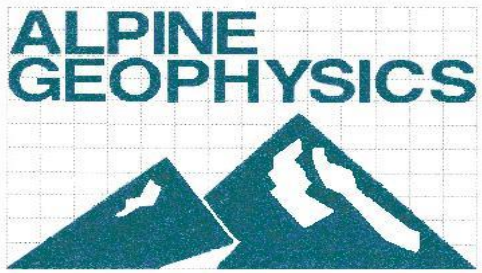


Air Quality Results of a Potential Cleaner Trucks Initiative Scenario

June 23, 2020

Gregory Stella
Alpine Geophysics, LLC

Heavy-duty Cleaner Trucks Initiative

- ANPR published in FR on January 21, 2020
  - Comment period open until February 20, 2020
  - https://www.govinfo.gov/content/pkg/FR-2020-01-21/pdf/2020-00542.pdf

> *"Some estimates suggest that **emission reductions of 90 percent may be achievable** across the heavy-duty engine market by model year 2027. We request information that would help us determine the appropriate levels of any new emission standards for the FTP and RMC cycles." (85 FR 3320) ---* [**emphasis added**]

- Modeling valuable if results available for NPR (targeted later 2020)
  - EPA currently in "information gathering" mode
    - Early stakeholder outreach
    - Assessing technical feasibility
    - Developing cost, benefit, inventories, AQ to inform proposal

CTI Scenario Inventory Development

- An emission inventory evaluation of the CTI, covering the modeling domain of the contiguous 48 states + DC, was completed for the calendar year 2035 by Oak Leaf Environmental Inc. for Manufacturers of Emission Controls Association (MECA)
  http://midwestozonegroup.com/files/OakLeaf_Report_June_2020.pdf

- “2035 Base Case” inventory was developed to include an on-road fleet projection to 2035 with no change in the underlying regulatory context (“on-the-books / on-the-way” controls)

- “2035 CTI Scenario” inventory additionally includes the impacts of the proposed CTI on onroad vehicle emissions

- Accordingly, the emissions impacts of the CTI are defined by the difference between the 2035 CTI Scenario and 2035 Base Case inventories

Inventory Development

- The 2035 Base and Scenario inventories were developed from the 2028 inventory of EPA's 2016v1 modeling platform by applying two sets of adjustment factors (AF):
  - Fleet Turnover (source: MOVES modeling)
  - Activity (source: USEPA & AEO2019 activity data)

- Four distinct inventory tasks
  - Activity forecast
  - CTI scenario emission factor development
  - MOVES modeling
  - Inventory processing

Inventory Development: Activity Forecast

- 2035 activity forecast developed from 2023 and 2028 NEI platform extrapolation to 2035 using growth rate to match that of the EIA publication *Annual Energy Outlook 2019*
- Three activity bases: vehicles, VMT, hours hoteling
- Adjustment factor based on ratio of activity levels (2035:2028) and resolved by county, vehicle type, roadway, and fuel type
- 3,000 to 80,000 factors depending on activity basis

Inventory Development: CTI Emission Factors

- MOVES modal emission rate inputs developed for CTI scenario case addressing the following regulatory elements
  - More stringent NOx standards
  - Increased durability requirements (impacting all criteria pollutants)
  - Anti-backsliding PM standards

- MOVES modal emission rates developed by regulatory class, fuel type, operating mode, vehicle age and model year
  - ~90,000 new rates developed to represent the CTI scenario in 2035

Inventory Development: Modeled Program Assumptions

Parameters of the CTI Program that Factor into the Fleet-Turnover Analysis							
Engine Type / Gross Vehicle Weight Rating (GVWR)	**Regulatory Useful Life of Engine Certifications (miles/yrs.)**		**NOx FTP (g/bhp-hr)**			**PM FTP (g/bhp-hr)**	
	Current	**CTI**	**Current**	**2024-26 CTI**	**2027+ CTI**	**Current**	**CTI**
HDDE* Class 8 (Heavy) GVWR >33,000 lbs.	435,000 / 10	1,000,000 / 15	0.2	0.05	0.02	0.01	0.005
HDDE Class 6-7 (Medium) 19,500 < GVWR ≤ 33,000 lbs.	185,000 / 10	550,000 / 15					
HDDE Class 3-5 (Light) 10,000 < GVWR ≤ 19,500 lbs.	110,000 / 10						
HDOE† GVWR >10,000 lbs.							

"90% NOx Reduction"

Inventory Development: MOVES Modeling

- MOVES2014b (v. Dec 2018) applied in “inventory mode” to generate inventories for three scenarios: 2028 Base, 2035 Base, and 2035 CTI
- MOVES output (mass emissions) used to develop fleet turnover adjustment factors

$$Fleet\ Turnover\ AF_{Base} = \frac{MOVES_{2035\ Base}}{MOVES_{2028\ Base}}$$

$$Fleet\ Turnover\ AF_{Control} = \frac{MOVES_{2035\ Control}}{MOVES_{2028\ Base}}$$

- “National domain” modeling: fleet turnover is national average

Inventory Development: MOVES Modeling (2)

- Modeling assumptions
  - 2028 fleet based on the 48-state aggregate of the 2016v1 modeling platform
  - 2035 fleet = 2028 fleet, as 2035 activity adjustments applied external to MOVES
  - National average defaults for input other than fleet
  - Hourly resolution (evaporative); daily resolution (all other processes)
  - Each month modeled
  - All pollutants / processes
- Emissions processed at the pollutant & SCC level and mapped to platform
- ~113,000 fleet turnover factors for each base and control cases

Inventory Development: Inventory Processing

- The 2035 Base and CTI Scenario inventories were developed from the 2028 inventory by applying adjustment factors (AF) developed:

$$2035\ Base\ Case = 2028_{2016v1\ Platform} \times Fleet\ Turnover\ AF_{Base} \times Activity\ AF$$

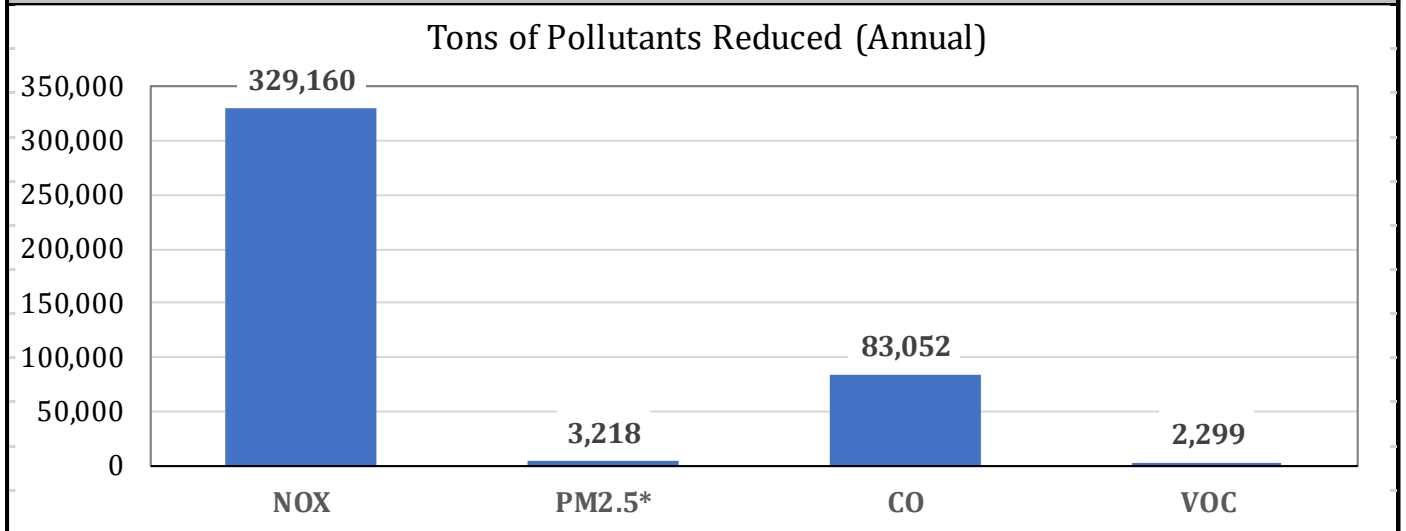
$$2035\ CTI\ Strategy = 2028_{2016v1\ Platform} \times Fleet\ Turnover\ AF_{CTI} \times Activity\ AF$$

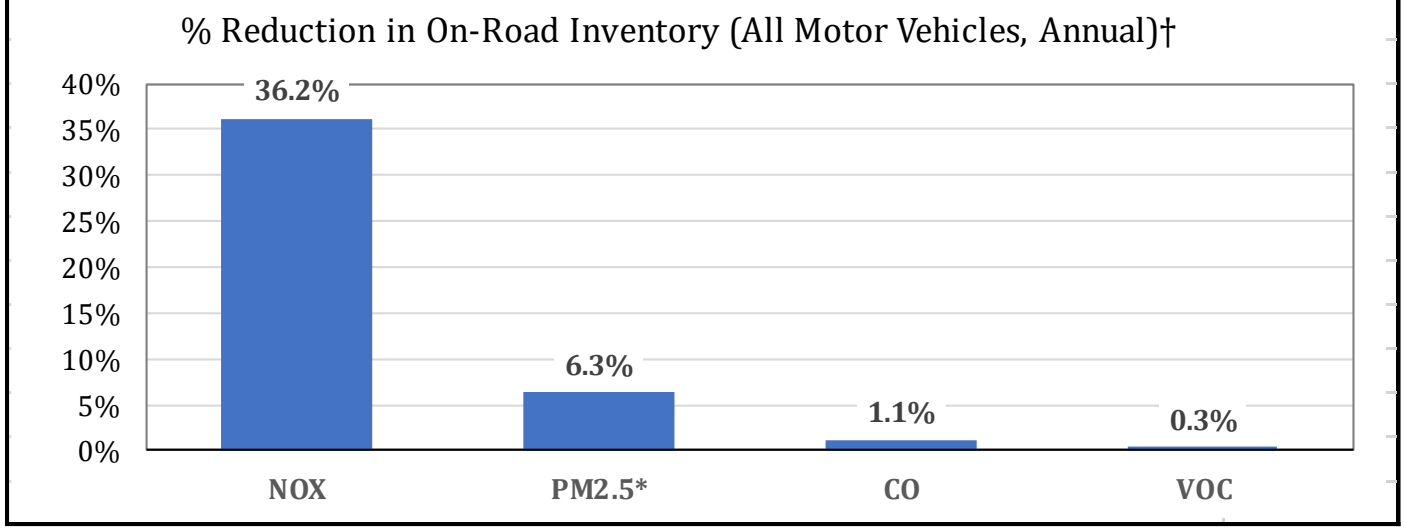
- Processing completed at the pollutant, rate type, and SCC level as defined in the modeling platform
- ~19 million records in each 2035 inventory database created

Cleaner Truck Initiative, 2035 Results Summary

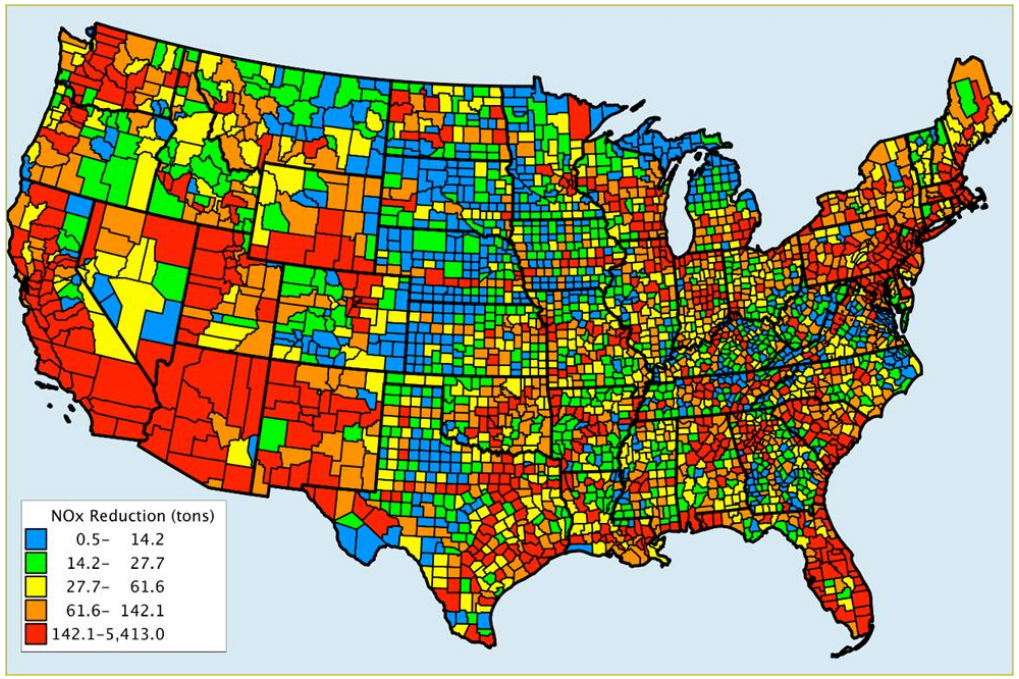
48-State Contiguous US

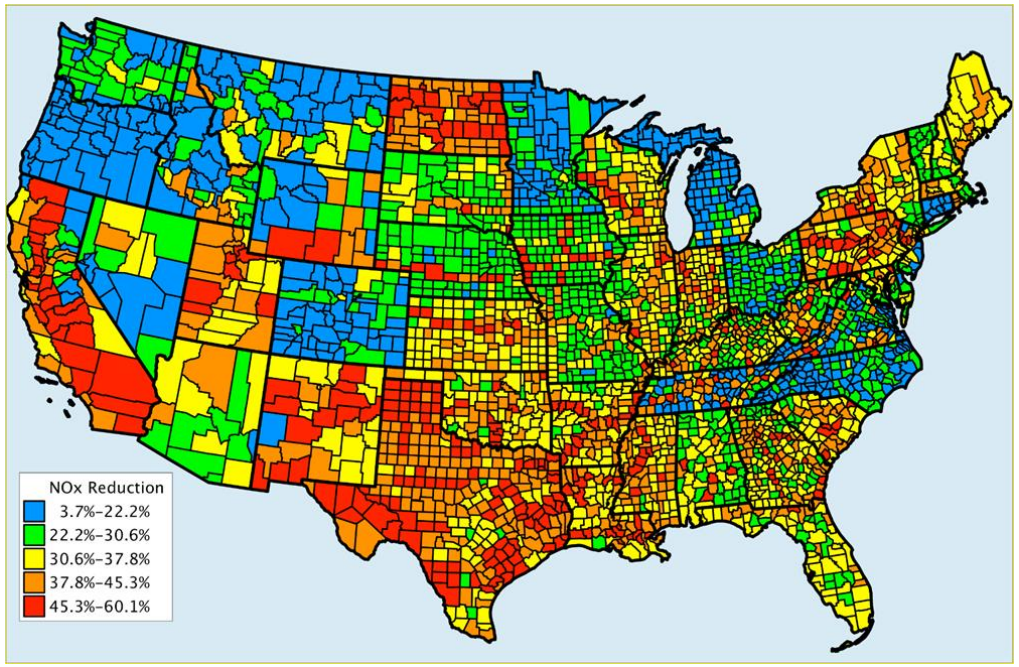
2035 Emissions Benefit





Source: http://midwestozonegroup.com/files/OakLeaf_Report_June_2020.pdf





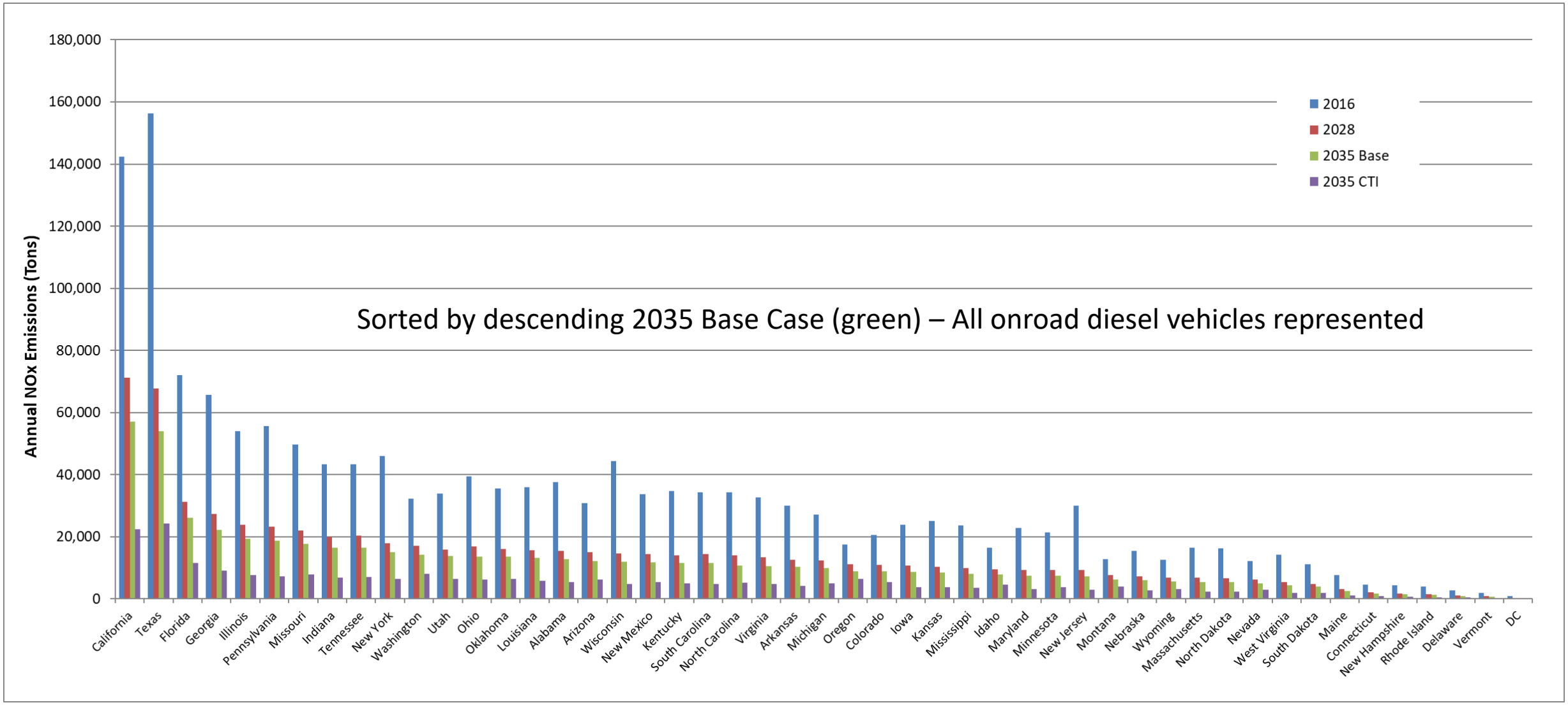
Emission and Modeling Inventory Descriptions

- 2016 / 2028 platform
  - Taken from EPA's 2016v1 "fh" modeling platform and projections
  - Includes all "OTB/OTW" promulgated rules for all sectors
  - https://www.epa.gov/air-emissions-modeling/2016v1-platform

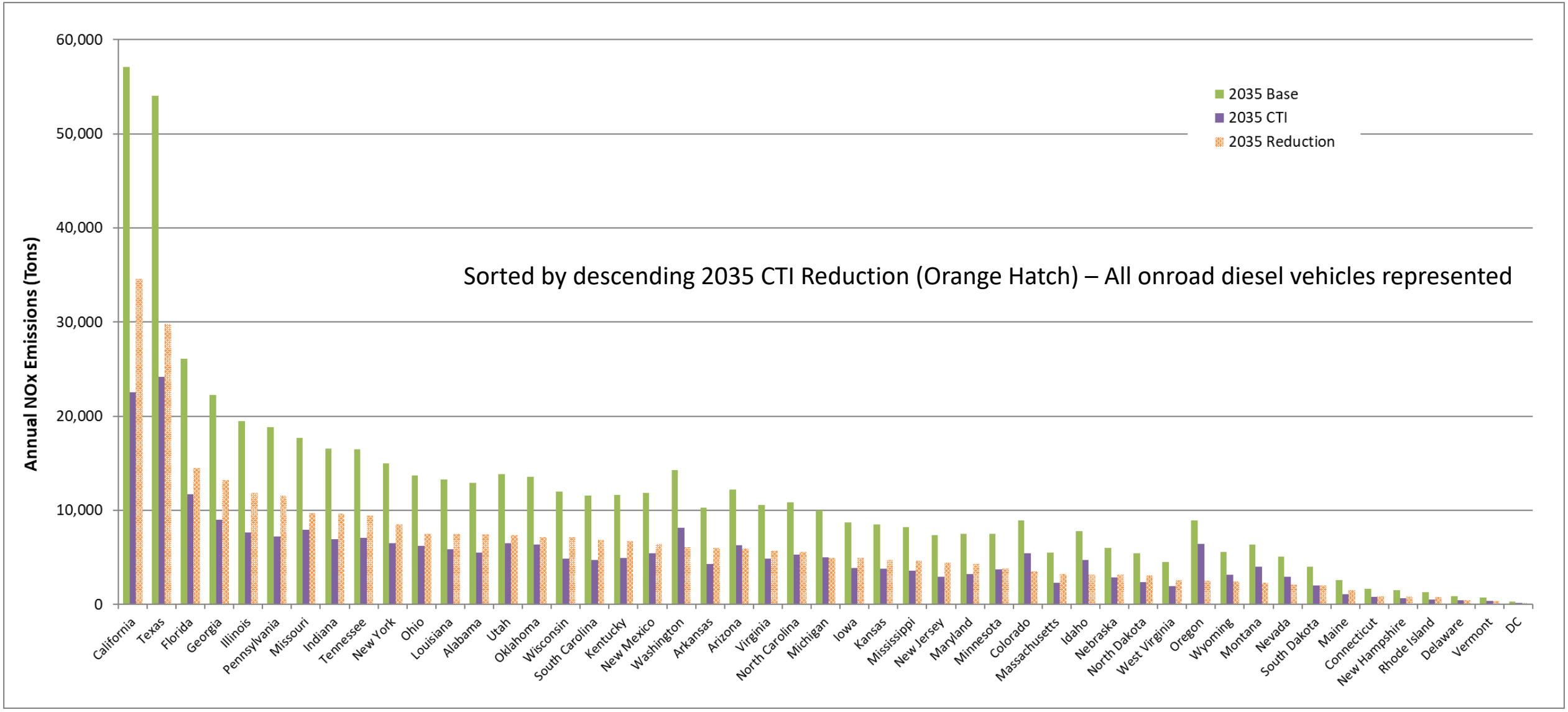
- 2035 Base Case
  - Oak Leaf Environmental projection of onroad source data to 2035
  - Includes all "OTB/OTW" promulgated rule implementation as configured in MOVES

- 2035 CTI Scenario
  - Perturbation of the 2035 Base Case with potential CTI scenario controls

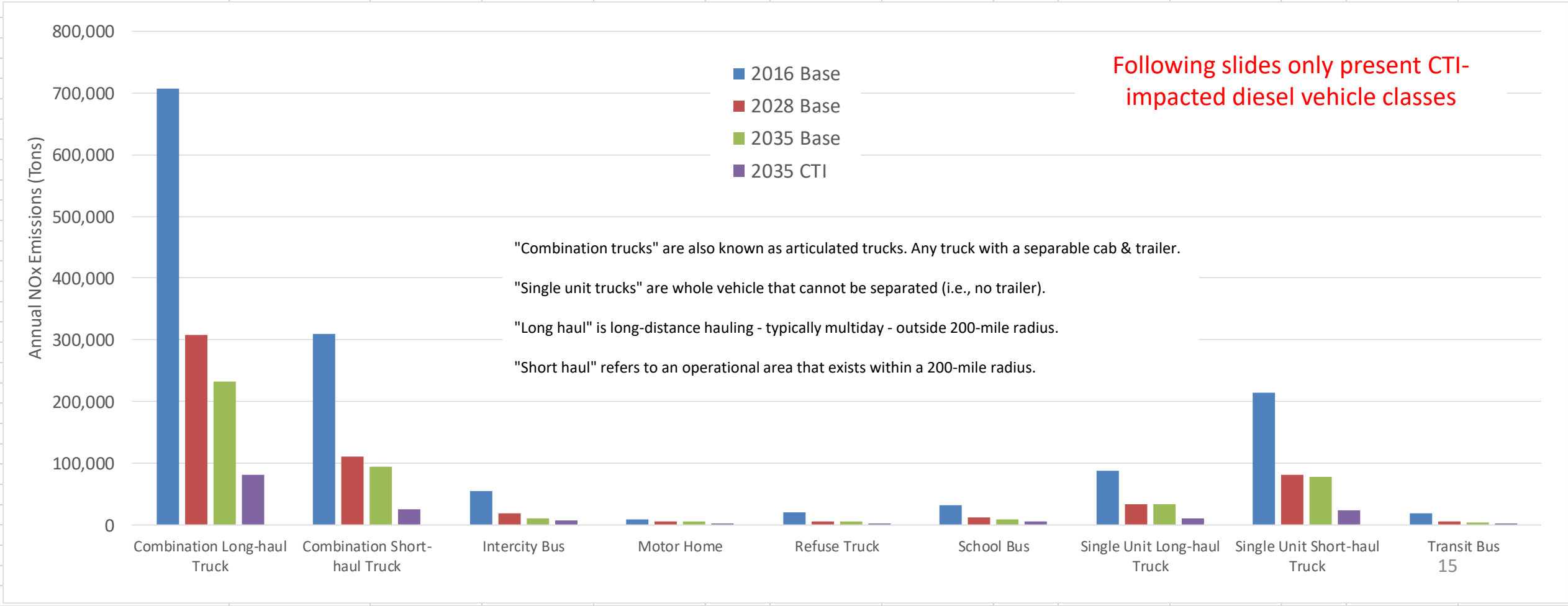
Onroad Diesel Vehicle NOx Emissions (tpy)



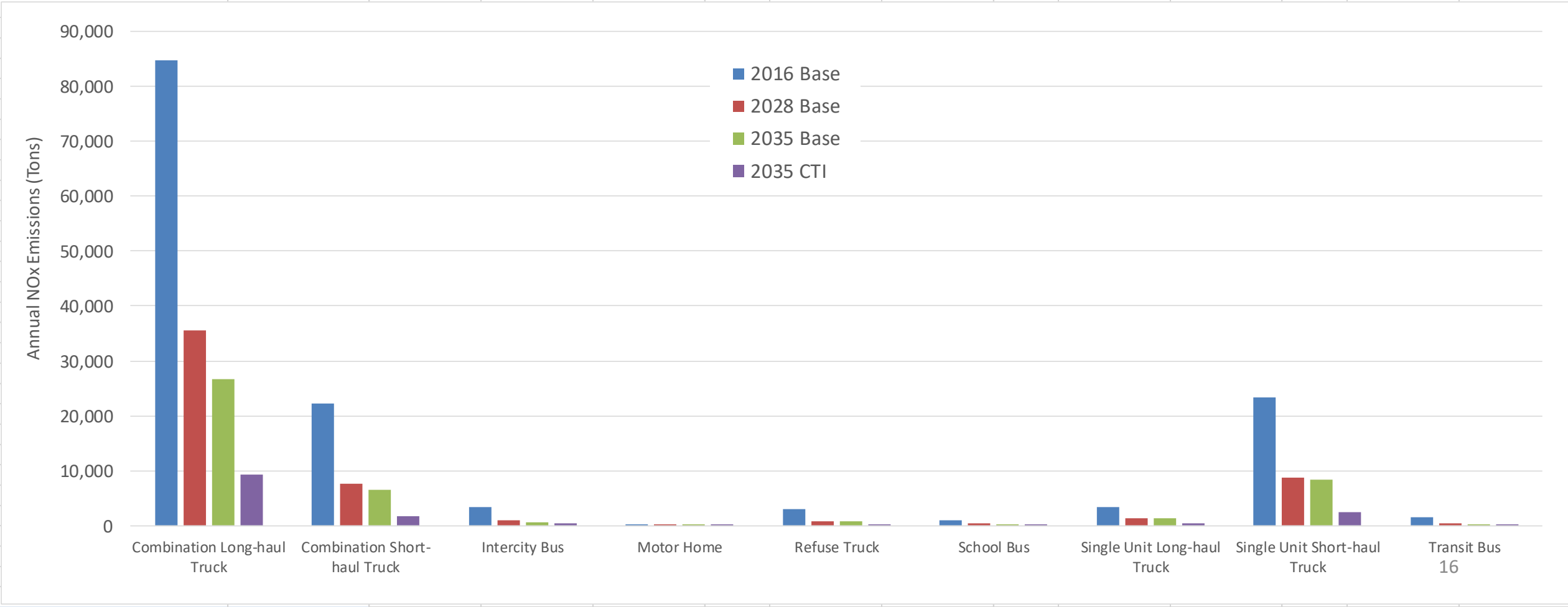
Onroad Diesel Vehicle NOx Reduction (tpy)



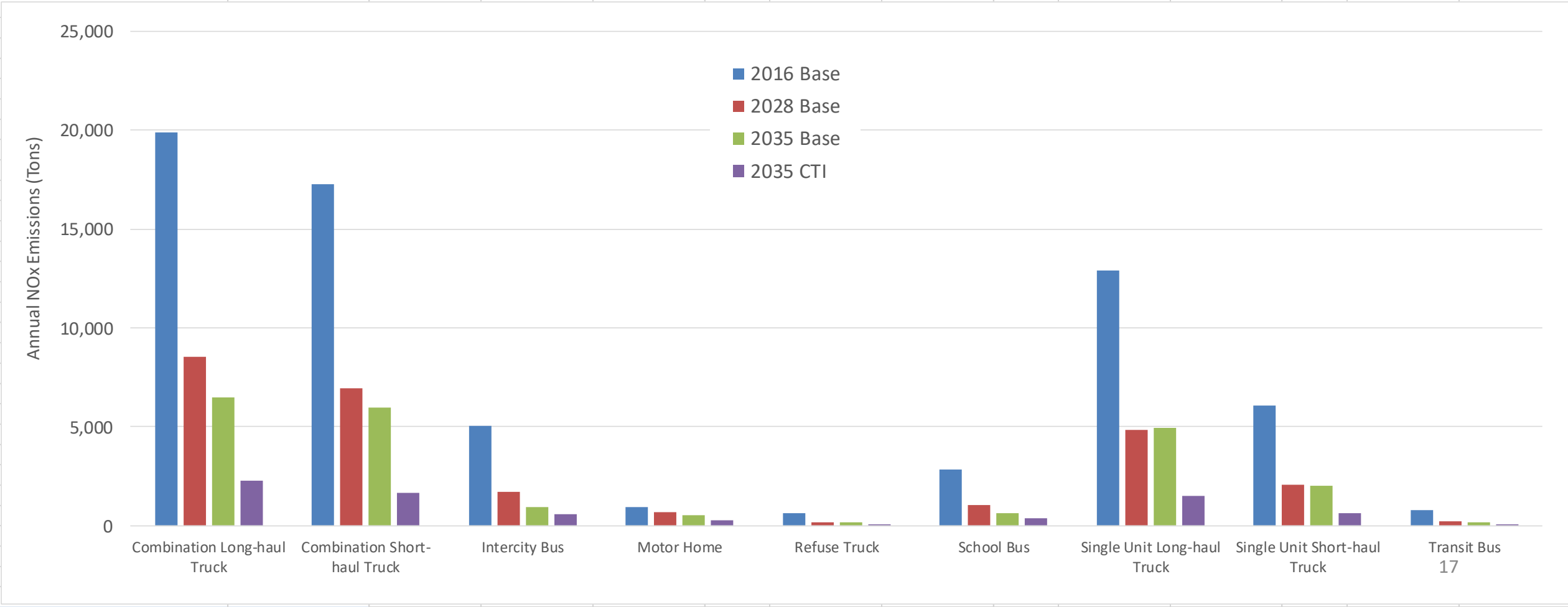
state	(All)		Annual NOx Emissions / Reductions									
county	(All)											
FUEL	Diesel					Reductions			Reductions			Reductions
						2016 Base - 2035 CTI			2028 Base - 2035 CTI			2035 Base - 2035 CTI
Row Labels	2016 Base	2028 Base	2035 Base	2035 CTI		Tons	%		Tons	%		Tons	%
Combination Long-haul Truck	706,324	308,287	232,366	80,993		625,331	89%		227,294	74%		151,373	65%
Combination Short-haul Truck	309,703	110,218	94,659	25,842		283,861	92%		84,376	77%		68,817	73%
Intercity Bus	55,283	19,058	10,551	6,566		48,717	88%		12,491	66%		3,985	38%
Motor Home	8,659	5,990	4,660	2,466		6,194	72%		3,524	59%		2,195	47%
Refuse Truck	19,576	5,597	5,357	1,483		18,093	92%		4,114	74%		3,874	72%
School Bus	31,491	12,716	8,131	4,737		26,754	85%		7,979	63%		3,394	42%
Single Unit Long-haul Truck	87,116	32,731	33,275	10,154		76,962	88%		22,577	69%		23,122	69%
Single Unit Short-haul Truck	214,060	81,761	78,165	23,937		190,123	89%		57,824	71%		54,228	69%
Transit Bus	19,334	5,114	3,364	1,649		17,685	91%		3,465	68%		1,715	51%



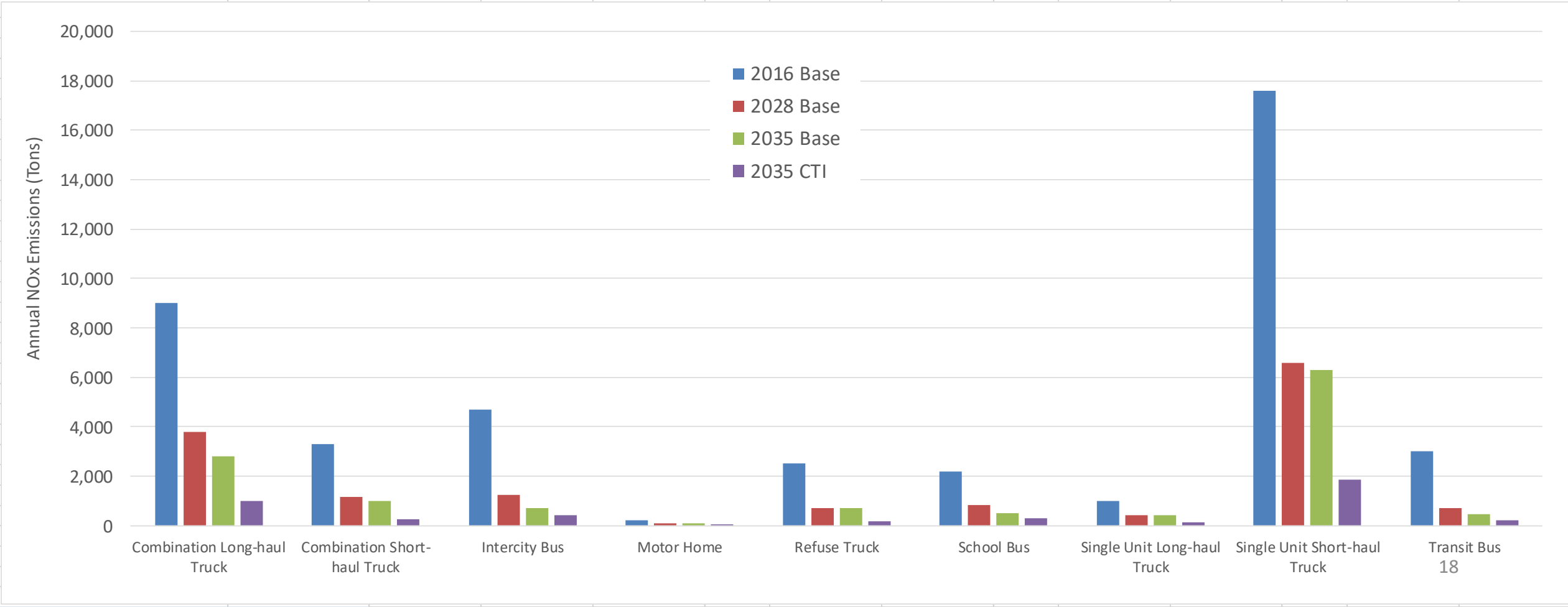
state	Texas		Annual NOx Emissions / Reductions									
county	(All)											
FUEL	Diesel					Reductions			Reductions			Reductions
						2016 Base - 2035 CTI			2028 Base - 2035 CTI			2035 Base - 2035 CTI
Row Labels	2016 Base	2028 Base	2035 Base	2035 CTI		Tons	%		Tons	%		Tons	%
Combination Long-haul Truck	84,714	35,546	26,597	9,347		75,367	89%		26,199	74%		17,250	65%
Combination Short-haul Truck	22,171	7,577	6,489	1,771		20,399	92%		5,806	77%		4,718	73%
Intercity Bus	3,474	1,000	551	344		3,130	90%		656	66%		207	38%
Motor Home	188	100	78	41		147	78%		59	59%		37	47%
Refuse Truck	3,081	860	842	233		2,848	92%		626	73%		609	72%
School Bus	1,004	334	209	123		882	88%		211	63%		86	41%
Single Unit Long-haul Truck	3,430	1,267	1,285	389		3,042	89%		878	69%		897	70%
Single Unit Short-haul Truck	23,278	8,776	8,336	2,454		20,824	89%		6,322	72%		5,883	71%
Transit Bus	1,566	394	260	127		1,438	92%		266	68%		132	51%



state	Florida		Annual NOx Emissions / Reductions									
county	(All)											
FUEL	Diesel					Reductions			Reductions			Reductions
						2016 Base - 2035 CTI			2028 Base - 2035 CTI			2035 Base - 2035 CTI
Row Labels	2016 Base	2028 Base	2035 Base	2035 CTI		Tons	%		Tons	%		Tons	%
Combination Long-haul Truck	19,886	8,553	6,472	2,258		17,628	89%		6,295	74%		4,214	65%
Combination Short-haul Truck	17,283	6,957	5,985	1,634		15,649	91%		5,323	77%		4,351	73%
Intercity Bus	5,033	1,703	947	591		4,442	88%		1,111	65%		356	38%
Motor Home	949	667	521	276		673	71%		391	59%		245	47%
Refuse Truck	646	164	161	45		602	93%		120	73%		116	72%
School Bus	2,837	1,030	646	379		2,458	87%		650	63%		267	41%
Single Unit Long-haul Truck	12,919	4,865	4,952	1,512		11,407	88%		3,354	69%		3,441	69%
Single Unit Short-haul Truck	6,054	2,082	2,003	615		5,439	90%		1,467	70%		1,388	69%
Transit Bus	763	229	152	74		689	90%		155	68%		77	51%



state	New York		Annual NOx Emissions / Reductions									
county	(All)											
FUEL	Diesel					Reductions			Reductions			Reductions
						2016 Base - 2035 CTI			2028 Base - 2035 CTI			2035 Base - 2035 CTI
Row Labels	2016 Base	2028 Base	2035 Base	2035 CTI		Tons	%		Tons	%		Tons	%
Combination Long-haul Truck	9,018	3,795	2,818	997		8,020	89%		2,798	74%		1,820	65%
Combination Short-haul Truck	3,302	1,147	985	269		3,033	92%		878	77%		716	73%
Intercity Bus	4,680	1,254	691	431		4,249	91%		823	66%		260	38%
Motor Home	198	99	77	41		157	79%		59	59%		36	47%
Refuse Truck	2,528	721	707	196		2,332	92%		525	73%		511	72%
School Bus	2,194	818	511	300		1,894	86%		518	63%		211	41%
Single Unit Long-haul Truck	1,005	406	412	125		880	88%		281	69%		287	70%
Single Unit Short-haul Truck	17,611	6,590	6,279	1,870		15,741	89%		4,720	72%		4,409	70%
Transit Bus	3,002	694	459	225		2,777	93%		469	68%		234	51%



Air Quality Simulations

- Using CAMx and EPA 2016 / 2028 “fh” base case modeling platform, Alpine Geophysics, LLC under contract to the Midwest Ozone Group (MOG), ran annual simulation to develop ozone and PM design values for “OTB/OTW” configuration (2028 Base Case)
  http://midwestozonegroup.com/files/Alpine_12km_Modeling_TSD_2028fh_May_2020_.pdf

- Incorporate 2035 CTI onroad emissions in place of 2028 onroad base case and reran CAMx model to generate air quality concentrations (CTI Scenario)
  http://midwestozonegroup.com/files/Alpine_Geophysics_-_CTI_Scenario_Modeling_TSD_-_June_2020.pdf

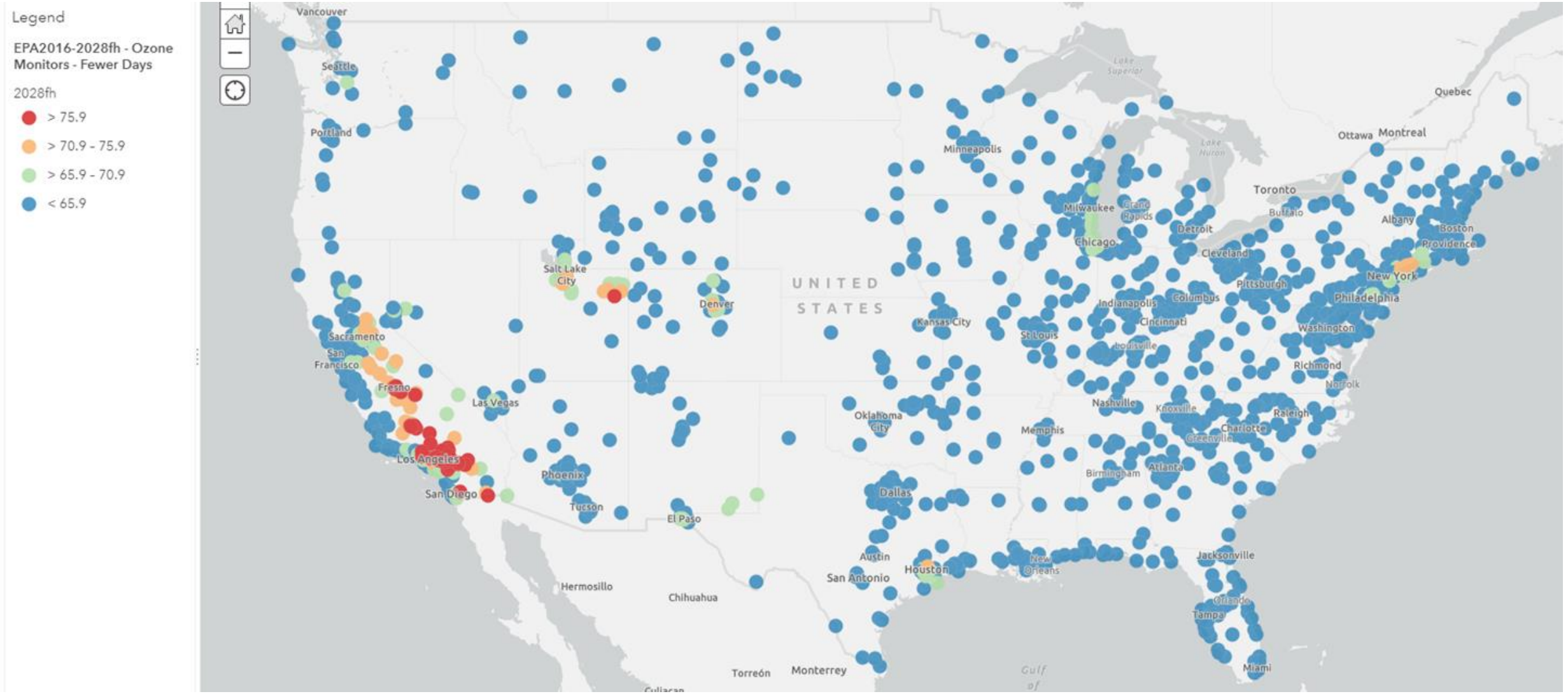
- Ozone maximum daily eight-hour average (MDA8), annual and daily $PM_{2.5}$ design value projections for 2028 base, CTI scenario case, and benefits of CTI compared to 2028 base case are presented here today

Modeled 2028 Base MDA8 Ozone (ppb)
Western States (left) / Eastern States (right)

			Ozone MDA8 (ppb)	
Monitor	State	County	2016v1	2028fh
60710005	California	San Bernardino	110.3	102.3
60719004	California	San Bernardino	108.7	99.9
60711004	California	San Bernardino	105.7	99.8
60714003	California	San Bernardino	104.0	95.6
60370016	California	Los Angeles	100.0	94.7
60712002	California	San Bernardino	97.7	91.1
60658001	California	Riverside	96.7	90.0
60370002	California	Los Angeles	94.3	89.3
60376012	California	Los Angeles	98.0	89.2
60651016	California	Riverside	99.7	89.0
60658005	California	Riverside	95.0	88.4
60371701	California	Los Angeles	92.0	87.6
60710012	California	San Bernardino	95.0	87.4
60650012	California	Riverside	95.3	85.7
490472003	Utah	Uintah	88.0	84.5
60714001	California	San Bernardino	90.3	83.0
60656001	California	Riverside	92.3	82.2
60372005	California	Los Angeles	84.7	81.5
60371201	California	Los Angeles	88.3	80.7
60292012	California	Kern	89.3	80.3
60195001	California	Fresno	91.0	79.7
60659001	California	Riverside	88.7	79.2
60190011	California	Fresno	90.0	79.1
60655001	California	Riverside	88.7	78.8
60290007	California	Kern	87.7	78.8

			Ozone MDA8 (ppb)	
Monitor	State	County	2016v1	2028fh
90019003	Connecticut	Fairfield	82.7	72.8
90013007	Connecticut	Fairfield	82.0	72.3
482010024	Texas	Harris	79.3	71.9
90010017	Connecticut	Fairfield	79.3	71.6
551170006	Wisconsin	Sheboygan	80.0	70.7
550590019	Wisconsin	Kenosha	78.0	69.8
360850067	New York	Richmond	76.0	68.2
481671034	Texas	Galveston	75.7	68.1
90099002	Connecticut	New Haven	79.7	67.9
481410037	Texas	El Paso	71.3	67.7
480391004	Texas	Brazoria	74.7	67.6
482010055	Texas	Harris	76.0	67.4
361030002	New York	Suffolk	74.0	67.2
551010020	Wisconsin	Racine	76.0	67.2
420170012	Pennsylvania	Bucks	79.3	67.1
170317002	Illinois	Cook	74.0	66.8
170310032	Illinois	Cook	72.3	66.8
482011034	Texas	Harris	73.7	66.8
361192004	New York	Westchester	74.0	66.6
170971007	Illinois	Lake	73.7	66.5
170310001	Illinois	Cook	73.0	66.5
90090027	Connecticut	New Haven	75.7	66.3
482010047	Texas	Harris	73.7	66.3
170314201	Illinois	Cook	73.3	66.2
90079007	Connecticut	Middlesex	78.7	66.1

2028 Base Case – Ozone Design Values (ppb)

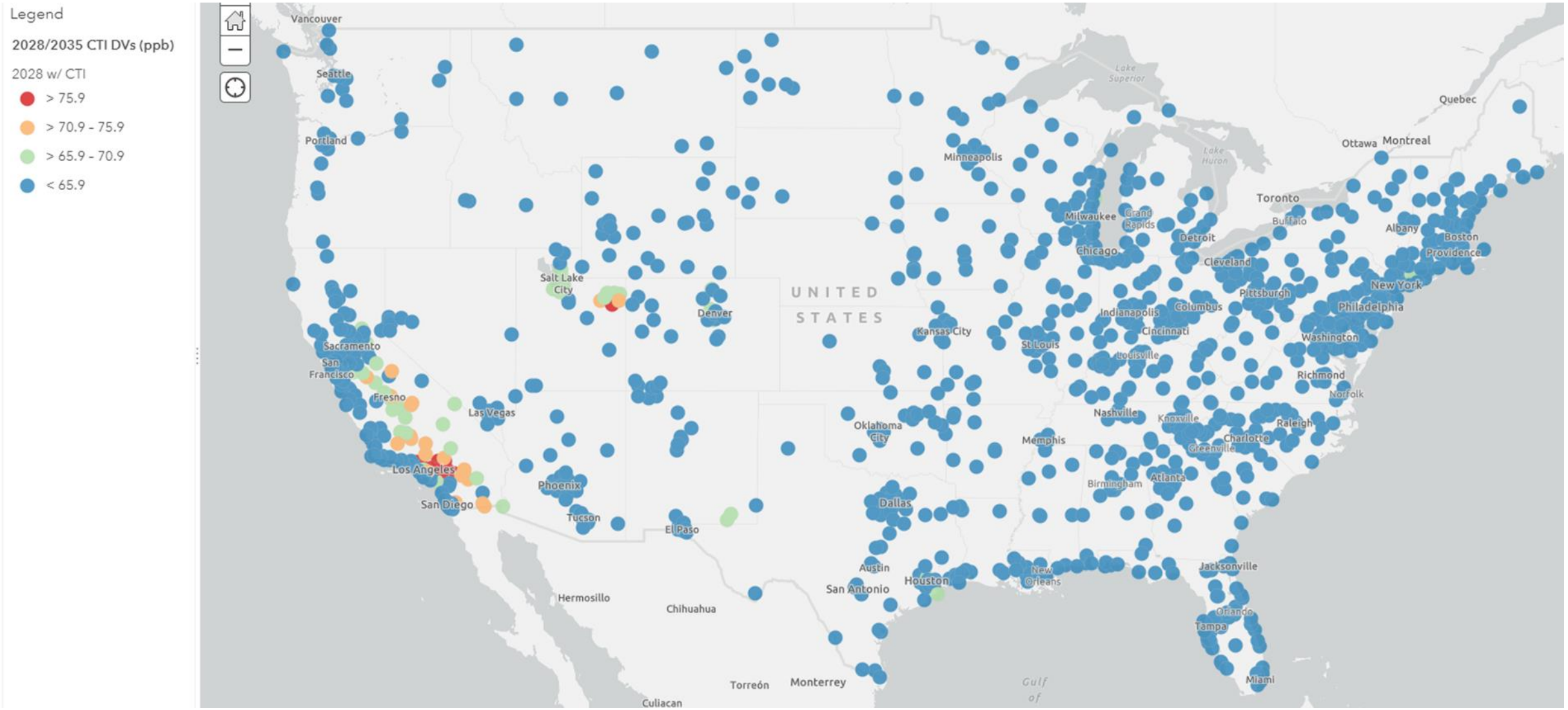


CTI Scenario MDA8 Ozone (ppb)
Western States (left) / Eastern States (right)

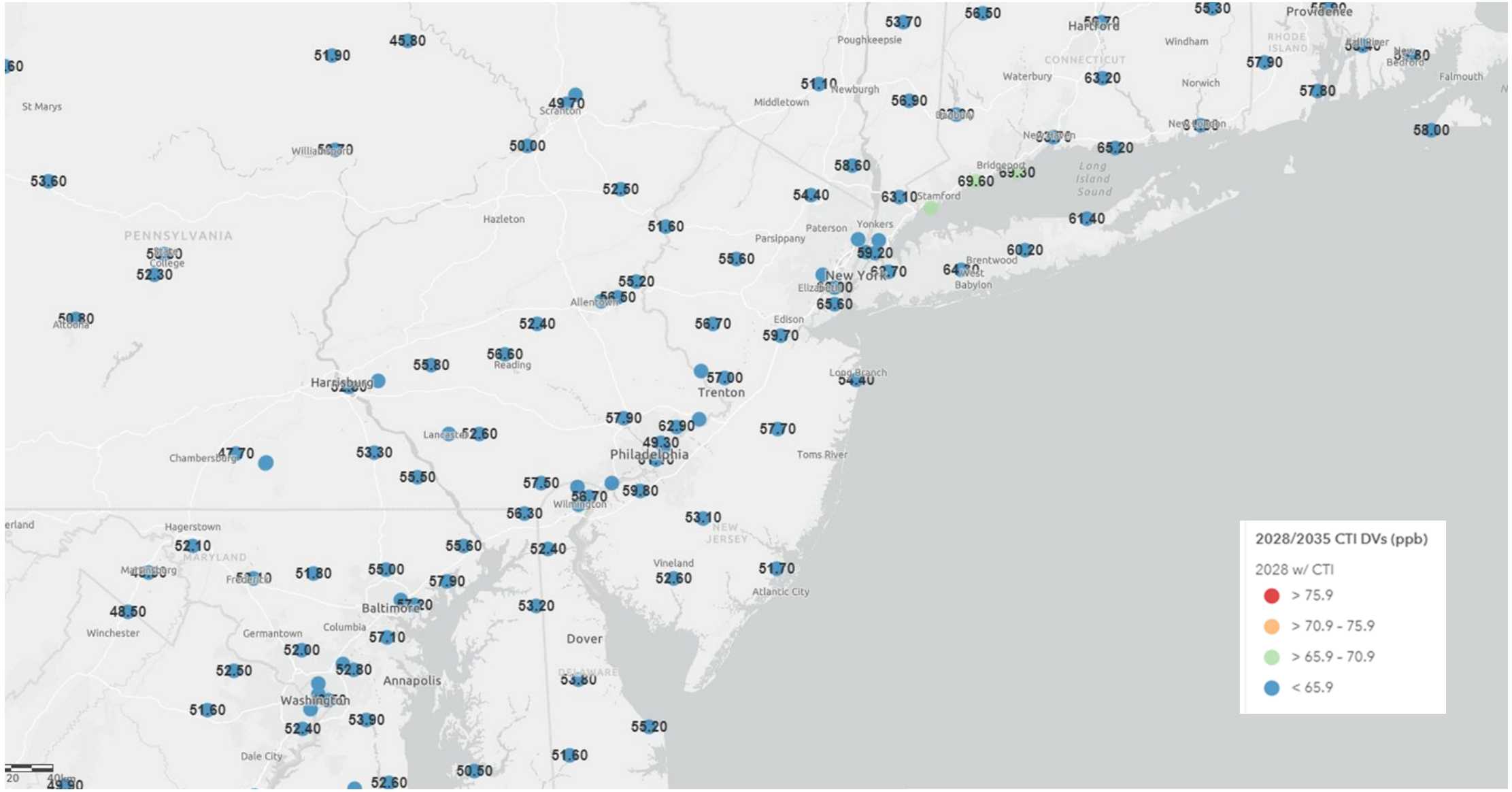
			Ozone MDA8 (ppb)		
Monitor	State	County	2016v1	2028fh	2028 w/ CTI
60710005	California	San Bernardino	110.3	102.3	96.1
60711004	California	San Bernardino	105.7	99.8	95.2
60719004	California	San Bernardino	108.7	99.9	93.4
60370016	California	Los Angeles	100.0	94.7	90.8
60714003	California	San Bernardino	104.0	95.6	89.4
60712002	California	San Bernardino	97.7	91.1	86.3
60370002	California	Los Angeles	94.3	89.3	85.6
60658001	California	Riverside	96.7	90.0	85.1
60376012	California	Los Angeles	98.0	89.2	84.4
60371701	California	Los Angeles	92.0	87.6	83.8
60658005	California	Riverside	95.0	88.4	83.6
490472003	Utah	Uintah	88.0	84.5	83.5
60651016	California	Riverside	99.7	89.0	82.7
60710012	California	San Bernardino	95.0	87.4	82.6
60650012	California	Riverside	95.3	85.7	79.4
60372005	California	Los Angeles	84.7	81.5	78.9
60714001	California	San Bernardino	90.3	83.0	78.2
60371201	California	Los Angeles	88.3	80.7	76.8
60656001	California	Riverside	92.3	82.2	76.4
60250005	California	Imperial	76.7	76.4	75.8
60292012	California	Kern	89.3	80.3	75.3
60379033	California	Los Angeles	87.3	78.8	75.0
60251003	California	Imperial	76.0	75.7	74.9
60290011	California	Kern	83.3	76.9	74.1
60659001	California	Riverside	88.7	79.2	74.0

			Ozone MDA8 (ppb)		
Monitor	State	County	2016v1	2028fh	2028 w/ CTI
90019003	Connecticut	Fairfield	82.7	72.8	69.6
482010024	Texas	Harris	79.3	71.9	69.5
90013007	Connecticut	Fairfield	82.0	72.3	69.3
551170006	Wisconsin	Sheboygan	80.0	70.7	68.2
90010017	Connecticut	Fairfield	79.3	71.6	67.9
550590019	Wisconsin	Kenosha	78.0	69.8	67.2
481671034	Texas	Galveston	75.7	68.1	66.7
481410037	Texas	El Paso	71.3	67.7	66.5
360850067	New York	Richmond	76.0	68.2	65.6
480391004	Texas	Brazoria	74.7	67.6	65.3
90099002	Connecticut	New Haven	79.7	67.9	65.2
482011034	Texas	Harris	73.7	66.8	64.8
551010020	Wisconsin	Racine	76.0	67.2	64.7
170310032	Illinois	Cook	72.3	66.8	64.6
481410058	Texas	El Paso	70.0	65.8	64.6
481410044	Texas	El Paso	69.0	65.5	64.4
482010055	Texas	Harris	76.0	67.4	64.3
361030002	New York	Suffolk	74.0	67.2	64.3
170971007	Illinois	Lake	73.7	66.5	64.2
170317002	Illinois	Cook	74.0	66.8	64.1
420170012	Pennsylvania	Bucks	79.3	67.1	63.8
90090027	Connecticut	New Haven	75.7	66.3	63.7
170310001	Illinois	Cook	73.0	66.5	63.6
482010047	Texas	Harris	73.7	66.3	63.5
170314201	Illinois	Cook	73.3	66.2	63.5

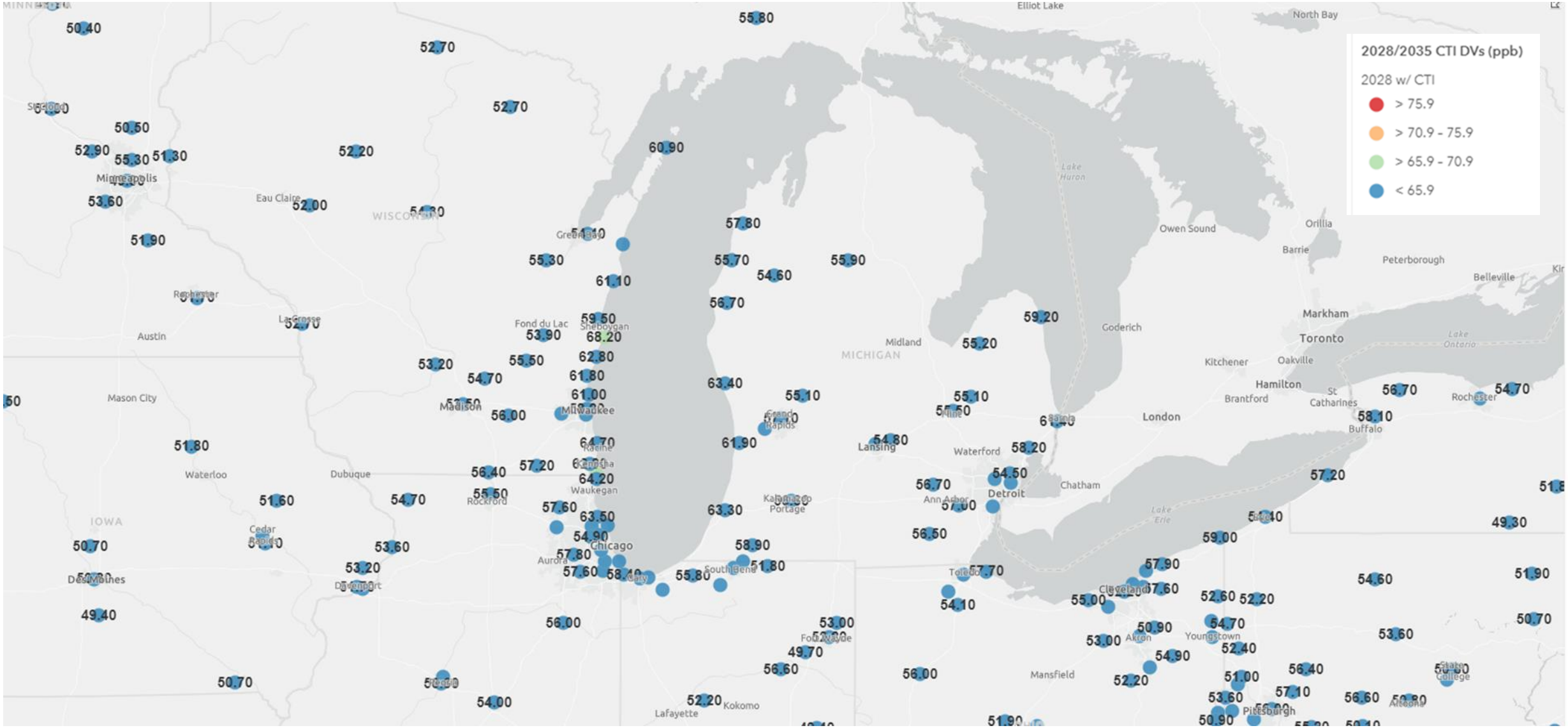
CTI Scenario – Ozone Design Values (ppb)



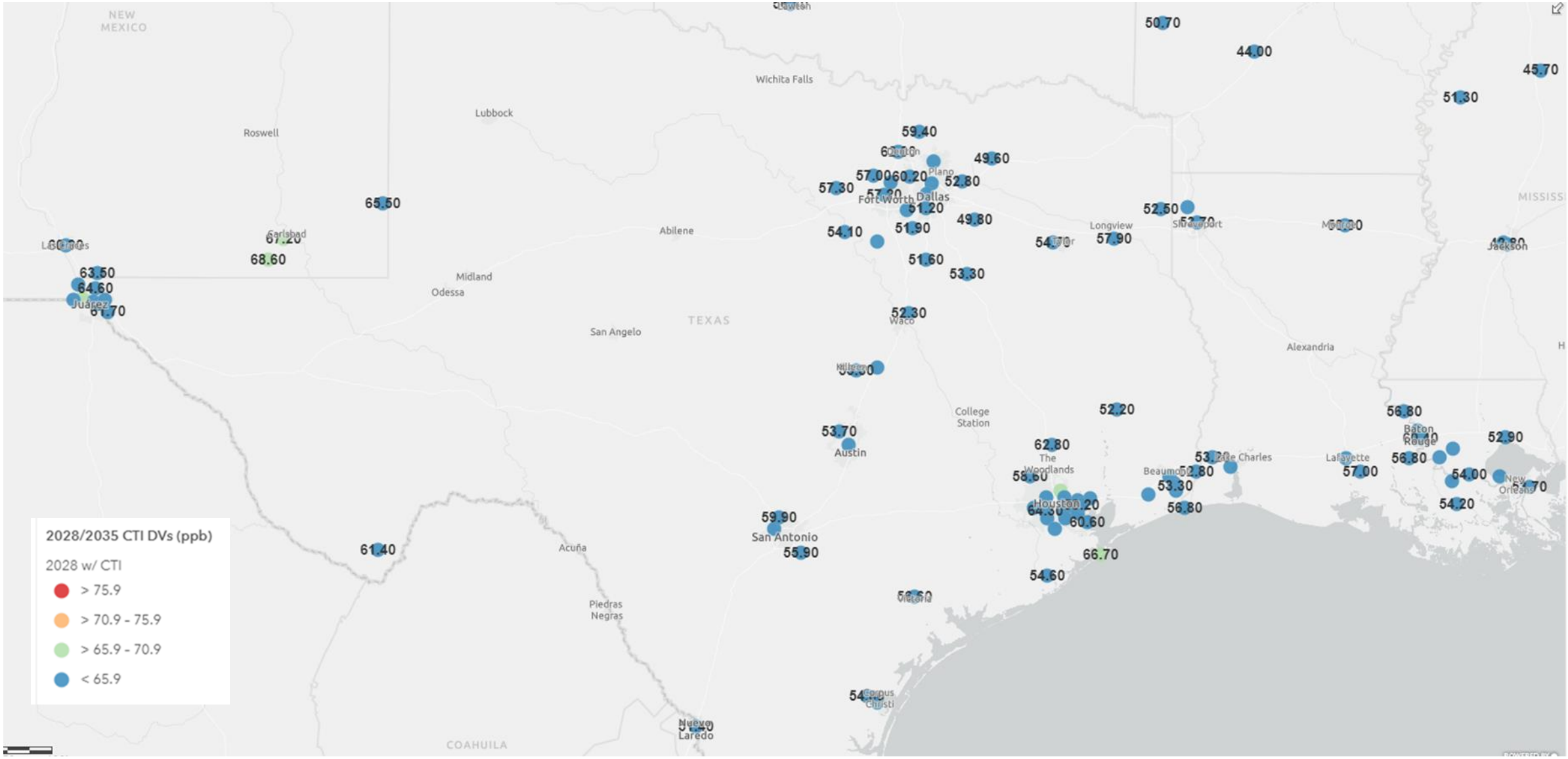
CTI Scenario – Ozone Design Values (ppb)



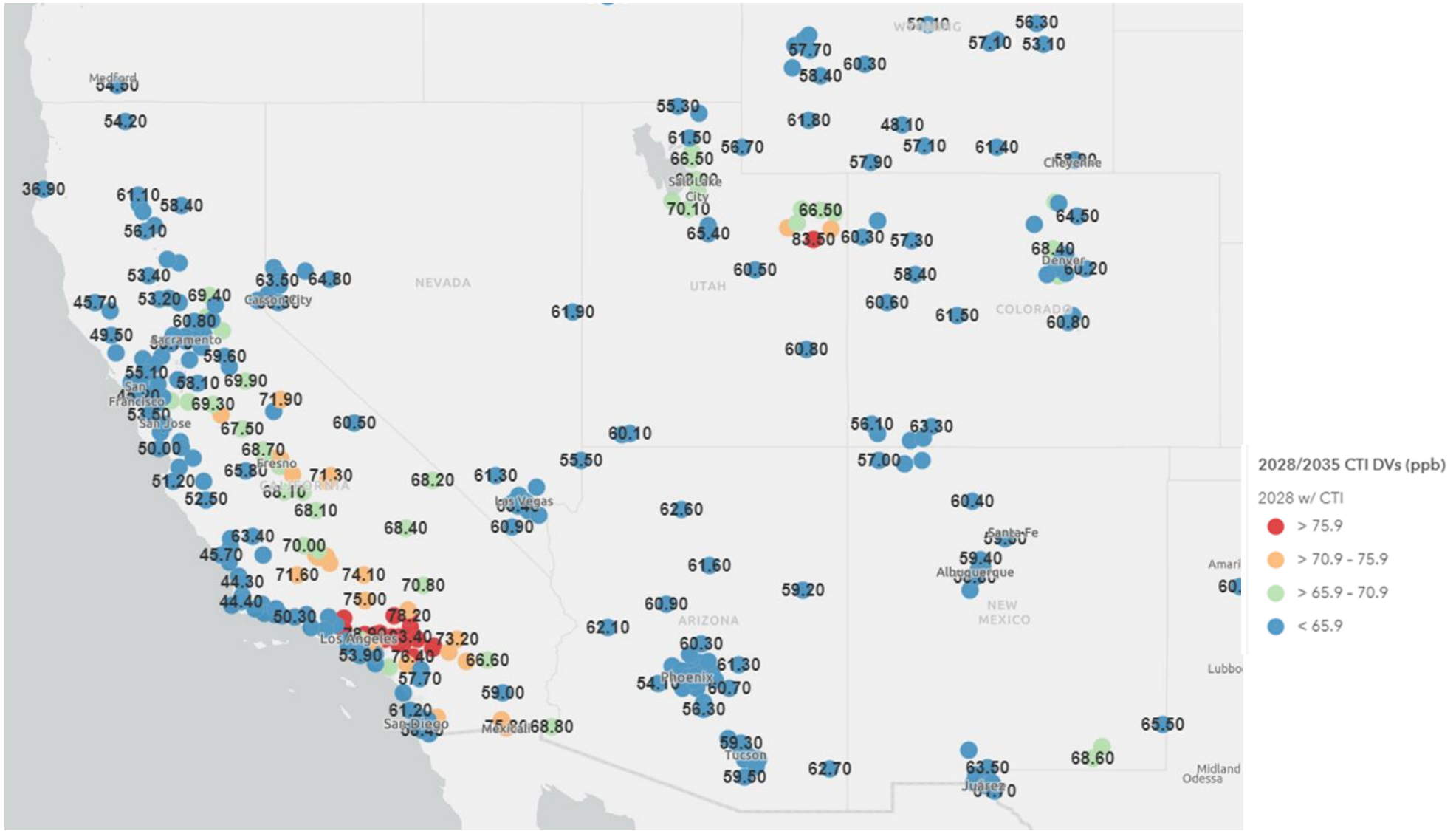
CTI Scenario – Ozone Design Values (ppb)



CTI Scenario – Ozone Design Values (ppb)



CTI Scenario – Ozone Design Values (ppb)

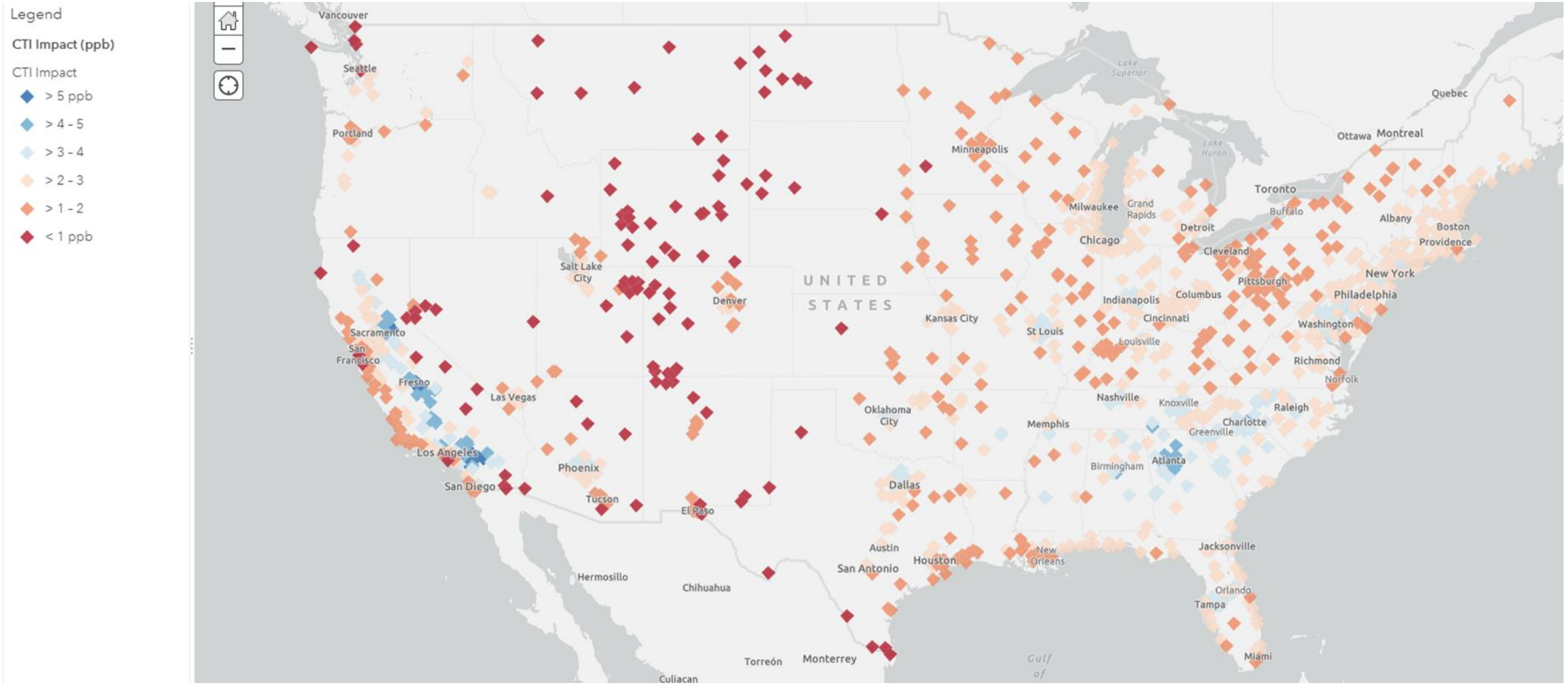


Largest Modeled CTI Scenario Impact (ppb) Western States (left) / Eastern States (right)

			Ozone MDA8 (ppb)		
Monitor	State	County	2028fh	2028 w/ CTI	CTI Impact
60719004	California	San Bernardino	99.9	93.4	6.5
60651016	California	Riverside	89.0	82.7	6.3
60650012	California	Riverside	85.7	79.4	6.3
60710005	California	San Bernardino	102.3	96.1	6.2
60714003	California	San Bernardino	95.6	89.4	6.2
60195001	California	Fresno	79.7	73.7	6.0
60190011	California	Fresno	79.1	73.1	6.0
60190007	California	Fresno	76.5	70.6	5.9
60656001	California	Riverside	82.2	76.4	5.8
60194001	California	Fresno	78.2	72.4	5.8
60655001	California	Riverside	78.8	73.4	5.4
60610003	California	Placer	73.2	67.9	5.3
60659001	California	Riverside	79.2	74.0	5.2
60170010	California	El Dorado	72.7	67.5	5.2
60670012	California	Sacramento	71.1	65.9	5.2
60170020	California	El Dorado	70.6	65.5	5.1
60292012	California	Kern	80.3	75.3	5.0
60719002	California	San Bernardino	78.2	73.2	5.0
60610006	California	Placer	70.2	65.2	5.0
60658001	California	Riverside	90.0	85.1	4.9
61072002	California	Tulare	71.0	66.1	4.9
60670002	California	Sacramento	69.6	64.7	4.9
60675003	California	Sacramento	67.6	62.7	4.9
60658005	California	Riverside	88.4	83.6	4.8
60710012	California	San Bernardino	87.4	82.6	4.8

			Ozone MDA8 (ppb)		
Monitor	State	County	2028fh	2028 w/ CTI	CTI Impact
131210055	Georgia	Fulton	60.3	55.4	4.9
131350002	Georgia	Gwinnett	54.0	49.2	4.8
130670003	Georgia	Cobb	51.3	46.5	4.8
130890002	Georgia	DeKalb	55.5	50.8	4.7
130970004	Georgia	Douglas	54.3	49.7	4.6
132470001	Georgia	Rockdale	56.8	52.5	4.3
371190046	North Carolina	Mecklenburg	58.6	54.4	4.2
130850001	Georgia	Dawson	49.7	45.5	4.2
131510002	Georgia	Henry	57.9	53.7	4.2
10730023	Alabama	Jefferson	51.4	47.2	4.2
11170004	Alabama	Shelby	51.3	47.1	4.2
470654003	Tennessee	Hamilton	53.2	49.1	4.1
10732006	Alabama	Jefferson	51.0	46.9	4.1
450830009	South Carolina	Spartanburg	53.1	49.1	4.0
130770002	Georgia	Coweta	51.2	47.2	4.0
10731003	Alabama	Jefferson	51.7	47.8	3.9
450791001	South Carolina	Richland	51.6	47.7	3.9
10731005	Alabama	Jefferson	50.8	46.9	3.9
481130075	Texas	Dallas	62.2	58.4	3.8
371190041	North Carolina	Mecklenburg	58.2	54.4	3.8
11011002	Alabama	Montgomery	48.2	44.4	3.8
10736002	Alabama	Jefferson	52.5	48.7	3.8
51191002	Arkansas	Pulaski	48.5	44.7	3.8
180970050	Indiana	Marion	60.7	57.0	3.7
291831004	Missouri	Saint Charles	60.1	56.4	3.7

CTI Scenario Impact – Ozone Design Values (ppb)



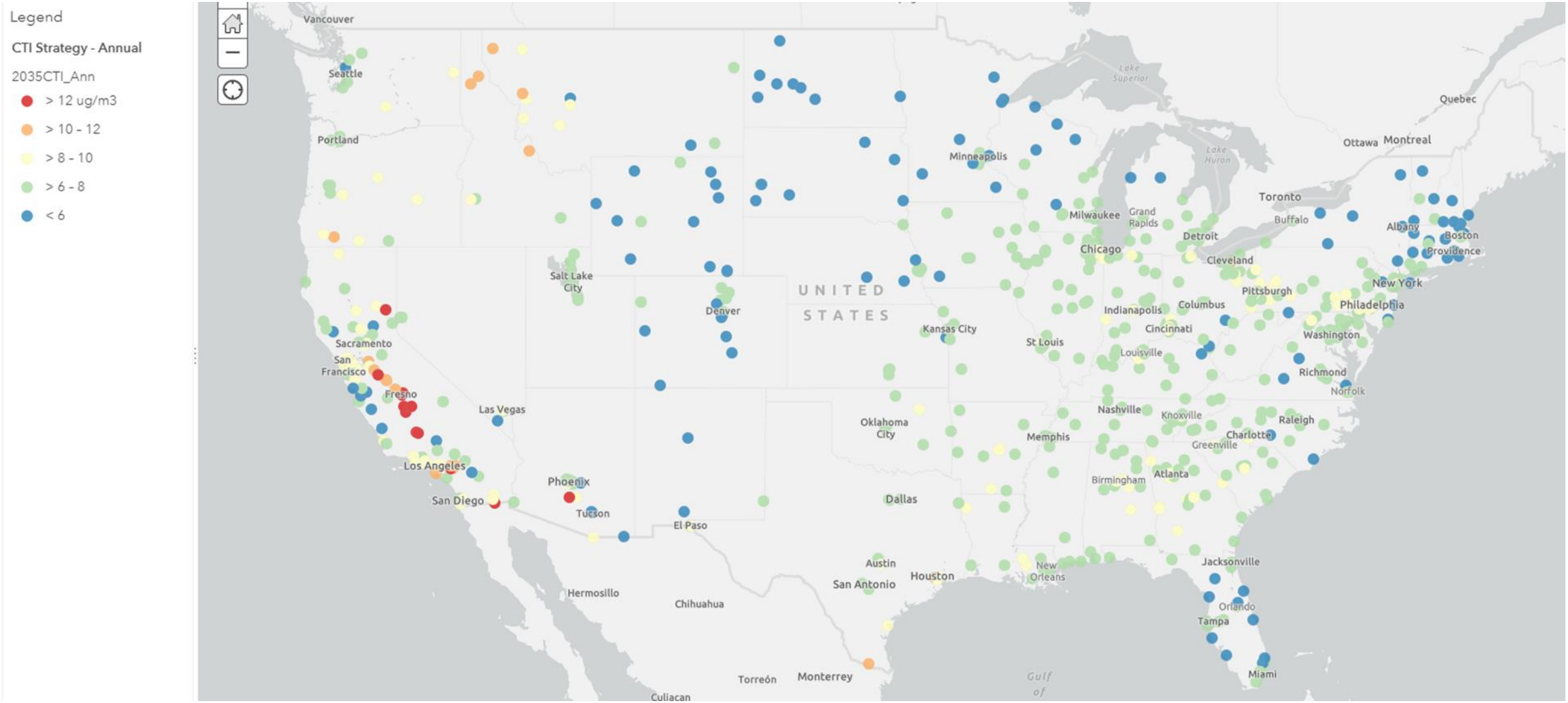
CTI Scenario Annual $PM_{2.5}$ ($\mu g/m^3$) Western States (left) / Eastern States (right)

			Annual PM-2.5 DV (ug/m3)			
Monitor	State	County	2028fh	2035 CTI	Delta (ug/m3)	Delta (%)
60290016	California	Kern	15.76	15.12	0.64	4.1%
60311004	California	Kings	15.16	14.61	0.55	3.6%
60310004	California	Kings	15.04	14.49	0.55	3.7%
61072002	California	Tulare	14.57	14.04	0.53	3.6%
60631010	California	Plumas	14.33	14.19	0.14	1.0%
60290014	California	Kern	14.10	13.51	0.59	4.2%
60250005	California	Imperial	13.47	13.41	0.06	0.4%
60658005	California	Riverside	13.41	13.06	0.35	2.6%
60195025	California	Fresno	13.05	12.53	0.52	4.0%
60190011	California	Fresno	12.91	12.36	0.55	4.3%
60195001	California	Fresno	12.74	12.29	0.45	3.5%
40213015	Arizona	Pinal	12.61	12.48	0.13	1.0%
60990006	California	Stanislaus	12.58	12.21	0.37	2.9%
60392010	California	Madera	12.09	11.73	0.36	3.0%
60771002	California	San Joaquin	12.06	11.75	0.31	2.6%
60990005	California	Stanislaus	12.06	11.66	0.40	3.3%
300530018	Montana	Lincoln	11.97	11.90	0.07	0.6%
60371302	California	Los Angeles	11.85	11.77	0.08	0.7%
60470003	California	Merced	11.84	11.52	0.32	2.7%
60658001	California	Riverside	11.84	11.50	0.34	2.9%
160590004	Idaho	Lemhi	11.71	11.63	0.08	0.7%
60371103	California	Los Angeles	11.56	11.44	0.12	1.0%
60371602	California	Los Angeles	11.54	11.44	0.10	0.9%
60712002	California	San Bernardino	11.24	10.96	0.28	2.5%
60472510	California	Merced	11.16	10.77	0.39	3.5%

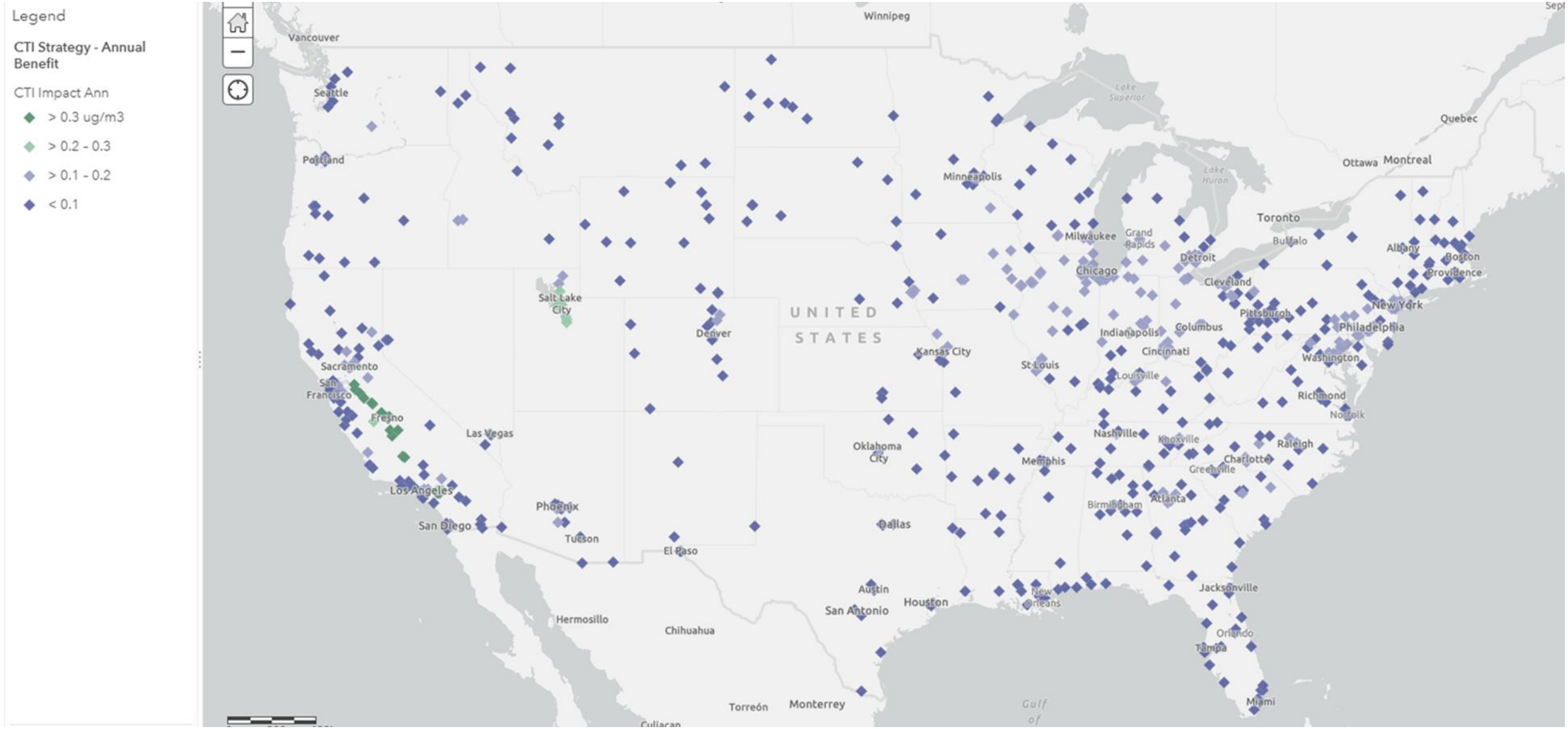
			Annual PM-2.5 DV (ug/m3)			
Monitor	State	County	2028fh	2035 CTI	Delta (ug/m3)	Delta (%)
420030064	Pennsylvania	Allegheny	11.02	10.91	0.11	1.0%
482150043	Texas	Hidalgo	10.27	10.22	0.05	0.5%
390350065	Ohio	Cuyahoga	10.18	10.04	0.14	1.4%
482011035	Texas	Harris	10.16	10.08	0.08	0.8%
261630015	Michigan	Wayne	9.94	9.79	0.15	1.5%
261630033	Michigan	Wayne	9.88	9.73	0.15	1.5%
420450002	Pennsylvania	Delaware	9.67	9.53	0.14	1.4%
10730023	Alabama	Jefferson	9.54	9.43	0.11	1.2%
220170008	Louisiana	Caddo	9.51	9.43	0.08	0.8%
390350038	Ohio	Cuyahoga	9.36	9.23	0.13	1.4%
421010055	Pennsylvania	Philadelphia	9.35	9.20	0.15	1.6%
420031301	Pennsylvania	Allegheny	9.29	9.19	0.10	1.1%
170313103	Illinois	Cook	9.25	9.04	0.21	2.3%
481410044	Texas	El Paso	9.22	9.17	0.05	0.5%
51191008	Arkansas	Pulaski	9.18	9.08	0.10	1.1%
133190001	Georgia	Wilkinson	9.15	9.06	0.09	1.0%
390810017	Ohio	Jefferson	9.13	9.03	0.10	1.1%
420050001	Pennsylvania	Armstrong	9.05	8.96	0.09	1.0%
180970081	Indiana	Marion	9.03	8.83	0.20	2.2%
470931013	Tennessee	Knox	9.01	8.88	0.13	1.4%
420210011	Pennsylvania	Cambria	9.00	8.91	0.09	1.0%
180970083	Indiana	Marion	8.99	8.78	0.21	2.3%
482010058	Texas	Harris	8.99	8.94	0.05	0.6%
390610014	Ohio	Hamilton	8.95	8.79	0.16	1.8%
420750100	Pennsylvania	Lebanon	8.95	8.81	0.14	1.6%

Sorted by descending CTI scenario DV (2035 CTI)
Green circles indicate largest impact by $\mu g/m^3$ in region

CTI Scenario – Annual $PM_{2.5}$ DVs ($\mu g/m^3$)



CTI Scenario Impact – Annual $PM_{2.5}$ (µg/m^3)



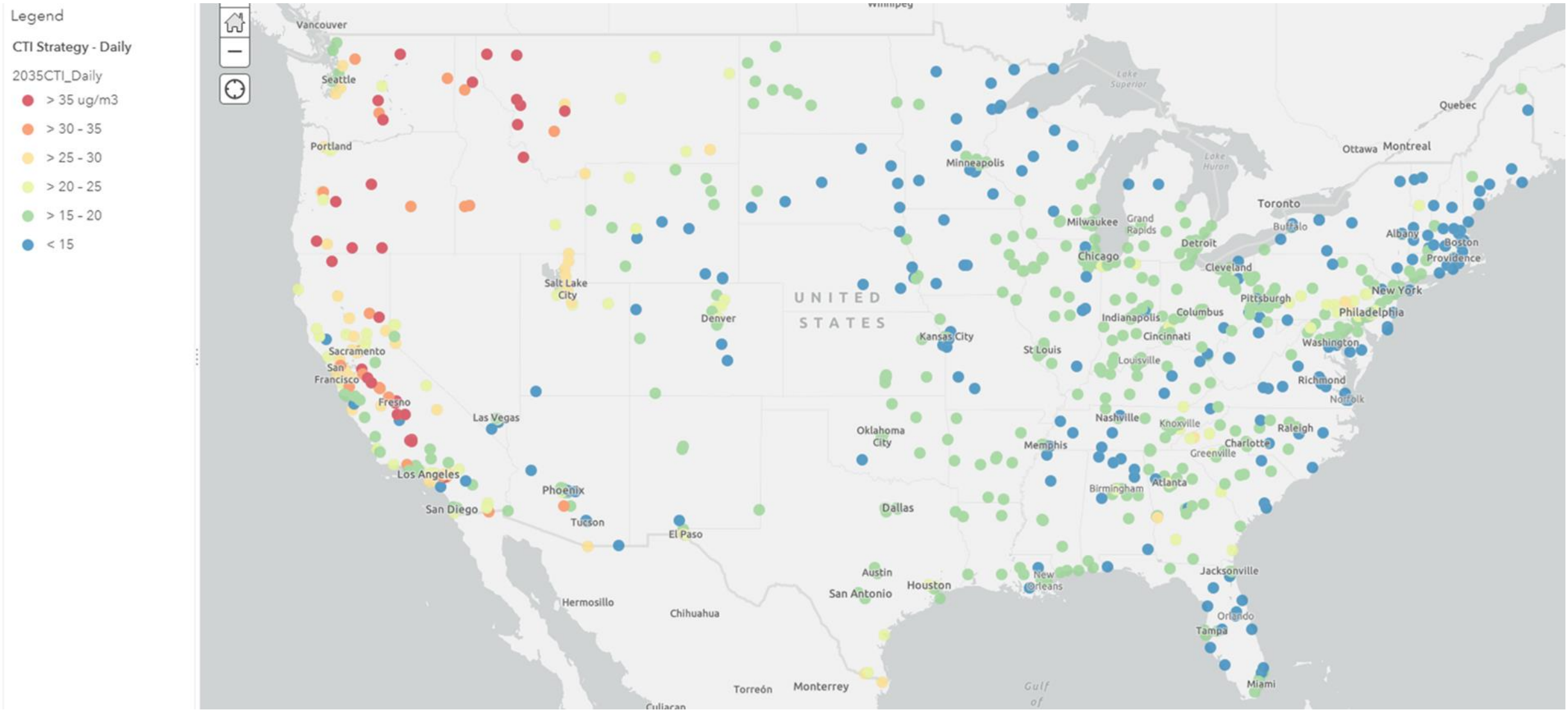
CTI Scenario Daily $PM_{2.5}$ ($\mu g/m^3$)
Western States (left) / Eastern States (right)

			Daily PM-2.5 DV (ug/m3)			
Monitor	State	County	2028fh	2035 CTI	Delta (ug/m3)	Delta (%)
530470013	Washington	Okanogan	60.2	59.8	0.4	0.7%
60290010	California	Kern	57.7	55.7	2.0	3.5%
300810007	Montana	Ravalli	56.2	55.9	0.3	0.5%
60290014	California	Kern	55.9	53.9	2.0	3.6%
60290016	California	Kern	55.7	53.9	1.8	3.2%
60311004	California	Kings	49.1	45.3	3.8	7.7%
60190011	California	Fresno	47.6	44.1	3.5	7.4%
60195025	California	Fresno	47.0	43.2	3.8	8.1%
60631010	California	Plumas	46.8	46.3	0.5	1.1%
61072002	California	Tulare	46.1	41.6	4.5	9.8%
410350004	Oregon	Klamath	44.9	44.7	0.2	0.4%
60932001	California	Siskiyou	43.1	42.8	0.3	0.7%
300530018	Montana	Lincoln	43.0	42.7	0.3	0.7%
300630024	Montana	Missoula	42.9	42.6	0.3	0.7%
160590004	Idaho	Lemhi	42.3	42.1	0.2	0.5%
60990006	California	Stanislaus	41.4	38.6	2.8	6.8%
300290049	Montana	Flathead	41.4	41.2	0.2	0.5%
60195001	California	Fresno	41.2	38.2	3.0	7.3%
300490026	Montana	Lewis and Clark	41.0	40.8	0.2	0.5%
410330114	Oregon	Josephine	40.9	40.5	0.4	1.0%
410370001	Oregon	Lake	40.6	40.3	0.3	0.7%
530770015	Washington	Yakima	40.4	40.1	0.3	0.7%
60010013	California	Alameda	39.8	39.3	0.5	1.3%
410392013	Oregon	Lane	39.8	39.5	0.3	0.8%
60771002	California	San Joaquin	39.4	37.1	2.3	5.8%

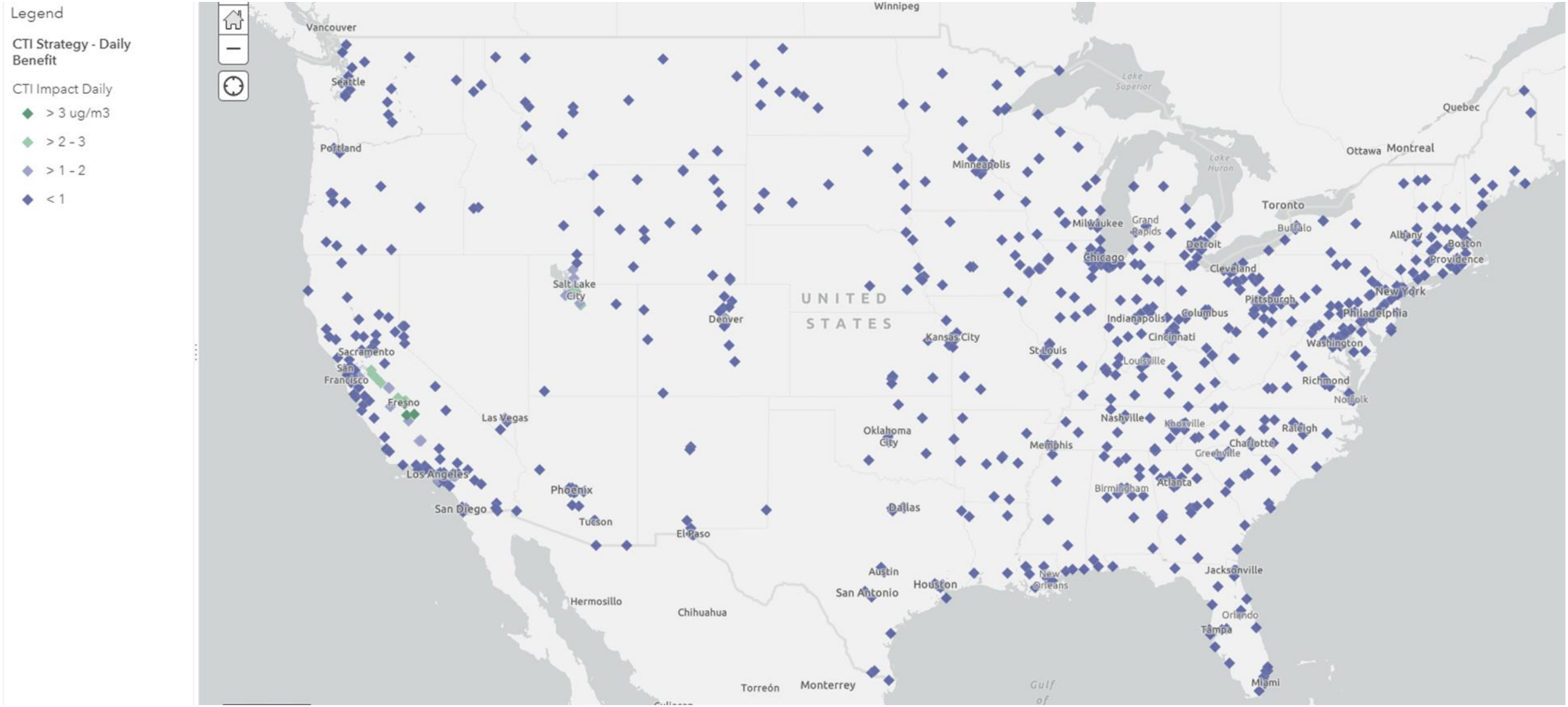
			Daily PM-2.5 DV (ug/m3)			
Monitor	State	County	2028fh	2035 CTI	Delta (ug/m3)	Delta (%)
420030064	Pennsylvania	Allegheny	32.9	32.7	0.2	0.6%
470931013	Tennessee	Knox	30.7	30.2	0.5	1.6%
480610006	Texas	Cameron	26.6	26.6	0.0	0.0%
132150011	Georgia	Muscogee	26.7	26.4	0.3	1.1%
482150043	Texas	Hidalgo	26.5	26.4	0.1	0.4%
420710012	Pennsylvania	Lancaster	26.2	25.9	0.3	1.1%
420750100	Pennsylvania	Lebanon	26.0	25.5	0.5	1.9%
370990006	North Carolina	Jackson	25.8	25.4	0.4	1.6%
482151046	Texas	Hidalgo	24.9	24.8	0.1	0.4%
481410044	Texas	El Paso	24.7	24.5	0.2	0.8%
420710007	Pennsylvania	Lancaster	24.9	24.4	0.5	2.0%
371730002	North Carolina	Swain	24.3	24.0	0.3	1.2%
483550032	Texas	Nueces	24.0	23.9	0.1	0.4%
420410101	Pennsylvania	Cumberland	24.1	23.6	0.5	2.1%
420430401	Pennsylvania	Dauphin	24.1	23.5	0.6	2.5%
261630015	Michigan	Wayne	23.8	23.4	0.4	1.7%
210130002	Kentucky	Bell	23.4	23.1	0.3	1.3%
261630033	Michigan	Wayne	23.2	22.8	0.4	1.7%
420110011	Pennsylvania	Berks	23.1	22.6	0.5	2.2%
450450015	South Carolina	Greenville	22.7	22.4	0.3	1.3%
420450002	Pennsylvania	Delaware	22.6	22.4	0.2	0.9%
470090011	Tennessee	Blount	22.5	22.2	0.3	1.3%
420031301	Pennsylvania	Allegheny	22.3	22.1	0.2	0.9%
180390008	Indiana	Elkhart	22.6	21.9	0.7	3.1%
540030003	West Virginia	Berkeley	22.3	21.9	0.4	1.8%

Sorted by descending CTI scenario DV (2035 CTI)
Green circle indicates largest impact by $\mu g/m^3$ in region (not shown in east)

CTI Scenario – Daily $PM_{2.5}$ DVs ($\mu g/m^3$)



CTI Scenario Impact – Daily $PM_{2.5}$ (µg/m^3)



Observations – 2028 Base Case – Ozone

- 2028 Base Case modeling demonstrates that most monitors in eastern U.S. attain 70 ppb ozone NAAQS with OTB/OTW control alone
  - Exceptions are Houston and key monitors in Connecticut

- California, Denver, and Uintah Basin in Utah (natural gas extraction) show nonattainment in 2028 Base Case

Observations – 2028 Base Case – $PM_{2.5}$

- 2028 base case modeling demonstrates that all monitors in eastern U.S. attain annual (12 µg/m^3) and daily (35 µg/m^3) $PM_{2.5}$ NAAQS with OTB/OTW control alone

- California and Pinal County (AZ) show annual nonattainment in 2028 Base Case and multiple states have monitors in nonattainment for daily standard

Observations – CTI Scenario – Ozone

- CTI scenario applied to 2028 base case eliminates ozone nonattainment with 70 ppb NAAQS everywhere east of Rockies
  - Central and southern California and Uintah Basin continue to show modeled ozone nonattainment even with CTI scenario applied

- Greatest ozone impact of CTI shown in urban areas and along highway corridors
  - Maximum impact seen in California (6.2 ppb at San Bernardino)
  - Atlanta has greatest improvement in eastern US (4.9 ppb)

Observations – CTI Scenario – Annual $PM_{2.5}$

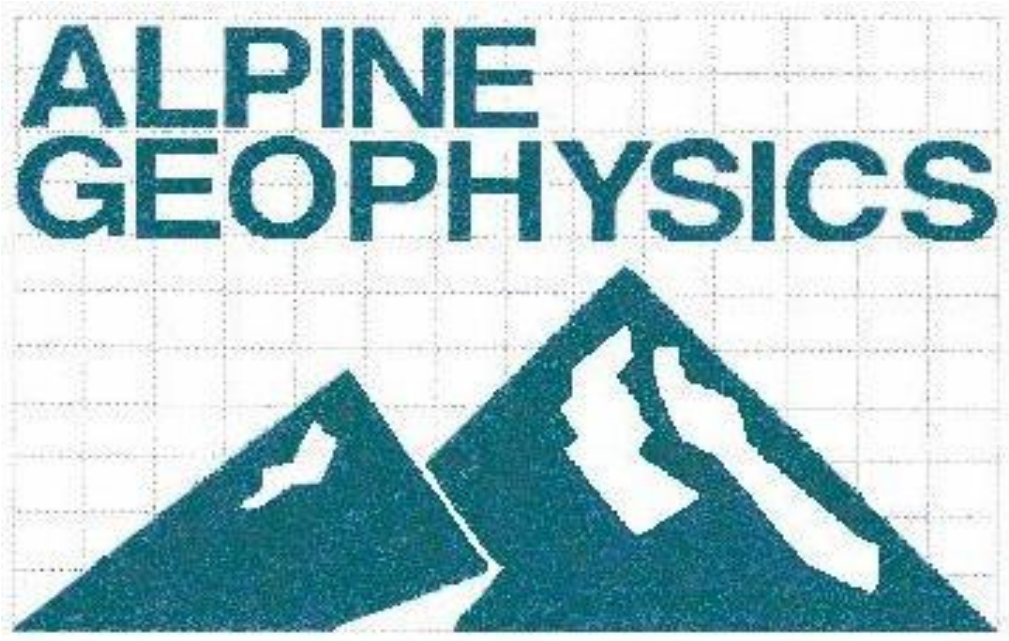
- CTI scenario applied to 2028 base case has noted impact on the annual $PM_{2.5}$ design value nationwide, showing modeled attainment changes at monitors in Madera, San Joaquin, and Stanislaus counties in California

- The greatest annual $PM_{2.5}$ impacts are reductions of 0.64 µg/m^3 (4.1%) seen in the west (Kern County, CA) and 0.21 µg/m^3 (2.3%) reduction in the east (Chicago)

Observations – CTI Scenario – Daily $PM_{2.5}$

- CTI scenario applied to 2028 base case also has impact on the daily $PM_{2.5}$ design value nationwide, showing modeled attainment changes at monitors in Madera, Merced, and San Joaquin counties in California

- The greatest daily $PM_{2.5}$ impacts are reductions of 4.5 µg/m^3 (9.8%) seen in the west (Tulare County, CA) and 0.9 µg/m^3 (4.5%) reduction in the east (Chicago)



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