

# Updates to Air Emissions Trends Methodology, 2002-2022: Spring 2023

## Background and Updates

Each year, the EPA updates data for air emissions trends for Criteria Air Pollutants (CAPs) except for Lead from 1970 the latest available year (usually one year before the current calendar year). For example, the version published in 2022 included data for the years 1970-2021. These data include carbon monoxide (CO), ammonia (NH<sub>3</sub>), nitrogen oxides (NO<sub>x</sub>), particulate matter 10 microns or less in diameter (PM<sub>10</sub>), particulate matter 2.5 microns or less in diameter (PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), and volatile organic compounds (VOC). EPA provides these emissions trends data as aggregated sectors (called Tier 1 categories) for both state and national trends. This document describes the spring 2023 trends data release, including the improvements that EPA has made in the emission trends estimation process for the years 2002-2022. EPA implemented these changes to minimize the effects of emissions estimation methodological changes during this period, so that the data are more reflective of actual emission changes that occurred.

These data rely on the National Emissions Inventory (NEI) and on year-specific data. For the interim years and years after the latest NEI year, EPA includes data from its emissions modeling platforms, provided on EPA's [Air Emissions Modeling website](#), which includes extensive Technical Support Documents. In many cases, EPA has created year-specific emissions estimates that can be included from these platforms. For years after the latest NEI year, EPA uses available data collections from continuous monitoring for electricity generating units. For mobile source emissions in years after the latest NEI year (i.e., 2020 for the current release), EPA uses future emissions projections from these emissions modeling platforms to extrapolate emissions from the latest NEI year to the next two years. Otherwise, for years after the latest NEI year, EPA holds emissions constant from the latest NEI value.

For the trends data released in the spring of 2023, EPA has added the year 2022 as the most recent year provided, and where appropriate, have incorporated data from the 2020 NEI estimates for the years 2020 through 2022. We have also incorporated data from the recently published methodology called EPA's Air QUALity Time Series project (EQUATES), as discussed below.

Another enhancement for the spring 2023 release in trends data for years 2002 through 2022, is the availability of elemental carbon (abbreviated "EC" and synonymous with "black carbon") and organic carbon (abbreviated "OC") components of PM<sub>2.5</sub> and data for the 60 EIS sectors in addition to the traditional Tier 1 categories. We also provide trends data by both EIS sector and Tier 1 category together to highlight the overlap between EIS sectors and Tier 1 categories. EIS sectors (listed in Table 2 below) provide additional details on the types of sources that contribute to each Tier 1 category; however, an EIS sector can contribute emissions to multiple Tier 1 categories.<sup>1</sup>

The methods and data prior to the year 2002 remain unchanged from prior trends data releases. Please refer to documentation on how air emission trends are computed for the years 1900-2001 ("[Trends Procedural Documentation](#)" on the [Air Pollutant Emissions Trends Data](#) web site).

---

<sup>1</sup> Both Tier1 categories and EIS sectors are derived through source classification code (SCC) assignments, which is the most detailed process-level available in NEI and the Emissions Modeling Platforms. More information on SCCs is available at <https://www.epa.gov/scc>, which includes a complete download of the latest SCC table with associated mapping to Tier1 categories and EIS Sectors.

Table 1 provides the pollutant coverage used in EPA’s trends data (both National and by State), and whether these are available by Tier 1 categories and EIS sectors, for the different time periods from the older methods to the updates we have made as part of the spring 2023 air emissions trends data release.

*Table 1: Sectors and Pollutants covered in EPA’s Air Emissions Trends Data*

| <b>Years</b> | <b>Pollutant Coverage</b>  | <b>Tier 1 / Sector Coverage</b> | <b>Methodology</b>   |
|--------------|--|---------------------------------|--|
| 1970-1989    | NO <sub>x</sub> , SO <sub>2</sub> , VOC, PM <sub>10</sub> , CO   | Tier 1 category                 | Old methods  |
| 1990-2001    | NO <sub>x</sub> , SO <sub>2</sub> , NH <sub>3</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , VOC         | Tier 1 category                 | Old methods  |
| 2002-2019    | NO <sub>x</sub> , SO <sub>2</sub> , NH <sub>3</sub> , PM <sub>2.5</sub> , PM <sub>10</sub> , VOC, EC, OC | Tier 1 category and EIS sector  | New methods based on EQUATES and the 2016v3 emissions modeling platform for 2016   |
| 2020-2022    | NO <sub>x</sub> , SO <sub>2</sub> , VOC, PM <sub>2.5</sub> , PM <sub>10</sub> , NH <sub>3</sub> , EC, OC | Tier 1 category and EIS sector  | 2020 NEI data, and for 2021 and 2022: 2020 NEI data merged with some year-specific data for point source, onroad, nonroad, and fire emissions. |

### Methods used in the updates made for 2002-2022

The improvements EPA has made to estimating the emission trends can be split into two parts. The first part covers the years 2002 through 2019, and the second part covers years 2020 through 2022. For the first part, EPA based these improvements on a recently published methodology called EPA’s Air QUALity Time Series project (EQUATES). This has been published in the [“Data in Brief” journal](#) in 2023 and includes annual emissions estimates for years 2002 through 2017. An [EPA website](#) also provides information about the project. The EQUATES emissions data were developed using to the extent possible, consistent input data and methods across all years for as many sectors as possible based on the 2017 NEI (which was the most recent publicly available national inventory at the time of the EQUATES work). This approach was taken in EQUATES to avoid artificial step-changes in emissions estimates due to changes in methodology that evolved over the sixteen-year period that do not reflect real-world activity data and processes that describe emissions for a given source. The actual data used reflect “version 1.1” of the EQUATES data, which has adjustments to emissions from livestock, fugitive dust, and solvents as compared to the original EQUATES. More information can be found here:

<https://www.epa.gov/cmaq/data-download-step-2#equates-emissions-trends>

While the EQUATES paper cited above provides detailed information on how these methods were incorporated across sectors, a summary is provided here. With a couple of exceptions listed below, in general, the EQUATES methodology starts with the most recent NEI data available at the time of the research (the 2017 NEI) as the baseline for methods and back-casts 2017 data to the year 2002 while holding those methods constant and accounting for year-to-year changes in activity data and emission factors. In summary, for each sector/source category, one of the following four general approaches was used to estimate emissions for the years 2002 through 2016:

- New methods for creating consistent emissions for all years
- Scale 2016 or 2017 emissions with scaling factors based on activity data and/or control information
- Use existing modeling platform data
- Leave flat at 2017 NEI levels

Table 2 (based on [the EQUATES paper](#)) provides a broad overview of how some of the source categories were handled based on the four general approaches listed above. More details can be found in the EQUATES paper.

*Table 2: Brief description of the method used to develop emissions for each source category.*

| <b>Source Category (and EIS data categories)</b> | <b>EIS Sector Name(s)</b>  | <b>Brief Method Description</b>   |
|--|--|---|
| Agriculture (nonpoint)                           | Agriculture - Livestock Waste<br>Agriculture - Fertilizer Application  | Livestock emissions based on scaling 2017 NEI values using animal head count data. Fertilizer emissions derived from bidirectional runs of CMAQ.  |
| Fuel combustion - Electric Generation (point)    | Fuel Comb - Electric Generation – Biomass<br>Fuel Comb - Electric Generation - Coal<br>Fuel Comb - Electric Generation - Natural Gas<br>Fuel Comb - Electric Generation - Oil<br>Fuel Comb - Electric Generation – Other | Based on existing hourly data (from multiple NEIs) for all years but processed using the most recent tools/methods.   |
| Fires (point, nonpoint)                          | Fires - Agricultural Field Burning<br>Fires - Prescribed Fires<br>Fires – Wildfires  | Based on new methods (see Section 2.1.3 of <a href="#">the EQUATES paper</a> ) to produce day-specific estimates.   |
| Fugitive Dust (nonpoint)                         | Agriculture - Crops & Livestock Dust<br>Dust - Construction Dust<br>Dust - Paved Road Dust<br>Dust - Unpaved Road Dust   | For agricultural dust, unpaved road dust, and paved road dust, used 2017 NEI data and scaling factors based on activity surrogates. All other sources used 2017 NEI data for all years.           |
| Aircraft (point)                                 | Mobile – Aircraft  | Based on 2017 NEI data and scaling factors based on Federal Aviation Administration Terminal Area Forecast data.  |
| Commercial Marine Vessels (nonpoint)             | Mobile – Commercial Marine Vessels   | Based on 2017 NEI data and scaling factors based on regional fuel consumption as an activity surrogate with additional pollutant-specific adjustments for fuel standards.                         |
| Nonroad equipment (nonroad)                      | Mobile - Non-Road Equipment - Diesel<br>Mobile - Non-Road Equipment - Gasoline<br>Mobile - Non-Road Equipment – Other  | Estimated using EPA’s Motor Vehicle Emission Simulator (MOVES) version 2014b supplemented with data for California and Texas.   |
| Onroad vehicles (onroad)                         | Mobile - On-Road Diesel Heavy Duty Vehicles<br>Mobile - On-Road Diesel Light Duty Vehicles<br>Mobile - On-Road non-Diesel Heavy Duty Vehicles<br>Mobile - On-Road non-Diesel Light Duty Vehicles                         | Emissions computed using emission rates from MOVES version 3, activity data back cast from 2017 NEI, and EQUATES meteorological data; supplemented with emissions data from California.           |
| Locomotives (nonpoint)                           | Mobile – Locomotives   | Based on 2017 NEI data and scaling factors based on fuel sales data as an activity surrogate with additional adjustment for specific pollutants to account for regulations and sulfur technology. |

| <b>Source Category (and EIS data categories)</b>  | <b>EIS Sector Name(s)</b>   | <b>Brief Method Description</b>  |
|---|---|--|
| Oil and Gas (point, nonpoint)   | Industrial Processes - Oil & Gas Production   | Point used year-specific modeling platform data (based on multiple NEIs). Nonpoint used Oil and Gas Tool for 2002, 2005, 2008, 2011, 2014, 2016, 2017 and adjustment factors for all other years.              |
| Commercial Cooking (nonpoint)   | Commercial Cooking  | Used year-specific modeling platform data (based on multiple NEIs).  |
| Fuel Combustion – Commercial / Institutional, Industrial, and residential other than wood (point, nonpoint) | Fuel Comb - Comm/Institutional - Biomass<br>Fuel Comb - Comm/Institutional - Coal<br>Fuel Comb - Comm/Institutional - Natural Gas<br>Fuel Comb - Comm/Institutional - Oil<br>Fuel Comb - Comm/Institutional - Other<br>Fuel Comb - Industrial Boilers, ICEs - Biomass<br>Fuel Comb - Industrial Boilers, ICEs - Coal<br>Fuel Comb - Industrial Boilers, ICEs - Natural Gas<br>Fuel Comb - Industrial Boilers, ICEs - Oil<br>Fuel Comb - Industrial Boilers, ICEs - Other<br>Fuel Comb - Residential - Natural Gas<br>Fuel Comb - Residential - Oil<br>Fuel Comb - Residential - Other | Commercial and industrial biomass used 2017 NEI data and scaling factors based on national-level consumption data. For all other emissions used year-specific modeling platform data (based on multiple NEIs). |
| Gas Stations (point, nonpoint)  | Gas Stations  | Linear interpolation between 2002 NEI and 2017 NEI data.   |
| Industrial Processes other than oil and gas production (nonpoint, point)                                    | Industrial Processes - Cement Manuf<br>Industrial Processes - Chemical Manuf<br>Industrial Processes - Ferrous Metals<br>Industrial Processes - Mining<br>Industrial Processes - NEC<br>Industrial Processes - Non-ferrous Metals<br>Industrial Processes - Petroleum Refineries<br>Industrial Processes - Pulp & Paper<br>Industrial Processes - Storage and Transfer  | Used year-specific modeling platform data (based on multiple NEIs).  |
| Other Nonpoint Sources - Miscellaneous  | Miscellaneous Non-Industrial NEC<br>Bulk Gasoline Terminals   | Used 2017 NEI data for all years.  |
| Waste Disposal (point, nonpoint)  | Waste Disposal  | Used 2017 NEI data for all years, except composting. For composting, scaled 2017 NEI values based on activity surrogate.   |
| Residential Wood Combustion (nonpoint)  | Fuel Comb - Residential – Wood  | Scaled 2017 NEI values based on national-level consumption data.   |

| Source Category (and EIS data categories)                | EIS Sector Name(s)  | Brief Method Description  |
|--|---|---|
| Volatile Chemical Products including Solvents (nonpoint) | Solvent - Consumer & Commercial Solvent Use<br>Solvent - Degreasing<br>Solvent - Dry Cleaning<br>Solvent - Graphic Arts<br>Solvent - Industrial Surface Coating & Solvent Use<br>Solvent - Non-Industrial Surface Coating | Based on new VCPy method (see section 2.1.14 of the EQUATES paper). |

For the year 2016, EPA did not use the EQUATES data for the emissions trends. Instead, EPA made use of the 2016 version 3 modeling platform data, which was developed for regulatory modeling efforts. Comparisons between these modeling platform data and EQUATES data for 2016 yielded limited differences, but the 2016v3 modeling platform data represents EPA’s best available 2016 estimates and therefore were selected for inclusion in the trends release. The 2016v3 platform incorporates emissions based on the MOtor Vehicle Emissions Simulator, version 3 (MOVES3), the 2017 NEI nonpoint inventory, the Western Regional Air Partnership oil and gas inventory, and inventories for Canada and Mexico. The 2016v3 platform supports a variety of regulatory projects at EPA including interstate transport analyses related to the 2015 Ozone NAAQS. More information on the [2016v3 Platform](#) data is available on our Air Emissions Modeling website.

In addition to the EQUATES-based emissions data available for the years 2002 through 2017, EPA used a combination of methods to create “EQUATES-like” data for 2018 and 2019. EPA estimated 2018 and 2019 emissions using the emissions modeling platform data for 2018 and 2019, with some minor modifications to some sectors that made the estimation methods more consistent with the 2002 through 2017 data from EQUATES. The 2018 and 2019 modeling platform data are based on the 2017 NEI (published in January 2021 along with other data specific to the year 2019, adjusted for EQUATES (for some sectors) as shown in Table 3). The [2018 Emissions Modeling Platform Technical Support Document](#) and the [2019 Emissions Modeling Platform Technical Support Document](#) provide more information on how 2018 and 2019 emissions were estimated.

The year 2017 in all cases is represented to the extent possible by 2017 NEI data, and the year 2020 is represented by 2020 NEI data. In contrast, year 2021 and 2022 estimates are based on the 2020 NEI with year-specific estimates for point sources, onroad and nonroad mobile sources, and fires as shown in Table 3.

*Table 3: Year-by-year methods/approach used to estimate emissions*

| Trends Year       | Methods Used, Comments   |
|-------------------|--|
| 1970-2001         | Old methods for all pollutants. Please see “ <a href="#">Trends Procedural Documentation</a> ” on the <a href="#">Air Pollutant Emissions Trends Data</a> site for more details on the methods used during this time frame. In addition, the spreadsheets of data posted at the above website should be consulted (“read me” and “development of data” spreadsheets, that describes specifics of how the emissions were estimated for the years during this timeframe. All emissions included at the national level including PR, VI, AK, and HI. PR, VI not included in state totals. Offshore and biogenic (soil and vegetation) emissions data are not included in any of the totals. |
| 2002 through 2015 | As discussed in the EQUATES paper, PR, VI, AK, and HI are included in all estimates. Offshore and biogenic (soil and vegetation) emissions data are not included in any of the totals.   |
| 2016              | The <a href="#">2016v3 Platform</a> .  |
| 2017              | <a href="#">2017 NEI</a> data, as discussed in the EQUATES paper.  |

| Trends Year | Methods Used, Comments   |
|-------------|--|
| 2018        | The year 2018 data were developed by using <a href="#">2018 Emissions Modeling Platform</a> data in various ways, including: 2018-specific point source data, a 2018-specific run of the oil and gas tool, use of EQUATES meteorological data for dust and onroad emissions calculations, extrapolation of 2017 data for some sectors, and use of EQUATES methods for some sectors (e.g., fires).  |
| 2019        | As with the year 2018, the year 2019 was developed by using the <a href="#">2019 Emissions Modeling Platform</a> data in various ways, including: 2019-specific point source data, a 2019-specific run using the oil and gas tool, use of EQUATES meteorological data for dust and on-road emissions computations, extrapolation of 2017 data for some sectors, and use of EQUATES methods for some sectors (e.g., fires).   |
| 2020        | <a href="#">2020 NEI</a> data  |
| 2021 & 2022 | <p><a href="#">2020 NEI</a> is used with the following exceptions:</p> <p>Onroad in the continental US (CONUS): interpolated between the <a href="#">2019 Emissions Modeling Platform</a> (2019ge) and the year-2023 projected emissions modeling data (2023gf) from the <a href="#">2016v3 emissions modeling platform</a>.</p> <p>Onroad in Alaska, Hawaii, Puerto Rich and Virgin Islands: interpolated between the <a href="#">2018 Emissions Modeling Platform</a> (2018gc) and the year-2023 projected emissions modeling data (2023fh) from the <a href="#">2016v1 emissions modeling platform</a>.</p> <p>Nonroad: interpolated between 2020NEI and 2023gf modeling platform data.</p> <p>EGUs: <a href="#">Clean Air Markets Program Data</a> on March 16, 2023.</p> <p>2021 Fires: Year-specific data developed in accordance with the 2020 NEI methods for fires, with activity for 2021 wildland fires generated using the 2021 Hazard Mapping System (HMS) remote sensed fire detects, 2021 ICS-209 Situation Reports, and 2021 NIFS wildland fire polygons.</p> <p>2022 Fires: Held constant at 2021 levels as no other data were available in time for the trends data release.</p> |