A Path Forward For Reducing Ozone in Maryland and the Mid-Atlantic States

Driving Policy With Science

What Has Worked
What Has Not Worked
What We Now Know
Where To Go From Here

Tad Aburn, Air Director, MDE
AQCAC - December 11, 2017
So ... How are we really doing?

Appear to be Winning Quite a Few Battles. Still A Lot More to Do.
We Have a Clear Path Forward

We understand the science of ozone better than ever
We’ve implemented programs that have worked in the real world
We need a two-part strategy

1. Local ... inside the Ozone Transport Region (OTR) controls are still important
   - Can help reduce about 1/3 of the ozone problem in most cities in the OTR

2. National or super-regional controls of nitrogen oxide (NOx) to reduce ozone transport are critical
   - Incoming ozone is already measured at levels approaching the 70 ppb standard
   - Regional contribution represents approximately 2/3 of the ozone problem in cities in the OTR
The solution to the ozone problem in the East has not changed
  • We know that widespread regional NOx reductions reduce ozone
  • Local controls also are important

We now have even better science proving that the solution will work
  • In most areas ... NOx reductions are now “supercharged” ... smaller reductions get greater benefits
  • CT/NY/NJ area is close to the tipping point for supercharged NOx reduction

We’re poised to make even greater progress ... more regional and local NOx reductions are on the way

We also have some very significant challenges with the new standard
Ozone Tended Downward from 1997-2017

The “Path Forward” at work …

- Effective super regional NOx reductions across the East such as the 2003/2004 “NOx SIP Call (power plants) and the 2007 NOx reductions from “Tier 2” (vehicle standards) ... complemented by
- Effective local controls in many OTC states
The Shrinking Ozone Problem

2000

8–HOUR OZONE DESIGN VALUE
2015 Ozone NAAQS (70 ppb)

8-Hour Ozone

* 2016 Data is considered Preliminary
The Shrinking Ozone Problem

8-Hour Ozone Meets Standard Exceeds Standard

1990

2016

<65 70 75 80 85 90 95 100 105 >110 ppb
The “Path Forward” at work ...
- Effective super regional SO2 reductions across the East. Primarily power plant controls like the Acid Rain Program and the early reductions from “CAIR”
- Effective local SO2 controls in many OTC states
Visibility Has Also Improved Significantly

The “Path Forward” at work …

- Again, effective super regional SO2 reductions across the East. Primarily power plant controls like the Acid Rain Program and the early reductions from “CAIR”
  - Effective local SO2 controls in many MANE-VU states
So Why is it Working?

In simple terms, we are making significant progress by addressing the 2 key parts to our ozone problem:

1. Local emissions
2. Regional emissions or transport

They bring us ozone in different ways and vary by day in terms of importance.

Continuing the progress will be more challenging.

Understanding the “How” piece of the ozone transport problem is critical to our current and future policy development and progress.
Understanding Ozone Transport

It’s complicated … but not that complicated … some key concepts

An “elevated reservoir” of ozone

• A transport cloud
• An elevated ocean of ozone
• The residual layer
• Where transport collects

Three different types of transport

1. Westerly Transport – Power plants are a major contributor
2. Night-time, Southerly Transport – Vehicles, power plants, more
3. “Local” or “City-to-City” Transport – An urban soup … Washington to Baltimore … Baltimore to Philly … NJ & NY to CT … to MA … to ME … etc. etc. etc.
THE EVOLUTION OF A BAD OZONE DAY

DAYTIME ... NIGHT TIME ... LONG DISTANCE TRANSPORT ... LOCAL EMISSIONS
The Four Phases of A Bad Ozone Day

1. The night before the bad ozone day
   - Ground Level ozone is mostly very low
   - Transported ozone builds up and is trapped aloft in an “elevated reservoir”

2. The morning of the bad ozone day
   - The elevated reservoir mixes down to ground level
   - As a result, the day starts with a “transport penalty” of 60% to 70% of the standard

3. The day of a bad ozone day
   - Local emissions cook and add ozone
   - Emissions from nearby areas (DC → Baltimore, NYC → CT) cook and add ozone
   - Daytime transport continues to add ozone

Add it all up on a bad day - 80 ppb ozone

4. The night after the bad ozone day
   - Everything starts again ... NJ/NY/CT plume gets transported up the NE coast to MA/RI/NH/ME
A classic, worst-case event on July 15, 1995

The Daily Ozone Creation Pattern

The colored line – Aloft monitors ... now supplemented with balloons

The gray line – MD ground level ozone monitors

Inversion Breaks The Regional Signal

Elevated Reservoir Before Inversion Break

Local and Regional Pollution Combined

Shenandoah NP, VA (Elevated)

Line: Average of Maryland Monitors (Near Sea-Level)

Shaded: Virginia near Sea-Level Monitors

Source: Maryland Department of the Environment
Daily Ozone Pattern - Very Recent - Maryland

May 25, 2016

Hourly Ozone Concentration (ppb)

- Variations of Near Sea-Level Monitors
- Piney Run, MD (Elevated)
- Average Profile of Maryland Monitors (Near Sea-Level)
- Methodist Hill, PA (Elevated)
- Shenandoah NP, VA (Elevated)

- Local and Regional Pollution Combined
- Inversion Breaks The Regional Signal
- Elevated Reservoir Before Inversion Break
Same Signal – Tennessee 2011

Aloft Ozone Reservoir (June 8, 2011)

1. Elevated Reservoir Before Inversion Break
2. Inversion Breaks The Regional Signal
3. Local and Regional Pollution Combined

Source: Maryland Department of the Environment

- Cove Mountain - GSMNP, TN (Elevated)
- FRYPAN, NC (Elevated)
- Line: Average Profile of Tennessee Monitors (Near Sea-Level)
- Shaded: Variations of Near Sea-Level Monitors
A Reservoir - Maybe More Like an Ocean - of Ozone
Sitting 2000 feet Above Us - While We Sleep

A balloon launch at 2:20 am south of Baltimore ... north of Washington

Ground Ozone is Low

Cloud of High Ozone Aloft... 60-75+ ppb

We see this before almost every bad ozone day

Source: Maryland Department of the Environment and Howard University
At least we are not seeing 100 ppb in the night time reservoir anymore

A balloon launch at 2:20 am south of Baltimore ... north of Washington

Nearly 100 ppb at 2:20 in the middle of the night
The Night-Time Elevated Ozone Reservoir

What creates the reservoir and how big is it?

- The night before every bad ozone day, a large reservoir of ozone sits above the OTC.
- What’s over MD on Tuesday night started off in Ohio and North Carolina on Monday.
  - MD’s pollution soup floats to New Jersey and New York.
  - New York’s pollution floats to CT and New England.
- Power plants, cars, trucks and other sources are all contributors to the elevated pollutant reservoir.
- Filled with ozone and ozone precursors.
An Ozone Transport Reservoir Example

May 17, 2017
6 am EDT

Monitors:
Ground level - Reading Lower
Aloft - Reading Higher

- Whiteface Mt., NY 59 ppb
- Mohawk Mt., CT 55 ppb
- Piney Run, MD 57 ppb
- Shenandoah NP, VA 65 ppb
- Horton Station, VA 62 ppb
The “Morning Of” a Bad Ozone Day

What was trapped aloft ... mixes down around 9 am as the earth heats up and the nocturnal inversion collapses

The “Transport Penalty” ... 50 to 70 ppb
At least we are not seeing 100 ppb as a transport penalty anymore

Aloft Ozone Reservoir (July 15, 1995)

100 to 110 ppb “Transport Penalty”
Day of the Event

A lot happens the day of the bad ozone event ...

- But remember, you’re already starting with a 50-60 ppb penalty from “day before” transport

Four key factors add pollution during the afternoon

1. Your low-level local emissions - which actually start at around morning rush hour - float and cook and begin to add to ozone levels around 10:00 and eventually to peak ozone levels in the late afternoon
2. The low-level emissions from areas just upwind of you also start at rush hour - float, cook and also gradually contribute to the afternoon peak
3. Continued “aloft” transport can continue to “mix down” all day long
4. Local meteorology, geography and chemistry can push ... and pull ... and redirect ... and trap ... and compress ozone to make late afternoon ozone even higher

More on these issues later
“Local” Emissions

In the real world, all emissions that can react at ground level to create ozone on the same day of an exceedance event are considered “local”

- Scientists call this the “local airshed”

Unfortunately the CAA works differently

- Nonattainment areas are almost always smaller than the local airshed
- Washington is part of the local airshed for the Baltimore Nonattainment Area (NAA)
- Much of Eastern PA, NJ and NY are part of the NJ/NY/CT airshed

Under the CAA this kind of local emission transport is handled by Transport (Good Neighbor) SIPs not Attainment SIPs
High aloft … daytime … ozone … between Baltimore and Washington

Daytime Transport - Baltimore

7/21/2017 - 2:49 pm
Beltsville, MD

Plenty of ozone still aloft (80+ ppb)

Subsidence pushes aloft pollution down

Surface ozone elevated

Source: Maryland Department of the Environment and Howard University
The Night After the Bad Ozone Day

The same cycle begins to repeat itself

• Elevated ozone reservoir builds overnight as the night time inversions traps ozone aloft
• Reservoir mixes down the next morning - the 50 to 60 ppb ozone transport penalty
• Local emissions and emissions from close by areas are added in to create afternoon peak ozone levels

For Northern New England - The New York City plume floats north - towards areas like Maine and Massachusetts

• New York City plume moves out over the Atlantic
• Moves up the New England Coast over night
• Winds push the plume back on to land and can sometimes be high enough to create exceedances in Maine and Massachusetts
THE THREE DIFFERENT TYPES OF TRANSPORT
OTC and the states work in partnership with local universities (UMD at College Park, UMBC, SUNY, Rutgers, Penn State and Howard University) to study ozone and fine particulate air pollution problems.

- MD has the luxury of a dedicated research fund

**Major focus ... Transport**

- Airplanes ... Balloons ... Lidar (laser based measurements)
- Profilers ... Satellites ... Special monitors ... Modeling
- Much, much more

**Early focus was Maryland and the Mid-Atlantic**

Some earlier research in Northern New England also looked at transport.

More recently, 2017 research shifted to the north to study the NJ/NY/CT area.
The Three Different Types of Transport

- Westerly Transport
- Night-time, Southern, "Low Level Jet" Transport
- City-to-City ... or "Local" Transport
Classic Ozone Weather for the OTR

Pollution Plume

Warm Moist Air Flow

Produced by: Maryland Department of the Environment
Westerly Transport

2016

NOx Emissions
SO2 Emissions

(Size is relative total facility emissions)
Fingerprinting Westerly Transport - Then

Classic work from 1995 - What can data tell us about its origin?

High Aloft Ozone
~ 100 ppb
3000 - 6000 ft

Does not correlate well with CO
* Not Cars *

Correlates well with SO₂
* Likely Power Plants *

Correlates with “Aged NOₓ”
* It’s Old *

Vertical Profiles of Ozone, CO, SO₂, and NOₓ at Luray, VA July 15, 1995 at 7 AM

Data Source: UMD

Back Trajectory

Vertical Profiles of Ozone, CO, SO₂, and NOₓ at Luray, VA July 15, 1995 at 7 AM

Data Source: UMD
Fingerprinting Westerly Transport - Now

Same basic story - Just less ozone

- High Aloft Ozone: ~ 70 ppb at 3000 ft
- Does not correlate well with CO: *Not Cars* *
- Correlates well with SO$_2$: *Likely Power Plants* *

Vertical Profiles of Ozone, CO, and SO$_2$ at Millington, MD July 19, 2013 at 12 PM

Data Source: UMD
The 2003/2004 “NO\textsubscript{X} SIP Call” as a case study. Significant NO\textsubscript{X} reductions from Federal Tier 2 Vehicle Standards occurring in the same time frame

- A classic ozone transport success story
- Incoming ozone levels collect in the elevated reservoir over night
- Real world programs like the NO\textsubscript{X} SIP Call (power plants) and the Tier 2 Vehicle Standards show that:
  - Adding regional controls ...
  - Results in regional NO\textsubscript{X} emission reductions ...
  - Which leads to reduced ozone in the elevated reservoir ...
  - Which lead to lower ozone at ground level and public health protection!
Maryland’s Westerly Transport “Spy” Site

More Recent Progress With Westerly Transport

<table>
<thead>
<tr>
<th>Period</th>
<th>Avg. all days June – August</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2012</td>
<td>52.7 ppb</td>
</tr>
<tr>
<td>2013-2016</td>
<td>44.2 ppb</td>
</tr>
</tbody>
</table>

Difference 8.5ppb

4-year daily maximum 8-hour ozone average: 2009-12 & 2013-16

Piney Run is a mountain-top monitor and measures the amount of ozone being transported into Maryland’s western border.
The Nocturnal Low Level Jet (NLLJ)

Fast-moving, narrow “river” of air typically around 1000 feet above the surface

In the Mid-Atlantic and New England, typically observed during the night between Appalachians and the Atlantic Ocean.

- Wind speeds can reach 40 mph or more.
- Stretches from NC to MD to NJ and further up the east coast.

Seen during most, Mid-Atlantic summer-time air pollution events.

- Some form of NLLJ on virtually all code orange or red days

Old and new findings:

- 10 years ago ... the presence of a NLLJ increased Baltimore ozone by 7 ppb.
- Past few years ... Ozone being transported by the NLLJ is still important, but it has decreased remarkably
Wind Speed and Wind Direction - Beltsville, MD on August 9 - 10, 2010

30 mph for 7 hours is about 210 miles

August 9th, 11 PM – 7 AM
Winds from the southwest at about 25 - 30 mph

August 10th, 10 PM – 8 AM
Winds from the southwest at about 25 - 40 mph

What does this graph tell us?
- Wind direction
- Wind speed
- From the ground up
Howard University launched 4 ozonesondes on July 12-13, 2008. The 10:30 PM (Saturday, July 12th) and 2:30 AM (Sunday, July 13th) occurred during a NLLJ event, as captured by MDE’s Wind Profiler.

At 2:30 AM, there was a 100 ppb “Code Red” Ozone spike at the NLLJ core. Air traveled 300+ miles at a speed of 22+ mph for 14+ hours.
NLLJ can still transport ozone but southerly winds in recent years have been associated with cleaner conditions. The NLLJ is cleaner than in the past!!!
10 years ago, we saw the NLLJ pushing high ozone levels from south to north all the time.

That has changed !!!

Large NO\textsubscript{x} reductions in VA are clearly linked to this progress

Should continue to improve as mobile source NO\textsubscript{x} is reduced by the Tier 3 Vehicle and Fuel Requirement and EGU emissions are further reduced by federal rules and continuing market pressures
City-to-City or “Local” Transport

- This type of transport is all at ground level. Westerly and NLLJ transport is aloft transport that mixes down.
- Surface winds in the OTR are typically from the southwest to the northeast.
- The morning pollution in Washington stays at ground level and floats downwind to become a major part of the afternoon pollution in Baltimore.
- The morning pollution in NJ, NY and New York City becomes part of the afternoon ozone pollution measured in CT.
- MD to PA ... PA to NJ ... NJ to NY ... NY to CT ... CT to MA ... MA to NH & ME ... and so on.
What Drives “Local” Transport?

Includes emissions in the nonattainment area, emissions from close by upwind cities and emissions from other emission sources in the “local airshed”

• In OTR low level winds generally push pollution from the southwest to the northeast - but not always

Sources include everything ...

• Cars, trucks and other mobile sources along the I-95 corridor
• Power plants including “peakers” that don’t run every day, but often run on the hottest (worst for ozone) days
• Collectively, the hundreds to millions of “mini” or area sources linked to people doing things (painting, consumer products, small businesses like dry cleaning and so on and so on...)

We know that reducing local NOx emissions works. In areas like New York City, reducing local volatile organic compounds (VOCs) also appears to be important
Approximations of the local airsheds for the Baltimore and the NJ/NY CT Nonattainment Areas

<table>
<thead>
<tr>
<th>Approximate 2011 NO(_x) Emissions</th>
<th>Tons per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltimore NAA</td>
<td>~ 70,000</td>
</tr>
<tr>
<td>Washington NAA</td>
<td>~ 96,000</td>
</tr>
<tr>
<td>Baltimore Local Airshed</td>
<td>~ 500,000</td>
</tr>
<tr>
<td>Just CT</td>
<td>~ 65,000</td>
</tr>
<tr>
<td>NJ/NY/CT NAA</td>
<td>~ 330,000</td>
</tr>
<tr>
<td>CT Local Airshed</td>
<td>~ 900,000</td>
</tr>
</tbody>
</table>
While local and city-to-city transport continue through the daytime ... on the worst ozone days ... daytime ozone transport from aloft is added to the mix.

- Wind and sunshine act like a boat propeller and “mix” air higher up with air near the surface.
- High atmospheric pressure causes a weather phenomenon called subsidence. Literally the atmosphere pushes the aloft air towards the surface.

Vertical mixing is a two-edged sword

- On days with dirty daytime aloft transport - dirtier air aloft is mixed down making ground-level ozone worse
- On days with less continuing transport cleaner air aloft is mixed down making ground-level ozone better
Three Other Critical Issues that Make Ozone in the OTR Challenging

Fine-scale but policy critical phenomena driven by local chemistry, meteorology, and geography make afternoon ozone extremely interesting but troublesome

• Changing chemistry - less ozone being formed - in most areas of the OTR
  ▪ But not as much in NJ/NY/CT !!!

• The build up of very high ozone over water bodies like the Chesapeake Bay, Long Island Sound and off the Northern New England Coast
  ▪ Higher ozone levels over water than over land

• Local wind patterns like Bay and sea breezes often push the high ozone over the water onto the land

• Other routine summertime wind patterns like something called the “Lee-Side Trough” can change flow of ozone from “west to east” ... to ... “south to north” ... sort of a hard left in MD/PA ... up to CT
In the Mid-Atlantic, NO\textsubscript{x} reduction efforts seem to be returning unexpected dividends. We know that regional NO\textsubscript{x} reductions will clearly reduce ozone levels. It appears that in 2017, enough NO\textsubscript{x} has been taken out of the system that the chemistry has changed:

• We now get more ozone reduction per every ton of NO\textsubscript{x} we reduce compared to 2000.
Why a Ton of NOx Reductions Works Better in Baltimore

- We can calculate the ozone production efficiency in an area and how it relates to measured NOx in the air.
  1. Look at all days in an area that are 85 degrees or higher.
  2. Look at the number of days you have an exceedance on weekdays (more NOx).
  3. Look at the number of days you have an exceedance on weekends (less NOx).
  4. Compare weekday measured NOx in the air to weekend NOx.
  5. Calculate the probability of an exceedance for weekdays and weekends.
  6. Compare years.
  7. What do we learn?

Probability of a weekday exceedance in Baltimore when it's hotter than 85 degrees in 2016:
- About 1 for every 3 hot days.
- About 9 ppb NO2 in the air.

Probability of a weekend exceedance in Baltimore when it's hotter than 85 degrees in 2016:
- Less than 1 for every 4 hot days.
- About 5 ppb NO2 in the air.

Steep slope shows dramatic increase in ozone production with less NOx.

The key to pushing the tipping point in NJ/NY/CT ... Keep reducing NOx emissions.
The dreaded “Land/Water Interface” issue
Why are the toughest monitors to solve (Harford, MD - Fairfield, CT - Suffolk, NY, Coastal NE) located right next to bodies of water?

- The Chesapeake Bay, the Long Island Sound, the Atlantic Ocean off of the northern New England coast, etc.
- Not unique to the OTC - Sheboygan WI another great example

The meteorology, geography and chemistry are slightly complicated

- ... but the reality is ozone is almost always higher over water than land
How do We Know Ozone is Higher Over Water?

Lot’s of studies, lots of theory say it is so

But, for the last three years, Maryland has run a research monitor at Hart-Miller Island - right in the middle of the Chesapeake Bay.

• It consistently reads higher for ozone on bad ozone days

Although a treasured resource, the Bay can be a “dirty air collector" and an “ozone factory”

• At night the water is warmer than adjacent land pulling polluted air from the land over the water. With sunlight the already polluted air over a body of water forms even more ozone.

• Water is often cooler than land. The mixing height over the water is always lower than on land. Less room to spread out - higher concentrations of ozone.

• Light reflectivity also increases over bodies of water and leads to increased ozone formation

• 2011 Discover AQ ozone study also showed that chemistry over the Chesapeake Bay can enhance ozone formation

Highest Ozone on Bad Days in MD
… Right in the middle of the Bay

Average Ozone Concentration (ppb) on Exceedance Days 2016
To make matters worse, meteorology and geography conspire to create Bay and sea breezes that push and pull the dirtier air over the water - back onto land where people live.

Sunlight warms the ground, heating the air above it. The air then rises due to its lower density. Puffy clouds may form.

Air starts to move horizontally in response to the rising air. Above the ground, air moves away from the rising air while at the surface it rushes to take its place. This creates “Bay Breezes”.

Downward moving air develops over the water to compensate for the horizontally moving air. Keeps area cloud-free.

Downward moving air acts to transport, trap and then concentrate pollution in a shallow layer above the water.

Landward moving air sweeps the higher ozone levels on to nearby coastal sites.
SO ... WHAT HAVE WE LEARNED
AND
WHERE DO WE GO NEXT
Sort of … Ozone season EGU NO\textsubscript{x} emissions continue to decrease across the East

> That said, still more work to do
> Most states had lowest ozone season NO\textsubscript{x} emissions on record in 2016
How About Mobile Source NOx Reductions?

Significant reductions in this sector as well ... more on the way

Mobile Source NOx Reductions in the OTC

Tons per ozone season (x 1000)
NOx Reductions As Seen From Satellites

$NO_2$ Reductions from Space - 2005 to 2014

Source: NASA's Aura Satellite
Focusing on the East

NO$_2$ Reductions from Space - 2005 to 2014

Source: NASA's Aura Satellite

Notice the change in NO$_2$ along the Ohio River Valley and along the I-95 Corridor
Aloft Ozone Reservoir - Lower Each Year ... i.e. Less Transport

Dramatic Progress in Reducing Long Distance, Aloft Transport
That’s All Great, But What Going on in Connecticut?

• Ozone has been going down in almost all of the East ... Except in Connecticut
• Why?
• Research shows that the NJ/NY/CT area has just started to reach the tipping point in the atmosphere that allows new NOx reductions to generate even greater ozone benefit
• It also appears that NOx emissions from EGUs that are directly upwind of NJ/NY/CT are not going down like they are elsewhere
Key Upwind Areas of Contribution ... EGUs - MD and CT

Let’s focus on key areas upwind of Connecticut

And key areas upwind of Baltimore, MD
Good news for MD.
Maryland and SE VA consistent downward trends. Southern VA and NC...something to look at.

CT...Hmmm. Eastern PA emissions have remained essentially unchanged since 2003!! NJ/NY/CT emissions increased ~30% in 2016 over 2015 to levels similar in 2011, 2012, 2013.

!! We understand the science of ozone better than ever
!! We’ve implemented programs that have worked in the real world
!! We need to continue to push two basic emission reduction policies

1. We know that widespread regional NOx reductions work
   - We must continue to push this issue - We know it works - Our #1 priority
     o New federal programs will help
     o OTC EGU optimization effort and Section 126 Petitions will help
     o Good Neighbor SIPs should help
     o Market changes and ... yes ... climate change efforts will help

2. We need to continue to push for even deeper NOx and VOC reductions in areas just upwind of OTC problem areas
   - Mostly upwind of Connecticut right now - A little Maryland
     - New NY rules on small generators should help
     - New OTC initiatives ... like idle reduction ... will help
     - Anything that we can do to reduce mobile source NOx will be critical
       - Aftermarket catalysts
       - Electric and other zero emission vehicles
More NOx Reductions - What’s on the Plate?

- **Key Federal Programs to Watch**
  - Tier 3 Vehicle and Fuel Standards - Large NOx reductions from fuels in 2020/2022
  - The Cross State Air Pollution Rule (CSAPR) Update - Significant NOx reductions 2017/2020 - Watch litigation

- **Actions that are In the Works**
  - Maryland MWC RACT rule (today’s meeting)
  - OTC aftermarket catalyst initiative (Spring OTC Meeting - 2017) - Meaningful NOx reductions
  - Idle Free Maryland Initiative (regional action at OTC Fall Meeting - 2017) - More NOx
  - Good Neighbor SIPs - Due in 2018 - Inside and outside of OTR
    - OTC states pushing 5 NOx reduction strategies - coal fired power plants run controls, uncontrolled power plants add controls, implement aftermarket catalyst initiative, enhance idle reduction programs, compressor stations
  - EPA actions on 126 Petitions - CT, DE & MD - Large potential NOx reductions
    - Pushing upwind power plants to simply run existing controls optimally (MD 2015 NOx Regulations) continues to be the most significant control option we have for the near term
Maryland’s 126 Petition

• 36 Units at 19 plants in 5 states
  o PA, WV, OH, KY and IN

• Petitions EPA to require these units to optimize the use of existing control technologies every day of the summer
  o Maryland’s 2015 NOx regulation established this requirement in MD

• Benefits are potentially very large
  o Up to a 300 tons per day of NOx reductions
  o 2 to 5 ppb ozone benefit according to modeling

• Maryland filed a law suit in August of 2017 because of EPA’s failure to respond to the Petition
Maryland’s 126 Petition and the 2017 CSAPR Update

• Did the CSAPR Update achieve the “Ask” in Maryland’s 126 Petition?
  • Sort of ... sometimes

• First year of implementation of the CSAPR Update (and the PA RACT 2 rule) did result in significant new NOx reductions

• That said, the CSAPR Update is still a “cap-and-trade” program where optimization of controls each day of the ozone season is not required

• Maryland has just completed sophisticated analyses of the 2017 emissions data (CAMD data) submitted by about 400 power plants across the East.
  • Available if folks are interested

• Bottom Line
  • Lots of Progress ... but ... still a lot of NOx reductions to be achieved ... if folks just simply run their NOx controls the way they were designed to be run
Lost NOx Reductions - By State

2017 Ozone Season Total NOx Emissions - Actual, Best Rates from Past & Best OS Operating Curve

2017 Ozone Season NOx: 161,578 Tons
2017 Ozone Season NOx @ Best: 115,116 Tons
Lost NOx Benefit: 46,461 Tons (404 tons/day)

2017 Ozone Season NOx @ Best Operating Curve: 121,741 Tons
Lost NOx Benefit: 39,837 Tons (340 tons/day)
Some Additional Observations from the 2017 Ozone Season CAMD Data Analysis

• **Good News** - There are more states with units that appear to be optimizing controls than states with units that are not
  – Many of the states that have been identified by EPA as contributing to Maryland appear to have many units not optimizing controls.
  – With reasonable efforts to optimize controls, up to 400 tons of additional daily NOx reductions could have been achieved in 2017.

• **More Good News** - Many states have a majority of their units close to meeting best historical rates.
  – AR, GA, IA, KS, LA, MD, MN, MO, NE, NJ, TN, TX, VA and WI all have a majority of reported units close to best historical rates
    • Accounting for low capacity operation, AL, IN, NH, PA and SC could also be considered as having a majority of the units close to best historical rates
  – Generally the same states that had a majority of reported units close to best historical rates in 2016.

• **Other News** - Many states have a significant number of units emitting at rates that are noticeably higher than best historical rates ... at least 6 contribute significantly to ozone in MD
  – AL, DE, FL, IL, IN, KY, MI, NC, NH, NY, OH, PA, SC and WV all have units exceeding best historical rates
  – Generally same states that had a majority of reported units exceeding best historical rates in 2016.
The real work is done by Mike Woodman, Dave Krask, Jen Hains, Joel Dreessen, James Boyle, Emily Bull, Hannah Ashenafi, Kathy Wehnes, Carolyn Jones and Roger Thunell at MDE and Tim Canty, Dan Goldberg, Hao He, Xirong 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, CT, VADEQ, LADCO, SESARM, NASA, HAQAST, MOG and EPA.