Health risk due to nanoparticles - epidemiological knowledge

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Content

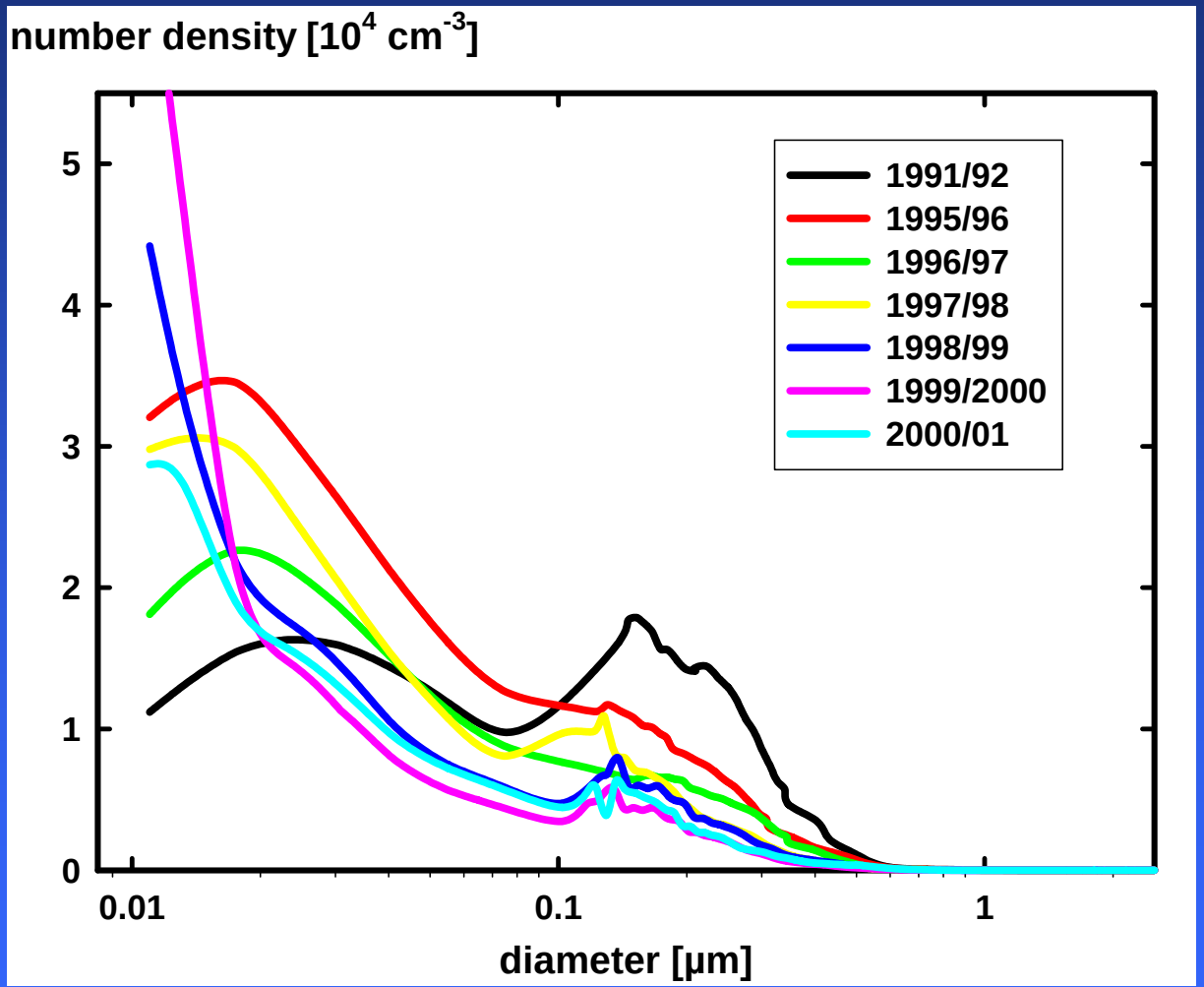
- Ambient concentrations
- Respiratory effects
- Cardiovascular effects
- Summary

Abbreviations:

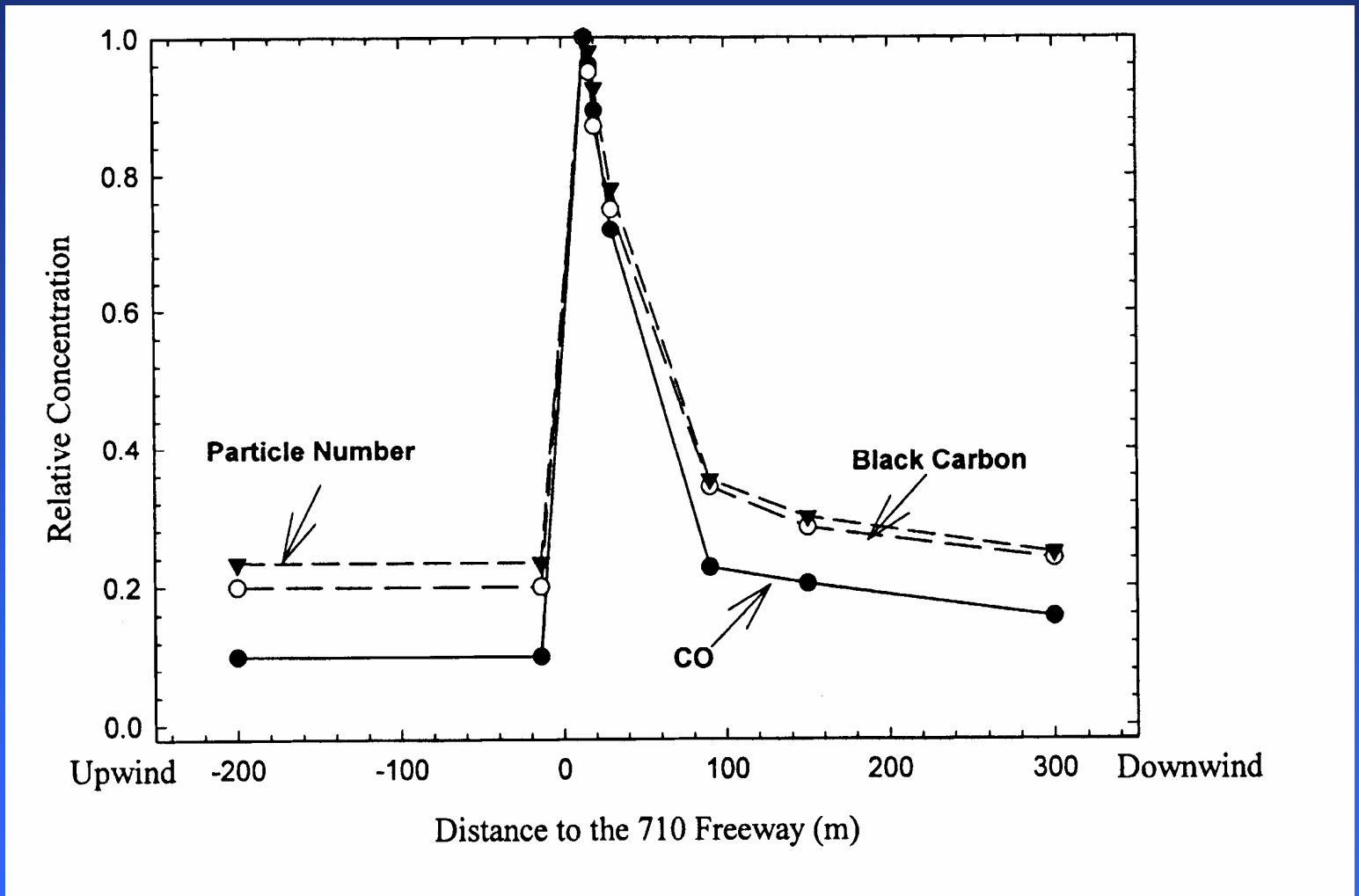
PM_{10}	fine and coarse particles	(mass)	< 10 μm
FP	fine particles	(mass)	< 2.5 μm
UP	ultrafine particles	(number)	< 0.1 μm

UP = nanoparticles

Particle distribution in Erfurt

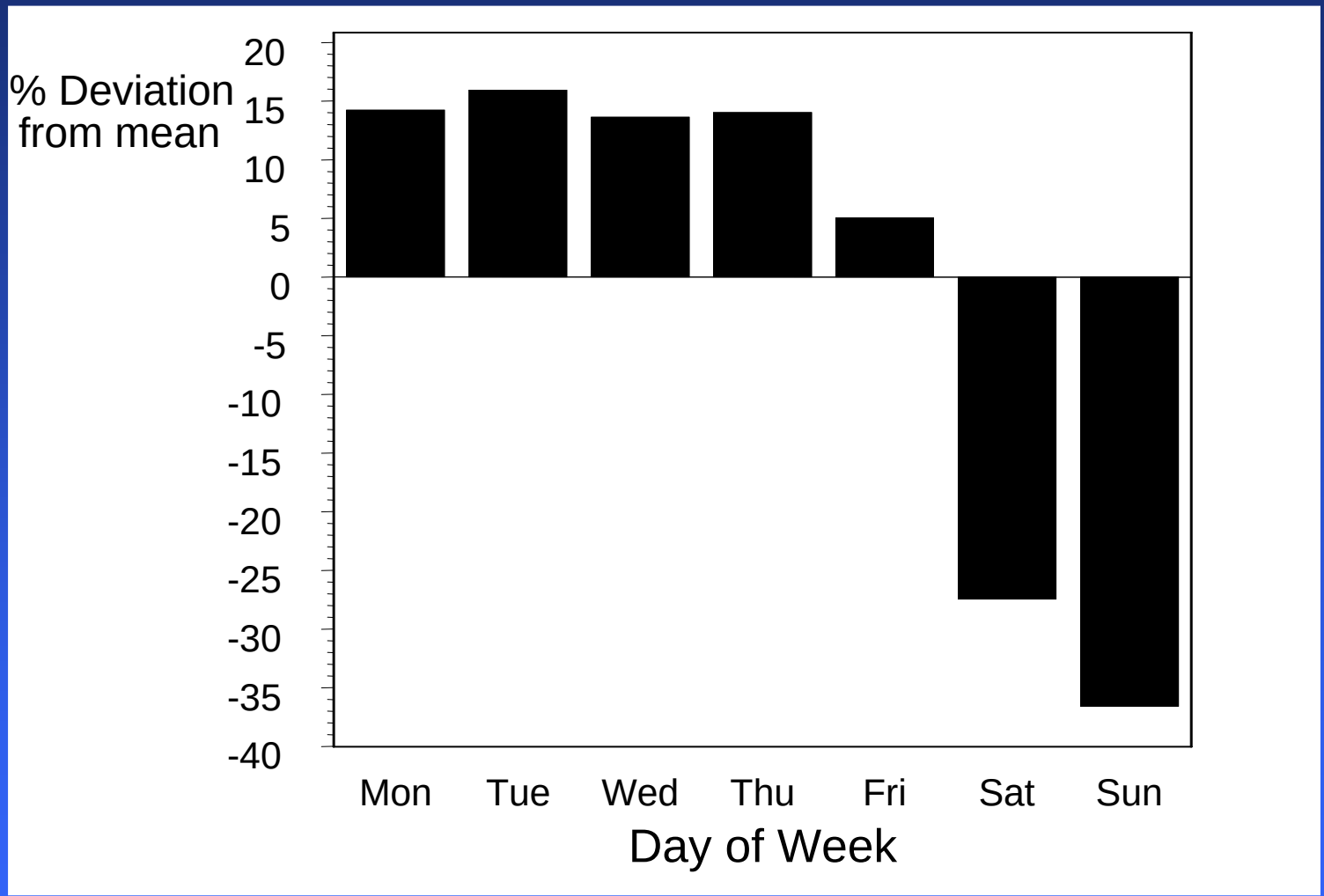


Relative particle number, BC, CO concentrations versus distance from the 710 freeway



Zhu et al (2002)

Day of week pattern of UP

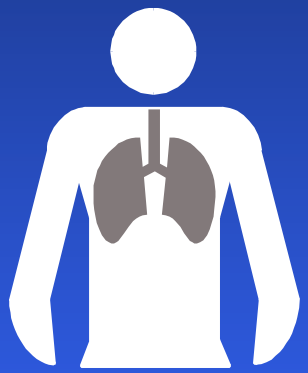


Ultrafine Particles at conventional workplaces

- Fumes from hot processes (e.g. smelting and refining metals; welding)
- Fumes from combustion processes (e.g. diesel motor emissions, carbon black manufacture)
- Bioaerosols (e.g. agriculture, biotechnology)

Who is susceptible and why?

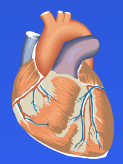
Inhalation of ambient particles



Local effects
Inflammation

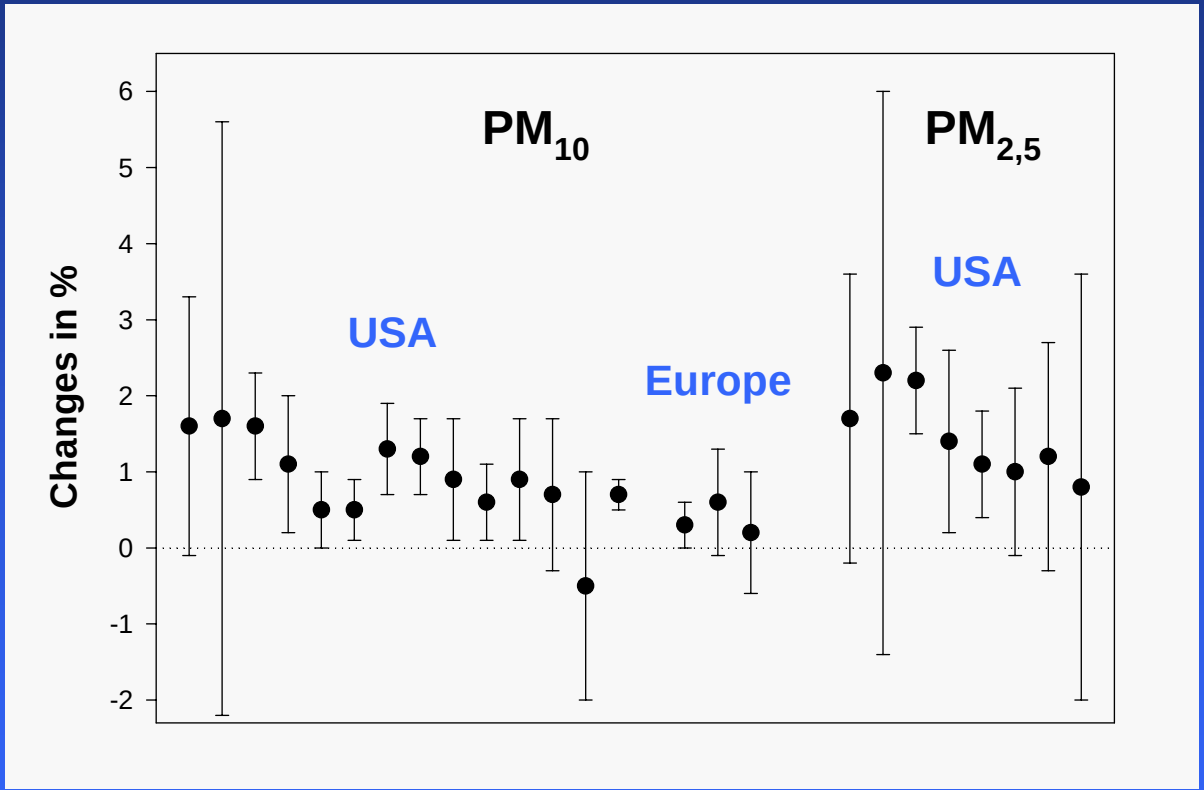
Asthma Attacks
Acute Bronchitis

Systemic effects
Acute phase proteins
Cytokines



Ischemia
Arrhythmia

Particulate matter was associated with mortality



WHO , 1997

Role of ultrafine particles

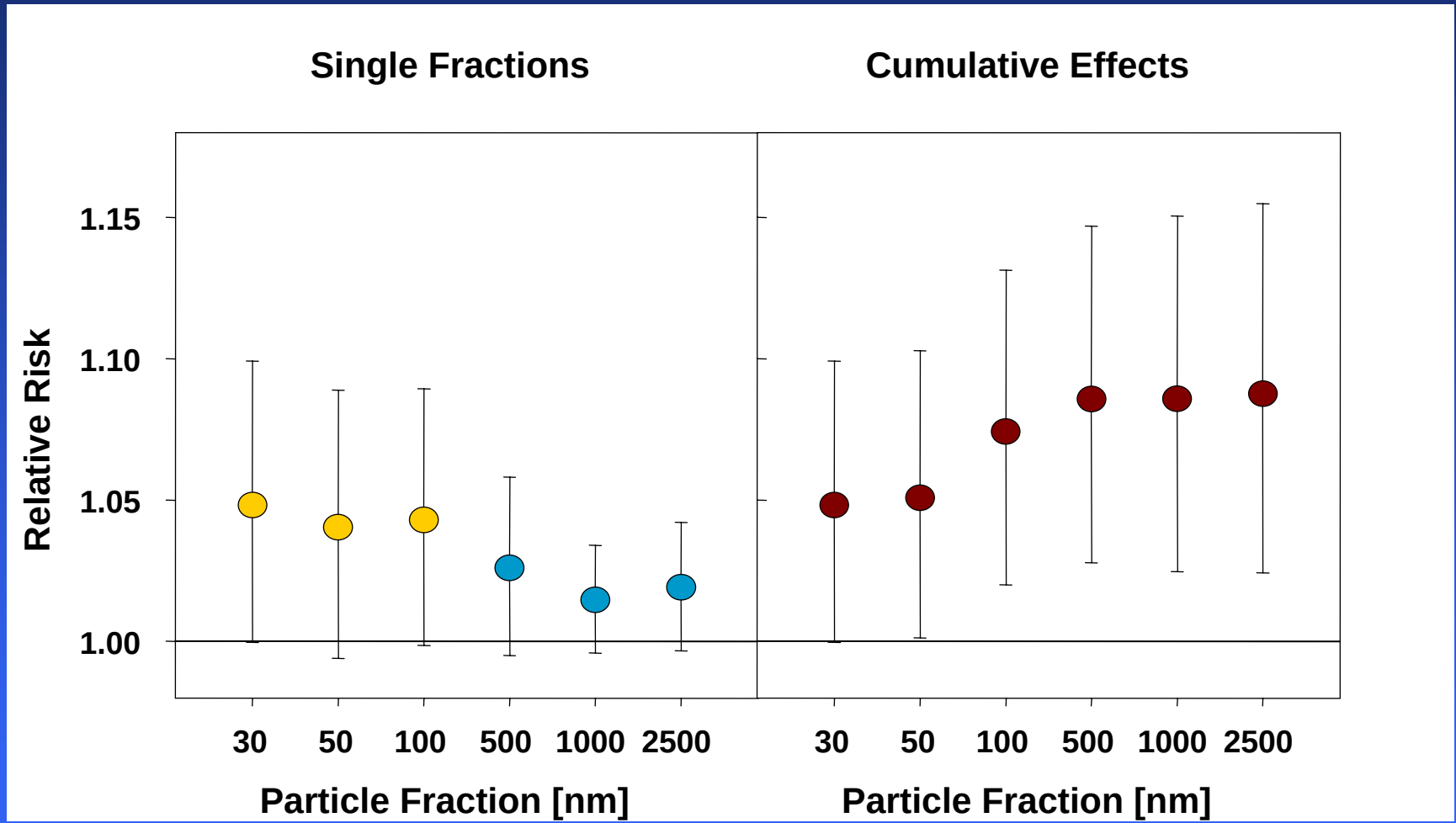
- Ultrafine particles are deposited in the alveolar region with high efficiency.
- The large surface of ultrafine particles can increase toxicity.
- Decreased phagocytosis allows enhanced interaction between ultrafine particles and the epithelium
- Ultrafine particles are dislocated from the alveolar space and might therefore elicit systemic effects.

Mortality Study on ultrafine particles

- Daily mortality counts were collected in Erfurt between summer 1995 and the end of 1998.
- Particle size distributions were measured with an aerosol spectrometer between 10 nm and 2.5 µm.
- Ultrafine particles were only moderately correlated with $PM_{2.5}$.

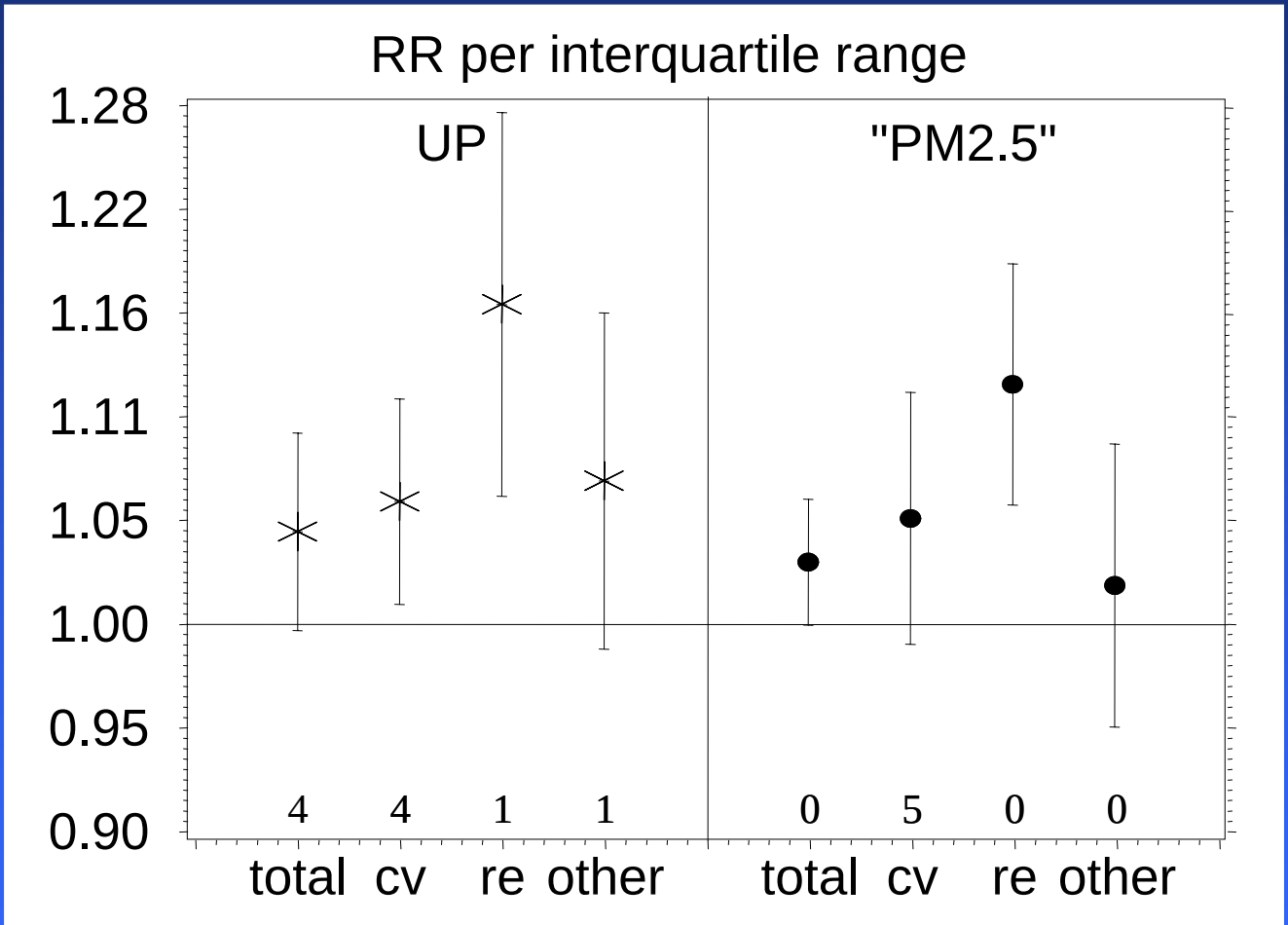
Wichmann et al. *HEI Report* 2000

Particle and Daily Mortality, 1995 to 1998, Erfurt

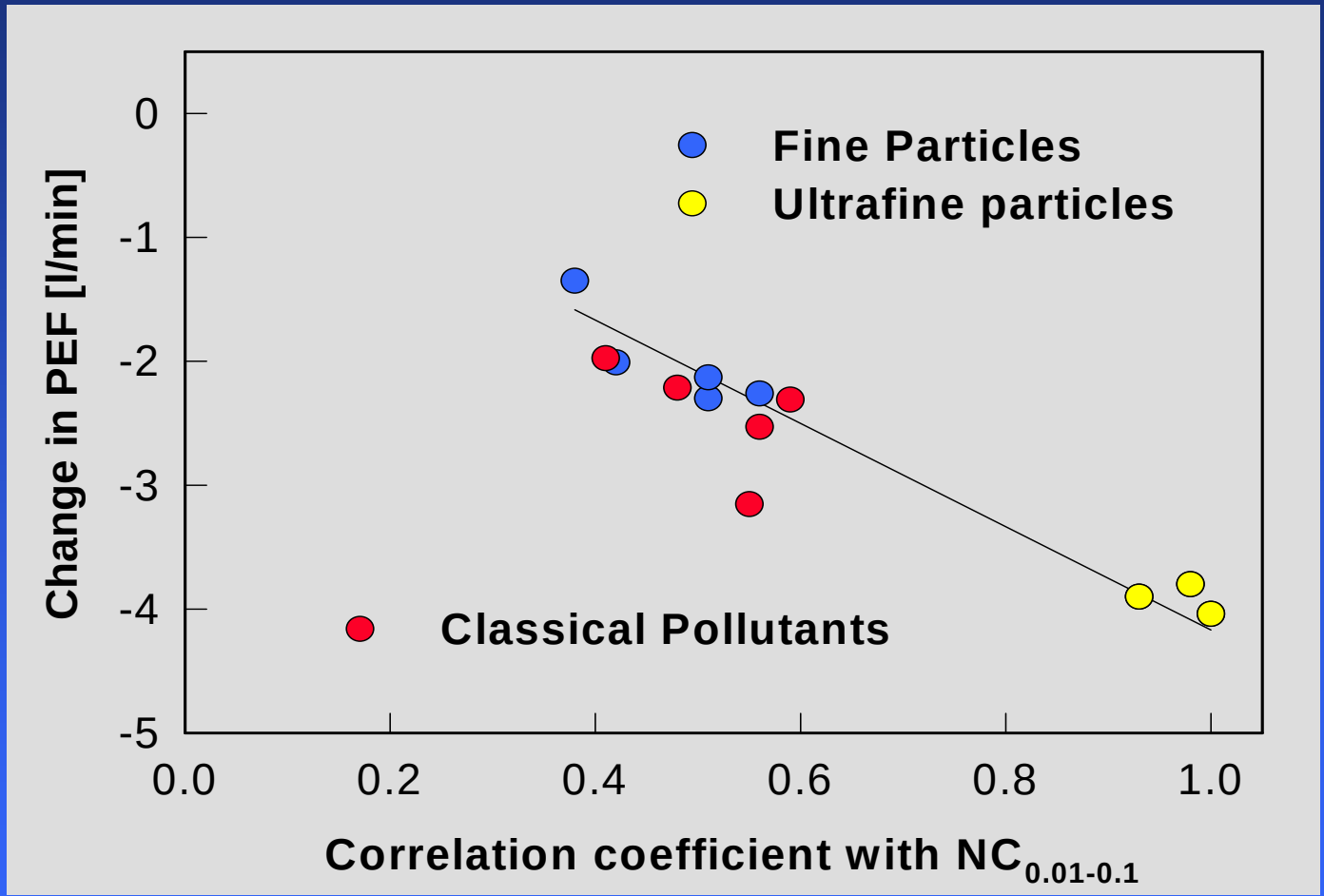


Wichmann et al. (2000)

Regression results by cause of death



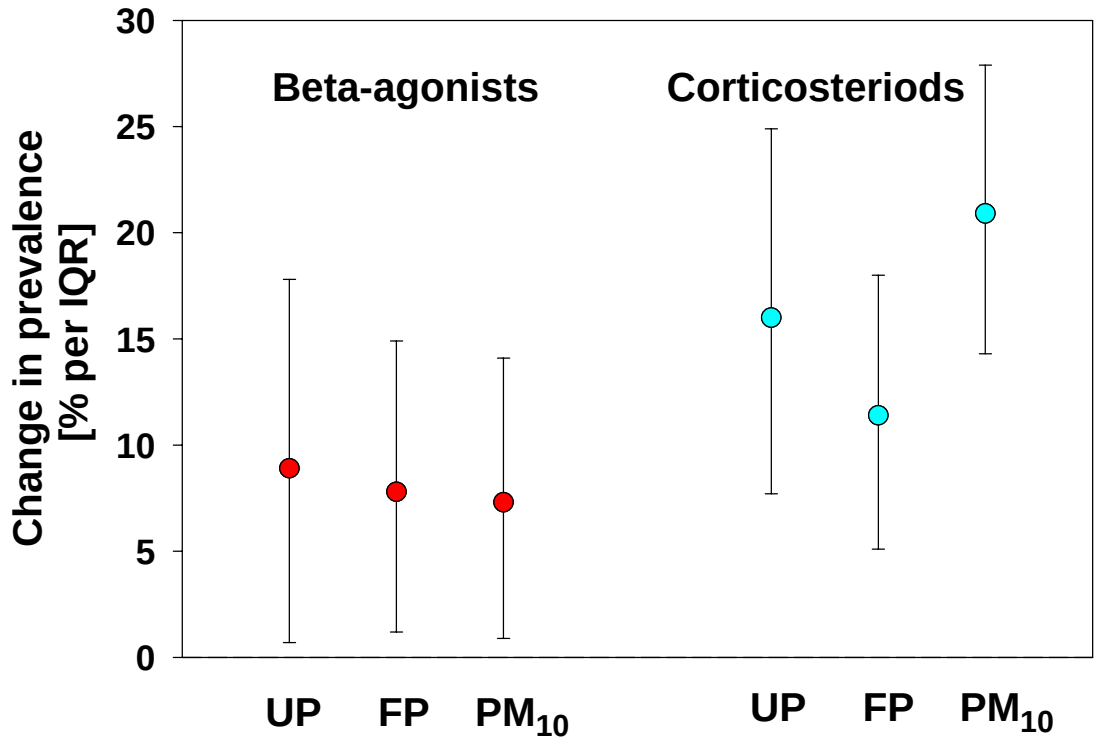
Lung function reduction in asthmatic adults



Peters et al. , 1997

Medication use increased in adult asthmatics (Erfurt)

52 subjects followed for 5 months during winter 96/97

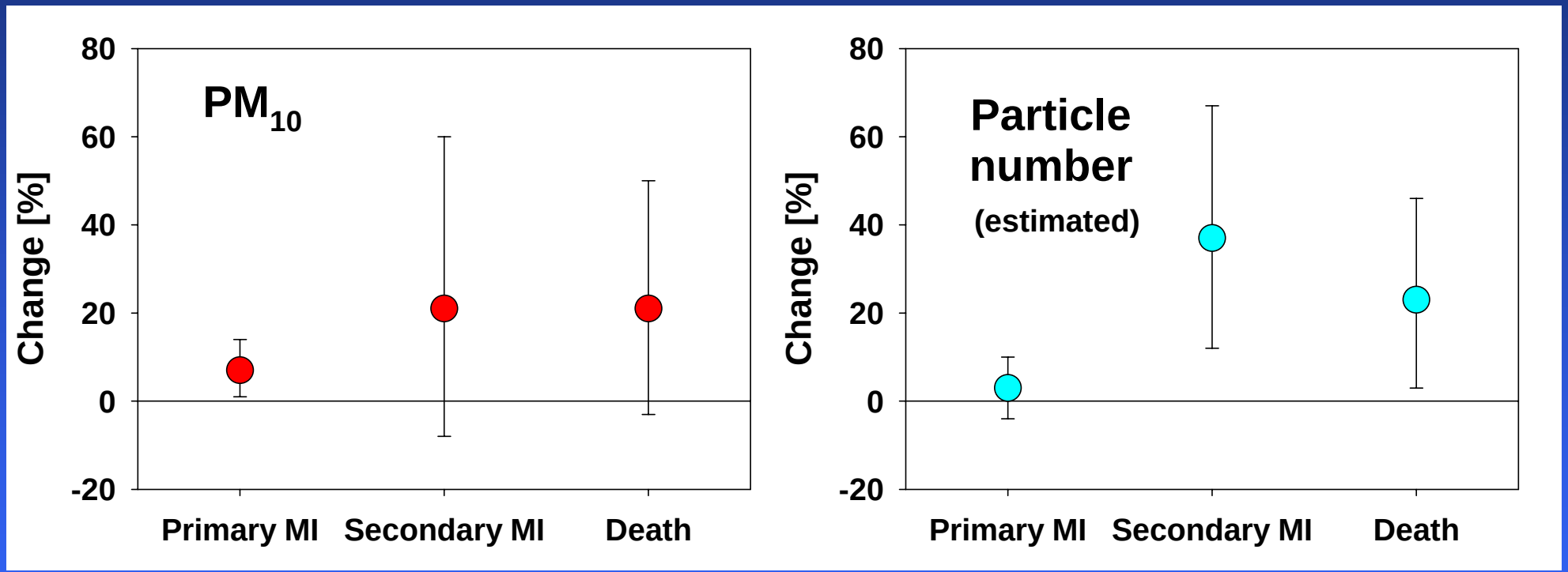


von Klot et al. (2000)

Potential mechanism leading to cardiovascular effects

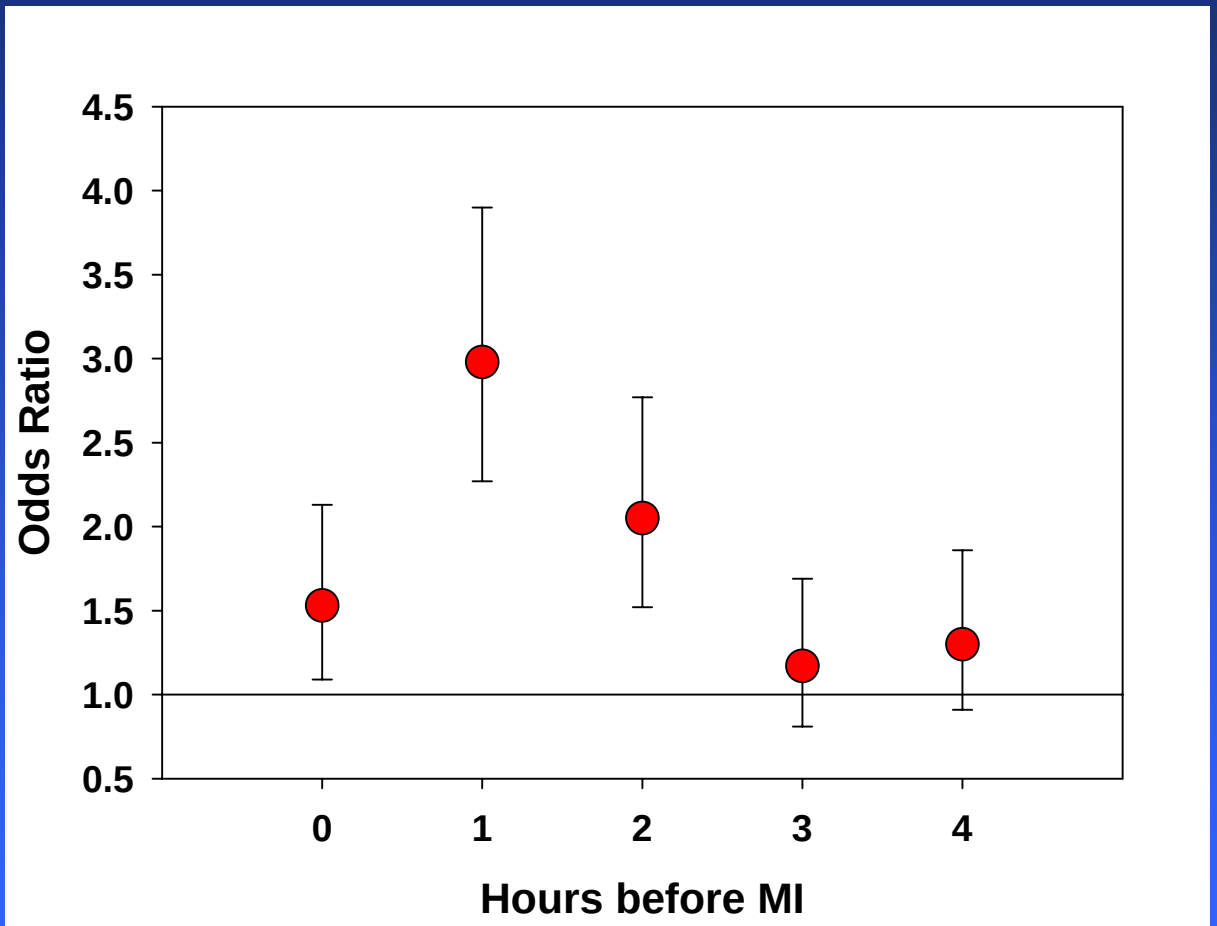
- Increased sympathetic activation and /or withdrawal of parasympathetic tone
- Imbalance of sympathetic and parasympatetic control
- Decreased heart rate variability
- Increased risk for cardiac events (alteration of myocardial substrate, increased myocardial vulnerability)

Particles and Myocardial Infarction in Augsburg



Traffic and Onset of Myocardial Infarction in Augsburg

- 691 MI survivors of the KORA MI Registry Augsburg
- Activities were recorded 4 days before the event
- Using a car, public transport or a bicycle might be a risk factor for MI



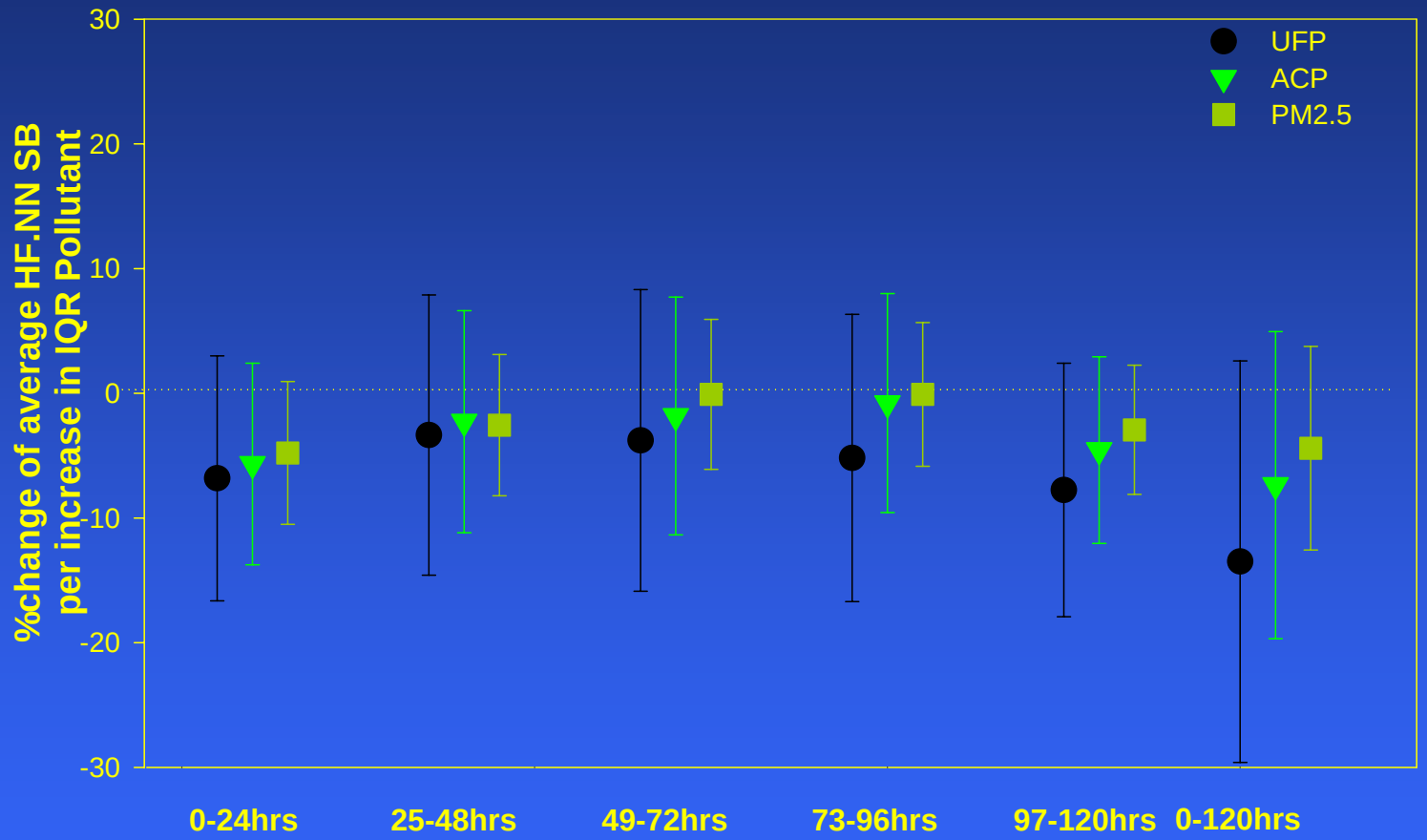
Peters et al. NEJM in press

Rochester Particle Center Study in Erfurt, Germany

- Panel Study in 56 patients with coronary artery disease (winter 2000/01)
- Panel Study in 37 patients with chronic obstructive pulmonary disease (winter 2001/02)
- Blood biomarkers and EKG recordings at 12 clinic visits
- Central monitoring of ultrafine and accumulation mode particles, $PM_{2.5}$

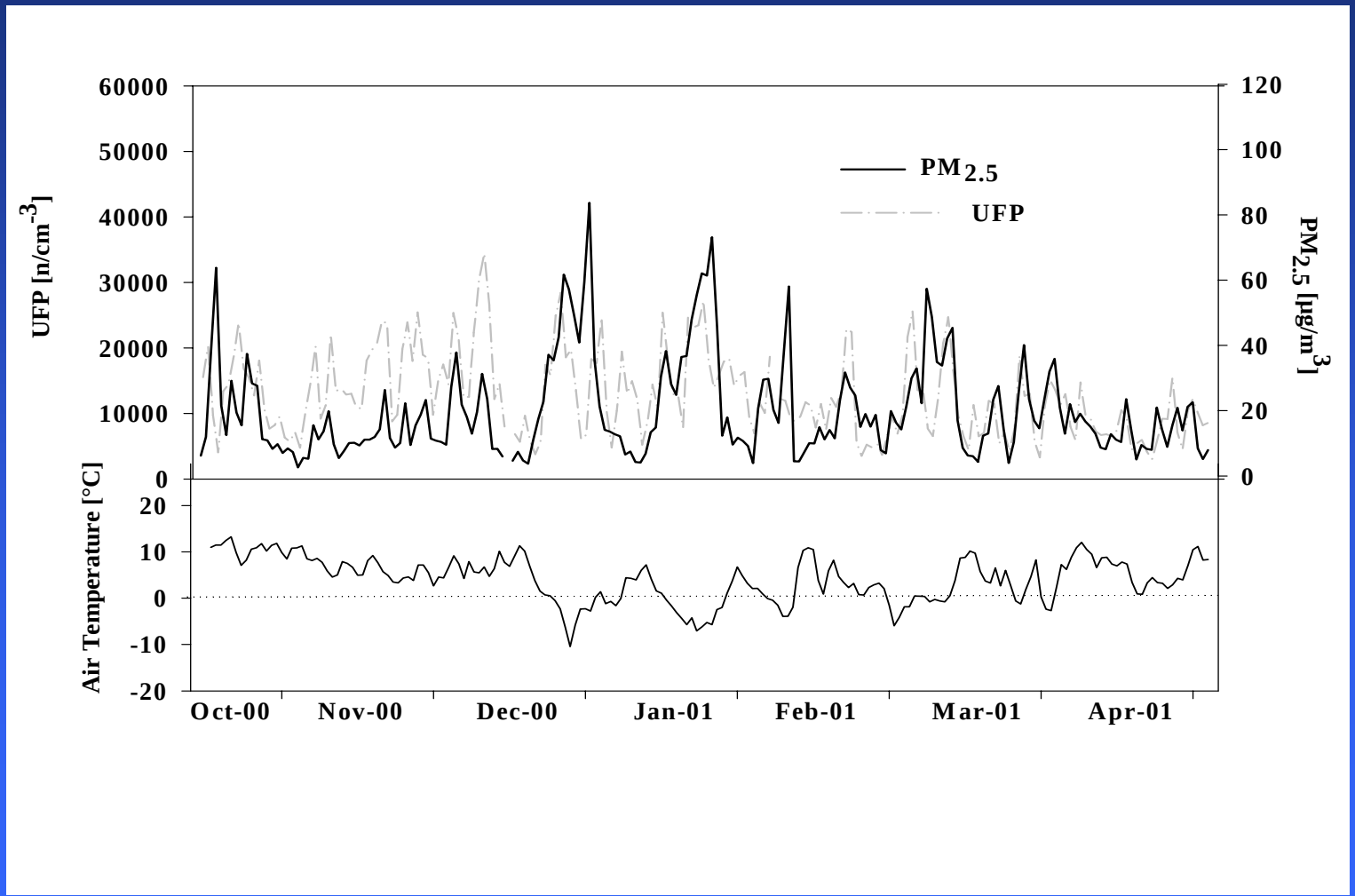
Particle effects on normalized HF in Erfurt

spontaneous breathing, 5 min recordings



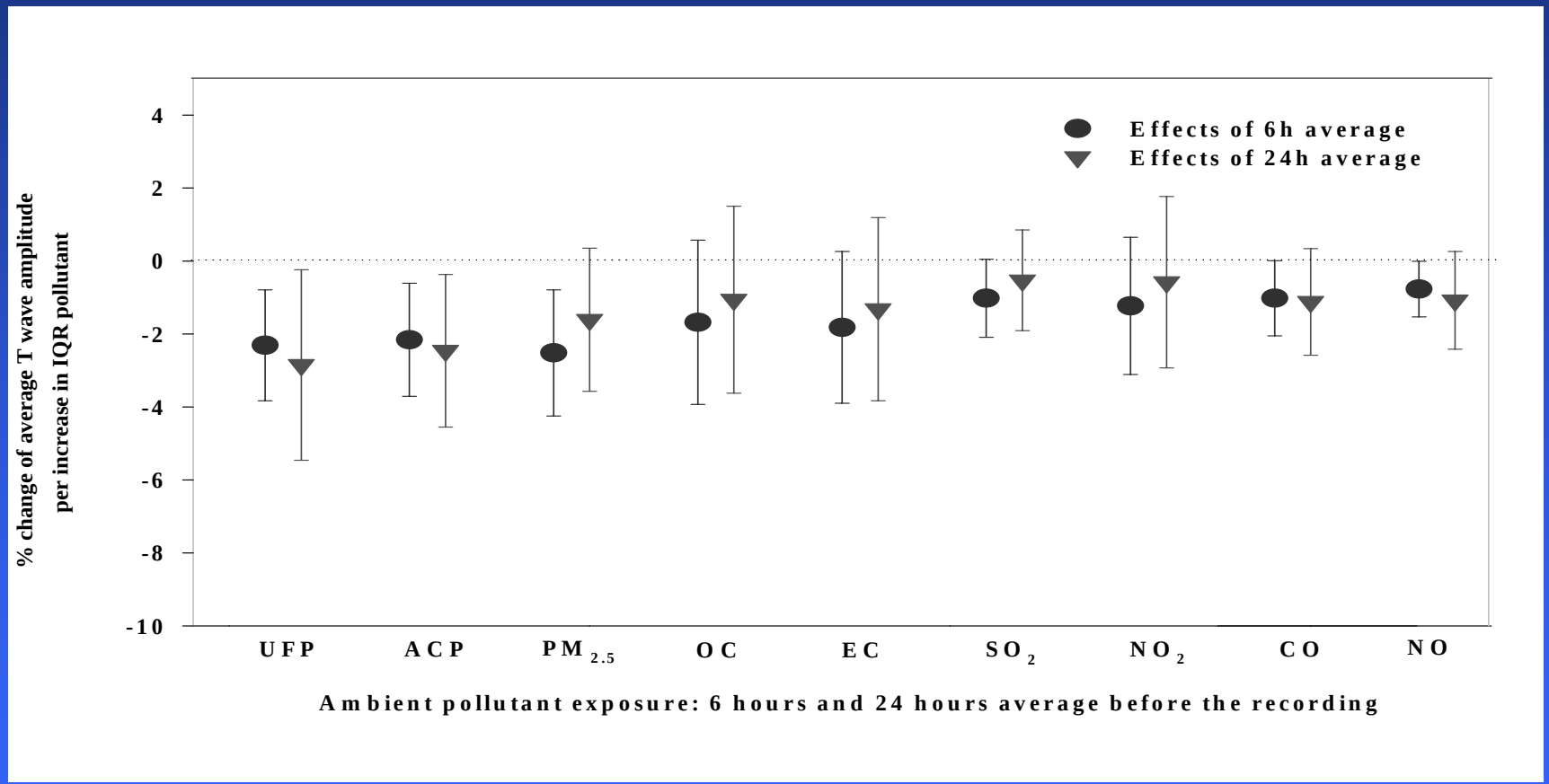
Exposure to average concentrations of ambient air particles concurrent and prior to the 24 hr recording

Ultrafine Particle number, $PM_{2.5}$ and Temperature (CAD panel, Erfurt, winter 2000/2001)



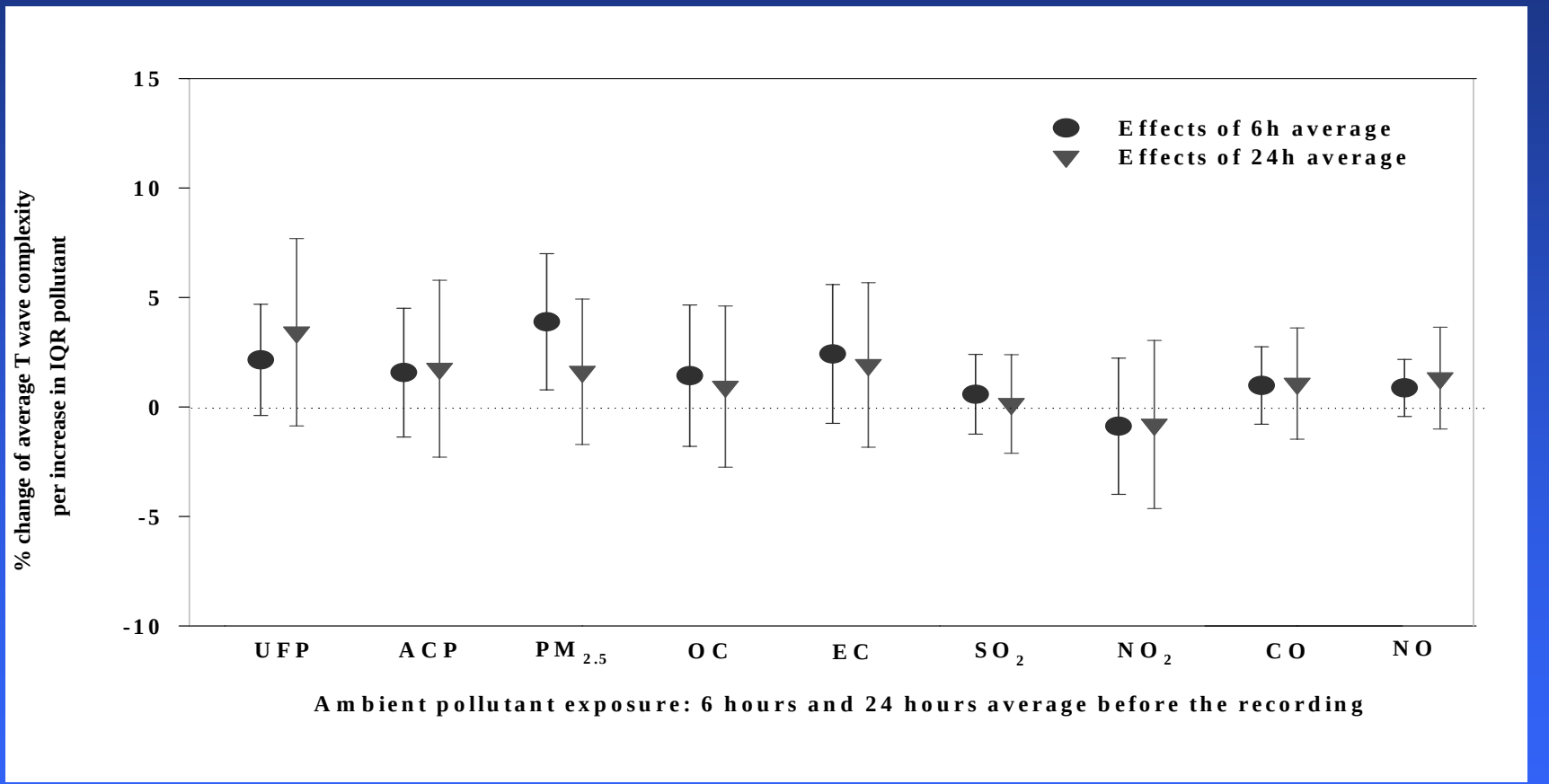
Particle effects on T wave amplitude in Erfurt

spontaneous breathing, 5 min recordings



Particle effects on T wave complexity in Erfurt

spontaneous breathing, 5 min recordings



Summary

- Main ambient source of UP is automobile traffic
- Health effects of UP on respiratory and cardiovascular endpoints shown, but open questions
- Epidemiology on technically produced nanoparticles missing (work place and environment)
- Epidemiology on UP from combustion may serve as model for nanoparticles