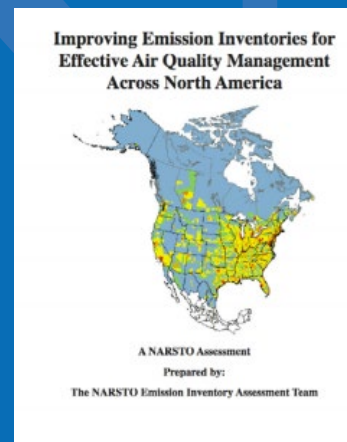


Reflecting on Progress since the 2005 NARSTO Emissions Inventory Report

George Pouliot, Melissa Day, Kirk Baker, Megan Beardsley,
Gregory Frost, Barron Henderson, Sherri Hunt, Venkatesh
Rao, Heather Simon, Tiffany Yelverton, David Mobley



Emission Inventory Conference
Dallas Texas July 29-August 2, 2019

Disclaimer

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NARSTO 2005 Emissions Inventory Report

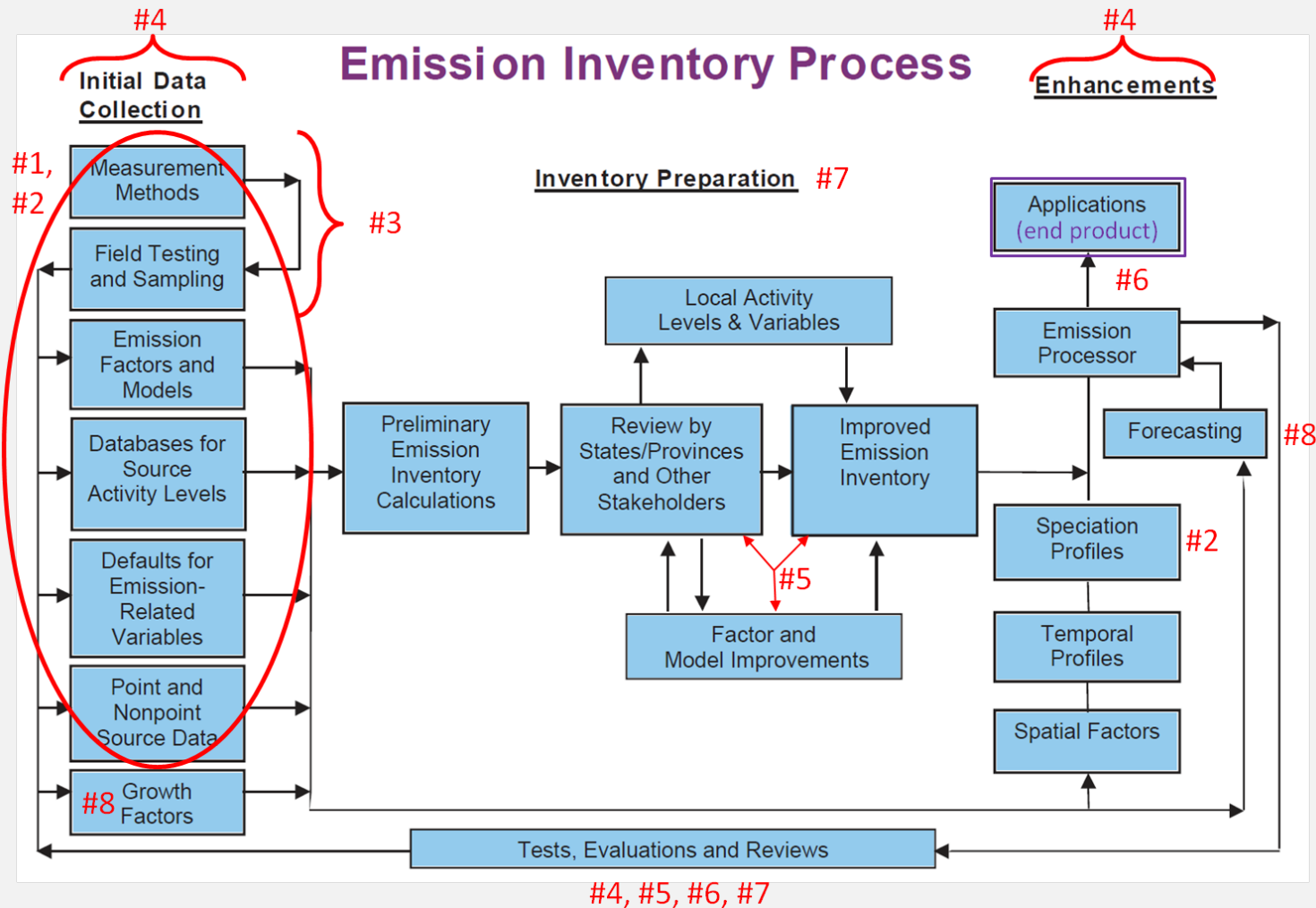
- NARSTO was a public/private partnership that worked towards improved air quality management in North America
- The 2005 publication “Improving Emission Inventories for Effective Air Quality Management Across North America: A NARSTO Assessment” sought to identify the strengths and weaknesses of North American emissions inventories
- That process yielded **8** key elements for improvement

NARSTO 2005 Emissions Inventory Report: 8 Recommendations

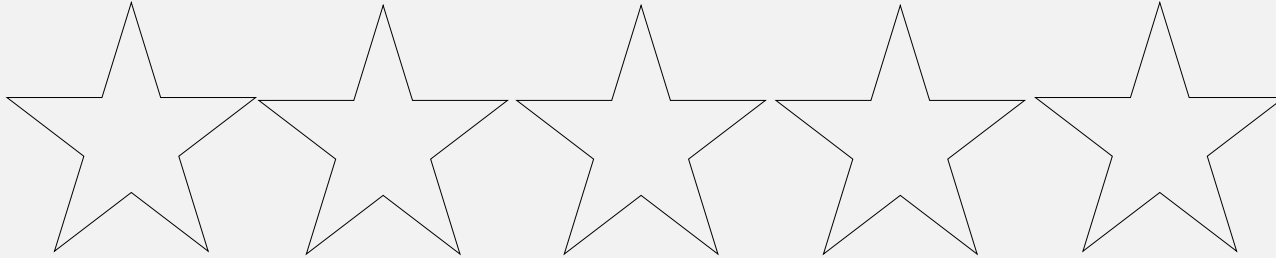
1. Reduce uncertainties associated with emissions from key under-characterized sources.
2. Improve speciation estimates.
3. Improve existing emission inventory tools and develop new ones.
4. Quantify and report uncertainty.
5. Increase inventory compatibility and comparability.
6. Improve user accessibility.
7. Improve timeliness.
8. Assess and improve emission projections.

How each Recommendation Fits into the Emission Inventory Process

1. Reduce uncertainties associated with emissions from key under-characterized sources.
2. Improve speciation estimates.
3. Improve existing emission inventory tools and develop new ones.
4. Quantify and report uncertainty.
5. Increase inventory compatibility and comparability.
6. Improve user accessibility.
7. Improve timeliness.
8. Assess and improve emission projections.



Propose a “subjective” 5 star rating to each of the 10 source categories in Recommendation #1 and to the remaining 7 recommendations.



These stars are my opinion and they are a rough assessment of how much things have improved since 2005.

1.Reduce uncertainties from key under-characterized sources

NARSTO Recommendation: Focus immediate measurement and development efforts on 10 areas of greatest known uncertainty.

Top 10 most uncertain	5 star rating
Fine particles & precursors	★★★★★
Toxic and HAPs	★★★★☆
Onroad vehicles	★★★★★
Offroad vehicles	★★★★☆
Agricultural NH ₃ sources	★★★★☆
Biogenic Source	★★★☆☆
Petrochemical industrial facilities	★★★★☆
Open biomass burning	★★★★☆
Residential wood combustion	★★★☆☆
Paved and Unpaved Road Dust	★☆☆☆☆

1.Reduce uncertainties from key under-characterized sources

MOVES most sophisticated and detailed emissions model for onroad and offroad sources



MOVES and Related Models

CONTACT US SHARE [social icons]

- MOVES and Related Models Home
- Latest MOVES Model
- MOVES Limited Use Models
- Tools for MOVES
- MOVES Training
- Methods to Produce Emission Inventories
- MOVES Algorithms
- MOVES Onroad Technical Reports**
- Nonroad Technical Reports
- MOVES Workshops & Presentations
- MOVES Model Review Work Group

MOVES Onroad Technical Reports

The technical reports for MOVES2014 describe the default inputs and algorithms for EPA's latest version of MOVES: MOVES2014b. Technical reports for earlier versions of MOVES are included here because much of the technical information in the latest versions of MOVES builds off of information developed for previous versions.

These reports focus on MOVES inputs and algorithms for cars, trucks and other onroad emission sources. MOVES also covers a wide variety of nonroad sources. See the [Nonroad Technical Reports](#) page for reports focused on MOVES nonroad inputs and algorithms.

On this page:

- [MOVES2014](#)
- [MOVES2010](#)
- [Draft MOVES2009](#)
- [MOVES2004](#)
- [MOVES Development](#)

You may need a PDF reader to view some of the files on this page. See [EPA's About PDF page](#) to learn more.

MOVES and Other Mobile Source Emissions Models

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MOtor Vehicle Emission Simulator (MOVES)

Latest version of MOVES

EPA's MOtor Vehicle Emission Simulator (MOVES) is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics.

Using MOVES

- [Latest MOVES Model](#)
- [MOVES Limited Use Models](#)
- [Tools to Develop or Convert MOVES Inputs](#)

Understanding Algorithms & Default Data

- [MOVES Algorithms](#)

Older Models

- [Previous MOVES Versions](#)
- [MOBILE Model](#)

Search MOVES and Other Models

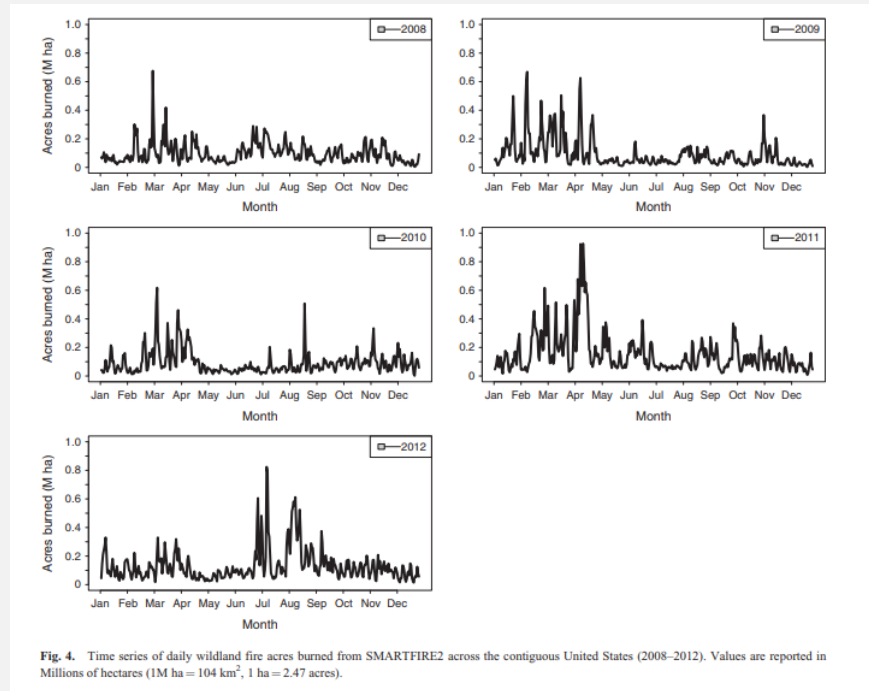
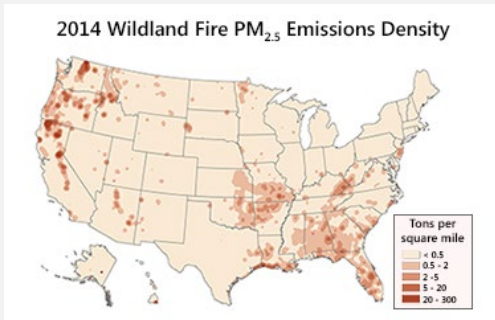
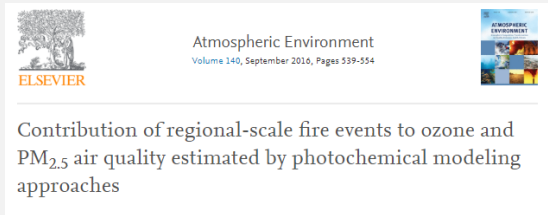


Current Status: MOVES incorporates a large amount of data; impact on air quality models continues to be studied

1. Reduce uncertainties from key under-characterized sources



Biomass Burning: Substantial Research continues on all aspects



Current Status: See Friday's Fire Session 10 AM Reunion A for some of the latest improvements/research

1. Reduce uncertainties from key under-characterized sources



Agricultural Ammonia Emissions: Source is bi-directional and requires a separate inline model within an air quality model

Biogeosciences, 10, 1635–1645, 2013
www.biogeosciences.net/10/1635/2013/
doi:10.5194/bg-10-1635-2013
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Evaluation of a regional air-quality model with bidirectional NH₃ exchange coupled to an agroecosystem model

J. O. Bash¹, E. J. Cooter¹, R. L. Dennis¹, J. T. Walker², and J. E. Pleim¹

¹National Exposure Research Laboratory, Office of Research and Development, US Environmental Protection Agency, Research Triangle Park, NC 27711, USA

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Correspondence to: J. O. Bash (bash.jesse@epa.gov)

Received: 4 May 2012 – Published in Biogeosciences Discuss.: 23 August 2012
Revised: 15 January 2013 – Accepted: 17 February 2013 – Published: 11 March 2013

Current Status: See J. Bash and Presentation 8:00 AM Reunion C and other presentations in that session

1. Reduce uncertainties from key under-characterized sources

Fine Particulates

- Significant work has been done to improve PM_{2.5} estimates both in measurement and in modeling.
- This is a very broad area of recommendation that encompasses nearly all emission sources.
- PM_{2.5} model performance has greatly improved and the CMAQ aerosol module has been significantly upgraded during past 15 years and is now at version 7.

Toxics and HAPs

- HAP and CAP inventories are becoming more consistent and are both part of the NEI
- much more work is needed to reduce uncertainty and improve consistency.

1. Reduce uncertainties from key under-characterized sources



Biogenic Emissions: limited resources have resulted in only modest updates to this sector



Petrochemical Facilities: Significant changes to this sector over the past 15 years; Oil and Gas reporting tool



Residential Wood Combustion: Updated temporal profiles and allocation based on temperature, still uncertainty of emission factors, appliance data. Surrogates have been an issue in the past but have been update



Paved and Unpaved Roads: except for updates to temporal allocation based meteorological parameters, only modest improvements for this sector

2. Improve speciation estimates

NARSTO Recommendation: Develop new and improve existing source speciation profiles and emission factors

SPECIATE 5.0 Released 2019



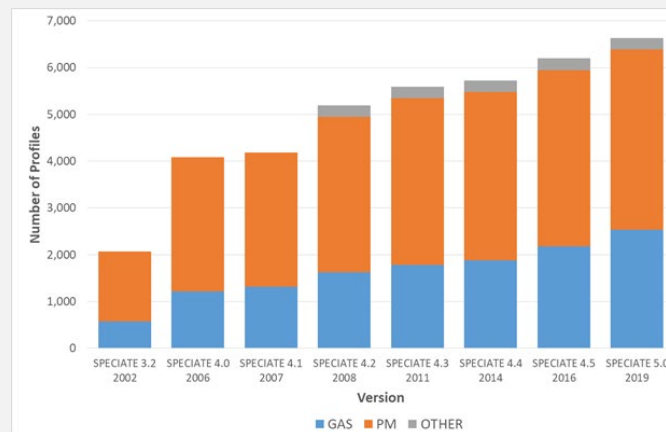
Atmospheric Environment
Volume 207, 15 June 2019, Pages 93-104



An assessment of important SPECIATE profiles in the EPA emissions modeling platform and current data gaps

Casey D. Bray ^{a, b}, Madeleine Strum ^c, Heather Simon ^c, Lee Riddick ^d, Mike Kosusko ^e, Marc Menetrez ^f, Michael D. Hays ^g, Venkatesh Rao ^h

Number of profiles added to the various releases of SPECIATE



Current Status: Release of SPECIATE 5.0 has greatly improved our methods for incorporating profiles into our modeling platforms (i.e. 2017 modeling platform)



3. Improve existing emissions inventory tools and develop new ones

Recommendation: Apply new technological capabilities to allow models to more closely approximate actual emissions

Atmospheric Environment 81 (2013) 102–111

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv



The observed response of Ozone Monitoring Instrument (OMI) NO₂ columns to NO_x emission controls on power plants in the United States: 2005–2011



Bryan N. Duncan^{a,*}, Yasuko Yoshida^{a,b}, Benjamin de Foy^c, Lok N. Lamsal^{a,d},
David G. Streets^e, Zifeng Lu^e, Kenneth E. Pickering^a, Nickolay A. Krotkov^a

A new global anthropogenic SO₂ emission inventory for the last decade: a mosaic of satellite-derived and bottom-up emissions

Fei Liu^{1,2}, Sungyeon Choi^{2,3}, Can Li^{2,4}, Vitali E. Fioletov⁵, Chris A. McLinden⁵, Joanna Joiner²,
Nickolay A. Krotkov², Huisheng Bian^{2,6}, Greet Janssens-Maenhout⁷, Anton S. Darmenov², and Arlindo M. da Silva²

¹Universities Space Research Association (USRA), GESTAR, Columbia, MD, USA

²NASA Goddard Space Flight Center, Greenbelt, MD, USA

³Science Systems and Applications Inc., Lanham, MD, USA

⁴Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD, USA

⁵Air Quality Research Division, Environment and Climate Change Canada, Toronto, ON, Canada

⁶Goddard Earth Sciences and Technology Center, University of Maryland, Baltimore, MD, USA

⁷European Commission, Joint Research Centre, Institute for Environment and Sustainability, Via Fermi, Ispra (VA), Italy

Current Status: The issue of how to incorporate new measurements and tools into emissions inventories needs to be continually addressed to make the best use of technological improvements. Comparing and contrasting techniques is recommended.




4. Quantify and report uncertainty

NARSTO Recommendation: Develop guidance, measures, and techniques to improve uncertainty quantification, and include measures of uncertainty as a standard part of reported emission inventory data.

- WebFIRE is an online database of criteria pollutant emissions factors that supplements existing AP-42 documents, can calculate uncertainty based upon emissions test characteristics and applications
- Future work: use updated historical (1750-2014) emissions time series in Community Emissions Data System (CEDs) to create uncertainty estimates for global inventory

Quantification of emission factor uncertainty

George Pouliot  Emily Wisner, David Mobley & William Hunt Jr.


Pages 287-298 | Accepted author version posted online: 20 Jan 2012, Published online: 24 Feb 2012

Current Status: More inclusion and quantification of uncertainty continues to be needed to assist research studies and prioritize inventory updates.



5. Increase inventory compatibility and comparability

NARSTO Recommendation: Define and implement standards for emission inventory structure, data documentation, and data reporting for North American emission inventories.



Atmospheric Environment
Volume 53, June 2012, Pages 4-14

Comparing emission inventories and model-ready emission datasets between Europe and North America for the AQMEII project

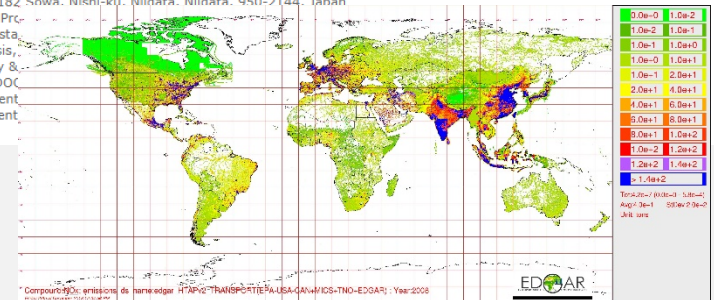
George Pouliot ^a, Thomas Pierce ^a, Hugo Denier van der Gon ^b, Martijn Schaap ^b, Michael Moran ^c, Uarporn Nopmongkol ^d

Show more

HTAP_v2.2: a mosaic of regional and global emission grid maps for 2008 and 2010 to study hemispheric transport of air pollution

G. Janssens-Maenhout^{1,12}, M. Crippa¹, D. Guizzardi¹, F. Dentener¹⁰, M. Muntean¹, G. Pouliot^{10,2}, T. Keating^{10,3}, Q. Zhang⁴, J. Kurokawa⁵, R. Wankmüller⁶, H. Denier van der Gon^{10,7}, J. J. P. Kuenen⁷, Z. Klimont⁸, G. Frost⁹, S. Darras¹⁰, B. Koffi¹, and M. Li^{10,4,11}

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⁷TNO, Department of Climate, Air and Susta.
⁸International Institute for Applied Analysis,
⁹NOAA Earth System Research Laboratory &
¹⁰Observatoire Midi-Pyrénées, CNRS, SEDOC
¹¹State Key Joint Laboratory of Environment
¹²Ghent University, Campus Ardoyen, Ghent



Current Status: The amount of publicly available documentation and communication from domestic and international inventories has increased significantly in recent years. Comparability of inventories developed with different goals remains a challenge, but comparisons can be useful for some sources and species if primary data is understood.

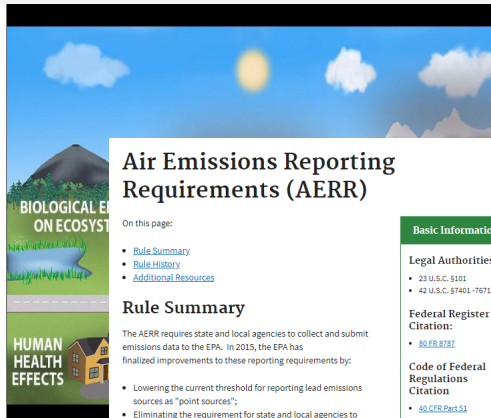


6. Improve user accessibility

NARSTO Recommendation: Improve user accessibility to emission inventory data, documentation, and emission inventory models through the Internet or other electronic formats.

2014 National Emissions Inventory Report

Air pollution – created by human activities such as vehicle use, industrial operations, and agriculture practices, or by natural events such as wildfires – can influence air quality and public health. This interactive National Emissions Inventory (NEI) Report explains how air emissions data are generated and used, and provides tools that explore emission trends and source contributions to air pollution. It highlights the most recent comprehensive and complete NEI, 2014 version 2, released in February 2018. [Skip ahead to NEI data.](#)



Air Emissions Reporting Requirements (AERR)

On this page:

- [Rule Summary](#)
- [Rule History](#)
- [Additional Resources](#)

Rule Summary

The AERR requires state and local agencies to collect and submit emissions data to the EPA. In 2015, the EPA has finalized improvements to these reporting requirements by:

- Lowering the current threshold for reporting lead emissions sources as "point sources";
- Eliminating the requirement for state and local agencies to report emissions from wildfires and prescribed fires;
- Requiring agencies to report the inputs needed to model emissions from mobile sources;
- Removing the requirements for agencies to report daily and seasonal emissions, and;
- Clarifying, removing, or simplifying some current emissions reporting requirements.

2014-2016 Version 7 Air Modeling Platforms

The 2014v7.1, 2015v7.1 (alpha), and 2016v7.1 (alpha) emissions modeling 2014 National Emissions Inventory version 2. These emissions modeling information needed to support the development of emissions inputs for including the inventories, and/or:

The 2014v7.1 platform was used for:

- [2014v7.1 Platform](#)
- [2015v7.1 \(alpha\) Platform](#)
- [2016v7.1 \(alpha\) Platform](#)

2017 National Emissions Inventory (NEI) Development Documentation

The NEI database includes air emissions sources of both criteria and hazardous air pollutants. Data are available for many facilities and county totals. The 2017 NEI is the most inventory on the three-year cycle and the EPA will create it using data provided by State, local and Tribal air agencies. The [Emissions Inventory System \(EIS\)](#) helps the EPA to build the NEI.

2017 NEI Plan

- [2017 NEI Plan](#)
- [Appendix 1 - Suggested SLT Timeline and QA Checks](#) (p. 29)
- [Appendix 2 - 2017 NEI Plan Code Changes](#) (p. 11)
- [Appendix 3 - Draft Schedule for Potential Point SCC Revisions](#) (p. 34)
- [Appendix 4 - 2017 Nonpoint Proposed Option Groups - Overview](#) (p. 72)

2017 NEI Resources for State, Local, Tribal Agencies

[Submit Instructions and Supporting Data for 2017 NEI](#)

Nonpoint

- [Exempted Pollutant List for Nonpoint SCCs](#) (p. 17)

[Contact Us](#) to ask a question, provide feedback, or report a problem.

Inventory Collaborative Wiki

2014 National Emissions Inventory (NEI) Data

Documentation | Data Summaries | **Data Queries** | Facility Mapping

Sector Summaries - Criteria and Hazardous Air Pollutants by 60 EIS emissions sectors

The following queries allow for generating custom data files and the results will be displayed on-screen with various options to download. The queries are used to generate subset summaries of either Sector or Tier aggregations.

*To use the multiple selection boxes hold CTRL and click on options you would like to include in your query. To select multiples in order, click your first option then hold SHIFT + click the last selection to highlight everything in between. To deselect options use the same method as with selecting. Please allow time for large queries to process (i.e. county aggregated for all pollutants, all regions, selected sector).

National / State / County or Tribe | **Geographic Aggregation**

National | **Region 1** | Connecticut | Maine | Massachusetts | New Hampshire

Pollutant | **Sector**

CO | **Agriculture** | Crops and Livestock Dust | Fertilizer Application | Livestock Waste | Dust

Collaborative? | Google Drive

Current Status: User accessibility has greatly improved, but the NEI process remains complex, requiring specialized expertise to fully implement.

7. Improve timeliness



NARSTO Recommendation: Create and support a process for preparing and reporting national emission inventory data on a yearly basis.

- Time ~37 months to produce version 2 NEIs: (e.g. NEI2008v2 report released Feb 2012; 2014version2 report released Feb 2018)

Having a multi-year inventory with consistent methodology would make long-term retrospective analysis easier and encourage use of existing inventories

- Researchers at EPA have produced a 1990-2010 gridded emissions inventory for regional chemical transport modeling
- Community Emissions Data System (CEDS) provides global 1750-2014 emissions
- EPA/ORD is planning a 2002-2017 set of emissions based on consistent methods to the extent possible

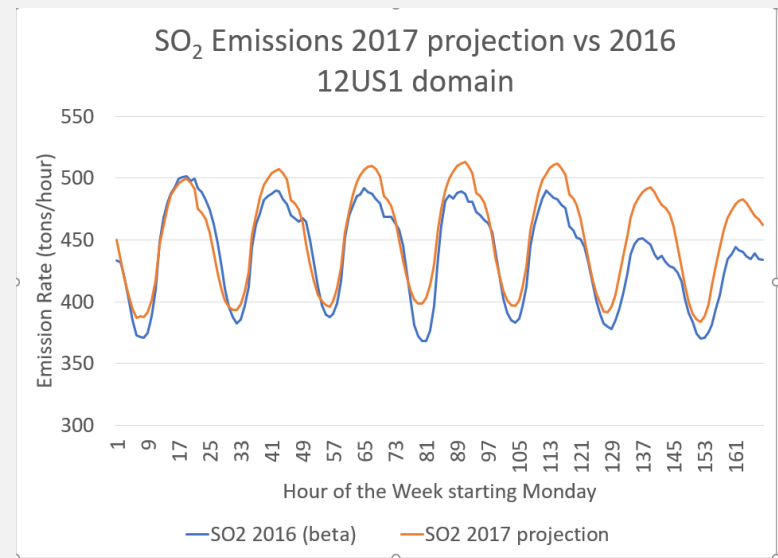
Current Status: The Toxics Release Inventory is annual; the NEI will maintain its three-year cycle barring significant increase in investment. Separate emissions inventories have been developed and should continue to be updated with clear documentation.

8. Assess and improve emission projections



NARSTO Recommendation: Emission projection methodologies for all emission inventory sectors in North America should be evaluated to determine the accuracy of past projections and identify areas of improvement for future projections.

- EPA-projected inventories are generated for modeling specific criteria pollutant rules, typically shorter term projections (i.e. 5- 10 years)
- National-scale Greenhouse Gas (GHG) projections are submitted in the US Biennial Report to the United Nations on longer-term time frames (i.e. projecting to 2050, 2100)



Current Status: Challenges remain when developing and maintaining appropriate emission projections, and when assessing accuracy of past emissions projections is needed to inform future projections.

Summary

1. Reduce uncertainties associated with emissions from key under-characterized sources. ★★☆☆☆
2. Improve speciation estimates. ★★☆☆☆
3. Improve existing emission inventory tools and develop new ones. ★★☆☆☆
4. Quantify and report uncertainty. ★☆☆☆☆
5. Increase inventory compatibility and comparability. ★★★★★
6. Improve user accessibility. ★★★★★
7. Improve timeliness. ★★☆☆☆
8. Assess and improve emission projections. ★★☆☆☆

Reflecting on progress since the 2005 NARSTO emissions inventory report

doi:10.1080/10962247.2019.1629363