Air Toxics Concentrations

Air toxics, also known as hazardous air pollutants (HAPs), are 188 pollutants that EPA has identified as being known or suspected to cause cancers and other adverse health effects, including damage to the immune system, neurological problems, respiratory effects, and birth defects. Most air toxics are emitted into outdoor air from anthropogenic sources, such as mobile sources and industrial sources. However, forest fires and other natural sources also emit air toxics. People exposed to air toxics at sufficient concentrations and durations may have an increased risk of getting cancer or experiencing other serious health effects.

This indicator presents outdoor air quality trends for the subset of air toxics believed to account for the greatest nationwide excess lifetime cancer risk estimated to result from inhalation exposure to outdoor air pollution emitted from sources of outdoor origin (U.S. EPA, 2022a; McCarthy et al., 2009; Weitekamp et al., 2021). Excess lifetime cancer risk refers to the additional or extra risk of developing cancer due to inhalation exposure to a toxic substance incurred over the lifetime of an individual. According to the 2022 release of EPA's Air Toxics Screening Assessment (AirToxScreen) (U.S. EPA, 2022a), which is based on 2018 emission inventory data, the 12 air toxics that contribute to 98.3 percent of the estimated increased cancer risk associated with breathing outdoor air pollution are:

- Formaldehyde
- Carbon tetrachloride
- Benzene
- Acetaldehyde
- Naphthalene
- Ethylene oxide
- Polycyclic aromatic hydrocarbons and polycyclic organic matter (PAH/POM)
- 1,3-Butadiene
- Hexavalent chromium
- Ethylbenzene
- Inorganic arsenic compounds
- Nickel compounds

This indicator presents trend data for the eight pollutants with the highest increased cancer risk and sufficient ambient air monitoring data to assess nationwide outdoor air quality trends. Monitoring data have not been collected at enough sites and for long enough to reliably assess outdoor air quality trends over the last decade for ethylene oxide or hexavalent chromium. Ambient monitoring data are not commonly measured for PAH/POM. Taken together, the eight air toxics displayed in this indicator account for 90.8 percent of the estimated nationwide increased cancer risks associated with breathing outdoor air pollution among the pollutants available in AirToxScreen that are known carcinogens (U.S. EPA, 2022a) and these include some of the most commonly measured air toxics in the ambient air. Information on emissions sources and health effects associated with the eight air toxics considered in this indicator are available from many sources (e.g., U.S. EPA, 2012), including Toxicological Profiles published by the Agency for Toxic Substances and Disease Registry and Toxicological Reviews available from EPA's Integrated Risk Information System.

This indicator presents ambient concentration trends for eight air toxics. Concentrations of gases are presented in micrograms per cubic meter ($\mu g/m^3$); and concentrations that involve contributions from particulate matter (i.e., arsenic) or both gas and particulate matter (i.e., naphthalene) are presented in nanograms per cubic meter (ng/m^3). Trends for the eight air toxics are based on annual

average concentrations, which were calculated from routine measurements collected at monitoring stations nationwide. For all pollutants considered in this indicator except for naphthalene, trends are evaluated from 2003 to 2020. For naphthalene, monitoring data are available to establish trends only from 2008 to 2020. The numbers of monitoring sites with sufficient data to calculate concentration trends varied by pollutant: from 16 sites for inorganic arsenic compounds to 133 sites for benzene. These include monitoring sites in the National Air Toxics Trends Sites (NATTS) network and all other known air quality monitoring sites in the United States where the pollutants were measured using comparable methods. The trend sites for a given pollutant were based on those that had sufficient data for calculating annual average concentrations for at least 75 percent of the years covered in the indicator. A complete account of data processing steps—including the site selection criteria and the approach used to consider non-detect observations—are explained in this indicator's technical documentation.

For all pollutants considered in this indicator except for inorganic arsenic compounds and naphthalene, monitors measure ambient air concentrations of gases. For inorganic arsenic compounds, monitors measure concentrations within particulate matter; and for naphthalene, the measurements consider contributions from both particulate matter and gases. The indicator presents data for the particle size fractions currently considered in the NATTS network: arsenic trends are based on measurements of particulate matter with aerodynamic diameters of 10 microns or smaller (PM_{10}), and trends for the particulate form of naphthalene are based on measurements of total suspended particulate (TSP).

What the Data Show

Exhibit 1 summarizes outdoor air quality trends for the eight air toxics considered in this indicator, and Exhibits 2 to 9 present the trends for the individual air toxics. For all eight air toxics, annual average concentrations decreased over the period of record considered in the indicator (2008-2020 for naphthalene and 2003-2020 for the remaining air toxics). The reductions ranged from 4 percent (for carbon tetrachloride) to 52 percent (for ethylbenzene and naphthalene). These downward trends in air toxics concentrations, which were all statistically significant, are generally consistent with downward trends in air toxic emissions that have been observed since 1990 (the Air Toxics Emissions indicator).

Also shown in Exhibits 2 to 9 are the 90^{th} and 10^{th} percentiles based on the distribution of annual averages at the monitoring sites. This provides additional graphical representation of the distribution of measured concentrations across the monitoring sites for a given year. Thus, the graphic displays the concentration range where 80 percent of annual measured values occurred for that year.

Limitations

- The data summarized in this indicator are based on the subset of monitoring sites with sufficient data over the period of record for the individual pollutants. These monitoring sites are primarily (but not exclusively) located in urban areas.
- The indicator presents trends for the eight air toxics that account for a majority of the estimated nationwide increased cancer risk attributed to breathing outdoor air pollution emitted from sources of outdoor origin and with data available to characterize trends as modeled in AirToxScreen. Many additional air toxics are commonly found in outdoor ambient air.
- To ensure that long-term trends are based on a consistent set of monitoring sites, selection criteria were applied to identify the subset of air toxics monitoring sites with sufficient data to assess trends over the period of record. Monitoring sites without sufficient data are not

included in the trend analysis. Nationwide trends in the distributions of average concentrations do not necessarily reflect trends at individual monitoring sites or at locations where monitoring has not occurred.

- Annual averages are calculated by taking into account non-detectable observations by incorporating their corresponding detection limit using regression on order statistics, introducing some uncertainty into the calculated trends, particularly for the 10^{th} percentiles shown in the exhibits. Uncertainty in trends is greatest for the pollutants with the highest proportion of data below detection.

Data Sources

This indicator was based on ambient air monitoring data downloaded from EPA's air quality trends website (Air Quality Trends Report) (U.S. EPA, 2022b). The technical documentation for this indicator describes the site selection criteria and data processing methodology that were applied to generate the trend charts for the individual air toxics on that website. The trends are based on the subset of monitoring stations that have sufficient data to assess trends since 2003 or 2008, depending on the pollutant.

References

McCarthy, M.C., T.E. O'Brien, J.G. Charrier, and H.R. Hafner. 2009. Characterization of the chronic risk and hazard of hazardous air pollutants in the United States using ambient monitoring data. Env Health Pers 117(5):790-796. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2685843

U.S. EPA (United States Environmental Protection Agency). 2022a. Data from the 2018 Air Toxics Screening Assessment (AirToxScreen). Accessed 2022. https://www.epa.gov/AirToxScreen.

U.S. EPA. 2022b. Our Nations Air: Trends through 2021. Accessed 2022. https://gispub.epa.gov/air/trendsreport/2022/#toxics.

U.S. EPA. 2012. Health effects notebook for hazardous air pollutants. https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants.

Weitekamp, C.A., M. Lein, M. Strum, M. Morris, T. Palma, D. Smith, L. Kerr, and M.J. Stewart. 2021. An examination of national cancer risk based on monitored hazardous air pollutants. Env Health Pers 129(3):037008.

Exhibit 1. Summary data for selected air toxics

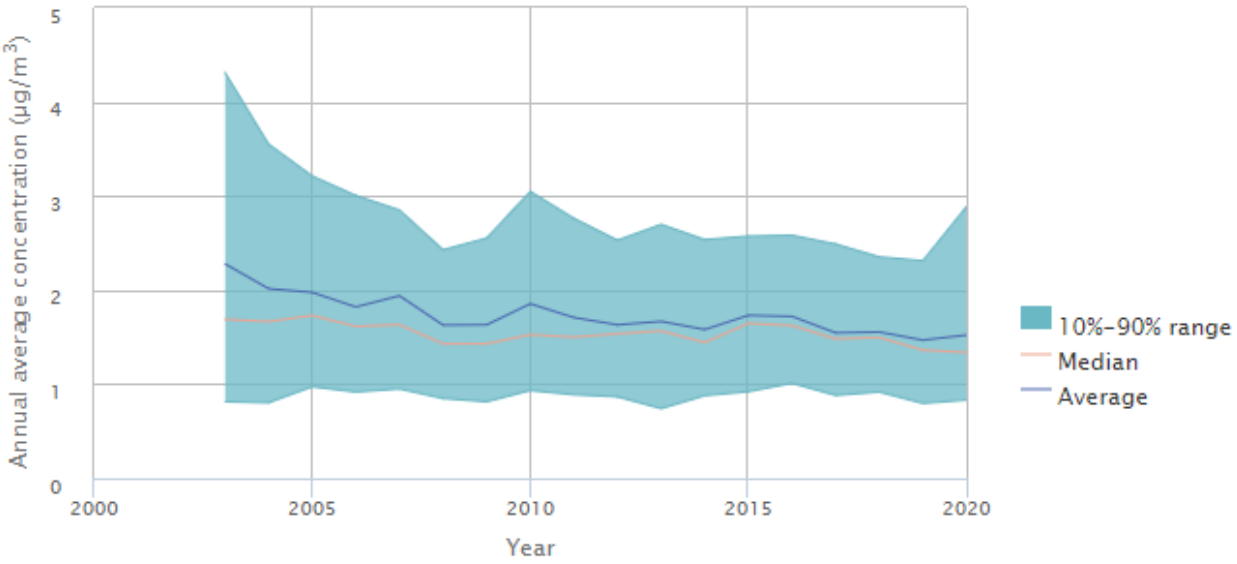
Pollutant	Trend Period	Number of Trend Sites	Percent Reduction in Average Concentrations over Trend Record	Exhibit Depicting Trend
Acetaldehyde	2003-2020	59	33%	2
Arsenic compounds	2003-2020	16	36%	3
Benzene	2003-2020	133	51%	4
1,3-Butadiene	2003-2020	72	45%	5
Carbon tetrachloride	2003-2020	101	4%	6
Ethylbenzene	2003-2020	103	52%	7
Formaldehyde	2003-2020	59	23%	8
Naphthalene	2008-2020	25	52%	9

A pollutant's "percent reduction in average concentration over trend record" is the percent change in average concentrations between the trend period's start year and end year.

The concentration trend for arsenic compounds is based on measurements of inorganic arsenic in PM_{10}. The concentration trend for naphthalene includes contributions of vapor-phase naphthalene and particulate naphthalene in TSP.

Data source: U.S. EPA, 2022b

Exhibit 2. Ambient acetaldehyde concentrations in the U.S., 2003–2020

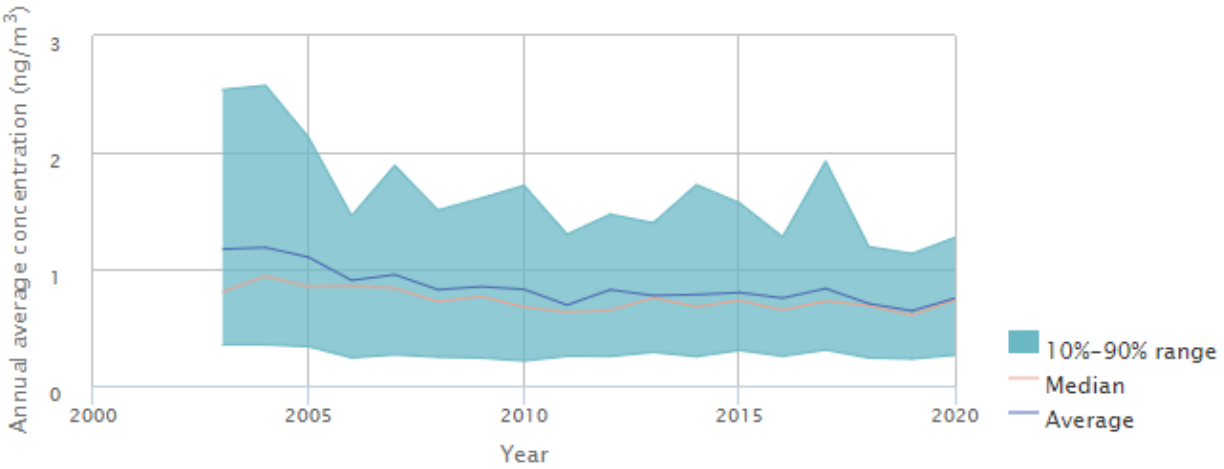


Coverage: 59 monitoring sites nationwide (out of a total of 73 sites measuring acetaldehyde in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 3. Ambient arsenic concentrations in the U.S., 2003–2020



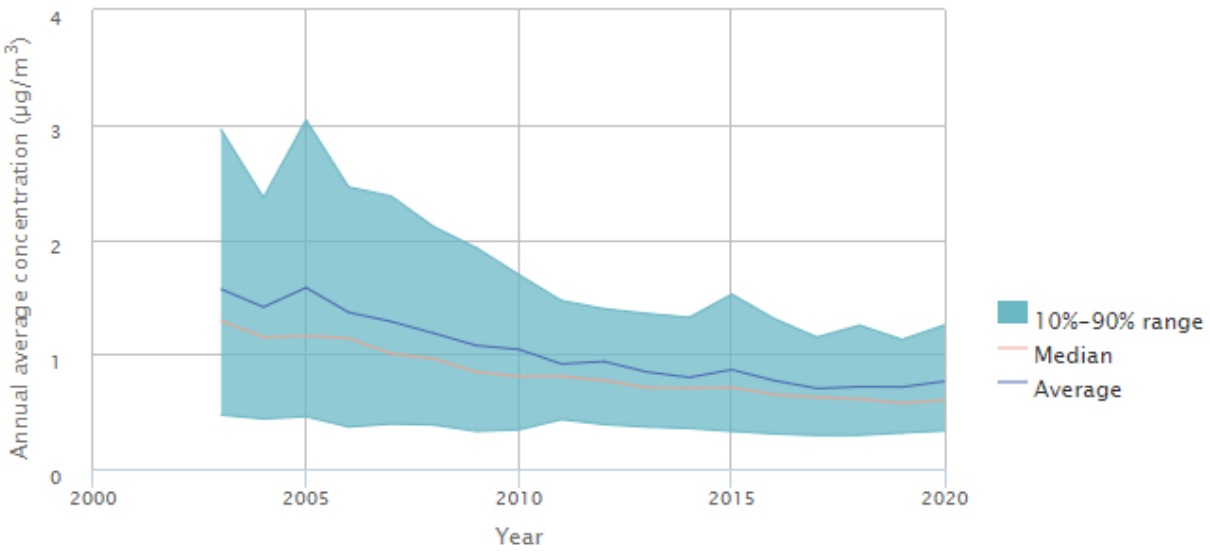
Coverage: 16 monitoring sites nationwide (out of a total of 42 sites measuring arsenic in 2020) that have sufficient data to assess trends since 2003.

The trend is based on arsenic concentrations measured in PM_{10}, which is the measurement currently used in the NATTS network. The indicator does not consider measurements in other particle size fractions.

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, 2022b

Exhibit 4. Ambient benzene concentrations in the U.S., 2003–2020

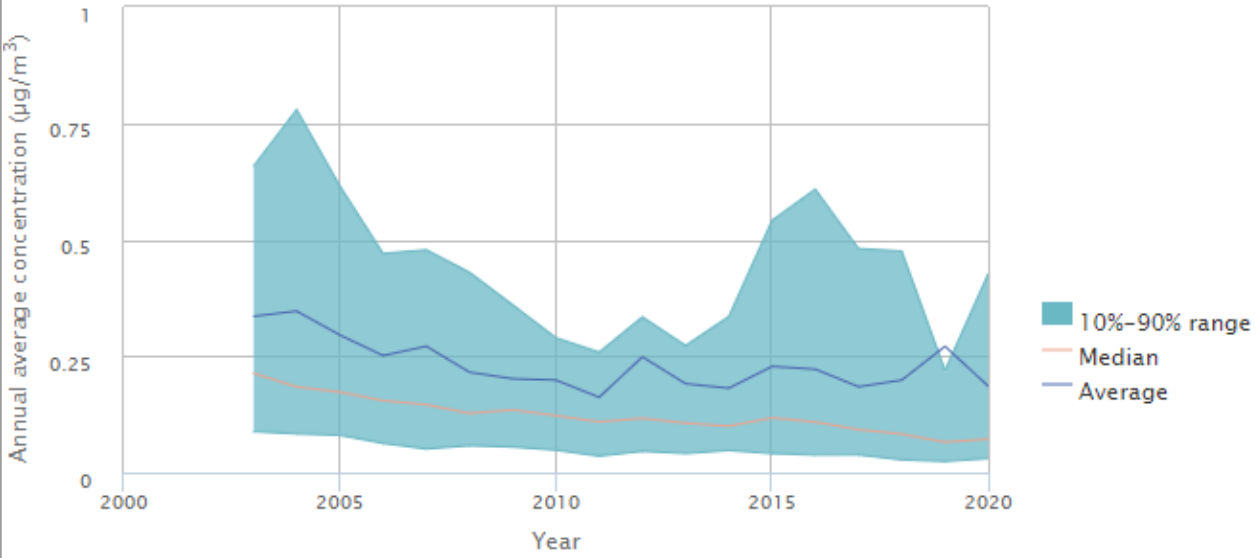


Coverage: 133 monitoring sites nationwide (out of a total of 198 sites measuring benzene in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 5. Ambient 1,3-butadiene concentrations in the U.S., 2003–2020

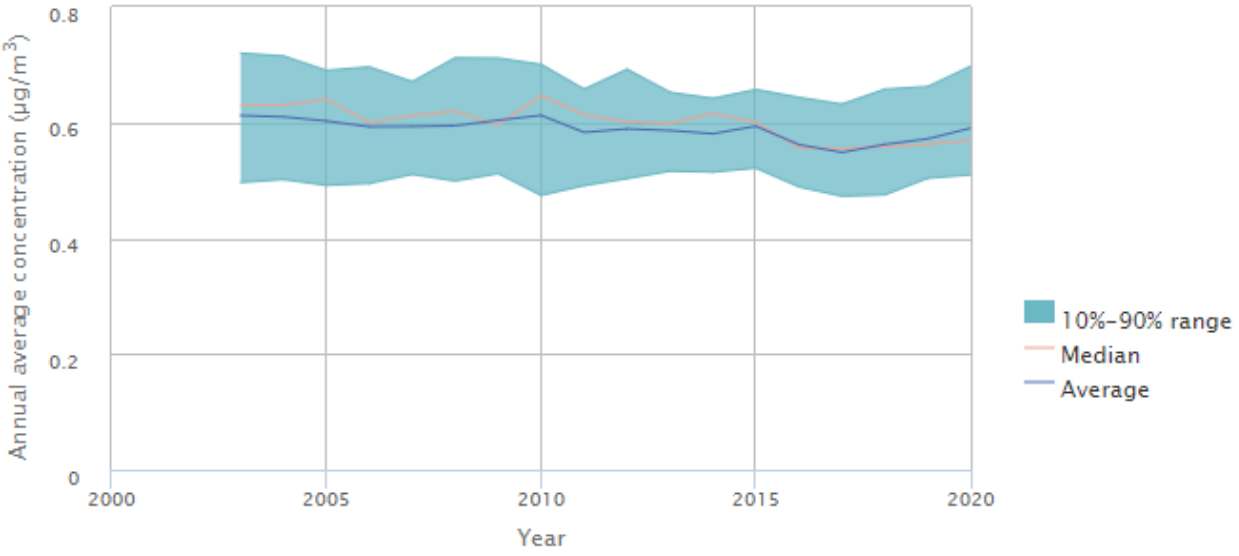


Coverage: 72 monitoring sites nationwide (out of a total of 119 sites measuring 1,3-butadiene in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 6. Ambient carbon tetrachloride concentrations in the U.S., 2003–2020

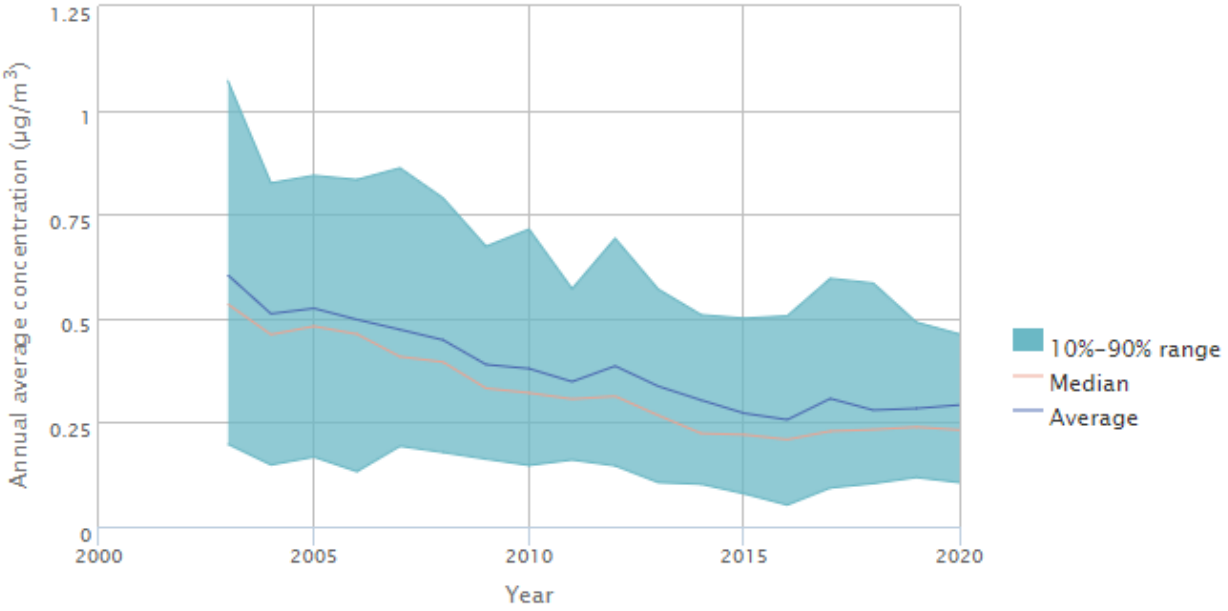


Coverage: 101 monitoring sites nationwide (out of a total of 176 sites measuring carbon tetrachloride in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 7. Ambient ethylbenzene concentrations in the U.S., 2003–2020

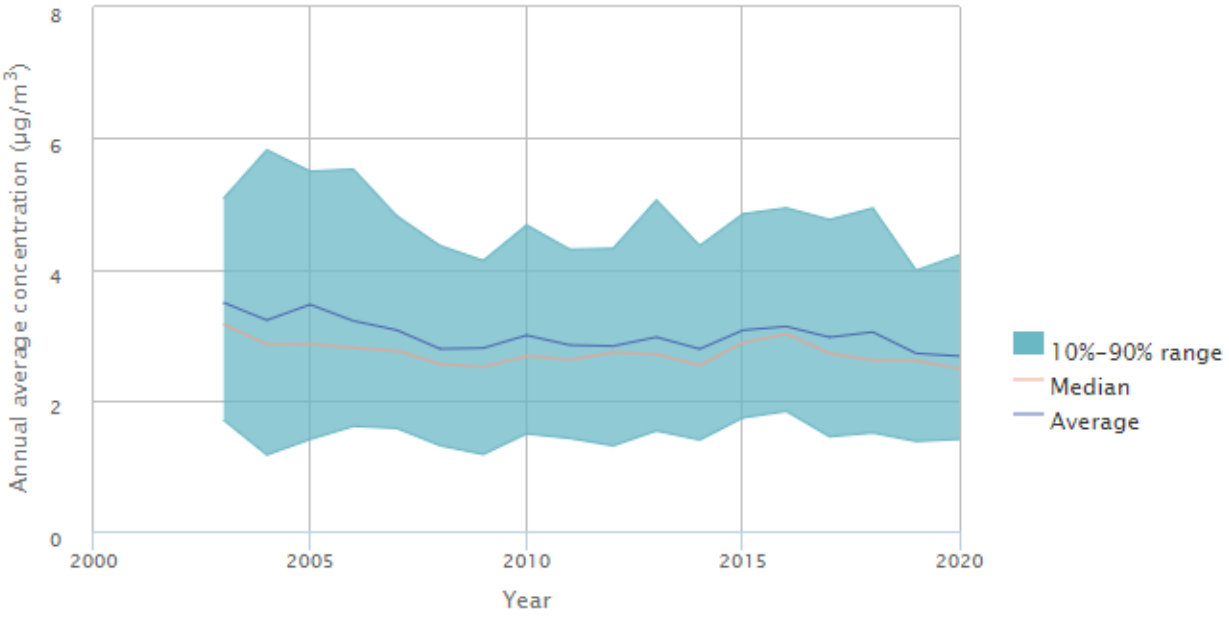


Coverage: 103 monitoring sites nationwide (out of a total of 185 sites measuring ethylbenzene in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 8. Ambient formaldehyde concentrations in the U.S., 2003–2020

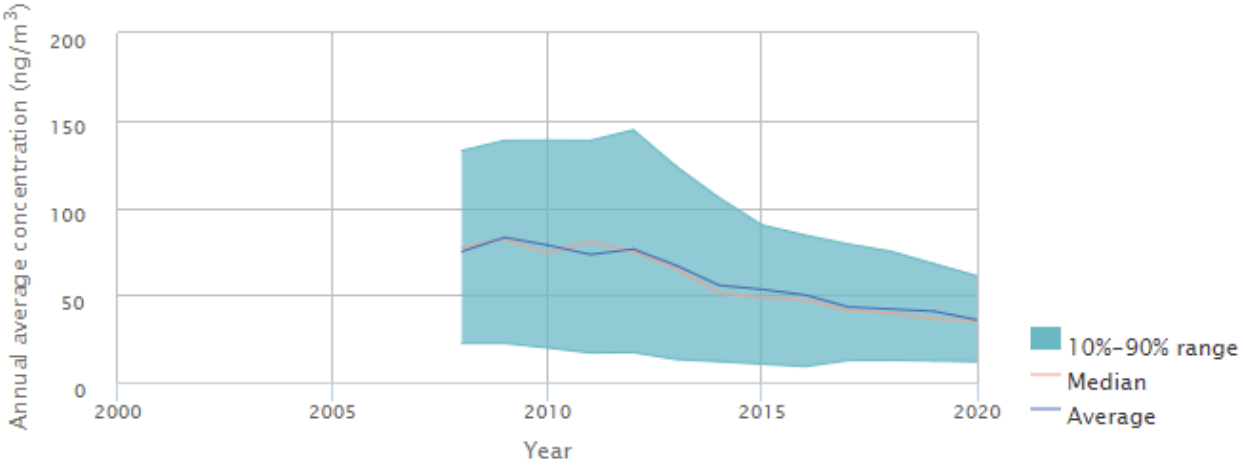


Coverage: 59 monitoring sites nationwide (out of a total of 73 sites measuring formaldehyde in 2020) that have sufficient data to assess trends since 2003.

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, 2022b

Exhibit 9. Ambient naphthalene concentrations in the U.S., 2008–2020



Coverage: 25 monitoring sites nationwide (out of a total of 29 sites measuring naphthalene in 2020) that have sufficient data to assess trends since 2008.

The trend is based on naphthalene concentrations measured in gases and in TSP, which are the measurements currently used in the NATTS network. The indicator does not consider measurements in other particle size fractions.

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, 2022b