Case Study:
Allegheny County $PM_{2.5}$ SIPs

Attainment Demonstration

Redesignation Request and Maintenance Plan

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Allegheny County Health Department (ACHD)

Air Quality Planning & Data Assessment

May 24, 2023

$PM_{2.5}$ Nonattainment Areas

Allegheny County Health Department

1997/2006 Standards

2012 Standards

2012 $PM_{2.5}$ NAAQS SIPs

Allegheny County Health Department

- 2012 $PM_{2.5}$ NAAQS SIPs for Allegheny County
  - Attainment demonstration → to get an area into attainment
    - Approved by EPA in 2021
  - Maintenance plan → to keep an area in attainment (10+ years)
    - Submitted to EPA in 2022
    - Redesignation request portion is technically not a SIP revision

- Related determinations from EPA
  - Review for completeness
  - Clean Data Determination (CDD)
  - Determination of Attainment by the Attainment Date (DAAD)

Attainment Demonstration Elements

- Elements for a typical attainment demonstration
  - Emissions inventories for the area
  - Control strategy for the area
  - Modeling demonstration (with emissions projections)
  - Review of reasonably available control measures/technologies (RACM/RACT)
  - Contingency measures (in case attainment is not achieved)
  - Supporting analysis (weight of evidence)
  - Reasonable further progress (RFP) and milestones
  - Transportation conformity and vehicle budget

- Typical size of attainment demonstration SIP submittal
  - Narrative: 100+ pages
  - Appendices: 1000+ pages

Understanding $PM_{2.5}$ in General

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- $PM_{2.5}$ is a complex pollutant, made up of several compounds
  - Contributions from many source sectors, both anthropogenic and biogenic
  - Can be emitted as a particle (primary) or formed from precursors (secondary)

- Understanding of $PM_{2.5}$ involves detailed analyses
  - Monitoring includes several types/compounds
  - Modeling of large area, with chemical transformation
  - Meteorological/transport analysis
  - Source apportionment

Source Influences within Allegheny County

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- Driving factors that contribute to excess $PM_{2.5}$ in Allegheny County
  - In-valley industrial emissions
  - Complex terrain (hills/valleys)
  - Temperature inversions, stagnant conditions

- Allegheny County is similar to other metro areas
  - Most sites are comparable to other Midwest/Northeast cities
  - Includes transport and urban core impacts
  - High concentration sites are not representative of entire county

Conceptual Model for $PM_{2.5}$ in SW PA

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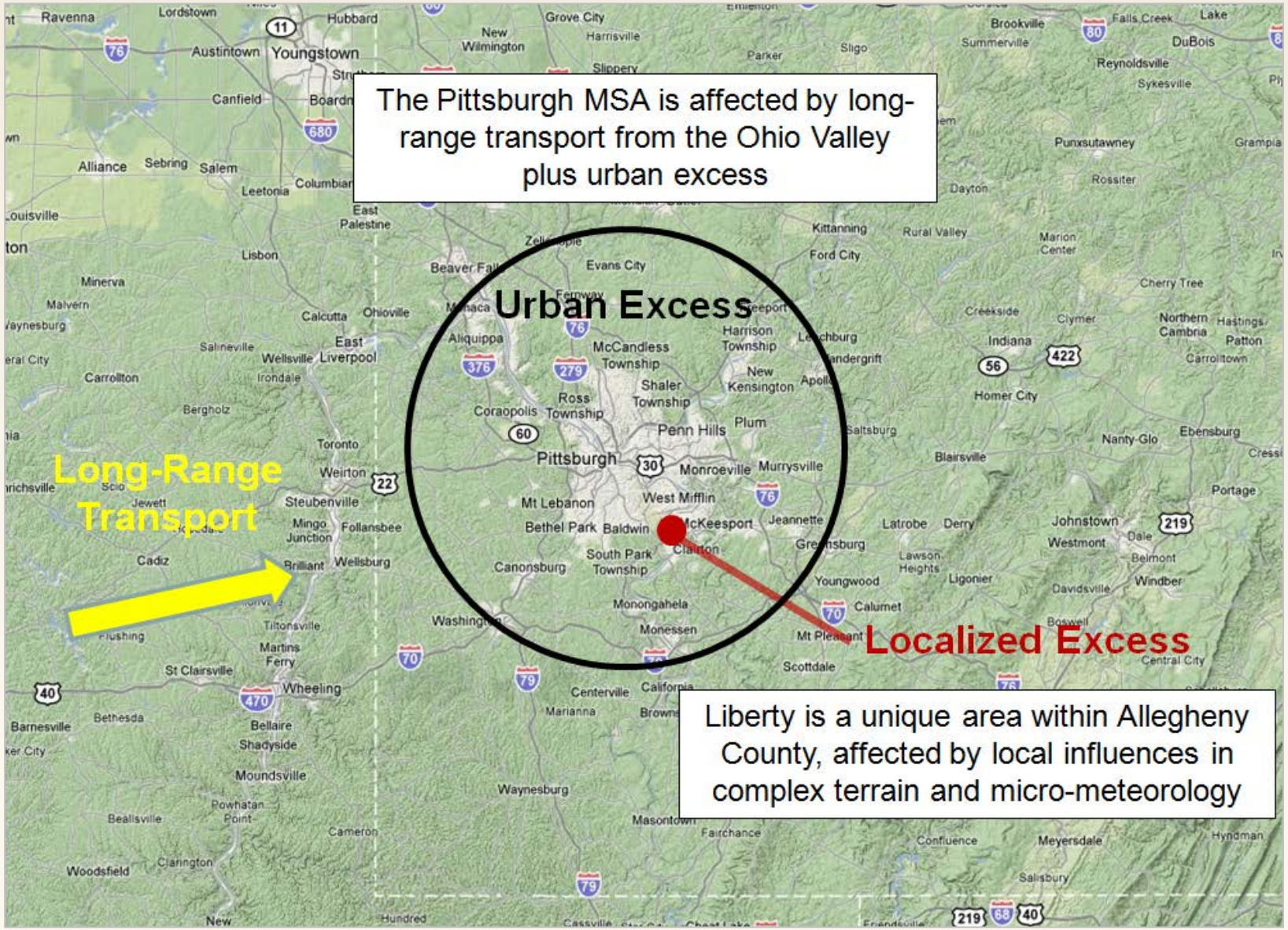

Total Electric Generation (MWh) from Coal-Fired Power Plants (2021)

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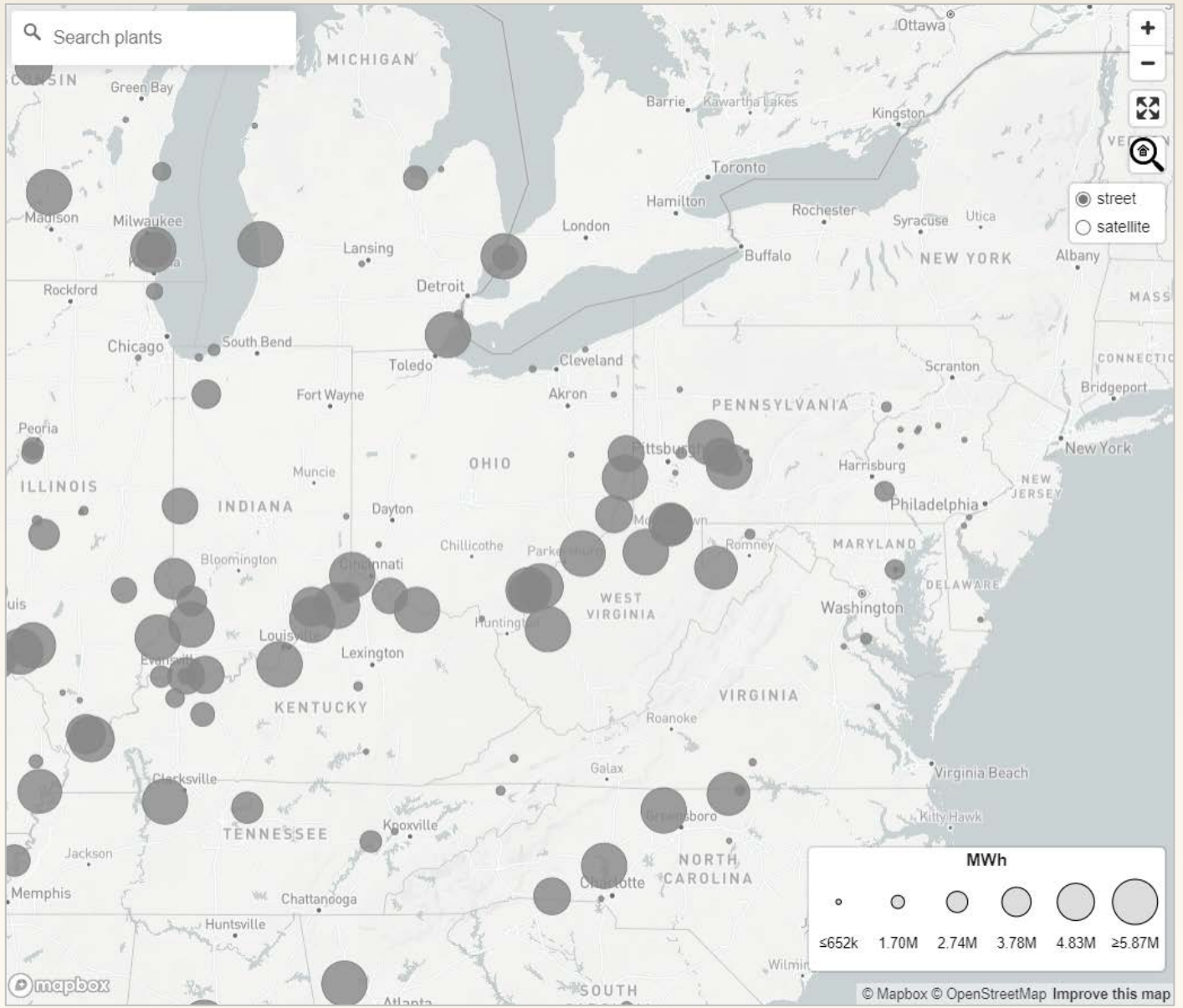

Taken from EPA eGRID Data Explorer

Example HYSPLIT Back-Trajectories

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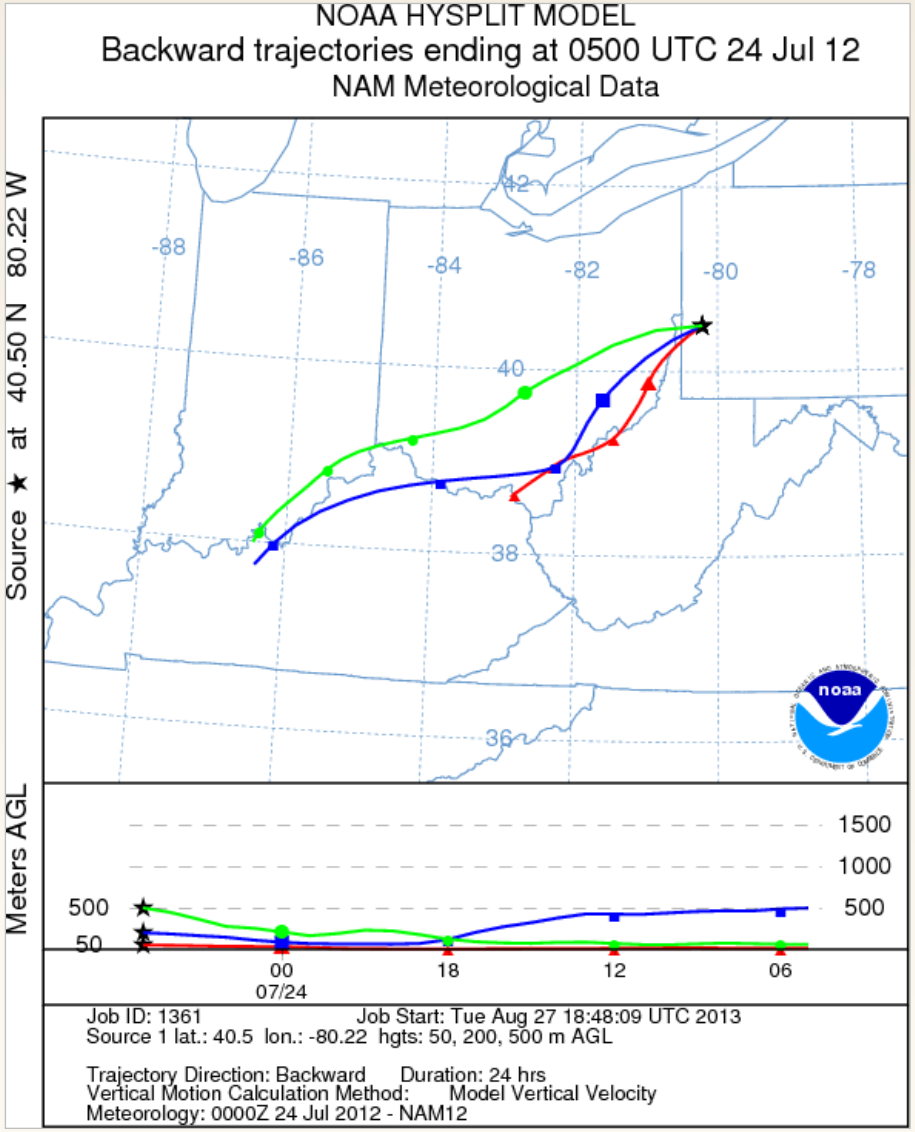

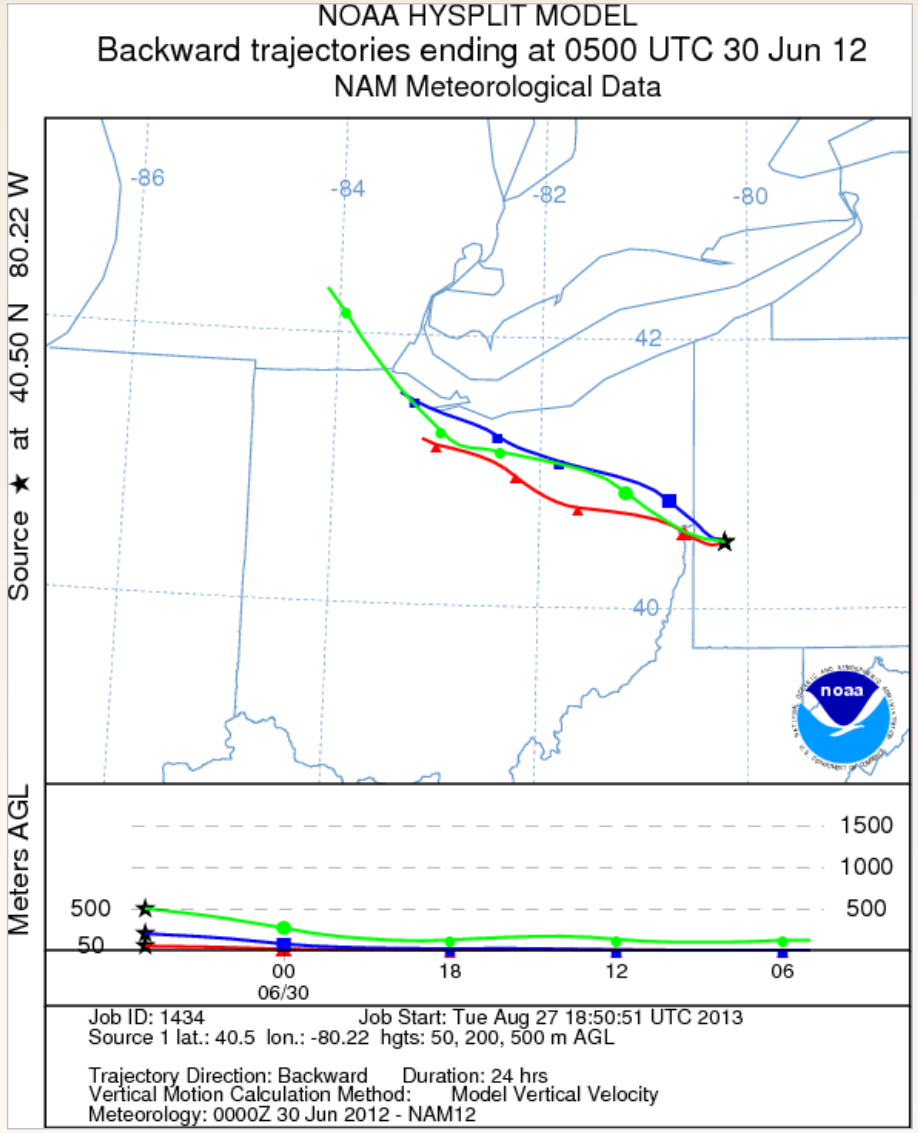

Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model

$PM_{2.5}$ PMF Source Apportionment, Tri-State Sites (2009-2017)

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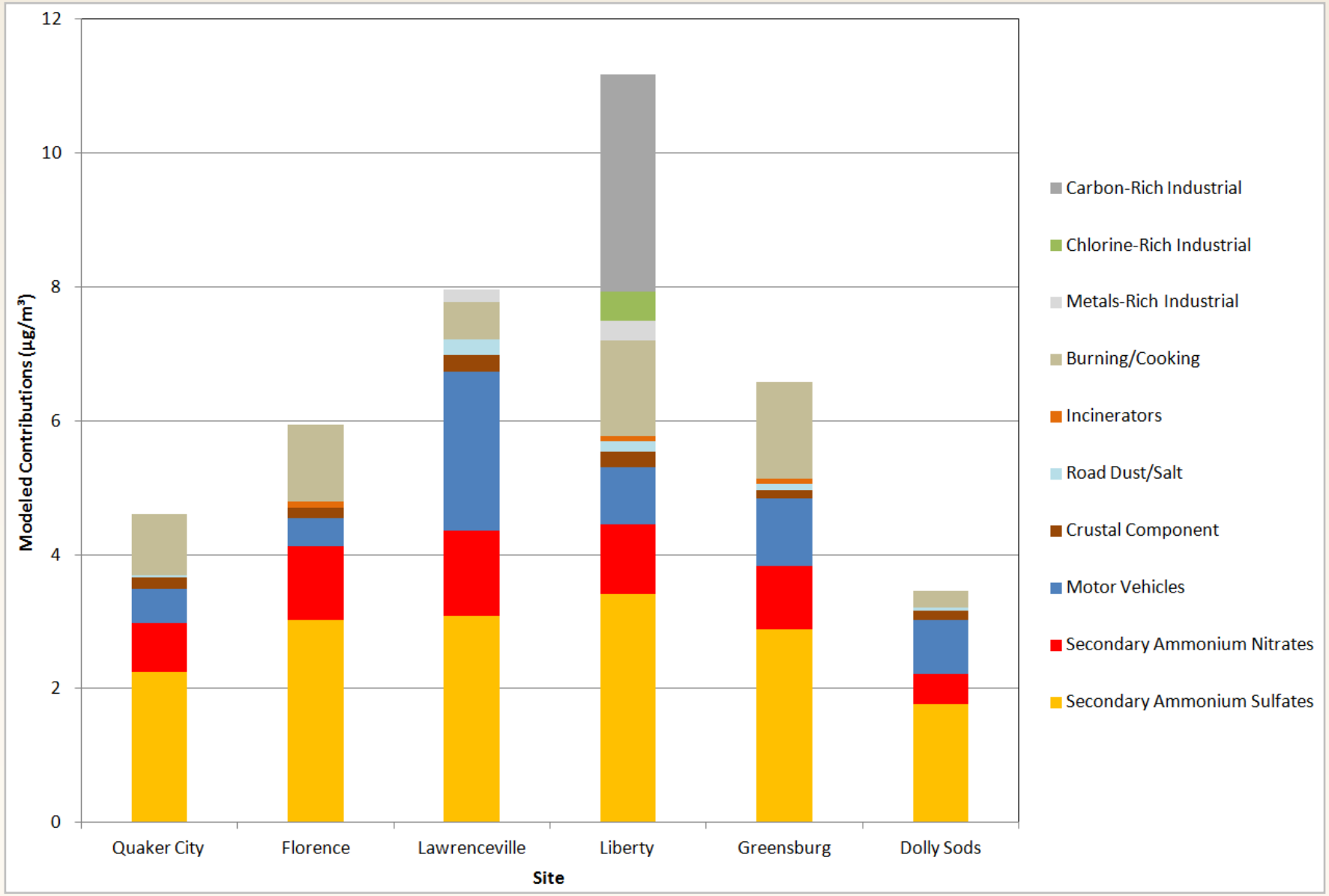

- Results from EPA Positive Matrix Factorization (PMF) source apportionment model
- Uses Chemical Speciation Network (CSN) monitored data
- Note: sum of species do not always equal FRM/FEM mass

2012 SIP Reductions

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- Base case 2011 → Future case 2021

- Point sources: local source modifications and shutdowns
- Area and mobile sources: regional/state rules and standards

- Inventories (emissions and modeling)
  - Combination of different resources
    - Allegheny County + MARAMA Alpha2
    - EPA v6.2 Model Platform (MP)
    - ERTAC v2.4
  - Future case 2021: interpolated for some source sectors

$PM_{2.5}$ Emissions Inventories

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Base Case 2011 Emissions Inventory

Allegheny County (2011)	$PM_{2.5}$	$PM_{2.5}$ (fil)	$PM_{2.5}$ (con)	PM_{10}	SO_2	NO_x	VOC	NH_3
Point Sources	2,503	1,338	1,164	2,987	13,460	11,128	1,669	207
Area Sources	2,491	2,011	480	4,683	1,528	6,979	11,200	621
Nonroad Mobile Sources	361	361	0	378	11	3,921	3,780	5
Onroad Mobile Sources	450	450	0	984	78	13,259	7,383	304
Fires	24	24	0	29	2	5	64	4
Biogenics	0	0	0	0	0	166	5,876	0
Total	**5,829**	**4,185**	**1,644**	**9,061**	**15,080**	**35,460**	**29,972**	**1,141**

Future Case 2021 Emissions Inventory

Allegheny County (2021)	$PM_{2.5}$	$PM_{2.5}$ (fil)	$PM_{2.5}$ (con)	PM_{10}	SO_2	NO_x	VOC	NH_3
Point Sources	2,256	1,256	999	2,722	5,921	7,928	1,534	202
Area Sources	2,708	2,226	472	5,486	1,079	6,664	10,221	615
Nonroad Mobile Sources	234	234	0	248	5	2,212	2,752	6
Onroad Mobile Sources	266	266	0	722	31	5,708	3,479	209
Fires	24	24	0	29	2	5	64	4
Biogenics	0	0	0	0	0	166	5,876	0
Total	**5,488**	**4,007**	**1,471**	**9,207**	**7,039**	**22,684**	**23,926**	**1,037**

Photochemical/Dispersion Models

- CAMx
  - Comprehensive Air Quality Model with Extensions
  - Photochemical grid model (PGM) that includes chemical transformation over large spatial scales
  - Utilizes multi-level prognostic gridded Weather Research and Forecasting (WRF) meteorology

- AERMOD
  - American Meteorological Society/Environmental Protection Agency Regulatory Model
  - EPA preferred dispersion model for near-field (50 km or less) impacts

$PM_{2.5}$ SIP Modeling, CAMx Model Domains

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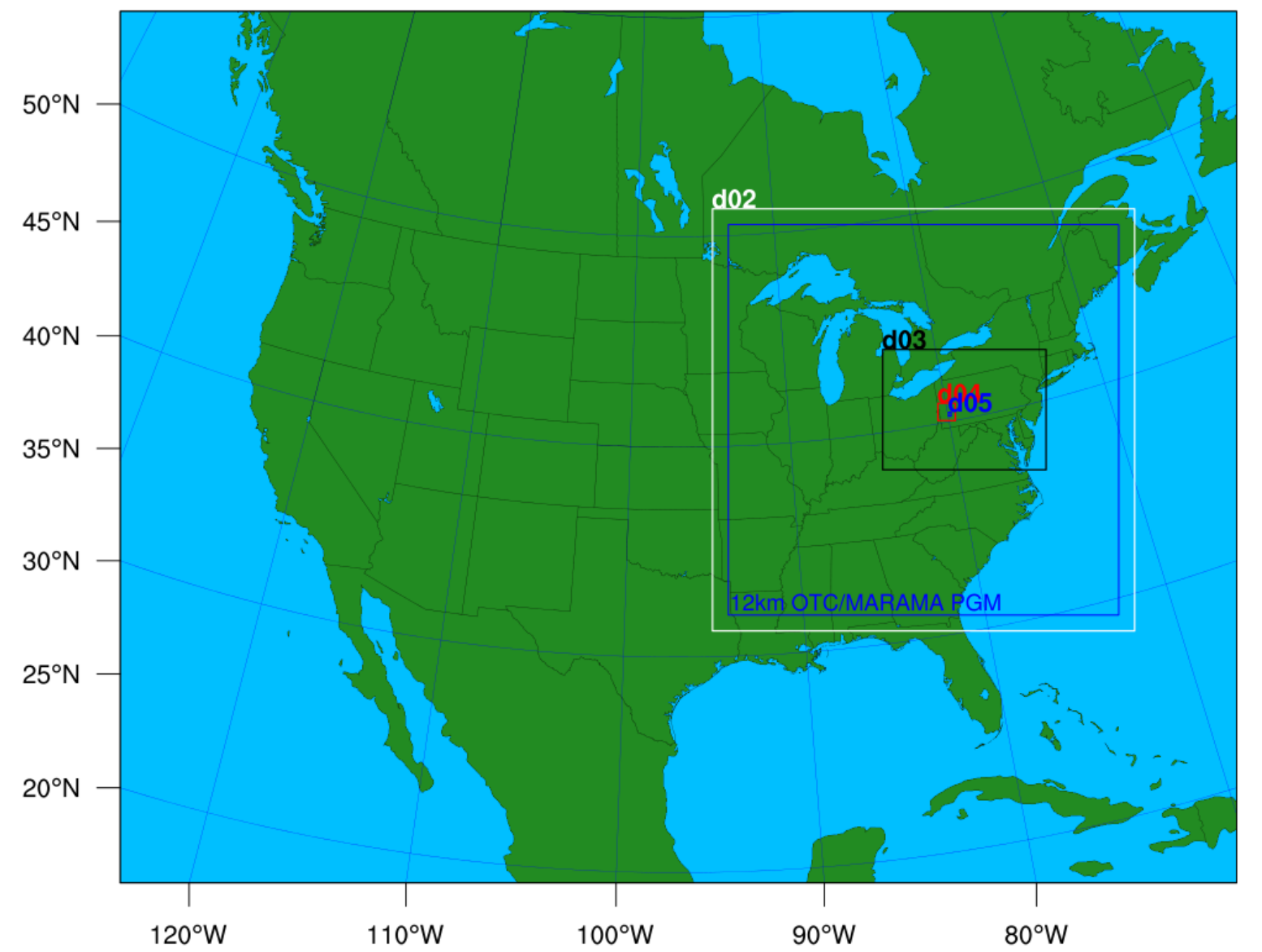

Resolutions

d01: 36 km
d02: 12 km
d03: 4 km
d04: 1.3 km
d05: 0.4 km

Resolution = lateral size of grid cell

Total $PM_{2.5}$ CAMx Results
2011 (left) and 2021 (right)

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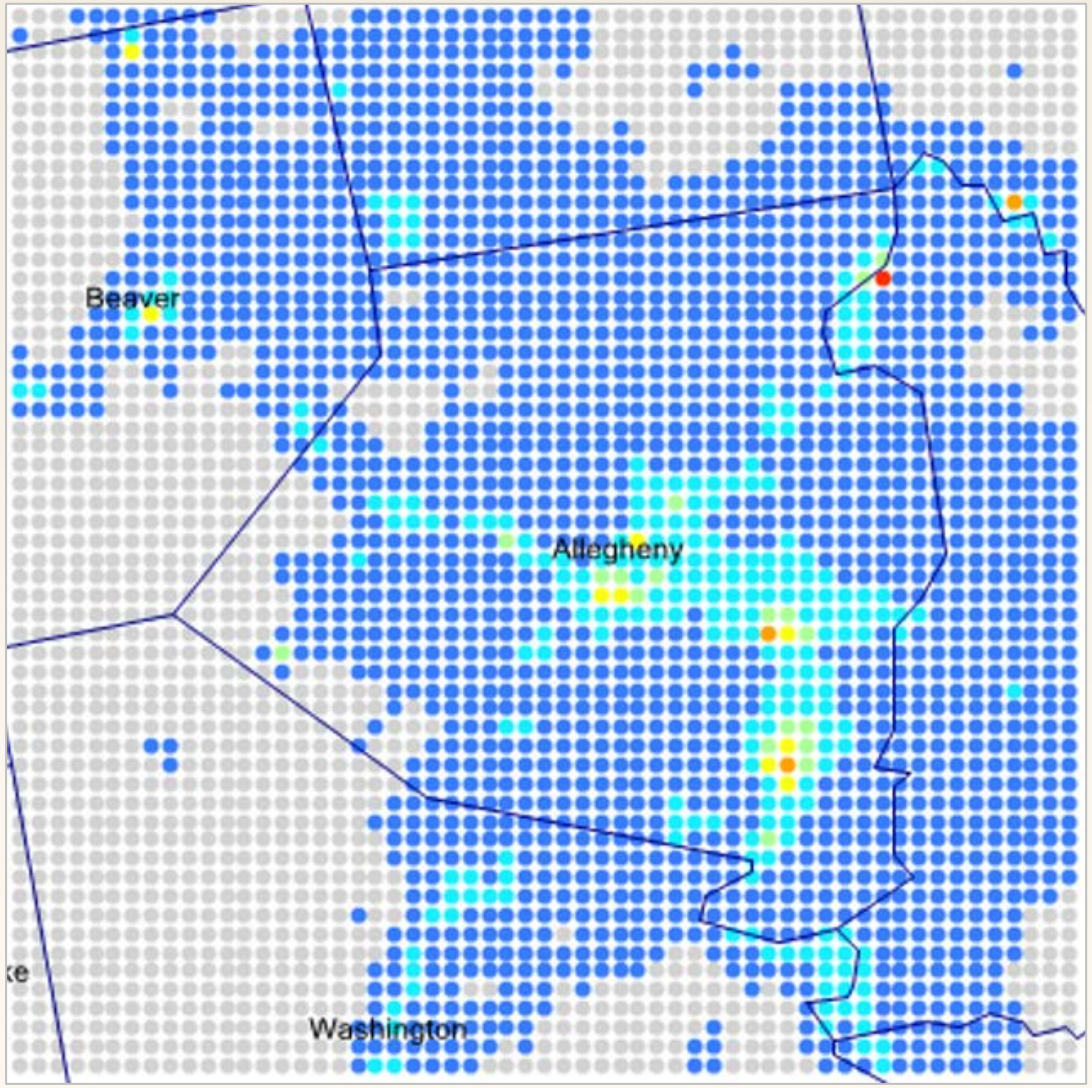
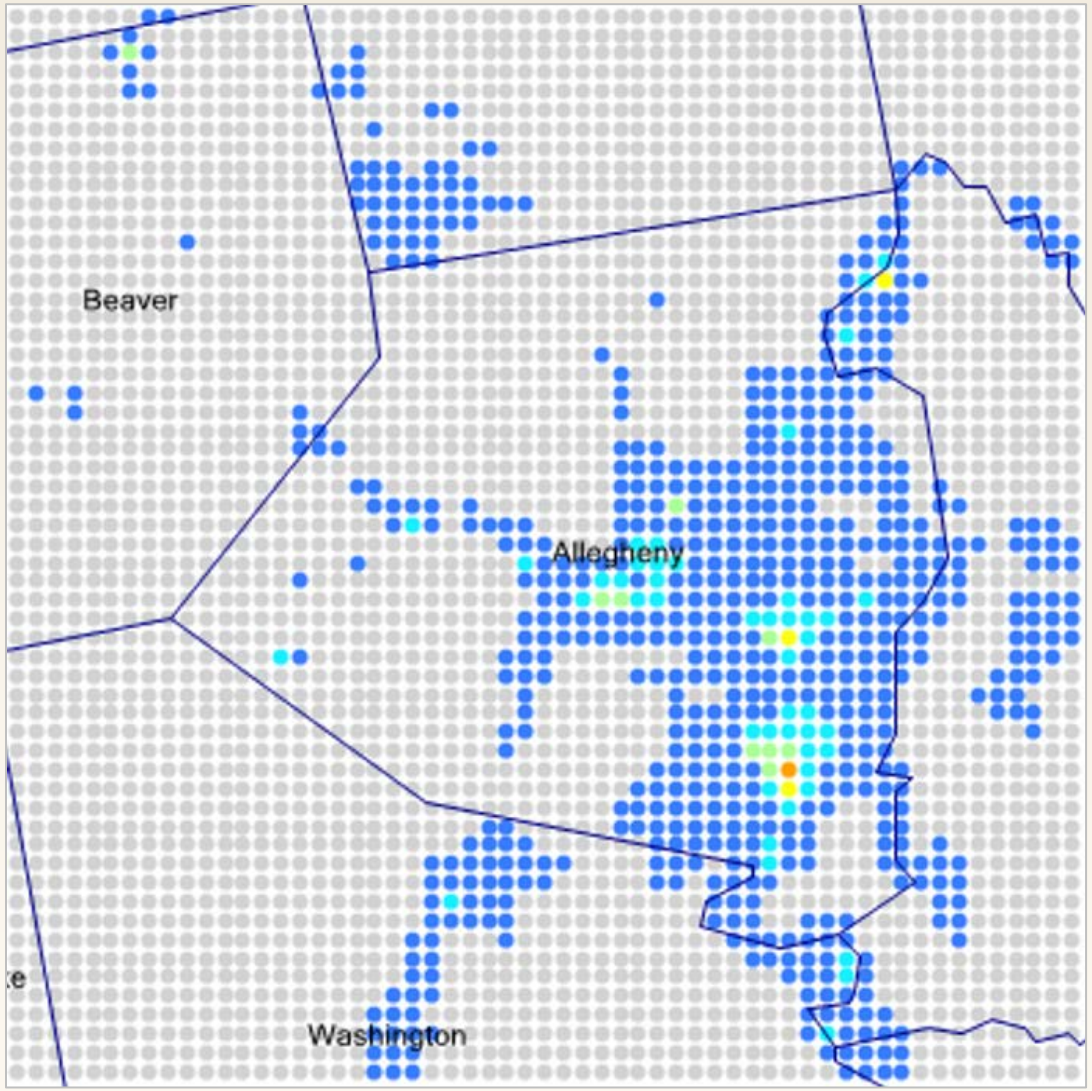
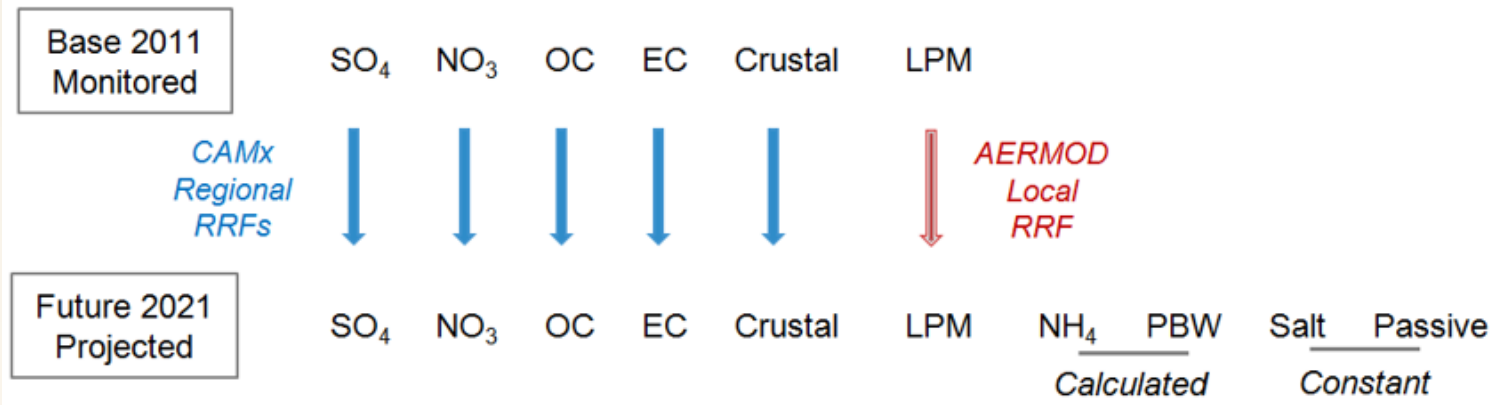




Note: scale not shown; results used in relative sense by species, applied to monitored values

Modeled Attainment

- Final modeling included combination of CAMx and AERMOD
  - AERMOD allowed for more specific source parameters and model options



- Modeled attainment by 2021
  - Actual monitored attainment achieved by 2020

Optional: Insignificance of Precursors

- Additional model sensitivity runs to determine the significance of VOC and NH_3 as precursors
  - One model run with 50% reduction of anthropogenic VOC emissions
  - Another model run with 50% reduction of anthropogenic NH_3 emissions

- Precursor can be deemed insignificant if sensitivity runs show less than significant contribution thresholds on design values
  - 0.2 µg/m³ on an annual basis
  - 1.3 µg/m³ on a 24-hour basis

- VOC and NH_3 analysis excluded from some SIP elements

RACM/RACT Analyses

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- Explained in the $PM_{2.5}$ Implementation Rule
- Review of available measures or technologies
  - For attainment, or to expedite attainment
- RACM/RACT analyses is very detailed
  - Some information was summarized from other pollutant analyses
  - Searches from EPA RACT/BACT/LAER Clearinghouse:
    - https://cfpub.epa.gov/rblc/index.cfm?action=Search.BasicSearch&lang=en

RFP/Milestones

- Reasonable Further Progress (RFP) and Quantitative Milestones (QM)
  - Shows progress toward attainment
- Milestone years of 2019 and 2022 (if needed)
  - Based on a schedule of 4.5 and 7.5 years after designation
- Linear progress
  - Emissions and monitored data
- Milestone reports are submitted to EPA

Nonattainment New Source Review (NNSR)

- Revisions to NNSR regulations

- VOC and NH_3 added as regulated precursors
  - Significant emission rates
    - 40 tons/year for VOC
    - 40 tons/year for NH_3
  - Significant air quality impact levels (SILs) for $PM_{2.5}$
    - 0.2 µg/m³, annual basis
    - 1.2 µg/m³, 24-hour basis

- Offset ratios of 1:1 for VOC and NH_3

Transportation Conformity/MVEB

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- Transportation conformity assessment was performed by Metropolitan Planning Organization (MPO)
- Motor Vehicle Emissions Budget (MVEB) adopted based on future case MOVES results
- For $PM_{2.5}$ and NO_x only

MVEB Emissions Levels	$PM_{2.5}$	NO_x
Onroad Mobile Sources	266	5,708

Weight of Evidence (WOE)

- Monitored data trends
- Additional controls not used in SIP
  - Expected modifications, deactivations, regional rules/regulations
- Population trends
  - Decreasing for Pittsburgh area
- Other measures
  - Related measures, non-regulatory, etc.

SIP Submittal/Review

- SIP submitted in 2019
  - Conditional approval by EPA in 2021
  - Contingency measures were not fully approvable
- Monitored attainment with 2018-2020 design values (DVs)
  - Continued attainment with subsequent DVs
- Clean data determination by EPA in 2022
  - Suspended most SIP elements, providing continued attainment
- ACHD proceeded with Redesignation/Maintenance

Requirements for Redesignation

- Attainment of the standards
  - Monitored data, modeled data
- State Implementation Plan (SIP) requirements met
  - Approved attainment demonstration
  - Other Clean Air Act (CAA) requirements
- Permanent and enforceable reductions in air quality levels
  - Controls, regulations
- Maintenance plan to ensure attainment for initial 10-year period

Maintenance Plan

- Requirements for maintenance plan
  - Attainment emissions inventory
  - Maintenance demonstration
  - Monitor network
  - Verification of continued attainment
  - Contingency provisions

- Maintenance demonstration test
  - Future maintenance inventories < attainment inventory
    - Attainment year: 2017
    - Interim year: 2026
    - Maintenance year: 2035

Actual Reductions from SIP Timeframe

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Allegheny County Totals (2012 NAAQS)	$PM_{2.5}$	$PM_{2.5}$ (fil)	$PM_{2.5}$ (con)	PM_{10}	SO_2	NO_x	VOC	NH_3
2011 Base Year	5,829	4,185	1,644	9,061	15,080	35,460	29,972	1,141
2017 Attainment Year	4,437	3,207	1,230	6,728	5,033	23,273	25,383	1,238
Reduction, Base to Control Year	-1,392	-978	-414	-2,333	-10,047	-12,187	-4,589	97
Percent Change	*-24%*	*-23%*	*-25%*	*-26%*	*-67%*	*-34%*	*-15%*	*9%*

Projection Methodologies

- Point and area sources
  - Planned future local modifications
  - Growth factors
    - Increasing: natural gas usage, construction/dust, chemicals, aircrafts, commercial cooking, wood burning, solvents
    - Decreasing: steel/metals manufacturing, oil usage, marine vessel/locomotive, gas cans

- Mobile sources (MOVES3)
  - Onroad and nonroad
  - Growth factors
    - Decreasing: gasoline/diesel, LPG/CNG, light/heavy duty
    - Increasing: PM_{10} increasing from passenger cars/trucks
      - Increased miles traveled led to increased brake and tire wear

Allegheny County Maintenance Test

Allegheny County Health Department

Allegheny County Totals	$PM_{2.5}$	$PM_{2.5}$ (fil)	$PM_{2.5}$ (con)	PM_{10}	SO_2	NO_x	VOC	NH_3	Total $PM_{2.5}$
2017 Attainment Year	4,437	3,207	1,230	6,728	5,033	23,273	25,383	1,238	59,364
2026 Interim Year	4,095	2,917	1,178	6,462	3,027	17,094	24,760	1,257	50,233
2035 Maintenance Year	4,095	2,903	1,191	6,551	3,009	15,861	24,728	1,271	48,963
Reduction, Attainment to Interim Year	-342	-290	-52	-266	-2,006	-6,179	-623	18	-9,132
Reduction, Attainment to Maintenance Year	-343	-304	-39	-177	-2,024	-7,413	-655	33	-10,401

Maintenance Contingency Measures

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- First-level warning
  - Monitor values exceed NAAQS in one year
- Second-level warning
  - Monitor values exceed NAAQS based on two-year average
- Action level
  - Monitor values violate NAAQS based on DVs
  - Select, develop, and implement one or more measures
  - Implementation within one year following violation

Identified Potential Contingency Measures

- Potential identified measures
  - Additional process controls at major sources
  - Tug/locomotive replacement
  - New wood-burning related programs
  - Additional voluntary diesel retrofits
  - New clean vehicle rebate program
  - Enhancement of Air Quality Action Day program

- New local episode regulation
  - Designed to control short-term $PM_{2.5}$ emissions during worst-case meteorological conditions
  - Not included as possible contingency measure

2012 NAAQS SIPs Link

- ACHD web site for SIPs:
  - https://www.alleghenycounty.us/Health-Department/Programs/Air-Quality/Regulations-and-SIPs.aspx
- Attainment Demonstration
  - Revision 90
- Redesignation Request and Maintenance Plan
  - Revision 100

Questions?