Background Surface Ozone Comments on the Health REA

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Background Ozone Affects Various Elements of Risk

- Diurnal patterns of background levels are too low based on the rollback methodology.
- The CMAQ/HDDM model employed in the second version of the REA may also underestimate the contribution of background O_3. If the model does not contain modules that can adequately address natural processes that contribute to background, such as stratospheric-tropospheric exchange, estimates of U.S. background levels will likely be subject to great uncertainties, which in turn, will affect risk estimates.

Background Ozone Affects Various Elements of Risk

- Using the Heat Map table (Table 7-9), 9 of the 12 cities are predicted by EPA to experience approximately 50% or more of O_3-related all-cause mortality based on epidemiological results for daily 8-h maximum O_3 levels between 25 and 50 ppb. Measured background O_3 concentrations are in the range of 25 to 50 ppb and at times, higher.
- The REA illustrates the probabilistic exposure-response relationships for FEV_1 decrement $\geq$ 10%. Although the probability of a response below 50 ppb is low, a large fraction of the population is estimated to be exposed to these low O_3 concentrations, which represent background.
- Lowest Measured Level (LML) values appear to be well below background levels.

Background O_3 Affects Absolute as Well as Delta Risk Values

- If background O_3 were in the 25-50 ppb range as indicated from empirical data, the ***absolute*** risk values in this range of concentrations would be lower and as a result, the total risk associated with (1) the recent conditions and (2) just meeting the current standard would be lower.
- The effect on the deltas if background O_3 were in the 25-50 ppb range would also more than likely result in considerably lower values.
- There is a tendency for the deltas to be higher for those cities that are predicted by the EPA to experience higher mortality under current conditions (i.e., Atlanta, Boston, Houston, Los Angeles, and New York) than the cities predicted to exhibit lower mortality (i.e., St. Louis, Baltimore, Cleveland, Denver, Detroit, Philadelphia, and Sacramento).
- This implies that estimates of background levels affect both the absolute as well as the delta calculations.

Background O_3 is an Important Underpinning of the Risk Estimates

- By removing the focus on the uncertainty associated with estimating background, the Agency provides greater credence to the predicted clinical and epidemiological risk estimates than is deserved.
- Without adequately discussing in the REA the uncertainties in estimating hourly average background O_3 concentrations, readers will focus on the magnitude of the absolute and difference values of the risk estimates.
- It is extremely important that the magnitude of the risk estimates be evaluated simultaneously with the large uncertainties associated with estimating U.S. background concentrations.

Lowest Measured Level (LML) Values Are Below Background

Table 7-5 Composite Monitor O_3 LML Used in Defining Ranges of Increased Confidence in Modeling Risk

Urban Study Area	8r max (city-specific O_3 season) ppb	8hr mean (reflects June-August levels) ppb
Metrics Based on 2007 Composite Monitors		
Atlanta	17	24
Baltimore	13	13
Boston	12	19
Cleveland	12	6
Denver	4	21
Detroit	13	19
Houston	6	10
Los Angeles	9	31
New York	10	10
Philadelphia	13	12
Sacramento	13	30
St. Louis	8	22
Metrics Based on 2009 Composite Monitors		
Atlanta	5	21
Baltimore	9	24
Boston	12	17
Cleveland	15	16
Denver	16	22
Detroit	14	11
Houston	7	15
Los Angeles	8	22
New York	8	12
Philadelphia	9	14
Sacramento	5	30
St. Louis	7	22

Heat Map Table and O_3 Background

Table 7-9 Heat Map Table: Short-Term O_3 Exposure-Related All-Cause Mortality – Recent Conditions (2007) (Bell et al, 2004 C-R functions) (illustrates distribution of O_3-related all-cause mortality across distribution of daily 8hr max O_3 levels for each urban study area – colors in cells reflect size of mortality estimate)

	Daily 8hr Max Ozone Level (ppb)																
Study area	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	>75	Total
Atlanta, GA	0	0	0	0	1	3	10	13	17	22	42	51	39	40	34	52	323
Baltimore, MD	0	0	0	0	2	4	6	14	14	14	14	10	16	4	5	3	106
Boston, MA	0	0	0	0	6	20	26	32	43	39	23	33	13	26	19	26	307
Cleveland, OH	0	0	0	0	1	5	7	13	13	15	14	9	6	10	7	7	109
Denver, CO	0	0	0	0	1	1	2	3	5	6	6	6	2	1	0	0	32
Detroit, MI	0	0	0	0	1	2	6	9	13	17	5	10	6	6	5	13	94
Houston, TX	0	0	2	7	18	23	34	30	26	28	21	15	9	19	12	2	244
Los Angeles, CA	0	0	1	10	26	41	69	66	99	87	103	88	46	40	24	27	729
New York, NY	0	0	0	15	22	60	69	70	99	60	49	40	50	73	27	23	658
Philadelphia, PA	0	0	0	0	1	4	6	10	11	11	12	11	11	8	7	7	98
Sacramento, CA	0	0	0	1	3	5	9	14	14	19	17	8	8	3	4	4	110
St. Louis, MO	0	0	0	0	1	3	8	14	18	16	24	21	24	10	9	25	174

Table 7-10 Heat Map Table: Short-Term O_3 Exposure-Related All-Cause Mortality – Simulation of Meeting the Current Standard (2007) (Bell et al., 2004 C-R functions) (illustrates distribution of O_3-related all-cause mortality across distribution of daily 8hr max O_3 levels for each urban study area – colors in cells reflect size of mortality estimate)

	Daily 8hr Max Ozone Level (ppb)																	
Study area	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	>75	Total	Delta
Atlanta, GA	0	0	0	0	2	5	12	18	21	57	43	45	29	16	6	4	260	63
Baltimore, MD	0	0	0	0	3	4	10	15	15	15	14	8	5	2	0	0	90	16
Boston, MA	0	0	0	1	8	23	24	48	26	39	32	14	26	24	7	11	282	26
Cleveland, OH	0	0	0	1	2	5	11	13	16	14	10	9	9	5	2	2	98	11
Denver, CO	0	0	0	0	1	1	3	3	7	7	5	2	0	0	0	0	30	3
Detroit, MI	0	0	0	0	1	3	7	10	17	9	9	7	7	6	6	4	86	8
Houston, TX	0	0	2	8	22	24	37	31	28	21	12	18	11	1	0	0	217	27
Los Angeles, CA	0	0	2	17	35	64	70	119	113	81	44	15	7	0	0	0	567	162
New York, NY	0	0	1	13	31	69	76	103	55	63	50	66	44	0	13	0	585	73
Philadelphia, PA	0	0	0	0	2	5	8	12	12	12	8	11	5	2	1	2	82	16
Sacramento, CA	0	0	0	1	3	7	15	14	21	13	8	5	3	0	1	0	90	20
St. Louis, MO	0	0	0	0	2	4	10	20	16	23	24	21	12	12	10	4	157	17

Nine of the 12 cities were predicted to experience approximately 50% or more of O_3-related all-cause mortality for daily 8-h maximum O_3 levels between 25 and 50 ppb.

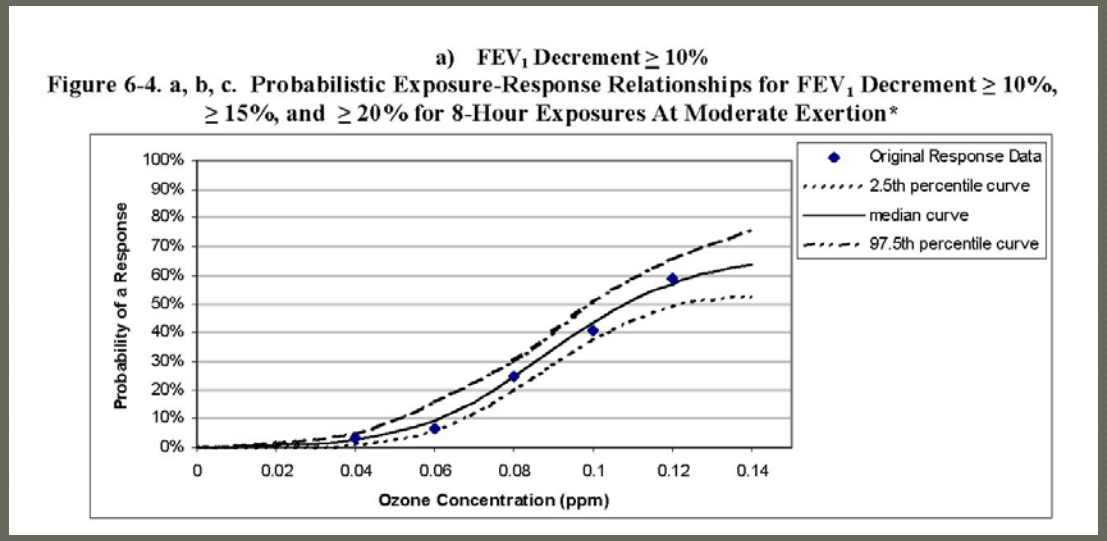
Estimates of All-Cause Mortality and O_3 Background

Table 1. Summary O_3-related all-cause mortality across daily 8-h maximum O_3 levels of 25-50 ppb for each urban study area under recent conditions that is based on the EPA's Heat Map analysis presented in Table 7-9.

City	O_3-related all-cause mortality	Percent of Total
Atlanta, GA	65	20%
Baltimore, MD	52	49%
Boston, MA	160	52%
Cleveland, OH	53	49%
Denver, CO	17	53%
Detroit, MI	47	50%
Houston, TX	141	58%
Los Angeles, CA	362	50%
New York, NY	358	54%
Philadelphia, PA	42	43%
Sacramento, CA	61	56%
St. Louis, MO	59	34%

Nine of the 12 cities were predicted to experience approximately 50% or more of O3-related all-cause mortality for daily 8-h maximum O3 levels between 25 and 50 ppb.

Probabilistic Exposure-Response for FEV_1 and O_3 Background



Although the probability of a response below 50 ppb is low, a large fraction of the population is estimated to be exposed to these low O_3 concentrations (US EPA, 2012a).Should the range of O_3 concentrations associated with U.S. background actually be much greater than predicted by the CMAQ model, then the risk predicted using clinical study results for the large fraction of the population may not be able to be reduced if reductions in emissions were to occur.

Extra Slides

The Importance of Background Ozone in Assessing Risk

- The estimation of background O_3 concentrations is important in order to adequately fulfill the Agency's goal of assessing the risk associated with O_3 exposures.

- Too low an estimate can result in

(1) Unreliable statistical significance outcomes associated with controlled laboratory exposure studies,
(2) Overestimated human health risk predictions, and
(3) Optimistic policy expectations of the levels to which hourly average O_3 concentrations can be lowered as a result of emission reduction requirements.

Examples of the Coincidence Tables

Table 3. Examples of coincidence tables relating number of days of STT-S = 0 or STT-S >0 with number of days when daily maximum hourly average O_3 concentration was either < 50 ppb or ≥ 50 ppb for Yellowstone NP (WY), Rocky Mountain NP (CO), and Georgia Station (GA) for March – June 2007. Coincidence value is calculated by summing the on-diagonal elements and dividing by the number of measurement days in the month.

	March		April		May		June	
	STT-S=0	STT-S >0	STT-S=0	STT-S >0	STT-S=0	STT-S >0	STT-S=0	STT-S >0
Yellowstone NP								
Max O_3 < 50 ppb	2	6	0	0	1	0	0	6
Max O3 ≥ 50 ppb	2	21†	3	27†	0	27†	3	21†
Coincidence value	0.74*		0.90*		1.00*		0.70*	
Rocky Mountain NP								
Max O3 < 50 ppb	2	4	1	4	0	0	0	0
Max O3 ≥ 50 ppb	1	23†	2	23†	8	23†	10	20†
Coincidence value	0.83*		0.80*		0.74*		0.67*	
Georgia Station								
Max O3 < 50 ppb	0	3	3	3	0	2	3	0
Max O3 ≥ 50 ppb	6	22†	1	23†	9	20†	8	19†
Coincidence value	0.71*		0.87*		0.65*		0.73*	

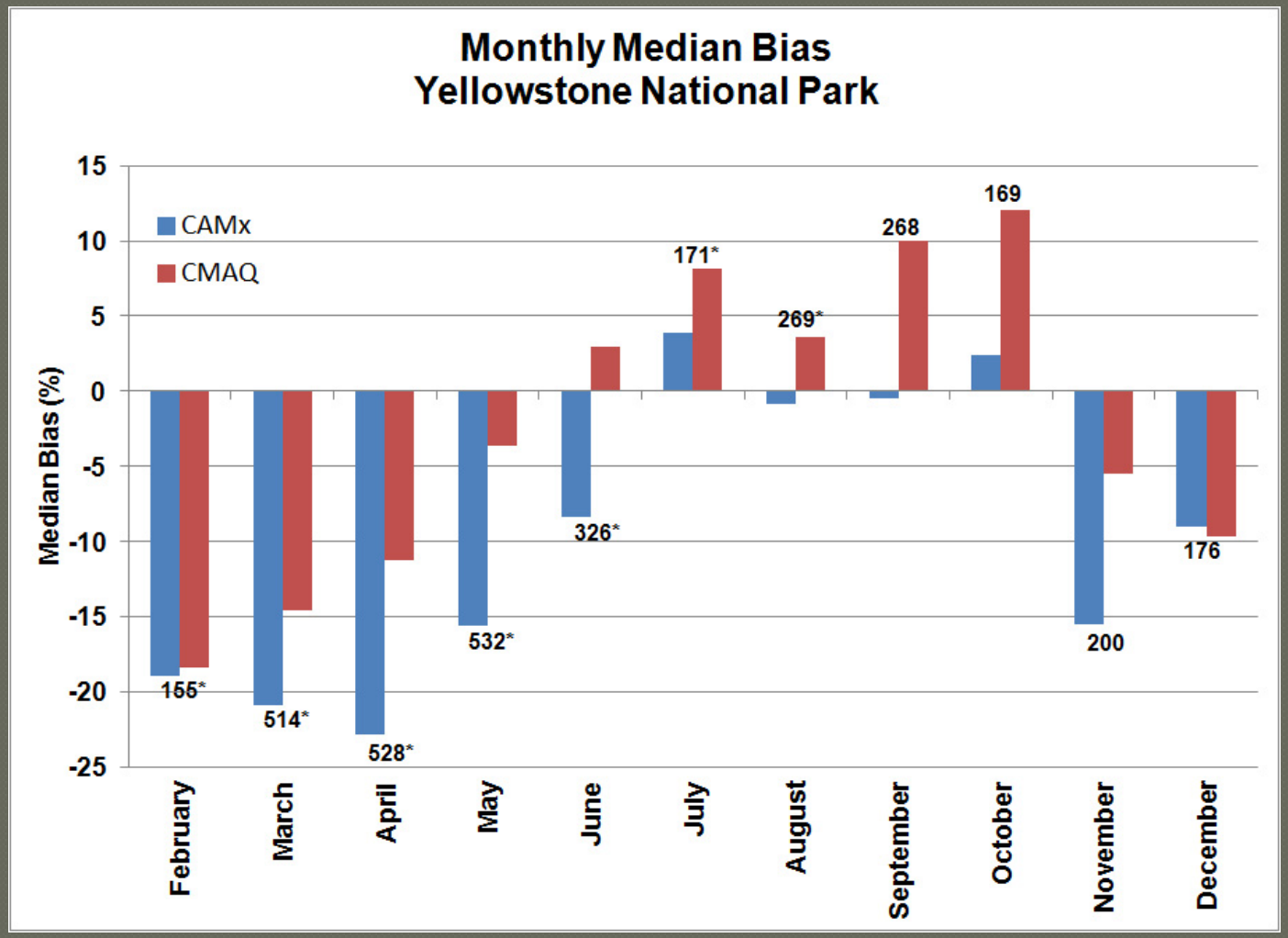
* Coincidence value statistically significant. See Section 2.3 for explanation.
† STT contribution to enhanced O_3 concentration considered to be important when coincidence value was statistically significant.

Source: Lefohn et al. (2012)

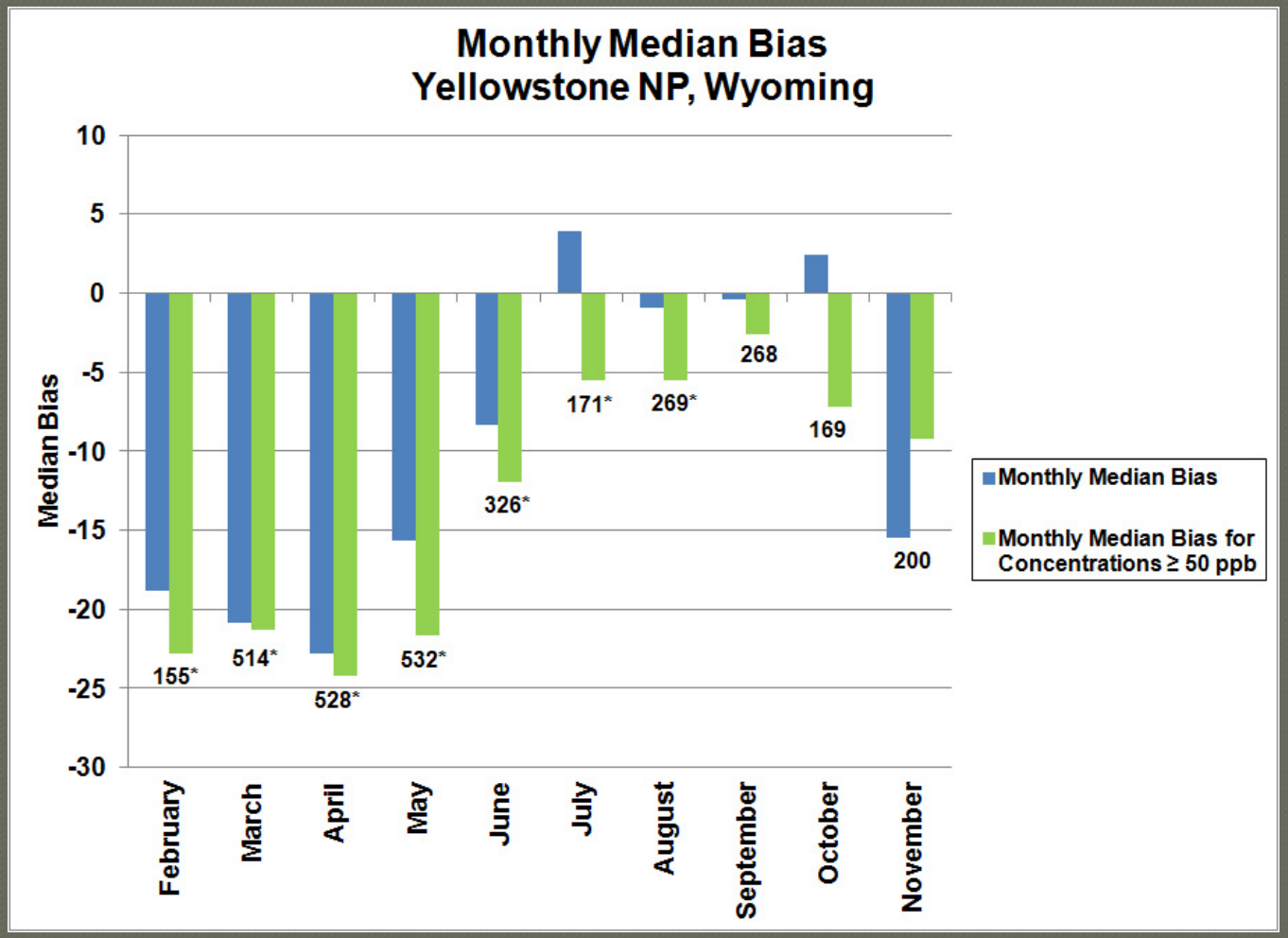
A More Realistic Approach

- Background O_3 plays a much more important part in assessing risk than the US EPA believes.
- Future modeling efforts to be applied in the second REA may be inadequate if STE is underestimated.
- The implementation of a methodology that includes the quantitative uncertainty in background hourly average O_3 concentrations provides a much more realistic bound of risk that then can be related to optional O_3 standard-setting scenarios.

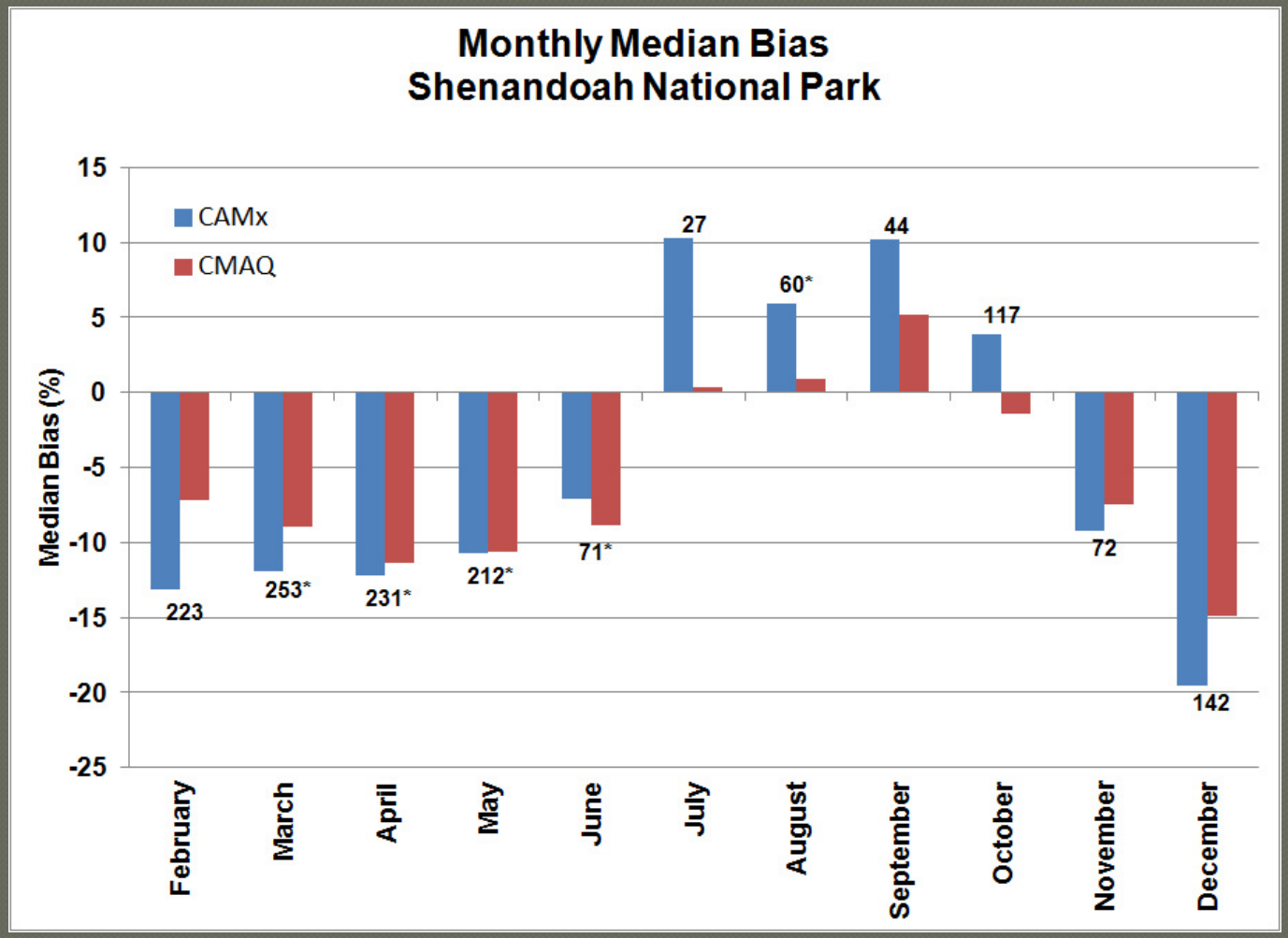
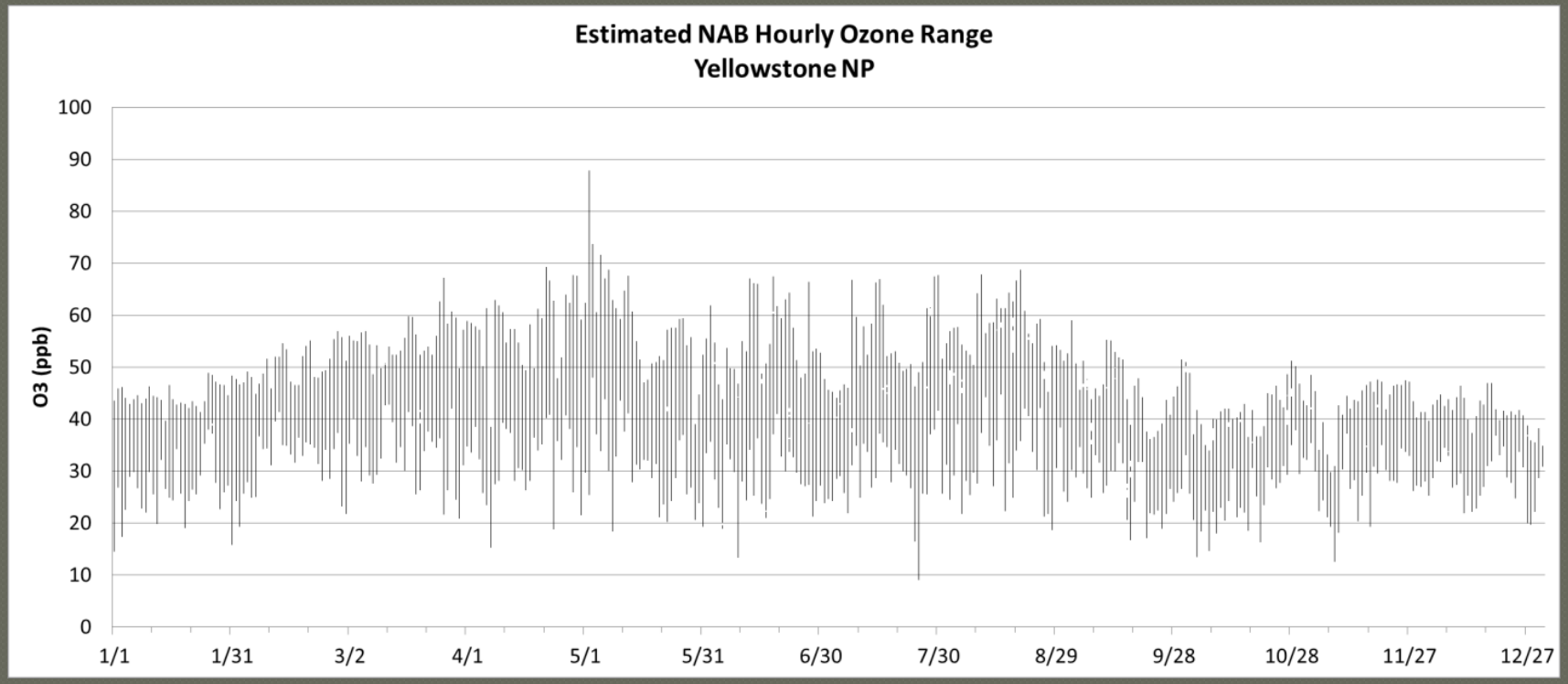
Under Predictions Observed Using CMAQ and CAMx for Yellowstone NP



Under Predictions ≥ 50 ppb Observed Using CAMx for Yellowstone NP



Under Predictions Observed Using CMAQ and CAMx for Shenandoah NP



An Example of Estimating Hourly Ozone Background Concentrations