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*Today:*

Discuss two critical aspects of urban $O_3$:

- In general, most of the $O_3$ in an urban area is transported in from the outside, not produced locally.
- On average, the dominant effect of local emissions in an urban area is to destroy, not produce, $O_3$.

*(Regulatory Question:* Are NOx controls beneficial for local urban $O_3$ control? *)
In general, most of the O$_3$ in an urban area is transported in from the outside, not produced locally.

Three flights from TexAQS 2000

Regional background can exceed 8-hr std.

DFW adds substantial amounts of O$_3$, but most is transported in from outside
In general, most of the O$_3$ in an urban area is transported in from the outside, not produced locally.

Urban O$_3$ violations have strong regional component.

At least in DFW, the highest exceedances are still dominated by local production.

(N June-Sept., 2002 APCA Calculations G. Yarwood et al.)

$y = 1.19x + 41.49$

$R^2 = 0.88$

Local production dominates

Regional transport dominates

DFW Maximum 8-hr Average Ozone (ppbv)

DFW Ozone Contribution (ppbv)
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Aircraft Data: TexAQS 2000 TexAQS 2006

(June-Sept., 2002 APCA Calculations G. Yarwood et al.)
On average, the dominant effect of local emissions in an urban area is to destroy, not produce, O$_3$.

Consider 3 areas:
- Marine Inflow
- Urban
- Far Downwind

(Channel Islands are not strongly affected by L.A. area emissions)
On average, the dominant effect of local emissions in an urban area is to destroy, not produce, O$_3$.

Average O$_3$ in marine background higher than in urban L.A. area, even during O$_3$ season.

Strong Weekend O$_3$ Effect: average max 1-hr avg. O$_3$ $\approx$ 30 ppbv higher on Sunday than weekday.

(The average is not an exceedance; regulatory considerations should focus on exceedances.)

On average, the dominant effect of local emissions in an urban area is to destroy, not produce, $O_3$.

In far downwind areas the weekend effect is reversed.

Far downwind average $O_3$ higher than in urban areas, but maxima are lower and exceedances are less common.

On average, the dominant effect of local emissions in an urban area is to destroy, not produce, O$_3$.

Average O$_3$ on weekday in L.A. is comparable to marine background during summer; but higher on weekends.

Strong Weekend O$_3$ Effect

![Graph showing O$_3$ and NO$_x$ concentrations over time]

(Left to right: O$_3$, NO$_x$, CO)

(June-August data)

Azusa, 1995

WE $<O_3>$ = 44

WD $<O_3>$ = 35

Channel Is. $<O_3>$ = 33

(The weekend, but not weekday, average is an exceedance.)

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**Strong Weekend O$_3$ Effect**

Weekend NO$_2$ lower: counterintuitive?

[Diagram showing O$_3$, NO$_x$ (ppbv) levels with data points for Azusa, 1995 and Channel Is., with WE $\langle$O$_3\rangle = 44$, WD $\langle$O$_3\rangle = 35$, and Channel Is. $\langle$O$_3\rangle = 33$ for (June-August data).]

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**Strong Weekend O$_3$ Effect**

Weekend NO$_2$ lower: counterintuitive?

O$_x$ = NO$_2$ + O$_3$ similar through week

Primary cause of Weekend O$_3$ Effect is titration of O$_3$ by local NO emissions

The Weekend $O_3$ Effect is primarily due to less local emissions, and hence less $O_3$ destruction, on weekends.

Consider 8 sites in southern California

Color-coded by longitude
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Consider 8 sites in southern California

Color-coded by longitude

Δ indicates (weekend-weekday)

Throughout L.A. Basin: ΔO$_3$ ≈ - ΔNO$_2$

Primary cause of Weekend O$_3$ Effect is titration of O$_3$ by local NO emissions

O₃ Weekend Effect: Does it have regulatory implications?

- In many areas average O₃ is higher on weekends
- Caused by lower NOx emissions on weekends

Therefore, do not implement NOx controls!

Is this a valid argument?

Maybe, if VOC limited chemistry were the primary cause

NOx inhibits O₃ production: \[ NO_2 + OH \rightarrow HNO_3 \]

But titration is the primary cause

Titration \[ NO + O_3 \rightarrow NO_2 + O_2 \]

Titration moves O₃ production downwind, which contributes to O₃ transported into urban area

Further analysis must focus on exceedances; treat titration and transport
Urban-Rural Interactions in O₃ Distributions: Implications

In general, most of the O₃ in an urban area is transported in from the outside, not produced locally.

For reliable results, photochemical models must accurately reproduce long-range transport, including boundary conditions.

On average, the dominant effect of local emissions in an urban area is to destroy, not produce, O₃.

For reliable results, photochemical models must accurately reproduce boundary layer evolution, which strongly affects the effect of NO + O₃ titration.

Both of these are difficult for models; box models certainly cannot