Tavola Rotonda
Nuove variabili per la qualità dell'aria

Particelle Ultrafini

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Directive EU/2024/2881

- it is important that pollutants of emerging concern, such as **ultrafine particles**, black carbon and elemental carbon, […], be measured at monitoring supersites at both rural background locations and urban background locations in order to support scientific **understanding of their effects on human health** and the environment, as recommended by the WHO.

- 'ultrafine particles' or 'UFP' means **particles with a diameter less than or equal to 100 nm**, where UFP are measured as the particle number concentrations per cm^3 for a size range with a **lower limit of 10 nm** with **no restriction on the upper limit**;

- in the absence of an EN standard method for sampling and measuring […] UFP, BC, size distribution of ultrafine particles, […], Member States may choose the sampling and measuring methods they use […].
Where international, EN or national standard reference measurement methods or CEN technical specifications are available, these **may** be used.

Table 1 – Pollutants to be measured at monitoring supersites at urban background locations

Pollutant	Type of measurement
PM10, PM2.5, UFP, BC	Fixed measurements
Size distribution of UFP	Fixed or indicative measurements

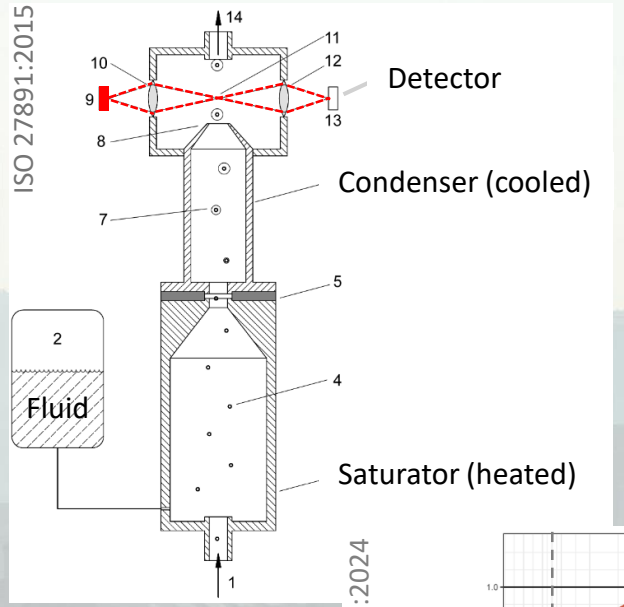
Table 2 – Pollutants to be measured at monitoring supersites at rural background locations

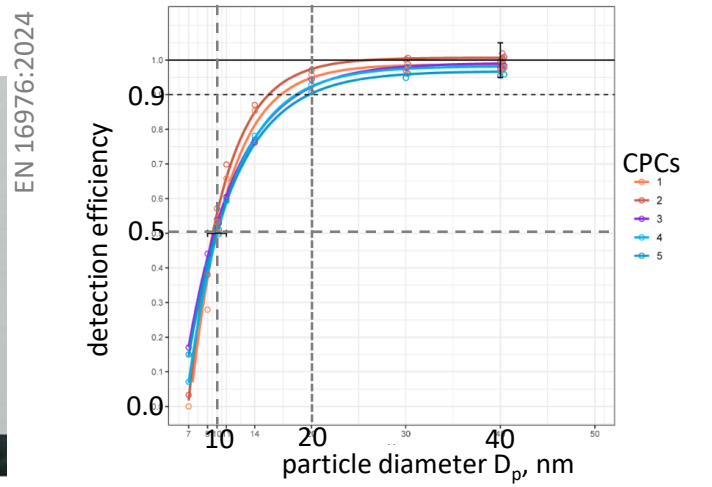
Pollutant	Type of measurement
PM10, PM2.5, UFP, BC	Fixed measurements

‘UFP’ measurements as particle number concentrations

European standard EN 16976:2024

- the standard method is based on a Condensation Particle Counter (CPC) operated in the counting mode
- D_{p50} = 10 nm ± 1 nm, D_{p90} < 20 nm, D_{p95} < 40 nm ± 10 nm
- the working fluid shall be butanol-1
- keep the relative humidity of the flow at the CPC inlet < 40 % (dryer). The relative humidity at the inlet of the CPC shall be monitored.
- coincidence correction and calibration factor shall be applied.





Current list of ACTRIS-Compliant CPCs – EN16976

based on existing performance tests

TSI

3750-10 CEN compatible (current model; calibration provided by CAIS-ECAC); performance test completed: compliance approved

GRIMM:

5410/5412 & 5421 CEN compatible (current model; calibration provided by CAIS-ECAC); performance test completed: compliance approved

Airmodus:

A20 CEN compatible (current model; calibration provided by CAIS-ECAC); performance test completed: compliance approved

AVL:

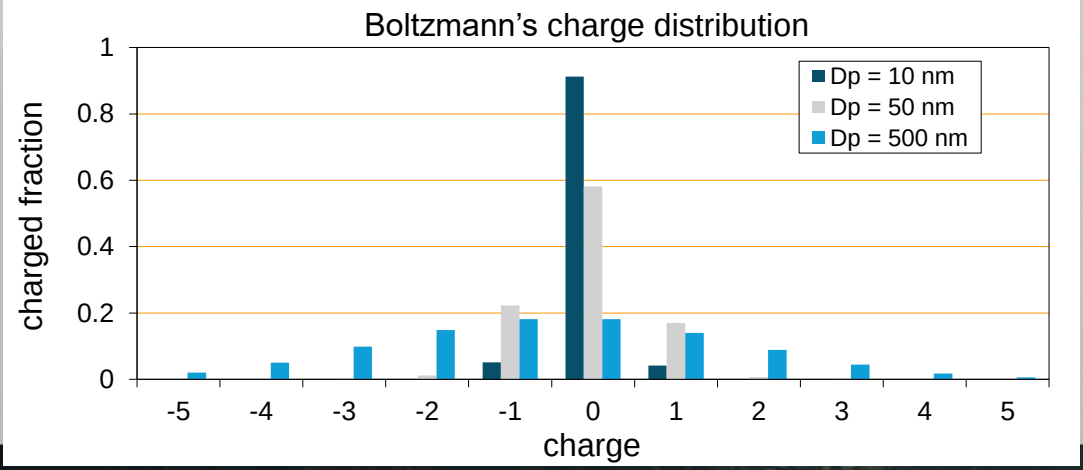
AVL Ultrafine Particle Monitor CEN compatible (current model; calibration provided by CAIS-ECAC); performance test completed: compliance approved

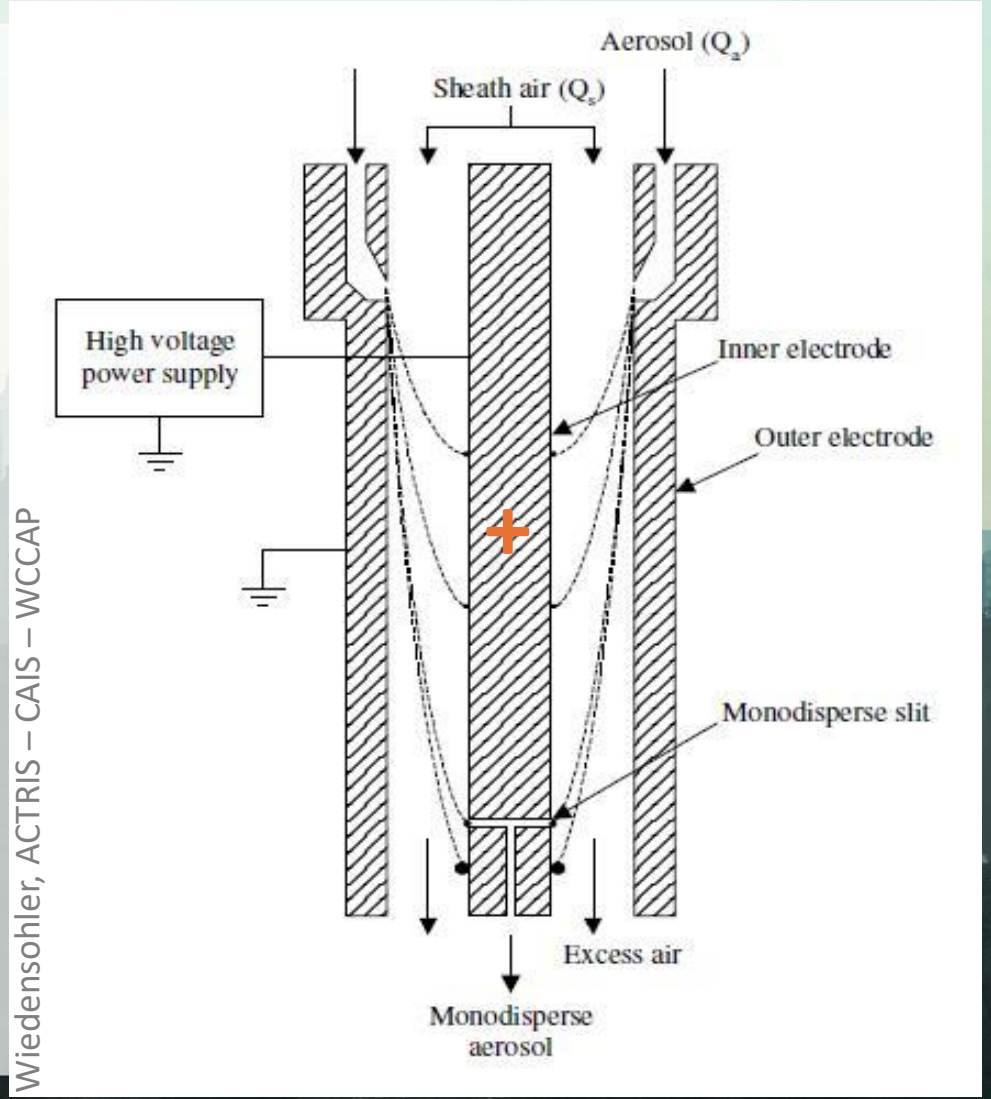
The costs of an EN- and ACTRIS-compliant CPC is in the range of approximately 20 to 25k€ plus VAT

Particle number size distribution measurements

Technical Specification CEN/TS 17434 (April 2020)

- standard method for determining particle number size distributions in ambient air in the size range **from 10 nm to 800 nm** at total concentrations up to approximately 10^5 cm^{-3} with a time resolution of a few minutes.
- method based on a **Mobility Particle Size Spectrometer** (MPSS) used with a **bipolar diffusion charger** and a **CPC** as the detector.





Wiedensohler, ACTRIS – CAIS – WCCAP

Mobility Particle Size Spectrometer(MPSS) – CEN/TS17434 – 10-800nm

The CEN/TS 17434 recommends following:

- CPC following the EN 16976
- Size Range 10 – 800 nm (PM1)
- Bipolar charger (radioactive nuclide; such as Kr85 or Ni63)
- DMA flow ratio: recommended 1:4 up to 1:10 → ACTRIS requirement
- Size resolution: minimum 16 bins per decade; recommended 32 bins per decade
- Size calibration with certified PSL particles (generally, 203 nm)
- Central calibration facility: Comparison against reference CPC & MPSS → ACTRIS requirement
- Uncertainties of $N_{10\text{-}800}$ to N_{CPC} during laboratory calibration at central facility: generally, around 15%

Additional information:

- Uncertainties of $N_{10\text{-}800}$ to N_{CPC} during measurements: depending on local conditions ~20% → no requirement
- Stand-alone CPC for a local quality control → ACTRIS requirement

Current list of ACTRIS-Compliant MPSS based on completed performance tests

TSI SMPS 3938W50-PP-CEN10: Classifier 308201 (positive HV) with DMA 3083 and CPC 3750-10
CEN TS17434 compatible (current model; calibration provided by CAIS-ECAC), compliance conditionally approved

TSI SMPS 3938W50-DP-CEN10: Classifier 308202 (dual HV) with DMA 3083 and CPC 3750-10
CEN TS17434 compatible (current model; calibration conditionality provided by CAIS-ECAC), compliance approved

TSI SMPS 3938W50-CEN10: Classifier 308200 (negative HV) with DMA 3083 and CPC 3750-10)
CEN TS17434 compatible (current model; calibration provided by CAIS-ECAC), compliance conditionally approved

GRIMM SMPS+C 5420 CEN compatible (current model; calibration provided by CAIS-ECAS), compliance approved

TROPOS MPSS CEN compatible (current model; calibration provided by CAIS-ECAC), compliance approved

UHEL MPSS CEN compatible with TSI 3750 CPC (calibration provided by CAIS-ECAC), compliance approved

FMI MPSS CEN compatible (calibration provided by CAIS-ECAC), compliance approved

Main difficulties regarding particle (UFP) number concentration and size distribution measurements

- **Air flow drying** => specific dryers (e.g. Nafion), dry air for the dryer counter flow
- **Particle losses:**
  - ultrafine particles are particularly affected by diffusion losses
  - losses shall be minimized (short stainless steel tubing recommended!), assessed and corrected for
  - losses cannot be assessed if the particle number size distribution is not known
- **Instruments get dirty**

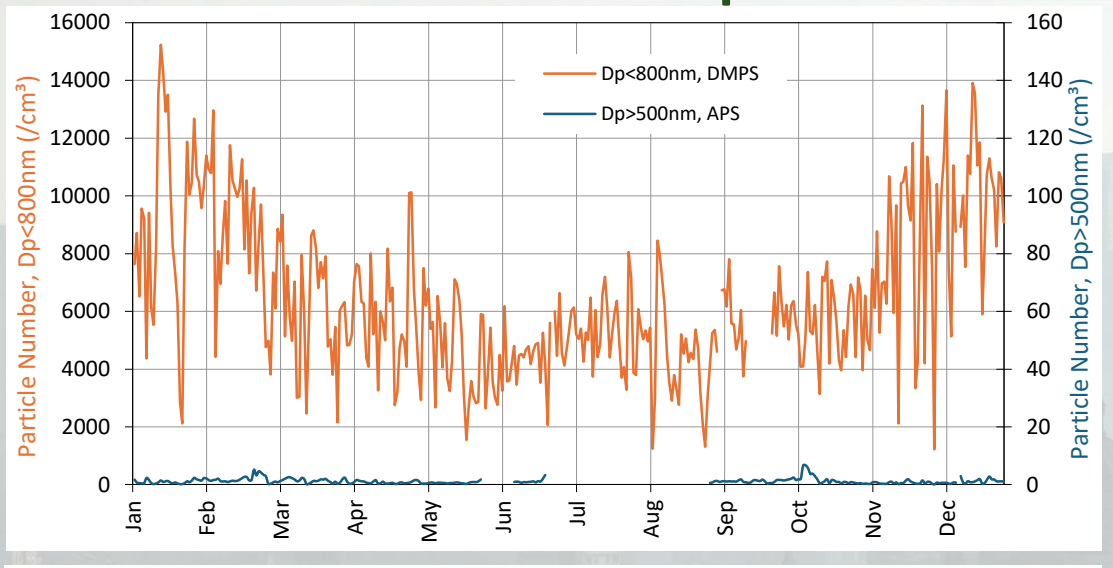
  ⇒ need to be taken apart regularly for cleaning
- **Lack of calibration standards for particle number measurements**

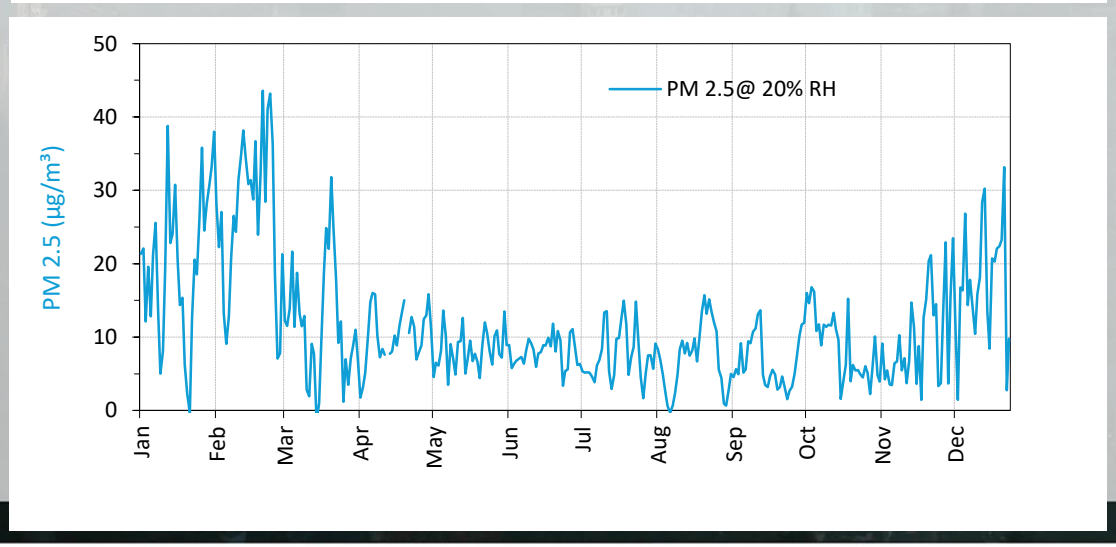
  ⇒ between calibration at dedicated laboratories (electrometer), Quality Control relies on closure testing

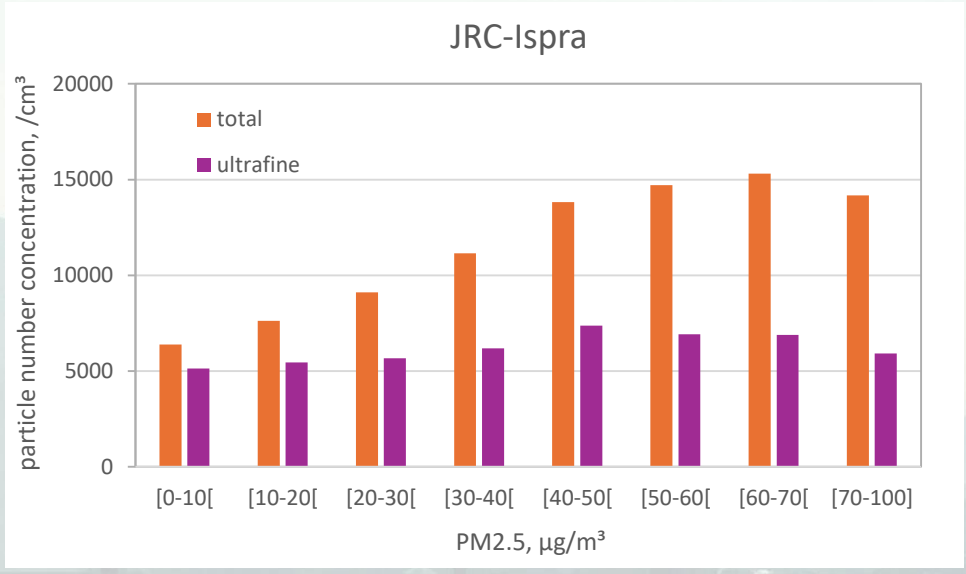
  ⇒ particle number concentration and size distribution to be measured independently in parallel

Information obtained from particle number concentration measurements

Daily values, JRC-Ispra, 2023







Long-term values, Putaud et al., 2010, 10.1016/j.atmosenv.2009.12.011

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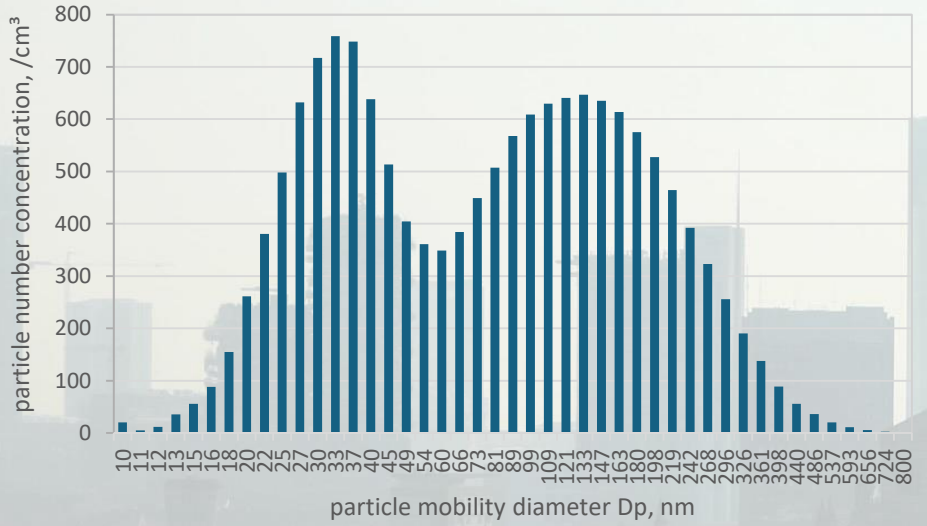
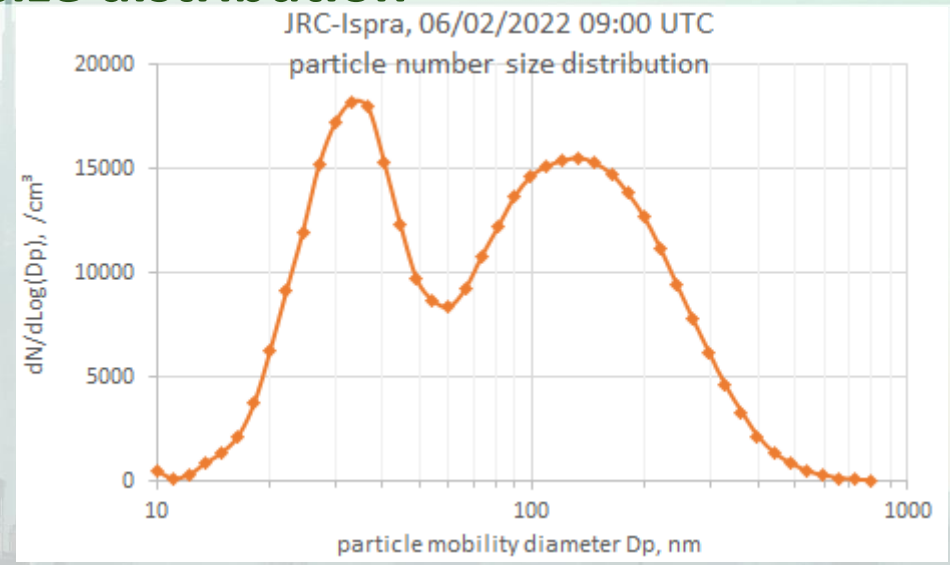
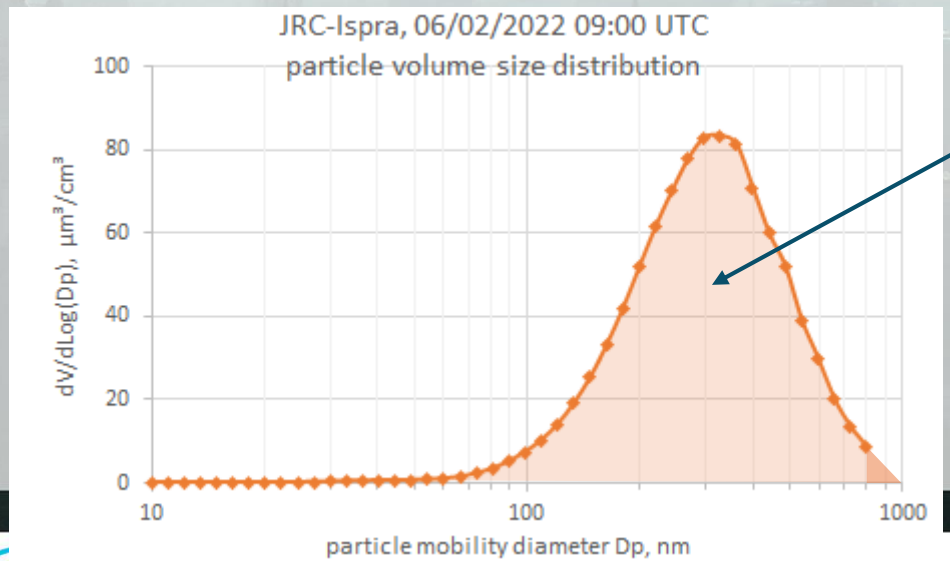
Information obtained from particle number size distribution







V = 40 µm³ / cm³
assuming d = 1.5
PM_1 = 60 µg/m³

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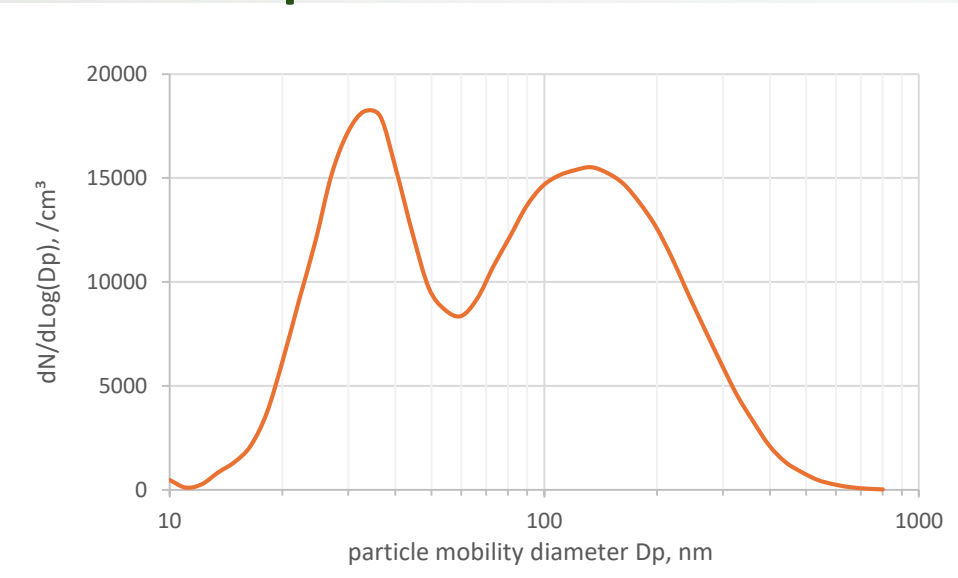
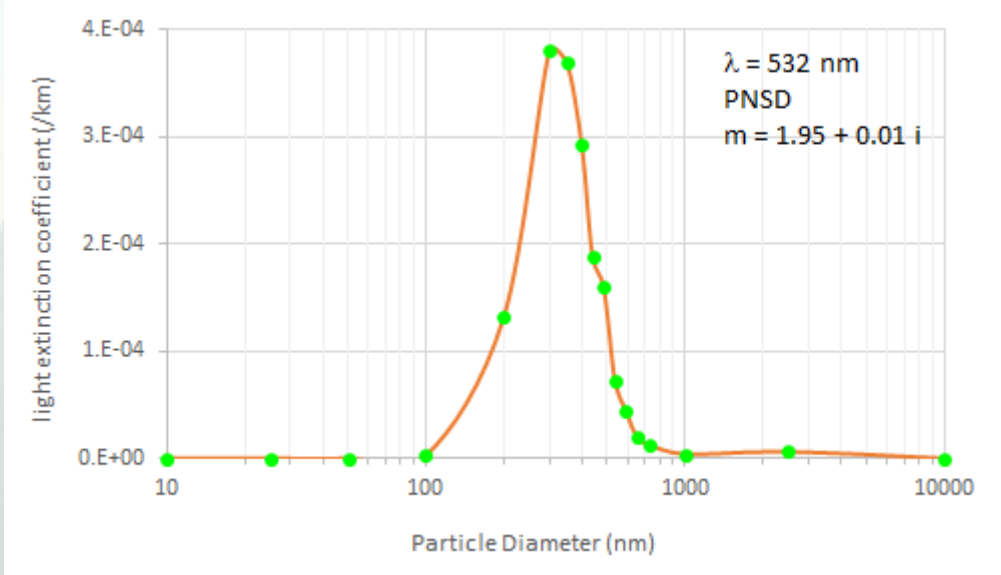
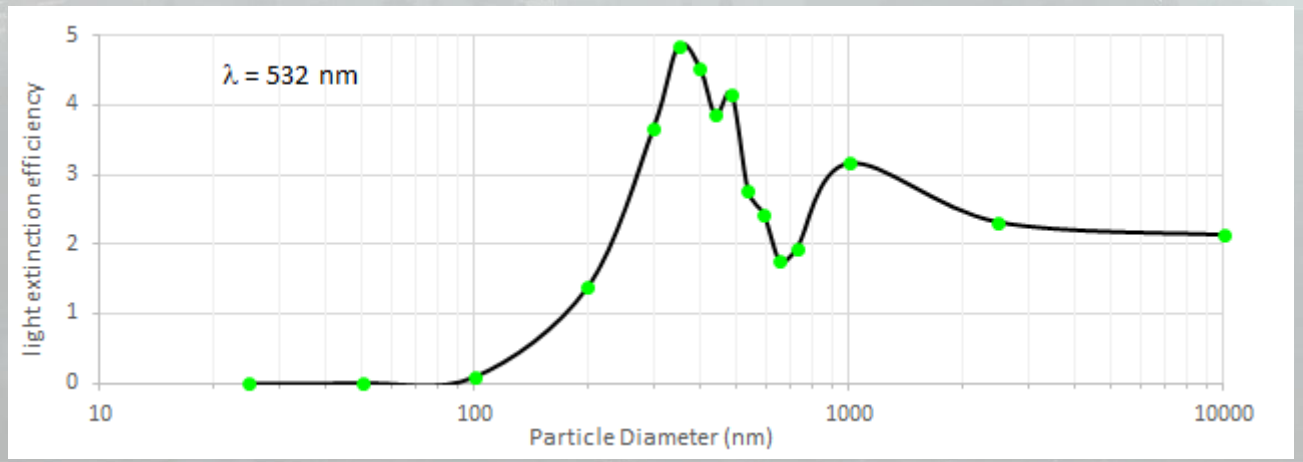
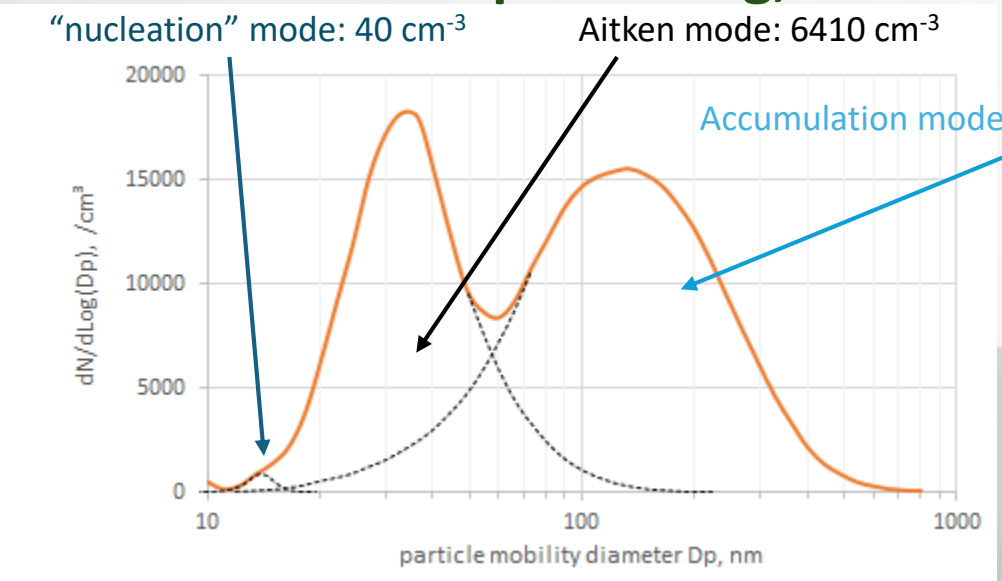
Climate Impact





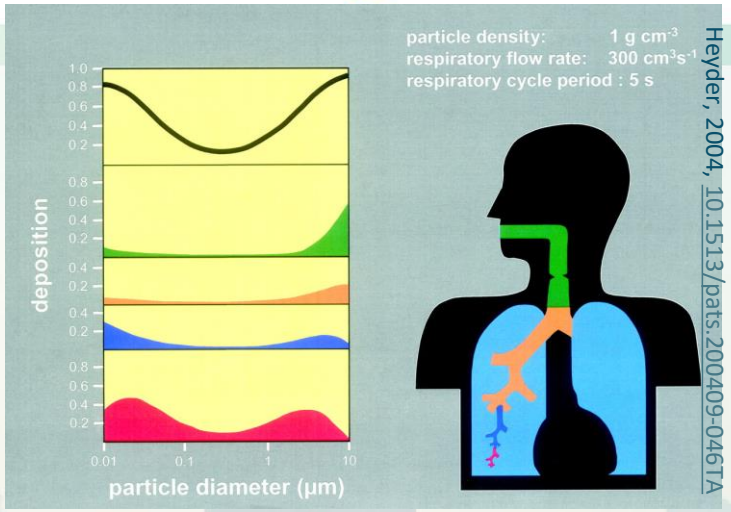


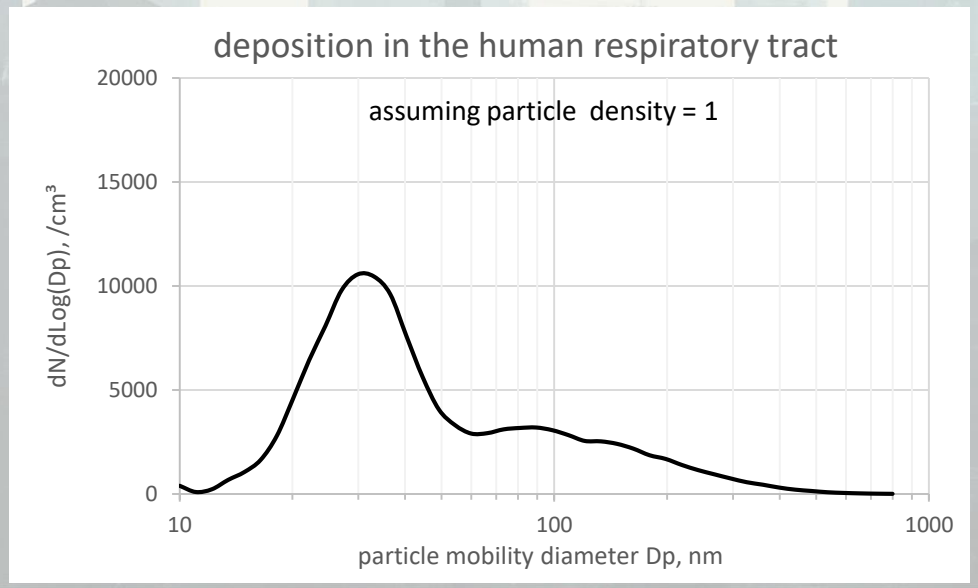
Particle sources & processing, and health impact



Dp< 100 nm: 9130 cm^{-3}

"total": 15400 cm^{-3}





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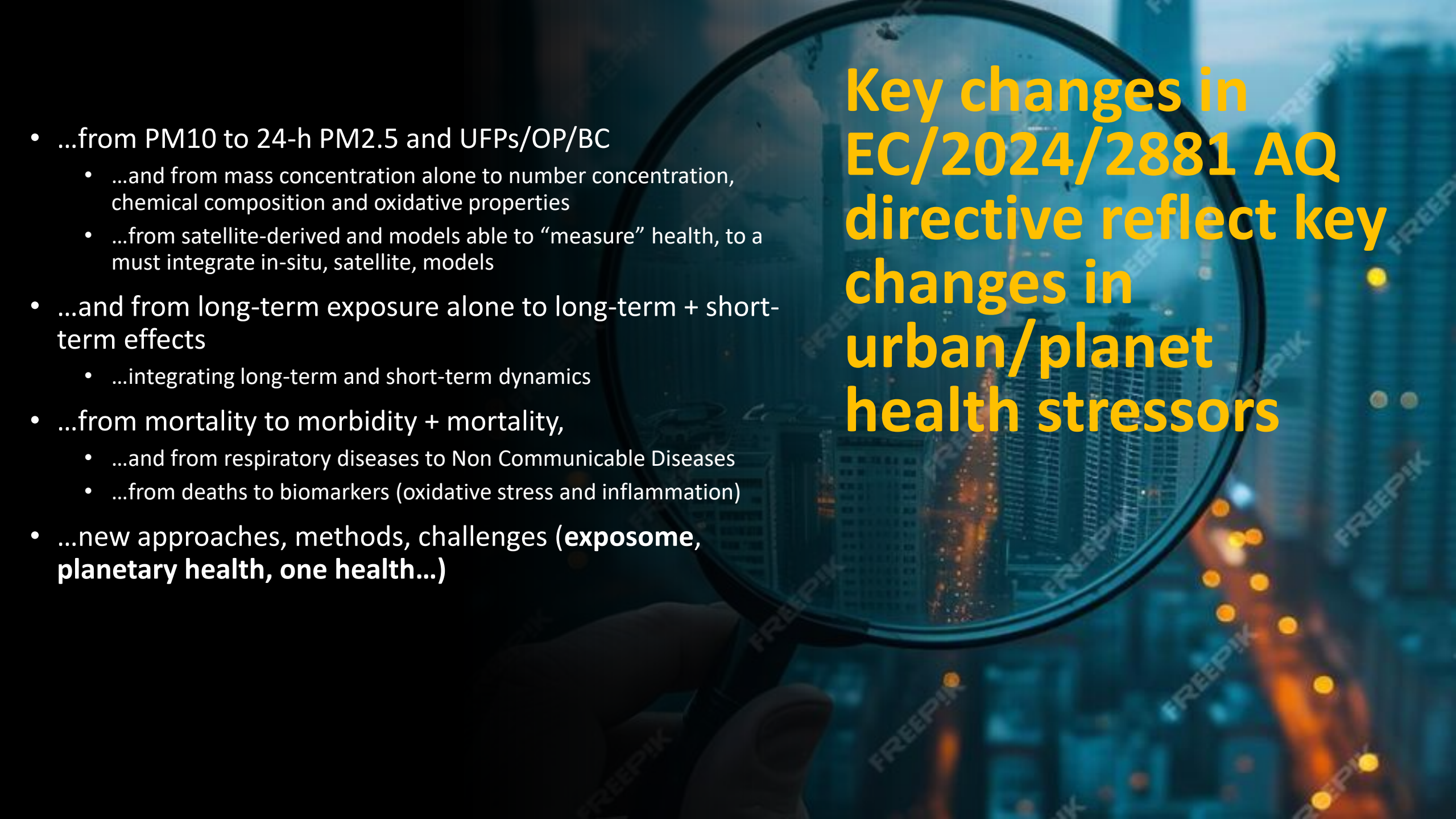

Key changes in EC/2024/2881 AQ directive reflect key changes in urban/planet health stressors

- …from PM10 to 24-h PM2.5 and UFPs/OP/BC
  - …and from mass concentration alone to number concentration, chemical composition and oxidative properties
  - …from satellite-derived and models able to “measure” health, to a must integrate in-situ, satellite, models
- …and from long-term exposure alone to long-term + short-term effects
  - …integrating long-term and short-term dynamics
- …from mortality to morbidity + mortality,
  - …and from respiratory diseases to Non Communicable Diseases
  - …from deaths to biomarkers (oxidative stress and inflammation)
- …new approaches, methods, challenges (**exposome**, **planetary health, one health…)**

Rationale for a change of paradigm in air quality

Environmental Science & Technology
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Critical Review

Assessing Adverse Health Effects of Long-Term Exposure to Low Levels of Ambient Air Pollution: The HEI Experience and What's Next?

Hanna Boogaard,* Dan L. Crouse, Eva Tanner, Ellen Mantus, Annemoon M. van Erp, Sverre Vedal, and Jonathan Samet

Cite This: *Environ. Sci. Technol.* 2024, 58, 12767−12783
Read Online

Only the stimulation of airway irritant receptors with ensuing systemic inflammation and oxidative stress is seemingly a realistic possibility in the very low-concentration context [and not lung inflammation or translocation]

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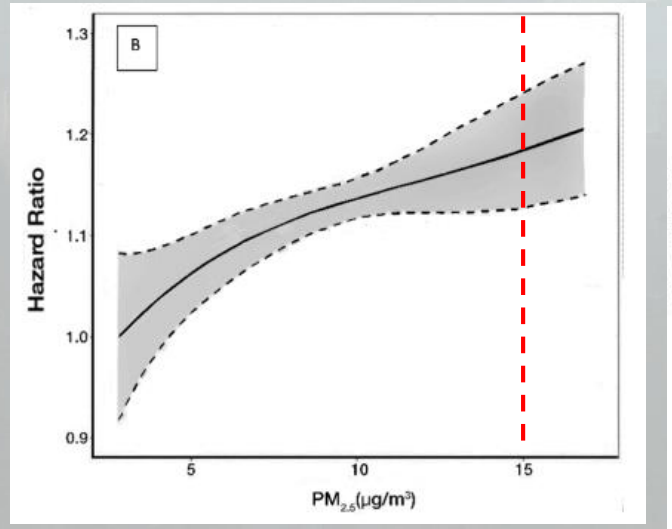
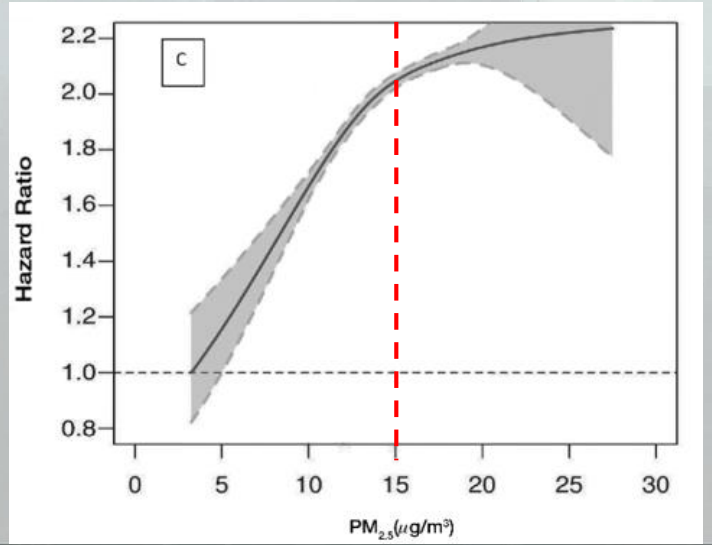
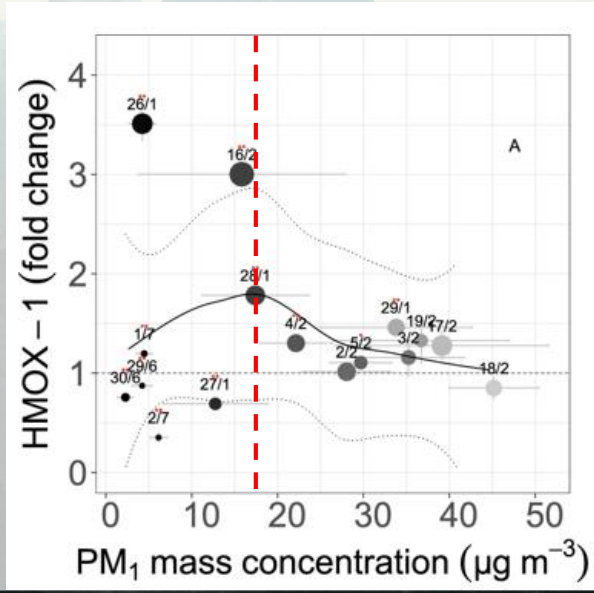
Exposure to urban nanoparticles at low PM_1 concentrations as a source of oxidative stress and inflammation

Francesca Costabile, Maurizio Gualtieri, Matteo Rinaldi, Silvia Canepari, Roberta Vecchi, Lorenzo Massimi, Gianluca Di Iulio, Marco Paglione, Luca Di Liberto, Emanuela Corsini, Maria Cristina Facchini & Stefano Decesari







RI URBANS

European Commission

CNR, Roma 07-08 aprile 2025

ITINERIS

New metrics for air quality

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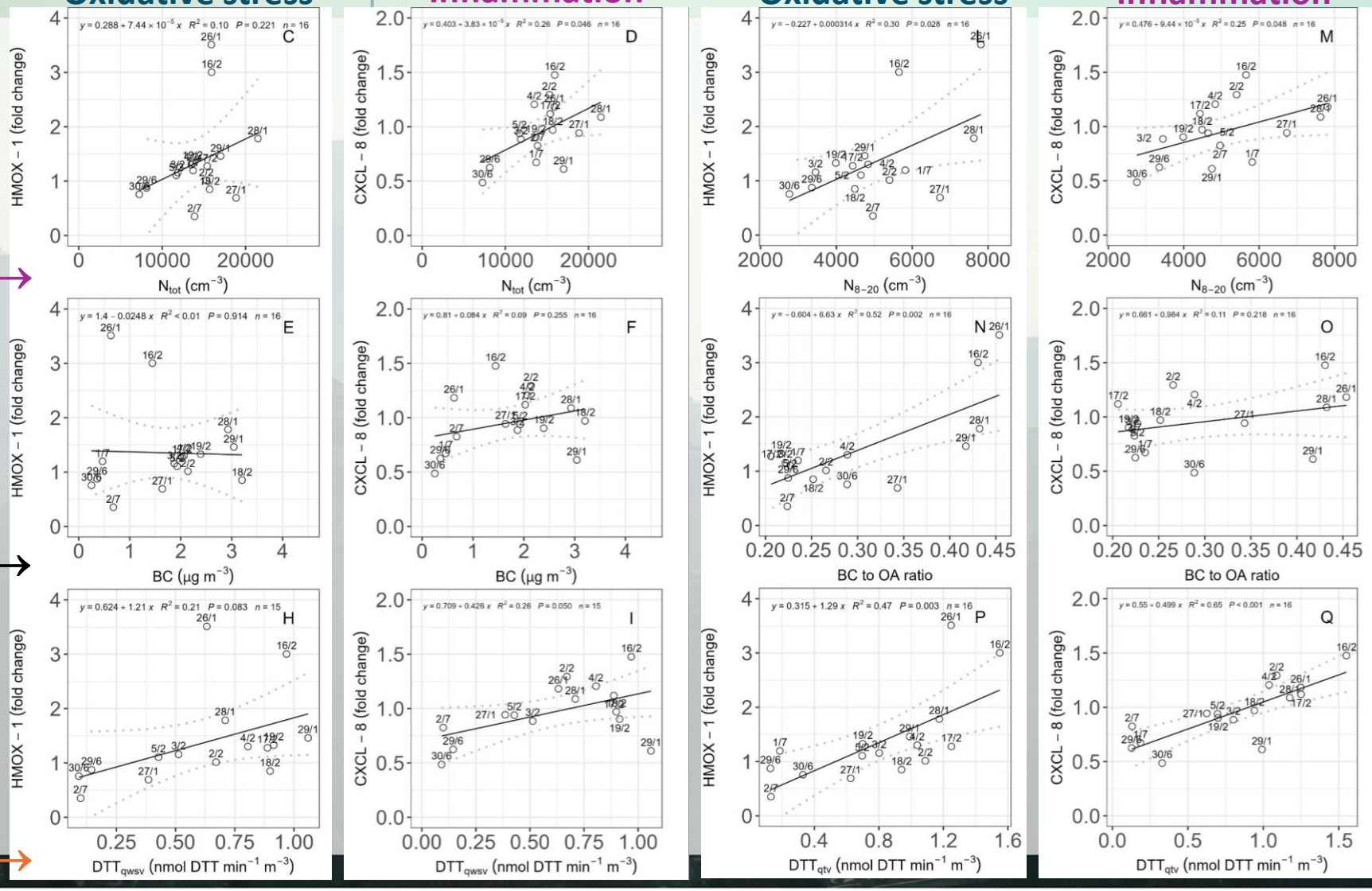
Exposure to urban nanoparticles at low PM_1 concentrations as a source of oxidative stress and inflammation

Francesca Costabile[1,2], Maurizio Gualtieri[3], Matteo Rinaldi[2,4], Silvia Canepari[5], Roberta Vecchi[6], Lorenzo Massimi[5], Gianluca Di Iulio[3], Marco Paglione[2,4], Luca Di Liberto[1], Emanuela Corsini[7], Maria Cristina Facchini[4] & Stefano Decesari[2,4]



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Thank you !

Questions ?

Discussion points

- **Italy shall establish 5-6 urban background supersites and 3 regional background supersites:**
  Are the Agencies in charge (if defined) already measuring particle number concentrations and/or size distributions?
- **RI-Urbans training:**
  - Attended the on-line training on particle number concentrations and/or size distribution?
  - Feedback: useful/useless, too easy/difficult, meeting expectations y/n, what should be done differently?
- **Readiness to implement particle number concentration / size distribution measurements acc. to recommendations:**
  - don't intend to follow recommendations (will user cheaper/simpler methods)
  - fully ready, does not need support
  - not fully ready: lack of budget, staff, experience (on sampling, measurement, data reporting,…), other…?
  - if any, which kind of support would be needed from Research Organisations (SOPs, tutorials, hot-line, …)
- **Reporting particle number concentration / size distribution data to EEA in NRT:**
  - No problem, will do it for sure
  - May be, depending on EEA requirements (raw data, processed data, free bins vs imposed bins, …)
  - May be, depending on ACTRIS support (nature, amount, ….)