

FILLING MISSING OZONE DATA

OLM and PVMRM Applications

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OZONE AND NO₂ MODELING

- Ozone currently used in regulatory modeling of NO₂
- NO reacts with ambient ozone to produce NO₂



- AERMOD employs two methods that use ozone data to calculate potential NO₂ concentrations:
 - The Ozone Limiting Method (OLM)
 - The Plume Volume Molar Ratio Method (PVMRM)

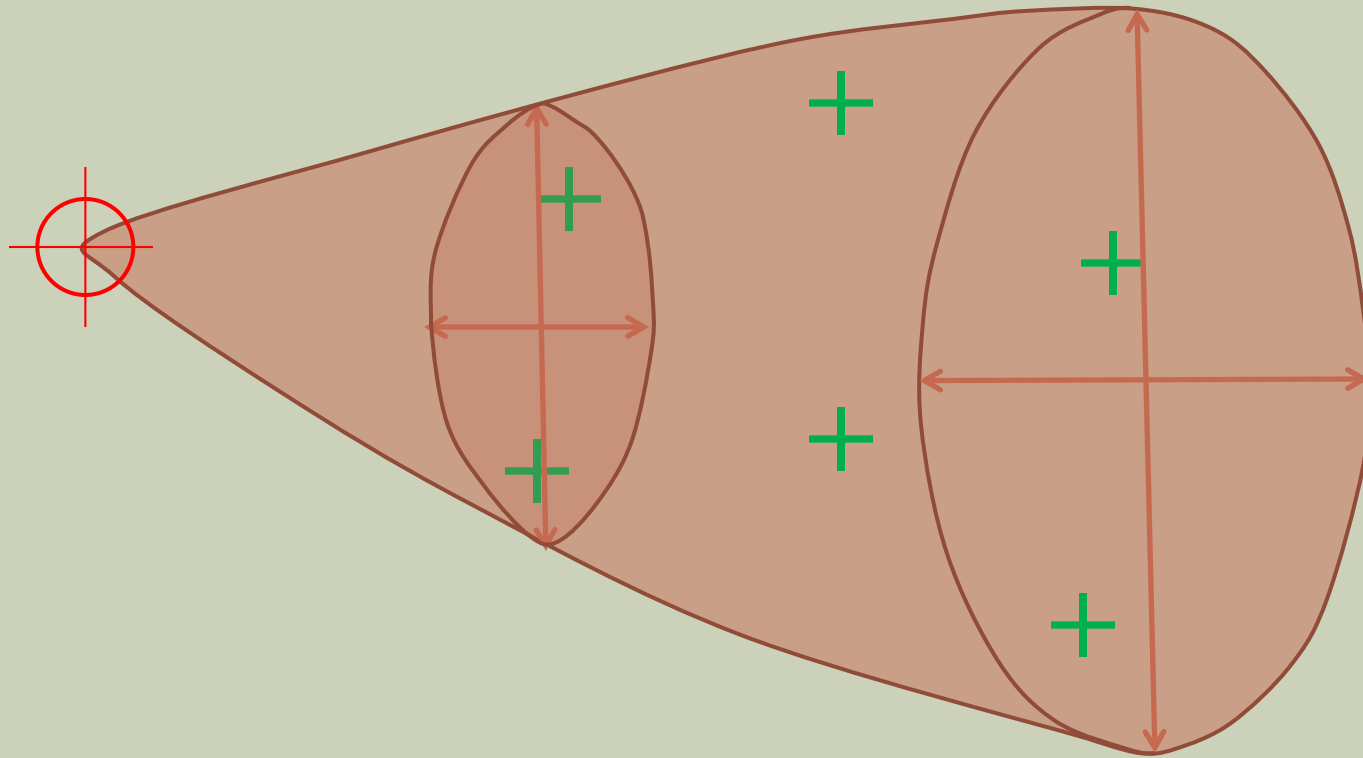
OZONE AND NO₂ MODELING - OLM

Is NO_x Concentration > Ambient O₃ Concentration?



*Assumes all ambient ozone available for conversion of NO to NO₂. With multiple sources can introduce some competition for ozone with OLMGROUP ALL

OZONE AND NO₂ MODELING – PVMRM



***Plume volume at each receptor determines amount of available ambient ozone for conversion. Also, merged plumes compete for available ozone.**

THE PROBLEM

Hourly ozone isn't recorded seamlessly...



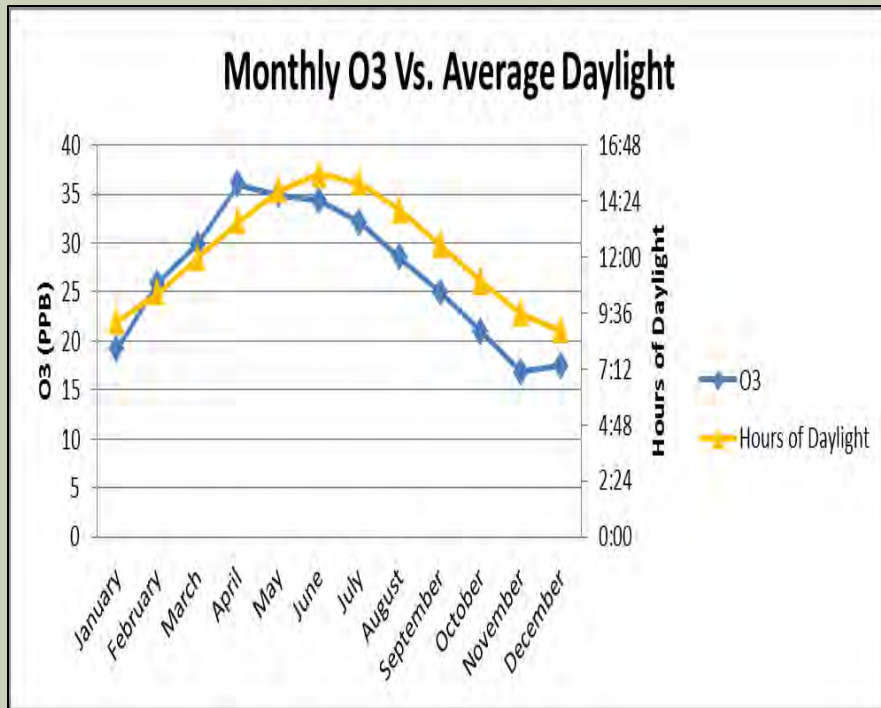
JUNE 28TH, 2010 EPA MEMO

- “Methods used to substitute for periods of missing data may play a more significant role in determining the 1-hour NO₂ modeled design value and should therefore be given greater scrutiny...”
- Ozone data must be concurrent with meteorological data for OLM and PVMRM

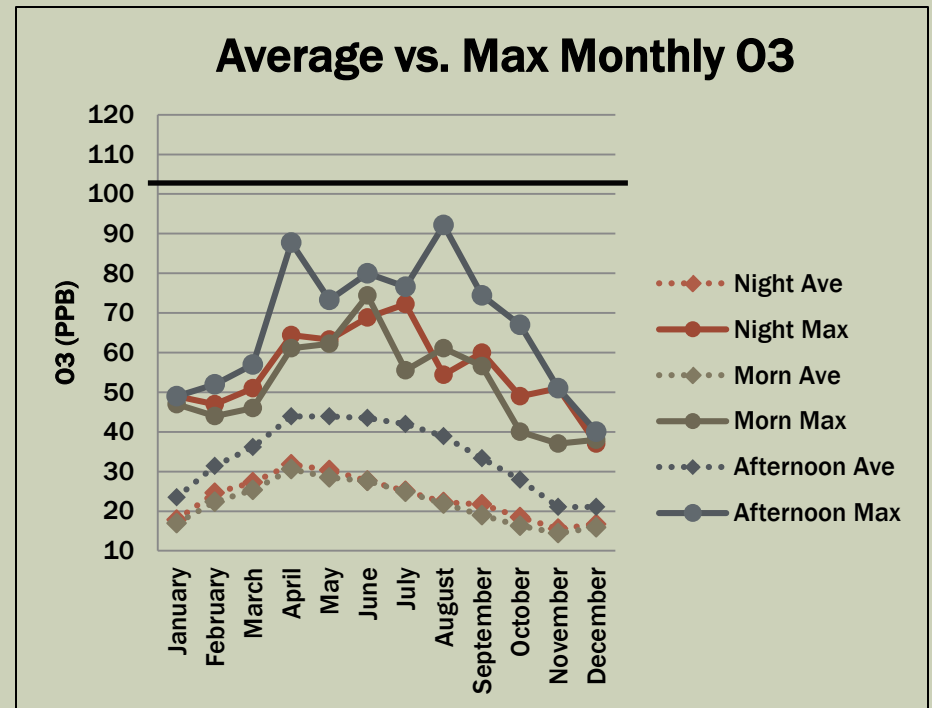


OZONE BEHAVIOR AND PAST PRACTICE

Seasonal Cycle



Diurnal Cycle



1) Not Representative

2) Not Concurrent (Met data 2006-2010, OZONEVAL more recent year)

RECENT PRACTICES – OTHER STATES

- Every method handled data gaps in preprocessing.

Small Gaps - Interpolation

	4 Hours	3 Hours	1 Hour
Michigan (2010)	X		
Florida (2010)		X	
California (2010)			X
California (2011)			X
Florida (2013)		X	

RECENT PRACTICES – OTHER STATES

- Every method handled data gaps in preprocessing.

Large Gaps – Varying Techniques

	Period H1H	Max Annual	Max Seasonal	Max Monthly	Month/hour max	Nearby Monitor	Day Before/After	Monthly Ave.
<u>MICHIGAN (2010)</u>				X				
<u>FLORIDA (2010)</u>							X	
<u>CALIFORNIA (2010)</u>						X		
<u>SOUTH DAKOTA (2011)</u>								X
<u>CALIFORNIA (2011)</u>		X	X	X	X			
<u>ARIZONA (2012)</u>					X			
<u>FLORIDA (2013)</u>							X	
<u>ARIZONA (2013)</u>	X		X	X	X			

NEW STRATEGY FOR MN

- Gaps filled during preprocessing

Small Gaps (1hr) - Interpolation

	Year	Month	Day	Hour	(ppm)	(ppb)
142	6	1	6	22	0.008	8
143	6	1	6	23	0.016	16
144	6	1	6	24	0.018	18
145	6	1	7	1	0.019	19
146	6	1	7	2	0.021	21
147	6	1	7	3	-99	-99000
148	6	1	7	4	0.02	20
149	6	1	7	5	0.019	19
150	6	1	7	6	0.018	18
151	6	1	7	7	0.014	14
152	6	1	7	8	0.013	13

Hour 2 = 21

Hour 4 = 20

$\frac{21 + 20}{2} = 20.5$ *After rounding, Hour 3 should be replaced with 21*

NEW STRATEGY FOR MN

- Gaps filled during preprocessing

Larger Gaps (>1hr) – Replace with Max Month/Hour Value

Year	Month	Day	Hour	(ppm)	(ppb)
10	1	24	8	0.037	37
10	1	24	9	0.037	37
10	1	24	10	0.036	36
10	1	24	11	0.035	35
10	1	24	12	0.035	35
10	1	24	13	0.034	34
10	1	24	14	-99	-99000
10	1	24	15	-99	-99000
10	1	24	16	-99	-99000
10	1	24	17	0.04	40
10	1	24	18	0.041	41
10	1	24	19	0.042	42
10	1	24	20	0.042	42
10	1	24	21	0.043	43

Now we find the max hourly values for January hours 14, 15, and 16

NEW STRATEGY FOR MN

- Gaps filled during preprocessing

Larger Gaps (>1hr) – Replace with Max Month/Hour Value

Hour	January	February	March	April	May	June	July	August	September	October	November	December
1	44	44	45	60	60	60	61	50	59	43	44	37
2	45	43	46	59	57	59	58	49	58	38	44	37
3	44	42	46	58	56	60	57	50	56	36	43	37
4	46	42	44	58	52	60	56	51	50	37	42	36
5	45	42	43	57	52	56	51	52	48	30	40	36
6	49	42	44	54	57	58	53	52	44	37	38	35
7	47	42	44	51	62	57	50	52	46	38	36	36
8	46	41	42	47	54	53	48	43	44	39	37	37
9	46	41	42	49	57	60	50	44	46	38	37	37
10	46	43	44	53	57	70	53	52	52	40	37	37
11	45	44	46	61	60	74	56	61	57	38	37	38
12	44	46	48	68	68	76	63	63	60	44	38	39
13	48	47	49	69	72	78	71	72	61	52	43	40
14	49	49	51	70	72	79	72	87	63	58	46	40
15	48	49	57	70	72	77	70	92	64	63	47	40
16	47	52	57	86	73	77	74	90	69	67	47	39
17	45	51	57	88	72	80	76	86	74	64	43	36
18	46	49	56	74	72	78	77	66	70	54	45	36
19	46	47	52	76	70	73	71	63	58	49	50	37
20	47	41	51	71	66	70	61	54	54	45	51	37
21	49	43	47	64	63	69	60	53	54	42	47	36
22	49	43	48	62	60	69	72	54	58	41	44	35
23	45	42	47	60	58	68	66	54	58	45	43	36
24	45	44	45	56	59	62	63	52	60	44	45	37
Max	49	52	57	88	73	80	77	92	74	67	51	40

MPCA generated table shows max monthly/hourly values

NEW STRATEGY FOR MN

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Larger Gaps (>1hr) – Replace with Max Month/Hour Value

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10	1	24	11	0.035	35
10	1	24	12	0.035	35
10	1	24	13	0.034	34
10	1	24	14	-99	-99000
10	1	24	15	-99	-99000
10	1	24	16	-99	-99000
10	1	24	17	0.04	40
10	1	24	18	0.041	41
10	1	24	19	0.042	42
10	1	24	20	0.042	42
10	1	24	21	0.043	43

Annotations: Red arrows point to the (ppb) values for hours 14, 15, and 16, which are labeled 49, 48, and 47 respectively.

Still protective but much more representative of seasonal and diurnal reality

EFFECTS OF OZONE SUBSTITUTION: DOES IT MATTER?

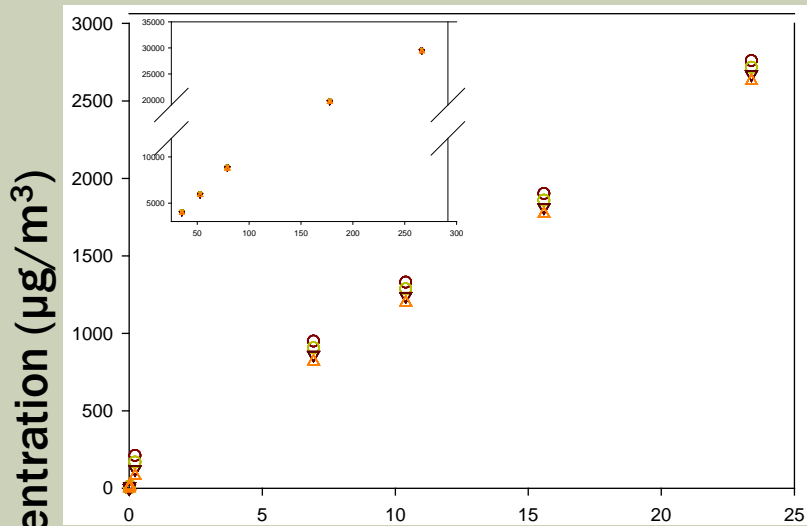
2006-10

Distribution of Monitor Data	OZONE (O ₃)
	(PPB)
Min	30
25 th quartile	53
75 th quartile	77
Max	100

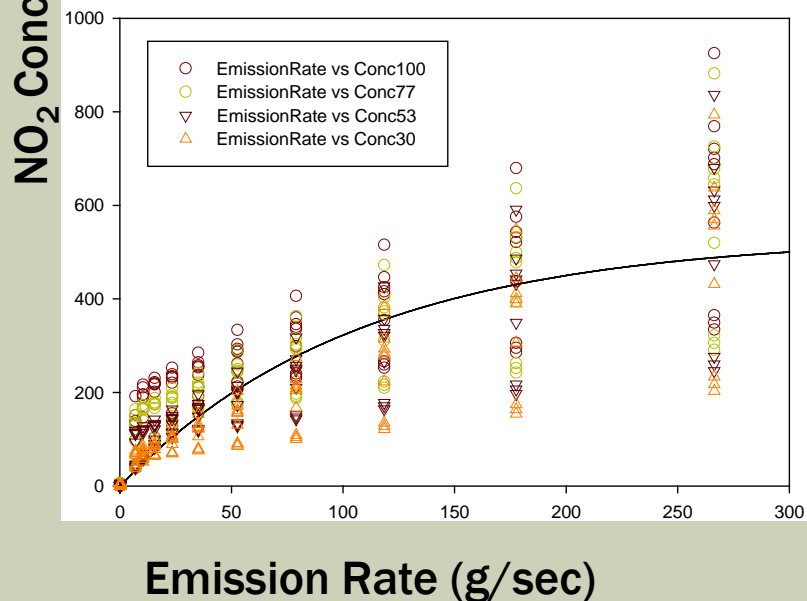
Method

- Model: AERMOD v12345
 - No Downwash
 - No Terrain
 - MSP Met data
 - NO₂ Model: OLM
- Baseline
 - 1053 stack configurations
 - NO → NO₂ = 100%
 - Time and Location of modeled maximum [NO₂]
- Ozone Substitution
 - Rerun Model at all [O₃]

STATISTICAL SIGNIFICANCE



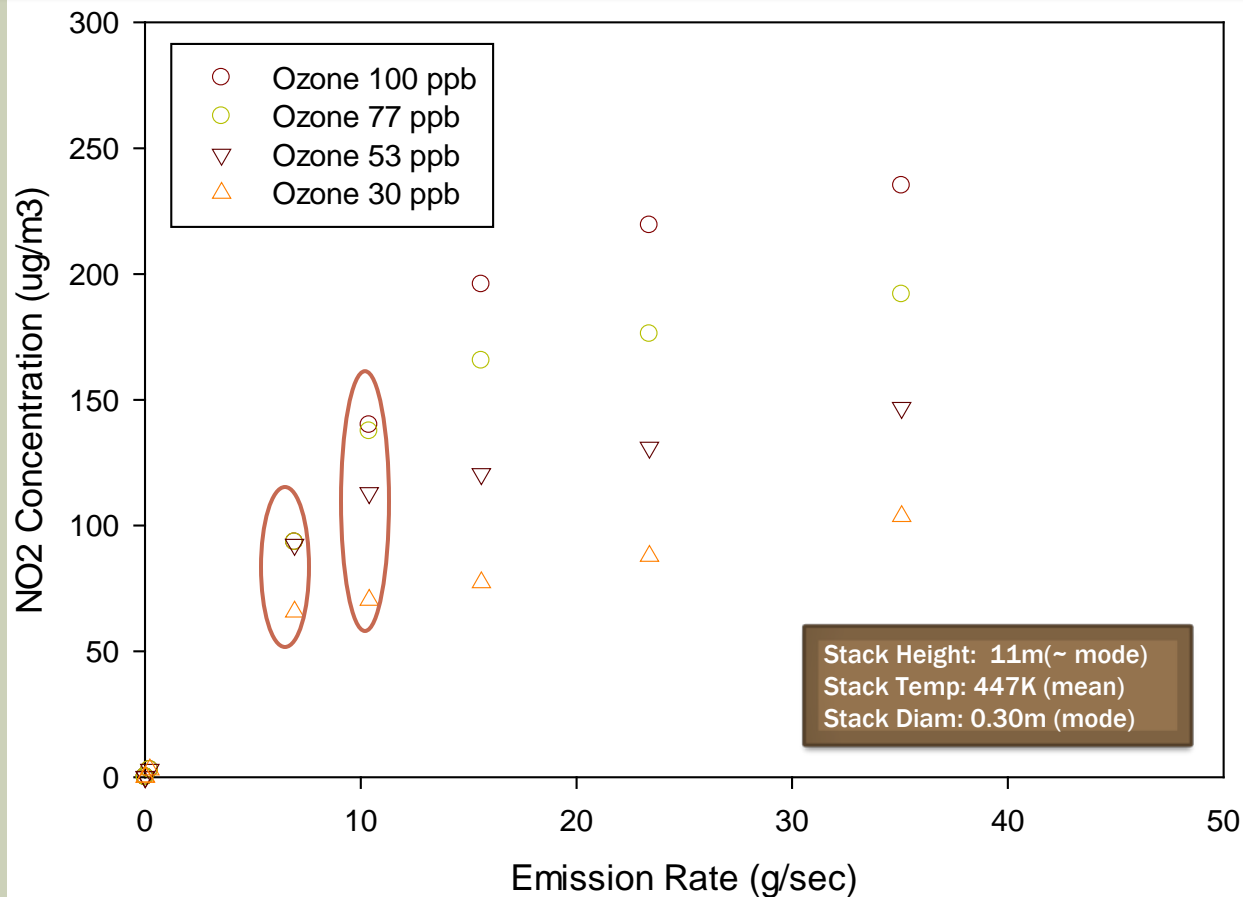
“Worst Case” Stack Parameters



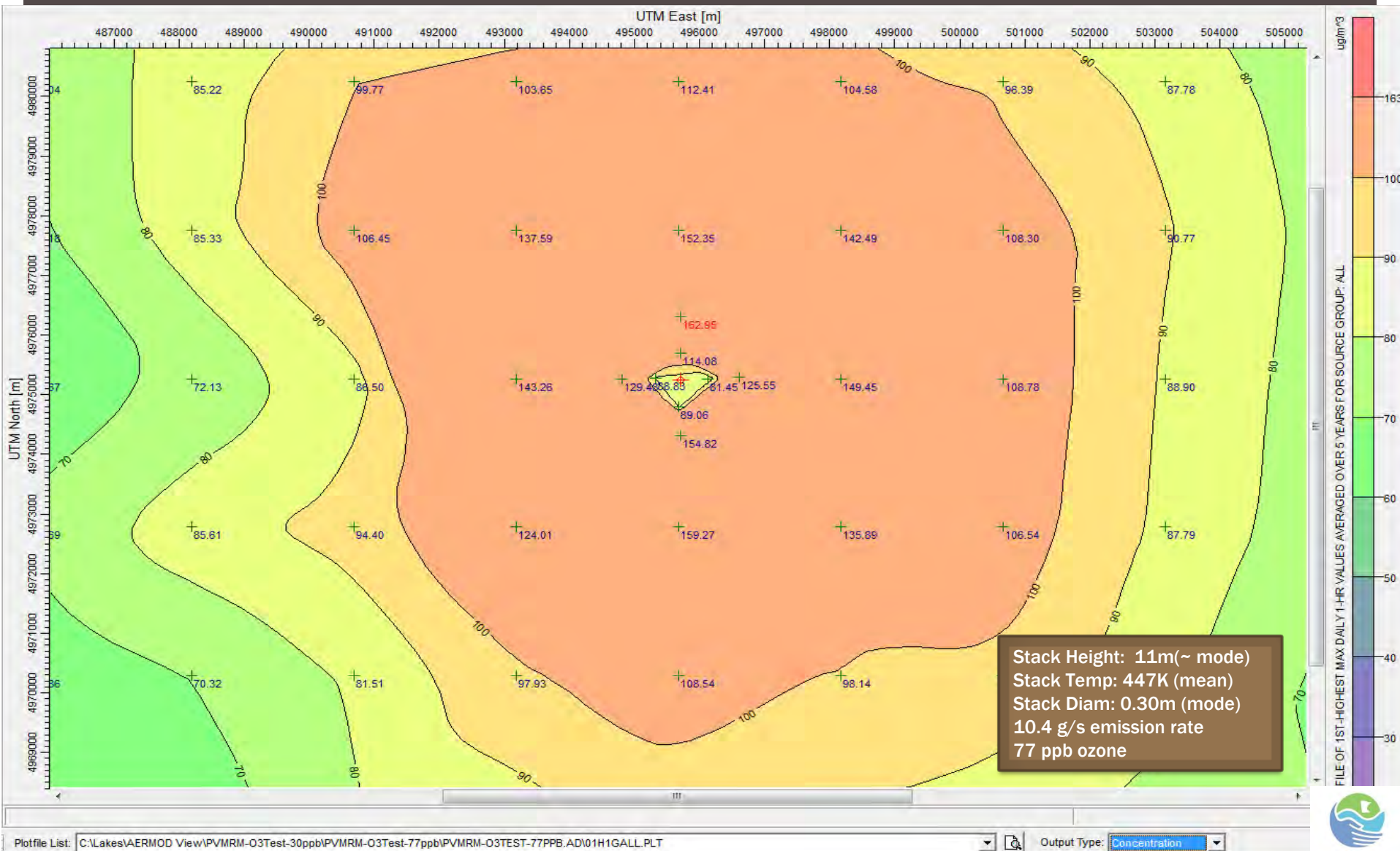
“Best Case” Stack Parameters

PRACTICAL SIGNIFICANCE - OLM

- ER = 6.93 g/sec
 - Substituting $O_3=77$ ppb for $O_3=30$ ppb yields a **27.7 $\mu\text{g}/\text{m}^3$** difference in NO_2 modeled concentration
- ER = 10.4 g/sec
 - Substituting $O_3=77$ ppb for $O_3=30$ ppb yields a **69.7 $\mu\text{g}/\text{m}^3$** difference in NO_2 modeled concentration



PRACTICAL SIGNIFICANCE – PVMRM

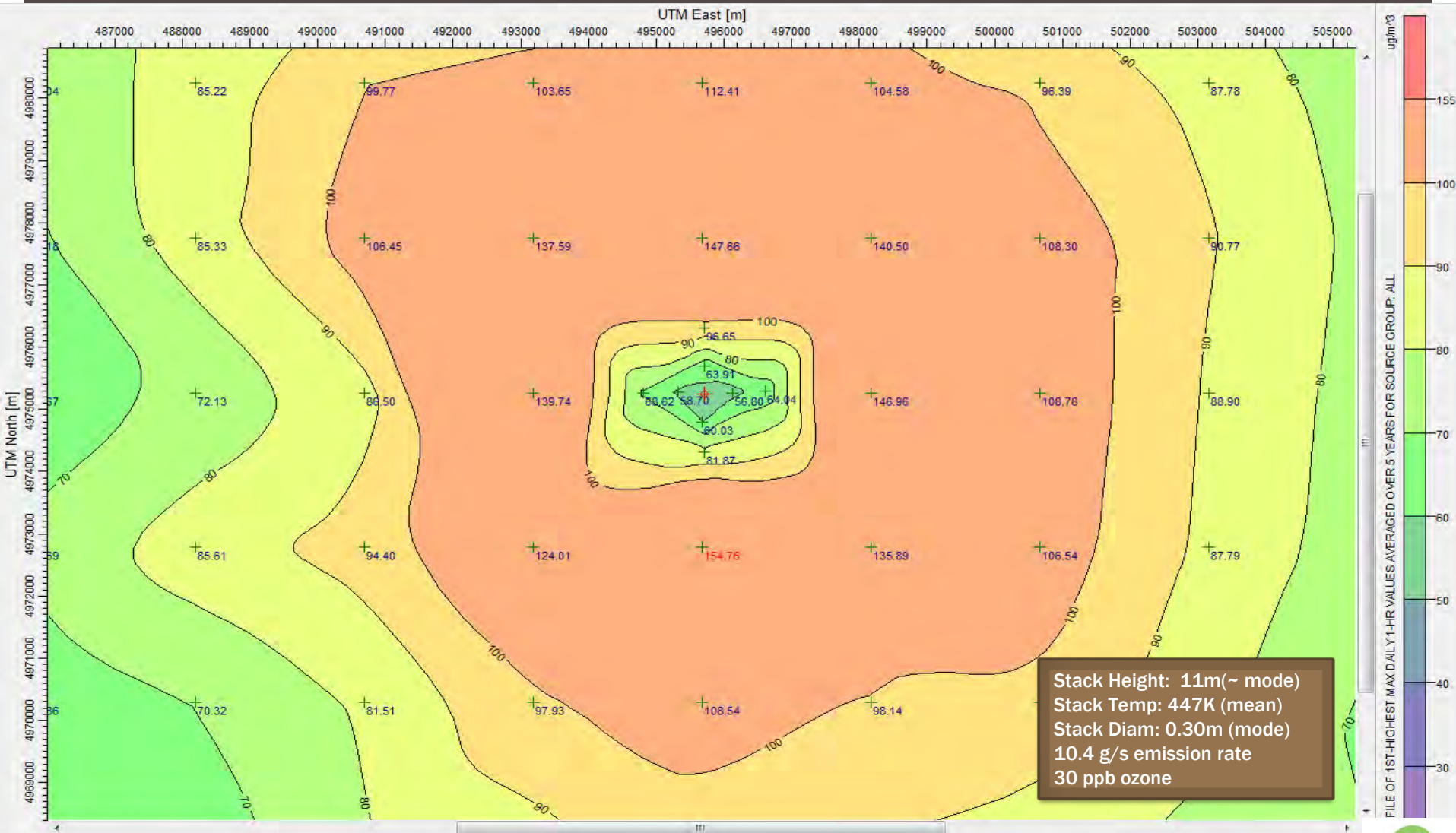


Stack Height: 11m (~ mode)
Stack Temp: 447K (mean)
Stack Diam: 0.30m (mode)
10.4 g/s emission rate
77 ppb ozone

FILE OF 1ST-HIGHEST MAX DAILY 1-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL



PRACTICAL SIGNIFICANCE – PVMRM



EFFECTS OF OZONE SUBSTITUTION: DOES IT MATTER?

- Yes

- If the max is occurring on an hour with missing ozone data
- Depending on stack parameters and emission rate can cause significant differences in concentrations, both statistical and practical.

NEXT STEPS

- EPA region 5 has reviewed and deemed this approach reasonable
 - Sent to EPA Headquarters in case of comments, none received
- MPCA recommends using this technique
 - PSD and Non-PSD
 - Met our goal of automating the missing hour filling process (Oct 2014)
 - AERMOD ready pre-processed hourly ozone files with missing hours filled available for all ozone monitors in Minnesota.

[REQUEST AT: AIRMODELING.PCA@STATE.MN.US](mailto:AIRMODELING.PCA@STATE.MN.US)

- Next goal to get files posted on MPCA website.

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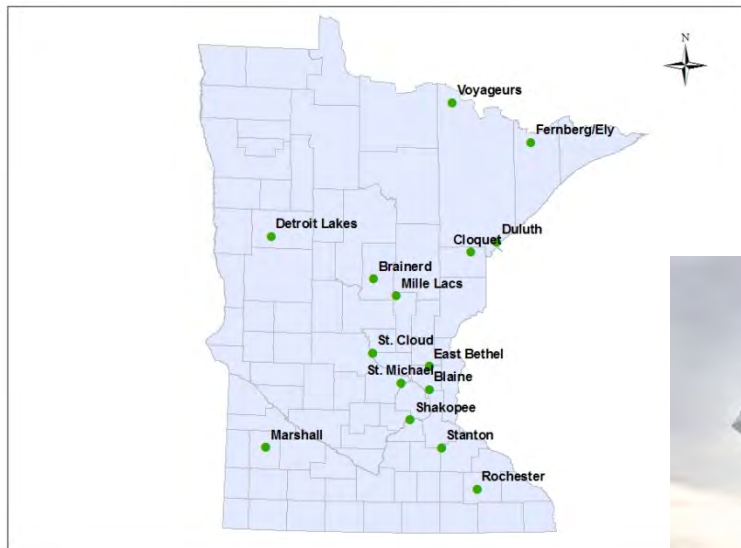
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QUESTIONS?

Ozone Monitors



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