Public Health Impacts of Projected 2050 Ozone Concentrations in Mecklenburg County, NC

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\textsuperscript{4}Division of Public Health, Department of Health and Human Services, State of North Carolina
Outline

• Primer on ozone
• Walk through the health impact formula
• Describe our data inputs and results
Ozone Creation

- Volatile Organic Compounds (VOCs)
- Nitrogen Oxides (NOx)
- Ozone (O₃)

Emissions
Ozone Reduction

- Volatile Organic Compounds (VOCs)
- Nitrogen Oxides (NOx)
- Ozone (O₃)

Emissions
Ozone Reduction

Volatile Organic Compounds (VOCs) + Nitrogen Oxides (NOx) + Ozone (O₃)
Your Best Guess?

How will ozone concentrations change in Mecklenburg County NC from today to 2050?

-20% - 10% No Change +10% +20%
Project Overview

Combine data on:

• Emergency department visits (current)
• Concentration-response associations from the epidemiological literature
• Ozone levels (current and projected)
• Population (current and projected)

to estimate the future burden of emergency department visits in Mecklenburg County, NC in 2050.

PLEASE NOTE:
These are preliminary results and should not be distributed or cited.
Health Impact Formula

\[ \Delta H = H_0 \left(1 - e^{-\beta \Delta Ozone}\right) \times \text{Population} \]

A. Baseline incidence – e.g. Asthma ED visits from 2006-2011
B. Concentration-response functions from epidemiological literature
C. Change in ozone concentrations
D. Population at risk
Health Data

NC DETECT

• State-wide surveillance data
• Primary data elements used:
  – ICD-9-CM diagnosis codes (up to 11)
  – Age / sex
  – Patient county of residence
  – Visit date/time
• Obtained via a data use agreement with state DPH data owners

9 hospitals within Mecklenburg County
Asthma ED Visit Incidence Rates

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gender</th>
<th>Asthma ED Visit Count (April-October, 2006-2011*)</th>
<th>Population (%) (Mean, 2006-2011)</th>
<th>Incidence Rate (per person-day*)</th>
<th>Average Count per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td>Female</td>
<td>2246</td>
<td>123321 (13.8)</td>
<td>1.51E-05</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>3872</td>
<td>127737 (14.3)</td>
<td>2.51E-05</td>
<td>3.2</td>
</tr>
<tr>
<td>20-44</td>
<td>Female</td>
<td>3157</td>
<td>182447 (20.4)</td>
<td>1.43E-05</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>2117</td>
<td>174691 (19.6)</td>
<td>1.00E-05</td>
<td>1.7</td>
</tr>
<tr>
<td>45-64</td>
<td>Female</td>
<td>1605</td>
<td>108978 (12.2)</td>
<td>1.22E-05</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>975</td>
<td>98713 (11.1)</td>
<td>0.82E-05</td>
<td>0.8</td>
</tr>
<tr>
<td>65+</td>
<td>Female</td>
<td>494</td>
<td>46046 (5.2)</td>
<td>0.89E-05</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>205</td>
<td>31242 (3.5)</td>
<td>0.54E-05</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Mid-</strong></td>
<td><strong>14671</strong></td>
<td><strong>893176</strong></td>
<td><strong>1.36E-5</strong></td>
<td><strong>12.1</strong></td>
</tr>
</tbody>
</table>

Data Source: NC DETECT, Apr-Oct 2006-2011

*74 days were determined to have data quality problems and were dropped from both the numerator and denominator.
## Concentration-Response Functions

<table>
<thead>
<tr>
<th>Study</th>
<th>Incidence Rate Ratio</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel et al., 2005 Atlanta, GA</td>
<td>1.022 (0.996, 1.049) per 25 ppb increment</td>
<td>0.000870 (0.000529)</td>
</tr>
</tbody>
</table>

2.2% increase in asthma ED visits per 25 ppb increase in ozone
Change in ozone

Current Ozone Concentrations 2006-2011

MONITOR DATA
Mean Daily Maximum
8 Hour Average (ppb):

Data Source: U.S. EPA Air Quality System
Mean of 3 monitors within county,
April-October

Future Ozone Projections 2050

MODEL DATA
Mean Daily Maximum
8 Hour Average (ppb):

Data Source: GCM: NCAR, Resolution: 12km, IPCC Scenario A1B, with Projected Anthropogenic Emissions Inventory, May-August
Current Ozone

North Carolina Counties with 8-Hour Ozone Violations, 2010-2012

Daily Max 8-hour Ozone Concentrations from 01/01/00 to 12/31/14

Parameter: Ozone (Applicable standard is 0.075 ppm)
CEAS: Charlotte-Gastonia-Concord, NC-SC
County: Mecklenburg
State: North Carolina
AQS Site ID: 37-119-0041, pcc 1

Source: http://daq.state.nc.us/monitor/data/o3design/o3nc10-12.pdf

Source: U.S. EPA AirData - http://www.epa.gov/airdata
Generated: April 23, 2014

Source: http://charmec.org/mecklenburg/county/LUESA/SOER/Pages/AirQualityOzone.aspx
Ozone Concentrations

Current Ozone Concentrations 2006-2011
Mean Daily Maximum 8 Hour Average (ppb): 51
Data Source: U.S. EPA Air Quality System
Mean of 3 monitors within county, April-October

Future Ozone Projections 2050
Mean Daily Maximum 8 Hour Average (ppb):
Data Source: GCM: NCAR, Resolution: 12km, IPCC Scenario A1B, with Projected Anthropogenic Emissions Inventory, May-August
Air Quality Model

- Model years: 2048-2050
- IPCC A1B Scenario
- Projected anthropogenic emissions inventory
- GCM: NCAR
- Future climate meteorology: CCSM 2050
- Downscaling: Analysis nudging technique
- 12km resolution

For more technical information, contact Adel Hanna at the UNC Institute for the Environment.
# Future Air Quality Model Specifications

<table>
<thead>
<tr>
<th></th>
<th>Set to baseline levels?</th>
<th>Set to projected future levels?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meteorology/ Climate</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Biogenic Emissions</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Anthropogenic Emissions</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Greenhouse Gas Scenario (IPCC SRES)</td>
<td></td>
<td>X (A1B)</td>
</tr>
</tbody>
</table>
Ozone Concentrations

Current Ozone Concentrations 2006-2011

Mean Daily Maximum 8 Hour Average (ppb): 51

Data Source: U.S. EPA Air Quality System
Mean of 3 monitors within county, April-October

Future Ozone Projections 2050

Mean Daily Maximum 8 Hour Average (ppb): 45

Data Source: GCM: NCAR, Resolution: 12km, IPCC Scenario A1B, with Projected Anthropogenic Emissions Inventory, May-August

Delta: ~6ppb
~11% decrease
Population Data

2010: 919,628
US Census 2010

2050: 1,908,598
US EPA ICLUS 1.3.2, A1 Scenario

Population

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>2010</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td>257,743</td>
<td>400,512</td>
</tr>
<tr>
<td>20-44</td>
<td>363,987</td>
<td>551,821</td>
</tr>
<tr>
<td>45-64</td>
<td>216,785</td>
<td>456,907</td>
</tr>
<tr>
<td>65+</td>
<td>81,113</td>
<td>499,358</td>
</tr>
</tbody>
</table>

PRELIMINARY DATA- DO NOT DISTRIBUTE OR CITE
Population Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Population Size</th>
<th>Demographic Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Constant Population (Held at 2010 Levels)</td>
<td>919,628</td>
<td></td>
</tr>
<tr>
<td>Data Source: U.S. Census 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) 2050 Population Size, with 2010 Age-Sex Distribution</td>
<td>1,908,598</td>
<td></td>
</tr>
<tr>
<td>Data Source: U.S. EPA ICLUS v1.3.2</td>
<td></td>
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<tr>
<td>(C) 2050 Population IPCC A1 Scenario</td>
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# Health Impact

## Asthma ED Visits Avoided, per warm season

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<tr>
<th>Age Group</th>
<th>(A) Constant Population (Held at 2010 Population Levels)</th>
<th>(B) 2050 Population Size, with 2010 Age-Sex Distribution</th>
<th>(C) 2050 Population IPCC A1 Scenario</th>
</tr>
</thead>
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<tr>
<td>0-19</td>
<td>9.9</td>
<td>20.6</td>
<td>15.4</td>
</tr>
<tr>
<td>20-44</td>
<td>8.6</td>
<td>18</td>
<td>13.2</td>
</tr>
<tr>
<td>45-64</td>
<td>4.3</td>
<td>9</td>
<td>9.1</td>
</tr>
<tr>
<td>65+</td>
<td>1.2</td>
<td>2.4</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24.0</strong></td>
<td><strong>49.9</strong></td>
<td><strong>44.7</strong></td>
</tr>
</tbody>
</table>
## Health Impact

### Asthma ED Visits Avoided, per warm season

| Age Group | (A) Constant Population (Held at 2010 Population Levels) | (B) 2050 Population, Simulating (C) 2050 Population Scenario: 
IPCC A1 Scenario |
<table>
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Seems small? Remember an average day sees about 12.1 asthma ED visits. This is roughly equivalent to removing 2 full days of visits from each warm season.
Summary

- Projected ↓ summertime ozone concentrations for Mecklenburg County, due to ↓ anthropogenic emissions.
- ↓ in asthma emergency department morbidity, moderately sensitive to future population demographics.

*Continued reductions in anthropogenic emissions are needed to offset climate-change-related increases in ozone and population dynamics*
Next Steps

• Scaling up to whole state of North Carolina
• Age group / Sex /Disease specific concentration-response functions
  • Asthma
  • COPD
  • Cardiovascular diseases
• 2nd air quality projection for 2050 that uses current emissions levels for comparison.
Acknowledgements

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- CISA Small Project Grant

- EPA –STAR Grant (Adel Hanna)
  R832751010

- CDC BRACE (Lauren Thie)
  1UE1EH001126-01

Note: Data were obtained from the NC DHHS/DPH NC DETECT system under a data use agreement. The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented.
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