Ambient Concentrations of Nitrogen Dioxide

Q: What are the trends in outdoor air quality and their effects on human health and the environment?

The above question pertains to all 'Outdoor Air' Indicators, however, the information on these pages (overview, graphics, references and metadata) relates specifically to "Ambient Concentrations of Nitrogen Dioxide". Use the right side drop list to view the other related indicators on this question.

Introduction

Nitrogen dioxide (NO_2) is a reddish-brown, highly reactive gas that is formed in the ambient air through the oxidation of nitric oxide (NO). Nitrogen dioxide is one in a group of highly reactive gases generically referred to as "nitrogen oxides" (NO_x), all of which contain nitrogen and oxygen in varying amounts. NO_x plays a major role in the formation of ozone in the atmosphere through a complex series of reactions with volatile organic compounds. NO_2 is the most widespread and commonly found nitrogen oxide (U.S. EPA, 2003).

Short-term exposures (e.g., less than 3 hours) to low levels of NO_2 may lead to changes in airway responsiveness and lung function in individuals with preexisting respiratory illnesses. These exposures may also increase respiratory illnesses in children. Long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause irreversible alterations in lung structure (U.S. EPA, 2008).

Atmospheric transformation of NO_x can lead to the formation of ozone and nitrogen-bearing particles (e.g., nitrates, nitric acid). Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic (e.g., fresh water bodies, estuaries, coastal water) systems. These effects can alter competition among existing species, leading to changes in species abundance and distribution within communities. For example, eutrophic conditions in aquatic systems can produce explosive growth of algae leading to hypoxia or an increase in levels of toxins harmful to fish and other aquatic life (U.S. EPA, 1993).

This indicator presents ambient NO_2 concentrations in parts per million (ppm) from 1980 to 2009, based on the annual arithmetic average. The indicator displays trends averaged over 81 sites in 61 counties nationwide that have consistent data for the period of record in the State and Local Air Monitoring Stations network or by special purpose monitors. It also shows trends in the annual average NO_2 measurements in each EPA Region. This indicator's exhibits display the annual average NO_2 National Ambient Air Quality Standard (NAAQS) as a point of reference, but the fact that the national or any regional average values fall below the standard does not mean that all monitoring sites nationally or in the EPA Region also are below the standard. This indicator displays trends in the number of the 81 sites nationwide at which NO_2 concentrations exceeded the level of the annual average standard over the period of record, but this statistic is not displayed for each EPA Region. Future versions of this indicator will compare 1-hour average concentrations of NO_2 to the recently promulgated 1-hour NAAQS.

What The Data Show

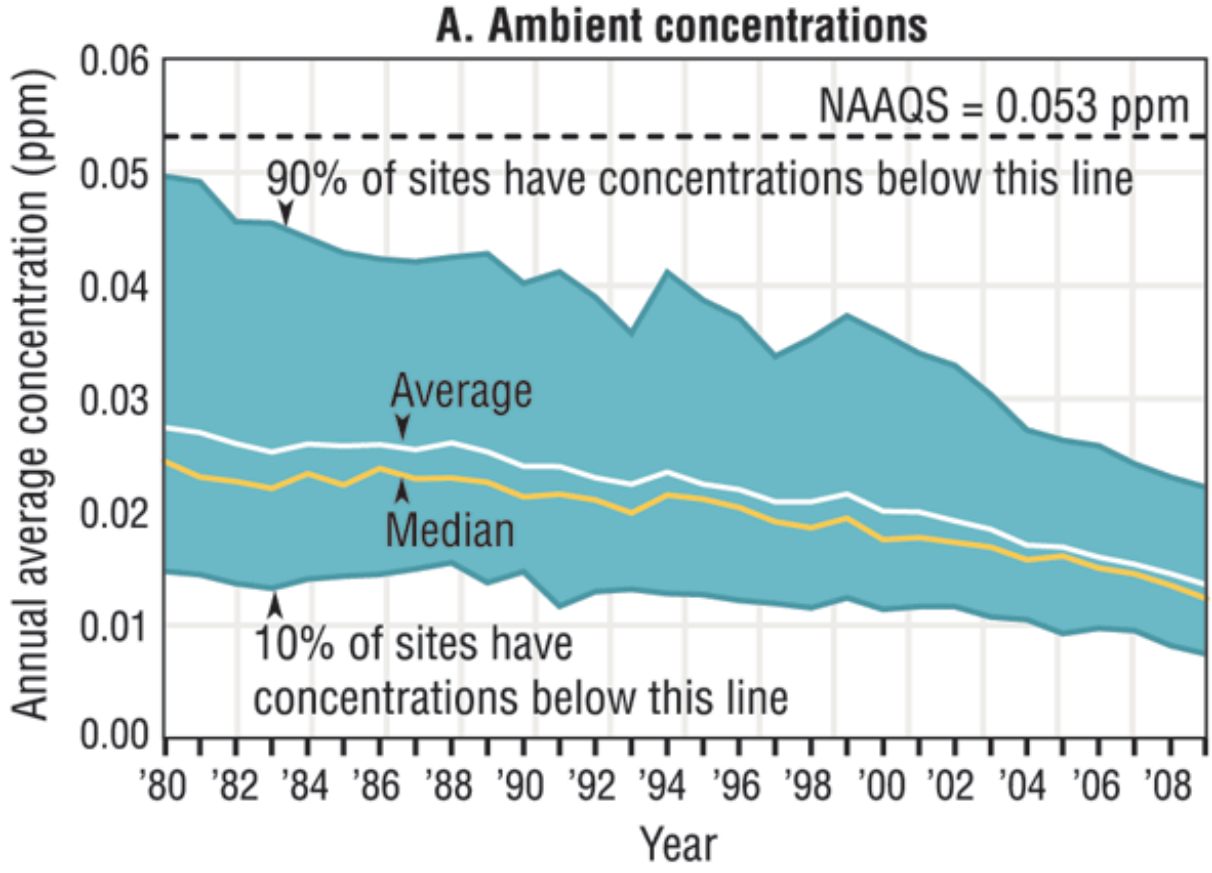
The national annual average NO_2 concentration in 2009 was 51 percent lower than that recorded in 1980 (Exhibit 2-9, panel A). Also shown on this graph are the 90^{th} and 10^{th} percentiles of NO_2 concentrations based on the distribution of annual statistics at the monitoring sites. This provides

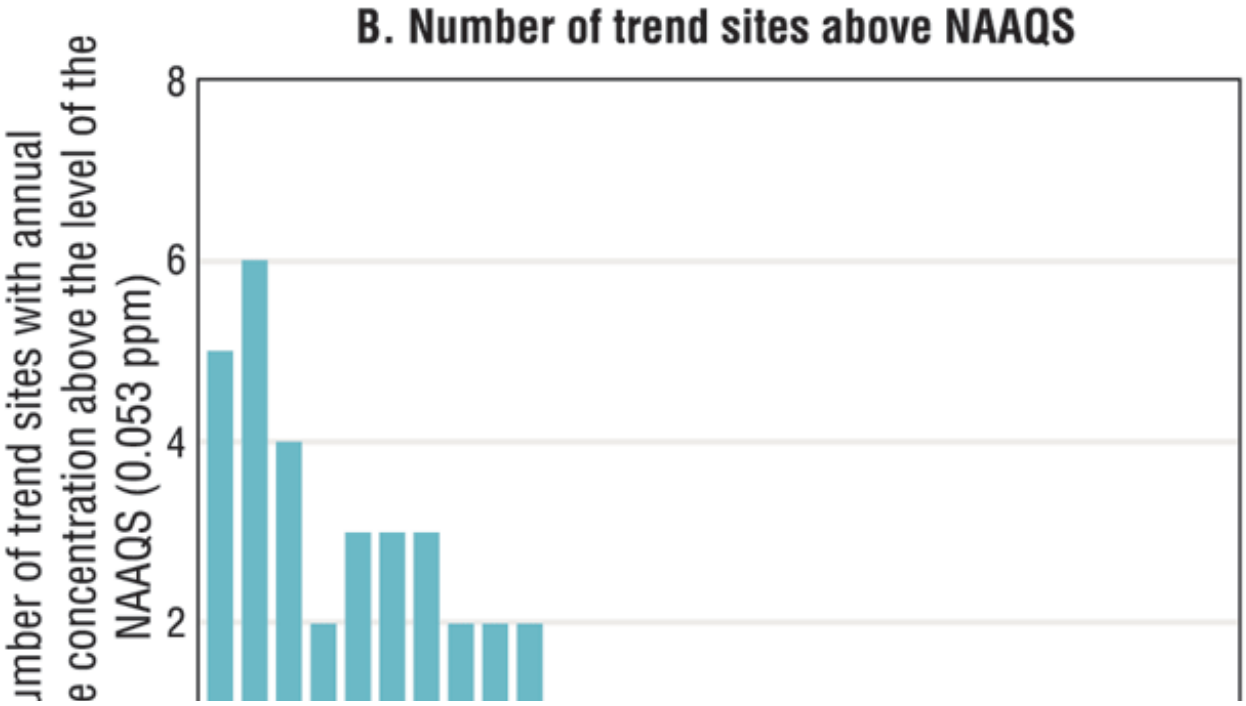
additional graphical representation of the distribution of measured concentrations across the monitoring sites for a given year. Thus, for each year, the graphic displays the concentration range where 80 percent of measured values occurred. The highest annual average NO_2 concentrations are typically found in urban areas. In addition, of the 81 sites used to determine this trend (out of 347 total monitoring sites that were operating in 2009), the number reporting NO_2 concentrations above the level of the NO_2 standard declined from six sites in 1981 to zero sites since 1992 (Exhibit 2-9, panel B).

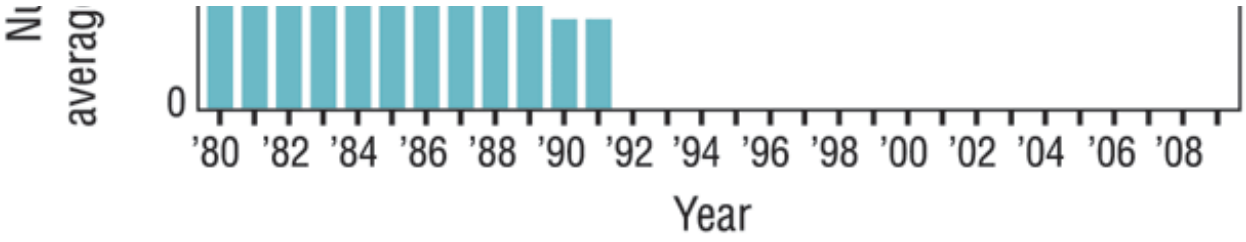
NO_2 levels in all EPA Regions with trend sites have steadily decreased since 1980, with percent reductions over this time ranging from 38 percent in Region 8 to 56 percent in Region 1 (Exhibit 2-10).

The decrease in NO_2 concentrations in this indicator is consistent with the decreasing NO_X emissions observed over the past decade (the Nitrogen Oxides Emissions indicator).

Exhibit 2-9. Ambient NO_2 concentrations in the U.S., 1980-2009[a]



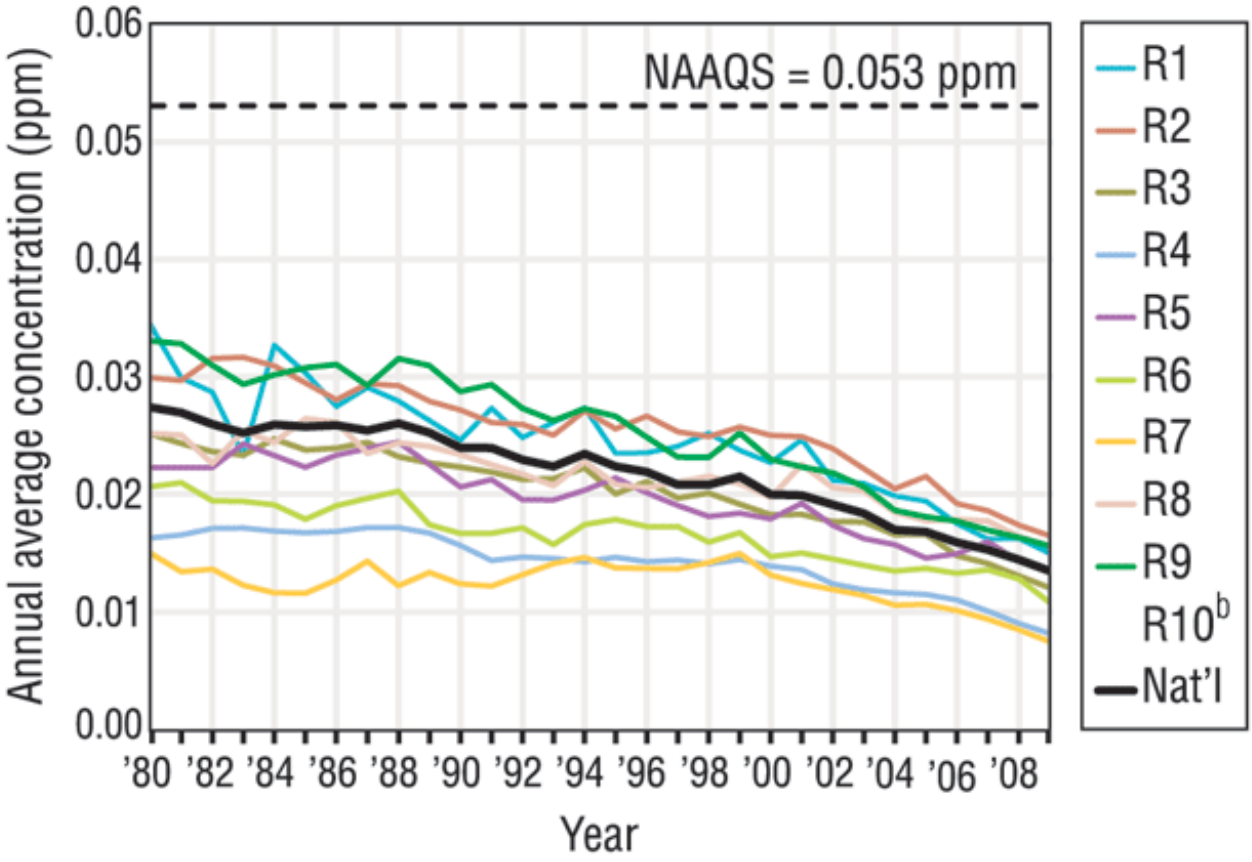




[a]**Coverage:** 81 monitoring sites in 61 counties nationwide (out of a total of 347 sites measuring NO_2 in 2009) that have sufficient data to assess NO_2 trends since 1980.

Data source: *U.S. EPA, 2010*

Exhibit 2-10. Ambient NO_2 concentrations in the contiguous U.S. by EPA Region, 1980-2009[a,b]



[a]**Coverage:** 81 monitoring sites in the EPA Regions (out of a total of 347 sites measuring NO_2 in 2009) that have sufficient data to assess NO_2 trends since 1980.

[b]States in Region 10 have removed NO_2 monitors in recent years because of low concentrations, and consequently none of this Region's monitoring sites have a complete record dating back to 1980. Thus, no trend line for Region 10 is shown.

Data source: U.S. EPA, 2010

Limitations

- Because ambient monitoring for NO_2 occurs almost exclusively in high-traffic urban areas, the average concentrations presented in this indicator likely may not reflect NO_2 levels in rural areas. Also, in rural areas, air mass aging could foster greater relative levels of peroxyacetyl nitrate (PAN) and nitric acid, which can cause a positive interference in NO_2 measurements.
- The measurement of NO_2 is based on the conversion of NO_2 to NO and the subsequent detection of NO using the chemiluminescence technique. Because there are other nitrogen-containing compounds, such as PAN and nitric acid, that can be converted to NO, the chemiluminescence technique may overestimate NO_2 concentrations due to these interferences. Measurement devices with ultraviolet photolytic converters are less prone to interferences than devices with heated surfaces (or catalysts) upstream of the chemiluminescence detector, but are not in widespread use.
- Because of the relatively small number of trend sites in some EPA Regions, the regional trends are subject to greater uncertainty than the national trends. Some EPA Regions with low average concentrations may include areas with high local concentrations, and vice versa.
- To ensure that long-term trends are based on a consistent set of monitoring sites, selection criteria were applied to identify the subset of NO_2 monitoring sites with sufficient data to assess trends since 1980. Monitoring sites without sufficient data are not included in the trend analysis. Some excluded monitoring sites reported NO_2 concentrations above the level of the NO_2 standard over the time frame covered by this indicator. In 2009, however, no monitoring sites in the U.S. measured annual average NO_2 concentrations above the level of the NAAQS.

Data Sources

Summary data in this indicator were provided by EPA's Office of Air Quality Planning and Standards, based on NO_2 ambient air monitoring data in EPA's Air Quality System (U.S. EPA, 2010) (http://www.epa.gov/ttn/airs/airsaqs/). National and regional trends in this indicator are based on the subset of NO_2 monitoring stations that have sufficient data to assess trends since 1980.

References

U.S. EPA (United States Environmental Protection Agency). 2010. Data from the Air Quality System. Accessed 2010. http://www.epa.gov/ttn/airs/airsaqs/

U.S. EPA. 2008. Integrated Science Assessment for Oxides of Nitrogen Health Criteria (Final Report). EPA/600/R-08/071. Research Triangle Park, NC. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=194645

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