United States • Canada
Air Quality Agreement

1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006

PROGRESS REPORT 2006

For additional information on the commitments and obligations in the Canada–United States Air Quality Agreement, please consult:

United States Environmental Protection Agency's website:

www.epa.gov/airmarket/usca/agreement.html

Environment Canada's website:

www.ec.gc.ca/cleanair-airpur/Pollution_Issues/Transboundary_Air/Canada_-_United_States_Air_Quality_Agreement-WS83930AC3-1_En.htm

American spellings are used in this report.

United States • Canada

Air Quality Agreement

15 years
of bilateral cooperation

Progress Report
2006

The International Joint Commission Requests Your Comments on This Report

The International Joint Commission is responsible for inviting comment on the Air Quality Agreement Progress Report and for providing a synthesis of the comments to governments to assist them in implementing the Agreement. The Air Quality Committee will have the benefit of this synthesis as it implements the Agreement and prepares the next Progress Report. Comments on any aspect of the Agreement would be appreciated.

Written comments on this report should be sent by February 28, 2007 to:

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List of Acronyms

µg/m^3	micrograms per cubic meter
AHI	Air Health Indicator
AIRMoN	Atmospheric Integrated Research Monitoring Network
AIRS	Aerometric Information Retrieval System
ANC	acid neutralizing capacity
AQA	Air Quality Agreement
AQHI	Air Quality Health Index
AQMP	Air Quality Management Plan
ASI	Algoma Steel Inc.
BDPS	Boundary Dam Power Station
CAC	Criteria Air Contaminants
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CAPMoN	Canadian Air and Precipitation Monitoring Network
CASTNET	Clean Air Status and Trends Network
CAVR	Clean Air Visibility Rule
CCME	Canadian Council of Ministers of the Environment
CEMS	continuous emission monitoring systems
CFR	Code of Federal Regulations
CI	continuous improvement
CO	carbon monoxide
CO_2	carbon dioxide
DEARS	Detroit Exposure and Aerosol Research Study
EPA	Environmental Protection Agency (United States)
EPS	Environmental Protection Service (Environment Canada)
GIS	geographic information system
GVRD	Greater Vancouver Regional District
IJC	International Joint Commission
IMPROVE	Interagency Monitoring of Protected Visual Environments
KCAC	Keeping Clean Areas Clean
km	kilometer
kt	kilotonne
LTM	Long-Term Monitoring
MDN	Mercury Deposition Network
MOE	(Ontario) Ministry of Environment
Mt	megatonne
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAMS	National Air Monitoring Stations
NAPAP	National Acid Precipitation Assessment Program
NAPS	National Air Pollution Surveillance
NARSTO	(formerly) North American Research Strategy for Tropospheric Ozone
NAtChem	National Atmospheric Chemistry
NATTS	National Air Toxics Trends Stations
NBP	NO_x Budget Trading Program
NEG/ECP	New England Governors and Eastern Canadian Premiers
NEI	National Emissions Inventory
NMMAPS	National Morbidity, Mortality, and Air Pollution Study
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NO_y	reactive odd nitrogen
NPRI	National Pollutant Release Inventory
NSPS	New Source Performance Standards
NTN	National Trends Network
OTC	Ozone Transport Commission
PAMS	Photochemical Assessment Monitoring Stations
PEMA	Pollutant Emission Management Area
PERC	perchloroethylene; tetrachloroethylene
PM	particulate matter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns (micrometers)
$PM_{10\text{-}2.5}$	particulate matter between 10 and 2.5 microns (micrometers)
PM_{10}	particulate matter less than or equal to 10 microns (micrometers)
ppb	parts per billion
ppbC	parts per billion carbon
ppm	parts per million
RPO	Regional Planning Organization
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations
SO_2	sulfur dioxide
SO_x	sulfur oxides
STN	$PM_{2.5}$ Speciation Trends Network
TIME	Temporally Integrated Monitoring of Ecosystems
VOC	volatile organic compound

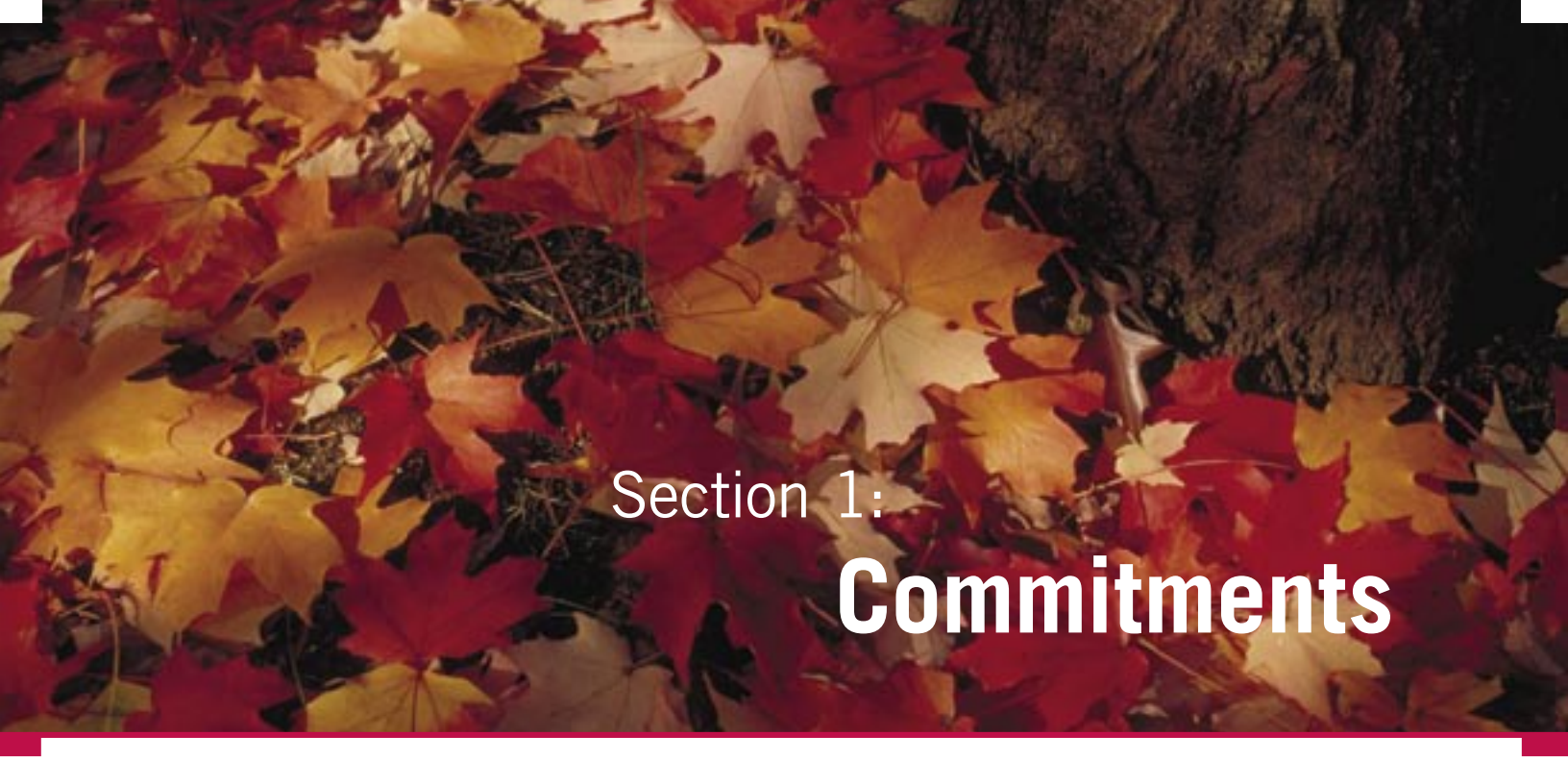
Introduction

The 2006 Progress Report, prepared by the bilateral Air Quality Committee, is the eighth biennial report compiled under the 1991 Canada–United States Air Quality Agreement. This report highlights actions undertaken by Canada and the United States in the last two years to address transboundary air pollution within the context of the Agreement—namely, acid rain and ground-level ozone.

Over the last two years, Canada and the United States have continued to successfully reduce their emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the major contributors to acid rain. Both countries have also made considerable progress in meeting the requirements of the Ozone Annex to reduce emissions of NO_x and volatile organic compounds (VOCs), the precursors to ground-level ozone. Canada and the United States have focused their actions on reducing these emissions from major sources such as electric generating units, industrial sources, and on-road and nonroad transportation. Each country's progress in achieving the requirements of the Acid Rain Annex and the Ozone Annex is summarized in Section 1 of the report.

The 2006 Progress Report includes the third five-year comprehensive review of the Air Quality Agreement, which has been organized in a question and answer format to better address requirements in the Agreement and public comments on the 2004 Progress Report submitted by the International Joint Commission. The review responds to several deferred issues from previous reviews in 1996 and 2002, highlights progress on several topics, and outlines future areas of potential focus.

In 2006, the Air Quality Agreement marked its 15-year anniversary. This Agreement has provided important opportunities for collaboration between Canada and the United States and has produced impressive results, not just in environmental improvements, but also in diplomacy and working relationships. Both countries rely on the Agreement as the mechanism to address air pollution issues and are committed to its continuing viability and relevance as new bilateral issues emerge. The Agreement's flexibility provides opportunities to go beyond the challenges identified by the Acid Rain and Ozone annexes, and the Parties look forward to considering whether and how to address bilateral issues associated with particulate matter, mercury, and other air pollutants.



Section 1:

Commitments

Acid Rain Annex

Overview

The Air Quality Agreement (AQA) established Annex I with specific sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emission target levels and a timetable for their achievement and made commitments to address visibility, prevent air quality deterioration in clean areas, and monitor emissions continuously. The commitments are based on both countries' acid rain reduction programs, which address the different emissions sources in the two countries. Together, we have made significant progress in preventing impacts from acid rain and reducing the acid rain on each side of the border. However, recent studies in both countries continue to show that further reductions are necessary to restore damaged ecosystems, particularly in the east.

Key Commitments and Progress: Sulfur Dioxide Emission Reductions

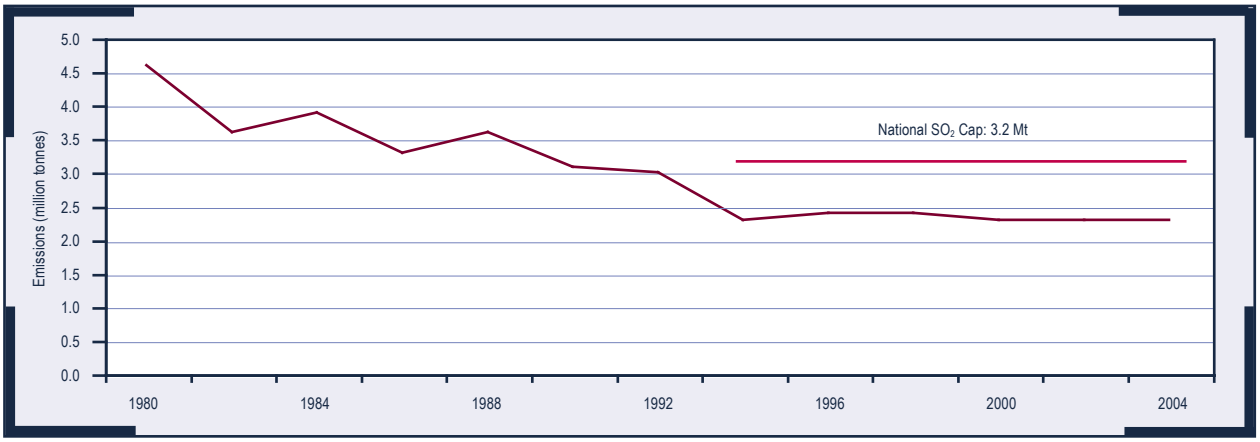
CANADA

Canada has been successful in reducing emissions of SO_2, a principal contributor of acid rain. In 2003, SO_2 emissions in the seven easternmost provinces, where elevated acid deposition continues to damage sensitive ecosystems, were 29 percent below the eastern Canada 2.3 million tonne[1] cap, even though the cap expired in December 1999. Canada's total SO_2 emissions have decreased about 50 percent since 1980 to 2.3 million tonnes in 2004, or 28 percent below the national cap of 3.2 million tonnes (see Figure 1).

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

Figure 1

Canadian SO_2 Emissions from Acid Rain Sources, 1980–2004



Source: Environment Canada

In the east, where acid rain continues to damage sensitive ecosystems, three provinces, Nova Scotia, Quebec, and Ontario, developed tighter regulations in 2005 to reduce emissions from major acid rain–causing sources. Details on these and other provincial actions are found at the end of Section 1.

Despite these efforts, the control of acidifying emissions has not occurred to the extent necessary to reduce acid deposition below critical loads (harmful levels) and ensure the recovery of aquatic and terrestrial ecosystems. A critical load is the maximum amount of acidifying deposition an ecosystem can tolerate in the long term without being damaged.

The goal of Canada's acid rain program—to reduce acid deposition to aquatic and terrestrial ecosystems to below critical loads for sulfur and nitrogen—is far from being achieved.

UNITED STATES

The United States has succeeded in meeting its goal to reduce SO_2 emissions from all sources by 10 million tons. Created by Title IV of the 1990 Clean Air Act Amendments, the Acid Rain Program employs a cap and trade mechanism to achieve high levels of SO_2 emission reductions from the highest emitting SO_2 sector, the electric power sector. In 2005, electric generating units in the United States reduced SO_2 emissions by 5.5 million tons, or 35 percent, compared with 1990 levels, and more than 40 percent compared with 1980 levels (see Figure 2). For further details, including a listing of affected units and complete emissions and allowance data related to the Acid Rain Program, visit http://cfpub.epa.gov/gdm.

The Clean Air Act sets a nationwide annual cap on SO_2 emissions from electric generating facilities. The number of SO_2 allowances allocated in a given year to a particular unit was determined by provisions in the Clean Air Act and the total allowances allocated each year must not exceed the national cap. Each allowance authorizes 1 ton of SO_2 emissions. Every year, each individual source must hold enough allowances to cover its annual emissions. Unused allowances may be sold, traded, or banked (saved) for future use. Banked allowances give sources the flexibility to determine how they will comply with program requirements. Many sources chose to substantially decrease their emissions during Phase I and to use or sell their banked allowances in the program's later years. Thus, annual fluctuations in SO_2 emissions are expected as sources move towards the final cap of 8.95 million tons in 2010.

In 2005, 3,446 electric generating units were subject to the SO_2 provisions of the Acid Rain Program. Variations in the number of units participating in

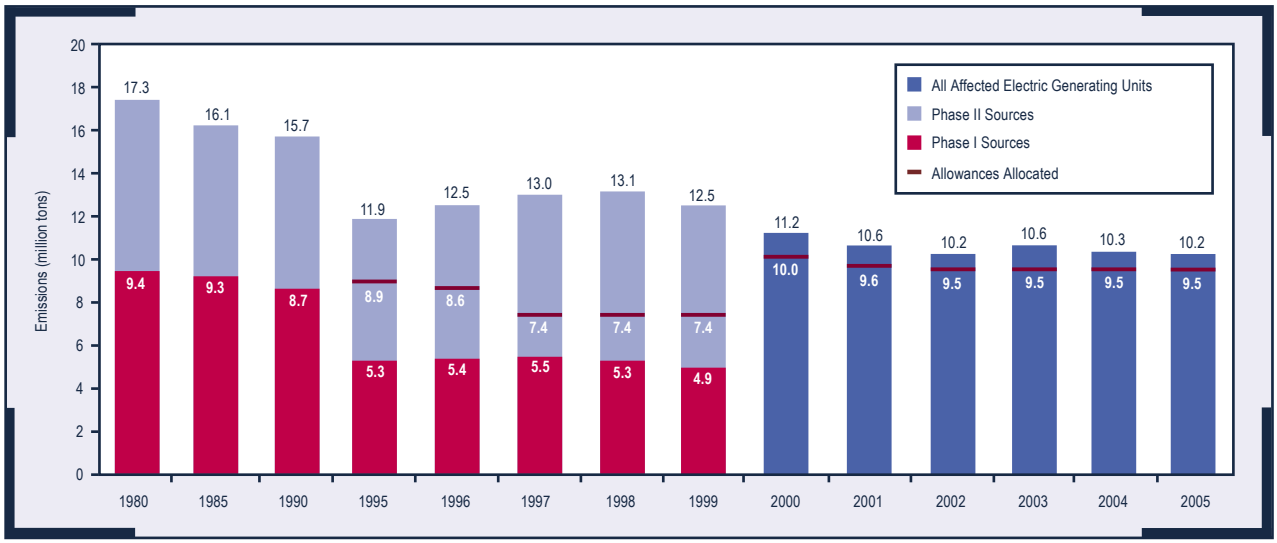
the program can result from retirements of some units and start-up of other units.

In 2005, a total of 9.5 million allowances were allocated. Sources actually emitted 10.2 million tons of SO_2, decreasing the allowance bank by 0.7 million tons to 6.2 million tons. Over the next several years, affected sources will continue to use banked allowances to help comply with the increasingly stringent requirements of the program. In addition, some sources in the eastern United States may also rely on banked allowances to comply with the lower cap for SO_2 under the Clean Air Interstate Rule (CAIR), promulgated in March 2005 and due to take effect beginning in 2010.

In addition to the electric power generation sector, other sources achieved reductions in SO_2 emissions, including smelters and sulfuric acid manufacturing plants. Smelters reduced emissions from 1.84 million tons in 1980 to 271,000 tons in 2002. The use of cleaner fuels in residential and commercial burners also contributed to the 10.6 million ton decline of SO_2 emissions from all sources, compared with the 1980 level of 25.9 million tons. (For more details, visit the 2002 National Emissions Inventory (NEI) at www.epa.gov/ttn/chief/trends/.)

Figure 2

U.S. SO_2 Emissions from Acid Rain Program Electric Generating Units, 1980–2005



Source: EPA

Key Commitments and Progress: Nitrogen Oxides Emission Reductions

CANADA

Though Canada has surpassed its NO_x emission reduction target at power plants, major combustion sources, and metal smelting operations by 100,000 tonnes below the forecast level of 970,000 tonnes, the country is continuing to develop programs to further reduce NO_x emissions nationwide (see section on Ozone Annex).

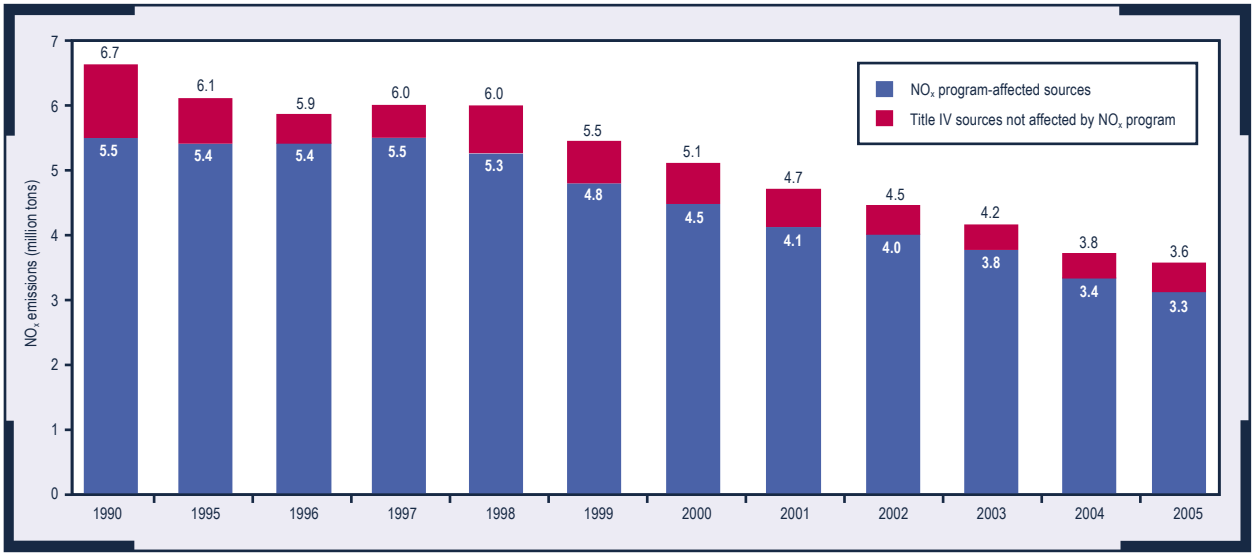
Mobile sources (cars, light-duty trucks, etc.) are the most significant sources of NO_x emissions, accounting for just over half (51 percent) of Canadian total emissions, with the remainder caused by power plants and other sources (see Figure 26, U.S. and Canadian National Emissions by Sector for Selected Pollutants, 2004). The Canadian federal government recently passed stringent standards for NO_x emissions from on-road and off-road sources effective between 2004 and 2009. Details can be found in the Ozone Annex section of the report.

UNITED STATES

Coal-fired electric utility units affected by the NO_x component of Title IV of the 1990 Clean Air Act Amendments (the Acid Rain Program) continue to exceed the annual goal of reducing emissions by 2 million tons below what they would have been without the program. In 2005, the 982 NO_x program–affected units reduced their combined NO_x emissions to 3.3 million tons (see Figure 3).

Figure 3

U.S. Title IV Utility Unit NO_x Emissions, 1990–2005



Source: EPA

Acid Deposition Monitoring, Modeling, Maps, and Trends

Airborne pollutants are deposited on the earth's surface by three processes: 1) wet deposition (rain and snow); 2) dry deposition (particles and gases); and 3) deposition by cloud water and fog. Wet deposition is comparatively easy to measure using precipitation samplers, and wet sulfate and nitrate deposition is regularly used to assess the changing atmosphere as it responds to decreasing or increasing sulfur and nitrogen emissions. In Canada, measurements of wet sulfate deposition are typically corrected to omit the contribution of sea salt sulfate at near-ocean sites (less than 62 miles (100 kilometers, or km) from the coast) to facilitate this comparison.

Figures 4 and 5 show the spatial patterns of wet sulfate deposition for two separate five-year periods, 1990–1994 and 2000–2004. Figures 6 and 7 present maps of wet nitrate deposition for the same five-year periods. No deposition contours are shown in Canada in Figures 5 and 7, because Canadian experts judged that the locations of the contour lines were unacceptably uncertain because of data paucity. This paucity is related to the following factors: the Province of Ontario ceased collecting wet deposition data in 1999; at this time, no validated wet deposition data are available from the Province of Quebec for years after 2002; the Province of Newfoundland and Labrador closed its monitoring network early in 2004; and the provinces of British Columbia, Saskatchewan, and Manitoba do not carry out regional-scale wet deposition monitoring. As a result, the five-year average deposition values in Canada are shown as colored circles at the locations of the remaining federal/provincial/territorial measurement sites. National experts from both countries are collaborating to determine consistent common uncertainty limits for future analyses. The maps for 1990–1994 differ slightly from those shown in the 2004 Progress Report because

stricter criteria for data completeness and improved detail were used to develop the new maps shown here.

It can be seen from the maps that wet sulfate deposition remains highest in eastern North America, and the gradient follows an axis running from the confluence of the Mississippi and Ohio rivers through the lower Great Lakes. A comparison of the 2000–2004 sulfate deposition map (Figure 5) with the 1990–1994 map (Figure 4) shows significant reductions in wet sulfate deposition in both the eastern United States and much of eastern Canada between the two periods.

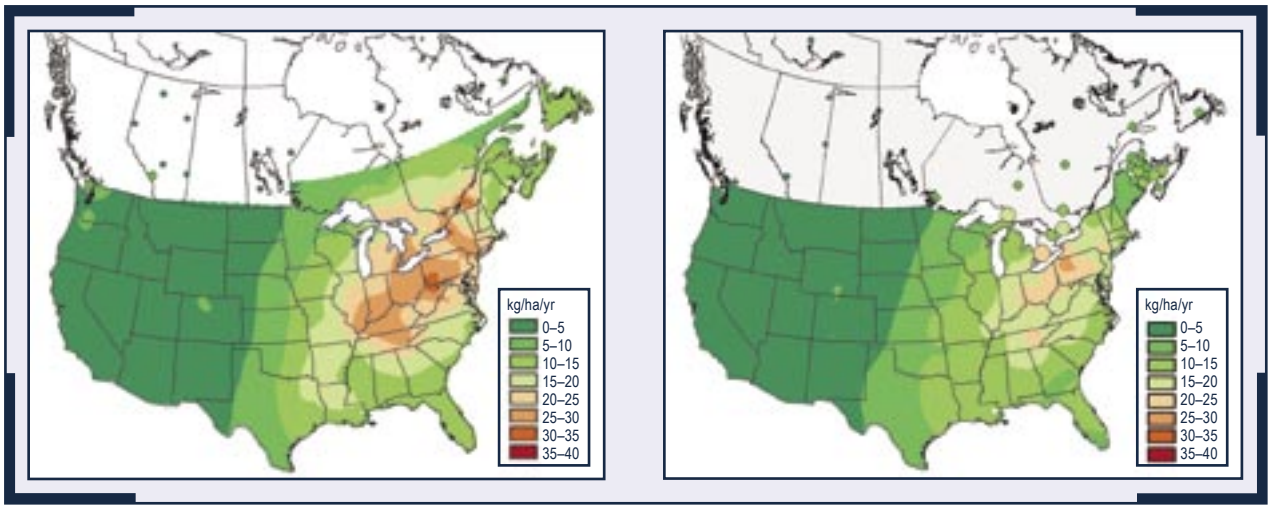
The pattern for wet nitrate deposition (Figures 6 and 7) shows a similar southwest-to-northeast axis, but the high-deposition area is more tightly focused around the lower Great Lakes. Reductions in wet nitrate deposition between the two five-year periods were more modest than for wet sulfate. The absence of data for Quebec and Newfoundland and Labrador precludes any firm conclusions on deposition trends for those provinces.

Figure 4

Mean sulfate wet deposition for 1990–1994, for comparison with Figure 5

Figure 5

Mean sulfate wet deposition for 2000–2004



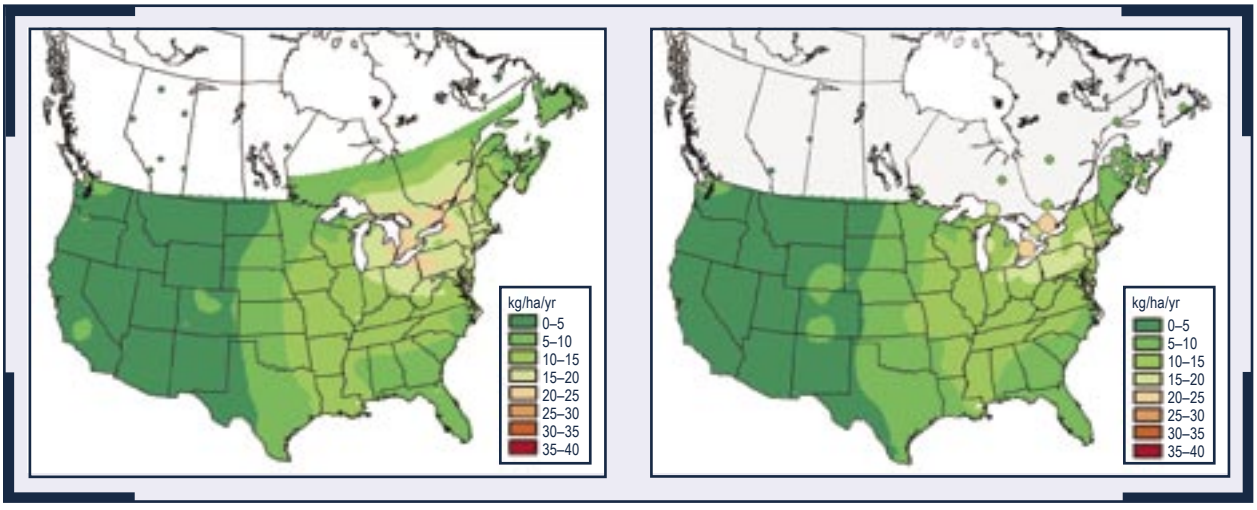
Note: Sulfate measurements are corrected for sea salt composition where appropriate.

Figure 6

Mean nitrate wet deposition for 1990–1994, for comparison with Figure 7

Figure 7

Mean nitrate wet deposition for 2000–2004



Source: National Atmospheric Chemistry (NAtChem) Database (www.msc-smc.ec.gc.ca/natchem/index_e.html) and National Atmospheric Deposition Program (NADP)

The foregoing changes in sulfate and nitrate wet deposition from the first half of the 1990s to 2000 through 2004 are considered to be directly related to decreases in SO_2 and NO_x emissions in both Canada and the United States. These emission reductions are outlined in the previous sections dealing with key commitments and progress on SO_2 emission reductions and NO_x emission reductions.

In Canada, wet and dry deposition are measured by the Canadian Air and Precipitation Monitoring Network (CAPMoN) (www.msc-smc.ec.gc.ca/capmon), and wet deposition alone is measured by several provinces and one territory. In the past two years, a few additional measurement sites were added to CAPMoN in the more remote regions of Canada in order to provide more extensive deposition data. However, the data available for 2000–2004 in Canada were insufficient to permit interpolation and contouring.

The United States has three coordinated acid deposition monitoring networks:

1. The National Atmospheric Deposition Program/National Trends Network (NADP/NTN), a collaboration of federal, state, and nongovernmental organizations measuring deposition chemistry (http://nadp.sws.uiuc.edu).
2. The NADP/Atmospheric Integrated Research Monitoring Network (AIRMoN), a subnetwork of NADP funded by the National Oceanic and Atmospheric Administration (http://nadp.sws.uiuc.edu/AIRMoN/).
3. The Environmental Protection Agency (EPA)/National Park Service Clean Air Status and Trends Network (CASTNET), which estimates dry deposition based on observational data (www.epa.gov/castnet).

Wet deposition measurement procedures for all U.S. and Canadian networks are acceptably comparable, and the wet deposition data are available from the individual networks and from a binational database that is accessible to the public at www.msc.ec.gc.ca/natchem/index_e.html. Canada and the United States have developed different methods for estimating dry deposition based on measured data and modeled dry deposition velocities. These methods have improved over the years, and both indicate the importance of dry deposition as a major contributor to total deposition in some areas of the continent. However, the results differ in detail, and no joint analysis is available at this time. Efforts are under way between the two countries to reconcile the different methods and results.

Acid Rain Program Benefits Far Exceed Costs

A recent analysis[2] of the U.S. Acid Rain Program estimates annual benefits of the program in 2010 to both Canada and the United States at $122 billion and costs for that year at $3 billion (in 2000 dollars)—a 40-to-1 benefit/cost ratio. These quantified benefits in the United States and Canada are the result of improved air quality prolonging lives, reducing heart attacks and other cardiovascular and respiratory problems, and improving visibility. The complete report is available in volume 77, issue 3, of the *Journal of Environmental Management* at www.sciencedirect.com/science/journal/03014797.

Emissions Monitoring

CANADA

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, trading of SO_2 and NO_x emissions is not currently a driver for electronic data reporting and CEMS installation. In December 2005, Environment Canada published an update of its guidelines for CEMS (*Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from*

[2] Chestnut, L.G. and Mills, D.M. (2005) A fresh look at the benefits and cost of the US Acid Rain Program. *Journal of Environmental Management*, Vol. 77, No. 3, pp. 252–266.

Thermal Power Generation, Report EPS 1/PG/7 (revised)). The report can be viewed at www.ec.gc.ca/cleanair-airpur/CAOL/electricity_Generation/protocols_performance/toc_e.cfm. This update was 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 and would achieve accuracy comparable to that achieved through 40 CFR Part 75.

As laid out in the Canada–U.S. Emissions Cap and Trading Feasibility Study, if a cross-border emissions cap and trading system were established, 40 CFR Part 75 requirements would need to be implemented in Canada. One major difference between Canada's EPS 1/PG/7 guidance and 40 CFR Part 75 is the emission data acquisition and reporting requirements in the United States.

A study is being undertaken to estimate the costs of upgrading from existing emission monitoring systems in place at Canadian electric generating units to CEMS that would be compliant with 40 CFR Part 75. Preliminary conclusions from this work indicate that the costs for Canadian electricity generators would relate to the type of CEMS chosen and to the type of unit (coal-fired, oil or gas, peaking, low mass emitter) in which the monitor would be installed, with coal-fired generators being the most affected. As well, all facilities would be required to add 40 CFR Part 75 data acquisition and reporting capabilities, and there would be some incremental control system costs for each unit in each facility.

★ UNITED STATES

Under the Acid Rain Program, affected units are required to measure and record emissions using CEMS (usually a concentration monitor in conjunction with a flow monitor to determine mass emissions) or an approved alternative measurement method and to report emissions electronically on a quarterly basis. All of the monitoring systems must pass rigorous quality assurance tests and operate with a high degree of accuracy and reliability.

In fact, the average percent monitor data availability (a measure of monitoring systems' reliability) for 2005 was 99 percent for coal-fired units. This number is based on reported monitor data availability for SO_2 monitors (99.5 percent), NO_x monitors (97.5 percent), and flow monitors (99.1 percent). Additionally, in recent years, new audit capabilities have been 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 emissions 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. Initially, electronic audits were conducted on the units that used continuous emission monitors. Beginning in 2006, EPA increased its electronic audit capabilities and now conducts audits on all affected units, regardless of the monitoring methodology used. For instance, all oil and gas units—including those that use alternative methods—are also audited. Results from the audits are promptly sent to the source, and correction of critical errors is required. In addition to the electronic audits, targeted field audits are conducted on sources that report suspect data. Compliance was virtually 100 percent in 2005, with only one of 3,446 units out of compliance.

Preventing Air Quality Deterioration and Protecting Visibility

CANADA

Pollution prevention, continuous improvement (CI), and Keeping Clean Areas Clean (KCAC) activities are all part of the Canada-wide Standards for particulate matter (PM) and ozone to prevent the deterioration of air quality and address the pollutants involved in visibility impairment. Visibility (how far an object can be seen) is often the first perception of smog, since PM reduces the clarity of what we see when present at high enough levels in the air.

Clean areas in Canada include our national parks. Environment Canada and Parks Canada have begun to informally explore options for air quality monitoring in these areas, including a program for visibility monitoring.

As part of the options being explored, Environment Canada has made an agreement with EPA and the U.S. Interagency Monitoring of Protected Visual Environments (IMPROVE), the program that supports visibility monitoring in U.S. national parks and wilderness areas. Under this agreement, IMPROVE has lent its visibility monitoring equipment to Environment Canada for evaluation with comparable equipment designed by Environment Canada. The IMPROVE equipment is currently deployed at the Environment Canada air quality research monitoring station located at Egbert, Ontario.

The Province of British Columbia continues to elaborate its approach to addressing CI and KCAC. For example, the Greater Vancouver Regional District (GVRD) adopted a new Air Quality Management Plan (AQMP) in October 2005 to maintain and improve air quality in the lower Fraser Valley airshed. The new AQMP aims to minimize the risk to human health from air pollution, improve visibility, and reduce the GVRD's contribution to global climate change. As the Canada-wide Standard for $PM_{2.5}$ (particulate matter less than or equal to 2.5 microns) is being met throughout the lower Fraser Valley and the Canada-wide Standard for ozone is exceeded only in the eastern part, the AQMP supports the CI/KCAC provisions of the Canada-wide Standards. New health-based ambient air quality objectives, established as part of the AQMP, are more stringent than the Canada-wide Standards for ozone and $PM_{2.5}$. In addition, CI, defined as "taking remedial and preventive actions to reduce emissions from human activities towards the long-term goal of reducing overall ambient concentrations and health risks," is a fundamental principle of the AQMP. The AQMP's emission reduction actions will reduce direct emissions of PM and ozone and PM precursors.

UNITED STATES

The U.S. Prevention of Significant Air Quality Deterioration Program protects public health from adverse effects that may occur from the addition of new sources of air pollution and 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 (pristine) areas by assessing impacts on visibility before construction permits are issued. Class I areas include 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 in 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. Improvements in visibility for the eastern United States are also expected from implementation of the CAIR.

The pollutants that impair visibility by scattering and absorbing light include sulfate, nitrate, and organic carbon compounds. Sulfate and nitrate particles are the result of SO_2 and NO_x gases that are transformed in the atmosphere. Sulfates are generally the largest

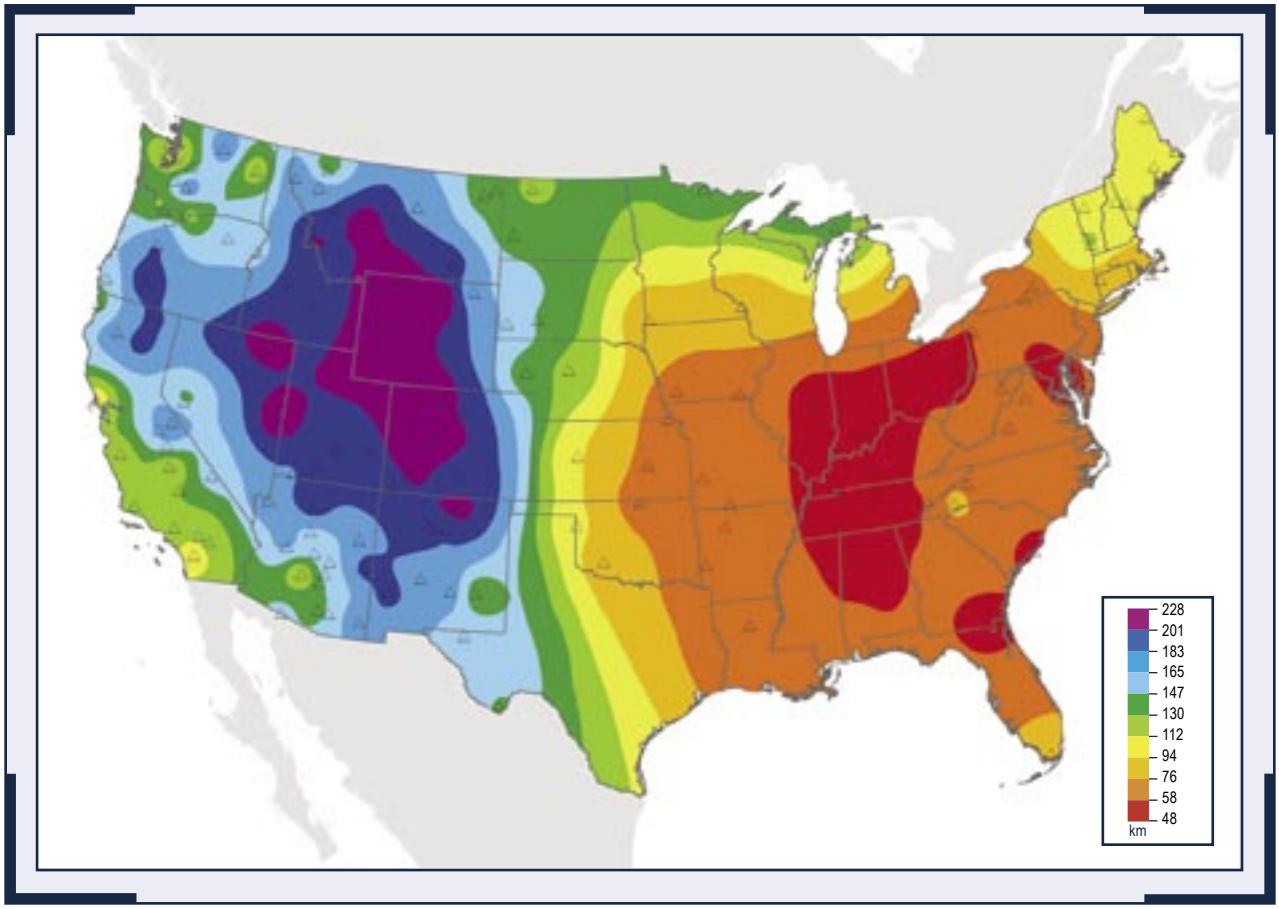
contributor to visibility impairment in both the east and the west, although humidity, organic carbon, and soil dust also play important roles.

"Standard visual range" is defined as the farthest distance a large dark object can be seen. This distance is calculated using fine and coarse particle data by multiplying concentrations of various types of particles by their extinction efficiency (how much they block light), adding those up, then adding the clean atmosphere extinction (scattering of light from gas molecules). The extinction calculation is done for each 24-hour period during which particle samples are taken. Currently, these samples are taken every third day, or 121 days per year. Therefore, the annual average standard visual range is the average of the calculated standard visual range for these 121 sample days. The visual range under naturally occurring conditions without pollution in the United States is approximately 45–90 miles (75–150 km) in the east and 120–180 miles (200–300 km) in the west.

Historical data from the IMPROVE network indicate modest improvement in visibility during the early 2000s. 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 2004, the mean visual range for the worst days in the east was only 20 miles (32 km), compared with 85 miles (136 km) for the best visibility days (see Figure 8). In the west, visibility impairment for the worst days remained relatively unchanged over the past decade, with the mean visual range for 2004 (58 miles,or 94 km) nearly the same as the 1992 range (61 miles, or 98 km). Although the period showed moderate improvements in some areas, overall visibility in the eastern United States is still significantly impaired in some national parks and wilderness areas, especially on days of high relative humidity.

Figure 8

Annual Average Standard Visual Range in the Contiguous United States, 2004



Source: National Park Service

Each state is a member of an independent Regional Planning Organization (RPO), which has been established to help member states work together to develop strategies to address visibility and regional haze. The five RPOs are the Mid-Atlantic/Northeast Visibility Union, the Visibility Improvement State and Tribal Association of the Southeast, the Midwest RPO, the Central States Regional Air Partnership, and the Western Regional Air Partnership. The RPOs hold their own technical work group sessions throughout the country to make decisions on joint technical work. The technical work to support the first round of state plans has resulted in a better understanding of transport near the border. 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.

Consultation and Notification Concerning Significant Transboundary Air Pollution

JOINT EFFORTS

Since 1994, Canada and the United States have continued to follow an established set of notification procedures 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 a potential for transboundary pollution. Since the last progress report in 2004, Canada has notified the United States of 7 additional sources, for a total of 44. The United States has notified Canada of 13 additional sources, for a total of 47.

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

Canada:
www.ec.gc.ca/cleanair-airpur/CAOL/canus/canus_applic_e.cfm

United States:
www.epa.gov./ttn/gei/uscadata.html

Following guidelines approved by the Air Quality Committee in 1998 for consultations requested by a Party on transboundary pollution concerns, Canada and the United States report ongoing progress on joint discussions concerning the Boundary Dam Power Station (BDPS) near Estevan, Saskatchewan, and Algoma Steel, Inc. (ASI) in Sault Ste. Marie, Ontario.

Boundary Dam

A binational BDPS Informal Consultation Group was formed to address transboundary pollution concerns around Estevan, Saskatchewan, and Burke County, North Dakota. Partners included representatives from Environment Canada, EPA, the North Dakota Department of Health, Saskatchewan Environment, and SaskPower (the operator of the BDPS). A transboundary ambient air monitoring network was established to track air quality changes in the region.

Since that time, SaskPower has completed the installation of electrostatic precipitators on all of its units, resulting in the virtual elimination of any visible PM plume. In 2004, an interim report summarized air quality trends from 1998 to 2003 and concluded that no exceedances of either U.S. or Canadian standards had been observed at any of the monitoring sites. Performance audits conducted in 2005 noted that all sites complied with the necessary operational and quality assurance criteria.

Accordingly, the BDPS Informal Consultation Group has proposed a transition plan to conclude this successful consultation. A report will be presented to the Canada–U.S. Air Quality Committee at its annual meeting in the fall of 2006, detailing the disposition of the monitoring equipment as well as summarizing the air quality data gathered in the region by the transboundary monitoring network.

Algoma Steel

The Canada–U.S. Algoma informal consultations began in 1998 to address concerns regarding local cross-border pollution. Representatives from the United States and Canada hold regular discussions to coordinate monitoring programs in the Sault Ste. Marie area and to address progress in abating potential transboundary pollution from the ASI facility in Ontario. Air quality monitoring on the Canadian side has been ongoing since the 1960s and on the U.S. side was initiated by the Inter-Tribal Council of Michigan in 2001. Sampling of fine PM and toxic air pollutants continues on both sides of the border.

During the last two years, Canadian and U.S. representatives have continued to meet to discuss progress towards reducing emissions from ASI and to share results of air monitoring studies. The data analysis subgroup has completed a draft report summarizing results of the ambient air monitoring program in the binational area during 2001–2003. Canadian and U.S. partners have agreed that this draft report should be identified as an "interim" document, and future reports will update the monitoring results, including the 2004–2005 data. The quality assurance/quality control subgroup continues to evaluate the monitoring equipment and the methods employed by both countries to ensure comparability of monitoring results.

Trend data from the consultation indicate that although emission rates have declined, total steel production at ASI has increased. The combined impact of these changes on air quality is not yet known, and citizen complaints are still being received by local agencies. The monitoring data also indicate that there are no exceedances of the NAAQS at the Michigan monitoring sites. However, several pollutants, such as total suspended particulates and coarse particulate matter (particulate matter less than or equal to 10 microns, or PM_{10}), exceed Ontario air quality criteria in the west end of Sault Ste. Marie. The Algoma bilateral consultation group will continue to monitor and report on this facility.

Ozone Annex

Overview

The Ozone Annex was added to the AQA in 2000 to address transboundary ground-level ozone. The Annex commits Canada and the United States to reducing emissions of NO_x and volatile organic compounds (VOCs), the precursors to ground-level ozone, a major component of smog. It defines a region in both countries, known as the Pollutant Emission Management Area (PEMA), which includes central and southern Ontario, southern Quebec, 18 U.S. states, and the District of Columbia. The states and provinces within this region are the areas where emission reductions are most important for reducing transboundary ozone. It is in this region in both countries where the emission reduction commitments apply.

Key Commitments and Progress

CANADA

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.

Emissions from vehicles, off-road equipment, and fuels account for over 60 percent of the NO_x emissions and over 30 percent of the VOC emissions in the Canadian portion of the PEMA. To address these emissions, the Ozone Annex commits Canada to controlling and reducing NO_x and VOC emissions from vehicles and fuels through regulation of sulfur content in gasoline and on-road diesel fuel and new emission standards for light-duty vehicles and trucks, heavy-duty vehicles, engines, and motorcycles, recreational marine engines, small engines such as lawn mowers, and others.

Canada has implemented a series of regulations to align Canadian emission standards for vehicles and engines with corresponding standards under the EPA rules. Canada has met all of its regulatory commitments except for the planned regulations to address emissions from marine spark-ignition engines, which are currently under development. By 2020, it is estimated that NO_x and VOC emissions from on-road and off-road vehicles and engines will be reduced by 55 and 38 percent, respectively, relative to emissions in 2005.

The On-Road Vehicle and Engine Emission Regulations were published in the *Canada Gazette*, Part II, on January 1, 2003. The regulations came into effect on January 1, 2004, and introduce more stringent national emission standards for 2004 and later model year new light-duty vehicles and trucks, heavy-duty vehicles, and motorcycles in alignment with U.S. federal standards. Going beyond the commitments in the Ozone Annex, on November 5, 2005, the proposed Regulations Amending the On-Road Vehicle and Engine Emission Regulations were published in the *Canada Gazette*, Part I. The regulations propose new requirements for 2006 and later model year on-road motorcycles to maintain

alignment with more stringent standards adopted by EPA, and final regulations are being prepared.

The Off-Road Small Spark-Ignition Engine Emission Regulations were published in the *Canada Gazette*, Part II, on November 19, 2003. The regulations came into effect on January 1, 2005, and establish emission standards for 2005 and later model year engines found in lawn and garden machines, light-duty industrial machines, and light-duty logging machines, in alignment with U.S. federal standards.

The Off-Road Compression-Ignition Engine Emission Regulations were published in the *Canada Gazette*, Part II, on February 23, 2005. The regulations came into effect on January 1, 2006, and introduce emission standards aligned with U.S. federal standards (Tier 2 and 3) for 2006 and later model year new diesel engines, such as those typically found in agricultural, construction, and forestry machines. Environment Canada plans to amend these regulations to incorporate the more stringent U.S. Tier 4 standards for the 2008 and later model years.

The proposed Marine Spark-Ignition Engine and Off-Road Recreational Vehicle Emission Regulations are being developed to introduce new emission standards for 2008 and later model years for new outboard engines, personal watercraft, all-terrain vehicles, snowmobiles, and off-road motorcycles in alignment with standards adopted by EPA.

Regulatory initiatives for fuels include the Sulphur in Gasoline Regulations, which limited the level of sulfur in gasoline to 30 mg/kg (equivalent to 30 parts per million (ppm)) as of January 1, 2005—a 90 percent reduction from preregulated levels; and the Sulphur in Diesel Fuel Regulations, which reduced the level of sulfur in diesel fuel used in on-road vehicles to 15 mg/kg (15 ppm) as of June 1, 2006. Beyond the requirements in the Ozone Annex, Environment Canada has amended the Sulphur in Diesel Fuel Regulations to reduce the level of sulfur in diesel fuel used in off-road, rail, and marine engines to 500 mg/kg (500 ppm) commencing in 2007 and down to 15 mg/kg (15 ppm) commencing in 2010 for off-road and in 2012 for rail and marine.

Stationary Sources of NO_x

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

In the Canadian portion of the PEMA, the largest source of NO_x emissions from industry is the fossil fuel–fired power sector. Therefore, Canada's commitment in the Ozone Annex focuses on achieving an emission requirement for this sector in the Canadian portion of the PEMA comparable to that in the U.S. portion of the PEMA.

Canada has made substantial progress to meet 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, by 2007. Emissions from power plants in the Ontario portion of the PEMA were approximately 78 kt in 1990 and had decreased by almost half by 2004. Further action in the province to achieve the cap includes agreements to purchase power from 19 new renewable energy projects, including three water power projects, three landfill gas and biogas projects, and 13 wind farms. To date, Ontario has contracted for a total of 1,370 MW of clean renewable energy—enough to power an estimated 350,000 homes. In April 2005, Lakeview Generating Station closed (O. Reg. 396/01), eliminating annual emissions of approximately 4,000 tonnes of NO_x and 15,000 tonnes of SO_2 upwind of the Greater Toronto Area. Ontario has committed to reducing its own government's electricity use by at least 10 percent by 2007.

Emissions data for 2003 show that NO_x (as NO_2) emissions from power plants in the Quebec portion of the PEMA exceeded the 5 kt cap by approximately 10 percent, due mainly to the increase in the hours of operation of the Tracy power plant. In 2004, the cap was met. To ensure that the 5 kt cap continues to be met, Quebec is now considering introducing a specific cap of 2,100 tonnes per year for the Tracy plant through regulations.

Proposed National Guideline on Renewable Low-Impact Electricity

Control and reduce NO_x emissions in accordance with a proposed national Guideline on Renewable Low-Impact Electricity.

A notice of a draft Guideline on Renewable Low-Impact Electricity (Green Power Guideline) was published in the *Canada Gazette*, Part I, in 2001. This guideline is providing national guidance on environmentally preferable electricity products and generation in Canada and establishing criteria for environmental labeling of qualifying electricity products under the Government of Canada Environmental Choice Program. Certification criteria contained in the guideline are already being used for certification of qualifying electricity products.

Canada intends to monitor 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. A list of all certification criteria documents for the Environmental Choice Program, including the criteria for renewable low-impact electricity, was published in the *Canada Gazette*, Part I, on August 14, 2004.

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) Regulations became law on February 27, 2003, and the last provision of these regulations went into effect on August 1, 2005. The regulations phased out the use of older-technology dry cleaning machines, which used and released larger quantities of tetrachloroethylene (commonly called perchloroethylene or PERC) than the newer-technology machines. The goal of the regulations was to achieve a 71 percent reduction of PERC releases at dry cleaning facilities from 1994 levels by August 2005. Environment Canada will complete an analysis in fall 2006 to determine whether this goal has been achieved. PERC has not been produced in Canada since 1993, and PERC imports to Canada were reduced by over 40 percent between 1994 and 2004. The number of dry cleaners using PERC in Canada also fell by 39 percent between 1994 and 2004.

The Solvent Degreasing Regulations, which came into force in July 2003, froze the consumption of trichloroethylene and PERC in cold and vapor solvent degreasing for three years from 2004 to 2006, which is to be followed by a 65 percent reduction in consumption in 2007 and subsequent years.

The Canadian Council of Ministers of the Environment (CCME) has endorsed 16 codes, guidelines and standards, or memoranda of understanding 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.

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

If required to achieve the Canada-wide Standard for ozone in the PEMA by 2010, measures will be in place to reduce NO_x emissions by 2005 and implemented between 2005 and 2010 for key industrial sectors and measures to address VOC emissions from solvents, paints and consumer products.

Multi-Pollutant Emission Reduction Analysis and Foundation documents were published for seven industrial sectors (pulp and paper, lumber and allied wood products, iron and steel, base metals smelting, hot mix asphalt paving, concrete batching, and electric power generation) that are key to achieving the Canada-wide Standards for PM and ozone. Provinces and territories can use the reports in preparing their jurisdictional implementation plans. The reports are available at www.ccme.ca. Jurisdictional implementation plans will outline more comprehensive actions being taken within each province and territory to achieve the Canada-wide Standards for PM and ozone by the 2010 target date.

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

- **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 Canadian Environmental Protection Act Environmental Codes of Practice for integrated and nonintegrated iron and steel mills are being updated in consultation with industry, nongovernment stakeholders, and the provinces to incorporate these environmental performance standards.
- **Base Metals Smelting:** A Final Notice requiring the preparation of pollution prevention plans by Canadian base metal smelters was published in the *Canada Gazette*, Part I, in April 2006. The Final Notice requires the development and implementation of a Smelter Emissions Reduction Program with facility annual release limit targets for 2008 and 2015 and notes the intention of the federal Environment Minister to develop base metal smelter regulations to be in effect by 2015.
- **Cement:** It is proposed to publish a national Environmental Code of Practice for Cement Manufacturing Facilities. This environmental code of practice is expected to include environmental performance standards to address releases of PM, NO_x, SO_2, and VOCs from the significant process sources of the portland cement manufacturing sector. This proposed environmental code of practice would build on existing CCME guidelines for cement kilns.
- **Pulp and Paper:** A multistakeholder group (Air Quality Forum) undertook a benchmarking exercise comparing the performance of Canadian mills with that of world leaders in terms of emissions performance and best technology. The Forum proposes to develop a 10-year agenda for the reduction of pulp and paper mill emissions.

Canada published a "Federal Agenda for the Reduction of VOC Emissions from Consumer and Commercial Products" in the *Canada Gazette*, Part I, in March 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.

The Federal Agenda identifies the development and implementation of three regulations to reduce VOC content in products. These regulations focus on consumer products, architectural industrial maintenance coatings, and auto refinish coatings. The first of these regulations, the architectural industrial maintenance coatings regulation, is expected to be published in the *Canada Gazette*, Part I, in fall 2006 and to be in place in 2007. The development of the other two regulations will follow.

Actions by the Province of Quebec

Quebec has made progress in meeting its Ozone Annex commitments by way of several regulatory actions. The proposed amendments to Quebec's Regulation

Respecting the Quality of the Atmosphere 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 Regulation Respecting the Quality of the Atmosphere are aimed at reducing emissions from 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 and Equipment, 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.

Quebec is also considering amending the above regulation in order to address vapor recovery initiatives, including gasoline storage, transfer depots, and service stations supplying 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.

Actions by the Province of Ontario

Ontario is on track to meet its Ozone Annex commitments by 2007, with the following programs, regulations, and guidelines:

- Ontario's Drive Clean program, a mandatory inspection and maintenance program for motor vehicles, reduces harmful vehicle emissions by identifying vehicles that do not meet provincial emission standards and requiring them to be repaired. Drive Clean applies to light-duty and heavy-duty nondiesel vehicles registered in the light-duty program area that extends across southern Ontario from Windsor to Ottawa. The program also applies to heavy-duty diesel vehicles registered anywhere in the province. Drive Clean rules and requirements are found in Regulation 361/98 under the Environmental Protection Act and Regulation 628/90 under the Highway Traffic Act.

  An independent analysis of Drive Clean data indicates that the program reduced smog-causing emissions (NO_x and VOCs) from light-duty vehicles in the program area by more than 81,200 tonnes from 1999 to 2003. In addition, it is estimated that Drive Clean has resulted in reductions of over 690,000 tonnes of carbon monoxide (CO) and more than 100,000 tonnes of carbon dioxide (CO_2). PM emissions from heavy-duty diesel vehicles were reduced by nearly 1,100 tonnes from 2000 to 2002.

  The Vehicle Emissions Enforcement Unit (Smog Patrol) complements the Drive Clean program by conducting roadside inspections of grossly polluting heavy-duty and light-duty vehicles. Since 1998, the Vehicle Emissions Enforcement Unit has conducted more than 41,000 vehicle inspections and issued more than 6,500 tickets.

- Stage 1 of the gasoline vapor recovery program (vapor recovery in bulk transfers; O. Reg. 455/94) has been implemented, and the program continues today.

- The Gasoline Volatility Regulation (O. Reg. 271/91), which has been ongoing since 1991, sets the limits of gasoline vapor pressure during the summer.

- Mandatory training is required every five years for at least one full-time employee of all dry cleaning establishments in Ontario (O. Reg. 323/94). In November 2001, a new environmental code of practice was established.

- NO_x and sulfur oxides (SO_x) emissions from new and modified stationary combustion turbines are limited under Ministry of Environment (MOE) Guideline A-5 through Certificates of Approval; monitoring and record keeping are required.

- In 2001, MOE Guideline A-9 imposed a NO_x emission limit on new or modified large boilers and heaters in industrial installations. This guideline adopts the National Emission Guideline for Commercial/Industrial Boilers and Heaters approved by the CCME in 1998. Implementation of this guideline is through the Certificates of Approval process.

- In February 2006, Ontario amended the Airborne Contaminant and Discharge Monitoring and Reporting Regulation (O. Reg. 127/01) to effect the harmonization of Ontario's and Environment Canada's air emissions reporting systems, which will reduce duplication of the reporting requirements of Ontario's industry while maintaining Ontario's commitment to protect the environment and public health.

Beyond the Ozone Annex, Ontario is also taking actions to reduce emissions from vehicles and fuels throughout the province. For example, southern Ontario's major public transit system, GO Transit, has moved to the use of low-sulfur diesel fuels year-round in its bus fleet. During the traditional smog season from May to September, its rail fleet also uses low-sulfur diesel fuels. In addition, Ontario is encouraging the use of vehicles powered by alternative fuels through the institution of a sales tax rebate program for such vehicles.

UNITED STATES

NO_x and VOC Program Updates

- **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 SIP Call (NO_x Budget Trading Program): The NO_x SIP Call Rule, issued by EPA in 1998, requires affected states to reduce ozone season NO_x emissions that cross state boundaries, forming ground-level ozone and contributing to ozone nonattainment in downwind states. The NO_x SIP Call does not mandate which sources must reduce emissions. Rather, it requires states to meet emission budgets and gives them flexibility to develop control strategies to meet those budgets.

Under the NO_x SIP Call, EPA developed the NO_x Budget Trading Program (NBP) to allow states to meet most or all of their emission budgets in a highly cost-effective manner through participation in a regionwide cap and trade program for electric generating units and large industrial boilers and turbines. All 19 affected states and the District of Columbia with 2003 or 2004 implementation deadlines chose to participate in the NBP. Fourteen of these states and the District of Columbia are located in the PEMA.

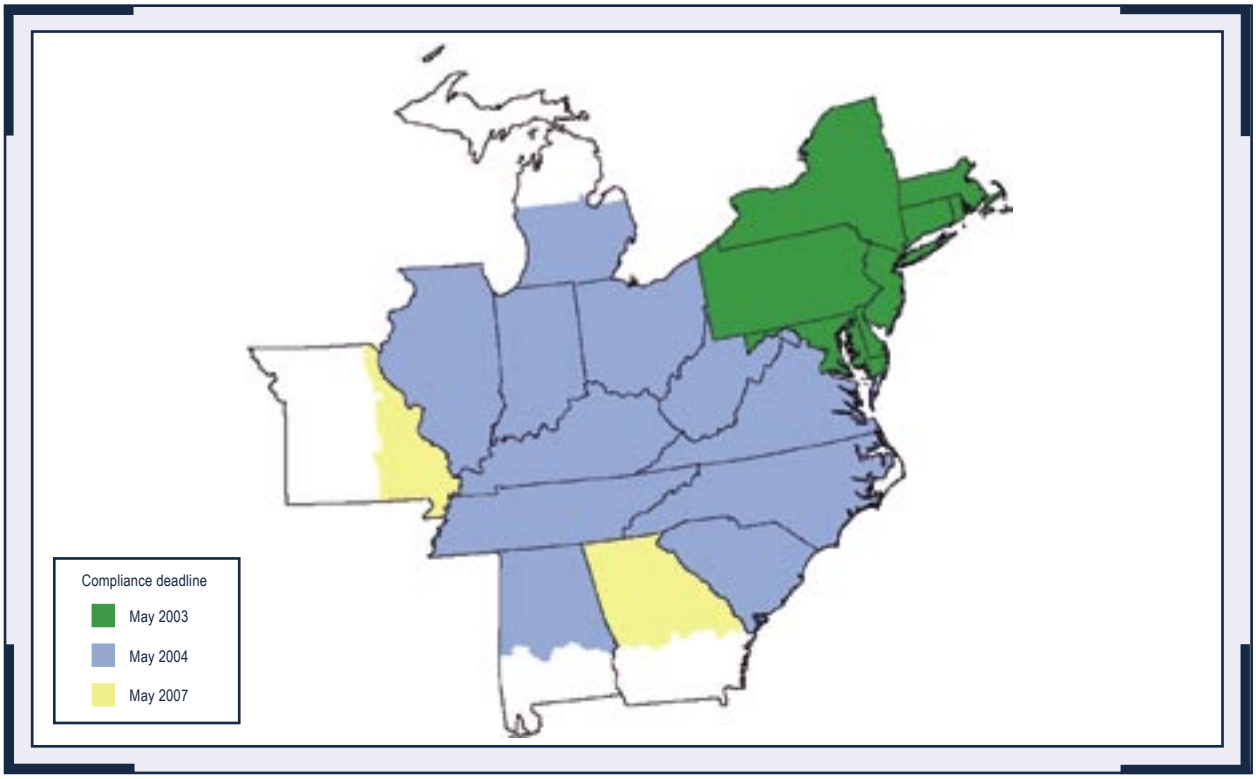
Figure 9 shows the states affected by the NO_x SIP Call along with implementation deadlines. Further information on the NO_x SIP Call, including compliance data, can be found at www.epa.gov/airmarkets/fednox/index.html. Compliance and emissions data for all NO_x budget sources can be found at http://cfpub.epa.gov/gdm.

Emission Reductions: In 2005, NBP sources continued to reduce ozone season NO_x emissions, emitting about 530,000 tons of NO_x—a 63,000 ton reduction from 2004. NO_x reductions from 2004 to 2005 occurred despite a significant increase in heat input across the region. NBP sources decreased NO_x emissions nearly 11 percent from 2004, while increasing total heat input (fuel use) by 7 percent. Overall, these sources have achieved reductions of 72 percent from 1990 ozone season NO_x levels. However, the significant decrease in ozone season NO_x emissions of 57 percent from 2000 to 2005 reflects additional reductions associated with NBP implementation (see Figure 10).

Compliance: Sources achieved over 99 percent compliance with the NBP in 2005. This success was achieved through a combination of new control equipment, banked allowances, and allowance trading. Only three NBP sources out of 2,570 electric generating and industrial units did not hold sufficient allowances to cover their ozone season NO_x emissions.

Figure 9

NO_x SIP Call Program Implementation

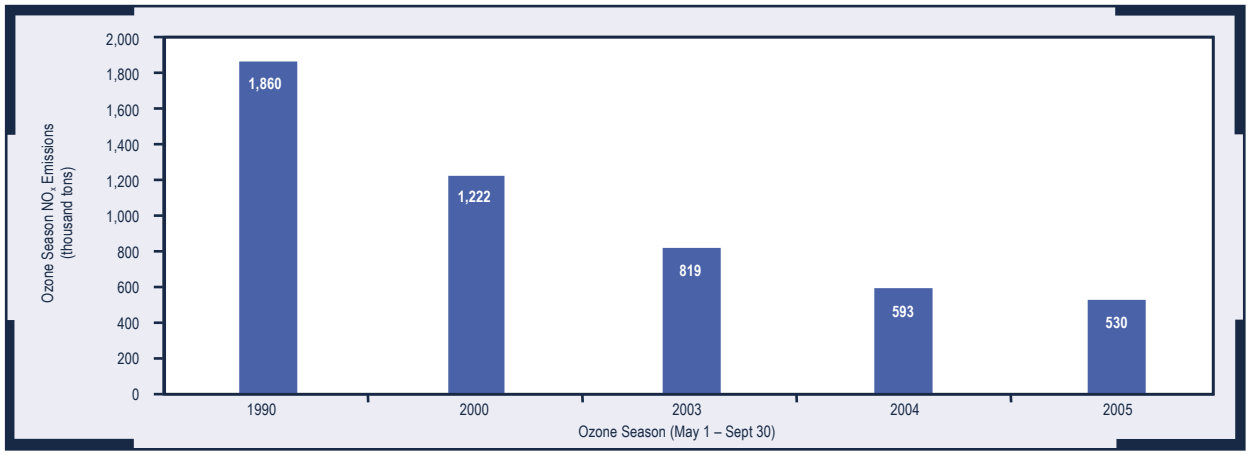


Note: The affected portions of Missouri and Georgia are required to comply with the NO_x SIP Call as of May 1, 2007. However, EPA has "stayed" the NO_x SIP Call requirements for Georgia while it responds to a petition to reconsider Georgia's inclusion in the NO_x SIP Call.

Source: EPA

Figure 10

Ozone Season Emissions under the NO_x Budget Trading Program



Source: EPA

New Source Performance Standards: All of the 36 categories of new source performance standards (NSPS) identified in the Ozone Annex for major new NO_x and VOC sources are in effect. In addition, EPA is currently in the process of finalizing NSPS for Stationary Compression-Ignition Internal Combustion Engines that will help achieve significant reductions of NO_x and VOC emissions from these sources beginning in 2007. Furthermore, in June 2006, EPA proposed

two nationally applicable emission standards: 1) an NSPS for NO_x, CO, and VOC emissions from new stationary spark ignited internal combustion engines; and 2) a National Emission Standards for Hazardous Air Pollutants rule that also addresses VOC emissions from existing and new reciprocating internal combustion engines. For more information on the Spark Ignited Internal Combustion Engine rule, see www.epa.gov/ttn/atw/nsps/sinsps/sinspspg.html, and for information on the Reciprocating Internal Combustion Engine rule, see www.epa.gov/ttn/atw/rice/ricepg.html. In February 2006, EPA finalized updates to the NSPS for utility and industrial boilers and combustion turbines. The updated standards for NO_x, SO_2, and direct filterable PM are based on the performance of recently constructed boilers and turbines. EPA is currently reviewing the NSPS for petroleum refineries and for equipment leaks at chemical plants and petroleum refineries. The equipment leak standards will be completed in October 2007. The petroleum refineries standard will be completed in April 2008.

VOC Controls on Smaller Sources: In 1998, EPA promulgated national rules for automobile repair coatings, consumer products, and architectural coatings. The compliance dates were January 1999, December 1998, and September 1999, respectively. From a 1990 baseline, the consumer products and architectural coatings rules are each 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. In addition, EPA has scheduled for regulation 15 remaining categories of consumer and commercial products under section 183(e) of the Clean Air Act. These categories are to be regulated in three groups, with deadlines of September 30 of 2006, 2007, and 2008. The current list of remaining categories, which may change slightly, includes flexible packaging printing materials; lithographic printing materials; letterpress printing materials; industrial cleaning solvents; flatwood paneling coatings; aerosol spray paints; paper, film, and foil coatings; plastic parts coatings; metal furniture coatings; large appliance coatings; fiberglass boat manufacturing materials; petroleum dry cleaning solvents; auto and light-duty truck assembly coatings; miscellaneous metal products coatings; and miscellaneous industrial adhesives.

Controls on Hazardous Air Pollutants: EPA has promulgated regulations to control hazardous air pollutant emissions for all of the 40 categories of industrial sources listed in the Ozone Annex that will reduce VOC emissions. Most of the sources are now required to be in compliance. Most recently, EPA has proposed new standards to control hazardous air pollutants from fuel, passenger vehicles, and gasoline cans to further reduce emissions of benzene and other mobile source air toxics. By 2030, the proposed Mobile Source Air Toxic Regulations and fuel and vehicle standards already in place will reduce toxic emissions from passenger vehicles to 80 percent below 1999 emissions. The proposed Mobile Source Air Toxic Regulations would take effect in 2009 for fuel containers, 2010 for passenger vehicles, and 2011 for fuel requirements.

Motor Vehicle Control Program: To address motor vehicle emissions, the United States committed to implementing regulations for reformulated gasoline; reducing air toxics from fuels and vehicles; and implementing controls and prohibitions on diesel fuel quality, light-duty vehicles, light-duty trucks, highway heavy-duty gasoline engines, and highway heavy-duty diesel engines. EPA has fully phased in requirements for reformulated gasoline in nonattainment areas; requirements for diesel fuel quality (including sulfur); 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 five nonroad engine categories identified in the Annex: aircraft, compression-ignition engines, spark-ignition engines, locomotives, and marine engines. Nonroad diesel fuel will have 99 percent less sulfur by 2010. In addition, EPA has promulgated more stringent (Phase 2) standards for 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.

Anticipated Additional Control Measures and Indicative Reductions

This section describes additional control measures that each country currently implements or anticipates implementing beyond the specific obligations of 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

Air quality monitoring across Canada between 2001 and 2003 showed that approximately half of Canadians were living in communities with three-year averages above the Canada-wide Standard air quality target for ozone of 65 parts per billion (ppb). British Columbia, Saskatchewan, Manitoba, Prince Edward Island, and Newfoundland and Labrador had no three-year averages above the target; the remaining provinces, however — Alberta, Ontario, Quebec, New Brunswick, and Nova Scotia — each had at least one monitoring station with three-year averages above the target.

Air pollution represents a serious threat to human health, the environment, and the competitiveness of Canada's economy. Canadians consistently identify air pollution as the most important environmental issue and a key health concern. To address the need for further reductions of the emissions of ozone and its precursor pollutants, Canada intends to develop a new Clean Air Act.

Area-Specific Reductions

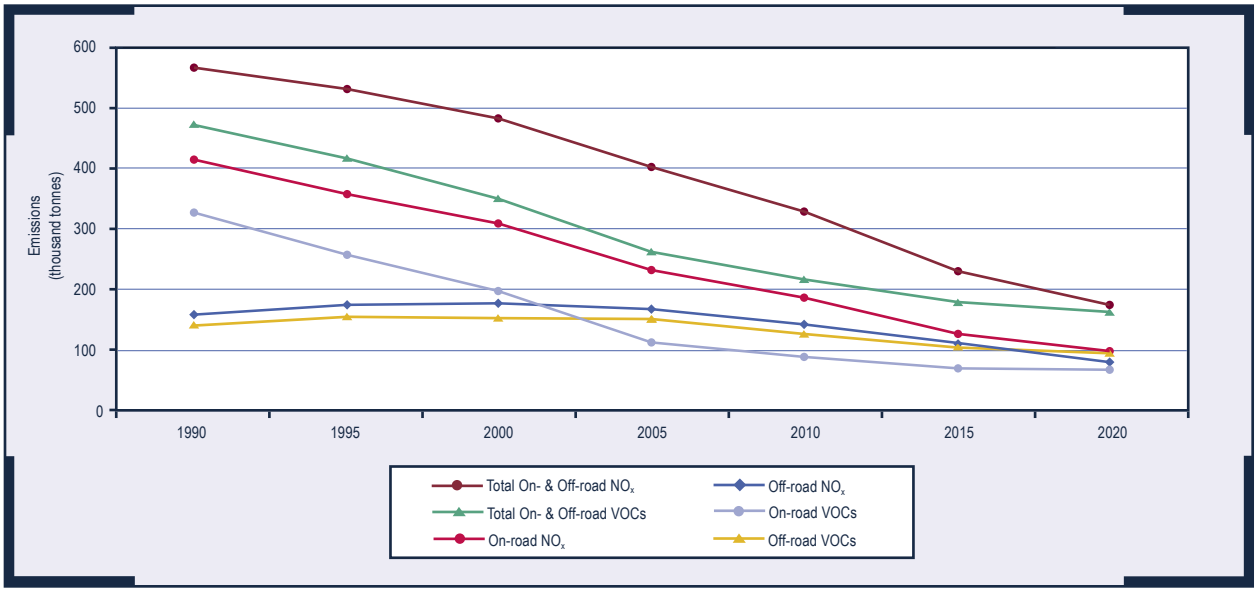
To further reduce emissions of NO_x and VOCs in the PEMA, Ontario and Quebec are each taking action on pollutant sources that are of concern in the provinces. In particular, Ontario has completed its Industry Emission Regulation (O.Reg. 194/05), which focuses on the emissions from key industrial sectors, including iron and steel, cement, petroleum refining, pulp and paper, and nonferrous smelting. In Quebec, the provincial Draft Air Quality Regulation was announced in November 2005 for comment. This draft regulation is an overhaul of the Regulation Respecting the Quality of the Atmosphere, which entered into force in 1979. The draft regulation aims to reduce and control contaminants with a view to further protecting the quality of the atmosphere and, consequently, human health and ecosystems. This legislation makes it possible to achieve Quebec's objectives in the fight against smog, acid precipitation, and toxic atmospheric pollution. It also seeks to reduce and control contaminants that may be the origin of local and regional problems associated with bad air quality.

Quantitative Estimates

In the Ozone Annex, Parties provided NO_x and VOC emission reduction estimates for 2010 associated with applying the control measures identified under Part III of the Annex. In every biennial progress report, the Parties further agreed to update these reduction forecasts to demonstrate that the commitments are being implemented and to ensure that the quantitative estimates reflect any emission estimation methodology improvements. The projected reduction of NO_x emissions that will be seen in the transboundary region in Ontario and Quebec (the PEMA) in 2010 with the implementation of the commitments for fossil fuel electric power generators and vehicles and fuels regulations is 43 percent by 2010 from 1990 levels. For VOC emissions in the region, the implementation of the regulations for dry cleaning, degreasing, and fuels will achieve a reduction of 54 percent by 2010 from 1990 levels. The largest source of NO_x and VOCs in the region comes from transportation, and the completion of the new vehicle standards and fuel regulations, as demonstrated by Figure 11, will have a very significant impact on the overall NO_x and VOC emissions in the ozone transboundary region.

Figure 11

Canadian NO_x and VOC PEMA Emissions and Projections from Transportation Sources, 1990–2020

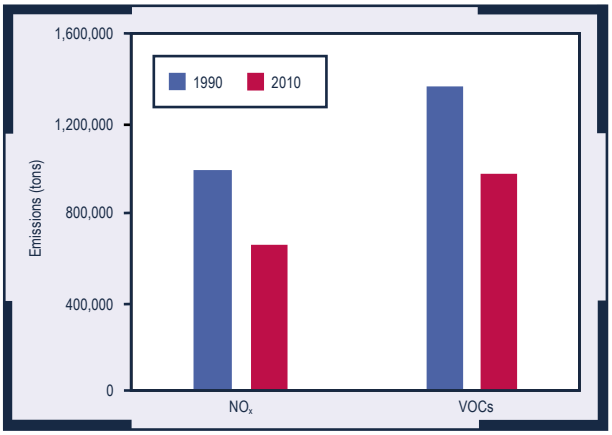


Source: Environment Canada

Overall, however, there continue to be sources of pollution in the PEMA that are increasing, as demonstrated by the fact that NO_x and VOC emissions in the PEMA are expected to decrease from 1990 levels by 34 percent and 29 percent, respectively, by 2010 (see Figure 12). In addition to increases that are being forecast for such sources as residential fuel wood combustion, air transportation, and certain industrial sources such as cement and concrete, these updated forecasts reflect recalculations of the emissions inventories and forecasts presented in the 2004 Progress Report. The recalculations incorporated better information on vehicle kilometres traveled and vehicle populations and better estimations for certain industrial emissions.

Figure 12

Canadian NO_x and VOC PEMA Emissions and Projections



Note: 2010 reflects all emission categories including those committed in the specific obligations in Part III of Annex 3 Specific Objectives Concerning Ground-Level Ozone Precursors.

Source: Environment Canada

National Reductions

In December 1999, EPA finalized new Tier 2 tailpipe emissions and low-sulfur fuel standards for light-duty vehicles. The emission standards will be fully phased in for the passenger cars and other small light-duty vehicles in 2007 and for the heaviest light-duty vehicles in 2009. The Tier 2 low-sulfur standards phase-in began in early 2004 and was fully phased in on January 1, 2006. These standards now apply equally to all passenger cars and light-duty trucks, including sport utility vehicles, minivans, pick-up trucks, and vans. When these standards are fully implemented, they will require passenger vehicles to be 77–95 percent cleaner than Tier 1 passenger vehicles (in effect from 1994 to 2004) 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. As a result of the Highway Diesel Rule, sulfur levels in diesel fuel will be reduced by more than 97 percent, from 500 to 15 ppm. Refiners started producing the cleaner-burning diesel fuel, ultra-low-sulfur diesel, for use in highway vehicles beginning June 1, 2006. The highway heavy-duty engine emission standards will begin with the 2007 model year and will be fully phased in by 2010. The program will reduce emissions of NO_x and nonmethane hydrocarbons by 2.6 million and 115,000 tons per year by 2030, respectively (95 percent below Tier 1 levels). Further information on this program can be found at www.epa.gov/otaq/highway-diesel/index.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 2008, through use of advanced exhaust aftertreatment technologies and ultra-low sulfur levels (15 ppm) in nonroad diesel fuel. Further information on these standards can be found at www.epa.gov/nonroad-diesel/index.htm.

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 began with the 2006 model year, and full emission reductions will be achieved by the 2010 model year. Further information on these rules can be found at www.epa.gov/otaq/recveh.htm.

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 (RACT); marine vessel loading; treatment storage and disposal facilities; municipal solid waste landfills; onboard refueling; residential wood combustion; vehicle inspection and maintenance; reformulated gasoline; cement kilns; internal combustion engines; large nonutility boilers and gas turbines; fossil fuel–fired utility boilers; and additional measures needed to attain the NAAQS.

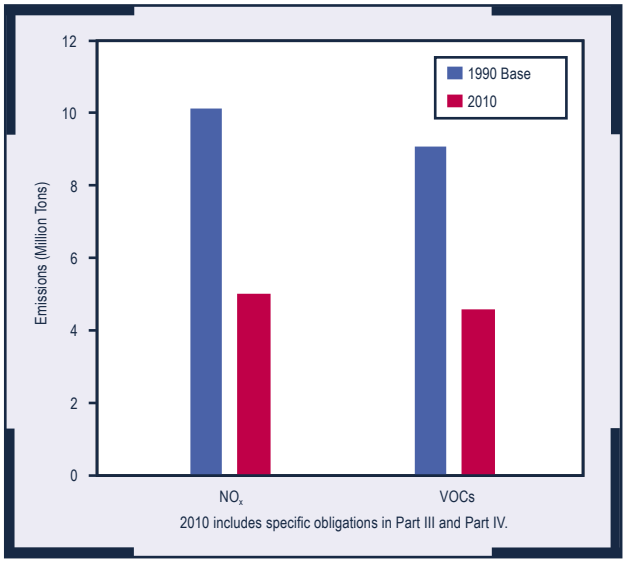
Quantitative NO_x and VOC Emission Reductions

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 13, 2010) are now estimated to reduce annual NO_x emissions in the PEMA by 51 percent from 1990 levels and to reduce annual VOC emissions in the PEMA by 49 percent from 1990 levels by 2010.

Figure 13

U.S. NO_x and VOC PEMA Emissions and Projections



Source: EPA

Reporting PEMA Emissions

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. Facilities are required to report their annual emissions to Environment Canada by June 1 of the following year. The reported information by facility is now publicly available on the Environment Canada website (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. Facilities that meet the reporting requirements for these additional VOC species have reported their 2003 and 2004 emissions to Environment Canada.

The compilation of the comprehensive 2002 Criteria Air Contaminants (CAC) emissions inventory has been completed. This latest emissions inventory for Canada coincides with the 2002 emissions inventory that was issued in February 2006 in the United States (www.epa.gov/ttn/chief/net/2002inventory.html). The 2002 emissions inventories will become the new baselines for air quality modeling and the development of emission reduction strategies in the two countries for the coming years.

Comprehensive CAC emission inventories for the years 2003 and 2004 are also being compiled in Canada and should be available in 2006.

In the United States, the NEI has been developed by EPA as a comprehensive national emissions inventory covering emissions in 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. The 2002 NEI is the most recent year for which actual emissions data are available. The emissions data included in this 2006 Progress Report are projections to 2003 and 2004 of the 2002 NEI emissions data (except for sources reporting emissions under the U.S. Acid Rain and NO_x Budget Trading Programs, which provide actual measured data through 2005). 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 and will be issued in 2008.

Table 1 shows preliminary Canadian and U.S. emissions in the PEMA for 2004 for NO_x and VOCs. Figures 14 and 15 show U.S. emission trends in

Table 1

PEMA Emissions, 2004

Emission Category	2004 Annual				2004 Ozone Season			
	NO_x		VOCs		NO_x		VOCs	
	(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 Sources	142	129	111	101	62	57	47	43
Non-Industrial Fuel Combustion	51	46	95	87	11	10	1	1
Electric Power Generation	53	48	1	1	20	18	0	0
On-Road Transportation	164	149	79	71	73	67	34	31
Nonroad Transportation	261	237	185	168	125	114	89	81
Solvent Utilization	0	0	275	250	0	0	115	104
Other Anthropogenic Sources	2	2	98	89	1	1	42	38
Forest Fires	0	0	0	0	0	0	0	0
Biogenics	–	–	–	–	–	–	–	–
TOTALS	**673**	**611**	**843**	**767**	**293**	**266**	**328**	**298**
TOTALS without Forest Fires and Biogenics	**673**	**611**	**843**	**767**	**293**	**266**	**328**	**298**
U.S. PEMA States: Annual and Ozone Season Emissions								
Industrial Emissions	609	552	244	221	254	230	102	92
Non-Industrial Fuel Combustion	343	311	866	785	143	130	361	327
Electric Power Generation	1,525	1,383	13	12	635	576	6	5
On-Road Transportation	2,622	2,379	1,466	1,330	1,093	991	611	554
Nonroad Transportation	1,502	1,362	1,114	1,010	626	568	464	421
Solvent Utilization	0	0	1,551	1,407	0	0	646	586
Other Anthropogenic Sources	60	54	463	420	25	23	193	175
Forest Fires*	3	3	7	6	2	2	5	5
Biogenics*	156	142	5,290	4,799	97	88	4,585	4,160
TOTALS	**6,820**	**6,187**	**11,013**	**9,991**	**2,874**	**2,608**	**6,972**	**6,325**
TOTALS without Forest Fires and Biogenics	**6,661**	**6,043**	**5,716**	**5,186**	**2,775**	**2,518**	**2,382**	**2,161**

*U.S. estimates for Forest Fires and Biogenics emissions based on 2002 data.

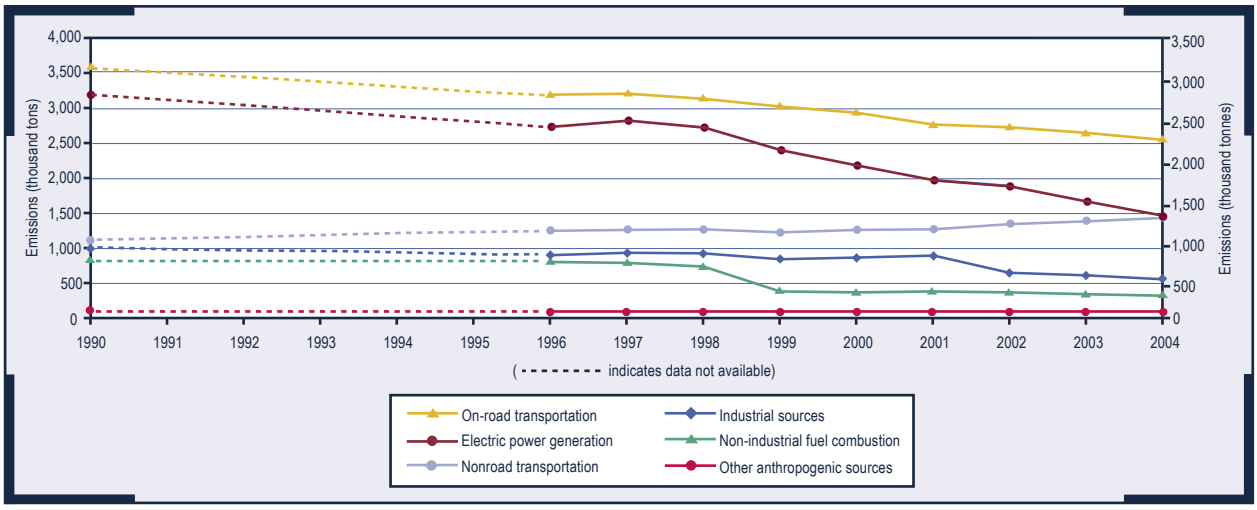
Source: EPA and Environment Canada

these areas for 1990–2004. The trend in the PEMA states is similar to the U.S. national 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 by 2000, but saw a significant spike upwards in 2001. The rise in non-industrial VOC emissions from 2001 to 2002 is due to residential wood combustion.

Figures 16 and 17 show Canadian NO_x and VOC PEMA emission trends for 1990–2004. For NO_x, most of the reductions come from on-road mobile and industrial sources, with increases in the non-industrial combustion and nonroad sectors. VOC emissions reductions and increases were observed similarly, though increases are only in the nonroad sector. 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 14

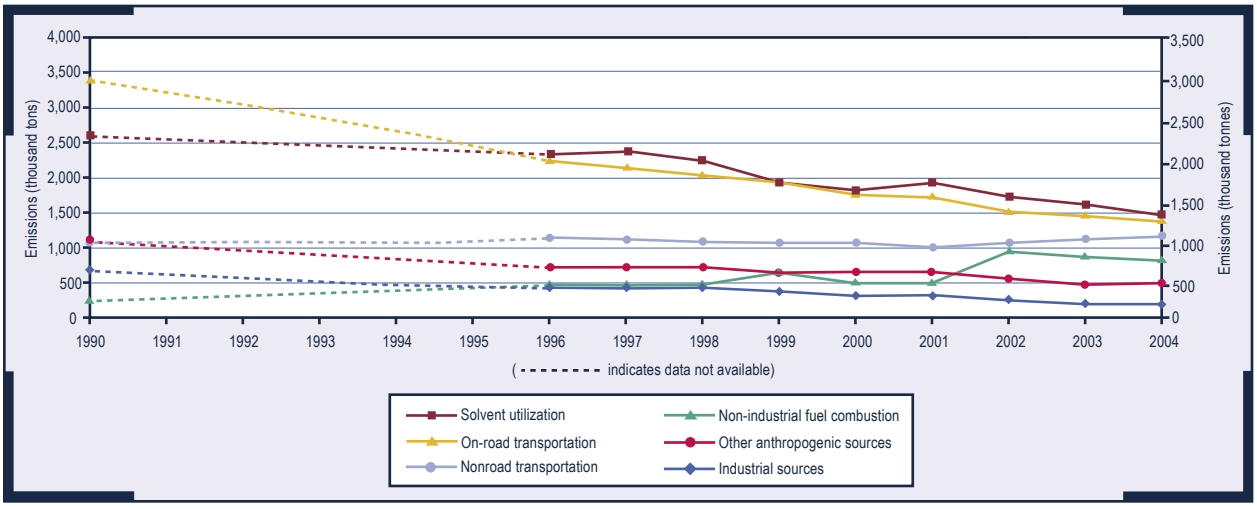
U.S. NO_x Emission Trends in PEMA States, 1990–2004



Note: The scales in Figures 14–15 and 16–17 are significantly different.
Source: EPA

Figure 15

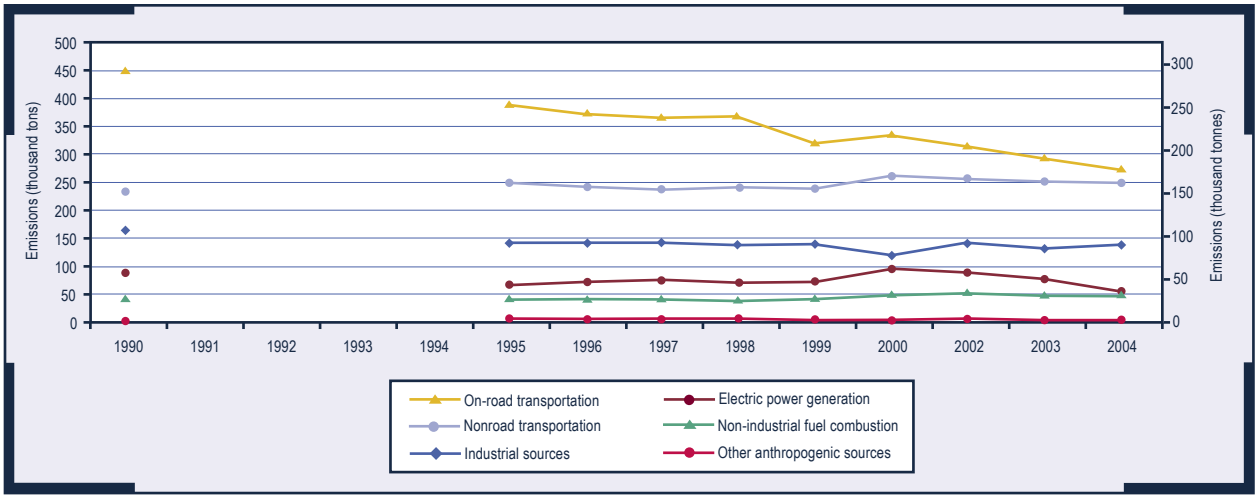
U.S. VOC Emission Trends in PEMA States, 1990–2004



Note: The scales in Figures 14–15 and 16–17 are significantly different.
Source: EPA

Figure 16

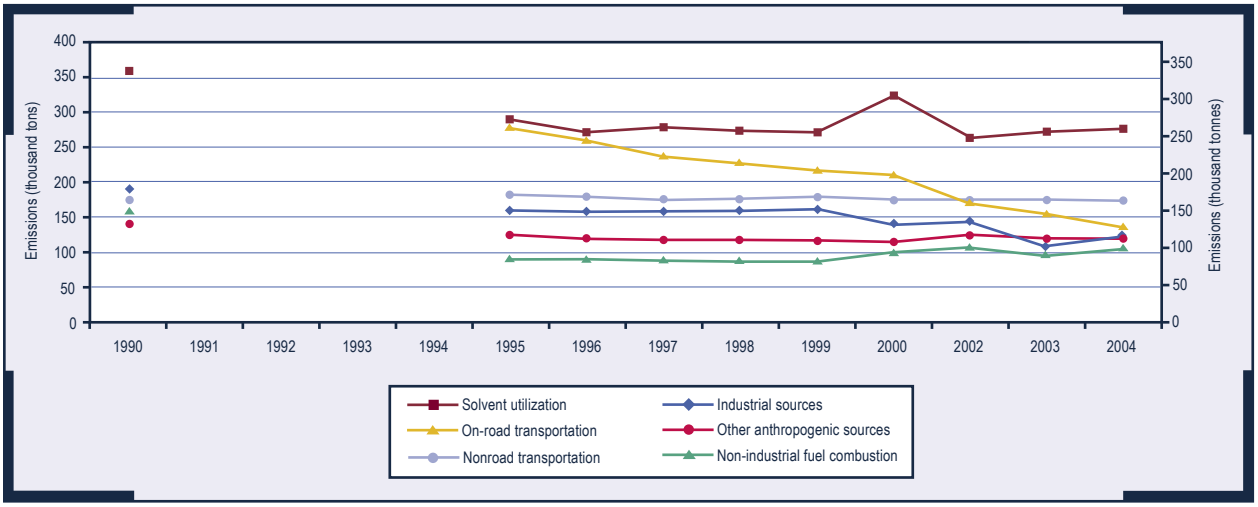
Canada NO_x Emission Trends in the PEMA Region, 1990–2004



Note: The scales in Figures 14–15 and 16–17 are significantly different.
Source: Environment Canada

Figure 17

Canada VOC Emission Trends in the PEMA Region, 1990–2004



Note: The scales in Figures 14–15 and 16–17 are significantly different.
Source: Environment Canada

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

JOINT COMMITMENT

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 2004.

Ambient Levels of Ozone in the Border Region

Figure 18 illustrates ozone conditions in the border region in the metrics of national standards. The reference period is 2002–2004. Only data from sites within 500 km (310 miles) of the Canada–U.S. border

that met data completeness requirements were used to develop these maps.

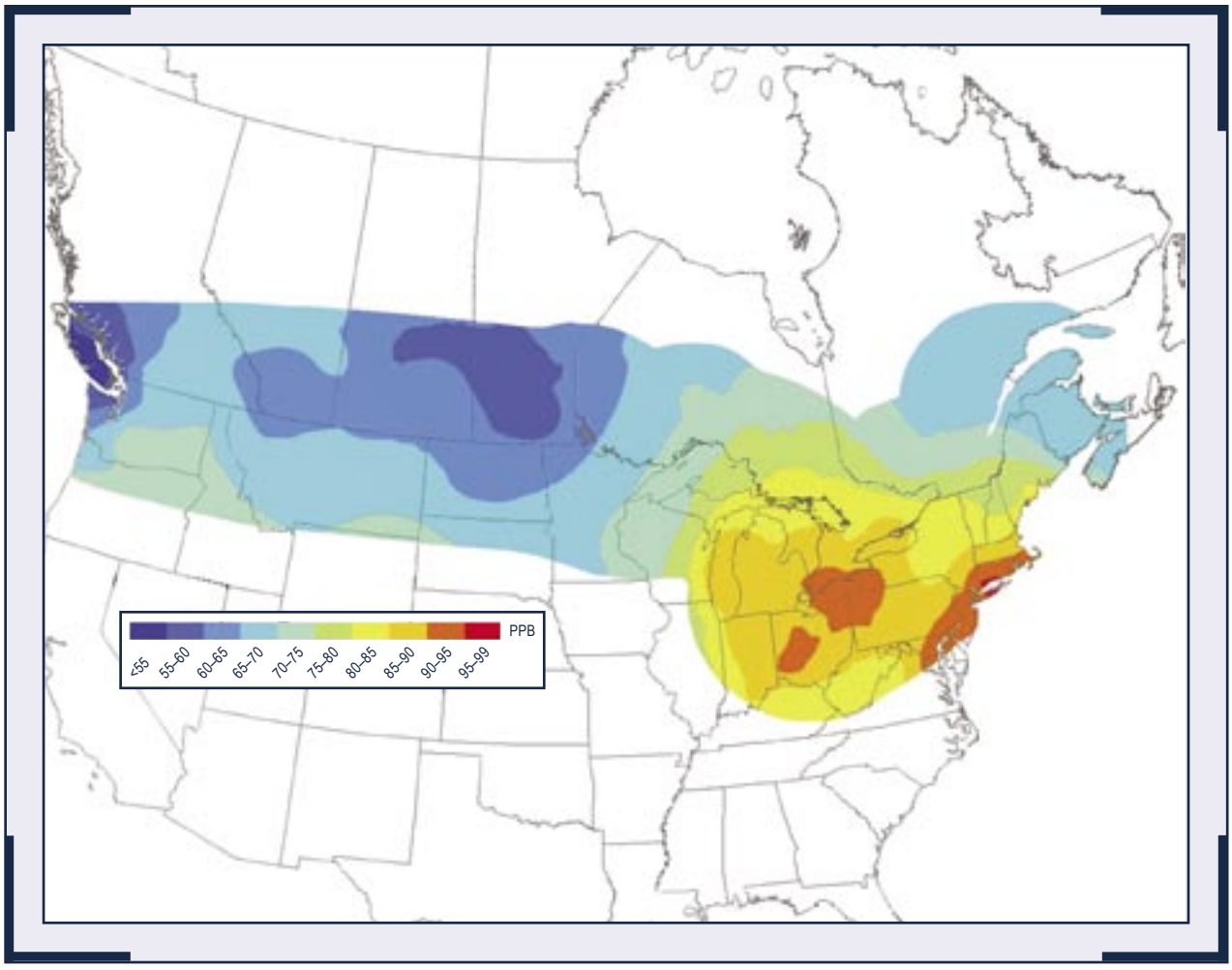
Figure 18 shows that higher ozone levels occur in the lower Great Lakes–Ohio Valley region and along the U.S. east coast. Lowest values are generally found in the west and in Atlantic Canada. Levels are generally higher downwind of urban areas, as can be seen in the western portions of lower Michigan, though the full detail of urban variation is not shown. Locally higher levels in the complex terrain of the Georgia Basin–Puget Sound area are also not well resolved in this map, though they are lower than in the east. For ozone, the data completeness requirement was that a site's annual fourth highest daily maximum 8-hour concentration (parts per billion by volume) be based on 75 percent or more of all possible daily values during the EPA-designated ozone monitoring season (May 1–September 30).

Ambient Concentrations of Ozone, NO_x, and VOCs

Annual ozone levels over time are presented in Figure 19, based on information from longer-term eastern sites within 500 km (310 miles) of the Canada–U.S. border. Ozone levels have decreased over the period.

Figure 18

Ozone Concentrations along the Canada–U.S. Border (Three-Year Average of the Fourth Highest Daily Maximum 8-Hour Average), 2002–2004



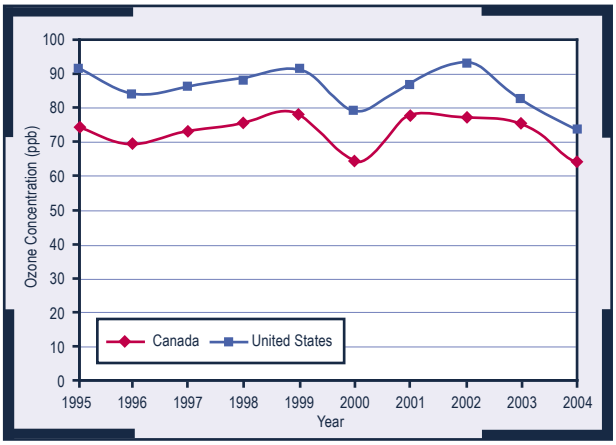
Note: Data contoured are the 2002–2004 averages of annual fourth highest daily values, where the daily value is the highest running 8-hour average for the day. Sites used had at least 75 percent of possible daily values for the period.

Source: Environment Canada National Air Pollution Surveillance (NAPS) Network Database (www.etcentre.org/NAPS/) and EPA Aerometric Information Retrieval System (AIRS) Database (www.epa.gov/air/data/index.html)

The apparent decreasing trend in ozone levels from 2002 is in part due to the cool, rainy summer of 2004 in eastern North America. There is also a complex regional pattern in ozone level variations, which is not evident from the graph shown in Figure 19.

Figure 19

Annual Fourth Highest Maximum 8-Hour Ozone Concentration for Sites within 500 km of the Canada–U.S. Border, 1995–2004



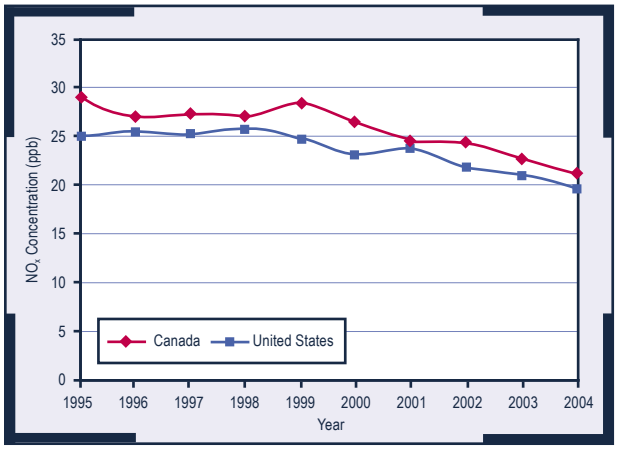
Source: EPA and Environment Canada

Figures 20 and 21 depict the annual levels of ozone precursors NO_x and VOCs in the eastern United States and Canada. These measurements represent information from a more limited network of monitoring sites than is available for ozone: Figure 22 shows the network of monitoring sites actually used to create the trend graphs in Figures 19–21. More rigorous data completeness criteria were used in site selection for these graphs than was the case for the 2004 Progress Report. As a consequence, the graphs in the two reports cannot be compared directly. Further, while the patterns of change over time shown in the national graphs here are considered comparable, the actual national values shown cannot be directly compared, as the site groups are considered to be too different.

The data in Figures 20 and 21 represent measurements for the "ozone season" (i.e., May through September). The data indicate a decline in the 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 20

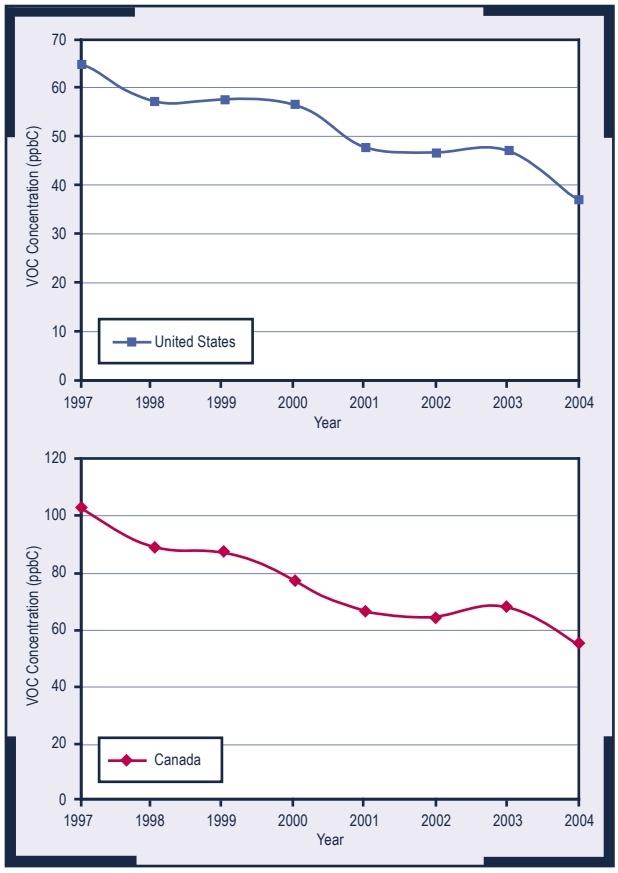
Ozone Season 1-Hour NO_x Concentration for Sites within 500 km of the Canada–U.S. Border, 1995–2004



Source: EPA and Environment Canada

Figure 21

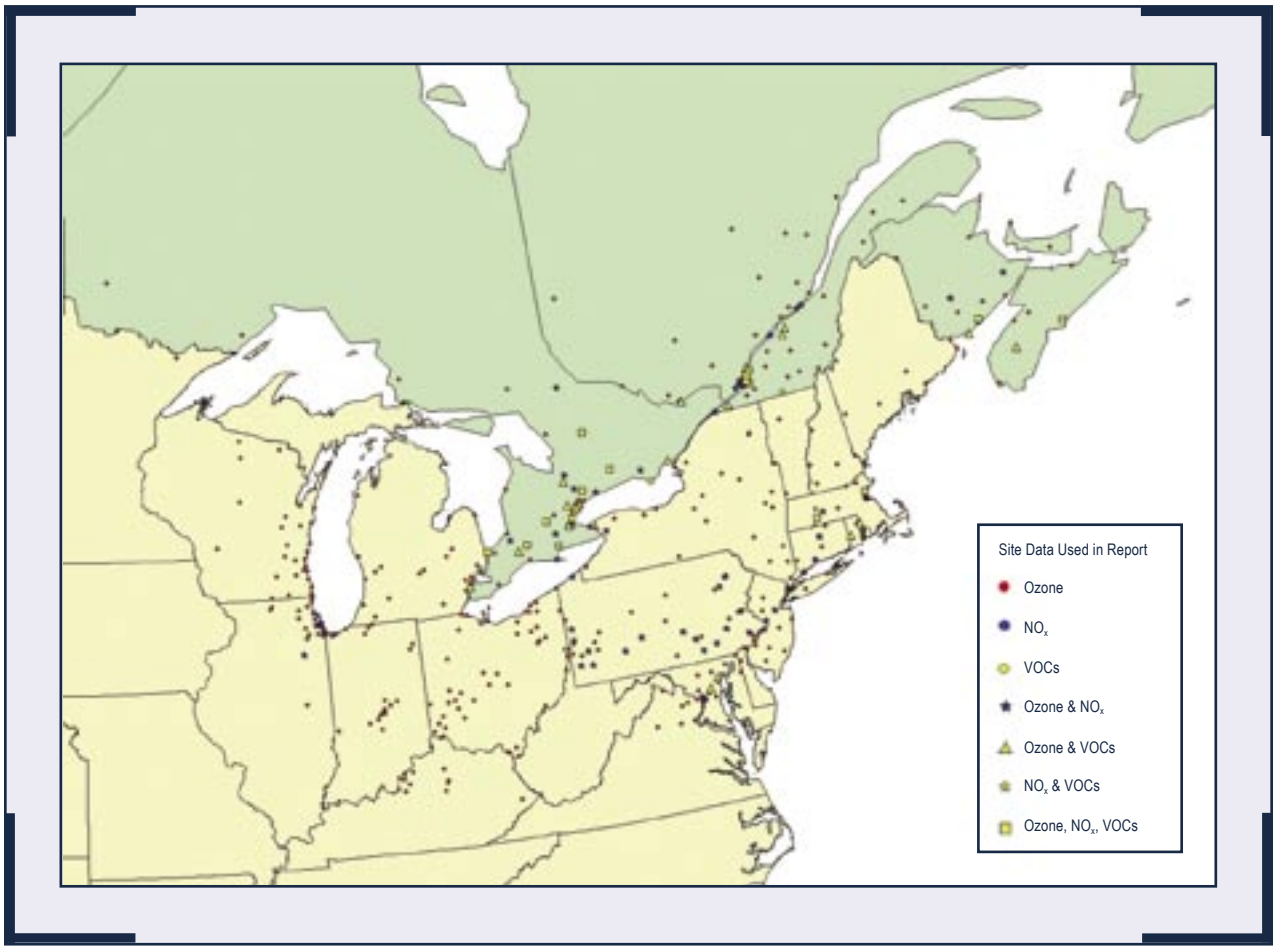
Annual Average 24-Hour VOC Concentration for Sites within 500 km of the Canada–U.S. Border, 1997–2004



Source: EPA and Environment Canada

Figure 22

Network of Monitoring Sites Used to Create Ambient Levels of Ozone, NO_x, and VOC Graphs



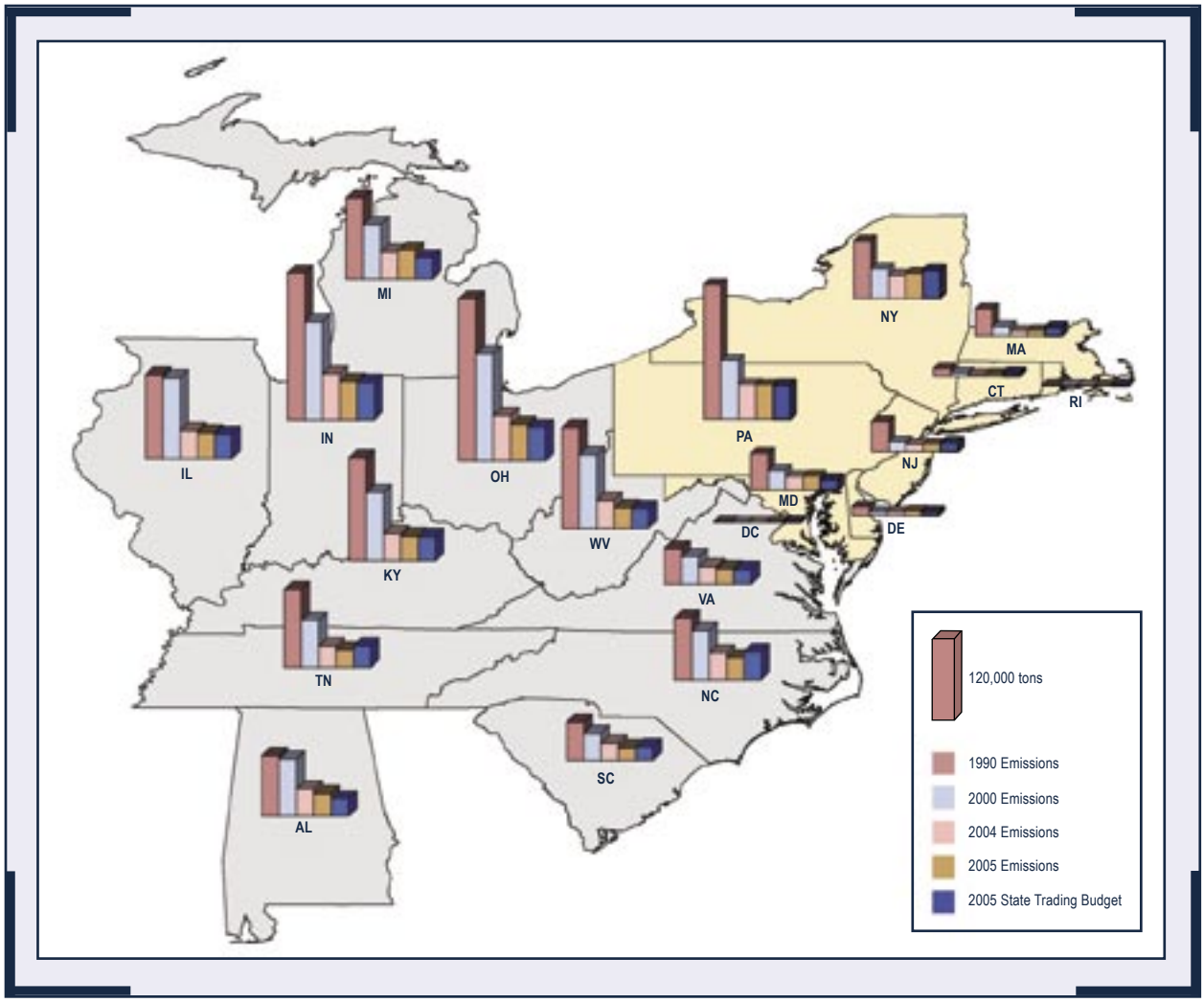
Source: EPA and Environment Canada

The 2004 Progress Report showed NO_x and VOC emission trends through 2002. Since 2002, NO_x emission reductions due to EPA's NO_x SIP Call have accelerated in the eastern United States. EPA has published an annual report since August 2004, providing an evaluation of ozone control programs in the eastern United States with a focus on the effects of the NO_x SIP Call and the NBP. The full reports can be found at www.epa.gov/airmarkets/cmprpt/index.html. It is useful to include some of the findings from the most recent report here because emission reductions in the eastern United States also impact areas in eastern Canada.

Effects of the NO_x SIP Call can be seen in Figure 23. While the NBP achieved an 11 percent overall decrease in NO_x emissions from 2004 to 2005, Figure 23 shows that emission reductions varied at a state-by-state level. These years were selected to analyze changes coinciding with the period of NO_x reductions attributable to the Acid Rain Program (1990), the Ozone Transport Commission (OTC) NO_x Budget Program (1999 through 2002), and the implementation of the NO_x SIP Call (starting in 2003 in eight states and in 2004 in 11 additional states). Given that 2005 was the first full ozone season compliance period for states outside the OTC, those states saw the most significant reductions from 2004. In addition, the increase in electricity demand in 2005, together with a large bank of available allowances, likely influenced individual source and company compliance decisions.

Figure 23

Ozone Season NO_x Emissions for 1990, 2000, 2004, and 2005, and 2005 Trading Budgets in the NO_x Budget Trading Program Region



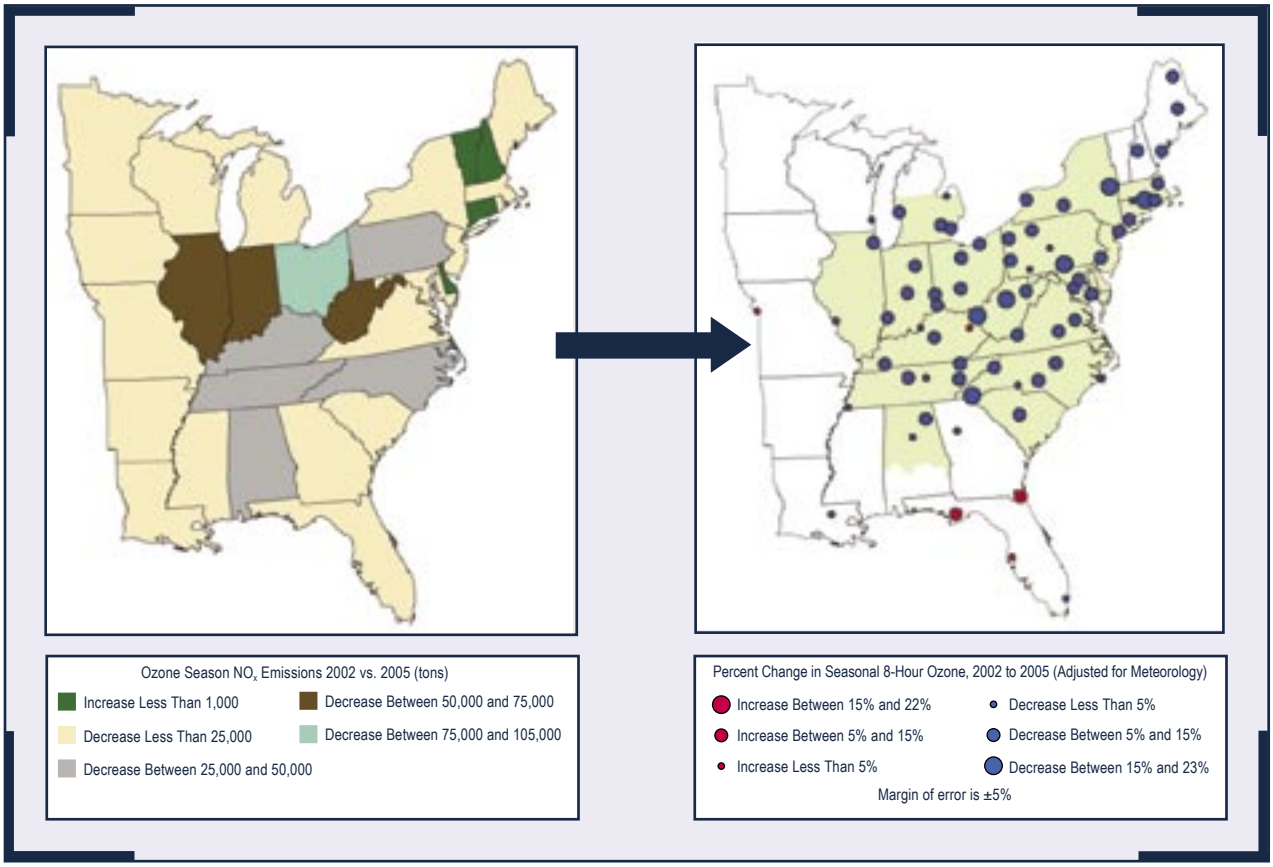
Note: The non-OTC states are shaded in gray; OTC states are shown in yellow.
Source: EPA

Figure 24 shows the relationship between reductions in power industry NO_x emissions and reductions in ozone after implementation of the NBP. Generally, there is a strong association between areas with the greatest NO_x emission reductions (such as the Midwest) and downwind sites exhibiting the greatest improvement in ozone levels. This suggests that NO_x transport has been reduced in the eastern United States. While EPA does not attribute all ozone reductions after 2002 to the NBP, it does show that the NBP has played a major role in reducing ozone concentrations.

Note that 8-hour ozone levels in Figure 24 were adjusted for meteorological impacts. Daily temperature, relative humidity, and wind speed can affect ozone levels. In general, warm dry weather is more conducive to ozone formation than cool wet weather. Because weather varies over space and time, EPA uses a statistical model to account for weather-related variability and makes meteorological adjustments to normalize weather conditions across the region. These adjustments provide a better estimate of the underlying ozone trend and the impact of emission changes.

Figure 24

Reductions in Ozone Season Power Industry NO_x Emissions and 8-Hour Ozone, 2002 vs. 2005



Note: States affected by the NO_x SIP Call are shaded light green in the Percent Change in Seasonal 8-Hour Ozone, 2002 to 2005 (Adjusted for Meteorology) map.

Source: EPA

EPA expects that NO_x and VOC emissions will continue to decrease as a result of these control programs. In addition, EPA's CAIR (www.epa.gov/cair/) will help reduce ozone further in the eastern United States. This landmark rule, issued March 10, 2005, will permanently cap power industry emissions of SO_2 and NO_x in the eastern United States, achieving significant reductions of these pollutants. The CAIR will build on the ozone season emission reductions from the NO_x SIP Call and, by 2009, reduce NO_x from electric generating units by an additional 216,000 tons in the CAIR region, or 28 percent from 2005 levels.

New Actions on Acid Rain, Ozone, and Particulate Matter

CANADA

In eastern Canada, where acid rain continues to damage sensitive ecosystems, three provinces, Nova Scotia, Quebec, and Ontario, developed tighter regulations in 2005 for major acid rain–causing emission sources. In 2005, new regulations to reduce SO_2 and NO_x emissions were promulgated by Ontario for seven industrial sectors and by Nova Scotia for the electric power sector. Nova Scotia's Air Quality Regulations require a 25 percent reduction in the SO_2 emission cap for the province's largest SO_2 emitter (Nova Scotia Power Inc.) beginning in 2005, a further 25 percent reduction in 2010, and a cap on NO_x emissions by 2009, reducing emissions by 20 percent from 2000 levels. Ontario's Regulation 194/05

(Industry Emissions – Nitrogen Oxides and Sulfur Dioxide) will lead to incremental reductions of SO_2 and NO_x emissions from facilities in seven industrial sectors. By 2015, this Regulation will result in a 46 percent reduction of SO_2 emissions from 1994 levels and a 21 percent reduction of NO_x emissions from 1990 levels from the regulated facilities. In Quebec, SO_2 emissions are already below the province's ceiling. New Brunswick is fulfilling its commitment to SO_2 reductions under the Acid Rain Strategy for Post-2000, primarily through emission reductions that are under way in the electric power generating sector.

In April 2006, Canada published the Final Notice requiring the preparation of pollution prevention plans by Canadian base metal smelters (see also Ozone Annex under Section 1). The Final Notice requires the development and implementation of a Smelter Emissions Reduction Program with facility annual release limit targets for 2008 and 2015 and notes the intention of the federal Environment Minister to develop base metal smelter regulations to be in effect by 2015.

The Canada-wide Standards for PM and ozone commit jurisdictions (federal, provincial/territorial) to the development of jurisdictional implementation plans. In 2004, *Ontario's Clean Air Action Plan: Protecting Environmental and Human Health* was published, which outlines the province's implementation plan in meeting the Canada-wide Standards, including a mix of regulations, economic incentives, and nonregulatory initiatives.

The federal government published its Interim Plan on PM and Ozone in 2001, which outlined initial strategies that the government will pursue to reduce levels of PM and ozone and meet the targets under the Canada-wide Standards process. A follow-up progress report was published in 2003 that discussed actions taken by the federal government to reduce PM and ozone, such as improvements to monitoring networks and reductions in emissions from vehicles and fuels. The Canada-wide Standards include a Reporting on Progress provision, which requires that all jurisdictions report annually on the achievement and maintenance of the standards beginning in 2011 and provide a comprehensive report on progress towards all provisions of the standards every five years, with the first jurisdictional comprehensive reports due in 2006.

★ 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. The 8-hour ozone standards are set at a level of 0.08 ppm and are met when the three-year average of the annual fourth highest daily maximum 8-hour concentrations is less than 0.08 ppm. After a lengthy legal battle, EPA published rules for implementation of the 8-hour ozone standard in two phases—the first on April 30, 2004, and the second on November 29, 2005. On April 30, 2004, EPA designated 126 areas as nonattainment for the 8-hour ozone standard based on three recent years of air quality data. The designations became effective on June 15, 2004, for all but 14 areas, which received deferrals of their designations based on their entering into "Early Action Compacts" in which they agreed to develop and implement an early plan to attain the standard by the end of 2007. All but 17 of the 126 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—based on requirements of the Clean Air Act—provides for attainment dates ranging from 2007 to 2021, based on the severity of an area's air quality problem. Phase 1 of the rule provided for the classification system for nonattainment areas, the timing of emission reductions needed for attainment, the revocation of the 1-hour standard, and anti-backsliding provisions for areas with responsibilities under the 1-hour standard. The Phase 2 rule provided the remaining guidance and provisions for

implementation of the 8-hour standard, including those related to the attainment demonstration and modeling, reasonably available control technology, reasonable further progress towards attainment, new source review under the 8-hour standard, and revisions to the reformulated gasoline rule. Information on the 8-hour ozone designations and implementation rulemakings can be found at www.epa.gov/ozonedesignations/regs.htm.

Particulate Matter Standards and Implementation

To provide additional protection from the adverse health effects of particles, in 1997, EPA issued NAAQS for $PM_{2.5}$. The annual standard was set at 15 micrograms per cubic meter ($\mu g/m^3$) and is met when the three-year average of the annual arithmetic mean $PM_{2.5}$ concentrations does not exceed 15 $\mu g/m^3$. The 24-hour standard is set at 65 $\mu g/m^3$ and is met when the three-year average of the 98th percentile of 24-hour concentrations does not exceed 65 $\mu g/m^3$.

The Clean Air Act requires EPA to review each air quality standard and related new scientific studies every five years. The current review of the PM standard is under way and is scheduled for completion in fall 2006. In January 2006, EPA proposed to maintain the annual $PM_{2.5}$ standard at 15 $\mu g/m^3$ and to establish a more protective 24-hour standard at 35 $\mu g/m^3$ (both with the same three-year form as the 1997 standards). EPA also proposed to revise the 24-hour PM_{10} standard, in part by establishing a new 24-hour standard for coarse PM using a new indicator for thoracic coarse particles (particles between 10 and 2.5 micrometers in diameter, or $PM_{10-2.5}$). The proposed 24-hour standard for $PM_{10-2.5}$ is 70 $\mu g/m^3$. Additional information on the 1997 PM standards, the recent scientific review, and the revisions to be finalized in 2006 can be found at www.epa.gov/air/particlepollution/index.html.

In April 2005, EPA designated 39 areas in the United States as not attaining the 1997 fine particle standards. Thirty-six of these areas are in the eastern United States (including Chicago, Detroit, and Cleveland, located on the Great Lakes), two are located in California, and one area (Libby, Montana) is located in the northwestern United States. States have until April 2008 to submit SIPs to EPA, which include strategies and regulations for reducing emissions of fine PM and its precursors. Attainment of the standards is to be as expeditious as practicable, with a presumptive attainment date (April 2010) within five years of designation. However, EPA can grant an attainment date extension of one to five years if a state provides a demonstration showing that attainment within five years is not practicable based on the severity of the air quality problem or the feasibility of emission controls.

A number of programs have been established to reduce emissions of fine particles and precursor pollutants from important sources such as on-road and nonroad vehicle engines and power plants. The Clean Air Nonroad Diesel Rule, finalized in May 2004, and the CAIR, finalized in March 2005, are two important federal regulations that will lead to future reductions in particle pollution. Under the Clean Air Nonroad Diesel Rule, standards for new engines will be phased in from 2008 to 2014, leading to significant public health benefits as older nonroad engines are replaced. The sulfur content in fuel will be reduced by 99 percent to 15 ppb by 2010.

The Clean Air Interstate Rule

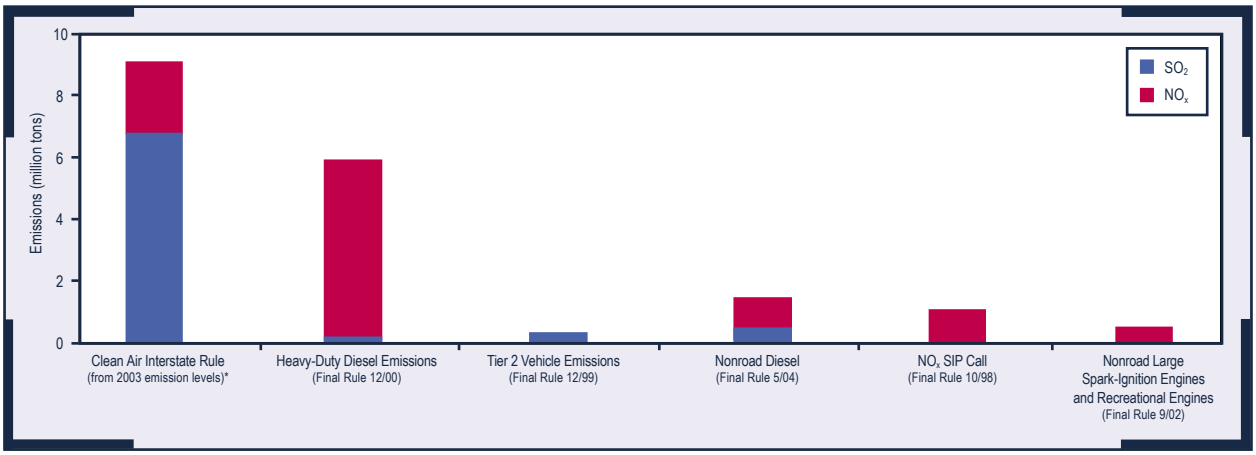
On March 10, 2005, EPA issued the final CAIR, which will result in the deepest cuts in SO_2 and NO_x emissions in more than a decade in the United States. The rule focuses on states whose power plant emissions are significantly contributing to fine particle and ozone pollution in other downwind states in the eastern United States. In an action signed on March 15, 2006, EPA included two additional states (New Jersey and Delaware) in the CAIR with respect to fine particle pollution. The CAIR requires 28 states in the eastern half of the nation and the District of Columbia to reduce emissions of SO_2 and/or NO_x. The CAIR establishes SO_2 and NO_x cap and trade programs for power plants that states can adopt to achieve the emission reductions in a highly cost-effective manner. On March 15, 2006, EPA also issued Federal Implementation Plans for the CAIR as a backstop to ensure that the emission reductions required by the CAIR will be achieved on schedule. The EPA established SO_2 and NO_x trading programs as the control strategy for the Federal Implementation Plans. EPA will withdraw the federal control requirements in a state once the state has an EPA-approved state plan in place for the CAIR.

The CAIR cap and trade programs will reduce power plant SO_2 emissions by 4 million tons by 2010 and by 5.1 million tons by 2015 and will reduce annual NO_x emissions by 1.4 million tons by 2009 and by 1.6 million tons by 2015 from 2005 levels for affected sources in the CAIR region.

See Figure 25 for emission reductions at full implementation of the CAIR compared with other recent major EPA rules.

Figure 25

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



Note: *These reductions are calculated from 2003 levels and do not reflect the full phase-in of the Acid Rain Program. Full implementation for mobile source rules is 2030. Full implementation for the CAIR is between 2020 and 2025.

Source: EPA

Section 2:

Related Air Quality Efforts

Canada–U.S. Border Air Quality Pilot Projects

Three Border Air Quality Projects completed in 2005 fulfilled a pledge made by the two countries in January 2003 to build on the continued success of the 1991 Canada–U.S. AQA. Their purpose was to explore opportunities for coordinated air quality management that could result in air quality improvements and the development of innovative strategies.

Canada–U.S. Emissions Cap and Trading Feasibility Study

The Canada–U.S. Emissions Cap and Trading Feasibility Study looked at the feasibility of developing a cross-border cap and trade program for SO_2 and NO_x emissions—emissions that are key components of fine particles, smog, regional haze, and acid rain in the transboundary region. The goals of this project were to examine key requirements and components of SO_2 and NO_x emissions cap and trading programs necessary to assess the feasibility of cross-border trading.

Using illustrative scenarios, economic modeling and air quality modeling were undertaken to predict the effects of caps and cross-border trading on the electricity sector and on air quality and the environment. Two key conclusions of the feasibility study are as follows:

- First, while the feasibility study demonstrates through air quality modeling that a cross-border NO_x and SO_2 emissions cap and trading program can reduce the total loading of pollutants into the environment over a broad geographic area, it is the levels and timing of the SO_2 and NO_x emission reduction requirements, or caps, in the electricity sector that determine the level and extent of the air quality and environmental benefits. Trading does not alter

the overall level of the emission reductions and consequent benefits.

- Second, faced with mandatory requirements to reduce emissions of SO_2 and NO_x, it is cheaper for the electricity sector to achieve the emission caps with trading as an option than without trading. The results mirror those seen in the United States, where the SO_2 and NO_x cap and trade programs have set emission reduction caps for electricity generators and provided sources with the opportunity to trade.

Based on the analysis done during this study, a cross-border emissions cap and trade program could be feasible, but certain critical program elements would be necessary:

- In Canada, enforceable SO_2 and NO_x emission caps for the electric power sector—and other sectors, as appropriate—that are comparable in stringency to emission reduction requirements in the United States.
- A commitment by the United States and Canada, including provinces, to pursue implementation of cross-border SO_2 and NO_x cap and trade.
- In both countries, legislative and/or regulatory changes to give the allowances in each country equivalency so that they could be traded freely and used for compliance in either country.
- Development in Canada of the regulations that would provide the basis for cross-border trading and in particular the emissions monitoring and reporting requirements for electric generating units, as well as development of the electronic tracking systems for emissions and allowances.

The United States and Canada have agreed to pursue additional modeling and analysis. The full report can be found on the EPA website at www.epa.gov/airmarkets/usca/feasstudy.pdf and also on Environment Canada's website at www.ec.gc.ca/cleanair-airpur/Can-US_Emission_Trading_Feasibility_Study-WS105E2511-1_En.htm.

Georgia Basin–Puget Sound International Airshed Strategy

This initiative, led by Environment Canada (Pacific and Yukon Region) and EPA (Region 10), addresses regional transboundary air quality issues. Other partners include Health Canada and representatives of state, provincial, and regional governments, as well as the Tribes and First Nations.

Work is proceeding in seven areas of cooperation: marine emissions, clean fleets and fuels, agricultural emissions, residential wood heating, notification of major new sources, communications and outreach, and transboundary science and data (emissions, population exposure, and health impacts). 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 Standards, and improving visibility. In November 2005, the Georgia Basin–Puget Sound International Airshed Strategy partners met to review progress on implementation of the strategy. At this meeting, partners focused on linking actions in these seven areas to the long-range Georgia Basin–Puget Sound International Airshed Strategy goals and identification of the projects with the best potential for environmental and human health benefits. Major efforts in 2005 and 2006 targeted on-road emission reductions by encouraging installation of technology to reduce diesel exhaust. This work was initiated in Puget Sound, communicated to partner agencies through the Georgia Basin–Puget Sound International Airshed Strategy process, and subsequently implemented in the Georgia Basin.

Additional details, including a more complete description of the transboundary cooperation results, are located at www.ec.gc.ca/cleanair-airpur/caol/canus/georgiabasin/index_e.cfm.

Great Lakes Basin Airshed Management Framework

The goal of the Great Lakes Basin Airshed Management Framework pilot project was to explore the feasibility of a coordinated air quality management approach in the Southeast Michigan–Southwest Ontario region. The project focused on the ground-level ozone and fine particle ($PM_{2.5}$) pollution problems that impact the cities of Detroit, Windsor, London, Sarnia, and Chatham, as well as the surrounding areas.

To date, representatives from federal, provincial, state, and local governments have come together to share information on current initiatives and priorities related to PM and ozone and to establish a structure of work groups for jointly investigating specific aspects of the two countries' current air quality management systems. In particular, the work groups focused on airshed characterization (emission inventory, modeling, monitoring), policy needs, human health studies, voluntary/early actions, and communications/outreach.

A report summarizing findings of work undertaken over the past two years, along with recommendations for coordinated airshed management in this border region, was completed in October 2005. All three levels of government in Canada and the United States and the International Joint Commission (IJC) worked cooperatively on the joint investigations that were undertaken and presented within this report. The report can be found on Environment Canada's website at www.ec.gc.ca/cleanair-airpur/caol/canus/great_lakes/index_e.cfm and also on EPA's website at www.epa.gov/airmarkets/usca/glb.pdf.

The report contains a general recommendation that a coordinated approach is desirable and feasible in the border region and that there may be applicability to other areas within the Great Lakes basin. The partners also recognized value in continuing their cooperation and dialogue. To that end, they will continue to work together over the next year in implementing some of the recommendations contained within the report.

In March 2006, EPA and Environment Canada representatives met in Vancouver, British Columbia, to discuss commonalities between the Border Air Quality Strategy projects in the Great Lakes and Pacific Northwest and the development of an air quality management template that could be applied to other cross-border areas.

New England Governors and Eastern Canadian Premiers

The conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) is a unique international relationship of six New England State governors (from Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) and five eastern Canadian premiers (from New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Quebec). The conference has addressed many topics, including the environment, economic development, tourism, energy, fisheries, trade, and agriculture, since its creation in 1973.

Through its Acid Rain and Air Quality Steering Committee, the activities of the NEG/ECP continue to provide an important regional coordinating mechanism for addressing air quality and acid rain issues, including transboundary air pollution. Recent efforts are focused on the following:

- Completion of the forest critical load mapping project to include all jurisdictions of the organization.
- Continued support of the web-based near-real-time ozone and $PM_{2.5}$ mapping.
- An assessment of outdoor wood-fired boiler emissions.

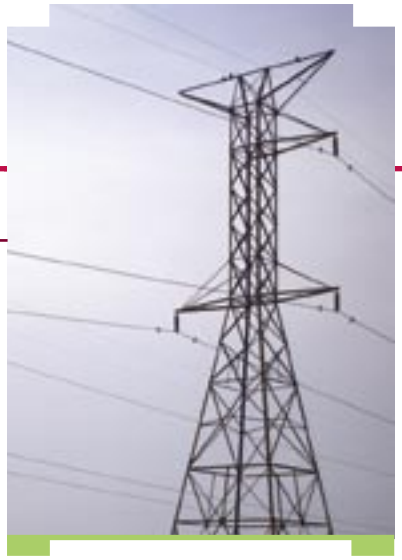
As well, individual jurisdictions within the organization are involved in a wide range of initiatives, the results of which are shared within the organization. These initiatives cover issues such as air toxics, residential wood combustion, mercury, and diesel emission cleanup programs.

An NEG/ECP environmental website is under development to provide easy access to reports and products for public education and outreach purposes. This site is now online but still under development at www.neg-ecp-environment.org/.

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 United States, the most recent emission inventory data are for the year 2002. The 2003 and 2004 emissions data in this report were developed by interpolating between 2002 emissions and 2010 projections developed to promulgate the CAIR.

Both countries were active participants in the NARSTO (formerly North American Research Strategy for Tropospheric Ozone) emission inventory assessment, which was completed in the summer of 2005. The final report is titled *Improving Emission Inventories for Effective Air Quality Management across North America*. This report includes recommendations for the long-term improvement of the emission inventory programs in both Canada and the United States as well as in Mexico, the third participant in NARSTO.

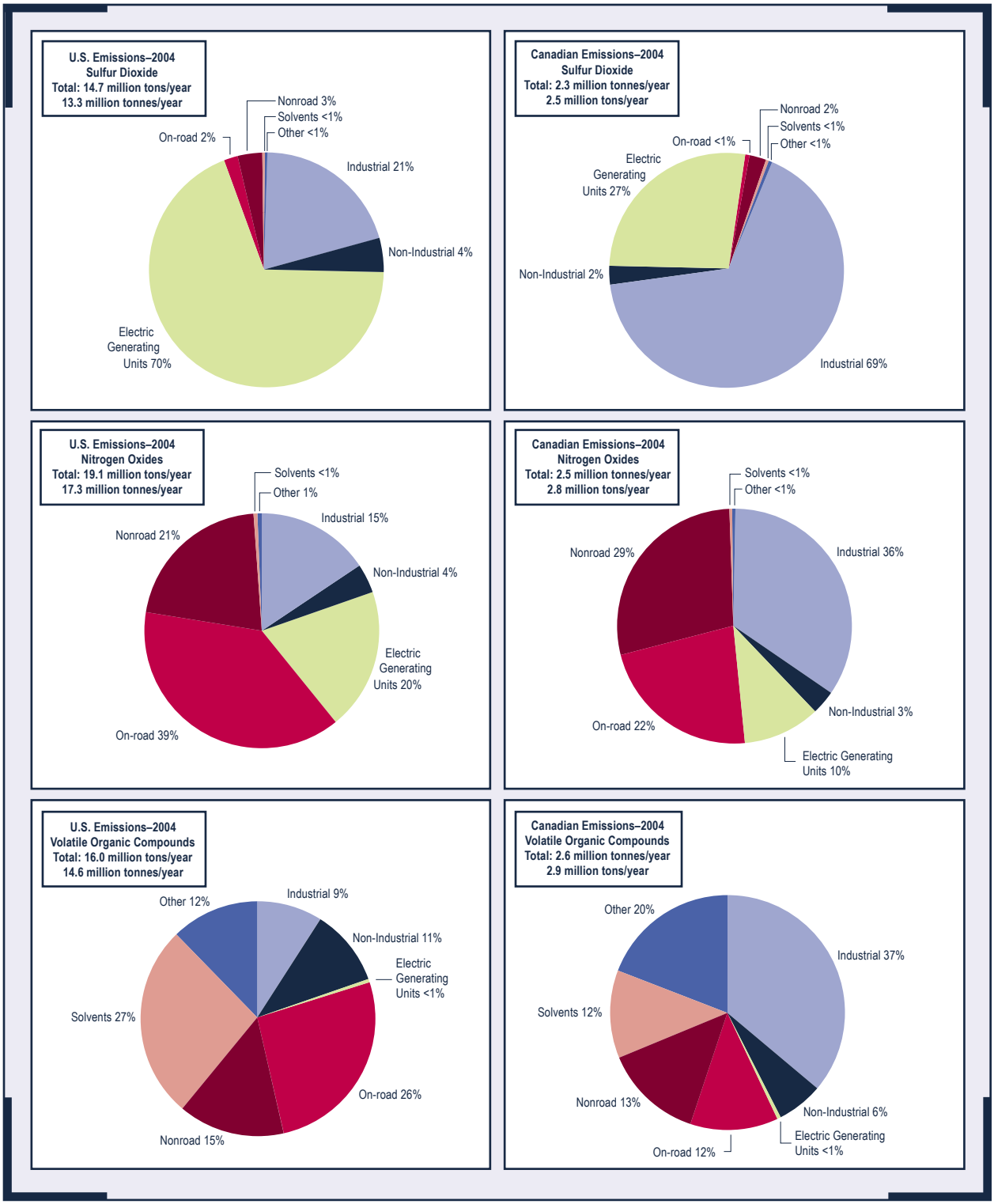
Emissions data for both countries for 2004 are presented in Figures 26, 27, 28, and 29. Figure 26 shows the distribution of emissions by source category grouping for SO_2, NO_x, and VOCs. The following observations can be made from Figure 26:

- SO_2 emissions in the United States stem primarily from coal-fired combustion in the electric power sector. Canadian SO_2 emissions come mostly from smelters in the industrial sector, with fewer emissions from the electric power sector, due to the large hydroelectric capacity in Canada. The distribution of NO_x emissions in the two countries is similar, with nonroad and on-road vehicles accounting for the greatest portion of NO_x emissions in both countries.

- 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.

Figure 26

U.S. and Canadian National Emissions by Sector for Selected Pollutants, 2004

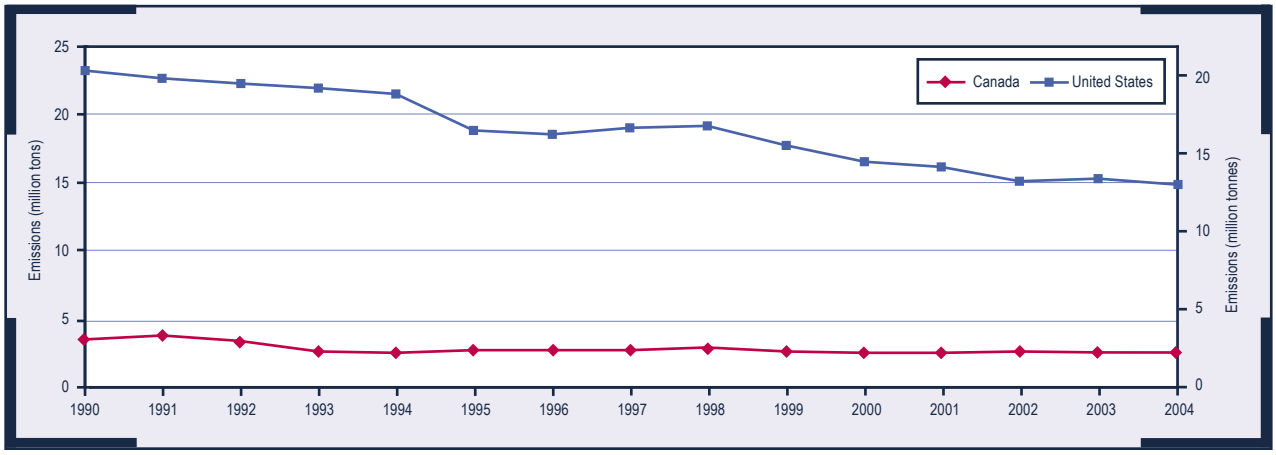


Source: EPA and Environment Canada

The emission trends, shown in Figures 27, 28, and 29 for SO_2, NO_x, and VOCs, respectively, show the relative contribution in emissions over the 1990–2004 period. In the United States, the major reductions in SO_2 emissions came from electric power generation sources. For NO_x, the reductions came from on-road mobile sources and electric power generation sources. For VOCs, the reductions were from on-road mobile sources and solvent utilization. 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 27

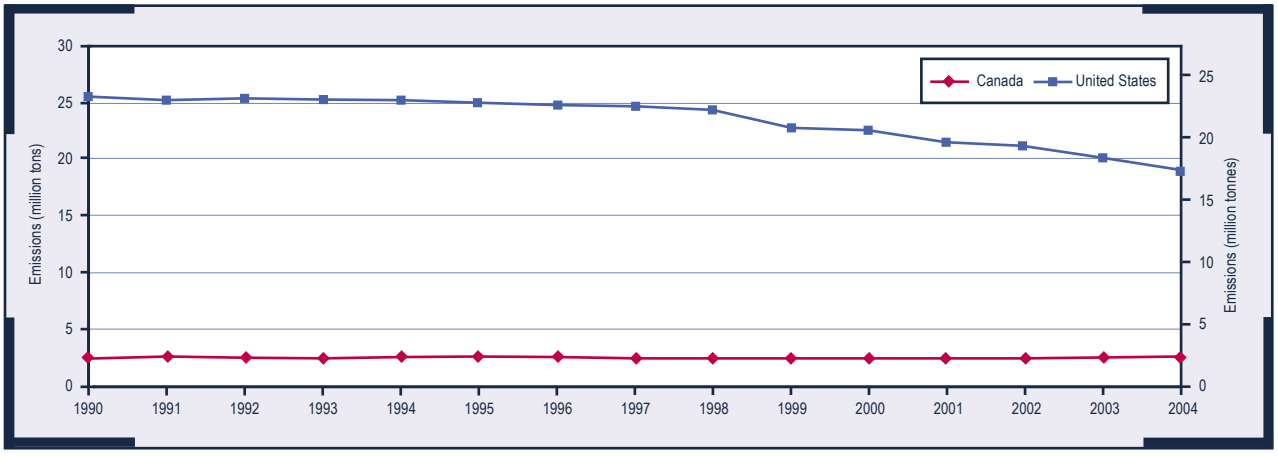
SO_2 Emissions in the United States and Canada, 1990–2004



Source: EPA and Environment Canada

Figure 28

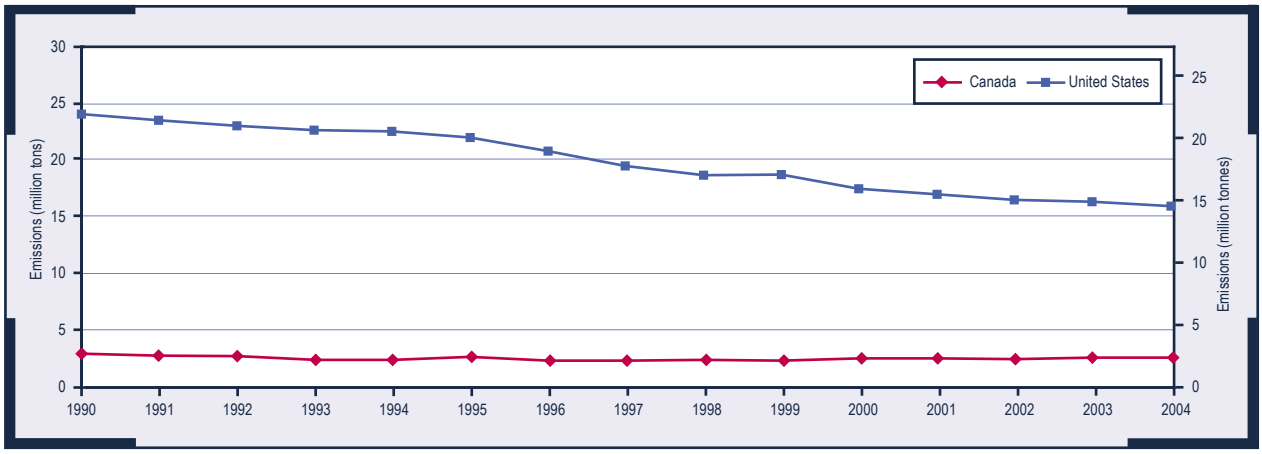
NO_x Emissions in the United States and Canada, 1990–2004



Source: EPA and Environment Canada

Figure 29

VOC Emissions in the United States and Canada, 1990–2004



Source: EPA and Environment Canada

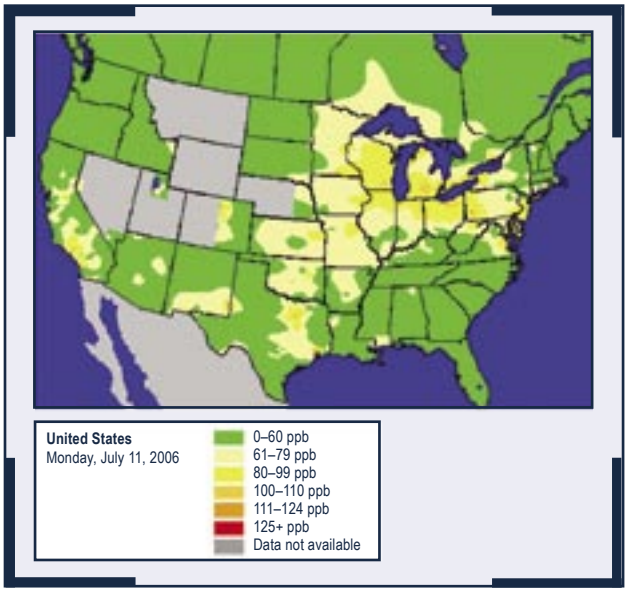
Air Quality Reporting and Mapping

JOINT EFFORTS

Each country is responsible for ensuring instrument calibration and comparability of measurements of ozone and PM. Since 2001, the jurisdictions in the United States and Canada have collaborated on contributing to the EPA-led AIRNow program (www.epa.gov/airnow). Since 2004, the website has been expanded to provide information on PM and ozone measurements on a continental scale year-round (see Figures 30 and 31). Canadian efforts continue to improve mapping by combining measurements with numerical forecasts from the operational air quality forecasting model. In each country, air quality forecasting services are being improved. Canada and the United States are collaborating in the continuing development of national air quality forecast models. Jurisdictions consult in preparing routine forecasts for border regions and in developing communications materials for the public.

Figure 30

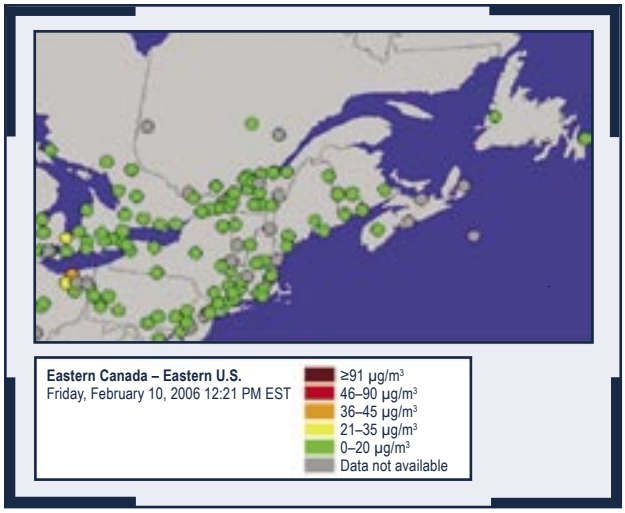
AIRNow Map Illustrating Real-Time Concentrations of Ground-Level Ozone (1-Hour Average Peak Concentration)



Source: EPA

Figure 31

AIRNow Map Illustrating Real-Time $PM_{2.5}$ Concentrations (3-Hour Average)



Source: EPA

CANADA

Environment Canada is continuing to expand and refurbish federal and provincial/territorial networks of monitoring stations across the country. Canada maintains two national ambient air quality monitoring networks, the National Air Pollution Surveillance (NAPS) network and CAPMoN. The NAPS network is a joint federal, provincial, territorial, and municipal network established in 1969. It is primarily an urban network, with over 260 air monitoring stations located in over 170 communities. The augmented CAPMoN is a rural network with 30 air monitoring stations in Canada and one in the United States.

The NAPS network gathers measurements on the components of smog (i.e., ozone, PM, SO_2, CO, NO_x, VOCs). Between 2002 and 2005, Environment Canada invested significantly in new equipment for the NAPS network, including 58 new and replacement ozone monitors, 36 new and replacement NO_x monitors, 11 new VOC samplers, 76 continuous $PM_{2.5}$ monitors (tapered element oscillating microbalances (TEOMs) and beta attenuation monitors (BAMs)), and eight new PM filter-based samplers. In addition, Environment Canada started a chemical speciation sampling program in December 2002 to characterize PM. Twelve sites are now operating across Canada. The agency also built two new laboratories to support this work and equipped them with an inductively coupled plasma–mass spectrometry instrument for metals analysis and an organic carbon/elemental carbon analyzer. Overall, since 2004, the network has expanded from 240 to 260 air monitors and now covers over 170 communities.

The ozone monitors at 18 CAPMoN sites continue to gather data in real time, in support of the Air Quality Prediction Program and for distribution to the U.S. AIRNow program. Integrated $PM_{2.5}$ and PM_{10} mass measurements, $PM_{2.5}$ speciation measurements, and VOC measurements are being made at five CAPMoN sites (within 500 km (310 miles) of the border). Reactive nitrogen compounds (including nitric oxide (NO), NO_2, and NO_y) are being continuously measured at three sites—the Centre for Atmospheric Research, Egbert, Ontario; Kejimkujik, Nova Scotia; and Saturna Island, British Columbia.

UNITED STATES

The majority of air quality monitoring performed in the United States is carried out by state and local agencies in five major categories of monitoring stations—State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), Photochemical Assessment Monitoring Stations (PAMS), $PM_{2.5}$ Speciation Trends Network (STN), and air toxics monitoring stations. In addition, ambient air monitoring is performed by the federal government (EPA, National Parks Service, and the National Oceanic and Atmospheric Administration), Tribes, and industry. A detailed description of current ambient air monitoring in the United States, as well as future plans, can be found in the December 2005 draft National Ambient Air Monitoring Strategy (www.epa.gov/ttn/amtic/monitor.html).

The primary purpose of the SLAMS/NAMS network is to determine compliance with the NAAQS for ozone, $PM_{2.5}$, PM_{10}, CO, SO_2, NO_2, and lead. Ozone is monitored at approximately 1,200 locations in the United States. Ambient monitoring for $PM_{2.5}$ is conducted at more than 1,100 SLAMS using the filter-based Federal Reference Method and at over 260 continuous $PM_{2.5}$ stations. Measurements of PM_{10}, CO, SO_2, NO_2, and lead are currently made at approximately 1,000, 400, 500, 400, and 200 sites, respectively.

Chemically speciated $PM_{2.5}$ data are collected at 54 urban trends sites and over 160 supplemental speciation sites as part of the STN. Speciated PM data are also collected at more than 50 rural sites and approximately 180 Class I areas as part of the IMPROVE Network (http://vista.cira.colostate.edu/improve). In addition, five urban sites are operating continuous chemical speciation technologies for nitrates, sulfates, and carbon. EPA and states will use the results from these five sites to consider whether these continuous measurement technologies will be used at additional locations. A new network of $PM_{10\text{-}2.5}$ monitoring is planned for monitoring compliance with the recently proposed $PM_{10\text{-}2.5}$ NAAQS. This network is expected to replace most of the existing PM_{10} network.

The PAMS network measures ozone and its precursors in the most severe ozone nonattainment areas. These data are used to aid in control strategy development, emissions reduction tracking, and improvements to ozone modeling and forecasting. These sites also provide information on pollutant transport and local meteorology. In 2005, over 100 PAMS sites were in operation in five regions of the United States: the Northeast, the Great Lakes area, Georgia (Atlanta area), five areas in Texas, and seven areas in California.

Toxic air pollutants are monitored at over 200 sites, including 23 National Air Toxics Trends Stations (NATTS) sites. The NATTS network is intended to provide long-term monitoring data for certain priority air toxics, including organic chemicals and metal toxics, across representative areas of the country in order to establish overall trends for these pollutants. The PAMS program also contributes a significant number of data on certain organic toxics. To complement NADP's Mercury Deposition Network (MDN), EPA is supporting a planned ambient speciated mercury network that will provide information on status and trends in mercury concentrations as well as dry deposition estimates. The effort will utilize the NADP committee structure as a platform for initiation and continued growth.

The NADP operates three monitoring networks for the purpose of determining geographical and temporal trends in precipitation chemistry. The largest and oldest of these is the NADP/NTN, which was established in 1978 and now operates over 230 precipitation monitoring sites across the nation. The network is a cooperative effort between the State Agricultural Experiment Stations, U.S. Geological Survey, U.S. Department of Agriculture, and numerous other governmental and private entities. The precipitation at each station is collected and then sent to the NADP Central Analytical Laboratory, where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (i.e., calcium, magnesium, potassium, and sodium). Comprehensive quality assurance programs ensure that the data remain accurate, precise, and comparable from year to year.

The NADP has also expanded its sampling to two additional networks. The NADP/MDN, currently

with over 90 sites, was formed in 1995 to determine trends of mercury in precipitation. Weekly samples of precipitation are collected in specially treated sampling vessels for shipment to the NADP Mercury Analytical Laboratory. All samples are analyzed for total mercury, and samples from participating locations are also analyzed for methyl mercury. Another network, NADP/AIRMoN, was formed for the purpose of studying precipitation chemistry with greater temporal resolution. Precipitation samples are collected daily from a network of nine sites and analyzed for the same constituents as the NADP/NTN samples.

EPA operates CASTNET, a long-term monitoring program established in 1988 to assess the effectiveness of SO_2 and NO_x emission reductions (www.epa.gov/castnet). CASTNET's objectives are to detect and quantify temporal and geographic trends in regional air quality and deposition for the United States. CASTNET currently comprises 88 regionally representative sites that measure ground-level ozone and weekly concentrations of total sulfur- and nitrogen-containing PM and precursor gases SO_2 and nitric acid. In addition, each site measures meteorological parameters for use in an inferential model to estimate dry deposition rates at the sites. The CASTNET program is currently evaluating an automated semicontinuous monitoring instrument that measures both gaseous (SO_2, nitric acid, ammonia) and aerosol components (sulfate, ammonium, nitrate, chloride, and other base cations).

One key aspect of the draft National Ambient Air Monitoring Strategy is the proposed introduction of a new multipollutant monitoring network referred to as NCore. Monitors at NCore multipollutant sites will measure particles ($PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$), ozone, SO_2, CO, NO_x ($NO/NO_2/NO_y$), and basic meteorology. It is anticipated that ammonia and nitric acid measurements will also be made at these sites in the future. Sites will be located in broadly representative urban (about 55 sites) and rural (about 20 sites) locations throughout the country. In many cases, states will likely collocate NCore sites with PAMS or NATTS sites to further promote multipollutant measurements. The objective of this network is to gather additional information needed to support emissions and air quality model development, air quality program accountability, and future health studies. In January 2006, EPA proposed revisions to the ambient air monitoring regulations to reflect NCore, which are expected to be finalized in late 2006. Information on the notice of proposed rulemaking for these revisions can be viewed at www.epa.gov/ttn/amtic/40cfr53.html.

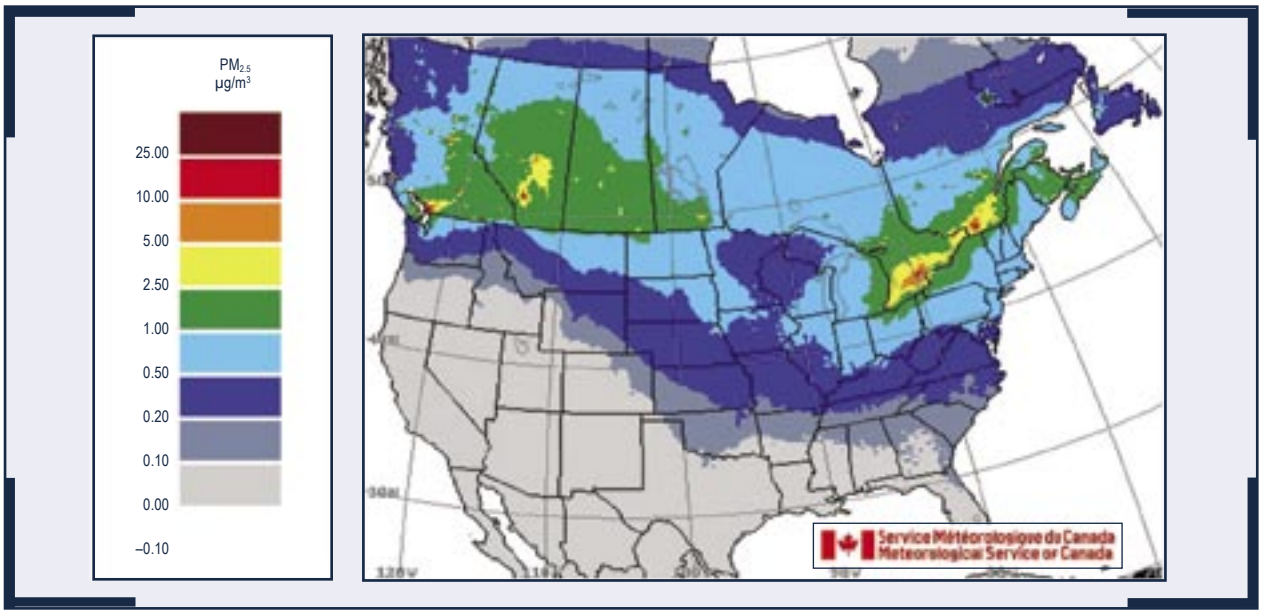
Update to the Transboundary Particulate Matter Science Assessment

In addition to the work carried out under the Transboundary PM Science Assessment (published in 2004), additional model scenarios have been carried out through the Canadian Meteorological Centre in Dorval, Quebec. For example, the CHRONOS model was applied for the summer of 2003 to determine the extent of the influence that Canadian emissions have on ambient PM in the United States.

Using the 0.2 $\mu g/m^3$ limit as a guide (it is used under the U.S. CAIR) to determine if one jurisdiction contributes significantly to another's nonattainment of the average annual $PM_{2.5}$ standard, the work demonstrates the influence of Canadian emissions on U.S. $PM_{2.5}$ levels. The influence of Canadian emissions on the United States extends significantly into the entire east coast of the United States as well as the Midwest and to a lesser extent the west coast (Figure 32).

Figure 32

Composite Map of the Influence of Canadian Emissions (U.S. Emissions Zeroed Out) on $PM_{2.5}$ Levels in the United States during the Summer of 2003



Source: Environment Canada

Health Effects

Health Canada has launched two research programs to characterize air pollution exposure and human health issues under the Canadian portion of the Border Air Quality Strategy, coordinated with research in the United States. Work has also continued on development of air health indicators, both for real-time reporting (Air Quality Health Index (AQHI)) and for development of a method for tracking health improvements due to changing air quality in the border area.

Research in the Great Lakes Basin Airshed

Health-related research activities in the Great Lakes basin airshed include the following:

- **Windsor Children's Respiratory Health Study:** This three-phase study targets a sensitive population in an area with relatively high air pollution. The first phase (December 2004) was a baseline questionnaire survey of approximately 20,000 Windsor elementary school students. The second phase (June 2005) involved cross-sectional tests of children's lung function and inflammation, and the third (December 2005) involved month-long daily lung function tests of 200 asthmatic children for correlation with outside air pollution. Data analyses are under way.
- **Windsor Exposure Assessment Study:** This project has two components. The first

is a spatial air pollution assessment study (2004–2007), which determines community levels of air pollutants such as PM, NO_2, SO_2, ozone, nitrate, elemental carbon/organic carbon, VOCs, polycyclic aromatic hydrocarbons, and acid vapor. The data from this study are used in support of the health research being carried out in the area. Methods for analysis include the geographic information system (GIS), which maps the area of influence for different pollutants. The second component of the project is to monitor personal exposure to air pollution, which matches the protocol of the EPA's Detroit Exposure and Aerosol Research Study (DEARS) in methodology. Healthy and non-smoking adults (2005) and school children (2006–2007) have been recruited to monitor air pollution levels in their indoor and outdoor environments and their personal exposure levels. The last test is scheduled for summer 2007.

- **Long-term Exposure to Air Pollutants and Mortality and Morbidity Rates including Cancer:** Mortality and morbidity rates for Windsor, Sarnia, and London since the late 1970s have been compared with Ontario provincial rates; the association with air pollution is now under investigation using GIS techniques.
- **Cardiovascular Effects of Air Pollution on Diabetic Patients:** The Windsor Diabetic Patients Panel study involves following diabetic patients for seven weeks to monitor their personal exposure to PM_{10} and their cardiovascular health markers. The results suggest that an acute exposure to particulate air pollution may be linked to an impaired cardiovascular function in diabetic patients.
- **Seniors' Health Study:** The Windsor Seniors' Health Study is investigating day-to-day indoor and outdoor exposure to varying levels of air pollutants and the influence on their cardiovascular function.
- **Pregnant Women and Birth Outcomes Study:** This is a feasibility study of pollution exposure and health and birth outcomes for 10 pregnant women in the area of Ottawa, Ontario.
- **In Vitro Toxicology Study:** The cytotoxicity of components of PM to human epithelial cells is studied, using particle samples from specific Windsor locations.

Research in the Georgia Basin–Puget Sound International Airshed

The research is being carried out by the University of British Columbia, the University of Victoria, and the University of Washington. The research is coordinated through a partnership between Health Canada and the British Columbia Centre for Disease Control and includes the following studies:

- **Establishment of a Childhood Disease Cohort:** A birth cohort of 120,000 children born in the Georgia Basin airshed was established to evaluate the relationship between air pollution exposure and respiratory disorders. Preliminary analyses have shown an association between air pollution and bronchiolitis.
- **Birth Outcomes in the GVRD:** British Columbia Perinatal Database Registry and the British Columbia Linked Health Database are being used to relate maternal air pollution exposure during pregnancy and adverse birth outcomes.
- **Personal Exposures and Activity Patterns of Pregnant Women and Infants:** Data have been collected on personal exposure, activity information, and exposure to traffic for 20 pregnant women (with a target of 40) as a function of stage of pregnancy and season.
- **Cardiovascular Cohort Study:** The British Columbia Linked Health Database is being used to enumerate a cohort of adults over the age of 45 in the Georgia Basin, to investigate the relationship between air pollution and cardiovascular disease among age groups independent of predisposing condition and among high-risk populations.
- **Walkability Study:** This GIS study will integrate land use and transportation network information to link walkability and emissions exposure, for ultimate application to Vancouver and Seattle.

- **Data Inventory and Consolidation:** A data inventory website has been developed (www.geog.uvic.ca/AIR) linking existing GIS information to facilitate estimation of individual exposure to air pollution. Data gaps and opportunities for improvement of data utilities have been identified.
- **Regional Infiltration Modeling:** Building characteristics from property assessment data are being used to develop a model of indoor versus ambient $PM_{2.5}$ levels for exposure assessment, validated by a monitoring campaign.
- **Modeling $PM_{2.5}$ with MODIS:** Satellite aerosol measures will be used to study temporal and spatial levels of $PM_{2.5}$.
- **Modeling Population Exposure:** A probabilistic model of personal exposures will be developed using GIS and randomly selected time–activity patterns, to assess errors in cohort exposures.
- **Enhanced Assessment of Exposure to Traffic and Wood Smoke:** Related technologies including GIS and monitoring campaigns were used to develop modeled and validated exposure estimates to the urban neighborhood scale for health studies and air quality management.
- **Particulate Matter Exposure and Infant Health in Puget Sound:** This study involves monitoring of a birth cohort for traffic and woodsmoke pollution using individualized geospatial exposure estimates to relate birth outcomes and air pollution.

Canadian Air Quality Health Index

In 2006, a comprehensive proposal for a new AQHI will be presented for approval of a multistakeholder steering committee. The AQHI is intended to replace existing indices for public reporting in use across Canada, all of which are based on a design from 1976, which does not reflect the current understanding of short-term health effects of air pollution. The index employs a linear, no-threshold concentration–response relationship of short-term health risks from multiple pollutants, expressed in a 0–10+ scale. Work to develop the AQHI started in 2001 in a multistakeholder context and has involved surveys and focus groups in 2004 and 2005 to develop communications messaging and more recent pilot testing of the proposed new index.

Canadian Air Health Indicator

A health indicator was proposed in May 2005, which may be used as a measure of progress in air quality management over time. The Air Health Indicator (AHI) is defined as the percentage of the number of daily deaths attributable to exposure to the pollutant of interest. The AHI is proportional to the level of risk, estimated using an appropriate statistical model, and the level of the pollutant of interest. The AHI may be used to evaluate spatial and temporal trends of air pollution and the related health risk in Canada since 1981. More analyses are being conducted to refine the methodology.

U.S. Report on Health Effects of Ozone

The health and welfare effects of ozone are documented and critically assessed in the EPA Ozone Criteria Document and EPA Ozone Staff Paper. At the end of February 2006, the final draft of the revised Ozone Criteria Document was released to the public. The final Ozone Criteria Document can be found at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=149923.

The purpose of this revised document, titled *Air Quality Criteria for Ozone and Other Photochemical Oxidants*, is to critically evaluate and assess the latest

scientific information published since the last review of the ozone NAAQS, completed in 1996. This new 2006 review focuses on useful new information that has emerged in the last decade and is pertinent in evaluating health and environmental effects data associated with ambient air ozone exposures. A separate EPA Ozone Staff Paper, prepared by EPA's Office of Air Quality Planning and Standards, will draw upon key findings/conclusions from this document, together with other analyses, to develop and present options for consideration by the EPA Administrator regarding review and possible revision of the ozone NAAQS.

There has been new research that suggests additional health effects beyond those that had been known when the 8-hour ozone standard was set in 1997. Since 1997, more than 1,700 new health and welfare studies relating to ozone have been published in peer-reviewed journals. Many of these studies have investigated the impact of ozone exposure on such health effects as changes in lung structure and biochemistry, inflammation of the lungs, exacerbation and causation of asthma, respiratory illness–related school absence, hospital and emergency room visits for asthma and other respiratory disorders, and premature mortality.

Ozone can irritate the upper and lower respiratory system, causing cough, throat irritation, and/or discomfort (e.g., pain) in the chest. Ozone can reduce lung function, cause wheezing, and make it more difficult to breathe deeply. During exercise, breathing may become more rapid and shallower than normal, thereby limiting a person's normal activity. Ozone can also aggravate asthma, leading to more asthma attacks that require a doctor's attention and/or the use of additional medication. In addition, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue, irreversible reductions in lung function, and a lower quality of life if the inflammation occurs repeatedly over a long period. People who are particularly vulnerable to ozone exposures include children, the elderly, and adults who are active outdoors (e.g., outdoor workers).

Aggravation of existing asthma resulting from short-term ambient ozone exposure was reported prior to setting the 1997 ozone standard and has been observed in studies published subsequently. In addition, a relationship between long-term ambient ozone concentrations and the incidence of new-onset asthma in adult males (but not females) was reported. Subsequently, an additional study suggested that incidence of new diagnoses of asthma in children is associated with heavy exercise in southern California communities with high ozone concentrations. This relationship was documented in children who played three or more sports and thus spent more time outdoors. It was not documented in those children who played one or two sports. Previous studies have shown relationships between ozone and hospital admissions in the general population. A study in Toronto reported a significant relationship between 1-hour maximum ozone concentrations and respiratory hospital admissions in children under the age of two. Given the relative vulnerability of children in this age category, there is particular concern about these findings. Increased rates of illness-related school absenteeism have been associated with 1-hour daily maximum and 8-hour average ozone concentrations in studies conducted in Nevada. These studies suggest that higher ambient ozone levels may result in increased school absenteeism.

The air pollutant most clearly associated with premature mortality is PM, with dozens of studies reporting such an association. However, repeated ozone exposure is a possible contributing factor for premature mortality, causing an inflammatory response in the lungs that may predispose elderly and other sensitive individuals to become more susceptible to other stressors, such as PM. The findings of other recent analyses provide evidence that ozone exposure is associated with increased mortality. Most recently, new analyses of the 95 cities in the National Morbidity, Mortality, and Air Pollution Study (NMMAPS) data sets showed associations between daily mortality and the previous week's ozone concentrations, which were robust to adjustment for PM, weather, seasonality, and long-term trends. Although earlier analyses undertaken as part of the NMMAPS did not report an effect of ozone on total mortality across the full year, the NMMAPS investigators in those earlier studies did observe an

effect after limiting the analysis to summer, when ozone levels are highest. Another recent study from 23 cities throughout Europe also found an association between ambient ozone and daily mortality.

Numerous recent epidemiological studies have reported associations between acute ozone exposure and mortality, as summarized in the Ozone Criteria Document.

Review of U.S. Ozone and Particulate Matter Air Quality Standards

EPA is currently reviewing the NAAQS for ozone; more information, including supporting documents, can be found at www.epa.gov/ttn/naaqs/standards/ozone/s_o3_index.html.

EPA reviewed the NAAQS for PM. PM is the generic term for a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. Particles may be emitted directly or formed in the atmosphere by transformation of gaseous emissions such as SO_x, NO_x, and VOCs. Exposure to PM has been associated with premature morbidity as well as indices of morbidity, including respiratory hospital admissions and emergency department visits, school absences, work loss days, restricted activity days, effects on lung function and symptoms, morphological changes, and altered host defense mechanisms.

The nation's air quality standards for PM were first established in 1971 and were significantly revised in 1987, when EPA changed the indicator of the standards to regulate inhalable particles smaller than or equal to 10 microns in diameter (PM_{10}). In 1997, EPA revised the PM standards, setting separate standards for fine particles, defined as PM less than or equal to 2.5 microns ($PM_{2.5}$).

Recent epidemiological studies have continued to report associations between short-term exposures to fine particles and effects such as premature mortality, hospital admissions or emergency department visits for respiratory disease, and effects on lung function and symptoms. In addition, recent epidemiological studies have provided some new evidence linking short-term fine particle exposures to effects on the cardiovascular system, including cardiovascular hospital admissions and more subtle indicators of cardiovascular health. Long-term exposure to $PM_{2.5}$ and sulfates has also been associated with mortality from cardiopulmonary diseases and lung cancer and effects on the respiratory system, such as decreased lung function or the development of chronic respiratory disease.

Epidemiological studies have also continued to support a relationship between short-term exposure to thoracic coarse particles and respiratory morbidity, with effects ranging from increased respiratory symptoms to hospitalization for respiratory diseases. New data also suggest associations with effects on the cardiovascular system and possibly with mortality.

There are several groups that may be susceptible or vulnerable to PM-related effects. These include individuals with preexisting heart and lung disease, older adults, and children.

The final revisions to the NAAQS for PM strengthen the short-term fine particle standard and retain the 24-hour PM_{10} standard for coarse particles. Information on the standards can be found at www.epa.gov/air/particles/standards.html.

U.S. Health Research

Health research in the United States has focused primarily on PM in recent years. EPA has a well-established health research program, consistent with the recommendations of the National Research Council's Committee on Research Priorities for Airborne Particulate Matter. The air health research program is directed towards two main objectives: reducing uncertainties in setting standards for protection of human and ecological health, and linking health effects to specific source types and PM attributes through an integrated multipollutant program.

Characterizing the hazardous component of PM is critically important to reducing uncertainties in setting future air quality standards and implementing those standards. Studies of the health effects associated with ambient and surrogate PM provide insights into the relative toxicity and mechanisms that relate to specific sources. Multi-city epidemiological and toxicological studies coordinated with the National Ambient Air Monitoring Strategy frame a systematic approach that integrates laboratory and field data to assess the health impacts of mixed components and sources. Research focuses on identifying susceptible groups with cardiovascular disease and diabetes and related animal models to address specific risk attributes (e.g., gene–environment, debilitation). EPA research efforts include a new cohort study to evaluate the long-term effects of ambient fine particles, currently responsible for the largest measurable benefits of PM regulation. Research to characterize mobile source roadway exposures and risks and reduce uncertainties associated with complex atmospheres (e.g., PM hazardous components, source attribution, co-pollutants, etc.) is under way.

There are several research studies taking place in the Detroit–Windsor area, coordinated with Canadian research efforts. They include DEARS, children's health studies focusing on characterizing the effects of environmental pollutants on asthma, and toxicological particle studies to characterize PM effects. These efforts are aimed at linking health effects to specific source types and PM attributes.

Acid Deposition Effects

Aquatic Effects Research and Monitoring

An assessment of the most recent information available on acid deposition effects on aquatic chemistry and biota in Canada was recently completed and summarized in the *2004 Canadian Acid Deposition Science Assessment*.[3] The assessment reveals a decreasing trend in lake sulfate levels in southeastern Canada in response to reductions in SO_2 emissions; however, many of these lakes are still acidified, and many do not meet a pH condition of ≥6, a key threshold for the sustenance of fish and other aquatic biota. Some of the factors believed to be mitigating changes in surface water quality include the widespread decline in base cations from watershed soils, the release of stored sulfur from soils (i.e., drought induced), and the impairment of within-lake alkalinity generating processes.

Overall improvements in the capacity of many lakes to support aquatic biota are being observed. For instance, a general increase in the number of breeding fish-eating waterbirds was observed in lakes in Ontario, Quebec, and Newfoundland, particularly those in close proximity to reduced emission sources. At the same time, algae, invertebrates, and waterbird food chains in many lakes in this region continue to show acidification impacts (i.e., direct effects of acidification, metal toxicity, loss of prey species, and reduced nutritional value of remaining prey), particularly in lakes and rivers where fish communities have been impacted. Atlantic salmon populations in rivers of the Southern Upland region of Nova Scotia continue to be severely impacted and will likely become extinct if adult survival rates remain at current low levels and pH recovery continues to be delayed.

[3] Jeffries, D.S., McNicol, D.K., and Weeber, R.C. (2005) Chapter 6: Effects on aquatic chemistry and biology. In: *2004 Canadian Acid Deposition Science Assessment* [CD-ROM]. Available from Environment Canada.

Biological recovery is very complex; therefore, complete community recovery will lag behind chemical improvements, possibly by several decades. It is also likely that lakes will recover to a state that is more dilute (lower ion concentrations and therefore more sensitive) than their preacidification state, and biological communities will be permanently altered.[4]

Terrestrial Effects Research

The effects of acid deposition on soils and forests were also assessed and summarized in the *2004 Canadian Acid Deposition Assessment*.[5] The net loss of base cations from forested catchments in eastern Canada has slowed down in response to declines in sulfate deposition, yet widespread net losses are still occurring. Weathering inputs of base cations are not sufficient to balance leaching losses, particularly for calcium. Also, there is mounting evidence regarding the relationship between the size of base cation reservoirs in forested watersheds and the acidification of surface waters as well as the lack of recovery of pH levels. Also, the negative effects of decreased fertility on tree vitality are becoming increasingly supported by recent studies. The threat to the productivity of eastern Canadian forests that are located in poorly buffered soils is of concern. Quantifying the relationship between acid deposition, base cation depletion, and forest health is difficult due to a number of confounding factors related to site conditions. Further research is needed to elucidate this relationship.

The assessment also reveals that eastern Canadian watersheds are exhibiting releases of sulfur from soils in excess of deposition. Two internal catchment sources, sulfate desorption and release via decomposition of organic matter, are considered the likely causes for the budget imbalance. The release of this extra sulfur acts as an additional acid load for soils and downstream waters and may be partly mitigating the recovery of surface waters in eastern Canadian forested watersheds.

Nitrogen, on the other hand, is an essential nutrient for tree growth that is often limiting in eastern Canadian ecosystems; thus, nitrogen saturation does not appear to be a problem in most eastern Canadian watersheds. Some signs of nitrogen saturation have been observed in watersheds in Ontario, which highlights the importance of continuing to monitor changes in nitrogen concentrations. In eastern Canadian watersheds, sulfate continues to be the primary acidifying agent.

Critical Loads and Exceedances

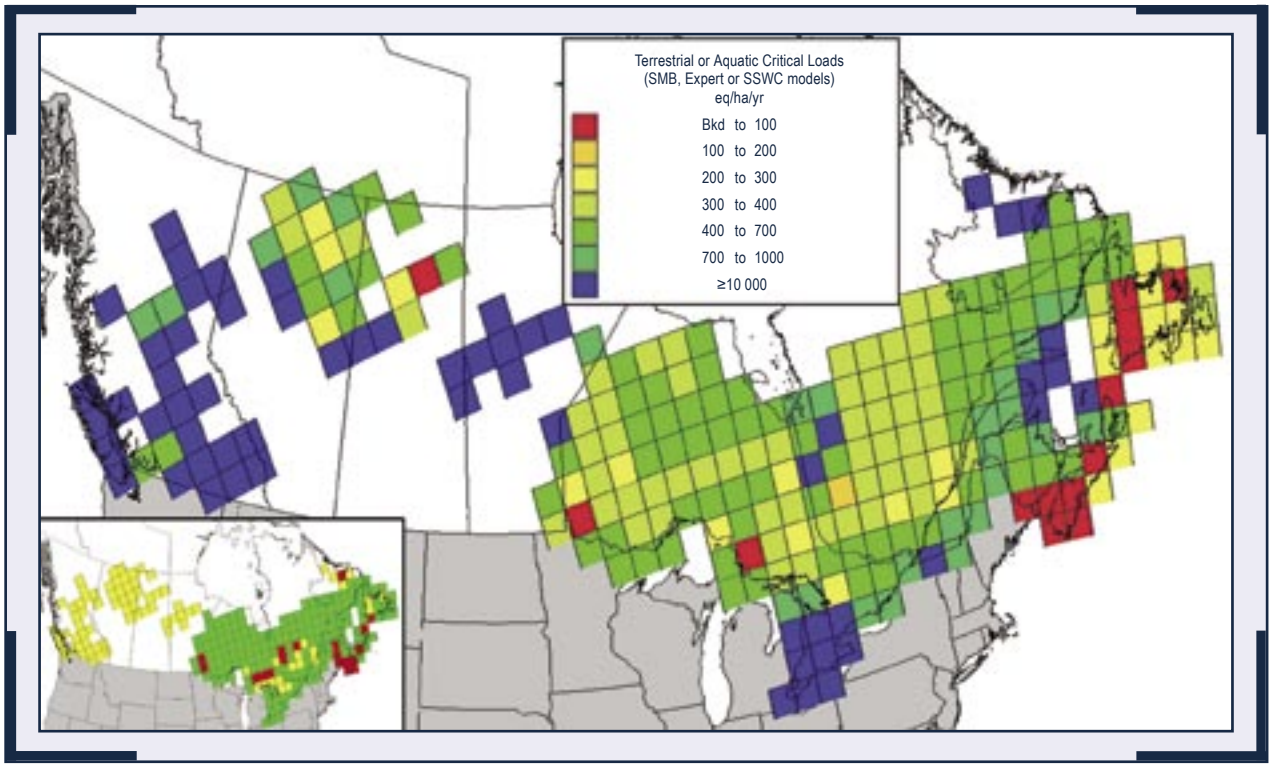
The critical load of acid deposition is defined as the maximum deposition that an ecosystem can assimilate without significant long-term harmful effects. Deposition of both nitrogen and sulfur compounds can contribute to a critical load exceedance, which has been used in Canada as the primary indicator of potential long-term environmental damage. For the first time in North America, new and combined critical load estimates have been generated for sulfur and nitrogen acid deposition for both sampled surface waters and upland forest soils using steady-state models (Figure 33). Since sulfur and nitrogen have different atomic weights, the combined critical load cannot be expressed in mass units (kilograms per hectare per year, or kg/ha/yr); instead, it is expressed in terms of ionic charge balance as "equivalents per hectare per year" (eq/ha/yr). Twenty kilograms of sulfate per hectare per year is the same as 416 eq/ha/yr.

[4] Weeber, R.C., Jeffries, D.S., and McNicol, D.K. (2005) Chapter 7: Recovery of aquatic ecosystems. In: *2004 Canadian Acid Deposition Science Assessment* [CD-ROM]. Available from Environment Canada.

[5] Houle, D. (2005) Chapter 5: Effects on forests and soils. In: *2004 Canadian Acid Deposition Science Assessment* [CD-ROM]. Available from Environment Canada.

Figure 33

Critical Loads of Acid Deposition for Canada



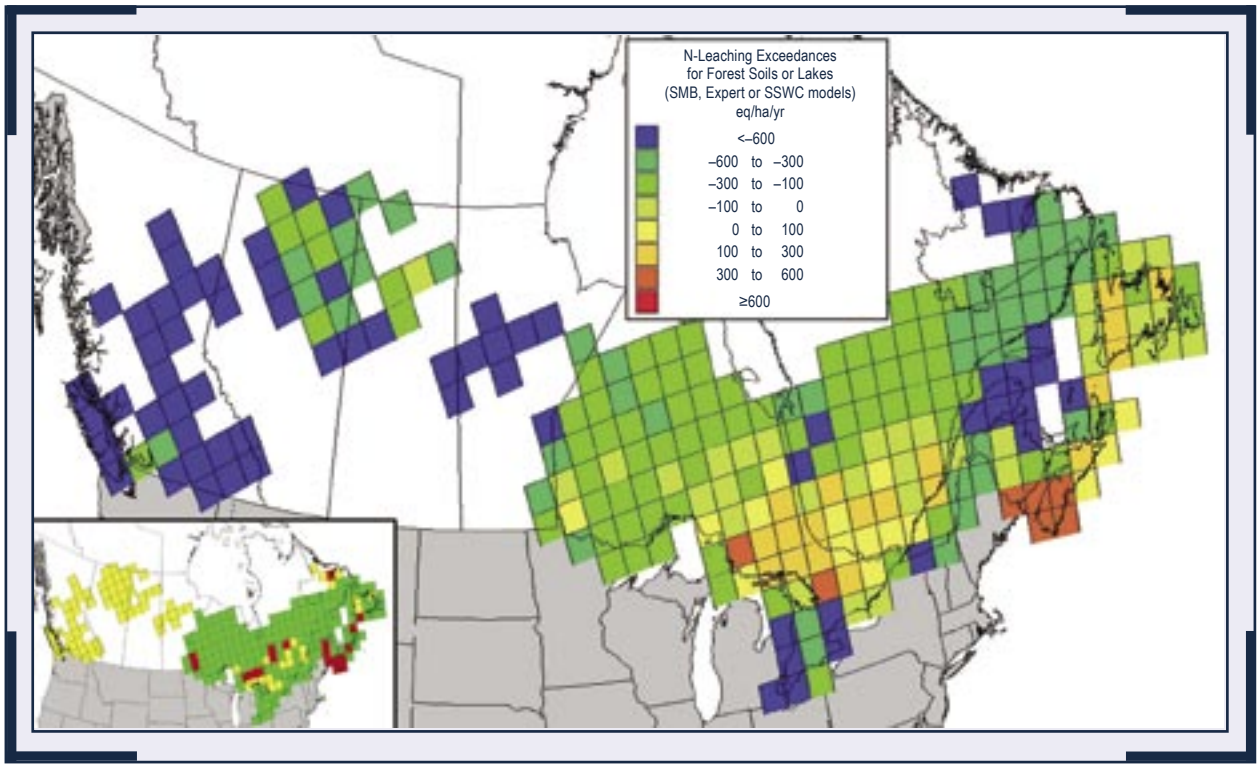
Note: Critical (maximum) loads of combined total sulfur and nitrogen acidity for Canada in equivalents/hectare/year calculated using a model appropriate to the receptor. The value for each grid cell represents the lowest of either the 5th percentile lake value or the 5th percentile soil polygon value. The index map (lower left) indicates which model was used for the grid cell value (red = Expert, yellow = Steady State Water Chemistry (SSWC), green = Simple Mass Balance (SMB)).

Source: Jeffries, D.S. and Ouimet, R. (2005) Chapter 8: Critical loads: Are they being exceeded? In: *2004 Canadian Acid Deposition Science Assessment* [CD-ROM]. Available from Environment Canada.

Exceedance calculations confirm that 21–75 percent of the mapped area in eastern Canada, corresponding to approximately 0.5–1.8 million square kilometers, continues to receive levels of acid deposition in excess of critical loads according to best- and worst-case assumptions of nitrogen-based acidification, respectively. The optimistic end of the range (Figure 34) estimates the current (minor) level of nitrogen-based acidification, whereas the pessimistic end of the range (Figure 35) offers a long-term view by assuming steady-state conditions in which all sulfur and nitrogen deposition is acidifying; in other words, nitrogen uptake no longer occurs due to ecosystem saturation.

Figure 34

Current Critical Load Exceedances for Canada



Note: Exceedance of critical loads of acidic deposition (eq/ha/yr of sulfur and nitrogen combined) based on current levels of nitrogen-based acidification. A negative exceedance indicates that the estimate of current deposition is less than the grid cell critical load. A positive critical load is indicative of ongoing environmental damage. Details as in Figure 33.

Source: Environment Canada

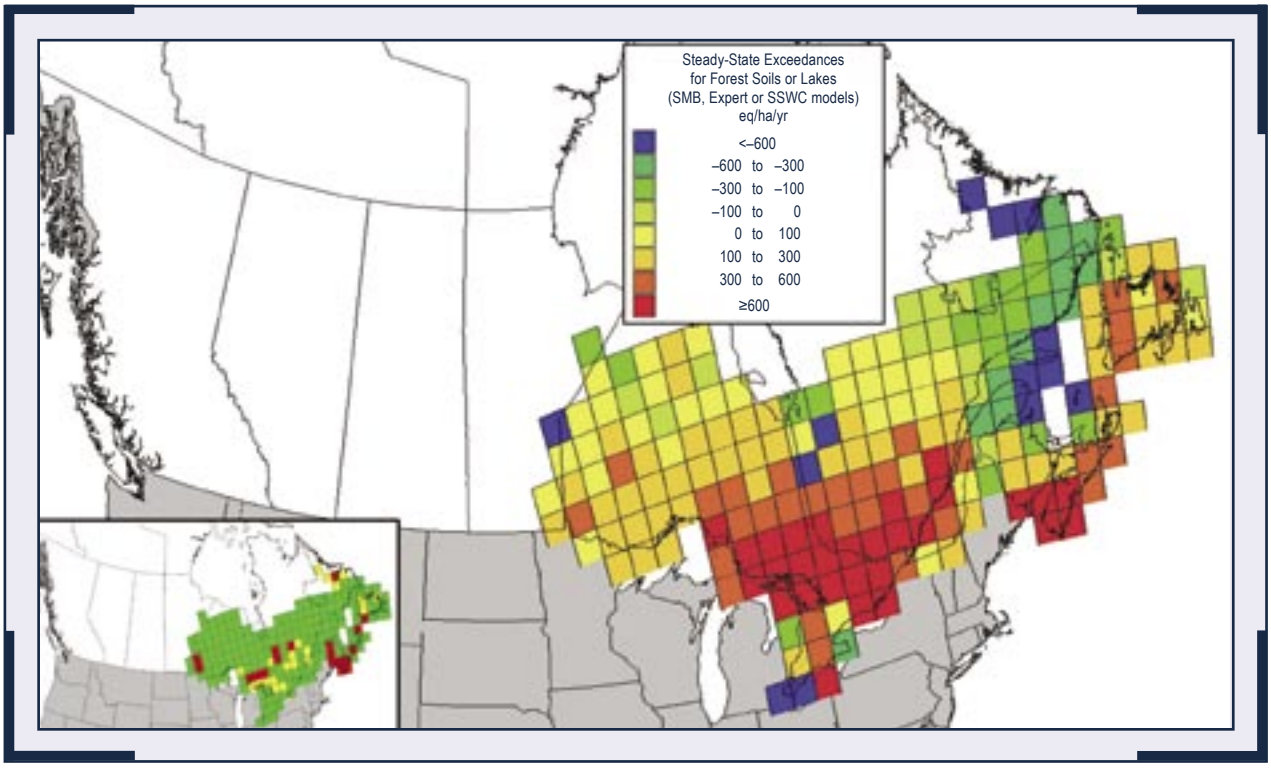
The Acid Deposition and Oxidant Model (ADOM) modeling results[6] show that a further 75 percent reduction in SO_2 emissions is required to meet sulfur critical loads for aquatic ecosystems, as published in the 1997 Acid Rain Assessment. Similar results are not yet available in terms of reductions needed to achieve new critical load values (Figure 33); however, given that new critical load estimates are lower than 1997 estimates in many areas and higher in a few areas, a reduction of 50–75 percent could be required to meet the newer critical loads.

Since the development of the above maps, new critical load and exceedance estimates have become available for forests in the provinces of Manitoba and Saskatchewan, funded by the CCME Acid Rain Task Group. Similar calculations for the Georgia Basin (British Columbia) and Alberta are in progress.

[6] Moran, M.D. (2005) Chapter 4: Current and proposed emission controls: How will acid deposition be affected? In: *2004 Canadian Acid Deposition Science Assessment* [CD-ROM]. Available from Environment Canada.

Figure 35

Long-term View of Critical Load Exceedances for Canada



Note: Exceedance of critical loads of acidic deposition (eq/ha/yr of sulfur and nitrogen combined) calculated using estimated current deposition and grid cell critical loads recomputed using the steady-state assumption of nitrogen saturation. In most areas, the environmental capacity to absorb nitrogen is not yet exhausted. A positive exceedance indicates that current deposition either is causing environmental harm or will do so eventually if it continues at the same level. Details as in Figure 33.

Source: Environment Canada

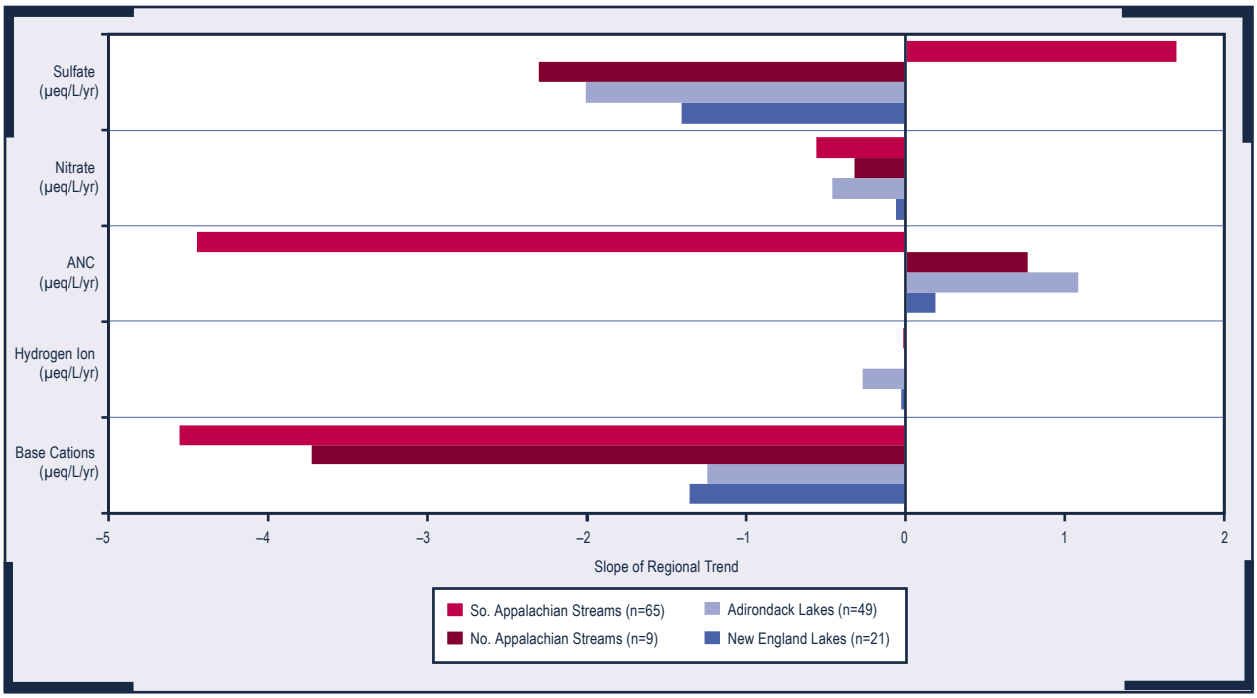
Recovery of Acidified Lakes and Streams

Acid rain is only one of many large-scale anthropogenic effects that are affecting lakes and streams in the United States. Climate variability, forest maturation, biological disturbances (e.g., pest outbreaks), and land use change can have an impact on ecosystems that are also affected by acid deposition. Nonetheless, scientists have demonstrated measurable improvements in some lakes and streams resulting from the Acid Rain Program. Scientists studied lakes and streams in four regions—New England, the Adirondack Mountains, the northern Appalachians (including the Catskill Mountains), and the southern Appalachians (including the Blue Ridge)—and found signs of recovery in many, but not all, of those areas (see Figure 36). These signs of recovery include reductions in sulfate and aluminum concentrations (see Table 2) and decreases in acidity. For example, 48 out of 49 monitored Adirondack lakes showed reductions in sulfate concentrations that correlate with reductions in atmospheric concentrations of sulfur. These reductions in sulfate, as well as reductions in nitrate concentrations that do not appear to be due to changes in atmospheric deposition, have resulted in increased pH and acid neutralizing capacity (ANC, an indicator of aquatic ecosystem recovery) as well as reductions in the amount of toxic inorganic aluminum in Adirondack lakes.

Increasing ANC was evident in two of the regions studied (Adirondacks and northern Appalachians). One-quarter to one-third of lakes and streams in these regions previously affected by acid rain are no longer acidic at base flow conditions, although they are still highly sensitive to future changes in deposition.

Figure 36

Regional Trends in Lake and Stream Acidification, 1990–2004



Note: Bars show the magnitude of the regional trend for each variable in each region.

Table 2

Results of Regional Trend Analyses on Lakes and Streams, 1990–2004

	Concentrations (µeq/L per Year)*						
	Sulfate	Nitrate	ANC	Base Cation	Hydrogen	Organic Acids	Aluminum
New England Lakes (n=21)	**–1.4**	**–0.02**	+0.18	**–1.35**	**–0.02**	+0.02	insufficient data
Adirondack Lakes (n=49)	**–2.0**	**–0.45**	**+1.08**	**–1.24**	**–0.26**	**+0.15**	**–4.72**
Northern Appalachian Streams (n=9)	**–2.3**	**–0.31**	**+0.76**	**–3.73**	–0.01	–0.03	insufficient data
Southern Appalachian Streams (n=65)	**+1.7**	**–0.55**	**–4.44**	**–4.56**	–0.01	insufficient data	insufficient data

*Except for aluminum (µg/L per year).

Note: Values show the slope of the regional trend (the median value for the trends in all of the sites in the region). Regional trends that are statistically significant are shown in bold.

Improvements in Surface Water

Long-term monitoring networks provide information on the chemistry of lakes and streams, which allow us to look at how water bodies are responding to changes in emissions. The data presented here show regional trends in acidification from 1990 to 2004 in areas of the eastern United States. For each lake or stream in the network, measurements of various indicators of recovery from acidification were taken. These measurements were plotted against time, and trends for the given lake or stream during the 15-year period were then calculated as the change in each of the measurements per year (e.g., change in concentration of sulfate per year). Using the trends calculated for each water body, median regional

changes were determined for each of the measures of recovery. A negative value of the "slope of the regional trend" means that the measure has been declining in the region, whereas a positive value means it has been increasing. The greater the value of the trend, the greater the yearly change in the measurement. Movement towards recovery is indicated by positive trends in ANC and negative trends in sulfate, nitrate, hydrogen ion, and aluminum. Negative trends in base cations and positive trends in organic acids can balance out the decreasing trends in sulfate and nitrate and prevent ANC from increasing.

A summary of the findings of this analysis follows:

- Sulfate concentrations are declining substantially in all but one of the regions. Lakes and streams in the southern Appalachians show increasing concentrations of sulfate. This area is unusual, because its soils can store large amounts of the sulfate that is delivered by deposition. After large amounts of sulfate have accumulated in the soils, stream water sulfate concentrations begin to increase. The southern Appalachians is the only region where atmospheric deposition chemistry and the chemistry of lakes and streams are "decoupled."
- Nitrate concentrations are decreasing significantly in all of the regions, although the magnitude of these changes is small, especially in New England. It should be noted, however, that this does not appear to reflect changes in emissions or deposition in these areas and is likely a result of ecosystem adjustments that are not yet fully understood.
- As a result of declining sulfate (and to some extent nitrate), the acidity of lake and stream water is decreasing in three of the four regions. In the Adirondacks and northern Appalachians, ANC is increasing. In New England, ANC appears to be increasing only slightly and is not significant, but hydrogen ion concentrations are declining. Declining hydrogen ion concentrations represent an increase in pH, which is increasing significantly in the Adirondacks.
- Base cations are important, because they buffer the impact of sulfur and nitrogen deposition. Base cation concentrations in lakes and streams are expected to decrease when rates of atmospheric deposition decline; if they decrease too much, however, they limit recovery in pH and ANC. The high rates of base cation decline in the northern Appalachians may be of concern but do not currently seem to be preventing recovery. However, this indicator will bear watching in the future.
- Organic acids are natural forms of acidity. Lakes and streams vary widely in how much natural acidity they have, and increases in organic acids over time, like declining base cations, can limit the amount of recovery we observe. Organic acid concentrations are currently increasing in many parts of the world, but the cause is still being debated. Of the regions monitored by EPA, only the Adirondacks is showing significant increases in organic acids, and their increase may be responsible for 10–15 percent less recovery (in ANC) than expected.
- Most of the regions do not have sufficient aluminum data to estimate trends. Aluminum is a critical element, because it increases when lakes and streams acidify and is very toxic to fish and other wildlife. The one region where good aluminum data exist, the Adirondacks, is showing strong declines in the most toxic form of aluminum (inorganic monomeric aluminum).
- As mentioned above, the southern Appalachians is unusual, in both its physiography and its response to changing atmospheric deposition. Because sulfate is increasing strongly in this region, many of the other chemical variables (e.g., ANC and pH) show trends typical of acidifying conditions, rather than recovery.

Long-Term Environmental Monitoring at EPA

EPA's Temporally Integrated Monitoring of Ecosystems (TIME) and Long-Term Monitoring (LTM) programs are designed to detect trends in the chemistry of regional populations of lakes or streams and to determine whether emission reductions have had the intended effect of reducing acidification. TIME/LTM monitor a total of 145 lakes and 147

streams, representing all of the major acid-sensitive regions of the northern and eastern United States (New England, Adirondack Mountains, northern Appalachian Plateau (including the Catskill Mountains), and the Ridge/Blue Ridge Provinces of Virginia). TIME/LTM measure a variety of important chemical characteristics, including ANC, pH, sulfate, nitrate, major cations (e.g., calcium and magnesium), and aluminum. While the representativeness of the TIME/LTM network is somewhat limited, the TIME program is the most coherent individual regional data set for this kind of analysis. In addition, the U.S. Geological Survey has been measuring surface water quality at several research watersheds throughout the United States, where sample collection during hydrologic events and ancillary data on other watershed characteristics have been used to assess the watershed processes controlling acidification of surface waters.

As described elsewhere in this report, implementation of the Acid Rain Program has successfully and substantially reduced emissions of SO_2 and NO_x from power generation sources in the United States. As described in the National Acid Precipitation Assessment Program (NAPAP) 2005 Report to Congress (www.al.noaa.gov/AQRS/reports/napapreport05.pdf), however, recent modeling and many published articles indicate that SO_2 and NO_x emission reductions achieved under Title IV are now recognized as insufficient to achieve full recovery or to prevent further acidification in some regions. The studies described above support that conclusion, showing that environmental improvements have been slow in many sensitive areas and that signs of recovery still are not evident in some areas. The NAPAP Report to Congress concluded that additional SO_2 and NO_x emission reductions from power plants and other sources are necessary to decrease deposition and further reduce the number of acidic lakes and streams in many regions of the United States. Additional emission reductions will be achieved through implementation of existing and future regulations to address transport of ozone and fine particles and mercury deposition, including the NO_x SIP Call in the eastern United States; Tier 2, Tier 3, and diesel rules affecting mobile sources; SIPs to achieve the ozone and fine particle NAAQS; and the recent Clean Air rules to reduce interstate transport of fine particles and ozone, mercury, and regional haze from power plants.

Conclusion

Canada and the United States work to fulfill the obligations set forth in the Air Quality Agreement. Both countries' efforts to reduce acid rain and control ground-level ozone through the Agreement have been significant. 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 Canada–United States transboundary region.

The Canada–U.S. Air Quality Agreement has been in place for 15 years and has proven to be a flexible and dynamic mechanism for bilateral environmental cooperation in reducing transboundary air pollution. The initial focus of the Agreement was on reducing emissions of sulfur dioxide and nitrogen oxides, the major contributors to acid rain. Both Canada and the U.S. have surpassed the emission reduction requirements in the Agreement. The Ozone Annex was added to the Air Quality Agreement in 2000 to address the transboundary flows of ground-level ozone and precursor pollutants, NO_x and VOCs. Both countries are on track to meet their emission reduction obligations in the Ozone Annex as outlined in the 2006 Progress Report.

A hallmark of the Agreement's organization is its two subcommittees, one to manage program monitoring and reporting and the other to oversee scientific and technical cooperation and research. Projects and efforts undertaken by these groups foster greater integration of methods and shared ideas between the two countries. Relationships spawned by the opportunities of technical staff to interact have produced more complete emission inventories, new air quality models, research reports, and regular discussions and collaboration. The importance of these relationships in the effectiveness of the Air Quality Agreement cannot be overstated.

The Air Quality Agreement will continue to serve as the primary mechanism to pursue further efforts to improve transboundary air quality, such as the consideration of a Particulate Matter Annex, including the geographic scope of such an annex; examination of cross-border emissions cap and trade; and joint modeling and analyses to support many of these areas.

Canada–U.S. Air Quality Agreement Review:

Third Comprehensive Assessment

Introduction

The purpose of the Air Quality Agreement (AQA or Agreement) Article X, "Review and Assessment of the Canada–United States Air Quality Agreement," is to ensure that the Parties periodically review and assess the Agreement to determine whether it is accomplishing its intended goals and whether it remains a practical and effective instrument to address shared concerns regarding transboundary air pollution. It requires the Parties to "conduct a comprehensive review and assessment of [the] Agreement, and its implementation, during the fifth year after its entry into force and every five years thereafter..."

The first AQA Assessment, conducted in 1996, addressed the question of whether the AQA was a good mechanism for fulfilling transboundary air obligations and outlined strengths and weaknesses of the Agreement in an article-by-article review. The first review also provided a summary of public comments from two 1995 meetings sponsored by the IJC for the purpose of soliciting public input on the biennial progress reports.

The second AQA Assessment, in 2002, occurred subsequent to the negotiated amendments contained in the Ozone Annex. These amendments had already addressed key issues in the Agreement of interest to the Parties. Therefore, the second AQA Assessment attended to the issues raised in the first review and outlined where progress had been made, while indicating where challenges continued to exist.

This third AQA Assessment responds to several deferred issues from previous reviews, in addition to highlighting progress on several topics and outlining future areas of potential focus. The review will also summarize and address comments made by the public and provided to the IJC in response to the 2004 Progress Report.

Issues Raised

1. What is the purpose of the Agreement? Have the Parties been successful in fulfilling their obligations under the Agreement and attending to its mission?

The U.S.–Canada AQA was signed in 1991 to serve as a dynamic mechanism for binational environmental cooperation to address transboundary air pollution. The Air Quality Committee (Committee) is made up of members of several federal agencies from both countries as well as state and provincial representatives and includes two subcommittees: the Subcommittee on Program Monitoring and Reporting and the Subcommittee on Scientific Cooperation. Acid Rain and Scientific Cooperation annexes were part of the original Agreement, as Annexes 1 and 2, created in 1991, and the Ozone Annex was added in 2000 as Annex 3.

The Agreement continues to function as the primary vehicle for transboundary cooperation on air issues, and both Parties are committed to honoring the obligations negotiated therein. The Agreement has made substantial progress in reducing emissions and deposition of acid rain and ozone precursors in the border region (see Section 1: Commitments, Acid Rain Annex and Ozone Annex of this 2006 Progress Report for details) and maintains the flexibility to address additional concerns. As of 2005, the United States has reduced total SO_2 emissions by 11.3 million tons, or 44 percent, from 1980 levels, and power plant SO_2 emissions by 5.5 million tons, or 35 percent, since 1990. Similarly, as of 2004, Canada has reduced SO_2 emissions by 2.3 million tonnes, or 50 percent, since 1980.

These significant reductions are a result of programs in both countries to control emissions and mirror the commitments made by both Parties in the Acid Rain Annex of the AQA. Canada continues to keep national SO_2 emissions below the 3.2 million tonne cap, while power industry facilities in the United States are well on their way to meeting the 8.95 million ton cap by 2010.

As new issues emerge and new assessments of specific pollutants are made, the Agreement has provided an effective mechanism to tackle these air pollution issues collaboratively. With a firm foundation based on joint scientific assessment of transboundary ozone and PM, the establishment of the Ozone Annex in 2000 and the ongoing discussions regarding a potential PM annex are examples of the success of the Agreement as a mechanism to effectively consider and address transboundary air issues.

In addition to the commitments negotiated in the Agreement, the Committee is dedicated to assisting regional and issue-specific organizations working to reduce transport of air pollution in the United States and Canada. The Committee supports several projects along the border by providing resources and expertise and by organizing information-sharing opportunities, such as the recent "Symposium on Ecosystem Response and Recovery" held at the Ecological Society of America's annual conference in Montreal.

While the Agreement has achieved success on many fronts, continued collaboration between the two Parties will achieve further progress in health and ecosystem protection, regional and geographic concerns, data and monitoring issues, public involvement, visibility protection, and innovation.

2. Are current sulfur dioxide, nitrogen oxides, and ozone objectives sufficient for the protection of human health and for recovery of ecosystems?

The first AQA Assessment in 1996 questioned the ability of objectives in the Agreement to adequately protect human health and ecosystems, with a specific focus on the effects of ozone. The Committee responded by conducting a joint scientific assessment of transboundary ozone and consequently negotiated and finalized an Ozone Annex in 2000.

Even with the creation of the Ozone Annex and the substantial emission reductions in both countries, concern was expressed again in the second assessment in 2002, and in public comments in response to the 2004 Progress Report, that the Agreement did not go far enough to reduce SO_2 and NO_x emissions to protect human health and to ensure ecosystem recovery.

Recent analyses show that much progress has been achieved, but that work remains to be done to reduce the harmful effects of SO_2, NO_x, and ozone. The *2004 Canadian Acid Deposition Science Assessment* synthesizes Canada's acid deposition science and provides a comprehensive examination of atmospheric and ecosystem responses to the reductions in SO_2 emissions. This report concludes that while much has been accomplished to reduce the impact on human health and the environment, the problem of acid deposition is not yet fully resolved.

Regarding ecosystem protection in the United States, the *National Acid Precipitation Assessment Program (NAPAP) 2005 Report to Congress: An Integrated Assessment* described recent modeling and numerous published articles that show that SO_2 and NO_x emission reductions achieved under Title IV are insufficient to achieve full recovery or to prevent further acidification in some regions. The NAPAP report concluded that additional SO_2 and NO_x emission reductions from power plants and other source sectors are necessary to decrease deposition and further reduce the number of acidic lakes and streams in many regions of the United States.

In 2000, the federal and provincial/territorial governments endorsed the Canada-wide Standards for PM and ozone in recognition of the significant adverse effects on health and the environment associated with these pollutants. The Canada-wide Standards were recognized as a first step towards the long-term goal of minimizing the impacts of these pollutants on human health and the environment. The Canada-wide Standards establish numeric targets for ambient levels of fine particles ($PM_{2.5}$) and ozone that jurisdictions have committed to achieve by 2010. $PM_{2.5}$ and ozone are pollutants for which there are no lower ambient levels that are entirely without health effects. This means that any reduction in the ambient levels of these pollutants provides an associated reduction in population health risk.

Among the provisions in the Canada-wide Standards, the federal and provincial/territorial governments are to participate in a review of the standards in 2005 and 2010 and to revise the standards, if appropriate, for years beyond 2015. The first review of the Canada-wide Standards was completed by 2005 and concluded that no revision to the standards was required.

In recognition of the need for further protection of human health, EPA revised the NAAQS for PM in September, 2006, to strengthen the short-term fine particle standard. Recent epidemiological studies have continued to report associations between short-term exposures to fine particles and effects such as premature mortality, hospital admissions or emergency department visits for respiratory disease, effects on lung function and symptoms, and effects on the cardiovascular system.

Moreover, both Canada and the United States have promulgated new regulations to further reduce SO_2, NO_x, and ozone. These include tighter regulations for major acid rain–causing emission sources in several eastern provinces (Nova Scotia, Quebec, and Ontario) in Canada and the new emission reductions associated with the CAIR, the Clean Air Mercury Rule (CAMR), and the Clean Air Visibility Rule (CAVR) in the United States.

Potential areas of work for the Committee include examining the use of critical loads in the United States, particularly for assessment purposes, as mentioned in the 1996 assessment, as well as revised ecological goals (particularly to assess the role of NO_x emissions in transboundary pollution issues), as requested in the 2002 assessment. Finally, several commenters in 2004 noted that there is a discrepancy between the emission reduction accomplishments made by both countries and the actual experience of their citizens, as the number of ozone days increases in major cities and asthma rates climb. The Committee continues to find opportunities to further reduce emissions to address these health and ecological problems as well as to study the correlation between reduction and effects and communicate that more clearly to the public.

3. Will the Agreement expand its purview to include commitments to reduce particulate matter and mercury emissions?

Both the 1996 and 2002 reviews, as well as numerous commenters on the 2004 Progress Report, have called for additional efforts to address transboundary contributions of PM and air toxics, notably mercury.

Under the Agreement, both Parties have begun to consider developing the role of the AQA in guiding the binational effort to address transboundary contributions of PM. Discussions among the Committee members and stakeholders on whether or not to create a PM Annex prompted the creation of the Joint Plan of Action for Addressing Transboundary Air Pollution in 1997. After a series of binational workshops, 2004 marked an exciting and unique accomplishment. The Subcommittee on Scientific Cooperation completed the first joint U.S.–Canadian transboundary science assessment of PM. Like the joint ozone assessment in 1998, this joint assessment of PM provides a scientific foundation for Committee consideration of a PM Annex to the Agreement. Discussions of the potential for negotiating a PM Annex will continue through the Committee's 2006 annual meeting this fall.

Currently, mercury is being addressed through several national and international initiatives. National initiatives in the United States include the recent promulgation of the CAMR (a regulation reducing mercury emissions by nearly 70 percent at full implementation, in part through co-benefits from the CAIR), and in Canada, the Canada-wide Standards for mercury. Both countries are also part of the Great Lakes Water Quality Agreement's Toxics Strategy, which includes mercury. Individual states and provinces also collaborate through the NEG/ECP Mercury Action Plan. Finally, both countries participate in several international and regional initiatives, including the Heavy Metals Protocol of the United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution, the Arctic Council Action Plan's mercury project, and the United Nations Environment Programme's global mercury program.

4. The Agreement seems to focus primarily on the eastern portions of Canada and the United States. How is the agreement working to deal with air pollution issues along other parts of the border, including the western parts of both countries? What initiatives are in place to deal with region-specific issues?

Historically, the damaging effects of acid rain have been concentrated in the eastern areas of Canada and the United States. Both emissions and ambient levels of SO_2 and NO_x are highest in the east, and, while ozone is a problem in urban areas across North America, ozone concentrations are highest in the eastern portions of the United States and Canada. Consequently, the Ozone Annex created a PEMA, which included 18 states and the District of Columbia in the eastern sections of the United States and portions of Ontario and Quebec in Canada. The areas in the United States and Canada included in the PEMA are home to approximately 40 percent of the U.S. population and over 50 percent of the Canadian population. The areas where emission reductions are focused were deemed the most important for transboundary ozone because they exceeded the ozone standards in either country and/or contributed to ozone transport.

Under current standards for PM in the United States, the only western state with a significant PM problem is California. The Committee has acknowledged recent research regarding the regional effects of PM. As mentioned previously, a joint PM assessment was completed in 2004, which indicates that the transport of PM and PM precursors can be significant enough in some regions to potentially compromise the attainment of national standards. The regions studied did not include the prairie regions of either country, but the report did provide evidence that the prairie regions are an area where transboundary flow, particularly related to visibility, should be monitored. The option of a new PM annex will be discussed by the Committee, including how far to extend the coverage of affected states and provinces.

Additionally, the Committee supports several regional initiatives and organizations working on air pollution issues specific to particular areas along

the border. Groups such as the NEG/ECP as well as several pilot projects created under the Border Air Quality Strategy announced in 2003 are examples of this local collaboration. These pilot projects include the Georgia Basin–Puget Sound International Airshed Strategy and the Great Lakes Basin Airshed Management Framework. Other groups, such as the BDPS Consultation Group, and discussions among Canadian and U.S. representatives regarding the ASI facility continue to address specific, localized, and regional air pollution issues.

Finally, a U.S.–Canada Emissions Cap and Trading Feasibility Study, developed under the auspices of the Agreement, was finalized in July 2005, analyzing the feasibility of a binational cap and trading program between the two Parties for SO_2 and NO_x emissions. The Committee's sponsorship of this study, as well as its support of various local and regional air pollution initiatives along the border, demonstrate both countries' commitment to an evolving, diverse, and multi-tiered response to transboundary air pollution.

Over the years, the Committee has received comments regarding the creation of regional transboundary air quality committees. The Parties agree that this is not necessary at the current time, considering the various international localized efforts already under way and the regional representation on both sides of the border that the Committee enjoys. That being said, efforts in both the United States and Canada are ongoing to communicate more clearly about the Agreement, its goals, and its work throughout the transboundary region to foster greater cooperation and continued improvements in border air quality.

5. What is being done to assess the impacts to human health from emissions in the border region?

In February 2006, EPA released the Ozone Criteria Document, summarizing the findings of the 1996 Ozone Criteria Document and critically assessing more than 1,700 new studies investigating the health effects of ozone (see Section 3: Scientific and Technical Cooperation and Research, U.S. Report on Health Effects of Ozone in this 2006 Progress Report for more details). Canada and the United States issued the first bilateral transboundary PM science assessment in 2004, as described in question 3, and have each conducted extensive research on PM, as discussed in the Health Effects section of this 2006 Progress Report. In addition, EPA is currently reviewing the NAAQS for ozone and PM. These standards are essential to protecting human health, as they establish national limits for pollutants to which states must adhere. There are financial and resource-based incentives for states to meet these ambient pollutant levels and consequences for nonattainment areas.

A recent study (Chestnut and Mills, see page 6) released in September 2005, analyzing the costs and benefits of Title IV (Acid Rain Program) of the Clean Air Act, showed annual health benefits reaching upwards of $114 billion (U.S. 2000 dollars) for Canada and the United States, while total health and ecosystem benefits totaled more than $122 billion (Canada received more than $6.4 billion in annual health benefits, while the United States received over $108 billion). The study reported that the U.S. Acid Rain Program and the subsequent reductions in SO_2, NO_x, PM, and ozone resulted in decreased incidences of mortality, heart attacks, asthma exacerbations, bronchitis, and upper and lower respiratory symptoms for adults and children in both the United States and Canada.

Finally, although not under the auspices of the AQA, a unique cross-border initiative called the Tribal LifeLine Project, a risk assessment software capturing exposures and risks for Indigenous peoples who practice subsistence lifestyles, represents an innovative collaboration among EPA and Health Canada as well as other Canadian governmental organizations.

6. How is the Agreement working to improve the quality, timeliness, comparability, and accessibility of U.S. and Canadian emissions, deposition, mapping, and modeling data? Is there a long-term strategy for building monitoring and tracking networks?

Concerns regarding the accessibility and accuracy of data related to transboundary air pollution have long been discussed under the auspices of the Agreement. Both Parties remain absolutely committed to the requirements in Annex 2, "Scientific and Technical

Activities and Economic Research." Under this annex, the United States and Canada have committed to share information and data related to monitoring networks, the effects of atmospheric pollution on human health and ecosystems, modeling, emission reduction technologies, market-based mechanisms, and other relevant topics. Furthermore, the annex specifically obligates both Parties to coordinate their deposition monitoring activities and emission reporting activities in order to improve these systems in both countries and to more readily share compatible information.

The United States and Canada continue to collaborate in several data-sharing projects, including the EPA-led AIRNow program, which provides real-time maps depicting ozone and PM levels on a continental scale.

In August 2005, NARSTO released its investigation and analysis of the current emission inventories for Canada, the United States, and Mexico. The final report, entitled *Improving Emission Inventories for Effective Air Quality Management Across North America: A NARSTO Assessment*, also provided recommendations to enhance existing emission inventories in the three countries. While the Agreement was not directly involved with this effort, the results of the assessment will likely be used to guide future emission-related data-sharing projects.

The Committee intends to focus in the future on efforts to enhance joint modeling initiatives, as sophisticated analyses of emission reduction scenarios using reliable and accurate models can assist in creating the best possible pollution reduction strategy.

The Committee will seek progress on tracking and reporting emission reductions. The United States continues to be concerned with ensuring that facility-specific emissions data from both Parties are publicly accessible.

Effective monitoring networks are crucial to our understanding and verification of the success of the various programs responsible for reducing SO_2, NO_x, ozone, PM, and other pollutants in Canada and the United States. In fact, deposition monitoring is one of the most essential components of the highly successful U.S. Acid Rain Program. Without substantial atmospheric deposition monitoring networks, it would be impossible to accurately track compliance, and programs would be unable to confirm that air quality improvements are actually taking place. As pollution control technologies improve, legislation is passed, and new regulations are promulgated, human health and ecosystems will experience great benefits as pollutant emissions decrease. However, it is essential to design, implement, and, most critically, maintain a system for providing an accurate account of the influence of such controls and regulations. As such, the Committee has expressed interest in developing requirements for the long-term maintenance and enhancement of monitoring networks in the United States and Canada.

Timeliness of data and the difference between U.S. and Canadian data set years are often highlighted in public comments. Transparency in program accomplishments and public access to information are vital to the U.S. Acid Rain Program. The United States and Canada make every effort to use the most recent data possible in order to honor the commitment of providing public access to timely and accurate data. However, the United States and Canada differ in the process of data approval, and this often translates to differences in when each country is able to publish its data.

In 2001, EPA and Environment Canada entered into a cooperative agreement to establish a common cooperative Canada–U.S. deposition database, analysis, and mapping capability, including a web-based data access system. Progress has been made under this agreement, including the development and deployment of an interactive, web-based tool for sharing a joint North American database of air quality and deposition-related data as well as the testing and deployment of ammonia monitoring instrumentation at U.S. and Canadian monitoring sites. The cooperative agreement has been extended until December 2007, and the United States and Canada will continue to work together to further the understanding of North American air quality through shared monitoring data and the joint development of monitoring methods.

7. Does the Committee plan on expanding the role of the IJC?

The role and responsibilities of the IJC were discussed at the 2005 fall meeting of the Air Quality Committee. The Committee agreed that the IJC can best assist in implementation of the Agreement by continuing to solicit and synthesize public comments on the progress reports and report back in a timely manner.

8. What initiatives exist to improve the outreach and communication methods of the Agreement?

The Committee has long been interested in transparency of its activities and of the programs it supports, as well as ensuring that the work accomplished through the Agreement is successfully communicated to the public. Outreach and communication materials have changed dramatically over the past few years, as evidenced by the release of the 2004 Progress Report, a shorter and highly accessible document with informative graphics and concise text. Public comment regarding the new layout and format of the progress report was very favorable.

The relevance of this topic continues today, and the Committee has expressed renewed interest in developing its ability to communicate effectively to the public and involve them in the process of protecting air quality. Specifically, the Committee has committed to enhancing its ability to effectively communicate to the public "without borders" on ozone air quality and sulfur and nitrogen deposition as well as emerging issues, particularly fine particles in the near term and mercury in the long term.

Several commenters in 1996 requested that stakeholders from environmental groups, industry, academia, and those with technical expertise be more involved with the AQA. A requirement was built into the 2000 Ozone Annex calling for the Air Quality Committee to assess progress on implementation of the obligations of the annex. In June 2004, Canada held a bilateral meeting in Quebec City at which stakeholders from environmental nongovernmental organizations, health nongovernmental organizations, and industry, as well as state, provincial/territorial, and federal representatives, offered their comments and review of progress on implementation of the Ozone Annex.

9. Are there any new developments or programs to prevent air quality deterioration and improve visibility in the United States and Canada?

Protection of visibility is an important area of concern under the Agreement. In the United States, states and Tribes are working through their Regional Planning Organizations to implement the new amendments to the Regional Haze Rule. These amendments make up the new CAVR, promulgated by EPA in June 2005. This new rule will improve visibility in U.S. national parks and wilderness areas and will likely provide improvements to air quality in Canada.

Since the second AQA Assessment, the Canadian Council of Ministers of the Environment has held national workshops to develop guidance to ensure common principles and consistency in implementing measures to continuously improve ambient air quality in areas where concentrations of PM and ozone are or were brought below the Canada-wide Standards levels, and to ensure that areas not affected by local air pollution remain clean. As highlighted in Section 1, options are explored to address the issue in Canada's national parks, while British Columbia is engaged in a new comprehensive Air Quality Management Plan to minimize risk to human health from air pollution, improve visibility, and reduce its contribution to global climate change in the lower Fraser Valley airshed.

Several federal initiatives to curb emissions have also largely contributed to continuous improvement, whether in terms of regulations or as emissions guidelines, codes of practice, or pollution prevention planning.

The United States continues to be concerned about Canada's lack of comparable regulations preventing the deterioration of air quality and the protection of visibility.

In terms of collaborative efforts, U.S. Regional Planning Organizations are looking into opportunities to work with Canadian air quality agencies to assess emissions and transport of air pollution.

10. How does the Agreement stay current with new and innovative programs and ideas?

Innovation is a key component to the success of any cooperative effort. Keeping up to date with new technology and innovative ideas has been a useful by-product of the networking and collaboration that occur on the subcommittees and through various Agreement projects. For instance, the Committee's interest in marine vessel emissions has become a regular feature of annual meetings. In addition, the cap and trading feasibility study was an innovative and bilateral response to the question of the feasibility of an international trading program.

Furthermore, voluntary programs in both countries continue to provide new and unique strategies in pollutant reduction efforts. Though much remains to be done, exploring issues such as these demonstrates a willingness to work collaboratively on emerging topics and to find new ways to protect human health and the environment in the United States and Canada.

The Committee will continue to foster the relationships built through cross-border cooperation, which are a hallmark of the Agreement, and will actively look for new ways to involve stakeholders to encourage innovation.

Conclusion

The United States and Canada continue to successfully meet the obligations set forth in the Agreement. Both countries' efforts to reduce acid rain and control ozone through the Agreement are particularly notable and are summarized in the 2006 Progress Report. The Agreement continues to serve as a highly effective vehicle through which to coordinate international and cross-border regional/local efforts to address transboundary air quality.

Through its binding commitments to reduce and cap pollutants, monitor emissions, and regularly report on actual changes in emissions, air quality, and the environment, the AQA provides a long-term framework and mechanism for making real progress in transboundary air quality and addressing the harmful effects of SO_2, NO_x, and ozone on human health and ecosystems in the United States and Canada. In addition, through direct sponsorship of initiatives and scientific studies, by providing support to binational organizations, and through international information sharing, the Agreement has become a valuable tool in examining numerous transboundary issues.

The AQA remains poised to serve as the primary federal vehicle to pursue further efforts to address transboundary air quality, such as consideration of a PM Annex, including the geographic scope of such an annex; development, maintenance, and enhancement of monitoring programs; examination of cross-border emissions cap and trade; joint modeling to support many of these areas; and, finally, enhancing our capacity to communicate "without borders."

Appendix:

U.S.–Canada Air Quality Committee

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

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Subcommittee on Scientific Cooperation Co-Chair:

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