Understanding Air Toxics and Carbonyl Pollutant Sources in Boulder County, Colorado

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Motivation

• Anderson Study in 1996 found higher aldehyde concentrations in Boulder than Denver
• Oil and natural gas production activities in neighboring counties increased and began to pose potential health risks
• Denver Metro North Front Range Area (DMA) is a non-attainment for failing to meet the 8-hr ozone NAAQS set by the EPA
Successful Partnerships

• BCPH, University of Colorado, and EPA Region 8 collaborated to form project team

• A number of students were trained and educated on measuring air quality; two of which now work at EPA

• Public Health staff gained valuable monitoring knowledge and experience and provided valuable information to residents
DMA NFR 2008 Nonattainment Area
5 Sampling Locations

Niwot Ridge

South Boulder

Denver
2008 Oil & Gas Activities

 existing permits

 pending permits

 (COGCC, 2008)
2008 Adjacent Oil & Gas Activities
2012 Oil and Gas Activities

Producing Oil and Gas Wells on Boulder and Weld Counties

(COGCC, 2012)
Project Objectives

- Delineate concentrations of local scale VOCs, carbonyls, and ozone
- Develop a baseline reference for longer-term measurements
- Evaluate and improve ambient air quality exposure and community-scale dispersion models
- Aid in air quality management strategies in Boulder County and Denver DMA including 2008 State Implementation Plan
Measurements
March 1 2007 – February 24, 2008

• Sampling
  – VOCs (27)
  – Carbonyls (8)

  24hr integrated sample every 6th day at each location (roughly 60 samples per site)
  Eight consecutive 3hr samples every 6th day at one location

• Insitu
  – Ozone
  – Meteorological data
Analytical issues with benzene, unable to detect propane, methane, ethane
Sampling Instrumentation
Seasonal Averages: VOCs

24hr Seasonal VOC Averages: All Sites

Each dot represents a season, starting with spring
Seasonal Averages: Carbonyls

24hr Seasonal Carbonyl Averages: All Sites

Each dot represents a season, starting with spring
8hr Average Ozone: Summer 2007
Eight 3-hr vs. 24-hr Formaldehyde: Longmont

The sum of the eight 3-hr samples compared well to the one 24-hr sample collected during the same period.
## Principal Components Analysis
### Source Attribution

<table>
<thead>
<tr>
<th>Potential Pollution Source Rank by Site</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boulder</strong></td>
<td>Mobile Source</td>
<td>Secondary Formation</td>
<td>Evaporative</td>
</tr>
<tr>
<td><strong>Longmont</strong></td>
<td>Evaporative</td>
<td>Secondary Formation</td>
<td>Mobile Source</td>
</tr>
<tr>
<td><strong>Lyons</strong></td>
<td>Secondary Formation</td>
<td>Evaporative</td>
<td>Mobile Source</td>
</tr>
<tr>
<td><strong>Niwot Ridge</strong></td>
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</tr>
</tbody>
</table>
Dispersion Modeling

- AERMOD & MOBILE6.2 models used
- Pollutants included in model
  - Formaldehyde
  - Acetaldehyde
  - BTEX
  - Hexane
  - Diesel PM
Predicted 2006 n-butane with 2007 Boulder Observed n-butane (ppbV)

Inventories underpredict n-butane direct emissions
Conclusions

• Overall carbonyl & VOC concentrations in 07-08 were lower than those in the Anderson Study
• Carbonyl concentrations peaked in the summer months, suggesting increased photochemistry
• VOC concentrations were relatively stable and were not seasonably variable
Conclusions

- From PCA results, mobile source exhaust, natural gas emissions, and meteorology are significant pollution sources.
- Ozone values varied from site to site, but increased significantly in summer.
- Ozone values exceeded the former/current 8-hour NAAQS values in South Boulder Creek, Longmont, and Lyons.
Recommendations

- Use higher resolution sampling durations for source apportionment
- Use analytical equipment capable of quantifying all natural gas markers
- Get EPA assistance with AQS uploads for community scale grants - don’t underestimate it
Acknowledgements

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  - Ken Distler and Michael Copeland
  - Gordon Pierce
  - Gregg Thomas
  - Larry Anderson
References