Meeting the Challenge of Cleaner Air

Canada • United States

Progress under the Air Quality Agreement

2008




A History of Cooperation

Multiple environmental and health problems (including acid rain, impaired visibility, damaged ecosystems, and respiratory illness) are caused or worsened by air pollution from mobile and stationary emission sources in Canada and the United States. Both nations have an interest in reducing transboundary air pollution. In 1991, the United States and Canada committed to reduce the impact of transboundary air pollution through the United States–Canada Air Quality Agreement (AQA). The AQA established a formal and flexible method of addressing transboundary air pollution and paved the way for cooperation on a variety of air quality issues, including acid rain, ozone, and particulate matter (PM).

This brochure provides an overview of the AQA and features recent progress made by the United States and Canada to control transboundary air pollution under the Agreement. A more complete presentation and discussion of this progress can be found in the 2008 Progress Report at <www.epa.gov/airmarkets/progsregs/usca/index.htm> and <www.ec.gc.ca/cleanair-airpur/Pollution_Issues/Transboundary_Air/Canada_United_States_Air_Quality_Agreement-WS83930AC3-1_En.htm>.

Air Quality Agreement

The 1991 Air Quality Agreement originally included two annexes. Annex 1, the Acid Rain Annex, focuses on the commitments of both nations to reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the primary precursors of acid rain. Under Annex 2, the Scientific and Technical Activities and Economic Research Annex, the United States and Canada agree to coordinate their respective air pollution monitoring networks and exchange information.

In December 2000, Annex 3, the Ozone Annex, was added to the Agreement. This Annex commits the two nations to reducing emissions of NO_x and volatile organic compounds (VOCs), the precursor pollutants to ground-level ozone. Ground-level ozone is the major component of smog.

In 2007 and 2008, negotiating sessions were held between the United States and Canada to discuss a PM Annex under the AQA.

A bilateral Air Quality Committee is responsible for coordinating the overall implementation of the AQA. Two subcommittees—*Program Monitoring and Reporting* and *Scientific Cooperation*—meet annually with the Air Quality Committee and carry out yearly activities. The two nations prepare a joint progress report every two years and conduct a regular five-year review and assessment of the Agreement.

Note: American spelling is used throughout this brochure.

The Acid Rain Challenge

Acid Rain

Acid deposition, more commonly known as acid rain, occurs when emissions of SO_2 and NO_X from power plants, vehicles, and other sources react in the atmosphere (with water, oxygen, and oxidants) to form various acidic compounds. These acidic compounds then fall to earth in either a wet form (rain, snow, or fog) or a dry form (gases and particles) and can harm aquatic and terrestrial ecosystems (particularly forests); affect human health; impair visibility; and damage automotive finishes, buildings, bridges, monuments, and statues.

Key Commitments of the Acid Rain Annex

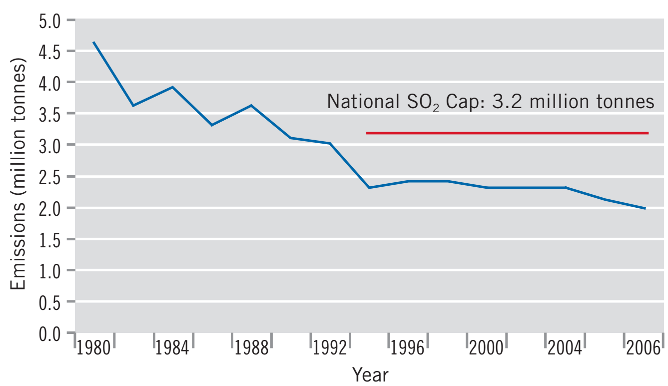
Both the United States and Canada have been successful in reducing SO_2 and NO_X emissions and thus, mitigating the impact of acid rain on each side of the border. Despite these achievements, however, further efforts are needed to restore all damaged ecosystems to their pre-acidified conditions.

Commitments and Progress: SO_2 Emission Reductions

CANADA:

- In 2006, Canada's total SO_2 emissions were 2 million tonnes,[1] or about 38 percent below the national cap of 3.2 million tonnes (Figure 1).
- SO_2 reductions represent more than a 55-percent decrease from Canada's total SO_2 emissions in 1980 and a 35-percent decrease from the 1990 emission level.
- SO_2 emissions in the seven easternmost provinces were 1.4 million tonnes in 2005, or nearly 40 percent below the (now expired) eastern Canada cap of 2.3 million tonnes.
- Canada is committed to further reducing acidifying emissions through the more recent Canada-wide Acid Rain Strategy for Post-2000.

Figure 1. Canadian SO_2 Emissions from Acid Rain Sources, 1980–2006



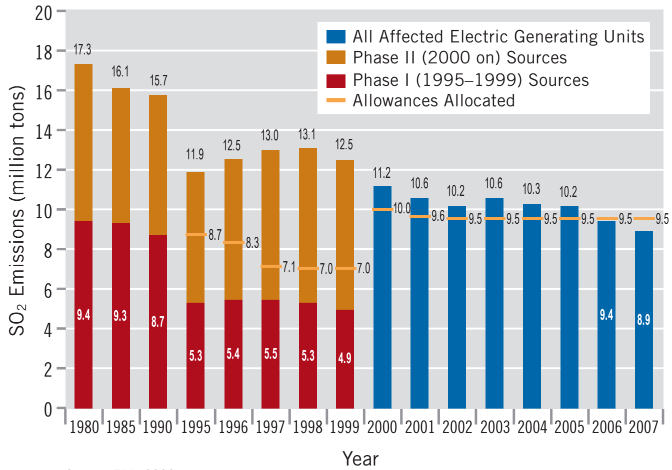
Source: Environment Canada, 2008

UNITED STATES:

- The United States succeeded in meeting its commitment to reduce annual SO_2 emissions by 10 million tons from 1980 levels by 2000.
- In 2007, emissions of SO_2 from the electric power sector fell below the 2010 national emission cap of 8.95 million tons for the first time, achieving the U.S. commitment three years early (Figure 2).
- National SO_2 emissions from all sources have fallen from nearly 26 million tons in 1980 to less than 13 million tons in 2007 (see <www.epa.gov/ttn/chief/trends>).
- Most of the reductions in SO_2 emissions are due to the Acid Rain Program (ARP), which requires major reductions of SO_2 and NO_X emissions from the electric power sector.

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

Figure 2. U.S. SO_2 Emissions from Acid Rain Program Electric Generating Units, 1980–2007



Source: EPA, 2008

Commitments and Progress: NO_X Emission Reductions

CANADA:

- Surpassed its NO_X emission reduction target at power plants, major combustion sources, and metal smelting operations by 100,000 tonnes below the forecasted level of 970,000 tonnes.
- Recently passed stringent standards for NO_X emissions from on-road and off-road sources, effective from 2004 to 2009.

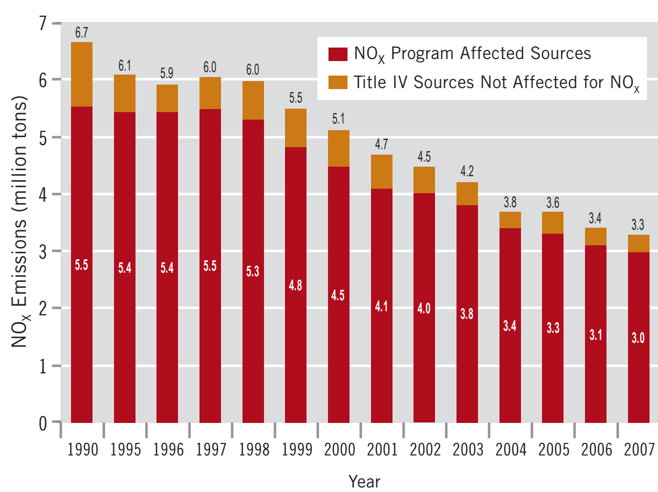
UNITED STATES:

- Emissions of NO_X from all NO_X program-affected units were 3 million tons, and total NO_X emissions from all sources covered by the ARP were 3.3 million tons (Figure 3).
- This level is 4.8 million tons less than the projected NO_X levels for 2000 without the ARP, or more than double the NO_X emission reduction goal under the Acid Rain Annex.

Preventing Air Quality Deterioration and Protecting Visibility

Under the Acid Rain Annex, Canada and the United States have recognized the importance of preventing air quality deterioration and protecting visibility from sources that could cause significant transboundary air pollution. In October 2007, a joint U.S.-Canada visibility workshop was held in Research Triangle Park, North Carolina. The U.S. Environmental Protection Agency (EPA), the U.S. Federal Land Managers, and Canadian government representatives came together to review the history of the U.S. visibility program and to share information and lessons learned from joint analyses, discuss international transport, and investigate future collaboration.

Figure 3. NO_X Emission Trends for All Acid Rain Program Units, 1990–2007



Source: EPA, 2008

Acid Deposition Trends

Both nations use wet deposition (rain or snow) data to assess how the atmosphere is responding to decreasing or increasing emissions of sulfur and nitrogen. Figures 4 and 5 show the U.S.–Canada spatial patterns of wet sulfate and wet nitrate deposition, respectively, for 1990 and 2005. The pattern from 1990 to 2005 illustrates that significant reductions occurred in wet sulfate deposition in both the eastern United States and much of eastern Canada. Reductions in wet nitrate deposition have generally been more modest than for wet sulfate deposition.

Figure 4. Annual Sulfate Wet Deposition

1990 2005

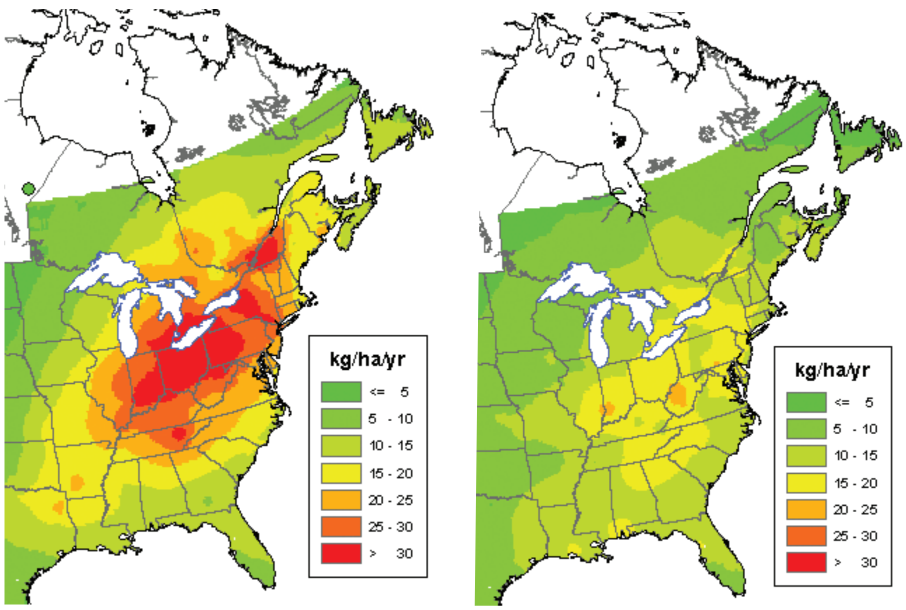
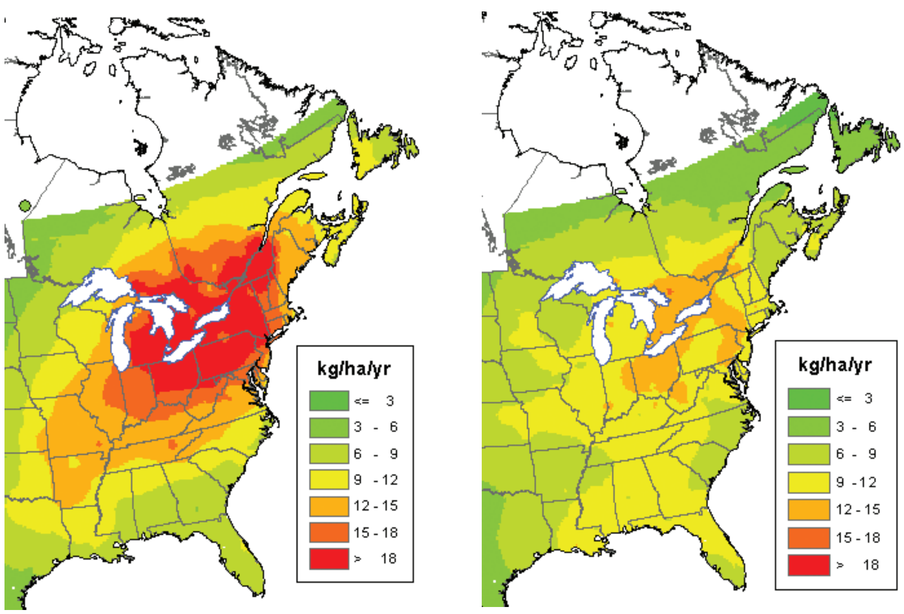


Figure 5. Annual Nitrate Wet Deposition

1990 2005



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

Consultation and Notification Concerning Significant Transboundary Air Pollution

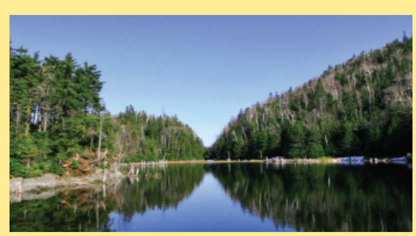
Since 1994, Canada and the United States have regularly notified each other concerning potential new sources and modifications to existing sources of transboundary air pollution within 62 miles (100 km) of the U.S.–Canada border. Since publication of the 2006 United States–Canada AQA Progress Report, Canada has notified the United States of eight additional sources, for a total of 52 Canadian notifications. The United States has notified Canada of nine additional sources, bringing the total number of U.S. notifications to 56. More information is available on the government Web sites of each country at:

Canada:

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

United States:

www.epa.gov/ttn/gei/uscadata.html



Making Progress on Ground-Level Ozone

Ground-Level Ozone

Ground-level ozone is a gas that forms when emissions of NO_x and VOCs react with other chemicals in the air in the presence of strong sunlight. NO_x and VOCs are emitted by combustion sources (such as vehicles and power plants). VOCs are also given off by solvents, cleaners, and paints. Ground-level ozone can cause or exacerbate respiratory illnesses and is especially harmful to young children, the elderly, and those suffering from chronic asthma and/or bronchitis. Ground-level ozone can affect leaves and roots of plants, especially trees, which can make them more susceptible to attack from insects and diseases and can reduce their ability to withstand droughts, windstorms, and manmade stresses such as acid rain.

Key Commitments of the Ozone Annex

The commitments to reduce NO_x and VOCs apply to a defined 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 the PEMA are the areas where emission reductions are most critical for reducing transboundary ozone.

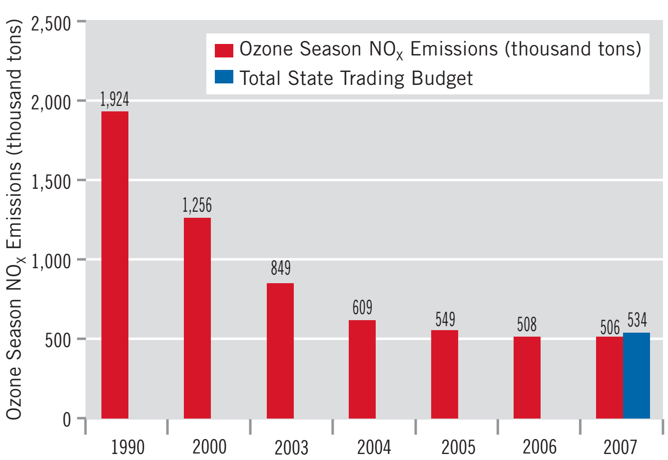
CANADA:

- The Ozone Annex commits Canada to new stringent NO_x and VOC emission reduction standards for vehicles, engines, and fuels. By 2020, it is estimated that NO_x and VOC emissions combined from on-road and off-road vehicles and engines in the Canadian portion of the PEMA will be reduced by 41 and 35 percent, respectively, compared to 2005 emissions.
- With regard to stationary sources, Canada is complying with its commitment to cap NO_x emissions from large fossil fuel-fired power plants in the Ontario and Quebec portions of the PEMA at 39 kt and 5 kt, respectively, for 2007.
- Canada has taken efforts to reduce VOC emissions by developing two regulations—one on dry cleaning and another on solvent degreasing—and using VOC emission limits for new stationary sources.
- The Canada-wide Standard (CWS) for ozone committed provincial jurisdictions to developing implementation plans outlining the comprehensive actions being taken within each jurisdiction to achieve the standards.

UNITED STATES:

- The Ozone Annex commits the United States to implementing the NO_x transport emission reduction program, known as the NO_x SIP Call, in the PEMA states that are subject to the rule.
- As of 2007, all affected states and the District of Columbia chose to meet the mandatory NO_x SIP Call emission reductions primarily through participating in the NO_x Budget Trading Program (NBP), a market-based cap and trade program.
- In the 2007 ozone season (May 1 to September 30), sources participating in the NBP emitted 506,312 tons of NO_x (Figure 6).This is almost 5 percent below the 2007 allowable NO_x emission level (total state trading budget).

Figure 6. Ozone Season NO_x Emissions under the NO_x Budget Trading Program



Source: EPA, 2008

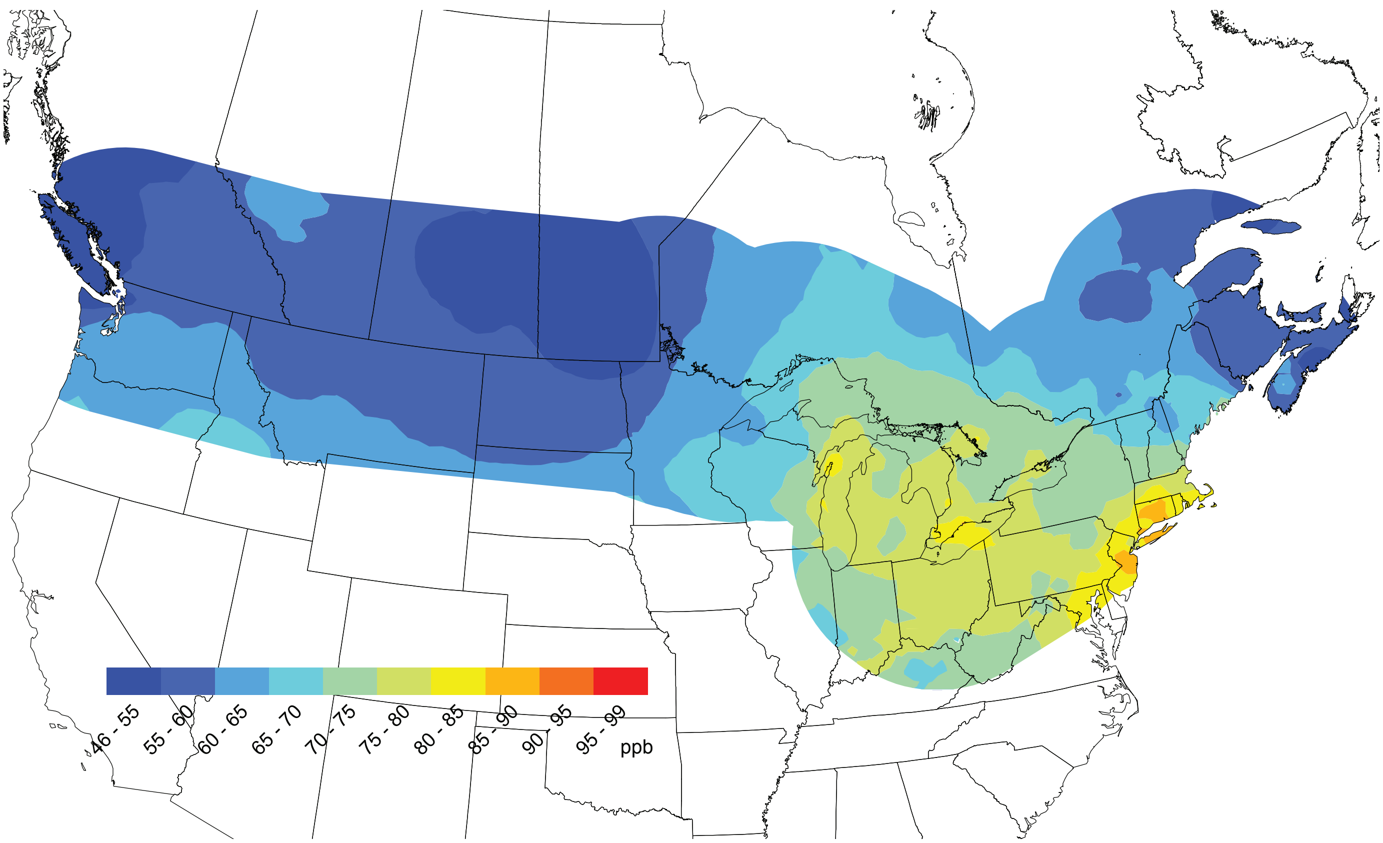
- To help reduce emissions of NO_x and VOCs from major new sources, EPA has promulgated New Source Performance Standards (NSPS) for the 36 categories of stationary sources identified in the Ozone Annex.
- To help reduce VOC emissions, EPA has promulgated regulations to control hazardous air pollutant emissions for the 40 categories of industrial sources listed in the Ozone Annex. Additionally, EPA has promulgated national rules for the control of VOCs in automobile repair coatings, consumer products, and architectural coatings.
- To address motor vehicle emissions, the United States committed to implementing regulations for reformulated gasoline, controls of emissions from new and in-use highway vehicles and engines, and controls and prohibitions on diesel fuel quality. EPA has applied engine standards for the five nonroad engine categories identified in the Ozone Annex.

Ambient Levels of Ozone

Under the Ozone Annex, the United States and Canada are required to report on the amount of ozone, NO_x, and VOCs in the air we breathe (i.e., ambient concentrations) from all relevant monitors within 500 km of the border. Both countries have extensive networks to monitor ground-level ozone and its precursors, and both governments prepare routine reports summarizing measurement levels and trends. The latest reported data from both countries are for 2006.

Figure 7 illustrates that higher levels of ozone occurred in the Great Lakes and Ohio Valley regions, as well as downwind of urban areas.

Figure 7. Ozone Concentrations along the Canada–U.S. Border (Three-Year Average of the Fourth Highest Daily Maximum 8-Hour Average), 2004–2006



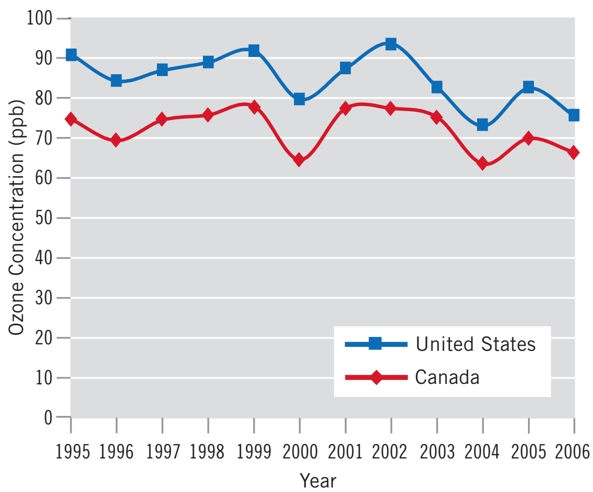
Note: Data contoured are the 2004–2006 averages of annual fourth highest daily values, where the daily value is the highest running 8-hour average for the day. Sites used had at least 75 percent of possible daily values for the period.

Source: Environment Canada National Air Pollution Surveillance (NAPS) Network Database, 2008 (www.etc-cte.ec.gc.ca/naps/index_e.html); EPA Aerometric Information Retrieval System (AIRS) Database (www.epa.gov/air/data/index.html)

Ambient Concentrations of Ozone, NO_x, and VOCs

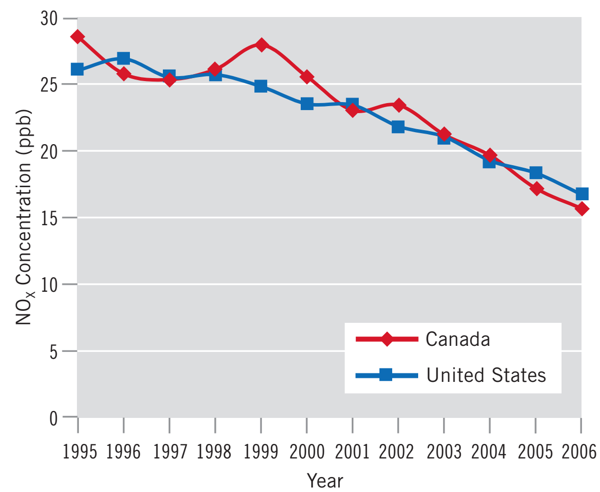
Figure 8 illustrates that ozone levels within the PEMA have decreased over time with a notable decline in ozone levels since 2002. Figures 9 and 10 depict the average ozone season levels of ozone precursors NO_x and VOCs in the eastern United States and Canada. Although NO_x and VOC concentrations have fluctuated over recent years, these fluctuations are most likely attributable to changes in weather conditions. Overall, the data indicate a downward trend in the ambient levels of both NO_x and VOCs.

Figure 8. Annual Average Fourth Highest Maximum 8-Hour Ozone Concentration for Sites within 500 km of the Canada–U.S. Border, 1995–2006



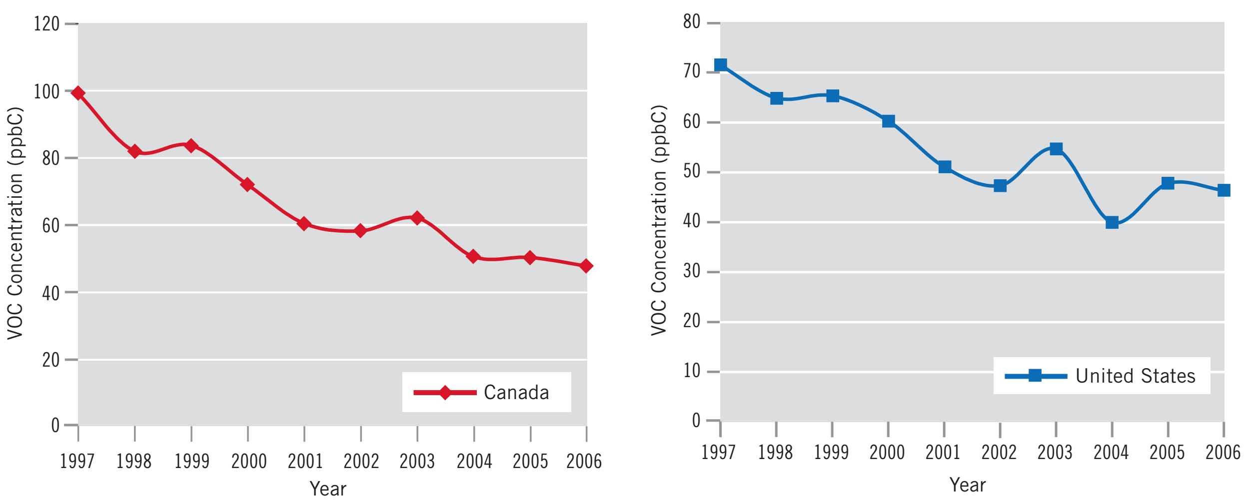
Source: EPA and Environment Canada, 2008

Figure 9. Average Ozone Season 1-Hour NO_X Concentration for Sites within 500 km of the Canada–U.S. Border, 1995–2006



Source: EPA and Environment Canada, 2008

Figure 10. Average Ozone Season 24-Hour VOC Concentration for Sites within 500 km of the Canada–U.S. Border, 1997–2006



Source: EPA and Environment Canada, 2008

New Actions on Acid Rain, Ozone, and Particulate Matter

CANADA

The federal government's clean air initiative, *Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution*, includes a regulatory framework for air emissions that sets out proposed mandatory and enforceable reductions in emissions of air pollutants and greenhouse gases from industrial sectors, as well as regulatory and other action plans for transportation and consumer and commercial products. In addition to delivering measurable overall health and environmental benefits, the expected reductions in SO_2 and NO_X emissions from industry and transportation will lead to reductions in acid deposition and improvements in visibility.

UNITED STATES

Due to recent research on health effects from ozone, EPA established new, tighter primary and secondary National Ambient Air Quality Standards (NAAQS) for ozone. In October 2006, EPA completed a required five-year review of the PM standards, maintained the existing annual $PM_{2.5}$ standard, and established a more protective 24-hour standard. EPA also retained the existing 24-hour PM_{10} standard but revoked the annual PM_{10} standard because of a lack of evidence linking health problems to long-term exposure to coarse particle pollution.

Particulate Matter

PM includes both solid particles and liquid droplets found in the air. Many manmade and natural sources emit PM directly or other pollutants that react in the atmosphere to form PM. PM comes in a range of sizes and is associated with numerous health effects. Particles less than 10 micrometers in diameter (PM_{10})—especially those less than 2.5 micrometers in diameter ($PM_{2.5}$)—pose the greatest health risk because they can be inhaled and impact both the respiratory and cardiac systems. Sulfates (SO_4) and nitrates (NO_3) formed from SO_2 and NO_X are significant components of $PM_{2.5}$. PM is also a major contributor to regional haze, which reduces visibility.

PM Annex Negotiations

Both countries are committed to negotiating the addition of a PM Annex to the United States–Canada AQA while actively developing and implementing emission reduction programs to reduce fine particle concentrations.

The United States and Canada have held two negotiating sessions on a PM Annex under the United States–Canada AQA: one in November 2007 and one in May 2008. Substantial progress was made during the most recent session, and intersessional work is continuing.

New England Governors (NEG) and Eastern Canadian Premiers (ECP)

The 31st Conference of the NEG/ECP was held in June 2007. During this meeting, the governors and premiers established a standing committee to draft a regional Transportation and Air Quality Action Plan. More information on this work and other work of the NEG/ECP can be found at <www.cap-cpma.ca/>.

Cooperation on Emissions Monitoring and Inventories

Emission Trends and Inventories

Ensuring that emission inventories are publicly available contributes to the success of both nations' emission reduction goals and air quality management programs. Emission inventories help identify the major sources of pollution, track the progress of control strategies, and provide important data for use in air quality models. Figures 11, 12, and 13 show emission trends for total SO_2, NO_X, and VOCs in Canada and the United States from 1990 to 2006.

In the United States, the major reductions in SO_2 emissions from 1990 to 2006 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, waste disposal and recycling, and chemical and allied products manufacturing and use.

In Canada, the major reductions in SO_2 emissions came from base metal smelters in the industrial sector. For NO_X, the reductions were from on-road mobile sources, electric power generation sources, and industrial sources. For VOCs, the reductions came from electric power generation sources, on-road mobile sources, and solvent utilization.

AIRNow Mapping

The EPA-led AIRNow program (www.airnow.gov) provides the public with easy access to real-time air quality information. Since 2001, the jurisdictions in the United States and Canada have collaborated to contribute air quality data to the AIRNow program. In 2004, the AIRNow Web site was expanded to provide information on PM and ozone measurements on a continental scale year-round. Canadian and U.S. efforts continue to improve air quality characterization by combining measurements with numerical forecasts from the operational air quality forecasting model. Each country is improving air quality forecasting services and continuing to develop national air quality forecast models.

Figure 11. U.S. and Canadian SO_2 Emissions, 1990–2006

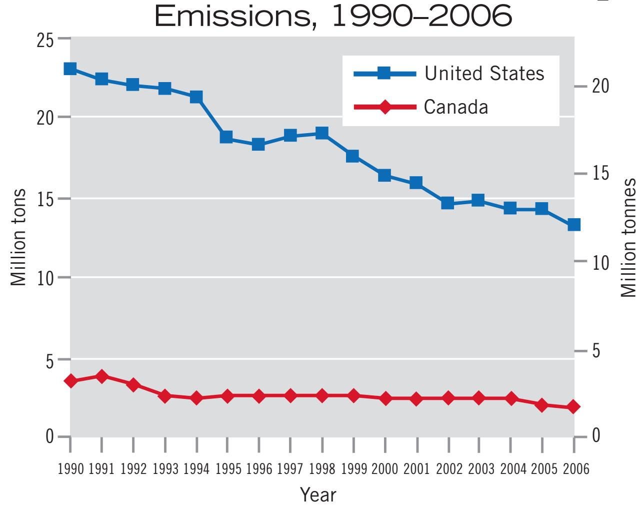


Figure 12. U.S. and Canadian NO_X Emissions, 1990–2006

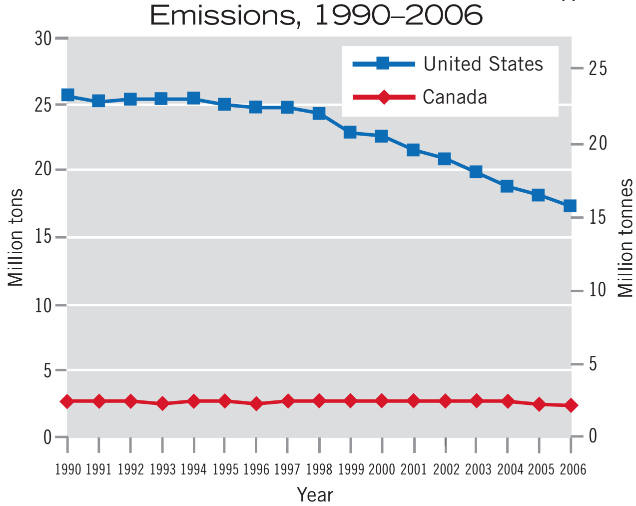
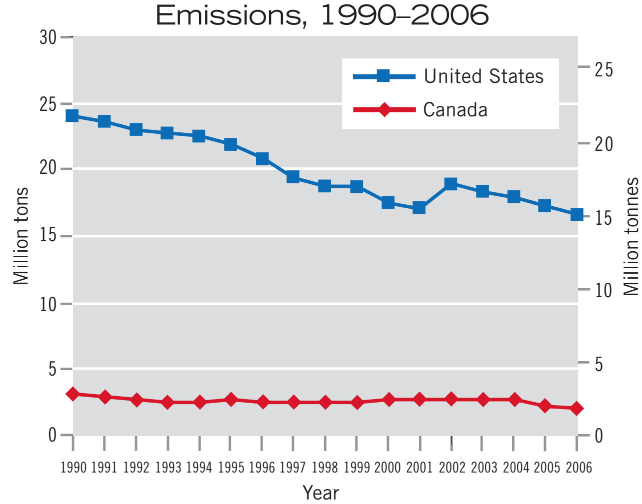


Figure 13. U.S. and Canadian VOC Emissions, 1990–2006



Figures 11-13, Source: EPA and Environment Canada, 2008

Research Efforts on the Effects of Air Pollution

Health Effects

CANADA

Between 2003 and 2007, Health Canada carried out 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. The research programs pertain to the Great Lakes Basin Airshed and the Georgia Basin-Puget Sound International Airshed. Further information on these studies can be found at <www.hc-sc.gc.ca/ewh-semt/air/out-ext/great_lakes-grands_lacs-eng.php> and <www.pyr.ec.gc.ca/airshed/index_e.htm>, respectively.

UNITED STATES

EPA conducts human health and exposure research as part of the Clean Air Research Program. The research conducted in this program includes studies focused on the Detroit–Windsor area, located within the PEMA. More information on these studies can be found at <www.epa.gov/dears/> and <www.epa.gov/dears/studies.htm>.

Aquatic Effects

In a recent study, Canadian and U.S. scientists analyzed trends in acidification of lakes and streams in eight regions of the northeastern United States and southeastern Canada. The scientists looked at data from 1990 to 2004, which approximately parallels the existence of the U.S.–Canada AQA.

One of the strongest trends found in this analysis was for sulfate, an acidic compound that is formed when SO_2 emissions combine with water, oxygen, and oxidants in the atmosphere. After sulfate is formed in the atmosphere it can fall back to earth and acidify surface waters such as lakes and streams, making it difficult for acid-sensitive aquatic organisms to survive. The results of this analysis indicate that U.S. and Canadian SO_2 emission reductions included in the AQA commitments have resulted in obvious, significant, and substantial declining sulfate trends in all but one of the regions examined.

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. For environmental impacts related to acidification, deposition of both nitrogen and sulfur compounds can contribute to a critical load exceedance.

CANADA

In the *2004 Canadian Acid Deposition Science Assessment,* for the first time in North America, new and combined critical load estimates were generated for sulfur and nitrogen acid deposition.

UNITED STATES

In the United States, the critical loads approach is not an officially accepted approach to ecosystem protection. However, recent activities within federal and state agencies, as well as the research community, indicate that critical loads might be emerging as a useful ecosystem protection and program assessment tool.

For More Information

In Canada

Air Emissions Priorities
Environment Canada
351 St. Joseph Boulevard
12th Floor, Place Vincent Massey
Gatineau, Quebec K1A0H3

Environment Canada's Web site:

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

In the United States

Clean Air Markets Division
U.S. Environmental Protection Agency
Mail Code 6204J
1200 Pennsylvania Avenue, NW
Washington, DC 20460

U.S. Environmental Protection Agency's Web Site:

www.epa.gov/airmarkets/progsregs/usca/index.htm

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