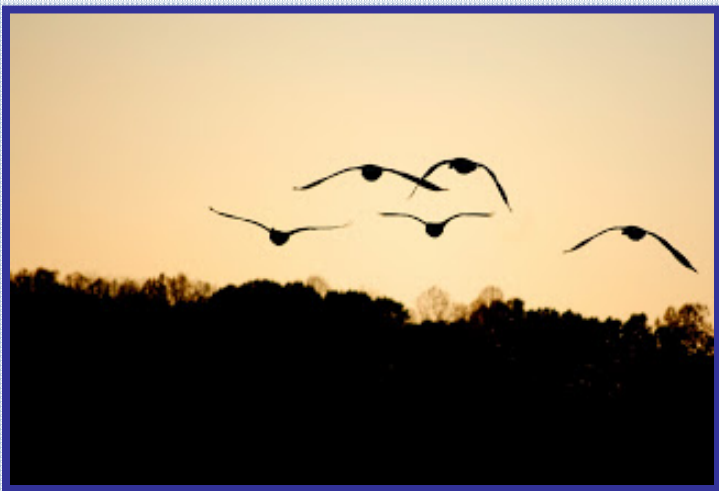


OTC Fall Meeting
November 14, 2013
Washington, DC

Ozone Transport – The Path Forward
So ... How are we really doing?



Topics Covered



- The Path Forward
 - A Recap
- What's working?
- Do we understand the science and what's needed to solve the ozone problem in the East?
- What are the current challenges?
 - Some positive movement
 - Some real challenges
- How and when will the current efforts bear fruit?



Making Progress on Cleaner Air

What We've Achieved Under the Clean Air Act Amendments of 1990, and Where We Need to Go

*Getting to the New Ozone Standards
A Pathway Forward*

November 10th, 2010
Sheraton Hotel Boston, MA

November 10, 2010 "Path Forward"
Presentation – Boston Massachusetts



11/15/2013

November 10, 2010 – The Conclusion

The Path Forward

We understand the science of ozone better than ever

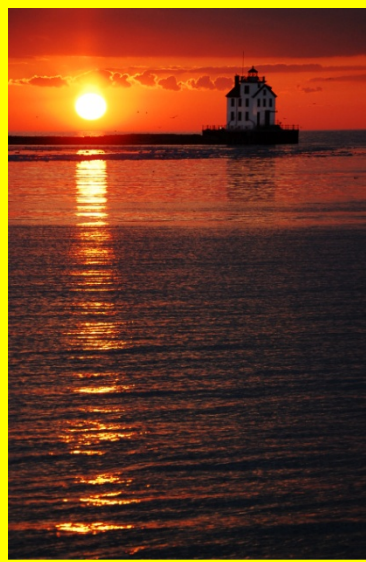
We've implemented programs that have worked in the real world

We need a two-part strategy

- Local (inside the OTR) controls are still critical
 - Can help reduce about 1/3 of the ozone problem in most OTC cities
- National/super-regional controls are now essential
 - Incoming ozone is already measured at levels above a 60-70 ppb standard
 - Regional contribution represents approximately 2/3 of the ozone problem in most OTC cities

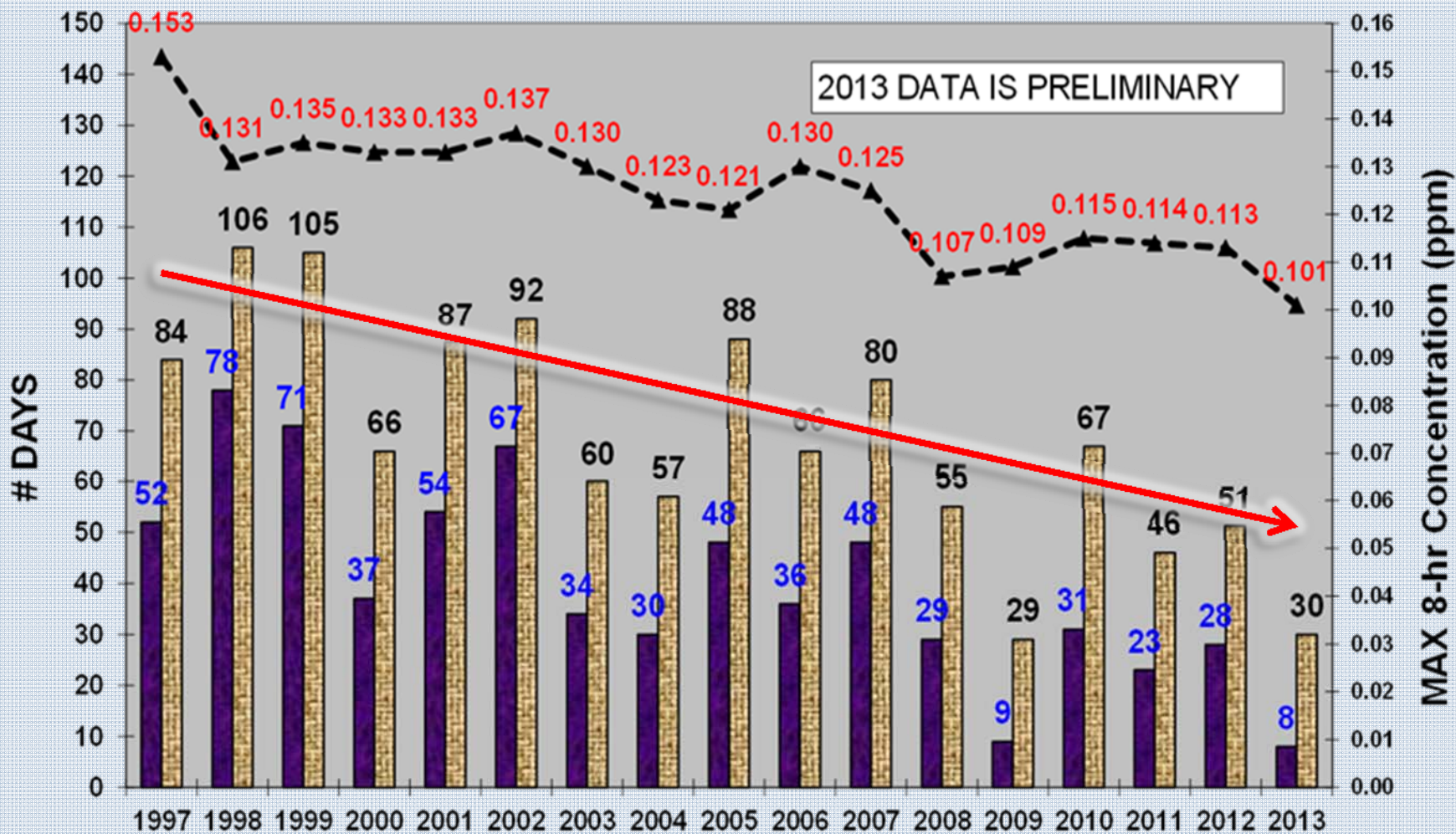


November 14, 2013



- The solution to the ozone problem in the East has not changed
- It is also the solution to our fine particle and regional haze problems
- We now have even better science proving that this solution will work
- Since 2010, there has been progress
- We're poised to make even greater progress in some areas
- We also have some very significant challenges in other areas

Ozone Progress 1997-2013 (OTR)

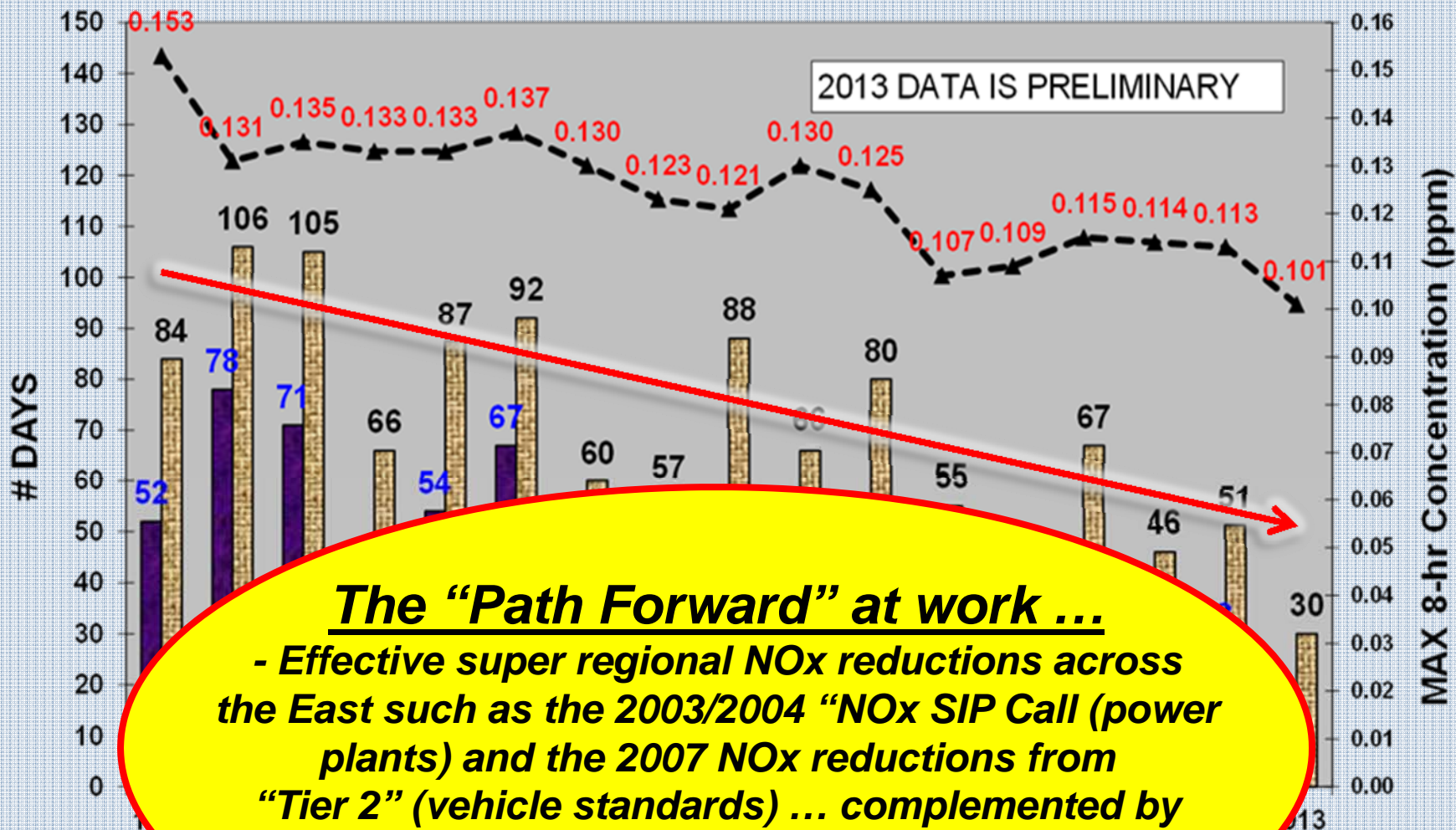


days > 84 ppb
 # days > 75 ppb
 -▲- MAX 8-HR



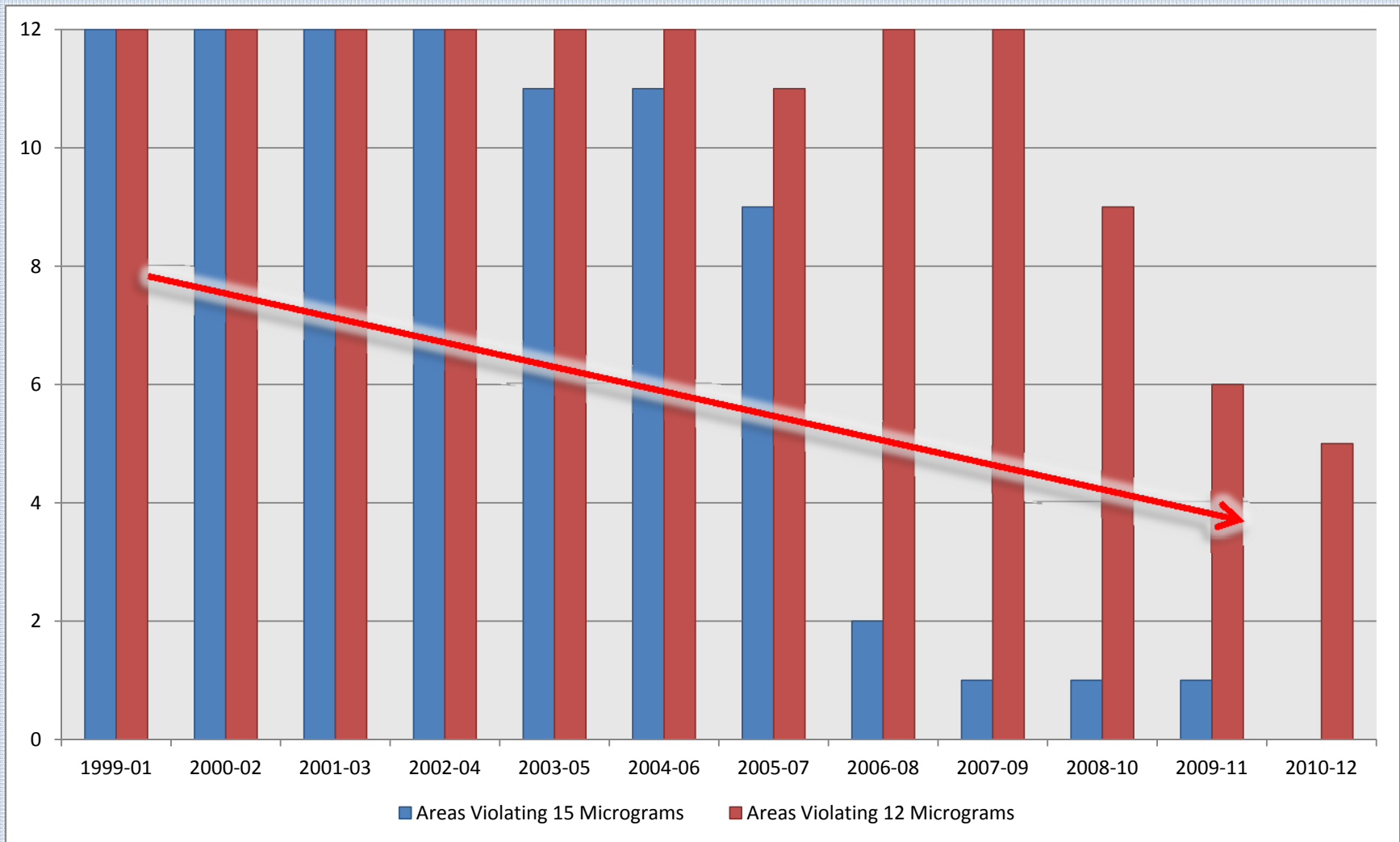
Created by Tom Downs, Maine DEP-BAQ - 9/4/2012

Ozone Progress 1997-2013 (OTR)

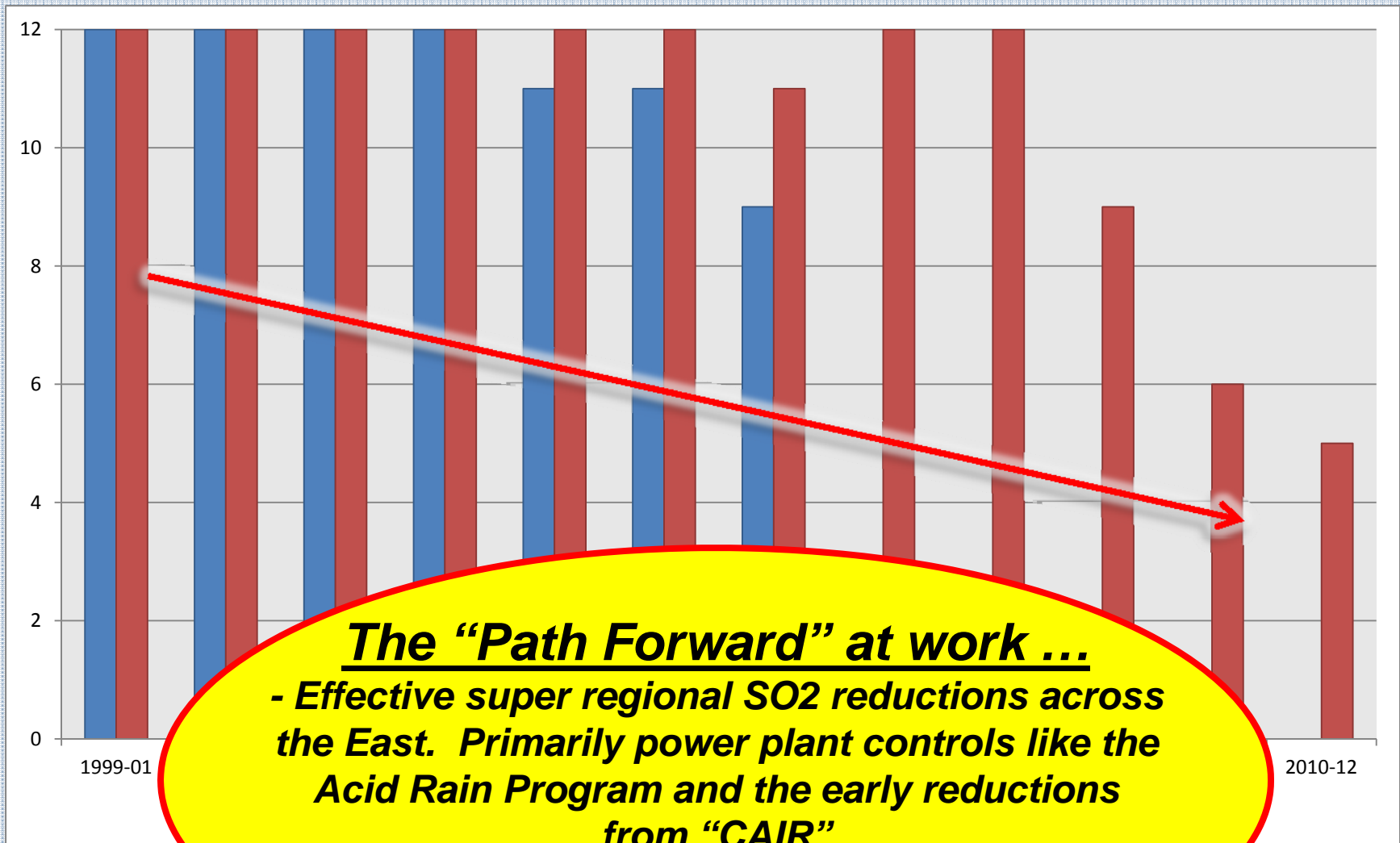


The "Path Forward" at work ...
 - Effective super regional NOx reductions across the East such as the 2003/2004 "NOx SIP Call (power plants) and the 2007 NOx reductions from "Tier 2" (vehicle standards) ... complemented by
 - Effective local controls in many OTC states

Number of PM_{2.5} Nonattainment Areas in MANE-VU Violating Standards



Number of PM_{2.5} Nonattainment Areas in MANE-VU Violating Standards

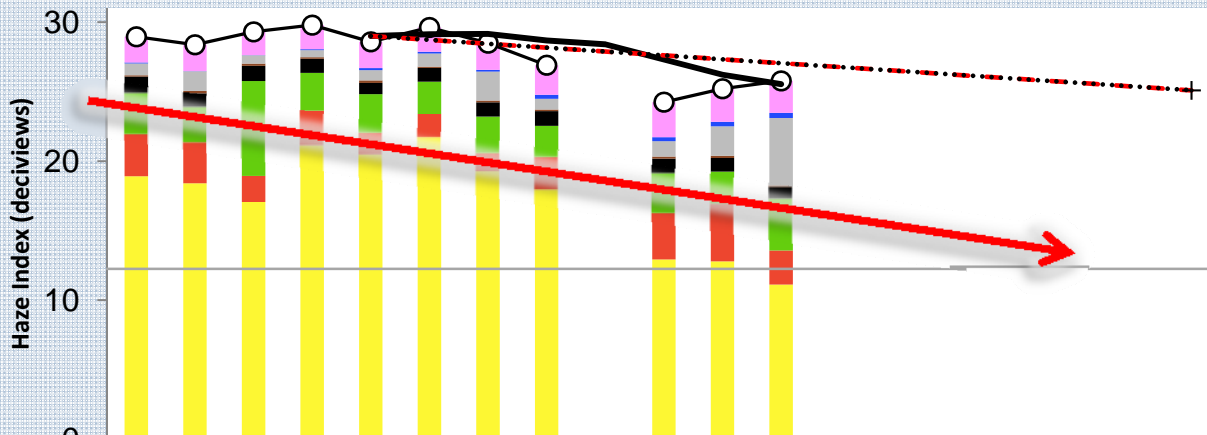


The "Path Forward" at work ...

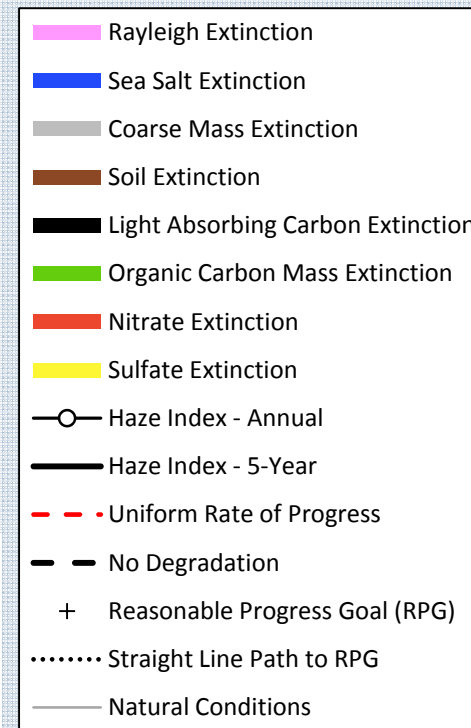
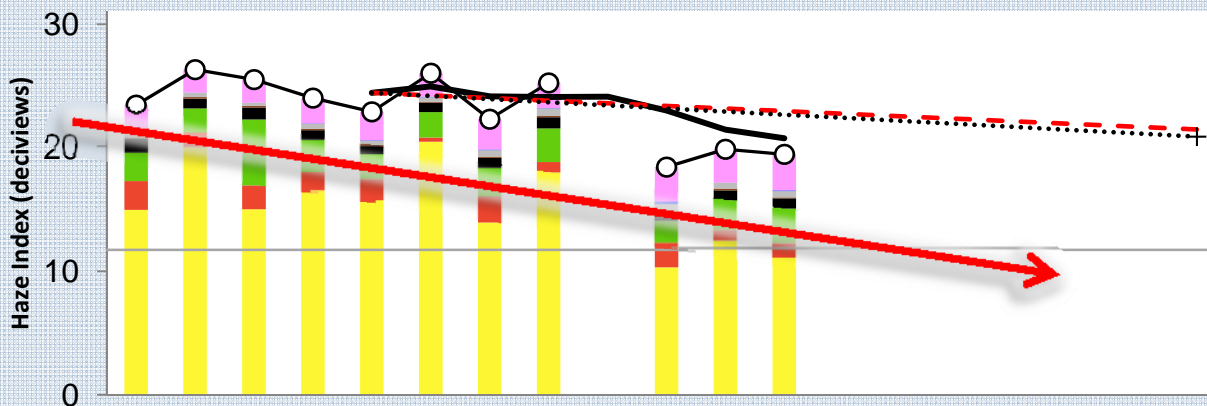
- **Effective super regional SO₂ reductions across the East. Primarily power plant controls like the Acid Rain Program and the early reductions from "CAIR"**
- **Effective local SO₂ controls in many OTC states**

Haze Speciation on 20% Worst Days

Brigantine Progress

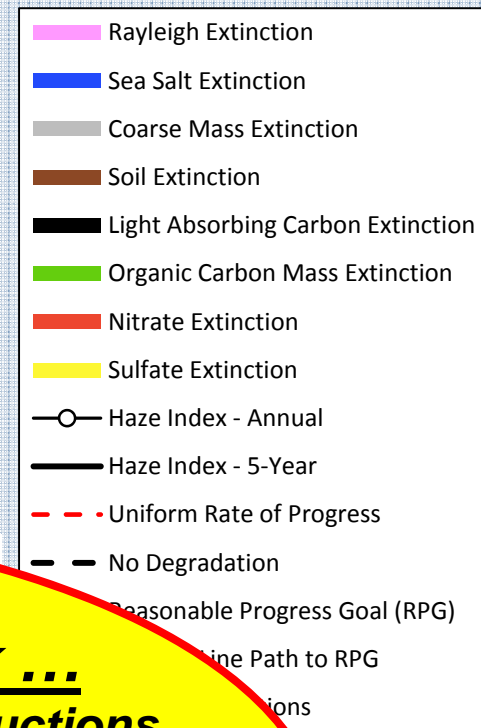
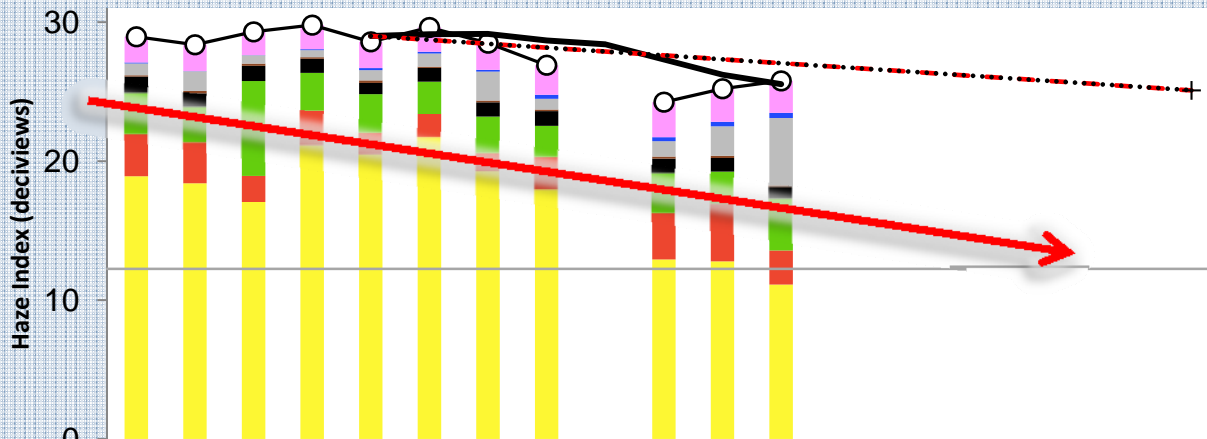


Lyebrook Progress

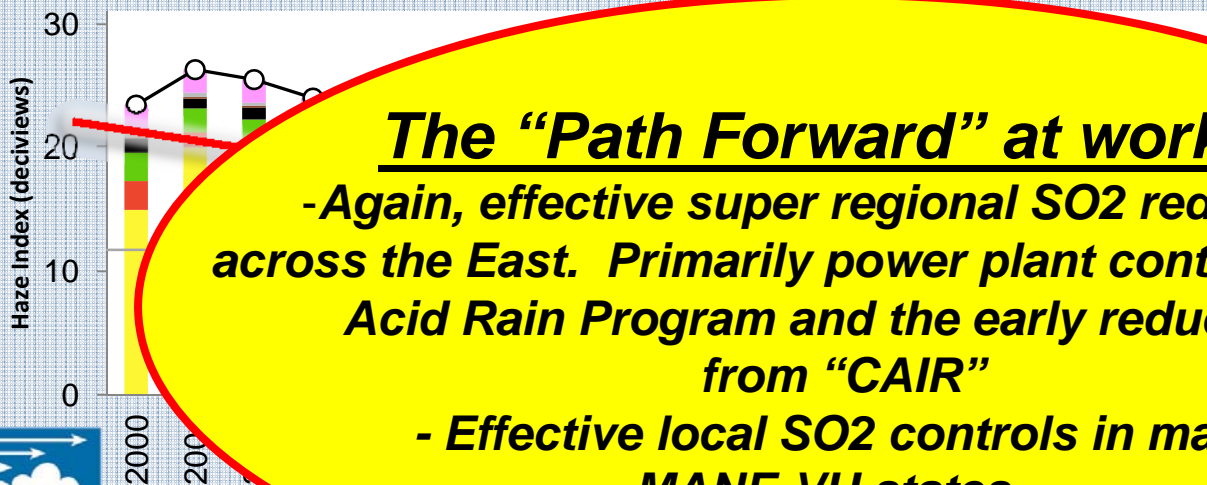


Haze Speciation on 20% Worst Days

Brigantine Progress



Lyebrook Progress



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

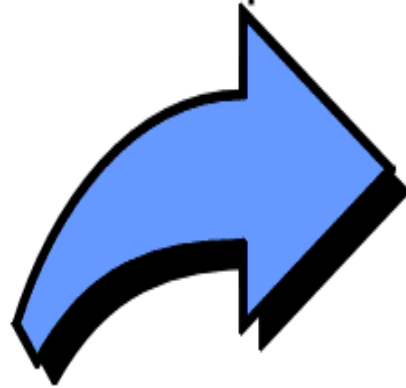
So Why is it Working?



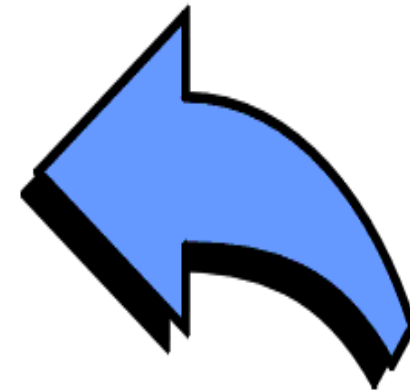
- In simple terms, there are two parts to our ozone problems in the OTC
 - A local emissions contribution ... and
 - A regional emissions (transport) contribution
 - They bring us ozone in different ways
- Understanding the “How” piece of the ozone transport problem is critical to our policy development

The Local Emissions Contribution

Volatile Organic
Compounds



Nitrogen
Oxides



Ozone

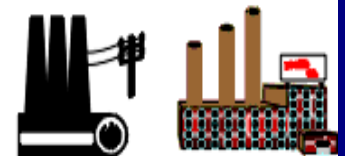
Biogenic

Area

Mobile

Off-road

Point



The Local Emissions Contribution

- Much simpler
- Local NO_x (nitrogen oxide) and VOC (volatile organic compound) emissions are released throughout the day
- NO_x and VOC interact with sunlight – throughout the day - to create ozone
 - Cars, power plants, everything else
- Summertime winds push the ozone – slowly – to the northeast
- Ozone peaks in the late afternoon
- Pretty simple
 - Emissions released – react – pushed northeast - create high ozone in the afternoon
- Complications
 - Nature's definition of “local” is not consistent with the CAA
 - Today's emissions also react with leftover ozone and emissions from the day before – and the day before that

B



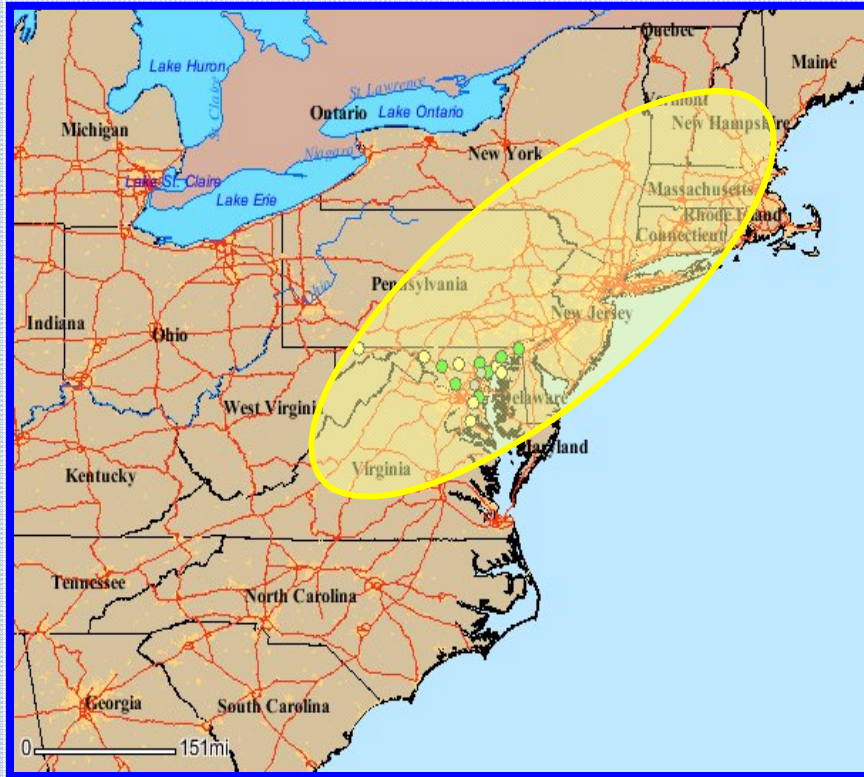
The Regional – Transport - Contribution



- More complicated
 - But not that complicated
- Four key concepts
 - An “Elevated Reservoir” of ozone that builds up over several days and pulses up and down to contribute to ground level ozone
- Three types of transport
 - From the West
 - From the South at night
 - From one city to the next
- For a bad day on Wednesday
 - The real action ... for transport ... starts on Sunday night when an elevated reservoir of ozone shows up at 3000 feet above the surface



The Elevated Ozone Reservoir



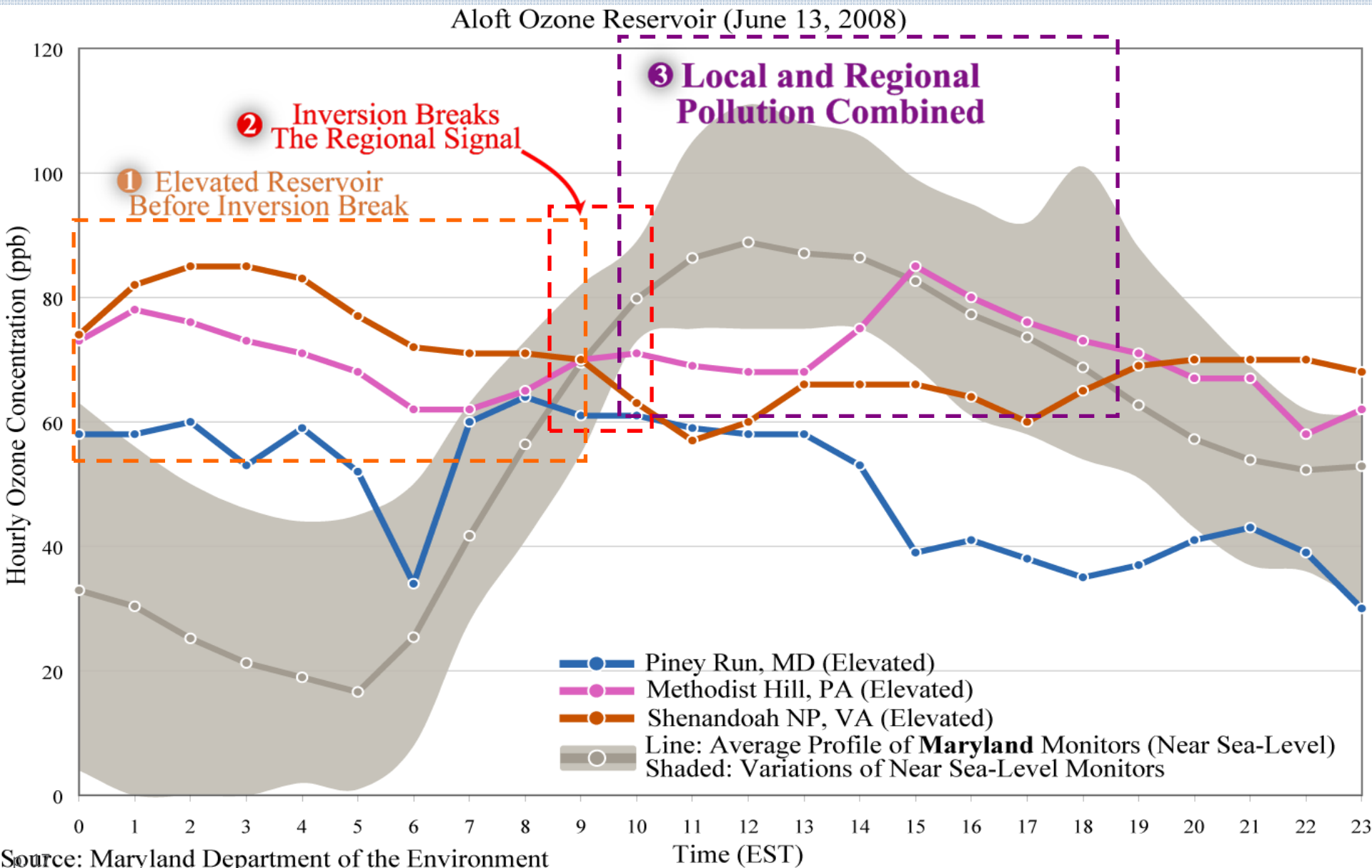
Every bad ozone day, in the morning hours, a large reservoir of ozone sits above the OTR and much of the East waiting to mix down.

- Ozone levels in the reservoir can routinely reach 60 to 100 ppb.
- In the morning, ozone levels at the surface are very, very low

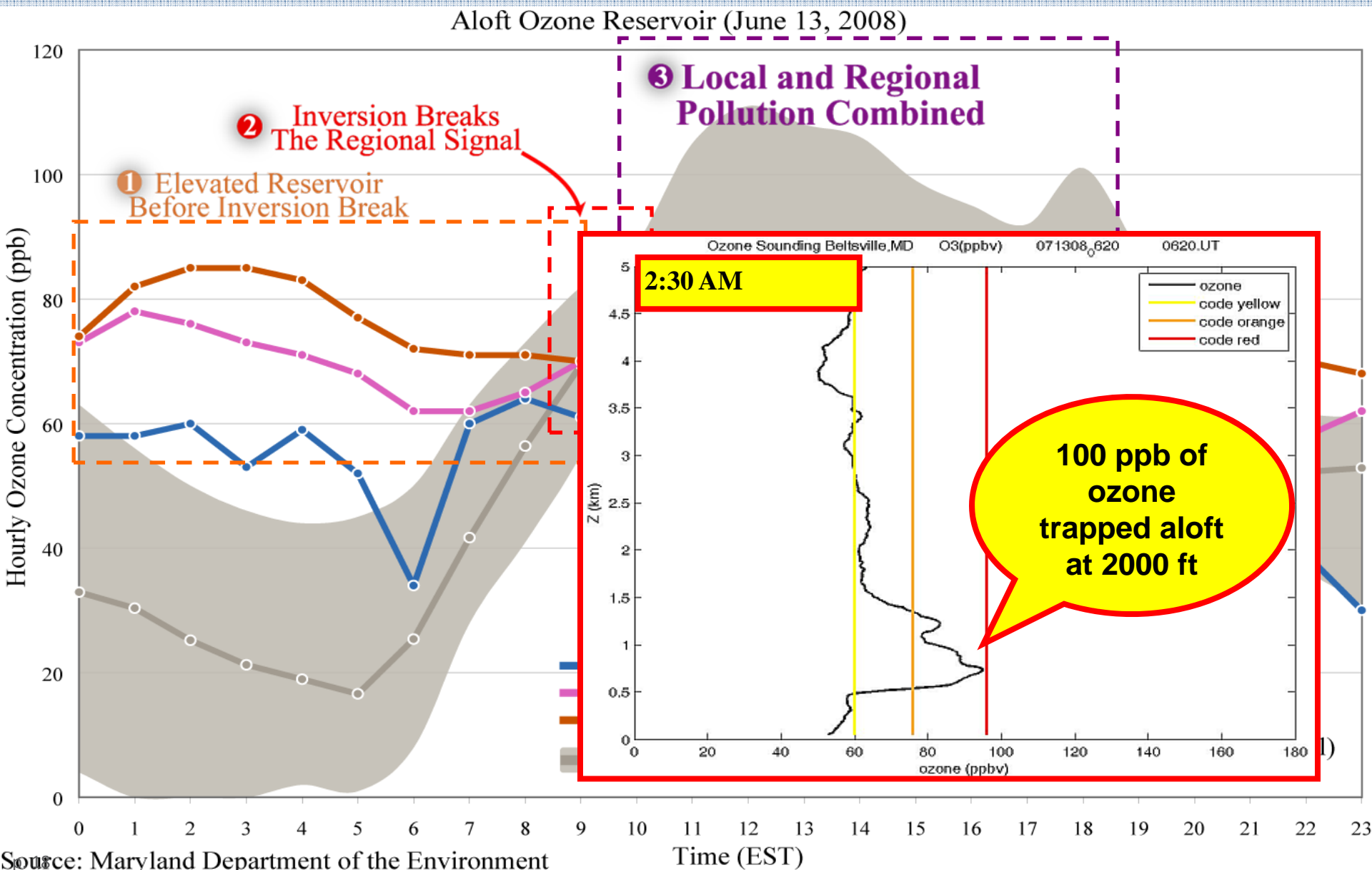
Between 9:00 and 11:00

- The “night-time inversion” breaks apart
- Ozone trapped aloft in the reservoir mixes down to the surface and degrades air quality.

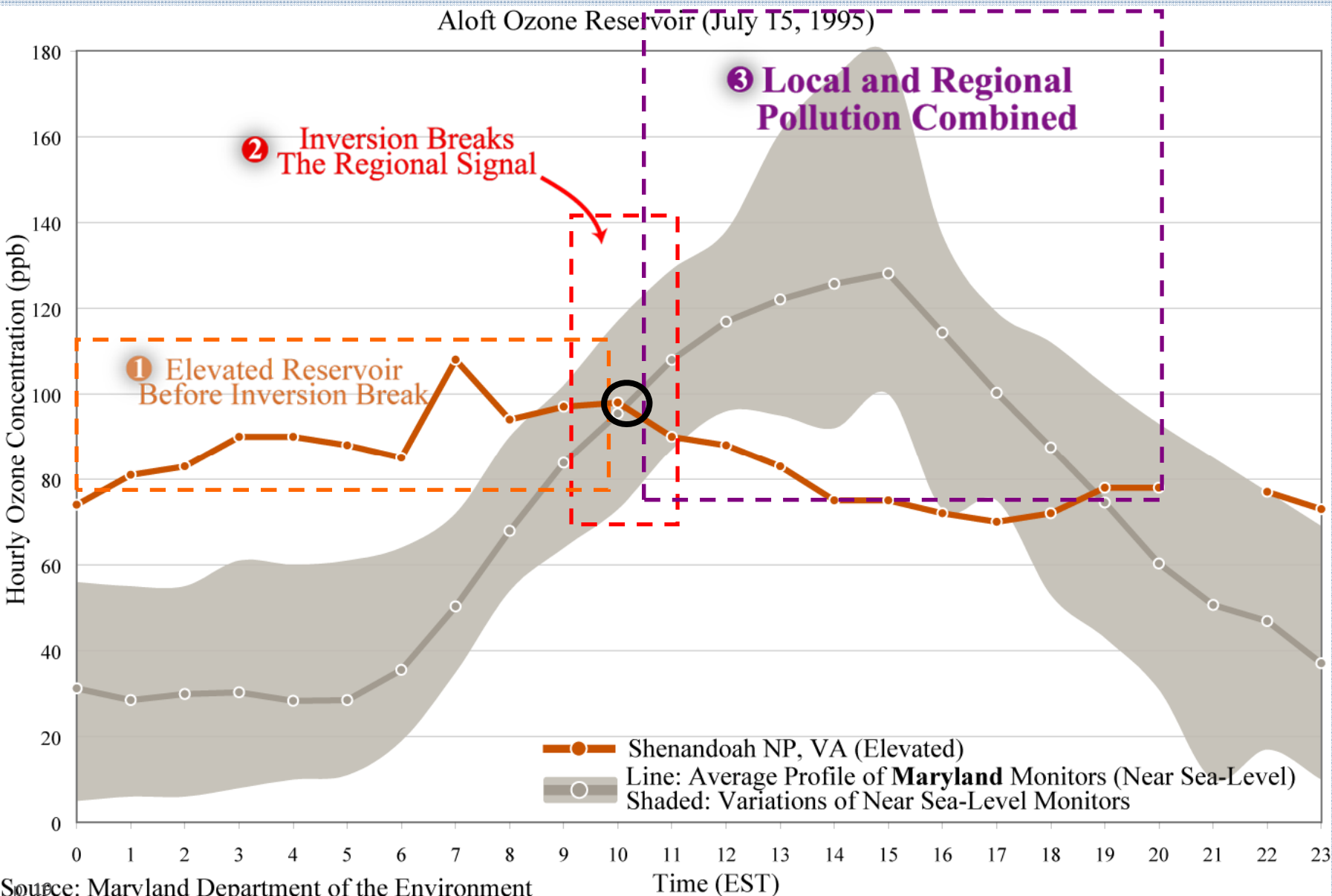
Visualizing the Elevated Reservoir



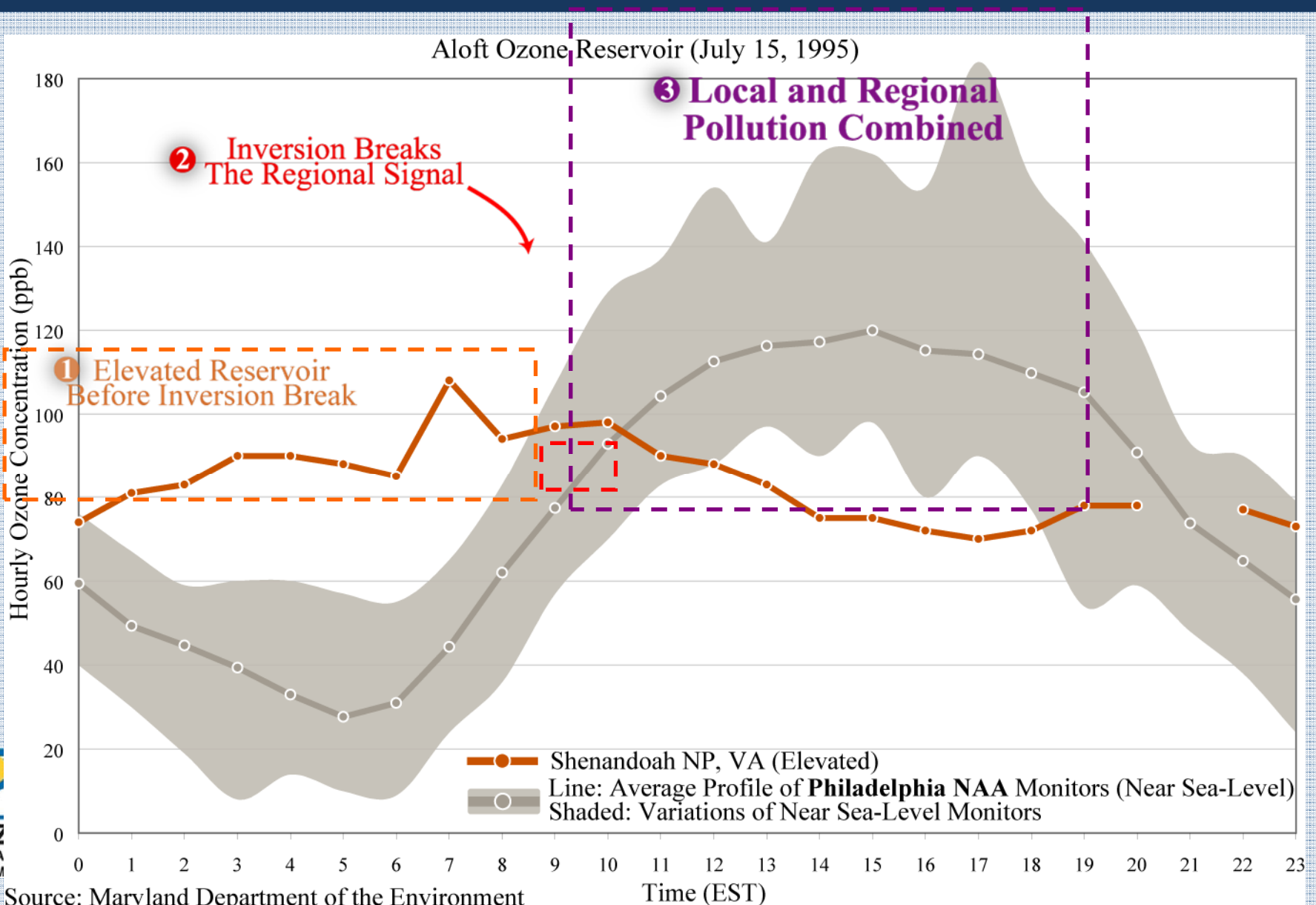
Visualizing the Elevated Reservoir



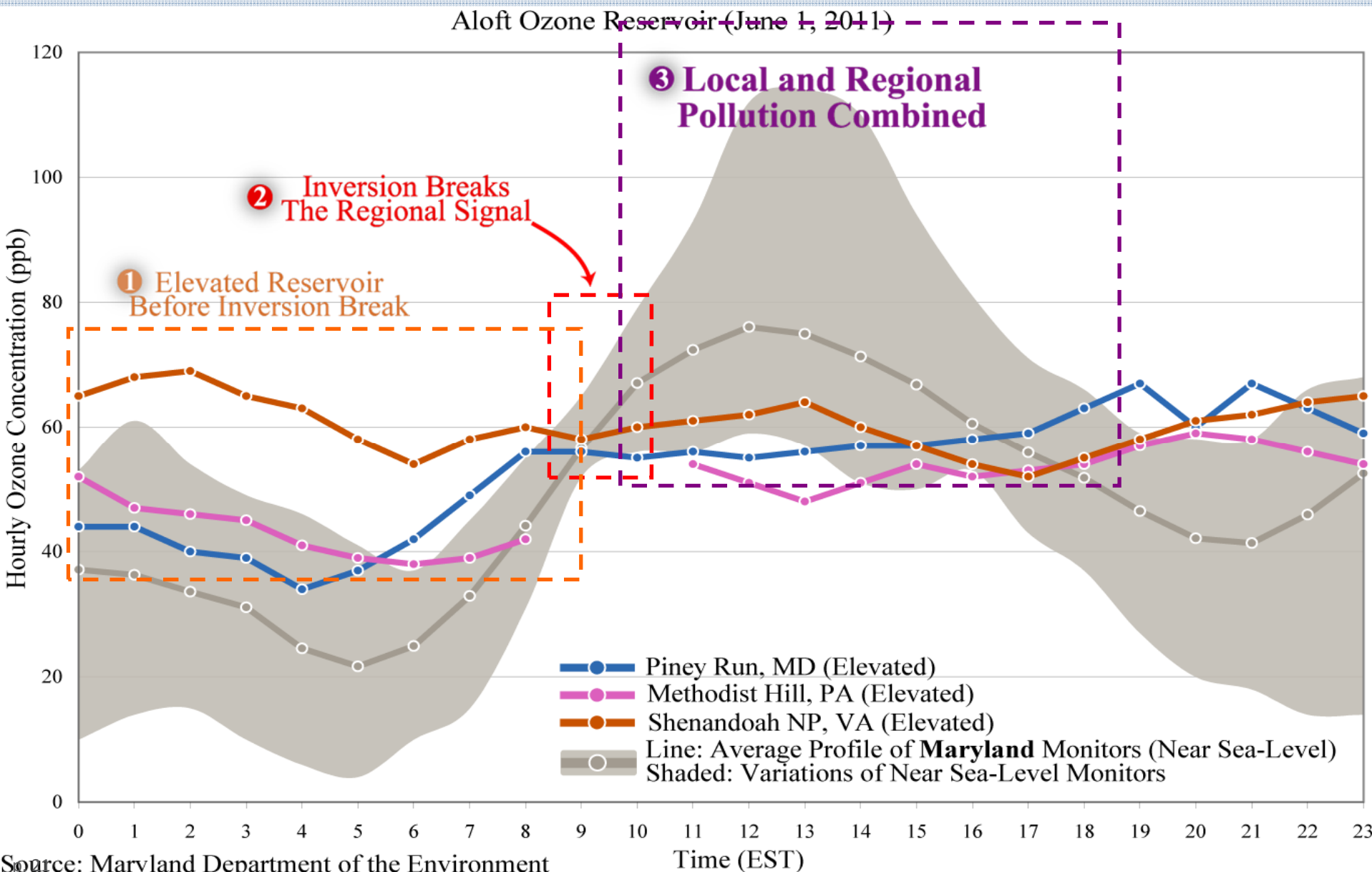
Same Signal - Maryland 1995



Same Signal – Philly 1995

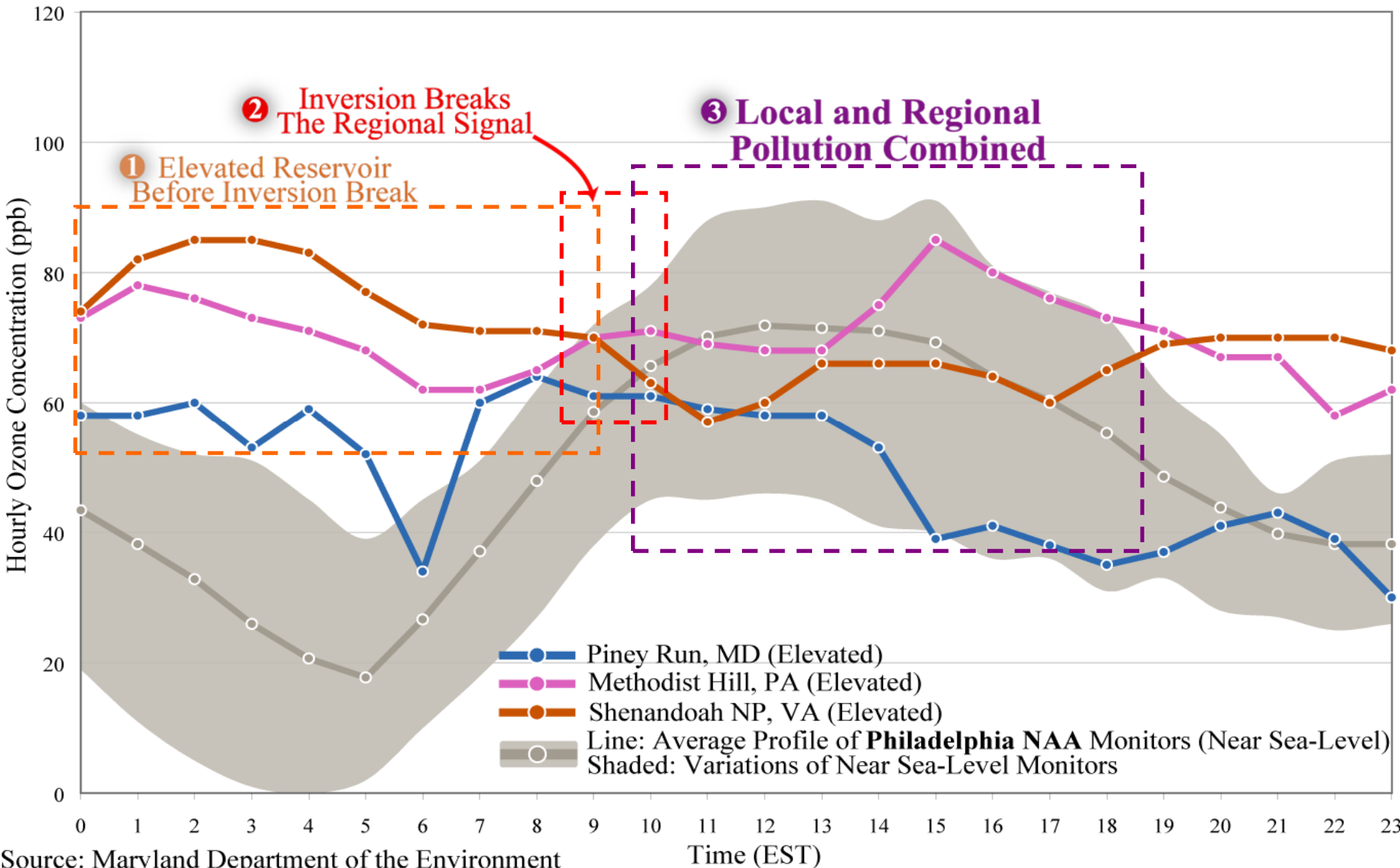


Same Signal – Maryland 2011



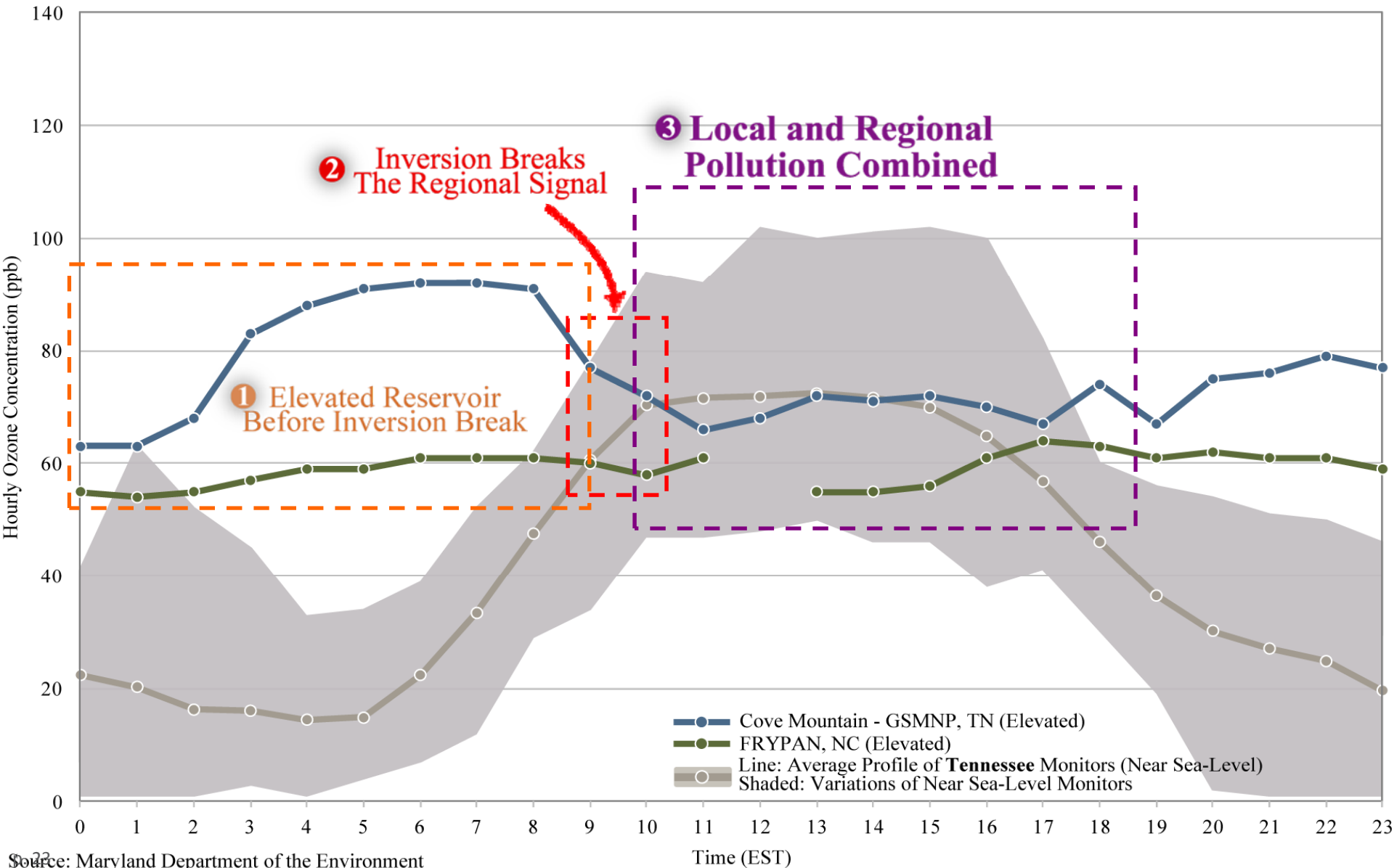
Same Signal – Philly 2008

Aloft Ozone Reservoir (June 13, 2008)



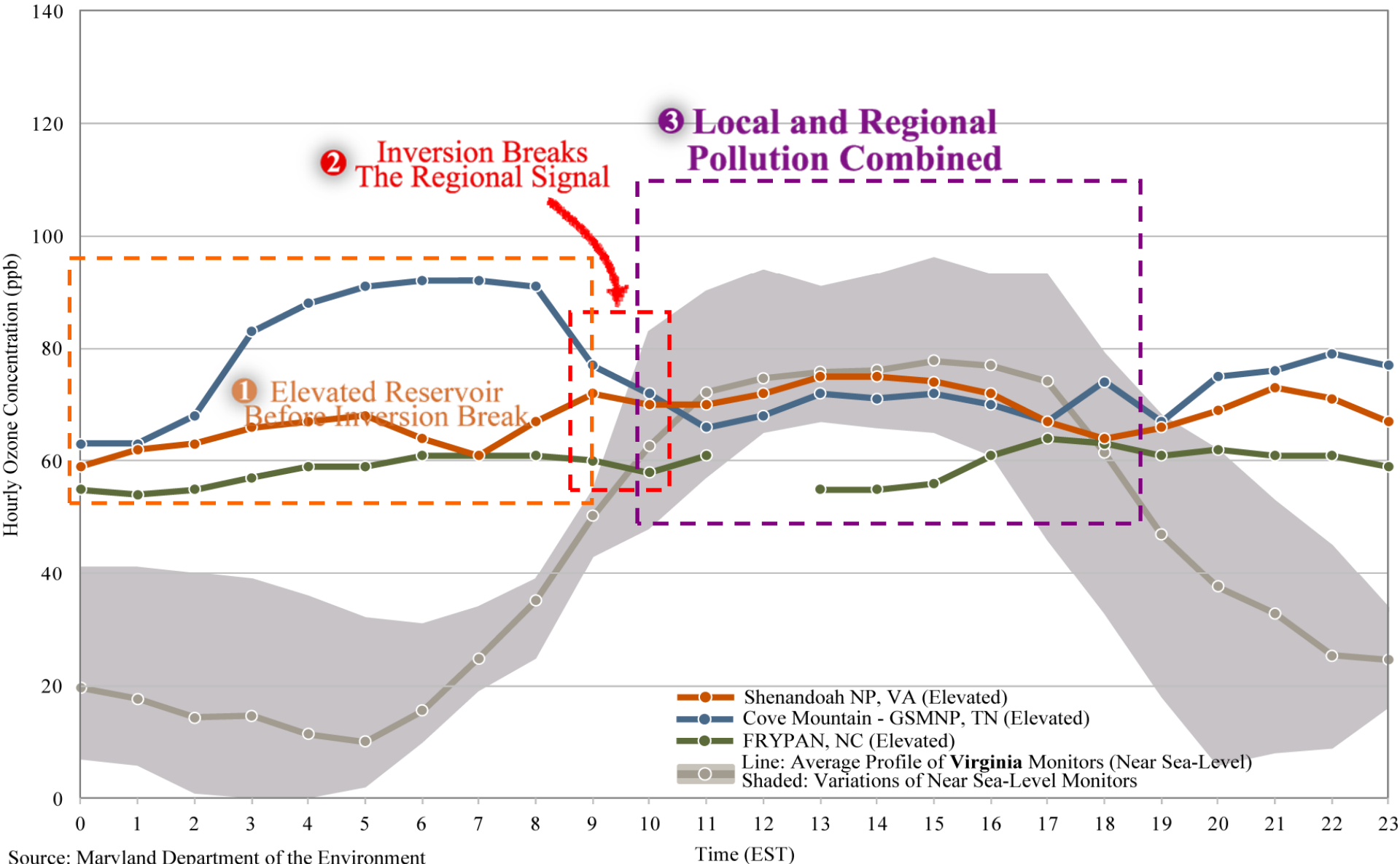
Same Signal – Tennessee 2011

Aloft Ozone Reservoir (June 8, 2011)



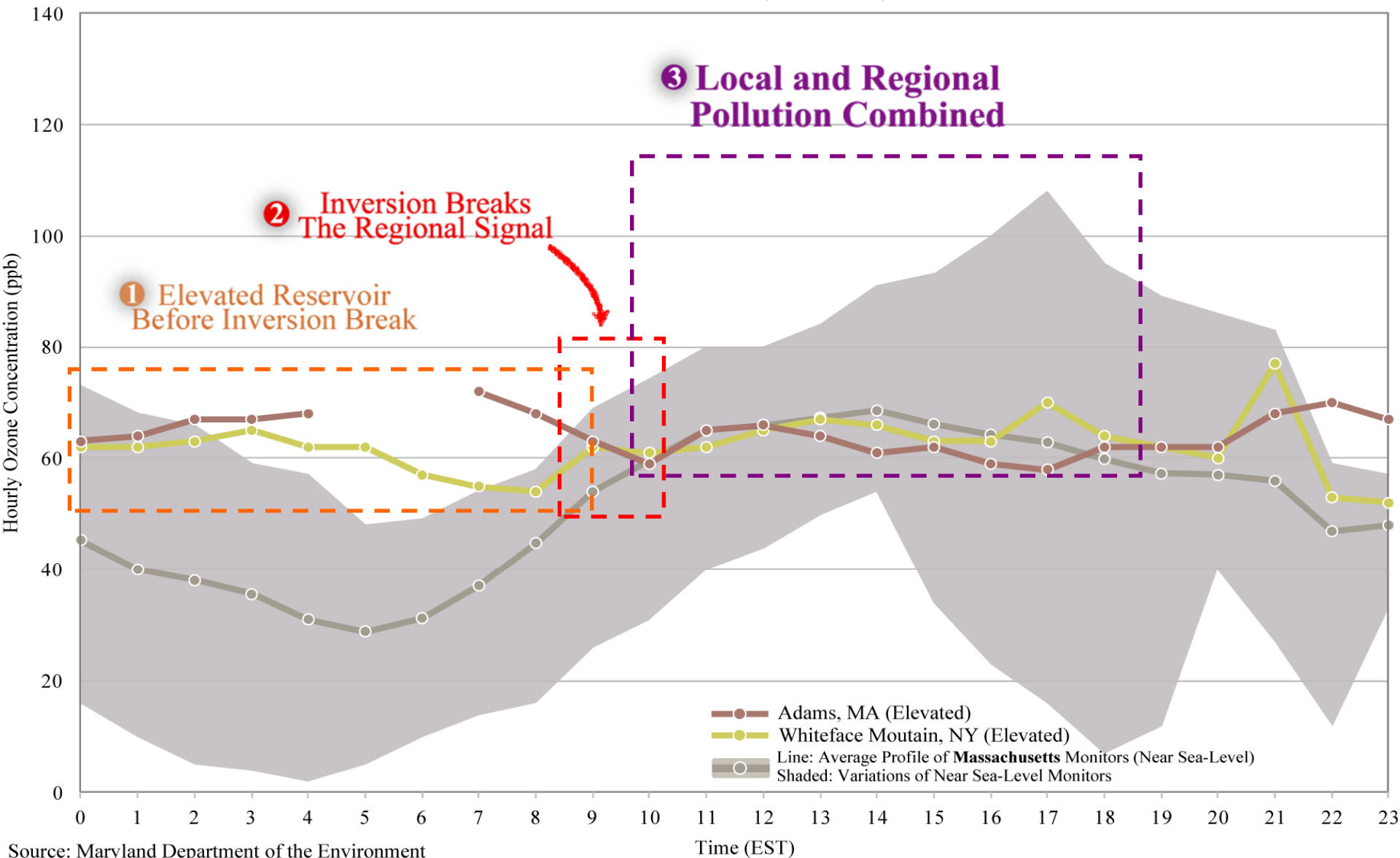
Same Signal – Virginia 2011

Aloft Ozone Reservoir (June 8, 2011)



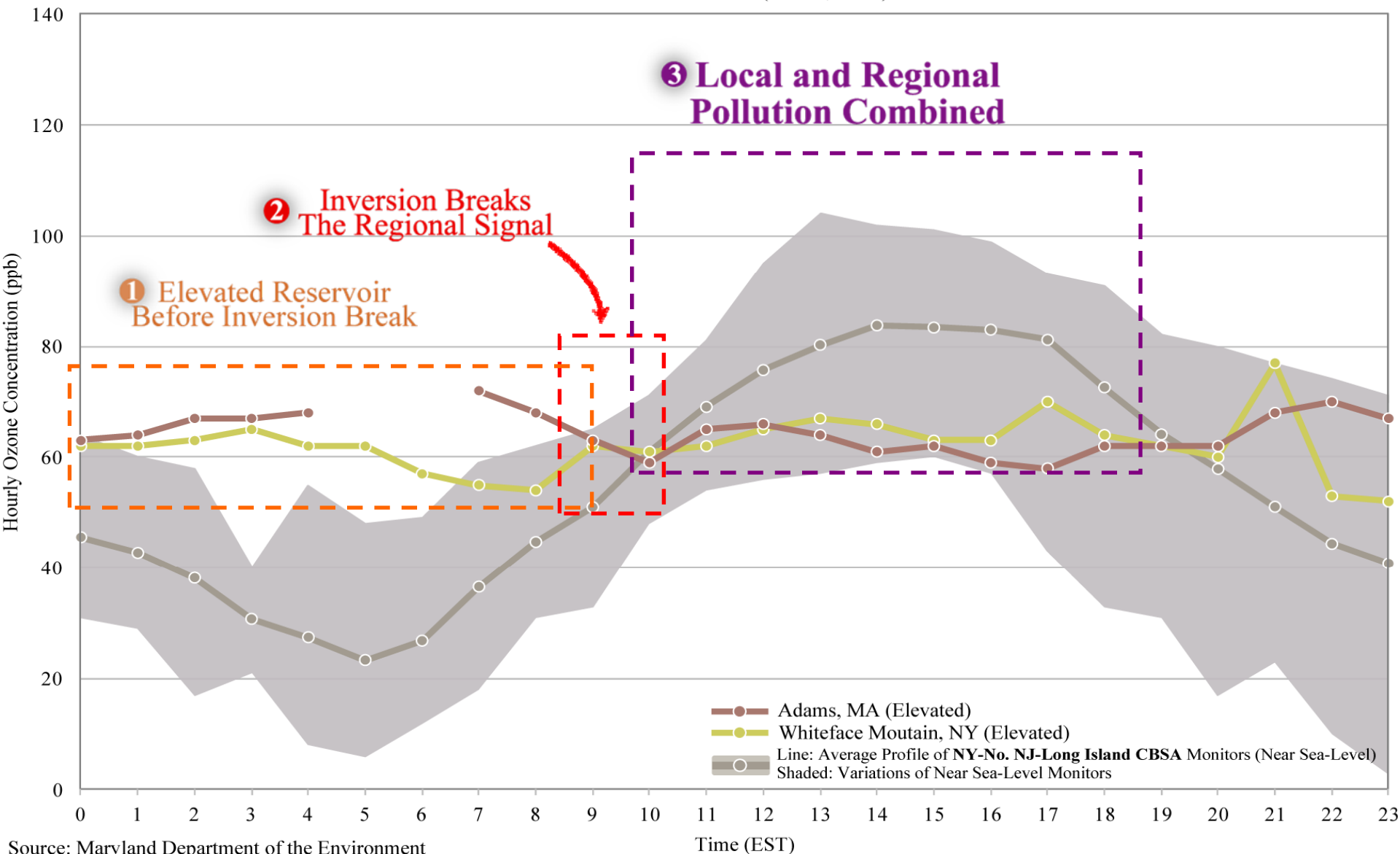
Same Signal – Massachusetts 2011

Aloft Ozone Reservoir (June 8, 2011)

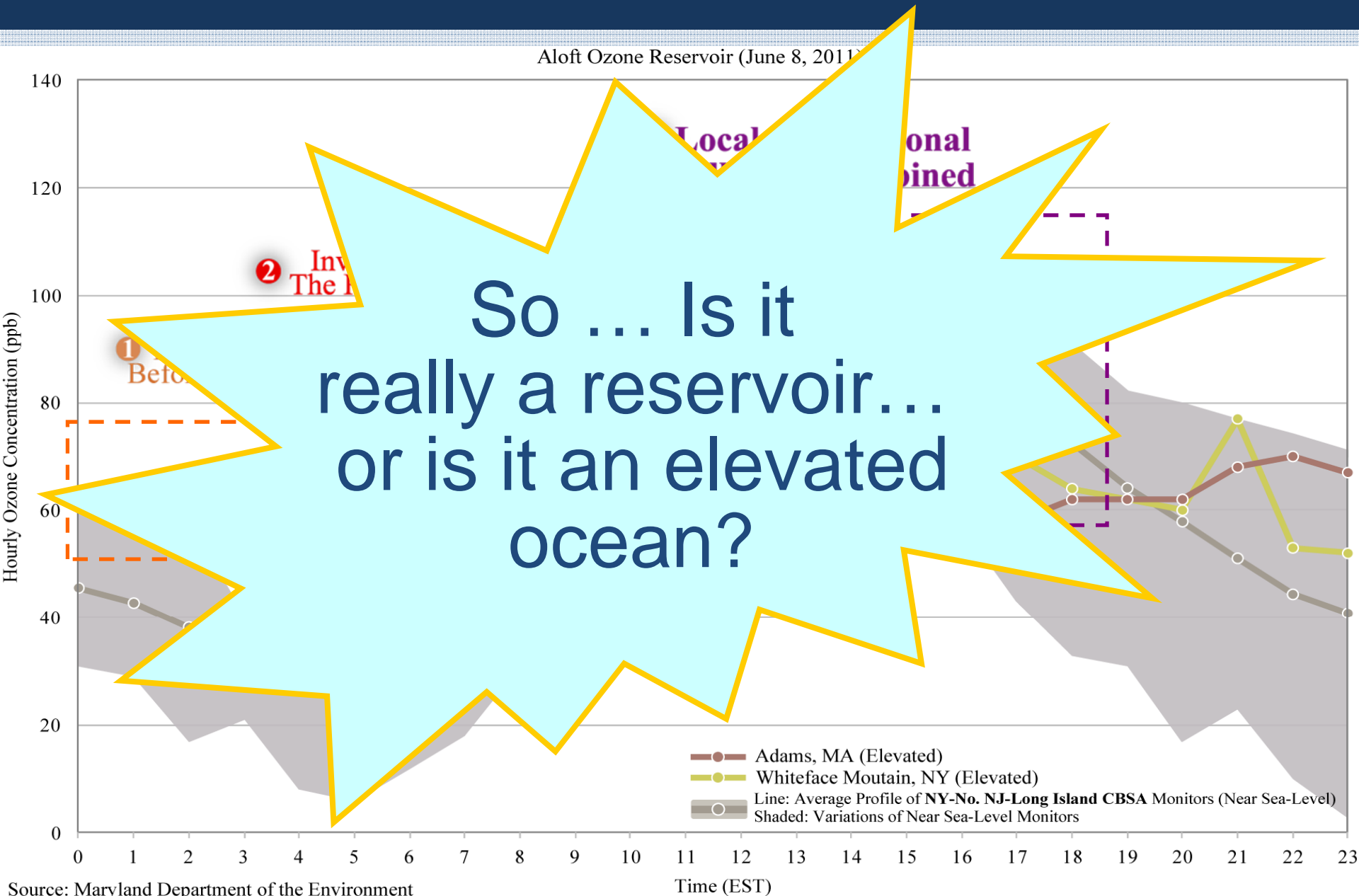


Same Signal – New York 2011

Aloft Ozone Reservoir (June 8, 2011)

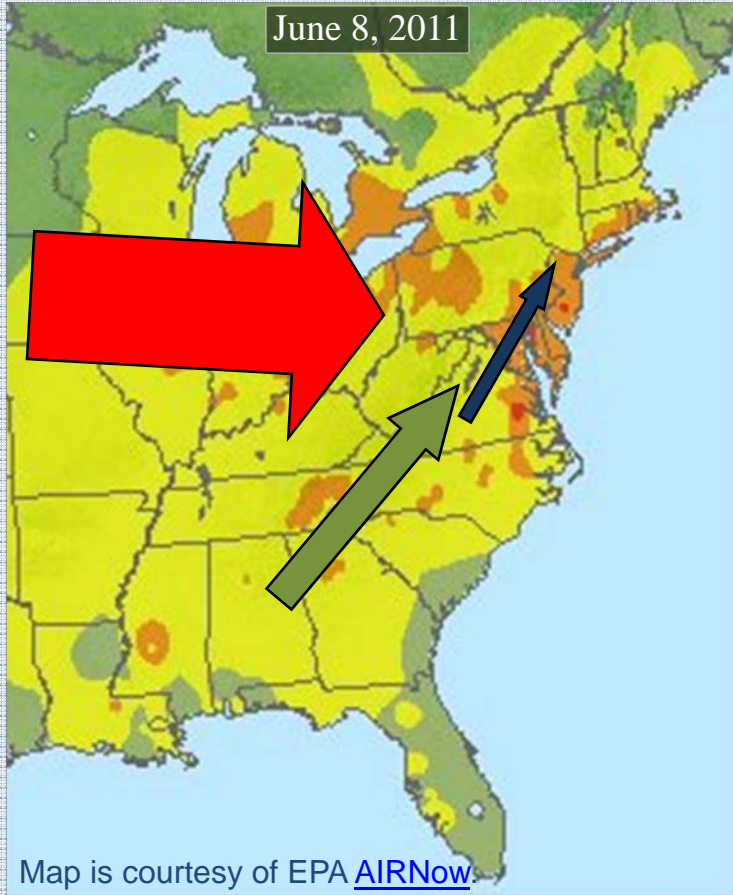


Same Signal – New York 2011



Filling the Reservoir

Three Different Types of Transport



Westerly Transport

- “Aloft” transport - 100s of miles
- Generally from W or NW
- Primarily power plants

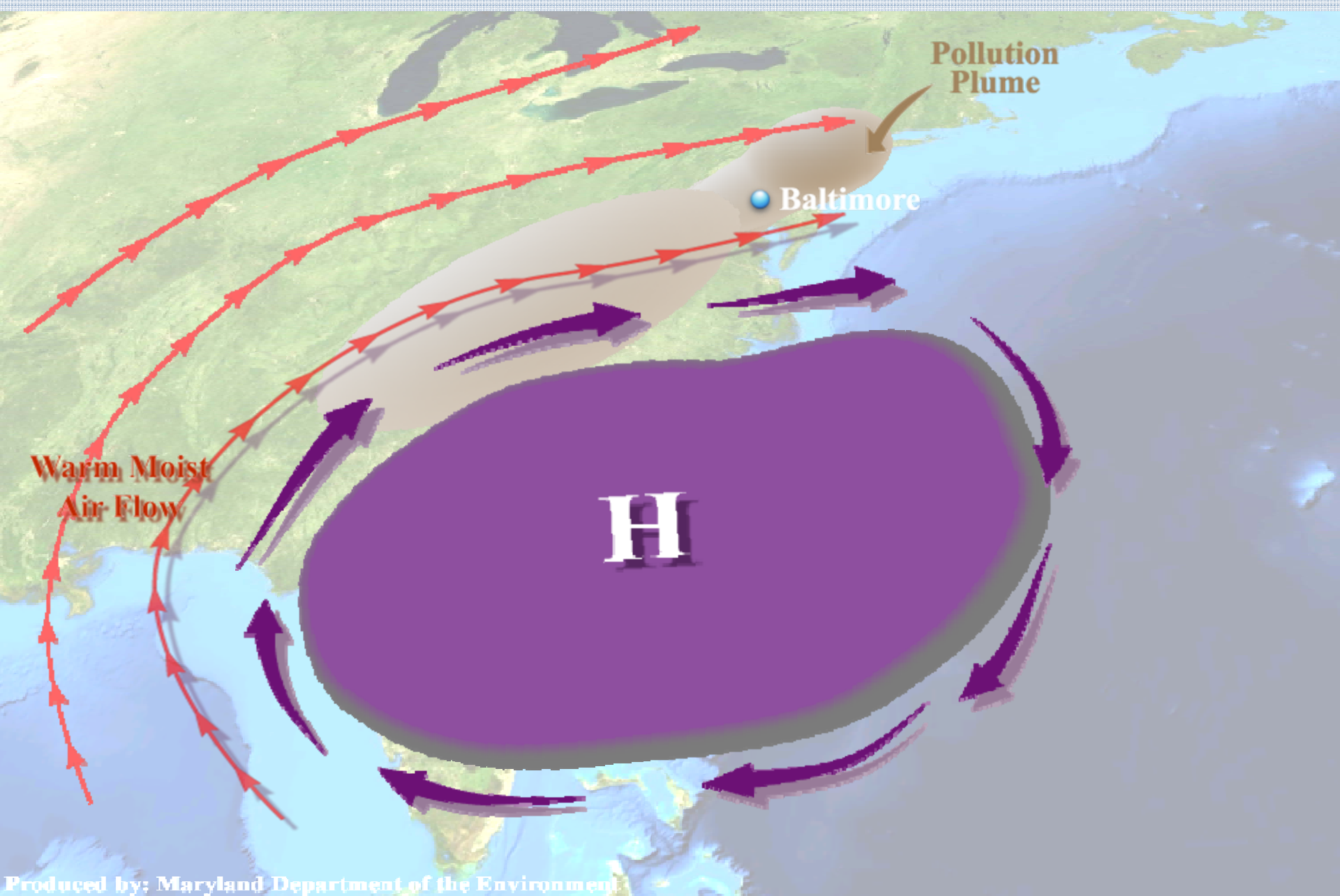
Southerly, Night-Time Transport

- Pushed by a “Nocturnal Low Level Jet (NLLJ)” of wind
- “Aloft” transport at night !!!
- 100s of miles
- SW to NE along the Atlantic
- Vehicles, power plants and other sources

City-to-City Transport

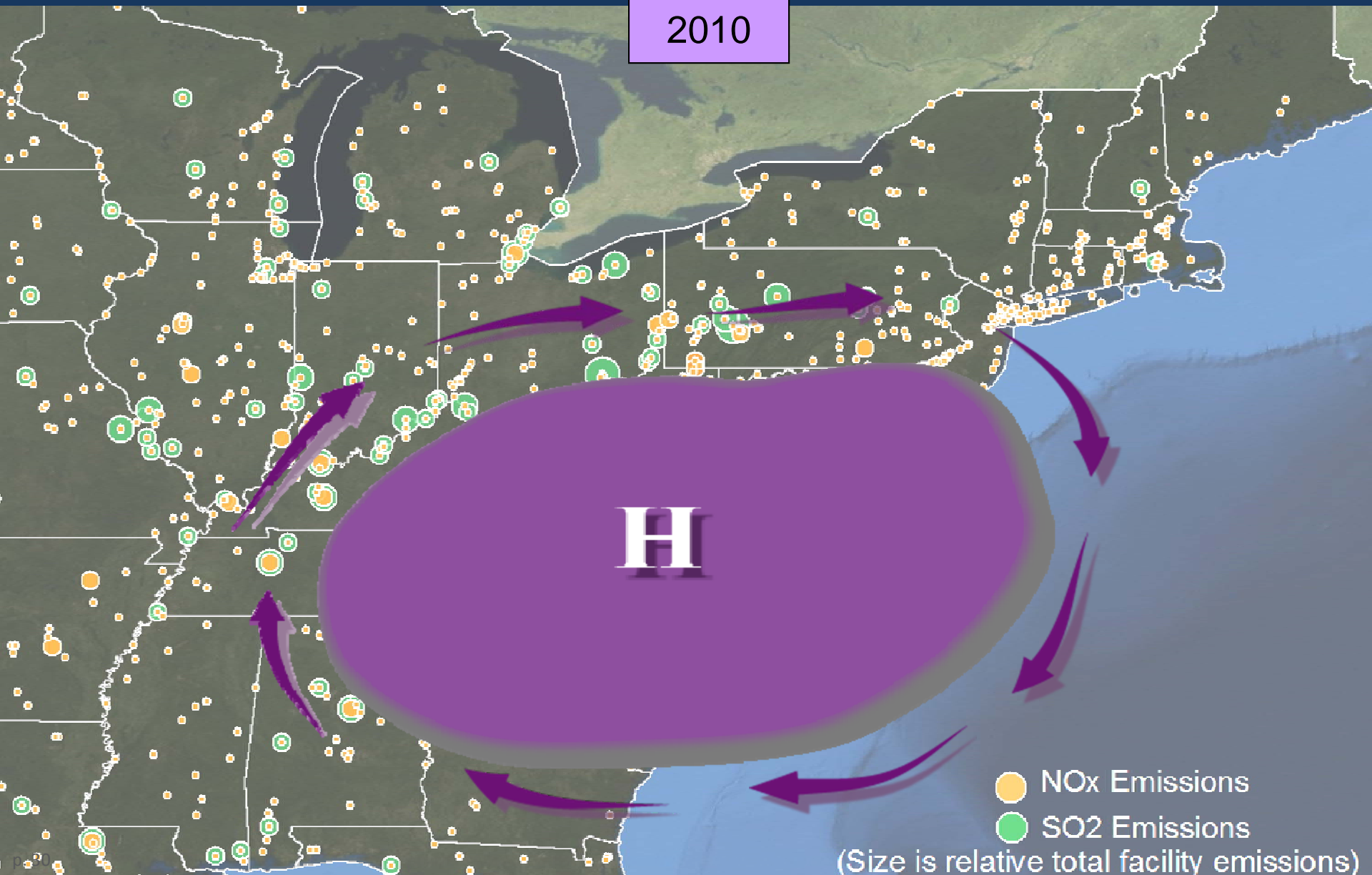
- Washington to Baltimore, Baltimore to Philadelphia, etc.
- All sources contribute

Classic “Bad” Ozone Weather



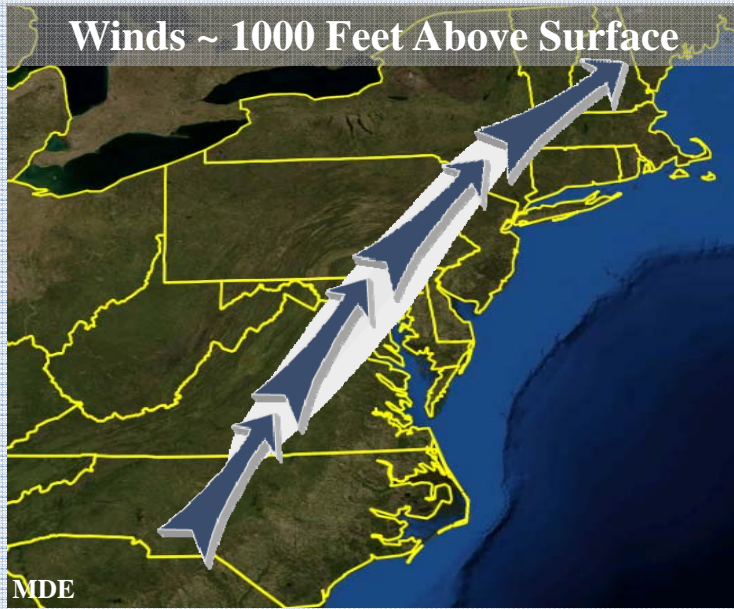
Westerly Transport

2010



Southerly Transport at Night

The Nocturnal Low Level Jet (NLLJ)

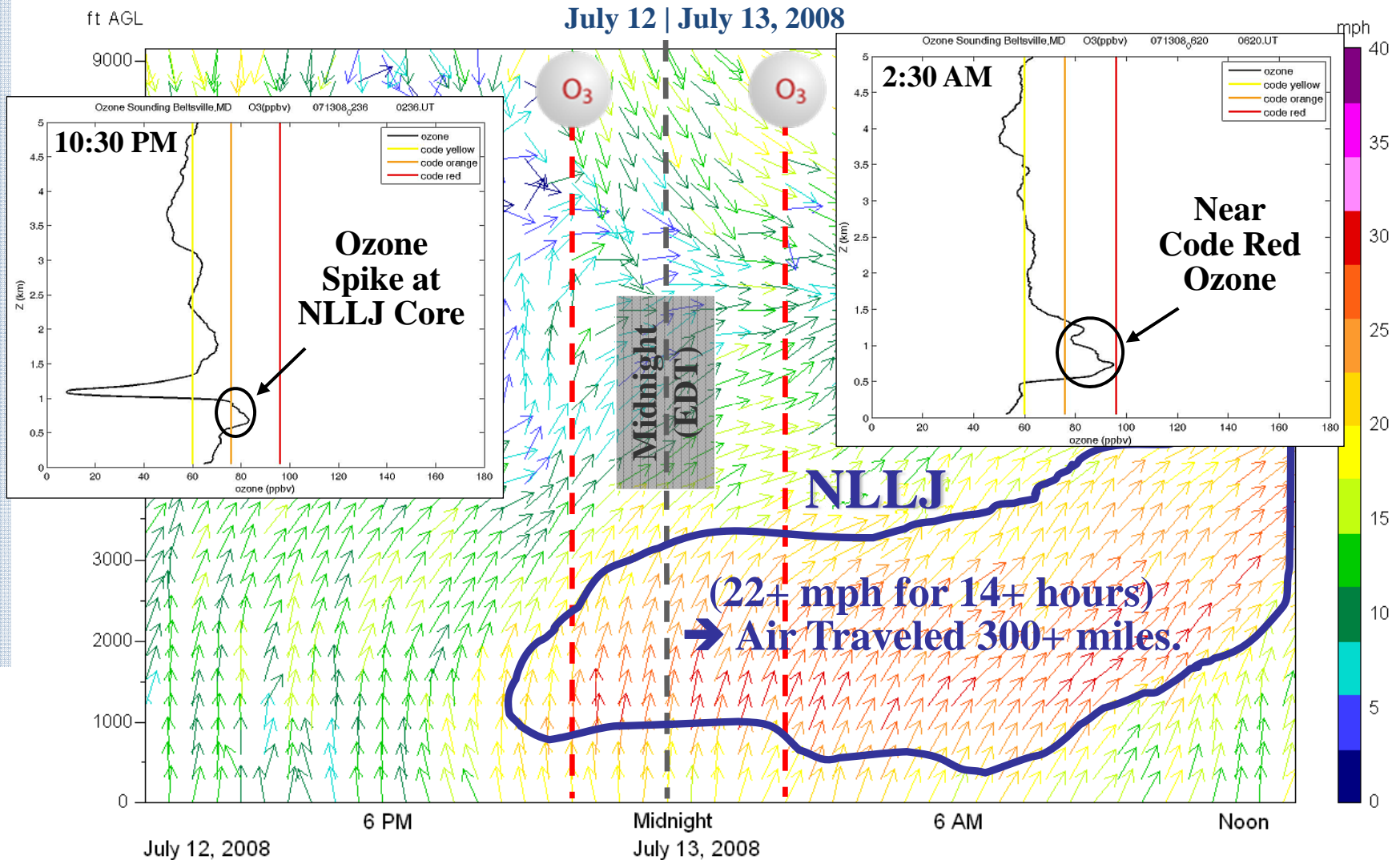


- Fast-moving, narrow “river” of air typically around 1000 feet above the surface
- In the Mid-Atlantic, typically observed during the night between Appalachians and the Atlantic Ocean.
 - Wind speeds can reach 40 mph or more.
 - Stretches from NC to MD to NJ and further up the east coast.
- Seen during most, Mid-Atlantic summertime air pollution events.
 - Some form of NLLJ on virtually all code orange or red days
- Recent findings indicate:
 - Presence of a NLLJ increased Baltimore maximum ozone by 7 ppb.
 - Ozone concentrations of 90 – 100 ppb have been measured in the NLLJ.

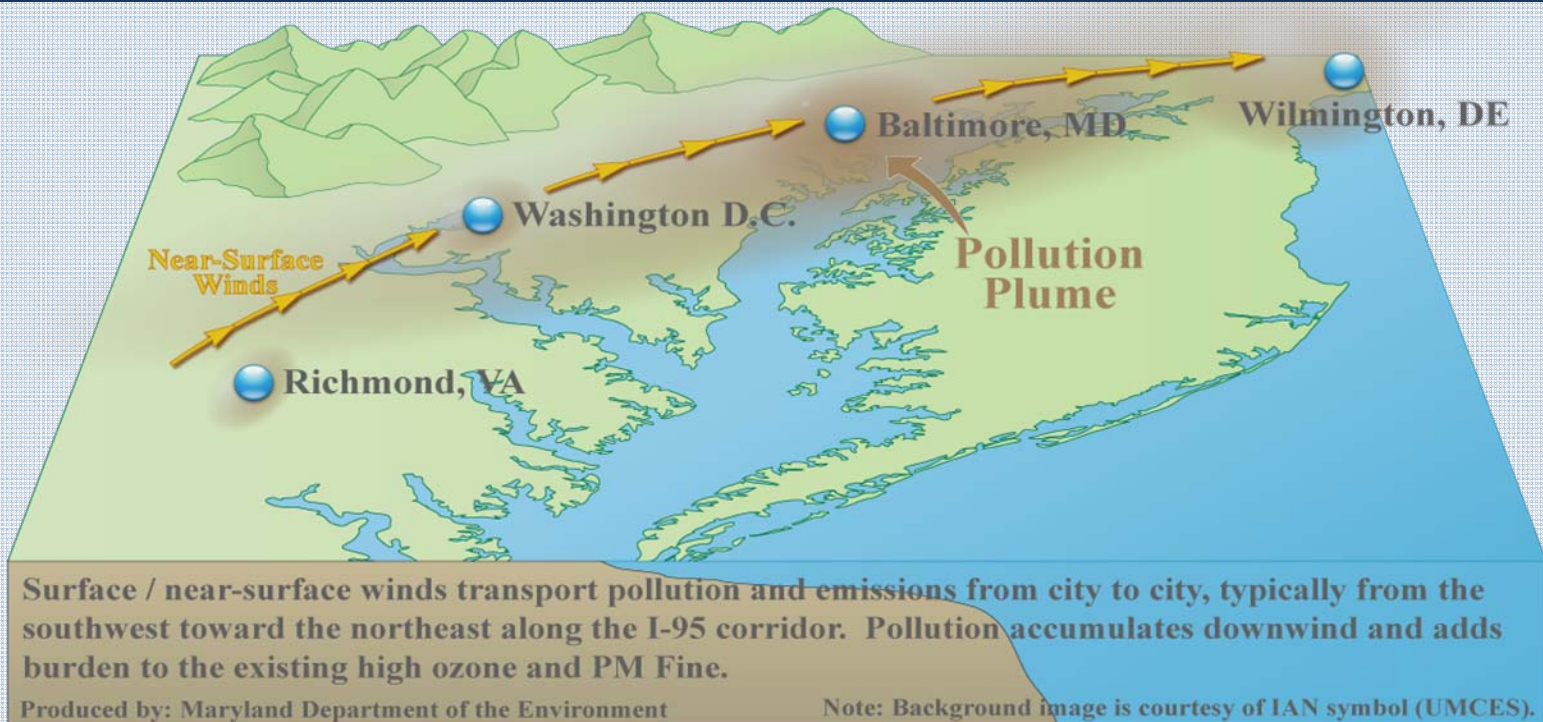


Measuring Ozone Transport in the NLLJ

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.



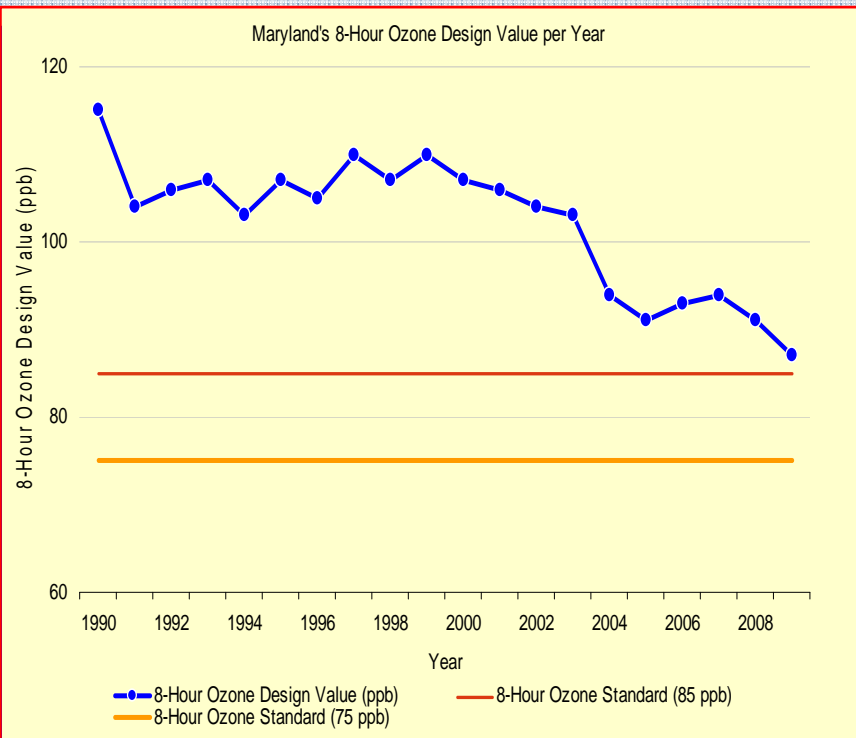
City-to-City “Local” Transport



- Surface winds are typically from the southwest to the northeast
- The morning pollution in Washington stays at ground level and floats downwind to become part of the afternoon pollution in Baltimore
 - Pollution from VA ⇒ DC ⇒ Baltimore ⇒ Philly ⇒ NJ ⇒ NY ⇒ CT ...
- Emissions from cars, area sources and stationary sources all contribute.

Regional NOx Reductions Work!

Ground Level Ozone Drops Dramatically in the Same Time Frame



The 2003/2004 NOx SIP Call as a case study.

- A classic ozone transport success story
- Incoming ozone levels (as high as 80 ppb) collect in an elevated reservoir over night
- Real world programs like the NOx SIP call have shown that
 - Adding regional controls
 - Results in regional NOx emission reductions ...
 - Which lead to reduced ozone in the elevated reservoir ...
 - Which lead to lower ozone at ground level and public health protection!

Using Baltimore as an Example



- Some of the worst ozone in the East
 - Only area designated by EPA as “Moderate” for the 75 ppb standard
 - Sort of silly
- No longer the “last purple dot” but still amongst the worst in the East
 - Update later from Jeff
- Often sees a “Perfect Storm” for high ozone
 - Local contribution is very important
 - Regional contribution (transport) by itself brings in ozone levels that are already above the 75 ppb standard

Using Baltimore as an Example

Baltimore is used in this example as it has great data. The example could just as easily be for New Castle-DE, Camden-NJ, Suffolk-NY, or Fairfield-CT. The upwind contributors may change a bit, but the transport process would be virtually identical.

A Hypothetical Bad Day in Baltimore

It's a Bad Ozone Day – a Wednesday in late July – Summer of 2014



- Baltimore has some of the worst ozone in the East
 - Only area designated by EPA as “Moderate” for the 75 ppb standard
- A “perfect storm” scenario
- By 5:00 pm on Wednesday, the Edgewood monitor records an 8-hour ozone level of 90 ppb
 - How did that monitor get so high?
 - Grounded in very solid science

A Hypothetical Bad Day in Baltimore

Sunday Night

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

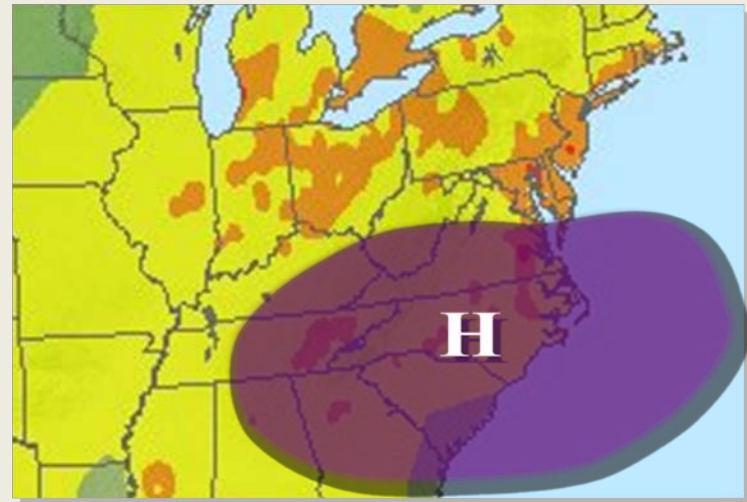
The weather begins to set up for a bad ozone event

Classic summer weather

- Bermuda high over North Carolina

2:00 AM: Aloft monitors (2000 feet above ground level) see ozone in the elevated reservoir at 55 ppb

- This is normal



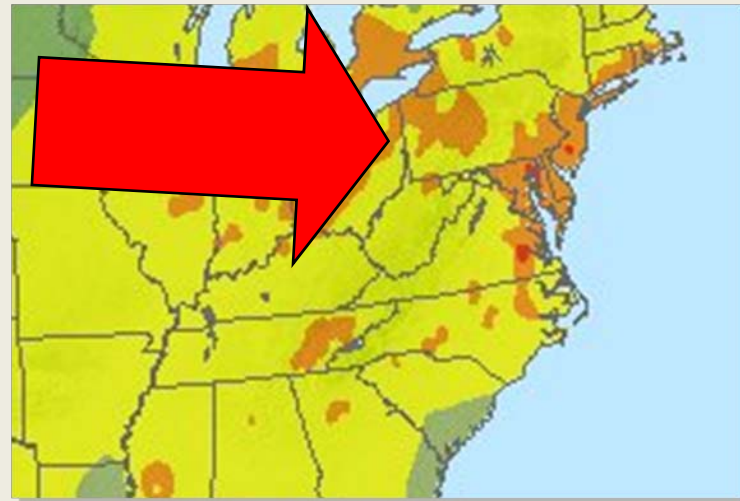
A Hypothetical Bad Day in Baltimore

Monday Morning

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

All day, power plant pollution from the Ohio River Valley is pushed by aloft winds

- From west to east
- Towards the Mid-Atlantic



A Hypothetical Bad Day in Baltimore

Monday Night

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

Mobile source pollution from the south is pushed by a low level jet

- Southwest to northeast
- Towards the Mid-Atlantic



A Hypothetical Bad Day in Baltimore

Tuesday Morning

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

6:00 AM - Aloft measurements show that an elevated reservoir has set up

- Hovering over the Mid-Atlantic with ozone at 65 ppb
- Edgewood's ozone is 35 ppb

Around 11:00 AM the ozone in the elevated reservoir mixes down to ground level

- Edgewood's ozone is 68 ppb at 11:00 AM

A Hypothetical Bad Day in Baltimore

Tuesday Afternoon

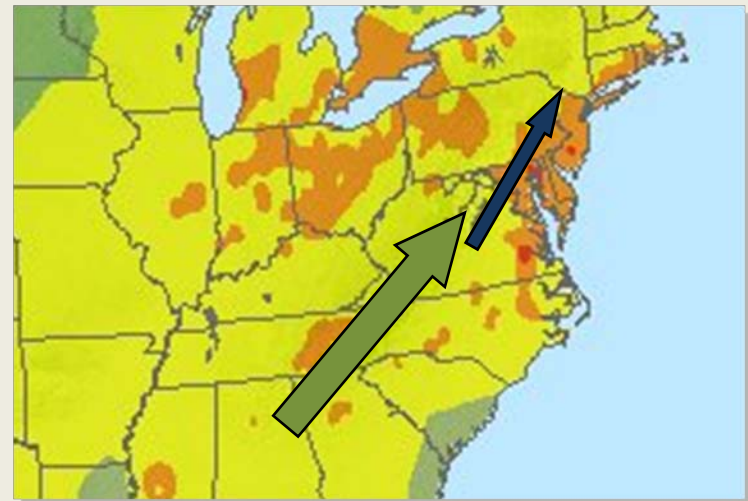
Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

Local mobile emissions add an additional 10 ppb of ozone

- Edgewood is at 79 ppb by 5:00 PM

After dusk, night-time inversion sets up

- That 79 ppb is now aloft
- The low level jet resumes



A Hypothetical Bad Day in Baltimore

**Wednesday
Very Early
Morning**

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

Just After Midnight

- Edgewood is at 35 ppb

Aloft measurements show an elevated reservoir has set up over the Mid-Atlantic with ozone levels at 79 ppb

Transport has now built up over several days

A Hypothetical Bad Day in Baltimore

Wednesday Morning

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

8:00 AM: Edgewood is at 40 ppb

9:00 to 11:00 AM: Nocturnal inversion breaks down

- Pollution trapped aloft overnight (79 ppb) mixes down

11:00 AM: Edgewood's readings jump to 79 ppb

- The transported pollution has mixed down
- Mobile source emissions from Washington and Baltimore join the party

Everything begins to cook in the hot July sun



A Hypothetical Bad Day in Baltimore

Wednesday Afternoon

Sunday	PM
Monday	AM
Monday	PM
Tuesday	AM
Tuesday	PM
Wednesday	AM
Wednesday	PM

All day, power plant transport moves from west to east

Emissions from Baltimore and Washington DC take over

- Primarily mobile sources
- Pushed by southwest to northeast summertime breezes

Monitors south of Edgewood begin to light up

- Beltsville (40 miles south of Edgewood) is high at 3:00
- Essex (15 miles south of Edgewood) is high at 4:00

Edgewood peaks - 90 ppb at 5:00 PM

A Hypothetical Bad Day in Baltimore

Transported pollution that had built up over several days

- Power plants, mobile sources and more
- 79 ppb

Primarily mobile source emissions from Baltimore and Washington have added to the problem

- 11 ppb



Resulted in the East's highest ozone on this hypothetical day in the summer of 2014

Reducing the Ozone Transport in the Elevated Reservoir

The key ... continuing to reduce regional NOx emissions

What's working ... What's in the works ... When will we have a solution

- What's working
 - OTC efforts
 - Some EPA efforts
 - Tier 3 Vehicle and Fuels
 - Indirect benefits from the Mercury and Air Toxics (MATS) rule
 - A state partnership effort
 - Market driven changes linked to low cost natural gas



More Regional NOx Reductions - Continued

What's working ... What's in the works ... When will we have a solution

- What's in the works?
 - Supreme Court takes up the Cross State Air Pollution Rule (CSAPR)
 - Legal action by a group of Mid-Atlantic and Northeastern "downwind" states
 - EPA's efforts to propose a new "Transport Rule"



EPA Efforts - Regional NOx Reductions

- Tier 3 Vehicle and Low Sulfur Fuel Proposal
 - By far, the most significant program to reduce ozone transport (2017)
- The ECA (Emission Control Area)
 - Significant NOx reductions from ships (2018 to 2020)
- Mercury & Air Toxics Standard (MATS) for power plants
 - Appears to be driving significant regional NOx reduction “co-benefits” by the 2017 timeframe
- More later from Ali, Chris and Jeff



OTC Efforts



- Much more – later - from Ali, Chris and Jeff
- Stationary sources
 - Largest contributor initiative
 - Consumer products
 - More ...
- Mobile sources
 - Mobile version of largest contributor
 - Working back through the inventories
 - More
- Transport modeling and analyses
 - Updated analyses of what it will take to meet the 75 ppb standard
 - Inter-Regional collaboration

A State Partnership/Collaborative



- Approximately 30 states in the East are working together to analyze what it will take to solve the ozone transport problem
- General agreement to start the effort by looking at 2018 NO_x reductions that appear to be on the way:
 - Vehicles
 - Power plants
 - Large boilers
- Timing
 - End of 2013 – Preliminary analysis
 - Middle of 2014 – Refined analysis
 - End of 2014 – Regional agreements on transport
- More from Jeff ... later

Market Changes – Natural Gas



Low cost natural gas is driving major change in several large NOx emitting categories

Power plants

- Many announced shut-downs
- Many conversions to natural gas
- Linked to MATS also
- Appears to be driving meaningful NOx reductions through 2018

Industrial, Commercial and Institutional (ICI) Boilers

- Coal units converting to natural gas
- Recent analyses appear to show up to a 50% reduction is possible by 2018

More later

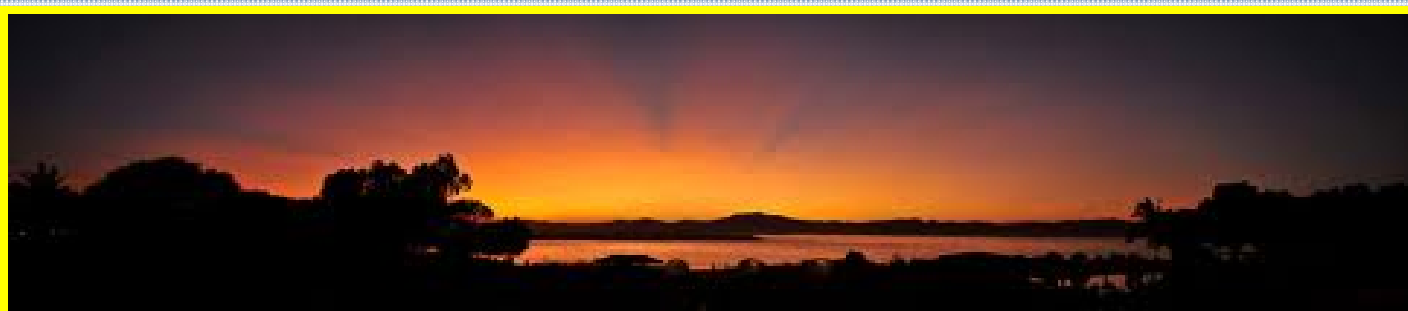
Supreme Court and CSAPR



- Many OTC states are supporting EPA
- Briefs submitted in September 2013
- Oral arguments scheduled for December 10th
- Decision most likely in the first half of 2014
- The CSAPR NO_x reductions were designed to meet the old 85 ppb standard
- More importantly, the Supreme Court decision will define the process for how and when states will be required to address transport for the future

Independent Legal Actions from Eastern States

- o A group of Mid-Atlantic and Northeast states have also been moving forward with legal actions to compel action on ozone transport
 - o Section 107 (very large nonattainment area) challenge
 - o Arguments in DC Circuit scheduled for early December
 - o Section 110A2D “Good Neighbor” SIP challenges
 - o Arguments delayed until after Supreme Court decision on CSAPR
 - o Section 176A Petition to expand the membership of the OTC
 - o May 30, 2013 letter to upwind states
 - o Petition under consideration
- o Section 126 Petitions under consideration



EPA's 2014 Transport Rule



Regional meetings with states on April 7 and 18

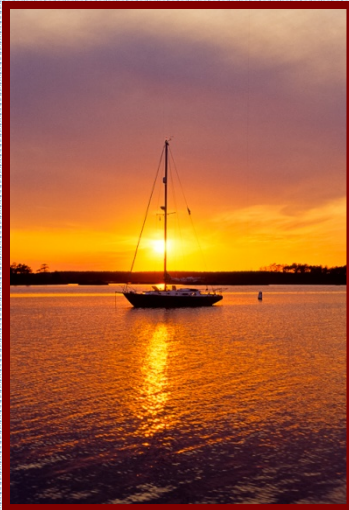
- One in the East ... one in the West

Multiple conference calls

- Some with Commissioners and Air Directors
- Others that are more technical

EPA has been very clear

- They will not propose a solution
- They will take a formal action to establish the "Good Neighbor" responsibilities for all upwind states
 - Could be an emission reduction requirement
 - Could be a requirement for the upwind state to adopt control programs to achieve a concentration reduction (ppb or ug/m3) in a specific downwind area



Proposed EPA Transport Rule

- Expected first half of 2014

The Schedule

The Analysis Phase

- 2013 to Late 2014
- EPA Modeling, OTC modeling, Collaborative modeling, OTC control program develop, Collaborative control program development
- “The Answer” by the end of 2014 or early 2015
- Attainment SIPs due in June 2015

The “Clean-Up-The Air” Phase

- 2013 to 2018
- Tier 3, MATS, Natural Gas, EPA Transport Rule, New Transport Strategies from groups like the OTC or the State Collaborative
- Clean air ... attainment ozone by 2018



Questions?

