Introduction

Large urban areas in eastern Texas, such as Houston and Dallas/Fort Worth, often experience high ozone pollution events during the summer months. Under the right meteorological conditions, ozone produced locally in these urban areas is transported into other areas of eastern Texas, where it increases the regional ozone background and may push smaller urban areas into ozone non-compliance. To quantify this export of ozone from Houston and Dallas/Fort Worth, we use airborne ozone lidar data collected during the Texas Air Quality Study (TexAQS) 2000 and TexAQS 2006. We selected six flights (four from 2006 and two from 2000) during which we mapped out the Houston/Ship Channel and Dallas/Fort Worth ozone plumes by flying multiple downwind transects across the plumes. From the lidar data we compute horizontal fluxes of ozone as well as ozone production rates in these plumes.

Instrumentation: TOPAZ Ozone Differential Absorption Lidar

For the TexAQS 2006 study, NOAA/ESRL developed TOPAZ (Tunable Optical Profiler for Aerosol and Ozone), a new-generation airborne ozone and aerosol lidar. This new lidar is lightweight and compact, so it can be flown on a rather small research aircraft, such as the NOAA Twin Otter. It incorporates the latest solid-state laser technology and its transmitter is tunable in the UV spectral region.

**TOPAZ specs:**
- 3 channels (285 – 310 nm, tunable)
- Pulse energy: 0.2 to 0.4 mJ
- Rep rate: 1 kHz
- Nadir-looking

**TOPAZ measurements:**
- Ozone & aerosol backscatter profiles
- Altitude coverage: surface up to 3.5 km
- Resolution: 10 s or 650 m horizontal, 100 m vertical (O3), 6 m (aerosol)
- Precision: 3 – 15 ppb

Methodology

Objective: Compute total horizontal flux of ozone produced by Houston and Dallas/Fort Worth metro areas.

**Approach:**
Use airborne lidar data from flight transects downwind of metro areas and calculate plume fluxes for each transect and ozone production rates between adjacent transects.

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

**Flux calculation:**
- Integrate excess ozone in plume (plume O₃ – background O₃) between surface and top of boundary layer and between horizontal plume edges.
- Multiply with horizontal wind speed (from wind profiler network) to yield flux in molecules O₃/sec for each transect.
- Angle between flight transect and plume is taken into account.

**Ozone production rate retrieval:**
- Take difference in integrated excess plume ozone between adjacent transects and divide by plume area.
- Divide by plume travel time between adjacent transects to compute ozone production rate in ppbv/h.

<table>
<thead>
<tr>
<th>Houston</th>
<th>Date</th>
<th>Wind direction</th>
<th>Wind speed, m/s</th>
<th>Time, CST</th>
<th>Background O₃, ppb</th>
<th>O₃ enhancement, ppb</th>
<th>Flux, molec O₃/s</th>
<th>Summary</th>
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<td>S</td>
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</table>

Errors in ozone flux and production rate calculation:
- O₃ cross section: < 3%
- O₃ RMS error: < 0.2%
- Plume boundaries: ~ 5%
- Background O₃ determination: ~ 6%
- Wind speed: 1 m/s or ~ 25%
- Total: < 30%

Flux results for transects with highest flux