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National Air Pollution Surveillance (NAPS) Network

Air Quality in Canada: 2001 Summary and 1990-2001 Trend Analysis

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Canada

NATIONAL AIR POLLUTION SURVEILLANCE (NAPS) NETWORK

AIR QUALITY IN CANADA: 2001 SUMMARY AND 1990-2001 TREND ANALYSES

Environmental Technology Advancement Directorate
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1.0 INTRODUCTION

This report characterises air quality in 2001 across Canada using measurements from the National Air Pollution Surveillance (NAPS) network. The report is intended to be a supplement to the NAPS Annual Data Summary for 2001 (EC 2002) and illustrates geographical and temporal variations in pollutant concentrations across Canada. Trends in pollutant levels over the period 1990 to 2001 are also provided. The atmospheric pollutants included in this report are sulphur dioxide, carbon monoxide, ground-level ozone, nitrogen oxides, particulate matter, and a number of organic and inorganic compounds. The air quality in Canada varies by both geographical location and time of year, and certain pollutants are associated with and present at levels of concern in specific areas.

2.0 NAPS NETWORK

2.1 Description of Network

The NAPS network was established in 1969 as a joint program of the federal, provincial and municipal governments to monitor and assess the quality of ambient air in Canadian urban centres. In 2001, the network consisted of 253 stations in 156 locations with over 600 monitors in operation (Appendix II). Additional air quality monitoring sites are located in some provinces; however, data from these sites are not reported to NAPS. This report deals only with data in the NAPS network database. The NAPS network co-operating agencies are listed below. Contact information for each agency is available in Appendix I.

NAPS Network Co-operating Agencies

Newfoundland and Labrador Department of Environment & Labour
Prince Edward Island Fisheries, Aquaculture and Environment
Nova Scotia Environment & Labour
New Brunswick Department of the Environment and Local Government
Gouvernement du Québec, Ministère de l'Environnement
Ville de Montréal, Direction de l’environnement
Ontario Ministry of the Environment
Manitoba Conservation
Saskatchewan Environment
Alberta Environment
British Columbia Ministry of Water, Land and Air Protection
Greater Vancouver Regional District (GVRD)
Yukon Department of Environment
Northwest Territories Resources, Wildlife and Economic Development
Government of Nunavut

Figure 2.1 Sites in Canada Participating in the National Air Pollution Surveillance Program

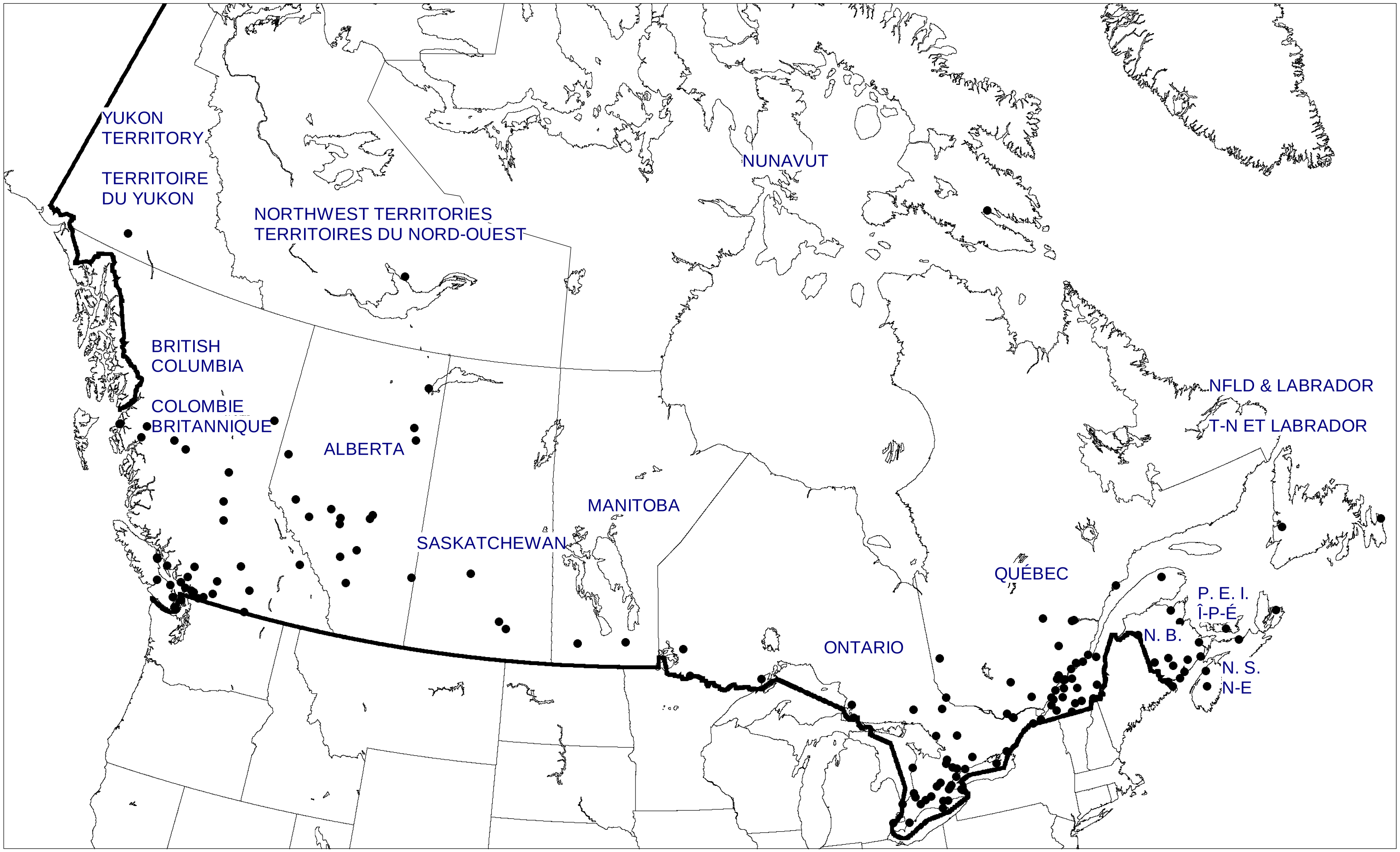


Figure 2.2a Sites in Eastern Québec and Atlantic Canada Participating in the NAPS Program

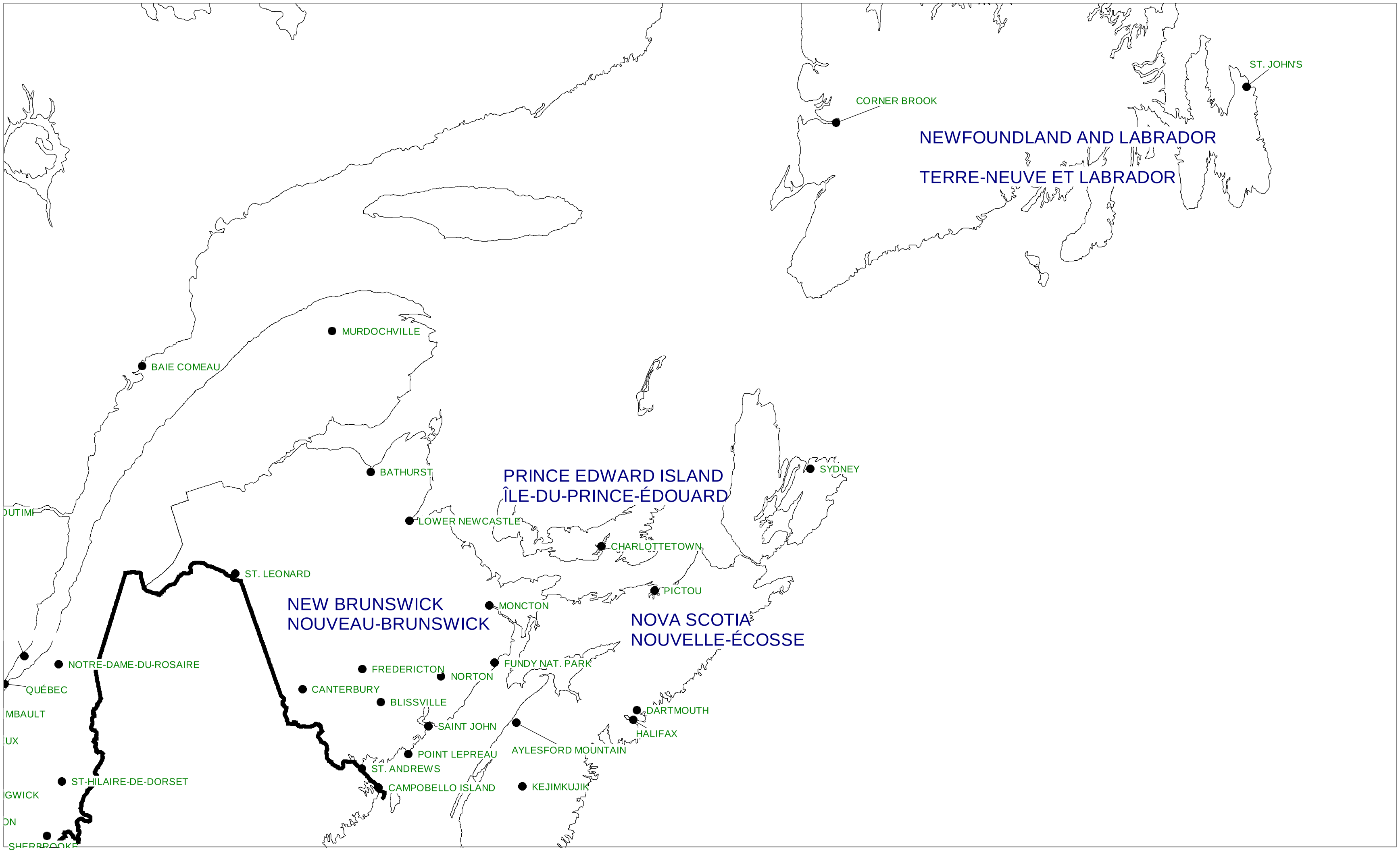


Figure 2.2b Sites in Québec Participating in the NAPS Program

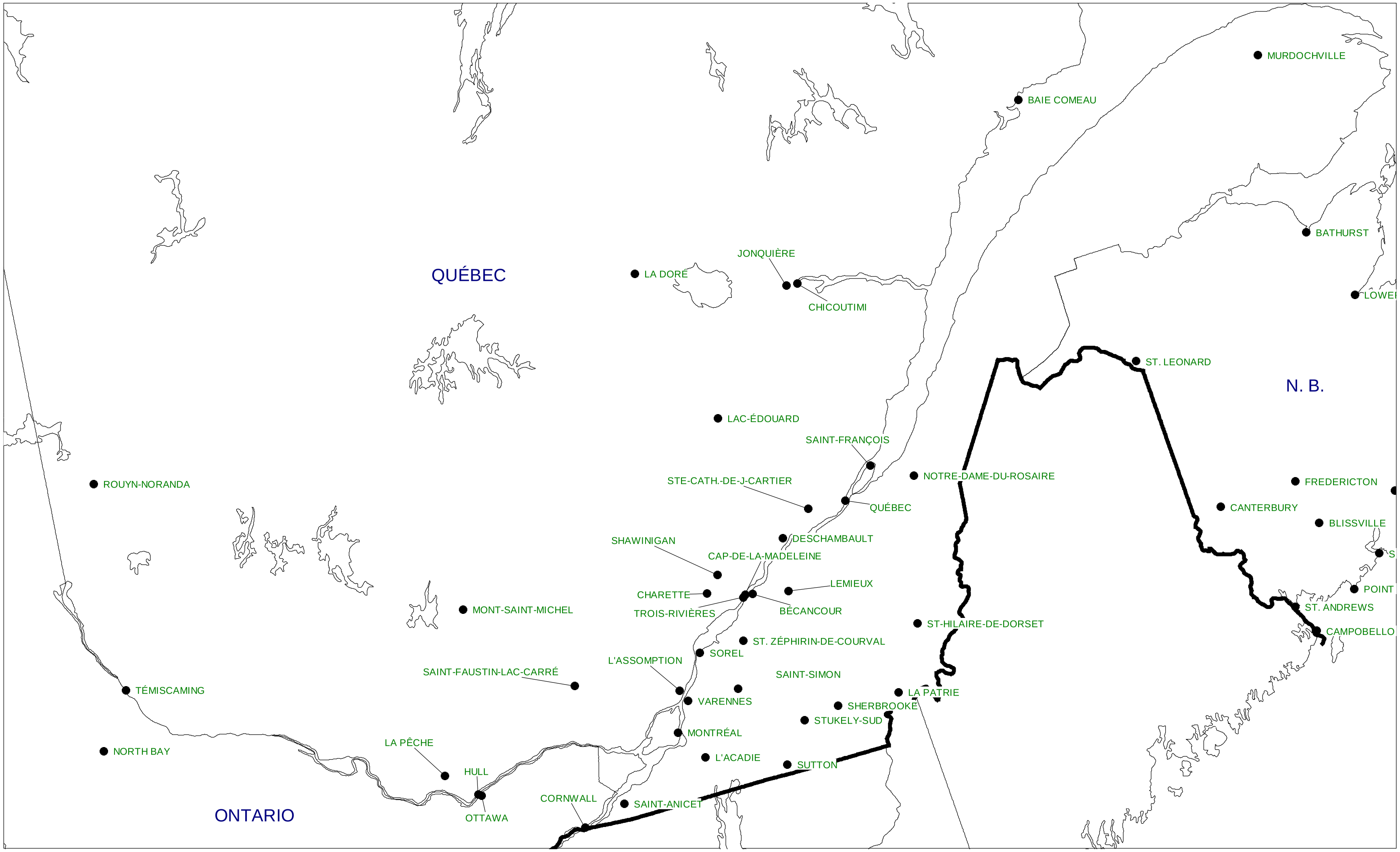


Figure 2.2c Sites in Ontario Participating in the NAPS Program

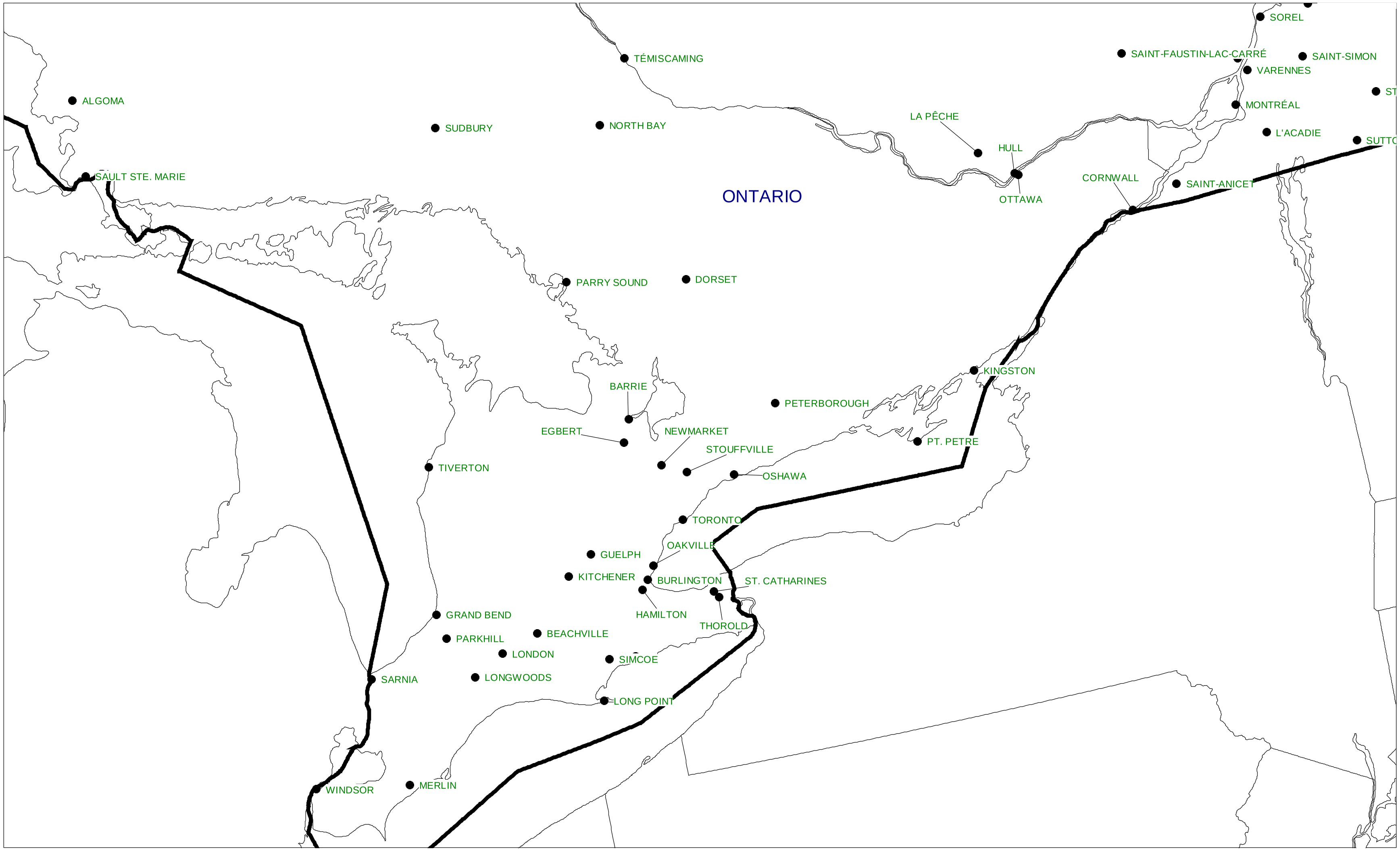


Figure 2.2d Sites in Northern Ontario, Manitoba, and Saskatchewan Participating in the NAPS Program

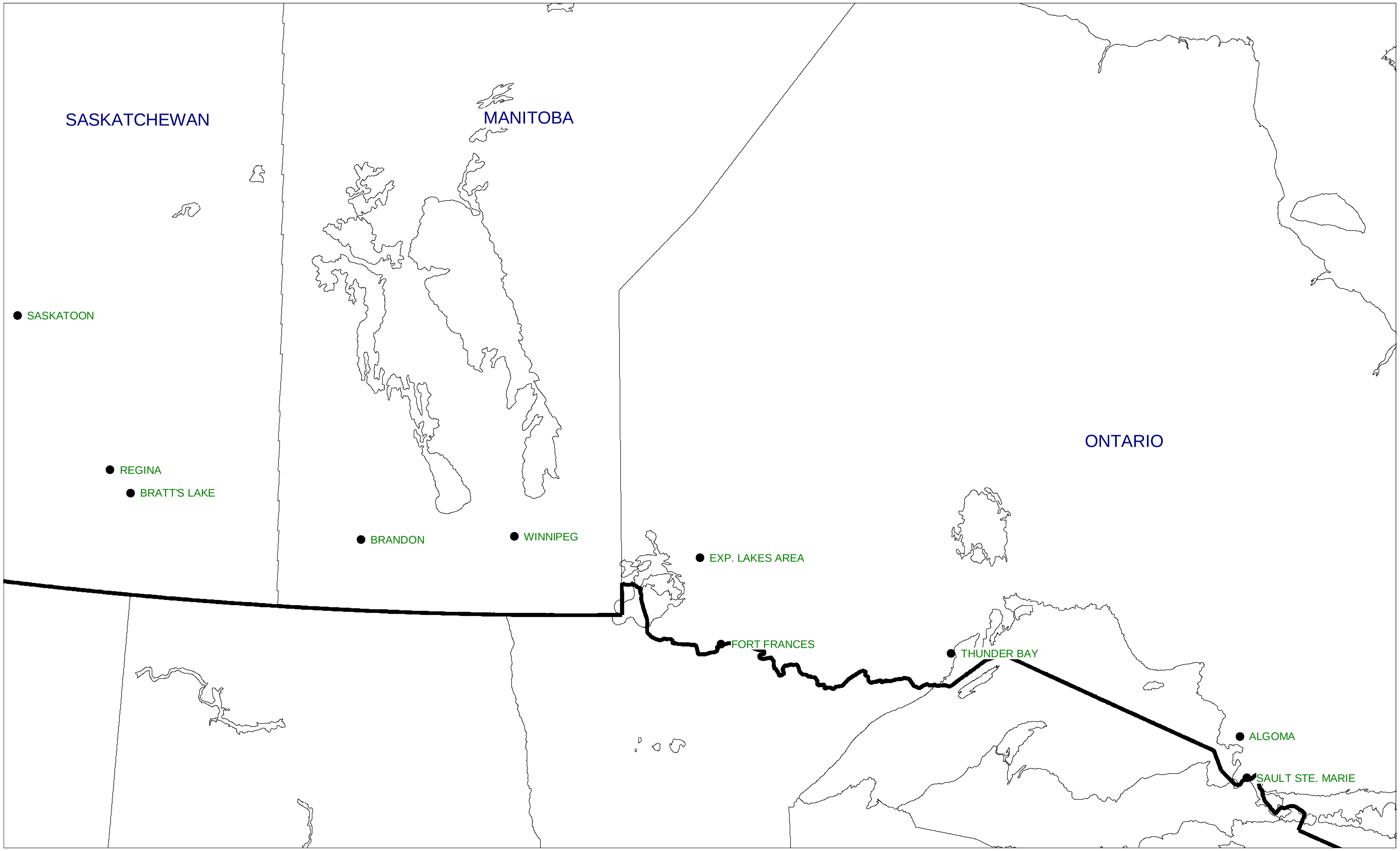


Figure 2.2e Sites in Alberta and British Columbia Participating in the NAPS Program

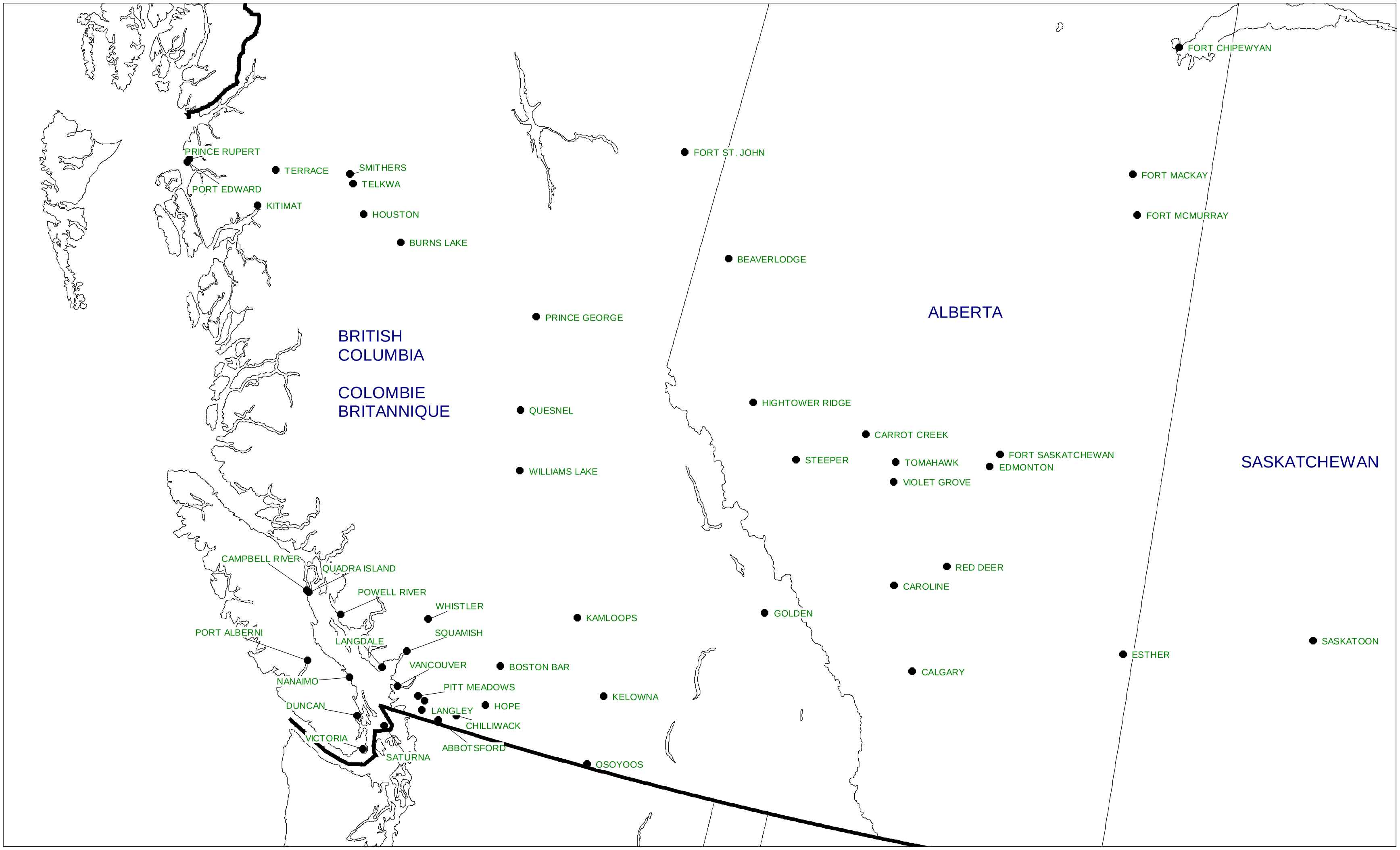
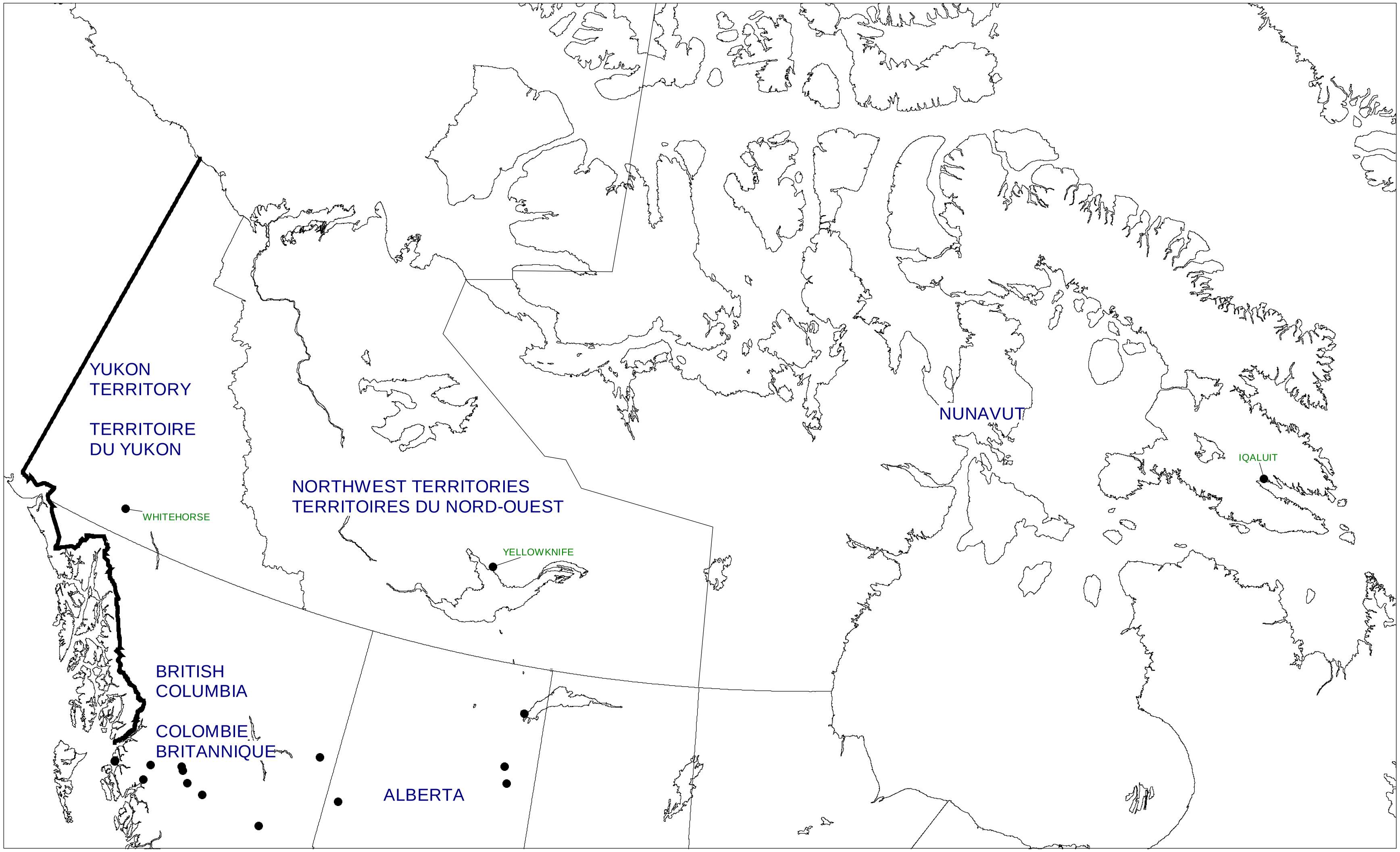


Figure 2.2f Sites in Yukon Territory, Northwest Territories and Nunavut Participating in the NAPS Program



2.2 Pollutants Measured

The NAPS program originally included continuous measurements of the ‘criteria’ air pollutants, including sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ground-level ozone (O_3), and total suspended particulate matter (TSP). The program now supports a number of other monitoring activities related to priority national air issues. For Canada’s national Smog Management Program, measurements of nitric oxide (NO), nitrogen oxides (NO_x), and volatile organic compounds (VOCs) are reported to the NAPS database. The NO and NO_X measurements are made continuously while VOC measurements are usually carried out over 24 hours once every six days. VOC samples are analyzed for over 150 individual compounds. An inhalable particulate matter (PM) monitoring program began in 1984 for particles with diameters less than 10 µm (PM_{10}) and less than 2.5 µm ($PM_{2.5}$) using dichotomous samplers. Filters from the dichotomous samplers are analysed for 50 elements, including metals such as arsenic, lead, and mercury, 14 inorganic and organic ions, and 11 inorganic cations. Details on the NAPS program can be found in (Dann 1994), (Dann and Wang 1995), (Brook et al. 1997), (Dann 1998), (Dann and Kreiger 2000), and (Dann and Wang 2001).

Continuous $PM_{2.5}$ and PM_{10} monitoring was introduced to the network in 1994. In 2001, there were over 150 continuous PM instruments (Rupprecht & Patashnick Tapered Element Oscillating Microbalance or TEOM instruments) in operation.

Table 2.1 provides a summary of pollutants measured in the NAPS network and stored in the NAPS database including start and end years. Pollutants covered in this report are in italics. A brief description of measurement methods is provided in Table 2.2.

Table 2.1 Pollutants Measured in the NAPS Network

Gases – 1 Hour (ppb)

Sulphur Dioxide 1974-2001
Nitrogen Dioxide 1974-2001
Carbon Monoxide (ppm) 1974-2001
Nitric Oxide 1980-2001
Ozone 1974-2001
Nitrogen Oxides 1980-2001

Particulate Matter – 1 Hour (µg/m^3)

Particulate Matter (2.5u) $PM_{2.5}$ 1995-2001
Soiling Index 1974-1997
Particulate Matter(10u) PM_{10} 1992-2001

Particulate Matter – 24 Hours (µg/m^3)

Suspended Particulate Matter SPM 1974-2001
Suspended Particulate Sulphate SPL 1974-1998
Particulate Lead $PL_{2.5}$ 1984-2001
Particulate Lead PL_{10} 1984-2001
Suspended Particulate Lead SPL 1974-1998
Particulate Matter PM_{10} 1984-2001
Particulate Sulphate $PS_{2.5}$ 1984-2001
Particulate Sulphate PS_{10} 1984-2001

Particulate Matter - 1 Month

Dustfall (g/m^2/30days) 1974-1989
Sulphation (mg/100cm^2/day) 1974-1989

Particulate Matter - 24 Hours (µg/m^3)

PM_{10} $PM_{2.5}$ Anions and Cations, Metals 1984-2001

Acetate
Aluminum
Ammonium
Antimony
Arsenic
Barium
Bismuth
Bromide
Bromine
Cadmium
Calcium
Cerium
Cesium
Chloride
Chlorine
Chromium
Cobalt
Copper
Fluoride
Formate
Gallium
Germanium
Indium
Iodine
Iron
Lanthanum
Lead
Magnesium
Manganese
Mercury
Molybdenum
Neodymium
Nickel
Niobium
Nitrate
Nitrite
Oxalate
Palladium
Particulate $PM_{2.5}$ & PM_{10}
Phosphate
Phosphorus
Potassium
Praseodymium
Rubidium
Scandium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphate
Sulphur
Tantulum
Tellurium
Thallium
Tin
Titanium
Tungsten
Vanadium
Yttrium
Zinc
Zirconium

Volatile Organic Compounds ($\mu g/m^3$) 1989-2001

1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,2 Dibromoethane
1,2,3-Trimethylbenzene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2-Diethylbenzene
1,3,5-Trimethylbenzene
1,3-Butadiene
1,3-Dichlorobenzene
1,3-Diethylbenzene
1,4-Dichlorobenzene
1,4-Dichlorobutane
1,4-Diethylbenzene
1-Butene
1-Butene/Isobutene
1-Butyne
1-Decene
1-Heptene
1-Hexene
1-Methylcyclohexene
1-Methylcyclopentene
1-Nonene
1-Octene
1-Pentene
1-Propyne
2,2,3-Trimethylbutane
2,2,4-Trimethylpentane
2,2,5-Trimethylhexane
2,2-Dimethylbutane
2,2-Dimethylhexane
2,2-Dimethylpentane
2,2-Dimethylpropane
2,3,4-Trimethylpentane
2,3-Dimethylbutane
2,3-Dimethylpentane
2,4-Dimethylhexane
2,4-Dimethylpentane
2,5-Dimethylbenzaldehyde
2,5-Dimethylheptane
2,5-Dimethylhexane
2-Ethyl-1-Butene
2-Ethyltoluene
2-Methyl-1-Butene
2-Methyl-1-Pentene
2-Methyl-2-Butene
2-Methyl-2-Pentene
2-Methylheptane
2-Methylhexane
2-Methylpentane
2-Pentanal
3,6-Dimethyloctane
3-Ethyltoluene
3-Methyl-1-Pentene
3-Methylheptane
3-Methylhexane
3-Methyloctane
3-Methylpentane
4-Ethyltoluene
4-Methyl-1-Pentene
Acetone
Acetylene
Acrolein
Alpha-Pinene
Benzaldehyde
Benzene
Beta-Pinene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Bromotrichloromethane
Butane
Carbontetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,2-Dimethylcyclohexane
cis-1,3-Dichloropropene
cis-1,3-Dimethylcyclohexane
cis-2-Butene
cis-2-Heptene
cis-2-Hexene
cis-2-Octene
cis-2-Pentene
cis-3-Heptene
cis-3-Methyl-2-Pentene
cis-4-Methyl-2-Pentene
Crotonaldehyde
Cyclohexane
Cyclohexene
Cyclopentane
Cyclopentene
Decane
Delta-Limonene
Dibromochloromethane
Dibromomethane
Dichloromethane
Dodecane
Ethane
Ethylbenzene
Ethylbromide
Ethylene
Formaldehyde
Freon 11
Freon 114
Freon 12
Freon 22
Heptane
Hexachlorobutane
Hexanal
Hexane
Hexylbenzene
Indane
Isobutane
Iso-Butylbenzene
Isopentane
Isoprene
Iso-Propylbenzene
Isovaleraldehyde
m and p-Xylene
Methyl Ethyl Ketone
Methyl Iso-Butyl Ketone
Methylcyclopentane
m-Tolualdehyde
Naphthalene
N-Butylbenzene
Nonane
N-Propylbenzene
Octane

o-Tolualdehyde
o-Xylene
p-Cymene
Pentane
Propane
Propionaldehyde
Propylene
p-Tolualdehyde
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans & cis-1,3-Dichloropropene
trans-1,2-Dichloroethylene
trans-1,2-Dimethylcyclohexane
trans-1,3-Dichloropropene
trans-1,3-Dimethylcyclohexane
trans-1,4-Dimethylcyclohexane
trans-2-Butene
trans-2-Heptene
trans-2-Hexene
trans-2-Octene
trans-2-Pentene
trans-3-Heptene
trans-3-Methyl-2-Pentene
trans-4-Methyl-2-Pentene
Trichloroethylene
Undecane
Vinylchloride

Semi-volatile Organic Compounds (µg/m^3) 1989-2001

1-Methylpyrene
2-Methylfluorene
3-Methylcholanthrene
7-Methylbenzo(a)anthracene
Acenaphthene
Acenaphthylene
Anthanthrene
Anthracene
Benzo (k)fluoranthene
Benzo(a)anthracene
Benzo(a)fluorine
Benzo(a)pyrene
Benzo(b)chrysene
Benzo(b)fluoranthene
Benzo(b)fluorene
Benzo(e)pyrene
Benzo(ghi)fluoranthene
Benzo(ghi)perylene
Chrysene
Dibenzo(ah)anthracene
Fluoranthene
Fluorene
Indeno Pyrene
Perylene
Phenanthrene
Pyrene
Triphenylene

Semi-volatile Organic Compounds (fg/m^3-TEQ) 1989-2001

Polychlorodibenzo-p-dioxin
Polychlorodibenzofuran
1,3-Dinitropyrene
1,6-Dinitropyrene
1,8-Dinitropyrene
12-Ethyl-6-nitrochrysene
1-Nitrobenzo(a)pyrene
1-Nitrobenzo(e)pyrene
1-Nitropyrene
2-Nitroanthracene
2-Nitrobenzo(a)pyrene
2-Nitrofluoranthene
2-Nitrofluorene
2-Nitropyrene
3-Nitrobenzo(a)pyrene
3-Nitrobenzo(e)pyrene
3-Nitrofluoranthene
4-Nitrobenzo(e)pyrene
4-Nitropyrene
6-Nitro-3,4-benzocoumarin
6-Nitrobenzo(a)pyrene
6-Nitrochrysene
7-Nitro-12-methylbenzo(a)anthracene
7-Nitrobenz(a)anthracene
9-Nitroanthracene
9-Nitrodibenzo(a,c)anthracene
9-Nitrophenanthrene
Hexachlorobenzene
Octachlorostyrene
Pentachlorophenol
Total Nitro-C13
Total Nitro-C14
Total Nitro-C16
Total Nitro-C18
Total Nitro-C20
Total Nitro-C22

2.3 Instrumentation and Data Collected

NAPS data are validated using automated and manual procedures. Data from network cooperating agencies are converted to a NAPS-compatible format and entered in the NAPS database. Although the agency data analyst has validated the data, they are also submitted to tests outlined by the United States Environmental Protection Agency. When data are flagged automatically or manually, the relevant agency must confirm the data before they are stored in the NAPS database.

Previous reviews and trend analyses of data from the NAPS network are found in a number of published reports (Fuentes and Dann 1994; Furmanzcyk 1994; EC 1996) and data files are available upon request (Appendix III).

2.4 Quality Assurance

The NAPS network cooperating agencies' quality assurance (QA) and quality control programs are supplemented by a quality assurance program conducted by Environment Canada. These ensure that the ambient air monitoring data collected from NAPS stations are valid, complete, comparable, representative, and accurate. Elements of the network QA program described in a report include site selection, sampling system requirements, site and analyzer operation, instrument calibration and reference standards, inter-laboratory testing and performance audit program, data validation and reporting, documentation, and training and technical support.

The methods used to measure pollutants for which national air quality objectives exist (sulphur dioxide, carbon monoxide, nitrogen dioxide, ozone and total suspended particulates) have been designated as "reference methods" or "equivalent methods" by the United States Environmental Protection Agency. The methods are strictly governed by operation or instruction manuals and applicable quality assurance procedures. Calibration standards used in the NAPS network are certified traceable to United Sates National Institute of Standards and Technology (NIST) primary standards. Standard Operating Procedures (SOPs) are available for VOC, dichotomous sampler mass, anions, cations and metals, and for semi-volatile organics. All analyses are conducted in a laboratory accredited by the Standards Council of Canada to ISO Standard 170

Table 2.2 Description of NAPS Network Instrumentation

Pollutant	Detection Principle	Units of Measurement	Minimum Reported Concentration	Type of Monitoring
Sulphur Dioxide	Ultraviolet fluorescence	ppb	1 ppb	Continuous
Carbon Monoxide	Non-dispersive infrared spectrometry	ppm	0.1 ppm	Continuous
Nitrogen Dioxide and Nitric Oxide	Chemiluminescence	ppb	1 ppb	Continuous
Ozone	Chemiluminescence	ppb	1 ppb	Continuous
	Ultraviolet photometry	ppb	1 ppb	Continuous
PM_{10} and $PM_{2.5}$	Inertial mass transducer (TEOM)	µg/m^3	1 µg/m^3	Continuous
	Beta attenuation method (BAM)	µg/m^3	1 µg/m^3	Continuous
Suspended Particulate Matter	Gravimetric	µg/m^3	1 µg/m^3	Intermittent (24-h sample every 6th day)
PM_{10} – SSI sampler	Gravimetric	µg/m^3	1 µg/m^3	Intermittent (24-h sample)
PM_{10} and $PM_{2.5}$ – Particulate Matter Dichotomous Sampler	Gravimetric	µg/m^3	1 µg/m^3	Intermittent (24-h sample)
PM_{10} and $PM_{2.5}$ – Elements Dichotomous sampler	X-ray Fluorescence	µg/m^3	0.01 µg/m^3	Intermittent (24-h sample)
PM_{10} and $PM_{2.5}$ – Ions Dichotomous sampler	Ion Chromatography	µg/m^3	0.1 µg/m^3	Intermittent (24-h sample)
Organic Compounds	Gas Chromatography, Mass Spectrometry	µg/m^3	0.05 µg/m^3	Intermittent (24-h sample)

ppm = parts per million by volume of air sampled
ppb = parts per billion by volume of air sampled
µg/m^3 = micrograms per cubic metre of air sampled

3.0 AIR QUALITY OBJECTIVES AND STANDARDS

3.1 National Air Quality Objectives

National ambient air quality objectives (NAAQOs) have traditionally been the benchmark against which Canada assesses the impact of anthropogenic activities on air quality and to ensure that current emission control policies are protecting human health and the environment. The first Canadian NAAQOs were developed in the mid-1970s. These objectives consisted of a three-tiered approach (maximum desirable, acceptable, and tolerable levels), which identified ranges of air quality with specific levels of effect.

Since the development of the NAAQOs, new science has brought new ways of looking at these values. Air quality objectives must be consistent with the philosophy of the Canadian Environmental Protection Act (CEPA) and be based upon recognized scientific principles that include risk assessment and risk management. While the NAAQOS represent national objectives, Provincial and Regional governments have the option of adopting these as objectives or as enforceable standards within their jurisdictions, or they may opt to adopt more stringent values based upon local jurisdictional needs and desires.

Reality is that today only the Acceptable and Desirable Levels of the NAAQOs are generally referred to in air quality management and reporting. While the NAAQO system has not formally been revised to a two-level system, and for the purposes of this report, the 2001 data are compared with the existing Acceptable and Desirable NAAQOs as summarized in Table 3.1.

Table 3.1 National Ambient Air Quality Objectives

Averaging Period	Maximum Desirable Level[†]	Maximum Acceptable Level[†]
Sulphur Dioxide (SO_2)		
Annual arithmetic mean	30 µg/m^3 (11 ppb)	60 µg/m^3 (23 ppb)
Average concentration over a 24-h period	150 µg/m^3 (57 ppb)	300 µg/m^3 (115 ppb)
Average concentration over a 1-h period	450 µg/m^3 (172 ppb)	900 µg/m^3 (334 ppb)
Suspended Particulate Matter		
Annual geometric mean	60 µg/m^3	70 µg/m^3
Average concentration over a 24-h period	-	120 µg/m^3
Carbon Monoxide (CO)		
Average concentration over a 8-h period	6 mg/m^3 (5 ppm)	15 mg/m^3 (13 ppm)
Average concentration over a 1-h period	15 mg/m^3 (13 ppm)	35 mg/m^3 (31 ppm)
Oxidants (Ozone) (O_3)		
Average concentration over a 1-h period	100 µg/m^3 (51 ppb)	160 µg/m^3 (82 ppb)
Nitrogen Dioxide (NO_2)		
Annual arithmetic mean	60 µg/m^3 (32 ppb)	100 µg/m^3 (53 ppb)
Average concentration over a 1-h period	-	400 µg/m^3 (213 ppb)

[†] Conditions of 25°C and 101 kPa are used as a basis for conversion from µg/m^3 to ppb/ppm.

3.2 Canada-wide Standards

In 1998, the federal and provincial governments agreed to establish Canada-wide Standards (CWS) for substances of high priority, consistent with the Canada-wide Accord on Environmental Harmonization. These include two substances that were being developed as Air Quality Objectives, namely particulate matter and ground-level ozone. Canada-wide Standards are science-based in the same manner as AQOs, but also explicitly recognize and incorporate a number of other factors including technical feasibility and economic issues.

CWS have the explicit buy-in of federal and provincial governments and involve the development of jurisdictional risk management plans to attain the agreed-upon Standard. Stakeholder consultation is a fundamental aspect of the CWS process and is conducted on all aspects of the Standard and associated management plans both at the provincial and federal level. Jurisdictions are currently in the process of designating their CWS reporting areas and monitoring stations. All information presented in this report that relates to the CWS is, therefore, strictly preliminary and is not to be construed as being indicative of the achievement status of the Standards. CWS achievement is due by 2010. Canada-wide Standards for fine particulate matter and ground-level ozone were ratified by the Canadian Council of Ministers for the Environment in June 2000. Additional information can be found on the CCME website at www.ccme.ca/ccme.

Canada-wide Standards provisions include a 24-hour average Standard for $PM_{2.5}$ set at 30 µg/m^3 and an 8-hour average Standard for ozone set at 65 ppb. The achievement of these Standards, due in 2010, is assessed based on the value of a specific statistic, or metric, the value of which depends on the measured ambient concentrations of $PM_{2.5}$ and ozone. Under the CWS, the metrics to use to assess achievement of the Standards are:

$PM_{2.5}$ CWS metric = the 3-year average of the annual 98th percentile of the 24-hour average (midnight to midnight) $PM_{2.5}$ concentrations.

Ozone CWS metric = the 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations.

Using the $PM_{2.5}$ and ozone *Guidance Document on Achievement Determination* (GDAD), jurisdictions are currently in the process of designating their Canada-wide Standards (CWS) reporting areas and CWS monitoring stations. ***All information presented in this report that may relate to the CWS is, therefore, strictly preliminary and is not to be construed as being indicative of the achievement status of the Standards***. The CWS achievement is due by 2010. The first comprehensive progress reports on all provisions of the CWS, including assessment of ambient levels and trends, and identification of communities where ambient levels are exceeding or approaching the Standards, will be completed in 2006 for the year 2005.

4.0 AMBIENT CONCENTRATIONS BY POLLUTANT IN 2001

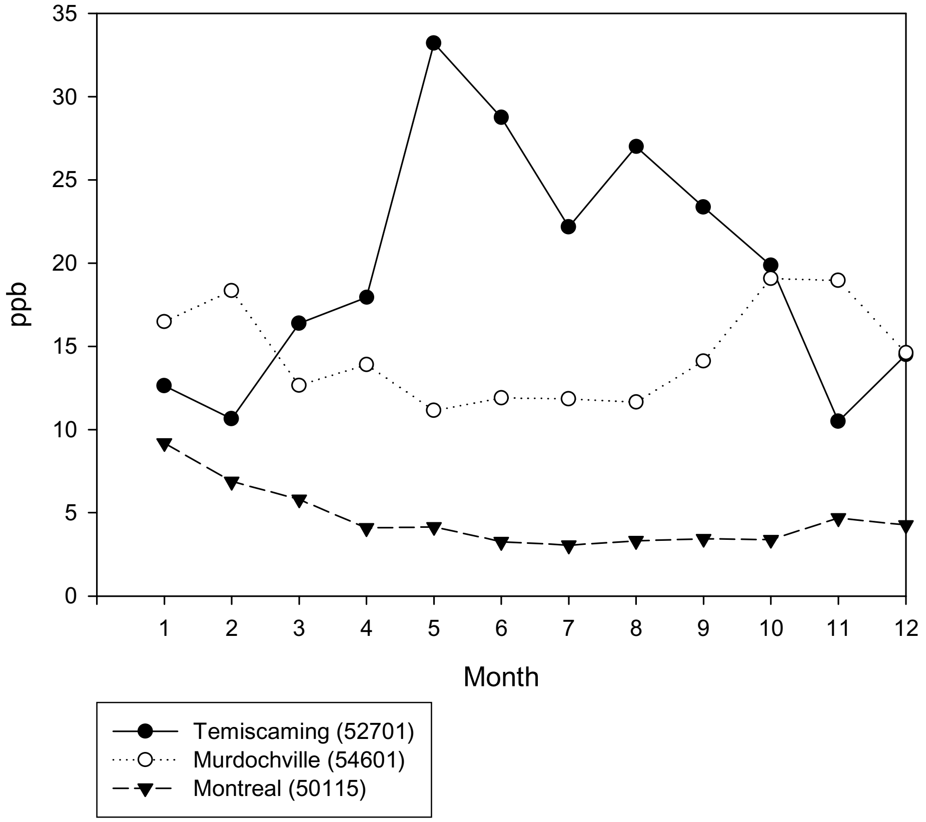
4.1 Sulphur Dioxide

Sulphur dioxide (SO_2) is a major precursor to acid deposition (acid rain). The two most important anthropogenic sources of atmospheric SO_2 are the burning of sulphur-containing fossil fuels (mainly coal and oil) in power plants and the smelting of metal ores. In urban areas, non-industrial fuel consumption and transportation are the primary emission sources. In 1995, industrial sources represented 73.5% of the total national SO_2 emissions, while non-industrial fuel consumption and transportation accounted for nearly all (99.7%) of the remainder (EC 1999). Atmospheric concentrations of SO_2 are generally highest in the vicinity of industrial sources. It should be noted that this report only draws on data submitted to the NAPS database. Although data are included from some sites near industrial sources, there are a number of other provincial and industrial self-monitoring sites across the country for which data were not available for this report. Results from these sites can be found in provincial air quality summary reports.

SO_2 measurement data are reported as 1-h concentrations. Mean monthly SO_2 concentrations are shown for three urban sites – Témiscaming and Murdochville, two sites influenced by industrial point sources, and a commercial site in Montréal – in Figure 4.1. The Murdochville and Montréal sites examples of sites near industrial point sources and urban source sites, respectively. SO_2 levels at the sites in Témiscaming and Murdochville were consistently higher than at the Montréal site. SO_2 levels at the

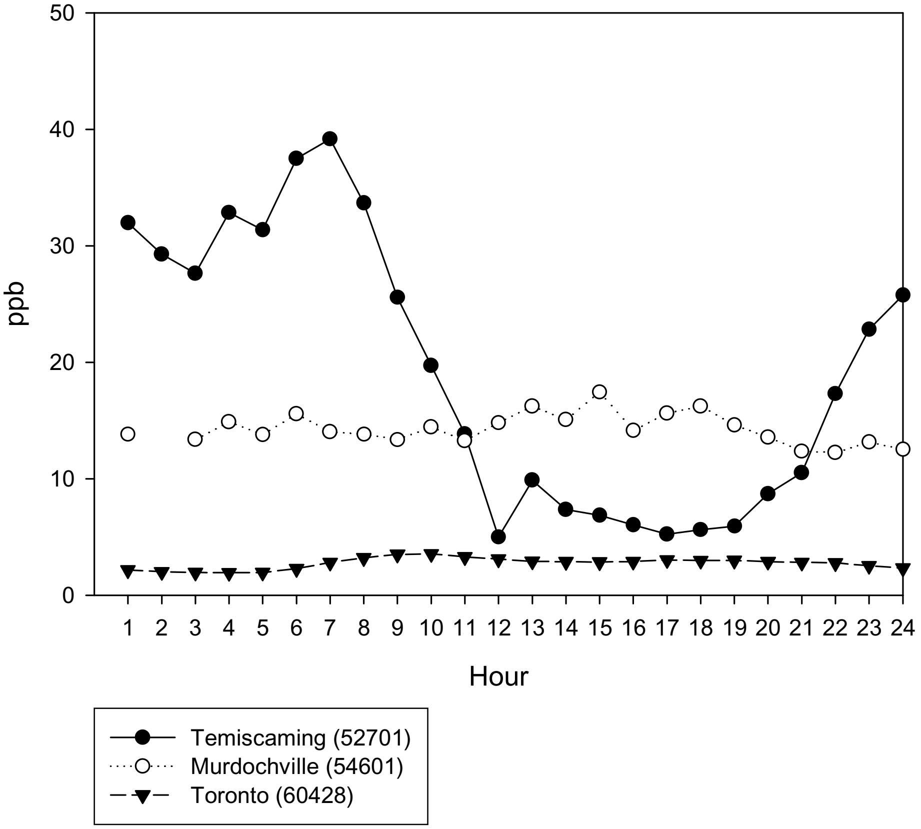
Murdochville and Montréal sites were both higher in the winter months than in the summer. This seasonal pattern was also observed at most other point-source and urban sites. SO_2 may be oxidized by reactions in the gas phase, liquid phase, and on the surfaces of solids. Sunlight intensity, the presence of oxidants (e.g., H_2O_2 and O_3) and/or oxidant precursors (e.g., volatile organic compounds), relative humidity, and the presence of fogs and clouds are all important to the conversion rate of SO_2 (Finlayson-Pitts and Pitts 1986). As a result, SO_2 oxidation rates are generally higher in the summer than winter. In addition, the mixing depth of the atmosphere is reduced in the winter, resulting in increased SO_2 concentrations. In contrast to the Murdochville and Montréal sites, the concentrations of SO_2 at the Témiscaming site were higher in the summer months than in the winter, possibly as a result of its valley topography and/or seasonal changes in prevailing wind direction.

Figure 4.1 Monthly Variations in SO_2 Concentrations at Three Selected Sites in 2001



Diurnal variations in SO_2 concentrations at three sites for 2001 are shown in Figure 4.2. The concentrations measured at the Murdochville and Toronto sites are examples of sites near industrial point sources and urban source sites, respectively. Non-point source sites showed relatively constant concentrations of SO_2 throughout the day, while sites near point sources had higher and more variable concentrations. Levels of SO_2 measured at the Témiscaming site were atypical, with the highest concentrations occurring at night and in the early morning. The Témiscaming site is located in the Ottawa River valley next to two lakes. In the presence of a strong SO_2 source, emissions may become trapped in the valley overnight and then dissipate when the night-time inversion breaks up in the morning.

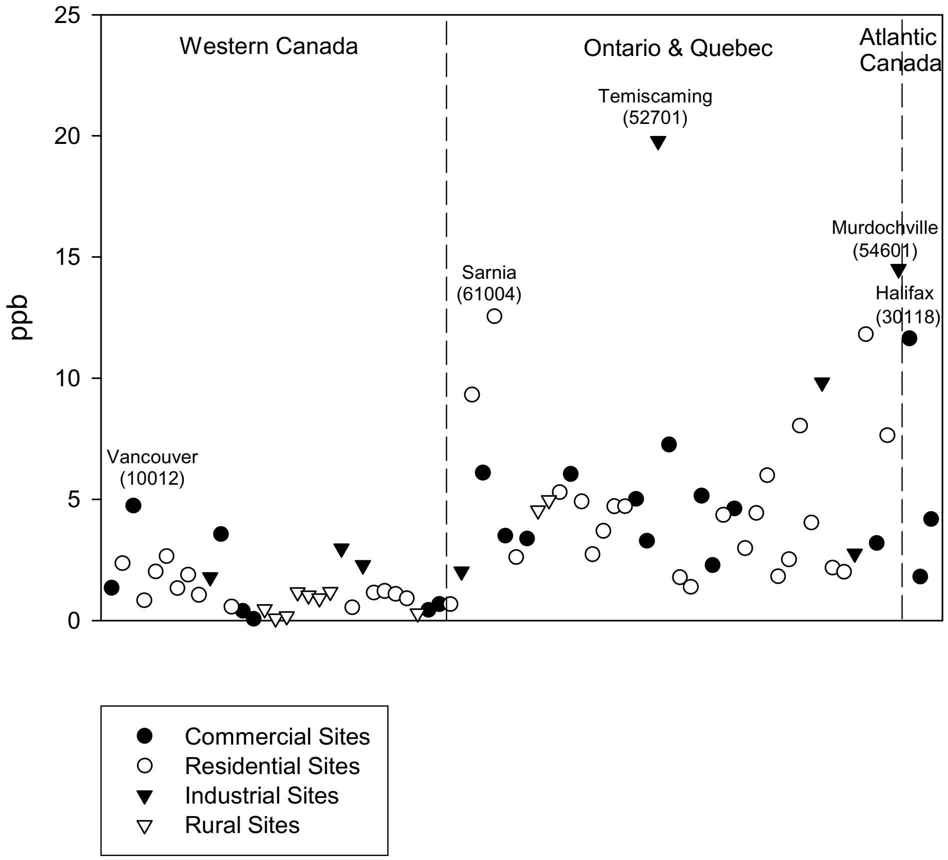
Figure 4.2 Diurnal Variations in SO_2 Concentrations at Three Selected Sites in 2001



Annual mean SO_2 concentrations at all measurement sites across Canada in 2001 are shown in Figure 4.3. Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number. Sites in western Canada (British Columbia, Alberta, Saskatchewan, and Manitoba) had the lowest annual mean concentrations of SO_2. The highest annual mean concentrations were observed in central and eastern Canada at sites near point sources (in descending order): Témiscaming (52701), Murdochville (54601), Sarnia (61004), Jonquière (50902), Halifax (30118), Shawinigan (51201), and Windsor (60211). The maximum acceptable NAAQO for SO_2, based on the annual arithmetic mean, is 23 ppb (Table 3.1). No sites exceeded the maximum acceptable annual mean NAAQO in 2001.

Figure 4.3 Annual Mean SO_2 Concentrations in 2001

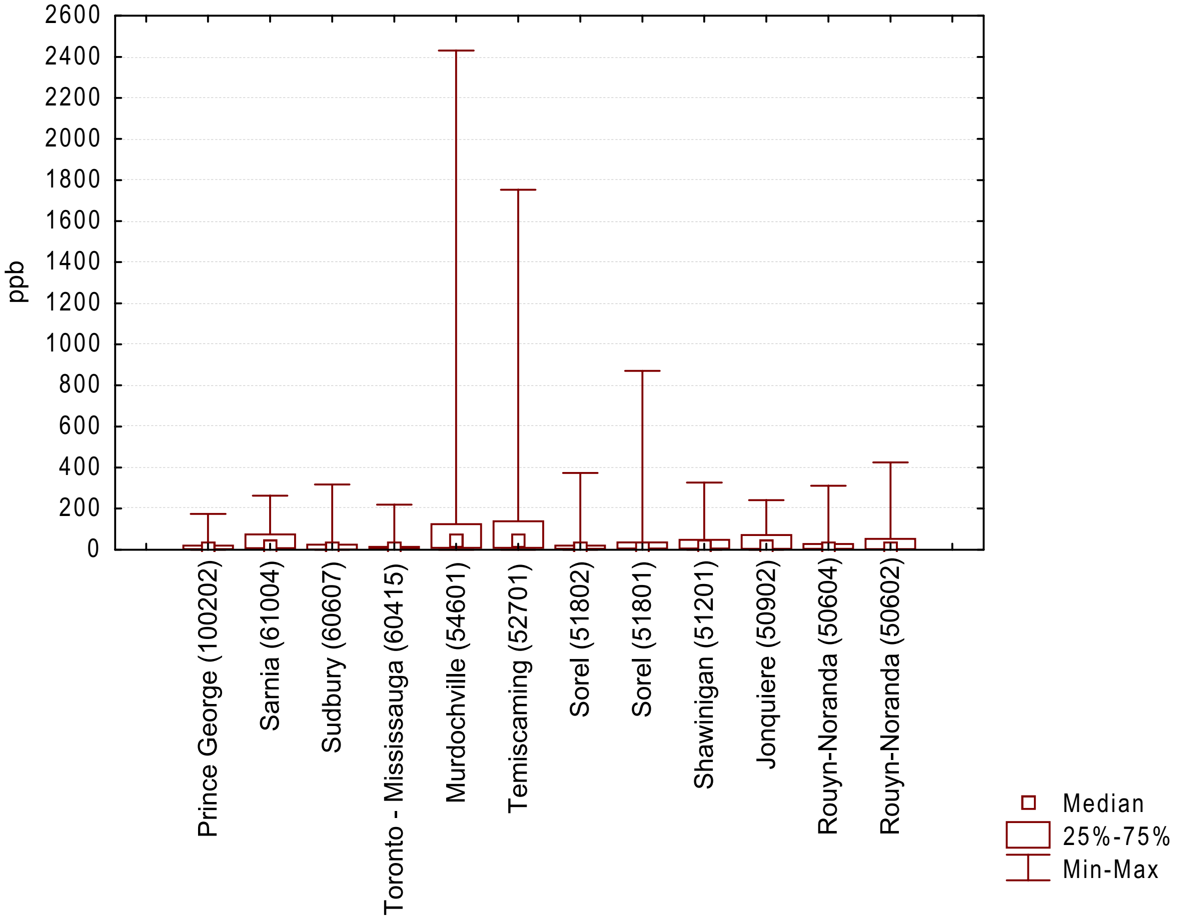
Note: Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number.



The maximum acceptable and desirable NAAQOs for SO_2, based on the average concentration over a 1-h period, are 334 ppb and 172 ppb, respectively (Table 3.1). Five sites near industrial point sources in Québec exceeded the maximum acceptable 1-h NAAQO in 2001: Murdochville (54601), Témiscaming (52701), Sorel (51801 & 51802), and Rouyn-Noranda (50602) (Figure 4.4). An additional seven sites exceeded the maximum desirable NAAQO in 2001: Shawinigan (51201), Sudbury (60607), Rouyn-Noranda (50604), Sarnia (61004), Jonquière (50902), Toronto - Mississauga

(60415), and Prince George (100202) (Figure 4.4). All other sites in Canada had SO_2 concentrations below the maximum desirable 1-h NAAQO.

Figure 4.4 Maximum 1-hr Concentrations of SO_2 in 2001 – Selected Sites



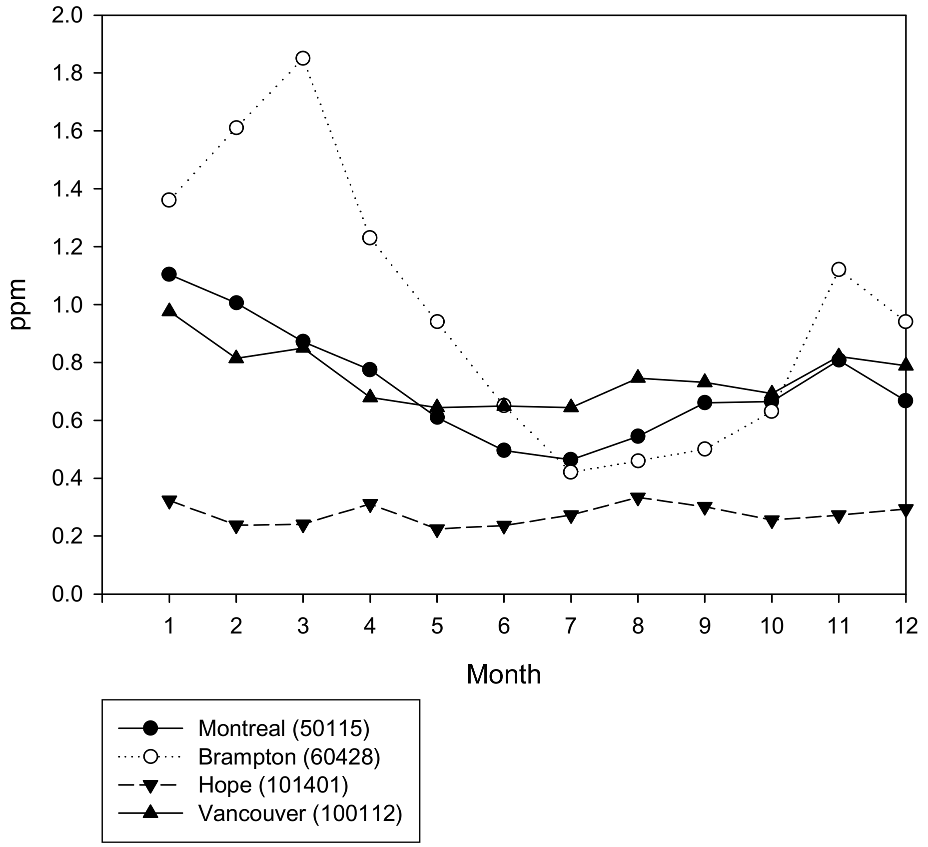
4.2 Carbon Monoxide

Carbon monoxide (CO) is a product of incomplete combustion and occurs in high concentrations in areas with heavy traffic. In 1995, transportation accounted for 65% of the total anthropogenic CO emissions in Canada (EC 1999). Peak CO concentrations in urban areas typically occur during the winter, when automotive emission rates are higher and dispersion is poorest, and at night when atmospheric inversions are present.

CO measurement data are reported as 1-h concentrations. CO concentrations at three urban sites for 2001 – Vancouver, Brampton (ON), and Montréal – and one rural site –

Hope (BC) – are shown in Figure 4.5 as examples of monthly variations in CO throughout the year. In general, average monthly concentrations of CO were highest at sites where the monitoring intakes were near heavy traffic. CO levels at the Brampton (ON), Montréal, and Vancouver sites were higher in the winter months than the summer. The major atmospheric sink for CO is through oxidation with the photochemically-generated OH radical (Bunce 1991). Thus, higher winter concentrations of CO observed at most sites are likely the result of the shallow mixing depths, reduced atmospheric chemistry rates, and increased vehicle emission rates during the colder months. Concentrations at Hope, a rural site, were of the same order of magnitude as natural background concentrations of CO and were relatively constant throughout the year.

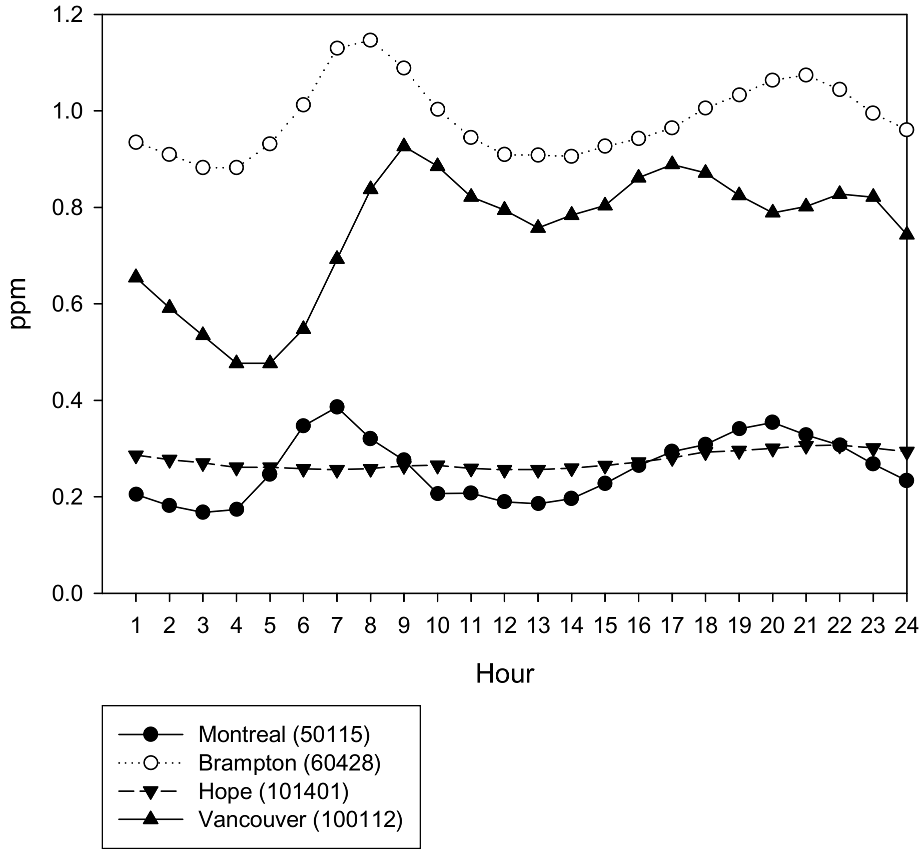
Figure 4.5 Monthly Variations in CO Concentrations at Four Selected Sites in 2001



Diurnal variations in CO concentrations are shown for the same four sites in Figure 4.6. The daily patterns at these sites were typical of urban and rural sites elsewhere in Canada. Higher 1-hr maximum levels of CO were observed at Brampton (ON) and

Vancouver, both sites with heavy traffic, than at Hope (BC), a rural site. Peak concentrations at all three urban sites occurred in the morning and late afternoon, corresponding with local rush hours, while concentrations of CO at Hope were relatively constant throughout the day. The maximum acceptable NAAQO, based on average concentrations over a 1-h period, is 31 ppm (Table 3.1). Concentrations of CO at all Canadian sites were well below the maximum acceptable 1-h NAAQO for CO.

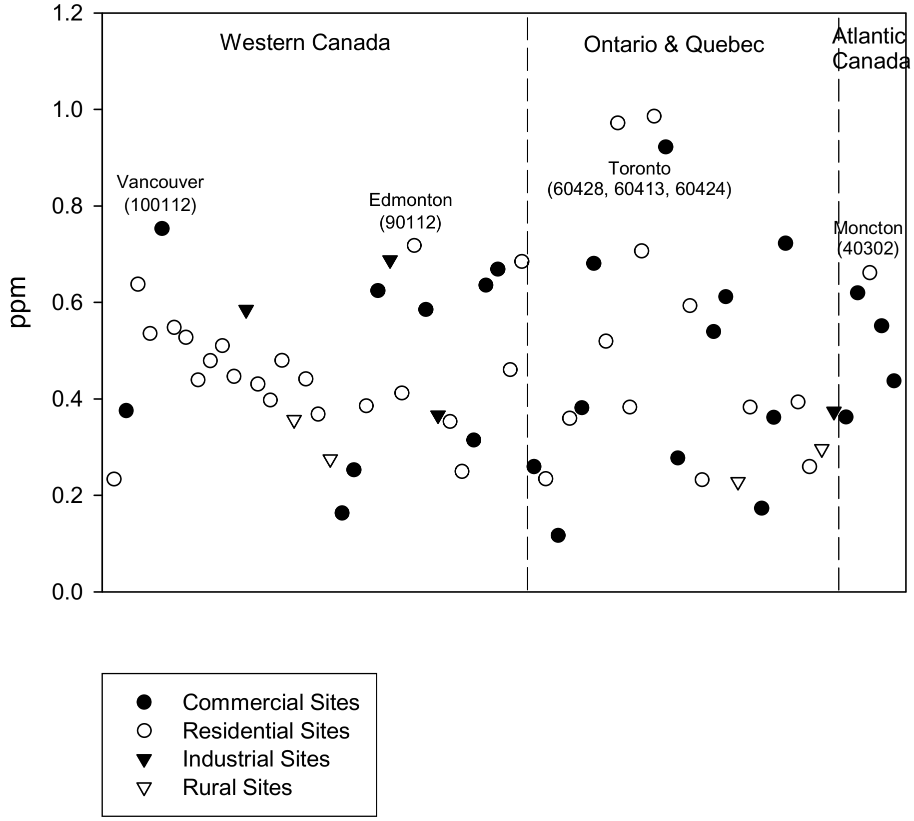
Figure 4.6 Diurnal Variations in CO Concentrations at Four Selected Sites in 2001



Annual mean concentrations of CO at sites across Canada in 2001 are shown in Figure 4.7. Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number. Ranges in mean CO concentrations were similar across the country, with the highest concentrations observed at urban sites with dense vehicular traffic (e.g., Toronto (60413, 60428, 60424), Vancouver (100112), and Edmonton (90112)). Concentrations at rural sites tended to be lower than at urban sites.

Figure 4.7 Annual Mean CO Concentrations in 2001

Note: Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number.



4.3 Nitrogen Oxides

Nitrogen oxides (NO_x) include nitric oxide (NO) and nitrogen dioxide (NO_2). Most anthropogenic NO_x originates from sources as NO, which is then oxidized to form NO_2. The major source of NO_x is high-temperature combustion such as fuel combustion in automobiles and industrial processes. In 1995, non-industrial fuel combustion and transportation accounted for 66% of total national NO_x emissions (EC 1999). NO_x is a precursor in the formation of tropospheric ozone and particulate matter.

NO and NO_2 measurement data are reported as 1-h concentrations. Monthly variations in NO and NO_2 concentrations are shown for three urban sites – Vancouver, Toronto, and Kitchener (ON) – and one rural site – l'Acadie (QC) – in Figures 4.8a and 4.8b. The highest monthly averages of NO and NO_2 of these sites were observed at the Toronto and Vancouver sites, both located in areas with heavy traffic. NO and NO_2 levels at all four sites were higher in the winter months than the summer, likely as a result of higher emissions (e.g., from home heating and increased car idling), shallow mixing depths, and reduced atmospheric chemistry rates during the colder months.

Figure 4.8a Monthly Variations in NO Concentrations at Four Selected Sites in 2001

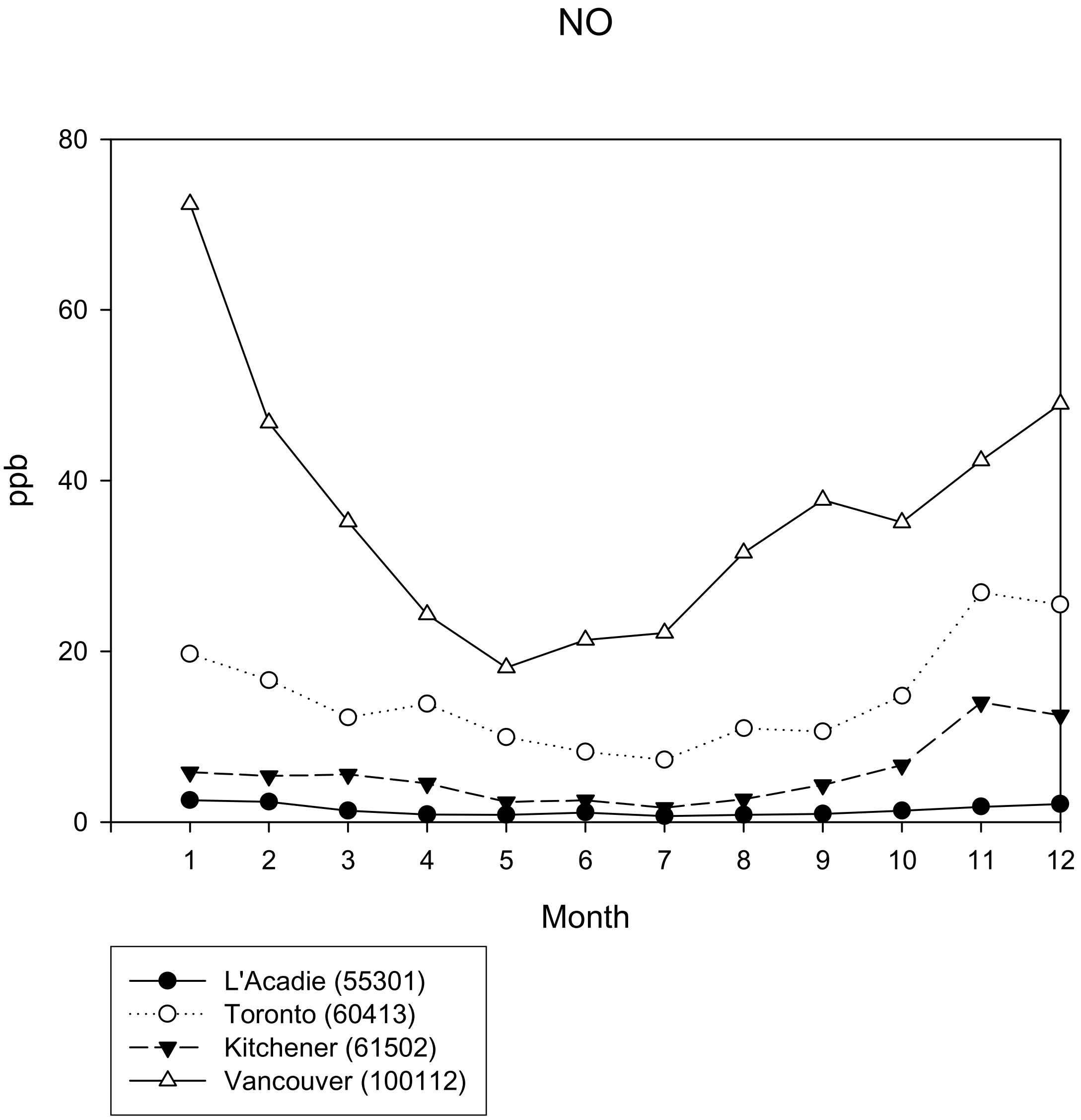
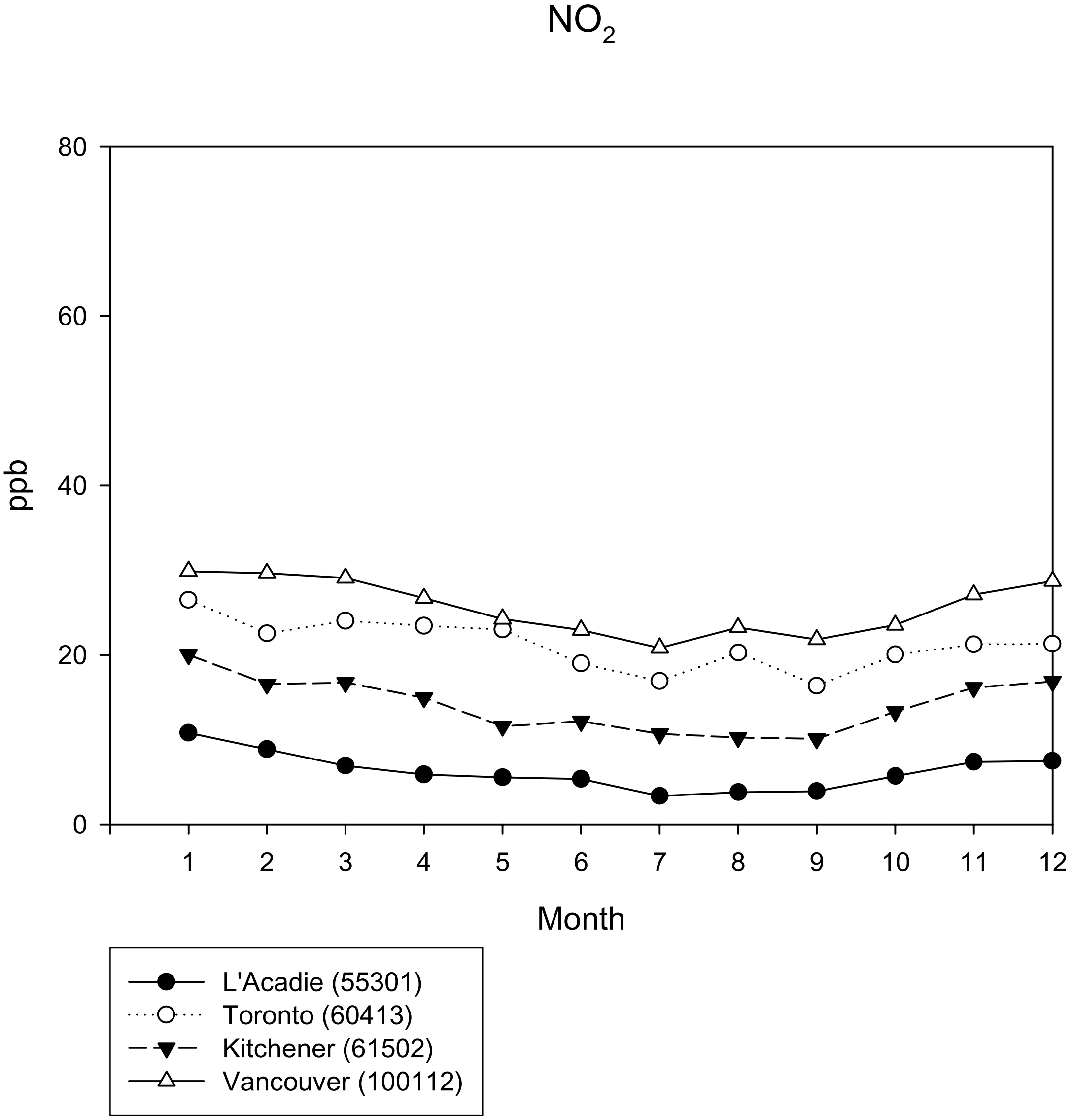


Figure 4.8b Monthly Variations in NO_2 Concentrations at Four Selected Sites in 2001



Diurnal variations in NO and NO_2 concentrations at three urban sites for 2001 – Toronto, Kitchener (ON), and Vancouver – and one rural site – Langley – are shown in Figure 4.9. The highest 1-hr concentrations of NO and NO_2 within these four sites were observed in Toronto and Vancouver, both areas with heavy traffic. Peak concentrations of NO and NO_2 at the urban sites occurred in the morning, corresponding with local rush hours. NO and NO_2 concentrations at the urban sites tended to decrease in the afternoon in response to a deepening mixing layer and increased rates of photochemistry, and rose again in the evening as the result of the collapsing boundary layer and decreased photochemistry. The concentrations of NO and NO_2 at Langley, a rural site, showed a similar pattern although the range of observed concentrations was much smaller. The maximum acceptable NAAQO for NO_2, based on the average concentration over a 1-h period, is 213 ppb (Table 3.1). Concentrations of NO_2 were below the maximum acceptable 1-hr NAAQO at all Canadian sites.

Figure 4.9a Diurnal Variations in NO Concentrations at Four Selected Sites in 2001

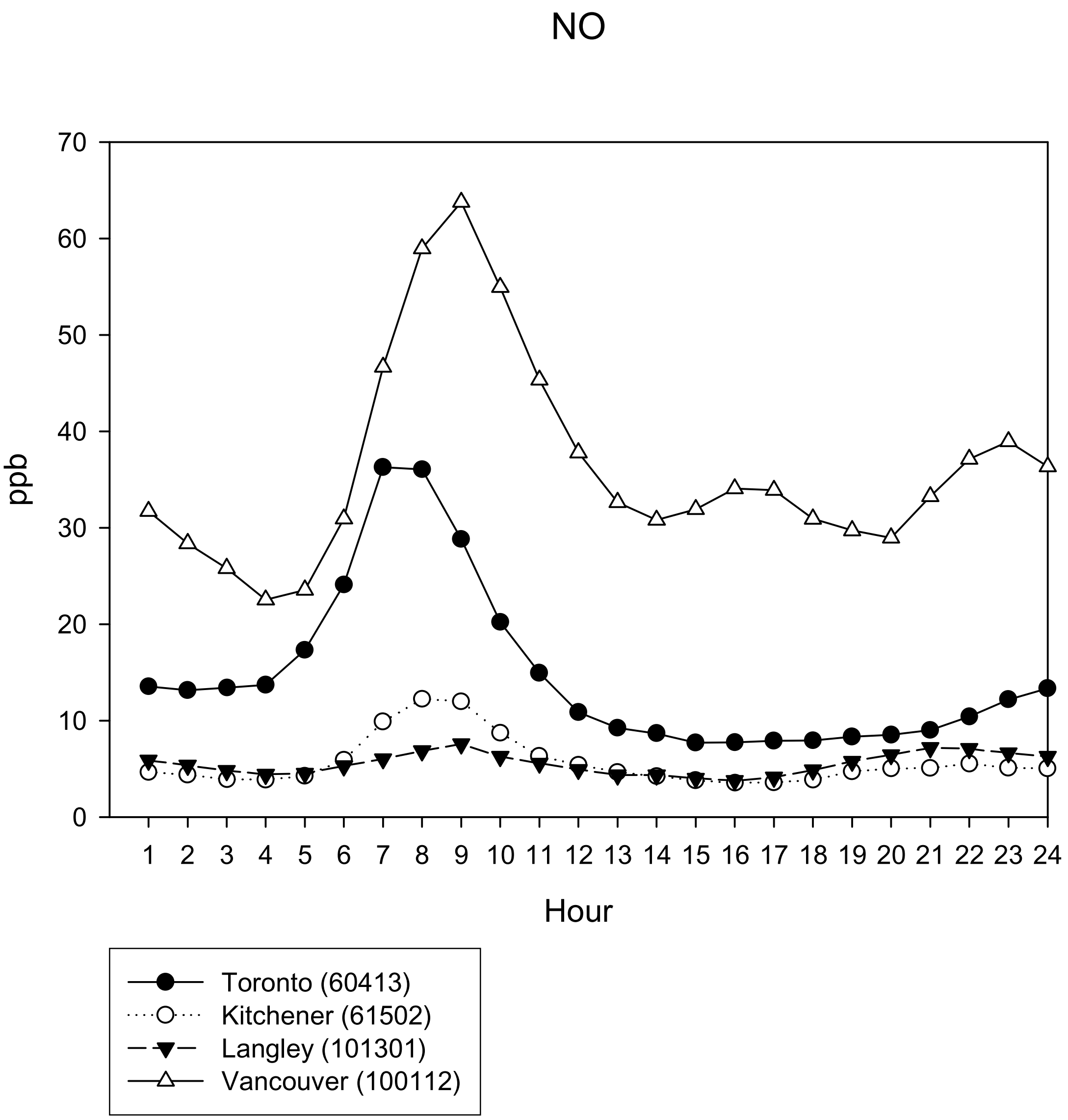
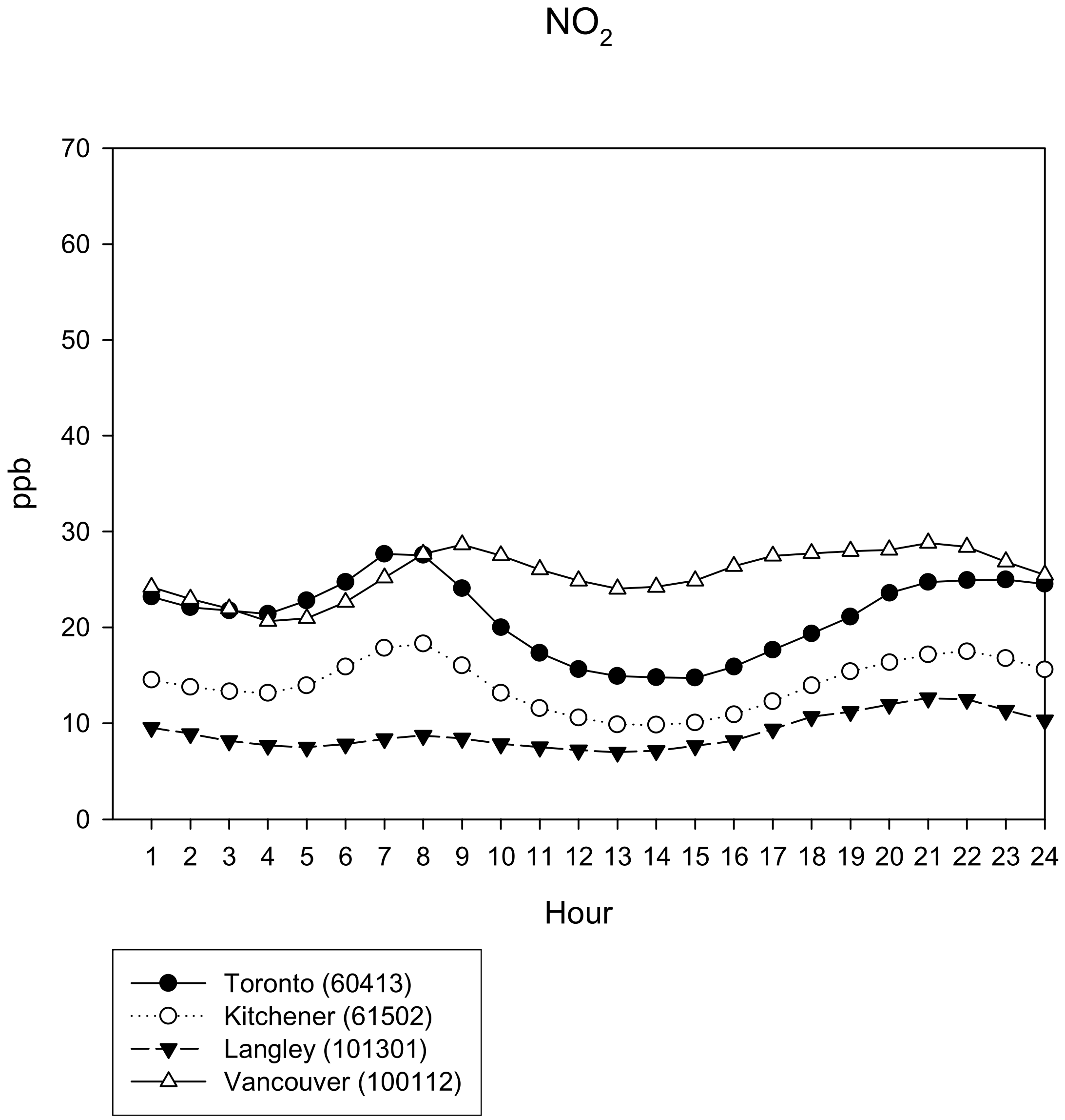


Figure 4.9b Diurnal Variations in NO_2 Concentrations at Four Selected Sites in 2001



Annual mean concentrations of NO and NO_2 across Canada in 2001 are shown in Figure 4.10. Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number. Again, the highest concentrations of both NO and NO_2 were observed at urban sites with dense vehicular traffic (e.g., Vancouver (100118), Calgary (90227), Ottawa (60101), Montréal (50109, 50115), and Halifax (30118)). Much lower levels of both compounds were present at rural sites. In general, NO concentrations were higher than NO_2 concentrations at urban sites, while the reverse was true at rural sites. The maximum acceptable NAAQO for NO_2, based on the annual arithmetic mean, is 53 ppb (Table 3.1). Concentrations of NO_2 were below the maximum acceptable annual mean NAAQO at all Canadian sites.

Figure 4.10a Annual Mean NO Concentrations in 2001

Note: Each data point represents the annual mean concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number.

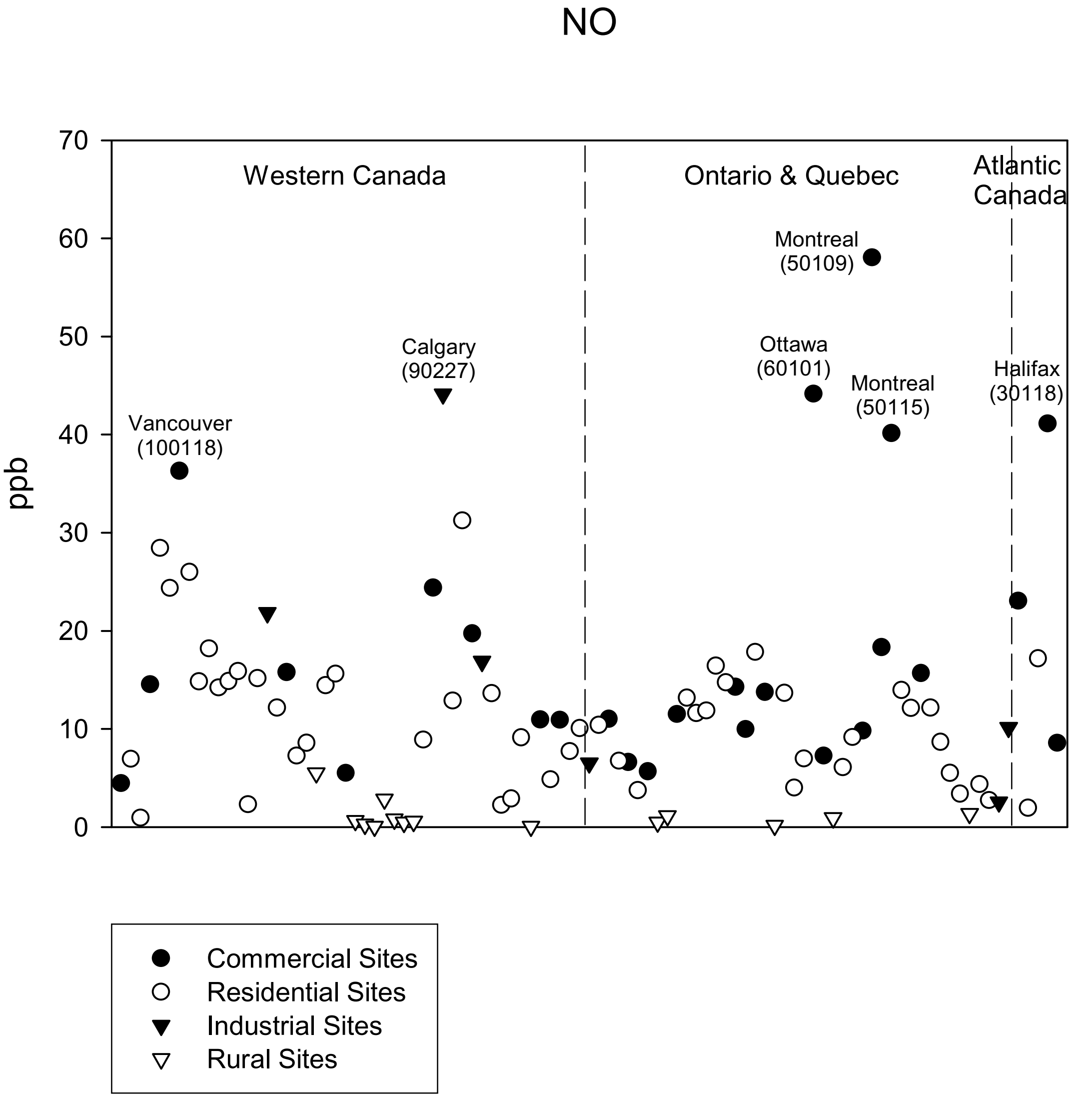
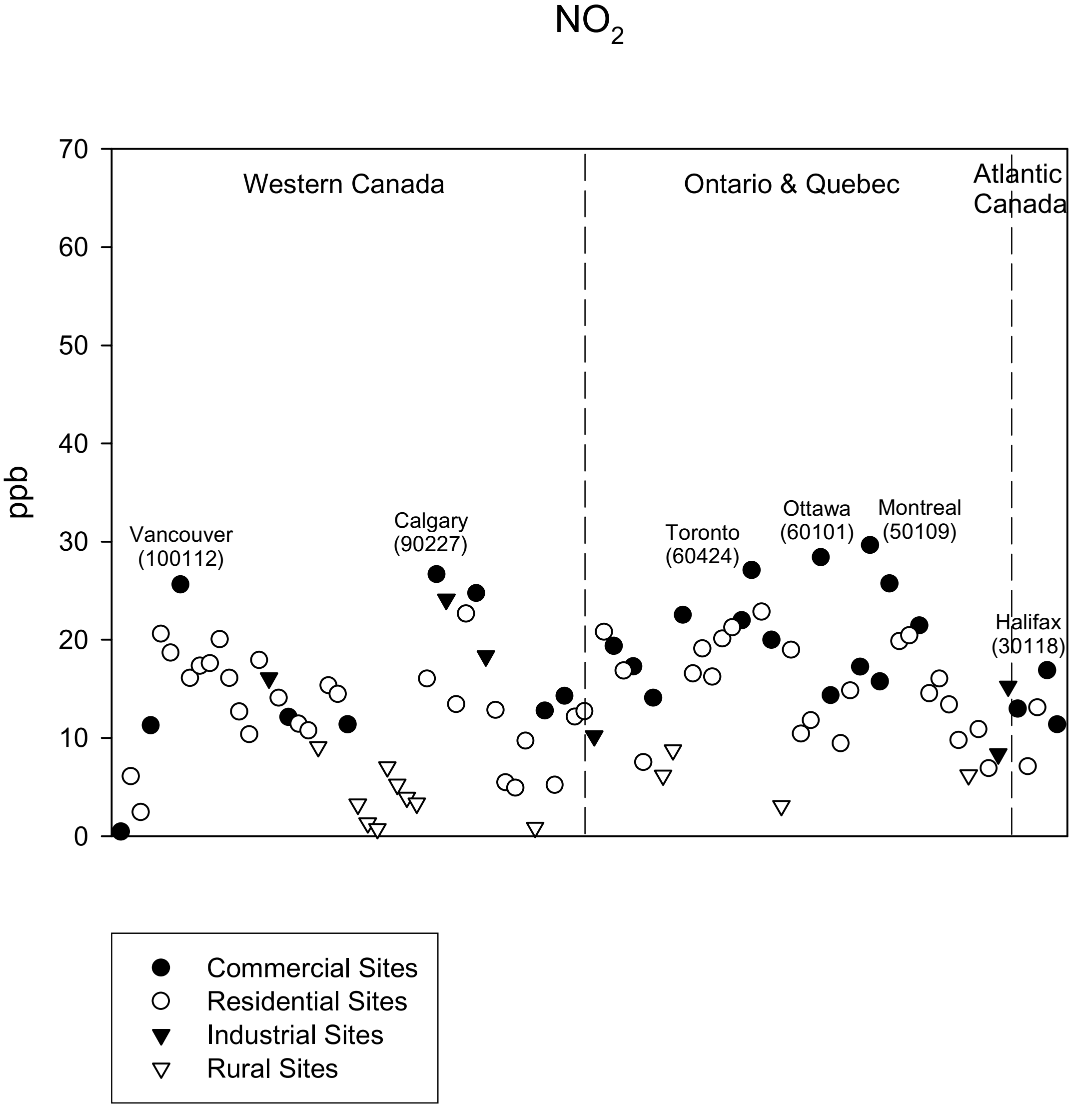
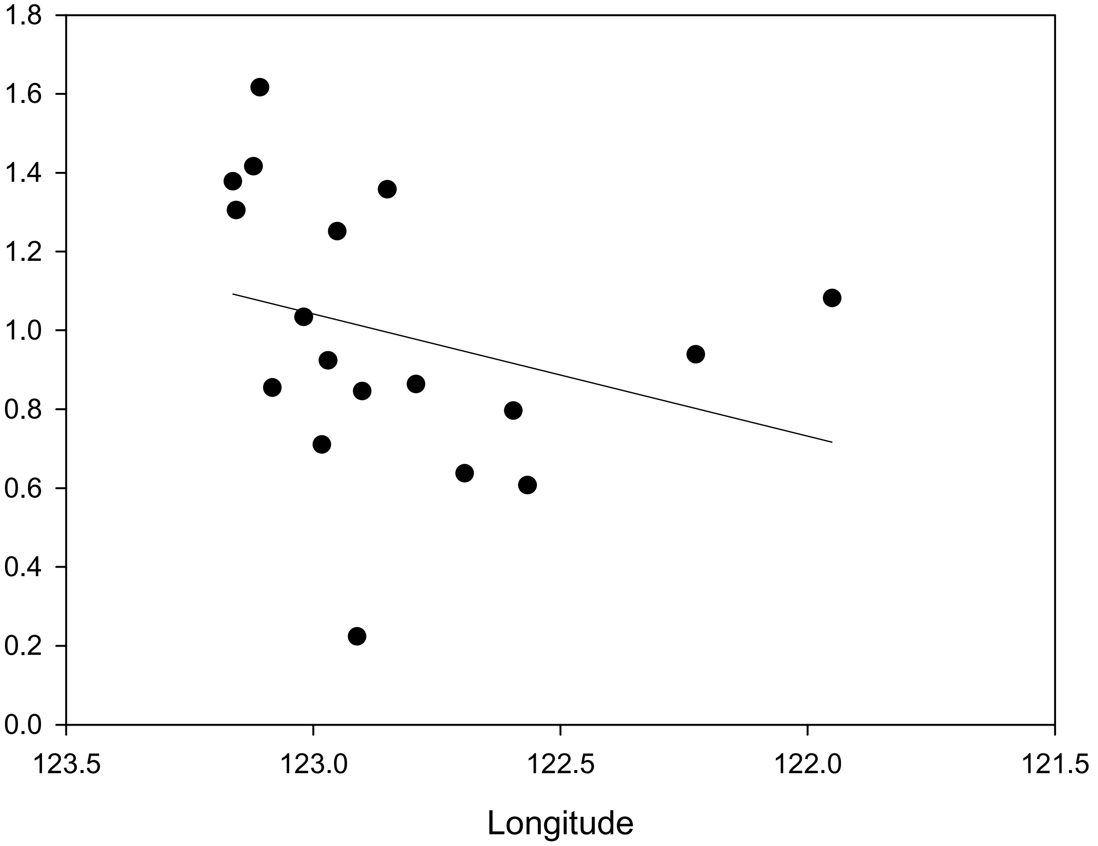


Figure 4.10b Annual Mean NO_2 Concentrations in 2001



As noted above, most NO_x is emitted from anthropogenic sources as NO, which is then oxidized in the atmosphere into NO_2. The ratio of NO:NO_2 decreases as an air mass ages. As a result, the ratio of NO:NO_2 tends to be lower in suburban and rural areas than in urban areas. The mean NO:NO_2 ratio at all urban sites in Canada in 2001 was 0.95, while the mean ratio at rural sites was 0.20. The Lower Fraser Valley, British Columbia provides a good illustration of decreasing NO:NO_2 ratios in an ageing air mass as it travels downwind of an urban centre. The urban core of the area is Vancouver, at the western edge of the Valley, with suburban and rural areas extending eastward. NO:NO_2 ratios at measurement sites within this area are shown in Figure 4.11 along with a regression line (95% confidence interval). The graph clearly shows the decrease in NO:NO_2 ratios from west to east.

Figure 4.11 NO:NO_2 Ratios in the Lower Fraser Valley, British Columbia



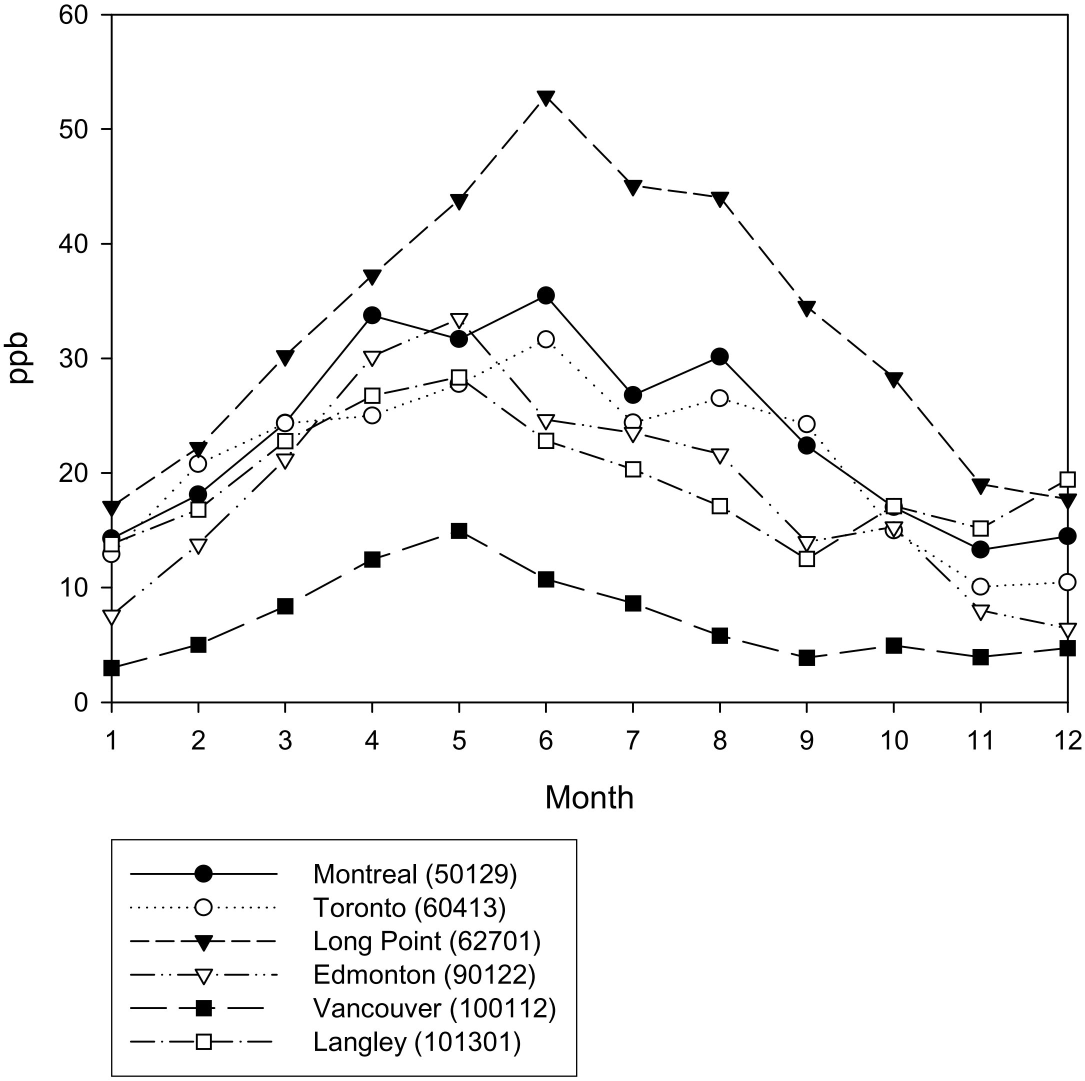
4.4 Ground-level Ozone

Ground-level ozone (O_3) is a major component of urban smog and is a persistent and pervasive environmental problem throughout much of North America. Unlike the other compounds discussed in this report, ozone is not an emitted pollutant. Ozone in the troposphere may be of photochemical or stratospheric origin. Photochemical ozone is the product of the product of photochemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight and temperatures greater than 15°C (Sillman 1993; Cardelino and Chameides 1995). Photochemical ozone is primarily responsible for summertime ozone episodes in and near several urbanised areas in Canada. Ozone in the troposphere may also originate from stratospheric intrusions (Lefohn et al. 2001). Background ozone concentrations in the lower troposphere are in the range of 0.04-0.08 ppm. Ozone concentrations of this magnitude measured during the photochemically quiescent winter and spring months at Canadian latitudes are likely the result of the transport of ozone from the stratosphere and upper troposphere to the surface (Lefohn et al. 2001).

An important feature of ozone production is the tendency for peak concentrations to occur 50-150 km downwind from urban centres where most anthropogenic VOCs and NO_x sources are located (Sillman 1993). This is because photochemical ozone results from reactions that require time to run their course. Ozone and its chemical precursors have relatively short atmospheric lifetimes near the ground but can be transported long distances aloft, resulting in regional ozone episodes characterized by elevated levels of ozone that may extend over hundreds of kilometres (Sillman 1993).

O_3 measurement data are reported as 1-h concentrations. Monthly variations in O_3 concentrations are shown for four urban sites – Montréal, Toronto, Edmonton, and Vancouver – and two rural sites – Long Point Provincial Park and Langley – in Figure 4.12. Concentrations of O_3 at all sites were higher in the summer months than the winter months. This seasonal pattern is due to the fact that significant amounts of photochemical ozone are formed only in the presence of sunlight and temperatures greater than 15°C (Cardelino and Chameides 1995).

Figure 4.12 Monthly Variations in O_3 Concentrations at Six Selected Sites in 2001



Diurnal variations in O_3 at two urban sites – Windsor and Toronto – and two rural sites – Parkhill and Long Point Provincial Park – on June 29 2001, a day with elevated O_3 concentrations at many Ontario sites, are shown in Figure 4.13. Concentrations of O_3 were lowest in the early morning hours, increased to peak levels in the afternoon, and decreased again in the evening.

Figure 4.13 Diurnal Variations in O_3 Concentrations at Four Ontario Sites on June 29, 2001

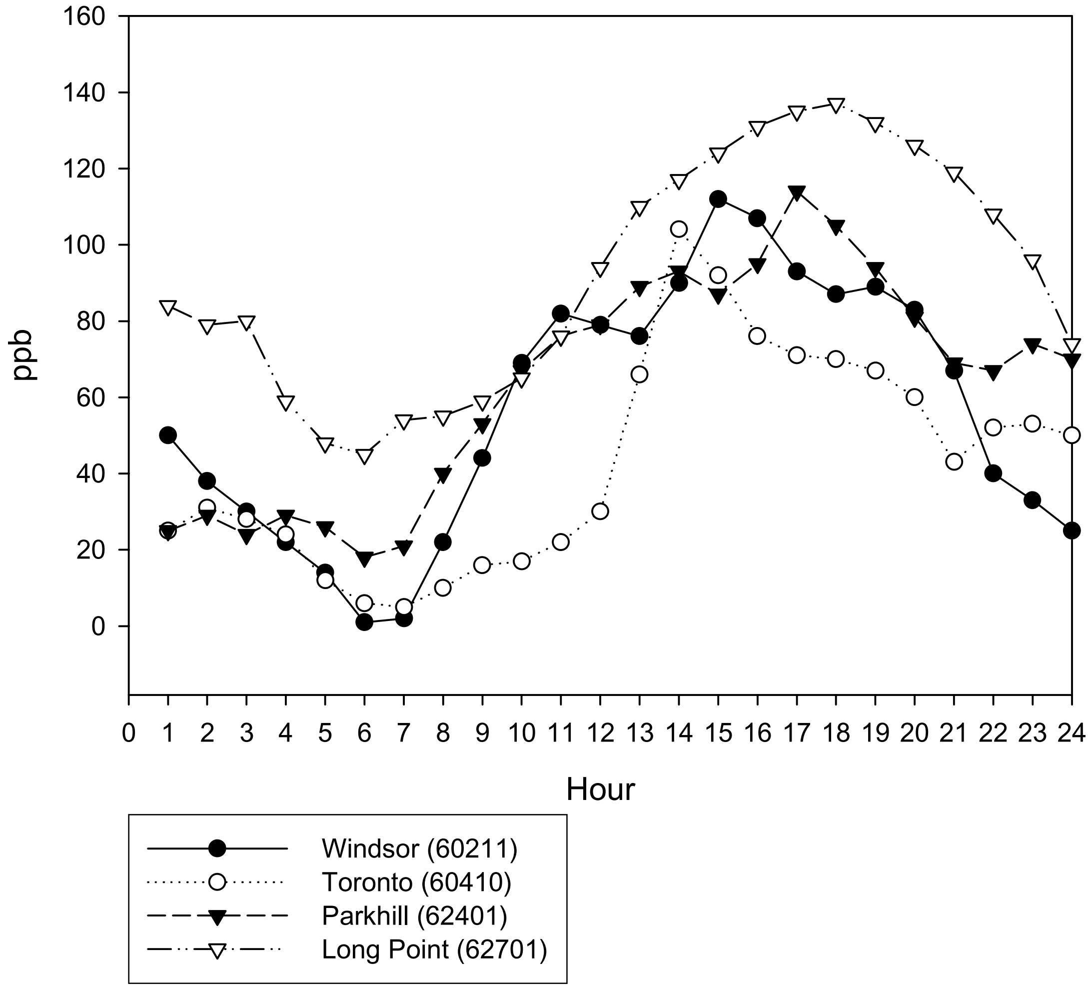
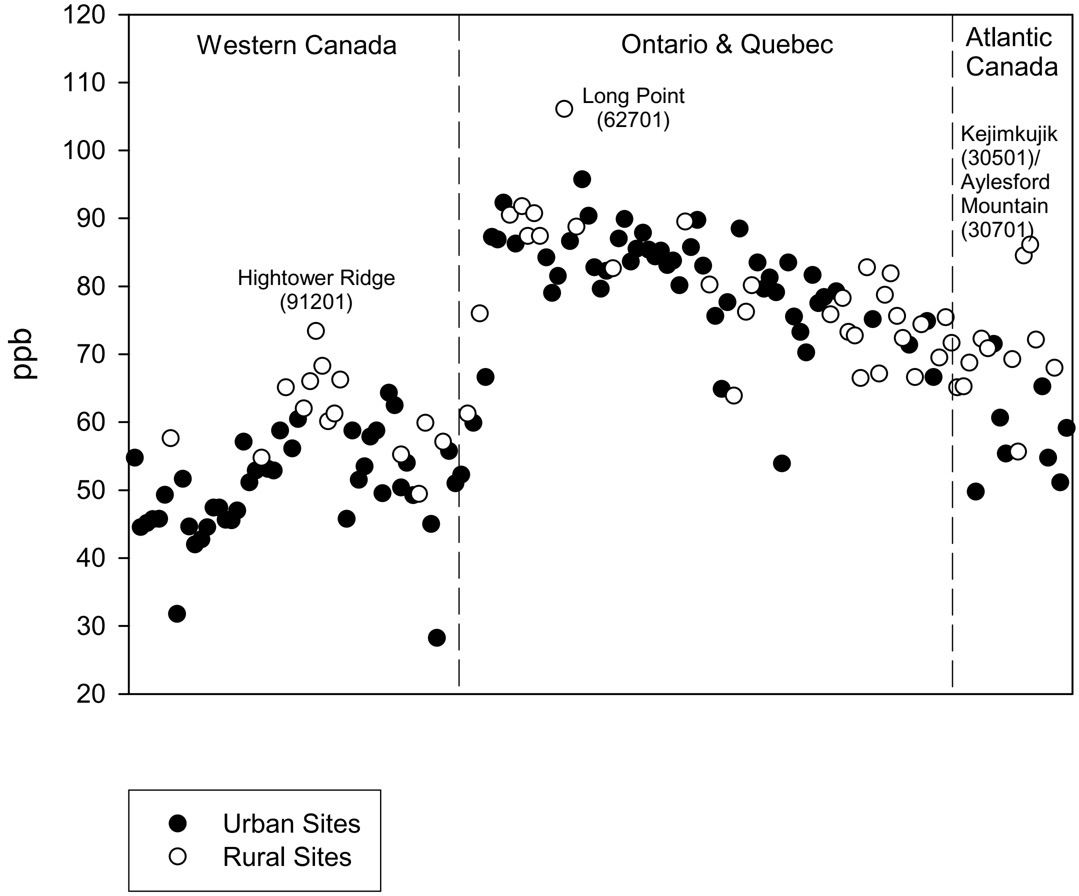


Figure 4.14 presents the 4th highest 8-hour measurements of O_3 in 2001. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number. In western Canada, only rural sites located in or near the Rocky Mountains recorded 4th highest values above 65 ppb. The origin of the ozone measured at these sites was likely due to the presence of upper tropospheric and stratospheric air that was transported down to the surface (Lefohn et al. 2001). In Ontario and Québec, 4th highest values above 65 ppb were recorded at almost all urban and rural sites, while in Atlantic Canada 4th highest values above 65 ppb occurred mostly at rural sites.

Figure 4.14 Fourth-highest, Daily Maximum 8-hour Average O_3 Concentrations in 2001.

Note: Each data point represents the fourth-highest, daily maximum 8-hour average concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number.



4.5 Particulate Matter

Particulate matter is typically categorized on the basis of size. Fine particles ($PM_{2.5}$) are those with mean aerodynamic diameter < 2.5 µm. Coarse particles are those between 2.5 µm and 10 µm diameter. PM_{10} refers to all particles with diameter < 10 µm and includes the $PM_{2.5}$ fraction and the coarse fraction of ambient PM. Particles found in the fine and coarse fractions are generally distinct in terms of source, formation process, chemical composition, and behaviour in the atmosphere (HC 1997). Fine particles can be formed during combustion and discharged directly to the atmosphere or can be formed in the atmosphere from the transformation of precursor emissions such as SO_2 and NO_x (secondary fine particles). Fine particles may persist in the atmosphere from a few days to a few weeks. Fine particles are primarily composed of ammonium, sulphate and nitrate, lead and other heavy metals, elemental carbon and organic compounds. Coarse particles originate primarily from wind blown dust (e.g., from fields, unpaved roads, construction), sea spray, and mining and quarrying operations. The coarse mode is largely made up of crustal elements such as oxides of iron, calcium, silicon, and aluminum. These particles are efficiently removed by gravitational settling and remain in the atmosphere for periods of a few hours to a few days (HC 1997).

Most particulate matter (89% and 72% for PM_{10} and $PM_{2.5}$, respectively, in 1995) comes from open sources (e.g., agricultural tilling, wind erosion, construction, dust from roads, forest fires). Non-open sources of particulate matter include industry, non-industrial fuel consumption, and transportation (EC 1999).

The particulate matter data reported in this section were collected by the continuous TEOM samplers and reported as 1-h concentrations. Figure 4.15 shows the mean monthly concentrations in 2001 at five urban sites for $PM_{2.5}$ (Hamilton, Winnipeg, Regina, Calgary, and Vancouver) and four urban sites for PM_{10} (Sarnia, Regina, Calgary, and Vancouver).

The highest $PM_{2.5}$ concentrations were observed at sites in southern Ontario. $PM_{2.5}$ concentrations in southern Ontario tended to be higher in summer months than in winter months with peak levels occurring in June. There was more variability between sites in the Prairies than in southern Ontario, but many Prairie sites showed higher $PM_{2.5}$ concentrations in the summer months with peak levels occurring in August. $PM_{2.5}$ concentrations in the Vancouver region were similar in magnitude to the Prairie sites but relatively constant throughout the year.

PM_{10} concentrations tended to be higher in the summer months than the winter months at sites in southern Ontario and the Prairies, although many of the Prairie sites showed secondary minima in June and July. PM_{10} concentrations were least variable at and between sites in the Vancouver area with relatively constant levels throughout the year.

Figure 4.15a Monthly Variations in $PM_{2.5}$ Concentrations at Selected Sites in 2001

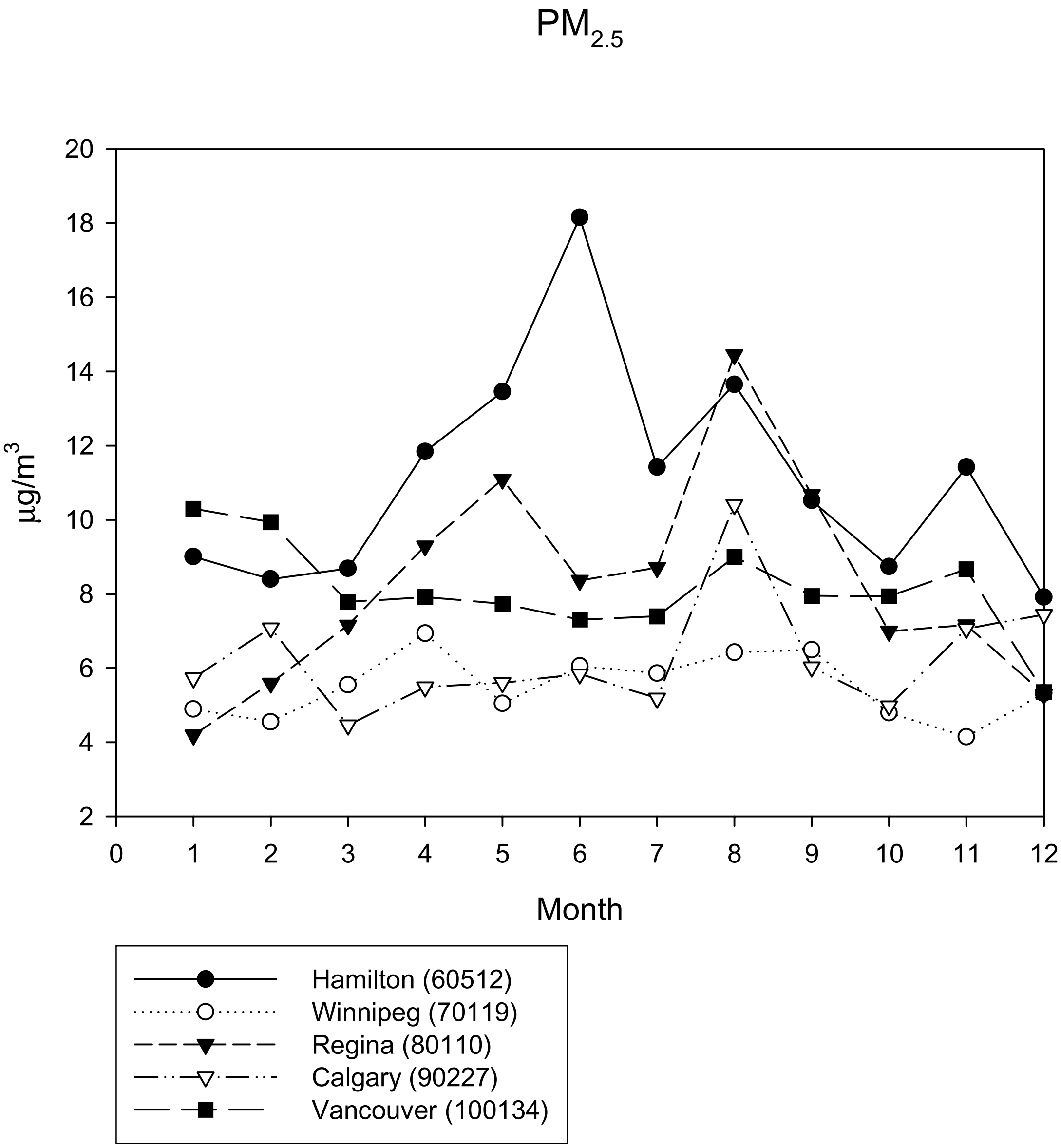
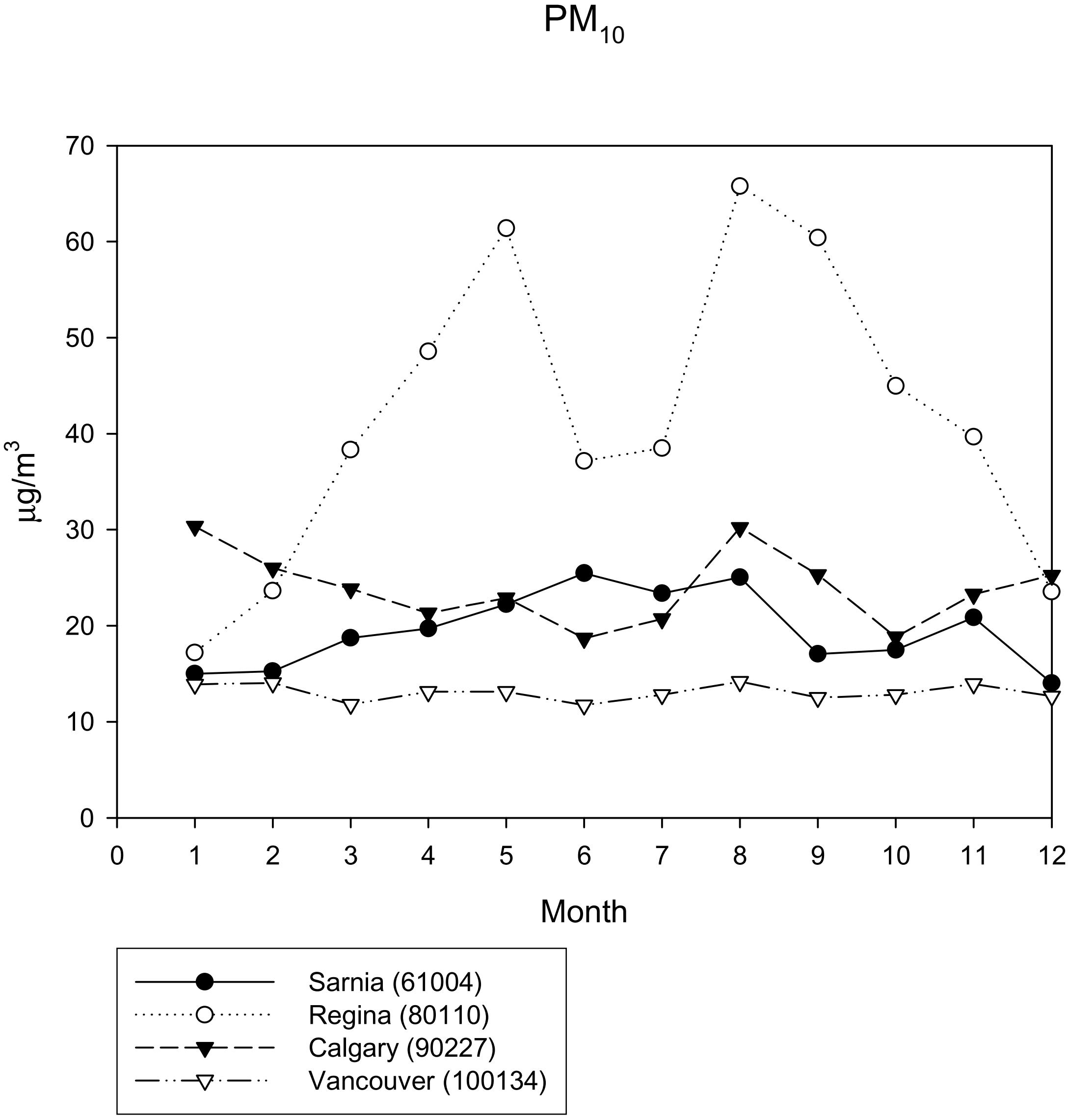


Figure 4.15b Monthly Variations in PM_{10} Concentrations at Selected Sites in 2001



Diurnal variations in $PM_{2.5}$ and PM_{10} concentrations are shown for five urban sites – Toronto, Winnipeg, Regina, Edmonton, and Vancouver – in Figure 4.16. PM_{10} concentrations were highest in the Prairies where much of the airborne particulate matter likely consists of crustal material (Brook et al. 1997). $PM_{2.5}$ and PM_{10} concentrations tended to peak during morning rush hours and were lowest in the hours before dawn, likely due to decreased overnight wind speeds.

Figure 4.16a Diurnal Variations in $PM_{2.5}$ Concentrations at Five Selected Sites in 2001

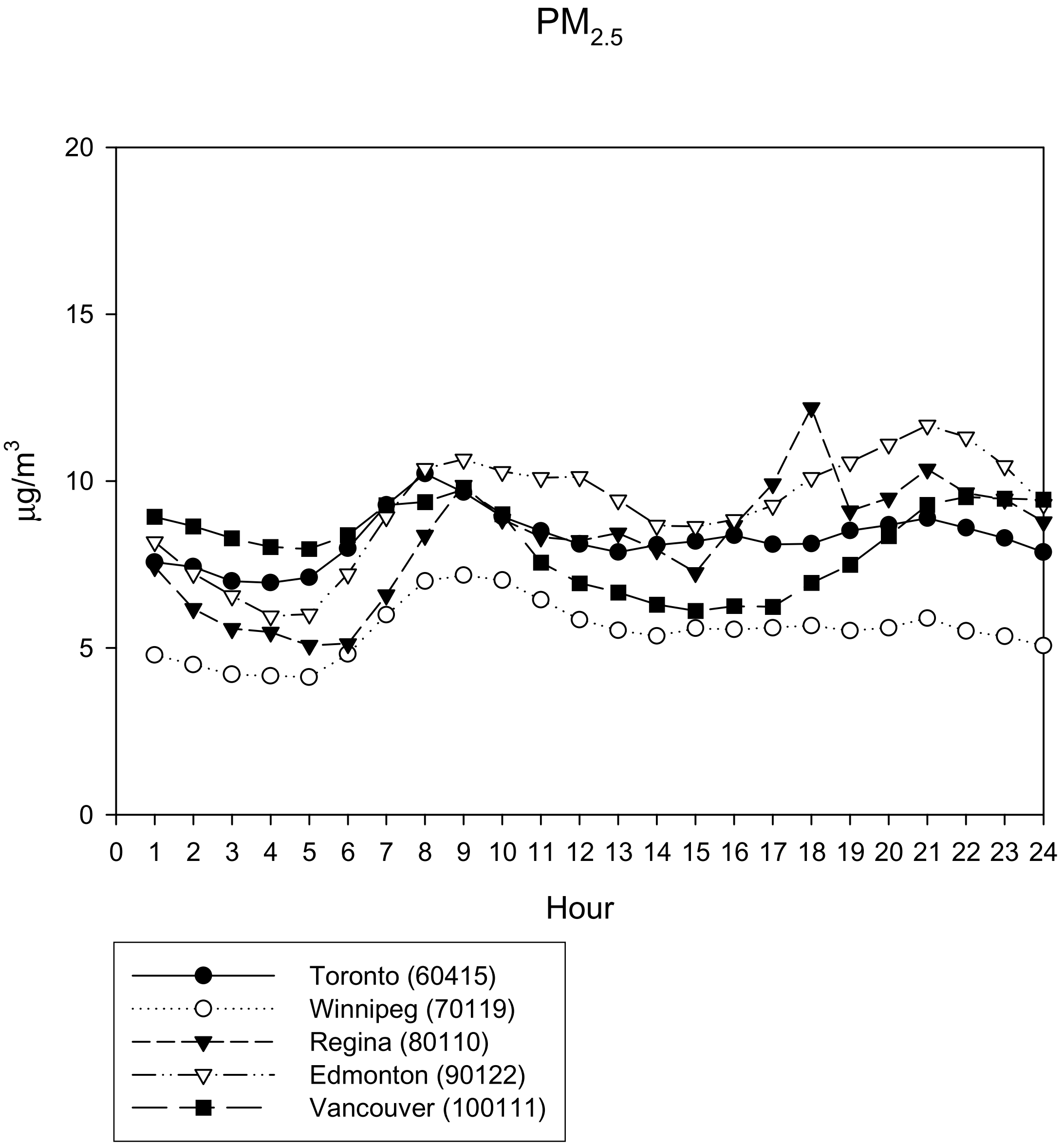


Figure 4.16b Diurnal Variations in PM_{10} Concentrations at Five Selected Sites in 2001

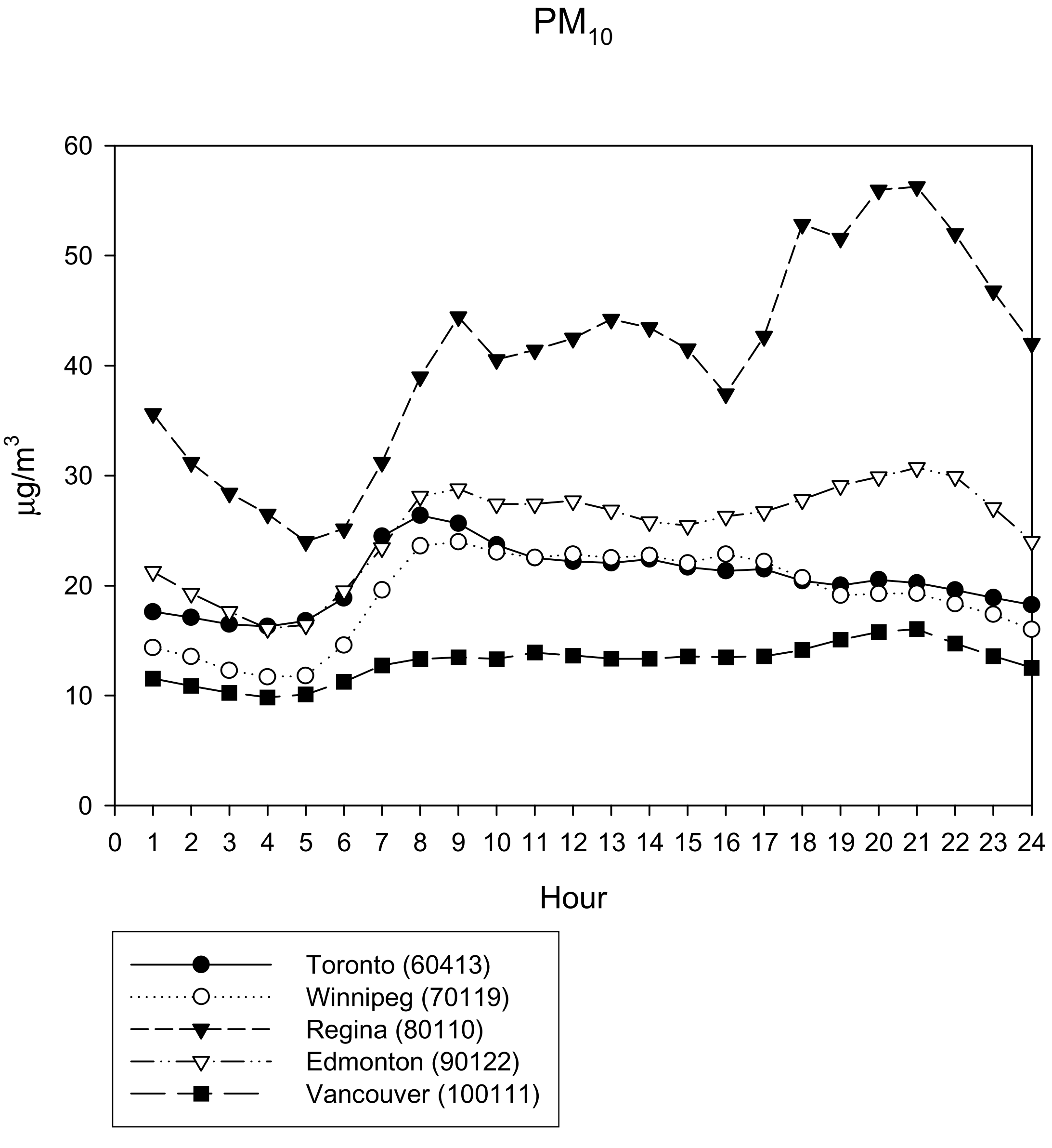
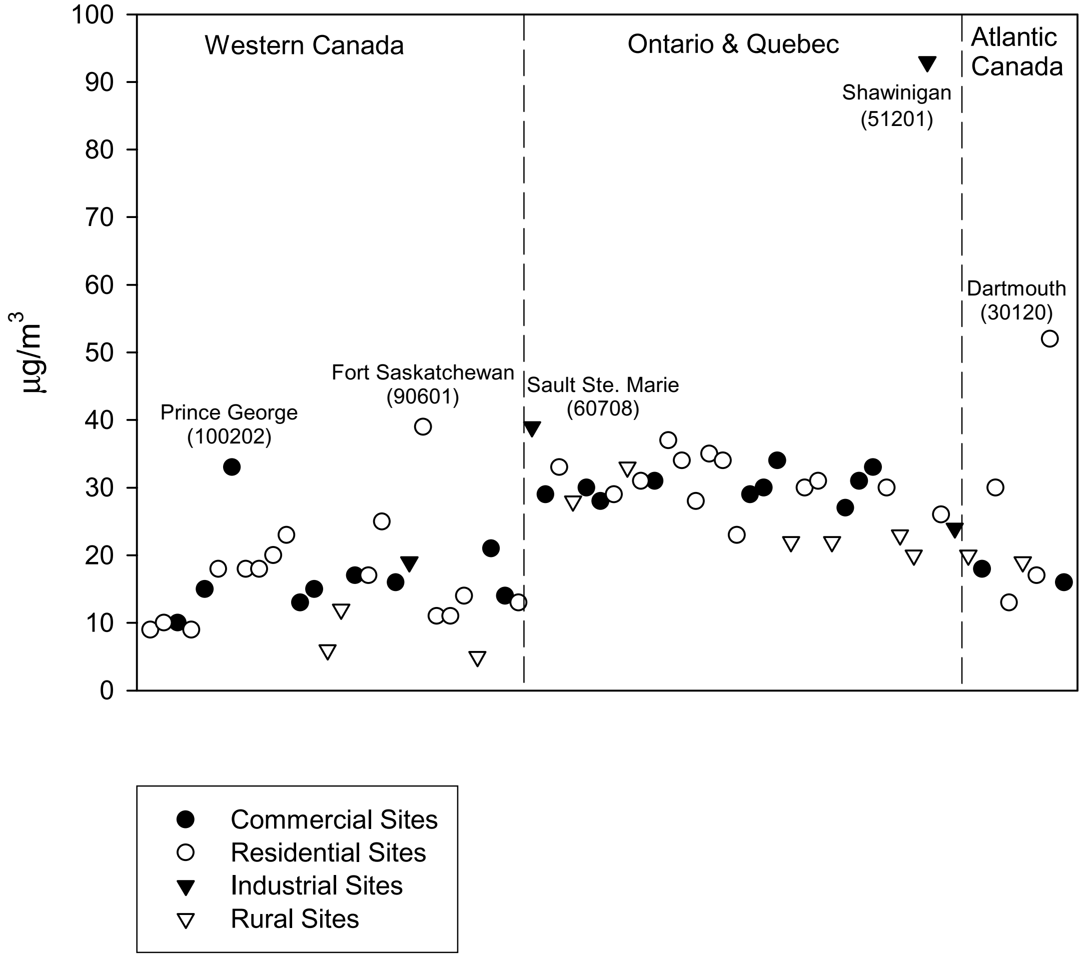


Figure 4.17 presents the 98th percentile of the 24-hour average $PM_{2.5}$ concentrations at sites across Canada in 2001. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number. The 98th percentile was greater than 30 µg/m³ at 17 sites. Most of these sites were located in Ontario, three were in Québec, one in Nova Scotia, one in Saskatchewan, and one in British Columbia. All but one of these sites (Simcoe) were

urban sites. The highest 98th percentile in 2001 was observed at Shawinigan, an industrial point source site.

Figure 4.17 98th Percentile $PM_{2.5}$ Concentrations in 2001

Note: Each data point represents the 98th percentile concentration for an individual site. Sites are plotted by longitude from west to east and the sites with the highest concentrations are identified by name and NAPS identification number.



4.6 Selected Volatile Organic Compounds

Volatile organic compounds (VOCs) are defined as organic compounds (excluding CO and CO_2) containing at least one carbon atom and with a vapour pressure of ≥ 0.01 kPa at 25˚C. In 1995, 26.3% of VOC emissions originated from industrial sources, 26.2% from open sources (agriculture, forest fires, landfills, and prescribed burning), 20.5%

from transportation, 11.4% from non-industrial fuel, and 15.3% from miscellaneous sources (EC 1999). VOCs in the atmosphere may be of concern because of the toxicity of the compound, its effect on stratospheric ozone or climate change, or because of its contribution to the production of tropospheric ozone. A number of VOCs have been identified as Priority Substances under the Canadian Environmental Protection Act (CEPA). These compounds have been identified as posing a risk to the health of Canadians or to the environment.

VOC samples are collected over 24-h periods at most sites. Figure 4.18 shows the distribution of 24-h concentrations of each compound discussed below at urban sites across Canada: St. John's (10102), Saint John (40208), Montréal (50103, 50104, 50115, 50121, 50129), Ottawa (60101, 60104), Windsor (60211), Kingston (60302), Toronto (60413, 60418, 60428), Hamilton (60512), London (60903), Sarnia (61004), Peterborough (61104), Kitchener (61502), Oakville (61602), Winnipeg (70119), Regina (80110), Edmonton (90121, 90130), Calgary (90227), and Vancouver (100111). Data from cities with more than one measurement site were combined.

1,1,1-Trichloroethane (methyl chloroform) is commonly used as a blowing agent and as a solvent in a variety of industrial applications. 1,1,1-Trichloroethane has been designated as a First Priority Substance List (PSL1) compound and is considered as "toxic" under CEPA. It is persistent in the troposphere with an atmospheric lifetime of 5-7 years and may be eventually transported to the stratosphere. The ozone-depleting potential of 1,1,1-trichloroethane is roughly one-tenth that of CFC-11, one of the most destructive CFC's (CEPA 1992). As expected for a compound with a relatively long atmospheric lifetime, the median and ranges in concentrations of 1,1,1-trichloroethane were similar at urban sites across the country. Concentrations showed relatively little variation throughout the year.

1,3-Butadiene is a product of incomplete combustion and an industrial chemical used in the production of polymers, rubbers, and latexes. 1,3-Butadiene enters the environment primarily from vehicle exhaust, fuel and wood combustion, and industrial emissions. While 1,3-butadiene is not persistent, it is ubiquitous in the urban environment because of its widespread combustion sources. 1,3-Butadiene is a reactive chemical with a high photochemical ozone creation potential; it is therefore a contributor to the formation of ground-level ozone. 1,3-Butadiene has been designated as a Second Priority Substance List compound (PSL2) and is considered as "toxic" under CEPA (CEPA 2000). Median concentrations of 1,3-butadiene at urban sites were highest at sites in Regina, Vancouver, and Calgary and lowest at sites in Saint John, Peterborough, and Kingston. The sites with the highest median concentrations also showed the greatest variability in concentrations. 1,3-Butadiene levels tended to be slightly lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

Benzene is used in the production of plastics and other chemical products and is an important component of gasoline. Vehicle emissions are the major source of benzene to the Canadian environment. Benzene has been designated as a First Priority Substance

List (PSL1) compound and is considered as “toxic” under CEPA (CEPA 1993). Median concentrations of benzene were highest at sites in Saint John, Oakville, Edmonton, Montréal (50103, 50115, 50104), and Vancouver, and lowest in Peterborough, Sarnia, London, and Kitchener. Concentrations at sites in Saint John, Oakville, Edmonton, Montréal, and Vancouver were likely influenced by emissions from nearby refineries and other industries with significant emissions of benzene. Concentrations of benzene tended to be lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

Butane is a major component of gasoline vapour that is primarily emitted in vehicle exhaust and the petrochemical industry. Butane has relatively low reactivity. Median concentrations of butane were highest at sites in Edmonton (90120), Oakville, and Saint John, reflecting the impact of refineries in the vicinity of these locations. The median and ranges of concentrations were similar at most other sites. Concentrations of butane tended to be lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

Dichloromethane is a PSL1 compound used in paint removal, as a blowing agent in foam production, and as a component in aerosols. Due to its volatility and the dispersive nature of its uses, the majority of dichloromethane used in Canada may be released into the atmosphere. Dichloromethane has been classified as “probably carcinogenic” and is considered as “toxic” under CEPA. Median concentrations of dichloromethane were similar at many sites, with many individual measurements lower than the detection limit of 0.027 $\mu g/m^3$. Higher median and ranges in concentrations were observed at sites in Kingston, Montréal (50104, 50115), Vancouver, Toronto (60418), Oakville, and Winnipeg, likely due to local emission sources.

Ethylene is primarily emitted in vehicle exhaust and by the petrochemical industry. It is a relatively reactive compound and thus can contribute to the formation of tropospheric ozone and particulate matter. Median and ranges of ethylene concentrations were highest at sites in Montréal (50115, 50103), Edmonton, and Calgary. Ranges of concentrations were similar at most other sites. The elevated levels at the sites in Edmonton and Montréal are likely due to local emissions from refineries and other industries. Additionally, sites in Montréal (50115) and Ottawa (60101) have their intakes at street level and measurements are strongly influenced by local vehicle emissions. Concentrations of ethylene tended to be lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

Isopentane is a major component of gasoline vapour. Similar to butane, isopentane is primarily emitted in vehicle exhaust and by the petrochemical industry and has relatively low reactivity. Concentrations of isopentane were highest at sites in Saint John, Edmonton (90121), and Oakville, reflecting the impact of refineries in the vicinity of these locations. Elevated concentrations at sites in Montréal (50115, 50103) and Vancouver were likely due to local industry emissions and vehicle exhaust. Median and ranges in concentrations were similar at other sites. Concentrations of isopentane tended to be slightly lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

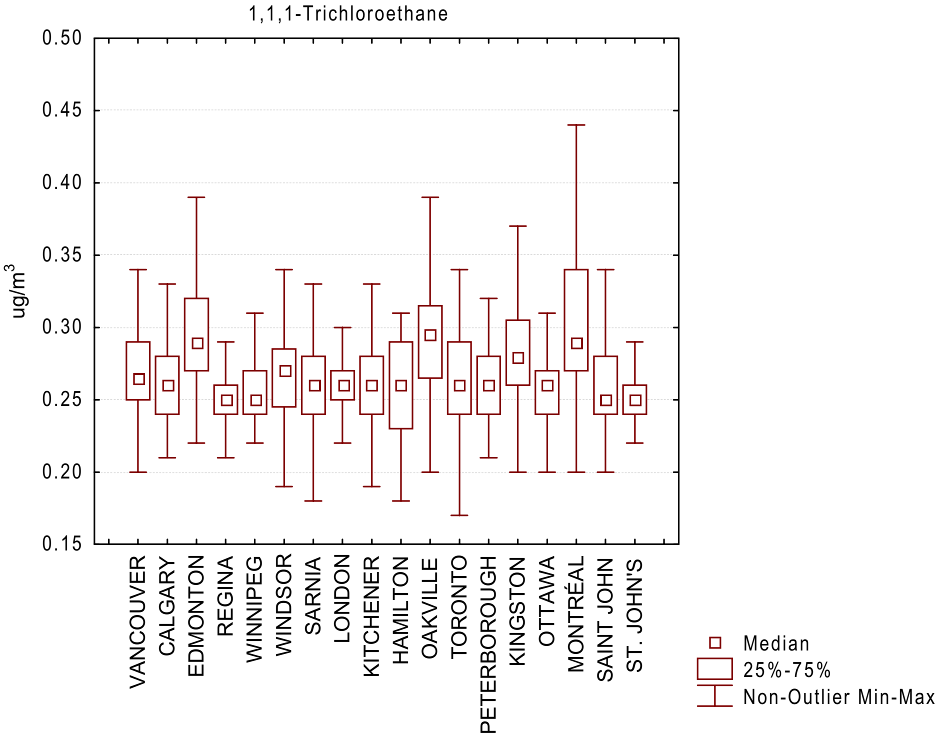
o-Xylene is emitted by oil refineries, automobile manufacturers, in vehicle exhaust, and as a product of combustion. o-Xylene is reactive in reactive in forming ozone and particulate matter. Xylenes are considered as “not toxic” under CEPA. The highest concentrations of o-xylene were measured at sites in Montréal (50115, 50103), Vancouver, and Saint John. Median and ranges in concentrations were similar at other urban sites. Concentrations of o-xylene tended to be slightly lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

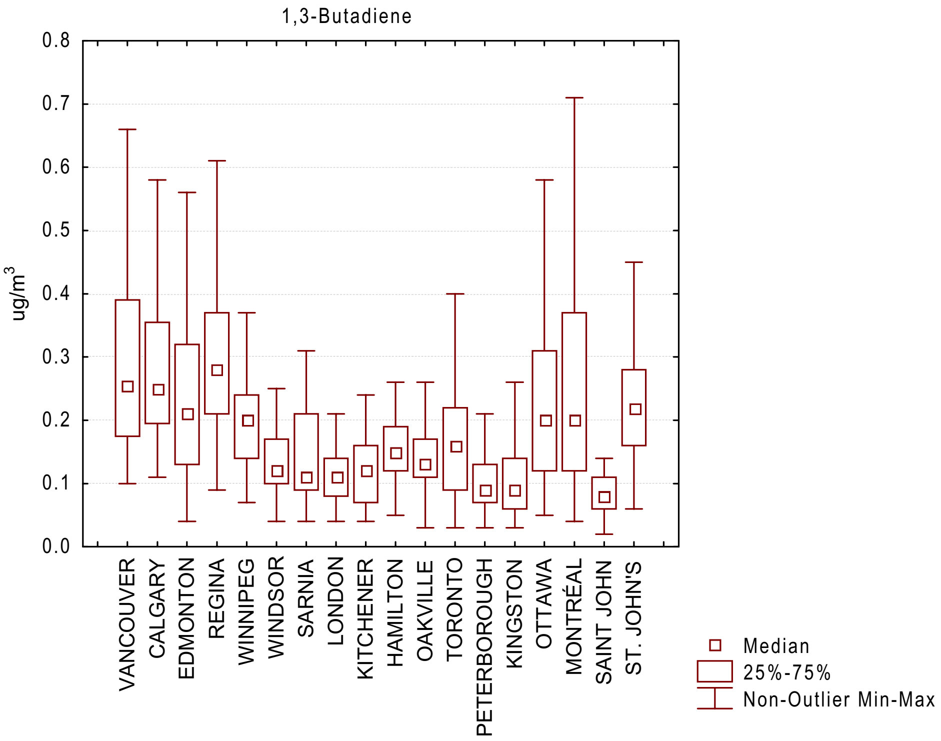
Tetrachloroethylene is a PSL1 compound used primarily as a solvent in the dry-cleaning and metal-cleaning industries. Since its uses are dispersive and do not result in its transformation or destruction, the majority of the tetrachloroethylene used in Canada is expected to enter the environment, primarily via the atmosphere. Tetrachloroethylene is considered as “toxic” under CEPA (CEPA 1994c). The highest median concentrations and ranges in concentrations of tetrachloroethylene were measured at sites in Regina, Montréal (50115), Toronto (60418), and Hamilton, and were likely due to the impact of local emission sources. Median and ranges of concentrations were similar at most other sites. Concentrations of tetrachloroethylene tended to be slightly lower in the summer months than the winter months due to the higher concentrations of oxidants and greater mixing depths caused by warm weather.

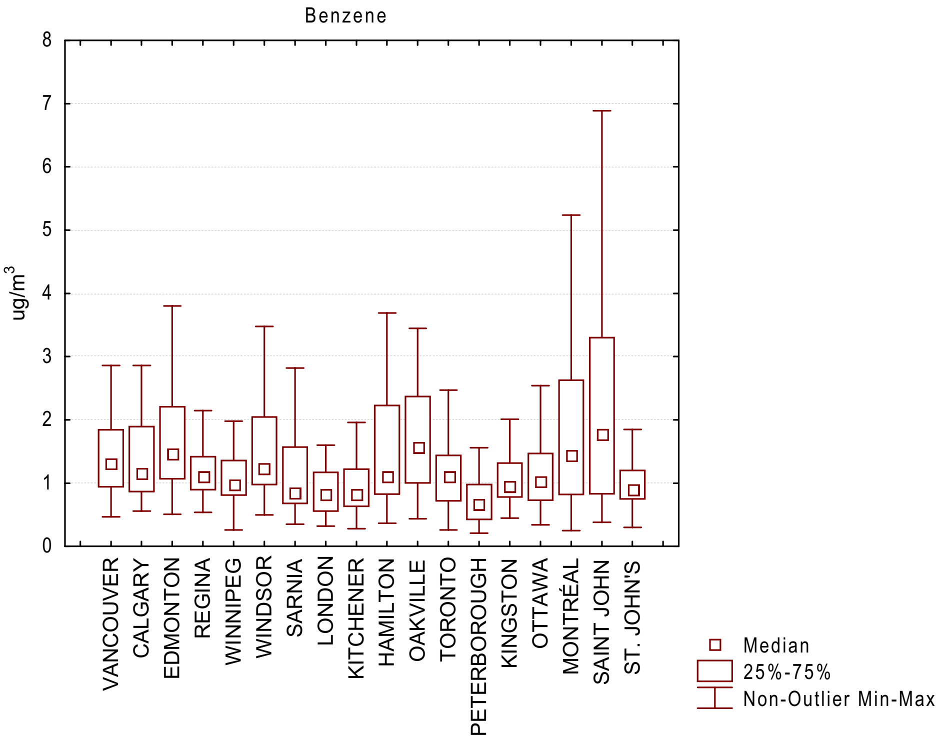
Toluene is found in gasoline and aviation fuel, and is used in the manufacturing of chemicals, explosives, dyes, and many other compounds. It is reactive in forming ozone and particulate matter. Toluene is considered as “not toxic” under CEPA. The highest median concentrations of toluene were measured at sites in Montréal (50115, 50103, 50104), Vancouver, Saint John, Toronto (60418), Winnipeg, and Oakville. Ranges in concentrations were similar at most sites. Concentrations of toluene were quite variable throughout the year and there was no consistent annual pattern between sites.

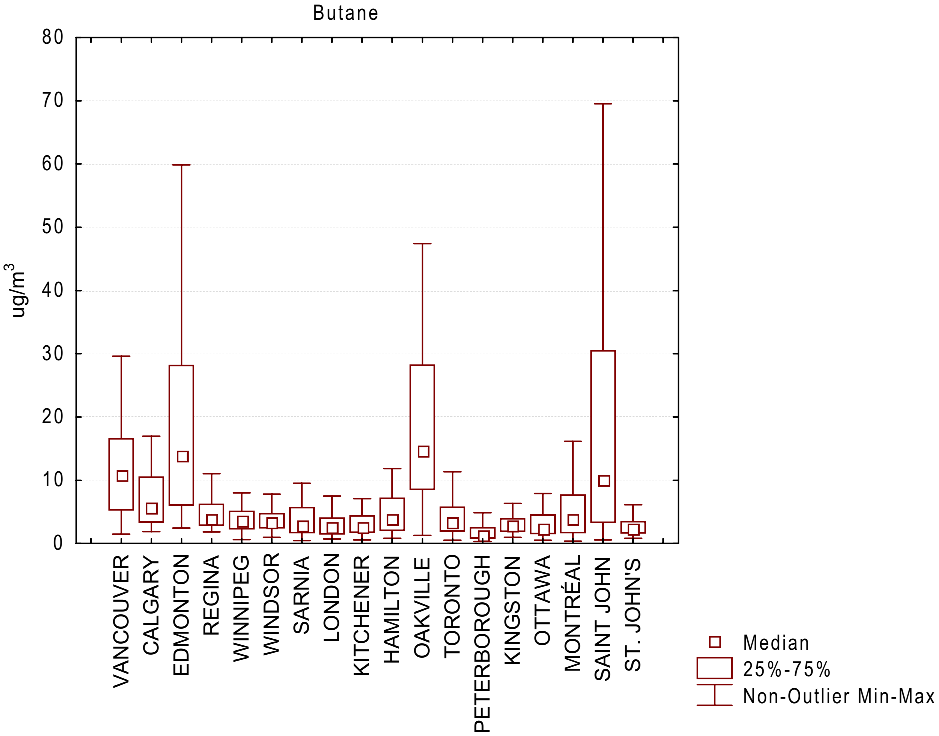
Total VOCs refers to the sum of C_2 – C_{12} hydrocarbons. Median total VOC concentrations were highest at sites in Saint John, Edmonton (90121), Oakville, Montréal (50103, 50115), and Vancouver, reflecting the impact of refineries in the vicinity of these sites, and were similar at other urban sites. Total VOC concentrations tended to be higher in the winter than in the summer.

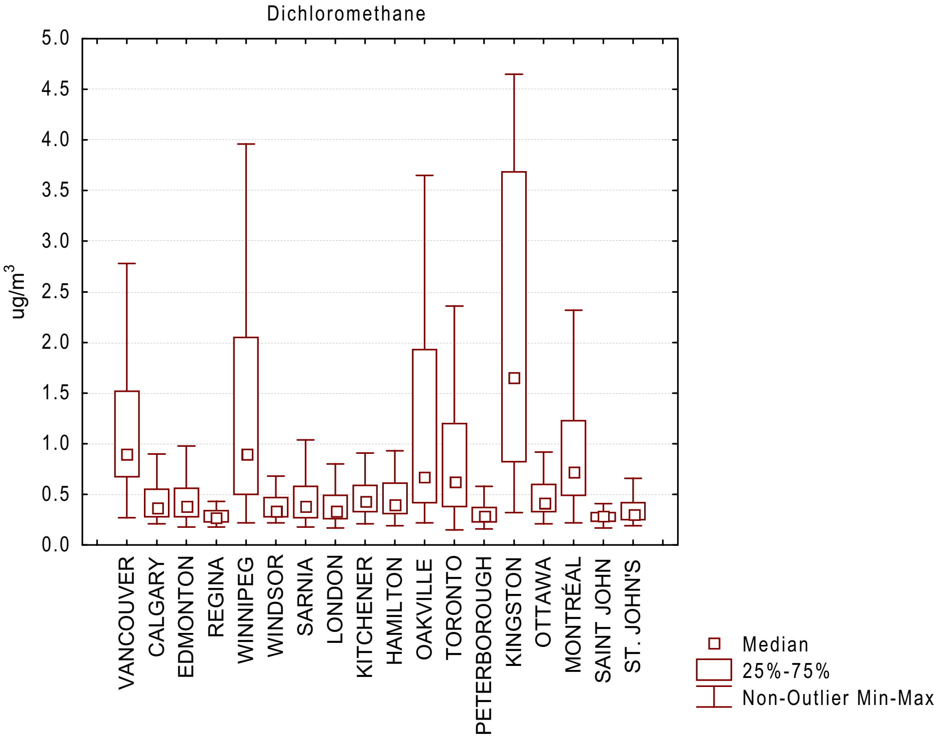
Figure 4.18 Concentrations of Selected Organic Compounds in 2001 – Urban Sites

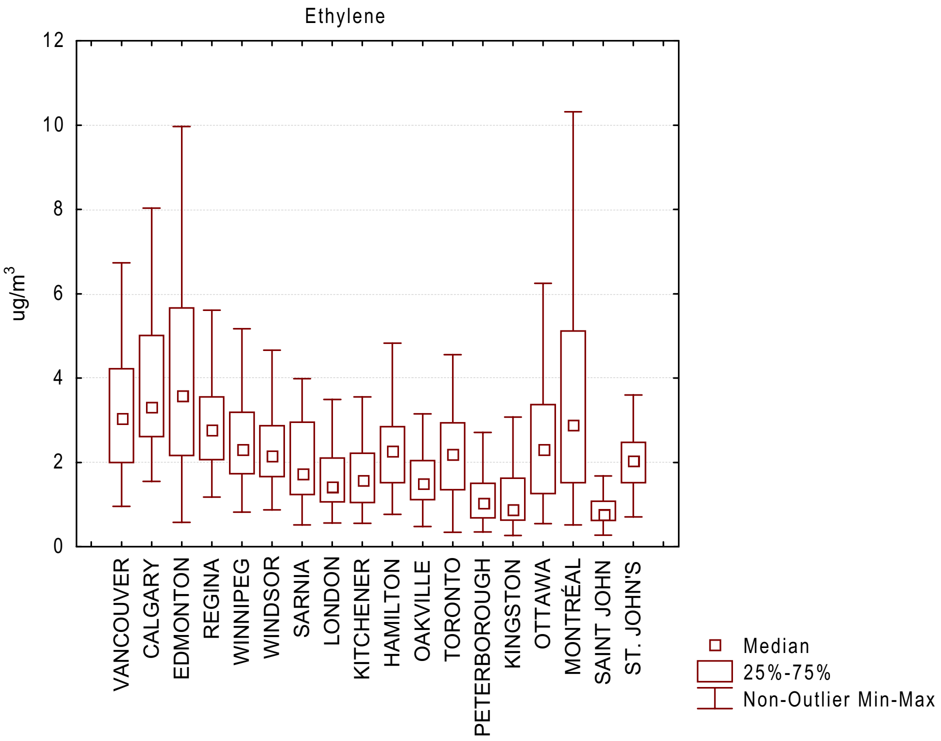


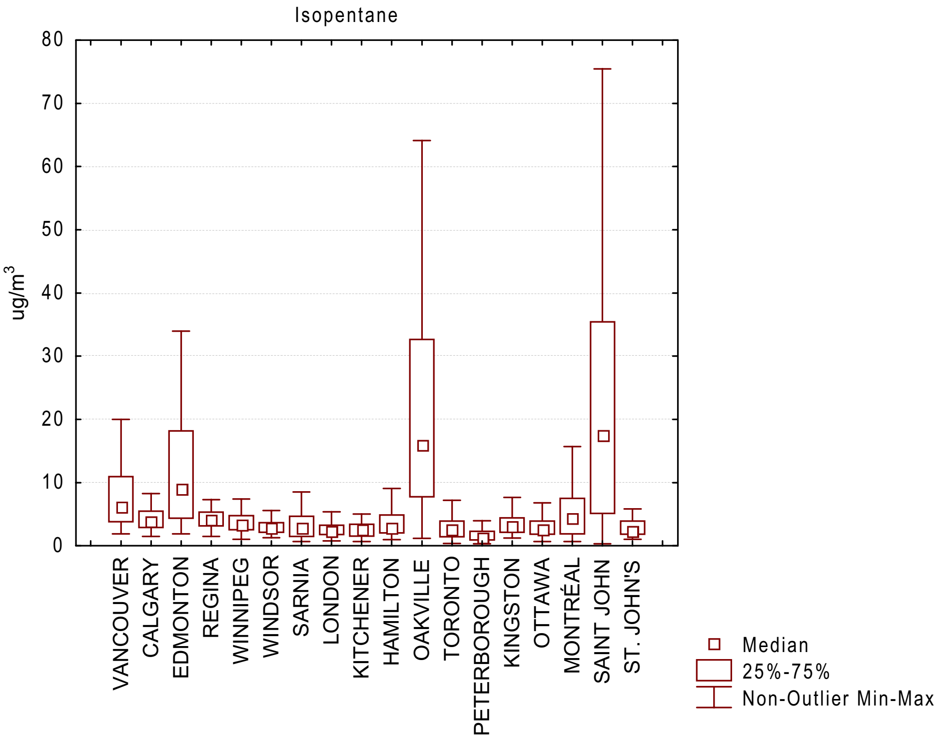

1,3-Butadiene
ug/m^3
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max

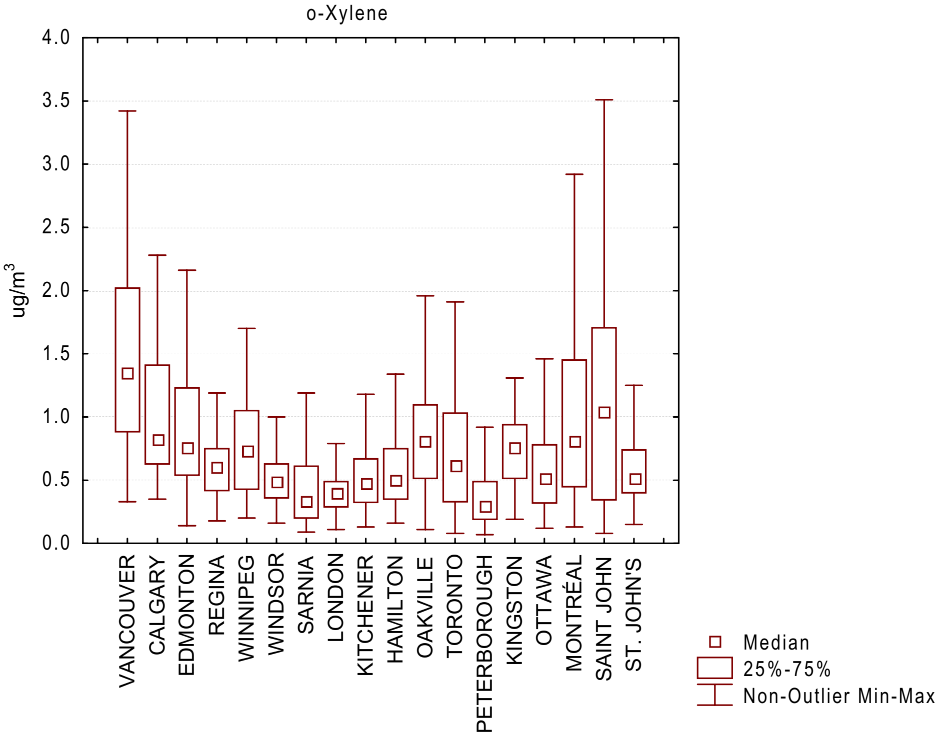

Benzene
ug/m^3
0
1
2
3
4
5
6
7
8
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max

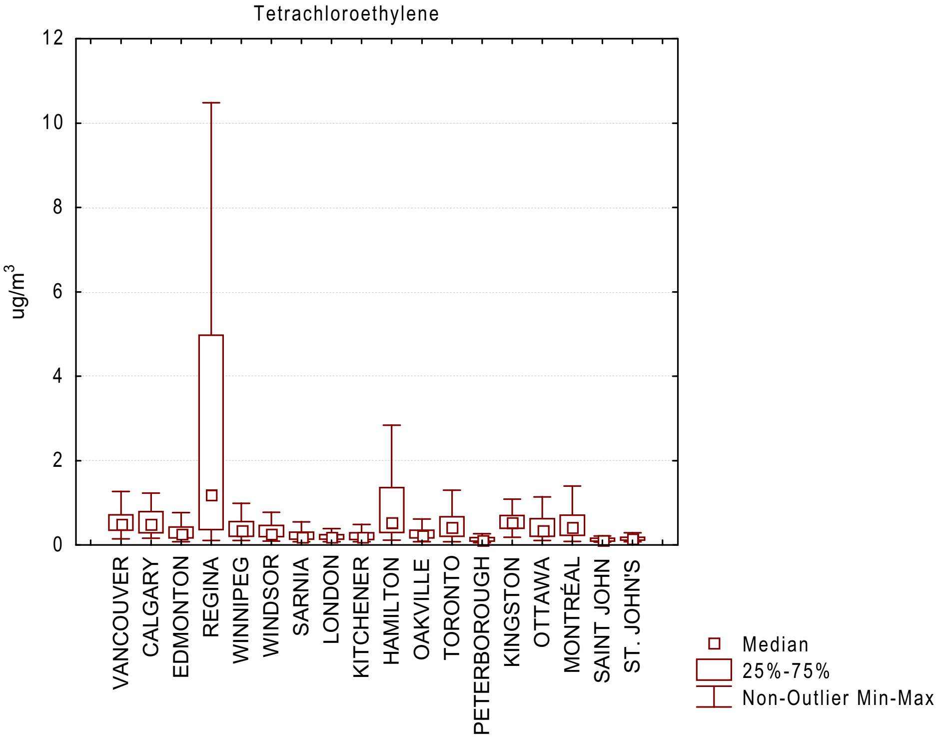

Butane
80
70
60
50
40
30
20
10
0
ug/m3
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max

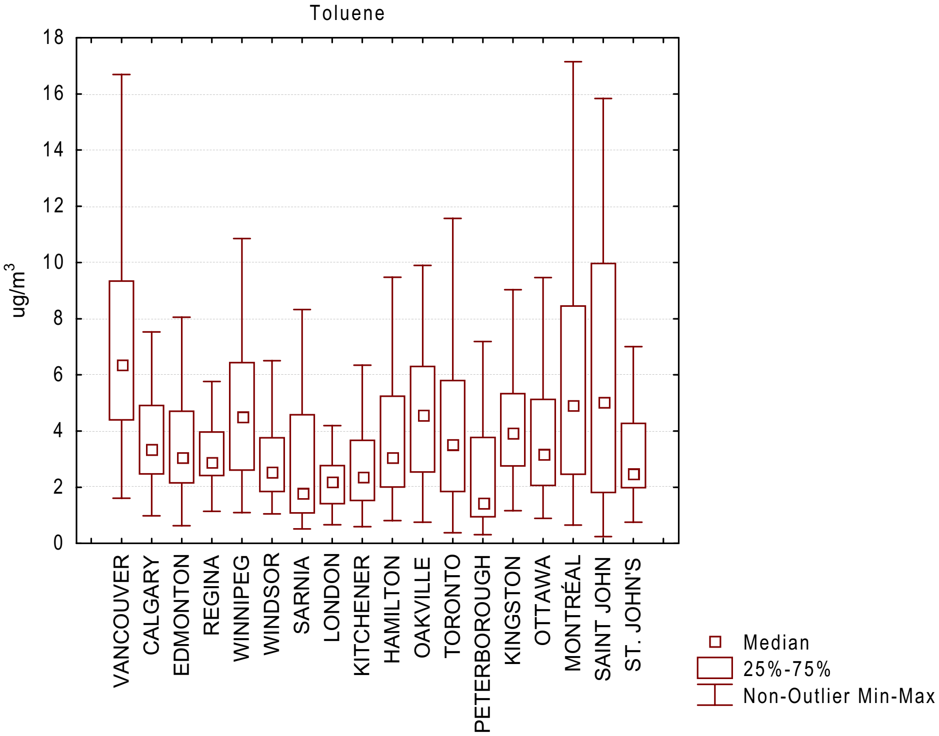

Dichloromethane
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ug/m3
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max

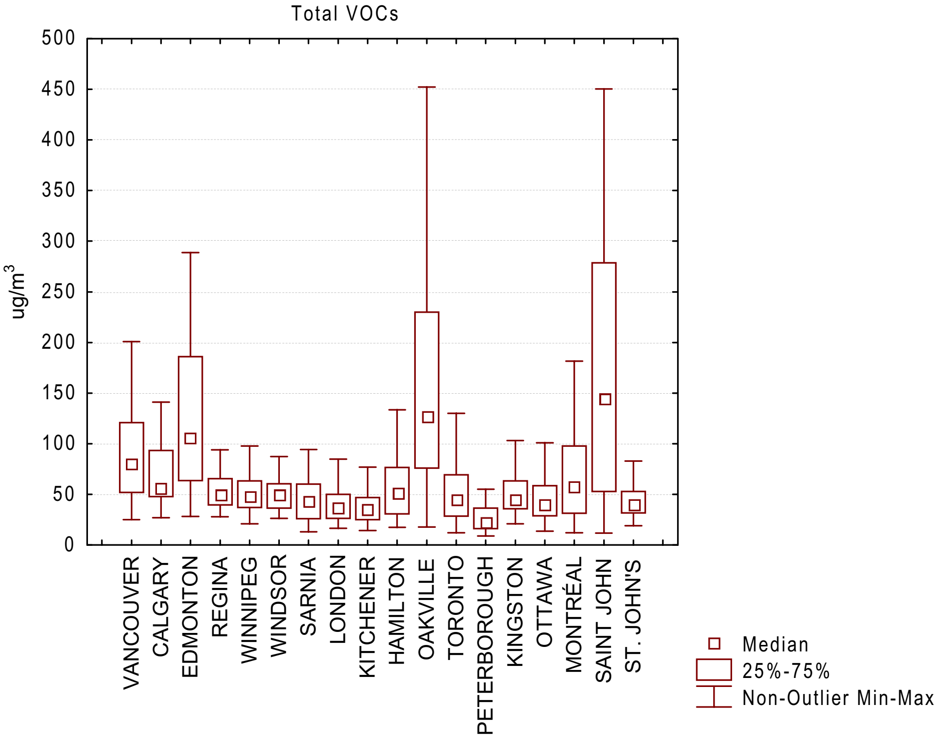

Ethylene
12
10
8
6
4
2
0
ug/m3
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max


Isopentane
80
70
60
50
40
30
20
10
0
ug/m3
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max


o-Xylene
ug/m^3
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max


Tetrachloroethylene
ug/m^3
12
10
8
6
4
2
0
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max


Toluene
ug/m^3
0
2
4
6
8
10
12
14
16
18
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max


Total VOCs
ug/m^3
0
50
100
150
200
250
300
350
400
450
500
VANCOUVER
CALGARY
EDMONTON
REGINA
WINNIPEG
WINDSOR
SARNIA
LONDON
KITCHENER
HAMILTON
OAKVILLE
TORONTO
PETERBOROUGH
KINGSTON
OTTAWA
MONTRÉAL
SAINT JOHN
ST. JOHN'S
Median
25%-75%
Non-Outlier Min-Max

4.7 Selected Inorganic Compounds

The NAPS program measures the particle bound fraction of metals and other inorganic compounds in the atmosphere. Metals measured under the NAPS program are not speciated; the data represent elemental totals. Metal and inorganic compound samples are collected over 24-h periods. Metal and other inorganic compound concentration data from dichotomous samplers were available for a limited number of urban sites. The data reported in this section represent the concentration of specific compounds in the coarse + fine fraction of particulate matter (PM_{10}) collected by the samplers. Figure 4.19 shows the distribution of 24-h concentrations of each inorganic compound discussed below at urban sites across Canada: Québec (50308), Montréal (50104, 50124, 50125), Ottawa (60104), Windsor (60211), Hamilton (60512), Winnipeg (70119), Edmonton (90130), and Vancouver (100111, 100118). Data from cities with more than one measurement site were combined.

Chromium is released into the environment as a result of industrial uses, the production and combustion of fossil fuels, and smelting and refining processes. Hexavalent chromium has been classified as “Carcinogenic to Humans” and is considered as “toxic” under CEPA (CEPA 1994a). The only sites with non-zero median concentrations of chromium were Montréal (50124, 50125) and Hamilton. Ranges in chromium concentrations were similar at most urban sites. The elevated concentrations at the Hamilton site were the result of emissions from the city’s iron and steel mills.

Copper is emitted into the atmosphere as a result of industrial uses, power generation, and smelting and refining processes. Median and ranges in copper concentrations were highest at a site in Montréal (50125) and Edmonton, and lowest at sites in Vancouver and Winnipeg. Ranges in concentrations were similar at most sites.

Median concentrations of iron were highest at sites in Windsor and Edmonton and lowest in Ottawa. The highest range in concentrations was observed at the site in Hamilton, reflecting the influence of the city’s iron and steel mills. Ranges in concentrations were similar at most other sites.

Manganese is released into the atmosphere a result of industrial uses, the production and combustion of fossil fuels, and smelting and refining processes. Manganese is a component of the gasoline additive methylcyclopentadienyl manganese (MMT). Median and ranges in manganese concentrations were highest at the site in Hamilton, once again as a result of the city’s iron and steel mills. The lowest concentrations were observed in Ottawa and Vancouver. Ranges in concentrations were similar at most urban sites.

Nickel and vanadium are both released in the combustion of heavy fuels by marine vessels and the pattern of concentrations observed at urban sites was similar for the two metals. Oxidic, sulphidic, and soluble forms of nickel have been classified as “Carcinogenic to Humans” and are considered as “toxic” under CEPA (CEPA 1994b). Nickel and vanadium concentrations were highest at sites in Montreal (50125, 50124) and Québec, both cities with marine vessel ports, and lowest at sites in Windsor and Winnipeg.

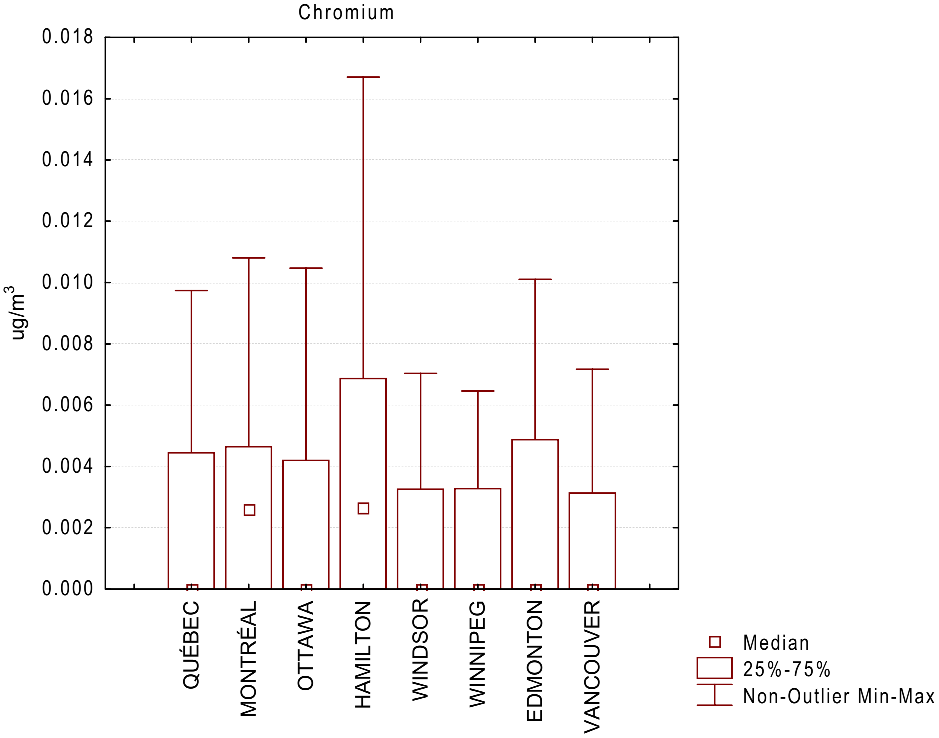
Lead is released into the environment as a result of industrial uses, power generation, and smelting and refining processes. Median concentrations of lead were highest at sites in Montréal (50125, 50124) and Québec. Ranges in concentrations similar to these sites were also observed at the Hamilton site. Median and ranges of concentrations of lead were lower at other urban sites.

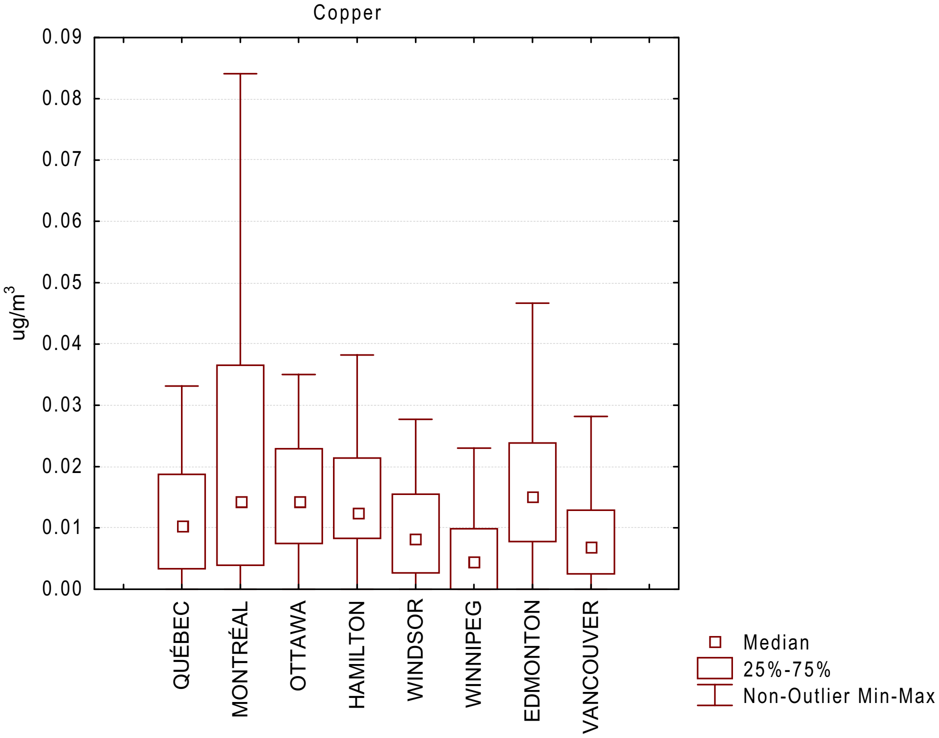
Zinc is emitted into the atmosphere as a result of chemical production industries, power generating stations, paper mills, and smelting and refining processes. The pattern of zinc concentrations at urban sites was quite variable. The highest median and ranges in concentrations were observed at sites in Québec and Windsor, while the lowest were observed at sites in Vancouver and Ottawa. The elevated concentrations at sites in Windsor were likely due to industrial operations in the area.

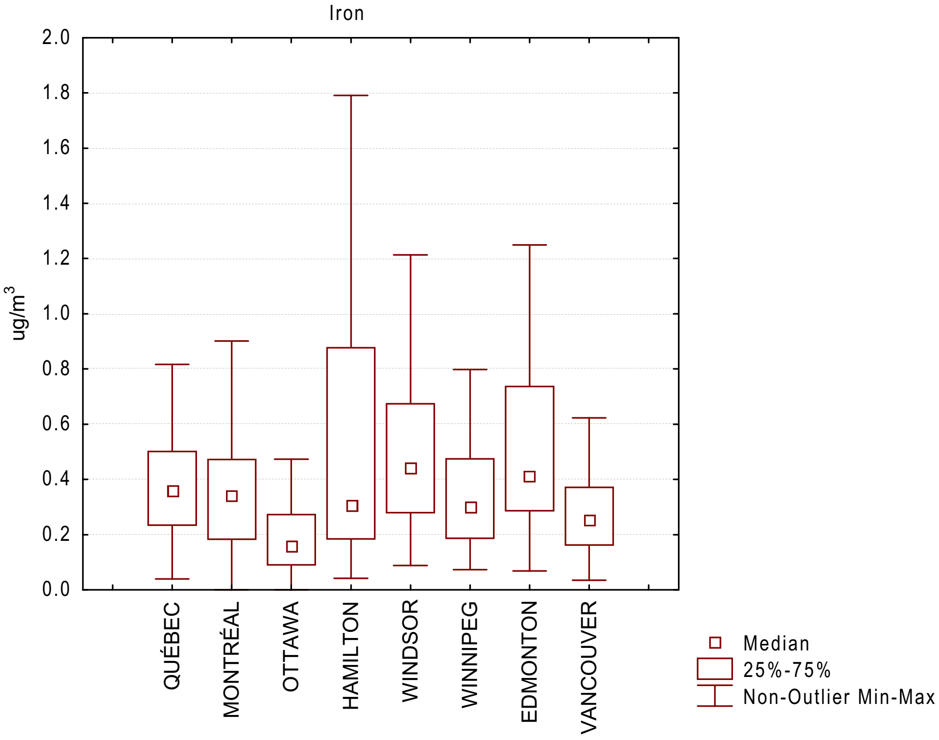
Sulphur is emitted into the atmosphere primarily as SO_2 (Section 4.1). Sulphates in particulate matter are formed from the oxidation of gaseous SO_2 in the atmosphere. Sulphates may be subject to long-range transportation. Sulphate concentrations at urban sites were variable, with higher concentrations at eastern sites than at western sites resulting from long-range transport. The highest median and ranges of concentrations were observed at sites in Hamilton and Montréal (50104), while the lowest were at sites in Vancouver, Winnipeg, and Edmonton.

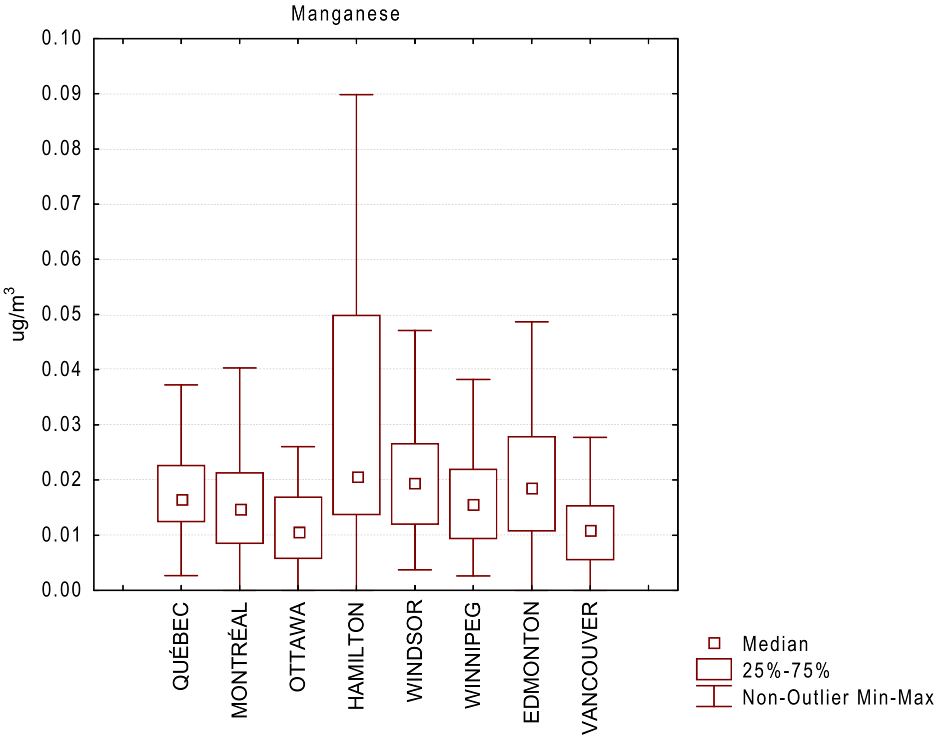
Total particulate matter mass was highest at sites in Montréal (50125, 50124), Hamilton, and Québec and lowest at sites in Vancouver.

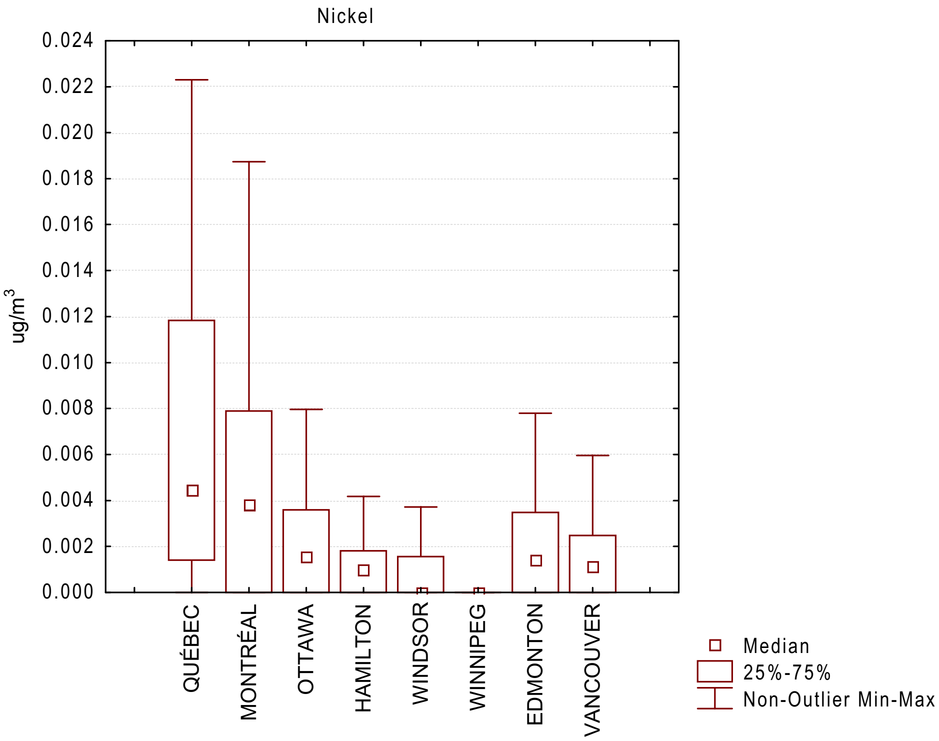
Figure 4.19 Concentrations of Selected Inorganic Compounds in 2001 – Urban Sites

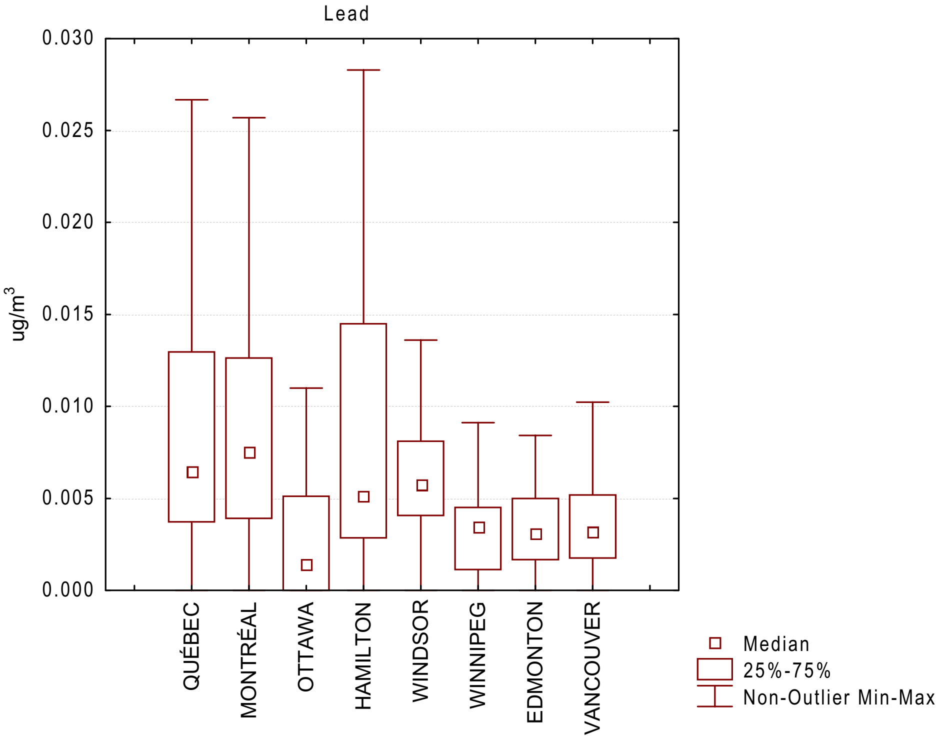


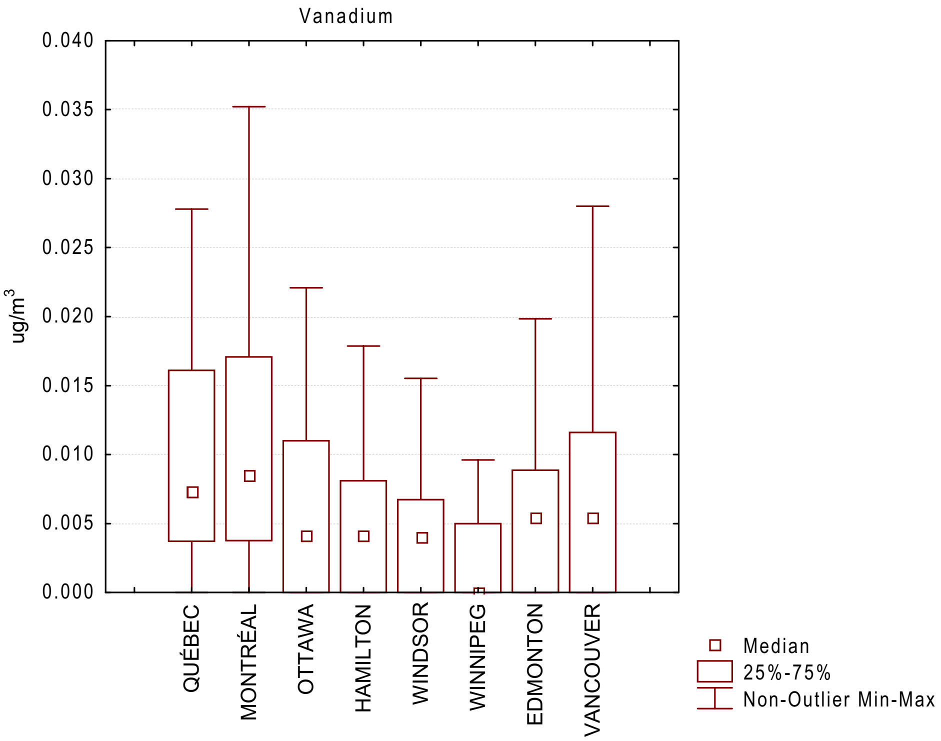


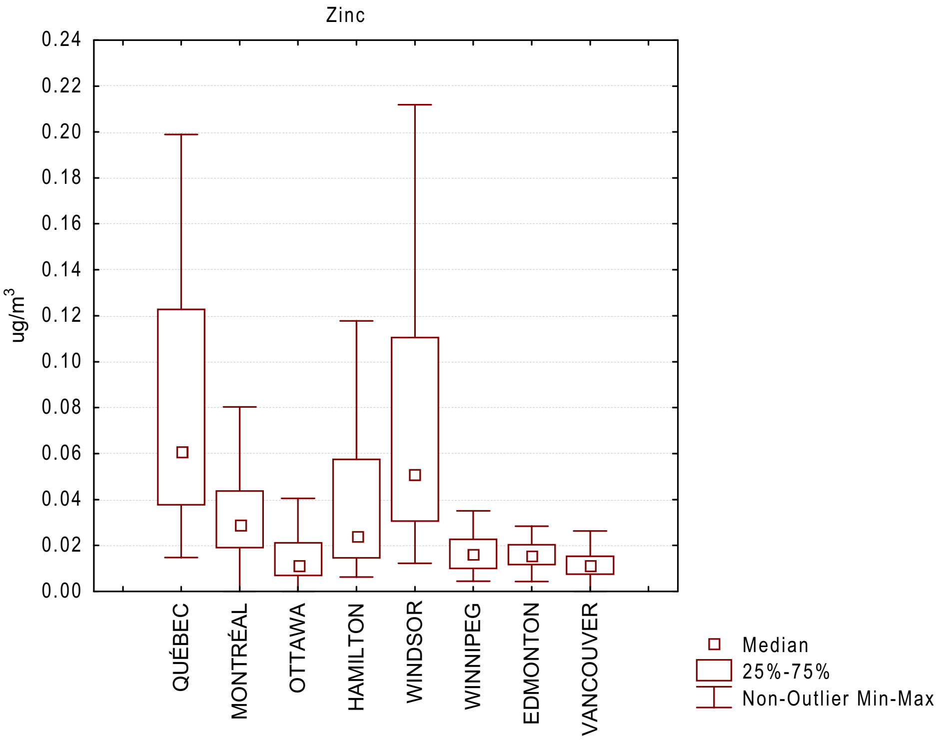

Iron
ug/m3
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max

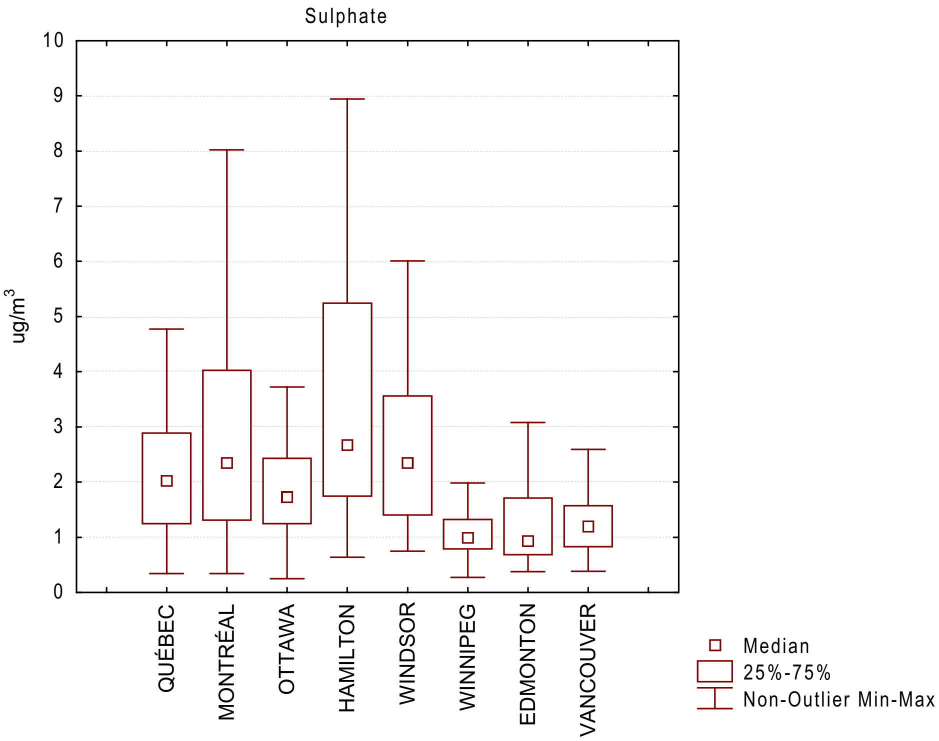

Manganese
ug/m3
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max


Nickel
ug/m3
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max


Lead
ug/m3
0.030
0.025
0.020
0.015
0.010
0.005
0.000
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max


Vanadium
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
ug/m^3
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max


Zinc
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
ug/m^3
QUÉBEC
MONTRÉAL
OTTAWA
HAMILTON
WINDSOR
WINNIPEG
EDMONTON
VANCOUVER
Median
25%-75%
Non-Outlier Min-Max



5.0 LONG-TERM TRENDS BY POLLUTANT

5.1 Sulphur Dioxide

Annual mean concentrations of SO_2 at most urban sites across Canada declined over the past decade. Figure 5.1 shows the mean annual concentration from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. The mean SO_2 concentration in 2001 was 32% lower than in 1990. The most significant decreases, as measured by the slopes of the linear regression lines for data from individual sites, were observed at sites in Saint John (40203), Shawinigan (51201), Vancouver (100110), and Hamilton (60511).

SO_x emissions data and forecasts were available from the Criteria Air Contaminants (CAC) 1995 Inventory and NRCan/AMG report "Canada's Emissions Outlook: An Update" December 1999. Total SO_x emissions decreased from 2634 kilotonnes in 1995 to 2488 kilotonnes in 2001, a decrease of 5.5%. Industrial sources accounted for the largest decrease in emissions during this time, while emissions from non-industrial fuel combustion increased.

Figure 5.1 Annual Mean Concentrations of SO_2, 1990-2001.

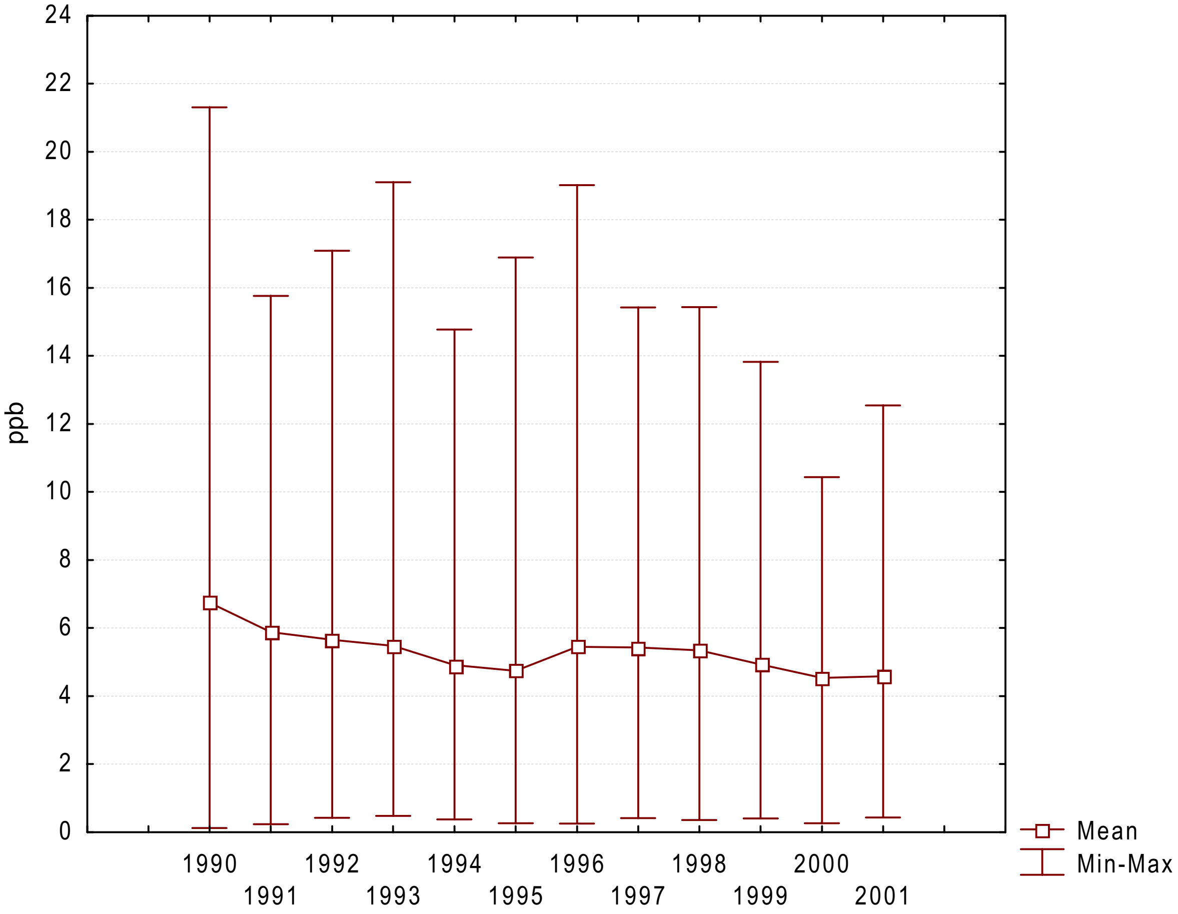
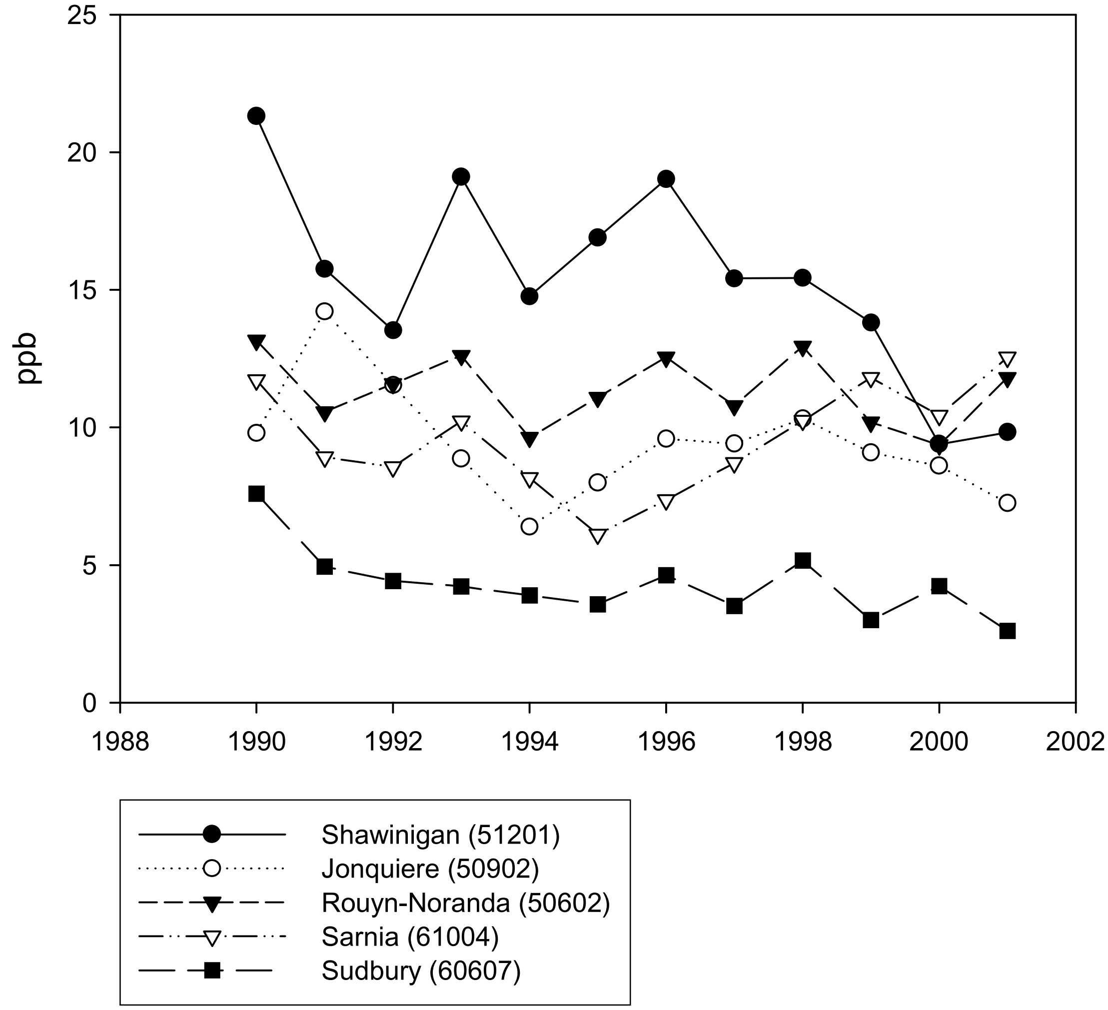


Figure 5.2 shows the trends in annual mean concentrations of SO_2 at five of the twelve sites that exceeded the maximum desirable 1-h NAAQO in 2001 (Section 4.1): Shawinigan (51201), Jonquière (50902), Rouyn-Noranda (50602), Sudbury (60607), and Sarnia (61004). Insufficient data were available to examine trends in annual means at the remaining sites. SO_2 concentrations decreased at the sites in Shawinigan and Sudbury, and remained roughly constant at Jonquière, Rouyn-Noranda, and Sarnia.

Figure 5.2 Annual Mean Concentrations of SO_2, 1990-2001 – Selected Sites

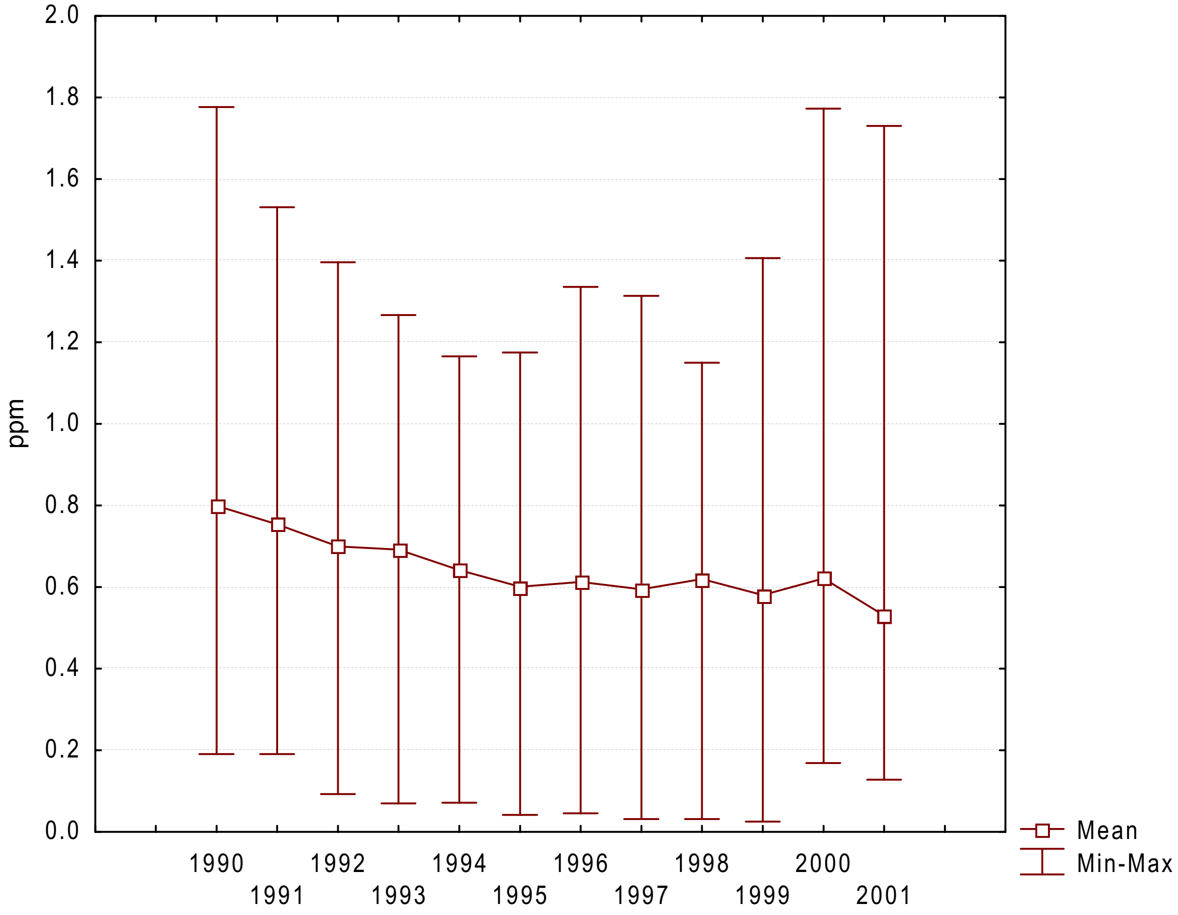


5.2 Carbon Monoxide

Annual mean concentrations of CO at most urban sites across Canada declined over the past decade. Figure 5.3 shows the mean annual concentration from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. The mean annual CO concentration in 2001 was 34% lower than in 1990. The most significant decreases, as measured by the slopes of the linear regression lines for data from individual sites, were observed at sites in Vancouver (100112), Windsor (60204), Edmonton (90130), and Calgary (90227).

CO emissions data and forecasts were available from the CAC 1995 Inventory and NRCan/AMG report "Canada's Emissions Outlook: An Update" December 1999. Total CO emissions decreased from 11658 kilotonnes in 1995 to 9171 kilotonnes in 2001, a decrease of 21.3%. Transportation (predominantly light duty gasoline vehicles) and industrial sources accounted for the largest decreases in emissions during this time.

Figure 5.3 Annual Mean Concentrations of CO, 1990-2001.



5.3 Nitrogen Oxides

Concentrations of both NO and NO_2 declined at most urban sites across Canada over the past decade. Figures 5.4 and 5.5 show the mean annual concentrations for NO and NO_2 from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. The mean annual concentration of NO in 2001 was 21% lower than in 1990, while the NO_2 concentration was 15% lower. The most significant decreases in NO, as measured by the slopes of the linear regression lines for data from individual sites, were observed at sites in Vancouver (100112, 100118, 100111), Edmonton (90130), Montréal (50115), and Toronto (60424), while the most significant decreases in NO_2 were at sites in Montréal (50113, 50110, 50119), Toronto (60423), Québec (50308), and Calgary (90227).

NO_x emissions data and forecasts were available from the CAC 1995 Inventory and NRCan/AMG report "Canada's Emissions Outlook: An Update" December 1999. Total NO_x emissions, excluding emissions from oil sands and upstream oil and gas industries (which affect relatively few urban sites), decreased slightly from 2406 kilotonnes in 1995 to 2379 kilotonnes in 2001, a decrease of 1.1%. Transportation (predominantly light duty gasoline vehicles) and industrial sources accounted for the largest decrease in emissions during this time, while non-industrial fuel combustion sources increased.

Figure 5.4 Annual Mean Concentrations of NO, 1990-2001.

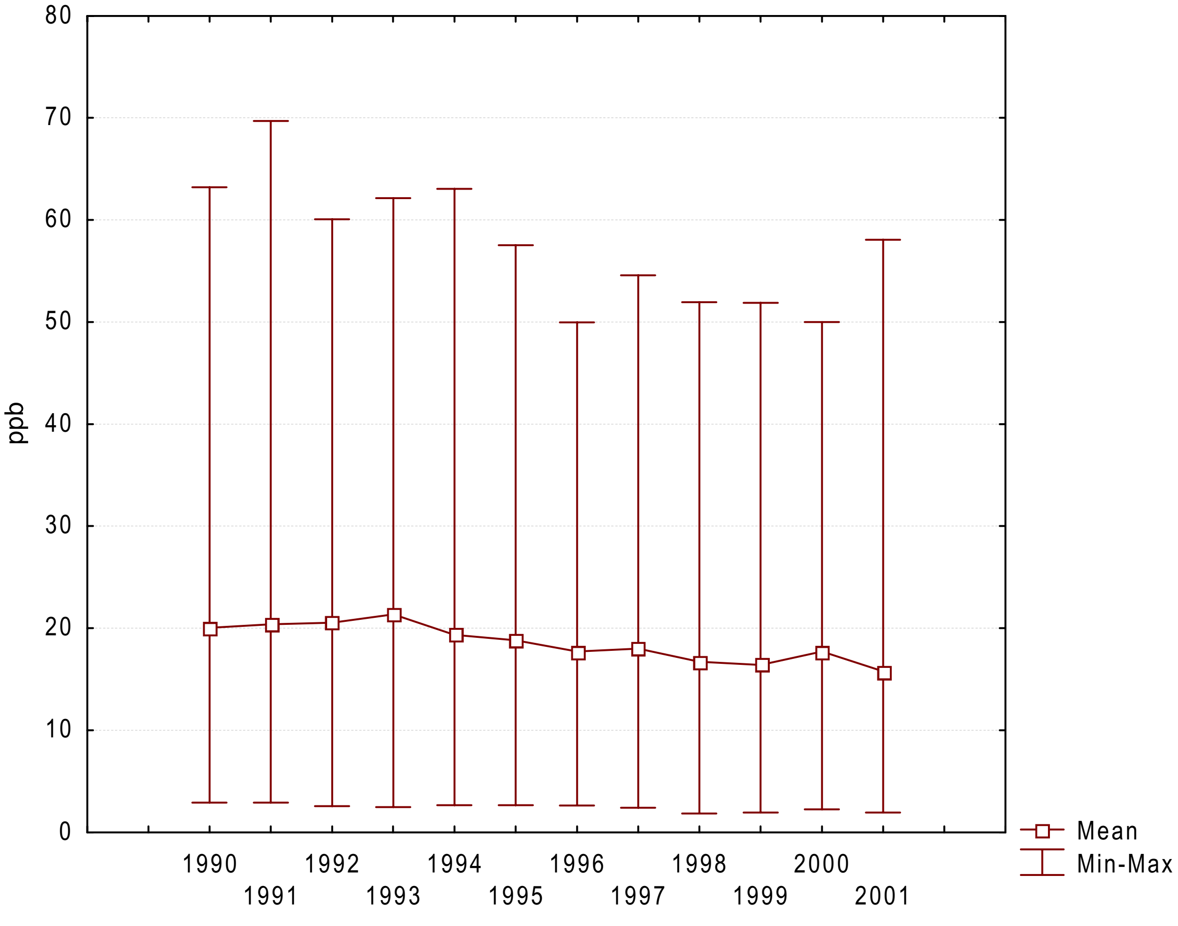
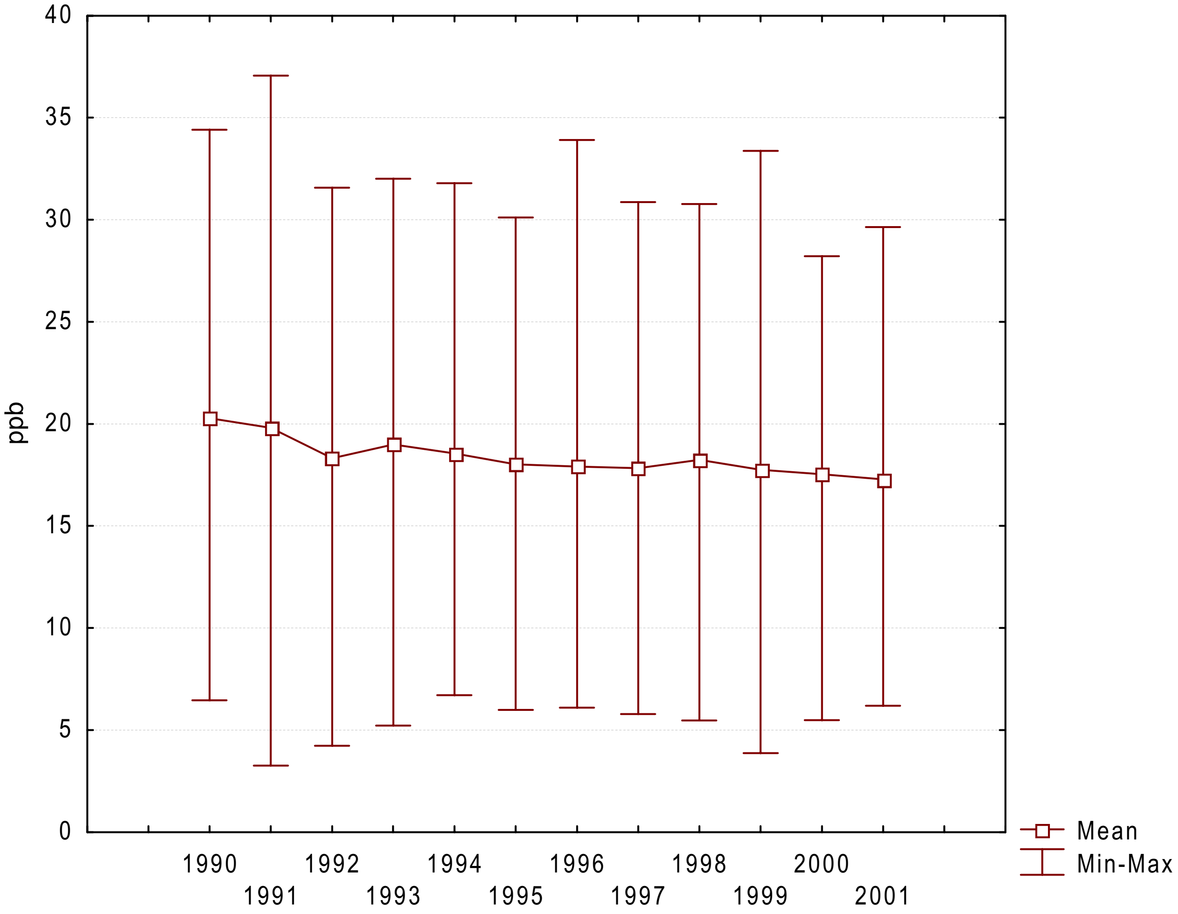


Figure 5.5 Annual Mean Concentrations of NO_2, 1990-2001.



5.4 Tropospheric Ozone

Trends in O_3 concentrations were examined by calculating the 4th highest 8-h measurement at each site for each year, and then averaging the values of all urban and rural sites. Missing years of data were calculated by linear interpolation from surrounding years. The results are shown in Figures 5.6 and 5.7. No clear trends were evident in the national averages at either urban or rural sites. Trends at individual sites were variable. The greatest decreases in O_3 levels, as measured by the slopes of the linear regression lines for data from individual sites, were observed at urban sites in Saint John (40203), Fort McMurray (90701), Vancouver (100111 and 100126), Kingston (60302), and Chilliwack (101101), and rural sites in Point Lepreau (40501), Blissville (40601), Fundy National Park (40401), St. Hilaire de Dorset (53701), and La Patrie (54901). The greatest increases were observed at urban sites in Stouffville (63201), Thunder Bay (60807), Toronto (60403, 60410), Montréal (50102), Ottawa (60101), and

Brandon (70203), and at rural sites in Simcoe (62601) and Experimental Lakes Area (64001).

Figure 5.6 Fourth Highest 8-h Maximum Ozone Concentrations, Urban Sites, 1990-2001.

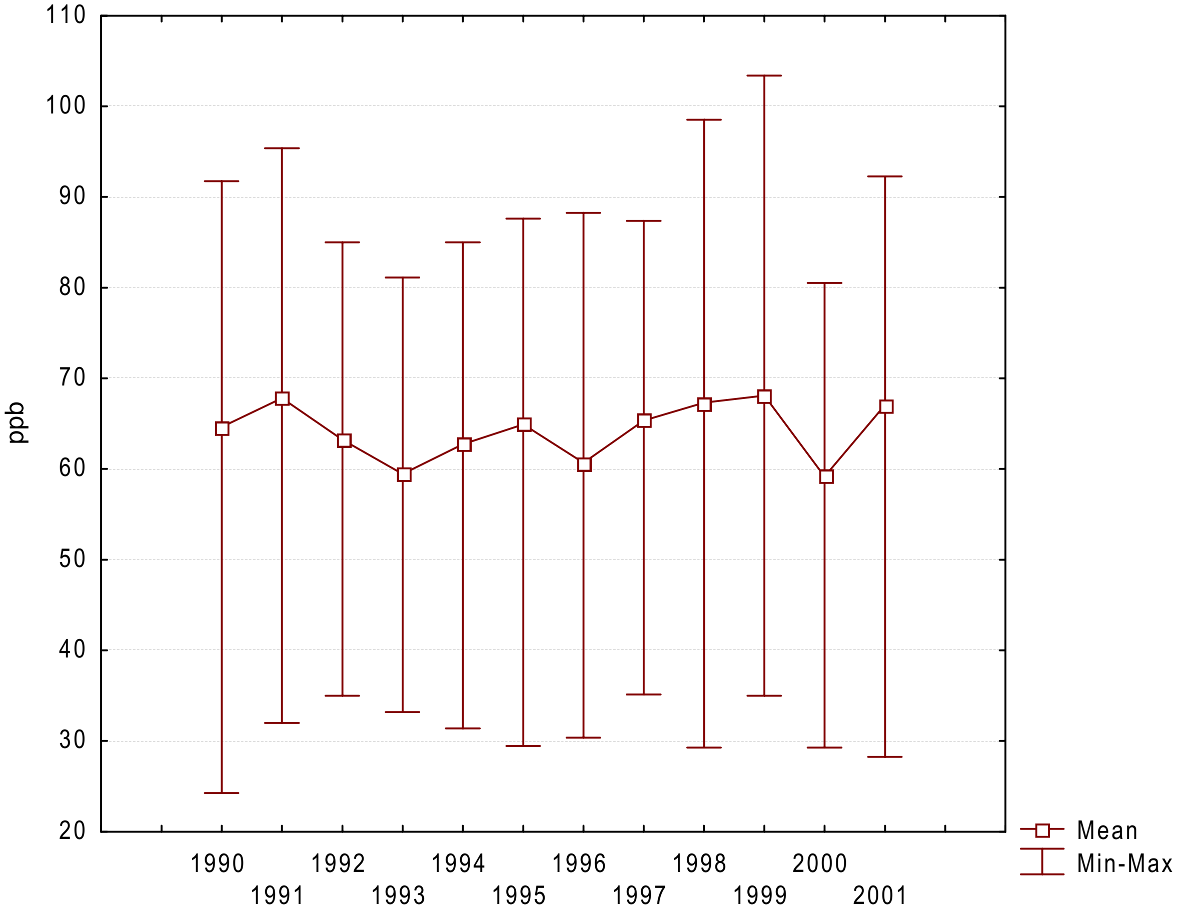
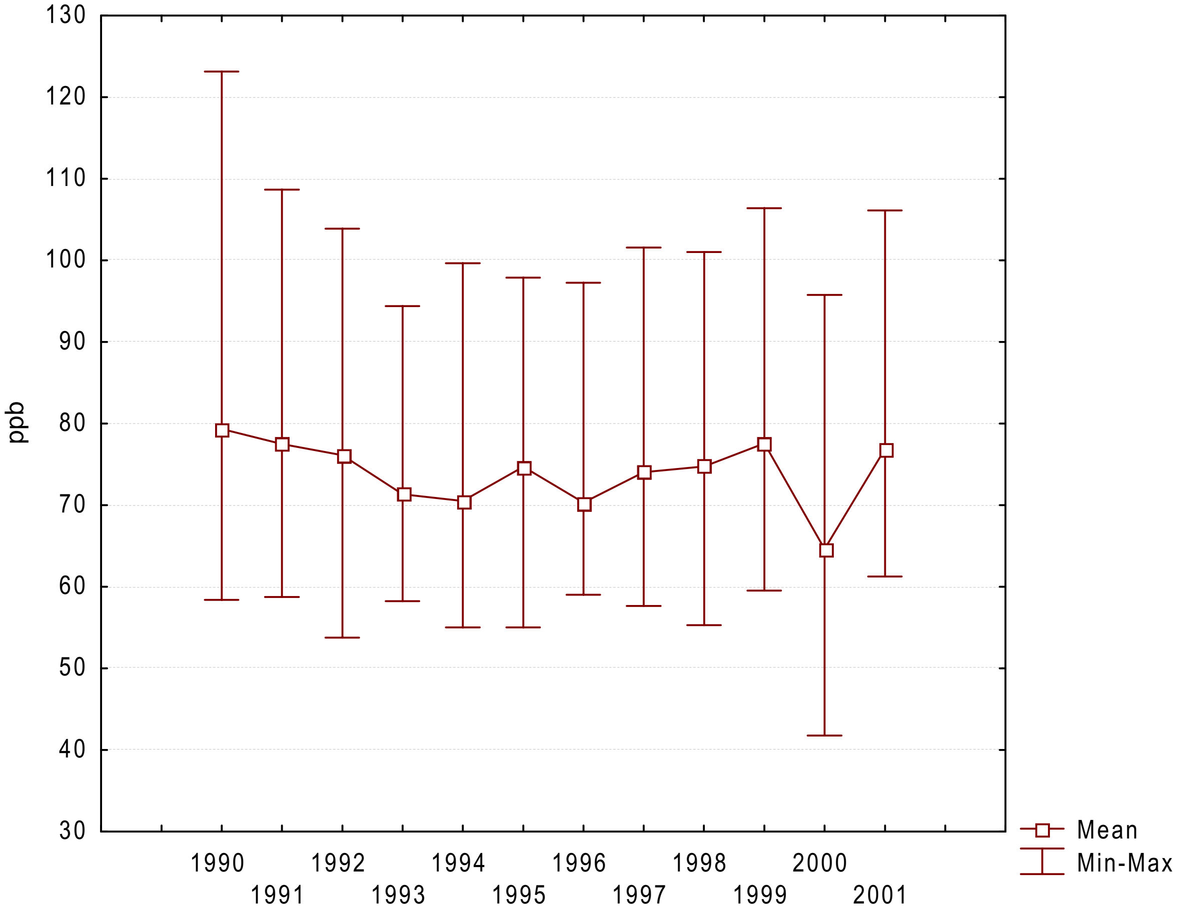
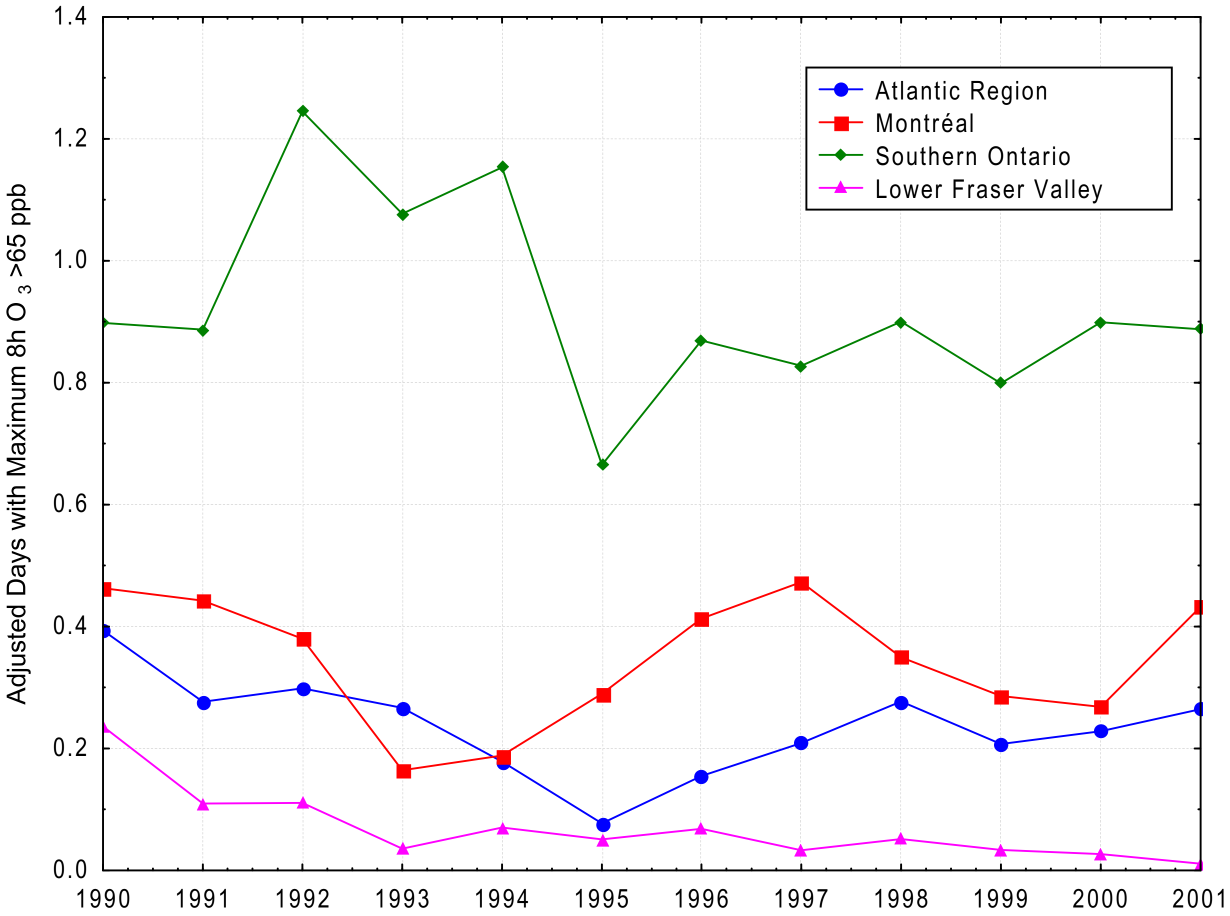


Figure 5.7 Fourth Highest 8-h Maximum Ozone Concentrations, Rural Sites, 1990-2001.



Meteorologically adjusted O_3 trends were also examined. The number of days with daily maximum 8-h O_3 concentrations greater than 65 ppb was calculated at each site for each year and then divided by the average number of days with daily maximum temperatures greater than 28 °C as recorded at nearby meteorological sites. The temperature adjustment is a crude way of accounting for yearly variation in meteorological conditions conducive to O_3 formation. Only sites with complete data were used in the analysis. Urban and rural sites were both included, but most sites were urban. Two sites in the Atlantic region, five sites in Montréal, 21 sites in southern Ontario, and six sites in the Lower Fraser Valley had complete data. The 3-yr running average values for each region are shown in Figure 5.8. The Lower Fraser Valley showed a slight but consistent decline in adjusted days with 8-h O_3 > 65 ppb, but no clear trends were evident in other regions.

Figure 5.8 Adjusted 3-yr Running Average of Days with Daily Maximum 8-h Ozone Concentrations > 65 ppb by Region, 1990-2001.



5.5 Particulate Matter

The particulate matter data in this section were collected by the dichotomous samplers. Data for trend analyses were available from a limited number (eight) of urban sites. Figures 5.9 and 5.10 shows the mean annual concentration from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. Annual mean concentrations of $PM_{2.5}$ decreased at all urban sites across Canada over the past decade, while annual mean concentrations of PM_{10} decreased at most urban sites. The mean annual $PM_{2.5}$ concentration in 2001 was 27% lower than in 1990, while the PM_{10} level was 34% lower. The most significant decreases in $PM_{2.5}$, as measured by the slopes of the linear regression lines for data from individual sites, were observed at sites in Vancouver (100118, 100111) and Montréal (50104), while the greatest decreases in PM_{10} were observed at sites in Winnipeg (70119), Montréal (50104), and Windsor (60211).

PM_{10} and $PM_{2.5}$ emissions data and forecasts were available from the CAC 1995 Inventory and NRCan/AMG report "Canada's Emissions Outlook: An Update" December 1999. Total PM_{10} emissions increased from 4667 kilotonnes in 1995 to 5194 kilotonnes in 2001, an increase of 11.3%. Open sources (predominantly dust from unpaved roads), industrial sources (predominantly iron ore mining), and non-industrial fuel combustion accounted for the largest increase in PM_{10} emissions during this time, while emissions from transportation sources decreased. Total $PM_{2.5}$ emissions increased from 929 kilotonnes in 1995 to 1001 kilotonnes in 2001, an increase of 7.7%. Open sources (predominantly dust from unpaved roads), industrial sources (predominantly iron ore mining and coal industry), and non-industrial fuel combustion accounted for the largest increase in emissions during this time, while emissions from transportation sources decreased. The contrasting trends in annual mean PM_{10} and $PM_{2.5}$ concentrations and emissions data likely reflects the urban nature of the measuring sites.

Figure 5.9 Annual Mean Concentrations of PM_{10}, 1990-2001.

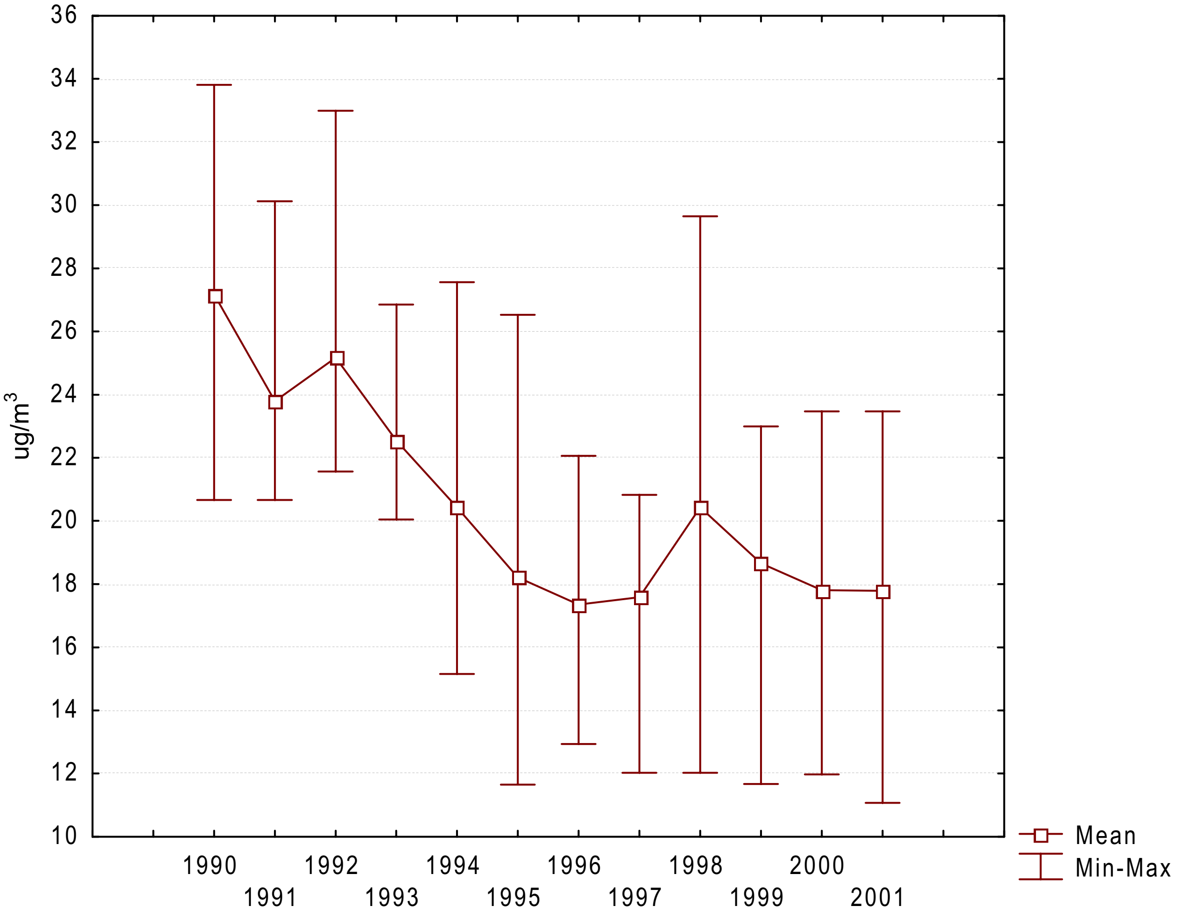
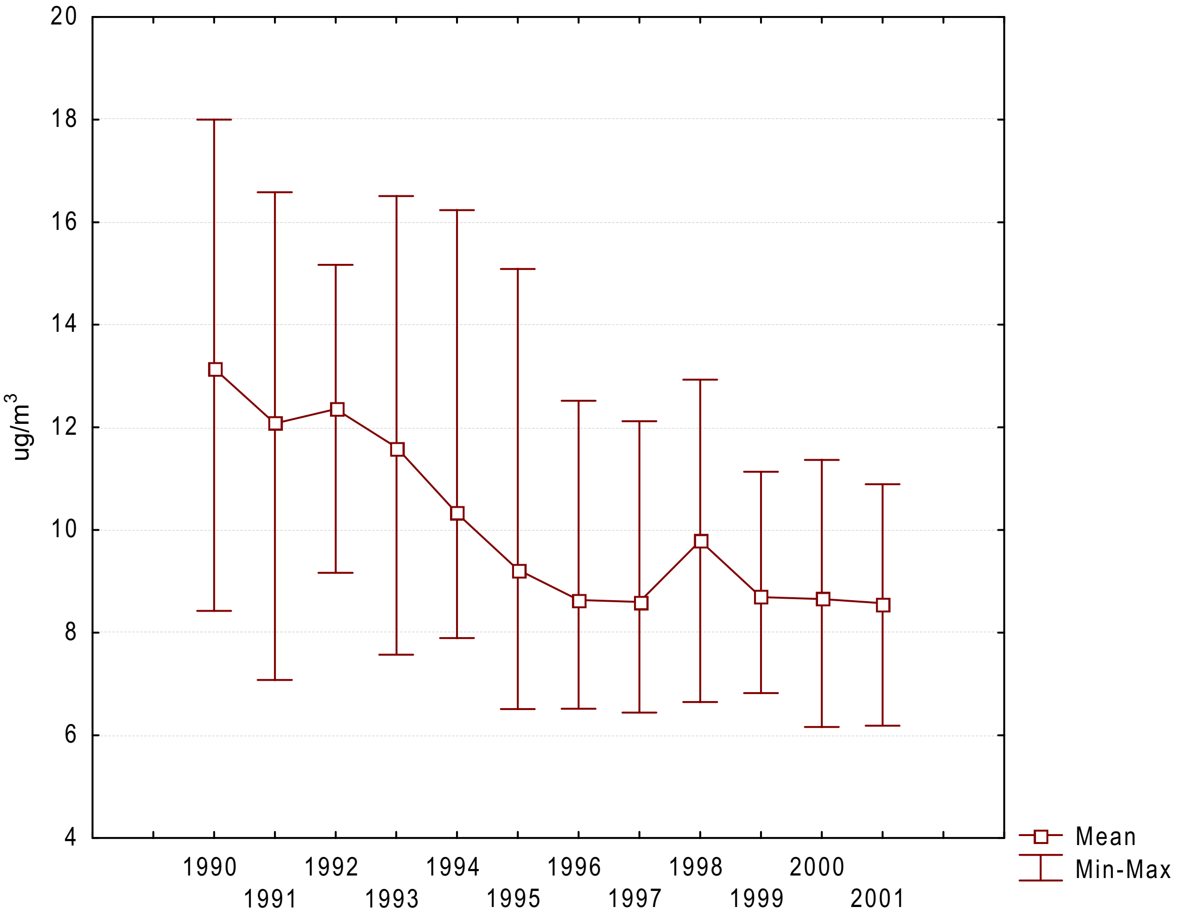


Figure 5.10 Annual Mean Concentrations of $PM_{2.5}$, 1990-2001.

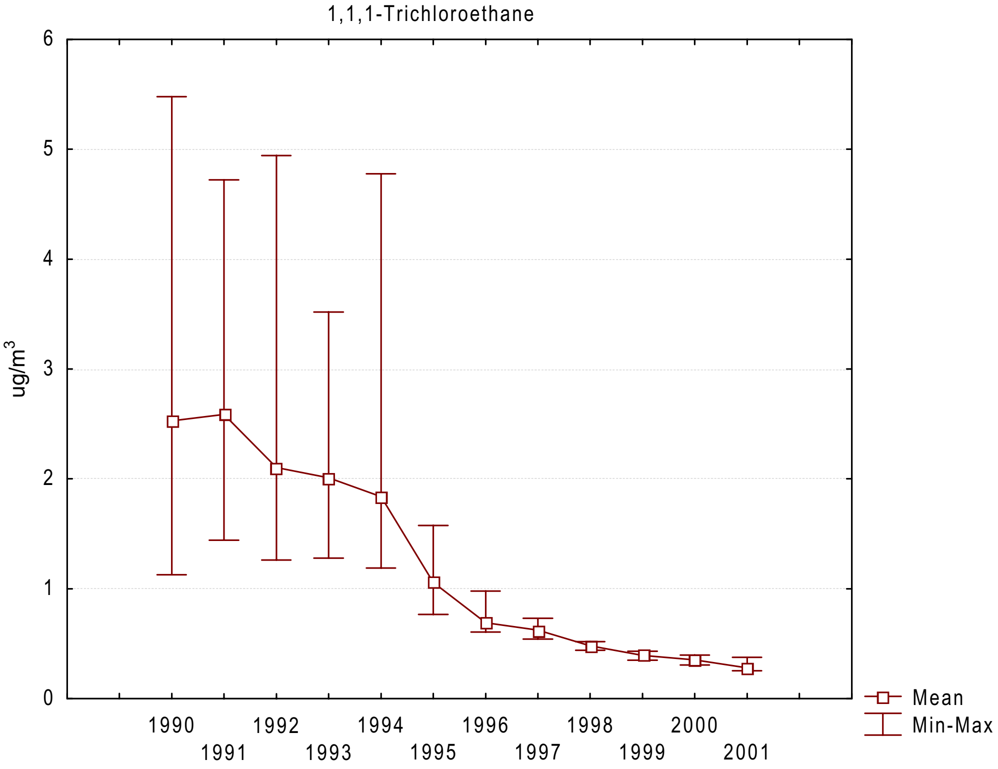


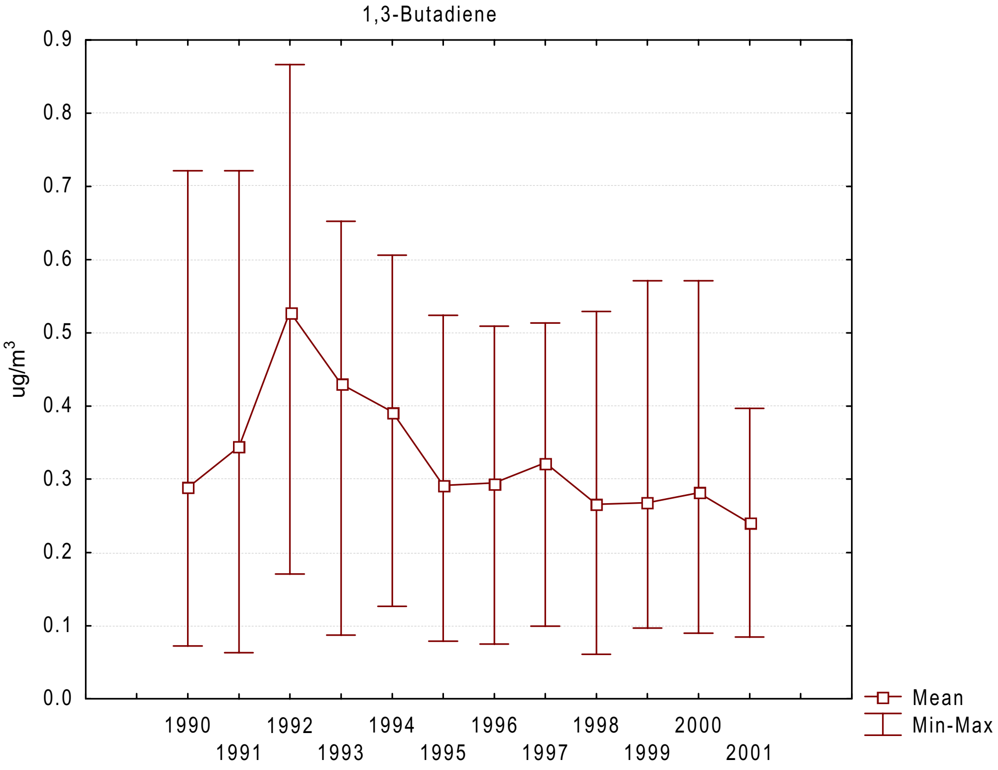
5.6 Selected Volatile Organic Compounds

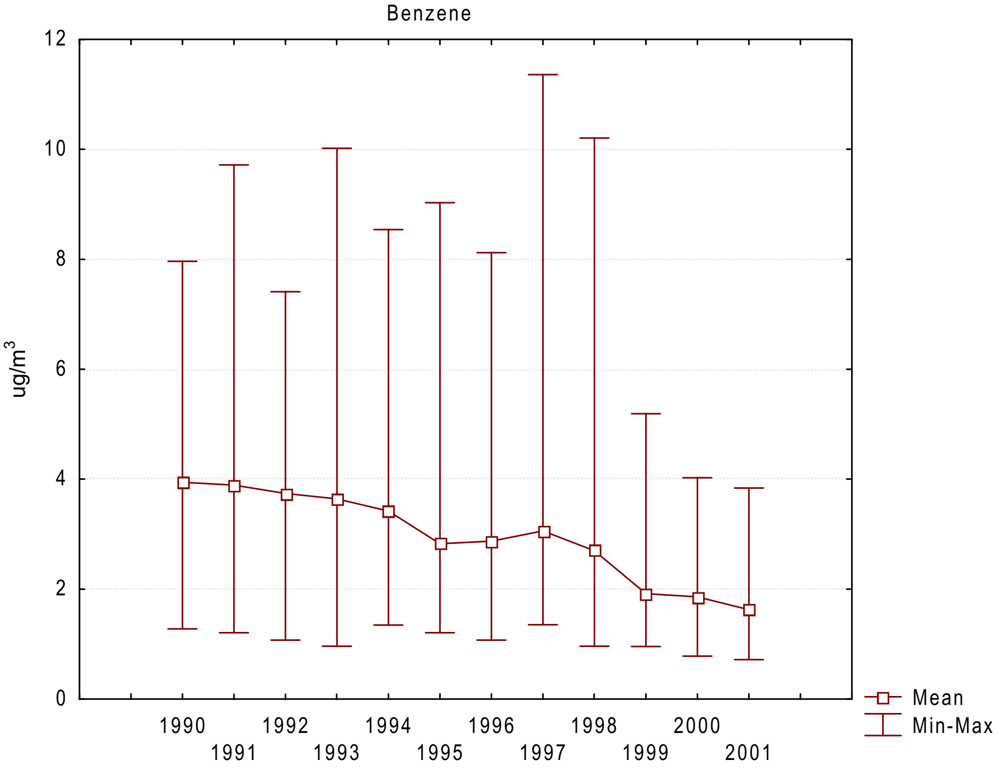
Concentrations of all selected organic compounds at urban sites decreased from 1990 to 2001 (Figure 5.11). Each data point represents the mean concentration from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. Total VOC concentrations also decreased during this period.

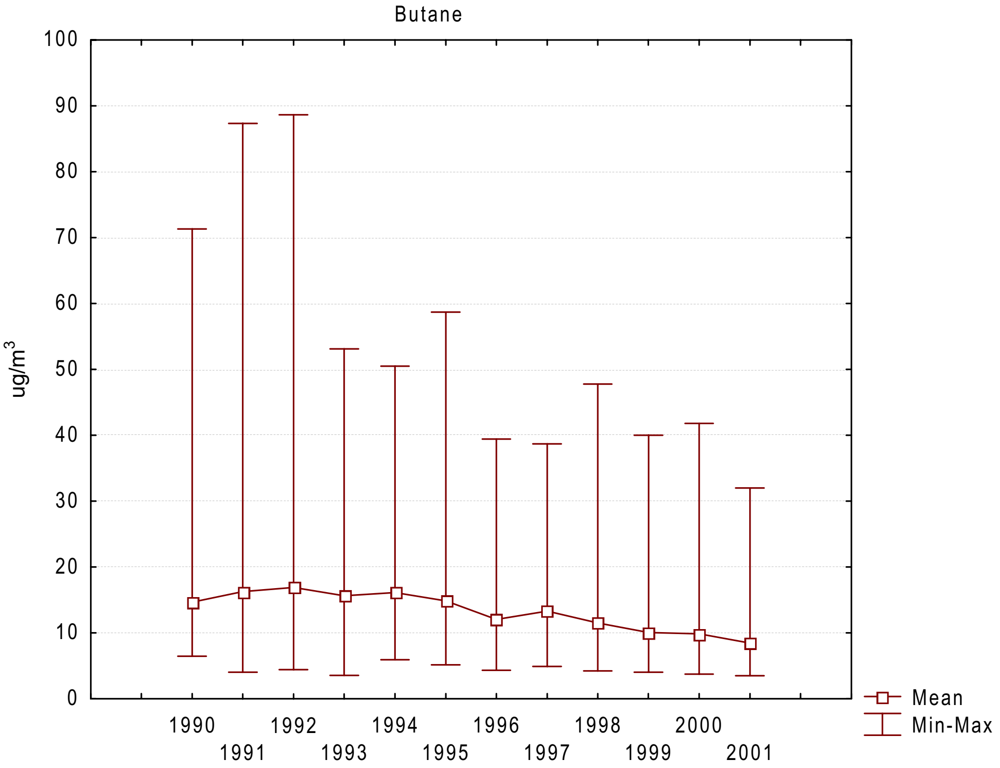
VOC emissions data and forecasts were available from the CAC 1995 Inventory and NRCan/AMG report "Canada’s Emissions Outlook: An Update" December 1999. VOC emissions decreased from 2675 kilotonnes in 1995 to 2480 kilotonnes in 2001, a decrease of 7.3%. Transportation (predominantly light duty gasoline vehicles) accounted for the largest decrease in emissions during this time.

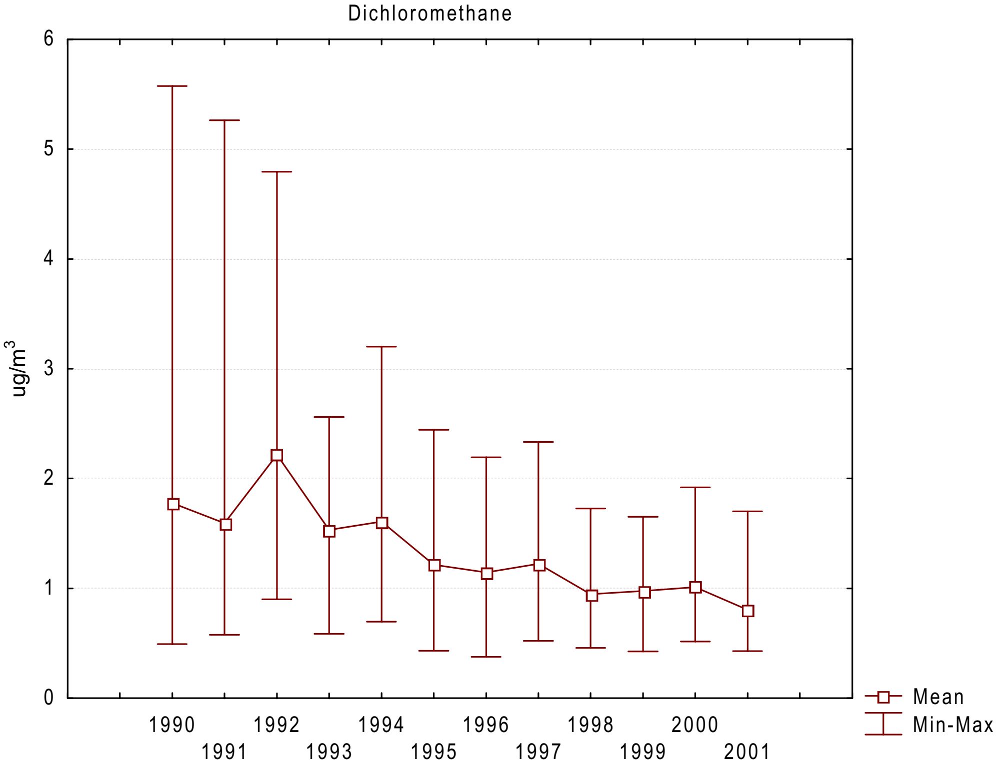
Figure 5.11 Annual Mean Concentrations of Selected Organic Compounds, 1990-2001.

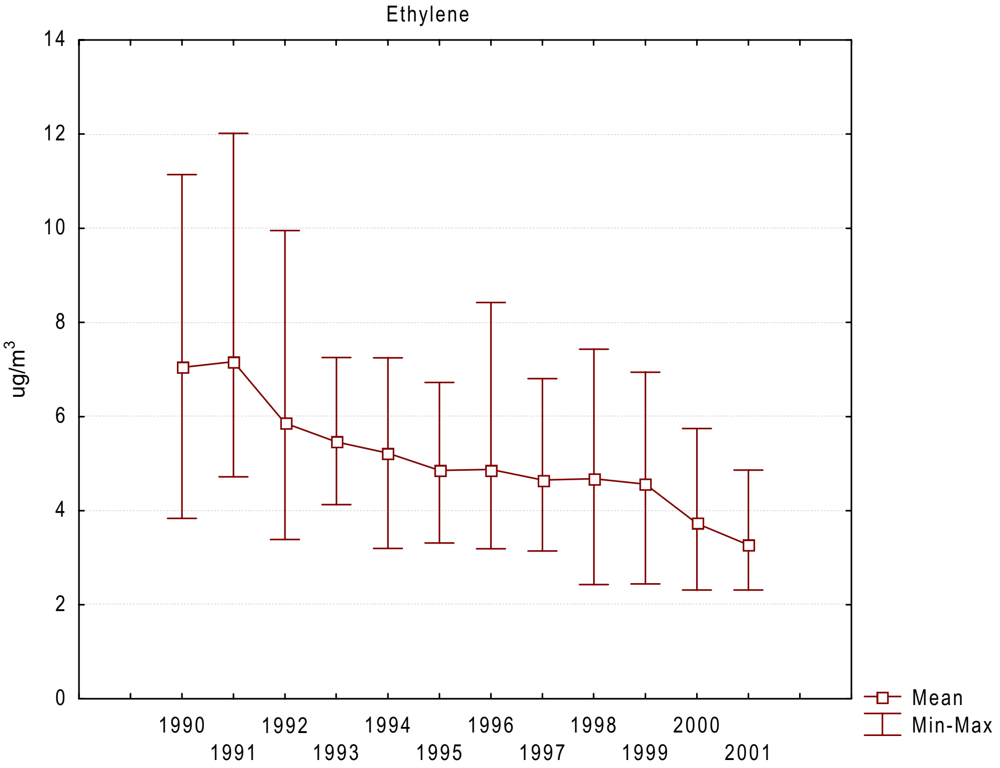


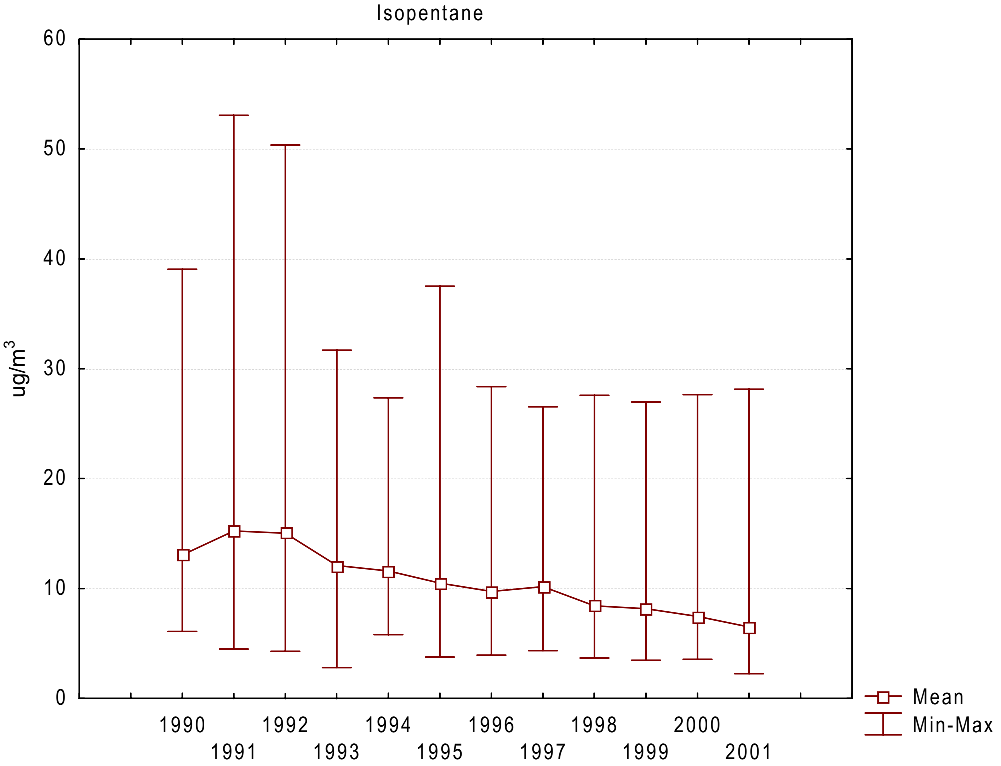

1,3-Butadiene
ug/m3
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

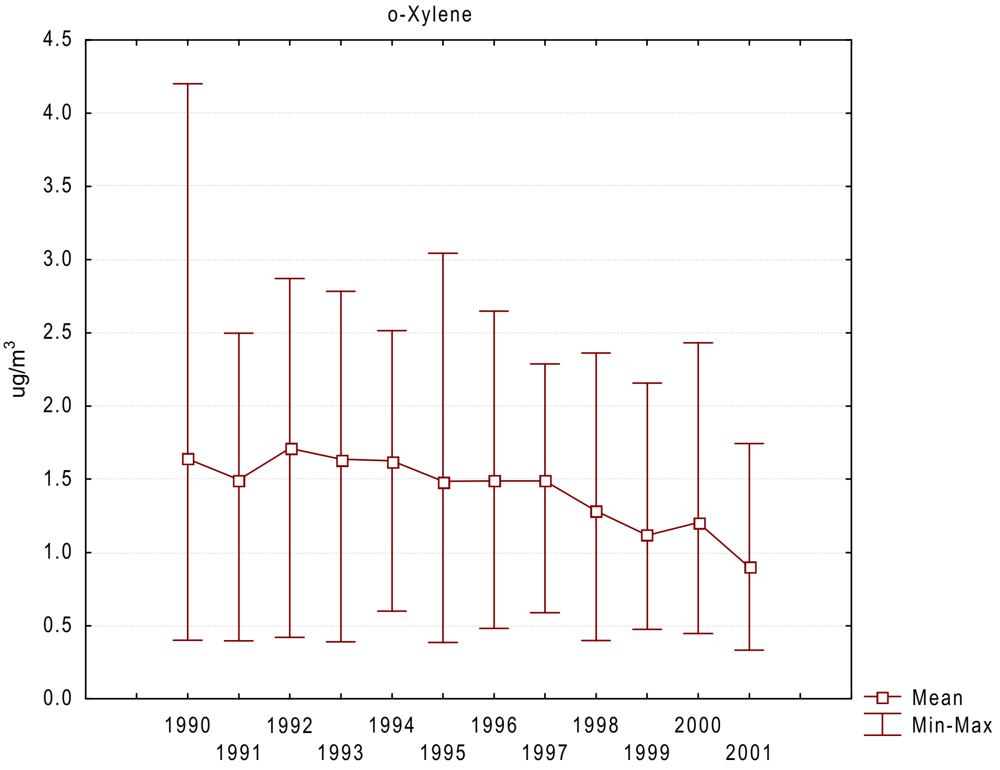

Benzene
ug/m3
0
2
4
6
8
10
12
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

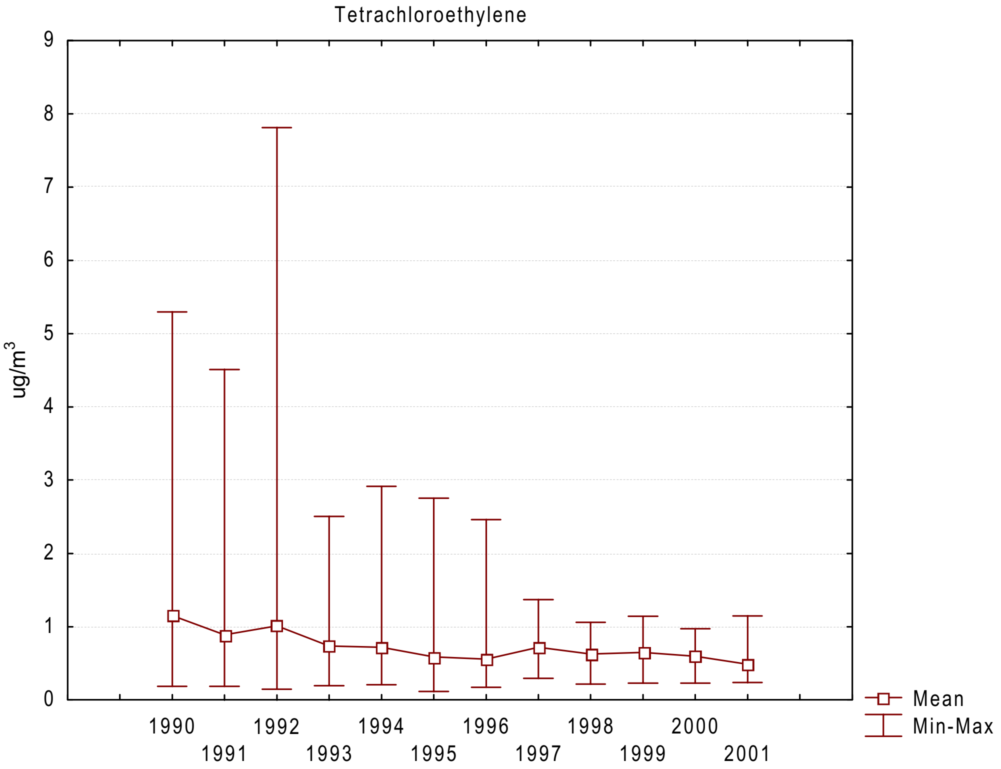

Butane
ug/m^3
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

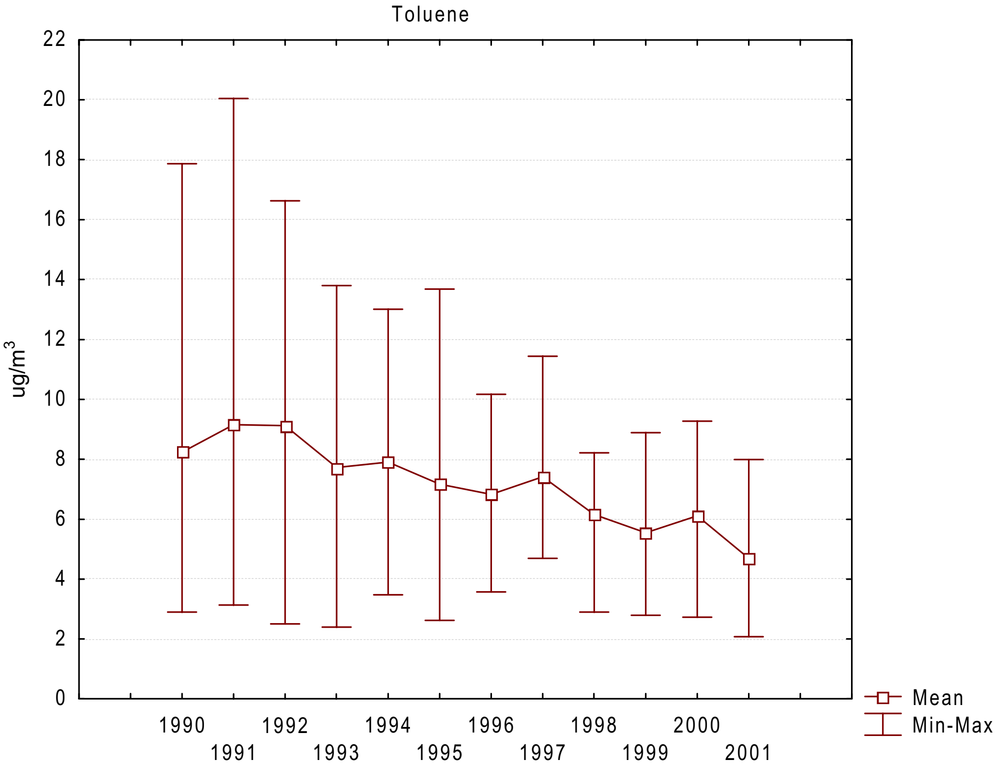

Dichloromethane
ug/m^3
6
5
4
3
2
1
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

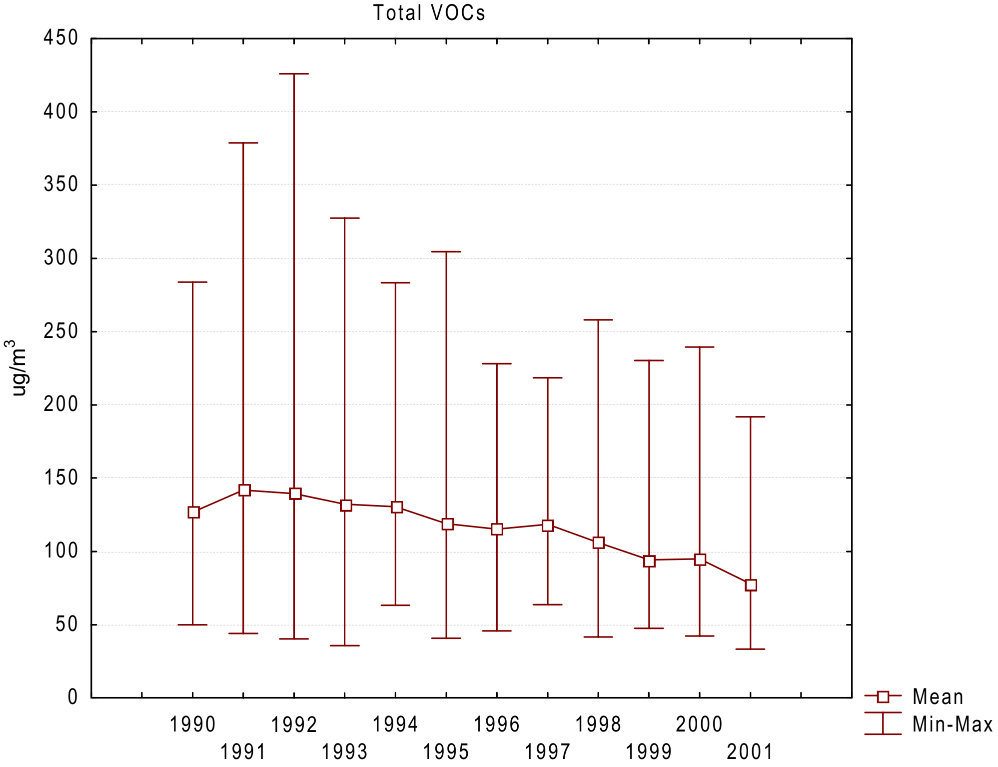

Ethylene
ug/m3
0
2
4
6
8
10
12
14
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


Isopentane
ug/m3
0
10
20
30
40
50
60
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


o-Xylene
ug/m3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


Tetrachloroethylene
ug/m3
0
1
2
3
4
5
6
7
8
9
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

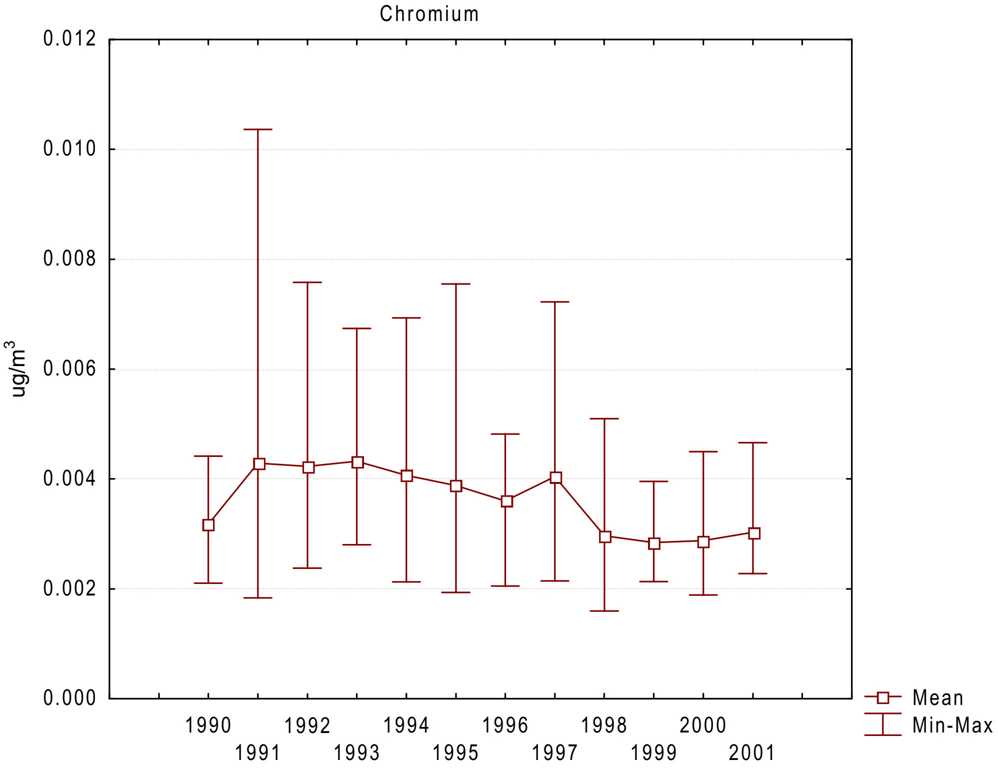

Toluene
ug/m^3
22
20
18
16
14
12
10
8
6
4
2
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

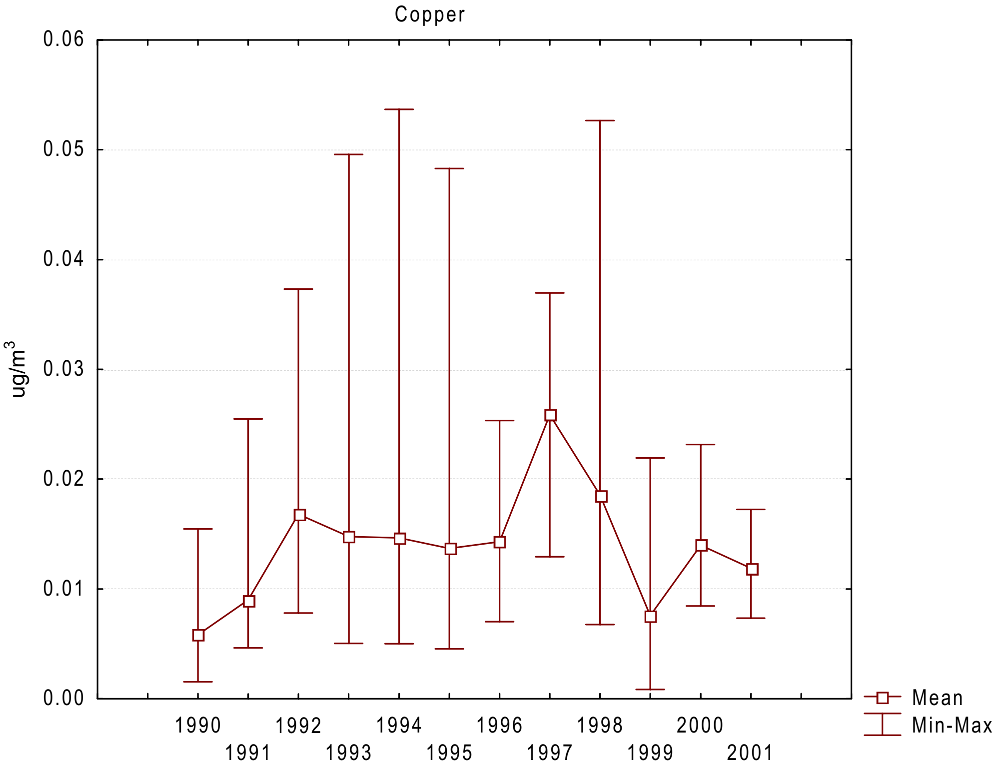

Total VOCs
ug/m^3
450
400
350
300
250
200
150
100
50
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

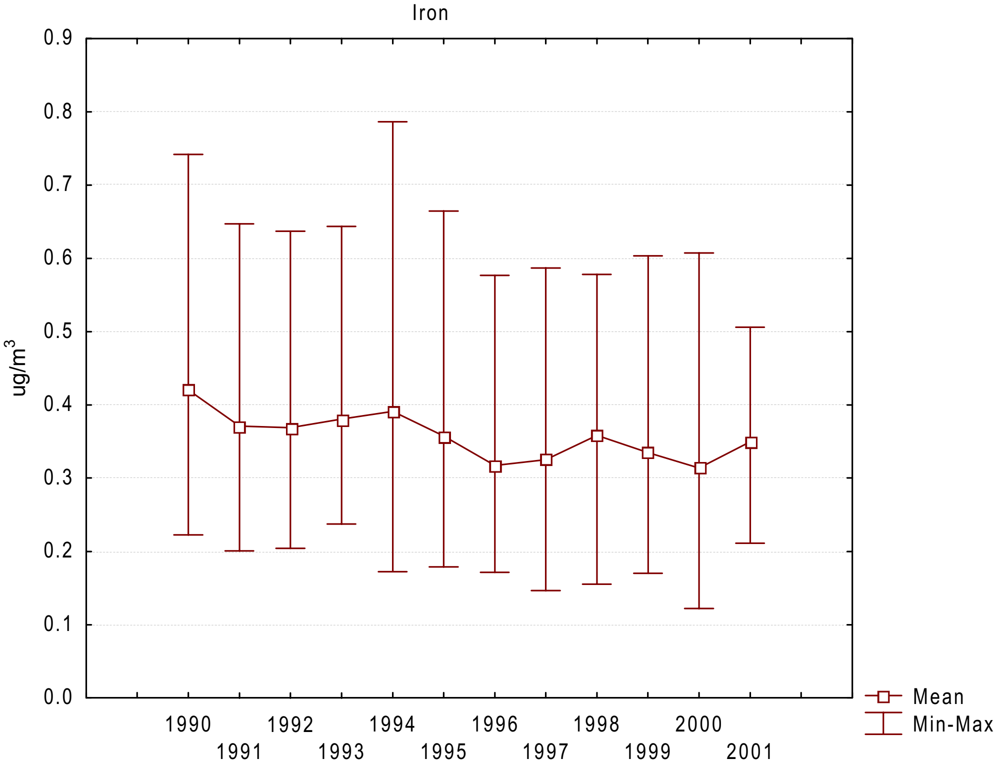
5.7 Selected Inorganic Compounds

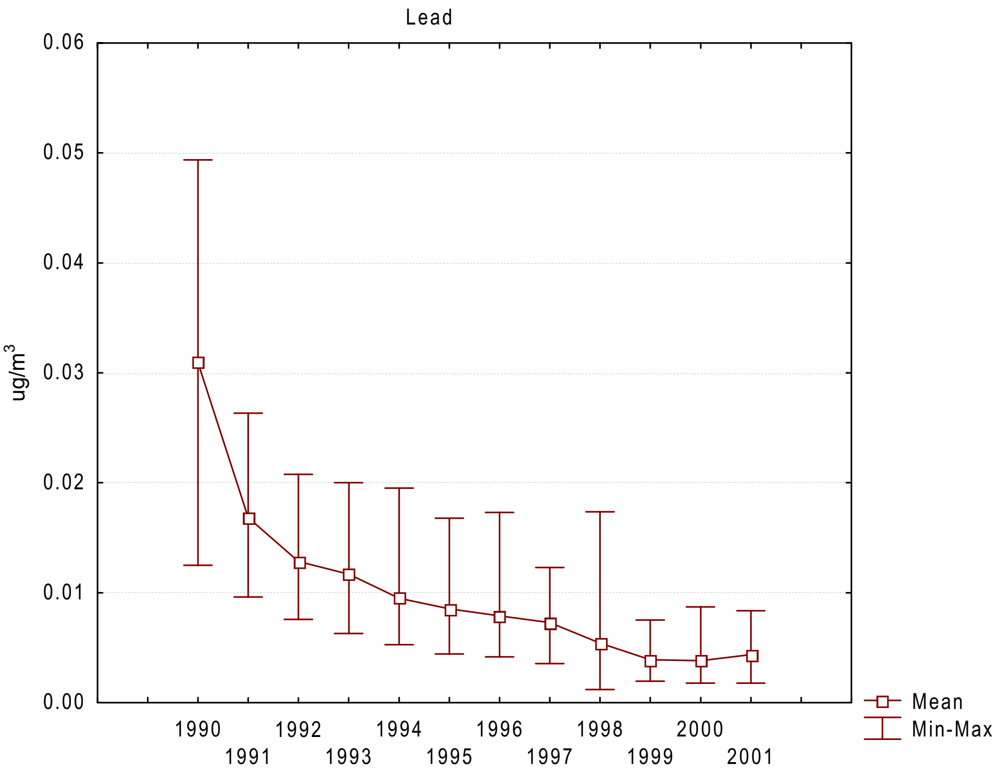
The data reported in this section represent the total PM_{10} mass ($PM_{2.5}$ + coarse) of specific compounds in the particulate matter collected by the dichotomous samplers. Figure 5.12 shows the annual mean concentrations for selected inorganic compounds for the period 1990-2001. Each data point represents the mean concentration from all urban sites with data for 80% of years from 1990-2001. Missing years of data were calculated by linear interpolation from surrounding years. Data for trend analyses were available from a limited number (eight) of urban sites. Trends in inorganic concentrations varied considerably between compounds at urban sites in Canada during this period. The greatest change observed was in lead concentrations, which decreased at urban sites in response to regulations requiring the removal of lead from gasoline. Iron, manganese, zinc, sulphate, and total particulate mass decreased in concentration during the past decade, while chromium, copper, nickel, and vanadium showed little net change.

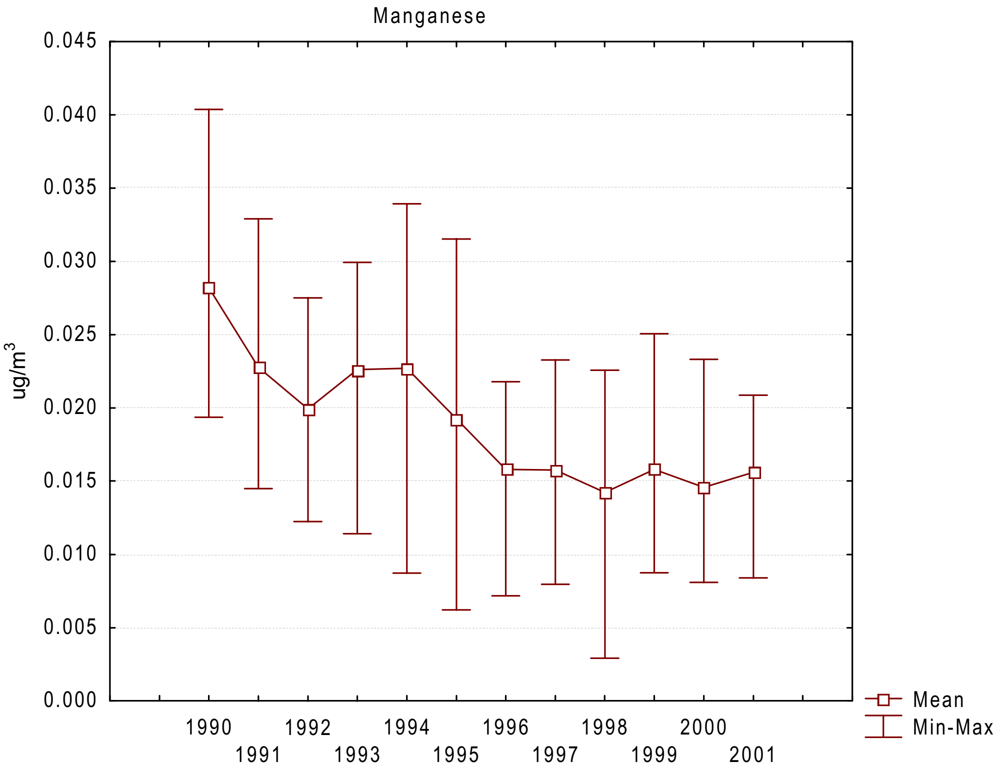
Figure 5.12 Annual Mean Concentrations of Selected Inorganic Compounds, 1990-2001.

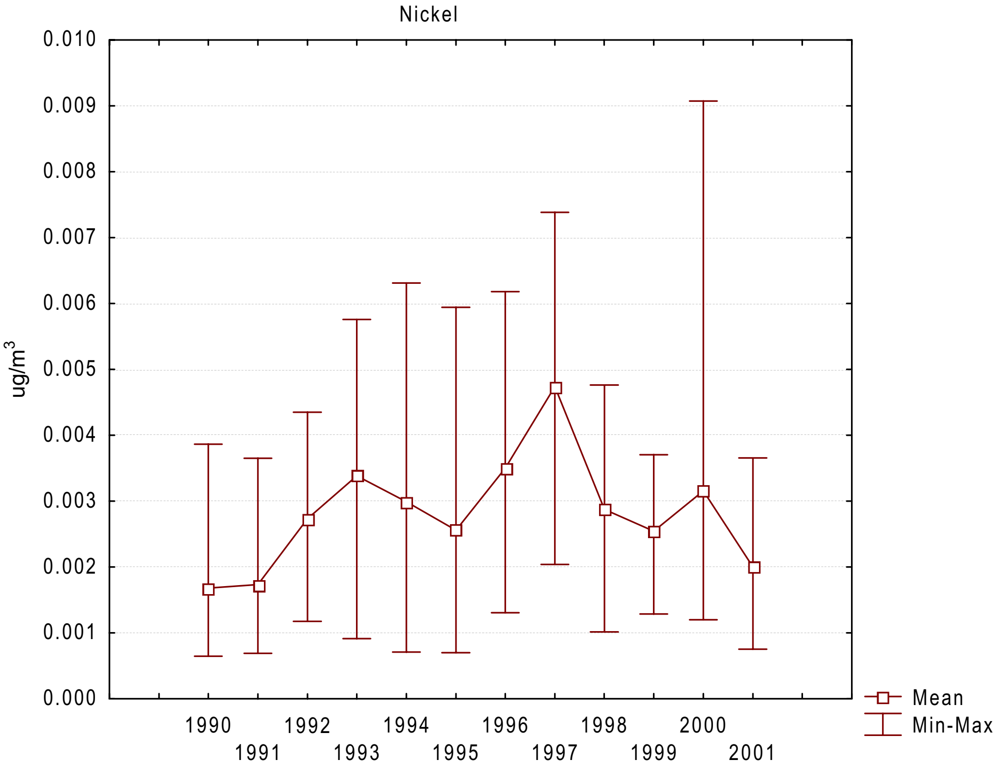



Copper
0.06
0.05
0.04
0.03
0.02
0.01
0.00
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

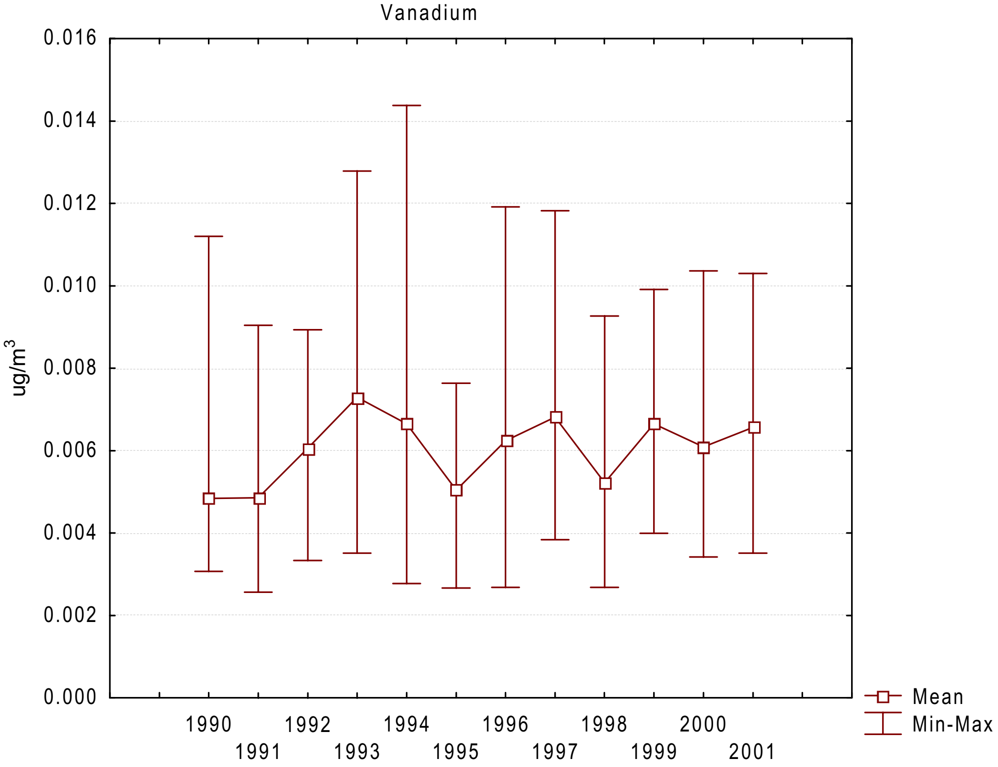

Iron
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


Lead
0.06
0.05
0.04
0.03
0.02
0.01
0.00
ug/m^3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

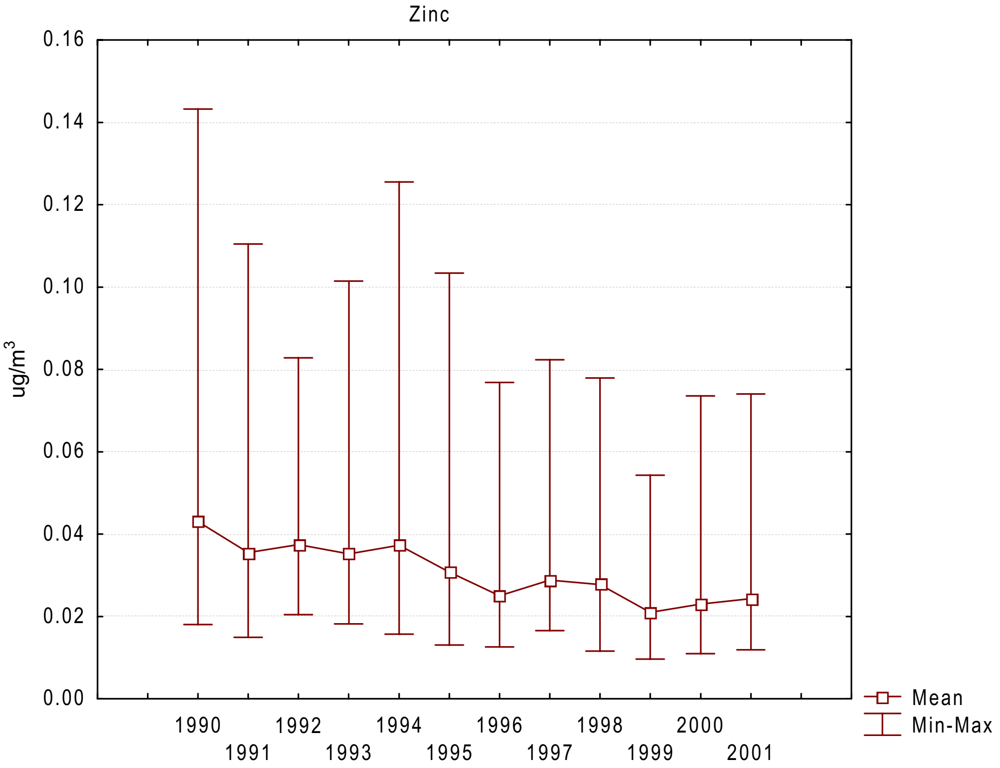

Manganese
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
ug/m^3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

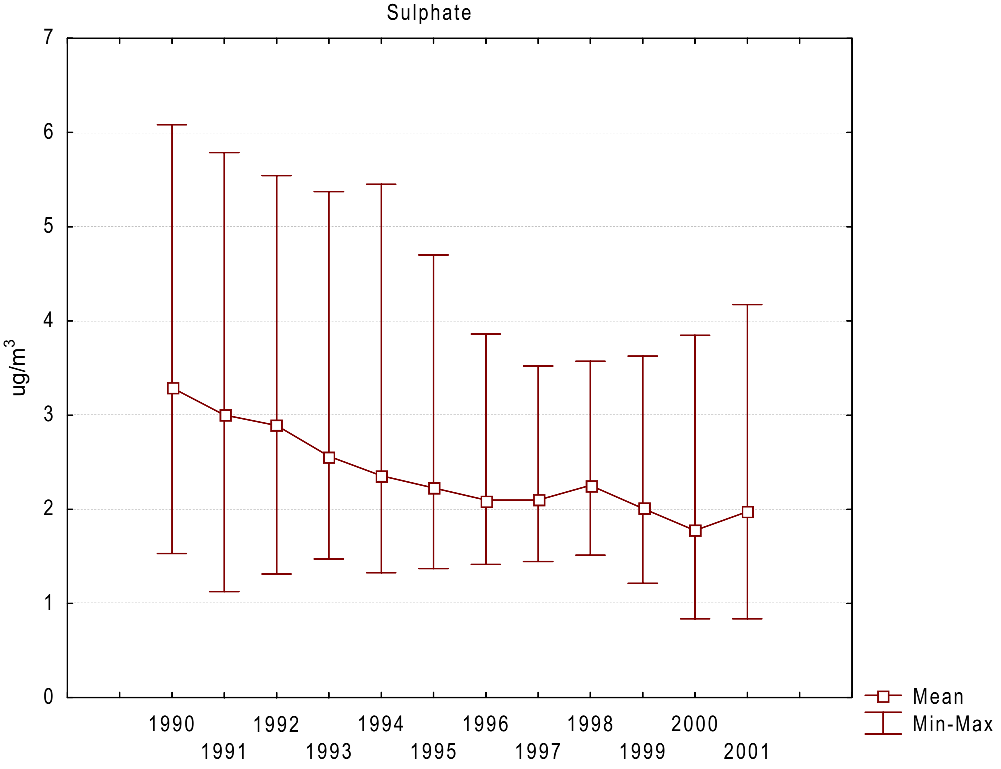


Nickel
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max



Vanadium
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


Zinc
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max


Sulphate
7
6
5
4
3
2
1
0
ug/m3
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Mean
Min-Max

6.0 CONCLUSIONS

Atmospheric pollutants measured by the National Air Pollution Surveillance network include sulphur dioxide, carbon monoxide, ground-level ozone, nitrogen oxides, fine and coarse particulate matter, and organic and inorganic compounds. The air quality in Canada varies by both geographical location and time of year. In addition, certain pollutants are associated with and present at levels of concern in specific areas.

Sulphur dioxide (SO_2) is a precursor to acid rain and particulate matter. The highest levels of SO_2 concentrations were observed in central and eastern Canada at sites near point sources. Twelve sites near industrial point sources (eight in Quebec, three in Ontario, and one in British Columbia) exceeded the maximum desirable 1-hr NAAQO for SO_2 in 2001, with five of these sites (all in Quebec) exceeding the maximum acceptable 1-h NAAQO. No sites exceeded the maximum acceptable annual mean NAAQO in 2001. Annual mean concentrations of SO_2 at most urban sites across Canada declined over the past decade. The mean SO_2 concentration in 2001 was 32% lower than in 1990.

Carbon monoxide (CO) is a product of incomplete combustion and occurs in high concentrations in areas with heavy traffic. Concentrations of carbon monoxide at urban sites were similar in magnitude across the country, with the highest concentrations observed at sites with dense vehicular traffic. Concentrations at rural sites tended to be lower than at urban sites. Concentrations of CO at all Canadian sites were well below the maximum acceptable 1-h NAAQO for CO. Annual mean concentrations of CO at most urban sites across Canada declined over the past decade. The mean annual CO concentration in 2001 was 34% lower than in 1990.

Nitrogen oxides (NO_x) include nitric oxide (NO) and nitrogen dioxide (NO_2). Most anthropogenic NO_x originates from sources as NO, which is then oxidized to form NO_2. The highest concentrations of NO and NO_2 were observed at urban sites with dense vehicular traffic, with peak concentrations of NO and NO_2 at urban sites occurring in the morning, corresponding with local rush hours. NO concentrations tended to be higher than NO_2 concentrations at urban sites, while the reverse was true at rural sites. Concentrations of NO_2 were below the maximum acceptable 1-hr NAAQO at all Canadian sites. Concentrations of both NO and NO_2 declined at most urban sites across Canada over the past decade. The mean annual concentration of NO in 2001 was 21% lower than in 1990, while the NO_2 concentration was 15% lower.

Ground-level ozone (O_3) is a major component of urban smog. Ozone is not an emitted pollutant, but is the product of photochemical reactions between NO_x and volatile organic compounds (VOCs). Concentrations of O_3 were higher in the summer months than in the winter months. Peak O_3 concentrations during ozone episodes occurred in the afternoon. The highest levels of O_3 were measured in the summer months at sites in Ontario, Quebec, and Atlantic Canada. No clear trends in O_3 concentrations, based on the fourth highest 8-h maximum concentrations, were evident at either urban or rural sites from 1990 to 2001.

Particulate matter (PM) is typically categorized on the basis of size, with $PM_{2.5}$ measuring < 2.5 µm and PM_{10} measuring < 10 µm. The highest $PM_{2.5}$ concentrations were observed at sites in southern Ontario, with concentrations tending to be higher in the summer months than in the winter. PM_{10} concentrations tended to be higher in the summer months than the winter months at sites in southern Ontario and the Prairies, although many of the Prairie sites showed secondary minima in June and July. Annual mean concentrations of $PM_{2.5}$ and PM_{10} decreased at urban sites across Canada over the past decade. The mean annual $PM_{2.5}$ concentration in 2001 was 27% lower than in 1990, while the PM_{10} level was 34% lower.

VOCs in the atmosphere may be of concern because of the toxicity of the compound, its effect on stratospheric ozone or climate change, or because of its contribution to the production of tropospheric ozone. A number of VOCs have been identified as Priority Substances under the Canadian Environmental Protection Act (CEPA). Total VOC concentrations were highest at sites near industrial point sources, with concentrations tending to be higher in the winter than in the summer. Concentrations of all selected organic compounds and total VOC concentrations at urban sites decreased from 1990 to 2001.

The NAPS program measures the particle bound fraction of metals and other inorganic compounds in the atmosphere. Concentrations of inorganic compounds varied considerably between compounds and between sites in 2001. Trends in inorganic concentrations also varied between compounds at urban sites in Canada. The greatest change observed was in lead concentrations, which decreased at urban sites in response to regulations requiring the removal of lead from gasoline.

7.0 APPENDICES

Appendix I – NAPS Network Co-operating Agencies

Newfoundland and Labrador Department of Environment & Labour
Pollution Prevention Division
Environmental Science and Monitoring
P.O. Box 8700, St. John's, NF A1B 4J6
Contact: Peter Haring, Environmental Chemist
Telephone: (709) 729-4147
Fax: (709) 729-6969
Email: pharing@mail.gov.nf.ca
Web: http://www.gov.nf.ca/env/Env/default.asp

Prince Edward Island Fisheries, Aquaculture and Environment
Pollution Prevention Division
Air Quality and Hazardous Materials
11 Kent Street, P.O. Box 2000, Charlottetown, PE C1A 7N8
Contact: Todd Fraser
Telephone: (902) 368-5037
Fax: (902) 368-5830
Email: ktfraser@gov.pe.ca
Web: http://www.gov.pe.ca/fae/

Nova Scotia Environment & Labour
Environment and Natural Areas Management Division
PO Box 697, Halifax, NS B3J 2T8
Contact: Johnny McPherson
Tel: (902) 424-2566
Fax: (902) 424-0503
Email: mcpherjp@gov.ns.ca
Web: www.gov.ns.ca/enla/

New Brunswick Department of the Environment and Local Government
Ministère de l’Environnement et Gouvernements locaux du Nouveau Brunswick
Air Sciences Section/Section des sciences de l'air
P.O. Box 6000, 20 McGloin Street, Fredericton, NB E3B 5H1
Contact: Randy Piercey
Telephone: (506) 457-4844
Fax: (506) 453-2265
Email: randy.piercey@gnb.ca
Web: www.gnb.ca/elg-egl

Gouvernement du Québec, Ministère de l'Environnement
Direction du suivi de l’état de l’environnement
Édifice Marie-Guyart, 7ième étage, 675, boul. René Lévesque Est, Québec, QC G1R 5V7
Contact: Ghislain Jacques
Téléphone: (418) 521-3820 poste 4569
Fax: (418) 643-9591
Courriel: ghislain.jacques@menv.gouv.qc.ca
Web: http://www.menv.gouv.qc.ca/

Ville de Montréal
Direction de l’environnement
Boul. 827 Crémazie Est, Bureau 301, Montréal, QC H2M 2T8
Contact: Claude Gagnon
Téléphone: (514) 280-4291
Fax: (514) 280-4285
Émail: claude.gagnon@cum.qc.ca
Web: http://www.rsqa.qc.ca/

Ontario Ministry of the Environment
Environmental Sciences and Standards Division
Environmental Monitoring and Reporting Branch
Air Monitoring, Air Quality Assessment & Reporting Unit
125 Resources Road, West Wing, Etobicoke, ON M9P 3V6
Contact: Phil Kiely
Telephone: (416) 235-5780
Fax: (416) 235-6037
Email: Phil.Kiely@ene.gov.on.ca
Web: http://www.ene.gov.on.ca/

Manitoba Conservation, Air Quality Section
123 Main Street, Suite 160, Winnipeg, MB R3C 1A5
Contact: Don Regehr
Telephone: (204) 945-7001
Fax: (204) 948-2357
Email: dregehr@gov.mb.ca
Web: http://www.gov.mb.ca/conservation/airquality

Saskatchewan Environment
Environmental Protection Branch
3211 Albert Street, Regina, SK S4S 5W6
Contact: Chris Gray
Telephone: (306) 787-6196
Fax: (306) 787-0197
Email: cgray@serm.gov.sk.ca
Web: http://www.gov.sk.ca/deptsorgs/overviews/?64

Alberta Environment
Environmental Assurance Monitoring Division, Air Quality Data Management
Oxbridge Place, 11th Floor, 9820 - 106th Street, Edmonton, AB T5K 2J6
Contact: Bob Myrick
Telephone: (780) 415-9364
Fax: (780) 427-7958
Email: bob.myrick@gov.ab.ca
Web: http://www.casadata.org
Web: http://www.gov.ab.ca/env/

British Columbia Ministry of Water, Land and Air Protection
Environmental Protection Division; Water, Air and Climate Change Branch
Water and Air Reporting and Monitoring Section
2975 Jutland Rd., Victoria, BC V8T 5J9
Mailing Address: PO Box 9339 STN PROV GOVT Victoria V8W 9M1
Contact: Robert Marsh
Telephone: (250) 387-9944
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Email: Robert.Marsh@gems7.gov.bc.ca
Web: http://wlapwww.gov.bc.ca/air/
Web: http://www.gov.bc.ca/wlap/

Greater Vancouver Regional District (GVRD)
Air Quality Department
4330 Kingsway, 6th Floor, Burnaby, BC V5H 4G8
Contact: Kenneth P. Stubbs, QEP, Division Manager, Monitoring and Assessment
Telephone: (604) 436-6747
Email: ken.stubbs@gvrd.bc.ca
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Telephone: (604) 436-6746
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Email: al.percival@gvrd.bc.ca
Web: http://www.gvrd.bc.ca

Yukon Department of Environment
Environmental Protection & Assessment Branch
P.O. Box 2703, Whitehorse, YT Y1A 2C6
Contact: Janine Kostelnik
Telephone: (867) 667-5456
Fax: (867) 393-6205
Email: Janine.Kostelnik@gov.yk.ca
Web: http://www.environmentyukon.gov.yk.ca/main/index.shtml

Northwest Territories Resources, Wildlife and Economic Development
Environmental Protection Service

P.O. Box 1320, Yellowknife, NT X1A 2L9
Contact: John McKay
Telephone: (867) 873-7821
Fax: (867) 873-0221
Email: John_mckay@gov.nt.ca
Web: http://www.gov.nt.ca/RWED/eps/index.htm

Government of Nunavut
Department of Sustainable Development
Environmental Protection Services
Contact: Earle G. Baddaloo, Director, Environmental Protection Services
Telephone: (867) 975-5910
Fax: (867) 975-5980
Email: ebaddaloo@gov.nu.ca
Web: http://www.gov.nu.ca/

Environment Canada, Meteorological Service of Canada
Canadian Air and Precipitation Monitoring Network (CAPMoN)
4905 Dufferin St., Downsview, ON M3H 5T4
Contact: Dave MacTavish
Telephone: (416) 739-4450
Fax: (416) 739-5704
Email: dave.mactavish@ec.gc.ca
Web: http://www.msc.ec.gc.ca/capmon/index_e.cfm

Environment Canada, Environmental Protection Service
Environmental Technology Advancement Directorate
Analysis and Air Quality Division
Environmental Technology Centre
335 River Road South, Ottawa, ON K1A 0H3
Contact: Paul Brunet
Telephone: (613) 991-9460
Fax: (613) 998-4032
Email: brunet.paul@etc.ec.gc.ca
Web: http://www.etc.ec.gc.ca/etchome_e.html

Appendix II – Sites Participating in the NAPS Program

STATION	INFLUENCE†	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
010102	C	354 WATER STREET	ST. JOHN'S, NEWFOUNDLAND AND LABRADOR	6	6	6	6		18				6
010301	C	BROOK STREET	CORNER BROOK, NEWFOUNDLAND AND LABRADOR		4	4	4		4				
020101	C	56 FITZROY ST.	CHARLOTTETOWN, PRINCE EDWARD ISLAND							9	9		
030101	C	TECHNICAL UNIVERSITY OF N.S.	HALIFAX, NOVA SCOTIA							12		12	
030118	C	1657 BARRINGTON STREET	HALIFAX, NOVA SCOTIA	8	8	8	8						8
030120	R	LAKE MAJOR ROAD	HALIFAX, NOVA SCOTIA						3				
030310	R	COUNTY JAIL	SYDNEY, NOVA SCOTIA	4			4		4				
030311	R	WHITNEY PIER FIRE STN.	SYDNEY, NOVA SCOTIA							2	2		
030501	R	NATIONAL PARK	KEJIMKUJIK, NOVA SCOTIA				4					4	4
030701	R	KINGS COUNTY	AYLESFORD MOUNTAIN, NOVA SCOTIA				3						
030901	R	91 BEACHES ROAD	PICTOU, NOVA SCOTIA				4						
040102	C	YORK STREET	FREDERICTON, NEW BRUNSWICK							7			
040103	C	ABERDEEN STREET	FREDERICTON, NEW BRUNSWICK		3	3	3		3				
040203	R	FOREST HILLS	SAINT JOHN, NEW BRUNSWICK	5		5	5	5	5		5		5
040204	R	1918 MANAWAGONISH ROAD	SAINT JOHN, NEW BRUNSWICK								6		
040205	C	REGIONAL CENTER	SAINT JOHN, NEW BRUNSWICK								6		
040206	C	189 PRINCE WILLIAM	SAINT JOHN, NEW BRUNSWICK	5	5	5	5						
040207	R	476 LANCASTER AVENUE W.	SAINT JOHN, NEW BRUNSWICK				3						
040302	R	5 THANET STREET	MONCTON, NEW BRUNSWICK		3	3	3		3				
040401	R	HASTINGS TOWER	FUNDY NAT. PARK, NEW BRUNSWICK				3						
040501	R	MAIN GATE	POINT LEPREAU, NEW BRUNSWICK				3						3
040601	R	AIRPORT ROAD	BLISSVILLE, NEW BRUNSWICK				3						
040701	R	BALL PARK	NORTON, NEW BRUNSWICK				3						
040801	R	MAIN STREET	CANTERBURY, NEW BRUNSWICK				3						
040901	R	HUNTSMAN MARINE RESIDENCES	ST. ANDREWS, NEW BRUNSWICK				3		3				
041001	D	CAMPOBELLO ISLAND	NEW BRUNSWICK, NOZN				8						
041101	U	MUNICIPAL AIRPORT	ST. LEONARD, NEW BRUNSWICK				3						
041201	U	55 ROUTE 11 HWY	LOWER NEWCASTLE, NEW BRUNSWICK				3						
041301	R	430 ST. PETERS AVENUE	BATHURST, NEW BRUNSWICK						4				
050102	R	JARDIN BOTANIQUE	MONTRÉAL, QUÉBEC	4		4	4						

STATION	INFLUENCE[†]	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
050103	R	1050 A, BOUL. SAINT-JEAN-BAPTISTE	MONTRÉAL, QUÉBEC	5	5	5	5				5		4
050104	C	1125 RUE ONTARIO EST	MONTRÉAL, QUÉBEC			14	14					14	14
050105	C	1212 RUE DRUMMOND	MONTRÉAL, QUÉBEC						11	11	11		
050109	C	2495 RUE DUNCAN	MONTRÉAL, QUÉBEC	5	5	5	5		3				
050110	C	11280 BOUL. PIE IX	MONTRÉAL, QUÉBEC		5	5	5		5				
050113	R	CHOMEDEY	MONTRÉAL, QUÉBEC		5	5	5			5			
050115	C	1001 BOUL DE MAISONNEUVE	MONTRÉAL, QUÉBEC	5	5	5	5						5
050116	R	3161 JOSEPH, VERDUN	MONTRÉAL, QUÉBEC	16		16	16						
050119	R	BOURASSA	MONTRÉAL, QUÉBEC			4	4			4			
050121	R	BROSSARD	MONTRÉAL, QUÉBEC	4		4	4			4	4		4
050124	R	7650 RUE CHÂTEAUNEUF	MONTRÉAL, QUÉBEC							4		4	
050125	R	11111 NOTRE-DAME EST	MONTRÉAL, QUÉBEC									4	
050126	R	20965 CHEMIN SAINTE-MARIE	MONTRÉAL, QUÉBEC			4	4		4	4	4		
050127	R	8110 BOUL. SAINT-MICHEL	MONTRÉAL, QUÉBEC								4		
050128	C	90-A RUE HERVÉ-SAINT-MARTIN	MONTRÉAL, QUÉBEC		4	4	4		4		4		
050129	R	12400 WILFRID-OUELLETTE	MONTRÉAL, QUÉBEC		4		4		4			4	4
050131	C	3250 STE-CATHERINE EST	MONTRÉAL, QUÉBEC						4	4	4		
050204	R	255 ST-RÉDEMPTEUR	HULL, QUÉBEC	16	16	16	16			16			
050308	I	DES SABLES	QUÉBEC, QUÉBEC	12	12	12	12		11	6	6	12	
050309	I	SAINT-ANGE	QUÉBEC, QUÉBEC			5	5			5			
050310	R	ST-CHARLES GARNIER	QUÉBEC, QUÉBEC				5						
050403	C	PARC WEBSTER	SHERBROOKE, QUÉBEC							17			
050503	C	RACINE	CHICOUTIMI, QUÉBEC							6			
050602	R	ÉCOLE LOOSEMORE	ROUYN, QUÉBEC	8									
050603	R	ÉCOLE MURDOCK	ROUYN, QUÉBEC							4			
050604	R	ROUYN-NORANDA	ROUYN, QUÉBEC	4									
050801	R	URSULINES	TROIS-RIVIÈRES, QUÉBEC	5			5		6	6	6		
050902	R	PARC BERTHIER	JONQUIÈRE, QUÉBEC	5						6	6		
051201	I	FRIGON	SHAWINIGAN, QUÉBEC	5					5	5	5		
051302	I	39 AVE. MANCE	BAIE COMEAU , QUÉBEC	12									
051501	R	SAINT-ZÉPHIRIN	ST. ZÉPHIRIN, QUÉBEC				1						
051801	R	ÉCOLE MARTEL 2	SOREL, QUÉBEC	4						4			
051802	R	RUE GEORGES	SOREL, QUÉBEC	4		4				4	4		

STATION	INFLUENCE†	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
052001	R	CHARETTE	CHARETTE, QUÉBEC				5			5			
052201	R	SAINT-SIMON	SAINT-SIMON, QUÉBEC				5			5			
052301	R	SAINT-FAUSTIN	SAINT-FAUSTIN, QUÉBEC				5			5			
052401	R	LA PÊCHE	LA PÊCHE, QUÉBEC				5						
052601	R	RANG DE LA BARONNIE	VARENNES, QUÉBEC			4	4						
052602	R	1870 ROUTE MARIE-VICTORIN	VARENNES, QUÉBEC	4									
052701	R	ÉCOLE THÉBERGE	TÉMISCAMING, QUÉBEC	4						4	4		
053201	R	PÉMONCA	LA DORÉ, QUÉBEC				5						
053301	R	FERME RAMCO	DESCHAMBAULT, QUÉBEC				5						
053401	R	CATHERINE	STE-CATH DE-LA-J-CARTIER, QUÉBEC				5						
053501	R	FRANÇOIS	SAINT-FRANÇOIS, QUÉBEC				5						
053601	R	N.-D.-DU-ROSAIRE	N.-D.-DU-ROSAIRE, QUÉBEC				5			5			
053701	R	HILAIRE	ST-HILAIRE-DE-DORSET, QUÉBEC				5			5			
053801	R	TINGWICK	TINGWICK, QUÉBEC				5						
053901	R	ÉDOUARD	LAC-ÉDOUARD, QUÉBEC				5						
054102	U	MONT SUTTON	SUTTON, QUÉBEC										2
054401	R	1128 DE LA GUERRE	ST. ANICET, QUÉBEC		2		2		2			2	2
054501	R	L' ASSOMPTION	L' ASSOMPTION, QUÉBEC		4		4		4				4
054601	R	MURDOCHVILLE	MURDOCKVILLE, QUÉBEC	4						4	4		
054703	R	8310 BOUL. BÉCANCOUR	BÉCANCOUR, QUÉBEC	5		5				5	5		
054801	R	STUKELY	STUKELY-SUD, QUÉBEC				5						
054901	R	LA PATRIE	LA PATRIE, QUÉBEC				5						
055001	R	MT-SAINT-MICHEL	MT-SAINT-MICHEL, QUÉBEC				8						
055201	F	CRANBERRY FARM	LEMIEUX, QUÉBEC				4						5
055301	A	1134 ROUTE 219	L'ACADIE, QUÉBEC			5	5		4	5	4		
055401	R	50 RUE ROY	CAP-DE-LA-MADELEINE, QUÉBEC	4									
060101	C	88 SLATER ST.	OTTAWA, ONTARIO	17	5	5	13						13
060104	C	RIDEAU & WURTEMBURG	OTTAWA, ONTARIO	4	4	4	4		4		4	4	4
060204	C	467 UNIVERSITY AVE. WEST	WINDSOR, ONTARIO	8	8	8	8		8		8		
060211	R	COLLEGE & SOUTH ST.	WINDSOR, ONTARIO	4		4	4	5				4	4
060212	I	WRIGHT & WATER ST.	WINDSOR, ONTARIO								4		
060213	R	3665 WYANDOTTE ST. E.	WINDSOR, ONTARIO								6		
060214	R	ST. GABRIEL S.S.	WINDSOR, ONTARIO								10		

STATION	INFLUENCE†	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
060215	R	ST. ALEXANDER S.S.	WINDSOR, ONTARIO								10		
060216	R	ST. GREGORY S.S.	WINDSOR, ONTARIO								10		
060302	R	133 DALTON AVENUE	KINGSTON, ONTARIO				5						5
060403	I	EVANS & ARNOLD AVE.	TORONTO, ONTARIO	5	5	5	5	5	5		5	5	5
060410	R	LAWRENCE & KENNEDY	TORONTO, ONTARIO			5	5	5					
060413	R	ELMCREST ROAD	TORONTO, ONTARIO	5	5	5	5	5					5
060415	R	QUEENSWAY W & HURONTARIO	TORONTO (MISSISSAUGA), ONTARIO	5	5	5	5		5				
060418	C	RUSKIN & PERTH ST.	TORONTO, ONTARIO										9
060421	C	YONGE ST. & FINCH AVE.	TORONTO, ONTARIO			5	5		5				
060424	C	BAY & GROSVENOR	TORONTO, ONTARIO	15	15	15	15		15				
060426	I	MEADOW PK, APPLE LANE C C	TORONTO, ONTARIO								1		
060427	C	223 COLLEGE STREET	TORONTO, ONTARIO										4
060428	R	525 MAIN ST. N. BRAMPTON	TORONTO, ONTARIO	5	5	5	5		4				5
060429	R	JUDSON ST. & ETONA CT.	TORONTO, ONTARIO	5	5	5	5	5	5		5	5	5
060511	R	467 BEACH BLVD.	HAMILTON, ONTARIO								4		
060512	C	ELGIN & KELLY	HAMILTON, ONTARIO	4	4	4	4		4		4	5	4
060513	R	VICKERS RD. & EAST 18TH. ST.	HAMILTON, ONTARIO	3		3	3		3		4		
060520	I	GERTRUDE & DEPEW ST.	HAMILTON, ONTARIO								4		
060605	C	19 LISGAR STREET	SUDBURY, ONTARIO								8		
060607	R	100 RAMSEY LAKE RD.	SUDBURY, ONTARIO	15	15	15	15						
060608	I	MARKET ST. COPPER CLIFF	SUDBURY, ONTARIO								4		
060707	I	331 PATRICK ST.	SAULT STE. MARIE, ONTARIO	3		3	3	3			3		
060708	I	BONNEY STREET	SAULT STE. MARIE, ONTARIO						3		3		
060807	R	615 JAMES STREET SOUTH	THUNDER BAY, ONTARIO	3	3	3	3	4	4		4		
060903	C	900 HIGHBURY AVENUE	LONDON, ONTARIO	4	4	4	4		4		3		4
061004	R	FRONT ST. AT C.N. TRACKS	SARNIA, ONTARIO	3	3	3	3	3	3		3		3
061005	R	MTC SHED	SARNIA, ONTARIO				4						
061006	I	6TH. LINE MOORE TWSP	SARNIA, ONTARIO								3		
061104	R	10 HOSPITAL DRIVE	PETERBOROUGH, ONTARIO	5	5	5	5	5	5				5
061201	R	BEDFORD & THIRD ST.	CORNWALL, ONTARIO	4			4						
061302	C	ARGYLE CRESCENT	ST. CATHARINES, ONTARIO	4	4	4	4		4				
061303	C	71 KING STREET	ST. CATHARINES, ONTARIO								12		
061502	C	WEST AVE. & HOMEWOOD	KITCHENER, ONTARIO	5	5	5	5		5				5

STATION	INFLUENCE[†]	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
061602	R	BRONTE RD. & WOBURN CRES.	OAKVILLE, ONTARIO	5	5	5	5				1		5
061701	R	RITSON RD. & OLIVE AVE.	OSHAWA, ONTARIO			5	5		5				
061802	R	70 DIVISION STREET	GUELPH, ONTARIO			4	4		4				
062001	R	O.P.P. STATION	NORTH BAY, ONTARIO			4	4		4				
062201	R	MOE WATER PUMP STN.	MERLIN, ONTARIO				4						
062401	R	PUC BLDG.	PARKHILL, ONTARIO				5						
062501	R	CON RD 2 LOT A	TIVERTON, ONTARIO				5		5				
062601	R	EXPERIMENTAL FARM	SIMCOE, ONTARIO	5		4	4		4			4	4
062701	R	PROVINCIAL PARK	LONG POINT, ONTARIO	4		4	4						
063001	R	HWY 2 & NORTH SHORE BLVD.	BURLINGTON, ONTARIO	5	5	5	5	4	4				
063201	R	HWY 47 & HWY 48	STOUFFVILLE, ONTARIO			5	5	5					5
063301	R	HWY 117 & PAINT LAKE ROAD	DORSET, ONTARIO			3	3		3				3
063601	R	LONGWOODS CONS. AUTHORITY	LONGWOODS, ONTARIO				4						4
063701	R	POINT BLAKE CONS. AREA	GRAND BEND, ONTARIO				3						
063802	I	WALPOLE S. PS, SANDUSK RD.	NANTICOKE, ONTARIO								4		
064001	R	EXP. LAKES AREA	ELA, ONTARIO				4						
064101	R	ALGOMA	ALGOMA, ONTARIO				4						
064401	R	EGBERT	EGBERT, ONTARIO				4					4	4
064502	R	ROBERT MOORE P.S.	FORT FRANCES, ONTARIO								9		
064601	R	PT. PETRE	PT. PETRE, ONTARIO									4	4
064801	I	EARL LANTZ PROPERTY	BEACHVILLE, ONTARIO								2		
064901	I	185 KING ST. S.	THOROLD, ONTARIO								4		
065001	R	83 PERRY STREET	BARRIE, ONTARIO	5	5	5	5		5				
065101	R	EAGLE ST. & McCAFFREY RD.	NEWMARKET, ONTARIO	5	5	5	5		5				
065201	R	7 BAY STREET	PARRY SOUND, ONTARIO				4						
070118	R	JEFFERSON & SCOTIA	WINNIPEG, MANITOBA		5	5	5		3				
070119	C	65 ELLEN STREET	WINNIPEG, MANITOBA		4	4	4	5	5			5	5
070203	R	1430 VICTORIA AVENUE EAST	BRANDON, MANITOBA			4	4	4	4				
080110	C	2505 11TH. AVENUE	REGINA, SASKATCHEWAN	10	10	10	10	10	10		10		10
080211	C	511 1ST AVENUE NORTH	SASKATOON, SASKATCHEWAN	5	5		5				5		
080901	R	RADIATION OBSERVATORY	BRATT'S LAKE, SASKATCHEWAN				4						
090121	I	17 STREET & 105 AVENUE	EDMONTON, ALBERTA	5	4	4	4		4				4
090122	R	13335 127 ST	EDMONTON, ALBERTA		4	4	4	4	4				

STATION	INFLUENCE[†]	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
090130	C	10255 - 104TH STREET	EDMONTON, ALBERTA	9	9	9	9		9		6	9	9
090218	I	BONNY BRK & 18A ST. S.E.	CALGARY, ALBERTA	3	3	3	3						
090222	R	39 ST. & 29 AVE. N.W.	CALGARY, ALBERTA		3	3	3						
090227	C	611-4TH STREET S.W.	CALGARY, ALBERTA		6	6	6	5	5			6	6
090302	R	73 STREET & RIVERSIDE DRIVE	RED DEER, ALBERTA	4	4	4	4		4				
090601	R	9209A 96TH AVE	FORT SASKATCHEWAN, ALBERTA	5	5	5	5		5				
090701	R	FRANKLIN AVENUE	FORT MCMURRAY, ALBERTA	4	4	4	4		4				
090702	R	TIMBERLEA SUBDIVISION	FORT MCMURRAY, ALBERTA	4		4	4		4				
090801	R	MAIN STREET	FORT MACKAY, ALBERTA	4		4	4		4				
090803	F	SYNCRUDE AIRSTRIP	FORT MACKAY, ALBERTA	4									
090804	F	MANNIX	FORT MACKAY, ALBERTA	4									
090805	F	BUFFALO VIEWPOINT	FORT MACKAY, ALBERTA	4									
091001	R	ESTHER	ESTHER, ALBERTA				2						
091201	R	SE 11 54 2 W6	HIGHTOWER RIDGE, ALBERTA	2		2	2	2	2				
091301	A	SE 2 51 6 W5	TOMAHAWK, ALBERTA	2		2	2	2	2				
091401	A	SE 17 48 08 W5	VIOLET GROVE, ALBERTA	2		2	2						
091501	A	BEAVERLODGE RESEARCH FARM	BEAVERLODGE, ALBERTA	2		2	2						
091601	A	SE 31 53 13 W5	CARROT CREEK, ALBERTA	2		2	2						
091701	F	NE 12 48 22 W5	STEEPER, ALBERTA	2		2	2	2					
091801	R	FORT CHIPEWYAN	FORT CHIPEWYAN, ALBERTA	2		2	2		2				
091901	R	16-30-034-5 W5	CAROLINE, ALBERTA	2		2	2						
100110	R	6400 E. HASTINGS & KENSINGTON	VANCOUVER, BRITISH COLUMBIA	4	4	4	4	5					
100111	I	MOODY & ESPLANADE PORT MOODY	VANCOUVER, BRITISH COLUMBIA	4	4	4	4	5			5	17	5
100112	C	ROBSON/HORNBY	VANCOUVER, BRITISH COLUMBIA	5	5	5	5						5
100118	R	2550 WEST 10TH AVENUE	VANCOUVER, BRITISH COLUMBIA	3	3	3	3	17			17	4	
100119	R	5455 RUMBLE STREET	VANCOUVER, BRITISH COLUMBIA	5	5	5	5	4					5
100121	R	75 RIVERSIDE DR. N. VANCOUVER	VANCOUVER, BRITISH COLUMBIA	4	4	4	4						
100125	R	8544 116TH AVE. DELTA	VANCOUVER, BRITISH COLUMBIA			4	4						
100126	R	RING ROAD BURNABY	VANCOUVER, BRITISH COLUMBIA			4	4						
100127	R	19000 & 72ND AVE. SURREY	VANCOUVER, BRITISH COLUMBIA		4	4	4	4					4
100128	R	WILLIAMS & ARAGON RICHMOND	VANCOUVER, BRITISH COLUMBIA	4	4	4	4	4					4
100130	R	SPERLING & LAUREL ST.	VANCOUVER, BRITISH COLUMBIA										4
100131	R	SEYMOR FALLS NORTH VANCOUVER	VANCOUVER, BRITISH COLUMBIA				4						

STATION	INFLUENCE[†]	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
100132	R	16TH ST. & JONES AVE NORTH VAN	VANCOUVER, BRITISH COLUMBIA	4	4	4	4	4					
100133	R	7815 SHELLMOUNT	VANCOUVER, BRITISH COLUMBIA										4
100134	R	3153 TEMPLETON STREET	VANCOUVER, BRITISH COLUMBIA	4	4	4	4	4	4				4
100135	R	1250 PINETREE WAY	VANCOUVER, BRITISH COLUMBIA		4	4	4						
100136	R	GROSVENOR CRESENT - BURNABY	VANCOUVER, BRITISH COLUMBIA	4									
100137	R	ETON AND MADISON AVE BURNABY	VANCOUVER, BRITISH COLUMBIA	4									
100202	C	1011 4TH AVENUE	PRINCE GEORGE, BRITISH COLUMBIA	4		4	4	18	18				
100203	C	1108 INDUSTRIAL WAY	PRINCE GEORGE, BRITISH COLUMBIA					5					
100209	R	7310 CLUFF	PRINCE GEORGE, BRITISH COLUMBIA					2					
100304	C	923 TOPAZ	VICTORIA, BRITISH COLUMBIA	5	5	5	5		5			5	
100307	R	2005 SOOKE ROAD	VICTORIA, BRITISH COLUMBIA				4		4				
100308	C	3300 WISHART ROAD	VICTORIA, BRITISH COLUMBIA					4	4				
100401	C	317 SEYMOUR ST.	KAMLOOPS, BRITISH COLUMBIA	15									
100402	C	MAYFAIR STREET	KAMLOOPS, BRITISH COLUMBIA	5	5	5	5	5	5				
100701	C	3333 COLLEGE WAY	KELOWNA, BRITISH COLUMBIA	7	7	7	7	10	10				
101003	R	32995 BEVAN AVE.	ABBOTSFORD, BRITISH COLUMBIA	4	4	4	4	4					
101004	R	31790 WALMSLEY AVENUE	ABBOTSFORD, BRITISH COLUMBIA						4				
101101	R	WORKS YARD	CHILLIWACK, BRITISH COLUMBIA	4	4	4	4	4	4				4
101202	R	18477 DEWDNY TRUNK	PITT MEADOWS, BRITISH COLUMBIA	4	4	4	4	4	4				
101301	R	23752 52ND AVENUE	LANGLEY, BRITISH COLUMBIA		3	3	3	4					
101401	R	AIRPORT	HOPE, BRITISH COLUMBIA		4	4	4	4					4
101501	R	23124 118TH AVENUE	MAPLE RIDGE, BRITISH COLUMBIA		4	4	4	4					
101601	R	38075 2ND AVENUE	SQUAMISH, BRITISH COLUMBIA				4	4					
101701	R	585 CALLANAN STREET	QUESNEL, BRITISH COLUMBIA					5	5				
101702	R	950 MOUNTAIN ASH ROAD	QUESNEL, BRITISH COLUMBIA					5	5				
101703	R	501 PINECREST ROAD	QUESNEL, BRITISH COLUMBIA					5	5				
101704	R	CORRELIEU SCHOOL	QUESNEL, BRITISH COLUMBIA					5	4				
102001	R	SATURNA	SATURNA, BRITISH COLUMBIA				4						
102102	R	280 LABIEUX ROAD	NAMAIMO, BRITISH COLUMBIA				4		4				
102103	R	CEDAR 7 WOOBANK RD	NAMAIMO, BRITISH COLUMBIA					4					
102301	R	WILDLIFE SANCTUARY	POWELL RIVER, BRITISH COLUMBIA			4		4	4				
102302	C	WILDWOOD MOTORS	POWELL RIVER, BRITISH COLUMBIA					4					
102401	R	4020 BROADWAY AVENUE	SMITHERS, BRITISH COLUMBIA		4	4	4	5					

STATION	INFLUENCE[†]	LOCATION	CITY	SO_2	CO	NO/ NO_2	O_3	TEOM PM_{10}	TEOM $PM_{2.5}$	TSP HIGH VOLUME	SSI PM_{10}	DICHOT PM_{10}	ORGANIC
102501	R	104 - 3220 EBY STREET	TERRACE, BRITISH COLUMBIA					5					
102601	R	5410 ARGYLE STREET	PORT ALBERNI, BRITISH COLUMBIA					5					
102701	R	1045 WESTERN AVENUE	WILLIAMS LAKE, BRITISH COLUMBIA				4	5	5				
102702	R	SKYLINE SCHOOL	WILLIAMS LAKE, BRITISH COLUMBIA					4	4				
102801	R	ADJACENT TO 660 WESTMERE	CAMPBELL RIVER, BRITISH COLUMBIA			5	5	5					
102802	R	2662 TYEE SPIT ROAD	CAMPBELL RIVER, BRITISH COLUMBIA					5					
103202	R	835 9TH AVENUE SOUTH	GOLDEN, BRITISH COLUMBIA					2					
103901	R	653 COLUMBIA STREET	KITIMAT, BRITISH COLUMBIA					4					
104401	R	770 PACIFIC STREET	PORT EDWARD, BRITISH COLUMBIA					2					
104501	R	LIGHTHOUSE ROAD	QUADRA ISLAND, BRITISH COLUMBIA					2					
104601	R	1304 BIRCH STREET	TELKWA, BRITISH COLUMBIA					2					
104701	R	HIGHWAY 16	PRINCE RUPERT, BRITISH COLUMBIA					2					
104801	R	6364 DEYKIN AVENUE	DUNCAN, BRITISH COLUMBIA					2					
105001	R	MEADOW PARK	WHISTLER, BRITISH COLUMBIA				2						
105101	R	FIREHALL	HOUSTON, BRITISH COLUMBIA					2	2				
105201	R	FIRE CENTRE	BURNS LAKE, BRITISH COLUMBIA					2					
105301	R	FORRES ROAD	LANGDALE, BRITISH COLUMBIA			5		5					
105401	R	47864 OLD BOSTON BAR ROAD	BOSTON BAR, BRITISH COLUMBIA					5					
105501	C	10015 100TH AVENUE	FORT ST. JOHN, BRITISH COLUMBIA					5	5				
105601	R	6601 89TH STREET	OSOYOOS, BRITISH COLUMBIA	4		4	4	4	4				
119002	C	2130 - 2ND AVENUE	WHITEHORSE, YUKON		4					4			
119003	C	1091 - 1ST AVENUE	WHITEHORSE, YUKON		4	4	4		4				
129001	C	50TH AVE. & 49TH STREET	YELLOWKNIFE, NORTHWEST TERRITORIES							7		7	
129002	C	4807 52ND STREET	YELLOWKNIFE, NORTHWEST TERRITORIES	15			15						
129302	C	RENEWABLE RESOURCES OFFICE	IQALUIT, NUNAVUT							4			

[†] Influences: C = urban commercial, R = urban residential, I = industrial, U = rural undeveloped, A = rural agricultural, F = rural forest

Appendix III – Data Requests

Standard and specific data files are available in various computer formats. To request specific data extracts, please contact:

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