

Documentation of 2022 Base Year Emissions Released in August 2024

The 2022v1 base year emissions for each sector were developed according to the below details and processed for air quality modeling using the [Sparse Matrix Operator Kernel Emissions \(SMOKE\) modeling system](#) version 5.1. Air quality model-ready emissions for the year 2022 and 10 days of spin-up are available for the Community Multiscale Air Quality (CMAQ) Modeling System on the 36US3 and 12US1 grids shown in Figure 1. The emissions were processed for the CB6R3_AE7 chemical mechanism.

Note: *Air quality model performance using these emissions data has not yet been assessed.*

For more information on this mechanism and recent emissions modeling techniques see [Technical Support Document: Preparation of Emissions Inventories for the 2020 Emissions Modeling Platform](#) (EPA, 2023). The corresponding technical support document for the 2022v1 emissions modeling platform will be developed in 2024.

Figure 1. Air Quality Modeling Domains



Development of Base Year Emissions for each 2022v1 Emissions Modeling Platform Sector

afdust (area fugitive dust):

- Paved roads were projected from 2020 to 2022 by applying factors to 2020 NEI emissions based on county total VMT trends, 2022 versus 2020. Posted numbers are fully adjusted with both meteorological and transport fractions.
- Animal dust, a.k.a. “dust kicked up by hooves” were projected from 2020->2022 using factors based on county and animal type based on animal count census data from the 2020 NEI versus the 2022 USDA Census of Agriculture. Emissions were held at 2020 levels for counties/animal types with zero or missing data in either 2020 or 2022. Projection factors limited to range of +/- 20%.
- Unpaved roads and all other sources in afdust (i.e., construction, agricultural tilling, mining) were held at 2020NEI levels. Adjustments were made to New Jersey unpaved road emissions in response to comments.
- To prepare air quality model-ready emissions, emissions were adjusted based on 2022 meteorology and transportable fraction.
- Some temporal profile changes were incorporated into the processing for this sector in response to comments. See below for more information.

airports:

- Emissions for Top 50 commercial airports other than ATL computed by running the Aviation Environmental Design Tool (AEDT) using a method similar to the 2020 NEI process. See [Documentation on the development of 2022 aviation emissions for top 50 airports](#) for more information.
- Emissions for Hartsfield-Jackson (ATL) airport were provided by Georgia EPD.
- All other airport emissions were projected from 2020 to 2022 using factors derived from the 2023 [Terminal Area Forecast](#) (TAF) with airport-specific values derived where available and state-level factors were used elsewhere.
- 2022-specific temporal profiles are used for emissions at airports.

beis:

- Biogenic Emissions Inventory System (BEIS) version 4, was run using the Biogenic Emissions Landuse Database (BELD) version 6 and year 2022 meteorology. This is consistent with how the biogenic emissions were developed for the 2020 NEI.

cmv_c1c2 (Category 1 and 2 Commercial Marine Vessels):

- Emissions for Category 1 and 2 commercial marine vessels (CMV) were computed using 2020 NEI methods using year 2022 Automatic Identification System (AIS) data. For more information see this document on the development of the [Category 1 and 2 Commercial Marine Vessel 2022 Emissions Inventory](#).
- During the acquisition of the 2022 AIS data from the U.S. Coast Guard, EPA was made aware of a data quality issue that started in late March and continued through late June of 2022. To address this, emissions were substituted in from the 2021 CMV C1C2 inventory for this period.

- An additional enhancement for the 2022 C1C2 CMV inventory was the development and application of a mask that was applied to remove any emissions over land due to stray AIS signals.

cmv_c3 (Category 3 Commercial Marine Vessels):

- The Category 3 CMV emissions were computed by EPA using 2020 NEI methods using 2022 Automatic Identification System (AIS) data.
- During the acquisition of the 2022 AIS data from the U.S. Coast Guard, EPA was made aware of a data quality issue that started in late March and continued through late June of 2022. To address this, emissions were substituted in from the 2021 CMV C3 inventory for this period.
- An additional enhancement for the 2022 C3 CMV inventory was the development and application of a mask that was applied to remove any emissions over land due to stray AIS signals and interpolated values.

fertilizer

- Fertilizer emissions will be computed in the late summer of 2024 using a bi-directional CMAQ run with 2022 emissions. Fertilizer emissions will then be extracted from the CMAQ run outputs and can be used to drive other air quality models.

livestock:

- Emissions for beef and dairy cattle, broilers, layers, and swine derived from the Farm Emissions Model (FEM). Includes 2022 census animal counts and input from Idaho and other animal counts from the [2022 Census of Agriculture](#) and run using 2022 meteorology.
- The livestock counts for North Carolina were adjusted in response to comments.
- Emissions for turkeys, horses, sheep, and goats were projected from 2020NEI based on factors derived from 2020 and 2022 census animal counts. Emissions were held at 2020 levels for counties/animal types with zero or missing data in either 2020 or 2022. Projection factors were limited to a range of +/- 20%.
- A new aspect of emissions modeling was the use of daily emissions totals instead of month-to-day temporal profiles.

nonpt (nonpoint sources not included in other sectors):

- Most emissions are from 2020 NEI unless otherwise noted (see Table 1 for more information).
- Bulk terminals/plants and pipeline gasoline: Projected from 2020 to 2022 using national factors derived from the [State Energy Data System](#) (SEDS) from the U.S. Energy Information Administration (EIA). We note that the use of national factors is not consistent with the task force request to use regional factors.
- All other fuel types: Emissions were projected from 2020 to 2022 using statewide factors based on the SEDS consumption dataset (see Table 1 and [2022 nonpt projection SCC xref MSN codes.xlsx](#) for more details).

- Human cremation: Emissions were projected from 2020 to 2022 using factors based on county-level death counts and statewide cremation rates.
- Projection factors from 2020 to 2022 were limited to a range of +/- 30%.
- Some emissions in Indiana were removed from this sector in response to comments.
- Emissions from open burning have been split out into a separate sector.
- Some temporal profile updates were implemented for this sector. See below for details.

nonroad:

- MOVES4 was run for 2022 using 2022 meteorological data.
- In California, 2020 and 2023 emissions provided by California Air Resources Board (CARB) were interpolated to 2022.
- Some temporal profiles were updated for this sector. See below for details.

np_oilgas:

- Most emissions from a run of the 2020 NEI oil and gas tool updated with 2022 activity data.
- Abandoned wells and blowdown and pigging emissions were included and derived separately for 2022.
- This second uses some state-provided factors and emissions data.
- Activity data feedback was received from NY, UT and WY and incorporated prior to computing the emissions.
- Colorado submitted their own nonpoint Oil and Gas inventory.
 - o Several edits have occurred in the last week; those edits are not included in Data Retrieval Tool at this time
 - o Colorado included exploration-related sources
 - o These emissions were augmented with HAPs based on their VOC emission and NH3, PM, SO2 and metals were added based on Oil and Gas Tool emissions.
- Oklahoma used 2020NEI emissions for production-related sources and applied state projection factors for oil, natural gas and condensate to get to year 2022 estimated emissions.
- Wyoming used 2020NEI emissions for production-related sources and applied county projection factors to get to year 2022 estimated emissions
- Pennsylvania submitted nonpoint emission for unconventional wells
 - o These emissions were subtracted out of the Oil and Gas Tool emissions to generate conventional well emissions.
- The Oil and Gas Tool emissions are used for EXPLORATION-related sources except for Colorado.
- The Point source subtraction process was used for New Mexico and Kansas within the 2022 Oil and Gas Tool emissions.
- Some updates to emissions in Texas were implemented in response to comments.
- 2022-specific monthly temporal profiles and spatial surrogates are used.

np_solvents:

- All emissions, except asphalt paving, are projected from the 2020NEI, including state-submitted emissions. Using 2021 data, a SCC-specific ratio derived and applied to 2020NEI emissions. This ensures state-submitted emissions magnitudes are preserved. For asphalt paving, 2020NEI emissions are carried forward.
- Some updates were made to emissions in New Jersey in response to comments.
- Some temporal profile updates were made for this sector. See below for details.

onroad:

- MOVES4 was run for 2022 in rates mode to derive emission factors and SMOKE-MOVES was run for each type of activity data and emission rates to compute emissions.
- Vehicle Miles Traveled (VMT) were based on Federal Highway Administration (FHWA) VMT data for 2022, with state-submitted data incorporated where provided. (VMT state submissions: AK CO CT DE GA KS ME MD MA MI NH NJ NY NC OR PA SC TN TX UT VA WA WV WI, and Jefferson County, KY.)
- In the final base year data, VMT for Colorado are based on EPA default data, and other activity based on VMT was adjusted as a result of this change.
- Vehicle Population (VPOP) data were carried forward from 2020NEI, with state-submitted data used where provided. (VPOP state submissions: DE, GA, NY, and WI) Vehicles were added in some areas to resolve discrepancies between VMT and VPOP.
- STARTS data were carried forward from 2020NEI, except where the VPOP changed (either via state submissions or VMT/VPOP discrepancy resolution), in which case STARTS activity was changed in proportion to the VPOP. (e.g. where VPOP increased, STARTS was increased proportionally, and vice versa.)
- HOTELING hours were calculated from 2022 VMT using the standard hours/mile factor applied to restricted road VMT for combination long-haul trucks.
- Off-network idling (ONI) hours were computed based on the year 2022 county databases and VMT.
- In California, emissions data provided by CARB in 2024 for 2020 and 2023 were interpolated to 2022.
- Speeds are based on data for January 2021 and temporal profiles are 2022-specific.

openburn (open burning):

- This new sector for 2022v1 platform was split out from the nonpt sector and includes emissions from yard waste, land clearing, and residential household waste burning (SCCs starting with 261).

ptagfire (agricultural fires):

- Use HMS detects that intersect with the USDA Crop Data Layer shapefile
- Used activity from GA, FL, ID, and WA
- Received some activity data from a few other states but determined that it would not improve the quality of the emissions dataset
- Generated emissions using a prototype Crop burn Module for Bluesky Pipeline authored by EPA-ORD.

- Several adjustments were made to this sector in response to comments.

ptfire-rx (prescribed fires):

- Activity data were developed based on the python SmartFire2 software maintained at USEPA to take activity data from various federal and state agencies to generate daily acres burned at specific latitude and longitude
 - o Federal activity sources included US Forest Service, Dept of Interior, National Interagency Fire Center, and ICS209
- Used US Forest Service's BlueSky Pipeline tool to generate emissions
- Flint Hills prescribed grassland burns are processed outside of Bluesky Pipeline using activity received from Kansas
 - o About 2M acres burned from mid-February through April
 - o Counties in eastern Kansas and Includes 4 counties in Oklahoma
- A new pile burn methodology was implemented for this inventory.
- See this technical memo on the development of the "beta" fire emissions for more information:
https://gaftp.epa.gov/Air/emismod/2022/v1/draft/fires/2022EMP_beta_version_fires_tech_memo.2024Apr12.pdf
- Several adjustments were made to the final emissions for this sector in response to comments.

ptfire-wild (wild fires):

- Used python SmartFire2 software maintained at USEPA to take activity data from various federal and state agencies to generate daily acres burned at specific latitude and longitude
 - o Federal activity sources included US Forest Service, National Interagency Fire Center, and ICS209
- Used US Forest Service's BlueSky Pipeline tool to generate emissions
- See this technical memo on the development of the "beta" fire emissions for more information:
https://gaftp.epa.gov/Air/emismod/2022/v1/draft/fires/2022EMP_beta_version_fires_tech_memo.2024Apr12.pdf
- Several adjustments were made to the final emissions for this sector in response to comments.

ptegu (Electric Generating Units):

- Emissions are based on 2022 NEI point source dataset from June 2024, with NO_x and SO₂ from Continuous Emissions Monitoring System (CEMS) data downloaded in January, 2024 inserted using the CEMConvert program for units matched to the NEI.
- Several adjustments were made to the emissions in this sector including latitude-longitude updates in response to comments and adjustments to stack parameters that were defaulted and outside of a reasonable range for specific processes.

ptnonipm (Point sources not in other point source sectors):

- All sources except rail yards are based on the 2022 NEI point source dataset from June 2024.
- Several adjustments were made to the emissions in this sector including latitude-longitude updates in response to comments and adjustments to stack parameters that were defaulted and outside of a reasonable range for specific processes.
- Some adjustments to sources in New Jersey, New Hampshire, and Texas were made in response to comments. Some additional states may have made their own adjustments directly in EIS.
- Railyards are included in this sector. For information on their development see this document on the [Development of 2022 locomotive emissions](#). Some rail yards from this data set were adjusted as a result of comments and detailed review of 2021 emissions data.
- Some temporal profile updates were implemented for this sector. See below for details.

pt_oilgas (oil and gas-related point sources):

- Emissions for this sector are based on the 2022 NEI point dataset from June 2024.
- Sources in the 2022 point dataset in which emissions are from 2020 or 2021 were projected to 2022 using EIA-based state projection factors.
 - o These state projection factors were applied to production-related NAICS codes in the inventory

rail:

- Line haul locomotive emissions updated from 2020 NEI based on 2023 fleet mix and 2022 fuel use data. See [Development of 2022 locomotive emissions](#) for more information.
- HAP augmentation was updated using corrected factors.

rcw (Residential Wood Combustion):

- 2020 NEI RWC emissions projected to 2021 using state-wide factors based on SEDS.
- Emissions provided by Idaho were incorporated. In California, emissions from SCC 2104008700 were replaced with EPA estimates per their request, and emissions from SCCs 21040082x0 were removed (except for NH3).

Emissions in Canada were mostly interpolated to 2021 based on the inventories ECCC provided for 2020 and 2023. Fires in Canada are based on a new method that uses tools similar to those used to develop the U.S. inventory.

Emissions in Mexico were pulled forward from the 2019 platform for many sectors (see <https://www.epa.gov/air-emissions-modeling/2019-emissions-modeling-platform-technical-support-document> for more information). Emissions in border states were updated based on the SEMARNAT 2018 inventory that was reviewed and edited in collaboration with EPA. Onroad emissions were based on MOVES-Mexico outputs interpolated to 2021. Fires in Mexico are

based on Fire INventory from NCAR (FINN). A new set of spatial surrogates for Mexico were developed for this platform.

Table 1. Methods to Prepare 2022 Nonpoint Sector Emissions

Sector	Source Category	Task Force Identified 2020-2022 Projection Method
Solvents	Solvents	EPA to develop growth factors representing the projected change in emissions from 2020 (to 2021 for v1 and to 2022 for v2) based on implementing the 2020 NEI emissions estimation methodology. The factors are to be applied to 2020 NEI emissions to address situations where 2020 NEI emissions were supplied by state/local agencies
Fugitive Dust (note that meteorological and transport fraction adjustments are separately applied in modeling process)	Paved Roads	Apply VMT-based growth rates to 2020 NEI emissions (i.e., 2022 VMT/2020 VMT); EPA will use state-supplied 2022 state-supplied VMT data where provided
	Agricultural Production – Livestock	Apply 2022/2020 livestock counts used to estimate 2022 ammonia emissions for the Ag. Livestock category (see row 26 below)
	Unpaved Roads	Hold constant
	Construction	Hold constant
	Agricultural Production – Crops	Hold constant
	Mining and Quarrying	Hold constant
Livestock	Agricultural Livestock	2021 livestock emission estimates available now; EPA expects to be able to develop 2022 estimates before April
Fertilizer	Agricultural Fertilizer	EPA will be newly running CMAQ/EPIC to estimate these emissions this summer (EPA needs to wait to get updated data output from an early CMAQ run)
Residential Wood	All subcategories	Apply EIA State Energy Data System residential wood consumption ratios (2021 SEDS currently available; 2022 available in May-perhaps update to 2022 SEDS for v2?)
All Other Nonpoint	All Other Nonpoint Source Fuel Combustion	Apply EIA State Energy Data System energy consumption ratios (2021 SEDS available for all fuels; 2022 data available for some fuels; perhaps update to 2022 SEDS for v2?)

	Stage 1 Gasoline Unloading at Service Stations	Apply EIA State Energy Data System Transportation Sector/Motor Gasoline consumption ratios
	Stage 1 Gasoline Unloading at Bulk Terminals/Plants	Apply EIA State Energy Data System Total Motor Gasoline consumption ratios
	Aviation Gasoline Stage I and II	Apply EIA State Energy Data System Aviation Gasoline consumption ratios
	Pipeline Gasoline	Apply EIA State Energy Data System Total Motor Gasoline consumption ratios
	Human Cremation	Estimate 2022 county-level number of cremations from 2022 actual county-level deaths from CDC's Wonder Database and 2022 state-level (projected) cremation rates from National Funeral Directors Association's "Cremation and Burial Report" and apply 2022/2020 county-level cremation ratios to 2020 NEI cremation emissions
	Commercial Cooking	Hold constant
	Portable Fuel Containers	Hold constant
	Asphalt Paving	Hold constant
	Open Burning	Hold constant
	Landfills/POTWs	Hold constant
	Charcoal Grilling	Hold constant

Temporal profile changes

We created new general TREF and TPRO datasets for 2022 platform, rather than continue to build off of datasets from older platforms. As part of this, the separate “ptagfire” PTREF was combined with the general cross reference so that ptagfire and ptfire_othna no longer need a separate PTREF.

Changes made to temporal profiles for the 2022v1 base year:

- **afdust:** New temporal profiles (monthly, weekly, hourly) were created to use for paved and unpaved roads. The monthly profile is based on monthly emissions from 2022hc onroad PM2.5 brake and tire wear, since that has less temperature dependence. Weekly and hourly profiles are based on averages of the TMAS profiles used in SMOKE-MOVES. Unpaved uses averages of passenger trucks only; paved uses weighted averages (3/4 LD excluding motorcycles, 1/4 HD excluding buses). There are separate hourly profiles for weekdays vs weekends.
- **afdust:** For ag tilling, flat day-of-week profiles are now being used along with new monthly profiles mostly based on nonroad ag emissions which are based on LADCO-provided MOVES data and more accurately reflect tilling activities, peaking in spring and fall.
- **afdust:** For dust from livestock, the monthly profiles for 2805100010 and 2805100050 (beef cattle and swine) were updated to the 2022 data from <https://u.osu.edu/beef/2023/10/25/more-heifers-supporting-feedlot-inventory/>. Profiles for other livestock dust not changed from the 2020 platform.
- **airports:** For airports, 2022-specific temporal profiles based on the [Aviation System Performance Metrics \(ASPM\)](#) data which provides specific monthly/daily/hourly for 77 airports were used. For

other airports, use state average for monthly/daily and (new for 2022) national average for hourly. Georgia provided monthly temporal profiles for ATL for commercial (one profile), and general+military (another profile).

- **nonpt** Evaporative SCCs (all active SCCs starting with 250105- and 250106-) now use a profile based on monthly total VOC emissions from 2022hc onroad evaporative off-network processes (RPP and RPV), based on the final 2022 onroad run.
- **nonpt**: Residential natural gas (2104006000) is using new monthly profiles by state based on Energy Information Administration (EIA) data. The data source is <https://www.eia.gov/dnav/ng/hist/n3010us2m.htm>.
- **nonroad**: Residential and commercial snowblowers were changed to flat day-of-week, since snow falls when it falls regardless of weekday/weekend.
- **np_solvents**: All asphalt SCCs (paving and roofing) are using new EIA-based monthly profiles for “asphalt and road oil” by PADD region. The data source is https://www.eia.gov/dnav/pet/PET_CONS_PSUP_A_EPPA_VPP_MBBL_A.htm.
- **np_solvents**: For interior painting, a.k.a. architectural coating (2401001000): created a new monthly profile PAINT22 based on 2022 data from <https://fred.stlouisfed.org/series/MRTSSM44412USN/>.
- **np_solvents**: For pesticides (scc in ('2461850000','2461800001','2460800000')), monthly profiles were changed as follows: AZ/CA/FL/HI/TX (the warmest states) are flat annual. Other moderately warm southeast states from North Carolina south and west to Oklahoma are flat from March through October. All other states are flat from April through September. This is based on a comment and follow discussions.
- **ptnonipm**: The profiles for 40202501 (surface coating for metals) was changed to hourly profile 11, which operates from 7am to 5pm.

In addition to the above updates, as has been done in recent modeling platforms, 2022-specific temporal profiles were used for oil and gas emissions (monthly); onroad activity data including vehicle miles-traveled, hoteling hours, and starts; residential wood combustion; livestock and fertilizer emissions.