Calculation of Ozone Fluxes from Lidar Aircraft Measurements

Christoph Senff, Mike Hardesty, Bob Banta, Lisa Darby, Raul Alvarez, Ann Weickmann, Scott Sandberg

TexAQS II - RSST Meeting
12 - 13 October 2006

Reminder: Data and findings are preliminary
Objective:
Compute total horizontal flux of ozone emitted by Houston and Dallas/Fort Worth metro areas

Approach:
Use airborne lidar data from flight transects downwind of metro areas and calculate plume flux for each transect

Meteorological Conditions:
Steady synoptic flow at speeds of several m/s

Additional Analysis (in the future):
Ozone production rates if multiple downwind transects are available
Flux calculation:
Integrate excess ozone in plume (plume O₃ – background O₃) between surface and top of boundary layer and between horizontal plume edges. Then multiply with horizontal wind speed to yield flux in molecules O₃ / sec for each transect.
Houston

Southerly flow: Aug 12 & 14
Houston
Northerly flow: Aug 30

Dallas
Northerly flow: Sep 13
## Results of flux calculations
(for transects farthest away from source)

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Date</th>
<th>Wind direction</th>
<th>Wind speed, m s⁻¹</th>
<th>Time, UTC</th>
<th>Background O₃, ppb</th>
<th>Flux, molec O₃ s⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Houston</strong></td>
<td>8/12</td>
<td>S</td>
<td>4.8</td>
<td>23:04 - 23:34</td>
<td>~30</td>
<td>4.0 * 10²⁶</td>
</tr>
<tr>
<td><strong>Houston</strong></td>
<td>8/14</td>
<td>S</td>
<td>4.0</td>
<td>22:59 - 23:26</td>
<td>~35</td>
<td>4.6 * 10²⁶</td>
</tr>
<tr>
<td><strong>Houston</strong></td>
<td>8/30</td>
<td>N</td>
<td>4.4</td>
<td>22:18 - 22:50</td>
<td>~60</td>
<td>4.4 * 10²⁶</td>
</tr>
<tr>
<td><strong>DFW</strong></td>
<td>9/13</td>
<td>N</td>
<td>4.1</td>
<td>21:50 - 22:30</td>
<td>~60</td>
<td>1.4 * 10²⁶</td>
</tr>
</tbody>
</table>
Preliminary Conclusions

- Above-background ozone flux emitted by Houston metro area is very similar for the 3 case studies (4.0 to 4.6 \times 10^{26} \text{ molec/s}).

- A flux of 4.3 \times 10^{26} \text{ molec O}_3 / \text{s emitted over 1 hour is equivalent to a 10-ppb increase in ozone over a 1200 square mile area, assuming a 2-km deep mixed layer.}

- Export of ozone from DFW metro area is about a factor of 3 less than from Houston (1.4 \times 10^{26} \text{ molec/s}).

**Next step:**

Apply same analysis to several TexAQS 2000 cases and compare results.