OTC Modeling Committee Update

OTC & MANE-VU Spring Stakeholders' Meeting

April 14, 2022

Accomplishments & Ongoing Work

- Tracking OTR ozone levels and the preliminary attainment status
- Modeling:
  - Completed V1 2016 and 2023 Modeling with CMAQ and CAMx
  - Starting updating to the new V2 emission inventories and performing new base case modeling for 2016, 2023 and 2026
  - Performed sensitivity modeling on the OTC 4km modeling subdomain
  - Nearing Completion - 2018/19 Episodic screening modeling for peak electric demand days
- Nearing completion of the draft Modeling Technical Support Document (TSD)
- Following the evolving science of regional research efforts

2008 and 2015 Ozone NAAQS Timelines

Ozone Timeline	2008 NAAQS	2015 NAAQS
Marginal Nonattainment Area Attainment Date		August 2021 (2018-20 data)
Moderate Nonattainment Area Attainment Date		August 2024 (2021-23 data)
Serious Nonattainment Area Attainment Date	July 2021 (2018-20 data)	August 2027 (2024-26 data)
Severe Nonattainment Area Attainment Date	July 2027 (2024-26 data)	August 2033
Extreme Nonattainment Area Attainment Data	July 2032	August 2038

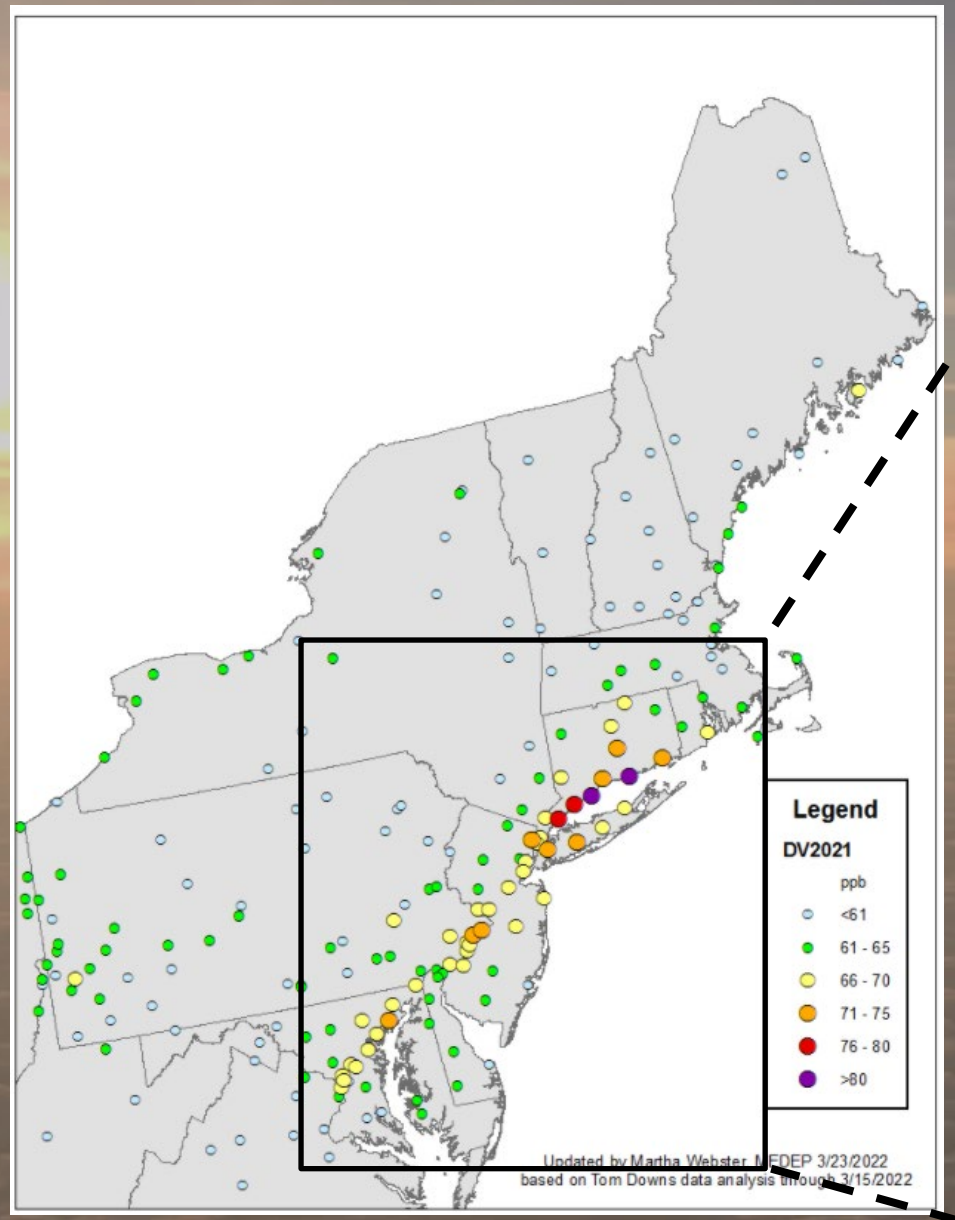
Proposed Bump-ups

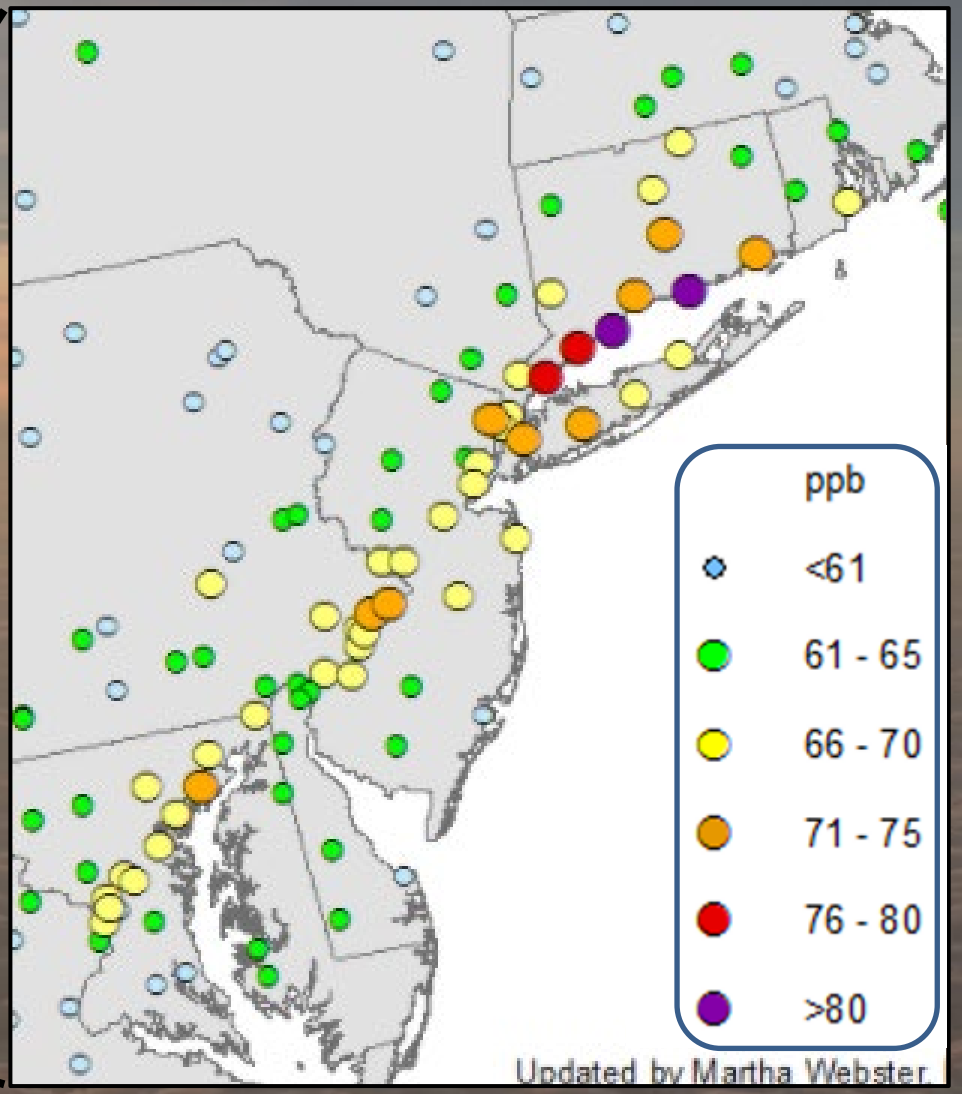
Gtr CT, Philly, Baltimore, (DC?) Nonattainment Areas

NY Nonattainment Area

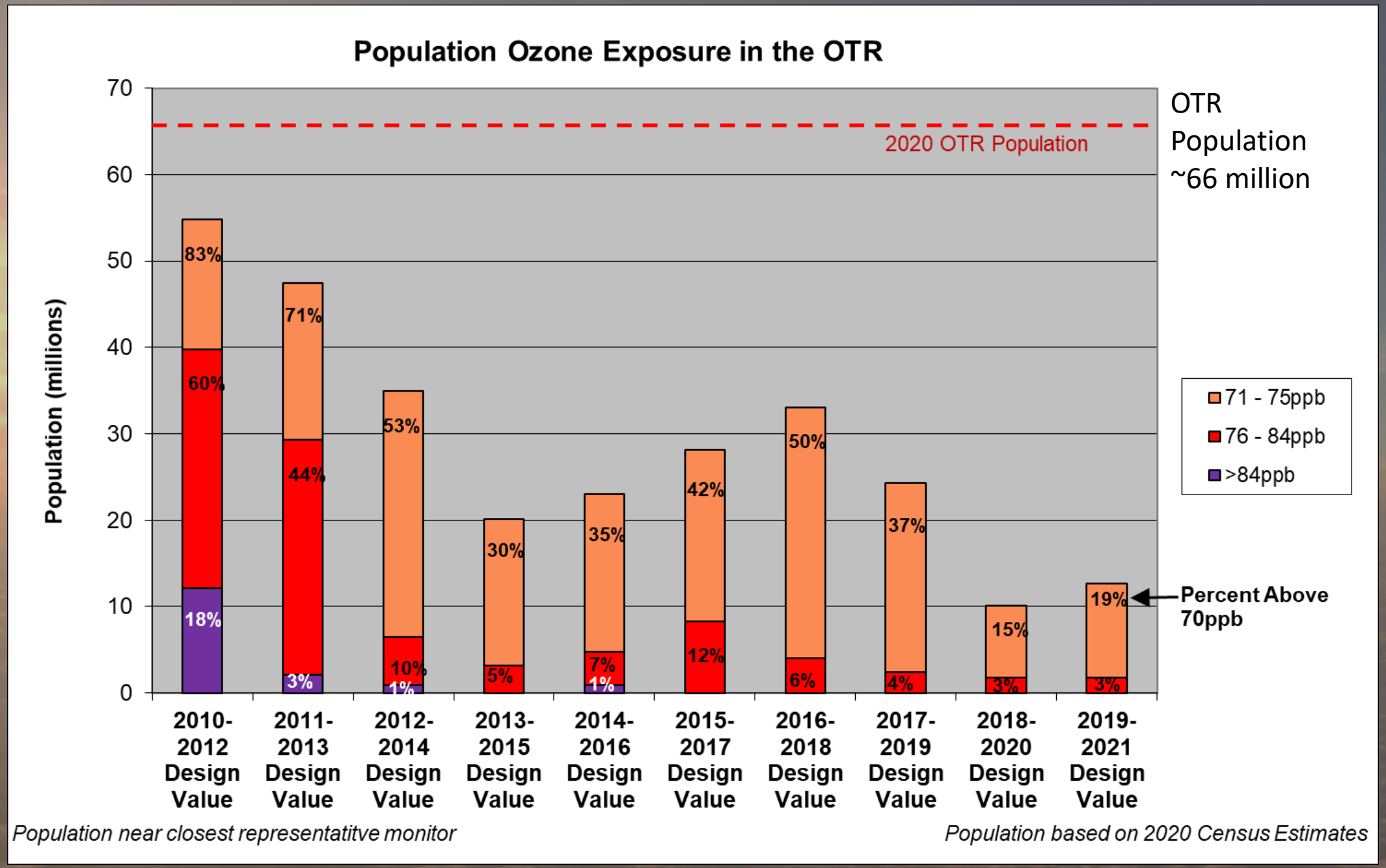
OZONE MONITORING AND NONATTAINMENT

Preliminary 2019-2021 Design Values





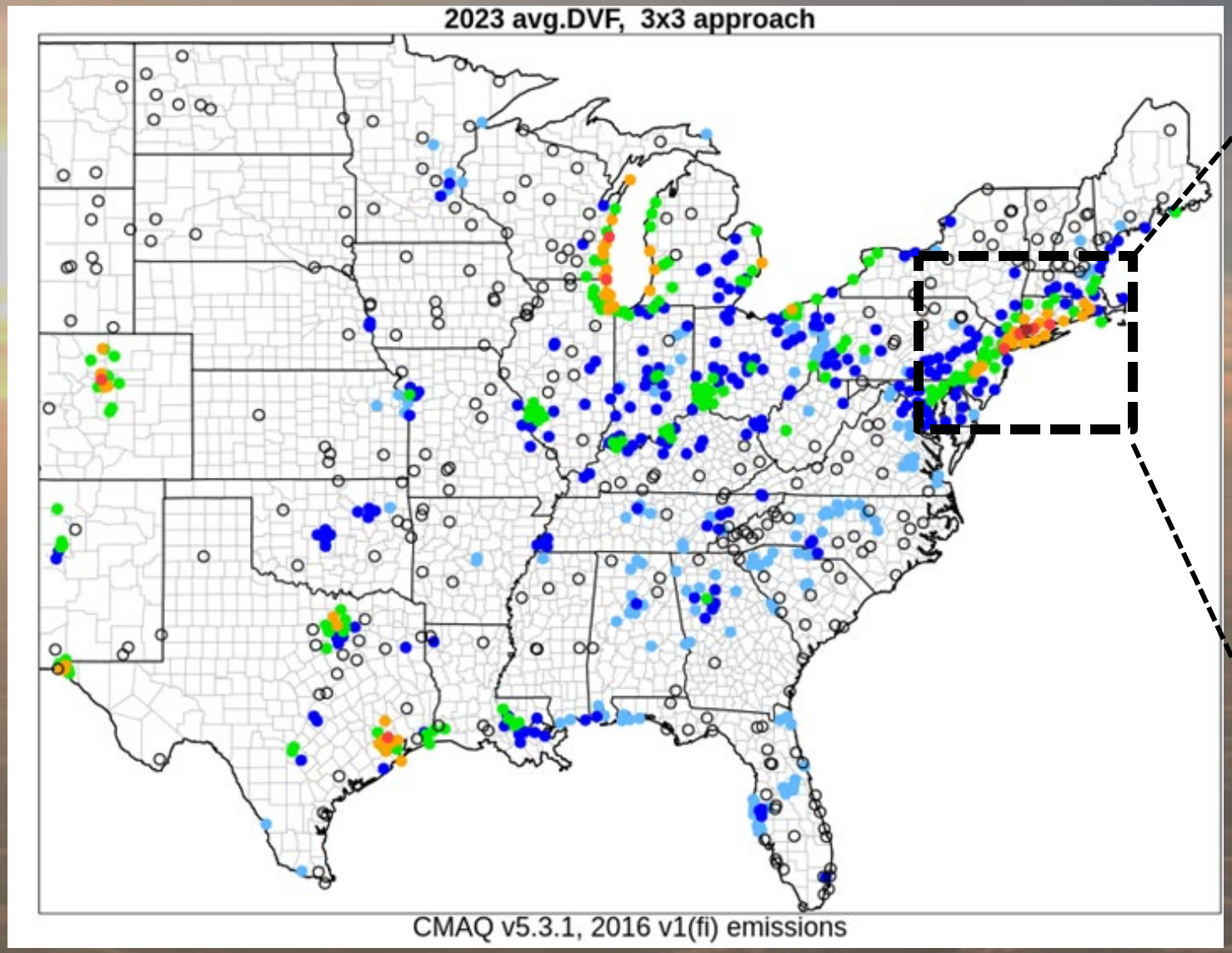
Ozone design values are the 3-year average of the year's 4th maximum 8-hour concentration at each monitor. It directly compares to the health standard (NAAQS).

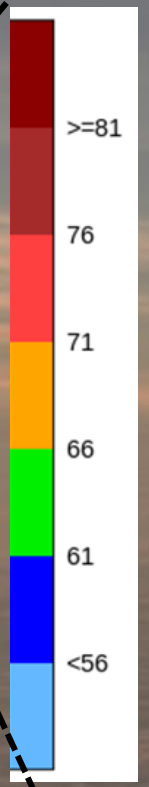

Population Ozone Exposure in the OTR
Population (millions)
70
60
50
40
30
20
10
0
2020 OTR Population
OTR Population ~66 million
71 - 75ppb
76 - 84ppb
>84ppb
Percent Above 70ppb
83%
60%
18%
71%
44%
3%
53%
10%
1%
30%
5%
35%
7%
1%
42%
12%
50%
6%
37%
4%
15%
3%
19%
3%
2010-2012 Design Value
2011-2013 Design Value
2012-2014 Design Value
2013-2015 Design Value
2014-2016 Design Value
2015-2017 Design Value
2016-2018 Design Value
2017-2019 Design Value
2018-2020 Design Value
2019-2021 Design Value
Population near closest representativte monitor
Population based on 2020 Census Estimates

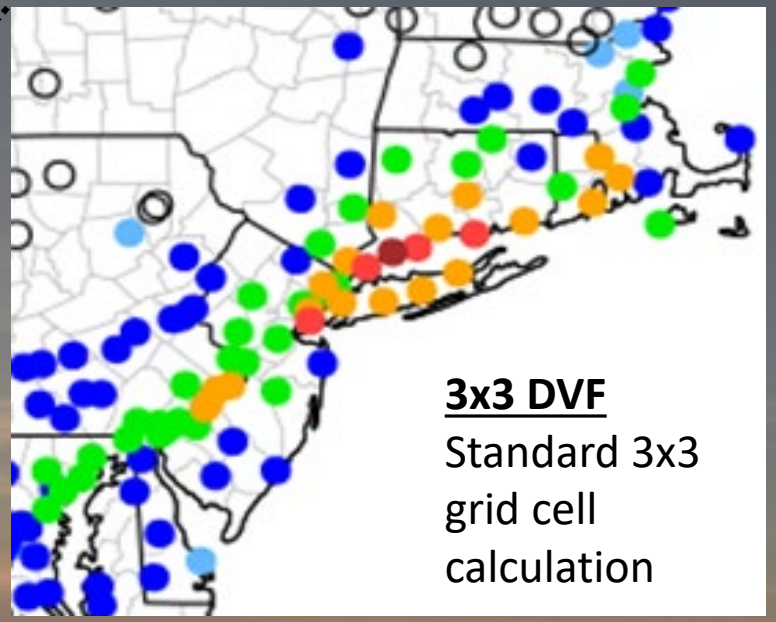
OTC MODELING FOR 2023

1. **V1 2023 BASE CASE**
2. HEDD EPISODIC SENSITIVITY MODELING
3. TAGGED EMISSION CONTRIBUTION MODELING

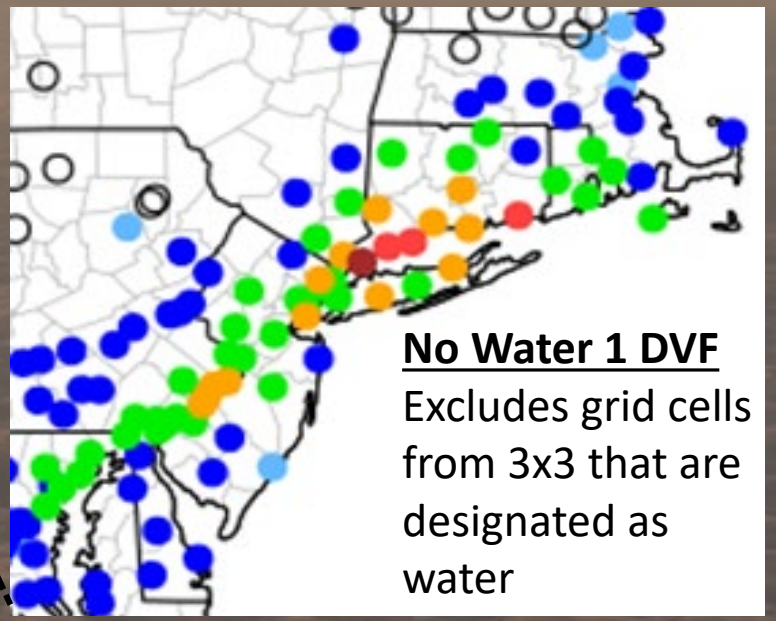
OTC 2023 Projected Design Values (V1) - CMAQ





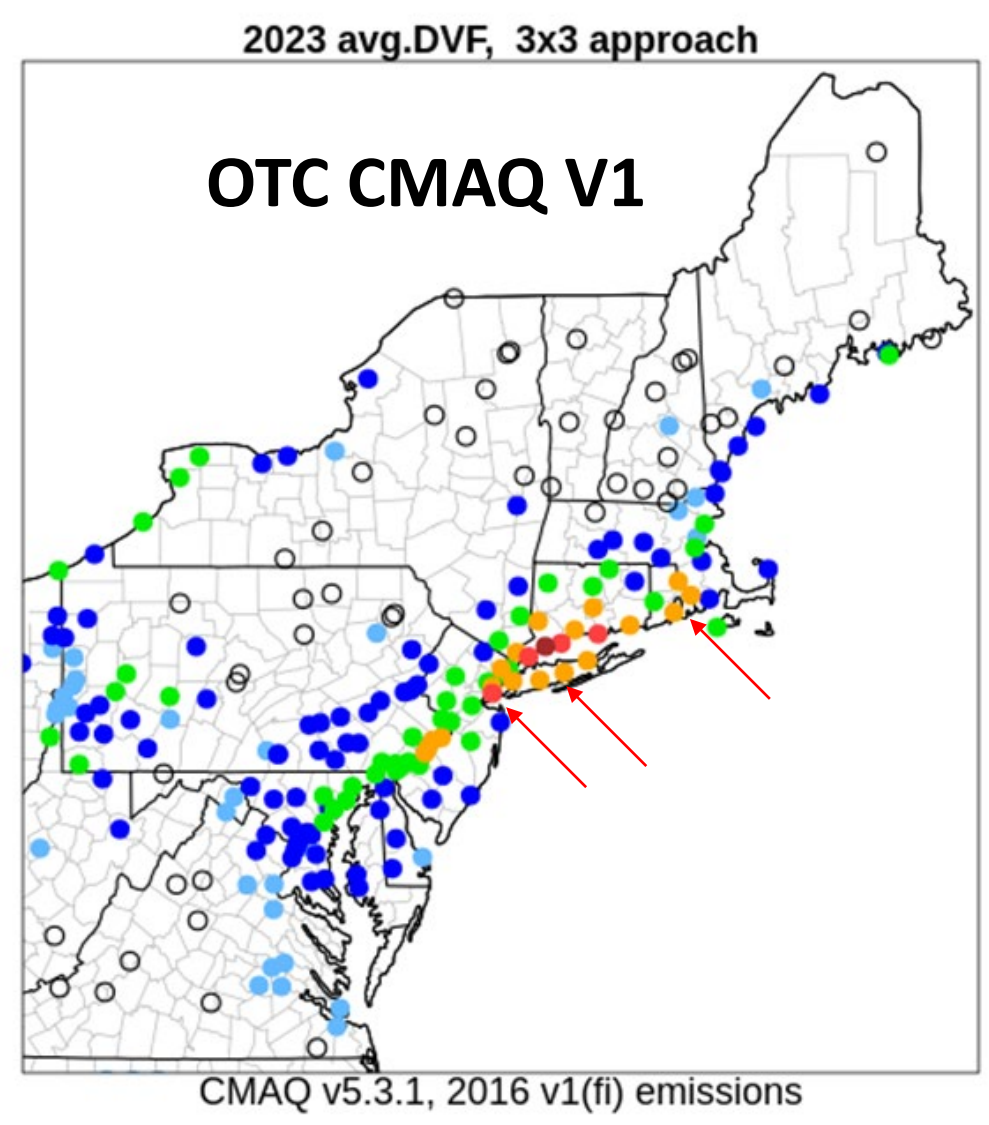


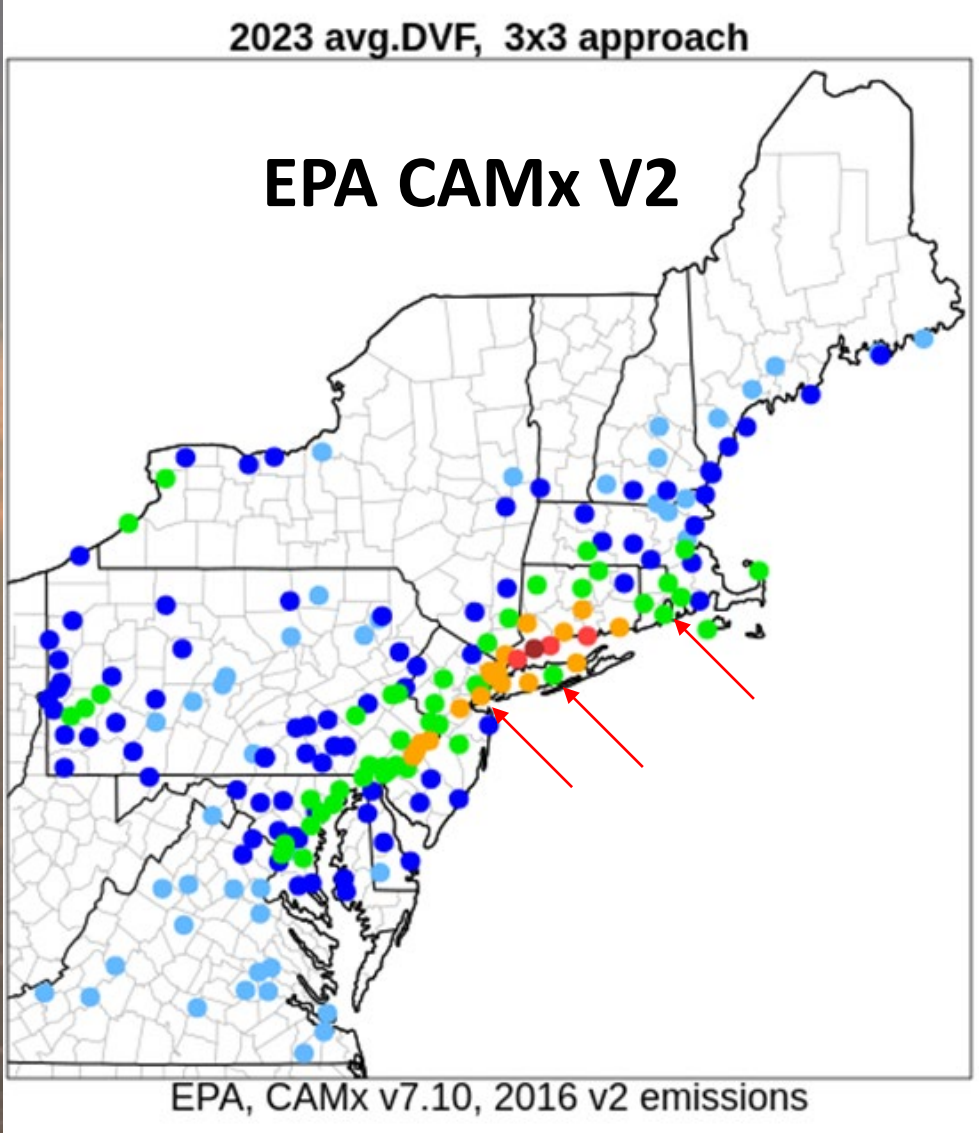
3x3 DVF
Standard 3x3 grid cell calculation



No Water 1 DVF
Excludes grid cells from 3x3 that are designated as water

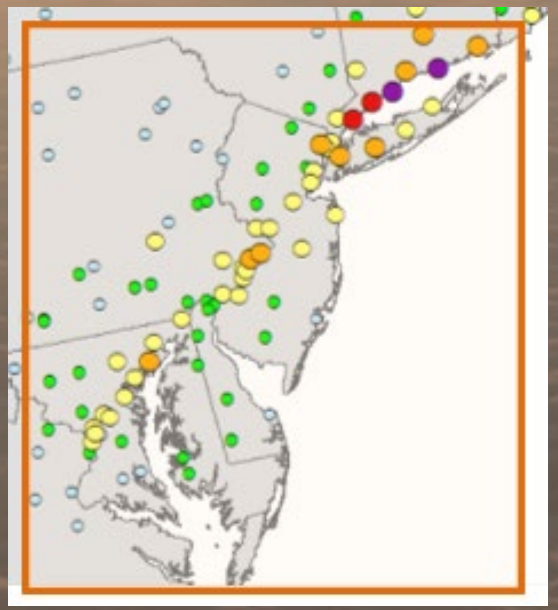
2023 Predicted Design Values - OTC V1 vs EPA V2





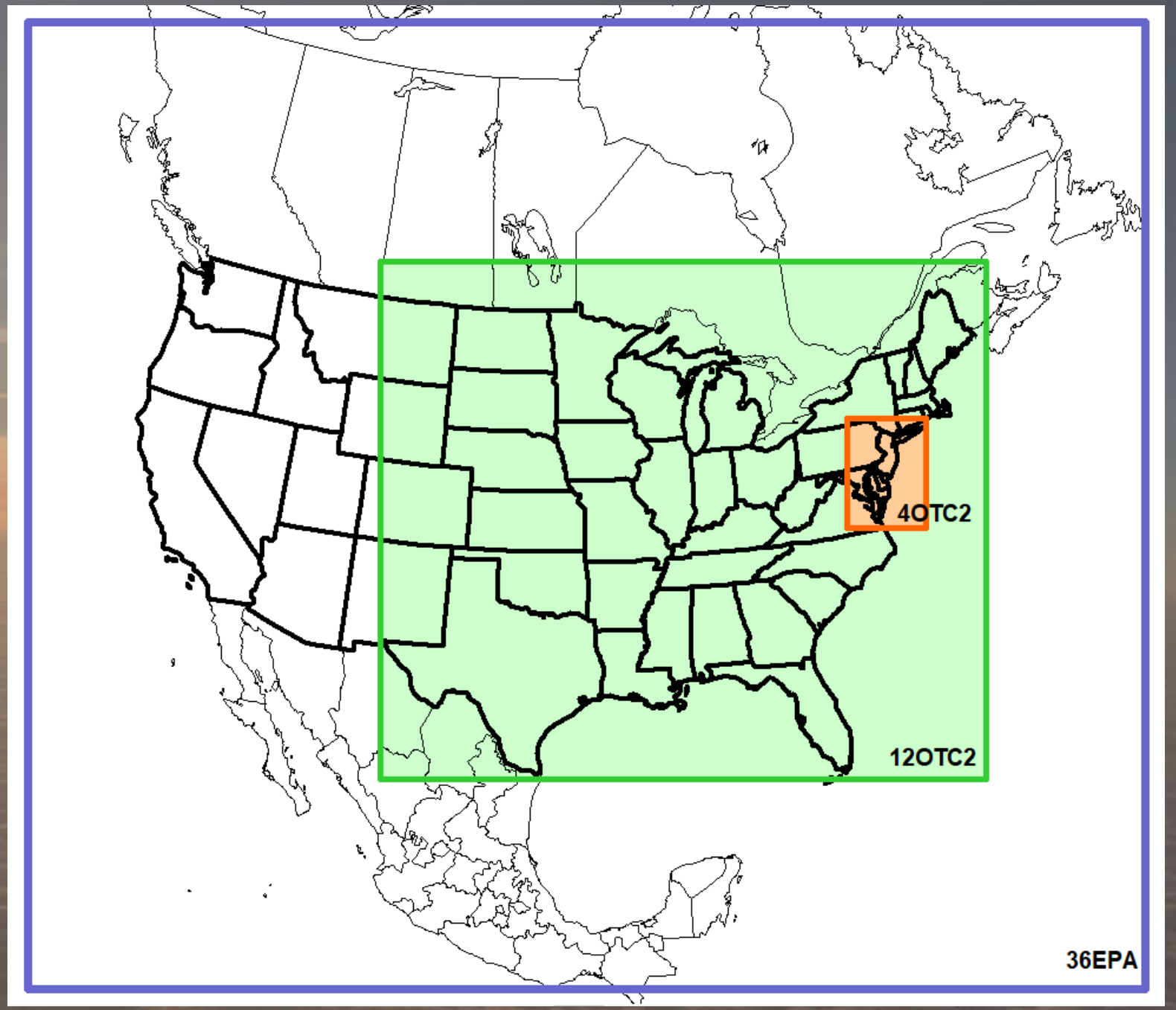
OTC Modeling Domains

- 4km OTC2 Domain
- 12km OTC2 Domain
- 36km EPA Domain



4km Domain

- High ozone monitors
- Near water
- Sharp concentration gradients



4km vs 12km Grid Resolution Modeling Comparison of 2023 Predicted Design Values (DVFs)

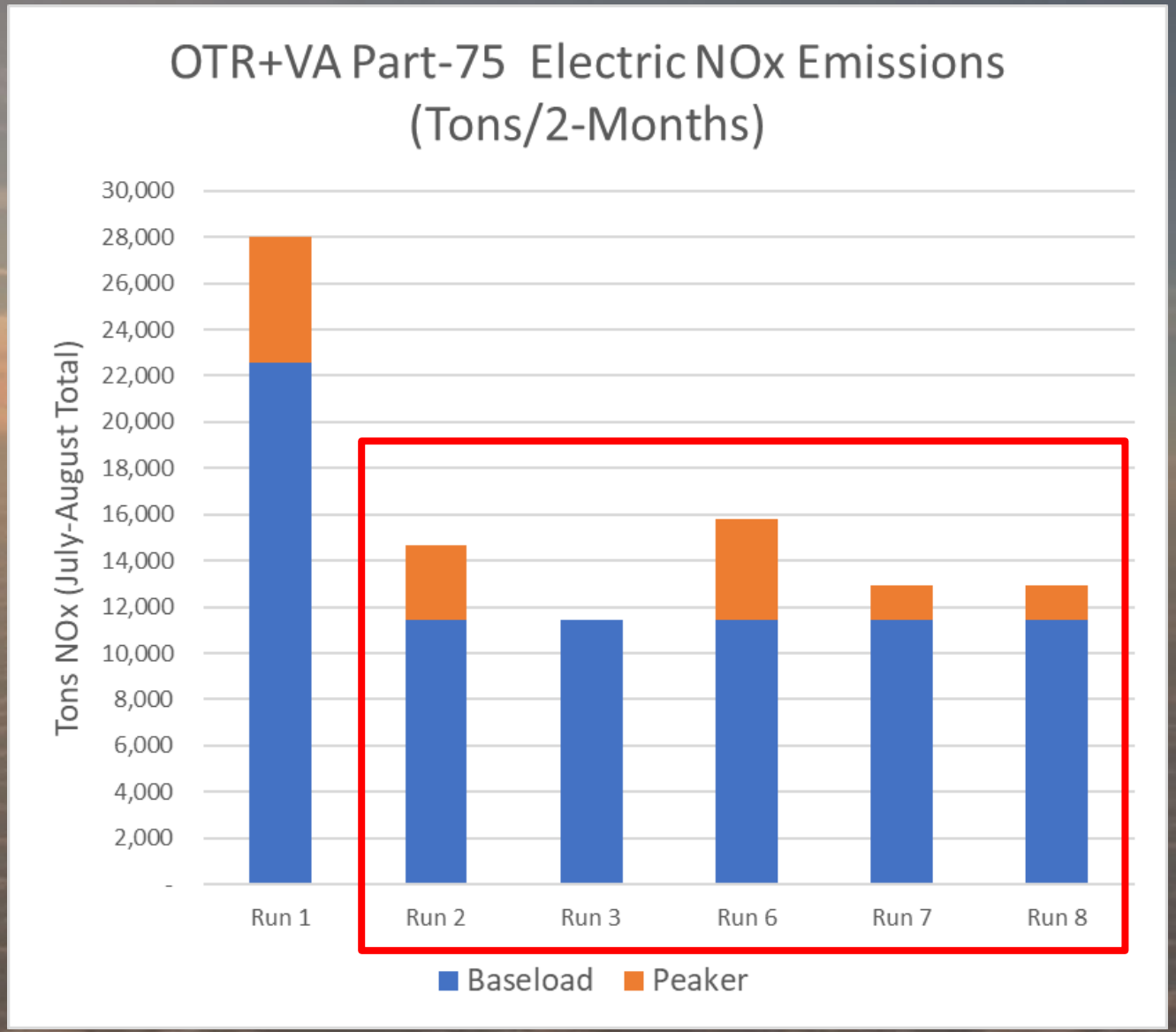
			2019-2021	12 km	4 km	Difference	12 km	4 km	Difference	12 km	4 km	Difference	12 km	4 km	Difference
OTC2 Subdomain High Ozone Monitoring Locations			Preliminary	CAMX	CAMX	CAMX	CAMX	CAMX	CAMX	CMAQ	CMAQ	CMAQ	CMAQ	CMAQ	CMAQ
2023 V1 Emission Projections			DV	3x3	3x3	3x3	3x3 NW1	3x3 NW1	3x3 NW1	3x3	3x3	3x3	3x3 NW1	3x3 NW1	3x3 NW1
90010017	CT	Greenwich Point Park - Greenwich	79	74	75	1	74	75	1	71	75	4	78	74	-4
90013007	CT	Lighthouse - Stratford	81	75	77	2	75	77	2	74	75	1	75	75	0
90019003	CT	Sherwood Island State Park - Westport	80	78	77	-1	76	77	1	80	76	-4	75	76	1
90031003	CT	McAuliffe Park	67	63	64	1	63	64	1	62	63	1	62	63	1
90079007	CT	Connecticut Valley Hospital - Middletown	74	70	70	0	70	70	0	68	69	1	68	69	1
90090027	CT	Criscuolo Park-New Haven	72	69	70	1	68	69	1	69	70	1	68	69	1
90099002	CT	Hammonasset State Park - Madison	82	71	73	2	72	73	1	71	73	2	70	73	3
90110124	CT	Fort Griswold Park - Groton	73	67	67	0	68	67	-1	67	68	1	71	68	-3
110010043	DC	MCMILLAN NCore-PAMS	68	61	63	2	61	63	2	60	61	1	60	61	1
240031003	MD	GLEN BURNIE	70	64	64	0	64	64	0	65	63	-2	63	63	0
240051007	MD	Padonia	69	62	62	0	62	62	0	61	61	0	61	61	0
240053001	MD	Essex	70	64	64	0	63	64	1	64	63	-1	62	63	1
240150003	MD	Fair Hill Natural Resource Management Area	67	64	65	1	64	65	1	64	63	-1	64	63	-1
240251001	MD	Edgewood	72	65	65	0	64	66	2	63	64	1	63	64	1
240259001	MD	Aldino	68	63	64	1	63	64	1	62	62	0	62	62	0
340030006	NJ	Leonia	71	69	68	-1	69	68	-1	68	66	-2	68	66	-2
340070002	NJ	Camden Spruce Street	66	67	69	2	67	69	2	66	67	1	66	67	1
340150002	NJ	Clarksboro	66	66	66	0	66	66	0	65	65	0	65	65	0
360810124	NY	QUEENS COLLEGE 2	71	67	68	1	68	68	0	66	67	1	65	67	2
360850067	NY	SUSAN WAGNER HS		71	69	-2	70	69	-1	74	70	-4	70	69	-1
361030002	NY	BABYLON	73	69	69	0	68	69	1	68	67	-1	67	67	0
361030004	NY	RIVERHEAD	69	68	67	-1	67	67	0	66	66	0	66	66	0
361192004	NY	WHITE PLAINS	69	70	68	-2	67	68	1	66	67	1	67	67	0
420170012	PA	Bristol	71	71	72	1	71	72	1	69	69	0	69	69	0
421010024	PA	North East Airport (NEA)	71	69	70	1	69	70	1	68	69	1	68	69	1
510130020	VA	Aurora Hills Visitors Center	66	61	63	2	61	63	2	60	62	2	60	62	2

OTC MODELING FOR 2023

1. V1 2023 BASE CASE
2. **HEDD EPISODIC SENSITIVITY MODELING**
3. TAGGED EMISSION CONTRIBUTION MODELING

Part-75 Electric Generation NOx Emissions

- Large decrease between 2016 Run 1 and 2018/19 ReBase Run 2
- Compared to the Run 2 ReBase scenario, worst-case scenario peaker emission are 30% higher and best-case emissions are 50% lower

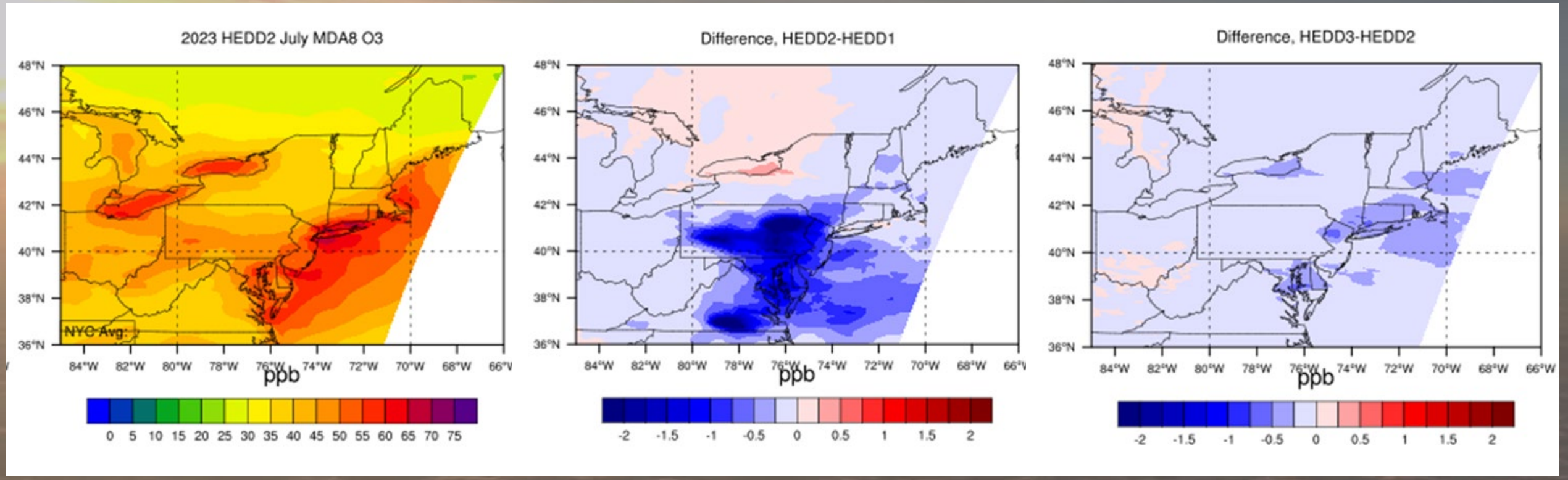


HEDD Episodic
Examples: Model Predicted Changes in Ozone

Run 2
2018/19 Model Output

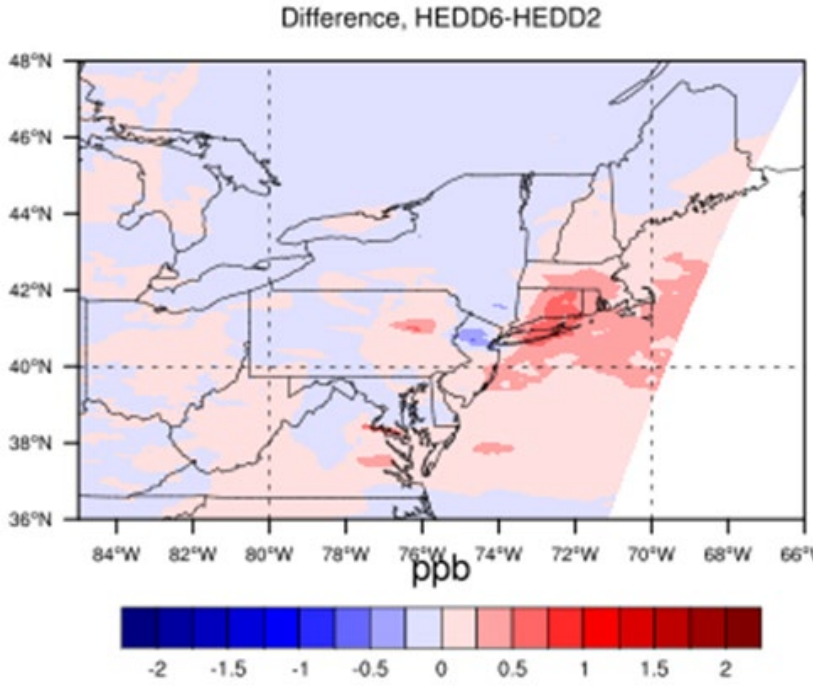
Run 1 – Run 2
2018/19 Difference from 2016

Run 2 – Run 3
2018/19 All Part-75 Peakers Off

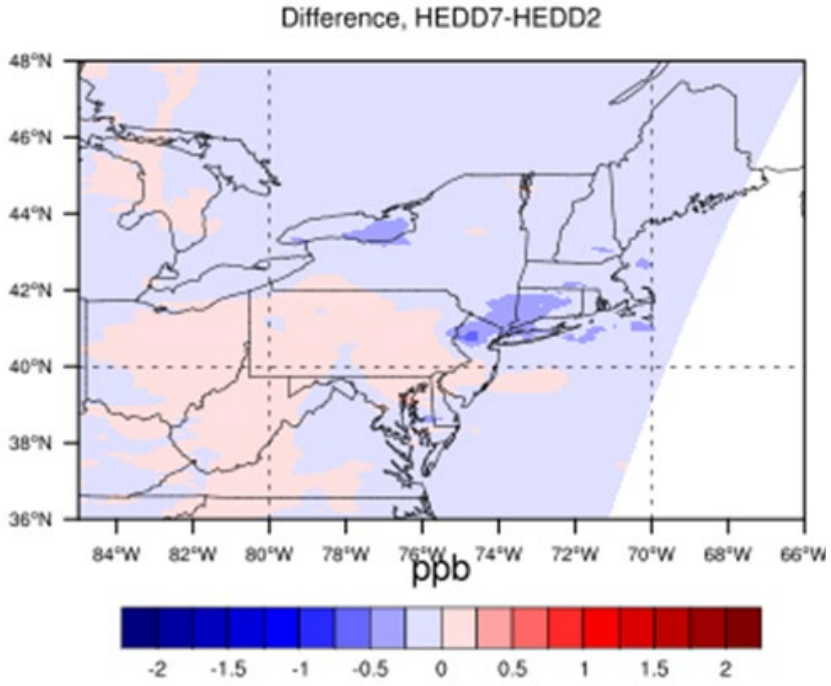


HEDD Episodic
Examples: 2018/19 Electric Load Maintained

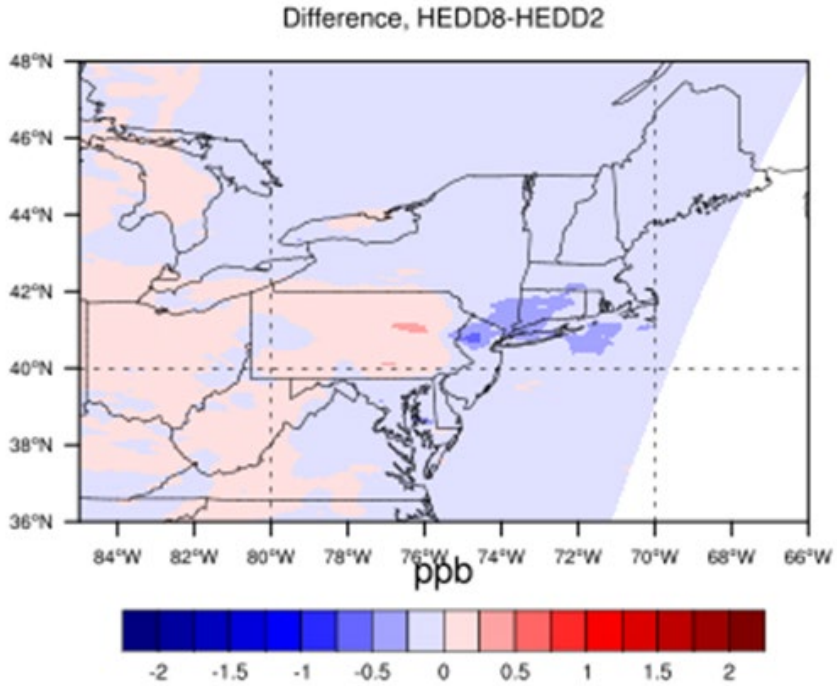
Run 2 – Run 6
Dirtiest First



Run 2 – Run 7
Cleanest First



Run 2 – Run 8
Most Operated First



OTC MODELING FOR 2023

1. V1 2023 BASE CASE
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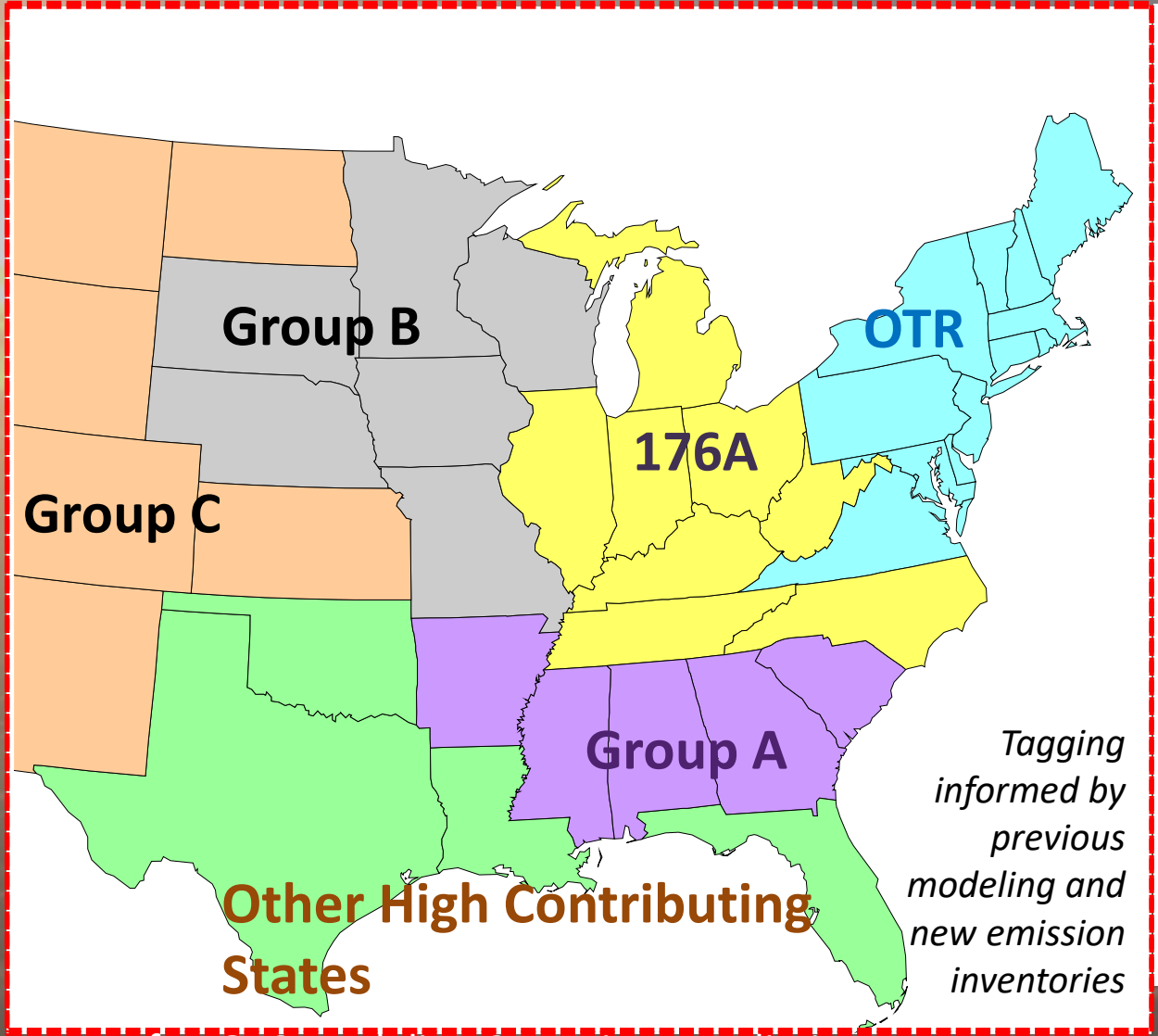
3. **TAGGED EMISSION CONTRIBUTION MODELING**

2023 CAMx Tagged Emission Ozone Contribution Modeling



Emission Sector	OTR + VA	176A	Other Large Contributing States	Clustered States (A, B, C)	Canada	Mexico
Area-nonpoint	By State	By State	By State	Cluster Group	Sector Group	Sector Group
Commercial Marine Vehicles	By State	By State	By State	Cluster Group		
EGU-ERTAC	By State	By State	By State	Cluster Group		
NonEGU	By State	By State	By State	Cluster Group		
NonRoad-diesel	By State	By State	By State	Cluster Group		
NonRoad-nondiesel	By State	By State	By State	Cluster Group		
OnRoad-diesel	By State	By State	By State	Cluster Group		
OnRoad-nondiesel	By State	By State	By State	Cluster Group		
Oil & Gas-point	By State	By State	By State	Cluster Group		
Oil & Gas-nonpoint	By State			Cluster Group		
EGU-Peaking Unit	By State	State Group	State Group	Cluster Group		
Rail	By State	State Group	State Group	Cluster Group		
Airport/Airplane to 3000'	By State	State Group	State Group	Cluster Group		
Agriculture	All Location Group					
Offshore CMV	All Location Group					
Offshore rigs	All Location Group					
Prescribed fire	All Location Group					
Other Anthropogenic	All Location Group					
Biogenic	All Location Group					
Boundary conditions	All Location Group					
Initial conditions	All Location Group					

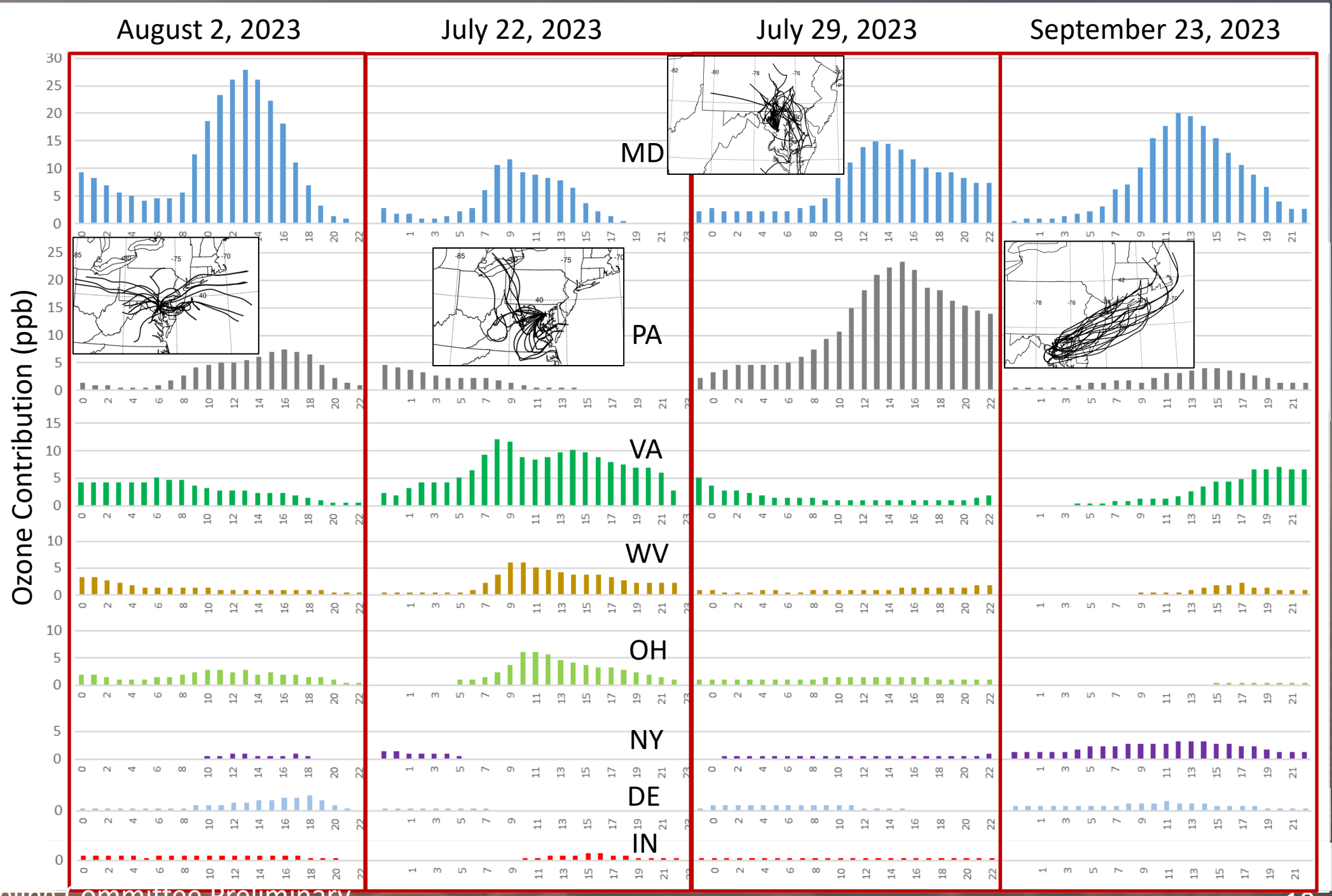
Variability

Variability Day-to-Day Hour-to-Hour

Beltsville, MD 4 High Ozone Days

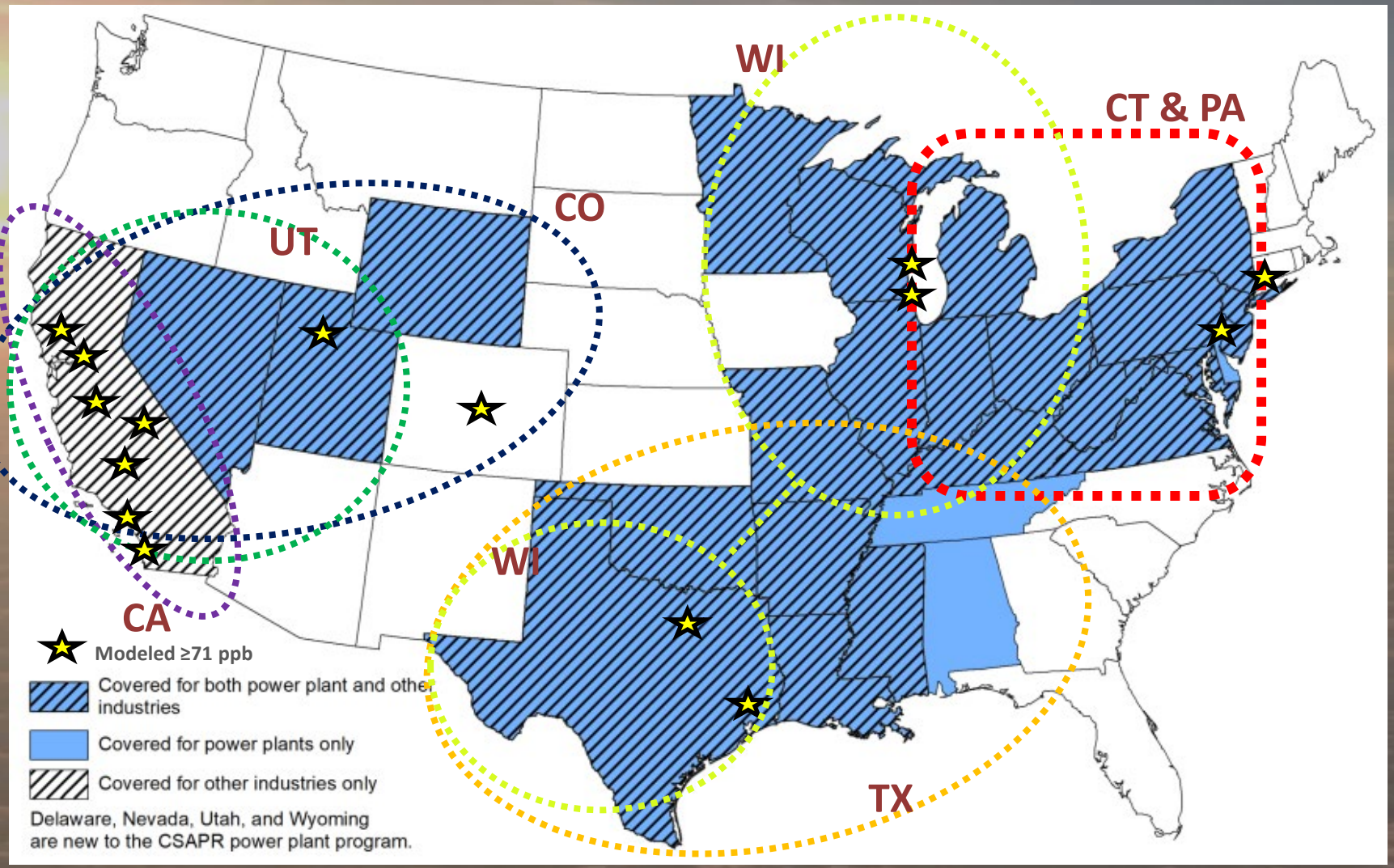
Contributions are highly variable

Which are truly significant?



EPA 2015 GOOD NEIGHBOR FIP

EPA 2015 Ozone NAAQS Good Neighbor Proposed Rule



- EGUs
- Reciprocating internal combustion engines in Pipeline Transportation of Natural Gas;
- Kilns in Cement and Cement Product Manufacturing;
- Boilers and furnaces in Iron and Steel Mills and Ferroalloy Manufacturing;
- Furnaces in Glass and Glass Product Manufacturing; and
- High-emitting, large boilers in Basic Chemical Manufacturing, Petroleum and Coal Products Manufacturing, and Pulp, Paper, and Paperboard Mills.

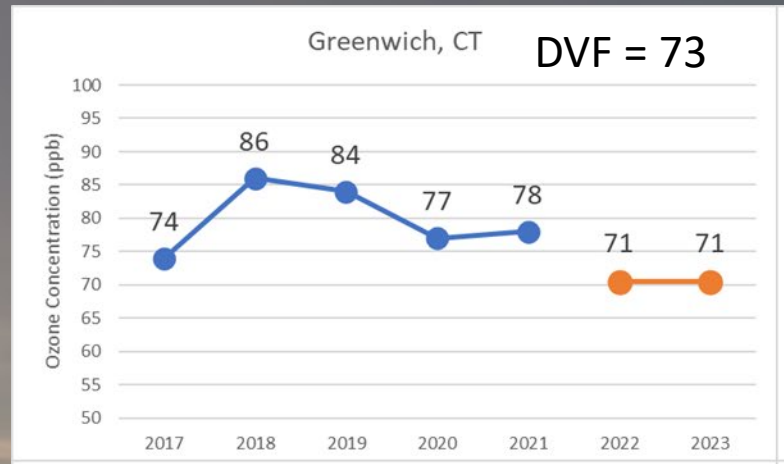
EPA 2015 Ozone NAAQS Good Neighbor Modeling

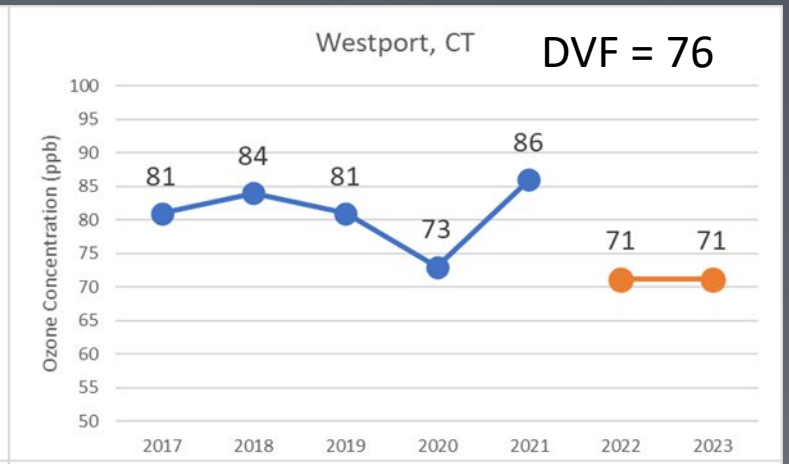
				CMAQ 12 km				CAMX 12 km				CAMx 4 km				EPA CAMx , v2, 12 km			
				3x3		3x3 no water 1		3x3		3x3 no water 1		3x3		3x3 no water 1		3x3		3x3 no water 1	
Site ID	State	Site name	2019-2021 pDV	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX	DVFavg.pre-trunc AVG	DVFmax.pre-trunc MAX
90019003	CT	Westport	80	80.6	80.9	75.5	75.8	78.3	78.6	76	76.2	77.9	78.2	77.8	78	76.8	77	76.1	76.4
90013007	CT	Stratford	81	74.6	75.5	75.1	76	75.8	76.7	75	75.9	77.1	78.1	77.1	78.1	74.7	75.6	74.2	75.1
360850067	NY	NYC-Susan Wagner HS		74.2	74.2	70.3	70.3	71.3	71.3	70.5	70.5	69.9	69.9	69.7	69.7	69.9	69.9	69.5	69.5
90099002	CT	Madison	82	71.8	73.9	70.8	72.8	71.6	73.7	72.3	74.4	73.7	75.8	73.6	75.8	72.1	74.2	71.8	73.9
90010017	CT	Greenwich	79	71.7	72.4	78.8	79.5	74.1	74.7	74.6	75.2	75.2	75.8	75.5	76.2	75.3	75.9	73	73.7
90090027	CT	New Haven-B	72	69.3	70.5	68.4	69.6	69.5	70.7	68.7	69.9	70.6	71.8	69.7	70.9	68.2	69.4	68	69.1
90079007	CT	Middletown	74	68.9	69.2	68.9	69.2	70.2	70.5	70.2	70.5	70.9	71.2	70.9	71.2	69.8	70.1	69.8	70.1
420170012	PA	Bristol	71	69.1	70.6	69.1	70.6	71.1	72.6	71.1	72.6	72.4	73.9	72.4	73.9	70.7	72.2	70.7	72.2
340170006	NJ	Bayonne	66	68.2	69.1	64.8	65.7	66	66.9	65.1	66	65.7	66.7	65.7	66.7	64.5	65.4	64.5	65.4
90011123	CT	Danbury	70	68.8	69.7	68.8	69.7	69.3	70.2	69.3	70.2	69.7	70.6	69.7	70.6	68.6	69.5	68.6	69.5
90110124	CT	Groton Fort Griswold	73	67.9	69.5	71.3	72.9	67	68.5	68	69.6	67.5	69.1	67.6	69.2	67	68.5	67.5	69.1
340030006	NJ	Leonia	71	68.1	68.7	68.1	68.7	69.2	69.9	69.2	69.9	68.4	69	68.4	69	68.5	69.2	68.5	69.2
421010024	PA	NEA	71	68.2	68.4	68.2	68.4	69.5	69.8	69.5	69.8	70.9	71.1	70.9	71.1	69.5	69.8	69.5	69.8
361030002	NY	Babylon	73	68.3	70.1	67.6	69.4	69.7	71.6	68.3	70.1	69.2	71.1	69.2	71.1	69	70.9	67.6	69.4
250051004	MA	Fall River		68.5	70.7	63.3	65.3	64.5	66.6	64.4	66.5					64.2	66.3	64	66
361192004	NY	White Plains	69	66.9	67.8	67.9	68.8	70.1	71.1	67.9	68.8	68.4	69.3	68.4	69.3	69.6	70.6	67	67.9
361030009	NY	Suffolk County	70	66.9	68.7	64.2	66	66.2	68.1	64.6	66.5	65.1	66.9	65.1	66.9	65.2	67	64.5	66.3
360810124	NY	NYC-Queens	71	66.5	68.1	65.7	67.2	67.9	69.5	68.1	69.7	68.9	70.5	68.9	70.5	67.8	69.4	67.5	69.1
421010048	PA	NEW	70	66.3	66.9	66.3	66.9	67.4	68	67.4	68	69.2	69.9	69.2	69.9	67.2	67.8	67.2	67.8
360290002	NY	Amherst	65	65.6	66.3	62.8	63.4	63.5	64.1	63.2	63.8					62.4	63	62.2	62.8
340070002	NJ	Camden-Spruce St	66	66.2	67.6	66.2	67.6	67.6	69.1	67.6	69.1	69.2	70.8	69.2	70.8	67.4	68.9	67.4	68.9
340150002	NJ	Clarksboro	66	65.8	66	65.8	66	66.1	66.4	66.1	66.4	66.6	66.9	66.6	66.9	65.3	65.6	65.3	65.6
440071010	RI	E Providence	65	67.1	70.3	61	63.9	62.1	65.1	62	65					61.9	64.8	61.5	64.4
361030004	NY	Riverhead	69	66.4	67.9	66.8	68.4	68.3	69.8	67.3	68.8	67.7	69.2	67.7	69.3	67.9	69.5	66.8	68.3
440090007	RI	Narragansett	67	66.1	67.8	64.9	66.5	63	64.6	62.1	63.6	63.3	64.9	63.1	64.6	63.1	64.6	61.4	62.9
340230011	NJ	Rutgers U	68	65.7	66	65.7	66	66.7	66.9	66.7	66.9	66.9	67.1	66.9	67.1	66.2	66.4	66.2	66.4

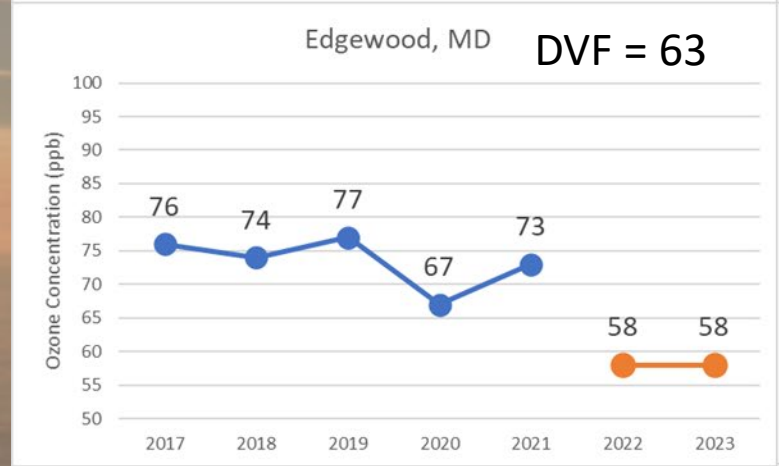
2022 and 2023 4th Highs needed to Meet EPA 2023 Transport Modeling Predictions

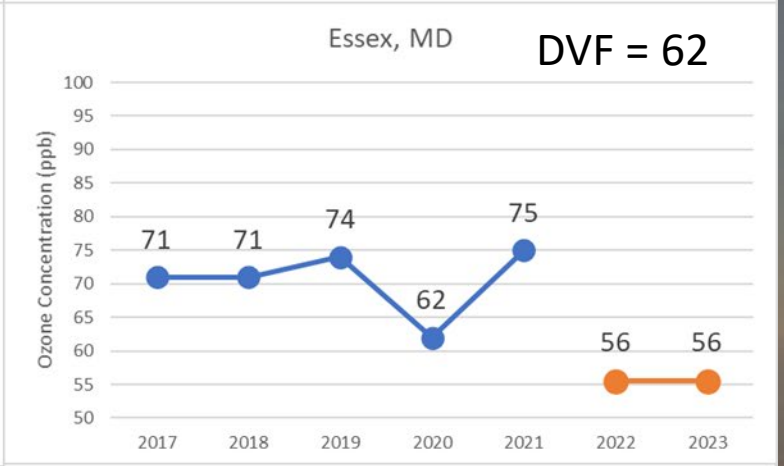
Blue Data is Monitored 4th Maximum

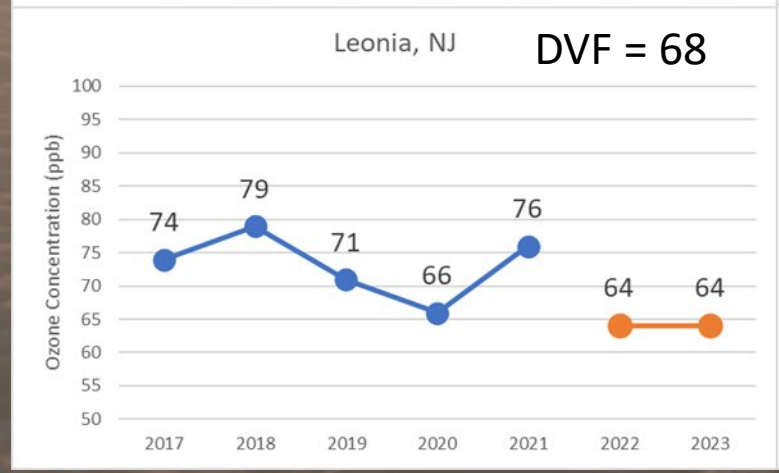
Orange Data is Calculated from Modeled DVF achieved factoring 2021 monitored 4th high as one of 3 data points

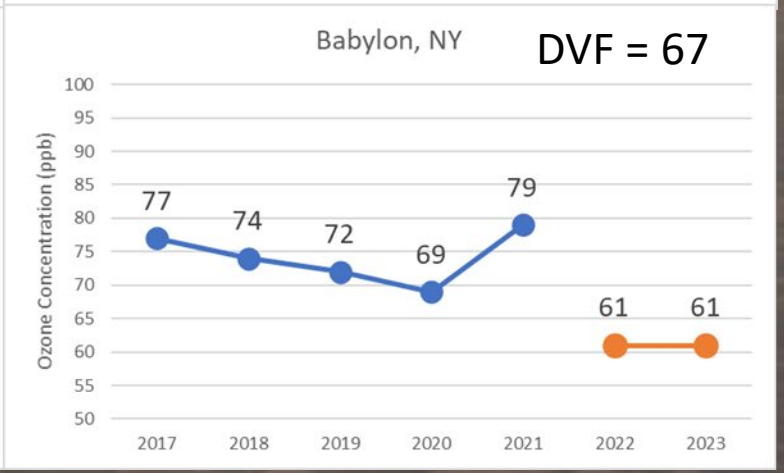












Summary

- Preliminary 2019-21 ozone design values and exceedance days down in most areas from – Some COVID connection?
  - Ozone violations continue from Maryland to Connecticut
  - Modeling for 2023 predicts more improvement than currently monitoring supports in some areas
- 2023 tagged emission modeling shows large day-to-day and hour-to-hour contribution variations, but most important emission sectors are relatively consistent
- Episodic modeling for HEDD is underway using actual hourly 2018/19 NOx emissions
  - Preliminary results indicate electric peaker emission ozone influences of up to 5 ppb (1-day 8-hour) and up to a 1 ppb (DVF)

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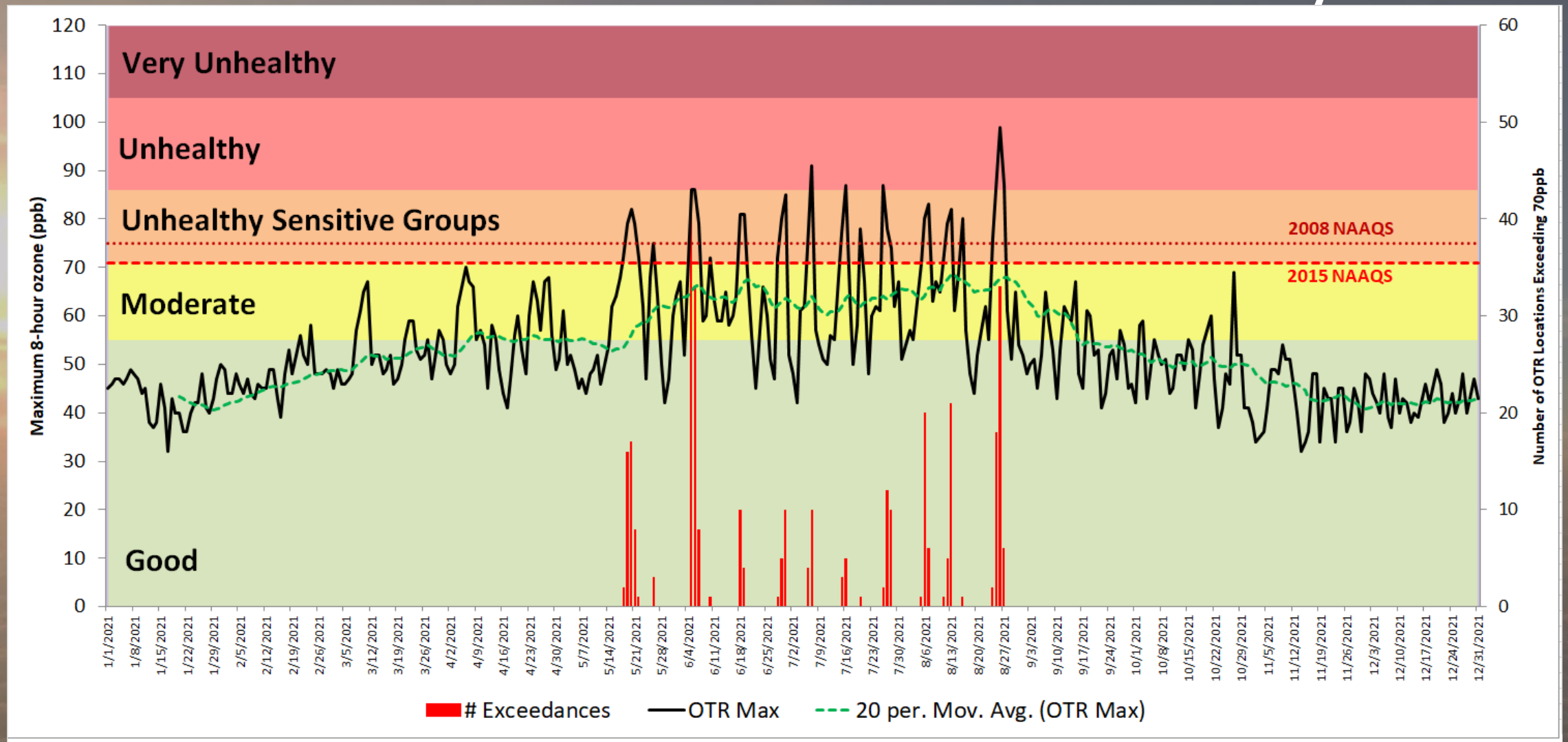
Bonus Slides

2021 Ozone Season - Preliminary



34 days exceeding 70ppb
26 days exceeding 75ppb
9 days exceeding 84ppb

103 different monitors in
56 different monitors in
9 different monitors in

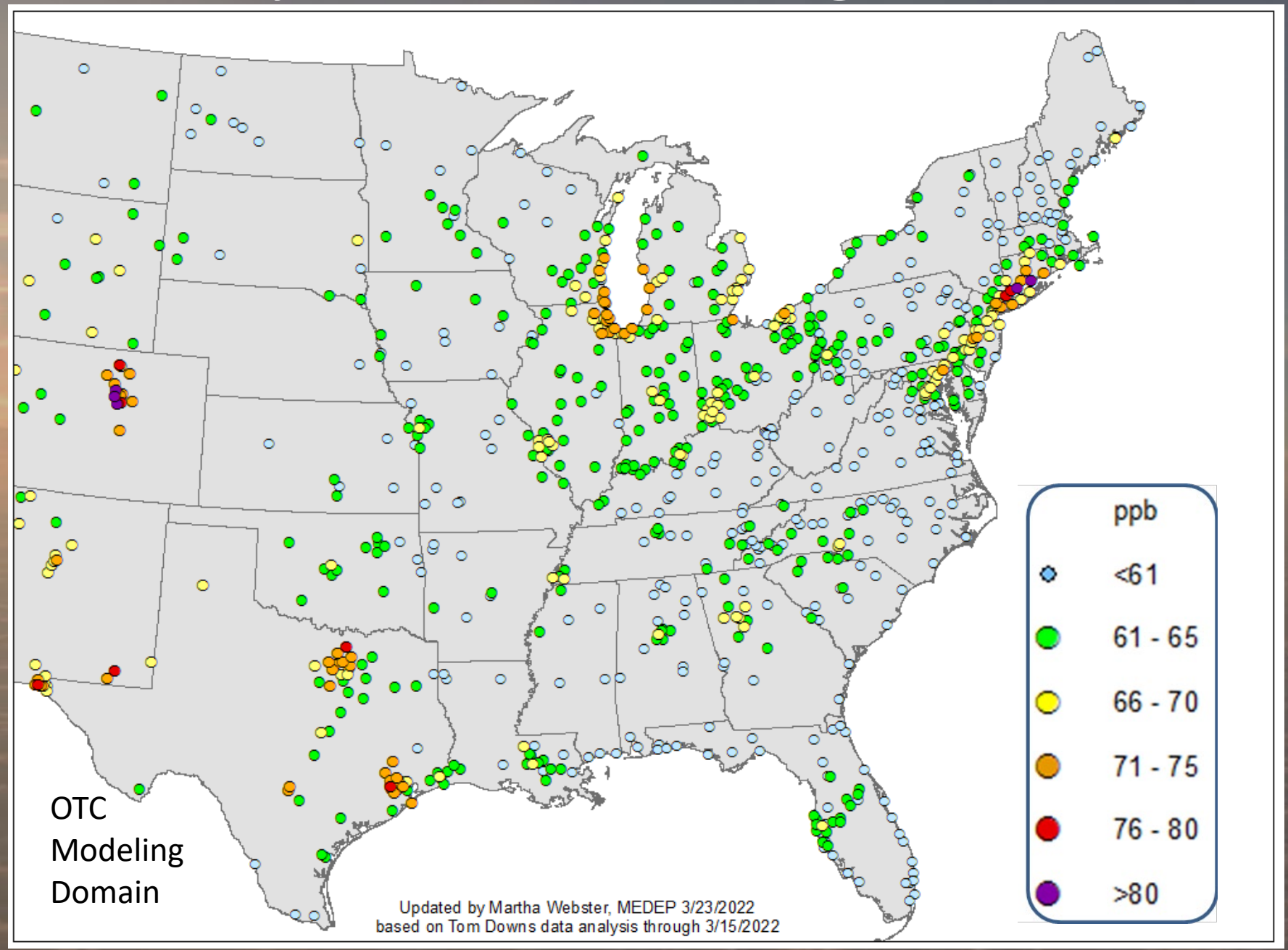
12 states (including DC) exceeded 70ppb
11 states (+DC) exceeded 75ppb
4 states exceeded 84 ppb

2019-2021 Ozone Attainment Status - Preliminary

Nonattainment Area	# Monitors Exceeding in NAA	Specific to Highest Ozone Monitor in Area: High Concentration Monitor Agency	Site Name	AQS Code	Preliminary 2019-21 DV	NAAQS	2021 NonAttainment Area Statistics: Max	Max 2nd High	Max 3rd High	Max 4th High	# Days >NAAQS
Greater CT	1	CT	Groton Fort Griswold	90110124	73	70	82	76	76	75	9
NYC	4	CT	Madison-combined (9002 3002	90099002	82	75	99	89	87	86	25
Philadelphia	2	PA	Bristol	420170012	71	70	86	80	77	77	14
Baltimore	1	MD	Edgewood	240251001	72	70	82	78	78	75	15
Washington	0	MD	Beltsville	240339991	70	70	82	77	74	72	8

All Violating Monitors: AQS Code	Agency	Site Name	Preliminary 2019-21 pDV	NAAQS	2021 Max	2nd High	3rd High	4th High	# Days >NAAQS
90010017	CT	Greenwich	79	75	94	82	78	78	8
90013007	CT	Stratford	81	75	91	87	87	86	8
90019003	CT	Westport	80	75	99	89	87	86	10
90099002	CT	Madison-combined (9002	82	75	89	85	84	83	10
90110124	CT	Groton Fort Griswold	73	70	79	76	76	75	6
240251001	MD	Edgewood	72	70	74	73	73	73	6
420170012	PA	Bristol	71	70	83	80	77	77	10
421010024	PA	NEA	71	70	86	78	74	72	7

Preliminary 2019-2021 Design Values



Draft – OTC Modeling Committee Preliminary

HEDD Episodic Modeling Emission Scenarios

- **Run B** - 2023 Base –All Sectors
- **Run 1** 2016 Part-75 Electric emissions, 2023 other sectors
- **Run 2** (Rebase): 2018/19 Part-75 Electric emissions, 2023 other sectors
- **Run 3** Run 2 base with zero Part-75 Peaking emissions
- **Run 6** Run 2 base with dirtiest Part-75 peaking units dispatched first
- **Run 7** Run 2 base with cleanest Part-75 peaking units dispatched first
- **Run 8** Run 2 base with most frequently operated Part-75 peaking units dispatched first

Runs 4 and 5 are on hold because of data limitations

(More detail included in bonus slides)

Scenarios

- **Run B** (2023 Base): 2023 emission inventory
- **Run 1** 2023 emissions inventory replacing all OTR+VA EGUs and non-EGUs hourly emissions with those from year 2016 (initial base).
- **Run 2** (Rebase): 2023 emission inventory replacing all OTR+VA EGUs and non-EGUs hourly emissions with 2018/19.
- **Run 3** Run 2 base with zero emissions for OTR+VA Part-75 identified peaking electric generating units.
- **Run 4** *Tabled for now due to lack of data availability* Run 2 base with **all** OTR+VA non-Part-75 units set to zero.
- **Run 5** *Tabled for now due to low emission differences*. Run 2 base with **all** OTR+VA non-electric generating units set to zero.
- **Run 6** Run 2 base with Part-75 identified peaking units replaced with dirtiest emitting units dispatched to meet actual 2016 hourly MW capacity by zone.
- **Run 7** Run 2 base with Part-75 identified peaking units replaced with cleanest emitting units dispatched to meet actual 2016 hourly MW capacity by zone.
- **Run 8** Run 2 base with Part-75 identified peaking units replaced based with most frequently (2018/19) operated peaking units dispatched to meet actual 2016 hourly MW capacity by zone.

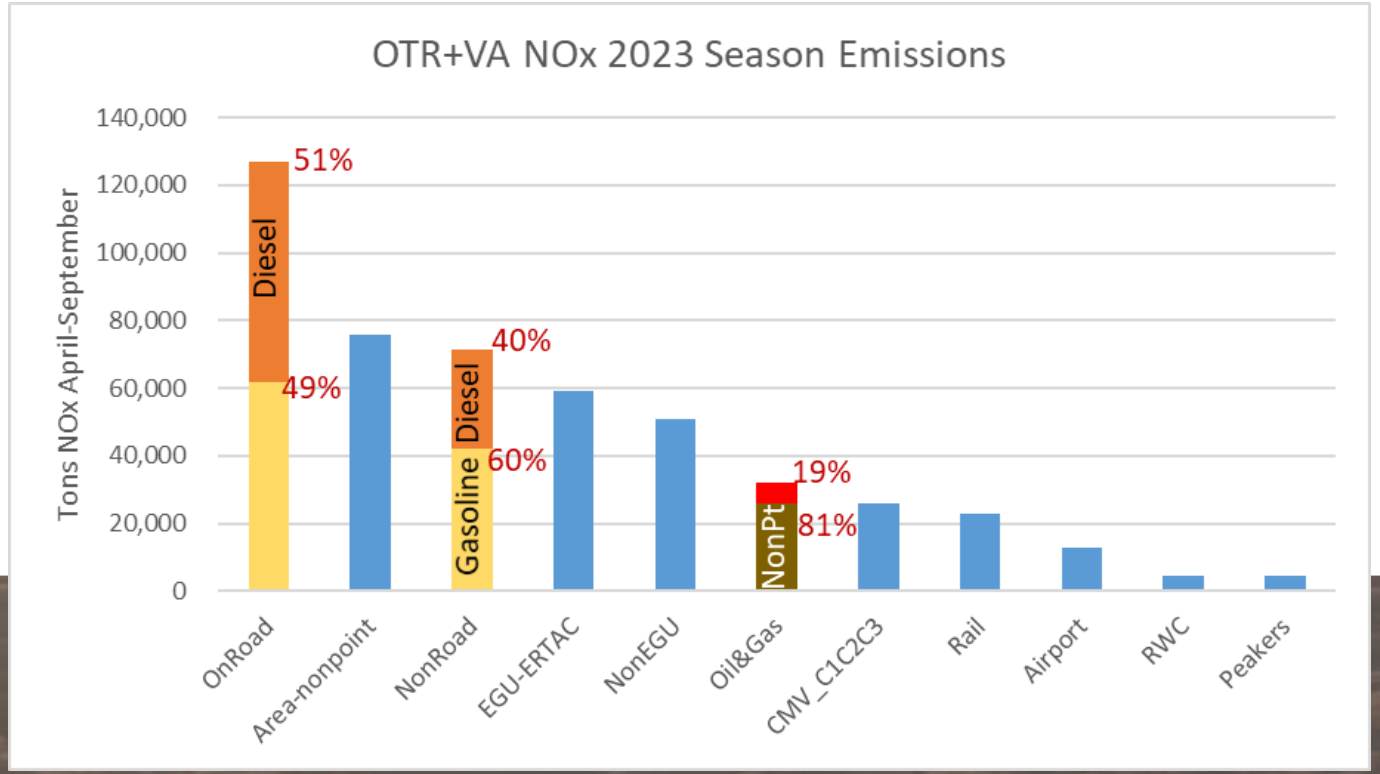
Preliminary Emission Sector Contributions to OTR

Top Emission Sectors (almost always significant in OTR):

- Area
- OnRoad – NonDiesel
- OnRoad – Diesel
- NonRoad – NonDiesel
- NonRoad – Diesel
- EGU
- NonEGU
- Oil & Gas
- Rail
- Airport

Sometimes Significant Emission Sectors

- Commercial Marine Vessels
- EGU Peakers

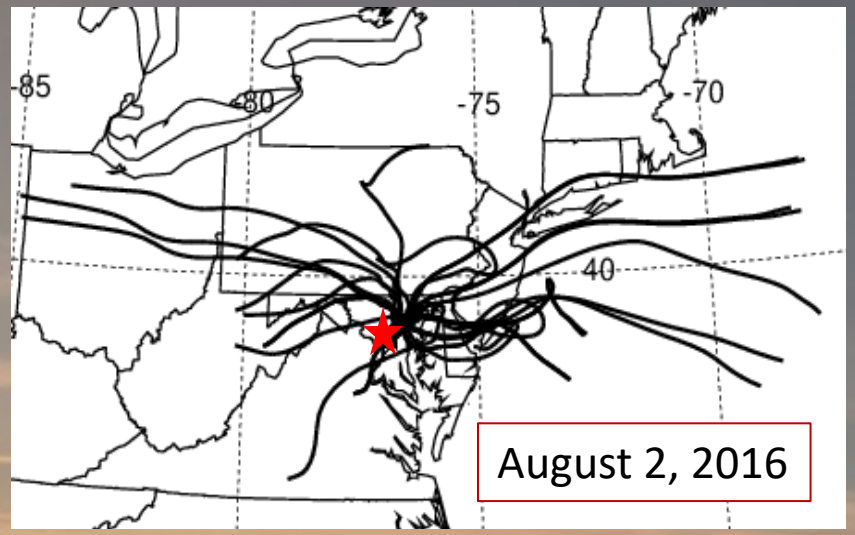


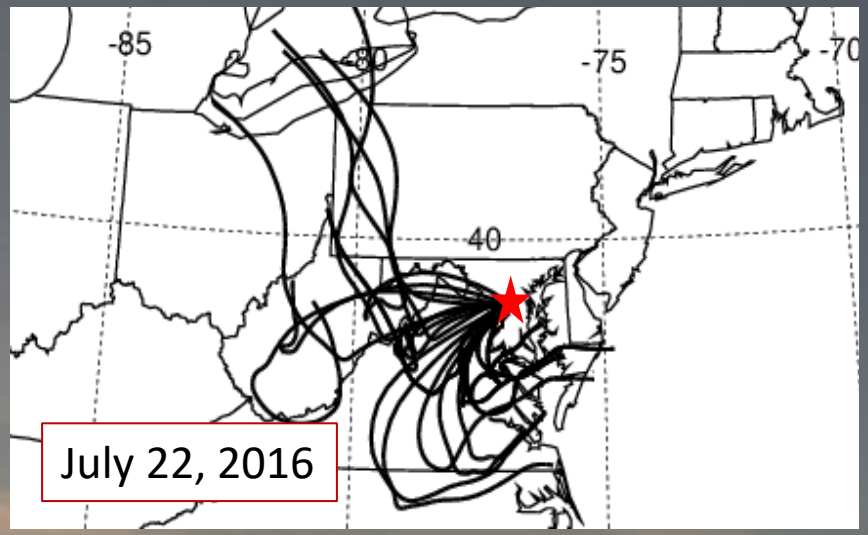
Variability

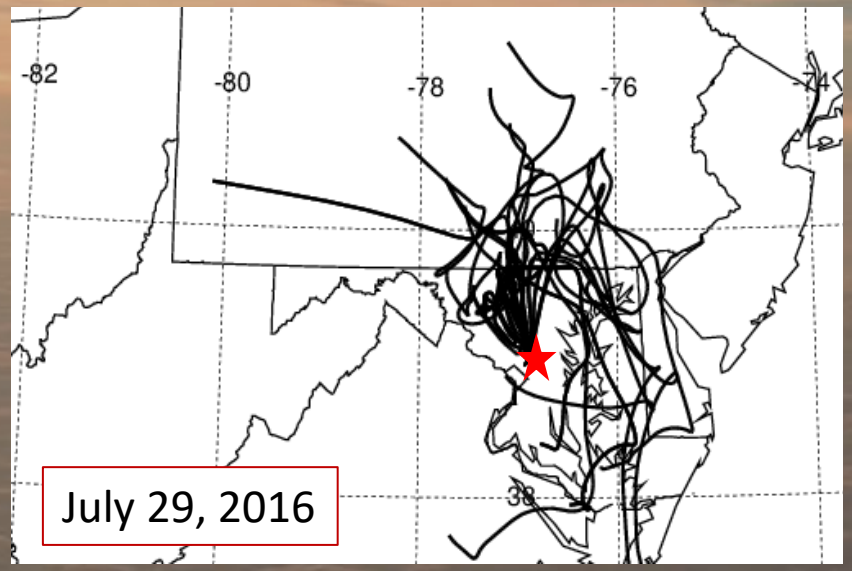
Variability
Day-to-Day
Hour-to-Hour

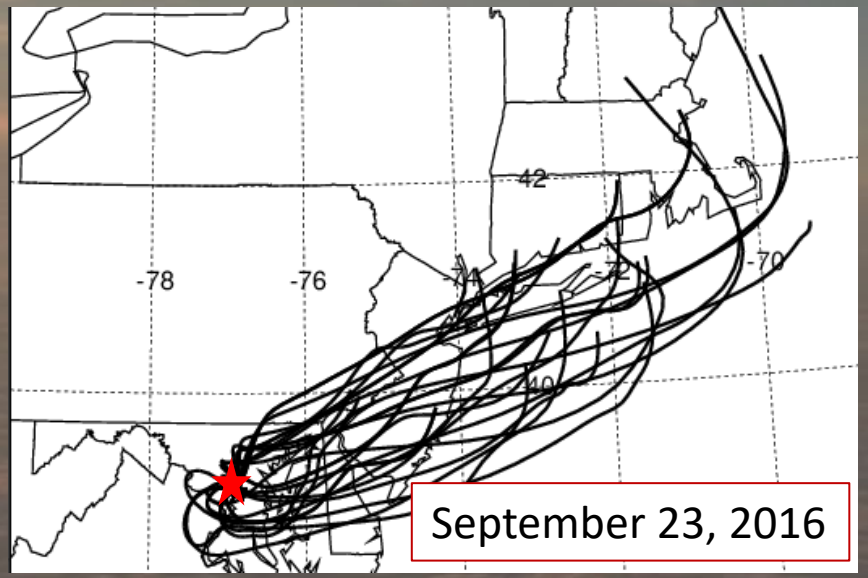
Beltsville, MD
4 High Ozone Days with very different wind patterns

Who is the significant contributor?









Summary Detail of Contribution Modeling

- OTC 2016 Modeling Platform – April 1- September 30
- APCA source apportionment using CAMx_v7.1, CB6r5, WRF_v3.8, & WRFCAMx_v4.6
- Collaborative projected 2023 (fi) emission inventory with BEISv3.61 and ERTAC 16.1
- OTC2 domain (273 e-w x 246 n-s x 35 vertical grid volumes)
- Emissions tagged for 24 emission sectors and 41 states plus the District of Columbia (322 total tags)
- Ozone contributions calculated for each emission tag for every hour of the ozone season
- Some summary discussions consider contributions for the highest 8-hour consecutive period for each day, while others look at the hourly detail

➢ Large variations in hourly ozone contributions on high ozone days are common and often are averaged out when summarizing data over longer durations

❖ How important are these short-term high contributions?