Method of Evidence Decomposition (MED) - Decomposing Risk Analysis in Space and Time – Main Ideas

- Individual risk at time t, location u =

    Baseline risk in perfectly clean air at time t, location u (function of known and unknown confouders) **+**

    Effect of *history of exposure* to particulate air pollution: relative rate - β

- Expected number of deaths is the aggregation of the individual risks

Multi-level Models: Decomposing Risk Analysis in Space and Time
Main Ideas

- Big issue in multi-level observational research is confounding from *unmeasured factors, Z*
  - Personal factors: smoking, exercise,..
  - Local factors: local infectious disease outbreaks, water quality,…
  - Regional factors: economy, weather,…
  - National factors: health services, health education,…
- Many confounders have characteristic temporal and spatial scales

Decomposing Risk Analysis in Space and Time – Main Ideas

- Decompose the exposure process into (orthogonal) components with distinct temporal and/or spatial scales
  - $X(t,u) = X_1(t,u) + X_2(t,u) + \ldots + X_k(t,u)$
- Estimate a separate relative rate for each component: $\beta_1, \beta_2, \ldots, \beta_k$
- Confounders will have largest effect on the coefficients at its characteristics time and space scale
- $\mathrm{B}_1 = \beta_2 \ldots = \beta_k$ is consistent with constant confounding or no confounding across space and time scales
- Accumulate "less confounded" coefficients to obtain robust estimator of shared β

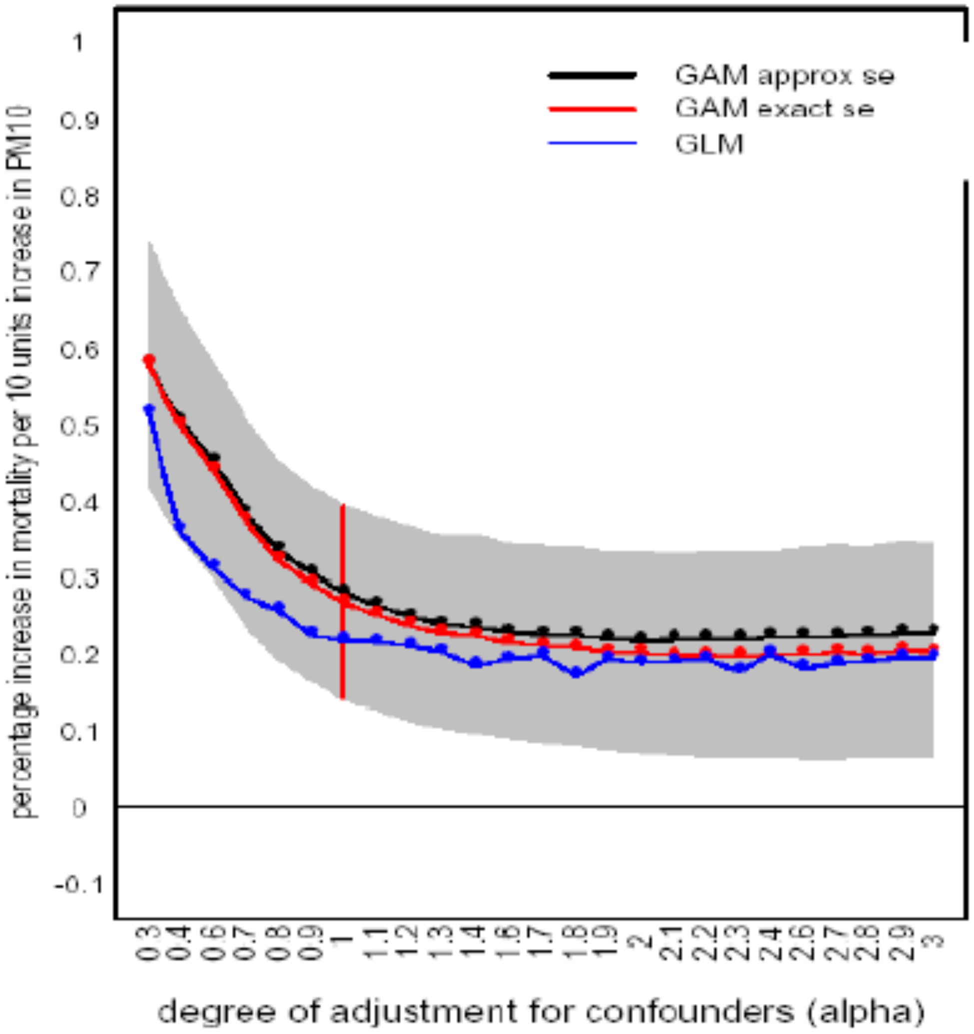
Decompose temporal variations into longer and shorter time scale components

X_1 - longer-term variation in particulate air pollution; e.g. smoother than monthly averages

X_2 – shorter-term variations = $X - X_1$

Regress Y on X_2 and on smooth function of X_1; use the coefficient β_2

Results for different splits of X1, X2. At the left, X2 = X (X1=0), at the right X1 is monthly averages and X2 is within-month variation only



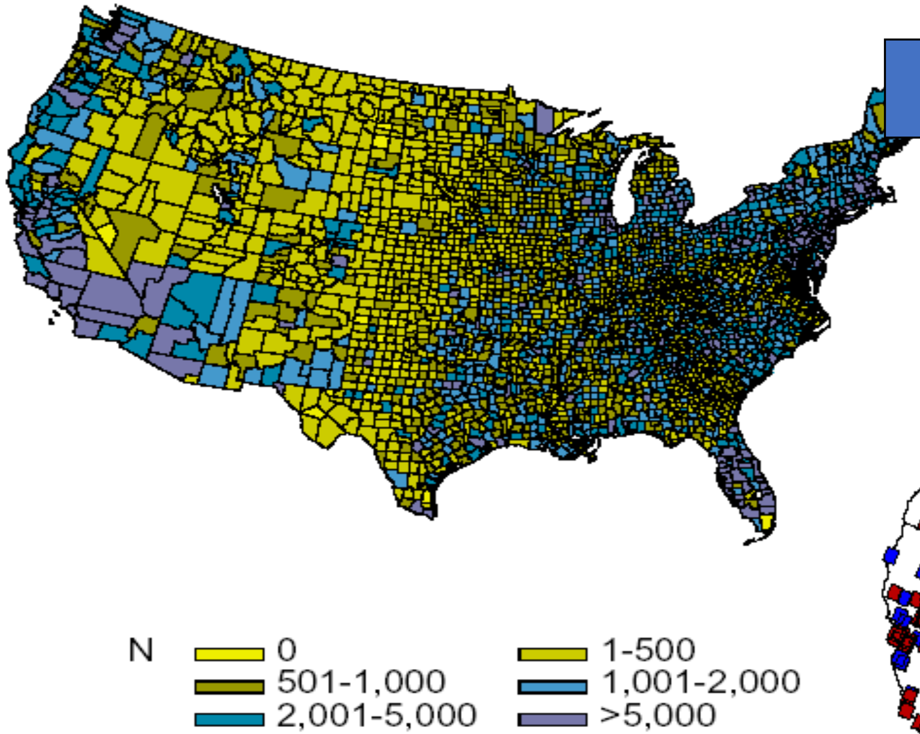
Example 2. Decomposing Cross-sectional (Entirely spatial) Mortality Effects by Region and Within-Region Spatial Scale

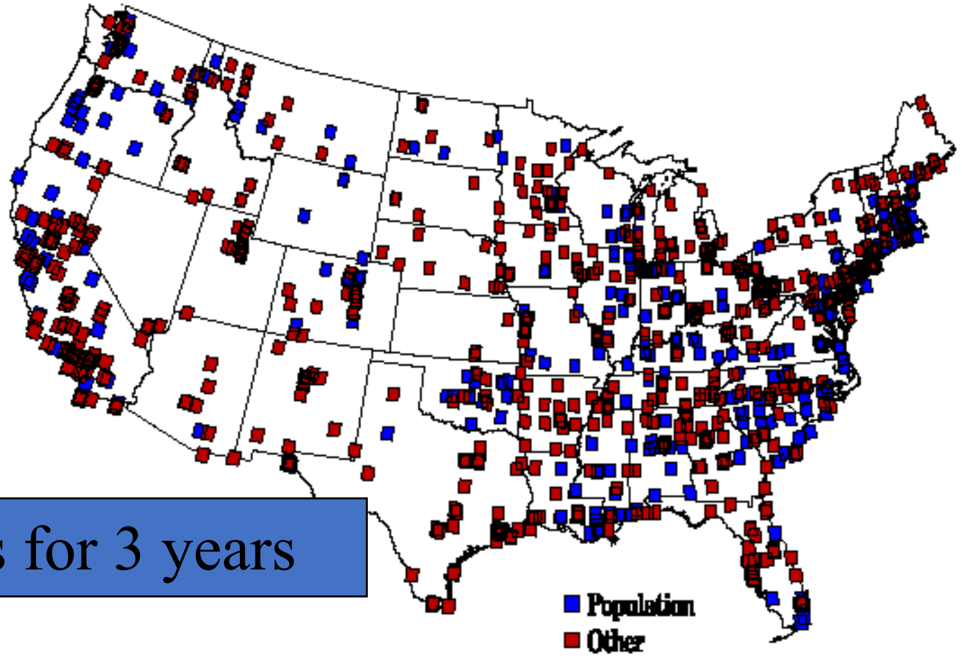
By region:

- X_1 – larger-scale regional averages
- X_2 – local variations about the regional averages

Medicare Air Pollution Study (MCAPS)
50 million Persons 65+

2 million deaths per year





PM2.5 at 327 locations for 3 years

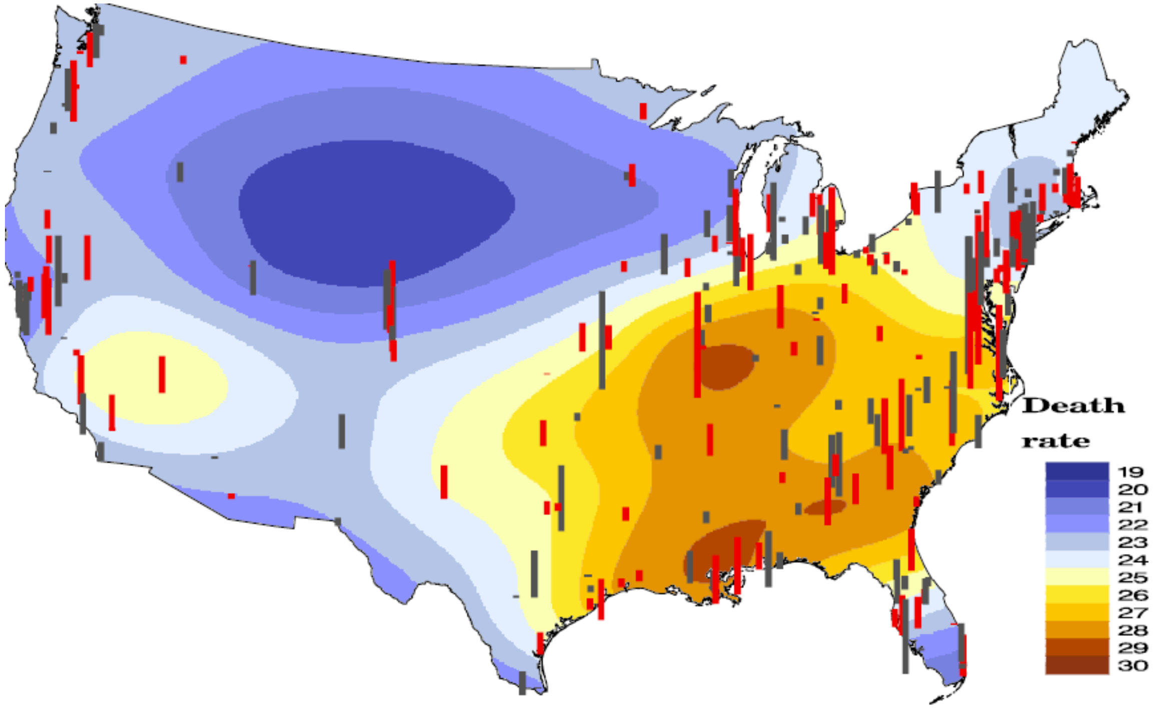
All-Cause Mortality Increase per 10 μg/m3 PM2.5
MCAPS Estimates for 250 Counties

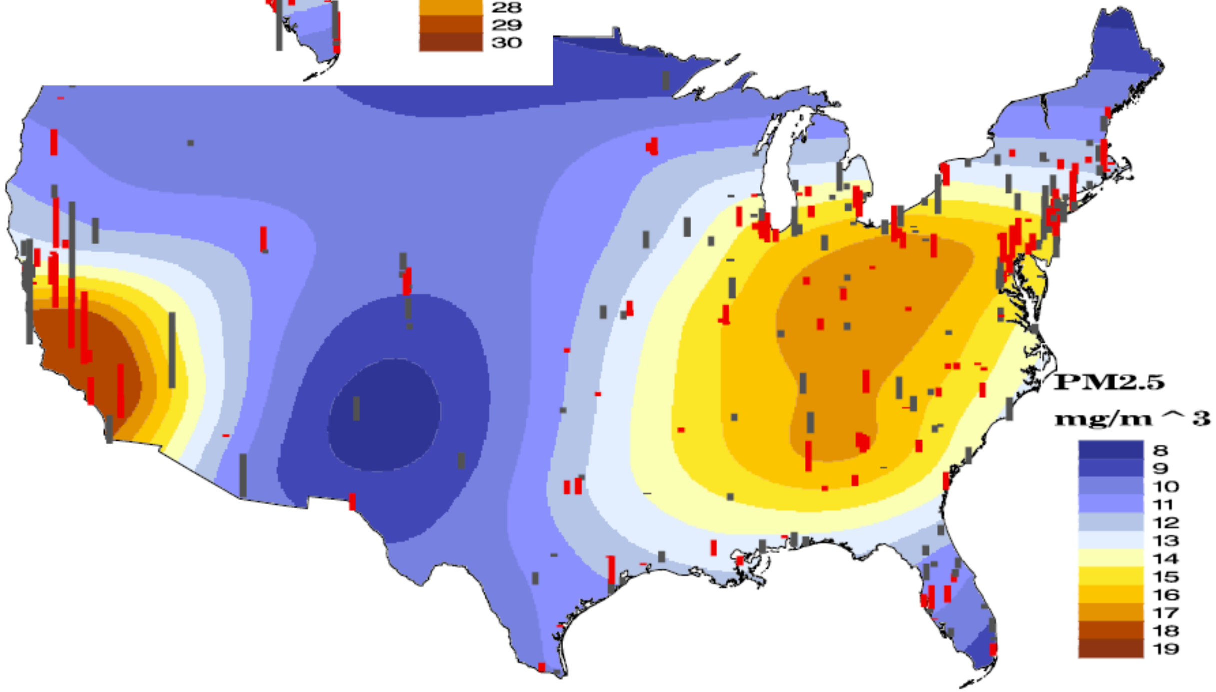
	Ages			
Adjustment	All	65-74	75-84	85+
Age-Gender (AG)	4.4 7.6 10.8	10.2 15.4 20.6	4.8 8.0 11.3	-3.1 -0.50 2.1
AG + SES	6.0 8.5 11.0	10.2 14.3 18.5	6.5 9.1 11.6	0.20 2.4 4.6
AG+SES+COPD	5.4 7.6 9.7	8.4 11.9 15.4	6.3 8.5 10.7	0.60 2.6 4.7

Mortality Risk Increases per 10 μg/m3 by Region

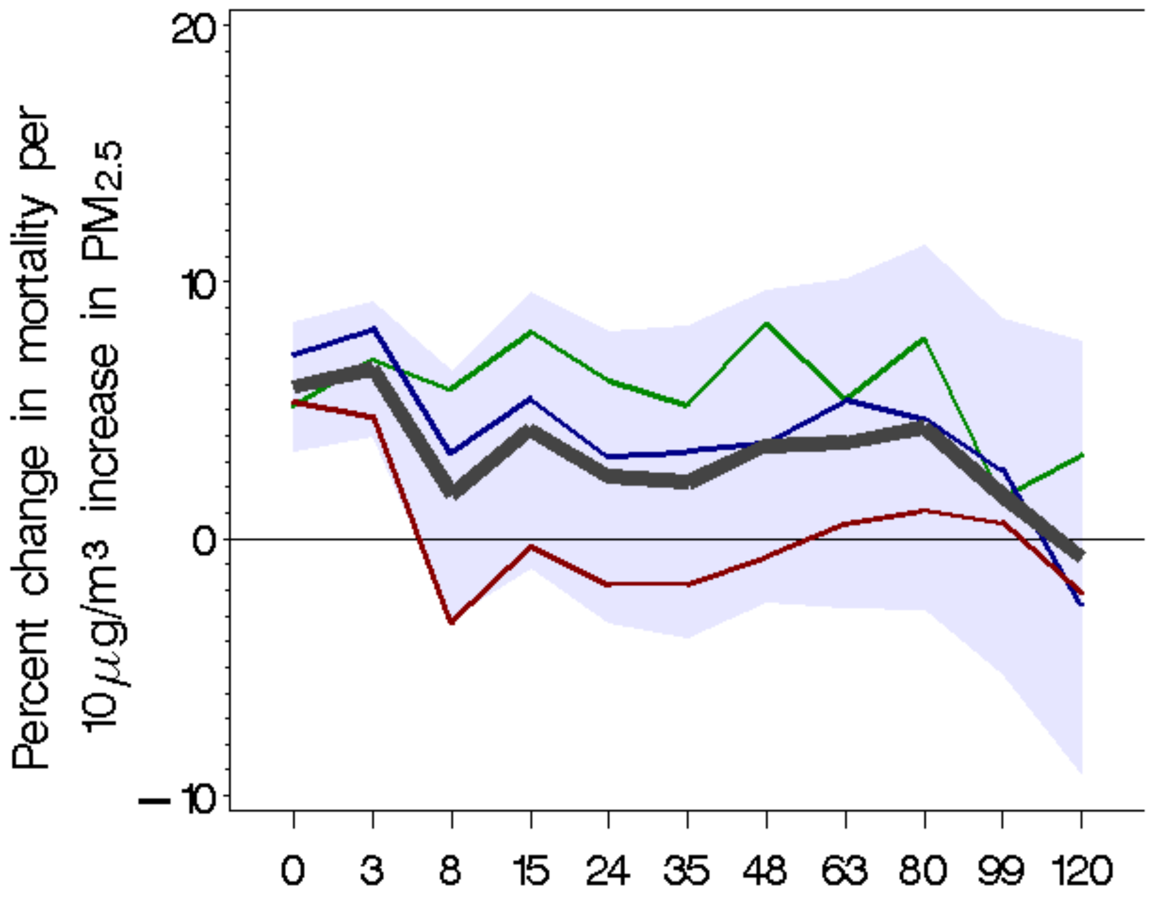
Adjustment	All	East	West Coast
Age-Gender (AG)	4.4 7.6 10.8	8.1 12.4 16.8	-2.2 2.8 7.9
AG + SES	6.0 8.5 11.0	6.8 10.6 14.5	-4.6 0.9 6.3
AG+SES+COPD	5.4 7.6 9.7	3.4 5.9 8.4	-6.1 -2.3 1.6

MED on MCAPS


Death
rate
19
20
21
22
23
24
25
26
27
28
29
30

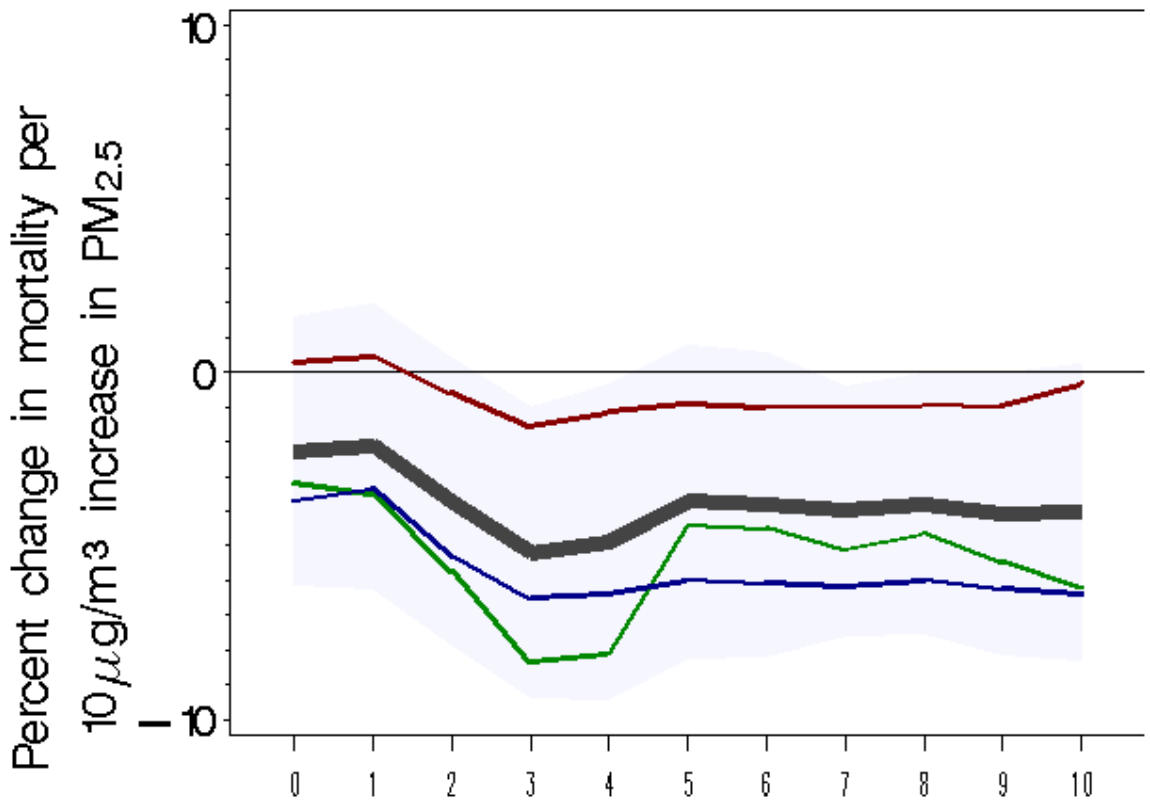

PM2.5
mg/m ^ 3
8
9
10
11
12
13
14
15
16
17
18
19

East Coast



Degrees of freedom for spatial smoother

West Coast



Degrees of freedom for spatial smoother

Example 3: Decomposing Chronic Effects (Past year) into Regional and Local Components

Average exposure for past year **=**

Average for region (X_1) **+**

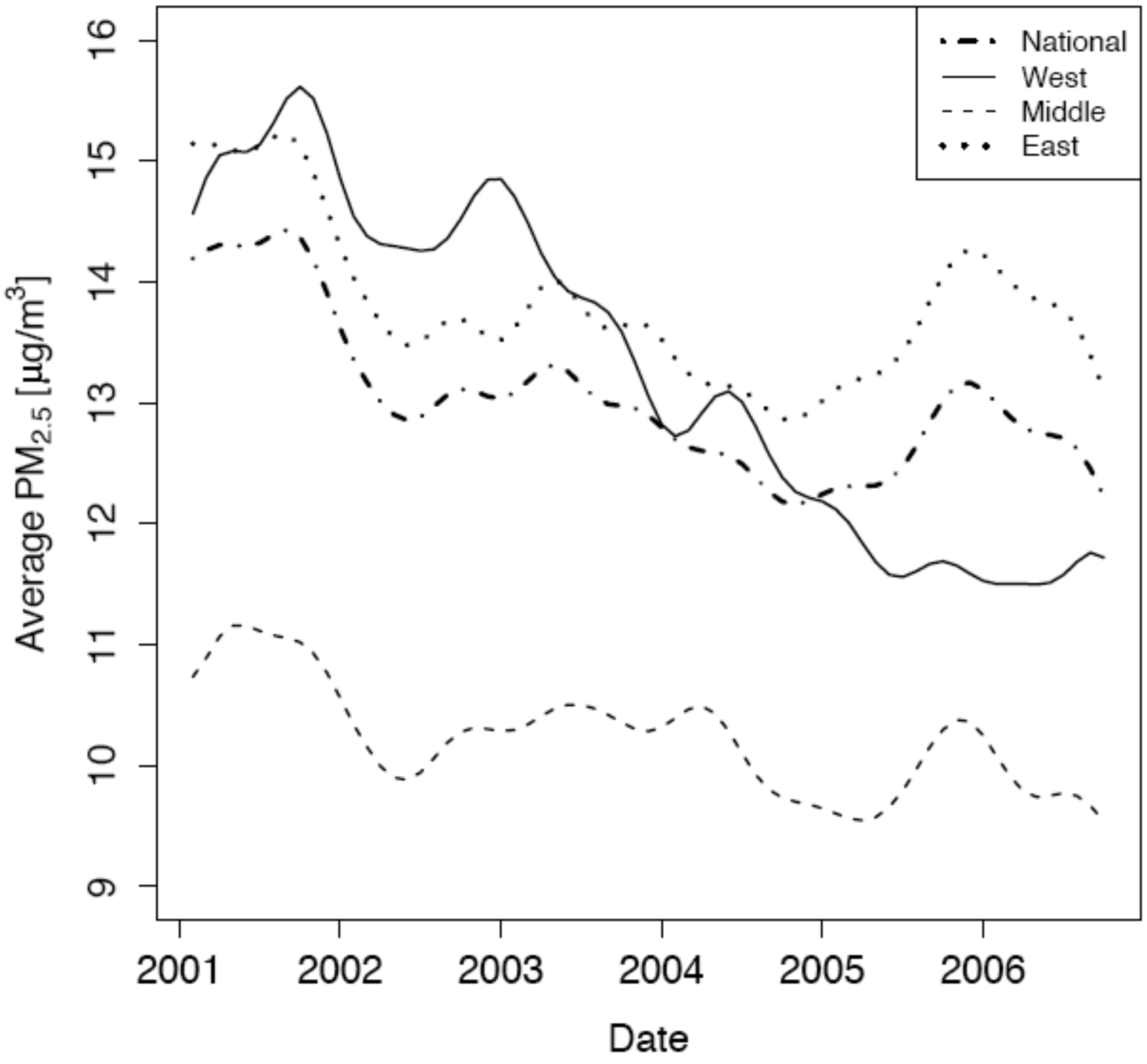
Deviation of city data from region's average (X_2)

Has mortality decreased with the decrease in particulate air pollution? **–vs-**

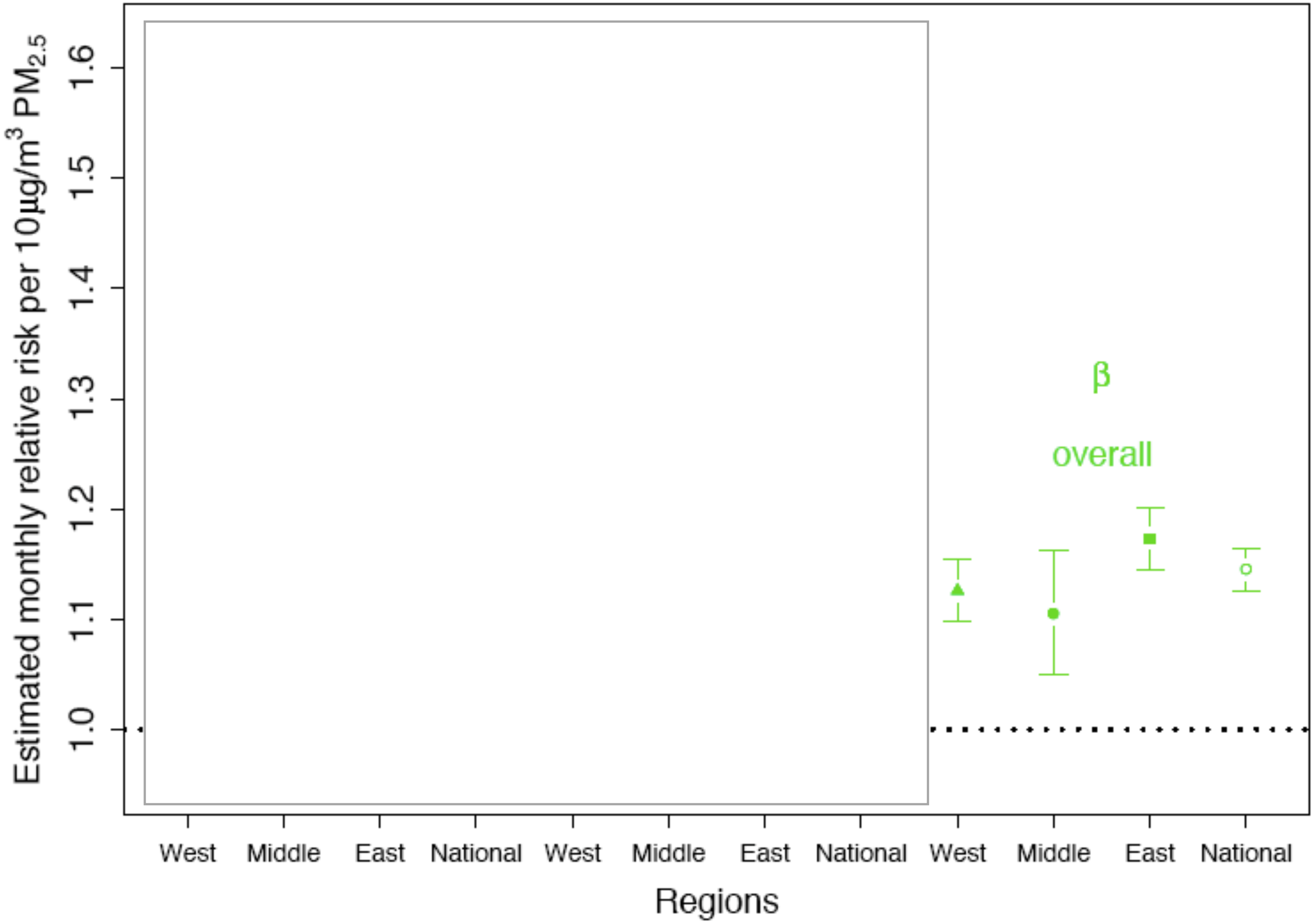
Has regional average mortality gone down with regional average air pollution (b_1) and;

Has mortality decreased more in cities with relatively greater decreases in air pollution? (b_2)

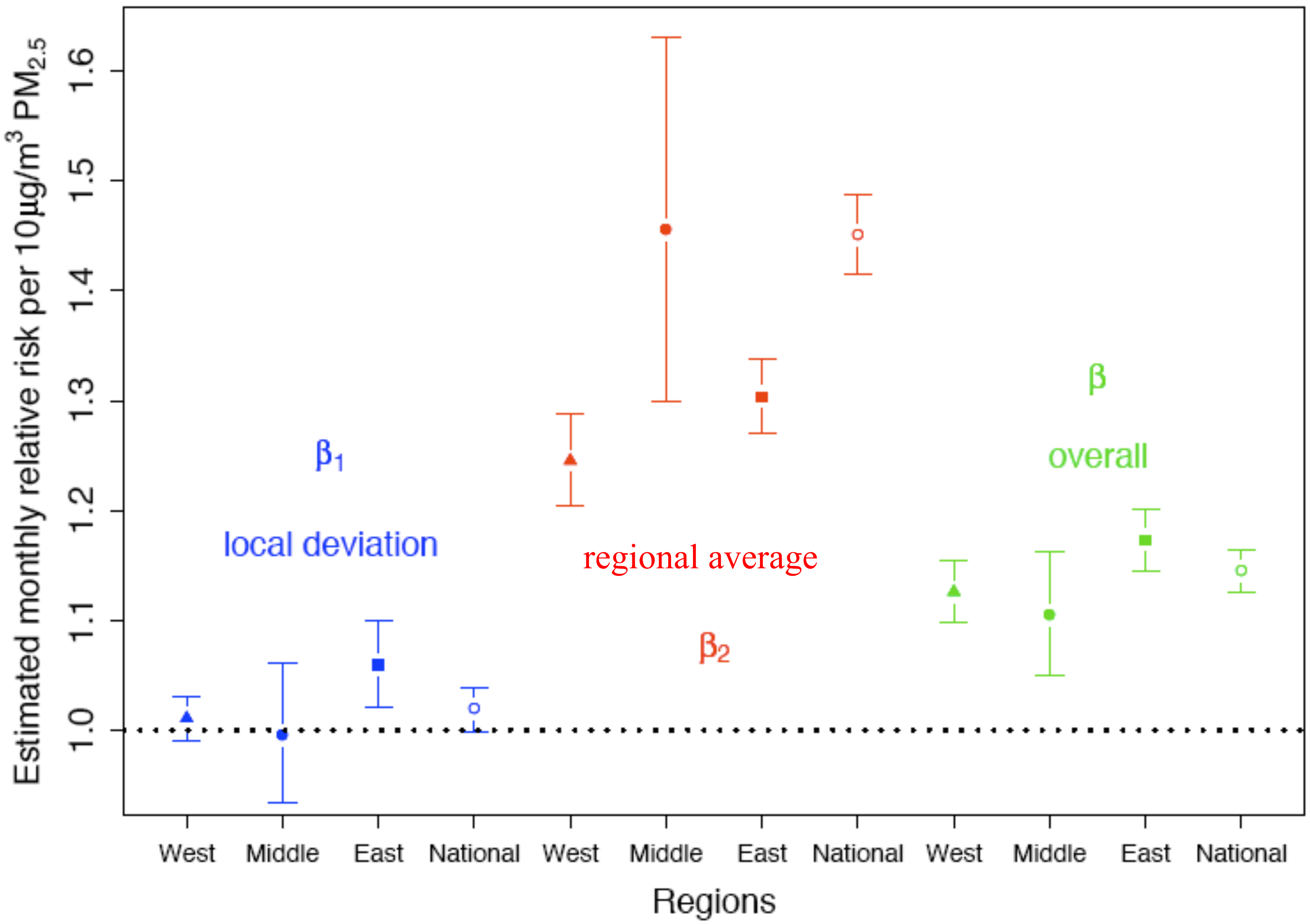
Trends in $PM_{2.5}$ [$\mu g/m^3$] by region



Results - Monthly Relative Risk Estimates



Results - Monthly Relative Risk Estimates



Main Points Once Again

Risk analysis decomposed in space and time for model estimation and checking

- Consistent effects in the east
- Ambiguities remain elsewhere