



Personal Monitoring Needs for Ozone Exposure Assessment and Health Effects Evaluations

June 26, 2018

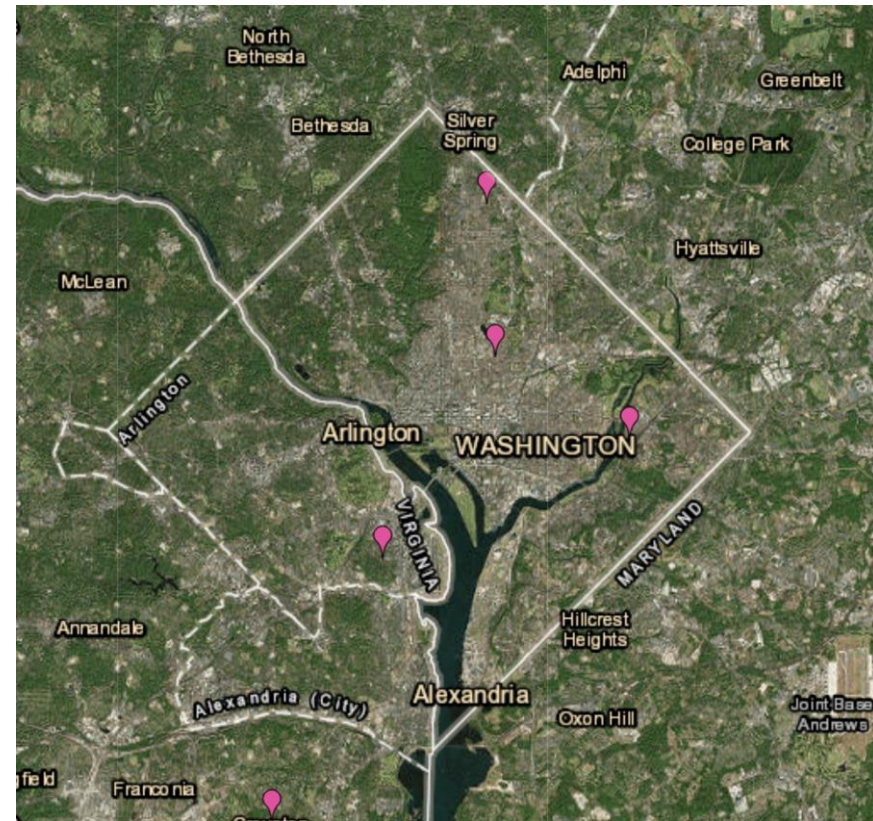
George D. Thurston, ScD.
Professor
NYU School of Medicine

Topics of Discussion

- Past Ozone Monitoring in Health Effects Studies
- Personal Exposure Assessment Challenges using Central Site Monitoring
- Future Performance Needs, from a Health/Air Pollution Epidemiology Perspective

Limitations in Past Central-Site Ozone Exposure Estimation for Population-Based Health Effects Studies

- Limited number of sites outdoors (e.g., 4 in DC)
- Quenching near NO Sources (e.g., Traffic):
[$\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$]
- Rooftop locations
- Differences between Indoors and Outdoors due to Ozone's high reactivity



Population Studies Were Informative, but Limited To Citywide Rooftop O₃ Avg. Exposures

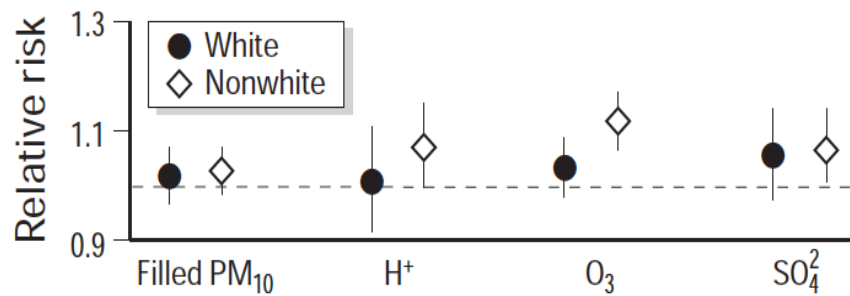
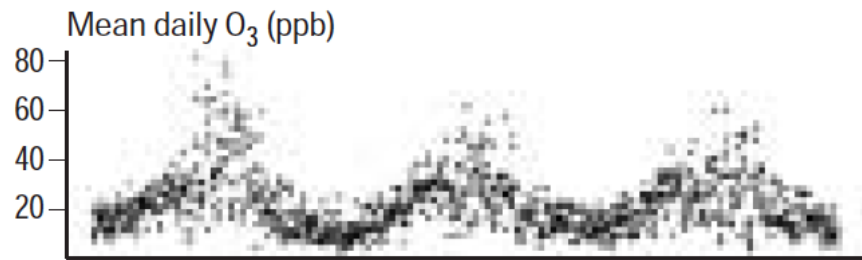


Figure 4. New York City, New York, race-specific relative risks (based upon the maximum minus mean increment) and their 95% CI for hospital admissions outcomes.

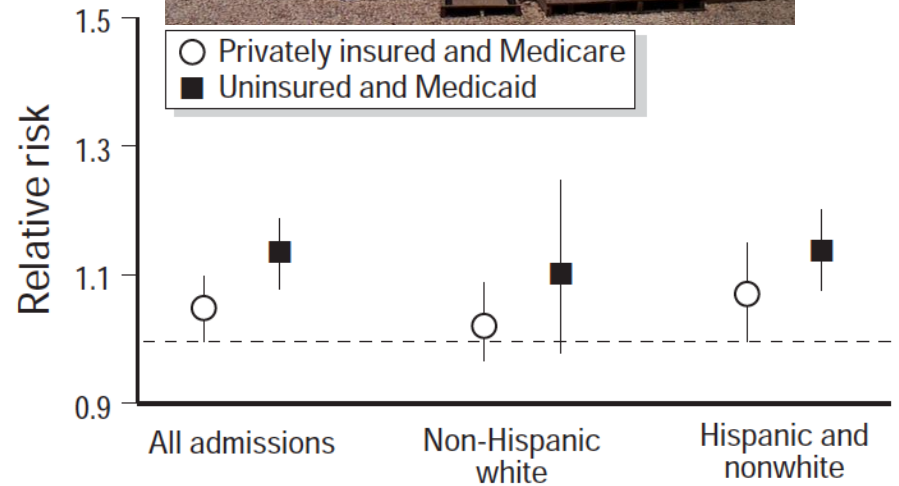
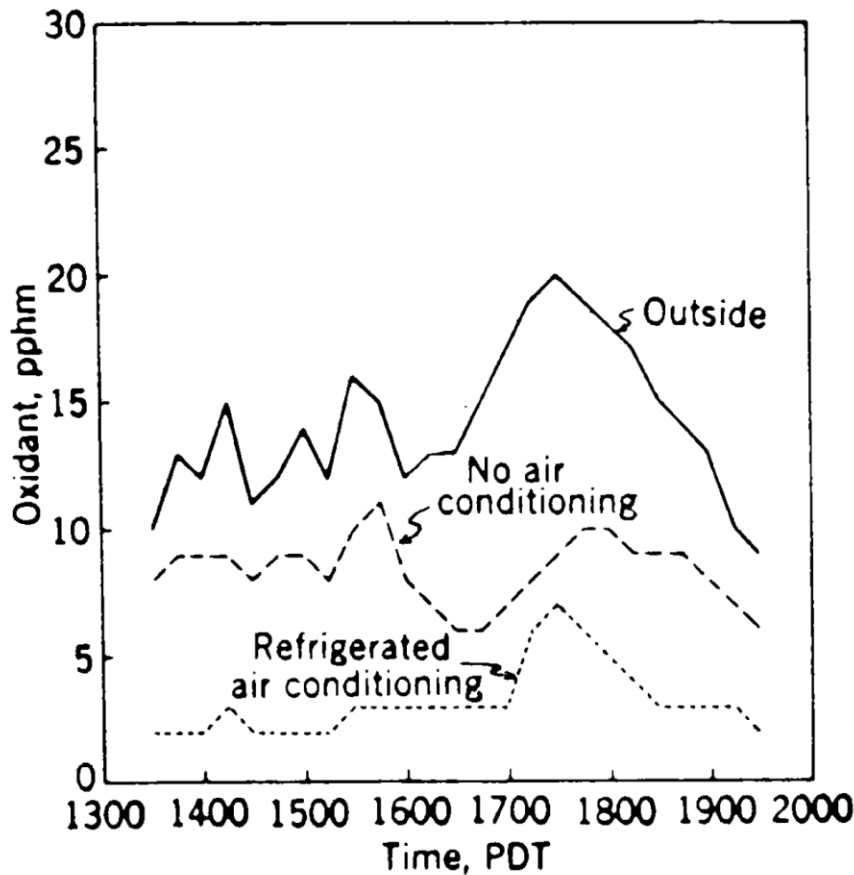


Figure 6. White and nonwhite O₃ relative risks (based upon the maximum minus mean increment) and their 95% CI for respiratory hospital admissions by insurance status in New York City, New York.

Outdoor Concentrations Differ Indoor vs. Outdoor, High vs. Low Traffic

FIG. 5. TOTAL OXIDANT CONCENTRATIONS OUTSIDE AND INSIDE AN AIR-CONDITIONED HOSPITAL (from ref. 13)

Heuss, Kahlbaum, and Wolff



(Expressed as ozone, 1 pphm = $21.4 \mu\text{g}/\text{m}^3$)

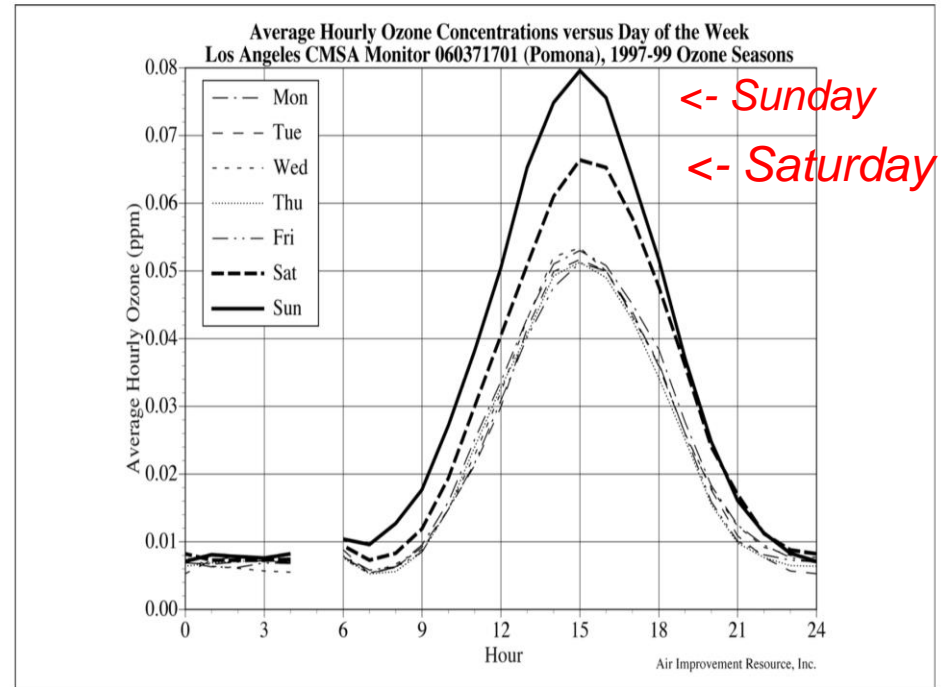


Figure 1. Average hourly O_3 concentrations vs. day of week for Los Angeles CMSA monitor 060371701 (Pomona), 1997-1999 O_3 seasons.

Outdoor Concentrations Differ With Height of Measurement

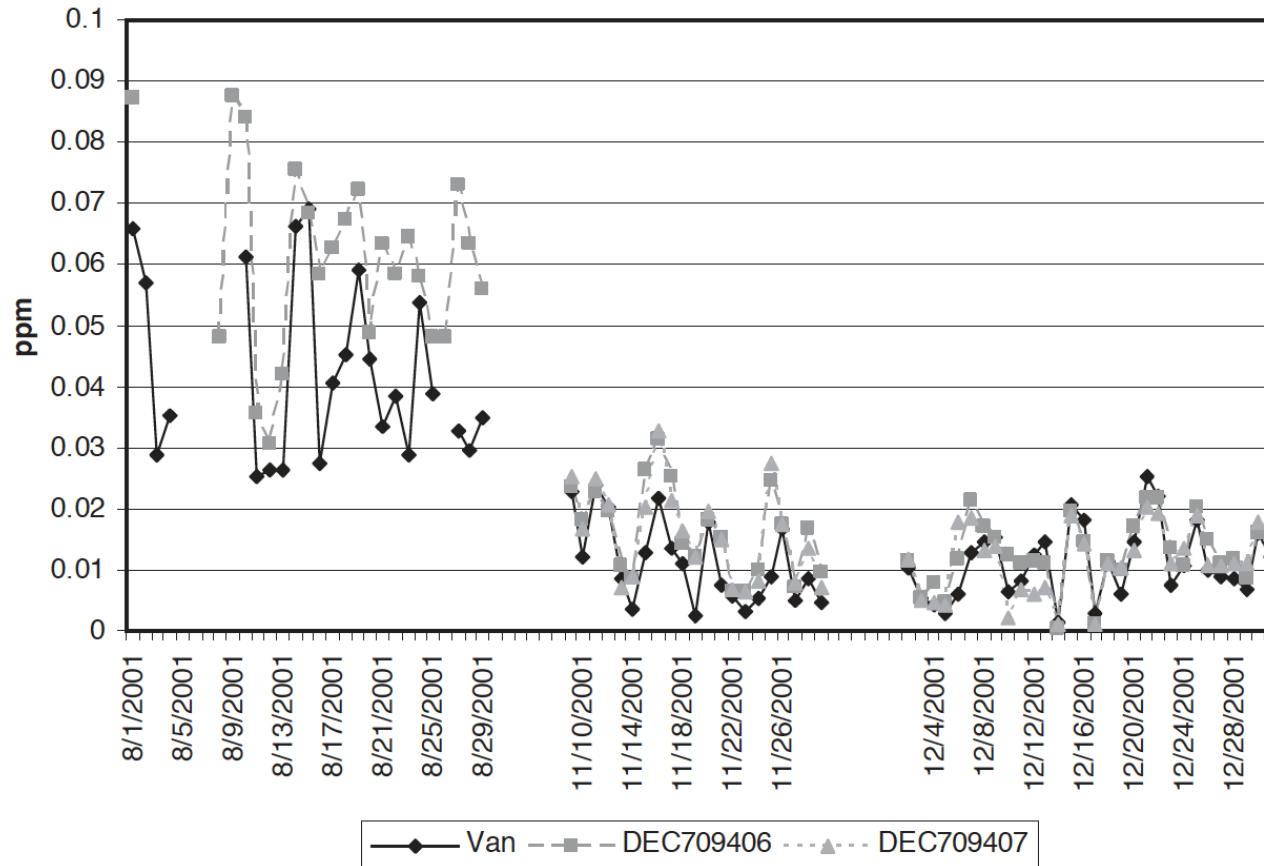
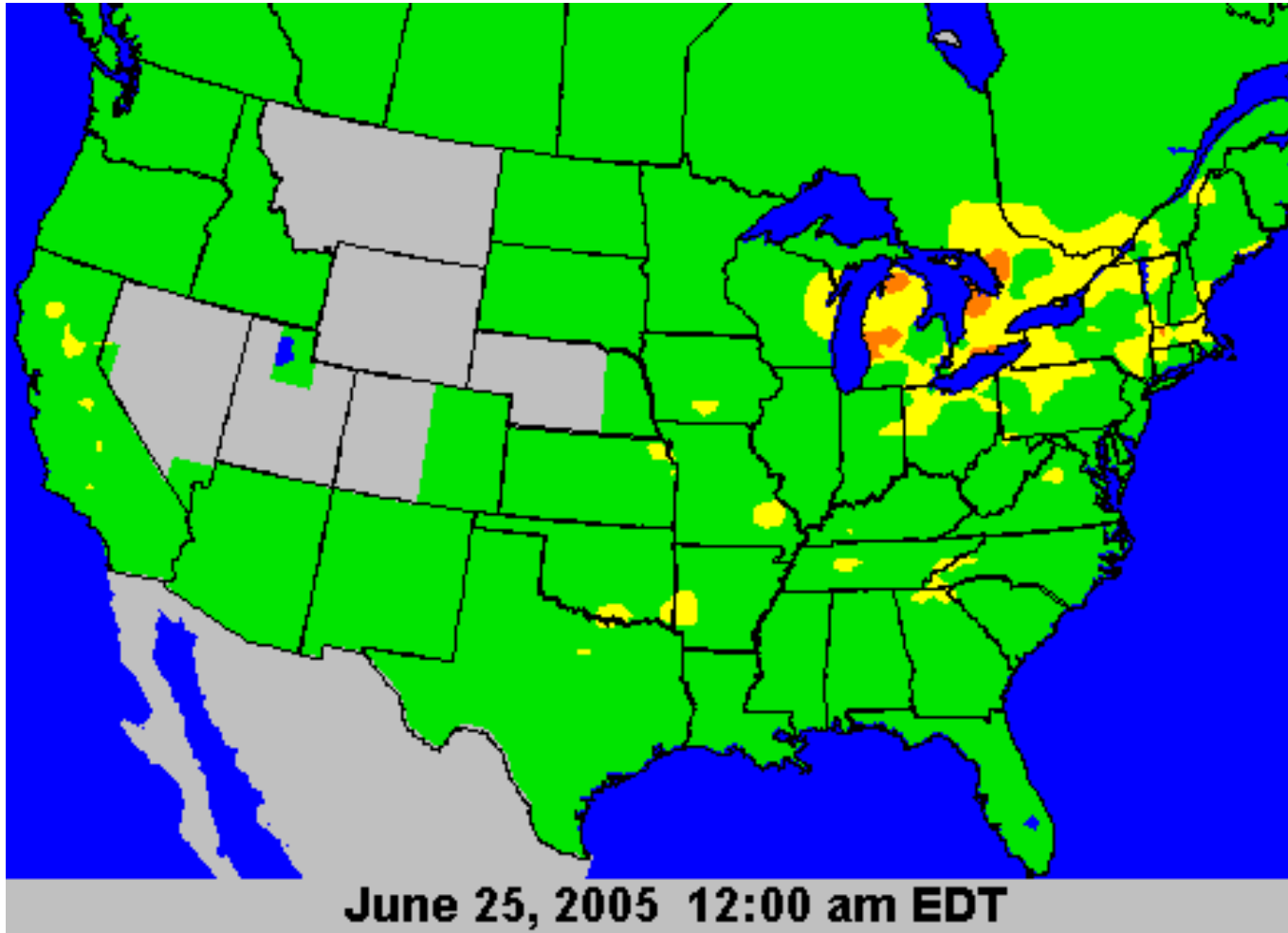


Fig. 6. Comparison of O₃ data, daily 1-h maxima, 2001.

Restrepo et al, A comparison of ground-level air quality data with New York State Department of Environmental Conservation monitoring stations data in South Bronx Atmospheric Environment, 2004.

Outdoor Concentrations Vary Widely Spatially and Over Time

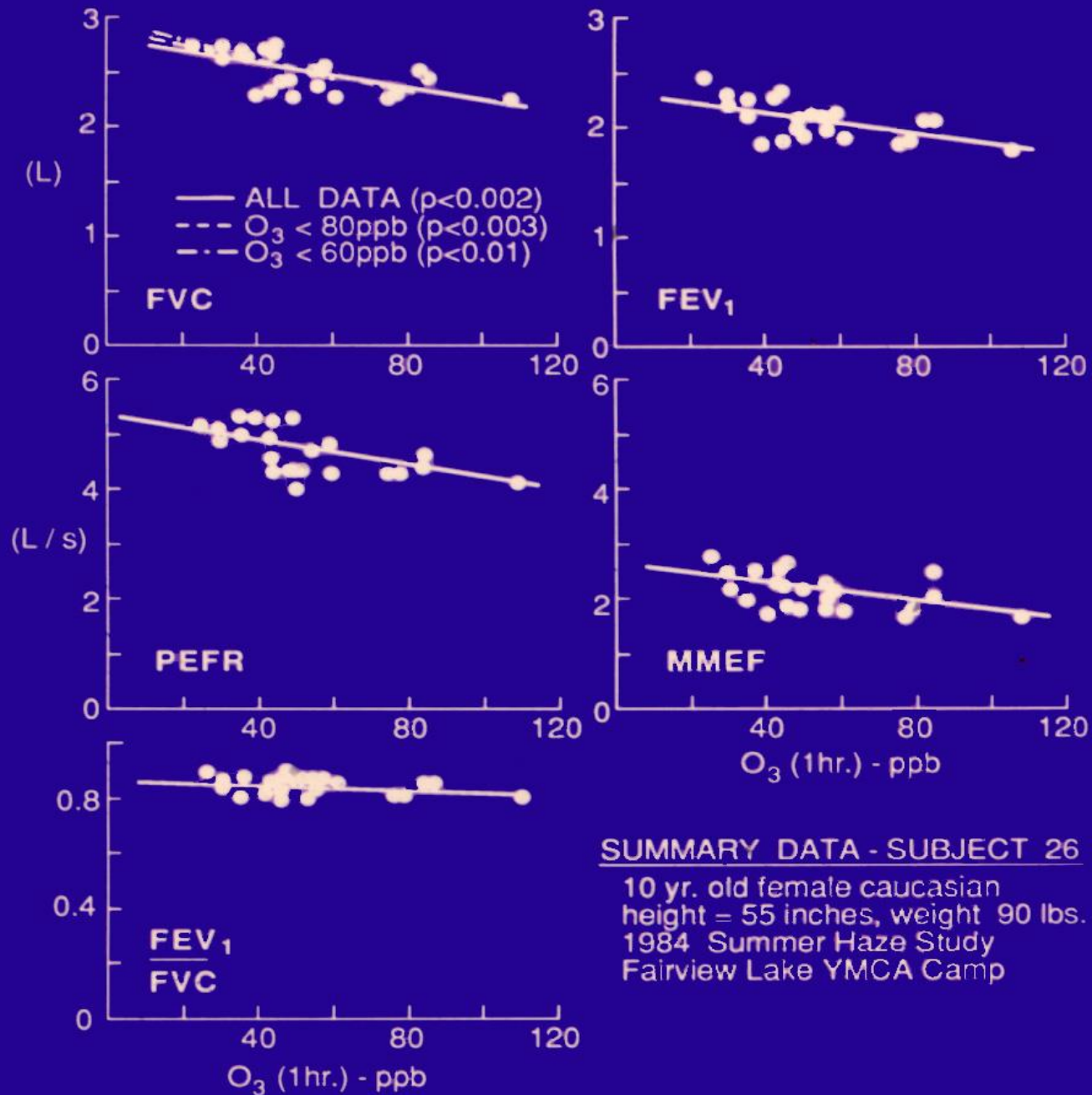


*Field Panel Studies
Helped Reduce
Exposure
Misclassification*



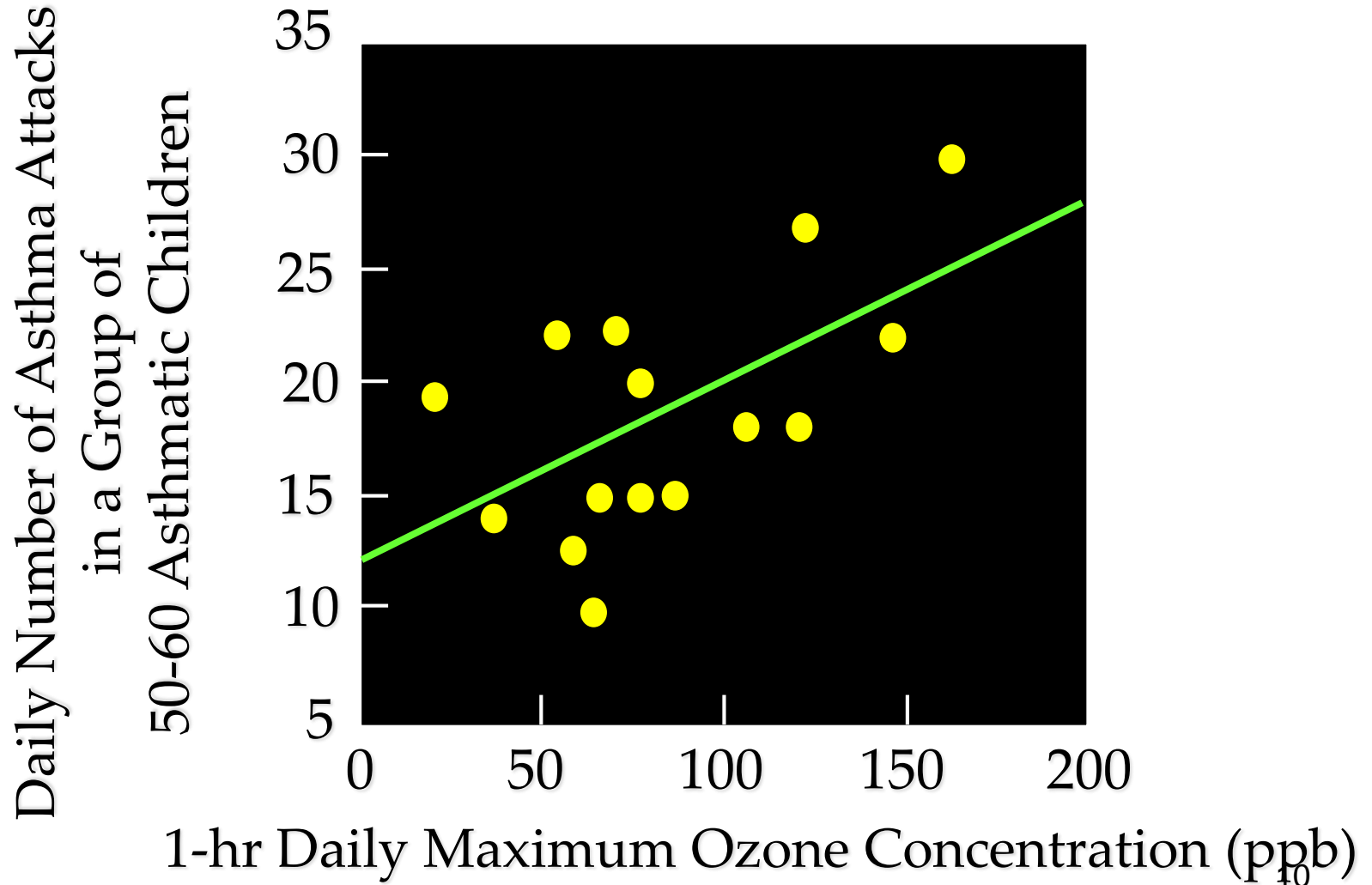
*The Fairview
Lake, NJ Study
Found
Lung Function
Decreases
Even With
Ozone Levels
Below the 1-Hr.
Legal Limits,
and
With
Larger
Impacts than
found in 1-hr.
Exposure
Chamber
Studies*

NYU - HARVARD - EPA FIELD STUDY - 1984



Daily Asthma Attacks in Children Increase as Pollution Levels Rise

(Thurston et al., JRCCM 1997)



Personal Health Measures Have Also Improved Over Time



<- **THEN:** Mechanical Peak Flow meters

NOW: Shirt Measurements ->

- ECG & Heartbeat monitor (HRV), and Heart Rate Recovery
- Breathing Rate (RPM), Minute Ventilation (L/min)
- Activity intensity, peak acceleration, steps, cadence, positions and sleep tracker
- Bluetooth connectivity



WEARABLE BODY METRICS

Portable Ozone Monitoring Options, Each with Advantages and Disadvantages, Include:

- **Electrochemical Ozone Sensor Systems**
- **UV Absorption Monitors**
- **Heated Metal Oxide Sensor Cell (HMOS)**
- **Badge/strip**

Ozone Monitoring Performance Needs for the Next Generation of Health Studies at the Personal Level

Technical Performance Aims

- Meet **Federal Reference Method** Equivalence Req'm'ts*
- **Short time resolution** (e.g., 1 minute to 1-hr)
- **Minimal Indoor HC, NO₂, or Humidity interferences** (e.g., many aromatic compounds absorb 254-nm UV light).
- **Low Minimum O₃ Detection limit** (e.g., down to below ambient background levels, <10 ppb).

* e.g., 2B POM in *Federal Register* / Vol. 80, No. 165 / Wednesday, August 26, 2015

Ozone Monitoring Performance Needs for the Next Generation of Health Studies at the Personal Level

Health Research Performance Aims

- **Convenient portability and reasonable cost** (e.g., < \$1000 per unit)
- **Long battery life**, easy recharge
- **Synchronous Geospatial Info** (e.g., with Smartphone)
- **Automated monitoring data Wireless Uploading**, with remote cross-checking and calibration (QA/QC).
- **Integration with continuous digital personal health metric monitoring** (e.g., respiratory and cardiac), rather than only once or twice per day health data.