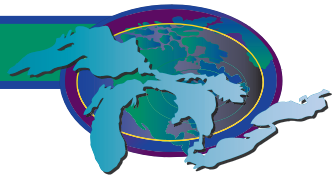

Air Quality
Indicator #4202

Disclaimer
The Air Quality indicator report was drafted in the fall of 2006 using data that were available at that time. Since then, a number of Canadian and U.S. governmental reports have been released with more up-to-date information. These reports include the United States-Canada Air Quality Agreement: 2006 Progress Report and the Government of Canada Five-year Progress Report: Canada-Wide Standards for Particulate Matter and Ozone. The information and data presented in these reports (and others) will be incorporated into the 2009 Air Quality indicator report.

Overall Assessment

Status:	**Mixed**
Trend:	**Improving**

Lake-by-Lake Assessment

Individual lake basin assessments were not prepared for this report.

Purpose
- To monitor the air quality in the Great Lakes ecosystem
- To infer the potential impact of air quality on human health in the Great Lakes basin

Ecosystem Objective
Air should be safe to breathe. Air quality in the Great Lakes ecosystem should be protected in areas where it is relatively good and improved in areas where it is degraded. This is consistent with ecosystem objectives being adopted by certain lakewide management plans, including Lake Superior, in fulfillment of Annex 2 of the Great Lakes Water Quality Agreement (GLWQA). This indicator also supports Annexes 1, 13, and 15.

State of the Ecosystem
Overall, there has been significant progress in improving air quality in the Great Lakes basin. For several substances of interest, both emissions and ambient concentrations have decreased over the last ten years or more. However, progress has not been uniform and differences in weather from one year to the next complicate analysis of ambient trends. Ozone and fine particulate matter can be particularly elevated during hot summers, and the trends are not consistent with those for related pollutants. Drought conditions result in more fugitive dust emissions from roads and fields, which may further contribute to the ambient levels of particulate matter.

In general, there has been significant progress with urban or local pollutants over the past decade or more, though somewhat less in recent years, with a few remaining problem districts. Ground-level ozone and fine particles remain a concern in the Great Lakes region, especially in the Detroit-Windsor region and extending northward to Sault St. Marie and eastward to Ottawa, the Lake Michigan basin, and the Buffalo-Niagara area. These pollutants continue to exceed the respective air quality criteria and standards at a number of monitoring locations in Southern Ontario and in the lower Great Lakes region in the U.S.

For the purposes of this discussion, the pollutants can be divided into urban (or local) and regional pollutants. For regional pollutants, transport is a significant issue, from hundreds of kilometers to the scale of the globe. Formation from other pollutants, both natural and man-made, can also be important. Unless otherwise stated, references to the U.S. or Canada in this discussion refer to nationwide averages.

Urban/Local Pollutants

Carbon Monoxide (CO)
Ambient Concentrations: In the U.S., CO levels for 2004 were the lowest recorded in the past 25 years. Ambient concentrations have decreased approximately 71% nationally from 1980 to 2004 and 42% nationally from 1993 to 2002. There are currently no nonattainment areas (areas where air quality standards are not met) in the U.S. for CO. In general, CO levels have decreased at the

same rate in the Great Lakes region as the nation as a whole.

In Ontario, the composite average of the one-hour maximum CO concentration decreased by 82% from 1971 to 2004, while the composite average of the eight-hour maximum concentration decreased 87%. Since 1995, average CO concentrations have only decreased 16%. Ontario has not experienced an exceedence of the 1-hour and 8-hour criteria since 1991.

Emissions: In the U.S., nationwide emissions of CO have decreased 33% from 1990 to 2002, the most recent year for which aggregate National Emissions Inventory (NEI) estimates are available. The reductions in CO emissions are almost entirely due to decreased emissions from on-road mobile sources, which have occurred despite yearly increases in vehicle miles traveled. In general, CO emissions have decreased at the same rate in the Great Lakes region as the nation as a whole.

In Canada, anthropogenic emissions (not including open sources such as forest fires) have decreased nationally by about 22% between 1990 and 2002, with a 29% decline in Ontario over the same time period. These declines are mainly the result of more stringent transportation emission standards.

Nitrogen Dioxide (NO_2)

Ambient Concentrations: In Ontario, ambient NO_2 concentrations have decreased 31% from 1975 to 2004. Over the last decade (1995 to 2004), average NO_2 concentrations declined 13%. The Ontario 1-hour and 24-hour air quality criterion for NO_2 were not exceeded at any of Ontario's monitoring stations in 2004.

In the U.S., the annual mean concentrations decreased 37% from 1980 to 2004. NO_2 levels in the Great Lakes region decreased at a slightly higher pace during this time period. An analysis of urban versus rural monitoring sites indicates that the declining trend seen nationwide and in the Great Lakes region can mostly be attributable to decreasing concentrations of NO_2 in urban areas (similar results can be found in Ontario). There are currently no NO_2 nonattainment areas in the U.S.

Emissions: In Canada, anthropogenic emissions of NO_x (not including open sources such as forest fires) stayed essentially unchanged with a slight increase of 5% between 1990 and 2002. However, emissions have decreased by about 11% in Ontario over the same time period. These declines are mainly the result of more stringent transportation emission standards.

In the U.S., emissions of NO_x decreased by about 18% from 1990 to 2002. The downward trend can be attributed to emissions reductions at electric utilities and on-road mobile sources. Although nationwide NO_x emissions have decreased, emissions from some source categories have increased including non-road engines. In general, NO_x emissions have decreased at a slightly greater rate in the Great Lakes region as compared to the nation as a whole.

For more information on oxides of nitrogen, refer to the Great Lakes Indicator Report #9000 Acid Rain.

Sulfur Dioxide (SO_2)

Ambient Concentrations: In the U.S., annual mean concentrations of SO_2 decreased 54% from 1983 to 2002. From 1993 to 2002, annual mean concentrations of SO_2 in the U.S. decreased 39%. The Great Lakes region experienced reducing trends on par with the national averages. Since the State of the Great Lakes 2005 report, the U.S. Environmental Protection Agency (U.S. EPA) approved the redesignation of Lake County, Indiana, and Cuyahoga County, Ohio, to attainment areas. There are currently no nonattainment areas for SO_2 in the Great Lakes region.

In Ontario, the average ambient SO_2 concentrations improved 86% from 1971 to 2004, with a 17% improvement since 1995. Ontario did not experience any violations of the one-hour SO_2 criterion (250 ppb), 24-hour criterion (100 ppb), or the annual criterion (20 ppb) in 2004.

Emissions: In the U.S., national SO_2 emissions were reduced 33% from 1990 to 2002 mostly in response to regulations imposing cuts on coal-burning power plants. SO_2 emissions in the Great Lakes region have decreased at a much greater rate than the national trend over this time period.

Canadian emissions decreased 29% nationwide from 1990 to 2002, but have remained relatively constant since 1995. Even with increasing economic activity, emissions remain about 29% below the target national emission cap. From 1990 to 2002, the emissions of SO_2 in Ontario decreased 47%. These reductions mostly were the result of the Eastern Canada Acid Rain Program

which primarily targeted major non-ferrous smelters and fossil fuel-burning power plants in the seven eastern-most provinces.

For more information on sulfur dioxide, refer to the Great Lakes Indicator Report #9000 Acid Rain.

Lead

Ambient Concentrations: U.S. concentrations of lead decreased 97% from 1980 to 2004 with most of the reductions occurring during the 1980s and early 1990s. Lead levels in the Great Lakes region decreased at nearly the same rate as the national trend over this time. There are no nonattainment areas for lead in the Great Lakes region.

Based on historical data, lead concentrations at urban monitoring stations in Ontario have decreased over 95%.

Emissions: National lead emissions in the U.S. decreased 98% from 1980 to 1999 mostly as a result of regulatory efforts to reduce the content of lead in gasoline. The declines since 1990 have been from metals processing and waste management industries.

Similar improvements in Canada have followed with the usage of unleaded gasoline.

Total Reduced Sulfur (TRS)

Ambient Concentrations: This family of compounds is of concern in Canada due to odor problems in some communities, normally near industrial or pulp mill sources. There is no apparent trend in the annual average concentrations of TRS in Ontario from 1990 to 2003. There are still periods above the ambient criteria near a few centers.

Emissions: Hydrogen sulfide accounts for more than half of total reduced sulfur emissions. There is no requirement to report TRS emissions in the National Pollutant Release Inventory (NPRI). However, there has been a requirement to report hydrogen sulfide emissions since 2000. Hydrogen sulfide emissions have increased about 47% from 2000 to 2003.

PM_{10}

Ambient Concentrations: PM_{10} is the fraction of particles in the atmosphere with a diameter of 10 microns or smaller. Annual average PM_{10} concentrations in the U.S. have decreased 28% from 1990 to 2004. Annual average concentrations in the Great Lakes region have decreased at nearly the same rate as the national trend over this time. The national 24-hour PM_{10} concentration was 31% lower than the 1990 level. 24-hour average concentrations in the Great Lakes region have decreased at nearly the same rate as the national trend over this time. There are currently no nonattainment areas in the Great Lakes region. Since the State of the Great Lakes 2003 report, the U.S. EPA approved the redesignation of 2 areas in Cook County, Illinois, to attainment areas.

Canada does not have an ambient target for PM_{10}. However, Ontario has an interim standard of 50 $\mu g/m^3$ over a 24-hour sampling period to guide decision-making.

Emissions: In the U.S., national direct source man-made emissions decreased 29% from 1990 to 2002. The fuel combustion source category experienced the largest absolute decrease in emissions (422,000 tons and 35%), while the on-road vehicle sector experienced the largest relative decrease (183,000 tons and 47%). The Great Lakes region experienced reducing trends on par with the national averages.

In Canada, anthropogenic emissions (not including open sources such as road dust) have decreased nationally by about 15% between 1990 and 2002.

Air Toxics

This term captures a large number of pollutants that, based on the toxicity and likelihood for exposure, have the potential to harm human health (e.g. cancer causing) or adverse environmental and ecological effects. Some of these are of local importance, near to sources, while others may be transported over long distances. Monitoring is difficult and expensive, and usually limited in scope because such toxics are usually present only at trace levels. Recent efforts in Canada and the U.S. have focused on better characterization of ambient levels and minimizing emissions. In the U.S., the Clean Air Act targets a 75% reduction in cancer "incidence" and a "substantial" reduction in non-cancer risks. The Maximum Available Control Technology (MACT) program sets emissions standards on industrial sources to reduce emissions of air toxics. Once fully implemented, these standards will cut emissions of toxic air pollutants by nearly 1.36 million tonnes per year from 1990 levels.

In February 2006, U.S. EPA released the results of its national assessment of air toxics (NATA) using 1999 emissions. The purpose of the national-scale assessment is to identify and prioritize air toxics, emission source types and locations which are of greatest potential concern in terms of contributing to population risk. From a national perspective, benzene is the most significant air toxic for which cancer risk could be estimated, contributing 25% of the average individual cancer risk identified in this assessment. Based on U.S. EPA's national emissions inventory, the key sources for benzene are on-road (49%) and non-road mobile sources (19%), and open burning, prescribed fires and wildfires (14%). U.S. EPA projects that on-road and non-road mobile source benzene emissions will decrease by about 60% between 1999 and 2020, as a result of motor vehicle standards, fuel controls, standards for non-road engines and equipment, and motor vehicle inspection and maintenance programs.

Of the 40 air toxics showing the potential for respiratory effects, acrolein is the most significant, contributing 91% of the nationwide average non-cancer hazard identified in this assessment. Note that the health information and exposure data for acrolein include much more uncertainty than those for benzene. Based on the national emissions inventory, the key sources for acrolein are open burning, prescribed fires and wildfires (61%), on-road (14%) and non-road (11%) mobile sources. The apparent dominance of acrolein as a non-cancer "risk driver" in both the 1996 and 1999 national-scale assessment has led to efforts to develop an effective monitoring test method for this pollutant. U.S. EPA projects acrolein emissions from on-road sources will be reduced by 53% between 1996 and 2020 as a result of existing motor vehicle standards and fuel controls.

The assessment estimates that most people have a lifetime cancer risk between 1 and 25 in a million from air toxics. This means that out of one million people, between 1 and 25 people have increased likelihood of contracting cancer as a result of breathing air toxics from outdoor sources, if they were exposed to 1999 levels over the course of their lifetime. The assessment estimates that most urban locations have air toxics lifetime cancer risk greater than 25 in a million. Risk in transportation corridors and some other locations are greater than 50 in a million. In contrast, one out of every three Americans (330,000 in a million) will contract cancer during a lifetime, when all causes (including exposure to air toxics) are taken into account. Based on these results, the risk of contracting cancer is increased less than 1% due to inhalation of air toxics from outdoor sources.

In Canada, key toxics such as benzene, mercury, dioxins, and furans are the subject of ratified and proposed new standards, and voluntary reduction efforts.

Ambient Concentrations: A National Air Toxics Trend Site (NATTS) network was launched in the U.S. in 2003 to detect trends in high-risk air toxics such as benzene, formaldehyde, 1,3-butadiene, acrolein, and chromium. There are four NATTS monitoring sites in the Great Lakes region including Chicago, IL, Detroit, MI, Rochester, NY and Mayville, WI. Some ambient trends have also been found from existing monitoring networks. Average annual urban concentrations of benzene have decreased 60% in the U.S. from 1994 to 2004.

Manganese compounds are hazardous air pollutants of special concern in the Great Lakes region. They are emitted by iron and steel production plants, power plants, coke ovens, and many smaller metal processing facilities. Exposures to elevated concentrations of manganese are harmful to human health and have been associated with subtle neurological effects, such as slowed eye-hand coordination. The most recent NATA results identify manganese compounds as the largest contributor to neurological non-cancer health risk in the U.S. Modeled estimates of ambient manganese compounds in all 3222 U.S. counties show that among the 50 counties with the highest concentrations nation-wide, 20 are located in U.S. EPA's Region 5. The median average annual manganese concentration at 21 trend sites showed a 14.7% decline between 2000 and 2004. Additional years of data will be needed to confirm this apparent trend.

In Ontario, average annual urban concentrations of benzene, toluene, and xylene have decreased about 45%, 38%, and 50% respectively from 1995 to 2004.

Emissions: The Great Lakes Toxics Inventory is an ongoing initiative of the regulatory agencies in the eight Great Lakes states and the Province of Ontario. Emissions inventories have been developed for 1996, 1997, 1998, 1999, 2001, and 2002, but different approaches were used to develop these inventories making trend analysis difficult.

In Canada, emissions are also being tracked through the NPRI. The NPRI includes information on some of the substances listed by the Accelerated Reduction/Elimination of Toxics (ARET) program. Significant voluntary reductions in toxic emissions have been reported through the ARET program.

In the U.S., emissions are also being tracked through the NEI and the Toxics Release Inventory (TRI). NEI data indicate that national U.S. air toxic emissions have dropped approximately 42% between 1990 and 2002, though emission estimates are subject to modification and the trends are different for different compounds. The 1999 NEI also showed that Region 5 had the highest manganese emissions of all U.S. EPA Regions, contributing 36.6% of all manganese compounds emitted nation-wide.

The TRI, which began in 1988, contains information on releases of nearly 650 chemicals and chemical categories from industries, including manufacturing, metal and coal mining, electric utilities, and commercial hazardous waste treatment, among others. Although the TRI has expanded and changed over the years, it is still possible to ascertain trends over time for core sets of toxics. The total reported air emissions of the TRI 1988 Core Chemicals (299 chemicals) in the eight Great Lakes states have decreased by about 78% from 1988 to 2004. According to the TRI, manganese emissions from point sources declined between 1988 and 2003 both nationally (26.2%) and in U.S. EPA Region 5 (36.7%). Year-to-year variability in manganese emissions is high, however, and recent emissions data (1996-2003) suggest a weaker trend: emissions dropped 7.6% and 12.4% nation-wide and in Region 5, respectively.

Regional Pollutants

Ground-Level Ozone (O_3)

Ozone is almost entirely a secondary pollutant, which forms from reactions of precursors (VOCs - volatile organic compounds and NO_x - nitrogen oxides) in the presence of heat and sunlight. Ozone is a problem pollutant over broad areas of the Great Lakes region. Local onshore circulations around the Great Lakes can exacerbate the problem, as pollutants can remain trapped for days below a maritime/marine inversion, which forms when a layer of warm air moves to lie over colder marine air, thus trapping the colder air. Consistently high levels are found in provincial parks near Lake Huron and Lake Erie, and western Michigan is impacted by transport across Lake Michigan from Chicago.

Ambient Concentrations: In 2004, ozone levels in the U.S. showed continued improvement. National assessments find some uneven improvement in peak levels, but with indications that average levels may be increasing on a global scale. Ozone levels are still decreasing nationwide, but the rate of decrease for 8-hour ozone levels has slowed since 1990. The Great Lakes region (including portions of U.S. EPA's Regions 2, 3 and 5) has experienced smaller decreases than nationwide averages (Figure 1). Many of the improvements in ozone concentrations during these times have been a result of local emission reductions in urban areas.

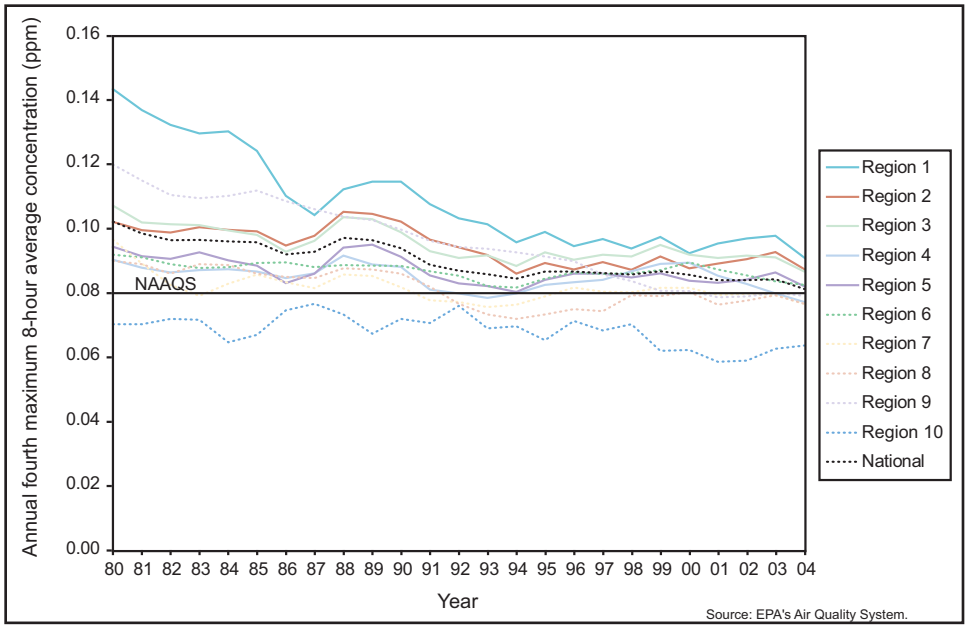

Figure 1. Trends in Fourth Highest Daily Maximum 8-hour ozone concentration (ppm) by U.S. EPA Region 1980-2004.

Source: Figure 004-4. Ambient ozone concentrations, 1980-2004, by EPA region; 2007 Report on the Environment (ROE) Technical Document. http://www.epa.gov/indicators/, last accessed September 5, 2006

To address the regional transport of ozone and ozone-forming pollutants in the eastern half of the country, the U.S. EPA developed a program to reduce regional NO_x emissions called the NO_x State Implementation Plan (SIP) Call in 2002. An analysis of 2002-2004 ozone data show that the NO_x SIP Call achieved an additional 4% reduction in seasonal 8-hour ozone concentrations. It is important to note that weather conditions in 2004 were not conducive to ozone formation, and that ozone levels in 2005 and 2006 could be higher than in 2004 depending on weather conditions. The NO_x SIP Call also appears to have caused a gradual decline in 8-hour daily maximum ozone concentrations (Figure 2).

Since the State of the Great Lakes 2005 indicator report, the 1-hour ozone standard was revoked in the U.S. and all 6 nonattainment areas in the Great Lakes basin were reclassified. Now there are 28 areas covering 70 counties in the Great Lakes basin designated as nonattainment for the 8-hour ozone standard (Chicago-Gary-Lake Co, IL-IN metropolitan (or metro) area; South Bend/Elkhart, IN; LaPorte County, IN; Fort Wayne, IN; Detroit-Ann Arbor metro area, MI; Flint metro area, MI; Grand Rapids metro area, MI; Muskegon County, MI; Allegan County, MI; Huron County, MI; Kalamazoo-Battle Creek metro area, MI; Lansing-East Lansing metro area, MI; Benton Harbor area, MI; Benzie County, MI; Cass County, MI; Mason County, MI; Jamestown, NY; Buffalo-Niagara Falls metro area, NY; Rochester metro area, NY; Jefferson County, NY; Toledo metro area, OH; Cleveland-Akron-Lorain metro area, OH; Erie, PA; Milwaukee-Racine metro area, WI; Sheboygan County, WI; Manitowoc County, WI; Kewaunee County, WI; and Door County, WI).

In Ontario, ozone concentrations continued to exceed Ontario's Ambient Air Quality Criterion (AAQC). In 2004, 28 of the 37 ambient Air Quality Index (AQI) monitoring stations in Ontario recorded exceedences of the 1-hour ozone AAQC on at least one occasion. Although the ozone levels continue to exceed Ontario's AAQC, the 1-hour maximum ozone concentrations recorded in Ontario have, on average, decreased by 13% from 1980 to 2004. Over the past 10 years (1995 to 2004), the annual composite means of one-hour ozone maximum concentrations have decreased by about 4%. In fact, the year 2004 recorded the lowest one-hour ozone maximum (84 ppb) over the last 25 years. This is partly related to the lack of weather conditions conducive to formation of ground-level ozone in 2004, but it also indicates that many of the efforts to curb emissions and improve the air quality in Ontario are working.

However, Ontario has experienced an overall increasing trend in seasonal mean ozone concentrations over the same 25-year period. The summer and winter seasonal ozone means have increased by approximately 25% and 44%, respectively (Figure 3). Similar increases in the background concentrations of ozone have been found in other parts of North America.

In Ontario, ozone data from 2002-2004

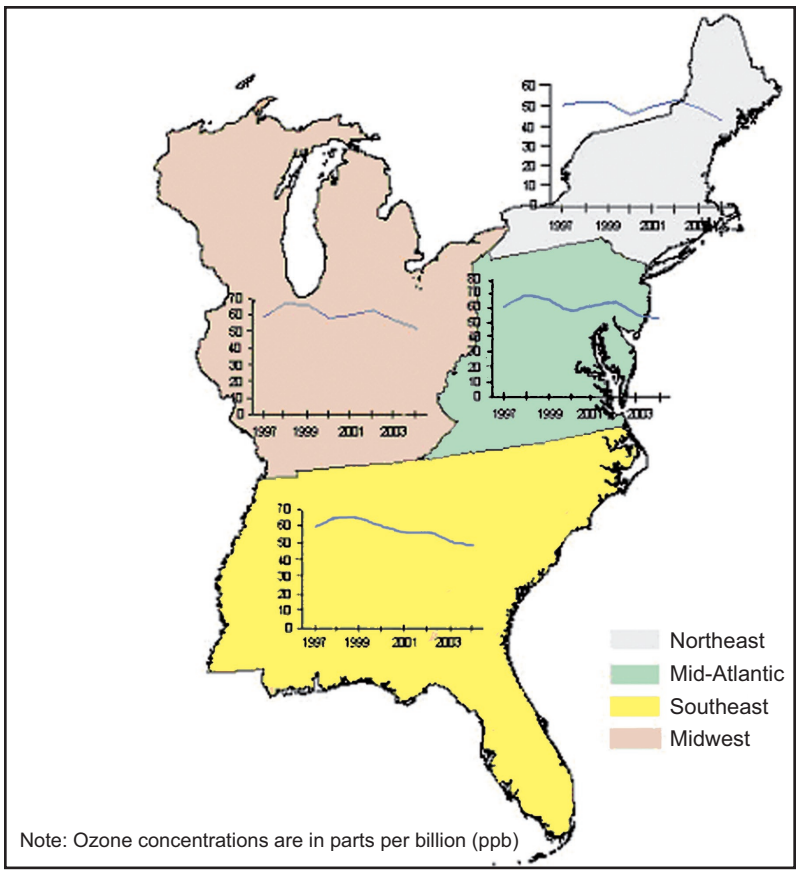

Figure 2. Rural Seasonal Average 8-hour Maximum Ozone Concentrations by Geographic Region, 1997-2004.

Source: Sidebar "Ozone Reduction in Rural Areas Shows Regional Improvements" on page 20 of U.S. Environmental Protection Agency (U.S. EPA). 2005a. Evaluating Ozone Control Programs in the Eastern United States: Focus on the NOx Budget Trading Program, 2004. EPA454-K-05-001. http://www.epa.gov/airtrends/2005/ozonenbp/, last accessed September 5, 2006

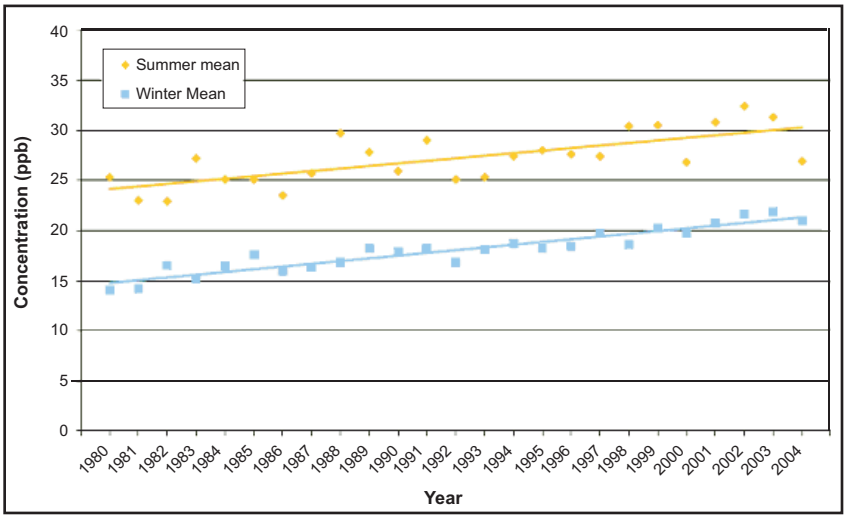

Figure 3. Trend of Ozone Seasonal Means at Sites Across Ontario, 1980-2004.

Source: Figure 2.5 of Ontario Ministry of the Environment. Air Quality in Ontario 2004 Report. Queen's Printer for Ontario, 2006. . ISBN 1710-8128 or 0-7794-9921-2. http://www.airqualityontario.com/press/publications.cfm, last accessed September 6, 2006

indicated that all but one monitoring site (Thunder Bay) in Ontario exceeded the Canada-Wide Standard (CWS) of 65 ppb based on the 4th highest ozone eight-hour daily maximum averaged over three years. The 4th highest eight-hour daily maximum ozone concentrations have increased from 1995 to 2004 throughout Ontario, with the exception of Windsor, London, and Ottawa. The highest percent increases occurred in the urban areas near the shore of Lake Ontario.

Emissions: In the U.S., VOC emissions from anthropogenic sources decreased 32% from 1990 to 2002. The rate of reduction in the Great Lakes basin was slightly less than the national average. In 2002, VOC emissions from biogenic sources were estimated to determine the relative contribution of natural versus anthropogenic sources. It was estimated that biogenic emissions contributed approximately 71% of all VOC emissions in the country. NO_x emissions in the U.S. have also decreased 18% from 1990 to 2002.

In Ontario, anthropogenic VOC emissions have decreased about 27% from 1990 to 2002. The reductions are mostly attributable to the transportation and petroleum refining sectors. VOC emissions in all of Canada have decreased 22% over the same time period. Canadian NO_x emissions have remained essentially unchanged with a slight increase of about 5% between 1990 and 2002. Emissions have decreased by about 11% in Ontario, however, over the same time period.

$PM_{2.5}$

This fraction of particulate matter (diameter of 2.5 microns or less) is a health concern because it can penetrate deeply into the lung, in contrast to larger particles. $PM_{2.5}$ is primarily a secondary pollutant produced from both natural and man-made precursors (SO_2, NO_X, VOC and ammonia).

Ambient Concentrations: In Canada, a CWS for $PM_{2.5}$ of 30 µg/m³ was established in June 2000. 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. As continuous $PM_{2.5}$ monitoring has only begun quite recently, there are not enough data to show any national long-term trends. In Ontario, fine particulate matter data from 2004 indicate that many areas in Ontario recorded 98th percentile daily averages of $PM_{2.5}$ above 30 µg/m³ (Figure 4). In Ontario, during summer episodes, $PM_{2.5}$ mainly consists of sulfate particles.

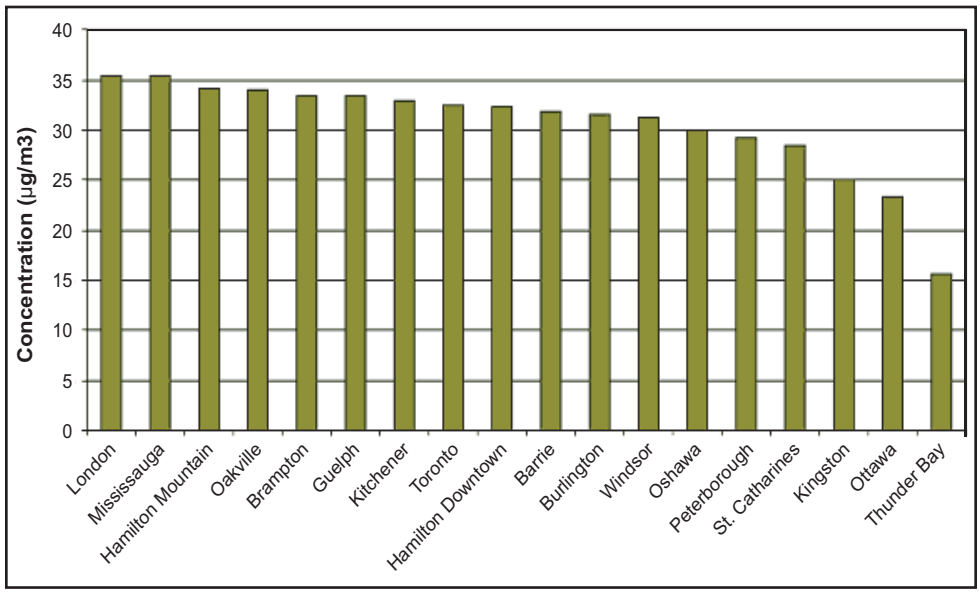

Figure 4. $PM_{2.5}$ Levels at Selected Sites Across Ontario, 98th Percentile $PM_{2.5}$ Daily Average, 2004.

Source: Figure 3.4 of Ontario Ministry of the Environment. Air Quality in Ontario 2004 Report. Queen's Printer for Ontario, 2006. . ISBN 1710-8128 or 0-7794-9921-2. http://www.airqualityontario.com/press/publications.cfm, last accessed September 6, 2006

In the U.S., annual average $PM_{2.5}$ concentrations in 2004 were the lowest since nationwide monitoring began in 1999. The trend is based on measurements collected at 707 monitoring stations that have sufficient data to assess trends over that period. Concentrations in 2004 represent an 11% decrease since 1999. The Great Lakes region has experienced a slightly greater decline than the national average. In 2004, the average 24-hour $PM_{2.5}$ concentration was also 11% lower than the average 1999 level. 24-hour $PM_{2.5}$ concentrations in the Great Lakes region decreased at nearly the same rate as the national trend over this time. Despite some uncertainties, the reductions in $PM_{2.5}$ concentrations in the Great Lakes region appear to be largely a result of emission reduction at sources that contribute to the formation of carbon-containing particles (Figure 5). Direct emissions of carbon-containing particles include motor vehicles and fuel combustion.

There are three areas in the Great Lakes region that are designated nonattainment for the $PM_{2.5}$ standard (Chicago-Gary-Lake Co, IL-IN metropolitan area; Detroit-Ann Arbor, MI metro area; and the Cleveland-Akron-Lorain, OH metro area).

Emissions: In the U.S., direct emissions from anthropogenic sources decreased 27% nationally between 1990 and 2002. However, this decreasing trend does not account for the formation of secondary particles. The largest absolute reduction in $PM_{2.5}$ emissions was seen in the fuel combustion source category (347,000 tons and 38%), while the largest relative reduction in $PM_{2.5}$ emissions was in the on-road vehicle category (175,000 tons and 54%).

In Canada, emissions (not including open sources such as road dust, construction operations, and forest fires) have decreased nationally by about 14% between 1990 and 2002.

Pressures

Continued economic growth, population growth, and associated urban sprawl are threatening to offset emission reductions achieved by policies currently in place, through both increased energy consumption and vehicle miles traveled. The changing climate may affect the frequency of weather conditions conducive to high ambient concentrations of many pollutants. There is also increasing evidence of changes to the atmosphere as a whole. Continuing health research is both broadening the number of toxics and producing evidence that existing standards should be lowered.

Management Implications

Major pollution reduction efforts continue in both the U.S. and Canada. In Canada, new ambient standards for particulate matter and ozone have been endorsed, with a 2010 achievement date. This will involve updates at the federal level and at the provincial level (the Clean Air Action Plan, and Ontario's Industry Emissions Reduction Plan). Toxics are also addressed at both levels. The Canadian Environmental Protection Act (CEPA) was recently amended.

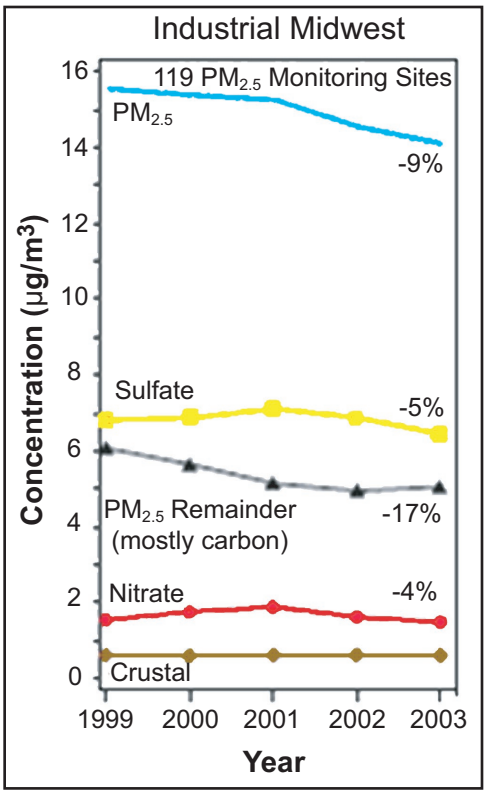

Figure 5. Trends of $PM_{2.5}$ and its chemical constituents in the Industrial Midwest of the U.S., 1999-2003.

Source: Figure 16 of U.S. Environmental Protection Agency (U.S. EPA). 2004a. The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003. EPA 454-R-04-002. http://www.epa.gov/air/airtrends/aqtrnd04/pm.html, last accessed September 5, 2006

In the U.S., new, more protective ambient air standards have been promulgated for ozone and particulate matter. MACT standards continue to be promulgated for sources of toxic air pollution. U.S. EPA has also begun looking at the risk remaining after emissions reductions for industrial sources take effect.

At the international level, Canada and the U.S. signed the Ozone Annex to the Air Quality Agreement in December 2000. The Ozone Annex commits both countries to reduce emissions of NO_x and VOCs, the precursor pollutants to ground-level ozone, a major component of smog. This will help both countries attain their ozone air quality goals to protect human health and the environment. Canada estimates that total NO_x reduction in the Canadian transboundary region will be between 35% and 39% of the 1990 levels by 2010. Under the Clean Air Action Plan, Ontario is also committed to reducing provincial emission of NO_x and VOCs by 45% of 1990 levels by 2015, with interim targets of 25% by 2005.

The U.S. estimates that the total NO_x reductions in the U.S. transboundary region will be 36% year-round by 2010 and 43% during the ozone season. Canada and the U.S. have also undertaken cooperative modeling, monitoring, and data analysis and developed a work plan to address transboundary PM issues. $PM_{2.5}$ networks will continue to develop in both countries to determine ambient levels, trends, and consequent reduction measures. Review of standards or objectives will continue to consider new information. Efforts to reduce toxic pollutants will also continue under North America Free Trade Agreement and through United Nations-Economic Commission for Europe protocols. The U.S. is continuing its deployment of a national air toxics monitoring network.

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