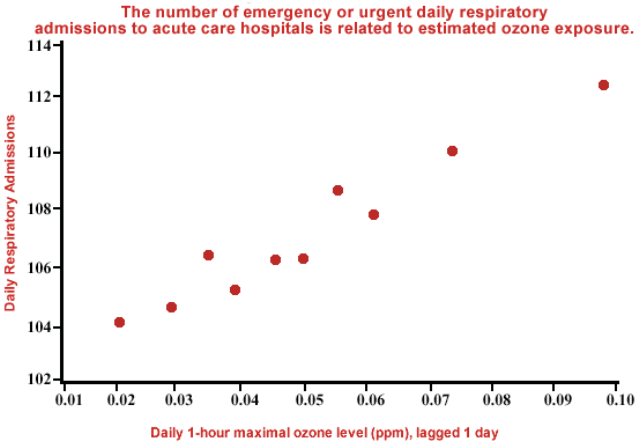
Atmos. Chem. Lecture 14, 10/28/13: Ozone pollution

Brief review of ozone chemistry
Dependence of O_3 on HC, NO_x
Rationale/effects of regulation
Background ozone

Midterm on Wednesday (Oct 30)

Ozone: health effects



http://www.epa.gov/o3healthtraining/population.html

Simplified ozone chemistry

$HC + OH (+ O_2) \rightarrow RO_2 + H_2O$

$RO_2 + NO \rightarrow RO + NO_2$

$RO + O_2 \rightarrow HO_2 + R'CHO$

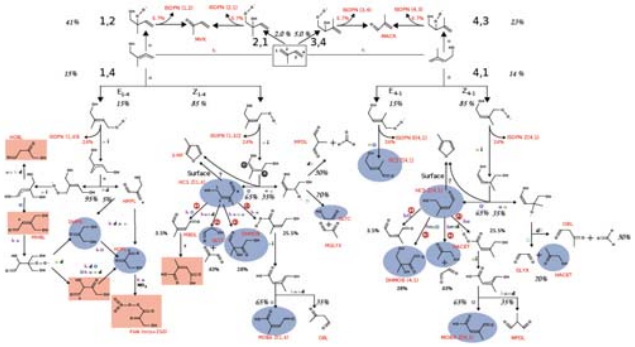
$HO_2 + NO \rightarrow OH + NO_2$

$NO_2 + hv \rightarrow NO + O$

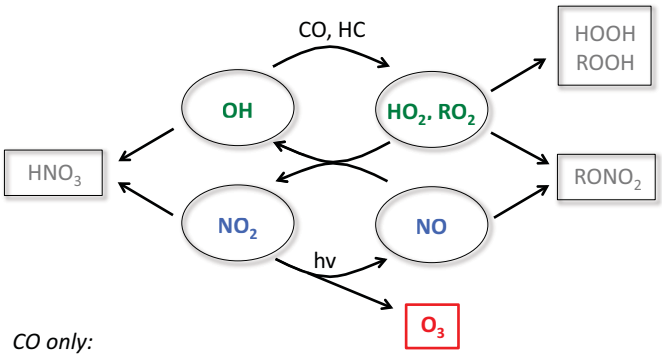
$O + O_2 + M \rightarrow O_3 + M$

note: because of $RO \rightarrow RO_2$ cycling, multiple RO_2's can be formed in a single oxidation step

Paulot et al, *ACP* 9:1479 (2009)



HO_x-NO_x coupling



CO only:

NO_x-limited: $$P_{O_3} = \frac{k_{HO_2+NO}[NO]}{(2k_{HO_2+HO_2})^{1/2}}\left(P_{HO_x}\right)^{1/2}$$

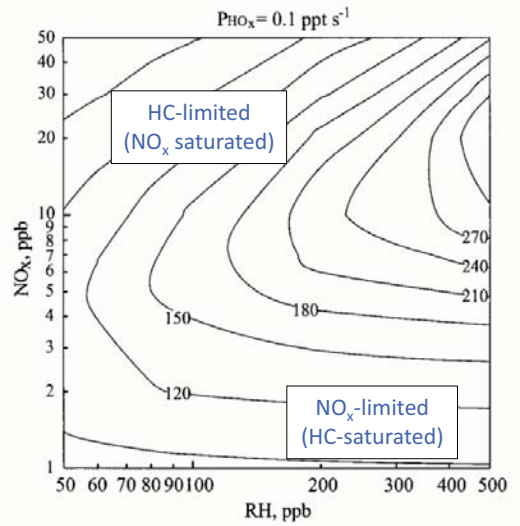
NO_x-saturated: $$P_{O_3} = \frac{k_{CO+OH}[CO]}{k_{OH+NO_2}[NO_2]}P_{HO_x}$$

Dependence of O_3 on HC, NO_x

Image removed due to copyright restrictions. See Table 6.3 in Seinfeld, J. H., and S. H. Pandis. *Atmospheric Chemistry and Physics*, 2nd ed. Wiley 2006.

S&P

Ozone isopleth plot



Jacob

Role of biogenic hydrocarbons

Models and observations of the impact of natural hydrocarbons on rural ozone

M. Trainer*, E. J. Williams*, D. D. Parrish*†, M. P. Buhr*, E. J. Allwine¶, H. H. Westberg¶, F. C. Fehsenfeld & S. C. Liu

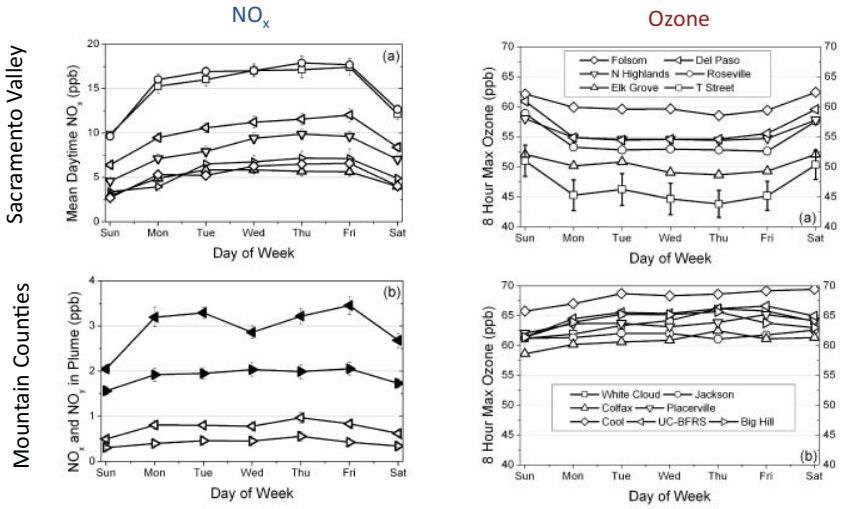
Nature 325:709 (1987)

Image removed due to copyright restrictions. See Fig. 4 in Trainer M., et al. "Models and Observations of the Impact of Natural Hydrocarbons on Rural Ozone." *Nature* 329 (1987): 705-7.

Screenshot removed due to copyright restrictions. See the abstract of the journal article, Chameides, W. L., et al., "The Role of Biogenic Hydrocarbons in Urban Photochemical Smog: Atlanta as a Case Study." *Science* 241 no. 4872 (1988): 1473-5.

Science 241:1473 (1988)

Weekend effect



Murphy et al., *ACP* 7:5327 (2007)

Dependence on NO, P_{HOx}

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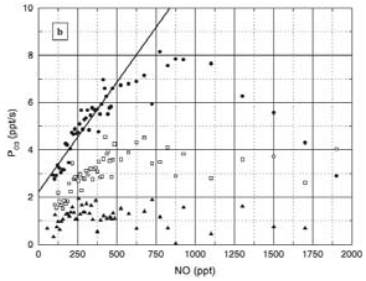


Thornton et al. *JGR* 107:4146 (2002)

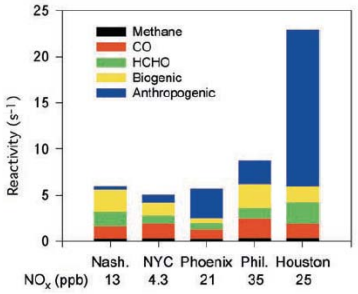
Ozone production efficiency

Number of O_3 molecules made by an average NO_x molecule
(radical chain length ε)

[Note: Additional material is discussed here during lecture.]

OPE: O_x vs. NO_z (=NO_y-NO_x)

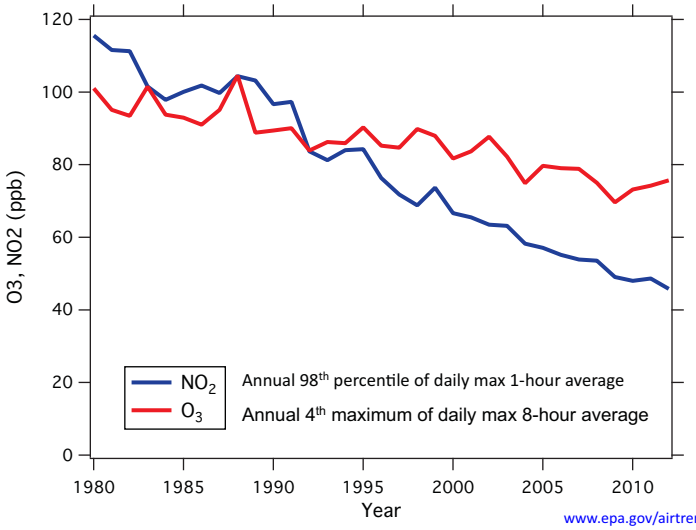
Image removed due to copyright restrictions. See Figure 6.11 in Seinfeld, J. H., and S. H. Pandis. *Atmospheric Chemistry and Physics*, 2nd ed. Wiley 2006.



S&P

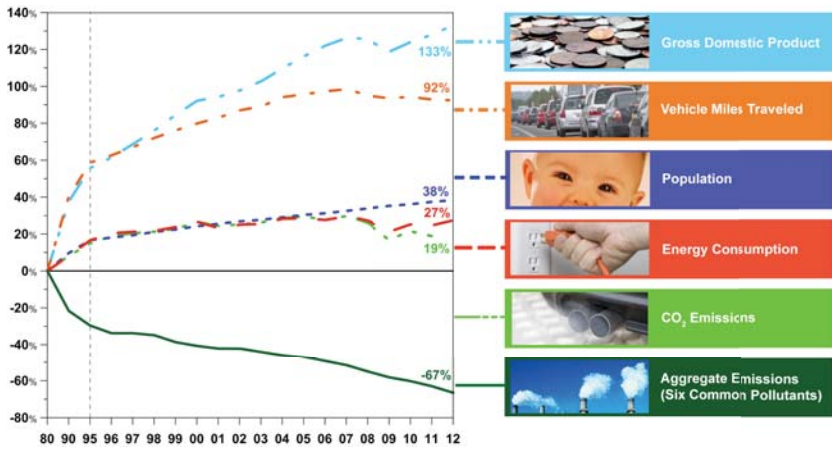
Kleinman et al., *GRL* 29:1467 (2002)

U.S. ozone trends, 1980-2012



www.epa.gov/airtrends/aqtrends.html

U.S. growth metrics, 1980-2012



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http://www.epa.gov/airtrends/aqtrends.html

Background (non-local) O_3

Image removed due to copyright restrictions. See Fig. 2 in Jaffe, D., et al. "Increasing Background Ozone During Spring on the West Coast of North America." *Geophysical Research Letters* 30, no. 12 (2003): 1613.

Jaffe et al., *GRL* 30:1613 (2003)

Global ozone background

Image removed due to copyright restrictions. See Table 2 in Fiore, A. M., et al. "Linking Ozone Pollution and Climate Change: The Case for Controlling Methane." *Geophysical Research Letters* 29, no. 19 (2002): 1919.

Fiore et al., *GRL* 29:1919 (2002)

Ozone pollution in a changing climate

Image removed due to copyright restrictions. See Table 6.1 in "Ground-Level Ozone in the 21st Century: Future Trends, Impacts and Policy Implications." The Royal Society Science Policy Report 15/08, October 2008.

Royal Society: *Ground-level ozone in the 21st century: future trends, impacts and policy implications*, 2008

1.84J / 10.817J / 12.807J Atmospheric Chemistry
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