Maryland Air Quality Monitoring

6 October 2010
DISCOVER-AQ science team meeting
Jennifer Hains
Air Monitoring Program
Maryland Department of the Environment
Monitoring goals

Non-Attainment → Attainment

Network summary
- Sites of interest for DISCOVER-AQ
- O₃ observations
- Surface and aircraft comparisons
- NO₂ 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), O₃ and PM₂.₅ 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 PM₂.₅ and O₃.
Network Objectives

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.

www.airnow.gov
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<th>Level</th>
<th>Averaging Time</th>
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<td>PM₁₀</td>
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<td>24-hour</td>
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http://www.epa.gov/air/criteria.html
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?
## Selected monitors

<table>
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<tr>
<th>Species</th>
<th>Aldino</th>
<th>Edgewood</th>
<th>Essex</th>
<th>Fairhill</th>
<th>HU-Beltsville</th>
<th>Padonia</th>
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* One monitor is continuous
How the data is used
Data is reported to the public
Used to create AQ forecasts

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<th>Current AQI</th>
<th>Forecast AQI</th>
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<td>Hagerstown</td>
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<td>93</td>
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<td>Millington</td>
<td>57</td>
<td>124</td>
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Click on the city name for more detailed information.

Printable summary
Clean air partners

www.cleanairpartners.net
The monitoring network


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

Maryland’s 2010 Monitoring Network
Monitor
• Fair Hill
• Rural (39.7011, -75.86)
• O₃, PM₂.₅ (24hr and continuous)
• ID → 240150003
Urban (39.3108, -76.4744)
In Parking lot
O₃, PM₂.₅, NO, NO₂ and NOₓ (and others).
PM₁₀ continuous → could switch to PM₂.₅.
ID → 240053001
Padonia

- Suburban (39.4620, -76.6313)
- In school parking lot.
- O₃ 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)
- \( \text{O}_3 \), PM\(_{2.5} \) (24hr and continuous)
- NO, NO\(_2\), NO\(_x\) and NO\(_y\) (and others).
- Wind profiler.
- ID → 240330030
- Rural (39.5633, -76.2039)
- Next to airport
- $O_3$, NO, NO$_2$ and NO$_y$
Major NO\textsubscript{x} Sources

Legend
- Railroads
- Interstates
- Air monitors
- NO\textsubscript{x} Sources

- I-95
- Active Railway
- Perryman
- Edgewood
- Brandon Shores
- C. P. Crane
- Edgewood Arsenal
- Herbert A. Wagner
Daily 1-hr O₃ max from Padonia, Essex, Edgewood and Aldino – 5 years
Daily $O_3$ max from Padonia, Essex, Edgewood and Aldino – 2010

Preliminary data

Bi-weekly ozone max (ppb)

05/01 05/29 06/26 07/24 08/21

2010
- UMD Aircraft PBL average (0.1-2 km) and 3-hr surface average.
- Good correlation but differences can be large (35 ppb).

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<tr>
<th></th>
<th>Ft. Meade</th>
<th>Aldino</th>
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<td>Slope (Aircraft/Surface)</td>
<td>0.60</td>
<td>0.71</td>
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<td>Intercept (ppb)</td>
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<td>$r^2$</td>
<td>0.55</td>
<td>0.72</td>
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<td>$n$</td>
<td>27</td>
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<tr>
<td>RMSD (ppb)</td>
<td>15</td>
<td>14</td>
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Aircraft data courtesy of UMD
Monitoring future
- 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 NO₂ concentrations.
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.

MDE goes beyond NAAQS monitoring by funding research for:

- **HU O₃ sondes**
  - Everette Joseph

- **PSU forecasting conceptual models**
  - Bill Ryan

- **UMD aircraft**
  - Russ Dickerson

- **UMBC lidar**
  - Ray Hoff.
Understanding transport

1. Local urban
   Reducing local emissions
   IMPORTANT

2. Short range
   DC ➔ Baltimore
   Baltimore ➔ Philly

3. Westerly

3. Southerly
   Nocturnal Low Level Jet
   At night, 100s of miles
The Elevated O₃ Reservoir

- 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.
Similar transport for PM$_{2.5}$

July 28, 2007

LIDAR Image

Satellite Image

Aerosols Aloft

Inversion Breaks

Mix with Local Pollutants

Source: The Smog Blog (UMBC)

Source: SSEC at University of Wisconsin-Madison
Reducing Westerly Transport

Selective Catalytic Reduction (SCR)

By 2011 SCRS will control 50 - 70% of Eastern coal fired power plants

Phase I

Phase II

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
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

Ozone Spike at NLLJ Core

NLLJ (22+ mph for 14+ hours) ➞ Air Traveled 300+ miles.

Near Code Red Ozone

Air Traveled 300+ miles.
How Big is the NLLJ?

MM5 Model Run – Highest Wind Speeds in Red

Graphics are courtesy of UMD at College Park.
Bay Breeze Occurrence

July 5, 2010 15 EST

http://www.airnowtech.org/gis/index.cfm
Bay breeze effects on O₃

Maximum Ozone Gradient by Event Type

<table>
<thead>
<tr>
<th>Ozone gradient (ppb)</th>
<th>Bay Breeze</th>
<th>Marginal</th>
<th>Non-Bay Breeze</th>
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<tbody>
<tr>
<td></td>
<td>n = 24</td>
<td>n = 15</td>
<td>n = 44</td>
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</table>

Gradient = Edgewood – Aldino

or

Essex – Padonia

Courtesy: Laura Landry MDE
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
<table>
<thead>
<tr>
<th>Location</th>
<th>CO</th>
<th>SO2</th>
<th>O3</th>
<th>NO2</th>
<th>NOY</th>
<th>PM2.5 Species</th>
<th>PM10</th>
<th>OC EC</th>
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<th>PAMS</th>
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* One monitor is continuous