

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



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The solution to the ozone problem in the East has not changed

- We know that widespread regional NO_x reductions reduce ozone
- Local controls also are important

We now have even better science proving that the solution will work

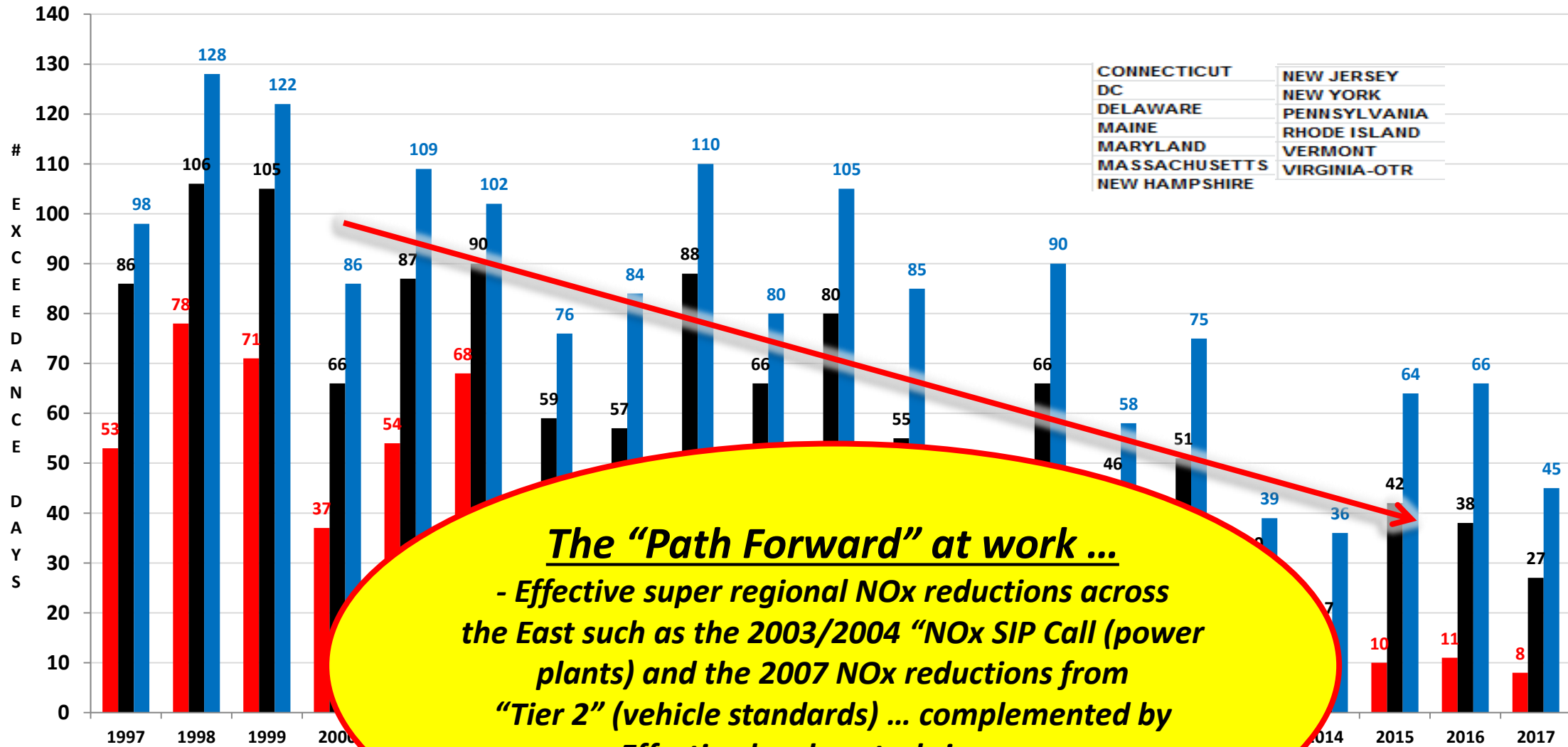
- In most areas ... NO_x reductions are now “supercharged” ... smaller reductions get greater benefits



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

We also have some very significant challenges with the new standard

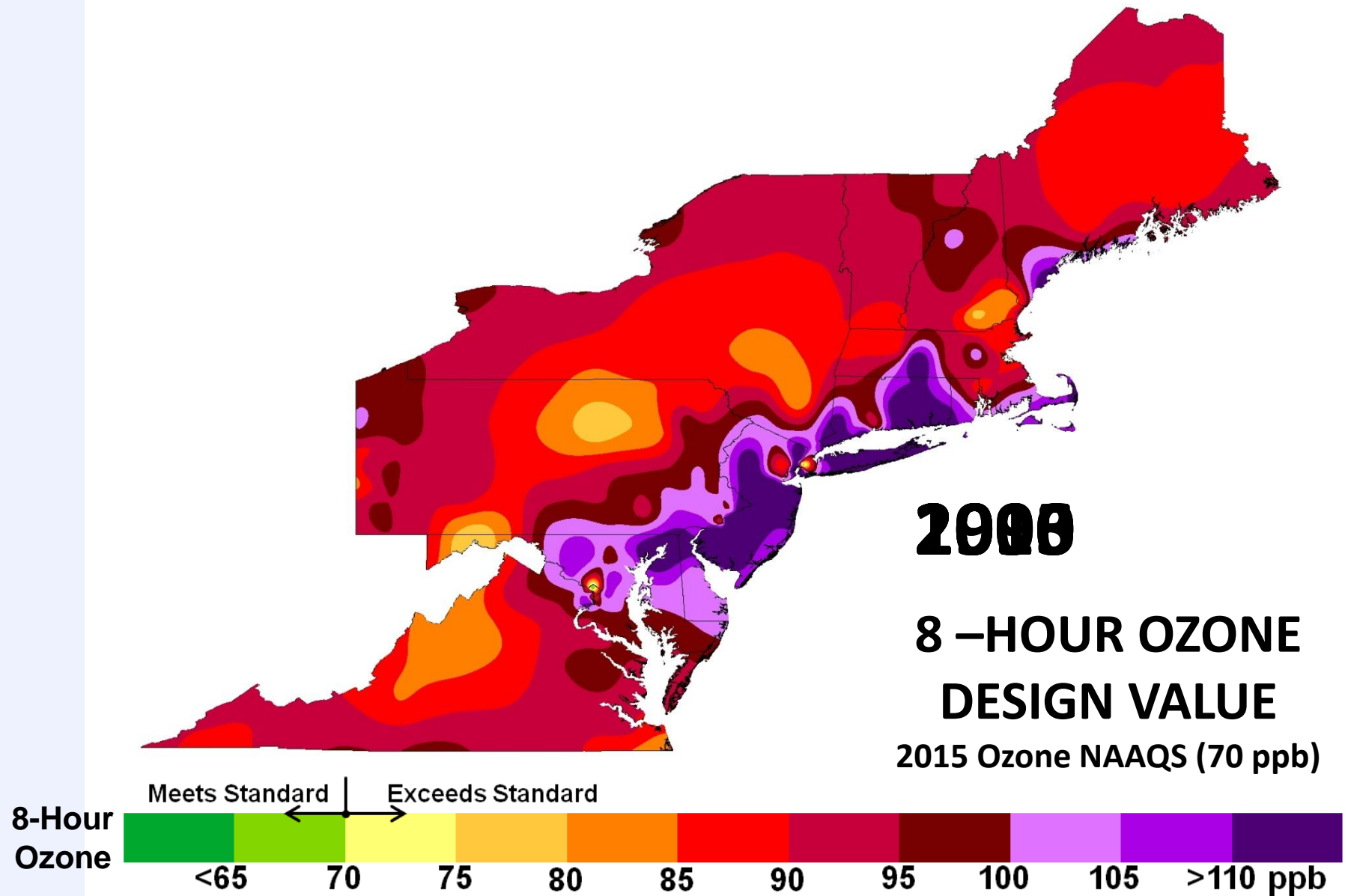
Ozone Trended Downward from 1997-2017



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



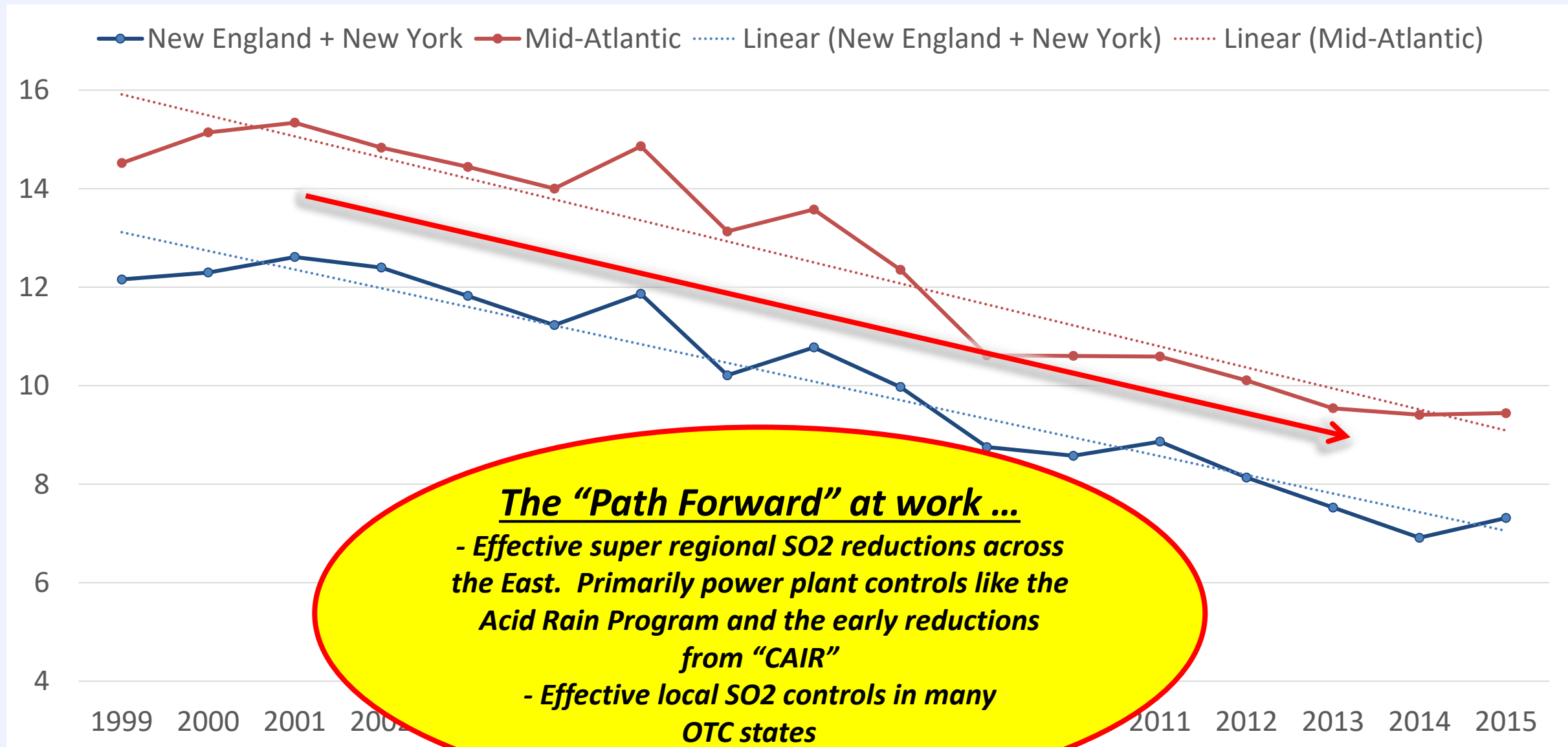
The Shrinking Ozone Problem



* 2016 Data is considered Preliminary



Fine Particulate ... Dramatic Downward Trend





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”

Edgewood, MD

Ground Level Ozone

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

50 ppb

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

10 ppb

10 ppb

10 ppb

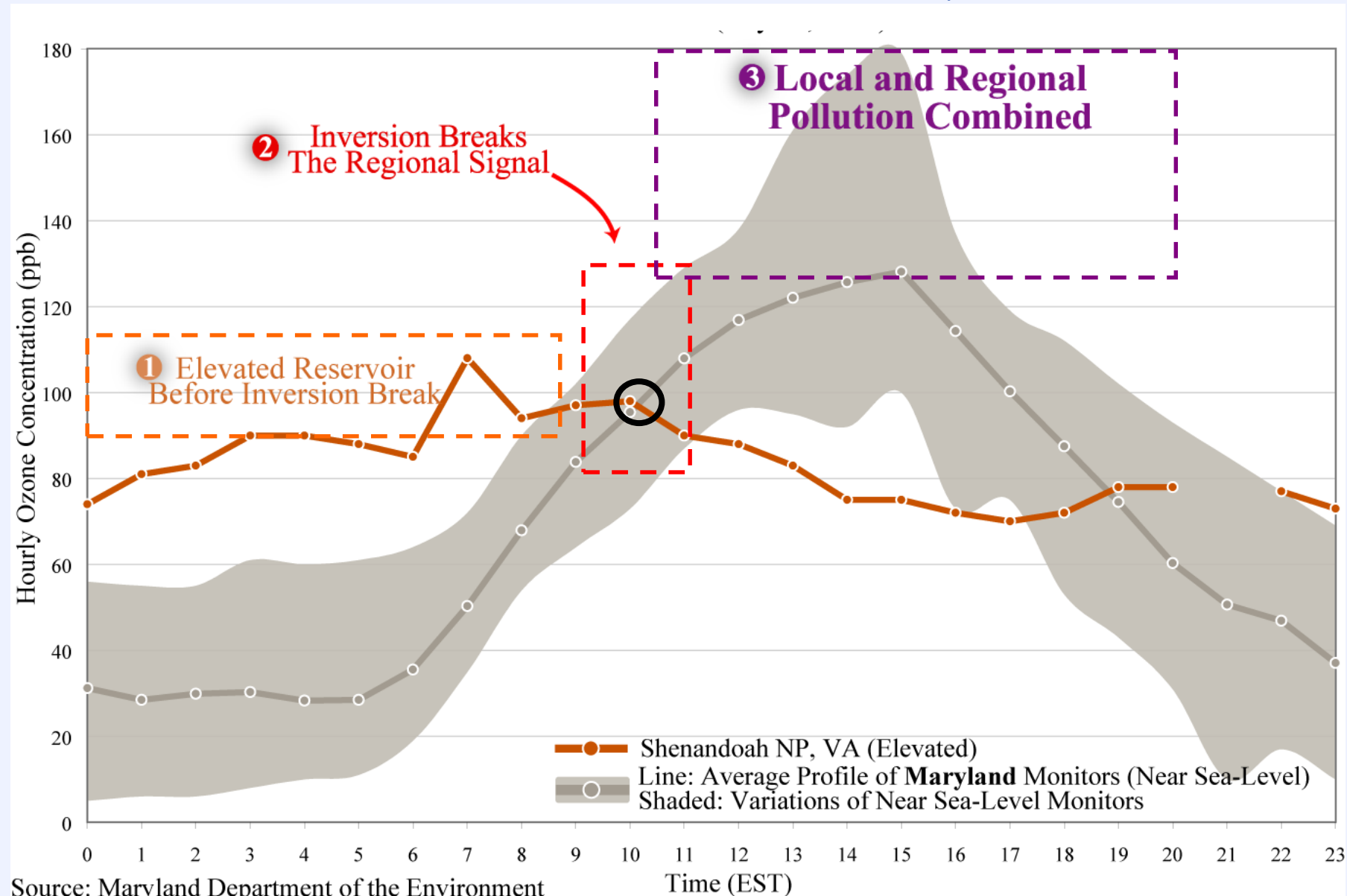
Add it all up on a bad day - 80 ppb ozone

80 ppb Exceedance Day

4. The night after the bad ozone day
 - Everything starts again ...

The Daily Ozone Creation Pattern

A classic, worst-case event on July 15, 1995

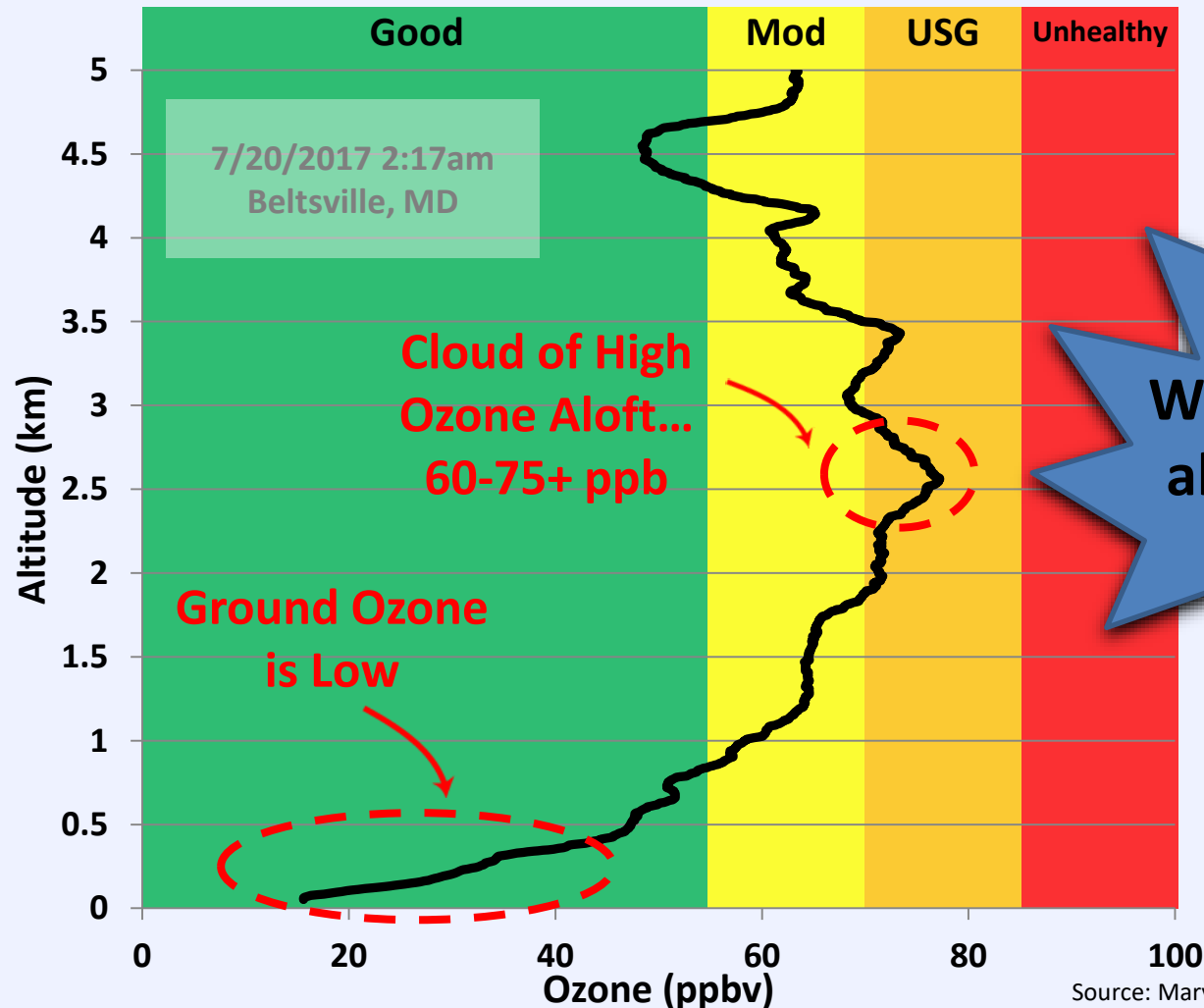


Source: Maryland Department of the Environment

The Night Before - July 2017

*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



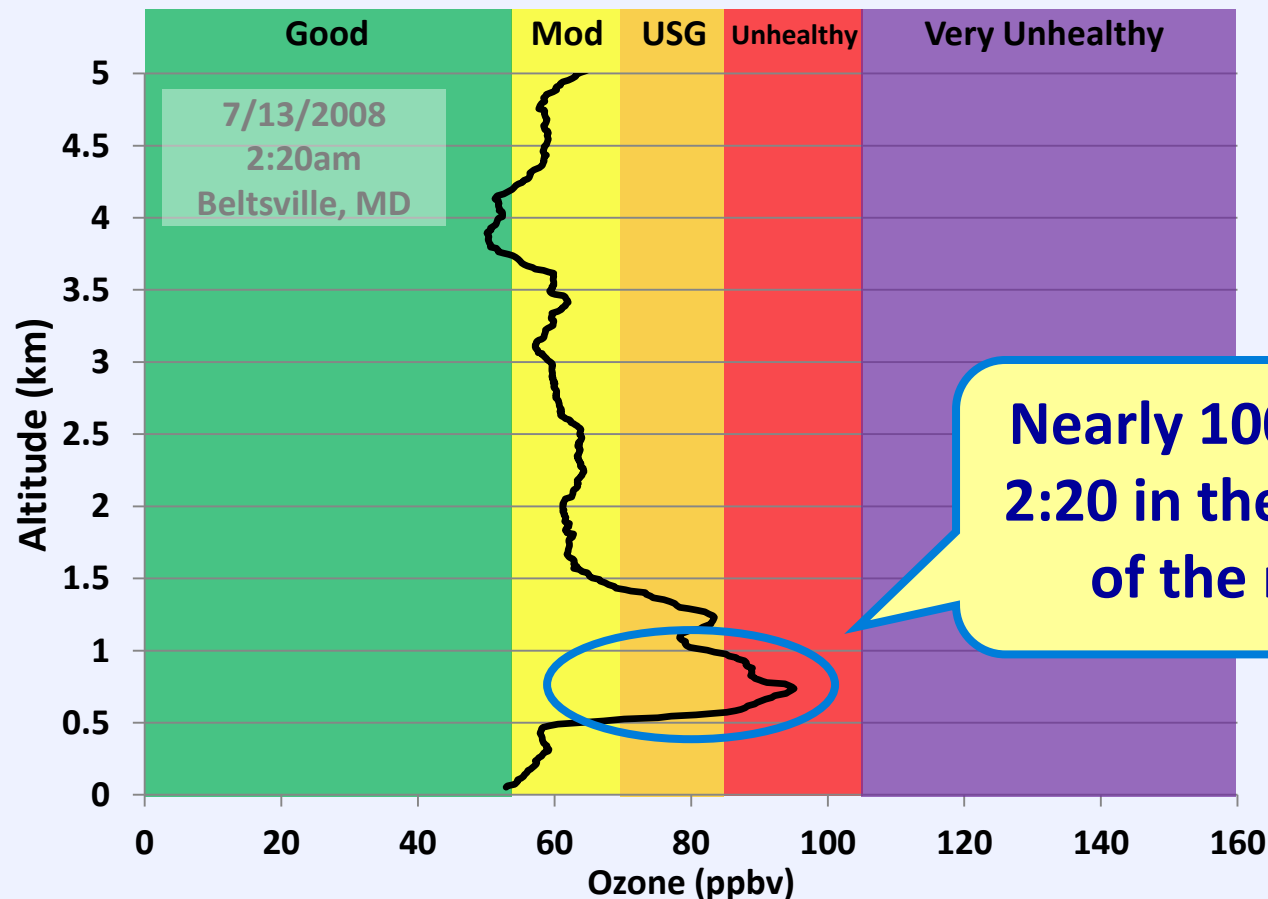
We see this before
almost every bad
ozone day



The Night Before - 2008

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



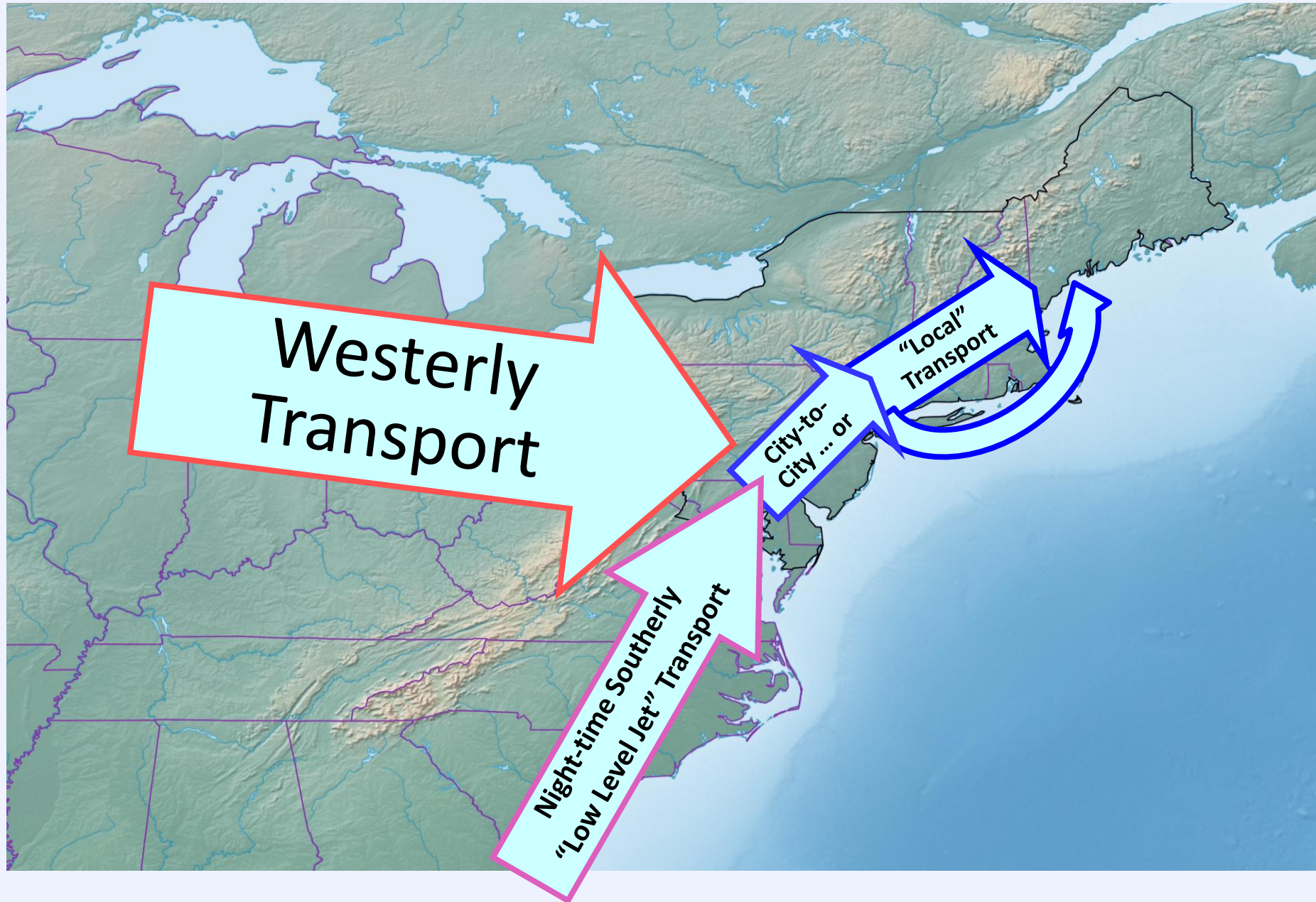
Nearly 100 ppb at 2:20 in the middle of the night



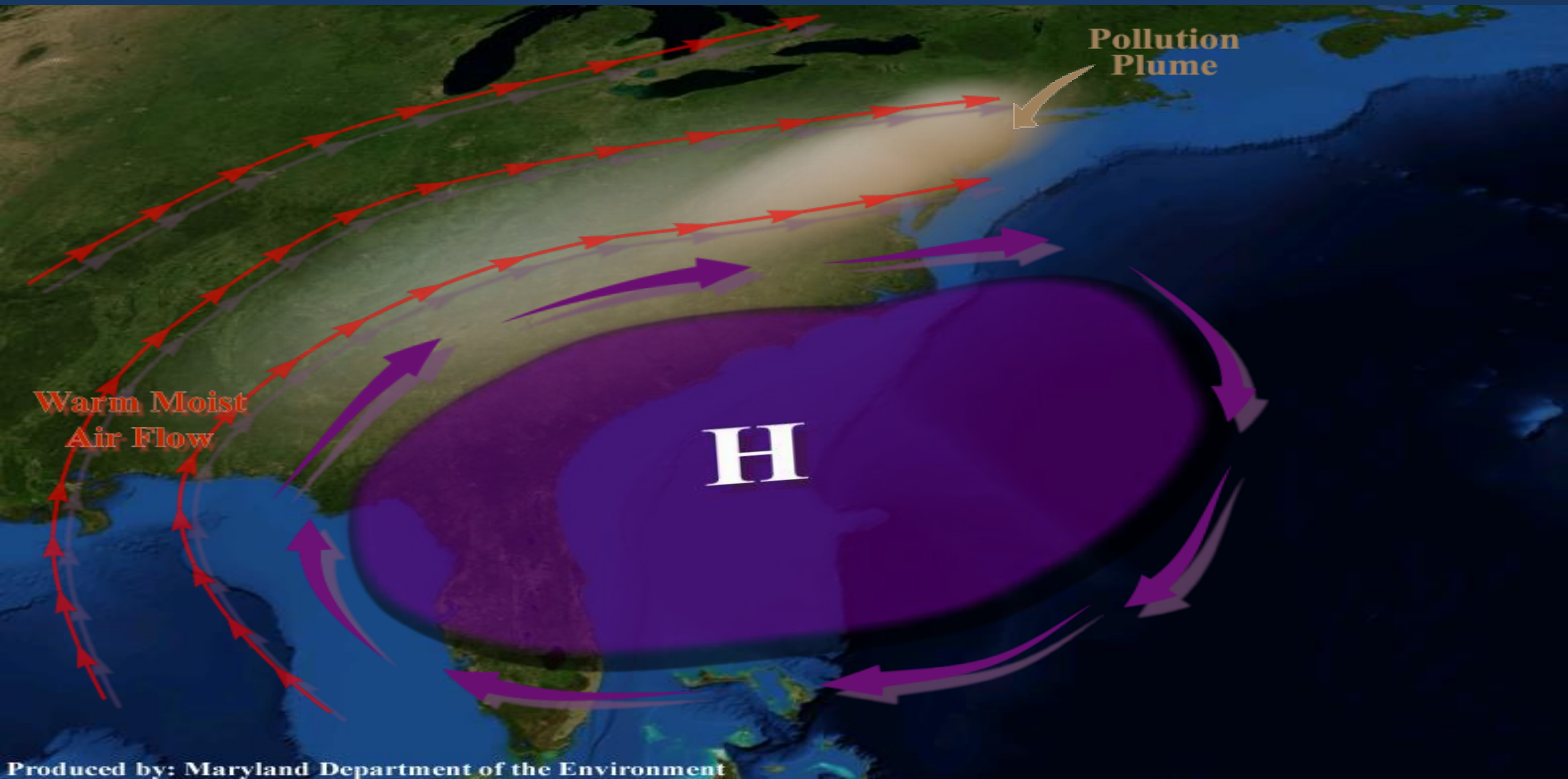
A bright sun is positioned in the upper right quadrant of the image, casting a strong, multi-rayed glow across the sky. The sky is a deep, clear blue. Several large, fluffy white clouds are scattered across the scene, with a prominent cluster on the left and another on the right. The overall atmosphere is bright and clear.

THE THREE DIFFERENT TYPES OF TRANSPORT

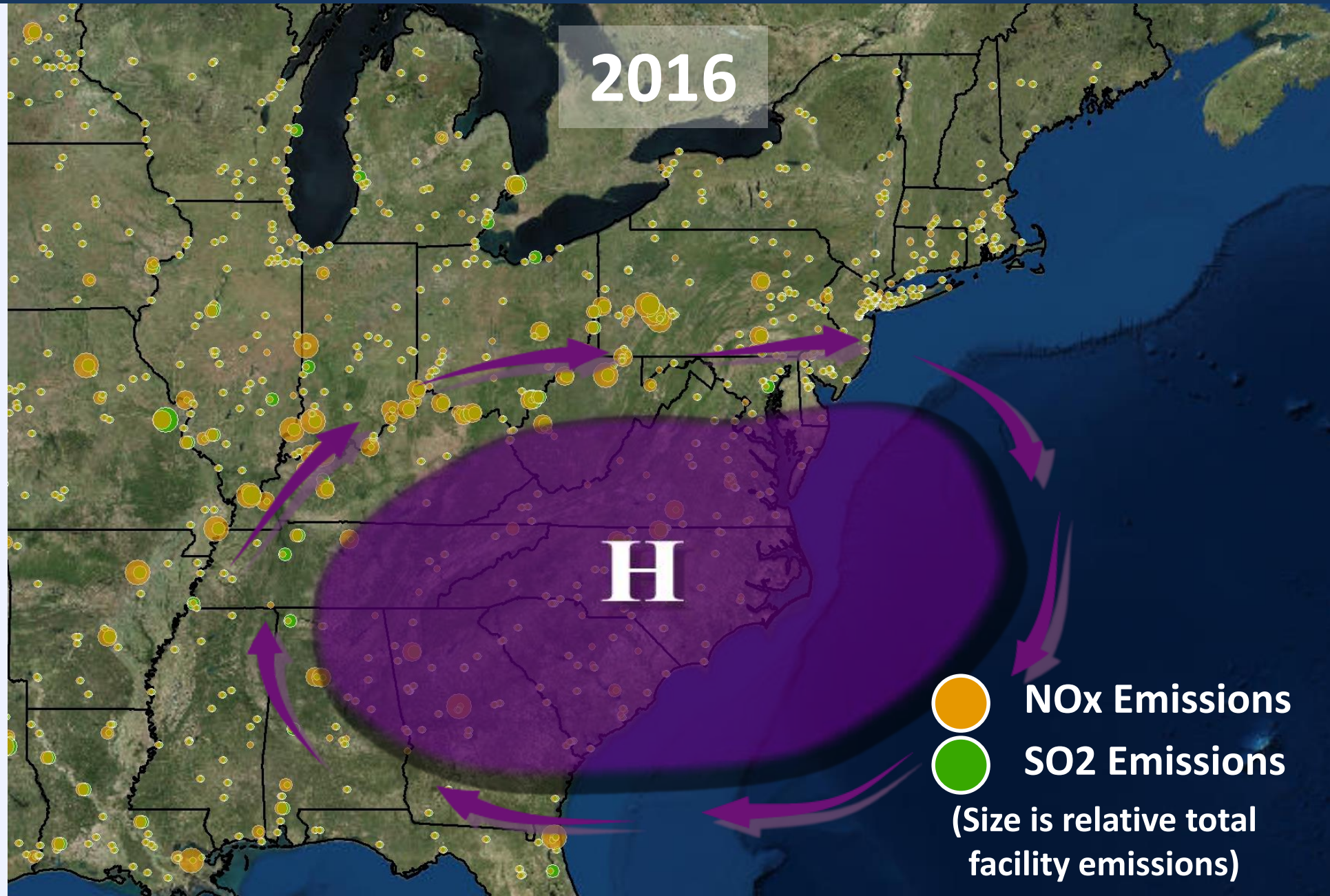
The Three Different Types of Transport



Classic Ozone Weather for the OTR

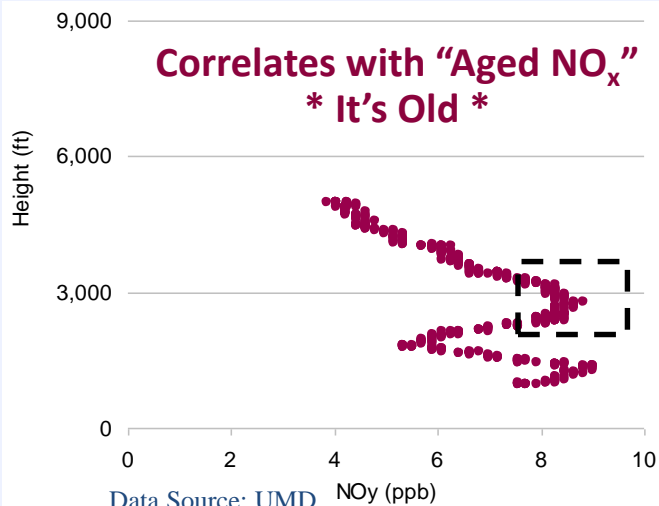
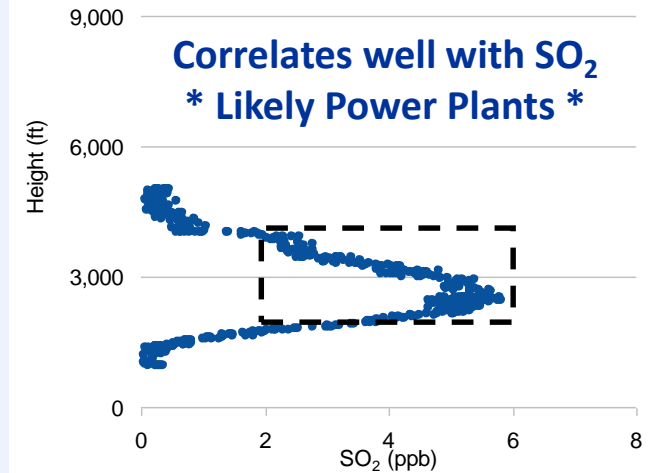
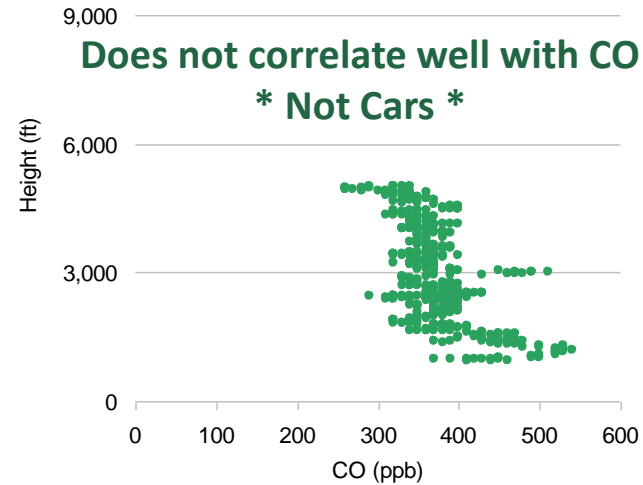
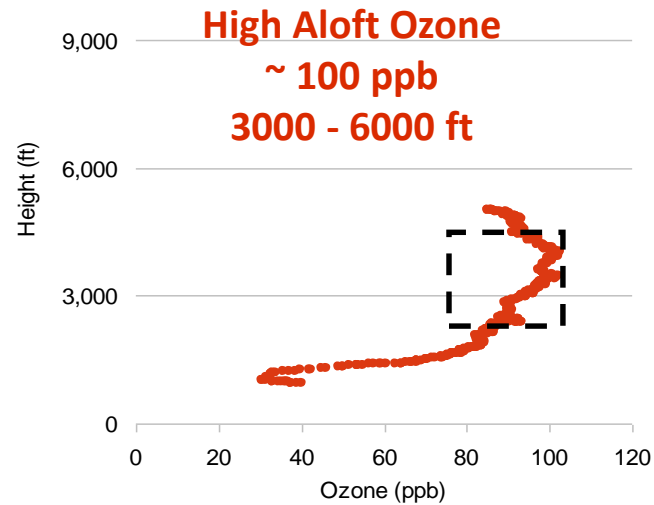


Westerly Transport



Fingerprinting Westerly Transport - Then

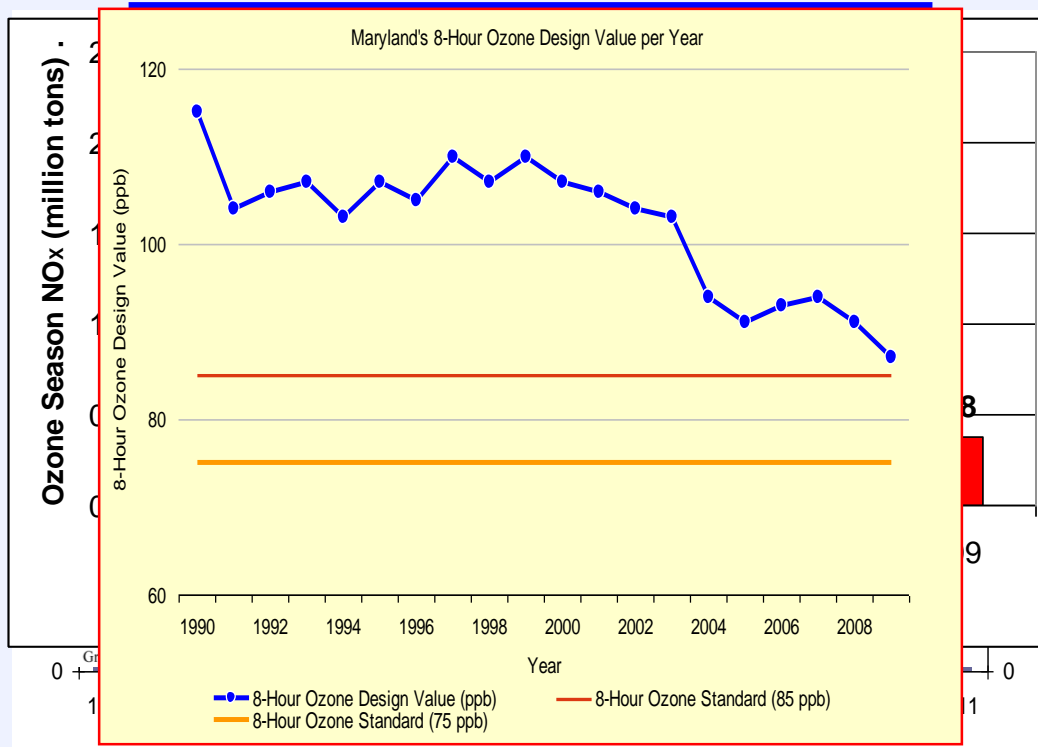
Classic work from 1995 - What can data tell us about its origin?



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

Reducing Westerly Transport – A Classic Case Study

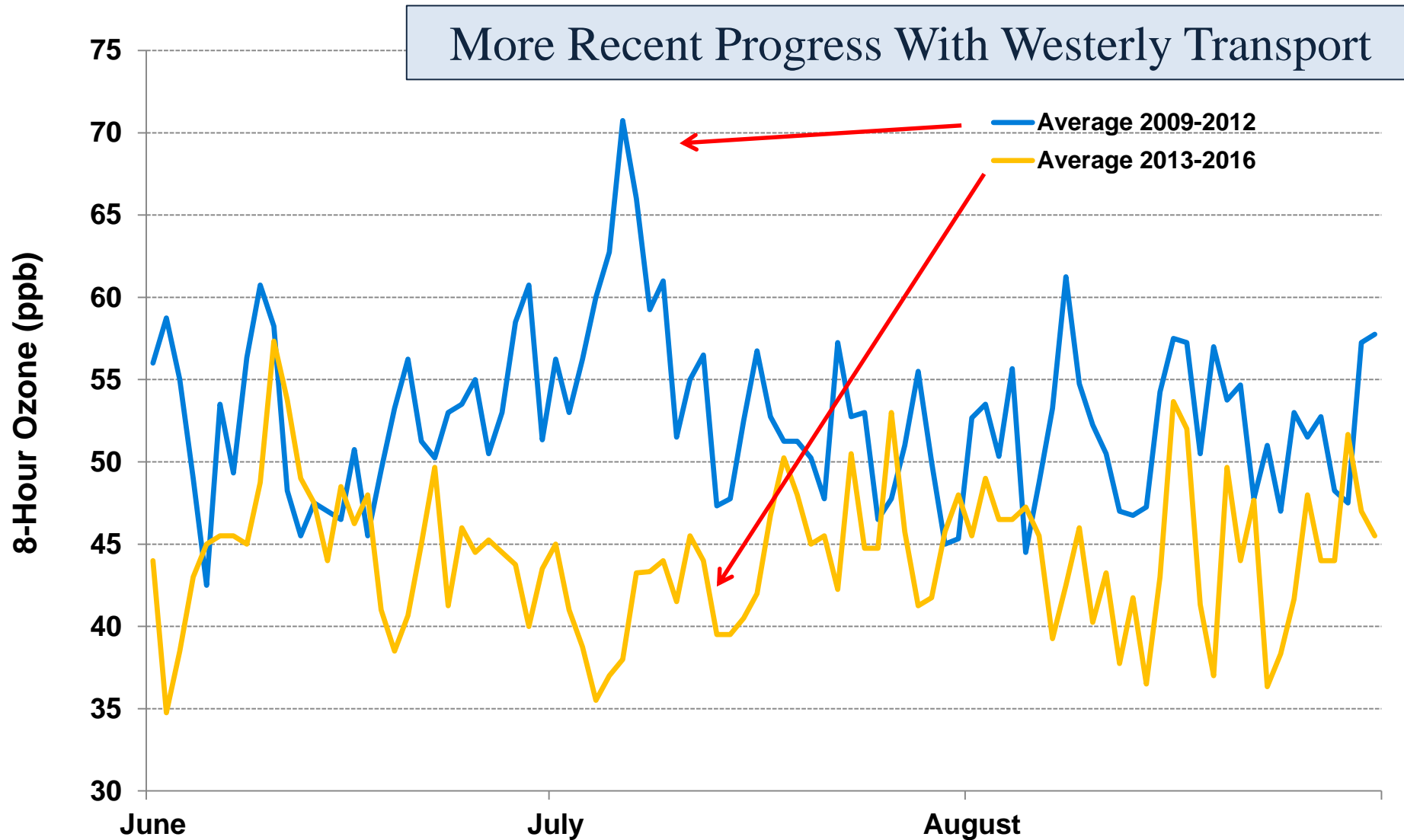
Ground Level Ozone Drops Dramatically in the Same Time Frame



The 2003/2004 “NO_x SIP Call” as a case study. Significant NO_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_x SIP Call (power plants) and the Tier 2 Vehicle Standards show that:
 - Adding regional controls ...
 - Results in regional NO_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



Period	Avg. all days June – August
2009-2012	52.7 ppb
2013-2016	44.2 ppb

Difference 8.5ppb

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

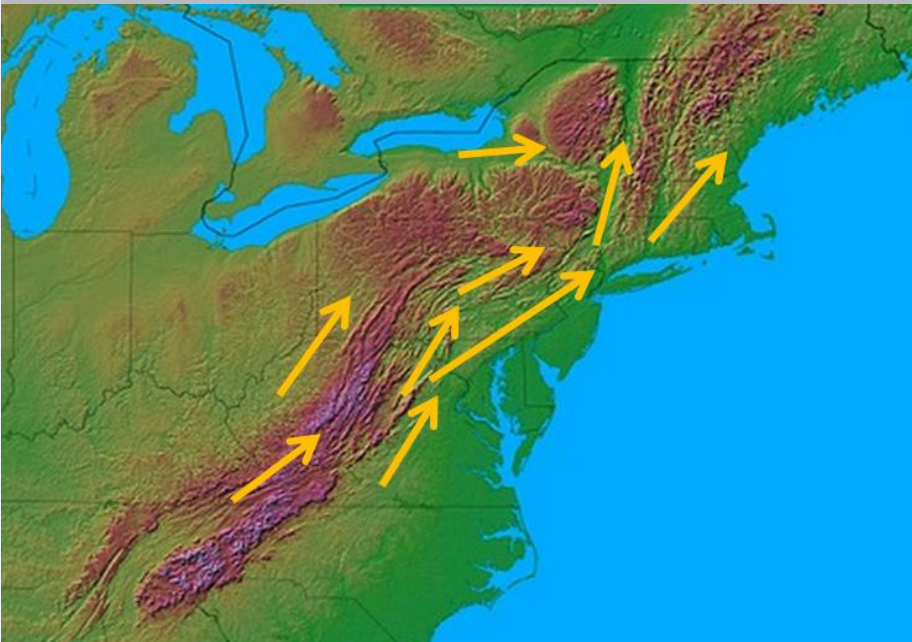


Piney Run is a mountain-top monitor and measures the amount of ozone being transported into Maryland's western border.

Southerly Transport at Night

The Nocturnal Low Level Jet (NLLJ)

Winds ~ 1000 Feet Above Surface



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



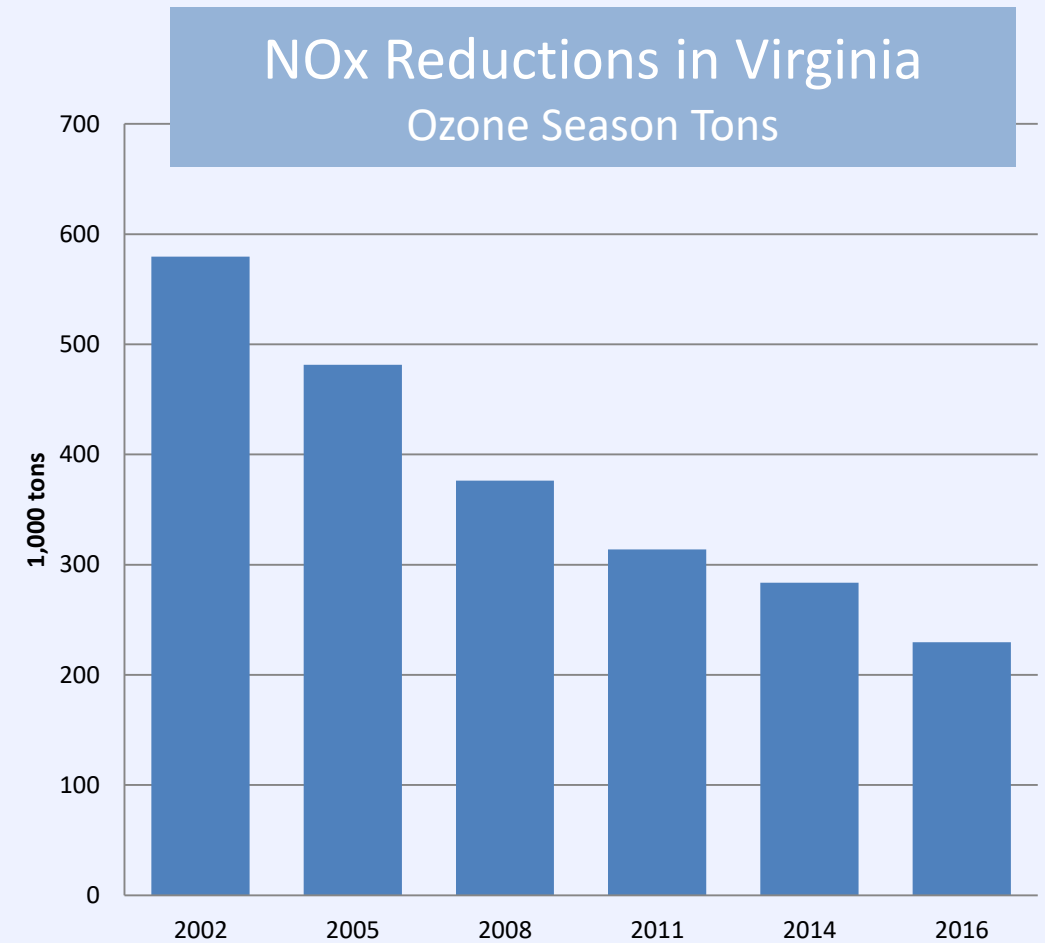
Lower Ozone in the NLLJ - Why?

10 years ago, we saw the NLLJ pushing high ozone levels from south to north all the time.

That has changed !!!

Large NO_x reductions in VA are clearly linked to this progress

Should continue to improve as mobile source NO_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
- MD to PA ... PA to NJ ... NJ to NY ... NY to CT ... CT to MA ... MA to NH & ME ... and so on



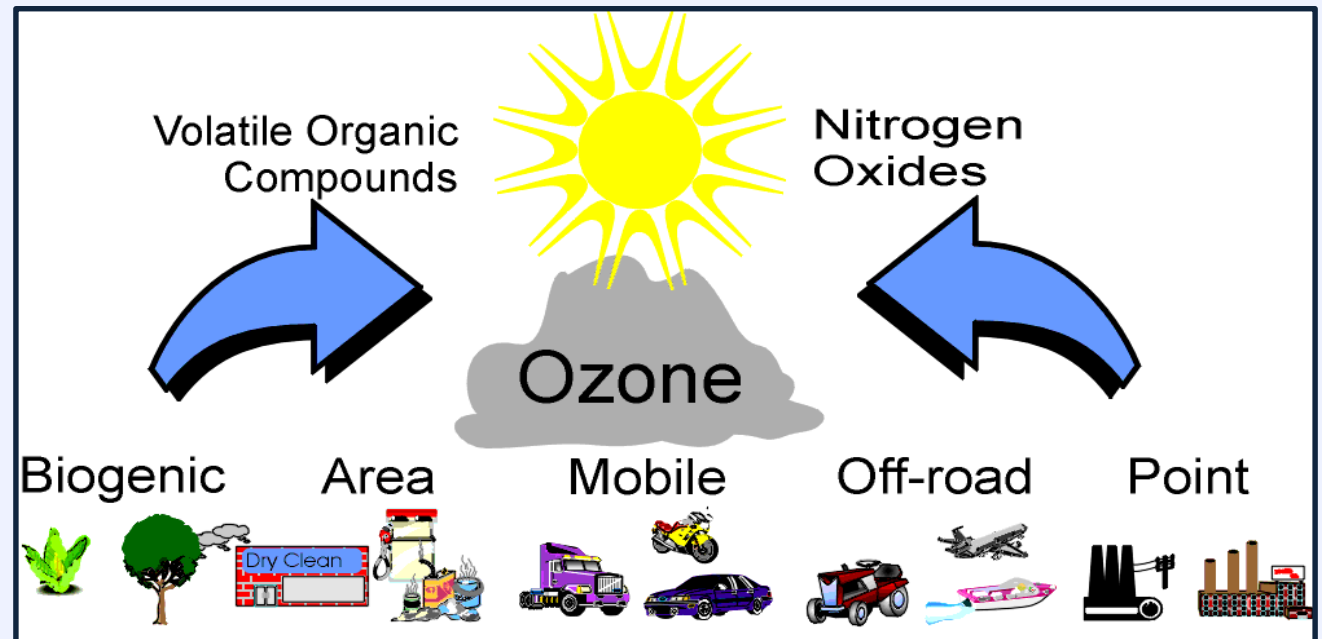
What Drives “Local” Transport?

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, gas stations, etc.)



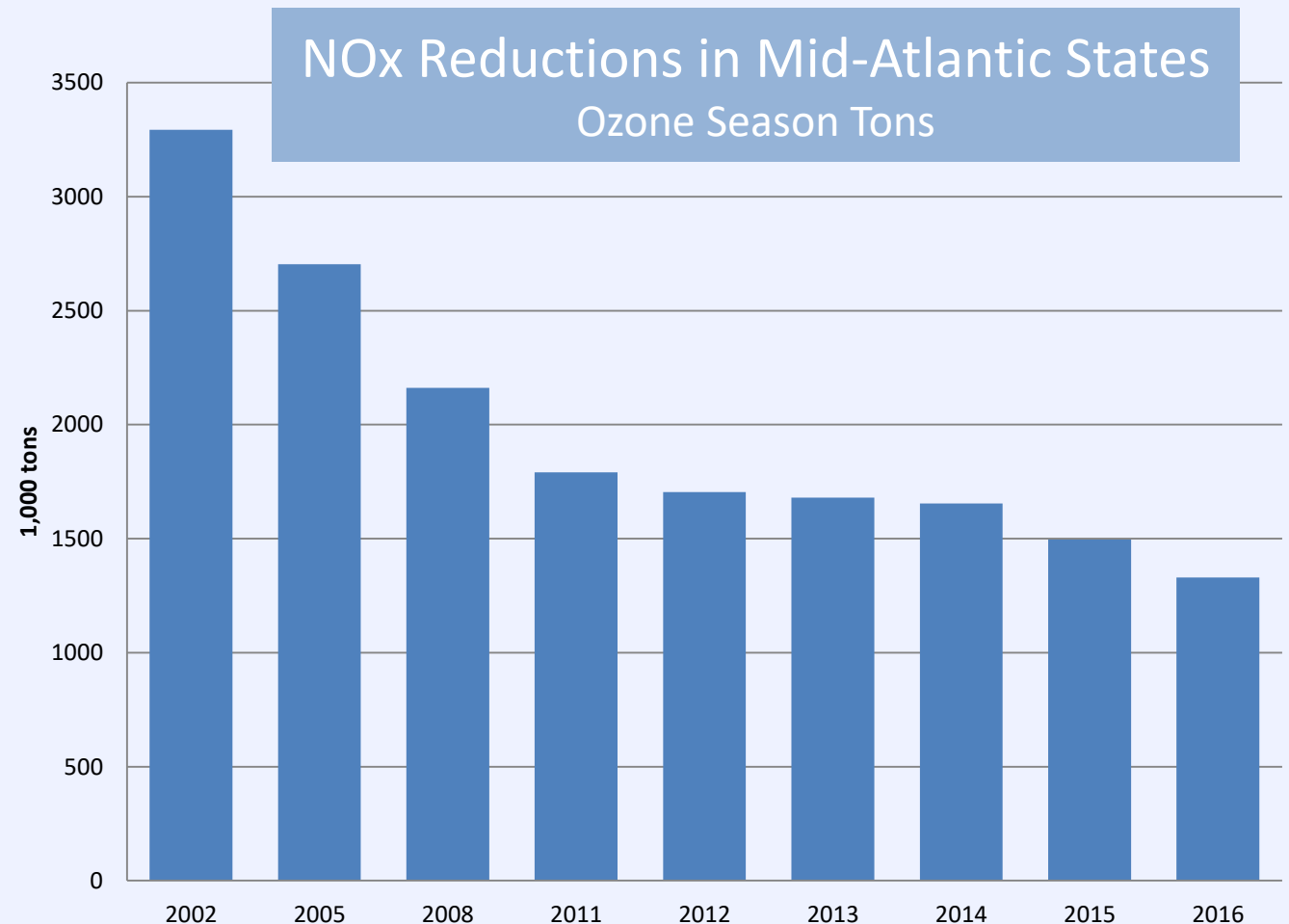
Changing Chemistry ... Some Good News

In the Mid-Atlantic, NO_x reduction efforts seem to be returning unexpected dividends

We know that regional NO_x reductions will clearly reduce ozone levels

It appears that in 2017, enough NO_x has been taken out of the system that the chemistry has changed

- We now get more ozone reduction per every ton of NO_x we reduce compared to 2000



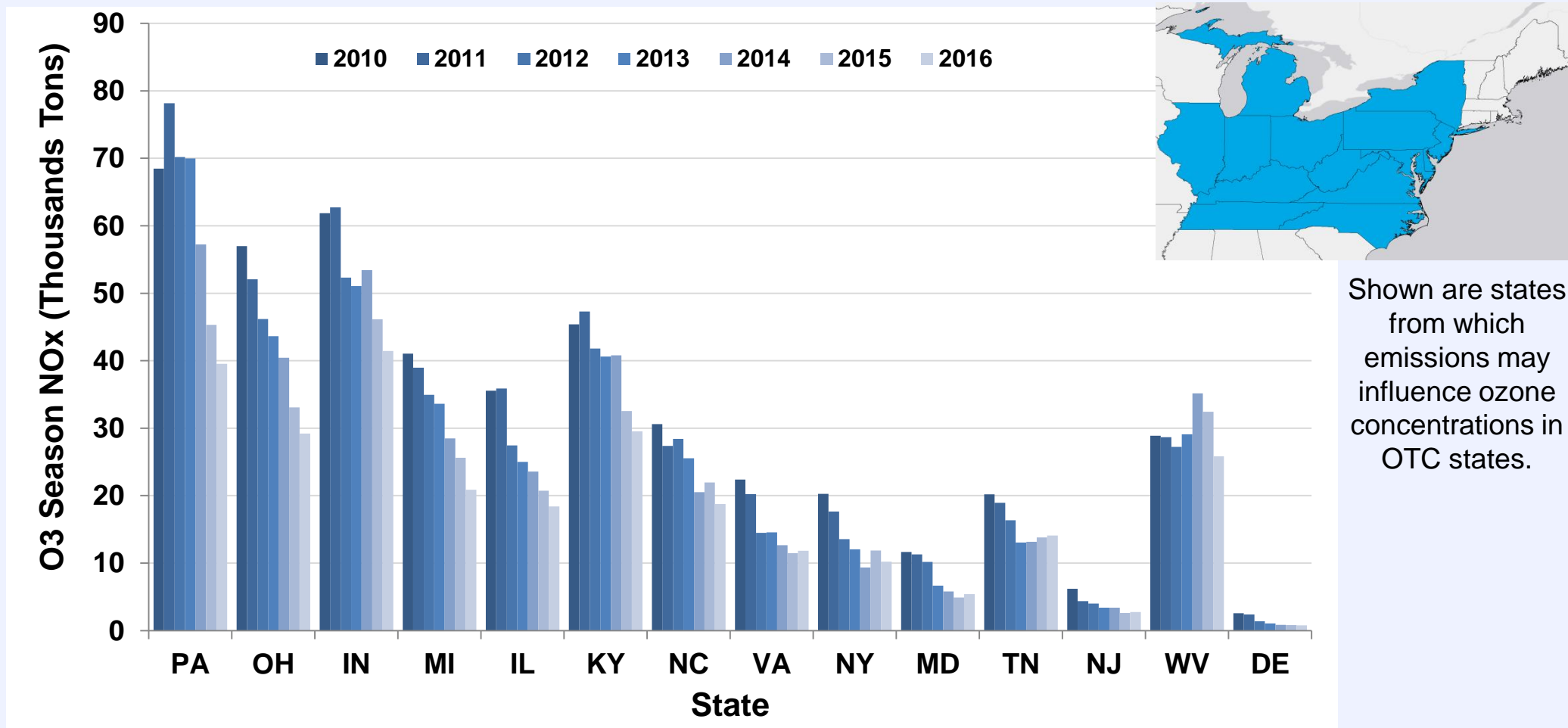


SO ... WHAT HAVE WE LEARNED
AND
WHERE DO WE GO NEXT

EGU Emissions - Are We Winning the War?

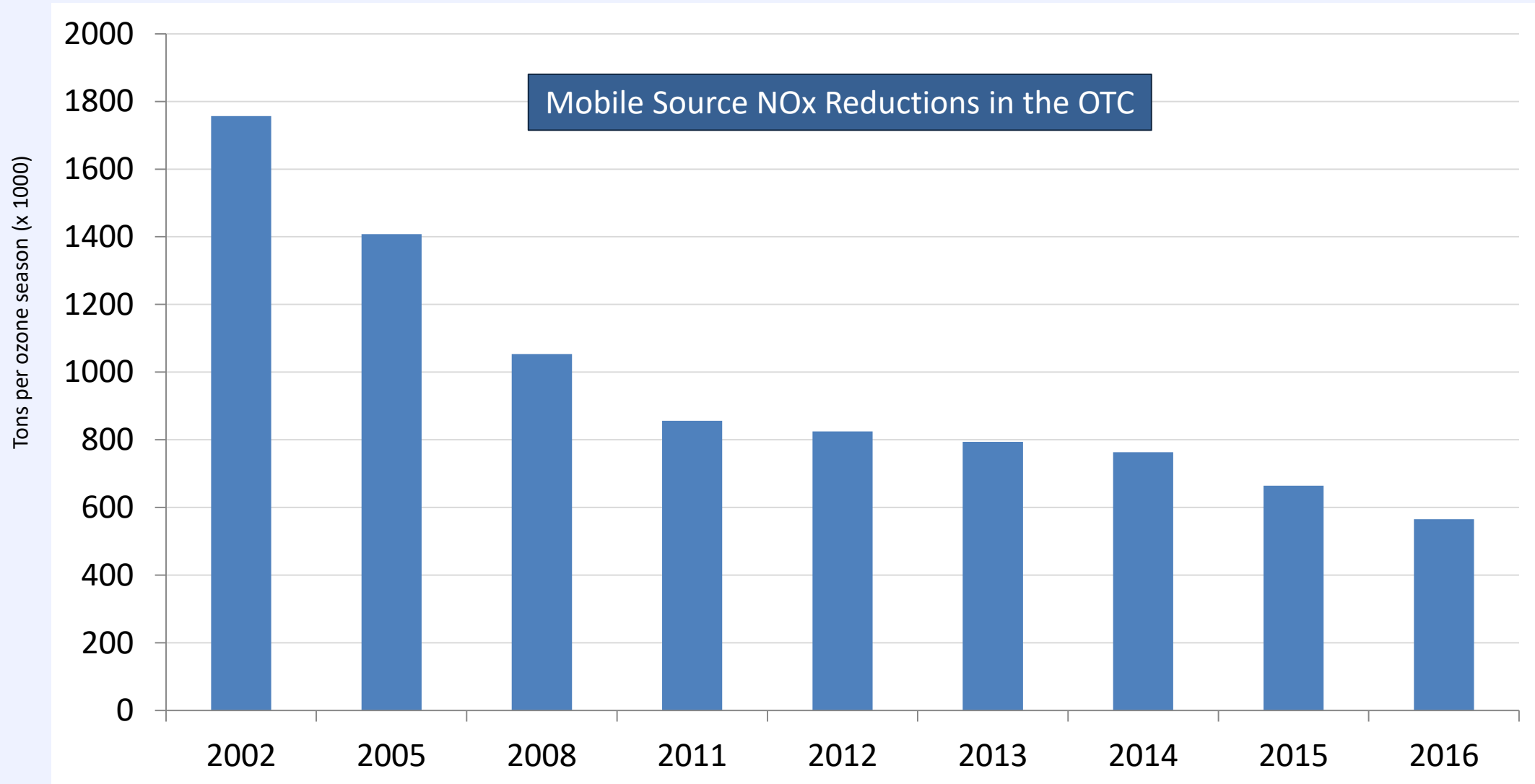
Sort of ... Ozone season EGU NO_x emissions continue to decrease across the East

- > That said, still more work to do
- > Most states had lowest ozone season NO_x emissions on record in 2016



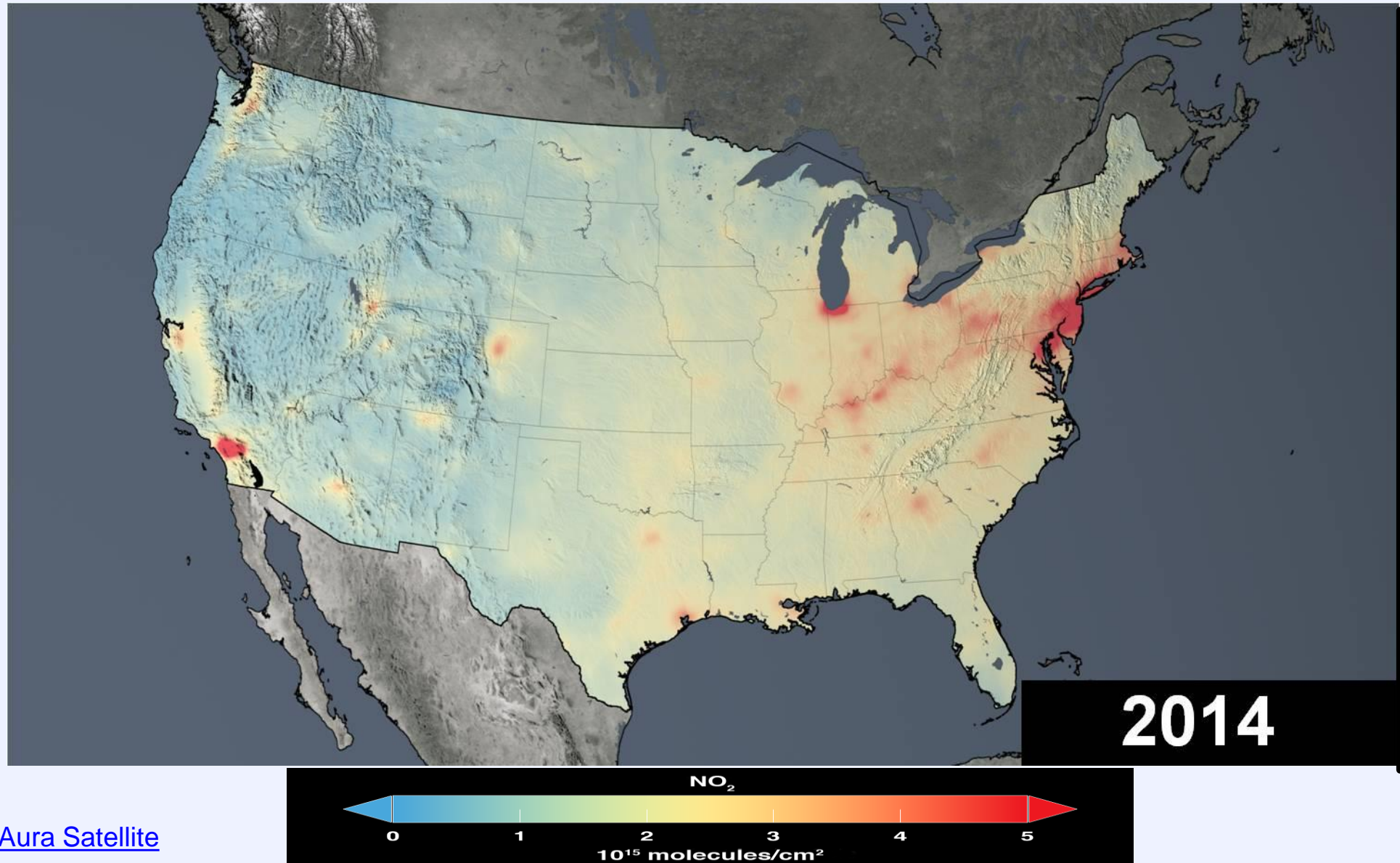
How About Mobile Source NOx Reductions?

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



NOx Reductions As Seen From Satellites

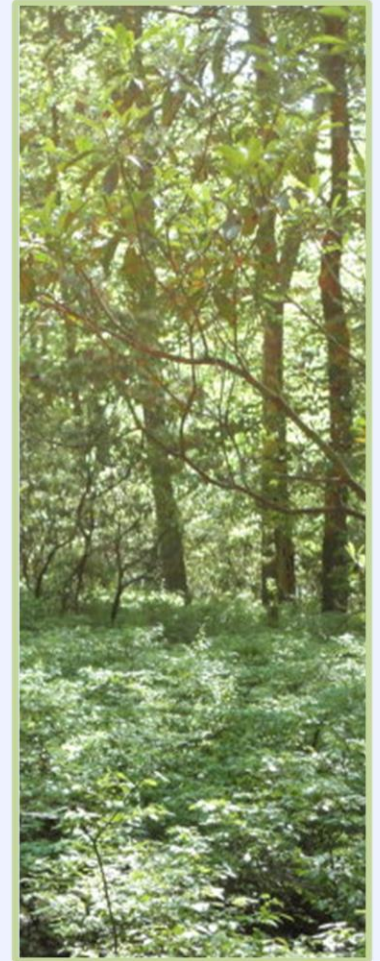
NO₂ Reductions from Space - 2005 to 2014



Source: [NASA's Aura Satellite](#)

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
 - 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
 - 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
 - Maryland's 2015 NO_x regulation established this requirement in MD
- Benefits are potentially very large
 - Up to a 300 tons per day of NO_x reductions
 - 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

