MARYLAND
DEPARTMENT OF THE ENVIRONMENT

Maryland Air Quality Monitoring

6 October 2010

DISCOVER-AQ science team meeting

Jennifer Hains

Air Monitoring Program

Maryland Department of the Environment

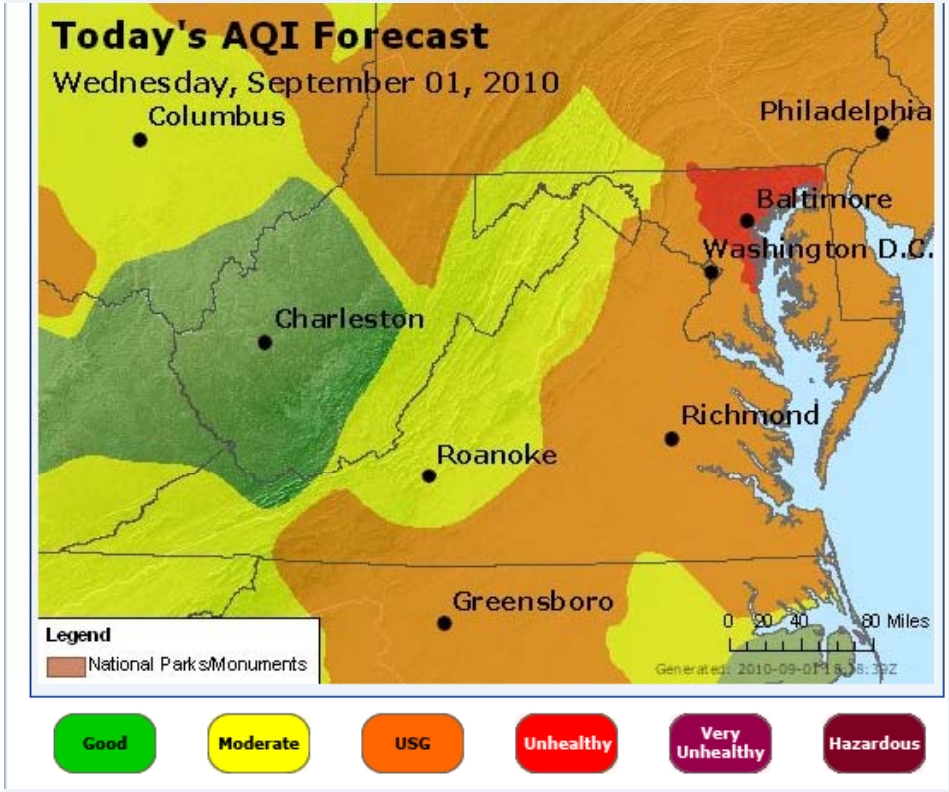
Outline

- Monitoring goals
- Non-Attainment → Attainment
- Network summary
  - Sites of interest for DISCOVER-AQ
  - O_3 observations
  - Surface and aircraft comparisons
  - NO_2 near road
- Understanding Maryland pollution
  - Local sources
  - Westerly transport
  - Nocturnal low level jet
  - Bay breeze effect

Air Monitoring Program Responsibilities

- Operate and maintain air quality monitoring network for Maryland.
- Data Management, Quality Control and Quality Assurance.
- Data is used for:
  - EPA Grant commitments.
  - NAAQS attainment status.
  - Report Air Quality Index (AQI), O_3 and $PM_{2.5}$ to AIRNOW and Clean Air Partners.
    - Used for verification of forecasting models.
  - Determine origin and nature of pollution episodes.
  - Determine local and national air quality trends.
  - Fulfill public and private requests.
  - University research (health and science).
- Special projects for toxics, regional haze and upper air meteorology.
- Issue daily air quality forecasts for $PM_{2.5}$ and O_3.

Network Objectives



www.airnow.gov

Network Design Objectives

- **Compliance with NAAQS**
- Emissions strategy development
- Provide data to public in timely manner
  - Air quality forecast
- Support air pollution research

Sites are located to measure…

- Highest concentrations
- In high population areas
- Impact of sources
- General background
- Regional transport
- Impacts on visibility, vegetation, etc.

NAAQS

Pollutant	Level	Averaging Time
O_3	0.075 ppm	8-hour
SO_2	75 ppb	1-hour
NO_2	53 ppb	Annual
	100 ppb	1-hour
$PM_{2.5}$	15.0 µg m^{-3}	Annual
	35 µg m^{-3}	24-hour
CO	9 ppm	8-hour
	35 ppm	1-hour
Pb	0.15 µg m^{-3}	Rolling 3-Month Average
	1.5 µg m^{-3}	Quarterly Average
PM_{10}	150 µg m^{-3}	24-hour

http://www.epa.gov/air/criteria.html

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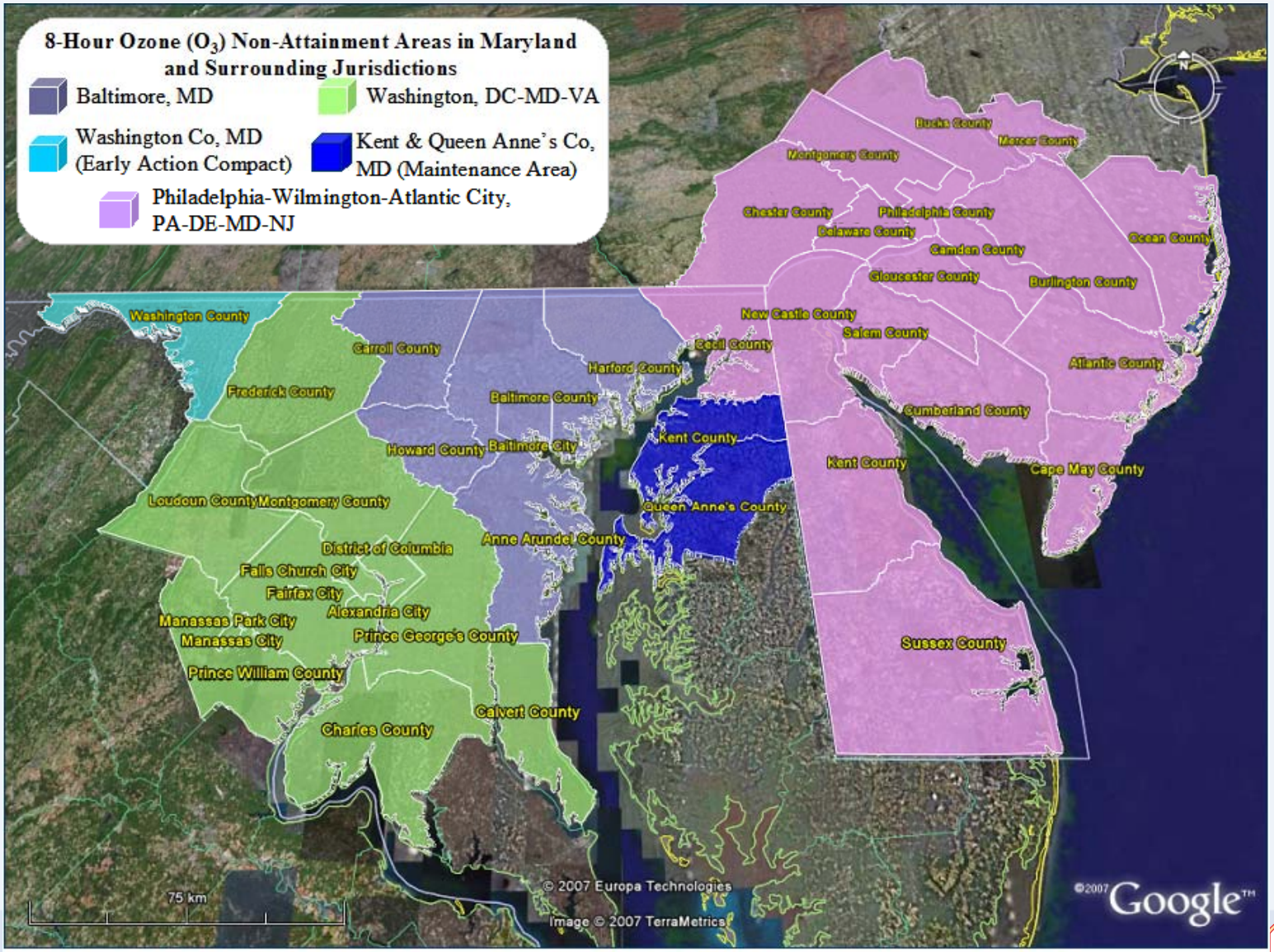
O_3 Non-attainment



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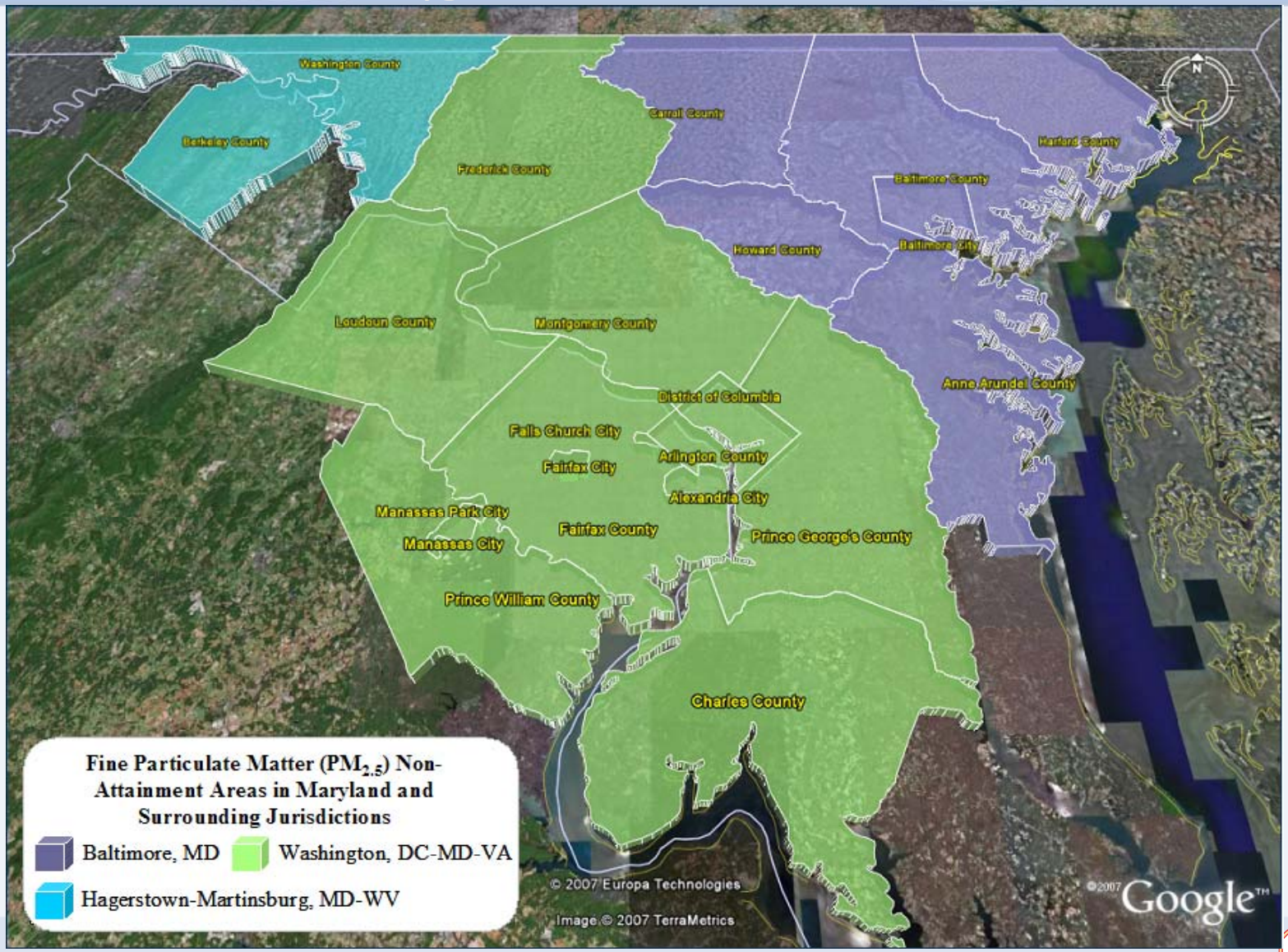
$PM_{2.5}$ Non-attainment



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Non-Attainment: What does it mean?

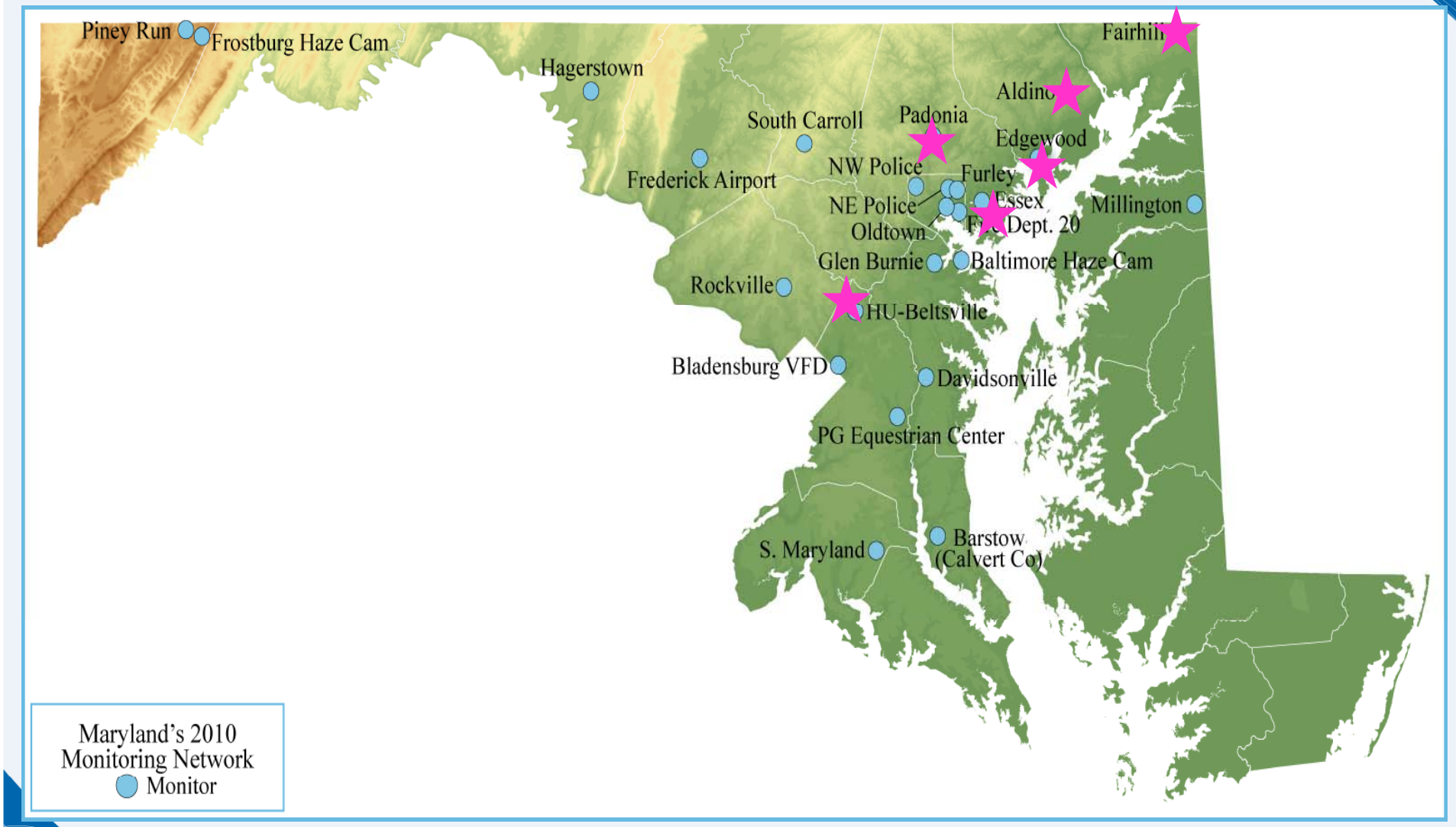
- MD must submit a State Implementation Plan (SIP).
- SIP describes how MD will demonstrate attainment and includes:
  - Emissions inventories (base and projected).
  - Control measures.
  - Attainment demonstrations.
    - Modeling.
  - Weight of Evidence.
    - AQ analysis.
    - Conceptual model.

- If SIP is not submitted or approved EPA may impose sanctions.
  - Withhold funds for highway projects.
  - Withhold AQ planning grants.
  - Impose federal implementation plan.

Questions to answer for SIP

- Do models get transport right –might national controls get us cleaner than models predict?
- How much MD pollution is from transport? How much is local?
- Are the models we use right?
- Will the air be cleaner in the future?
- How effective are local controls versus national controls?

MDE monitoring network



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Selected monitors

	Aldino	Edgewood	Essex	Fairhill	HU-Beltsville	Padonia
O_3	1	1	1	1	1	1
$PM_{2.5}$		1	1	2*	2*	2
CO			1		2	
SO2			1		2	
NO NO_2	1		1		1	
NO_X			1		1	
NO_Y	1				1	
$PM_{2.5}$ Species			1		1	
PM_{10}			1*			
OC EC					1	
Sulfate					1	
PAMS			1		1	
Toxics			1		1	

* One monitor is continuous

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How the data is used

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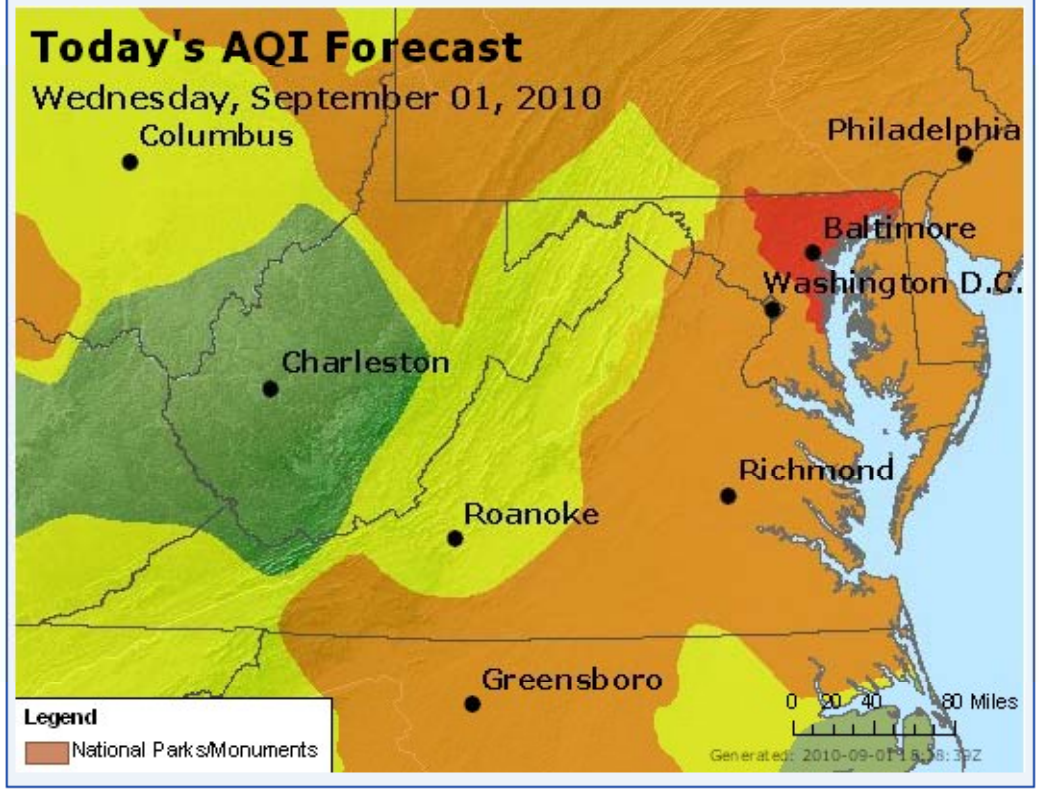
www.airnow.gov

Forecast | Current AQI | AQI Animation



Good | Moderate | USG | Unhealthy | Very Unhealthy | Hazardous

Click on the city name for more detailed information. printable summary	FORECAST Wed Sep 1	FORECAST Thu Sep 2	CURRENT AQI
Baltimore	161	124	114
Hagerstown	100	93	74
Millington	124	84	57

Data is reported to the public

Used to create AQ forecasts

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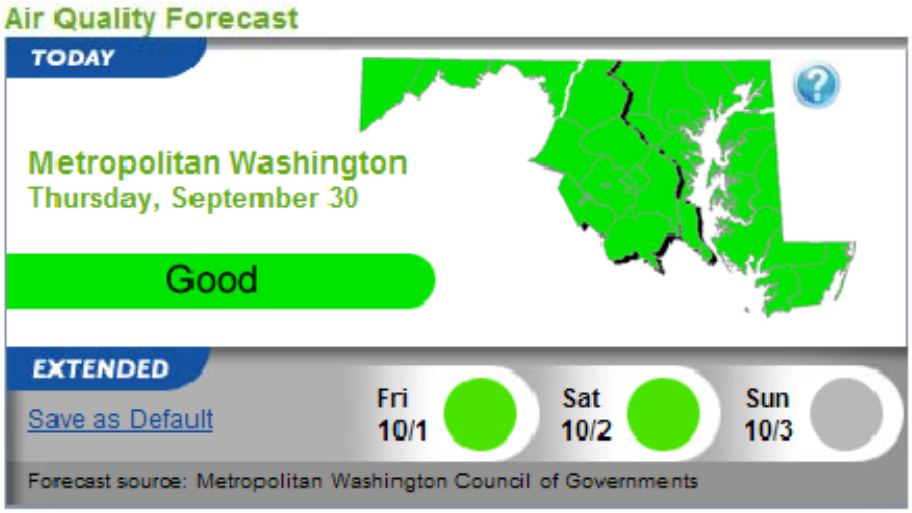
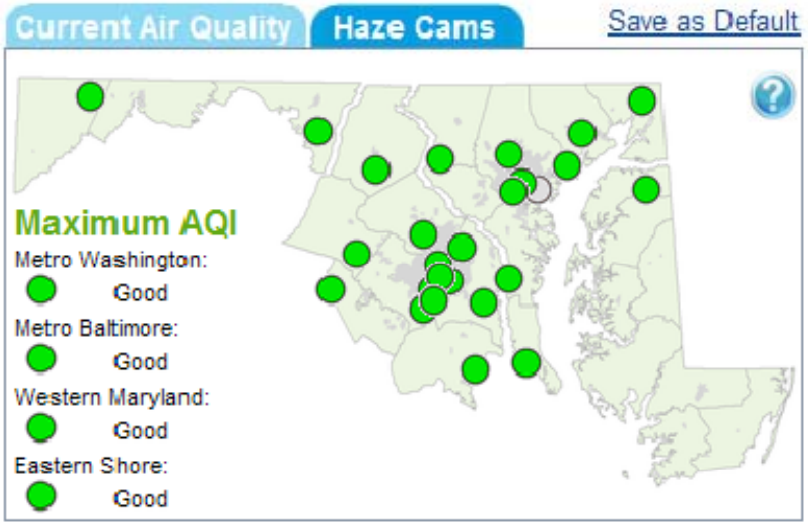
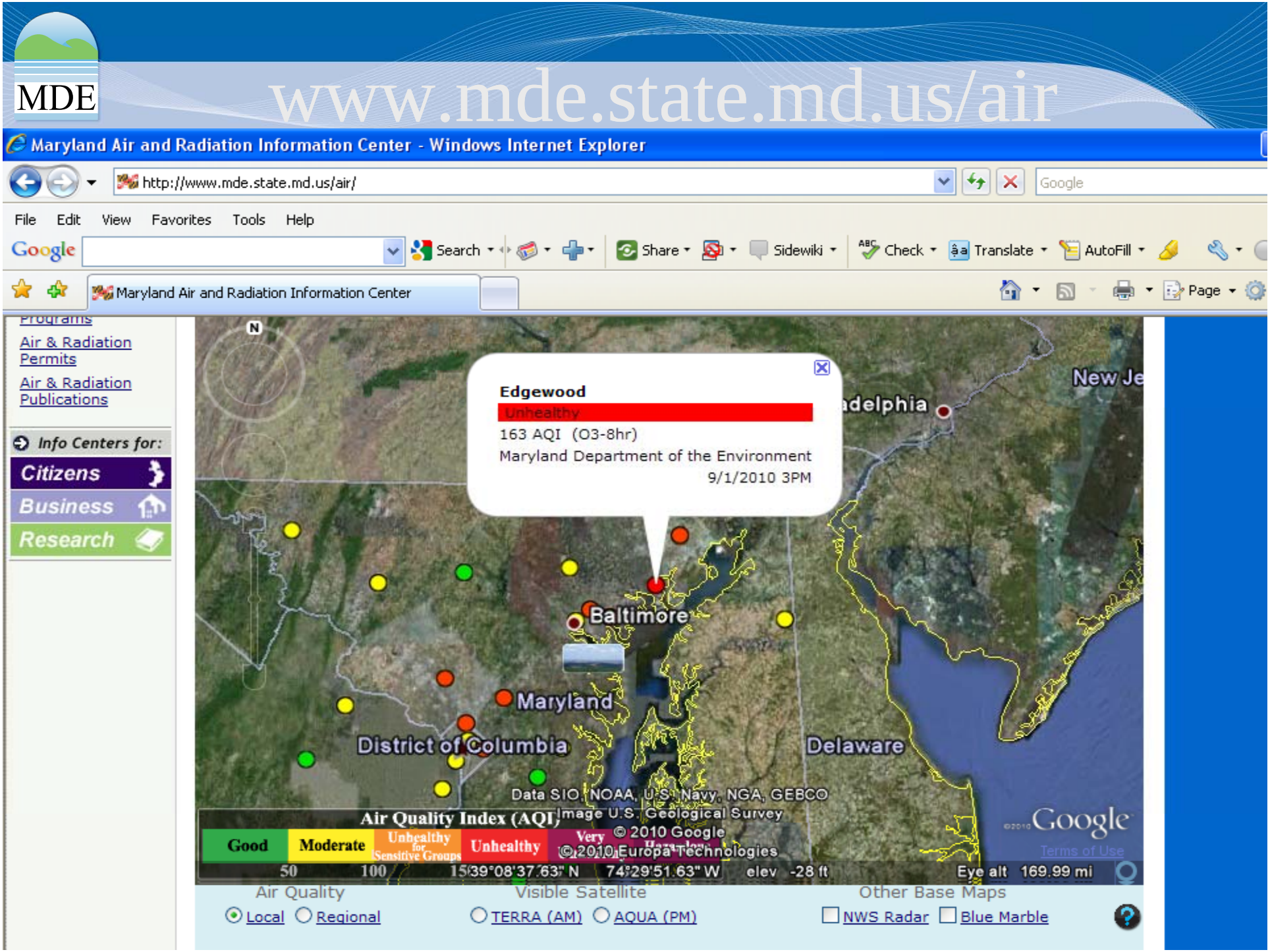
Clean air partners





www.cleanairpartners.net


MDE
www.mde.state.md.us/air
Maryland Air and Radiation Information Center - Windows Internet Explorer
http://www.mde.state.md.us/air/
File Edit View Favorites Tools Help
Search Share Sidewiki Check Translate AutoFill
Maryland Air and Radiation Information Center
Page
Air & Radiation Permits
Air & Radiation Publications
Info Centers for:
Citizens
Business
Research
Edgewood
Unhealthy
163 AQI (O3-8hr)
Maryland Department of the Environment
9/1/2010 3PM
Baltimore
Maryland
District of Columbia
Delaware
New Je
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
© 2010 Google
© 2010 Europa Technologies
Google
Terms of Use
Air Quality Index (AQI)
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
Very
50
100
39°08'37.63" N 74°29'51.63" W elev -28 ft
Eye alt 169.99 mi
Air Quality
Local
Regional
Visible Satellite
TERRA (AM)
AQUA (PM)
Other Base Maps
NWS Radar
Blue Marble

Data sources

The monitoring network

http://www.mde.state.md.us/assets/document/MDNetworkPlan2009.pdf

Data sources

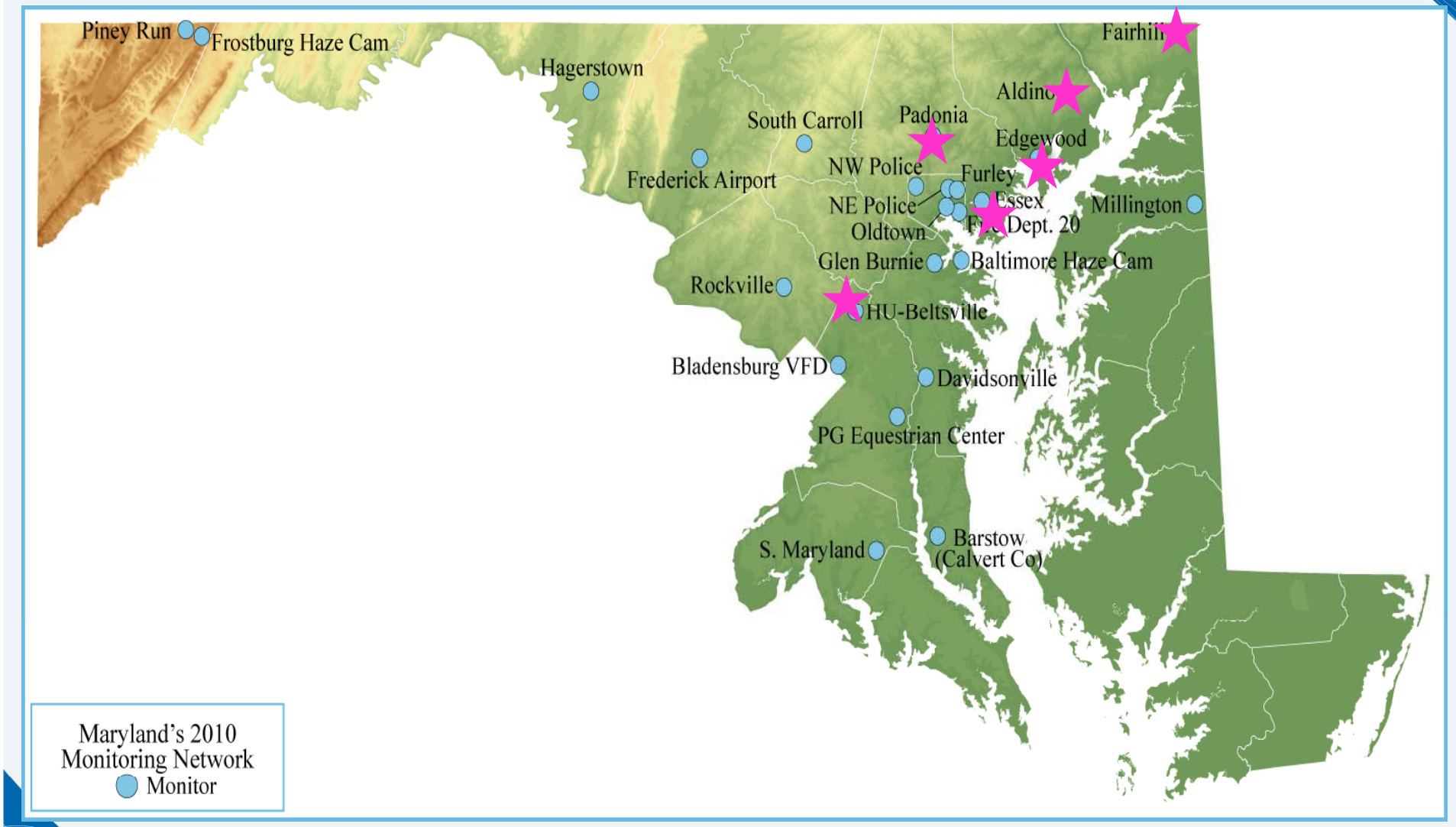
http://www.epa.gov/air/airpolldata.html

http://www.epa.gov/ttn/airs/aqsdatamart/

http://www.epa.gov/airexplorer/

http://www.marama.org/technical-center/air-quality-data-analysis/tools-a-resources

Possible DISCOVER-AQ sites



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Fair Hill

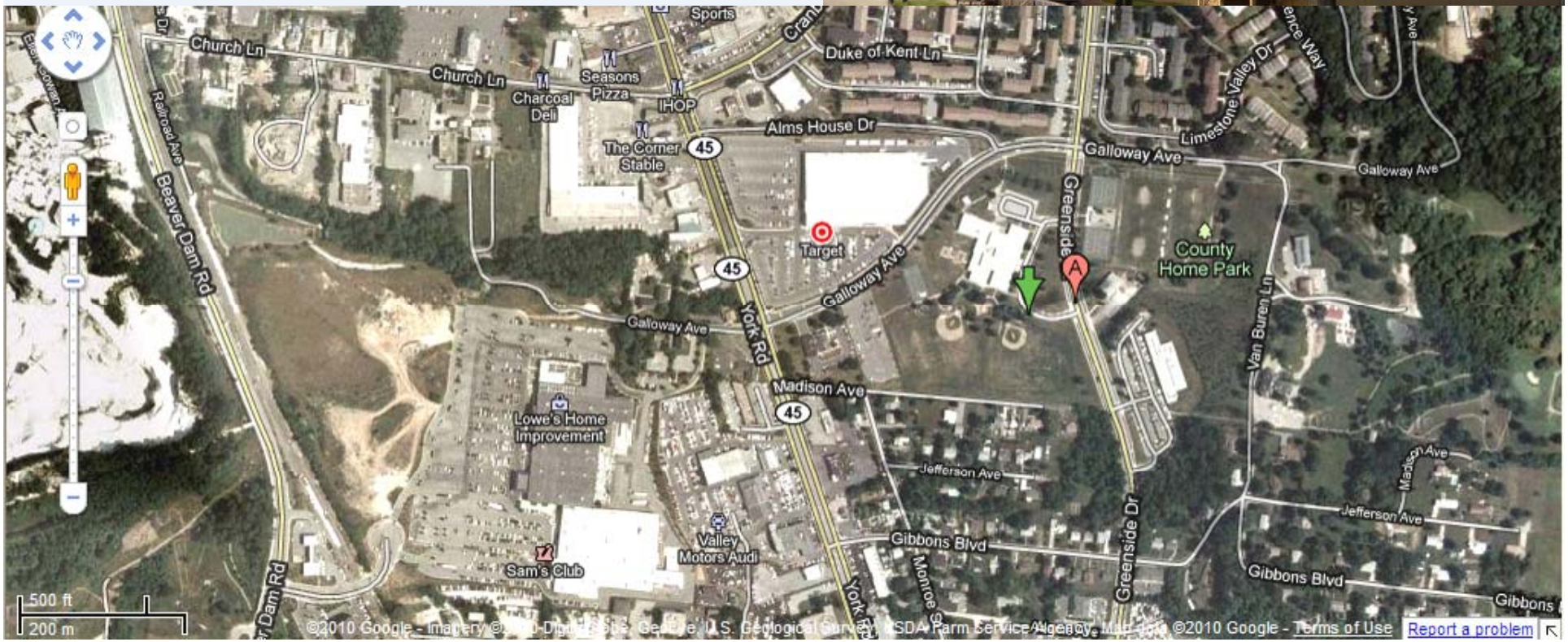
- Rural (39.7011, -75.86)
- O_3, $PM_{2.5}$ (24hr and continuous)
- ID → 240150003

Essex

- Urban (39.3108, -76.4744)
- In Parking lot
- O_3, $PM_{2.5}$, NO, NO_2 and NO_y (and others).
- PM10 continuous →could switch to $PM_{2.5}$.
- ID → 240053001

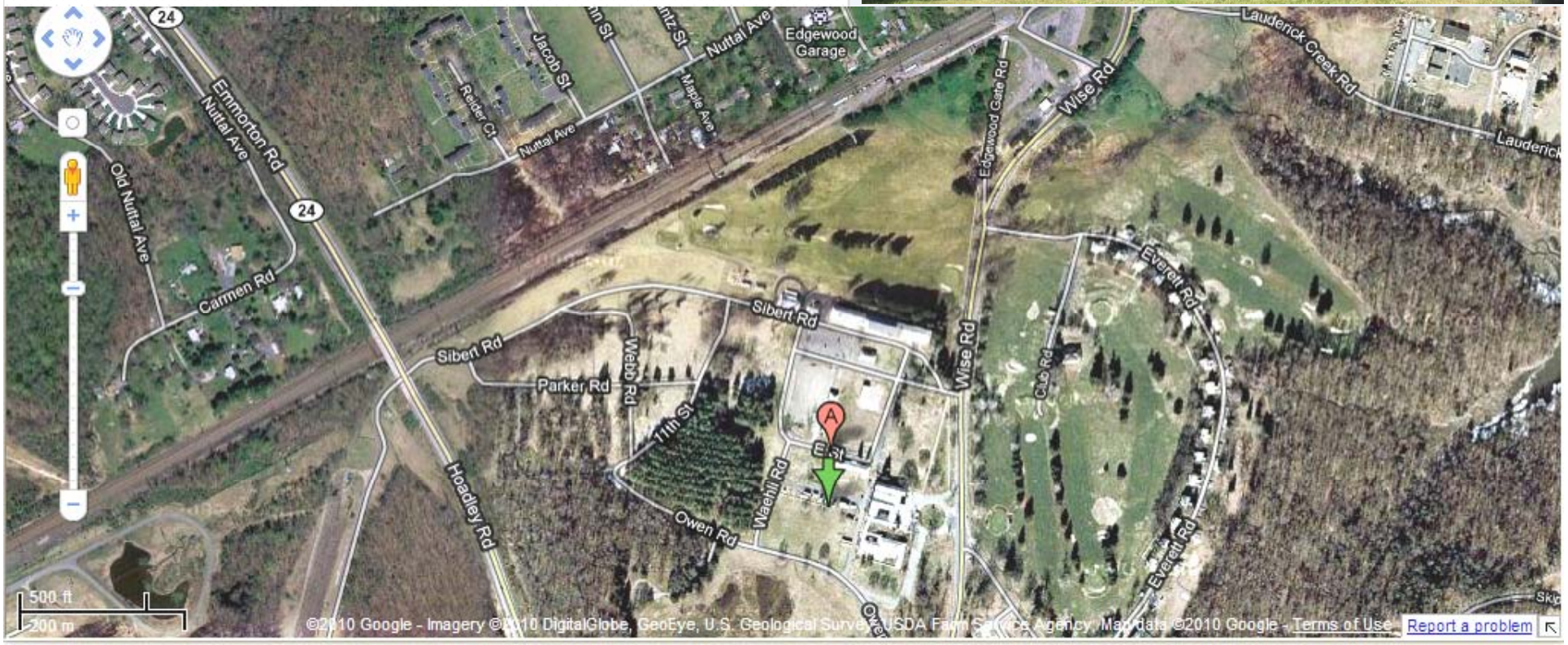
Padonia

- Suburban (39.4620, -76.6313)
- In school parking lot.
- O_3 and $PM_{2.5}$
- ID → 240051007



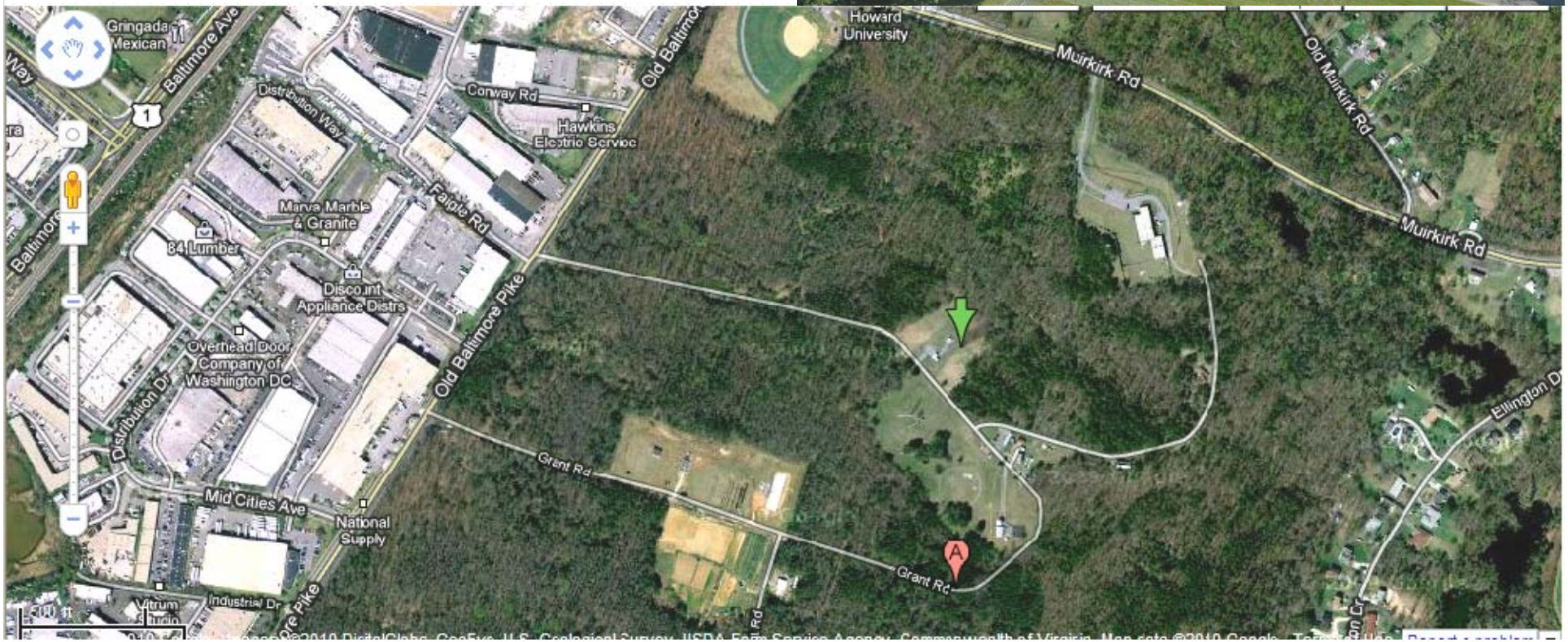
Edgewood

- Suburban (39.41,-76.2967)
- Military base
- O3, $PM_{2.5}$
- ID → 240251001



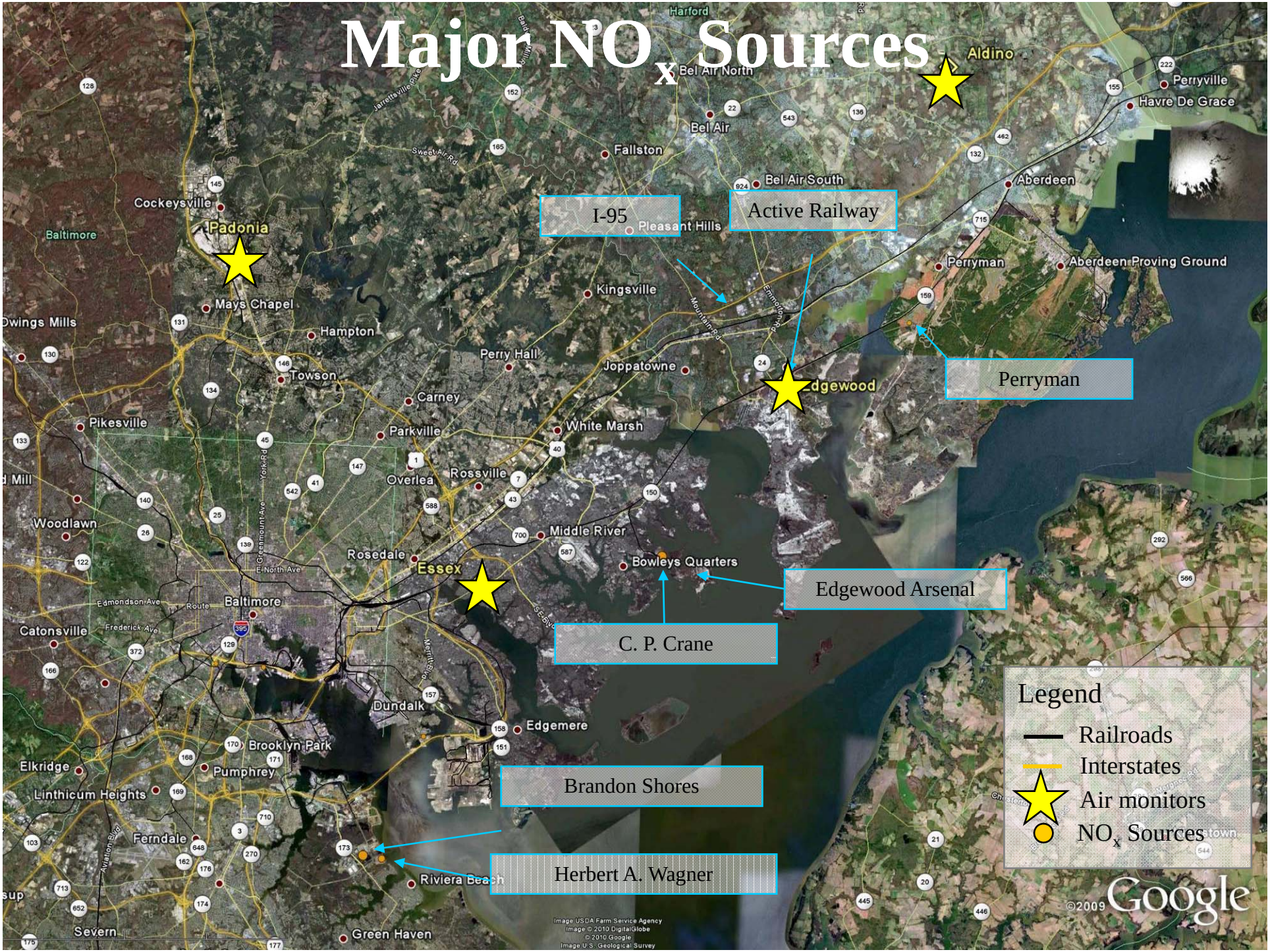
HU-Beltsville

- Suburban (39.0553, -76.8783)
- O_3, $PM_{2.5}$ (24hr and continuous)
- NO, NO_2, NOxand NO_y (and others).
- Wind profiler.
- ID → 240330030

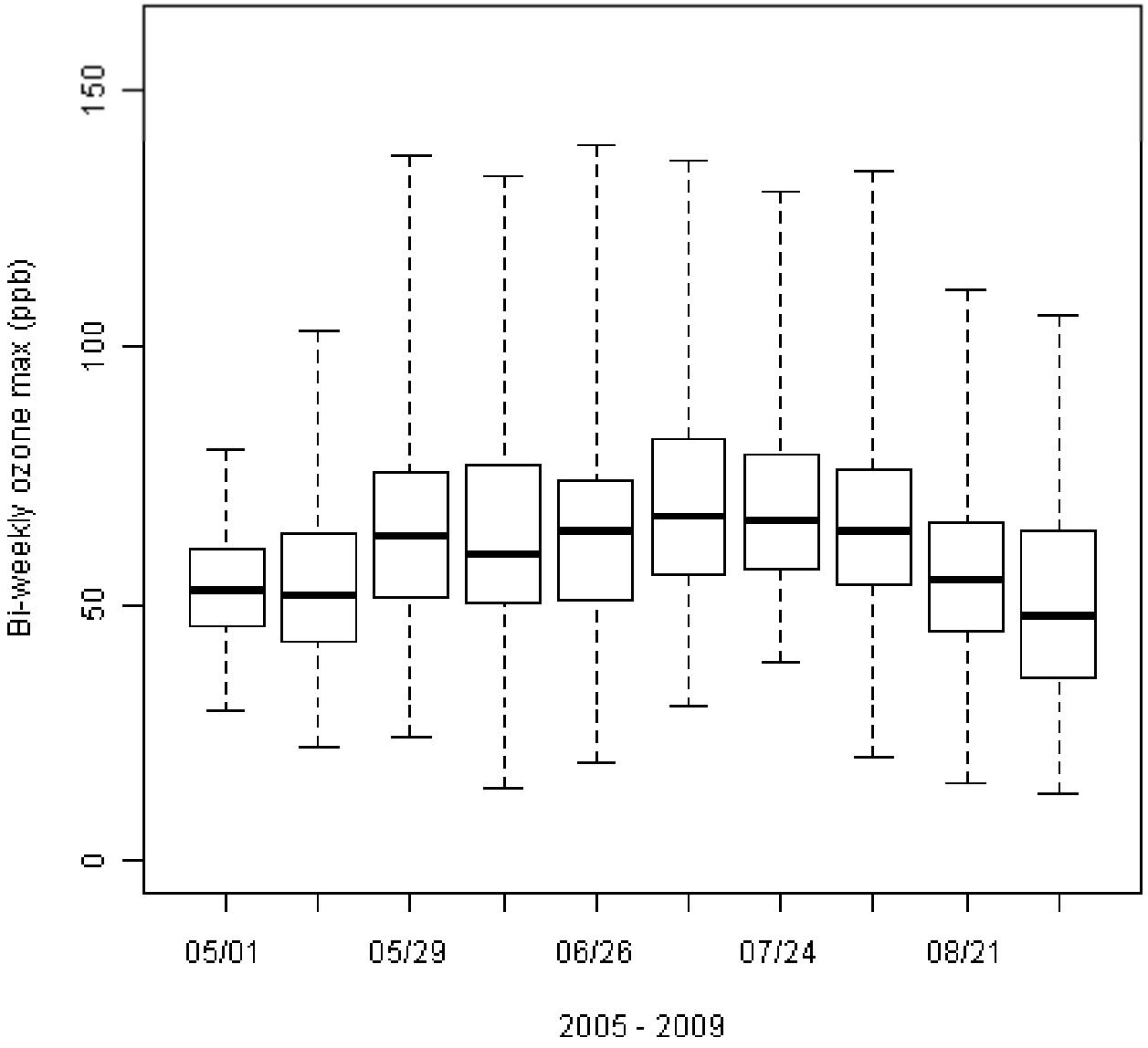


Aldino

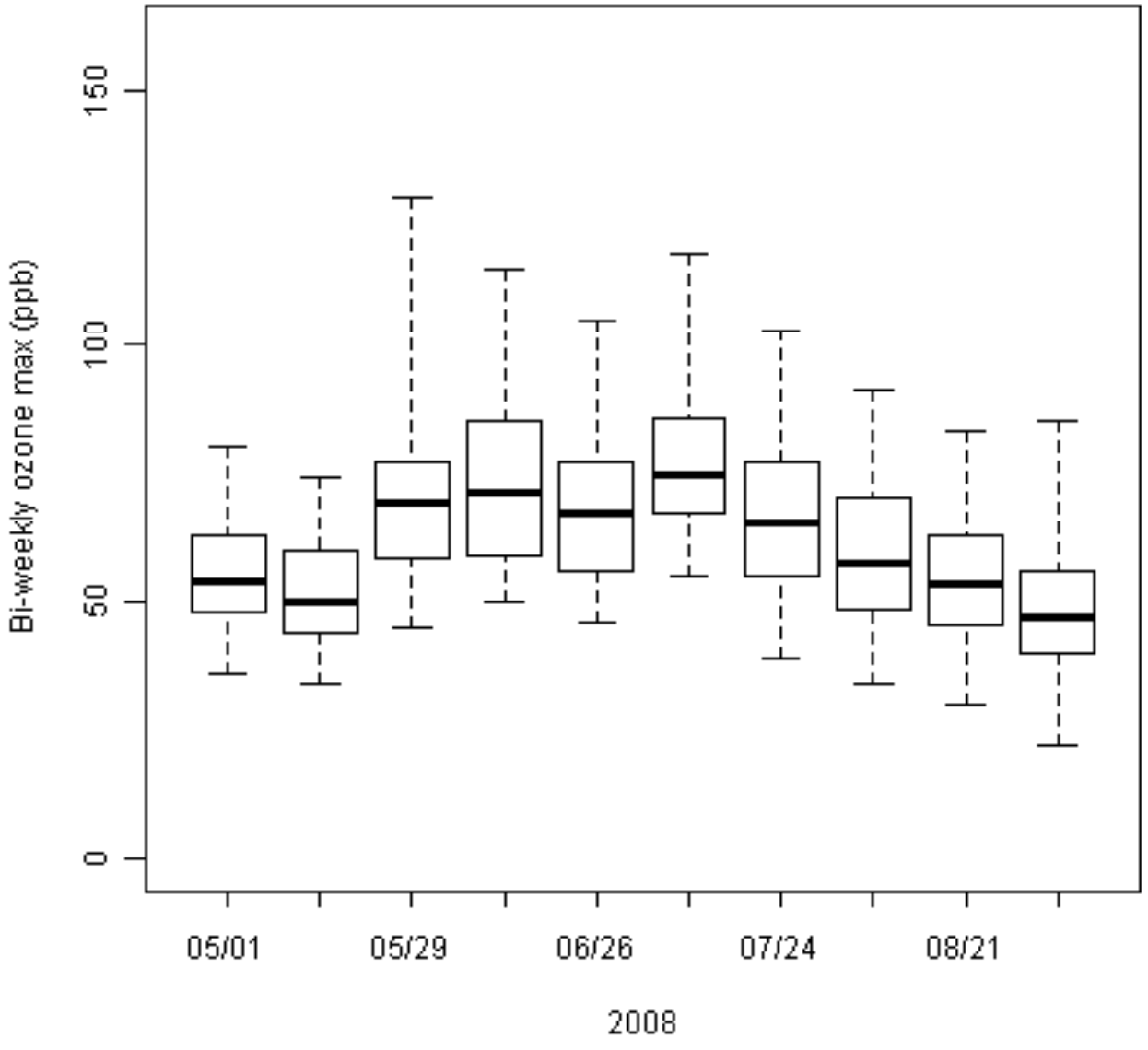
- Rural (39.5633, -76.2039)
- Next to airport
- O_3, NO, NO_2 and NO_y


Major NOx Sources
I-95
Active Railway
Perryman
Edgewood Arsenal
C. P. Crane
Brandon Shores
Herbert A. Wagner
Legend
Railroads
Interstates
Air monitors
NOx Sources
Harford
Aldino
Bel Air North
Bel Air
Fallston
Bel Air South
Aberdeen
Perryville
Havre De Grace
Cockeysville
Padonia
Baltimore
Pleasant Hills
Kingsville
Perryman
Aberdeen Proving Ground
Mays Chapel
Owings Mills
Hampton
Towson
Perry Hall
Joppatowne
Edgewood
Carney
Pikesville
Parkville
White Marsh
Overlea
Rossville
Woodlawn
Middle River
Rosedale
Essex
Bowleys Quarters
Baltimore
Catonsville
Dundalk
Edgemere
Brooklyn Park
Elkridge
Pumphrey
Linthicum Heights
Ferndale
Riviera Beach
Severn
Green Haven
©2009 Google

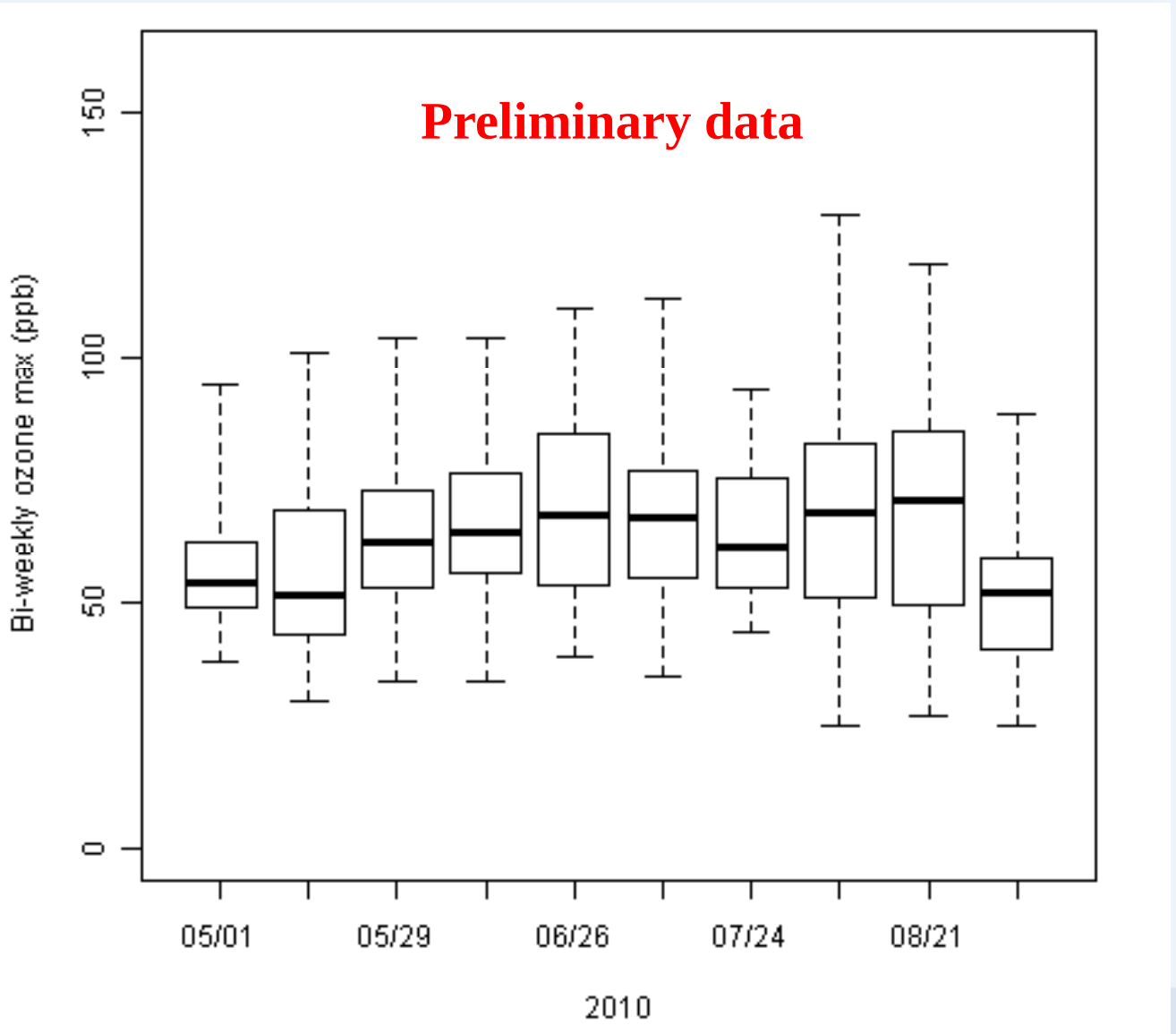
Daily 1-hr O_3 max from Padonia, Essex, Edgewood and Aldino – 5years



Daily O_3 max from Padonia, Essex, Edgewood and Aldino – 2008



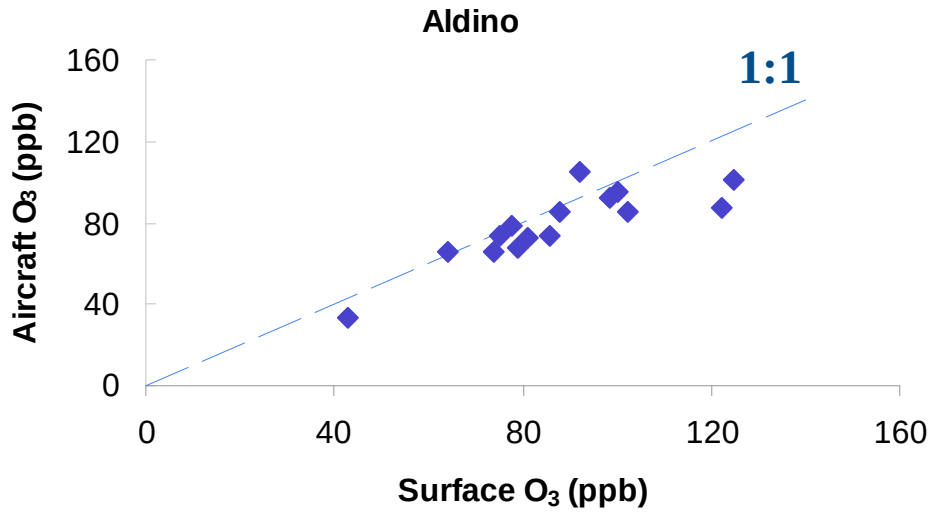
Daily O_3 max from Padonia, Essex, Edgewood and Aldino – 2010

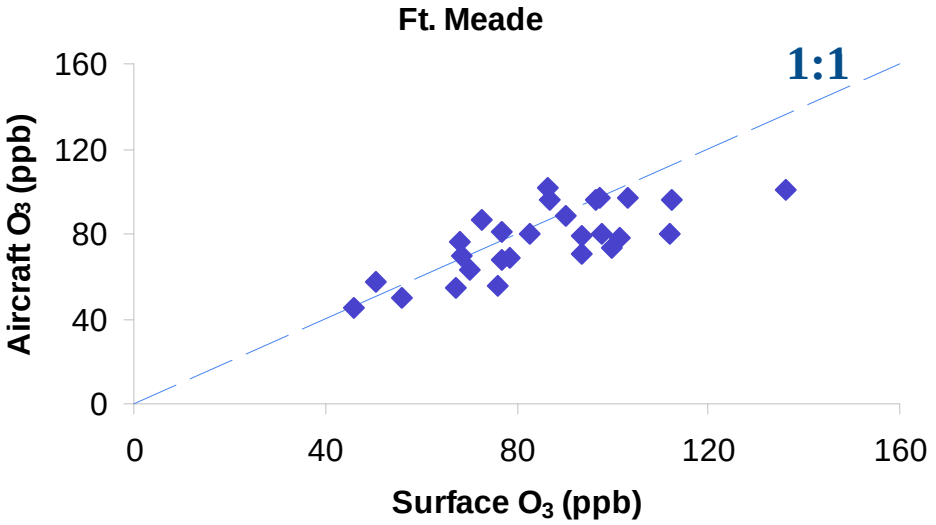


Surface and Aircraft comparisons

- UMD Aircraft PBL average (0.1-2 km) and 3-hr surface average.
- Afternoon, summertime, high O_3 event observations (1999-2003).
- Good correlation but differences can be large (35 ppb).

	Ft. Meade	Aldino
Slope (Aircraft/Surface)	0.60	0.71
Intercept (ppb)	27	17
r^2	0.55	0.72
n	27	15
RMSD (ppb)	15	14





Aircraft data courtesy of UMD

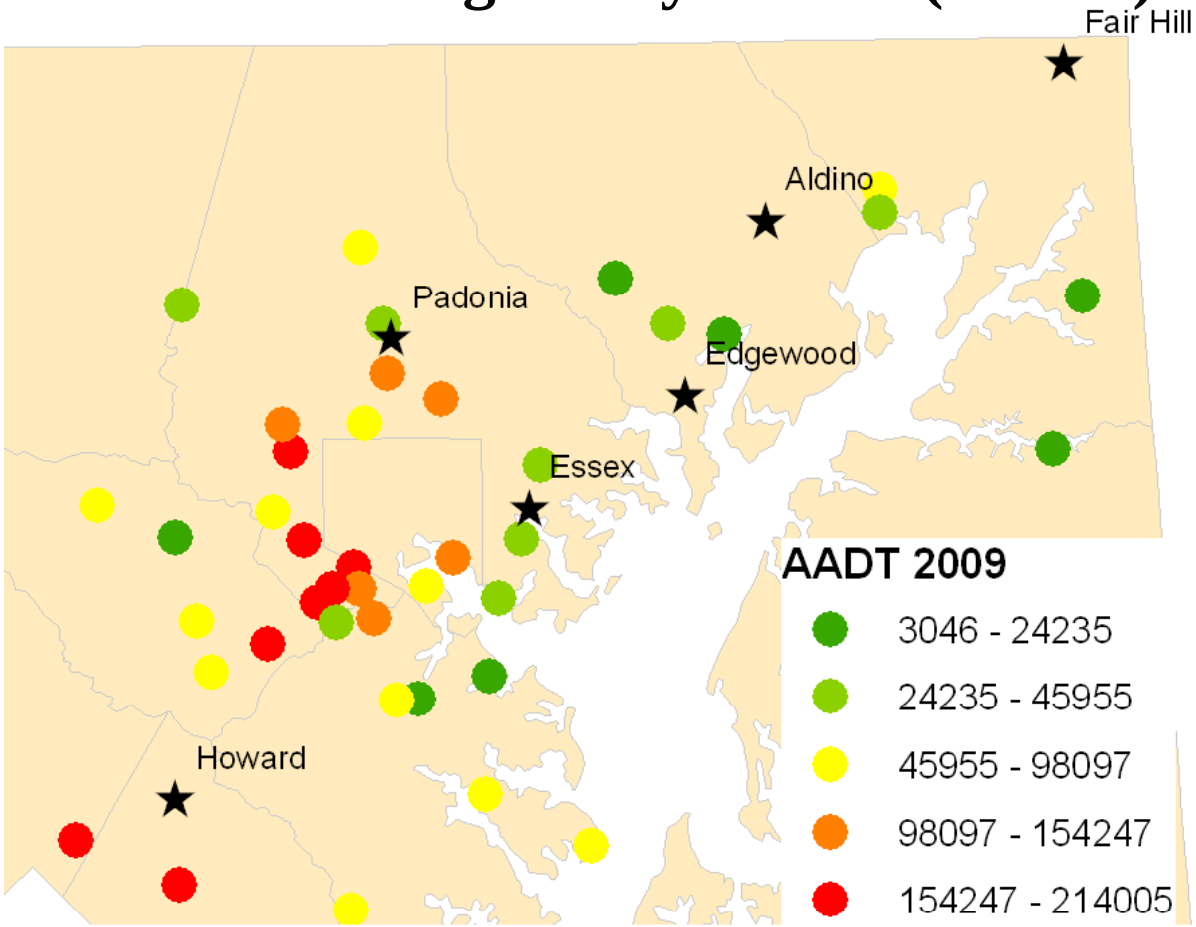
Monitoring future

NO_2 Near road

- MDE will site a near road monitor next summer using traffic counts.
  - Congestion and population may also be examined.
- EPA will conduct a pilot study – summer 2011.
- Required start date is January 1, 2013.
  - MDE required to site 3 monitors.
- Perhaps DISCOVER-AQ can help us determine locations with maximum NO_2 concentrations.

MD Traffic Monitors

Annual Average Daily Traffic (AADT)



- Permanent monitors measure hourly traffic.
- 80 permanent sites in MD, 20 sites measure traffic classes.
- Special project monitors
  - volume, class, turning movement and occupancy.
- 3760 short term sites
  - 48 hrs every three years.
  - Measure volume, class and speed.
  - Used to derive finer resolution counts.

http://www.sha.maryland.gov/oppen/HISD%20Traffic%20Monitoring%20System%20Program.pdf

Science of air pollution in MD

MDE goes beyond NAAQS monitoring by funding research for:

HU O_3 sondes

Everette Joseph

PSU forecasting conceptual models

Bill Ryan

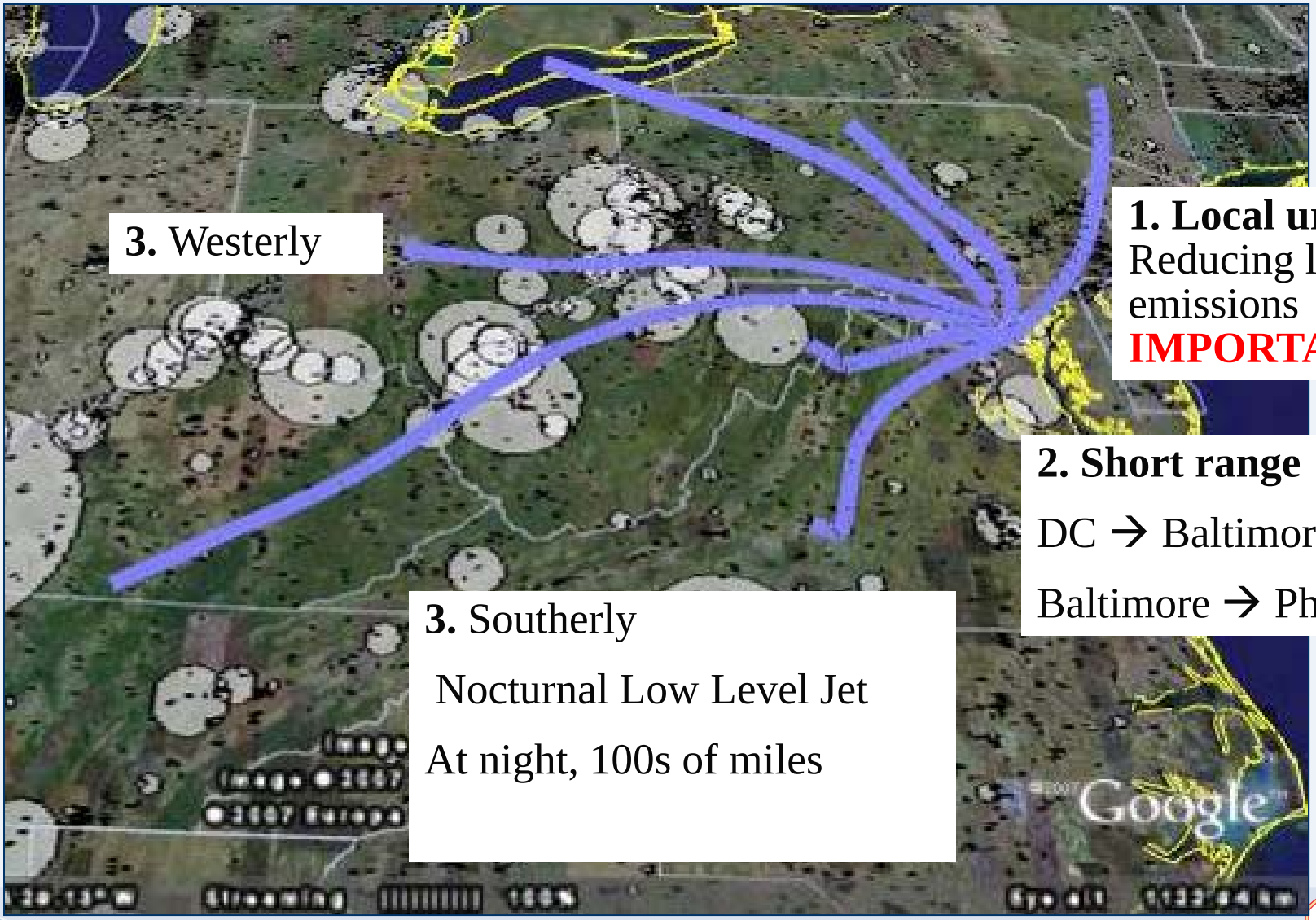
UMD aircraft

Russ Dickerson

UMBC lidar

Ray Hoff.

Understanding transport



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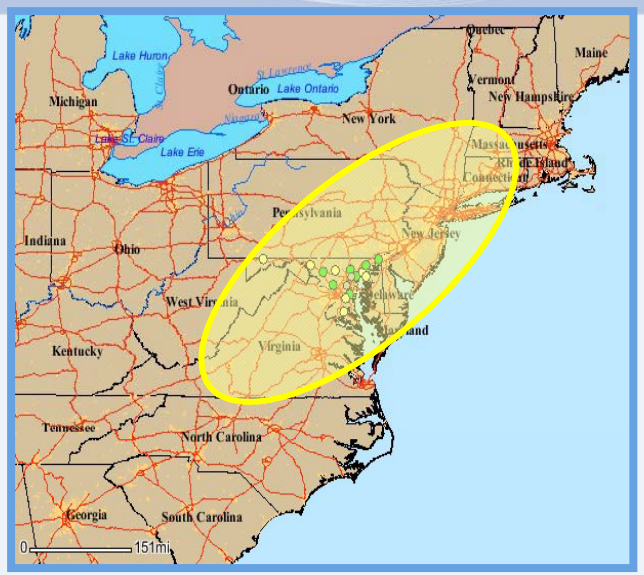
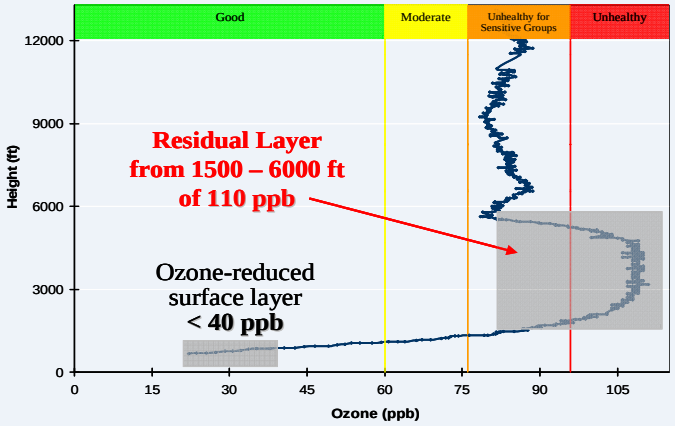
The Elevated O_3 Reservoir



Incoming Ozone
August 2, 2005 (7:00 AM EDT)
Beltsville, MD



Source: Maryland Department of the Environment & Howard University

- Every bad ozone day, in the morning hours, a large reservoir of ozone sits above Maryland and the Mid-Atlantic area waiting to mix down.
  - Ozone values in the reservoir can reach 60 - 100 ppb.
  - Morning surface ozone values are small.
- Around 10:00 or 11:00, the ozone in the reservoir mixes down to the surface and degrades air quality.

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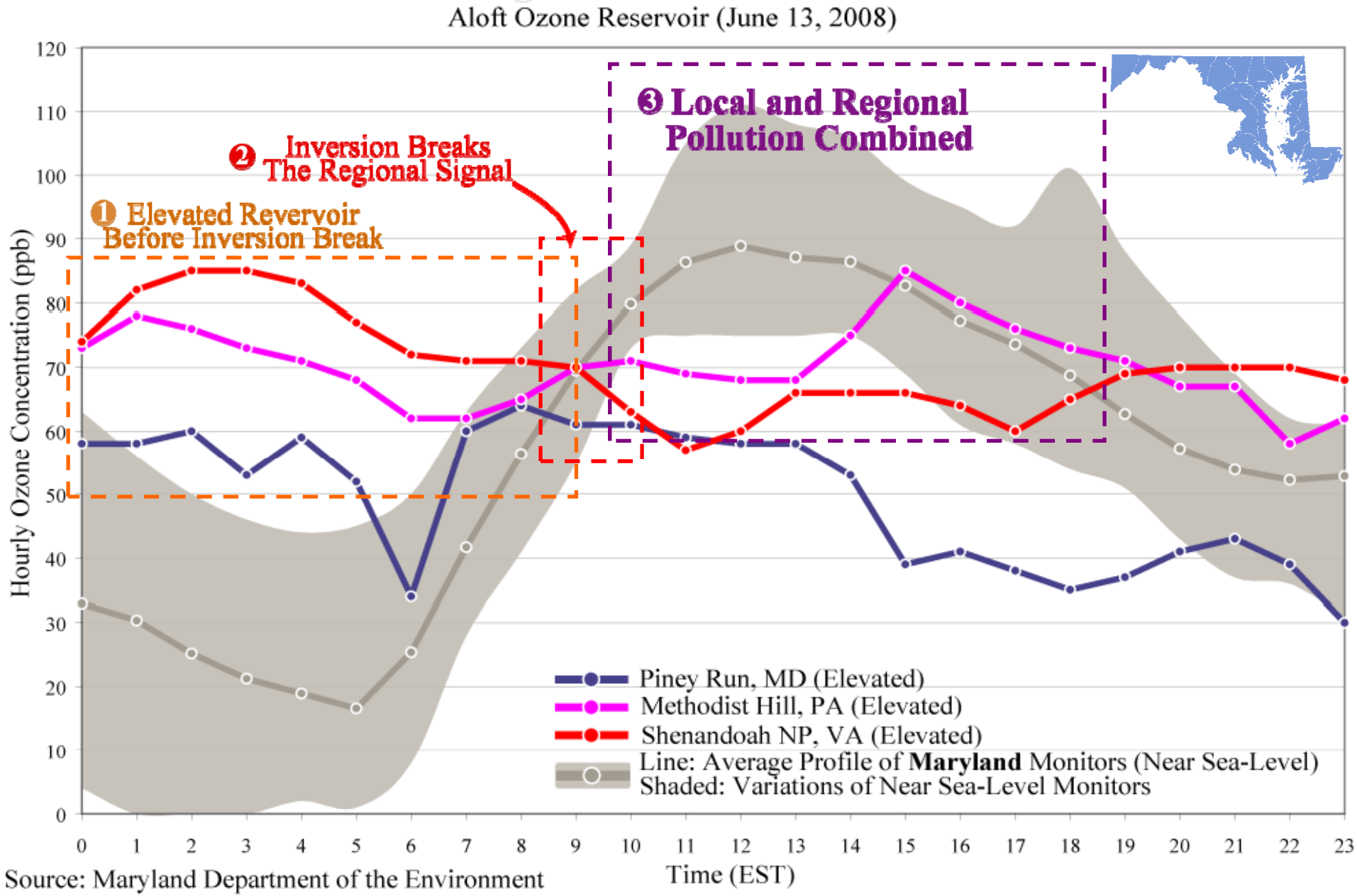
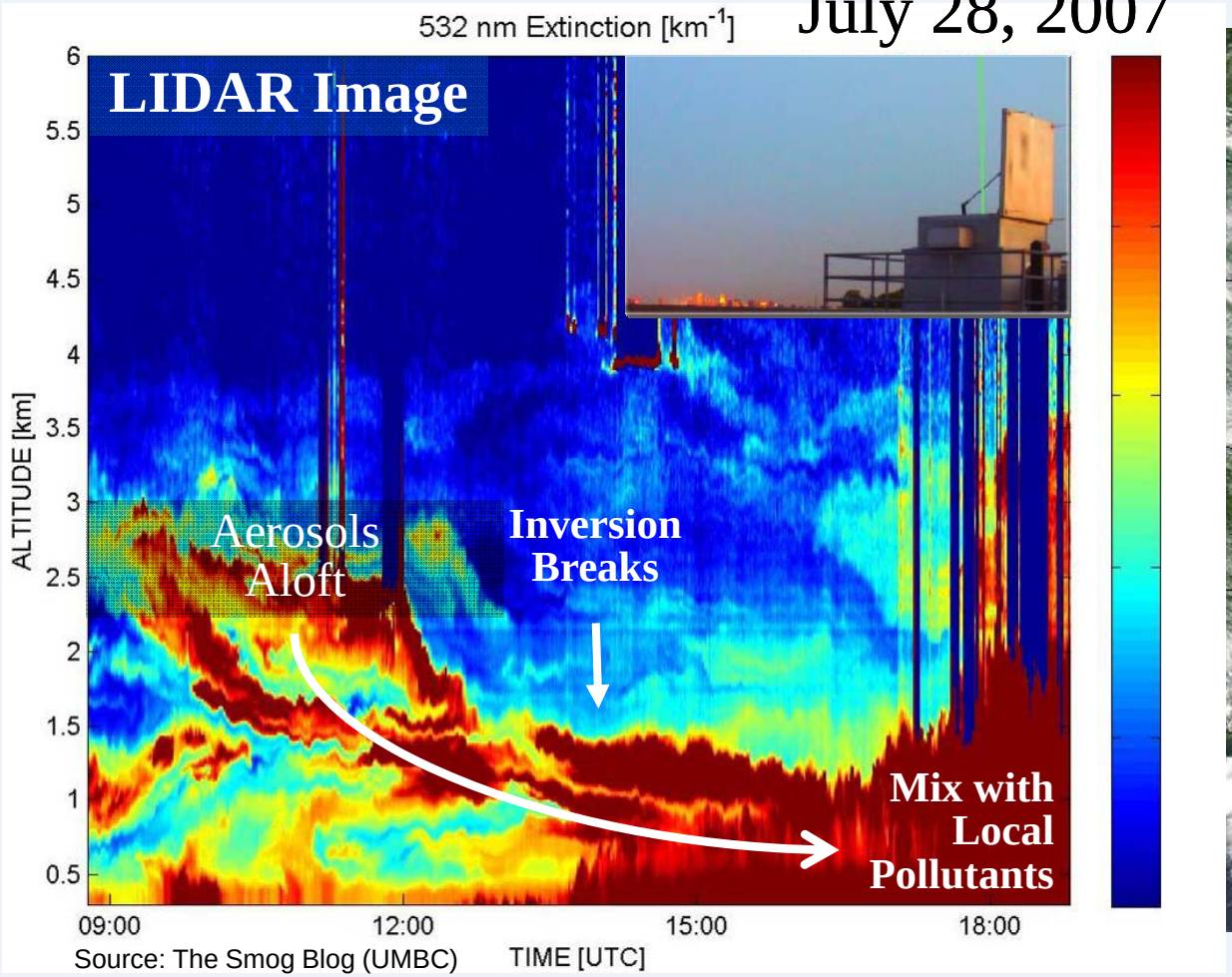
Elevated O_3 reservoir – MD - 2008



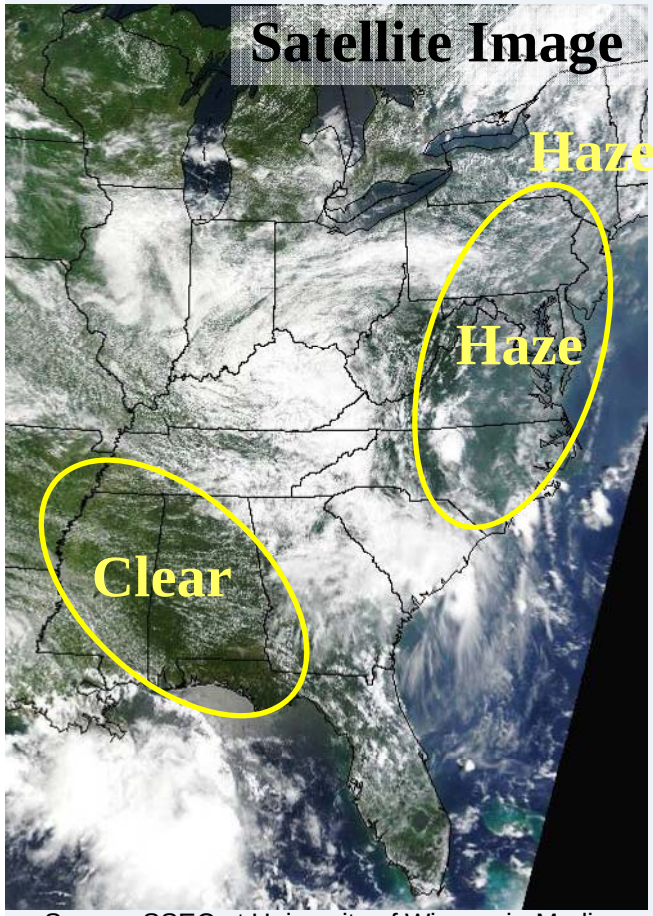
Source: Maryland Department of the Environment

Similar transport for $PM_{2.5}$

July 28, 2007



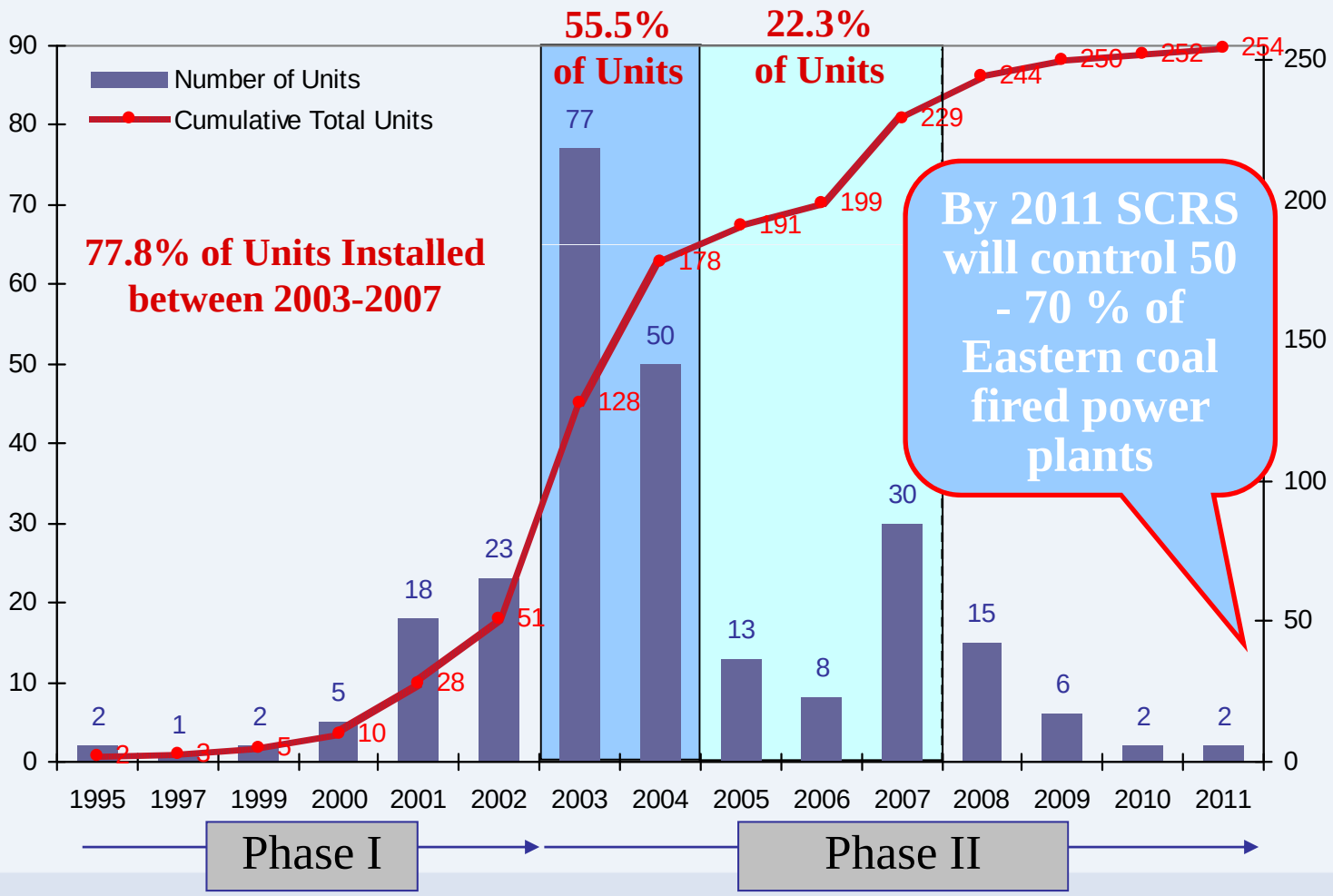
Source: The Smog Blog (UMBC)



Source: SSEC at University of Wisconsin-Madison

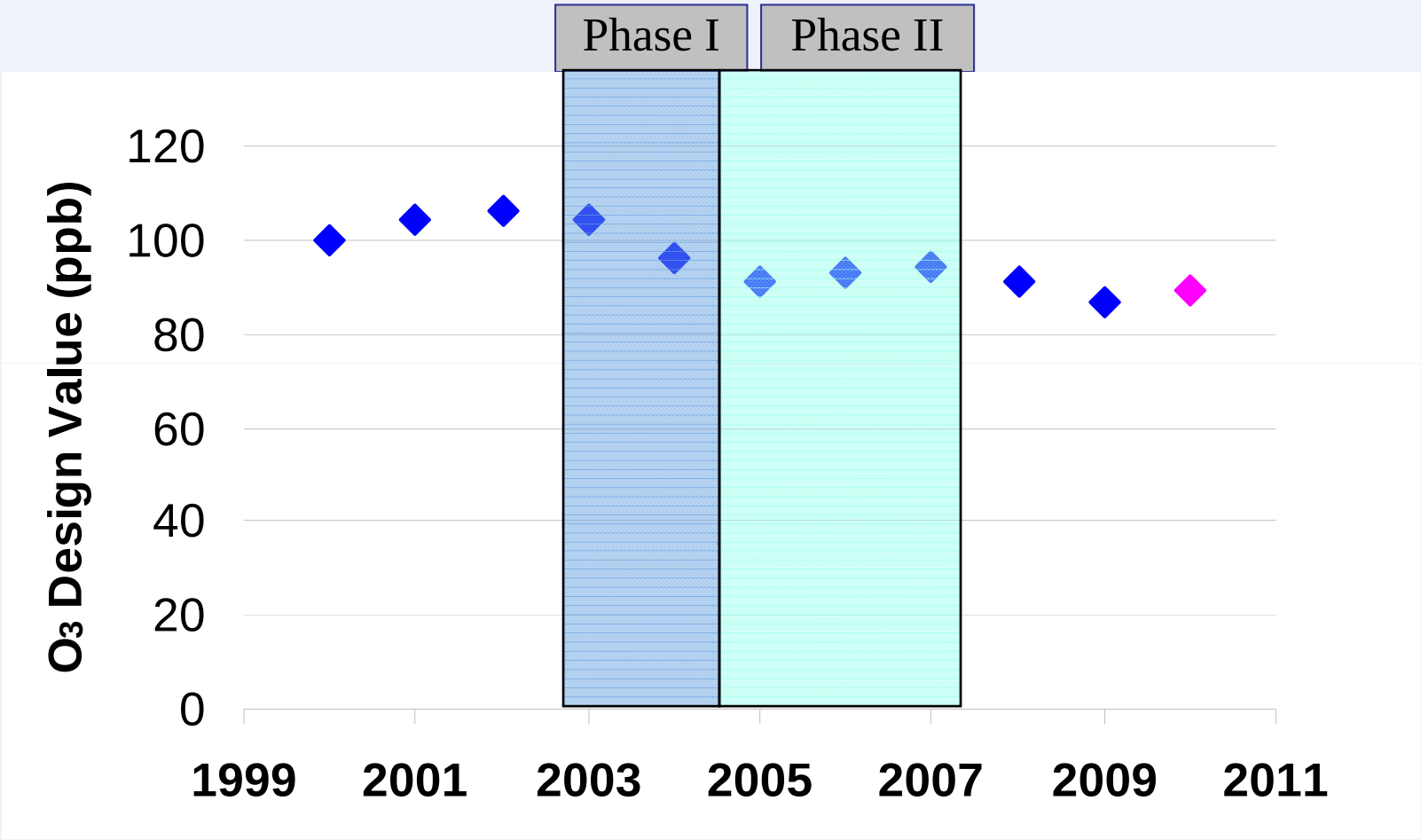
Reducing Westerly Transport

Selective Catalytic Reduction (SCR)



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

SCR effects Edgewood ozone



Design value = 3-yr average of the 4th highest daily max 8-hour average O_3

2010 is preliminary

Southerly Transport at Night

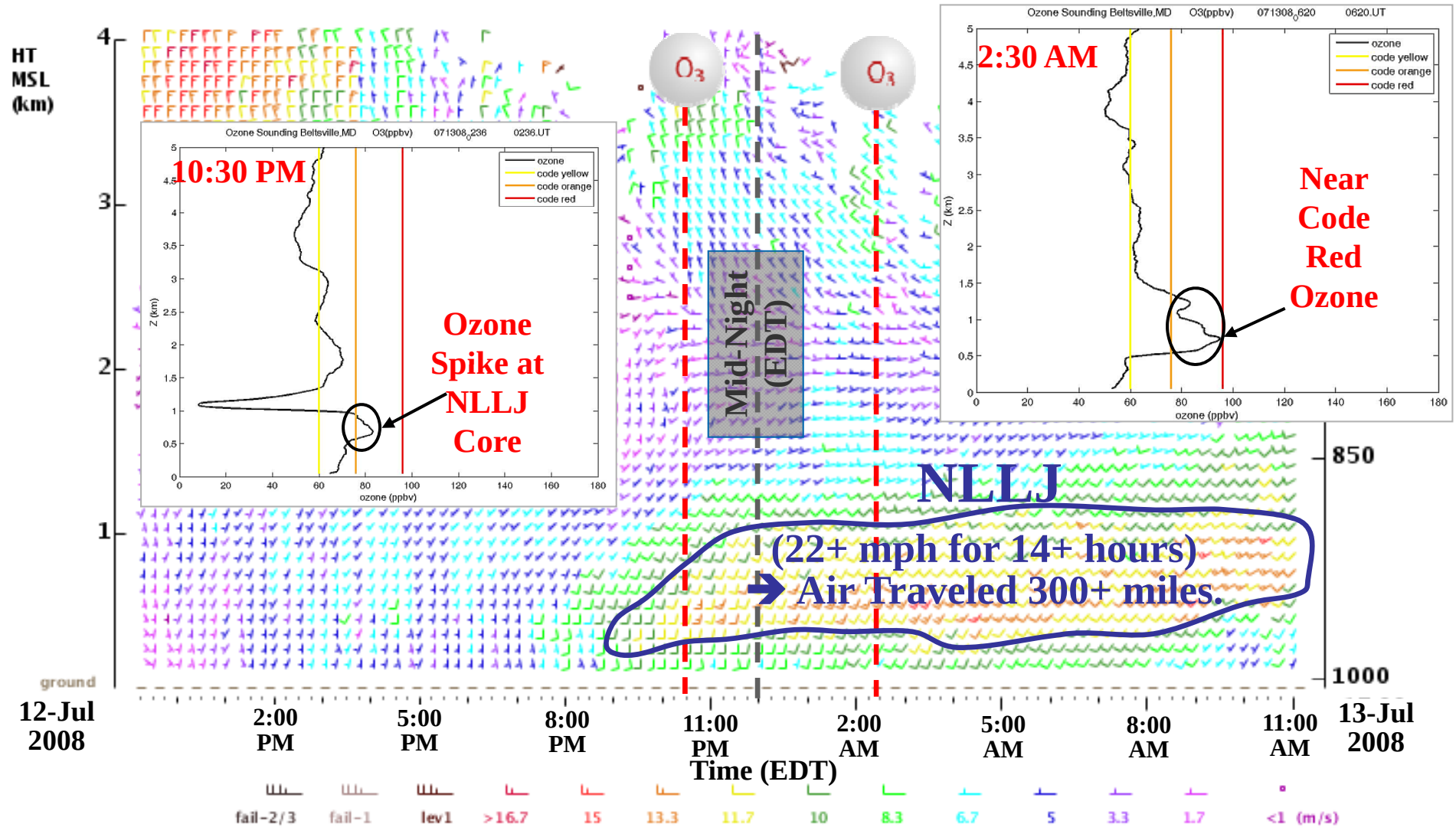
The Nocturnal Low Level Jet (NLLJ)

- 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 summer-time 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

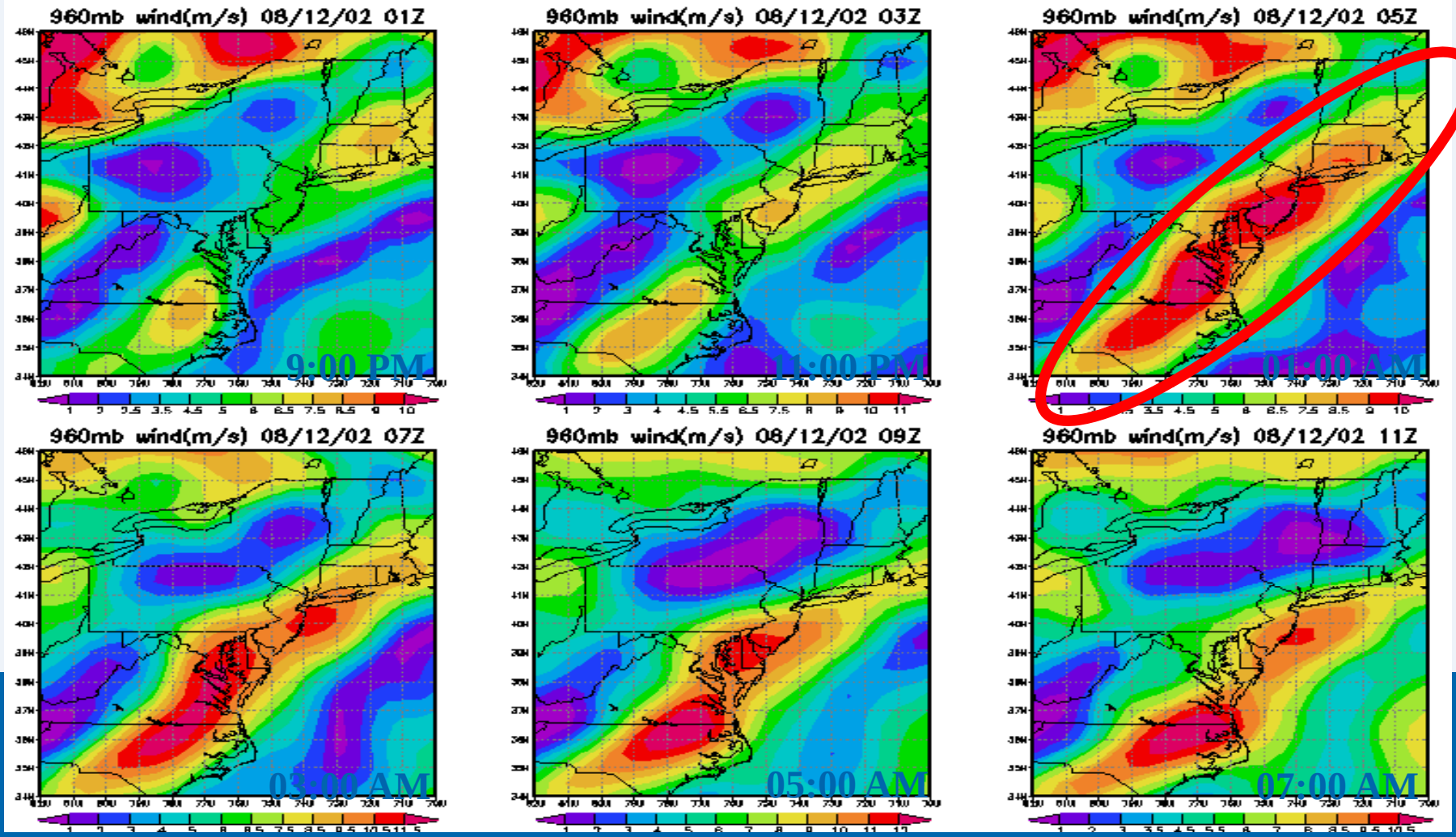
Wind speed, direction and ozone

Beltsville, MD July 12-13 2008



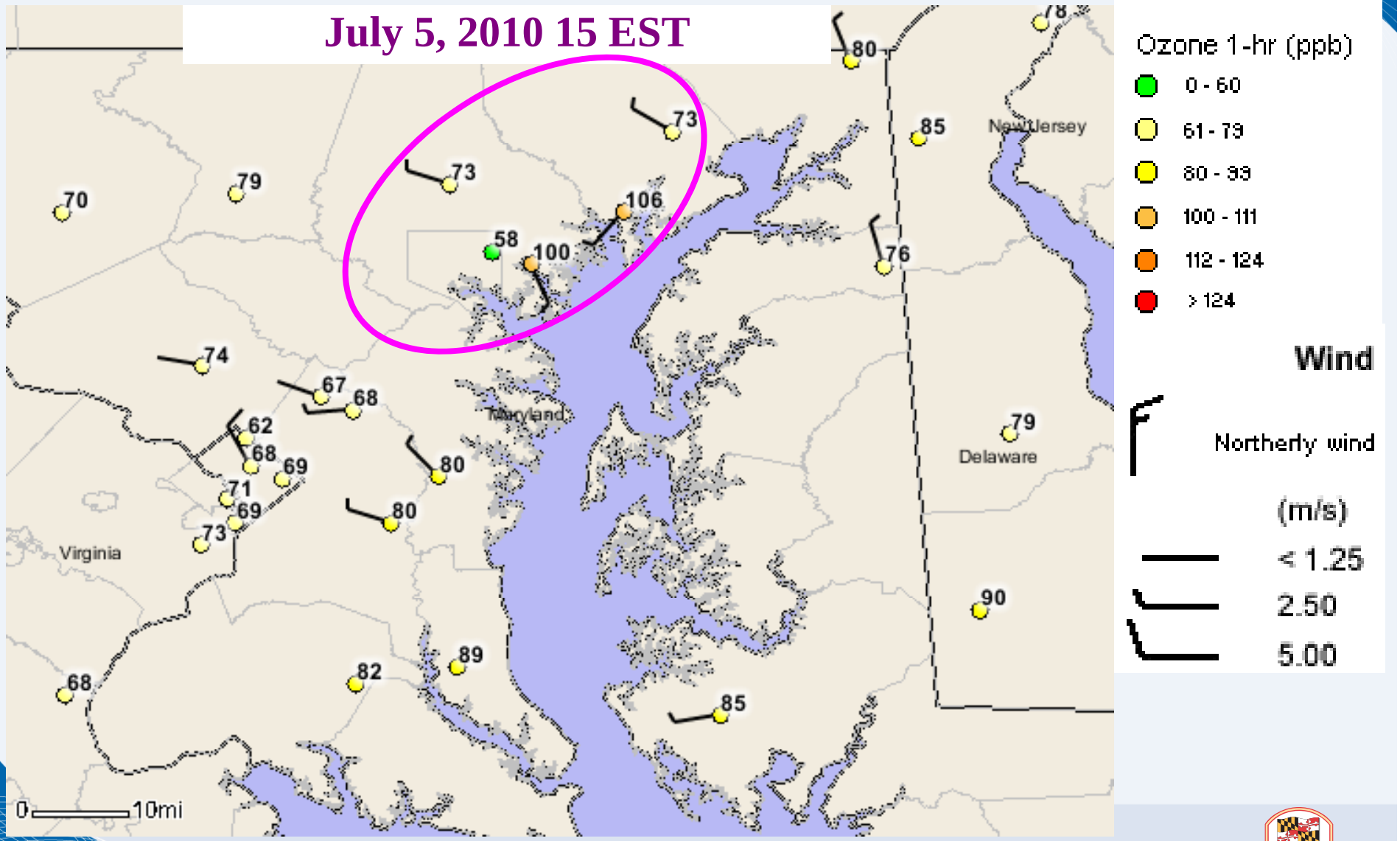
How Big is the NLLJ?

MM5 Model Run – Highest Wind Speeds in Red



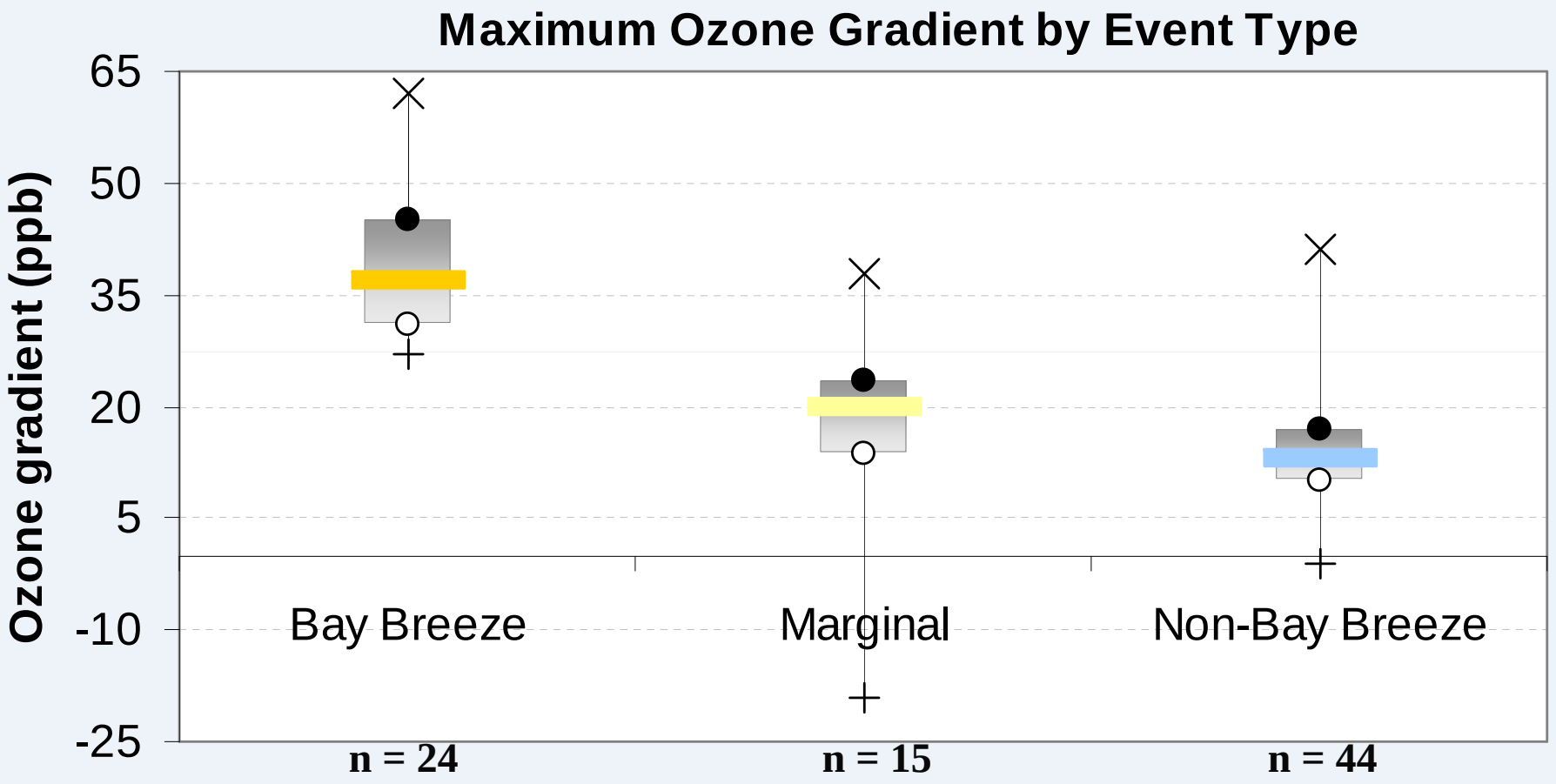
Graphics are courtesy of UMD at College Park.

Bay Breeze Occurrence



http://www.airnowtech.org/gis/index.cfm

Bay breeze effects on O_3



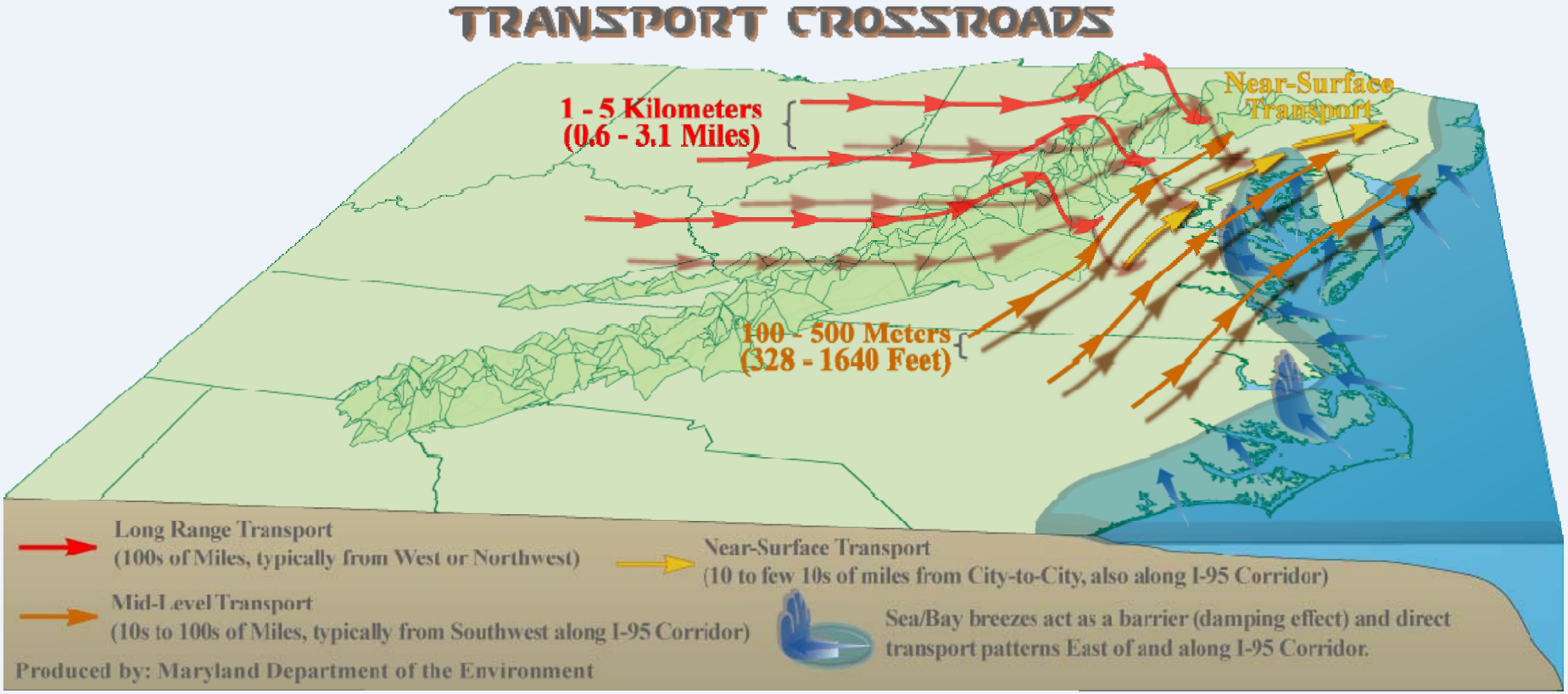
Gradient = Edgewood –Aldino

or

Essex – Padonia

Courtesy: Laura Landry MDE

When Transport Patterns Collide



- Westerly, local and southerly/NLLJ transport converge on the Mid-Atlantic area.
- Sea and bay breezes act as a barrier or wall and funnel ozone and other air pollutants up the Northeast Corridor.

Contact

Jennifer Hains

MDE

jhains@mde.state.md.us

410-537-4027

MDE monitoring network

	CO	SO2	O3	NO NO2	NOX	NOY	PM2.5	PM2.5 Species	PM10	OC EC	Sulfate	Neph	PAMS	Toxics	TOTALS
Aldino			1	1		1									4
Bladensburg							1								1
Calvert Co.			1												1
Davidsonville			1												1
Edgewood			1				1								2
Essex	1	1	1	1	1		1	1	1*				1	1	11
Fairhill			1				2*								3
Frederick			1												1
Fire Dept 20							1		1						2
Furley			1												1
Glen Burnie							1		3*						4
Hagerstown			1				2*								3
HU-Beltsville	2	2	1	1	1	1	2*	1		1	1		1	1	16
Millington			1				1*								2
NE Police							1							1	2
NW Police							1								1
Oldtown	1			1	1		2*			1		1		1	9
Padonia			1				2								3
PG Equestrian Center			1				2								3
Piney Run	2	2	1	1		1	1*			1	1	1			11
Rockville			1				2*								2
South Carroll			1												1
Southern Maryland			1												1
TOTALS	**6**	**5**	**17**	**5**	**3**	**3**	**23**	**2**	**5**	**3**	**2**	**2**	**2**	**4**	**86**

* One monitor is continuous

MARYLAND
DEPARTMENT OF THE ENVIRONMENT