AIR POLLUTION AND HEALTH: TAKING STOCK OF THE PROPOSED **REVISION TO THE** AMBIENT AIR QUALITY DIRECTIVE

CLEAN AIR IN EUROPE FOR ALL









Reviewing the latest science on air pollution and health – Part 2

Chairs: Gerard Hoek (Utrecht University) and Göran Pershagen (Karolinska Institutet)

I > INSTITUTE OF EPIDEMIOLOGY



Pollutants of "emerging concern": Current state of knowledge

Prof. Dr. Annette Peters, Dipl.-Biol, Dr. rer. hum. biol., MSc, FISEE

Director, Institute of Epidemiology, Helmholtz Munich Full Professor of Epidemiology, Ludwig-Maximilians Universität, München Adjunct Associate Professor, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston

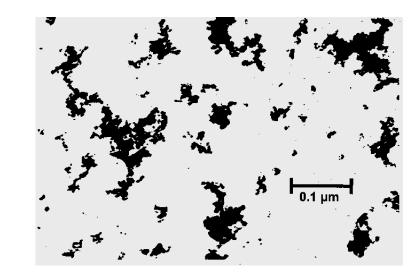
Clean Air in Europe for All, Brussels May 24, 2023

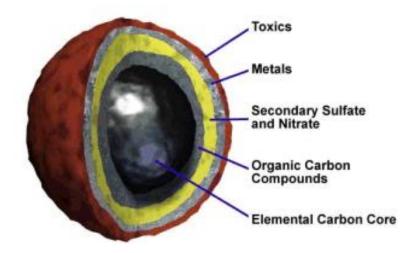
Harmful Environment



Particle properties related to health effects

- Fine particles
- Coarse particles
- Ultrafine particles
- Particle composition
 - Black carbonaceous particles
 - Secondary organic aerosols
 - Secondary inorganic aerosols

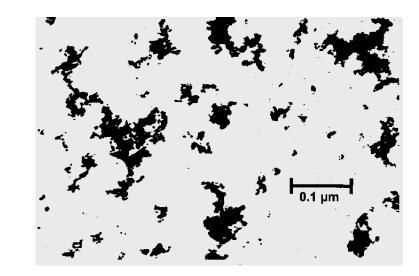


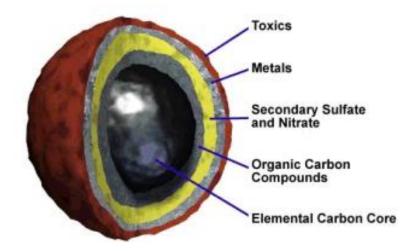


HELMHOLTZ MUNICI

Particle properties related to health effects

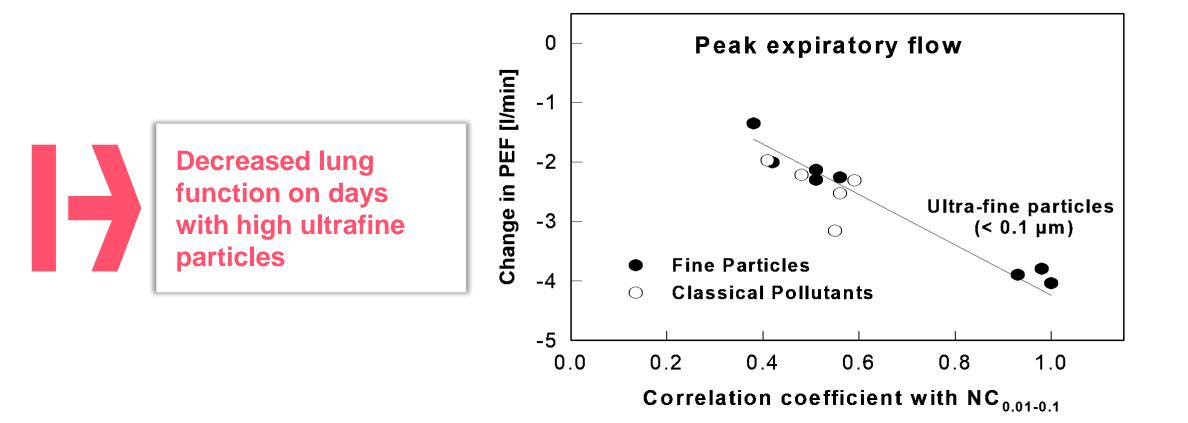
- Fine particles
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HELMHOLTZ MUNICI

Where it all started: Panel Study in Asthmatics



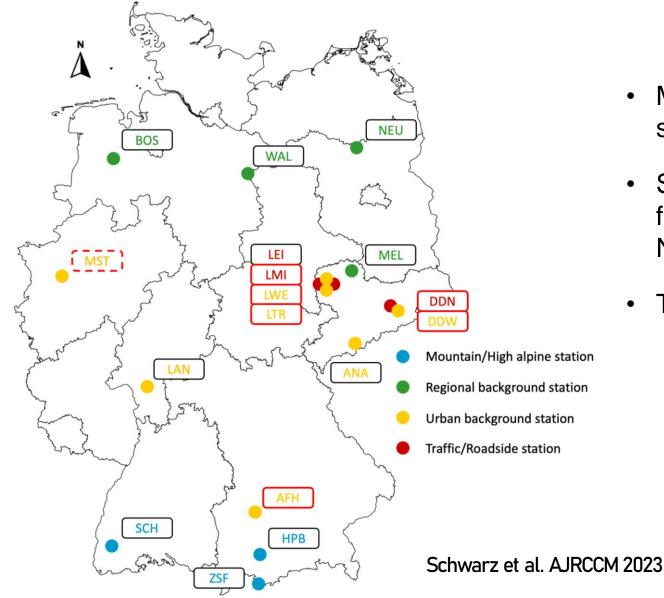
WHO Good Practice Statements: Ultrafine Particles

- 1. Quantify ambient ultrafine particles (UFP) in terms of particle number concentrations (PNC) with a lower limit of \leq 10 nm and no restriction on the upper limit.
- 2. **Expand** the common **air quality monitoring strategy** by integrating UFP monitoring into the existing air quality monitoring.
- Distinguish between low and high PNC to guide decisions on the priorities of UFP source emission control. Low PNC can be considered < 1 000 particles/cm³ (24-hour mean). High PNC can be considered > 10 000 particles/cm³ (24-hour mean) or 20 000 particles/cm³ (1-hour mean).
- 4. Utilize emerging science and technology to advance the assessment of exposure to UFP for their application in **epidemiological studies** and UFP management.



Daily concentrations of ultrafine particles are linked to mortality

Time-series study of ultrafine particles

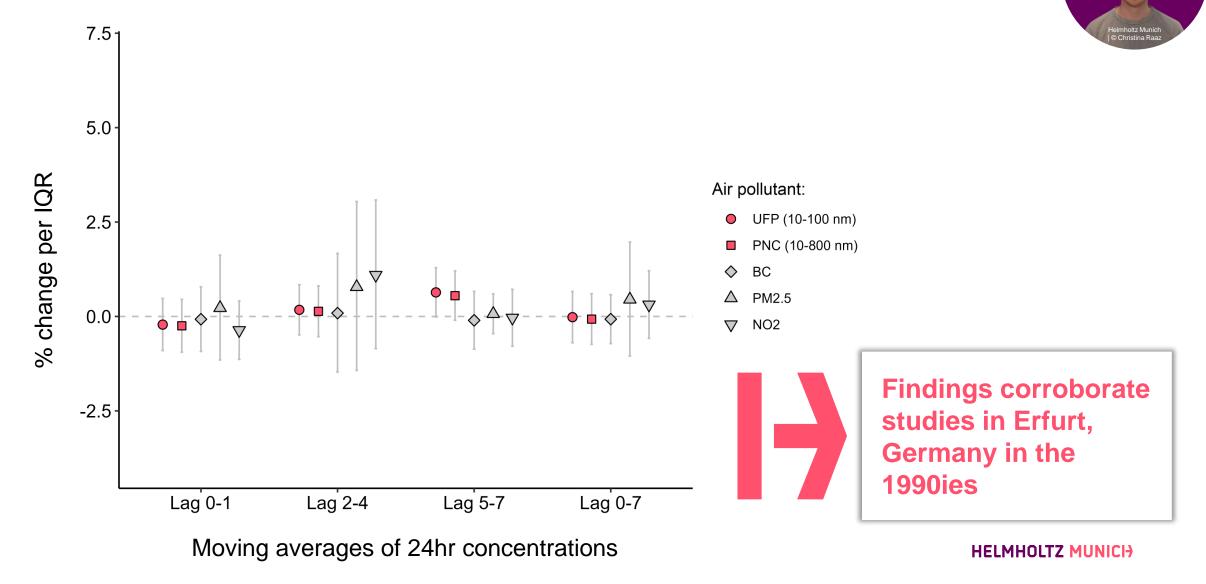




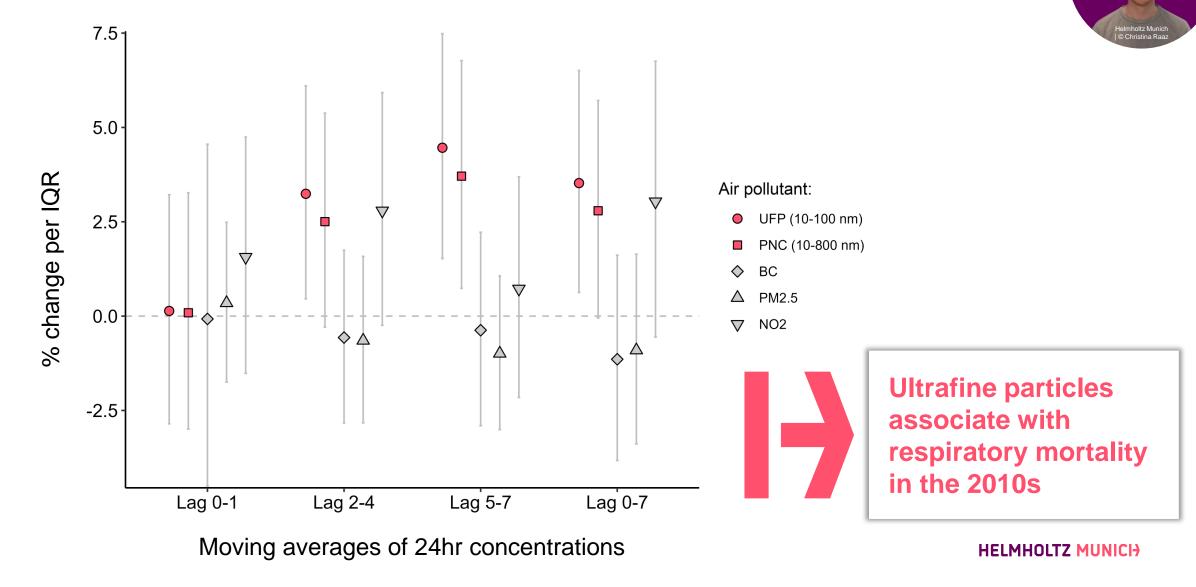
- Multi-center epidemiological time series study between 2010 and 2017
- Six stations that were part of the former German Ultrafine Aerosol Network (GUAN)
- Two-stage modelling design:
 - I. Station-specific confounder adjusted Poisson regression
 - II. Novel multi-level meta-analytical approach for environmental research

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Ultrafine particle effects on natural mortality

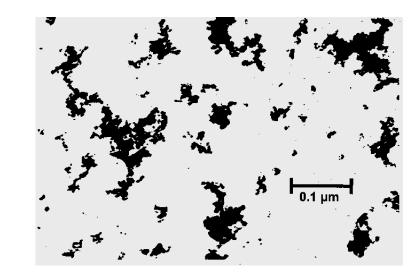


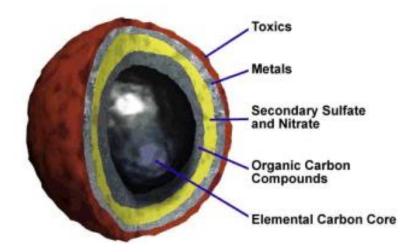
Ultrafine particle effects on respiratory mortality



Particle properties related to health effects

- Fine particles
- Coarse particles
- Ultrafine particles
- Particle composition
 - Black carbonaceous
 particles
 - Secondary organic aerosols
 - Secondary inorganic aerosols





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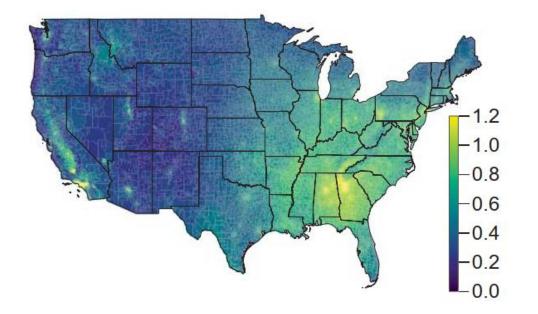
WHO Good Practice Statements: Black / Elemental Carbon

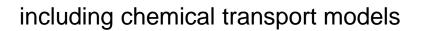
- 1. Make systematic measurements of black carbon (BC) and/or elemental carbon (EC). Such measurements should not replace or reduce the existing monitoring of pollutants for which guidelines currently exist.
- 2. Undertake the production of emission inventories, exposure assessments and source apportionment for BC/EC.
- 3. Take measures to reduce BC/EC emissions from within the relevant jurisdiction and, where considered appropriate, develop standards (or targets) for ambient BC/EC concentrations.

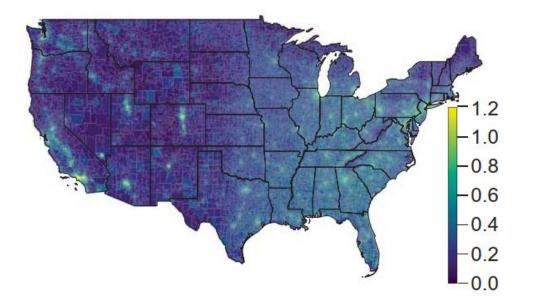


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Modelling Black Carbon in the United States





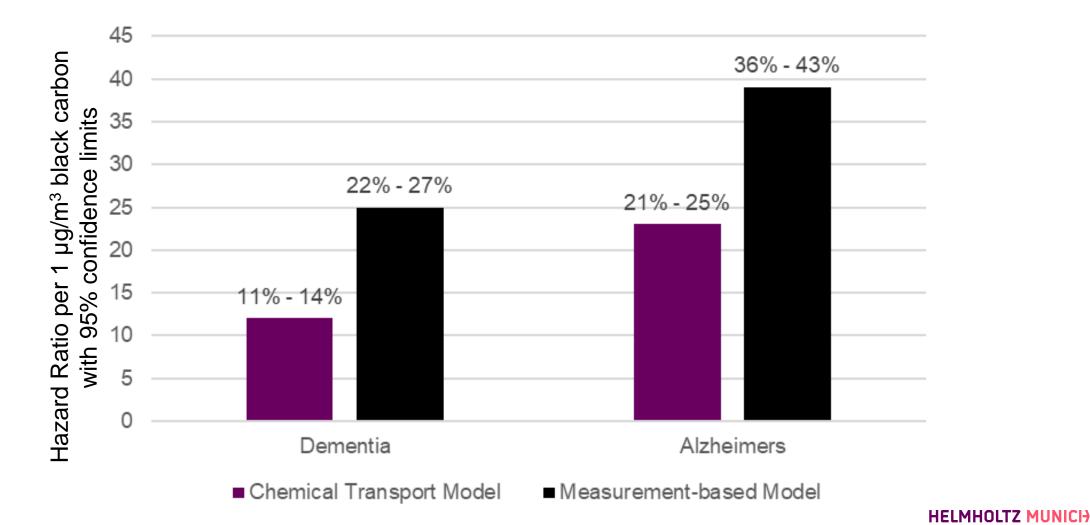


including measurement station data

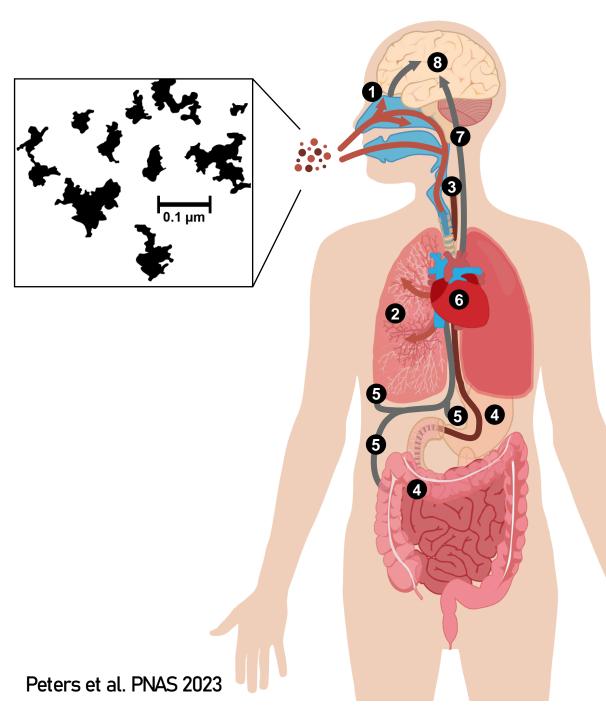
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Shi et al. PNAS 2023

Black carbon and neurodegenerative disease exacerbation



Shi et al. PNAS 2023





Ultrafine particles (UFP) deposited in the nasal cavity translocate to the brain via the olfactory nerve

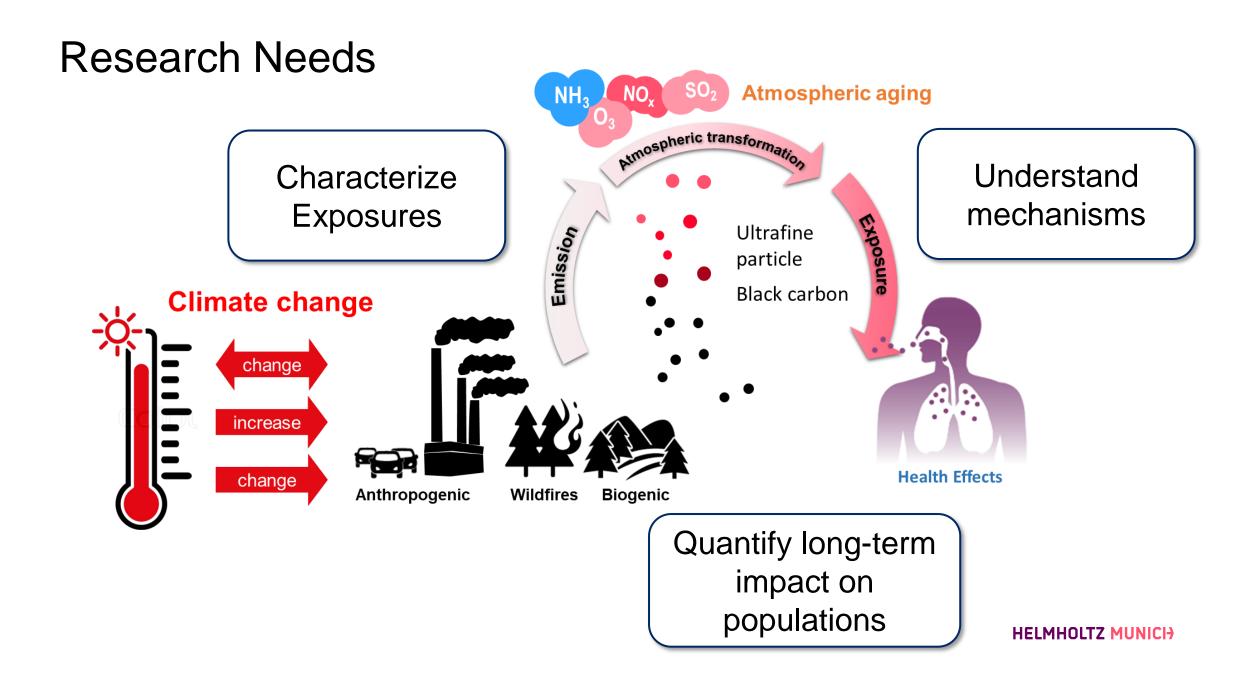
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5

8

- Particles deposited in the lung activate the immune system
- 3 Particles are swallowed after clearance from the lung or deposition in the upper airways
 - the lung or deposition in the upper airways
 - Particles reach the gastrointestinal tract
 - UFP and constituents translocate into the blood stream
- 6 UF
 - UFP and constituents passage the heart
 - UFP and constituents from different organs reach the brain vasculature

UFP and constituents induce localized and diffuse inflammatory responses, protein misfolding, glial and vascular dysfunction, and neuronal degradation leading to different forms of dementia



Quantification and control of ultrafine particles and black carbon is needed



ozone, nitrogen dioxide, sulfur dioxid and carbon monoxide



World Health



Thank you.

POLLUTANTS FROM "NATURAL SOURCES" (WILDFIRE SMOKE & SAHARAN DUST): INNOCENT BYSTANDERS OR IMPORTANT ONES?



Clean Air in Europe For All, Brussels, 24th May 2023



Xavier Querol, Aurelio Tobias Environmental Geochemistry and Atmospheric Research (EGAR) Institute of Environmental Assesment and Water Research (IDAEA-CSIC)



- Natural emissions of atmospheric pollutants influencing air quality
- Desert dust
- Wildfires (natural?)
- Final considerations





Natural atmospheric pollutants influencing air quality

The problems are qualitative and quantitative different in the emission and receptor regions

NATURAL EMISSIONS

- Biogenic (VOCs, PM, bioaeros.)
- Sea salt (PM)
- Volcanic (PM, SO₂, NOx, CO)
- Wildfires (PM, NOx, NH₃, CO)
- Desert dust (PM)

These tend to coincide both in time and space, and with heatwaves



EMISSION REGION

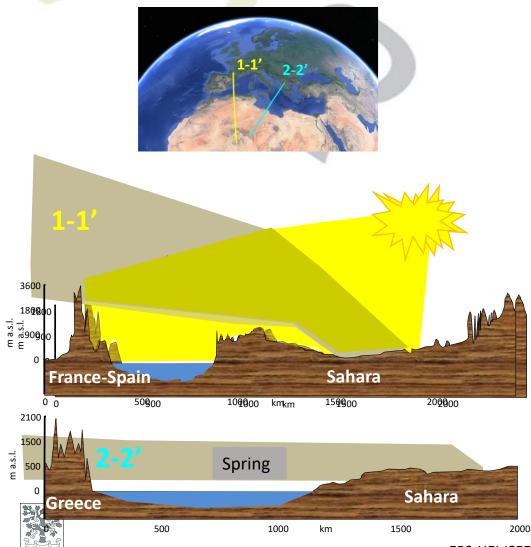


RECEPTOR REGION

Desert dust

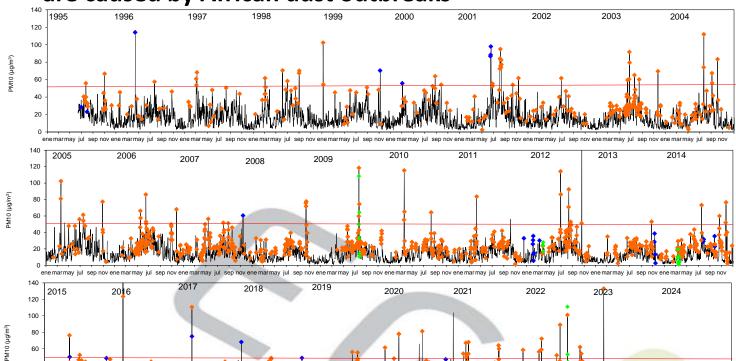
CSIC

Querol X., et al., 2019. Environment International



PM₁₀ MONAGREGA (REMOTE SITE) SPAIN

115 out of 128 exceedances of the DLV registered in 29 years are caused by African dust outbreaks

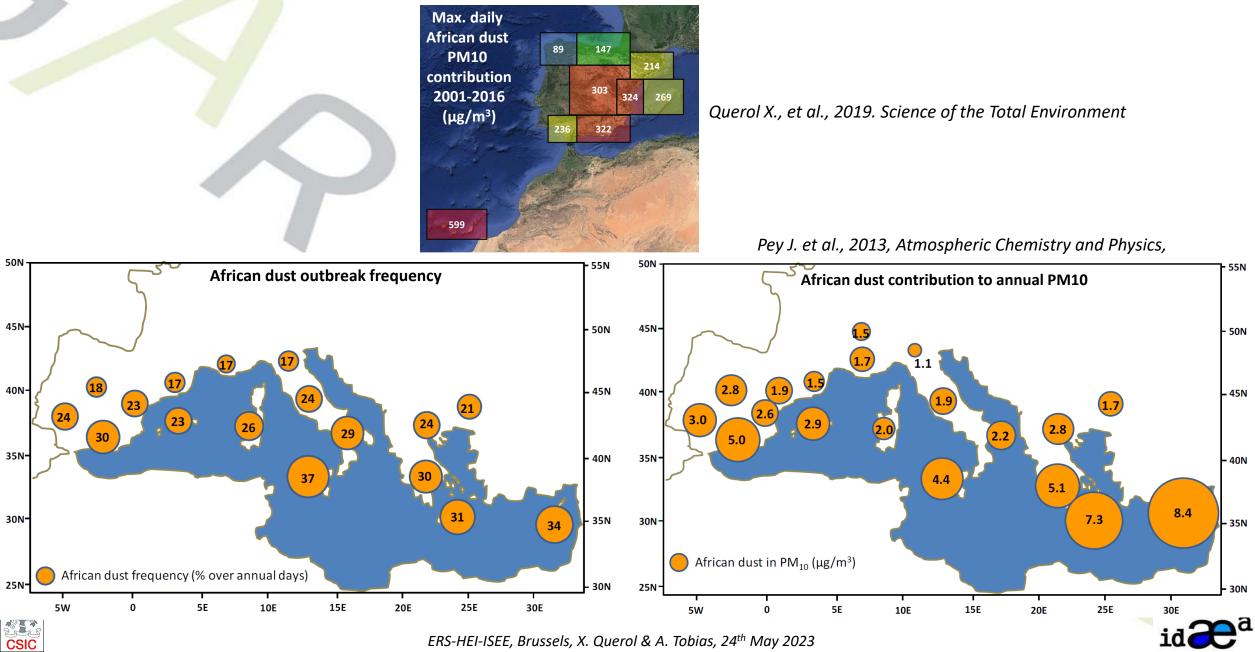


African dust outbreaks

Forest fires

Local dust from Monegros

Desert dust



Desert dust

SYSTEMATIC REVIEW MORTALITY-DUST: META-ANALYSIS

Tobias et al., 2023. Under review, Environment International

SHORT-TERM ASSOCIATIONS (GENERAL POPULATION, STUDIES 2002-2022)

Premature mortality increase in dust/non-dust days

Morbidity increase in dust/non-dust days

| | Ν | Lag %IRR (95%CI) p-value | | Ν | Lag, %IRR (95%CI) p-value |
|----------------|----|---------------------------------|-------------|----|---------------------------------|
| All-cause | 25 | Lag 0, 1.25 (0.63, 1.88) <0.001 | Respiratory | 10 | Lag 0, 4.73 (3.31, 6.14) <0.001 |
| Cardiovascular | 25 | Lag 0, 1.66 (0.40, 2.91) 0.010 | | 6 | Lag 1, 3.07 (1.45, 4.69) <0.001 |
| | | | | 5 | Lag 3, 3.07 (1.36, 4.79) <0.001 |

Effect modification of premature mortality PM10 (per each increase of 10 µg m⁻³)

| | | Ν | Lag %IRR (95%CI) p-value |
|--------------------------|---------------|---|---------------------------------|
| | Non-dust days | 5 | Lag 0, 0.77 (0.44, 1.10) <0.001 |
| | | 8 | Lag 1, 0.94 (0.90, 0.97) <0.001 |
| | Dust Days | 5 | Lag 0, 0.81 (0.46, 1.15) <0.001 |
| IRR: Increase Risk Ratio | | 5 | Lag 2, 0.49 (0.21, 0.75) 0.001 |
| CI: Confidence Intervals | | 4 | Lag 3, 0.73 (0.35, 1.11) <0.001 |
| N: n. of studies | | 4 | Lag 4, 0.41 (0.02, 0.79) <0.001 |



Wildfires

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SHORT-TERM HEALTH EFFECTS FROM OUTDOOR EXPOSURE TO BIOMASS BURNING EMISSIONS: A REVIEW

Karanasiou A., et al., 2021, Science of the Total Environment

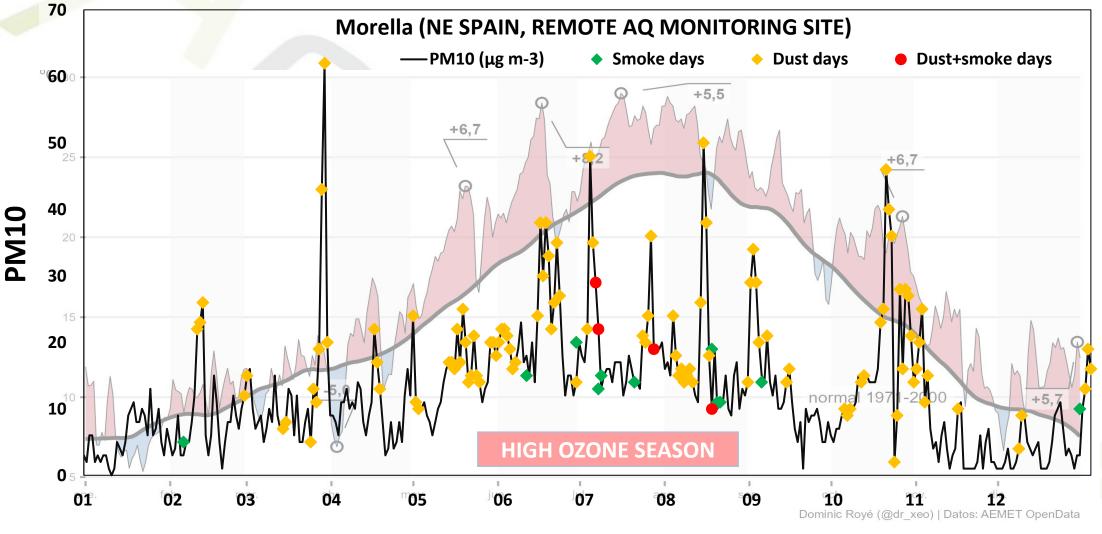
SHORT-TERM ASSOCIATIONS (GENERAL POPULATION, STUDIES 2002-2020)

| Premature mortality increase in smoke days | | | Morbidity increase in smoke days | | | |
|--|---|------------------------|----------------------------------|------|---------------------|--|
| | Ν | %IRR (95%CI) | • | Ν | , %IRR (95%CI) | |
| All-cause | | | Respiratory | | · · · · | |
| Smoke (yes/no) | 4 | 2.65 (1.02, 4.20) | Smoke (yes/no) | 7 | 10.52 (3.87, 17.18) | |
| PM10 (10 μg m ⁻³) | 5 | 1.31 (0.91, 1,71) | PM2.5 (10 μg m ⁻³) | 13 | 4.10 (2.86, 5.34) | |
| | | | PM10 (10 μg m ⁻³) | 5 | 4.83 (0.06, 9.60) | |
| Cardiovascular | | | Asthma | | | |
| Smoke (yes/no) | 4 | 4.45 (0.96, 7.95) | Smoke (yes/no) | 5 | 38.26 (7.91, 68.60) | |
| | | | PM2.5 (10 μg m ⁻³) | 13 | 9.19 (5.71, 12.68) | |
| | | | PM10 (10 μg m ⁻³) | 5 | 10.35 (4.44, 16.26) | |
| | | | COPD | | | |
| | | | Smoke (yes/no) | 4 | 13.33 (7.31, 19.34) | |
| | | | PM2.5 (10 μg m ⁻³) | 12 | 3.92 (1.13, 6.70) | |
| | | | PM10 (10 μg m ⁻³) | 4 | 3.95 (1.65, 6.24) | |
| | | | Ischemic heart dise | ease | | |
| | | | Smoke (yes/no) | 3 | 5.45 (0.80, 10.10) | |
| | | EDS HELISEE Drussals X | Querol & A. Tobias 24th May 20 | 172 | | |



Wildfires, dust and heatwaves

DAILY TEMPERATURES IN SPAIN 2022 COMPARED WITH 1971-2000 MEAN





Wildfires, dust and heatwaves

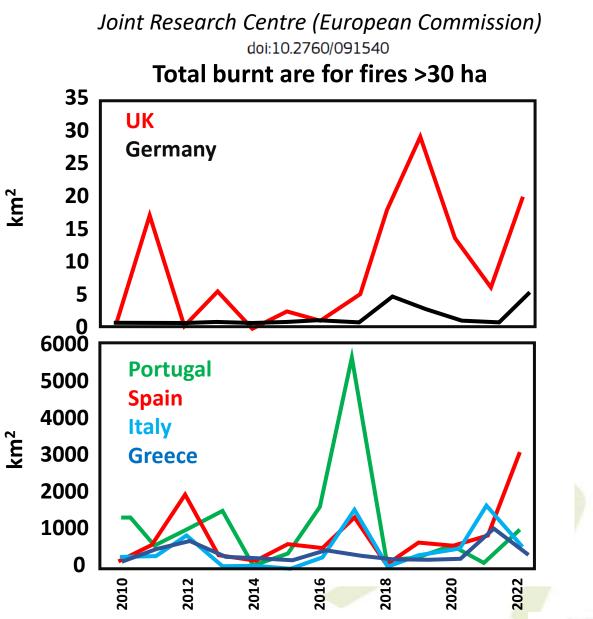
Salvador P., et al., 2022. npj Climate and Atmospheric Science

Number of dust episodes over the Iberian Peninsula increase near 0.8 day year⁻¹, in 1948-2020, and probably with more frequency affecting Central and Northern Europe

| Table 1 | . Trend analysis for days under any ADO CT for the 1948–2020 | |
|---------|--|--|
| period | ł. | |

| Days under ADO CT | Number of days | GT | TPOT | TANOM |
|-------------------|----------------|---------|---------|---------|
| All days | 0.77*** | 0.41** | 0.02** | 0.02** |
| Spring | 0.98** | 0.39* | 0.02* | 0.02*** |
| Summer | 0.78** | 0.52*** | 0.04*** | 0.03*** |
| Autumn | NT | NT | NT | 0.02*** |
| Winter | 0.67* | 0.38*** | 0.02*** | 0.02* |

Results of the Theil-Sen trend analysis. Values of the Slope estimator in days year⁻¹, for the number of days under ADO atmospheric circulation types (ADO CT) and the mean levels of GT (m year⁻¹), TPOT (°C year⁻¹) and TANOM (°C year⁻¹) averaged over the Iberian Peninsula and the Balearic Islands during those days. ***, **, * and +: statistically significant value at the 99.9%, 99%, 95% and 90% confidence level, respectively, NT: no trend.

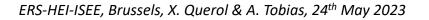




Final considerations

- There is a body of evidence for health effects (mortality and morbidity) of PM arising from forest fires and desert dust
 - Dust as effect modifier (in Europe) show an increase of risk for cardiovascular mortality and for respiratory and child asthma morbidity
 - Wildfires increase all-causes and cardiovascular mortality and respiratory morbidity
- Dust and smoke days coincide very often, and these together with heatwaves, and in the high ozone season, thus synergistic effect probably occur
- Alert systems should be implemented (existing for dust since 2001 in some areas of Europe) to alert the most susceptible population to take protection measures. Also clear messages should be given for the protection
- Actions should be taken to decrease human exposure to susceptible pollution in the affected areas and abate emissions (when possible)
 - Implement short-term action measures to decrease emissions of local pollutants
 - Alert the population
 - Promote remote working during episodes
 - Abate resuspension of deposited dust by road traffic after major episodes (washout with phreatic, non-drinking, water)





Thank you very much for your attention!!!!!

European Respiratory Society (ERS) Health Effects Institute (HEI) International Society for Environmental Epidemiology (ISEE)





For supporting the reviews on health effects of dust and biomass burning

World Health Organization

> GOBIERNO DE ESPAÑA Y EL RETO DE

For supporting the Spanish desert dust alert system since 2001



EC Horizon 2020, LC-GD-9-1-2020, Research & Innovation Action Number: 101036245



xavier.querol@idea.csic.es

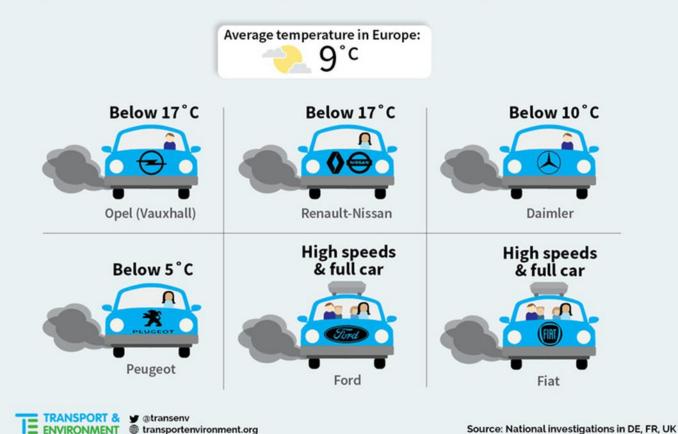


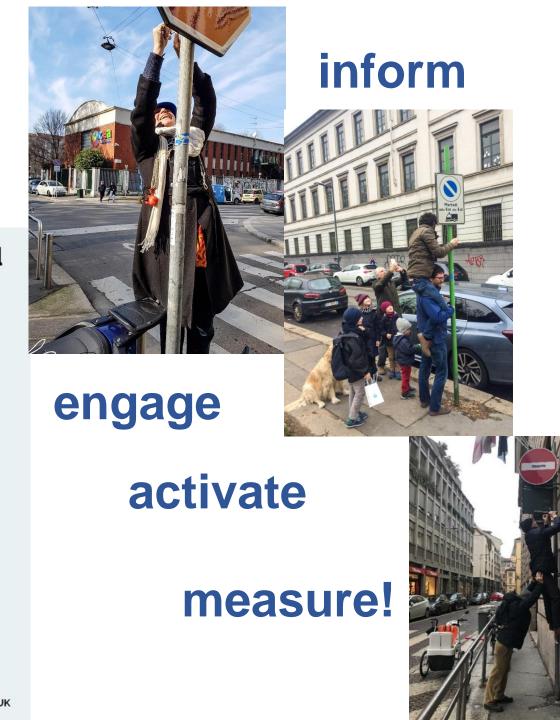
Citizen science perspective: New avenues for research and action

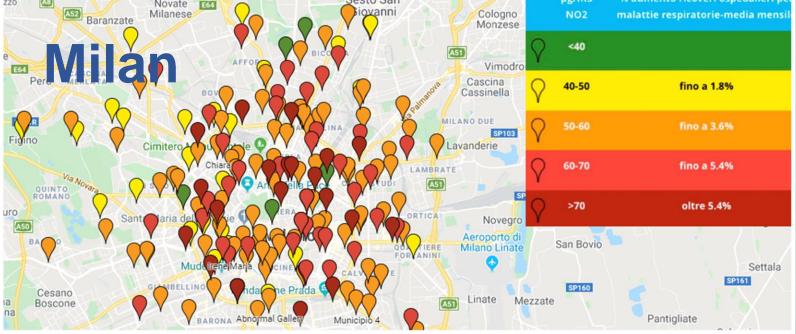


When the problem exists but it is disavowed, ignored?

When carmakers begin turning down pollution control









2018 A lurf map was developed using the citizens' data: it showed 594 premature deaths resulting from exposure of the Milan population to > $40\mu g/m^3 NO2$ -[RR (95%CI) per 10 µg/m³ 1.055 (HRAPIE)]



Comun



A lurf map was developed using the citizens' data: it showed **120 premature deaths** resulting from exposure of the Rome population to > 40µg/m³ NO2 and **2.634 premature deaths** counterfactual 20µg/m³ NO2 - [RR (95%CI) per 10 µg/m³ 1.055 (HRAPIE)]

May 2019, Raggi: «Stop diesel Euro 3»





Rome, Naples and Milan

The comparison on NO2 pollution

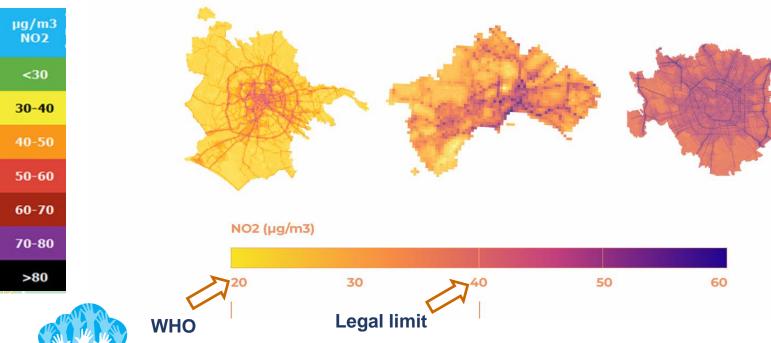
2020

MUNICIPIO MUNICIPIO

CITTADINI PER L'ARIA







Rome **1713** premature deaths counterfactual 20 µg/m³ NO2 = 6,2% of overall morta

Naples **667** premature deaths counterfactual 20 μ g/m³ NO2 = **6,65%** of overall mortality

Milan **1507** premature deaths counterfactual 20 µg/m³ NO2= **10,9%** of overall mortality



V.MATTEUCCI 57.6

DO YOU KNOW WHAT YOU BREATHE? SAI COSA RESPIRI?

Scopri la stima delle concentrazioni di NO2 al tuo indirizzo a Milano

Discover the estimate of the NO2 concentrations at your address



Gango Monforde

Milano



HEALTH IMPACT

La sched

come spiega l'Arpa, è «un

gas di color

tossico e irritantes É più dens

dell'aria e pe questo tende a ristagnare ivello del sur

è stata di é

quasi strada per strada (coi una definizione per quadrat da 50 metri per lato) e si ved

nfine la collocazione delle ol re mille scuole, dagli asili a icei, dalle pubbliche alle pri

te. Moltissime, come si not a colpo d'occhio, sono co

ate proprio nei pressi dell indi arterie di scorrimente

telle che per livello di smo

ono un reticolato di viola ir

Se questa è l'immagine,

che oltre 110 mila bambini e studenti respirano ogni gior-

no aria nociva con un livello

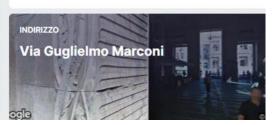
delle scuole si tre

veleni molto al di sopra dei niti di legge. L'altro 45 per

izione in numeri dell

The chronic exposure to **41 µg/m³** NO2 is associated with a 48% increase of the risk of asthma in children and a 36% increase risk of acute respiratory respiratory infections

SMOG INMLANSTREET BY STREET A TOXIC LAYER OVER THE SCHOOLS



Limite medio annuo

di legge

Soglia annua a tutela

della salute

HEALTH IMPACT The chronic exposure to 41 µg/m³ NO2 is associated with a 16% increase of mortality risk and a 16% increase risk of hischemic heart disease event

Sottoscrivi l'appello!

(uno dei quadranti più traffi-cati e inquinati della città) ci sono una dozzina di sc Le migliaia di bambini gazzi che le frequentar spirano un livello di bio fi azoto intorno ai 55 micro sea impone di non super fimite di 40. Le linee guid 1 ornate invece dall'O zione mondiale della el 2021 dicono che per p eggere la salute la soglia rebbe essere molto più ba a, 10 microgrammi. Sono questi i limiti che b ena tenere a mente quan rova a navigare sulla ma

La mappa dell'No2 dei Cit-adini per l'aria sarà da oggi ui sito dell'associazione e germette un doppio livello di consultazione. Oltre alla ricer-ca sulte scuole, può essere consultata anche per indiriz-zo, ad esempio di residenza o di lavoro, e restituisce sia i li-velli di inquinamento, sia le stime di quali possano essere i danni per la sultate con riferi-

danni per la salute con rife

nento alle ricerche scientifi he più aggiornate, dunqu aumento del rischio di mor

alità e di infarto per gli adult l'asma le patologie respira-

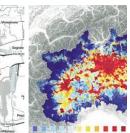
telligenza artificiale e anche illa base dei dati raccolti da

aia di milanesi che ha do l'ultimo ren

rie per i bambini e i r a mappa è stata elaborata fruttando un meccanismo di

La mappa elaborata dai «Cittadini per l'aria» Oltre 110 mila bambini e ragazzi ogni giorno

respirano biossido di azoto oltre i limiti di legge La concentrazione di gas in piazzale Loreto





Write to your mayor!

Via Vincenz

Carso al Parte Vite















WE COULD NOT DO WITHOUT RESEARCHERS!





















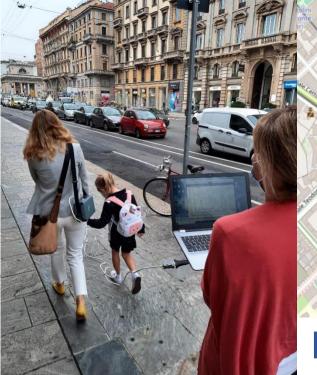












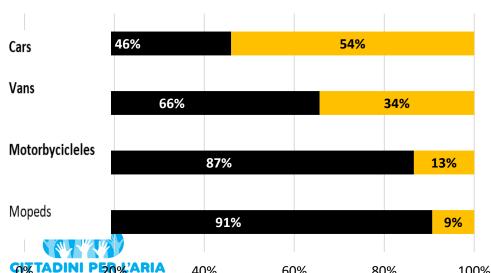
CICLO-STAFFETTA ECCO LE MAPPE CON I RISULTATI

I LIVELLI DI INQUINAMENTO LUNGO I PERCORSI

Evidence is crucial for change

Caserma

Quota of samples dirty and clean by vehicle type





TAKE-AWAYS

- Citizens science enables representation of the problem to the public and policy-makers
- Citizens scientists acquire **awareness**, **support research** with additional knowledge and become key-players of **knowledge sharing**
- Citizens science is **popular m** The co-authors are many and very vocal!
- Citizens science projects provide continuing **opportunity to address** the issue and are **highly replicable**
- Citizens science is a useful tool for policy-makers as it provides fresh usable data to enhance and improve policies







Collaboration among esearchers and citizens is fun? YES!

EVEREAD



AI COSA RESPIRI? SCOPRIAMOLO INSIEME

SCOPRIAMOLO INSIEME



#NO2NOGRAZIE

PARTECIPA ALLA CAMPAGNA DI MONITORAGGIO DELLA QUALITA' DELL'ARIA

Scansiona il QR code per iscriverti alla campagna





CleanCities













Thank you and keep in touch!







