Maryland Analyses of Good Neighbor SIPs

Who Might Owe What … and … Will it Work?

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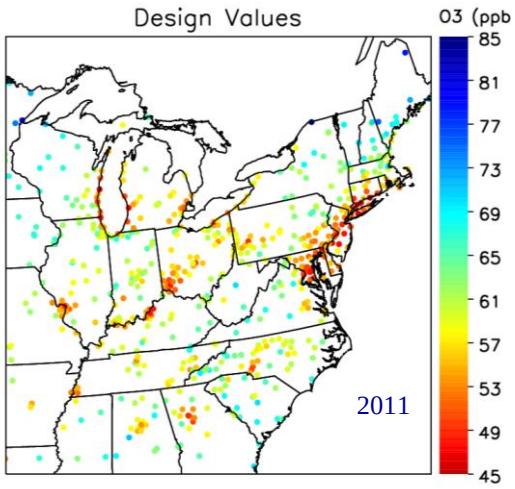

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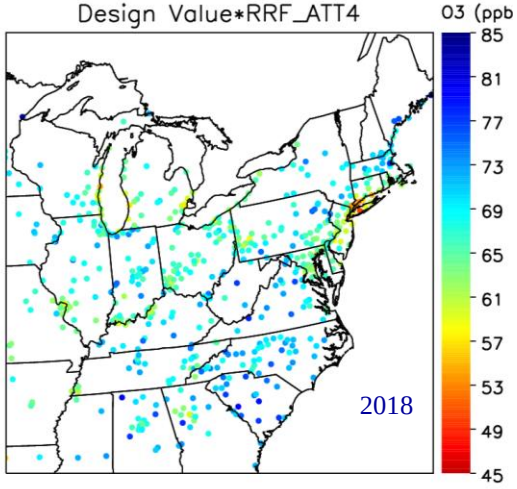


Tad Aburn, Air Director, MDE

MOG Meeting – Cincinnati, Ohio – May 7, 2015

Topics

- Why NOx?
- Baltimore – Cleanest area in the East?
  - Maybe for a year
- Maryland's Attainment Modeling and SIP – Where are we?
  - Local controls and Good Neighbor agreements
- EPAs February 22, 2015 memo
  - What might it mean?
- What other help could I use?
- Just a little science

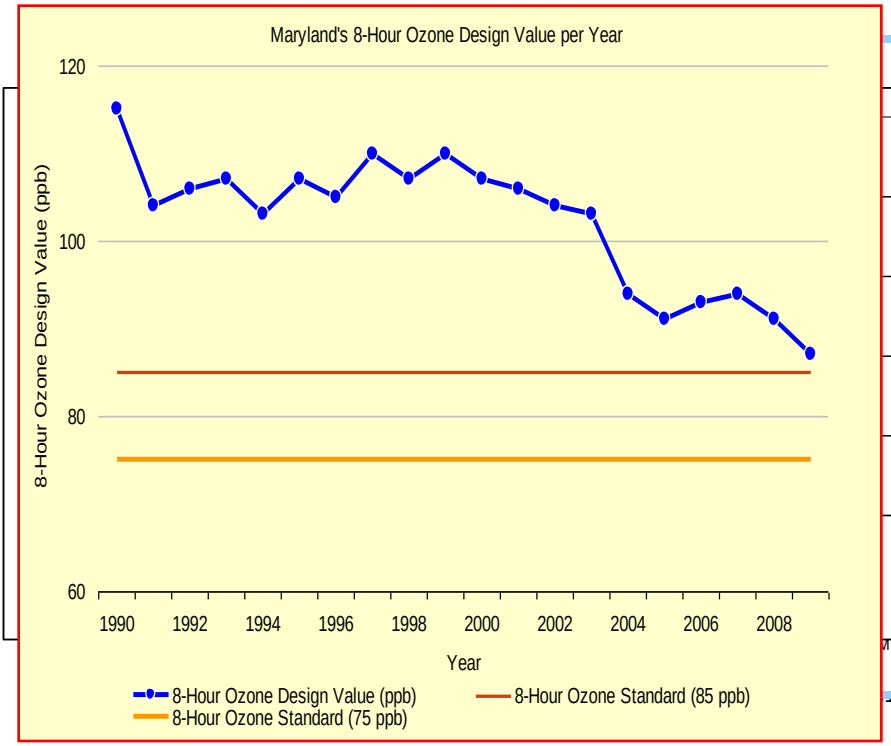
Why NOx?

"All models are wrong … some are useful"
– George E.P. Box, 1987

- Our continued push for more regional NOx reductions is based more on our research than our modeling
- The models still struggle to capture transport benefits from widespread regional NOx strategies
- When the model results aloft do not match what we measure aloft … We worry
- VOC reductions do help – just not a lot – and only in certain areas
- I will touch upon some of our emerging research on NOx at the end of the presentation

Why NOx? – A Case Study

Ground Level Ozone Drops Dramatically in the Same Time Frame

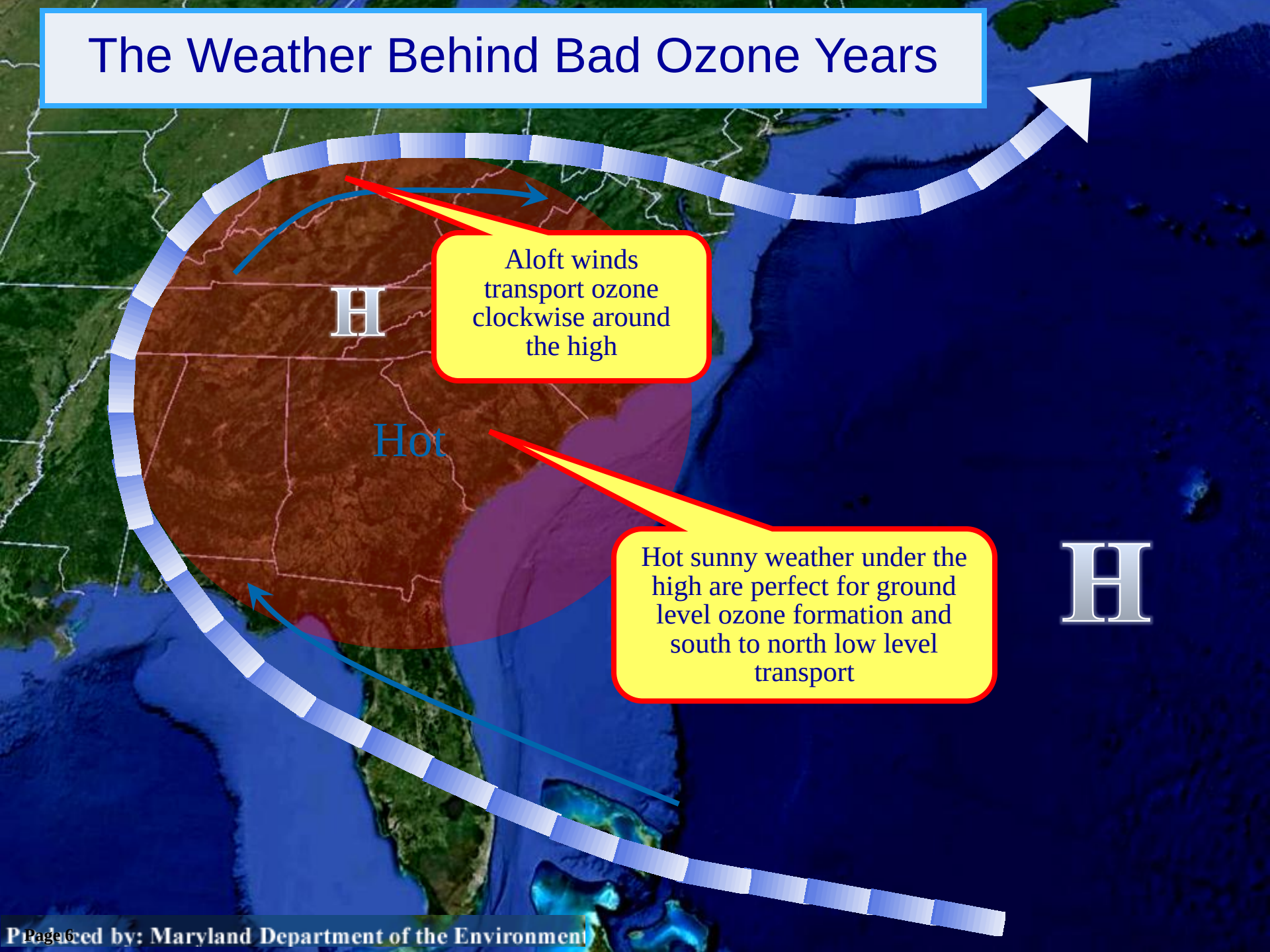


- The 2003/2004 "NOx SIP Call" as a case study. Significant regional nitrogen oxide (NOx) reductions from Federal Tier 2 Vehicle Standards occurring in the same time frame
  - A classic ozone transport success story
  - Incoming ozone levels collect in an elevated reservoir over night
  - Real world programs like the NOx SIP Call (power plants) and the Tier 2 Vehicle Standards show that:
    - Adding regional controls …
    - Results in regional NOx emission reductions …
    - Which leads to reduced ozone in the elevated reservoir …
    - Which lead to lower ozone at ground level and public health protection!

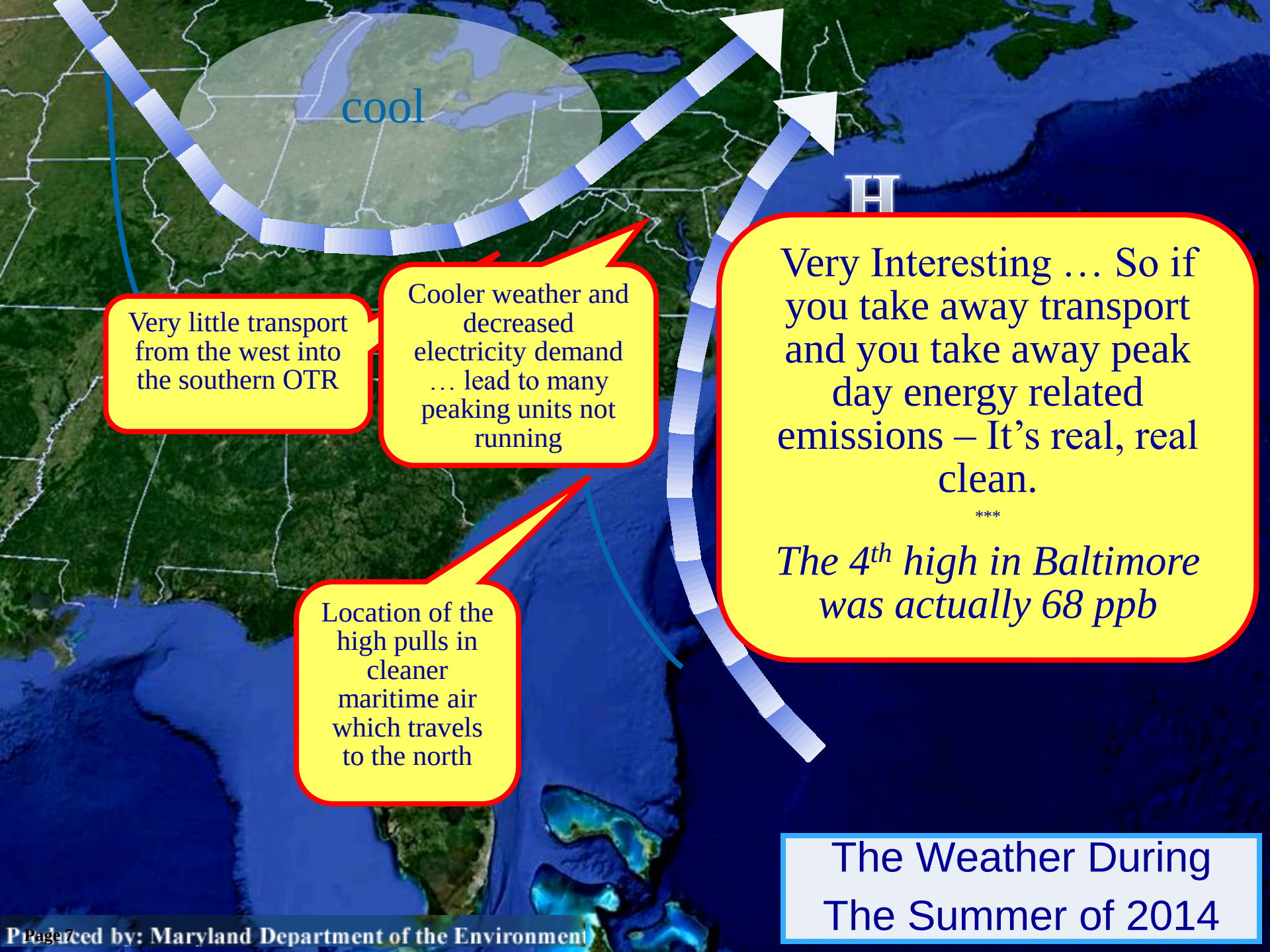
The Strange Story of Ozone in Baltimore

- Historically … some of the highest ozone in the Country
- Highest ozone … but lowest emissions of any city in the DC to Boston corridor
- In 2010 to 2012 Baltimore had the highest ozone levels in the East
  - Only area in the East designated as "Moderate" by EPA
  - Only area in the East that is required to submit a SIP in 2015
- Then some kind of miracle happened … maybe I should just take the credit
  - Measured very low ozone in 2013 and 2014
  - Lower than DC, lower than Philly, way lower than CT/NY/NJ
  - If 2014 repeats in 2015 and 2016 – We'll most likely meet the next standard – it was really clean in 2014
- EPA proposed a Clean Data Determination for Baltimore in March of 2015
- Maryland tells EPA to not take the current data too seriously … we take our CAA responsibility to attain standards as expeditiously as possible very seriously … so … we still plan to submit our SIP in 2015
- So what the heck is going on – was it really a miracle?

The Weather Behind Bad Ozone Years



Produced by: Maryland Department of the Environment

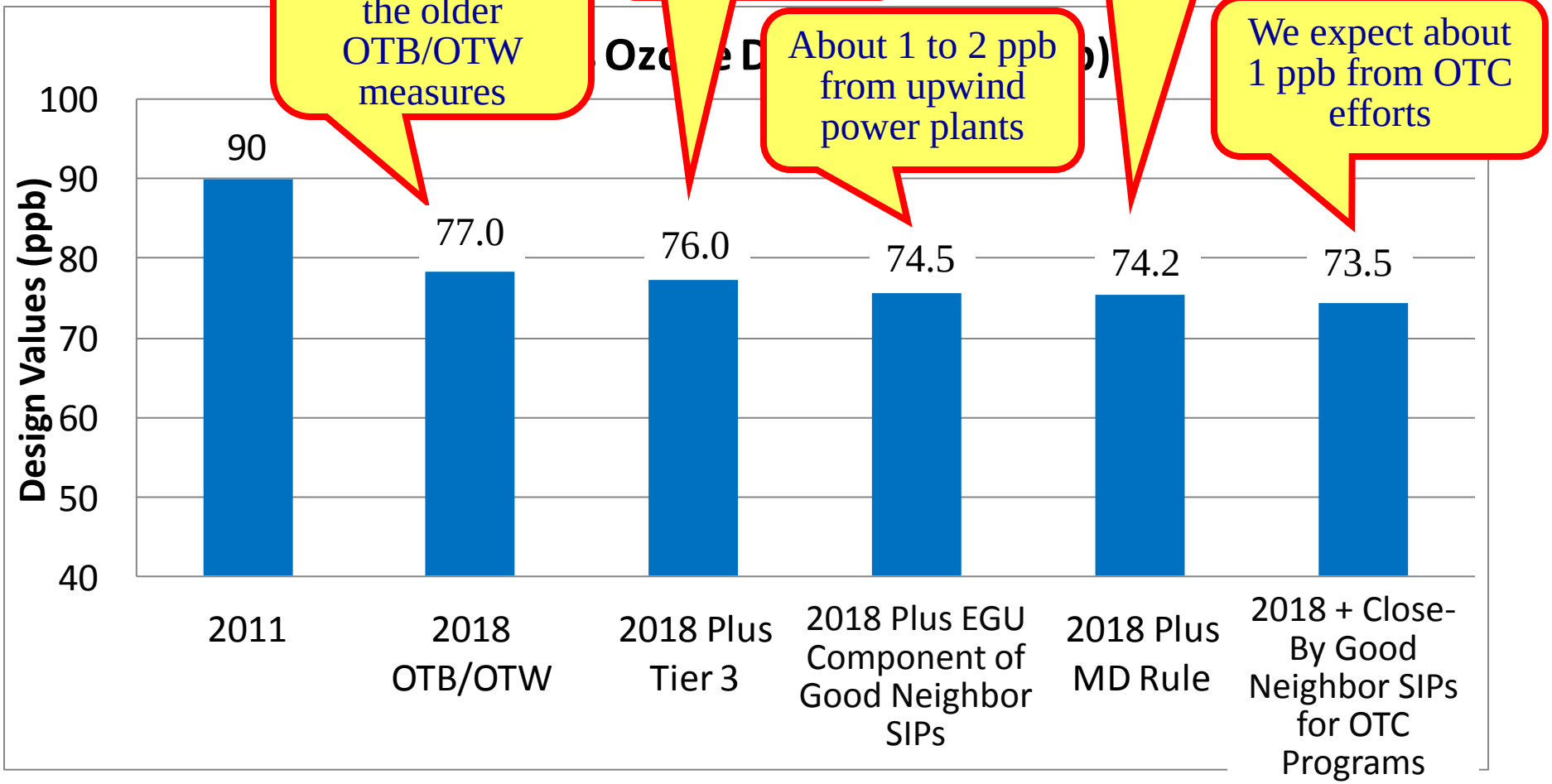

cool
H
Very little transport from the west into the southern OTR
Cooler weather and decreased electricity demand … lead to many peaking units not running
Location of the high pulls in cleaner maritime air which travels to the north
Very Interesting … So if you take away transport and you take away peak day energy related emissions – It's real, real clean.
***
The 4th high in Baltimore was actually 68 ppb
The Weather During
The Summer of 2014
Produced by: Maryland Department of the Environment

The Maryland Attainment SIP

- Based upon three separate sets of detailed analyses:
  - Comprehensive photochemical modeling of natonal, super-regional, regional and local strategies … NOx focused
  - Analyses of new OTC measures being acted on or considered in the 13 OTC states
    - Mostly NOx
  - Data analysis of every coal-fired EGU in the East
    - Controls, retirements and how they are run
    - Three packages shared with state Air Directors

Modeling for Edgewood MD

… Looks … a… …en the W…



The Maryland Plan – Other Problem Areas

Control Measures in the Maryland Plan

- Measures that are "on the way" include:
  - Over 40 control programs: generally older federal programs that continue to generate deeper reductions as they phase in or as fleets turn over
- "Optimized" Electric Generating Unit (EGU) reductions include:
  - All coal-fired units in selected eastern states (MD, PA, VA, NC, TN, KY, WV, OH, IN, IL, MI, CT, NJ, NY, WI, LA, MO) running controls in the summertime consistent with emission rates measured in earlier years
- New OTC and local Maryland measures include:
  - Nine new Ozone Transport Commission (OTC) model reduction programs for mobile sources and other sources implemented in just the OTC states … and
  - Additional EGU and mobile source reductions just in MD

• Sheboygan, WI	551170006	84.3	75.4	75.2 ✓	75.2

Other Difficult Monitors in the East

County, State	AQS #	Design Value 2011	2018 Measures "on the way"	2018 – Add in Optimized EGUs	2018 – Add new OTC and local MD measures
Prince Georges, MD	240338003	82.3	68.6	67.0	66.0
New Castle, DE	100031010	78.0	66.6	65.1	64.1
Bucks, PA	420170012	80.3	69.3	68.0	67
Fairfax, VA	510590030	82.3	69.4	68.1	67.1
Wayne, MI	261630019	78.7	72.9	72.8	72.8
Mecklenburg, NC	371191009	79.7	63.5	63.0	63.0
Fulton, GA	131210055	81.0	70.3	70.1	70.1
Knox, TN	470931020	71.7	61.7	61.2	61.2
Hamilton, OH	390610006	82.0	69.7	67.5	67.5
Franklin, OH	390490029	80.3	69.7	69.2	69.2

All values in parts per billion (ppb)

What Might it Take for CT?

NY/NJ/CT Nonattainment Area

- There are very preliminary analyses started that begin to look at how a strategy that targets smaller combustion sources … with relatively large peak day NOx emissions … might help the NY/NJ/CT nonattainment area
- This sensitivity run (10% extra NOx in NY, NJ, CT, PA and MD) was designed to get a very rough idea of how that kind of a strategy might work

County, State	AQS #	Design Value 2011	2018 Future Projections			
			Measures "on the way"	Add in Optimized EGUs	Add new OTC & local MD measures	Add in 10% Extra NOx Reduction in NY, NJ, CT, PA and MD
Fairfield, CT	090013007	84.3	73.0	72.5	71.5	71.0
Fairfield, CT	090019003	83.7	75.5	75.1	74.1	73.6
Suffolk, NY	361030002	83.3	78.2	77.7	76.7	75.7
Fairfield, CT	090010017	80.3	76.4	75.9	74.9	74.5
New Haven, CT	090099002	85.7	74.1	73.8	72.8	71.7

What Inside the OTC Measures are Included?

- Mobile Source Initiatives
  - Aftermarket Catalyst effort
  - ZEV/CALEV state programs
  - Onroad and offroad idling
  - Heavy Duty I&M
  - Smartways
- NOx and VOC reductions
- New potential initiatives like Ports are not included

- Stationary and Area Source Efforts
  - Third Generation OTC/SAS Initiatives
    - Consumer products
    - Architectural and Industrial Maintenance (AIM) Coatings
    - Auto coatings
    - Ultra Low NOx burners
- NOx and VOC reductions

Reductions from OTC Measures

OTC Model Control Measures	Regional Reductions (tons per year)	Regional Reductions (tons per day)
Aftermarket Catalysts	14,983 (NOx) 3,390 (VOC)	
On-Road Idling	19,716 (NOx) 4,067 (VOC)	
Nonroad Idling	16,892 (NOx) 2,460 (VOC)	
Heavy Duty I & M	9,326 (NOx)	
Enhanced SMARTWAY	2.5%	
Ultra Low NOx Burners	3,669 (NOx)	10 (NOx)
Consumer Products	9,729 (VOC)	26 (VOC)
AIM	26,506 (VOC)	72 (VOC)
Auto Coatings	7,711 (VOC)	21 (VOC)

… About a 150 ton per day total NOx Emission Reduction in the 13 OTC states

- Just in the OTC states – for now
- Reductions developed as part of OTC Committee work
- Thanks to Roger Thunell. Emily Bull, Marcia Ways, Joseph Jakuta and Julie McDill
- These emission reduction estimates are being updated as we speak

EPA's Recent Transport Guidance

- On January 22, EPA issued a guidance memo to begin a process that will require states to submit Good Neighbor SIPs to address ozone transport in the East
  - A 2011 requirement that's a little late
- The guidance builds from Supreme Court decisions … and provides preliminary analyses to identify which states are contributing significantly to downwind problem areas
- The Maryland modeling can begin to give us a glimpse of how the EPA process may play out and what states may owe in their Good Neighbor SIPs

Who Contributes to Whom

- EPA has performed preliminary modeling to identify which states may owe Good Neighbor SIPs for selected downwind problem areas … Future problems for **nonattainment** and **maintenance** both identified. Texas problem areas not included.

	Contributing States from Preliminary EPA Analyses																				
Problem Monitors	**AL**	**AR**	**DE**	**IA**	**IL**	**IN**	**KS**	**KY**	**LA**	**MD**	**MI**	**MO**	**NJ**	**NY**	**OH**	**OK**	**PA**	**TN**	**TX**	**VA**	**WI**	**WV**
Harford, MD						x		x			x				x		x		x	x		x
Fairfield, CT ★										x	x		x	x	x		x			x		x
Fairfield, CT ★										x			x	x	x		x			x		x
Suffolk, NY ★					x	x				x	x		x		x		x		x	x		x
Fairfield, CT ★					x	x				x			x	x	x		x			x		x
New Haven, CT ★						x				x			x	x	x		x			x		x
Jefferson, KY					x	x					x				x							
Allegan, MI		x		x	x	x	x					x				x			x		x	
St. Charles, MO	x	x			x				x							x		x	x			
Camden, NJ ★			x		x	x		x			x	x		x	x		x		x			x
Gloucester, NJ ★			x		x	x		x		x	x			x	x		x		x	x		x
Richmond, NY ★			x			x		x		x			x		x		x			x		x
Philadelphia, PA ★			x		x	x		x		x			x		x			x	x	x		x
Sheboygan, WI					x	x	x		x		x	x				x			x			

In the same nonattainment area … ★ = NY/NJ/CT ★ = Philadelphia

Who Might Owe What?

… What do the MD analyses say about what control measures states may need to include in their Good Neighbor SIPs?

- Very preliminary – Based upon current modeling effort
- For all of the toughest areas: Harford County, MD - NJ/NY/CT nonattainment area – Sheboygan, WI … all of the other tough areas in the east … except Texas

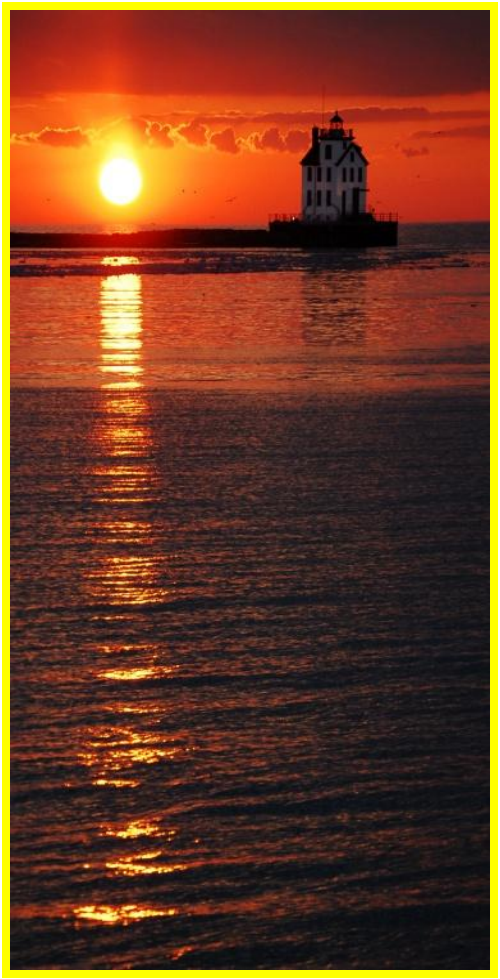
Control Programs Needed	CT	DE	IL	IN	KY	MD	MI	MO	NJ	NY	OH	PA	TN	TX	VA	WV
Optimized EGU controls	x	x	x	x	x	+	x	x	x	x	x	x	x	x	x	x
Aftermarket Catalyst	x	x				x			x	x		x			x	
On- and off-road idling	x	x				x			x	x		x			x	
OTC VOC initiatives	x	x				x			x	x		x			x	
SmartWays	x	x				x			x	x		x			x	
Smaller Combustion	?					?			?	?		?			?	

OK to Talk About …

.. *Something Other than EGUs?*

- There is more to transport than just power plants
- A few thoughts on this issue
- A question for the folks in this room to consider

  - *Thanks to Rob Kaleel and the LADCO modelers for their OSAT contribution work*



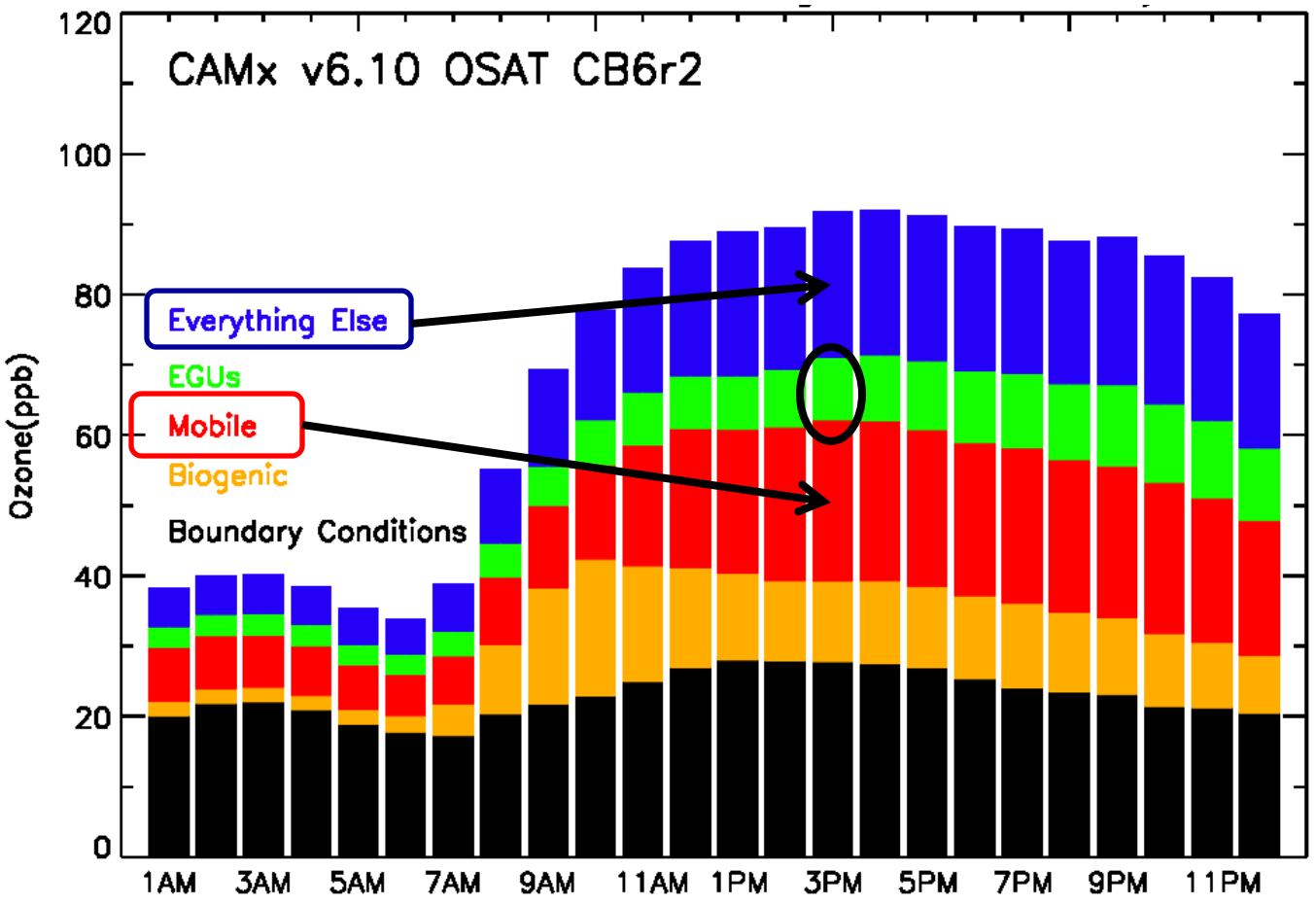
LADCO OSAT - Edgewood, MD

- The CAMX model has a source apportionment tool called OSAT (Ozone Source Apportionment Tool) that allows the model to work backwards and ask questions like "what states" or "what source sectors" sent the ozone to Edgewood MD – or Sheboygan WI – or Atlanta GA?
- The following series of OSAT runs from Maryland and LADCO generate similar answers and are designed to help identify …
  - "What source sectors are remaining significant contributors to eastern, mid-west and southern problem areas.
- Helpful for current Good Neighbor efforts, but also informative for looking ahead to the next standard

Ozone Contribution (%)

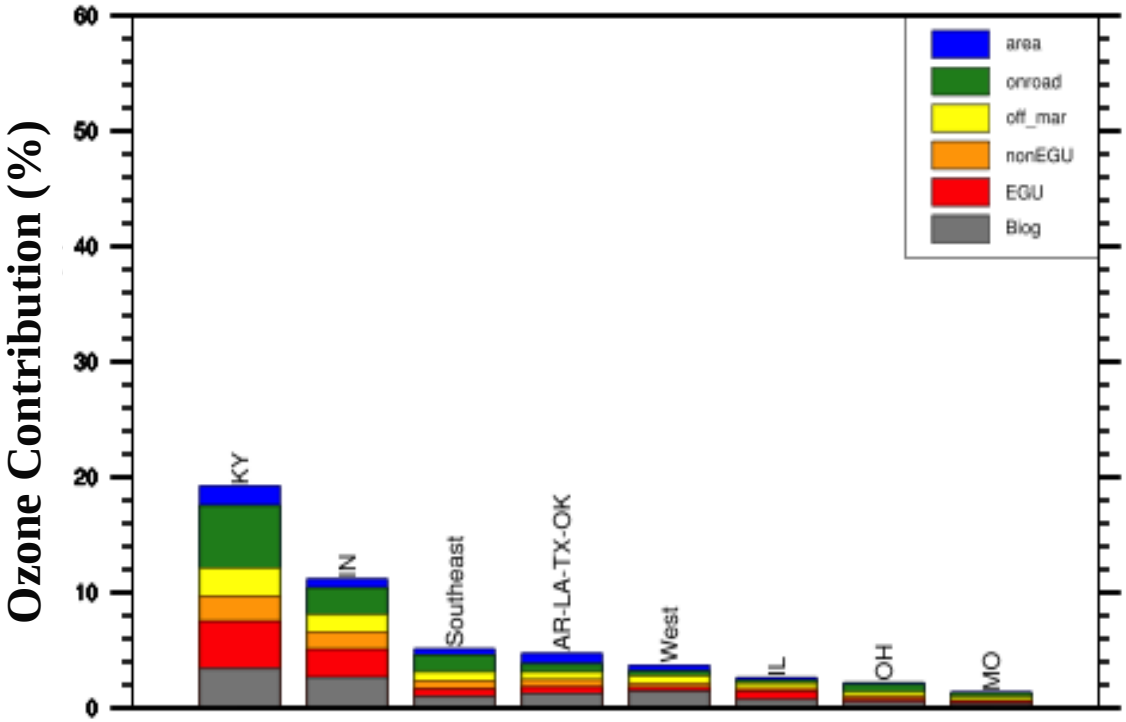
UMD OSAT - Edgewood, MD

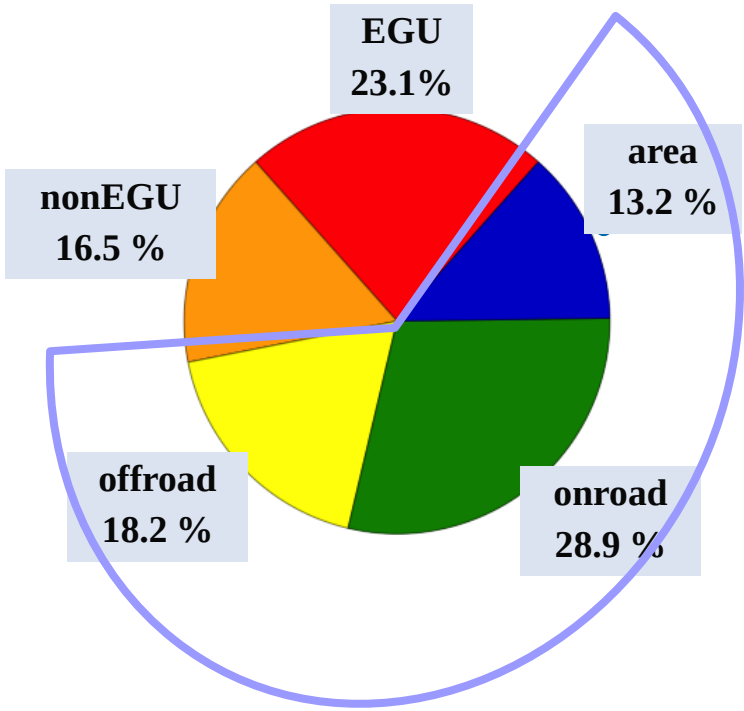
- Daily contribution from OSAT – July 7, 2011
- Anthropogenic contribution dominated by "other than EGU" source sectors



LADCO OSAT - Louisville, KY

75 ppb O_3 threshold-ERTAC 2.2

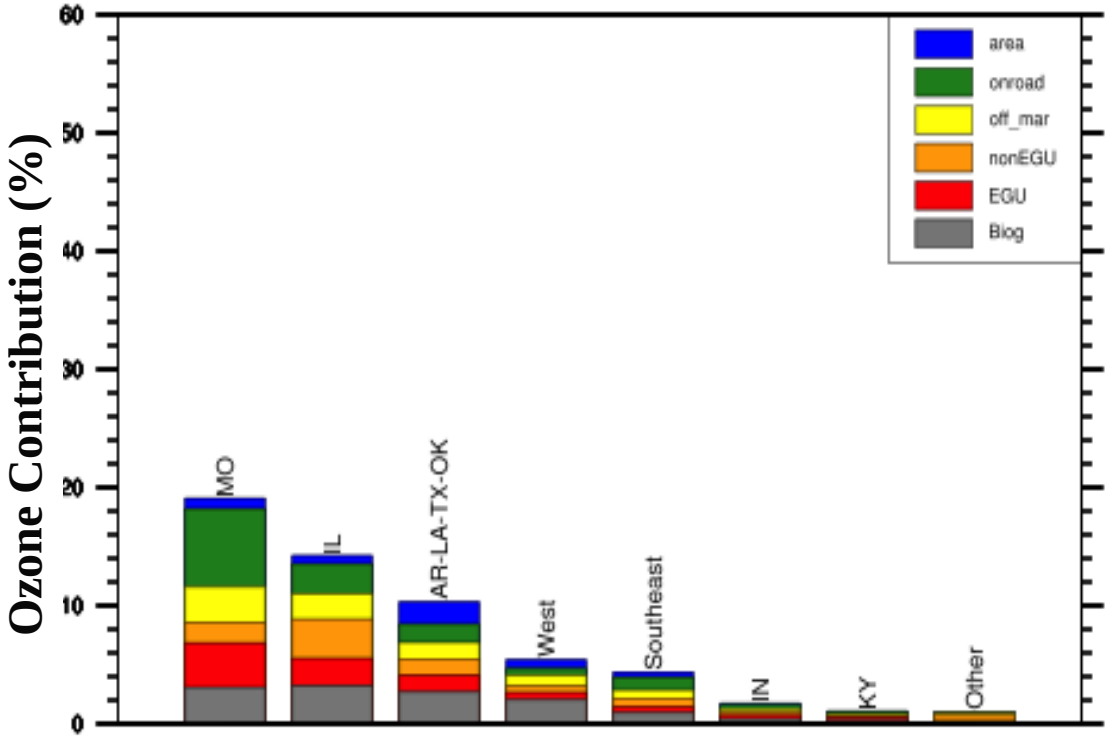


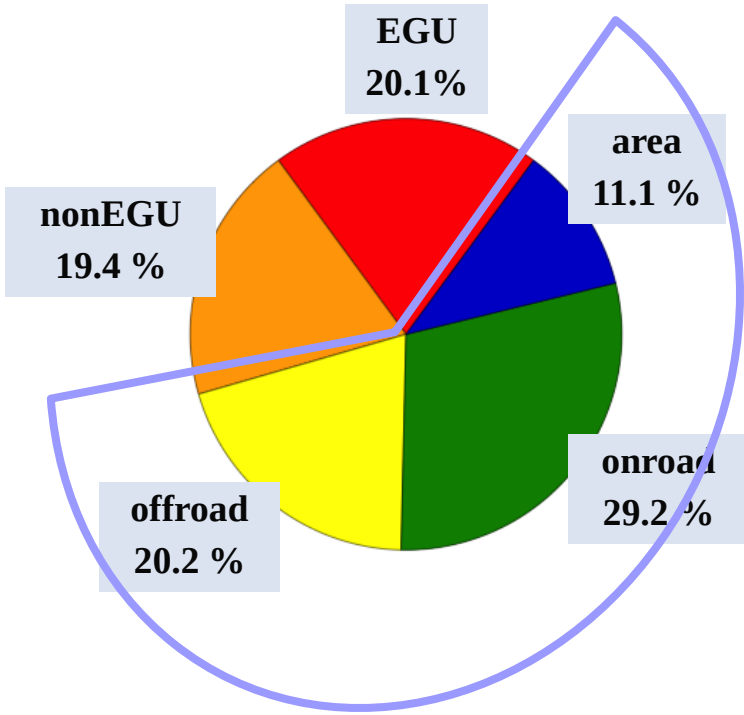


Boundary condition contribution not shown

LADCO OSAT - St. Louis, MO

75 ppb O_3 threshold-ERTAC 2.2

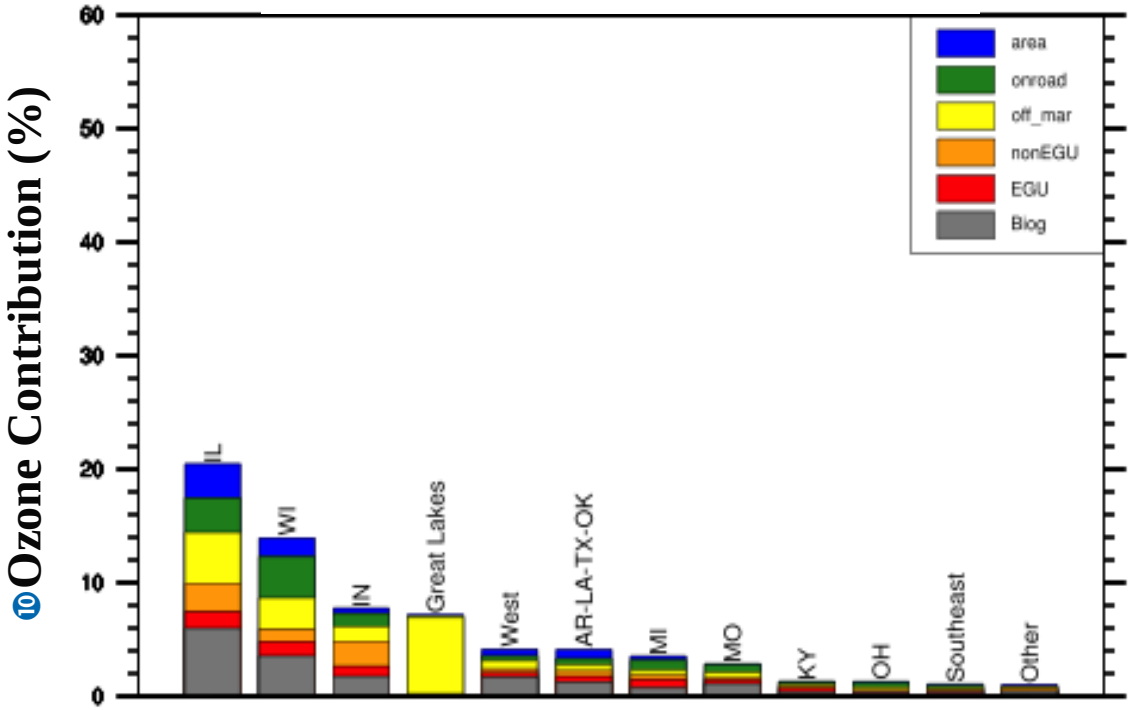




Boundary condition contribution not shown

LADCO OSAT - Sheboygan, WI

75 ppb O_3 threshold-ERTAC 2.2



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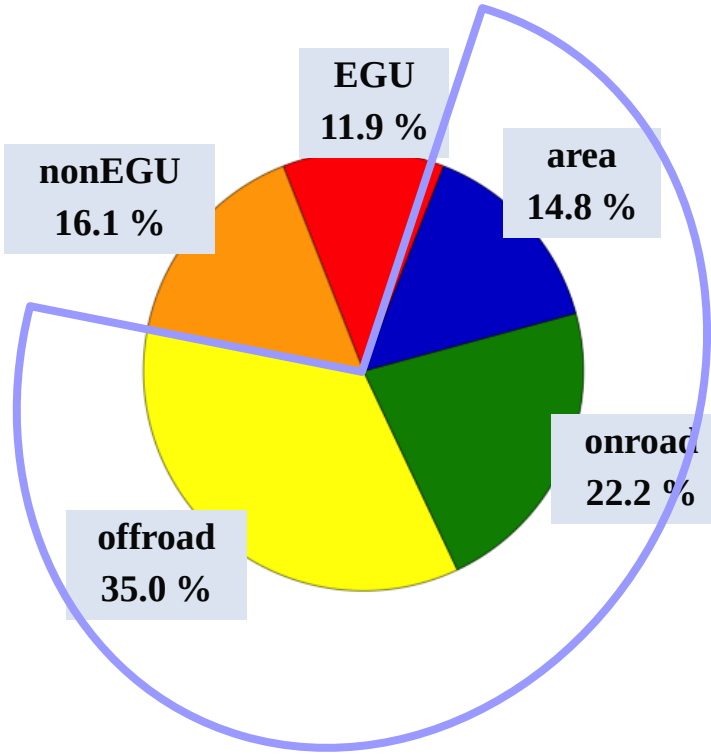

UMD OSAT – Sheboygan, WI

- Daily contribution from OSAT – July 7, 2011
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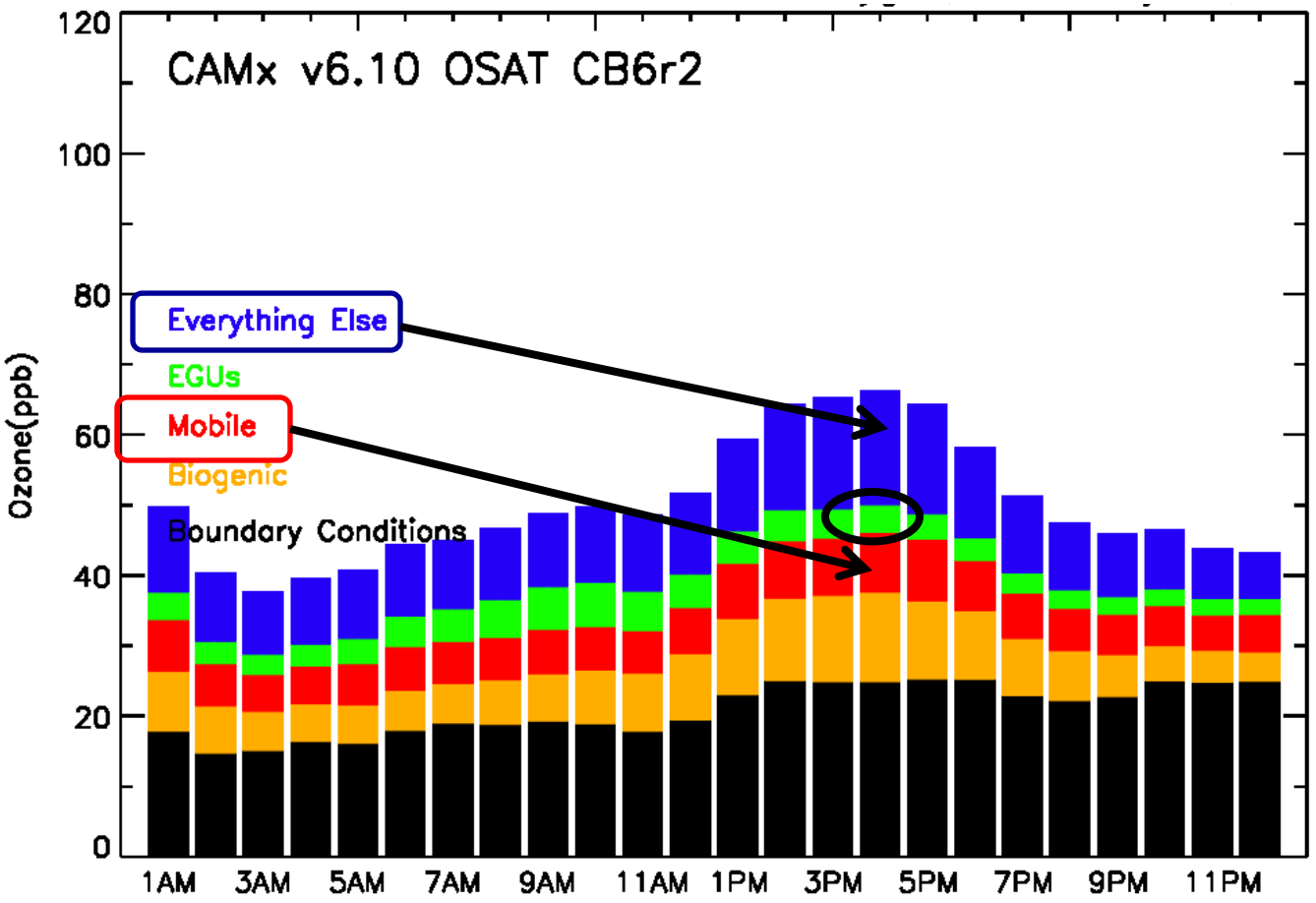
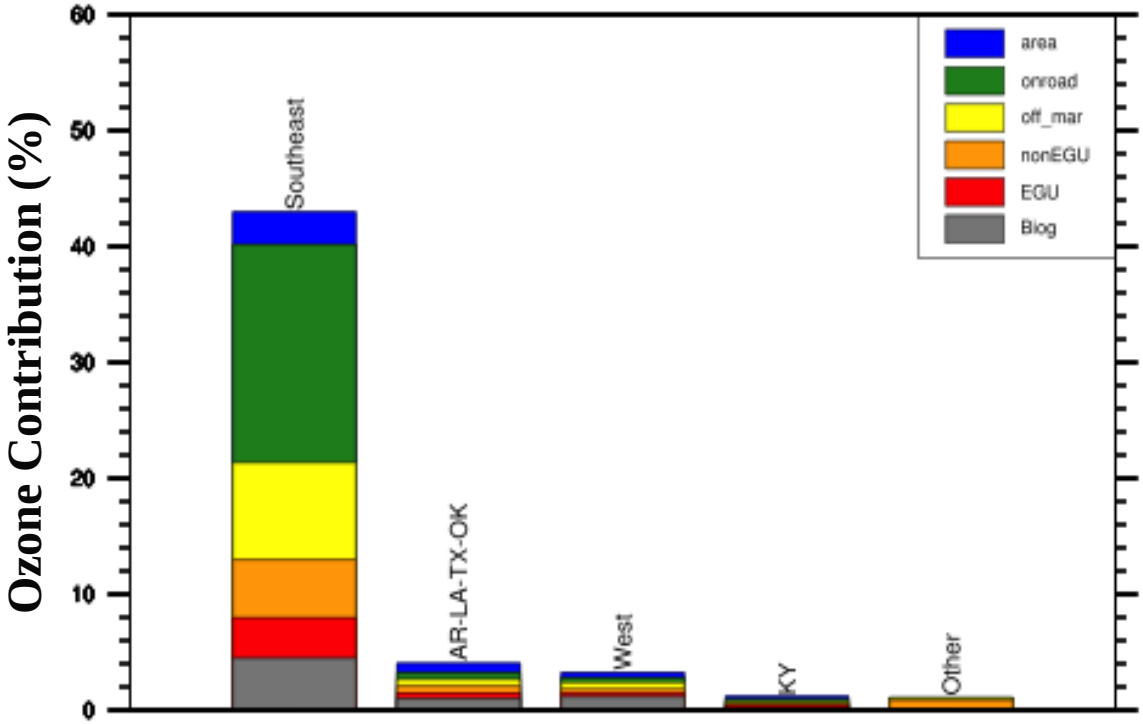
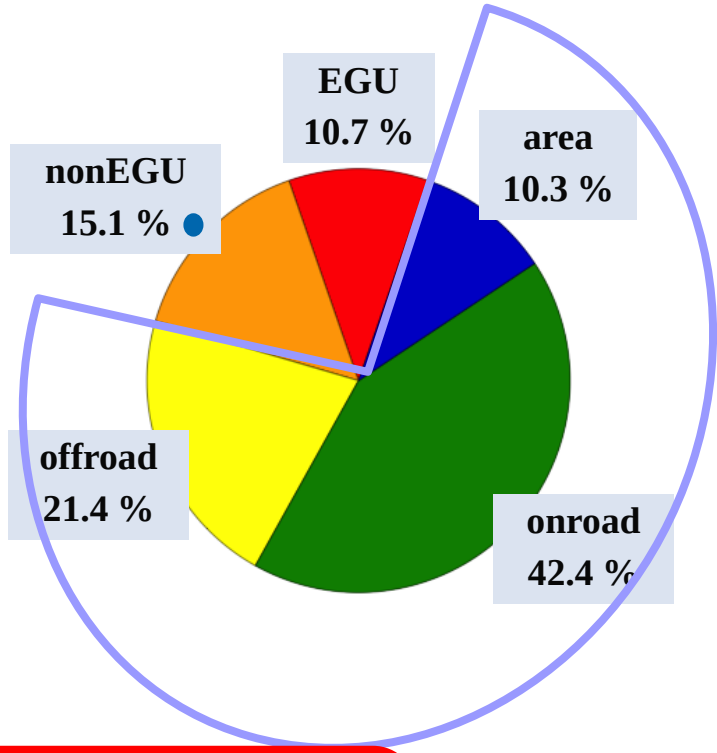


LADCO OSAT - Atlanta, GA

75 ppb O_3 threshold-ERTAC 2.2





It appears that contribution from onroad and offroad mobile and area sources are … or will be … meaningful contributors to eastern ozone transport

Three Additional Early Actions for Consideration

- The OTC states have developed model regional programs for several mobile and area source strategies
- Three appear to be low hanging fruit as they are supported by affected sources … with one common complaint …
  - "This OTC Model Program would work best if implemented by EPA - through a Federal Rule"
- The Three:
  - OTC Model Aftermarket Catalyst Rule
    - About 150 tons per day (tpd) of new NOx reduction across the East
  - The Third Generation OTC Model Consumer Product Rule
    - About 90 tpd of new VOC reductions across the East
  - The Third Generation OTC Model AIM Rule
    - Over 220 tpd of new VOC reductions across the East
- Would be great to have support from other states and the private sector for a federal rule for these categories

MD Thoughts on Control Measures

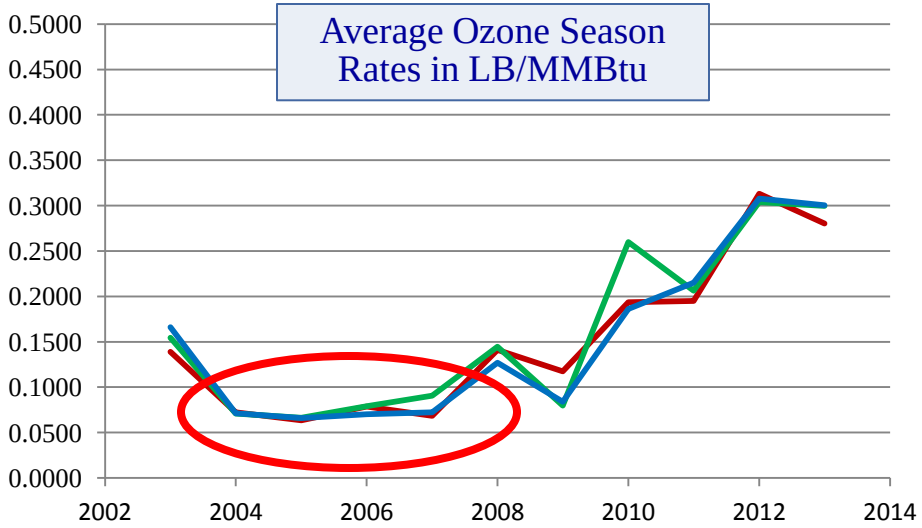
… EPAs question to us on April 8th … What does the Maryland modeling tell us about short-term control measures that may be needed for Good Neighbor SIPs?

- Running EGU controls well (Optimized EGUs) appears to be a common sense strategy that would be beneficial to many areas …
  - For Good Neighbor responsibilities and for future potential designations
    - At a minimum, EGUs should be expected to run their controls well enough to at least meet 30-day rolling average rates consistent with better rates seen in earlier years when controls were run more efficiently
      - This can be done very simply as a constraint on the Federal trading programs
      - More in a minute
  - Up to 500 tpd of NOx reductions in the East
- The nine OTC measures appear to be important for inclusion in Good Neighbor SIPs for states in the OTR – Maybe other areas?
  - About 150 tpd NOx reduction in the 13 OTC states. VOC reductions as well.
- Three "not EGU" control programs may be very helpful if implemented as a Federal Rule
  - Expanded OTC Aftermarket Catalysts … Expanded OTC Consumer Products … Expanded OTC AIM Rule – All across the East

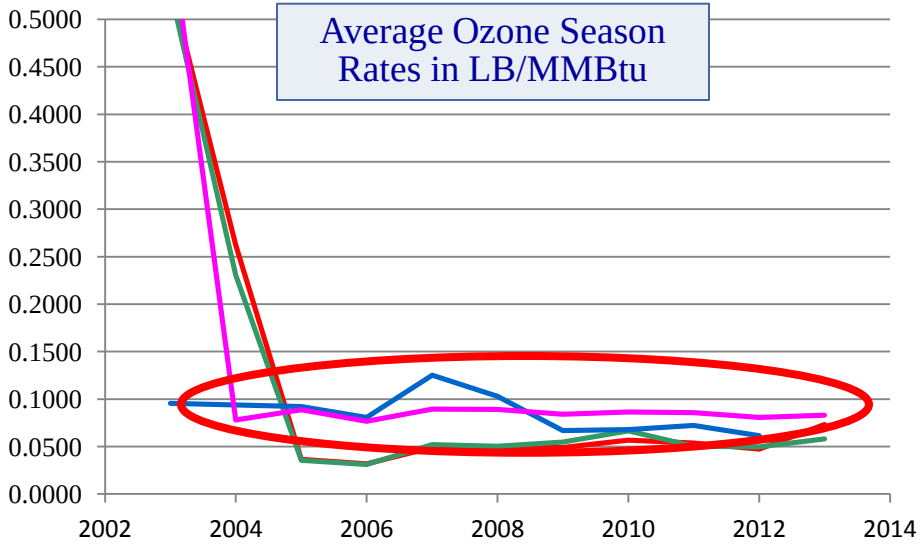
A Straw Proposal From MD

- Can we find a common sense way to insure that EGU controls are run reasonably well … when they are needed … while also providing considerable flexibility to affected sources
  - MD's basic approach … Trading programs are good and do work
    - However, when the underlying market behind a market-based program changes … that market based program needs to be adjusted
  - The straw proposal … Assume some kind of ongoing trading program that sets annual and ozone season caps for EGUs
    - Look at historical performance for units that have SCRs and SNCRs
      - Adjust as needed to address potential issues with low capacity operation, mercury and other issues
    - Focus on units owned by the same owner within a single state
    - Establish 30-day rolling average rates for a companies "statewide system" that must be met (a constraint on how trading can work) from June 1 to August 30

Constraining Trading - An Example



- 3 units in one state under common ownership
- Better performance in the past
- These 3 units would be required to constrain their trading plan to meet something like a
  - 0.08 to 0.10 LB/MMBtu as a 30-day rolling average from June 1 to August 30



- 4 units in one state under common ownership
- Consistent performance
- These 4 units would be required to constrain their trading plan to meet something like a
  - 0.08 to 0.10 LB/MMBtu as a 30-day rolling average from June 1 to August 30

A Little Bit on Some of Our New Science

- Several emerging research efforts appear to show that:
  - Further away NOx reductions may be more important than we think
  - Power plant emissions may be more important than we think
  - Mobile source emissions may be less important than we think
  - The modeling may be overly optimistic
  - A ton of NOx reductions in 2020 may generate more ozone reduction than a ton of NOx reduction in 2000

Comparing the Model to the Observations

- U of M has conducted extensive analyses of how the various outputs from the CMAQ and CAMX models compare to the comprehensive data collected as part of the 2011 NASA DISCOVER-AQ campaign.
- What they saw:
  - Comparison between satellite observations of tropospheric column NO2 and CMAQ NO2 output shows model biased high in urban regions (too much NO2) and low in rural regions (not enough NO2)
    - Are mobile emissions accurate?
  - Alkyl nitrates aloft several times higher in CMAQ (with CB05) than observed during Discover AQ
    - Is the aloft chemistry capturing transport?
  - CO/NOy ratio lower in CMAQ than observed during Discover AQ or in the NEI (EPA National Emissions Inventory)
    - Again, is the mobile inventory accurate?

The Beta Runs

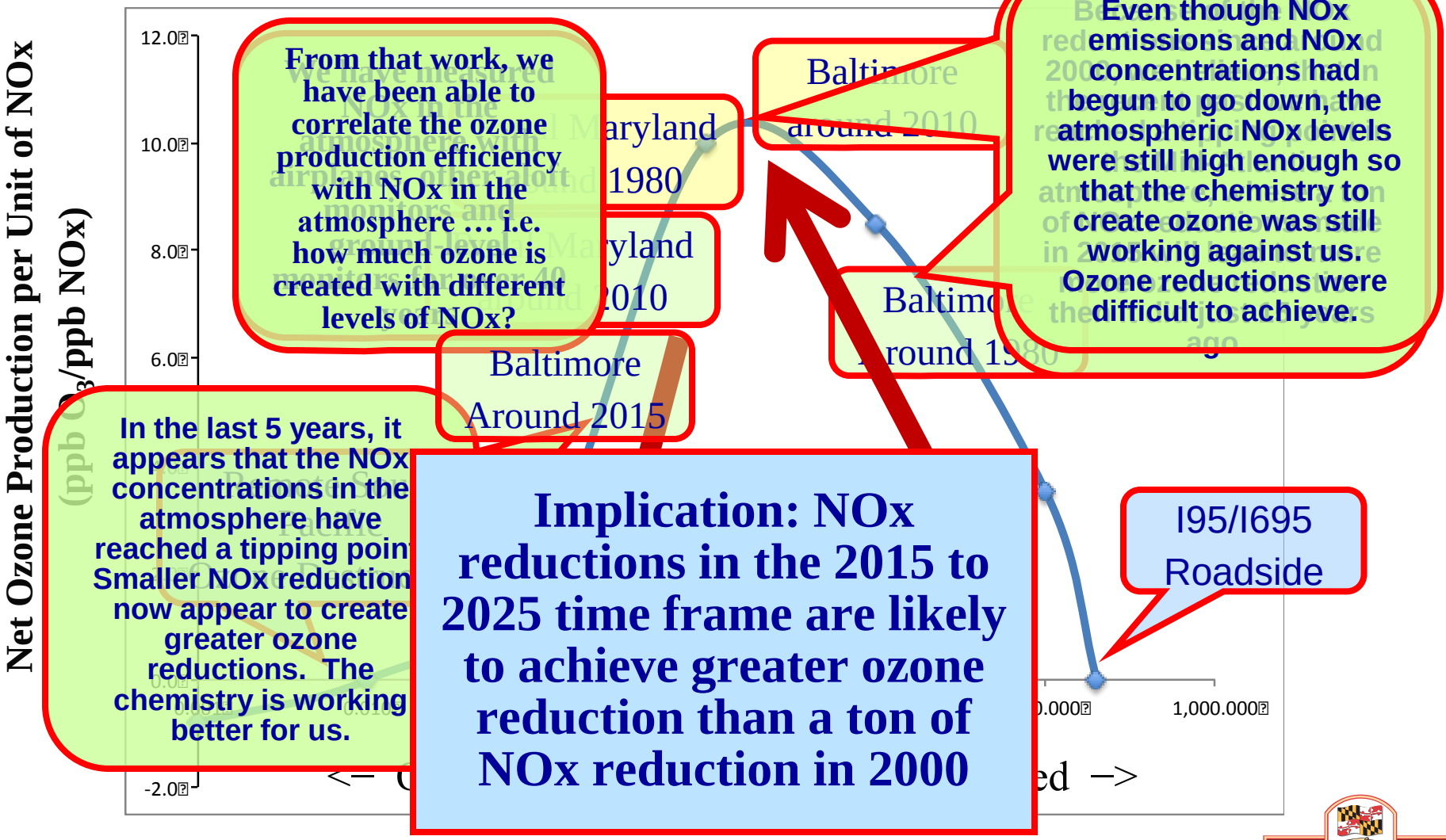
- To see if these disconnects between the model output and the measured data can be fixed, U of M has developed a set of model runs (called the Beta runs) to see how the model reacts if changes are made to the model inputs
  - Modified the alkyl nitrate (NTR) chemistry aloft
  - Halved the mobile source emissions
- Result: Model output appears to be much closer to observed data seen in Discover AQ
- Research papers from U of M on both of these issues are available

Potential Implications

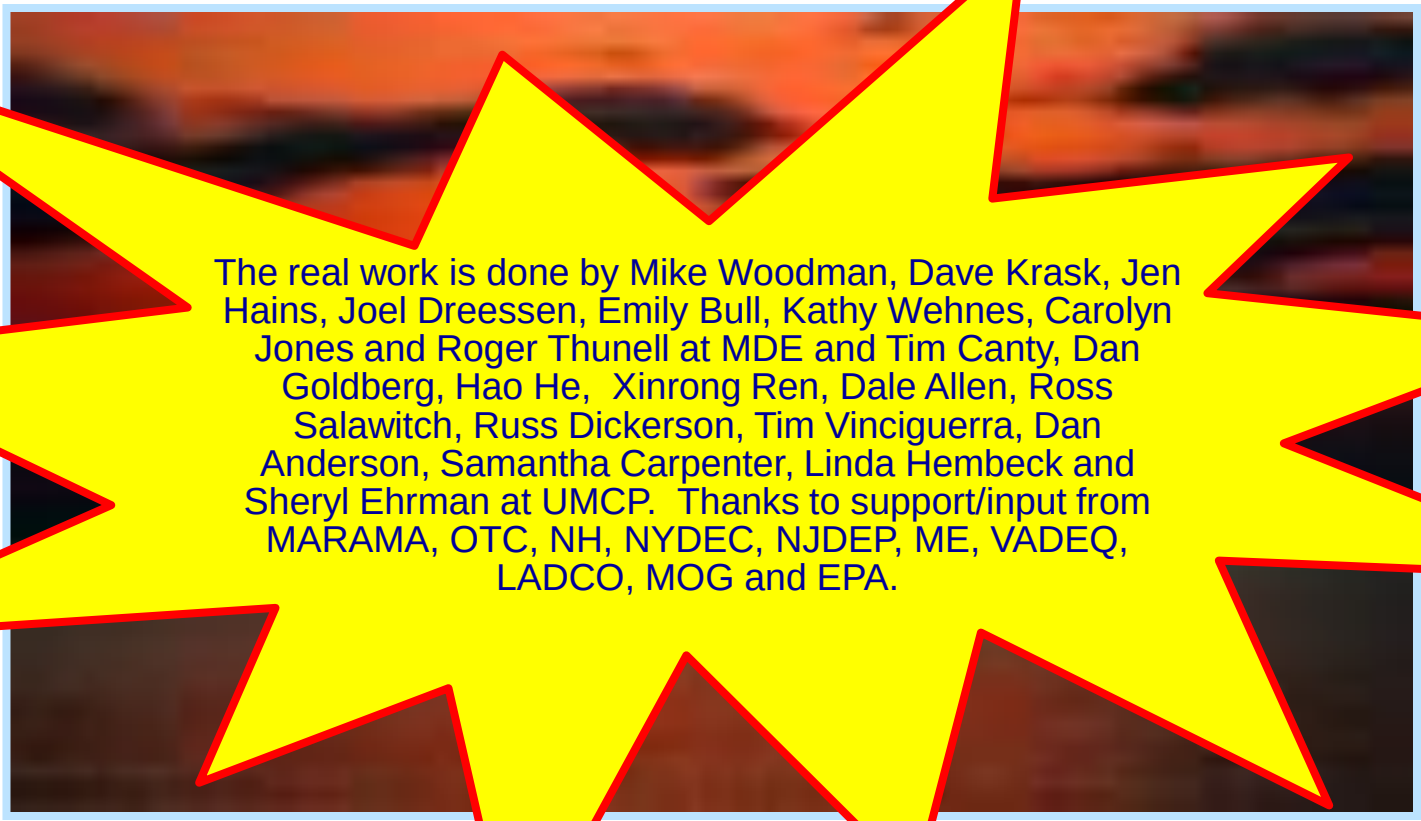
- Still very preliminary research, but the implications could be significant
- Appears to support the hypothesis that:
  - Further away NOx reductions may be more important than we think
  - Power plant NOx emissions may be more important than we think
  - Mobile source NOx emissions may be less important than we think
  - The modeling may be overly optimistic

Have We Reached a Tipping Point with NOx?

Schematic diagram of ozone production efficiency for the eastern US. - Getting over the hump



Thanks



The real work is done by Mike Woodman, Dave Krask, Jen Hains, Joel Dreessen, Emily Bull, Kathy Wehnes, Carolyn Jones and Roger Thunell at MDE and Tim Canty, Dan Goldberg, Hao He, Xinrong Ren, Dale Allen, Ross Salawitch, Russ Dickerson, Tim Vinciguerra, Dan Anderson, Samantha Carpenter, Linda Hembeck and Sheryl Ehrman at UMCP. Thanks to support/input from MARAMA, OTC, NH, NYDEC, NJDEP, ME, VADEQ, LADCO, MOG and EPA.