

Lessons Learned from Los Angeles: 5 Decades of Efforts, but Air Still Not as Clean as Needed

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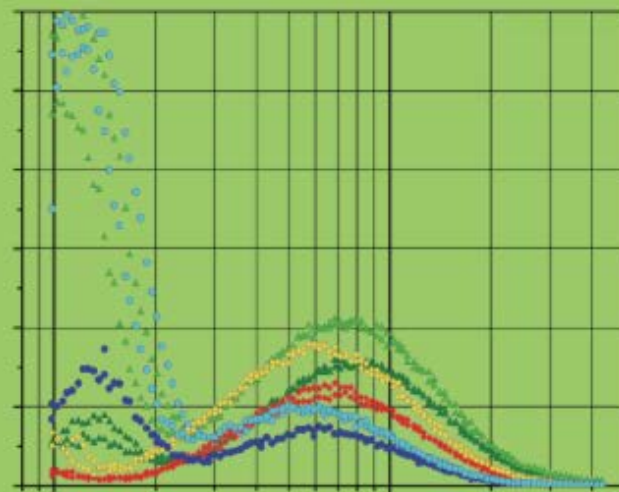
Boulder, Colorado USA

1 July 2015

Invitation and call for papers to the

19th ETH-Conference on
Combustion Generated
Nanoparticles

Focus Event:
Air Quality in Megacities



June 28th – July 1st, 2015
ETH Zurich, Switzerland
www.nanoparticles.ethz.ch

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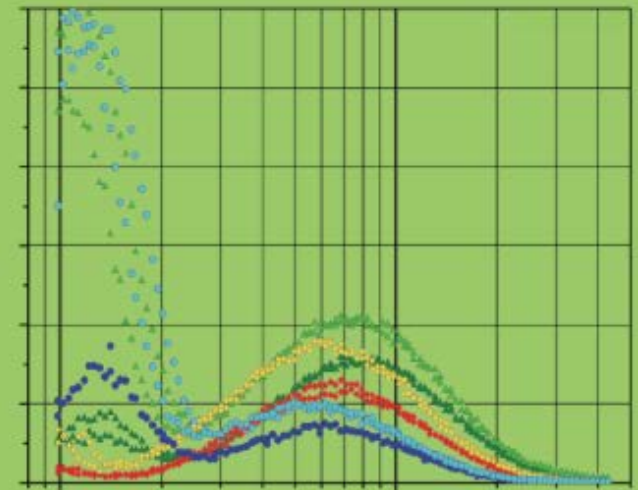
Today:

1. Severe air pollution in urban areas is an old problem
2. How was air quality improved in Los Angeles? (Can this experience be a useful guide for today's developing cities)
3. Los Angeles had an advantage

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1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center



January 1948

China Central Television (CCTV) building Beijing



January 2013

Air pollution in Los Angeles in mid-20th century was second to none

1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center

24-hour average PM_{10} concentrations exceeded $600 \mu\text{g}/\text{m}^3$ in Los Angeles
(*National Academy of Engineering Report*, 2007)

January 1948

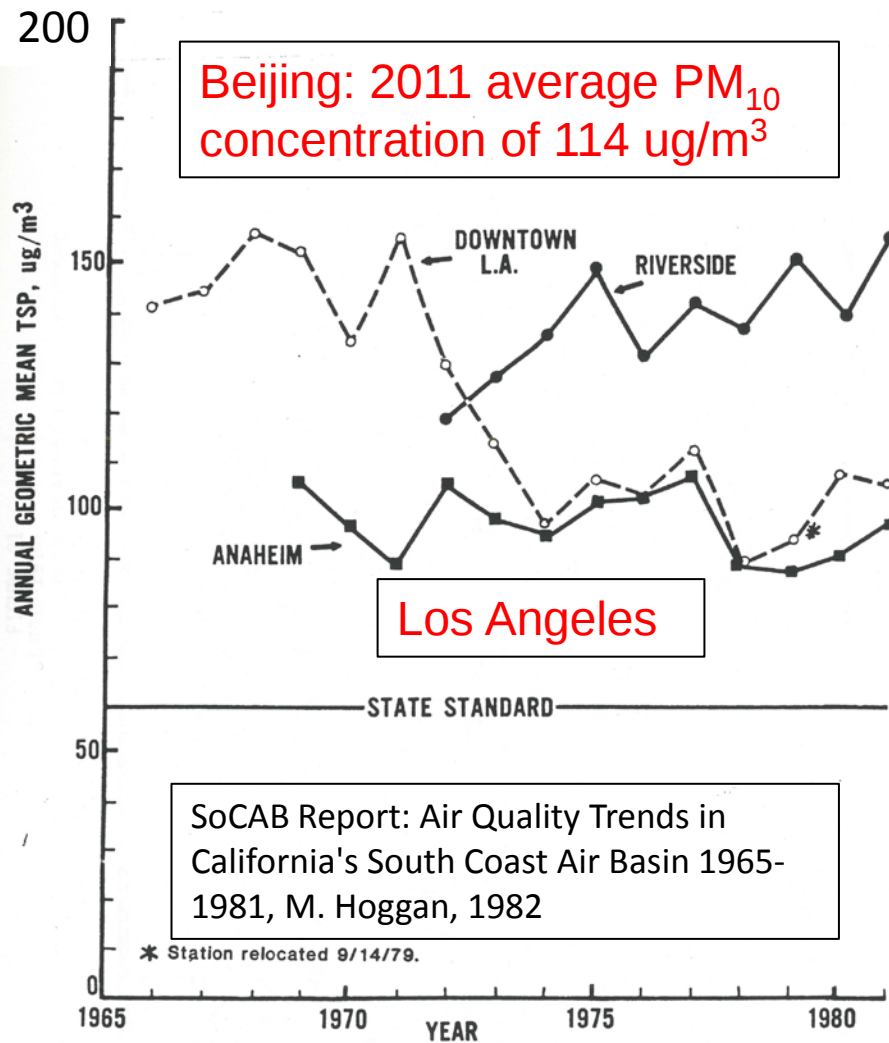
China Central Television (CCTV) building Beijing

Peak PM_{10} concentrations exceeded $1150 \mu\text{g}/\text{m}^3$ in Beijing
(Zheng et al., *Atmos. Chem. Phys.*, 2015)

January 2013

1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center



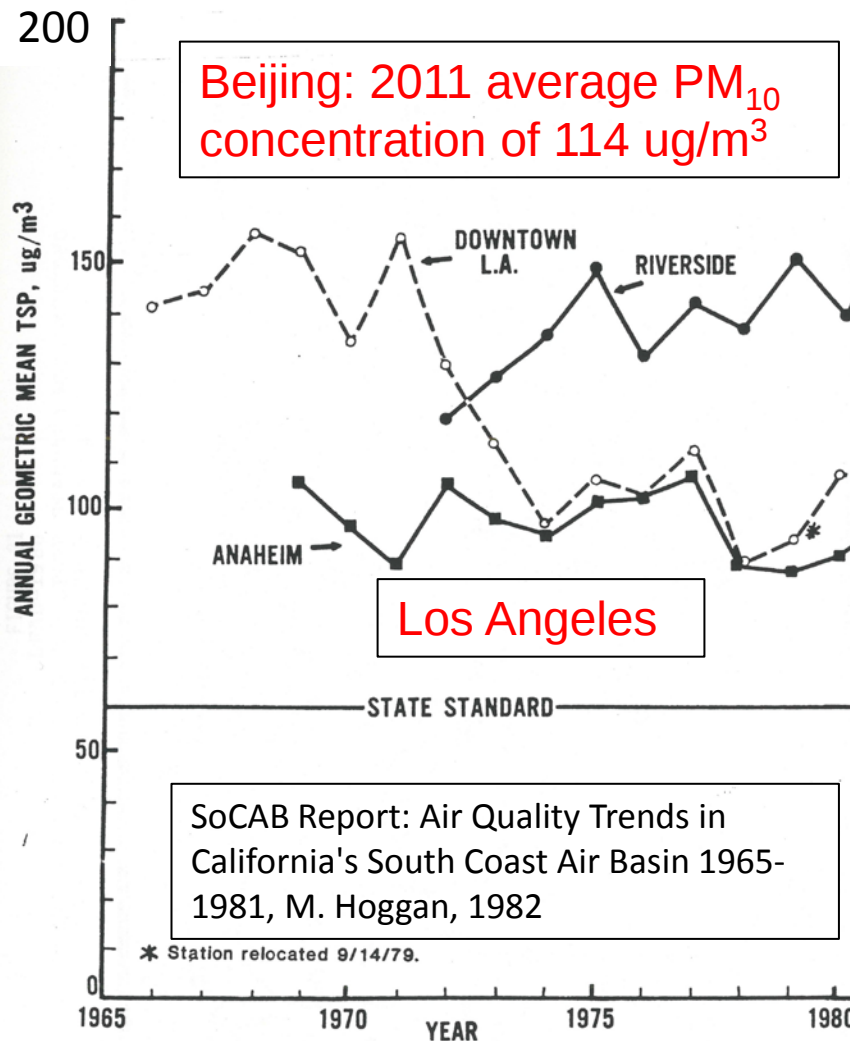
January 1948

Central Television Building Beijing

January 2013

1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center



Peak PM_{10} concentrations reached $120 \mu g/m^3$

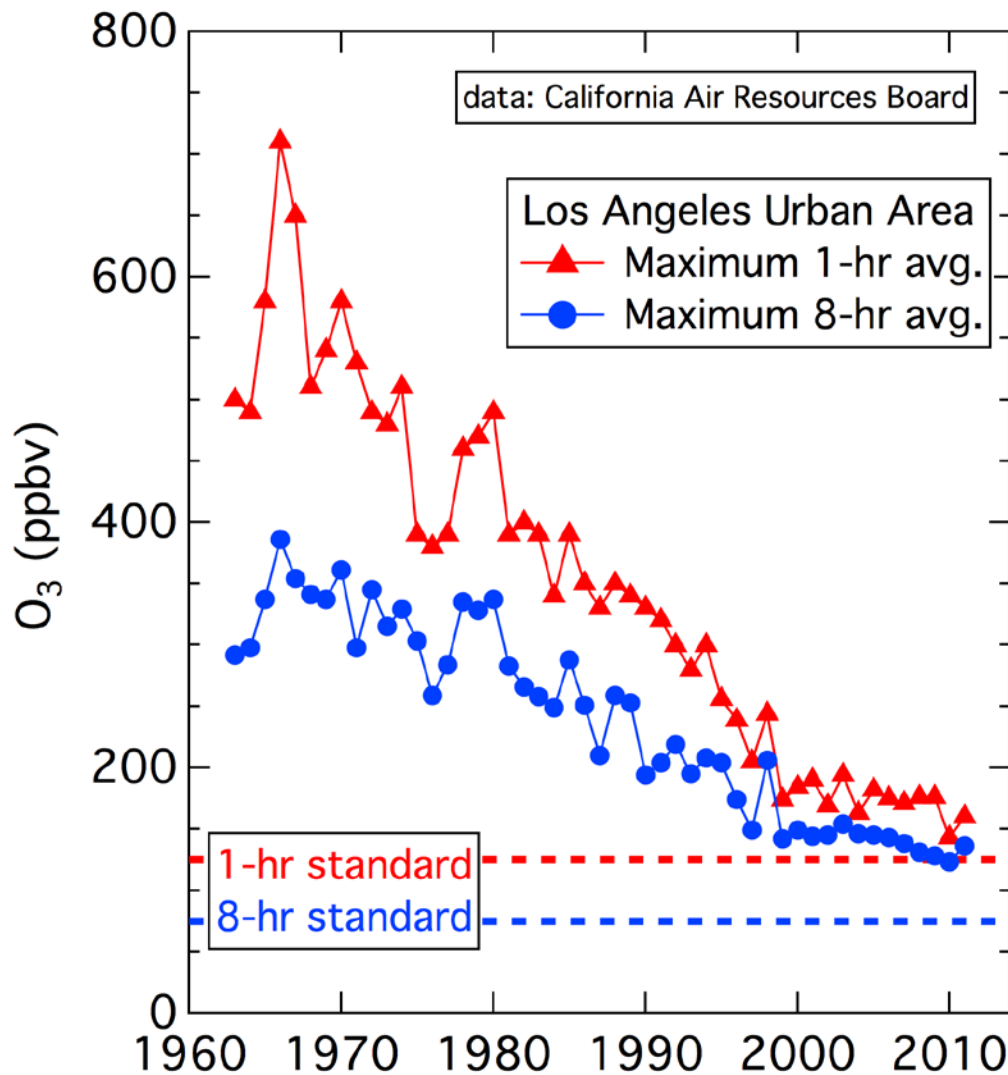
14 March 2015

Paris chokes on pollution; City of Light becomes City of Haze –
Los Angeles Times

1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center

Tremendous progress has been made, but it required > 5 decades!



January 1948

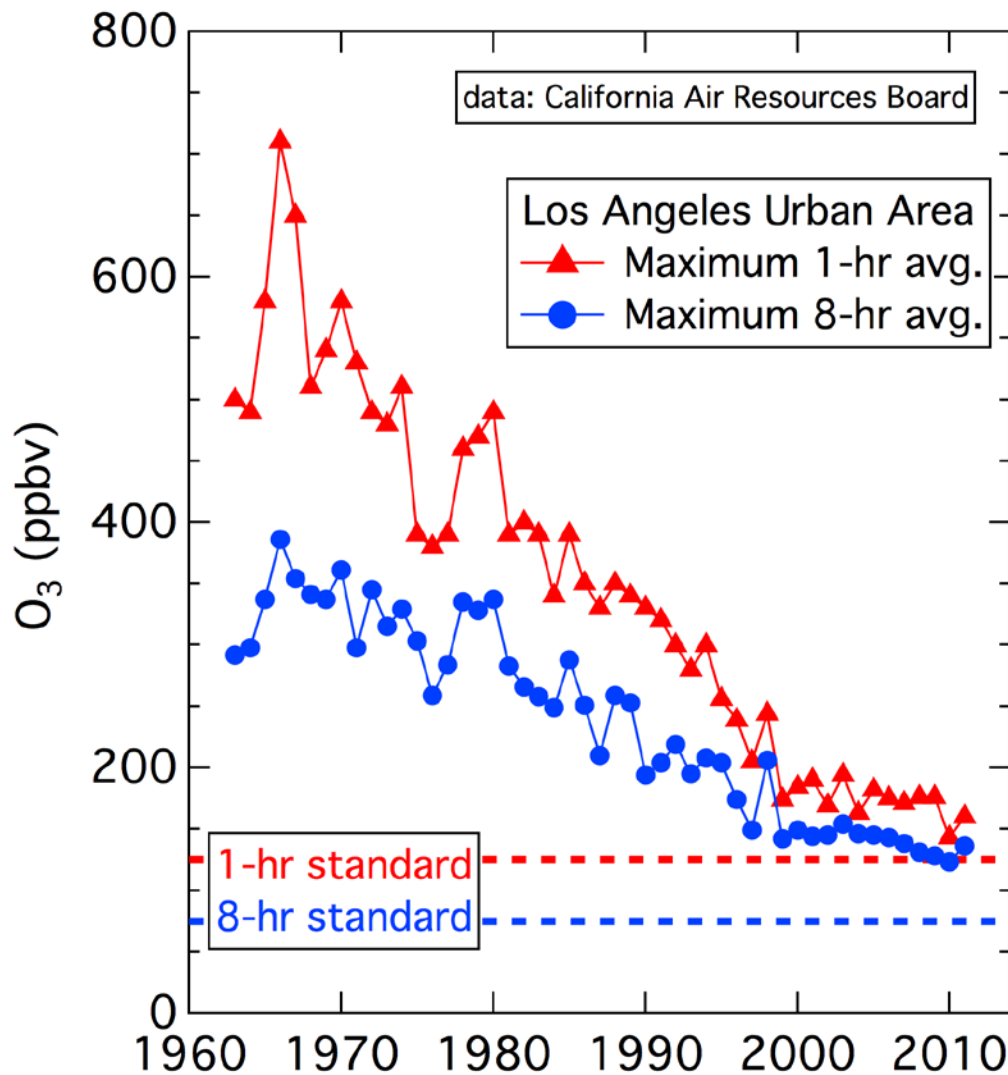
Ozone (O_3) exceeded 600 ppbv in Los Angeles (> 350 ppbv 8-hour average)

O_3 seldom if ever has exceeded 200 ppbv in Beijing – higher in downwind plumes

1. Severe air pollution in urban areas is an old problem

Los Angeles Civic Center

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January 1948

2. How was air quality improved in Los Angeles?

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Emissions from all sources addressed!

- Open burning banned
- Industrial emissions controlled
- Power plant emissions controlled, or moved elsewhere.



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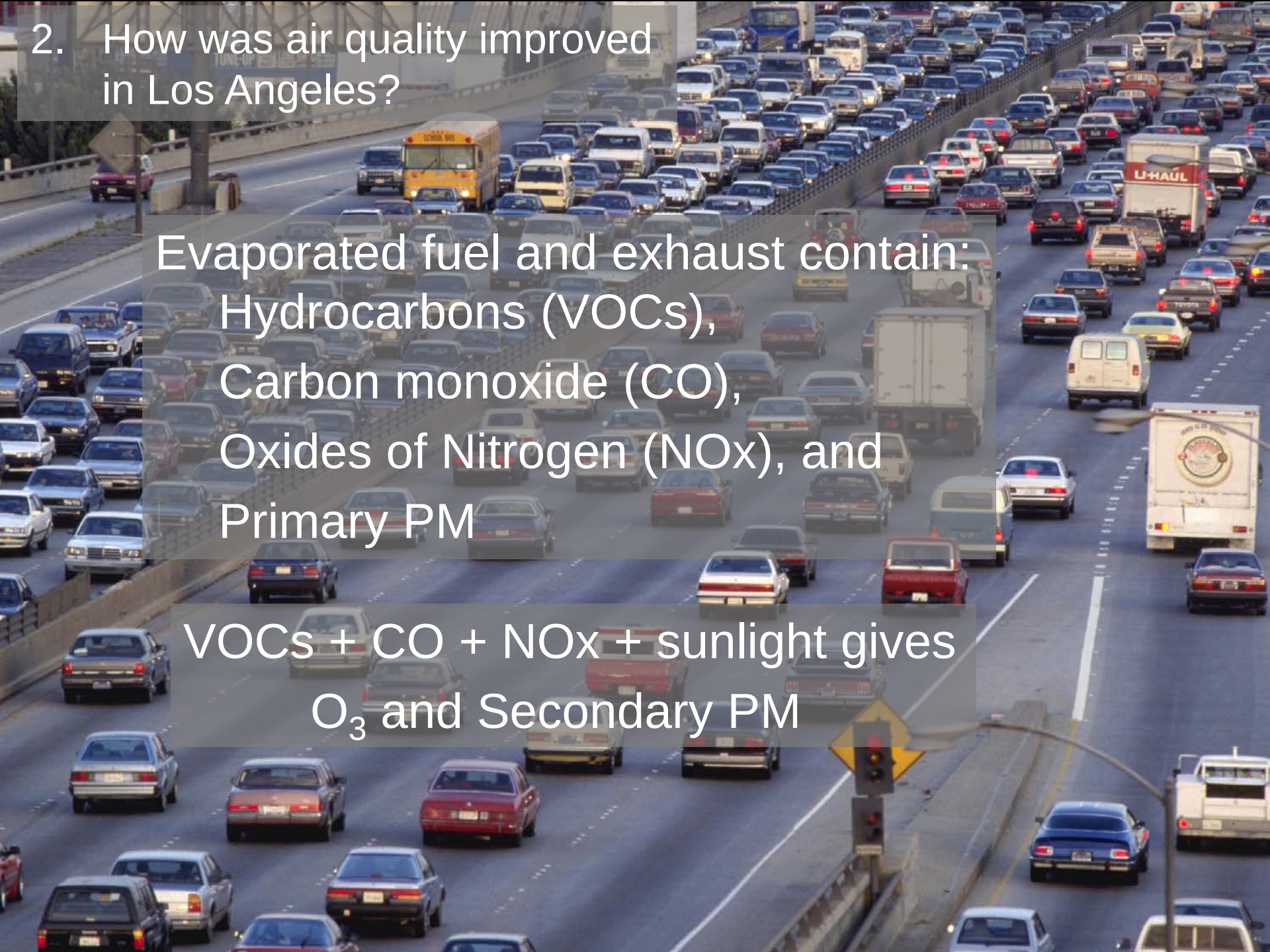
- Open burning banned
- Industrial emissions controlled
- Power plant emissions controlled, or moved elsewhere.
- U.S. Urban Areas: Motor Vehicles dominate emissions.



2. How was air quality improved in Los Angeles?

Evaporated fuel and exhaust contain:
Hydrocarbons (VOCs),
Carbon monoxide (CO),
Oxides of Nitrogen (NOx), and
Primary PM

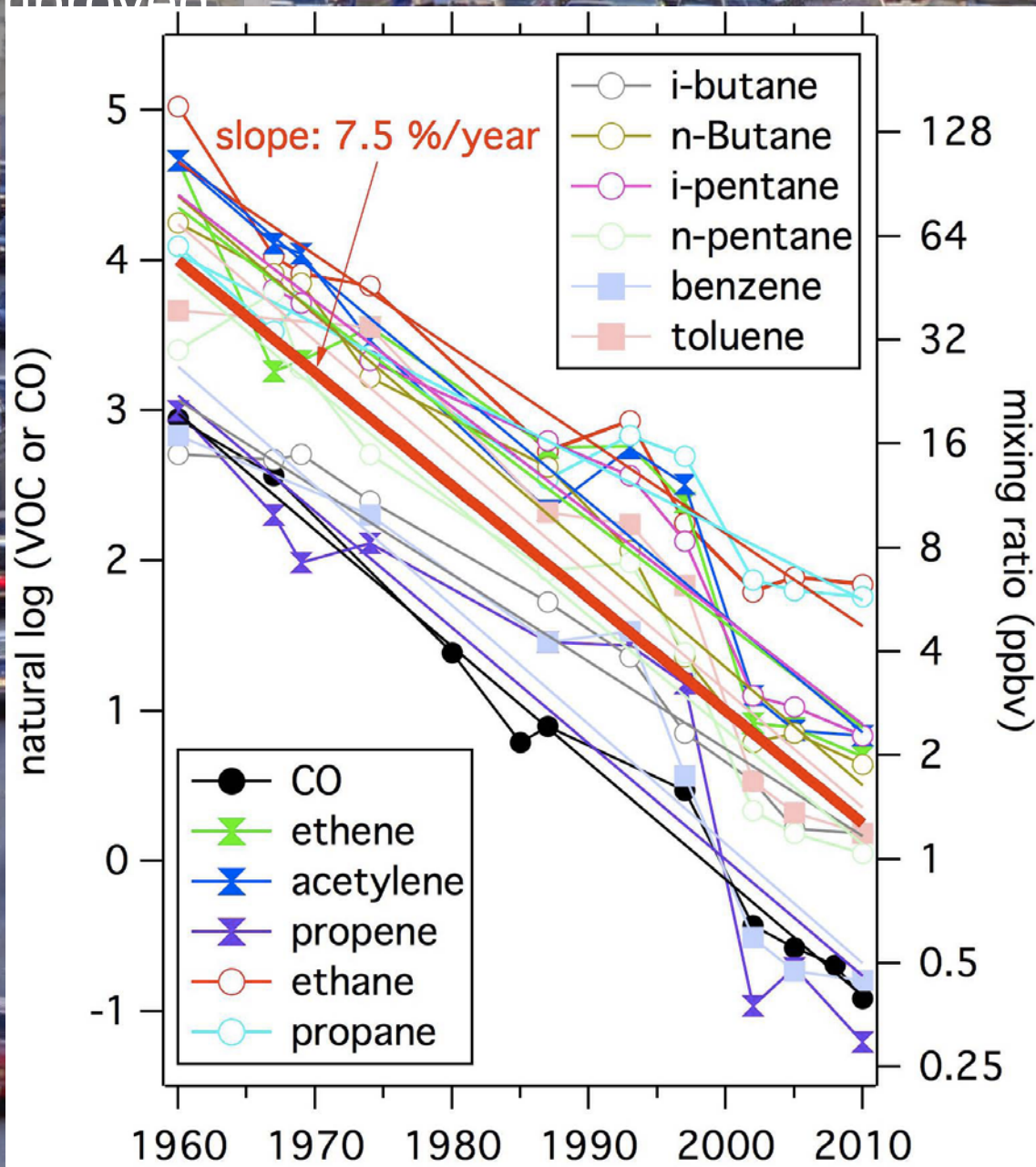
VOCs + CO + NOx + sunlight gives
O₃ and Secondary PM



2. How was air quality improved in Los Angeles?

Ambient VOC and CO concentrations decreased by **factor of ~50** in 5 decades

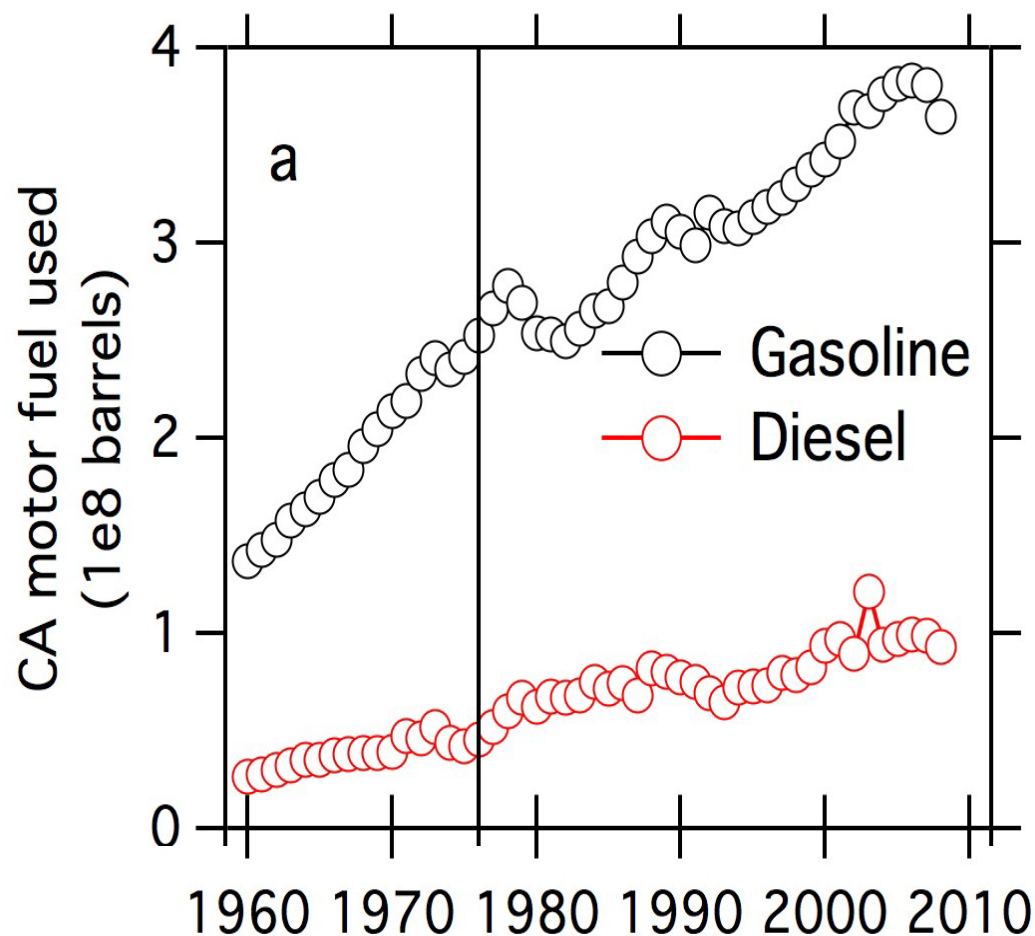
This and following slides summarize data collected from a variety of sources at a variety of sites



2. How was air quality improved in Los Angeles?

Ambient VOC and CO concentrations decreased by **factor of ~50** in 5 decades

...even while fuel use increased by factor of ~3.

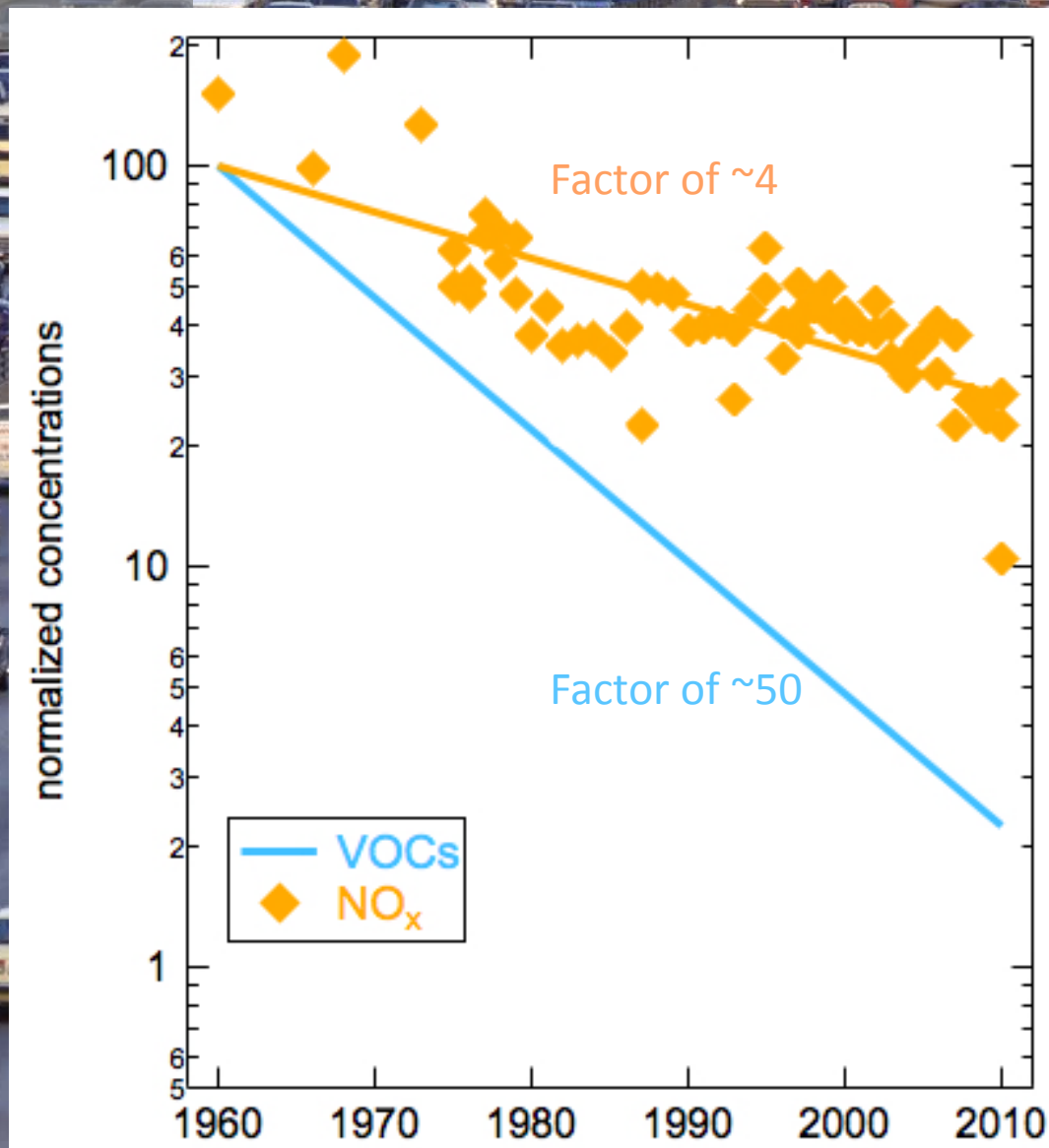


Per km traveled, modern U.S. vehicles emit ~1% of VOCs and CO compared to 1960 vehicles

2. How was air quality improved in Los Angeles?

Response of pollutants to emission controls:

NO_x reductions much slower than VOC reductions.

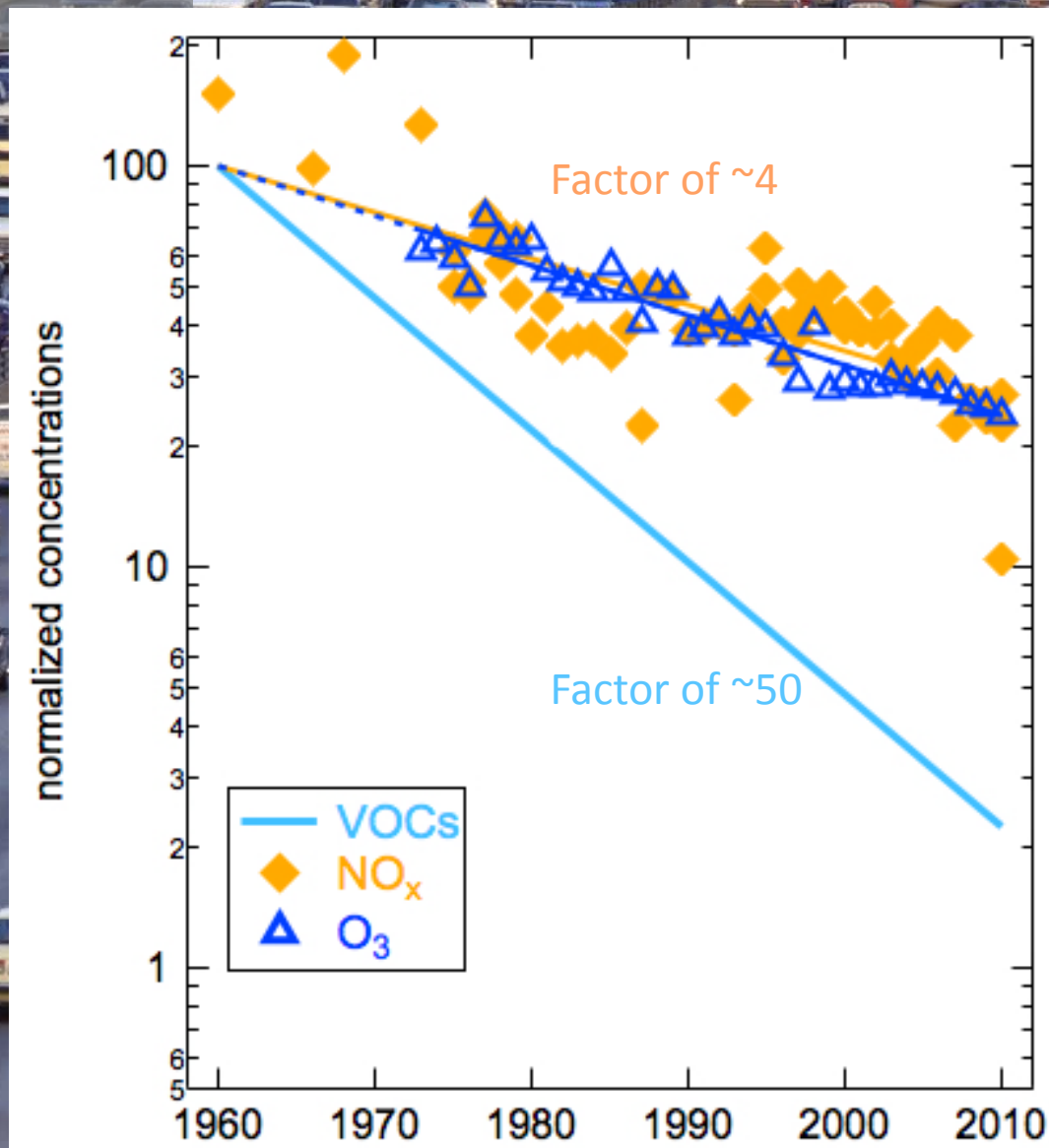


2. How was air quality improved in Los Angeles?

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Response of O_3 is not proportional to VOC reductions.



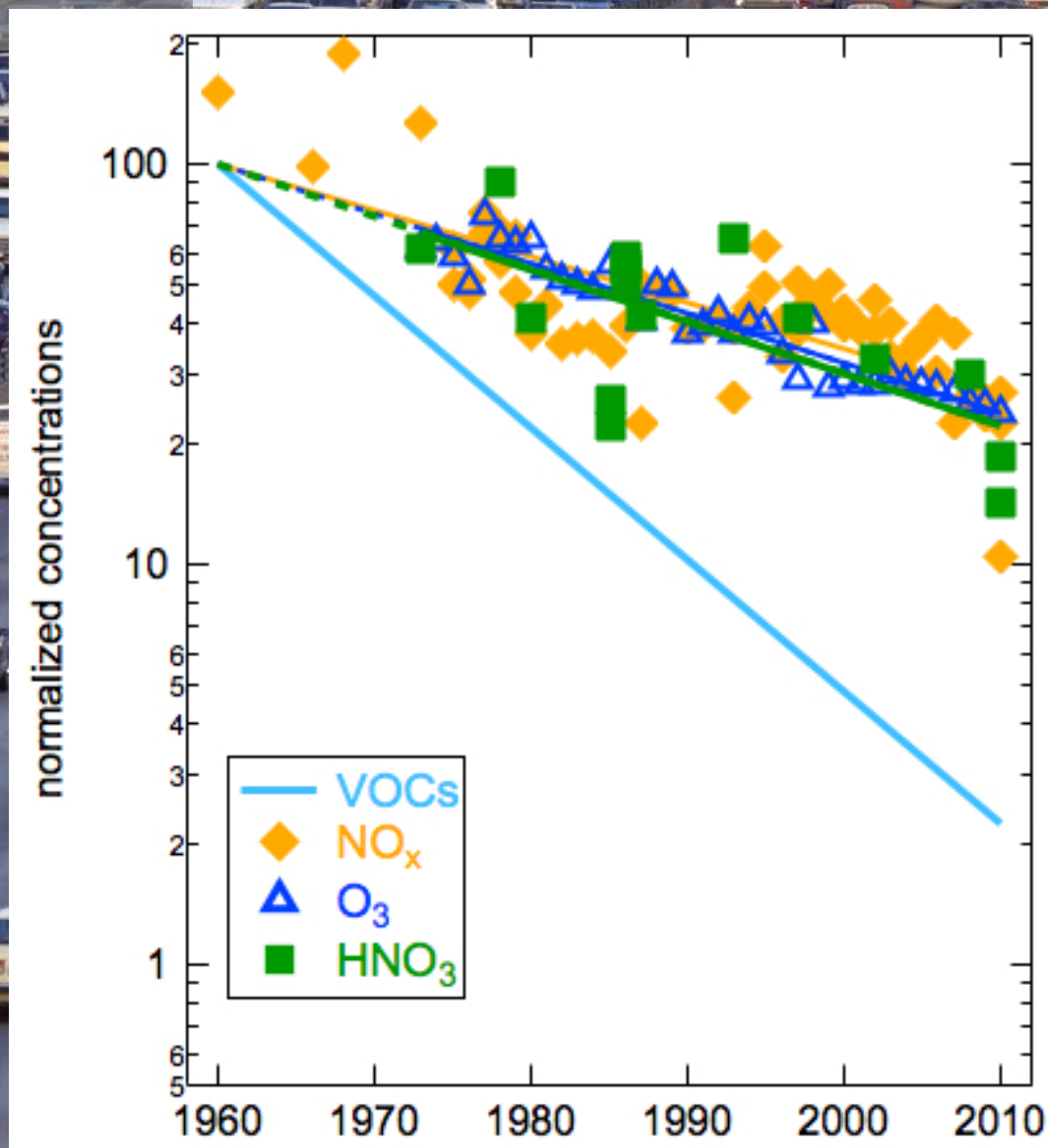
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Response of O_3 is not proportional to VOC reductions.

Reduction in HNO_3 has followed NO_x reduction.



2. How was air quality improved in Los Angeles?

Response of pollutants to emission controls:

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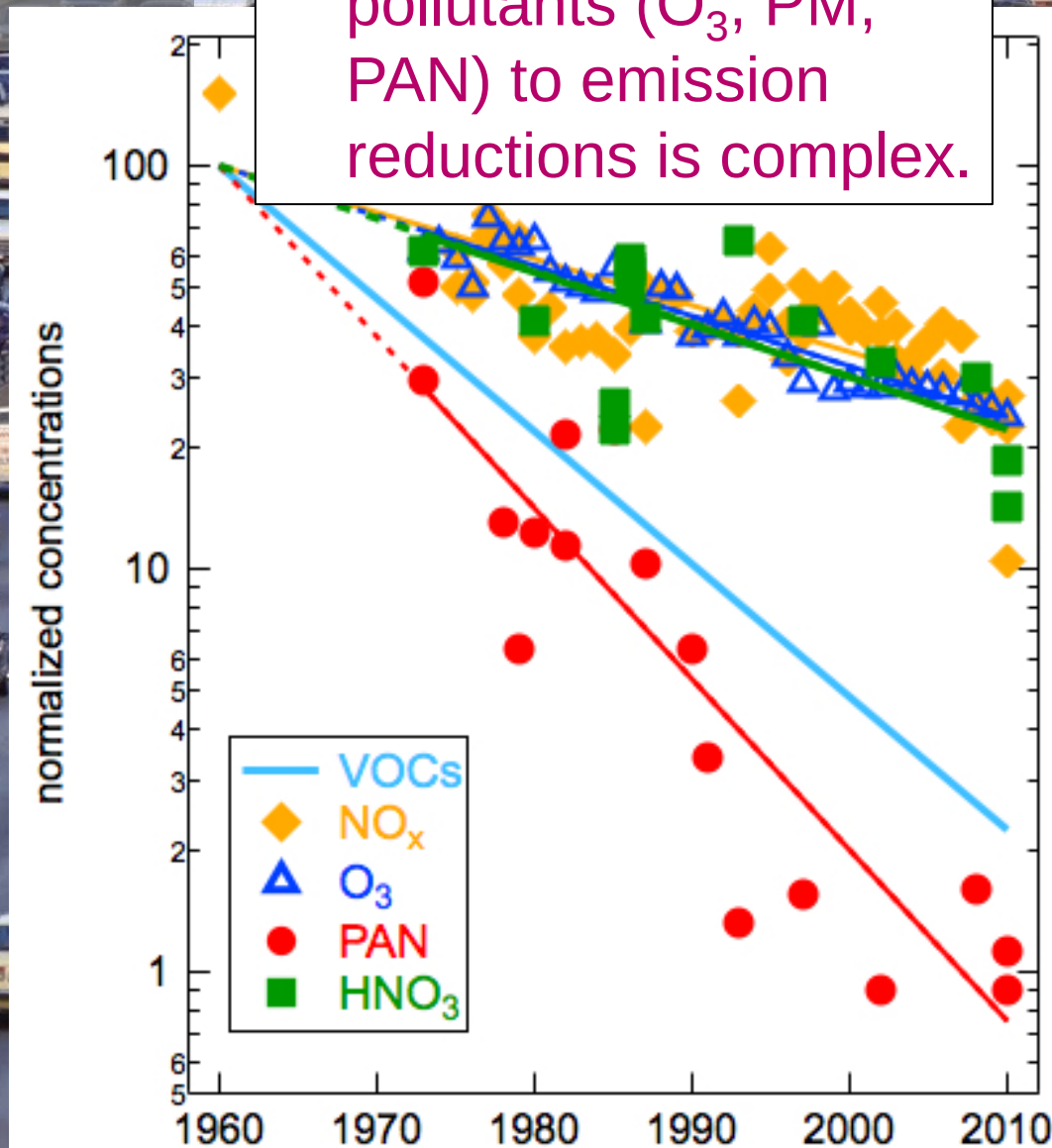
Response of O_3 is not proportional to VOC reductions.

Reduction in HNO_3 has followed NO_x reduction.

Reduction in PAN has been very different.

PAN (peroxyacetyl nitrate) was responsible for severe eye irritation in Los Angeles.

Response of secondary pollutants (O_3 , PM, PAN) to emission reductions is complex.



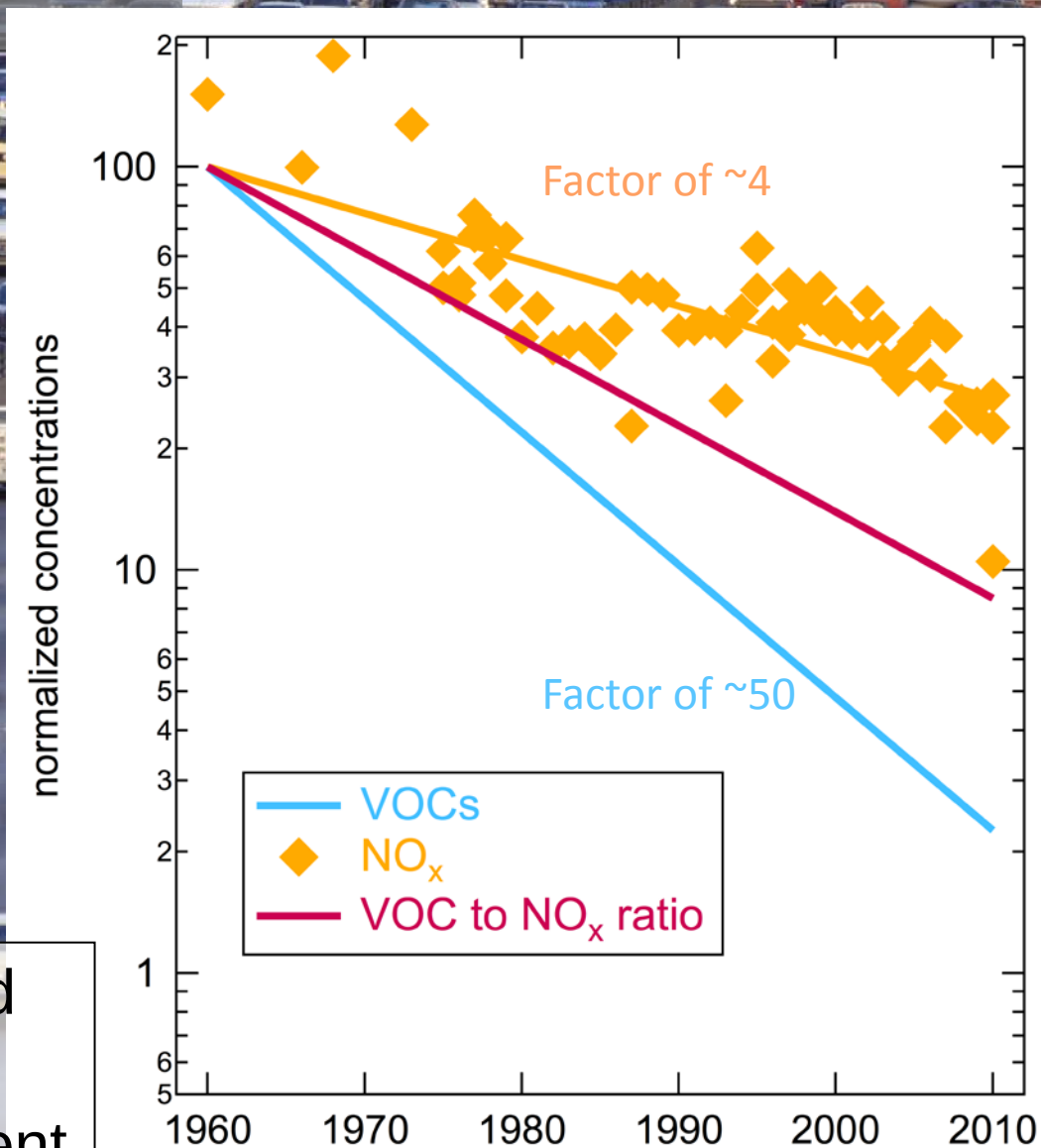
2. How was air quality improved in Los Angeles?

Response of pollutants to emission controls:

NO_x reductions much slower than VOC reductions.

It is not yet possible to model all major aspects of this 50 years of Los Angeles progress

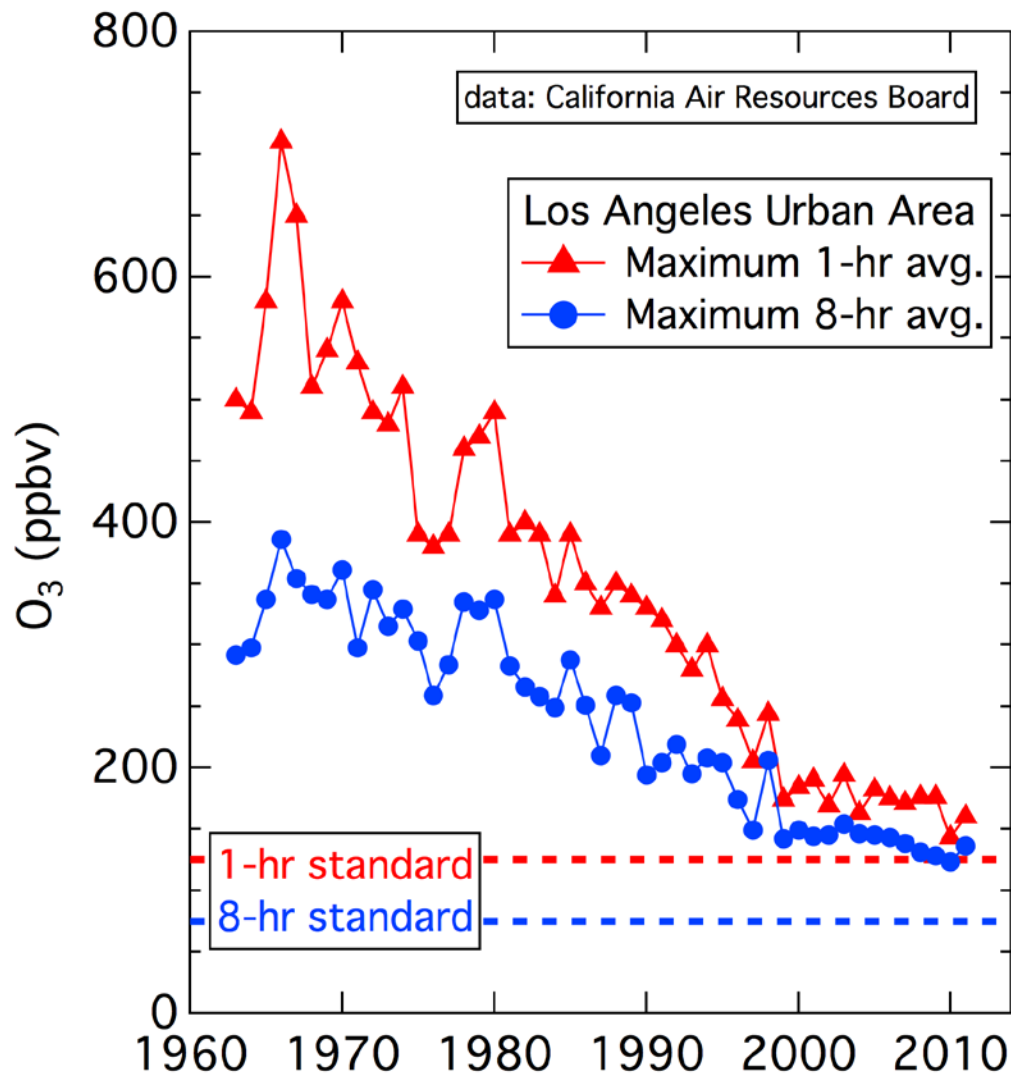
VOC to NO_x ratio decreased by factor of 12 in L.A. - Photochemical environment has changed.



2. How was air quality improved in Los Angeles?

Los Angeles Civic Center

Tremendous progress has been made, but it required > 5 decades!



January 1948

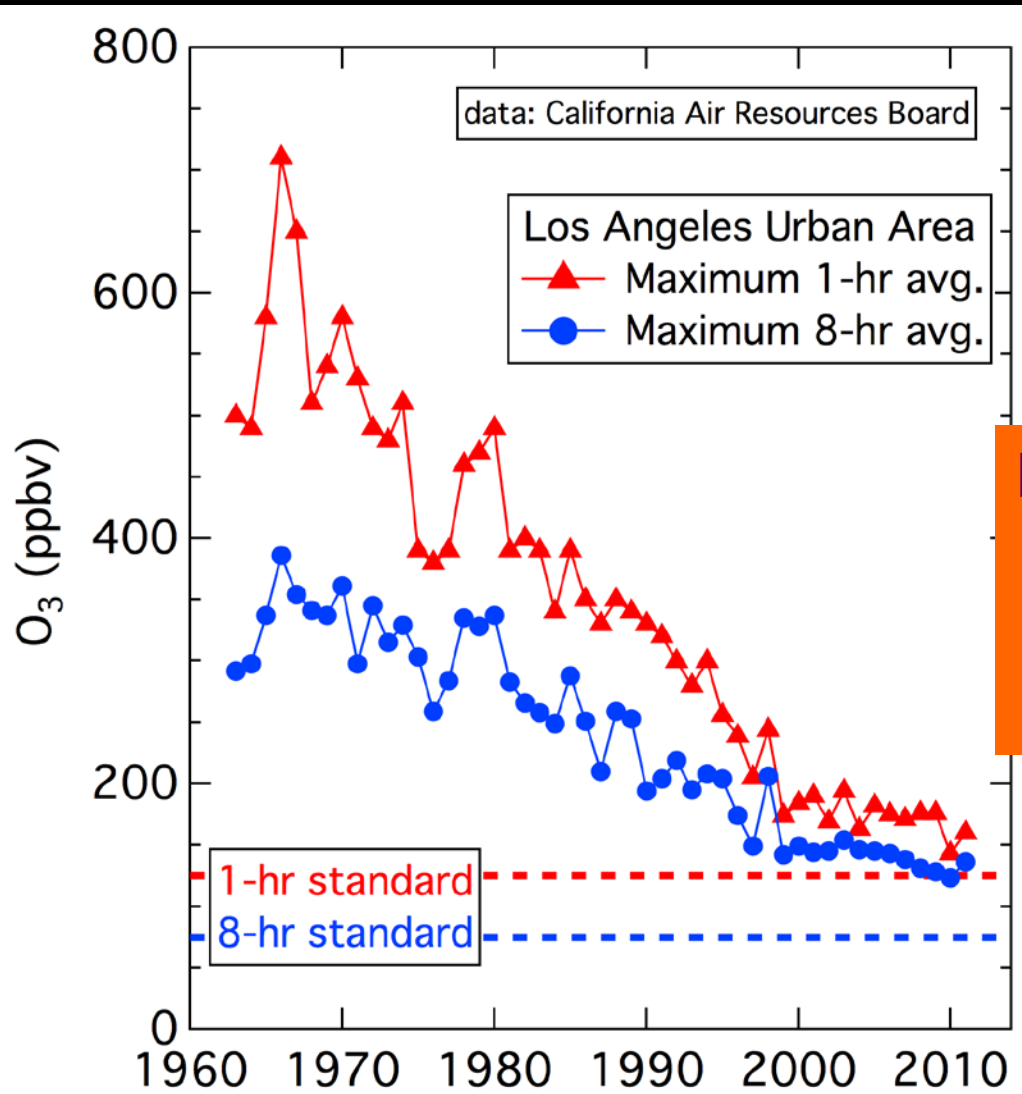
Why did it take so long?

2. How was air quality improved in Los Angeles?

- Substantial Science and Engineering Challenges

- What are the important emission sources?
- How can we control those emissions?

Amazing technical success



Emission controls developed over decades are now a tremendous resource for others!

Why did it take so long?

2. How was air quality improved in Los Angeles?

- **Substantial Social Challenges** – Every proposed emission control effort was met by strident protests from those controlled.

A long, exhausting political and legal process has been required.



Why did it take so long?

2. How was air quality improved in Los Angeles?

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Utilities Choke on Asthma Research

Polluting industries have mounted a major campaign against protection for sensitive populations under the Clean Air Act

1981

Why did it take so long?

2. How was air quality improved in Los Angeles?

- **Substantial Social Challenges** – Every proposed emission control effort was met by strident protests from those controlled.

Cleaning Up the Clean Air Act



1981

A Brookings paper finds that good luck, not good regulation, reduced pollution in the 1970's

Contrary to popular myth, enforcement of the Clean Air Act has not been responsible for the general improvement in air quality since the 1960's, according to a new report issued by the Brookings Institution.* Most of the improvement in the last decade may be attributable to the "good luck" of a limping economy and the continuing substitution of clean fuels (oil and natural gas) for coal. That is the

The authors of the paper agree that controls imposed by the Environmental Protection Agency (EPA) have reduced emissions from new plants and new automobiles. But they claim that "the application of pollution controls to existing plants and older cars has been limited, and costs have been excessive, largely because Congress has failed to confront the difficult issues" of how to attack

forces a return to coal, air pollution could get markedly worse."

The authorization for the Clean Air Act of 1970 expired in September and, pending renewal, the law is being kept alive by a continuing resolution. Hearings are under way in both the House and Senate, but there is little prospect of new legislation before next year. The Brookings paper is clearly intended to

2. How was air quality improved in Los Angeles?

Citizen Activists to Protest 'Out-of-Control' Regulators; Air Quality Management District Called #1 'Job Killers'

PRNewswire, 7 June 2006

- **Substantial Social Challenges** – Every proposed emission control effort was met by strident protests from those controlled.

A long, exhausting political and legal process has been required.

Remarkable that emission control efforts have been sustained over 50 years.

ECONOMY DERAILED

STATE-BY-STATE IMPACTS OF THE EPA REGULATORY TRAIN WRECK

WWW.REGULATORYTRAINWRECK.COM

ALEC

American
Legislative
Exchange
Council

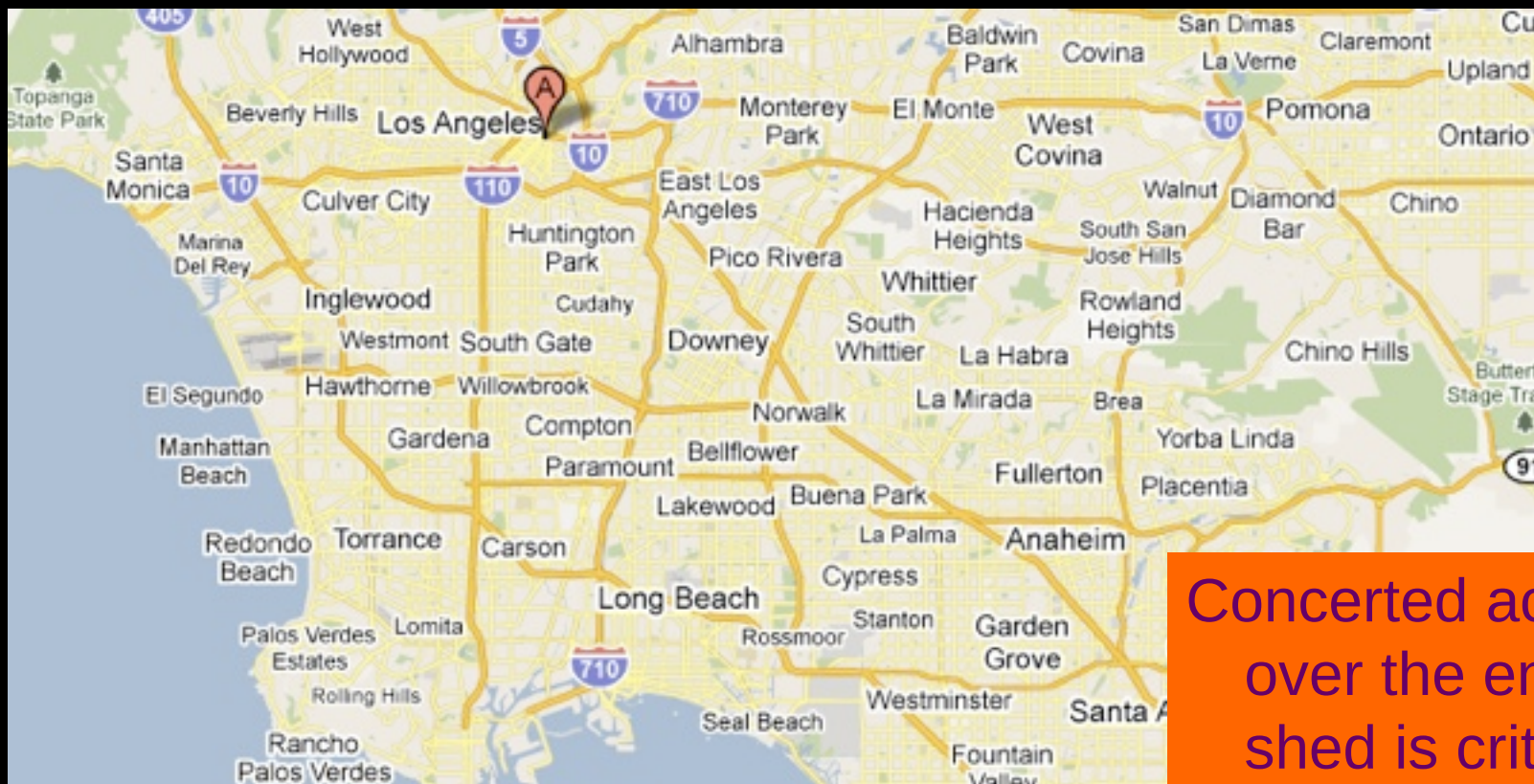
21 June 2015

Limited Government • Free Markets • Federalism

Why did it take so long?

2. How was air quality improved in Los Angeles?

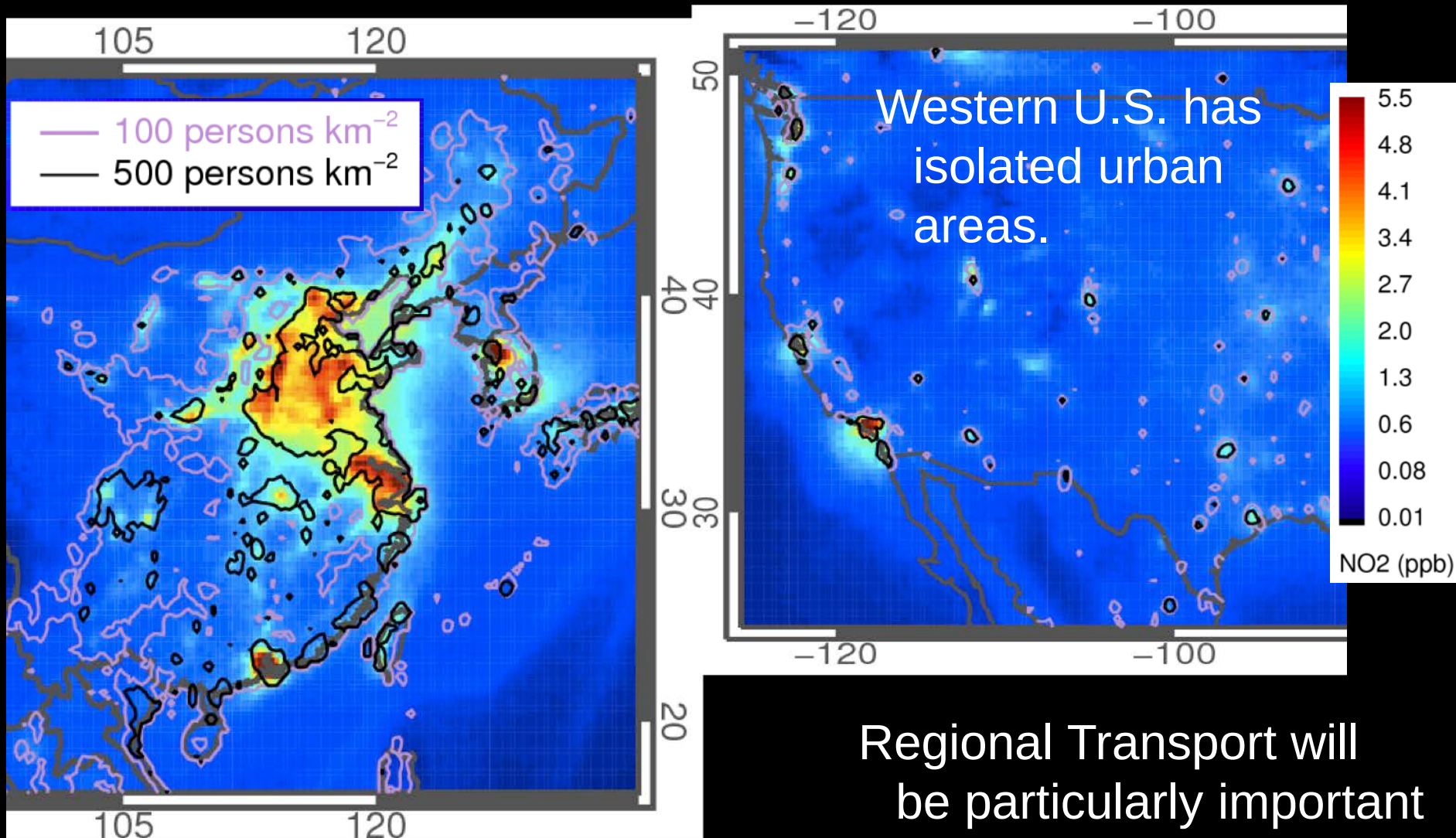
- Substantial Political Challenges



Concerted action
over the entire air
shed is critical

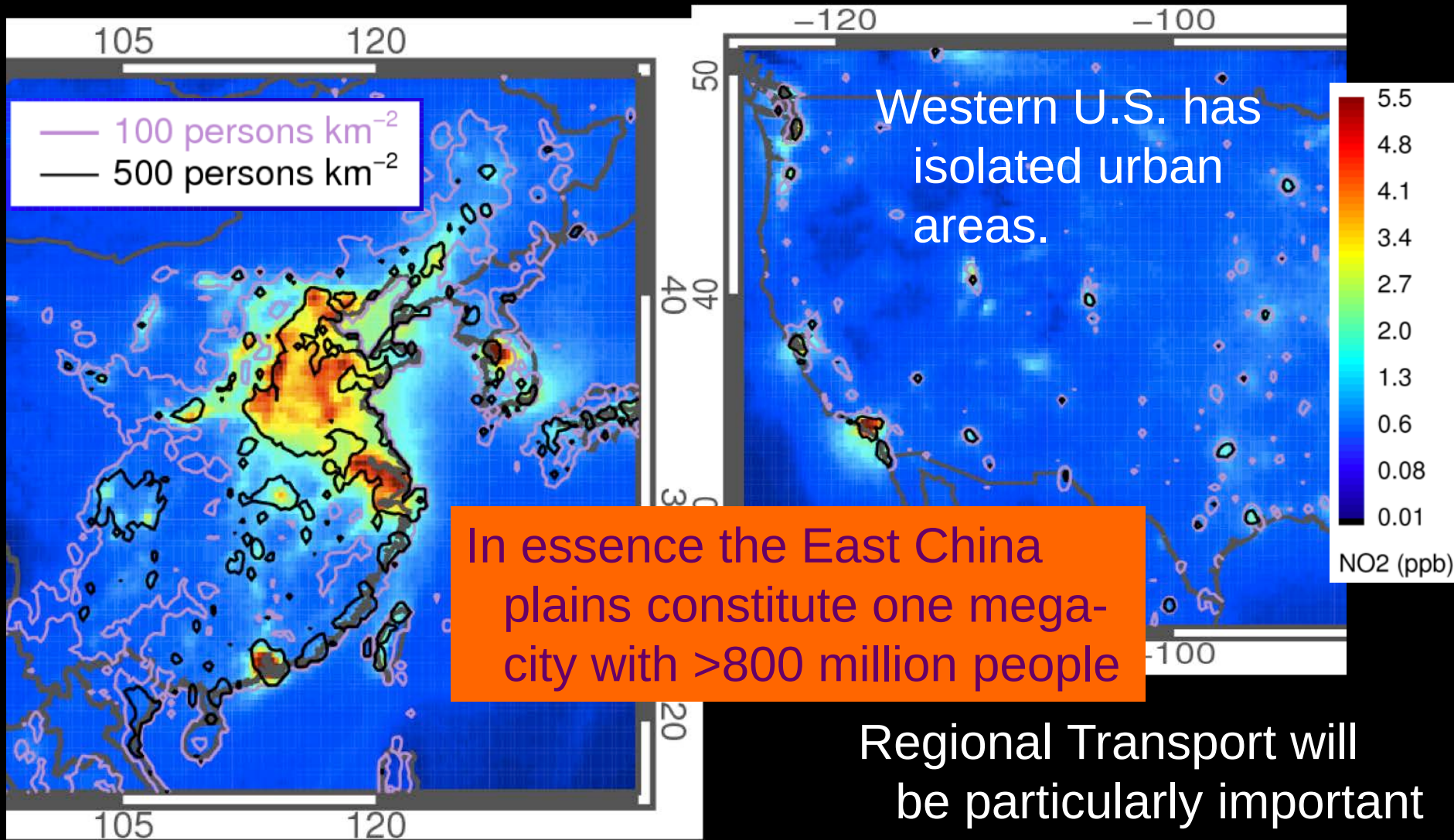
- The Los Angeles Basin contains 3 counties, and more than 50 separate cities
- Progress was slow until South Coast Air Quality Management District was formed in 1977

3. Los Angeles had an advantage



Colors: Surface NO₂ concentration from satellite
Contours: Population density

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Colors: Surface NO₂ concentration from satellite
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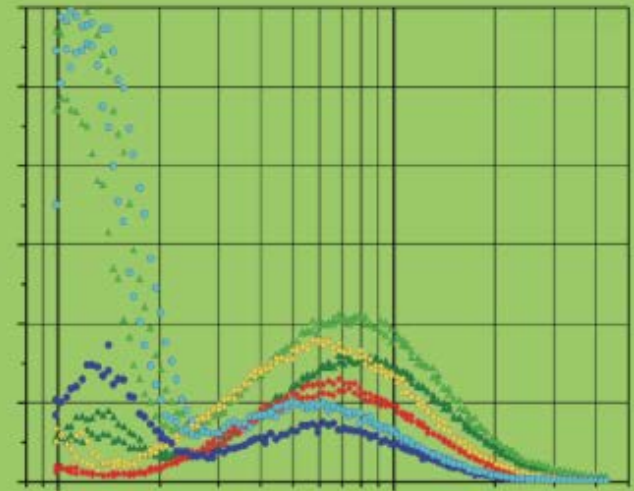
Today:

1. Air Pollution in today's developing mega-cities is no worse than in earlier developing mega-cities
2. Improving urban air quality is possible, ... but requires very substantial emission reductions: The Los Angeles experience – **Scientific, social, and political dimensions.**
3. Regional transport was not important in Los Angeles – **Exacerbate political dimension?**

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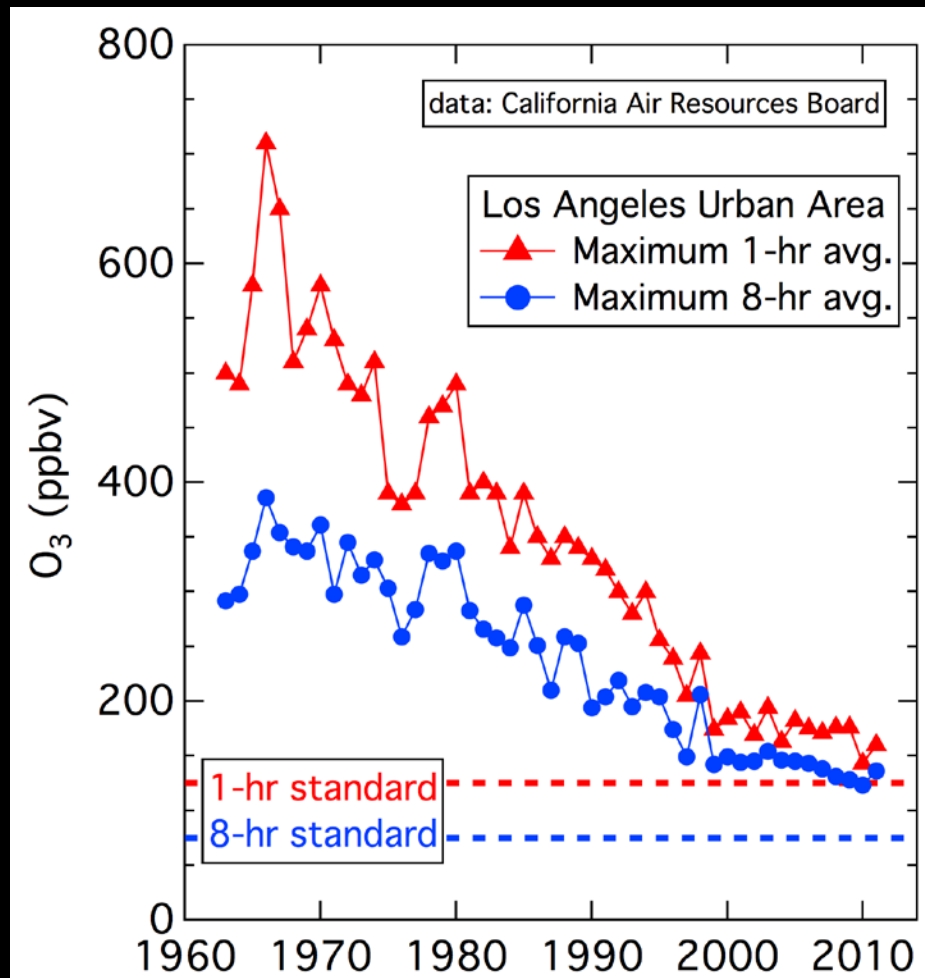
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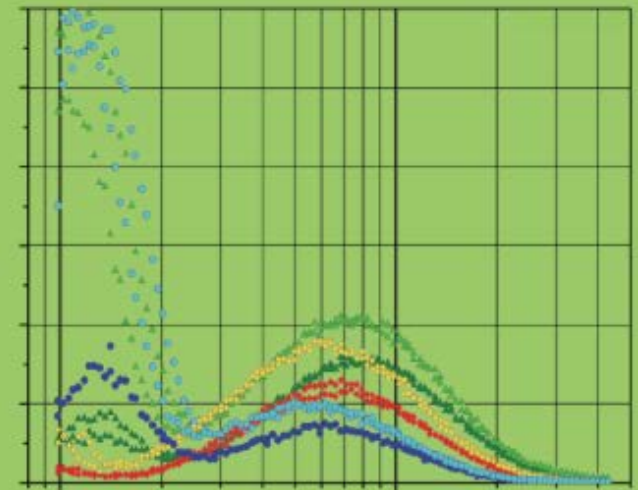
Open Question: How Clean is
Clean Enough?



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