Draft Proposed Approach for Consideration of Chemical Co-exposure in TSCA Risk Evaluations

October 16, 2024

Jason Todd, Ph.D, Senior Science Lead OCSPP/IO

Outline

- Background and Regulatory Context (Sections 1-2)
- Goals of Evaluation (Section 2)
- Scope (Section 3)
- Metrics Supporting Goal 1 (Section 4 – 6)
- Metrics Supporting Goal 2 (Section 4, 5, and 7)
- Summary, Potential Application, and Future Direction (Section 8)

Background – TSCA Regulatory Context

- Evaluation and managing of chemical risks is done through implementation of the Toxic Substances Control Act (TSCA)
- Historically risk evaluations in OPPT have been single chemical assessments with consideration of routes and pathways separately
- Wide acknowledgement in scientific and regulatory community of multiple facility and chemical exposures
- Oftentimes releases in proximity to general human populations

Background – TSCA Regulatory Context

- Must consider reasonably available information consistent with best available science
- Decisions based on weight of scientific evidence
- Requires the consideration of potentially exposed susceptible subpopulations (PESS)
- Recent amendments to potential PESS include consideration of overburdened communities

PESS and Relation to EJ

- Direction within EPA and publication of several Executive Orders have encouraged better consideration and incorporation of EJ principles and the evaluation of these overburdened communities into Agency work
- EJ defined as “the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment.”
- Fair treatment is further defined by EPA as meaning that “no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies

Aggregate and Cumulative Approaches

- Many communities may be subject to multiple chemical releases and multiple released chemicals
- Evaluation of proximity to releases in *Fenceline Assessment*
- Recent inclusion of aggregate analysis within OPPT REs
- To address multiple chemical exposures OPPT has released *Draft Principles of Cumulative Risk Assessment* and a *Draft Proposed Approaches in Phthalates*

Goals of this Effort

To evaluate how OPPT could better inform the presence of chemical co-exposures for the general population

Report Goals:

1) To support identification of potential PESS
2) To consider chemical co-exposures as part of an individual chemical risk evaluation

Framing of Co-exposure Evaluation

- Initial step in the process for looking at co-exposure
- How these efforts can be better incorporated into program is ongoing
- Expect refinement as time goes along
- Must be considered under the statutory language of TSCA

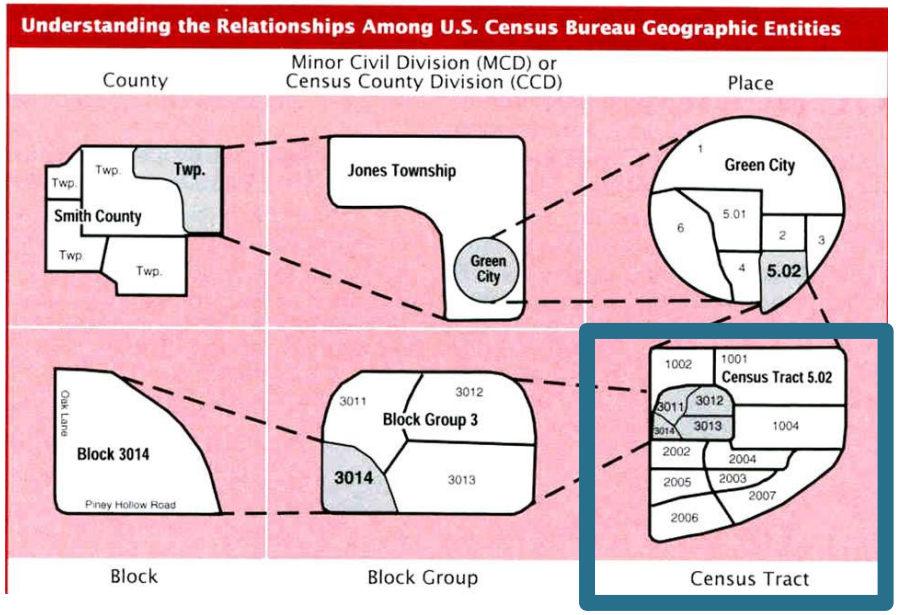
Scope

- Co-exposure are areas with chemical exposures in same geographic space
- Screening level analysis
- Chemicals may not share toxicological properties
- Not considering additive exposure or risk across chemicals
- Not considering non-chemical stressors
- Industrial releases to air are the focus
- Cancer risk is focus. Use existing cancer risk values in used datasets

Methods and Tools - AirToxScreen

- Office of Air product that estimates exposures and risk for majority of HAPs using NEI data
- Characterizes multiple source contributions
- Utilizes AERMOD and CMAQ for estimation of air concentrations and HAPEM for estimation of exposure concentrations
- Calculates individual and total chemical cancer risk across all chemicals
- Total of 72 chemicals or groups in cancer risk characterization
- Outputs presented at census tract level.

Census Small-Area Geography



AirToxScreen – Assumptions

- “Provides screening-level estimates of the risk of cancer and other potentially serious health effects from inhaling air toxics”
- Varying sub-models with different assumptions, along with datasets of different spatial and temporal resolution all contribute to uncertainty
- Provides a ‘snapshot’ of outdoor air quality if emission levels remained the same for assessment year

Analyses Conducted

Support for Goal 1: Identification of possible PESS at national and regional scales

- Number of facility releases
- Number of chemicals released from facilities
- Number of chemicals meeting chemical risk benchmarks
- Chemical risk combinations; and

Support for Goal 2: Consideration of chemical co-exposures as part of an individual risk evaluation

- Two Chemical Specific Case Studies
  - Includes bivariate analysis of individual chemical risk and co-exposure of other chemicals.

NEI Releases and Chemicals Released

- 2019 NEI dataset represents nearly 49,000 reported releases and associated chemicals released
- Releases represent individual stack releases. There may be multiple identified releases at a given facility
- Varying reporting protocols may lead to aggregation of releases
- Magnitude of release is not considered in these metrics
- Should be considered separate from each other

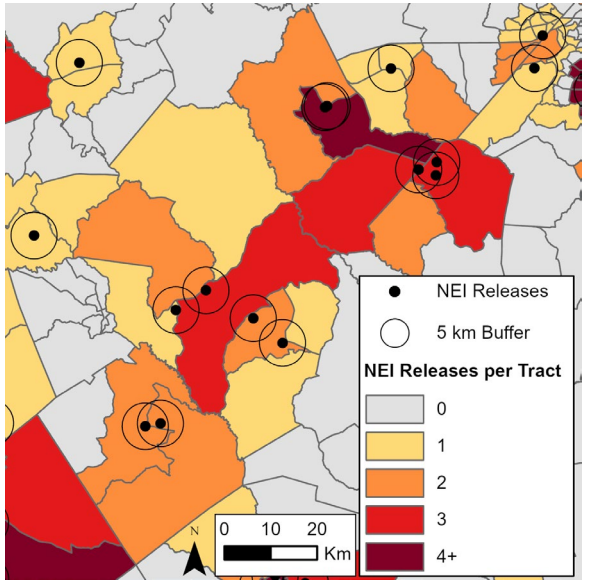


Figure 6-1. Example of number of NEI releases by census tract.
Each NEI release is shown with its 5 km buffer. Scale: 1:1,400,000

NEI Releases

Table 6-1. Number of NEI releases within a census tract or within 5 km of a census tract

Number of NEI Releases	Within a Tract		Within 5 km of a tract	
	Number of tracts	Percent of all	Number of tracts	Percent of all
0	55,237	75.2	9,930	13.5
1 – 2	13,326	18.1	16,929	23.1
3 – 10	4,286	5.8	26,819	65.5
11 – 25	481	0.7	11,463	15.6
26 – 50	78	0.1	4,198	5.7
>50	18	< 0.1	4,087	5.6
Non-zero	18,189		63,496	
Mean/median of non-zero release tracts	2.6/1		16.8/5	
Maximum	210		846	

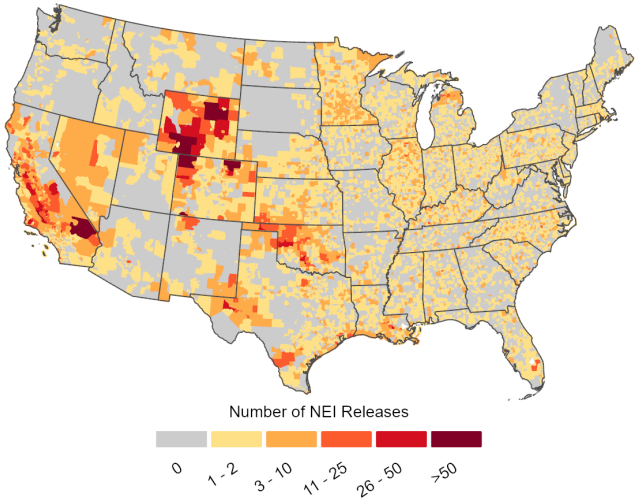


Figure 6-1. Number of NEI releases within a census tract.
Category breaks are based on natural breases in the overall distribution. Scale 1:50,000,000. Data not shown for AK, HI, PR, or USVI.

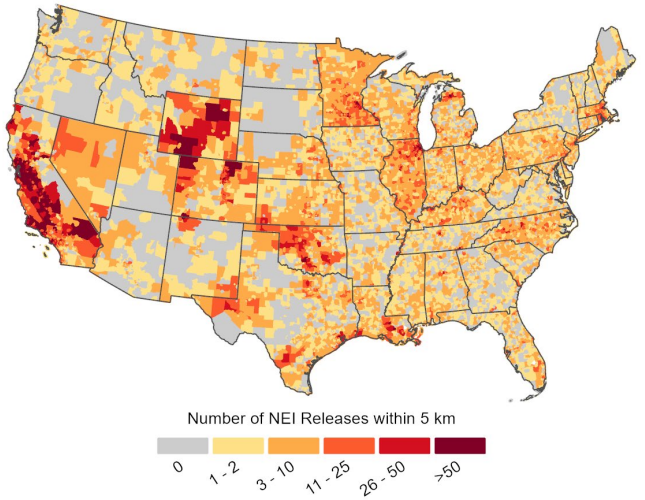


Figure 6-2. Number of NEI releases within 5 km of a census tract.
Category breaks are based on natural breaks in the overall distribution. Scale 1:50,000,000. Data not shown for AK, HI, PR, or USVI.

Factors Influencing Metric Interpretation

- Size of census tracts – Urban vs. Rural
- Annual timescale of data unable to determine whether releases simultaneous or overlapping
- Different reporting protocols across different reporting agencies may influence

Chemicals Released

Table 6-2. Number of released chemicals within a census trat and within 5 km of a census tract

Number of Chemicals Released	Within a tract[1,2]		Within 5 km of a tract[1]	
	Number of Tracts	Percent of all	Number of Tracts	Percent of all
0	56,781	77.3	12,441	16.9
1 – 5	5,246	7.1	7,578	10.3
6 – 10	4,867	6.6	12,146	16.5
11 – 15	4,341	5.9	17,734	24.2
16 – 20	1,231	1.7	10,808	14.7
21 – 25	634	0.9	9,263	12.6
≥26	326	0.4	3,456	4.7
Mean/Median w/ zero tracts	2.1/0		11.8/12	
Mean/median of non-zero tracts	9.4/9		14.2/13	
Maximum	62		62	

[1]Census tracts with either no land area or no population are omitted from analysis.
[2]Nationwide there are 73,426 evaluated tracts

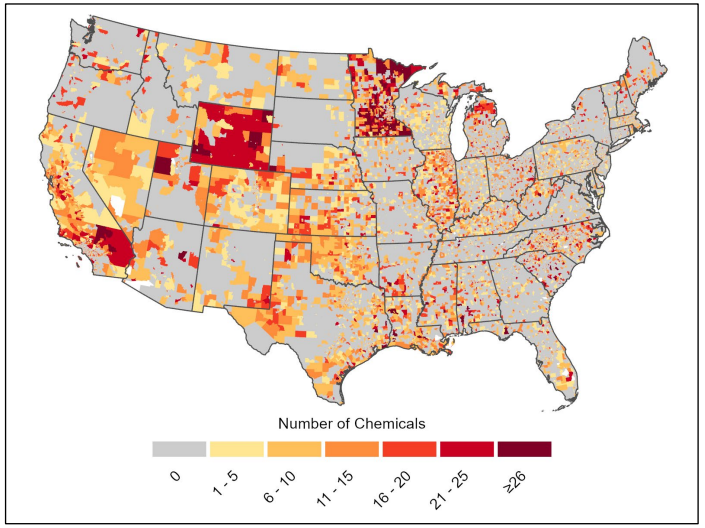


Figure 6-3. Number of chemicals released within each census tract.
Scale = 1:50,000,000. Data not shown for AK, HI, PR, or USVI.

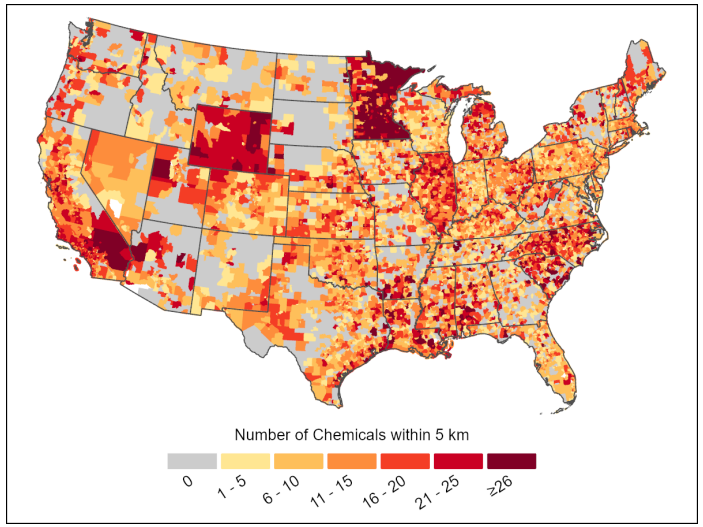


Figure 6-4. Number of chemicals released within 5 kilometers of each census tract.
Scale = 1:50,000,000. Data not shown for AK, HI, PR, or USVI.

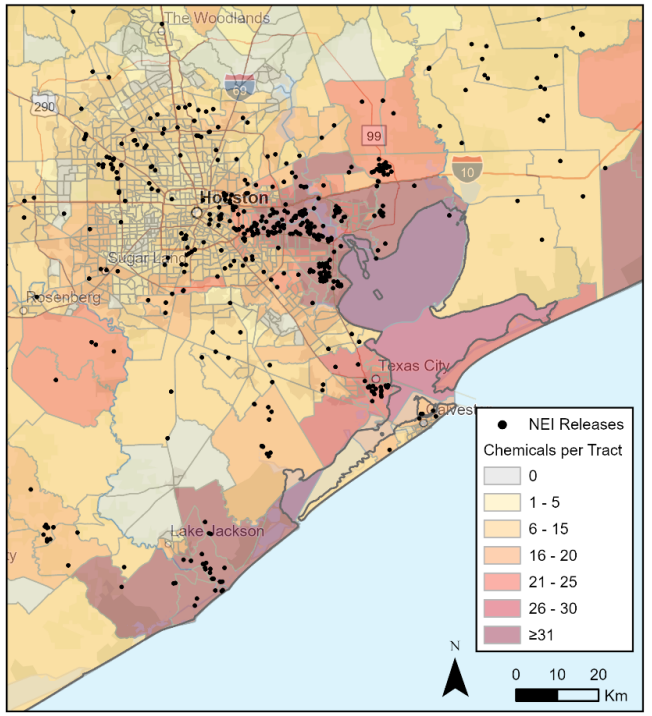
Regional Example

Main Messages of Release Analyses

- Able to discern geographic areas with higher levels of NEI releases and chemicals released. Regional scale potentially most helpful.
- Characterizing by 5km buffer makes marked difference across indices
- Does not take into account magnitude of releases or potential risk
- Analysis impacted by reporting, tract sizing and temporality
- Overall gives insight into co-exposure and potential PESS. Highlights areas for additional analysis.

Houston

a)



Baton Rouge - New Orleans

b)

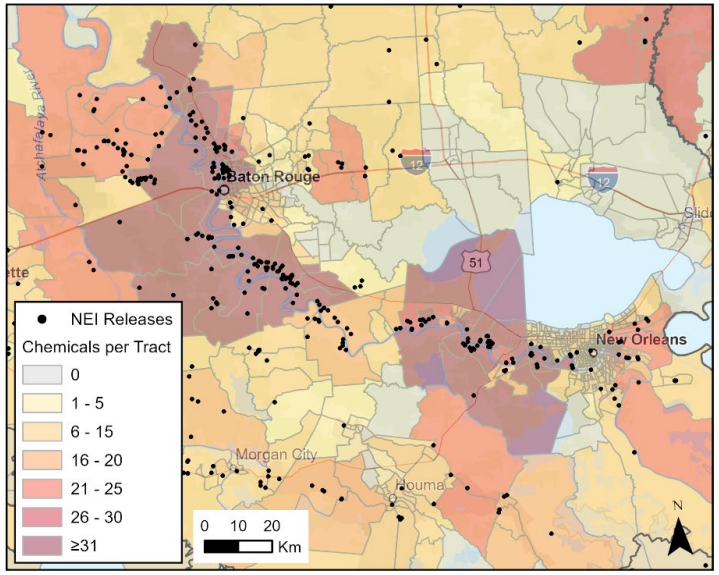


Figure 6-5. NEI releases and number of chemicals released from those facilities within 5 km of census tracts in a) Houston, Texas metropolitan area and b) Baton Rouge - New Orleans, Louisiana corridor. Basemap credits are via World Street Map in ArcGIS Pro.

Evaluation of ATS Estimated Chemical Risk Patterning

- Data filtered to look at chemicals with a tract meeting risk thresholds
- On average 10.9 chemicals per tract at 10^{-7}; 4.5 chemicals per tract at 10^{-6}

Main Messages

- Identified differentiation across nation depending on benchmark
- Common for multiple chemicals to be above relevant risk thresholds
- Potentially useful for identifying areas needing aggregate or cumulative analysis, PESS

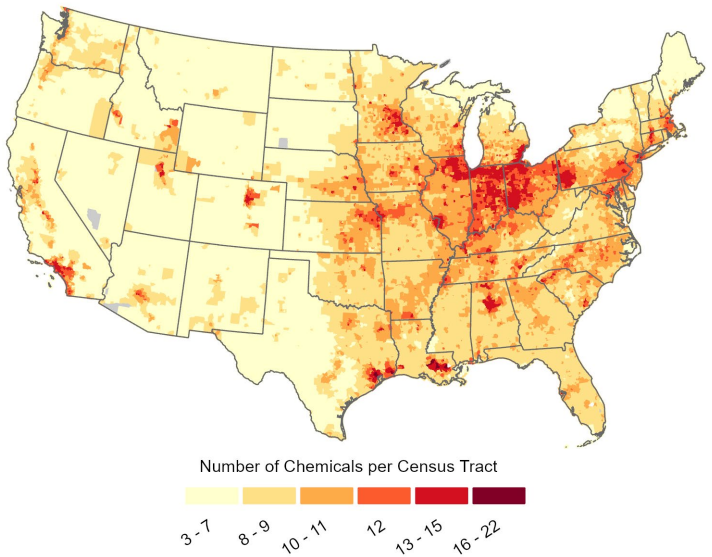


Figure 6-7. Number of chemicals per census tract exceeding the one-in-ten-million (10^{-7}) cancer risk benchmark within AirToxScreen.
Note areas in grey represent those tracts having no land area, population, or match within the ATS dataset. Scale 1:50,000,000. Data not shown for AK, HI, PR, and USVI.

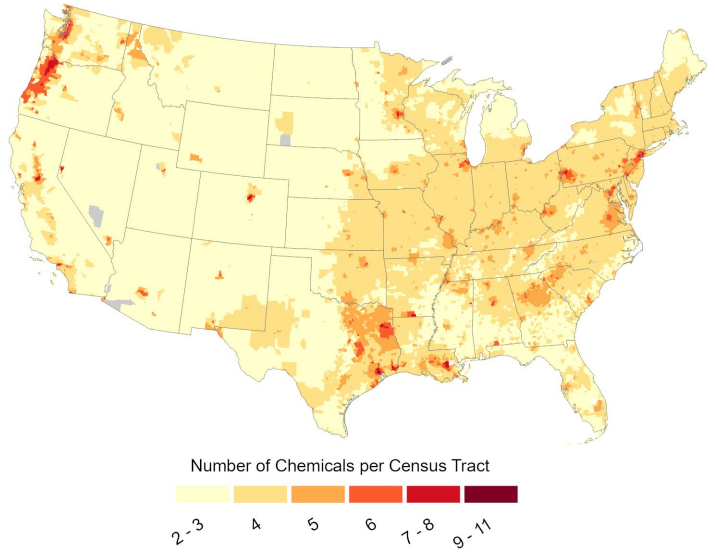


Figure 6-8. Number of chemicals per census tract exceeding the one-in-a-million (10^{-6}) cancer risk benchmark within AirToxScreen
Note areas in grey represent those tracts having no land area, population, or match within the ATS dataset. Scale 1:50,000,000. Data not shown for AK, HI, PR, and USVI.

Chemical Risk Combinations

- Case Study: Looked at tracts nationwide that contained 12 chemicals greater than $1x10^{-7}$ cancer benchmark
  - Total of 15,696 tracts with 148 unique combinations
  - 4 chemical combinations with >1% of all tracts in class
- At 10^{-6} benchmark, 4 chemicals per tract is most common. 97% of all tracts a single 4-chemical combo

Main Messages

- Few chemical combinations dominate overall distribution
- Offers opportunity for targeting these combinations and their interactions
- Possible more unique combinations may play disproportionate role at smaller scales
- Can also target combinations relevant to specific chemical

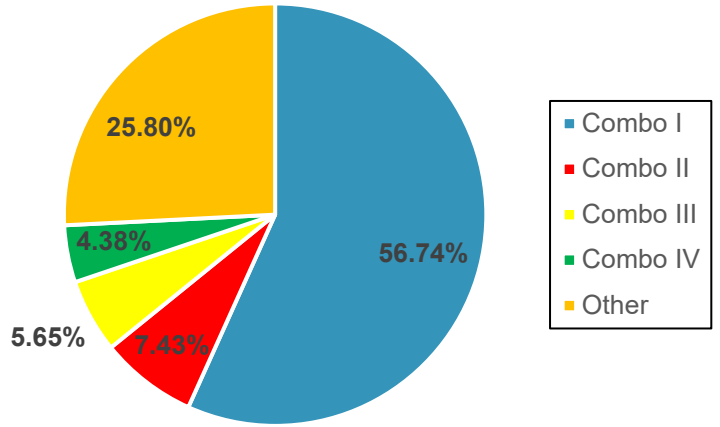


Figure 6-9. Distribution of chemical combinations for tracts with 12 chemicals greater than $1x10^{-7}$ cancer benchmark (n = 15,696 tracts nationwide with 148 unique combinations).
Combos I, II, III, and IV are those chemical combinations making up greater than 1% of all tracts with 12 chemicals. "Other" category represents the combined total of 144 other 12 chemical combinations in this class.

Introduction for Goal 2

Goal 2: To consider chemical co-exposures as part of an individual chemical risk evaluation

- Most risk evaluations based on an individual chemical of interest
- Chose two case study chemicals with different risk drivers to illustrate approach
- Have anonymized the chemicals to focus on methodologies
- Combined with previous analysis of number of chemicals reaching risk benchmarks to create bivariate evaluation

Chemical A Case Study

- Secondary formation is driver of risk for this chemical – 74% of total risk on average
- Over 22,000 unique NEI releases
- Releases occupy 10,205 tracts
- Estimated releases range from <<1 – 251,514 kg/yr
- Mean: 332 kg/yr; Median (0.1 kg/yr)
- Estimated risks per tract range from 0.23 – 4.46/million
- ATS has done the nationwide modeling for OPPT. Acts as a good first screen.

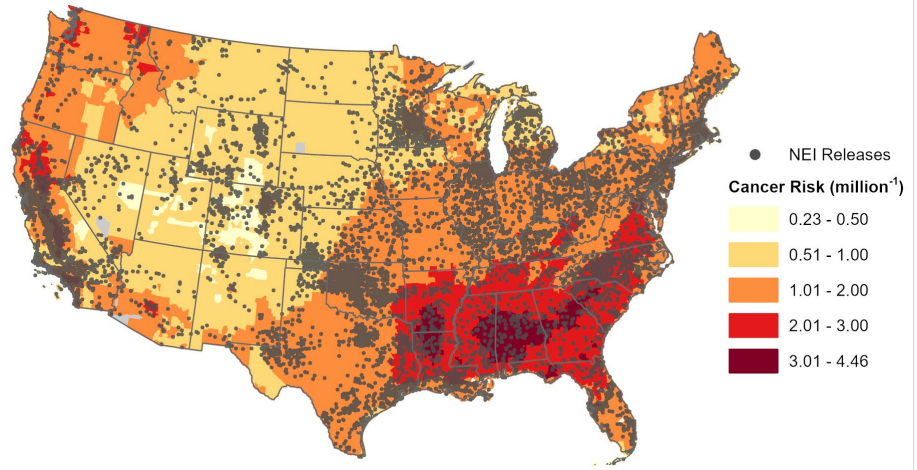


Figure 7-1. NEI releases and estimated cancer risk within the AirToxScreen dataset for Chemical A. Data are shown by census tract. Data not shown for AK, HI, PR, and USVI

Chemical A Bivariate Analysis

Table 7-1. Estimated risk of chemical A for census tracts within 5 km of a release with average and maximum number of co-occurring chemicals at the one in ten million and one in a million risk thresholds in those tracts.

Chemical Risk (million^{-1})	Tracts	Number of Modeled Chemicals			
		Avg>0.1/1M	Max	Avg>1/1M	Max
0 - 0.5	144	5.1	9	2.0	2
0.5 - 1	3,000	7.8	14	2.8	6
1 - 2	35,029	10.5	21	3.7	10
2 - 3	10,228	10.6	18	3.9	9
>3	875	10.0	14	4.0	9
Grand Total	49,276	10.3	21	3.7	10

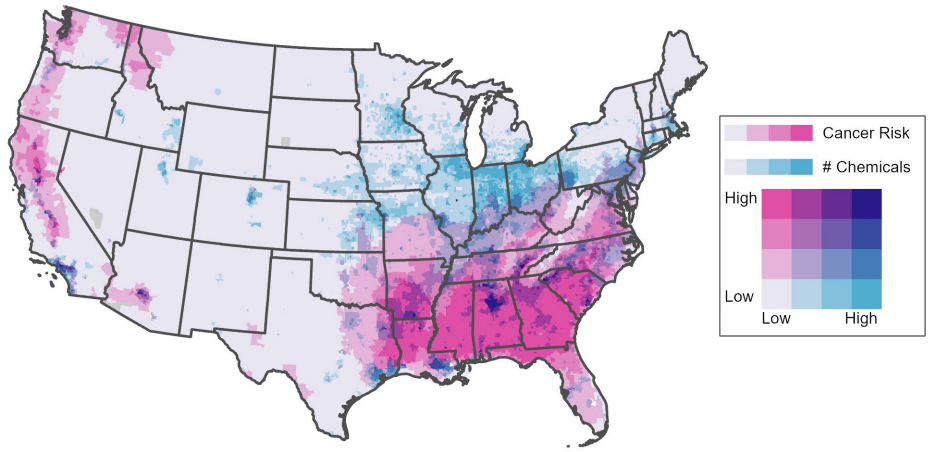


Figure 7-2. Bivariate distribution of Chemical A cancer risk (in pink) with number of other chemicals with estimated risks greater than 1 in 10 million within AirToxScreen (in blue).
Data are shown by census tract. Scale 1: 50,000,000. Data not shown for AK, HI, PR, and USVI

Main Messages

- Tabular information aids in identifying co-exposure across individual chemical risk spectrum
- Aids in identifying possible tipping points or risk from individual chemical alone
- Bivariate plot visually identifies areas with individual chemical risk + additional chemical burden

Chemical B Case Study

- Risk driven by point and nonpoint releases. Nationally per tract:
  - 15% of risk from point release
  - 85% of risk from nonpoint.
- 3,467 unique NEI releases
- Releases occupy 2,571 tracts
- Estimated releases range from <<1 – 22 kg/yr
- Mean: 0.06 kg/yr; Median (8.0×10^{-4} kg/yr)
- Estimated risks per tract range from 0 – 3.48/million

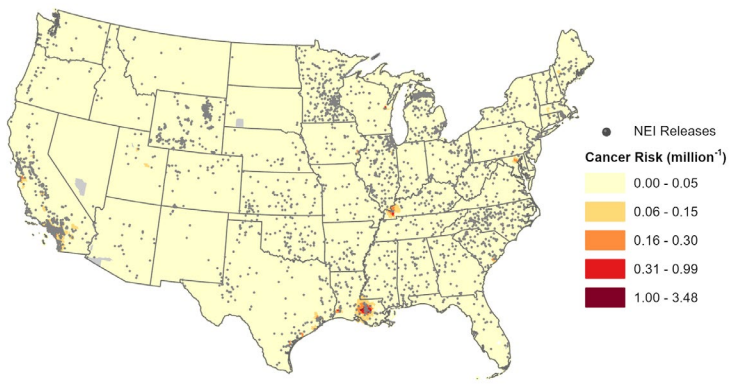


Figure 7-3. Estimated Cancer risk of Chemical B in AirToxScreen dataset.
Risks are shown per census tract. Scale 1:50,000,000. Data not shown for AK, HI, PR, and USVI.

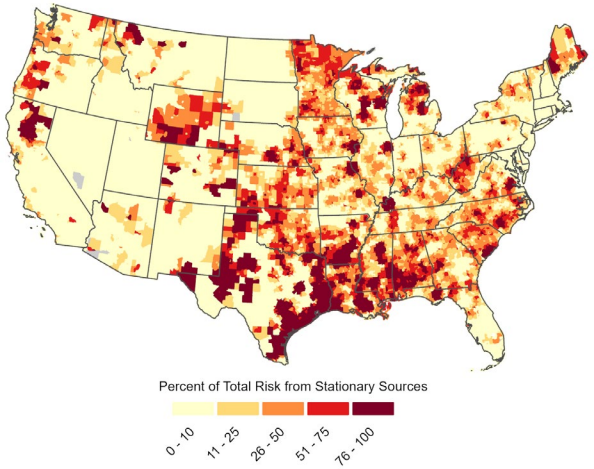
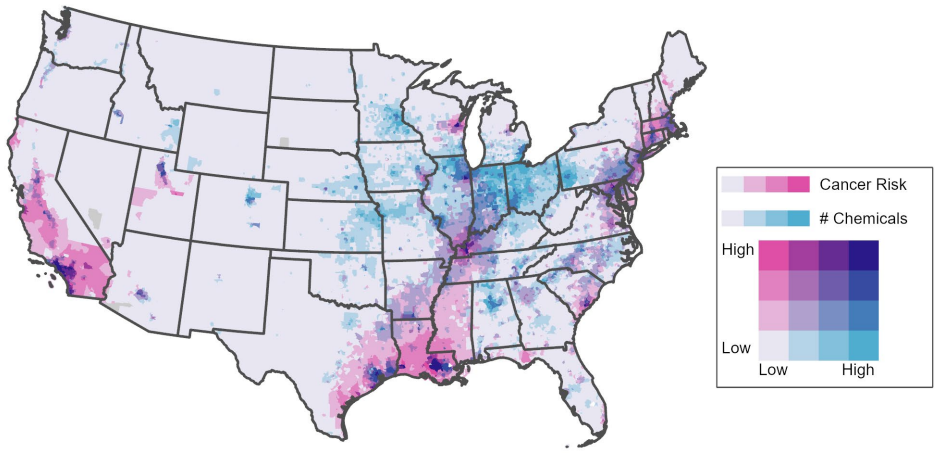


Figure 7-4. Percent of total cancer risk for Chemical B from stationary point sources.
Percent is shown by census tract. Scale 1:50,000,000. Data not shown for AK, HI, PR, and USVI.

Chemical B Bivariate Analysis

Table 7-2. Estimated risk of chemical B in census tracts within 5 km of a release with average and maximum number of co-occurring chemicals at the one in ten million and one in a million risk thresholds in those tracts.

Chemical Risk (million^{-1})	Tracts	Number of Modeled Chemicals			
		Avg>0.1/1M	Max	Avg >1/1M	Max
0 - 0.05	15,373	11.1	18	4.5	10
0.05 - 0.15	2,912	12.5	19	5.1	11
0.15 - 0.3	1,667	12.0	21	4.6	11
0.3 -1	276	12.5	21	4.7	8
>1	34	15.8	18	5.8	8
Grand Total	20,262	11.4	21	4.6	11



with number of other chemicals with estimated risks greater than 1 in 10 million within AirToxScreen (in blue).
Data are shown by census tract. Scale 1:50,000,000. Data not shown for AK, HI, PR, and USVI.

Major Messages

- Tabular information aids in identifying co-exposure across individual chemical risk spectrum
- Aids in identifying possible tipping points or risk from individual chemical alone
- Bivariate plot visually enables identification of areas with individual chemical risk + additional chemical burden

Summary and Potential Application

- AirToxScreen offers a readily available nationwide dataset of most HAP chemicals for screening level evaluation across of number of co-exposure metrics
- Able to identify areas of potential PESS at national to regional scales
- Geospatial tools allow for repeatable and adaptable approach moving forward
- Identifies areas of individual chemical risk
- Can be used to identify areas of increased burden from co-occurring chemicals.

Potential Future Direction

- Represents initial contribution with more formal framework or implementation plan needed
- Comparison to census block level 2020 ATS
- Census-based structure allows potential future incorporation of EJ metrics (e.g. EJScreen)
- Comparison to other exposure and risk models such as RSEI
- Developed metrics for other pathways or routes

Questions?

Thanks

Jason Todd
Contact me: todd.jason@epa.gov

Charge Questions

Charge Question 1

AirToxScreen is an EPA modeling tool that estimates ambient airborne chemical exposure and risk across the United States to the census tract level. Given the model's strengths, limitations, and assumptions, please comment on the appropriateness of using AirToxScreen for screening level chemical co-exposure in the context of TSCA chemical evaluation.

Charge Question 2

This draft document proposes multiple potential metrics to inform chemical co-exposure. These proposed metrics include:

- Number of chemical releasing facilities;
- Number of chemicals released from facilities;
- Number of chemicals meeting chemical risk benchmarks;
- Chemical risk combinations; and
- Bivariate distribution of individual chemical risk with potential chemical co-exposure

Please comment on the utility, strengths, and uncertainties of these metrics. Please include in your comments discussion of the methods used to develop these metrics.

Charge Question 3

The two stated goals for this paper are:

1) support identification of potential PESS; and
2) consider chemical co-exposure as part of an individual chemical risk evaluation.

Please comment on the extent to which the analyses and methodologies proposed within this document support these goals.