Ozone Effect on Mortality

A multi-site time series studie

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Outline of Presentation

- Introduction
- Aims
- Method and analysis
- Summary
- Future work

Ozone & Morbidity / Mortality

- Pulmonary function declines with repeated daily ozone exposure (<0.25 ppm).
- Positive association has been found between respiratory admission & summer ozone exposure.
- Significant association has been found between daily mortality & ozone in Los Angeles, New York.
- Ozone exposure might be related to daily fluctuations in admissions for congestive heart failure in the elderly.

- **Audrey, Galizia, 1999; Delvin RB, 1991; Folinbee LJ, 1988; Kinney PL, 1996**
- **Richard Burnett, and etc, 1996, 1997.**
- **P.L. Kinney and H. Ozkaynak, 1991, Association bw/ ozone & daily mortality**

NMMAPS Data

(The national mortality morbidity Air pollution study)

- **Mortality (1987 – 1994)**
  -- National Center for Health Statistics
  - **Total, CVD, RESP, Oth for three age groups (<65, 65-75, >75)**
- **Air pollution (1987 – 1994)**
  -- Environmental Protection Agency
  - **PM_{10}, O_3, CO, SO_2, and NO_2**
- **Meteorology (1987 – 1994)**
  -- National Climatic Data Center
  - **Temperature and dew point**
- **Summer months only (6,7,8,9)**

Location of Cities

Outcome

- **CVDRESP death = CVD + RESP**
- **Reasons:**
  - **People with existing respiratory diseases might be more sensitive to ozone exposure.**
  - **Ozone exposure might be related to congestive heart failure in the elderly.**
  - **O3 exposure is likely not to be associated with other-cause related death.**

- **Audrey, Galizia, 1999; Delvin RB, 1991; Folinbee LJ, 1988; Kinney PL, 1996**
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Aims

1. to estimate city-specific and overall relative rates of CVD & RESP mortality from summer exposure to ozone combining information across the largest 20 US cities.
2. to explore the exposure-response time lag.
3. to investigate the confounding effects of other pollutants
4. to explore the sensitivity of the results to the adjustment for trends.

Confounding

- Meteorology confounders:
  - **Temperature**
  - **Dew point temperature**
- Biologic confounders:
  - **Age**
  - **Time**
  - **Day of week.**
- Confounding from other pollutants:
  - **PM_{10}, CO, SO_2, and NO_2**

Stage I - city-specific effect

- Poisson time series regression by Generalized Additive Model
- Model:

  log (E[y]) ~ [O3] + age + dow
  + s(Time,8) + s(temperature,8)

  log (E[y]) ~ [O3] + [mix pollutant] + age + dow
  + s(Time,8) + s(temperature,8)
- [O3]: different lag --- lag 0/1/2
- [mix pollutant]: **PM_{10}, CO, SO_2, and NO_2**

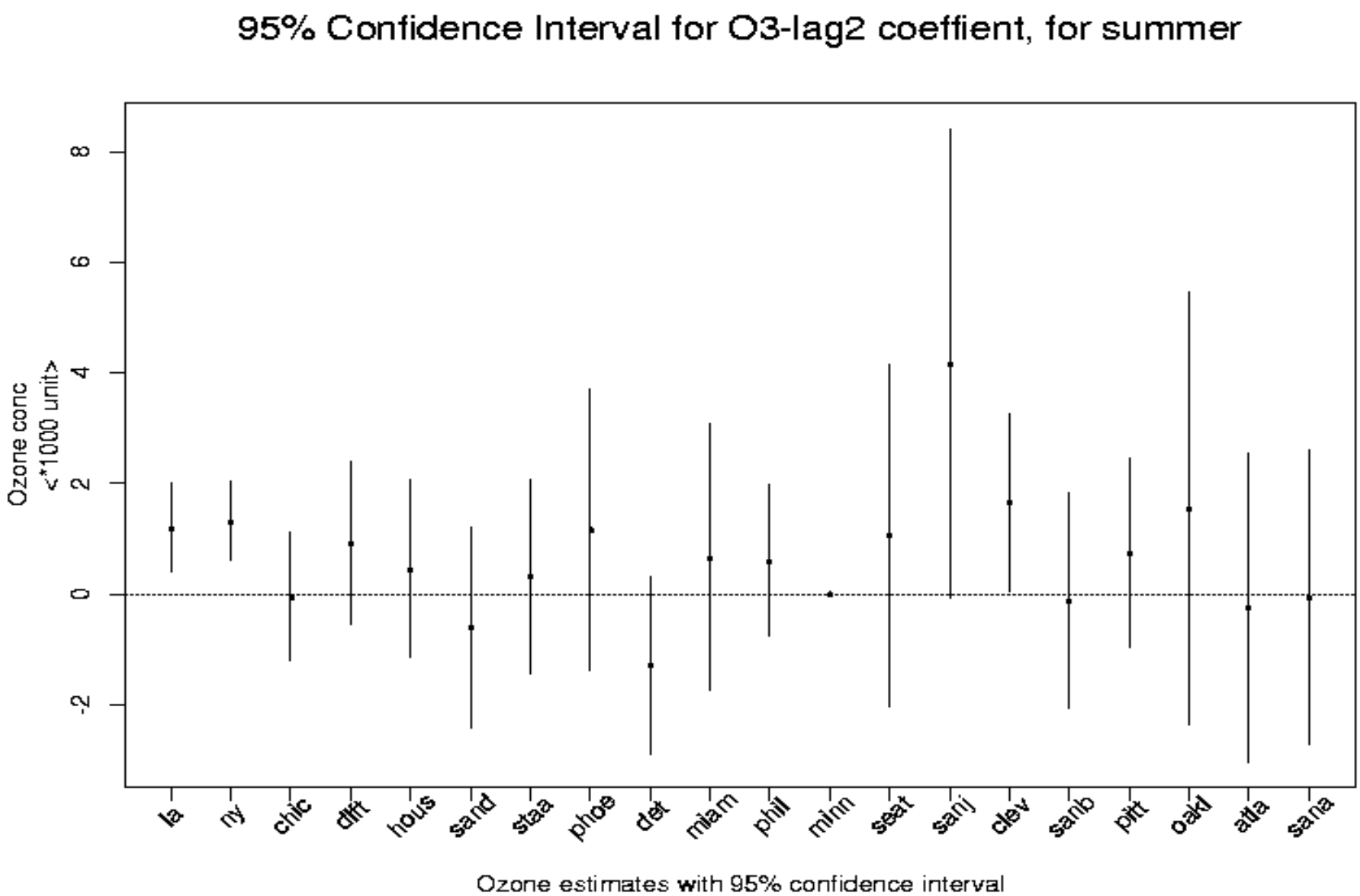
Stage II – Bayesian Hierarchical model

- $\beta_i^c \sim N(\theta_i^c, \sigma_i^2)$
- $\theta_i^c, \sim N(\mu, \tau^2)$

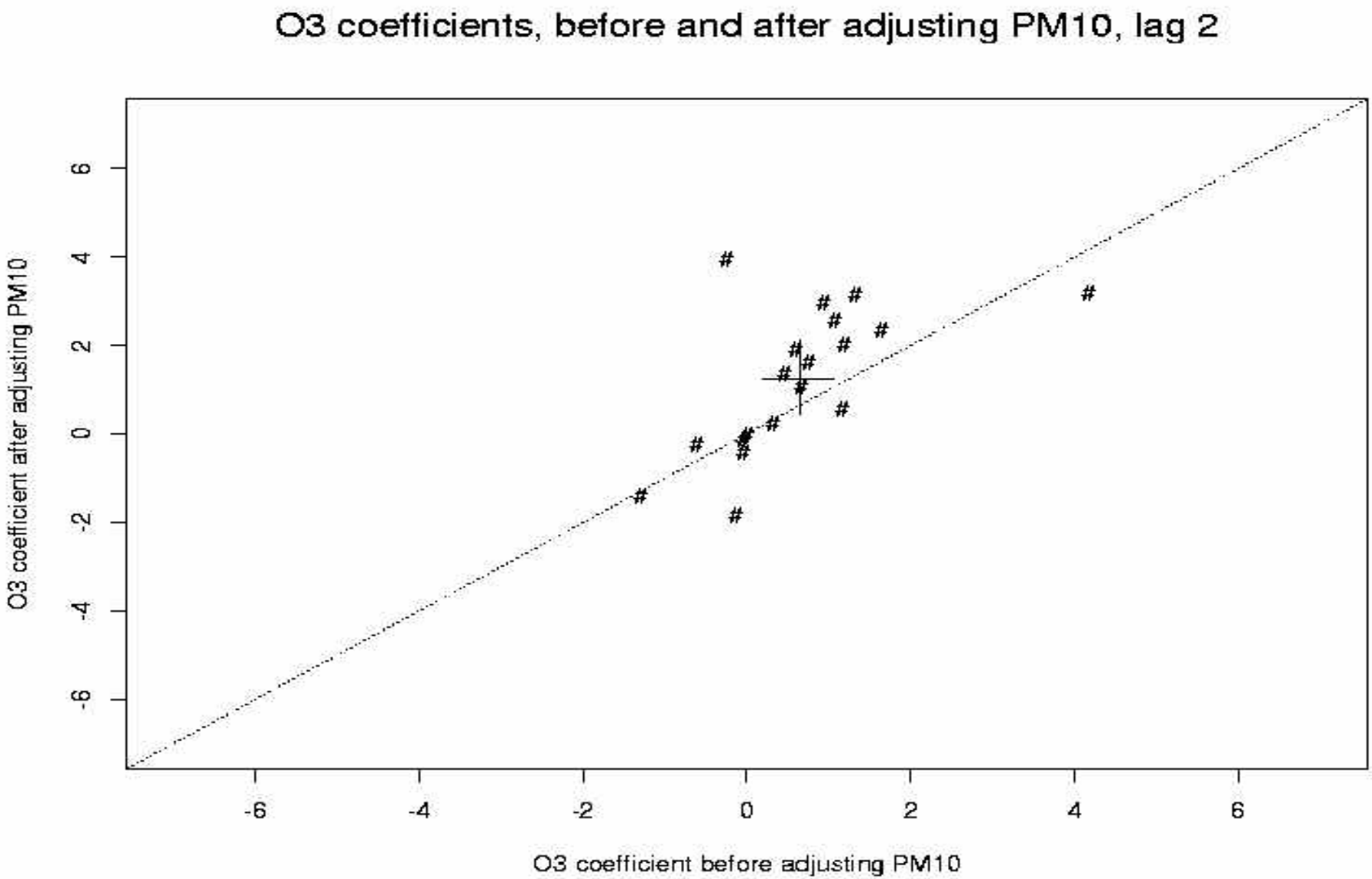
- μ: the overall log odds ratio of CVD & RESP mortality from summer ozone exposure combining information across the largest 20 US cities.

- Using BUGS for the analysis under non-informative prior.

Univariate Ozone Effect



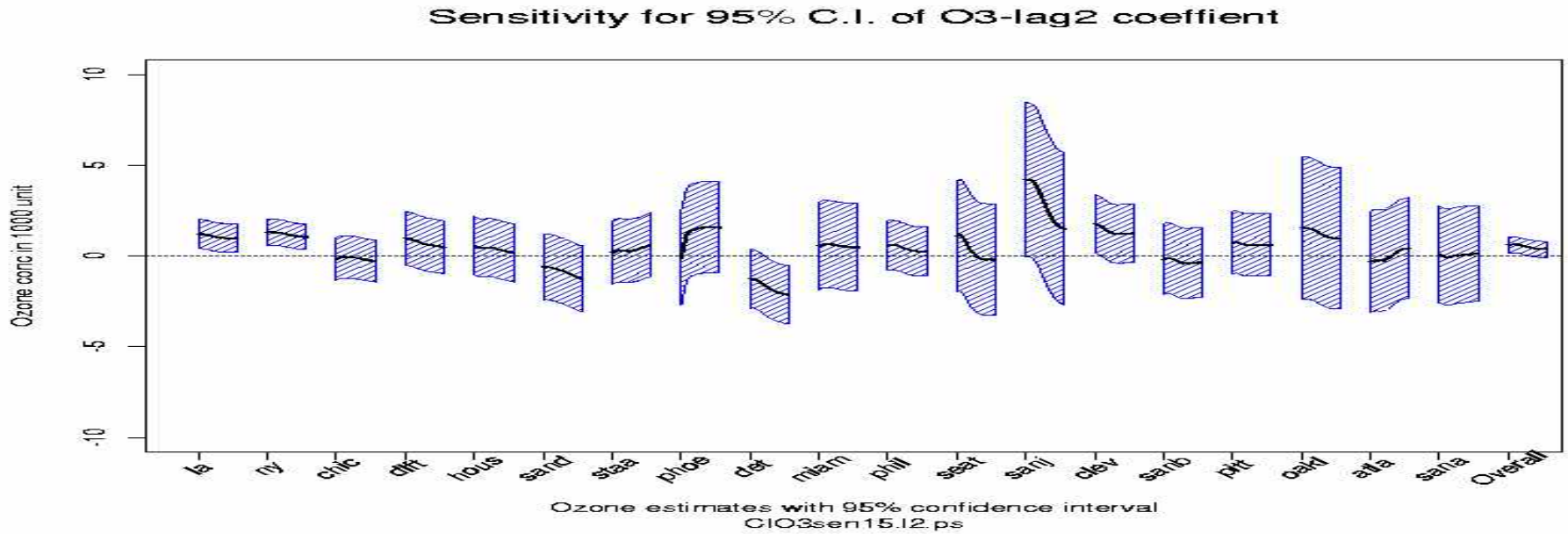
Ozone Effect Adjusted by PM10, lag 2

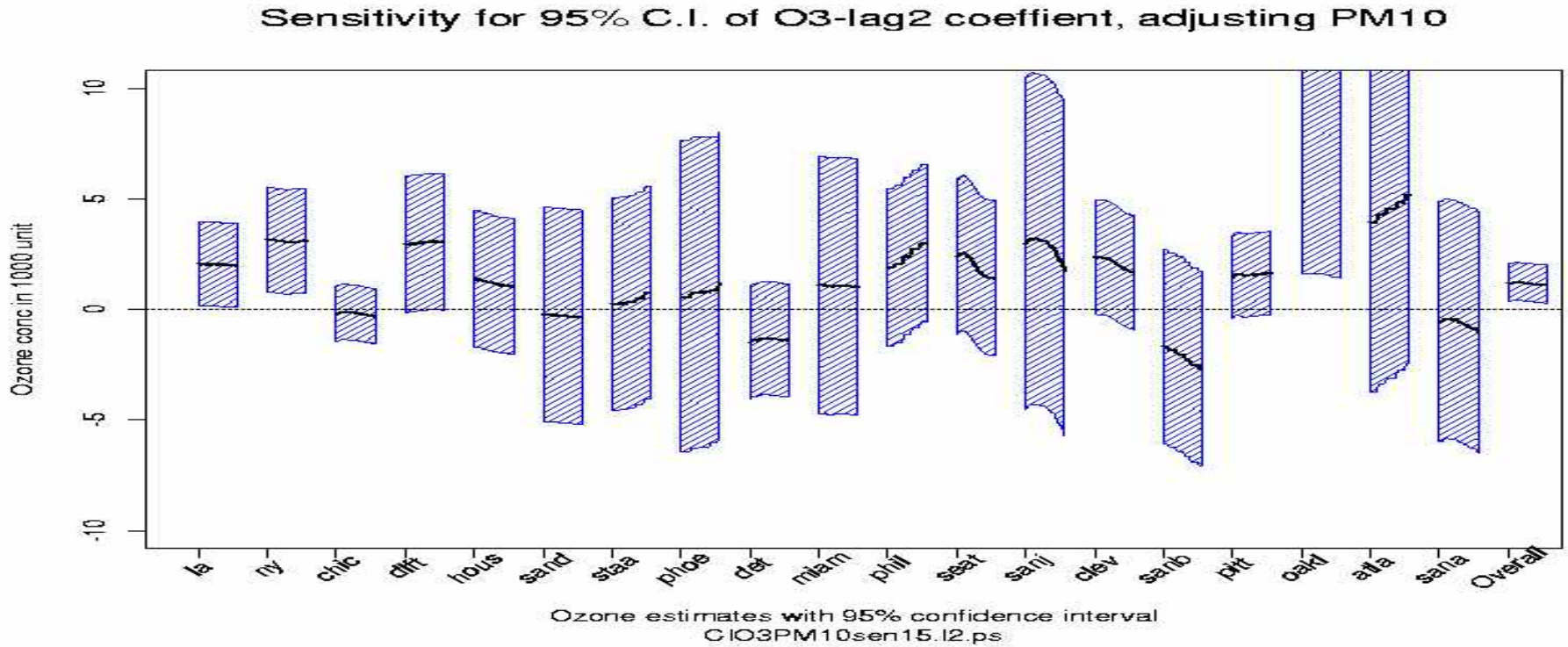


Estimates on Overall ozone effect

Table 5, O3 - 20 cities total effect on CVD & RESP

slope	O3 + PM_{10}	O3 +NO2	O3 + SO2	O3 + CO
O3 lag 0	0.088 (- 1.169, 1.36) 0.359 (- 0.117, 0.836)	0.303 (- 0.186,0.764) 0.359 (- 0.117,0.836)	0.267 (- 0.233,0.756) 0.359 (- 0.117,0.836)	0. 314 (- 0.151, 0.751) 0.359 (- 0.117, 0.836)
O3 lag1	- 0.397 (- 1.348, 0.512) 0.504 (0.083, 0.900)	0.534 (- 0.014, 1.02) 0.504 (0.083, 0.900)	0.456 (- 0.003,0.888) 0.504 (0.083, 0.900)	0. 50 (0.074, 0.89) 0.504 (0.083, 0.900)
O3 lag2	1.247 (0.435, 2.123) 0.660 (0.206, 1.065)	0.663 (0.127, 1.146) 0.660 (0.206, 1.065)	0.665 (0.179, 1.11) 0.660 (0.206, 1.065)	0.649 (0.191, 1.06) 0.660 (0.206, 1.065)


Sensitivity for 95% C.I. of O3-lag2 coeffient
Ozone conc in 1000 unit
10
5
0
-5
-10
la
ny
chic
dlft
hous
sand
staa
phoe
det
miam
phil
seat
sanj
clev
sanb
pitt
oakl
atla
sana
Overall
Ozone estimates with 95% confidence interval
ClO3sen15.l2.ps


Sensitivity for 95% C.I. of O3-lag2 coeffient, adjusting PM10
Ozone conc in 1000 unit
10
5
0
-5
-10
la
ny
chic
dlft
hous
sand
staa
phoe
det
miam
phil
seat
sanj
clev
sanb
pitt
oakl
atla
sana
Overall
Ozone estimates with 95% confidence interval
ClO3PM10sen15.l2.ps

Results

- Overall, there is statistically significant positive association between ambient summer O3 and CVD & RESP mortality at lag 1 and lag 2.
- The association between mortality and summer ozone is confounded by **PM_{10}**, but not confounded by **CO, SO_2, and NO_2**.
- The city-specific and overall ozone effects results under univariate and multi-pollutants models are not sensitive to the selection of the number of d.f. in the smooth function of time.

Discussion

- Measurement error
- Multi-pollutants model
- Comparison of Case-crossover design and Time-series design
- Clustering on synoptic whether to control temperature effect
- Is the association between ambient O3 and mortality confounded by ultra-fine particle?

Acknowledgments

- Thanks a lot for Dr. Dominici and Dr. McDermott help and guidance.

- Thank Dr. Bandeen-Roche for the great information on confounding.

Any Questions ?