AIR QUALITY REPORT
FOR BRITISH COLUMBIA:

Ground-Level Ozone Concentrations
(1986-1997)

Air Resources Branch
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EXECUTIVE SUMMARY

Ground-level ozone is an important component of urban smog that is formed from reactions involving nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. The motor vehicle is a major source of both NOx and VOCs.

Ozone is a respiratory irritant, and has been associated with a decline in lung function and increased hospitalizations for those with pre-existing respiratory problems. Recent studies indicate that ozone may be causing health effects, even at low concentrations. Ozone is also harmful to plants and to various materials.

Ozone is currently being monitored at more than 25 sites in the province. The monitoring network is most dense in the Lower Fraser Valley (LFV), reflecting both the large population and the high historical ozone concentrations found in this region. Data are forwarded to a central electronic database for storage.

This report provides an overview of provincial ozone levels based on data collected between 1986-1997. Data from 19 sites were evaluated. Site selection was based in part on data availability and on obtaining as broad a geographical cross section of the province as possible. Hence, sites with the worst or the best air quality in the province in any particular year may not have been considered here.

Unless noted otherwise, analyses were based on hourly ozone concentrations. The following observations were drawn from these analyses.

- There is great temporal and spatial variability in ozone concentrations measured throughout the province.
- The highest hourly concentrations were observed during the summer months, when conditions are most conducive to ozone formation.
- During much of the late 1980's, the highest hourly concentrations were observed at sites immediately downwind of the most densely populated areas of the LFV, at sites in Port Coquitlam and Port Moody. Ozone concentrations were particularly high during the summer of 1988, when much of North America was under the influence of a strong high pressure system that resulted in extended periods of poor air quality. During this

period, the Port Coquitlam monitoring site recorded a maximum hourly concentration of 425 $\mu g / m^3$.

- More recently, the highest hourly concentrations were recorded in Hope in 1993 (176 $\mu g / m^3$), Port Coquitlam in 1994 (213 $\mu g / m^3$), Hope in 1995 and 1996 (188-206 $\mu g / m^3$), and Kelowna in 1997 (168 $\mu g / m^3$).
- On an annual basis, mean hourly concentrations ranged from less than 10 $\mu g / m^3$ to 45 $\mu g / m^3$. Over the last five years, the highest mean concentrations were typically monitored at sites further downwind of the more densely populated areas of the LFV (e.g. Surrey, Langley and Hope) and sites outside of the LFV (e.g. Victoria, Kamloops, Kelowna, Williams Lake and Prince George).
- The lowest mean concentrations were consistently observed in Downtown Vancouver (Robson Square), where NOx emissions from vehicle exhaust are likely responsible for the destruction of local ozone.
- On a monthly basis, the highest hourly mean concentrations were typically observed during the spring months, particularly during April and May. This finding is partly attributed to the increased contributions of stratospheric ozone which occur during the spring, when the stratosphere is closest to the earth's surface. The highest concentrations reported during this period were 60-61 $\mu g / m^3$ in Kamloops.
- In contrast, the lowest monthly mean concentrations were typically observed between November and January. Ozone concentrations at Vancouver (Robson Square) averaged less than 10 $\mu g / m^3$ during this period.
- The 95th percentile concentration, which represents the level below which 95% of the concentrations fall, is a useful indicator of long-term trends. Although very high hourly concentrations were observed in the late 1980's, a number of sites reported their highest or second highest 95th percentile and mean concentrations in 1996. These sites included Vancouver (Robson Square), Richmond, North Delta, Burnaby (Kensington Park) and Hope. Data from the Hope site indicates that the annual mean concentration consistently increased each year between 1993-96.

- The national air quality objectives for ozone are currently under review. The current one-hour maximum acceptable level is 160 $\mu g / m^3$. In the late 1980's, the majority of exceedances of this level occurred in the Port Coquitlam / North Vancouver / Pitt Meadows area. More recently, exceedances have also been observed in Surrey, Langley, Abbotsford, Chilliwack, Hope and Kelowna.
- In contrast, no exceedances of the air quality objective were recorded in Victoria, Squamish, Vancouver (Robson Square), Kamloops and Prince George between 1986-1997. However, three of the sites (Victoria, Squamish and Kamloops) reported hourly concentrations in excess of 150 $\mu g / m^3$.
- A cumulative ozone exposure index, SUM06, was also calculated. SUM06 values are used to assess the exposure of vegetation to ozone during the growing season. A value of 11.6 mg / m^3-h over a three-month period is expected to provide protection to 95% of crops. Exceedances of this level were generally limited to the period prior to 1989, with the exception of the Hope site, where exceedances were recorded in 1995 and 1996.
- Hourly mean, 95th percentile and maximum concentrations observed at various sites in the province in 1997 were compared. Based on this combination of parameters, the highest concentrations were reported for sites in Kelowna and Kamloops. This finding indicates that these sites experience both a high background concentration of ozone throughout the year, and periods of elevated ozone concentrations during the warm, sunny summer months. This finding also suggests that ozone may be an emerging issue in these rapidly growing areas.
- Eight-hour average concentrations were also calculated. Standards or objectives based on an 8-hour average are believed to provide better protection against longer exposure periods. There are currently no national objectives based on an 8-hour averaging period. However, for comparison purposes, 8-hour average concentrations were evaluated against the U.K. standard of 50 ppb (approximately 100 $\mu g / m^3$). This level was exceeded at most sites at least once per year, and a maximum of 253 times in Kelowna in 1987.

ACKNOWLEDGMENTS

A number of individuals within the Ministry lent their knowledge and advice to the analysis of the data and the review of the draft report. Particular thanks go to staff of the Air Resources Branch, Victoria, and the Regional Air Quality Meteorologists.

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1. INTRODUCTION

Ozone (O_3) is a colourless and reactive gas that occurs naturally in trace amounts in the atmosphere. Most of the atmospheric ozone is found in the stratosphere, which is a layer extending between 10 to 50 km above the earth's surface. The stratospheric ozone layer protects the earth's inhabitants from the sun's harmful ultraviolet (UV) radiation. At ground level, however, ozone can be harmful to human health, vegetation and various materials. A major component of urban smog, it is formed in the lower atmosphere from reactions involving nitrogen oxides (NOx) and reactive hydrocarbons called "volatile organic compounds" (VOCs) in the presence of sunlight. It can be transported hundreds of kilometres in the horizontal direction, resulting in high ozone concentrations at sites well removed from where precursor emissions are greatest. On occasion, it is also transported downward in the atmosphere from the ozone-rich stratosphere.

Health Effects

One of the main concerns regarding ground-level ozone is its effects on our lungs. Specifically, this highly reactive substance is known to damage lung tissue. Compartments in the lung fluid lining and cell membranes appear to be the first areas targeted by ozone (Pryor et al., 1991). In the studies reviewed in the Report of the Health Objective Working Group (HOWG, 1997), a clear relationship was observed between daily variations in ozone at ambient concentrations observed in Canada, and a variety of adverse health effects including small changes in lung function, increases in symptoms of respiratory discomfort, increases in the use of medication, and increased doctors and hospital emergency room visits. Researchers found an approximate 1% increase in hospitalizations and an 8.5% increase in hospital emergency department visits for asthma-related and general respiratory illnesses for each 10 ppb increase in the daily one-hour maximum ozone concentration. A small but positive association with increased mortality was observed in five of the nine epidemiological studies reviewed. However, a stronger relationship between pollutant concentration and increased mortality was observed with particulate matter than with ozone.

Recent studies exhibit a lack of an observable threshold effect level for ozone (Thurston, 1995; Schwartz, 1996, Burnett et al., 1994). This means that even at low concentrations, ozone may be causing health effects. Children have the greatest risk due to the large amounts of time they spend outdoors during the summertime, when ozone concentrations are highest. Adults who are moderately active outdoors, such as construction workers and outdoor workers, are also at greater risk.

Effects on Vegetation and Materials

Elevated ozone levels can also affect the ability of plants to produce and store food (U.S. EPA, 1996a). Short-term exposures of approximately 200-240 $\mu g / m^3$ are reported to be toxic to a large number of plants, resulting in leaf damage, crop yield loss and reduced biomass production. Longer-term exposures of 100-180 $\mu g / m^3$ are associated with chronic stresses on vegetation that can lead to reduced plant growth and yield, and greater susceptibility to pests, disease, and injury from other environmental stresses. Species that are sensitive to ozone exposure include beans, tomato and wheat. Effects on long-living species such as trees may accumulate over the years, resulting in damage to entire forests or ecosystems.

A number of materials are susceptible to ozone damage. As reviewed in the U.S. EPA criteria document (1996a), ozone exposure is known to cause embrittlement and cracking of natural rubber (e.g. Mueller and Stickney, 1970), to weaken textile fibres (e.g. Zeronian et al., 1971) and to change the colour of some dyes (e.g. Matsui et al., 1988). It is also believed to cause cracking of paint.

Sources of Ozone Precursors

Because ozone is not directly emitted into the atmosphere, the control of ozone must occur through the control of its precursor species: NOx and VOCs. NOx, which is composed of nitrogen oxide (NO) and nitrogen dioxide (NO_2) gases, is emitted primarily during the combustion of fossil fuels and biomass. VOCs are emitted during the incomplete combustion of fuel, the evaporation of fuels, solvents, paints and dry-cleaning

fluids, and also from natural sources such as vegetation.

In 1995, a total of 302 kilotonnes of NOx and 236 kilotonnes of VOC were emitted from anthropogenic (i.e. human-related) sources in British Columbia (MELP, 1998). Biogenic (i.e. natural) sources contributed a further 2,509 kilotonnes of VOCs and 13 kilotonnes of NOx. Relative contributions from anthropogenic NOx and VOC sources are summarized in Figures 1.1 and 1.2, respectively. The transportation sector, pipeline transport and the crude petroleum and natural gas processing industry respectively accounted for 53, 12 and 8% of NOx emissions, whereas the transportation sector, oil and gas operations, the wood products industry and solvent evaporation respectively accounted for 29, 19, 15 and 10% of VOC emissions.

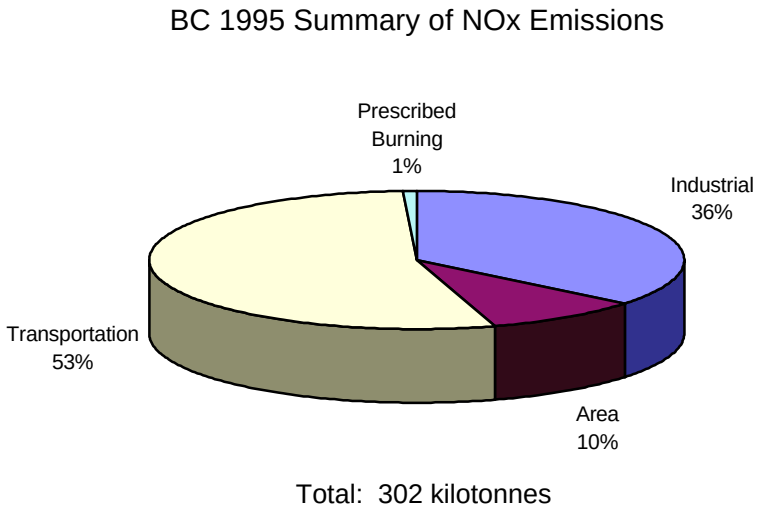


Figure 1.1 Breakdown of provincial NOx emissions from anthropogenic sources for 1995 (MELP, 1998).

Due to the varied nature of VOCs, VOC emission estimates are not necessarily indicative of contributions to ozone formation. VOCs vary in terms of their reactivity in the atmosphere and the extent to which by-products promote or inhibit ozone formation.

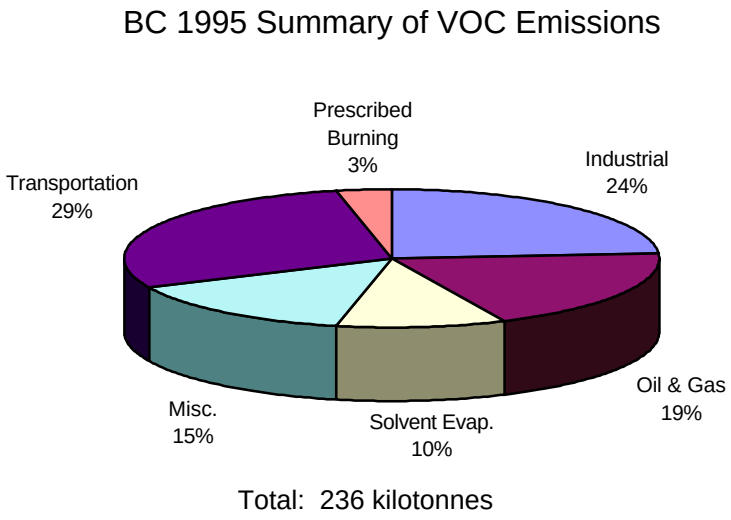


Figure 1.2 Breakdown of provincial VOC emissions from anthropogenic sources for 1995 (MELP, 1998).

The impact of a source on ozone formation will therefore depend in part on the composition of its VOC emissions and the relative emission rates. Based on measurements obtained during the Pacific'93 study in the Lower Fraser Valley (LFV) and maximum ozone reactivity factors derived by Carter (1991), Bottenheim et al. (1997) estimated that of the ozone formed downwind of the city of Vancouver, more than 35% involved aromatic compounds (e.g. toluene and xylene), up to 15% were from alkenes (e.g. ethene and propene) and approximately 10% were from isoprene. Alkanes (e.g. propane, butane and pentane) accounted for up to 60% of the carbon mass, but only 40% of the ozone produced, reflecting the low ozone-forming potential of its constituents.

A detailed inventory including emission estimates of individual VOC species is not available in B.C. Using broad categories based on functional groups, SENES (1994) estimated that gasoline vehicles emitted approximately 50% of aromatic VOCs in the LFV in 1990. Gasoline marketing and solvent usage contributed an additional 19 and 15%, respectively. No specific estimates were provided for alkene emissions. Emissions of aliphatics, which include alkanes, alkenes, alkynes, and their cyclic analogs, originated from the following sources: gasoline vehicles (59%), solvent usage (18%), refineries (7%)

and gasoline marketing (6%). Isoprene emissions were wholly attributed to biogenic sources such as forests and agricultural crops.

A further item to be considered in ozone control strategy is the impact that distant sources have on local air quality. Due to the complex chemistry involved in ozone formation (as discussed further in the following section), the area of highest ozone concentrations is typically located downwind of the area of highest precursor emissions. In the LFV, ozone concentrations in urban areas such as Vancouver and Burnaby are significantly lower than those observed at more rural sites in the central valley. Hence, in developing emission control strategies, it is important to consider the impact on an entire airshed rather than just the source region. In cases where long-range transport is a major source of ozone, such as in eastern Canada and the eastern U.S., a regional approach must be considered.

Atmospheric Chemistry

The formation of ground-level ozone occurs through a series of reactions involving the photolysis of nitrogen dioxide (NO_2):

$$NO + O_3 \rightarrow NO_2 + O_2 \quad \text{(R1)}$$

$$NO_2 + h\nu \rightarrow NO + O \quad \text{(R2)}$$

$$O_2 + O + M \rightarrow O_3 + M \quad \text{(R3)}$$

where $h\nu$ refers to light at wavelengths less than 424 nm and M refers to a third molecule such as nitrogen or oxygen. In the absence of other chemical species, the formation of NO_2 is at the expense of ozone, and a steady state is achieved in which ozone is continuously formed (R3) and destroyed (R1).

In the presence of other chemical species such as VOCs, the conversion of NO to NO_2 is enhanced without destroying ozone, resulting in increased ozone levels. Briefly, hydroxyl (OH) radicals that are photochemically produced react with VOCs (RH) to produce peroxy (RO_2) and hydroxy radicals (HO_2). These radicals then react with NO to produce NO_2. The reactions are described as follows:

$$RH + HO \rightarrow R + H_20 \quad \text{(R4)}$$

$$R + O_2 + M \rightarrow RO_2 + M \quad \text{(R5)}$$

$$RO_2 + NO \rightarrow RO + NO_2 \quad \text{(R6)}$$

$$RO + O_2 \rightarrow HO_2 + RCHO \quad \text{(R7)}$$

$$HO_2 + NO \rightarrow NO_2 + HO \quad \text{(R8)}$$

$$2(NO_2 + h\nu) \rightarrow 2(NO + O) \quad \text{(R9)}$$

$$2(O + O_2 + M) \rightarrow 2(O_3 + M) \quad \text{(R10)}$$

$$Net: RH + 4O_2 + h\nu \rightarrow 2O_3 + H_2O + R_1R_2CO$$

where *RCHO* refers to an aldehyde or a ketone. Due to the complexity of the reactions, the relationship of ozone with its precursors is highly nonlinear, i.e. a decrease in VOCs or NOx may not result in a similar decrease in ozone. In fact, under some circumstances, increased ozone levels may result from reduced NOx emissions. Hence, the design of effective control measures requires an in-depth understanding of the atmospheric chemistry and the emissions in a particular airshed.

Background Ozone Concentrations

Ozone levels vary widely on both a seasonal and geographic basis. The natural component of background levels represents contributions from stratospheric ozone, the photochemically initiated oxidation of naturally produced methane and carbon dioxide, and the photochemically initiated oxidation of biogenic VOCs (U.S. EPA, 1996b). For this reason, it is difficult to identify a single background concentration. It is estimated that for sites that are remote from anthropogenic sources, daily maximum concentrations of 70-96 $\mu g / m^3$ (May-September) and monthly average concentrations of 50-80 $\mu g / m^3$ (May-September) can be expected (DAWG, 1997).

Ozone Concentrations in BC

Regional ozone levels have been summarized by the Greater Vancouver Regional District (GVRD, 1997), Johnson (1996) for the Skeena Region, Lamble and Fudge (1996) for Prince George, Plain (1996) for the Cariboo Region, and Josefowich and Reid (1996) for Kamloops and Kelowna. The last provincial review of ambient ozone levels was based on

data collected between 1983-1987 (MOE, 1989). Hence, this report provides a timely update of ambient ozone levels reported at various monitoring sites throughout the province. This review is limited to data collected over a 12-year period between 1986-97.

2. SAMPLING METHODOLOGY

Two different techniques have been used to measure ozone concentrations in the provincial monitoring network: chemiluminescence and ultraviolet (UV) absorption. The chemiluminescence instruments were used predominantly in the 1970's and early 1980's, after which UV instruments have been used exclusively.

In chemiluminescence monitors, ozone is reacted with ethylene to form an electronically excited product (formaldehyde). The decay of this product is associated with the emission of light. The emission intensity is linearly proportional to the concentration of ozone. Although typical airborne contaminants are not known to interfere with chemiluminescence measurements, a positive interference from water vapour has been reported (Kleindienst et al., 1988). The Federal Reference Method for monitoring ozone in the United States is the chemiluminescence-type approach (Federal Register, 1971).

The UV absorption approach utilizes the fact that ozone absorbs strongly in the range of 254 nm, which coincides with the emission line of a low-pressure mercury lamp. Transmission of a 254 nm light through the sample air is compared with light transmitted through air which has been removed of ozone by a manganese dioxide (MnO_2) scrubber. Ozone measurements are directly derived from a comparison of the two signals. A number of such instruments have been designated by the U.S. EPA as equivalent to the Federal Reference Method, and UV absorption photometry is now the predominant method used to determine compliance with standards in the United States (U.S. EPA, 1996a). An advantage of UV absorption spectrometers relative to chemiluminescence monitors is that they require no gas supplies. Potential disadvantages are associated with the fact that any contaminant that absorbs 254-nm light and is removed by the MnO_2 scrubber will contribute to an overestimation of ozone concentrations. Such contaminants include aromatic hydrocarbons, mercury vapour and sulphur dioxide.

Several different monitor types have been used in the provincial monitoring

network over the past 12 years. A list of the various models, including monitoring principles and upper and lower detection limits, is provided in Table 2.1. Monitors described as "GVRD" are used in GVRD monitoring network only.

Table 2.1 Ozone monitors used in provincial monitoring network.

Monitor Code	Monitor Name	Monitoring Technique	Upper Limit ($\mu g / m^3$)	Lower Limit ($\mu g / m^3$)
8648010	Bendix 8002	chemiluminescence	980	9.8
8648011	ML 8410	chemiluminescence	980	9.8
8648012	Dasibi 1003-PC	UV absorption	980	9.8
8648013	TECO 49	UV absorption	980	9.8
8648014	API Model 400	UV absorption	980	9.8
8648020	GVRD	UV absorption	1960	0
8648021	ML 8810	UV absorption	980	9.8

3. QUALITY ASSURANCE

A province-wide audit program ensures that all ozone samplers are regularly calibrated, maintained and operated. Data from all samplers are forwarded to a central electronic database for storage. The data must meet a number of screening criteria before being accepted onto the database. This is done to ensure that only valid data are archived.

4. SAMPLING SITES IN BC

Ground-level ozone has been monitored at nearly 35 sites in BC. The majority of these sites are located in the GVRD, reflecting the fact that ozone tends to be an urban problem in this province. The current monitoring network includes over 25 samplers. The names and locations of past and present ozone monitors in the BC network are presented in Appendix I. Monitors are located in all regions of the province, with the exception of the Kootenays.

5. MEASURES OF AIR QUALITY

As a measure of the air quality in a region, contaminant levels are often compared to

air quality objectives or *air quality standards.* Air quality objectives are developed by environmental and health authorities to provide *guidance* for environmental protection decisions. They are based on scientific studies which consider the effects of the contaminant on such receptors as humans, wildlife, vegetation, and materials, as well as aesthetic qualities such as visibility. Air quality standards typically consist of an ambient level and plans to attain the ambient level. Health and environmental effects are considered along with the technical and economic feasibility of attaining the standards. Air quality standards are generally more binding than air quality objectives.

The current set of national ambient air quality objectives for ozone are based on a multi-tiered approach to air quality management, where

- the maximum desirable level is intended to provide long-term protection,
- the maximum acceptable level is intended to provide adequate protection against adverse effects on human health, vegetation and animals, and
- the maximum tolerable level indicates concentrations above which there is a diminishing margin of safety. Exceedances of this level require appropriate action without delay to protect the health of the general population.

The objectives for ozone are as shown in Table 5.1.

Table 5.1 National ambient air quality objectives for ozone (Canada Gazette, 1989).

	Concentration ($\mu g / m^3$)		
Averaging Period	1-hour	24-hour	annual
maximum desirable level	100	30	-
maximum acceptable level	160	50	30
maximum tolerable level	300	-	-

Ozone is currently a candidate for Canada-wide standards under a sub-agreement of the Canada-Wide Accord for Environmental Harmonization, which was accepted by the Canadian Council of Ministers of the Environment in January 1998. Canada-wide ozone standards and regional implementation plans are expected to be developed over the next few years.

In the U.S., the primary 1-hour standard of 0.12 ppm, or approximately 240 $\mu g / m^3$, is being phased out or replaced by an 8-hour standard of 0.08 ppm, or approximately 160 $\mu g / m^3$ (U.S. EPA, 1997). Compliance is based on a complex formula which utilizes the average of the 4th highest 8-hour maximum daily concentration for each year over a 3-year period. The U.K. has also adopted an ambient ozone standard based on the 8-hour averaging period (U.K. DOE, 1997). The level of 0.05 ppm, or approximately 100 $\mu g / m^3$, is based on a level in which effects on public health, including sensitive individuals, are expected to be small.

To protect vegetation from the effects of ozone, an objective in the form of the SUM06 parameter was recommended by the National Vegetation Objective Working Group (VOWG, 1997). SUM06 refers to the sum of hourly ozone concentrations greater than 0.06 ppm (120 $\mu g / m^3$), summed over 12 hours per day during the three-month period when ozone concentrations are at their highest. The recommended range of reference levels is 5.8-7.5 ppm-h (11.6-15.0 mg / m^3-h), which would provide protection to 90-95% of crops.

6. EVALUATION OF OZONE LEVELS

Before discussing ozone levels in B.C., brief explanations are provided to describe the terminology used, the typical characteristics of ambient ozone levels, and the types of graphical tools used in this report to describe ozone concentrations at each of the monitoring sites.

6.1 Terminology

The following explains terms which are regularly used in this document:

- *data capture* - In this application, it refers to the percentage of samples available in any specified period. For instance, if 8760 samples are expected in any one year, and 7,884 measurements are made, the data capture is 90%. Data capture is an important parameter because it reflects how representative the samples are for the period in question. For example, an annual average based on only one sample has little meaning. In general, caution should be exercised in interpreting results based on less than 75% data capture.
- *mean* - Also known as the average, it is defined as the sum of the data, divided by the number of available data. Over any time period, an actual measurement may fall below or above the mean concentration.
- *95th percentile* - The 95th percentile represents the value below which 95% of the sample falls. For example, a 95th percentile concentration of 50 $\mu g / m^3$ indicates that 95% of measurements are less than 50 $\mu g / m^3$. This value is less affected by extreme events than the maximum, so is generally a better indicator of long-term trends.
- *exceedance frequency* - This gives a measure of how often a specific air quality objective is exceeded. For instance, if the objective is exceeded two times out of ten, the exceedance frequency is 20%.
- *SUM06* - As defined in Section 5.
- *ozone season* - This refers to the period between May and September, when elevated ozone levels resulting from photochemical activity in the lower atmosphere are most likely to occur.

In Section 7, these terms will be used to describe ozone levels at selected BC sites.

6.2 Characteristics of Ground-Level Ozone

Ground-level ozone results from photochemical reactions taking place in the atmosphere and to a lesser extent from the down-mixing of ozone from the stratosphere (i.e. stratospheric intrusions). It is subject to large yearly, seasonal and daily variations,

reflecting changes in meteorological conditions as well as changes in precursor gas emissions. It is also subject to large spatial variations across a single airshed, reflecting local meteorological conditions and the proximity of a site to sources of ozone precursors and to ozone sinks. A basic understanding of these factors is helpful in interpreting the analyses of ozone data presented in Section 7. In the following, the characteristics of ozone levels resulting from photochemical production and stratospheric intrusions are discussed, and examples are provided.

Photochemical Production

In the photochemical production of ozone, NOx and VOCs react in the presence of sunlight to form ozone. A description of the conditions conducive to ozone formation, particularly as they relate to a severe episode in the LFV in September 1988, is provided by Steyn et al. (1990). Periods of elevated ozone concentrations typically occur during the warm summer months, when the long hours of sunshine, high temperatures and light winds are conducive to the buildup of pollutants. The characteristic ozone profile is one in which concentrations increase after sunrise and peak during the late afternoon along with ambient temperatures. Concentrations are generally depleted overnight as a result of reactions with other gases and deposition processes.

As an example, hourly ozone measurements obtained from monitoring sites in Port Coquitlam and Hope between July 19-25, 1994 are presented in Figure 6.1. Hourly temperature measurements from the Pitt Meadows Airport are also included in this plot. This period was characterized by high temperatures, daytime westerly winds (sea breezes) which carried pollutants up-valley, and very light winds during the night. The typical diurnal pattern reflecting the photochemical production of ozone is evident, with ozone concentrations peaking in the mid-afternoon along with temperature, and reaching a minimum during the night. The highest concentration reported in the LFV during the episode was 213 $\mu g / m^3$ at Port Coquitlam on July 20. Conditions on this day were characterized by very light winds (<2.5 m/s) and the highest temperatures of the episode (maximum 33.2°C). Concentrations approaching 200 $\mu g / m^3$ were measured in Hope on the

following two days. However, by July 25, maximum daily temperatures dropped to 23°C and ozone levels declined to less than 70 $\mu g / m^3$ at both sites.

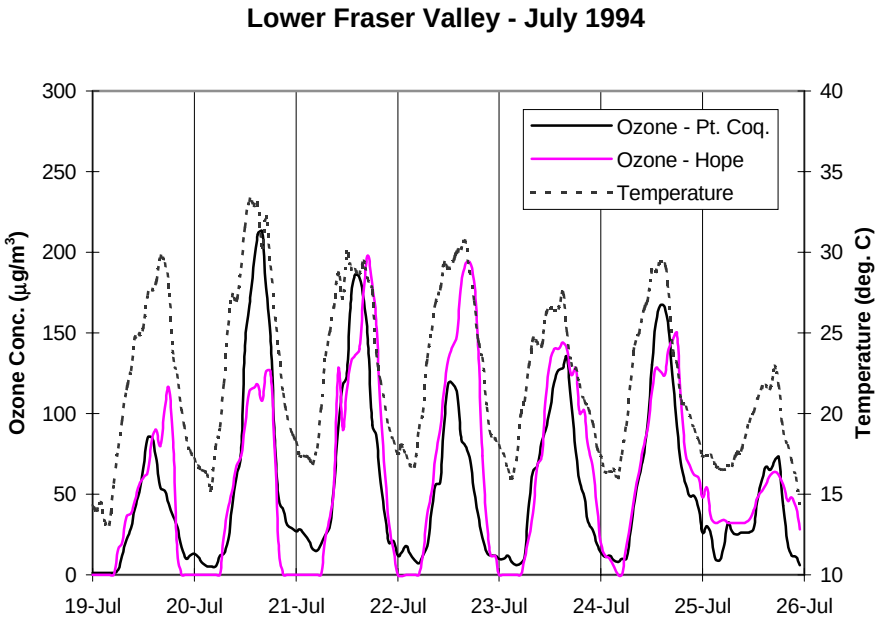


Figure 6.1 Time series of hourly ozone measurements, Port Coquitlam and Hope, July 19-25, 1994. Hourly temperature measurements from Pitt Meadows Airport are also shown.

Based on the hourly ozone data obtained during this episode, the following observations were made:

- Very high concentrations (>160 $\mu g / m^3$) were observed at both sites, but not necessarily on the same days, reflecting the complex mix of emissions and wind patterns in the valley.
- The daily maxima in Hope lagged the maxima in Port Coquitlam by at least two hours (with the exception of July 23), reflecting in part the time it takes for the polluted urban plume to travel up the valley to Hope.
- Nighttime ozone levels in Hope were generally reduced to zero, while detectable concentrations were observed in Port Coquitlam. This suggests that nighttime NOx emissions in Hope were sufficient to destroy local ground-level ozone.

To further illustrate how ozone levels vary from day-to-day and from site-to-site,

Figure 6.2 shows the maximum hourly ozone concentrations observed at a number of sites in southwestern British Columbia during this episode. The sites are arranged from west to east. Clearly, the lowest concentrations throughout the episode were measured in Victoria and urban sites located on the western edge of the LFV. The highest concentrations were recorded at sites downwind of the urban areas of Vancouver and Burnaby. While no extreme values were reported in Kelowna, ozone concentrations at this site were consistently high throughout the episode.

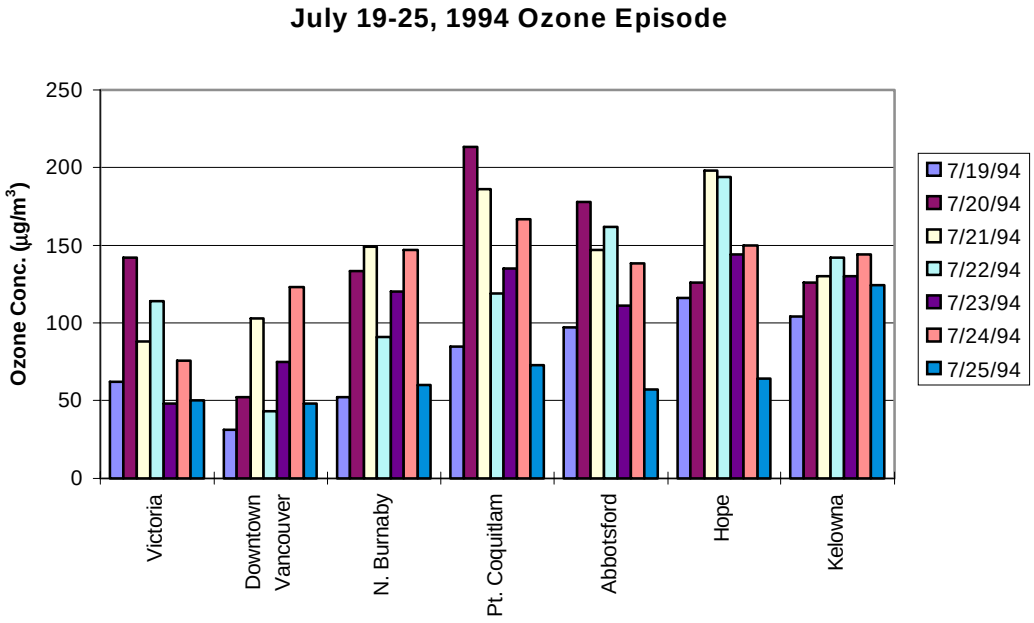


Figure 6.2 Daily maximum hourly ozone concentrations at various sites in southwestern BC, July 19-25, 1994.

Stratospheric Intrusions

The stratosphere and troposphere are separated by a layer of the atmosphere called the "tropopause". The transport of ozone-rich air from the stratosphere to the troposphere is associated with a number of processes: (1) the folding of the tropopause in the core of the jet stream; (2) the seasonal adjustment of the height of the tropopause; (3) medium- and small-scale eddy transport across the tropopause; and (4) large-scale motions such as mean meridional circulation (Altshuller, 1986). Although stratospheric intrusions may occur anytime of the year or day, they are typically observed during the spring in western

Canada, when the tropopause is closest to the earth's surface (DAWG, 1997). They are generally associated with the passage of major weather systems such as cold fronts, which can transport the ozone-rich air to the surface.

A period of elevated ozone concentrations in Williams Lake between February 25-March 1, 1993 is shown in Figure 6.3. The first day was characterized by sub-zero temperatures, light winds and patterns typical of photochemical production, whereby ozone and temperature measurements peaked during the mid-afternoon and reached a minimum during the early morning hours.

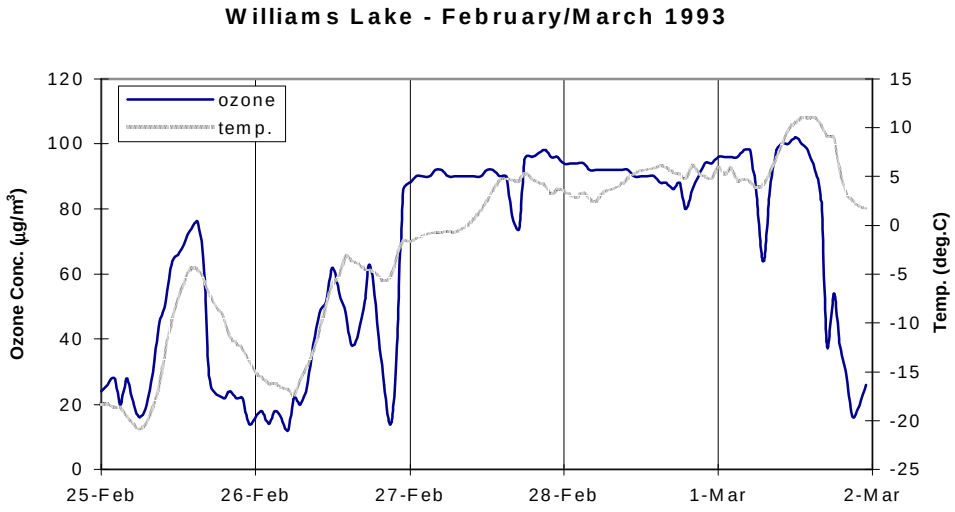


Figure 6.3 Time series of hourly ozone and temperature measurements, Williams Lake, February 25-March 1, 1993.

During the evening of February 26, winds shifted from easterly to southeasterly. Over a two-hour period, wind speeds doubled, temperatures rose by 3.6ºC and ozone levels increased by 50 $\mu g / m^3$ to almost 90 $\mu g / m^3$. During the next 2-1/2 days, temperatures remained well above the freezing level and ozone concentrations consistently exceeded 80 $\mu g / m^3$ day and night (with the exception of 3 hours). Winds were predominantly from the southeast. A maximum ozone concentration of 102 $\mu g / m^3$ was reached during the afternoon of March 1. Later in the evening, winds shifted to easterly and both temperature and ozone measurements began to decline.

A number of factors suggest that the elevated ozone levels observed during this period were a result of transport from the stratosphere. The lack of diurnal variation in ozone levels suggests a source of ozone other than photochemical production and / or a lack of excess NOx emissions to consume ozone during the nighttime. The observation of strong winds which accompanied the increase in ozone levels indicates intense mixing in the atmosphere and therefore provides a mechanism for how stratospheric ozone could be transported to the surface. The event occurred during the late winter / early spring when the tropopause is closest to the earth and stratospheric ozone concentrations are high. Finally, the town of Williams Lake is a small community located in the northern interior of the province. Medium or long-range transport from other areas is unlikely.

6.3 Sample Plots

A description of the types of graphical information that will be presented for each of the monitoring sites in Section 7 is provided in the following.

The first figure (Figure 6.4) shows a time series of the maximum hourly (or 1-hour average) ozone concentration (in units of $\mu g / m^3$) observed each day of the sampling period. The time series is presented to show the large day-to-day variations in ozone levels. Seasonal variations are also noted, with ozone concentrations highest during the summer and lowest during the winter months. To indicate periods when ozone concentrations are exceptionally high, the national ambient 1-hour air quality objective (AQO) of 160 $\mu g / m^3$ is shown.

Annual variations or trends in hourly ozone concentrations are shown in Figure 6.5. Maximum, 95th percentile and mean concentrations (in $\mu g / m^3$) are presented for each year. Large year-to-year variability in ozone maxima reflect the large interannual variability in meteorological conditions, precursor emissions and other factors that influence ozone concentrations. Relatively less year-to-year variability is observed in 95th percentile and mean concentrations.

The actual number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ in any one year are presented in Figure 6.6. This plot provides another means

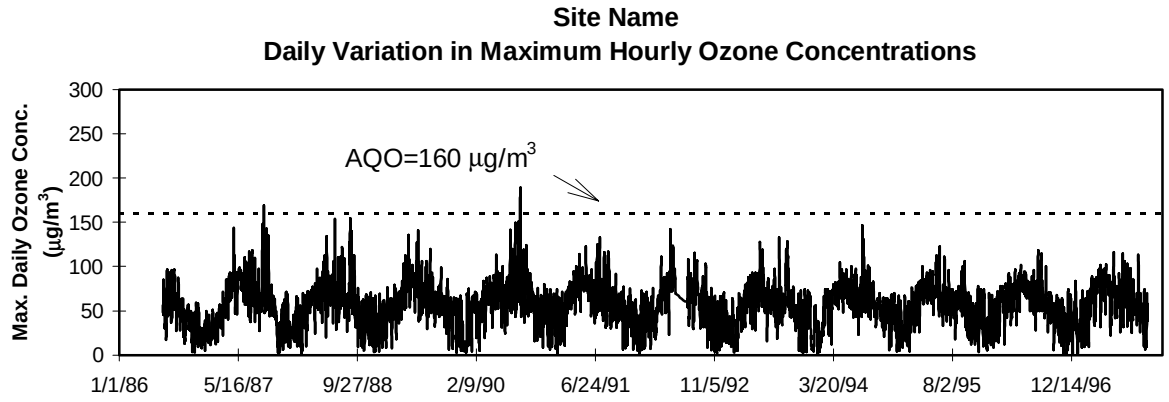


Figure 6.4 Sample time series of daily 1-hour maximum ozone concentrations. The 1-hour ambient air quality objective (AQO) of 160 $\mu g / m^3$ is shown by the dashed line.

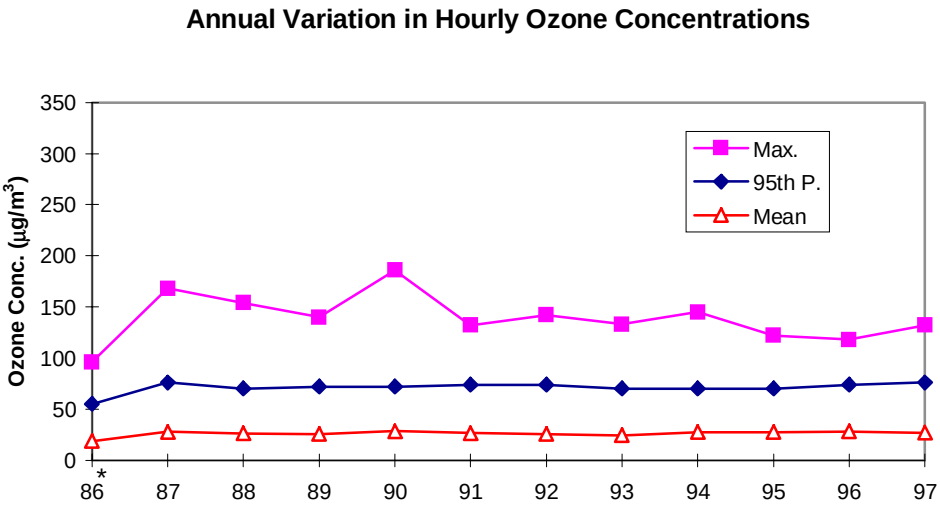


Figure 6.5 Sample plot of annual variations in 1-hour maximum ("Max."), 95th percentile ("95th P.") and mean ("Mean") ozone concentrations.

to show the distribution of hourly ozone concentrations. The levels of 100 and 160 $\mu g / m^3$ respectively represent the national 1-hour maximum desirable and maximum acceptable levels for ozone. Where the maximum desirable level is used as a long-range planning goal, exceedances of this level will indicate short-term deviations from the long-term

goals. Exceedances of the maximum acceptable level indicate poor air quality and the possible need for a reduction in activities that emit ozone precursors, such as motor vehicle use or industrial activities. In the sample plot, it is seen that while exceedances of the maximum desirable level frequently occur, excursions above the maximum acceptable level are rare.

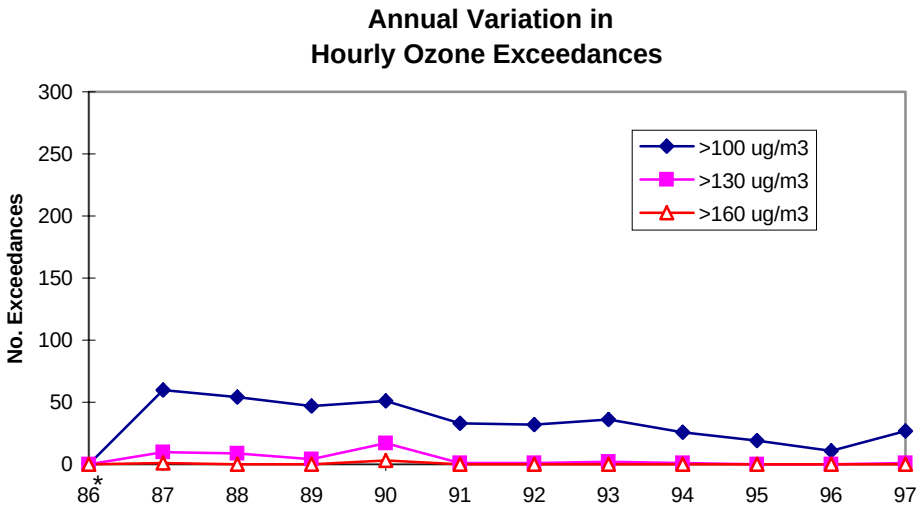


Figure 6.6 Sample plot of the annual number of exceedances of 100, 130 and 160 $\mu g / m^3$ ozone.

Monthly variations in the distribution of hourly ozone concentrations are shown in Figure 6.7. All available hourly data were aggregated on a monthly basis, and then maximum, 95th percentile and mean concentrations were computed. This figure is intended to show the seasonal variability in hourly ozone concentrations to ambient concentrations and therefore shed light on the ozone formation mechanisms contributing to ambient concentrations. In this example, the maximum hourly concentration was observed during the month of August, when photochemical production of ozone is important. However, 95th percentile and mean concentrations were highest during the months of April and May, likely reflecting stratospheric contributions to ambient levels. Examples of photochemical and stratospheric ozone events were described in further detail in Section 6.2.

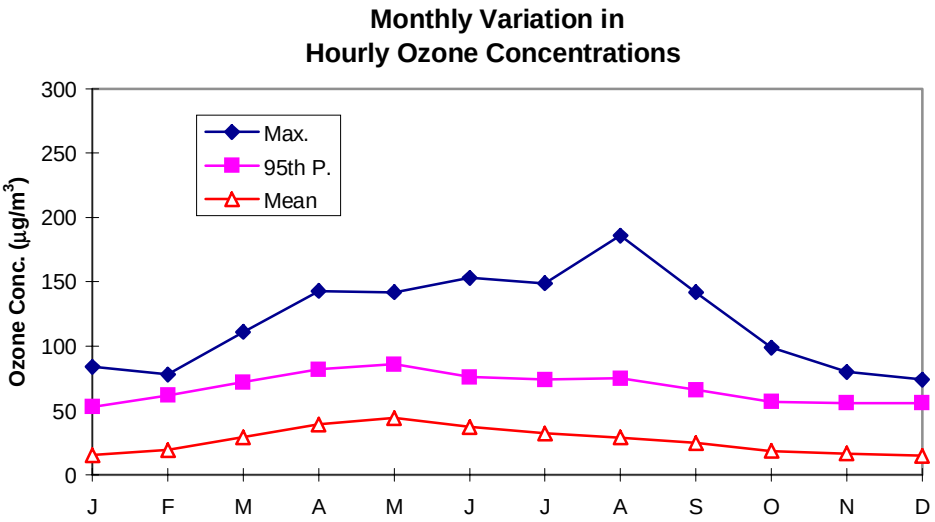


Figure 6.7 Sample plot of monthly variations in 1-hour maximum ("Max."), 95th percentile ("95th P.") and mean ("Mean") ozone concentrations.

Maximum SUM06 values are presented in Figure 6.8. SUM06 is a parameter used to characterize the exposure of vegetation to harmful levels of ozone during the growing season. It is based on the sum of hourly ozone concentrations in excess of 60 ppb-h (120 mg/m^3-h) during daylight hours over a three-month period when ozone levels are highest. The values shown represent the maximum SUM06 value observed each year. SUM06 values of 5.8-7.5 ppm-h (11.6-15.0 mg/m^3-h) are expected to provide protection to 90-95% crops (VOWG, 1997). In the sample plot, SUM06 values are safely within the levels intended to protect 95% of crops.

Daily variations in the maximum 8-hour average concentration are presented in Figure 6.9. The 8-hour average is expected to correlate better with the health effects of concern at the lowest ozone concentrations, and to be a more robust indicator of air quality (U.S. EPA, 1996b). For comparison purposes, the U.K. standard of 0.05 ppm (approx. 100 $\mu g/m^3$) is shown in the sample plot. Clearly, exceedances of this level were observed at least once a year between 1987-1997, although exceedances were most frequent in the late 1980's.

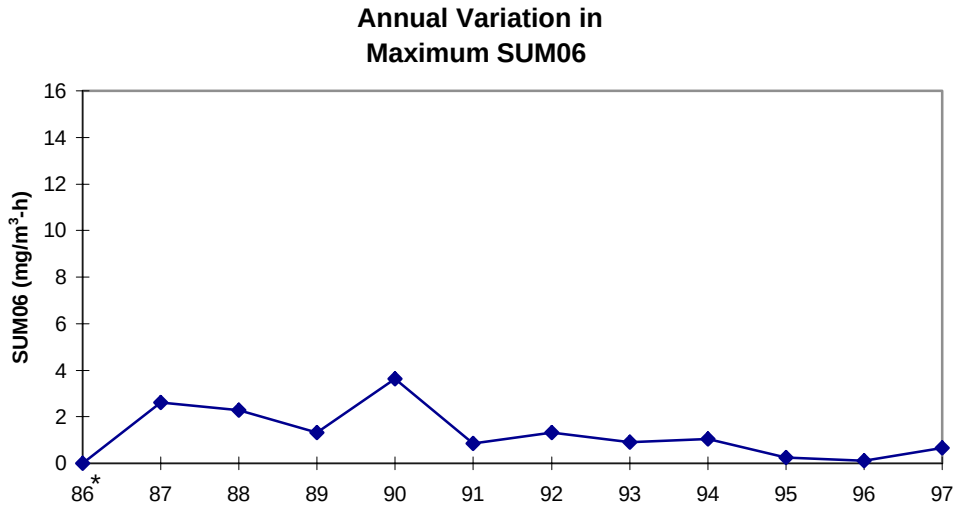


Figure 6.8 Sample plot of annual variations in maximum SUM06 values.

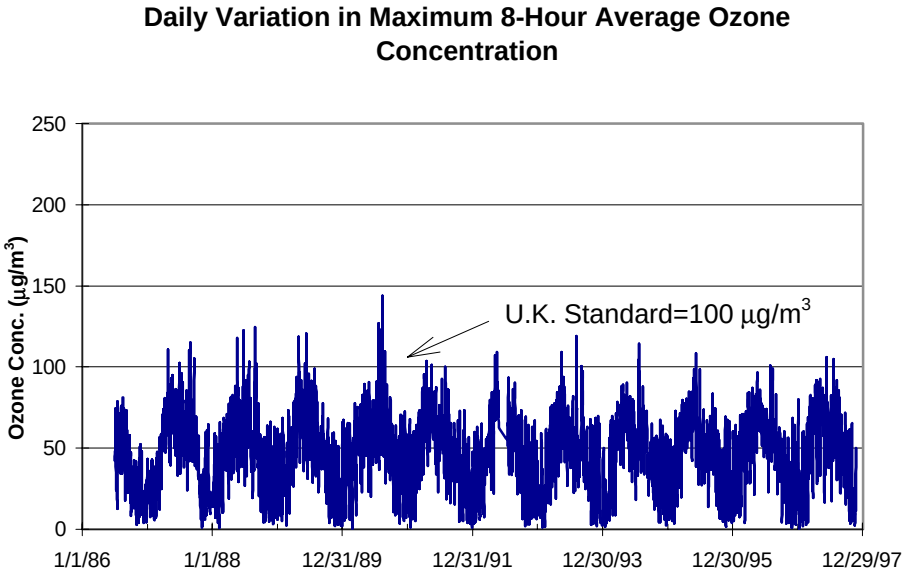


Figure 6.9 Sample plot showing daily variation in maximum 8-hour average ozone concentrations.

7. OZONE LEVELS IN BC

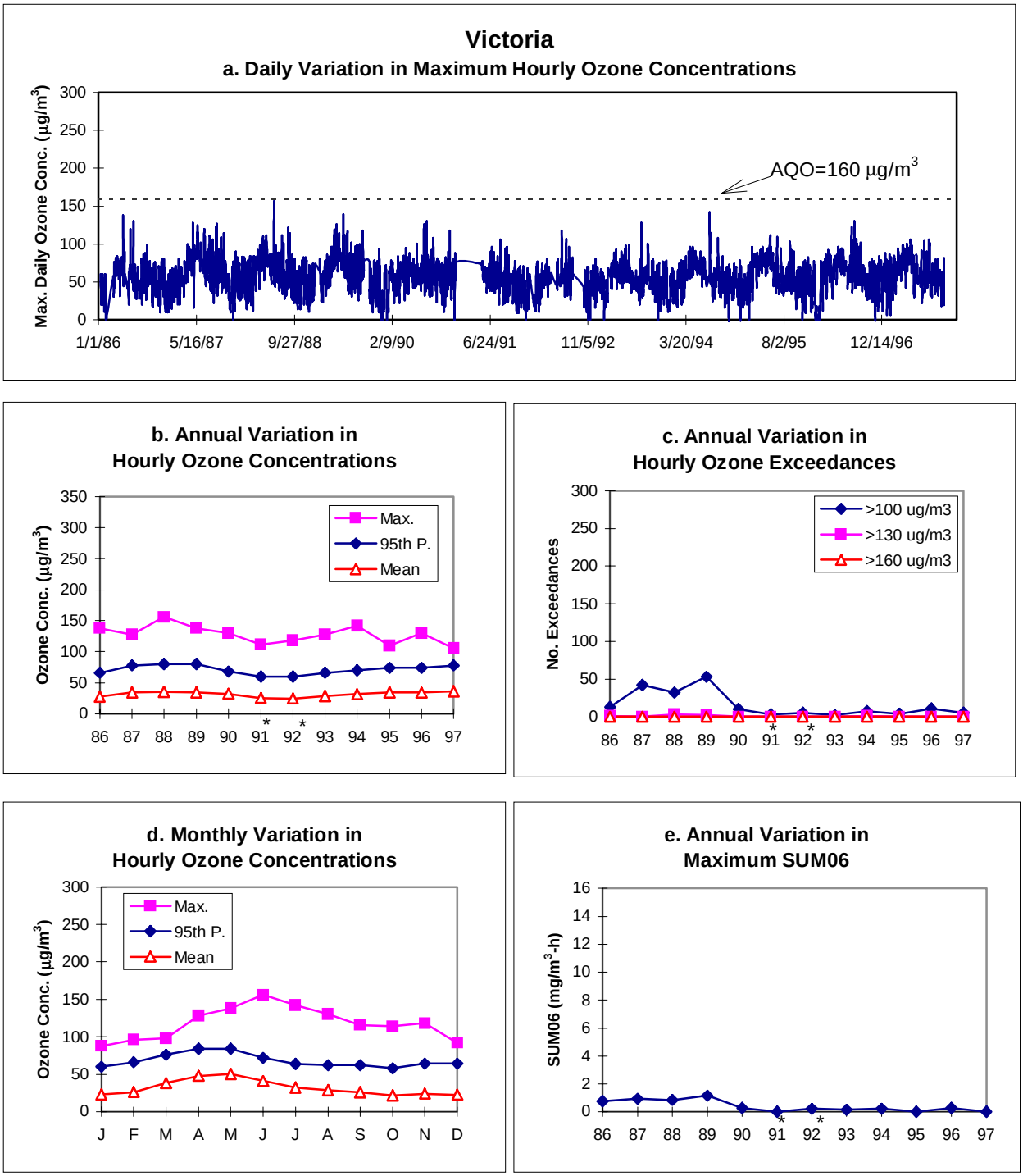
In the following, an overview of ozone levels measured between 1986-1997 at selected stations within the province is provided. The reader is referred to Section 6.3 for an explanation of the types of information contained within the figures shown. Site selection was generally based on data availability and, where more than one monitor was located in a community, on how well the site represented conditions throughout the community. It should be noted that although each monitoring station meets a set of minimum siting criteria set out by BC Environment, local differences exist in terms of a number of factors which will affect measurements: proximity to sources, local land use types, topography and meteorological conditions. Hence, care should be exercised in extending information from one point to an entire community, and in comparing measurements from one community to another.

7.1 VANCOUVER ISLAND

7.1.1 Victoria

Ambient ozone levels in Victoria were monitored at the Cook Street site from January 1976 to January 1983. The monitoring site at 1250 Quadra Street began operation in January 1983. This site was closed in October 1997, in preparation for relocation elsewhere in Victoria. Data collected between 1986-1997 are summarized in Figures 7.1 and 7.2. With the exception of 1991 and 1992, data capture was satisfactory over this 12-year period, although data collected in 1997 does not include measurements from November and December.

Daily variations in maximum hourly ozone concentrations are presented in Figure 7.1a. Seasonal and day-to-day variability were evident, but no extremely high values were observed. Annual trends in hourly concentrations, as shown in Figure 7.1b, indicate that while the highest concentrations were observed during the late 1980's, current levels appear to be approaching the earlier levels. Between 1987-1989, mean and 95th percentile concentrations ranged from 34-35 and 78-80 $\mu g / m^3$, respectively. In comparison,



* Less than 75% data capture.

Figure 7.1 Summary of ozone statistics, Victoria. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 µg / m^3. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

corresponding concentrations between 1994-1996 were 32-35 and 70-74 $\mu g / m^3$, respectively. The 95th percentile concentrations have steadily increased since 1993.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.1c. No exceedances of the air quality objective of 160 $\mu g / m^3$ were observed over the 12-year period. Since 1990, few exceedances of 100 $\mu g / m^3$ have been reported in any one year.

Monthly variations in hourly ozone concentrations are shown in Figure 7.1d. The highest concentrations were observed during June and August. A maximum of 156 $\mu g / m^3$ was reported in June 1988. On average, however, higher concentrations were reported during the spring months. Between April and May, mean concentrations were approximately 48-51 $\mu g / m^3$ and 95th percentile concentrations were 84 $\mu g / m^3$. The lowest levels were typically found between October and January, when mean concentrations were less than 25 $\mu g / m^3$ and 95th percentile concentrations ranged from 58-64 $\mu g / m^3$.

Maximum SUM06 values, which provide a measure of ozone exposure of vegetation during the growing season, are shown in Figure 7.1e. Although low throughout the 12-year period, the SUM06 values have hovered near zero since 1990.

Daily variations in the maximum 8-hour average concentrations are presented in Figure 7.2. Exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ ranged from 2 to 29 times between 1986-1990. No exceedances have been observed since 1991. The greatest number of exceedances (29) occurred in 1990, when 8-hour average concentrations reached 122 $\mu g / m^3$.

7.2 HOWE SOUND

7.2.1 Squamish

Ozone measurements have been made from the Squamish government building (2nd Street) since July 1995. Data collected between 1995 and 1997 are summarized in Figures 7.3 and 7.4. Data capture was satisfactory for both 1996 and 1997.

Daily variations in hourly ozone maxima are presented in Figure 7.3a and long-

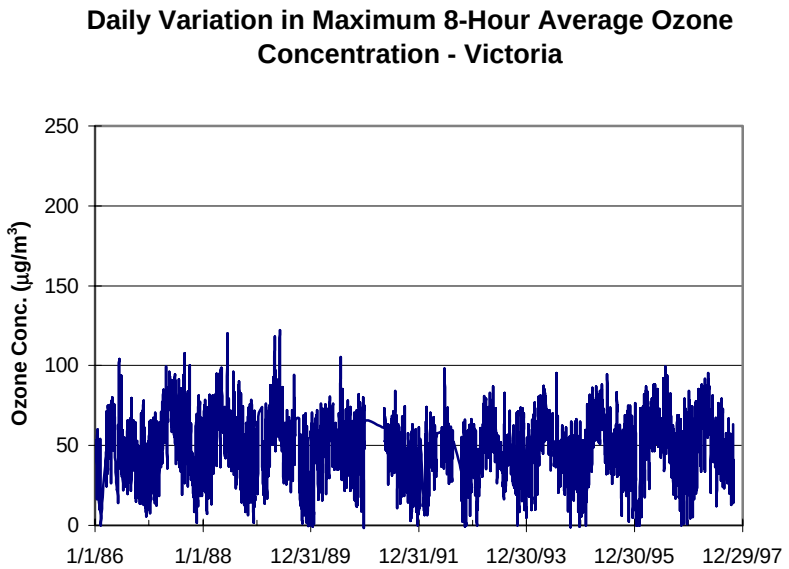


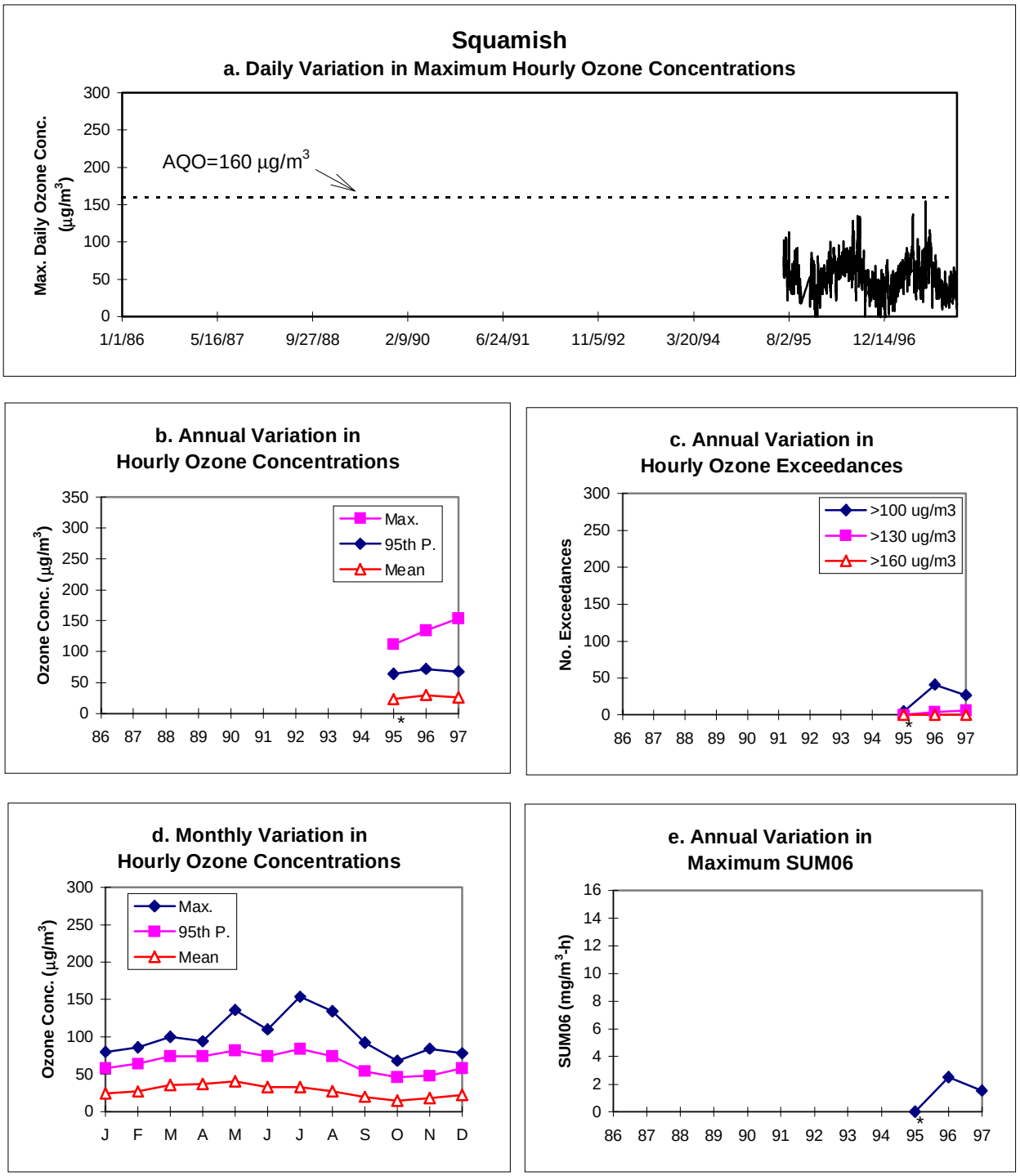
Figure 7.2 Daily variation in maximum 8-hour average ozone concentrations, Victoria.

term trends are shown in Figure 7.3b. Mean and 95th percentile concentrations were, respectively, 30 and 72 $\mu g / m^3$ in 1996, and 26 and 68 $\mu g / m^3$ in 1997. As shown in Figure 7.3c, no exceedances of the air quality objective of 160 $\mu g / m^3$ were observed. The maximum hourly concentration recorded at this site was 154 $\mu g / m^3$ in 1997. The annual number of exceedances of 100 $\mu g / m^3$ ranged from 27-41.

Monthly variations in hourly ozone concentrations are summarized in Figure 7.3d. The highest hourly concentrations (110-154 $\mu g / m^3$) were observed between May and August. In contrast, mean concentrations were highest between March and May (36-40 $\mu g / m^3$) and lowest between September and November (15-20 $\mu g / m^3$).

SUM06 values, which provide a measure of ozone exposure of vegetation during the growing season, are shown in Figure 7.3e. Maximum values did not exceed 3 mg / m^3-h during both 1996 and 1997.

Variations in the maximum daily 8-hour average concentration are shown in Figure 7.4. A maximum concentration of 133 $\mu g / m^3$ was reported in 1997. The U.K. standard of approximately 100 $\mu g / m^3$ was exceeded 25 times during 1996 and 15 times in 1997.



* Less than 75% data capture.

Figure 7.3 Summary of ozone statistics, Squamish. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

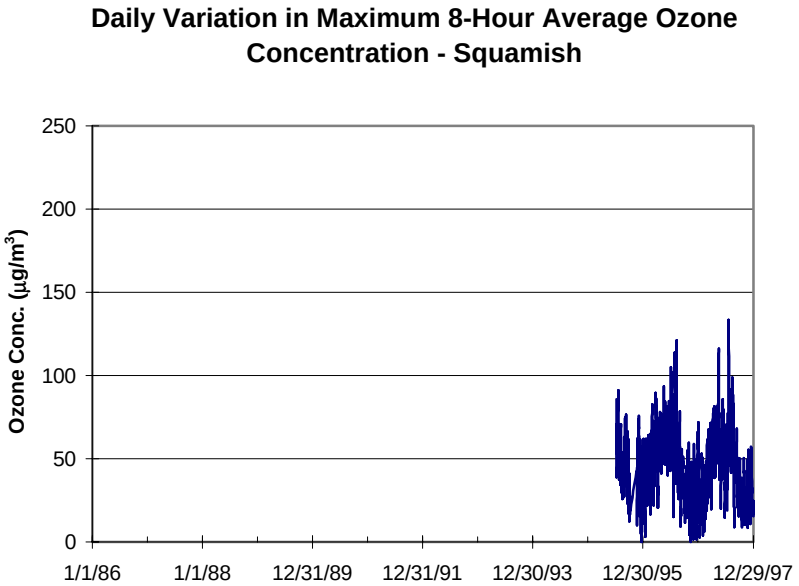


Figure 7.4 Daily variations in maximum 8-hour average ozone concentrations, Squamish.

7.3 LOWER MAINLAND REGION/GVRD

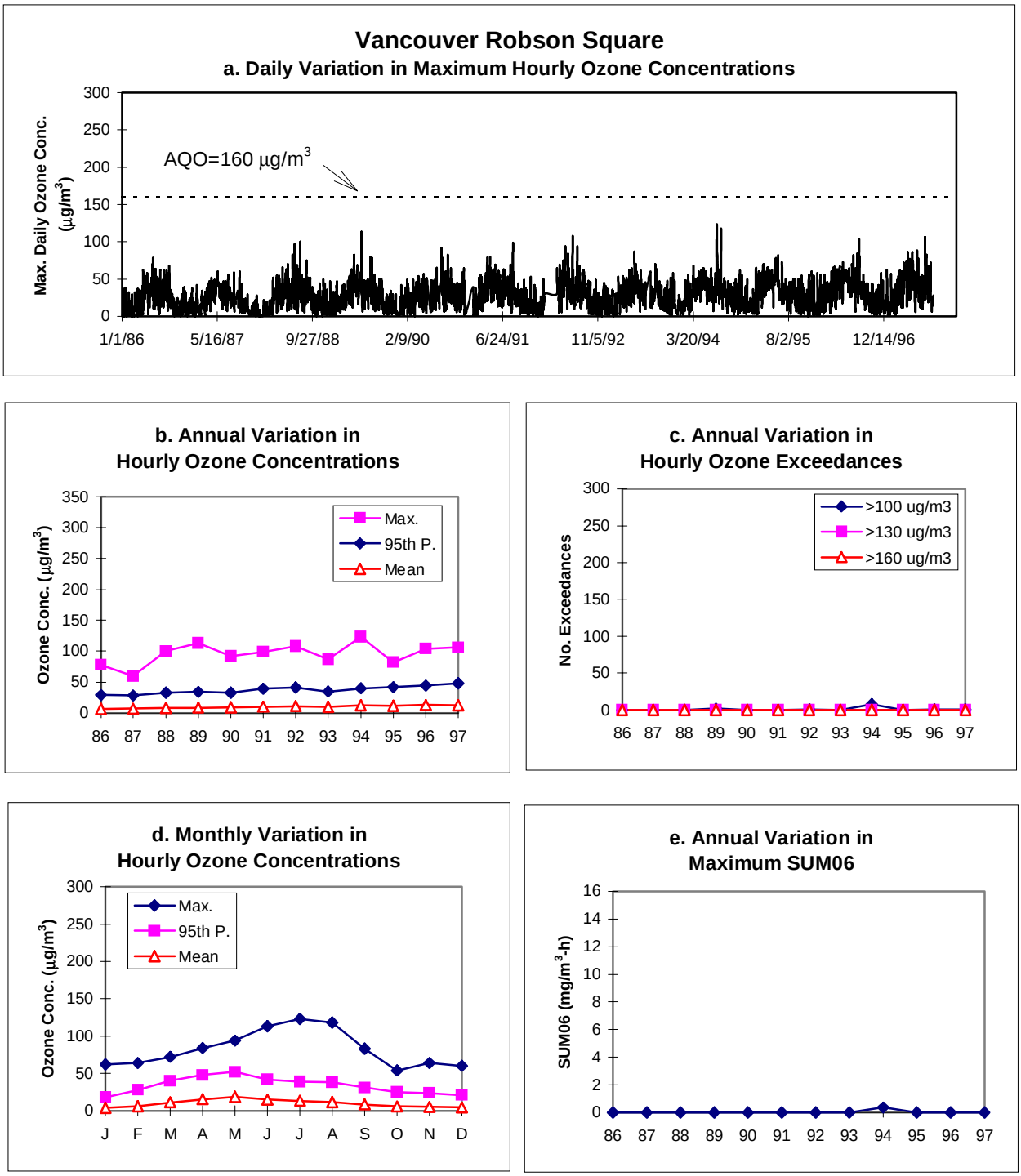
7.3.1 Vancouver (Robson Square)

Ozone concentrations have been monitored at Robson Square in Downtown Vancouver since August 1980. Data collected between 1986-1997 are summarized in Figures 7.5 and 7.6. Data capture was satisfactory throughout the 12-year period.

Daily variations in maximum hourly ozone concentrations are presented in Figure 7.5a. It is clear that ozone levels monitored at the Robson Square site do not exhibit as much variability as those found elsewhere in the LFV. This is likely a result of the large pool of NOx emissions from the motor vehicle sector in the downtown core, which results in the rapid destruction of local ozone.

Long-term trends presented in Figure 7.5b suggest that ozone levels may be increasing. Over the 12-year period, mean, 95th percentile and maximum concentrations ranged from 7-13 $\mu g / m^3$, 28-48 $\mu g / m^3$ and 60-123 $\mu g / m^3$, respectively. The highest mean concentrations were reported over the last four years.

The number of hours in which ozone concentrations exceeded 100, 130 and 160



* Less than 75% data capture.

Figure 7.5 Summary of ozone statistics, Vancouver Robson Square. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

$\mu g / m^3$ are summarized in Figure 7.5c. No exceedances of the air quality objective of 160 $\mu g / m^3$ were observed. Exceedances of 100 $\mu g / m^3$ were limited to the years 1989, 1992, 1994, 1996 and 1997.

Monthly variations in hourly ozone levels are presented in Figure 7.5d. Maximum concentrations were highest during July and August, with a maximum of 123 $\mu g / m^3$ reported in July 1994. On average, however, higher concentrations were reported in the spring. During the month of May, mean and 95th percentile concentrations were 19 and 52 $\mu g / m^3$, respectively. In contrast, the lowest levels were typically observed in December and January, with mean and 95th percentile concentrations of 4-5 $\mu g / m^3$ and 18-21 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.5e. Between 1986-1997, SUM06 values remained low, never exceeding 0.5 mg / m^3-h.

Figure 7.6 shows the daily variations in maximum 8-hour average ozone concentrations. Between 1986-1997, no exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ were observed.

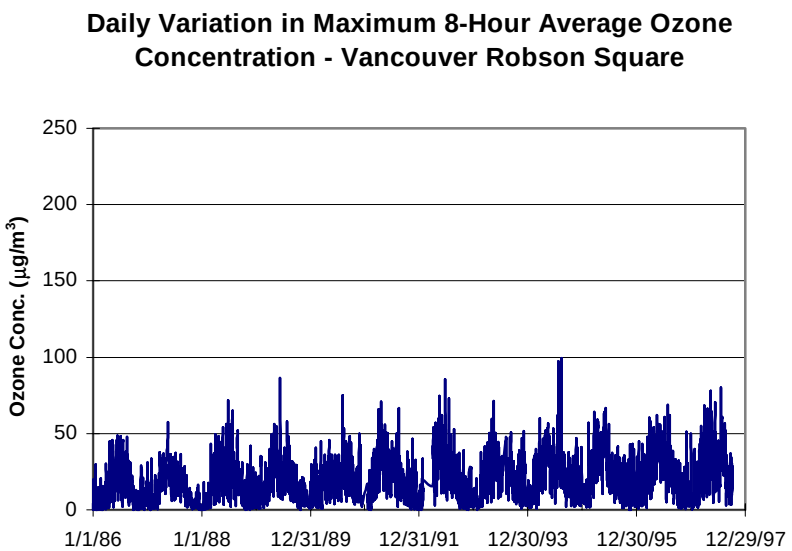


Figure 7.6 Daily variations in maximum 8-hour average ozone concentrations, Vancouver Robson Square.

7.3.2 Vancouver (Kitsilano)

Ozone levels have been monitored from the grounds of Kitsilano High School, on the west side of Vancouver, since August 1980. Data collected between 1986-1997 are summarized in Figures 7.7 and 7.8. With the exception of the first year, data capture was satisfactory.

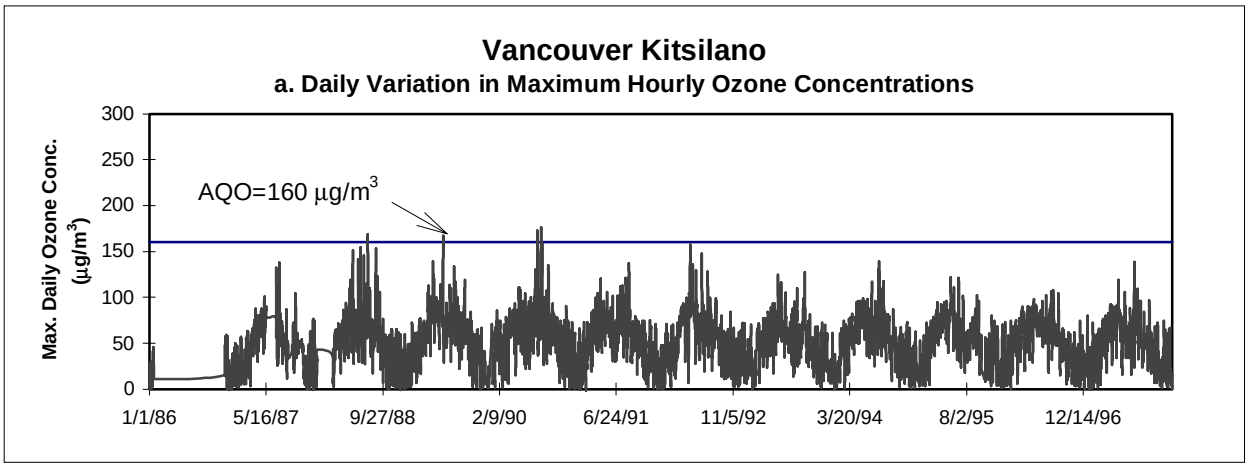
Maximum hourly ozone concentrations are plotted on a daily basis in Figure 7.7a. Long-term trends presented in Figure 7.7b show a decline in maximum concentrations over the 12-year period, while 95th percentile and mean concentrations have shown little change. Between 1987-1990, maximum, 95th percentile and mean concentrations ranged from 138-176 $\mu g / m^3$, 62-75 $\mu g / m^3$ and 17-23 $\mu g / m^3$, respectively. Between 1994-1997, corresponding values ranged from 108-138, 66-70 and 20-22 $\mu g / m^3$, respectively.

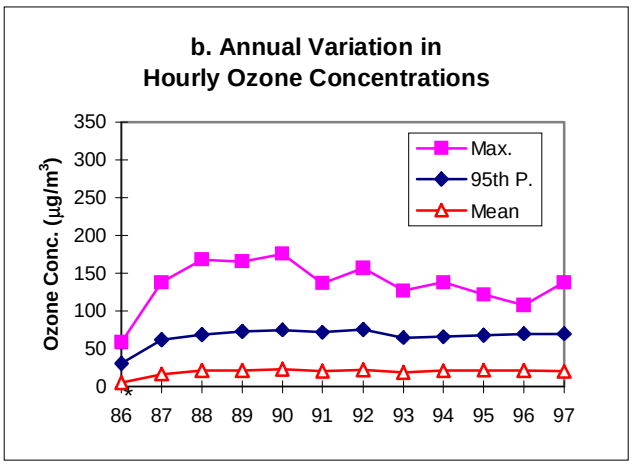
The number of hours in which ozone levels exceeded 100, 130 and 160 $\mu g / m^3$ are shown in Figure 7.7c. No exceedances of 160 $\mu g / m^3$ were reported outside of the period between 1988-1990. Exceedances of 100 $\mu g / m^3$ have generally declined since 1988, with the fewest number (8) occurring in 1996.

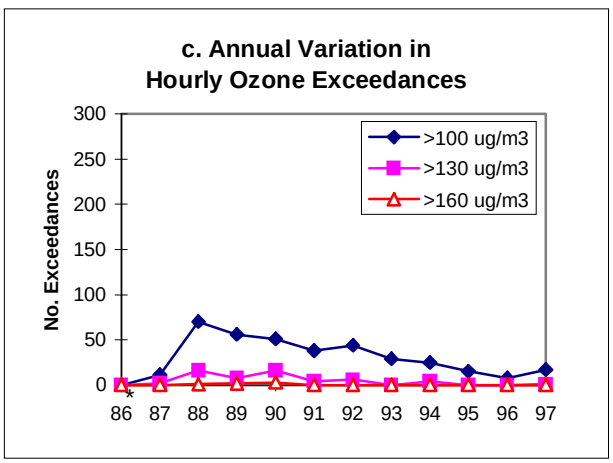
Monthly variations in hourly ozone levels are presented in Figure 7.7d. The highest hourly concentrations were observed in July and August, with a maximum concentration of 176 $\mu g / m^3$ reported in August 1990. On average, however, higher concentrations were reported during the spring months. Between April and May, mean and 95th percentile concentrations ranged from 32-38 $\mu g / m^3$ and 80-85 $\mu g / m^3$, respectively. In contrast, the lowest levels were typically observed between October and February, with mean and 95th percentile concentrations of 9-13 $\mu g / m^3$ and 41-54 $\mu g / m^3$, respectively.

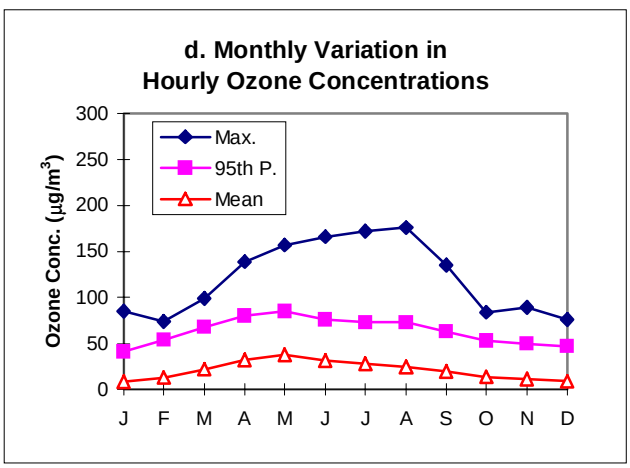
SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are presented in Figure 7.7e. SUM06 values were generally low, ranging from less than 0.1 to 3.5 mg / m^3-h. The lowest values were observed in 1996.

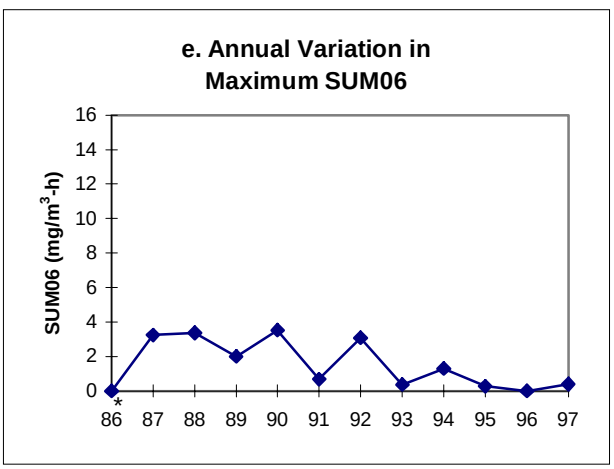
Figure 7.8 shows the daily variation in maximum 8-hour average concentrations. The highest concentration recorded between 1986-1997 was 146 $\mu g / m^3$ in 1990.











* Less than 75% data capture

Figure 7.7 Summary of ozone statistics, Vancouver Kitsilano. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

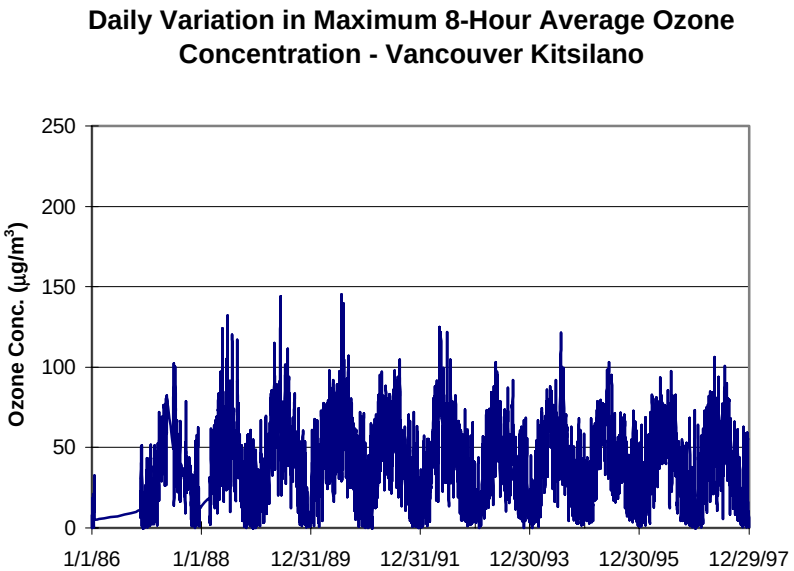


Figure 7.8 Daily variations in maximum 8-hour average ozone concentrations, Vancouver Kitsilano.

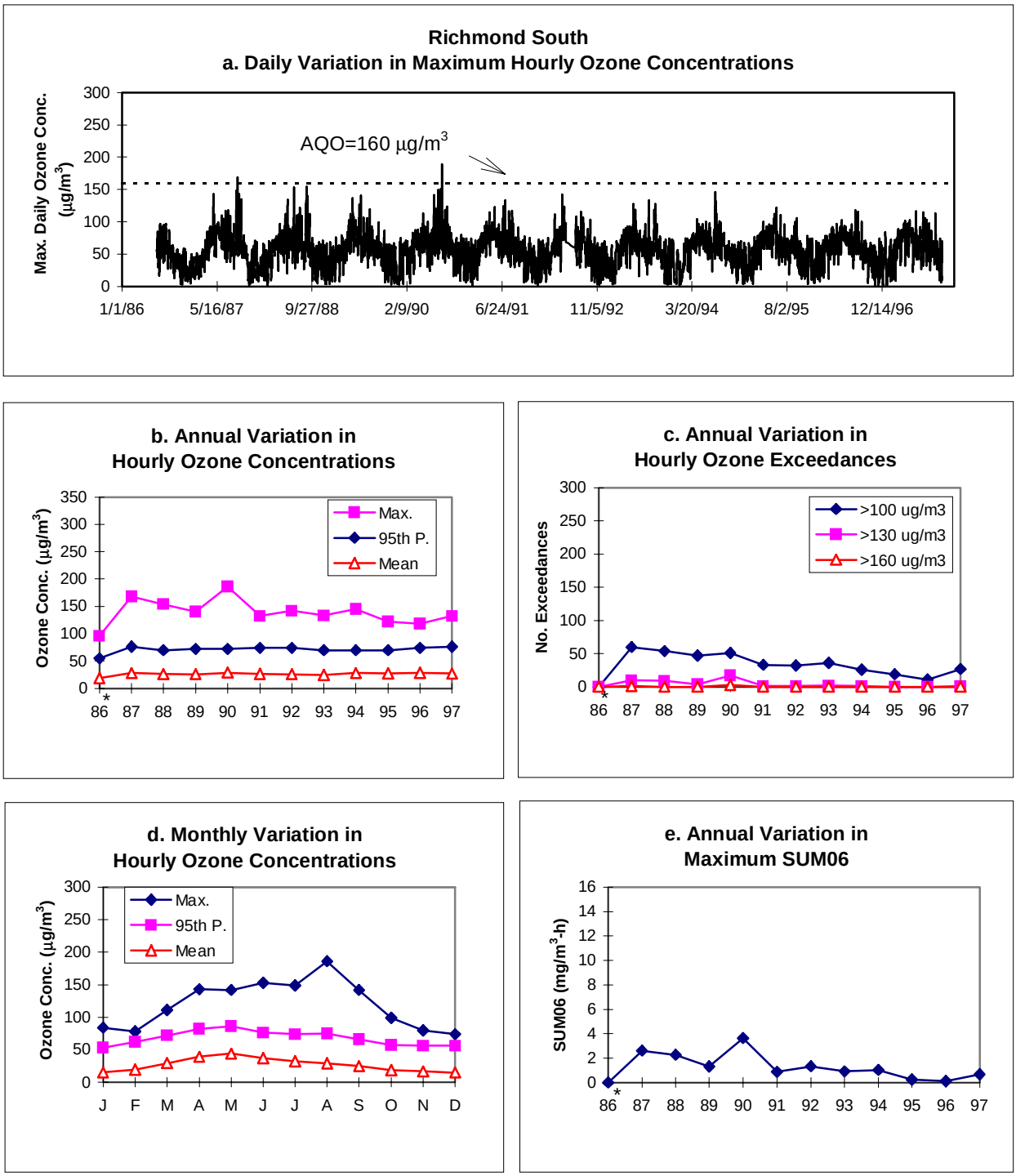
Exceedances of the U.K. 8-hour standard of approximately 100 $\mu g / m^3$ were observed every year with the exception of 1996. In both 1988 and 1990, a total of 25 exceedances were reported. In contrast, five or fewer exceedances have been observed since 1991.

7.3.3 Richmond

Ozone concentrations have been monitored in South Richmond since July 1986. Data collected between 1986-1997 are summarized in Figures 7.9 and 7.10. With the exception of 1986, data capture rates have been satisfactory.

Daily variations in maximum hourly ozone concentrations are shown in Figure 7.9a. Periods of elevated ozone levels in 1987 and 1990 are clearly evident. Long-term trends presented in Figure 7.9b indicate no consistent directional patterns. Between 1987-1997, annual mean concentrations ranged from 24-29 $\mu g / m^3$, 95th percentile concentrations from 70-76 $\mu g / m^3$ and maximum concentrations from 118-186 $\mu g / m^3$. Corresponding values in 1997 were 27, 76 and 132 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.9c. Exceedances of the air quality objective of 160



* Less than 75% data capture

Figure 7.9 Summary of ozone statistics, Richmond South. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

$\mu g / m^3$ occurred in 1987 (1) and 1990 (3). Between 1987 and 1996, the number of exceedances of 100 $\mu g / m^3$ generally declined, with the fewest exceedances (11) observed in 1996.

Monthly variations in hourly ozone levels are presented in Figure 7.9d. The highest hourly concentrations were observed between June and August, with a maximum of 186 $\mu g / m^3$ reported in August 1990. On average, however, higher concentrations were reported during the spring months. Between April and May, mean concentrations ranged from 39-44 $\mu g / m^3$ and 95th percentile concentrations ranged from 82-86 $\mu g / m^3$. The lowest levels were typically found between December and January, with mean and 95th percentile concentrations of about 15 and 53-56 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of the ozone exposure of vegetation during the growing season, are shown in Figure 7.9e. Between 1987-1997, maximum annual values were low, ranging from 0.2-3.6 mg / m^3-h. Maximum SUM06 values have not exceeded 1 mg / m^3-h since 1992.

Figure 7.10 shows daily maximum 8-hour average concentrations. The highest reported concentration was 143 $\mu g / m^3$ in 1990. The U.K. standard of approximately 100

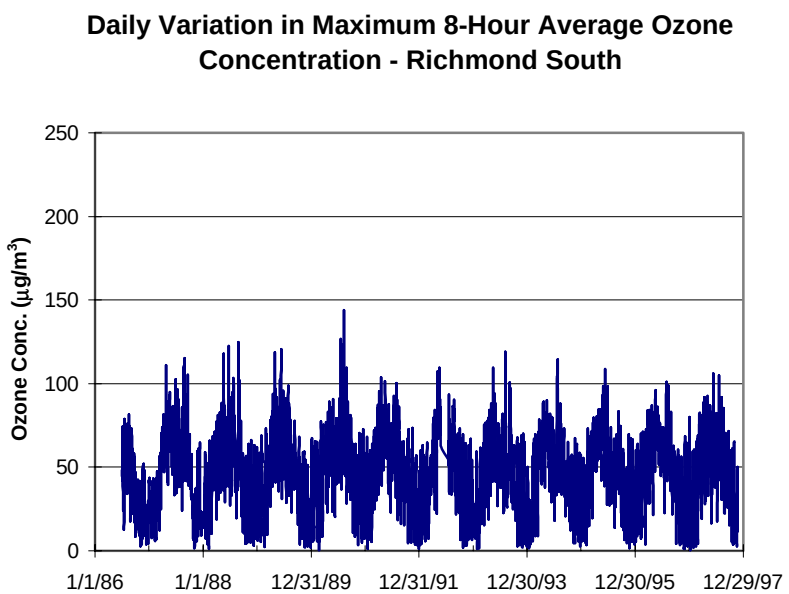


Figure 7.10 Daily variations in maximum 8-hour average ozone concentrations, Richmond.

$\mu g / m^3$ has been exceeded at least once a year since 1987, with the most exceedances (27) occurring in 1990.

7.3.4 North Delta

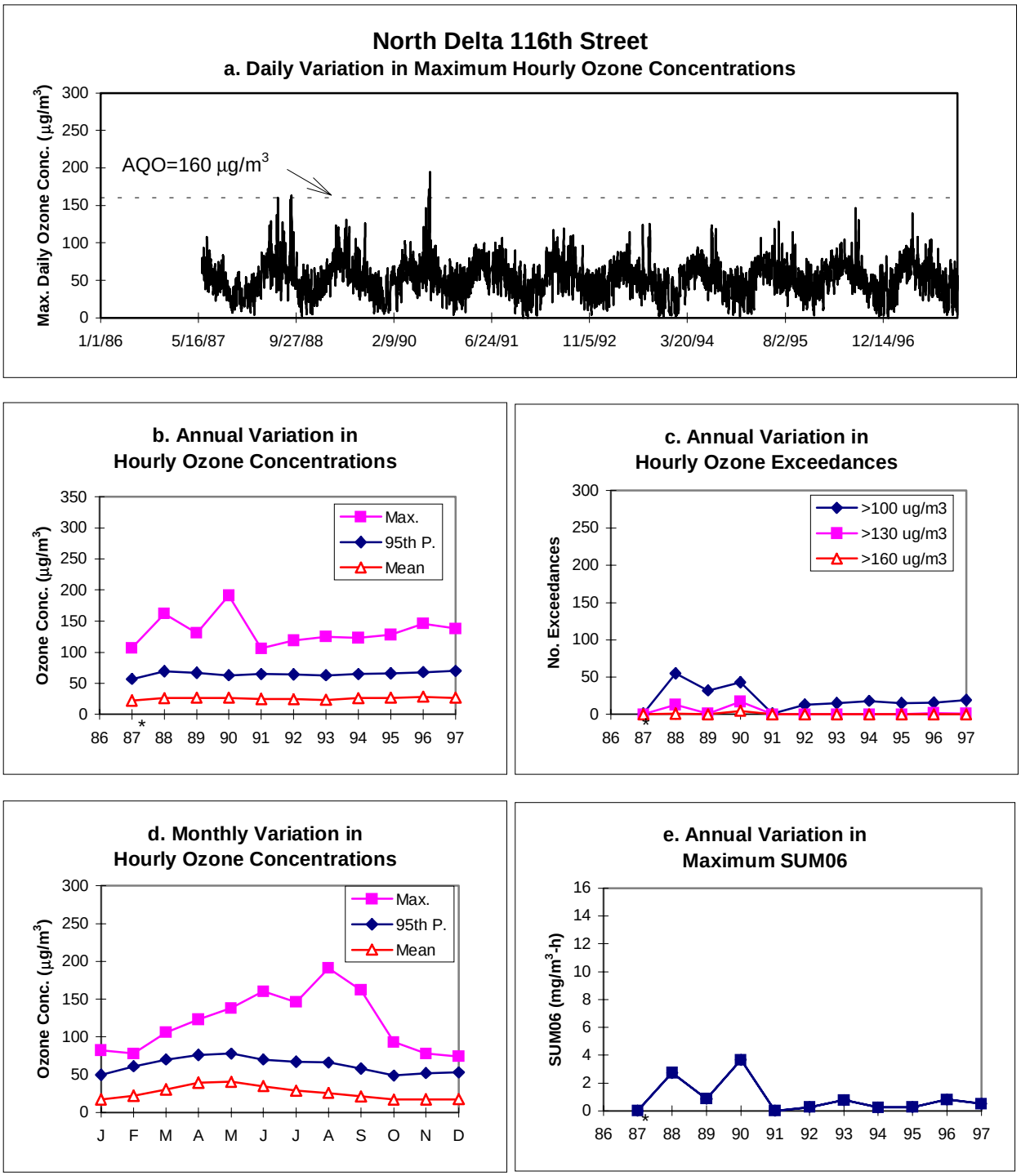
Ozone has been monitored from a site along 116th Street in North Delta since July 1987. Data are summarized in Figures 7.11 and 7.12. Data capture was satisfactory from 1988 onwards.

Daily variations in maximum hourly ozone concentrations are shown in Figure 7.11a. Periods of elevated ozone concentrations in 1988 and 1990 are clearly evident. Annual statistics presented in Figure 7.11b indicate that while the highest hourly concentrations were reported between 1988-1990, maximum concentrations have generally increased since 1991. Between 1988-1990, annual mean, 95th percentile and maximum concentrations ranged from 26-27 $\mu g / m^3$, 63-69 $\mu g / m^3$ and 131-191 $\mu g / m^3$, respectively. Between 1995-1997, corresponding values ranged from 27-29, 66-70 and 128-146 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.11c. Exceedances of the air quality objective of 160 $\mu g / m^3$ occurred in 1988 (1) and 1990 (5). Since this time, no further exceedances have been reported. Exceedances of 100 $\mu g / m^3$ have numbered less than 25 since 1991.

Monthly variations in hourly ozone levels are presented in Figure 7.11d. The highest hourly concentrations were observed between June and September, with a maximum of 191 $\mu g / m^3$ reported in August 1990. On average, however, higher concentrations were reported during the spring months. Between April and May, mean concentrations were approximately 39-41 $\mu g / m^3$ and 95th percentile concentrations were 76-78 $\mu g / m^3$. The lowest levels were typically found between October and January, with mean and 95th percentile concentrations of 17-18 $\mu g / m^3$ and 49-53 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.11e. Maximum annual values between 1988-



* Less than 75% data capture.

Figure 7.11 Summary of ozone statistics, North Delta. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

1997 were generally low, ranging from less than 0.1 to 3.7 mg/m^3-h. SUM06 values of 1 mg/m^3-h or lower have been reported since 1991.

Figure 7.12 shows the maximum daily 8-hour average concentrations. The highest reported concentration was 136 $\mu g/m^3$ in 1988. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ occurred during every year between 1987-1997, with the exception of 1991, 1992 and 1994. The most exceedances (31) occurred in 1988.

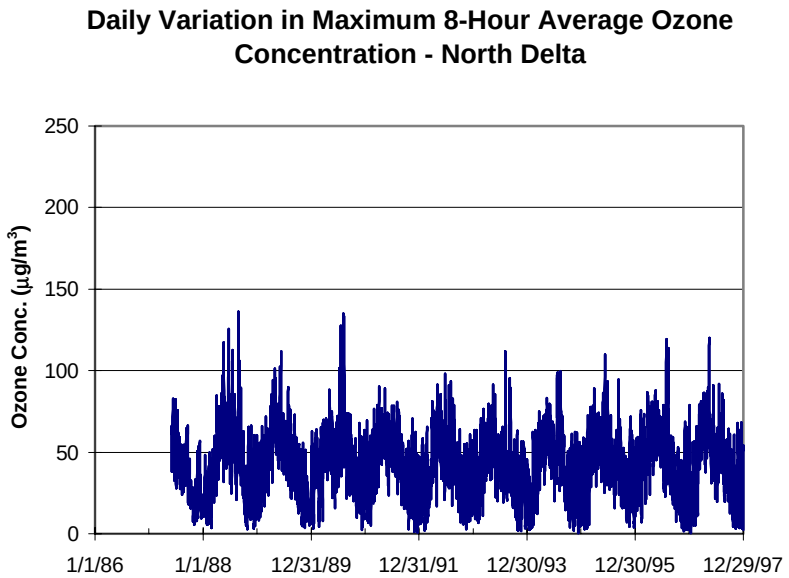
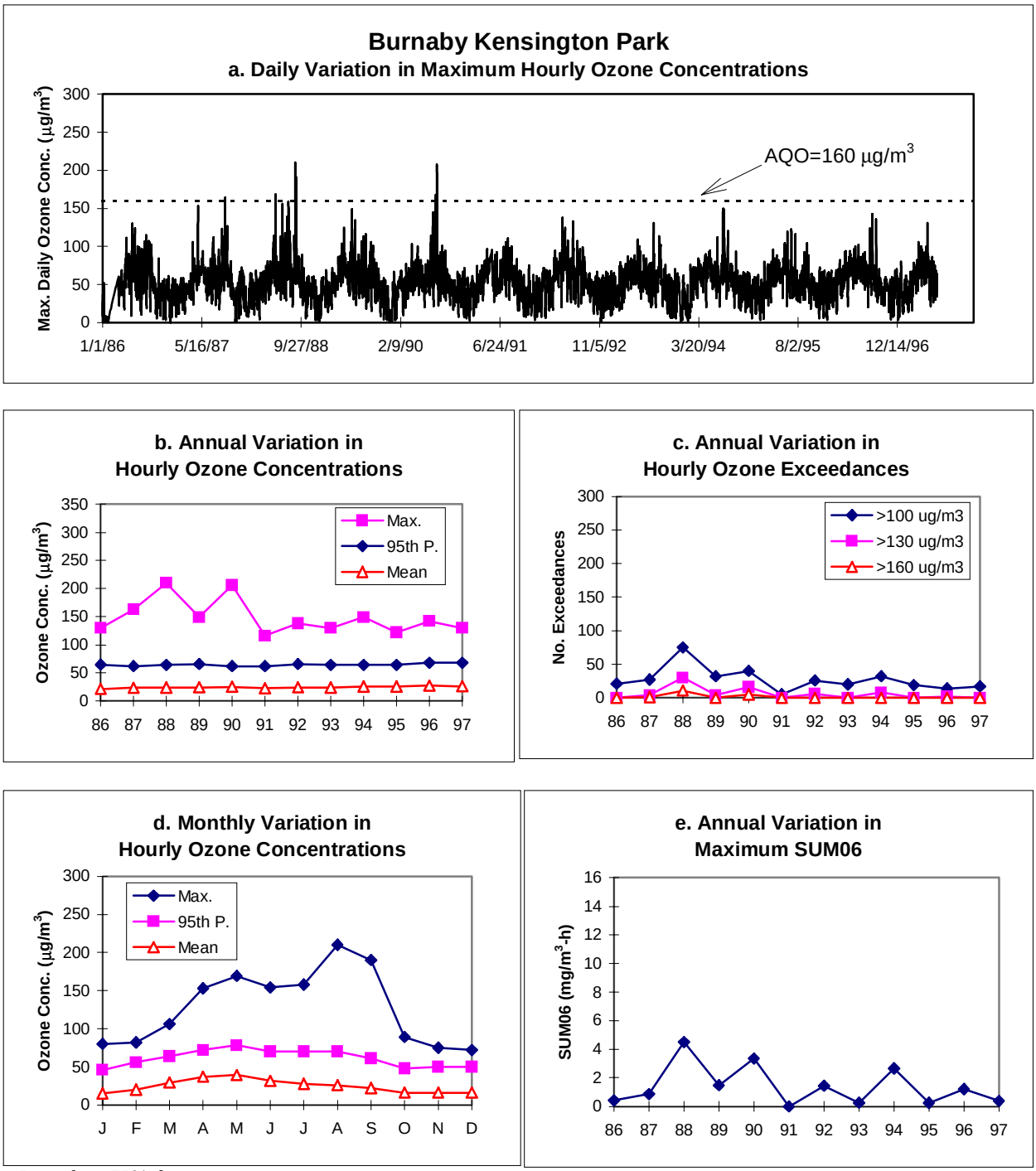


Figure 7.12 Daily variations in maximum 8-hour average ozone concentration, North Delta.

7.3.5 Burnaby

Ozone has been monitored at Kensington Park, Burnaby since August 1980. Data collected between 1986-1997 are summarized in Figures 7.13 and 7.14. Data capture was satisfactory throughout the 12-year period.

Daily variations in maximum hourly ozone concentrations are shown in Figure 7.13a. Periods of elevated ozone levels in 1987, 1988 and 1990 are clearly evident. Long-term trends are presented in Figure 7.13b. While maximum hourly concentrations appear to have decreased over the 12-year period, 95th percentile and mean concentrations have remained the same or increased slightly. Between 1987-1990, maximum, 95th percentile



* Less than 75% data capture

Figure 7.13 Summary of ozone statistics, Burnaby Kensington Park. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

and mean concentrations ranged from 149-210, 62-66 and 23-25 $\mu g / m^3$, respectively. Corresponding concentrations between 1994-1997 were 122-149, 64-68 and 26-28 $\mu g / m^3$.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.13c. Exceedances of the air quality objective of 160 $\mu g / m^3$ were limited to the years 1987, 1988 and 1990. The greatest number of exceedances (11) occurred in 1988. Annual exceedances of 100 $\mu g / m^3$ ranged from 5-75, with the greatest number occurring in 1988.

Monthly variations in hourly ozone levels are presented in Figure 7.13d. The highest hourly concentrations were observed between August and September, with a peak of 210 $\mu g / m^3$ reported in August 1988. On average, higher concentrations occurred during the spring months. Between April and May, mean and 95th percentile concentrations ranged from 37-39 $\mu g / m^3$ and 72-78 $\mu g / m^3$, respectively. In contrast, the lowest concentrations were typically observed between October and January, with mean and 95th percentile concentrations of 15-16 and 46-50 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.13e. SUM06 values were generally low, ranging from less than 0.1 to 4.5 mg / m^3-h. The maximum SUM06 value in 1997 was 0.4 mg / m^3-h.

Figure 7.14 summarizes the maximum daily 8-hour average concentrations between 1986-1997. A maximum concentration of 169 $\mu g / m^3$ was reported in 1988. Exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ occurred at least two times each year, with the exception of 1991, when no exceedances were observed. The most exceedances (47) occurred in 1988.

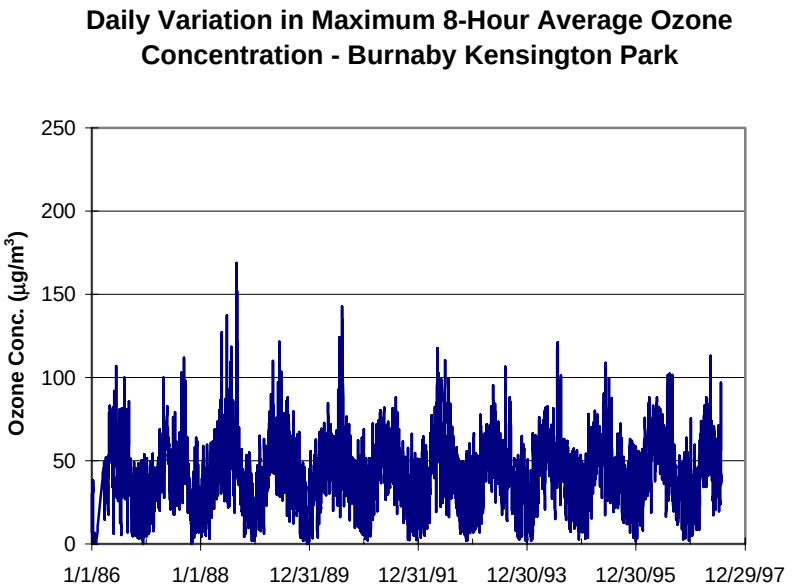


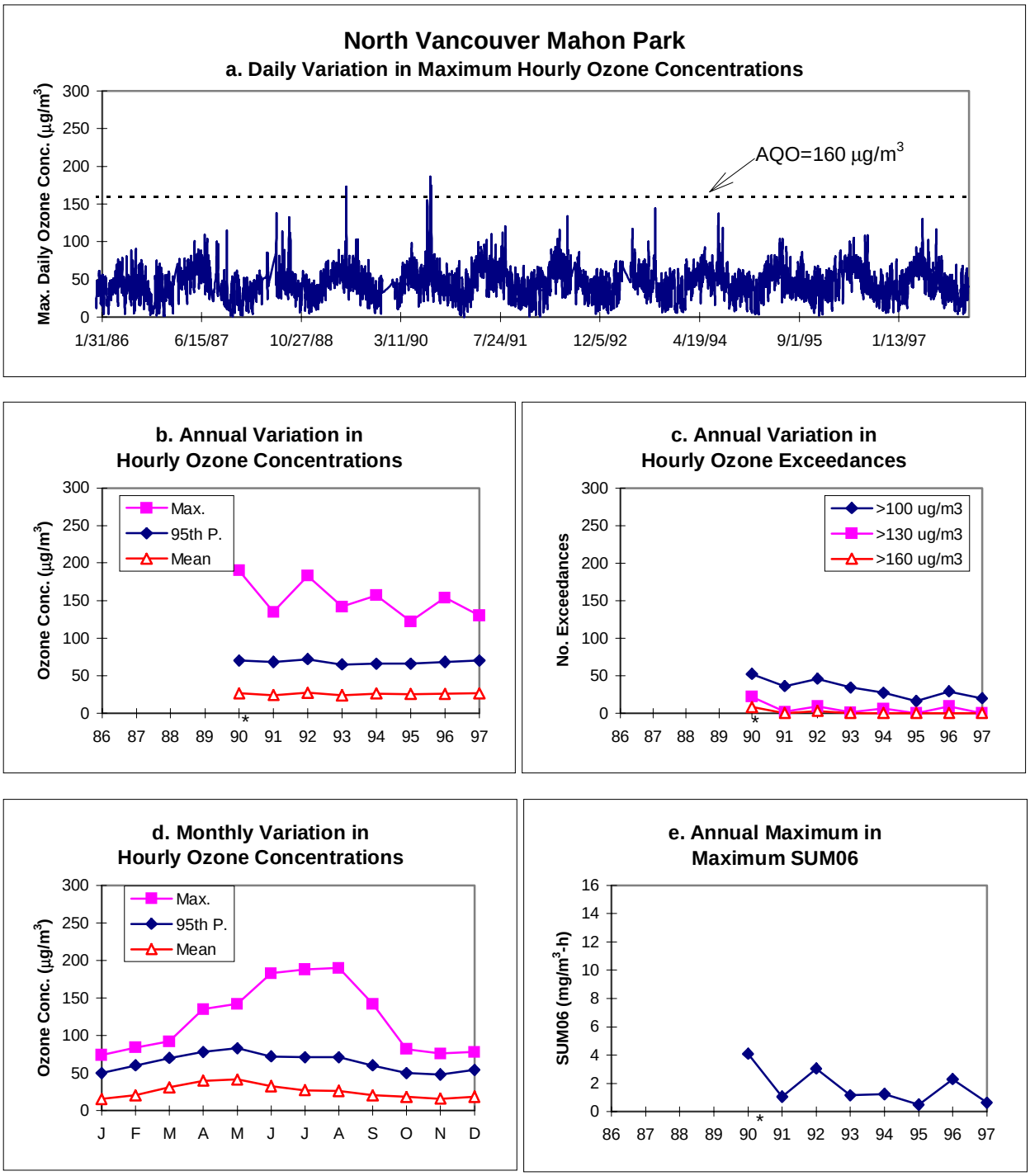
Figure 7.14 Daily variations in maximum 8-hour average ozone concentrations, Burnaby Kensington Park.

7.3.6 North Vancouver

Ozone has been monitored at Mahon Park in North Vancouver since April 1990. Data collected between 1990-1997 are summarized in Figures 7.15 and 7.16. Data capture was satisfactory in all years except 1990.

Daily variations in maximum hourly ozone concentrations are shown in Figure 7.15a. Periods of elevated ozone levels in 1990 and 1992 are clearly evident. Long-term trends are presented in Figure 7.15b. Between 1991-1997, mean, 95th percentile and maximum concentrations ranged from 24-27 $\mu g / m^3$, 65-72 $\mu g / m^3$ and 122-183 $\mu g / m^3$, respectively. The highest concentrations were reported in 1992, although mean and 95th percentile concentrations in 1997 were very close to 1992 levels.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.15c. No exceedances of the air quality objective of 160 $\mu g / m^3$ have been observed since 1992. Between 1991-1997, the number of exceedances of 100 $\mu g / m^3$ ranged from 16-46, with the fewest number occurring in 1995.



* Less than 75% data capture.

Figure 7.15 Summary of ozone statistics, North Vancouver Mahon Park. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g/m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

Monthly variations in hourly ozone levels are presented in Figure 7.15d. The highest concentrations were observed between June and August, with the maximum of 190 $\mu g / m^3$ occurring in August 1990. On average, however, higher concentrations were observed during the spring months. During April and May, mean and 95th percentile concentrations ranged from 40-42 $\mu g / m^3$ and 78-83 $\mu g / m^3$, respectively. In contrast, the lowest levels were observed between October and January, with mean and 95th percentile concentrations ranging from 15-18 $\mu g / m^3$ and 48-54 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.15e. SUM06 values were consistently low, ranging from 0.5-3.0 mg / m^3-h between 1991-1997. The maximum value in 1997 was 0.6 mg / m^3-h.

Figure 7.16 shows the maximum daily 8-hour average concentrations. The highest concentration reported was 159 $\mu g / m^3$ in 1990. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ were observed at least three times each year between 1990-1997. The most exceedances (26) occurred in 1990.

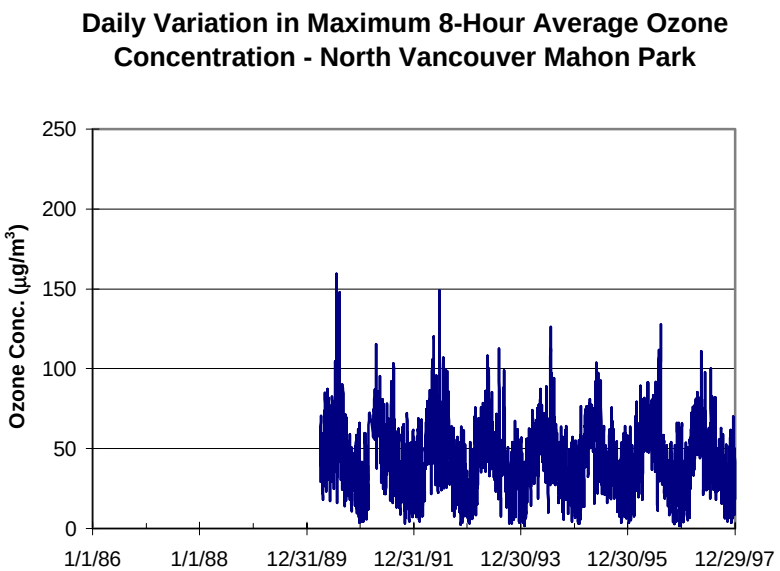


Figure 7.16 Monthly 8-hour average ozone concentrations, North Vancouver Mahon Park.

7.3.7 Port Moody

Ozone has been monitored at Rocky Point Park in Port Moody since August 1980. Data collected between 1986-1997 are summarized in Figures 7.17 and 7.18. Data capture at this site was satisfactory throughout the 12-year period.

Daily maximum ozone concentrations are shown in Figure 7.17a. Clearly, very high ozone levels have been observed at this site in the past, particularly between 1986-1990. Long-term trends presented in Figure 7.17b indicate that ozone levels in the 1990's have not approached the high levels reported in the late 1980's. Between 1986-1990, mean, 95th percentile and maximum hourly concentrations ranged from 22-24, 76-82 and 191-298 $\mu g / m^3$, respectively. In contrast, corresponding levels between 1993-97 ranged from 21-23, 70-72 and 156-172 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.17c. Exceedances of the air quality objective of 160 $\mu g / m^3$ have occurred at least once each year, with the exception of 1991, 1993 and 1995-1997, when no exceedances were reported. The most exceedances (42) occurred in 1988. The number of exceedances of 100 $\mu g / m^3$ ranged from 17-228, with the most occurring in the late 1980's and the fewest occurring in 1997.

Monthly variations in hourly ozone concentrations are presented in Figure 7.17d. The highest concentrations were observed during the summer months, with a maximum of 298 $\mu g / m^3$ reported in August 1988. The 95th percentile concentrations peaked between May and August at levels of 88-90 $\mu g / m^3$. Mean concentrations were typically highest during the late spring, with concentrations between April and June ranging from 34-38 $\mu g / m^3$. In contrast, the lowest ozone levels were observed between November and January, with mean and 95th percentile concentrations of 9-11 and 40-46 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.17e. While maximum SUM06 values during 1988-1990 were very high, ranging from 8-16 mg / m^3-h, values have not exceeded 5

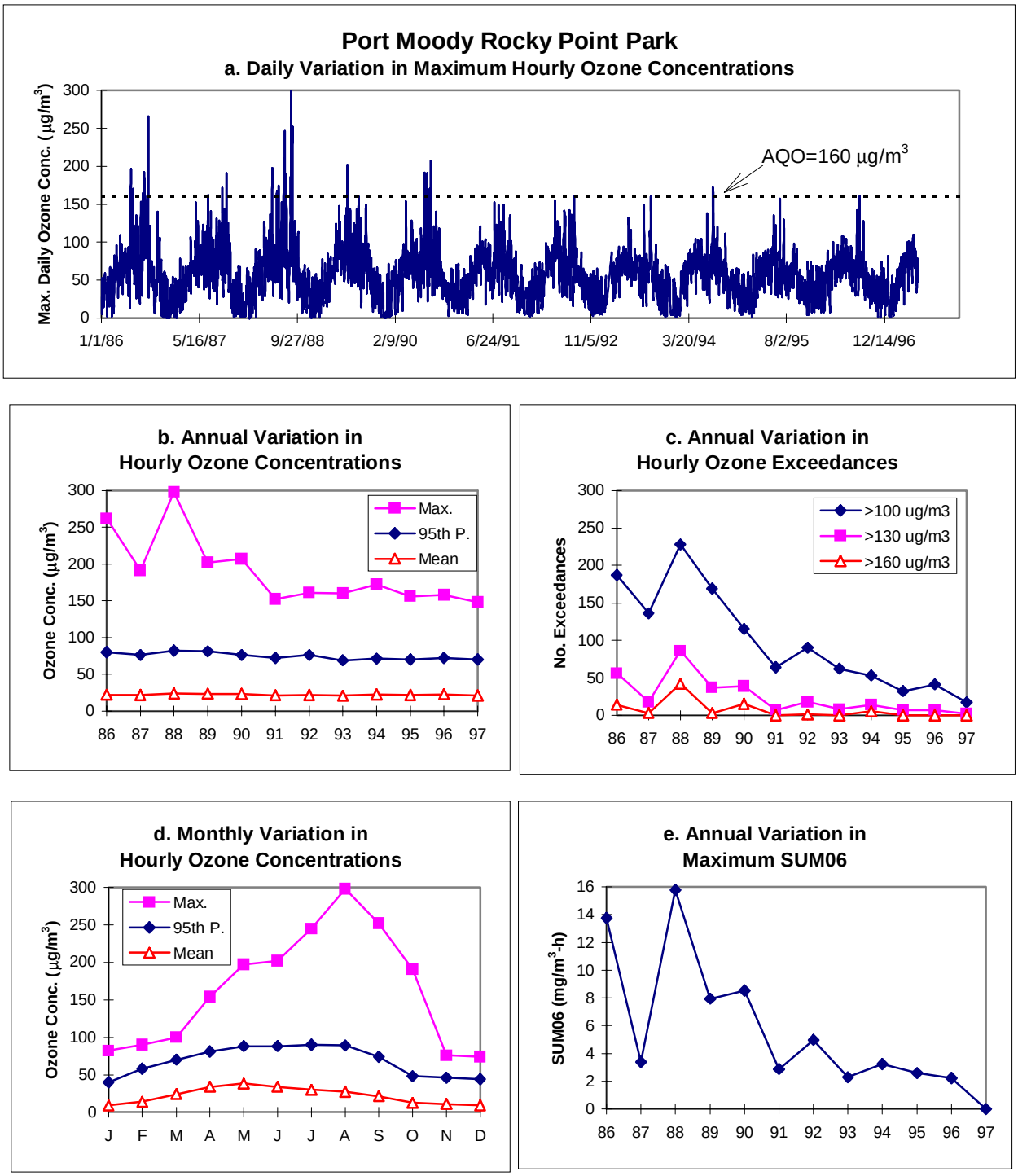


Figure 7.17 Summary of ozone statistics, Port Moody Rocky Point Park. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

mg/m^3-h since 1991.

Figure 7.18 presents the maximum daily 8-hour average concentrations. The highest reported concentration was 235 $\mu g/m^3$ in 1988. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ were recorded at least 6 times each year between 1986-1997. The most exceedances (149) occurred in 1988.

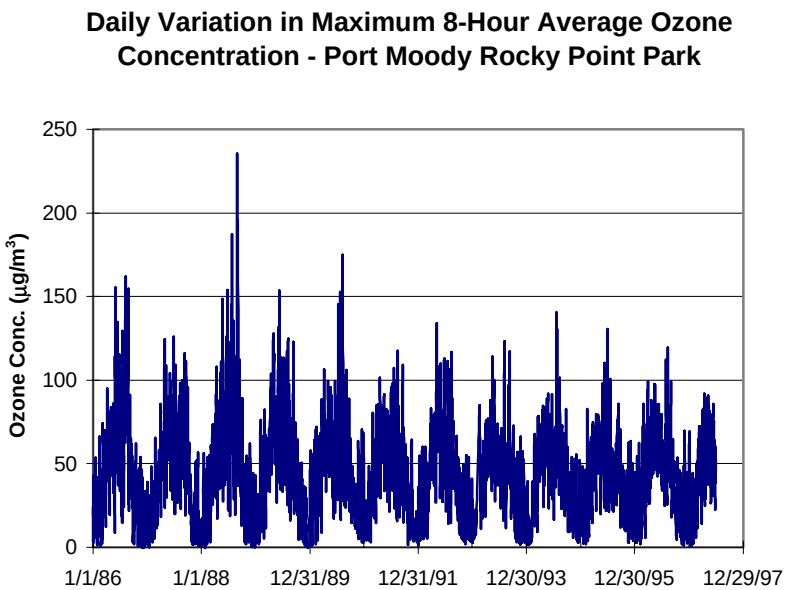
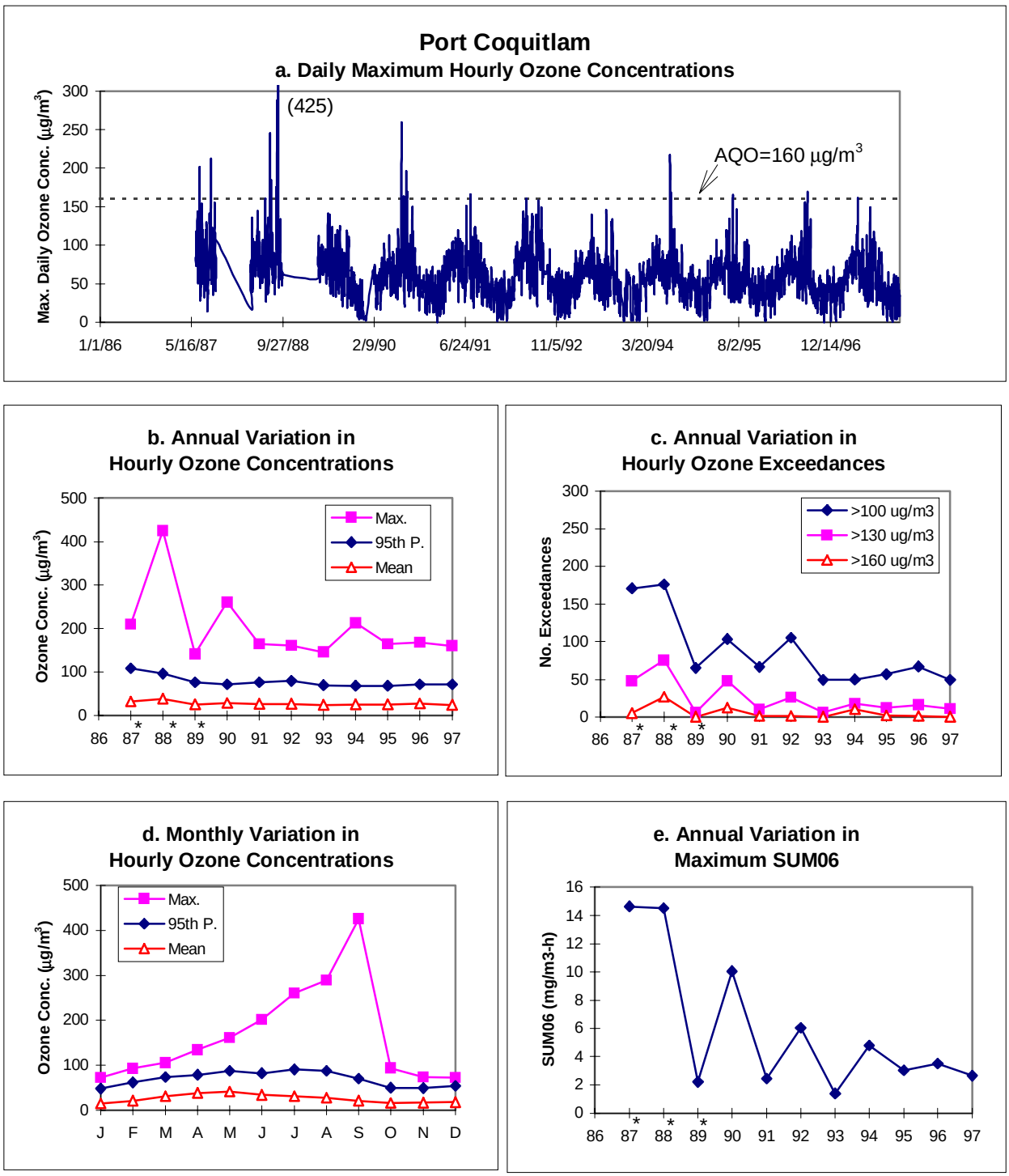


Figure 7.18 Monthly maximum 8-hour average ozone concentrations, Port Moody Rocky Point Park.

7.3.8 Port Coquitlam

Ozone concentrations have been monitored in Port Coquitlam (at the corner of Hamilton and Paisley) since October 1987. Initially, monitoring was limited to the summer "ozone" months. Monitoring has been conducted on a year-round basis since 1990. Data capture since this time has been satisfactory. Data collected between 1987-1997 are summarized in Figures 7.19 and 7.20.

Daily variations in the maximum hourly ozone concentration are shown in Figure 7.19a. Very high ozone concentrations were observed at this site in the past, as evident in 1987-88, 1990 and 1994. Long-term trends are shown in Figure 7.19b. Clearly, while



* Less than 75% data capture.

Figure 7.19 Summary of ozone statistics, Port Coquitlam. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

recent concentrations have not approached 1988 levels, very high concentrations (>200 $\mu g / m^3$) have occurred as recently as 1994. Due to the seasonal monitoring prior to 1990, mean and 95th percentile concentrations from this period are likely biased on the high side. Between 1990-97, mean and 95th percentile concentrations ranged from 24-28 $\mu g / m^3$ and 68-79 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.19c. Exceedances of the air quality objective of 160 $\mu g / m^3$ were observed during every year except 1989, 1993 and 1997. The most exceedances (27) occurred in 1988. The number of exceedances of 100 $\mu g / m^3$ ranged from 49-176, with the most occurring in 1987 and 1988.

Monthly variations in hourly ozone levels are presented in Figure 7.19d. Concentrations in excess of 160 $\mu g / m^3$ were observed during the months of May to September, with the highest concentration of 425 $\mu g / m^3$ recorded in September 1988. The 95th percentile concentrations also peaked during the late spring / summer, with levels ranging from 82-91 $\mu g / m^3$ between May and August. Mean concentrations were highest between April and May, with concentrations ranging from 39-41 $\mu g / m^3$. In contrast, the lowest levels were observed between October and January, with mean and 95th percentile concentrations ranging from 15-18 $\mu g / m^3$ and 48-54 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.19e. The highest levels were reported in 1987-1988, when maximum values ranged from 14-15 mg / m^3-h. These values are in excess of the levels expected to protect 95% of crops (11.6 mg / m^3-h). However, in recent years, SUM06 values have been moderately low, averaging 3 mg / m^3-h between 1995-1997.

Maximum daily 8-h average concentrations are shown in Figure 7.20. The highest reported concentration was 237 $\mu g / m^3$ in 1988. The U.K. standard of approximately 100 $\mu g / m^3$ was exceeded at least ten times each year between 1987-1997. The most exceedances (112) occurred in 1988.

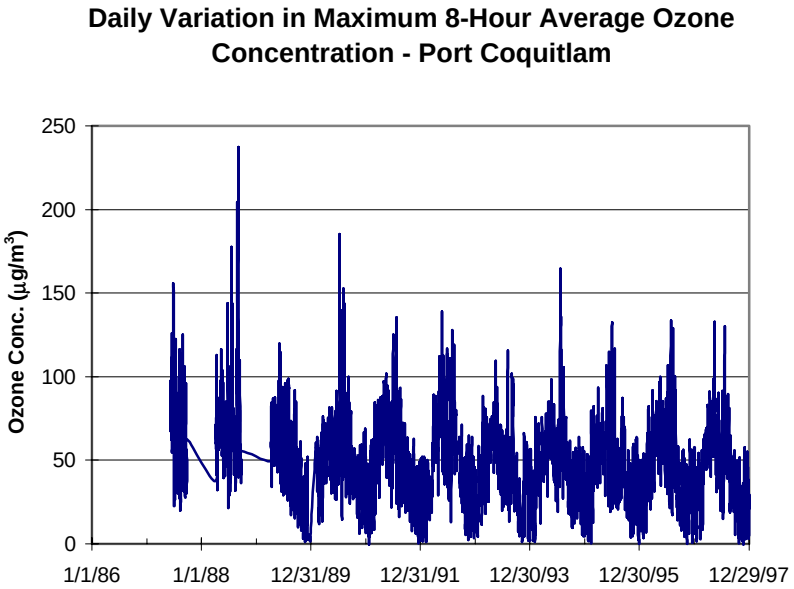


Figure 7.20 Daily variations in maximum 8-hour average ozone concentrations, Port Coquitlam.

7.3.9 Surrey

Ozone monitoring has been conducted at the Surrey East site (19000 block of 72nd Avenue) since January 1984. Data collected between 1986-1997 are summarized in Figures 7.21 and 7.22. Data capture during this period was satisfactory.

Daily variations in maximum hourly ozone concentrations are plotted against time in Figure 7.21a. Clearly, very high concentrations were observed in 1988 and 1990. Long-term trends are shown in Figure 7.21b. Over the 12-year period, mean and 95th percentile concentrations ranged from 30-37 $\mu g / m^3$ and 71-90 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.21c. Exceedances of the air quality objective of 160 $\mu g / m^3$ ranged from 0-30 hours per year, whereas exceedances of 100 $\mu g / m^3$ ranged from 52-229 hours per year. In both cases, the most exceedances occurred in 1988.

Monthly variations in hourly ozone levels are presented in Figure 7.21d. The highest concentrations were observed between May and September, with a maximum of 317 $\mu g / m^3$ reported in September 1988. The 95th percentile concentrations were

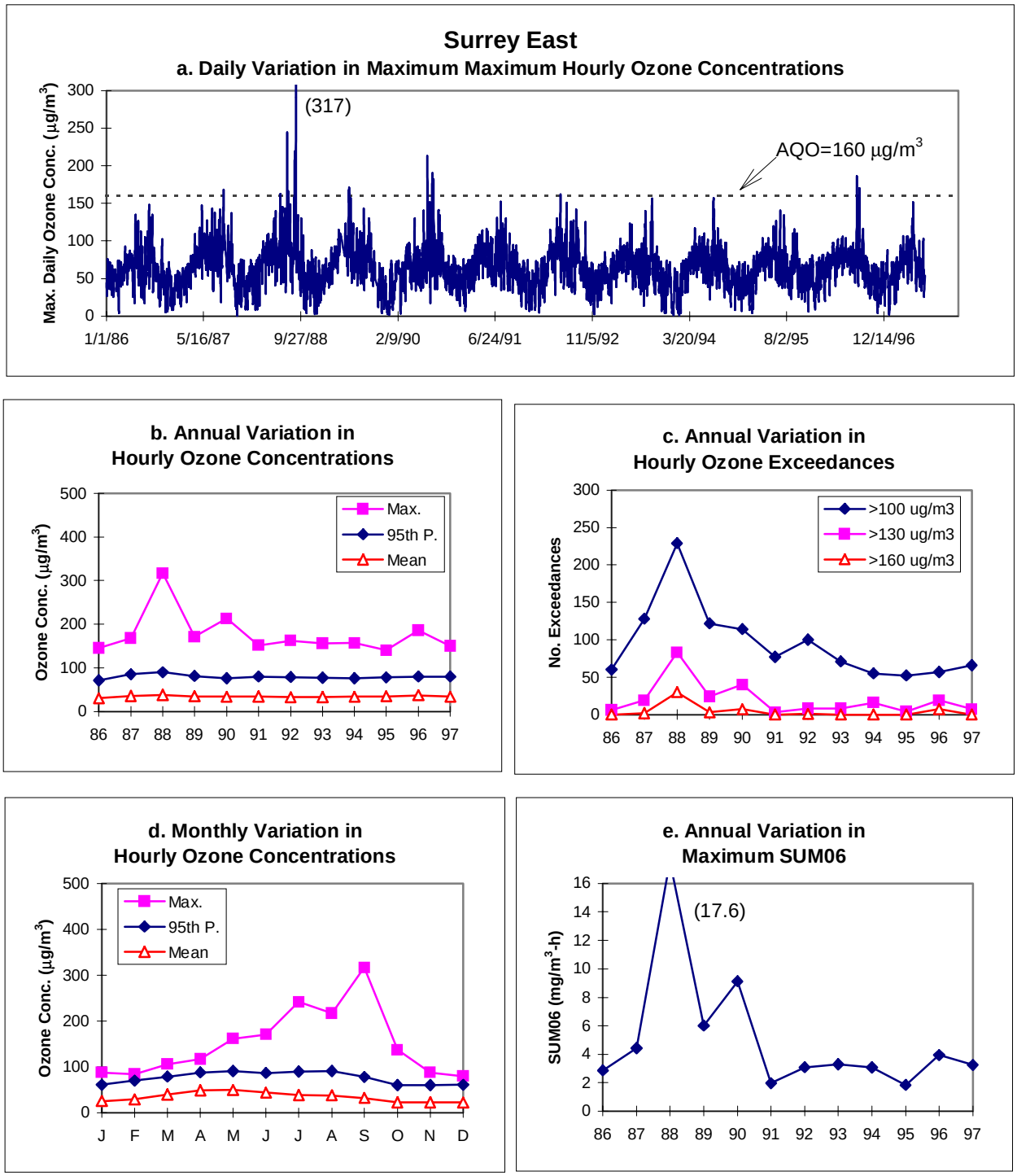


Figure 7.21 Summary of ozone statistics, Surrey East. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

highest between April and August, with values ranging from 87-91 $\mu g / m^3$, while mean concentrations peaked between April and May, with values ranging from 49-50 $\mu g / m^3$. The lowest concentrations were found between October and December, when mean and 95th percentile concentrations were 22-23 $\mu g / m^3$ and 60-61 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.21e. SUM06 values have ranged from low to very high, with annual maxima varying from 1.8-17.6 mg / m^3-h. However, values have not exceeded 5 mg / m^3-h since 1990. In 1997, the maximum SUM06 value recorded was 3.2 mg / m^3-h.

Daily maximum 8-hour average concentrations are presented in Figure 7.22. A maximum concentration of 199 $\mu g / m^3$ was reported in 1988. The U.K. standard of approximately 100 $\mu g / m^3$ was exceeded at least 23 times during any one year. The most exceedances (158) occurred in 1988.

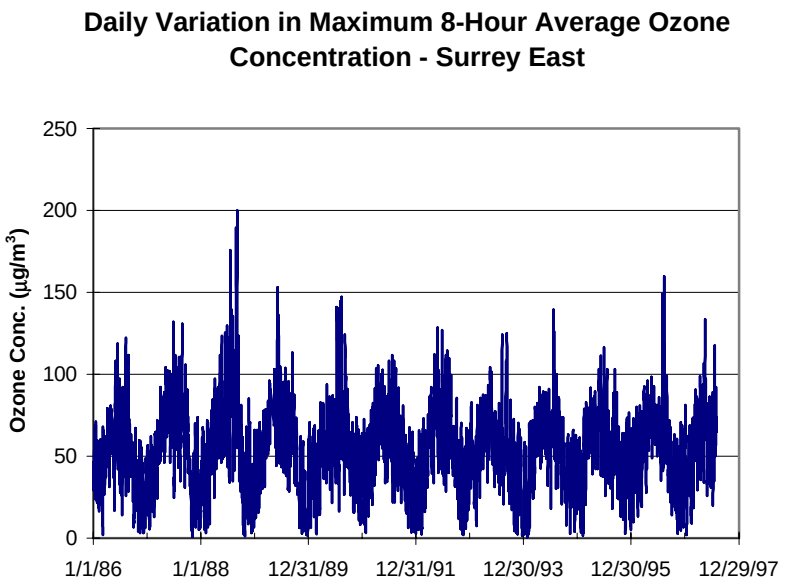


Figure 7.22 Daily variations in maximum 8-hour average ozone concentrations, Surrey.

7.3.10 Langley

An ozone monitor has been located at the Langley Central site since January 1994. Earlier measurements were made at the Langley Peterson School. Data from the Central site are summarized in Figures 7.23 and 7.24. Data capture over the past four years has been satisfactory.

Daily variations in maximum hourly ozone concentrations are presented in Figure 7.23a. Elevated levels were observed in both 1994 and 1996. Long-term trends are shown in Figure 7.23b. Mean and 95th percentile concentrations ranged from 37-41 and 82-83 $\mu g / m^3$ during the four-year period. Maximum hourly concentrations ranged from 158-188 $\mu g / m^3$.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.23c. Exceedances of the air quality objective of 160 $\mu g / m^3$ occurred at least once each year, with the exception of 1997, when maximum concentrations reached 158 $\mu g / m^3$. The number of exceedances of 100 $\mu g / m^3$ declined from 114 in 1994 to 84 in 1997.

Monthly variations in hourly ozone concentrations are summarized in Figure 7.23d. The highest maximum (188 $\mu g / m^3$) and 95th percentile concentrations (98 $\mu g / m^3$) occurred during the month of July. The highest mean concentrations (51 $\mu g / m^3$) were found between April and May.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.23e. Maximum values were moderately low, ranging from 3.5-6.1 mg / m^3-h.

Maximum daily 8-hour average concentrations are presented in Figure 7.24. A maximum concentration of 160 $\mu g / m^3$ was reported in 1994. Exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ ranged from 38-53, with the most number occurring in 1994.

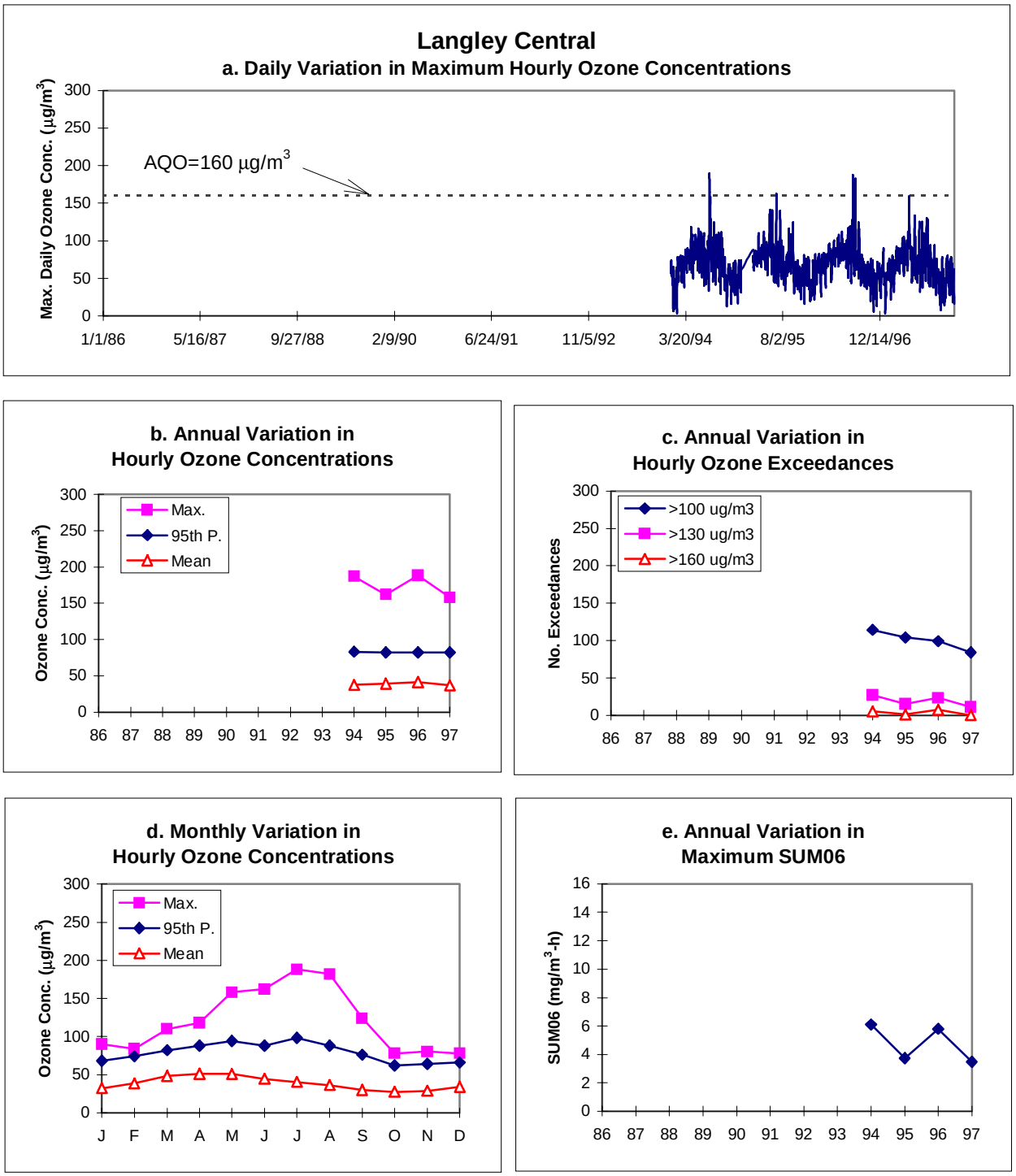


Figure 7.23 Summary of ozone statistics, Langley Central. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

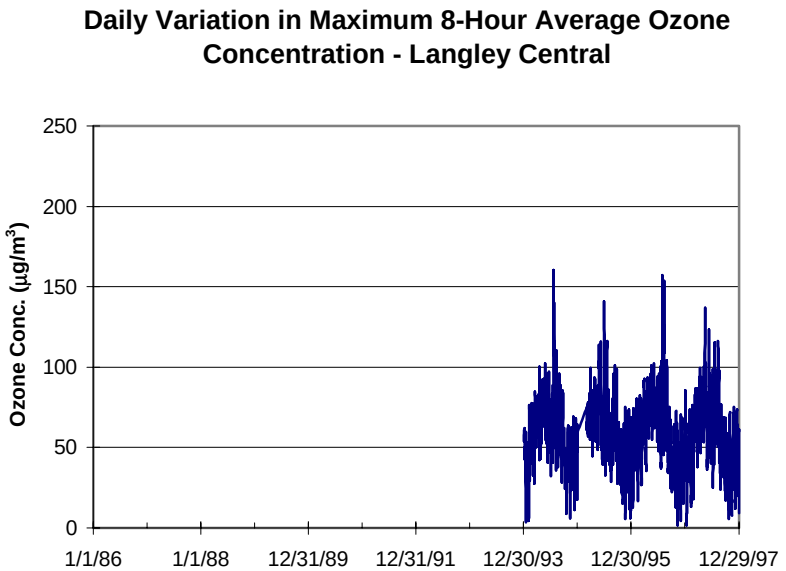


Figure 7.24 Maximum monthly 8-hour average ozone concentrations, Langley.

7.3.11 Abbotsford

Ozone has been monitored from the site of the Abbotsford Public Library since February 1992. Earlier measurements were made at the Abbotsford Airport. Data from the Library site are summarized in Figures 7.25 and 7.26. Data capture at this site has been satisfactory.

Daily variations in maximum hourly ozone concentrations are shown in Figure 7.25a. Long-term trends are shown in Figure 7.25b. Between 1992-1997, maximum and 95th percentile concentrations ranged from 136-178 and 70-79 $\mu g / m^3$, respectively. Mean concentrations ranged from 25-28 $\mu g / m^3$, and were highest in 1996.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.25c. The air quality objective of 160 $\mu g / m^3$ was exceeded in 1992 and 1994-1995. No exceedances occurred in 1993, 1996 or 1997. The number of exceedances of 100 $\mu g / m^3$ ranged from 46-127 times per year, with the most occurring in 1992.

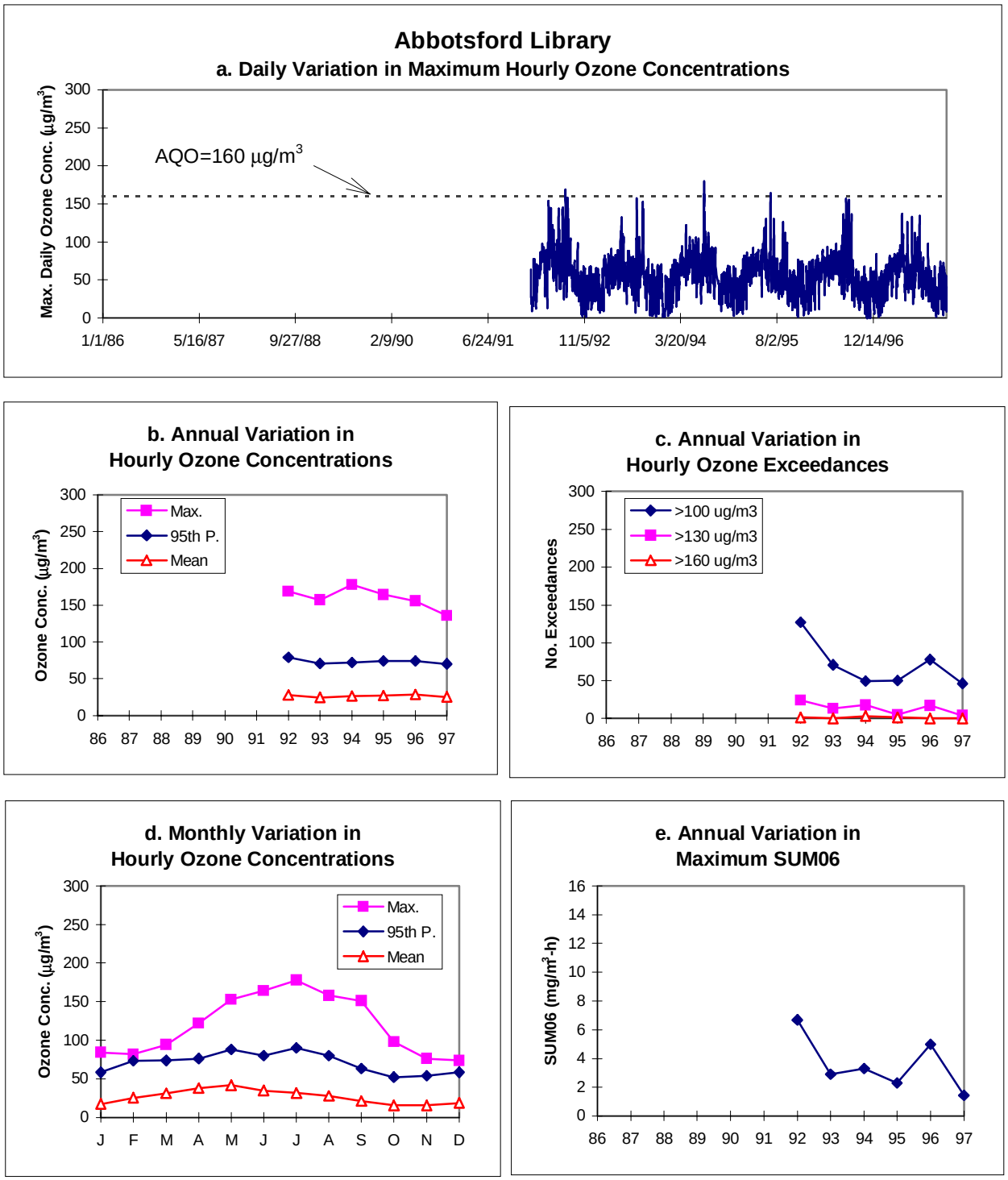


Figure 7.25 Summary of ozone statistics, Abbotsford. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

Monthly variations in hourly ozone levels are presented in Figure 7.25d. The highest hourly concentrations were observed between May and September, with a maximum of 178 $\mu g / m^3$ reported in July 1994. The highest 95th percentile concentrations were found between May and August (80-90 $\mu g / m^3$), while the highest mean concentrations were found between April and May (38-42 $\mu g / m^3$).

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.25e. Annual maximum values were generally low, ranging from 1.4-6.7 mg / m^3-h. The lowest values were observed during 1997.

Maximum daily 8-hour average concentrations are presented in Figure 7.26. A maximum concentration of 133 $\mu g / m^3$ was reported in 1992. The U.K. standard of approximately 100 $\mu g / m^3$ was exceeded at least 17 times per year between 1992-1997. The most exceedances (66) occurred in 1992.

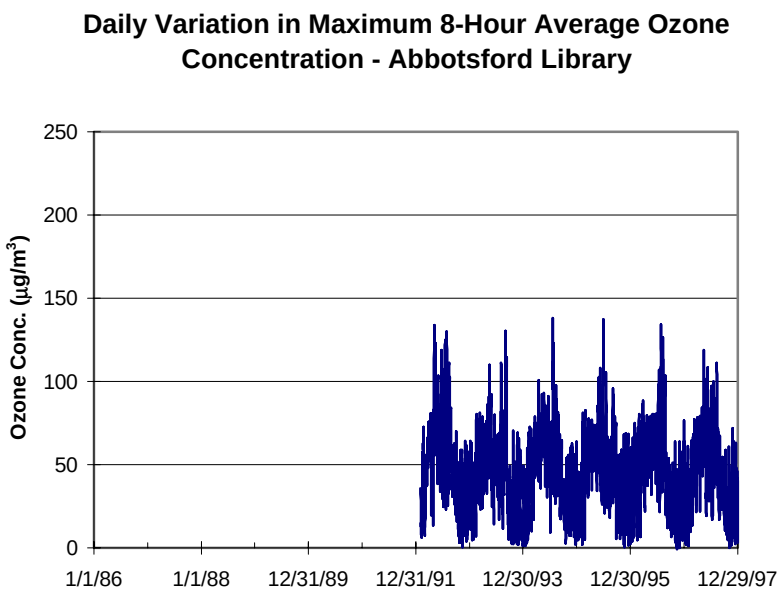


Figure 7.26 Daily variations in maximum 8-hour ozone concentrations, Abbotsford Library.

7.3.12 Chilliwack

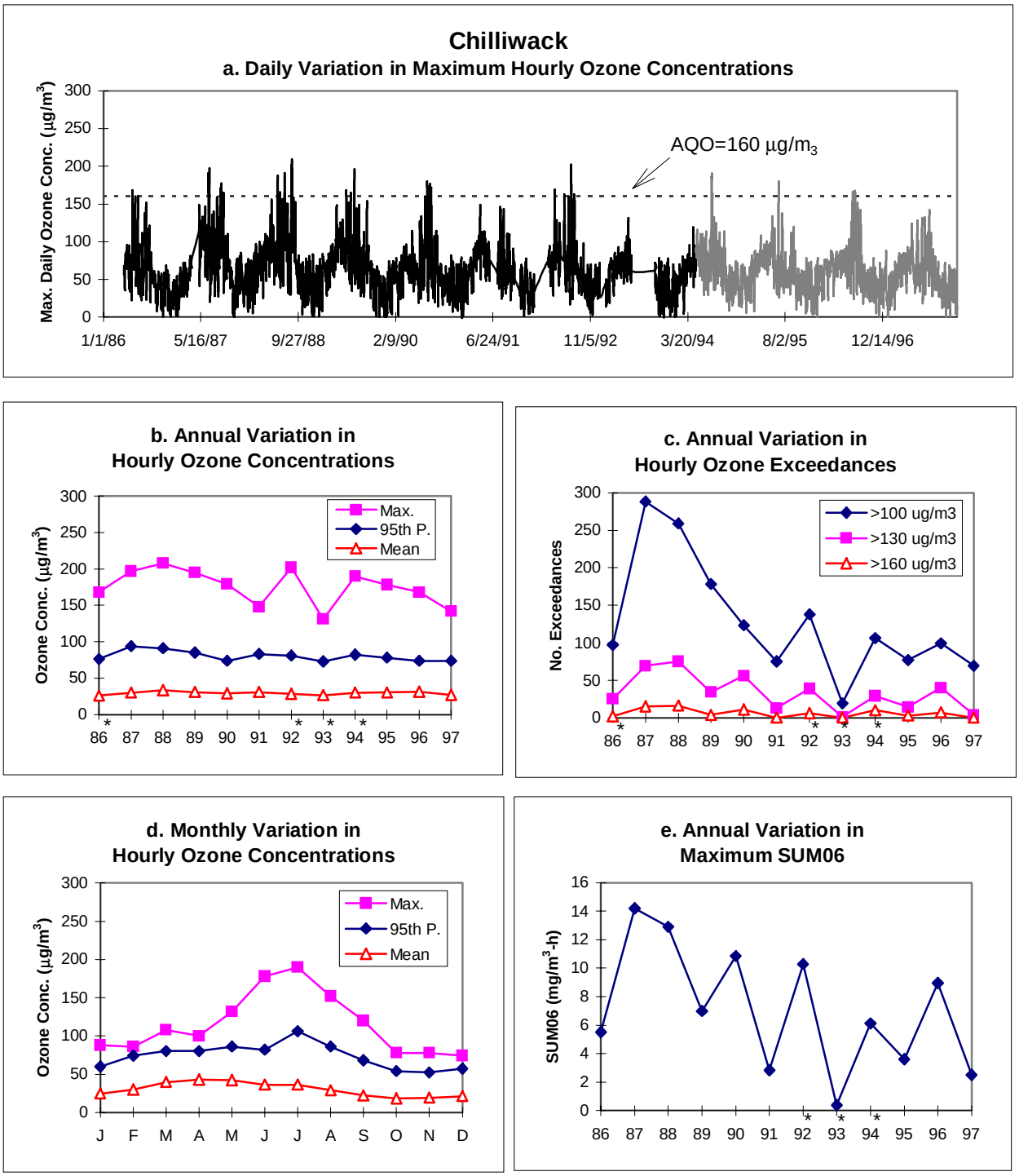
Hourly ozone measurements have been taken at various sites in Chilliwack:

Chilliwack Airport between February 1979 and March 1986, Chilliwack Works Yard between April 1986 and May 1994, and Chilliwack Airport since May 1994. Data are summarized in Figures 7.27 and 7.28. Unless specified otherwise, data presented here are from the Works Yard prior to 1994 and from the Airport site from 1994 onwards. Data capture at these sites was satisfactory with the exception of the periods 1986 and 1992-1994.

Daily variations in maximum hourly ozone concentrations from both the Works Yard and Airport sites are plotted against time in Figure 7.27. Clearly, periods of elevated ozone concentrations have been observed throughout the 12-year period. Long-term trends are shown in Figure 7.27. Although no consistent directional patterns are evident, ozone levels in recent years are substantially lower than during the late 1980's. Between 1987-1989, mean, 95th percentile and maximum concentrations ranged from 30-33, 85-94 and 195-208 $\mu g / m^3$, respectively. In comparison, corresponding concentrations between 1995-1997 ranged from 27-31, 74-78 $\mu g / m^3$, and 142-178 $\mu g / m^3$. However, recent levels are still high relative to many other sites in the province.

The number of hours in which ozone concentrations exceeded the air quality objective of 160 $\mu g / m^3$ are summarized in Figure 7.27. Exceedances were observed at least once each year with the exception of 1991, 1993 and 1997, when no exceedances were recorded. A maximum of 288 exceedances of 100 $\mu g / m^3$ were reported in 1988. Since the relocation of the monitoring site to the Airport, this number has fallen to less than 110 per year.

Monthly variations in hourly ozone levels from the Airport site are presented in Figure 7.27. The highest hourly concentrations were observed during June and July (178-190 $\mu g / m^3$). In contrast, the highest mean concentrations were found during April and May (42-43 $\mu g / m^3$), while the highest 95th percentile concentrations occurred between May and August (82-106 $\mu g / m^3$). The lowest concentrations were observed between October and December, when mean and 95th percentile concentrations ranged from 18-21 and 52-57 $\mu g / m^3$, respectively.



* Less than 75% data capture.

Figure 7.27 Summary of ozone statistics, Chilliwack. (a) Daily 1-hour maximum concentrations. Dark and light grey lines refer to data from Works Yard and Airport, respectively. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g / m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.27e. Annual maximum values as high as 14.2 mg/m^3 h have occurred over the past 12 years. This level is well beyond that recommended to provide protection to 95% of crops. However, SUM06 values in recent years have been low to moderate, ranging from 2.5-9.0 mg/m^3-h.

Daily maximum 8-hour average concentrations are presented in Figure 7.28. A maximum concentration of 160 $\mu g/m^3$ was reported in 1987. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ occurred at least three times each year. The most exceedances (166) occurred in 1987.

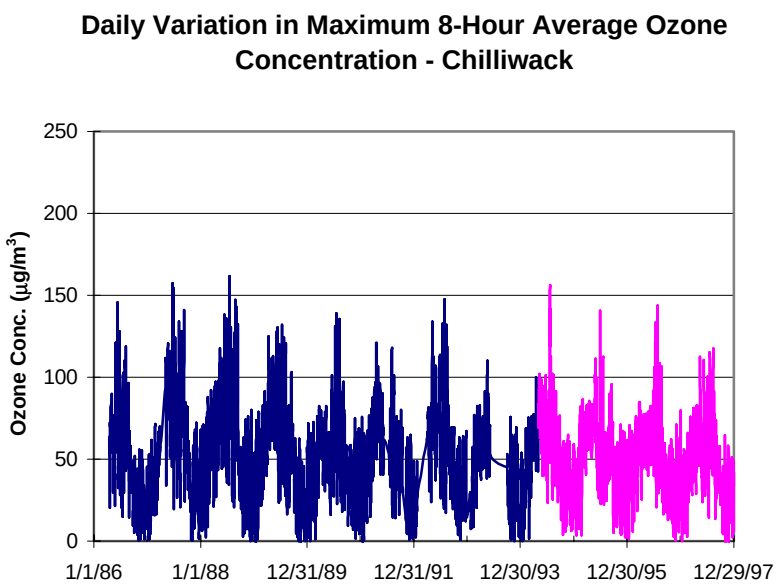


Figure 7.28 Daily variations in maximum 8-hour average ozone concentrations, Chilliwack. Dark and light grey lines show data from Works Yard and Airport, respectively.

7.3.13 Hope

Ozone was monitored at the Hope Firehall between May 1991 and November 1996. Beginning in August 1996, measurements were made at the Hope Airport. Data are summarized in Figures 7.29 and 7.30. Unless specified otherwise, data collected from 1991-1996 are from the Firehall site, and 1997 data are from the Airport site. Data capture was

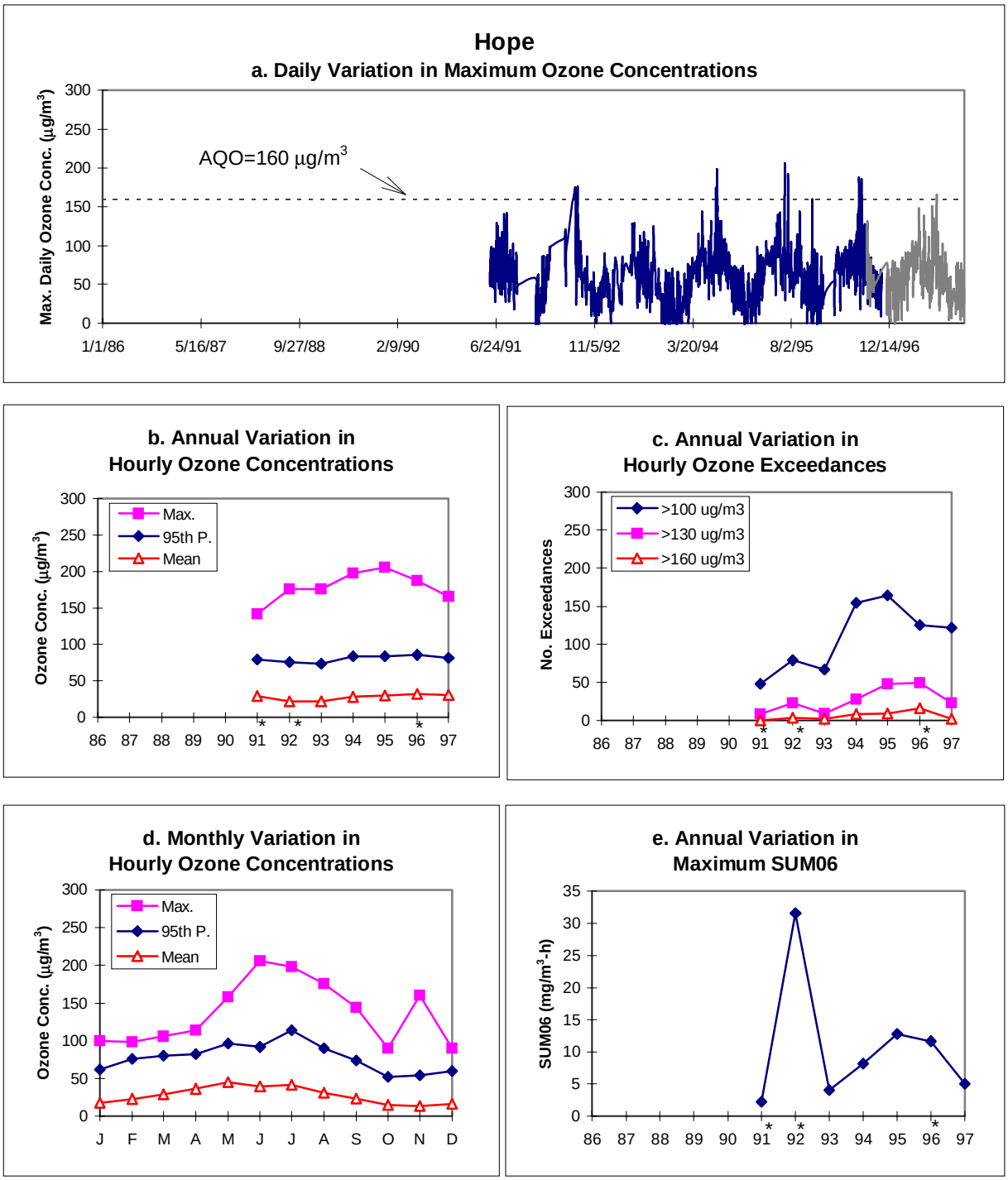
satisfactory between 1993-95 and in 1997.

Daily variations in maximum hourly ozone concentrations from both sites are presented in Figure 7.29a. In general, the seasonal and day-to-day variability characteristic of ambient ozone levels is evident, but periods of elevated ozone levels are also noted outside of the ozone season. Long-term trends are shown in Figure 7.29b. Between 1993-1995, the highest hourly levels in the province were observed at the Hope site, with concentrations ranging from 176-206 $\mu g / m^3$. Mean and 95th percentile concentrations ranged from 23-31 $\mu g / m^3$ and 74-84 $\mu g / m^3$, respectively. In 1997, mean, 95th percentile and maximum concentrations were 31, 82 and 166 $\mu g / m^3$, respectively.

The number of exceedances of 100, 130 and 160 $\mu g / m^3$ are presented in Figure 7.29c. Between 1992-97, the air quality objective of 160 $\mu g / m^3$ was exceeded from 2-16 times per year, which was more frequent than at any other site in the province. The number of exceedances of 100 $\mu g / m^3$ over the same period ranged from 67-164 times, with the most occurring in 1995.

Monthly variations in hourly ozone levels based on data collected at the Firehall site are shown in Figure 7.29d. The highest hourly concentrations were observed between May-August, with a maximum concentration of 206 $\mu g / m^3$ reported in June 1995. The highest mean concentrations (39-45 $\mu g / m^3$) and the highest 95th percentile concentrations (92-114 $\mu g / m^3$) were found between May and July. In contrast, the lowest concentrations were generally observed between October and December, with mean and 95th percentile concentrations ranging from 13-17 $\mu g / m^3$ and 52-60 $\mu g / m^3$, respectively.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.29e. SUM06 values for the Hope monitoring site have been among the highest in the province in recent years. In July 1992, values approached 32 mg / m^3-h, which is well above the level recommended to protect 95% of crops (11.6 mg / m^3-h). Since that time, maximum SUM06 values have range d from 4-13 mg / m^3-h.



* Less than 75% data capture.

Figure 7.29 Summary of ozone statistics, Hope. (a) Daily 1-hour maximum concentrations. Dark and light grey line show data from Firehall and Airport sites, respectively. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 µg / m^3. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

Maximum daily 8-hour average concentrations are presented in Figure 7.30. A maximum concentration of 165 $\mu g / m^3$ was reported in 1994. Exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ were observed each year. The most exceedances (127) were reported in 1995.

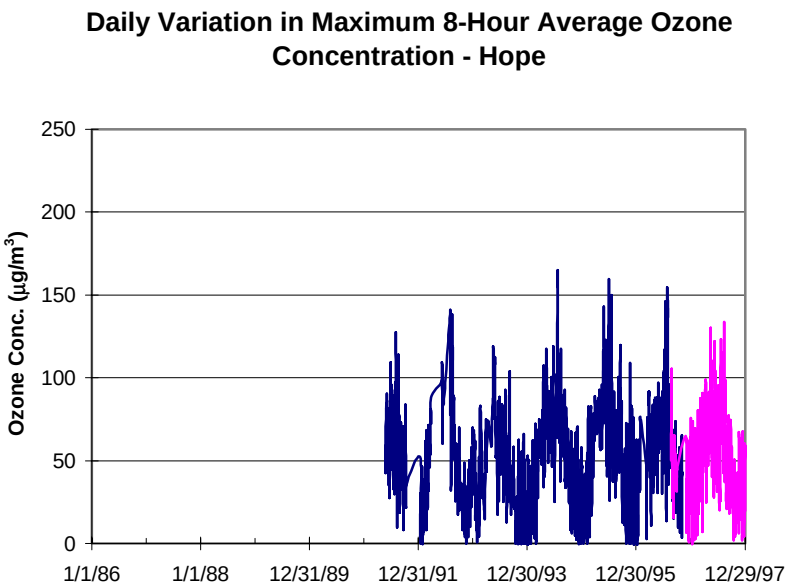


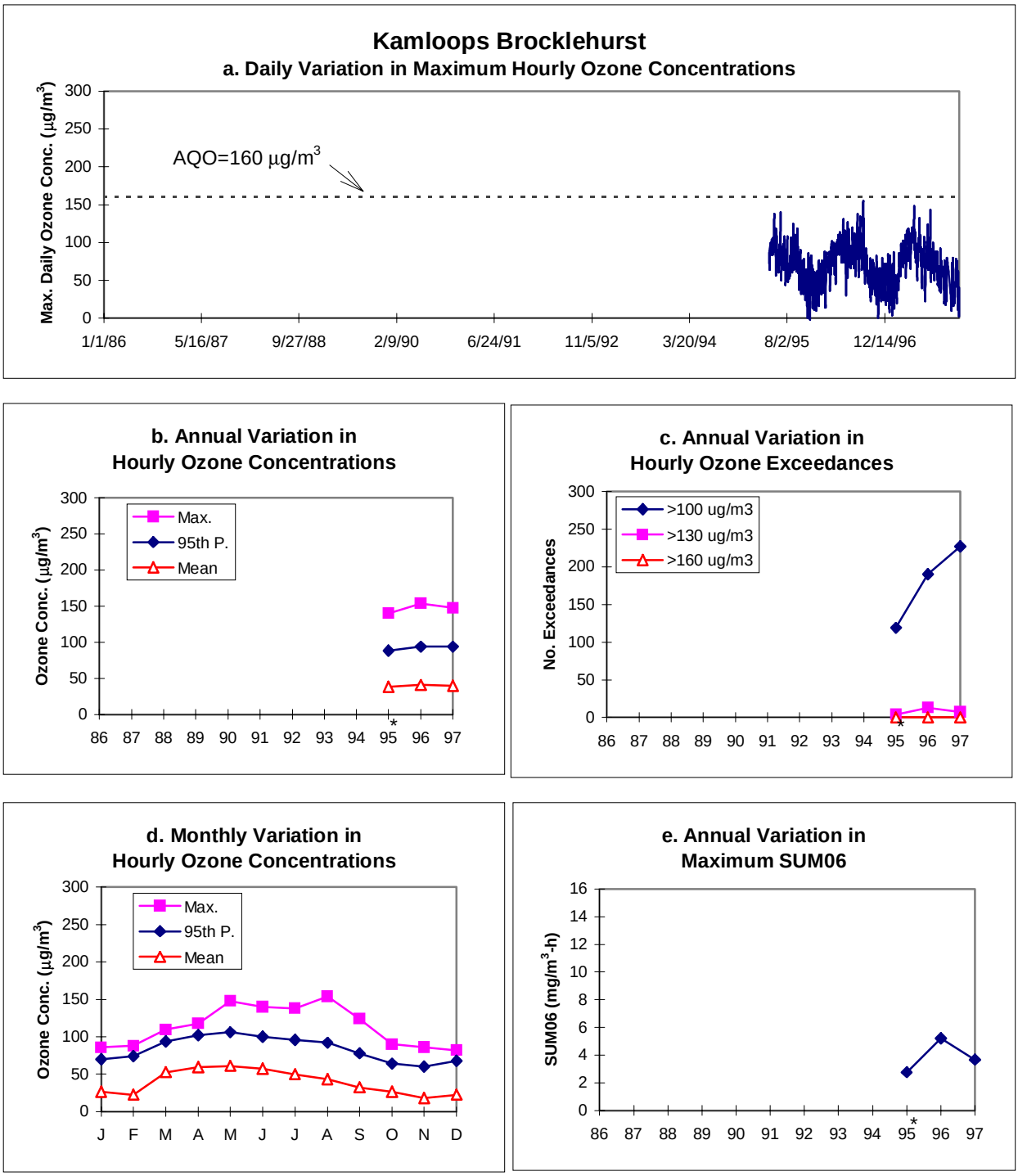
Figure 7.30 Daily variations in maximum 8-hour ozone concentrations, Hope. Dark and light grey lines show data from the Firehall and Airport sites, respectively.

7.4 SOUTHERN INTERIOR REGION

7.4.1 Kamloops

Ozone measurements at the Brocklehurst site in Kamloops date from May 1995. Data are summarized in Figures 7.31 and 7.32. Data capture has been satisfactory since 1996.

Figure 7.31a shows the seasonal and diurnal variations in daily maximum hourly ozone concentrations. Annual statistics are summarized in Figure 7.31b. Between 1996 and 1997, mean, 95th percentile and maximum concentrations were 40-41, 94 and 148-154 $\mu g / m^3$, respectively.



* Less than 75% data capture.

Figure 7.31 Summary of ozone statistics, Kamloops Brocklehurst. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g/m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

The number of exceedances of 100, 130 and 160 $\mu g / m^3$ are presented in Figure 7.31c. No exceedances of the air quality objective of 160 $\mu g / m^3$ have been reported to date. Exceedances of 130 $\mu g / m^3$ totalled 7-13 over the past two years. In contrast, exceedances of 100 $\mu g / m^3$ were numerous (190-227), far exceeding those observed at sites in the more densely populated regions of the LFV in recent years.

Monthly variations in hourly ozone concentrations are presented in Figure 7.31d. The highest hourly concentrations were observed between May and August (138-154 $\mu g / m^3$). The highest mean and 95th percentile concentrations were found between April and June, with values ranging from 57-61 and 100-106 $\mu g / m^3$, respectively. Monthly mean concentrations between April and June were higher than at any other site in the province. The lowest concentrations were observed between October and February, with mean concentrations of 18-27 $\mu g / m^3$ and 95th percentile concentrations of 60-74 $\mu g / m^3$.

SUM06 values, which provide a measure of ozone exposure by vegetation during the growing season, are shown in Figure 7.31e. Maximum values in 1996 and 1997 were moderately low, ranging from 3.7-5.2 mg / m^3-h.

Maximum daily 8-hour average concentrations are presented in Figure 7.32. A

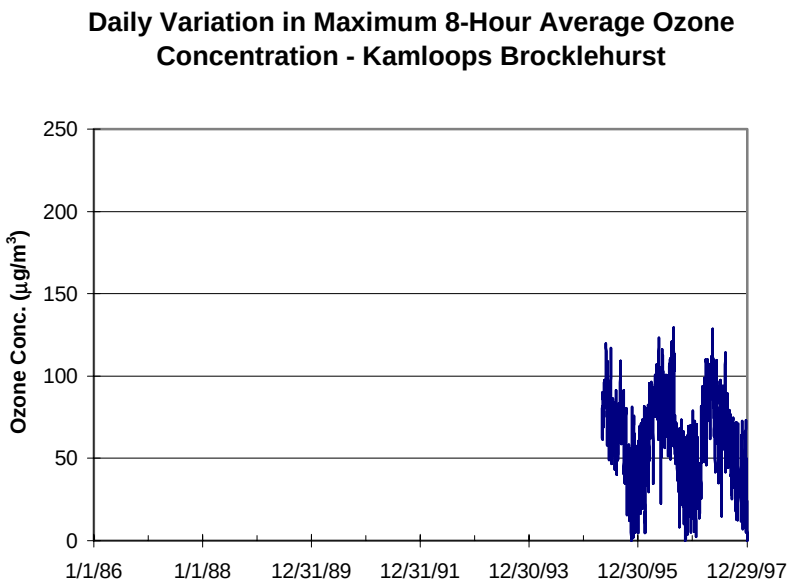


Figure 7.32 Daily variations in maximum 8-hour average ozone concentrations, Kamloops Brocklehurst

maximum concentration of 129 $\mu g / m^3$ was reported in 1996. Exceedances of the U.K. standard of approximately 100 $\mu g / m^3$ were observed at least 67 times during each year. The most exceedances (146) occurred in 1997.

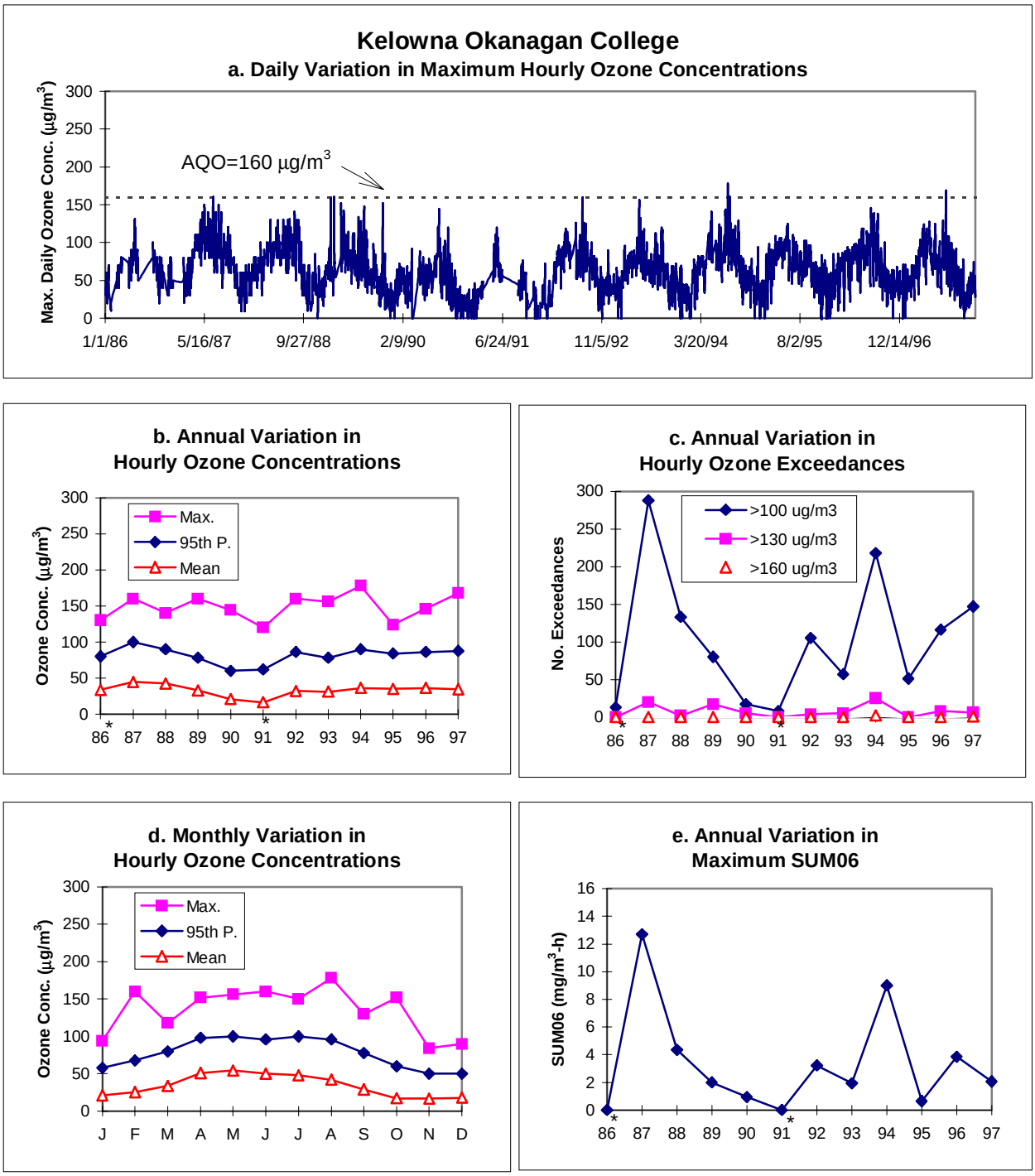
7.4.2 Kelowna

Ozone has been monitored at the KLO campus of Okanagan College in Kelowna since August 1983. Data collected between 1986-97 are summarized in Figures 7.33 and 7.34. Data capture at this site has been satisfactory with the exception of during 1986 and 1991.

Seasonal and day-to-day variability are shown in the plot of daily maximum one-hour ozone concentrations in Figure 7.33a. Long-term trends are presented in Figure 7.33b. Excluding data from 1986 and 1991, maximum and 95th percentile concentrations ranged from 124-178 mg / m^3 and 60-100 $\mu g / m^3$, respectively. Mean concentrations were among the highest in the province, ranging from 21-45 $\mu g / m^3$. No consistent trends were evident, although mean ozone concentrations during the period of 1994-97 (34-36 $\mu g / m^3$) were higher than any previous period since 1987-88 (42-45 $\mu g / m^3$).

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.33c. The air quality objective of 160 $\mu g / m^3$ was exceeded only three times (twice in 1994 and once in 1997). Exceedances of 100 $\mu g / m^3$ ranged from 17-288 (1986 and 1991 excluded), with the most occurring in 1988.

Monthly variations in hourly ozone levels are presented in Figure 7.33d. The highest hourly concentrations were observed during the months of May-September, but elevated levels were also recorded during February and October. The maximum concentration of 178 $\mu g / m^3$ was observed in August 1994. On average, the highest concentrations were observed between April and August, with mean and 95th percentile concentrations ranging from 42-54 $\mu g / m^3$ and 96-100 $\mu g / m^3$, respectively. In contrast, the lowest concentrations typically occurred between October and December, with mean and 95th percentile concentrations of 17-18 $\mu g / m^3$ and 50-60 $\mu g / m^3$, respectively.



* Less than 75% data capture.

Figure 7.33 Summary of ozone statistics, Kelowna Okanagan College. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g/m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.33e. Values ranged from less than 0.6 to a high of 12.7 mg/m^3-h in 1987. However, with the exception of 1994, SUM06 values have not exceeded 5 mg/m^3-h since 1987. In 1997, the maximum SUM06 value was 2.1 mg/m^3-h.

Maximum daily 8-hour average concentrations are presented in Figure 7.34. A maximum concentration of 149 $\mu g/m^3$ was recorded in 1994. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ occurred during each year between 1986-1997. The most exceedances (257) occurred in 1987.

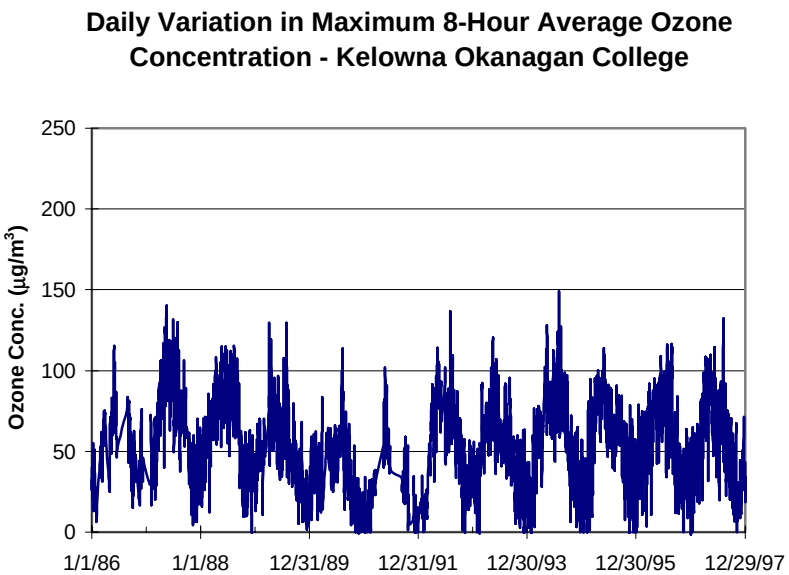


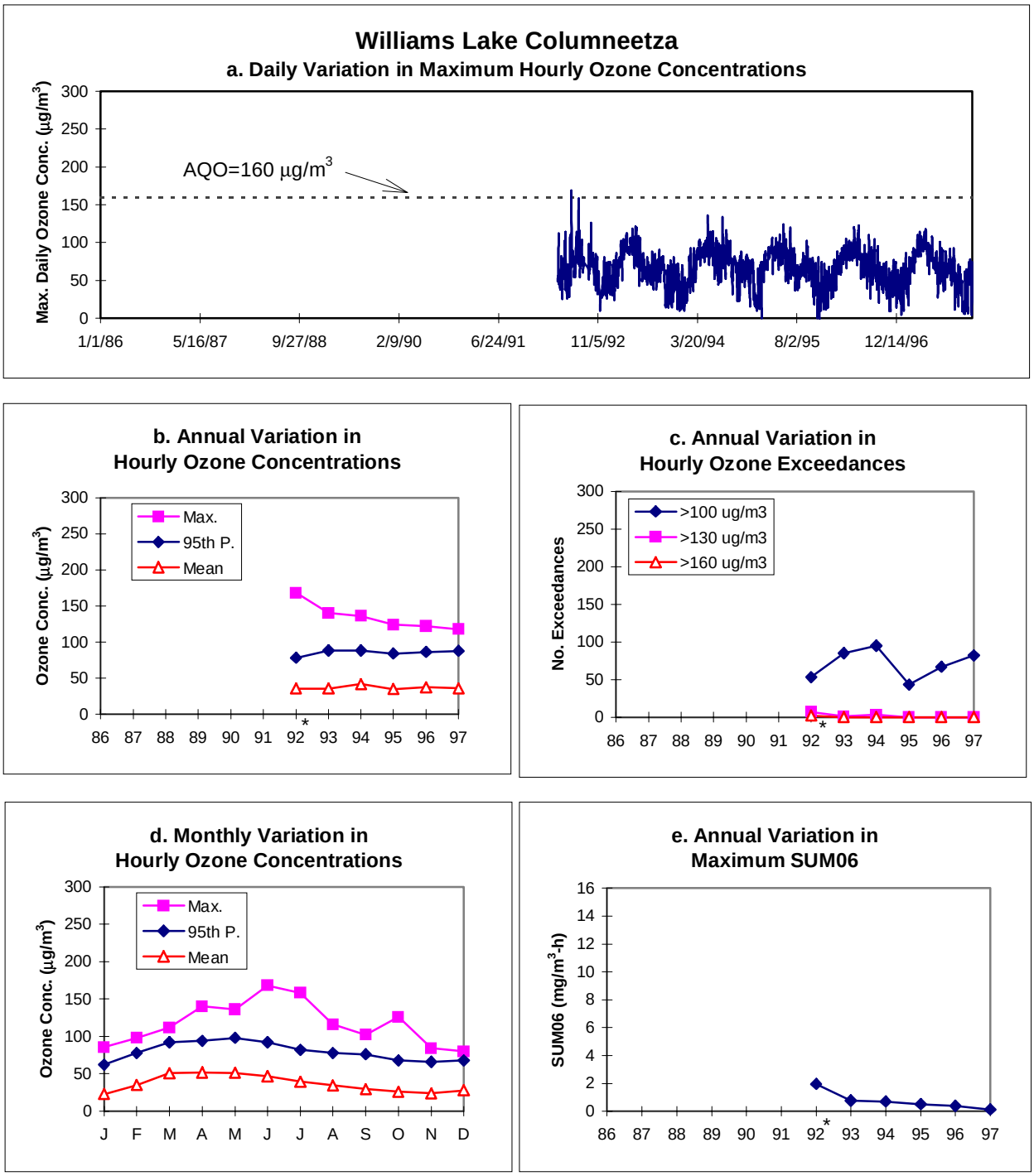
Figure 7.34 Daily variations in maximum 8-hour average ozone concentrations, Kelowna Okanagan College.

7.5 CARIBOO REGION

7.5.1 Williams Lake

Ozone concentrations have been monitored at the Williams Lake Columneetza site since April 1992. Data capture has been satisfactory since 1993. Data are summarized in Figures 7.35 and 7.36.

Seasonal and day-to-day variability are evident in the plot of daily maximum hourly ozone concentrations in Figure 7.35a. It is clear that while periods of elevated



* Less than 75% data capture.

Figure 7.35 Summary of ozone statistics, Williams Lake Columneetza. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 $\mu g/m^3$. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

ozone levels do occur in Williams Lake, the day-to-day variability is less than observed at sites in southwestern BC and the Okanagan. Annual variations are presented in Figure 7.35b. Between 1993-1997, maximum, 95th percentile and mean concentrations ranged from 118-140 $\mu g / m^3$, 84-88 $\mu g / m^3$ and 35-42 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.35c. The air quality objective of 160 $\mu g / m^3$ has not been exceeded since 1993. The number of exceedances of 100 $\mu g / m^3$ ranged from 43-95, with the most occurring in 1994.

Monthly variations in hourly ozone levels are shown in Figure 7.35d. The highest concentrations were observed between June and July, with a maximum of 168 $\mu g / m^3$ reported in June 1992. On average, the highest concentrations were found during the spring. Between March and June, mean and 95th percentile concentrations ranged from 51-52 $\mu g / m^3$ and 92-98 $\mu g / m^3$, respectively. As discussed in Section 6.2, the relatively high concentrations observed during March are likely a result of stratospheric intrusions which transport ozone-rich air from the stratosphere to the lower atmosphere.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.35e. Annual maxima have been very low, with no values greater than 2 mg / m^3-h recorded.

Maximum daily 8-hour average concentrations are presented in Figure 7.36. A maximum concentration of 130 $\mu g / m^3$ was reported in 1992. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ were reported for each year between 1992-1997. The most exceedances (38) occurred in 1994.

7.6 OMINECA-PEACE REGION

7.6.1 Prince George

Ozone measurements from Plaza 400 in Prince George are available from June 1994. The Plaza 400 site is among the most northern ozone monitoring sites in the province. Data are summarized in Figures 7.37 and 7.38. Data capture has been satisfactory since 1996.

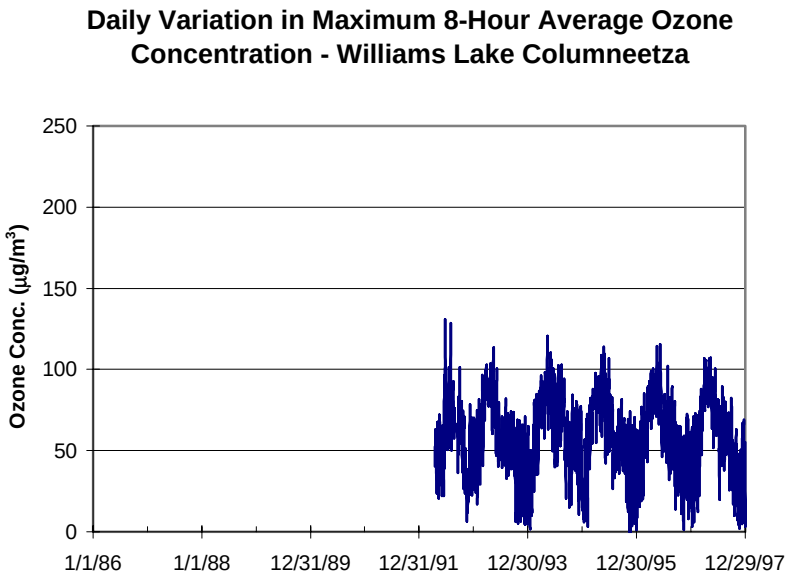
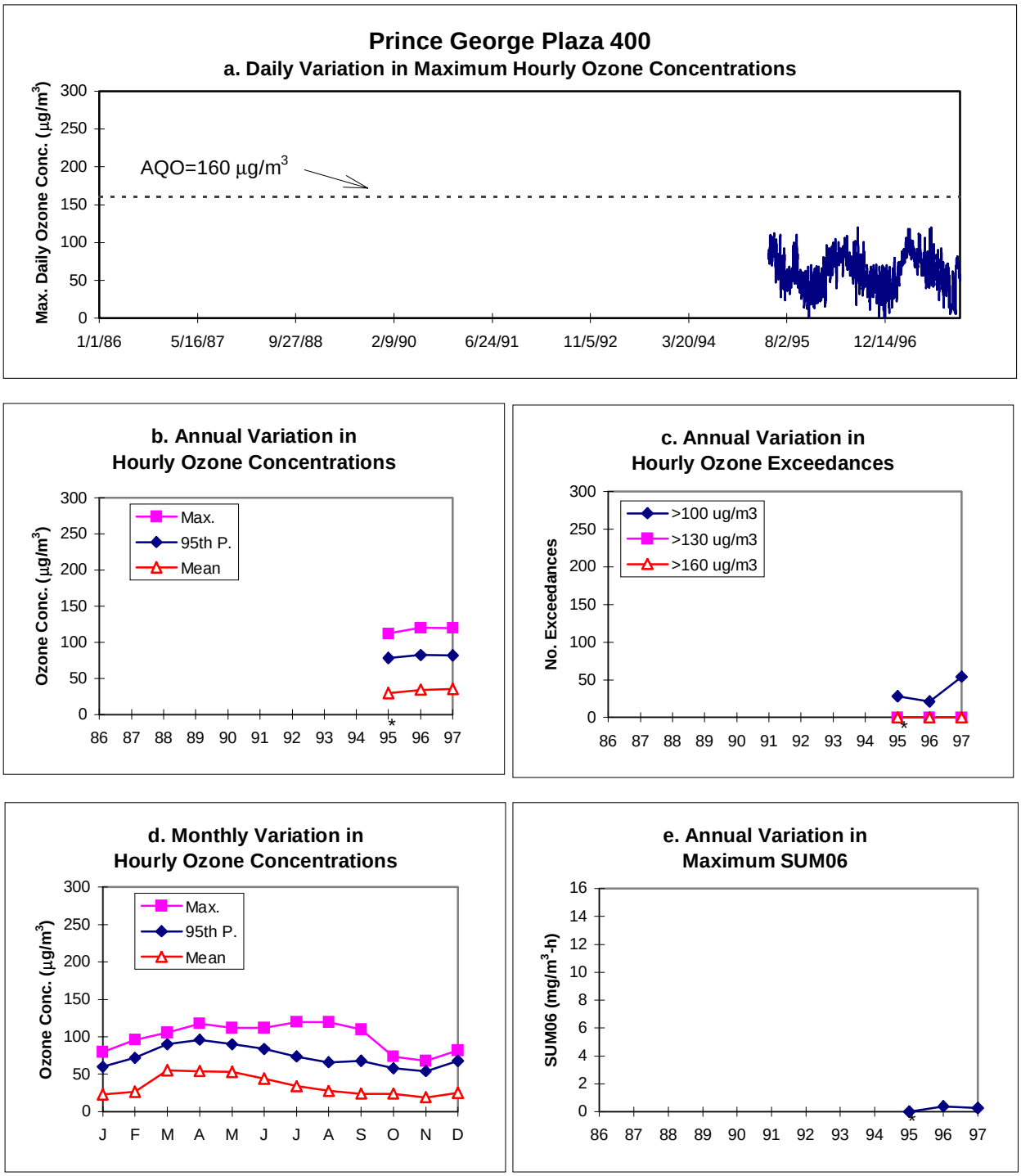


Figure 7.36 Daily variations in maximum 8-hour average ozone concentrations, Williams Lake Columneetza.

Daily variations in the maximum hourly ozone concentrations are plotted against time in Figure 7.37a. Annual statistics are summarized in Figure 7.37b. Maximum, 95th percentile and mean concentrations in 1996 and 1997 were 120, 82 and 34-35 $\mu g / m^3$, respectively.

The number of hours in which ozone concentrations exceeded 100, 130 and 160 $\mu g / m^3$ are summarized in Figure 7.37c. No exceedances of 130 or 160 $\mu g / m^3$ have been recorded to date. Exceedances of 100 $\mu g / m^3$ totalled 21 and 54 in 1996 and 1997, respectively.

Monthly variations in hourly ozone concentrations are presented in Figure 7.37d. The highest hourly concentrations were observed in April (118 $\mu g / m^3$) and July-August (120 $\mu g / m^3$). However, on average, concentrations were highest between March and May, with mean concentrations of 53-55 $\mu g / m^3$ and 95th percentile concentrations of 90-96 $\mu g / m^3$. The lowest concentrations were observed in November, with mean and 95th percentile concentrations of 19 and 54 $\mu g / m^3$, respectively.



* Less than 75% data capture.

Figure 7.37 Summary of ozone statistics, Prince George Plaza 400. (a) Daily 1-hour maximum concentrations. (b) Annual 1-hour maximum, 95th percentile and mean concentrations. (c) Annual number of exceedances of 100, 130 and 160 µg/m^3. (d) Monthly 1-hour maximum, 95th percentile and mean concentrations. (e) Maximum annual SUM06 values.

SUM06 values, which provide a measure of ozone exposure by vegetation during the ozone season, are shown in Figure 7.37e. Annual maximum values have been very low, with values of 0.4 and 0.3 mg/m^3-h reported for 1996 and 1997, respectively.

Maximum daily 8-hour average concentrations are presented in Figure 7.38. A maximum concentration of 109 $\mu g/m^3$ was reported in 1996. Exceedances of the U.K. standard of approximately 100 $\mu g/m^3$ were observed each year between 1995-1997. The most exceedances (18) occurred in 1997.

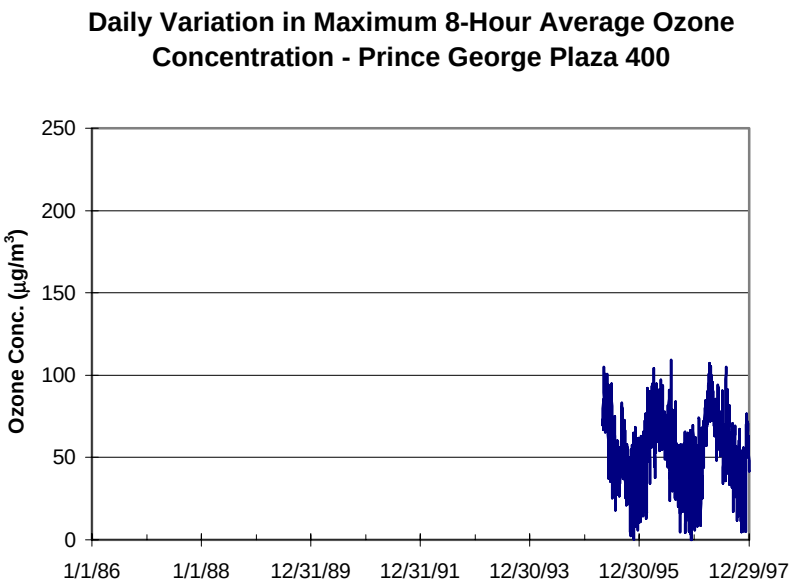


Figure 7.38 Daily variation in maximum 8-hour average ozone concentrations, Prince George Plaza 400.

7.7 Inter-site Comparison for 1997

Site-to-site differences in ambient ozone concentrations reflect a host of factors which affect the formation, transport and destruction of ozone. These factors include large-scale and local meteorological conditions, sources of precursor emissions, and ozone sinks. Hourly ozone data from selected sites are compared for the most recent year of observations (1997). Figures showing maximum, 95th percentile and mean concentrations for 1997 are shown in Figures 7.39-7.41, respectively.

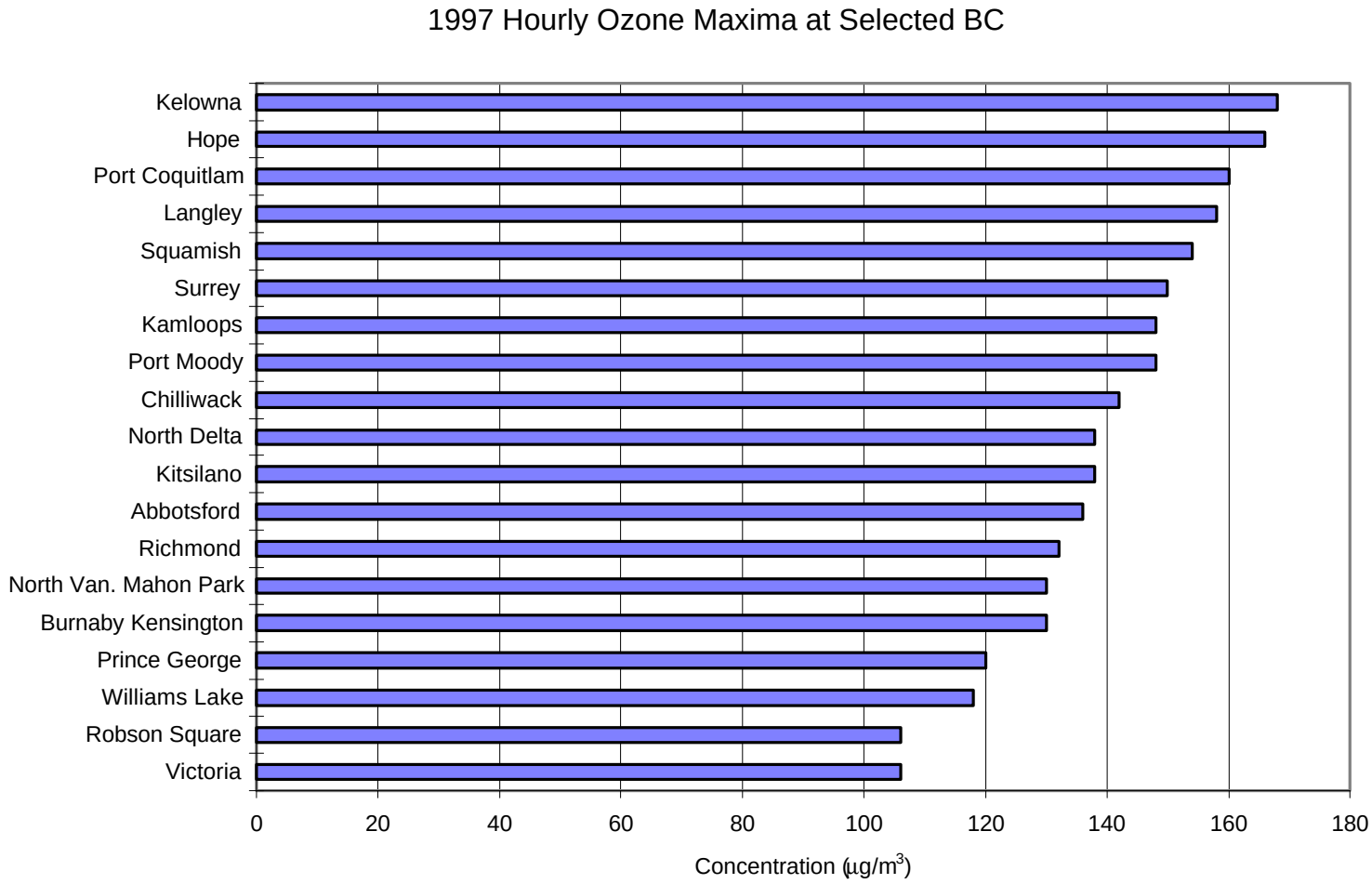


Figure 7.39 Maximum hourly ozone concentrations at selected BC sites, 1997.

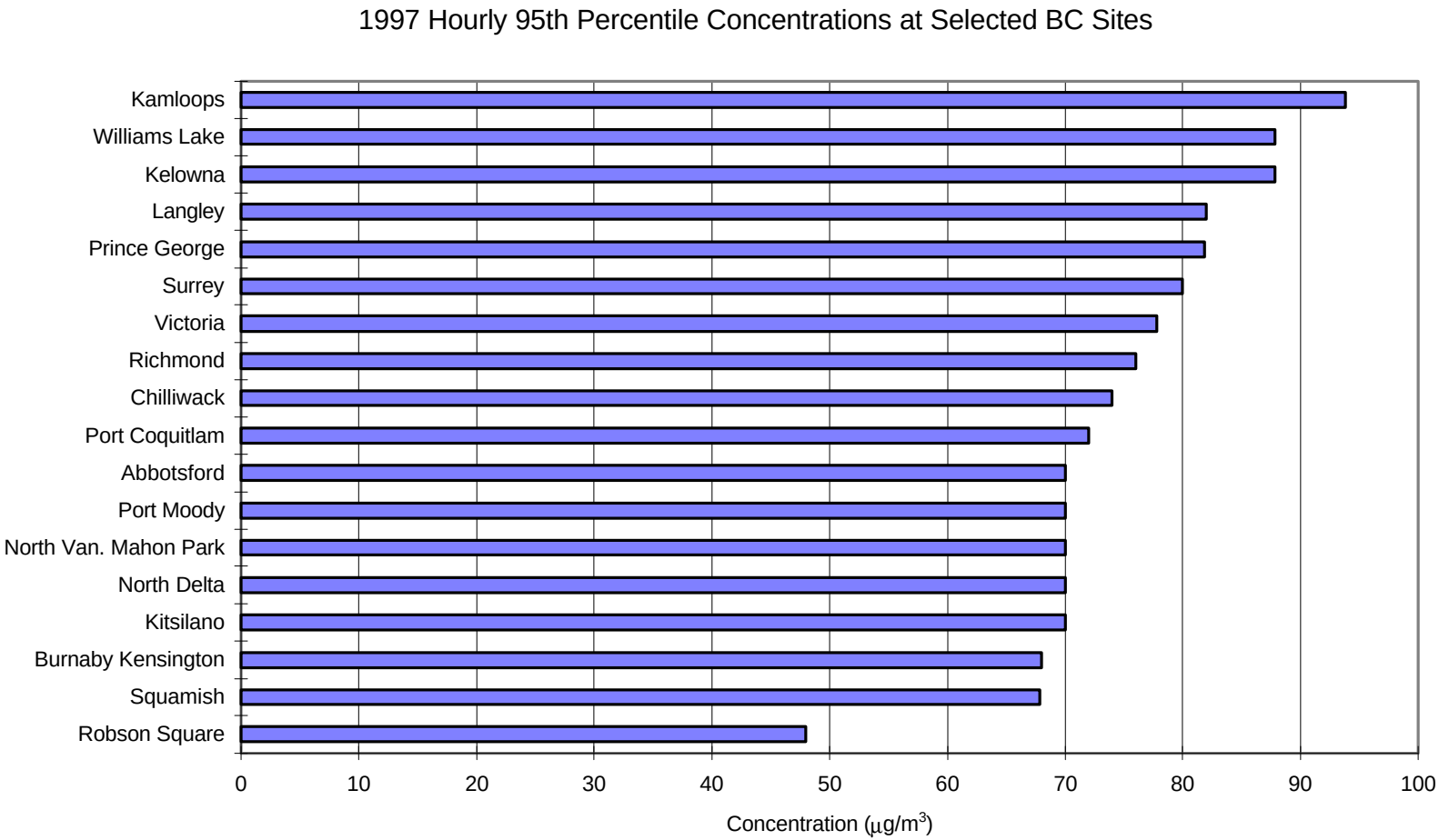


Figure 7.40 Hourly 95th percentile ozone concentrations at selected BC sites, 1997.

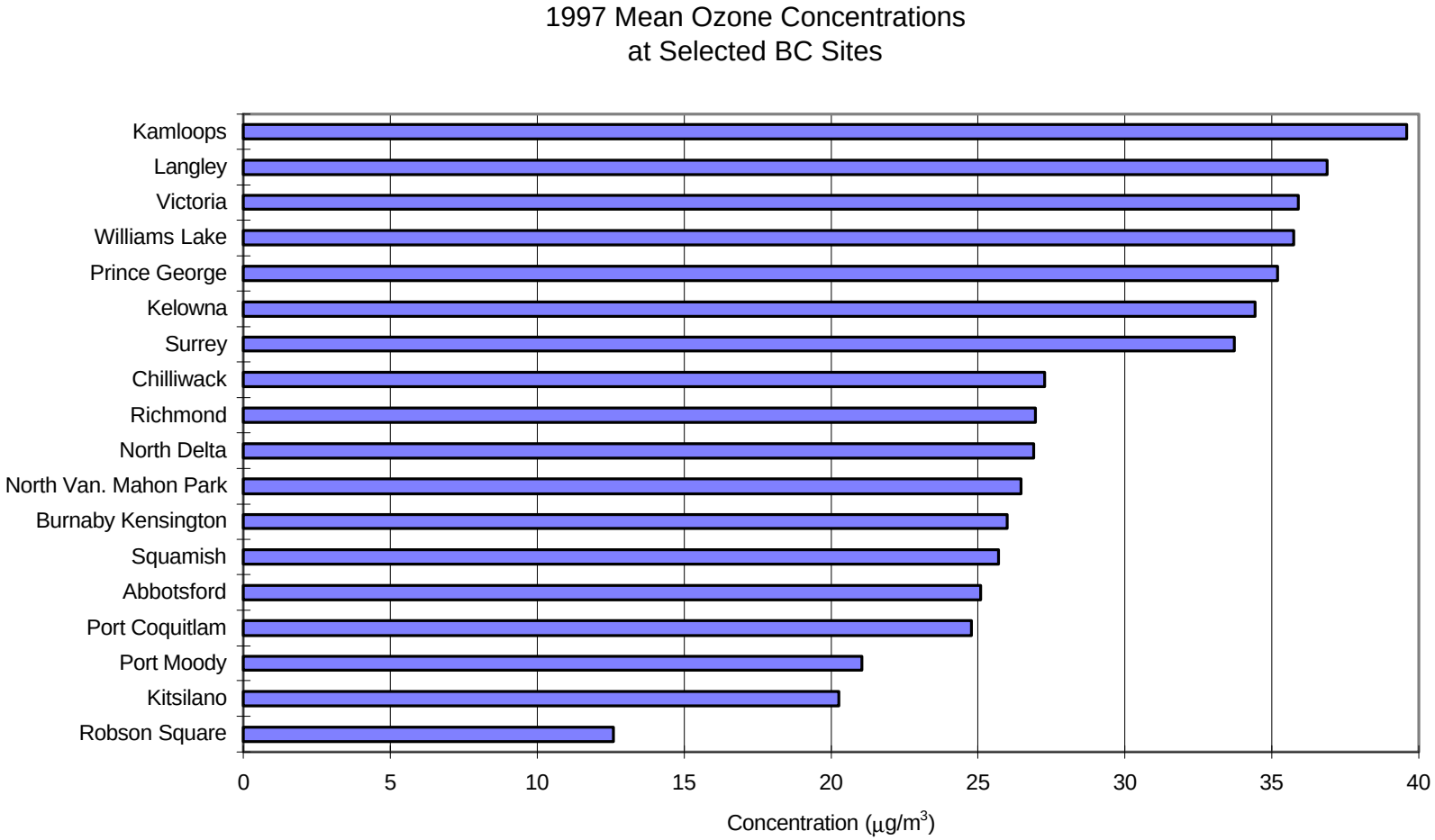


Figure 7.41 Annual hourly mean ozone concentrations at selected BC sites, 1997.

Prior to 1997, the highest hourly ozone concentrations in the province were reported in the LFV. In 1997, the provincial one-hour maxima of 168 $\mu g / m^3$ occurred in Kelowna, as shown in Figure 7.39. The only other exceedances of the air quality objective of 160 $\mu g / m^3$ were observed at Anmore in the LFV (data not shown) and Hope, which both recorded a maximum of 166 $\mu g / m^3$.

In contrast to the above, the lowest maximum concentrations were observed in Victoria, Vancouver Robson Square, Williams Lake and Prince George. Victoria is a coastal site located along the Straight of Juan de Fuca, and generally subject to good ventilation. Robson Square is located in the downtown core of Vancouver, where high NOx emissions from the motor vehicle sector likely contribute to the scavenging of local ozone. Both Williams Lake and Prince George are located in the northern interior of the province, and therefore subject to lower rates of solar insolation, which may affect the photochemical production of ozone. However, a number of other factors such as local emission patterns and pollutant recirculation patterns may also contribute to this finding.

As presented in Figure 7.40, the highest 95th percentile concentrations in 1997 were observed in Kamloops, Williams Lake, Kelowna, Langley, Prince George and Surrey. Clearly, these sites do not necessarily coincide with those experiencing the highest maximum concentrations. Furthermore, four of the six sites are located outside of the LFV. Relatively high concentrations year-round contribute to these findings, although Kamloops and Kelowna both periodically experience elevated concentrations during the summer months. In contrast, the lowest 95th percentile concentrations were found in Vancouver Robson Square, Squamish and Burnaby Kensington Park. All three sites are in close proximity to large NOx sources which may act to scavenge local ozone, i.e. motor vehicles, a pulp mill and an oil refinery, respectively.

Finally, as shown in Figure 7.41, the highest annual mean concentrations were observed in Kamloops, Langley, Victoria, Williams Lake, Prince George and Kelowna. Five of these sites are located outside of the LFV, reflecting the relatively higher year-round concentrations at these sites. In contrast, the lowest mean concentrations were observed in Vancouver Robson Square, Kitsilano and Port Moody. Kitsilano is located on the western

edge of the LFV, and is therefore located upwind of the major source regions during episodic type conditions. As shown in Figure 7.39, the Port Moody site does experience periods of very high ozone concentrations. However, in 1997, they were brief in duration.

Of the selected sites, only Kelowna was among the 6 highest in terms of maximum, 95th percentile and mean concentrations. These findings indicate that this site has both a high baseline ozone concentration and is periodically exposed to conditions conducive to elevated ozone concentrations. High concentrations were also observed in Kamloops, suggesting that sites in the Southern Interior have a potential for future episodes of elevated ozone concentrations.

8. SUMMARY

Ground-level ozone is an important component of urban smog that is formed from reactions involving NOx and VOCs in the presence of sunlight. The motor vehicle is a major source of both NOx and VOCs. Ozone is a respiratory irritant, and has been associated with a decline in lung function and increased hospitalizations for those with pre-existing respiratory problems. It is also harmful to plants and to various materials, including rubber.

Ozone is currently being monitored at more than 25 sites in the province. The monitoring network is most dense in the LFV where 20 of the monitors are located. Analyses were conducted on data collected between 1986-1997 at 19 of the provincial and GVRD sites.

In summary, the following observations were made:

1. Ozone concentrations vary greatly from year to year, season to season, day to day and hour to hour, reflecting the impact that meteorology and local emissions have on ozone levels.
2. In general, the highest ozone levels were observed in the LFV. Most recently, however, elevated concentrations have also been observed in Kelowna.
3. During the late 1980's, ozone maxima were typically observed immediately to the east of the most densely populated regions in the LFV, at sites such as Port Moody and Port Coquitlam. Between 1993-1996, the highest or second highest concentrations were

regularly reported for Hope. While this may suggest an eastward shift in the region of highest ozone concentrations, it may also be attributed to the eastward expansion of the monitoring network to include Hope in 1991.

4. The highest hourly ozone concentrations were typically reported during the summer of 1988. As observed in many parts of the U.S. and Canada during this period, meteorological conditions favourable to the buildup of ozone (i.e., sunshine, high temperature, light winds and reduced mixing in the atmosphere) dominated. Elevated concentrations were reported throughout the province. A peak of 425 $\mu g / m^3$ was monitored in Port Coquitlam during September 1988.
5. Annual mean concentrations ranged from less than 10 $\mu g / m^3$ to 45 $\mu g / m^3$. Over the last five years, the highest mean concentrations were typically monitored at sites further downwind of the main emissions area of the LFV (i.e. Surrey, Langley and Hope) and sites outside of the LFV (e.g. Victoria, Kamloops, Kelowna, Williams Lake and Prince George). The lowest levels were consistently observed in Downtown Vancouver (Robson Square), where NOx emissions from vehicle exhaust are likely responsible for consuming free ozone.
6. While maximum ozone concentrations have not approached the very high levels which were observed in 1988, a number of sites reported their highest or second highest annual mean concentration and 95th percentile concentration in 1996: Vancouver (Robson Square), Richmond, North Delta, Burnaby (Kensington Park) and Hope. Data from the Hope site indicates that the annual mean concentration consistently increased each year between 1993-96.
7. A combination of high maximum, 95th percentile and mean concentrations relative to other sites in the province in 1997 indicates that sites in Kelowna and Kamloops have both a high background concentration of ozone throughout the year, and the potential for periods of elevated ozone concentrations during the warm, sunny summer months.
8. Hourly concentrations were typically highest during the summer months, when conditions are most conducive to ozone formation. Maximum hourly ozone levels were

found to track maximum temperature readings quite well during this period (e.g. at Port Coquitlam and Hope).

9. Mean concentrations were highest during the months of April and May. At the Kamloops Brocklehurst site, concentrations during this period were the highest in the province, averaging 60-61 $\mu g / m^3$. Mean concentrations were generally lowest between November and January.
10. The highest 95th percentile concentrations occurred during April and May at the following sites: Victoria, Vancouver (Robson Square), Vancouver (Kitsilano), Richmond, North Delta, Burnaby (Kensington Park), North Vancouver, Kamloops, Williams Lake and Prince George.
11. At sites in Squamish, Port Moody, Port Coquitlam, Surrey, Langley, Abbotsford, Chilliwack, Hope and Kelowna, the highest 95th percentile concentrations occurred between May and August.
12. Elevated ozone concentrations were also reported during periods outside of the ozone season. Temperature was a poor indicator of maximum ozone concentrations during these events, suggesting a source other than photochemical activity. The down-mixing of stratospheric ozone is a likely contributor to the elevated ozone levels in these instances.
13. Exceedances of the national maximum acceptable level of 160 $\mu g / m^3$ were most numerous during 1988, when many areas in North America reported very high ozone concentrations. In the late 1980's, the majority of exceedances occurred at sites in the Port Coquitlam / North Vancouver / Pitt Meadows area. More recently, exceedances have also been observed at sites in Surrey, Langley, Abbotsford, Chilliwack, Hope and Kelowna.
14. In contrast, Victoria, Squamish, Vancouver (Robson Square), Kamloops and Prince George did not record a single exceedance of 160 $\mu g / m^3$ between 1986-1997.
15. The highest maximum daily 8-hour average concentrations were observed in Port Coquitlam. A maximum of 239 $\mu g / m^3$ was reported at this site in 1988.

16. In lieu of a comparable Canadian objective or standard to evaluate 8-hour average concentrations in B.C., the U.K. standard of approximately 100 $\mu g / m^3$ was used. The U.K. standard was exceeded at least once per year at most sites. Exceptions included Victoria (1991-1997), Kitsilano (1996), North Delta (1991-1992, 1994) and Burnaby Kensington (1991), which recorded no exceedances during the years noted in parentheses. The most exceedances observed in any one year was 253 times in Kelowna in 1987.
17. Over the past three years (1995-1997), the fewest number of exceedances were observed in Victoria, Kitsilano, Richmond, North Delta, North Vancouver and Burnaby Kensington. The number of exceedances at these sites averaged less than 10 per year. In contrast, the highest average number of exceedances per year (identified in parentheses) occurred in Kamloops (112), Hope (97), Chilliwack (44), Langley (44) and Kelowna (42)
18. SUM06 values, which are indicative of ozone exposure over the course of the growing season, varied widely from site to site, ranging from less than 1 mg / m^3-h to 32 mg / m^3-h in Hope in 1992. In general, those sites located on the western edge of the LFV reported lower levels. SUM06 values in excess of 11.6 mg / m^3-h, the level identified to protect 95% of crops, were observed at sites at Port Moody, Port Coquitlam, Surrey, Abbotsford, Hope and Kelowna. With the exception of the Hope site, each of these exceedances occurred in 1988 or earlier. High SUM06 values at Hope have been observed as recently as 1995 (12.8 mg / m^3-h) and 1996 (11.8 mg / m^3-h).

9. REFERENCES

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Appendix I:

Ozone Monitoring Locations
and
Status

Table I-1. Summary of ozone sampler locations and status.

Region	Station ID	Station Location	Start Date	Last Date
Vancouver Island	0110000	Victoria Air1 (Cook St.)	01-Jan-76	31-Jan-83
	0110030	Victoria P.A.P.S. (Quadra St.)	26-Jan-83	active
	E223361	Duncan Mobile	01-Jul-96	24-Oct-96
Lower Mainland / GVRD	0310081	Abbotsford Airport	01-Jan-78	30-Mar-94
	0310162	Port Moody (Rocky Point Park)	01-Aug-80	active
	0310167	Anmore	01-Aug-80	active
	0310169	Eagle Ridge	01-Aug-80	active
	0310172	Squamish	05-Jul-95	active
	0310173	Chilliwack Airport	01-Feb-79	07-Mar-86
	0310174	Vancouver (Robson Square)	01-Aug-80	active
	0310175	Vancouver (Kitsilano)	01-Aug-80	active
	0310176	Vancouver (Marpole)	01-Aug-80	06-May-93
	0310177	Burnaby (Kensington Park)	05-Aug-80	active
	0310178	Burnaby (Confederation Park)	01-Aug-80	active
	0310179	North Vancouver (Second Narrows)	01-Aug-80	31-May-94
	0310180	Lions Gate	01-Feb-79	07-Mar-86
	E206167	Pemberton Clover Rd.	01-Feb-85	30-May-86
	E206169	Pitt Meadows	21-May-85	06-Mar-96
	E206269	North Delta (Annacis Island)	01-Apr-84	07-Aug-86
	E206270	Burnaby Mountain	01-Jun-84	active
	E206271	Surrey East	01-Jan-84	active
	E206612	Chilliwack (Works Yard)	17-Apr-86	18-May-94
	E206707	Langley Peterson School	12-Jun-86	22-May-91
	E207723	North Delta (116th St.)	01-Jul-87	active
	E207417	Richmond South	01-Jul-86	active
	E207418	Burnaby South	01-Oct-87	active
	E207420	Burnaby Edwards	01-Apr-90	30-Apr-90
	E207421	Port Coquitlam North	08-Jun-87	active
	E207422	Burnaby Lake (Caribou Dam)	01-May-87	30-Se p-87
	E207724	Burnaby Lake (Sperling and Sprott)	20-Apr-88	30-Sep-92
	E209177	North Vancouver (Mahon Park)	01-Apr-90	active
	E209178	Langley Central	01-Jan-94	active
	E214615	Hope	23-May-91	04-Nov-96
	E217029	Abbotsford (Downtown)	01-Feb-92	active
	E220891	Chilliwack (Airport)	01-May-94	active
	E231001	Seymour Falls	09-May-85	active
	E223756	Hope Airport	19-Aug-96	active

Table I-1. Summary of ozone sampler locations and status (continued).

Region	Station ID	Station Location	Start Date	Last Date
Southern Interior	E206898	Kamloops (Brocklehurst)	01-May-95	active
	E223885	Grand Forks Mobile	30-Oct-96	16-Apr-97
Cariboo	0550502	Williams Lake Columneetza	15-Apr-92	active
Skeena	E206589	Smithers St. Josephs	25-Jun-97	active
	E220621	Terrace (Airport)	08-Jun-94	03-Oct-94
	E223827	Kitimat Rail	08-May-97	04-Nov-97
Omineca-Peace	0450307	Prince George (Plaza 400)	28-Apr-95	active
	E225868	Prince George (Hartland Highlands)	14-Apr-97	29-Sep-97
Okanagan .	0500869	Penticton NAPS (Carmi School)	22-Nov-83	04-Jun-87
	0500886	Kelowna (Okanagan College)	04-Aug-83	active
	E222853	Vernon City Mobile	23-Dec-95	28-May-96
	E223885	Grand Forks Mobile	30-Oct-96	16-Apr-97

Appendix II:

Summary of Ozone Statistics at Selected Monitoring Sites in British Columbia

Summary of Annual and Monthly Ozone Statistics - Victoria

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	7094	0	0	10	24	42	58	66	80	138	27.9	21.2	13	1	0	0.2	0.0	0.0
87	8042	0	0	14	32	52	68	78	92	128	34.4	24.4	42	0	0	0.5	0.0	0.0
88	8114	0	0	14	34	52	70	80	94	156	35.2	24.9	32	3	0	0.4	0.0	0.0
89	7149	0	0	12	32	52	70	80	96	138	34.3	25.7	53	2	0	0.7	0.0	0.0
90	8137	0	0	12	32	50	62	68	80	130	32.0	22.6	10	0	0	0.1	0.0	0.0
91	5152	0	0	10	24	40	52	60	72	112	25.3	20.3	3	0	0	0.1	0.0	0.0
92	5717	0	0	0	24	40	52	60	72	118	24.6	20.3	5	0	0	0.1	0.0	0.0
93	8133	0	0	12	28	44	58	66	78	128	28.6	21.4	2	0	0	0.0	0.0	0.0
94	7966	0	0	14	32	50	62	70	82	142	31.7	22.6	7	1	0	0.1	0.0	0.0
95	8259	0	0	16	34	52	68	74	84	110	34.6	23.5	4	0	0	0.0	0.0	0.0
96	8342	0	0	12	34	54	68	74	86	130	34.2	25.1	11	0	0	0.1	0.0	0.0
97	6697	0	4	14	34	54	70	78	88	106	35.9	24.0	5	0	0	0.1	0.0	0.0
J	6551	0	0	8	18	36	54	60	74	88	23.0	20.0	0	0	0	0.0	0.0	0.0
F	6569	0	0	10	22	44	60	66	76	96	26.2	22.3	0	0	0	0.0	0.0	0.0
M	7332	0	0	16	38	58	70	76	84	98	38.1	24.0	0	0	0	0.0	0.0	0.0
A	7482	0	12	30	52	66	78	84	94	128	47.7	24.7	30	0	0	0.4	0.0	0.0
M	7216	0	16	36	54	67	78	84	94	138	50.5	22.8	30	1	0	0.4	0.0	0.0
J	7730	0	14	28	42	54	64	72	96	156	41.0	20.3	52	5	0	0.7	0.1	0.0
J	8106	0	10	20	32	42	54	64	88	142	32.1	18.5	32	1	0	0.4	0.0	0.0
A	8098	0	0	14	28	42	54	62	86	130	28.8	20.4	25	0	0	0.3	0.0	0.0
S	7072	0	0	2	24	42	54	62	82	116	25.9	21.7	12	0	0	0.2	0.0	0.0
O	7495	0	0	2	18	36	52	58	68	114	21.8	19.4	5	0	0	0.1	0.0	0.0
N	7500	0	0	0	20	40	56	64	74	118	24.1	21.2	1	0	0	0.0	0.0	0.0
D	7651	0	0	0	18	38	54	64	74	92	22.7	21.2	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Squamish

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	0																	
93	0																	
94	0																	
95	3153	0	0	0	18	38	54	64	84	112	23.1	22.4	5	0	0	0.2	0.0	0.0
96	8363	0	0	10	28	48	64	72	90	134	29.9	24.6	41	4	0	0.5	0.0	0.0
97	8371	0	2	6	20	40	58	68	88	154	25.7	22.2	27	6	0	0.3	0.1	0
J	1423	0	0	6	22	40	52	58	64	80	24.2	19.1	0	0	0	0.0	0.0	0.0
F	1304	0	2	10	24	40	56	64	78	86	26.7	20.3	0	0	0	0.0	0.0	0.0
M	1422	0	2	16	36	52	68	74	88	100	35.6	23.5	0	0	0	0.0	0.0	0.0
A	1380	0	4	16	36	58	70	74	82	94	37.0	24.0	0	0	0	0.0	0.0	0.0
M	1423	0	4	18	42	60	72	82	98	136	40.3	25.7	10	2	0	0.7	0.1	0.0
J	1345	0	0	12	30	52	66	74	90	110	32.8	24.2	2	0	0	0.1	0.0	0.0
J	2036	0	0	6	28	52	70	84	116	154	32.5	28.5	37	7	0	1.8	0.3	0.0
A	2131	0	0	2	24	44	62	74	104	134	27.1	25.7	24	1	0	1.1	0.0	0.0
S	2057	0	0	0	16	34	48	54	74	92	19.8	19.7	0	0	0	0.0	0.0	0.0
O	1572	0	0	0	12	24	38	46	56	68	14.7	15.1	0	0	0	0	0	0
N	1662	0	0	4	14	28	42	48	66	84	18.1	16.7	0	0	0	0.0	0.0	0.0
D	2132	0	0	8	18	34	52	58	68	78	22.3	18.6	0	0	0	0.0	0.0	0.0
Note: The following outlier was removed: 136 µg/m^3 @ 10/3/9719:00.																		

Note: All Concentrations in µg/m^3

Summary of Annual and Monthly Ozone Statistics - Vancouver Robson Square

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	8624	0	0	0	2	9	21	29	45	78	6.7	10.2	0	0	0	0.0	0.0	0.0
87	8261	0	0	1	3	10	21	28	41	60	7.2	9.6	0	0	0	0.0	0.0	0.0
88	8470	0	0	1	3	12	25	33	50	100	8.3	11.6	0	0	0	0.0	0.0	0.0
89	8337	0	0	1	3	13	26	34	50	113	8.8	11.8	2	0	0	0.0	0.0	0.0
90	7693	0	0	1	4	13	26	33	47	92	8.9	11.4	0	0	0	0.0	0.0	0.0
91	8201	0	0	1	3	16	30	39	54	99	10.1	13.5	0	0	0	0.0	0.0	0.0
92	7050	0	0	1	4	17	32	41	58	108	10.8	14.4	1	0	0	0.0	0.0	0.0
93	8003	0	1	2	4	14	28	35	52	87	9.9	12.0	0	0	0	0.0	0.0	0.0
94	8567	0	1	2	6	20	34	40	55	123	12.4	14.0	8	0	0	0.1	0.0	0.0
95	8435	0	0	2	6	18	34	42	58	82	11.8	14.0	0	0	0	0.0	0.0	0.0
96	8598	0	0	2	6	20	36	44	58	104	12.8	14.9	1	0	0	0.0	0.0	0.0
97	8515	0	0	2	4	20	38	48	64	106	12.6	16.0	1	0	0	0.0	0.0	0.0
J	8397	0	0	0	2	4	12	18	32	62	3.9	6.6	0	0	0	0.0	0.0	0.0
F	7147	0	0	0	2	8	19	28	42	64	6.2	9.5	0	0	0	0.0	0.0	0.0
M	8012	0	0	1	5	17	32	40	56	72	11.2	13.6	0	0	0	0.0	0.0	0.0
A	8504	0	0	2	10	26	40	48	61	84	15.5	16.0	0	0	0	0.0	0.0	0.0
M	8425	0	1	4	14	31	44	52	64	94	18.9	17.2	0	0	0	0.0	0.0	0.0
J	8217	0	2	3	10	23	36	42	58	113	15.0	14.4	3	0	0	0.0	0.0	0.0
J	8268	0	1	2	8	21	32	39	60	123	13.3	13.9	6	0	0	0.1	0.0	0.0
A	8268	0	0	2	6	19	31	38	58	118	11.7	13.8	4	0	0	0.0	0.0	0.0
S	8361	0	0	1	4	13	24	31	45	83	8.4	10.7	0	0	0	0.0	0.0	0.0
O	8516	0	0	1	2	7	18	25	37	54	5.9	8.3	0	0	0	0.0	0.0	0.0
N	8474	0	0	0	2	6	16	24	40	64	5.1	8.4	0	0	0	0.0	0.0	0.0
D	8165	0	0	1	2	4	12	21	39	60	4.7	7.7	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Vancouver Kitsilano

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100 ug/m3	>130 ug/m3	>160 ug/m3
86	1512	0	0	0	1	6	19	31	51	59	5.5	10.7	0	0	0	0.0	0.0	0.0
87	7052	0	0	0	6	30	50	62	78	138	17.0	21.5	11	2	0	0.2	0.0	0.0
88	7274	0	0	0	10	39	60	69	99	168	21.7	25.5	70	16	1	1.0	0.2	0.0
89	8205	0	0	1	9	39	61	73	96	166	21.6	25.9	56	8	2	0.7	0.1	0.0
90	8378	0	0	1	11	42	63	75	93	176	23.2	26.4	51	16	3	0.6	0.2	0.0
91	8593	0	0	0	9	37	60	72	90	137	20.8	25.1	38	4	0	0.4	0.0	0.0
92	8593	0	0	1	10	38	62	76	93	157	22.2	26.0	44	6	0	0.5	0.1	0.0
93	8527	0	0	2	8	34	55	65	84	127	19.3	22.7	29	0	0	0.3	0.0	0.0
94	8561	0	0	2	10	38	58	66	84	138	21.2	23.6	25	4	0	0.3	0.0	0.0
95	8059	0	0	2	10	38	58	68	84	122	21.8	23.4	15	0	0	0.2	0.0	0.0
96	8527	0	0	2	10	38	60	70	84	108	21.6	23.8	8	0	0	0.1	0.0	0.0
97	8574	0	0	0	8	36	58	70	86	138	20.3	24.2	17	1	0	0.2	0.0	0.0
J	7591	0	0	0	2	9	28	41	60	85	8.2	13.8	0	0	0	0.0	0.0	0.0
F	6796	0	0	0	3	20	45	54	65	74	12.9	18.2	0	0	0	0.0	0.0	0.0
M	7896	0	0	1	12	40	60	68	79	99	21.9	23.8	0	0	0	0.0	0.0	0.0
A	7700	0	0	5	26	56	73	80	92	139	32.2	28.0	25	1	0	0.3	0.0	0.0
M	7570	0	2	9	35	62	78	85	105	157	37.6	29.6	103	7	0	1.4	0.1	0.0
J	7113	0	1	8	28	51	66	76	98	166	31.5	25.9	58	15	2	0.8	0.2	0.0
J	7945	0	0	4	22	46	62	73	104	172	27.9	25.8	94	18	3	1.2	0.2	0.0
A	7692	0	0	2	16	41	60	73	97	176	24.4	25.4	61	15	1	0.8	0.2	0.0
S	7564	0	0	1	9	36	54	63	83	135	19.6	22.6	23	1	0	0.3	0.0	0.0
O	7642	0	0	1	4	22	44	53	66	84	13.6	17.9	0	0	0	0.0	0.0	0.0
N	7958	0	0	0	4	14	39	50	64	89	11.4	16.5	0	0	0	0.0	0.0	0.0
D	8388	0	0	0	2	10	32	47	64	76	9.0	15.2	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Richmond South

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	4318	0	1	4	12	31	46	55	76	96	18.8	18.7	0	0	0	0.0	0.0	0.0
87	8459	0	2	5	20	45	65	76	96	168	27.8	25.5	60	10	1	0.7	0.1	0.0
88	8397	0	1	4	19	45	63	70	93	154	26.3	24.9	54	9	0	0.6	0.1	0.0
89	8623	0	1	3	18	44	61	72	94	140	25.6	25.1	47	4	0	0.5	0.0	0.0
90	8679	0	1	4	24	49	63	72	91	186	28.6	25.5	51	17	3	0.6	0.2	0.0
91	8519	0	1	4	19	46	64	74	90	132	26.5	25.3	33	1	0	0.4	0.0	0.0
92	7408	0	1	3	17	44	64	74	90	142	25.6	25.3	32	1	0	0.4	0.0	0.0
93	8542	0	1	3	16	43	61	70	87	133	24.3	24.5	36	2	0	0.4	0.0	0.0
94	8508	0	1	4	23	48	63	70	86	145	27.7	24.8	26	1	0	0.3	0.0	0.0
95	8540	0	2	4	22	48	62	70	86	122	27.5	24.6	19	0	0	0.2	0.0	0.0
96	8617	0	2	4	24	48	66	74	86	118	28.3	25.1	11	0	0	0.1	0.0	0.0
97	8550	0	0	2	20	48	66	76	90	132	27.0	26.5	27	1	0	0.3	0.0	0.0
J	7950	0	1	3	8	24	43	53	64	84	15.4	17.1	0	0	0	0.0	0.0	0.0
F	7275	0	1	2	9	34	54	62	70	78	19.3	20.7	0	0	0	0.0	0.0	0.0
M	7899	0	1	4	24	52	66	72	82	111	29.2	25.4	1	0	0	0.0	0.0	0.0
A	7766	0	2	11	40	64	76	82	94	143	39.3	28.4	34	3	0	0.4	0.0	0.0
M	7904	0	2	19	47	67	80	86	99	142	44.2	28.5	74	3	0	0.9	0.0	0.0
J	7055	0	2	16	38	56	69	76	96	153	37.2	24.7	52	5	0	0.7	0.1	0.0
J	8410	0	2	12	30	49	62	74	103	149	32.2	24.2	92	7	0	1.1	0.1	0.0
A	8730	0	1	6	25	46	62	75	101	186	29.0	25.4	94	23	4	1.1	0.3	0.0
S	8396	0	1	2	18	44	58	66	92	142	24.8	23.9	49	5	0	0.6	0.1	0.0
O	8630	0	1	2	9	33	50	57	68	99	18.6	19.6	0	0	0	0.0	0.0	0.0
N	8478	0	0	2	8	28	48	56	66	80	16.6	18.8	0	0	0	0.0	0.0	0.0
D	8667	0	1	2	6	23	46	56	66	74	14.9	18.0	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - North Delta 116th St.

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	4963	0	4	7	18	33	48	57	73	107	22.2	17.6	1	0	0	0.0	0.0	0.0
88	8630	0	2	6	21	41	58	69	91	162	26.1	23.1	55	13	1	0.6	0.2	0.0
89	8615	0	2	6	22	43	59	67	87	131	26.7	22.7	32	1	0	0.4	0.0	0.0
90	8579	0	1	6	24	43	56	63	86	191	26.8	22.1	43	17	5	0.5	0.2	0.1
91	8314	0	1	5	21	41	57	65	81	106	24.9	21.8	1	0	0	0.0	0.0	0.0
92	8489	0	1	5	20	40	55	64	82	119	24.5	21.6	13	0	0	0.2	0.0	0.0
93	8514	0	1	4	18	38	54	63	80	125	23.5	21.3	15	0	0	0.2	0.0	0.0
94	8540	0	1	6	22	42	57	65	80	123	25.9	21.9	18	0	0	0.2	0.0	0.0
95	8561	0	2	6	24	42	58	66	80	128	26.6	21.8	15	0	0	0.2	0.0	0.0
96	8597	0	2	8	26	44	60	68	82	146	28.5	22.5	16	2	0	0.2	0.0	0.0
97	8582	0	2	6	22	44	60	70	86	138	26.9	23.1	19	1	0	0.2	0.0	0.0
J	7282	0	1	4	11	29	43	50	62	82	17.3	16.6	0	0	0	0.0	0.0	0.0
F	6578	0	1	4	14	39	54	61	70	78	22.0	20.9	0	0	0	0.0	0.0	0.0
M	7206	0	2	8	30	48	62	70	81	106	30.5	22.9	2	0	0	0.0	0.0	0.0
A	7044	0	6	20	40	57	70	76	86	123	39.2	23.3	10	0	0	0.1	0.0	0.0
M	7295	0	8	22	40	58	71	78	93	138	40.6	23.4	37	1	0	0.5	0.0	0.0
J	7480	0	6	19	34	49	62	70	90	160	34.9	21.3	48	5	0	0.6	0.1	0.0
J	8041	0	3	12	26	42	57	67	96	146	28.8	21.5	53	6	0	0.7	0.1	0.0
A	8041	0	2	7	22	39	56	66	93	191	25.8	22.3	56	18	5	0.7	0.2	0.1
S	7734	0	1	3	16	34	50	58	82	162	21.2	20.3	22	4	1	0.3	0.1	0.0
O	8010	0	1	3	11	28	42	49	60	93	16.8	16.4	0	0	0	0.0	0.0	0.0
N	7708	0	1	3	10	28	44	52	64	78	17.4	17.2	0	0	0	0.0	0.0	0.0
D	7965	0	0	3	10	30	46	53	63	74	17.5	17.7	0	0	0	0.0	0.0	0.0
Note: The following outliers were removed: 389 µg/m^3 @ 3/26/97 19:00; 219 µg/m^3 at 3/26/97 20:00																		

Note: All Concentrations in µg/m^3

Summary of Annual and Monthly Ozone Statistics - Burnaby Kensington Park

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	7319	0	0	3	15	34	52	65	85	130	21.4	21.6	21	0	0	0.3	0.0	0.0
87	8444	0	2	6	19	37	52	62	83	163	23.5	20.5	27	4	1	0.3	0.0	0.0
88	8626	0	1	5	19	38	55	64	95	210	24.1	23.0	75	30	11	0.9	0.3	0.1
89	8499	0	1	5	19	39	55	66	87	149	24.3	21.9	32	4	0	0.4	0.0	0.0
90	8527	0	2	7	21	39	54	62	83	206	25.1	21.2	40	16	5	0.5	0.2	0.1
91	8115	0	1	4	18	37	53	62	79	116	22.7	20.7	5	0	0	0.1	0.0	0.0
92	8591	0	1	5	19	39	56	66	86	138	24.5	22.1	26	6	0	0.3	0.1	0.0
93	8525	0	2	5	19	39	55	64	83	130	24.1	21.3	20	0	0	0.2	0.0	0.0
94	8282	0	2	8	22	40	56	64	82	149	25.9	21.3	32	8	0	0.4	0.1	0.0
95	8544	0	2	8	22	40	56	64	80	122	25.8	20.9	19	0	0	0.2	0.0	0.0
96	8322	0	2	8	24	42	60	68	84	142	27.7	22.0	14	2	0	0.2	0.0	0.0
97	8403	0	2	8	22	40	56	68	84	130	26.0	21.5	17	0	0	0.2	0.0	0.0
J	8585	0	0	2	9	25	39	46	60	80	15.1	15.6	0	0	0	0.0	0.0	0.0
F	7355	0	0	4	14	33	48	56	70	82	19.9	18.8	0	0	0	0.0	0.0	0.0
M	8313	0	3	12	28	44	58	64	76	106	29.3	20.3	1	0	0	0.0	0.0	0.0
A	8421	0	8	20	36	53	66	72	85	153	36.8	21.5	13	1	0	0.2	0.0	0.0
M	8393	0	8	20	38	56	70	78	95	169	39.1	23.2	52	7	1	0.6	0.1	0.0
J	8121	0	6	14	29	45	61	70	91	154	31.7	21.7	53	11	0	0.7	0.1	0.0
J	8576	0	3	9	23	41	58	70	102	158	27.6	23.0	92	16	0	1.1	0.2	0.0
A	8427	0	2	6	20	39	58	70	99	210	25.6	23.7	75	23	10	0.9	0.3	0.1
S	8314	0	1	4	17	35	52	61	88	190	22.3	21.3	42	12	6	0.5	0.1	0.1
O	8459	0	1	3	11	26	40	48	60	89	16.2	16.0	0	0	0	0.0	0.0	0.0
N	8448	0	1	3	10	26	41	50	60	75	16.1	16.1	0	0	0	0.0	0.0	0.0
D	8785	0	0	2	9	26	42	50	62	72	15.9	16.6	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - North Vancouver Mahon Park

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	6455	0	2	7	21	40	60	70	94	190	26.4	23.9	52	22	8	0.8	0.3	0.1
91	7772	0	2	5	18	39	58	68	86	135	24.1	22.7	36	2	0	0.5	0.0	0.0
92	8404	0	2	5	21	44	61	72	91	183	27.0	24.2	46	9	3	0.5	0.1	0.0
93	8494	0	2	4	17	40	56	65	85	142	23.8	22.2	34	1	0	0.4	0.0	0.0
94	8303	0	2	6	22	40	57	66	85	157	25.9	21.9	27	6	0	0.3	0.1	0.0
95	8579	0	2	6	20	40	56	66	82	122	25.3	21.9	16	0	0	0.2	0.0	0.0
96	8298	0	2	6	20	40	58	68	86	154	25.7	22.8	29	9	0	0.3	0.1	0.0
97	8572	0	2	6	22	42	60	70	86	130	26.5	22.5	20	0	0	0.2	0.0	0.0
J	5017	0	0	2	8	26	42	50	61	74	15.5	16.2	0	0	0	0.0	0.0	0.0
F	4633	0	2	4	13	34	52	60	72	84	20.4	19.8	0	0	0	0.0	0.0	0.0
M	4334	0	2	10	28	50	63	70	80	92	30.9	22.8	0	0	0	0.0	0.0	0.0
A	5592	0	8	22	40	56	70	78	88	135	39.6	22.9	14	1	0	0.3	0.0	0.0
M	5840	0	8	21	40	60	75	83	102	142	41.6	25.0	60	2	0	1.0	0.0	0.0
J	5427	0	5	14	29	47	64	72	93	183	32.4	22.6	27	6	3	0.5	0.1	0.1
J	5825	0	2	7	22	42	58	71	106	188	27.0	24.1	73	17	4	1.3	0.3	0.1
A	5822	0	2	6	20	40	59	71	106	190	26.1	24.4	68	22	4	1.2	0.4	0.1
S	5642	0	1	3	13	33	50	60	82	142	20.2	20.5	18	1	0	0.3	0.0	0.0
O	5690	0	2	4	12	29	43	50	61	82	17.9	16.5	0	0	0	0.0	0.0	0.0
N	5446	0	2	3	10	25	40	48	62	76	15.7	15.8	0	0	0	0.0	0.0	0.0
D	5609	0	2	4	12	30	46	54	64	78	18.3	17.6	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Port Moody

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	8398	0	0	0	8	37	64	80	122	262	22.1	29.1	187	56	14	2.2	0.7	0.2
87	8451	0	0	1	9	37	62	76	108	191	21.6	27.1	136	18	3	1.6	0.2	0.0
88	8531	0	0	1	9	40	67	82	131	298	23.9	31.6	228	86	42	2.7	1.0	0.5
89	8625	0	0	1	9	40	67	81	116	202	23.3	29.1	169	37	3	2.0	0.4	0.0
90	8609	0	0	2	11	38	63	76	108	207	23.0	27.4	115	39	15	1.3	0.5	0.2
91	8466	0	0	2	9	36	59	72	96	152	21.2	24.8	64	7	0	0.8	0.1	0.0
92	8592	0	0	2	8	36	62	76	102	161	21.5	26.3	90	18	1	1.0	0.2	0.0
93	7650	0	1	2	8	35	58	69	95	160	20.8	24.4	62	8	0	0.8	0.1	0.0
94	8375	0	1	2	11	38	59	71	92	172	22.1	24.6	53	14	5	0.6	0.2	0.1
95	8164	0	0	2	12	36	58	70	88	156	21.6	23.8	32	7	0	0.4	0.1	0.0
96	8532	0	0	2	12	38	60	72	94	158	22.8	24.8	41	7	0	0.5	0.1	0.0
97	8311	0	0	2	10	36	58	70	88	148	21.1	24.0	17	2	0	0.2	0.0	0.0
J	8581	0	0	1	3	11	29	40	56	82	9.0	13.2	0	0	0	0.0	0.0	0.0
F	7356	0	0	1	4	21	44	58	76	90	13.8	19.3	0	0	0	0.0	0.0	0.0
M	8670	0	0	2	15	44	62	70	84	100	24.0	24.8	0	0	0	0.0	0.0	0.0
A	8436	0	0	5	31	57	73	81	97	154	33.9	28.4	58	12	0	0.7	0.1	0.0
M	8674	0	2	10	36	61	79	88	114	197	38.2	30.1	184	25	6	2.1	0.3	0.1
J	8313	0	2	8	28	52	74	88	122	202	33.8	29.3	216	56	8	2.6	0.7	0.1
J	8395	0	0	4	21	47	72	90	130	245	30.0	31.1	288	81	23	3.4	1.0	0.3
A	8567	0	0	2	15	45	70	89	132	298	27.4	32.2	303	90	33	3.5	1.1	0.4
S	8288	0	0	1	8	36	58	74	109	252	21.4	27.0	133	33	12	1.6	0.4	0.1
O	8646	0	0	1	3	20	38	48	67	191	12.4	17.2	12	2	1	0.1	0.0	0.0
N	8418	0	0	1	4	14	36	46	61	76	10.8	15.0	0	0	0	0.0	0.0	0.0
D	8360	0	0	1	3	10	32	44	62	74	9.4	14.4	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Port Coquitlam

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	2664	0	0	6	22	48	84	108	142	210	32.5	34.7	171	48	5	6.4	1.8	0.2
88	3983	0	2	10	32	58	80	96	154	425	38.6	35.6	176	75	27	4.4	1.9	0.7
89	6116	0	1	3	17	41	62	76	102	141	25.1	25.5	65	6	0	1.1	0.1	0.0
90	7704	0	0	5	23	46	61	72	110	260	28.2	26.2	103	48	12	1.3	0.6	0.2
91	8425	0	0	2	19	44	64	76	97	165	26.0	25.9	66	10	1	0.8	0.1	0.0
92	8065	0	1	3	19	43	65	79	106	161	26.5	26.8	105	26	1	1.3	0.3	0.0
93	8097	0	0	3	17	41	60	69	92	146	24.2	24.2	49	6	0	0.6	0.1	0.0
94	8612	0	1	4	20	42	58	68	90	213	25.8	24.1	50	18	10	0.6	0.2	0.1
95	8623	0	0	4	20	42	58	68	92	164	25.5	23.6	57	12	2	0.7	0.1	0.0
96	8633	0	0	6	22	44	62	72	98	168	27.3	24.4	67	16	1	0.8	0.2	0.0
97	8649	0	0	4	18	40	60	72	92	160	24.8	24.2	49	11	0	0.6	0.1	0.0
J	4985	0	0	2	6	28	42	48	58	72	15.0	16.9	0	0	0	0.0	0.0	0.0
F	4962	0	0	2	13	38	56	62	80	93	21.4	22.4	0	0	0	0.0	0.0	0.0
M	5866	0	0	4	29	52	66	74	85	106	30.6	25.3	4	0	0	0.1	0.0	0.0
A	7019	0	4	14	41	59	72	79	93	134	38.8	25.6	28	1	0	0.4	0.0	0.0
M	7316	0	7	19	40	60	77	87	110	161	41.1	26.9	151	25	1	2.1	0.3	0.0
J	7301	0	4	14	29	49	70	82	126	202	34.3	26.8	166	57	5	2.3	0.8	0.1
J	7934	0	3	10	22	46	72	91	139	260	31.3	30.4	285	108	25	3.6	1.4	0.3
A	7876	0	1	6	17	42	69	87	126	289	27.6	29.6	217	61	18	2.8	0.8	0.2
S	7519	0	0	2	10	34	56	70	106	425	21.1	26.6	107	24	10	1.4	0.3	0.1
O	6332	0	0	1	9	29	44	50	60	94	16.2	17.7	0	0	0	0.0	0.0	0.0
N	6187	0	0	2	10	30	44	49	61	74	16.9	17.3	0	0	0	0.0	0.0	0.0
D	6274	0	0	2	10	34	48	54	63	72	18.3	19.1	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Surrey East

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	8302	0	2	11	27	46	62	71	95	145	30.2	23.2	60	6	0	0.7	0.1	0.0
87	8179	0	2	12	32	53	73	85	106	168	35.4	27.1	128	19	2	1.6	0.2	0.0
88	8289	0	2	12	33	57	78	90	131	317	37.5	31.2	229	83	30	2.8	1.0	0.4
89	7825	0	2	12	31	53	70	81	109	171	34.7	26.7	122	24	3	1.6	0.3	0.0
90	8450	0	4	13	30	51	66	76	110	213	33.7	25.3	114	40	7	1.3	0.5	0.1
91	8434	0	3	12	31	51	68	80	100	152	34.1	25.1	77	3	0	0.9	0.0	0.0
92	8565	0	3	11	29	50	69	79	104	162	32.8	25.6	100	8	1	1.2	0.1	0.0
93	8415	0	3	10	30	51	69	77	97	156	32.9	25.4	71	8	0	0.8	0.1	0.0
94	8512	0	2	13	32	51	66	76	95	157	33.8	24.5	55	16	0	0.6	0.2	0.0
95	8513	0	4	14	32	52	68	78	94	140	34.6	24.3	52	4	0	0.6	0.0	0.0
96	8585	0	4	18	36	54	70	80	96	186	37.2	24.9	57	19	7	0.7	0.2	0.1
97	8421	0	2	12	30	52	68	80	98	150	33.7	25.1	66	7	0	0.8	0.1	0.0
J	8626	0	2	6	23	41	54	61	71	88	25.3	19.9	0	0	0	0.0	0.0	0.0
F	7729	0	1	6	26	48	63	70	78	84	28.7	23.4	0	0	0	0.0	0.0	0.0
M	8536	0	4	20	40	59	72	79	89	106	39.7	24.5	10	0	0	0.1	0.0	0.0
A	8120	0	16	31	49	68	81	88	99	117	49.0	24.2	61	0	0	0.8	0.0	0.0
M	8368	0	18	31	48	68	83	91	111	162	49.7	25.0	197	17	1	2.4	0.2	0.0
J	8219	0	14	26	40	58	76	87	120	171	43.5	24.8	198	46	4	2.4	0.6	0.0
J	8672	0	9	18	32	54	75	90	127	242	38.4	27.7	263	70	17	3.0	0.8	0.2
A	8680	0	6	16	32	55	76	91	126	217	37.6	28.6	253	66	18	2.9	0.8	0.2
S	8049	0	3	11	27	48	67	78	112	317	32.1	26.7	137	37	10	1.7	0.5	0.1
O	8422	0	2	5	18	36	53	60	74	137	22.6	20.1	12	1	0	0.1	0.0	0.0
N	8380	0	1	4	18	38	52	60	70	88	22.7	19.9	0	0	0	0.0	0.0	0.0
D	8689	0	1	4	16	36	54	61	69	80	21.9	20.1	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Langley Central

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	0																	
93	0																	
94	8401	0	2	12	38	56	72	83	105	187	37.5	27.5	114	27	5	1.4	0.3	0.1
95	7195	0	2	16	40	60	74	82	106	162	39.2	27.0	104	15	1	1.4	0.2	0.0
96	8604	0	2	20	42	60	74	82	104	188	41.3	26.5	99	23	7	1.2	0.3	0.1
97	8577	0	2	12	36	56	72	82	100	158	36.9	26.6	84	11	0	1.0	0.1	0.0
J	2192	0	2	10	34	50	62	68	74	90	32.3	22.2	0	0	0	0.0	0.0	0.0
F	2003	0	2	12	44	60	70	74	80	84	38.6	25.0	0	0	0	0.0	0.0	0.0
M	2891	0	6	28	54	68	78	82	92	110	48.1	25.6	5	0	0	0.2	0.0	0.0
A	2817	0	8	34	56	72	82	88	98	118	51.1	26.2	18	0	0	0.6	0.0	0.0
M	2924	0	8	30	54	72	86	94	114	158	50.9	28.5	79	11	0	2.7	0.4	0.0
J	2818	0	4	26	44	62	78	88	110	162	44.3	27.0	54	13	1	1.9	0.5	0.0
J	2927	0	2	16	34	60	80	98	144	188	40.4	31.7	139	44	9	4.7	1.5	0.3
A	2918	0	2	12	32	56	74	88	116	182	36.4	28.8	78	8	3	2.7	0.3	0.1
S	2825	0	1	4	26	48	66	76	100	124	29.9	25.8	28	0	0	1.0	0.0	0.0
O	2748	0	1	6	26	46	56	62	70	78	27.4	21.1	0	0	0	0.0	0.0	0.0
N	2796	0	2	10	28	46	58	64	72	80	28.8	20.6	0	0	0	0.0	0.0	0.0
D	2918	0	2	16	36	51	62	66	72	78	34.0	21.2	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Abbotsford Library

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	7802	0	2	5	18	46	66	79	111	169	27.6	27.2	127	24	1	1.6	0.3	0.0
93	8538	0	1	4	16	42	62	71	95	157	24.8	24.8	71	13	0	0.8	0.2	0.0
94	8183	0	1	4	20	44	63	72	94	178	26.9	25.3	49	18	3	0.6	0.2	0.0
95	8331	0	2	4	20	46	64	74	94	164	27.3	25.0	50	5	1	0.6	0.1	0.0
96	8564	0	0	4	22	48	66	74	98	156	28.4	26.0	78	17	0	0.9	0.2	0.0
97	8552	0	0	4	18	42	60	70	92	136	25.1	24.2	46	4	0	0.5	0.0	0.0
J	3645	0	0	2	8	28	50	58	68	84	17.4	19.3	0	0	0	0.0	0.0	0.0
F	3998	0	2	4	14	48	66	73	80	82	25.2	25.2	0	0	0	0.0	0.0	0.0
M	4307	0	2	7	26	53	68	74	83	94	31.2	25.1	0	0	0	0.0	0.0	0.0
A	4222	0	4	16	38	58	70	76	84	122	37.5	24.4	5	0	0	0.1	0.0	0.0
M	4269	0	6	18	40	60	78	88	113	153	41.5	27.6	99	11	0	2.3	0.3	0.0
J	4220	0	4	14	32	52	70	80	104	164	34.9	25.1	50	7	1	1.2	0.2	0.0
J	4382	0	2	8	24	46	73	90	129	178	31.7	29.5	148	39	4	3.4	0.9	0.1
A	4363	0	1	5	20	44	66	80	114	158	27.8	27.2	78	17	0	1.8	0.4	0.0
S	3948	0	0	2	12	35	54	63	101	151	21.0	23.5	41	7	0	1.0	0.2	0.0
O	4274	0	0	1	7	28	44	52	62	98	15.5	17.6	0	0	0	0.0	0.0	0.0
N	4216	0	0	2	6	26	46	54	66	76	15.6	18.2	0	0	0	0.0	0.0	0.0
D	4126	0	0	2	9	34	52	58	66	74	18.7	20.0	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Chilliwack

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	6010	0	0	3	18	42	63	76	112	168	26.1	26.6	97	25	2	1.6	0.4	0.0
87	7398	0	0	3	21	48	75	94	130	197	30.2	31.7	288	69	15	3.9	0.9	0.2
88	8565	0	0	5	25	55	79	91	127	208	33.3	32.0	259	75	16	3.0	0.9	0.2
89	8496	0	0	3	23	52	73	85	114	195	30.8	30.0	178	34	4	2.1	0.4	0.0
90	8499	0	0	5	24	48	65	74	112	179	29.3	26.7	123	56	11	1.4	0.7	0.1
91	7032	0	1	4	24	50	72	83	102	148	30.7	28.2	75	13	0	1.1	0.2	0.0
92	6532	0	0	4	21	45	67	81	121	202	28.5	28.4	138	39	6	2.1	0.6	0.1
93	5337	0	0	3	18	45	66	73	86	131	26.3	25.3	19	1	0	0.4	0.0	0.0
94	5718	0	1	4	24	48	70	82	110	190	30.3	28.5	106	29	10	1.9	0.5	0.2
95	8438	0	0	6	26	48	68	78	98	178	30.4	26.0	77	14	3	0.9	0.2	0.0
96	8547	0	0	6	28	50	66	74	106	168	31.3	26.4	99	40	7	1.2	0.5	0.1
97	8381	0	0	6	22	44	64	74	96	142	27.3	24.7	69	4	0	0.8	0.0	0.0
J	2169	0	0	4	24	42	54	60	68	88	24.7	20.5	0	0	0	0.0	0.0	0.0
F	1934	0	2	8	26	48	64	74	84	86	30.1	24.0	0	0	0	0.0	0.0	0.0
M	2177	0	4	20	40	60	74	80	86	108	39.7	24.5	2	0	0	0.1	0.0	0.0
A	2116	0	8	24	42	64	74	80	86	100	42.7	24.1	0	0	0	0.0	0.0	0.0
M	2867	0	4	20	42	64	78	86	108	132	42.2	27.4	49	1	0	1.7	0.0	0.0
J	2753	0	2	14	34	54	72	82	106	178	36.4	26.8	41	9	3	1.5	0.3	0.1
J	2890	0	1	8	26	56	84	106	148	190	36.2	35.0	177	68	17	6.1	2.4	0.6
A	2896	0	0	4	22	46	70	86	114	152	29.0	28.9	69	9	0	2.4	0.3	0.0
S	2823	0	0	2	14	38	58	68	91	120	22.1	23.8	13	0	0	0.5	0.0	0.0
O	2746	0	0	2	12	32	46	54	62	78	18.2	18.1	0	0	0	0.0	0.0	0.0
N	2805	0	0	2	14	32	46	52	66	78	19.1	18.0	0	0	0	0.0	0.0	0.0
D	2908	0	0	4	16	36	51	57	66	74	21.2	19.2	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Hope

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	3149	0	0	0	26	48	68	80	110	142	29.7	28.1	48	8	0	1.5	0.3	0.0
92	5309	0	0	0	14	36	60	76	108	176	22.2	26.7	79	23	3	1.5	0.4	0.1
93	7396	0	0	0	14	40	64	74	98	176	22.7	26.6	67	9	2	0.9	0.1	0.0
94	7990	0	0	0	20	48	72	84	112	198	28.2	30.1	154	28	8	1.9	0.4	0.1
95	8000	0	0	0	24	52	76	84	120	206	30.5	31.2	164	48	9	2.1	0.6	0.1
96	6126	0	0	0	28	54	76	86	124	188	32.6	31.5	125	49	16	2.0	0.8	0.3
97	8340	0	0	4	24	50	72	82	108	166	30.9	28.5	122	23	2	1.5	0.3	0.0
J	3121	0	0	0	10	32	50	62	74	100	17.8	21.3	0	0	0	0.0	0.0	0.0
F	2471	0	0	0	12	40	68	76	82	98	22.6	25.9	0	0	0	0.0	0.0	0.0
M	2998	0	0	0	20	54	72	80	90	106	28.7	28.7	2	0	0	0.1	0.0	0.0
A	2555	0	0	0	36	64	78	82	90	114	36.5	30.0	6	0	0	0.2	0.0	0.0
M	2836	0	0	16	46	72	86	96	126	158	45.4	33.2	119	19	0	4.2	0.7	0.0
J	3397	0	0	14	38	60	80	92	122	206	39.4	30.7	104	19	6	3.1	0.6	0.2
J	3294	0	0	12	34	62	92	114	160	198	41.3	37.4	256	99	28	7.8	3.0	0.9
A	4118	0	0	0	26	50	76	90	122	176	31.3	31.0	116	21	4	2.8	0.5	0.1
S	4036	0	0	0	18	42	60	74	100	144	23.7	26.2	32	5	0	0.8	0.1	0.0
O	3607	0	0	0	10	24	42	52	70	90	14.4	18.4	0	0	0	0.0	0.0	0.0
N	2762	0	0	0	0	22	42	54	70	160	13.1	18.8	2	2	0	0.1	0.1	0.0
D	2775	0	0	0	0	32	52	60	74	90	16.7	21.5	0	0	0	0.0	0.0	0.0
Note: The following outliers were removed: 156 µg/m^3 @ 3/18/92 12:00; 214 µg/m^3 @ 11/12/94 21:00; 174 µg/m^3 @ 9/10/96 11:00.																		

Note: All Concentrations in µg/m^3

Summary of Annual and Monthly Ozone Statistics - Kamloops Brocklehurst

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	0																	
93	0																	
94	0																	
95	5636	0	0	12	36	60	78	88	108	140	38.1	29.9	119	4	0	2.1	0.1	0.0
96	8415	0	0	14	40	66	84	94	110	154	40.8	31.2	190	13	0	2.3	0.2	0.0
97	8013	0	4	12	36	62	84	94	110	148	39.6	30.1	227	7	0	2.8	0.1	0.0
J	1429	0	0	4	22	44	62	70	76	86	26.5	22.9	0	0	0	0.0	0.0	0.0
F	1314	0	0	2	14	38	64	74	84	88	22.6	24.6	0	0	0	0.0	0.0	0.0
M	1422	0	4	30	58	76	88	94	104	110	52.6	29.6	21	0	0	1.5	0.0	0.0
A	1380	0	16	35	62	86	98	102	114	118	59.6	30.4	96	0	0	7.0	0.0	0.0
M	2138	0	18	36	64	84	100	106	124	148	61.0	30.9	189	5	0	8.8	0.2	0.0
J	2068	0	20	36	58	78	92	100	114	140	57.3	27.5	97	2	0	4.7	0.1	0.0
J	2140	0	12	28	50	70	86	96	108	138	49.9	27.3	47	3	0	2.2	0.1	0.0
A	2143	0	6	20	42	62	82	92	124	154	43.4	28.6	72	14	0	3.4	0.7	0.0
S	2067	0	0	10	30	52	68	78	96	124	32.2	26.2	14	0	0	0.7	0.0	0.0
O	2139	0	0	4	24	46	58	64	76	90	26.6	22.5	0	0	0	0.0	0.0	0.0
N	1694	0	0	0	10	32	54	60	76	86	18.2	21.5	0	0	0	0.0	0.0	0.0
D	2130	0	0	0	16	38	58	68	74	82	22.5	22.1	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Kelowna Okanagan College

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	4226	0	0	10	30	50	70	80	90	130	33.6	25.4	13	0	0	0.3	0.0	0.0
87	7220	0	10	10	40	70	90	100	120	160	44.6	32.7	288	20	0	4.0	0.3	0.0
88	7626	0	10	20	40	60	80	90	110	140	42.4	29.2	133	2	0	1.7	0.0	0.0
89	7654	0	0	12	28	52	68	78	102	160	32.8	26.1	80	17	0	1.0	0.2	0.0
90	7140	0	0	0	16	34	50	60	82	144	20.8	21.5	17	5	0	0.2	0.1	0.0
91	4619	0	0	0	10	26	48	62	84	120	16.5	21.4	8	0	0	0.2	0.0	0.0
92	6940	0	0	0	26	54	76	86	104	160	32.2	29.7	105	4	0	1.5	0.1	0.0
93	8262	0	0	10	28	50	68	78	98	156	31.3	26.0	57	5	0	0.7	0.1	0.0
94	7400	0	0	10	32	58	76	90	116	178	36.3	30.5	218	25	2	2.9	0.3	0.0
95	8379	0	0	10	34	58	76	84	98	124	35.2	28.4	51	0	0	0.6	0.0	0.0
96	8411	0	0	12	34	58	76	86	104	146	36.2	29.0	116	8	0	1.4	0.1	0.0
97	8357	0	0	10	30	54	76	88	106	168	34.4	28.5	147	6	1	1.8	0.1	0.0
J	7133	0	0	0	18	36	50	58	70	94	21.4	19.2	0	0	0	0.0	0.0	0.0
F	6741	0	0	0	20	46	60	68	82	160	25.5	23.7	3	2	0	0.0	0.0	0.0
M	7264	0	0	10	30	58	74	80	90	118	34.1	27.7	10	0	0	0.1	0.0	0.0
A	5963	0	10	26	52	76	90	98	110	152	51.0	30.0	141	8	0	2.4	0.1	0.0
M	8126	0	14	32	54	76	90	100	120	156	54.2	29.4	374	17	0	4.6	0.2	0.0
J	7307	0	16	30	50	70	86	96	112	160	50.3	26.8	187	6	0	2.6	0.1	0.0
J	6457	0	12	26	46	66	86	100	120	150	48.0	28.1	236	23	0	3.7	0.4	0.0
A	6835	0	4	18	40	62	82	96	122	178	42.1	30.0	234	35	3	3.4	0.5	0.0
S	7884	0	0	4	22	50	68	78	98	130	29.2	26.5	47	0	0	0.6	0.0	0.0
O	7923	0	0	0	10	30	50	60	70	152	17.0	20.0	1	1	0	0.0	0.0	0.0
N	7033	0	0	0	12	28	42	50	66	84	16.7	17.5	0	0	0	0.0	0.0	0.0
D	7568	0	0	0	14	30	46	50	64	90	18.0	18.2	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Williams Lake Columneetza

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	5422	0	0	12	34	58	70	78	100	168	35.7	27.2	53	7	2	1.0	0.1	0.0
93	8334	0	0	12	30	60	78	88	102	140	35.5	29.3	85	1	0	1.0	0.0	0.0
94	8112	0	0	16	40	66	80	88	102	136	41.6	28.9	95	3	0	1.2	0.0	0.0
95	8362	0	0	10	30	60	76	84	96	124	34.9	29.2	43	0	0	0.5	0.0	0.0
96	8183	0	0	12	34	60	78	86	98	122	37.3	29.2	67	0	0	0.8	0.0	0.0
97	8390	0	2	8	32	58	78	88	100	118	35.7	28.9	82	0	0	1.0	0.0	0.0
J	3558	0	0	6	18	38	54	62	70	86	23.0	20.0	0	0	0	0.0	0.0	0.0
F	3238	0	0	12	34	56	72	78	90	98	35.0	25.8	0	0	0	0.0	0.0	0.0
M	3558	0	10	24	56	78	88	92	102	112	50.9	30.3	48	0	0	1.3	0.0	0.0
A	3800	0	0	22	56	80	90	94	104	140	51.7	31.5	54	1	0	1.4	0.0	0.0
M	4298	0	0	26	54	78	92	98	110	136	51.5	31.6	154	2	0	3.6	0.0	0.0
J	4146	0	0	22	48	70	84	92	108	168	46.8	29.0	107	4	2	2.6	0.1	0.0
J	4104	0	0	16	40	60	74	82	100	158	39.5	27.1	39	4	0	1.0	0.1	0.0
A	4229	0	0	10	34	56	70	78	94	116	34.6	27.2	16	0	0	0.4	0.0	0.0
S	3588	0	0	0	24	54	68	76	88	102	29.6	27.0	2	0	0	0.1	0.0	0.0
O	4098	0	0	0	20	48	62	68	80	126	26.3	24.5	5	0	0	0.1	0.0	0.0
N	3908	0	0	0	18	42	58	66	76	84	23.8	22.2	0	0	0	0.0	0.0	0.0
D	4278	0	0	6	22	50	64	68	74	80	27.9	23.8	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual and Monthly Ozone Statistics - Prince George Plaza 400

Year/	No.		Percentiles										No. Exceedances			Exceedance Freq. (%)		
Month	Hours	Min.	10th	25th	50th	75th	90th	95th	99th	Max.	Mean	Std.	>100 ug/m3	>130 ug/m3	>160 ug/m3	>100	>130	>160
86	0																	
87	0																	
88	0																	
89	0																	
90	0																	
91	0																	
92	0																	
93	0																	
94	0																	
95	5548	0	0	0	26	48	66	78	96	112	29.4	26.3	28	0	0	0.5	0.0	0.0
96	8290	0	0	10	34	56	74	82	94	120	34.3	27.7	21	0	0	0.3	0.0	0.0
97	8358	0	2	8	34	58	74	82	96	120	35.2	27.2	54	0	0	0.6	0.0	0.0
J	1423	0	0	4	18	40	54	60	68	80	22.9	20.5	0	0	0	0.0	0.0	0.0
F	1250	0	0	2	20	46	64	72	84	96	26.4	25.1	0	0	0	0.0	0.0	0.0
M	1419	0	10	36	64	76	86	90	96	106	55.3	27.8	3	0	0	0.2	0.0	0.0
A	1429	0	6	28	60	78	90	96	106	118	54.0	30.4	44	0	0	3.1	0.0	0.0
M	2004	0	10	31	58	74	84	90	102	112	53.0	27.6	25	0	0	1.2	0.0	0.0
J	2056	0	2	22	47	64	78	84	96	112	44.0	26.2	10	0	0	0.5	0.0	0.0
J	2124	0	0	16	34	50	64	74	94	120	33.8	23.5	16	0	0	0.8	0.0	0.0
A	2136	0	0	2	28	44	58	66	84	120	27.8	22.7	3	0	0	0.1	0.0	0.0
S	2055	0	0	0	18	42	58	68	86	110	23.8	23.7	2	0	0	0.1	0.0	0.0
O	2119	0	0	2	24	40	50	58	68	74	24.1	19.8	0	0	0	0.0	0.0	0.0
N	2041	0	0	0	14	34	50	54	64	68	19.2	19.2	0	0	0	0.0	0.0	0.0
D	2140	0	0	0	18	46	62	68	74	82	25.1	24.4	0	0	0	0.0	0.0	0.0

Note: All Concentrations in $\mu g/m^3$

Summary of Annual Maximum SUM06 Values

	Maximum Annual SUM06 Value (mg/m^3-h)											
Site\Year	86	87	88	89	90	91	92	93	94	95	96	97
Victoria	0.7	0.9	0.8	1.1	0.3	0.0	0.2	0.1	0.2	0.0	0.3	0.0
Squamish										0.0	2.5	1.5
Vancouver Robson Square	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
Vancouver Kitsilano		3.2	3.4	2.0	3.5	0.7	3.1	0.4	1.3	0.3	0.0	0.4
Richmond South	0.0	2.6	2.3	1.3	3.6	0.9	1.3	0.9	1.0	0.2	0.1	0.7
North Delta 116th Street		0.0	2.7	0.9	3.7	0.0	0.3	0.8	0.2	0.3	0.8	0.5
Burnaby Kensington Park	0.4	0.9	4.5	1.5	3.3	0.0	1.4	0.3	2.7	0.2	1.2	0.4
North Vancouver Mahon Park					4.1	1.1	3.0	1.2	1.2	0.5	2.3	0.6
Port Moody Rocky Point Park	13.8	3.4	15.8	8.0	8.5	2.9	5.0	2.3	3.2	2.6	2.2	0.0
Port Coquitlam		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surrey East	2.9	4.4	17.6	6.0	9.1	1.9	3.1	3.3	3.1	1.8	3.9	3.2
Langley Central									6.1	3.7	5.8	3.5
Abbotsford Library							6.7	2.9	3.3	2.3	5.0	1.4
Chilliwack	5.5	14.2	12.9	7.0	10.9	2.9	10.3	0.4	6.1	3.6	9.0	2.5
Hope						2.2	31.6	4.0	8.2	12.8	11.7	5.0
Kamloops Brocklehurst										2.8	5.2	3.7
Kelowna OK College	0.0	12.7	4.4	2.0	0.9	0.0	3.2	1.9	9.0	0.6	3.8	2.1
Williams Lake Columneetza							2.0	0.8	0.7	0.5	0.4	0.1
Prince George Plaza 400										0.0	0.4	0.3

Exceedances of UK 8-Hour Ozone Standard

	Number of 8-hour averages >100 μg/m^3											
Site\Year	86	87	88	89	90	91	92	93	94	95	96	97
Victoria	2	5	9	29	2	0	0	0	0	0	0	0
Squamish										0	25	15
Vancouver Robson Square	0	0	0	0	0	0	0	0	0	0	0	0
Vancouver Kitsilano	0	1	25	17	17	3	25	4	5	2	0	4
Richmond South	0	16	20	13	27	7	12	10	7	4	1	12
North Delta 116th Street		0	31	10	29	0	0	5		5	12	8
Burnaby Kensington Park	2	5	47	13	28	0	10	4	18	3	4	6
North Vancouver Mahon Park	0	0	0	0	26	4	23	8	10	3	15	9
Port Moody Rocky Point Park	117	41	149	84	68	16	52	25	25	16	13	6
Port Coquitlam		83	112	10	66	11	56	15	35	31	29	21
Surrey East	23	47	158	62	81	32	45	33	31	25	38	33
Langley Central									53	38	51	42
Abbotsford Library							66	25	26	17	37	21
Chilliwack	48	166	156	95	81	30	94	6	52	33	68	30
Hope						16	55	42	97	127	92	72
Kamloops Brocklehurst										67	122	146
Kelowna OK College	10	253	89	30	5	2	56	30	135	14	51	60
Williams Lake Columneetza							33	22	38	21	37	38
Prince George Plaza 400										8	9	18