Intra-Urban Variation in Air Pollution – Implications for Nutritional Interventions

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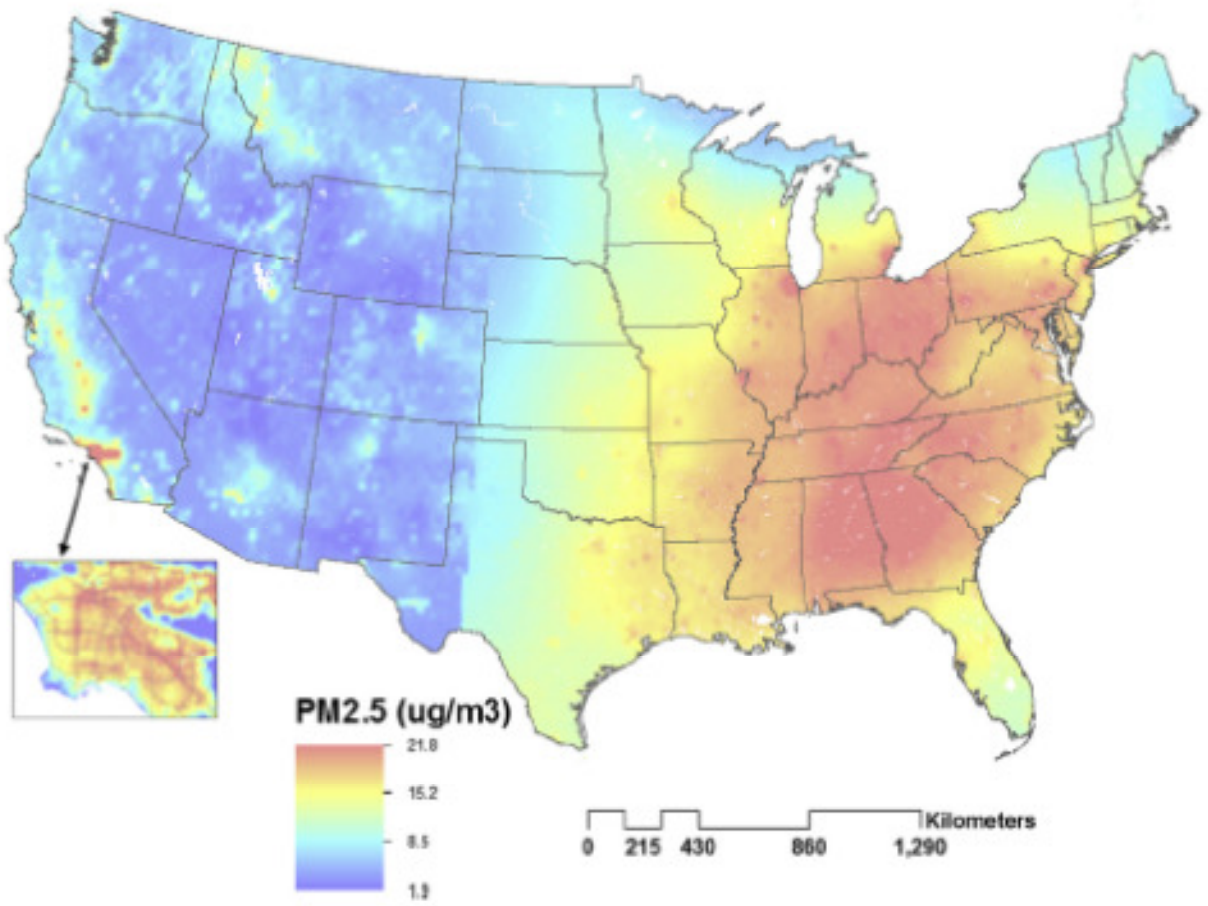
Motivation

- Ambient fine particulate air pollution ($PM_{2.5}$) has been associated with respiratory and cardiovascular disease, lung cancer, and reduced life expectancy (Pope et al, 2011).

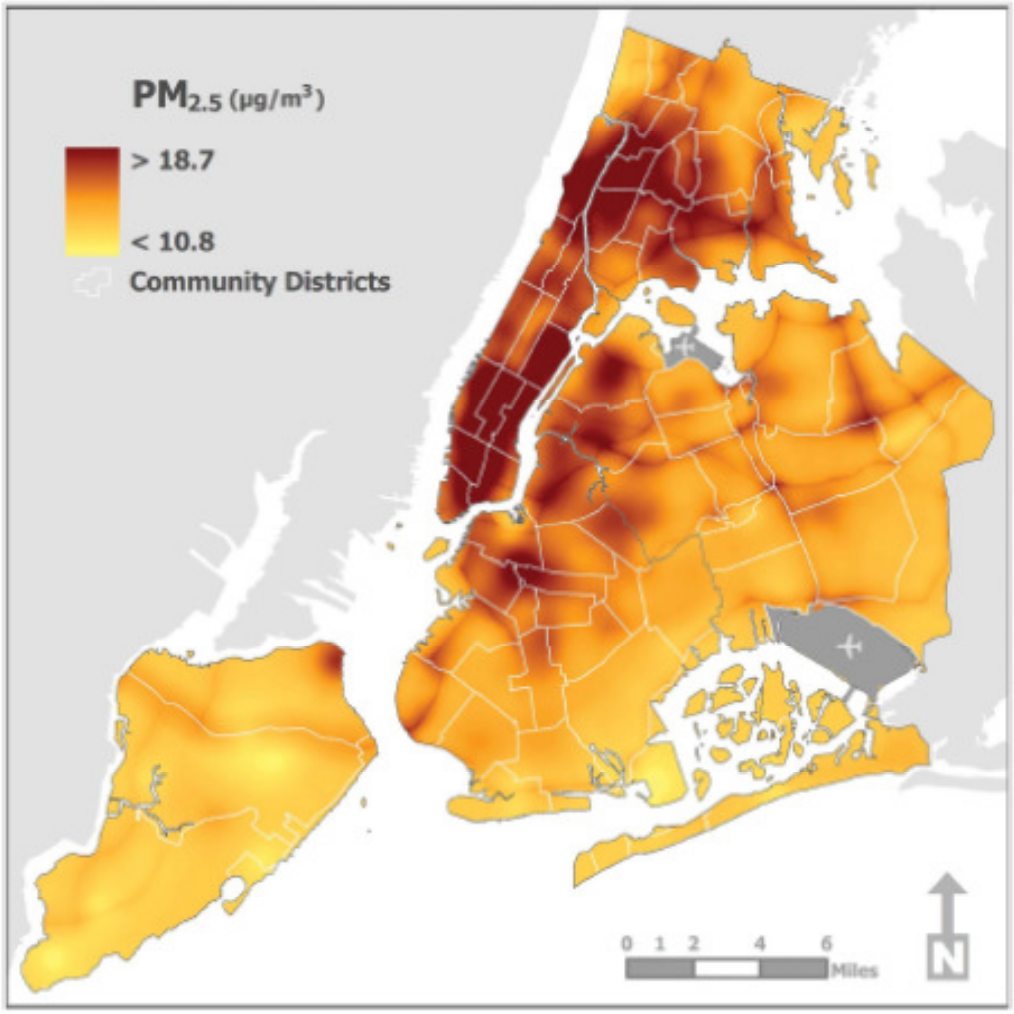
- Health effects of air pollution vary spatially within urban areas
  - by chemical composition (Bell, 2009)
  - and population susceptibility (Jerrett et al, 2005).

$PM_{2.5}$ exposures vary across regions…



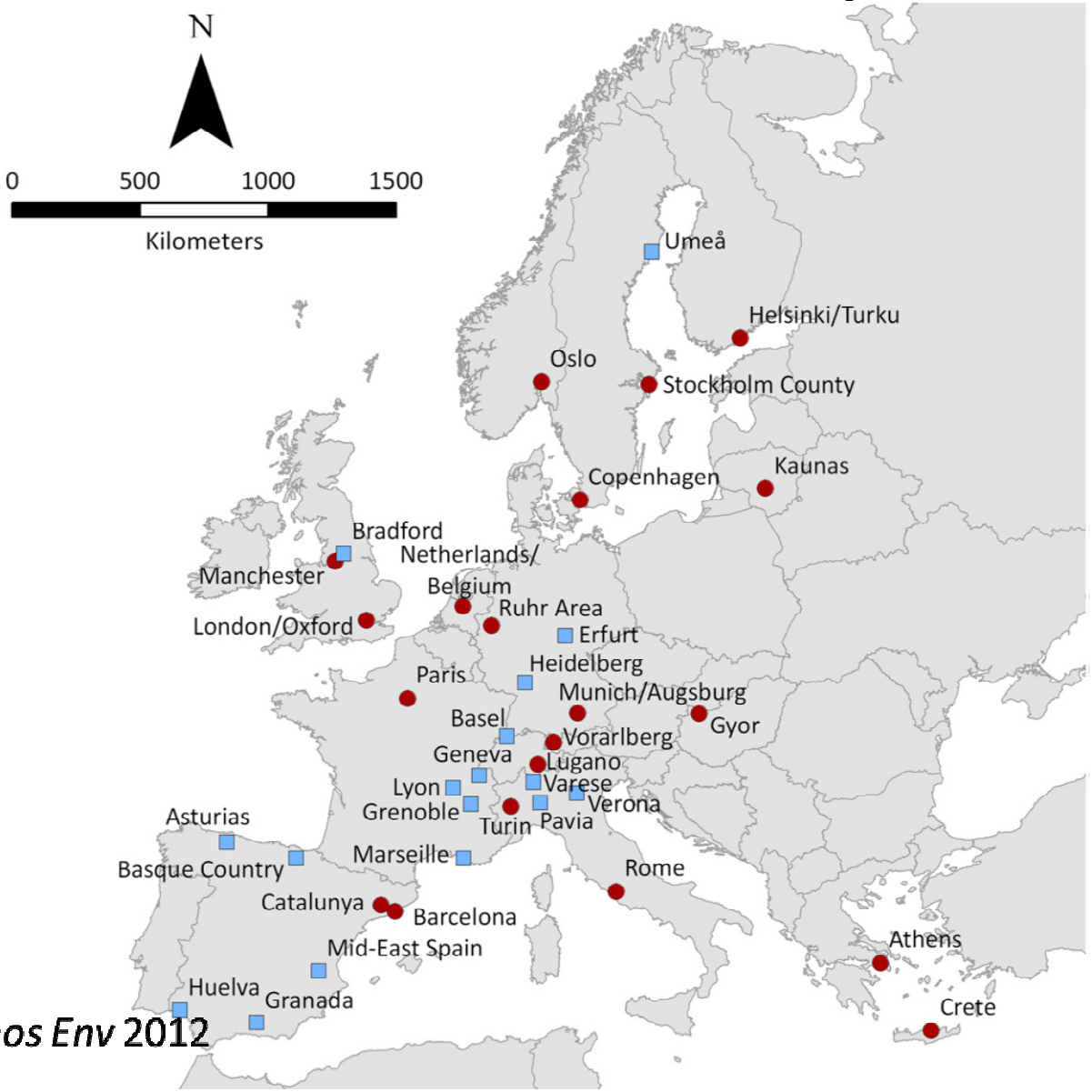
Sampson et al., A regionalized national universal kriging model using Partial Least Squares regression for estimating annual $PM_{2.5}$ concentrations in epidemiology, *Atmospheric Environment* 2013

And within urban areas…



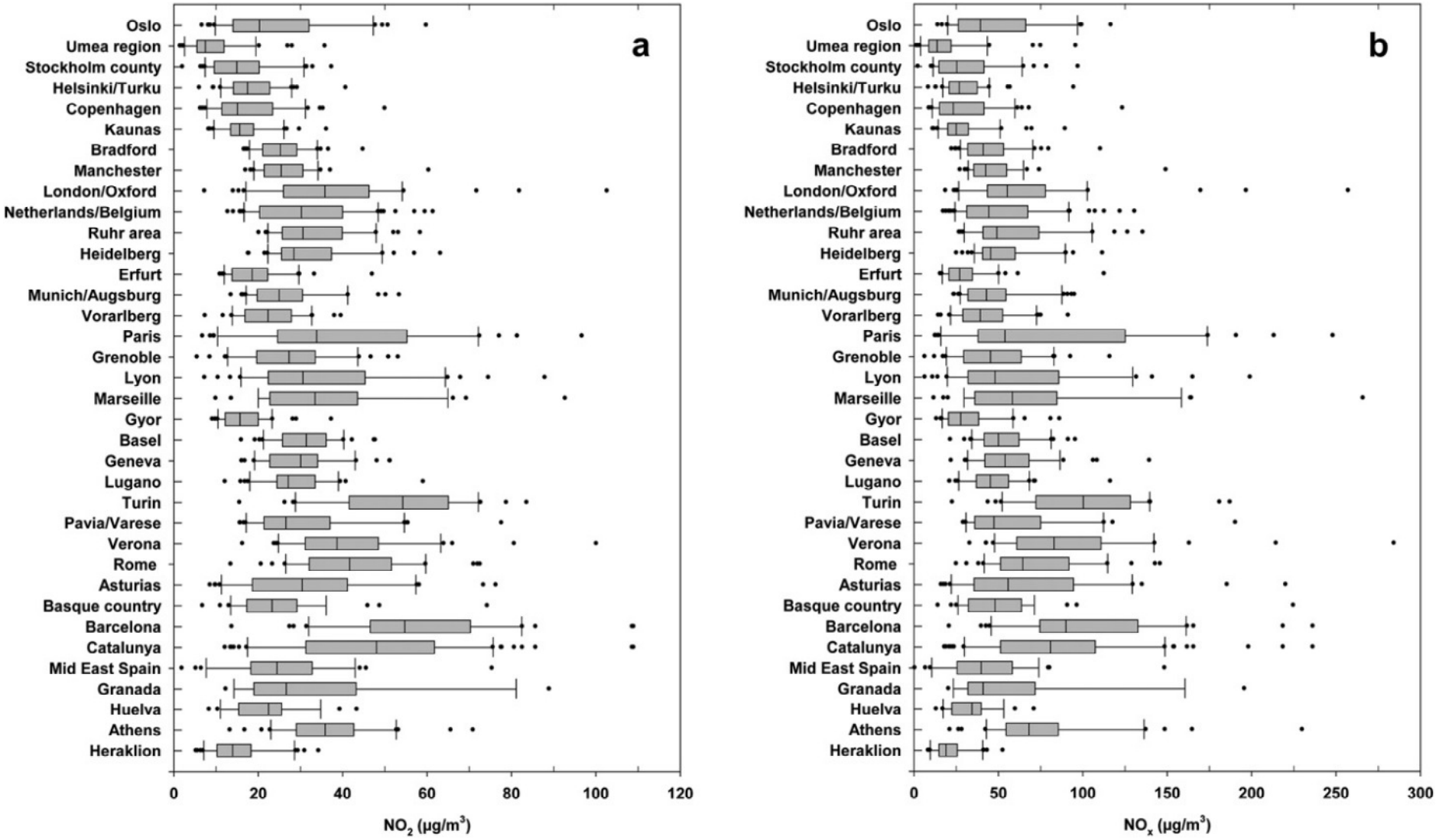
Clougherty et al., Intra-urban spatial variability in wintertime street-level concentrations of multiple combustion-related air pollutants: the New York City Community Air Survey (NYCCAS), *J Expos Sci Environ Epidem* 2013

European Study of Cohorts for Air Pollution Effects (ESCAPE)



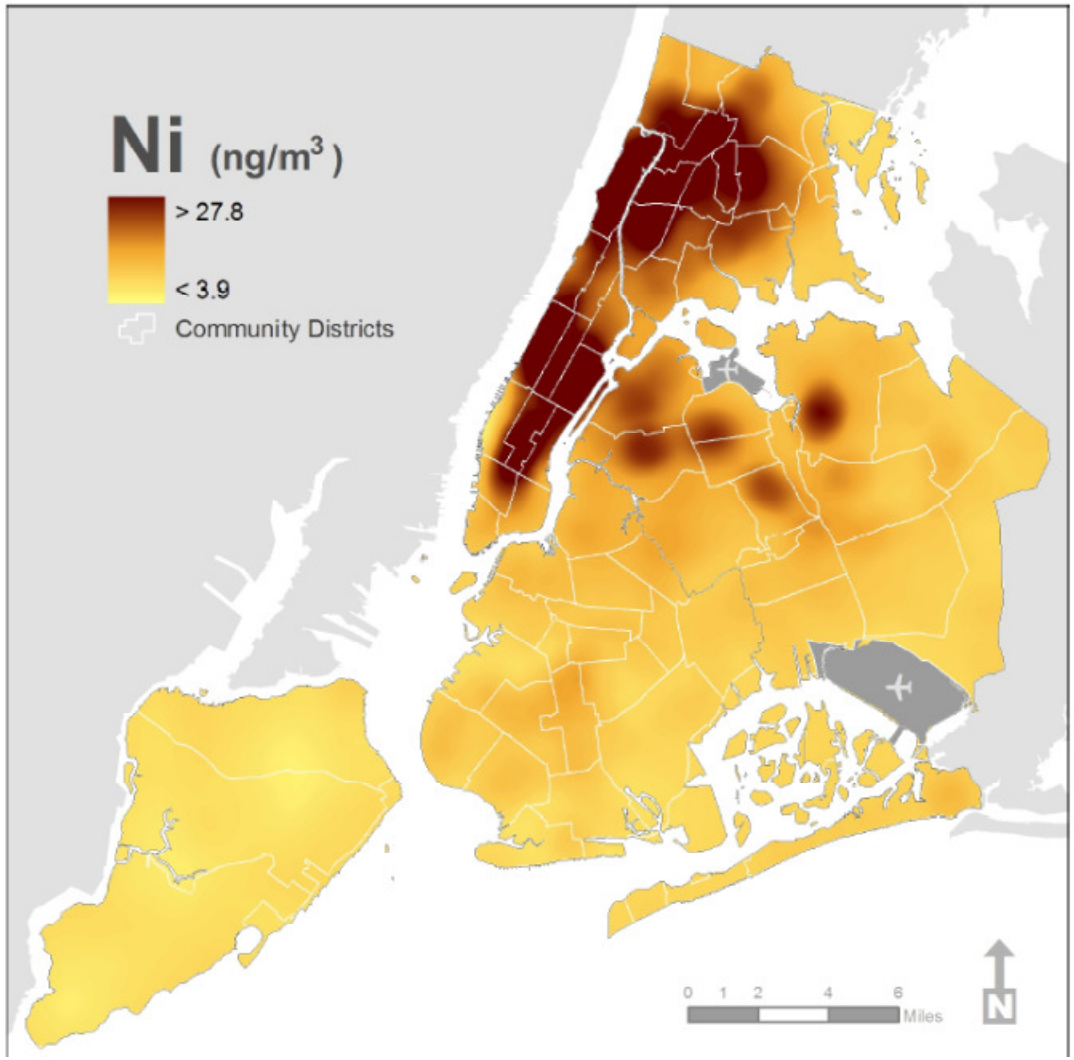
Cyrys et at, *Atmos Env* 2012

Pollutant concentrations vary within and between European cities



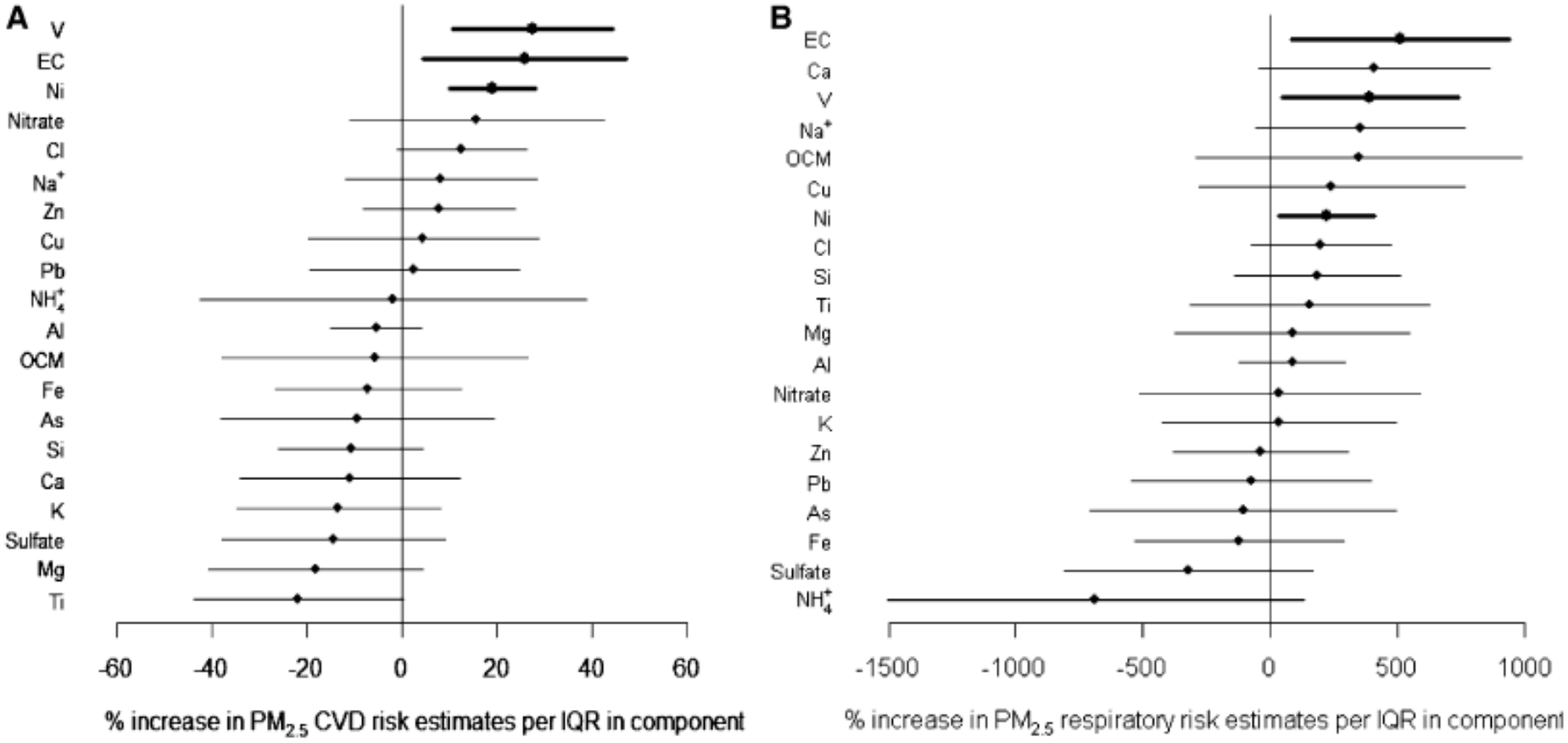
Cyrys et at, *Atmos Env* 2012

Importantly, $PM_{2.5}$ composition also varies within cities…



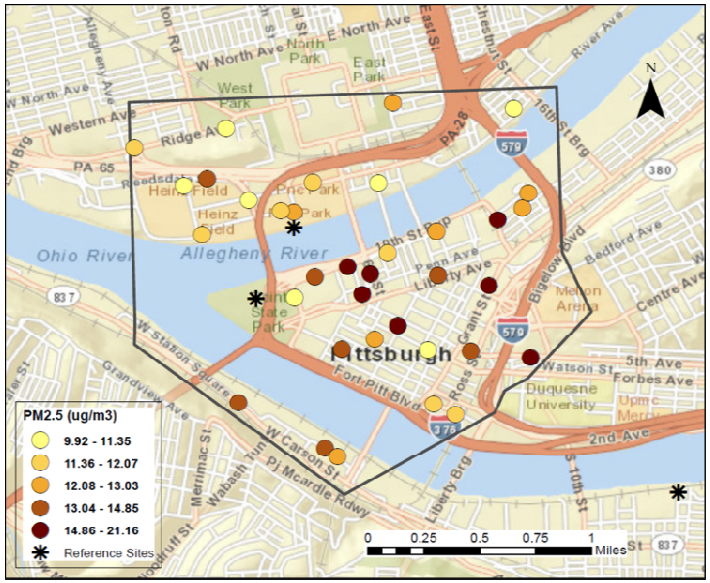
http://www.nyc.gov/html/doh/downloads/pdf/eode/nyccas-ni-report0510.pdf

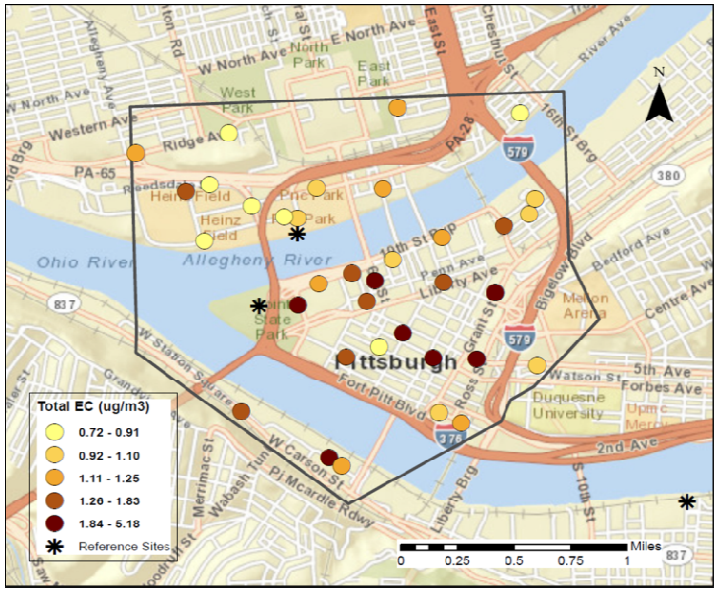
And PM components can differently impact health.

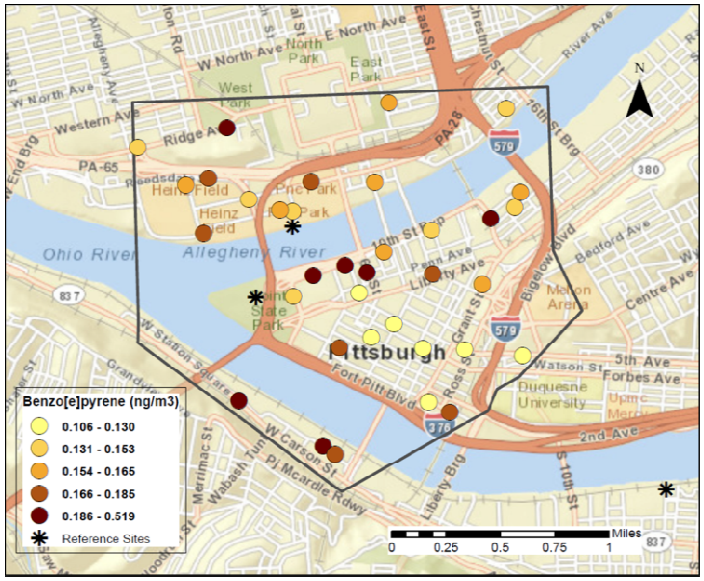


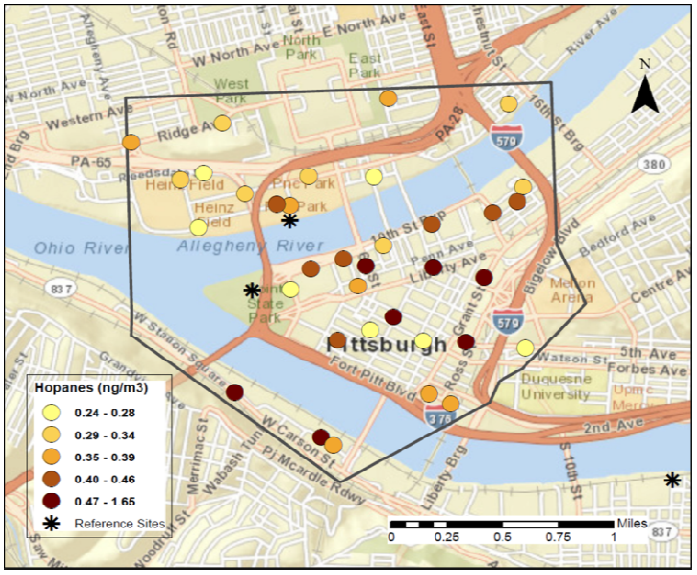
Bell et al, 2009

Chemical composition can vary even within small urban areas…



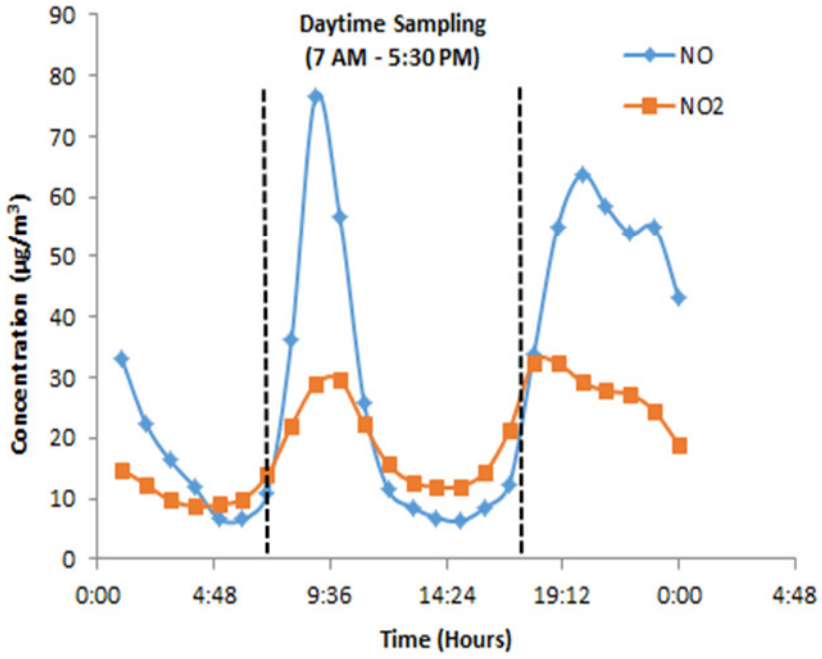




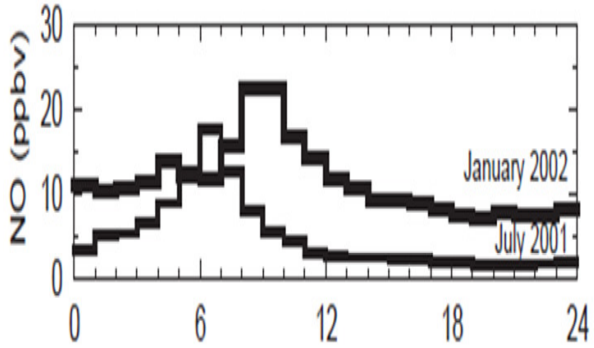


Concentrations and composition can vary by time of day and season

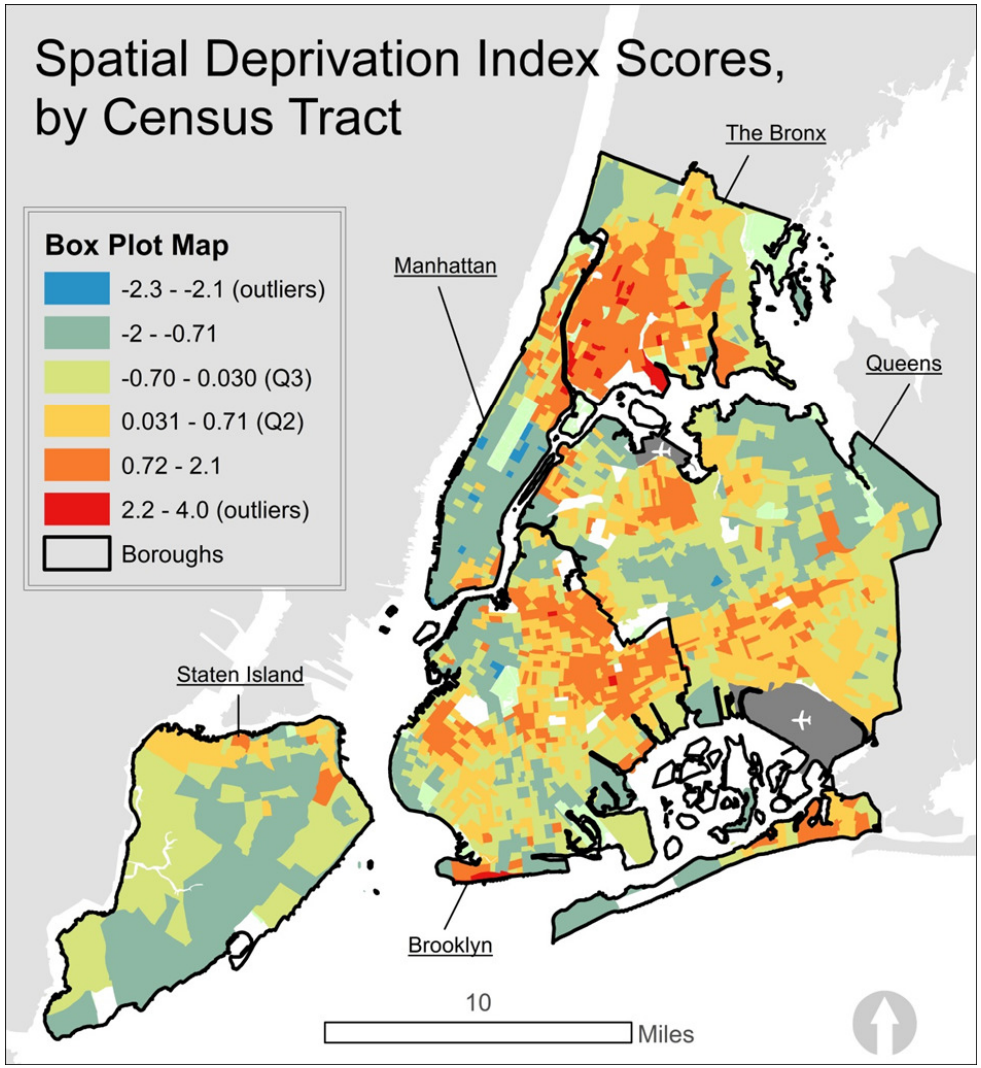
Christchurch, New Zealand



Pittsburgh, PA USA



and then there in spatial patterning in susceptibility within cities…



Carr Shmool et al., *forthcoming*

Why does this matter for understanding air pollution health effects??…

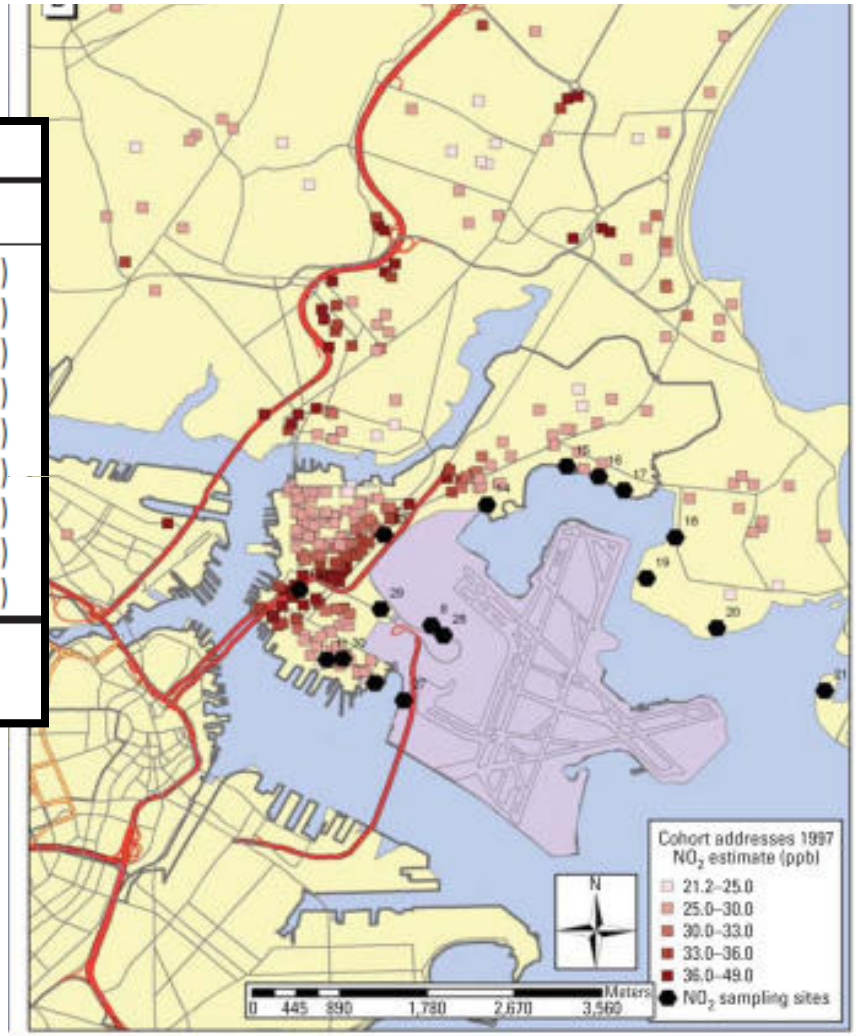
- Epidemiologic evidence of greater pollution susceptibility among lower-SEP populations. (Krewski et al., 2000; Jerrett et al., 2004)
  - Have not identified "causal components" of SEP.
  - Chronic stress may be one important contributor.
    (Clougherty et al., 2006, 2007; Chen et al., 2008)
- Stressors (e.g., traffic-related noise) spatially correlated with pollution (e.g., traffic-related air pollution)
  - Complicating, confounding the epidemiology
- Chronic stress confers broad physiologic changes, known as allostatic load (McEwen 1998)
  - HPA-axis function (e.g., cortisol)
  - Glucocorticoid receptor alteration
  - Sympathetic-adrenal-medullary (SAM) axis
  - Early life immune function (e.g., Th-1/Th-2)

Synergistic Effects of Traffic-Related Air Pollution and Exposure to Violence on Urban Asthma Etiology

Table 4. Multivariate model for asthma diagnosis [OR (95% CI)].

	Full cohort
Maternal asthma (ever diagnosed)	1.31 (0.58–2.96)
In utero tobacco smoke exposure	1.07 (0.44–2.58)
Maternal smoking since birth	1.10 (0.70–1.72)
Less than high school education	1.14 (0.71–1.81)
Child's sex (female)	0.85 (0.54–1.34)
Child's age (≥ 7 years)	1.44 (0.90–2.33)
High ETV	0.89 (0.56–1.43)
NO_2 year of diagnosis: low ETV	0.99 (0.73–1.34)
NO_2 year of diagnosis: high ETV	1.63 (1.14–2.33)

ORs for NO_2 are associated with a 1-SD (4.3 ppb) increase.



Clougherty JE, et al *Environ Health Perspect*. 2007 Aug;115(8):1140-6.

Toxicological results suggest stress-differing respiratory response to PM

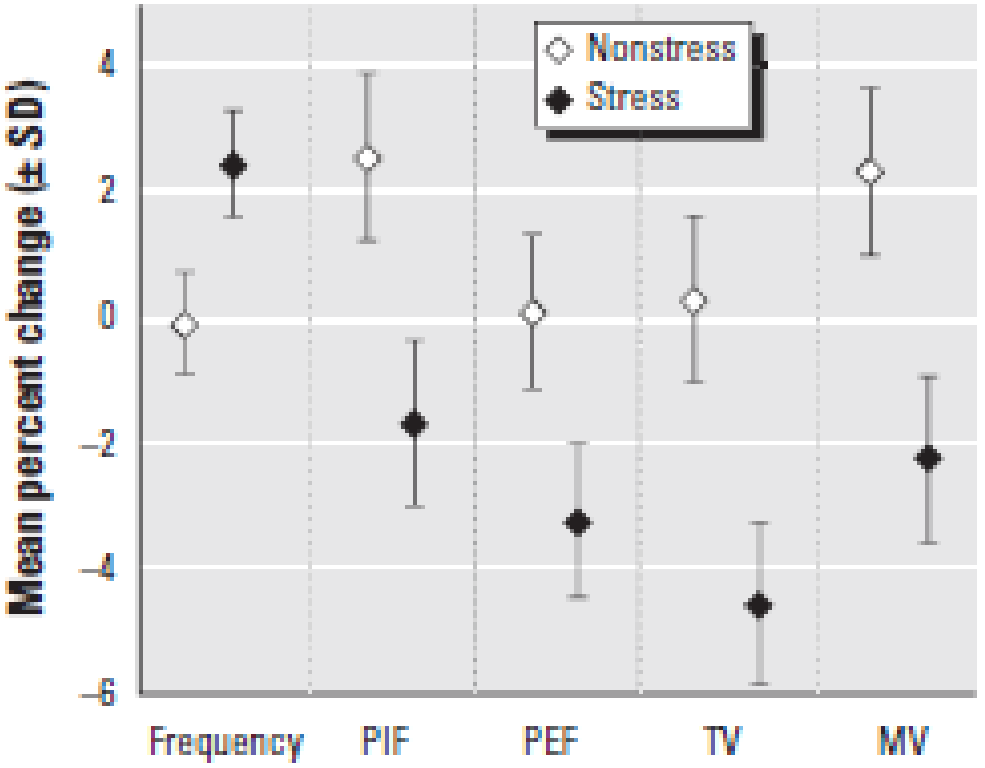


Figure 1. Estimated change in respiratory measures with a 1-SD (164.5 μg/m^3) change in PM mass concentration, by stress group.

Clougherty et al., *EHP*, 2010

Possible implications for nutritional interventions

- May need better understand pollutant mix/ $PM_{2.5}$ chemical composition in target areas
  - And susceptibility patterns
- Key outcomes to start with?
  - Asthma/ respiratory disease? Cardiovascular?
- Likely need target pathways impacted by multiple pollutants/ stressors
  - e.g., inflammation
- Need think about both spatial variation, *timing* of exposures, and physiologic impacts

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Thank you very much

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