

Background Surface Ozone Comments on the ISA

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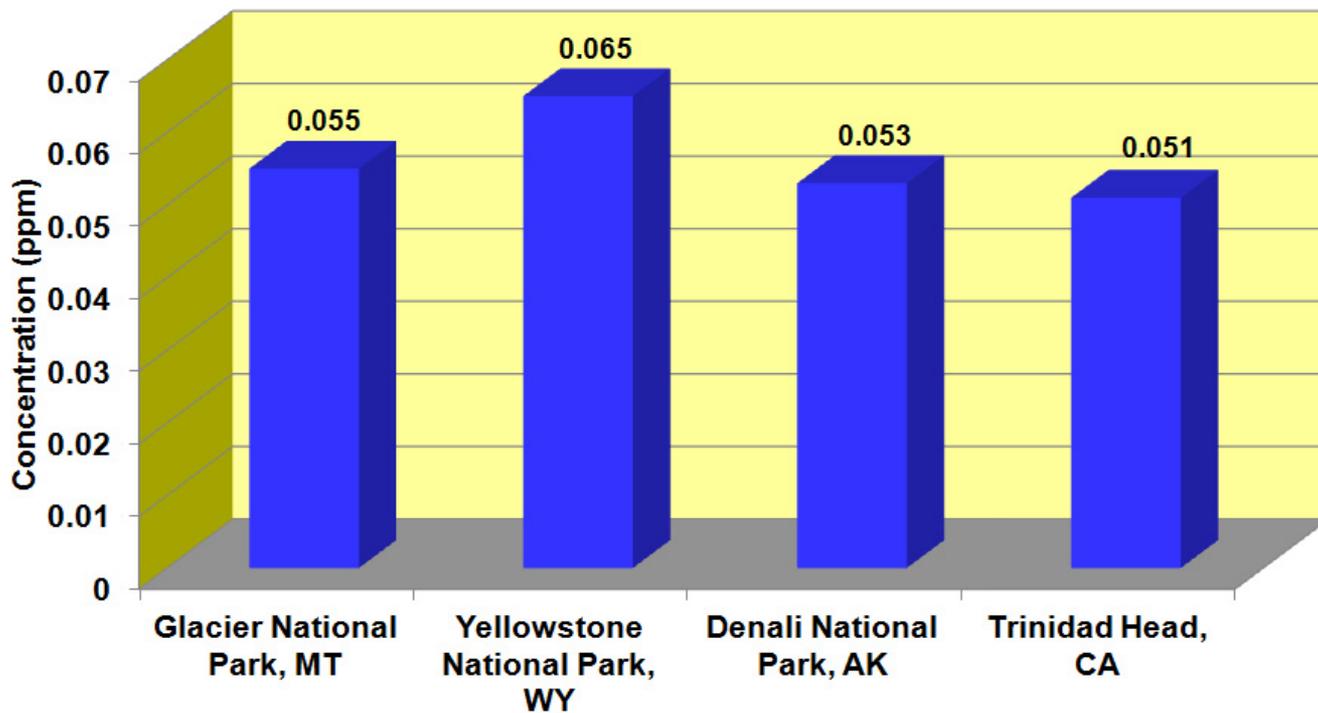
September 11, 2012

Bottom Lines

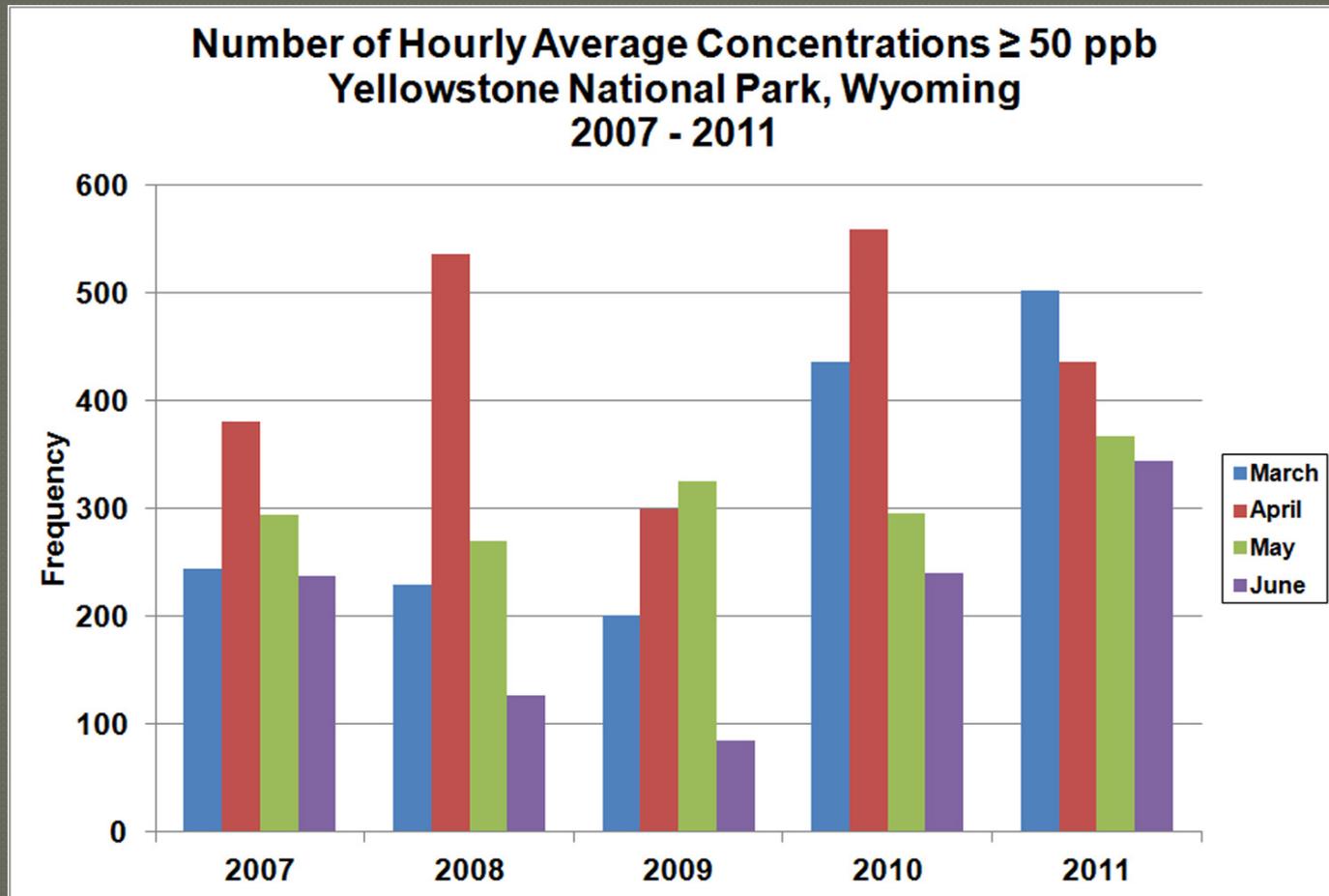
- Evidence published in the literature indicates that the stratosphere is an important contributor to surface background O₃ at both high and low-elevations.
- Underestimates in O₃ background from models appear to be related to several reasons, including difficulties in characterizing the contribution from the stratosphere.
- Besides high-elevation sites in the Intermountain West and West, low-elevation monitoring sites across the entire US experience enhanced O₃ concentrations (i.e., ≥ 50 ppb) that are coincident with stratospheric contributions.
- Officials in Alberta, Canada observe high springtime O₃ levels that they many times attribute to natural phenomena, such as stratospheric O₃. Consequently, they depend upon the 1-hour average concentration metric of 82 ppb instead of the Canada Wide Standard 8-hour average metric of 65 ppb for assessing human health effects.

Fourth Highest 8-h Average O₃ Concentrations

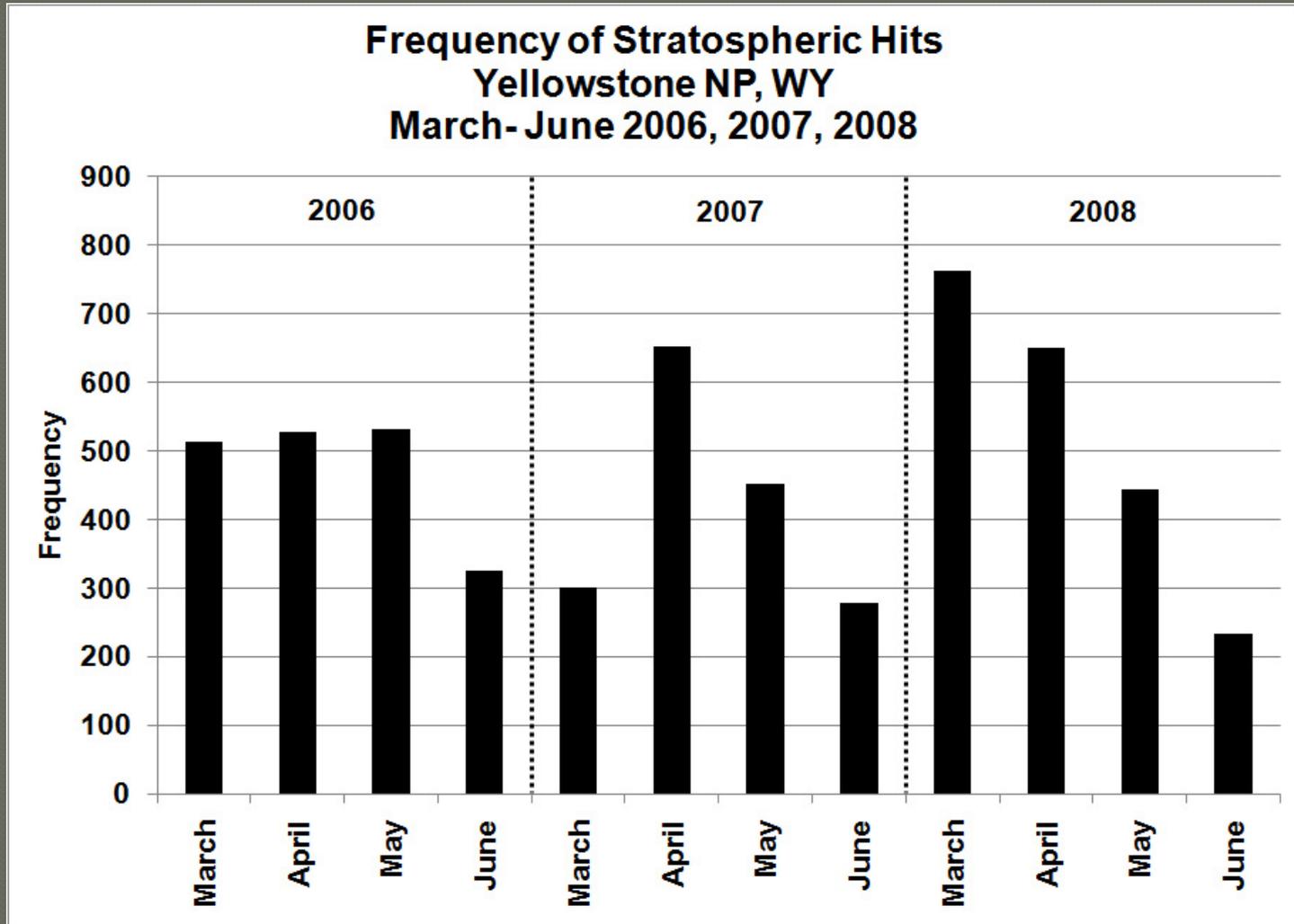
**Background Sites and Concentrations in the U.S.
Fourth Highest 8-Hour Daily Maximum Concentration
Averaged Over 3 Years
2009-2011**



Enhanced Hourly Average O₃ Concentrations at Yellowstone NP



Frequency of Stratospheric Hits



The Stratosphere and Its Effects on Implementing the Canadian-Wide Standard in Alberta

- In Alberta, continuing to track the frequency, trend and spatial pattern of events with O₃ concentrations greater than 82 ppb for a one hour average is important to consider because most cases are associated with local smog production.
- ***In contrast, observations above the 65 ppb 8-hour CWS level occur regularly both during local smog episodes and perhaps even more often as a result of high springtime O₃ levels that can be heavily influenced by natural phenomena, including stratospheric O₃.***
- Consequently, the provincial government continues to maintain an hourly objective. Observations above this threshold are less common than observations above the CWS benchmark

Source: The Canadian Smog Science Assessment, 2012; Chapter 7
– Regional Aspects of Smog (page 57).

Difficulty in Estimating Background Ozone

- The EPA points out that currently all chemical transport models and not just the ones evaluated in the ISA, have difficulty in predicting day-specific quantities (i.e., 1-h and 8-h average concentrations). (page 3-63)
- The difficulty in replicating 1-h and 8-h concentrations within reasonable bounds appears to be related to several reasons, including the specific modules used to describe specific processes (e.g., stratospheric-tropospheric exchange).

The Stratosphere - An Important Contributor to O₃ Background

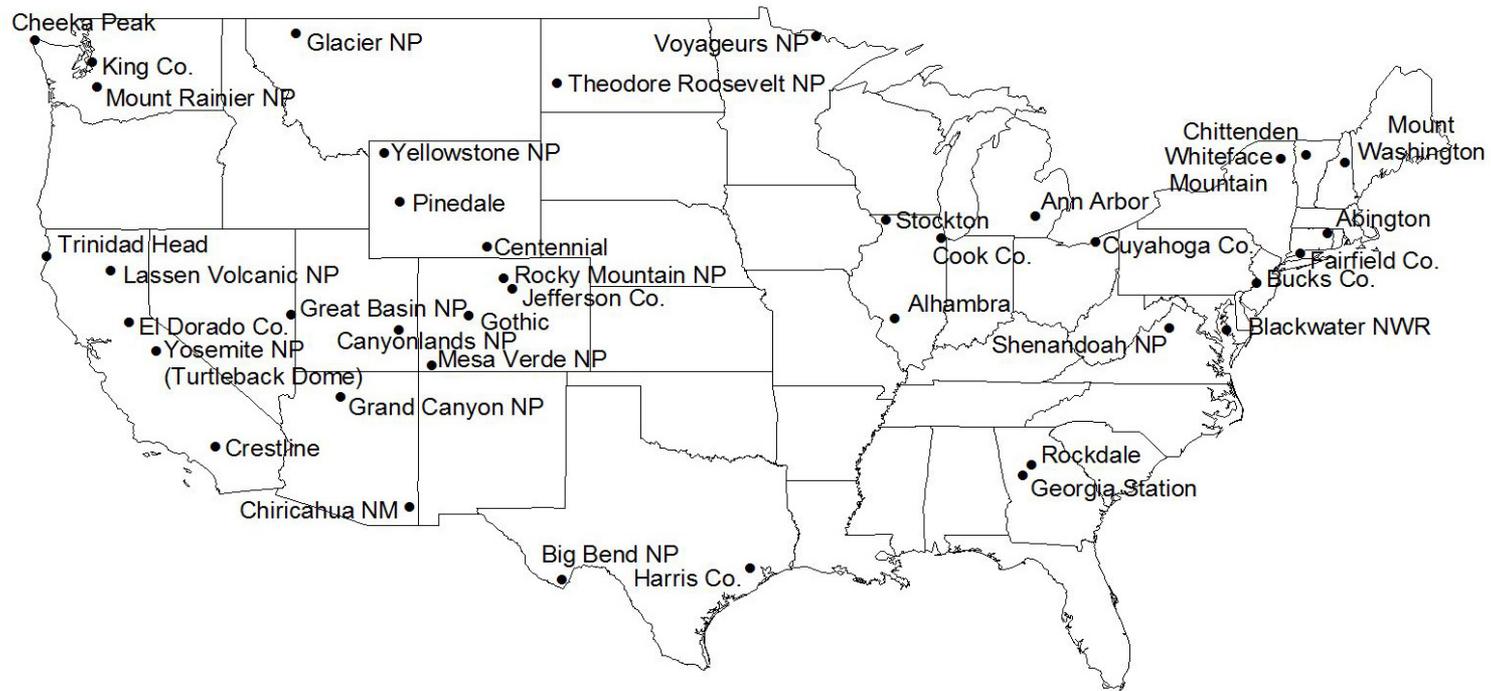
- Results published in the literature reports that the stratosphere is an important contributor to surface background O₃ at both high and low-elevations (Lefohn et al., 2001; Ambrose et al., 2011; Cooper et al., 2011; Lefohn et al., 2011; Langford et al., 2012; Emery et al., 2012; Lefohn et al., 2012-in press; Lin et al., 2012-submitted).

Lefohn et al. (2011)

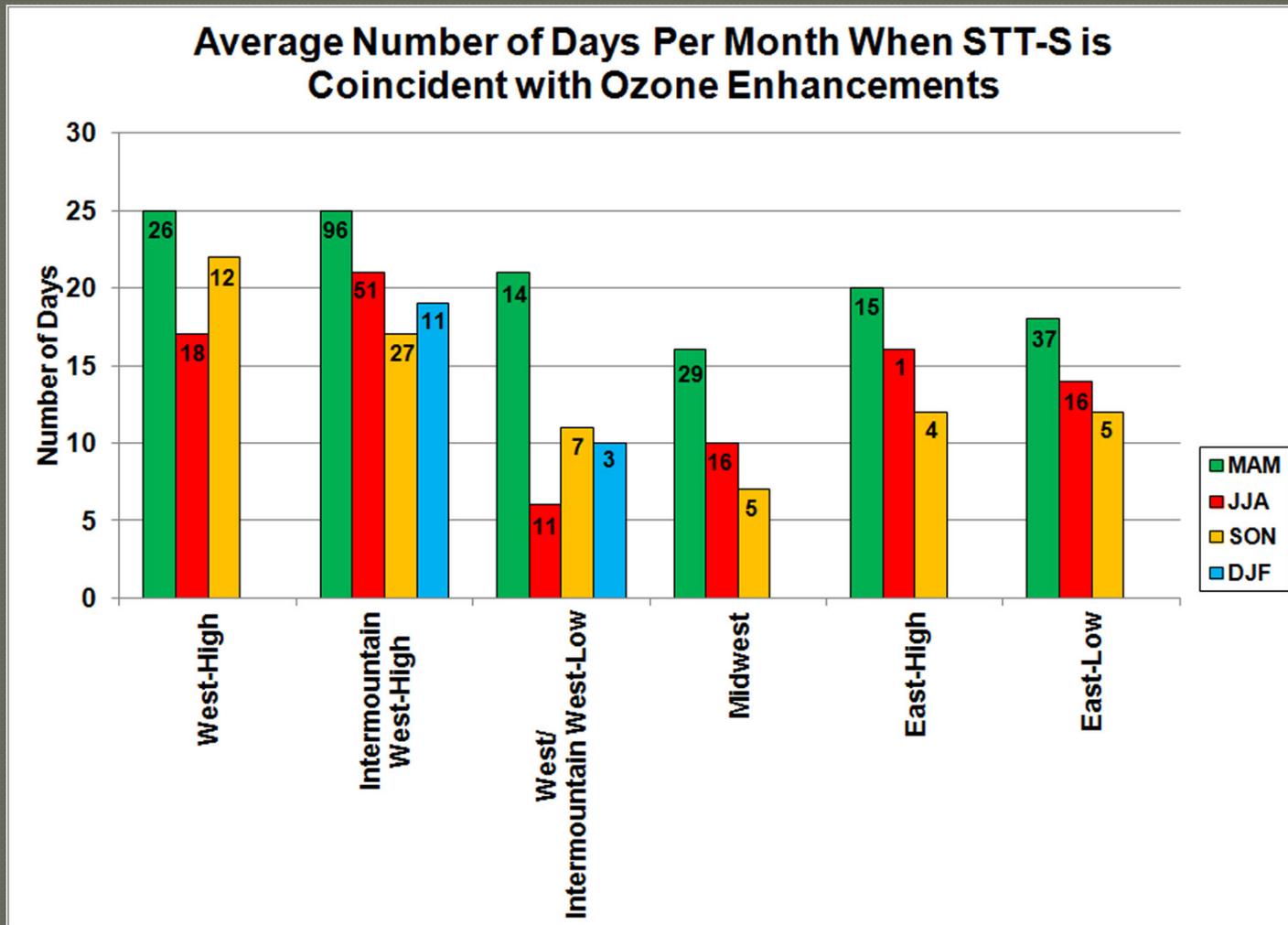
- Lefohn et al. (2011) investigated the effect of stratospheric events and their associated O₃ concentration enhancements in the western and northern tier of the US.
- For most of the sites analyzed, Lefohn et al. (2011) reported that stratospheric contributions were frequent and were related to enhanced surface O₃ concentrations ≥ 50 ppb at both high- and low-elevation monitoring sites.

- Lefohn et al. (2012) analyzed 39 high- and low-elevation monitoring sites in the US.
- Besides the high-elevation sites in the Intermountain West and West, low-elevation monitoring sites across the entire US experienced enhanced O₃ concentrations (i.e., ≥ 50 ppb) coincident with stratospheric contributions.

Location of Sites in Lefohn et al. (2012) In Press

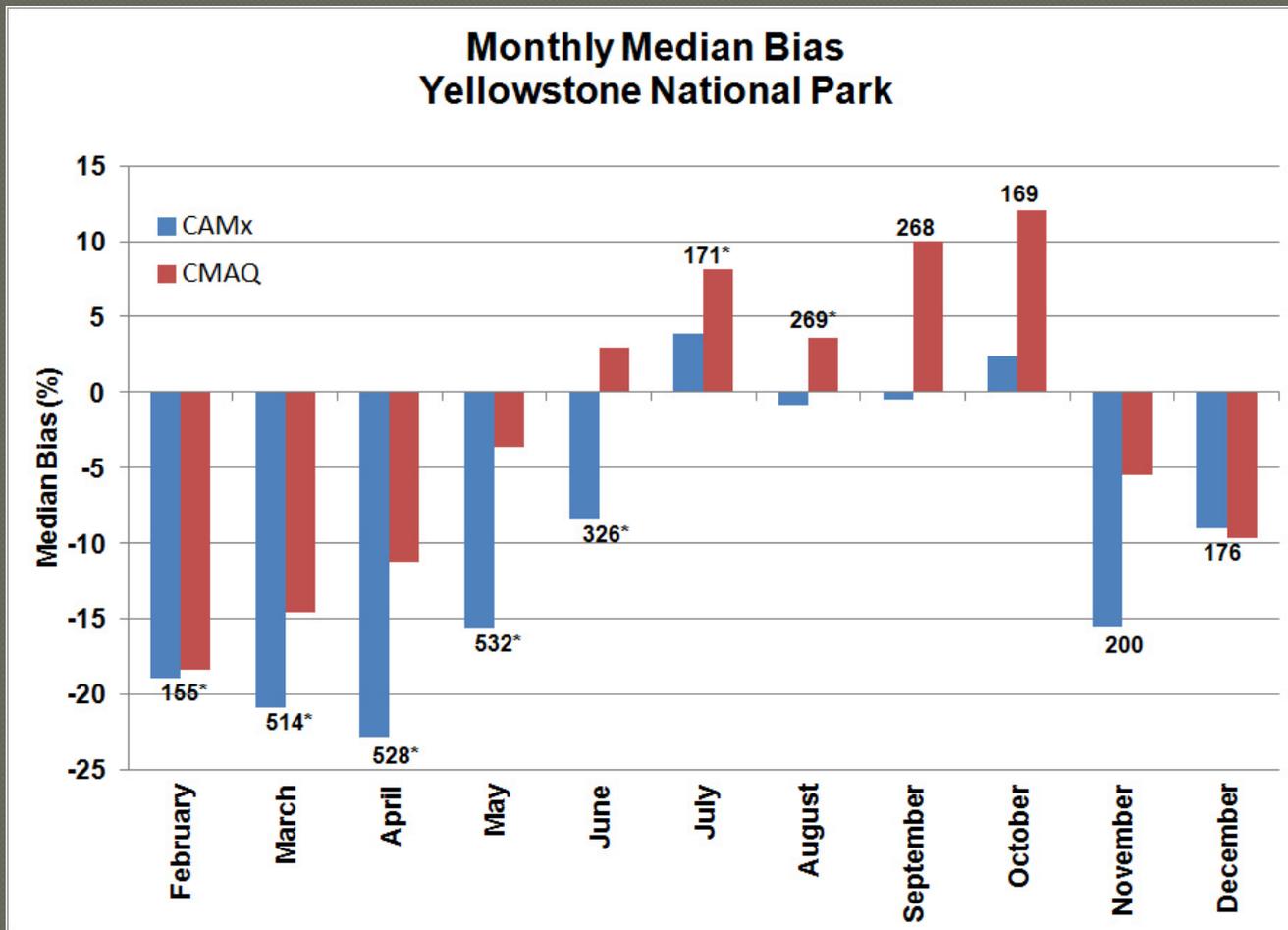


Stratospheric Influence on Daily Maximum Hourly Average Concentration Enhancements

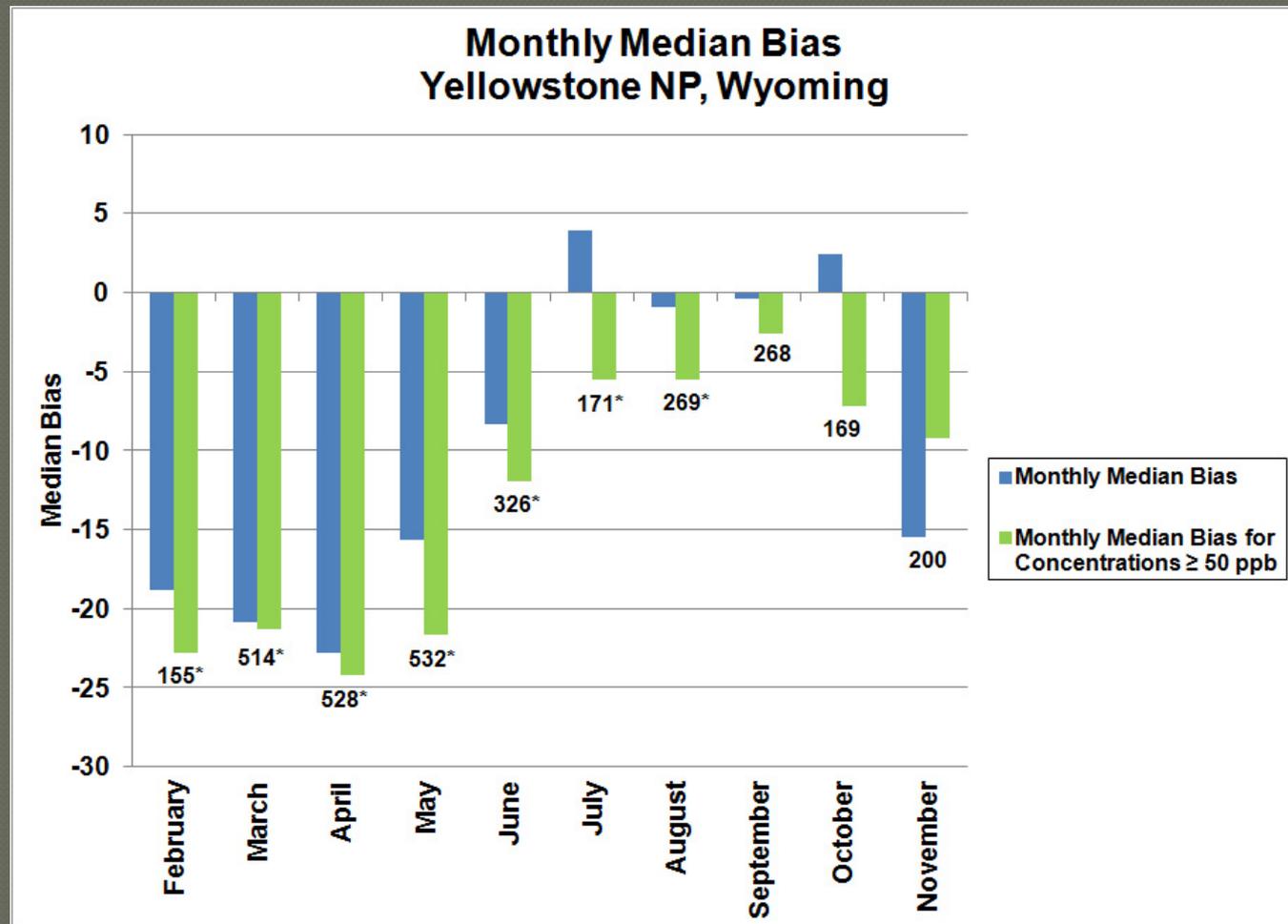


Extra Slides

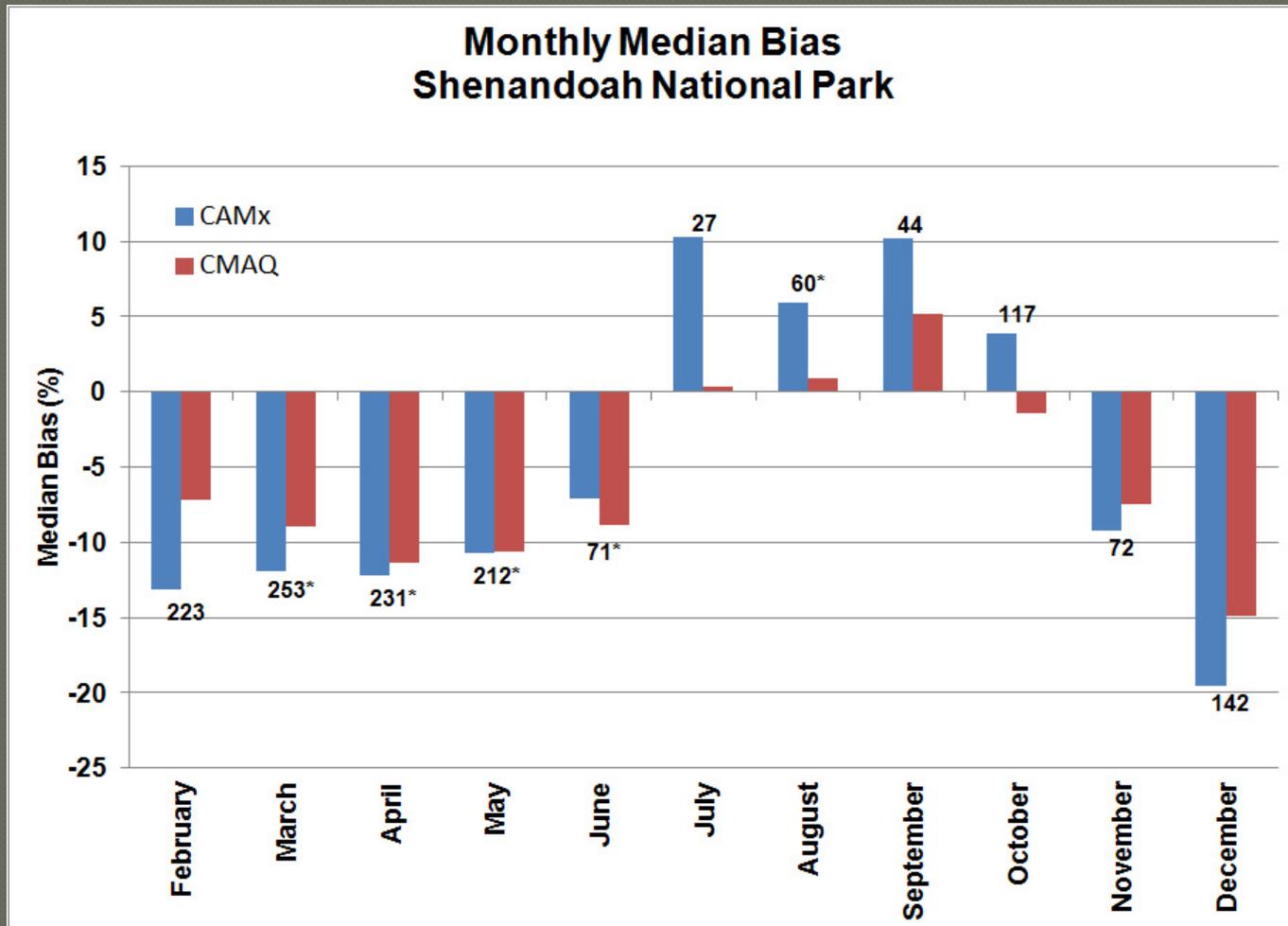
Under Predictions Observed Using CMAQ and CAMx for Yellowstone NP



Under Predictions ≥ 50 ppb Observed Using CAMx for Yellowstone NP



Under Predictions Observed Using CMAQ and CAMx for Shenandoah NP



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 O₃ 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.

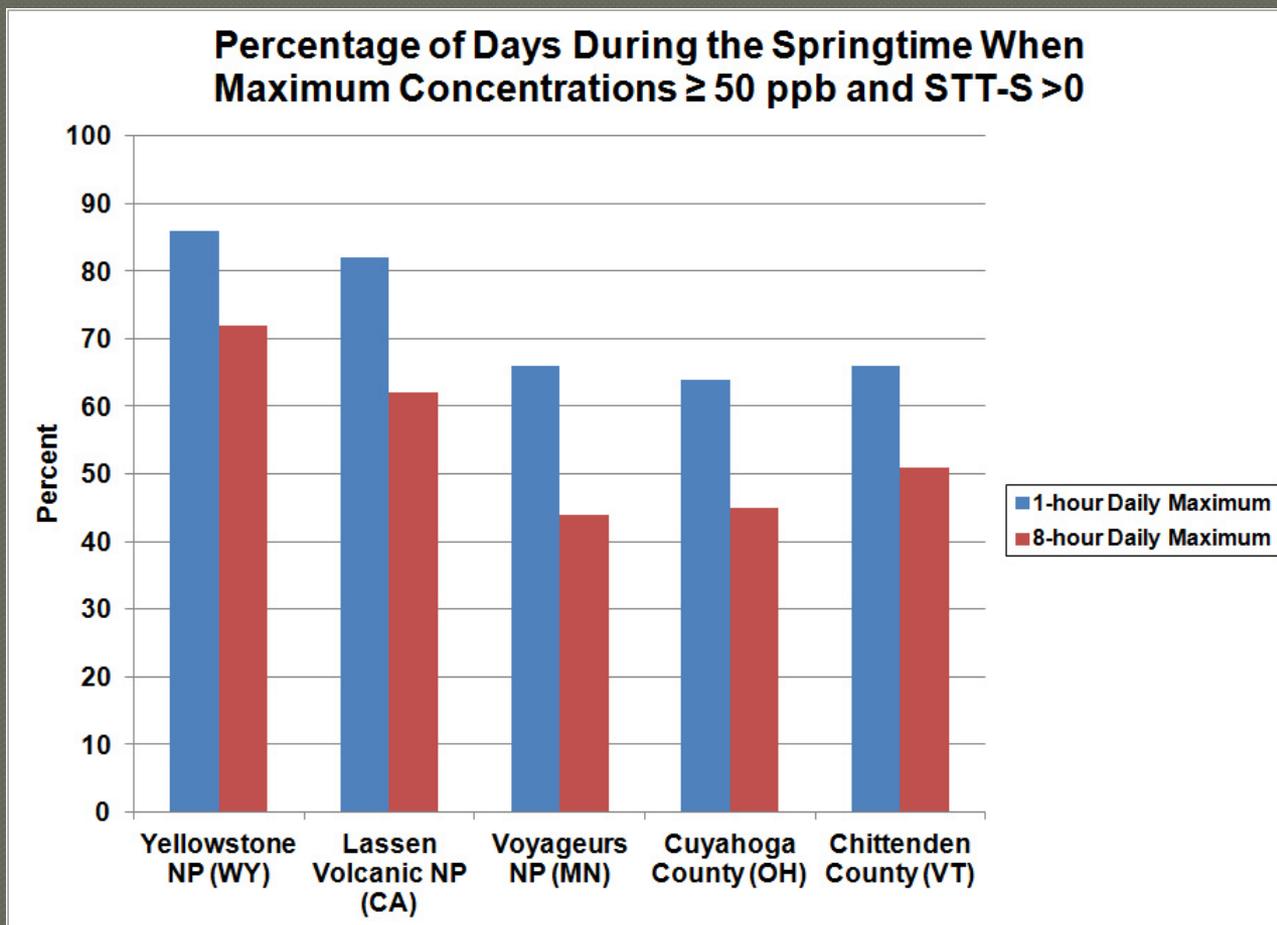
	March		April		May		June	
	STT-S=0	STT-S >0						
Yellowstone NP								
Max O ₃ < 50 ppb	2	6	0	0	1	0	0	6
Max O ₃ ≥ 50 ppb	2	21†	3	27†	0	27†	3	21†
Coincidence value	0.74*		0.90*		1.00*		0.70*	
Rocky Mountain NP								
Max O ₃ < 50 ppb	2	4	1	4	0	0	0	0
Max O ₃ ≥ 50 ppb	1	23†	2	23†	8	23†	10	20†
Coincidence value	0.83*		0.80*		0.74*		0.67*	
Georgia Station								
Max O ₃ < 50 ppb	0	3	3	3	0	2	3	0
Max O ₃ ≥ 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 O₃ concentration considered to be important when coincidence value was statistically significant.

Source: Lefohn et al. (2012)

During Months in Which Non-STT-S Events Were Infrequently Related to O₃ Enhancements



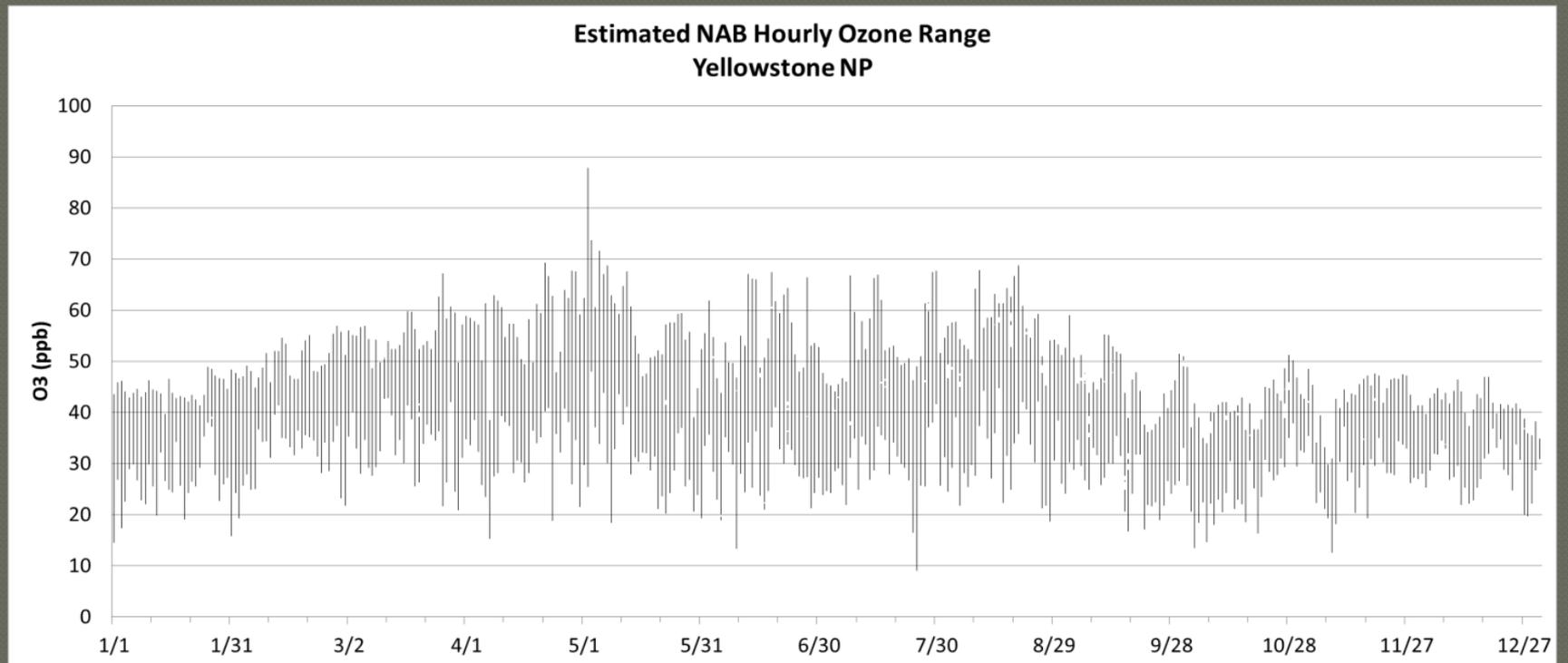
Non-STT-S events can be related to lightning, wildfires, and anthropogenic sources.

Source: Data from Lefohn et al. (2012)

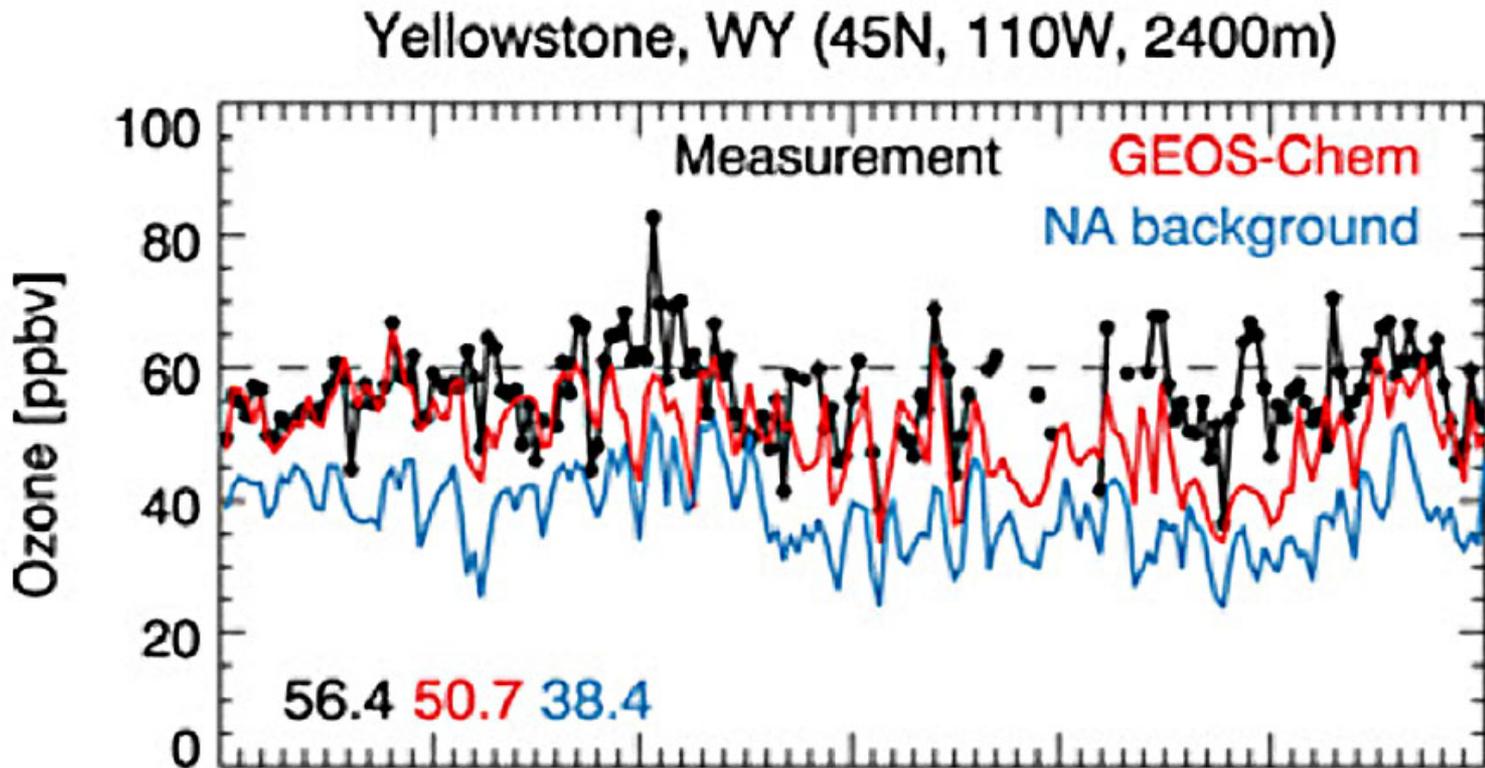
A More Realistic Approach

- Background O₃ 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 O₃ concentrations provides a much more realistic bound of risk that then can be related to optional O₃ standard-setting scenarios.

An Example of Estimating Hourly Ozone Background Concentrations



Under Predictions Observed Using GEOS-Chem for Yellowstone NP in 2006



Source: ISA, page 3-154.