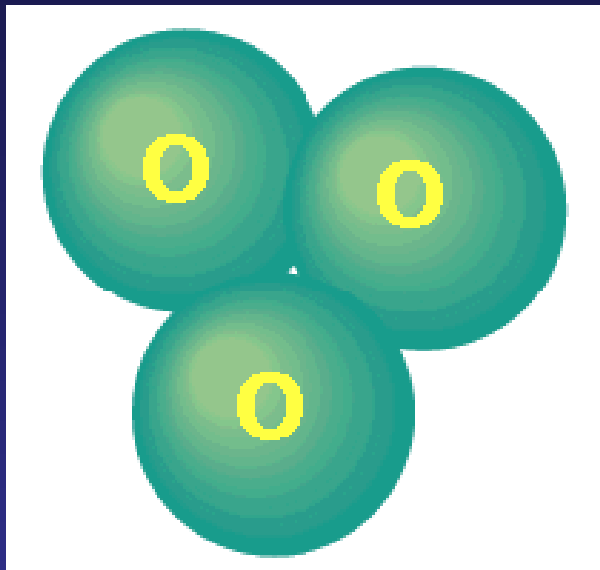


Tropospheric Ozone and Air Quality



Ozone (O₃)

Introduction: Motivation and Background

Jim Wilczak (PSD) and Joost DeGouw (CSD)

Emissions, Chemistry and Transport:

Christoph Senff and Joost DeGouw (CSD)

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Georg Grell (GSD)

Future Outlook:

Joost DeGouw (CSD)

Good Ozone



30 miles

Protective Ozone Layer

Stratosphere

Troposphere

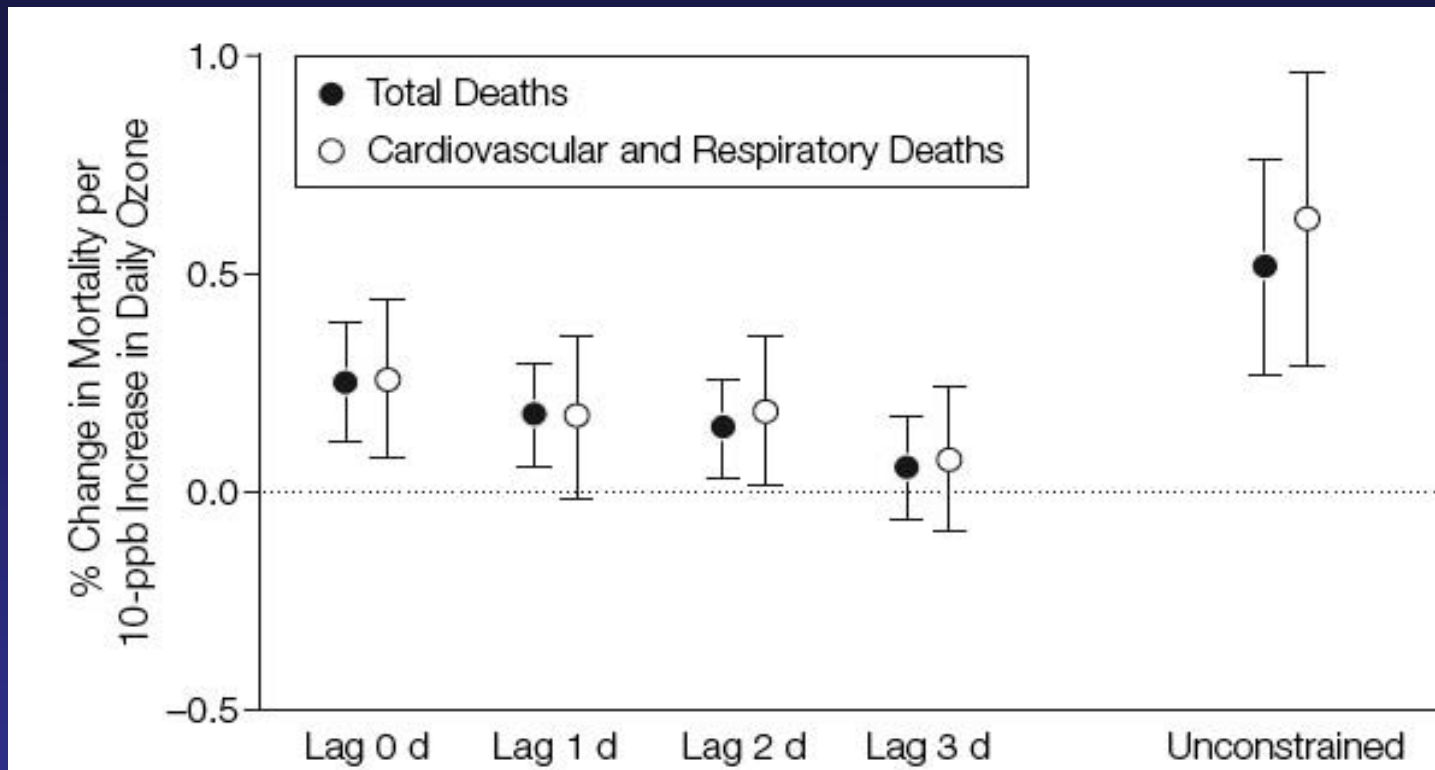
6 miles

Smog

Earth

Bad Ozone

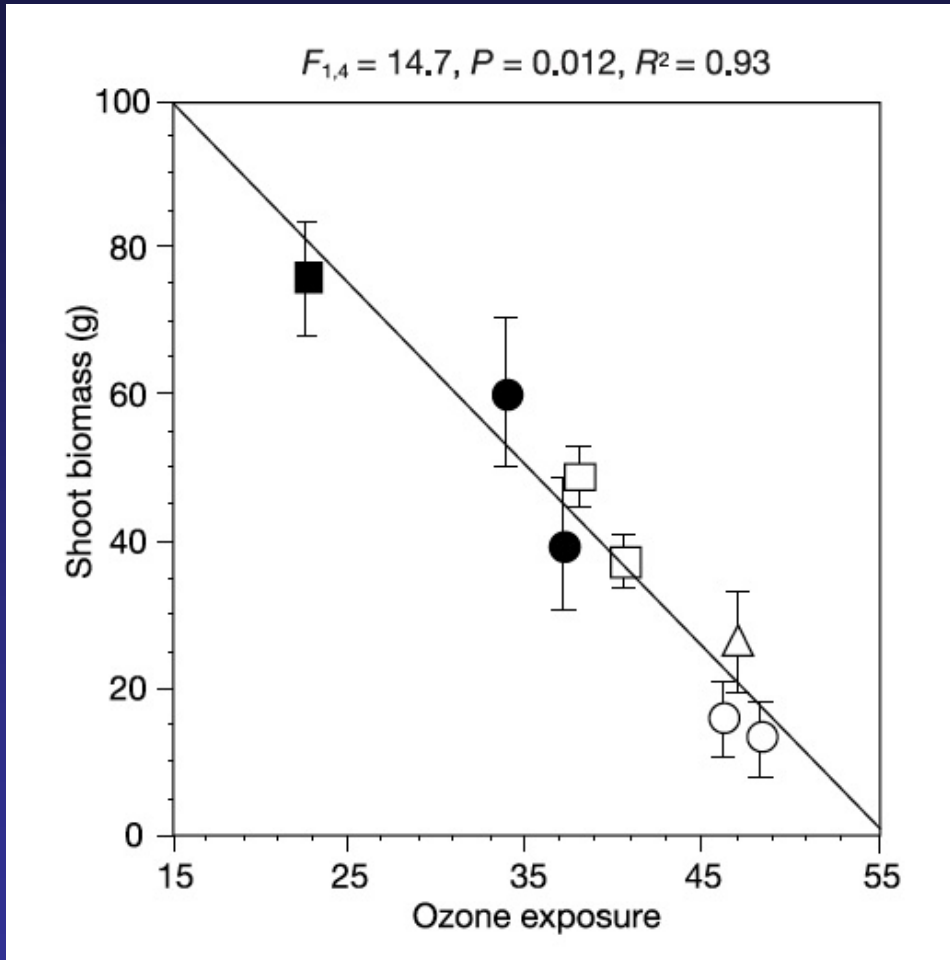
Impacts of Elevated Ozone: Human Health



Bell et al., JAMA 2004

- Health-related costs to society >\$100 Billion
 - Damages respiratory tract; causes and aggravates asthma
- Reduce lung capacity enhances mortality: >20,000 premature deaths per year
- Adverse health effects are observed at levels below present 84 ppb EPA standard

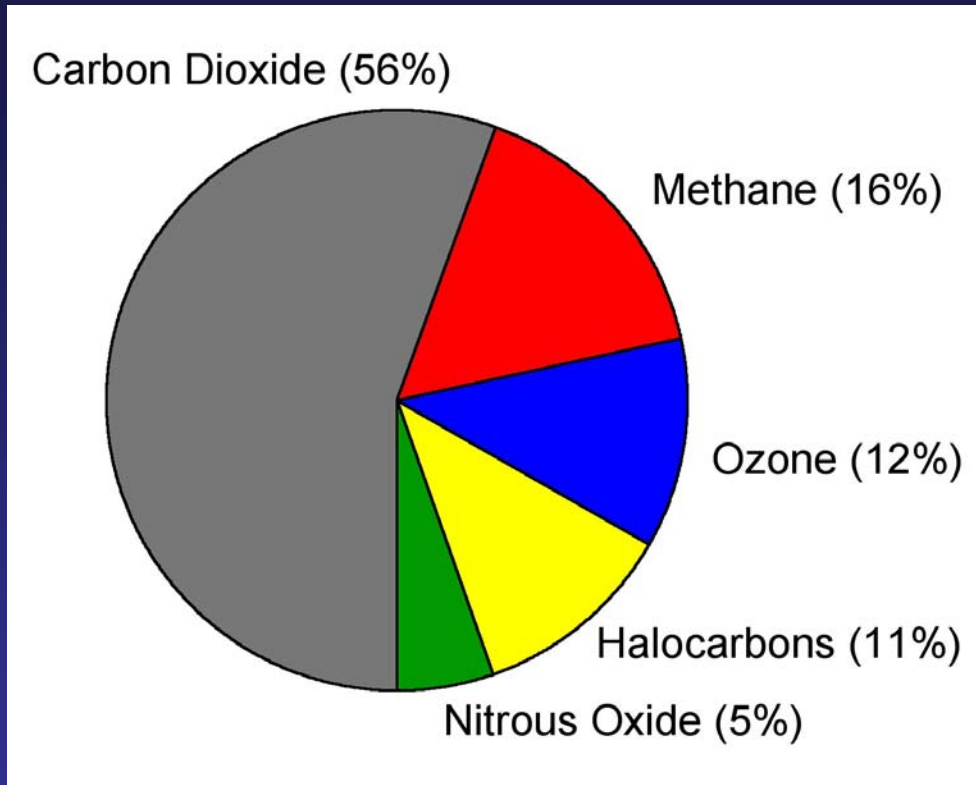
Impacts of Elevated Ozone: Ecosystem



- Reduction in crop yields costs \$3-5 Billion/year
- Reduced carbon uptake leaves more CO₂ in the atmosphere

Gregg et al., *Nature* 2003

Impacts of Elevated Ozone: Climate

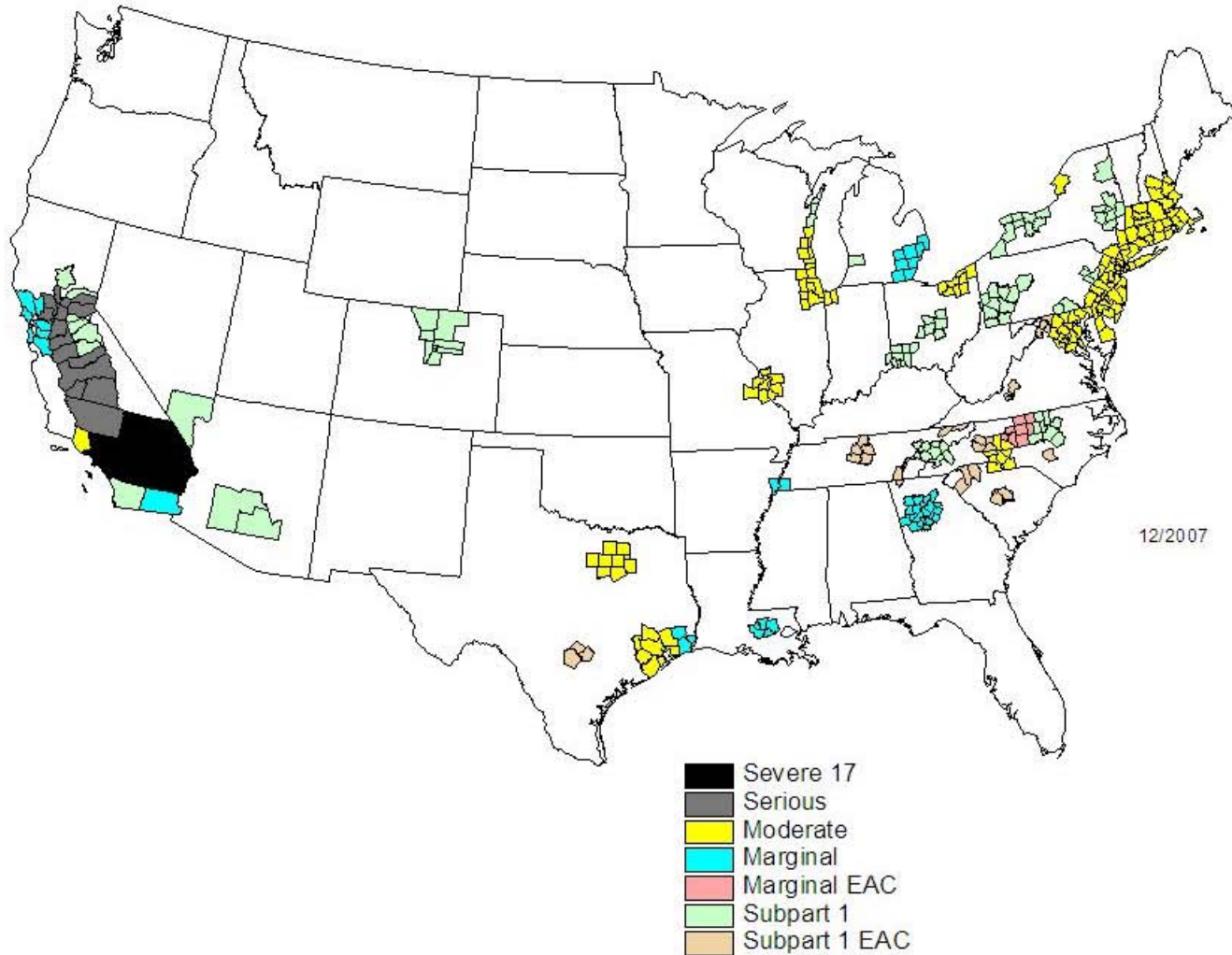


Relative contribution to radiative forcing from the five main greenhouse gases in the troposphere

IPCC, 4th Assessment report, 2007

- Ozone is a greenhouse gas, accounting for 12% of radiative forcing due to all anthropogenic greenhouse gases.

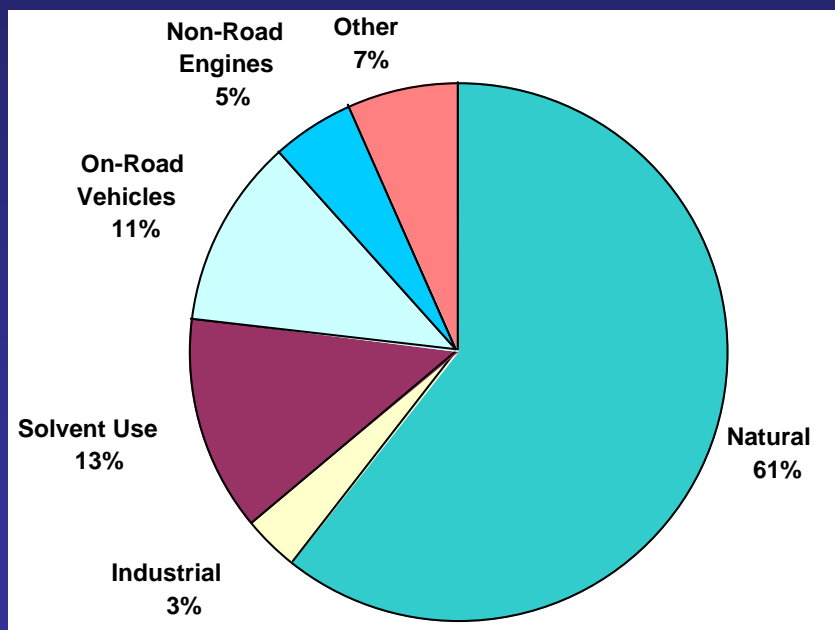
Counties Designated Nonattainment for EPA 84 ppb 8-hour Ozone Standard



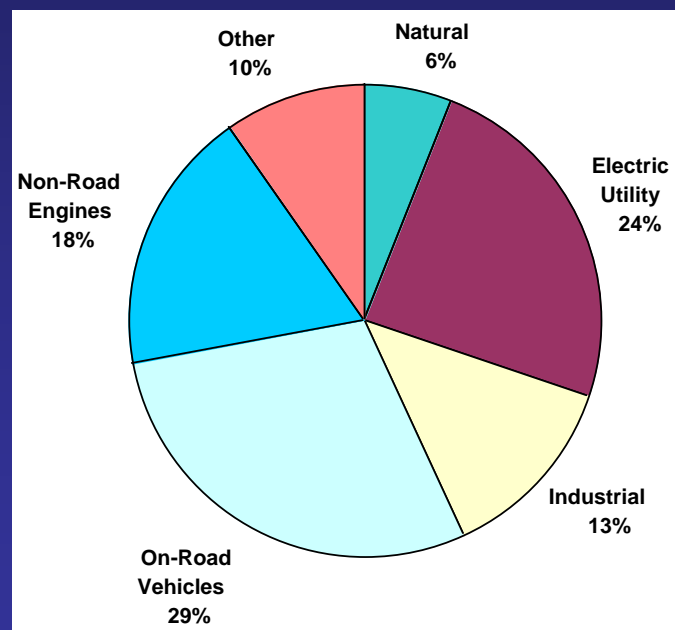
Formation of Ozone in the Troposphere

de Gouw &
Senff (CSD)

Ozone is not directly emitted but formed from the photochemical oxidation of volatile organic compounds (VOCs) in the presence of nitrogen oxides (NO_x):



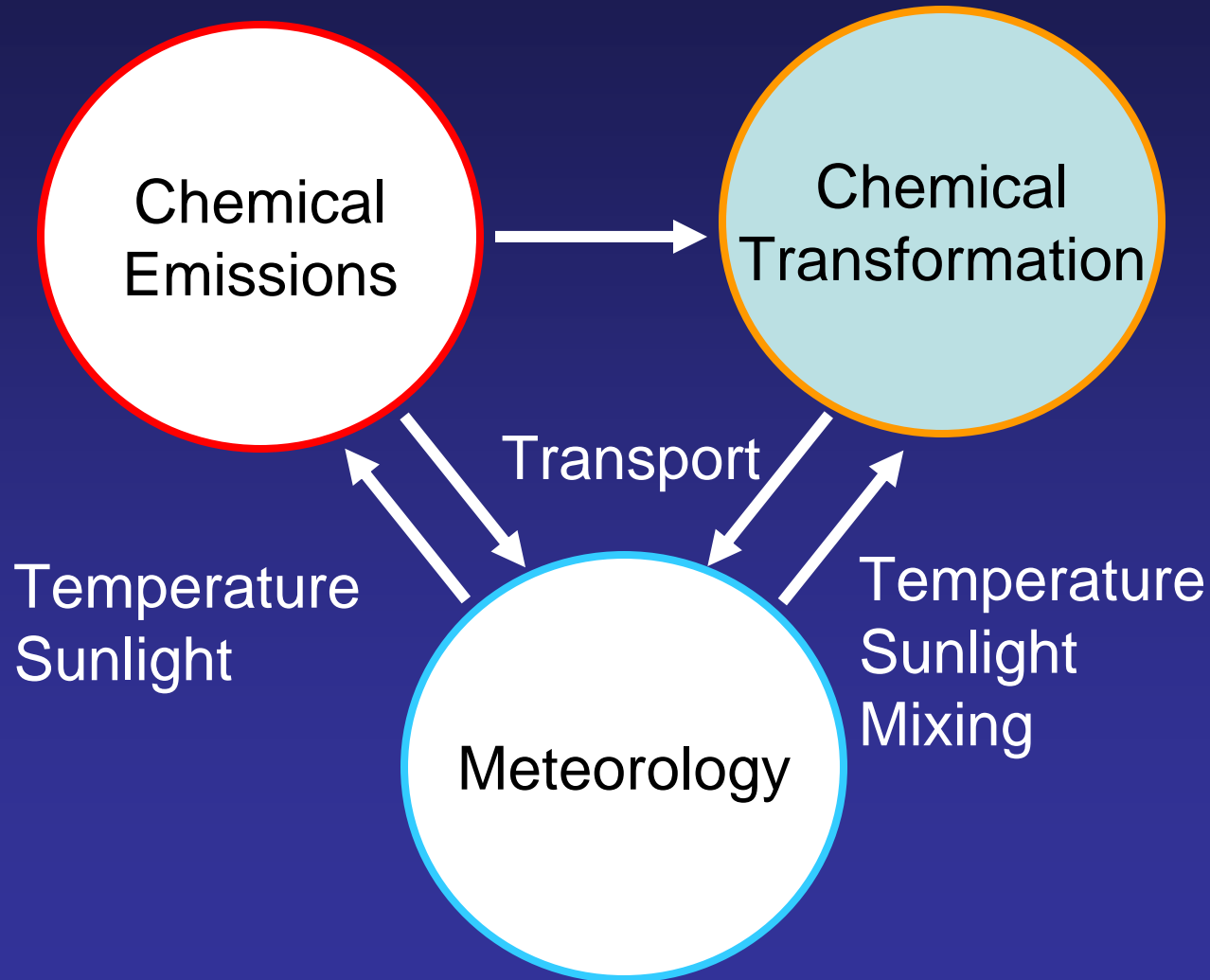
U.S. Sources of VOCs



U.S. Sources of NO_x

Model of Ozone Life-Cycle

Grell (GSD)
Bao (PSD)



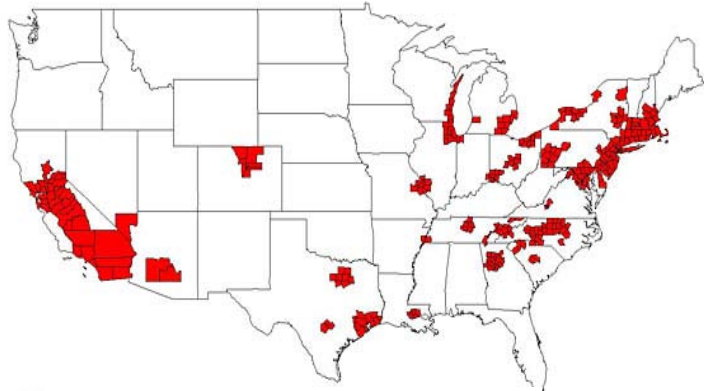
California ozone compliance costs

- More than \$50 Billion for California to reach compliance with EPA 84 ppb standard
 - Automotive emissions including gasoline reformulation
 - Power plant emissions
 - Ship fuel
 - Catalytic converters on trains, replacing diesel engines on construction and agricultural equipment
 - Consumer products (e.g., paint, lawnmowers, aerosol sprays)

EPA is Conducting a Review of the Ozone Standard

Based on known health effects, recommendation is to reduce maximum allowable ozone from 84 ppb to between 60-80 ppb.

Attainment and Nonattainment Areas in the U.S.
8-Hour Ozone Standard

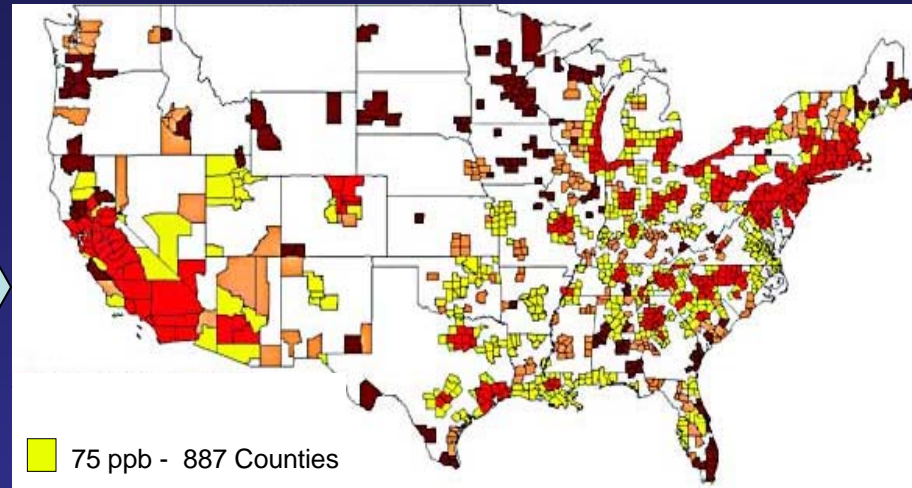


■ Nonattainment Areas (347 Counties)

Source: U.S. EPA

12/2007

Changing
Standards



■ 75 ppb - 887 Counties
■ 70 ppb - 1091 Counties
■ 60 ppb - 1243 Counties

Source: Based upon U.S. EPA data interpreted by A.S.L. & Associates, Helena, MT

7/2007

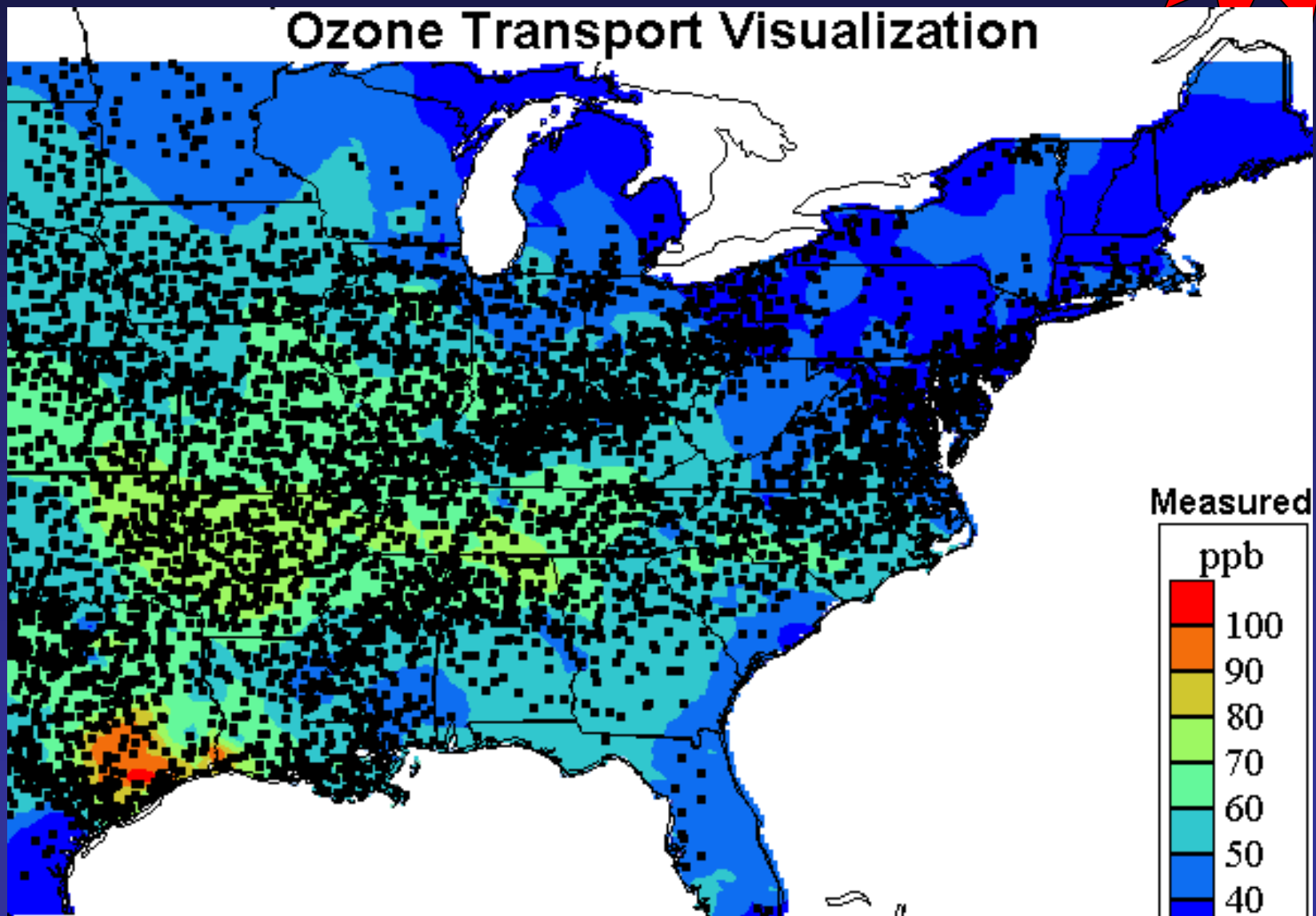
Present Nonattainment Areas

Estimated Future Nonattainment
Areas

- *With new standard, questions regarding meteorological transport will become even more important*

Grell (GSD)
Bao (PSD)

Ozone Transport Visualization

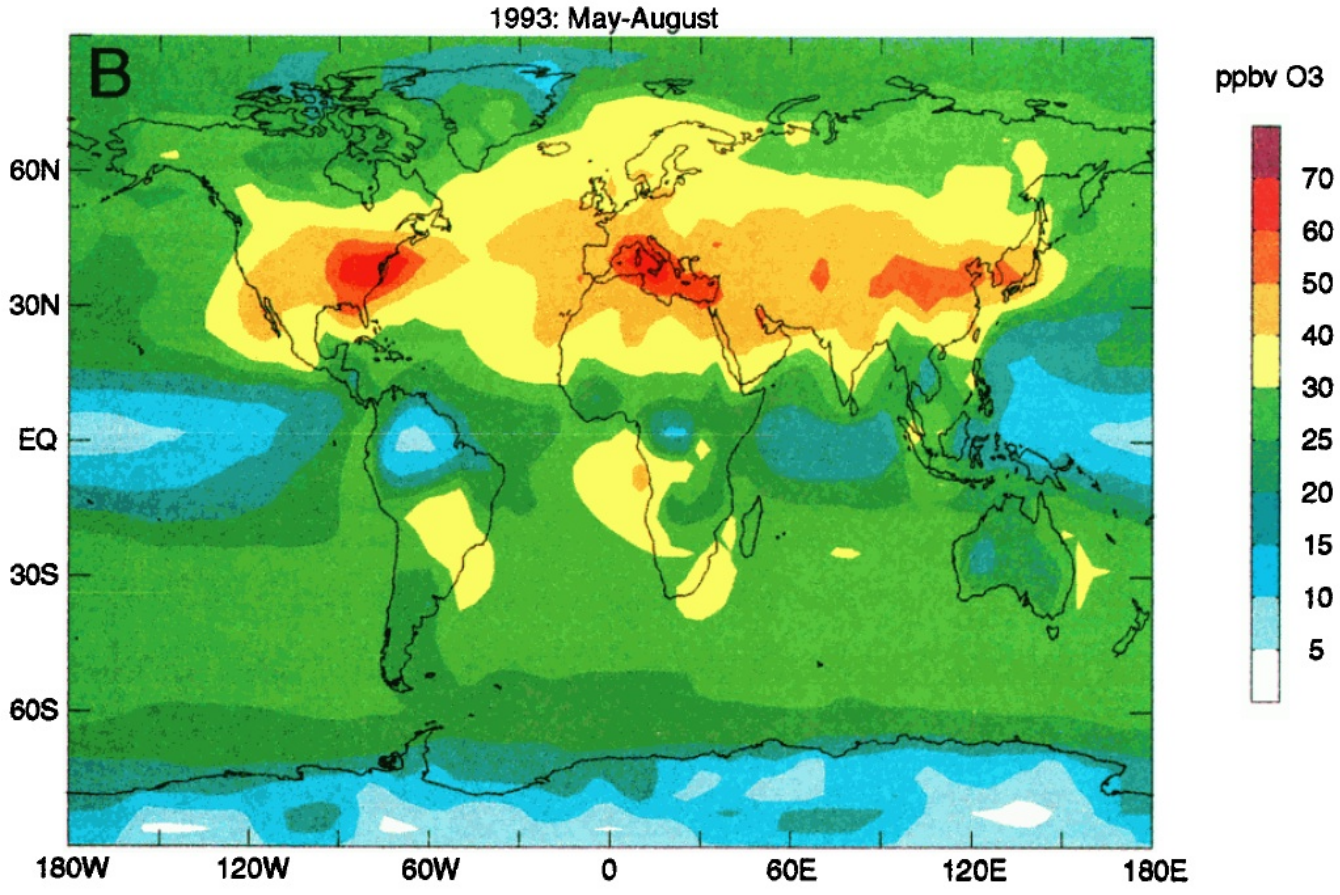


06/06/1991 14:00

Particles: Flow Visualization

Global Distribution of Ozone

Schnell (GMD)



Lelieveld & Dentener, *JGR* 2000

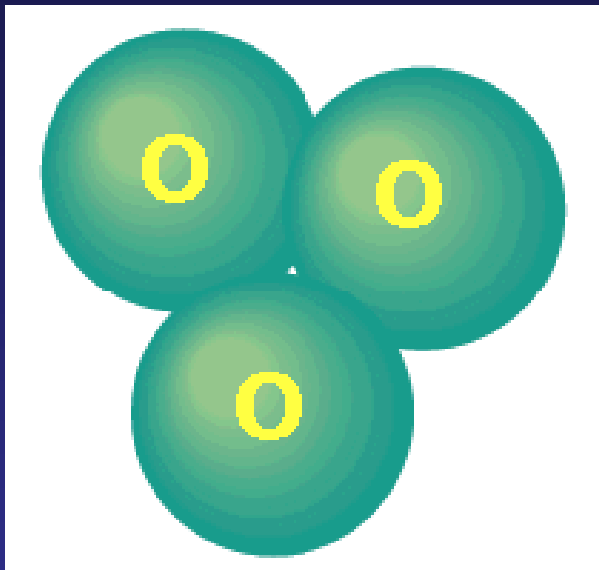
Northern Hemisphere Summer:

- Surface maxima over U.S., Mediterranean and E. Asia
- Transport is a global issue

Ozone Research in NOAA

- ESRL
 - (CSD-emissions, transformations)
 - (GMD- global distribution)
 - (PSD-meteorological processes)
 - (GSD-model development)
- NOAA (ARL, NWS, GFDL)
- NOAA (research & forecasting)-EPA (mostly regulatory)

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