Summary of the DISCOVER-AQ Campaign and Incorporation of the Results into MDE’s O₃ Conceptual Model

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Introduction

- **O₃ conceptual model** – Qualitative look at O₃ sources and transport patterns as well as effectiveness of control measures.

- Most sites in MD exceed the O₃ 75 ppb NAAQS → Edgewood is the most problematic.
  - Downwind from Baltimore/Washington.
  - Nearby sources.
  - Westerly winds and bay breeze convergence zone traps pollution.

- We collaborate with nearby Universities to investigate O₃ events with aircraft and balloon launches.
The Baltimore NAA continues to struggle with the 8-hour $O_3$ NAAQS.
- Edgewood is the “troublesome monitor”.

In 2011 Edgewood reported 17 $O_3$ exceedance days.

Edgewood influences:
- Chesapeake Bay breeze - Caused by a sharp gradient between land and water temperatures.
- Stagnation
- Temperatures generally $\geq 90$ F.

DISCOVER-AQ provided multi-platform measurements to examine sources and transport of $O_3$. 

Source: AIRNow-Tech
DISCOVER-AQ Mission

A challenge for Earth-observing satellites measuring air quality is to distinguish between pollution high in the atmosphere and that near the surface where people live and breathe. This summer NASA begins a multi-year airborne field campaign to tackle this challenge.

The project is called DISCOVER-AQ, which stands for Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality. NASA's Langley Research Center in Hampton, Va., is the lead center for the mission.
Sampling conducted during July 2011, with 16 exceedance days.

Observations

- 3 aircrafts – 254 spirals.
- 6 surface sites
- 4 aerosol lidars
- 2 O₃ sonde locations
- 1 tethered balloon
- 1 ship

Courtesy: Jim Crawford, NASA
In July Aldino and Edgewood had the most exceedance days (10 and 12).

Edgewood had 3 code red days.

- 8-hr avg. > 96 ppb
- Examples: July 2 and 22.
Part of July 1-3 episode.

Daily max 8-hour O$_3$ $\rightarrow$ 107 ppb at Edgewood.

Contributors:
- High pressure system.
- Max. temperature @ BWI at 91°F.
- Stagnant conditions throughout the day.
- Appalachian Lee Side Trough (APLT).
- Bay breeze.

Beltsville wind profiler

Sources: AIRNow, NOAA-ARL, NOAA MADIS, HU, PSU, Hysplit, Laura Landry-MDE
Surface winds at Essex and Edgewood show onshore flow while winds at Padonia and Aldino show northwesterly winds.

Sodar at Edgewood also shows onshore flow.
Stagnation leads to high O$_3$ around the region.

Bay breeze contributes to code red O$_3$ at Edgewood and code orange at Essex.

Essex $\rightarrow$ 87 ppb O$_3$ Code orange

Edgewood $\rightarrow$ 107 ppb O$_3$ Code red

Time is EST
Bay breeze impacts Padonia - Aldino

Padonia → 92 ppb O₃ Code orange

Aldino → 98 ppb O₃ Code red

Time is EST
O₃ gradient in P3 transects

Could Bay breeze impact inner city Furley?

O₃ from P3 between 0.3 – 0.6 km
Surface O₃ circled in black.
July 22- Code orange impacted a slightly smaller region than July 2.
July 22 - Overview

- Primary meteorological features
  - High pressure system off the coast.
  - Max. temperature @ BWI at 106 F.
  - NLLJ in the morning, stagnation in the afternoon.
  - Transport regime was primarily from the west to northwest.
  - An Appalachian Leeside Trough (APLT) near I95 corridor.

Sources: NOAA MADIS, NOAA ARL, Airnow
Morning O₃ (50 ppb) at Piney Run and other elevated sites may have been transported to the Baltimore area and then mixed down.
Surface winds show bay breeze between Essex and Padonia.
Morning elevated \( \text{O}_3 \) may have mixed down by the afternoon.

Sharp \( \text{O}_3 \) decrease at noon (Essex, Edgewood).
July 22 P3 transects

Morning elevated O\textsubscript{3} above Essex and Edgewood may have mixed down by afternoon.

O\textsubscript{3} from P3 only between 0.3-0.6 km
Surface O\textsubscript{3} circled in black.
Bay breeze at Essex may have been the trigger for thunderstorms early in the day.

Thunderstorm activity 1130-1230 EST.
- Storm cells appear to extend to Edgewood.
- Cloud cover blocked out sun and stalled O₃ formation.
- Dissipated just before 13 EST.

Once clouds cleared...
- The bay breeze formed again near Essex.
- O₃ was able to recover and reach high values later in the day.
DISCOVER-AQ provided a wealth of data to examine O₃ exceedance days in Maryland.

Aircraft, balloon and lidar observations help us understand pollution aloft and how pollution is transported into the region.

We will continue to analyze the data and collaborate with nearby universities and federal agencies.
Contact

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