Department of the Environment

2007 Ozone Season

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Status, Trends, Continuing Progress

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Maryland Department of the Environment

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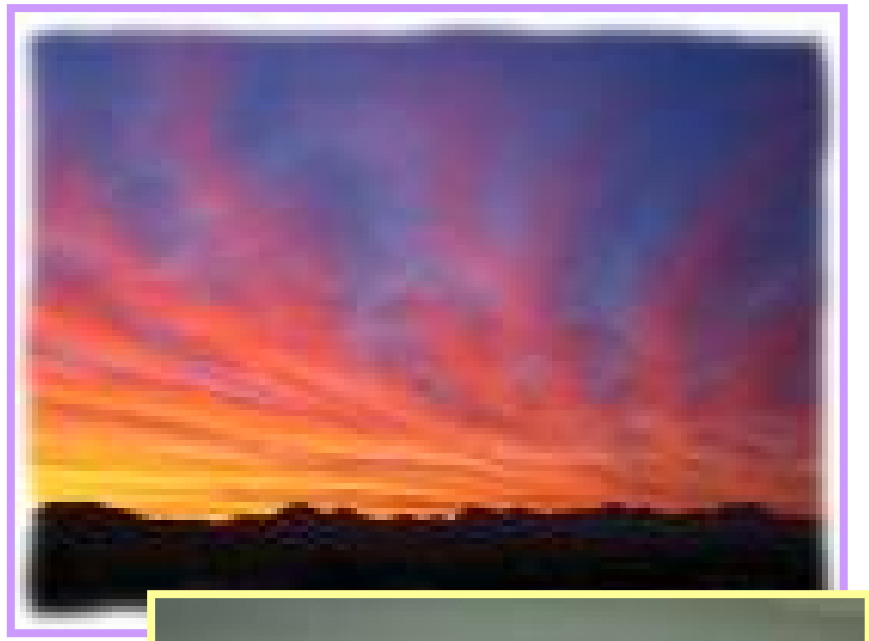
OTC Fall Meeting
Arlington, VA
November, 14 2007

MDE

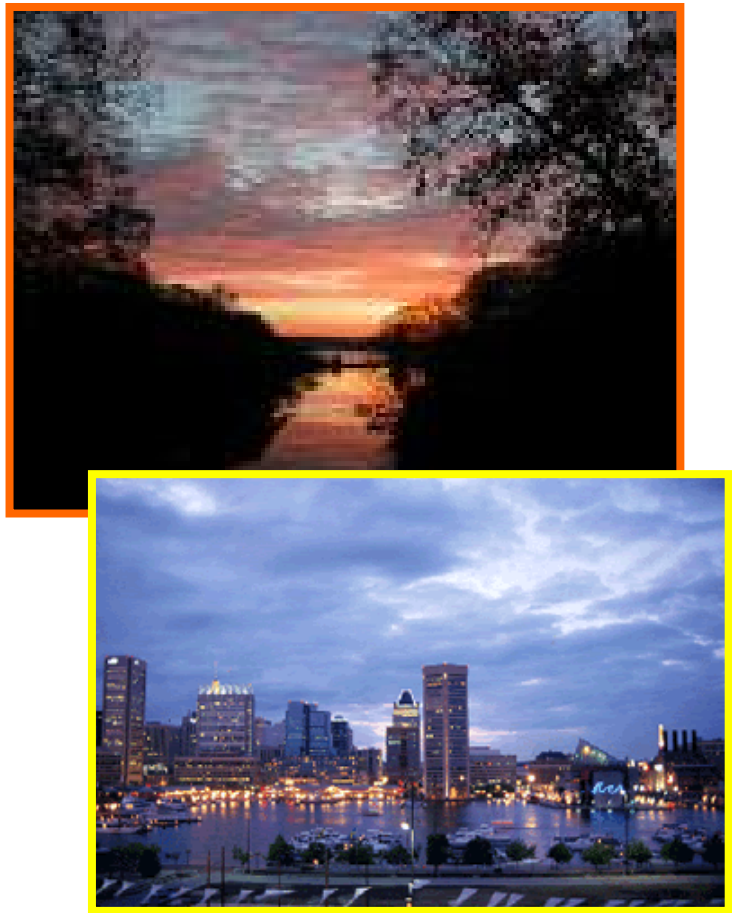
Topics Covered

- Trends and Continuing Progress
- Snapshot of 2007 Ozone Season
- The New Standard
  - Future Challenges

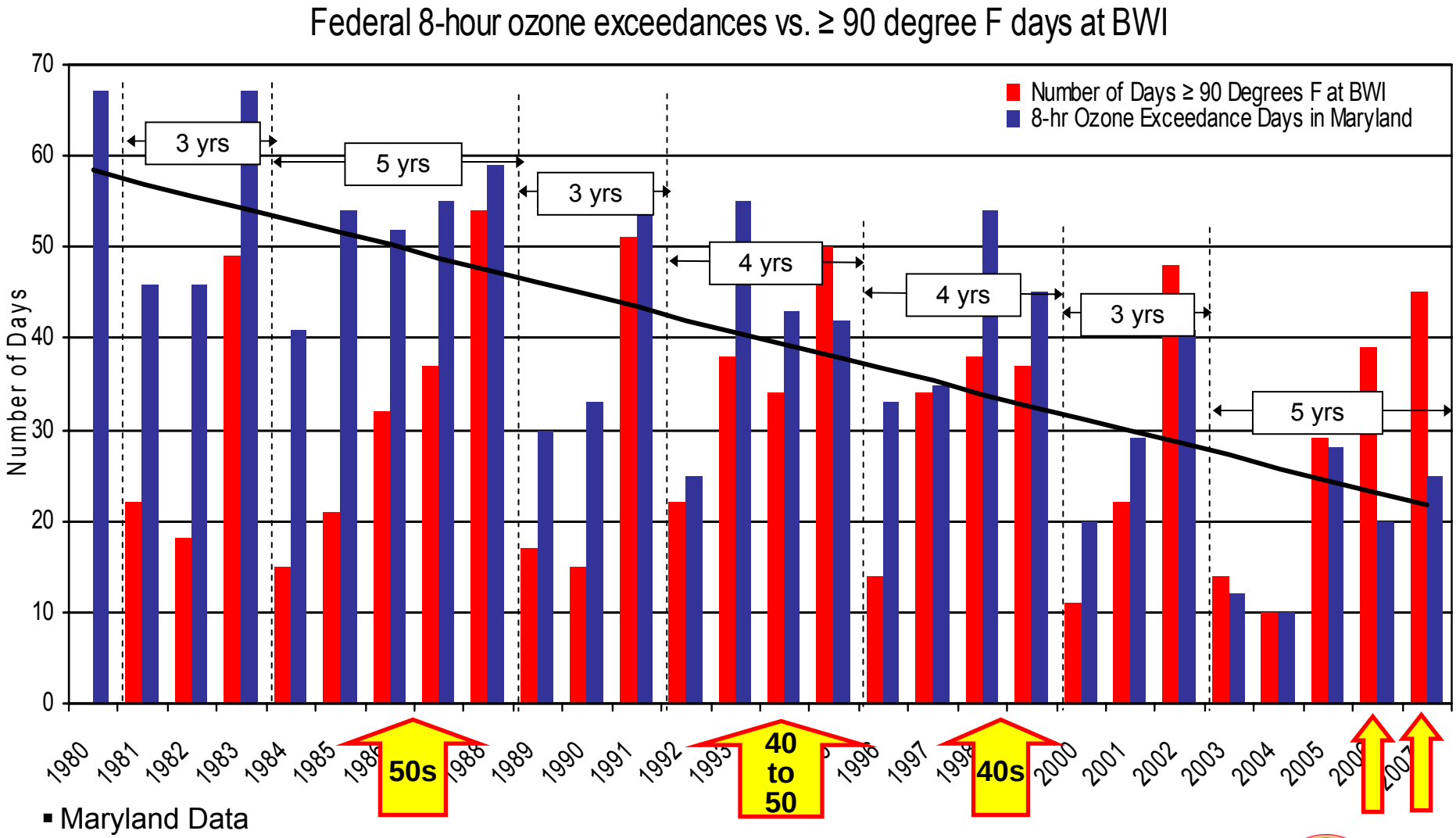


Take Home Messages

- We've made tremendous progress in reducing ozone over the past 5 years
- Attaining the 8-Hour Standard by 2010 continues to be a challenge for much of the OTR
- Complying with an even tougher ozone standard will be even more challenging
- The NOx reduction programs for power plants are working – working very well

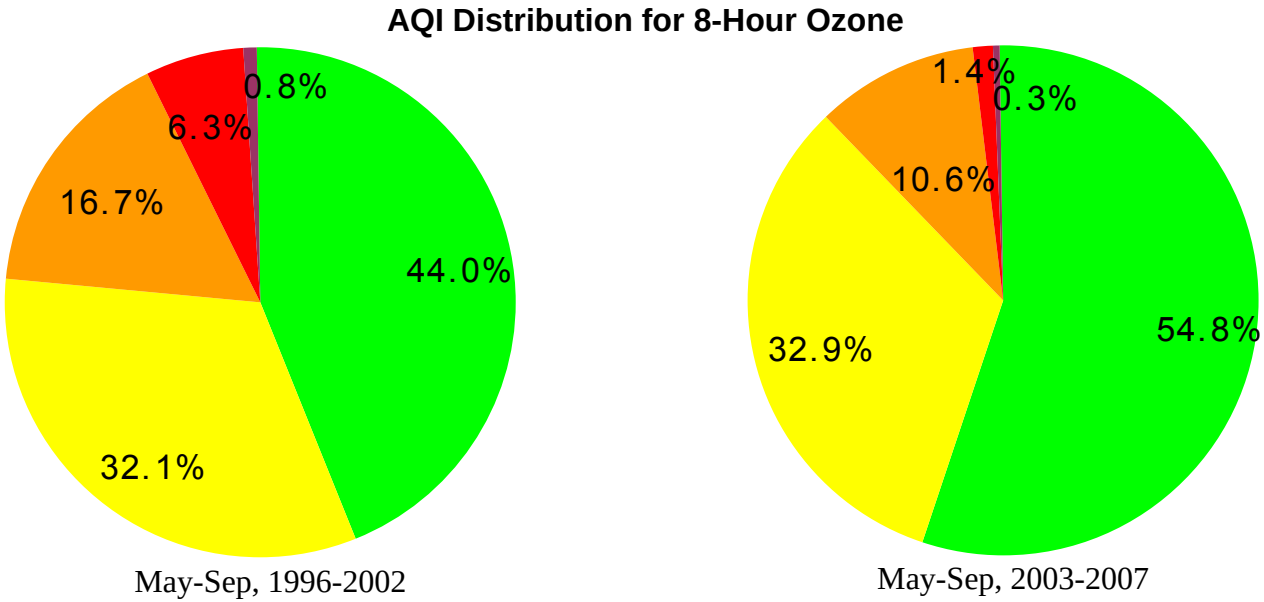


8-hour Exceedance Days and 90 Degree Days



Note: 2007 data are preliminary.

Where's The Red?



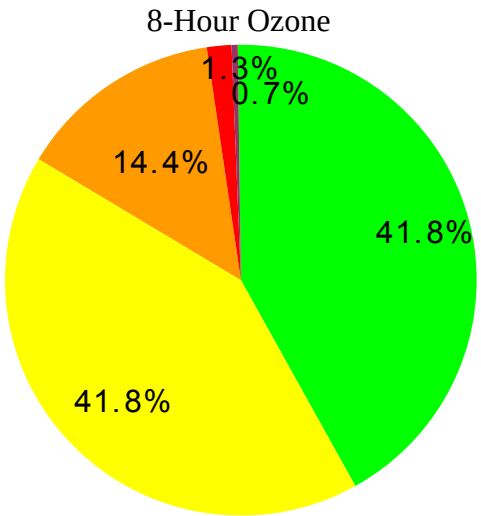
- Ground-level ozone has improved significantly from the mid-90s to recent years.
- Percentage of days reaching Unhealthy for Sensitive Groups (USG) AQI levels or above have dropped from 23.8% (1996-2002) to 12.3% (2003-2007), **an improvement of 48.3%**.
- While "**Bad**" **air days** have been **decreasing** rapidly, "**Good**" **air days** have also been **increasing** rapidly.

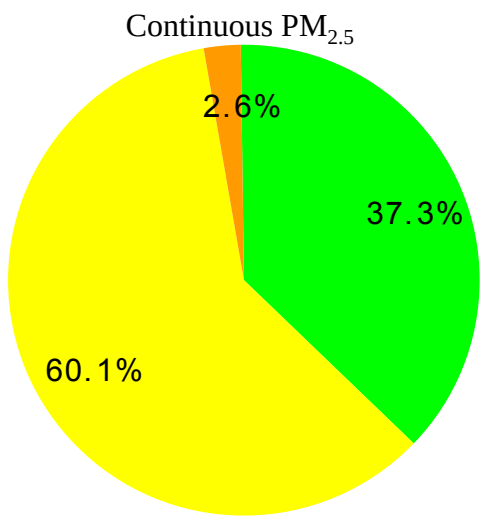
Air Quality Index

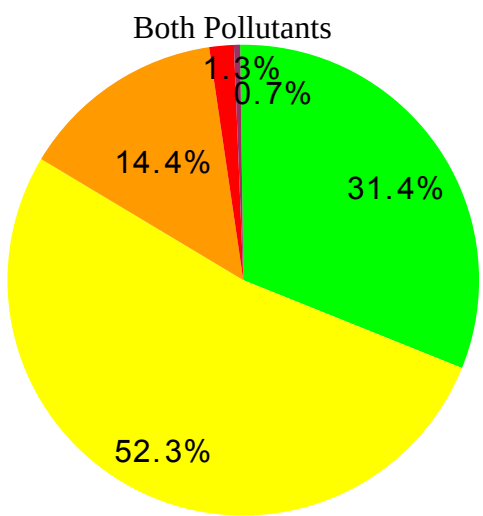
0-50 Good	51-100 Moderate	101-150 UGS*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

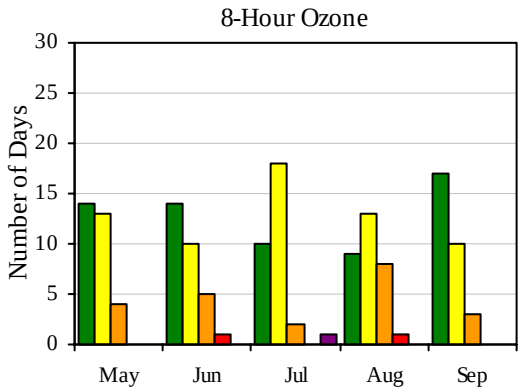
Note: 2007 data are preliminary.

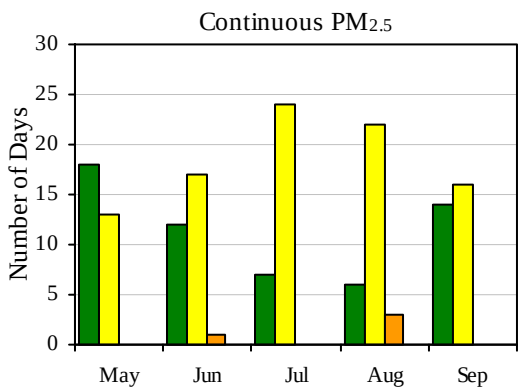
AQI - Ozone or PM Driven?

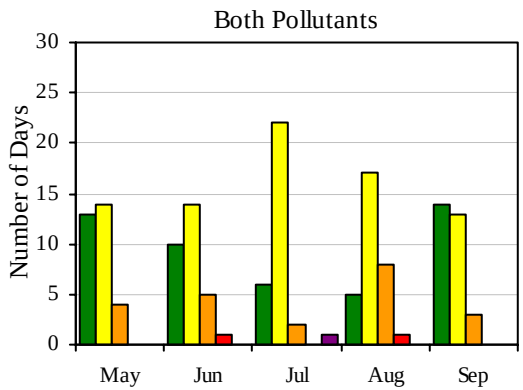












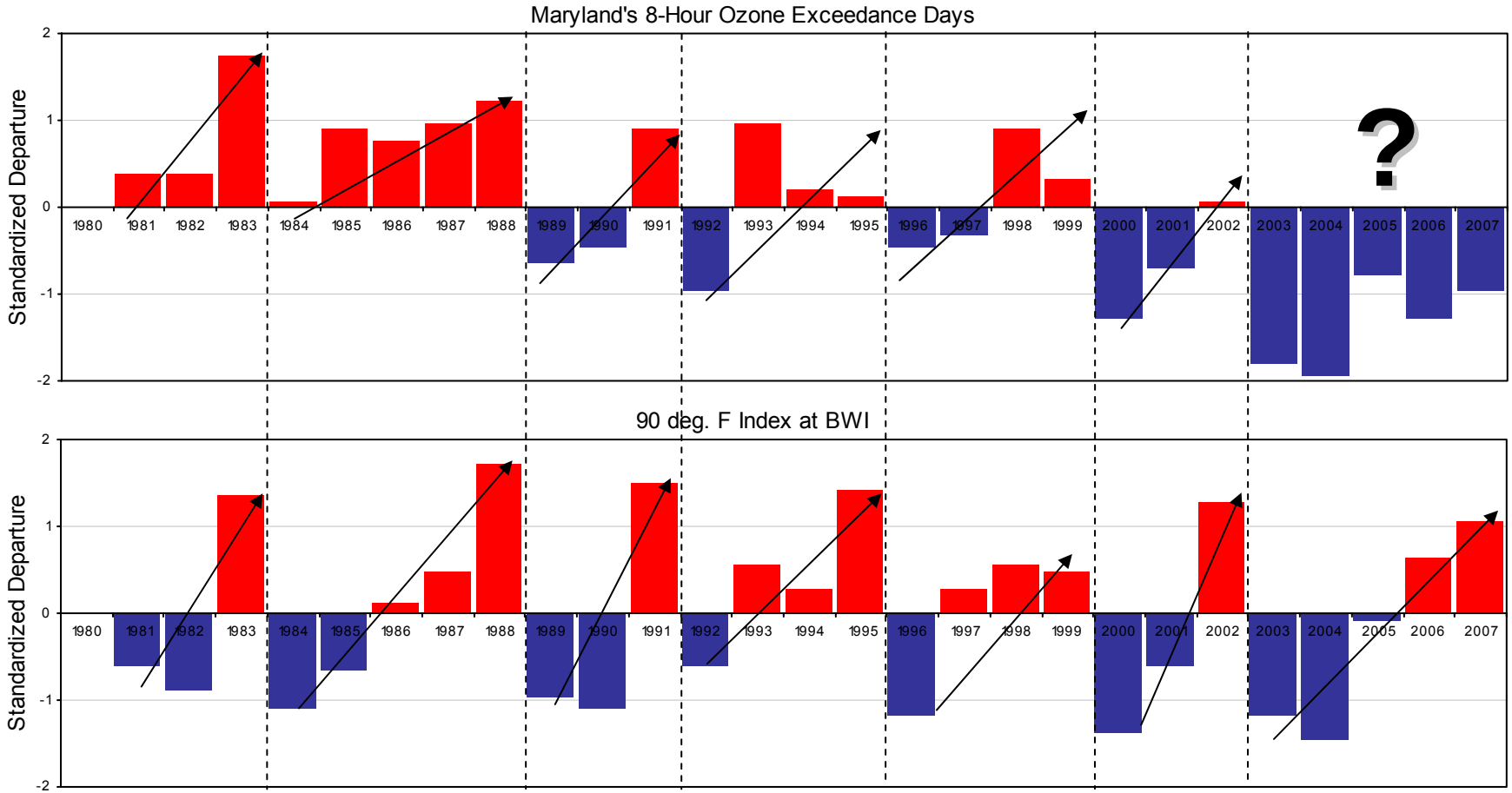
- 8-hour **ozone** is **primary pollutant during high pollution events** (Unhealthy for Sensitive Groups or above).
- However, **particle pollution** is an **important** part of overall air quality in Maryland, especially for **Moderate Days**.

Air Quality Index

0-50 Good	51-100 Moderate	101-150 UGS*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

Note: 2007 data are preliminary.

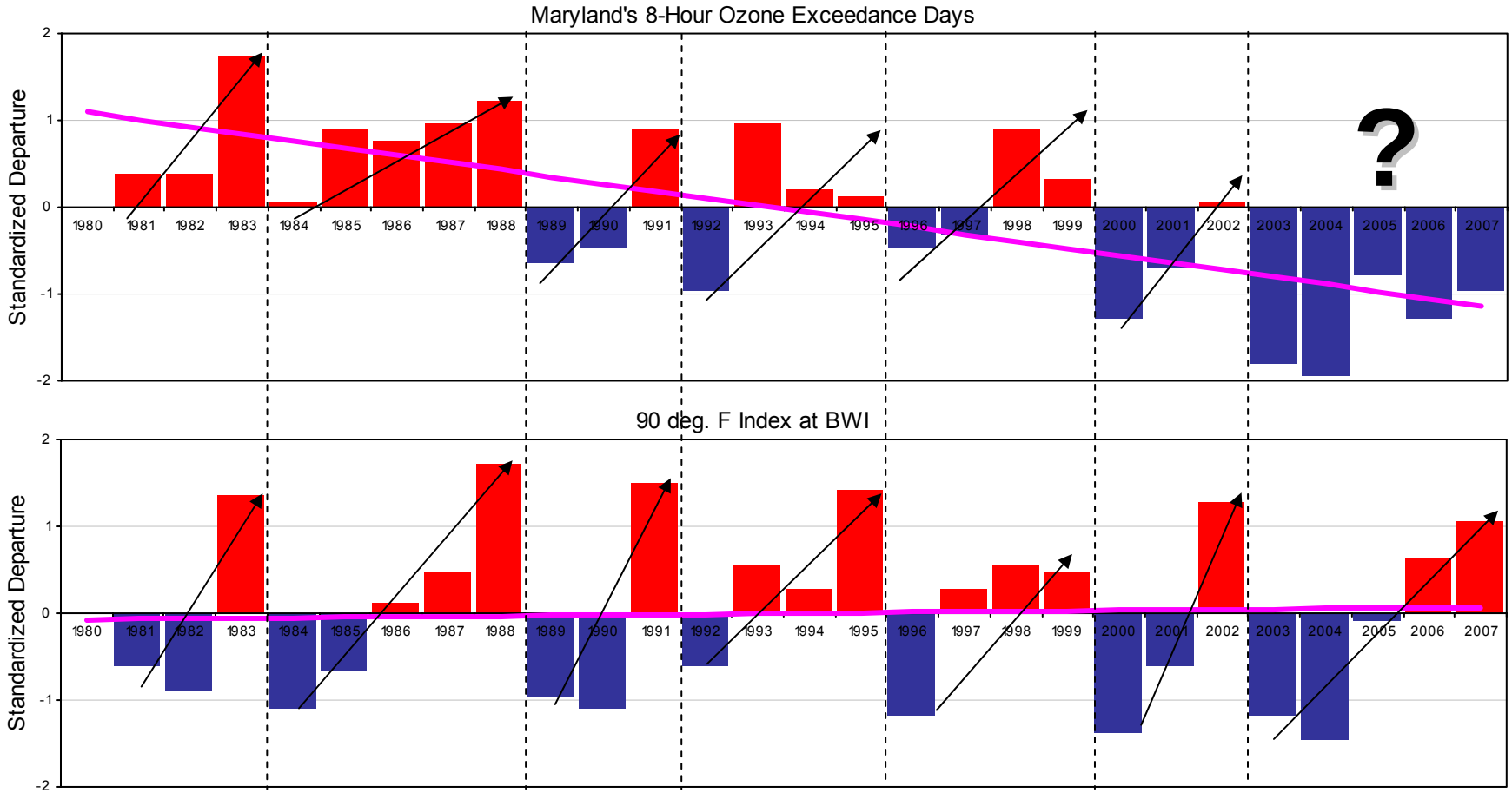
Hot Weather and High Ozone – A Shift?



- Standardized departure of both **8-hour ozone** and **90 deg days** at BWI **follow a periodic cycle** through 2002. Correlation is **0.66** (This is what makes air quality forecasting possible!)
- Why is 8-hour ozone exceedance days in Maryland consistently below normal between 2003-2007 despite what the temperature data tell us otherwise?

Hot Weather and High Ozone

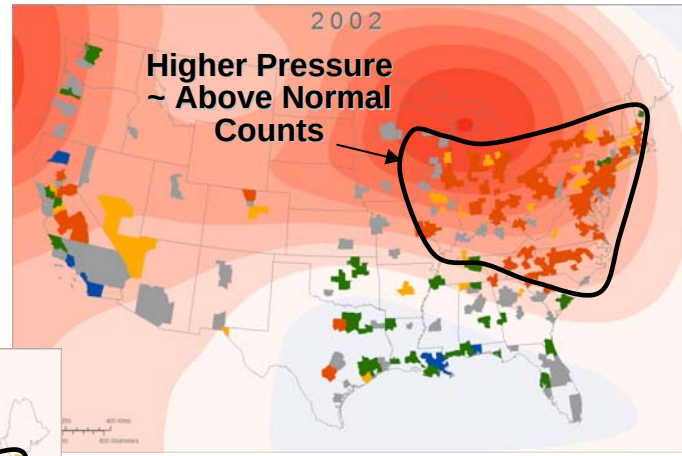
Less Ozone When It's Hot – Could It Be Controls Are Working?



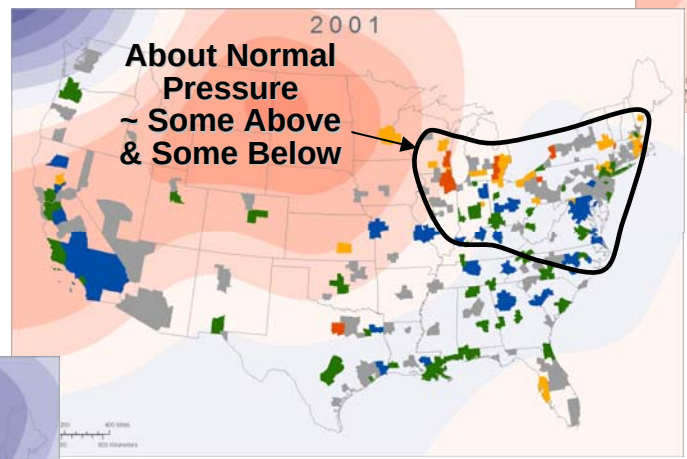
- Standardized departure of Maryland's **8-hour ozone** and **90 deg days** at BWI **follow a periodic cycle** through 2002. Correlation is **0.66** (This is what makes air quality forecasting possible!)
- Temperature data at BWI indicates a flat trend from 1981-2007. **Climatology doesn't change** during that time frame.
- BUT **8-hour ozone data** clearly **indicates** a **downward trend**.
- Explanation for hypothesis**: air quality trend is entering a new phase**!

Hot Summers And High Ozone

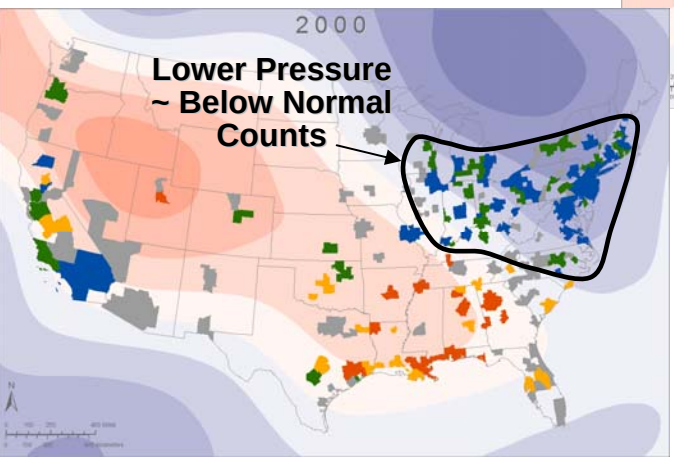
- 2000 to 2002
- Typical Ozone Summers
- Cooler Summers (Blue) – Lower than average ozone
- Hotter Summers (Red) – Higher than average ozone



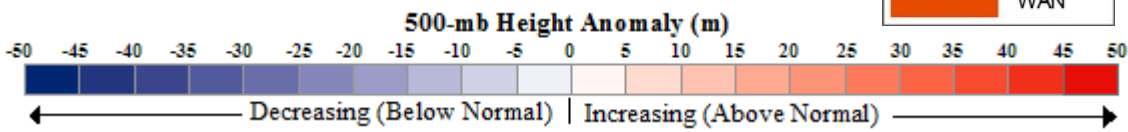
Year 3



Year 2



Year 1

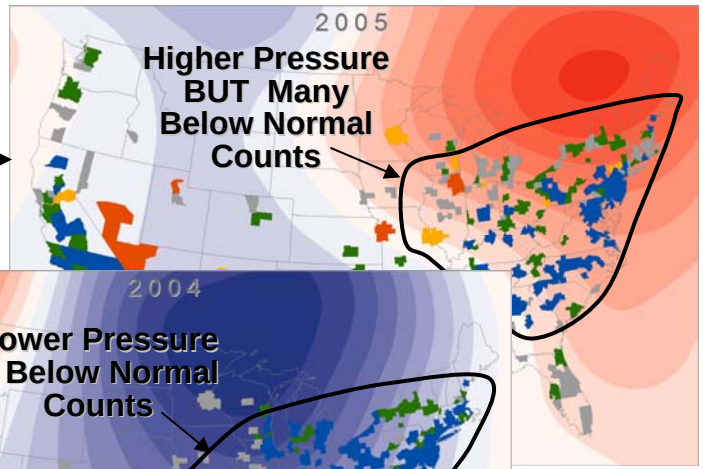


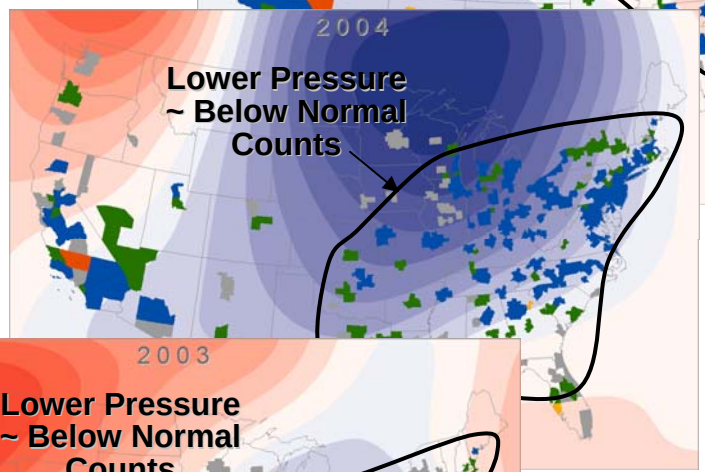
Data sources: AIRNowTech and ESRL CDC Plotting and Analysis
Note: Some preliminary AQ data are also included in analysis.

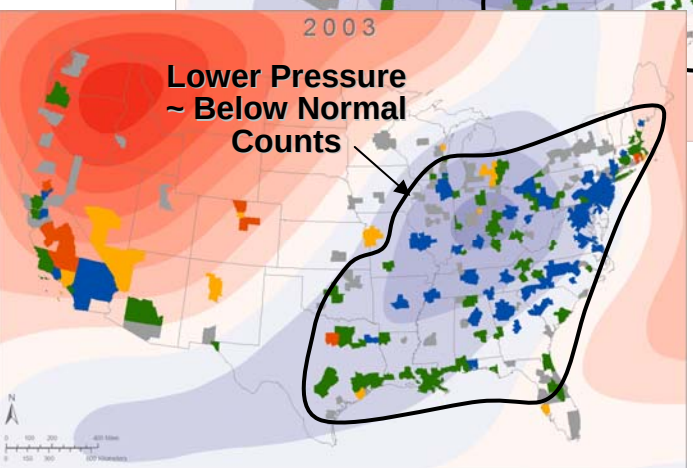
Hot Summers And High Ozone – A Change?

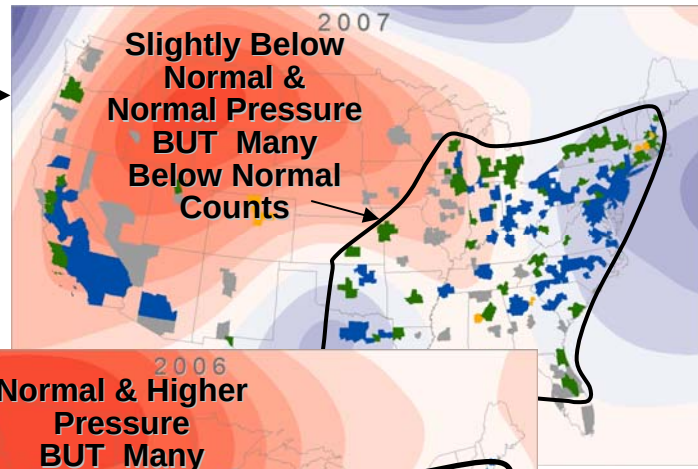
Relationship broke down … All MSAs in Mid-Atlantic, Northeast, and Northern Plains favor improving air quality despite of higher than normal pressure pattern. WHY?

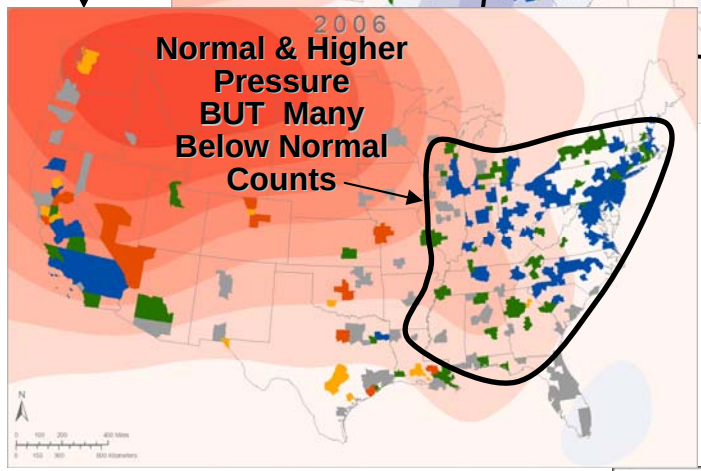
Relationship starting to break …

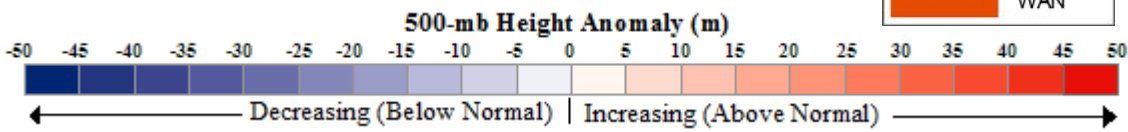








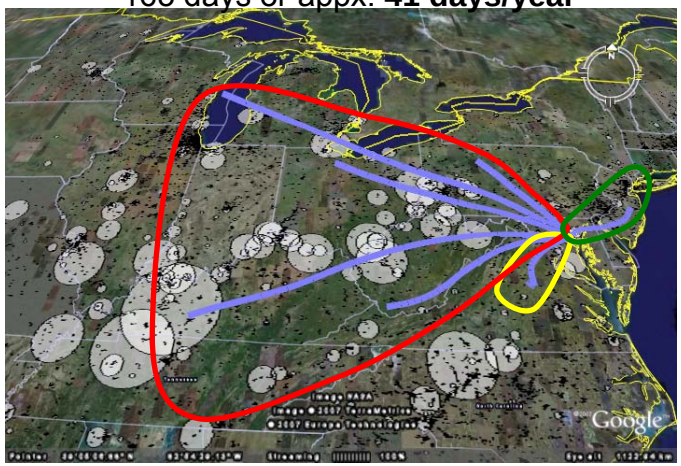




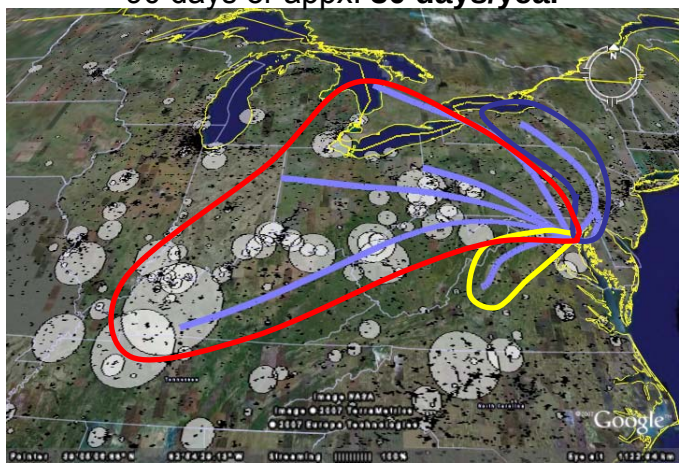
Data sources: AIRNowTech and ESRL CDC Plotting and Analysis
Note: Some preliminary AQ data are also included in analysis.

Have Transport Patterns Changed?

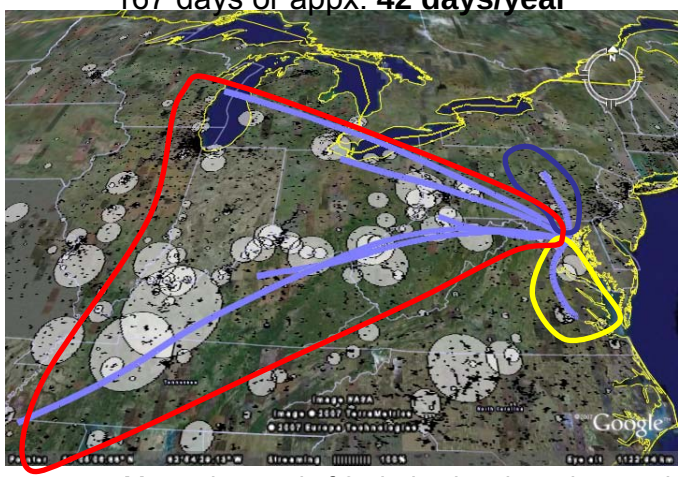
1992-1995 8-hr ozone exceedance days
165 days or appx. **41 days/year**



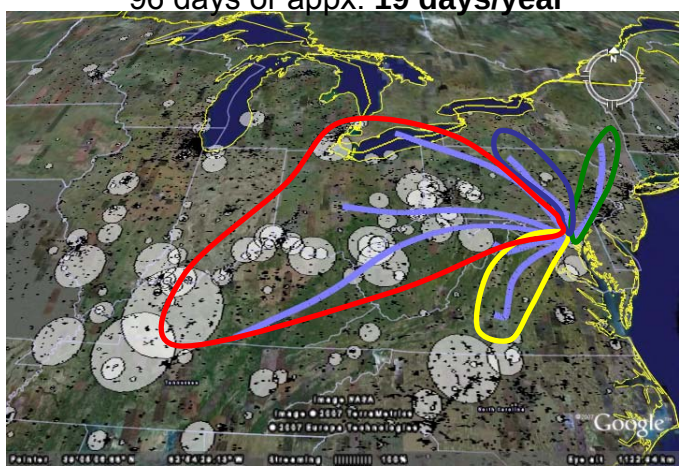
2000-2002 8-hr ozone exceedance days
90 days or appx. **30 days/year**



1996-1999 8-hr ozone exceedance days
167 days or appx. **42 days/year**



2003-2007 8-hr ozone exceedance days
96 days or appx. **19 days/year**

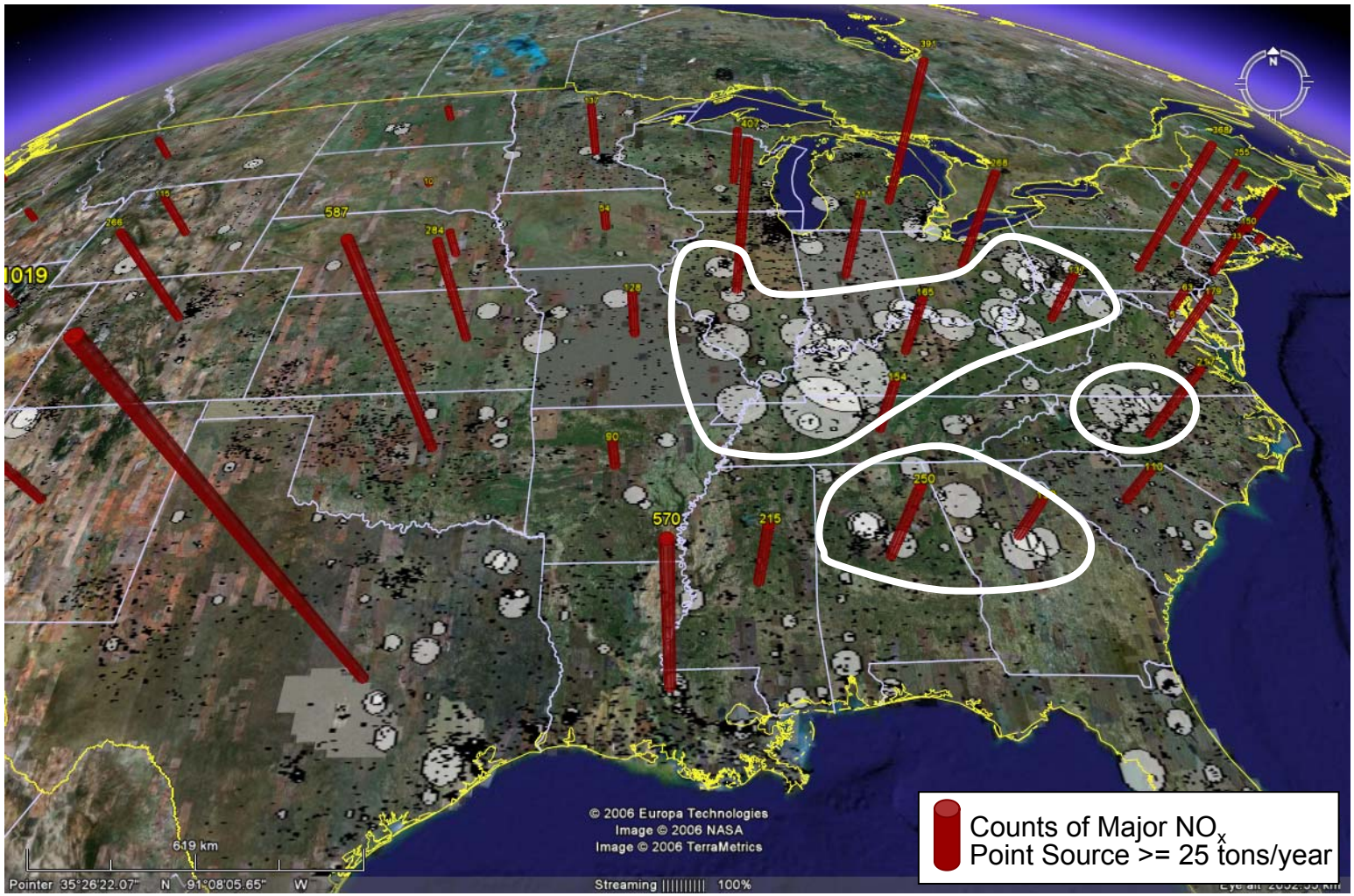


- Westerly, southwesterly, and northwesterly flow (highlighted in red) dominate all periods. These are common for long range transport (hundreds to thousands of kilometers)
- South / southeasterly flow (highlighted in yellow) are persistent in all periods. This flow pattern is a good example of short range transport (tens to hundreds of kilometers).
- North / Northwesterly flow (highlighted in blue) are persistent for periods from 1996-2006).
- Northeasterly / Reverse corridor flow (highlighted in green) are persistent during the first and last period.
- Overall **transport patterns have not changed** that much over the past 16 years.
- **Decrease** in "**bad air quality days**" through the periods are **driven primarily by controls**.

Mean clustered of 24-hr back trajectories terminating at BWI (1000 m-agl) at 11 UTC (6:00 EST).
EDAS, NGM, and Reanalysis Meteorological data.
Time ensemble trajectories for each clusters in each period can be found in Appendixes A1-A4.

Note: (a) Visit NOAA ARL HYSPLIT Model website for further information on back trajectory.
(b) Visit EPA's National Emission Inventory (NEI) Database website for further information on emission data.

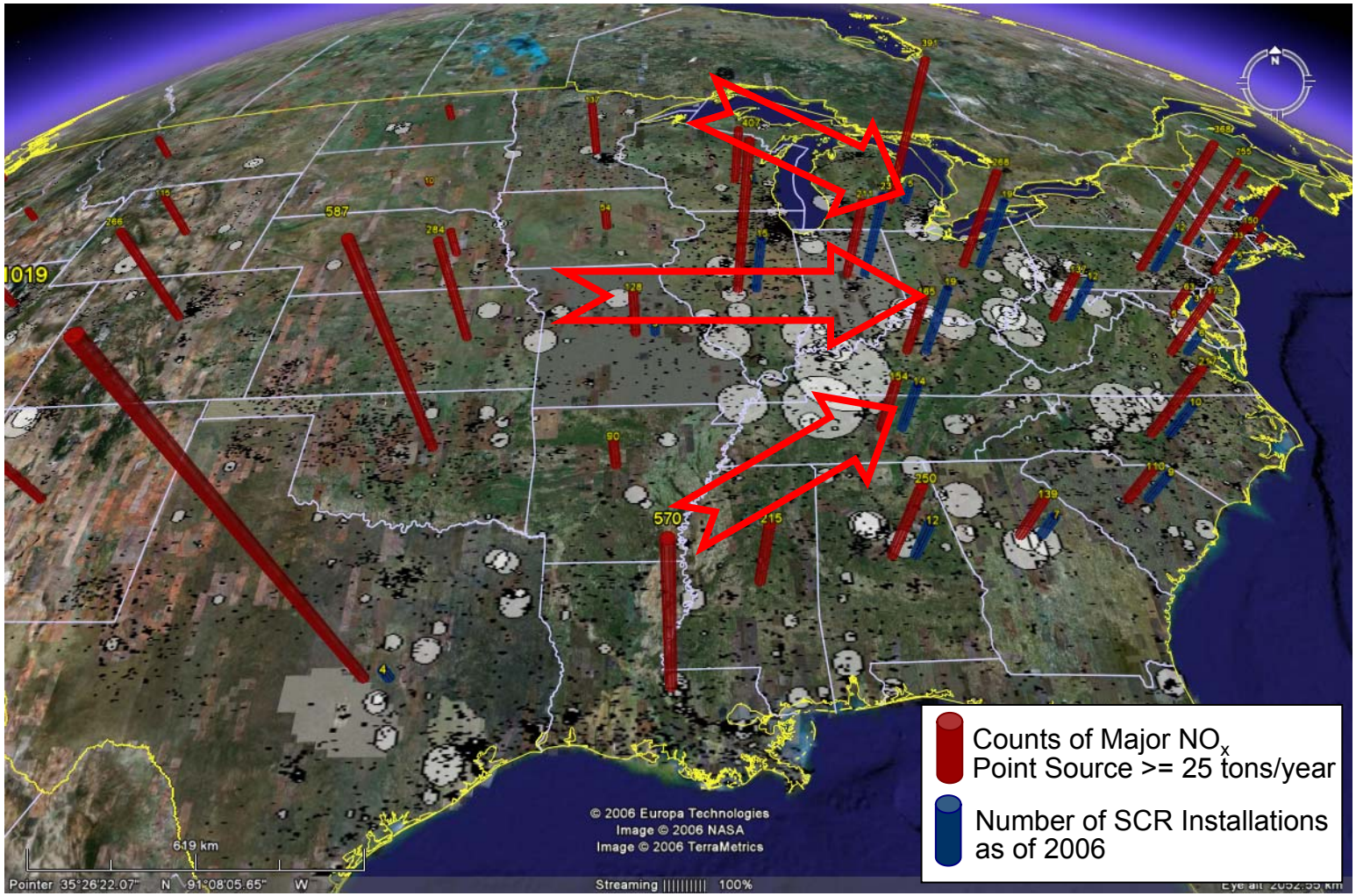
Where are Major NO_x Point Sources?



1999 emission data from NEI database show "BIG" NO_x point sources are located along Ohio River Valley region, portion of the Southeast, and Southern Mid-Atlantic region.

Note: Emission data extracted from the EPA's National Emission Inventory (NEI) Database.

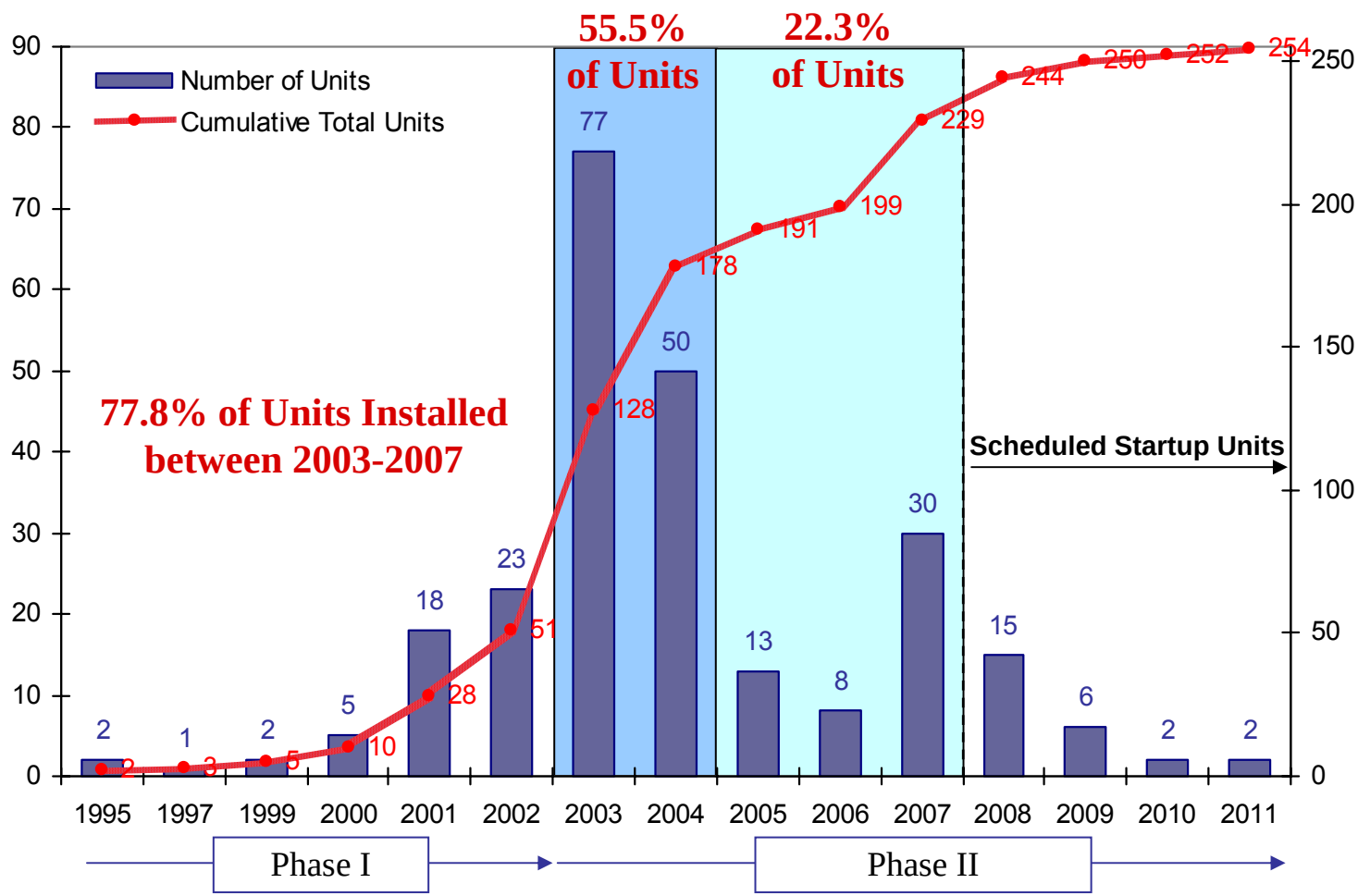
SCRs Being Installed



Selective Catalytic Reduction (SCR) technology are implemented at many units to reduce NO_x emissions (one of the ozone precursors). Majority of **SCR installations** as of 2006 are **happening where the controls are needed the most** (i.e. the Ohio River Valley).

Note: (a) Emission data extracted from the EPA's National Emission Inventory (NEI) Database.
(b) SCR installation data comes from the Institute of Clean Air Companies (ICAC).

SCR Units Over Time



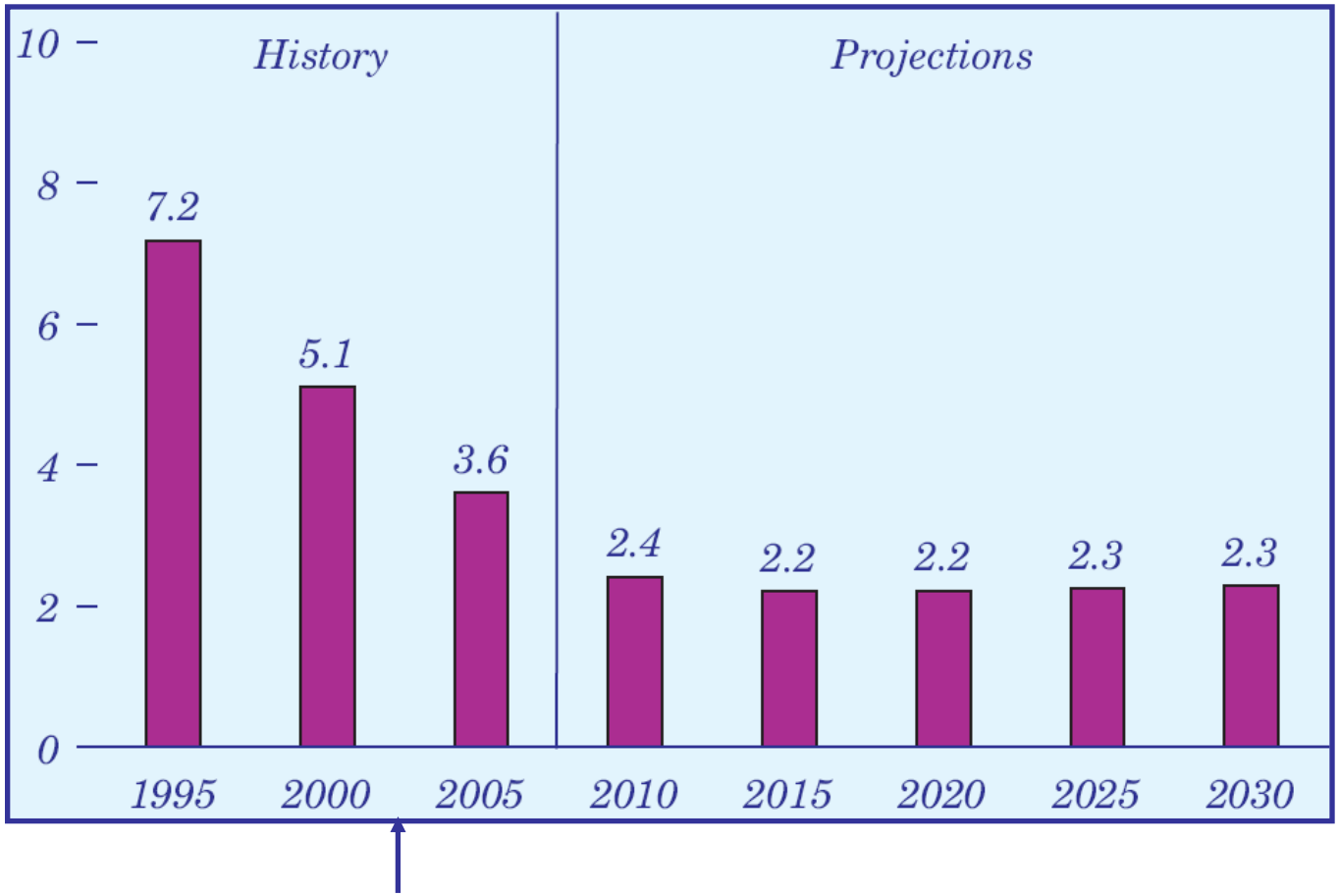
Minimal SCR Units
Expect Minimal NO_x Reductions

Large Number of SCR Units Installed
Expect SIGNIFICANT NO_x Reductions
Especially after 2003-2004
Ground-level ozone should decrease dramatically

Data courtesy of The Institute of Clean Air Companies (ICAC).

NO_x Emissions Over Time

U.S. Nitrogen oxides (NO_x) emissions from electricity generation, 1995-2030 (million short tons)



RAPID decline in NOx emissions after Phase II of NO_x Controls. It coincides with a SHARP decrease in ground-level ozone across the eastern U.S. during 2003-2007.

Figure extracted from the "Annual Energy Outlook 2007 with Projections to 2030" report. Additional information can be found at Energy Information Administration (EIA) website.

EPA Analysis – Same Results

Ozone Season NO_x Emissions from All NOx Budget Program (NBP) Sources

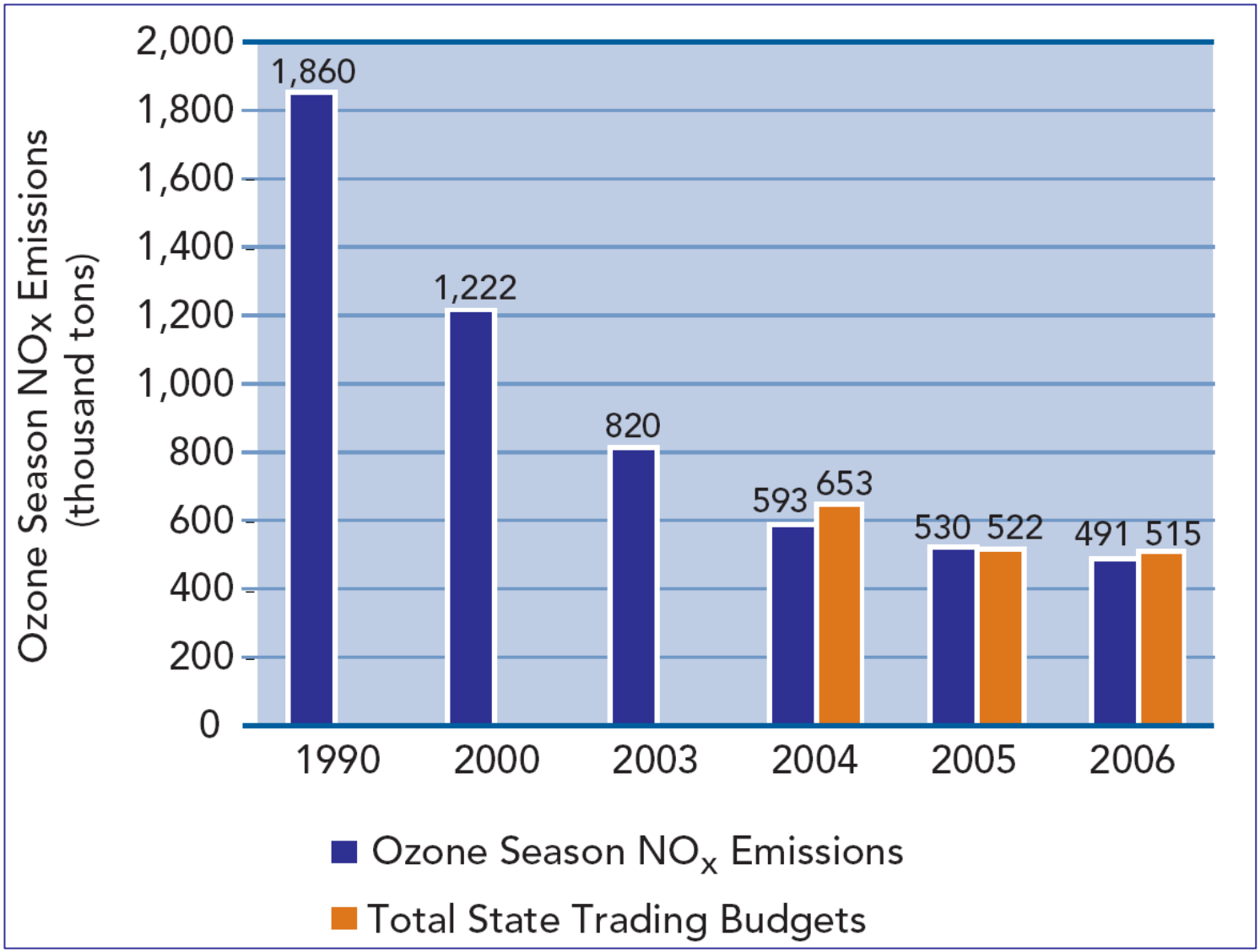
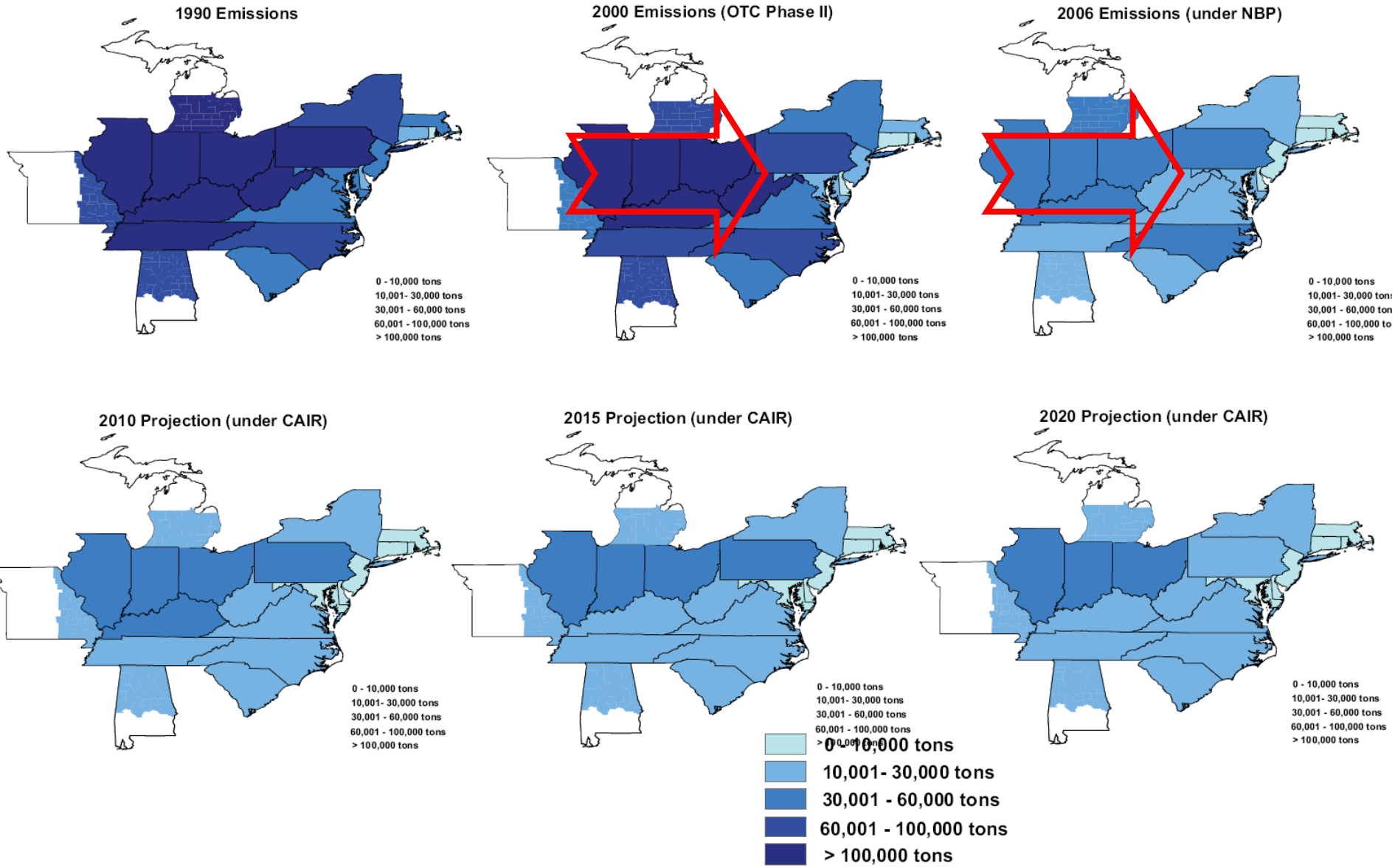


Figure extracted from EPA's NOx Budget Program 2006 Progress Report. Visit Clean Air Markets website for further details.

NOx Reductions - Geographically



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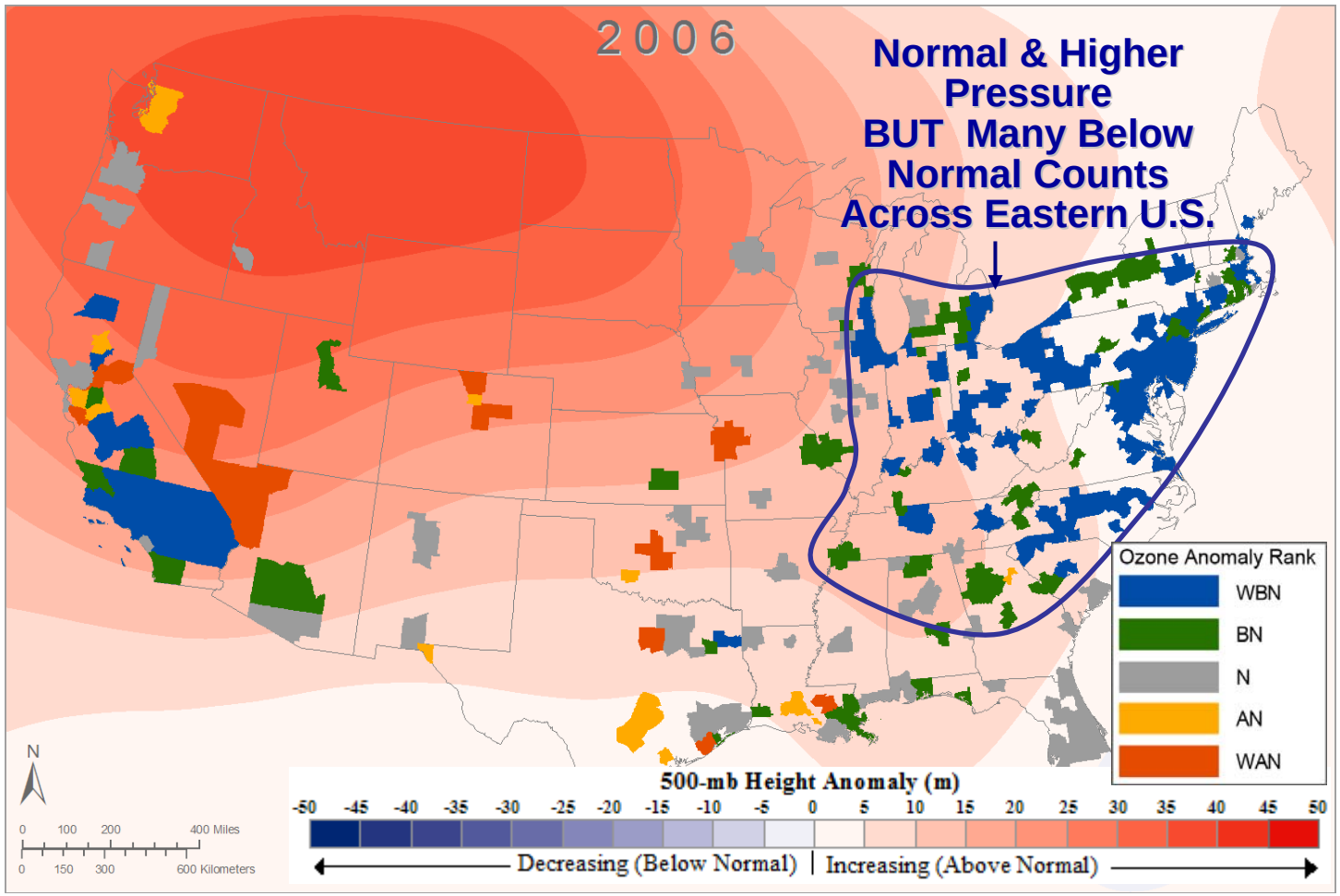
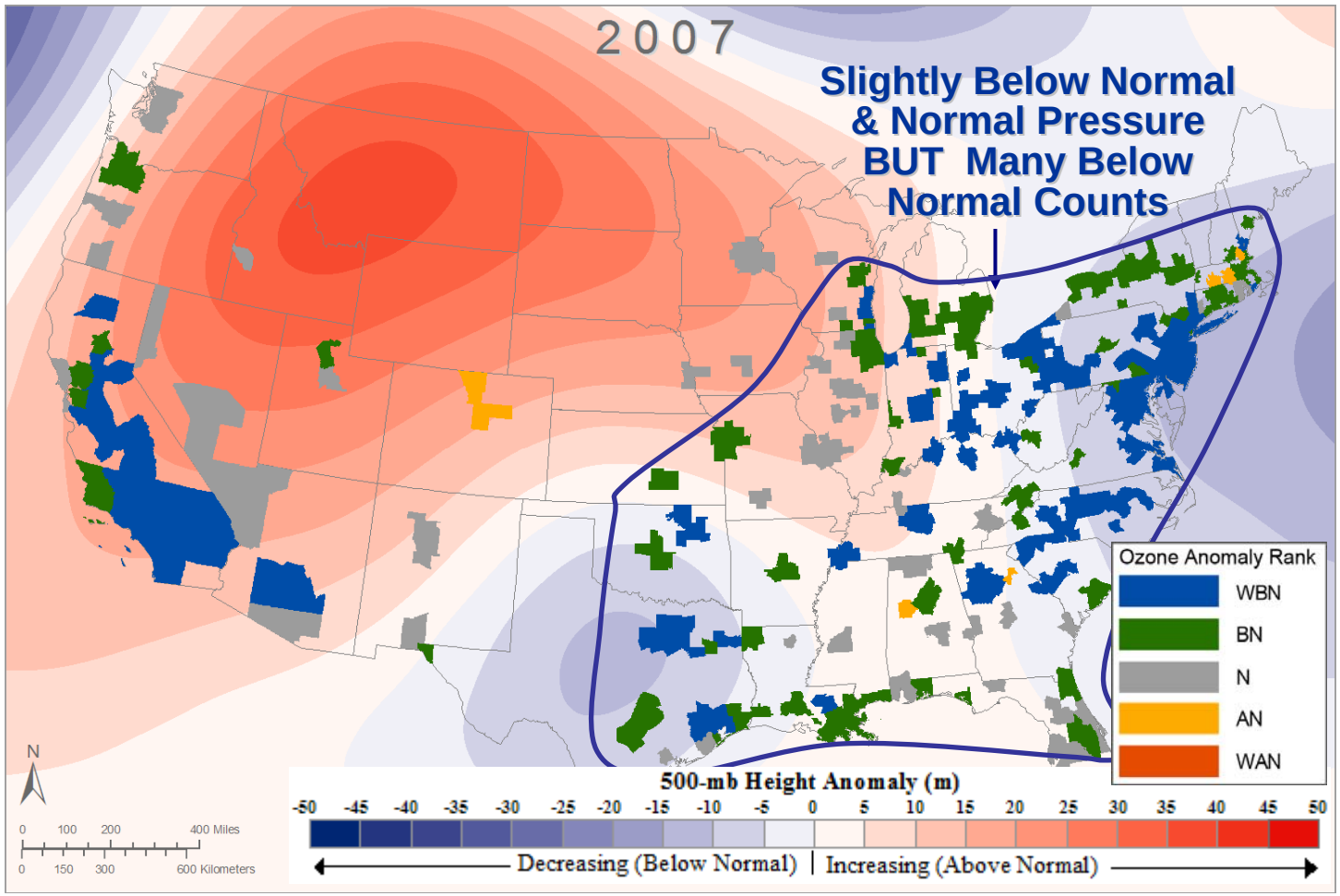
2006 Weather and Ozone



Despite of higher than normal pressure pattern during Jun-Aug 2006, 8-hour ozone counts are well below normal across the Northeast, Mid-Atlantic, and portions of Midwest.

Data sources: AIRNowTech and ESRL CDC Plotting and Analysis
Note: Some preliminary AQ data are also included in analysis.

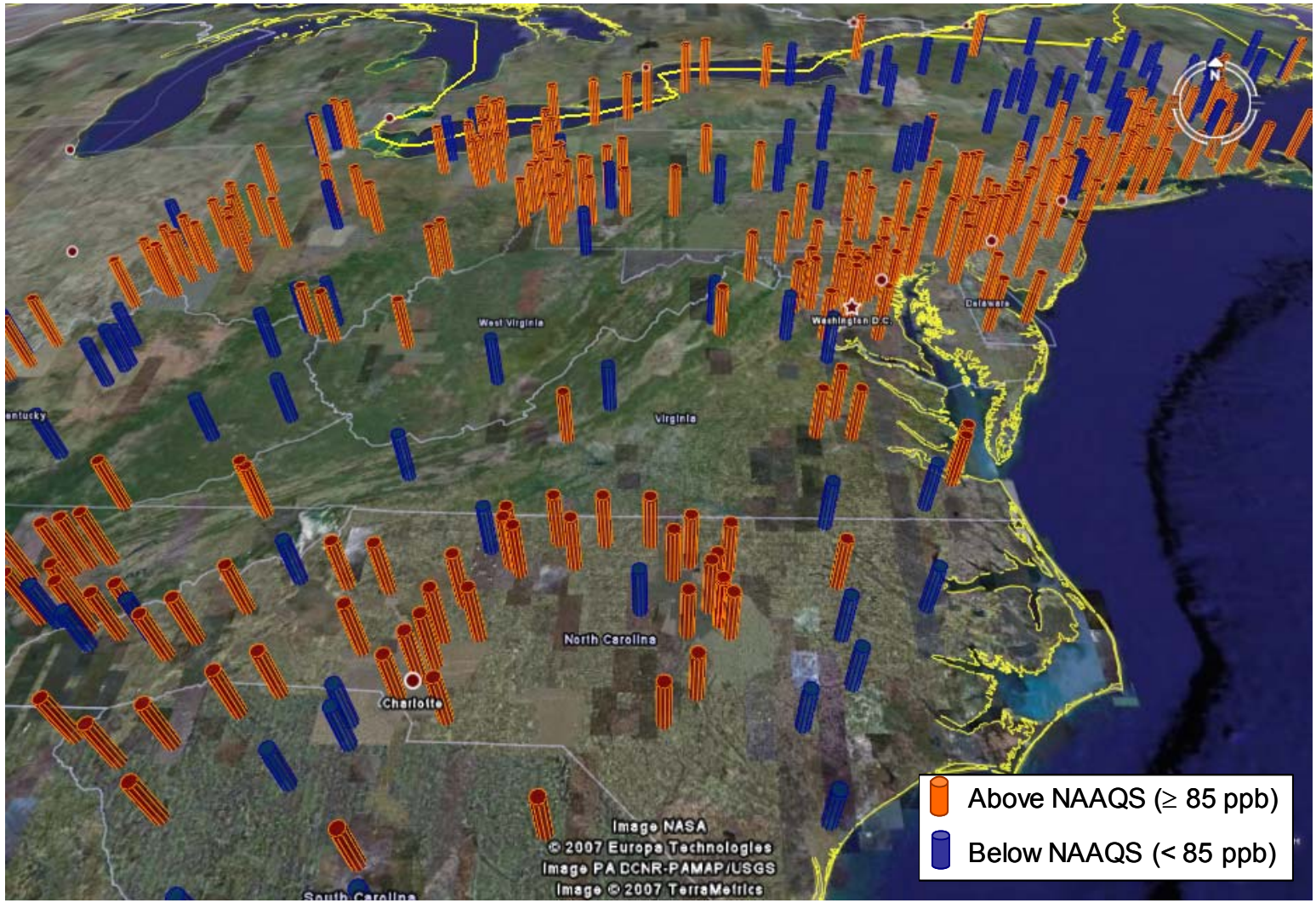
2007 Weather and Ozone



Slightly below normal and normal pressure patterns are observed during Jun-Aug 2007. 8-hour ozone counts continued to remain well below normal across the Northeast, Mid-Atlantic, Southeast, Plains, and Great Lakes regions.

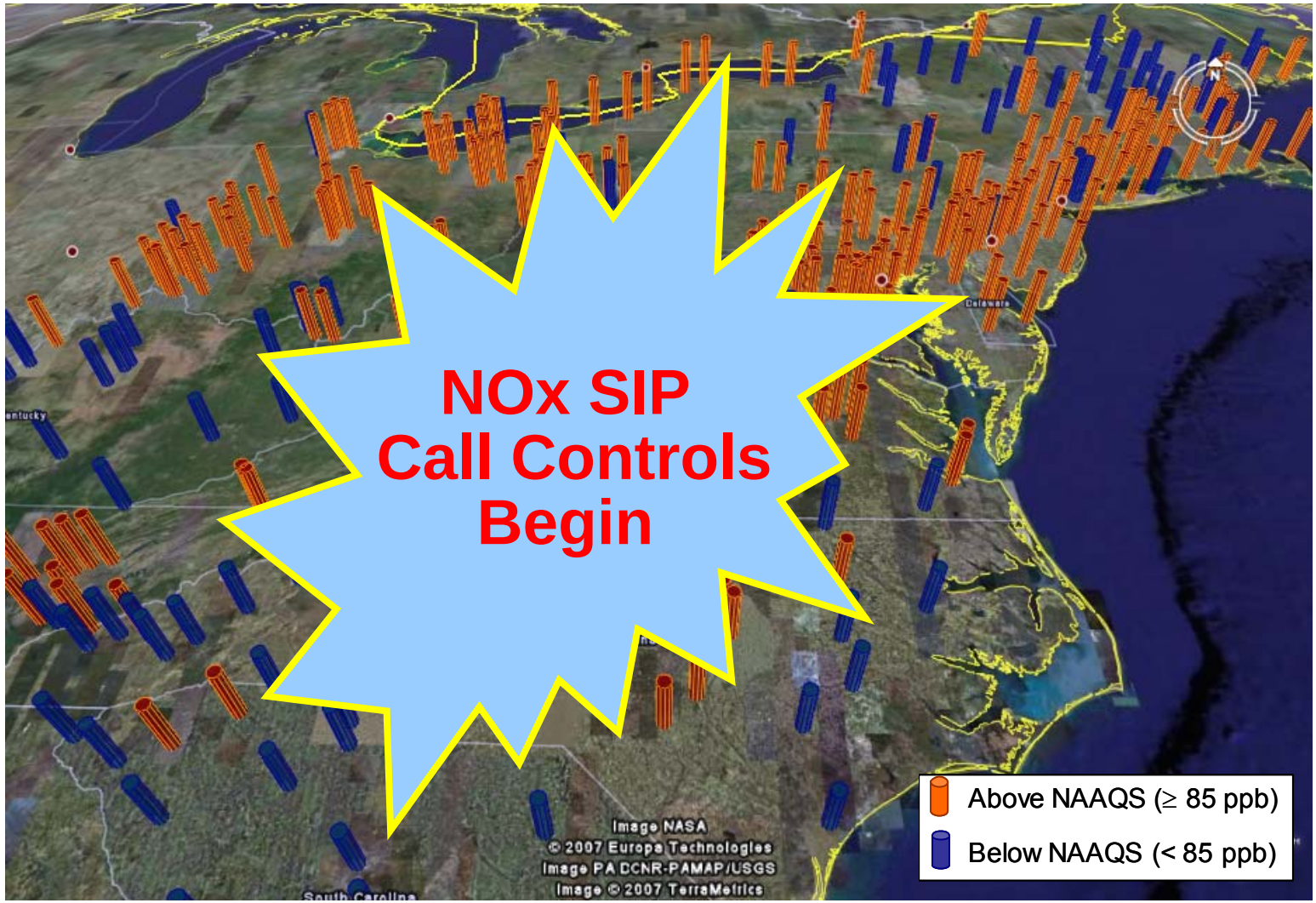
Data sources: AIRNowTech and ESRL CDC Plotting and Analysis
Note: Some preliminary AQ data are also included in analysis.

2002 - Improving Design Values



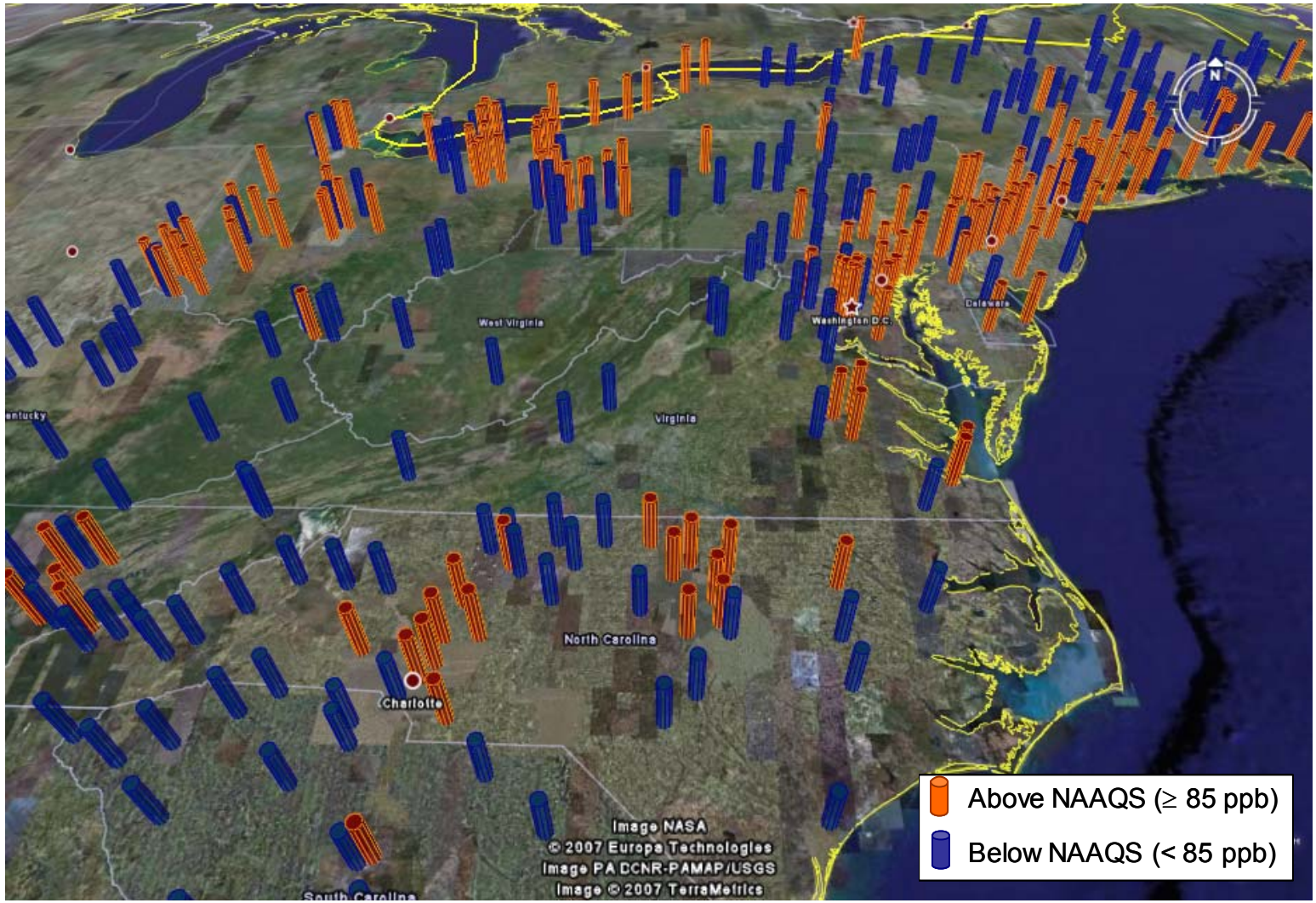
BEFORE the majority of **SCR Units were installed**, much of the **Eastern U.S. do not meet** the 8-hr **ozone standard**.

2003 - Improving Design Values



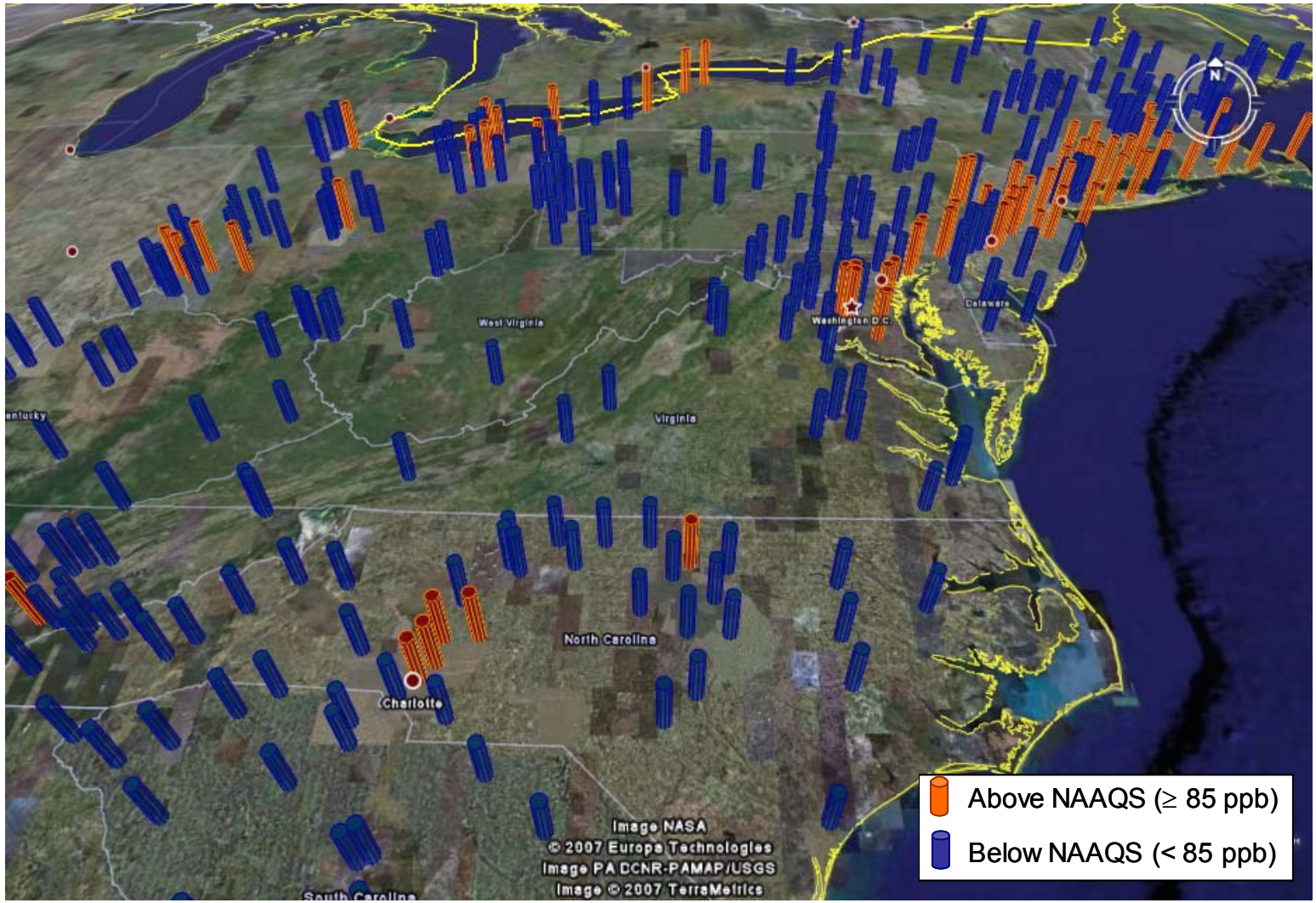
The **FIRST** year of "**Transition Phase**" when most SCR Units were installed. **No major change noted in the attainment status** for 8-hr **ozone**.

2004 - Improving Design Values



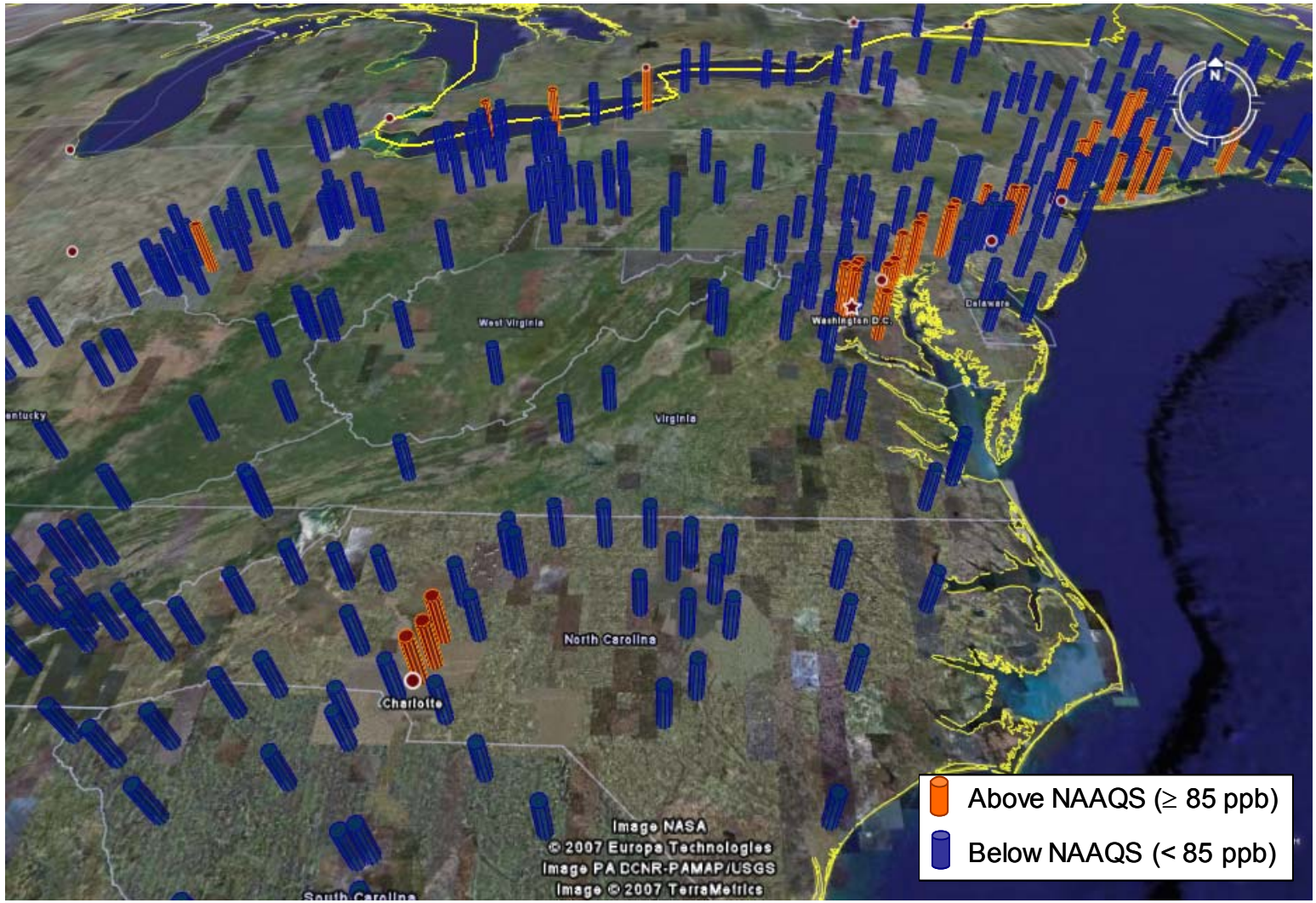
The **SECOND** year of "**Transition Phase**" when most SCR Units were installed. A **notable number of monitors went into attainment**. Although temperatures and precipitation during the summer of 2004 were not conducive for ground-level ozone formation, they are not the sole reason for reduced ozone.

2005 - Improving Design Values



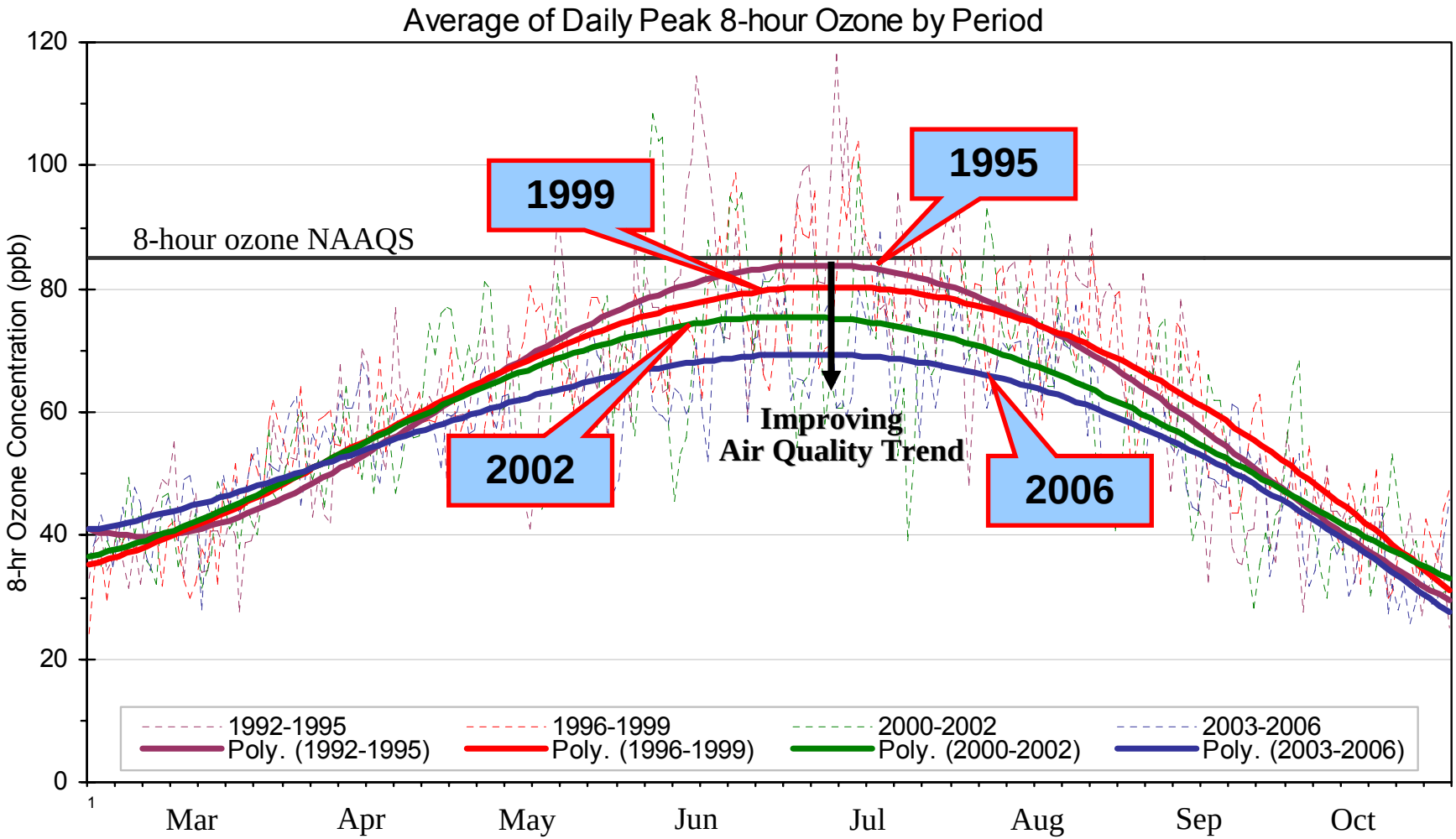
AFTER the **majority of SCR Units** were **installed**, **much of the Eastern U.S. went into attainment**. Temperatures and precipitation data for the summer of 2005 were conducive for ground-level ozone formation. However, strong decrease in regional ozone concentrations occurred.

2006 - Improving Design Values



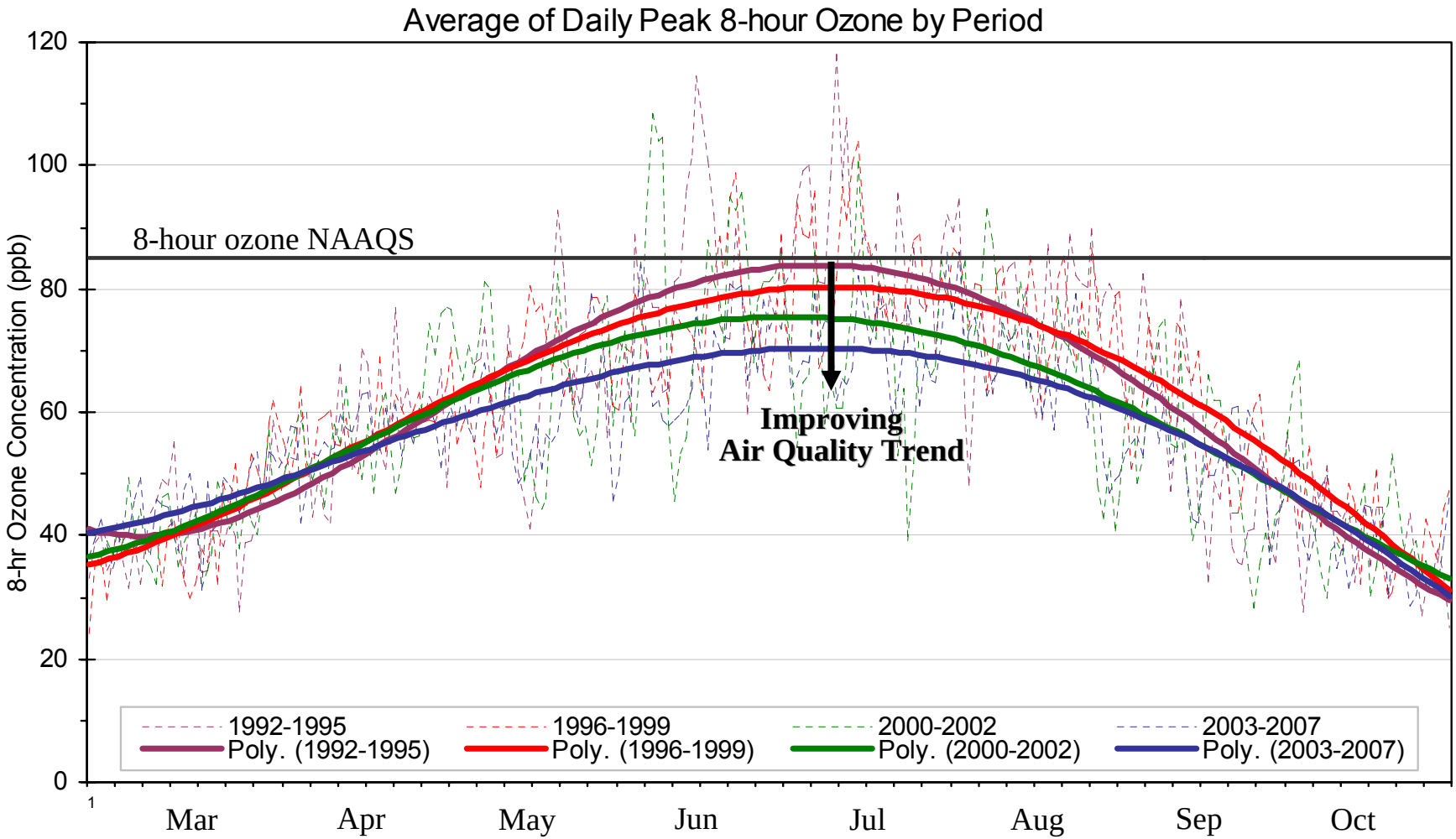
Ground-level **ozone** in the **Eastern United States continues to show significant improvements** in 2006 despite meteorological conditions that favored poor air quality. 8-hour ozone design values for many **monitors along the I-95 corridor**, **especially downwind of Maryland**, **went from non-attainment status in 2005 to attainment status in 2006**.

Ozone Season Trends in Maryland



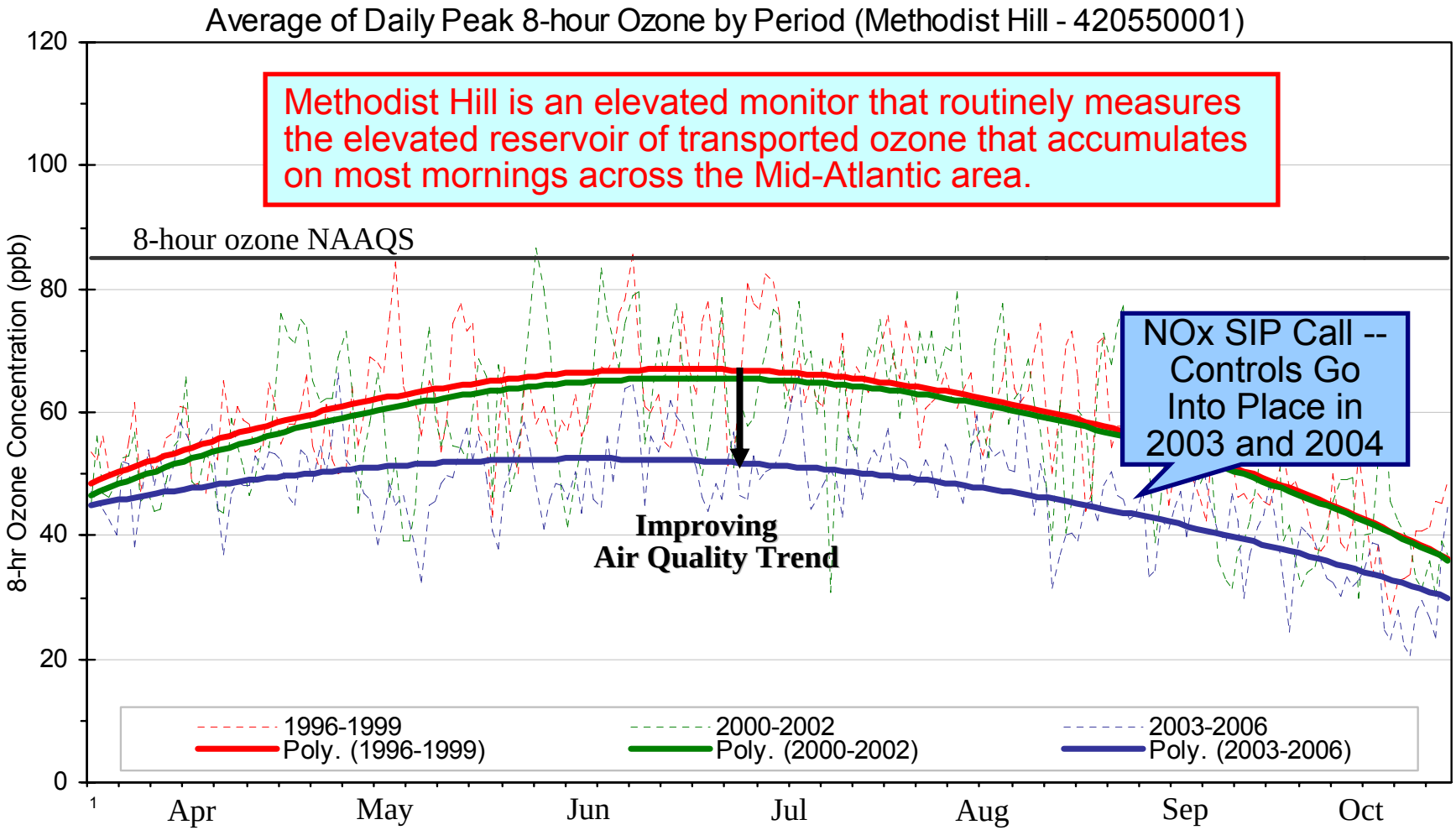
- During the 1990s, 8-hr ozone data in Maryland shows a slight improvement (~4 ppb decrease).
- After implementation of regional NO_x controls (after 2000), a notable decrease of 10 ppb were observed.
- **Approximately 15 ppb decrease was observed from 1990s to 2000s.**

Ozone Season Trends in Maryland
(With 2007 Data)



- 2007 data shifted the trend line for the last period (2003-2007) slightly upward.
- However, the overall progress remains at **approximately 14 ppb as observed from 1990s to 2000s**.

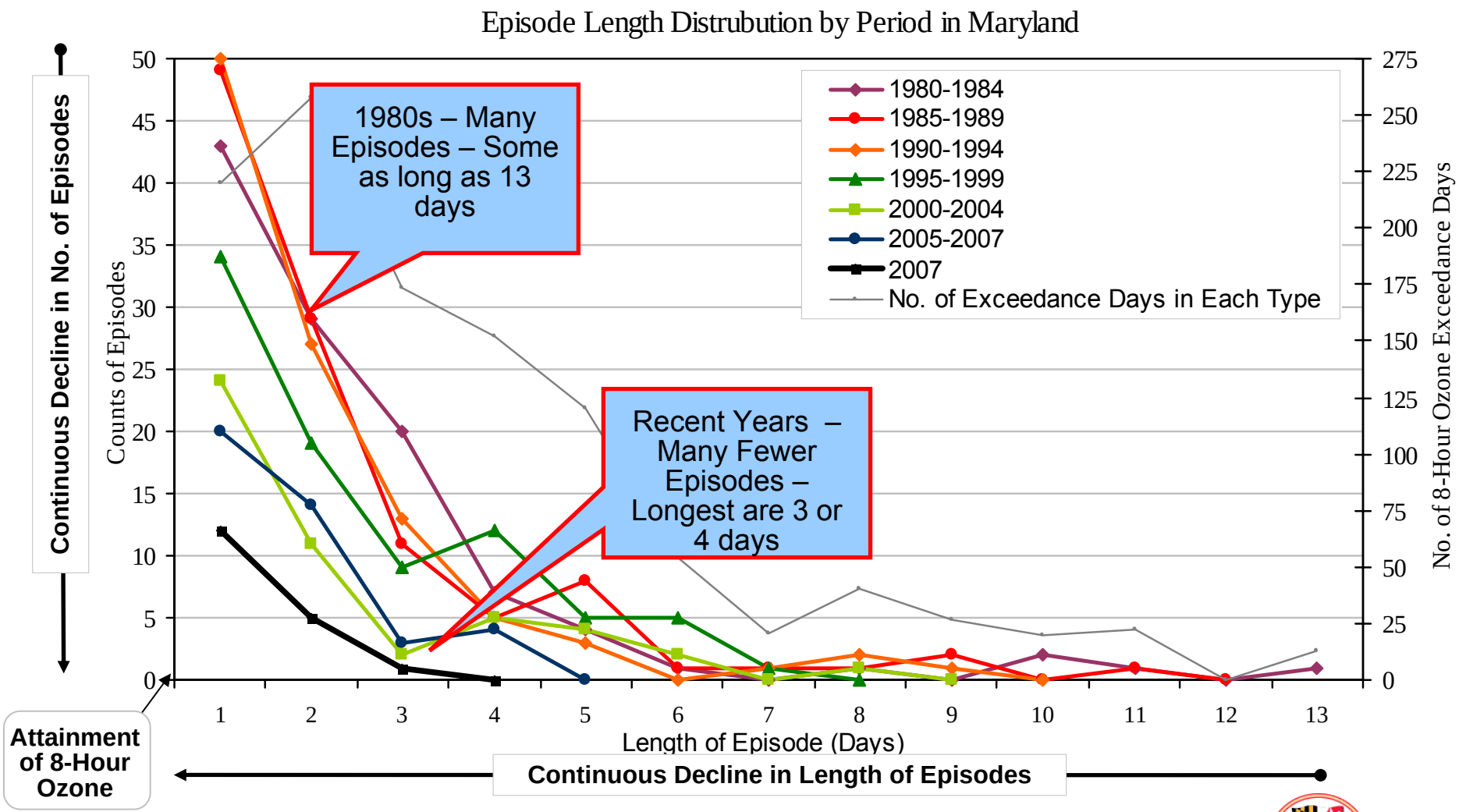
Reducing Transported Ozone



- Reductions in regional ground-level ozone were also observed at elevated monitors (Methodist Hill).
- Slight improvement of ~2ppb occurred during the 1990s.
- After implementation of regional NO_x controls (after 2000), a notable decrease of 13 ppb were observed.
- **Approximately 15 ppb decrease was observed from 1990s to 2000s.**

Note: 2006 data are preliminary.

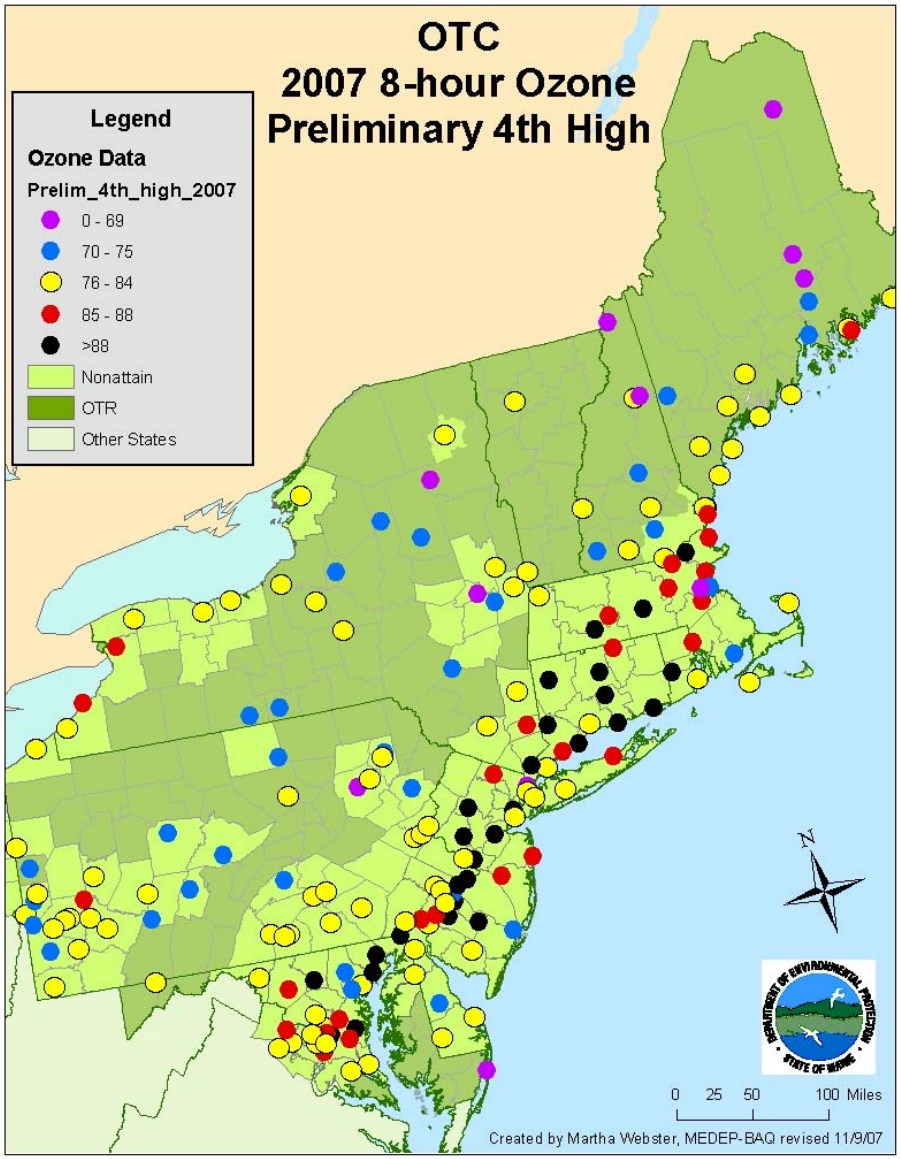
Ozone Episodes – Fewer and Shorter

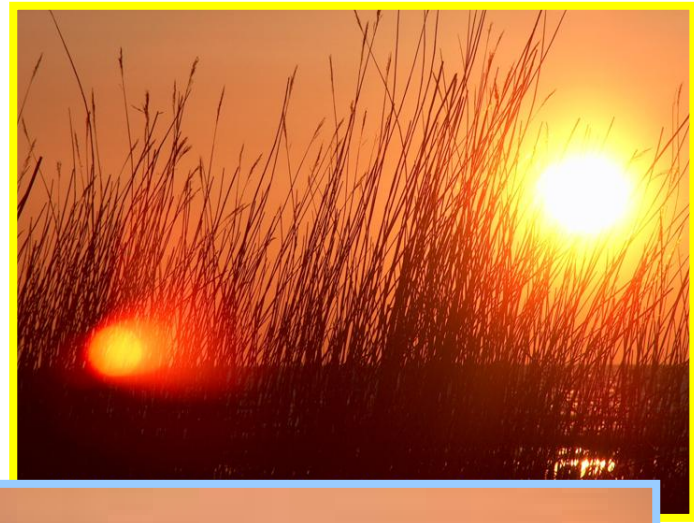


Air quality episodes have shrunk in both duration and counts of events. This is the evidence that ozone plume has been shrinking.

Note: 2007 data are preliminary.

2007 Ozone Levels





Meeting a New Ozone Standard

OTC Attainment and Sensitivity Modeling for Ozone

AIRS-ID	State	Monitor	2002	2012 BOTB/OTW	2018 SensEGU
340290006	NJ	Colliers Mills	106.0	86	81
90013007	CT	Stratford	98.3	86	83
361030009	NY	Holtsville	97.0	86	82
420170012	PA	Bristol	99.0	84	80
90093002	CT	Madison	98.3	83	81
340070003	NJ	Camden	98.3	83	81
340155001	NJ	Clarksboro	98.3	83	80
90010017	CT	Greenwich	95.7	83	81
340071001	NJ	Ancora St. Hos	100.7	82	79
421010024	PA	Northeast	96.7	82	79
340210005	NJ	Rider Univ.	97.0	81	77
510130020	VA	Arlington Co.	96.7	80	75
510590018	VA	Fairfax Co.	96.7	79	75
361030002	NY	Babylon	93.7	82	82
361192004	NY	White Plains	91.3	82	82
90011123	CT	Danbury	95.7	81	78
90019003	CT	Westport	94.0	81	79
90099005	CT	Hamden	93.3	81	79
340030005	NJ	Teaneck	91.7	81	81
240251001	MD	Edgewood	100.3	80	77

New Ozone Standard – 60 to 75 ppb

Special Thanks

- Duc Nguyen, MDE
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- Mike Woodman, MDE
- The U. of M. RAMMP Team

Take Home Messages

- We've made tremendous progress in reducing ozone over the past 5 years
- Attaining the 8-Hour Standard by 2010 continues to be a challenge for much of the OTR
- Complying with an even tougher ozone standard will be even more challenging
- The NOx reduction programs for power plants are working – working very well