HEALTH EFFECTS OF AIR POLLUTION – IMPLICATIONS FOR AQ MONITORING

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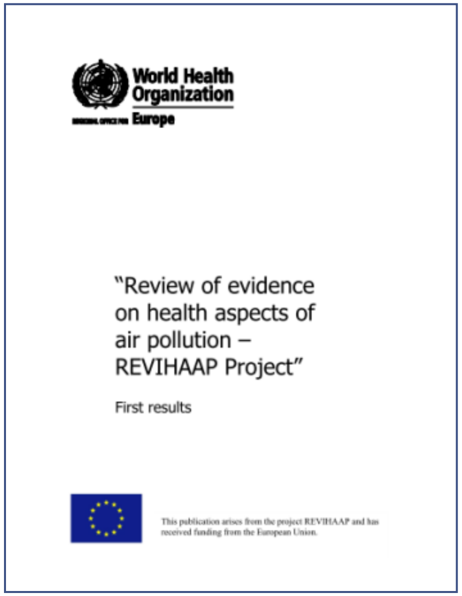
AirMonTech, Brussels 16 May 2013

This presentation:

1) **Summary of the results of the WHO – EC project "Review of evidence on health aspects of air pollution - REVIHAAP"**


World Health Organization
Europe

"Review of evidence on health aspects of air pollution – REVIHAAP Project"

First results

This publication arises from the project REVIHAAP and has received funding from the European Union.

2) **Implications for AQ monitoring**

About REVIHAAP

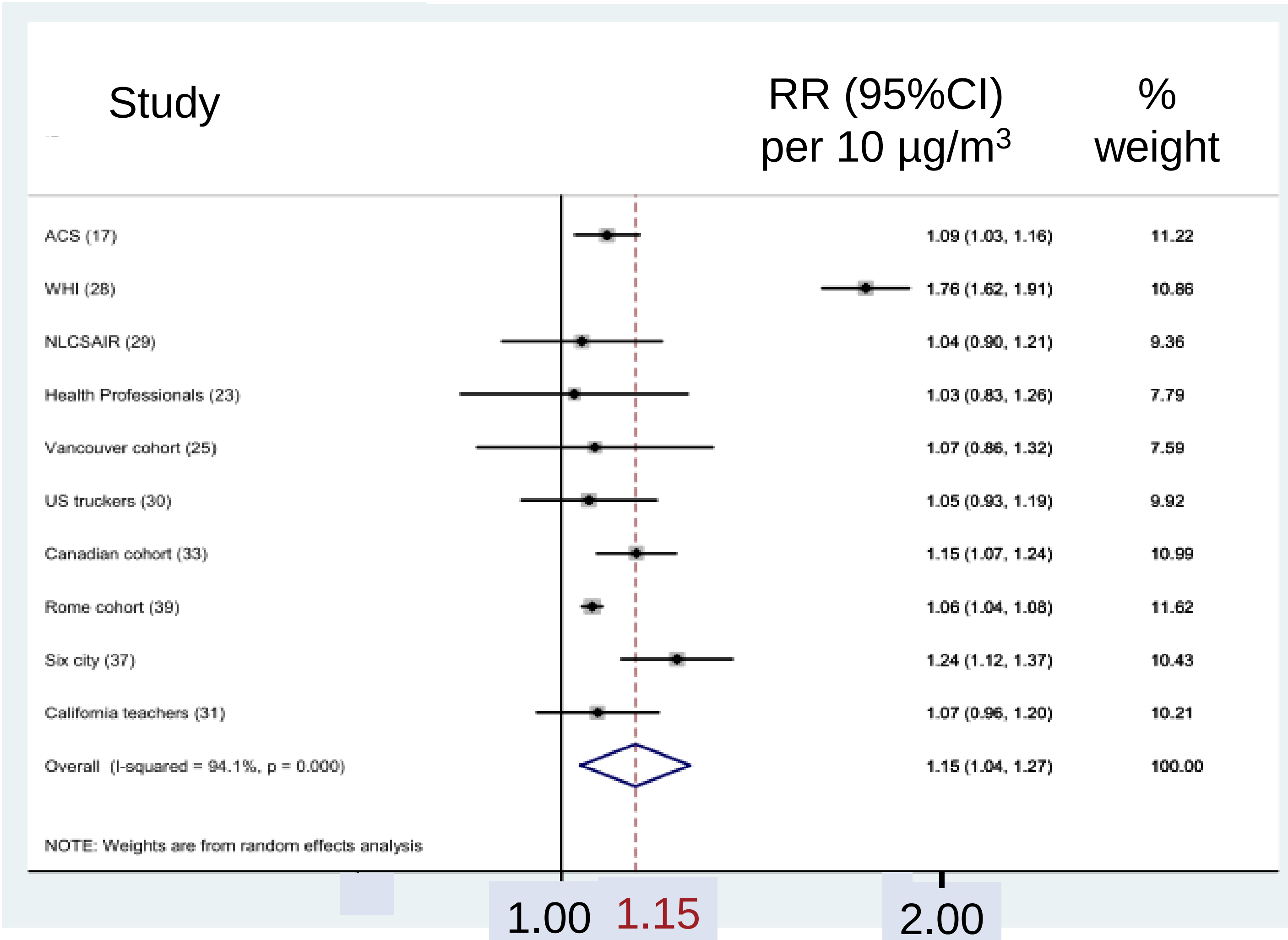
- WHO project jointly financed by WHO and EC, managed by WHO/ECEH (Marie-Eve Heroux)
- Evidence review in response to 24 key policy questions from the EC
- Timing: 18 months, Sept 2011 – April 2013
- Steering Advisory Committee (8 experts, 2 meetings, multiple TCs)
- Review of evidence and drafting the answers: 29 experts
- External review: 30 experts
- Two expert meetings (Aug 2012 & Jan 2013)
- Answers published on-line http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap
- Full rationales to be published in June 2013
- Followed by a sister project: “Health risks of air pollution in Europe – HRAPIE” - health risk assessment, emerging issues. (June 2012-Aug 2013)

REVIHAAP: selected conclusions on PM (A1)

The scientific conclusions of the 2005 WHO Guidelines about the evidence for a causal link between $PM_{2.5}$ and adverse health outcomes in humans have been confirmed and strengthened and, thus, clearly remain valid.

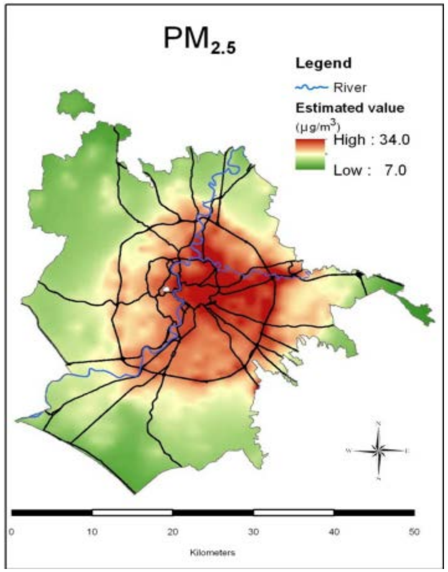
- New studies on short- and long-term effects;
- Long-term exposure to $PM_{2.5}$ are a cause of cardiovascular mortality and morbidity;
- More insight on physiological effects and plausible biological mechanisms linking short- and long-term $PM_{2.5}$ exposure with mortality and morbidity;
- Studies linking long-term exposure to $PM_{2.5}$ to several new health outcomes (e.g. atherosclerosis, adverse birth outcomes, childhood respiratory disease)

Meta-analysis of the association between long-term exposure to $PM_{2.5}$ and cardiovascular mortality



Hoek et al, EnvHealth 2013

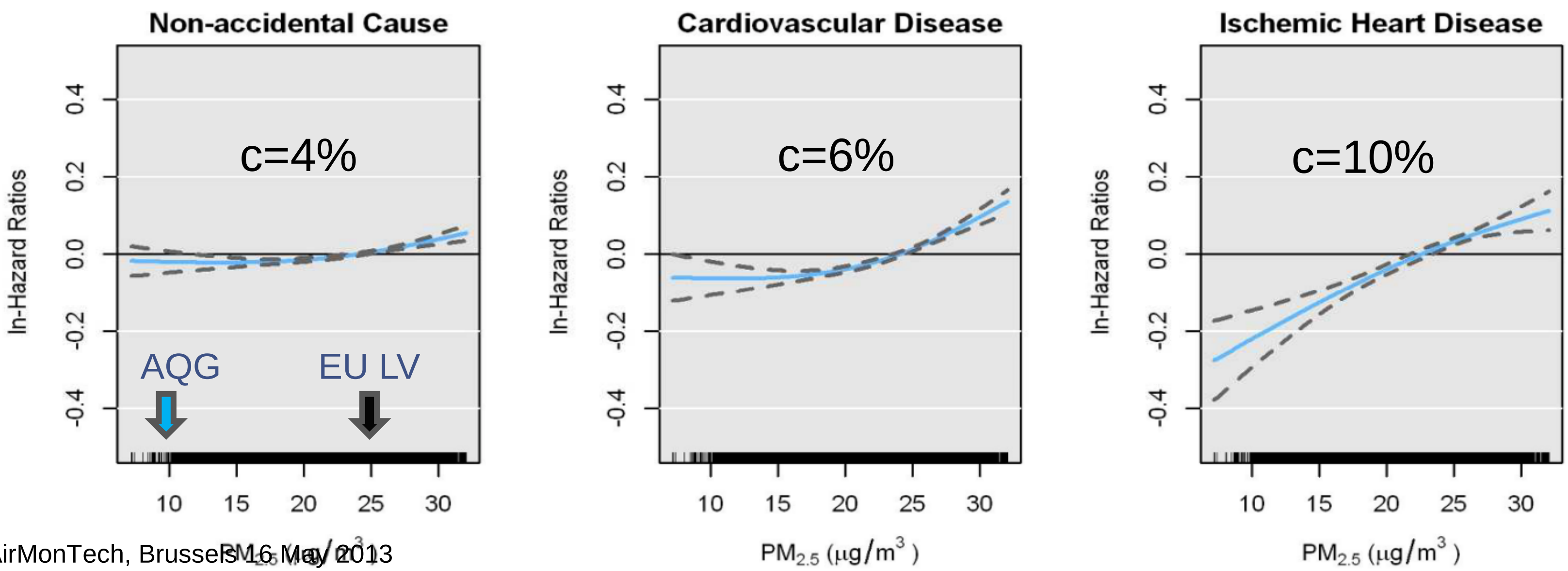
Mortality and long-term exposure to PM2.5



Results of a cohort study in Rome (1.3 million adults followed from 2001 to 2010)

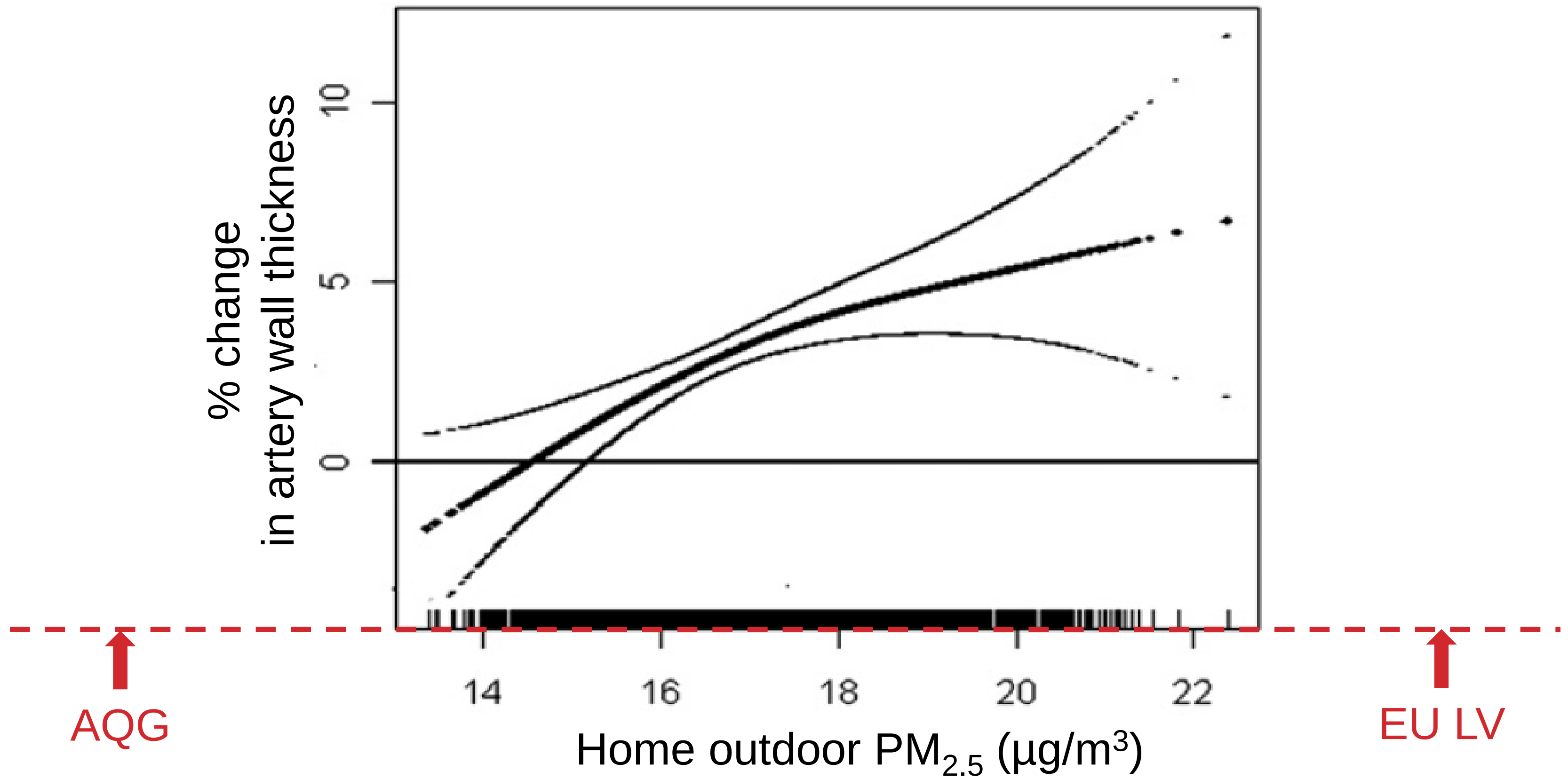
PM2.5: 3-dimensional Eulerian model (1x1 km)

c= % increase in risk per 10 µg/m^3



Cesaroni et al. EHP 2013

Carotid artery wall thickness (=risk of atherosclerosis) and long-term $PM_{2.5}$ exposure



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Heinz Nixdorf RECALL study, Ruhr region, Germany

Bauer et al, JACC 2010

Mortality and long-term PM2.5 exposure

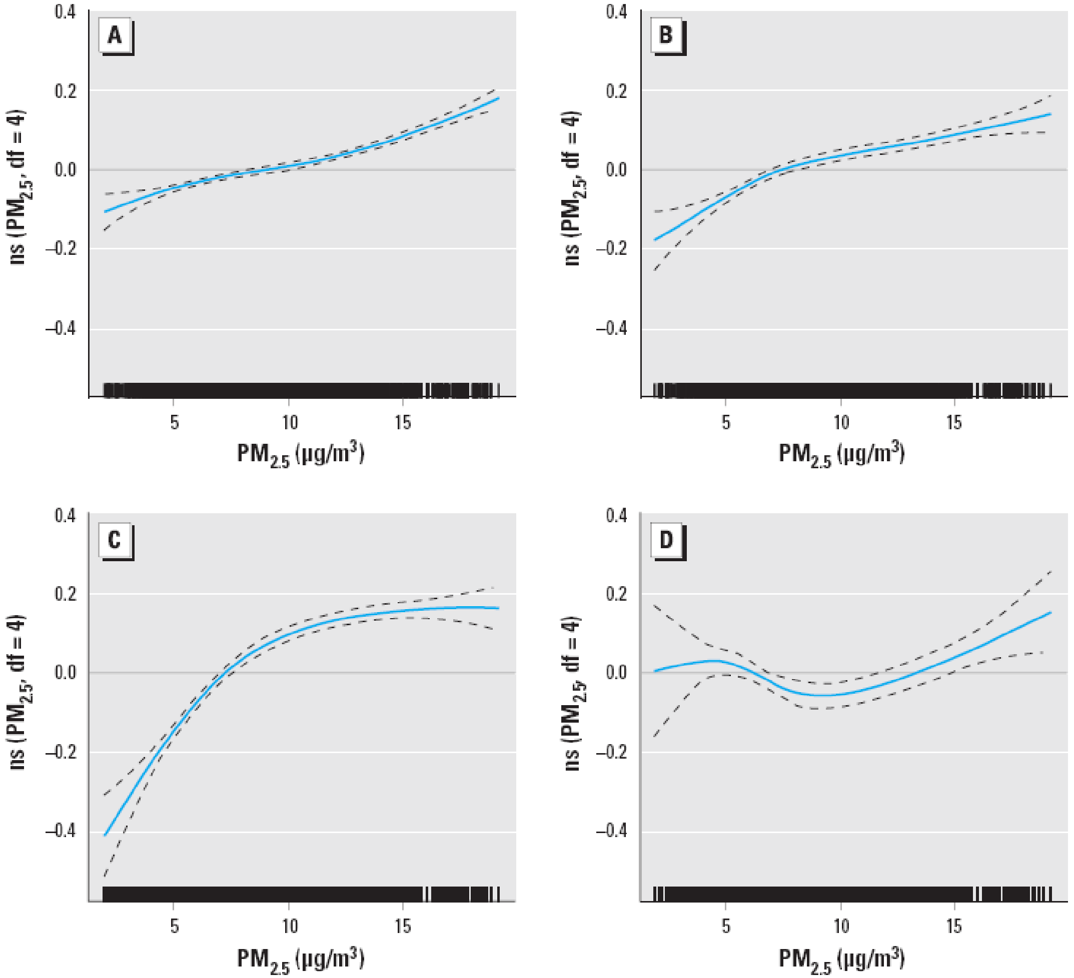
Results of a Canadian cohort study (2.1 million adults, 1991-2001)

All non-accidental

Cardiovascular

Ischemic heart disease

Cerebrovascular



PM2.5 estimated from satellite observations + monitoring

Crouse et al, EHP 2012

REVIHAAP: selected conclusions on PM, cont.

- Both short term (such as 24-hour average) and long term (annual means) exposure to $PM_{2.5}$ affect health. (A3)

- Maintaining independent short-term and long-term limit values for ambient PM_{10} in addition to $PM_{2.5}$ to protect against the health effects of both fine and coarse particles is well supported. (A4)

- In the absence of a threshold and in light of linear or supra-linear risk functions, public health benefits will result from any reduction of $PM_{2.5}$ concentrations whether or not the current levels are above or below the limit values. (A5)

REVIHAAP:
selected conclusions on PM (A2)

- Black carbon, secondary organic aerosols, and secondary inorganic aerosols may provide valuable metrics for the effects of mixtures of pollutants from a variety of sources. (A2)

- Short-term exposures to coarse particles (including crustal material) are associated with adverse respiratory and cardiovascular health effects, including premature mortality. (A2)
- …

REVIHAAP: selected conclusions on PM (A2)

- There is increasing, though as yet limited, epidemiological evidence on the association between short-term exposures to ultrafine (<0.1 µm) particles and cardiorespiratory health, as well as the health of the central nervous system.

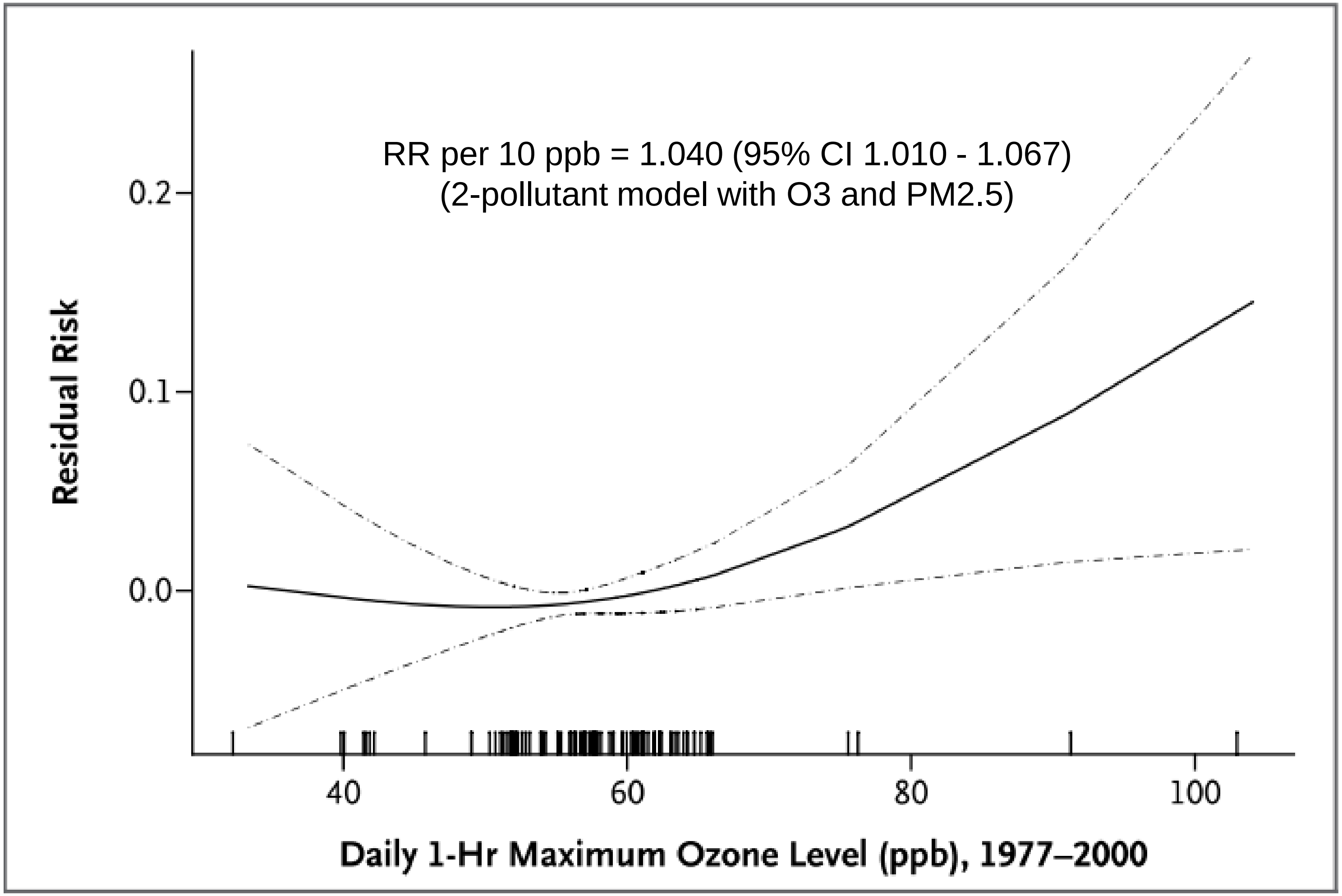
- Clinical and toxicological studies have shown that ultrafine particles (in part) act through mechanisms not shared with larger particles that dominate mass-based metrics, such as $PM_{2.5}$ or PM_{10}.

REVIHAAP:
selected conclusions on ozone (B1)

- **New evidence for an effect of long-term exposure to ozone on:**
  - respiratory (and cardiorespiratory) mortality (ACS study);
  - mortality among persons with potentially predisposing conditions (COPD, diabetes, congestive heart failure, and myocardial infarction);
  - asthma incidence, asthma severity, hospital care for asthma and lung function growth.

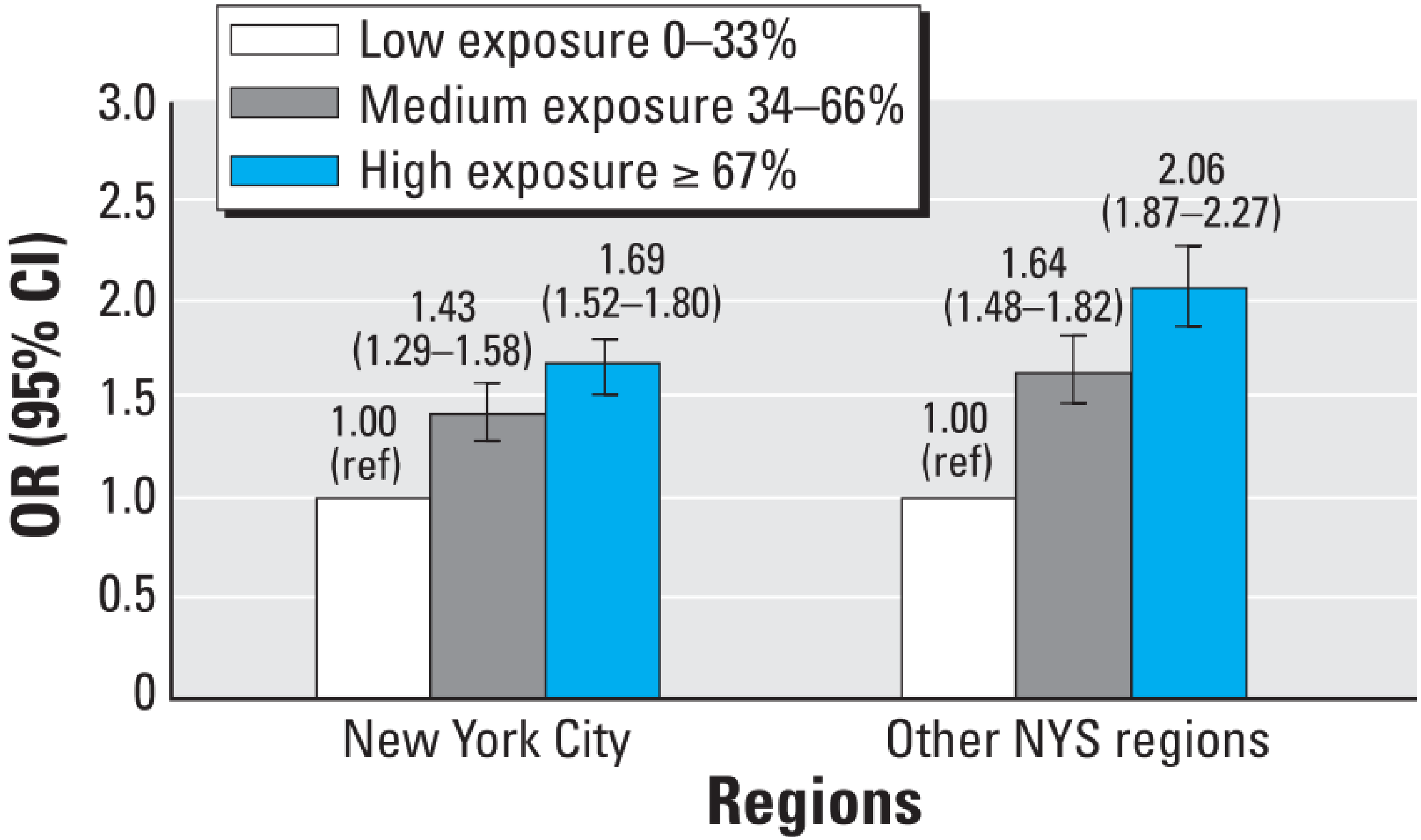
Long term O3 exposure and risk of death due to respiratory causes

ACS cohort of 448 thousand adults followed for 18 years



Jerrett et al, NEJM 2009

Risk of asthma hospital admissions in children and mean O3 in 1995-1999



Lin et al, EHP 2008

REVIHAAP:
selected conclusions on ozone, cont.

- **Adverse effects of exposure to daily ozone concentrations (maximum daily 1-hr or 8-hr mean) on:**
  - all-cause, cardiovascular and respiratory mortality;
  - respiratory and cardiovascular hospital admissions, after adjustment for the effects of particles (PM_{10}).

- **The evidence for a threshold for short term exposure is not consistent, but where a threshold is observed, it is likely to lie below 45 ppb (90 µg/m^3) (max 1-hr). (B2)**

Associations between short-term exposure to ozone and mortality and hospital admissions in European cities in the APHENA study

Outcome	Per cent increase in deaths/admissions (95% CI) per 10 µg/m^3 increment in daily maximum 1-hour ozone concentrations	
	Single pollutant	**Adjusted for PM_{10}**
All-cause mortality [a]	0.18 (0.07–0.30)	0.21 (0.10–0.31)
Cardiovascular mortality: 75 years and older [a]	0.22 (0.00–0.45)	0.21 (-0.01–0.43)
Cardiovascular mortality: younger than 75 years [a]	0.35 (0.12–0.58)	0.36 (0.10–0.62)
Respiratory mortality [b]	0.19 (-0.06–0.45)	0.21 (-0.08–0.50)
Cardiac admissions: older than 65 years [a]	-0.10 (-0.46–0.27)	0.64 (0.36–0.91)
Respiratory admissions: older than 65 years [b]	0.19 (-0.28–0.67)	0.32 (0.05–0.60)

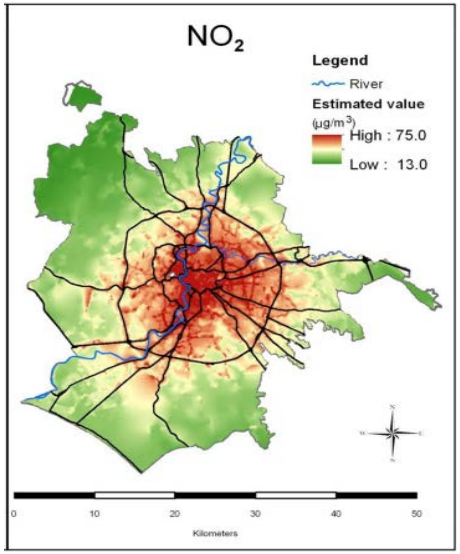
[a] lag 0-1 results; [b] lag 1 results

Katsouyanni et al 2009

REVIHAAP: selected conclusions on NO_2 (C2-3,D1)

- New studies document associations between day-to-day variations in NO_2 and variations in mortality, hospital admissions, and respiratory symptoms;
- New studies showing associations between long-term exposure to NO_2 and mortality and morbidity;
- Both short- and long-term studies have found these adverse associations at concentrations that were at or below the current EU LV (= WHO AQG);
- The associations between NO2 and short-term health effects in many studies remain after adjustment for other pollutants (including PM_{10}, $PM_{2.5}$, black smoke).
- **… it is reasonable to infer that NO_2 has some direct effects**.
- No evidence to suggest changing the averaging time for the short-term EU limit value (1-hour) (D1)

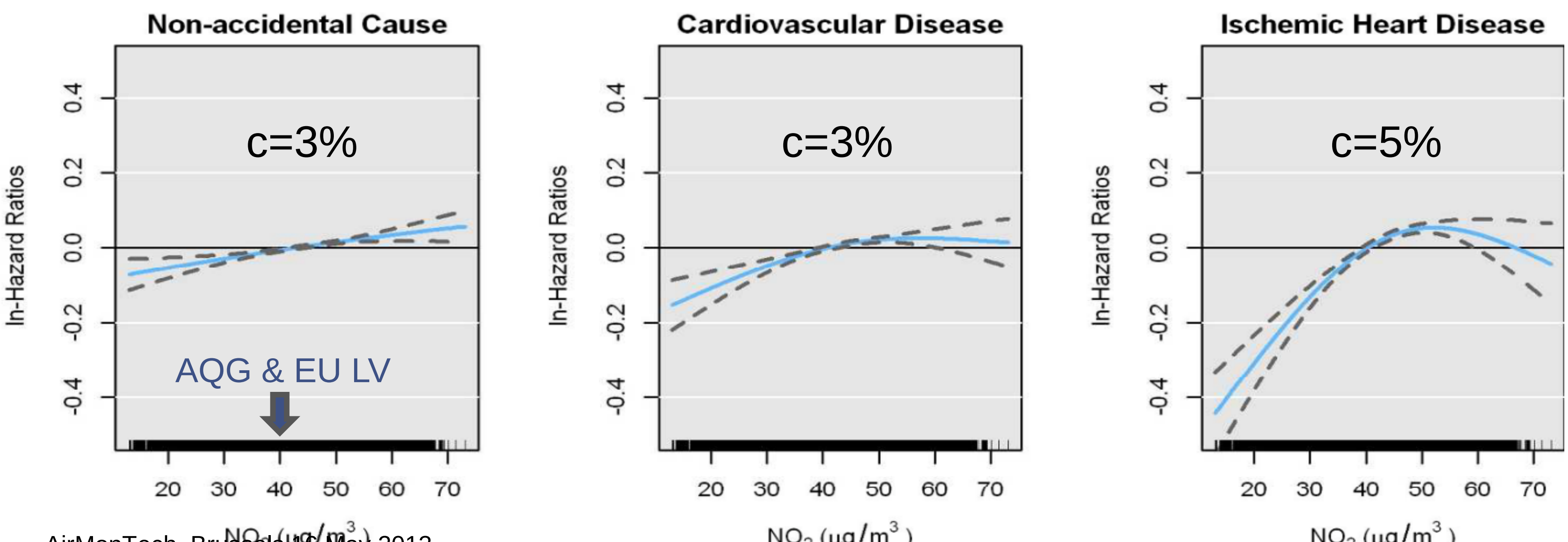
Mortality and long-term exposure to NO2



Results of a cohort study in Rome (1.3 million adults followed from 2001 to 2010)

NO2 estimates: Ogawa samplers in 78 sites, 1-week in Feb, May, Oct 2007 + LUR model

c= % increase in risk per 10 µg/m^3



Cesaroni et al. EHP 2013

REVIHAAP: selected conclusions on health risks of proximity to roads (C1):

- Elevated health risks associated with living in close proximity to roads is unlikely to be explained by $PM_{2.5}$ mass;
- Current evidence does not allow discernment of the pollutants or pollutant combinations that are related to different health outcomes although association with tail pipe primary PM is increasingly identified;
- Toxicological research indicates that non-exhaust pollutants could be responsible for some of the observed health effects.

REVIHAAP Conclusions

Considerable amount of new scientific information on health effects of PM, O_3 and NO_2 observed at levels commonly present in Europe, has been published in the recent years. It:

- supports the scientific conclusions of the WHO Air Quality Guidelines updated in 2005;
- indicates that the effects can occur at air pollution concentrations lower than those serving to establish the 2005 Guidelines;
- povides scientific arguments for the decisive actions to improve air quality and reduce the burden of disease associated with air pollution in Europe.

This presentation:

1) **Summary of the results of the WHO – EC project “Review of evidence on health aspects of air pollution - REVIHAAP”**

2) **Implications for AQ monitoring**

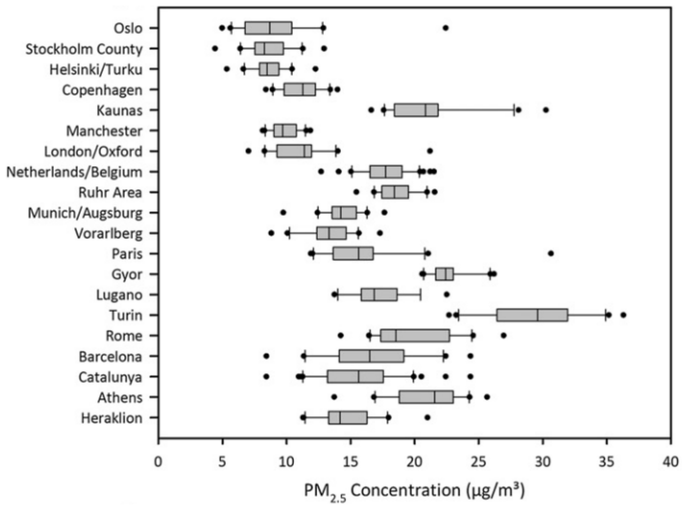
- For assessment of exposure in epidemiological studies
- For assessment of impacts of air pollution on population health

REVIHAAP: Critical data gaps (A7/C9) – selected conclusions on exposure assessment in epidemiological studies

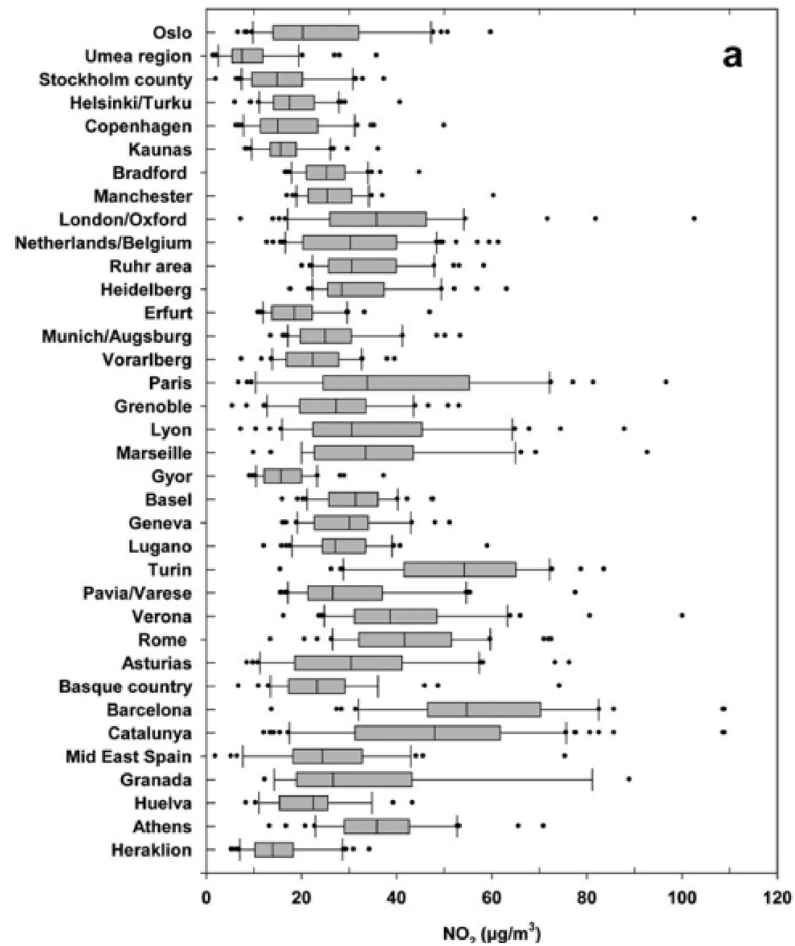
- More collaboration is needed between health and atmospheric science both for complex monitoring and modeling, especially for exposure of complex mixtures with strong spatial and temporal variability.
- More monitoring is needed, both in regular way and into projects in coordination with health specialists. The use of supersites to perform simultaneous studies using the same monitoring and health evaluation approaches across Europe is strongly suggested. These studies should be done with a multi-pollutant approach.

Spatial variability of PM2.5 and NO2 in Europe: ESCAPE study

PM2.5



NO2



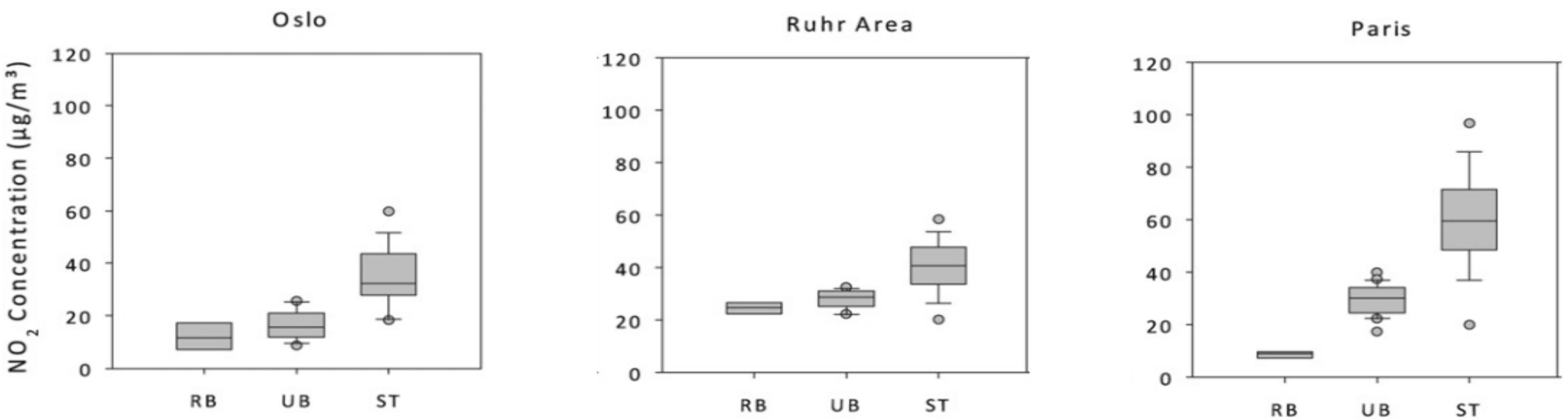
% of variance explained by **within area** variability:

PM2.5:	19%
PM2.5 absorbance:	52%
NO2:	60%

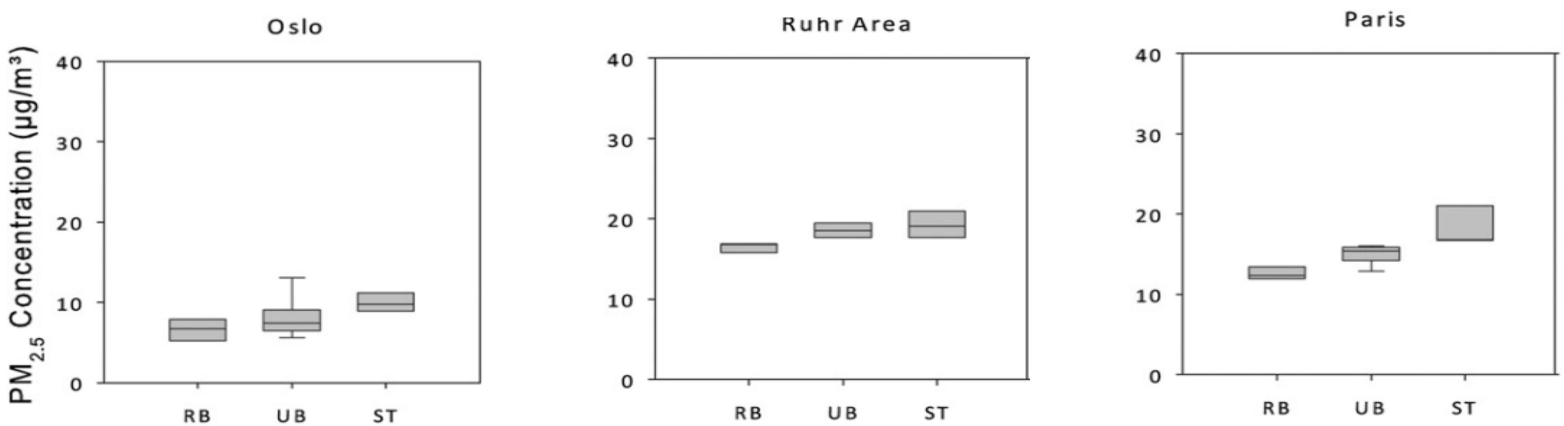
Eeftens et al, 2012; Cyrys et al, 2012

Spatial variability of PM2.5 and NO2 in Europe: ESCAPE study

NO2: 3 areas out of 36

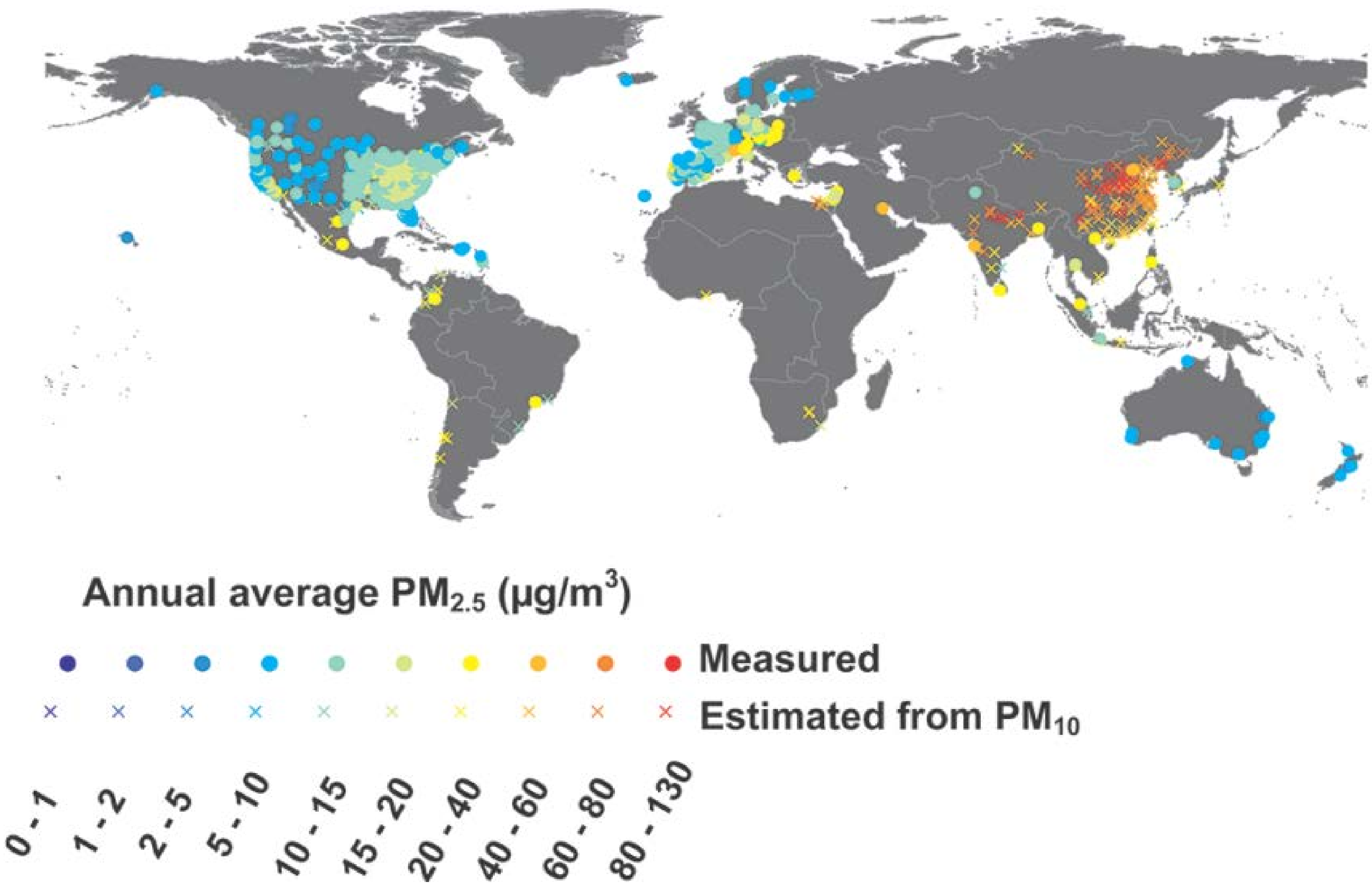


PM2.5: 3 areas out of 20



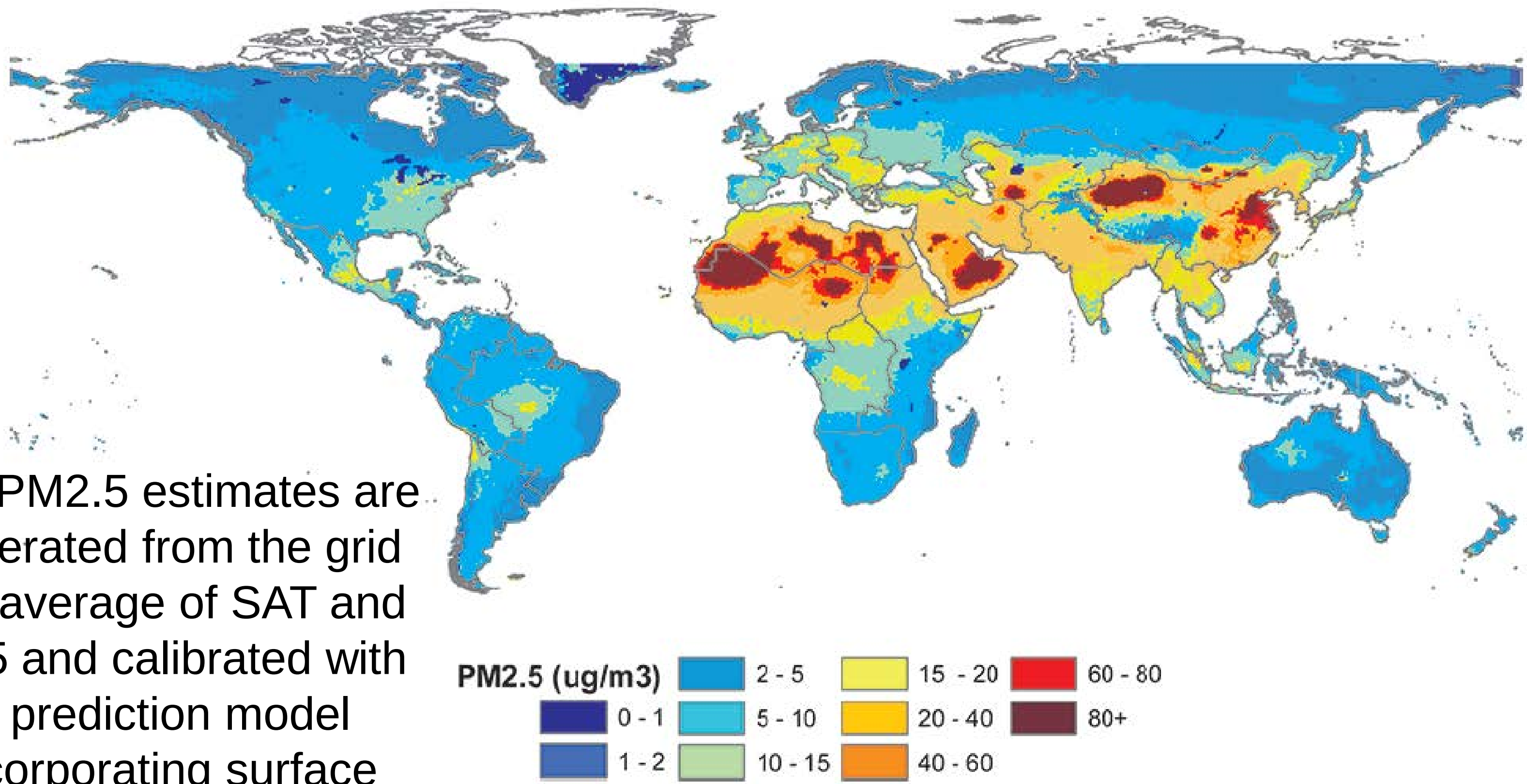
Eeftens et al, 2012; Cyrys et al, 2012

Available measured (and estimated from PM10 measurements) annual (2005) average PM2.5 concentrations



Brauer et al, Atm Sc & Tech 2012

Estimated 2005 annual average $PM_{2.5}$ concentrations used for GBD 2010 project

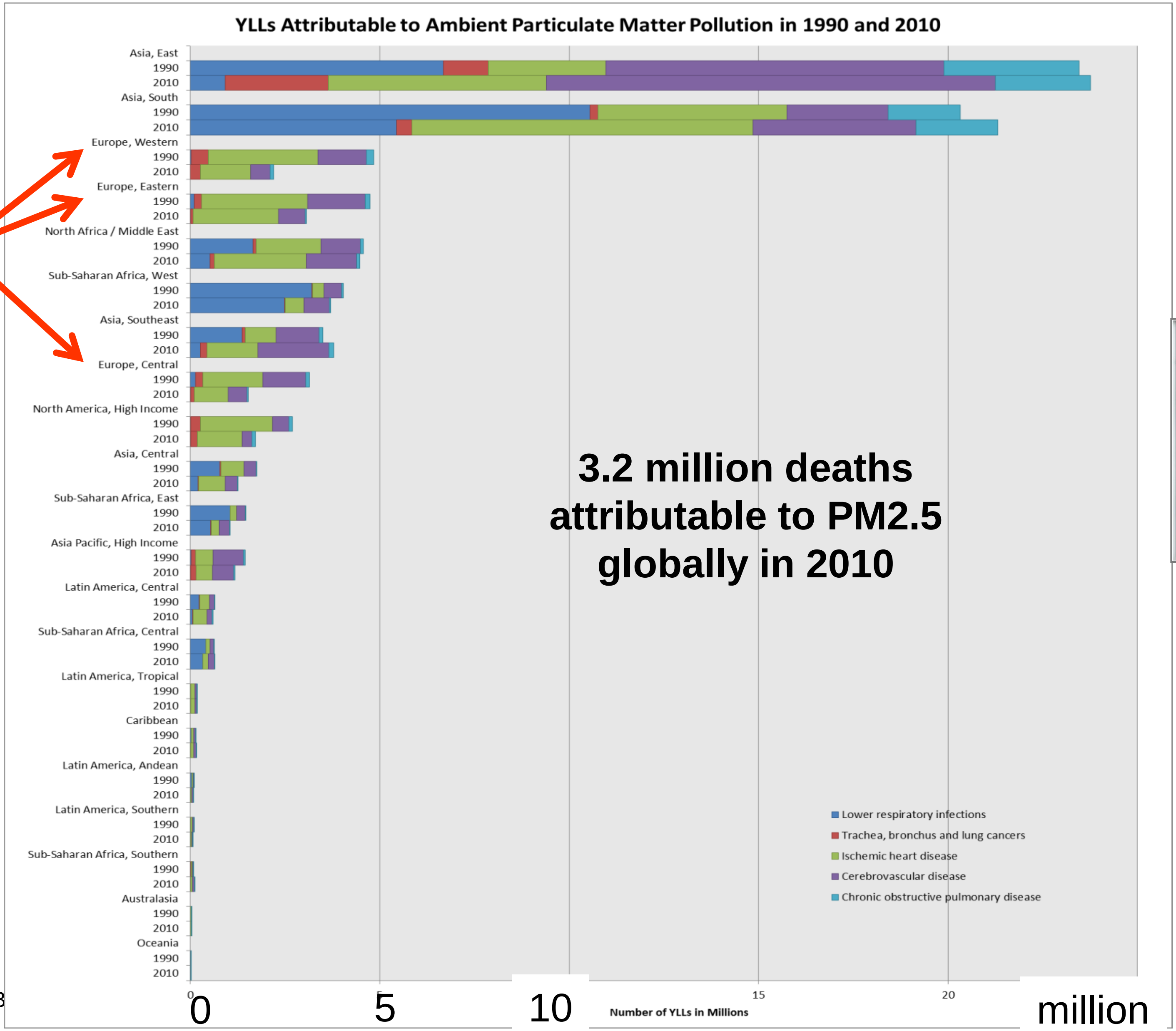


The PM2.5 estimates are generated from the grid cell average of SAT and TM5 and calibrated with a prediction model incorporating surface measurements.

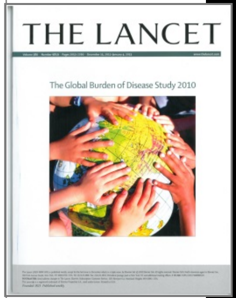
Brauer et al, Atm Sc & Tech 2012

Years of life lost due to PM – GBD 2010 project

Europe



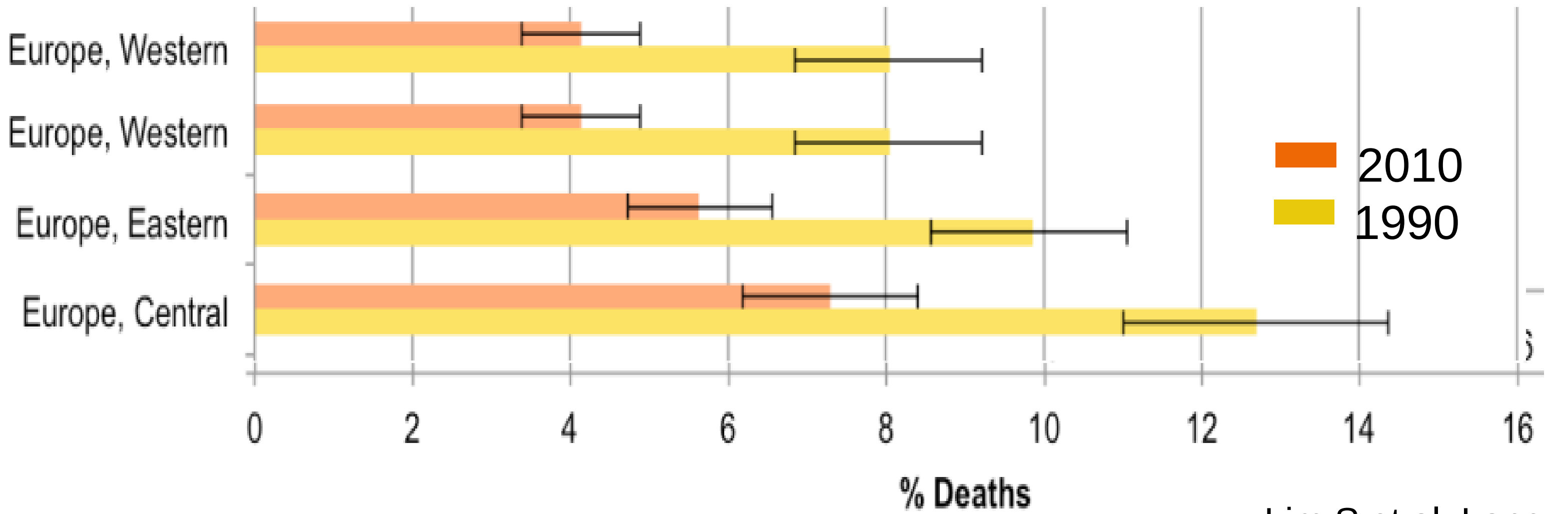
3.2 million deaths attributable to PM2.5 globally in 2010

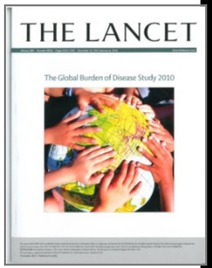


Lim S et al. Lancet 2012

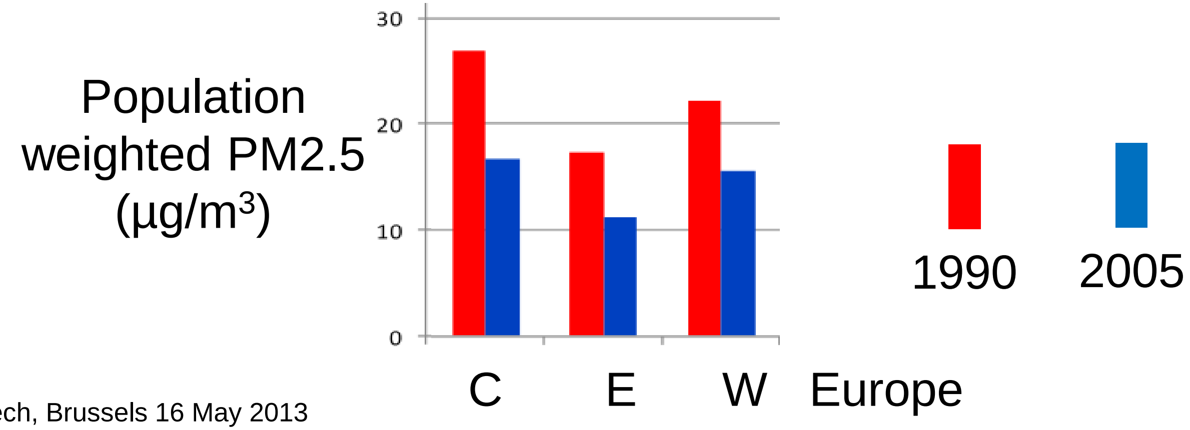
Percent of all deaths attributable to PM in Europe, 1990 and 2010

GBD 2010 project





Lim S et al. Lancet 2012



Brauer et al, EST 2011

Conclusions on AQ monitoring

1) Monitoring for research on health effects of air pollution:

- Assessment of exposure to mixtures;
- Sufficient spatial resolution;
- Introduction of new parameters with simultaneous assessment of "old" indicators of pollution.

2) Monitoring for health impact assessment

- Fusion of monitoring, modelling and remote sensing;
- Simple methods for monitoring in low-resource locations;

Thank you