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Using MERPs Guidance for Ozone and $PM_{2.5}$ Permitting

Louisiana A&WMA Annual Conference

16 October 2019

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Presentation Outline

- Context for Secondary Pollutants
- Tier 1 and Tier 2 Overview
- MERPs Introduction
- Example 1: Secondary Ozone
- Example 2: Primary and Secondary $PM_{2.5}$
- Class I Refinements
- Key Considerations

Context for Secondary Pollutants

When to assess secondary impacts?

Ozone:

Pursuant to 40 CFR 52.21, a proposed project with a project increase of VOC or NO_X emissions in excess of 100 tpy triggers an ambient ozone impact analysis for the project.

Secondary $PM_{2.5}$:

Combination of…

1. Project direct $PM_{2.5}$ emissions compared to SER and
2. Project SO_2 and NOx emissions compared to respective SERs

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Tier 1 and Tier 2 Overview

Guideline on Air Quality Models

Estimating single-source impacts on ozone and secondary $PM_{2.5}$:

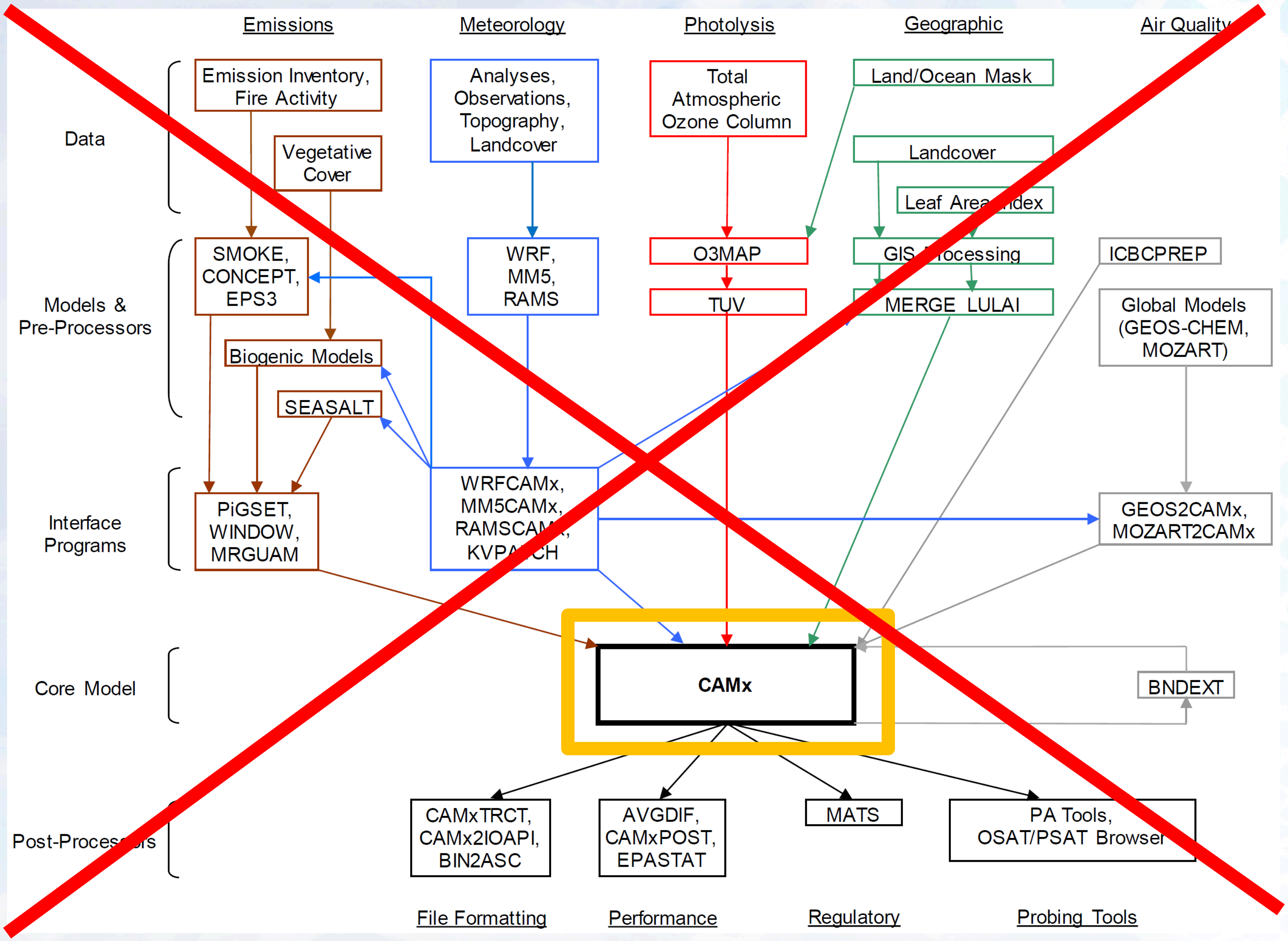
Tier 1

- Technically credible relationships between emissions and ambient impacts
- Existing modeling results or studies deemed sufficient

Tier 2

- Case-specific application of chemical transport modeling
- Anticipates few situations where a Tier 2 demonstration would be necessary

Avoid Tier 2



Emissions
Meteorology
Photolysis
Geographic
Air Quality
Data
Emission Inventory, Fire Activity
Vegetative Cover
Analyses, Observations, Topography, Landcover
Total Atmospheric Ozone Column
Land/Ocean Mask
Landcover
Leaf Area Index
Models & Pre-Processors
SMOKE, CONCEPT, EPS3
WRF, MM5, RAMS
O3MAP
TUV
GIS Processing
MERGE LULAI
ICBCPREP
Global Models (GEOS-CHEM, MOZART)
Biogenic Models
SEASALT
Interface Programs
PiGSET, WINDOW, MRGUAM
WRFCAMx, MM5CAMx, RAMSCAMx, KVPATCH
GEOS2CAMx, MOZART2CAMx
Core Model
CAMx
BNDEXT
Post-Processors
CAMxTRCT, CAMx2IOAPI, BIN2ASC
AVGDIF, CAMxPOST, EPASTAT
MATS
PA Tools, OSAT/PSAT Browser
File Formatting
Performance
Regulatory
Probing Tools

Tier 1 Demonstrations

Use existing empirical relationships between precursors and secondary impacts based on modeling systems

↓

MERPs → tool under PSD permitting program:
provides a simple way to relate maximum downwind impacts with a critical air quality threshold

↓

PSD → separate MERPs developed to relate:
VOCs and/or NOx → O_3
SO_2 and/or NOx → secondary $PM_{2.5}$

MERPs Introduction

EPA MERPs Guidance - SCRAM

Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program (74 pp, 3.1 MB About PDF) - April 2 EPA 454/R-19-003. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

2019

- A spreadsheet (224 KB) with the underlying maximum impact and MERPs information for each hypothetical source

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

APR 3 0 2019

OFFICE OF AIR QUALITY PLANNING AND STANDARDS

MEMORANDUM

SUBJECT: Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program

FROM: Richard A. Wayland, Director
Air Quality Assessment Division

TO: Regional Air Division Directors

Annual PM2.5 SO2 | Daily PM2.5 SO2 | Annual PM2.5 NOX | Daily PM2.5 NOX | **MDA8 O3 VOC** | MDA8 O3 NOX

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	METRIC	PRECURSOR	POLL	State	County	FIPS	EMISSIONS	STACKH	CONC	MERP	LATITU	LONGIT	CZ	CZNAM	terravg	urbmax	DOMAIN	SOURC
110	MDA8	VOC	OZONE	Louisiana	Acadia	22001	500	10	0.114	4378	30.2409	-92.6165	6	South	6	6.5	12EUS2	15
111	MDA8	VOC	OZONE	Louisiana	Acadia	22001	1000	10	0.247	4050	30.2409	-92.6165	6	South	6	6.5	12EUS2	15
112	MDA8	VOC	OZONE	Louisiana	Acadia	22001	1000	90	0.222	4502	30.2409	-92.6165	6	South	6	6.5	12EUS2	15
113	MDA8	VOC	OZONE	Louisiana	Acadia	22001	3000	90	0.992	3024	30.2409	-92.6165	6	South	6	6.5	12EUS2	15
114	MDA8	VOC	OZONE	Louisiana	Lincoln	22061	500	10	0.043	11551	32.4762	-92.7109	6	South	68	5.8	12EUS2	14
115	MDA8	VOC	OZONE	Louisiana	Lincoln	22061	1000	10	0.087	11520	32.4762	-92.7109	6	South	68	5.8	12EUS2	14
116	MDA8	VOC	OZONE	Louisiana	Lincoln	22061	1000	90	0.089	11254	32.4762	-92.7109	6	South	68	5.8	12EUS2	14
117	MDA8	VOC	OZONE	Louisiana	Lincoln	22061	3000	90	0.274	10969	32.4762	-92.7109	6	South	68	5.8	12EUS2	14
118	MDA8	VOC	OZONE	Louisiana	Orleans	22071	500	10	0.201	2491	30.0919	-89.879	6	South	1	50.4	12EUS2	10
119	MDA8	VOC	OZONE	Louisiana	Orleans	22071	1000	10	0.415	2410	30.0919	-89.879	6	South	1	50.4	12EUS2	10
120	MDA8	VOC	OZONE	Louisiana	Orleans	22071	1000	90	0.382	2618	30.0919	-89.879	6	South	1	50.4	12EUS2	10
121	MDA8	VOC	OZONE	Louisiana	Orleans	22071	3000	90	1.294	2319	30.0919	-89.879	6	South	1	50.4	12EUS2	10

MERPs: Secondary Formation Tool

Potential way of evaluating secondary impacts of $PM_{2.5}$ and Ozone

↓

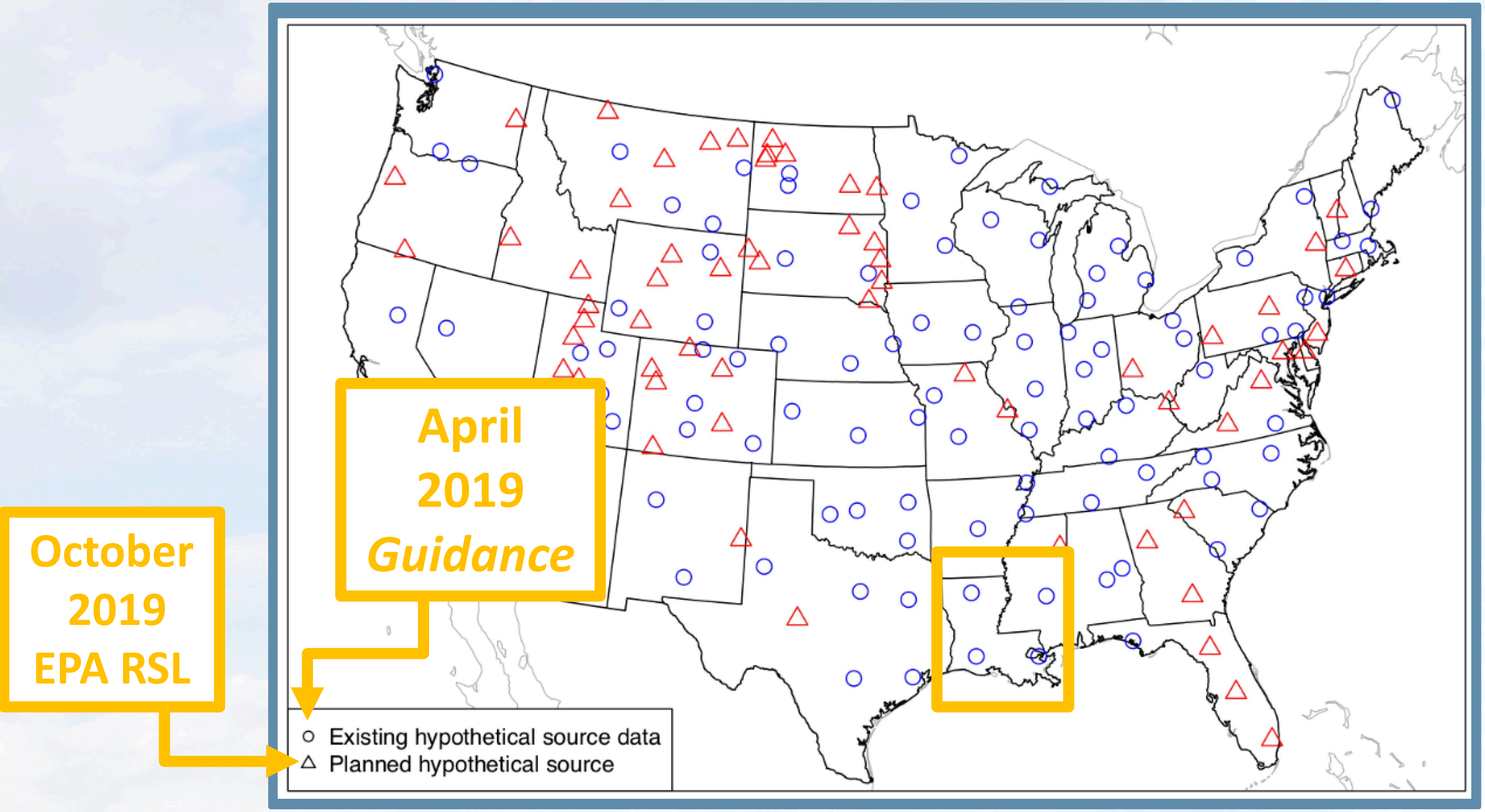
MERPs → an annual tpy precursor emission rate from a hypothetical evaluated source (in photochemical modeling) that corresponds to an air quality impact at the level of the SIL.

↓

Example → An SO_2 MERP for the daily $PM_{2.5}$ standard is calculated to be 367 tons. This means that if the PSD source emits 367 tpy, the daily $PM_{2.5}$ impact resulting from the SO_2 emissions would be at the level of the SIL (1.2 µg/m^3).

Hypothetical Sources

EPA provided guidance MERP values for numerous hypothetical sources, evaluated by region.



Baker et al, 2016
Kelly et al, 2015
IWAQM3–NFI Report

Ozone

Example 1

Ambient Ozone Impacts

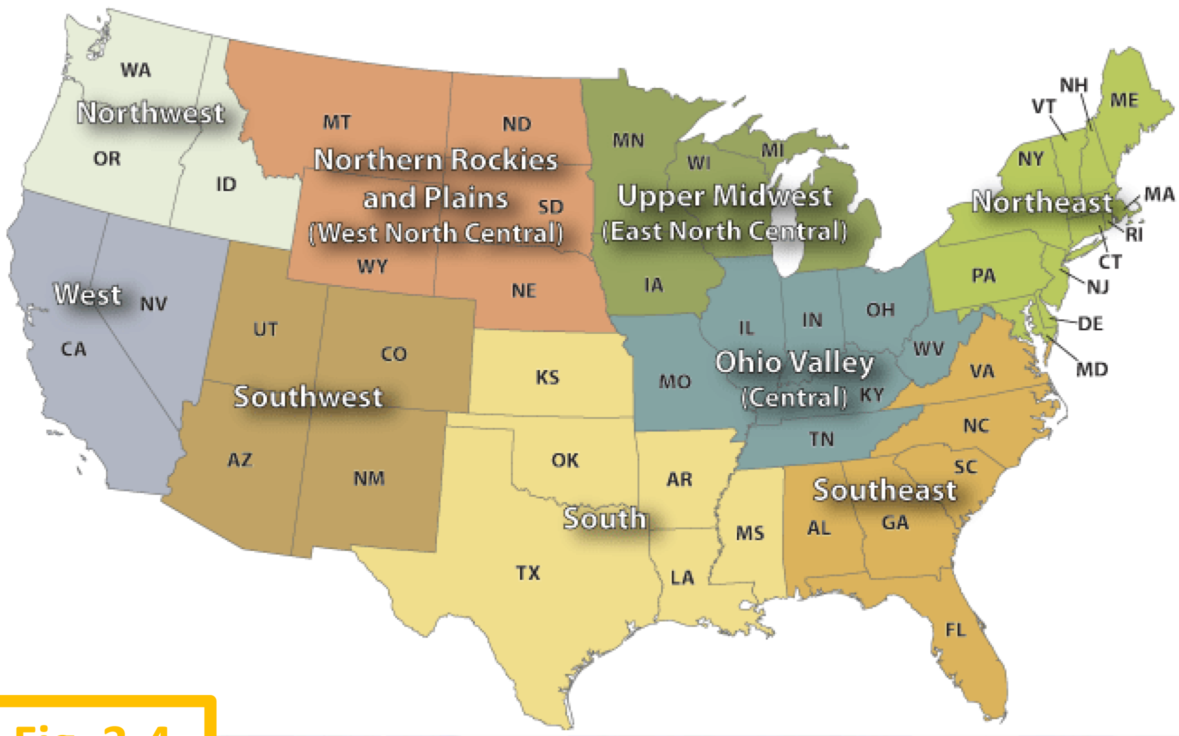
VOC = 485 tpy

NOx = 510 tpy

Surface Level Release

Ambient Ozone Impacts: SIA

STEP 1: Use lowest illustrative MERP from the South Climate Zone



Climate Zone	Sources
Northeast	10
Southeast	9
Ohio Vally	19
Upper Midwest	12
Rockies/Plains	14
South	17
Southwest	15
West	6
Northwest	3

Fig. 3-4

Ambient Ozone Impacts: SIA

STEP 1: Use lowest illustrative MERP from the South Climate Zone

	8-hr O_3 from NO_X			8-hr O_3 from VOC		
Climate Zone	Lowest	Median	Highest	Lowest	Median	Highest
Northeast	209	495	5,773	2,068	3,887	15,616
Southeast	170	272	659	1,936	7,896	42,964
Ohio Valley	126	340	1,346	1,159	3,802	13,595
Upper Midwest	125	362	4,775	1,560	2,153	30,857
Rockies/Plains	184	400	3,860	1,067	2,425	12,788
South	190	417	1,075	2,307	4,759	30,381
Southwest	204	422	1,179	1,097	10,030	144,744
West	218	429	936	1,094	1,681	17,086
Northwest	199	373	4,031	1,049	2,399	15,929

Table 4-1

Ambient Ozone Impacts: SIA

STEP 1: Use lowest illustrative MERP from the South Climate Zone

Project Impact in ppb...

$$= \left(\frac{NOx\ Project\ Emissions}{NOx\ MERP}\right) + \left(\frac{VOC\ Project\ Emissions}{VOC\ MERP}\right) * \text{SIL}$$

$$= \left(\frac{510\ tpy\ Project}{190\ tpy\ MERP}\right) + \left(\frac{485\ tpy\ Project}{2{,}307\ tpy\ MERP}\right) * 1.0\ \text{ppb}$$

$$= \mathbf{2.89}\ ppb$$

$$\mathbf{2.89}\ ppb > \mathbf{1.0}\ ppb\ Ozone\ SIL$$

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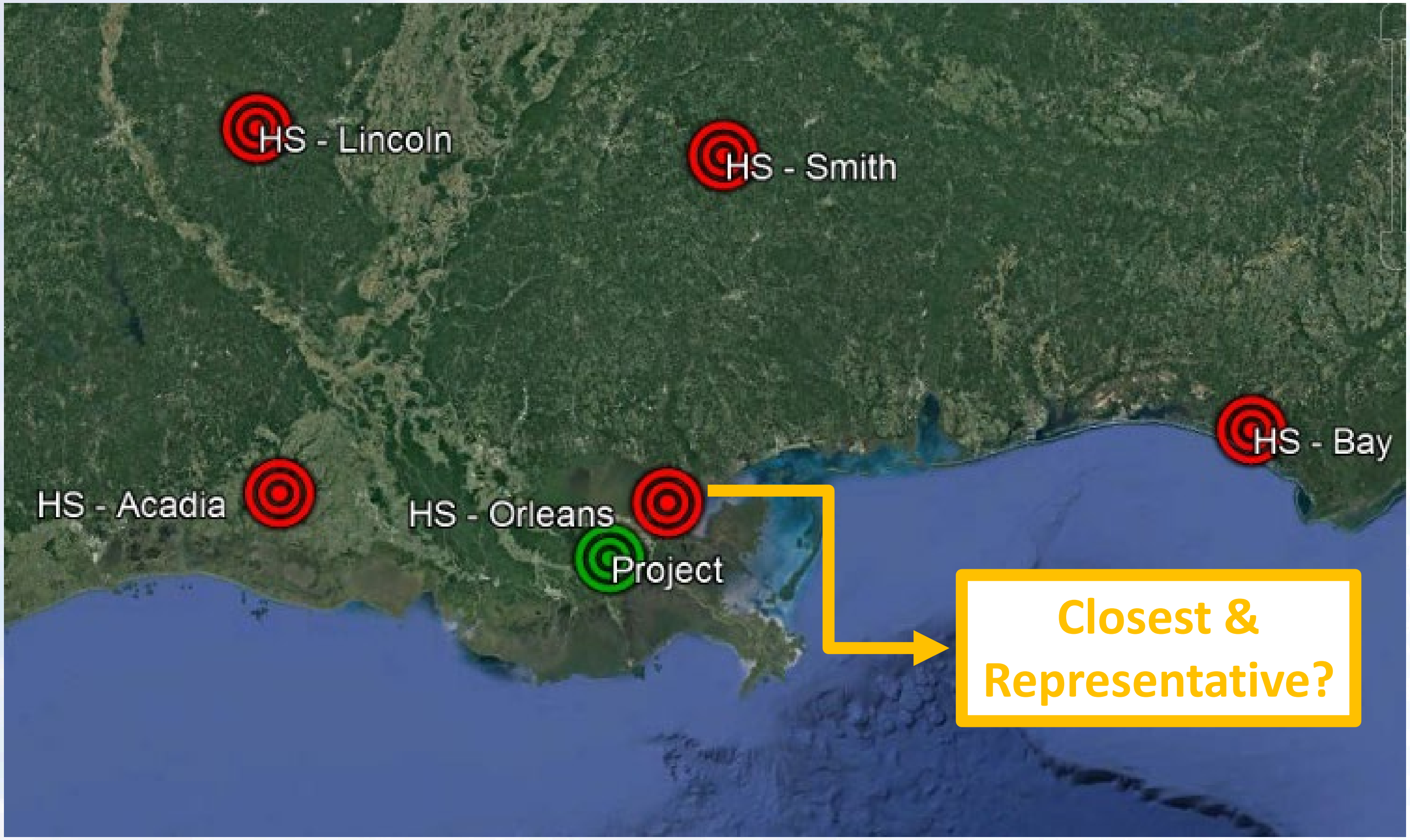
Ambient Ozone Impacts: SIA

STEP 2: Select lowest MERP from nearby sources with similar stack height



$$Assume > 1.0\ ppb\ Ozone\ SIL$$

Ambient Ozone Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Assess Comparability

- Nearby local and regional sources of pollutants and their emissions
- Rural/urban nature of the area and terrain features
- Ambient concentrations of relevant pollutants where available
- Average/peak temperatures and humidity

Ambient Ozone Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Orleans Hypothetical Source - VOC

Emissions (tpy)	Stack Height (m)	Concentration (ppb)	MERP (tpy)
500	**10**	**0.201**	**2,491**
1,000	10	0.415	2,410
1,000	90	0.382	2,618
3,000	90	1.294	2,319

April 2019 MS Excel Spreadsheet

Ambient Ozone Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Orleans Hypothetical Source – NOx

Emissions (tpy)	Stack Height (m)	Concentration (ppb)	MERP (tpy)
500	**10**	**1.116**	**448**
500	90	1.332	375
1,000	90	2.480	403
3,000	90	6.017	499

April 2019 MS Excel Spreadsheet

Ambient Ozone Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Project Impact in ppb...

$$= \left(\frac{NOx\ Project\ Emissions}{NOx\ MERP}\right) + \left(\frac{VOC\ Project\ Emissions}{VOC\ MERP}\right) * \text{SIL}$$

$$= \left(\frac{510\ tpy\ Project}{448\ tpy\ MERP}\right) + \left(\frac{485\ tpy\ Project}{2{,}491\ tpy\ MERP}\right) * 1.0\ \text{ppb}$$

$$= 1.33\ ppb$$

$$1.33\ ppb > 1.0\ ppb\ Ozone\ SIL$$

Ambient Ozone Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

In this case, based on EPA modeling results for a representative hypothetical source, air quality impacts of O_3 from this project source would be expected to exceed the EPA recommended 8-hour O_3 SIL.

Ambient Ozone Impacts: CIA

STEP 3: Select most representative nearby source for similar scenario

$$\boldsymbol{Projected\ Design\ Value\ with\ Project\ in\ ppb\ldots}$$

$$\boldsymbol{= Project\ Impact + Monitored\ Design\ Value}$$

$$= 1.33\ ppb + 65\ ppb$$

$$\boldsymbol{= 66.33\ ppb}$$

$$\boldsymbol{66.33\ ppb < 70\ ppb\ Ozone\ NAAQS}$$

Secondary $PM_{2.5}$

Previous Secondary $PM_{2.5}$ Guidance

- May 20, 2014
  - Guidance for $PM_{2.5}$ Permit Modeling

Assessment Case	Description of Assessment Case	Primary Impacts Approach	Secondary Impacts Approach
Case 1: No Air Quality Analysis	Direct PM2.5 emiss[illegible]0 tpy SER NOx and SO2 em[illegible]py SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 e[illegible] NOx and SO2 emi[illegible]	[illegible] preferred or [illegible]ed alternative [illegible]ispersion model	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissi[illegible] NOx and/or SO2 e[illegible]	[illegible]endix W preferred or [illegible]roved alternative [illegible]rsion model	• Qualitative • Hybrid qualitative / quantitative • Full quantitative photochemical grid modeling
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and/or SO2 emissions ≥ 40 tpy SER	N/A	• Qualitative • Hybrid qualitative / quantitative • Full quantitative photochemical grid modeling

Recent Secondary $PM_{2.5}$ Guidance

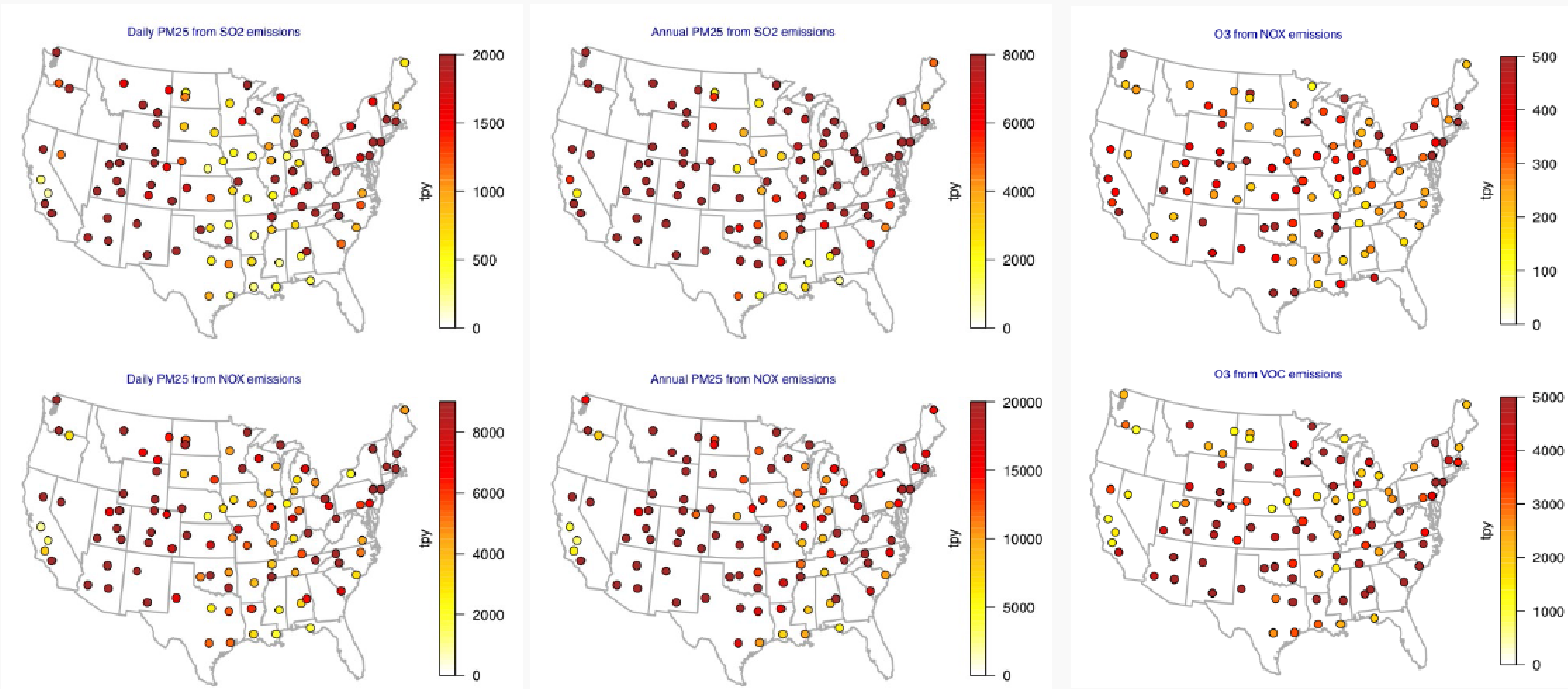
> Either assess fully for $PM_{2.5}$ or not at all

Assessment Case	Description of Assessment Case	Primary Impacts Approach	Secondary Impacts Approach
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER Both NOx and SO2 emissions < 40 tpy SER	N/A	N/A
Case 2: PM2.5 Assessment (Primary and Secondary Air Quality Impacts)	Direct PM2.5 emissions ≥ 10 tpy SER or NOx and/or SO2 emissions ≥ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	• **Tier 1 Approach (*e.g.*, MERPs)** • **Tier 2 Approach (Chemical Transport Modeling)** • **Qualitative (Very Rare Situation)**

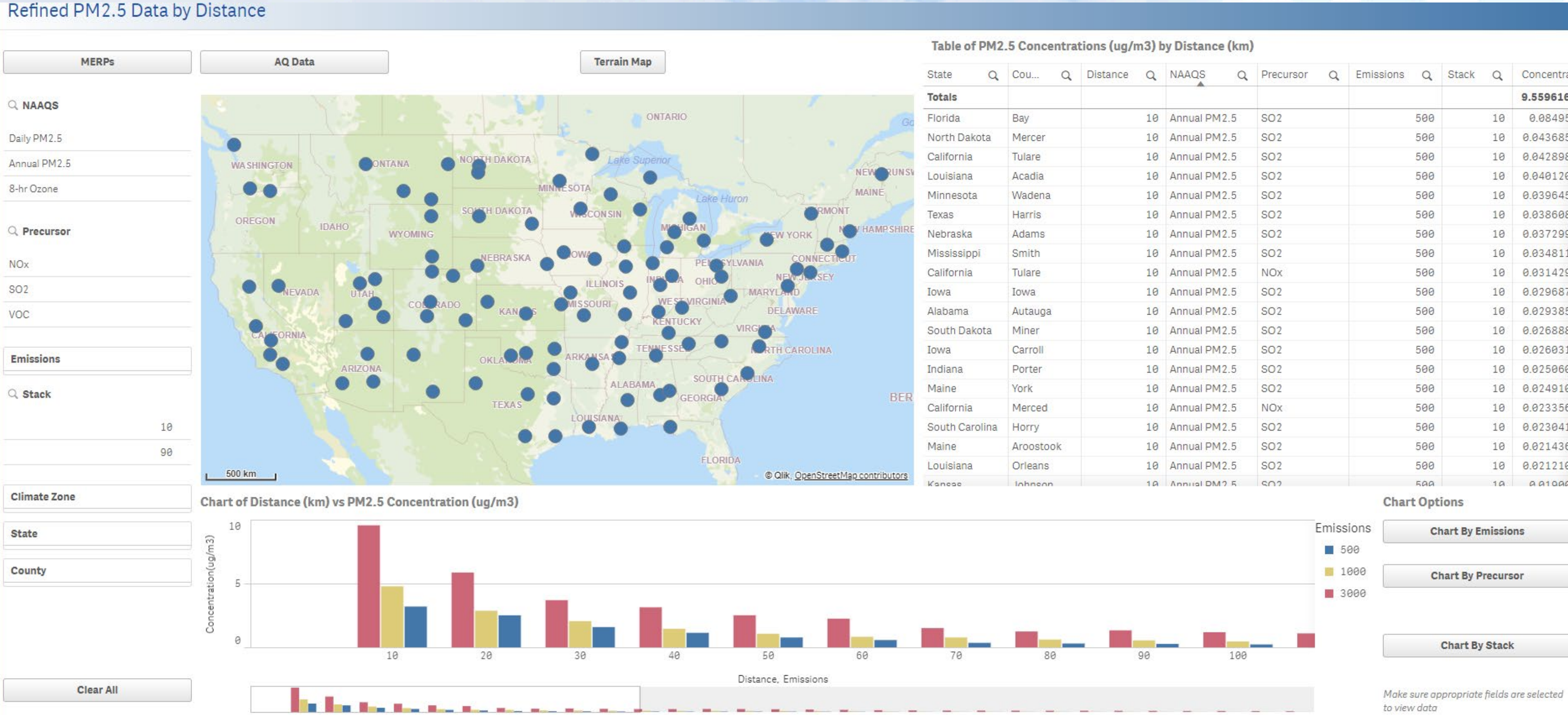
* "Ozone and $PM_{2.5}$ Permit Modeling Guidance", presented June 5, 2018 at EPA RSL Modeler's Workshop, Boston, MA.

Different Data for $PM_{2.5}$ vs O_3

Illustrative MERPs for PM2.5 and O3



MERPS View



State	Cou...	Distance	NAAQS	Precursor	Emissions	Stack	Concentra
Totals							**9.559616**
Florida	Bay	10	Annual PM2.5	SO2	500	10	0.08495
North Dakota	Mercer	10	Annual PM2.5	SO2	500	10	0.043685
California	Tulare	10	Annual PM2.5	SO2	500	10	0.042898
Louisiana	Acadia	10	Annual PM2.5	SO2	500	10	0.040120
Minnesota	Wadena	10	Annual PM2.5	SO2	500	10	0.039645
Texas	Harris	10	Annual PM2.5	SO2	500	10	0.038608
Nebraska	Adams	10	Annual PM2.5	SO2	500	10	0.037299
Mississippi	Smith	10	Annual PM2.5	SO2	500	10	0.034811
California	Tulare	10	Annual PM2.5	NOx	500	10	0.031429
Iowa	Iowa	10	Annual PM2.5	SO2	500	10	0.029687
Alabama	Autauga	10	Annual PM2.5	SO2	500	10	0.029385
South Dakota	Miner	10	Annual PM2.5	SO2	500	10	0.026888
Iowa	Carroll	10	Annual PM2.5	SO2	500	10	0.026031
Indiana	Porter	10	Annual PM2.5	SO2	500	10	0.025060
Maine	York	10	Annual PM2.5	SO2	500	10	0.024910
California	Merced	10	Annual PM2.5	NOx	500	10	0.023356
South Carolina	Horry	10	Annual PM2.5	SO2	500	10	0.023041
Maine	Aroostook	10	Annual PM2.5	SO2	500	10	0.021436
Louisiana	Orleans	10	Annual PM2.5	SO2	500	10	0.021210
Kansas	Johnson	10	Annual PM2.5	SO2	500	10	[illegible]

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Example 2

Secondary $PM_{2.5}$ Impacts

SO_2 =
100 tpy

NOx =
510 tpy

$PM_{2.5}$ =
25 tpy

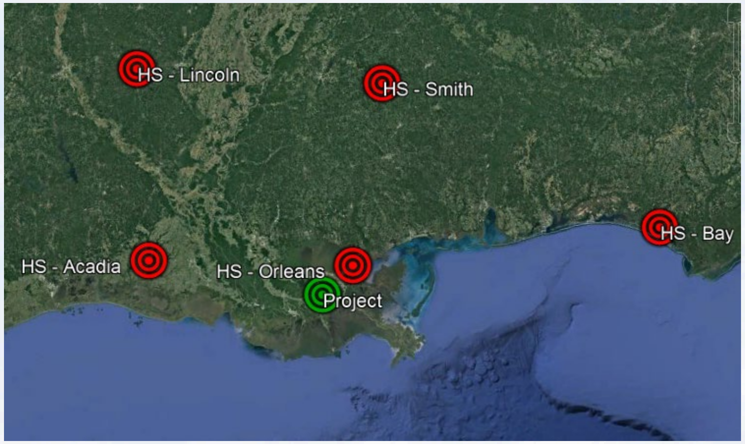
Primary $PM_{2.5}$
24hr Model =
<u>0.7 μg/m³</u>

Secondary $PM_{2.5}$ Impacts: SIA

STEP 1: Use lowest illustrative MERP from the South Climate Zone

$$Primary + Secondary\ PM_{2.5} > 1.2\ \mu g/m^3\ SIL$$

STEP 2: Select most representative nearby source for similar scenario



Secondary $PM_{2.5}$ Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Orleans Hypothetical Source - NO_x

Emissions (tpy)	Stack Height (m)	Concentration ($\mu g/m^3$)	MERP (tpy)
500	**10**	**0.261**	**2,300**
1,000	10	0.638	1,881
1,000	90	0.288	4,161
3,000	90	0.996	3,616

April 2019 MS Excel Spreadsheet

Secondary $PM_{2.5}$ Impacts: SIA

STEP 3: Select most representative nearby source for similar scenario

Orleans Hypothetical Source – SO_2

Emissions (tpy)	Stack Height (m)	Concentration ($\mu g/m^3$)	MERP (tpy)
500	**10**	**0.699**	**859**
1,000	10	2.622	458
1,000	90	1.02	1,176
3,000	90	5.216	690

April 2019 MS Excel Spreadsheet

Secondary $PM_{2.5}$ Impacts: SIA

<u>STEP 3</u>: Select most representative nearby source for similar scenario

$$\textit{Secondary 24hr } PM_{2.5}$$

$$= Project\ NOx\ Emissions * \left(\frac{NOx\ Hypo. Source\ Modeled\ Impact\ \left(\frac{\mu g}{m^3}\right)}{NOx\ Hypo.\ Source\ Emissions} \right) + Project\ SO_2\ Emissions * \left(\frac{SO_2\ Hypo. Source\ Modeled\ Impact\ \left(\frac{\mu g}{m^3}\right)}{SO_2\ Hypo.\ Source\ Emissions} \right)$$

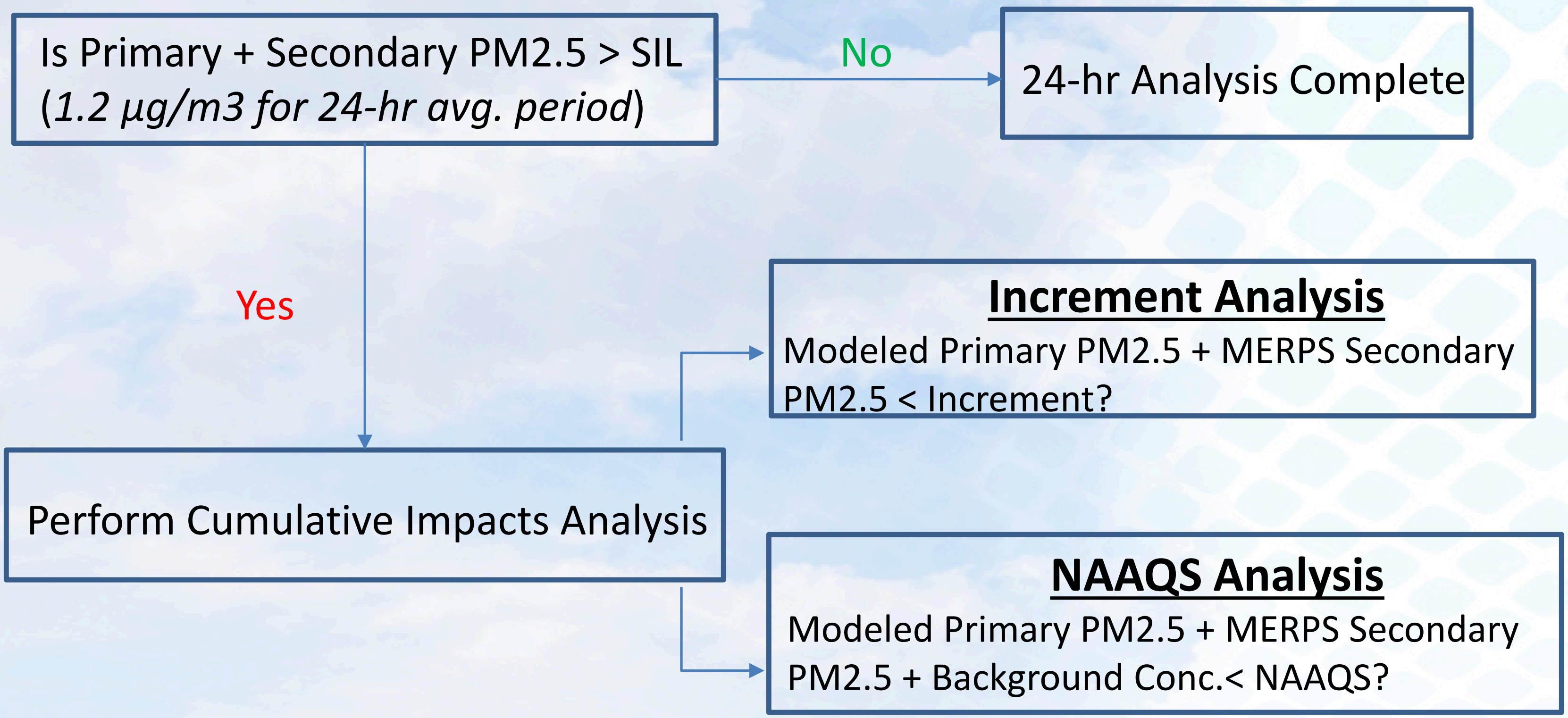
$$= 510 * \left(\frac{0.261 \left(\frac{\mu g}{m^3}\right)}{500\ tpy} \right) + 100 * \left(\frac{0.699 \left(\frac{\mu g}{m^3}\right)}{500\ tpy} \right)$$

$$= 0.41\ \mu g/m^3$$

<u>Primary + Secondary $PM_{2.5}$ Impacts</u>

$1.11\ \mu g/m^3 < 1.2\ \mu g/m^3$ $PM_{2.5}$ SIL

What if Primary + Secondary $PM_{2.5}$ Impacts > SIL



Class I Refinements?

Class I Impacts

Distance to nearest Class I area

~70 miles
~115 km

Class II $PM_{2.5}$ SIL=
<u>1.2 µg/m³</u>

Class I $PM_{2.5}$ SIL=
<u>0.27 µg/m³</u>

Class I Refinements

Table A-1. Daily 24-hour and annual average $PM_{2.5}$ impacts from NO_X and SO_2 sources from CUS hypothetical source 10: Orleans, Louisiana

Precursor	Stack	Distance (km)	Maximum 24-hr Impact (µg/m3) Emissions (tpy)			Maximum Annual Impact (µg/m3) Emissions (tpy)		
			500	*1000*	*3000*	*500*	*1000*	*3000*
NO_x	H	≥50	0.0511	0.1053	0.3452	0.0013	0.0026	0.0088
NO_x	L	≥50	0.0891	0.1836		0.0021	0.0049	
SO_2	H	≥50	0.1455	0.2733	1.1161	0.0050	0.0099	0.0389
SO_2	L	≥50	0.1667	0.3363		0.0062	0.0136	

Precursor	Stack	Distance (km)	24-hr Impact (µg/m3) Emissions (tpy)			Annual Impact (µg/m3) Emissions (tpy)		
			500	*1000*	*3000*	*500*	*1000*	*3000*
NO_x	H	10	0.1179	0.2884	0.9955	0.0024	0.0059	0.0239
NO_x	H	20	0.0604	0.1514	0.6421	0.0020	0.0043	0.0158
NO_x	H	30	0.0690	0.1442	0.4540	0.0016	0.0034	0.0130
NO_x	H	40	0.0538	0.1092	0.3384	0.0014	0.0029	0.0111
NO_x	H	50	0.0295	0.0614	0.2257	0.0011	0.0024	0.0090
NO_x	H	60	0.0322	0.0662	0.2170	0.0011	0.0023	0.0083
NO_x	H	70	0.0311	0.0636	0.2079	0.0012	0.0025	0.0086
NO_x	H	80	0.0380	0.0776	0.2500	0.0013	0.0026	0.0081
NO_x	H	90	0.0433	0.0885	0.2829	0.0012	0.0024	0.0073
NO_x	H	100	0.0451	0.0924	0.2971	0.0012	0.0025	0.0075

MERPS View

Refined PM2.5 Data by Distance

MERPs | AQ Data | Terrain Map

NAAQS

- Daily PM2.5
- Annual PM2.5
- 8-hr Ozone

Precursor

- NOx
- SO2
- VOC

Emissions

Stack

- 10
- 90

Climate Zone

State

County

Clear All

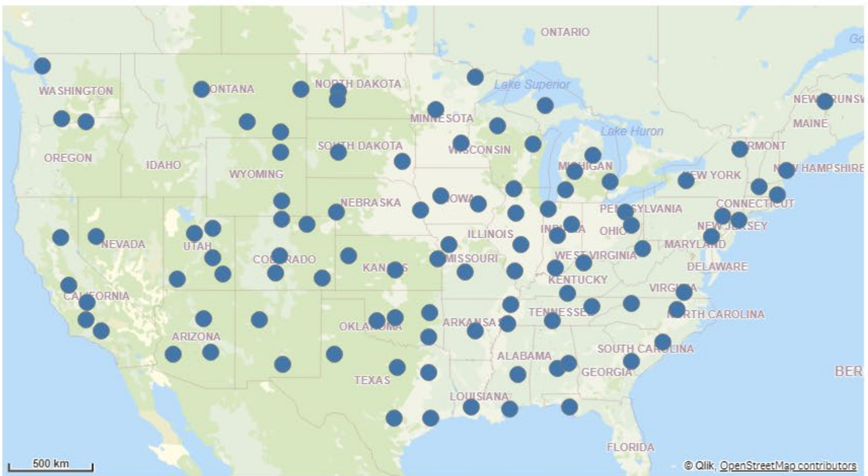


Table of PM2.5 Concentrations (ug/m3) by Distance (km)

State	Cou...	Distance	NAAQS	Precursor	Emissions	Stack	Concentra
Totals							**9.559616**
Florida	Bay	10	Annual PM2.5	SO2	500	10	0.08495
North Dakota	Mercer	10	Annual PM2.5	SO2	500	10	0.043685
California	Tulare	10	Annual PM2.5	SO2	500	10	0.042898
Louisiana	Acadia	10	Annual PM2.5	SO2	500	10	0.040120
Minnesota	Wadena	10	Annual PM2.5	SO2	500	10	0.039645
Texas	Harris	10	Annual PM2.5	SO2	500	10	0.038608
Nebraska	Adams	10	Annual PM2.5	SO2	500	10	0.037299
Mississippi	Smith	10	Annual PM2.5	SO2	500	10	0.034811
California	Tulare	10	Annual PM2.5	NOx	500	10	0.031429
Iowa	Iowa	10	Annual PM2.5	SO2	500	10	0.029687
Alabama	Autauga	10	Annual PM2.5	SO2	500	10	0.029385
South Dakota	Miner	10	Annual PM2.5	SO2	500	10	0.026888
Iowa	Carroll	10	Annual PM2.5	SO2	500	10	0.026031
Indiana	Porter	10	Annual PM2.5	SO2	500	10	0.025060
Maine	York	10	Annual PM2.5	SO2	500	10	0.024910
California	Merced	10	Annual PM2.5	NOx	500	10	0.023356
South Carolina	Horry	10	Annual PM2.5	SO2	500	10	0.023041
Maine	Aroostook	10	Annual PM2.5	SO2	500	10	0.021436
Louisiana	Orleans	10	Annual PM2.5	SO2	500	10	0.021210
Kansas	Johnson	10	Annual PM2.5	SO2	500	10	0.01900

Chart of Distance (km) vs PM2.5 Concentration (ug/m3)

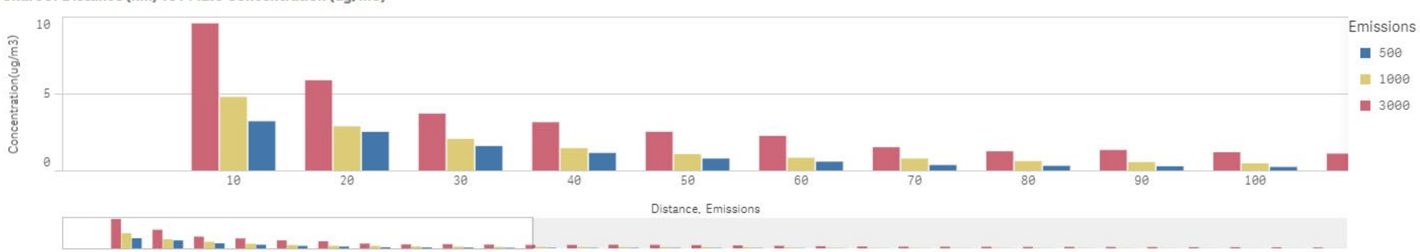


Chart Options

Chart By Emissions

Chart By Precursor

Chart By Stack

Make sure appropriate fields are selected to view data

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Key Considerations

Key Considerations

- Model $PM_{2.5}$ even if not triggering PSD for direct $PM_{2.5}$
- Evaluate NO_X and SO_2 even if project does not trigger PSD for these pollutants
- Which sources should be modeled?
  - *Project-affected only vs. project-affected plus contemporaneous sources*
  - *What if contemporaneous sources are different for primary vs. precursor emissions?*
  - *Contemporaneous increases already accounted for in background monitor concentration?*
  - *Fugitive Sources (Road emissions, cooling towers, storage piles etc.)*

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Key Considerations

- SILs for Class I areas
  - *Stringent Thresholds*
  - *Distance-dependent secondary $PM_{2.5}$ refinements*
- Some additional time and effort is added to project scope (Tier 1 vs Tier 2?)
- PSD Applicability Impact?
- Agency Review Time?

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Thank you for your attention.

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