2014 HGB Ozone Summary

John Jolly
Air Monitoring and Data Analysis Section
TCEQ

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Outline

- Magnitude of decrease in 2014 from previous years
- Evaluation of variables – what might explain the decrease?
- Evaluation of specific 2014 days with peak 8-hour ozone $\geq 75$ ppb
- What are limitations of this analysis?
Number of 8-Hour Periods with Ozone >= 75 ppb in HGB, by Year (Ozone Season) and Monitor
Maximum Daily 8-Hr Ozone in HGB in 2011, with Windspeed/Wind Direction at Time of Max

Few dates with low windspeeds did not reach 60 ppb
Many dates with low windspeeds did not reach 60 ppb
Houston 2014 Temperature vs Long-Term Average

Station: HOUSTON NWSO, TX

Highest Mean Temp: 71.63°F (2012)
Lowest Mean Temp: 66.88°F (1993)
Mean Temp in 2014: 70.74°F
Houston 2014 Precipitation vs Long-Term Average

Station: HOUSTON NWSO, TX

Wettest: 77.98 in (2001)
Driest: 28.24 in (2011)
In 2014: 36.38 in
2011:
\[ y = 105 - 3.9 \times ws \]
\[ r^2 = 0.41 \]

2014:
\[ y = 78 - 2.0 \times ws \]
\[ r^2 = 0.14 \]
Back trajectory patterns, 2011 vs 2014

**Manvel Croix: 20 Days >= 75 ppb**
- 7 days Trajectory Cluster 2
- 5 days Trajectory Cluster 3
- 8 days Trajectory Cluster 4

**Manvel Croix: 3 Days >= 75 ppb**
- 3 days Trajectory Cluster 3
## 2011 vs 2014 Trajectories

<table>
<thead>
<tr>
<th>Direction / Source Area</th>
<th>Length</th>
<th>Count of Trajectories</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2011</td>
<td>2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>High Ozone</td>
<td>All</td>
<td>High Ozone</td>
</tr>
<tr>
<td>North (continental)</td>
<td>Long</td>
<td>44</td>
<td>7</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>East/Northeast</td>
<td>Short</td>
<td>44</td>
<td>8</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>Gulf Coast / N Gulf of Mexico</td>
<td>Medium/Long</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Southeast (Gulf of Mexico)</td>
<td>Short</td>
<td>103</td>
<td>5</td>
<td>71</td>
<td>0</td>
</tr>
<tr>
<td>Southeast (Gulf of Mexico)</td>
<td>Long</td>
<td>47</td>
<td>0</td>
<td>93</td>
<td>0</td>
</tr>
</tbody>
</table>
5-hr Back Trajectories for 2014 Days >= 75 ppb at Manvel Croix

- 8/25 1600
  105 ppb (1-hour)

- 8/13 1300
  107 ppb (1-hour)

- 10/25 1500
  135 ppb (1-hour)
6-hr Back Trajectories, 2011 and 2014, For Days Where Peak 8-Hour Ozone at Manvel Croix >= 70 ppb
6-hr Back Trajectories, 2011 and 2014, For Days Where Peak 8-Hour Ozone at Manvel Croix 60-69 ppb
6-hr Back Trajectories, 2011 and 2014, For Days Where Peak 8-Hour Ozone at Manvel Croix 50-59 ppb
6-hr Back Trajectories, 2011 and 2014, For Days Where Peak 8-Hour Ozone at Manvel Croix 40-49 ppb
2011: Trajectories, by Class, Originating / Passing Through Industrial Areas of Eastern Harris County

Total: 12
High: 4
High-Med: 3
Low-Med: 3
Low: 2
2014: Trajectories, by Class, Originating / Passing Through Industrial Areas of Eastern Harris County

Total: 20
High: 2
High-Med: 4
Low-Med: 7
Low: 7
2011: Trajectories, by Class, Originating / Passing Through Houston Urban Core

Total: 18
High: 5
High-Med: 4
Low-Med: 3
Low: 6
2014: Trajectories, by Class, Originating / Passing Through Houston Urban Core

Total: 25
High: 3
High-Med: 2
Low-Med: 5
Low: 15
### NO\textsubscript{x} Trends using Theil–Sen Method on 99th Percentile of Monthly Data

<table>
<thead>
<tr>
<th>Station</th>
<th>Channelview</th>
<th>Clinton</th>
<th>Houston Aldine</th>
<th>Houston Bayland Park</th>
<th>Houston Deer Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>-3.99 [-7.07, -0.83] units/year \textsuperscript{*}</td>
<td>2.36 [-4.93, 1.22] units/year</td>
<td>-2.15 [-4.41, -0.1] units/year \textsuperscript{+}</td>
<td>-4.13 [-7.29, -0.03] units/year \textsuperscript{+}</td>
<td>-1.87 [-3.15, -0.42] units/year \textsuperscript{**}</td>
</tr>
</tbody>
</table>

| Houston East                 | -4.06 [-6.36, -1.44] units/year \textsuperscript{**} | -0.63 [-0.96, -2.56] units/year \textsuperscript{**} | -0.06 [-0.11, -2.8] units/year \textsuperscript{**} | -0.48 [-9.40, -2.3] units/year \textsuperscript{***} | 1.5 [-0.31, 8.42] units/year \textsuperscript{+} |

| Houston Texas Avenue         | 0.2 [-0.08, 0.46] units/year \textsuperscript{**} | 0.95 [-1.57, 0.72] units/year \textsuperscript{+} | -4.44 [-8.14, 0.84] units/year \textsuperscript{+} | -0.85 [-2.33, 0.15] units/year \textsuperscript{+} | -0.53 [-1.78, 0.02] units/year \textsuperscript{+} |

| HRM 3                       | -1.8 [-3.02, -0.55] units/year \textsuperscript{+} | -0.32 [-0.82, 0.2] units/year \textsuperscript{+} | 0.6 [-1.84, 2.04] units/year \textsuperscript{+} | -1.5 [-2.97, 0.91] units/year \textsuperscript{+} | 1.8 [-0.29, 3.96] units/year \textsuperscript{+} |

| Lang                        | -0.3 [-2.86, 2.26] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Lynchburg Ferry             | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Mustang Grove Park          | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Northwest Harris County     | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Park Place                  | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Seabrook Friendship Park    | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |

| Wallisville Road            | -2.0 [-3.08, -0.99] units/year \textsuperscript{+} | -0.54 [-2.86, 0.42] units/year \textsuperscript{+} | -0.94 [-2.86, 0.42] units/year \textsuperscript{+} | -0.42 [-1.57, 0.72] units/year \textsuperscript{+} | -0.28 [-1.08, 0.55] units/year \textsuperscript{+} |
### HGB 2010 – 2014 Reported Point Source NOx Emissions (TCEQ EI)

<table>
<thead>
<tr>
<th>CNTY_NAME_TXT</th>
<th>CONTAM_CD</th>
<th>CONTAM_NAME_T</th>
<th>SumOfANN_QTY</th>
<th>YR_CAPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARRIS</td>
<td>70400</td>
<td>NITROGEN OXIDES</td>
<td>15886.8563</td>
<td>2010</td>
</tr>
<tr>
<td>HARRIS</td>
<td>70400</td>
<td>NITROGEN OXIDES</td>
<td>16120.6009</td>
<td>2011</td>
</tr>
<tr>
<td>HARRIS</td>
<td>70400</td>
<td>NITROGEN OXIDES</td>
<td>15733.685</td>
<td>2012</td>
</tr>
<tr>
<td>HARRIS</td>
<td>70400</td>
<td>NITROGEN OXIDES</td>
<td>15772.7534</td>
<td>2013</td>
</tr>
</tbody>
</table>
Summary

- Ozone decreases observed from 2011/12 to 2013/14 are pervasive and substantial
  - Number of 8-hr periods decreased considerably
  - Number of days >= 75 ppb at Manvel Croix (design value monitor) decreased from 20 (2011) to 3 (2014)
  - Area design value decreased 19 ppb (monotonically) from 2011 to 2014
  - Ozone at Manvel Croix C84:
    - 2011: 20 days >= 75 ppb
    - 2014: 3 days >= 75 ppb

- Potentially Explanatory Variables
  - NOx
    - 2% decrease in reported point source Nox emissions, 2010 to 2013
    - 6 of 15 monitors show statistically significant decrease in 99th percentile NOx from 2010 to early 2015
  - VOCs
    - Just 2 of 8 Harris County monitors show statistically significant decreases in 99th percentile rx-weighted concentrations between 2010 and 2014
  - Weather: normal year for precipitation/temperature
Summary

- Potentially Explanatory Variables
  - Wind speed
    - This analysis does not suggest that higher windspeeds in 2014 vs 2011 were responsible for lower ozone in 2014
    - PSCF/ Residence Time analysis would help (trajectory length
  - Emissions from source areas
    - Surface Trajectories:
      - In 2014, trajectories that passed through / originated in both Houston urban and Ship Channel industrial areas were associated with lower ozone than those in 2011.
    - HYSPLIT trajectories
      - In both 2011 and 2014, short trajectories to E/NE associated with high ozone in HGB.
      - In 2011, longer north (continental) and short Gulf (marine) trajectories associated with high ozone, but these source areas not associated with high ozone in 2014
Future Work

- Evaluate upwind areas/states’ emissions/concentrations in 2014 vs 2011
- Case studies of specific high ozone days – windspeeds, NOx and VOC concentrations, wind curvature
- PSCF – residence time over different parts of HGB