Urban-Rural Interactions in O_3 Distributions (Edited PPT)

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David D. Parrish, Ph.D.
NOAA Earth System Research Lab

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:

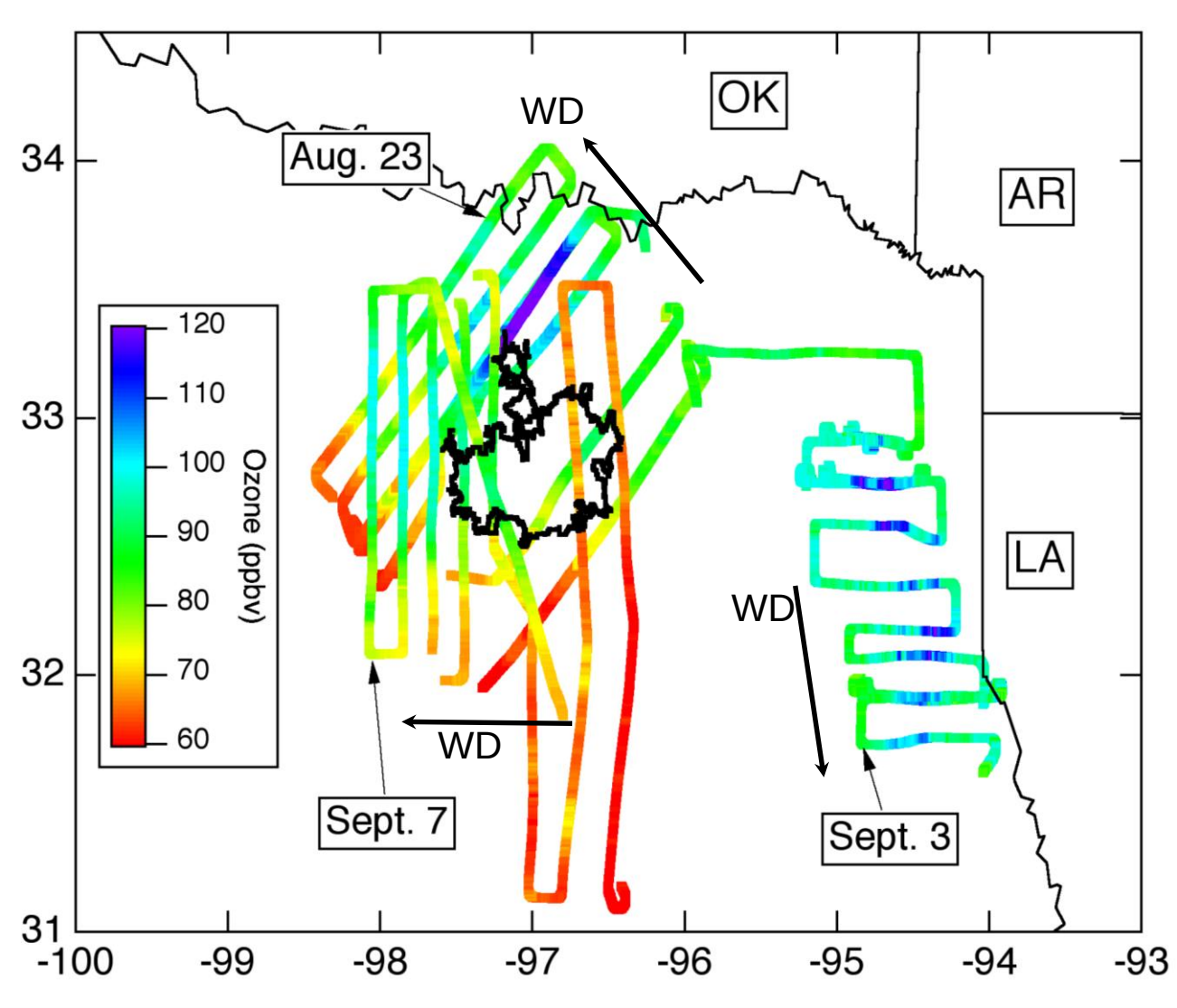
Are NOx controls beneficial for local urban O_3 control?)

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



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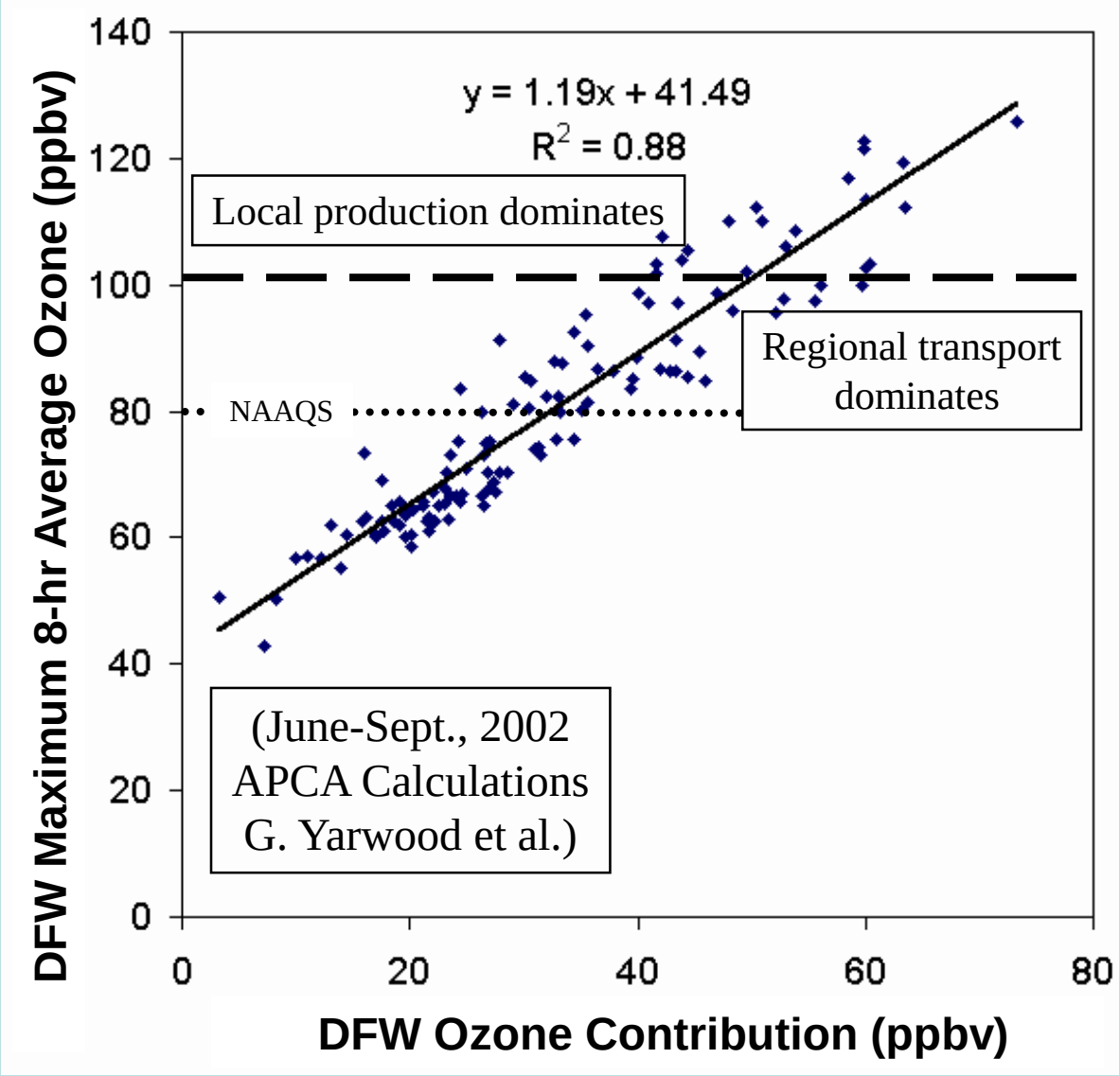
Urban O_3 violations have strong regional component.

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



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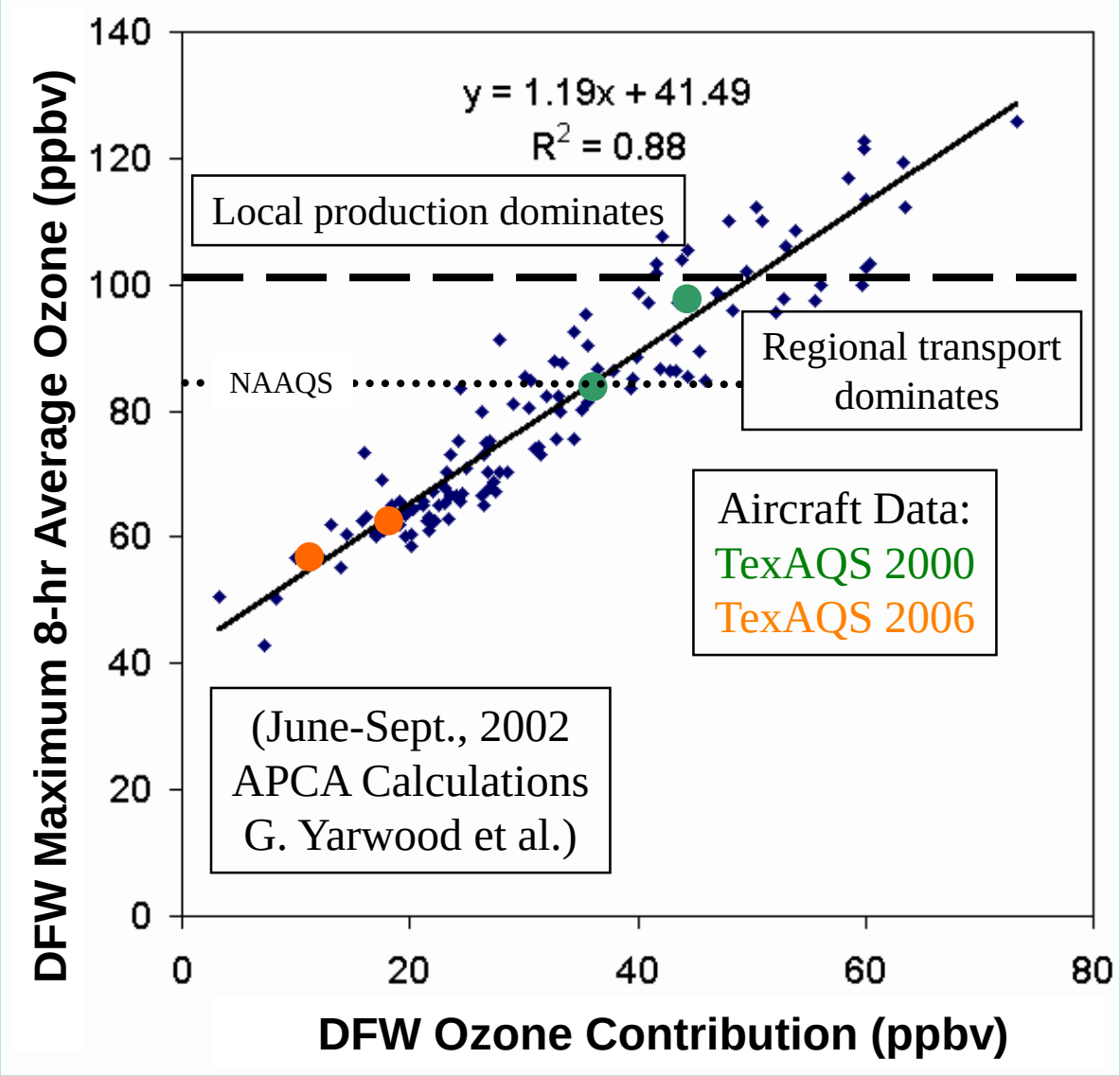

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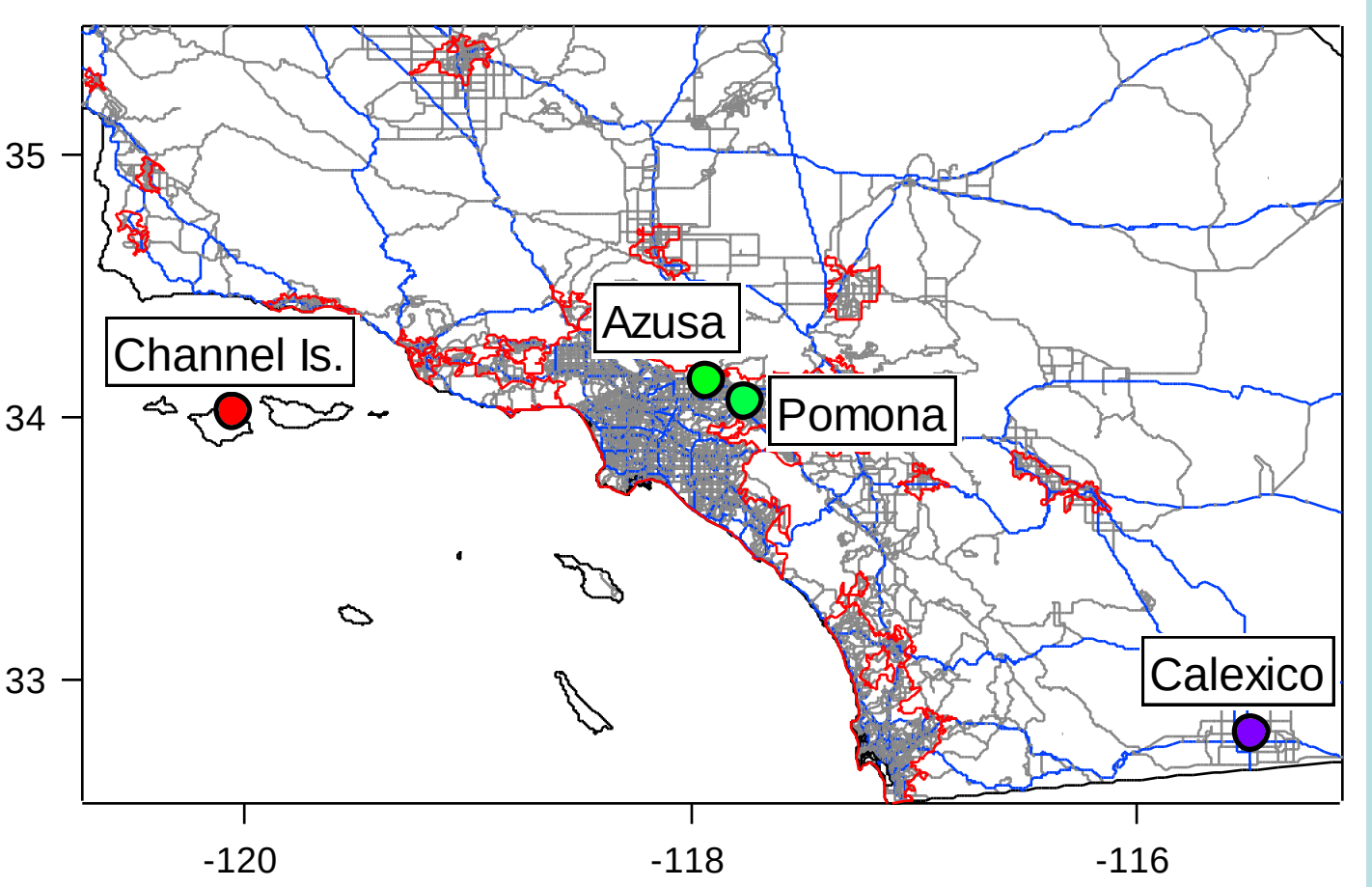
Consider 3 areas:

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.)

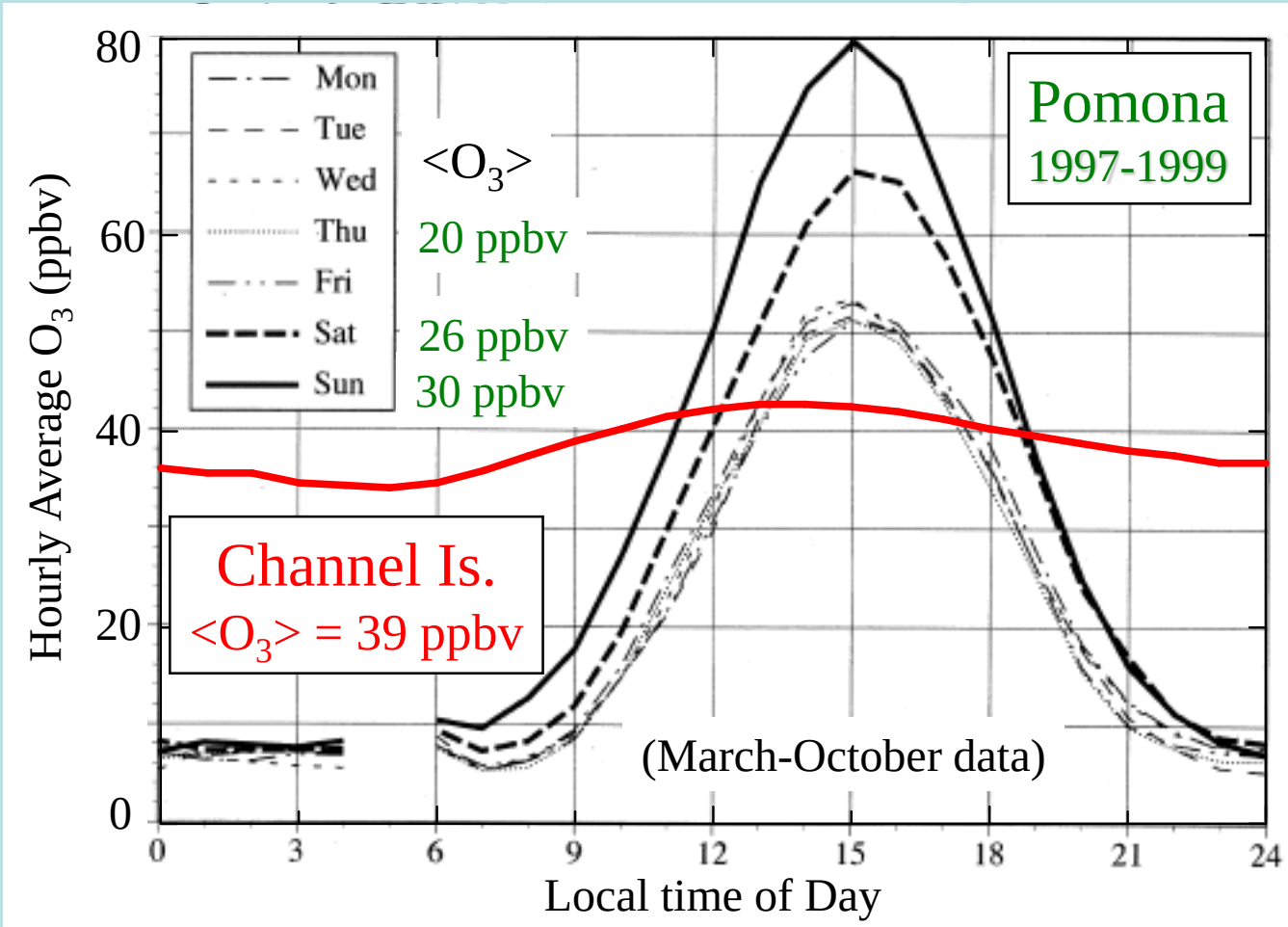


Figure from Huess et al., (2003) Weekday/Weekend Ozone Differences: What Can We Learn from Them?, *J. Air & Waste Manage. Assoc.*, **53**:772-788.

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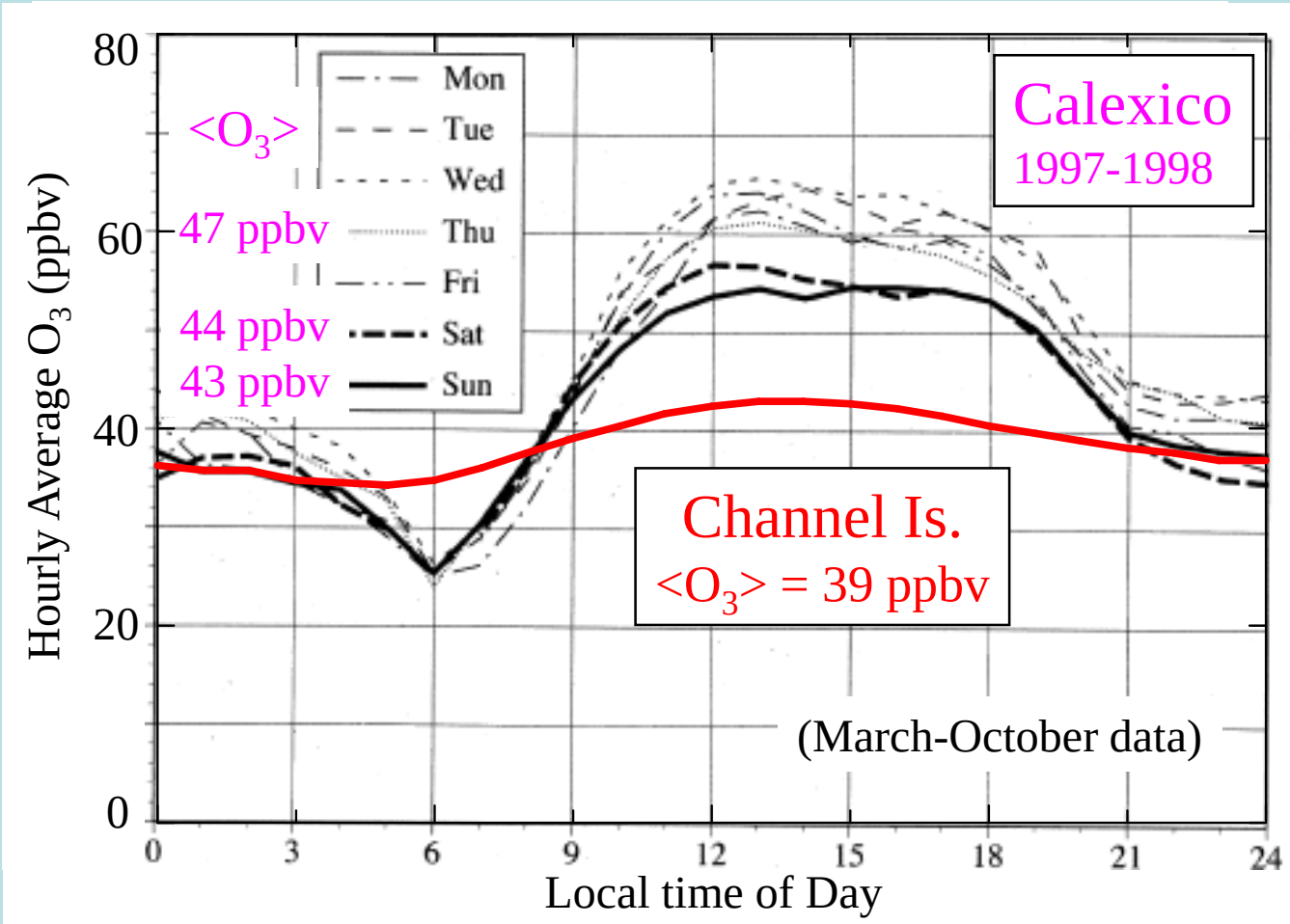
In far downwind areas the weekend effect is reversed

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



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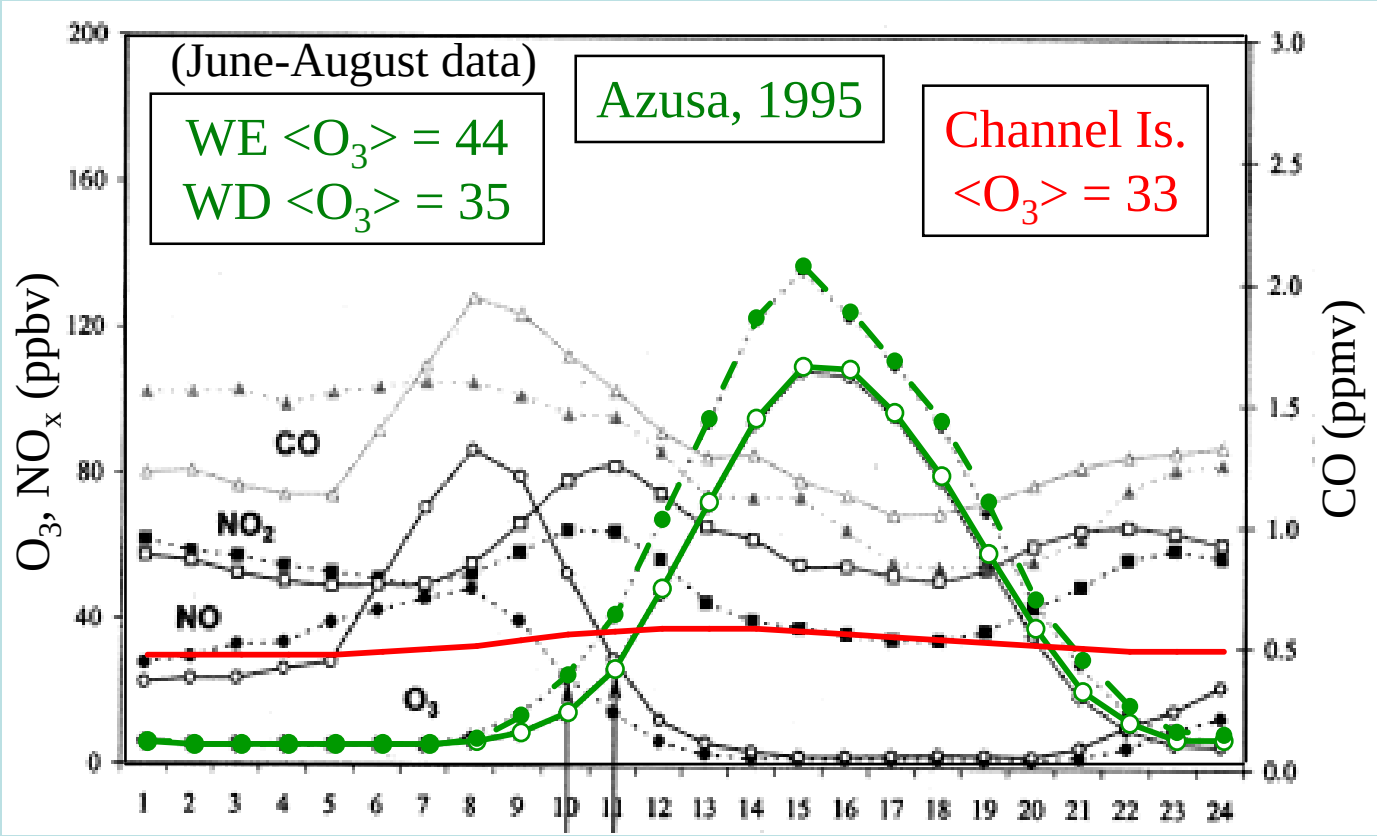
Average O_3 on weekday in L.A. is comparable to marine background during summer; but higher on weekends.

Strong Weekend O_3 Effect



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

Figure from Fujita et al., (2003) Evolution of the Magnitude and Spatial Extent of the Weekend Ozone Effect in California's South Coast Air Basin, 1981-2000, *J. Air & Waste Manage. Assoc.*, **53**:802-815.

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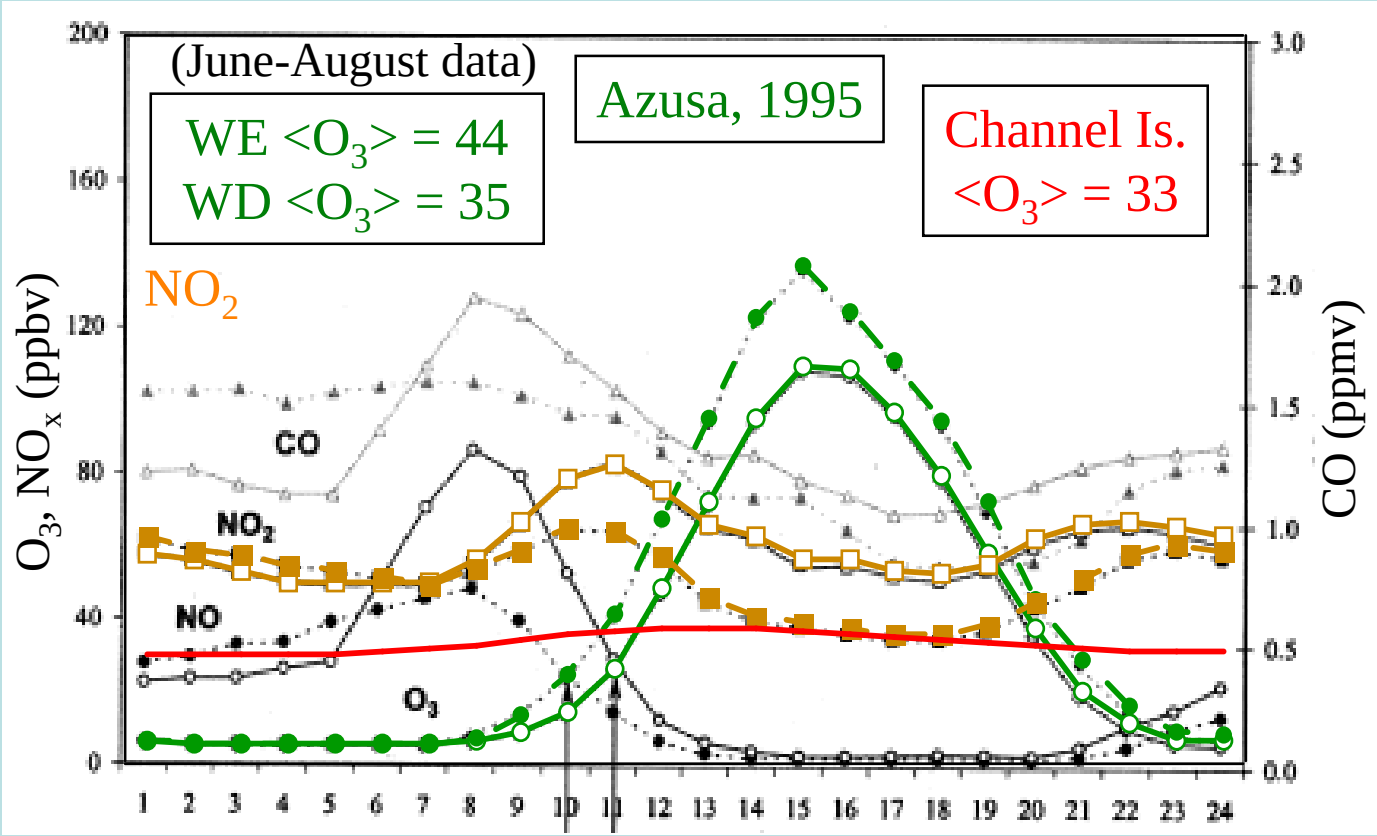
Weekend NO_2 lower: counterintuitive?



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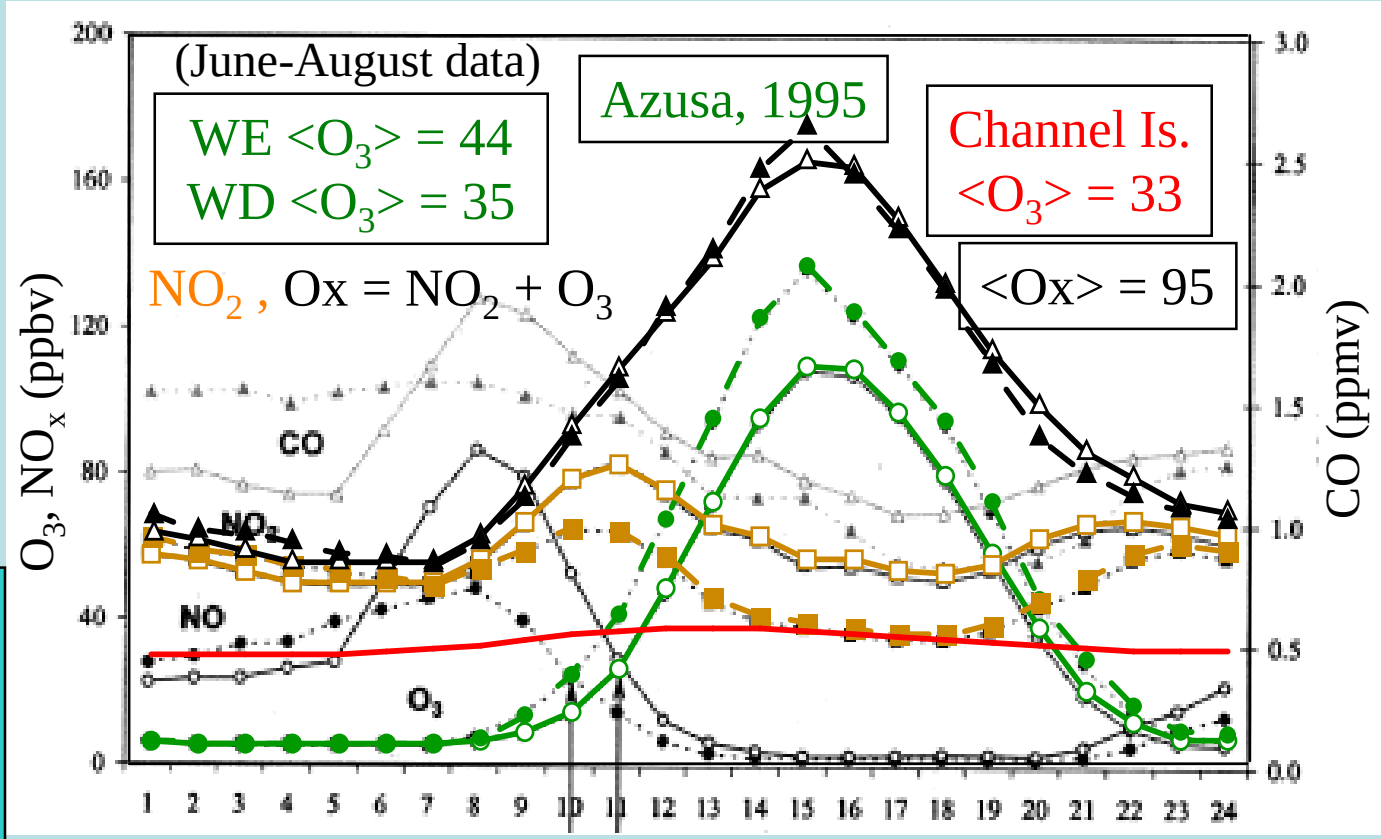
Strong Weekend O_3 Effect

Weekend NO_2 lower: counterintuitive?

$Ox = NO_2 + O_3$ similar through week

Primary cause of Weekend O_3 Effect is titration of O_3 by local NO emissions



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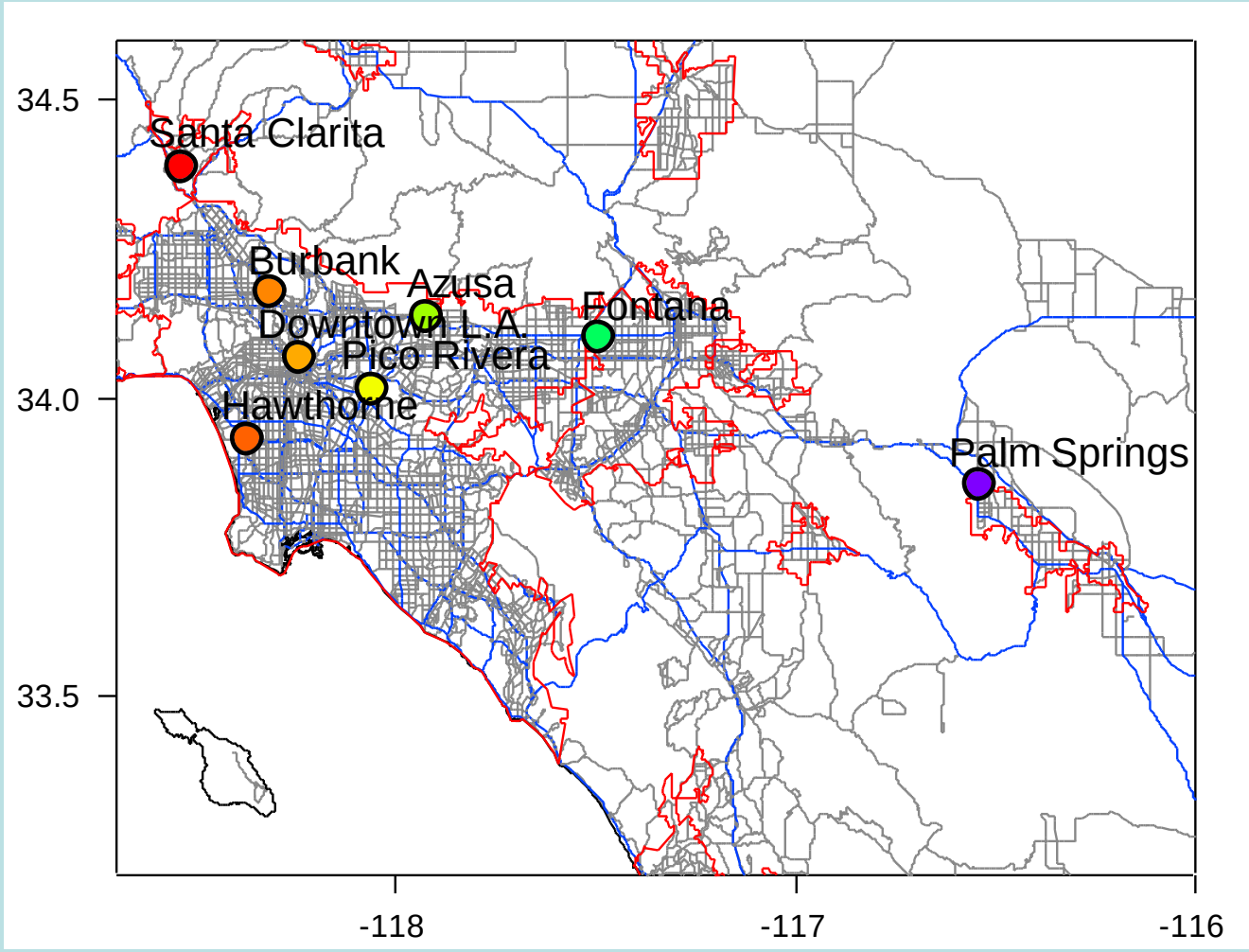
The Weekend O_3 Effect is primarily due to less local emissions, and hence less O_3 destruction, on weekends.

Consider 8 sites in southern California

Color-coded by longitude



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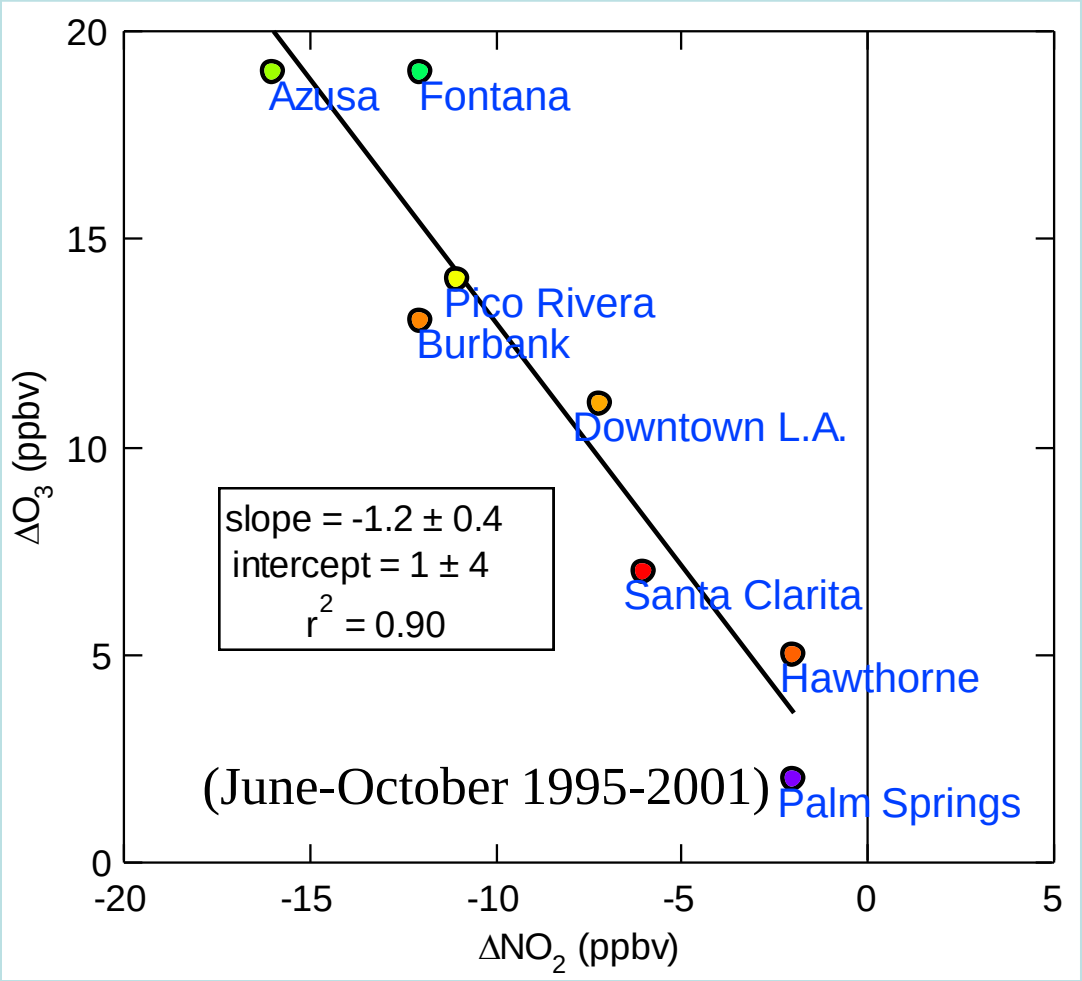
Δ indicates (weekend-weekday)

Throughout L.A. Basin:
$\Delta O_3 \approx - \Delta NO_2$

Primary cause of Weekend O_3 Effect is titration of O_3 by local NO emissions



Data from Qin et al., (2004) Weekend/weekday differences of ozone, NO_x, CO, VOCs, PM10 and the light scatter during the ozone season in southern California, *Atmos. Environ.*, **38**:3069-3087.

O_3 Weekend Effect: Does it have regulatory implications?

- In many areas average O_3 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 O_3 production: $NO_2 + OH \Rightarrow HNO_3$

But titration is the primary cause

Titration $NO + O_3 \Rightarrow NO_2 + O_2$

Titration moves O_3 production downwind, which contributes to O_3 transported into urban area

Further analysis must focus on exceedances; treat titration and transport

Urban-Rural Interactions in O_3 Distributions: Implications

In general, most of the O_3 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, O_3.

For reliable results, photochemical models must accurately reproduce boundary layer evolution, which strongly affects the effect of NO + O_3 titration.

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