

Building National High Resolution Rail Inventories Through Regional Collaboration

Mark Janssen – Lake Michigan Air Directors

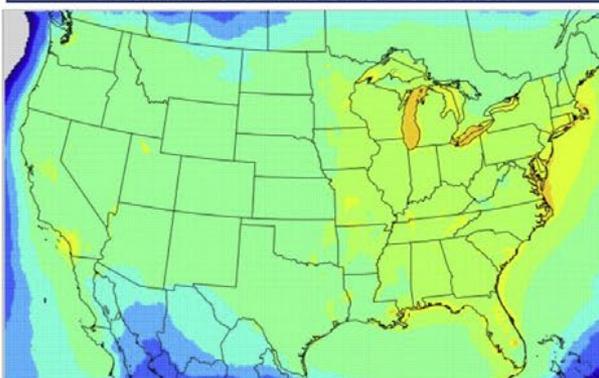
Matthew Harrell – Illinois EPA

Emissions Inventory Conference

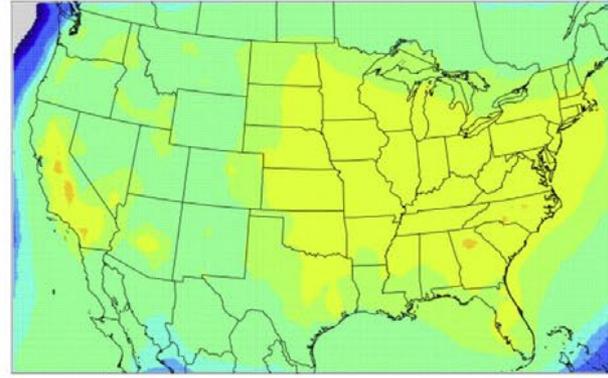
Dallas, Texas

July 29 – Aug 2, 2019

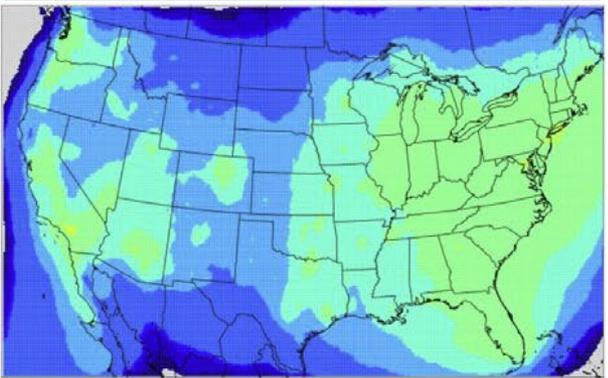
Nonroad Recreational



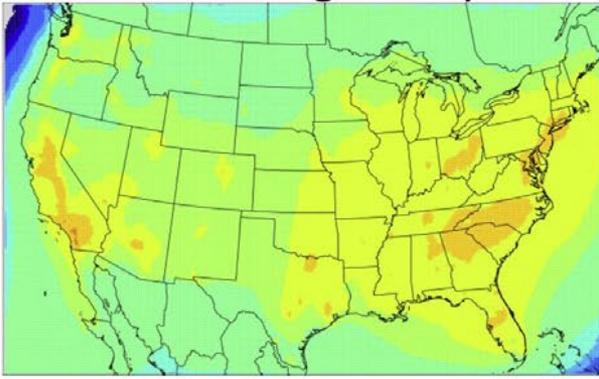
Nonroad Diesel



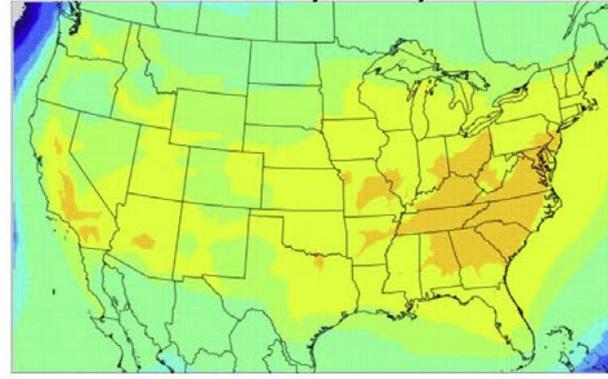
Lawn & Garden Commercial



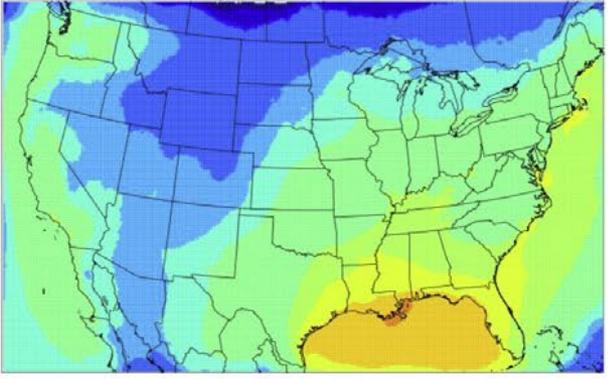
Onroad Light-Duty



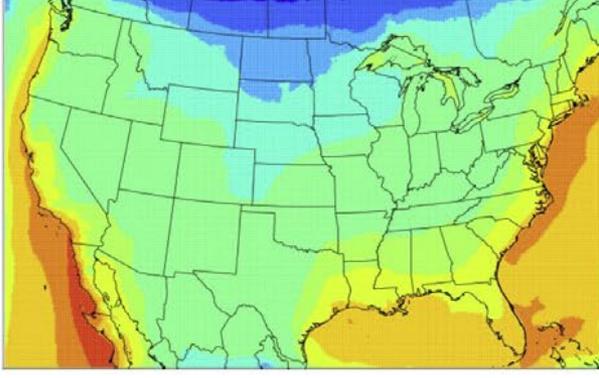
Onroad Heavy-Duty Diesel



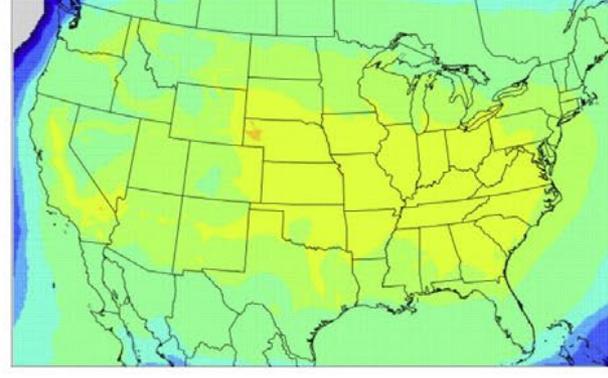
C1/C2 Marine



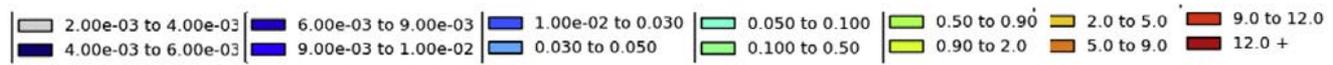
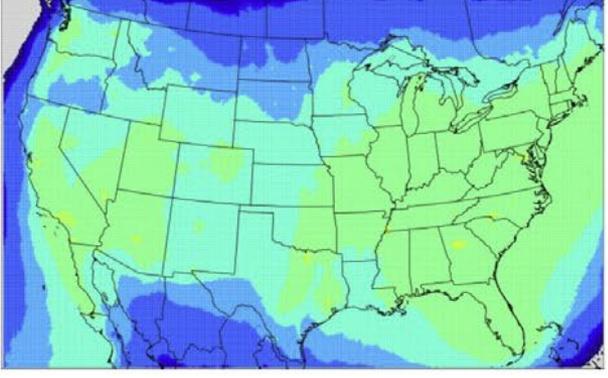
C3 Marine



Rail



Aircraft Landing & Take-off



History



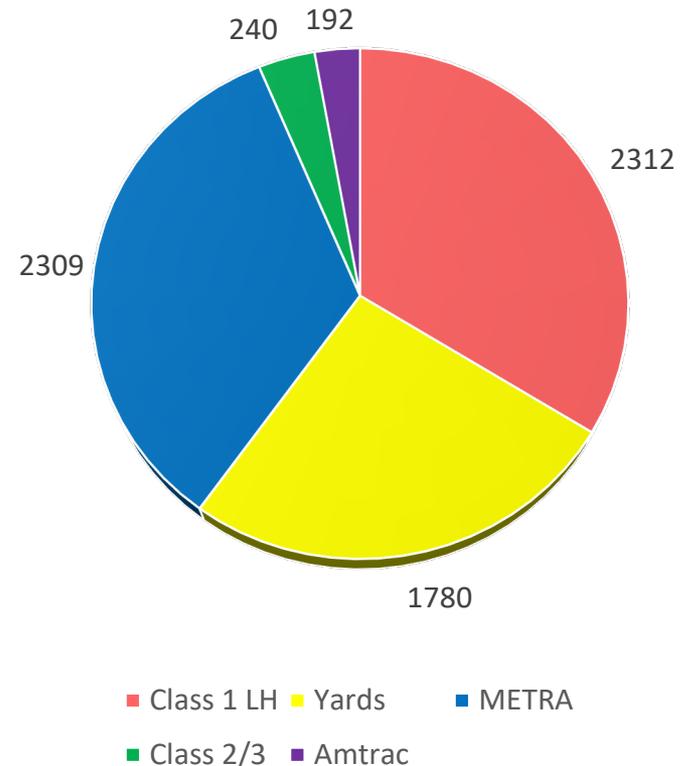
- ERTAC rail has been building rail inventories for the NEI since 2008.
- We have had steady improvement on methods and transparency since the first versions.
- Regulations promulgated in June 2008 resulted in 90% reduction in emissions for new engines.
 - It has been difficult to reproduce the calculations used in the 2008 rule.
- 2016 Emissions Inventory Collaborative formed in early 2018 to build inventories for next round of SIPS and 2017 NEI.
- Structure for Guidance, Notes, and WIKI to hold it all together.
 - <http://views.cira.colostate.edu/wiki/wiki/9169>

Parts of the Rail Inventory



- Class 1 Line Haul, 6 largest railroads in country. Each dominates a region of the country.
 - ~85% of national emissions.
 - Link level nationally
- Yards, Mostly class 1 yards.
 - 60K gallons/engine, 3x one diesel truck
 - Each yard is a point in the NEI
- Class 2/3 railroads
 - Smaller railroads but can be significant locally
 - Includes commuter railroads
- Amtrak – National passenger railroad

Cook County IL,
NOX Tons/Year



Class 1 Line Haul



- ERTAC requests all class 1 railroads approve release of Federal Railroad Administration(FRA) proprietary link level database of traffic.
- Each link has owner and active railroads identified with Millions Gross Ton (MGT).
- Illinois EPA cleans up database when links are missing or non-continuous.
- We take R1 reported fuel use by company and develop Gallons/MGT mile for each railroad. This fuel consumption index value is then applied to all links.
- Once we have link level fuel use by company we apply company emission rates or default fleet wide emission rates based on technology tier.

Table 4. 2016 Line-haul Locomotive Emission Factors by Tier, AAR Fleet Mix (grams/gal)⁴

Emission Rates by Tier

Units: grams/gallon

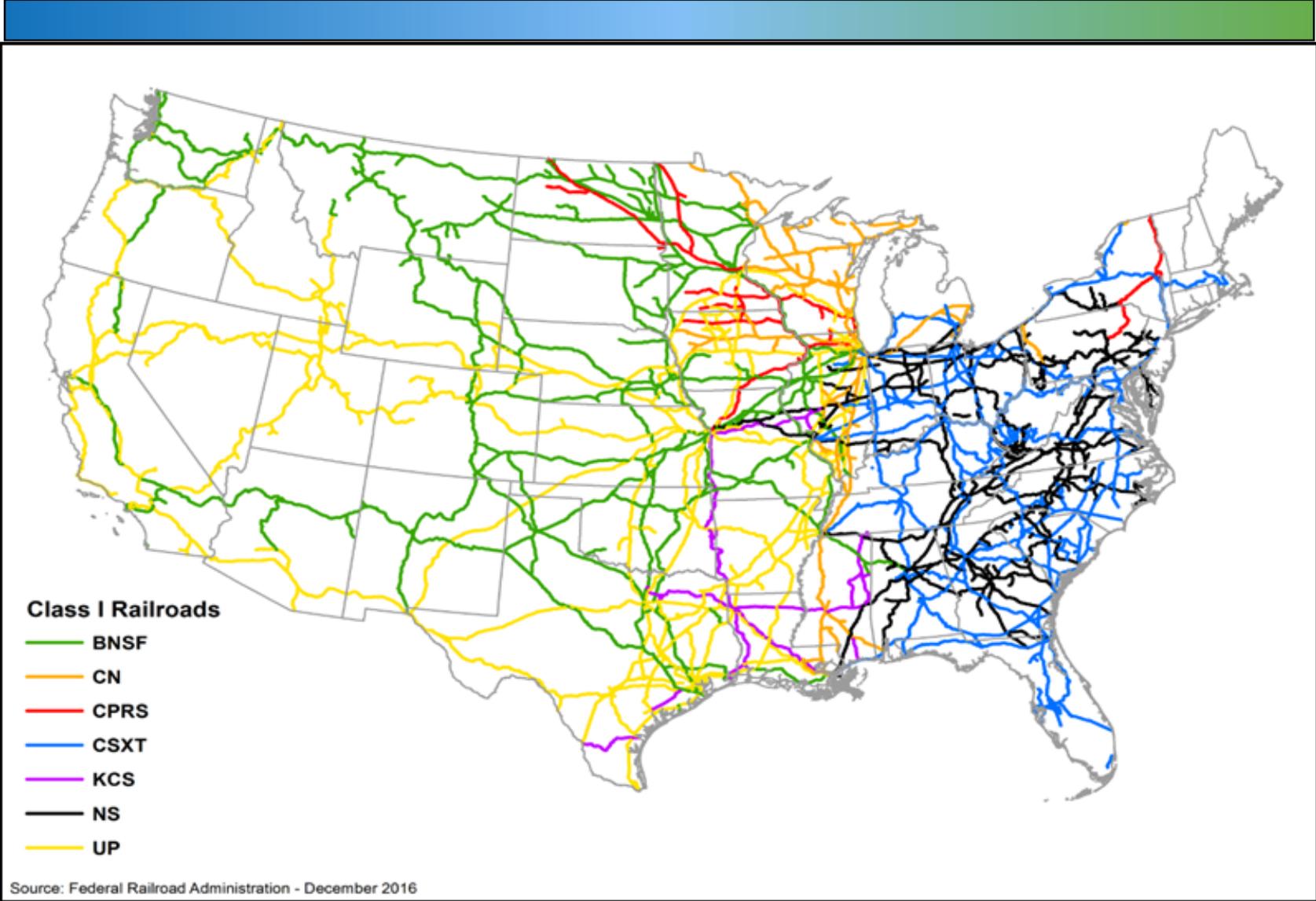


Tier Level	AAR Fleet Mix Ratio	PM ₁₀	HC	NO _x	CO
Uncontrolled (pre-1973)	0.047494	6.656	9.984	270.4	26.624
Tier 0 (1973-2001)	0.188077	6.656	9.984	178.88	26.624
Tier 0+ (Tier 0 rebuilds)	0.141662	4.16	6.24	149.76	26.624
Tier 1 (2002-2004)	0.029376	6.656	9.776	139.36	26.624
Tier 1+ (Tier 1 rebuilds)	0.223147	4.16	6.032	139.36	26.624
Tier 2 (2005-2011)	0.124536	3.744	5.408	102.96	26.624
Tier 2+ (Tier 2 rebuilds)	0.093607	1.664	2.704	102.96	26.624
Tier 3 (2012-2014)	0.123113	1.664	2.704	102.96	26.624
Tier 4 (2015 and later)	0.028988	0.312	0.832	20.8	26.624
2016 Weighted EF's	1.000000	4.117	6.153	138.631	26.624

Class 1 Railroad Links



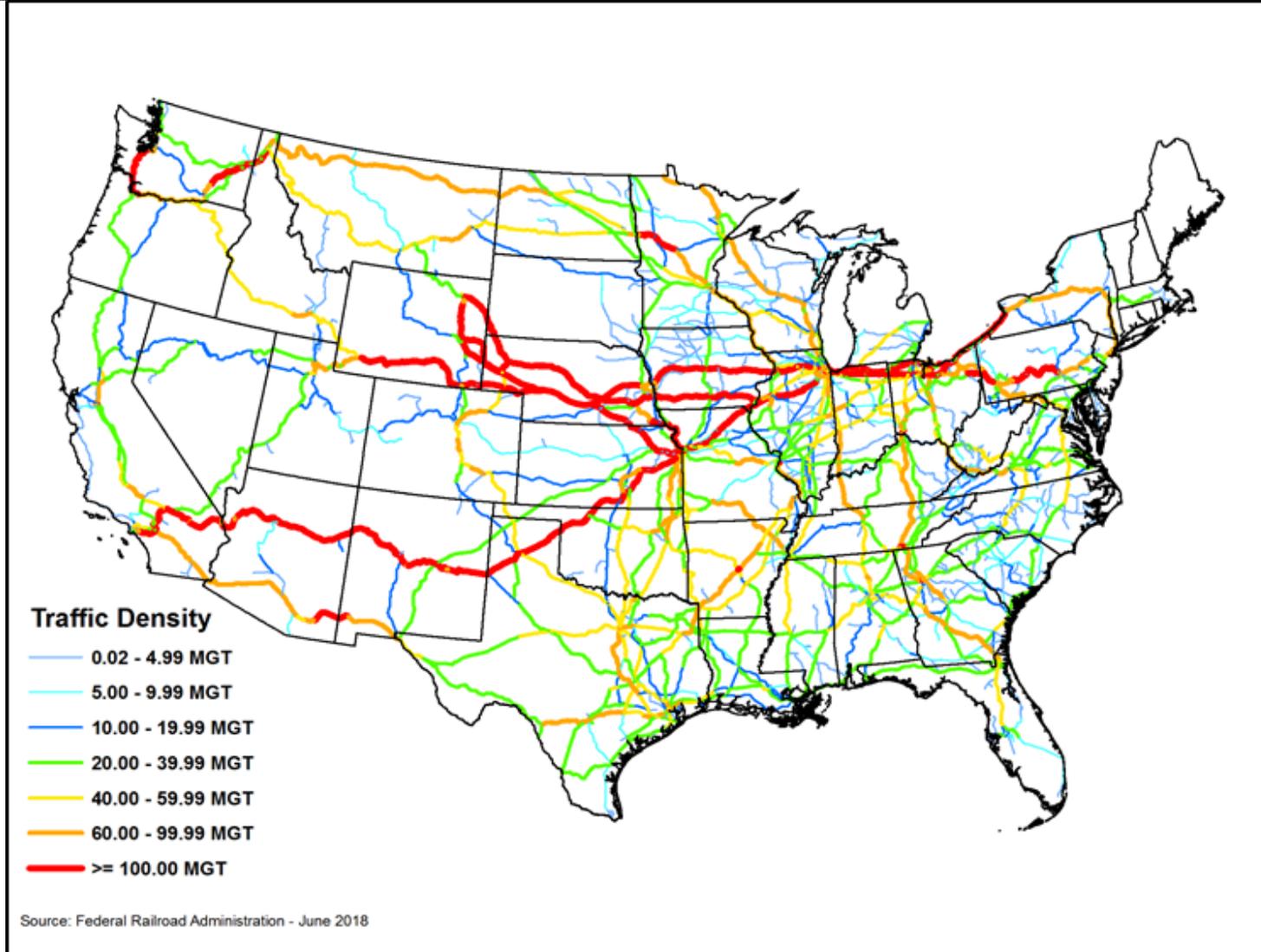
LADCO



FRA Traffic Density Database



LADCO



Switching Engines



- Each yard is identified as a point. Exist in NEI/EIS with unique EIS ID.
- Can have multiple companies at a given yard. Each company is its own “Device”
- 3 Companies(UP,BNSF,KCS) gave us yard level switching engine counts.
- For remaining companies we used 2011 switcher counts unless a state agency developed yard specific activity.
- For larger yards and yards in states that could do the work we used Google Earth to identify yard locomotives
- Matt Harrell(IL) and Dennis Mcgeen(MI) develop guidance document on how to identify engines.

Identifying Engines and Slugs



- Use google earth to identify individual engines and count all engines at a yard.
- This is imprecise because sometimes there are inactive engines or engines that have left the yard at the time of the photo.
- Slug is a locomotive engine without a diesel engine.
- It gets its power from a companion engine.
- In this inventory we count Slugs as $\frac{1}{2}$ of a full engine



Sean Gulden. Digital image. CSXT EMD GP40-2 6406 & EMD Road Slug 2200. Railroad Picture Archives.NET. May 16, 2012.
<<http://www.rrpicturearchives.net/showPicture.aspx?id=3165959>>



Yard Emissions Calculations



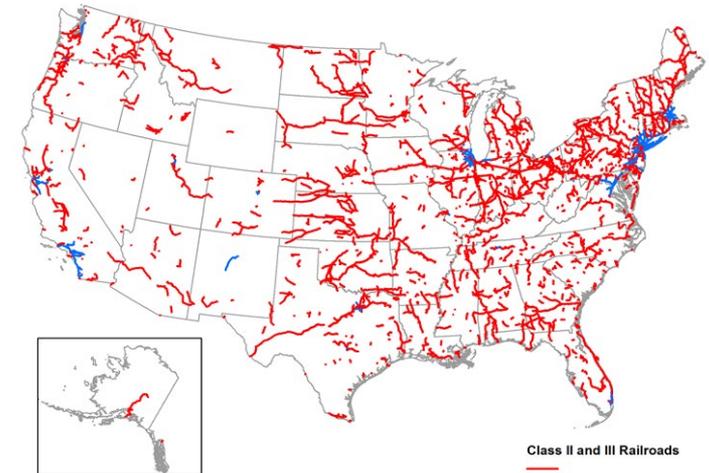
- Once we have yard counts we divide total company R1 fuel use by number of identified engines to create a company specific yard engine fuel consumption value and apply that to all yards in the system.
- If states/companies can supply yard specific fuel use then that will be used. This happened for a number of Non-Class 1 railroads
- Use company specific emission rate if available otherwise Class 1 specific value is used.

Yard Name	Supplied Activity	Supplied Fuel use	Final 2016 Fuel Use	2016 Nox Tons/Year	2016 PM10 Tons/Year	2016 PM2.5 Tons/Year	
ARGENTINE YARD		31.0	2857352.572	2857353	561.02	14.7	14.26
BAILEY		28.0	1851942.644	1851943	363.62	9.53	9.243
DERAMUS		27.0	492679.125	492679	96.734	2.54	2.459
NORTHTOWN		23.0	2119971.263	2119971	416.24	10.9	10.58
GATEWAY		20.0	1322816.174	1322816	259.73	6.81	6.602
ENGLEWOOD		20.0	1322816.174	1322816	259.73	6.81	6.602
SOUTH ST PAUL		19.0	1256675.365	1256675	246.74	6.47	6.272
GALESBURG		18.0	1659107.945	1659108	325.75	8.54	8.281
OSBORN		18.0	1703030.212	1703030	334.38	8.76	8.5

Class 2/3 Line Haul



- Class 2/3 are smaller railroads.
- Collect company specific fuel use or assume an average track mile fuel use based on AASLRR(Short Line Association) 2011 fuel consumption value of 148 Millions gallons
- There is a lot of variation. Some companies with relatively little track can have big fuel use(Belt Railway of Chicago). There are also lots of defunct or little used “recreational” railroads with little fuel use. Local data can help.
- Once we have fuel use/track mile we calculate emission at the county level.
- Commuter rail is calculated the same way. activity data(fleet mix and fuel use) was collected for all large diesel commuter lines.



Class II and III Railroads

Commuter Railroads

- Calculated in nearly the same way as class 2/3 except that we can have state specific emission rates and allow states to give us data.
- Only about 60 Million gallons/year.
- Do not have route schedules so all links have even distribution of fuel use by link.

Final Results for 2016



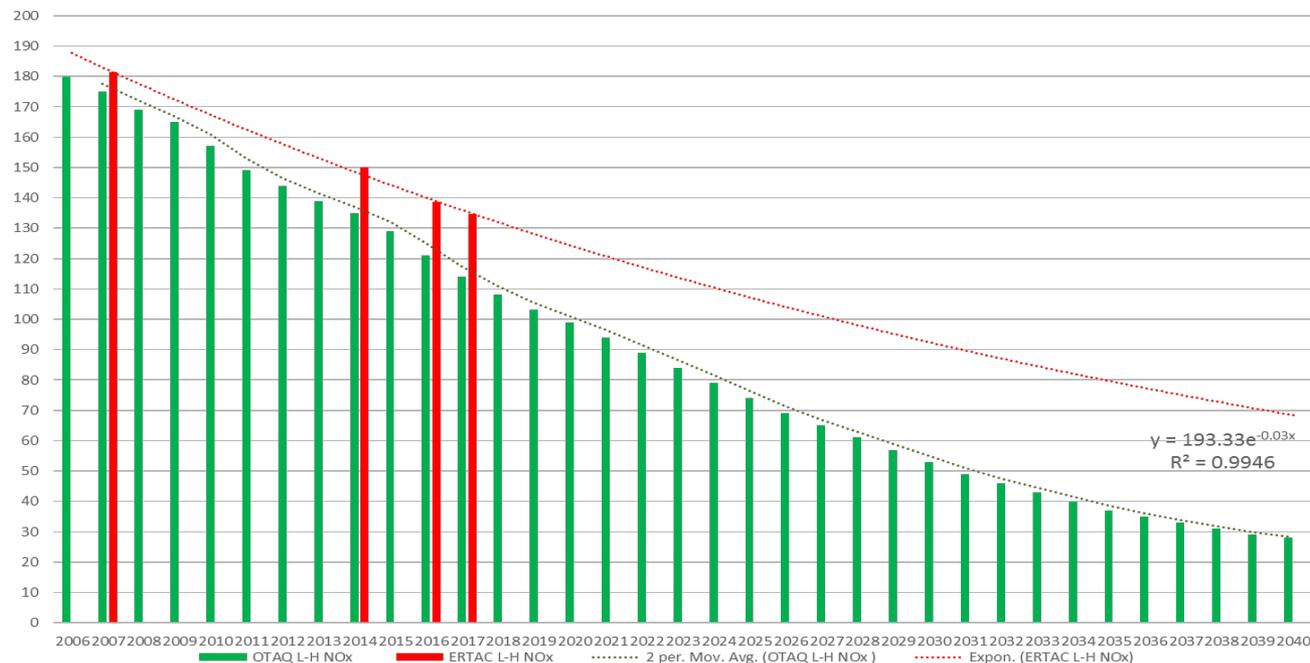
Rail Sector	Fuel Use (gal/year)	Emissions (tons/year)						
		NO _x	PM _{2.5}	HC	SO ₂	CO	NH ₃	VOC
Class I Line-Haul	3,203,595,133	489,562	14,102	21,727	332	94,020	294	22,879
Class I Yard Switching	205,024,565	40,255	1,023	2,504	21.2	6,286	18.8	2,636
Class II and III Railroads	144,858,501	34,503	977	1,511	15.0	4,251	13.3	1,511
Commuter Railroads	96,395,816	21,427	626	967	10.0	2,829	8.9	967
Amtrak	60,545,490	12,226	419	648	6.3	1,777	5.6	648

Created projection Inventories

2020, 2023, 2028



- Used AEO growth rates which were very flat. 4.7% net growth 2016-2028.
- Developed projected emission rate based on extrapolation of past emission rates. This follows anecdotal evidence that companies are not buying tier 4 engines as fast as expected in 2008 rule.



How States Contributed



- Illinois(Matt Harrell) and Michigan(Dennis Mcgeen) did significant work to develop inventory and used google earth to identify many yards.
- No EPA funds. States/LADCO did 99% of the work to develop the inventory.
- You can improve state input by making calculations/data/methods as transparent as possible. All non-line haul calculations and data are public.
- Handful of states worked with group to identify yard locomotives in their states with Google earth.
- Some states provided Class 2/3 fuel use including commuter line fuel use.

Where we go from here.



- Finalizing version 1 inventory and final NEI 2017.
- Supporting any modeling needs states have.
- Supplying inventory data to local entities. Can supply link level activity data when we get approval from Class 1 Railroads.
- Short list of improvements for next NEI cycle.