

Report on the Environment <https://www.epa.gov/report-environment>

Nitrogen Dioxide Concentrations

Nitrogen dioxide (NO₂) is one of many highly reactive gases collectively referred to as “nitrogen oxides” (NO_x), all of which contain nitrogen and oxygen in varying amounts. Direct air emissions of NO_x generally comprise a mix of nitric oxide (NO) and NO₂, with a ratio in favor of NO. Specific emissions sources of NO_x that can affect local air quality include on-road vehicles, airports, railyards, shipping ports, home wood burning, intense industrial and chemical processes, activities for oil and gas development, and wildfires (see [Nitrogen Oxides Emissions](#) indicator). Once emitted to the air, NO reacts rapidly in the presence of ozone to form NO₂. In fact, in U.S. urban locations, most measured airborne NO₂ comes from the reaction of these two precursors, rather than from direct NO₂ emissions (U.S. EPA, 2016).

Scientific evidence indicates that short-term NO₂ exposures, ranging from 30 minutes to 24 hours, can cause the exacerbation of asthma symptoms, in some cases resulting in emergency room visits or hospital admissions. Additionally, long-term NO₂ exposures are likely to have a causal relationship with respiratory effects, based on evidence for development of asthma (U.S. EPA, 2016).

Atmospheric transformation of NO_x and other pollutants leads to the formation of nitrogen-bearing particles that can eventually deposit to the surface, causing acidification, nitrogen enrichment, and other ecological effects. Acidification from the deposition resulting from current emission levels causes a cascade of effects that harm susceptible aquatic and terrestrial ecosystems, including slower growth and injury to forests and localized extinction of fishes and other aquatic species (see [Acid Deposition](#) indicator). Further, deposition of reactive nitrogen particles along with other non-atmospheric sources (e.g., fertilizers and wastewater) causes a suite of ecological changes within sensitive ecosystems. Examples include increased primary productivity in most nitrogen-limited ecosystems, biodiversity losses, changes in carbon cycling, and eutrophication and harmful algal blooms in freshwater, estuarine, and ocean ecosystems (U.S. EPA, 2020).

This indicator presents ambient NO₂ concentrations in parts per billion (ppb) using two averaging times: 1-hour averages to be consistent with the short-term primary National Ambient Air Quality Standard (NAAQS) and annual averages to present trends consistent with the long-term NO₂ NAAQS. Trend data are based on measurements from the State and Local Air Monitoring Stations network and from other special purpose monitors. The number and spatial coverage of monitoring sites vary: between 1990 and 2021, 89 monitoring sites in 67 counties nationwide have sufficient data to characterize annual average trends; and between 1990 and 2021, 64 monitoring sites in 50 counties nationwide have sufficient data to characterize 1-hour trends. Trends are displayed for the entire nation and for each EPA Region with monitoring sites with sufficient long-term data.

Trends in 1-hour NO₂ concentrations are presented for the 98th percentile of 1-hour daily maximum concentrations for each calendar year. All exhibits in this indicator present the NO₂ NAAQS as a point of reference. The fact that the national or regional concentrations fall below the standards does not mean that all monitoring sites nationally or in the EPA Region also are below the standards. The indicator displays trends in the number of trend sites nationwide at which NO₂ concentrations exceeded the level of the standards, but these statistics are not displayed for the EPA Regions.

What the Data Show

The national annual average NO₂ concentration in 2021 was 61 percent lower than that for 1990 (Exhibit 1). Also shown on this graph are the 90th and 10th percentiles of NO₂ 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 NO₂ concentrations are typically found in urban areas. In addition, of the 89 sites used to determine the trend for annual average concentrations (out of 409 total monitoring sites that were operating in 2021), the number reporting NO₂ concentrations above the level of the NO₂ standard declined from one site in 1990 to zero sites since 1992 (Exhibit 2).

Annual average NO₂ levels in the EPA Regions with trend sites steadily decreased since 1990, with the largest percent reduction (65 percent) in Regions 1 and 9 (Exhibit 3). There was not sufficient data to assess NO₂ concentration trends in EPA Regions 7 and 10. The decrease in NO₂ concentrations in this indicator is consistent with the decreasing NO_x emissions reported in the [Nitrogen Oxides Emissions](#) indicator.

The 98th percentile of 1-hour NO₂ concentrations also exhibited a downward trend. From 1990 to 2021, the concentrations decreased by 54 percent across the 64 sites with sufficient data (Exhibit 4). Among these sites, the number reporting concentrations above the level of the 2010 1-hour NAAQS decreased from nine sites in 1990 to zero sites from 2004 to 2021 (Exhibit 5).

Limitations

- Because ambient monitoring for NO₂ occurs almost exclusively in high-traffic urban areas, the average concentrations presented in this indicator likely may not reflect NO₂ concentrations 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 NO₂ measurements.
- The measurement of NO₂ is based on the conversion of NO₂ 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 NO₂ 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. In addition, the 89 trend sites with sufficient data for annual trends are not dispersed uniformly across all states in the EPA Regions. The 89 sites for annual trends are located in 22 states. In the remaining 28 states, there currently are insufficient long-term NO₂ data from monitoring sites to include in this indicator.
- To ensure that long-term trends are based on a consistent set of monitoring sites, selection

criteria were applied to identify the subset of NO₂ monitoring sites with sufficient data to assess trends since 1990. Monitoring sites without sufficient data are not included in the trend analysis. Some excluded monitoring sites reported NO₂ concentrations above the level of the NO₂ standard in some of the years covered by this indicator. In 2021, however, no monitoring sites in the U.S. measured annual average NO₂ concentrations above the level of the NAAQS.

Data Sources

Summary data in this indicator were downloaded from EPA's National Air Quality: Status and Trends of Key Air Pollutants website (U.S. EPA, 2021a) (<https://www.epa.gov/air-trends>). The summary data are based on NO₂ ambient air monitoring data in EPA's Air Quality System. National and regional trends in this indicator are based on the subset of NO₂ monitoring stations that have sufficient data to assess trends since 1990.

References

U.S. EPA (United States Environmental Protection Agency). 2022a. Data from the National Air Quality: Status and Trends of Key Air Pollutants website. Accessed 2022.

<https://www.epa.gov/air-trends>.

U.S. EPA. 2022b. History of the national ambient air quality standards for oxides of nitrogen. Accessed 2022. https://www3.epa.gov/ttn/naaqs/standards/nox/s_nox_history.html.

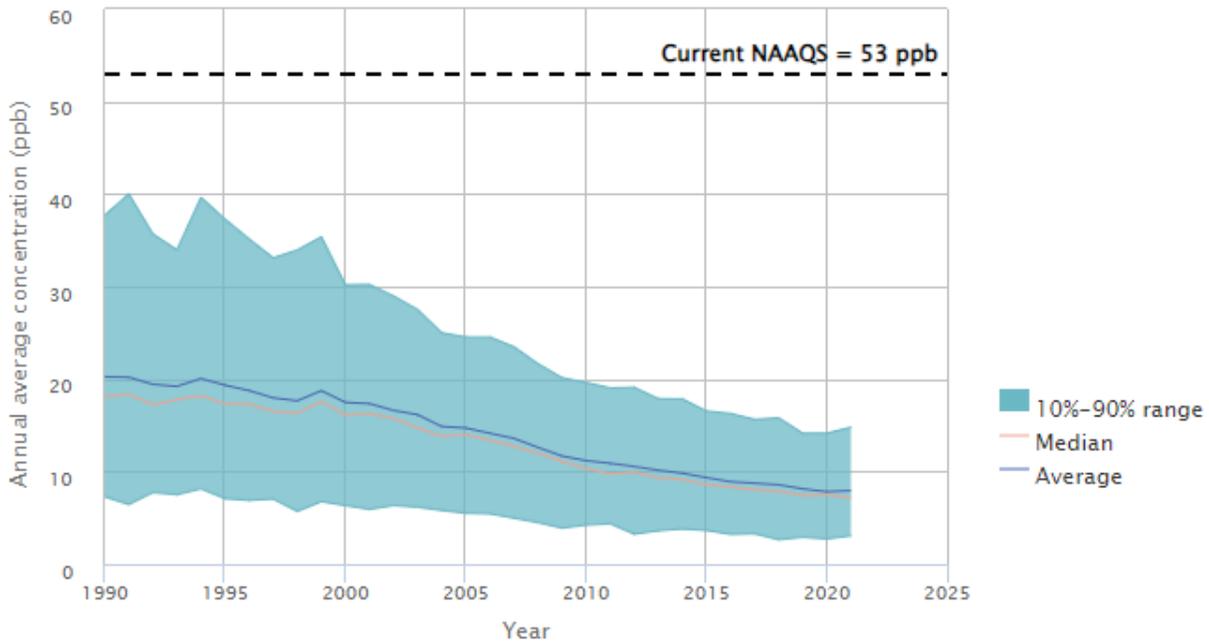
U.S. EPA. 2020. Integrated science assessment for oxides of nitrogen, oxides of sulfur and particulate matter—ecological criteria. EPA/600/R-20/278. Research Triangle Park, NC.

<https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=349473>.

U.S. EPA. 2016. Integrated science assessment for oxides of nitrogen—health criteria. EPA/600/R-15/068. Research Triangle Park, NC.

<https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=310879>.

Exhibit 1. Ambient annual NO₂ concentrations in the U.S., 1990–2021



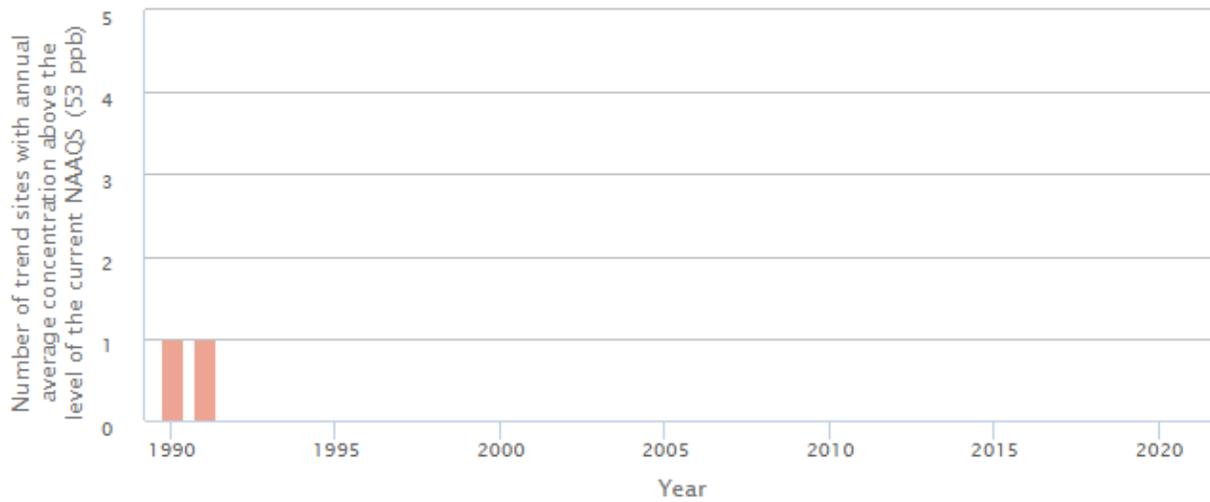
The current annual NO₂ NAAQS was established in 1971 and has been confirmed in subsequent reviews (U.S. EPA, 2022b).

Coverage: 89 monitoring sites in 67 counties nationwide (out of a total of 409 sites measuring NO₂ in 2021) that have sufficient data to assess annual NO₂ trends since 1990.

Analysis shows that these trends are statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022a

Exhibit 2. Ambient annual NO₂ concentrations above the level of the current NAAQS in the U.S., 1990–2021



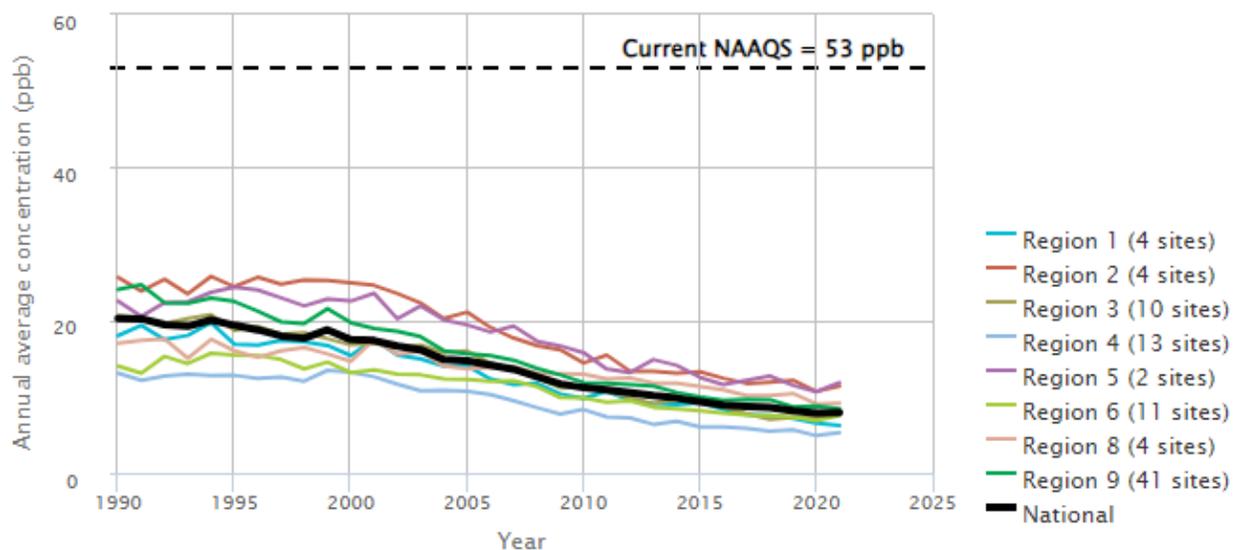
The current annual NO₂ NAAQS was established in 1971 and has been confirmed in subsequent reviews (U.S. EPA, 2022b).

Coverage: 89 monitoring sites in 67 counties nationwide (out of a total of 409 sites measuring NO₂ in 2021) that have sufficient data to assess annual NO₂ trends since 1990.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022a

Exhibit 3. Ambient annual NO₂ concentrations in the contiguous U.S. by EPA Region, 1990–2021



The current annual NO₂ NAAQS was established in 1971 and has been confirmed in subsequent reviews (U.S. EPA, 2022b).

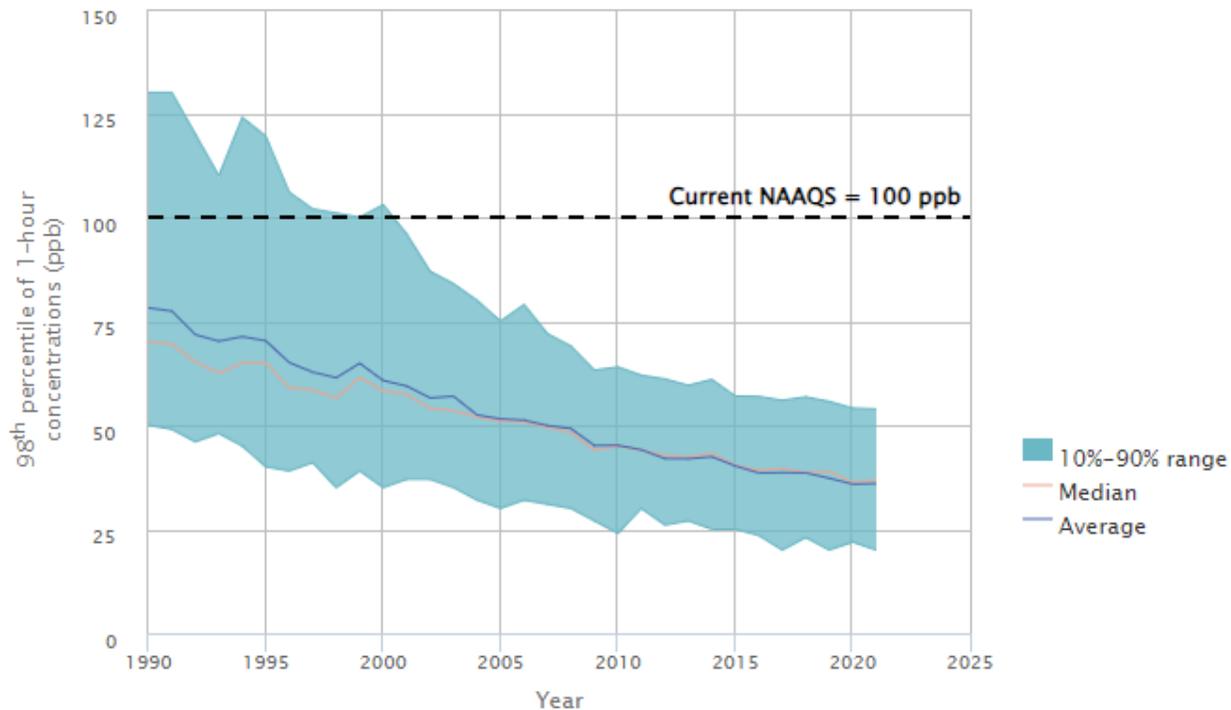
Coverage: 89 monitoring sites in 67 counties nationwide (out of a total of 409 sites nationwide measuring NO₂ in 2021) that have sufficient data to assess annual NO₂ trends in the contiguous U.S. since 1990.

States in Regions 7 and 10 have removed NO₂ monitors in recent years because of low concentrations, and consequently none of these Regions' monitoring sites has a complete record dating back to 1990. Thus, no trend lines for Regions 7 and 10 are shown.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022a

Exhibit 4. Ambient 1-hour NO₂ concentrations in the U.S., 1990–2021



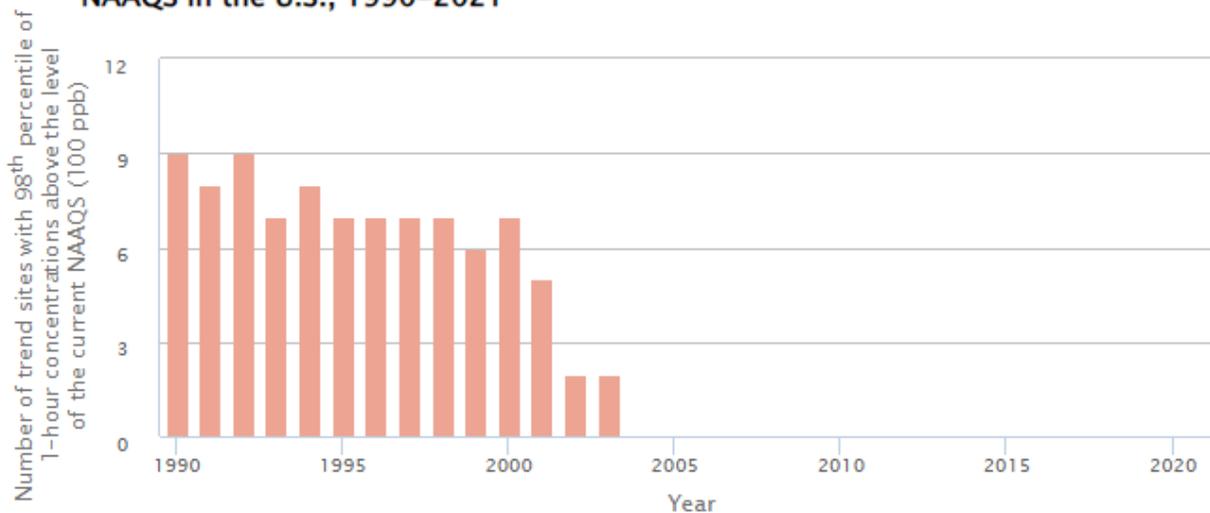
The current 1-hour NO₂ NAAQS was established in 2010 and is shown to provide context for the magnitude of pollutant concentrations. No 1-hour NO₂ NAAQS existed prior to 2010 (U.S. EPA, 2022b).

Coverage: 64 monitoring sites in 50 counties nationwide (out of a total of 409 sites measuring NO₂ in 2021) that have sufficient data to assess 1-hour NO₂ trends since 1990.

Analysis shows that these trends are statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022a

Exhibit 5. Ambient 1-hour NO₂ concentrations above the level of the current NAAQS in the U.S., 1990–2021



The current 1-hour NO₂ NAAQS was established in 2010 and is shown to provide context for the magnitude of pollutant concentrations. No 1-hour NO₂ NAAQS existed prior to 2010 (U.S. EPA, 2022b).

Coverage: 64 monitoring sites in 50 counties nationwide (out of a total of 409 sites measuring NO₂ in 2021) that have sufficient data to assess 1-hour NO₂ trends since 1990.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022a