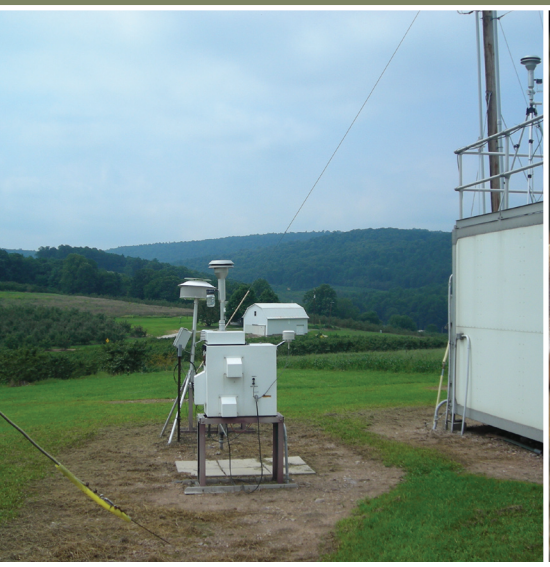
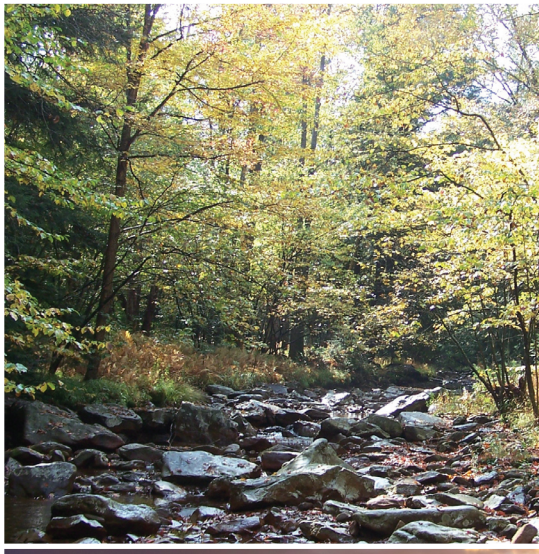
Acid Rain and Related Programs: 2008 Highlights





EPA United States Environmental Protection Agency

The Acid Rain Program (ARP), established under Title IV of the 1990 Clean Air Act (CAA) Amendments, requires major emission reductions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x), the primary precursors of acid rain, from the electric power industry. The SO_2 program sets a permanent cap on the total amount of SO_2 that may be emitted by electric generating units (EGUs) in the contiguous United States, and includes provisions for trading and banking emission allowances. The program is phased in, with the final 2010 SO_2 cap set at 8.95 million tons, a level of about one-half of the emissions from the power sector in 1980.

NO_x reductions under the ARP are achieved through a program that applies to a subset of coal-fired EGUs and is closer to a traditional, rate-based regulatory system. Title IV requires NO_x emission reductions for certain coal-fired EGUs by limiting the NO_x emission rate (expressed in lb/mmBtu) to a value based on a unit's boiler type. The goal of the NO_x program is to limit NO_x emission levels from the affected coal-fired boilers so that their emissions are at least 2 million tons less than the projected level for the year 2000 without implementation of Title IV. EPA estimated this projected number to be 8.1 million tons.

From July to October 2009, the U.S. Environmental Protection Agency (EPA) released three reports detailing progress under the ARP. These reports can be accessed at <www.epa.gov/airmarkets/progress/arp08.html>. This report highlights the key results from the previous reports and discusses the start of the Clean Air Interstate Rule (CAIR).

For more information on the ARP please visit: <www.epa.gov/airmarkets/progsregs/arp/index.html>. Detailed emission results and other facility and allowance data are also publicly available on EPA's Data and Maps Web page at <camddataandmaps.epa.gov/gdm>. To view emission and other facility information in an interactive file format using Google Earth or a similar three-dimensional platform, go to <www.epa.gov/airmarkets/progress/interactivemapping.html>. Additionally, updated quarterly SO_2 emission data for ARP coal-fired power plants can be found at <www.epa.gov/airmarkets/quarterlytracking.html>. For general information on cap and trade programs please visit: <www.www.epa.gov/captrade/>.

Key Components of the ARP SO_2 Trading Program

Phases and Reductions: Title IV of the 1990 Clean Air Act Amendments set a goal of reducing annual SO_2 emissions by 10 million tons from all sources (8.4 million tons from power plants) below 1980 levels. To achieve these reductions, the law required a two-phase tightening of the restrictions placed on fossil fuel-fired power plants. Phase I began in 1995 and Phase II began in the year 2000.

Allowance Allocation: The EPA allocates allowances to affected utility units based on their historic fuel consumption and a specific emissions rate. Each allowance permits a unit to emit 1 ton of SO_2 during or after a specified year.

Annual Reconciliation: For each ton of SO_2 emitted in a given year, one allowance is retired, that is, it can no longer be used. Allowances may be bought, sold, or banked. At the end of each year, sources are granted a 60-day grace period to ensure that they have sufficient allowances to match their SO_2 emissions during the previous year. If they need to, they may buy allowances during the grace period. Sources may sell allowances that exceed their emissions or bank them for use in future years.

Allowance Trading: SO_2 allowance trading minimizes compliance costs, and since unused allowances can be sold to other program participants, the system encourages units to reduce emissions beyond required levels.

Flexible Compliance: Each source can choose the most efficient way to reduce its SO_2 emissions. Installing new control technology, switching to lower-sulfur fuel, or optimizing existing controls are all options.

Stringent Monitoring: Each source must continuously measure and record its emissions of SO_2, NO_x, and CO_2, as well as heat input, volumetric flow, and opacity. In most cases, a continuous emission monitoring system (CEMS) must be used.

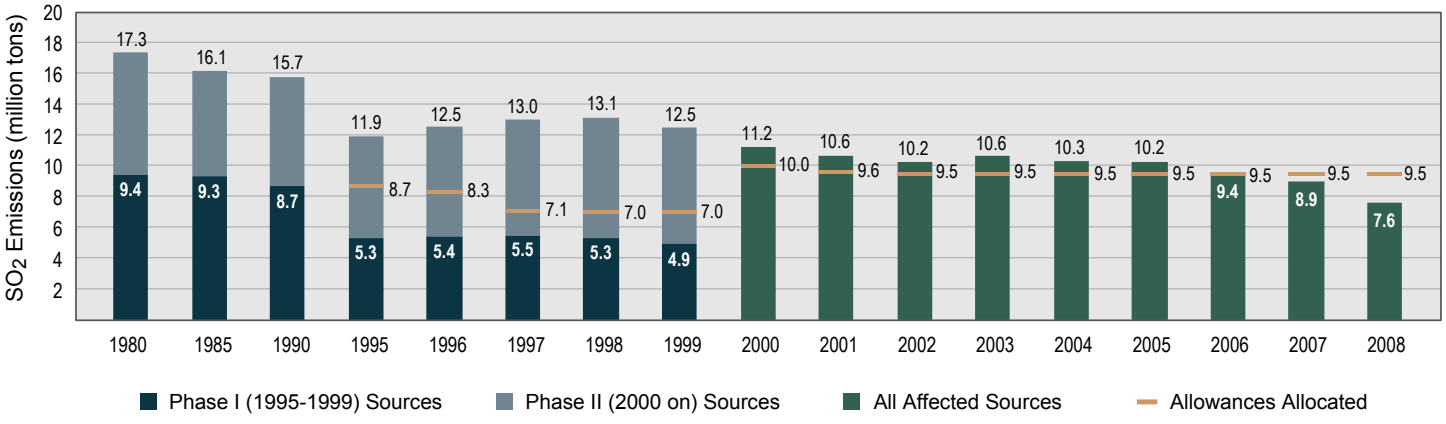
Automatic Penalties and Enforcement: Any source that fails to hold enough allowances to match its SO_2 emissions for the previous year must pay to EPA by July 1 an automatic penalty of $2,000 (inflation-adjusted to $3,337 for 2008) per ton of emissions in excess of allowances held. The source must also immediately surrender to EPA an amount (referred to as an "offset") of allowances, issued for the year the payment is due, equalling the tons of excess emissions. Moreover, each ton of excess emissions and each day of the year in which they occur constitute a violation of the Clean Air Act, subject to a discretionary monetary penalty.

Key Results of the SO_2 Trading Program

Affected Units: The SO_2 requirements under the ARP apply to EGUs, fossil fuel-fired combustors that serve a generator that provides electricity for sale. The vast majority of ARP SO_2 emissions result from coal-fired EGUs (close to 99 percent), although the program also applies to oil and gas units. There were 3,572 EGUs subject to the ARP's SO_2 requirements in 2008. These units were at 1,346 facilities and 419 of those facilities had coal-fired generating units.

SO_2 Emission Reductions: As Figure 1 shows, ARP units have reduced annual SO_2 emissions by 56 percent compared with 1980 levels and 52 percent compared with 1990 levels. Sources emitted 7.6 million tons of SO_2 in 2008, well below the current annual emission cap of 9.5 million tons,

Figure 1: SO_2 Emissions from Acid Rain Program Sources, 1980-2008



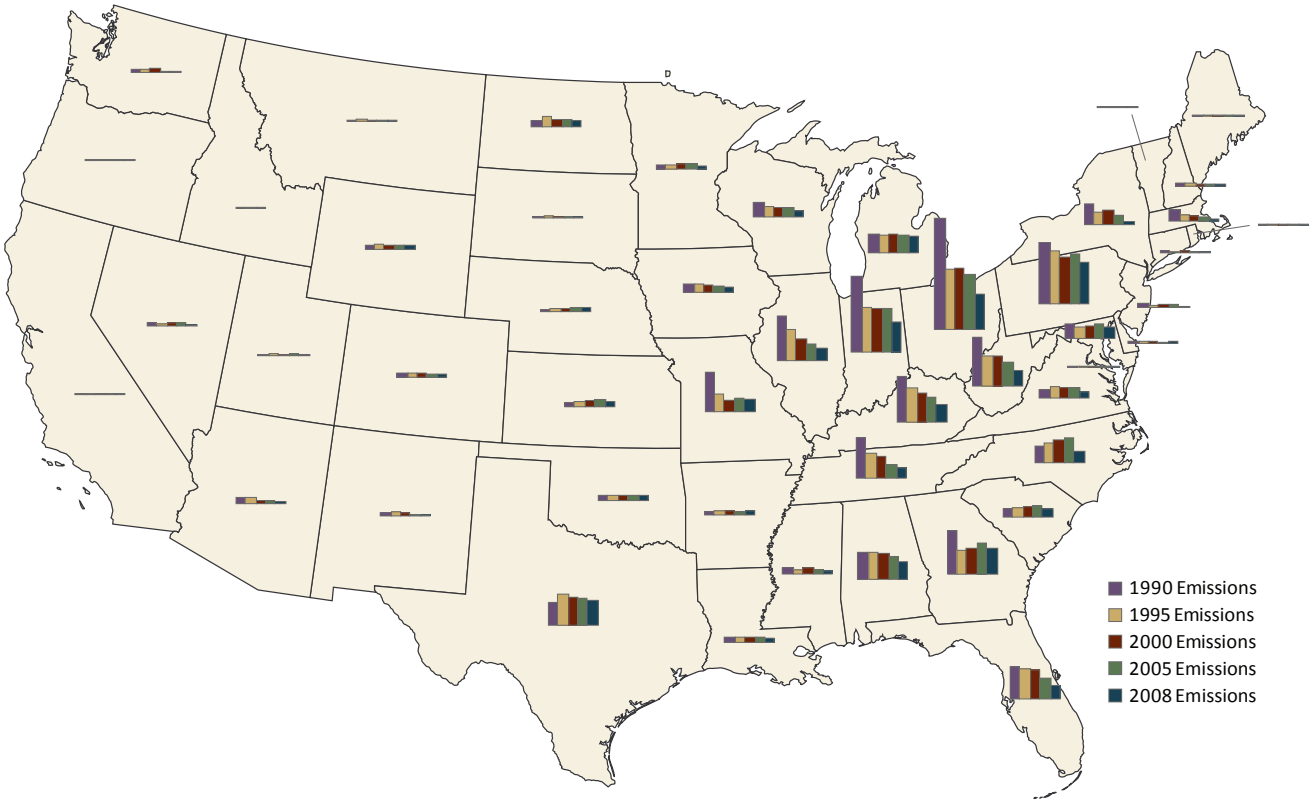
Source: EPA, 2009

and already below the statutory annual cap of 8.95 million tons set for compliance in 2010. Figure 2 shows state-by-state SO_2 emission reductions. The states with the highest emitting sources in 1990 have generally seen the greatest SO_2 reductions under the ARP.

Compliance: In 2008, all ARP units complied with the requirement to hold enough allowances to cover SO_2 emissions.

Allowances: In 2008, EPA allocated 9.5 million SO_2 allowances under the ARP. Together with 6.7 million unused al-

Figure 2: State-by-State SO_2 Emission Levels for Acid Rain Program Sources, 1990-2008



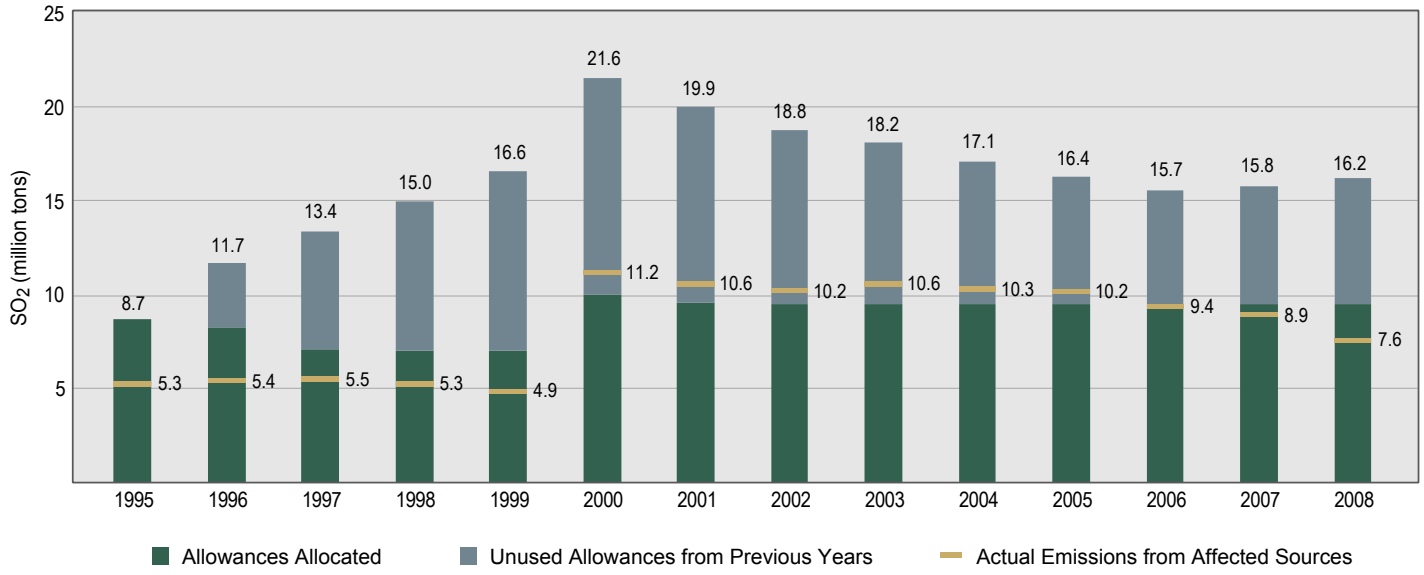
Scale: Largest bar equals 2.2 million tons of SO_2 emissions in Ohio, 1990.

Source: EPA, 2009

lowances carried over (or banked) from prior years, there were 16.2 million allowances available for use in 2008. ARP sources emitted approximately 7.6 million tons of SO_2 in 2008, less than the allowances allocated for the year, and far less than the total allowances available (see Figure 3). Thus after the 2008 allowance reconciliation, the number of banked allowances increased to 8.6 million. In 2010, the total number of Title IV allowances allocated annually will drop to 8.95 million and remain statutorily fixed at that annual level.

Allowance Market: Figure 4 shows the annual volume of SO_2 allowances transferred under the ARP (excluding allocations, retirements, and other transfers by EPA) since

Figure 3: SO_2 Emissions and the Allowance Bank, 1995-2008



Source: EPA, 2009

Figure 4: SO_2 Allowances Transferred under the ARP

Source: EPA, 2009

official recording of transfers began in 1994. About 5.9 million allowances (42 percent) were transferred in economically significant transactions (i.e., between economically unrelated parties). Transfers between economically unrelated parties are considered a better indicator of an active, functioning market than are transactions among the various facility and general accounts associated with a given company.

Key Results of the NO_x Program

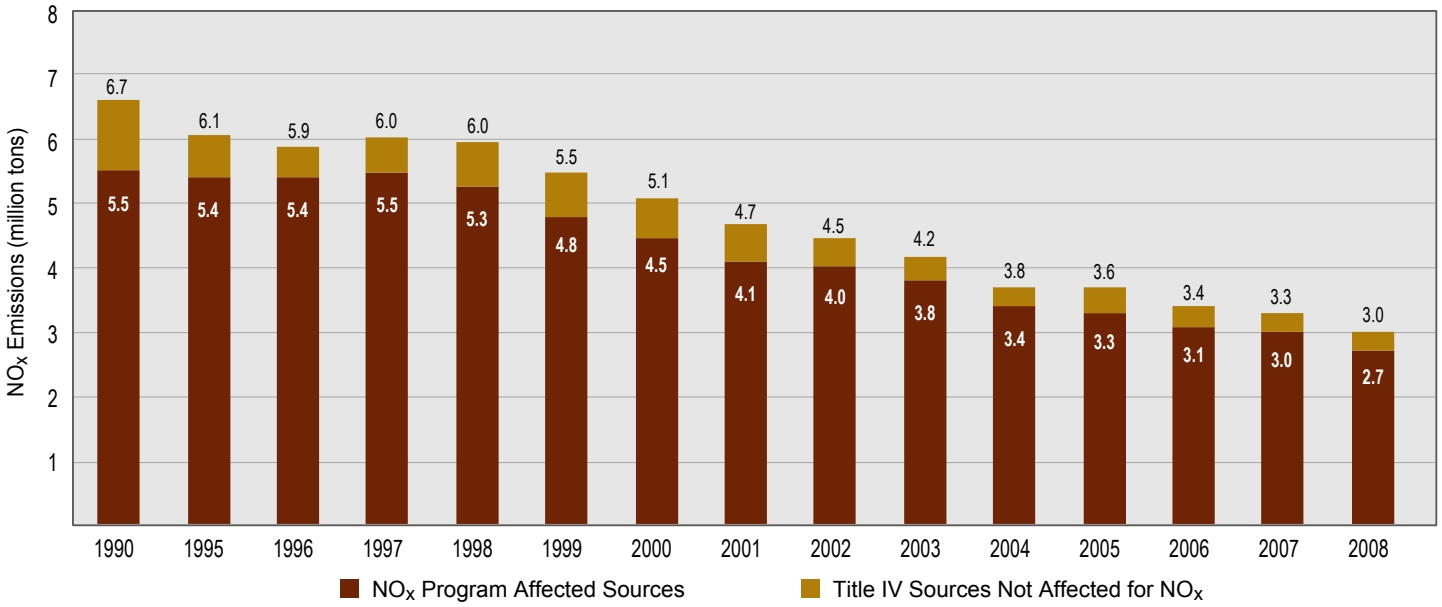
NO_x Emission Reductions: Figure 5 shows that NO_x emissions from all ARP sources were 3.0 million tons in 2008. This level is 5.1 million tons less than the projected level in 2000 without the ARP (8.1 million tons), or more than double the Title IV NO_x emission reduction objective. Although the ARP was responsible for a large portion of these annual NO_x reductions, programs such as the NO_x Budget Trading Program and other regional and state NO_x emission control programs also contributed significantly.

Compliance: In 2008, 969 coal-fired generation units at 383 facilities were subject to the ARP NO_x Program. All units achieved compliance in 2008.

Environmental Results

SO_2 Air Quality: Data collected from monitoring networks show that the decline in SO_2 emissions from the power industry has improved air quality. The national composite average of SO_2 annual mean ambient concentrations decreased 71 percent between 1980 and 2008.

Figure 5: NO_x Emission Trends for All Acid Rain Program Units, 1990-2008



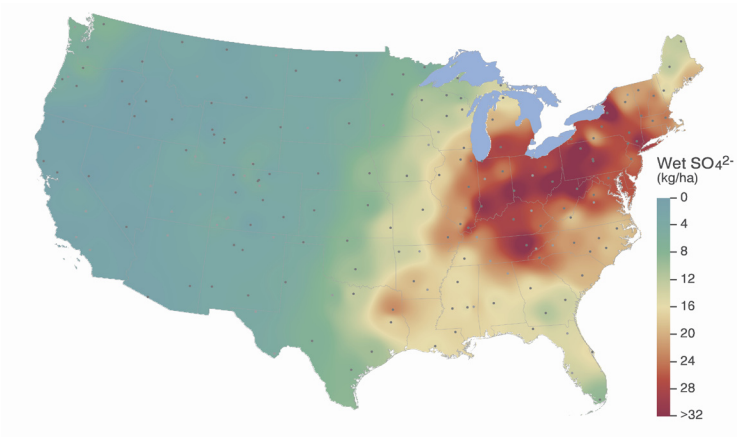
Source: EPA, 2009

Acid Deposition Improvements: Monitoring data show significant improvements in the primary acid deposition indicators:

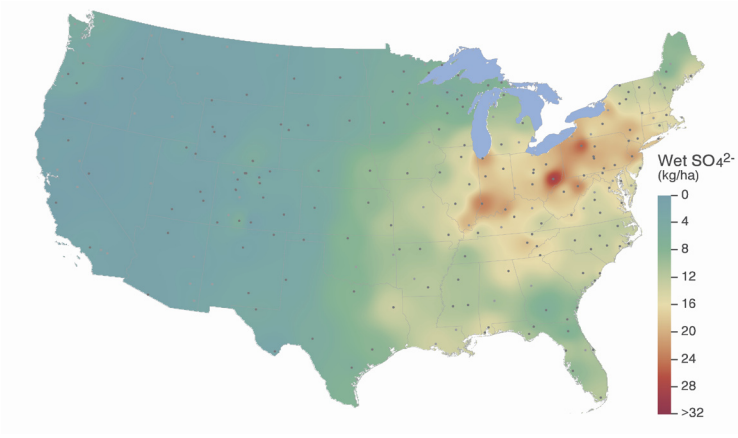
- **Wet Sulfate Deposition:** Between the 1989 to 1991 and 2006 to 2008 observation periods, decreases in wet deposition of sulfate averaged more than 30 percent for the eastern United States (see Figure 6).

Figure 6: Annual Mean Wet Sulfate Deposition

1989-1991



2006-2008

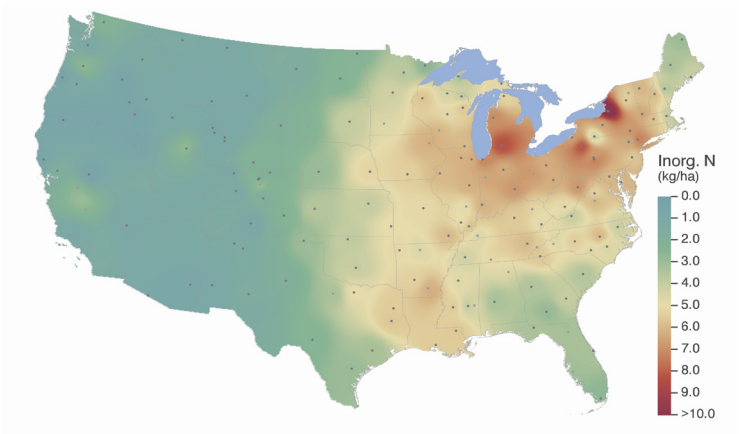


Source: NADP, 2009

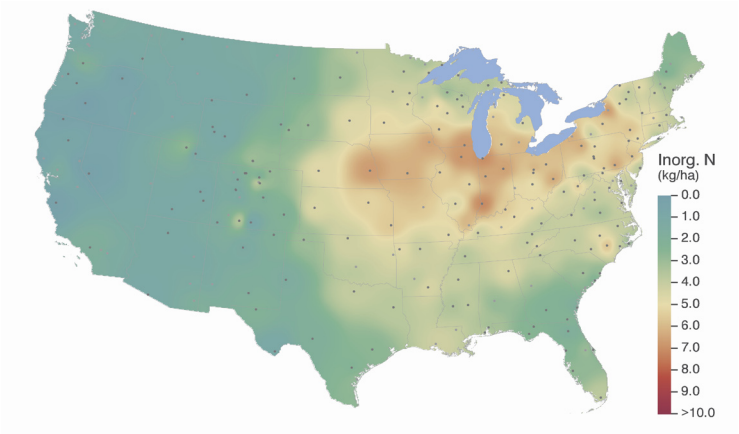
- **Nitrogen Deposition:** Inorganic nitrogen in wet deposition decreased in the Mid-Atlantic and Northeast, but to a lesser extent than sulfur (see Figure 7). Wet nitrogen deposition is influenced by sources outside the ARP.

Figure 7: Annual Mean Wet Inorganic Nitrogen Deposition

1989-1991



2006-2008

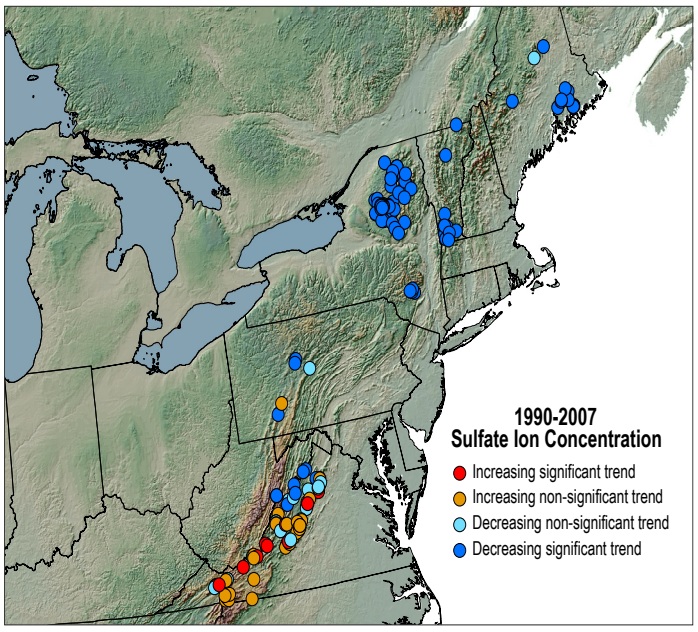


Source: NADP, 2009

Surface Water Quality Improvements: Acid rain, resulting from SO_2 and NO_x emissions, negatively affects the health of lakes and streams and creates chemical conditions that may adversely impact fish and other aquatic animals. Surface water chemistry provides direct indicators of the potential effects of acidic deposition on the overall health of aquatic ecosystems. Surface water monitoring networks, like EPA's Long-Term Monitoring (LTM) program, provide information on how water bodies are responding to changes in emissions. Since the implementation of the ARP, scientists have found signs of recovery in many, but not all, of the lakes and streams studied in the eastern United States:

- **Sulfate Concentrations:** Measurements of sulfate in surface waters provide important information on the level of acidification of a water body. Decreasing sulfate concentrations in surface water signify a trend toward recovery from acidification. Figure 8 shows that sulfate concentrations are declining at almost all sites in the Northeast (New England, Adirondacks/Catskills and Pennsylvania [Northern Appalachians]). However, in the Southern Blue Ridge (Central Appalachians), sulfate concentrations in many streams are increasing.

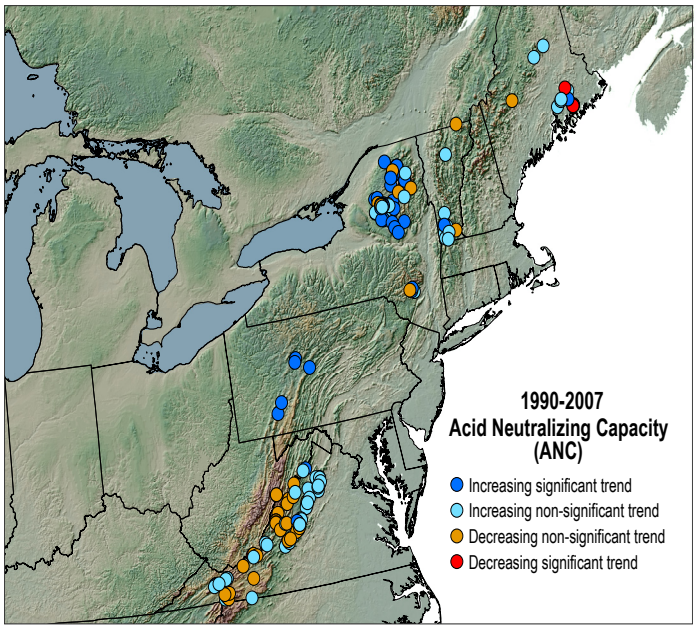
Figure 8: Trends in Lake and Stream Water Chemistry at LTM Sites, 1990-2007, Sulfate Ion Concentration (µeq/L/yr)



Source: EPA, 2009

- **Acid Neutralization Capacity (ANC):** ANC is a measure of the sensitivity of a water body to acidification. Movement toward recovery of an acidified aquatic ecosystem is indicated by an increase in ANC. Figure 9 shows that ANC is on average increasing in three of the four regions, which in part can be attributed to declining sulfate deposition. The site trends also indicate variation within each region. Only two sites indicate a significant downward trend in ANC.

Figure 9: Trends in Lake and Stream Water Chemistry at LTM Sites, 1990-2007, ANC Levels (µeq/L/yr)



Source: EPA, 2009

Human Health Benefits

Benefits from the ARP include the prevention of human health-related impacts, such as premature death, asthma exacerbation, and hospital admissions for respiratory and cardiovascular ailments. Emissions of SO_2 and NO_x are precursors to formation of fine particulate matter ($PM_{2.5}$), while NO_x also contributes to the formation of ground-level ozone. These air pollutants are detrimental to human health. By reducing power sector emissions of SO_2 and NO_x, ambient air quality is improved thus improving human health.

EPA recently updated the estimated U.S. $PM_{2.5}$ and ozone health-related benefits due to ARP implementation for the prospective year 2010 that were originally published in a 2005 journal article.[1] The results of the revised assessment show that estimated $PM_{2.5}$ health benefits due to ARP implementation in 2010 are valued at $170–$410 billion (2008 dollars). The benefits are primarily from reduced premature mortality of 20,000 to 50,000 incidences per year in 2010. Using updated methods to assess ground-level ozone benefits from ARP implementation in 2010 results in total health benefits ranging from $4.1–$17 billion (2008 dollars). The benefits are primarily from reduced premature mortality of 430 to 2,000 incidences per year in 2010. These updated benefits do not include human welfare benefits due to better ecological conditions, such as improved visibility and reduced acidification of lakes and streams.

Clean Air Interstate Rule

CAIR was issued on March 10, 2005, in order to build on the emission reductions under the NBP and the ARP. The rule was designed to permanently lower emissions of SO_2 and NO_x in the eastern United States. CAIR, as promulgated, was designed to help states address ozone nonattainment and attain the NAAQS for $PM_{2.5}$ by reducing transported precursors, SO_2 and NO_x. CAIR was also expected to improve visibility in Class 1 areas, including national parks, monuments, and wilderness areas. To achieve these emission reductions, it created three separate compliance programs: an annual NO_x program, an ozone season NO_x program, and an annual SO_2 program.

Each of the three programs uses a two-phased approach, with declining emission caps in each phase. The first phase began in 2009 for the NO_x annual and NO_x ozone season programs, and will start in 2010 for the SO_2 annual program. The rule also establishes a second phase for all three programs beginning in 2015.

All 28 states and the District of Columbia chose to be part of the EPA-administered regional CAIR trading programs. Monitoring and reporting according to EPA's stringent regulations began in 2008 for the NO_x programs and in 2009 for the SO_2 program.

Litigation and CAIR Replacement Rule

On July 11, 2008, the U.S. Court of Appeals for the D.C. Circuit issued a ruling vacating CAIR in its entirety. EPA and other parties requested a rehearing, and on December 23, 2008, the Court revised its decision and remanded CAIR to EPA without vacatur. This ruling leaves CAIR and the CAIR Federal Implementation Plans (FIPs)—including the CAIR trading programs—in place until EPA issues new rules to replace CAIR.

While the court did not impose a deadline by which EPA must issue the replacement rules, EPA estimates that development and finalization of replacement rules could take about two years. EPA is committed to issuing rules to replace CAIR that will help states address the interstate air emissions transport problem in a timely way and that fully comply with the requirements of the Clean Air Act and the opinions of the D.C. Circuit.

Current CAIR Implementation

The CAIR NO_x ozone season and CAIR NO_x annual program requirements to hold allowances equivalent to ozone season and annual emissions started in 2009.

The CAIR SO_2 program requirements for continuous monitoring and reporting started January 1, 2009. Acid Rain sources that are already complying with Part 75 monitoring and reporting provisions essentially do not have to do anything additional to comply with CAIR SO_2 monitoring requirements. Sources not subject to the Acid Rain Program but subject to CAIR began complying with Part 75 monitoring and reporting this year. The requirement to hold allowances in the CAIR SO_2 program begins January 1, 2010.

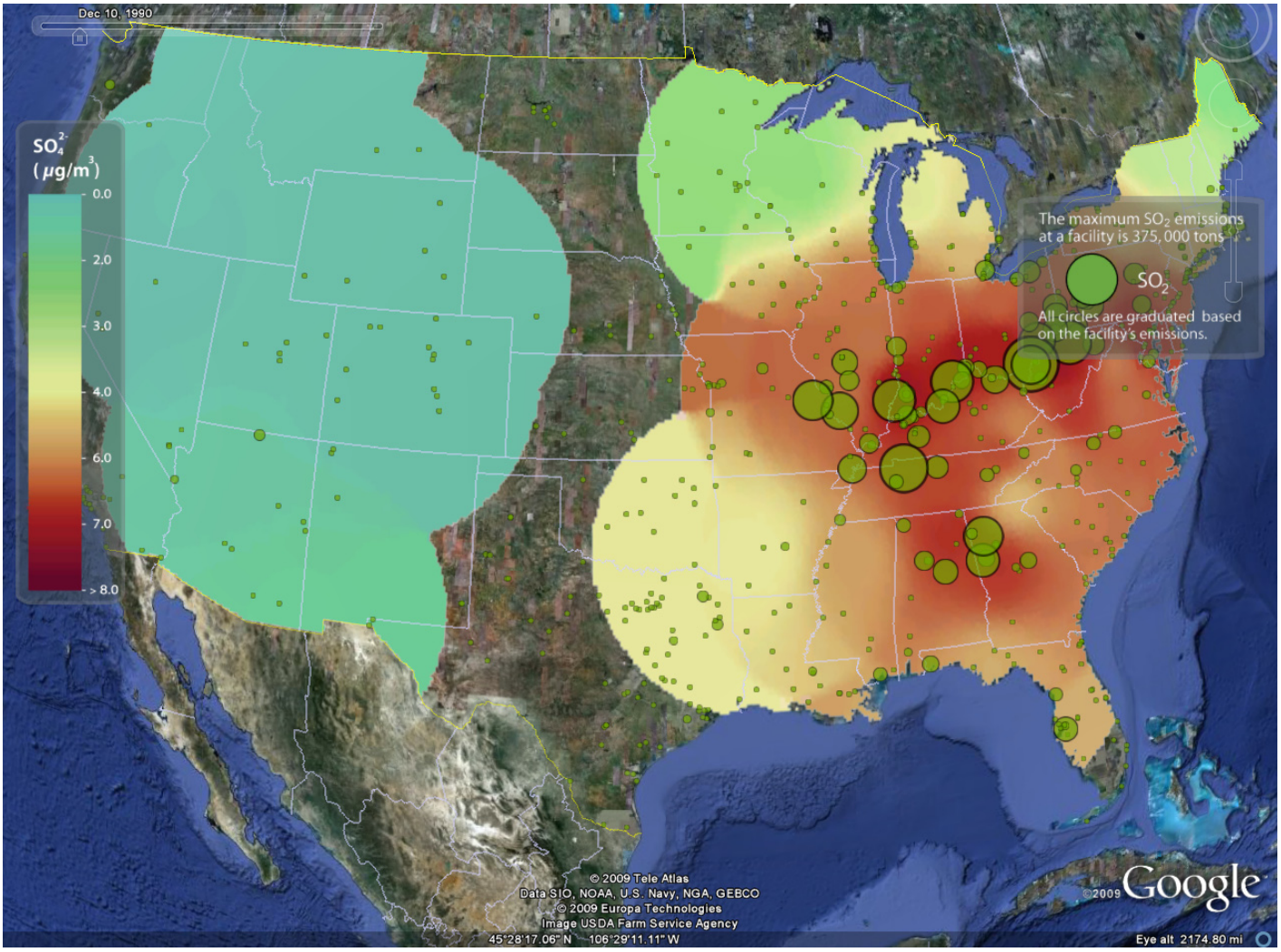
[1] Chestnut, L. G., and Mills, D. M. 2005. A fresh look at the benefits and costs of the US Acid Rain Program, *Journal of Environmental Management,* 77(3): 252-266.

Online Information, Data, and Resources

The availability and transparency of data, from emission measurement to allowance trading to deposition monitoring, is a cornerstone of effective cap and trade programs. CAMD, in the Office of Air and Radiation's Office of Atmospheric Programs, develops and manages programs for collecting these data and assessing the effectiveness of cap and trade programs, including the ARP.

The CAMD Web site provides a public resource for general information on how market-based programs work and what they have accomplished, along with the processes, information, and tools necessary to participate in any of these market-based programs. For information about EPA's air emission trading programs, see <www.epa.gov/airmarkets>. For information about the ARP, see <www.epa.gov/airmarkets/progsregs/arp/index.html>.

Figure 10: U.S. Sulfur Dioxide Emissions from ARP Sources and Ambient Sulfate Concentration, 1990



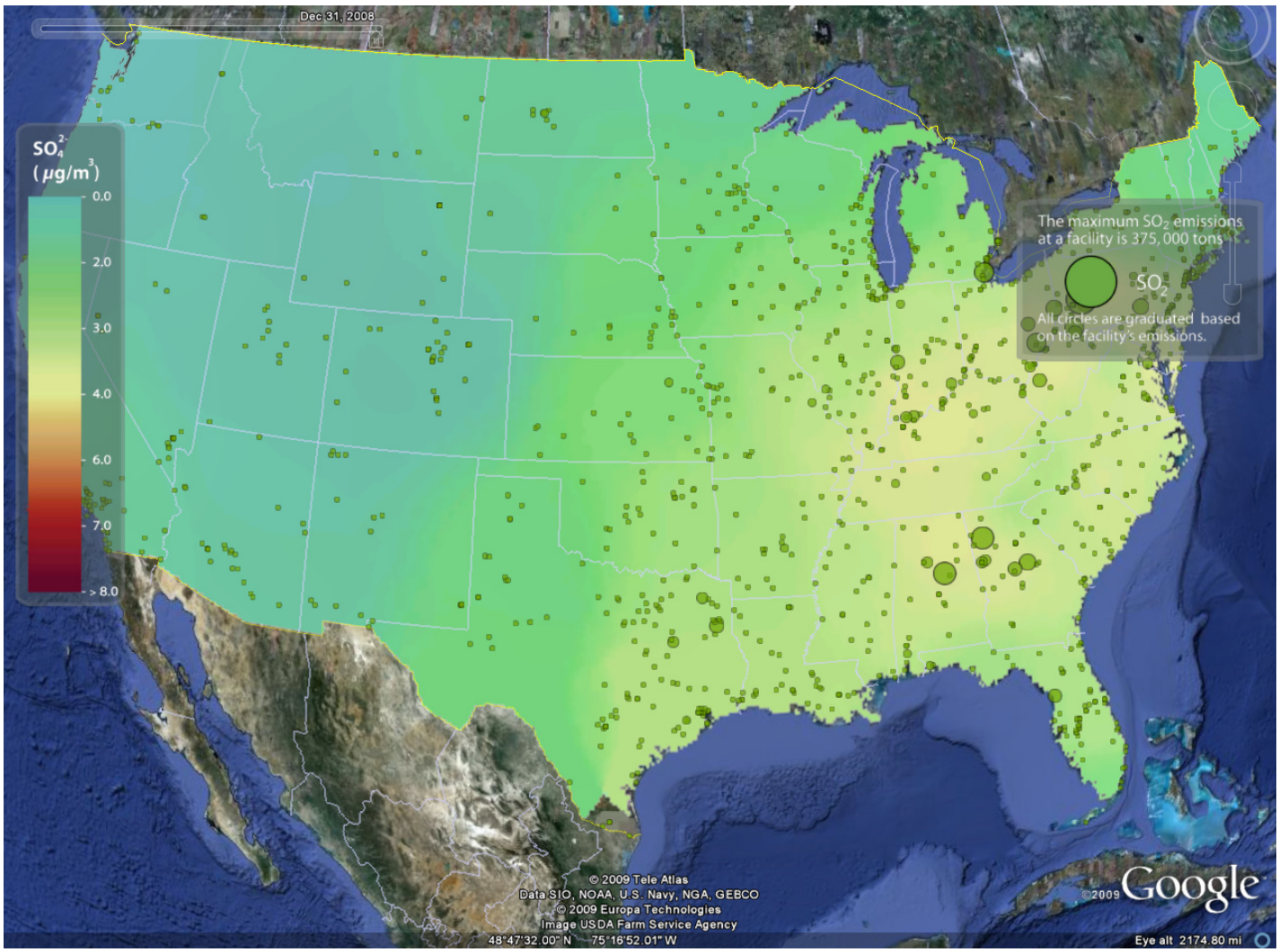
Note: This example depicts 1990 SO_2 emissions from ARP sources along with 1990 sulfate concentration data as measured by the CASTNET monitoring program.

Source: EPA, 2009

To increase data transparency, EPA has created supplementary maps that allow the user to display air market program data geospatially on an interactive 3D platform. Figures 10 and 11 are examples of these interactive maps. The maps come in the form of a KMZ file (a compressed KML file) that is downloaded directly to the user's computer. Data can be explored in new and meaningful ways by turning different layers on and off, overlaying data points and satellite imagery, and using navigation tools to change the view of the Earth's surface. KMZ/KML files are supported by programs such as Google Earth, ESRI Arc Explorer, and NASA WorldWind View. These interactive mapping applications provide a unique way to identify environmental trends and track the progress of various EPA programs, such as the ARP.

For more information or to utilize the program, visit the Web site at <epa.gov/airmarkets/progress/interactivemapping.html>.

Figure 11: U.S. Sulfur Dioxide Emissions from ARP Sources and Ambient Sulfate Concentration, 2008



Note: This example depicts 2008 SO_2 emissions from ARP sources along with 2007 sulfate concentration data as measured by the CASTNET monitoring program.

Source: EPA, 2009

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www.epa.gov/airmarkets