

2002 National Summary of Ambient PM_{2.5} and Ozone

Report prepared for the Joint Action
Implementation Co-ordinating Committee

by

Environment Canada

September, 2004



Executive Summary

This is the second annual National Summary on ambient fine particulate (PM_{2.5}) and ozone. Its main objective is to summarise the PM_{2.5} and ozone data collected in 2002 in a form that is consistent with the Canada-wide Standards (CWS) numerics, but the achievement status of the CWS is not evaluated. All PM_{2.5} and ozone levels discussed in the report are in relation to the daily 24-hour average concentration for PM_{2.5} (represented by *daily 24-hour PM_{2.5}*) and to the daily maximum 8-hour average concentration for ozone (*Dmax 8-hour O₃*).

In 2002, the 98th percentile of the daily 24-hour PM_{2.5} was 7.6 µg/m³ at Whitehorse and ranged from 9.4 to 31.6 µg/m³ in British Columbia, 8.0 to 24.9 µg/m³ in Alberta, 16.7 to 21.9 µg/m³ in the Saskatchewan - Manitoba region, 23.1 to 41.0 µg/m³ in Ontario, 26.4 to 37.8 µg/m³ in Québec and 11.1 to 29.8 µg/m³ in Atlantic Canada. The 98th percentile was higher than 30.0 µg/m³ at 27 of 69 monitoring sites. Fifteen of these were located in Ontario, 10 in Québec, 1 in Alberta and 1 in British Columbia. Days with daily 24-hour PM_{2.5} exceeding 30 µg/m³ (*PM_{2.5} exceedance days*) occurred at 53 sites, or at one or more monitoring site in every region except Whitehorse. The highest number of exceedance days at any one monitoring site within a region was 7 in each of British Columbia and Alberta, 2 in Saskatchewan - Manitoba, 17 in Ontario, 12 in Québec and 6 in Atlantic Canada.

In 2002, the 4th highest Dmax 8-hour O₃ was 55.8 ppb at Whitehorse and ranged from 32.9 to 62.0 ppb in British Columbia, 49.5 to 74.0 ppb in Alberta, 32.6 to 56.3 in Saskatchewan - Manitoba, 59.3 to 107.6 ppb in Ontario, 56.1 to 82.6 ppb in Québec and 46.1 to 78.8 in Atlantic Canada. The 4th highest Dmax 8-hour O₃ was higher than 65.0 ppb at 83 of 154 monitoring sites. Of these sites, 39 were in Ontario, 33 in Québec, 8 in Alberta and 3 in Atlantic Canada. Days with Dmax 8-hour O₃ exceeding 65 ppb (*ozone exceedance days*) occurred at 105 sites, or at one or more monitoring site in every region except Whitehorse. The highest number of exceedance days at any one site within a region was 2 in British Columbia, 7 in Alberta, one in the Saskatchewan - Manitoba region, 49 in Ontario, 17 in Québec and 20 in Atlantic Canada.

The year 2002 was a high ozone year in Ontario and Québec, and somewhat of a high year in Alberta, especially in terms of the number of ozone exceedance days. For these regions, an increased number of hot days in 2002 likely contributed the most in making 2002 a high ozone year. In British Columbia, Saskatchewan-Manitoba and Atlantic Canada, 2002 was more or less a typical ozone year. Over the last ten years (1993 - 2002), the average 4th highest Dmax 8-hour O₃ and the average number of ozone exceedance days remained more or less unchanged in Western Canada, and increased somewhat in Eastern Canada.

Acknowledgements and Disclaimer

This report was prepared by Domenic Mignacca of the Environmental Protection Service (EPS), Transboundary Air Issues Branch (TAIB) with the assistance of Tom Dann of EPS, Analysis and Air Quality Division, by Robert Vet of the Meteorological Service of Canada (MSC), Air Quality Research Branch (AQRB), Dennis Herod (TAIB) Heather Atkinson (TAIB) and Dan Jutzi (TAIB). Special thanks are extended to Mike Shaw of AQRB for producing the maps for Figures 3 and 6 of the report. Thanks are also extended to Gilles Morneau and Mario Benjamin of MSC, Québec region, and to Tracy Inkpen and David Mullins of TAIB for their comments. JAICC members and their representatives are also thanked for their review and comments.

The views expressed in this report and its accompanying appendices are strictly those of the respective main authors and do not reflect the views of Environment Canada and other jurisdictions.

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1. INTRODUCTION

Environment Canada, at the request of the Joint Action Implementation Co-ordinating Committee (JAICC) of the Canada-wide Standards (CWS) for particulate matter (PM) and ground-level ozone (ozone), prepared this 2nd annual report on ambient fine particulate matter (PM_{2.5}) and ozone. Its main objective is to summarise the PM_{2.5} and ozone concentrations measured in 2002 in a form that is consistent with the Canada-wide Standards (CWS) numerics, but the achievement status of the CWS is not evaluated.

All PM_{2.5} and ozone levels discussed in the report are in relation to the daily 24-hour average concentration for PM_{2.5} (represented by daily 24-hour PM_{2.5}) and to the daily maximum 8-hour average concentration for ozone (represented by Dmax 8-hour O₃). For PM_{2.5}, the presented information includes the 98th percentiles of the daily 24-hour PM_{2.5} and the number of days with daily 24-hour PM_{2.5} exceeding 30 µg/m³. For ozone, the presented information includes the 4th highest Dmax 8-hour O₃ and the number of days with Dmax 8-hour O₃ exceeding 65 ppb. This information is presented nationally and also regionally for up to seven regions: Whitehorse (WH), British Columbia (BC), Alberta (AB), Saskatchewan-Manitoba (SK-MB), Ontario (ON), Québec (QC) and Atlantic Canada (AC). Other information includes an indication of how typical were the ozone concentrations in 2002, and qualitative ozone trends information for Western and Eastern Canada.

The complete document consists of this report and two appendices. The information mentioned above is presented in the report. Appendix I includes regional trends in ozone and on some of the factors that can influence local ozone such as ambient concentrations of ozone precursors, precursors emissions and air temperature. It also includes a qualitative primer on ambient ozone to provide a basic indication of its complexities which may help to put in perspective the observed ozone trends. Appendix II provides an outline of the data analysis procedures used and information on the 2002 monitoring networks and lists the sites considered for the various data presented in the report and Appendix 1. Appendix II also includes a brief update on the PM_{2.5} monitoring methods comparability.

2. CANADA-WIDE STANDARDS NUMERICS

The PM and ozone Canada-wide Standards (CWS) prescribe numerical standards for $PM_{2.5}$ and ozone, their statistical achievement forms and their achievement date. The standards and their achievement forms are:

$PM_{2.5}$ standard – 30 $\mu\text{g}/\text{m}^3$ as a 24-hour average.

Achievement of the standard is based on the 3-year average of the annual 98th percentiles of the daily, 24-hour (midnight to midnight) average concentrations (the *$PM_{2.5}$ CWS achievement metric*).

Ozone standard – 65 ppb as an 8-hour average.

Achievement of the standard is based on the 3-year average of the annual 4th highest daily maximum 8-hour average concentrations (the *ozone CWS achievement metric*).

Jurisdictions have committed to achieve the standards by 2010. For a given community, the $PM_{2.5}$ standard will be achieved if the value of the $PM_{2.5}$ CWS achievement metric in 2010 (based on the 98th percentile in 2010, 2009 and 2008) is less than or equal to 30 $\mu\text{g}/\text{m}^3$ at all CWS reporting areas in the community, and the ozone standard will be achieved if the value of the ozone CWS achievement metric in 2010 (based on the annual 4th highest in 2010, 2009 and 2008) is less than or equal to 65 ppb at all CWS reporting areas in the community.

As previously mentioned, this report does not evaluate the achievement status of the CWS. The first comprehensive progress report on all provisions of the CWS, including assessment of ambient levels and trends, and identification of communities where ambient levels are above or approaching the standards, will be completed in 2006 for the year 2005.

3. FINE PARTICULATE

This Section presents an overview of the daily 24-hour average $PM_{2.5}$ concentrations (*daily 24-hour $PM_{2.5}$*) in 2002. The presented information includes the 98th percentiles of the daily 24-hour $PM_{2.5}$ and the number of days with daily 24-hour $PM_{2.5}$ exceeding $30 \mu\text{g}/\text{m}^3$ (*$PM_{2.5}$ exceedance days*). All $PM_{2.5}$ concentrations presented in this report were measured by the TEOM© method.

3.1 98th Percentile Concentrations

The 98th percentiles for 2002 are presented in Figure 1. Monitoring sites in this figure are classified as Large Urban, Small Urban and Rural. Large Urban sites are located in communities with population of over 100,000 and Small Urban sites are located in communities with population of 100,000 or less. Rural sites are located in areas where the land-use is primarily rural, but some of these sites may be immediately downwind of urban areas. In 2002, a 98th percentile of the daily 24-hour $PM_{2.5}$ could be reported for 69 sites, and a list of these sites is provided in Appendix II.

In 2002, 27 of the 69 sites recorded a 98th percentile that was above $30.0 \mu\text{g}/\text{m}^3$. The majority of these sites were located in Ontario (15) and Québec (10), one in Alberta and one in British Columbia. The British Columbia and Alberta sites were both Small Urban. The 98th percentile was among the highest in Ontario and Québec, with values ranging from 23.1 to $41.0 \mu\text{g}/\text{m}^3$ in Ontario, and 26.4 to $37.8 \mu\text{g}/\text{m}^3$ in Québec. In other regions, the 98th percentile was $7.6 \mu\text{g}/\text{m}^3$ at the Whitehorse site and ranged from 9.4 to $31.6 \mu\text{g}/\text{m}^3$ in British Columbia, 8.0 to $24.9 \mu\text{g}/\text{m}^3$ in Alberta, 16.7 to $21.9 \mu\text{g}/\text{m}^3$ in Saskatchewan - Manitoba, and 11.1 to $29.8 \mu\text{g}/\text{m}^3$ in the Atlantic Provinces. A regional summary of the 98th percentiles, showing the range in the 98th percentiles over all three site types, is presented in Figure 2.

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Figure 1: The 2002 98th percentiles of the daily 24-hour PM_{2.5}.

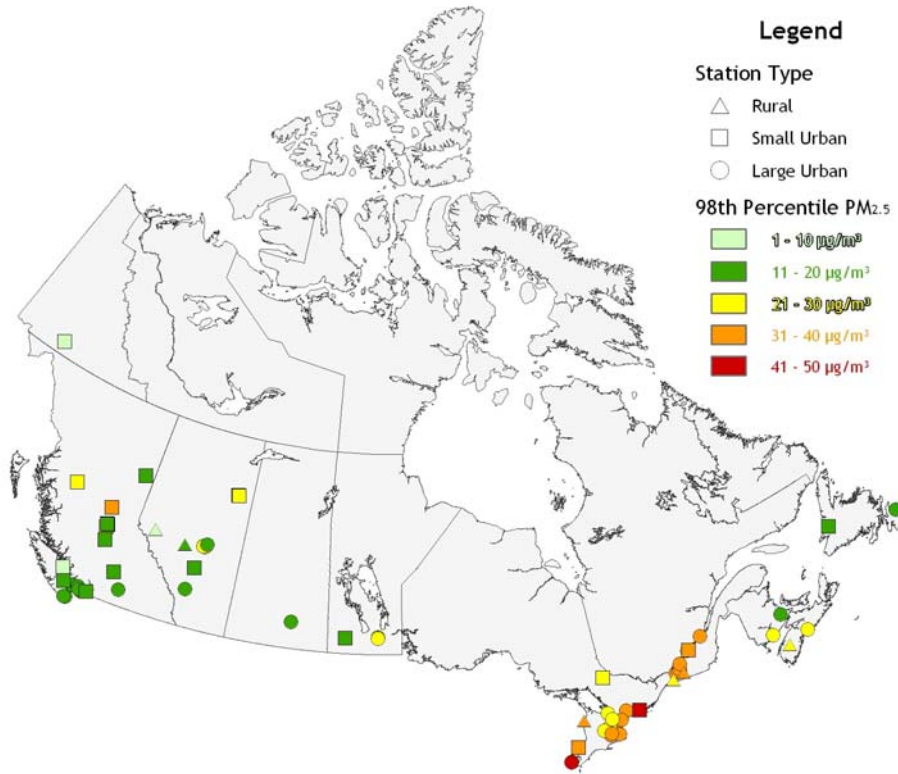
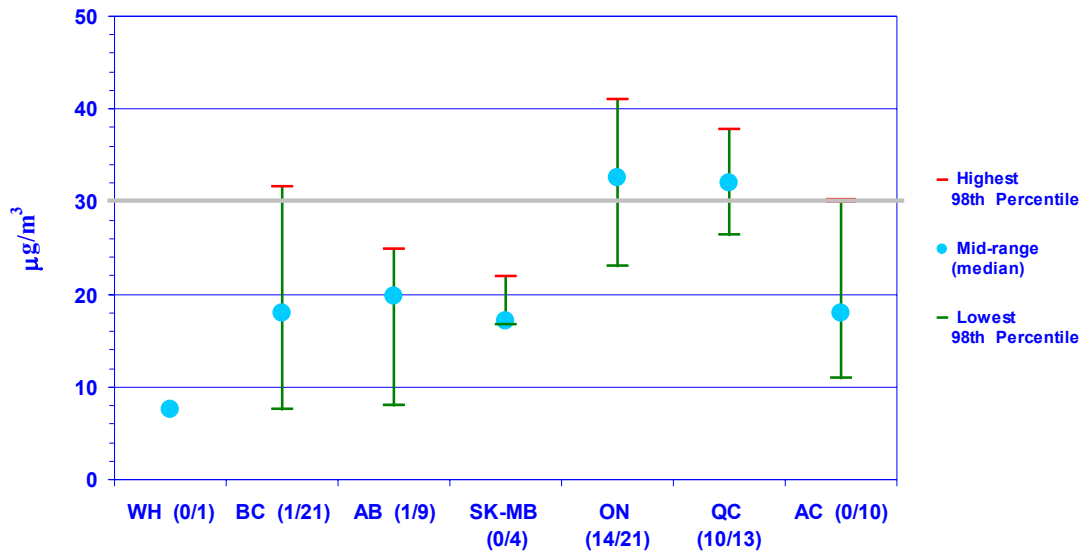


Figure 2: The 2002 regional range (over all sites) in the 98th percentiles of the daily 24-hour PM_{2.5}.



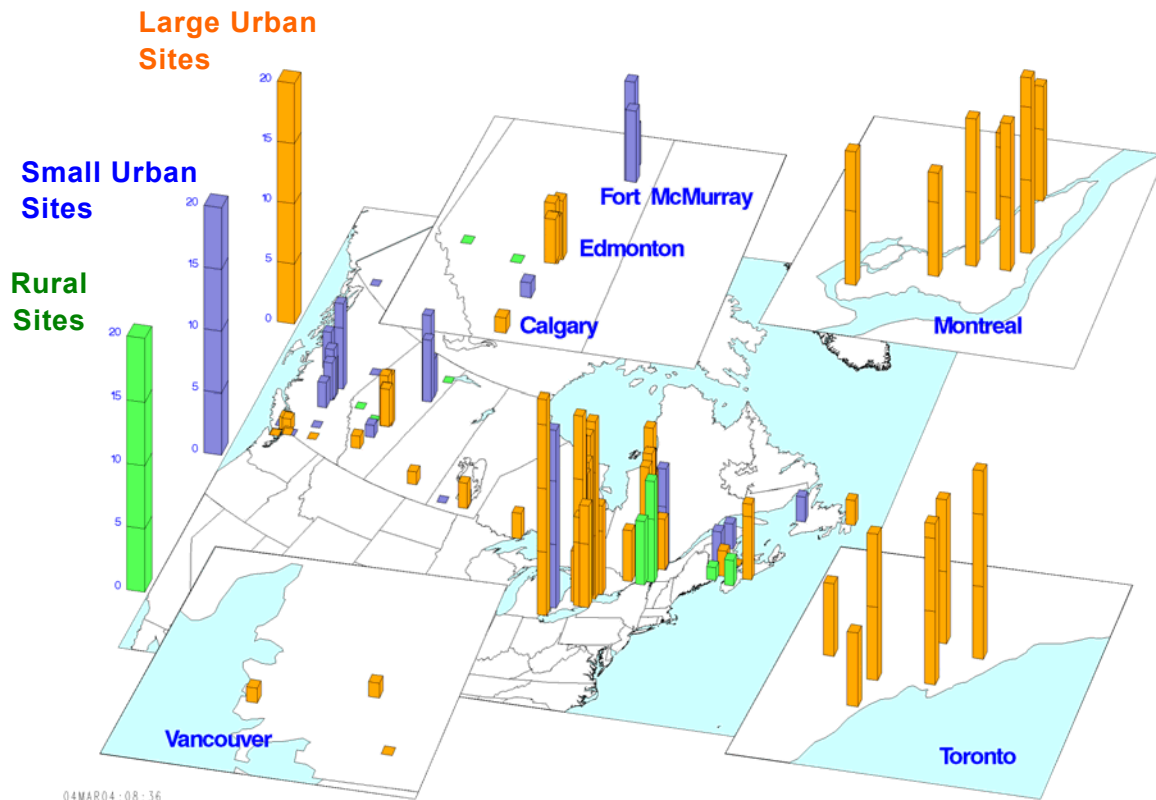
(n/N): n = number of sites with 98th percentile > 30.0 µg/m³. N = total number of sites.

3.2 Exceedance Days

The number of days with daily 24-hour PM_{2.5} exceeding 30 µg/m³ in 2002 are presented in Figure 3. The number of exceedance days could be reported for 67 sites of which 53 recorded one or more exceedances. Exceedance days occurred in each region except Whitehorse, with the number of exceedance days at any one site being among the highest in Ontario and Québec.

The range of exceedance days was zero to 7 in British Columbia and Alberta; zero to 2 in Saskatchewan- Manitoba; zero to 17 in Ontario; 4 to 12 in Québec; and zero to 6 in Atlantic Canada.

Figure 3: The 2002 number of days with daily 24-hour PM_{2.5} exceeding 30 µg/m³.



4. OZONE

This Section presents an overview of the daily maximum 8-hour average ozone concentration (*Dmax 8-hour O₃*) in 2002. The presented information includes the 4th highest *Dmax 8-hour O₃*, and the number of days with *Dmax 8-hour O₃* exceeding 65 ppb (exceedance days).

4.1 Fourth Highest Concentrations

The 4th highest *Dmax 8-hour O₃* for 2002 are presented in Figure 4. Monitoring sites were classified as outlined in Section 3.1. In 2002, a 4th highest *Dmax 8-hour O₃* could be reported for 154 sites and a list of these sites is provided in Appendix II.

In 2002, 83 of the 154 sites recorded a 4th highest *Dmax 8-hour O₃* that was above 65.0 ppb. The majority of these sites were located in Ontario (39) and Québec (33), eight were in Alberta and 3 in Atlantic Canada. The 4th highest *Dmax 8-hour O₃* was the highest in Ontario and Québec, with values ranging from 59.3 to 107.6 ppb in Ontario, and 56.1 to 82.6 in Québec. In other regions, the 4th highest *Dmax 8-hour O₃* was 55.8 ppb at Whitehorse site and ranged from 32.9 to 62.0 ppb in British Columbia, 49.5 to 74.0 ppb in Alberta, 32.6 to 56.3 in Saskatchewan - Manitoba, and 46.1 to 78.8 in Atlantic Canada. A regional summary of the 4th highest *Dmax 8-hour O₃*, showing the range in the 4th highest over all three site type, is presented in Figure 5.

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Figure 4: The 2002 fourth highest Dmax 8-hour O₃.

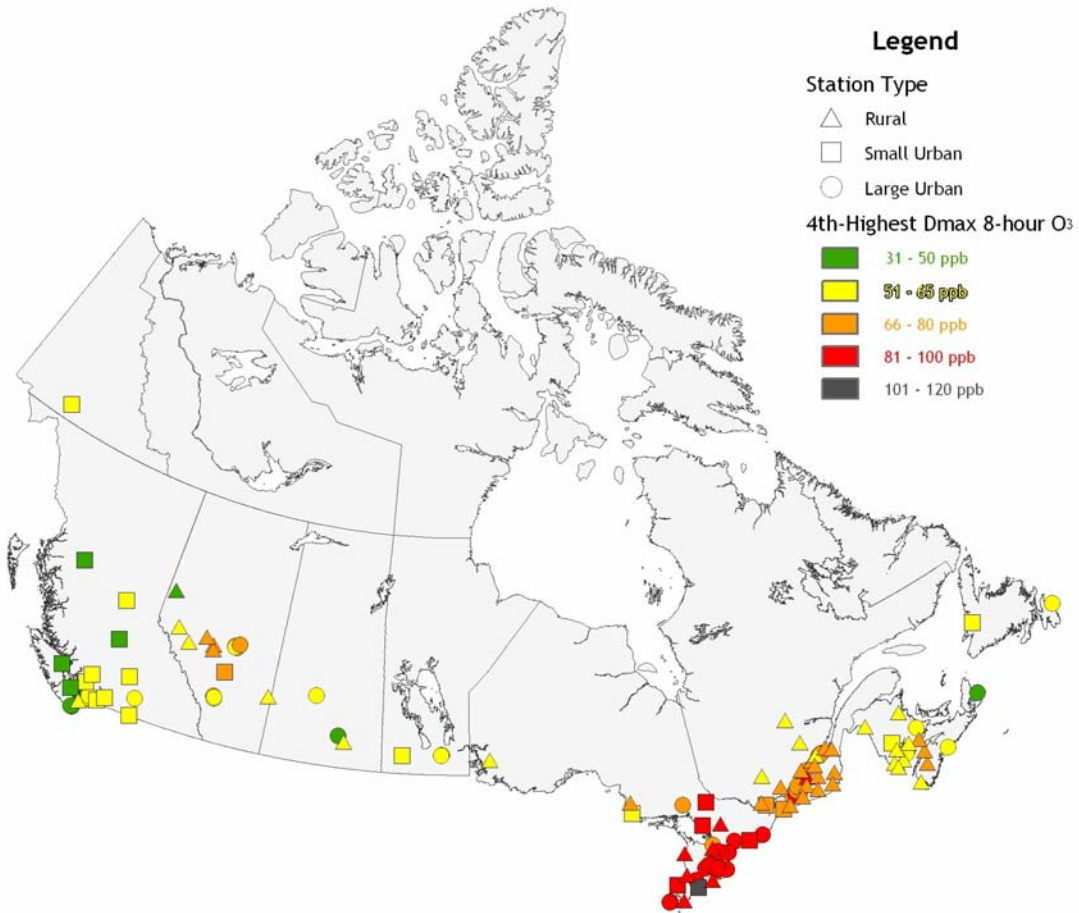
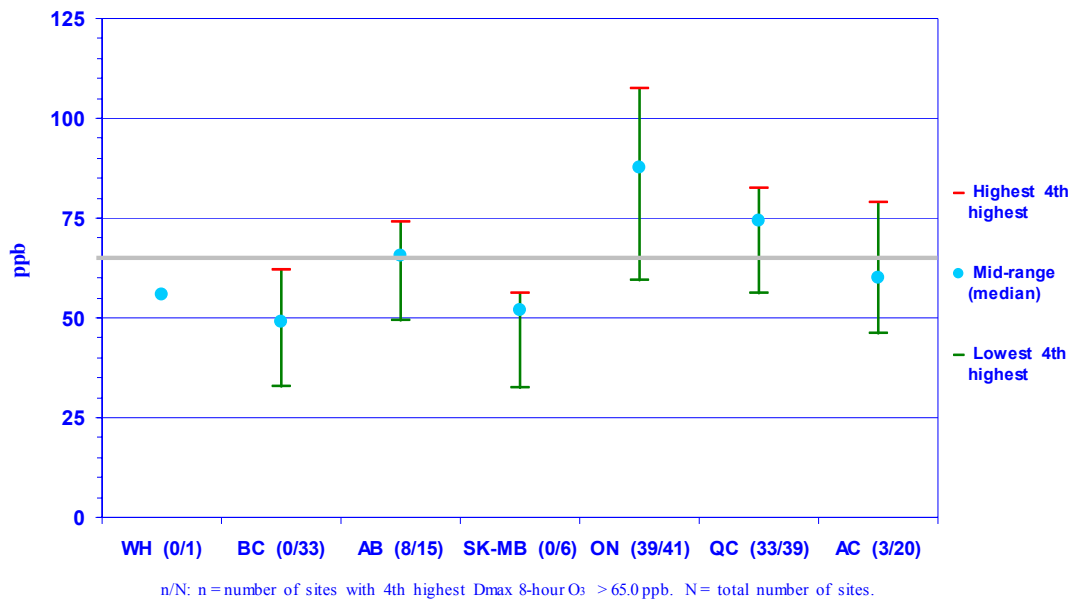


Figure 5: The 2002 regional range (over all sites) of the 4th Highest Dmax 8-hour O₃.

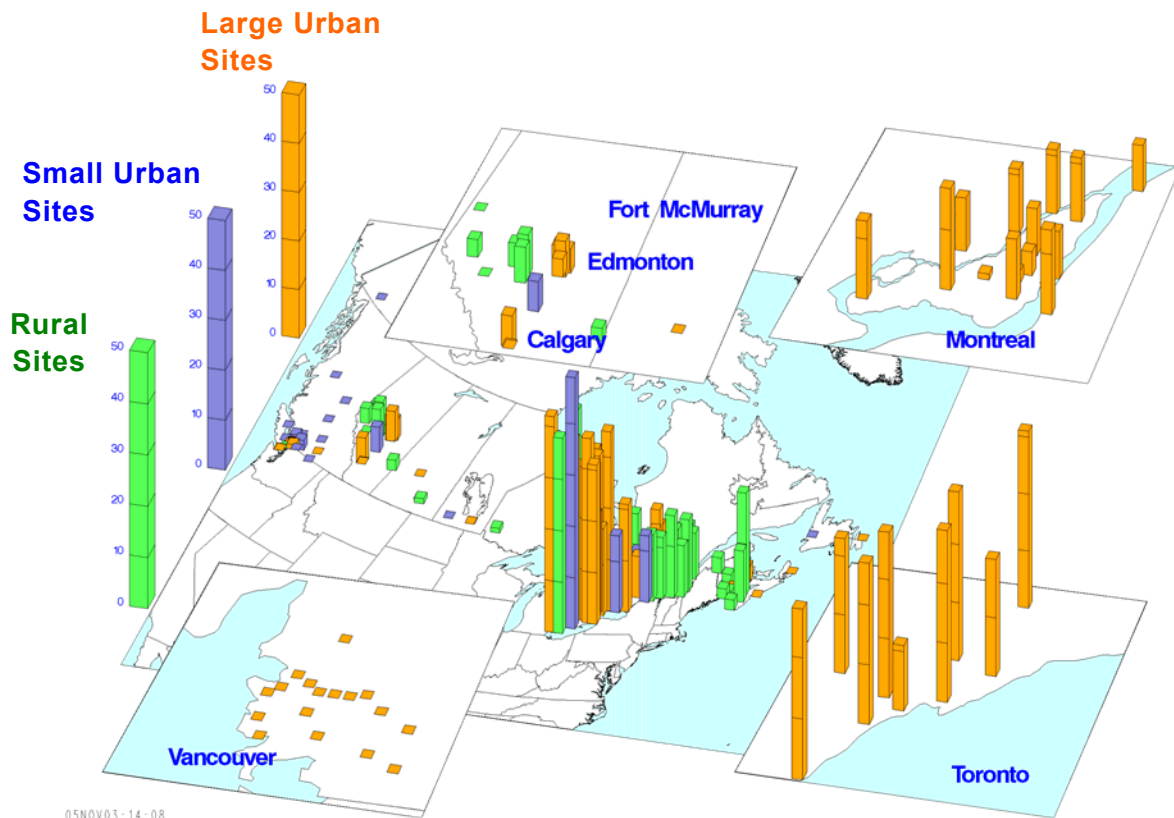


4.3 Exceedance Days

The number of days with the Dmax 8-hour O₃ exceeding 65 ppb in 2002 are presented in Figure 6. The number of exceedance days could be reported for 154 sites of which 105 recorded one or more exceedances. Exceedance days occurred in each region except Whitehorse, with the number of exceedance days at any one site being among the highest in Ontario, Atlantic Canada and Québec.

The range of exceedance days was zero to 2 in British Columbia; zero to 7 in Alberta; zero to 1 in Saskatchewan-Manitoba; 1 to 49 in Ontario; zero to 17 in Québec; and zero to 20 in Atlantic Canada. For each region, half of the (considered) monitoring sites recorded no exceedances in British Columbia; 4 or more in Alberta; 28 or more in Ontario; 9 or more in Québec; and 1 or more in Atlantic Canada.

Figure 6: The 2002 number of days with Dmax 8-hour O₃ exceeding 65 ppb.

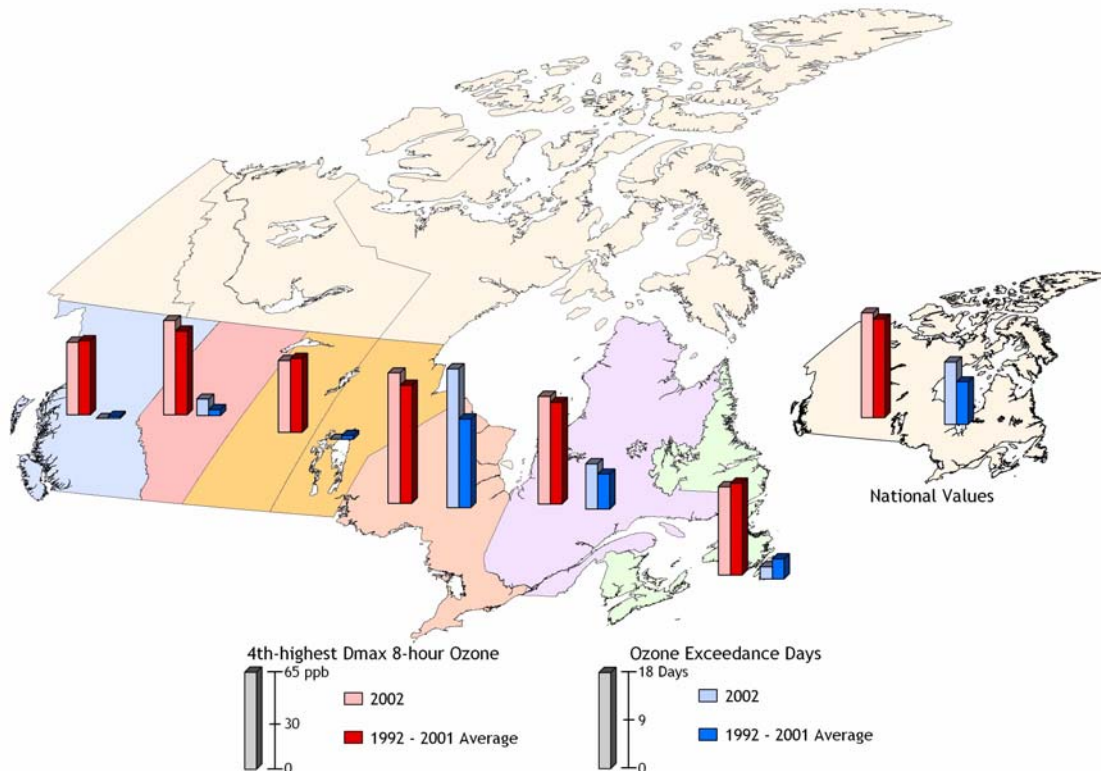


5. HOW TYPICAL WAS OZONE IN 2002

To obtain an indication of how typical the ozone concentrations were in 2002, the 2002 national and regional average 4th highest Dmax 8-hour O₃ and the average number of ozone exceedance days were compared with their corresponding averages for the ten-year period from 1992 to 2001 (Figure 7). Appendix II provides an outline of the procedures used to compute the national and regional averages.

Nationally, 2002 was slightly a high year in terms of the average 4th highest Dmax 8-hour O₃ and a high year in terms of the average number of exceedance days, with the 2002 averages being 5 and 45% higher respectively than the previous 10-year averages. Regionally, 2002 was a typical year in British Columbia and Saskatchewan- Manitoba, and a high year in Alberta, Ontario and Québec. The 2002 average 4th highest Dmax 8-hour O₃ and the average number of exceedance days were respectively 13 and 180% higher than the previous ten-year averages in Alberta; 10 and 57% higher in Ontario; and 6 and 29% higher in Québec. For these latter three regions, an increased number of hot days in 2002 likely contributed the most in making 2002 a high ozone year as discussed in Section 5 and 6 of Appendix I. For Atlantic Canada, 2002 was somewhat of a typical year in terms of the 4th highest Dmax 8-hour O₃, and somewhat of a low year in terms of the average number of exceedance days.

Figure 7: Regional ozone in 2002 compared with previous ten years.

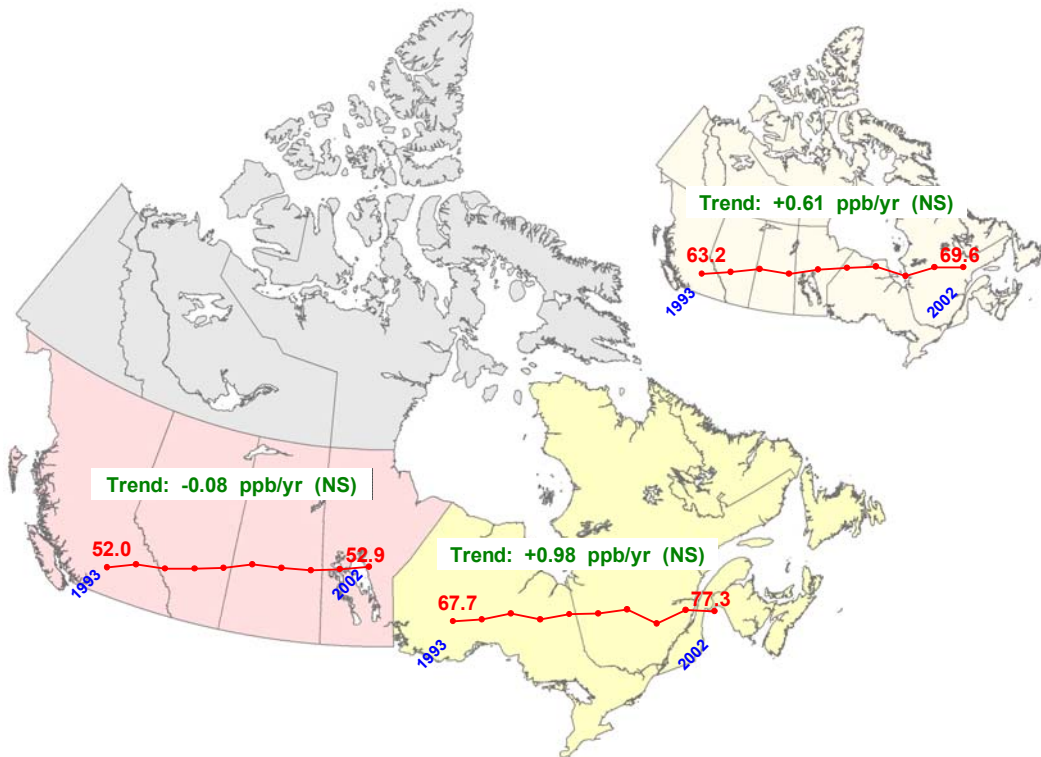


6. OZONE TEN YEAR TRENDS

This Section provides a qualitative indication of the changes in the annual 4th highest Dmax 8-hour O₃ and the average annual number of ozone exceedance days for the ten-year period from 1993 to 2002. These two ozone measures were averaged over all considered monitoring sites nationally and for sites in Western and Eastern Canada. Western Canada includes here British Columbia, Alberta, Saskatchewan and Manitoba; and Eastern Canada includes Ontario, Québec, New Brunswick and Nova Scotia. The averages were computed over all three site types and the total number of sites considered was 103, with 32 sites in Western Canada and 71 sites in Eastern Canada; a list of the considered sites is provided in Appendix II. More detailed trends information is provided in Appendix I.

The changes in the average annual 4th highest Dmax 8-hour O₃ are presented in Figure 8. This Figure also includes the numerical rate of change, or trend, and whether the trend is statistically significant or not (at the 95% confidence level). Nationally, the average 4th highest Dmax 8-hour O₃ increased somewhat over the ten year period at the rate of 0.61 ppb per year. The average 4th highest increased in Eastern Canada (0.98 ppb/year) and remained more or less unchanged in Western Canada. The increasing trends nationally and in Eastern Canada are both statistically insignificant. This implies that systematic changes in factors that affect ozone were probably not the cause of the increasing trend, but perhaps occurred from chance variations alone.

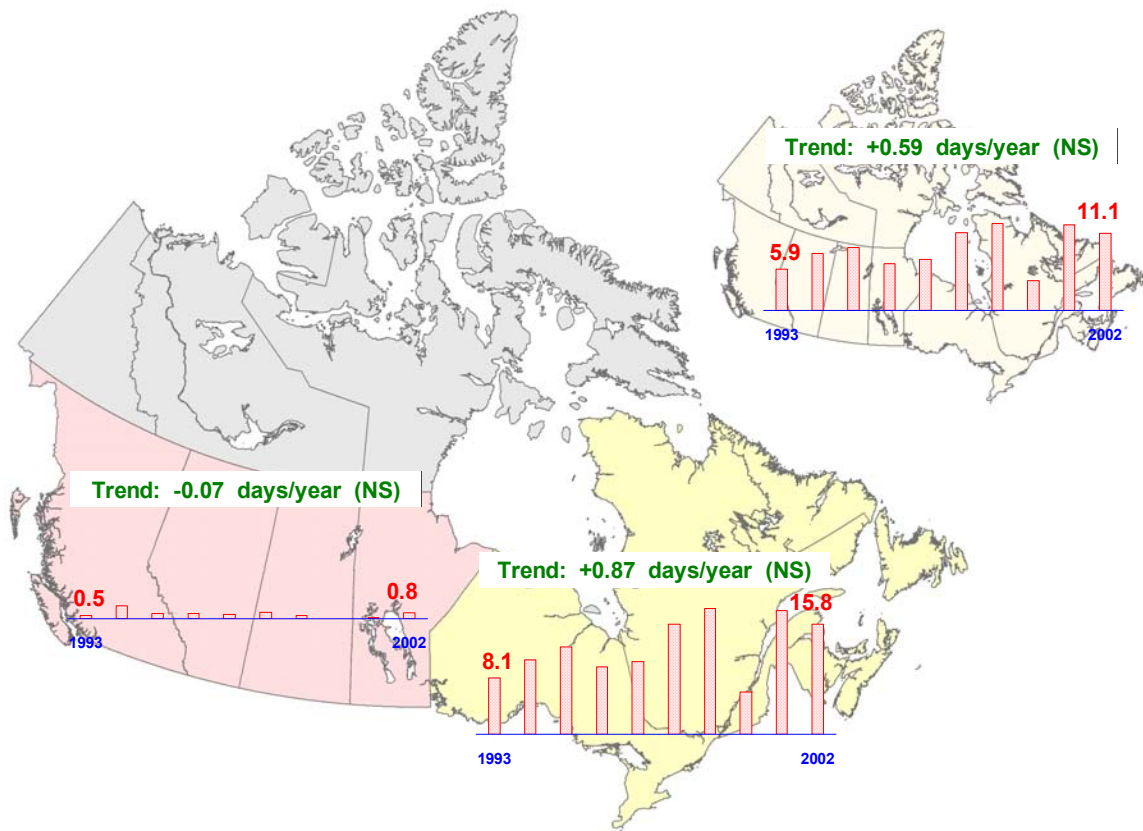
Figure 8: Ten-year trends in the average annual 4th highest Dmax 8-hour O₃.
NS means that the trend is not statistically significant.



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Figure 9 presents the changes in the average annual number of ozone exceedance days. Nationally, the average number of exceedance days increased over the ten year period at the rate of 0.59 days per year. Regionally, the average number of exceedance days increased in Eastern Canada (0.87 days/year) and remained more or less unchanged in Western Canada. As with the average 4th highest Dmax 8-hour O₃, the increasing trends in the average number of exceedance days nationally and in Eastern Canada are also both statistically insignificant.

Figure 9: Ten-year trends in the average annual number of ozone exceedance days. NS means that the trend is not statistically significant



Figures 8 and 9 indicate that, on average, the 4th highest Dmax 8-hour O₃ and the number of ozone exceedance days were both higher in Eastern Canada, and that the national trends were largely a reflection of sites in Eastern Canada. This latter finding is mostly attributed to the much greater number of sites in Eastern Canada. It should also be noted that, although the increasing trends discussed in this Section are all statistically insignificant, the same analysis performed on a site-type basis indicates statistically significant increasing trends nationally and for some regions as discussed in Appendix 1.