United States • Canada

Air Quality Agreement

Progress Report 2004

American spelling is used throughout the *2004 Progress Report*.

United States • Canada
Air Quality Agreement

Progress Report
2004

The International Joint Commission Requests Your Comments on This Report

The International Joint Commission (IJC) is responsible for inviting public comment on the Air Quality Agreement Progress Reports and for providing a synthesis of the comments to the governments to assist them in implementing the Agreement. Comments on any aspect of the Agreement would be appreciated.

- Do you feel the Agreement has been successful?
- Are there other transboundary air quality issues that should be addressed throughout this Agreement?
- Are the progress reports useful?

Written comments on this report should be sent by February 28, 2005 to:

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Contents

Introduction

The 2004 Progress Report, *prepared by the bilateral Air Quality Committee, is the seventh biennial report compiled under the 1991 United States–Canada Air Quality Agreement. While building upon previous progress reports, this report reviews key actions taken by the United States and Canada in the last two years to address transboundary air pollution under the Agreement. It also covers each country's progress in achieving the requirements of Annex 1—the Acid Rain Annex. In addition, this report specifically focuses on actions taken by each country to meet new requirements under Annex 3—the Ozone Annex.*

To prepare the 2004 Progress Report, *the Air Quality Committee took into account public comments it received through the International Joint Commission (IJC) regarding the* 2002 Progress Report. *(A summary of nearly 40 comments received can be found on the IJC Web site at <www.ijc.org/php/publications/html/airquality/index.html>). In addition, the report reflects decisions made at the June 2004 meeting in Canada to review progress in implementing the Ozone Annex. In preparation for the June meeting, in-country stakeholder meetings were held in March and May 2004.*

Section 3 of this document addresses the joint report, Transboundary Transport, Trends in, and Analysis of Fine Inhalable Particles in the Transboundary Region. *This technical report on particulate matter is the product of a scientific collaboration between the United States and Canada and is being used for decisionmaking on future updates to the Air Quality Agreement. It is just one example of the ways in which both countries are working together to further address their common air quality goals.*

Section 1:

Commitments

Acid Rain Annex

Overview

Since the Acid Rain Annex was developed as part of the original Air Quality Agreement in 1991—to address sulfur dioxide (SO_2) and nitrogen oxides (NO_X) emissions, particularly from electric power generation, as well as visibility protection, preventing air quality deterioration in clean areas, and emissions monitoring—the United States and Canada have taken significant actions to address acid rain. Both countries have established objectives for emission limitations or reductions, programs to implement these objectives, as well as timetables for implementation.

Progress on Canadian and U.S. Sulfur Dioxide Emission Reductions[1]

CANADA

Canada has been very successful in reducing the emissions of SO_2, a principal cause of acid rain.[2]

In 2001, SO_2 emissions in the seven easternmost provinces, where elevated acid deposition

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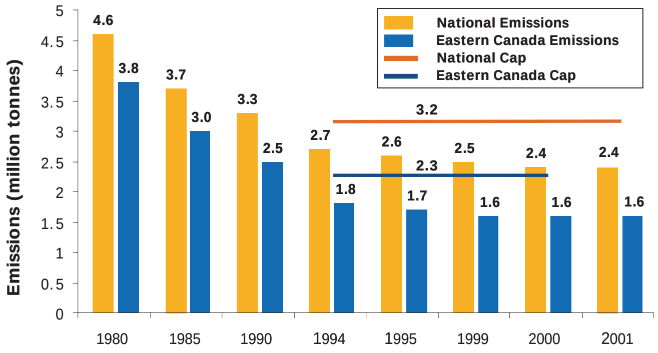
[1] The SO_2 commitments are listed in the United States–Canada Air Quality Agreement Annex 1: Specific Objectives Concerning Sulfur Dioxide and Nitrogen Oxides, Section 1. Sulfur Dioxide, Part A for the United States and Part B for Canada.

[2] Sulfate deposition is the primary acidifying agent in eastern Canada and the United States. The relative importance of nitrogen deposition is expected to increase, however, as sulfur deposition decreases.

Figure 1. Canadian SO_2 Emissions from Acid Rain Sources* (1980–2001)



* Total SO_2 emissions

Source: Environment Canada

continues to damage sensitive ecosystems, were 28 percent below the eastern Canada 2.3 million tonne[3] cap, even though the cap expired in December 1999. Canada's total SO_2 emissions have decreased about 50 percent since 1980, to 2.4 million tonnes in 2002, or 25 percent below the national cap. (See Figure 1 to compare eastern Canada emissions to national emissions and from 1980 to 2001.)

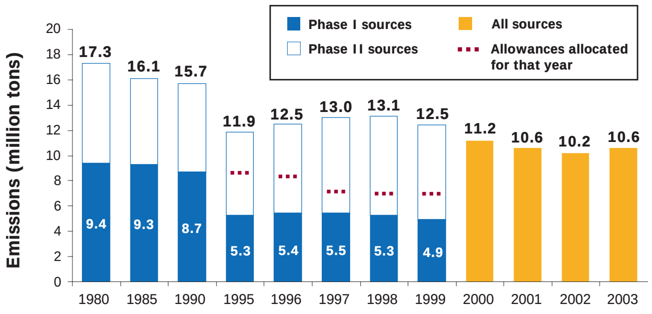
The Canada-wide Acid Rain Strategy for Post-2000 serves as a framework for addressing the country's acid rain problem. The long-term goal of the Strategy is to achieve critical loads[4] for acid deposition for aquatic and terrestrial ecosystems. As part of the Strategy, the provinces of Ontario, Quebec, New Brunswick, and Nova Scotia all committed to an additional 50 percent reduction in their SO_2 emissions beyond their 1985 Eastern Canada Acid Rain Program targets by 2010.[5] Although these provinces have not yet finalized plans for implementing the new reductions, each has taken significant steps towards identifying measures for industrial sectors to achieve the specified reductions.

UNITED STATES

The United States has made substantial progress in reducing SO_2 emissions, with the highest level of reduction being achieved by the electric power sector. By 2003, four years into Phase II of the Acid Rain Program, electric power sources in the United States reduced SO_2 emissions by 5.1 million tons, or 32 percent, compared to 1990 levels, and more than 38 percent compared to 1980 levels. (Figure 2 shows the trend in SO_2 emissions from 1980 to 2003 for electric power sources.) Reductions from all source categories are expected to result in an SO_2 emission reduction of 10 million tons annually from 1980 levels, with 8.5 million tons achieved by the electric power sector alone. In 2003, 3,497 electric generating units were subject to the SO_2 provisions of the Acid Rain Program. (Annual fluctuations in the number of units participating in the program can result from retirements of some units and start-up of other units. For further details, visit <http://cfpub.epa.gov/gdm/>.)

Under the Acid Rain Program, the number of allowances allocated in a given year to a particular unit is determined by provisions in the Clean Air Act. All allowances are tradable, allowing them to be bought or sold. Every year, however, each individual source must hold enough

Figure 2. U.S. SO_2 Emissions from Electric Power Generation (1980–2003)



Source: EPA

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[3] One tonne is equal to 1.1 short tons.

[4] Critical loads are the maximum amount of acidifying deposition an ecosystem can tolerate in the long term without being damaged. Canada's goal for acid rain is to meet its critical loads.

[5] Ontario's target is currently 2015, although the province has proposed and is consulting on advancing the timeline to 2010. Nova Scotia's forecast of 94.5 kilotonnes by 2010 is a reduction target from existing sources and is not meant to be a cap.

allowances to equal or exceed its annual emissions. Allowances that are not used or sold in a given year are carried over (or banked) for future use. Banked emissions give sources the flexibility to emit more in years when energy demand is higher without affecting the total emissions cap under the program. Thus, annual fluctuations in SO_2 emissions are expected.

In 2003, a total of 9.5 million allowances were allocated; however, sources actually emitted 10.6 million tons, decreasing total banked allowances by 1.1 million tons. Over time, affected sources will continue to use banked allowances to help comply with the more stringent Phase II requirements.

In 2003, national annual SO_2 emissions under the Acid Rain Program were 400,000 tons (4 percent) higher than 2002 levels. Acid rain sources increased their heat input by 1.2 percent compared with 2002. One reason for this increase was that nuclear generation was down 2 percent in 2003, for the first time since 1998. More importantly, the price of natural gas rose by 55 percent in 2003, which resulted in approximately a 9 percent decline in natural gas generation. Sources were forced to use other types of generation to meet electricity demand, and that need was primarily filled by coal-fired and oil-fired generation. Despite the increase in emissions from 2002 levels, emissions under the Acid Rain Program were lower than 2000 levels and substantially lower than 1990 levels.

In addition to the electric power generation sector, other sources achieved reductions in SO_2 emissions, including smelters and sulfuric acid manufacturing plants. The use of cleaner fuels in residential and commercial burners also contributed to the nearly 41 percent decline of SO_2 emissions from all sources, compared to the 1980 level of 25.9 million tons. (For more details, visit the National Emission Inventory at <www.epa.gov/airtrends/reports.html>.)

Progress on Canadian and U.S. Nitrogen Oxides Emission Reductions[6]

CANADA

Though Canada has surpassed its NO_x emission reductions target at power plants, major combustion sources, and metal smelting operations by 100,000 tonnes below the forecast level of 970,000[7] tonnes, the country is continuing to develop programs to further reduce NO_x emissions nationwide (see Section 2). In fact, the provinces and federal government are working together to achieve multi-pollutant emission reductions for pollutants contributing to particulate matter (PM) and ozone for key industrial sectors. Analytical studies have characterized pollutants that chemically react to form PM and ozone (including NO_x). In addition, a range of emission control options, including measures and actions to reduce NO_x emissions, were identified for several sectors contributing significantly to emissions of PM and ozone precursors. These options should be useful to assist jurisdictions in identifying best available technologies (BAT) and developing plans to meet the Canada-wide Standards for PM and ozone by 2010.

In addition to the efforts to reduce NO_x emissions from stationary sources such as industries, Canada's agenda to reduce the largest source of NO_x emissions—from vehicles and fuels—is aggressive. Details for implementing this agenda can be found in the ozone section of this report, under "Key Commitments and Progress" on page 10.

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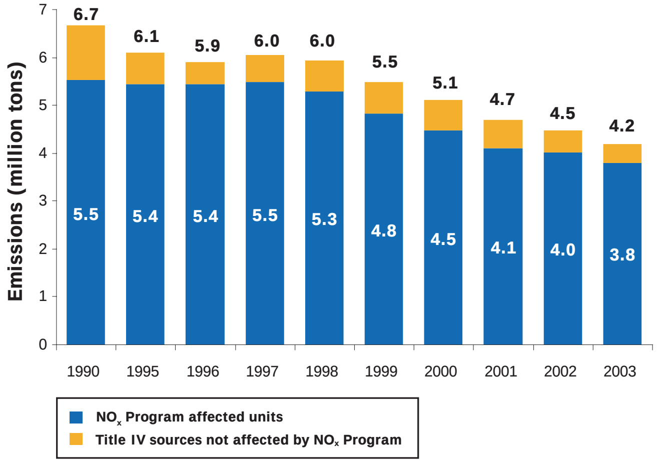
[6] The NO_x commitments are listed in the United States–Canada Air Quality Agreement Annex 1: Specific Objectives Concerning Sulfur Dioxide and Nitrogen Oxides, Section 2. Nitrogen Oxides, Part A for the United States and Part B for Canada.

[7] The 970,000 tonnes is forecast for 2005 in the NO_x/VOC Emission Forecast 90-B in the 1990 NO_x/VOC Management Plan. Historical emissions and projections are subject to change as methodologies improve for estimating and forecasting emissions.

UNITED STATES

Coal-fired electric utility units affected by the NO_x component of the Acid Rain Program continue to meet and exceed the annual 2 million ton reduction goal from what emission levels would have been without the program, set by Title IV of the 1990 Clean Air Act Amendments. In 2003, the 1,004 NO_x program-affected units reduced their combined NO_x emissions to 3.8 million tons. In addition, total NO_x emissions for all Acid Rain Program-affected units were 4.2 million tons (see Figure 3 for NO_x emissions from 1990 to 2003).

Figure 3. U.S. NO_x Emissions from Electric Power Generation (1990–2003)



Source: EPA

Emissions Monitoring

CANADA[8]

Canada has met its commitments to estimate emissions of NO_x and SO_2 from new electricity utility units and existing electricity units greater than 25 megawatts (MW) using a method of comparable effectiveness to continuous emission monitoring systems (CEMS) and to investigate the feasibility of using CEMS by 1995. In Canada, emissions trading of SO_2 and NO_x is not currently a driver for electronic data reporting and CEMS. Currently, Environment Canada is undertaking an update of its 1993 guidelines for CEMS ("Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation," Report EPS 1/PG/7) based, in part, on experience gained from the use of 40 CFR Part 75 specifications for CEMS in the United States. Although CEMS and data reporting requirements for power plants and industrial sources involved in emissions trading in the United States are not fully mirrored in Canada, it has been concluded that EPS 1/PG/7-compliant CEMS in Canada would meet Canadian monitoring requirements for domestic purposes. However, the feasibility of cross-border emissions trading is now being examined and indications are that certain enhancements of emissions monitoring in Canada would be required, if there was cross-border trading.

UNITED STATES[9]

Under the Acid Rain Program, affected units are required to measure and record emissions using CEMS or an approved alternative measurement method and report emissions electronically. All of the monitoring systems operate with a high degree of reliability. In fact, the percent monitor data availability (a measure of monitoring systems' reliability) for 2003 was 99 percent for coal-fired units. Additionally, in 2003, new audit capabilities were added, including software that performs hourly checks to catch errors, miscalculations, and oversights in monitoring and reporting systems. These audits help ensure the completeness, high quality, and integrity of emission data as well as highlight a number of potential "red flags" that require additional verification. Accurate emissions monitoring remains the backbone of trading program integrity.

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[8] The Canadian commitments are listed in the United States–Canada Air Quality Agreement, Annex 1: Specific Objectives Concerning Sulfur Dioxide and Nitrogen Oxides, Section 3, Compliance Monitoring, Part A and B. Utility Units and Other Major Stationary Sources, Subsection 2 and 3 for Canada and for both parties.

[9] The U.S. commitments are listed in the United States–Canada Air Quality Agreement Annex 1: Specific Objectives Concerning Sulfur Dioxide and Nitrogen Oxides, Section 3, Compliance Monitoring, Part A. Utility Units, Subsection 1 for the United States and 3 for both parties.

Acid Deposition Monitoring, Modeling, Maps, and Trends[10]

Airborne pollutants are deposited on the earth's surface by three processes: 1) wet deposition (rain or snow); 2) dry deposition (particles and gases); and 3) deposition by cloud water and fog. Wet deposition is comparatively easy to measure using precipitation gauges and is regularly used as the reference measure for comparison with emissions.

Early 1990s sulfate and nitrate wet deposition data are illustrated in Figures 4 and 6, to be compared with 2002 data in Figures 5 and 7, to show trends. Wet sulfate deposition measurements are corrected for sea-salt, to derive non-sea-salt sulfate (nss SO_4^{2-}), at sites in proximity to oceans. Blank areas on the maps indicate that measurement data were

Figure 4. Average Wet Sulfate Deposition (1990–1994)

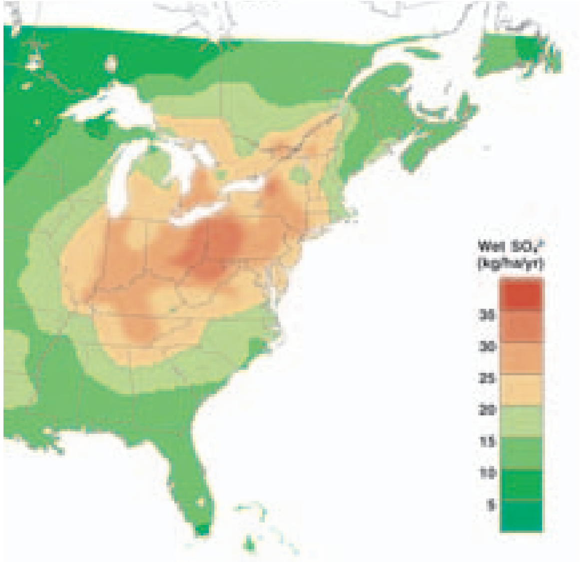


Figure 5. Annual Wet Sulfate Deposition (2002)

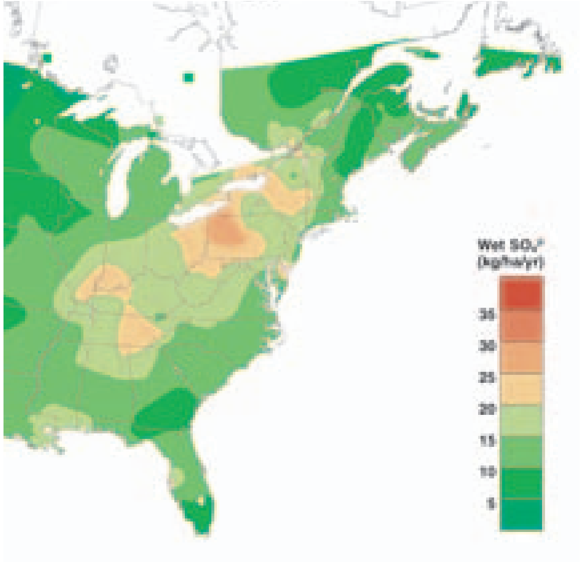


Figure 6. Average Wet Nitrate Deposition (1990–1994)

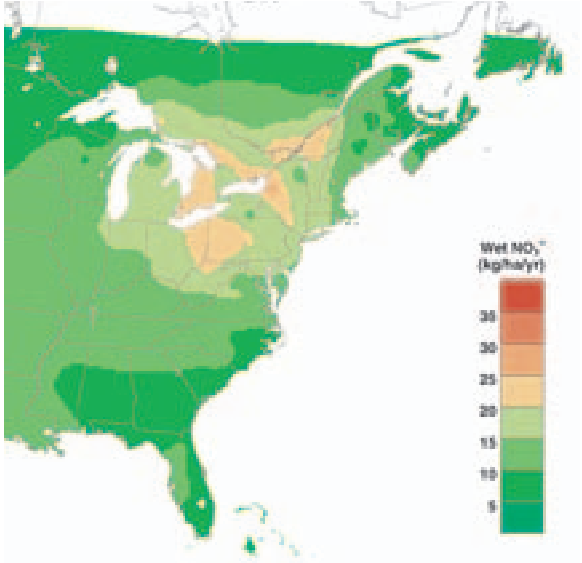
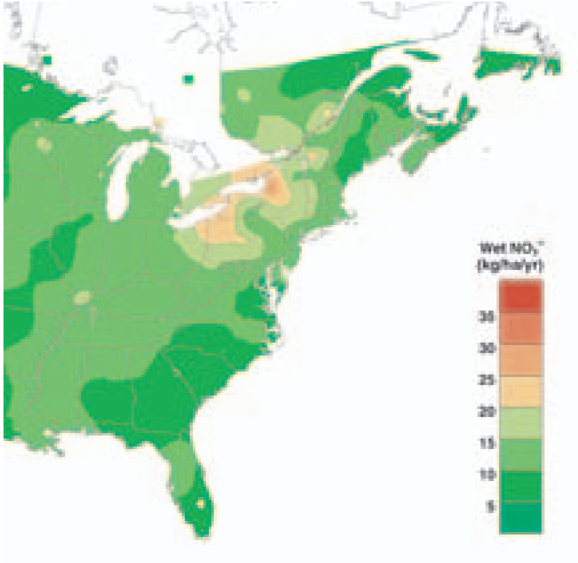


Figure 7. Annual Wet Nitrate Deposition (2002)



Source: NAtChem (www.msc-smc.ec.gc.ca/natchem/index_e.html) and NADP (http://NADP.sws.uiuc.edu)

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[10] The commitments are listed in the United States–Canada Air Quality Agreement Article VI and Annex 2: Scientific and Technical Activities and Economic Research.

insufficient for the creation of deposition contours. Figures 4 and 6 are each five-year averages for baseline comparisons, whereas Figures 5 and 7 are the most recent annual averages for which data are available. Comparison of one year's data with a five-year average might introduce a bias due to specific weather conditions in 2002.

Wet sulfate deposition is greatest in eastern North America, along an axis running from the Mississippi River to the lower Great Lakes. Decreasing deposition is evident in the Ohio River basin and southern Ontario and Quebec.

Sulfate deposition of more than 25 kg/ha/yr persists south of Lake Erie; however, this amount is still a significant reduction from the early 1990s, when wet deposition in this area exceeded 30 kg/ha/yr.

The pattern for wet nitrate deposition is centered on the lower Great Lakes with an axis running from southeastern Missouri towards the Gulf of St. Lawrence. Comparison of 2002 data with the average for 1990 through 1994 shows persistent deposition.

Trends in wet deposition of sulfate and nitrate correspond to changes in SO_2 and NO_x emissions.

In Canada, wet and dry deposition components are measured in the federal Canadian Air and Precipitation Monitoring Network (CAPMoN) (www.msc-smc.ec.gc.ca/capmon). Some provincial governments (e.g., British Columbia, Alberta, Quebec, New Brunswick, Nova Scotia, Newfoundland) and the Northwest Territories support wet deposition sites. Recently a few additional sites in the more remote portions of Canada have been added to CAPMoN to provide more detailed deposition data.

The United States has three coordinated acid deposition networks:

1) The National Atmospheric Deposition Program/National Trends Network (NADP/NTN), a collaboration of federal, state, and non-governmental organizations measuring deposition chemistry (http://nadp.sws.uiuc.edu).
2) The NADP/Atmospheric Integrated Research Monitoring (AIRMoN) network (a subnetwork of NADP operated by the National Oceanic and Atmospheric Administration).
3) The EPA/National Park Service Clean Air Status and Trends network (CASTNET), which provides dry deposition data (www.epa.gov/castnet).

Procedures for all U.S. and Canadian networks are standardized and contribute to an integrated, consistent dataset, which is accessible to the public at <www.msc.ec.gc.ca/natchem/index_e.html>. Techniques for estimating dry deposition based on measurement data are undergoing steady improvement, as there are indications that this contribution to total deposition might have been underestimated in the past.

Preventing Air Quality Deterioration and Protecting Visibility[11]

In certain areas in the United States and Canada, many visitors are not able to see the spectacular vistas they expect. During much of the year, a veil of white or brown haze hangs in the air, obstructing the view. Most of this haze comes from air pollution, carried by the wind, often many hundreds of miles from where it originated.

CANADA

Pollution prevention, continuous improvement (CI), and Keeping Clean Areas Clean (KCAC) activities are all part of the Canada-wide Standards to prevent the deterioration of air quality and address the pollutants involved in visibility impairment. These activities are being conducted in addition to achieving the standards for PM and ozone by the 2010 target date. The

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[11] The commitments are listed in the United States–Canada Air Quality Agreement Annex 1: Specific Objectives Concerning Sulfur Dioxide and Nitrogen Oxides, Section 4. Prevention of Air Quality Deterioration and Visibility Protection, Part A for the United States and Part B for Canada.

KCAC principle recognizes that polluting "up to a limit" is not acceptable and that the best strategy to avoid future problems is to keep clean areas clean. CI applies to areas with ambient pollutant levels below those of existing standards but still above levels associated with observable health effects. The CI framework encourages jurisdictions to take remedial and preventive actions to reduce emissions from anthropogenic sources to the extent practicable. Jurisdictions are currently developing a national guidance document on CI/KCAC, which is expected to be completed in late 2004.

Federal, provincial, and territorial governments are working with stakeholders to establish implementation plans and programs for the Canada-wide Standard for $PM_{2.5}$ and ozone that apply pollution prevention and best management practices. These practices could include ensuring that new facilities and activities incorporate the best available economically feasible technology (BAEFT) to reduce PM and ozone levels and reviewing new activities that might contribute to PM and ozone level increases.

One of the largest contributors from stationary sources is the electric power sector. Therefore, in January 2003, the government of Canada set out more stringent emission targets for key air pollutants from new fossil fuel power plants in "New Source Emission Guidelines for Thermal Electricity Generation" issued under the Canadian Environmental Protection Act (CEPA) of 1999. These guidelines are intended to provide national emission standards for application by the provinces to new coal-, oil-, and gas-fired, steam-electric power plants. The new guidelines include revised emission limits for SO_2, NO_x, and PM, consistent with the performance capability of current BAEFTs. In particular, the new emission limits align with U.S. standards and best available control technology (BACT) determinations.

UNITED STATES

The U.S. Prevention of Significant Deterioration (PSD) program protects public health and the environment from adverse effects that could occur from the addition of new sources of air pollution. It also ensures that air quality in many areas of the country remains better than levels mandated by the National Ambient Air Quality Standards (NAAQS). The program preserves and protects air quality in Class I areas by assessing impacts on visibility before construction permits are issued. Class I areas are national parks and wilderness areas such as the Grand Canyon, Yosemite, and the Great Smokies. The Regional Haze Program requires states to develop plans to improve visibility conditions at Class I areas with the goal of restoring natural visibility conditions in about 60 years. The first set of plans is due in early 2008.

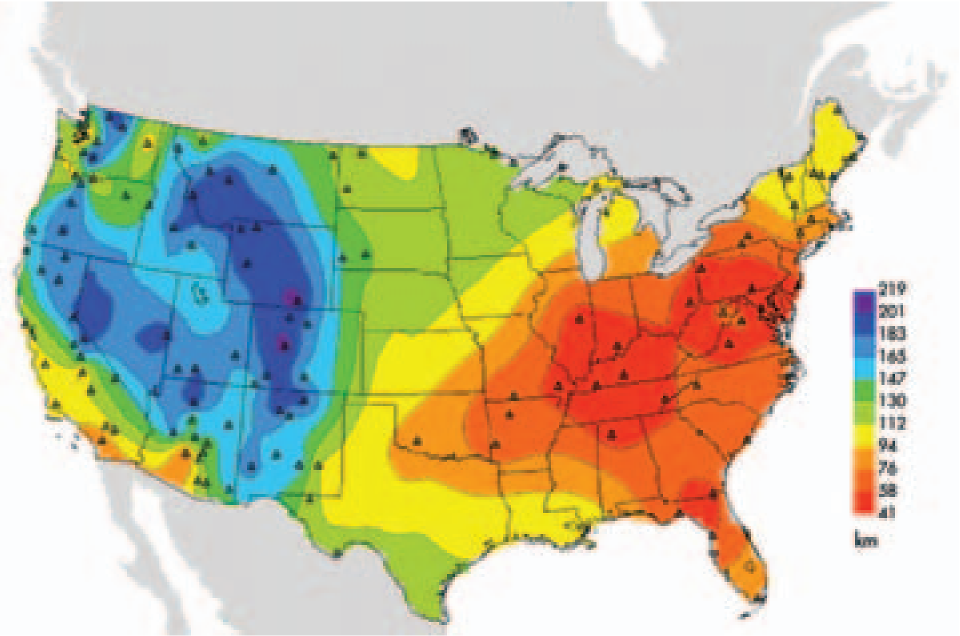
SO_2 and NO_x gases are transformed in the atmosphere into fine particles of sulfates and nitrates. Sulfate and nitrate particles scatter and absorb light, impairing visibility and contributing to haze. Sulfates are generally the largest contributor to visibility impairment in both the East and the West. The visual range under naturally occurring conditions without air pollution in the United States is approximately 45 to 90 miles (75 to 150 km) in the East and 120 to 180 miles (200 to 300 km) in the West.

Data from the IMPROVE (Interagency Monitoring of Protected Visual Environments) network indicate little change in visibility during the past decade. (See Figure 8 for the annual average standard visual range.) The level of visibility impairment on the worst visibility days in the West is similar to the levels seen on the best visibility days in the East. In 2001, the mean visual range for the worst days in the East was only 18 miles (29 km), compared to 73 miles (117 km) for the best visibility. In the West, visibility impairment for the worst days remained relatively unchanged over the 10-year period, with the mean visual range for 2001 (63 miles, or 103 km) nearly the same as the 1992 level (61 miles, or 98 km). Although that 10-year period showed moderate improvements in some areas, overall visibility in the East is still significantly impaired in national parks and wilderness areas, especially on the haziest days.

To implement the requirements of the Regional Haze Program, states work together in five regional planning organizations (RPOs) to develop strategies to address regional haze and visibility. The five RPOs are the Mid-Atlantic/Northeast Visibility Union (MANE-VU), the State and Tribal Association of the Southeast (VISTAS), the Midwest RPO, the Central States Regional Air Partnership (CENRAP), and the Western Regional Air Partnership (WRAP). The RPOs hold their own technical work group sessions throughout the country to make decisions on joint technical work, such as assessments of international transport. The RPOs coordinate technical information on emissions, ambient monitoring, and air quality modeling activities. The RPOs are seeking ways for more involvement by air quality agencies in Canada in their assessment of pollutant formation and transport. (For more information on the U.S. visibility program and RPOs, see <www.epa.gov/air/visibility/index.html>.)

On February 23–24, 2004, the International Joint Commission's Air Quality Advisory Board held a Workshop on Clean Areas and PSD in Vancouver, British Columbia. The purpose of this workshop was to review the current challenges and possible joint opportunities for clean area management policies in the transboundary region. The workshop examined the PSD and Regional Haze programs in the United States and the KCAC provisions of the Canada-wide Standards for ozone and PM.

Figure 8. Annual Standard Visual Range (2002)



Source: National Park Service

Consultation and Notification of Significant Transboundary Air Pollution[12]

JOINT EFFORTS

The United States and Canada have ongoing notification procedures, established in fall 1994, to identify possible new sources and modifications to existing sources of transboundary air pollution within 62 miles (100 km) of the border. Notifications can occur for new and existing sources located outside of the 62 mile (100 km) region if governments believe that there is the potential for transboundary pollution. Since the last progress report in 2002, the United States has notified Canada of 11 additional sources, for a total of 34. Canada has notified the United States of 11 additional sources as well, for a total of 37.

Transboundary notification information is available on the Internet sites of the two governments at:

> ***Canada:***
> www.ec.gc.ca/pdb/can_us/canus_applic_e.cfm
>
> ***United States:***
> www.epa.gov/ttn/gei/uscadata.html

The United States and Canada report significant continuing progress on joint discussions around the Boundary Dam Power Station (BDPS) near Estevan, Saskatchewan, and Algoma Steel, Inc. in Sault Ste. Marie, Ontario.

SaskPower, the operator of BDPS, has completed the installation of electrostatic precipitators (ESPs) on all units at the power station. The ambient air monitoring network was established prior to installing the ESPs to track changes in air quality before and after installation of this control technology. The latest report of ambient air monitoring data from the network through 2003 showed no exceedances of the applicable ambient air quality standards at any of the sites.

U.S. and Canadian representatives of the federal, state, and provincial governments, the Inter Tribal Council in Michigan, and Algoma Steel continue to operate a comprehensive ambient air monitoring network in the United States and Canada. A report was prepared summarizing all monitoring data collected in the binational area between 2001 and 2003. The draft report was issued in late fall of 2004 and included a brief executive summary for public information and a longer technical report. The Canadian federal and provincial agencies have worked with the steel company to achieve emission reductions. Despite these abatement measures, citizens in Michigan continue to express their concern about the pollution from this plant.

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[12] The commitments listed in this section come from the United States–Canada Air Quality Agreement, Article V, Assessment, Notification, and Mitigation.

Ozone Annex

Overview

The United States and Canada signed the Ozone Annex to the Air Quality Agreement in December 2000 (www.ec.gc.ca/air/pdfs/can_usa_e.pdf). This Annex is expected to significantly reduce NO_X and volatile organic compound (VOC) emissions—the precursor pollutants to ground-level ozone, a major component of smog. This Annex defines a transboundary region in each country, known as the Pollutant Emission Management Area (PEMA) (see Figure 9). The states and provinces within this region are the areas where emission reductions are most important for transboundary ozone. In the United States, the region covers 18 states and the District of Columbia (approximately 40 percent of the U.S. population). In Canada, the region includes central and southern Ontario and southern Quebec (more than 50 percent of Canada's population).

Key Commitments and Progress

CANADA[13]

Vehicles, Engines, and Fuels

New stringent NO_x and VOC emission reduction standards for vehicles, including cars, vans, light-duty trucks, off-road vehicles, small engines, and diesel engines, as well as fuels.

Canada is on track to implement all of its commitments for vehicles, engines, and fuels. Consistent with the Federal Agenda on Cleaner Vehicles, Engines, and Fuels announced on February 19, 2001, Environment Canada is implementing regulations that will align Canadian emission standards with the U.S. Environmental Protection Agency (EPA) rules for corresponding vehicles and engines.

The On-Road Vehicle and Engine Emission Regulations were published in the Canada Gazette, Part II, on January 1, 2003, and came into effect on January 1, 2004, for light- and heavy-duty vehicles and motorcycles. These regulations replaced earlier vehicle emission regulations under Transport Canada's Motor Vehicle Safety Act. The first-ever regulations for off-road engines, the Off-Road Small Spark-Ignition Engine Emissions Regulations, were published on

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[13] The commitments listed in this section are summarized from the Ozone Annex 3: Specific Objectives Concerning Ground Level Ozone Precursors, Part III—Specific Obligations, Section A for Canada.

November 19, 2003, and become effective in 2005. These two regulations, together with the Sulfur in Diesel Fuel Regulations and current regulations and programs, will result in an estimated 73 percent reduction of NO_x emissions from on-road vehicles by 2020, compared with the continuation of current emission controls.

A discussion draft of the planned Off-Road Compression-Ignition Emission Regulations was issued in July 2003, prior to a formal proposal planned for 2004. These regulations will be followed in 2004 and 2005 by proposals for recreational marine engines (outboards and personal watercraft), large spark-ignition engines (engines above 19 kilowatts (kW)), and recreational vehicles (such as snowmobiles and all-terrain vehicles). Together, these regulations will cover all vehicle and engine types used in mobile applications.

In the Ozone Annex, Canada committed to continue the application of its existing fuel regulations that address sulfur in gasoline, for instance, and to develop and implement a new regulation to reduce the allowable level of sulfur in on-road diesel fuel. These commitments have been met with the publication of the Sulfur in Diesel Fuel Regulations in the Canada Gazette, Part II, on July 31, 2002. The regulations limit the level of sulfur in diesel fuel used in on-road vehicles to a maximum of 500 parts per million (ppm), reduced to 15 ppm commencing in 2006. Beyond the requirements in the Ozone Annex, Environment Canada is preparing to propose regulations to control sulfur in diesel fuel for use in off-road, rail, and marine engines aligning with U.S. levels and timing (i.e., off-road: 500 ppm in 2007 and 15 ppm starting in 2010, and rail and marine: 500 ppm in 2007 and 15 ppm in 2012).

Stationary Sources of NO_x

Annual caps by 2007 of 39 kilotonnes (kt) of NO_x (as NO_2) emissions from fossil-fuel power plants in the PEMA in central and southern Ontario, and 5 kt of NO_2 in the PEMA in southern Quebec, aligned with U.S. standards.

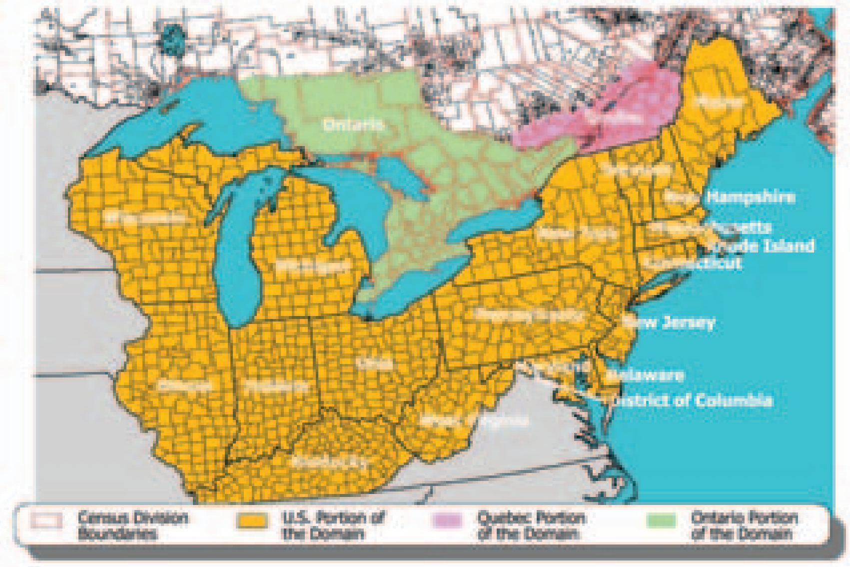
Canada will comply with its commitment to cap NO_x emissions from large fossil fuel-fired power plants in the Ontario and Quebec portions of the PEMA at 39 kt and 5 kt, respectively. Emissions from power plants in the Ontario PEMA were approximately 78 kt in 1990 and approximately 79 kt in 2002, but progress is underway towards reductions by 2007. Preliminary emissions data for 2003 indicate that NO_x (as NO_2) emissions from power plants in the Quebec PEMA are above the 5 kt cap. This is mainly due to the increased hours of operation for the Tracy power plant. Quebec is currently considering setting a specific regulatory cap for the Tracy plant to help meet the 5 kt cap.

Proposed National Guideline for Renewable Low-Impact Electricity

Development of a proposed national Guideline for Renewable Low-Impact Electricity.

After extensive multi-stakeholder consultation, a notice of a draft Renewable Low-Impact Electricity (Green Power) Guideline was published in the Canada Gazette, Part I, in December 2001. This guideline will provide national guidance on environmentally preferable electricity products and generation in Canada and will establish certification criteria for environmental labeling of qualifying electricity products under Canada's Environmental Choice Program (ECP).

Figure 9. Ozone Annex Pollutant Emission Management Area (PEMA)



Source: United States–Canada Air Quality Agreement, Ozone Annex

In fact, these criteria are already being used for certification of qualifying electricity products under this program.

Canada intends to monitor market uptake of these criteria as an indicator of improvement in the environmental performance of electricity generation and distribution sectors. Publication of a final guideline will be considered with other options to maintain and enhance continuous improvement in the environmental performance of this industry.

Measures to Reduce VOCs

Reduction of VOC emissions through the development of two regulations, one on dry cleaning and another on solvent degreasing and the use of VOC emission limits for new stationary sources.

The Tetrachloroethylene (Use in Dry Cleaning and Reporting Requirements) Regulation became law on February 27, 2003, and is expected to result in a 70 percent reduction of tetrachloroethylene (PERC) releases at dry-cleaning facilities from 1994 levels, by August 2005. The Solvent Degreasing Regulation went into effect on July 24, 2003, and is expected to result in a 65 percent reduction in consumption of trichloroethylene (TCE) and PERC in solvent degreasing by 2007.

The Canadian Council of Ministers of the Environment (CCME) has also completed and endorsed 16 codes, guidelines, and standards, or MOUs, for solvent-use subsectors. These documents are used to provide guidance to jurisdictions for reducing VOC emissions from many industrial/commercial sectors, including, paints, coatings, printing, and storage tanks. In addition, a number of CCME codes or guidelines, developed in the early to mid-1990s, are being reviewed for updating.

Measures for NO_X and VOC Emissions to Attain the Canada-wide Standard for Ozone

Achievement of the Canada-wide Standard for ozone in the PEMA by 2010, by undertaking by 2005 and implementing between 2005 and 2010 measures to reduce NOx emissions based on a multi-pollutant emission reduction approach for key industrial sectors, and measures to address VOC emissions from solvents, paints, and consumer products.

After completing analysis reports for the six industrial Multi-Pollutant Emission Reduction Strategies (MERS) sectors (i.e., pulp and paper, lumber and allied wood products, iron and steel, base metals smelting, hot mix asphalt plants, and concrete batch plants) as well as the electric power generation sector, Canada was able to determine that these six industrial sectors are key to achieving the Canada-wide Standards for PM and ozone. The information was prepared in consultation with provinces and stakeholders and is publicly accessible from the CCME Web site (www.ccme.ca/initiatives/standards.html). The reports contain a description of each sector, emissions released, performance standards, available pollution prevention and control techniques, and preliminary analyses of technically feasible emission reduction options. Provinces and territories will use the reports in preparing their implementation plans.

To provide further information and support to Canadian provinces and territories in developing their implementation plans, the following activities are underway:

- **Iron and Steel:** Environmental performance standards are being developed to address releases of PM, NO_x, SO_2, and VOCs from the significant process sources of the iron and steel sector. The existing CEPA Environmental Codes of Practice for integrated and non-integrated iron and steel mills will be updated through consultation with industry, non-government stakeholders, and the provinces to incorporate environmental performance standards for air pollutants, including precursors to PM and ozone, as well as total PM.
- **Base Metal Smelting and Refining:** The development of a draft Environmental Code of Practice is under discussion in consultation with industry, non-governmental stakeholders, and provinces with particular emphasis on setting emission guidelines for SO_2 and PM discharges.
- **Cement:** The background information necessary to produce a foundation report for the cement manufacturing industry is under development for a planned national environmental code of practice.

Canada published a "Federal Agenda for the Reduction of VOC Emissions from Consumer and Commercial Products" as a Notice of Intent in the Canada Gazette, Part I, on March 27, 2004. This Agenda outlines actions to be taken between 2004 and 2010 to reduce emissions from these sources and emphasizes alignment with measures in the United States, recognizing the North American market for many of these products.

In addition, the federal government has several measures in place that should either directly or indirectly result in VOC emission reductions in the solvent use sector. These include Guidelines for Volatile Organic Compounds in Consumer Products under CEPA published in 2003.

Quebec Portion of the PEMA

Measures to reduce NO_x and VOC emissions in the Quebec portion of the PEMA.

Quebec made progress in meeting its Ozone Annex commitments due to several regulatory actions. The planned amendments to Quebec's Regulation Respecting the Quality of the Atmosphere (RRQA) contain stricter standards aimed at reducing NO_x emissions from new and modified industrial and commercial boilers, in accordance with CCME guidelines. In addition, when burners on existing units must be replaced, the replacements must be low-NO_x burners.

With respect to VOC emissions, the amendments to the RRQA are aimed at reducing emissions from both the manufacture and application of surface coatings, commercial and industrial printing, dry cleaning, above-ground storage tanks, petroleum refineries, and petrochemical plants.

Pursuant to its Regulation on Petroleum Products (RPP), Quebec is currently applying provisions aimed at reducing gasoline volatility during the summer months in the city of Montreal and the Gatineau–Montreal section of the Windsor–Quebec City corridor.

These amendments will address Stage 1 initiatives, including gasoline storage, transfer depots, and service stations for both new and existing installations in the Quebec portion of the Windsor–Quebec City corridor. The city of Montreal is currently enforcing regulatory provisions concerning gasoline vapor recovery in its territory.

Ontario Portion of the PEMA

Measures to reduce NO_x and VOC emissions in the Ontario portion of the PEMA.

Ontario has fully met the Ozone Annex commitments with the following regulations and guidelines:

- The Ontario Drive Clean program (Ontario Environmental Protection Act Regulation 361/98) was launched in the Greater Toronto Area and Hamilton on April 1, 1999. Drive Clean requires mandatory vehicle emissions inspection and maintenance to reduce emissions of NO_x, carbon monoxide (CO), and VOCs. As of July 2002, the Drive Clean program has expanded to include southern Ontario's entire smog zone—an area that includes an estimated 5.5 million vehicles. The Drive Clean program's standards for light-duty vehicles were tightened by 11.5 percent (from the original limits) in 2003 and will be tightened an additional 11.5 percent in 2005.

  Ontario requires all diesel-powered heavy-duty trucks and buses to pass an annual emissions test and has imposed new standards tightening opacity levels. (Opacity is a measure of the degree to which a substance blocks the passage of light rays.)

Ontario also requires that all heavy-duty diesel school buses meet the stricter of the two emission standards in place for other heavy-duty diesel vehicles each year: a 35 percent opacity level on April 1, 2004, and a 30 percent level on April 1, 2005.

The Drive Clean's Smog Patrol conducts random roadside testing of suspected polluting vehicles and can issue tickets for violations. Beginning in July 2002, the Smog Patrol increased its staff to 30 members to enhance enforcement. Since 1998, the Smog Patrol has conducted more than 29,000 vehicle inspections and issued more than 5,250 tickets.

- Stage 1 of the gasoline vapor recovery program was implemented in 1994, and the program continues today.
- The volatility in gasoline regulation has been ongoing since 1991.
- Mandatory training is required every five years for at least one full-time employee of all dry cleaning establishments in Ontario. A new training course for dry cleaners has been successfully piloted by the Ministry of the Environment (MOE) and is now widely available through Seneca College to dry cleaners across Ontario.
- NO_x and SO_x from new and modified stationary combustion turbines are limited under MOE Guideline A-5 through Certificates of Approval; monitoring and recording are required.
- In March 2001, MOE Guideline A-9 (Boilers and Heaters) came into effect for NO_x emissions limits. Large boilers and heaters (new and modified; greater than 10.5 gJ/h fuel feed rate; oil- and gas-fired) are covered. Implementation through Certificates of Approval is expected to reduce NO_x emissions by 29,000 tonnes by 2015.
- As of May 2001, the Airborne Contaminant Discharge Monitoring and Reporting Regulation (Ontario Environmental Protection Act Regulation 127/01), which replaces Ontario's Electricity Generation Monitoring and Reporting Regulation (Ontario Regulation 227/00), requires mandatory tracking and annual public reporting by facilities in Ontario if they emit significant amounts (above designated limits) of more than 350 air pollutants.

All reporting facilities are required to report annual and smog season (May 1 to September 30) emissions each year by June 1. Emitters with equipment having a heat input greater than 73 MW must file quarterly reports on SO_2 and NO_x within 60 days of the end of each quarter. The reports are made publicly available via Ontario's new (June 2002) online emissions reporting registry, OnAIR, at <www.ene.gov.on.ca/environet/onair/splash.htm>.

UNITED STATES[14]

- ***Implementation of the NO_x transport emission reductions program, known as the NO_x SIP (State Implementation Plan) call, in the PEMA states that are subject to the rule.***
- ***Implementation of existing U.S. vehicle, nonroad engine, and fuel quality rules to achieve both VOC and NO_x reductions.***
- ***Implementation of existing U.S. rules for control of emissions from stationary sources of hazardous air pollutants and control of VOCs from consumer and commercial products, architectural coatings, and automobile repair coatings.***
- ***Implementation of 36 existing U.S. new source performance standards, to achieve VOC and NO_x reductions from new sources.***

NO_x and VOC Program Updates

- **NO_x SIP Call (NO_x Budget Trading Program).** The NO_x SIP call requires affected states to adopt and implement NO_x control measures to ensure that seasonal NO_x emissions do not exceed specified levels. As the result of court actions, EPA divided the NO_x SIP Call into two phases. Phase 1 accounts for approximately 90 percent of the emission reductions required by the NO_x SIP call and had a compliance date of May 31, 2004. The compliance date for the Phase 2 reductions is May 1, 2007. Phase 1 will provide approximately 900,000 tons of NO_x emission reductions in the SIP call region, which covers all of the states in the PEMA except for Maine, New Hampshire, Vermont, and Wisconsin.

  All of the affected states adopted a NO_x cap and trade program for large electric generating units and large industrial boilers and turbines as the major control strategy. All jurisdictions have met the compliance deadline so far. Eight states and the District of Columbia voluntarily adopted a May 1, 2003, compliance date for Phase 1 and, thus, are achieving NO_x emission reductions one year earlier than required by the NO_x SIP call. Further information on the NO_x SIP call can be found at <www.epa.gov/ttn/naaqs/ozone/rto/sip/index.html>. Compliance and emission data for all NO_x budget sources can be found at <www.epa.gov/airmarkets/fednox/index.html>.

- **Motor Vehicle Control Program.** To address motor vehicle emissions, the United States committed to implementing regulations for reformulated gasoline, controls and prohibitions on diesel fuel quality, light-duty vehicles, light-duty trucks, gasoline heavy-duty highway engines, and diesel heavy-duty highway engines.

  EPA has fully phased in requirements for reformulated gasoline in nonattainment areas; diesel fuel quality (including sulfur) to 500 ppm; standards for highway heavy-duty engines; and vehicle standards for light-duty cars and trucks, including on-board refueling for control of evaporative emissions.

- **Nonroad Engine Standards.** EPA has applied engine standards in all of the five nonroad engine categories identified in the Annex: aircraft, compression-ignition engines, spark-ignition engines, locomotives, and marine engines. In addition, EPA has promulgated more stringent (Phase 2) standards for

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[14] The Commitments listed in this section come from Ozone Annex 3 Specific Objectives Concerning Ground Level Ozone Precursors, Part III—Specific Obligations, Section B for the United States.

compression ignition engines and spark ignition engines. The Phase 2 standards are in effect for compression-ignition engines, and the Phase 2 standards for spark ignition engines will be fully phased in by 2007.

- **New Source Standards.** All of the 36 categories of new source performance standards identified in the Ozone Annex for major new NO_x and VOC sources are in effect.
- **VOC Controls on Smaller Sources.** In 1998, EPA promulgated national rules for automobile repair coatings, consumer and commercial products, and architectural coatings. The compliance dates were January 1999, December 1998, and September 1999, respectively. From a 1990 baseline, the consumer and commercial products and architectural coatings rules each are estimated to achieve a 20 percent reduction in VOC emissions, and the automobile repair coatings rule is estimated to achieve a 33 percent reduction in VOC emissions.
- **Controls on Hazardous Air Pollutants.** EPA has promulgated regulations to control hazardous air pollutant emissions for all of the 40 categories listed in the Ozone Annex that will reduce VOC emissions. EPA is currently implementing the majority of the regulations. Several regulations have future compliance dates, but all will be implemented prior to 2010.
- **Nonroad Engines.** The motor vehicle control program and nonroad engine regulations discussed previously under NO_x controls also provide reductions in VOC emissions.

Anticipated Additional Control Measures and Indicative Reductions[15]

This section describes additional control measures that each country anticipates implementing beyond the specific obligations in the Ozone Annex. It also provides NO_x and VOC emission reduction estimates for the PEMA from implementation of both the specific obligations and the additional measures.

CANADA

National Reductions

Achieving the Canada-wide Standard for ozone by 2010 is the shared responsibility of federal and provincial/territorial governments. By 2005, all jurisdictions will have published their implementation plans outlining the measures they will take to achieve the standard. The federal government published its Interim Plan in 2001 and updated it in 2003. It includes a mix of regulations, economic instruments, and voluntary initiatives that are best suited to implementation on a national scale.

Area-Specific Reductions

Ontario continues to make progress towards its commitments under the Ozone Annex and has committed to reducing NO_x and VOC emissions by 45 percent below 1990 levels by 2015 under the Anti-Smog Action Plan.

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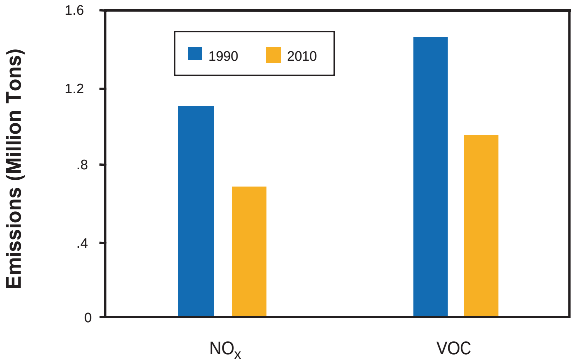
[15] The progress addressed in this section results from Annex 3 Specific Objectives Concerning Ground Level Ozone Precursors, Part IV—Anticipated Additional Control Measures and Indicative Reductions, Section A for Canada and Section B for the United States.

Quebec proposes to modify its Regulation Respecting the Quality of the Atmosphere in order to reduce NO_x emissions from new and modified industrial and commercial boilers and to reduce emissions of VOCs from both the manufacture and application of surface coatings, commercial printing, dry cleaning, oil refineries, and petrochemical plants. It is also considering implementing initiatives to reduce emissions from light- and heavy-duty motor vehicles.

Quantitative Estimates

In the Ozone Annex, Parties provided NO_x and VOC emission estimates associated with applying the control measures identified under Part III of the Annex. Using national emission data for 2000 and an improved methodology for emission projections, the specific NO_x and VOC emission reduction obligations in the Annex are now estimated to reduce annual NO_x emissions in the PEMA from 1990 levels by 39 percent by 2010, and annual VOC emissions in the PEMA from 1990 levels by 35 percent by 2010 (see Figure 10).

Figure 10. Canadian NO_x and VOC PEMA Emissions and Projections



2010 includes specific obligations in Part III.

Source: Environment Canada

UNITED STATES

National Reductions

In December 1999, new Tier 2 tailpipe emissions and low-sulfur fuel standards for light duty vehicles were finalized. The emission standards are being phased in beginning with the 2004 model year, and the low-sulfur fuel standards beginning in early 2004. These standards now apply equally to all passenger cars and light-trucks, including sport utility vehicles (SUVs), minivans, pick-up trucks, and vans. They require passenger vehicles to be 77 to 95 percent cleaner than those on the road today and reduce the sulfur content of gasoline up to 90 percent. Further information on these standards can be found at <www.epa.gov/otaq/regs/ld-hwy/tier-2/index.htm>.

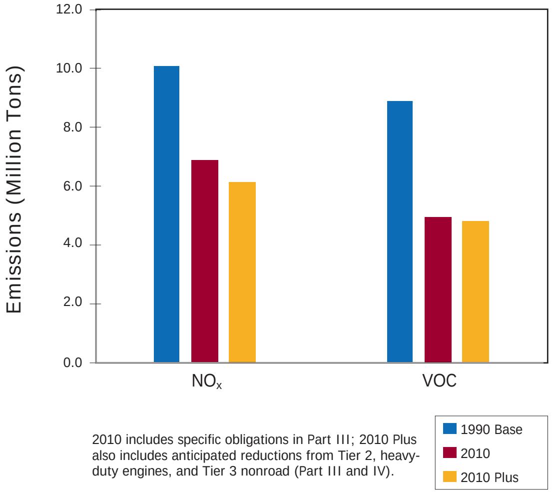
In December 2000, EPA finalized a comprehensive program that regulates the highway heavy-duty engine and its fuel as a single system. New emission standards will take effect in 2004 and increase in stringency in 2007. The program will reduce emissions of NO_x and nonmethane hydrocarbons (NMHCs) by 2.6 million and 115,000 tons per year by 2030, respectively (95 percent below current levels). Further information on this program can be found at <www.epa.gov/otaq/ diesel.htm>.

With stringent controls in place for highway sources, nonroad engines powering farm and construction equipment contribute a higher fraction of the remaining inventory of pollutants. Since 1996, EPA has published a number of rules applying standards to engines in many nonroad categories.

The Tier 3 nonroad standards were published in October 1998, and take effect between 2006 and 2008, depending upon engine size. EPA has also published Tier 4 standards. These stringent standards will achieve at least 90 percent reductions in NO_x and PM, starting in 2011, through use of advanced exhaust aftertreatment technologies and ultra-low sulfur levels in nonroad diesel fuel. Further information on the standards can be found at <www.epa.gov/nonroad>.

EPA published regulations for recreational vehicles in November 2002. The regulations cover snowmobiles, all-terrain vehicles, and off-highway motorcycles. Phase-in of the emission reductions begins in 2006 with full emission reductions by 2010. Further information on these rules can be found at <www.epa.gov/otaq/recveh.htm>.

Figure 11. U.S. NO_x and VOC PEMA Emissions and Projections



2010 includes specific obligations in Part III; 2010 Plus also includes anticipated reductions from Tier 2, heavy-duty engines, and Tier 3 nonroad (Part III and IV).

Source: EPA

Area-Specific Reductions

EPA is implementing NO_x and VOC control measures in specific areas as required by applicable provisions of the Clean Air Act. The measures include: NO_x and VOC reasonably available control technology; marine vessel loading; treatment storage and disposal facilities; municipal solid waste landfills; onboard refueling; residential wood combustion; vehicle inspection/maintenance; reformulated gasoline; and additional measures needed for attainment.

Quantitative NO_x and VOC Emission Reductions

In the Ozone Annex, the United States provided NO_x and VOC emission reduction estimates associated with the application of the control strategies identified under Part III and Part IV of the Annex. EPA has updated these estimates using national data sets that were completed in October 2002. The new estimates show greater VOC and NO_x reductions by 2010 than originally projected.

The specific emission reduction obligations (see Figure 11, 2010), in conjunction with the anticipated national and area-specific reductions (see Figure 11, 2010 Plus), are now estimated to reduce annual NO_x emissions in the PEMA from 1990 levels by 39 percent by 2010 and annual VOC emissions in the PEMA from 1990 levels by 46 percent by 2010.

Reporting PEMA Emissions[16]

JOINT COMMITMENT

Provide information on all anthropogenic NO_x and all anthropogenic and biogenic VOC emissions within the PEMA from a year that is not more than two years prior to the year of the biennial progress report, including:

- ***Annual ozone season (May 1 to September 30) estimates for VOC and NO_x emissions by the sectors outlined in Part V, Section A of the Ozone Annex.***
- ***NO_x and VOC five-year emission trends for the sectors listed above as well as total emissions.***

Canada and the United States have complied with emission reporting requirements in the Ozone Annex. In Canada, the National Pollutant Release Inventory (NPRI) list of substances was expanded in 2002 to include precursors of ground-level ozone and components of smog such as NO_x, VOCs, SO_x, total PM, PM_{10}, $PM_{2.5}$, and CO. Many facilities reported their 2002 emissions to Environment Canada by June 1, 2003. The reported information by facility is now publicly available on the Environment Canada Web site (www.ec.gc.ca/ pdb/npri).

In 2003, the NPRI was further expanded to require reporting of 60 additional VOC species to support the requirements of both Canadian and U.S. air quality models. All facilities that meet the

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[16] The commitments listed in this section come from Annex 3: Specific Objectives Concerning Ground Level Ozone Precursors, Part V—Reporting, Section A.

reporting requirements for these additional VOC species were expected to report their 2003 emissions to Environment Canada by June 1, 2004.

The compilation of the comprehensive 2002 Criteria Air Contaminants (CAC) emissions inventory has been initiated in Canada and should be completed during the latter part of 2004. It is expected that the 2002 emissions inventory will become the new baseline for scientific analyses, air quality modeling, and the development of emission reduction strategies in both Canada and the United States.

In the United States, emission data were obtained from the 2002 National Emissions Inventory (NEI). The NEI has been developed by EPA as a comprehensive national emissions inventory covering all U.S. states for point sources, nonpoint sources, on-road mobile sources, nonroad mobile sources, and natural sources. The NEI includes criteria pollutants and hazardous air pollutants. For 2002, U.S. states were required to report their criteria pollutant data from all of the source categories to EPA. The U.S. regulations require that states report emissions from all sources once every three years; the next comprehensive U.S. emissions inventory will be for 2005.

Table 1 shows preliminary Canadian and U.S. emissions in the PEMA in 2002 for NO_x and VOCs. Figures 12 and 13 show U.S. emission trends in these areas for 1990–2002. The trend in the PEMA states is similar to the U.S. national

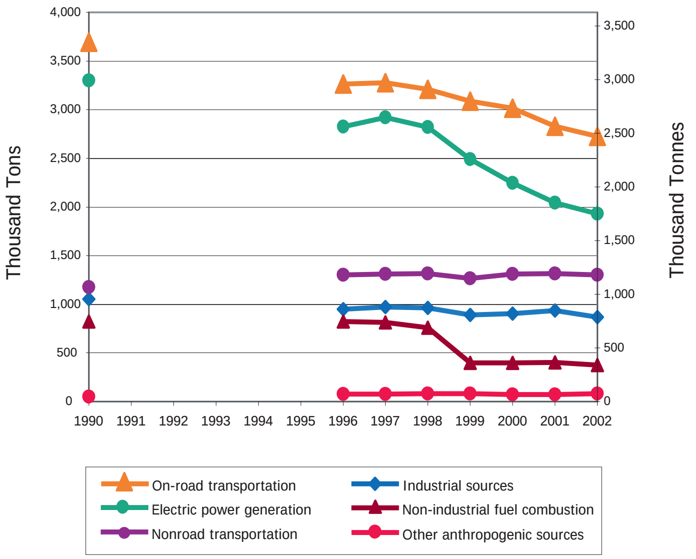
Table 1. PEMA Emissions (2002)

	2002 Annual				2002 Ozone Season			
	NO_x		VOC		NO_x		VOC	
Emission Category	(1000 Tons)	(1000 Tonnes)	(1000 Tons)	(1000 Tonnes)	(1000 Tons)	(1000 Tonnes)	(1000 Tons)	(1000 Tonnes)
Canadian PEMA Region: Annual and Ozone Season Emissions								
Industrial Emissions	109	99	170	154	45	41	71	64
Non-industrial Fuel Combustion	45	41	143	130	9	8	1	1
Electric Power Generation	87	79	1	1	33	30	0	0
On-road Transportation	501	456	173	157	228	207	74	67
Nonroad Transportation	243	221	172	157	117	106	83	76
Solvent Utilization	0	0	330	300	0	0	136	124
Other Anthropogenic Sources	2	2	81	74	1	1	27	25
Forest Fires	—	—	—	—	—	—	—	—
Biogenic Emissions	9	8	902	818	6	5	675	612
TOTALS	**996**	**906**	**1,972**	**1,791**	**439**	**398**	**1,067**	**969**
TOTALS: without Forest Fires and Biogenics	**987**	**896**	**1,070**	**970**	**433**	**393**	**392**	**354**
U.S. PEMA States: Annual and Ozone Season Emissions								
Industrial Emissions	868	787	284	258	369	335	122	111
Non-industrial Fuel Combustion	376	341	385	349	160	145	164	149
Electric Power Generation	1,932	1,753	17	15	821	745	7	6
On-road Transportation	2,725	2,472	1,601	1,452	1,167	1,059	683	620
Nonroad Transportation	1,302	1,181	996	904	556	504	425	386
Solvent Utilization	1	1	1,833	1,663	1	1	777	705
Other Anthropogenic Sources	79	72	603	547	32	29	252	229
Forest Fires	3	3	7	6	2	2	5	5
Biogenic Emissions	156	142	5,290	4,799	97	88	4,585	4,160
TOTALS	**7,442**	**6,752**	**11,016**	**9,993**	**3,205**	**2,908**	**7,020**	**6,371**
TOTALS: without Forest Fires and Biogenics	**7,283**	**6,607**	**5,719**	**5,188**	**3,106**	**2,818**	**2,430**	**2,206**

Source: EPA and Environment Canada (preliminary estimates) trend. For NO_x, most of the emission reductions come from on-road mobile sources and electric utilities. Over this same period, the reductions in VOC emissions are primarily from on-road mobile sources and solvent utilization. VOC emissions from non-industrial fuel combustion increased after 1998 and then returned to a downward trend.

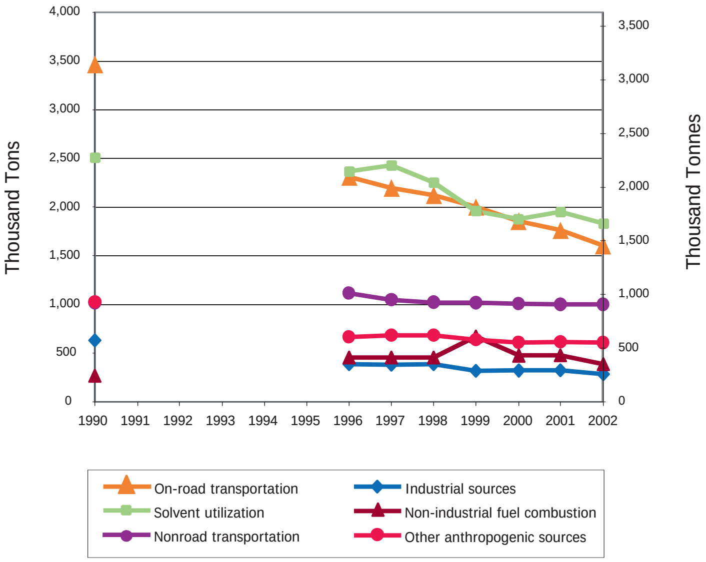
Figures 14 and 15 show Canadian NO_x and VOC PEMA emission trends for 1990–2002. For NO_x, most of the reductions come from on-road mobile and industrial sources. NO_x emissions from electric power generation increased after 1999. Over this same period, the reductions in VOC emissions are primarily from on-road mobile and non-industrial fuel combustion sources.

Figure 12. U.S. NO_x Emission Trends in PEMA States (1990–2002)



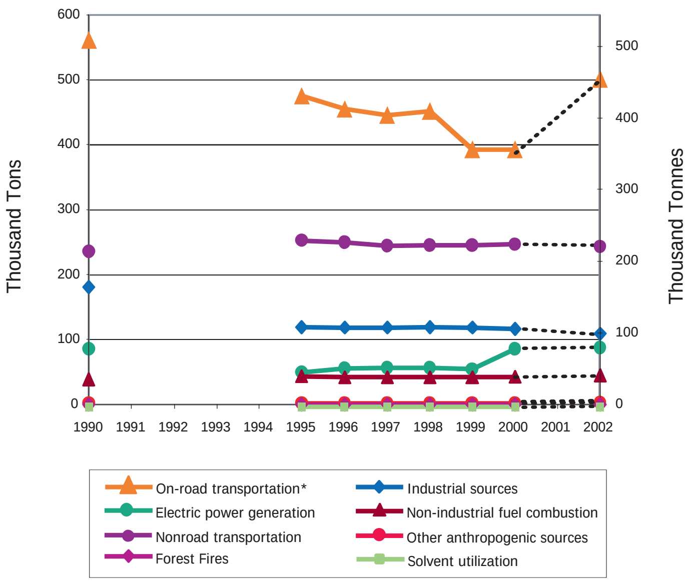
Source: EPA

Figure 13. U.S. VOC Emission Trends in PEMA States (1990–2002)



Source: EPA

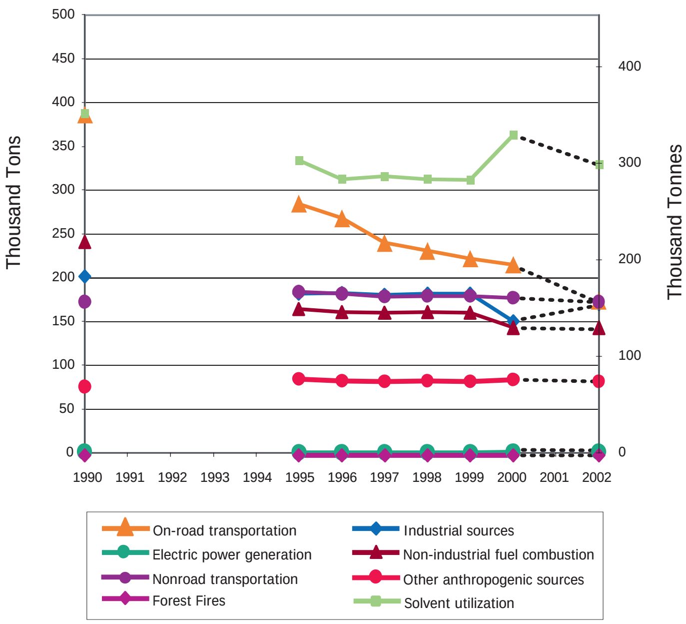
Figure 14. Canada NO_x Emission Trends in PEMA Region (1990–2002)



* The change in on-road emissions between 2000-2002 reflects a reclassification of heavy-duty vehicles, not an increase in emissions. The impact of this reclassification on historical year emissions is being assessed and will be reflected in future updates.

Source: Environment Canada

Figure 15. Canada VOC Emission Trends in PEMA Region (1990–2002)



Source: Environment Canada

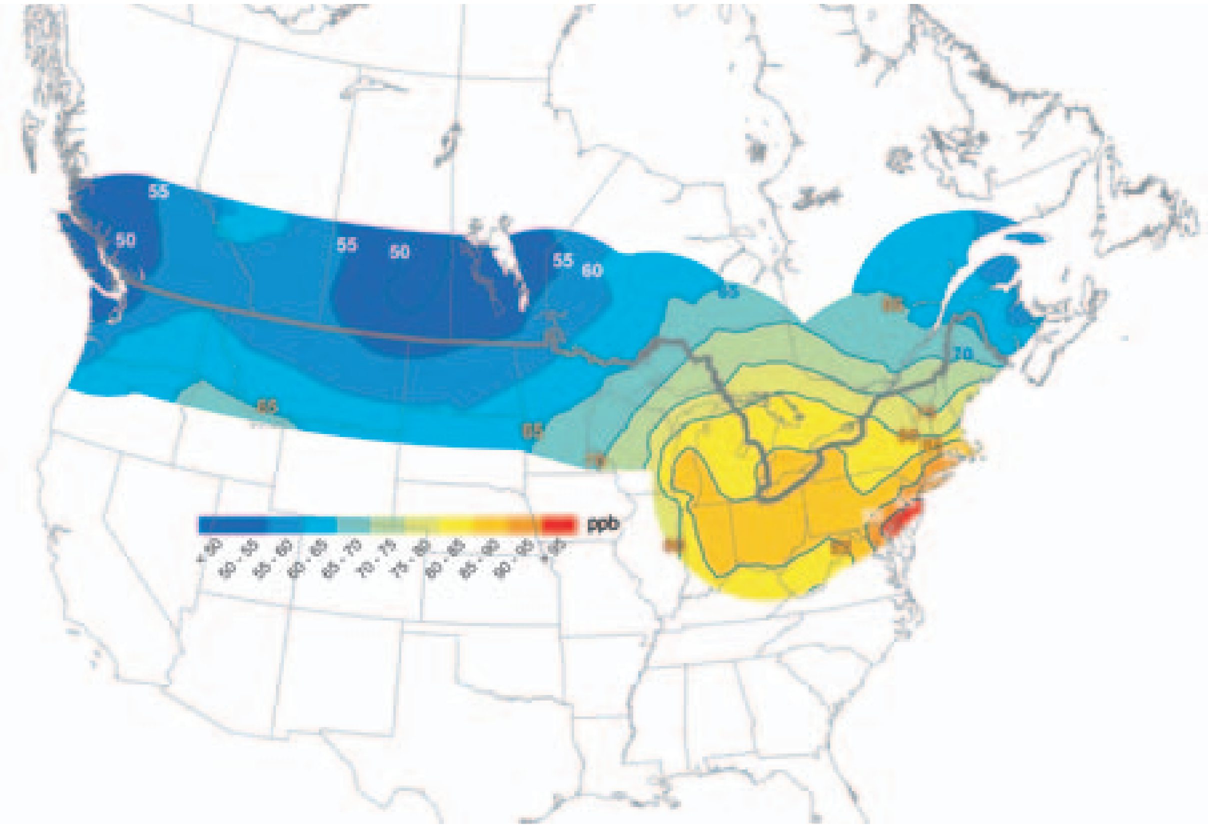
Reporting Air Quality for All Relevant Monitors within 500 km of the Border between the United States and Canada[17]

JOINT COMMITMENT

***Ambient Concentrations for Ozone, VOCs, and NO$_x$*:** Both the United States and Canada have extensive networks to monitor ground-level ozone and its precursors. Both governments prepare routine reports summarizing measurement levels and trends. The latest complete, quality-assured data set is for 2002.

- **10-Year Trends in Ambient Concentrations for Ozone, VOCs, and NO$_x$:** U.S. and Canadian data that met certain data completeness requirements were used to create the spatial interpolation shown in Figure 16. However, only sites within 500 km of the United States–Canada border were displayed. For ozone, these criteria required that each annual fourth-highest daily maximum 8-hour concentration be based on 75 percent or more of all possible daily values during the EPA-designated ozone monitoring season. Note that the highest values are generally near major urban areas in the eastern border region, and the lowest values are generally found in the West.

Figure 16. Ozone Concentrations (ppb) along the U.S.–Canada Border
(Average Annual Fourth Highest Daily Maximum 8-Hour Average Ozone, 2000–2002)



Source: Environment Canada-NAPS Database (www.etcentre.org/NAPS/) and EPA AIRS Database (www.epa.gov/air/data/index.html)

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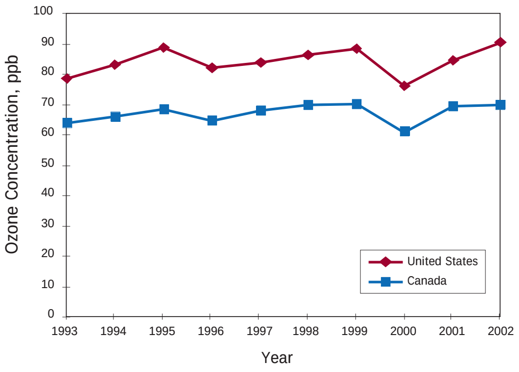
[17] The data listed in this section result from requirements in Annex 3: Specific Objectives Concerning Ground Level Ozone Precursors, Part V—Reporting, Section C and D.

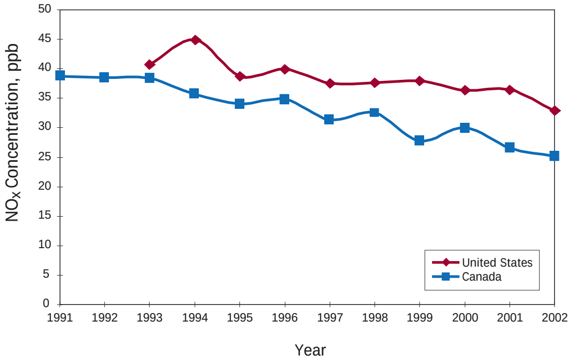
Figure 17. Composite Trends: Annual Fourth Highest Maximum 8-Hour Ozone Concentration for Sites within 500 km of the U.S.–Canada Border



(Note: 2002 data are not representative of current long-term trends)

Source: EPA and Environment Canada

Figure 18. Composite Trends: Annual Average 1-Hour NO_x Concentration for Sites within 500 km of the U.S.–Canada Border

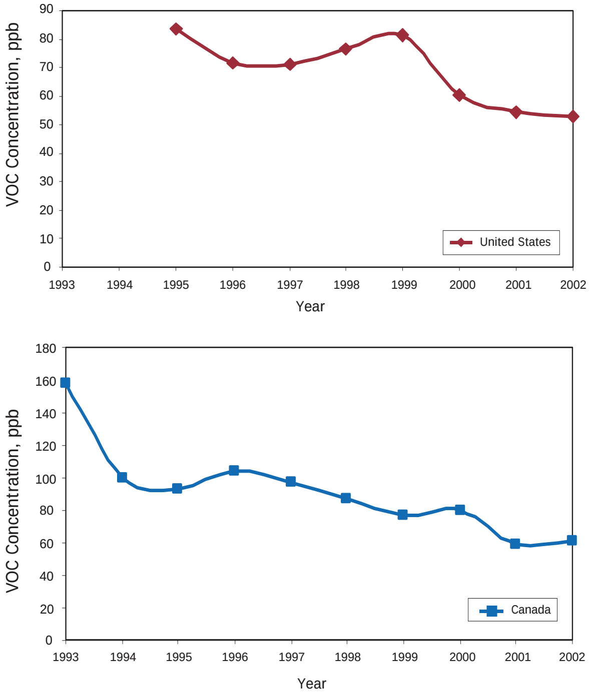


Source: EPA and Environment Canada

Trends in ozone concentrations over time are presented in Figure 17, based on information from longer-term eastern sites within 500 km of the United States–Canada border. Ozone trends are nearly flat for the period, though there is a complex regional pattern.

Figures 18 and 19 depict the trends in the ozone precursors NO_x and VOCs in the eastern United States and Canada. These measurements represent information from a more limited network of sites than is available for ozone; for example, there are no suitable NO_x sites in the western United States within the border region. Available data show a decline in ambient levels of both pollutant families. The limited correspondence between composite ozone and precursor trends could reflect the regional complexity of the problem, as well as network limitations.

Figure 19. Composite Trends: Annual Average 24-Hour VOC[18] Concentration for Sites within 500 km of the U.S.–Canada Border



Source: EPA and Environment Canada

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[18] For the U.S., these values represent the sum of the VOC target species collected at Photochemical Assessment Monitoring Stations (PAMS)

Summary of Ozone Annex Review Meeting

Part VI of the Ozone Annex calls for the Parties to assess progress in implementing the obligations of the Ozone Annex in 2004. On June 11, 2004, Canada hosted a bilateral meeting of the Air Quality Committee in Quebec City. The purpose of the meeting was to report on progress in implementing the Ozone Annex in the United States and Canada. Presentations at the meeting demonstrated that both countries are meeting specific obligations under the Annex.

Stakeholders representing environmental nongovernmental organizations (NGOs), health NGOs, and industry joined states and representatives of provinces and federal governments from both countries to review and comment on progress. Some key points elucidated during the meeting follow:

- Within 500 km of the United States–Canada border, ozone levels were high in 2002 relative to a multi-year average, reflecting weather patterns of that year as well as emissions.
- While composite site average ozone shows no real trend, there is a decreasing trend in concentrations of the precursor emissions of NO_x and VOCs.
- Air quality and emission levels in 2002 will be used as a benchmark against which to track future progress.
- Progress in implementing science and technical commitments was described, including obligations associated with data, tools, methodologies, and joint studies to assess transboundary flows.
- Continued efforts in health and environmental effects tracking were described.
- Stakeholders look for citizenry to be more engaged through greater outreach efforts.

Stakeholders requested a status meeting in 2006 to underscore the importance of continued progress toward the long-term objective of the Annex, which is to achieve the respective health-based ozone air quality standards.

Progress and Updates on Ozone and Particulate Matter

CANADA

Canada-wide Standards for PM and Ozone: In May 2000, Canada announced the development of a Clean Air Agenda aimed at improving air quality in Canada and reducing negative impacts on human health and the environment. The federal government's action plan on PM and ozone is one of a number of immediate and long-term efforts developed under the Clean Air Agenda.

In May 2001, the federal government added PM_{10} to the List of Toxic Substances in Schedule 1 of CEPA 1999. The government also added the principal precursors to PM_{10} (SO_2, NO_x, VOCs, and ammonia (NH_3)) and ozone and its precursors (NO_x and VOCs) to Schedule 1 in July 2003. Future risk management strategies aimed at reducing PM_{10} and ozone will focus on reductions in the precursors. In April 2001, the federal government published its Interim Plan on Particulate Matter and Ozone, which outlines the initial strategies the government will pursue to reduce levels of PM and ozone and meet the targets agreed to under the Canada-wide Standard process.

Specific areas identified for action in the Interim Plan include transportation, petroleum fuels, and stationary sources. The plan also provides for further scientific research and analysis of the smog problem, better ambient air monitoring and reporting, and public education.

In November 2003, the government of Canada published the report, *Clean Air in Canada: 2003 Progress Report on Particulate Matter and Ozone*. This report provides information on actions taken by the federal government to reduce PM and ozone since publication of the Interim Plan. Specific elements discussed in the *2003 Progress Report* include improvements to monitoring networks, reductions in emissions from vehicles and fuels, and actions taken under CEPA 1999 (see Section 1, Commitments, Ozone Annex in this report). Subsequent reports are planned for publication every two years.

Furthermore, Canada expanded the NPRI in 2002 to require industries to report their emissions of several criteria air contaminants, including PM, NO_x, SO_2, and VOCs. Under the Interim Plan, Canada is also implementing multi-pollutant emission reduction strategies for key industrial sectors (see Section 1, Commitments, Ozone Annex in this report).

UNITED STATES

Revised Ozone Standards and Implementation

In 1997, EPA set 8-hour ozone standards to protect against longer exposure periods of concern for human health and the environment.[19] Following years of litigation, the federal courts upheld EPA's action in setting the NAAQS. Information on the 8-hour ozone standard can be found at <www.epa.gov/ttn/naaqs>. On June 2, 2003, EPA proposed a rule to implement the 8-hour ozone standard. The Agency finalized Phase 1 of the

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[19] The 8-hour ozone standards are set at a level of 0.08 ppm and are met when the 3-year average of the annual fourth highest daily maximum 8-hour concentration is less than 0.08 ppm.

implementation rule on April 15, 2004, and expects to finalize Phase 2 in the fall of 2004. On April 15, 2004, EPA designated 126 areas as nonattainment for the 8-hour ozone standard based on three recent years of air quality data. A significant number of these areas are located in the eastern United States. The nonattainment areas are required to develop and implement control plans to reduce emissions of ozone-causing pollution. The implementation rule provides for attainment dates ranging from 2007 to 2021 based on the severity of an area's air quality problem. Information on the 8-hour ozone designations and implementation rulemakings can be found at <www.epa.gov/ttn/naaqs/ozone/o3imp8hr> and <www.epa.gov/ozonedesignations/>.

PM Standards and Implementation

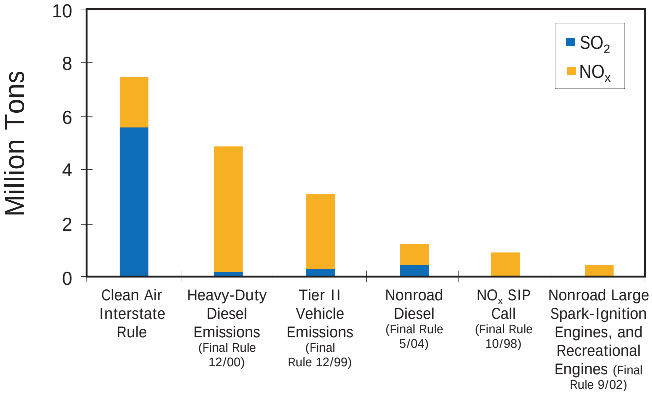
In 1997, EPA issued standards for particulate matter smaller than 2.5 microns ($PM_{2.5}$) to provide further protection from the adverse health effects of particles. The annual standard is set at 15 µg/m^3, and is met when the three-year average of the annual arithmetic mean $PM_{2.5}$ concentrations does not exceed 15 µg/m^3. The 24-hour standard is set at 65 µg/m^3 and is met when the three-year average of the 98th percentile of 24-hour concentrations does not exceed 65 µg/m^3. Information on the $PM_{2.5}$ standards can be found at <www.epa.gov/ttn/naaqs>. EPA is currently evaluating whether to propose standards for coarse particles (particles with size between 2.5 and 10 microns).

States submitted their recommended designations for $PM_{2.5}$ nonattainment areas to EPA by February 15, 2004. EPA will finalize the designations by December 31, 2004. Preliminary analyses of the data show that areas not meeting the annual $PM_{2.5}$ standard are likely to be located primarily across a broad region of the eastern United States and in California. Based upon the final EPA designations, states will have until 2008 to submit SIPs. Attainment of the NAAQS is to be as expeditious as practicable, but should be completed within five years from the date of designation, January 2010. If a state is unable to demonstrate attainment by then and can justify an extension, EPA can extend the attainment date up to another five years, to January 2015.

Clean Air Interstate Rule

On January 30, 2004, EPA proposed the Clean Air Interstate Rule, designed to dramatically reduce and permanently cap emissions of SO_2 and NO_x from major sources such as power plants. The proposed rule focuses on states whose power plant emissions are significantly contributing to fine particle and ozone pollution in other downwind states in the eastern United States. The proposed rule would cover a total of 29 states and the District of Columbia. Under this rule, the proposed cap and trade program, if adopted by the states, would annually reduce power plant SO_2 emissions by approximately 3.6 million tons by 2010, across states covered by the rule, with reductions ultimately reaching more than 5 million tons annually, when fully implemented. Annual NO_x emission reductions also would be substantial, totalling about 1.5 million tons by 2010 and 1.8 million tons by 2015. If not superceded by legislation, EPA expects to issue a final rule by the end of 2004. See Figure 20 for emission reductions at full implementation of the Clean Air Interstate Rule compared to other recent major EPA rules.

Figure 20. Clean Air Interstate Rule and Other Major Air Pollution Rules since 1990: Annual Emission Reductions at Full Implementation



Source: EPA

Section 2:

Related Air Quality Efforts

New England Governors and Eastern Canadian Premiers

The activities of the New England Governors and Eastern Canadian Premiers (NEG/ECP) continue to provide an important regional coordinating mechanism for addressing air quality issues, including transboundary air pollution. Recent efforts have focused on the following:

- Continuation of the Air Quality Forecasting and Advisory program.
- Additional measurements and analysis of ground-level ozone, $PM_{2.5}$, and PM speciation measurements.
- Aircraft-based measurements of mass transport of air pollutants during smog episodes.
- Vertically resolved measurement of tropospheric ozone.
- Local airshed application of the Air Quality Valuation model to better understand the health costs of air pollution in the region.
- Development of an integrated emission inventory database to support air quality model applications for eastern North America.

Following a survey of New England states and eastern Canadian provinces in late 2002, and with the assistance of the Northeast States for Coordinated Air Use Management (NESCAUM), NEG/ECP released a status report entitled *Clean Mobile Source Diesel Initiatives in the Northeast States and Eastern Canadian Provinces* at the annual meeting of the governors and premiers in September 2003. This report led to the adoption of a resolution to address diesel emissions, and a Diesel Emissions Work Group has since been established to develop measures to control diesel emissions in the region. In addition, NEG/ECP released a brochure entitled *Acid Rain Partnership-Progress Report 2003* at the September 2003 meeting. This publication is intended to raise awareness of efforts underway to address the regional impact of acid rain.

An NEG/ECP environmental Web site is under development to provide easy access to reports and products for public education and outreach purposes.

U.S.–Canada Border Air Quality Strategy Pilot Projects

In January 2003, Minister David Anderson of Canada and EPA Administrator Christine Todd Whitman announced the Border Air Quality Strategy (BAQS)—a commitment to build on the transborder air quality improvements of the last decade through future cooperative projects. Both governments were charged with identifying appropriate pilot projects in consultation with states, provinces, and local governments. In June 2003, three pilot projects of interest to Canada and the United States were announced, as described below.

U.S.–Canada Emissions Trading Feasibility Study

This national-level project will assess the feasibility of a cross-border cap and trade program for stationary sources of SO_2 and NO_x emissions. This trading feasibility study, conducted jointly by the United States and Canada, will undertake foundation analyses on emission cap and trade programs in the United States, including reviewing current arrangements in both countries regarding legal design, emissions measurement, monitoring, reporting and tracking, compliance and enforcement, and public availability of information. The study will identify where differences and gaps exist.

In early 2004, information sessions were held in eastern and western Canada to inform governments, industry, and stakeholders about the study and discuss experiences under the U.S. cap and trade programs. A U.S. stakeholder meeting on the project was also held in Washington, DC, in May 2004. A final joint report is expected to be completed in summer 2005.

Georgia Basin–Puget Sound International Airshed Strategy

This initiative, led by Environment Canada–Pacific and Yukon Region and EPA Region 10, will address regional transboundary air quality issues. Other partners include representatives of state, provincial, and regional governments, as well as the tribes and first nations and the non-government organization community.

Activities in 2003 included:

- Developing a methodology to quantify human health impacts from degraded air quality in the Georgia Basin–Puget Sound.
- Analyzing assessment and notification procedures for significant new air emission sources (e.g., power plants).
- Moving forward with the scientific airshed characterization (completed in June 2004).
- Launching a Web site featuring the best air quality management practices in the region (www.pyr.ec.gc.ca/airshed/).
- Completing a study on potential air quality management models in the transboundary airshed.
- Reaching agreement among all partner agencies on the format, approach, and development timeline for the Georgia Basin–Puget Sound International Airshed Strategy.

All of this work advances the goals of coordinating technical assessments, maintaining good air quality in the Georgia Basin–Puget Sound airshed, protecting ecosystems and human health, meeting the continuous improvement goals of the Canada-wide Standard, and improving visibility.

Great Lakes Basin Airshed Management Framework

This pilot project allows for a joint investigation of local and sub-regional airshed management in a contiguous urban area that crosses the border. It is envisioned that air quality in the Great Lakes Basin will be improved through cooperative regional management of the airshed, with the involvement of all levels of government, the public, the private sector, aboriginals, and academia, with a view to improved population and ecosystem health. The project will focus on the ground-level ozone and fine PM pollution problems that impact the cities of Detroit and Windsor and surrounding areas.

A multi-stakeholder Great Lakes Basin Steering Committee has been established to investigate local transboundary air issues. The goal of this network is to exchange information on environmental management systems; identify opportunities, challenges, and obstacles in establishing a joint international airshed management approach; and develop a template for a coordinated airshed management approach. Four working groups have been formed to explore airshed characterization (emission inventory, modeling, monitoring), policy, voluntary/early actions, and communications/outreach.

Section 3:

Scientific and Technical Cooperation and Research

Emission Inventories and Trends

JOINT EFFORTS

The United States and Canada have updated and improved their emission inventories and projections to reflect the latest information available. These emission inventories were also processed for U.S. and Canadian air quality models to support the technical assessment of air quality problems.

In the fall of 2003, the two countries held a workshop on Innovative Methods for Emission Inventory Development under the auspices of NARSTO.[20] As a followup to the workshop, an Emissions Inventory Assessment is underway that will provide recommendations to improve the quality, timeliness, comparability, and cost of compiling emission inventories in North America. A draft of the assessment report will be available by late 2004.

Emissions data for both countries for 2002 are presented in Figures 21, 22, 23, and 24. Figure 21 shows the distribution of emissions by source category grouping for SO_2, NO_x, and VOCs.

- SO_2 emissions in the United States stem primarily from coal-fired combustion in the electric power sector; Canadian SO_2 emissions stem mostly from coal-fired combustion in the industrial sector, with few emissions from the electric power sector, due to the large hydroelectric capacity in Canada.
- The distribution of NO_x emissions is very similar between the two countries, except that emissions from the electric power sector are proportionately higher in the United States, again reflecting more coal combustion in that sector.
- VOC emissions are the most diverse of the emission profiles in each country. The most significant difference is that most VOCs come from the industrial sector in Canada. This is the result of the proportionately higher contribution of oil and gas production in Canada.

The emission trends, shown in Figures 22, 23, and 24, for NO_x, VOCs, and SO_2 show the relative contribution in emissions over the 1990–2002 period. In the United States, the major reductions in NO_x emissions came from

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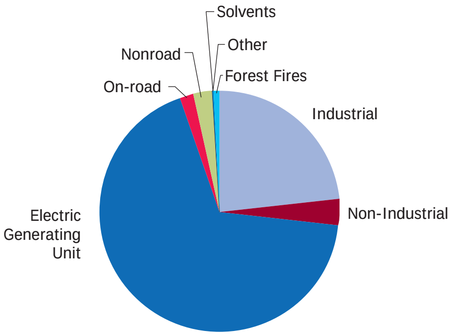
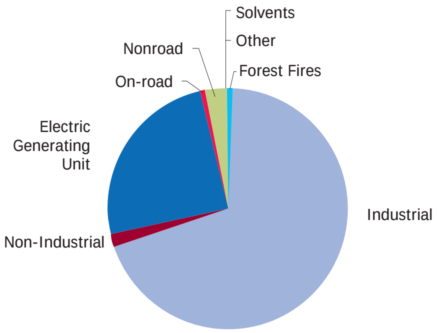
[20] Formerly an acronym for "North American Research Strategy for Tropospheric Ozone," the term NARSTO has become simply a wordmark signifying this tri-national, public-private partnership, which addresses the issue of tropospheric pollution, including ozone and suspended particulate matter.

Figure 21. U.S. and Canada National Emissions by Sector for Selected Pollutants (2002)

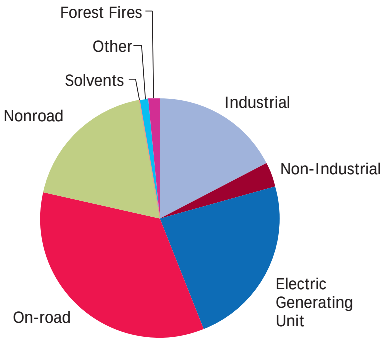
U.S. Emissions–2002
Sulfur Dioxide
Total: 15.8 million tons/year



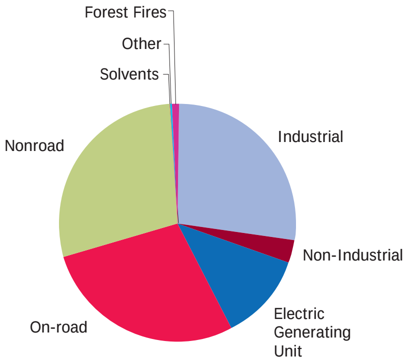
Canadian Emissions–2002
Sulfur Dioxide
Total: 2.7 million tons/year



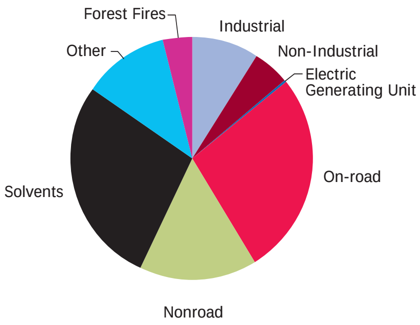
U.S. Emissions–2002
Nitrogen Oxides
Total: 21.2 million tons/year



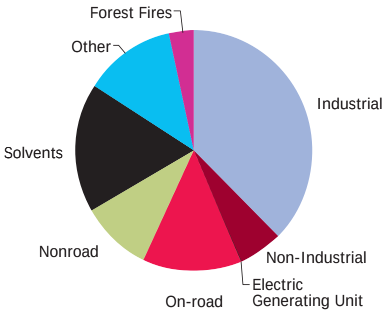
Canadian Emissions–2002
Nitrogen Oxides
Total: 2.8 million tons/year



U.S. Emissions–2002
Volatile Organic Compounds
Total: 16.7 million tons/year



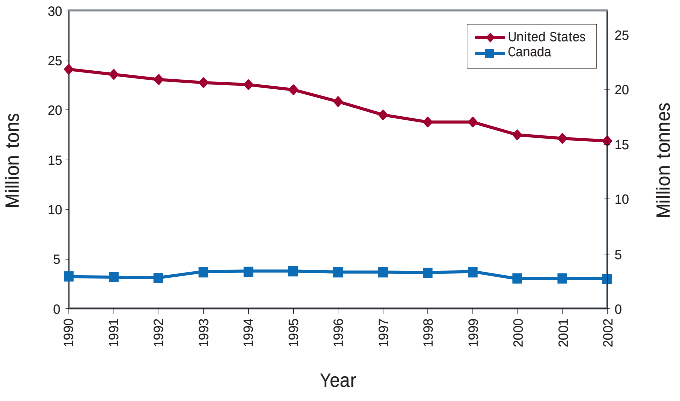
Canadian Emissions–2002
Volatile Organic Compounds
Total: 2.9 million tons/year



Source: EPA and Environment Canada

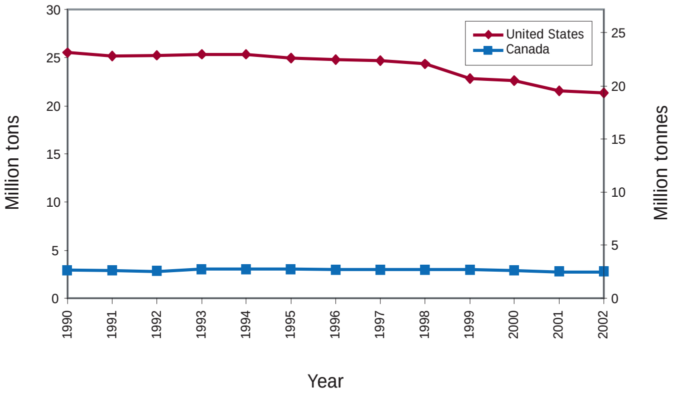
on-road mobile sources and electric power generation sources. For VOCs, the reductions came from on-road mobile sources and solvent utilization. For SO_2, the reductions were from electric power generation sources. For all three pollutants during this time period, the United States generated substantially more emissions than Canada. At the same time, while both countries have seen major reductions in SO_2 emissions, the United States has shown greater emission reductions than Canada for VOCs and NO_x.

Figure 23. U.S.–Canada VOC Emissions



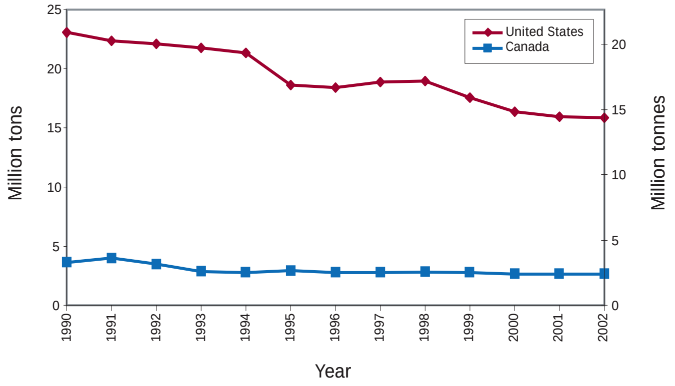
Source: EPA and Environment Canada

Figure 22. U.S.–Canada NO_x Emissions



Source: EPA and Environment Canada

Figure 24. U.S.–Canada SO_2 Emissions



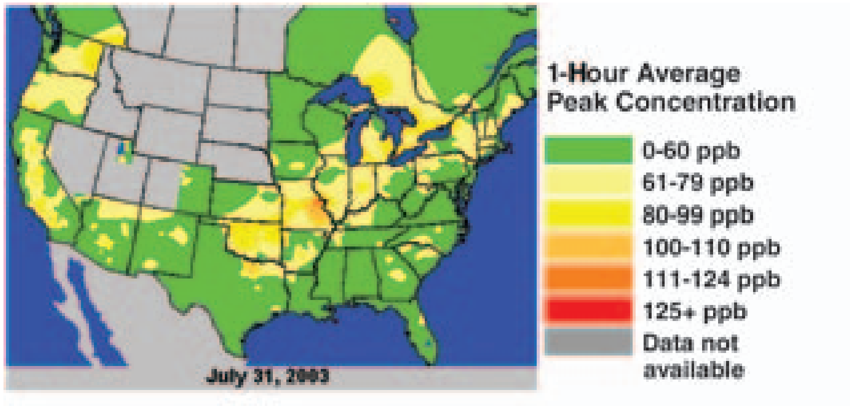
Source: EPA and Environment Canada

Air Quality Reporting and Mapping

JOINT EFFORTS

Each country is responsible for ensuring calibration and routine comparability of ozone measurement data. Since 2001, the United States and Canada have collaborated on contributing to the EPA-led AIRNOW program (www.epa.gov/airnow). This Web site provides real-time maps depicting ozone levels on a continental scale in season (see Figure 25) and,

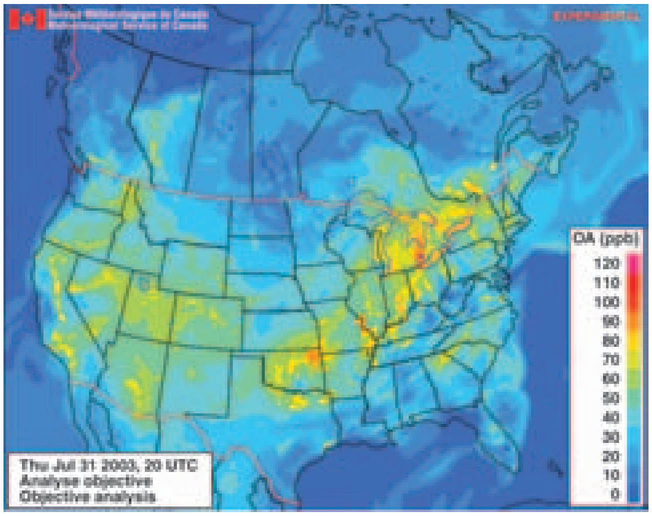
Figure 25. AIRNOW Map Illustrating Real-time Concentrations of Ground-level Ozone



Source: EPA

since 2003, year-round particulate levels in the United States. Canadian scientists have been experimenting with algorithms to improve the mapping effort, using a combination of real-time ozone data and information from Canada's operational air quality forecasting model, CHRONOS (see Figure 26 for an example).

Figure 26. Analysis of Ground-level Ozone for July 31, 2003



This analysis combines measurement data and predictions from the Canadian CHRONOS model to optimize the information presented.

Source: Environment Canada

CANADA

Environment Canada is expanding and refurbishing federal and provincial networks of monitoring stations across the country. Canada maintains two national ambient air quality monitoring networks. The National Air Pollution Surveillance (NAPS) Network is a joint federal, provincial, territorial, and municipal network established in 1969. It is primarily an urban network, with more than 240 air monitors at more than 136 sites. The federal Canadian Air and Precipitation Monitoring Network (CAPMoN) is a rural network with 23 air monitoring stations in Canada and one in the United States. Some provinces and municipalities operate CAPMoN networks that integrate the local NAPS sites.

The NAPS network gathers measurements on the components of smog (i.e., ozone, PM, SO_2, CO, NO_x, VOCs, ions, and metals). In 2002 and 2003, Environment Canada invested in new equipment for the NAPS network, including 18 new and replacement ozone monitors, 15 new and replacement NO_x monitors, 34 continuous $PM_{2.5}$ monitors (Tapered Element Oscillating Microbalances (TEOMs)), and three PM dichotomous samplers. In addition, Environment Canada started a chemical speciation sampling program in December 2002 to characterize PM. The agency also built two new laboratories to support this work and equipped them with an ion-coupled plasma-mass spectroscopy (ICP-MS) instrument for metals analysis and an organic carbon/elemental carbon analyzer.

In 2002, Environment Canada refurbished the ozone monitors in CAPMoN with new instruments. The agency purchased and tested new equipment for $PM_{2.5}$, 10 mass measurements, and PM composition measurements. In addition, Environment Canada started PM mass measurements at one site and made preparations for PM equipment installation at other network sites.

At present, the ozone monitors in CAPMoN are gathering data in real-time, in support of the Air Quality Prediction Program, and for distribution to the U.S. AIRNOW program. $PM_{2.5}$, 10 mass measurements, $PM_{2.5}$ speciation measurements, and VOC measurements are being made at five CAPMoN sites (within 500 km of the border). Nitrogen compounds (including NO_x) are being measured at two sites—the Centre for Atmospheric Research, Egbert (Ontario) and Kejimkujik (Nova Scotia).

UNITED STATES

EPA's ambient air quality monitoring program is carried out by state and local agencies and consists of three major categories of monitoring stations that measure the criteria pollutants: State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Special Purpose Monitoring Stations (SPMS). Additionally, a fourth category of monitoring station, the Photochemical Assessment Monitoring Stations (PAMS), which measures ozone precursors (approximately 60 volatile hydrocarbons and carbonyl), is required by the 1990 Clean Air Act Amendments. Descriptions of these networks can be found at <www.epa.gov/oar/oaqps/qa/monprog.html>.

EPA also operates the Clean Air Status and Trends Network (CASTNET), a long-term monitoring program established to assess the effectiveness of SO_2 and NO_x emission reductions. CASTNET's objectives are to define the geographic distribution of pollutants and atmospheric deposition fluxes, detect and quantify trends in pollutants and deposition, and provide data on the dry deposition component of acid deposition and ground-level ozone concentrations in rural areas over broad geographic regions of the United States (www.epa.gov/castnet/).

To monitor ozone, the United States operates 856 SLAMS and 198 NAMS sites. Additionally, state, local, tribal, and other non-governmental agencies operate approximately 332 SPMS for ozone. There is little distinction among the state, local, or tribal SLAMS, NAMS, or SPMS sites; the data are all used for similar purposes. The PAMS networks measure ozone precursors in the most severe ozone nonattainment areas. These sites also provide information on pollutant transport and local meteorology. In 2003, approximately 89 PAMS were in operation in five regions of the United States: the Northeast, the Great Lakes area, Georgia (Atlanta), Texas (primarily Houston), and seven areas in California.

Ambient monitoring for $PM_{2.5}$ is conducted at approximately 1,100 Federal Reference Method (FRM) $PM_{2.5}$ sites, with approximately 267 continuous ambient monitors. These are particularly needed for public data reporting and mapping efforts currently being planned. EPA is focused on real-time data reporting through the AIRNOW system in the 36 metropolitan areas that are carried by various media sources, including *USA Today*. Additionally, chemically speciated PM data are collected at 54 urban trends sites, 221 supplemental sites, more than 50 rural sites using IMPROVE protocols, and approximately 180 IMPROVE sites in Class 1 areas. EPA currently operates five urban sites that use continuous chemical speciation technologies for nitrates, sulfates, and carbon, and expects to add up to seven more urban sites in 2005. The Agency will use the results from these sites to consider whether to use this continuous measurement technology at other state locations. Tribal agencies are also providing additional fine PM data through the use of both filter-based FRM and the IMPROVE protocols.

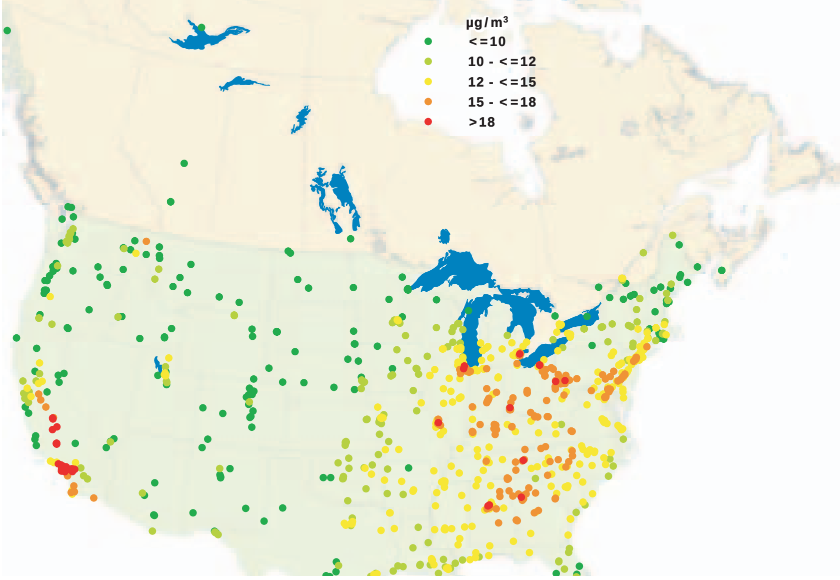
Transboundary Particulate Matter Science Assessment

As an outgrowth of the Joint Plan of Action for Addressing Transboundary Air Pollution, signed in 1997, the governments of Canada and the United States have completed a joint science assessment report on PM. This document represents the first Canada-United States science assessment of an air pollution issue and is serving as a basis for decisionmaking for possible updates to the Air Quality Agreement. Results from three binational workshops between 1999 and 2003 identified several key objectives for a Canada-United States transboundary PM science assessment. This section outlines these objectives and findings, along with several figures from the report, as examples of supporting analyses.

- ***Objective 1: Identify whether a fine PM problem exists in the border region, based on current standards.***
- ***Objective 2: Identify the extent of the problem; if standards are exceeded, where, when, and by how much?***

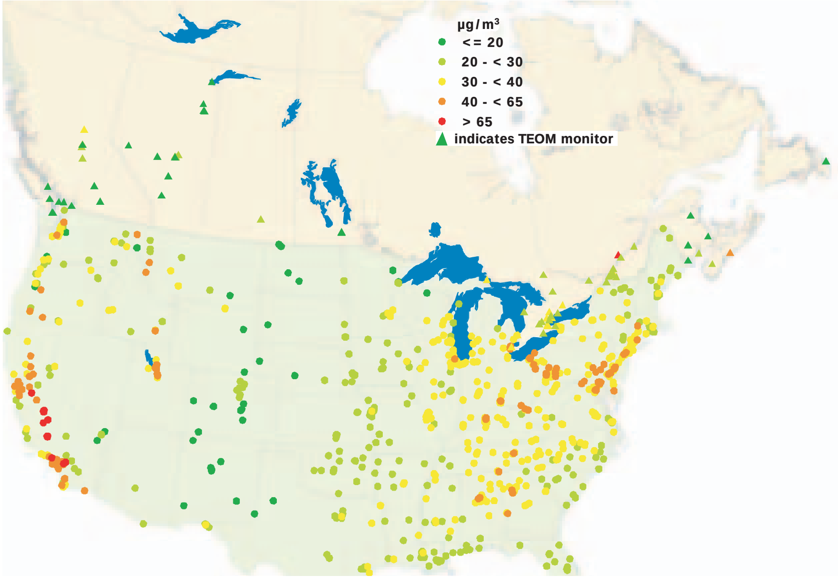
Recent air quality monitoring data indicate that annual average levels of $PM_{2.5}$ are as high as 18 µg/m³ in the northeastern United States, but are consistently lower than 12 µg/m³ in the mid-continental states (see Figure 27). When Canadian hourly TEOM observations are included, a more detailed picture of ambient levels can be seen. The 98th percentile values for the years 2000 to 2002 are shown in Figure 28. The northeastern United States is again a region of high ambient PM levels, with 98th percentile values in excess of 30 µg/m³ at many of the sites. Canadian locations exhibit generally lower levels of $PM_{2.5}$, although concentrations greater than 30 µg/m³ occur in several regions of the country for the years 2000 to 2002, particularly in the Windsor–Quebec City corridor.

Figure 27. Mean Concentrations of $PM_{2.5}$ at Canadian Dichotomous and U.S. FRM Monitors in the Border Region (2000–2003)



(Note: Canadian sites are years 2000–2002; all sites do not include three years of data.)

Figure 28. 98th Percentile $PM_{2.5}$ Concentrations at Canadian TEOM and U.S. FRM Sites (2000–2002)



(Note: Canadian sites do not all include three years of data.)

Source: Figures adapted from "Transboundary Transport, Trends in and Analysis of Fine Inhalable Particles in the Transboundary Region: Science Assessment." A Report by the Canada-U.S. Air Quality Committee, Subcommittee 2: Scientific Cooperation. November 2004.

- ***Objective 3: Describe the PM issue in terms of geographic regions (e.g., West, Central, East).***

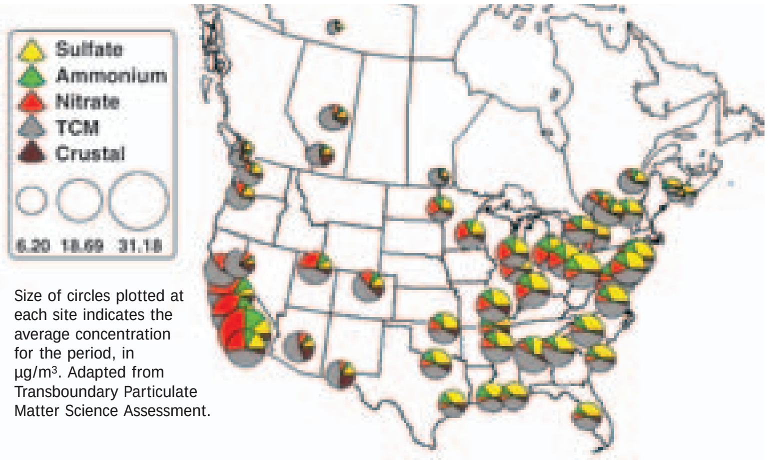
Current ambient levels of $PM_{2.5}$ in the border regions exceed the standards set for $PM_{2.5}$, primarily in the eastern portion of the border domain. Some sites in the Georgia Basin–Puget Sound airshed have elevated $PM_{2.5}$ levels (with very few sites exceeding either standard for the time periods evaluated), but the levels are generally lower than in the East in Canada and the United States. Urban concentrations of $PM_{2.5}$ (Figure 29) are higher than rural sites (Figure 30) in all regions of both Canada and the United States (note scale of embedded pie charts).

- ***Objective 4: Identify PM precursors of concern on a regional or sub-regional basis.***

$PM_{2.5}$ in the border region consists of, in order of relative importance to annual $PM_{2.5}$ levels: organic/black carbon, sulfate, nitrate, ammonium, soil dust, and trace elements. Secondary particulate (i.e., ammonium, nitrate, and sulfate) plays a key role under episodic conditions in Ontario. In the United States–Canada border region, carbon and sulfates are the dominant species of $PM_{2.5}$ aerosols in spring, summer, and fall. In the United States, nitrates are a major species in the winter in the Northeast, and carbon is a major species in the winter in the Northwest.

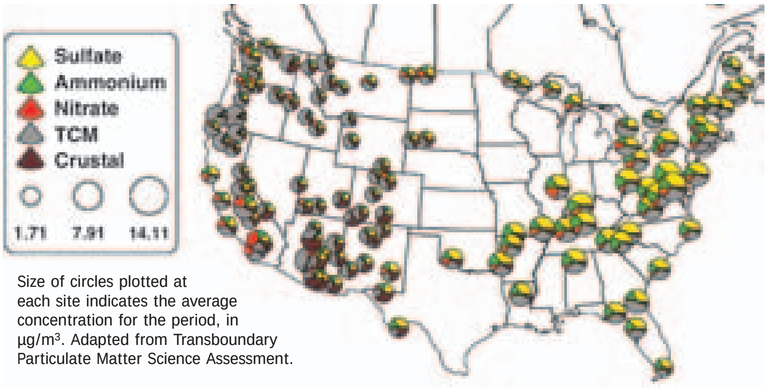
Anthropogenic emissions of SO_2, NO_x, and ammonia are identified as PM precursors of concern in the East and Midwest United States. Comparison of urban and rural speciation and levels (Figures 29 and 30, noting difference in scale) indicate important natural sources of total carbonaceous material (TCM), and also anthropogenic sources, such as motor vehicles or solvent usage. Forest fires are a significant, though episodic, source of TCM.

Figure 29. Summary of Urban $PM_{2.5}$ Speciation Data from EPA and NAPS Speciation Networks (September 2001–August 2002)



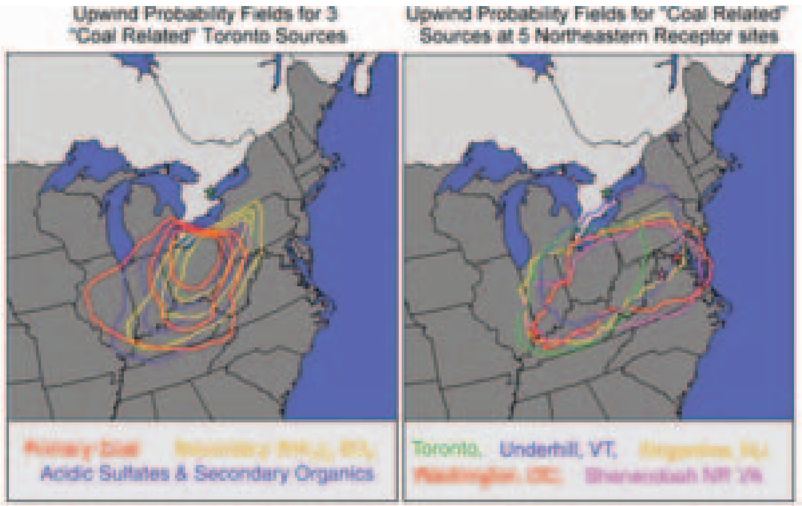
Size of circles plotted at each site indicates the average concentration for the period, in µg/m³. Adapted from Transboundary Particulate Matter Science Assessment.

Figure 30. Summary of Rural $PM_{2.5}$ Speciation Data from U.S. IMPROVE and Canadian Networks (September 2001–August 2002)



Size of circles plotted at each site indicates the average concentration for the period, in µg/m³. Adapted from Transboundary Particulate Matter Science Assessment.

Figure 31. Source-receptor Analysis for Ambient Contaminants Related to Coal-fired Emissions



Using measurements at receptor sites in Toronto and in the eastern United States, based on air mass trajectories. The different particle constituents are indicated in different colors; nested contours identify source regions with increasing probability. From Transboundary Particulate Matter Science Assessment.

Source: Figures adapted from "Transboundary Transport, Trends in and Analysis of Fine Inhalable Particles in the Transboundary Region: Science Assessment." A Report by the Canada-U.S. Air Quality Committee, Subcommittee 2: Scientific Cooperation. November 2004.

- ***Objective 5: Describe source regions of PM and its precursors in the context of geographic regions (i.e., West, Central, East).***

Emissions from the northeastern United States and southern Canada have an impact on $PM_{2.5}$ levels in many areas of the two countries, including as far east as Nova Scotia and New Brunswick, particularly influencing the top 25th percentile of $PM_{2.5}$ concentrations in these regions. Source-receptor analyses indicate that several areas contribute to elevated PM levels in eastern North America. These areas include, but are not restricted to:

- Air masses originating from a relatively large area from southeast Ohio to the western part of Virginia and western Kentucky to central Tennessee, which tended to result in relatively high $PM_{2.5}$ concentrations over northeastern North America.
- The Windsor–Quebec City Corridor.
- The U.S. Midwest and Boston to Washington, D.C. corridor.
- The Ohio River Valley.
- Northern Alberta and Saskatchewan and central United States (e.g., Montana, North Dakota).
- Vancouver/Seattle, Oregon, and Northern California.

Figure 31 shows an example of the source determination work, illustrating a source-receptor analysis for ambient contaminants related to coal-fired plant emissions, using measurements at Toronto and sites in the eastern United States. The study identifies a coherent and plausible source region.

- ***Objective 6: Describe emissions of PM precursors.***

A common inventory of PM precursors SO_2, NO_x, and NH_3 was created based on shared U.S. (1990 and 1996) and Canadian (1990 and 1995) emission information. Annual total emissions are presented in Figures 32, 33, and 34. Emissions of SO_2 and NO_x are concentrated in the industrial Midwest, northeastern United States, and southern Ontario. Emissions of NH_3 are concentrated further west in the central Midwest region. The emissions of SO_2, NO_x, and NH_3, and their contributions to $PM_{2.5}$ levels, vary seasonally.

Figure 32. U.S.–Canada 1995–1996 SO_2 Emissions

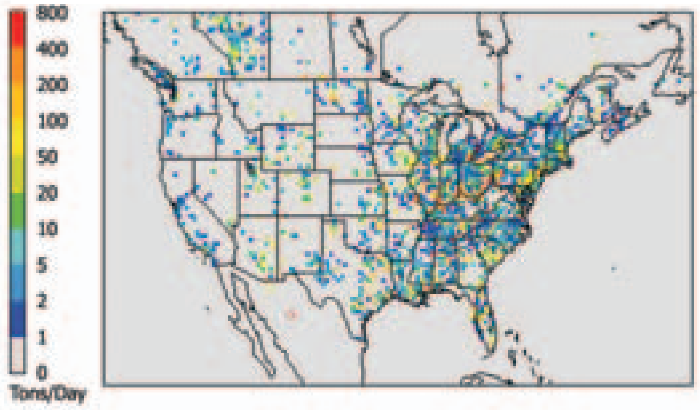


Figure 33. U.S.–Canada 1995–1996 NO_x Emissions

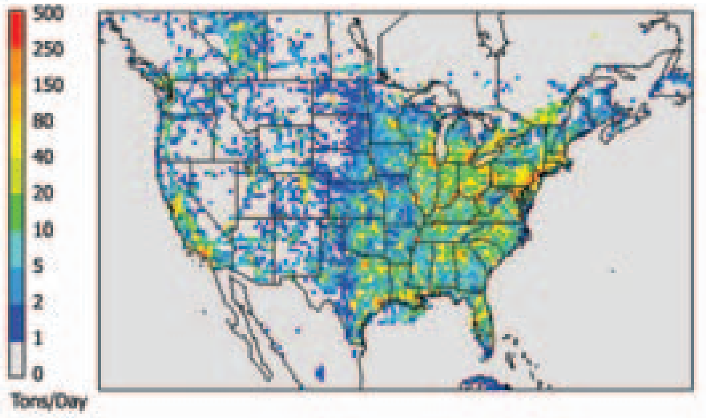
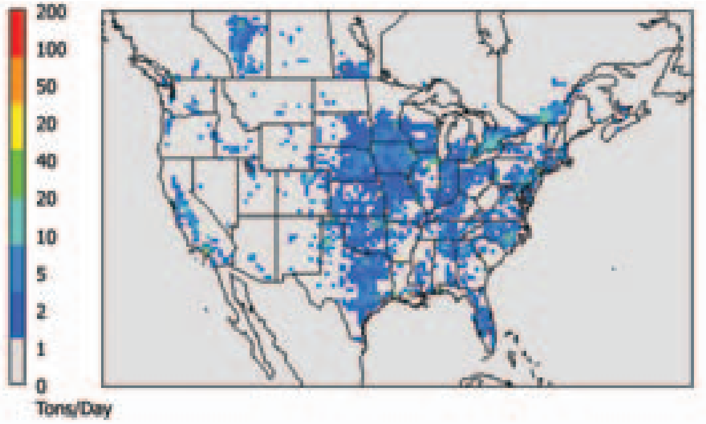


Figure 34. U.S.–Canada 1995–1996 NH_3 Emissions

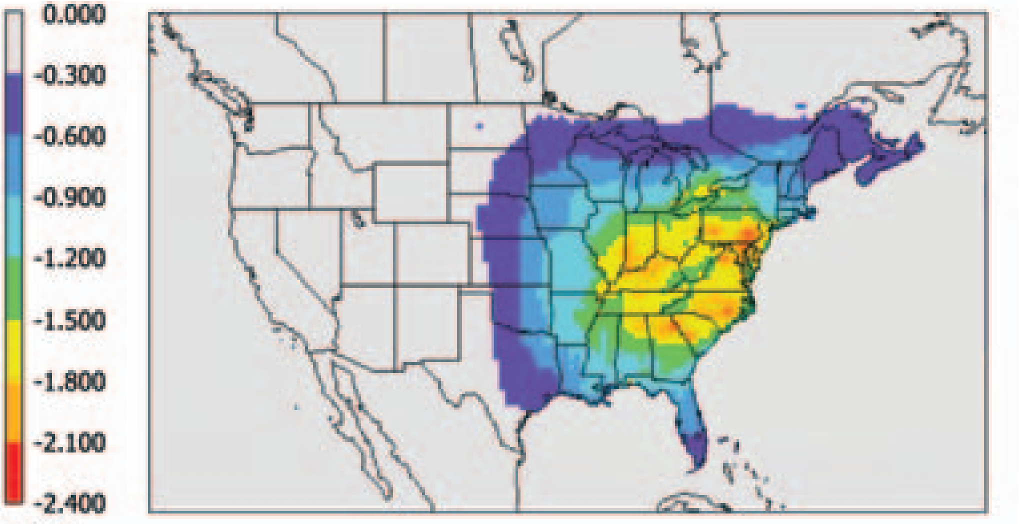


Source: Figures adapted from "Transboundary Transport, Trends in and Analysis of Fine Inhalable Particles in the Transboundary Region: Science Assessment." A Report by the Canada-U.S. Air Quality Committee, Subcommittee 2: Scientific Cooperation. November 2004.

- ***Objective 7: Identify the effect of current and proposed emission reduction scenarios on fine PM levels in North America.***

Projected $PM_{2.5}$ reductions were estimated with model scenarios using shared emission scenarios for 2010 and 2020, which were developed based on the common U.S.–Canada Inventory. U.S. work used the model, REMSAD, focusing on annual levels, while the Canadian model, AURAMS, was applied to a winter and a summer episode of high particulate levels. U.S. and Canadian controls that are expected to be implemented were found to result in maximum annual reductions of $PM_{2.5}$ of 2.3 µg/m^3 in 2020 (see Figure 35). The reductions vary temporally and spatially, with larger reductions in the eastern portion of the REMSAD modeling domain. Proposed additional SO_2 and NO_x emission reductions should provide additional reductions in ambient $PM_{2.5}$ levels in eastern North America. The observed $PM_{2.5}$ reductions might vary by season and will depend strongly on reductions in $PM_{2.5}$ sulfate ion mass (Figure 36).

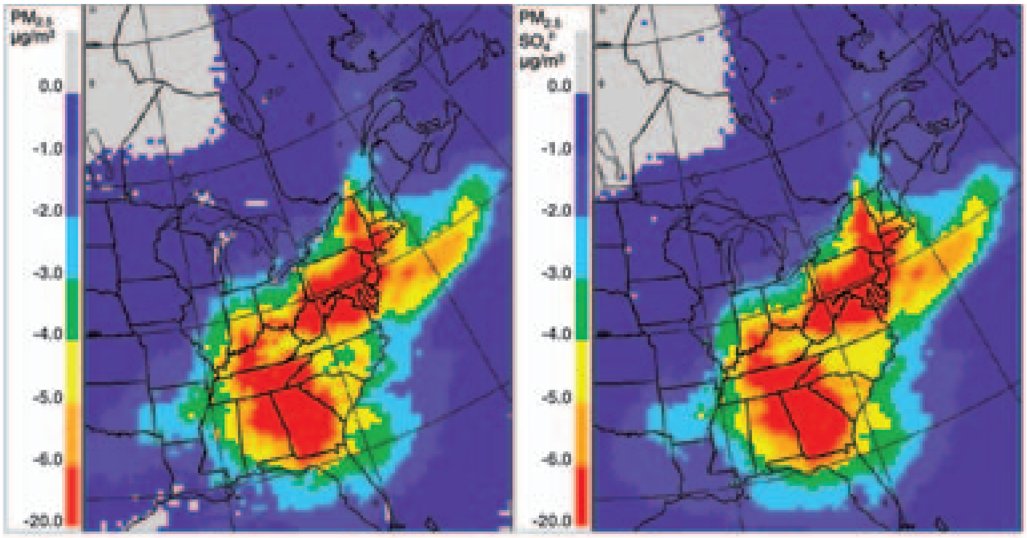
Figure 35. Anticipated Reductions in Annual $PM_{2.5}$ Concentration in 2020 from Expected U.S. and Canadian Controls



Source: Figures adapted from "Transboundary Transport, Trends in and Analysis of Fine Inhalable Particles in the Transboundary Region: Science Assessment." A Report by the Canada-U.S. Air Quality Committee, Subcommittee 2: Scientific Cooperation. November 2004.

Results were developed using the REMSAD model with a full year model run (1996 meteorology). From Transboundary Particulate Matter Science Assessment. For clarity, results over Atlantic Ocean are not shown.

Figure 36. Anticipated Reductions in $PM_{2.5}$ Concentration, and in Its Sulfate Composition from Additional U.S. and Canadian Controls



Results were developed using the Canadian model AURAMS, based on an 11-day summer ozone episode (July 8-18, 1995, meteorology). From Transboundary Particulate Matter Science Assessment.

Health Effects

Canada and the United States generally collaborate on health effects research at the hands-on working level. Individual researchers or research groups share methodologies and datasets to advance understanding of the nature and extent of air pollution effects on human health. In this framework, Health Canada completed health science updates for $PM_{2.5}$ and ozone in support of the Canada-wide Standards process. As a result of the pace of toxicological and epidemiological research on these substances, the review considered progress in understanding health effects of these pollutants. The updates to the health science assessments for $PM_{2.5}$ and ozone conclude that the new evidence gathered from clinical, toxicological, and epidemiological studies continues to support the standards.

Health Canada, in collaboration with EPA officials, initiated discussions for the development of possible surveillance mechanisms to monitor health and air pollution bilaterally. Health Canada hosted a bilateral federal (Canada/United States) science workshop in March 2003. The Tracking Public Health Impacts of Transboundary Air Pollution Workshop presented a suite of indicators to identify the health impacts of investments resulting in long-term air quality changes. Work towards the development of a valid air health indicator is ongoing.

Health effects of air pollution research in the United States has focused primarily on PM in recent years. EPA has a well-established PM health effects research program, consistent with the recommendations of the National Research Council's Committee on Research Priorities for Airborne Particulate Matter. Key findings of recent PM health effects research were presented in a draft Criteria Document and in a draft Staff Paper developed as part of EPA's regular review of its NAAQS for PM.

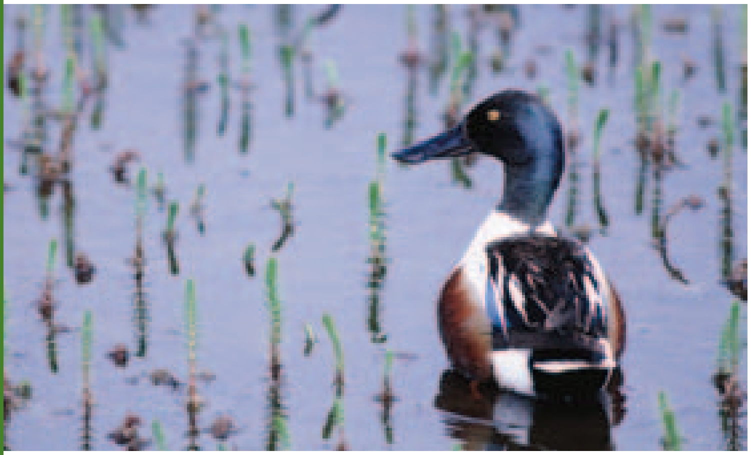
The results of some recent research related to PM health effects are provided below:

- Recently published epidemiologic studies have continued to provide evidence linking serious health effects with exposure to fine particles. Of particular note are the re-analysis and followup analyses completed using updated data from the American Cancer Society cohort that show long-term exposure to fine particles and sulfates (a fine particle component) to be associated with increased mortality from cardiovascular diseases. A full discussion of the new evidence is included in the Canadian and U.S. scientific review documents described previously.

- New total respiratory deposition data were obtained from healthy adults for ultra-fine particles, and an empirical formula was developed to estimate the total deposition in various breathing conditions. The new empirical formula will be useful for improving the health risk assessment process by relating exposure and activity information to the internal dose, which has a direct relevance to the biological responses. Studies determined that as many as 10 times more particles are deposited in certain regions of the lungs in people with pulmonary disease, which might indicate that their increased susceptibility is due to receiving an increased dose.
- Multiple hypotheses now exist describing the biological mechanisms by which very small concentrations of inhaled PM produce cardiovascular and pulmonary changes contributing to increased illness and death. Similarly, laboratory studies and animal models that mimic human disease have stimulated several theories about how the physicochemical properties of PM produce toxicity. No single attribute seems to exist that makes PM toxic, but size and certain chemical components (e.g., metals) appear to be involved. This finding is supported by both laboratory and field evidence.

Aquatic Effects Research and Monitoring

Research and monitoring for aquatic effects from air pollution involves numerous studies of water chemistry trends and biological recovery coordinated within the international scientific community. One such forum is the International Cooperative Program on Assessment and Monitoring of Acidification of Rivers and Lakes (www.niva.no/ICP-waters/ICP_index.htm), established under the Convention on Long-Range Transboundary Air Pollution (LRTAP). As reported in the *2002 Progress Report*, monitoring data show water chemistry improvements in response to steadily decreasing emissions of sulfur oxides, but this improvement is occurring in a complex pattern reflecting emissions of other substances, different lake characteristics, and climate interactions. Conspicuous recovery is only seen in limited areas that formerly had very high initial deposition levels.



These complex interactions are evaluated through the application of dynamic models developed using information from detailed process studies. Generalization to regional levels requires some calibration of key parameters, but such model applications help to understand the past and project future recovery. For example, application of the MAGIC (Model of Acidification of Groundwater in Catchments) model to lakes in Atlantic Canada suggests that the chemical condition of the lakes is much improved compared to the condition in the mid-1970s. Further recovery requires additional reductions in acidic deposition (up to 50 percent), however, and will take decades to occur in some areas. A summary of such work for Canada will be published shortly in the 2004 Canadian Acid Rain Science Assessment.

EPA scientists recently concluded a 10-year analysis of water quality data in the United States to determine how U.S. waters are responding to the reduction in acid deposition that has occurred over that time period.[21] The analysis indicates that acid neutralizing capacity (ANC)—a measure of the ability to buffer acidity—in lakes in the Adirondacks, Appalachians, and Upper Midwest has begun to increase, a sign of greater capacity to withstand acidity and a sign of recovery. Lakes in the northeastern United States, however, as well as streams in the Blue Ridge region of Virginia and West Virginia, do not yet show signs of recovery. All areas monitored by EPA's acidic surface water monitoring program, except for Blue Ridge streams, show that sulfate concentrations in lakes are declining. The analysis indicates that this reduction is occurring fastest in the most acid-sensitive waters and that the reductions in sulfate concentrations in water are a direct result of implementation of the U.S. Clean Air Act Amendments of 1990.

The Hubbard Brook Research Foundation continues to support comprehensive research and monitoring of the effects of acid deposition in the northeastern United States. One recent publication, *Acid Rain Revisited: Advances in Scientific Understanding Since the Passage of the 1970 and 1990 Clean Air Act Amendments*[22], provides a concise overview of the most important research results over the last years. The authors report that acid deposition is accelerating base cation leaching from soils and increasing aluminum concentrations in soil porewater. Acid deposition also increases the concentration of sulfur and nitrogen in soils, leaches calcium from red spruce needles and base cations from sugar maples, making them more susceptible to freezing, pests, drought, and other stresses, and, of course, acidifies lakes and streams. The study also reports positive progress as a result of implementation of the Clean Air Act but that more emission reductions are needed for full recovery to take place.

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[21] Stoddard, J. L., J. S. Kahl, F. A. Deviney, D. R. DeWalle, C. T. Driscoll, A. T. Herlihy, J. H. Kellogg, P. S. Murdoch, J. R. Webb, and K. E. Webster. 2003. Response of surface water chemistry to the Clean Air Act Amendments of 1990. EPA620-R-03-001, U.S. Environmental Protection Agency, Washington, DC.

[22] Driscoll, C.T., G.B. Lawrence, A.J. Bulger, T.J. Butler, C.S. Cronan, C. Eagar, K.F. Lambert, G.E. Likens, J.L. Stoddard, K.C. Weathers. 2001. Acid Rain Revisited: Advances in scientific understanding since the passage of the 1970 and 1990 Clean Air Act Amendments. Hubbard Brook Research Foundation. Science Links™ Publication, Vol. 1, No. 1.

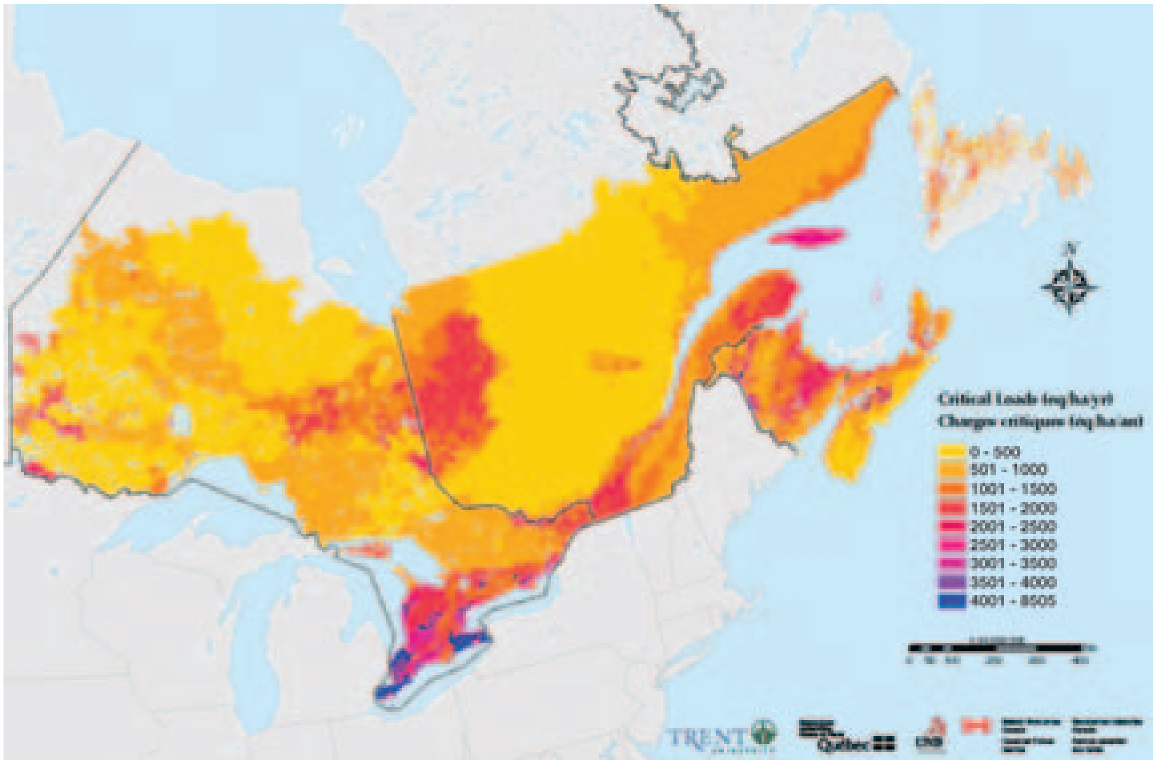
Forest Effects

Canadian and U.S. governments are involved in a joint Forest Mapping Project under the Acid Rain Action Plan endorsed by the NEG/ECP. The project involves applying a protocol developed and published in 1991 to assess forest sensitivity to atmospheric sulfur and nitrogen deposition. The maps covering Quebec and the Atlantic provinces, along with the New England states, will depict critical loads, or sustainable loads, for sensitive forest ecosystems. These “loads” depict the maximum deposition of atmospheric sulfur and nitrogen that a forest ecosystem can sustain without a net loss in soil reserves of plant nutrients. Although the government of Ontario is not part of the NEG/ECP, the province has also carried out critical loads mapping through a contract with Trent University. Figure 37 is a Canadian product of the collaborative project, published in the 2004 Canadian Acid Rain Assessment. In this figure, critical loads depict a “no harvest” scenario. Depending on the harvesting practice used, additional soil nutrient losses could occur, thus reducing the critical load for a given forest ecosystem.

U.S. and Canadian scientists continue to work at the U.S.-led Aspen Free-Air CO_2 Enrichment (FACE) Project (http://aspenface.mtu.edu), established in 1997 on a site in northern Wisconsin. The free-air experiment is in its seventh year (1998–2004), studying trembling aspen, paper birch, and sugar maple exposure to elevated CO_2 and ozone concentrations. Aspen FACE is the world’s largest, open-air climate change research facility and the only FACE site where scientists can study the impact of the greenhouse gases carbon dioxide (CO_2) and ozone on forest ecosystems.

These two gases act in opposing ways, and they can be harmful even at relatively low concentrations. Ozone offsets or moderates the positive responses induced by elevated CO_2. Aspen FACE

Figure 37. Critical Loads for Forest Soils in Canada



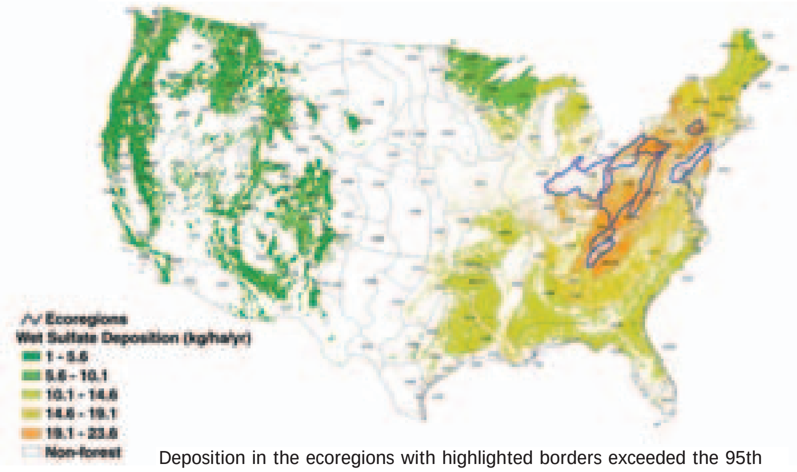
Critical loads for forest soils in Canada, representing the combined effects of both acidic sulfur and nitrogen deposition. For sulfur, 1000 eq/ha/yr is equivalent to 16 kg/ha/yr; for nitrogen, to 14 kg/ha/yr. This figure is a preliminary result of the 2004 Canadian Acid Rain Science Assessment. To obtain permission to reproduce this map in whole or in part, contact the Canadian Forest Service Atlantic Forestry Centre (afcpublications@nrcan.gc.ca).

ozone exposure ranged between 78 and 93 ppb from 1998 to 2003, which is the fourth highest annual daily maximum 8-hour concentration. This exposure induced negative effects in aspen, which have cascaded through the ecosystem from gene expression to productivity. It has been found that ozone delays leaf-out and significantly accelerates leaf-drop in the fall, thus shortening the effective growing season for aspen (North America's most widely distributed forest tree species) between four and six weeks.

The U.S. Department of Agriculture (USDA)/U.S. Forest Service initiated the Forest Health Monitoring Program in 1991 (www.na.fs.fed.us/spfo/fhm) as a multi-agency cooperative effort to determine the status, changes, and trends of forest health indicators in all forest ecosystems in the United States. An analysis of spatial trends in average annual wet sulfate and inorganic nitrogen deposition (1994–2001) is presented in Figures 38 and 39. Sulfur and nitrogen deposition remains high in sensitive ecoregions. Figure 40 shows the results of an ozone bioindicator study, which found that the oak-hickory forests of southern Illinois and Indiana are in the highest risk category for ozone damage. Most ecoregion sections in the north central and western United States had a biosite index of less than 5 (see Table 2).

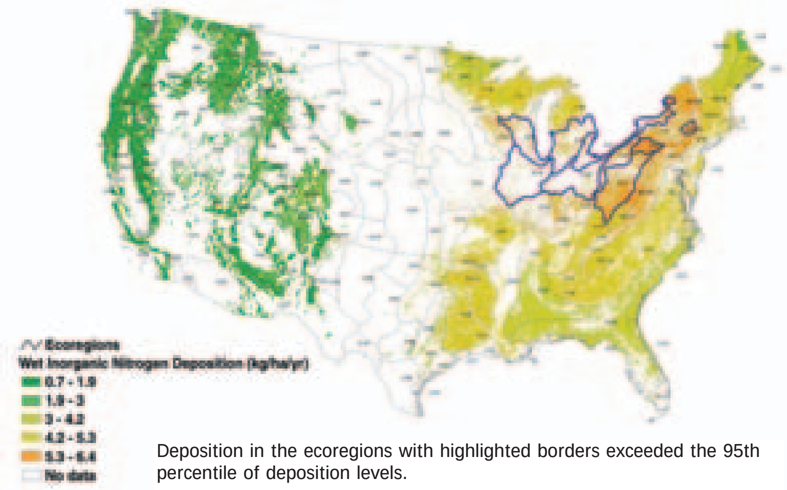
The most recent U.S. research on the effects of acid deposition on forest ecosystems

Figure 38. USDA Evaluation of Annual Average Wet Sulfate Deposition by Ecoregion (1994–2001)



Deposition in the ecoregions with highlighted borders exceeded the 95th percentile of deposition levels.

Figure 39. USDA Evaluation of Annual Average Wet Inorganic Nitrogen Deposition by Ecoregion (1994–2001)



Deposition in the ecoregions with highlighted borders exceeded the 95th percentile of deposition levels.

Figure 40. USDA Ozone Bioindicator Expressed as a Biosite Index

Based on surveys for ozone damage to vegetation from 1997–2001. See Table 2 for information on the index.

Table 2. USDA Ozone Biosite Index Categories, Risk Assumption, and Possible Impact

Biosite Index	Bioindicator Response	Assumption of Risk to Forest Resource	Possible Impact
0 to < 5.0	Little or no foliar injury	None	Visible injury to isolated genotypes of sensitive species (e.g., common milkweed, black cherry).
5.0 to <15.0	Light to moderate foliar injury	Low	Visible injury to highly sensitive species (e.g., black cherry; effects noted primarily at the tree-level).
15.0 to < 25.0	Moderate to severe foliar injury	Moderate	Visible injury to moderately sensitive species (e.g., tulip poplar; effects noted primarily at the tree-level).
≥25	Severe foliar injury	High	Visible injury leading to changes in structure and function of the ecosystem.

focuses on the effects of biogeochemical processes that affect plant uptake, retention, and cycling of nutrients within forested ecosystems. In particular, researchers now know that documented decreases in base cations (calcium, magnesium, potassium, and others) from soils in the northeastern and southeastern United States are at least partially attributable to acid deposition.[23] Other research has shown that unpolluted temperate forests can become separated from historic sources of nutrients in bedrock and rely almost exclusively on atmospheric deposition for all necessary nutrients, providing a new picture of the sensitivity of forests to air pollution.[24] Finally, research on red spruce has indicated that calcium loss from needles as a result of acid deposition can make trees more susceptible to disease, frost, and drought.[25]

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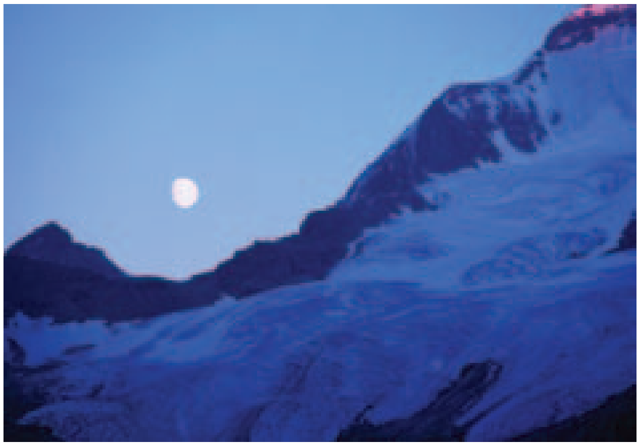
[23] Lawrence, G. W., M. B. David, S. W. Bailey and W. C. Shortle. 1997. Assessment of calcium status in soils of red spruce forests in the northeastern United States. Biogeochemistry 38:19-39; Huntington, T. G., R. P. Hooper, C. E. Johnson, B. T. Aulenbach, R. Cappellato and A. E. Blum. 2000. Calcium depletion in a southeastern United States forest ecosystem. Soil Science Society of America Journal 64:1845-1858.

[24] Kennedy, M.J., L.O. Hedin, and L.A. Derry. 2002. Decoupling of unpolluted temperate forests from rock nutrient sources revealed by natural 87Sr/86Sr and 84Sr tracer addition. Proc. Natl. Acad. Sci. 99:9639-9644.

[25] DeHayes, D. H., P. G. Schaberg, G.J. Hawley, G. R. Strimbeck. 1999. Acid rain impacts calcium nutrition and forest health: Alteration of membrane-associated calcium leads to membrane destabilization and foliar injury in red spruce. BioScience. 49:789-800.

Conclusion



The United States and Canada have continued to fulfill the obligations set forth in the Air Quality Agreement successfully. Implementation of each country's acid rain control program is a notable achievement of the Agreement; however, both countries recognize that additional efforts are necessary to address ongoing human health and environmental problems, particularly in highly sensitive areas and within the United States–Canada transboundary region.

The United States and Canada successfully negotiated an Ozone Annex in 2000, and the 2004 Progress Report *is the first biennial report to incorporate information on the progress being made to address transboundary ozone pollution in the eastern border regions of each country. To assist in completing this first review of progress, the United States and Canada met in Quebec City in June 2004 and, with stakeholders, outlined the programs that have been implemented in each country, discussed the emission reductions expected, and charted the ozone air quality levels that will serve as benchmarks for future reviews of progress to meet the ozone air quality standards in each country.*

Efforts to address PM levels in the air are important in both the United States and Canada. Within the context of the Air Quality Agreement, transboundary PM transport has become an issue of interest. The conclusions of a joint scientific report on transboundary PM were issued in 2004 and are summarized in the 2004 Progress Report*. The first joint effort of this kind to be undertaken by the two countries, these conclusions and those of other joint analyses, such as that in the Georgia Basin–Puget Sound of British Columbia and Washington State, provide the basis for moving forward in a bilateral context. In particular, these conclusions guide the countries in addressing PM and other air-related matters with priority given to the eastern half of the two countries and with due consideration given to the issues identified in the shared airshed in the Georgia Basin–Puget Sound and the Rocky Mountain region.*

Human health and the environment have benefited greatly from progress made under the U.S.–Canada Air Quality Agreement. Both countries look forward to assessing the results of implementing the Ozone Annex and to addressing additional transboundary air pollution problems.

Appendix

United States–Canada Air Quality Committee

United States Co-Chair:

Claudia McMurray
Deputy Assistant Secretary for the Environment
U.S. Department of State

Members:

Bruce Hicks
Director, Air Resources Lab
National Oceanic and Atmospheric Administration

Brian McLean
Director, Office of Atmospheric Programs
U.S. Environmental Protection Agency

Steve Page
Director, Office of Air Quality Planning & Standards
U.S. Environmental Protection Agency

Bruce Polkowsky
Air Resources Division
National Park Service

Steve Rothblatt
Director, Air and Radiation Division, Region 5
U.S. Environmental Protection Agency

David Shaw
Acting Director, Division of Air Resources
New York State Department of Environmental Conservation

Ed Watts
Office of Policy and International Affairs
Department of Energy

Subcommittee on Program Monitoring and Reporting Co-Chair:

Brian McLean
Director, Office of Atmospheric Programs
U.S. Environmental Protection Agency

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Environment Canada

Members:

Randy Angle
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Alberta Environment

Raynald Brulotte
Air Quality Division
Quebec Ministry of the Environment

Marc-Denis Everell
Meteorological Service of Canada
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Foreign Affairs and International Trade

Marcie Girouard
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Nova Scotia Department of Environment and Labour

John Lowe
Energy Policy Branch
Natural Resources Canada

Gord Owen
Air Pollution Prevention Directorate
Environmental Protection Service
Environment Canada

Mark Raizenne
Healthy Environments and Consumer Safety Branch
Health Canada

Tony Rockingham
Air Policy and Climate Change Branch
Ontario Ministry of the Environment

Hu Wallis
Water, Air and Climate Change Branch
British Columbia Ministry of Water, Land and Air Protection

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Director, Transboundary Air Issues Branch
Environmental Protection Service
Environment Canada

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Meteorological Service of Canada
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Notes

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www.ec.gc.ca/pdb/can_us/canus_links_e.cfm

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