

Seasonal Analyses of PM₁₀ and Mortality

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May 17, 2004

(Joint work with Francesca Dominici, Roberto Pastor-Barriuso, Scott Zeger, and Jonathan Samet)

Why a seasonal analysis?

- Understand temporal and regional variation in short-term effects of particulate matter (PM)
 - Particulate matter mixture changes with season
 - Different sources
 - Meteorology
 - Guide future analyses of PM constituent data
 - Better understand the health effects of PM constituents

Updated NMMAPS Data

- Original NMMAPS had daily mortality, pollution, and weather data for 90 cities.
- Data covered years 1987–1994
- Updated database covers 1987–2000 and has data for 100 cities.
- Availability of PM_{10} data varies by city and by time period:
 - 1 in 6 days
 - 1 in 3 days
 - Every day

City-specific Poisson regression models

$$Y_t \sim \text{Poisson}(\mu_t)$$

$$\text{Var}(Y_t) = \mu_t \phi$$

$$\log \mu_t = \beta(t) x_{t-\ell} + \text{DOW} + \text{Indicator for age category}$$

$$+s(\text{temp}) + s(\text{temp}_{1-3})$$

$$+s(\text{dewpoint temp}) + s(\text{dewpoint temp}_{1-3})$$

$$+s(\text{time}; 7 \text{ df per year})$$

$$+s(\text{time}; 1 \text{ df per year}) \times \text{age category}$$

- Y_t : mortality count for day t

- $x_{t-\ell}$: pollution exposure at day t and lag ℓ

Main effect

$$\beta(t) = \beta$$

(used in previous NMMAPS analyses)

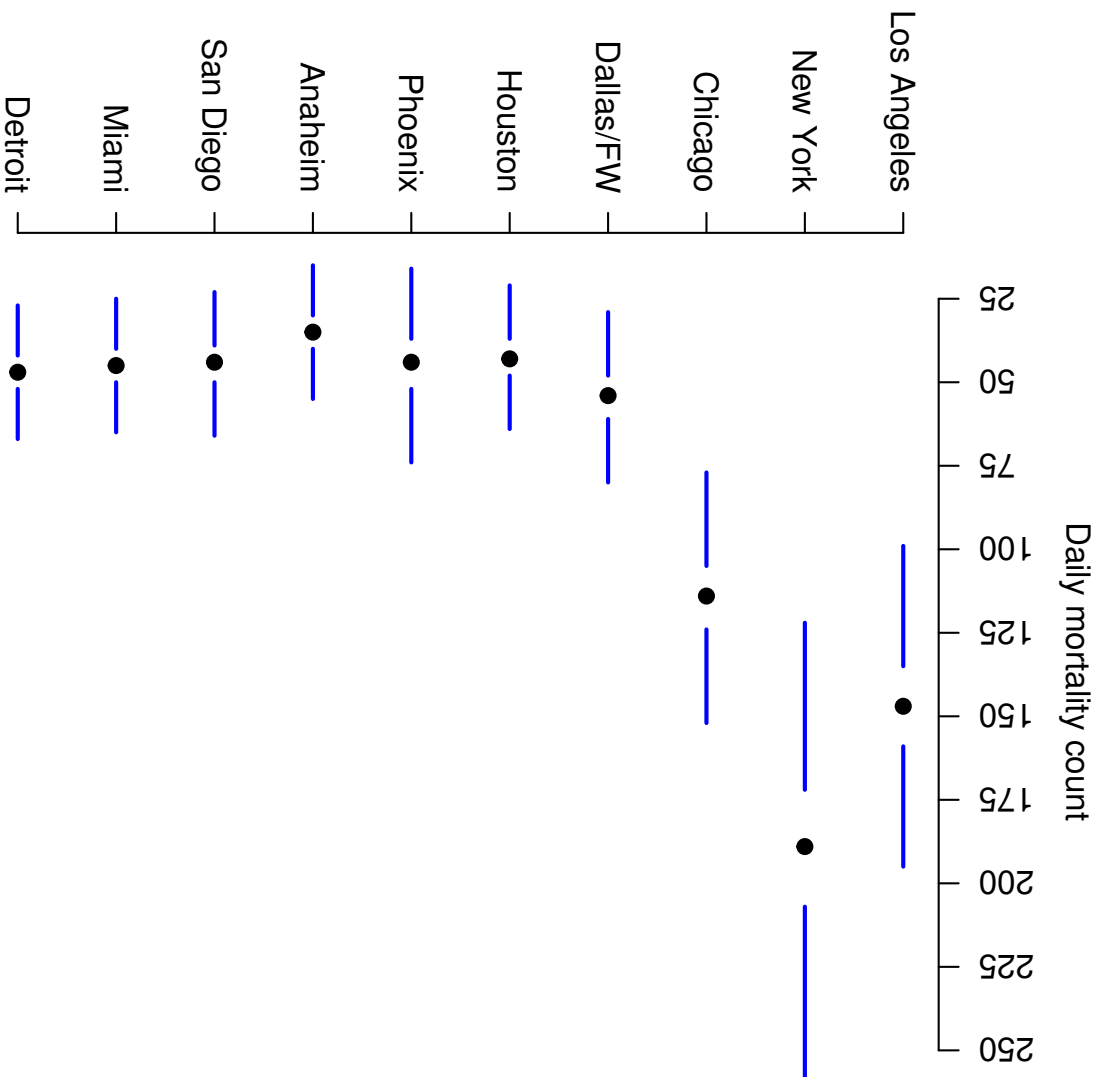
Seasonal models

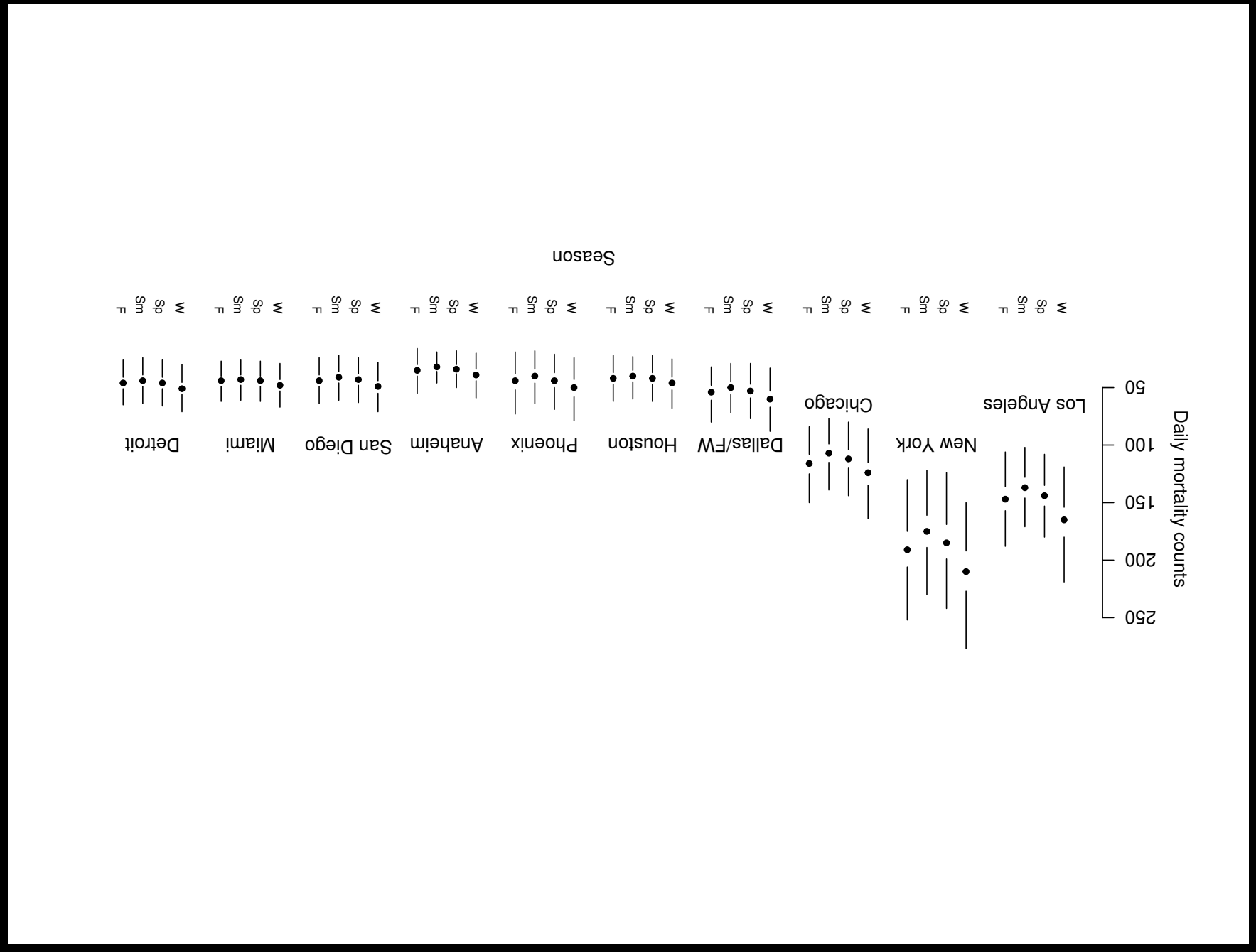
• Seasonal indicator:

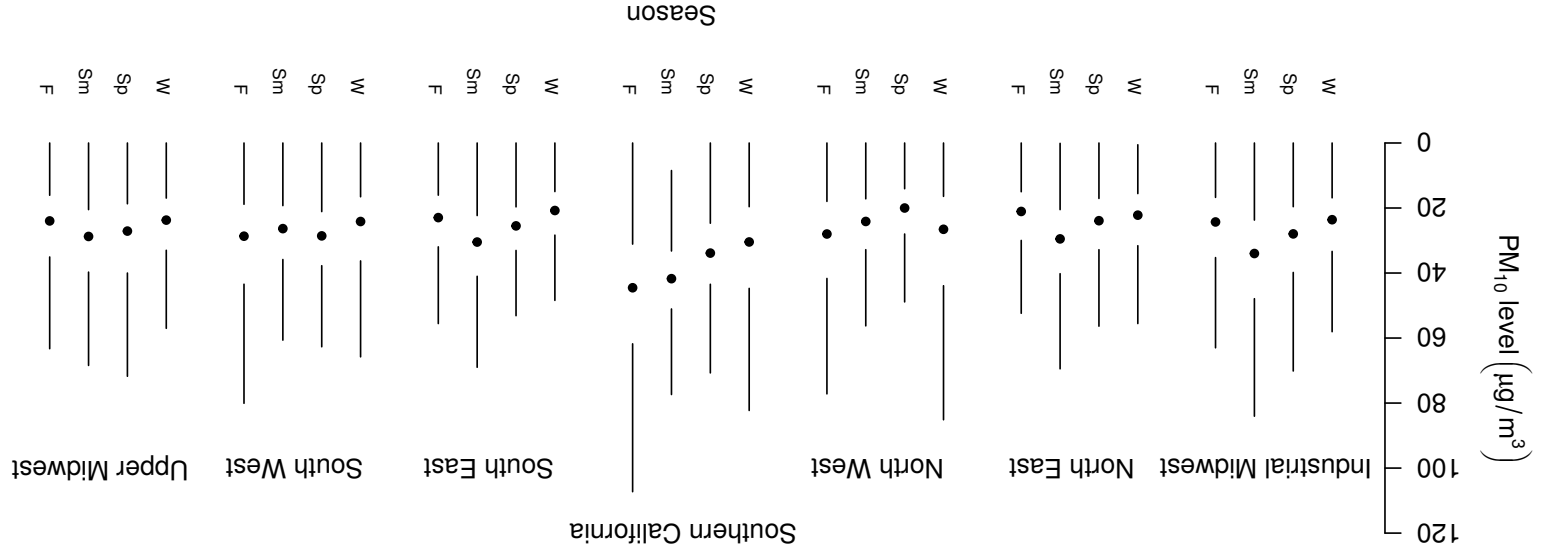
$$\beta(t) = \beta_W I^{\text{winter}} + \beta_{Sp} I^{\text{spring}} + \beta_{Sm} I^{\text{summer}} + \beta_F I^{\text{fall}},$$

• Smooth periodic:

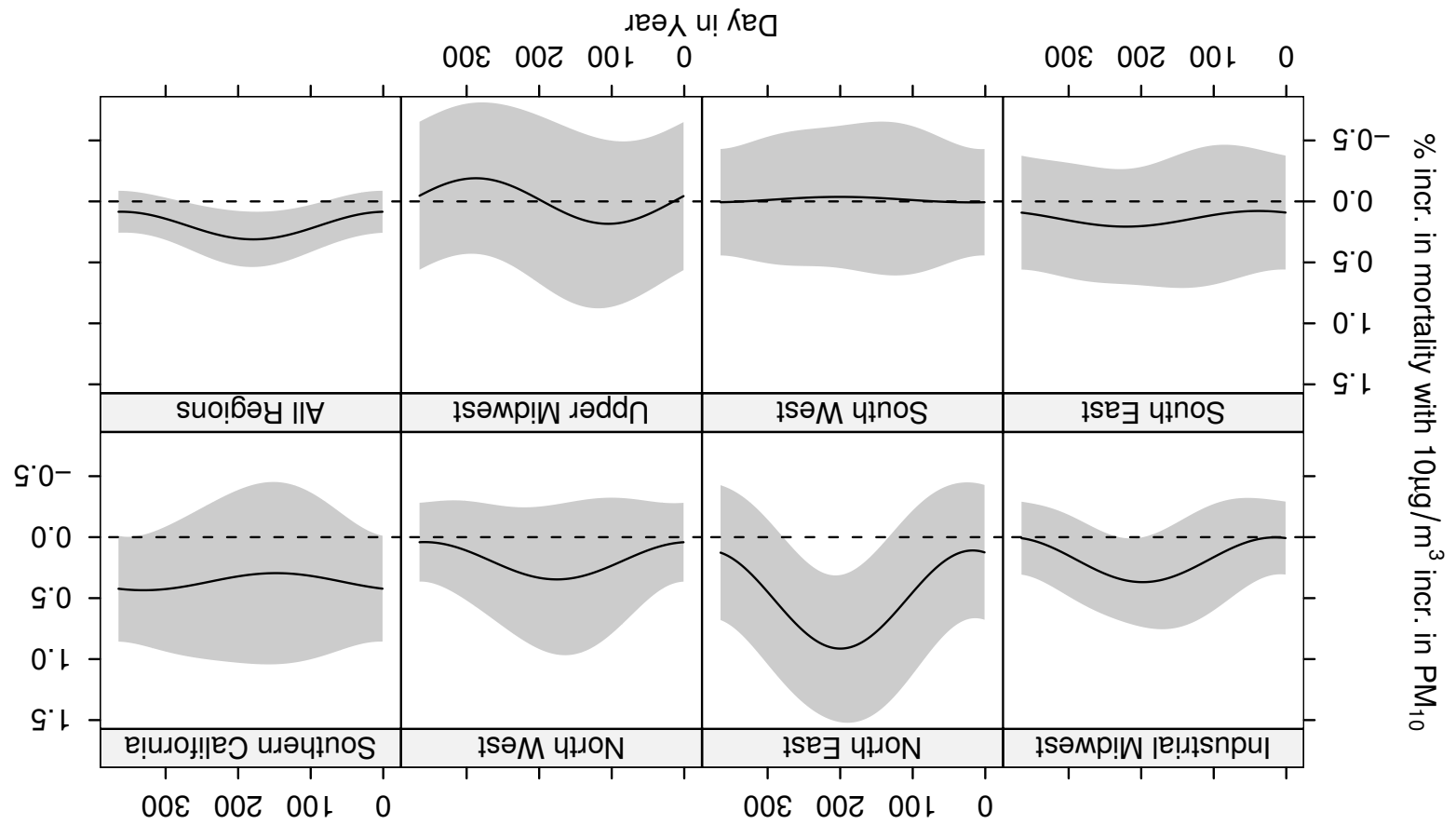
$$\beta(t) = \beta_0 + \beta_1 \sin(2\pi t/365) + \beta_2 \cos(2\pi t/365)$$



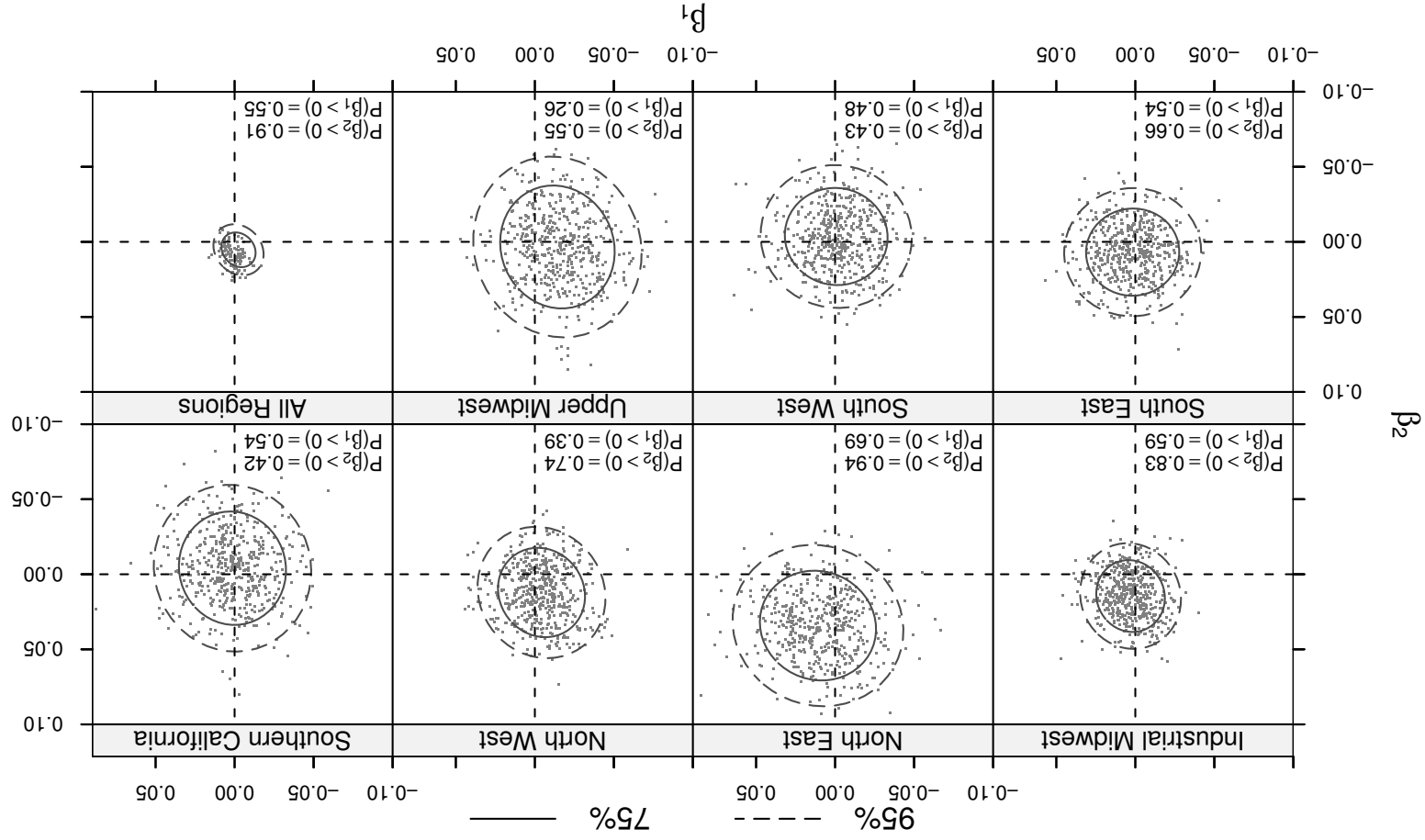




Seasonal patterns by region

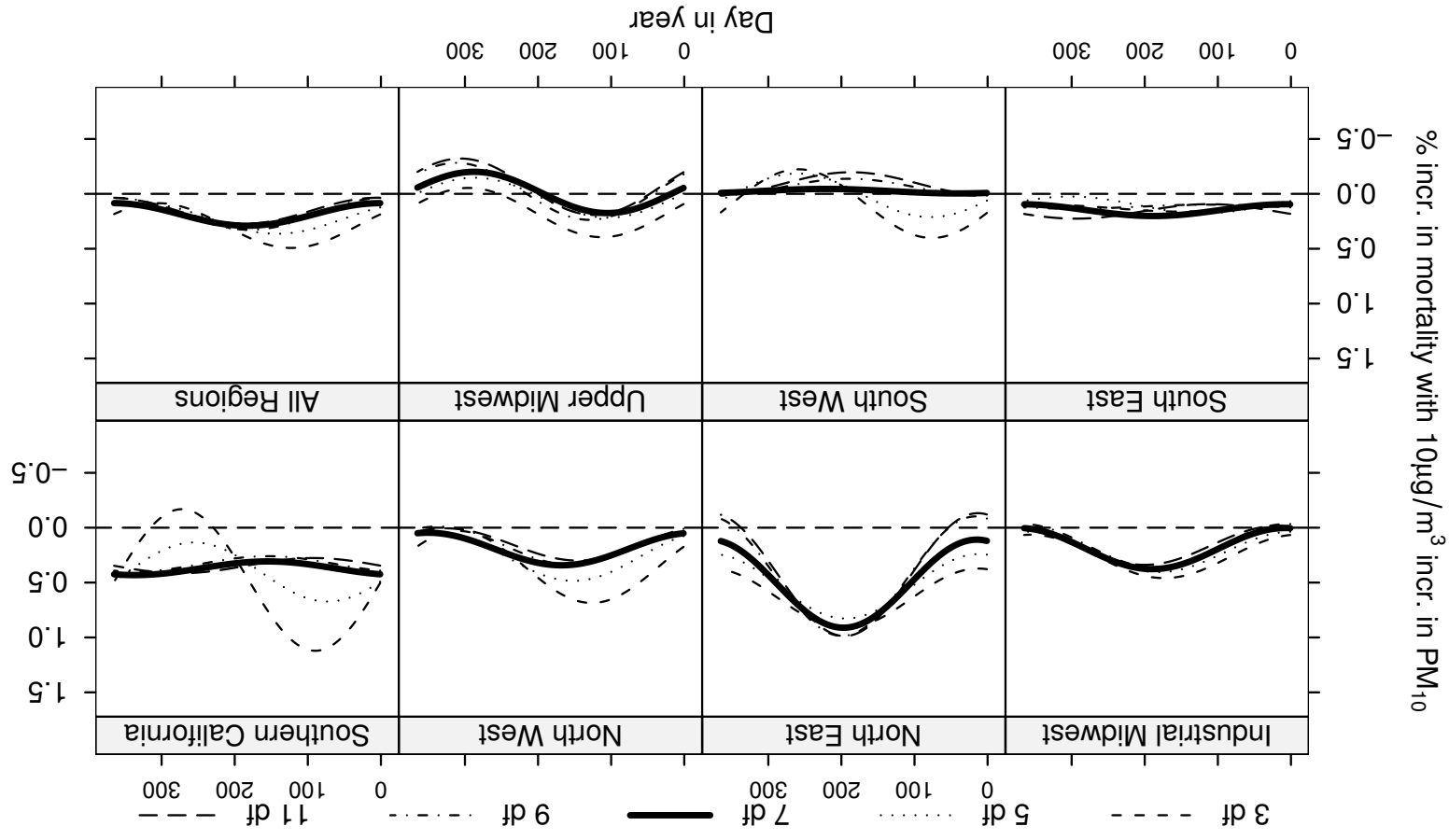


Posterior distribution for seasonal coefficients

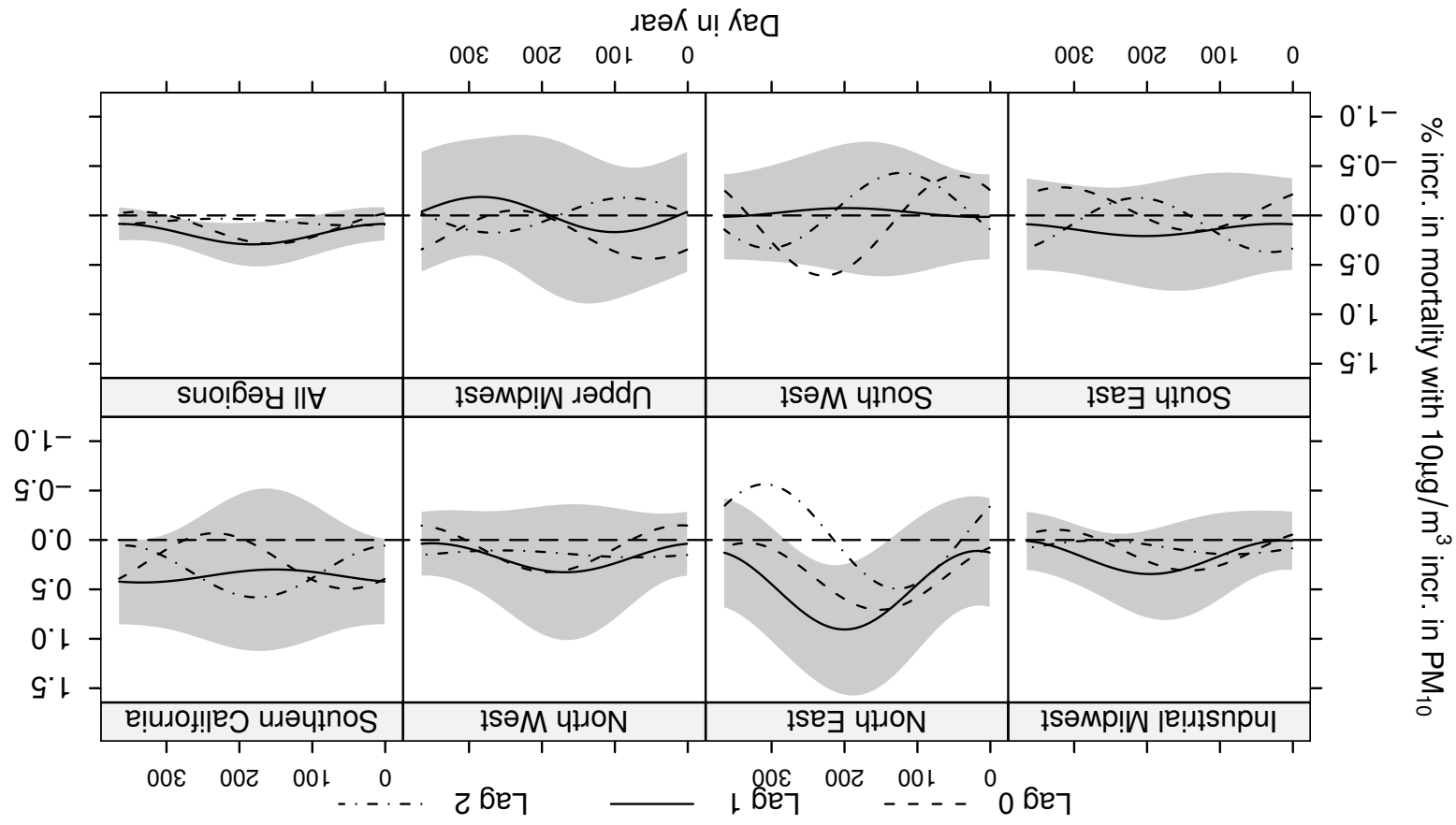


$$\beta(t) = \beta_0 + \beta_1 \sin(2\pi t/365) + \beta_2 \cos(2\pi t/365)$$

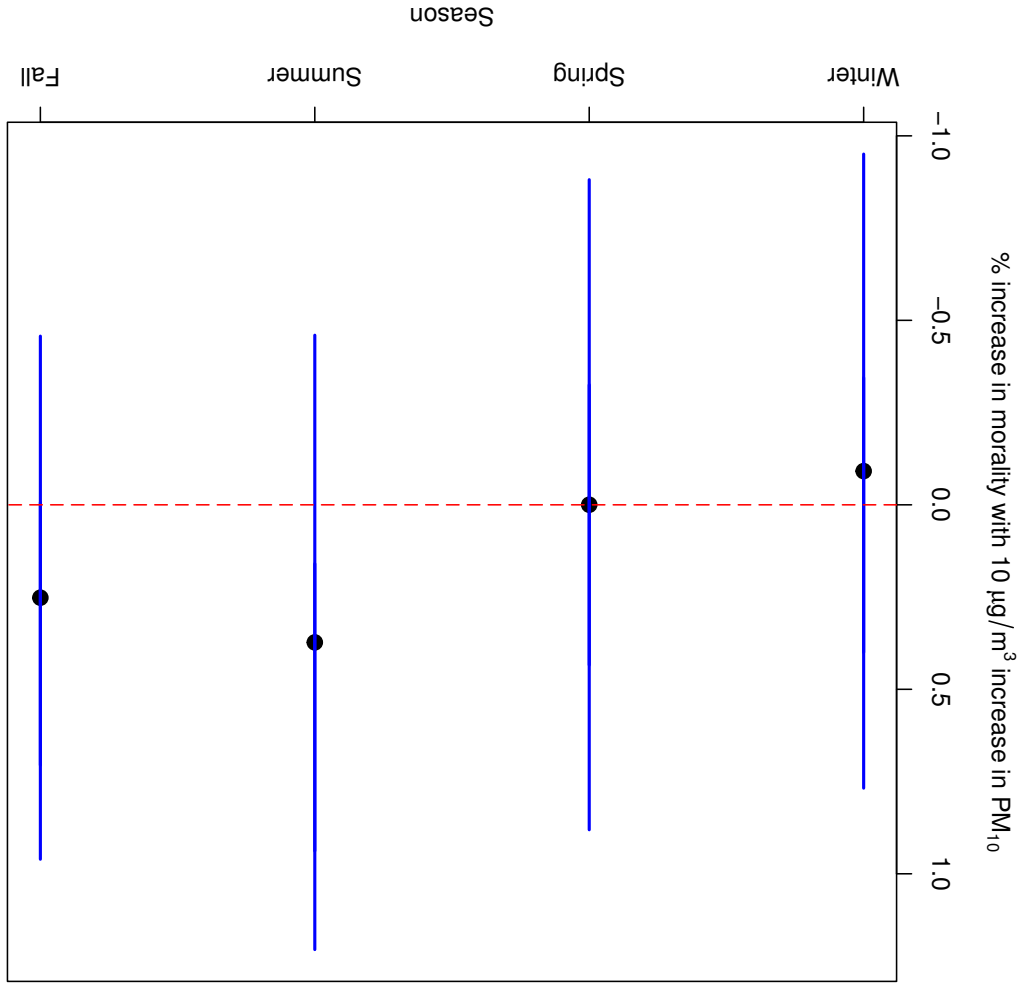
Sensitivity to the smooth function of time (Lag 1)



Seasonal patterns by region and exposure lag



Seasonal distributed lags model for 19 cities



What next?

- *"The current NAAQS for PM is both size and mass-based and implicitly assumes that all particles of a given size have the same toxicity per unit mass, irrespective of chemical composition.... A better understanding of characteristics that modulate toxicity could lead to targeted control strategies specifically addressing those sources having the most significant adverse effects on public health." – Research Priorities for Airborne Particulate Matter: IV Continuing Research Progress, NRC, March 2004*
 - *"...to inform regulatory discussions on control strategies, a systematic research effort is required to develop a better understanding of the health effects of different components of the PM mixture and the mechanisms of PM effects."*
- HEI Perspectives, April 2002.

What next?

- Develop specific hypotheses for PM and mortality
- Examine spatial-temporal variation of PM constituent/speciation data.
- Develop a better understanding of the toxicity of PM components