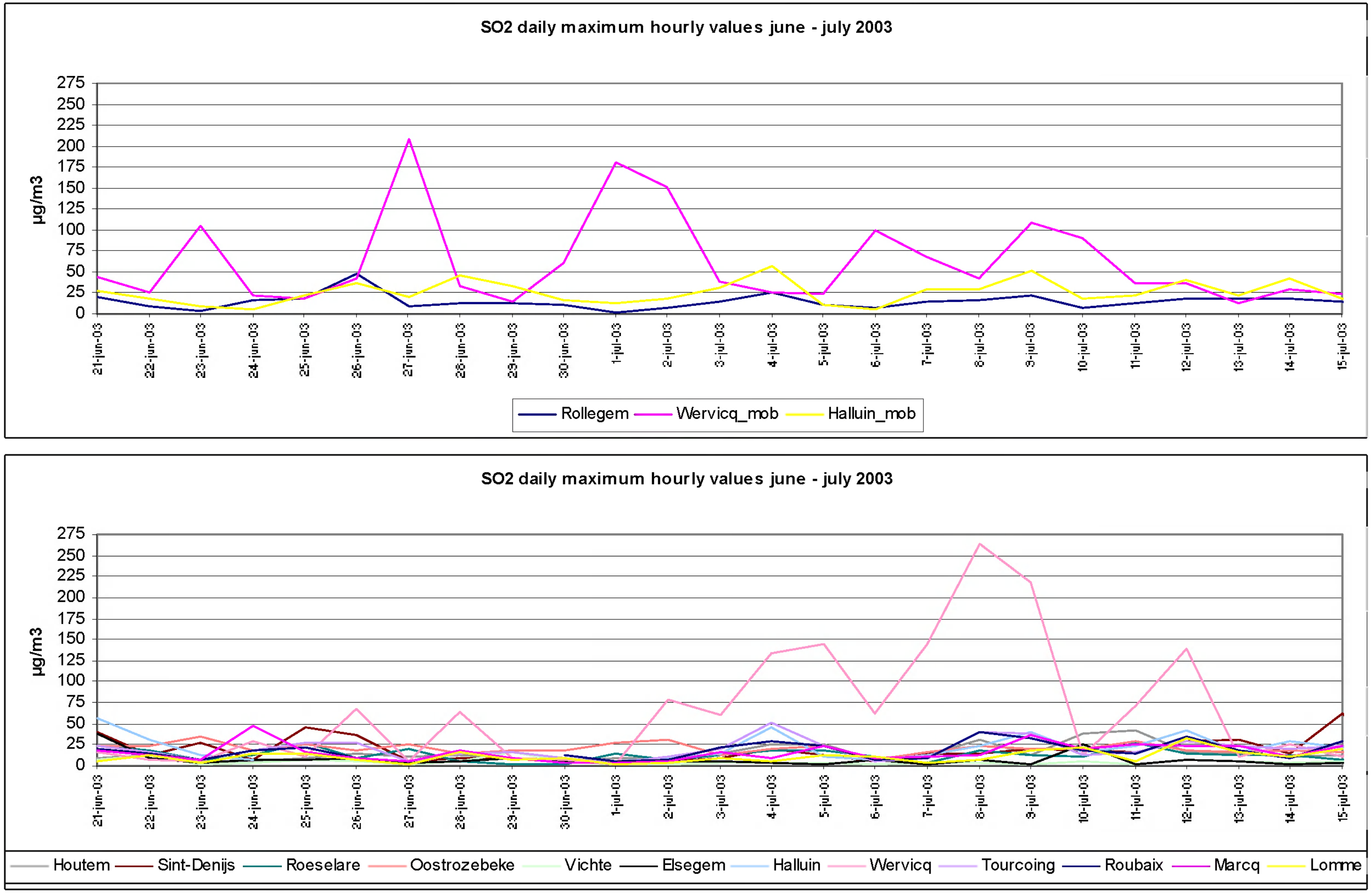


Figure C : SO2 daily maximum hourly values (continued)

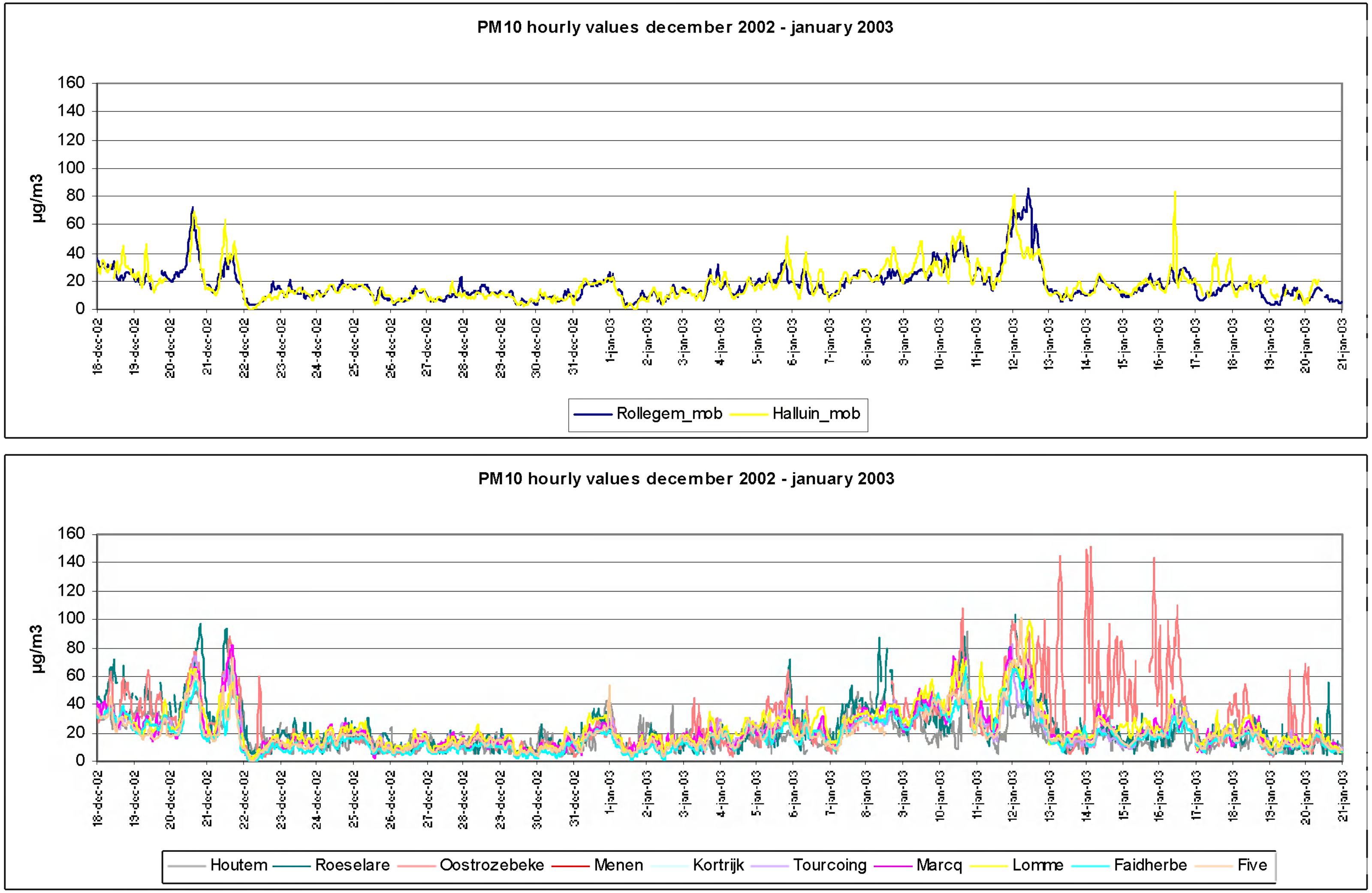
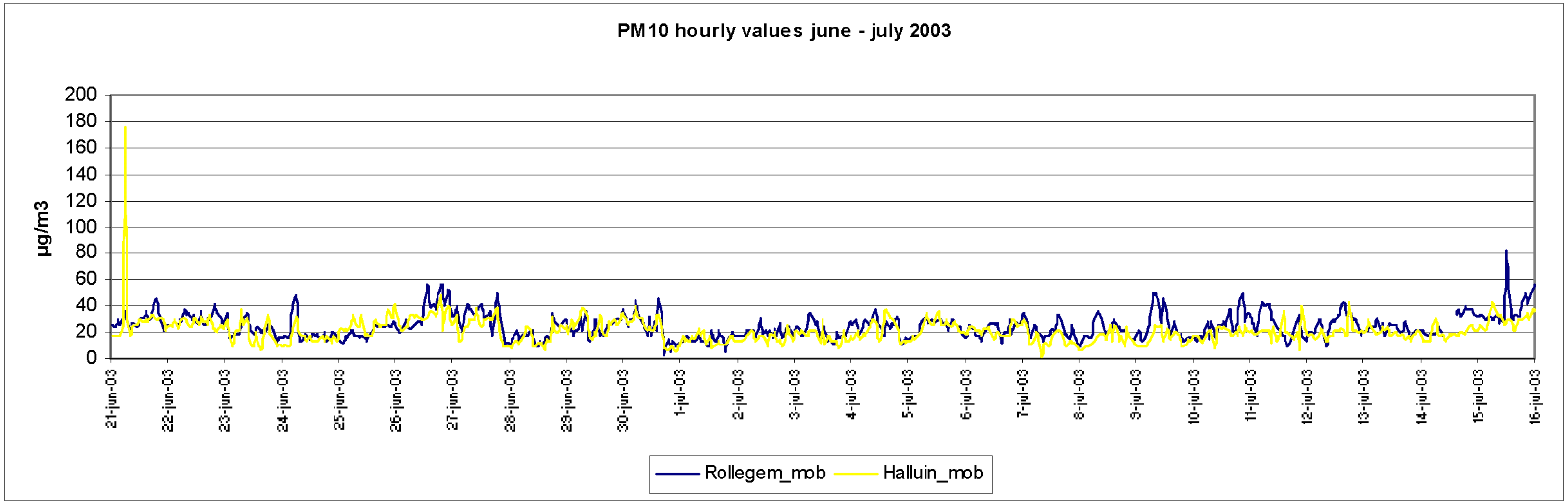


Figure D : PM10 hourly values



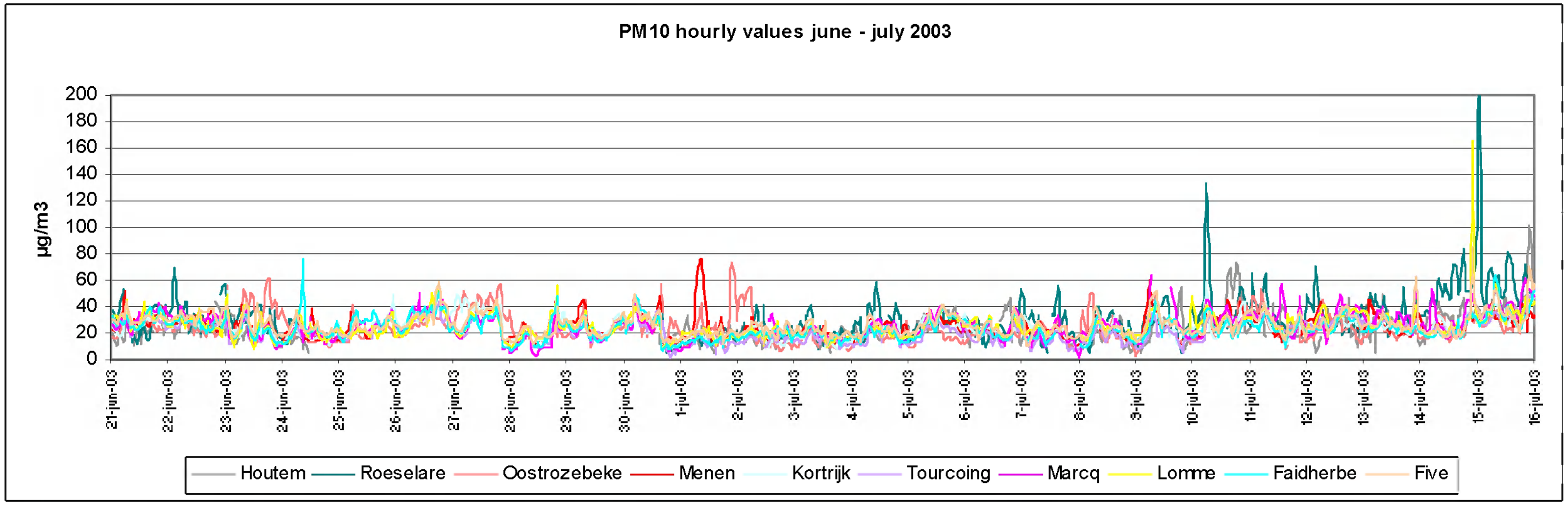
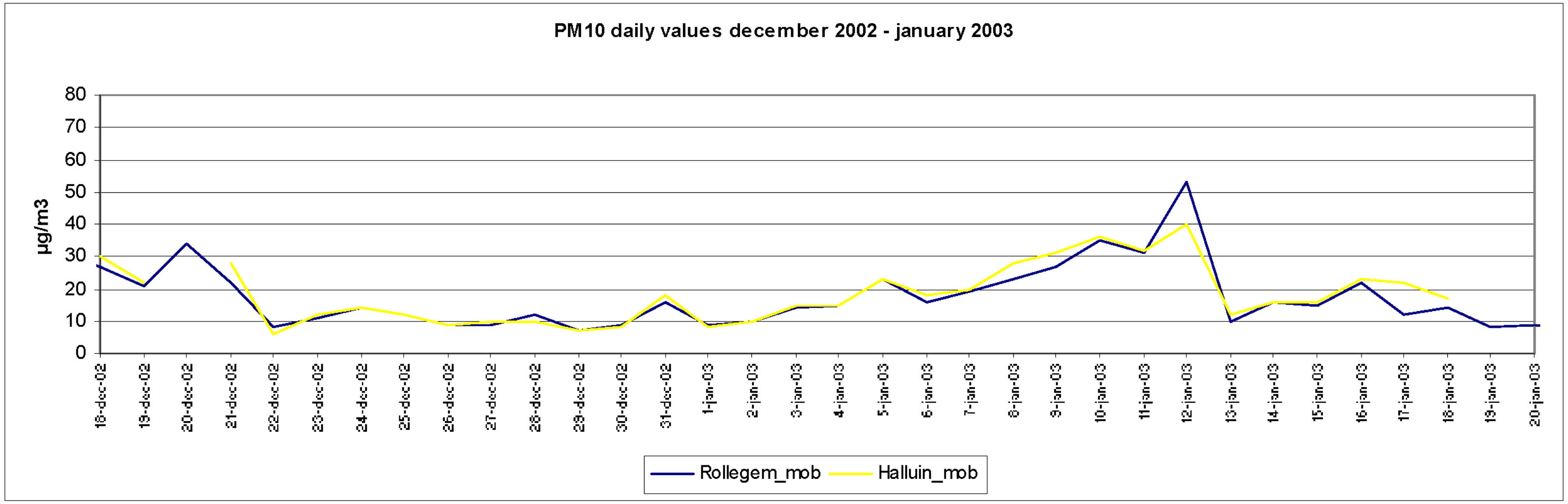


Figure D : PM10 hourly values (continued)



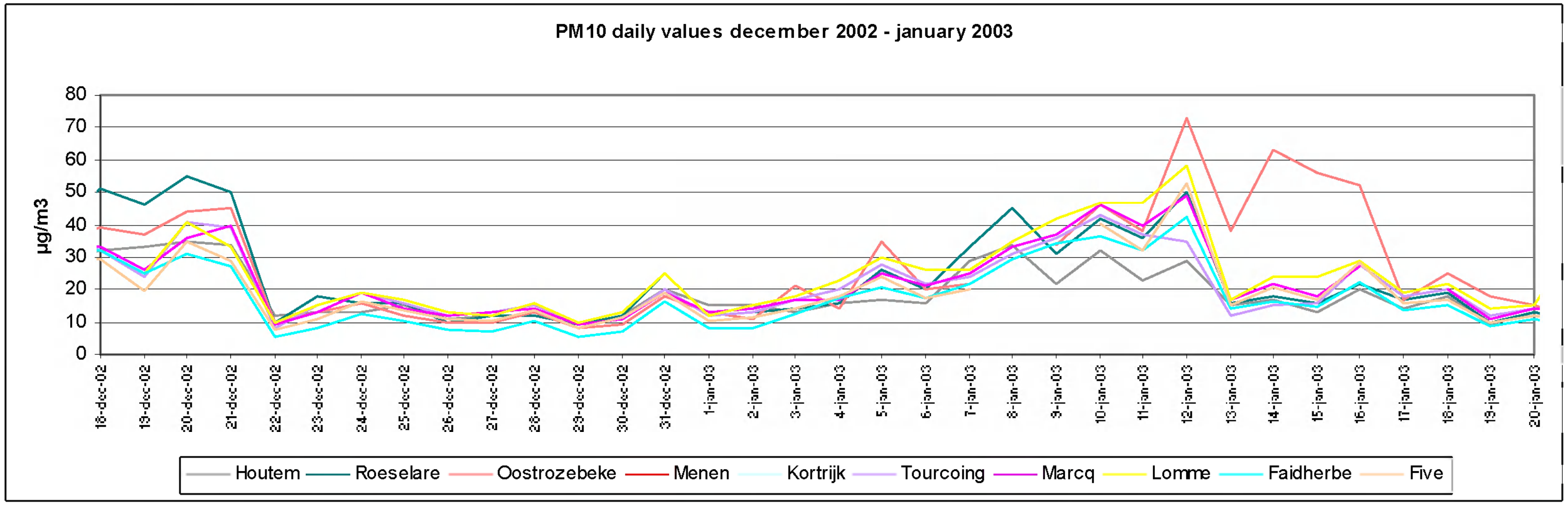
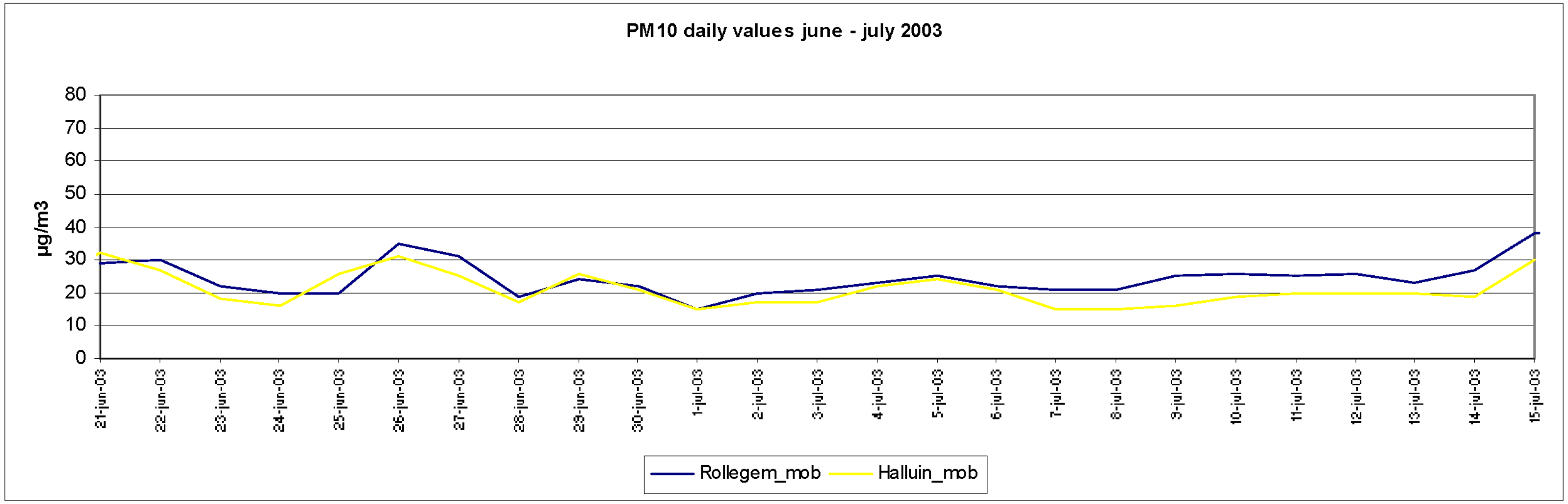


Figure E : PM10 daily values



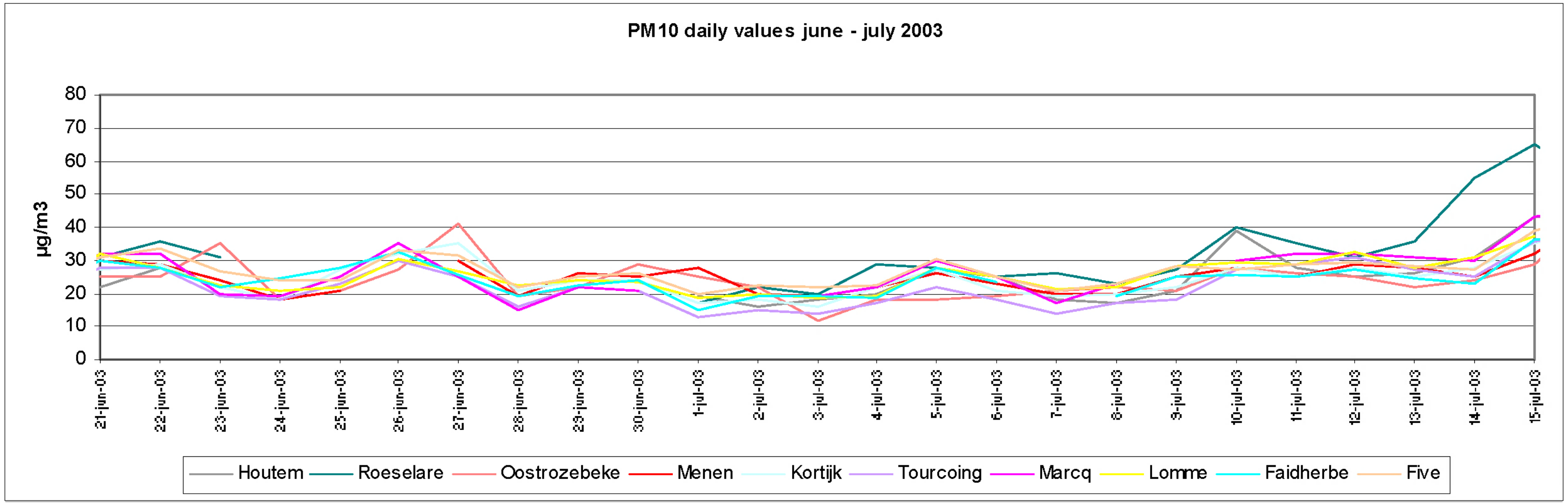
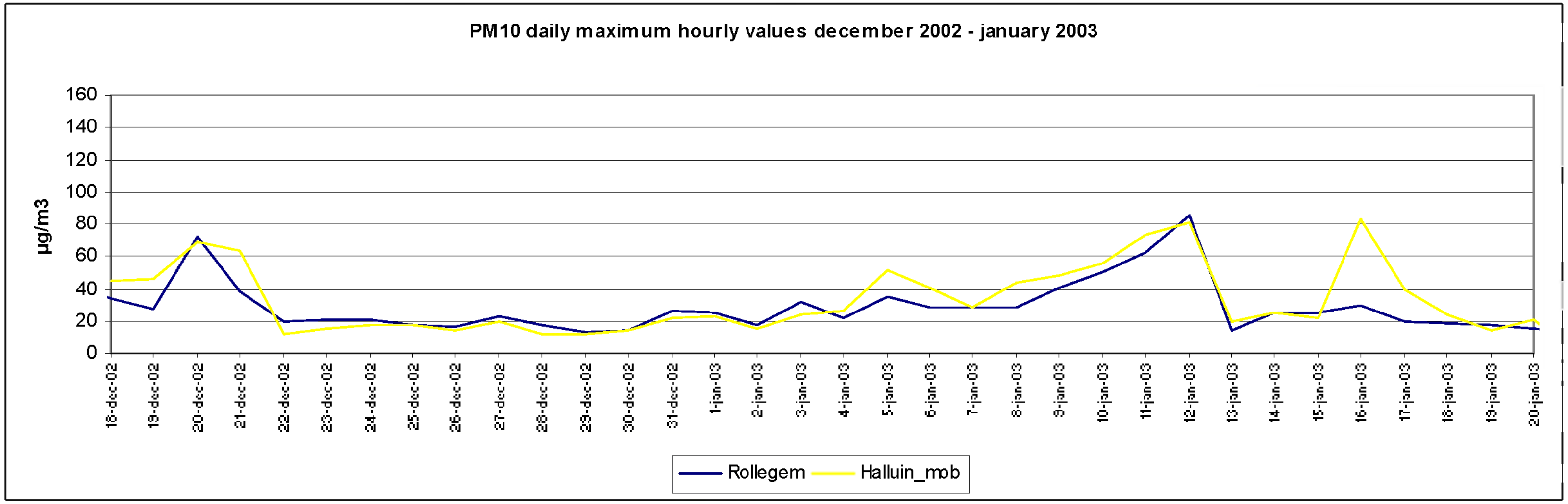


Figure E : PM10 daily values (continued)



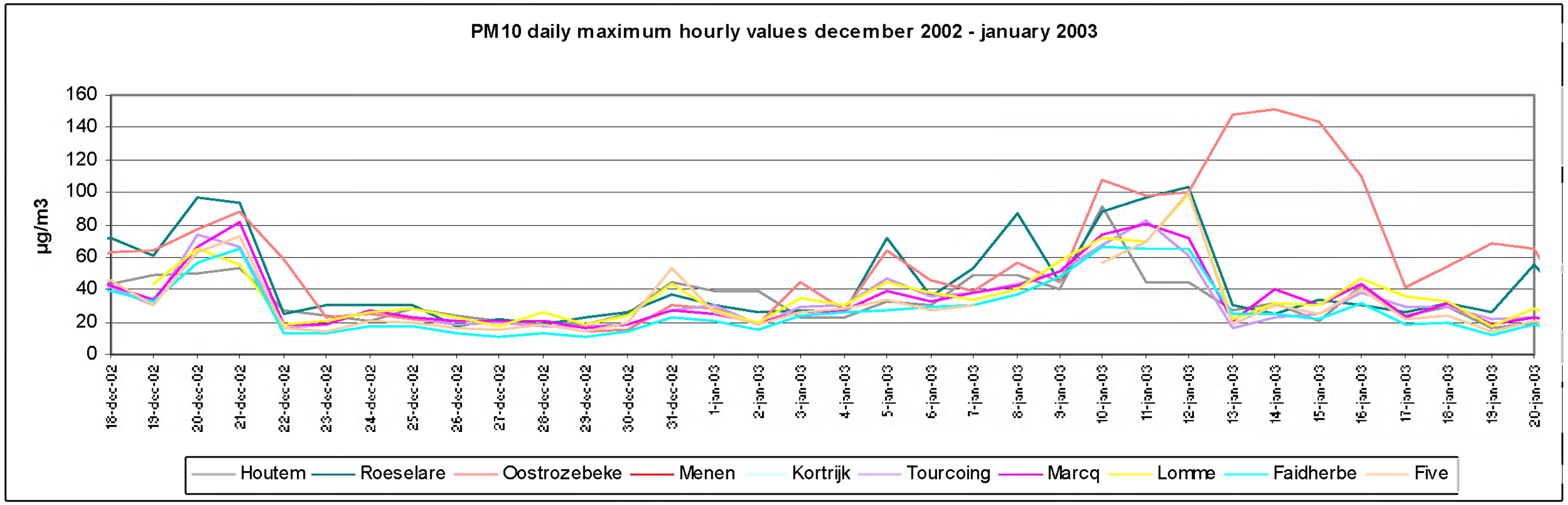


Figure F : PM10 daily maximum hourly values

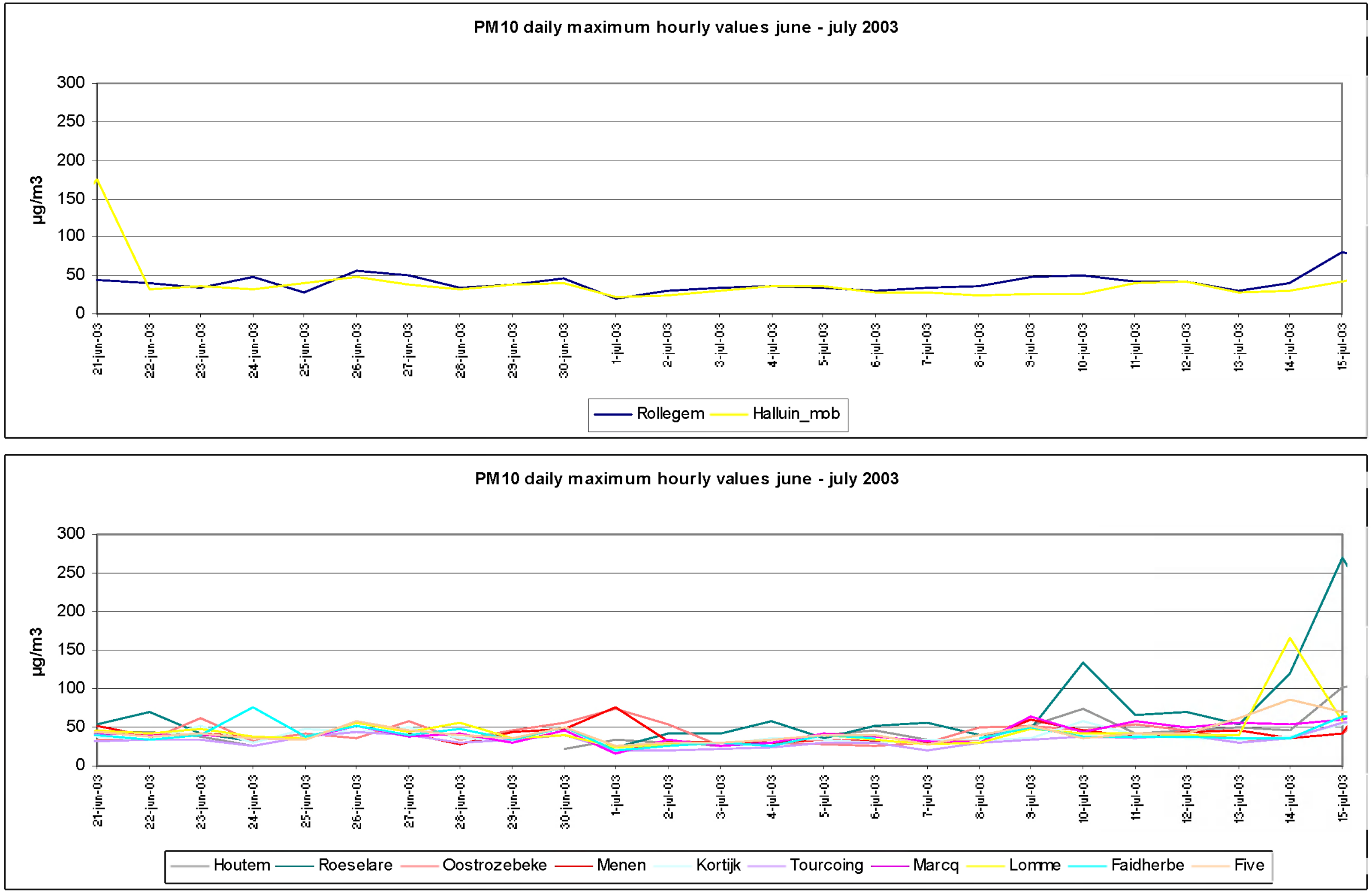


Figure F : PM10 daily maximum hourly values (continued)

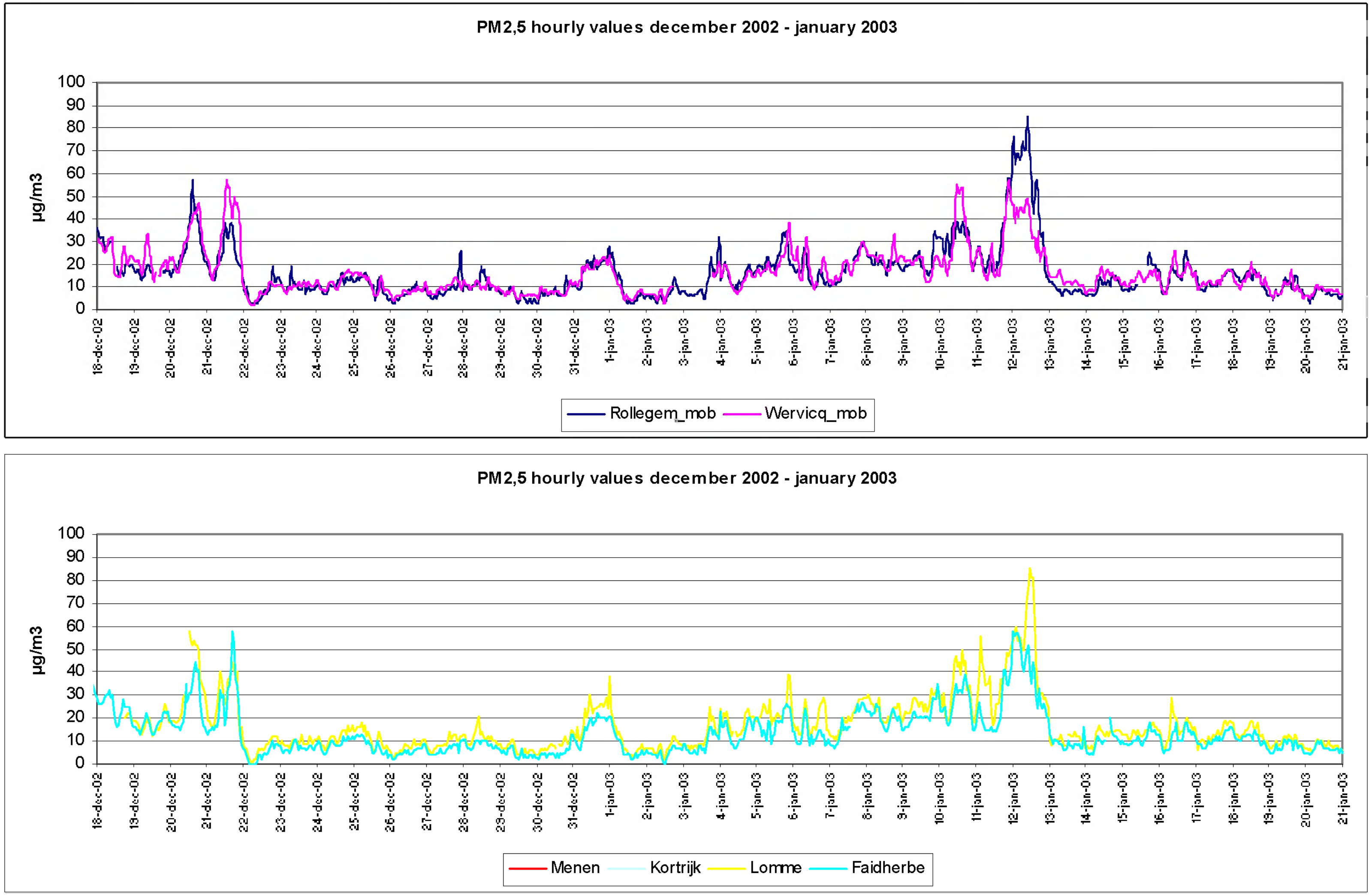
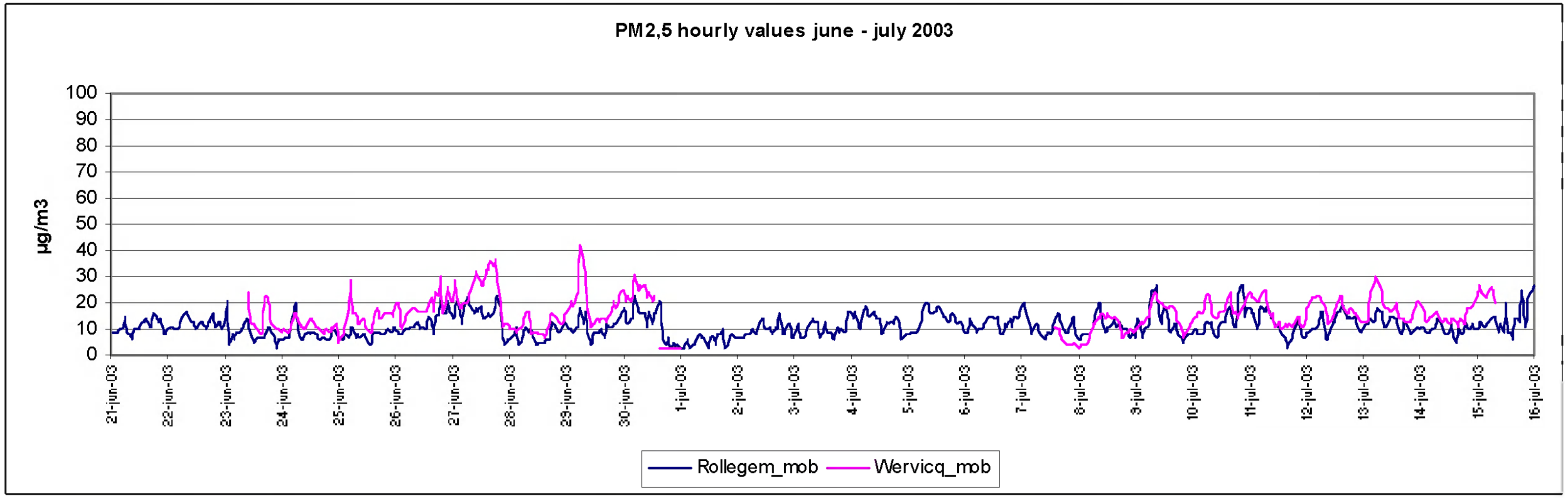


Figure G : PM2,5 hourly values



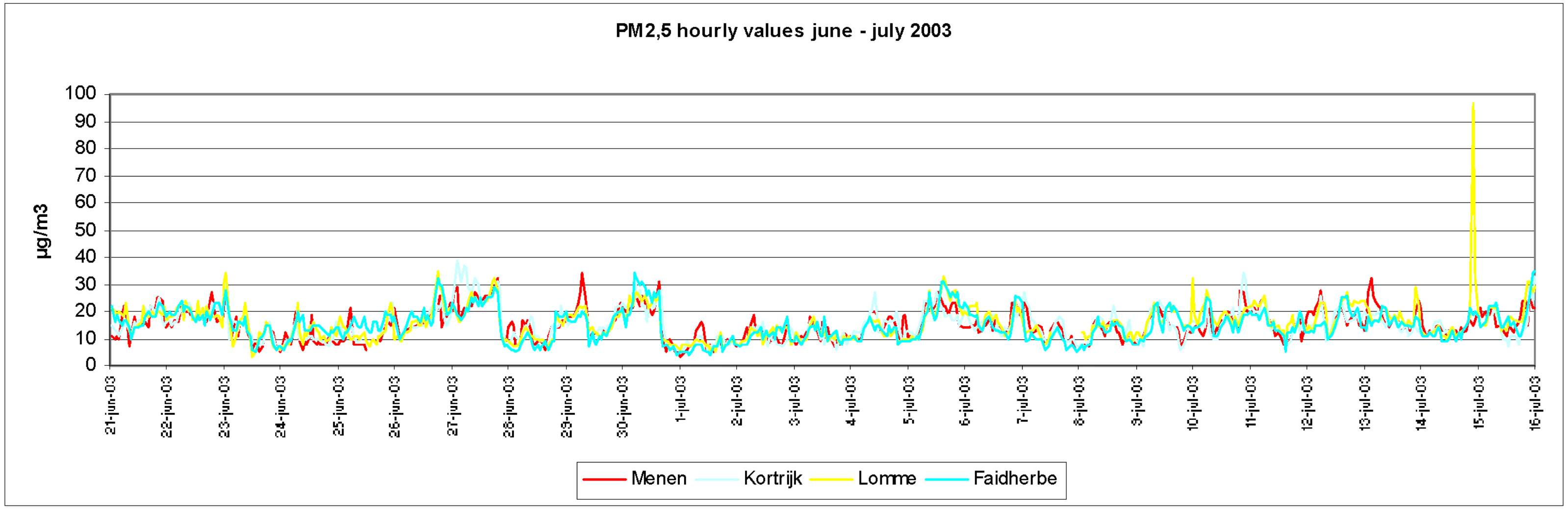


Figure G : PM2,5 hourly values (continued)

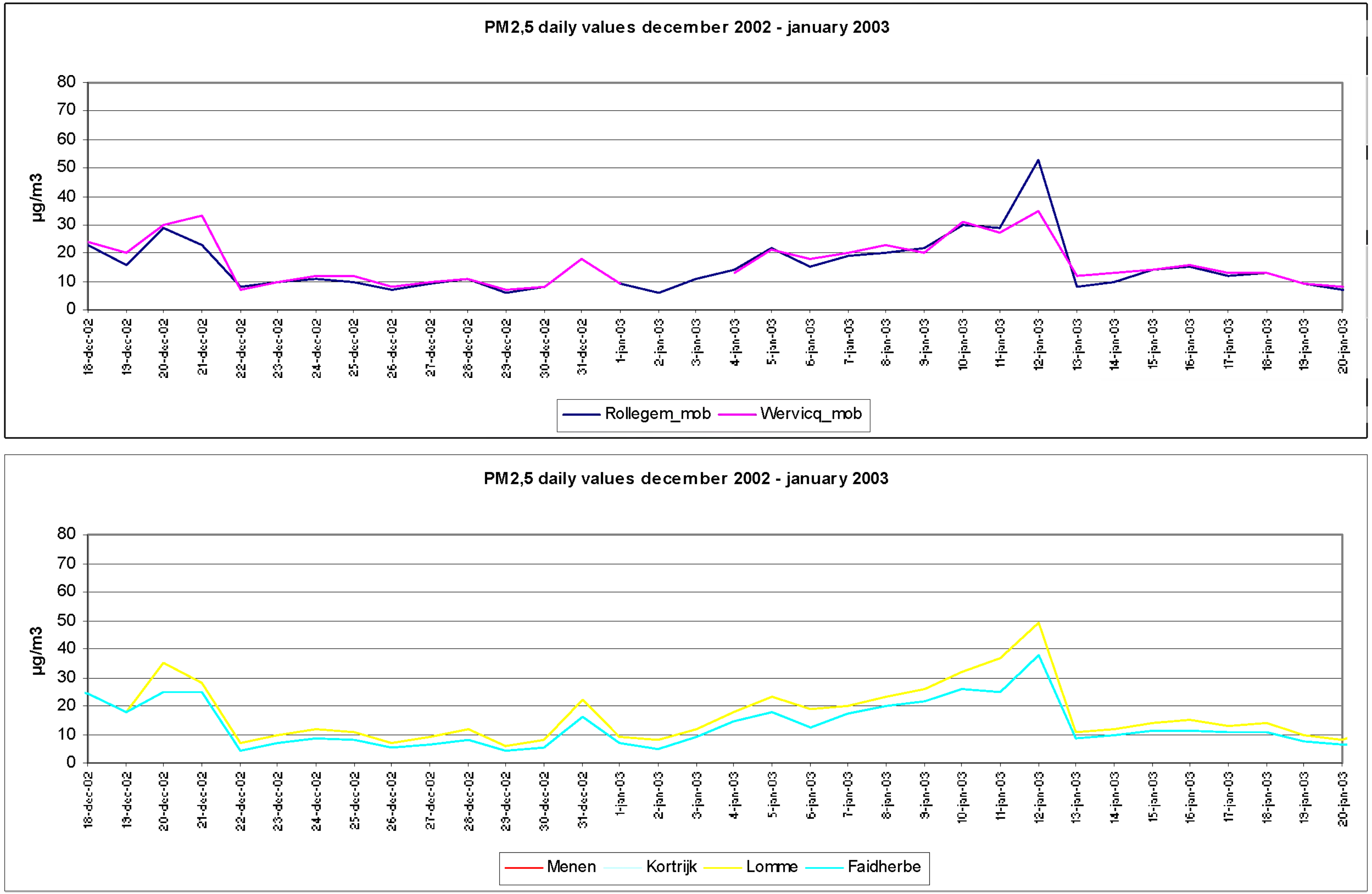
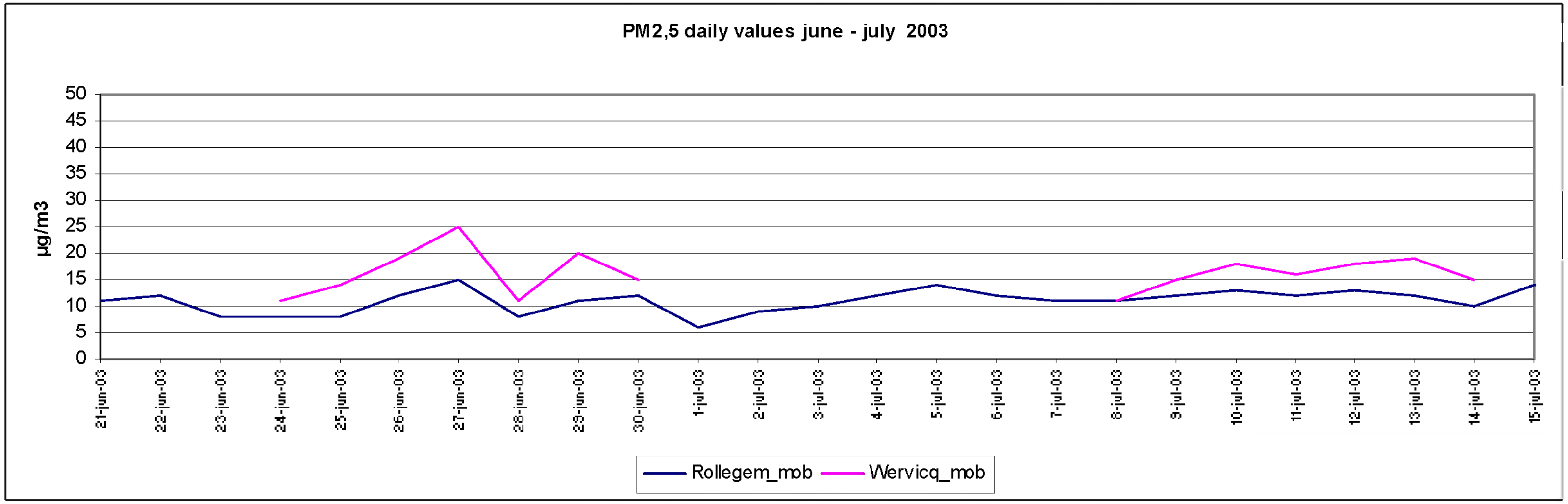


Figure H : PM2,5 daily values



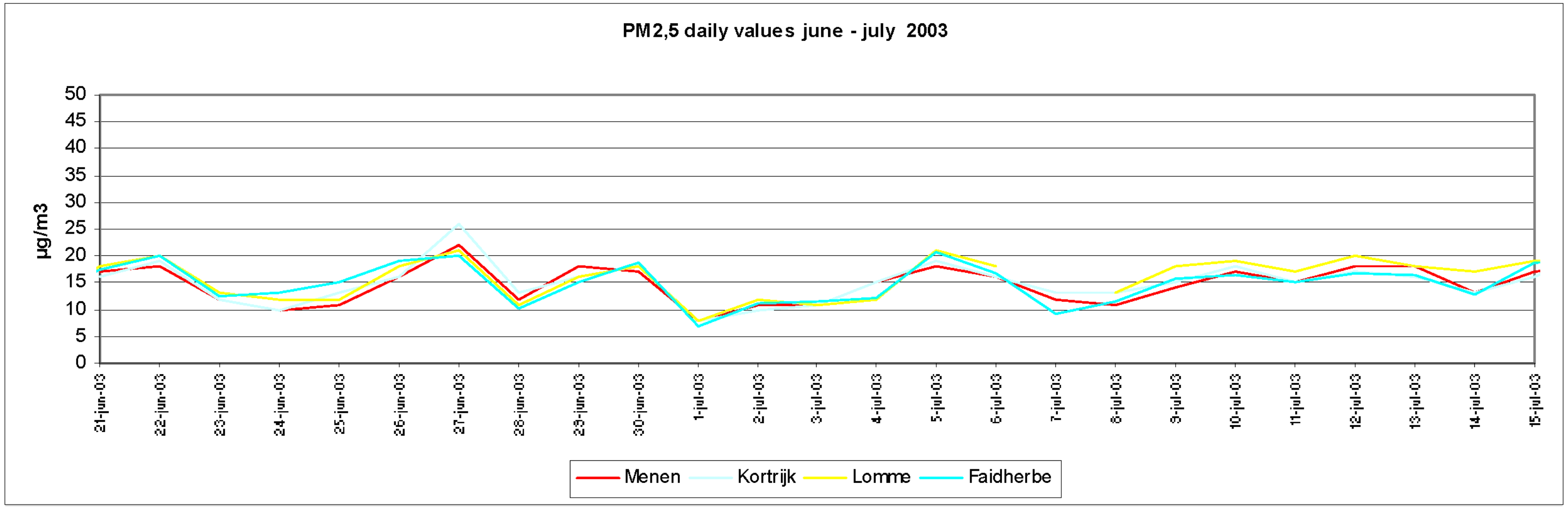
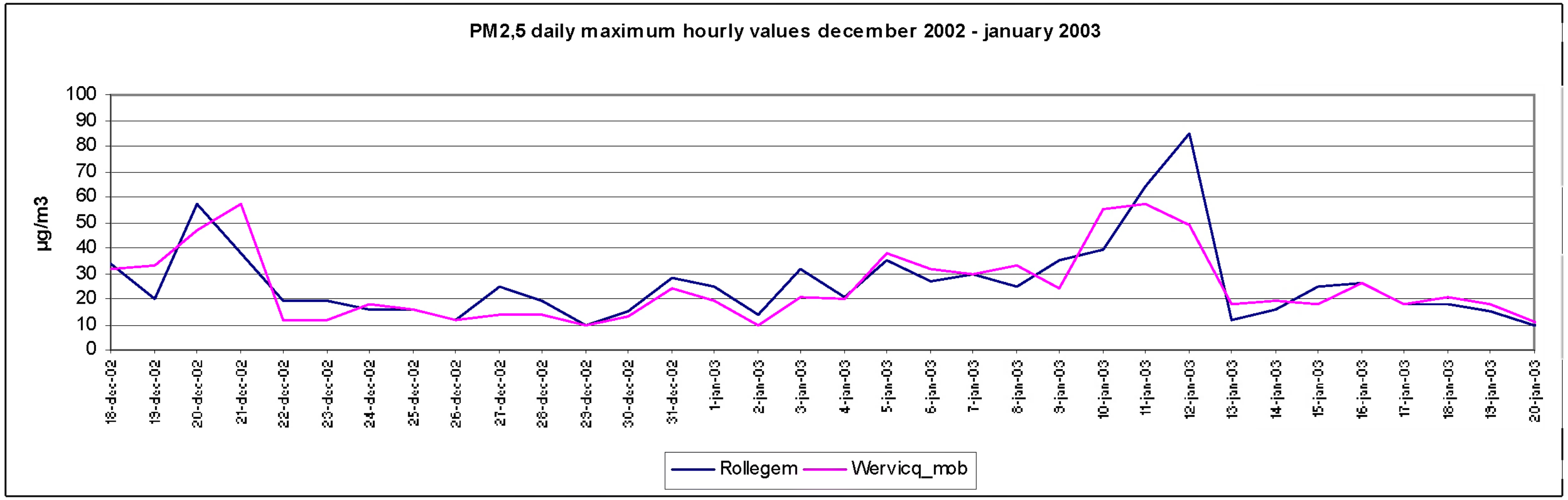


Figure H : PM2,5 daily values (continued)



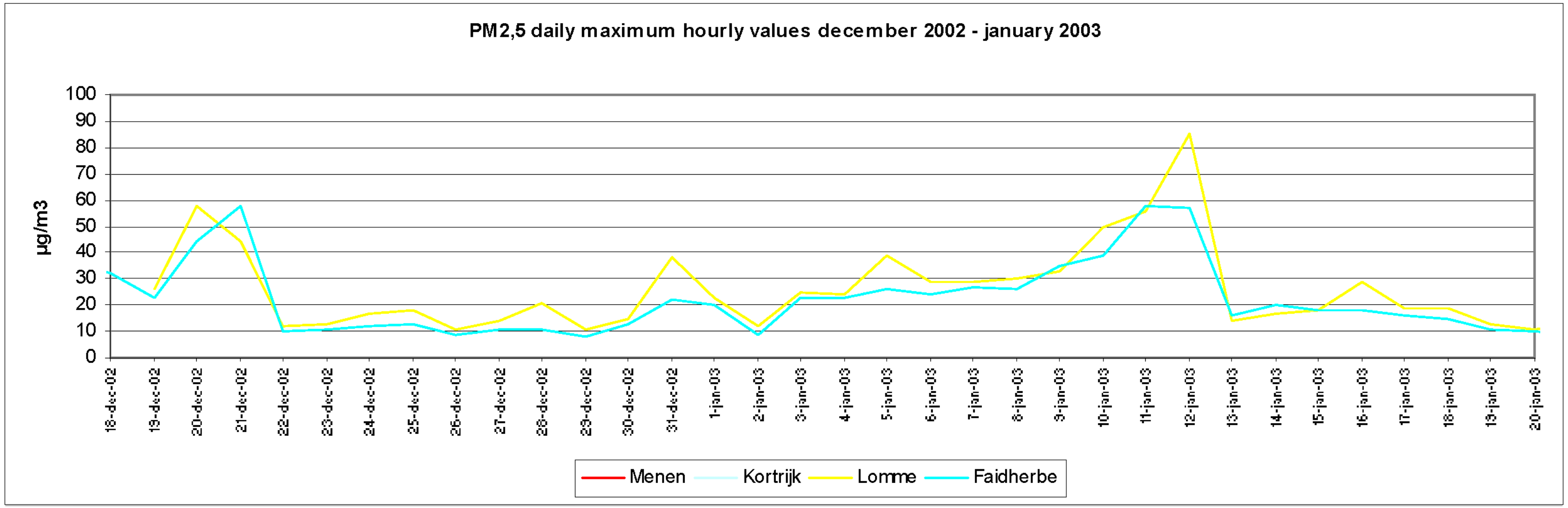
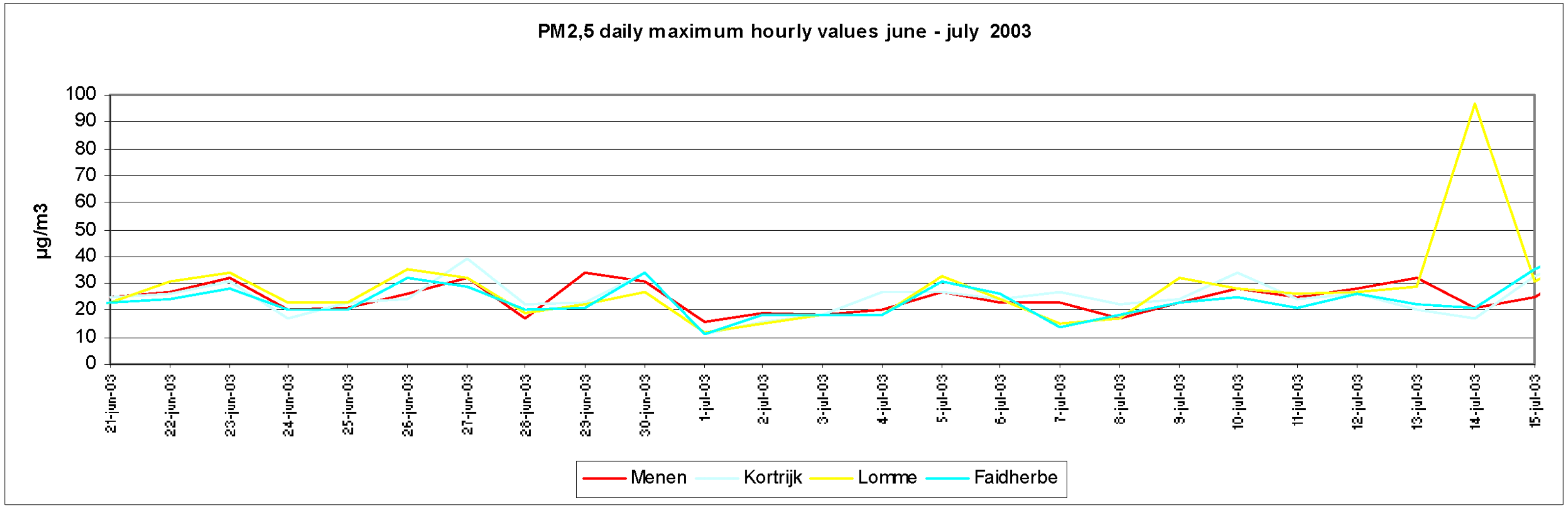


Figure I : PM2,5 daily maximum hourly values



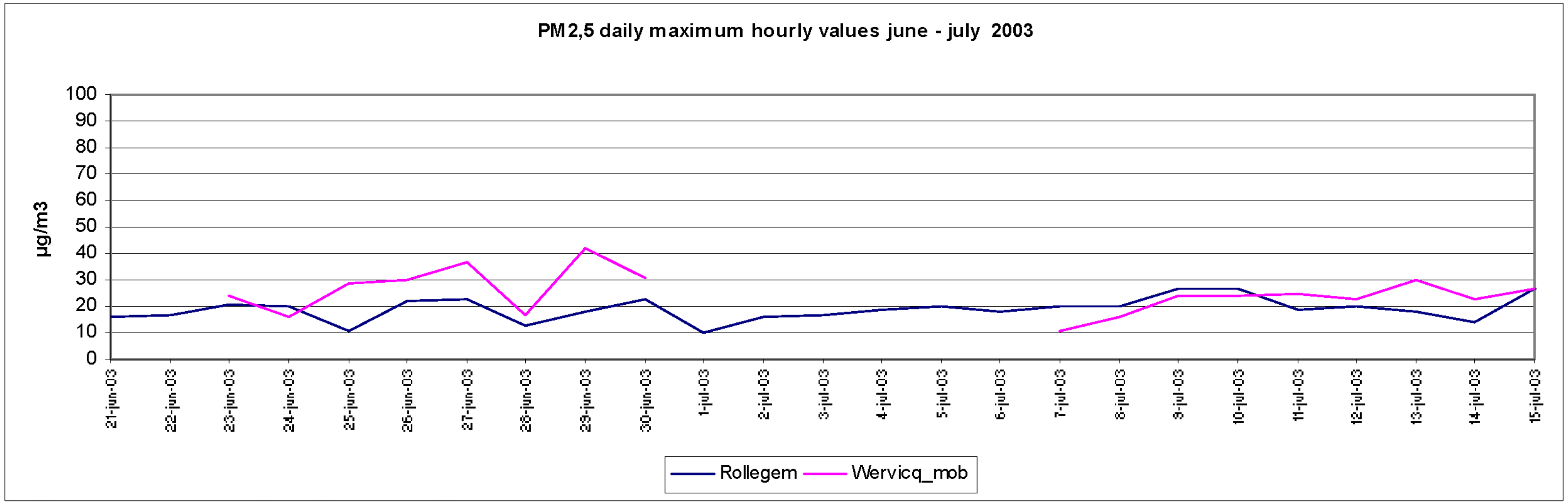


Figure I : PM2,5 daily maximum hourly values (continued)

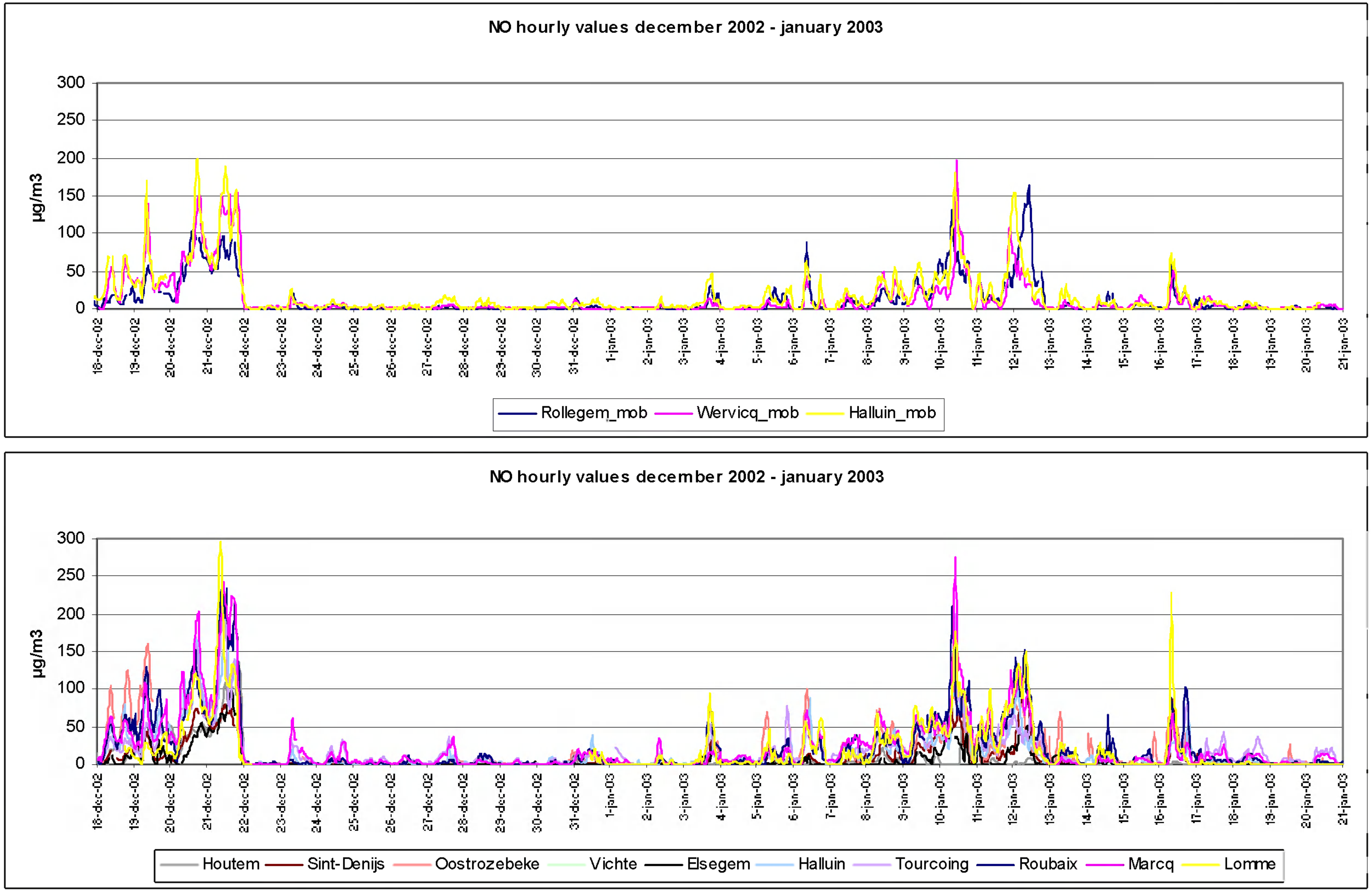
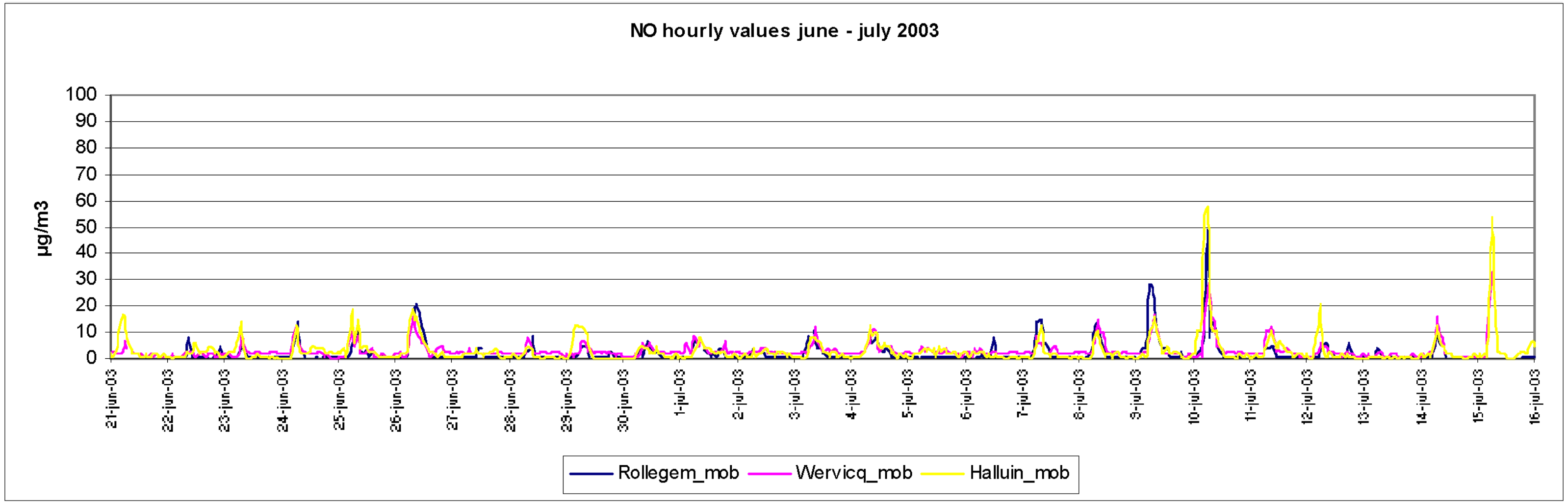


Figure J : NO hourly values



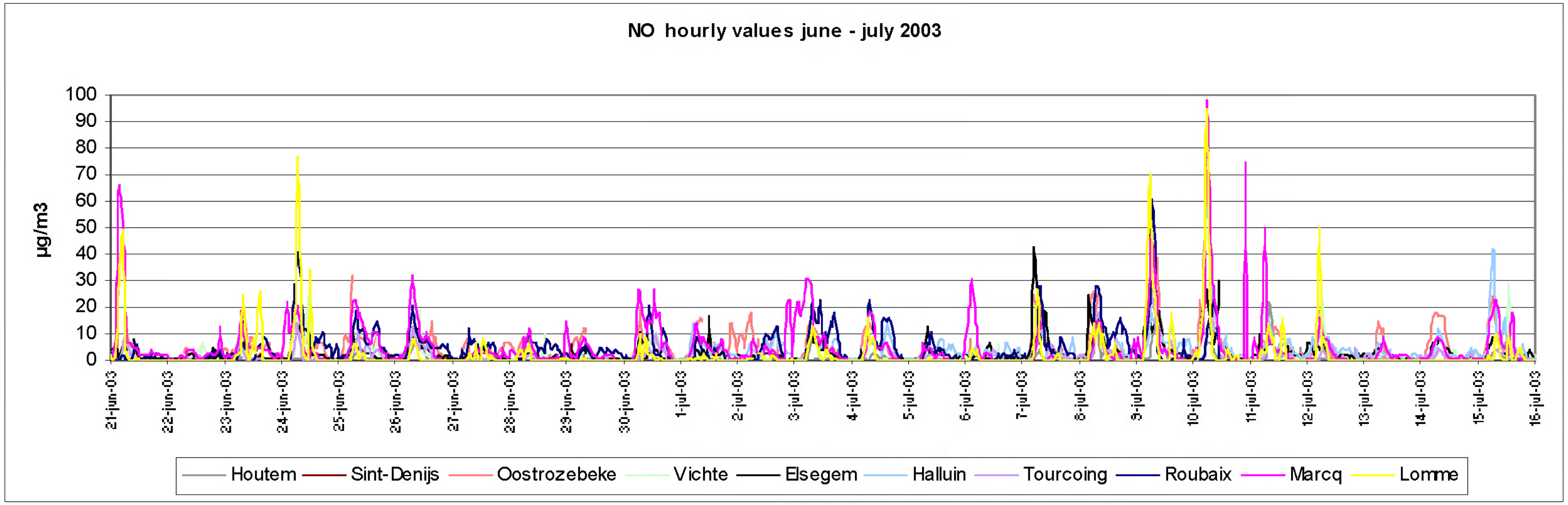
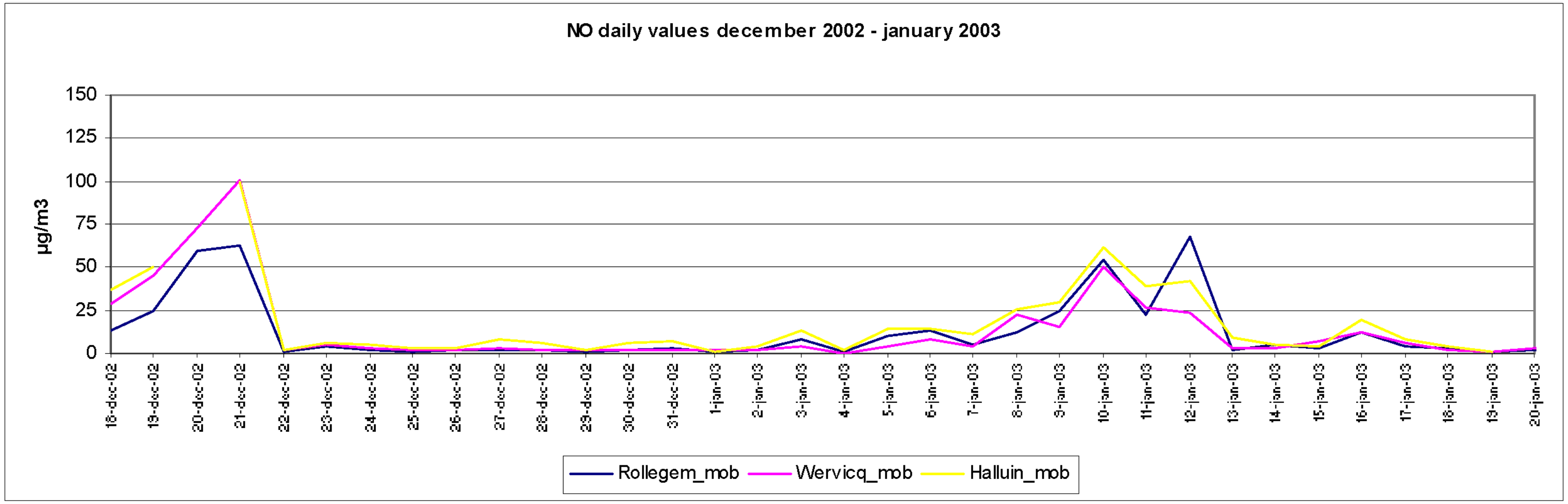


Figure J : NO hourly values (continued)



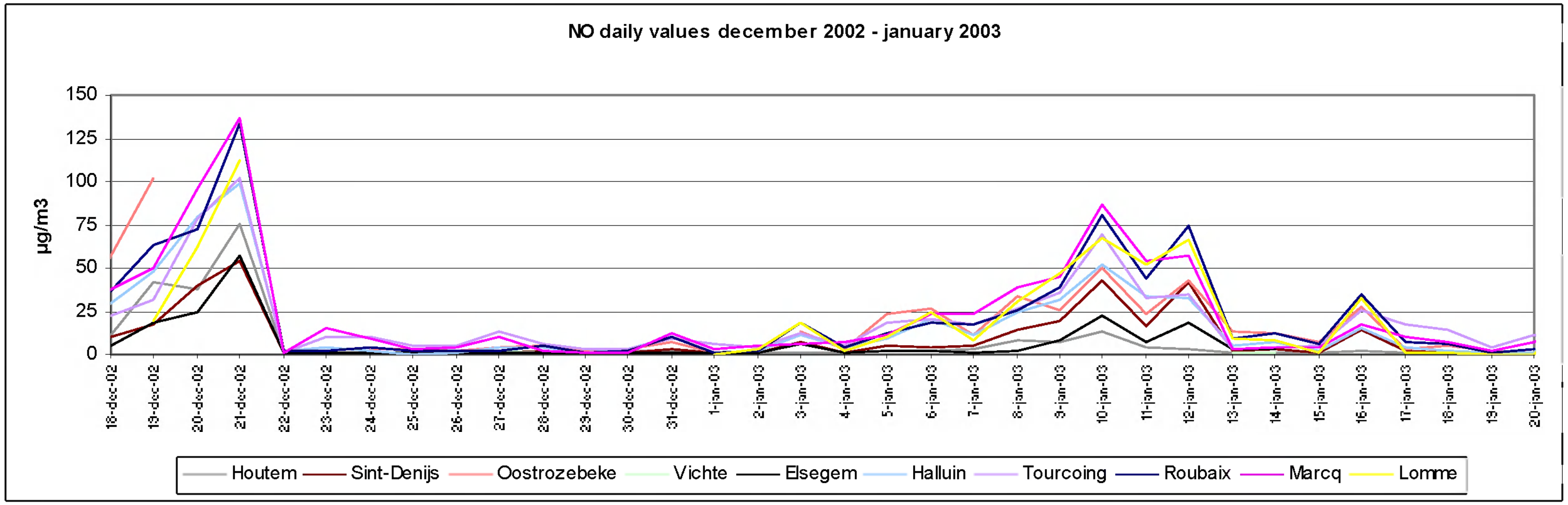


Figure K : NO daily values

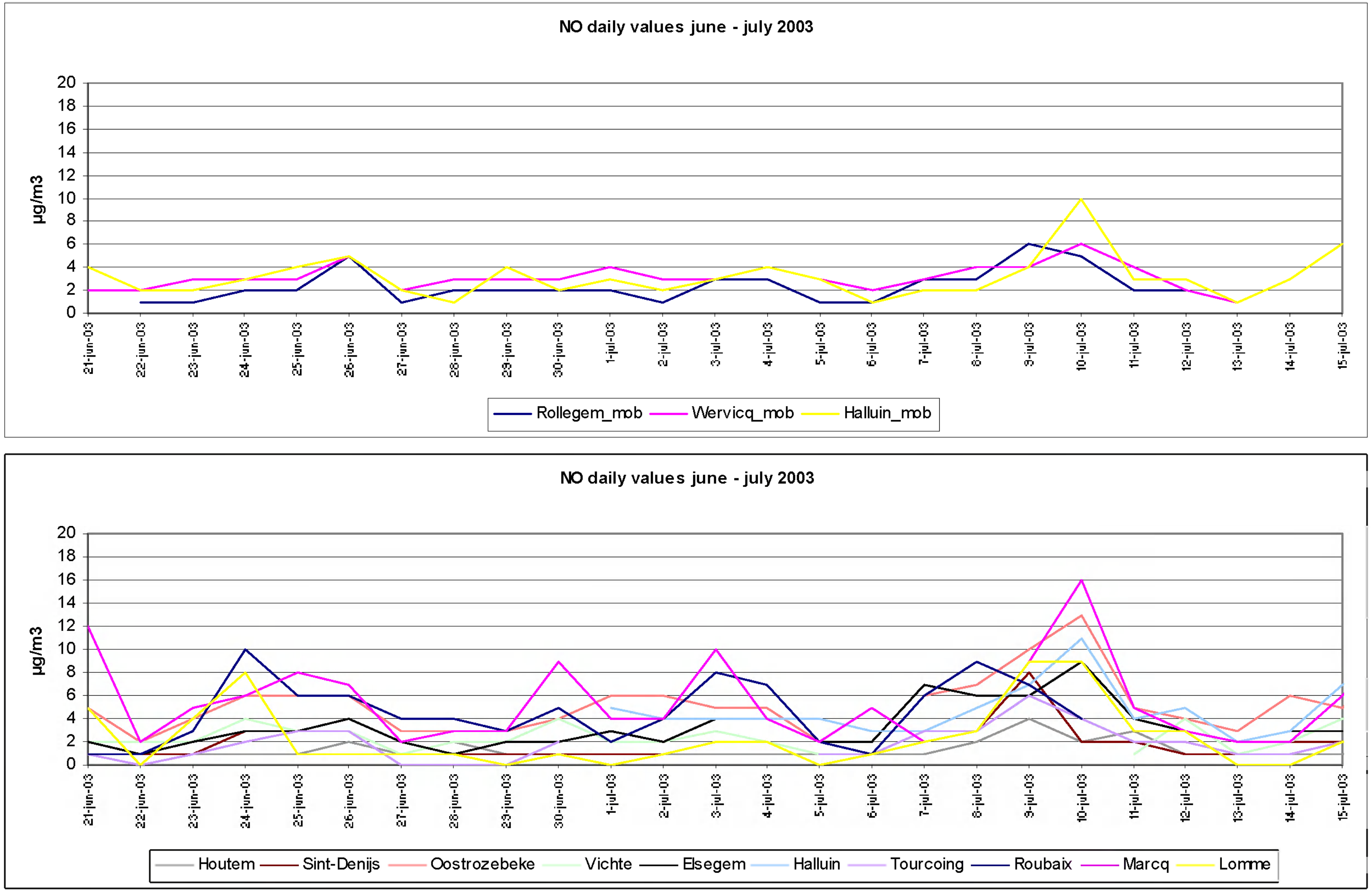
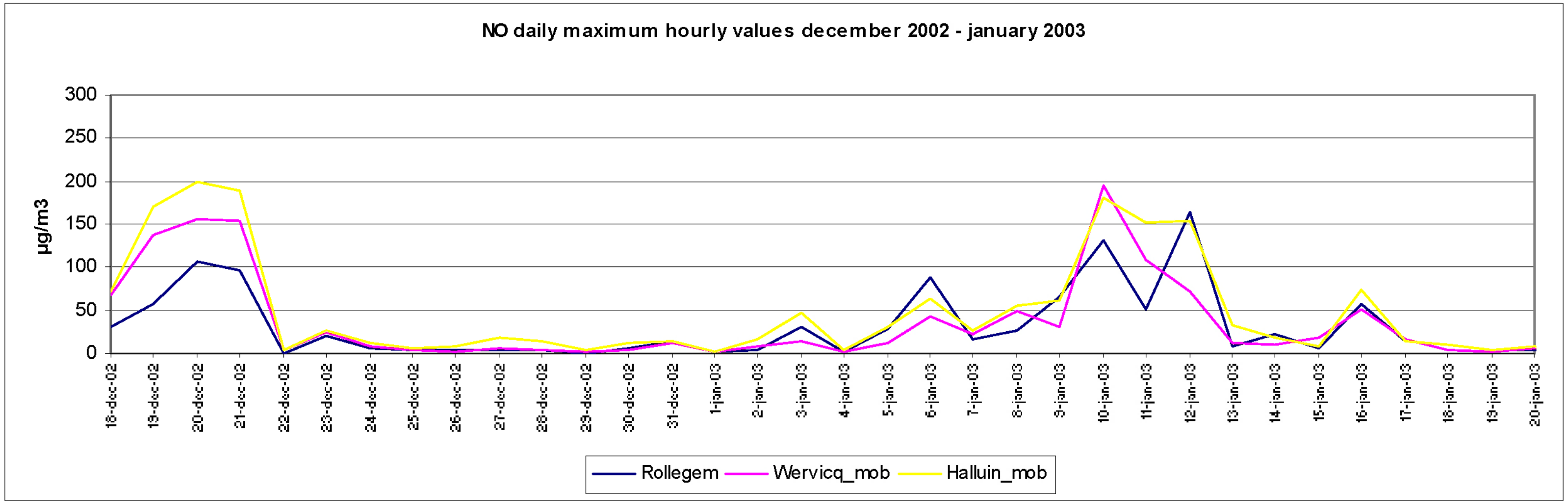


Figure K : NO daily values (continued)



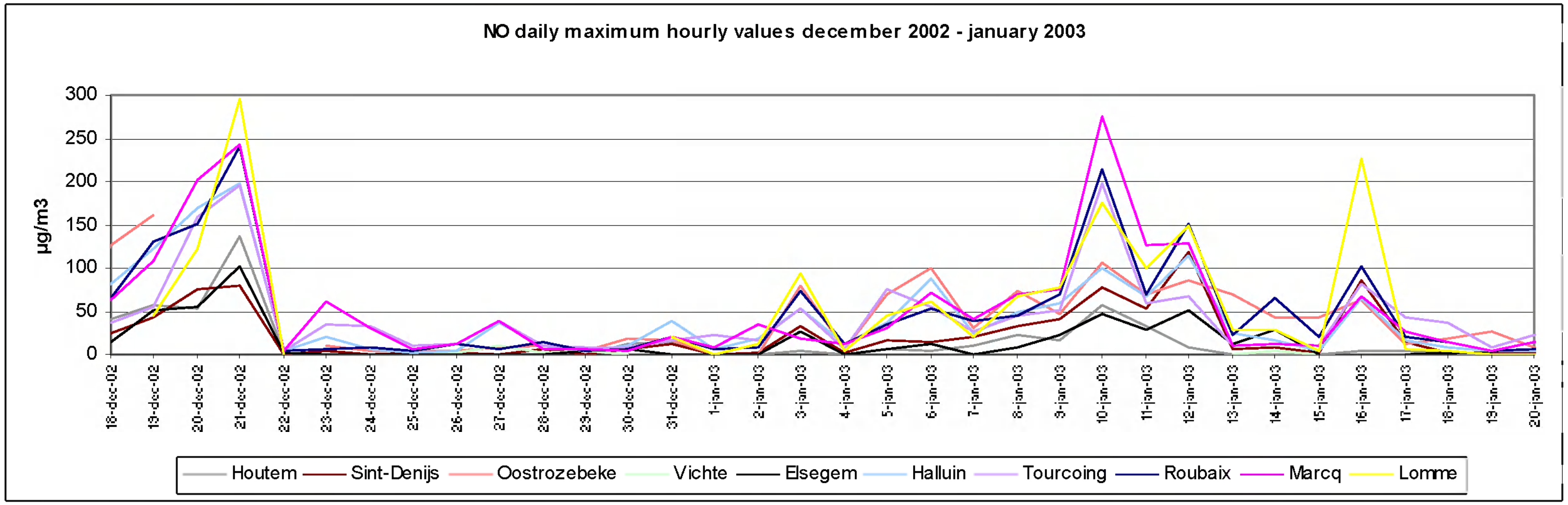
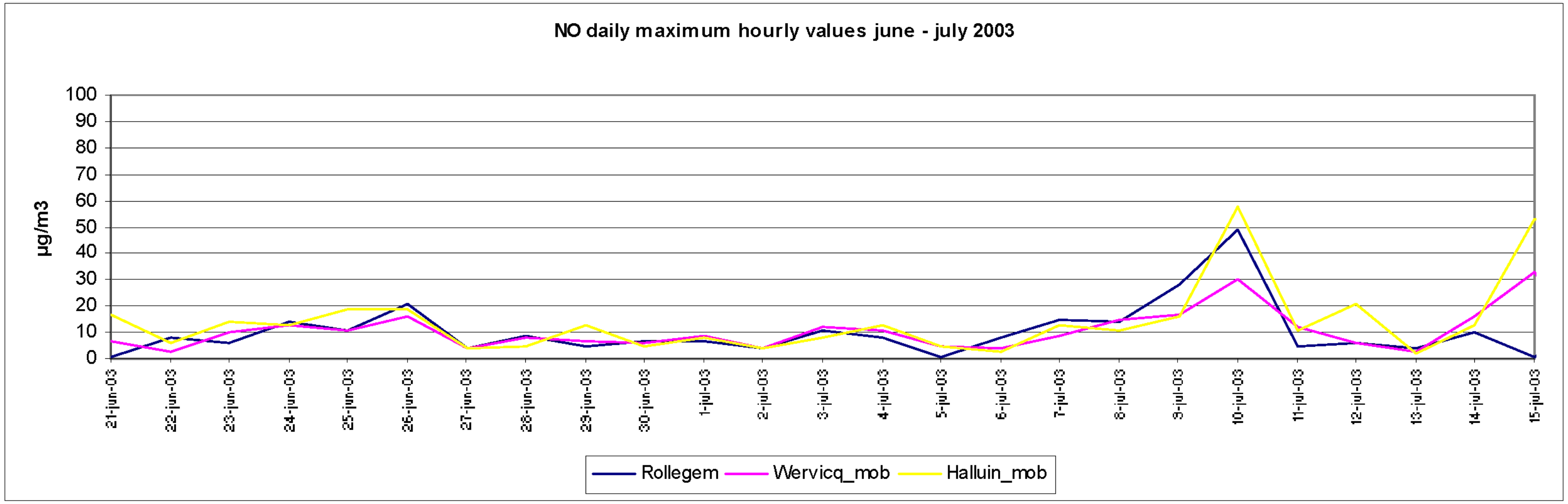


Figure L : NO daily maximum hourly values



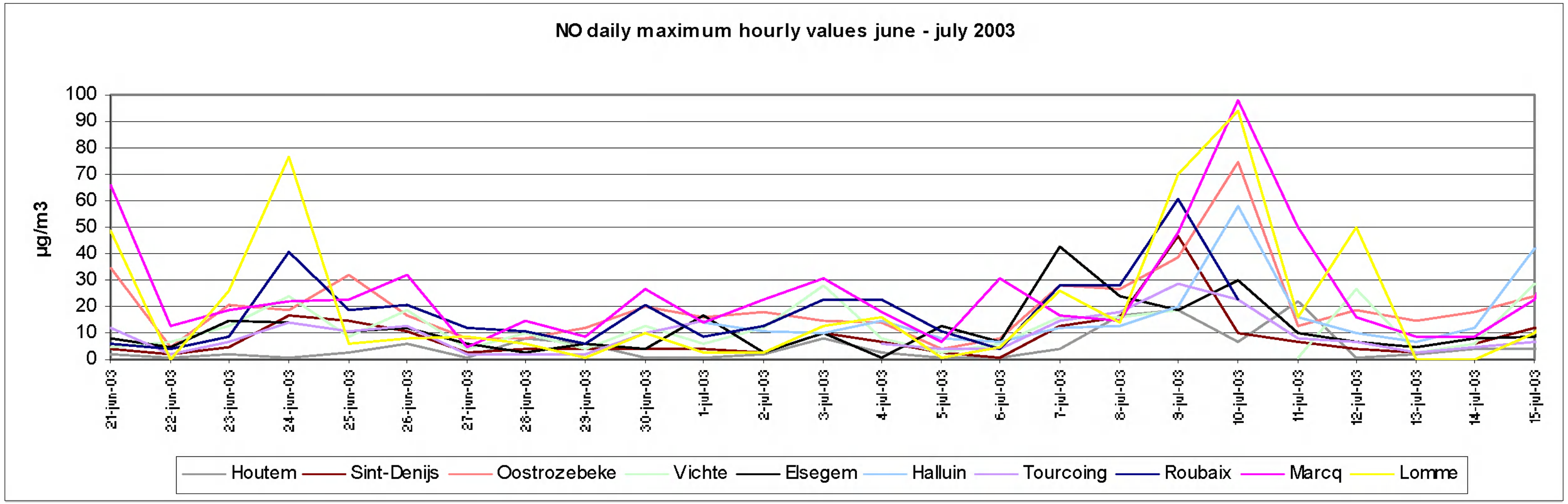


Figure L : NO daily maximum hourly values (continued)

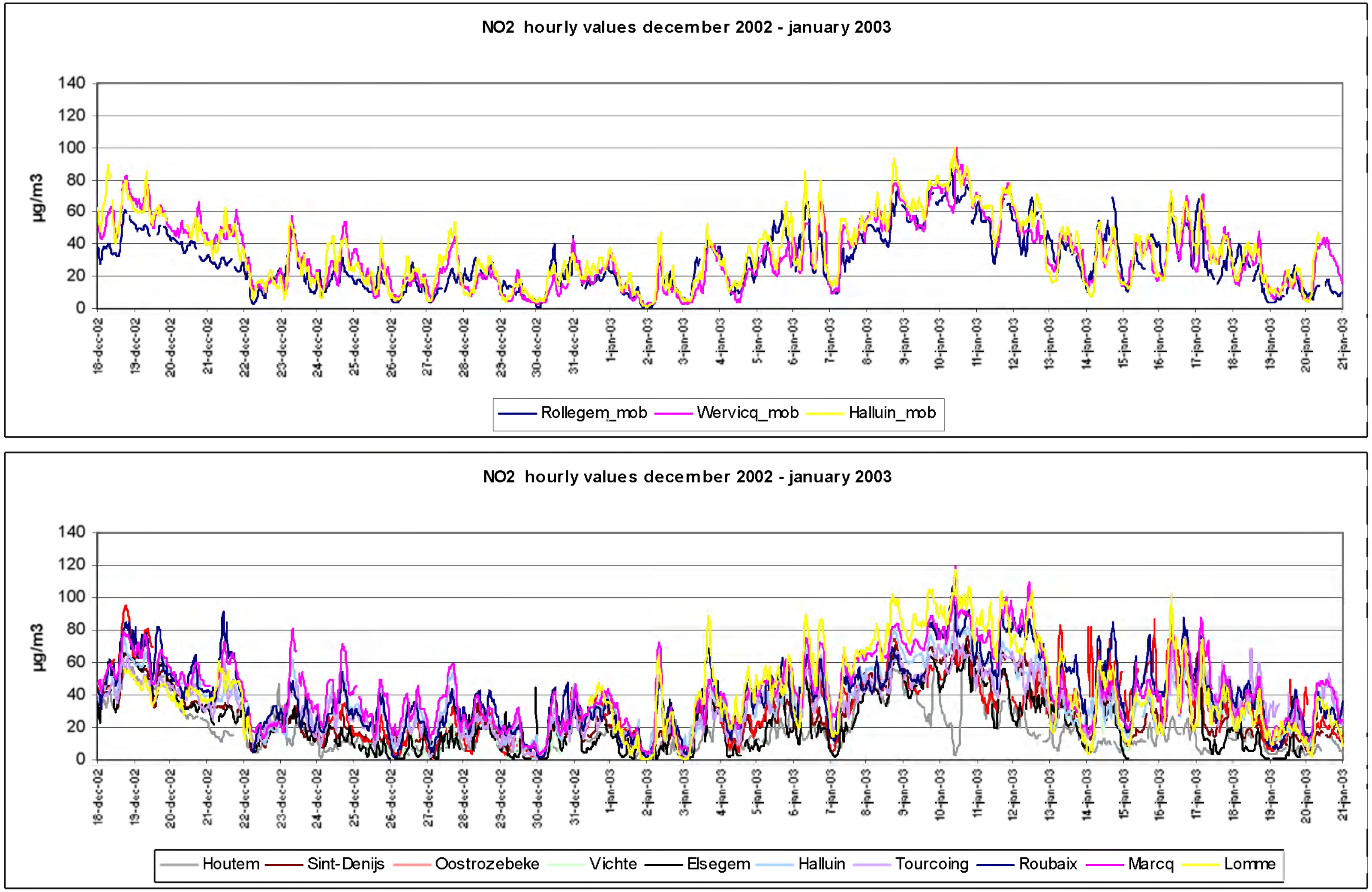
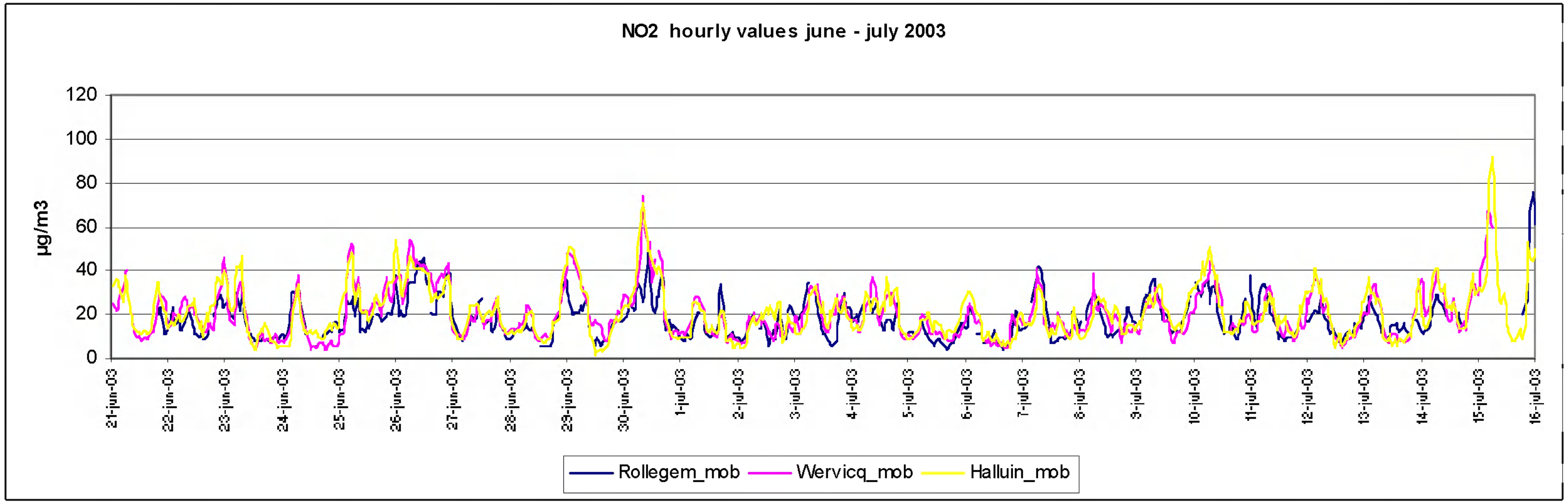


Figure M : NO$_2$ hourly values



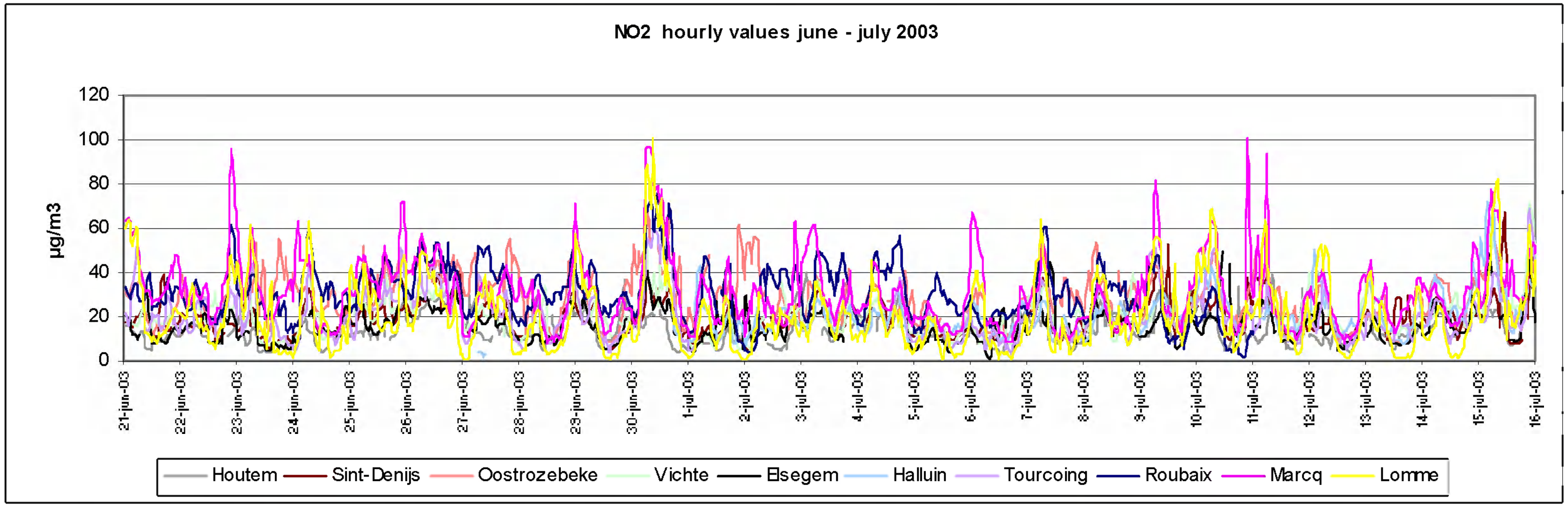
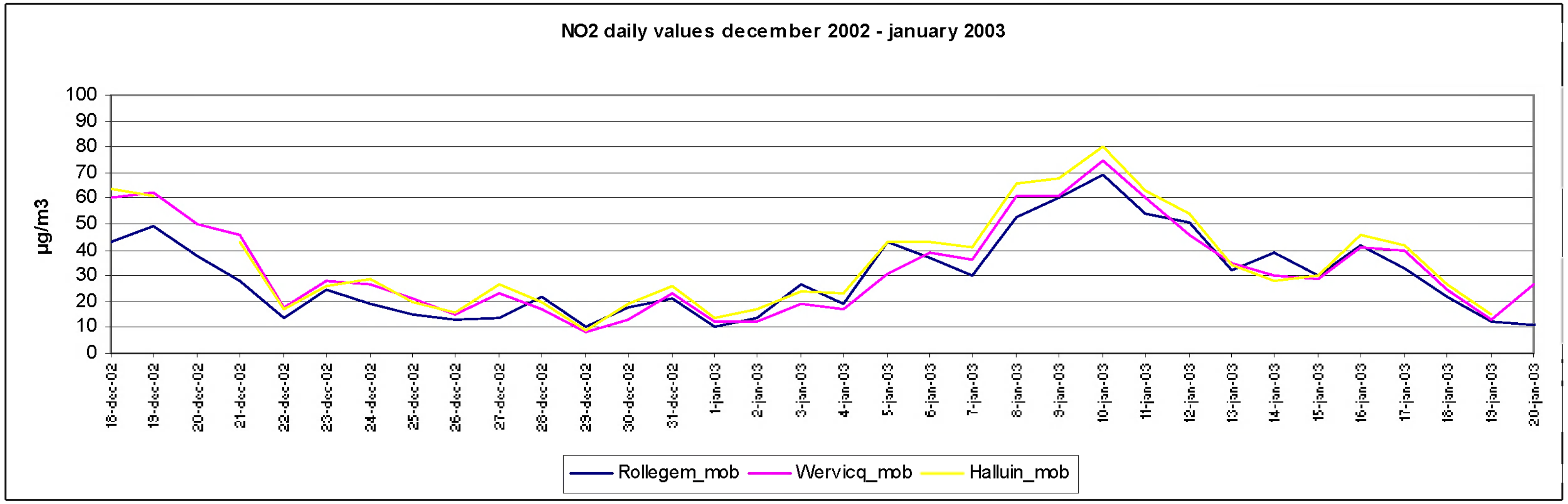


Figure M : NO_2 hourly values (continued)



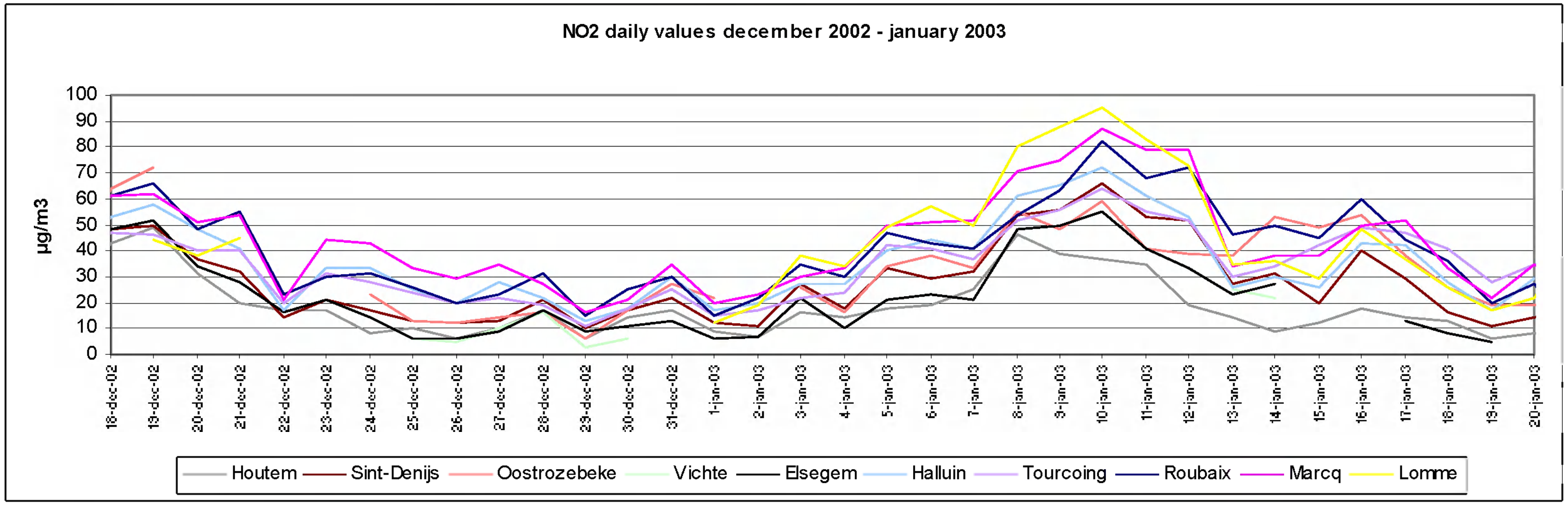
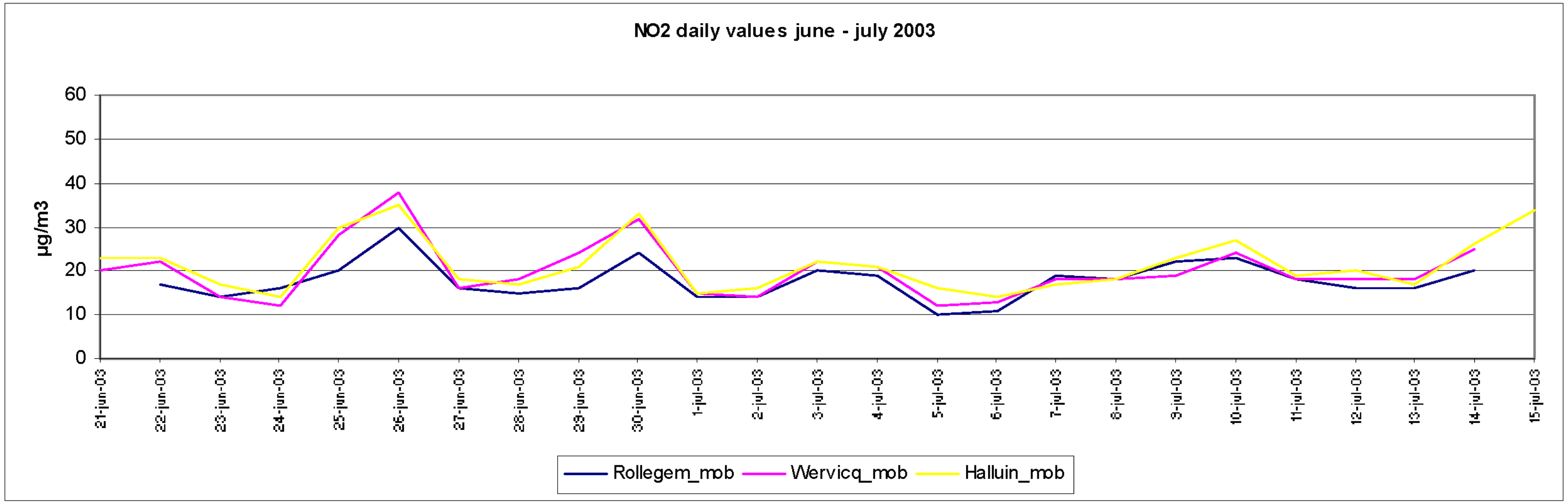


Figure N : NO_2 daily values



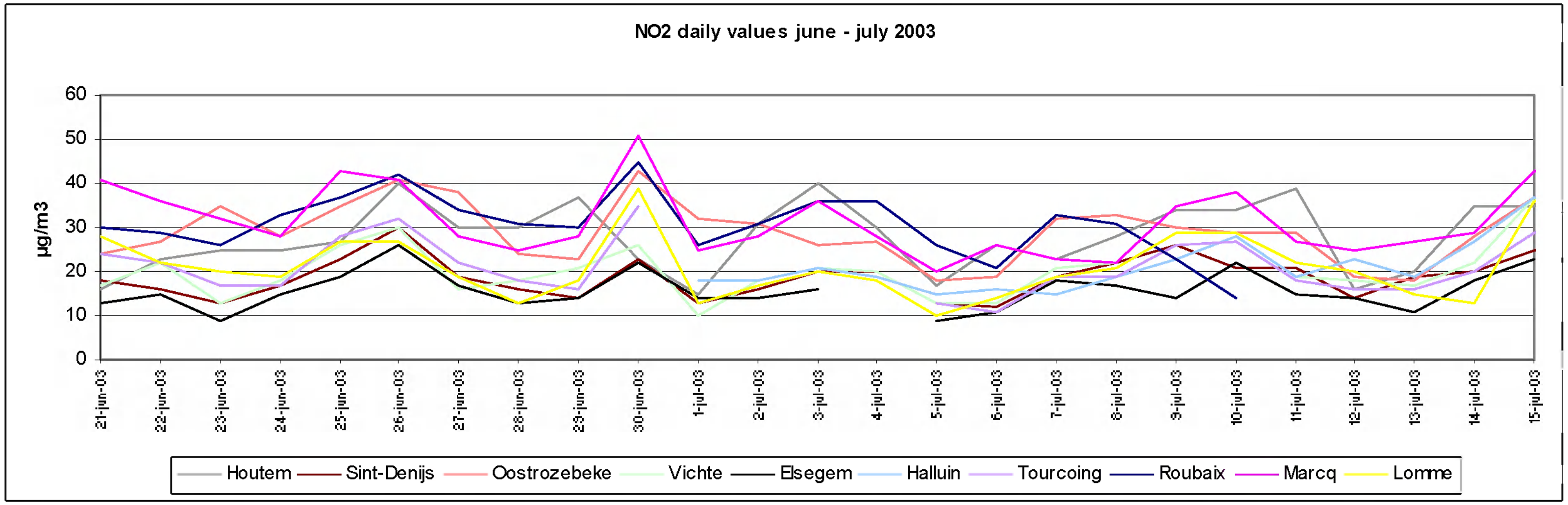
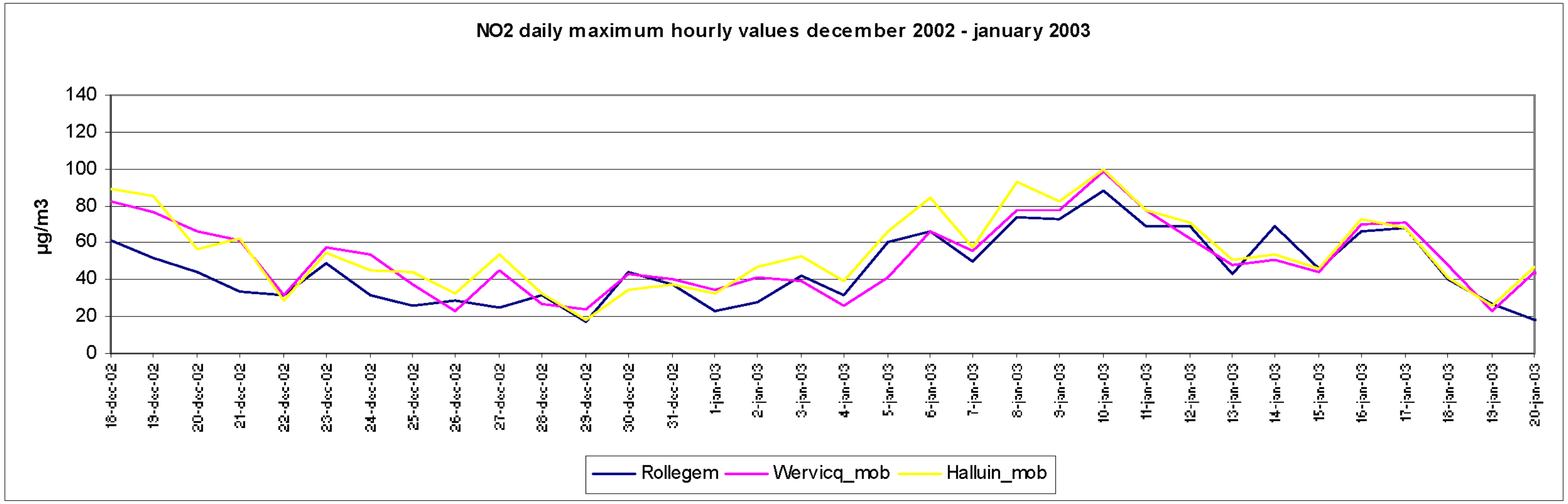


Figure N : NO_2 daily values (continued)



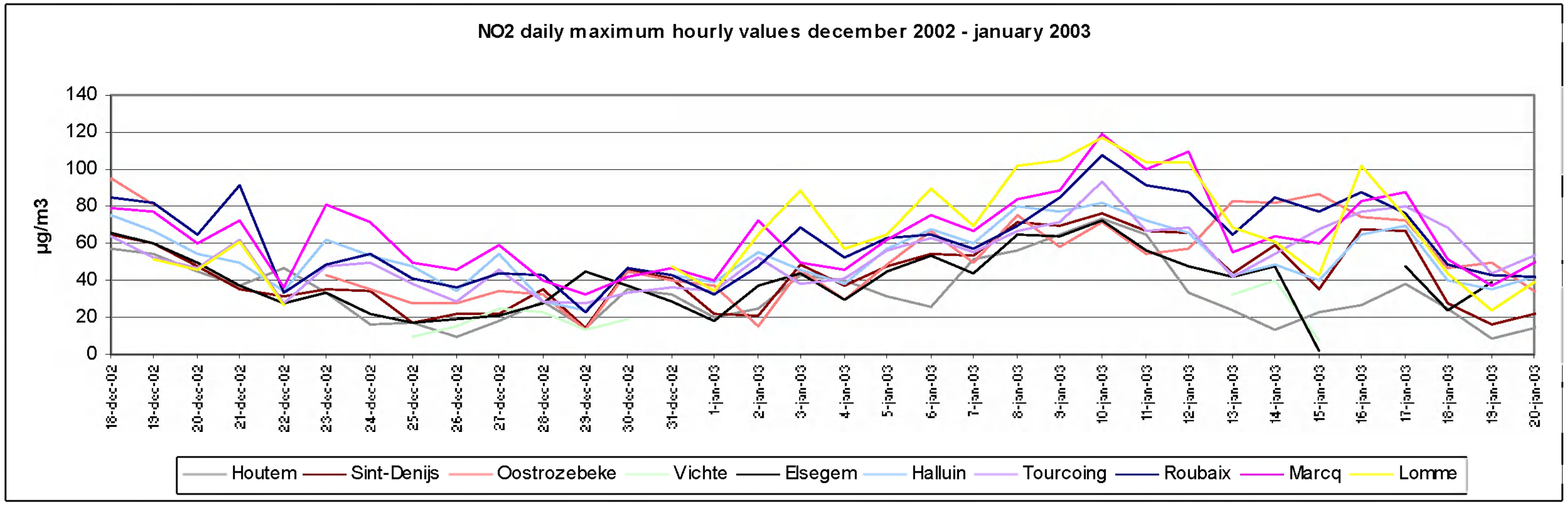


Figure O : NO_2 daily maximum hourly values

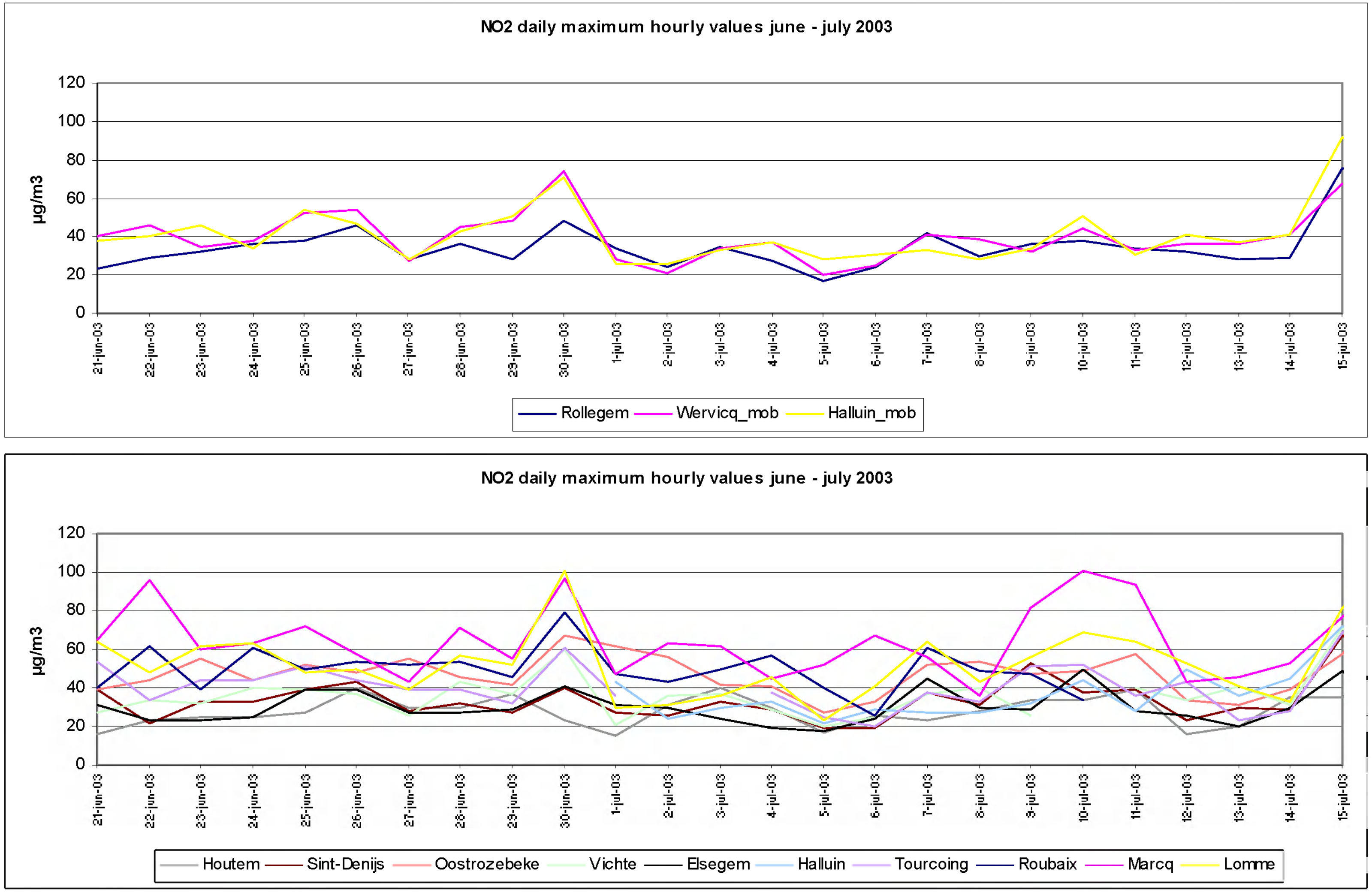


Figure O : NO_2 daily maximum hourly values (continued)

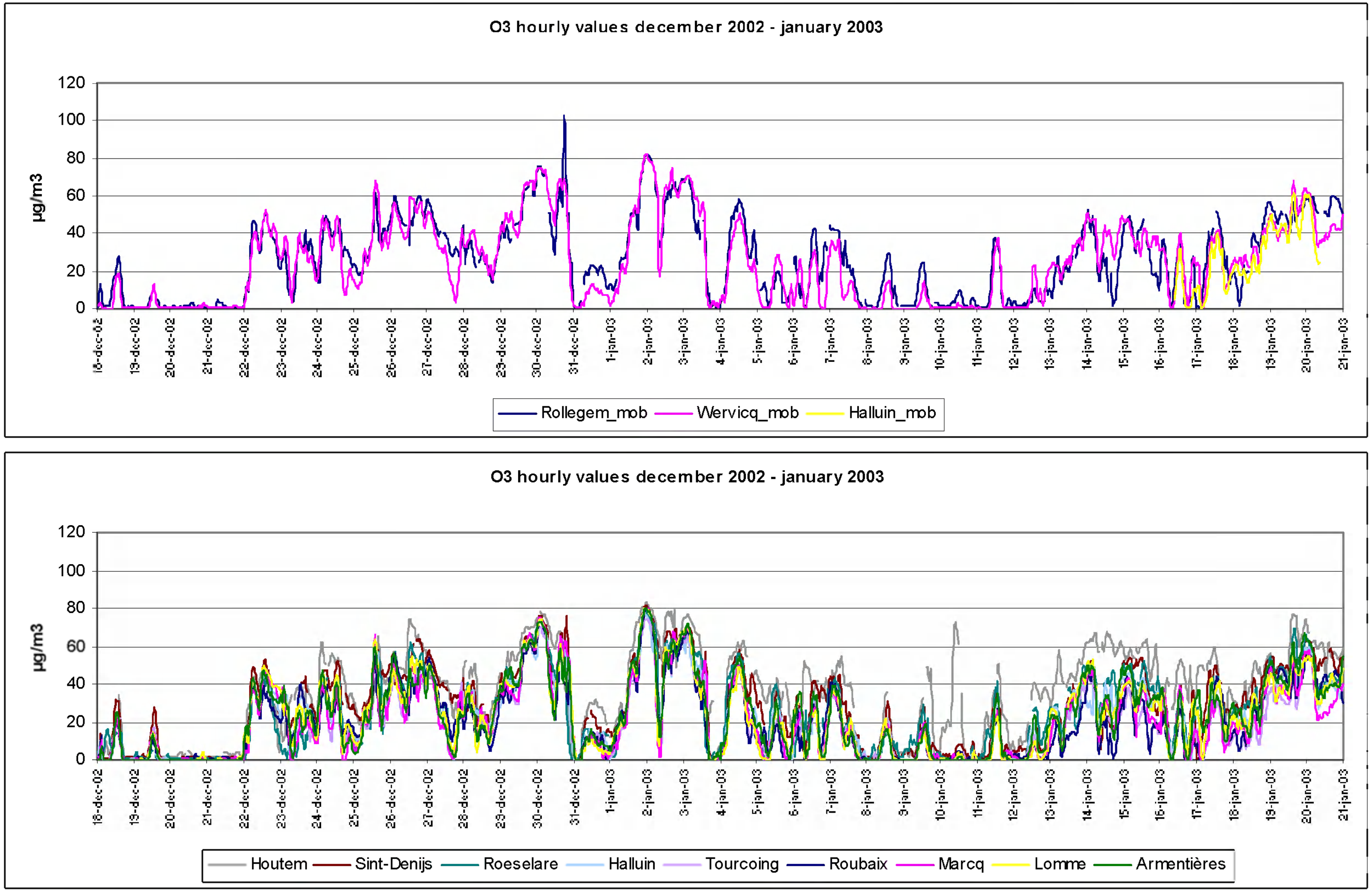
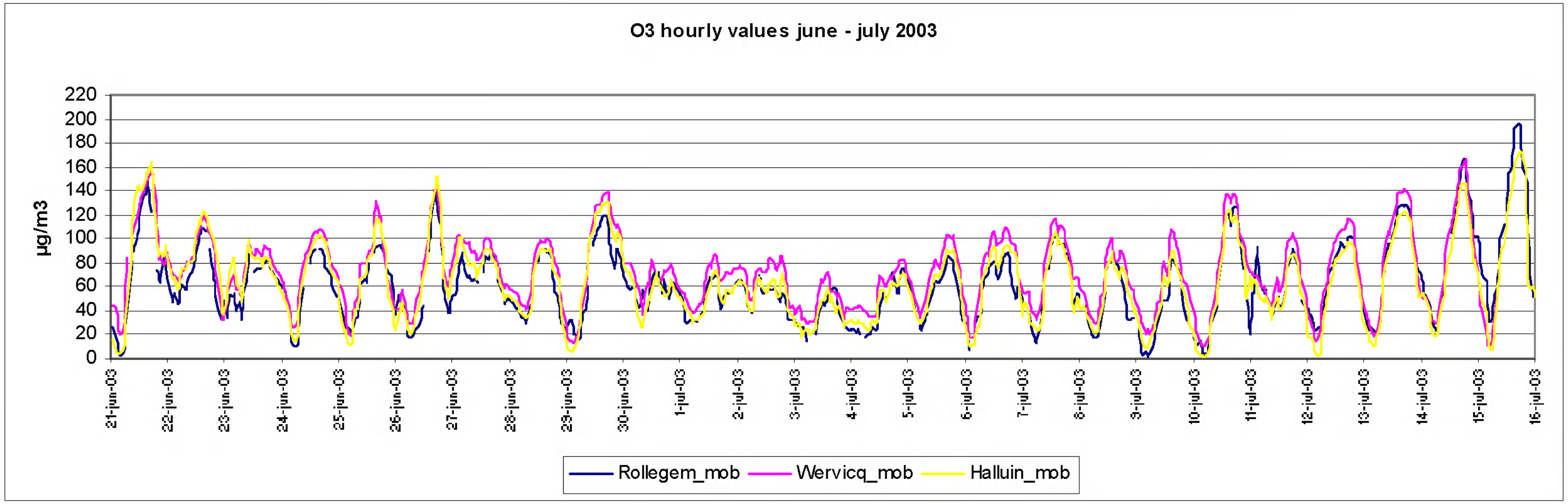


Figure P : O_3 hourly values



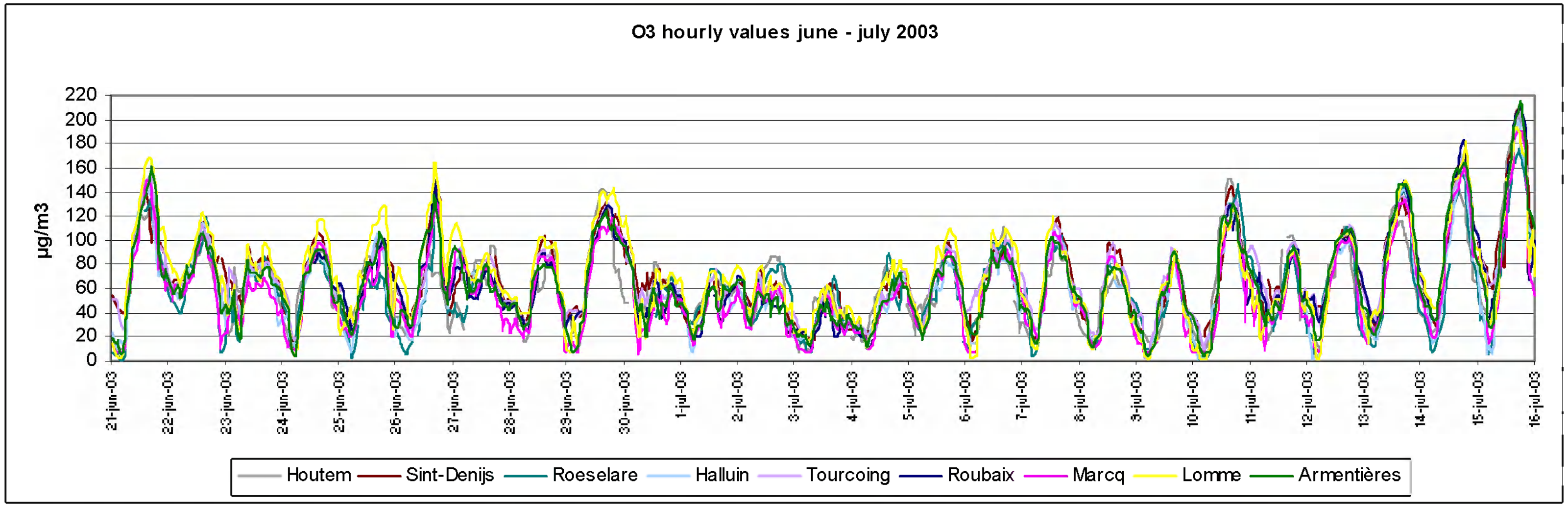
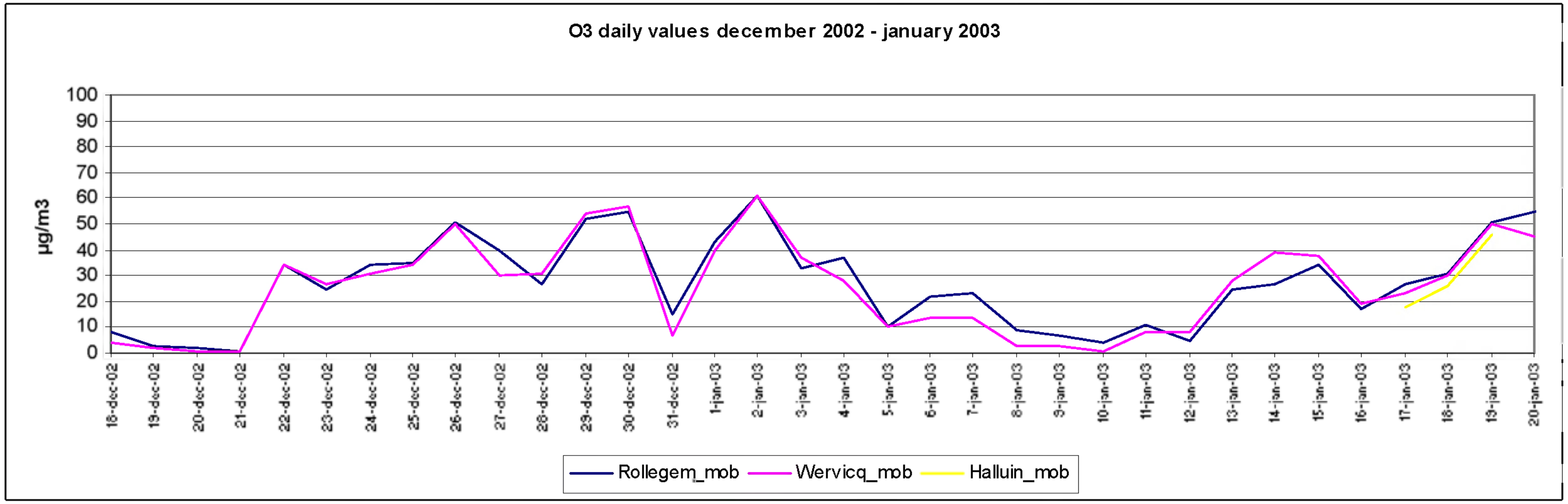


Figure P : O_3 hourly values (continued)



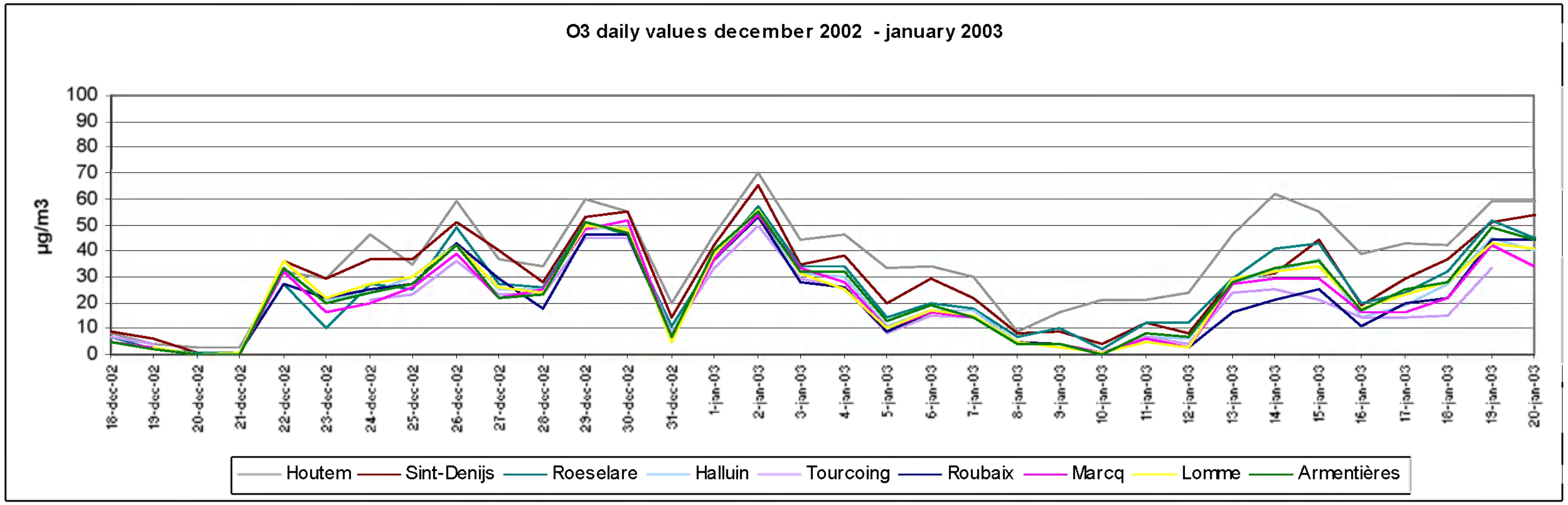
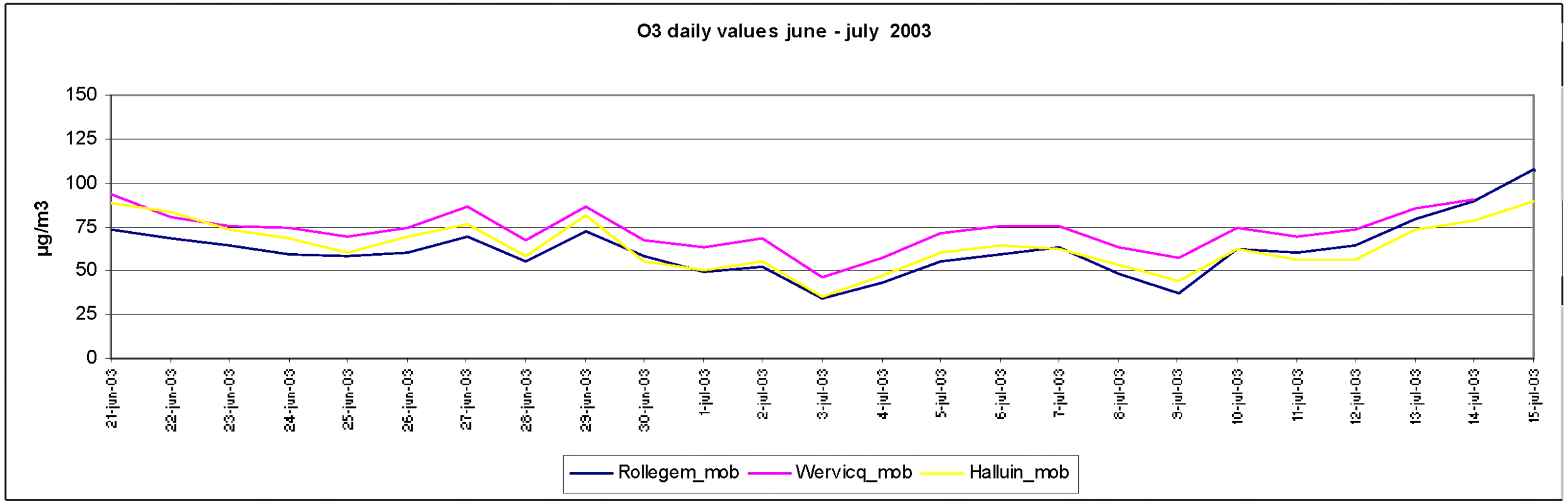


Figure Q : O_3 daily values



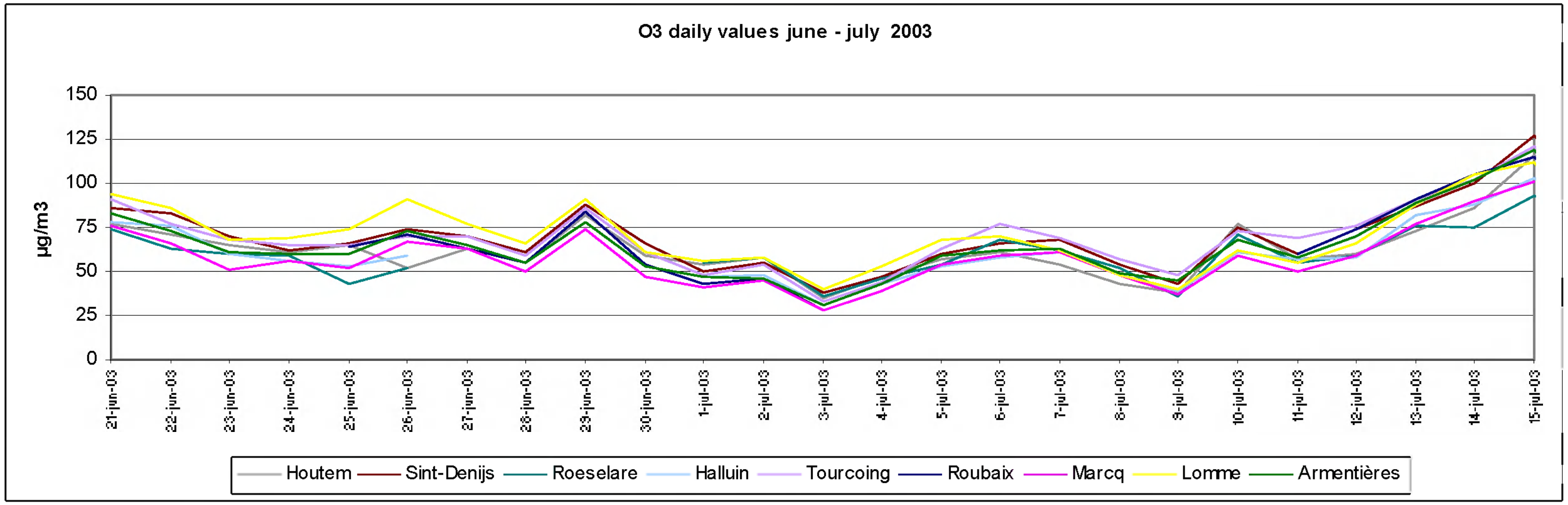


Figure Q : O_3 daily values (continued)

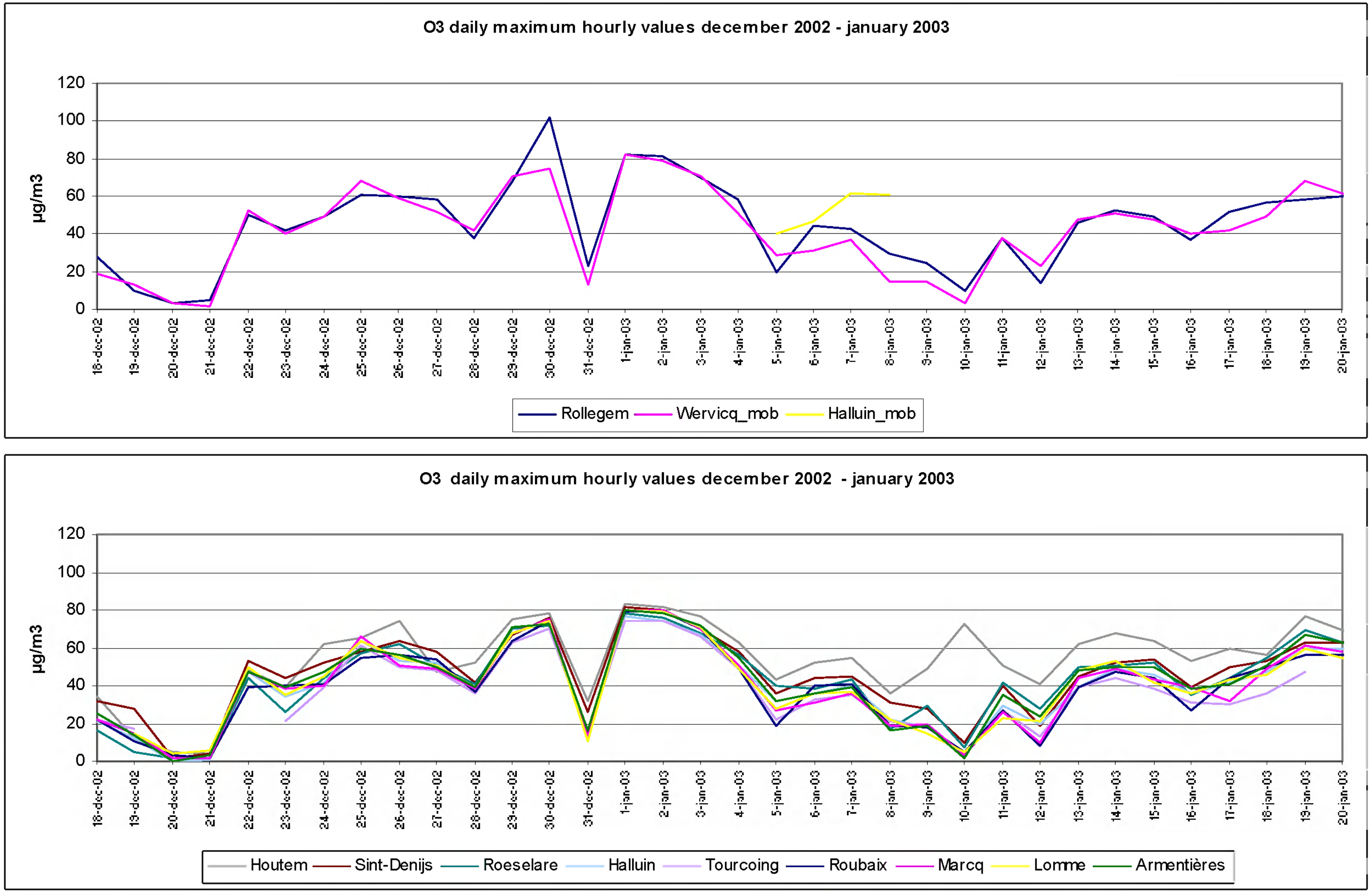
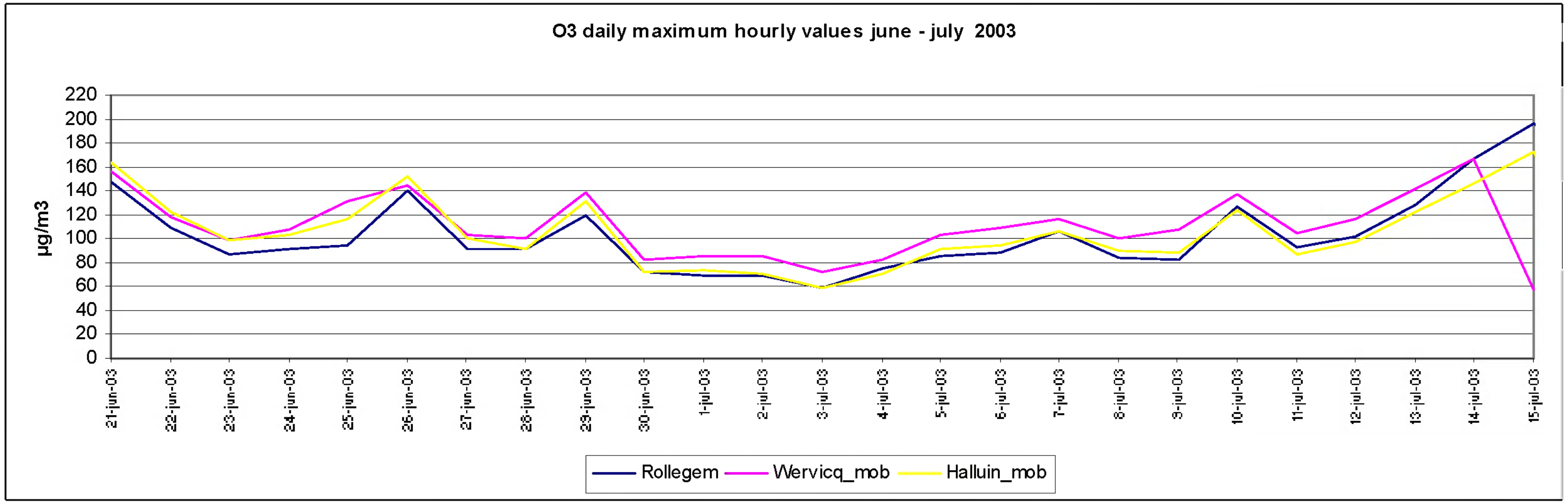


Figure R : O$_3$ daily maximum hourly values



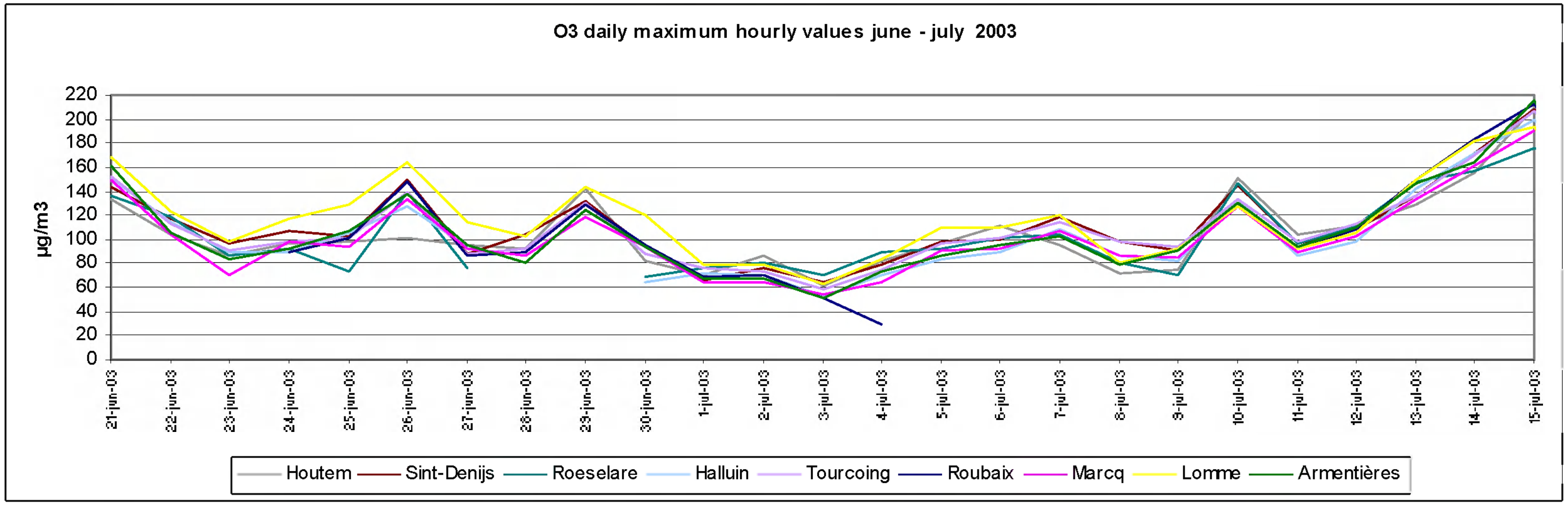


Figure R : O_3 daily maximum hourly values (continued)

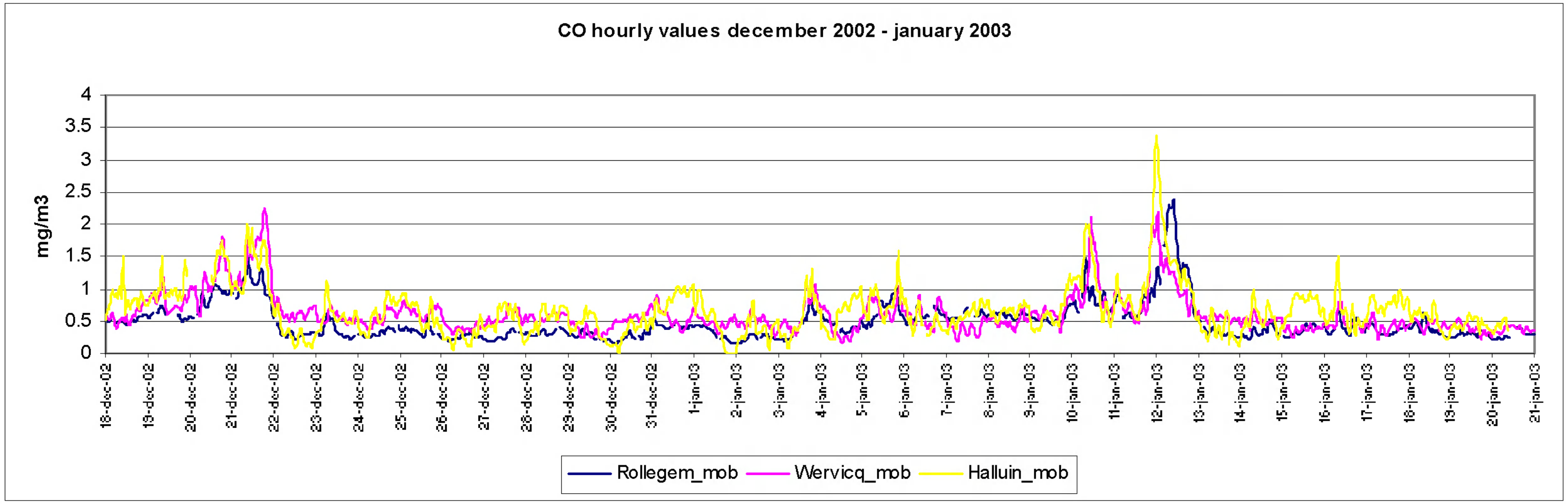


Figure S : CO hourly values

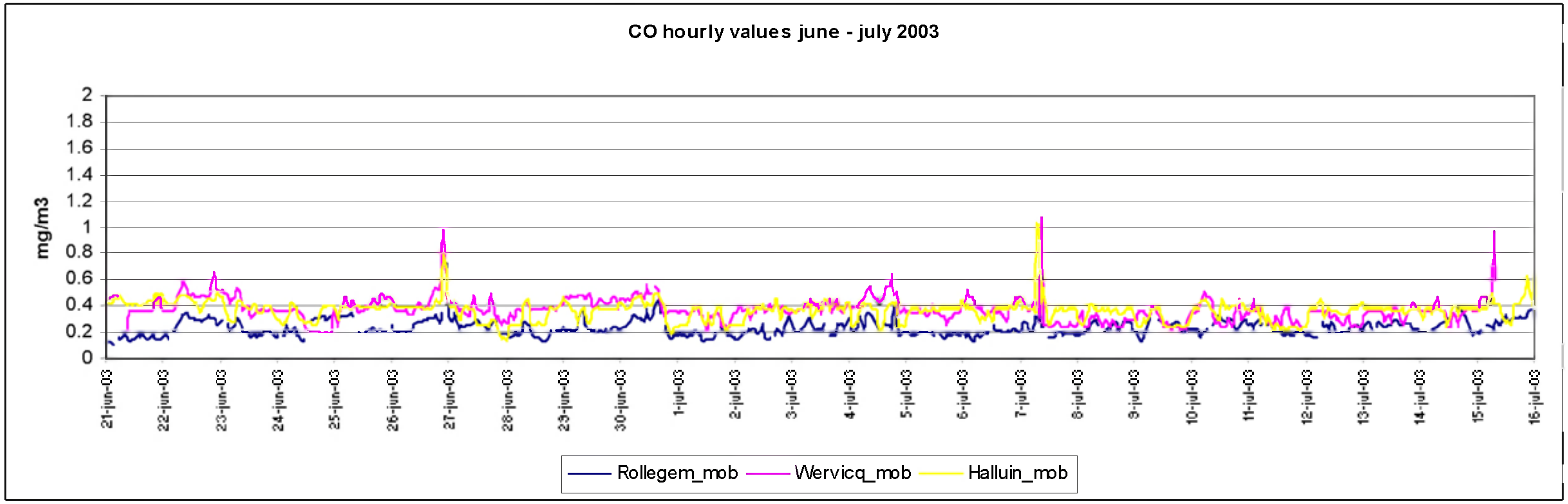


Figure S : CO hourly values (continued)

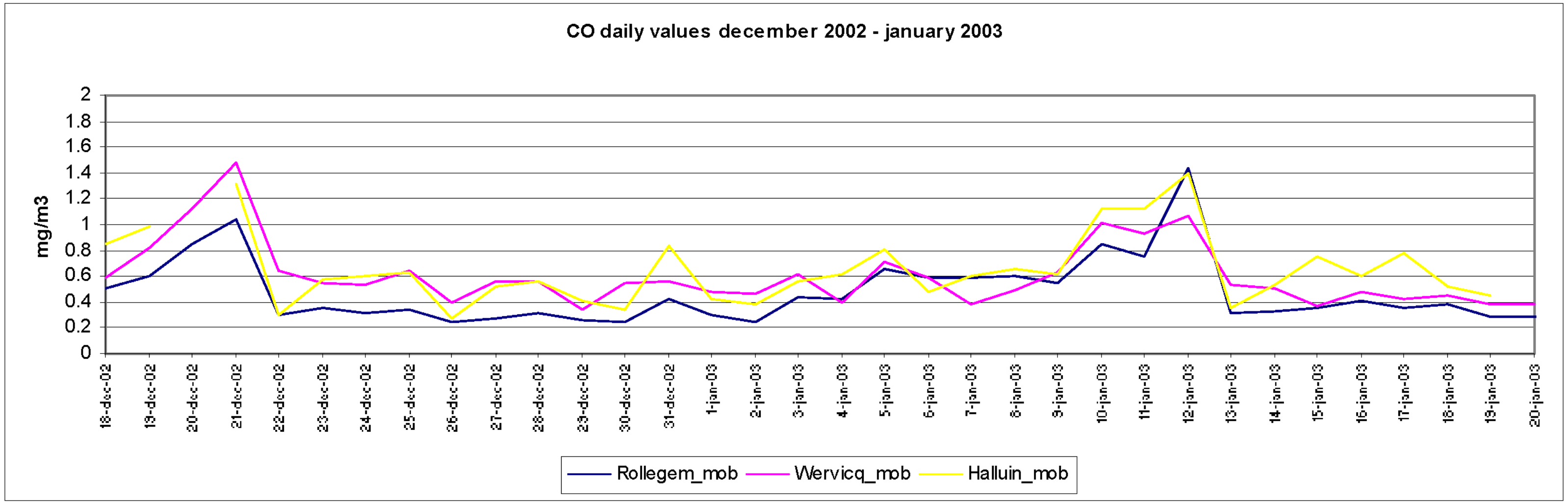


Figure T : CO daily values

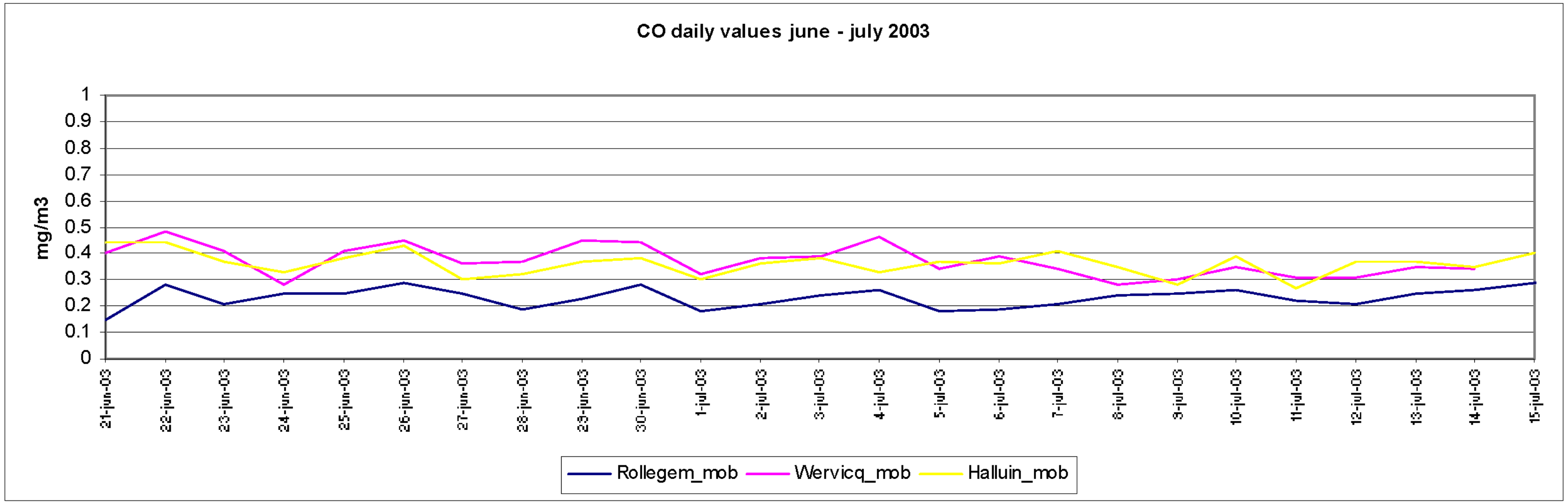


Figure T : CO daily values (continued)

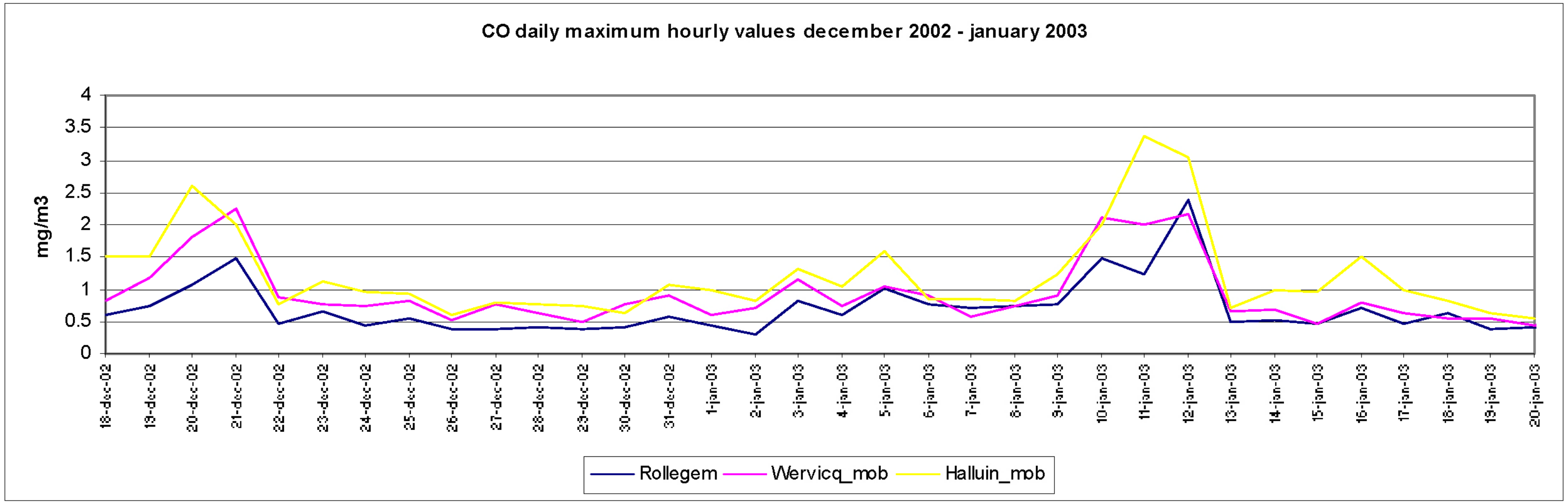


Figure U : CO daily maximum hourly values

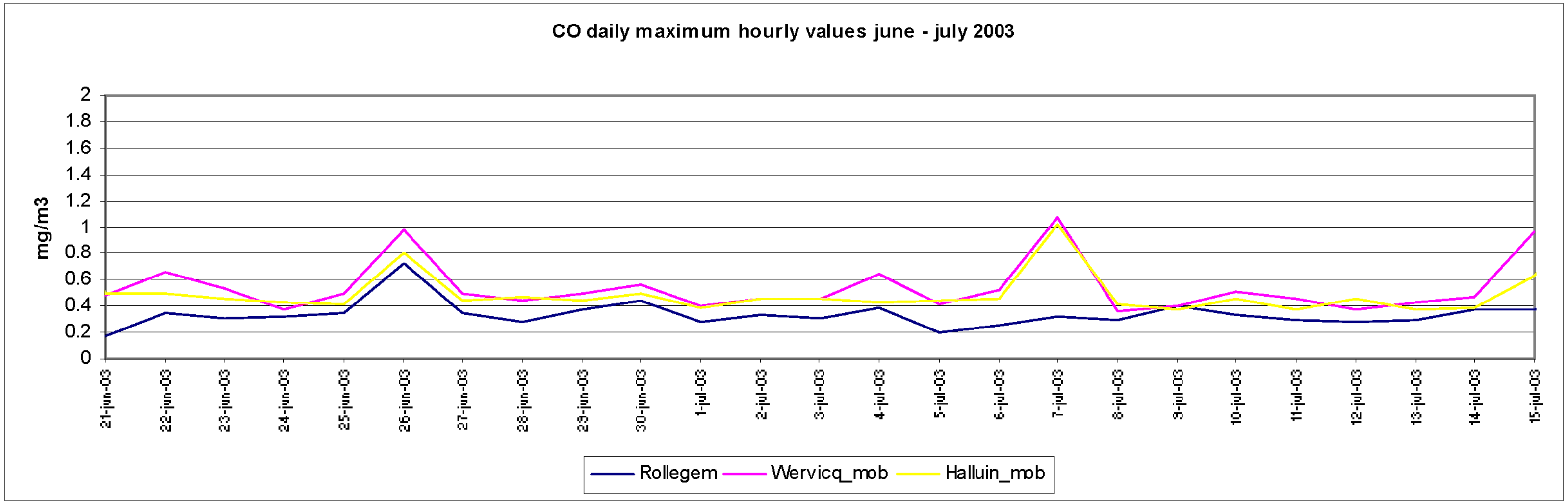
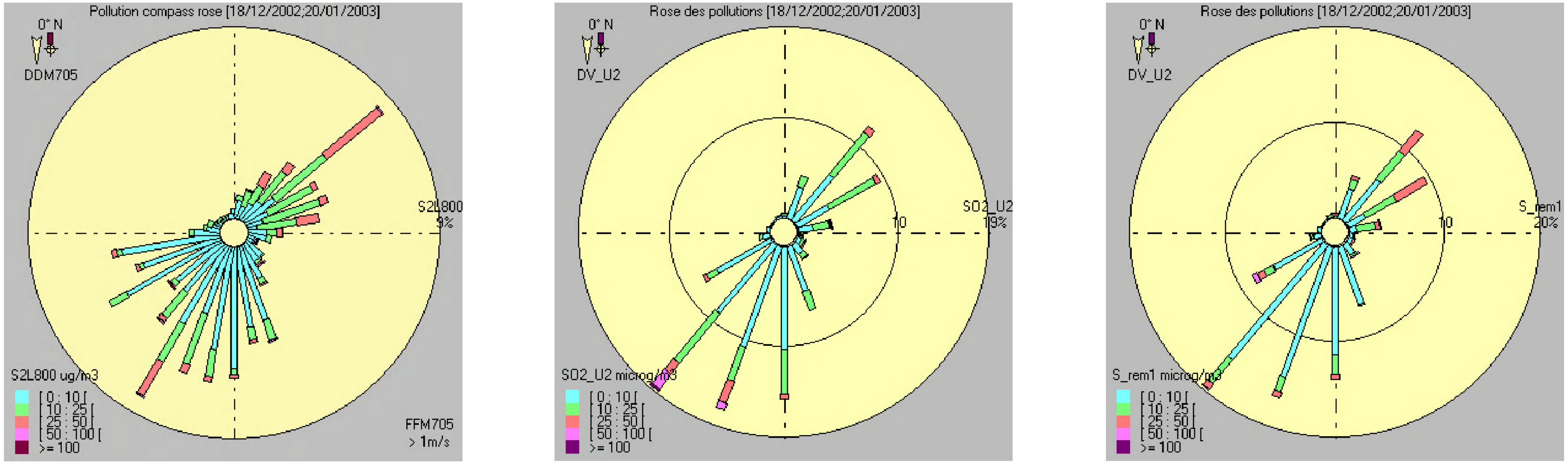
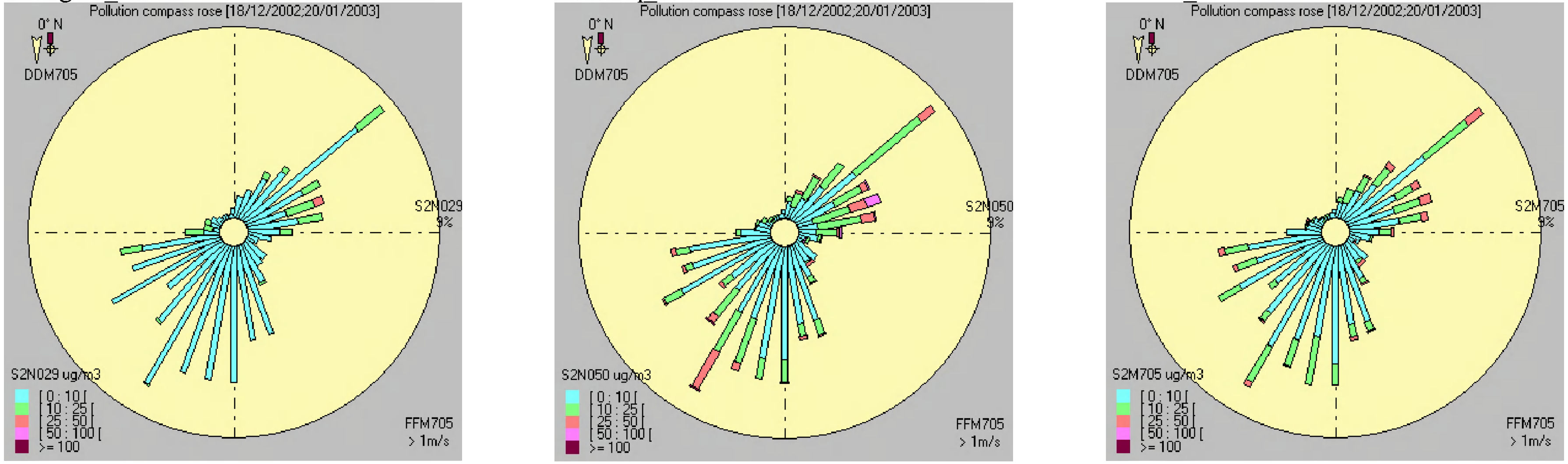


Figure U : CO daily maximum hourly values (continued)

Annex 2 : Pollution roses of the mobile laboratories and fixed stations in the studied area

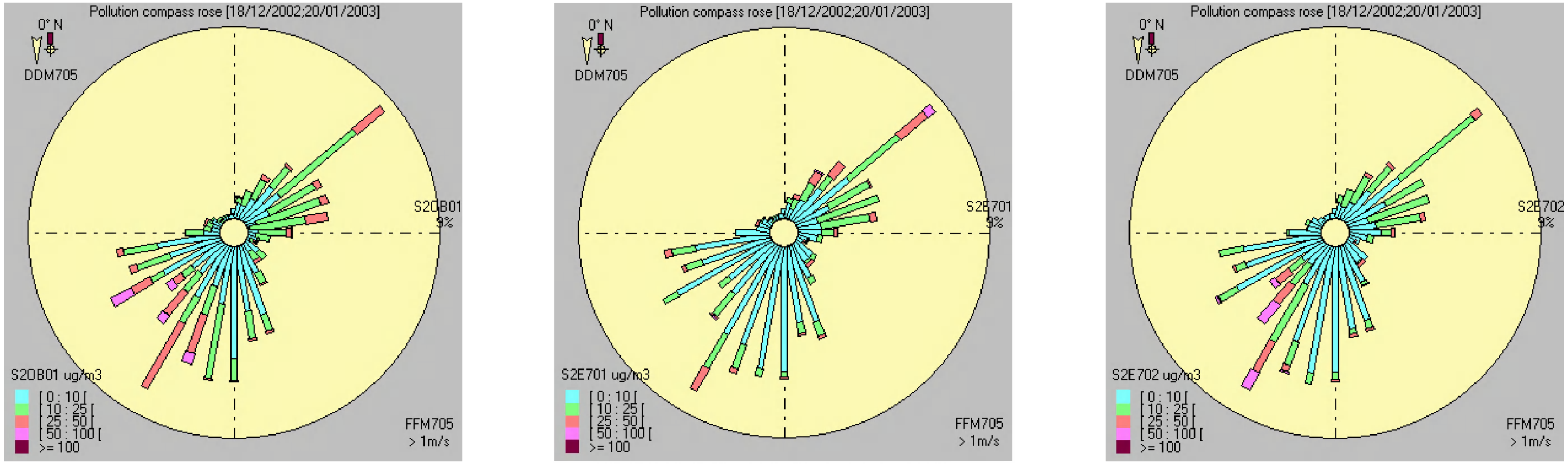


Rollegem_mob Wervicq_mob Halluin_mob

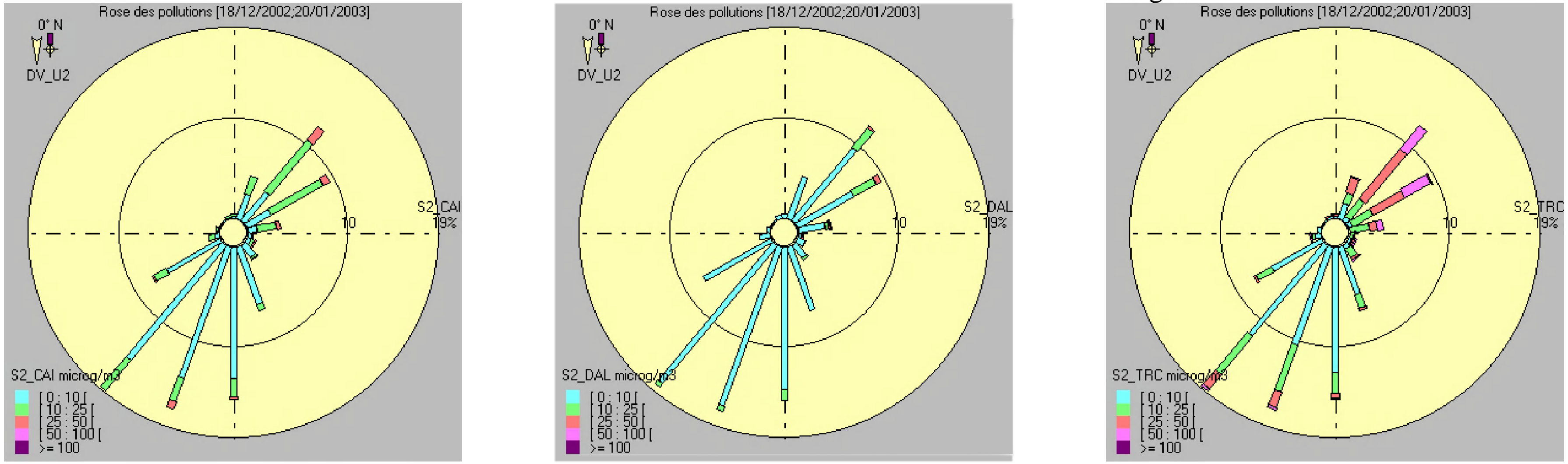


Houtem Sint-Denijs Roeselare

Figure A : SO2 pollution roses winter

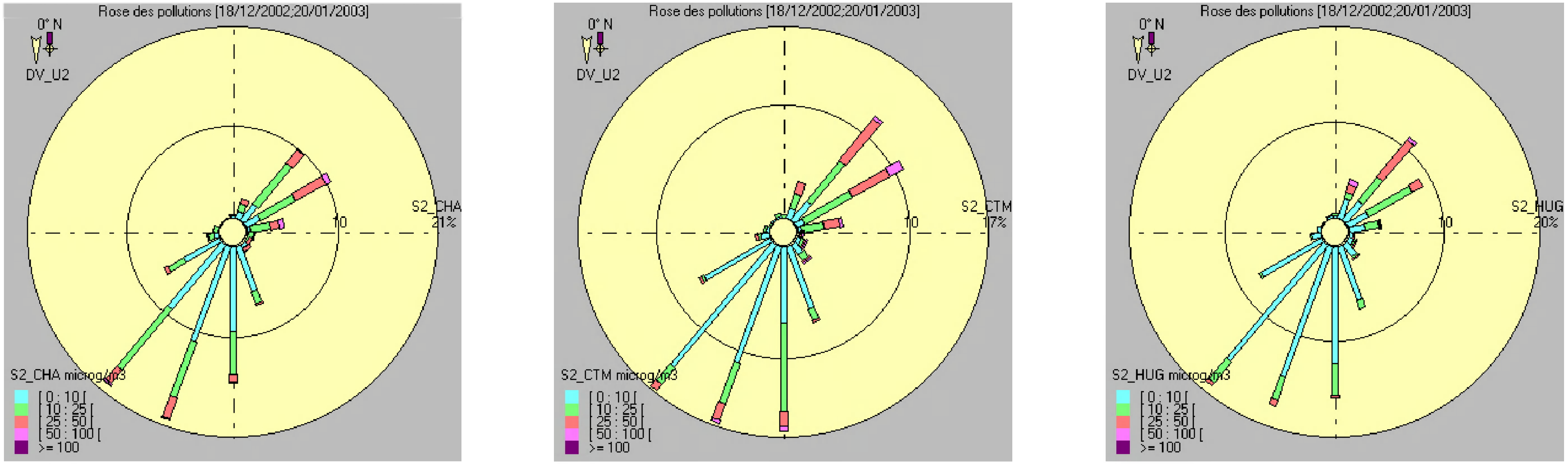


Oostrozebeke Vichte Elsegem



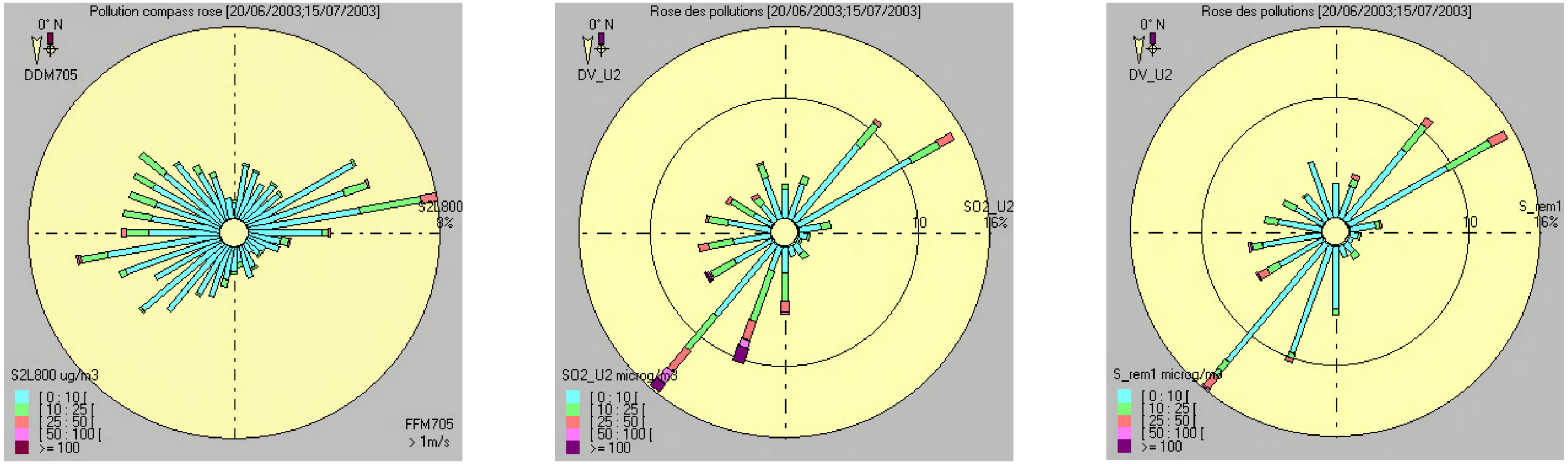
Halluin Wervicq Tourcoing

Figure A : SO2 pollution roses winter (continued)



Roubaix Marcq Lomme

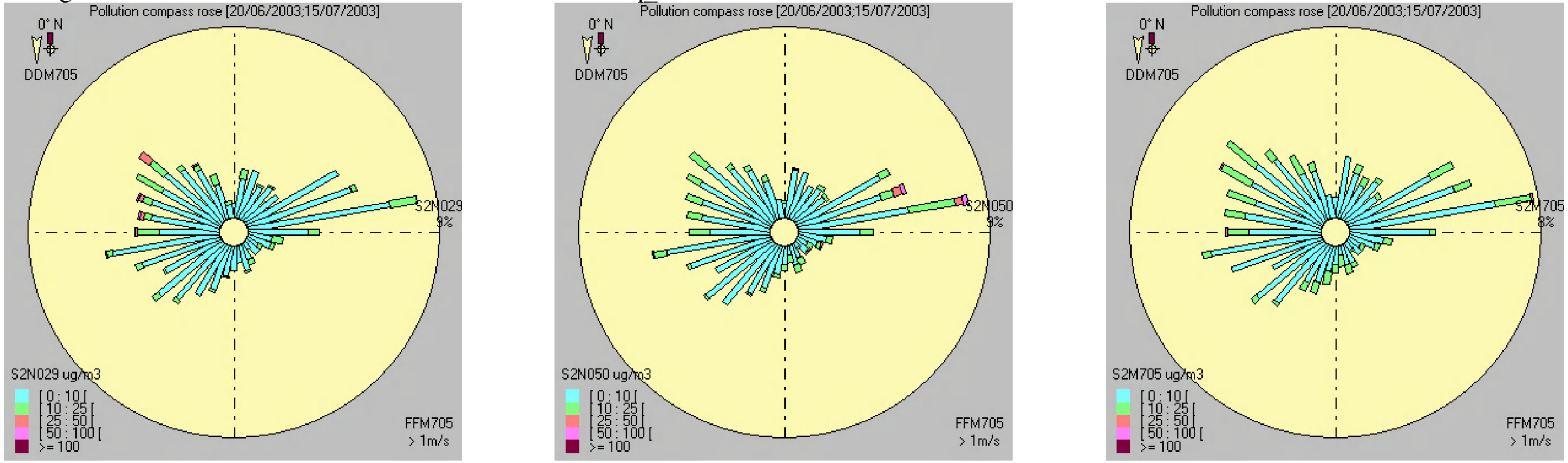
Figure A : SO2 pollution roses winter (continued)



Rollegem mob

Wervicq_mob

Halluin mob

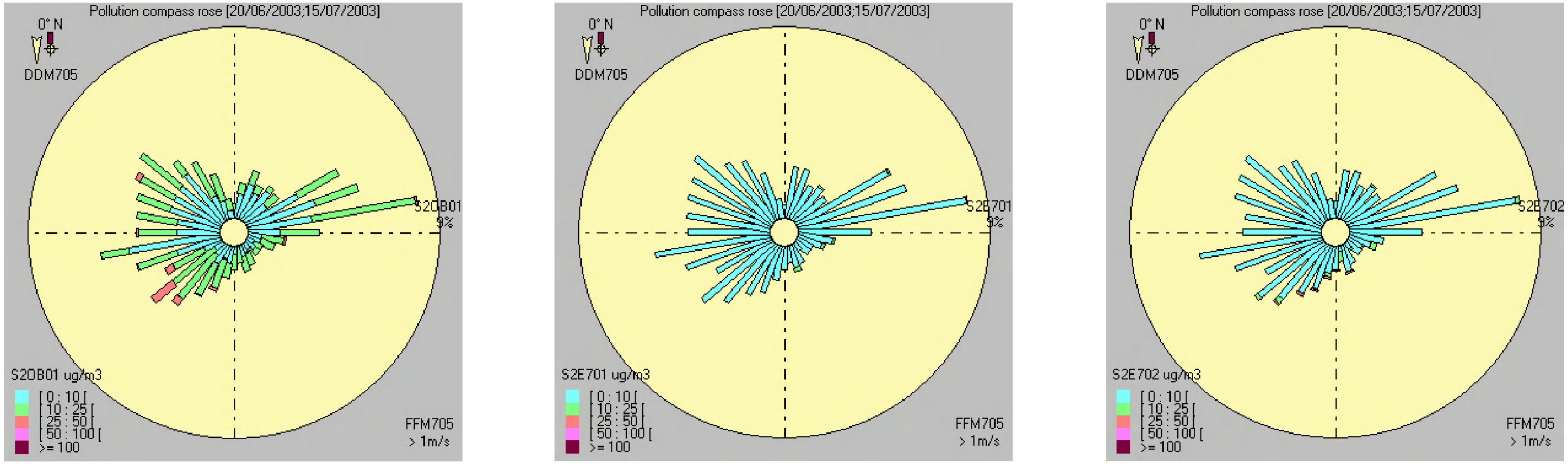


Houtem

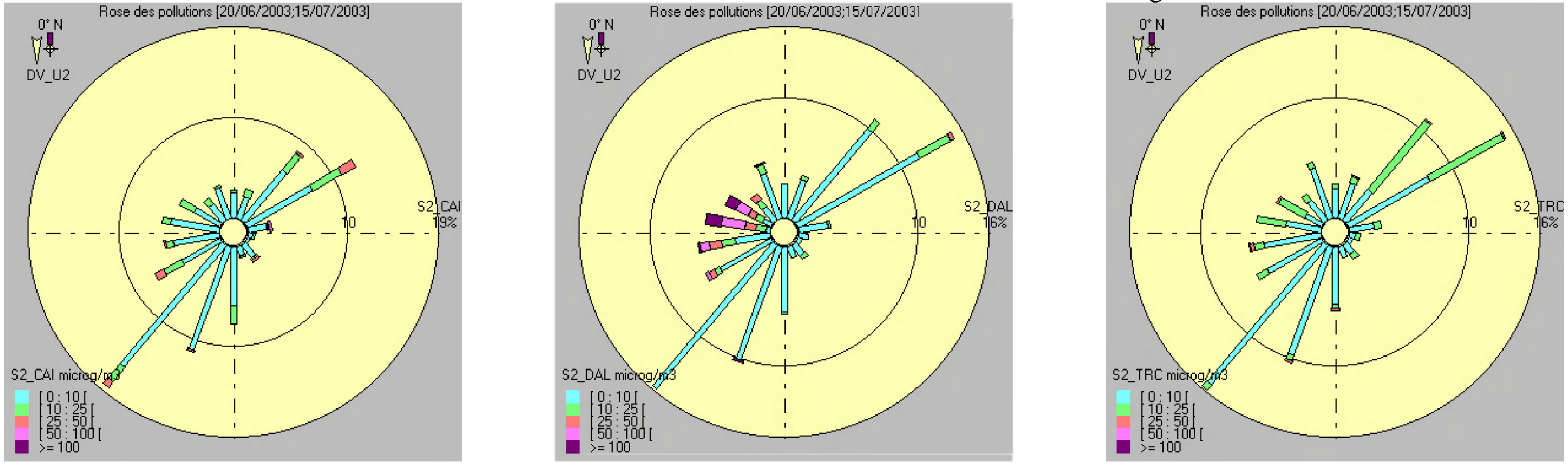
Sint-Denijs

Roeselare

Figure B : SO2 pollution roses summer

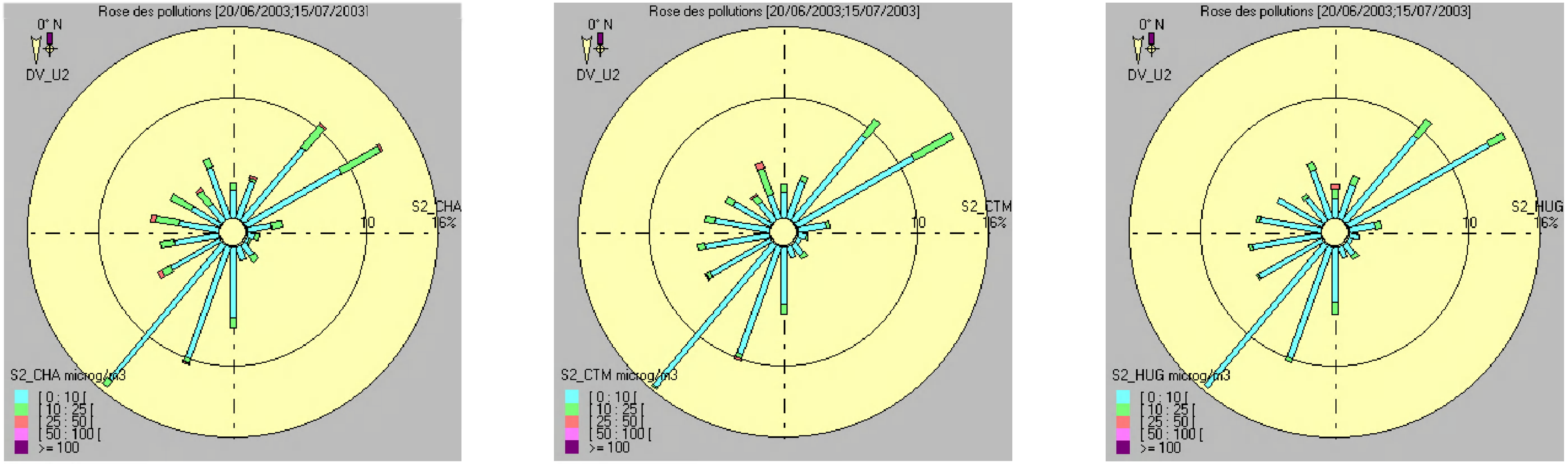


Oostrozebeke Vichte Elsegem



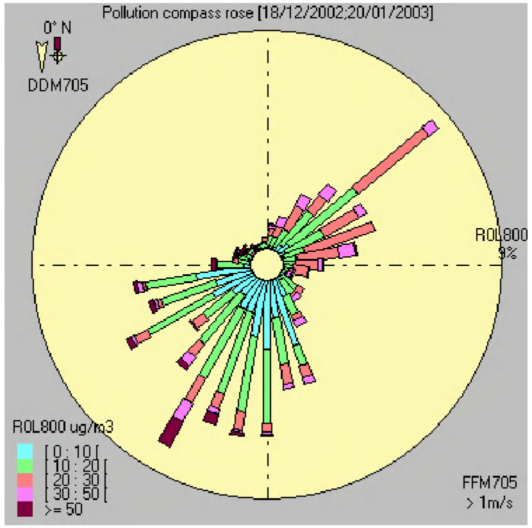
Halluin Wervicq Tourcoing

Figure B : SO2 pollution roses summer (continued)

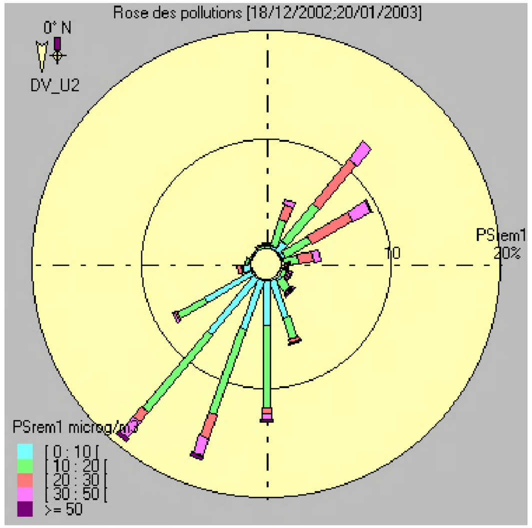


Roubaix Marcq Lomme

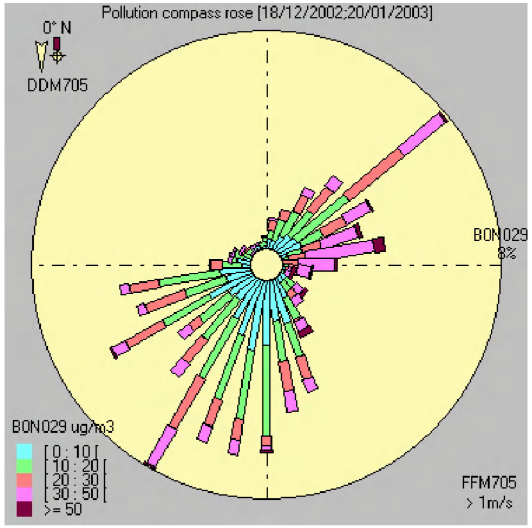
Figure B : SO2 pollution roses summer (continued)



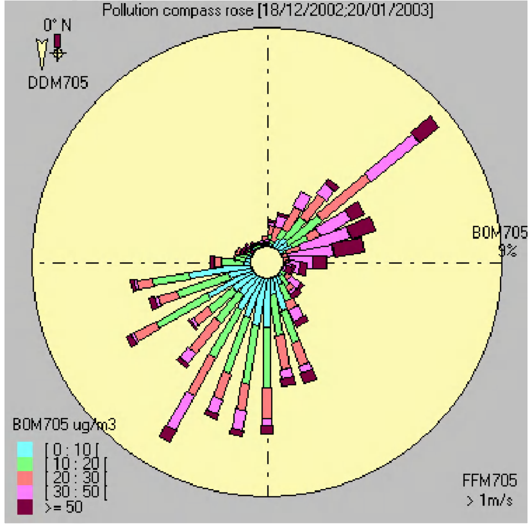
Rollegem



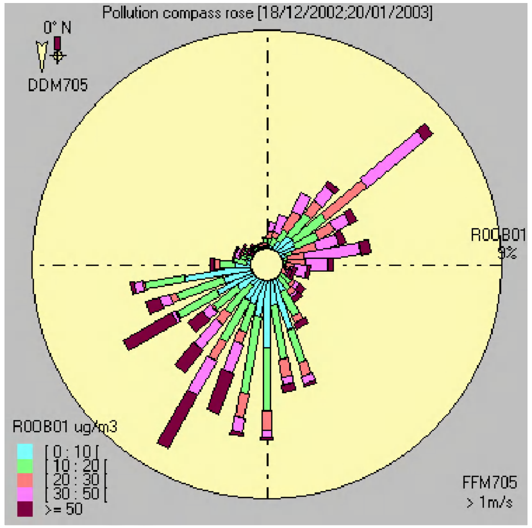
Halluin mob



Houtem



Roeselare

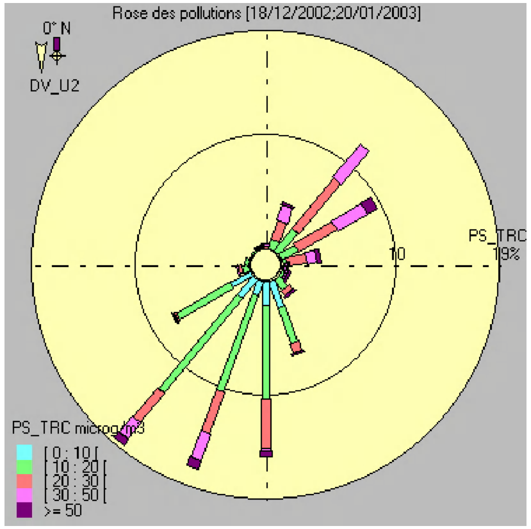


Oostrozebeke

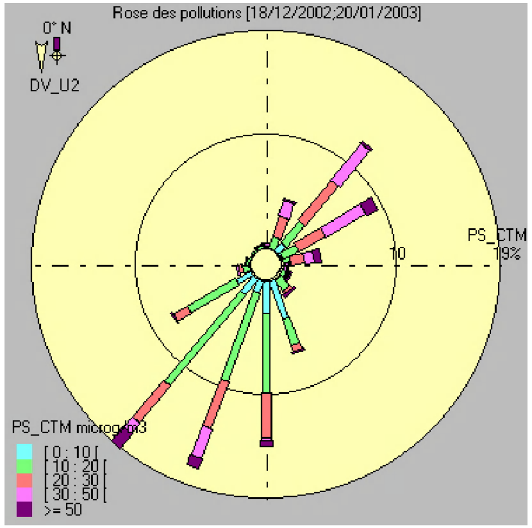
Menen

Figure C : PM10 pollution roses winter

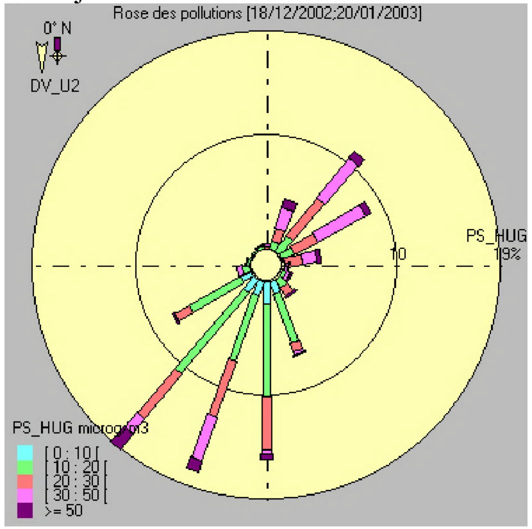
Kortrijk



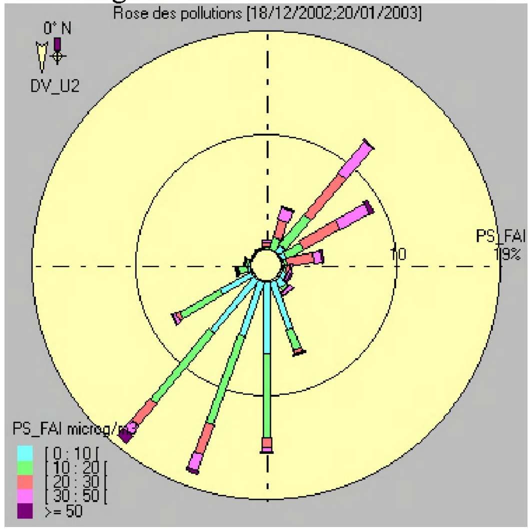
Tourcoing



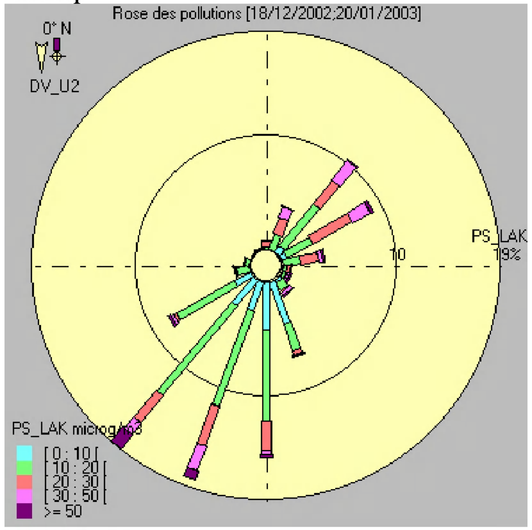
Marcq



Lomme

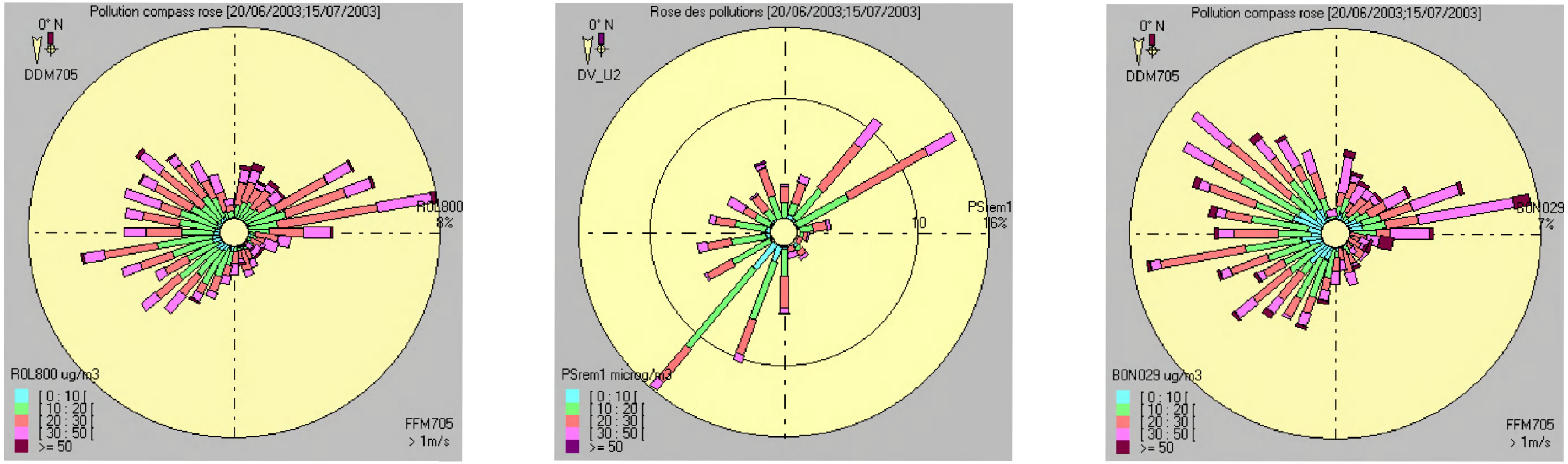


Lille Faidherbe

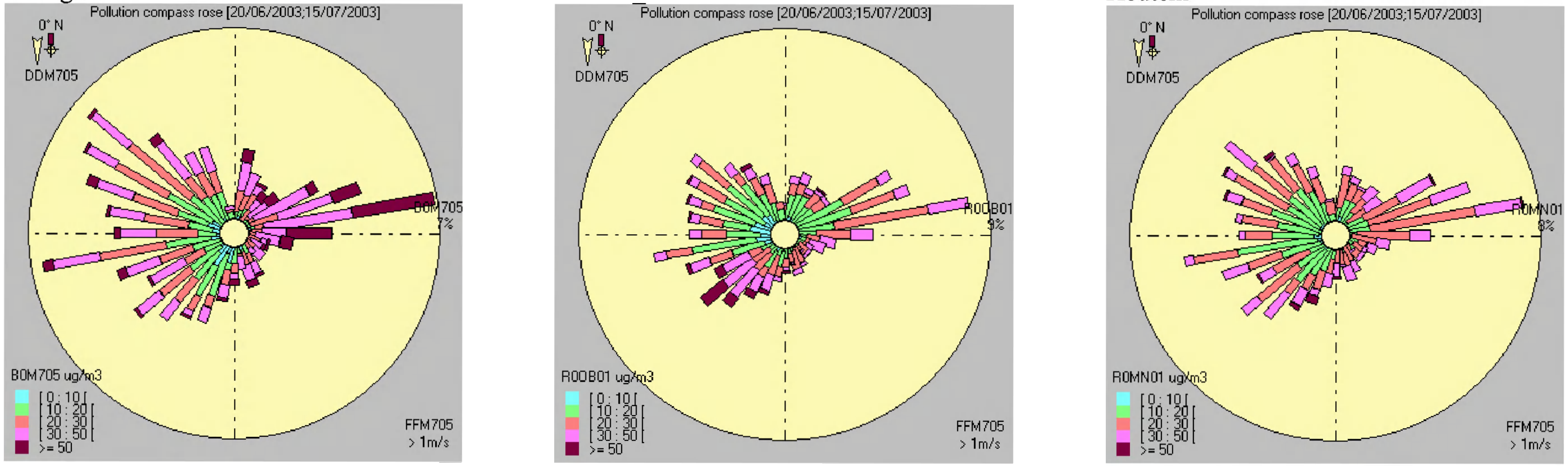


Lille Fives

Figure C : PM10 pollution roses winter (continued)

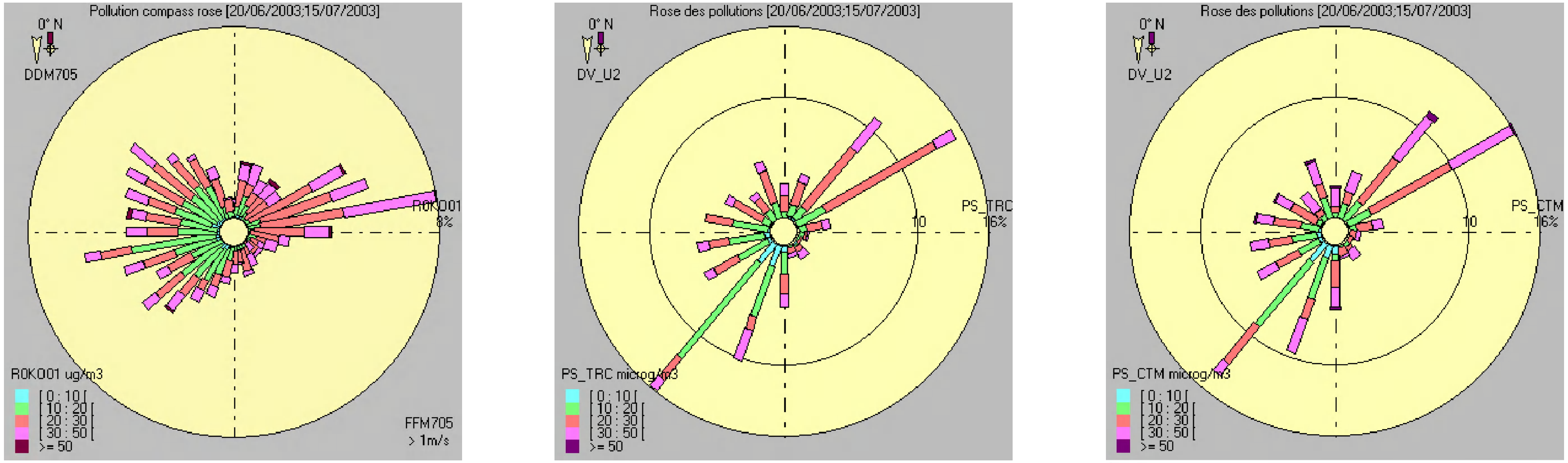


Rollegem Halluin_mob Houtem

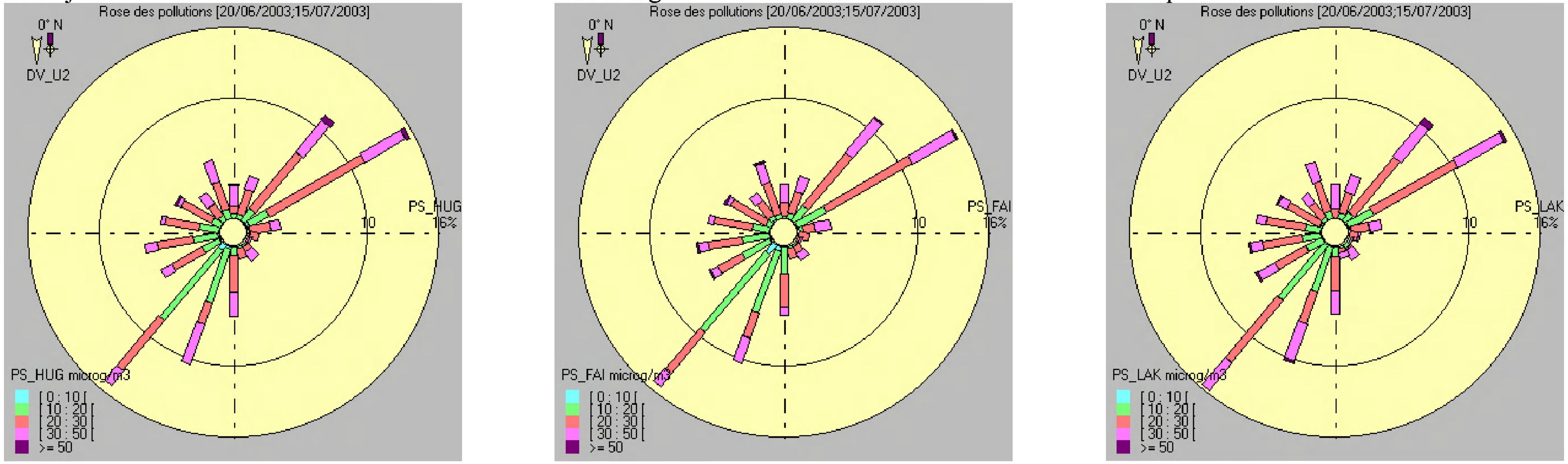


Roeselare Oostrozebeke Menen

Figure D : PM10 pollution roses summer

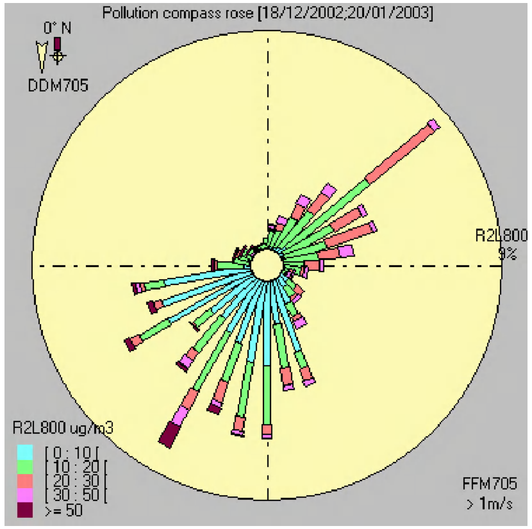


Kortrijk Tourcoing Marcq

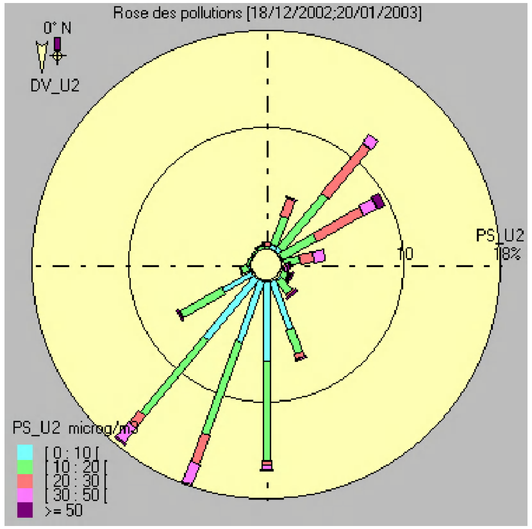


Lomme Lille Faidherbe Lille Fives

Figure D : PM10 pollution roses summer (continued)

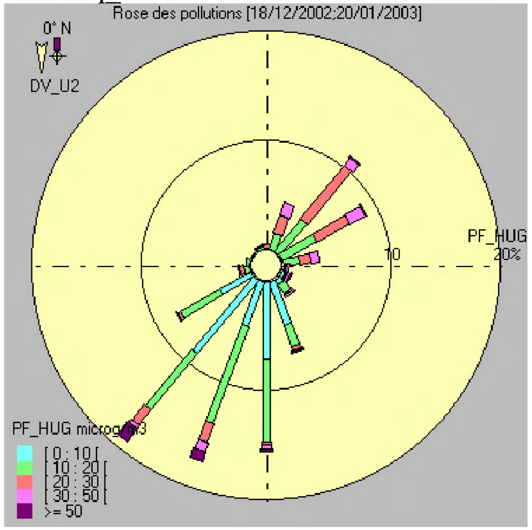


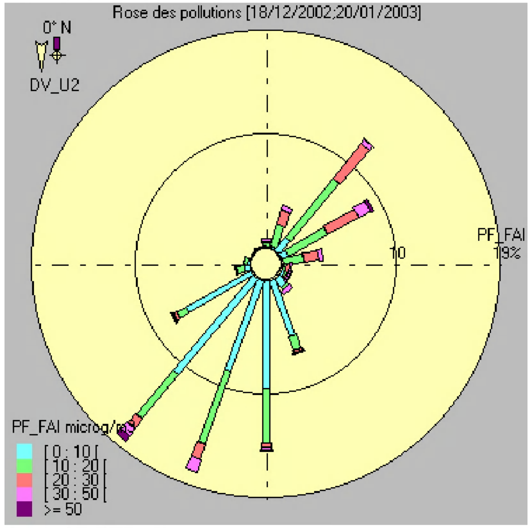
Rollegem_mob



Wervicq_mob

Menen



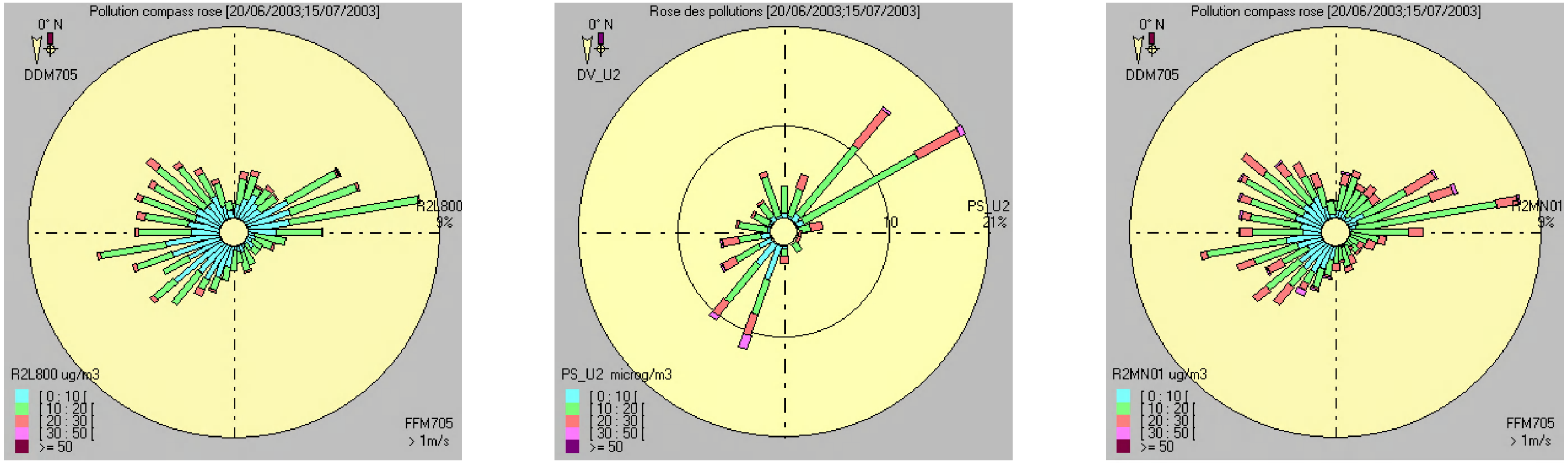


Kortrijk

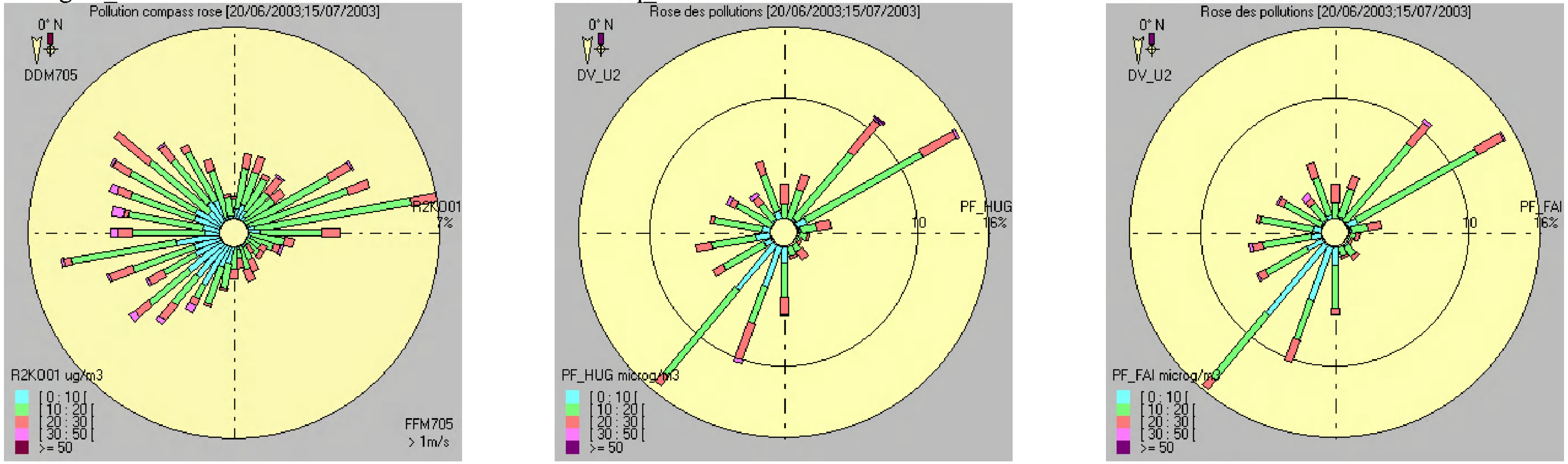
Lomme

Lille Faidherbe

Figure E : PM2,5 pollution roses winter

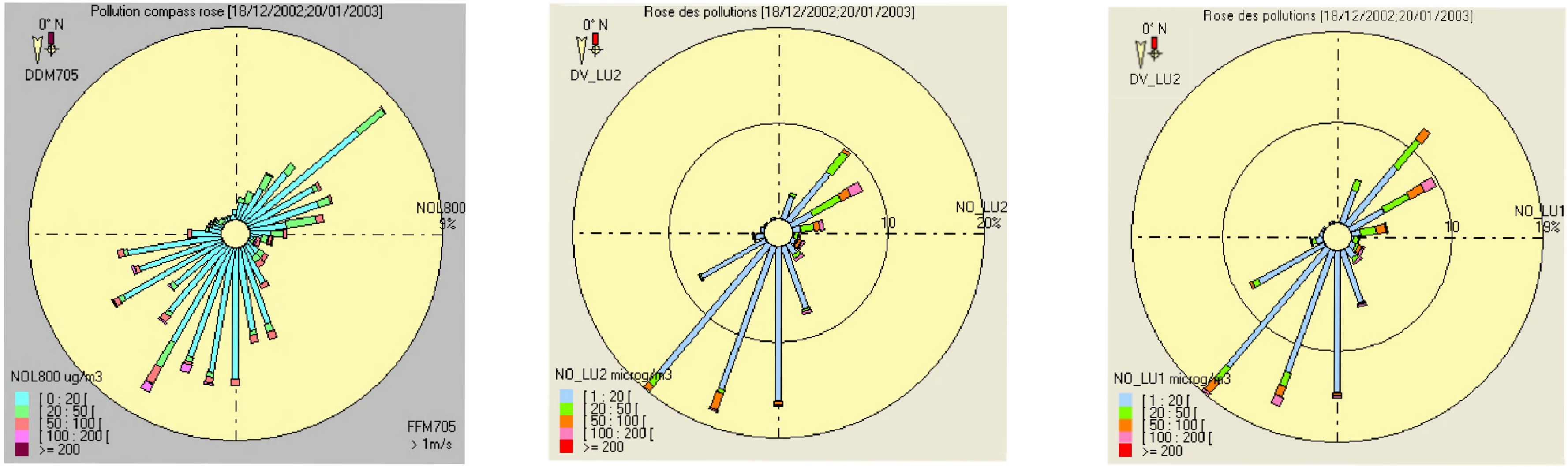


Rollegem_mob Wervicq_mob Menen

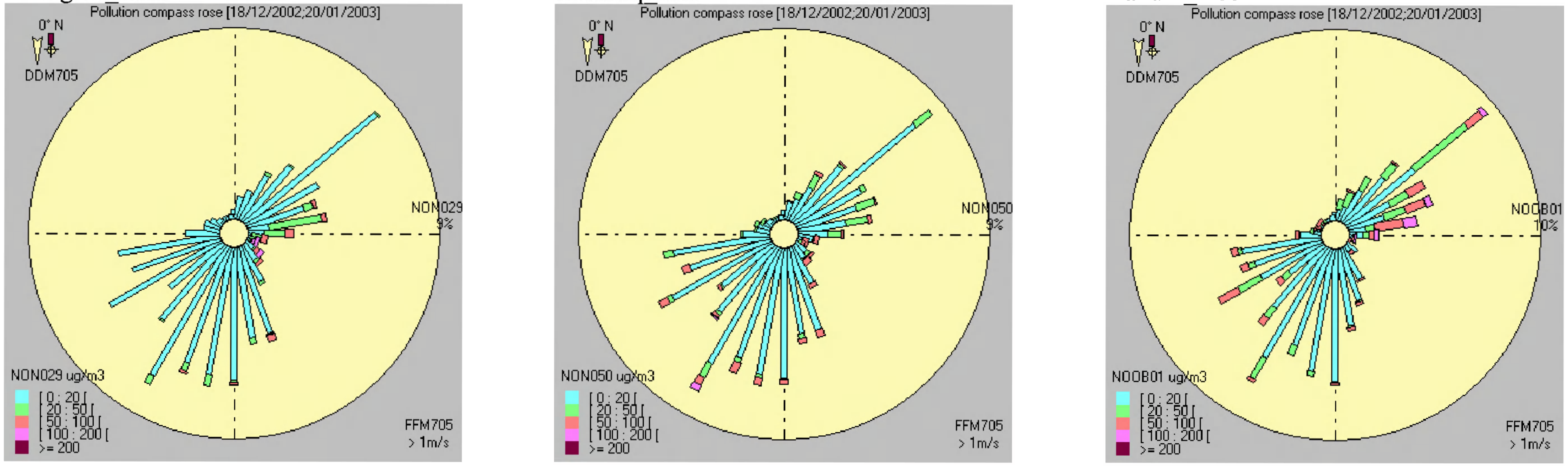


Kortrijk Lomme Lille Faidherbe

Figure F : PM2,5 pollution roses summer

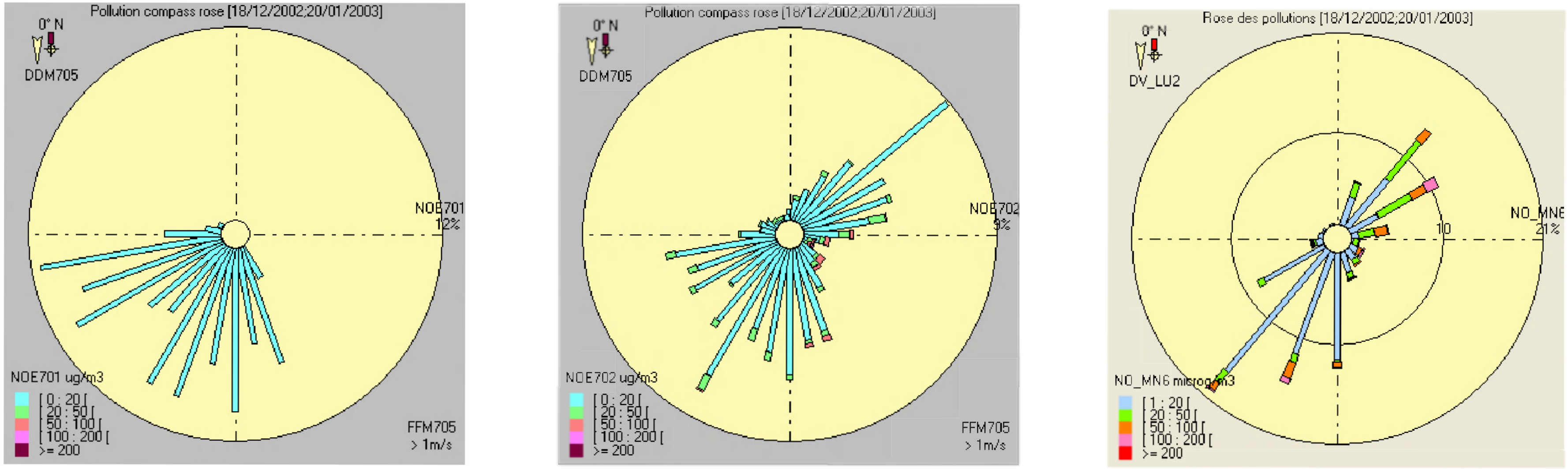


Rollegem_mob Wervicq_mob Halluin_mob

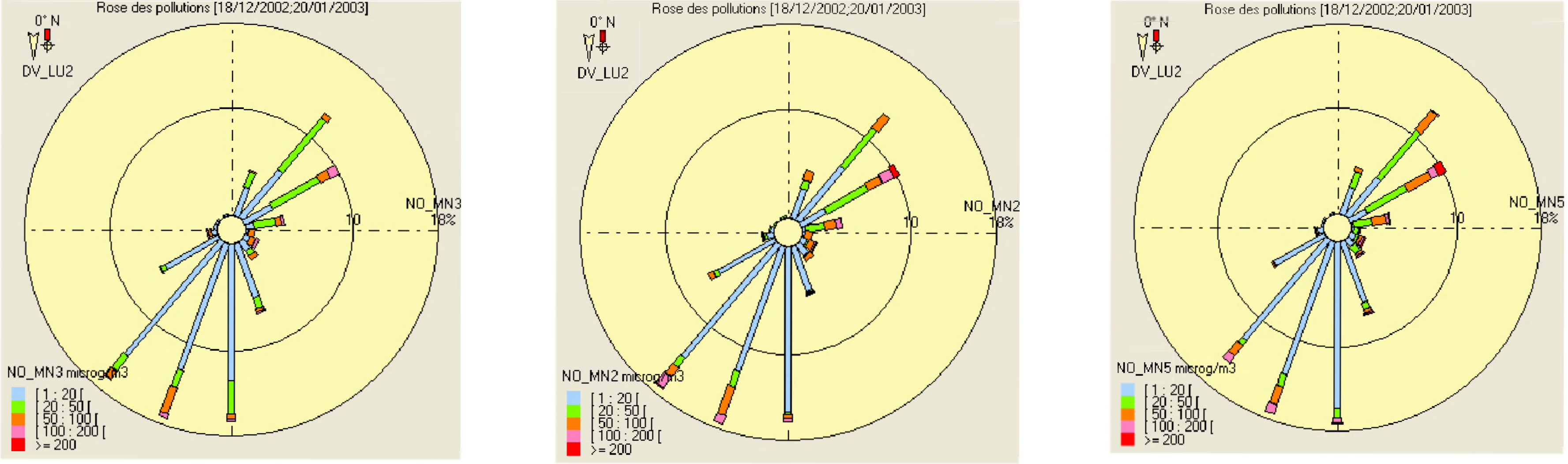


Houtem Sint-Denijs Oostrozebeke

Figure G : NO pollution roses winter

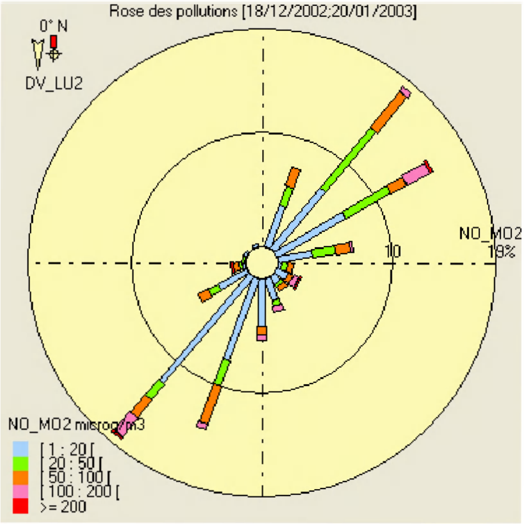


Vichte Elsegem Halluin



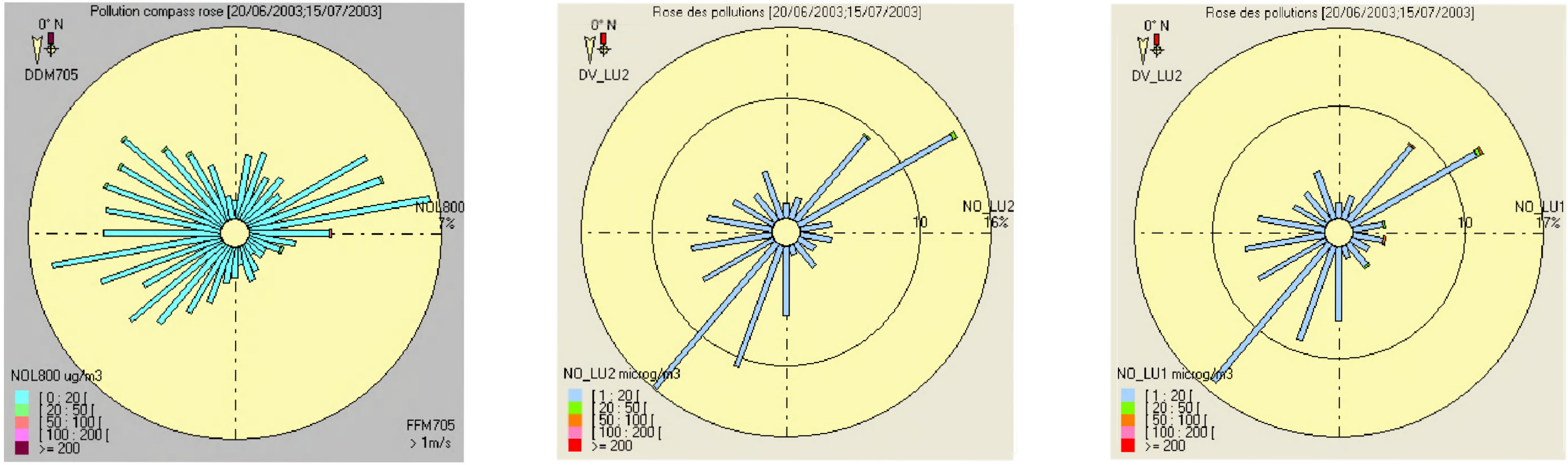
Tourcoing Roubaix Marcq

Figure G : NO pollution roses winter (continued)

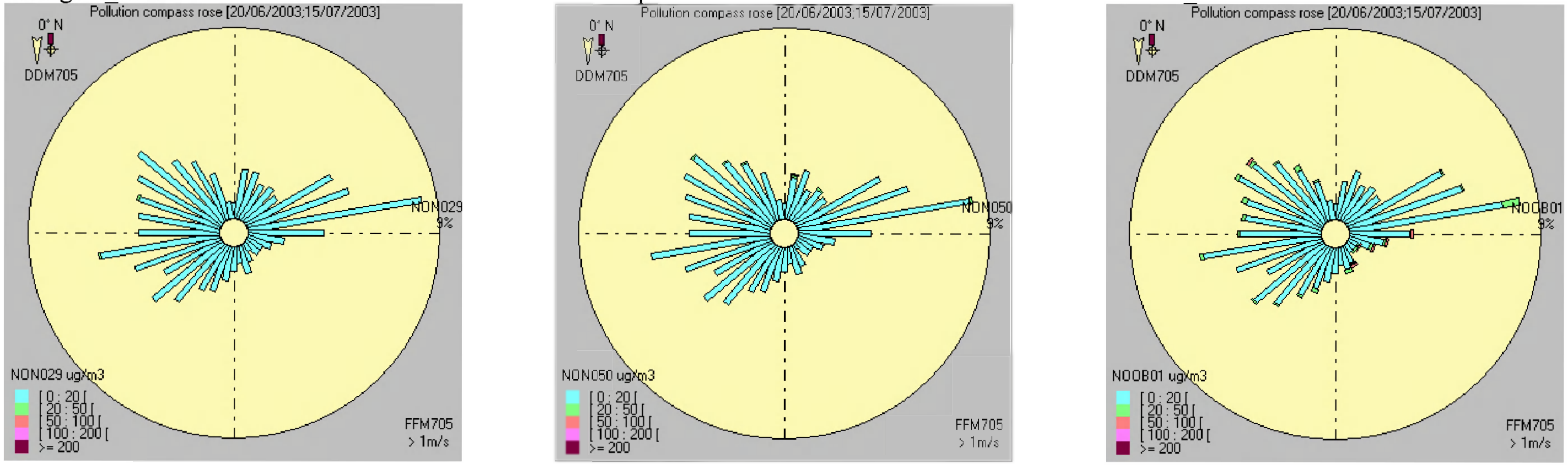


Lomme

Figure G : NO pollution roses winter (continued)

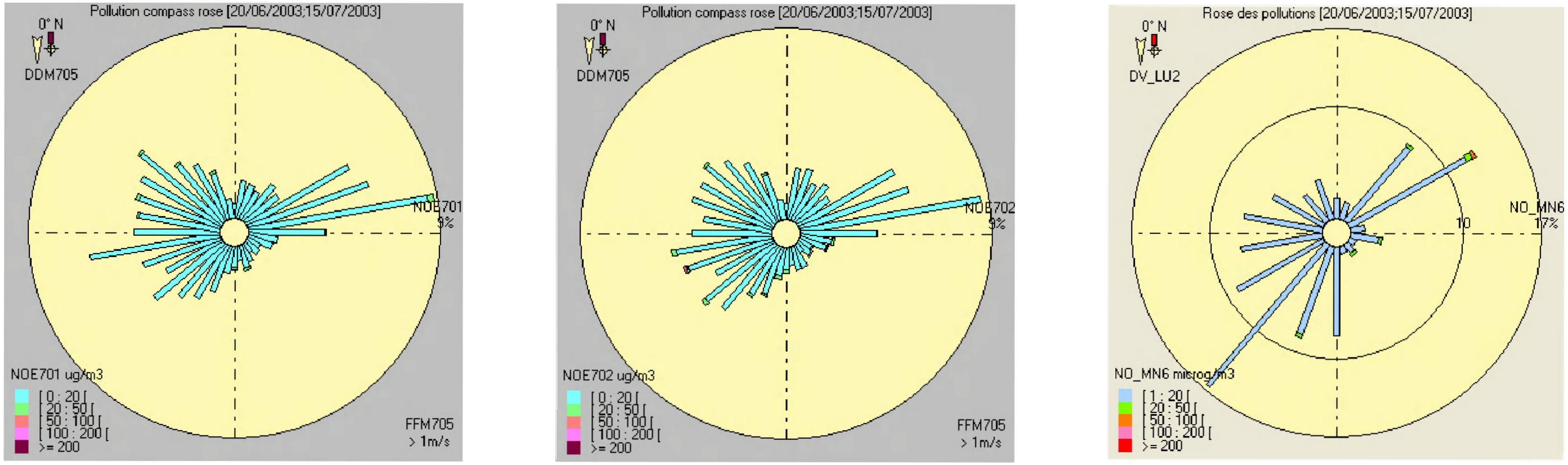


Rollegem_mob Wervicq_mob Halluin_mob

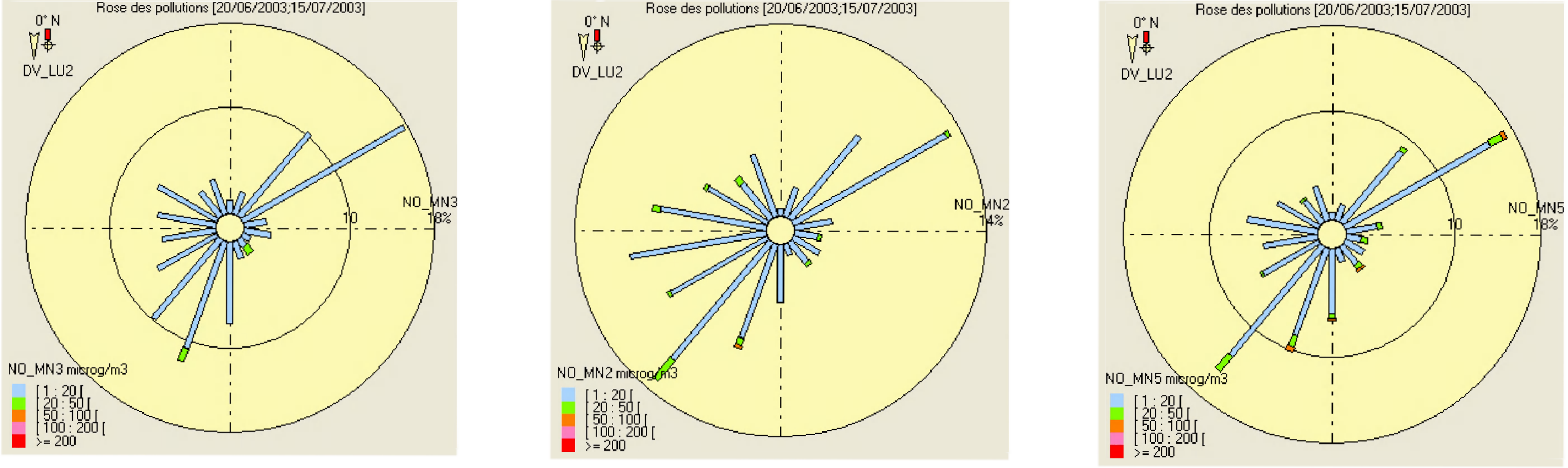


Houtem Sint-Denijs Oostrozebeke

Figure H : NO pollution roses summer

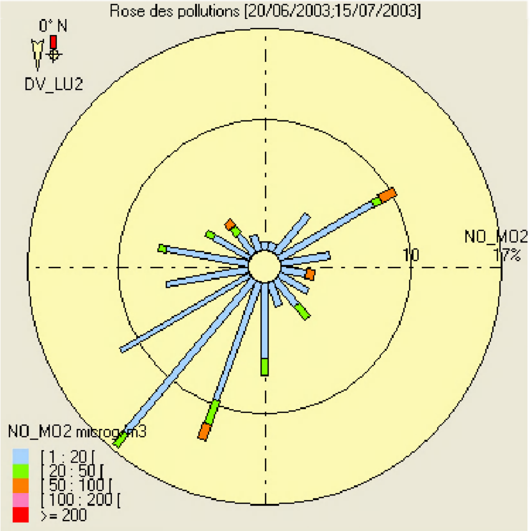


Vichte Elsegem Halluin



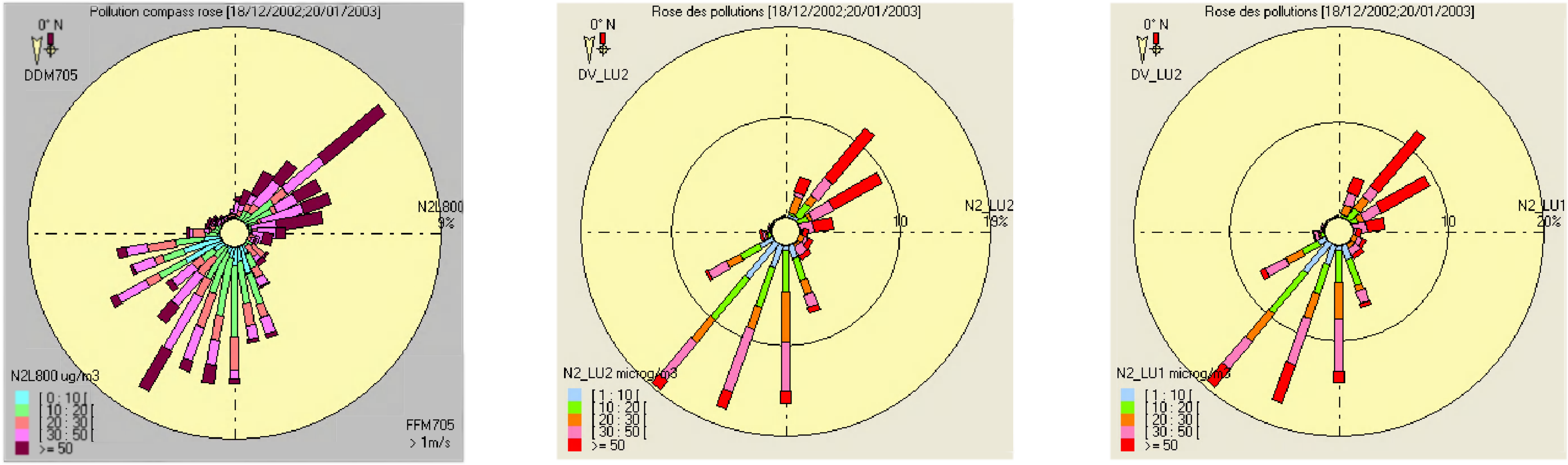
Tourcoing Roubaix Marcq

Figure H : NO pollution roses summer (continued)

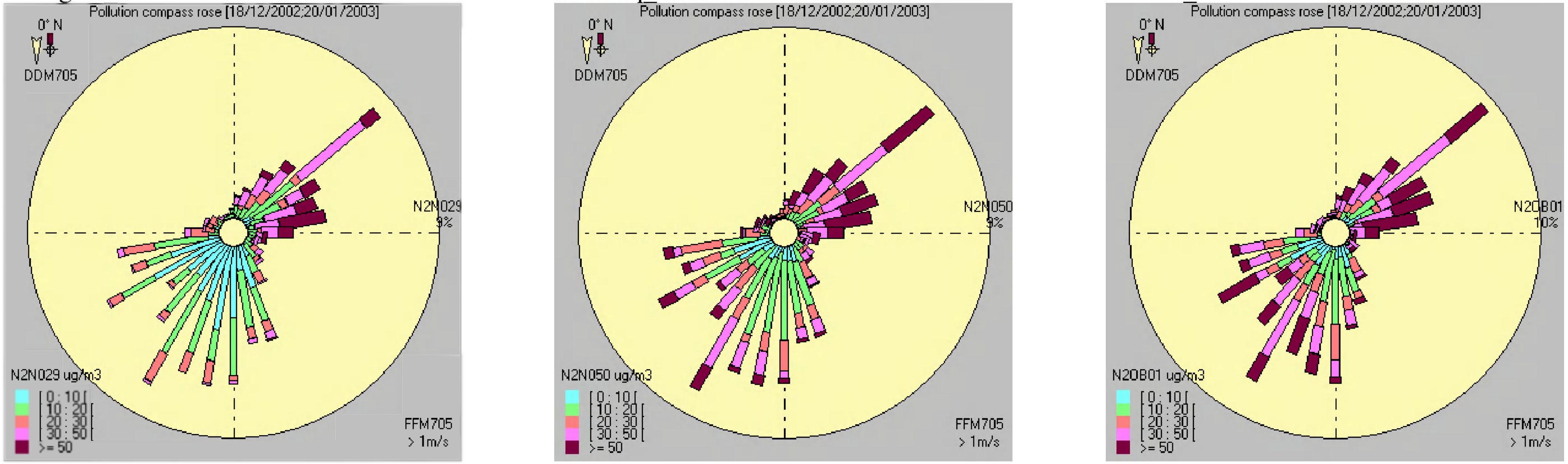


Lomme

Figure H : NO pollution roses summer (continued)

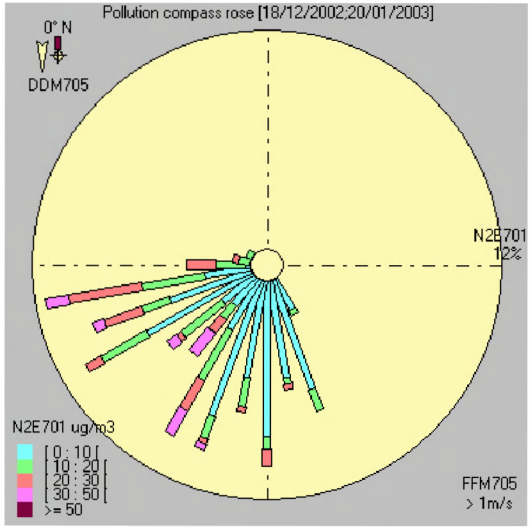


Rollegem_mob Wervicq_mob Halluin_mob

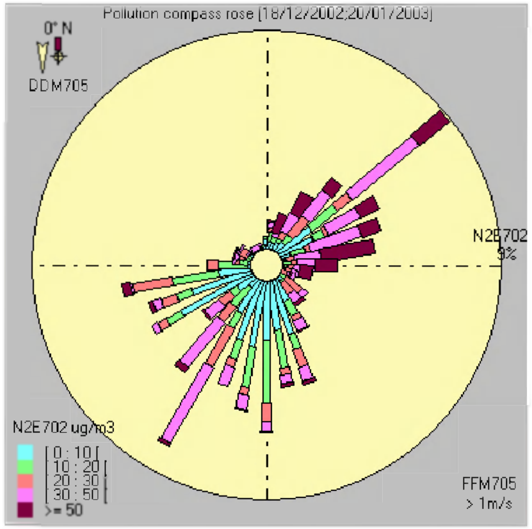


Houtem Sint-Denijs Oostrozebeke

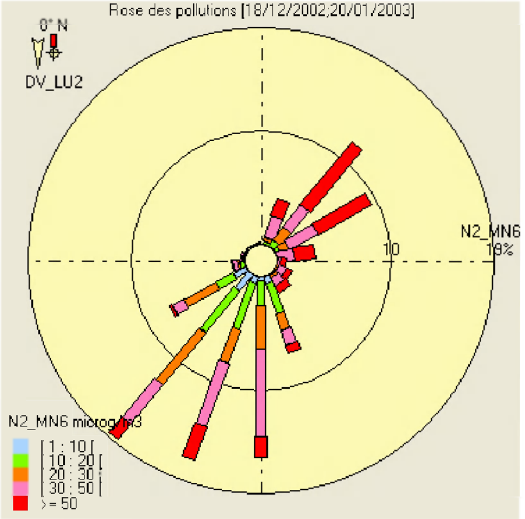
Figure I : NO2 pollution roses winter



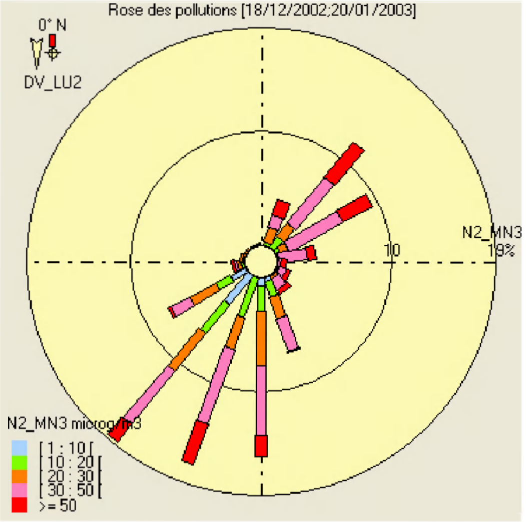
Vichte



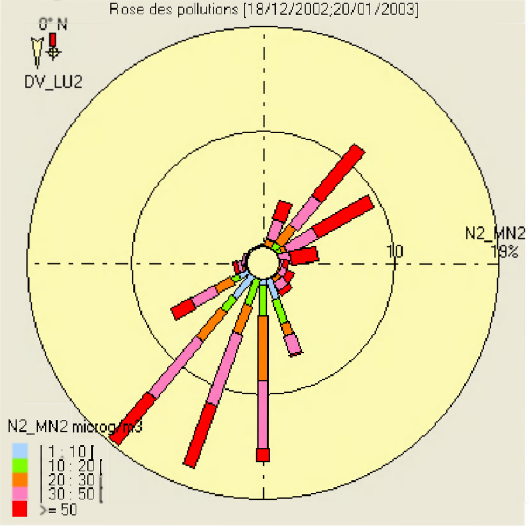
Elsegem



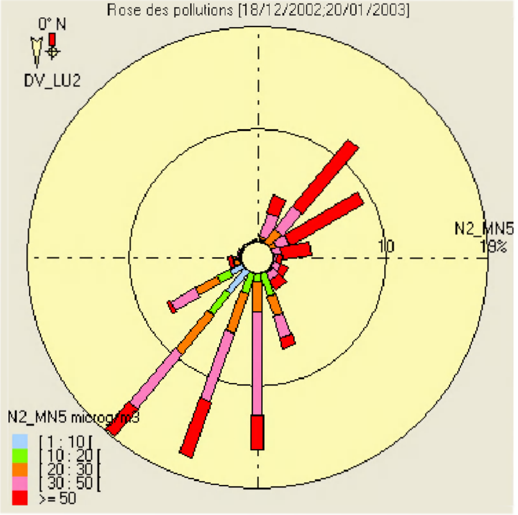
Halluin



Tourcoing

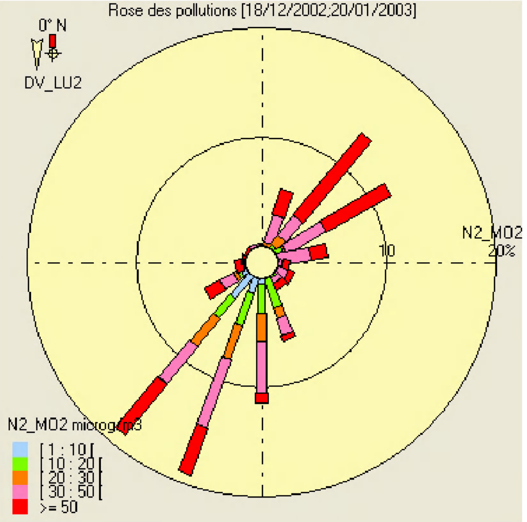


Roubaix



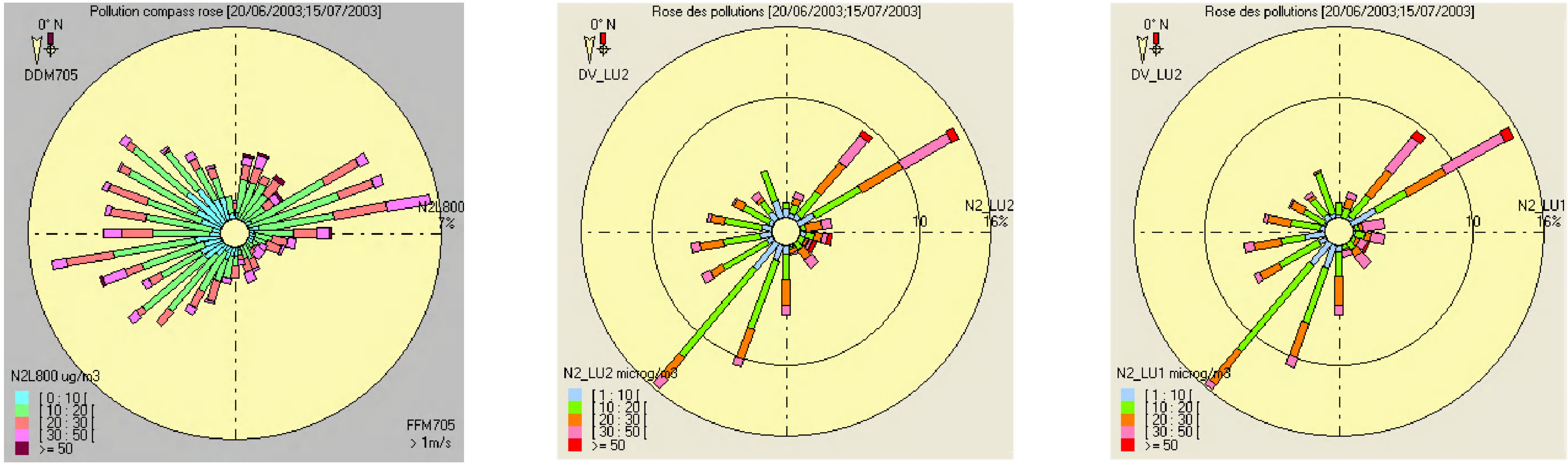
Marcq

Figure I : NO2 pollution roses winter (continued)

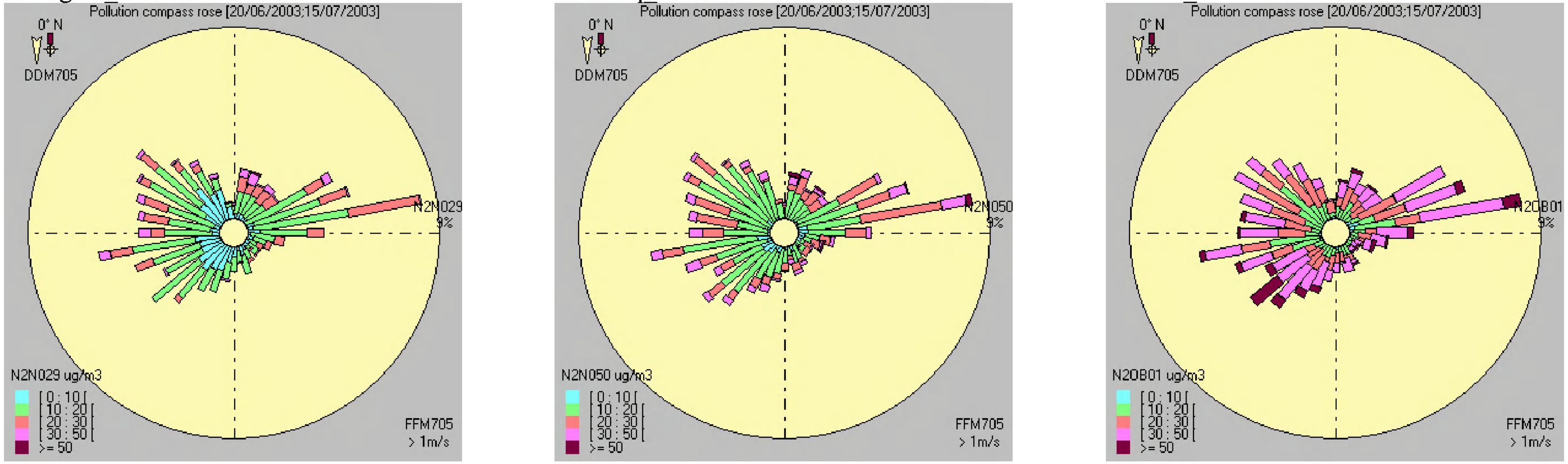


Lomme

Figure I : NO2 pollution roses winter (continued)

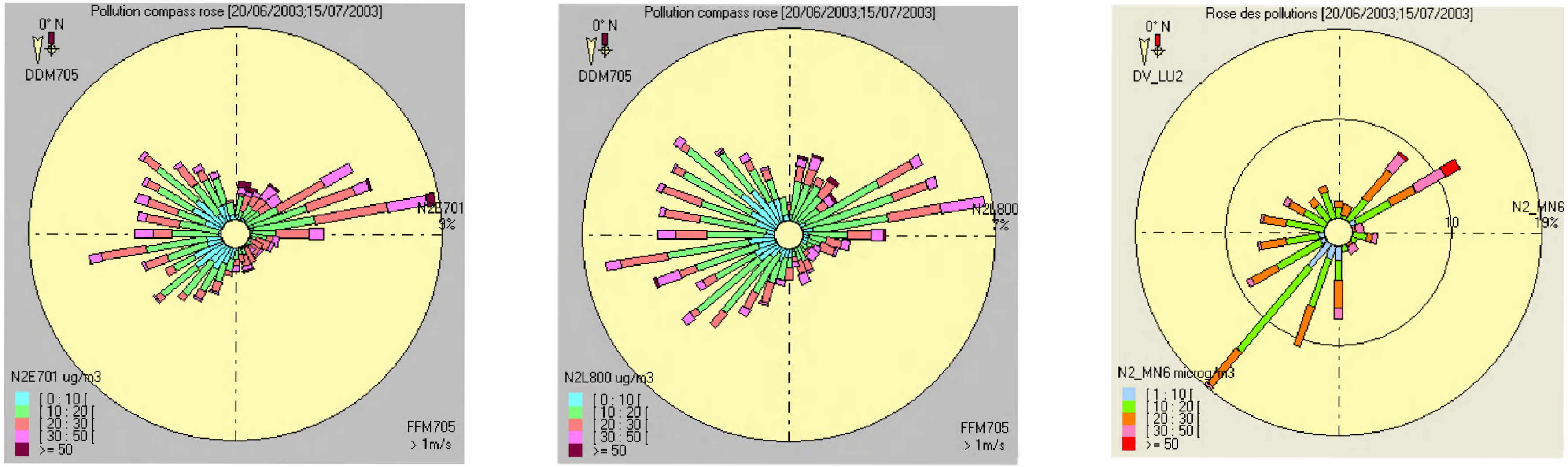


Rollegem_mob Wervicq_mob Halluin_mob

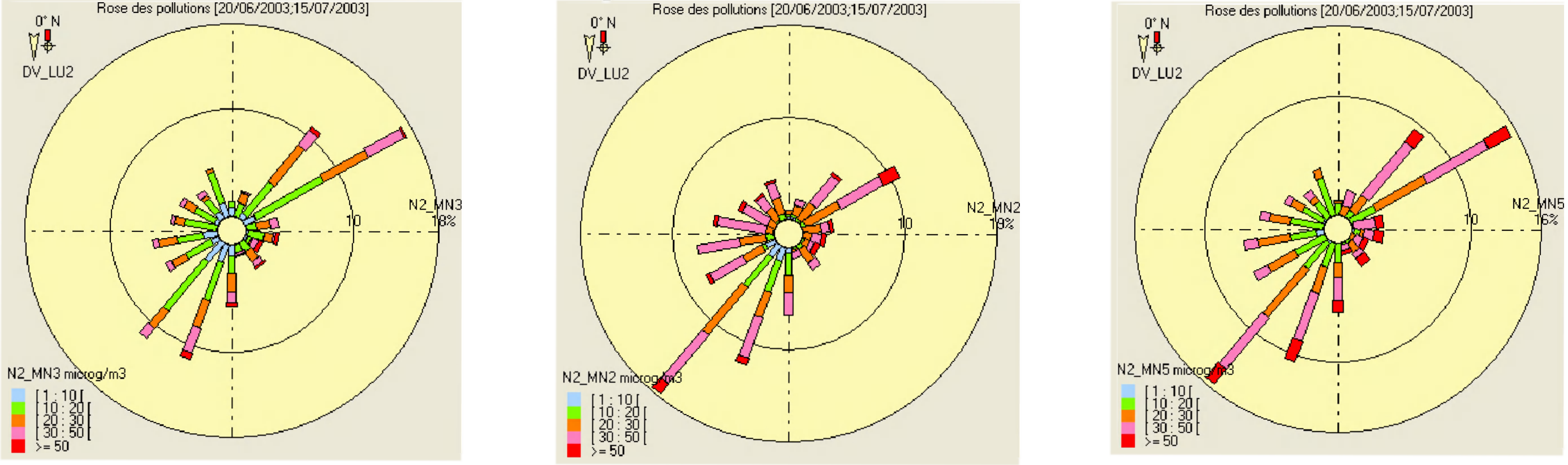


Houtem Sint-Denijs Oostrozebeke

Figure J : NO2 pollution roses summer

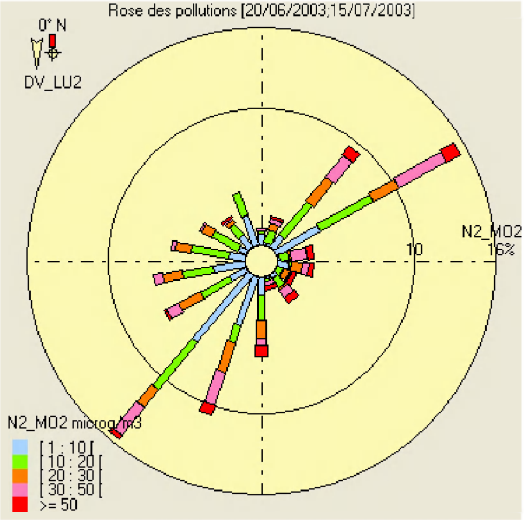


Vichte Elsegem Halluin



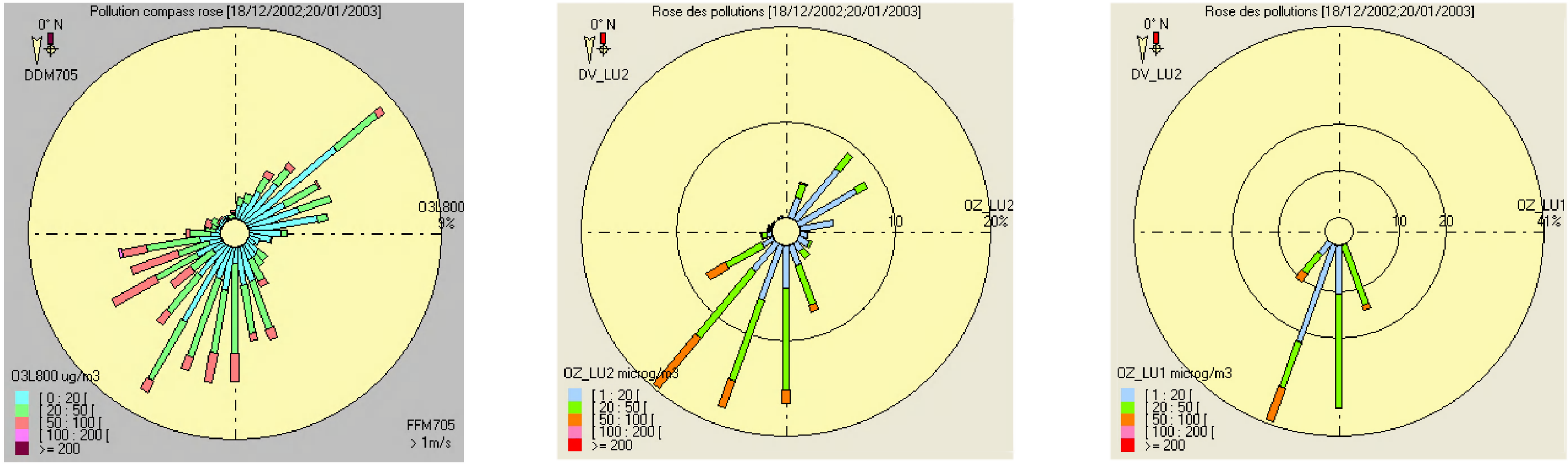
Tourcoing Roubaix Marcq

Figure J : NO2 pollution roses summer (continued)

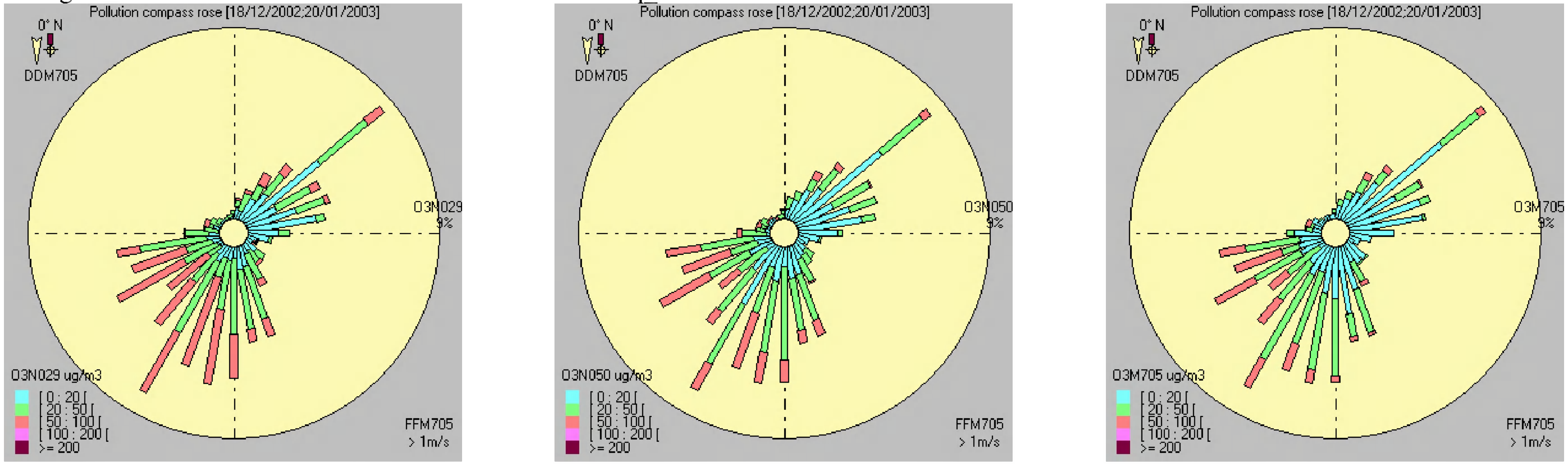


Lomme

Figure J : NO2 pollution roses summer (continued)

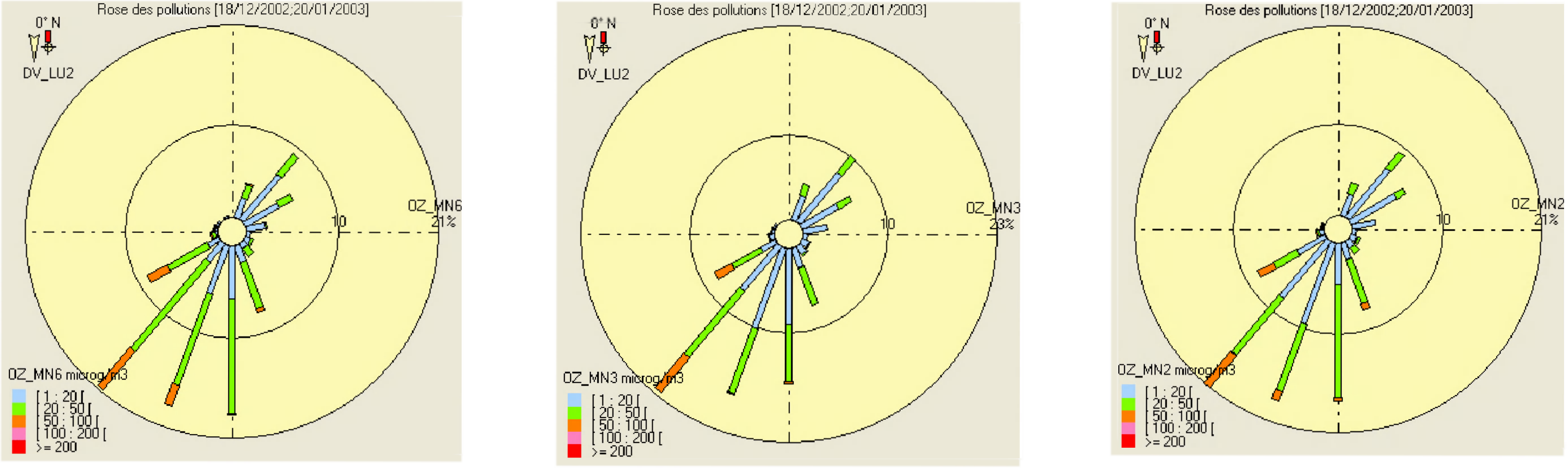


Rollegem mob Wervicq_mob Halluin mob

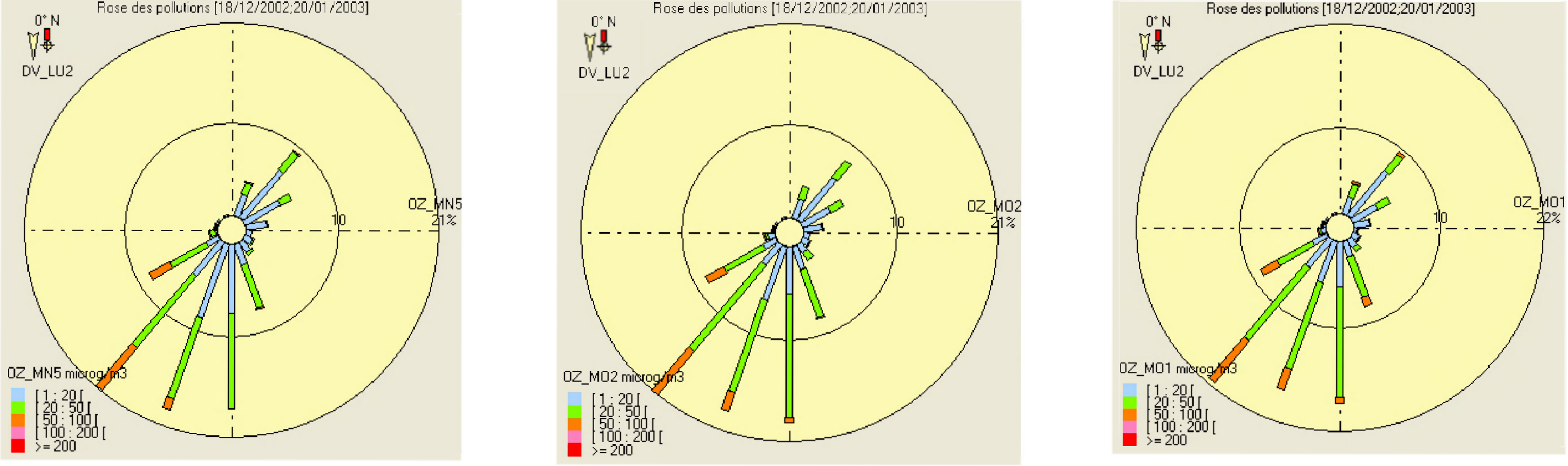


Houtem Sint-Denijs Roeselare

Figure K : O3 pollution roses winter

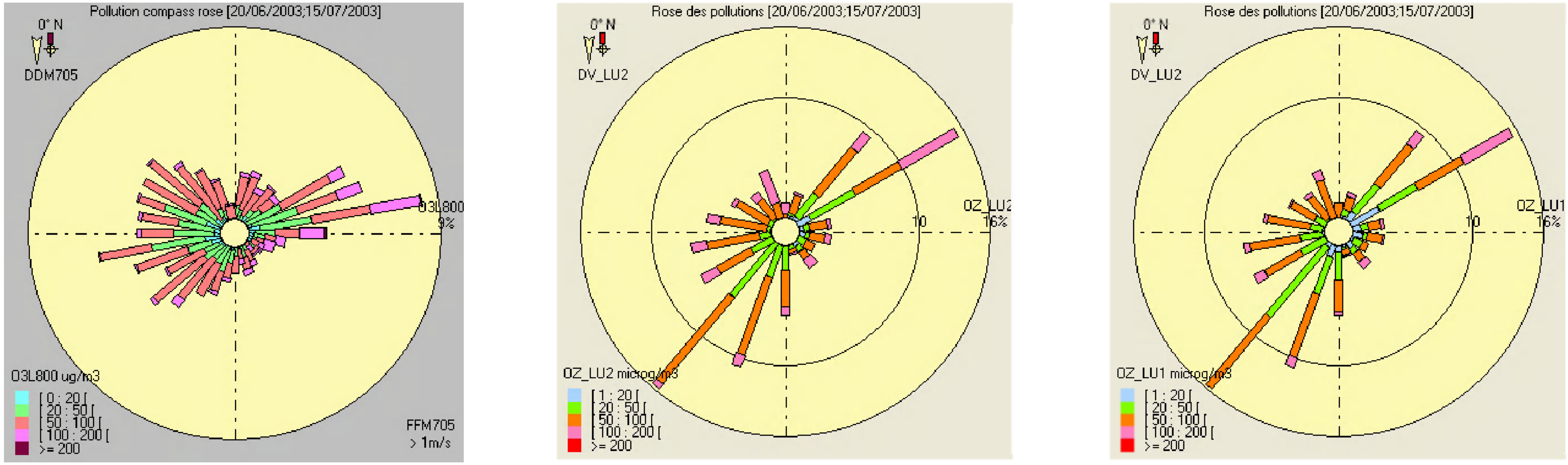


Halluin Tourcoing Roubaix

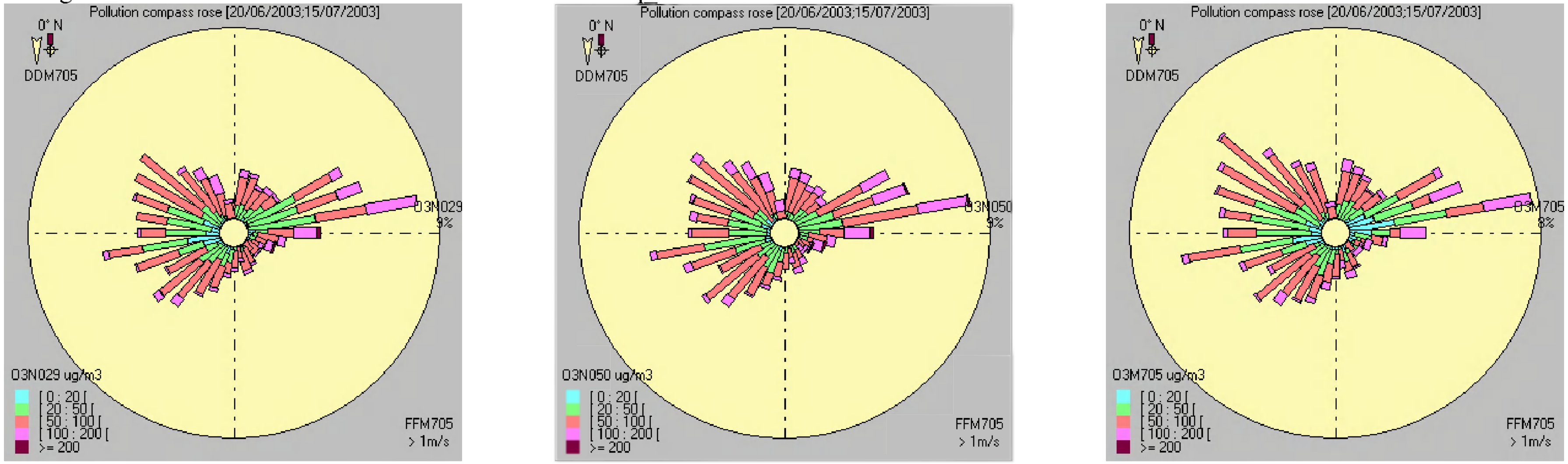


Marcq Lomme Armentières

Figure K : O3 pollution roses winter (continued)

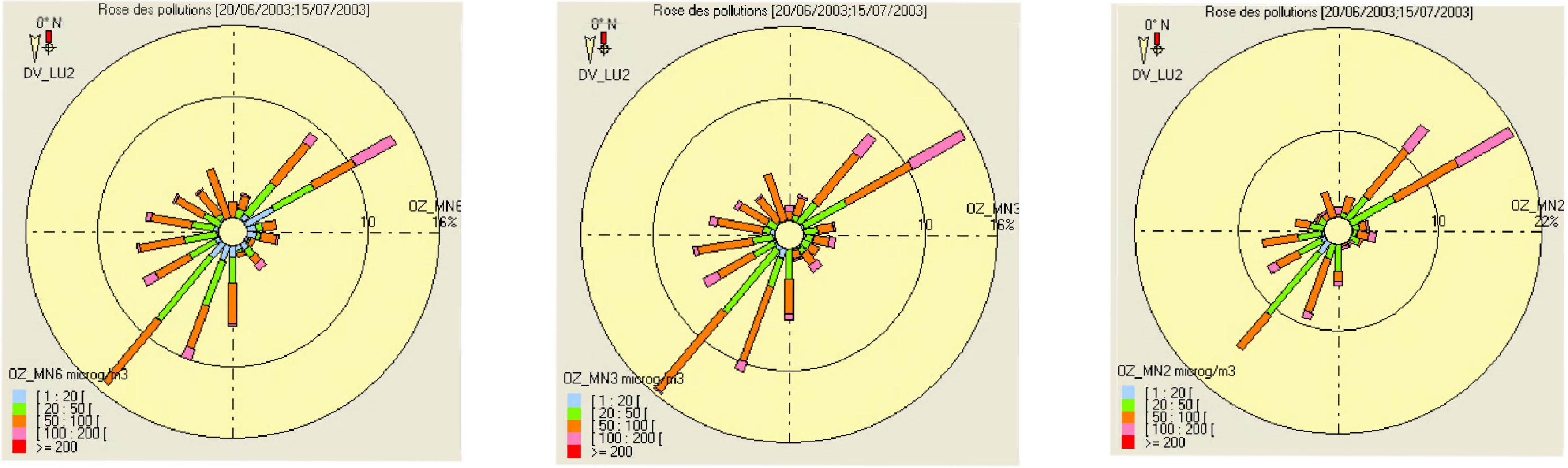


Rollegem mob Wervicq_mob Halluin mob



Houtem Sint-Denijs Roeselare

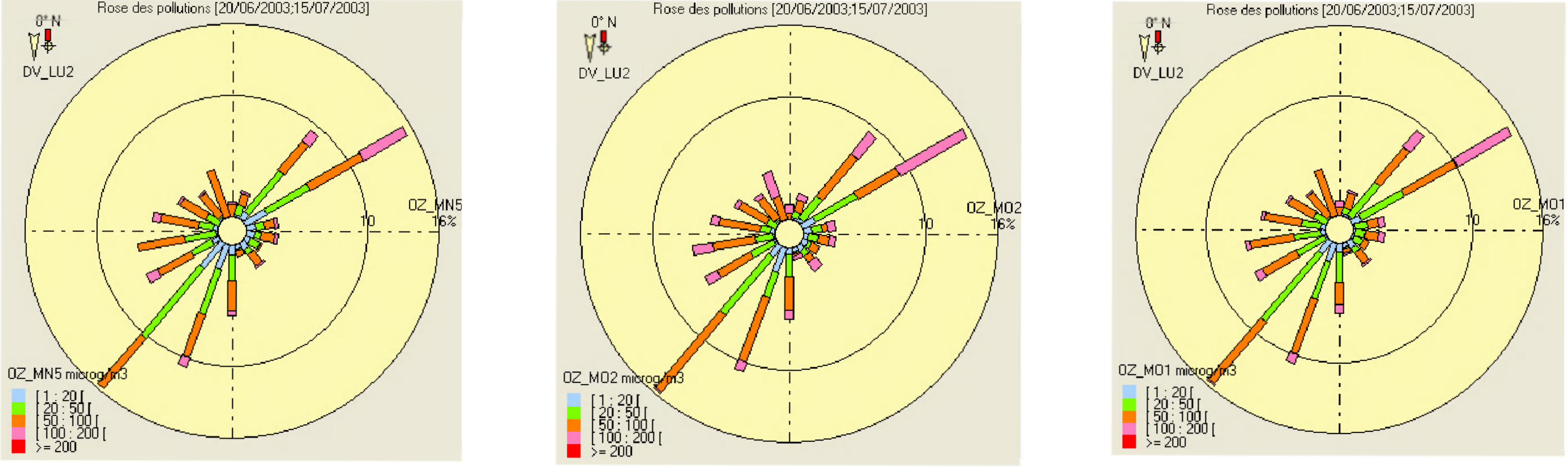
Figure L: O3 pollution roses summer



Halluin

Tourcoing

Roubaix

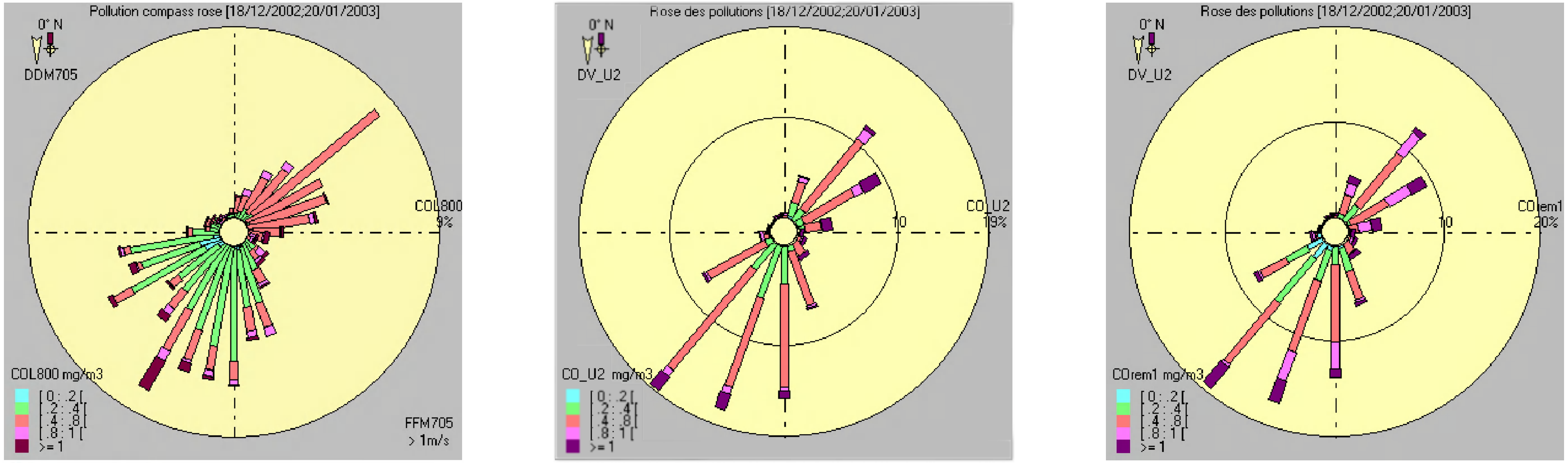


Marcq

Lomme

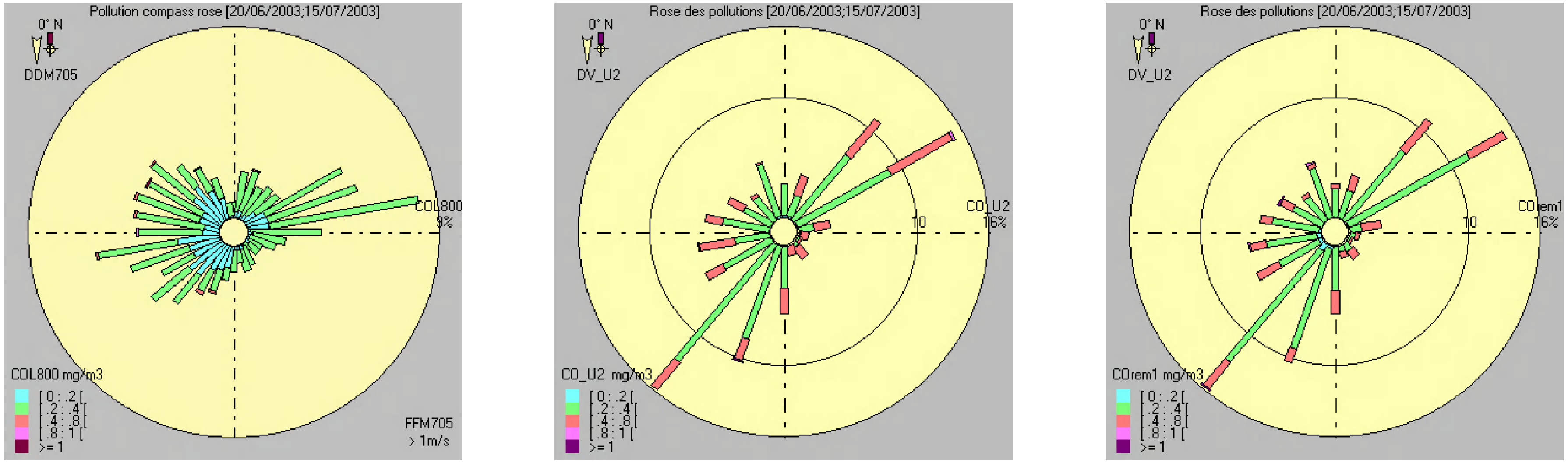
Armentières

Figure L: O3 pollution roses summer (continued)



Rollegem_mob Wervicq_mob Halluin_mob

Figure M : CO pollution roses winter



Rollegem_mob Wervicq_mob Halluin_mob

Figure N : CO pollution roses summer

Annex 3 : Dioxin and PCB depositions

Table A : Dioxin depositions 1993-2001 (pg TEQ/m².day)

													WHO-TEF (0,5xDL)	WHO-TEF (0,5xDL)
Location	**1993-1994**	**sep-oct '95**	**dec'95-feb'96**	**aug-sep '96**	**apr-may '97**	**nov-dec '97**	**apr-may '98**	**oct-nov '98**	**apr-may '99**	**oct-nov '99**	**april-may '00**	**nov-dec '00**	**may-june '01**	**nov-jan'02**
Measurements nearby waste incinerators														
Beveren									5,8	2,4	3,2	6,0	4,0	8,5
Drogenbos°									18	7,6	5,0	9,6		
Dudzele									2,5	4,3	1,6	2,7	4,8	
Edegem					9,0	9,4								
Eeklo									12	9,0	2,3	3,2	4,0	6,7
Gent 1, INW		34	26	15										
Gent 2, Massaustraat					111	52	31	108	11	123	6,8	6,8	7,7	8,5
Gent 3, Koestraat							15	21	4,9	156	5,0	5,2	7,2	3,5
Gent 4, Groothandelsm.									6,3	168	4,9	6,3	4,4	4,8
Gent 5, Gestichtstraat									6,4	52	5,2	8,5	11	5,7
Gent 6, terreinwegdienst												8,4		
Gent 7, Arduinstraat												7,3		
Gent 8, Verlorenbroodstr.												5,9		
Harelbeke									$7,8^+$	5,3	6,0	11	5,4	9,3
Houthalen						16^+	1,8	12	(5-14)	1,2	0,94	4,9	2,9	5,2
Knokke-Heist									1,7	4,1	3,3	5,3		
Wilsele 1 - Electrabel		8,1	18	15	27	44	9,9	6,4	(5-14)	9,4	8,7	13	39	3,3
Wilsele 2 -Dijledreef														3,9
Wilsele 3 - Lefèvrelaan														3,3
Leuven-Stella												2,5		
Melsele	108	8,1	12	11										
Menen 1 Rekkem					48	107	1,8	19	16	3,5	5,4	6,9	4,4	2,2
Menen 2 Wervikstraat	1025	78	118	122	49	221	42	29	78	20	47	35	12	4,5
Menen 3 Ter Berken					62	94	7,0	18	24	4,2	7,0	12	3,9	3,6
Menen 4 Franse grens							8,0	11	16	5,1	16	6,2	12	5,1
Menen 5 Sluizenkaai									22	7,0	16	10	6,4	4,7
Moerkerke	14	6,4	5,5	8,1										
N/O-Heembeek					1,5									
Diegem						21	25	14	21	4,0	4,8	4,5	4,4	2,2
Machelen									18	9,8	12	8,3	9,3	4,5
Oostende		8,2	12	7,5					7,0	5,9	6,0	7,1	4,6	3,8
Roeselare 1									28	13	29	$15^{\S}$	14	15

Roeselare 2												10	4,5	7,5
													WHO-TEF (0,5xDL)	WHO-TEF (0,5xDL)
Location	**1993-1994**	**sep-oct '95**	**dec'95-feb'96**	**aug-sep '96**	**apr-may '97**	**nov-dec '97**	**apr-may '98**	**oct-nov '98**	**apr-may '99**	**oct-nov '99**	**april-may '00**	**nov-dec '00**	**may-june '01**	**nov-jan'02**
Roeselare 3												8,7	8,9	4,0
St. Niklaas 1	46	17	6,8	24	21	14	7,1	5,3	3,4	5,2	4,4	4,9		
St. Niklaas 2							6,3	5,8	3,1	5,6	3,7	8,4	3,6	2,4
St. Pieters-Leeuw°									13	3,4	3,5	5,0		
Stabroek						16	11	15	6,3	4,9	6,1	10	3,1	5,2
Tienen						6,4	7,8	7,2	7,6	5,3	3,1	6,4		
UCL/Kraainem					0,72	8,6								
Wilrijk / Ter Beke					3,6	12^{+}	7,5^{+}	8,6^{+}	13^{+}	5,9^{+}	5,0	9,6	12	4,1
Wilrijk / Neerland						9,2^{+}	3,4^{+}	16^{+}	6,8^{+}	3,8^{+}	2,5	4,8	11	10
Wilrijk / Aartselaar									9,0^{+}	5,7^{+}	3,7	7,3	11	5,9
Wilrijk 5													5,9	6,1
Measurements nearby industrial installations														
Antwerpen 1, Polderdijkweg									14	3,3	2,7	6,4	3,1	6,4
Antwerpen 2, Ekersedijk									8,0	7,9	4,8	8,3	5,0	8,8
Beernem													10	3,7
Beerse									6,9	5,1	7,7	13	3,6	4,8
Berendrecht	211	4,4	6,8	5,2										
Boechout									3,8	2,6				
Denderleeuw													4,5	6,3
Duffel							6,9	8,9	13	4,3				
Evergem											5,4	8,3	4,2	2,7
Genk 1					7,0	9,4		12	6,1	5,2	1,1	9,2		
Ham	41	13	9,5	6,5										
Hasselt													3,7	4,2
Heusden-Zolder					3,4	11	5,8	9,8	5,0	2,8	1,1	3,1		
Hoboken 1, Curiestraat							31	32	16	11	49	25	35	18
Hoboken 2, J. Leemansl.									30	13	17	12	5,7	8,6
Hoboken 3, Herbekestr.									8,2	9,8	5,0	6,4		
Hoboken 4, Schansstraat										7,4	7,6	4,3		
Hoboken 5, spoorlijn										12	9,7	7,3	4,8	6,1
Hoboken 6, Hof Ter Heide										5,0	2,0	7,8		
Kruibeke										6,8	8,5	7,1		
Kruishoutem													5,1	27
Ieper							1,4	Det.lim.$^{\pm}$	2,9	1,8				
Izegem					19	24	2,5	8,0	9,1	9,5	9,0	11	3,5	3,7
													WHO-	WHO-

Location	**1993-1994**	**sep-oct '95**	**dec'95-feb'96**	**aug-sep '96**	**apr-may '97**	**nov-dec '97**	**apr-may '98**	**oct-nov '98**	**apr-may '99**	**oct-nov '99**	**april-may '00**	**nov-dec '00**	TEF (0,5xDL) **may-june '01**	TEF (0,5xDL) **nov-jan'02**
Lichtervelde							1,1	5,5	3,7	5,6				
Moeskroen					16	33	0,33	24	18	8,6	6,4	14	6,4	5,9
Mortsel							7,6	2,6	11	4,7				
Olen 1		13		34	3,4	24	12	62	41	65	30/32	23/25	11	23
Olen 2									29	22	17	20	3,9	14
Olen 3											9,7	10	2,6	7,1
Olen 4												70	15	6,4
Oostrozebeke									8,0	6,7	7,8	14	12	8,4
Overijse 1											1,2	2,7		
Overijse 2											0,83	3,5		
St. Katelijne Waver									5,0	5,4				
Tessenderlo											6,5	21	2,5	7,8
Val Meer									6,3	2,6	1,1	5,7	2,2	4,2
Wevelgem													3,1	3,3
Wielsbeke1, Bossenstr.											5,3	17	4,4	8,8
Wichelen							12	6,3	3,5	2,8				
Zelzate 1	46	24	38	10	21	28	3,9	23	8,4	14	5,2	22	2,5	3,4
Zelzate 2							4,0	48	10	14	9,3	19	5,0	2,3
Zelzate 3							9,3	31	8,5	11	11	(a)	3,4	2,7
Zelzate 4 (Rieme)									9,0	38	11	14	2,8	2,0
Zelzate 5 (Langelede)									12	16	6,8	46	4,5	5,9
Zelzate 6													3,2	4,5
Zelzate 7													27	5,4
E Measurements near the Northern border of France														
Adinkerke									3,0	2,4	3,2	2,7		
De Panne									1,8	1,6				
Veurne									1,2	1,2	1,8	2,0	3,6	3,3
Poperinge											2,3	2,2		
Wervik											4,2	(b)	3,9	2,9
Measurements nearby crematoria														
Brugge									4,5	6,0				
Wilrijk 4, G. Fabréln.									8,2	2,5				
Measurements in urban areas														
Antw-Merksem		14	8,6	12			11	25	25	6,8	4,4/4,4	13/9,4	3,4	4,6
Antw-Borgerhout					0,9	7,5								
Kortrijk													3,7	5,9
													WHO-	WHO-

Location	**1993-1994**	**sep-oct '95**	**dec'95-feb'96**	**aug-sep '96**	**apr-may '97**	**nov-dec '97**	**apr-may '98**	**oct-nov '98**	**apr-may '99**	**oct-nov '99**	**april-may '00**	**nov-dec '00**	TEF (0,5xDL) **may-june '01**	TEF (0,5xDL) **nov-jan'02**
Mechelen													3,3	5,5
Vilvoorde	31	12	13	17	2,7	15	5,6	16	5,9	3,4	3,9	4,8	3,1	3,1
Gent 5											9,7	8,2	3,3	6,6
F *Measurements in high traffic areas*														
Aalter									8,3	5,2				
Antwerpen, Ring									9,6	7,5				
Mechelen									13	4,6				
G *Measurements nearby airports*														
Oostende 1												3,4		4,1
Oostende 2												4,2		5,0
Zaventem 1												3,5		10
Zaventem 2												2,7		6,6
Zaventem 3												2,3		4,5
H *Measurements in rural areas*														
Eksel	8,0	2,5	3,9	4,0	3,1	6,9								
Mol (Hoeve SCK)	1,9	5,3	4,3	8,8	0,7	9,0	4,4	11	5,0	3,3	6,4	8,0	4,9	3,5
Moelingen						10	4,2	/	5,7	5,2	4,3	9,0		
Peer										5,1	4,0	6,5	5,6	4,4

(a) : The measured value is not retained because of a lower value measured by a reference laboratory abroad
(b) : extreme high values were not retained because no sources could be found; in March lower values were measured again

🟥 x > 26 pg TEQ/m².day (increased)
🟩 x ≤ 6 pg TEQ/m².day (not increased)
⬜ 6 < x ≤ 26 pg TEQ/m².day (moderately increased)

Till 2001 depositions were calculated by I-NATO-TEF-values
From 2001 depositions were calculated by WHO-TEF-values

Table B : Dioxin and PCB126 in 2002 and 2003 (pg TEQ/m².day)

Location	April-June '02		Oct-Dec '02		April-June '03		Oct-Dec '03	
	dioxins	PCB126	dioxins	PCB126	dioxins	PCB126	dioxins	PCB126
Measurements nearby waste incinerators and industrial installations								
Beveren	7,2	3,5	4,2	<1	2,4	1,9	1,9	<1
Eeklo					7,9	2,5	3,2	<1
Gent 1, Massaustraat	3,5	1,7	2,2	<1				
Gent 2, Koestraat	3,1	2,4	4,5	1,0	2,8	2,0	3,1	<1
Gent 3, Groothandelsmarkt	3,9	1,1	6,4	1,7				
Halle					5,8	2,7	3,2	1,2
Harelbeke	3,4	1,9	3,9	<1				
Houthalen	7,2	1,1	6,3	<1	2,4	1,1	4,3	<1
Wilsele 1 - Electrabel	2,5	1,3	2,1	<1	2,9	3,0	20	1,5
Wilsele 2 -Dijledreef	6,8	2,9	53	15	2,3	1,6	7,1	<1
Wilsele 3 - Lefèvrelaan	3,2	2,3	4,6	1,5	3,2	2,5	3,0	1,9
Menen 1 Rekkem	2,6	2,1	2,5	<1	2,3	1,5	2,8	<1
Menen 2 Wervikstraat	26	41	24	38	13	32	9,0	19
Menen 3 Ter Berken	4,5	2,5	4,7	1,5	2,5	2,3	13	26
Menen 4 Franse grens	19	17	4,3	3,4	11	30	13	51
Menen 5 Sluizenkaai	6,2	13	6,2	2,7	5,5	8,8	4,8	2,6
Menen 6 Galloo					23	33		
Diegem	3,5	1,2	4,9	<1	4,3	4,4	8,9	4,2
Machelen	7,0	9,3	2,1	<1				
Oostende					4,3	3,0	3,3	1,2
Roeselare 1	6,4	18	11	12	5,9	15	3,1	<1
Roeselare 2	5,0	1,2	2,7	<1	3,1	2,2	2,6	<1
St. Niklaas 2	17	<1	2,2	<1	3,9	2,0	4,1	<1
Stabroek	4,0	2,6	6,0	<1	4,3	2,0	2,0	<1
Tienen					2,4	1,5	2,1	<1
Wilrijk / Ter Beke	8,3	4,7	2,4	<1				
Wilrijk / Neerland	4,1	1,7	3,6	<1	3,4	<1	3,3	2,2
Antwerpen 1, Polderdijkweg	6,5	1,7	6,1	1,5				
Antwerpen 2, Ekersedijk	7,3	2,8	7,7	2,1	6,8	3,0	3,8	3,1
Beernem	2,9	<1	33	2,8	2,7	1,9	3,1	<1
Beerse	4,2	2,8	4,0	<1	12	2,4	21	1,9
Berendrecht					2,4	1,4	2,0	<1
Buggenhout 1					2,9	1,3		
Buggenhout 2					2,3	2,2		
Evergem	3,6	2,2	6,5	<1				
Genk 2, Swinnenwijerweg					45	223	10	21
Genk, Krelstraat							3,5	<1
Genk, Steyfkens							5,5	<1
Genk, Warsco							2,5	<1
Genk, Isolair							5,7	5,4
Genk, Werkhuizen							2,5	<1
Gent 9, Scheepzatestr					34	87	17	14
Gent 10							6,3	1,9
Hasselt	2,2	<1	3,5	<1				
Hoboken 1, Curiestraat	24	3,9	4,8	<1	15	2,8	16	1,6
Hoboken 2, J. Leemanslaan	32	2,8	3,7	<1	3,0	1,6	7,7	1,7
Hoboken 5, spoorlijn	4,2	2,3	1,9	<1	3,7	3,4	4,9	1,1
Izegem	3,9	1,1	5,5	<1				
Kruishoutem	4,9	1,4	2,1	<1	4,7	2,2	7,7	1,9
Moeskroen	3,0	1,4	5,2	<1	2,9	2,0	5,9	<1
Olen 1	11	2,5	3,4	<1	6,3	6,0	5,4	<1
Olen 2	6,9	2,0	3,2	<1	4,4	4,6	3,6	<1
Olen 3	5,4	1,2	4,1	<1				
Olen 4	64	6,6	9,7	<1	7,0	1,3	9,3	4,0
Oostrozebeke	8,3	1,8	3,5	<1	31	2,6	41	2,0
Tessenderlo	3,5	1,3	2,9	<1	3,1	1,3	3,3	<1
Wevelgem	4,0	1,2	4,8	<1				

Location	**April-June '02**		**Oct-Dec '02**		**April-June '03**		**Oct-Dec '03**	
	dioxins	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**
Wielsbeke1 Bossenstraat	9,4	1,2	5,8	<1	4,5	1,3	16	1,2
Wielsbeke2 R. De Ghellinckstr					5,3	2,3	16	4,2
Willebroek					11	17	54	73
Zelzate 1	4,5	1,3	15	<1	5,1	2,5	9,4	1,1
Zelzate 2	8,2	1,8	33	1,9				
Zelzate 3	12	4,1	6,3	<1	36	3,1	9,5	1,1
Zelzate 4	9,7	2,6	15	1,2				
Zelzate 5 (Langelede)	6,7	1,7	5,6	<1	3,2	1,3	6,8	<1
Zelzate 6	5,9	1,5	13	<1	3,9	3,4	11	1,5
Zelzate 7	5,0	1,4	7,9	<1	2,7	1,2	5,2	<1
Measurements near the Northern border of France								
Veurne	6,3	1,7	18	3,5	2,5	3,1	27	9,1
Wervik	5,0	1,9	2,9	<1	7,9	3,7	3,2	<1
Measurements nearby crematoria								
Brugge	5,0	1,3	18	1,1	4,7	1,5	4,5	<1
Wilrijk 4, G. Fabréln.	10	1,2	4,3	<1	4,3	1,5	2,3	<1
Lochristi	2,7	<1	12	<1	5,7	3,2	7,6	<1
Measurements in urban areas								
Antw-Merksem	4,6	2,0	5,9	4,3	3,5	3,6	7,4	1,9
Kortrijk	2,8	1,2	4,5	<1				
Mechelen	2,6	<1	6,8	<1				
Vilvoorde	4,1	2,3	17	3,4				
Gent 5	15	6,7	9,2	9,9	3,0	4,3	4,9	6,1
Measurements in rural areas								
Mol (Hoeve SCK)	2,3	1,1	5,2	1,6	2,3	<1	5,5	2,9
Mechelen	11	1,5	5,1	3,1				
Postel	6,0	1,6	2,1	<1				
Tielt-Winge	2,6	1,1	4,6	1,1				
Wingene	3,7	<1	3,1	<1				
Zwevegem	2,2	<1	4,8	<1				
Measurements in areas where waste is burnt in the open air								
Horebeke					2,3	1,3	8,8	3,3
Aarschot					3,0	1,8	3,0	1,1
Alveringem					2,0	2,0	5,3	2,5
Alken					3,4	4,4	4,1	<1
Zwalm					2,0	1,4	4,4	<1
Geraardsbergen					2,5	1,3	3,6	<1

🟥 x > 26 pg TEQ/m².day (increased)
🟩 x ≤ 6 pg TEQ/m².day (not increased)
⬜ 6 < x ≤ 26 pg TEQ/m².day (moderately increased)

Table C : Deposition of dioxins and PCB126 at locations where monthly samples are taken during a whole year (pg TEQ/m².day)

	Olen 1		Zelzate 2		Hoboken 1		Menen2		Menen 6	
	dioxins	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**
2-3-00	56		13							
3-4/00	4,5		7,8							
4-5/00			10							
5-6/00	27		14							
6-7/00	30		6							
7-8/00	51		<DL							
8-9/00	11		5,1							
9-10/00	15		9,6							
10-11/00	14				53		47			
11-12/00	20		28		26		35			
12-1/01	6,3		7,2		27		11			
1-2/01	14		21		23		33			
2-3/01					11		19			
3-4/01					54		19			
Average	**22,6**		**12,2**		**32,3**		**27,3**			
			Zelzate 3							
4-5/01	11		8,0		44		13			
5-6/01	3,9		3,4		56		16			
6-7/01	22		30		20		12			
7-8/01	9,8		4,6		29		13			
8-9/01	6,9		4,4		7,6		9,2			
9-10/01	5,0				21		21			
10-11/01	4,9		11							
11-12/01			8,2		17		4,5			
12-1/02	9,1		2,7		18		4,2			
1-2/02	23		14		13		31			
2-3/02	7,2		15		22		15			
Average	**9,7**		**9,5**		**23,5**		**13,7**			
4-5/02	4,5	1,8	11	2,2	12	2,8	26	41		
5-6/02	11	2,5	12	4,1	24	3,9	25	123		
6-7/02	15	2,6	6,8	1,2	16	3,9	12	46		
7-8/02	20	5,1	5,7	5,2	5,4	3,5	11	44		
8-9/02	4,9	<1,2	9,0	<1,6	16	5,3	5,8	21		
9/02	19	2,0	8,3	1,2	23	3,8	32	124		
9-10/02	4,6	<1	11	2,0	16	4,0	43	109		
10-11/02	2,8	<1	21	1,8	4,1	<1	24	38		
11-12/02	3,4	<1	6,3	<1	4,8	<1	9,1	14		
12-1/03	4,0	<1	9,8	1,1	4,2	<1	13	28		
1-2/03	6,2	<1	5,2	<1	4,7	<1	8,5	8,7		
2-3/03	4,3	1,1	7,9	1,5	10	2,3	33	59		
Average	**8,4**		**9,5**		**11,7**		**20,1**			
3-4/03					15	4,6	13	32		
4-5/03	6,3	6,0	36	3,1	15	2,8	24	65	23	33
5-6/03					17	3,6	23	66	37	79
6-7/03	4,2	1,1	4,9	2,7	10	3,1	19	47	41	96
7-8/03					40	3,3	11	28	12	23
8-9/03	4,6	<1	5,6	1,1	11	1,6	14	28	18	42
9-10/03					6,0	<2	25	102	32	123
10-11/03	5,4	<1	9,5	1,1	16	1,6	18	52		
11-12/03					13	1,1	9,0	19		
12-1/04	18	1,9			119	4,6	15	33		
1-2/04			34	2,5	12	1,5	19	32		
2-3/04	7,1	1,7			7,0	5,4	6,6	8,4		
3-4/04			42	2,9						
Average	**7,6**		**22,0**		**23,4**		**16,5**		**27,2**	

🟥 x > 26 pg TEQ/m².day (increased)
🟩 x ≤ 6 pg TEQ/m².day (not increased)
⬜ 6 < x ≤ 26 pg TEQ/m².day (moderately increased)

Depositions calculated with I-TEFs: above thick line; Depositions calculated with WHO-TEFs: under thick line

Table D : Deposition of dioxins and PCB126 nearby shredder installations (pg TEQ/m².day)

	11. Menen2		**Menen 6**		**Gent**		**Genk 2**		**Willebroek**	
	dioxins	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**	**dioxins**	**PCB126**
3-4/03	13	32								
4-5/03	24	65	23	33						
5-6/03	23	66	37	79	34	87	45	223	11	17
6-7/03	19	47	41	96						
7-8/03	11	28	12	23						
8-9-03	14	28	18	42	30	101	32	166	20	35
9-10/03	25	102	32	123	27	142			32	83
10-11/03	18	52							54	73
11-12/03	9,0	19			17	14	10	21		
12-1/04	15	33								
1-2/04	19	32								
2-3/04	6,6	8,4								

🟥 x > 26 pg TEQ/m².day (increased)
🟩 x ≤ 6 pg TEQ/m².day (not increased)
⬜ 6 < x ≤ 26 pg TEQ/m².day (moderately increased)

Annex 4: Backward trajectories at Menen

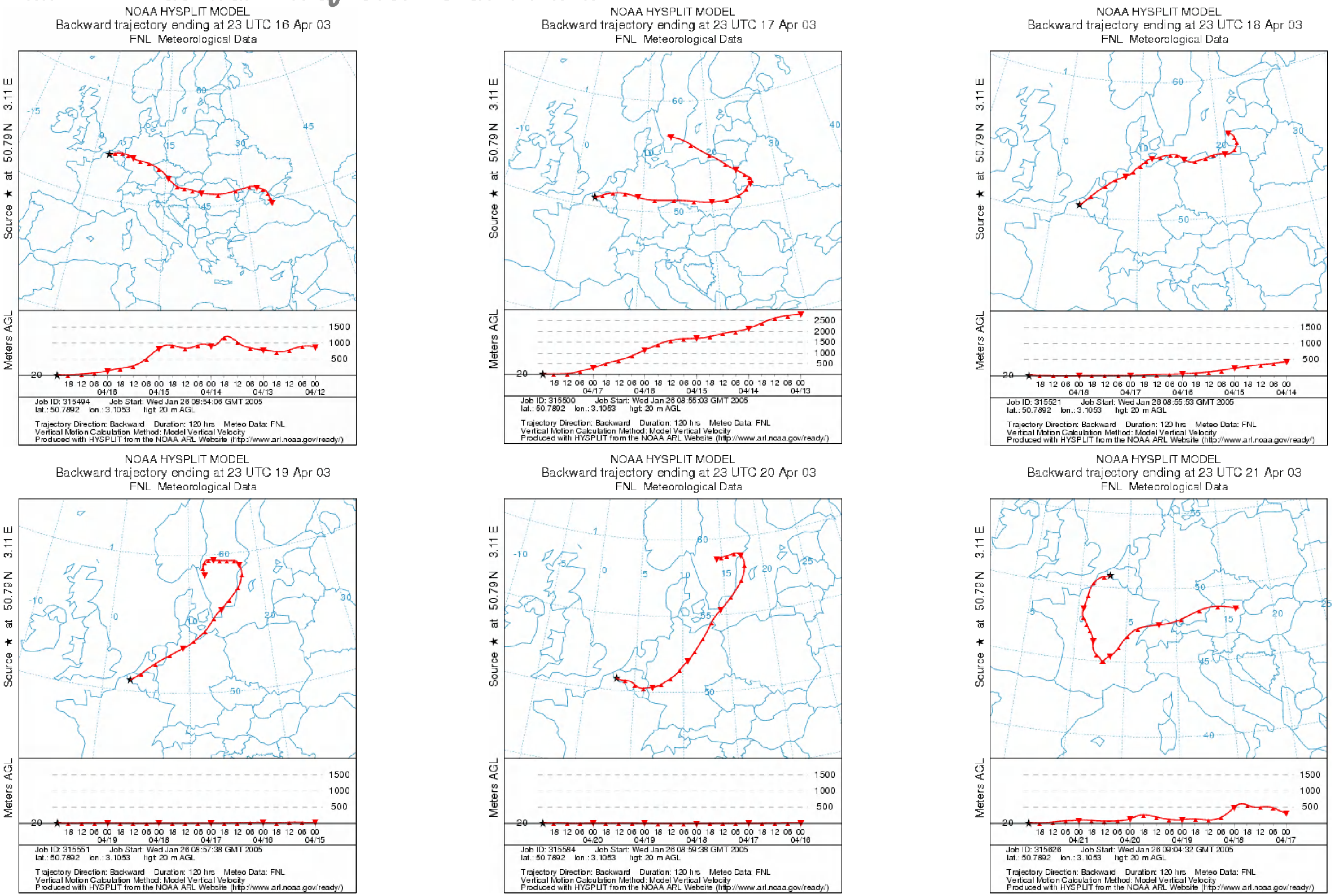


Figure A: Campaign 1

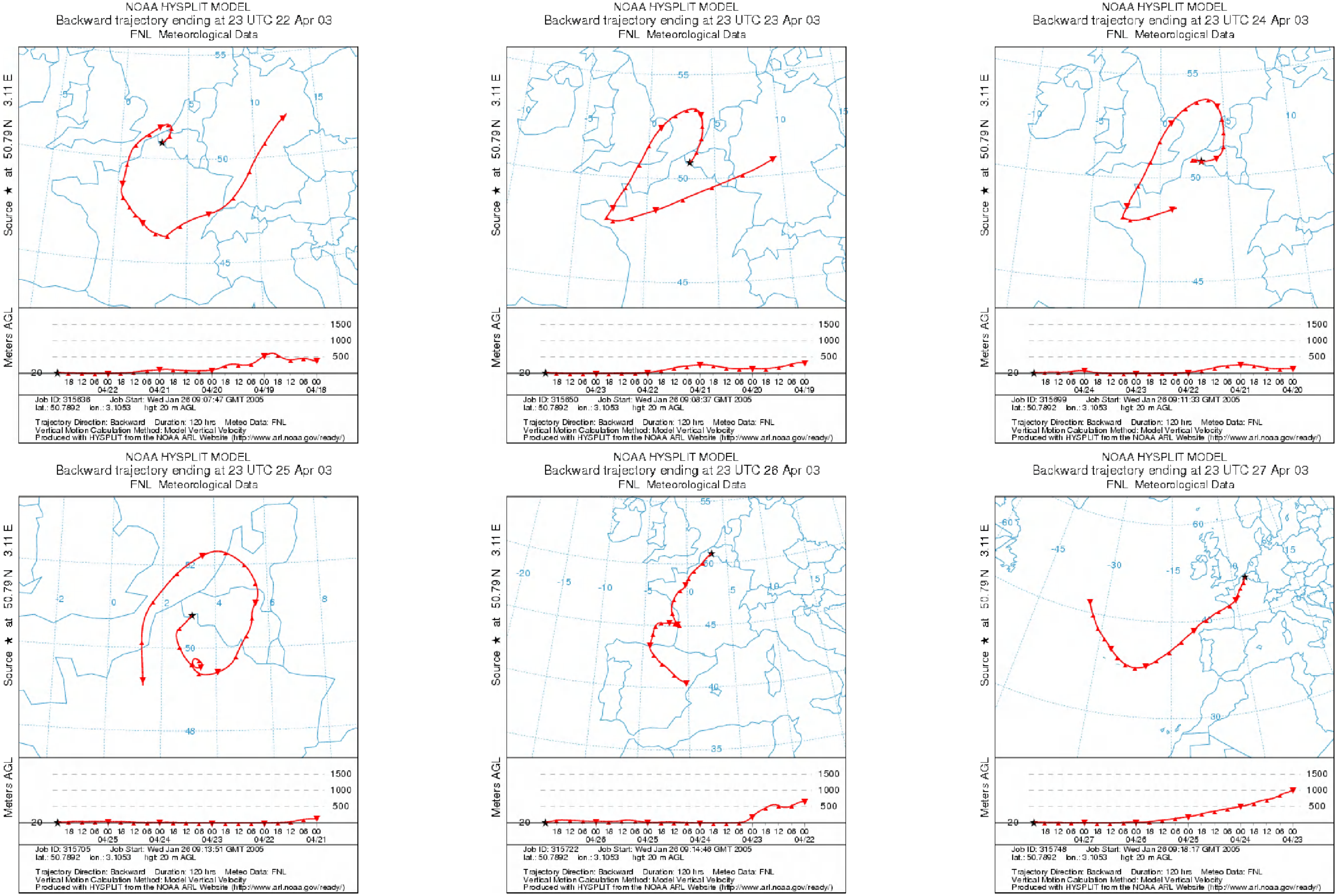


Figure A: campaign 1 (continued)

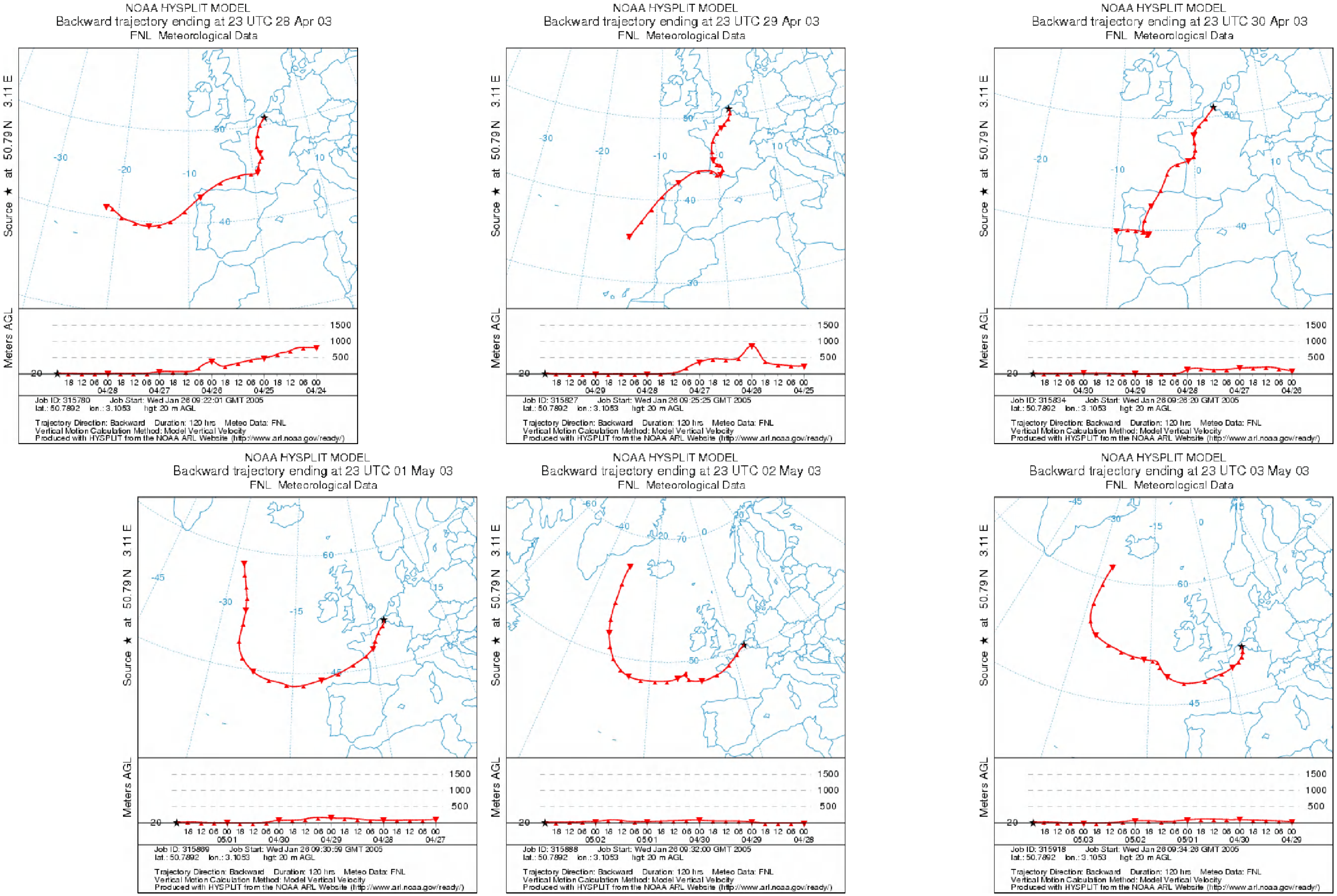


Figure A: campaign 1 (continued)

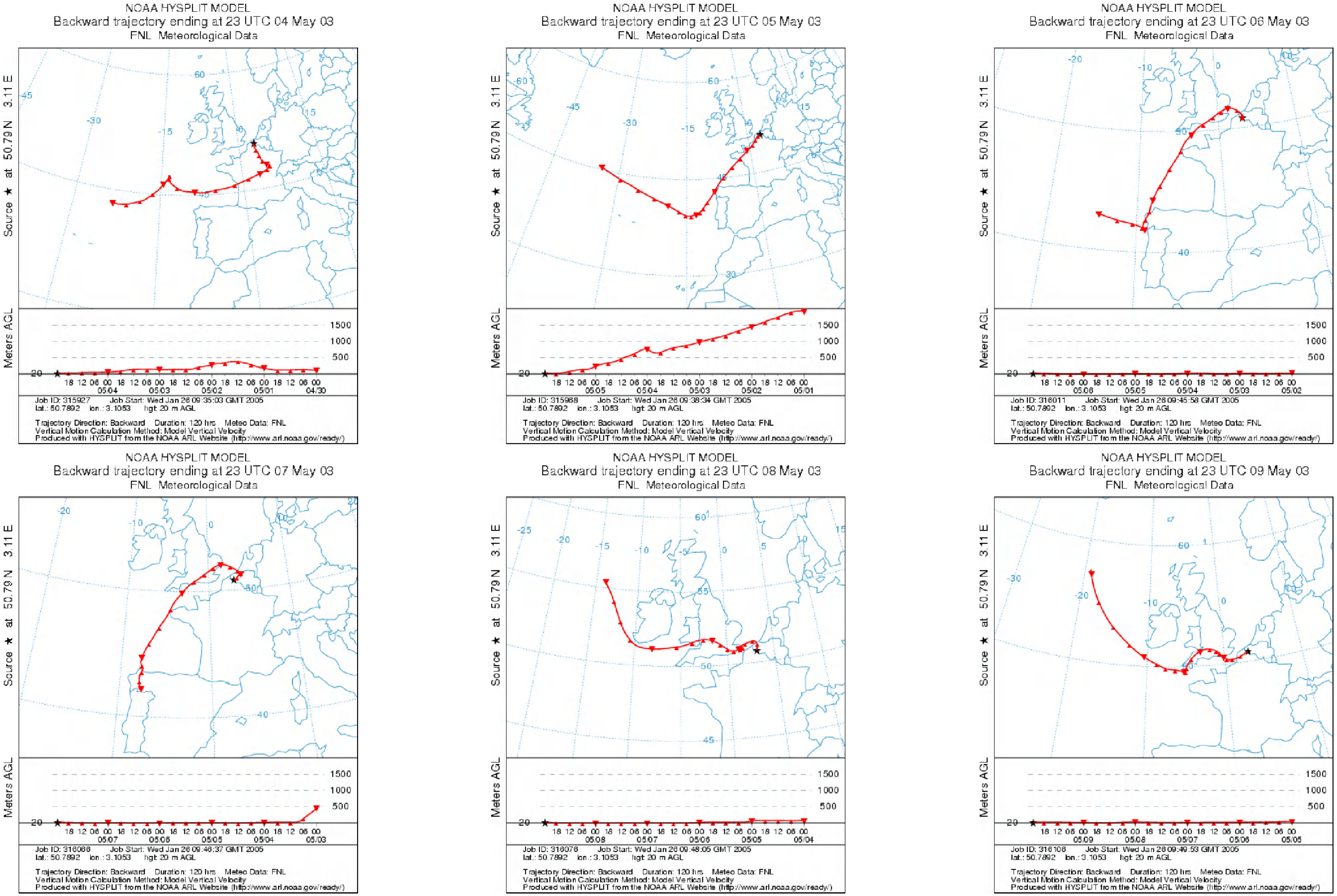


Figure A: campaign 1 (continued)

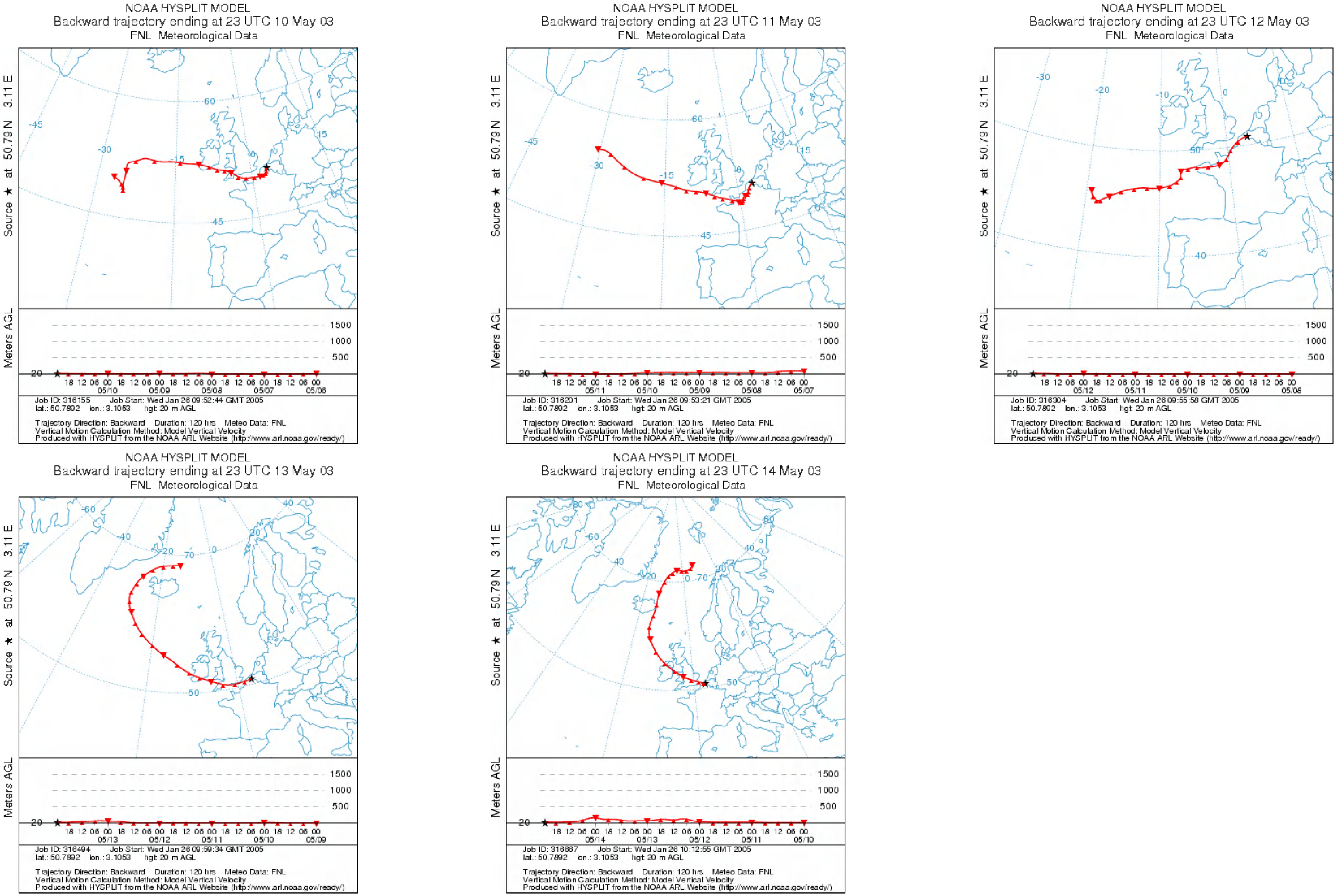
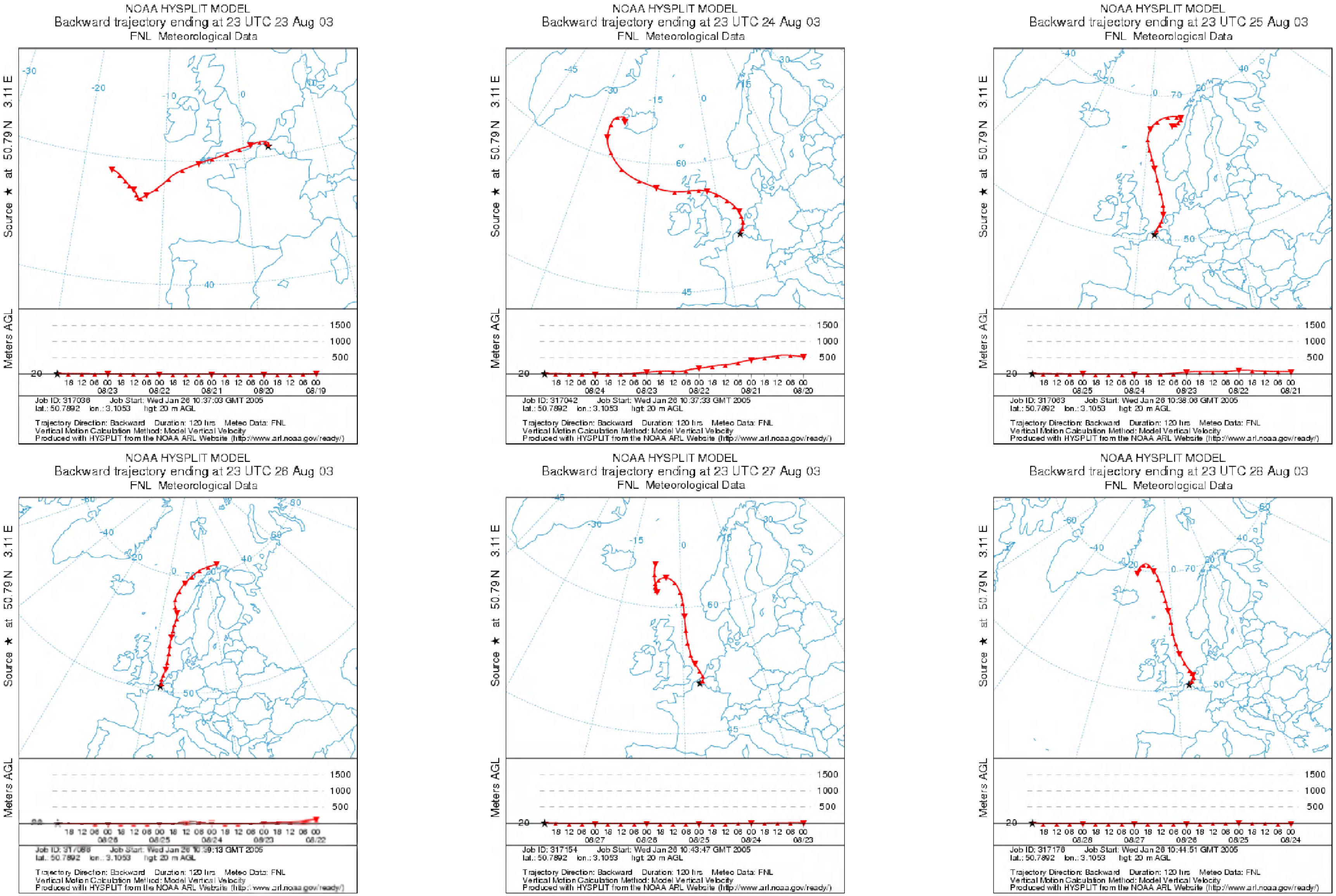


Figure A: campaign 1 (continued)



NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 23 Aug 03
FNL Meteorological Data

NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 24 Aug 03
FNL Meteorological Data

NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 25 Aug 03
FNL Meteorological Data

NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 26 Aug 03
FNL Meteorological Data

NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 27 Aug 03
FNL Meteorological Data

NOAA HYSPLIT MODEL
Backward trajectory ending at 23 UTC 28 Aug 03
FNL Meteorological Data

Figure B: Campaign 2

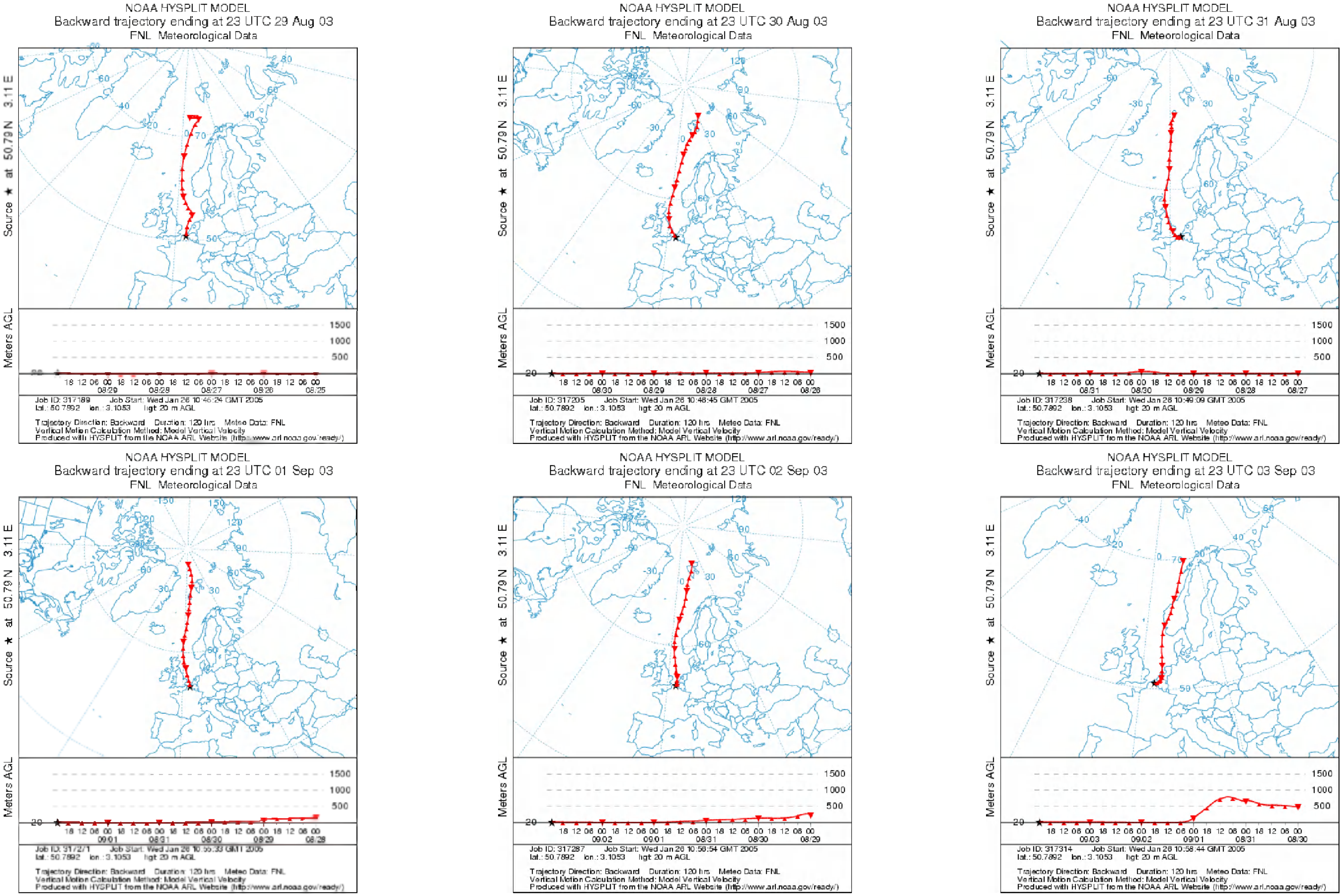


Figure B: Campaign 2 (continued)

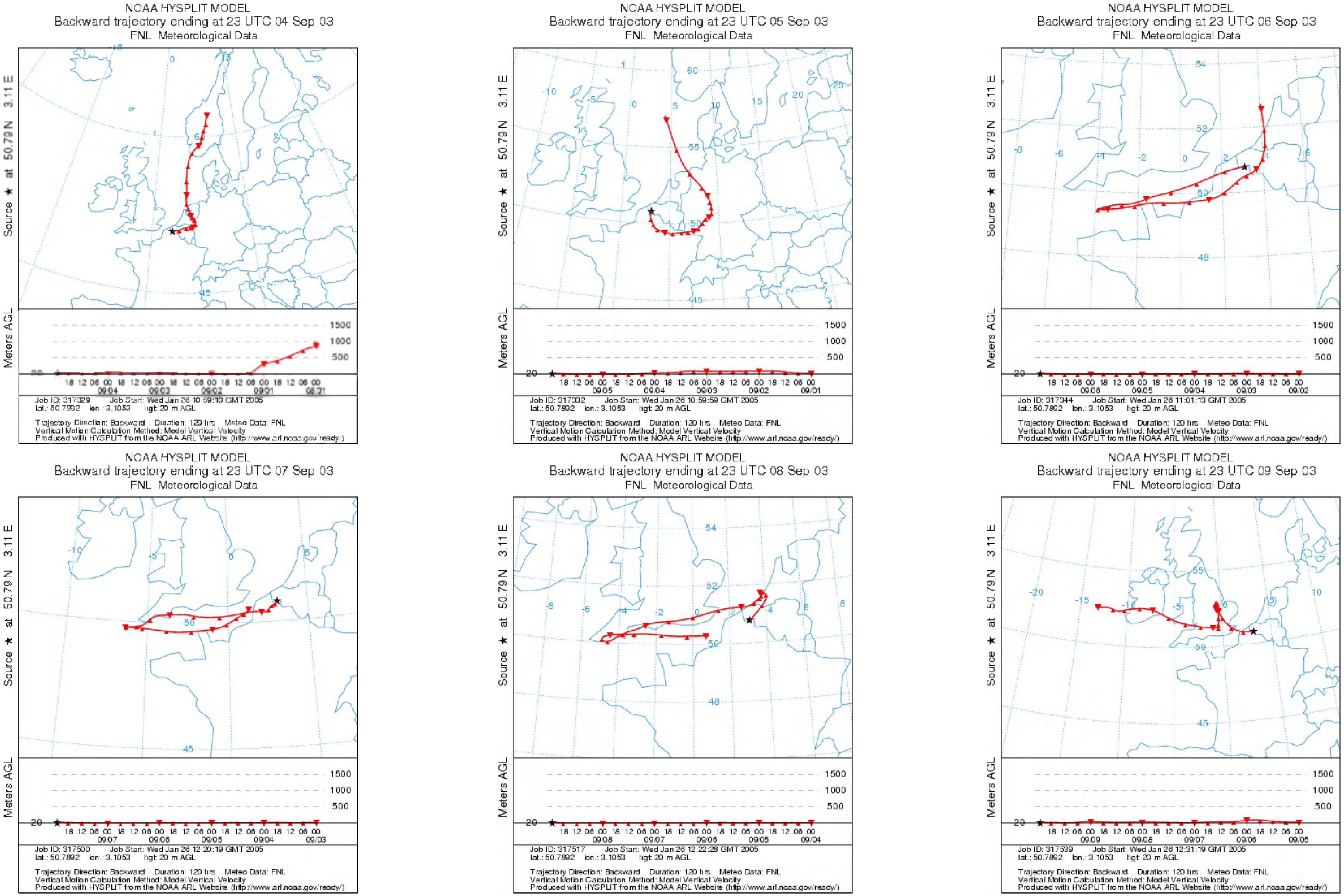


Figure B: Campaign 2 (continued)

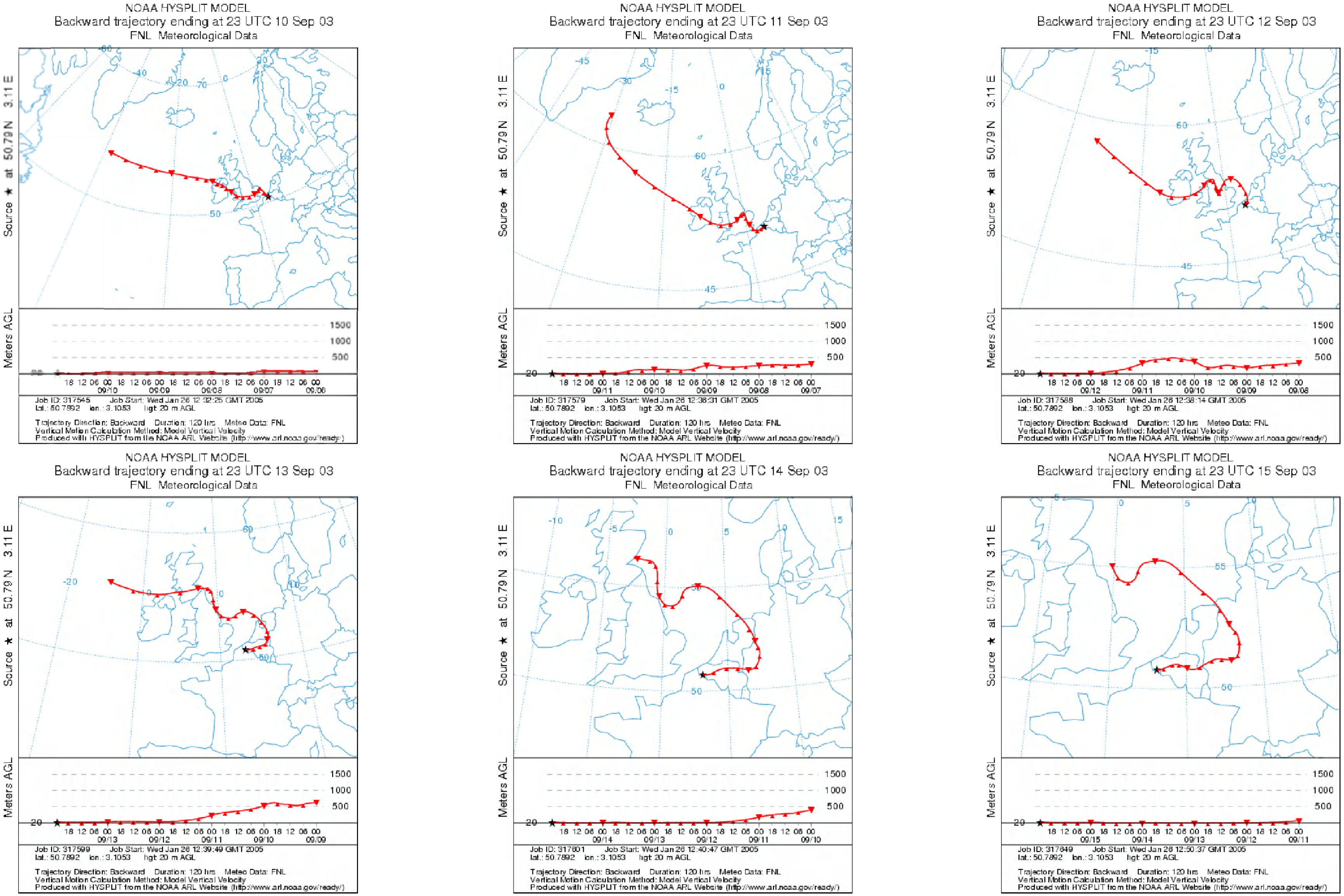


Figure B: Campaign 2 (continued)

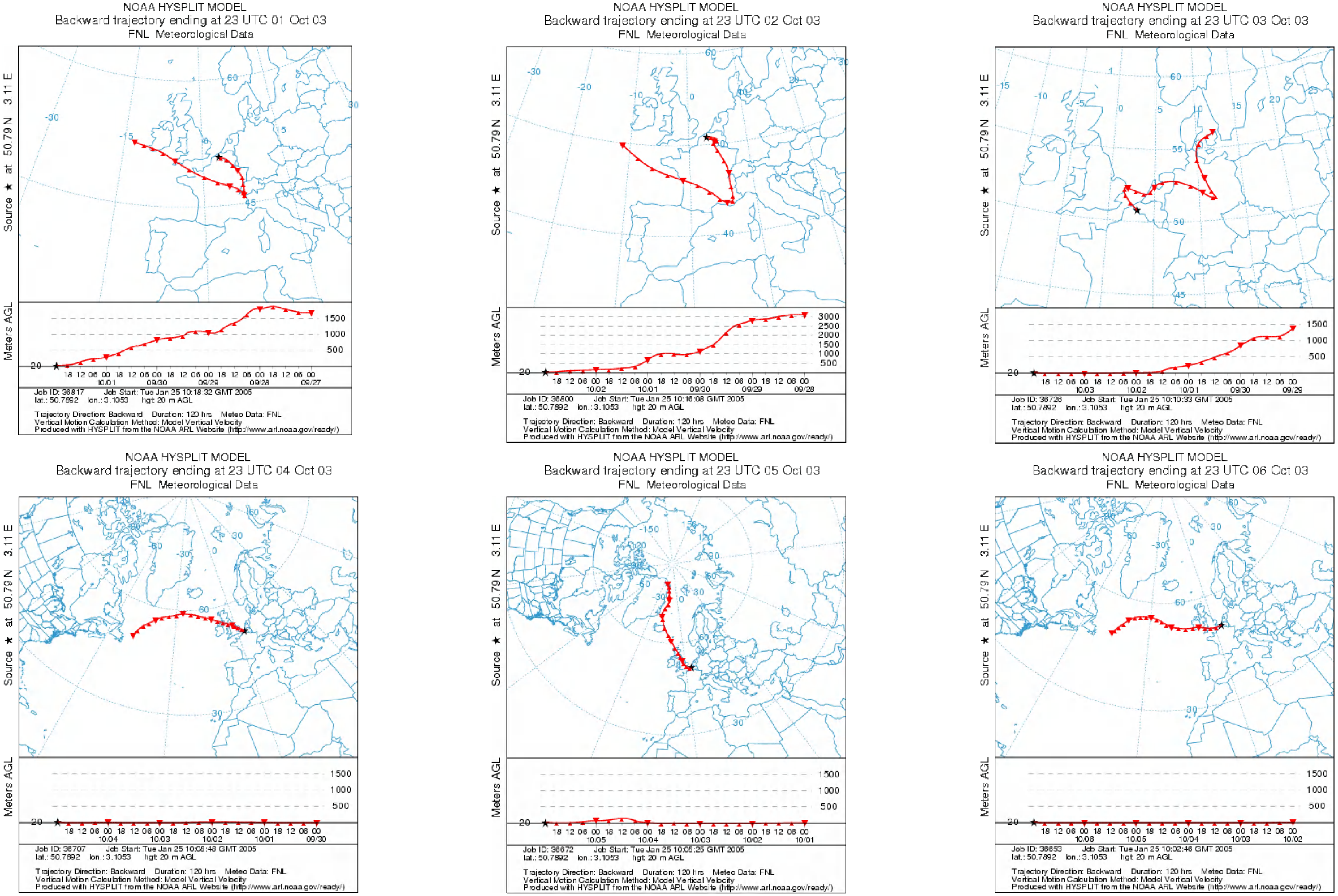


Figure C: Campaign 3

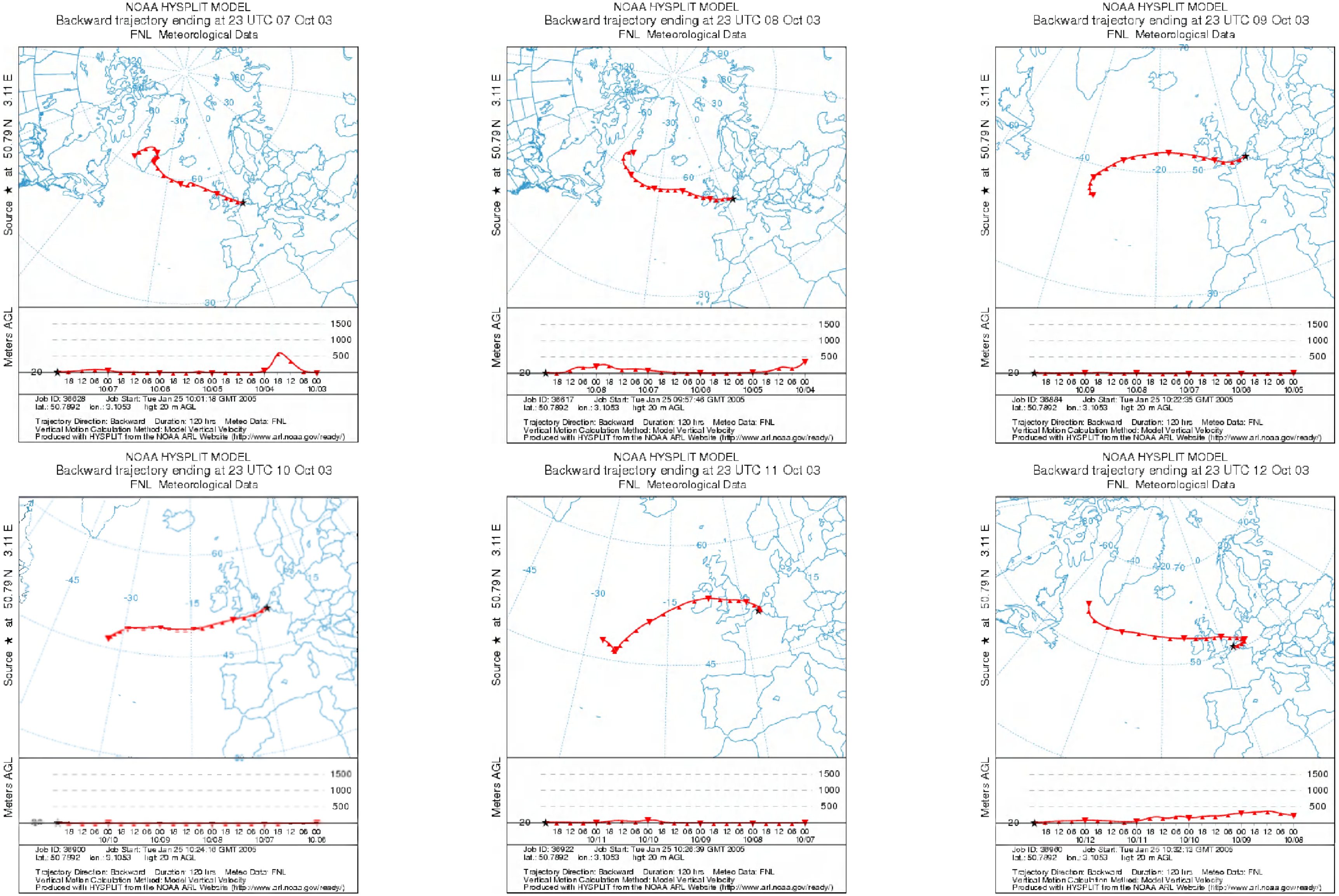


Figure C: Campaign 3 (continued)

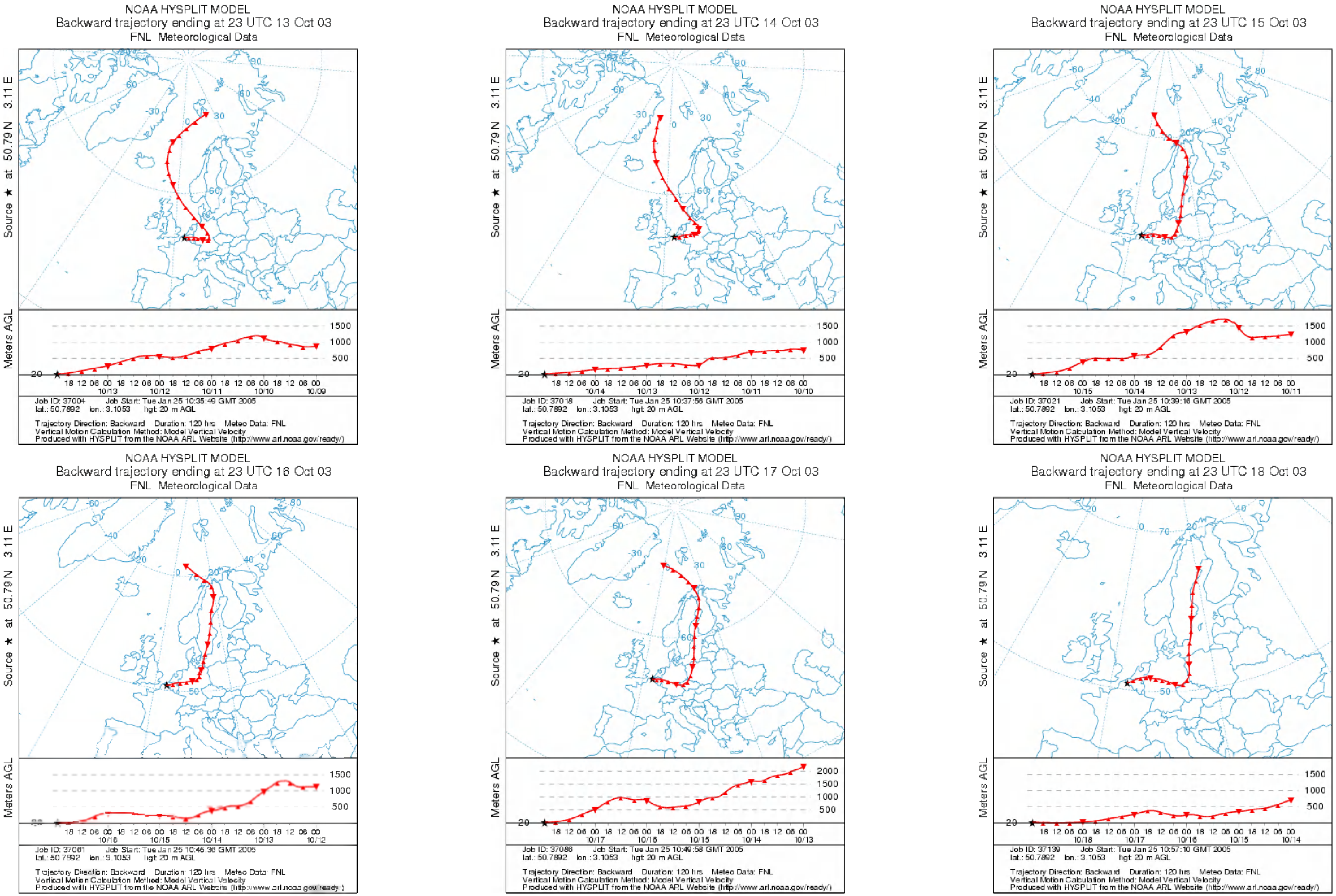


Figure C: Campaign 3 (continued)

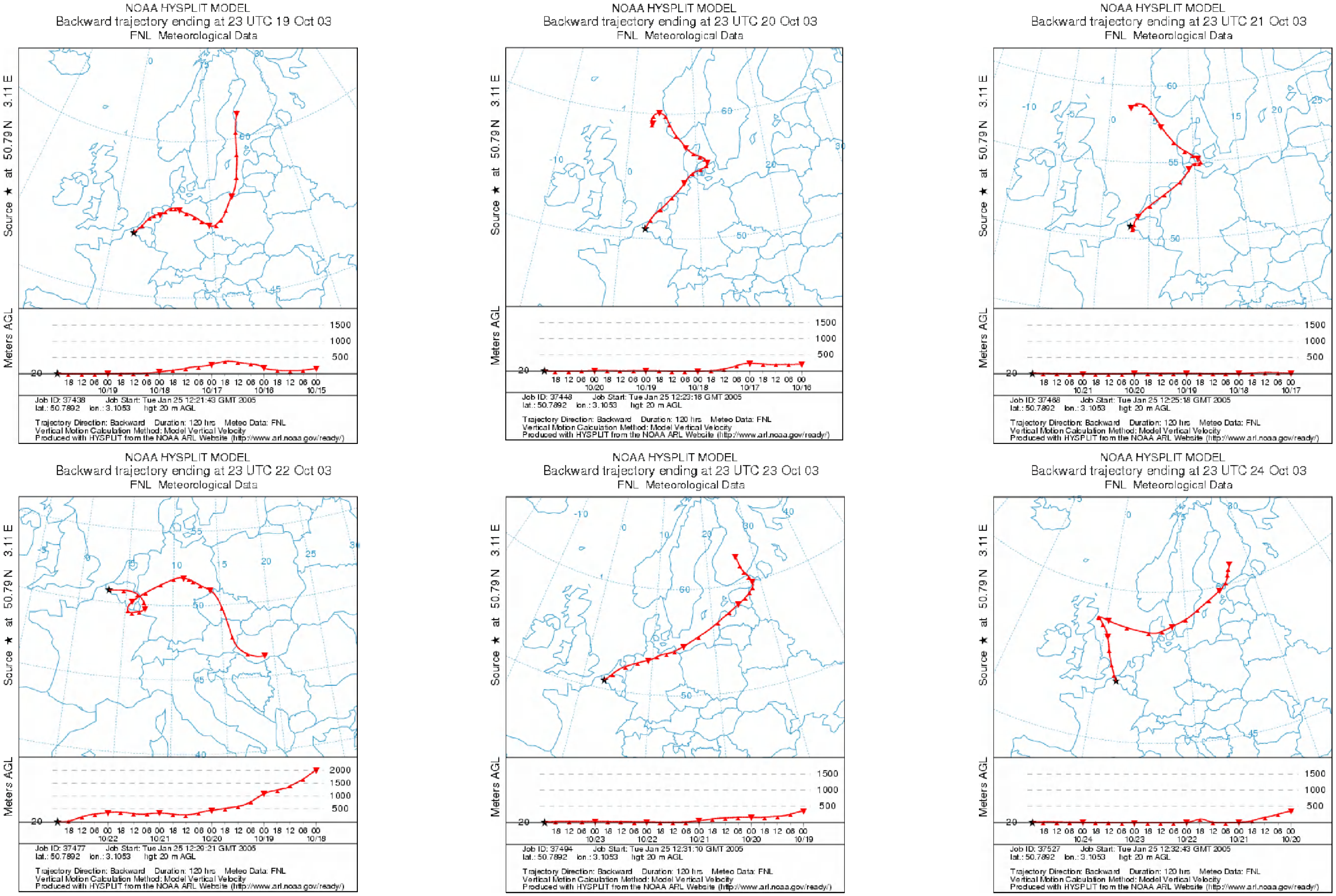


Figure C: Campaign 3 (continued)

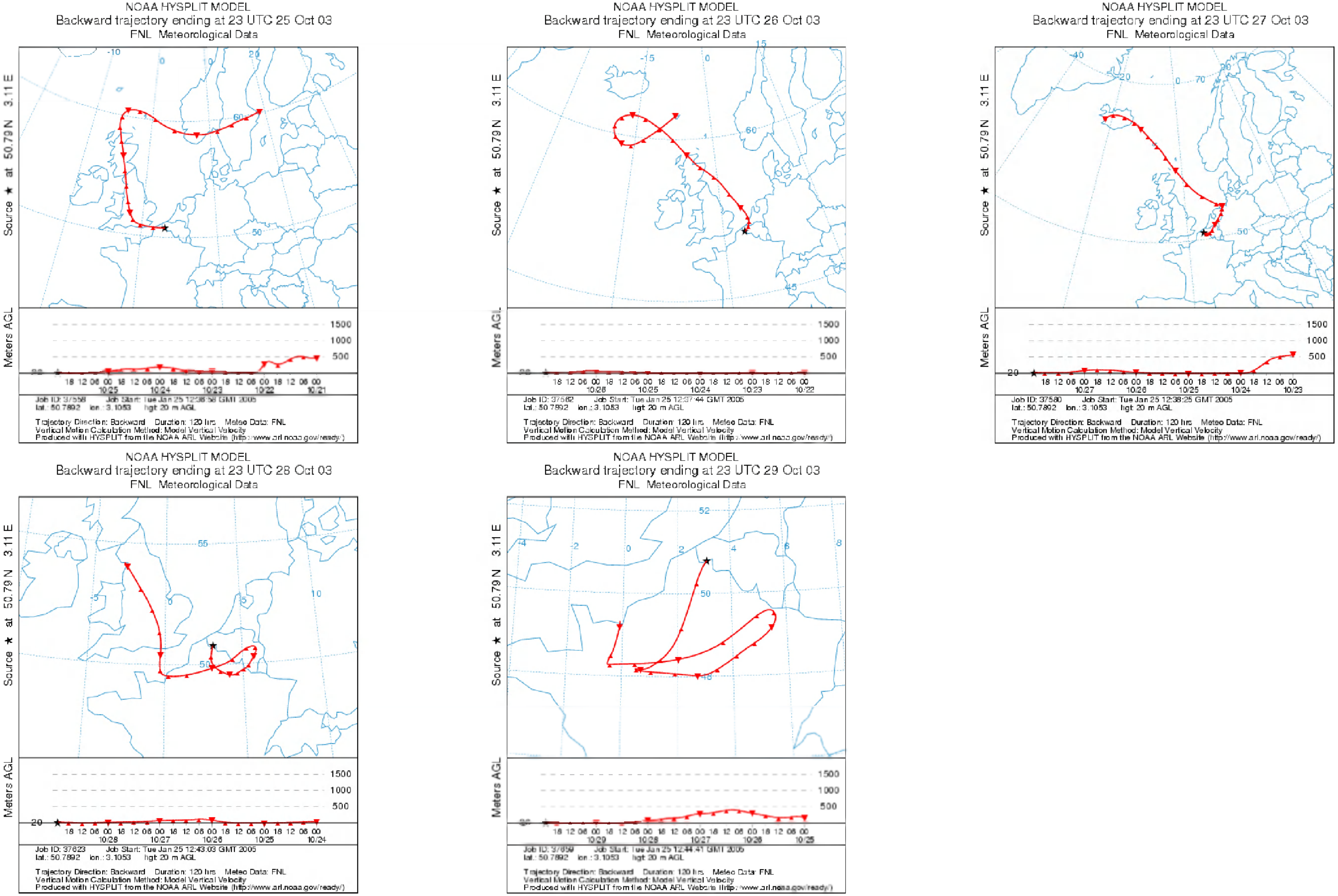


Figure C: Campaign 3 (continued)

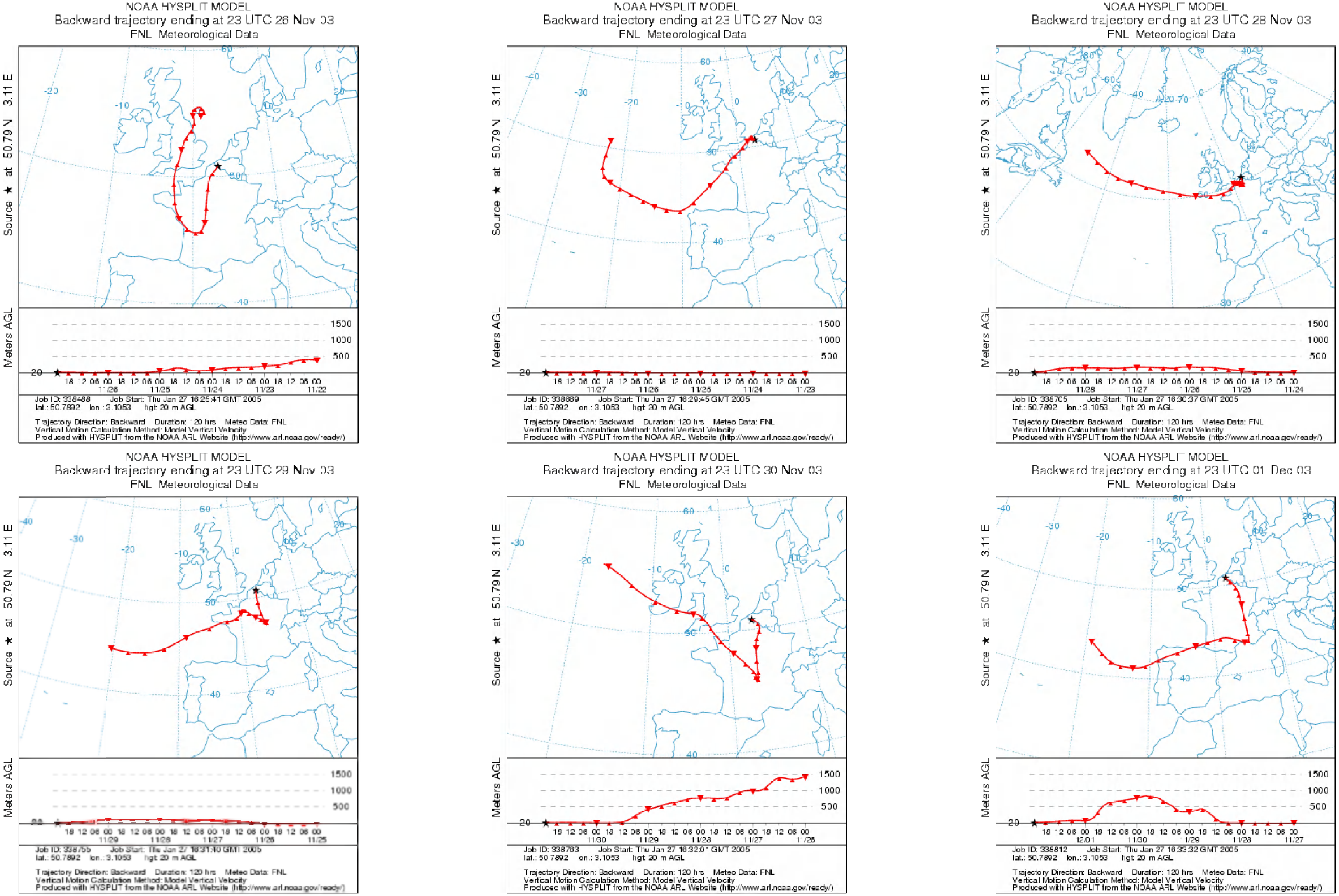


Figure D: Campaign 4

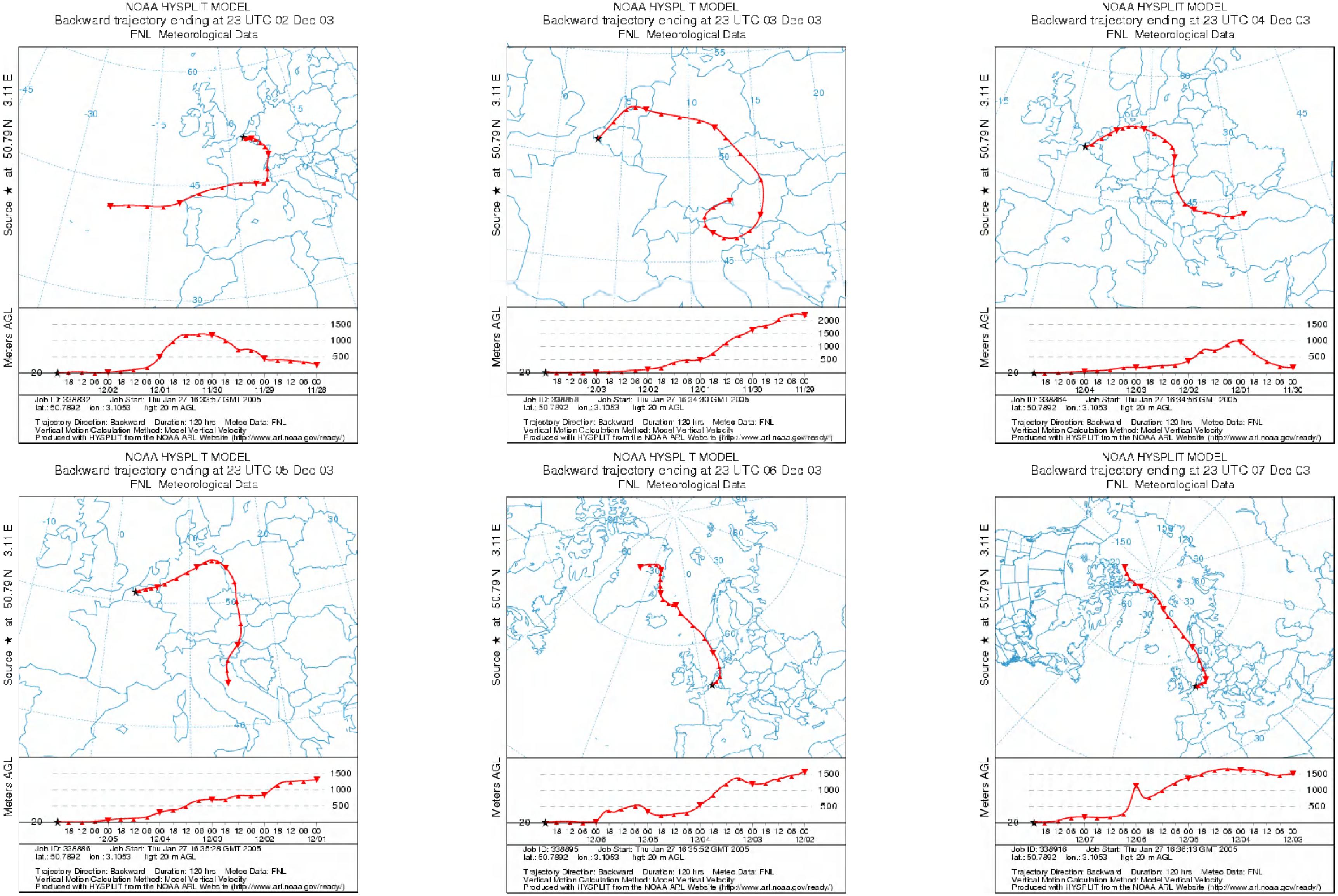


Figure D: Campaign 4 (continued)

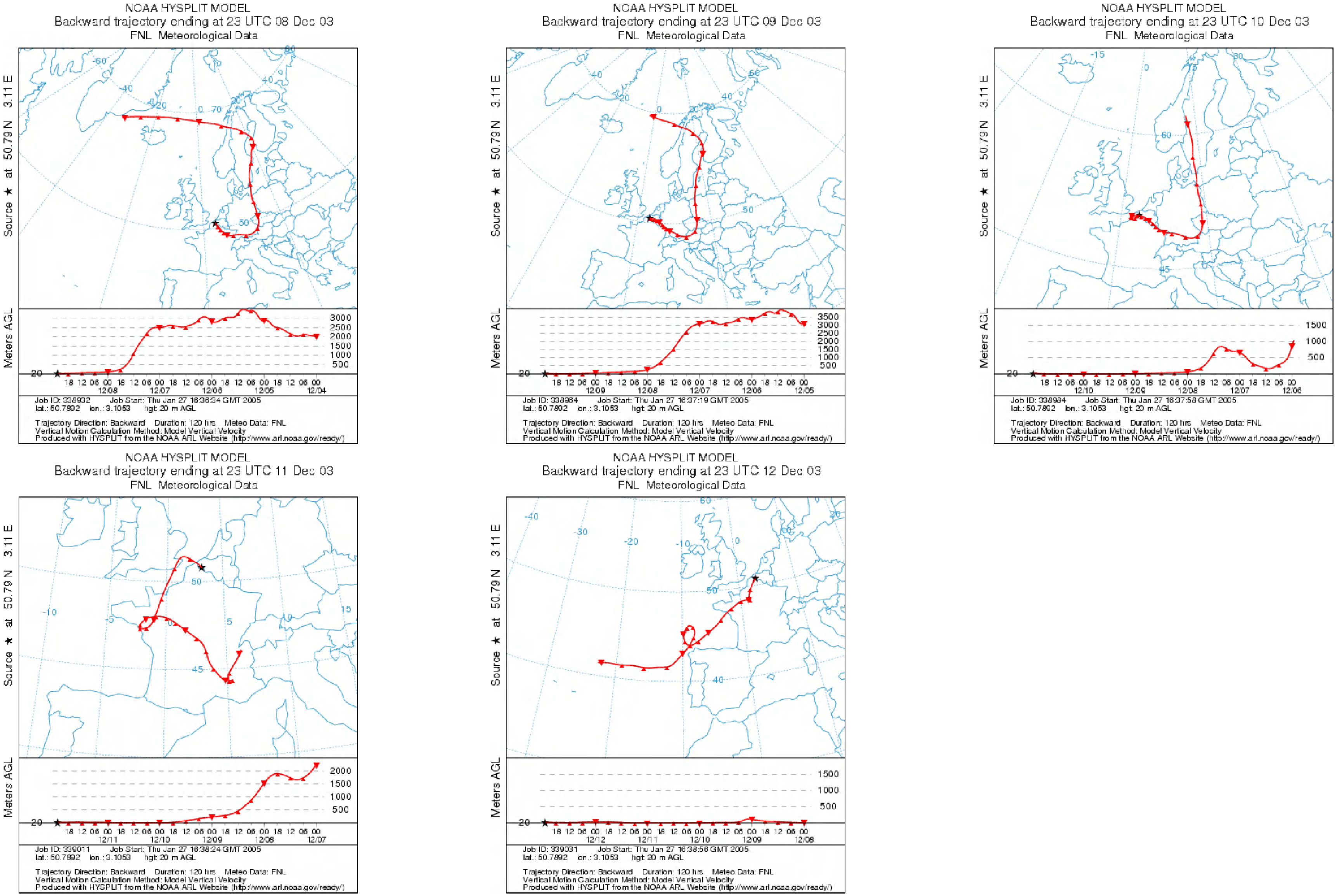


Figure D: Campaign 4 (continued)