Weekend/Weekday Ozone Study in the South Coast Air Basin

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Overview of Presentation

• Trends of Ozone and Precursor (VOC and NOx) Concentrations in the South Coast Air Basin (SoCAB)

• Day-of-Week Variations in Ozone and Precursor Concentrations

• Factors that explain the trends in the weekend/weekday differences in ozone
  – 1) inhibition of ozone formation by NO
  – 2) rate of ozone formation

• Source Apportionment of Ozone Precursors, NOx and Hydrocarbons

• Photochemical Box Model Results
Trends in Maximum 1-hour Ozone and Number of Annual Exceedances of the Federal 1-hour Ozone Standard in the SoCAB from 1976 to 2001
Mean Weekly Variations in Ozone

Azusa, Summer 2000

Ozone (ppb)
Mean Weekly Variations in NO, NOx and CO

Azusa, Summer 2000

NO and NOx (ppb)

CO (ppm)

Sun Mon Tue Wed Thu Fri Sat
Correlations of Saturday and Sunday Versus Midweek*
Hourly Daytime (0600 to 2000, PDT) O₃ and NO at Azusa, 1999-2000

Saturday

\[ \text{O}_3: y = 1.32 \times \]
\[ R^2 = 0.99 \]
\[ \text{NO: } y = 0.51 \times \]
\[ R^2 = 0.98 \]

Sunday

\[ \text{O}_3: y = 1.55 \times \]
\[ R^2 = 0.99 \]
\[ \text{NO: } y = 0.29 \times \]
\[ R^2 = 0.98 \]

NOx emissions are 50% and 70% lower on Saturdays and Sundays, respectively, than on weekdays; ozone is 32% and 55% higher on Saturdays and Sundays than on weekdays.

* Tuesday to Thursday
Azusa, Summer 1995

O₃ and NO (ppm)

- **Carry Over**
  - O₃, NO₂, and PAN
  - HONO and HCHO
  - NO, CO, and VOC

- **O₃ Accumulation**
  \[ t = t_{O₃\text{max}} - t_{NO=O₃} \]

- **Post Maximum O₃**
  - Declining photolysis rate, increasing mixing and ventilation, and titration of O₃ by fresh NO emissions

- **O₃ Inhibition**
  - (due to NO titration)

- **NO**

<table>
<thead>
<tr>
<th>Hour (PDT)</th>
<th>WE O₃</th>
<th>WD O₃</th>
<th>WE NO</th>
<th>WD NO</th>
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<tbody>
<tr>
<td>1-10</td>
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<td>11-24</td>
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- **t_{NO=O₃} on weekdays**
- **t_{NO=O₃} on weekends**
Duration and Rate of Ozone Accumulation
Mean of 12 sites in SoCAB, 1981-98

Duration (hours)

Rate (ppb/hour)
Weekday Variations in NMHC/NOx by Period
Four-Site Means and Standard Deviations of the Means
1. While ozone levels have dropped sharply in the SoCAB, highest levels now occur more frequently on weekends, with highest values on Sundays.

2. The decrease in ozone precursor concentrations on weekends is proportionately greater for NO than NMHC resulting in higher NMHC/NOx ratios.

3. Current (1999-2000) NMHC/NOx ratios in SoCAB are about half of the ratios in 1987. This decrease in ratios (and hence a decrease in ozone) is due primarily to reductions in NMHC, not decreases in NOx.

4. Ozone is higher on weekends in the SoCAB for two reasons: 1) lower early morning NOx emissions, resulting in less titration or removal of morning ozone; and 2) higher VOC or NMHC/NOx ratios, resulting in higher ozone accumulation rates.
Sampling Locations During the Fall 2000 Field Study

Measurements – NO, NOy, CO, C₂-C₁₂ HC, C₈-C₁₈ HC, and black carbon
Source Apportionment of NMHC During Fall 2000 Field Study

Nonmethane Hydrocarbons

<table>
<thead>
<tr>
<th>NMHC (ppbC)</th>
<th>Mon, 10/2/00</th>
<th>Wed, 10/4/00</th>
<th>Sat, 10/7/00</th>
<th>Sun, 10/8/00</th>
<th>Tue &amp; Fri</th>
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Legend:
- Gasoline Exhaust
- Diesel Exhaust
- Gasoline Vapor
- CNG
- LPG
- Surface Coatings
- Consumer Products
- Unexplained
Weekend/Weekday Differences in Ambient NOx Associated with CO and Black Carbon During 9:00 a.m. to Noon

<table>
<thead>
<tr>
<th>NOx (CO)</th>
<th>NOx (BC)</th>
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<tr>
<td>Sun/Mon</td>
<td>0.75</td>
</tr>
<tr>
<td>Sat/Wed</td>
<td>0.94</td>
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Monitoring Stations
A – Azusa
L – Los Angeles, N. Main
P – Pico Rivera
U – Upland

Mean Wednesday
± 1 sigma

Mean Sunday
± 1 sigma

Ozone (ppb)
SUMMARY PART 2 OF 2

1. Gasoline exhaust and gasoline vapor account for ~80 percent of ambient NMHC in on-road samples and at regional air monitoring locations suggesting that gasoline emissions are responsible for the majority of ozone found in the SoCAB.

2. The majority of reductions in NOx emissions from mobile sources on weekends is associated with less diesel truck traffic.

3. STI investigators project that emissions of VOC and NOx in the SoCAB in 2010 are comparable to weekend emissions in 2000. If these emission projections prove to be accurate, ozone will be higher in 2010 in a large portion of the urbanized areas of SoCAB relative to current levels.

4. Ozone isopleth diagram shows that an ozone disbenefit will result if NOx emissions are decreased at current levels of VOC until ambient NOx levels are decreased by roughly 90 percent to about 10-12 ppb.