Projecting Emissions Inventories for Air Quality Modeling of Future Years

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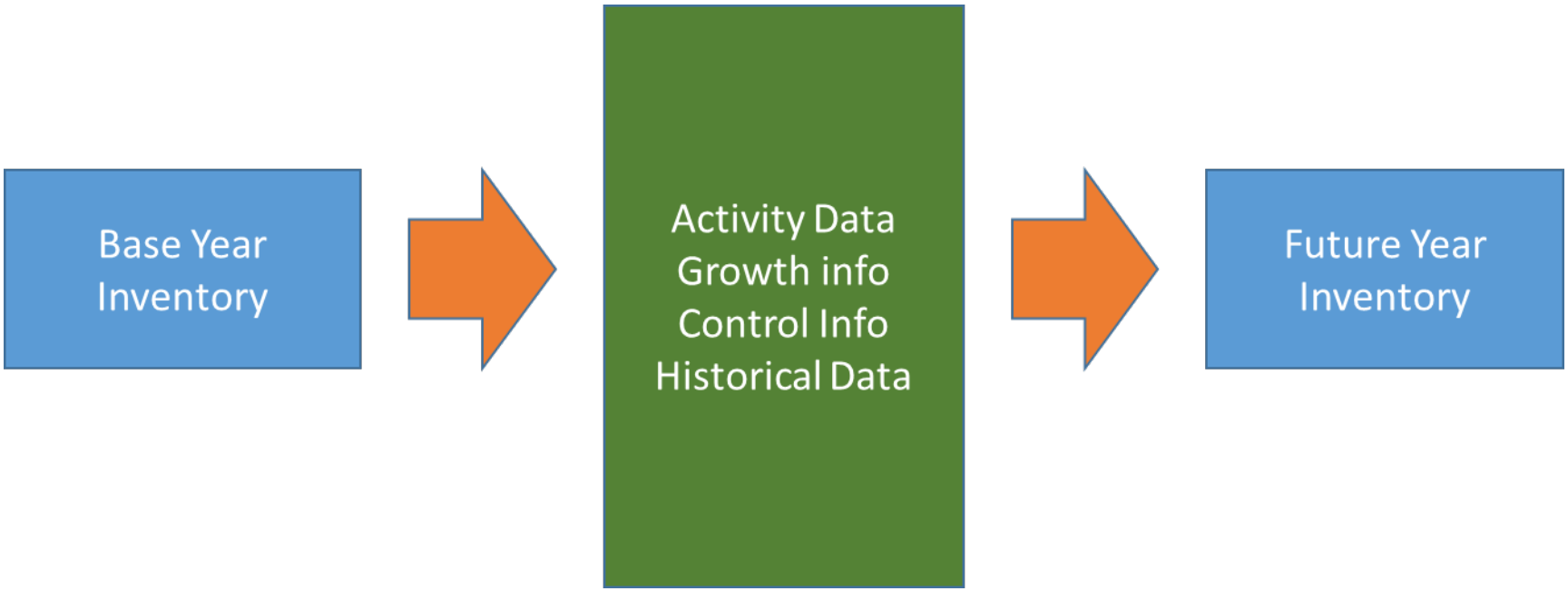
Future Year Projections Course Outline and Schedule

- 1:25 Introduction to projections
- 1:40 Control Strategy Tool overview
- 2:00 Nonpoint projections
- 2:20 EGU projections
- 2:35 Break
- 2:45 Oil and gas projections
- 3:05 Airports, Non-EGU point
- 3:20 Onroad and Nonroad projections
- 3:45 Commercial marine vessel and rail
- 4:00 Wrap up and final questions

Future Year Projections

- Overview
  - Projections require inventories and ancillary data
  - Strive for consistency in methods when there are multiple future years
- Estimate changes between base and future years
  - Activity changes
  - Rules / technology changes in intervening years
  - Facility and unit closures
  - Interpolation / extrapolation often difficult
- Projection techniques
  - Apply factors and/or percent reductions that account for activity change and controls to a set of sources
  - Add or replace a sector inventory or portion thereof
  - Use a model to compute the future year inventory

Future Year Projections Overview



Once created, the future year inventory is then processed by SMOKE in a similar way as if it were a base year inventory

Why Develop Projected Emission Inventories?

- Near-term projections to historic years
  - The full NEI is developed every three years (2011, 2014, 2017, 2020 …) but we often need to do air quality modeling for years other than NEI years (e.g., 2016)
  - For years in the past, existing data can help inform the projection
- Longer-term future projections (e.g., 2023, 2028, 2035)
  - We need to evaluate policy options and impacts of changing emissions and use the results in a relative sense
  - EPA develops Regulatory Impact Analyses (RIAs) for regulations
    - Describe the potential social benefits and social costs
  - Interstate transport: The Clean Air Act's "good neighbor" provision requires EPA and states to address interstate transport of air pollution that affects downwind states' ability to attain and maintain National Ambient Air Quality Standards (NAAQS)
  - Other types of analyses: regional haze, etc.

Developing Projections (1/2)

- Future year emission inventories are developed starting with the **base-year inventory and modeling platform**
  - Techniques vary by sector
- For non-historic year projections, meteorology is kept the same as base year, so base year-specific fires and biogenic emissions are used in the future years

Developing Projections (2/2)

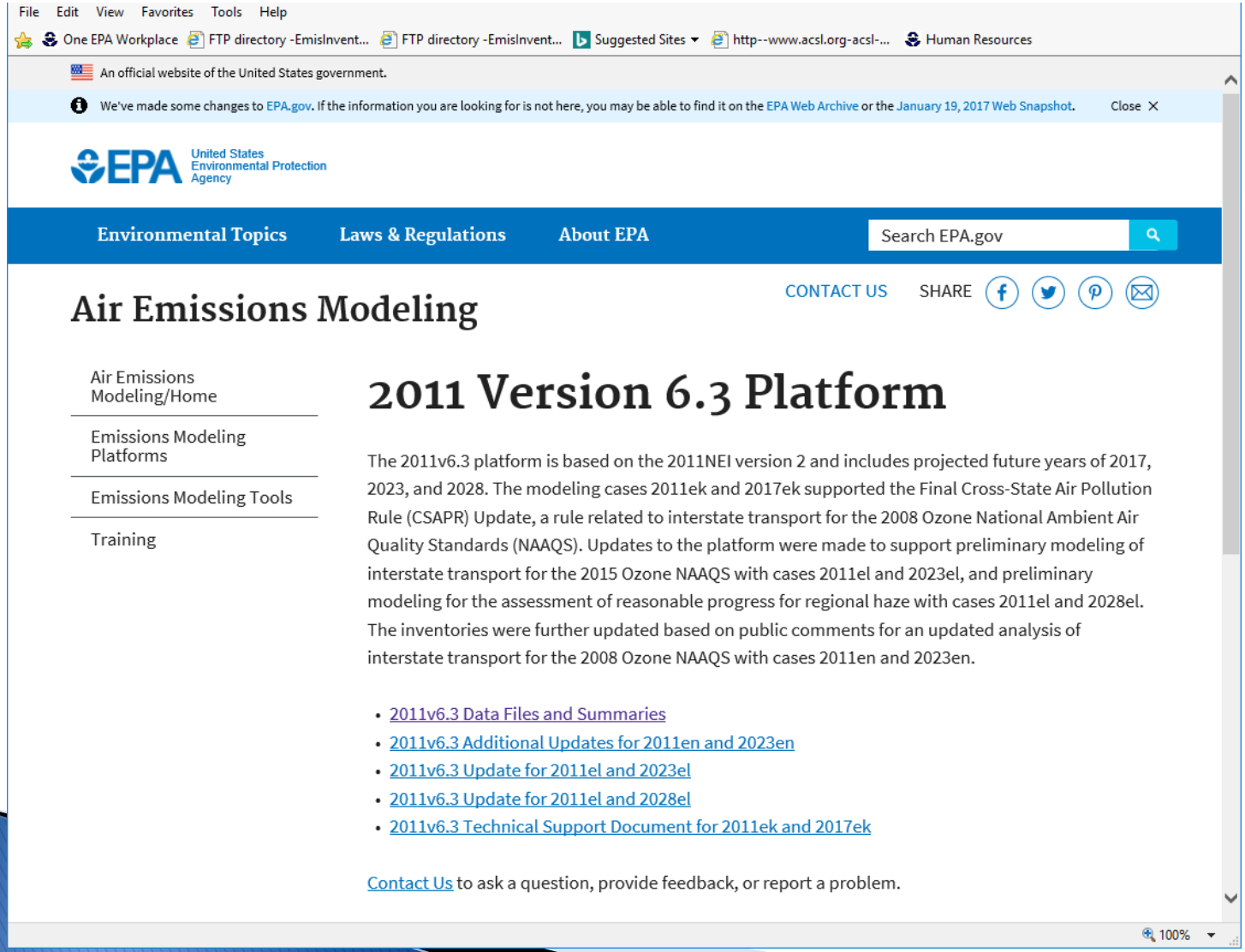
- Factors to consider for each sector include:
  - Confidence in base year inventory data
  - Historical data available since base year
  - What sources of information are available for each sector
    - Databases (e.g. Annual Energy Outlook (AEO))
    - Models (e.g. Integrated Planning Model (IPM) for EGUs)
  - How can these sources of information be used for estimating emissions? (e.g., to update activity data)
  - Spatial and temporal resolution of information
  - Federal and state rules that go into effect in the intervening years are considered
  - Point sources: consent decrees, planned shutdowns, etc.

Modeling Platforms with Projections

- 2011v6.3 platform
  - https://www.epa.gov/air-emissions-modeling/2011-version-63-platform
  - Based on 2011 NEI version 2 with updates (used 5+ years)
  - Supported the Final Cross-State Air Pollution Rule (CSAPR) Update with cases **2011ek** and **2017ek**, and **2017ek_cntl**
  - Added **2011el** and **2023el** for a preliminary analysis of ozone transport with respect to the 2015 National Ambient Air Quality Standard (NAAQS) for ozone
    - **2011en** and **2023en** provided updates
  - Added **2028el** for regional haze
- 2016 Platform
  - 2016 beta is now a real base year, not a projection
  - 2016 Beta platform has draft projections but 2016v1 will have final projections

2011v6.3 Data on Web Site

https://www.epa.gov/air-emissions-modeling/2011-version-63-platform



Projection Techniques

- Inventory projection techniques differ for different modeling platform sectors
  - Some done using the **Control Strategy Tool** (CoST) within the Emissions Modeling Framework (EMF)
  - Others are taken as outputs from models
- Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is used to prepare the emissions for air quality models (e.g. CMAQ, CAMx)

Projections overview: Sectors projected based on NEI emissions

Sector(s)	Data sources and techniques used
Agricultural NH3 (ag)	USDA animal population growth estimates, livestock only.
Fugitive dust (afdust)	County-level VMT and population Annual Energy Outlook (AEO)-based projections to paved roads.
Residential Wood Combustion (rwc)	2015 Wood heaters New Source Performance Standards (NSPS) with growth and appliance change-outs/retirement assumptions.
Class 1&2 CMV + trains (cmv_c1c2, rail)	Locomotive and Marine (RIA-based) rule growth and controls; California data scaled from CARB inventories.
Class 3 CMV (cmv_c3)	Regional-based growth factors + ECA-IMO engine and fuel controls, extending from ports (state), to near-offshore (EEZ) to global; California scaled from CARB data.
Oil and Gas (pt_oilgas, np_oilgas)	AEO production forecast and historical activity. Various NSPS impacts + local information.
Remaining non-EGUs (ptnonipm, nonpt)	AEO production, consumption fuel-based growth. Various NSPS impacts + local information. Numerous additional growth/control/closure information.

Projections overview: Sectors not projected from NEI base year emissions

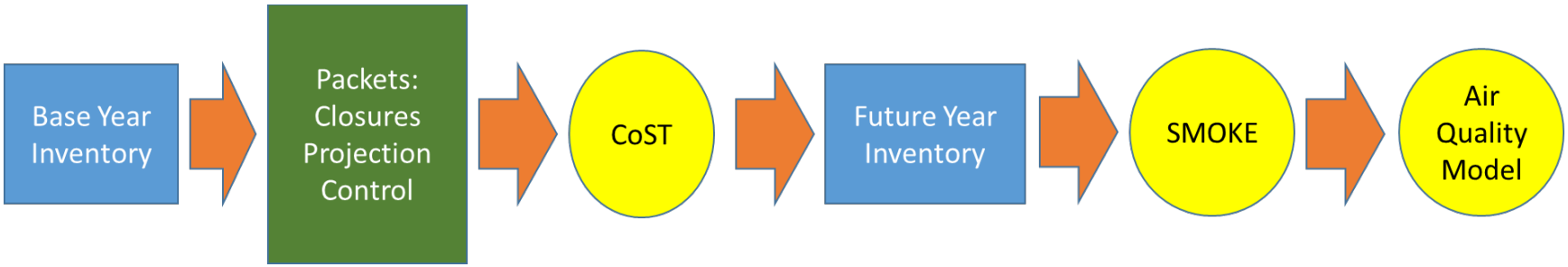
Sector(s)	Data sources and techniques used
EGUs (ptegu)	Integrated Planning Model (IPM), Eastern Regional Technical Advisory Committee (ERTAC) EGU model
Onroad mobile (onroad)	MOVES2014b w/ projected activity, fuels, inspection and maintenance, controls, speciation; Include state inputs California magnitude from CARB but temporalized based on SMOKE-MOVES
Nonroad mobile (nonroad)	MOVES2014vb projected inventories (previously NMIM/NONROAD), except for California data provided by CARB
Canada/Mexico (othar, othpt, othon)	Canada: apply projection factors; sometimes adjust based on changes to U.S. inventories Mexico: Future-year inventories projected from 2008 base year inventory plus MOVES-Mexico
Biogenics & Fires (beis, agfire, ptfire)	No projections, same as base year in non-historc projections due to constant meteorology

Future-year Emissions Modeling Ancillary Data

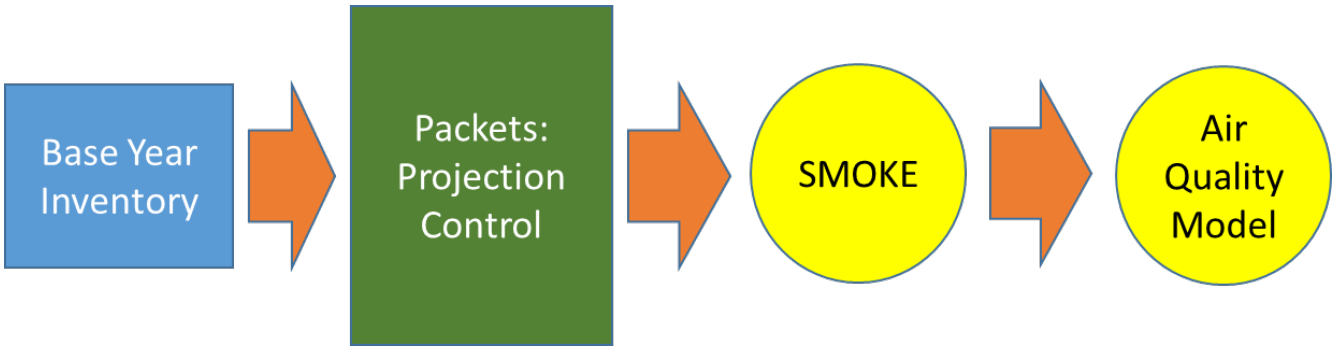
- Most ancillary (i.e., non-inventory) data stays the same in the base and future year modeling
- Meteorology is held constant
- Spatial surrogates are constant
- Temporal profiles are constant for most sectors (except for EGUs)
- Speciation profiles are constant for many sources
  - Updated in future year for mobile sources

Available Tools for Projection of non-EGU Point/Nonpoint Projections

Control Strategy Tool (CoST) – a good organizational and reporting tool



SMOKE – traditional approach; good for simplified projection tasks



Questions?

Any questions on the basic concepts of projections?

Control Strategy Tool (CoST)

- Part of the Emissions Modeling Framework (EMF)
  - https://cmascenter.org/cost/
  - Used to project most NEI non-EGU point and nonpoint inventories
  - Exceptions include stand-alone future year inventories (e.g., biodiesel and cellulosic plants, new cement kilns)
- Has a hierarchy for how "packets" are applied
- Tracks the impact of each packet on the inventory
- Used for projections, but also includes algorithms for other analyses like maximum emissions reduction and least-cost

Control Strategy Tool: Packet Types

- CLOSURE
  - Facility, unit, stack and/or process-level
  - Effective date needed
  - July 1 cut-off (apply if before July 1 of target year)
- PROJECTION
  - Scalars (e.g., 0.3 = 70% reduction, 2.0=100% increase)
  - All inventories: geographic (FIPS state / county), pollutant, source classification code (SCC)
  - Point only: target a facility/sub-facility / or North American Industry Classification System (NAICS)
- CONTROL
  - Similar facility/geographic/SCC/pollutant applicability as PROJECTION packets
  - Percent reductions (0-100), optional rule effectiveness and rule penetration
  - Compliance date optional
  - July 1 cut-off

Closure Packet Example

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	region_c	facility_id	unit_id	rel_point_	process_i	facility_name	effective_date		comment					
2	1013	7212711	10819013			Coastal Forest Products	1/1/2012		! EIS unit closure status=PS: Coastal Forest Products LLC					
3	1015	923311	48124913			Chemical Agent Disposa	1/1/2013		! EIS unit closure status=PS: Chemical Agent Disposal Facility					
4	1015	923311	48125613			Chemical Agent Disposa	1/1/2013		! EIS unit closure status=PS: Chemical Agent Disposal Facility					
5	1017	7441811	10843613			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
6	1017	7441811	10843713			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
7	1017	7441811	10843813			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
8	1017	7441811	10843913			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
9	1017	7441811	10844013			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
10	1017	7441811	10844113			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
11	1017	7441811	10844213			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
12	1017	7441811	10844313			Knauf Fiber Glass	1/1/2013		! EIS unit closure status=PS: Knauf Fiber Glass					
13	1025	10631911	58459413			Scotch Gulf Lumber LLC	1/1/2013		! EIS unit closure status=PS: Scotch Gulf Lumber LLC					
14	1033	7212211	10828213			Wise Alloys LLC	1/1/2012		! EIS unit closure status=PS: Wise Alloys LLC					
15	1035	10545111	83303913			Pruet Production Comp	1/1/2012		! EIS unit closure status=PS: Pruet Production Company					
16	1035	10545111	83304013			Pruet Production Comp	1/1/2012		! EIS unit closure status=PS: Pruet Production Company					

README | CoST Packet Matching Hierarchy | **CLOSURES_packet_example** | PROJECTION_packet_example | PROJECTION_extended_e ...

Closures are applied for a target year (e.g., 2020): Records with effective dates up to July 1 of target year will be applied

Closures can be applied at multiple levels:

- Region_cd (FIPS) – state & county code
- Facility (plant)
- Unit (point)
- Release point (stack)
- Process (segment)
- New format: country_cd, tribal_cd, SCC

Projection Packet Example

	A	B	C	D	E	F	G	L	M	N	P	Q
1	Country_cd	Region_cd	facility_id	unit_id	rel_point_id	process_id	...	SCC	Poll	Reg_code	NAICS	Ann_proj_
2	US	09001	14621711	88741013	96626912	120536814						1.044
3	US	09001	14621711	99532913	96626612	140180514						1.044
4	US	09001	14621711	99533013	96626512	140180614						1.044
5	US	09001	14621711	99533113	96626712	140180714						1.044
10	US	09003	2753811	41000513	39105612	48269014						1.044
11	US	09003	2753811	41000613	39105912	48268914						1.044
12	US	09003	2753811	41000713	39105712	48268814						1.044
13	US	09003	2753811	41000813	39105512	48268714						1.044
22	US	09007	2706711	40863013	38981012	48745614						1.044
23	US	09007	2706711	40863113	38980912	48745514						1.044
27	US	09007	2706711	40863513	38981312	48745114						1.044
67	US	24009	5169611	87920713	84068812	119329114						1
68	US	24009	5169611	87920813	84068912	119329214						1
69	US	24009	5169611	87920913	84069012	119329314						1
70	US	24009	5169611	87921013	84069112	119329414						1
71	US	24009	5169611	87921113	84069212	119329514						1
72	US	24009	5169611	87921213	84069312	119329614						1
73	US	24009	5169611	87921313	84069412	119329714						1

PROJECTION_packet_example | PROJECTION_extended_exampl ...

Factors to apply are here

Projection entries can also be specified at multiple levels

- An older / simpler version with only FIPS, SCC, proj_factor, and POLL also exists

Control Packet Example

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
1	FIPS	SCC	POLL	Primary Control	Control Efficiency %	rule eff	rule pen	SIC	MACT	APPFLAG	REPFLAG	plantid	pointid	stackid	segment	compliance_date	NAICS	comments
2	09000	2102001000	CO		34.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
3	09000	2102001000	NOX		4.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
4	09000	2102001000	PM10-PRI		4.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
5	09000	2102001000	PM25-PRI		4.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
6	09000	2102001000	SO2		4.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
7	09000	2102001000	VOC		34.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
8	09000	2102002000	CO		34.0	100	100			Y	R					1/1/2016		"! Boiler MACT /I
110	09001	10300501	CO		6	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
111	09001	10300501	NOX		4	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
112	09001	10300501	PM10-PRI		4	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
113	09001	10300501	PM25-PRI		4	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
114	09001	10300501	SO2		4	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
115	09001	10300501	VOC		6	100	100			Y	A	843611				1/1/2016		"! ICI Boiler MAC
116	09003	10200501	CO		6	100	100			Y	A	918811				1/1/2016		"! ICI Boiler MAC
117	09003	10200501	NOX		4	100	100			Y	A	918811				1/1/2016		"! ICI Boiler MAC
118	09003	10200501	PM10-PRI		4	100	100			Y	A	918811				1/1/2016		"! ICI Boiler MAC

... Closure_effective_date | Extended_Format_Mapping

Ending FIPS with 000 applies to entire state
Rule effectiveness and penetration usually 100
APPFLAG of Y means to apply it
REPFLAG of R means replace existing controls, A means add on
Applied if compliance_date is before July 1 of target year
Note: A newer control format supports: country_cd, region_cd, facility_id, unit_id, rel_point_id, process_id, tribal_code, etc.

Control Strategy Tool: Hierarchy

- CLOSURES, PROJECTION, CONTROL packet types applied separately in a run
- All packets for each type concatenated and QA'd
- Most-specific applicable row (compliance date, application flag) supersedes more general entries
- Care needed when there are overlapping consent decrees, comments, broad control programs
  - Need to be careful how you build packets
  - **QA is very important to ensure output from strategy matches intentions – especially where the same sources are impacted by multiple packets**

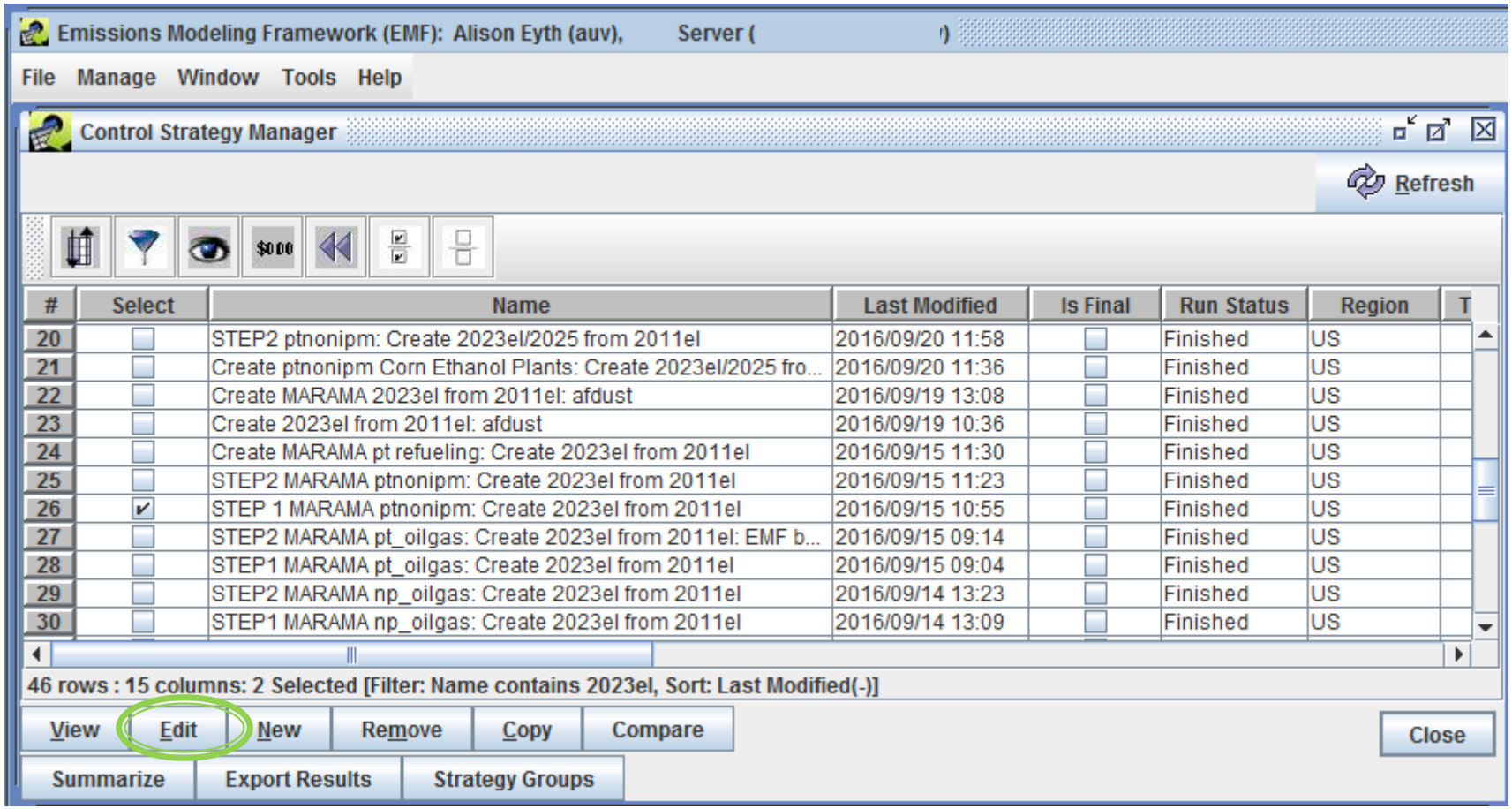
CoST Packet Priorities

General <– Specific

Rank	Matching Hierarchy	Inventory Type
1	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID, SCC, POLL	point
2	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID, POLL	point
3	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, POLL	point
4	REGION_CD, FACILITY_ID, UNIT_ID, POLL	point
5	REGION_CD, FACILITY_ID, SCC, POLL	point
6	REGION_CD, FACILITY_ID, POLL	point
7	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID, SCC	point
8	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID	point
9	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID	point
10	REGION_CD, FACILITY_ID, UNIT_ID	point
11	REGION_CD, FACILITY_ID, SCC	point
12	REGION_CD, FACILITY_ID	point
13	REGION_CD, NAICS, SCC, POLL	point, nonpoint
14	REGION_CD, NAICS, POLL	point, nonpoint
15	STATE, NAICS, SCC, POLL	point, nonpoint
16	STATE, NAICS, POLL	point, nonpoint
17	NAICS, SCC, POLL	point, nonpoint
18	NAICS, POLL	point, nonpoint
19	REGION_CD, NAICS, SCC	point, nonpoint
20	REGION_CD, NAICS	point, nonpoint
21	STATE, NAICS, SCC	point, nonpoint
22	STATE, NAICS	point, nonpoint
23	NAICS, SCC	point, nonpoint
24	NAICS	point, nonpoint
25	REGION_CD, SCC, POLL	point, nonpoint
26	STATE, SCC, POLL	point, nonpoint
27	SCC, POLL	point, nonpoint
28	REGION_CD, SCC	point, nonpoint
29	STATE, SCC	point, nonpoint
30	SCC	point, nonpoint
31	REGION_CD, POLL	point, nonpoint
32	REGION_CD	point, nonpoint
33	STATE, POLL	point, nonpoint
34	STATE	point, nonpoint
35	POLL	point, nonpoint

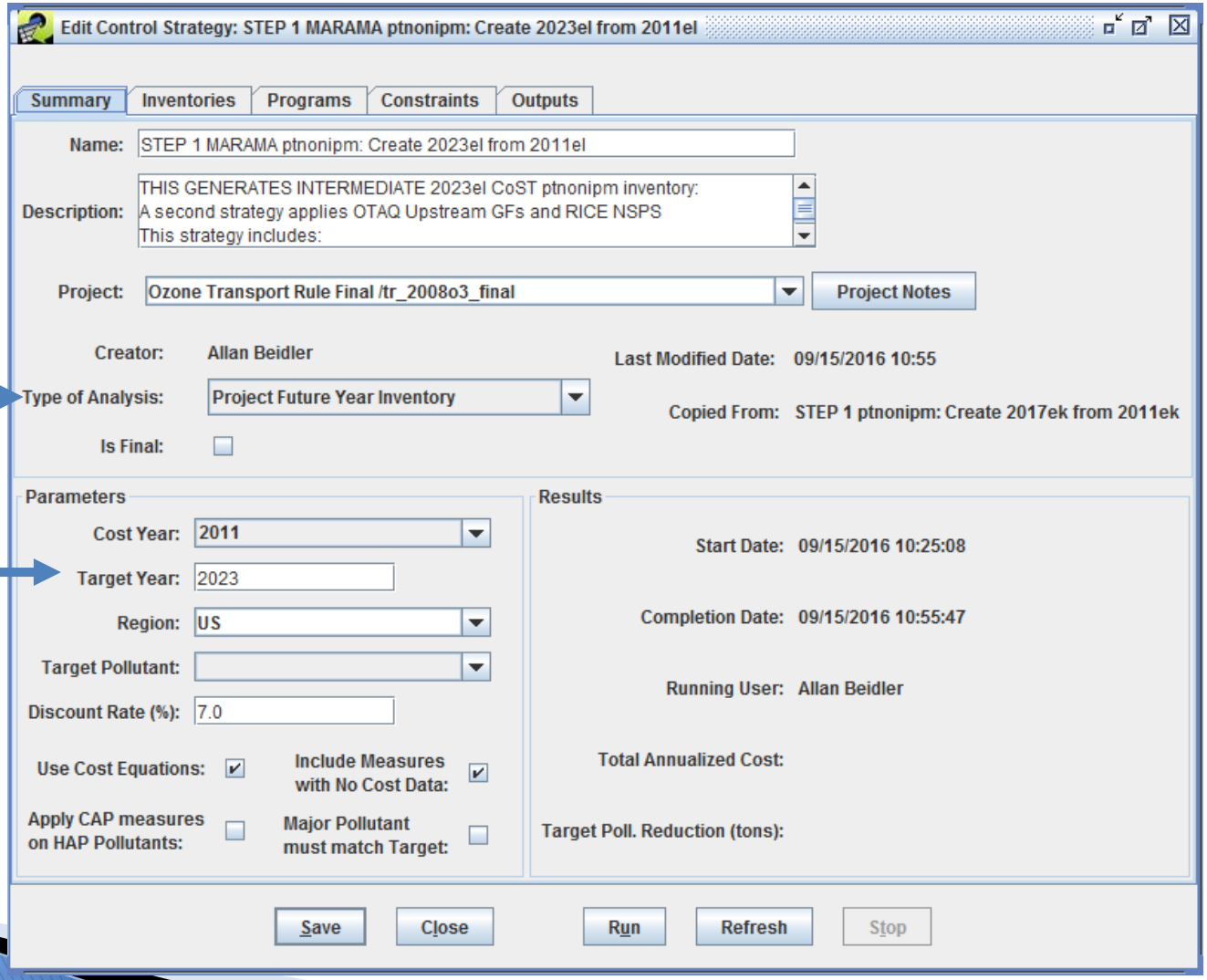
Entries in packets that are **more specific** have **higher priority** than the more general ones

Control Strategies within the Emissions Modeling Framework

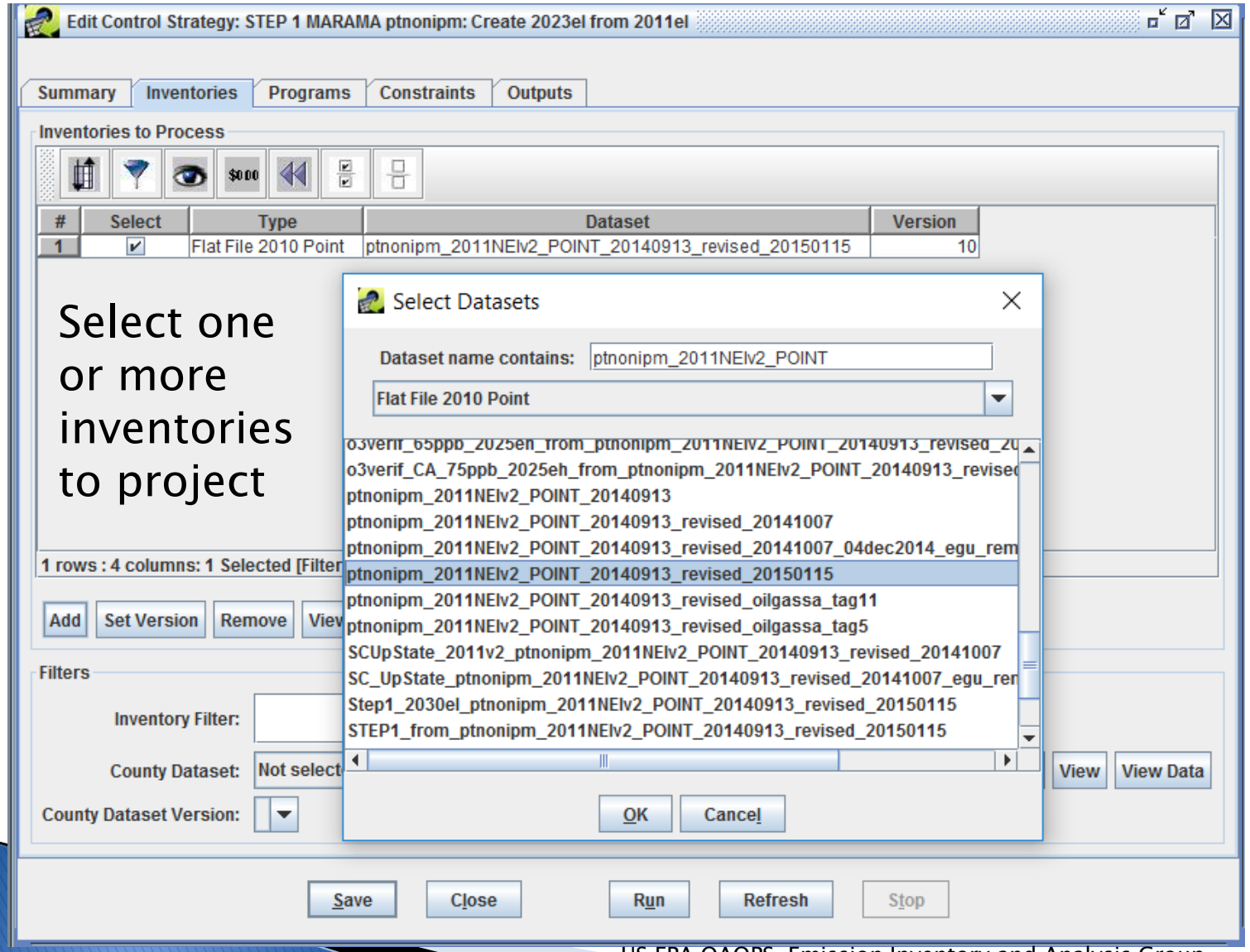


Editing a Control Strategy

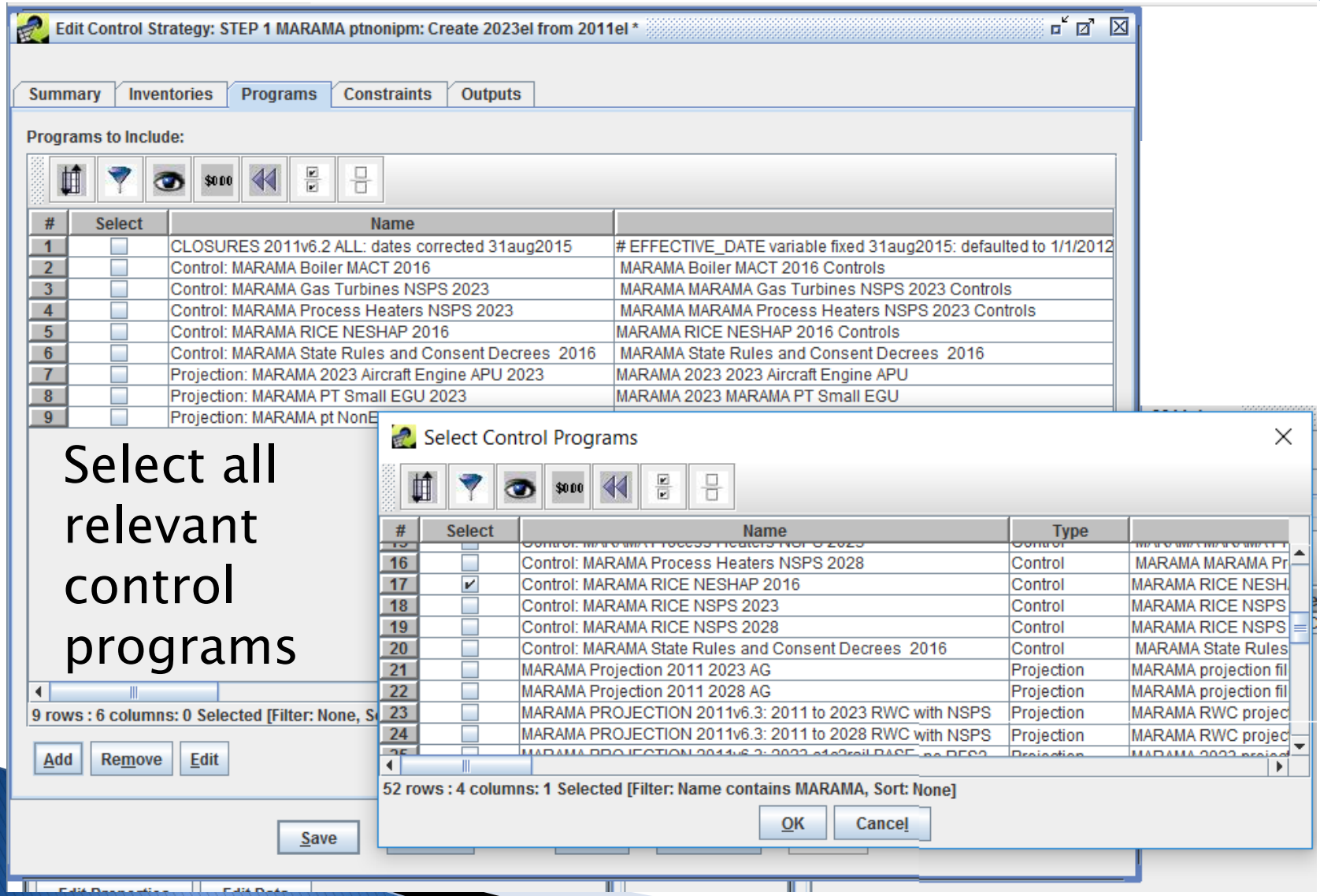
Type of Analysis and Target Year are key parameters



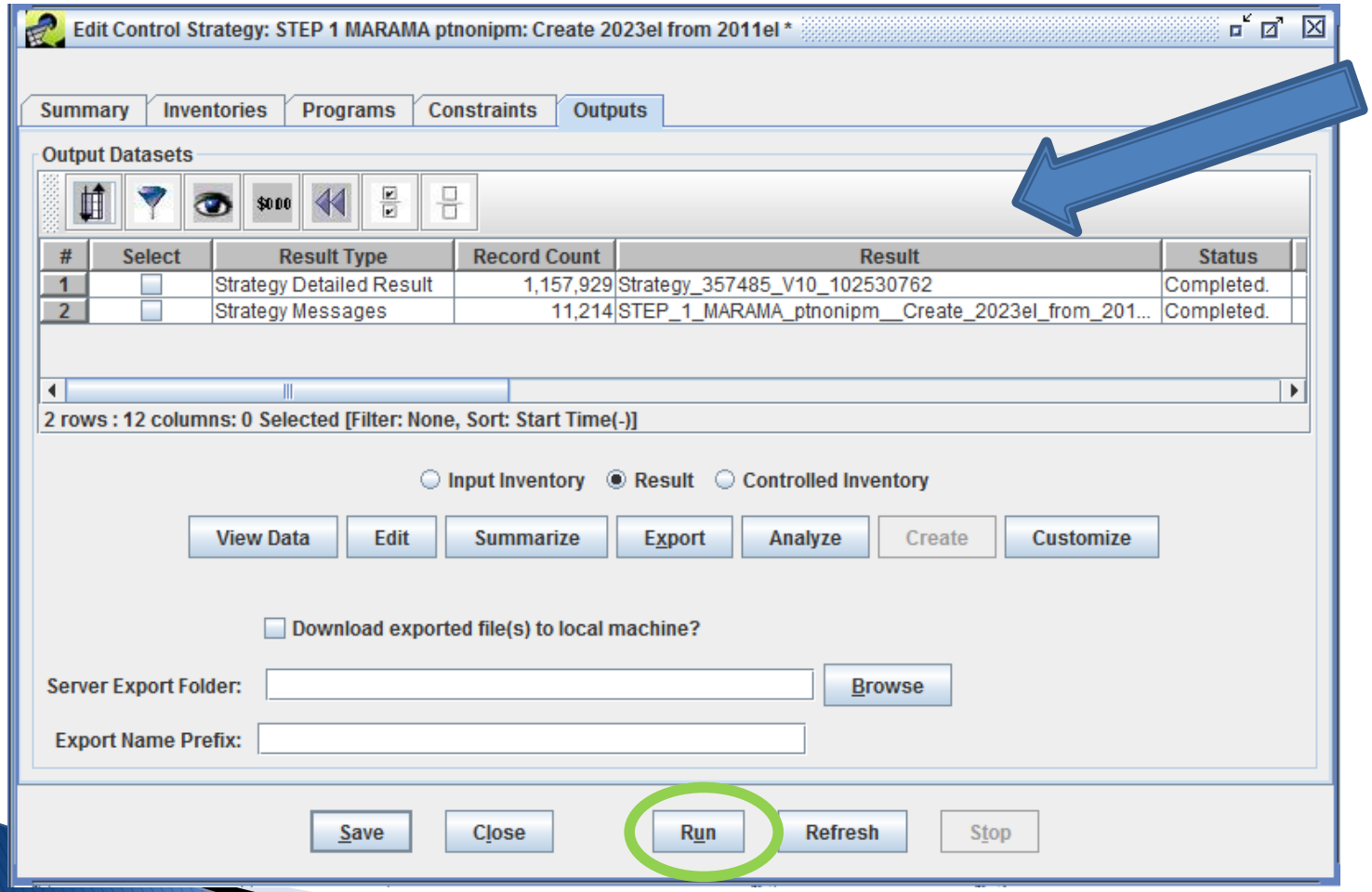
Select Inventories for Strategy



Select Control Programs to Apply



Control Strategy Tool: Outputs



After strategy is run, Outputs will appear: a Detailed result and Messages

It is important to review these outputs

Summaries of detailed result are also helpful

After QA, create a controlled inventory

Example Detailed Result (only selected columns shown)

Data Viewer [Dataset:Strategy_357485_V10_074258544, Version: Initial Version, Table: CSDR_357485_V10_ptnonipm_2011NEIv2_POINT_2014_20160115074258544]

Sort Order

Row Filter: (POLL in ('NOX', 'SO2', 'PM10-PRI', 'VOC')) and (EMIS_REDUCTION > 5) and (FIPS in ('17127','17031'))

Apply

Current: 1 - 50 Filtered: 50 of 3960569

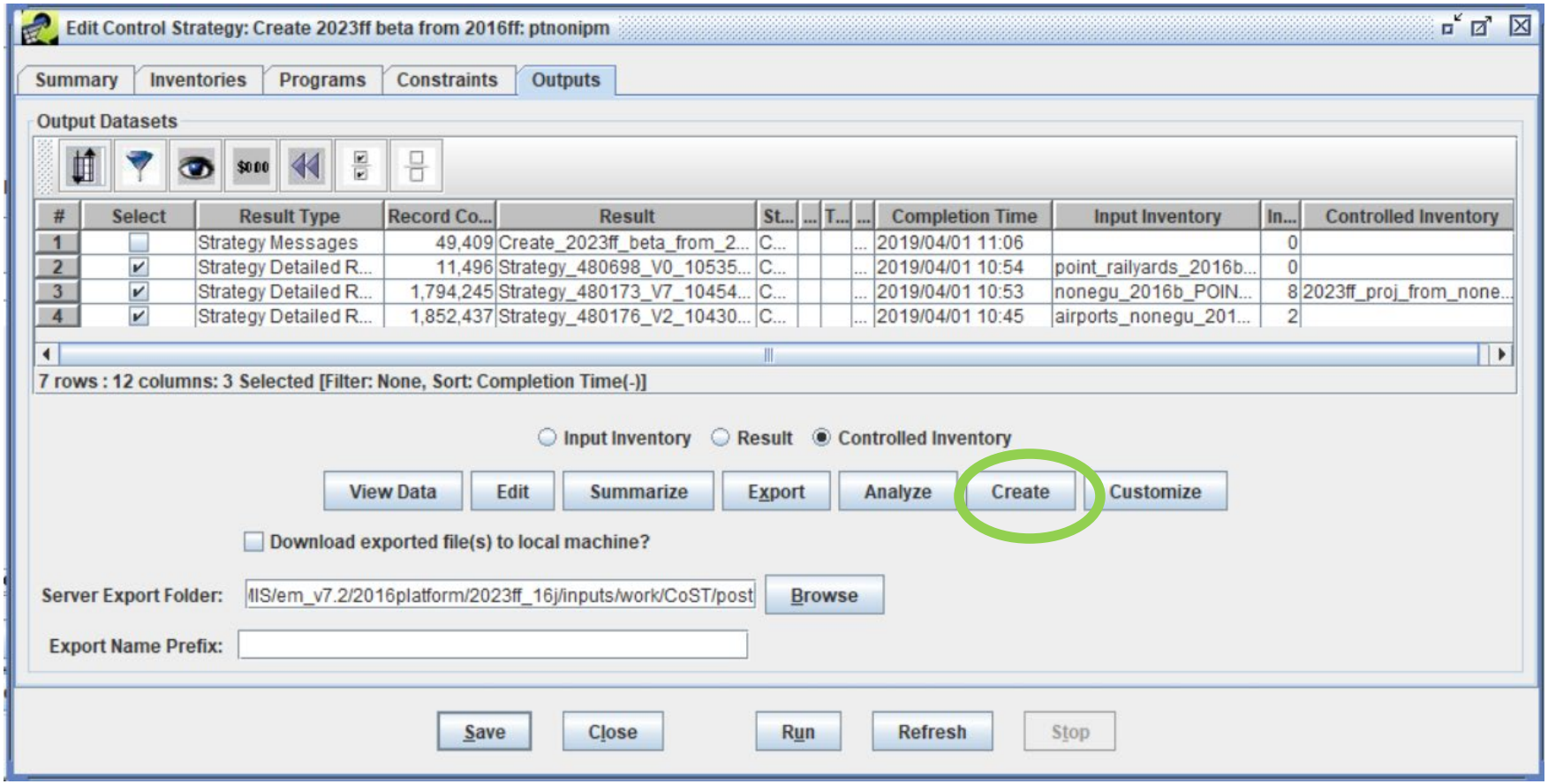
Decimal Places: 2 | Show Commas | Format | Reset View

DISABLE Boolean	CM_ABBREV String(20)	POLL String(20)	SCC String(12)	REGIO Strin	FACILITY_ID String(20)	UNIT_ID String(20)	REL_POINT_I String(20)	PROCESS_ID String(20)	ANN_COST_PER_TOI Double	PERCENT_REDUC Double	ADJ_FACTO Double	FINAL_EMISSIO Double	EMIS_REDUCTION Double	INV
	PLTCLOSURE	VOC	30102051	17031	7333811	59554613	55028612	85652014				.00	6.64	
	PLTCLOSURE	VOC	30101520	17031	7333811	9708913	55028712	44861214				.00	9.37	
	PLTCLOSURE	VOC	40500601	17031	7411511	10371313	10263412	44513814				.00	21.75	
	PLTCLOSURE	PM10-PRI	30510299	17031	7995611	4070413	3969912	44821114				.00	7.16	
	PROJECTION	NOX	28500201	17031	14422011	87126213	83279512	117829914			.86	160.82	25.53	
	PROJECTION	NOX	28500201	17031	14422111	87126313	83279612	117830014			.86	338.49	53.73	
	PROJECTION	NOX	28500201	17031	14422211	87126513	83279812	117830214			.86	82.90	13.16	
	PROJECTION	NOX	28500201	17031	14422511	87126813	83280112	117830514			.86	118.00	18.73	
	PROJECTION	NOX	28500201	17031	14422611	87126913	83280212	117830614			.86	197.93	31.42	
	PROJECTION	NOX	28500201	17031	14422711	87127113	83280412	117830814			.86	160.07	25.41	
	PROJECTION	NOX	28500201	17031	14423011	87127813	83281112	117831514			.86	164.91	26.18	
	PROJECTION	NOX	28500201	17031	14423111	87127913	83281212	117831614			.86	41.29	6.56	
	PROJECTION	NOX	28500201	17031	14423211	87128113	83281412	117831814			.86	231.51	36.75	
	PROJECTION	NOX	28500201	17031	14466111	87180313	83333612	117884114			.86	131.72	20.91	
	PROJECTION	NOX	28500201	17031	14480111	87127013	83280312	117830714			.86	291.42	46.26	
	PROJECTION	NOX	28500201	17031	14480611	87127213	83280512	117830914			.86	162.47	25.79	
	PROJECTION	NOX	28500201	17031	14480711	87127313	83280612	117831014			.86	37.15	5.90	
	PROJECTION	NOX	28500201	17031	14480811	87127413	83280712	117831114			.86	53.35	8.47	
	PROJECTION	NOX	28500201	17031	14481011	87127513	83280812	117831214			.86	158.06	25.09	
	PROJECTION	NOX	28500201	17031	14481711	87128013	83281312	117831714			.86	92.87	14.74	
	UNKNOWNMSR	NOX	30190003	17031	7313911	9840713	9709612	47191614		16.32		26.97	5.26	
	UNKNOWNMSR	NOX	30501402	17031	7335811	8292313	54871712	47267714		90.00		12.91	116.23	
	UNKNOWNMSR	SO2	30501402	17031	7335811	8292313	54871712	47267714		70.00		14.90	34.77	
	UNKNOWNMSR	NOX	30501402	17031	7335811	8292313	54871812	47267714		90.00		13.53	121.76	
	UNKNOWNMSR	SO2	30501402	17031	7335811	8292313	54871812	47267714		70.00		15.61	36.42	
	UNKNOWNMSR	NOX	30501402	17031	7335811	8292313	8183212	47267714		90.00		14.55	130.99	
	UNKNOWNMSR	SO2	30501402	17031	7335811	8292313	8183212	47267714		70.00		16.79	39.18	
	NDSCRCMDY	NOX	30500606	17127	7808811	2232913	2152112	42916714	5,674.48	90.00		118.82	1,069.43	

Add Note

Close

Create Controlled inventory



Once the detailed results are quality assured, create Controlled inventories by selecting the results of interest and clicking Create to generate the controlled inventories

Control Strategy Tool: Sectors/ Relative Complexity

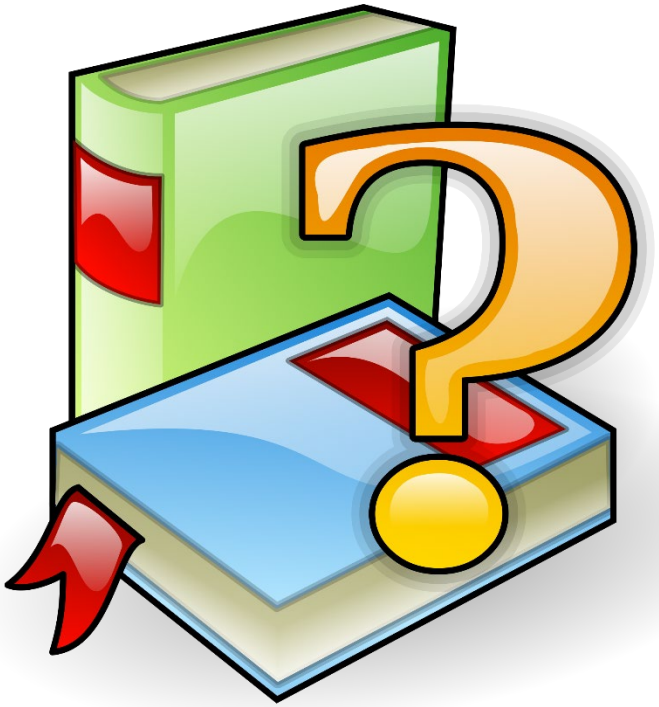
- Some packets shared over multiple sectors, some packets contain several sources of data/programs
- Simple sectors: afdust, ag, rwc, cmv_c1c2, cmv_c3, rail:
  - 1 projection packet for each sector
- Oil & gas nonpoint (np_oilgas):
  - 3 packets
- Remaining nonpoint (nonpt):
  - 4 packets
- Oil & gas point (pt_oilgas):
  - 8 packets
- Non-EGU point, not oil & gas (ptnonipm):
  - 14 packets

Projections: Quality Assurance

- CoST detailed results
  - Review carefully to make sure the packets have been applied as you intended
  - Use Compare Datasets feature of EMF to review FIPS/SCC combinations in older and newer strategies
  - Do multiple levels of comparison depending on nature of the packets used: e.g., state, SCC, NAICS, poll, facility, unit
- Use EMF to generate Structured Query Language (SQL)-based QA reports
  - By control program
  - Geography (e.g., state, county)
  - Source classification code (SCC)
  - Can limit pollutants in summary
  - Option to show "unaffected" sources
- Create custom reports and summaries
- Filter / sort in CoST then export to CSV

Questions?

- Any questions on the Control Strategy Tool?



Nonpoint Projections

Data Sources for Nonpoint Projections

- Energy Information Administration/Annual Energy Outlook
  - Oil & gas, industrial sources
- Data from multiple EPA offices
  - Office of Research and Development: animal NH3
  - Office of Air Quality Planning and Standards: RICE NESHAPs, regional haze, consent decrees, oil & gas, RWC
  - Office of Transportation and Air Quality: portable fuel containers (PFCs), upstream emissions
  - Office of Atmospheric Programs: oil & gas
  - Office of Enforcement and Compliance Assurance (OECA): consent decrees
- Outside agencies
  - Federal: animal projections
  - State/local/regional: closures, projections, ICI boilers, fuel sulfur
  - Contractors: projections and controls for industrial sources including oil & gas, RWC
- Collaboration needed to determine "most-appropriate" data for each source category

Nonpoint Projections: Ag NH3

- Animal-specific livestock only (no fertilizer approach: fertilizer future year = base year)
- Based on *national* population estimates from the USDA and state submitted state- and county-based growth factors
- Historical trends comparing number of animals vs production rates, net impact through 2028:
  - Slight increases for cows, turkey
  - Increases in pork, broilers, layers and poultry

Nonpoint Projections: Ag NH3 Equations

Table 18. Beef long-term projections

Item	Units	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cattle inventory	1,000 head	91,918	93,585	94,500	94,500	93,912	93,416	93,136	92,773	92,265	92,017	92,061	92,365
Beef cow inventory	1,000 head	30,166	31,210	31,875	32,225	31,932	31,721	31,629	31,411	31,173	31,070	31,117	31,341
Total cow inventory	1,000 head	39,476	40,559	41,300	41,700	41,448	41,261	41,184	40,986	40,763	40,680	40,742	40,986

Note: Totals may not add due to rounding. Cwt = hundredweight.

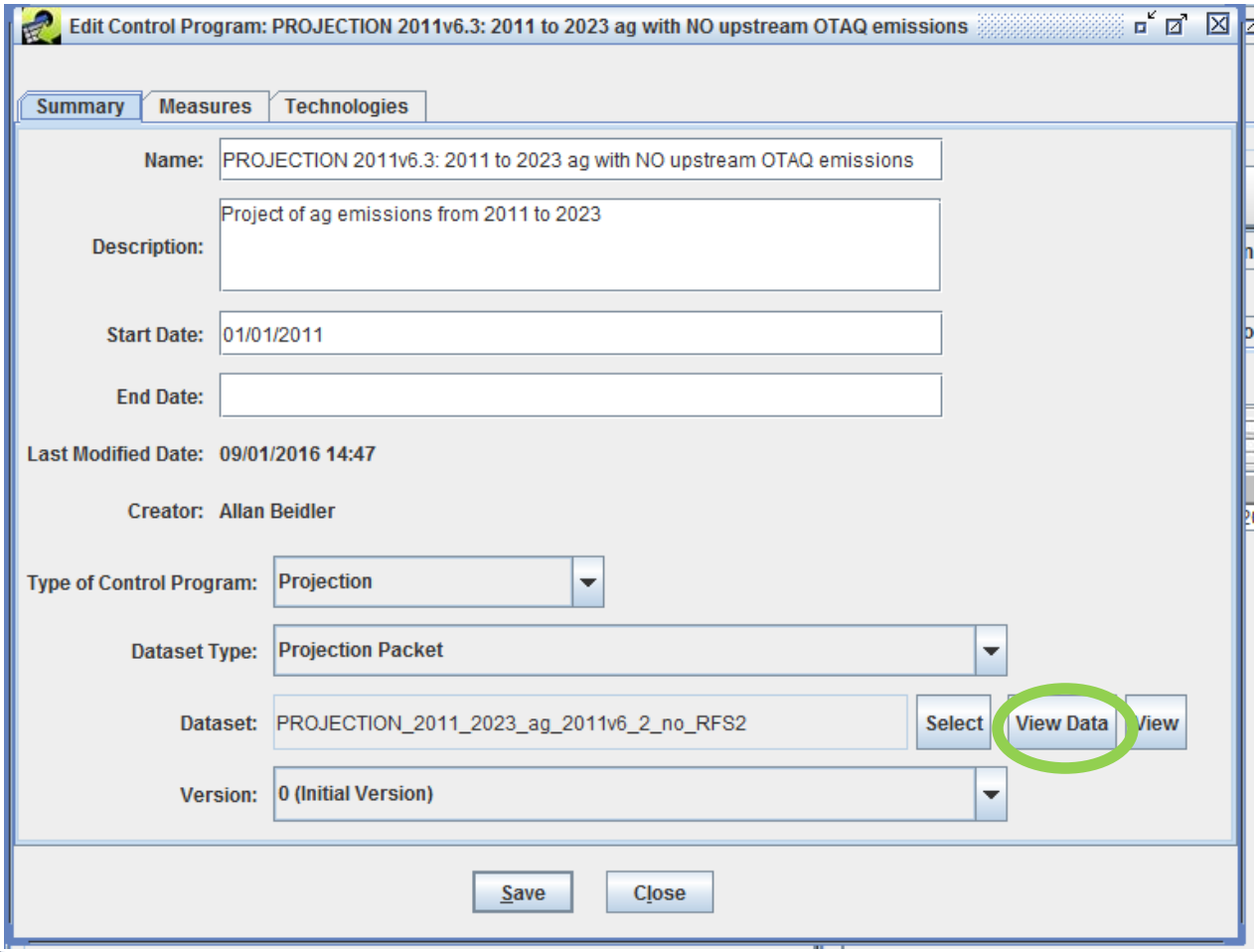
Projection Factor:

$$\frac{Projection\ year\ value}{Base\ year\ value}$$

Example: Beef cows projected to 2023 from 2016

$$\frac{31{,}411}{30{,}166} = 1.04$$

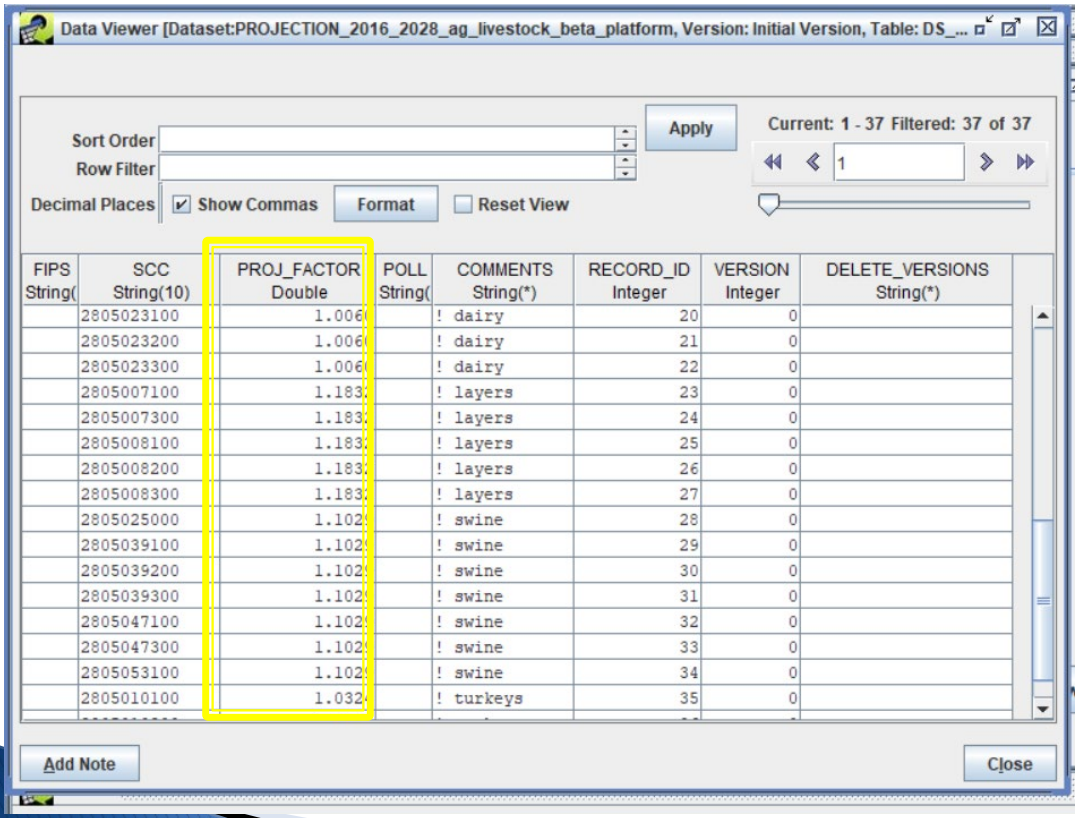
Ag Control Program



Select a dataset for the control program then view the data…

Nonpoint Projections: Ag NH3 (continued)

Ag Projection packet in EMF data viewer
(SCC-specific, but not FIPS or POLL-specific)



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	2805023100	1.006		! dairy	20	0	
	2805023200	1.006		! dairy	21	0	
	2805023300	1.006		! dairy	22	0	
	2805007100	1.183		! layers	23	0	
	2805007300	1.183		! layers	24	0	
	2805008100	1.183		! layers	25	0	
	2805008200	1.183		! layers	26	0	
	2805008300	1.183		! layers	27	0	
	2805025000	1.102		! swine	28	0	
	2805039100	1.102		! swine	29	0	
	2805039200	1.102		! swine	30	0	
	2805039300	1.102		! swine	31	0	
	2805047100	1.102		! swine	32	0	
	2805047300	1.102		! swine	33	0	
	2805053100	1.102		! swine	34	0	
	2805010100	1.032		! turkeys	35	0	

Base Year Emissions x PROJ_FACTOR = Projected Emissions

For each pollutant and SCC

* If State or Regional data were available, this calculation would apply the corresponding projection factor based on FIPS and SCC

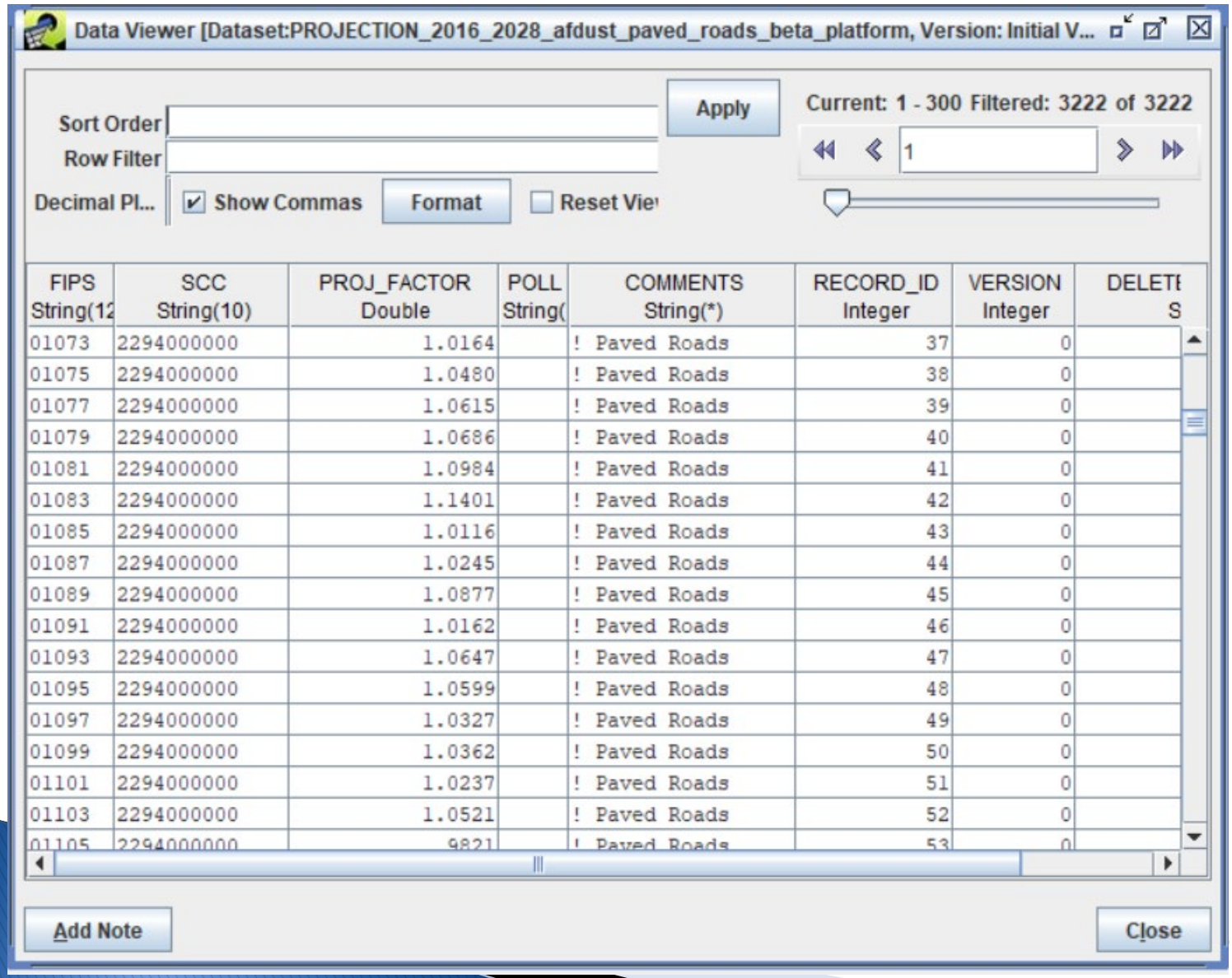
Nonpoint Projections: Fugitive Dust

- Impacts paved road dust only; unpaved road dust held constant for future years in 2016 platform
- Function of VMT on roads
- Onroad VMT projected to future year using AEO
- County projection factor equation

$$\text{PROJFAC} = \frac{\text{(Future-year total county VMT)}}{\text{(Base-year total county VMT)}}$$

Future emis = PROJFAC * base emis

Example Fugitive Dust Packet



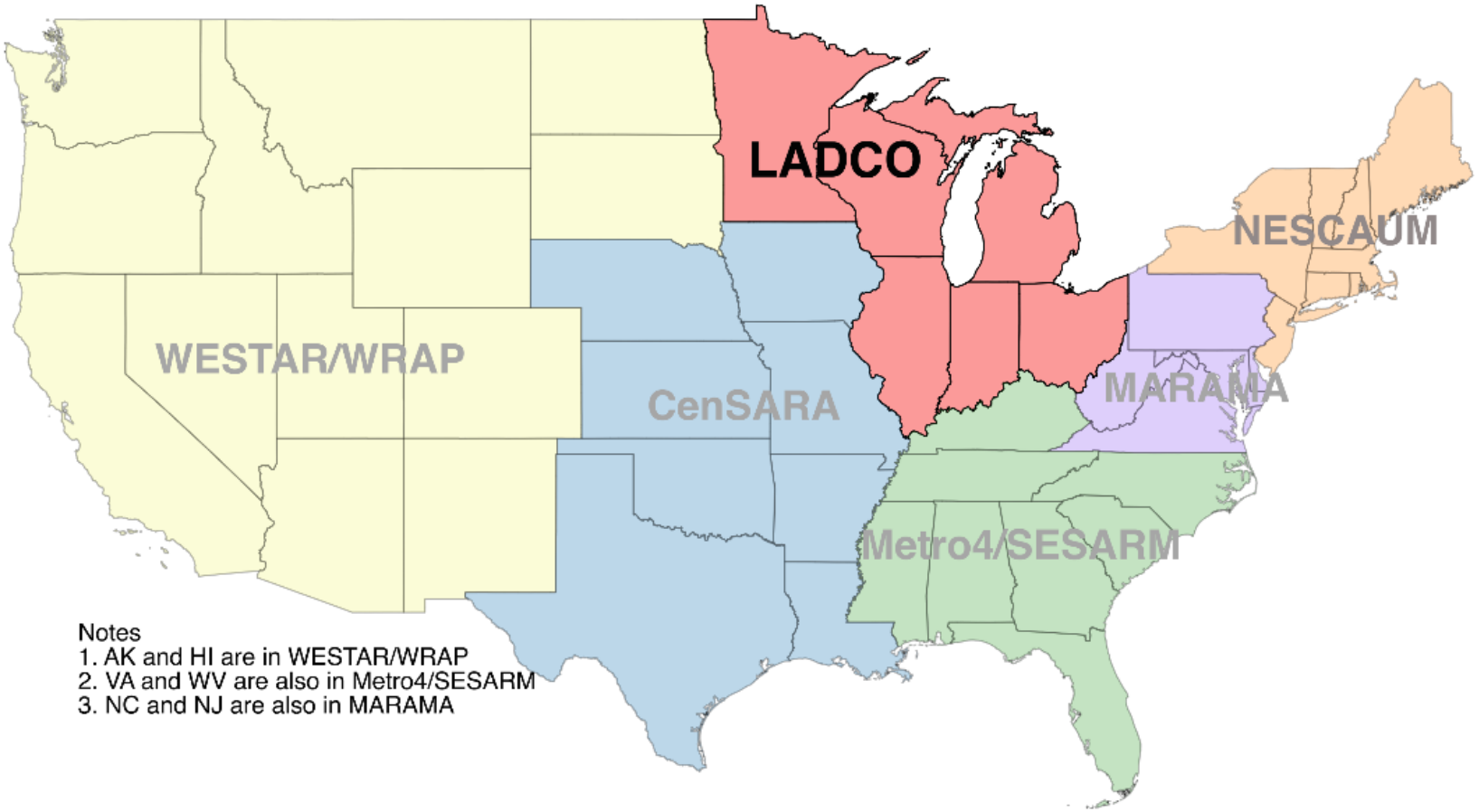
FIPS String(12	SCC String(10)	PROJ_FACTOR Double	POLL String(	COMMENTS String(*)	RECORD_ID Integer	VERSION Integer	DELETE S
01073	2294000000	1.0164		! Paved Roads	37	0	
01075	2294000000	1.0480		! Paved Roads	38	0	
01077	2294000000	1.0615		! Paved Roads	39	0	
01079	2294000000	1.0686		! Paved Roads	40	0	
01081	2294000000	1.0984		! Paved Roads	41	0	
01083	2294000000	1.1401		! Paved Roads	42	0	
01085	2294000000	1.0116		! Paved Roads	43	0	
01087	2294000000	1.0245		! Paved Roads	44	0	
01089	2294000000	1.0877		! Paved Roads	45	0	
01091	2294000000	1.0162		! Paved Roads	46	0	
01093	2294000000	1.0647		! Paved Roads	47	0	
01095	2294000000	1.0599		! Paved Roads	48	0	
01097	2294000000	1.0327		! Paved Roads	49	0	
01099	2294000000	1.0362		! Paved Roads	50	0	
01101	2294000000	1.0237		! Paved Roads	51	0	
01103	2294000000	1.0521		! Paved Roads	52	0	
01105	2294000000	9821		! Paved Roads	53	0	

Projection factors are specific to each county the same for each pollutant

QA of ag/afdust Projections

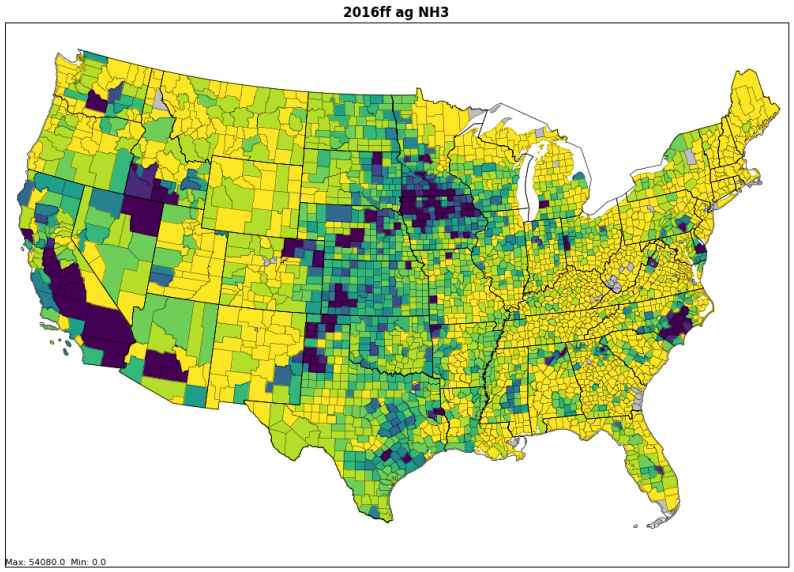
- Compare base and future year emissions to ensure that factors were properly applied
- Create percent and absolute difference maps to make sure that results are as expected
- Note: Future year fugitive dust inventories undergo meteorological and transport fraction reductions like the base year ones do

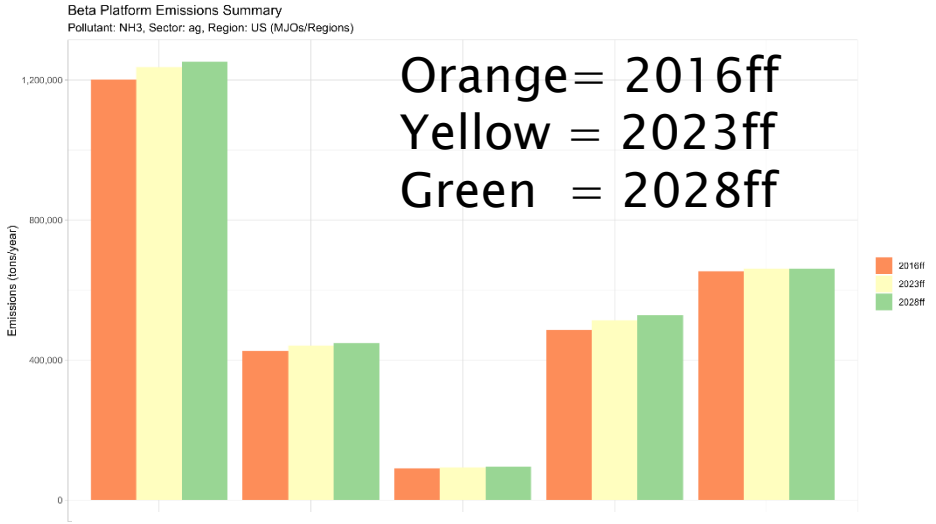
Regional Grouping for Bar Charts



Source: https://www.ladco.org/wp-content/uploads/Images/MJOs_Feb2019.png

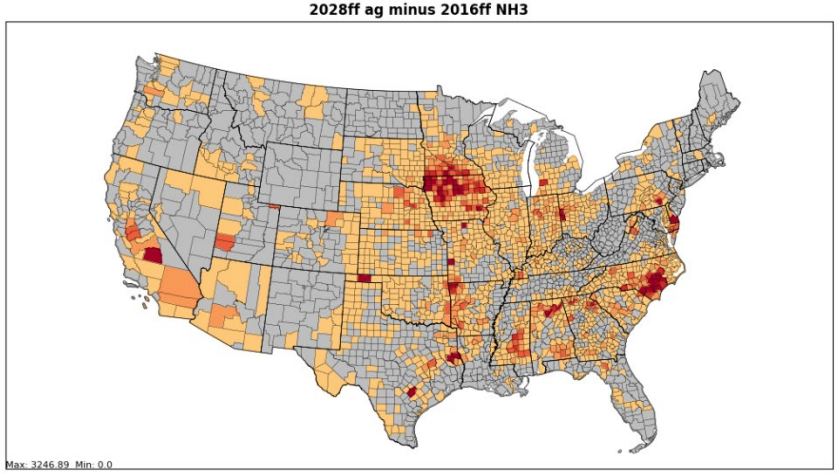
Changes in ag NH3 emissions 2016-2028

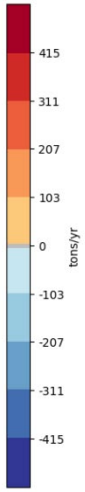




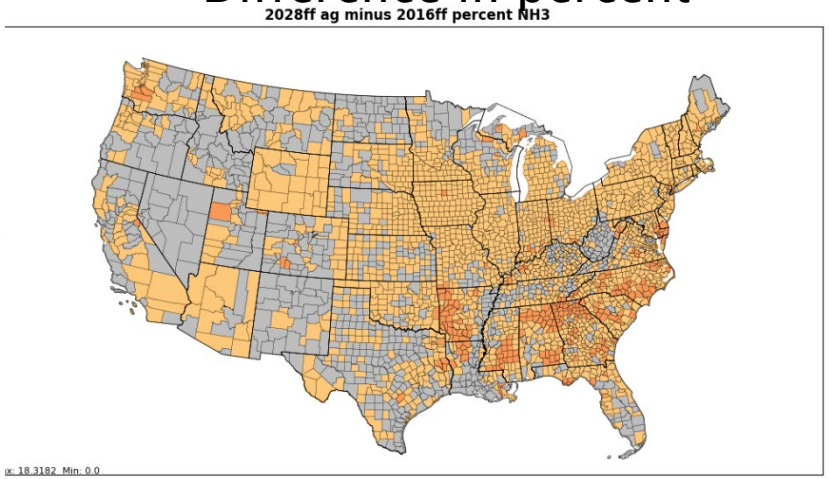
CENRAP LADCO Northeast SESARM WRAP

Difference in tons

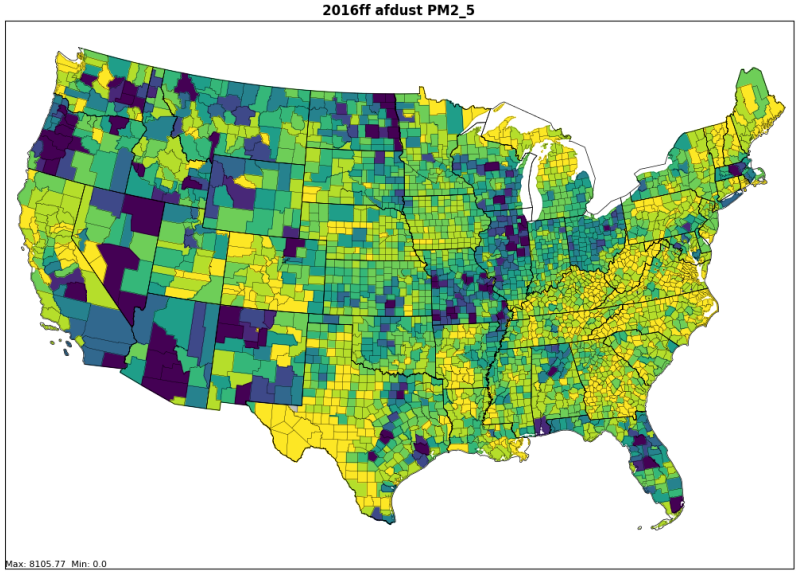


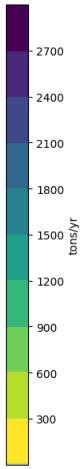


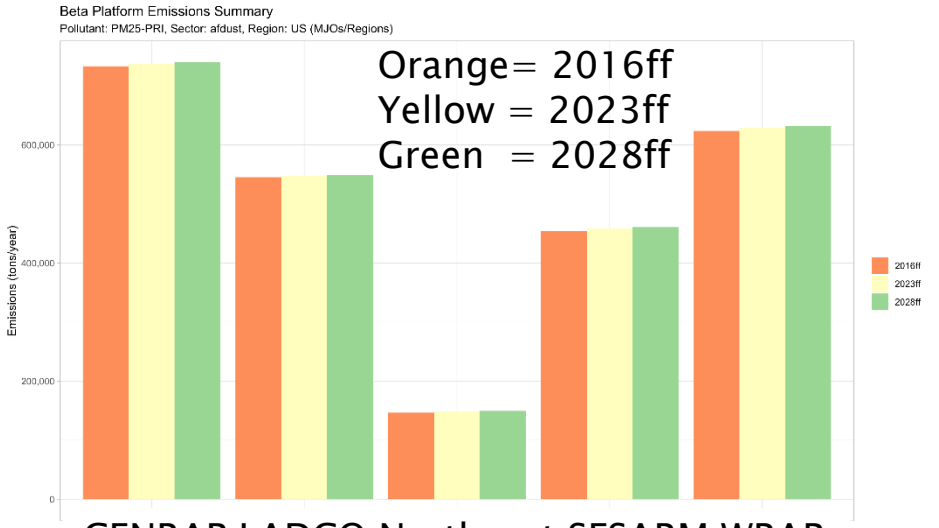
Difference in percent



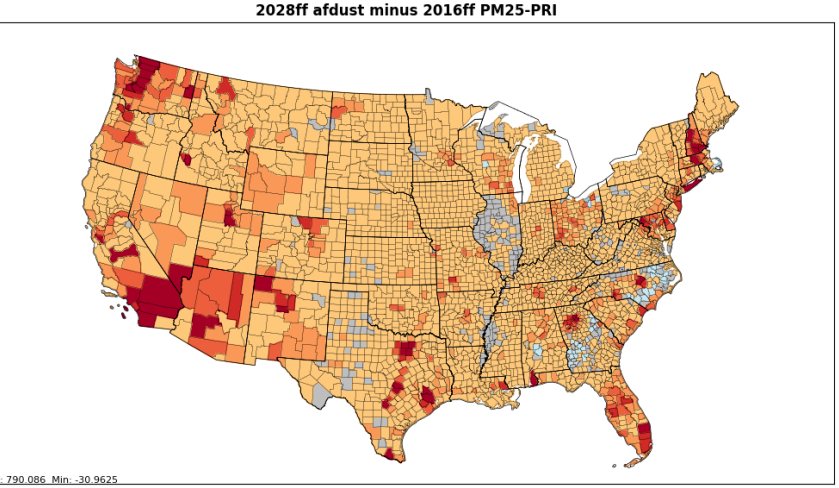
Changes in afdust PM2.5 2016-2028

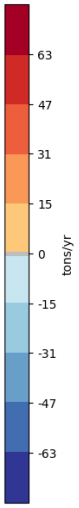


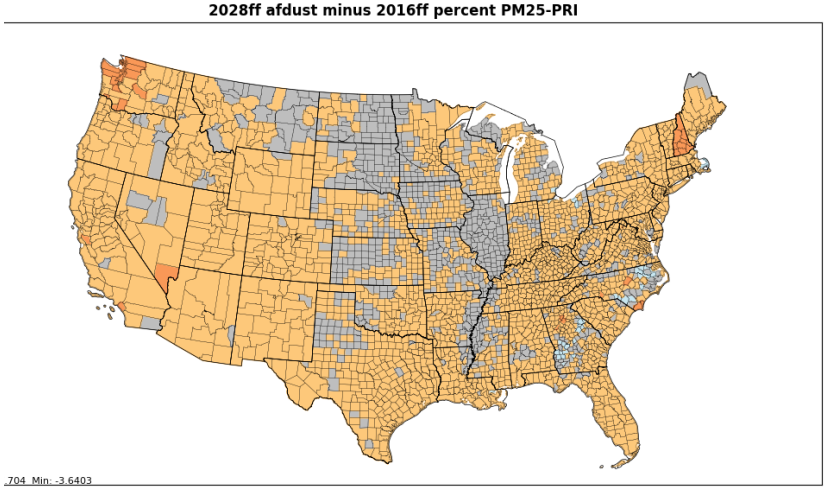


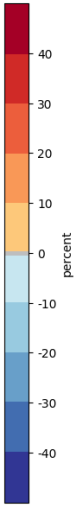


CENRAP LADCO Northeast SESARM WRAP









Nonpoint Projections: Residential Wood Combustion

- Growth derived from year 2012 appliance shipments and revenue forecasts (e.g. US Bureau of Economic Analysis)
- Updated to include the NSPS for 'wood heaters': https://www.epa.gov/residential-wood-heaters/final-2015-new-source-performance-standards-residential-wood-heaters
- Net decrease rather than increase in RWC emissions vs business as usual approach in prior platform
- Reflect year 2015 rulemaking and minor corrections
- Appliance-specific retirement/replacement rates for most sources
- "No-change" assumption used in western states: WA, OR, CA
- Burn bans not addressed due to their unpredictable episodic nature

Packets for RWC projections

- Different factors are applied by SCC (i.e., fireplaces, fireplace inserts, wood stoves), emissions held constant in CA, OR, WA

Sort Order: SCC, FIPS, POLL | Apply | Current: 1 - 184 Filtered: 184 of 184

Row Filter:

Decimal Places | Show Commas | Format | Reset View

FIPS String(12	SCC String(10)	PROJ_FACTOR Double	POLL String(16)	COMMENTS String(*)	RECORD_ID Integer	VERSION Integer	DELETE_VERSIONS String(*)
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	2104008310	.8167	PM10-PRI		10	0	
	2104008310	.8167	PM25-PRI		11	0	
	2104008310	.8340	VOC		12	0	
	2104008310	.8230			13	0	
06000	2104008320	1.0000	PM10-PRI		46	0	
06000	2104008320	1.0000	PM25-PRI		47	0	
06000	2104008320	1.0000			48	0	
41000	2104008320	1.0000	PM10-PRI		78	0	
41000	2104008320	1.0000	PM25-PRI		79	0	
41000	2104008320	1.0000			80	0	
53000	2104008320	1.0000	PM10-PRI		110	0	
53000	2104008320	1.0000	PM25-PRI		111	0	
53000	2104008320	1.0000			112	0	
	2104008320	1.0748	PM10-PRI		14	0	
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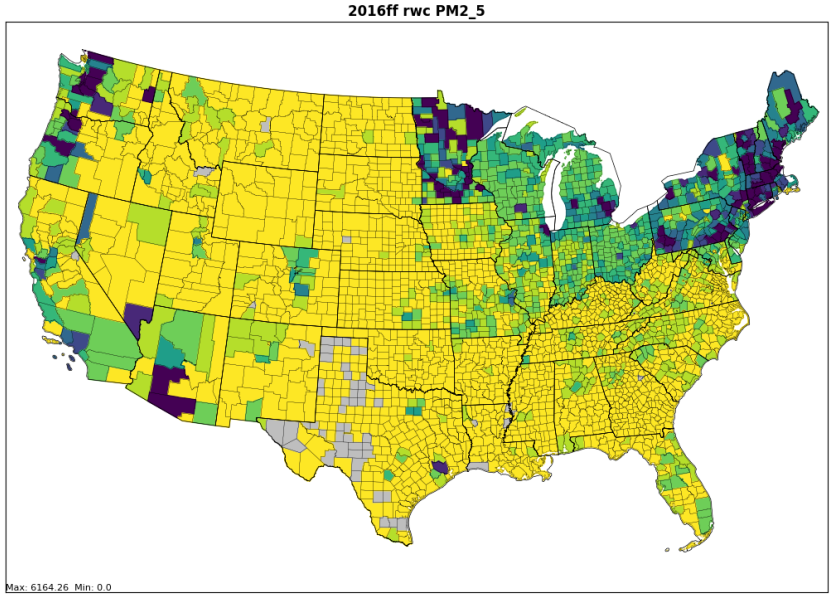
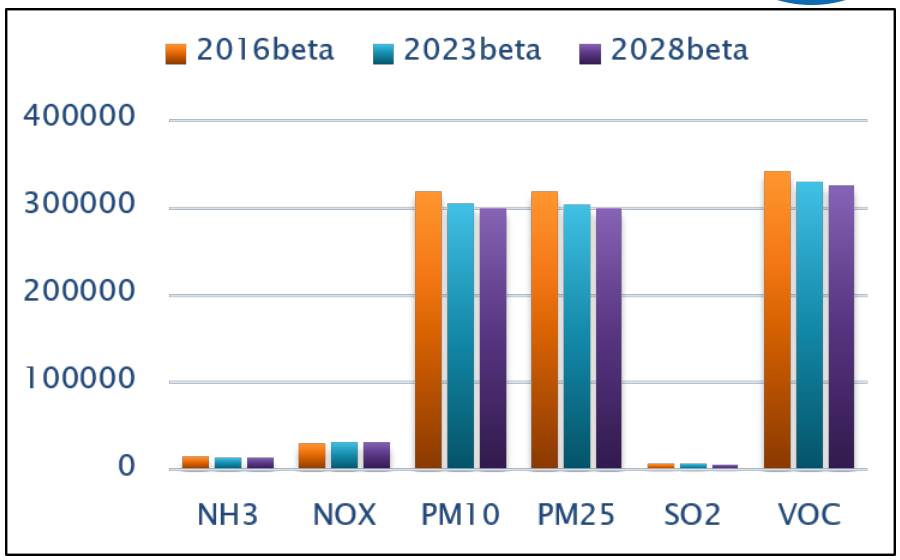
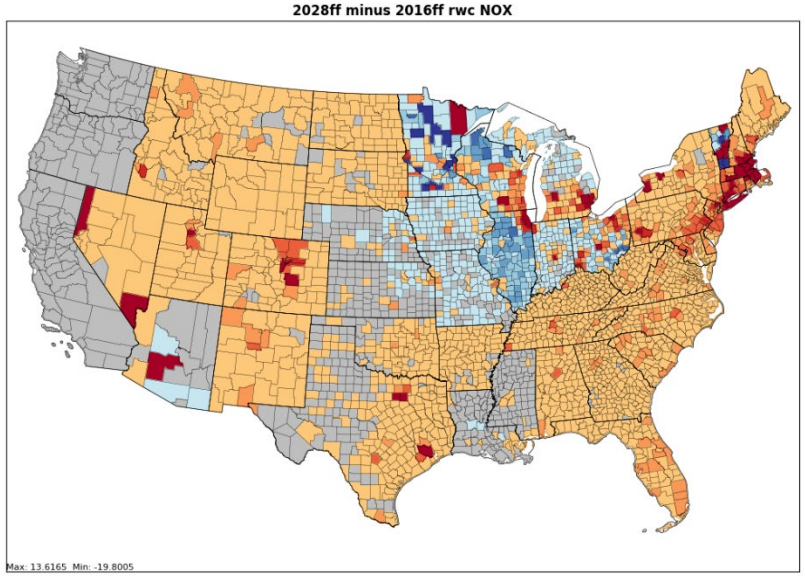
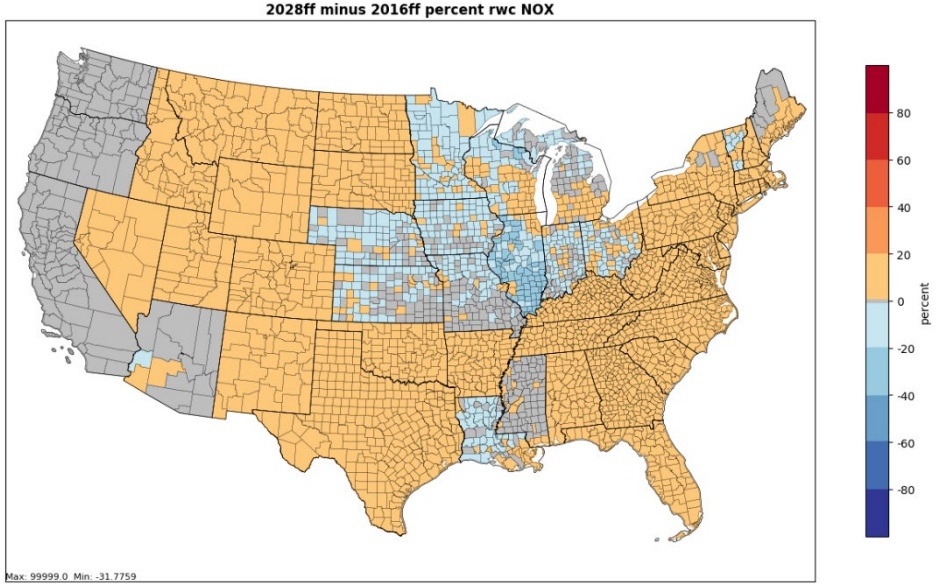
	2104008320	1.1608			16	0	

Changes in RWC Emissions 2016-2028









Questions?

- Any remaining questions on nonpoint sectors?

EGU Projection Methods

- EPA primarily uses the Integrated Planning Model (IPM)
  - The National Electric Energy Data System (NEEDS) database defines the sources used in IPM
  - NEEDS is regularly updated to reflect announced retirements and planned controls
    - Data sources include EIA Form 860, Emissions Tracking System (ETS) / CAMD Data and stakeholder comments
  - IPM has been updated over time to account for new data, including energy supply, demand, and prices, from a variety of sources, including EIA's Annual Energy Outlook
  - IPM output emissions are "dropped in" to replace ptegu emissions that were used in the base year
- For the 2023en case, engineering analysis was used
  - Incorporated historic 2016 emissions and other known upcoming changes to project to 2023
- ERTAC EGU model has been developed by MJOs
  - Used by many states and groups for planning purposes

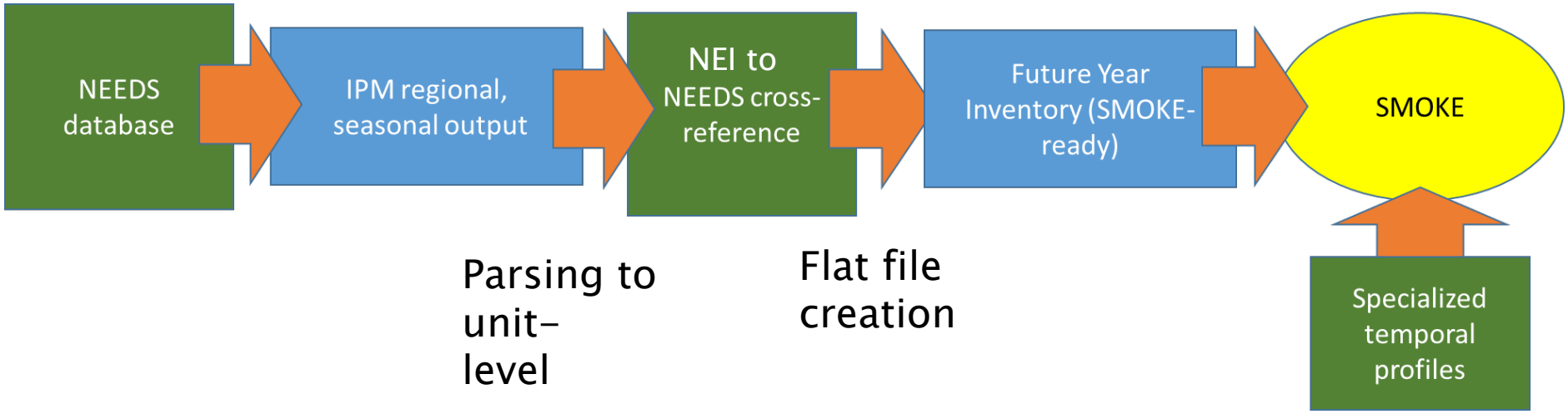
EGU Projections with IPM

- EGUs are identified in the NEI point inventory by filling in the IPM_YN column of the flat file
  - Populated from a set of alternate IDs stored in EIS
  - Sometimes there are not 1-1 matches between units in the NEI and the NEEDS database used by IPM
- IPM reflects impacts of rules in intervening years
  - E.g., CSAPR, MATS, BART
- IPM v6 produces outputs for these years:
  - 2021, 2023, 2025, 2030, 2035, 2040, 2045, 2050
  - Updated inputs, assumptions, and features
- More information on IPM is available here: https://www.epa.gov/airmarkets/clean-air-markets-power-sector-modeling

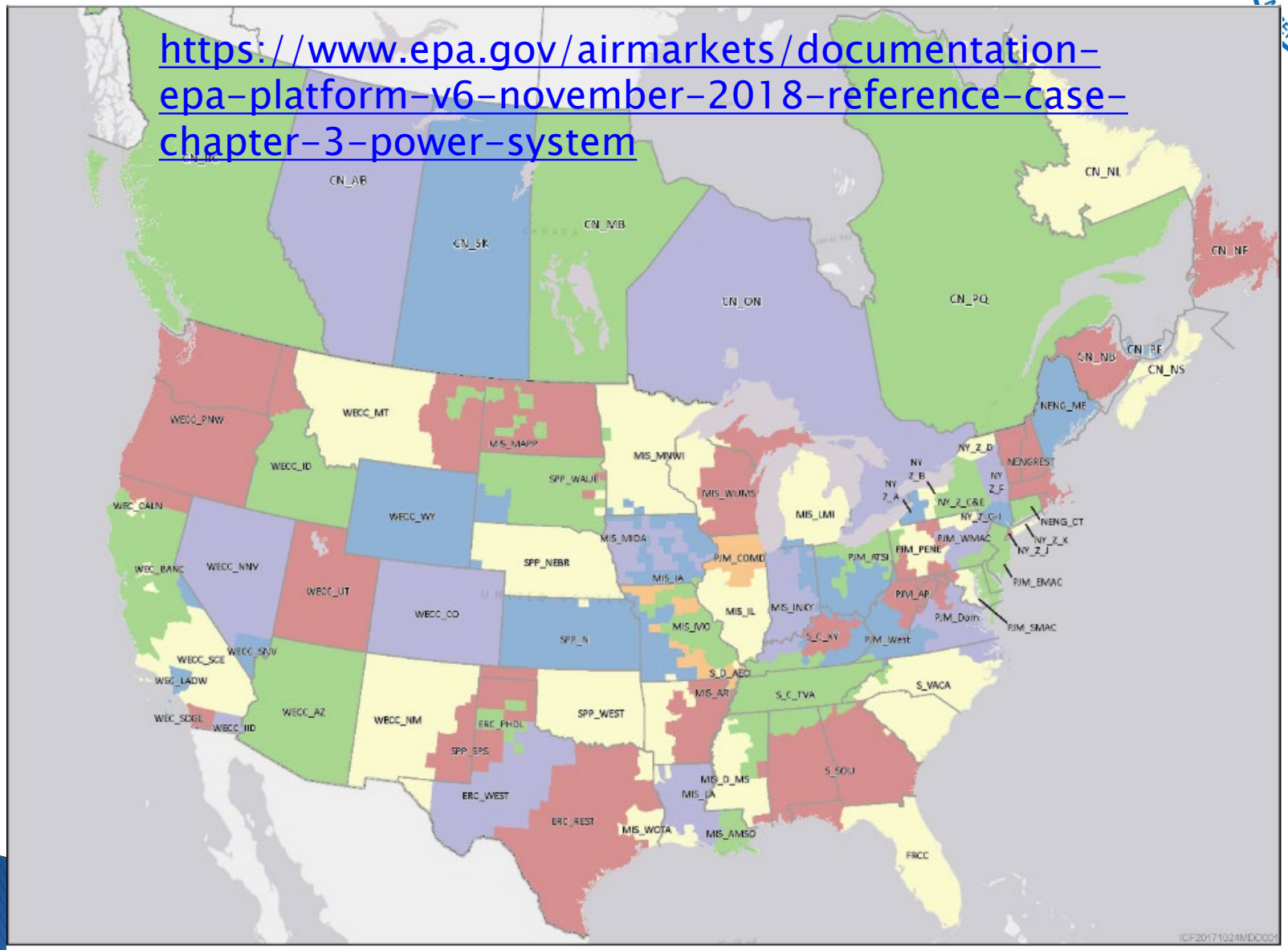
Flat Files Created from IPM Outputs

- IPM regional, seasonal outputs are converted to a Flat File format that can be input to SMOKE
  1. For a specific model output year, parse results to unit-level for each season (Pollutants = NO_x, SO_2, Hg, CO_2)
  2. SMOKE-ready Flat file is created from parsed file
     - Cross reference from National Electric Energy Data System (NEEDS) to NEI units is used to assign NEI-compatible IDs, locations, stack parameters (improved with state review)
     - PM emissions are created as a postprocess based on emission factors, fuel, and control information
- The base year EGU inventory is fully replaced by the flat file inventory output from IPM
  - IPM results not used in air quality modeling for geothermal, nuclear, wind, solar, or hydro

Future year EGU Processing with IPM



Map of 67 IPMv6 Output Regions

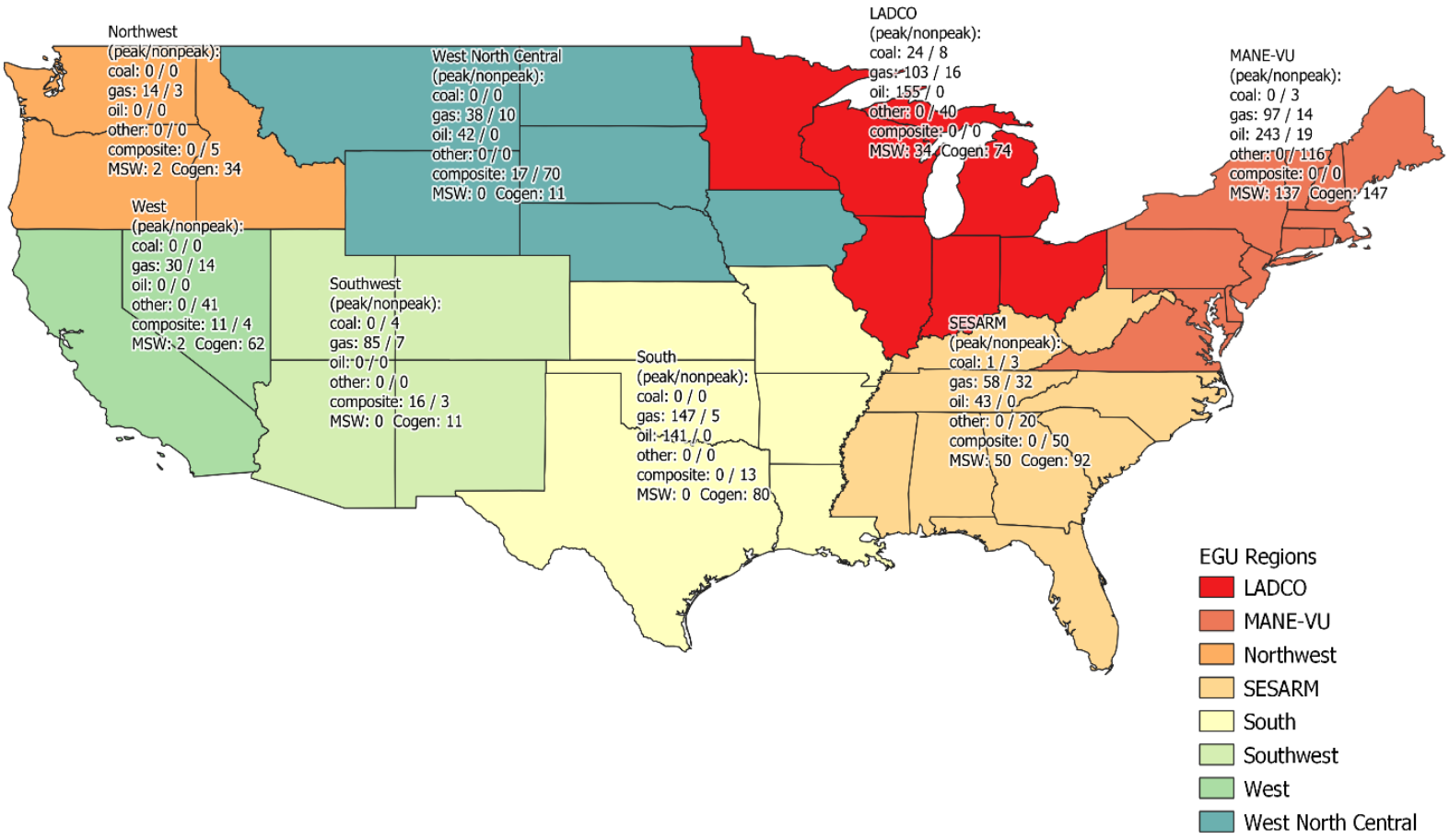


EGU Temporal Allocation for Future Years

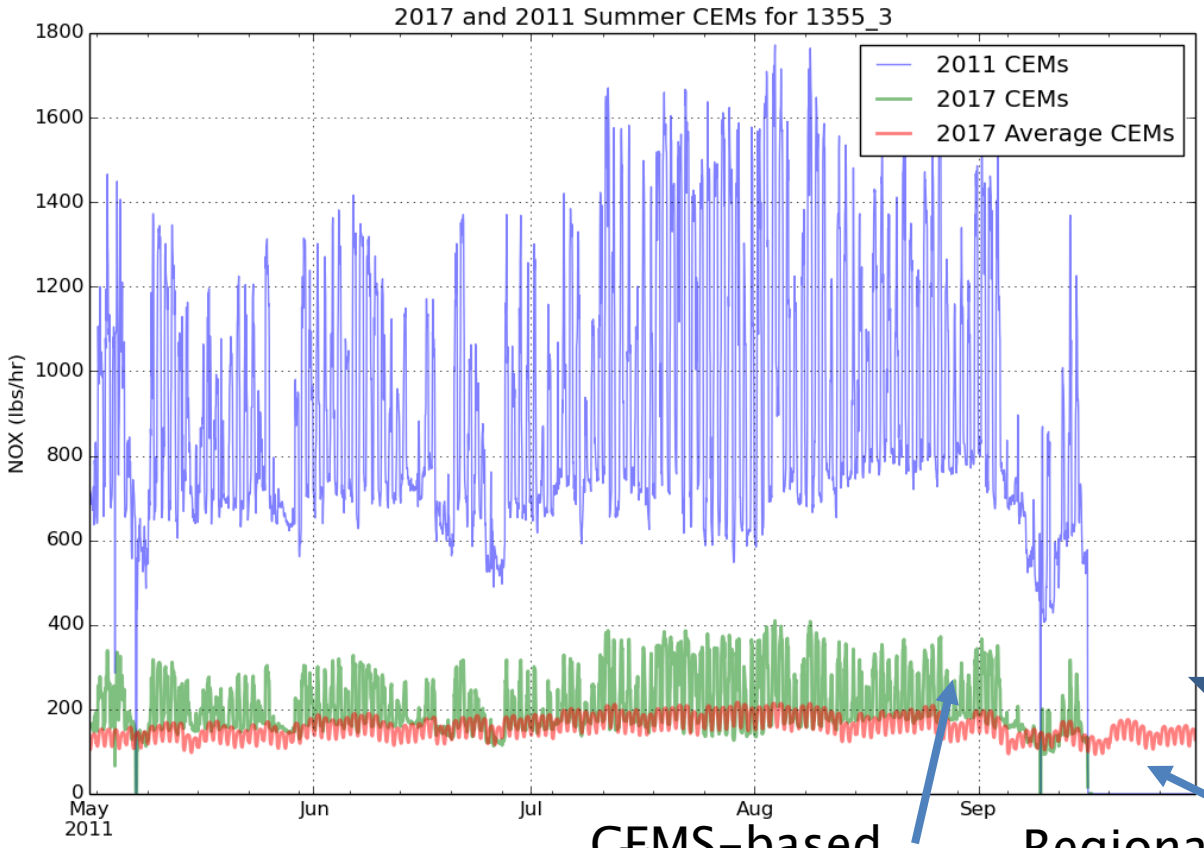
- For sources with CEMS that exist in both base and future years, allocate seasonal emissions to base year (2011 or 2016) hourly temporal pattern of CEMS data by pollutant (i.e., NOx, SO2)
  - Compute hourly ratio for each hour of season in base year and multiply that by the seasonal total to get the future year hourly emissions
- Units not matched to CEMS data (aka "non-CEMS") are temporalized using fuel- and pollutant-specific regional average profiles to allocate emissions to month, then day, then hour
  - Method is also used for new units, units with no base year emissions, units that change fuels from base to future, and units with large predicted increases in emissions

Temporal profile regions are Consistent with those used in base year

Small EGU 2016beta Temporal Profile Application Counts



Example Temporal Plots: base year, unit-specific, regional



1. Compute fraction of emissions @ each hour of the season (winter/summer)

2. Future emissions @ each hour = seasonal emissions * hourly factor

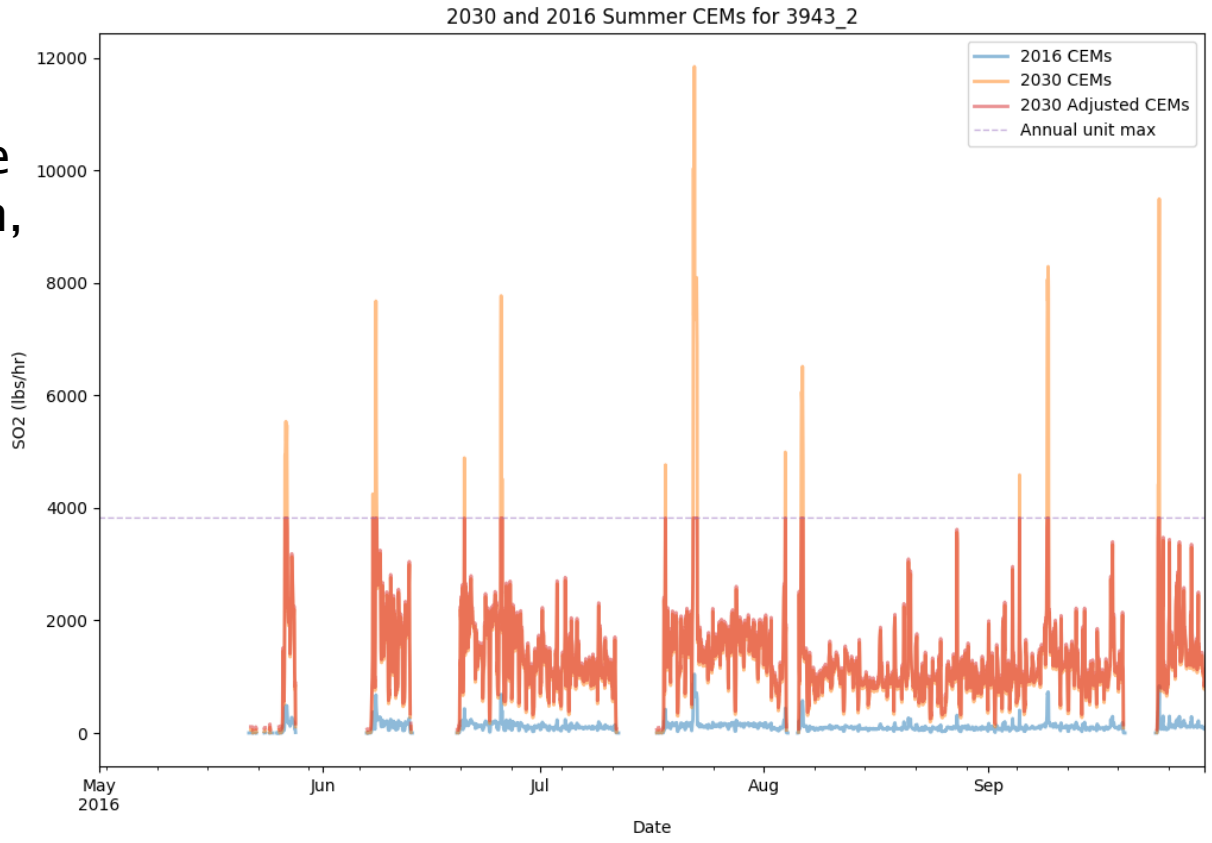
Seasonal emissions going down in this example

CEMS-based profile (green) has service gaps

Regional average profile (red) does not include gaps

Adjust Emissions Below Historic Maximum

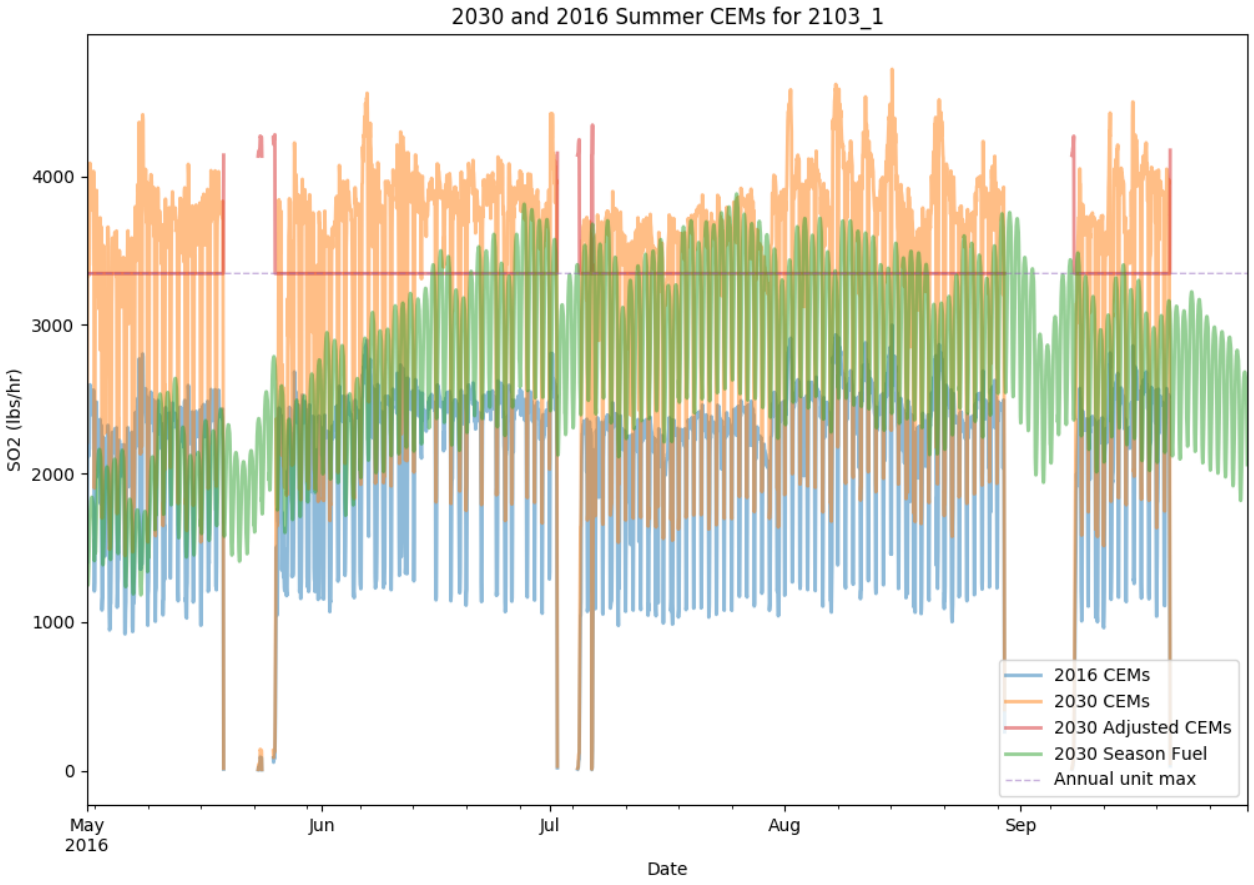
When emissions are found to go above the historic maximum, allocate the excess evenly to other hours



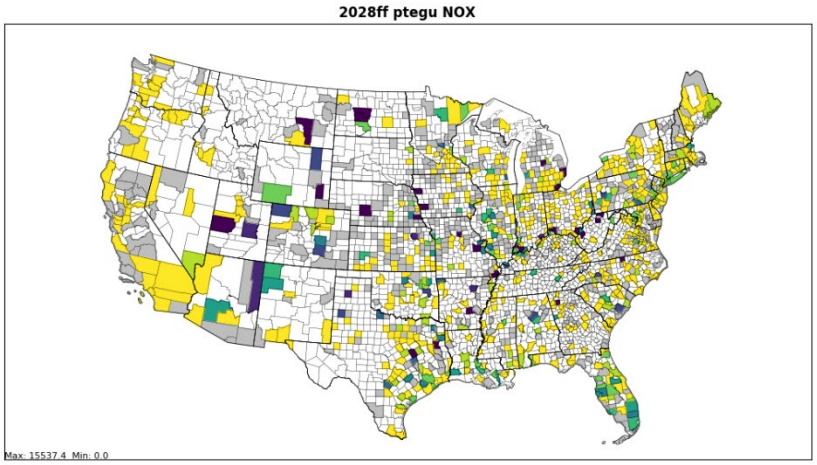
Use Regional Profile when Cannot Adjust below Historic Maximum

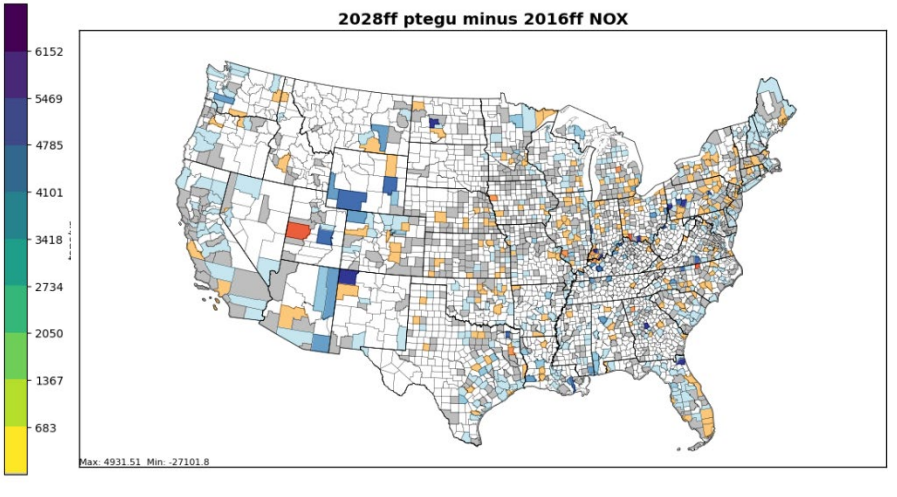
See 2023en emissions modeling TSD for more details

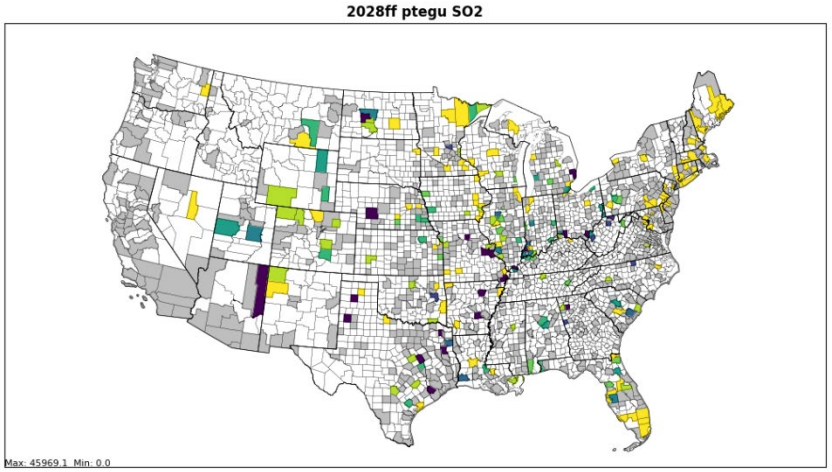
Regional Profile Applied but Exceeds Historic Maximum in Some Hours

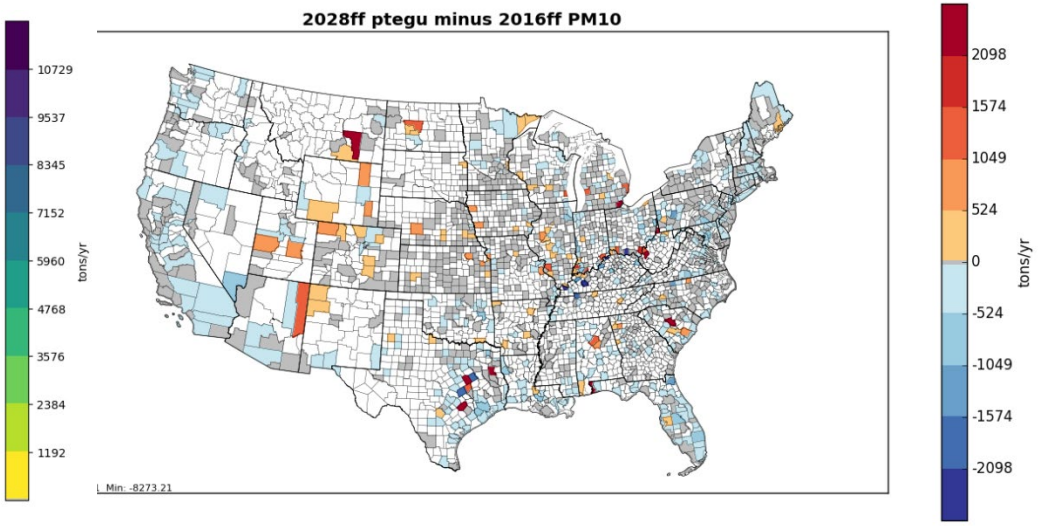


Changes in EGU emissions 2016-2028









Questions?

- Any questions on EGU projections?

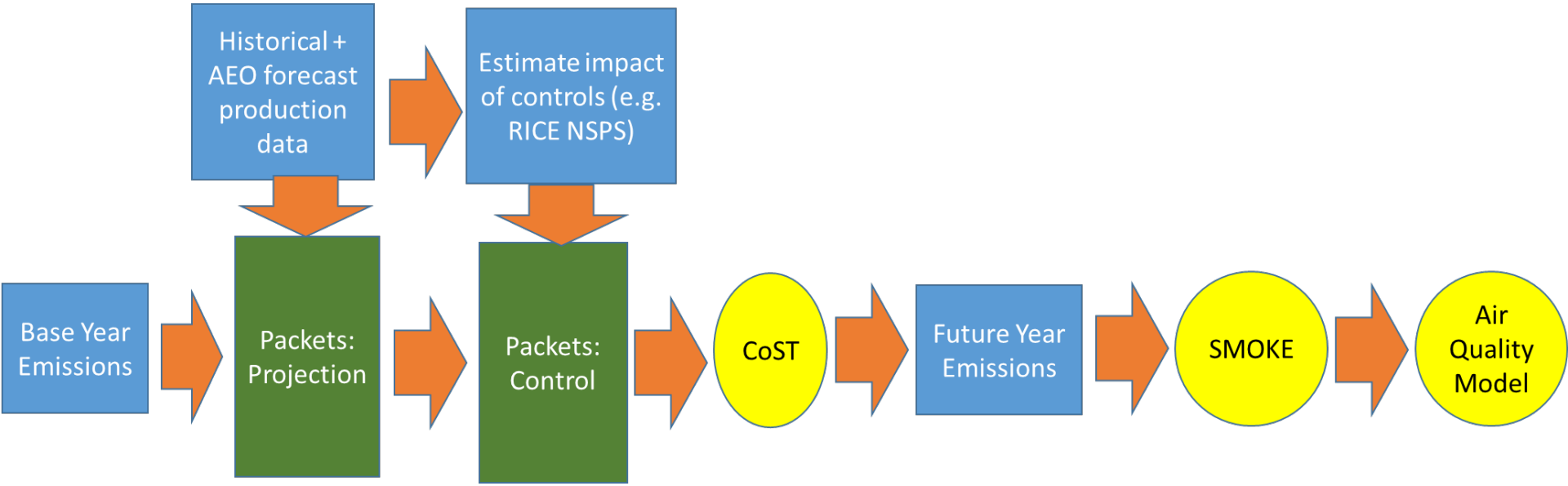
Oil and Gas Projections

- Volatile sector; industry changing frequently
- Various data sources
  - State and county historical data
  - Annual Energy Outlook (AEO) tables
- Various approaches are available

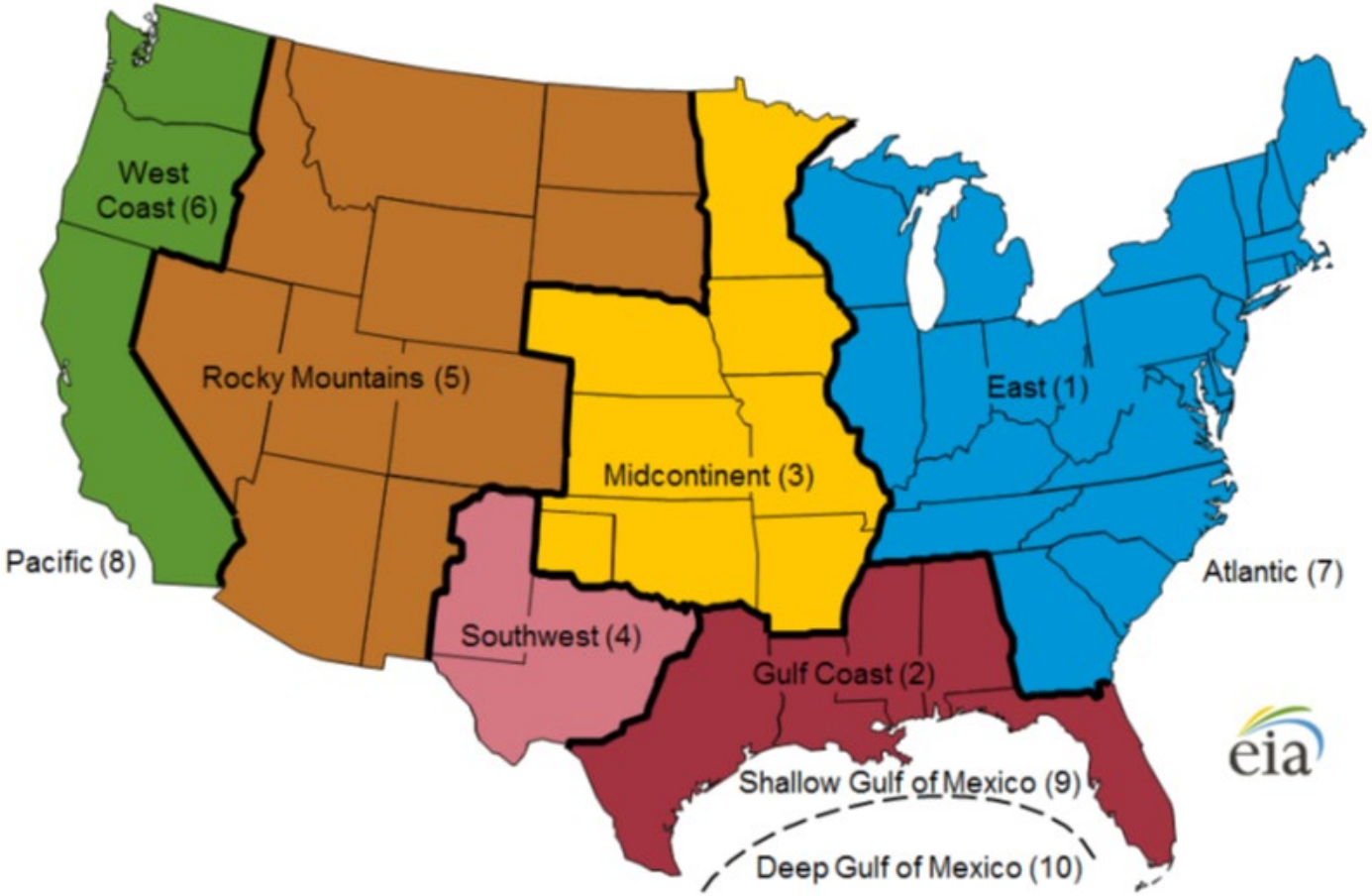
Oil and Gas Projections Overview

- Data sources
  - Annual Energy Outlook (AEO) production forecast data from the Energy Information Administration (EIA) to estimate activity in future years
  - State historical production data to capture recent growth
  - County historical exploration data from recent years
- New Source Performance Standards (NSPS) applications
- Includes both point and nonpoint sources
  - Point: Production, Pipelines, other supporting activities
  - Nonpoint: Production and Exploration
- Includes data and comments from states and regional planning organizations on the 2016 emissions platform

Applying Growth and Control Factors to Project Emissions



Oil and Gas Supply Regions: AEO2018



Source: U.S. Energy Information Administration.

Oil and Gas Supply Regions: AEO2019

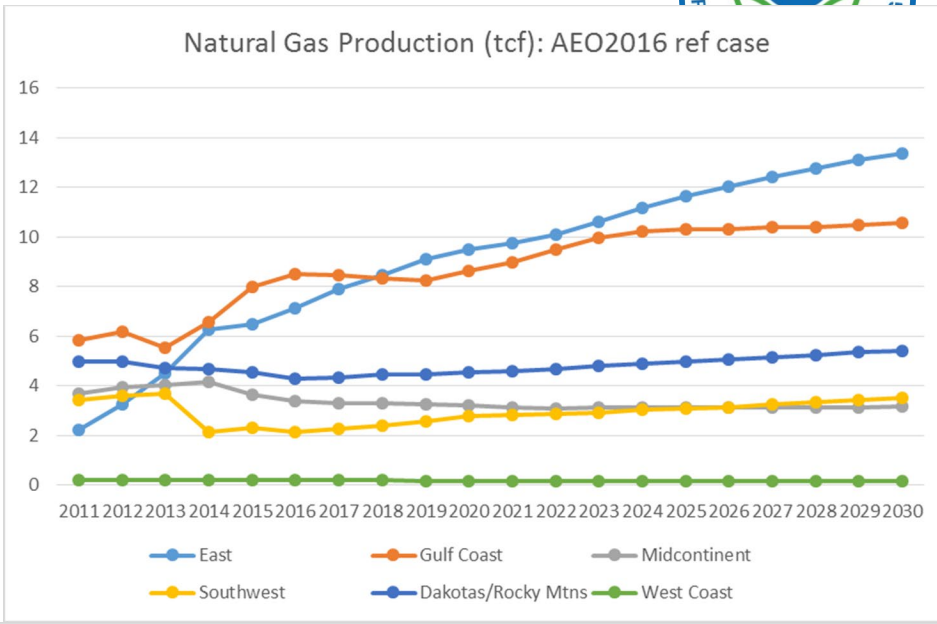
Rocky Mountain/Dakota region in AEO2018 now broken up into 2 regions

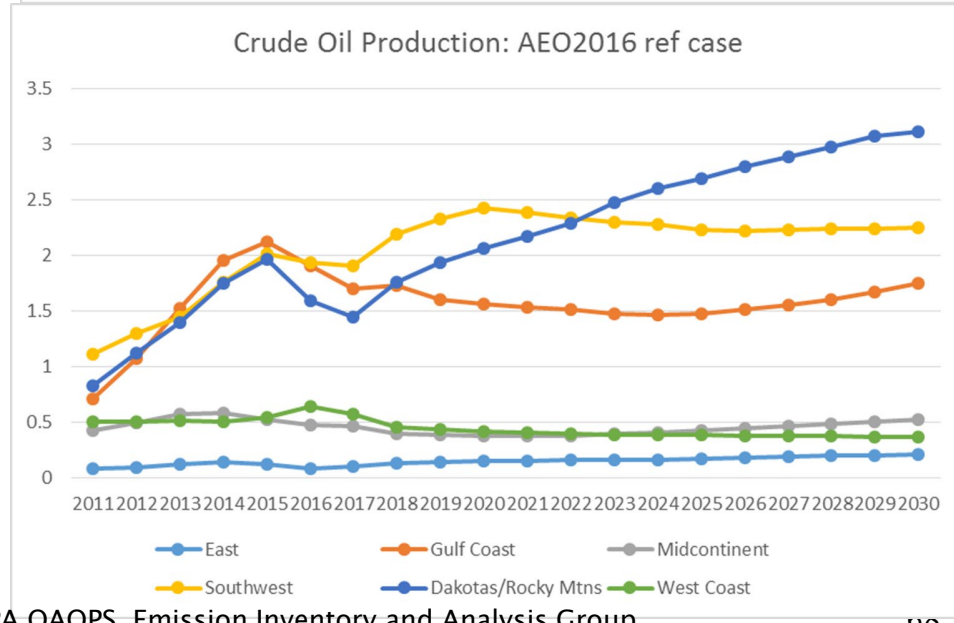
Oil and Gas Projections: Supply Region-Level Forecasts Method

- AEO Tables: Regional production
  - Table 60: lower 48 crude oil production
  - Table 61: lower 48 natural gas production
- AEO Tables: national production
  - Table 14: Oil and gas supply
    - Coalbed methane production
    - Natural gas liquids production
    - Offshore production: state-owned sources only
- Develop oil/gas/both cross-reference by source classification code (SCC) to apply regional/national factors

Oil and Gas Projections: Supply Region-level example used for 2011 platform

- Applied this method for 2011v6.3 modeling platform along with state-specific factors supplied from MARAMA
- Large regions where only 2-3 states make up the bulk of the production can cause issues with smaller-producing states in the region





AEO Supply Region example

60. Lower 48 Crude Oil Production and Wellhead Prices by Supply Region															
Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Production 1/															
(million barrels per day)															
Lower 48 Total	8.42	8.76	9.47	9.96	10.27	10.49	10.59	10.60	10.82	10.84	10.82	10.91	10.99	11.07	11.10
Lower 48 Onshore	6.75	6.98	7.61	7.95	8.22	8.40	8.54	8.69	8.83	8.94	9.03	9.19	9.31	9.43	9.54
East	0.15	0.15	0.18	0.18	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.24	0.24	0.24
Gulf Coast	1.65	1.57	1.61	1.80	1.84	1.87	1.91	1.95	1.97	1.97	1.98	1.99	1.99	1.98	1.98
Midcontinent	0.61	0.62	0.62	0.63	0.62	0.62	0.62	0.63	0.63	0.64	0.64	0.66	0.67	0.67	0.66
Southwest	2.11	2.49	2.99	3.09	3.29	3.43	3.52	3.61	3.68	3.74	3.79	3.85	3.90	3.95	3.99
Dakotas/Rocky Mountains	1.72	1.75	1.87	1.95	1.96	1.98	1.99	2.00	2.04	2.09	2.12	2.19	2.25	2.33	2.40
West Coast	0.51	0.41	0.34	0.31	0.31	0.30	0.29	0.29	0.28	0.28	0.27	0.27	0.27	0.26	0.26
Lower 48 Offshore	1.67	1.77	1.85	2.01	2.05	2.09	2.05	1.91	1.99	1.90	1.78	1.73	1.68	1.64	1.56
Gulf	1.62	1.70	1.79	1.95	1.99	2.03	2.00	1.86	1.94	1.85	1.74	1.68	1.62	1.57	1.49
200 meters	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
than 200 meters	0.21	0.19	0.13	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.06
Deep (Federal)	1.39	1.48	1.63	1.80	1.86	1.90	1.88	1.75	1.84	1.77	1.66	1.60	1.55	1.50	1.42
Pacific	0.05	0.08	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.07
State	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
Federal	0.01	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.04
Atlantic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Federal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

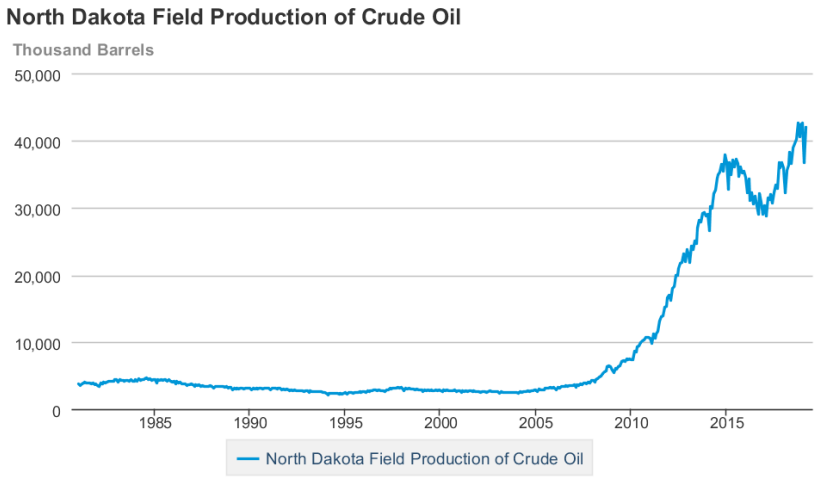
AEO Supply Region Example (2)

60. Lower 48 Crude Oil Production and Wellhead Prices by Supply Region

Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Production 1/													
(million barrels per day)													
Lower 48 Total	8.42	8.76	9.47	9.96	10.27	10.49	10.59	10.60	10.82	10.84	10.82	10.91	10.99
Lower 48 Onshore	6.75	6.98	7.61	7.95	8.22	8.40	8.54	8.69	8.83	8.94	9.03	9.19	9.31
East	0.15	0.15	0.18	0.18	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.24	0.24
Gulf Coast	1.65	1.57	1.61	1.80	1.84	1.87	1.91	1.95	1.97	1.97	1.98	1.99	1.99
Midcontinent	0.61	0.62	0.62	0.63	0.62	0.62	0.62	0.63	0.63	0.64	0.64	0.66	0.67
Southwest	2.11	2.49	2.99	3.09	3.29	3.43	3.52	3.61	3.68	3.74	3.79	3.85	3.90
Dakotas/Rocky Mountains	1.72	1.75	1.87	1.95	1.96	1.98	1.99	2.00	2.04	2.09	2.12	2.19	2.25
West Coast	0.51	0.41	0.34	0.31	0.31	0.30	0.29	0.29	0.28	0.28	0.27	0.27	0.27
East Projection factor	1.000	1.020	1.211	1.256	1.302	1.344	1.393	1.429	1.468	1.499	1.534	1.605	1.629
Gulf Coast factor	1.000	0.951	0.978	1.087	1.113	1.133	1.157	1.183	1.193	1.195	1.199	1.202	1.206
Lower 48 Offshore	1.67	1.77	1.85	2.01	2.05	2.09	2.05	1.91	1.99	1.90	1.78	1.73	1.68
Gulf	1.62	1.70	1.79	1.95	1.99	2.03	2.00	1.86	1.94	1.85	1.74	1.68	1.62
200 meters	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
than 200 meters	0.21	0.19	0.13	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.06
Deep (Federal)	1.39	1.48	1.63	1.80	1.86	1.90	1.88	1.75	1.84	1.77	1.66	1.60	1.55
Pacific	0.05	0.08	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
State	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Federal	0.01	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Atlantic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Oil and Gas Projections: Historical State Data + AEO Supply Region Method

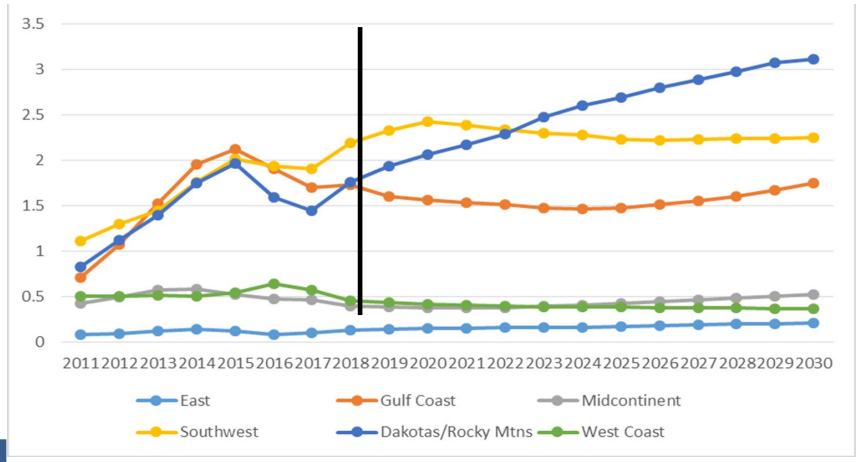
Historical state change



eia Source: U.S. Energy Information Administration

X

AEO Supply Region change



Combined factors representing both historical state data and AEO supply region change for each state

Oil and Gas Projections: Online Historical State Data

- Historical state production data publicly available on EIA website used to project sources from a base year to a recent year (e.g. 2016 to 2017 or 2018)
  - Natural Gas
    http://www.eia.gov/dnav/ng/ng_sum_lsum_a_epg0_fgw_mmcf_a.htm
  - Crude Oil
    http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm
  - Coalbed methane
    https://www.eia.gov/dnav/ng/ng_prod_coalbed_s1_a.htm

Oil and Gas Projections: Historical State Data Bridge to Supply Region-Level Forecast

- Then use AEO Supply Region production forecasts to project from 2017 or 2018 to desired future year
  - Some adjustments based on historical trends for "low production" states may be needed
- Combine factors to get a state-specific projection factor from base year to desired future year
- For nonpoint sources use SCC-oil/gas/both cross-reference to apply state-specific factors
- For point sources use a oil/gas/both cross-reference by SCCs and North American Industry Classification System (NAICS) codes to apply state-specific factors

Oil and Gas Projections: NSPS Controls

- New Source Performance Standards applications
  - Oil and Gas (VOC)
  - Process Heaters (NOX)
  - Reciprocal Internal Combustion (IC) Engines (NOX, CO and VOC)
  - Natural Gas Turbines (NOX)
- Point and nonpoint sources where applicable

Oil and Gas Projections: NSPS Controls

- For future-year NSPS controls, we attempted to control only new sources/equipment
  - Accounts for growth and retirement of existing sources and the differences between the new and existing source emission rates

$$\text{Control\_Efficiency}\ (\%) = 100 * (1 - [(P_f - 1) * Fn + (1 - Ri)^t + (1 - (1 - Ri)^t) * Fn] / P_f)$$

P_f = growth rate expressed as ratio (e.g. 1.5=50% cumulative growth)

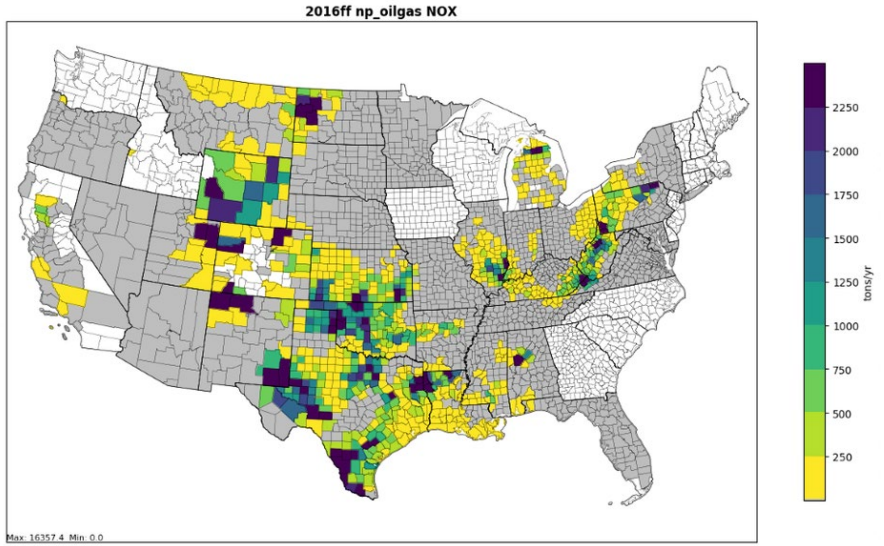
t = number of years between base and future years

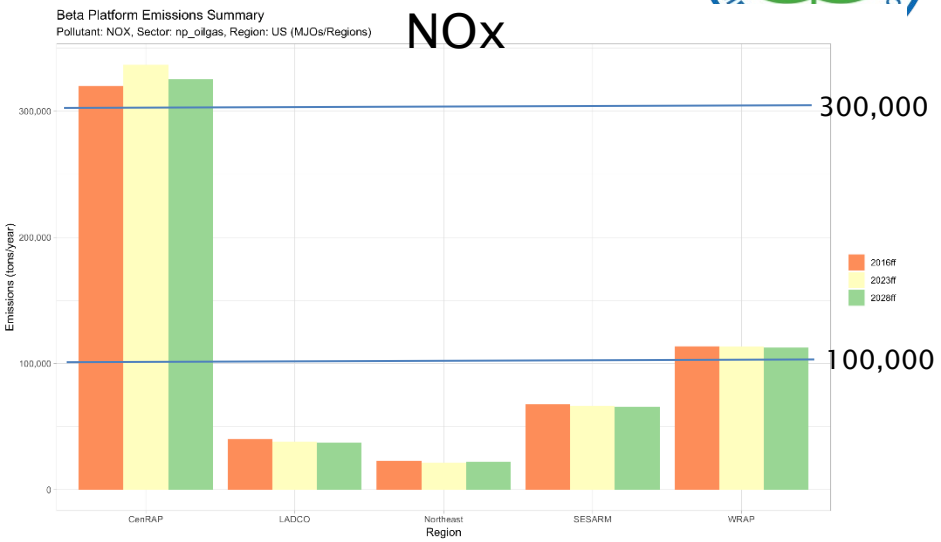
Fn = emission factor ratio for new sources

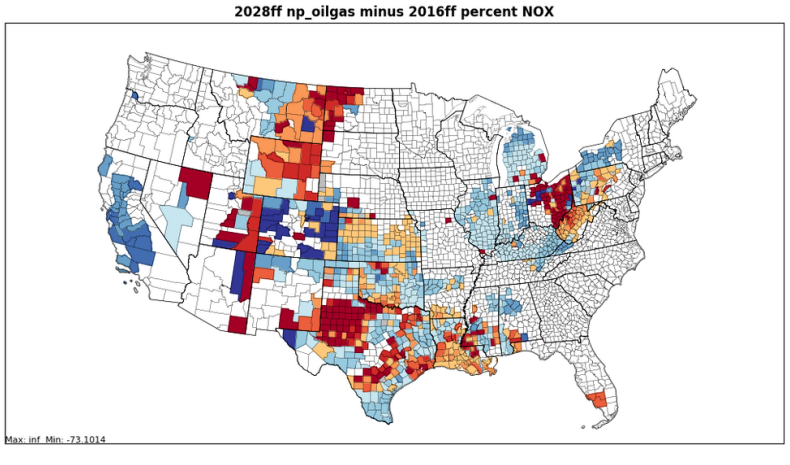
Ri = retirement rate, expressed as decimal (e.g., 3.3%=0.033)

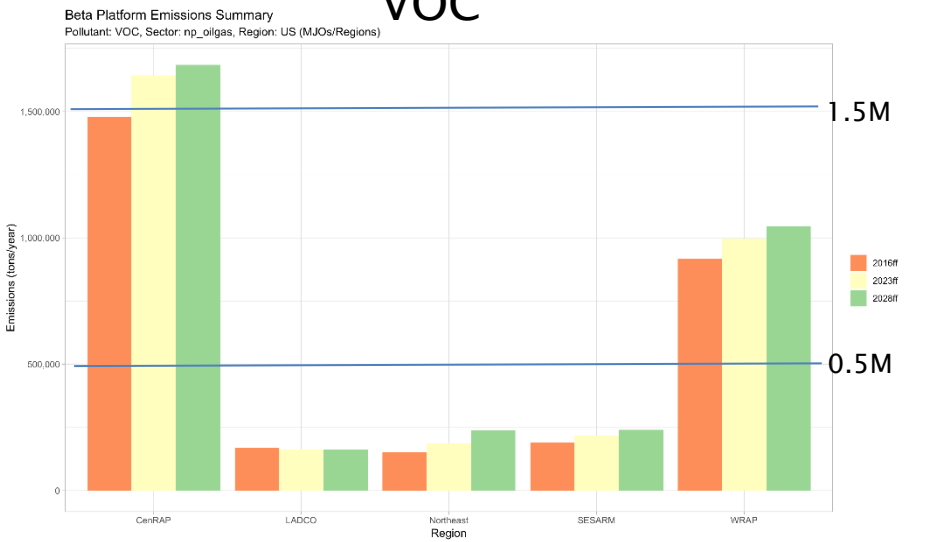
Changes in Nonpoint Oil/Gas 2016 to 2028 beta

NOx

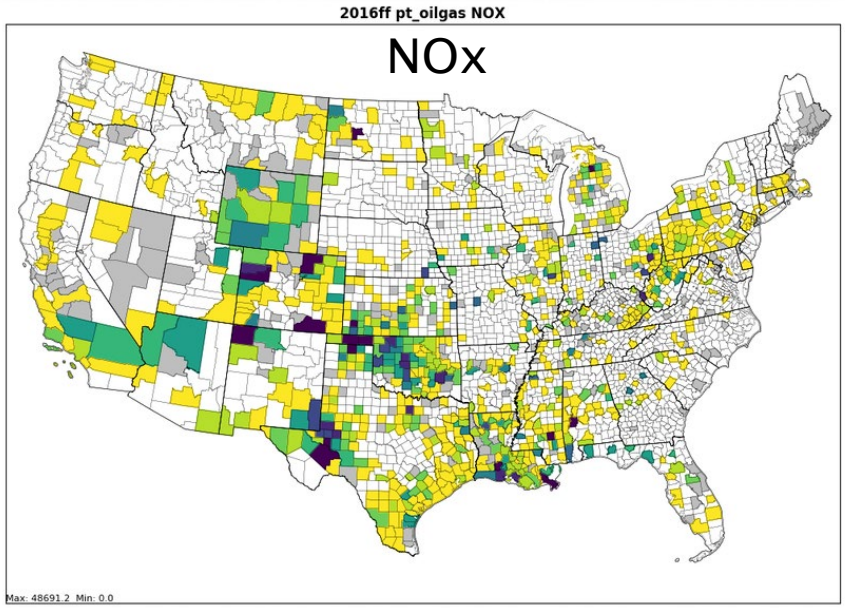


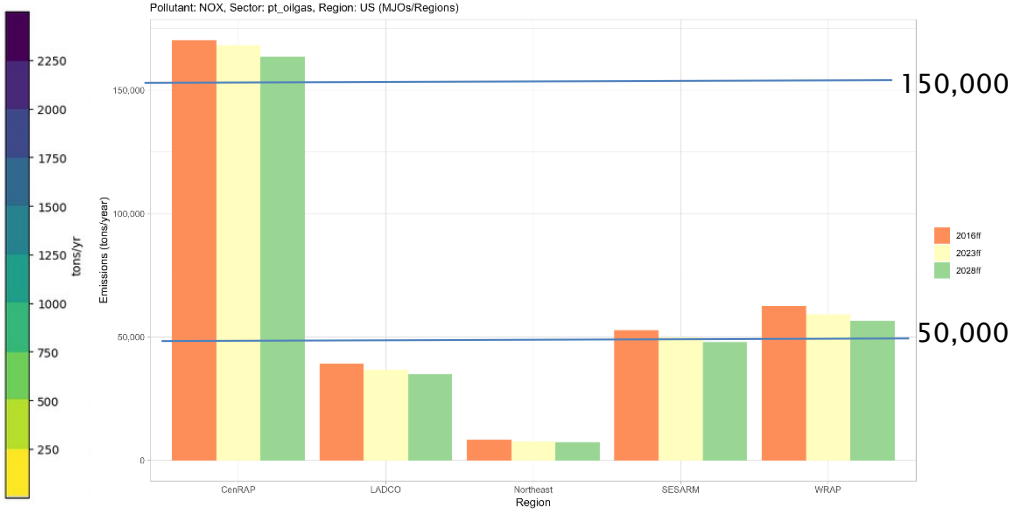


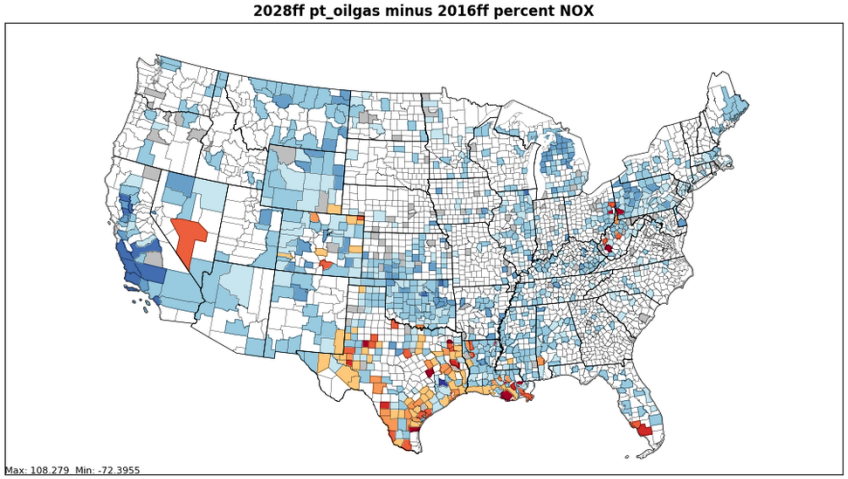


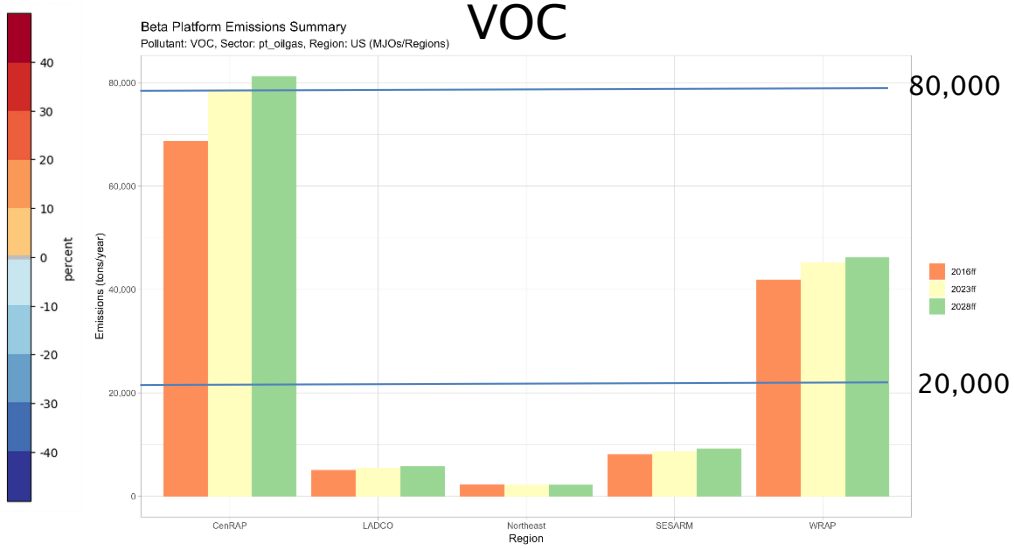


Changes in Point Oil/Gas 2016 to 2028 beta









Possible Future Work for Oil and Gas Projections

- Continue to examine methods to take basin-level information into account where possible
- Include more state or county historical data when possible
- Better incorporate state and any updated federal regulations on emissions
- Improve NAICS and SCC cross-references
  - Some states submit with different SCCs than others
- Consider approaches for other non-production related point sources (e.g. pipelines and other supporting activities)

Questions on Oil and Gas Projections?

Non-EGU Point Projections: Aviation

- Aircraft emissions are in ptnonipm sector
- Projected itinerant ITN (i.e., take off and landing) operations information available from the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System:
- https://www.faa.gov/data_research/aviation/taf/
- Two sets of projections factors used:
  - State-level for low traffic airports
  - Airport-specific factors for larger airports
  - 15,000 of 24,000 factors = 1.0 including most military aircraft; others could be less than or equal to 1.0

Example Projection Factors for Aviation

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01000	2267008005	2.0000		AL State-specific ITN aggregated for Commercial Aircraft: LPG Airport Gr
01000	2268008005	2.0000		AL State-specific ITN aggregated for Commercial Aircraft: CNG Airport Gr
01000	2270008005	2.0000		AL State-specific ITN aggregated for Commercial Aircraft: Diesel Airport
01000	2275000000	2.0000		AL State-specific ITN aggregated for All Aircraft Types and Operations
01000	2275001000	1.0000		AL State-specific ITN aggregated for Military Aircraft, Total
01000	2275020000	2.0000		AL State-specific ITN aggregated for Commercial Aviation, Total
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01000	2275060011	.5000		
01000	2275060012	.5000		
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01000	27501015	1.0000		
01000	27502011	2.0000		
01000	27505001	1.0000		
01000	27505011	1.0000		

Sort Order

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Apply

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Decimal Places ☑ Show Commas Format ☐ Reset View

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01045	2275050012	1.0178		LOCID=DHN: Dothan Rgnl: General Aviation, Turbine	171	
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01073	2267008005	1.6771		LOCID=BHM: Birmingham Intl: Commercial Aircraft: LPG ...	258	
01073	2268008005	1.6771		LOCID=BHM: Birmingham Intl: Commercial Aircraft: CNG ...	259	
01073	2270008005	1.6771		LOCID=BHM: Birmingham Intl: Commercial Aircraft: Dies...	260	
01073	2275000000	1.6771		LOCID=BHM: Birmingham Intl: All Aircraft Types and Op...	261	
01073	2275001000	1.0890		LOCID=BHM: Birmingham Intl: Military Aircraft, Total	262	
01073	2275020000	1.6771		LOCID=BHM: Birmingham Intl: Commercial Aviation, Total	263	
01073	2275050011	.9873		LOCID=BHM: Birmingham Intl: General Aviation, Piston	264	

Non-EGU CoST Packets

- Closures: 2016 beta platform
- Control: 2016-2028 nonpt ptnonipm RICE NSPS beta platform
- Control: 2016-2028 ptnonipm Natural Gas Turbines NSPS beta platform
- Control: 2016-2028 ptnonipm Process Heaters NSPS beta platform
- Control: 2016-202X ptnonipm AZ Regional Haze beta platform
- Control: 2016-202X ptnonipm CISWI beta platform
- Control: 2016-202X ptnonipm Consent Decrees and other comments
- Control: 2016-202X ptnonipm NSPS Subpart Ja beta platform
- Control: 2016-20XX MANEVU Sulfur beta platform
- Control: 2016-20XX NC Boiler MACT beta platform
- PROJECTION 2016-2028 industrial SCC beta platform
- PROJECTION 2016-2028 industrial SCC-NAICS beta platform
- PROJECTION 2016-2028 ptnonipm aircraft beta platform
- PROJECTION 2016-2028 rail beta platform

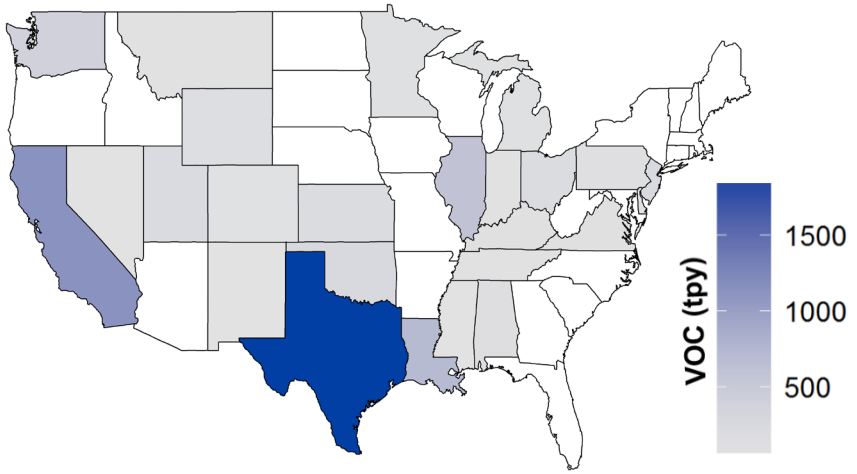
Non-EGU Projections: Non-CoST

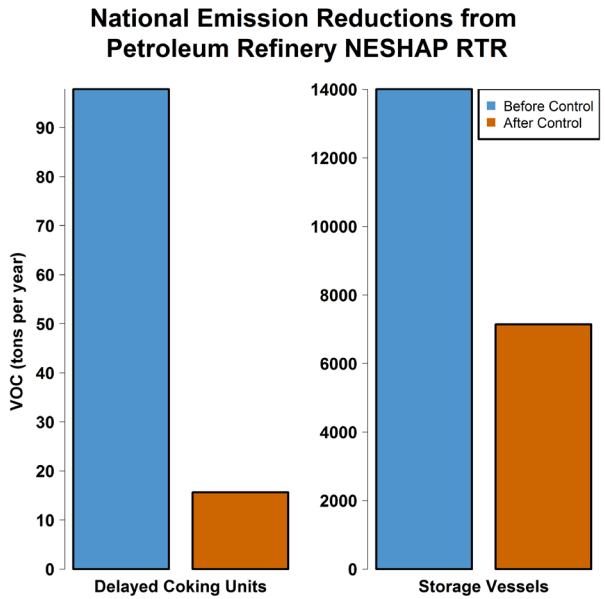
- Some future-year sources do not exist in the NEI for the base year
  - Biodiesel and cellulosic ethanol plants
  - Other sources added based on comments
- Take emissions for these sources as they are reported / provided
  - These are put into separate inventory files
  - Hard to project to additional future years

Non-EGU Projections:
Petroleum Refineries – NSPS Subpart JA

Rule effective February 2016 – VOC reductions from controls at delayed coking units and storage vessels

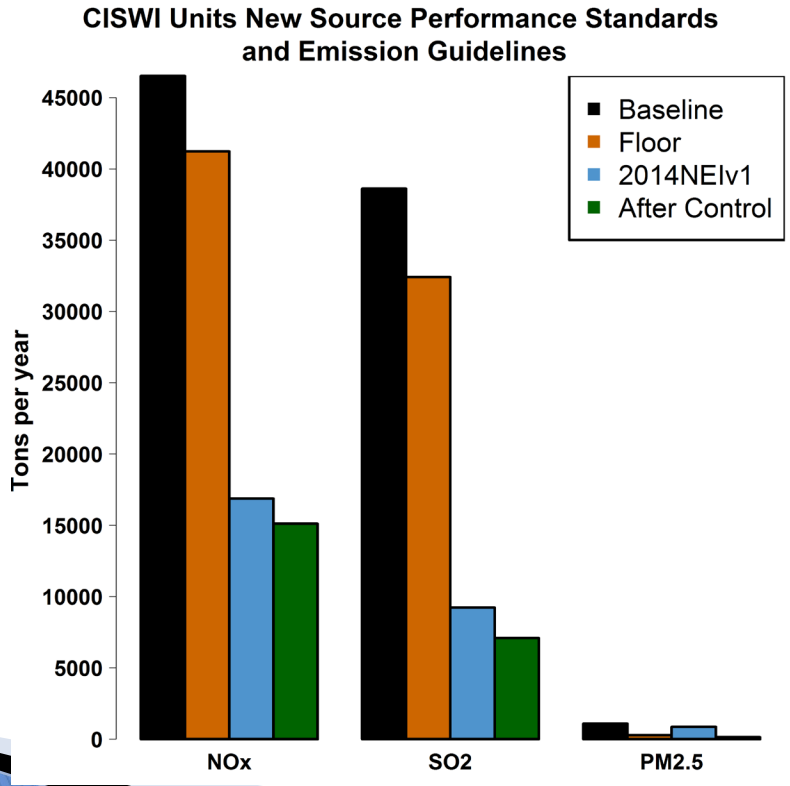
- Across-the-board control factor for impacted units
  - 84% for delayed coking units; 49% for storage vessels





Non-EGU Projections:
CISWI Units – NSPS and Emission Guidelines

- Considers the MACT for incinerators, energy recovery units, waste-burning kilns, small, remote incinerators
- All impacted units are to have control devices in place by 2018

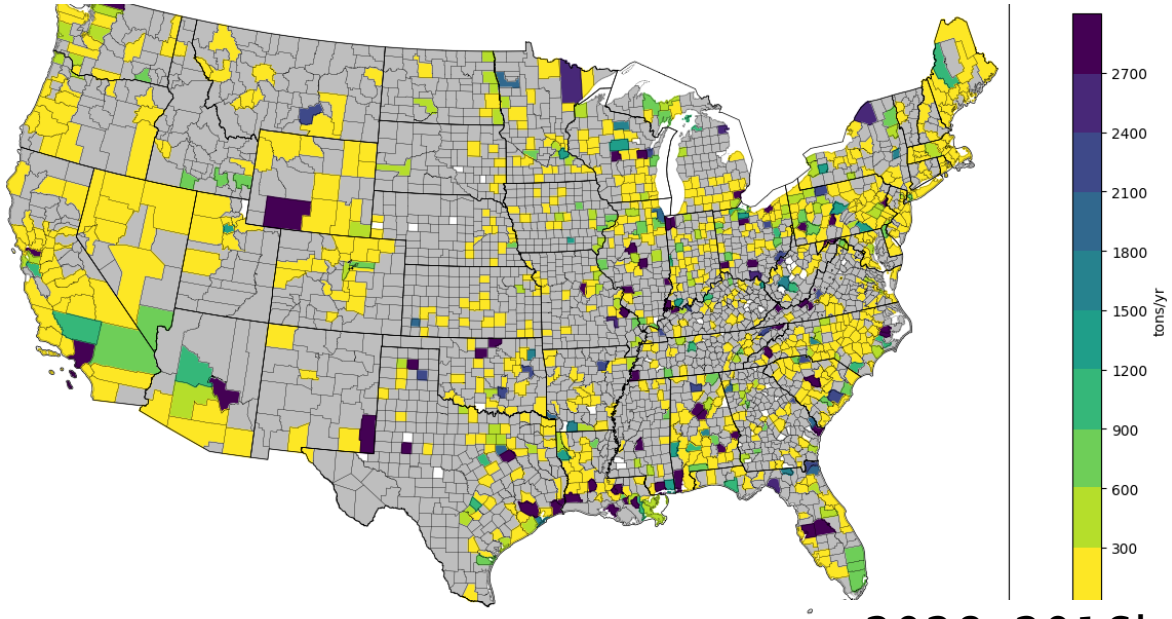


Existing control devices and baseline emissions based on a 2008-2009 Information Collection Request

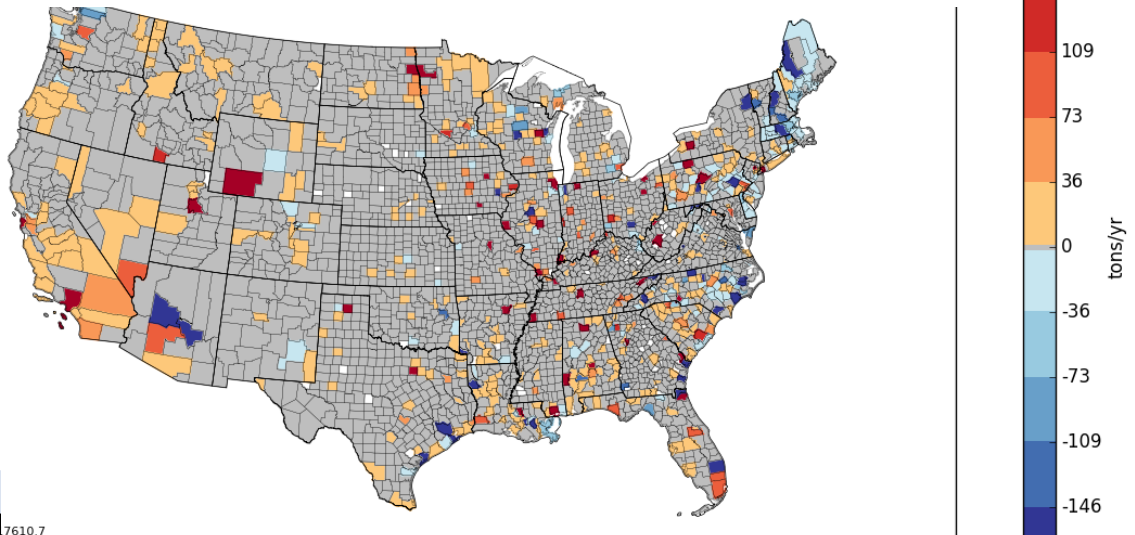
Floor emissions represent all units' emissions after employing least-cost controls to meet MACT standard

Changes in Non-EGU Point 2016-2028

2016beta non-EGU Point SO2



2028-2016beta non-EGU Point SO2



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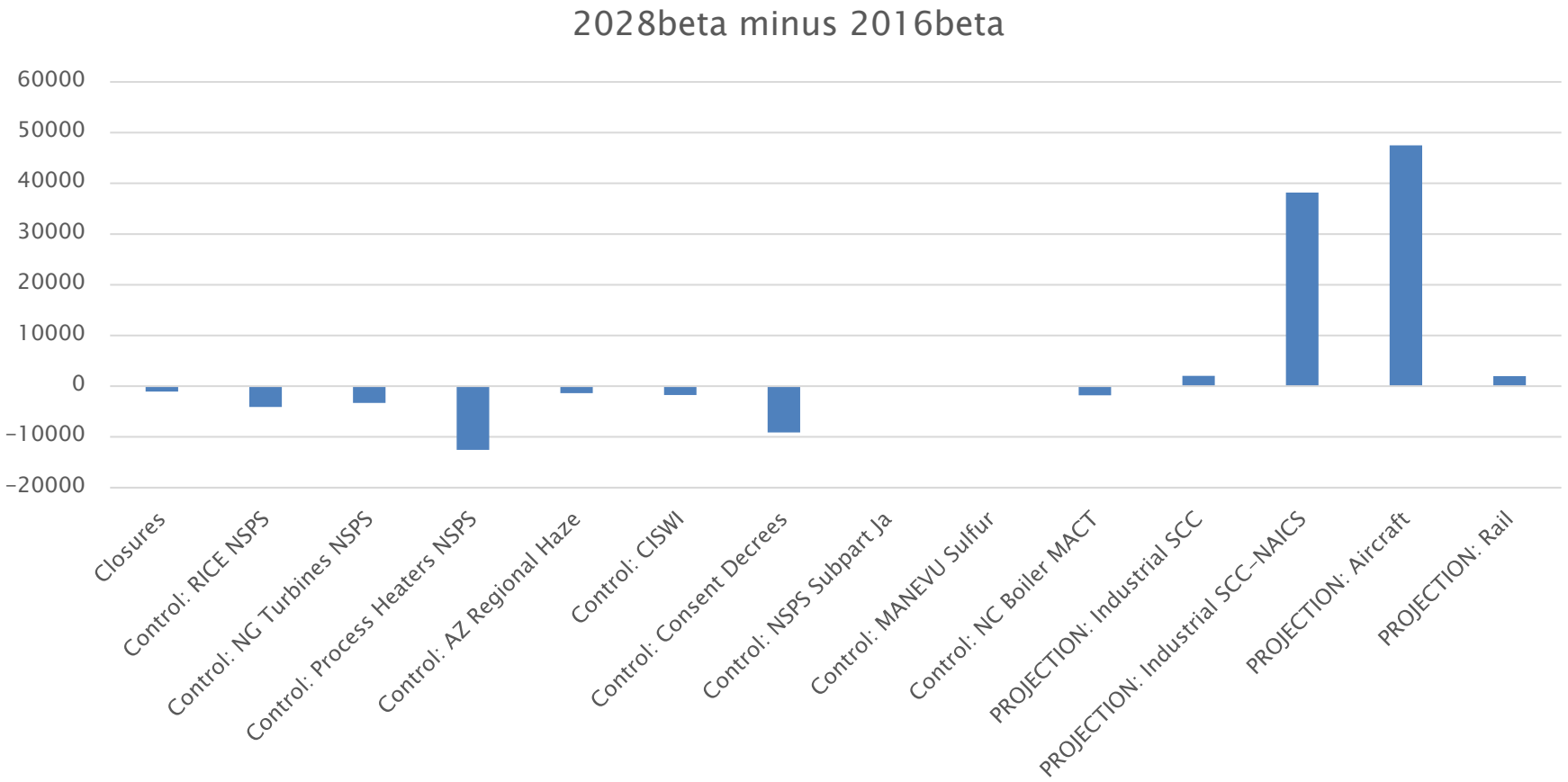
Projections High-level impacts: ptnonipm sector NO_X



CoST can isolate the impact of each control/projection packet

Non-EGU Projections: Challenges/Limitations

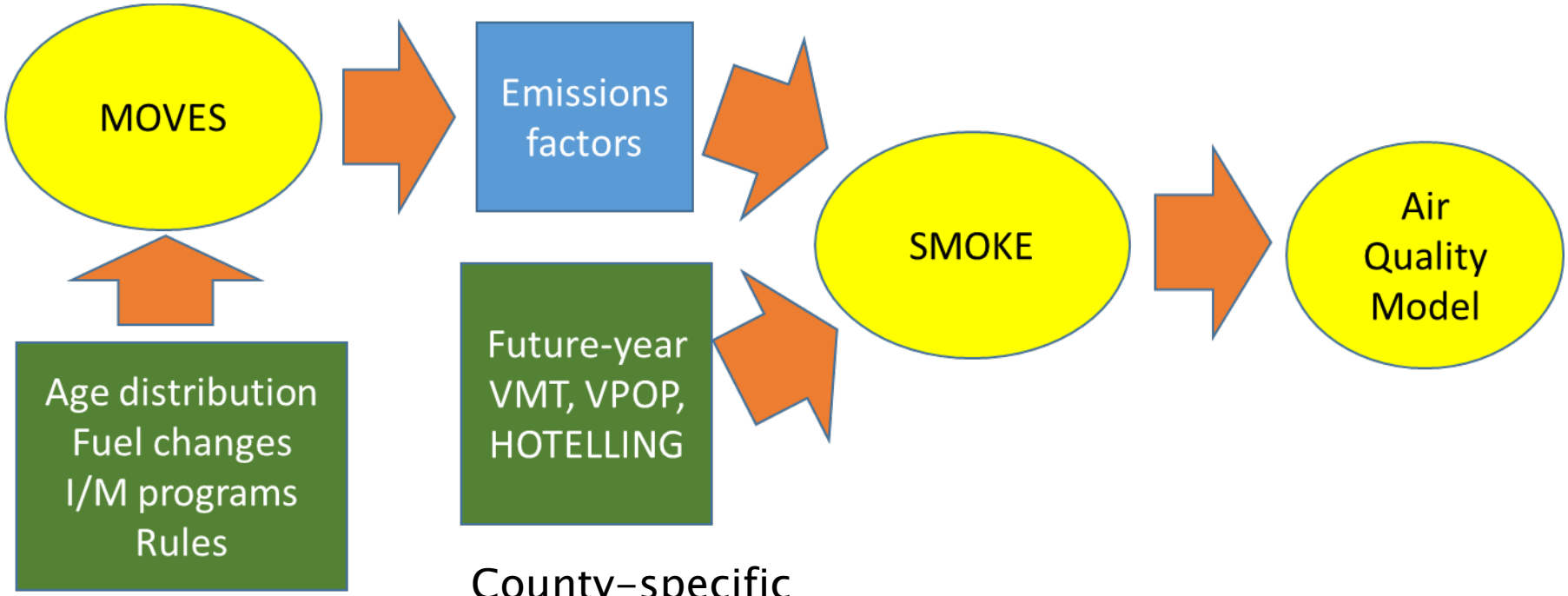
- Response to comments on prior platforms:
  - Many different sources of data – need to correctly layer these so appropriate controls/projections apply
- State/Regional-submitted data
  - Some data provided for a complete range of years, but other data provided for 2023 but not for 2028
- Promulgated vs proposed rules vs SIP inventories are confusing
- Rapidly-changing world!
  - 2019 AEO released + 2017 NEI being developed

Questions on Non-EGU Point?

Onroad Projections Overview

- MOVES2014b is used to develop emission factors for light-duty and heavy-duty vehicles
- Main components adjusted for projections:
  - Regulatory impacts (e.g., Tier-3, LD & HD GHG/CAFE standards, Modifications to Renewable Fuel Standard (RFS2), Mobile Source Air Toxics Rule (MSAT), California LEVIII)
  - Fuel composition changes
  - Inspection and Maintenance (I/M) programs
  - Vehicle age distributions (in some cases)
  - Vehicle Miles Traveled (VMT) and other activity data
  - Most of these changes are included in the approximately 300 representative county databases from which emission factors are computed
  - SMOKE combines activity data and emission factors

Onroad Projections Data Flow



MOVS is run for each representative county

County-specific activity data are used for each county

Onroad Emission Processes and Inputs

- On-roadway emissions [Rate per Distance]
  - Exhaust, evaporative, evaporative permeation, refueling, brake and tire wear
  - *Primary inputs*: **vehicle miles traveled** (VMT), average speeds, speed profiles, and temperature (gridded, hourly)
- Off-network emissions (i.e. parked vehicles)
  - Exhaust from starts, evaporative, evaporative permeation, refueling, hot soak (after a trip) [rate-per-vehicle (RPV)]
  - Evaporative fuel vapor venting and diurnal (when vehicles are parked for a long period) [rate-per-profile (RPP)]
  - *Primary inputs*: **vehicle population** (VPOP) and Temperature
- Hoteling:
  - Extended idle and auxiliary power units (APU) for combination long-haul trucks
  - *Primary inputs*: **Hoteling hours** and T (gridded, hourly) [rate-per-hour (RPH)]

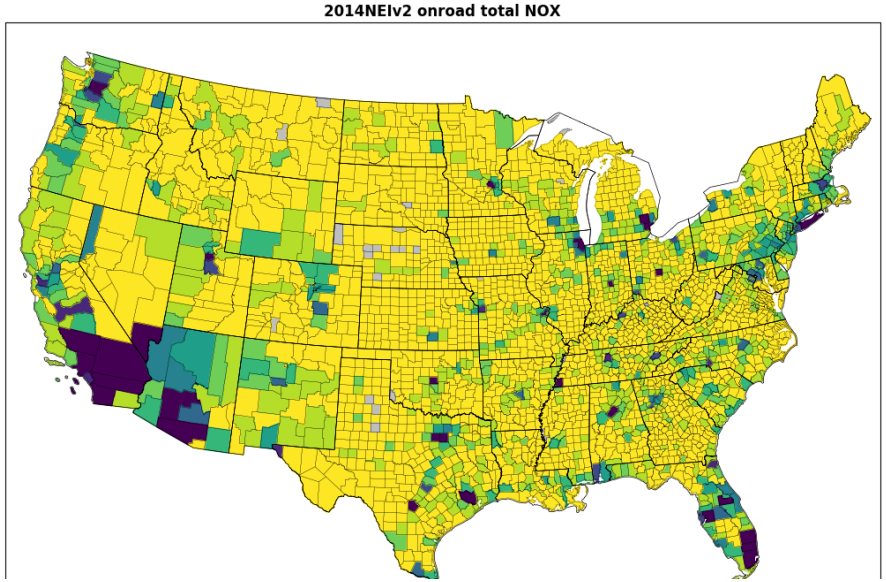
Onroad Projections Details

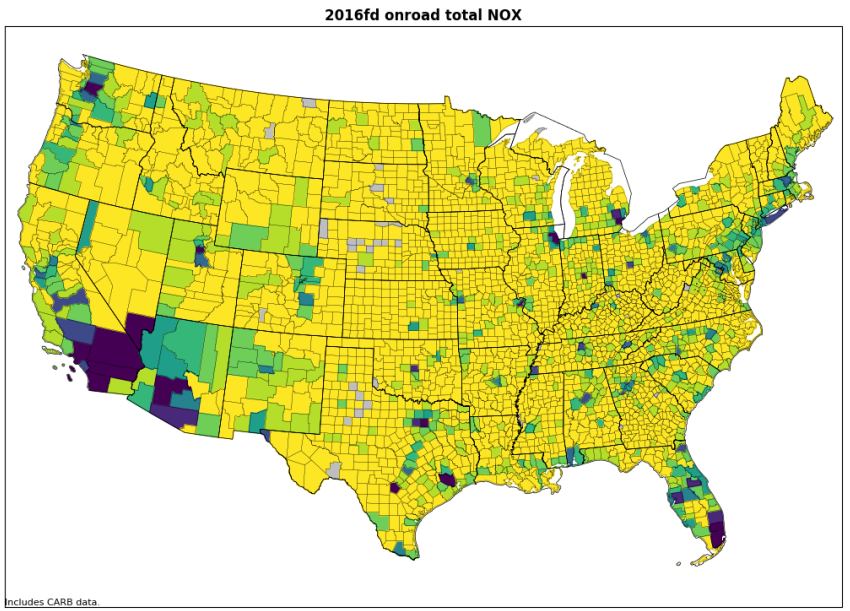
- Constant between base year and future year
  - Meteorology
  - Representative counties
    - If change representative counties, will create artificial spatial inconsistencies between base and future years
  - Spatial surrogates for gridding
  - Speeds
  - Temporal profiles
- Speciation is *not* constant
  - Dependent on model year, fuel, etc.
- Approaches differ for short-term vs. longer-term
  - MOVES CDBs updated and runs done for both

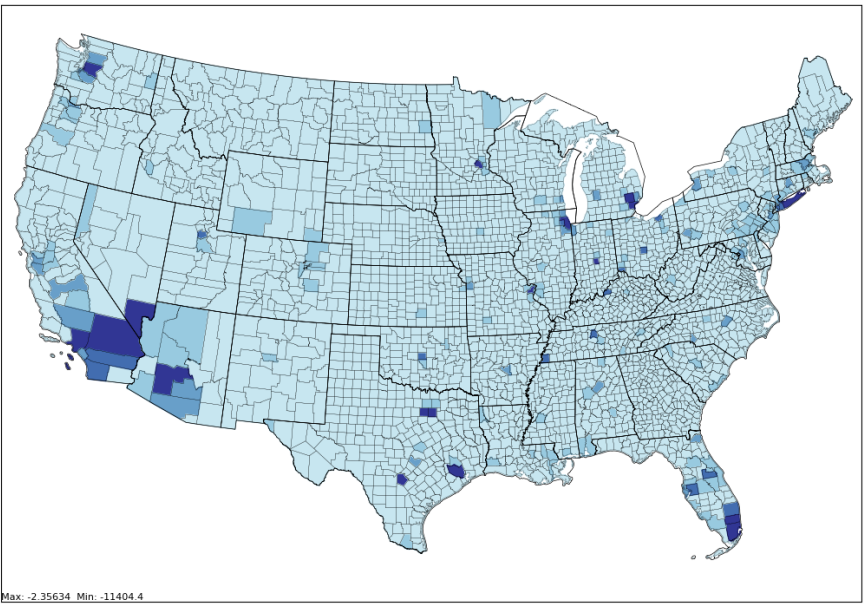
Short-term Projection for 2016

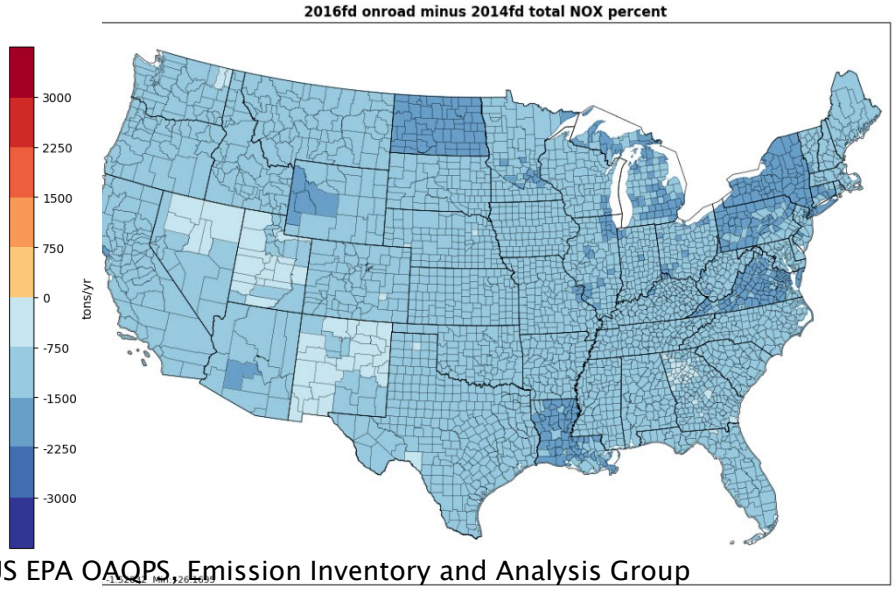
- FHWA provided urban / rural county-level VMT for 2016
  - By road type: interstate, freeways, arterials, collectors, local
- 2016 VMT projected from 2014NEIv2 using *state+urban and state+rural factors* derived from FHWA VM-2 tables
  - https://www.fhwa.dot.gov/policyinformation/statistics/2014/vm2.cfm
  - https://www.fhwa.dot.gov/policyinformation/statistics/2016/vm2.cfm
  - Use *state overall* factors when changes in urban/rural definitions between caused factors to be more different than they should be for two years of change
  - State DOT web sites can sometimes have different trends than FHWA
- Preserved 2014v2 ratio of VMT/hoteling hour for long-haul combination trucks in 2016
- Preserved 2014v2 ratio of VMT/vehicle was in the 2016 vehicle Population (VPOP)
- QA: Compare original and projected activity data

Onroad NOx: 2016 vs 2014NEIv2









Longer-term VMT projections

- Activity data for longer-term projections based on AEO
  - Light-Duty gas, diesel and E-85
    - Table 42: LD vehicle miles travelled by technology type
      - Motorcycles, cars, light-duty trucks
  - Heavy-Duty gas and diesel, Bus CNG
    - Table 50: Freight Transportation Energy Use
      - Heavy-Medium (Buses and Single Unit trucks)
      - Heavy (Combo Unit Trucks)
  - Light-duty Geographic variation using projected human population dat

AEO example: Light duty VMT

42. Light-Duty Vehicle Miles Traveled by Technology Type

(billion miles, unless otherwise noted)

Technology Type	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Conventional Vehicles 1/										
Gasoline ICE Vehicles	2,381.3	2,437.1	2,504.8	2,547.2	2,570.3	2,579.3	2,583.1	2,577.3	2,570.2	2,563.4
TDI Diesel ICE	12.4	16.0	18.7	21.9	25.1	28.4	32.5	37.4	43.6	50.9
Alternative-Fuel Vehicles 1/										
Ethanol-Flex Fuel ICE	221.8	239.5	259.2	277.4	291.3	301.5	309.3	315.2	320.1	324.2
100 Mile Electric Vehicle	1.5	2.7	3.3	3.9	4.1	4.6	5.4	6.7	8.4	10.4
200 Mile Electric Vehicle	0.6	1.4	2.0	2.6	3.3	4.3	5.9	8.1	10.7	13.6
Plug-in 10 Gasoline Hybrid	1.0	1.9	2.9	3.8	4.7	5.6	6.7	8.1	9.8	11.4
Plug-in 40 Gasoline Hybrid	0.9	1.6	2.4	3.4	4.4	5.6	7.0	8.6	10.6	12.6
Electric-Diesel Hybrid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Electric-Gasoline Hybrid	40.1	45.5	50.6	55.0	59.7	64.1	68.6	72.7	77.0	81.2
Natural Gas ICE	1.2	1.7	2.3	3.0	3.7	4.4	4.9	5.2	5.3	5.5
Natural Gas Bi-fuel	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Propane ICE	0.4	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8
Propane Bi-fuel	1.9	2.2	2.6	2.8	3.0	3.0	2.9	2.7	2.7	2.6
Fuel Cell Gasoline	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Cell Methanol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Cell Hydrogen	0.0	0.1	0.2	0.3	0.4	0.9	1.5	2.5	3.6	4.8
VMT Equation Components										
Total VMT (billion miles)	2,664.8059	2,751.9343	2,851.4399	2,923.7825	2,972.6289	3,004.5771	3,030.6011	3,047.1963	3,064.6091	3,083.6128

AEO example: Growth Factors

AEO-specific categories are grouped to create growth factors

VMT Equation Components											
Total VMT (billion miles)	2,664.8059	2,751.9343	2,851.4399	2,923.7825	2,972.6289	3,004.5771	3,030.6011	3,047.1963	3,064.6091	3,083.6128	3,
Technology Type	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	
LD gas (11,21,31,32)	2,423.4055	2,486.0983	2,560.6678	2,609.3738	2,639.0408	2,654.6549	2,665.3263	2,666.6998	2,667.5899	2,668.6644	2,
LD diesel (21,31,32)	12.4066	15.9521	18.6998	21.8796	25.1023	28.4458	32.5447	37.4695	43.7279	51.0905	
LD E-85 (21,31,32)	221.7503	239.5037	259.2292	277.4115	291.2845	301.5420	309.3427	315.1891	320.0553	324.1617	
LD electric (21)	2.0600	4.1227	5.3325	6.5023	7.3951	8.9699	11.3625	14.8238	19.0704	24.0737	
LD Natural Gas	2.8271	3.4479	4.1409	4.8596	5.6402	6.3556	6.8572	7.0470	7.1840	7.3591	
LD Propane	2.3550	2.7414	3.2165	3.5056	3.7256	3.7425	3.6288	3.5094	3.4211	3.4165	
LD Fuel Cell Hydrogen	0.0015	0.0679	0.1535	0.2502	0.4408	0.8664	1.5386	2.4575	3.5607	4.8468	
Total VMT check	2,664.8059	2,751.9342	2,851.4402	2,923.7826	2,972.6293	3,004.5771	3,030.6009	3,047.1962	3,064.6095	3,083.6128	3,
GROWTH FROM 2014	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	
LD gas (11,21,31,32)	1.0000	1.0259	1.0566	1.0767	1.0890	1.0954	1.0998	1.1004	1.1008	1.1012	
LD diesel (21,31,32)	1.0000	1.2858	1.5072	1.7635	2.0233	2.2928	2.6232	3.0201	3.5246	4.1180	
LD E-85 (21,31,32)	1.0000	1.0801	1.1690	1.2510	1.3136	1.3598	1.3950	1.4214	1.4433	1.4618	
LD electric (21)	1.0000	2.0014	2.5887	3.1565	3.5899	4.3544	5.5159	7.1962	9.2577	11.6865	
LD Natural Gas	1.0000	1.2196	1.4647	1.7189	1.9950	2.2481	2.4255	2.4926	2.5411	2.6031	
LD Propane	1.0000	1.1641	1.3658	1.4886	1.5820	1.5892	1.5409	1.4902	1.4527	1.4507	
LD Fuel Cell Hydrogen	1.0000	45.7755	103.5185	168.7343	297.2259	584.2124	1037.4970	1657.1092	2401.0223	3268.2326	
Total VMT	1.0000	1.0327	1.0700	1.0972	1.1155	1.1275	1.1373	1.1435	1.1500	1.1572	

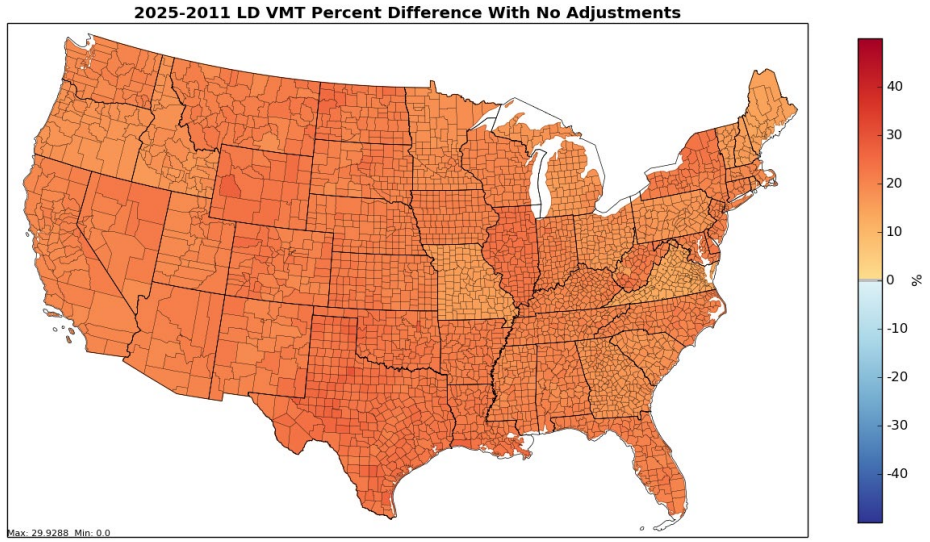
VMT projections variation (1 of 2)

- Use AEO to get magnitude of change nationally
- Adjust light duty (LD) VMT projections geographically based on expected human population changes
- Analysis indicated strong correlation between human population and LD VMT
- Correlation between population and medium and heavy duty (MD/HD) VMT is not as strong
  - Use national factors for medium and heavy duty

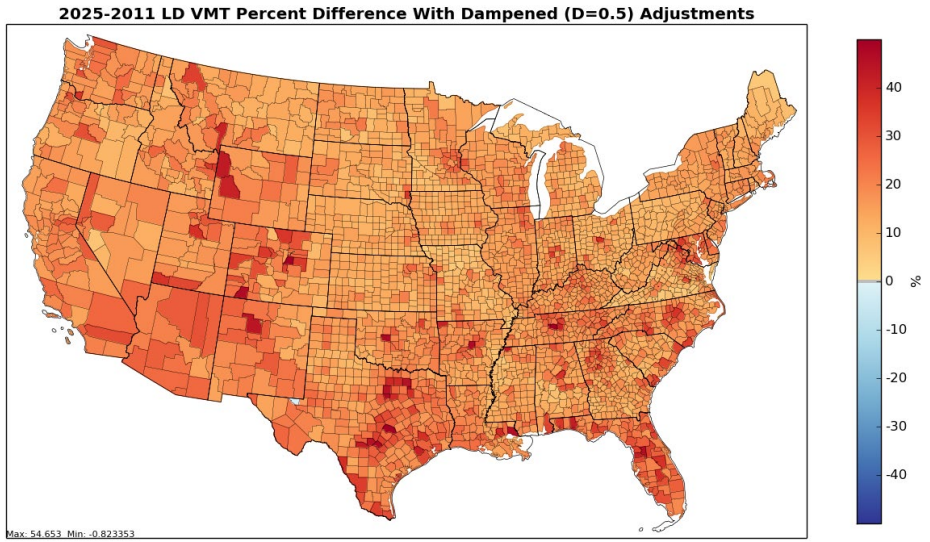
VMT projections variation (2 of 2)

- LD VMT projections for 2025 from 2011

National projection



With adjustment based on human population changes

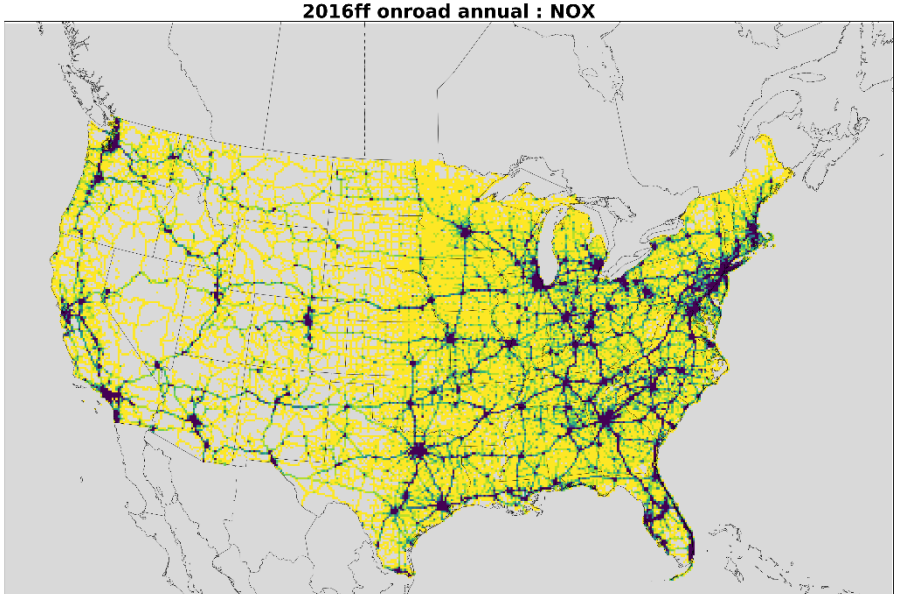


Onroad Projection Details

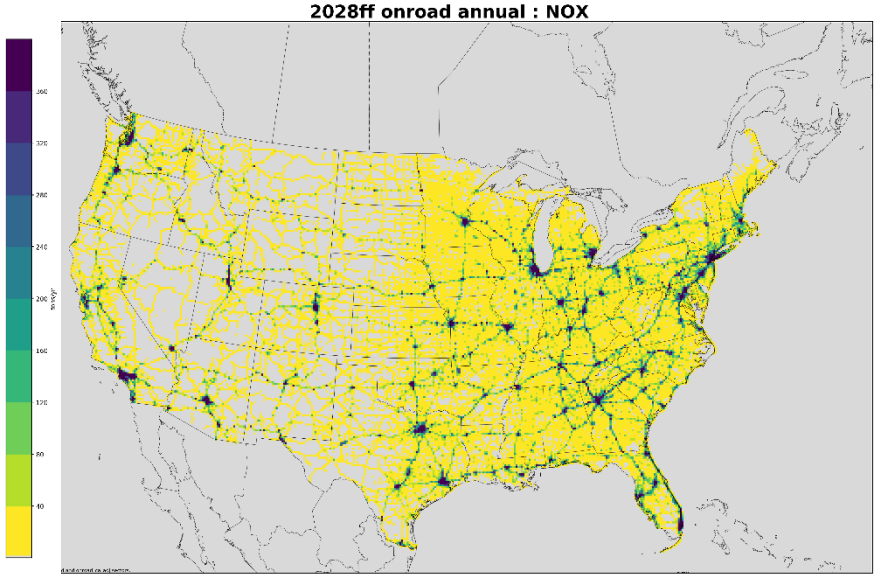
- Vehicle Population (VPOP) uses same projection factors as VMT
- Hoteling
  - Calculate the total hoteling hours from future year combination long-haul restricted VMT
  - Split between auxiliary power units (APUs) and extended idling (EXT) changes in future years due to greater penetration of APUs
- Speciation
  - Changes in model year and fuels impacts not only the emissions but the speciation
  - Speciation internal to MOVES2014 makes it possible to consider detailed model year, regulatory class, and fuel information

Changes in Onroad NOx and VOC emissions 2016-2028

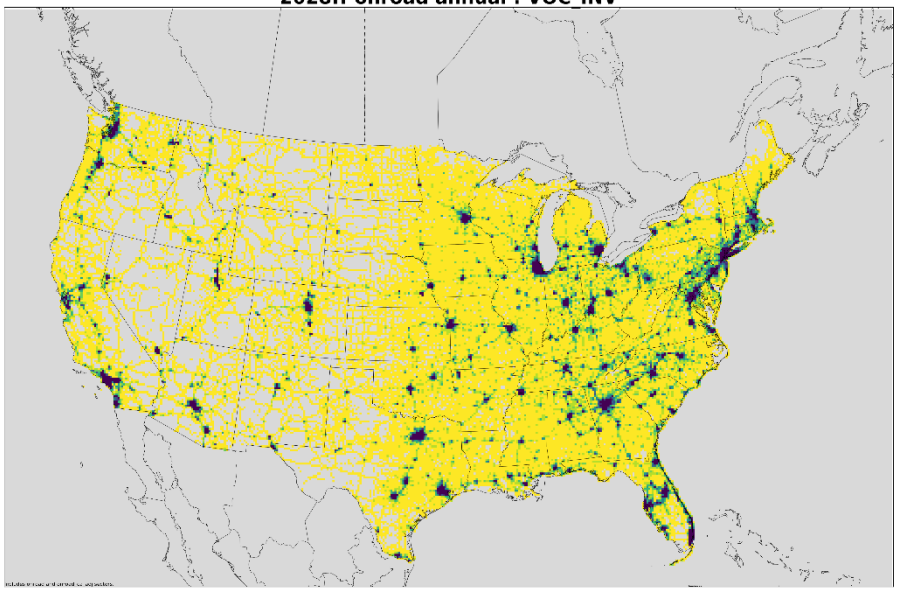
2016ff onroad annual : NOX



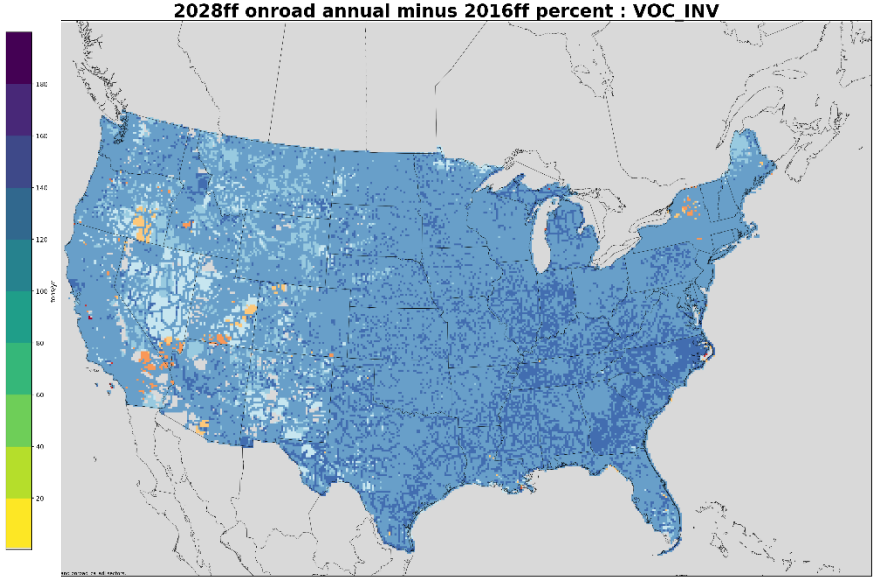
2028ff onroad annual : NOX



2028ff onroad annual : VOC_INV



2028ff onroad annual minus 2016ff percent : VOC_INV



Nonroad Projection Overview

- Nonroad sector = Exhaust, evaporative, and refueling emissions from nonroad engines (not including CMV, aircraft and locomotives)
  - Construction equipment, recreational marine, lawn & garden
- Nonroad has been within MOVES since MOVES2014a
  - Previously used National Mobile Inventory Model (NMIM)
- Regulatory programs included:
  - Nonroad spark-ignition engines
  - Locomotive & marine engines less than 30L/cylinder
  - Clean Air Nonroad Diesel Final Rule

Nonroad Projection Details

- Unlike onroad, can use the same input county databases as the base year
- Run for future year with appropriate Meteorology (consistent with base year)
- Fuels should be consistent with the future year and ideally with the onroad fuels
- VOC speciation differs from base year to account for shift toward 10% ethanol fuels for nonroad
- California-projected emissions used in CA
- MOVES2014b included updated growth factors

Nonroad updates in MOVES2014b

- MOVES2014b (released Aug. 2018) improves estimates of emissions from nonroad equipment
  - Updated Tier 4 engine technology categories to account for after-treatment configurations
  - Updated Tier 4 engine population fractions, emission factors, and speciation profiles
  - Updated nonroad marine diesel sulfur levels to be 15 ppm for 2014 and later (down from 55-56 ppm)
  - Harmonized nonroad diesel sulfur with onroad diesel for most calendar years since 2007 (up from 11 ppm)
  - Updated nonroad engine population growth rates with state-level, equipment sector-specific annual growth indices
    - **This is the primary driver of differences in emissions between MOVES2014b and previous versions of the model**

Nonroad sector-level national summary 2016 alpha vs beta

- Alpha produced with MOVES2014a include state inputs from 2014NEI
- Beta produced with MOVES2014b; all emissions in tons
- See 2016 Wiki: *http://views.cira.colostate.edu/wiki/wiki/9179*

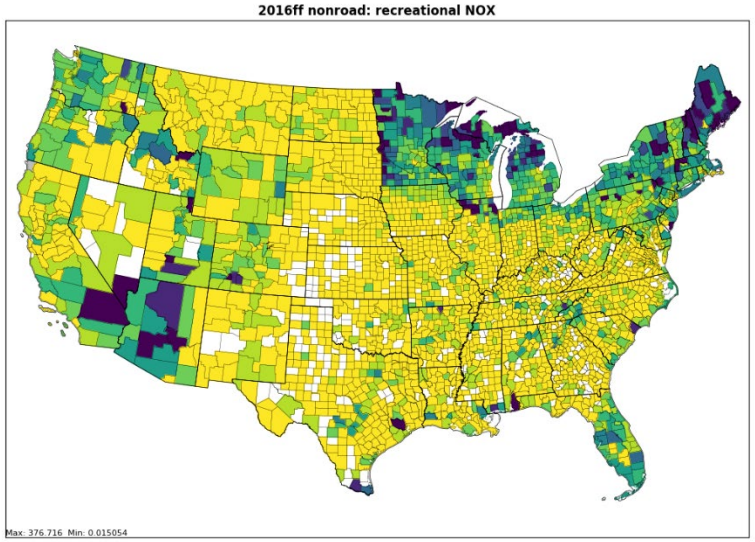
Nonroad Sector	NOx			VOC			PM2.5		
	alpha	beta	% diff	alpha	beta	% diff	alpha	beta	% diff
Agricultural	342799	321634	-6.2%	38152	33350	-12.6%	25551	24647	-3.5%
Construction	358132	320811	-10.4%	61497	51171	-16.8%	30281	28407	-6.2%
Lawn & Garden	71762	70177	-2.2%	330000	326293	-1.1%	21687	21581	-0.5%
Commercial	89084	69148	-22.4%	86228	66660	-22.7%	7248	5772	-20.4%
Industrial	99266	95174	-4.1%	13667	15263	11.7%	5008	5060	1.0%
Recreational	26885	15590	-42.0%	513175	250105	-51.3%	14159	6748	-52.3%
Pleasure Craft	134873	113979	-15.5%	351984	336904	-4.3%	5147	4786	-7.0%
Railroad Maintenance	2193	1969	-10.2%	433	407	-6.1%	244	220	-9.9%
Underground Mining	2663	2691	1.1%	515	521	1.2%	270	281	4.0%
Logging	4838	4510	-6.8%	4838	4510	-6.8%	1065	578	-45.8%

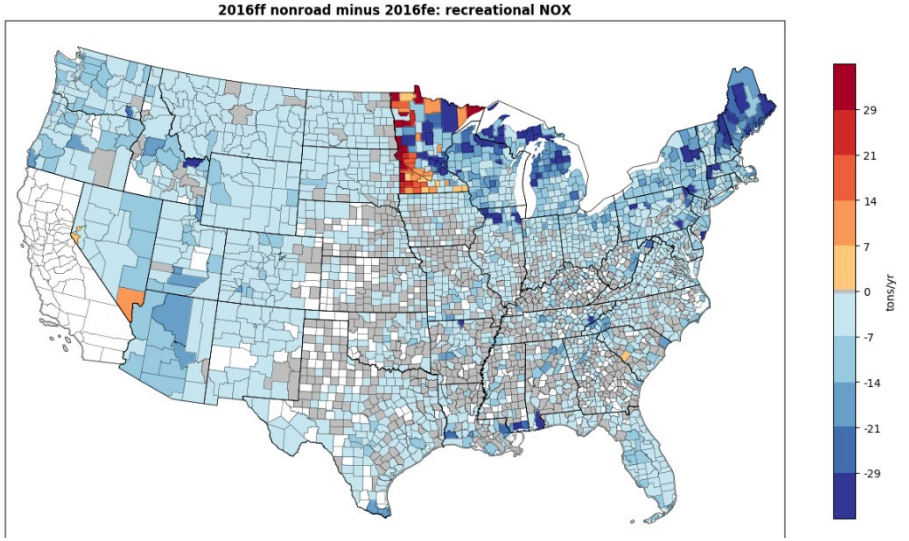
Note: emissions from Airport Support and Oil Field Equipment are excluded from nonroad inventories.

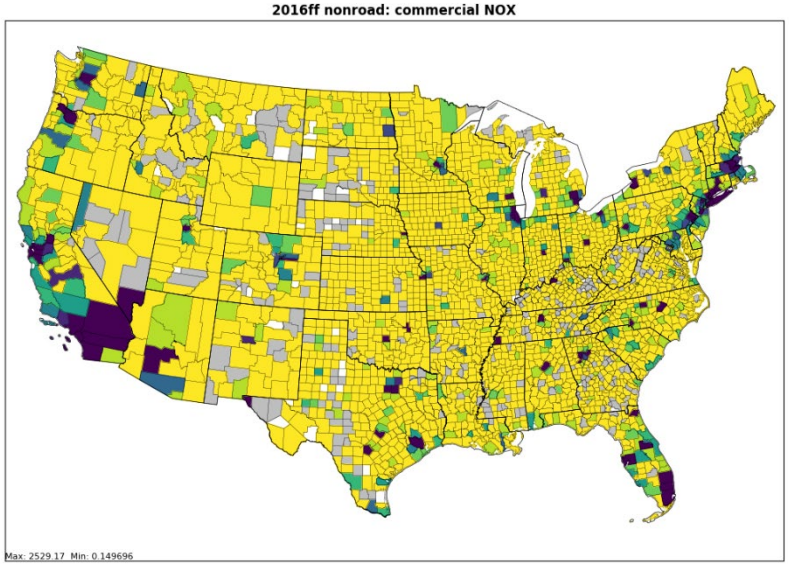
** Growth trends to future years also updated in MOVES2014b **

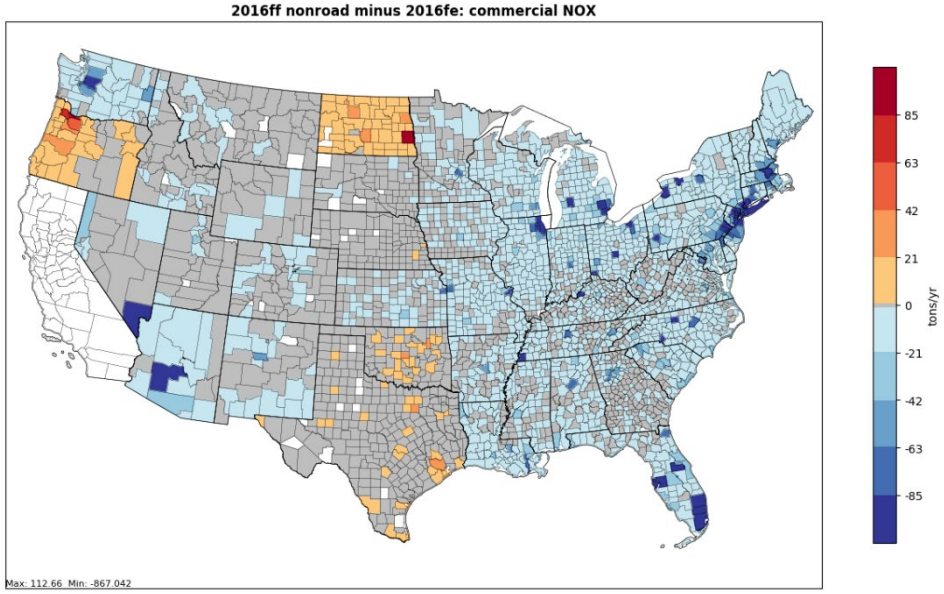
See MOVES2014b Nonroad Technical Reports (https://www.epa.gov/moves/nonroad-technical-reports)

Recreational and Commercial Nonroad NOx: 2016ff and Changes from 2016fe

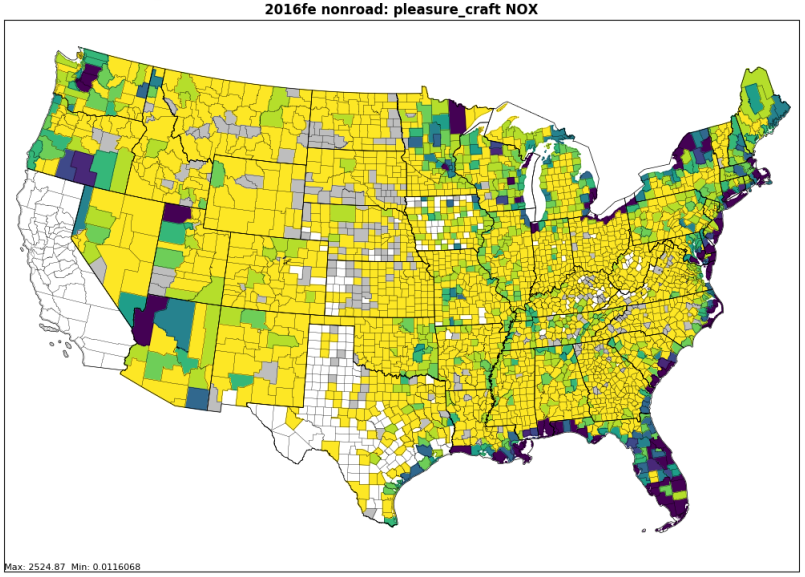


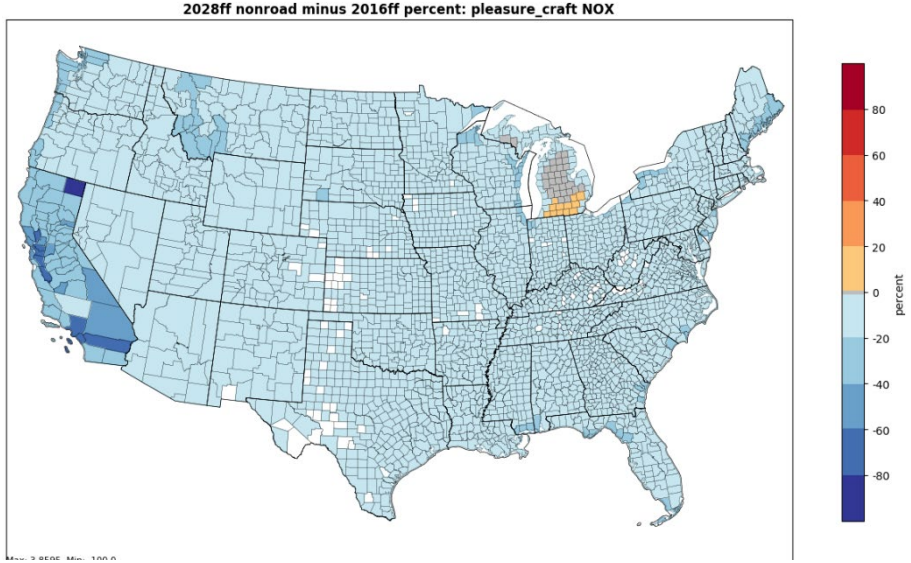


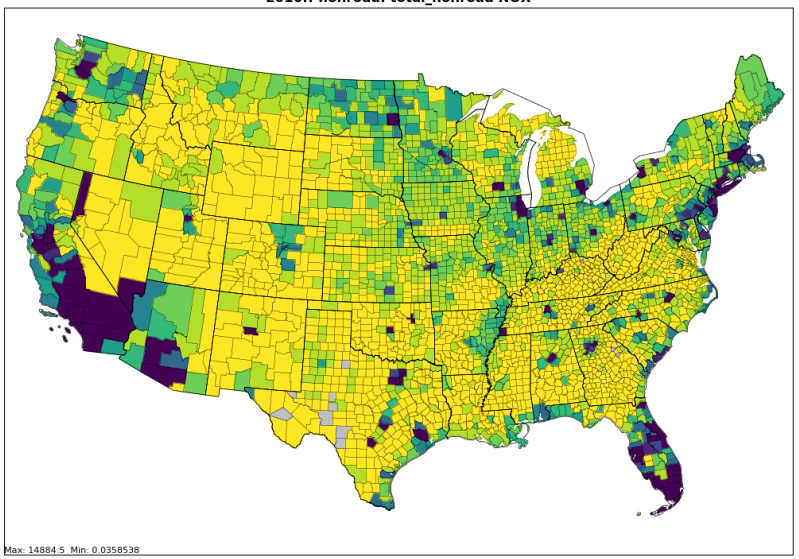


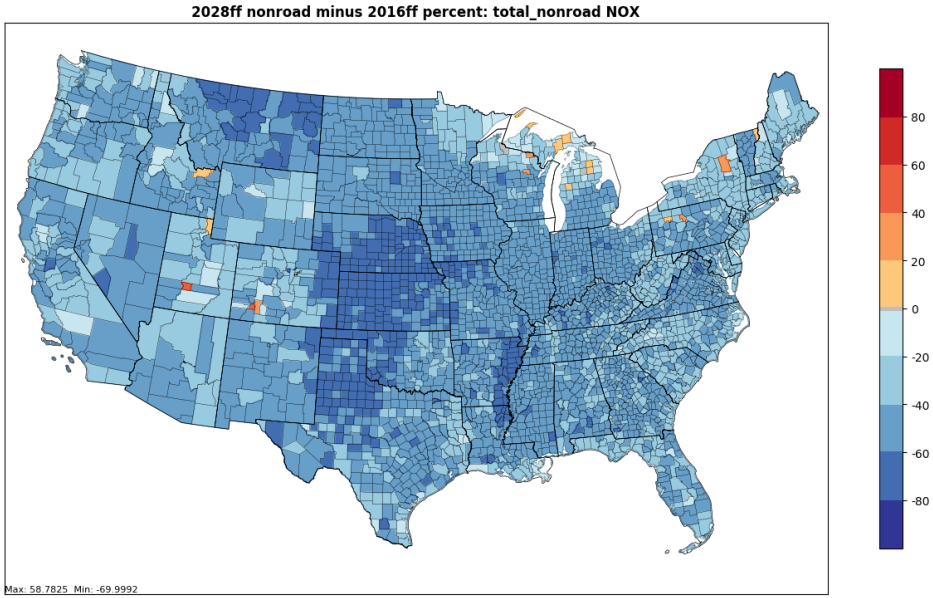


Pleasure craft and Total Nonroad NOx 2016ff vs 2018ff









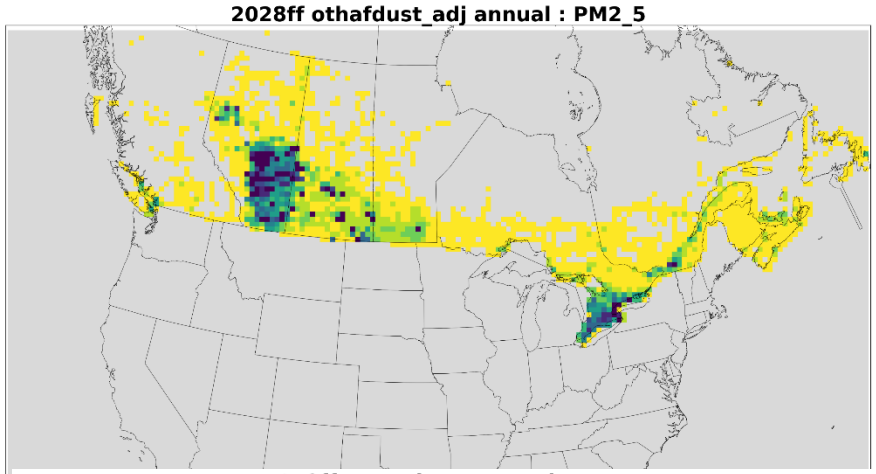
US EP

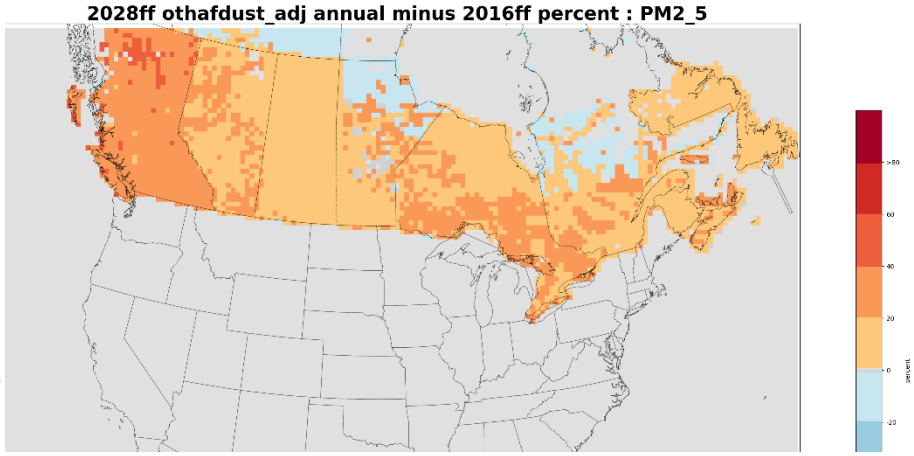
Questions on onroad or nonroad projections?

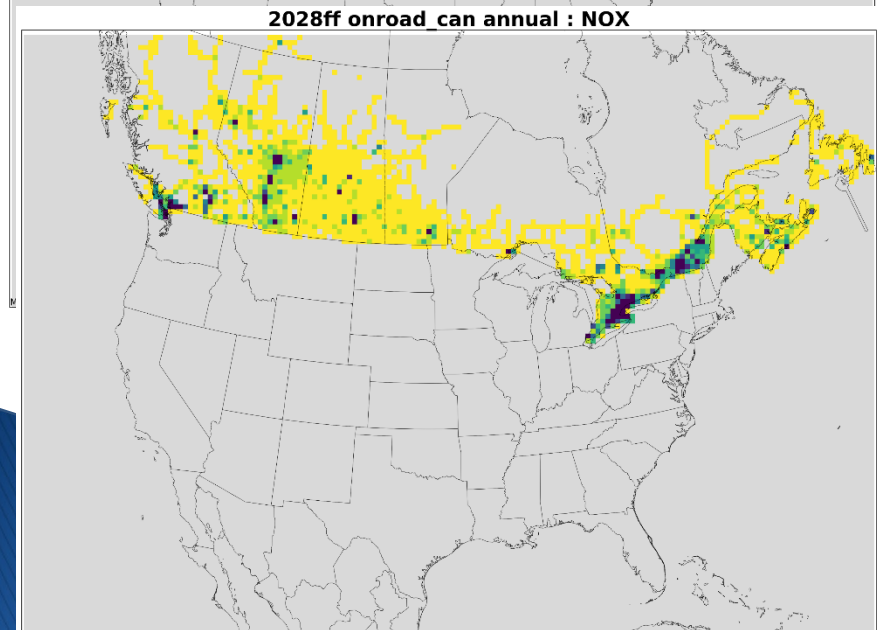
International Projections

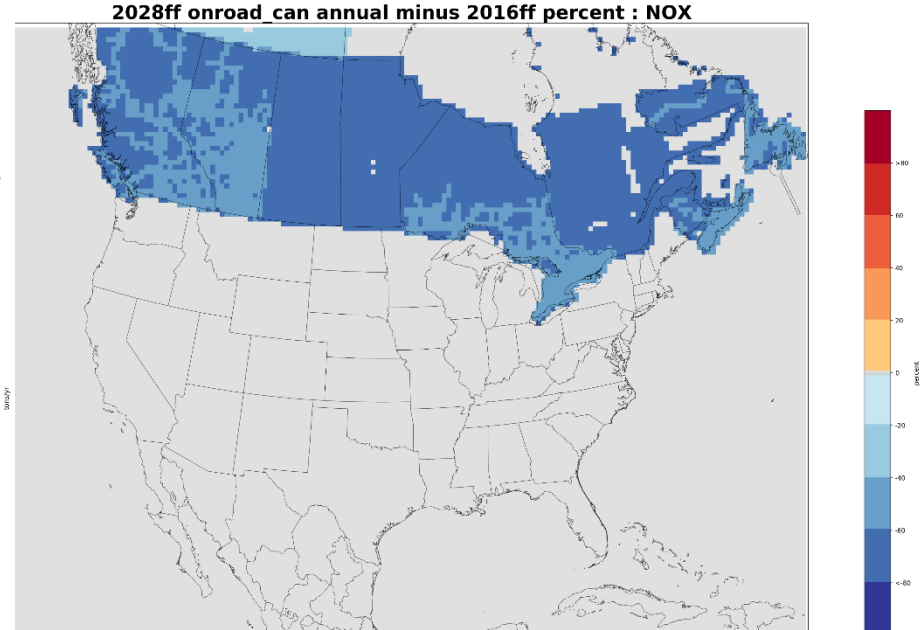
- Canada
  - Base year is 2015
  - Projection factors to various years provided by Environment and Climate Change Canada
    - Updated inventories computed by EPA based on factors
- Mexico
  - Mexico point, nonpoint, nonroad inventories projected to years 2018, 2025 and 2030 and interpolate as needed – better data needed
  - Interpolate MOVES-Mexico outputs as needed between available years of 2014, 2017, 2020, 2023 and 2028

2028 Canada Afdust PM2.5 and Onroad NOx emissions with changes from 2016 at 36km

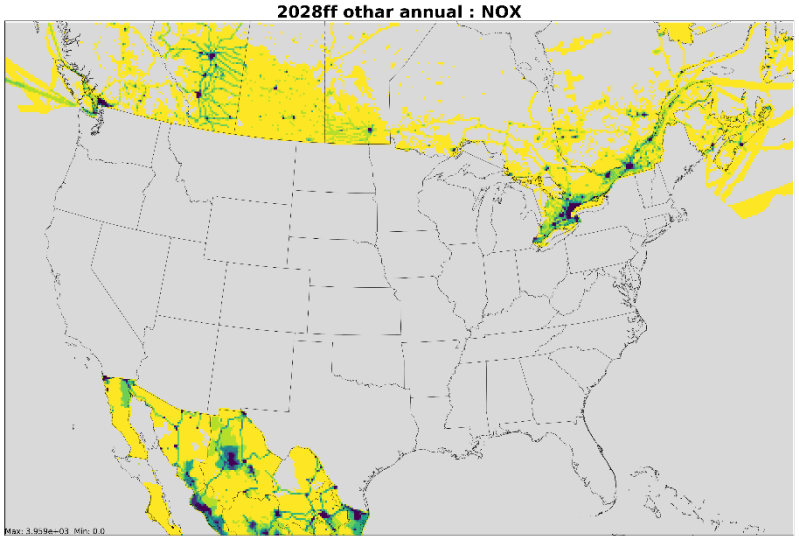


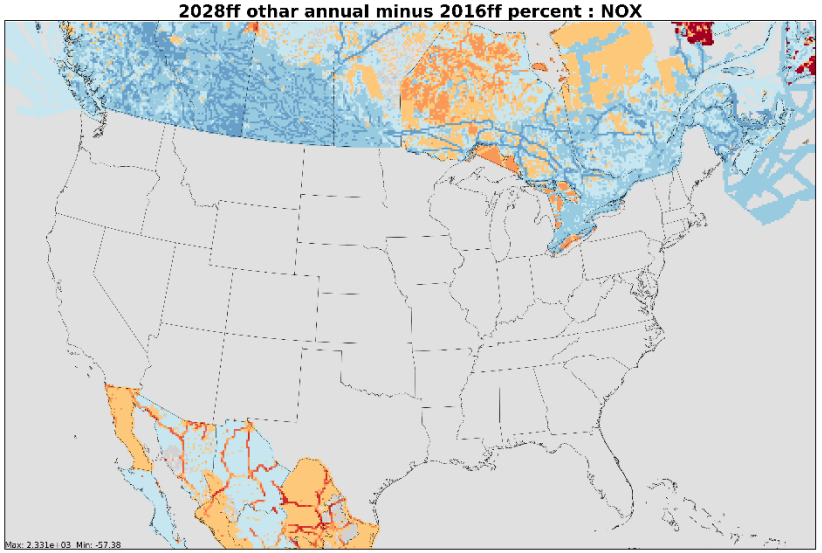


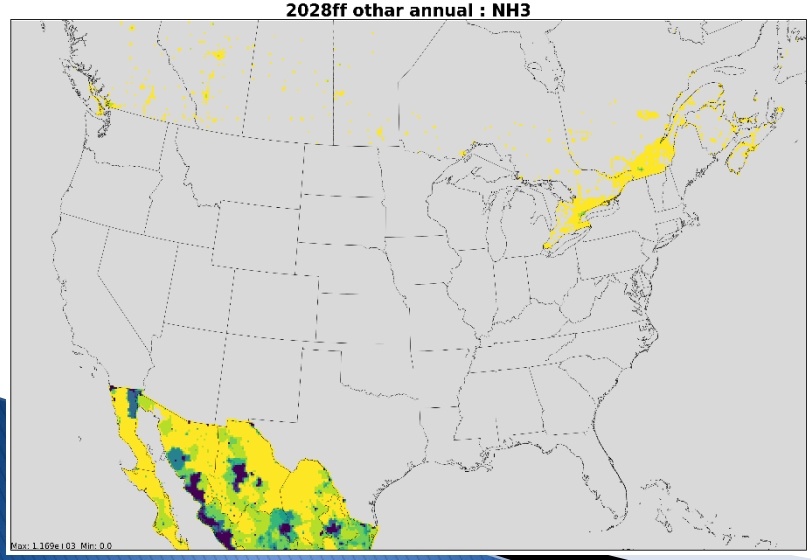


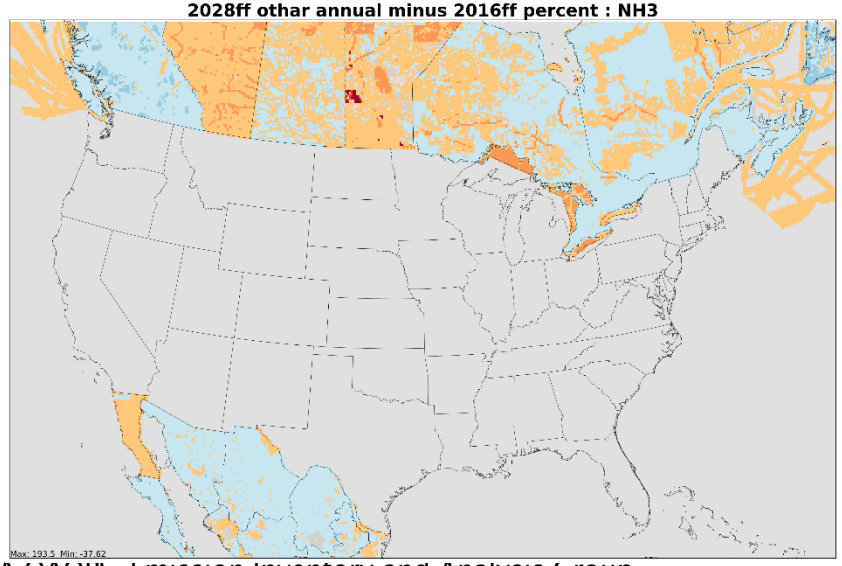


Othar 2028 NOx and NH3 and changes from 2016



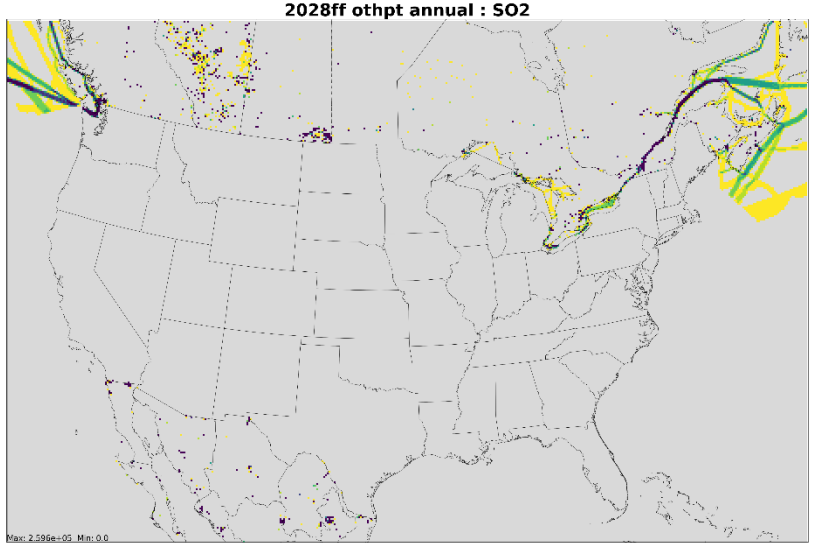




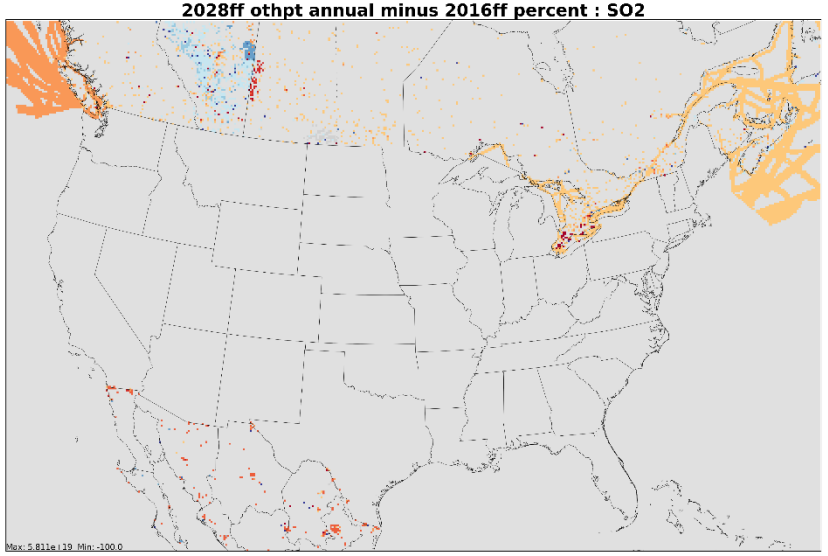


Othpt SO2 and NH3

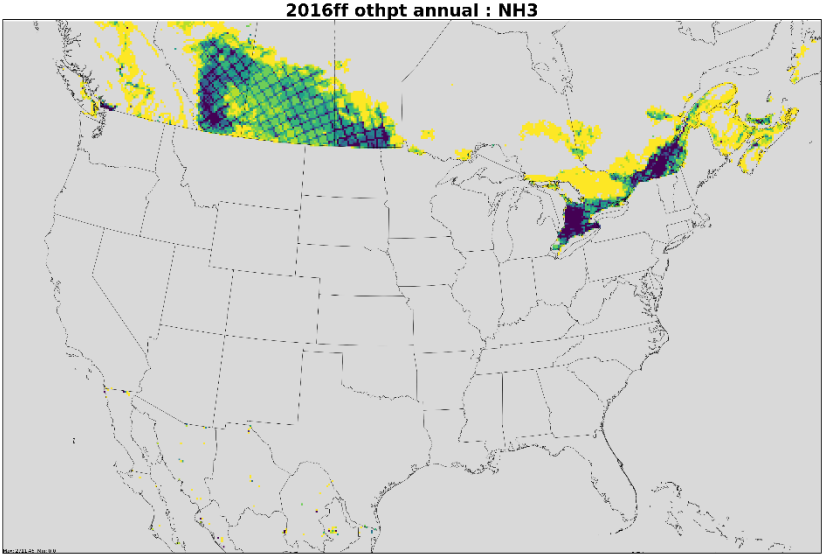
2028ff othpt annual : SO2



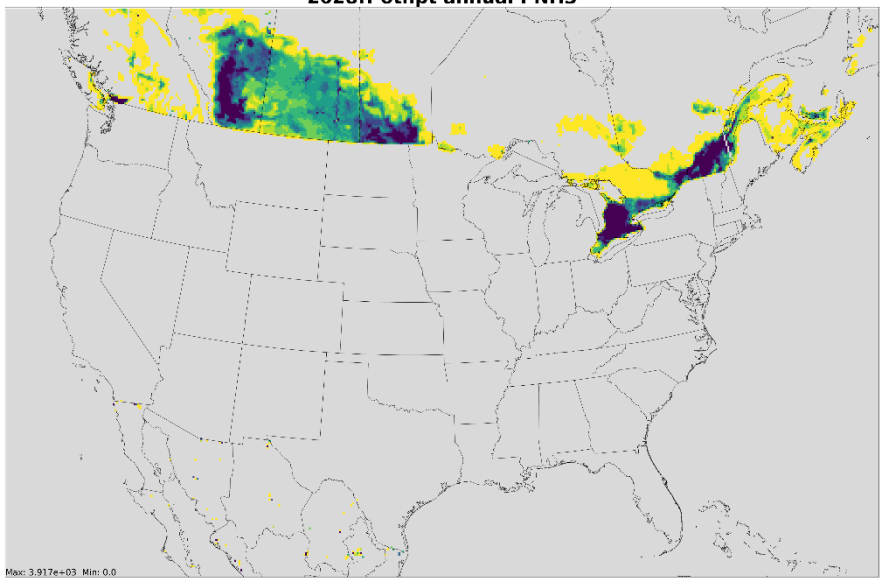
2028ff othpt annual minus 2016ff percent : SO2



2016ff othpt annual : NH3



2028ff othpt annual : NH3



Questions?

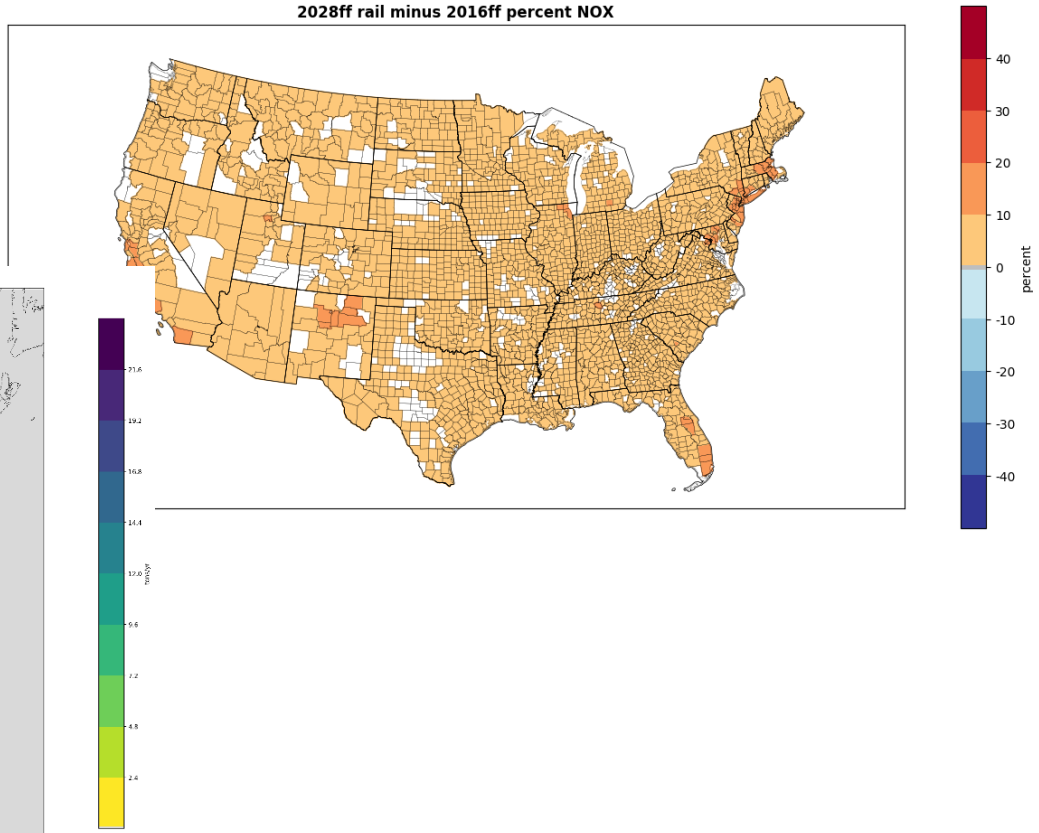
- Any questions on international emissions projections?

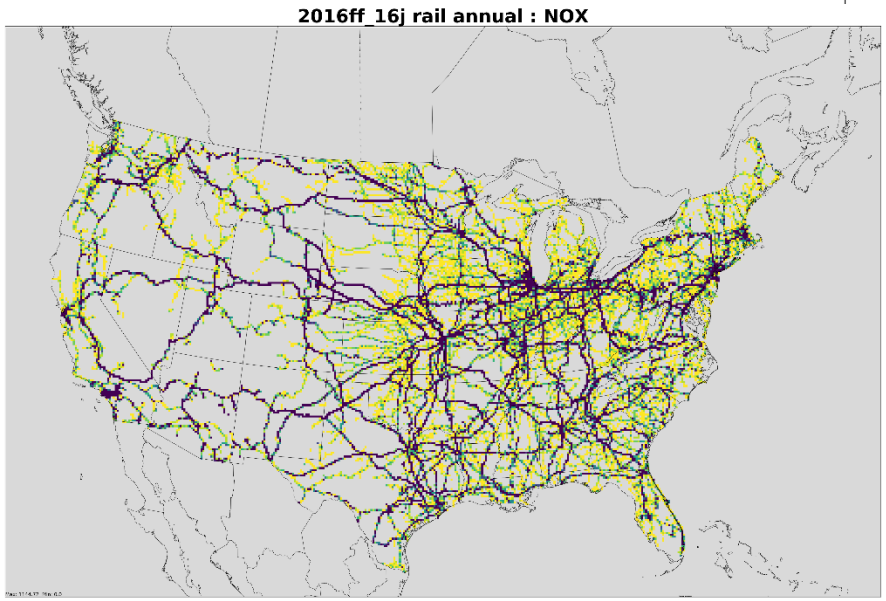
CMV and rail Projections

- Rail includes on-rail line locomotives
  - Yard Locomotives in point source inventory use different factors
- The future year cmv and rail emissions account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections for freight
- Regulatory programs:
  - Final Locomotive-Marine rule for engines less than 30L/cylinder, Clean Air Nonroad Diesel Rule
  - Category 3 marine diesel engines Clean Air Act and International Maritime Organization Standards
    - CMV Exclusive Economic Zone (EEZ) reductions:
      SO2 reductions in EEZ 200 nautical miles from state waters by 2015, and implemented globally by 2020

National Projections for Rail NOx

	2016-to-2023	2016-to-2028
Passenger trains	+8.8%	+16.2%
Freight and Yard Locomotives	+0.8%	+4.7%





Regional Projections for CMV C3 2016beta

Region	2016-to-2023 NOX	2016-to-2023 other pollutants	2016-to-2028 NOX	2016-to-2028 other pollutants
US East Coast	-6.1%	27.7%	-7.5%	49.7%
US South Pacific	-24.8%	20. 9%	-34.0%	45.9%
US North Pacific	-3.4%	22.6%	-4.1%	41.3%
US Gulf	-6.9%	20.8%	-12.4%	36.4%
US Great Lakes	8.7%	14.6%	19.8%	28.3%
Other	23.1%	23.1%	42.6%	42.6%[8]

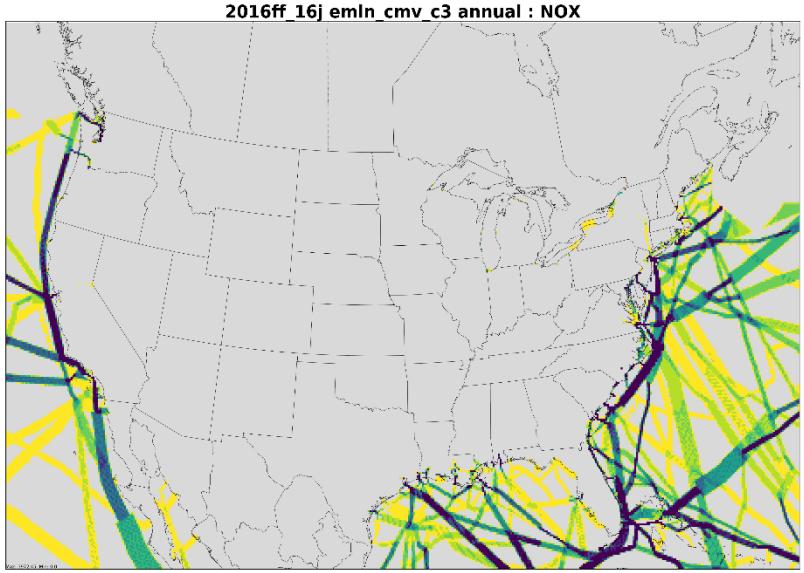
Regional CMV C3 emissions 2016, 2023 and 2028 beta

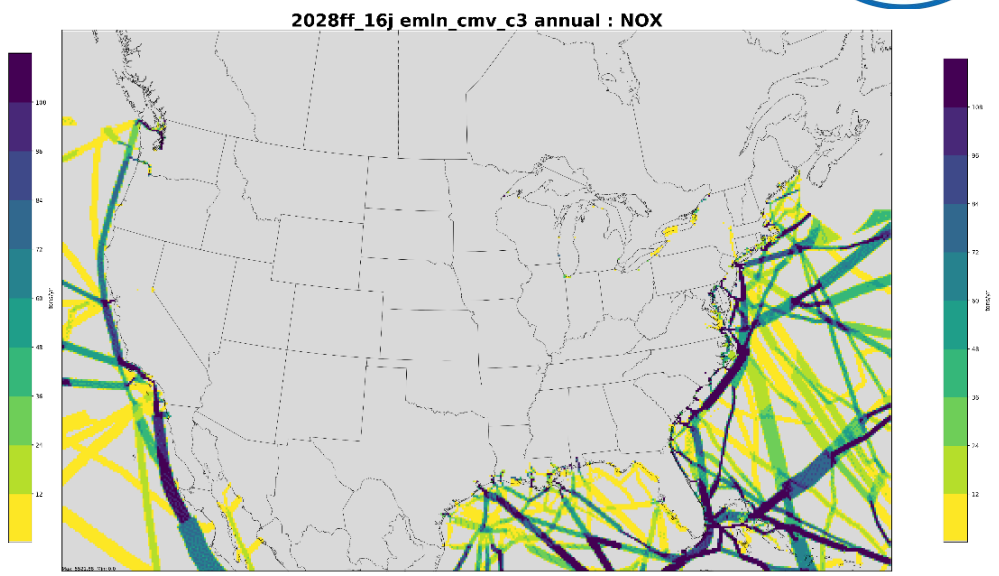
Region	Pollutant	SCC	SCC Description	2016ff	2023ff	2028ff
US State Waters	CO	2280003100	Port Emissions	2,624	3,295	3,829
US State Waters	CO	2280003200	Underway Emissions	8,156	10,137	11,689
US Federal Waters	CO	2280003200	Underway Emissions	45,047	55,954	65,536
US State Waters	NOX	2280003100	Port Emissions	23,561	22,105	21,568
US State Waters	NOX	2280003200	Underway Emissions	82,673	77,671	75,215
US Federal Waters	NOX	2280003200	Underway Emissions	468,064	416,157	395,655

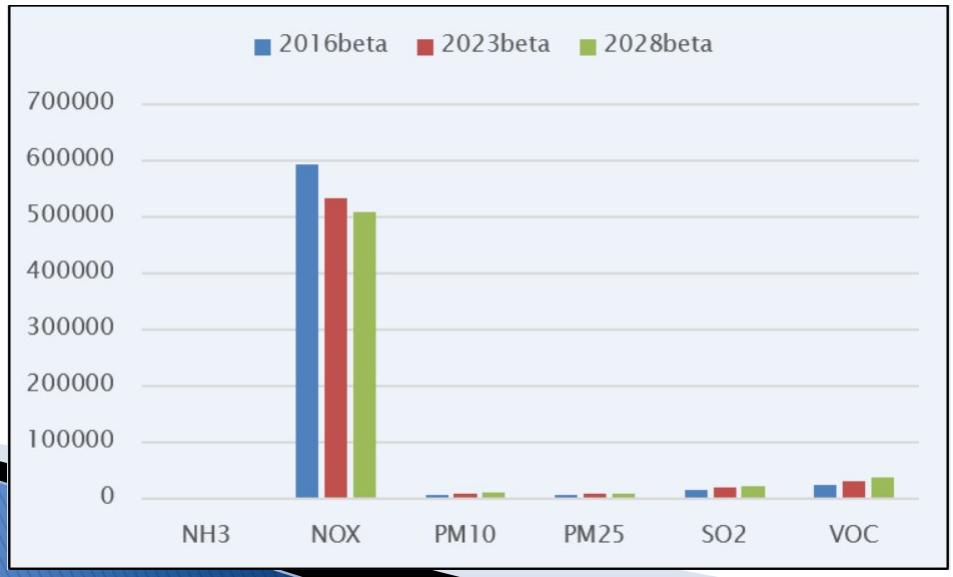
Regional Projections for CMV C1/C2 2016beta

Pollutant	2014-to-2016	2014-to-2023	2014-to-2028
CO	-1.4%	-2.7%	-1.1%
NOX	-7.4%	-34.6%	-48.7%
PM10	-11.0%	-36.2%	-49.6%
PM2.5	-11.0%	-36.2%	-49.6%
SO2	-60.3%	-86.2%	-86. 5%
VOC	-8.0%	-37.0%	-51.4%

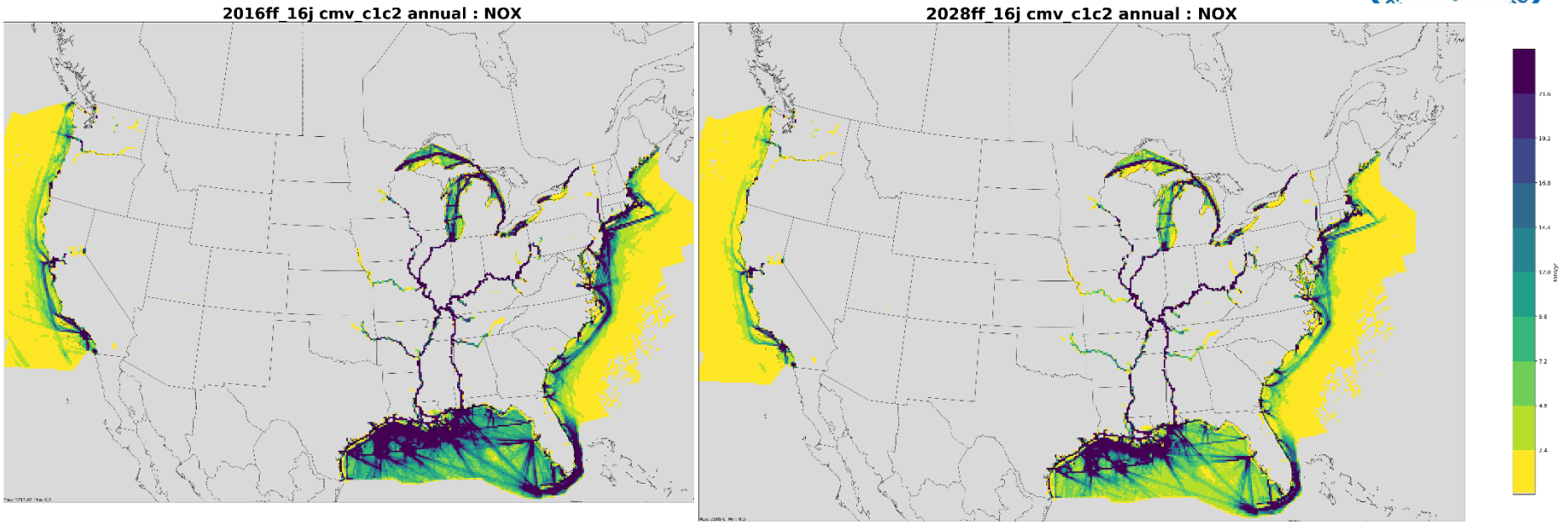
Changes in CMV C3 NOx 2016-2028

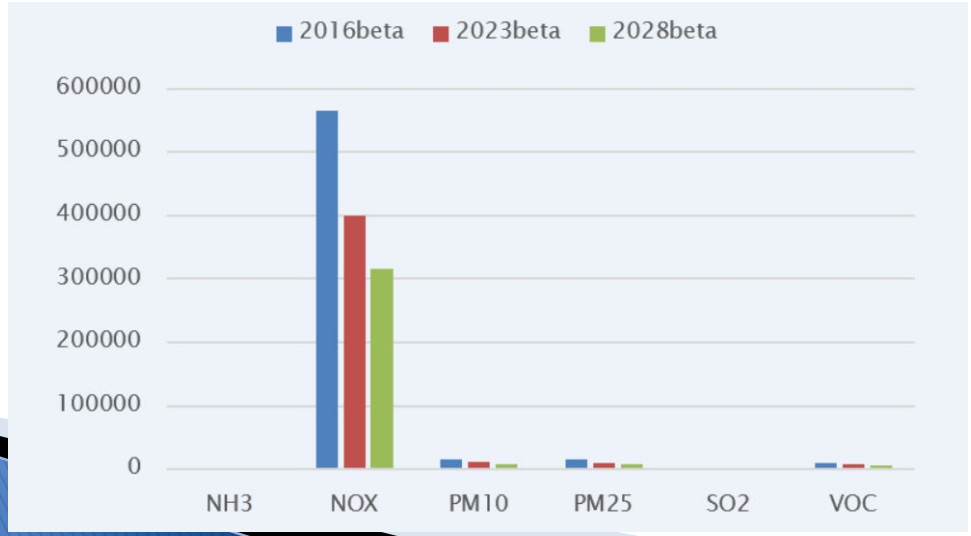






Changes in CMV C1C2 NOx 2016-2028





Questions?

- Any questions on CMV or rail projections?

Ongoing work and New Directions

- 2016 modeling platform
  - Workgroups wrapping up
  - Preparing emissions for version 1 for the years 2016, 2023, 2028
  - Beta platform for 2016 currently available
  - V1.0 platform coming soon
- Possible New Directions
  - Projections of changes in land use/population
    - Surrogates, New sources, Biogenics, Ag fertilizer
  - Improve Mexico inventory
  - Incorporate WRAP oil and gas and EGU inventories
  - Fires: Impact on biogenics, future year modeling treatment

Emissions Modeling Software and Data Downloads

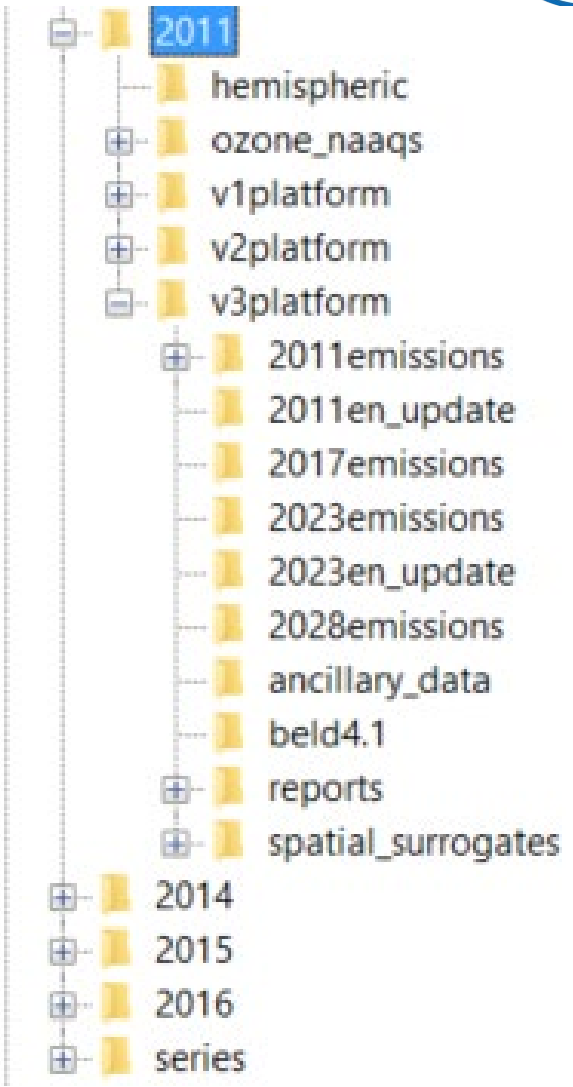
- The CMAS Center distributes many tools (https://www.cmascenter.org/)
  - SMOKE, CMAQ, VERDI (visualization), the Surrogate Tool, Spatial Allocator, Speciation Tool, and the Control Strategy Tool which includes the Emissions Modeling Framework
- SMOKE software and documentation is available from http://www.cmascenter.org/smoke
- A WIKI for SMOKE that answers common questions about emissions modeling is here: https://www.airqualitymodeling.org/index.php

Emissions Modeling Platform Data Availability

- EPA's modeling platform data, documentation, scripts available from
  - https://www.epa.gov/air-emissions-modeling
  - Version 6 platforms include:
    - 2011v6.3: January 2017 NODA (2011el/2023el), Final Cross-State Air Pollution Rule (CSAPR) Update (2011ek/2017ek), hemispheric case
  - Version 7.0 platform for NATA based on 2014NEIv1
  - 2016 alpha platform with compatible 2014 and 2015
  - Spatial surrogates available for 4km, 12km, 36km
  - Speciation data for CB05, CB6, SAPRC07TB
  - Temporal profiles for all sectors

Emissions Modeling FTP site

Several versions of the 2011 platform plus versions of 2014,2015, and 2016 are available on the FTP site: ftp://newftp.epa.gov/air/emismod



2016 beta Release Documentation

- http://views.cira.colostate.edu/wiki/wiki/9169
- Specification Sheets
- 27 documents in a standardized format
- Describe the sector, the SCCs/sources included in the sector, data sources, processing methods
- Graphical and tabular summaries of the data

Documentation

The documentation is available as a separate document for each modeling sector:

- Biogenic - MEGAN
- Biogenic - BEIS

- Mobile - Onroad
- Mobile - Nonroad
- Mobile - Nonroad - C1/C2 Commercial Marine Vessels
- Mobile - Nonroad - C3 Commercial Marine Vessels
- Mobile - Nonroad - Rail

- Nonpoint - Agriculture
- Nonpoint - Area Fugitive Dust
- Nonpoint - RWC
- Nonpoint - Other

- Oil & Gas - Nonpoint
- Oil & Gas - Point

- Point - EGU - ERTAC
- Point - EGU - IPM
- Point - non-IPM
- Point - Fires - Agricultural
- Point - Fires - Wild and Prescribed

- Canada - Mobile - Onroad
- Mexico - Mobile - Onroad
- Canada/Mexico - Point
- Canada/Mexico - Point - Fires
- Canada/Mexico - Nonpoint
- Canada - Nonpoint - Area Fugitive Dust
- Canada - Point - Dust
- Canadian Inventory Documentation

- Meteorological Model Performance Evaluation for 2016

Downloading from IWDW

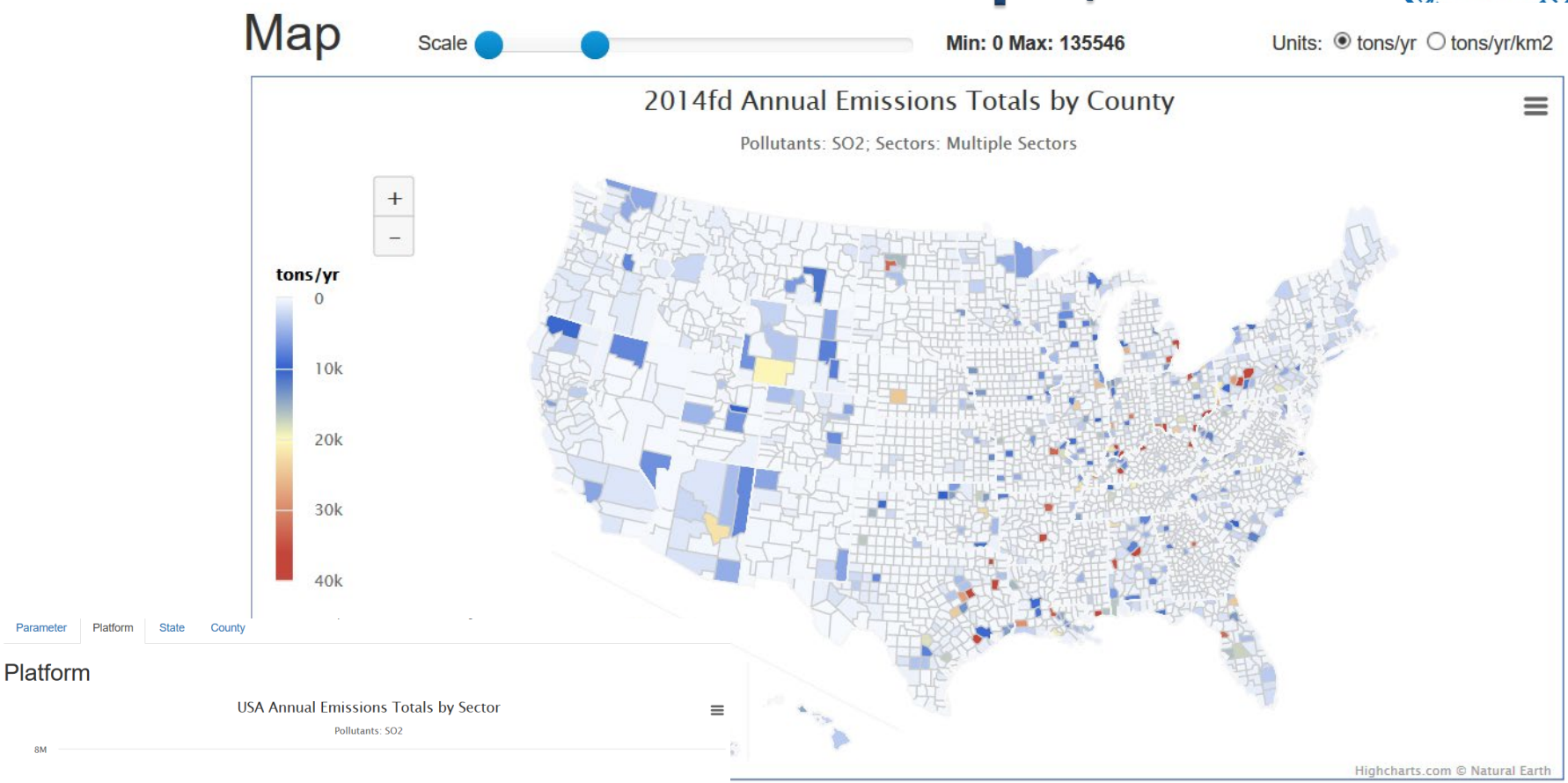
Once you log in with your account, select the components you need

Emissions

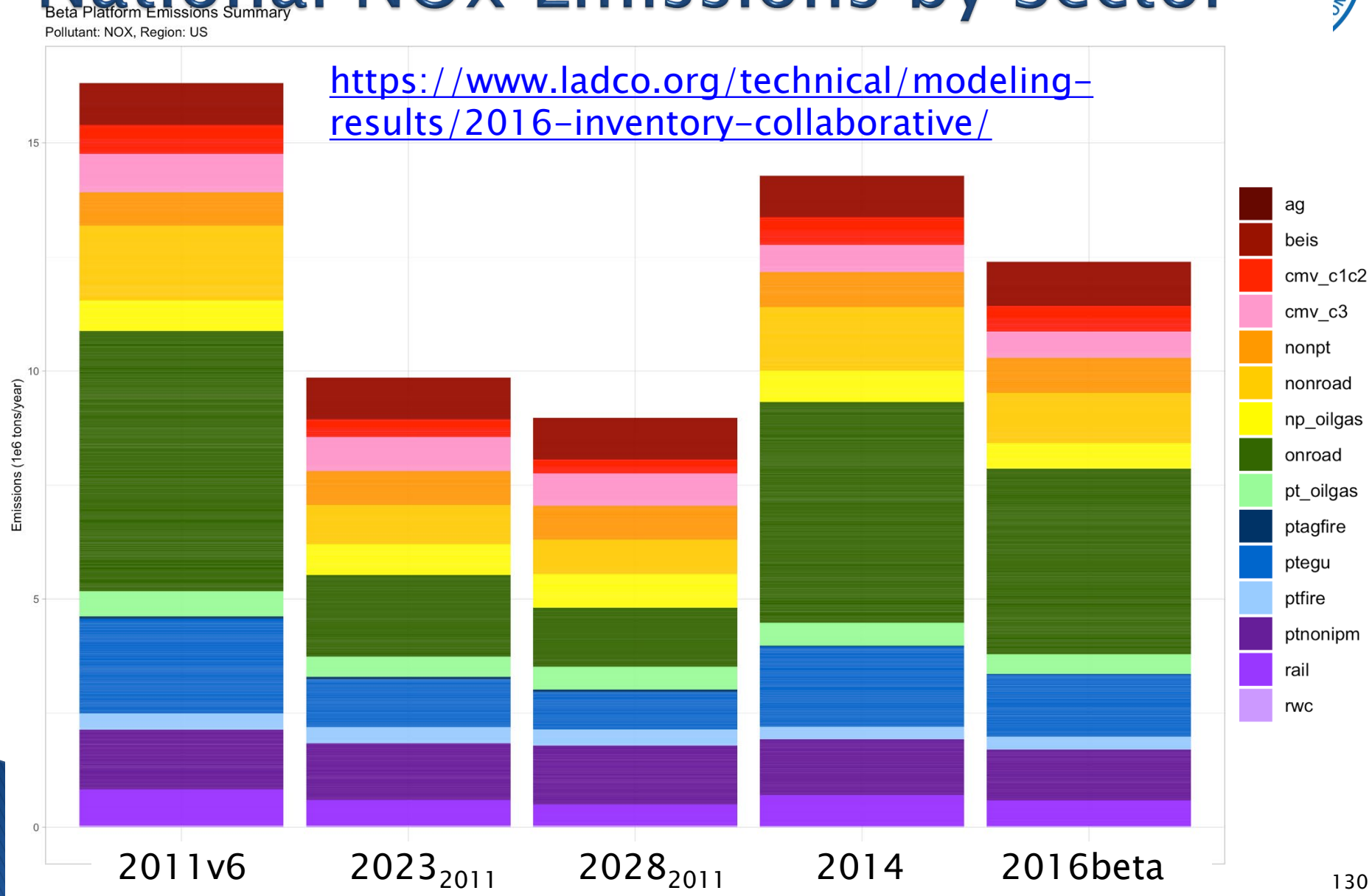
	Name	Description	Notes	Source	Status	Size	Files	Available
☐	Inventory Data	2016beta inventory data	2016 base year emissions inventories for the 2016beta emissions modeling platform	EIC	Available	5 GB	1	3/1/2019
☐	MOVES Emissions Factors	MOVES emissions factor tables	2016 base year MOVES emissions factor look up tables	EPA	Available	47 GB	1	3/1/2019
☐	BELD Landuse Tiles	BEIS biogenic model landuse input files	North American BELD4.1 tiles for calculating emissions with BEIS3; includes scripts and tools for windowing tiles to modeling domains	EPA	Available	665 MB	1	3/1/2019
☐	Ancillary Emissions Data	2016beta non-inventory emissions data	Spatial/chemical/temporal allocation and other non-inventory data for the 2016beta emissions modeling platform	EPA	Available	2 GB	1	3/1/2019
☐	Emissions Processing Tools	Software scripts for processing the 2016beta emissions	SMOKE and other support software scripts for preparing the 2016-base year emissions for the 36US3 and 12US2 modeling grids	EPA	Available	216 MB	1	3/1/2019
☐	Premerged emissions - 12K	12K pre-merged emissions	12K pre-merged emissions inputs (12US2). Includes BEIS3 (12US1, 12US2, 36US3) and MEGAN3 (12US2) biogenics.	EPA	Available	559 GB	1126	3/1/2019
☐	CAMx-ready - 36K (36US3)	36K gridded emissions	CAMx 36K gridded emissions inputs (36US3)	EPA	Available	3.5 TB	752	3/1/2019
☐	CAMx-ready - 12K (12US2)	12K gridded emissions	CAMx 12K gridded emissions inputs (12US2)	EPA	Available	3 TB	752	3/1/2019
☐	CMAQ-ready - 36K (36US3)	36K gridded emissions	CMAQ 36K gridded emissions inputs (36US3)	EPA	Available	442 GB	3143	3/1/2019
☐	CMAQ-ready - 12K (12US1)	12K gridded emissions	CMAQ 12K gridded emissions inputs (12US1	EPA	Available	961 GB	3519	3/1/2019
☐	CMAQ-ready - 12K (12US2)	12K gridded emissions	CMAQ 12K gridded emissions inputs (12US2)	EPA	Available	441 GB	752	3/1/2019

Annual Meteorological Data

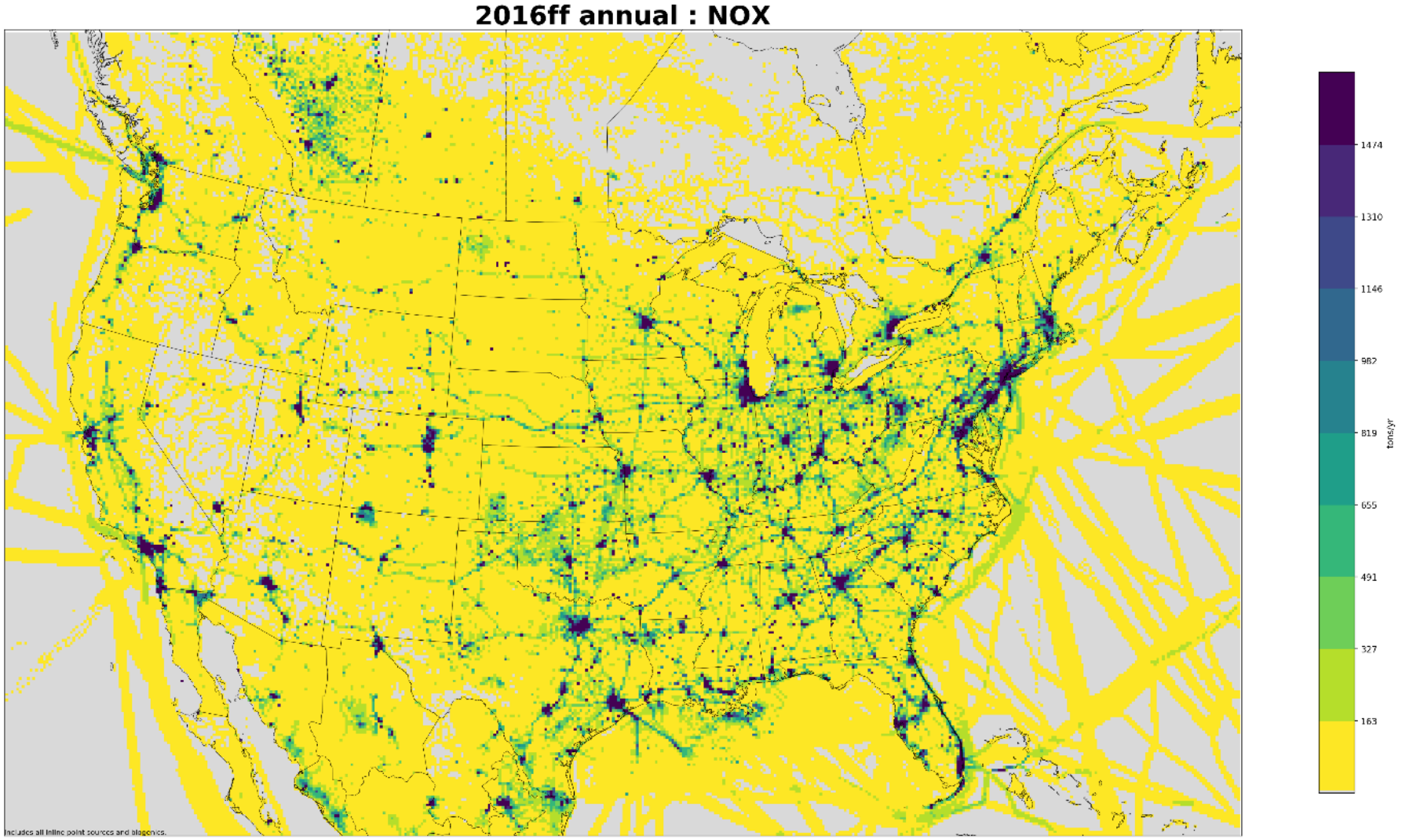
IWDW Interactive map / chart



LADCO Example Stacked Bar Plot: National NOx Emissions by Sector



Also on LADCO: Gridded Plots e.g., 2016 Annual 12-km Gridded NOx (tons/year)



Final Questions?

- We hope that we have conveyed many of the consideration and complexities of emissions modeling
- Any final questions for today?
- Contacts: eyth.alison@epa.gov, vukovich.jeffrey@epa.gov, farkas.caroline@epa.gov