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Improvement of Locomotive and Rail Yard Activity Data Sources for the Emissions Inventory Development

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Texas A&M Transportation Institute

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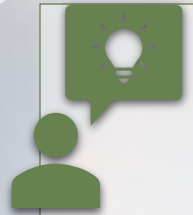
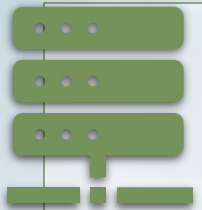
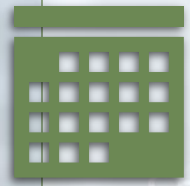
Background



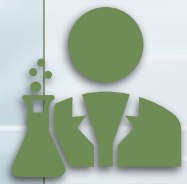
Periodic statewide locomotive and rail yard emissions inventory is required under the Air Emissions Reporting Requirements (AERR) to support the Environmental Protection Agency's (EPA's) comprehensive three-year cycle National Emissions Inventory (NEI).



Statewide locomotive and rail yard emissions inventory is also required to support state implementation plan (SIP) development and air quality planning



In 2021, the Texas A&M Transportation Institute (TTI) helped the Texas Commission on Environmental Quality (TCEQ) deliver the 2020 analysis year locomotive and rail yard nonroad mobile source emissions inventory (EI) data for the EPA's 2020 NEI.



– Applied the latest available data by then.

– Lack of response and activity data from Class I railroad activity.

– The yard location and fuel usage data could be improved.

Project Team

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Research Goals

Streamline and improve the **data source** for the development of locomotive and rail yard source EIs

Develop an **updated** Texas-specific fleet mix and an **improved** locomotive and rail yard source EIs

Locomotive Sector Emissions Source Classification Codes

SCC[1]	SCC Description (Levels 1 through 4)	Data Category
2285002006	Mobile Sources; Railroad Equipment; Diesel; Line-Haul Locomotives: Class I Operations	Nonpoint
2285002007	Mobile Sources; Railroad Equipment; Diesel; Line-Haul Locomotives: Class II / III Operations	Nonpoint
2285002008	Mobile Sources; Railroad Equipment; Diesel; Line-Haul Locomotives: Passenger Trains (Amtrak)	Nonpoint
2285002009	Mobile Sources; Railroad Equipment; Diesel; Line-Haul Locomotives: Commuter Lines	Nonpoint
2285002010	Mobile Sources; Railroad Equipment; Diesel; Yard Locomotives	Nonpoint
28500201	Internal Combustion Engines; Railroad Equipment; Diesel; Yard Locomotives	Point

Previous Studies on Activity Estimation – Line-Haul

Federal Railroad Administration (FRA) density data is the best choice for Class I line-haul activity estimation and distribution if available. However, it may not provide accurate estimates for Class II and III line-haul activity estimation and distribution.

Surface Transportation Board (STB) R-1 Report is the reliable source to acquire statewide fuel consumption for Class I Operator.

Direct usage data from Class II and III operators will be desirable. Fuel consumption from the North American Rail Lines (NARL) could be the alternative if no direct data from Class II and III operators.

Previous Studies on Activity Estimation – Yards and Fleet Mix

ERTAC's collection of switchers developed through Google earth provides a surrogate way to estimate yard activity and very coarse estimates.

ERTAC collected the activity by model year or fleet mix data for different types of operators for 2016 while EPA's emission factors by carrier type and year have the fleet mix information built-in from 2009 study.

Other Texas-Specific Data Sources Reviewed

- Statewide Analysis Model (SAM)
- TxDOT 2019 Texas Rail Plan
- BTS: Freight Analysis Framework 4 (FAF 4)
- Transportation Routing Analysis Geographic System (TRAGIS)
- American Short Line and Regional Railroad Association (ASLRRA).
- Denton County Transportation Authority (DCTA) and Trinity Railway Express (TRE)
- Amtrak data from the Bureau of Transportation Statistics (BTS).

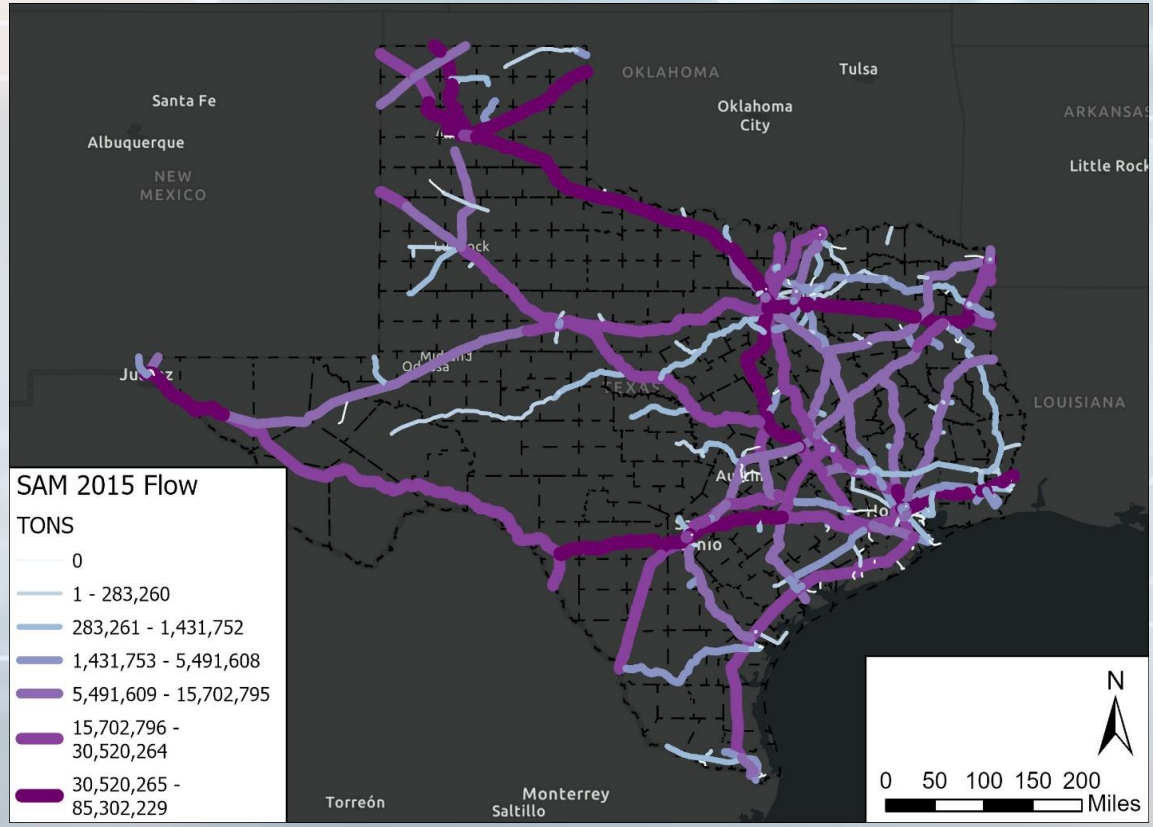
Activity Estimation Data Source Summary

Data Element	Source – 2020 Texas Locomotive and Rail Yard AERR EI	Source – Current Study
Line-Haul Statewide Fuel Usage	Collected based on the STB's R-1 report and the Bureau of Transportation Statistics (USDOT BTS, 2019) freight flow by state, Amtrak reports, and ten Class III operators, TRE, and DCTA.	no change
Yard Statewide Fuel Usage	Obtained from STB R-1 report for Class I operators. Estimates are based on a fuel usage rate and operator's yard miles for non-Class I operators.	**Updates with the yard location inventory**
Line-Haul and Yard Fleet Mix	Uses EPA's default fleet mix from EPA's "Emission Factor for Locomotive" technical highlights. (EPA, 2009)	**Uses the national value from ERTAC's 2017 NEI**

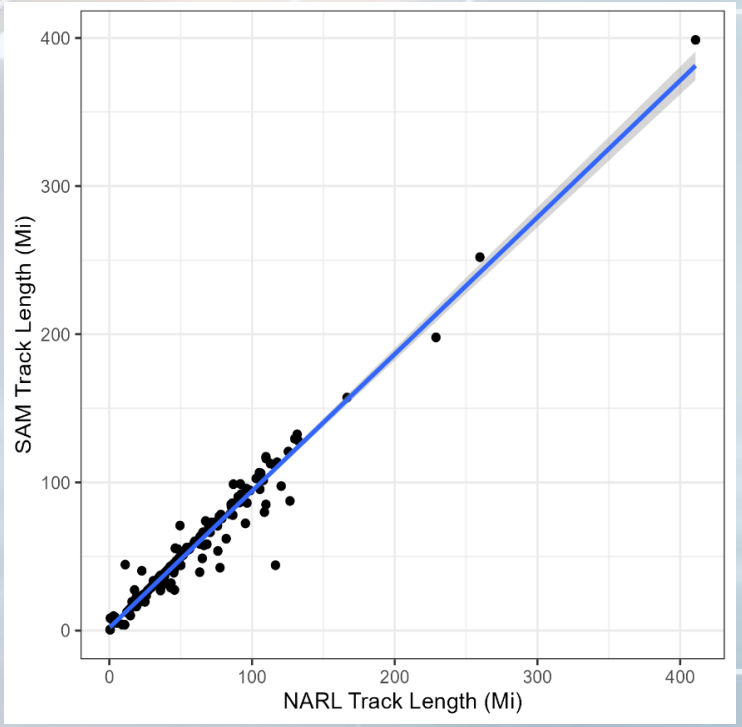
Activity Estimation Data Source Summary

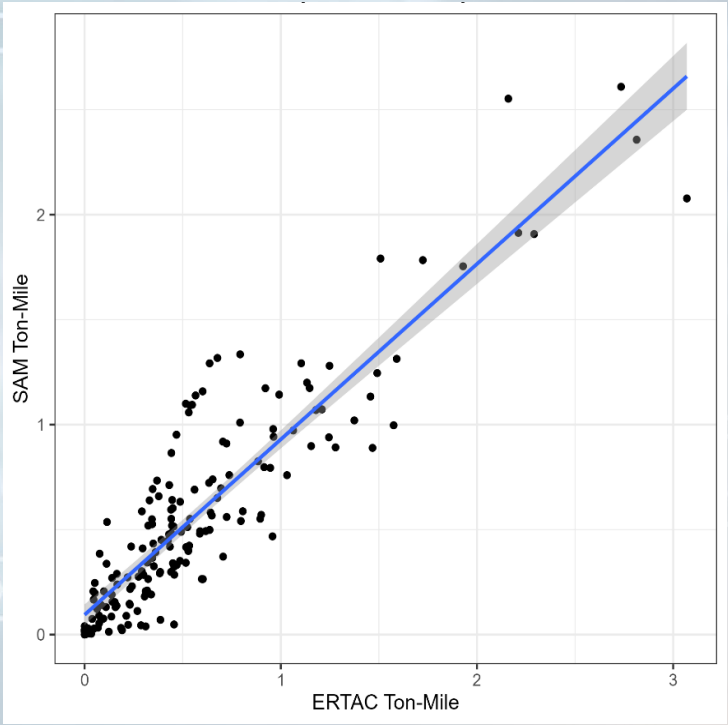
Data Element	Source – 2020 Texas Locomotive and Rail Yard AERR EI	Source – Current Study
Class I Line-Haul Activity Distribution by Counties	Based on EPA's 2017 locomotive NEI which uses densities[4] from FRA.	**SAM or TRAGIS assignment.**
Non-Class I Line-Haul Activity Distribution by Counties	Based on track miles.	no change
Yard Location Inventory	Based on EPA's 2017 locomotive NEI prepared by ERTAC.	**Manually reviewing previous studies, 2017 NEI, and the NARL shapefiles.**
Yard Activity Distribution	Based on EPA's 2017 locomotive NEI prepared by ERTAC.	**Based on yard miles by operators extracted from NARL.**

Class I Line-Haul Activity Estimation – SAM 2015



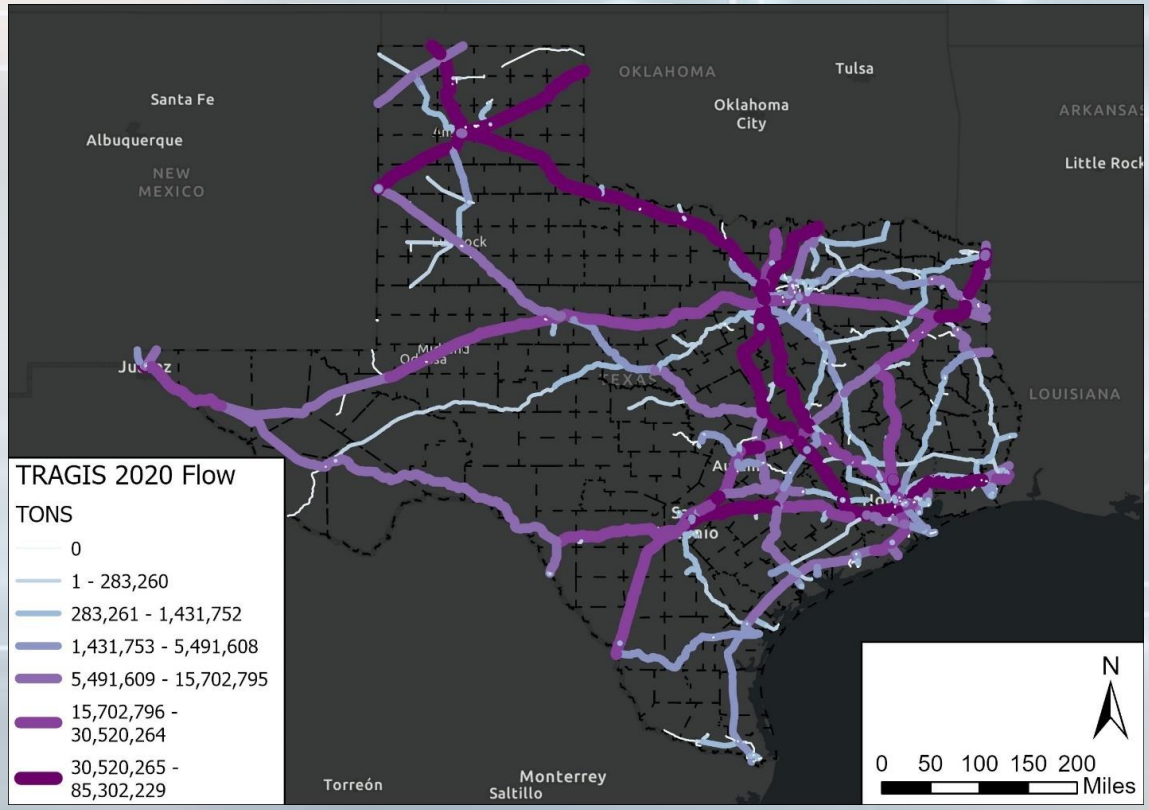
Class I Line-Haul Activity Estimation – SAM vs. NARL/ERTAC



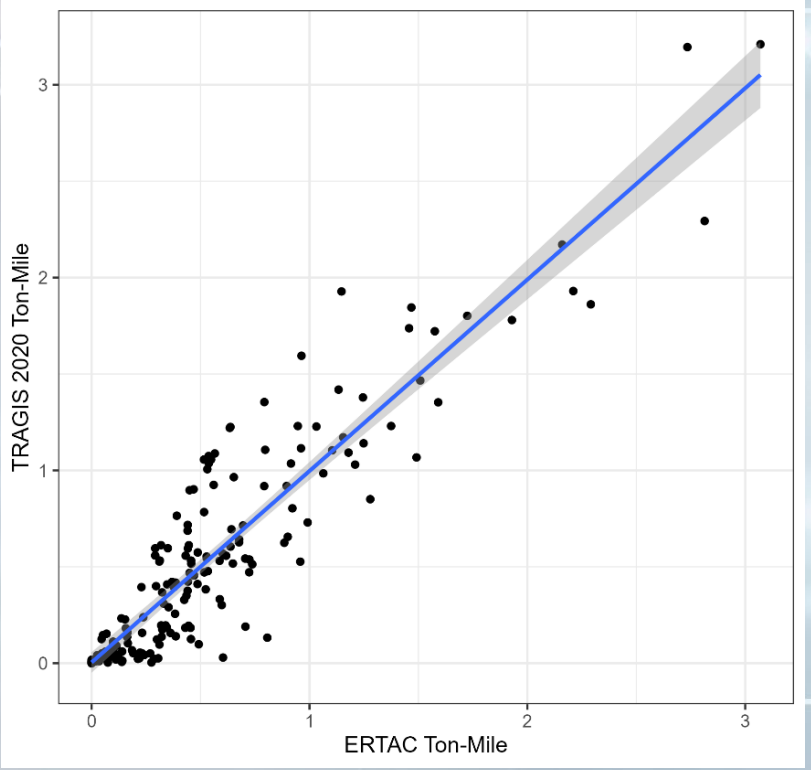


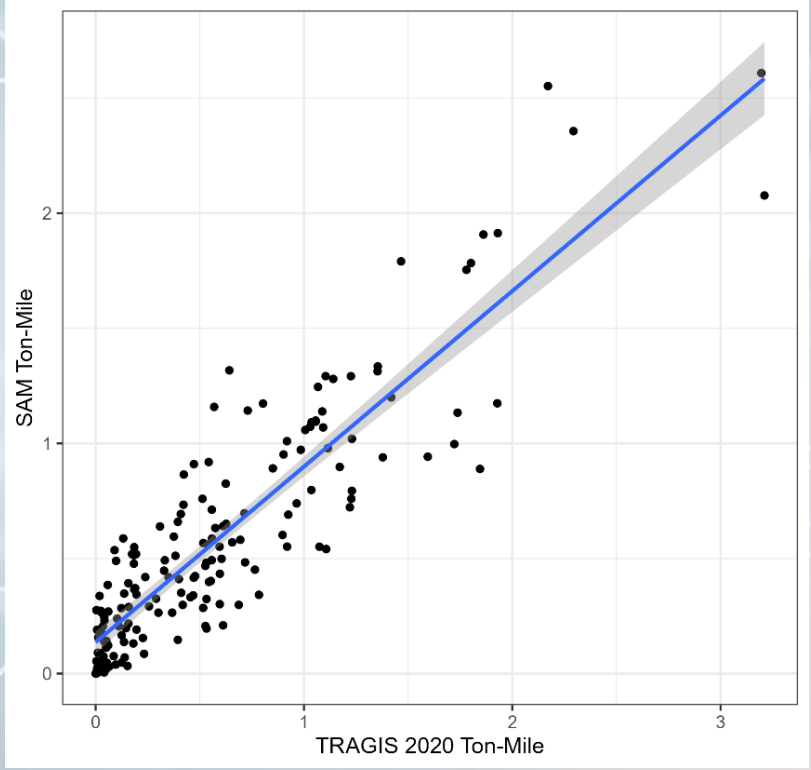
Correlation is 0.8965472 with a 95th percentile two-sided confidence interval of (0.8627531, 0.9223669)

Class I Line-Haul Activity Estimation – TRAGIS 2020



Class I Line-Haul Activity Estimation – TRAGIS vs. ERTAC and SAM





Correlation is 0.912254 with a 95th percentile two-sided confidence interval of 0.8833717 and 0.9342335

Class I Line-Haul Activity Estimation – Summaries

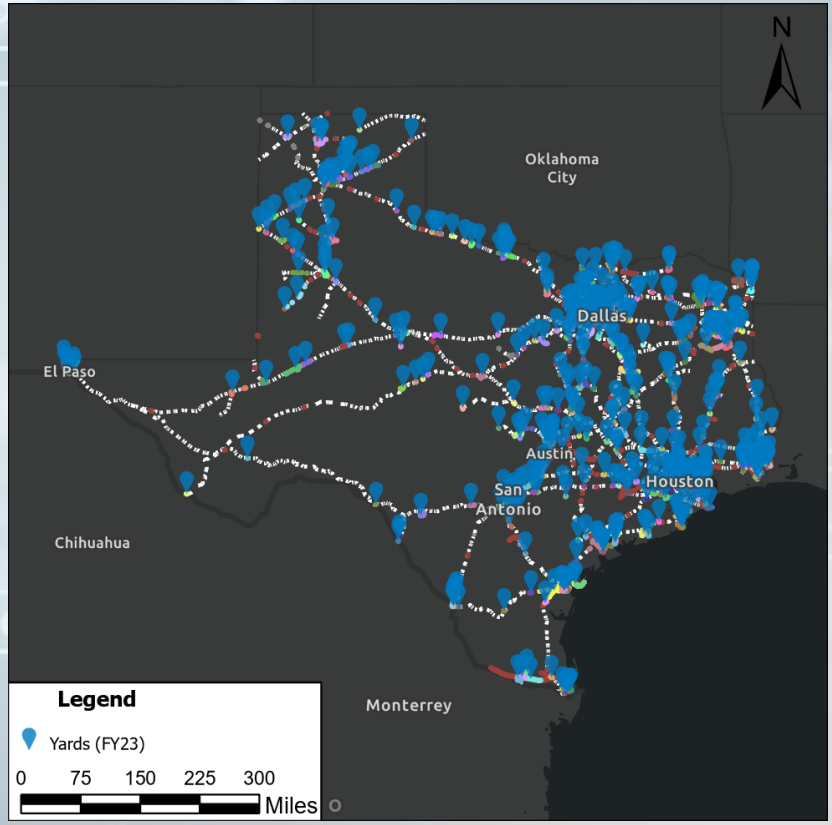
Summaries

- Both 2015 SAM and 2020 TRAGIS data were highly correlated with the NARL, 2017 ERTAC NEI data.
- Both are good candidates to replace the existing 2017 ERTAC data
- 2020 TRAGIS data were applied in this study for emission impact study.

Yard Activity Estimation – Locations

Summaries

- 541 yards were identified in this study.
- 324 of these 541 yards are the same as the 366 yards identified in ERTAC's 2017 locomotive NEI. Forty-two (42) yards included in the ERTAC study either did not have corresponding tracks on the NARL shapefile or had a duplicate yard nearby.
- TTI also identified 217 additional yards based on the satellite view of the area near the NARL yard and minor industrial lead lines need to be added to the EPA's EIS and assigned corresponding unique emission unit identifiers and unit emission process identifiers for these yards in the future NEI.



Emission Inventory Sensitivity Analysis - Scenarios

Scenario	Class I Line-Haul Activity	Yard Activity	Class III Activity	Fleet Mix
Base Scenario	ERTAC's 2017 study/ NEI 2017	ERTAC 2017.	Activity distribution based on carrier miles.	EPA defaults.
Scenario 1	Same as the base case.	Same as the base case.	Same as the base case.	**ERTAC 2017**
Scenario 2	**TRAGIS 2020**	**NARL yard track mileage for the distribution of yard fuel.**	**Updated Line miles due to changes in numbers of yards**	Same as the base case
Scenario 3	**TRAGIS 2020**	**NARL yard track mileage for the distribution of yard fuel.**	**Updated Line miles due to changes in numbers of yards**	**ERTAC 2017**

Emission Inventory Sensitivity Analysis – Statewide Observations

Statewide Annual CAP Emissions (Short Tons) across Scenarios.

Pollutant	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 1 (% Diff)	Scenario 2 (% Diff)	Scenario 3 (% Diff)
CO	8285.49	8285.49	8316.75	8316.75	0.00	0.38	0.38
NH_3	25.82	25.82	25.91	25.91	0.00	0.35	0.35
NO_X	32093.69	41942.31	32239.12	42082.07	30.69	0.45	31.12
PM_{10}-PRI	767.95	1265.25	771.11	1268.88	64.76	0.41	65.23
$PM_{2.5}$-PRI	744.92	1227.30	747.97	1230.81	64.76	0.41	65.23
SO2	29.01	29.01	29.11	29.11	0.00	0.34	0.34
VOC	1370.46	2077.72	1380.24	2090.61	51.61	0.71	52.55

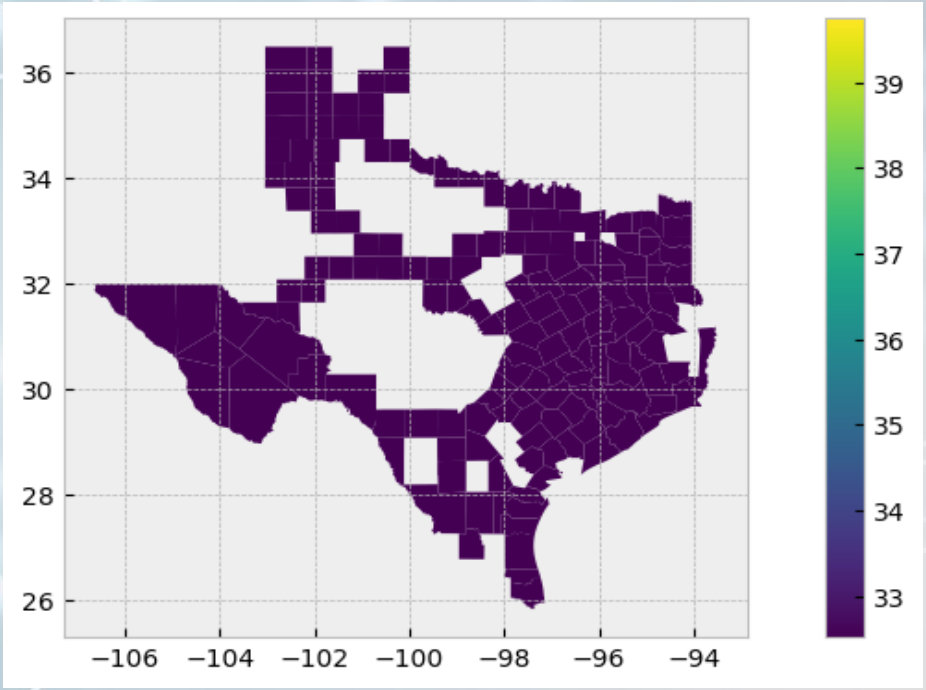
Emission Inventory Sensitivity Analysis – County Observations

Observations:

- NO_x emissions are uniformly increased in all the county emissions

Plausible reason(s):

- The differences are coming from the national fleet mix in EPA emission rates and the ERTAC fleet mix.
- NO_x emission rates are depending on the fleet.



Scenario 1 vs. Base Scenario Percentage Difference in Countywide NO_X Emissions by Class I Activities

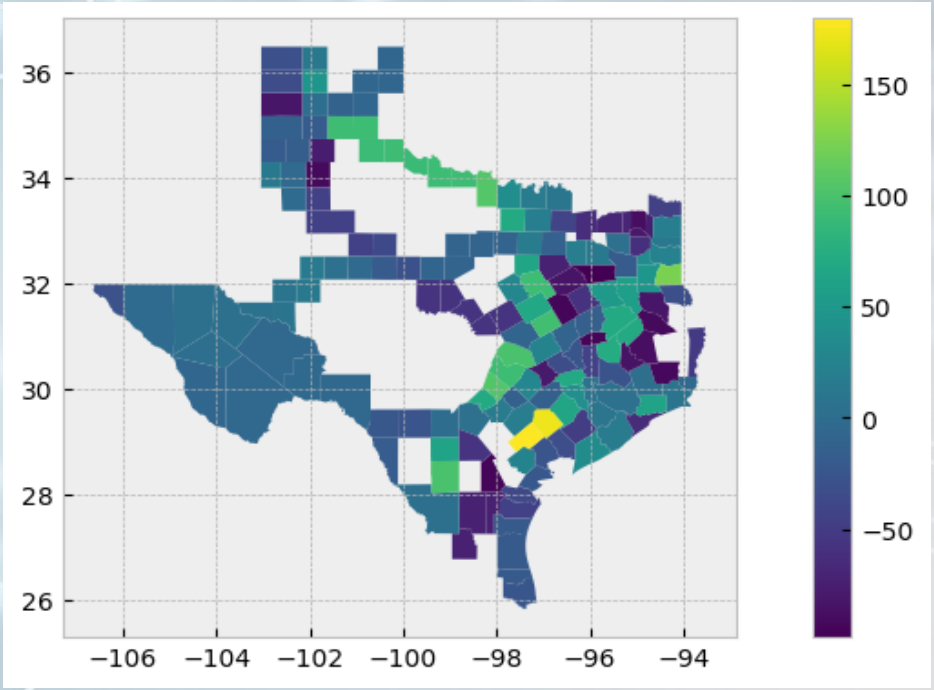
Emission Inventory Sensitivity Analysis – County Observations

Observations:

- Significant changes in the Class I emissions for individual counties even though statewide emissions changes were minimal.

Plausible reason(s):

- Significant activity and activity distribution changes in TRAGIS data at county level.



Scenario 2 vs. Base Scenario Percentage Difference in Countywide NO_X Emissions by Class I Activities

Emission Inventory Sensitivity Analysis – Non-attainment Area Observations

Ozone Non-Attainment Area Annual NO_x Emissions Quantity (Short-Ton) for Different Scenarios and Percent Change Relative to Base Case

COG	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 1 (% Diff)	Scenario 2 (% Diff)	Scenario 3 (% Diff)
San Antonio	577.37	748.05	616.36	793.47	29.56	6.75	37.43
Houston-Galveston-Brazoria	3606.67	4321.98	2941.45	3687.48	19.83	-18.44	2.24
Dallas-Forth Worth	3061.44	3991.08	3398.52	4443.52	30.37	11.01	45.14
El Paso	574.18	726.08	425.53	536.22	26.45	-25.89	-6.61

Emission Inventory Sensitivity Analysis – Non-attainment Area Observations

El Paso Non-Attainment Area Annual PM_{10} Emissions Quantity (Short-Ton) for Different Scenarios and Percent Change relative to Base Case.

SCC	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 1 (% Diff)	Scenario 2 (% Diff)	Scenario 3 (% Diff)
Amtrak	0.21	0.63	0.21	0.63	208.06	0.05	208.22
Class I	9.66	16.57	6.91	11.86	71.49	-28.43	22.73
Class II/III	0.13	0.15	0.05	0.05	19.14	-64.99	-58.28
Yard	3.15	3.59	2.56	2.92	13.85	-18.64	-7.37
Total	**13.14**	**20.94**	**9.73**	**15.46**	**59.31**	**-26.00**	**17.63**

Summary of Findings

- Updated the railyards based on NARL and previous EIs by ERTAC and ERG.
- Updated the Class I activity distribution across Texas counties.
- Updated the fleet mix with the most recent available data.
- Conducted a sensitivity analysis to understand how emissions would be impacted due to the above changes, in isolation and combined.

Next Steps

- Compare with 2020 NEI to identify improvements or discrepancies.
- Coordinate with the EPA through TCEQ about adding 217 additional yards identified in this study to have EIS IDs for subsequent Texas-specific NEI submittal.

- Obtain the Texas-specific fleet mix.
- Update the Class III fuel usage.
- Conduct an in-depth study of railyards in Texas.

Questions?

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