



WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN

Claudia Mohr :: Laboratory of Atmospheric Chemistry :: Paul Scherrer Institute

Nanoparticles, climate and health: From observations to impact

26th ETH Nanoparticles Conference - June 20, 2023

Changing the world: *Net-zero* target

Global total net CO₂ emissions

Billion tonnes of CO₂/yr

50

40

30

20

10

0

Swiss approve net-zero
climate law

Pathways limiting
global warming to 1.5°C.



2050 2060 2070 2080 2090 2100

Net-zero 2050: Anthropogenic CO₂ emissions are balanced by anthropogenic CO₂ removals

Air quality and climate
change mitigation:
Role of nanoparticles?

www.swissinfo.ch

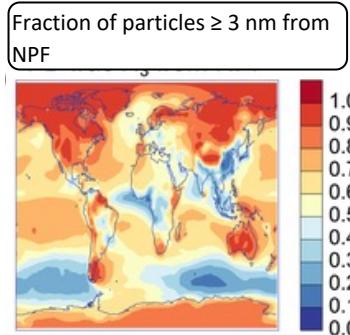


Take-home messages

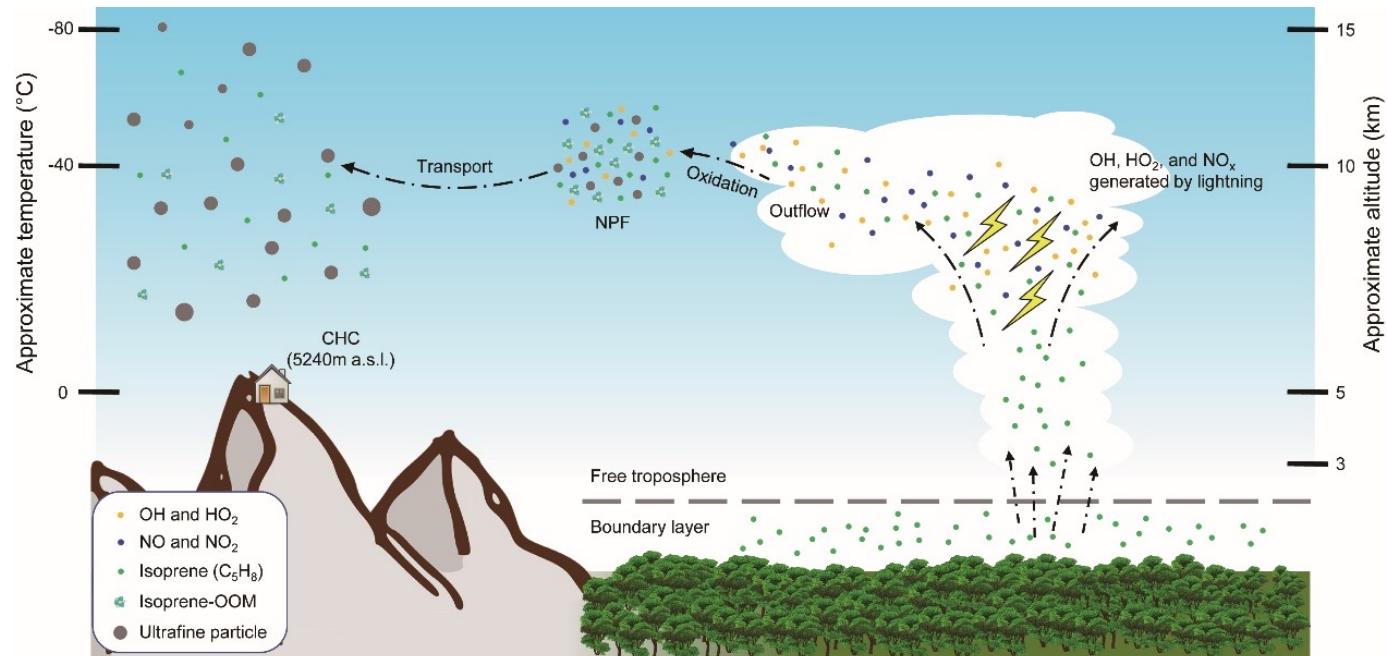
- A changing world – changing the world: Nanoparticle sources, emissions, processes will be highly influenced by climate change and air quality mitigation strategies in the near future
 - Important to improve analytical tools, models, knowledge
 - Natural emissions will likely become more important
 - Non-exhaust emissions will likely become more important
 - Alternative fuels will become more important
 - Secondary formation processes?
 - Effects on health?



New particle formation over Amazonia

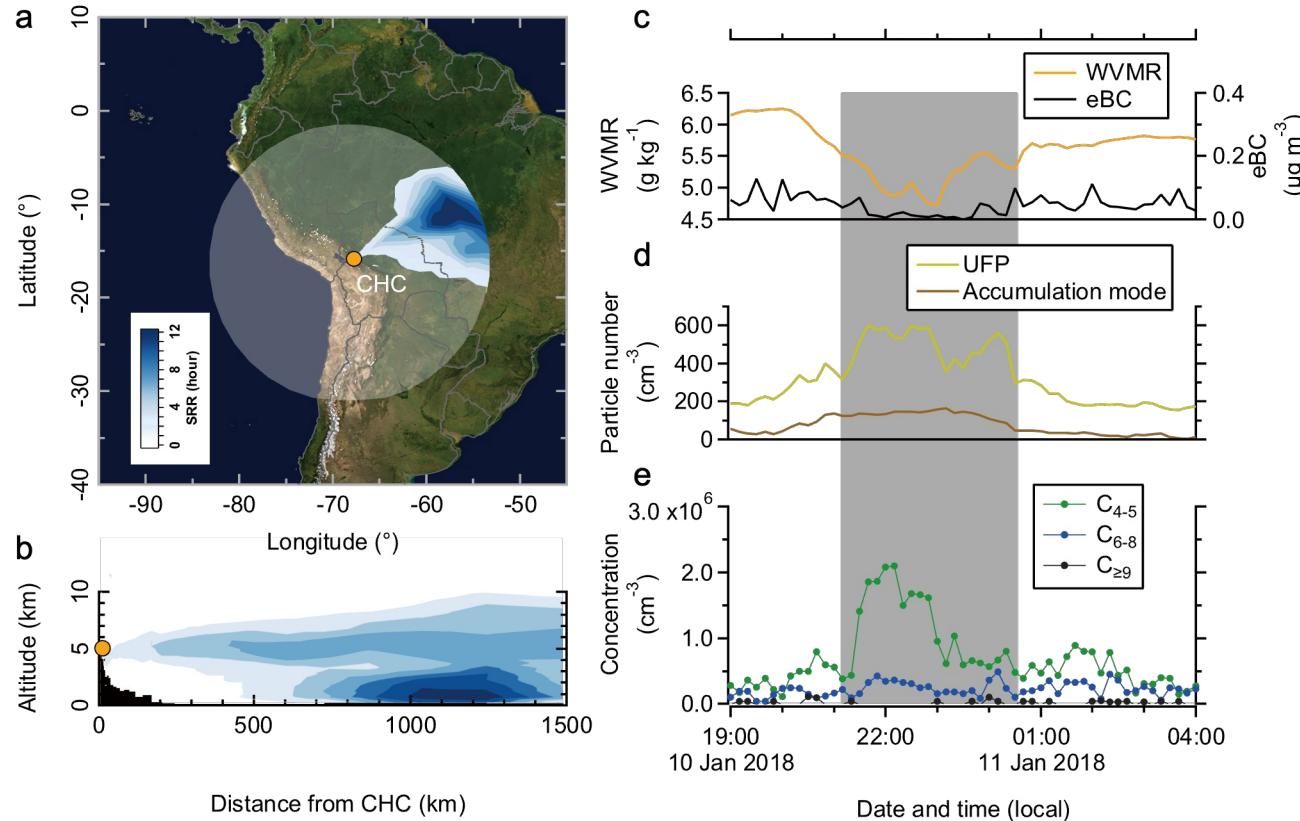


Gordon et al., JGR, 2017

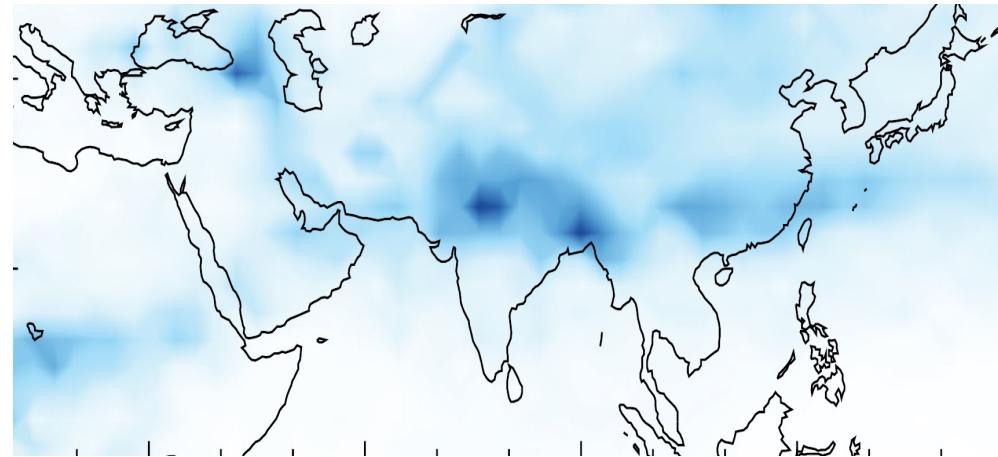


Zha et al., NSR, 2023

Observations of nanoparticles and precursors in free tropospheric air from Amazonia



NPF in the upper troposphere can be simulated in the CLOUD chamber at CERN

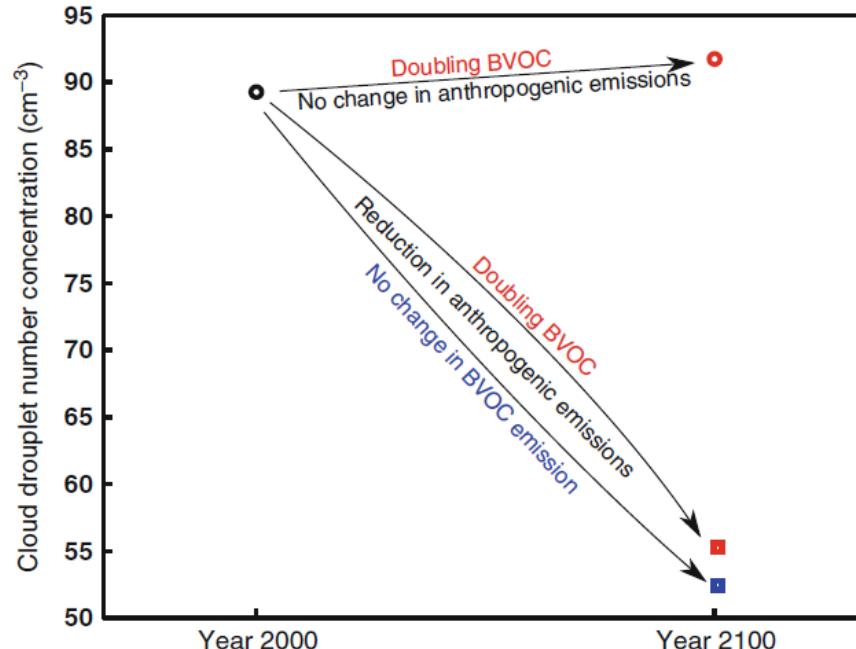


Wang et al., *Nature*, 2022

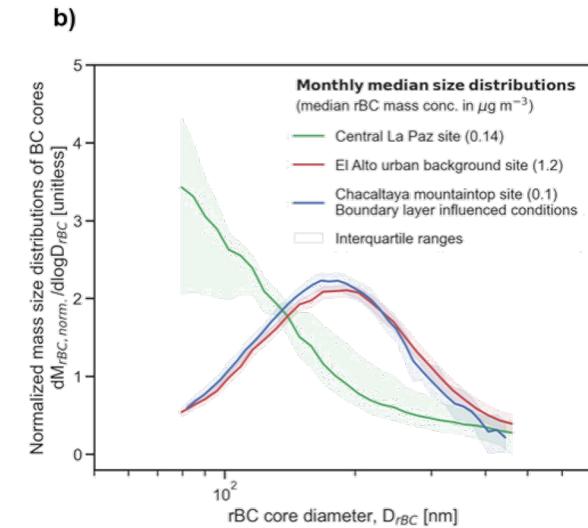
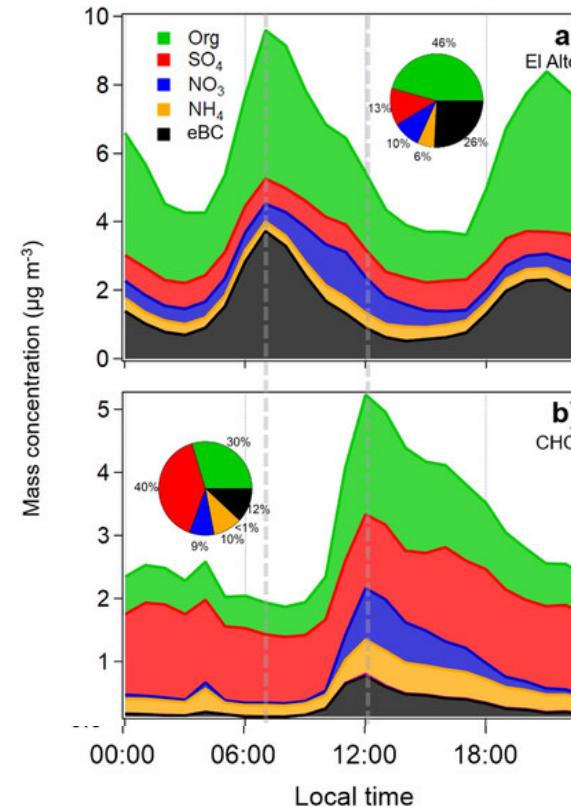


- Much more particles formed in upper troposphere via previously unaccounted mechanism ($\text{HNO}_3\text{--H}_2\text{SO}_4\text{--NH}_3$)
- Particles affect climate because they act as cloud seeds

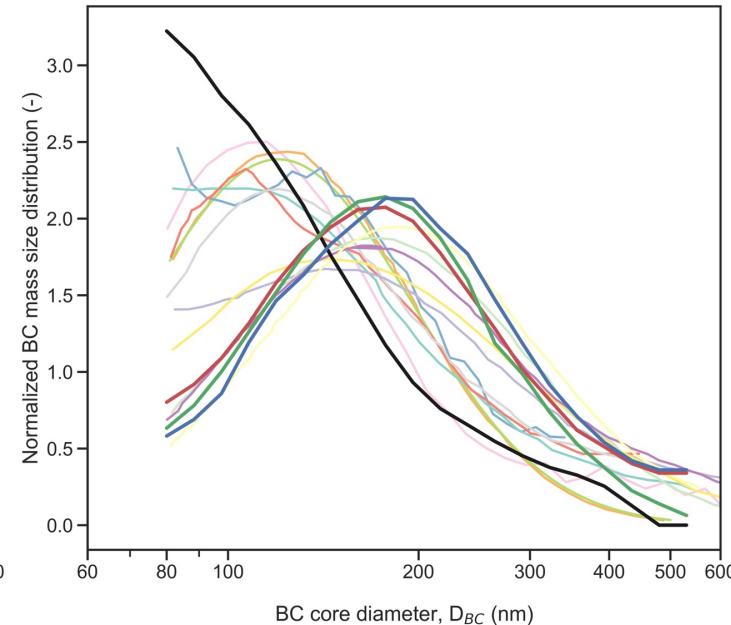
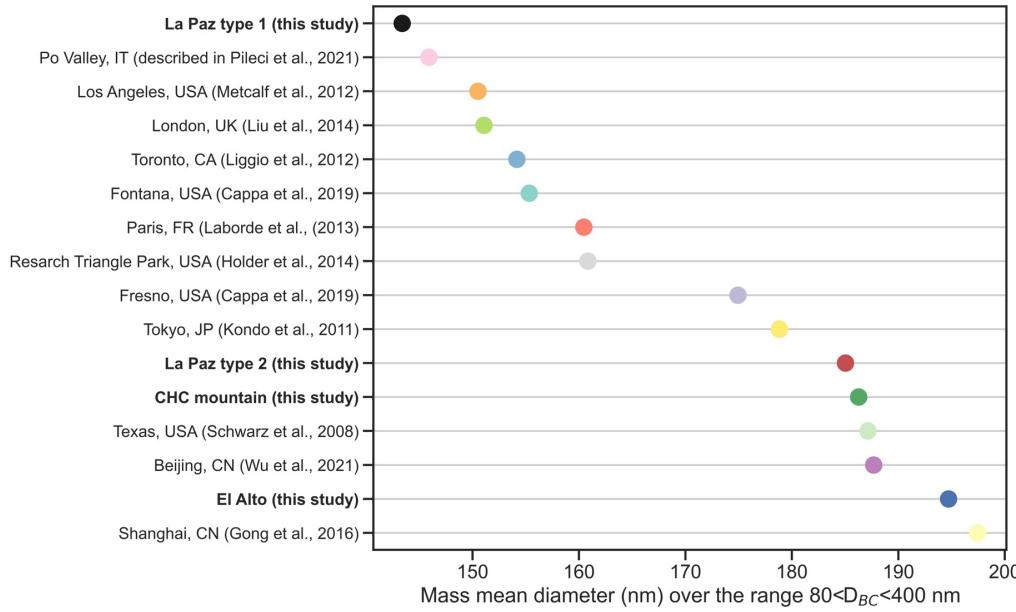
Future changes in biogenic and anthropogenic nanoparticle precursors: Effect on number concentrations



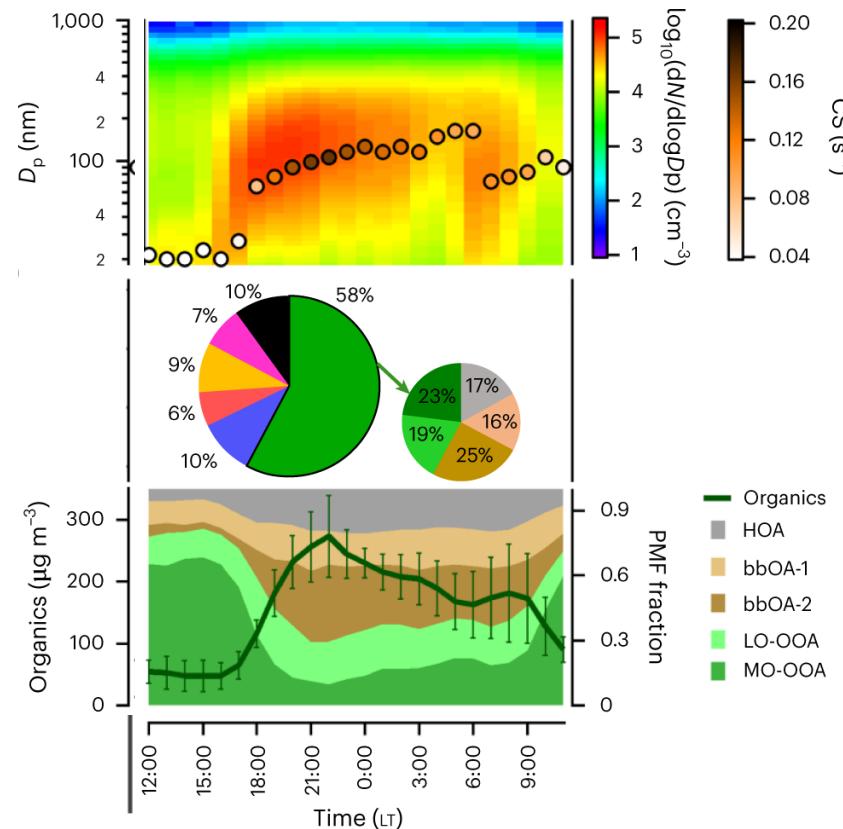
Back to Bolivia: Air masses were also arriving from the city of La Paz – El Alto



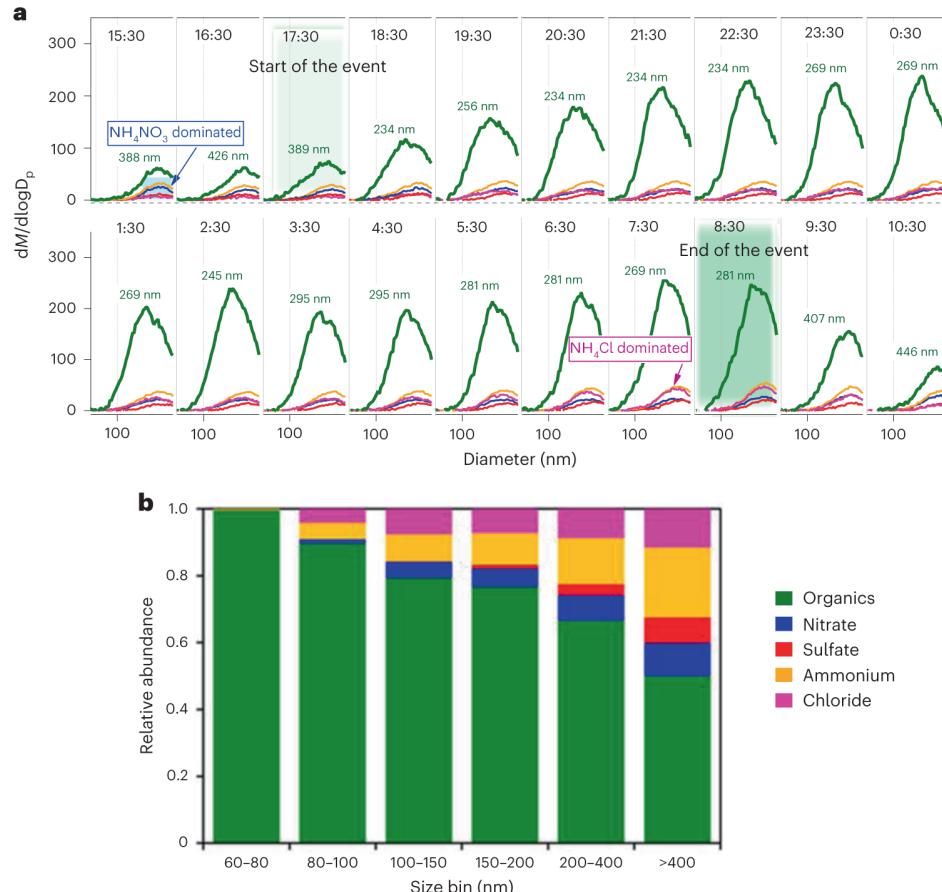
Black carbon size distributions from Bolivia and other places in the world



No oxidants at night: What is responsible for nocturnal nanoparticle growth in Delhi?

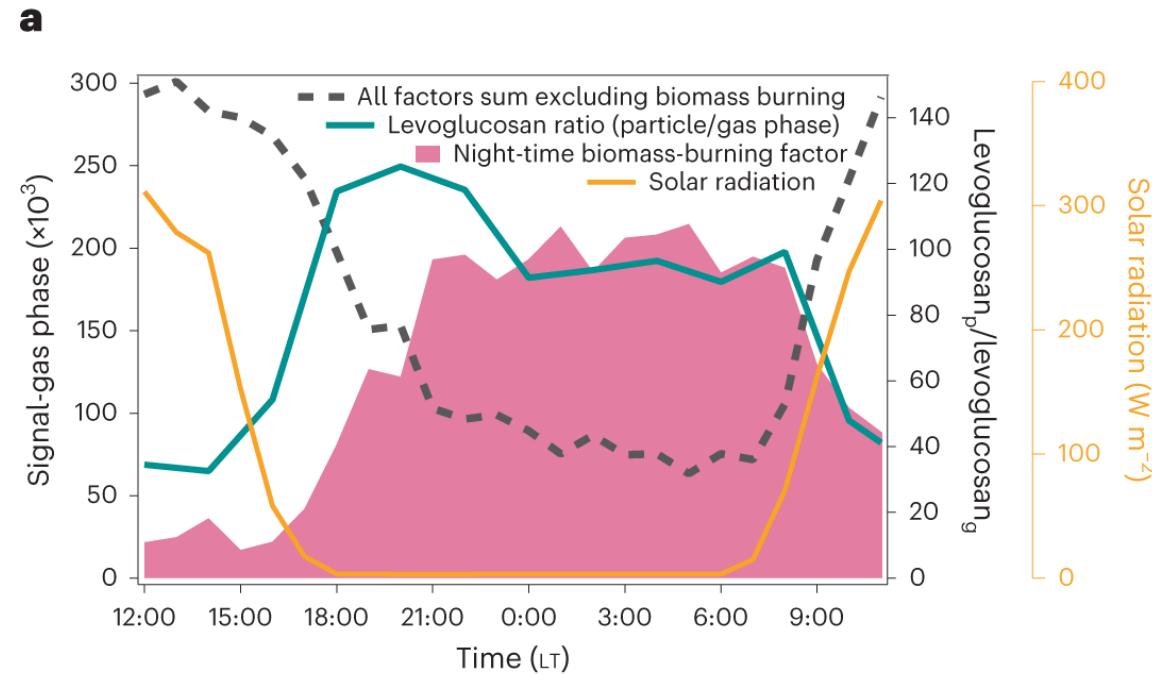


Organic compounds grow particles

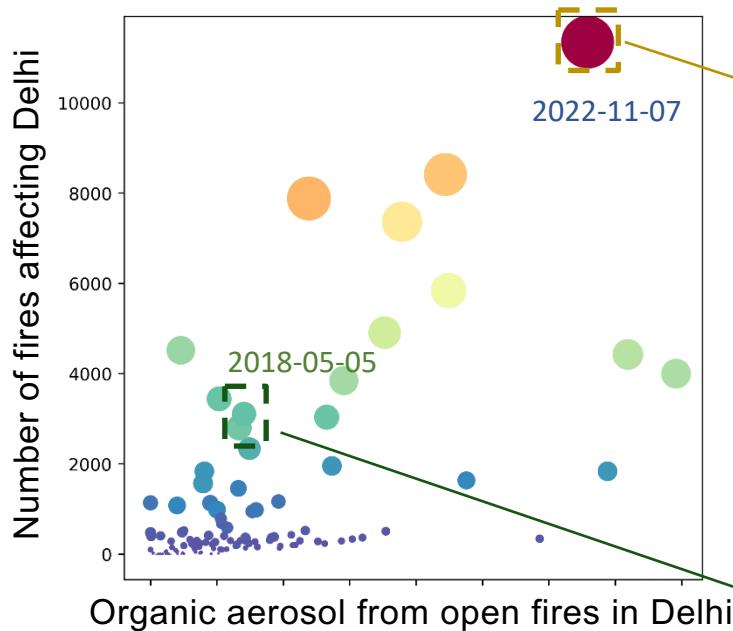


What compounds? Biomass burning vapors

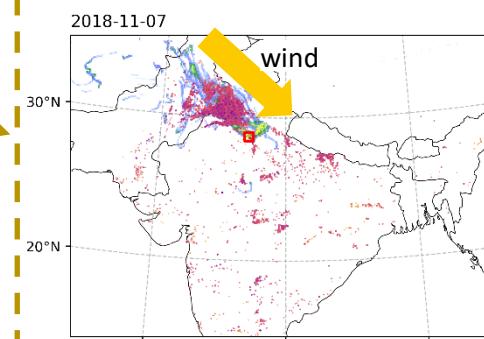
- Gas-phase measurements help identify the vapors responsible for particle growth



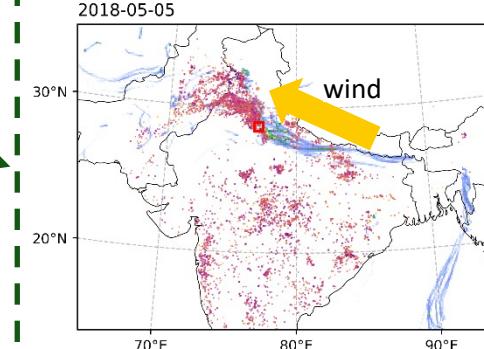
Impact of agricultural/wild fires on air quality in Delhi



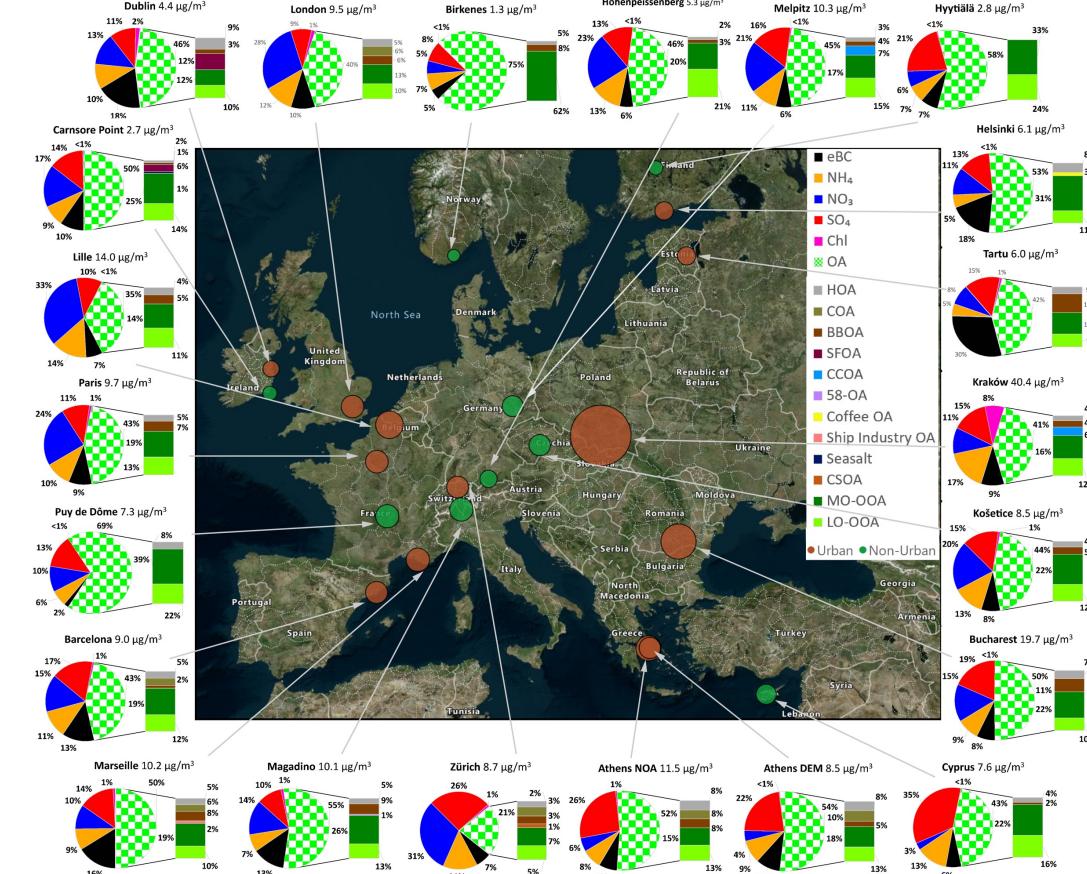
3-days backward plumes passing over intensive fires in northwest India



Intensive fire burning days but not in upwind region



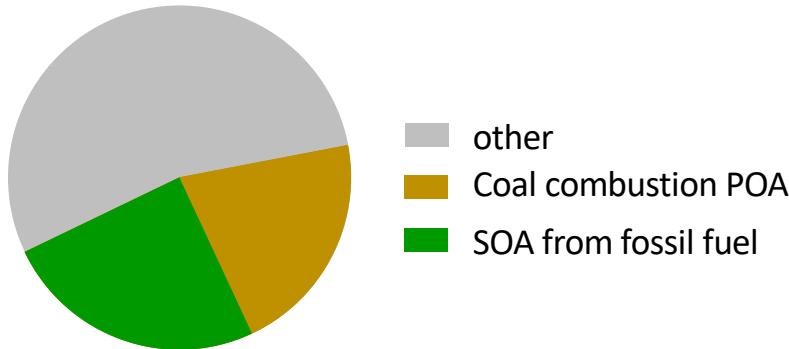
Sources of nanoparticles in Europe



Fossil fuels and air quality in Europe

- Coal is widely used as a fuel, globally but also in Europe
- What are the consequences for air quality?

Before ban: Almost half of organic aerosol from residential coal combustion!



Casotto et al., Sci. Tot. Env., 2022

Practical example:

Winter Krakow, Poland: ban of solid-fuel use



What will happen to road traffic?

Non-exhaust emissions will dominate road traffic emissions in near future

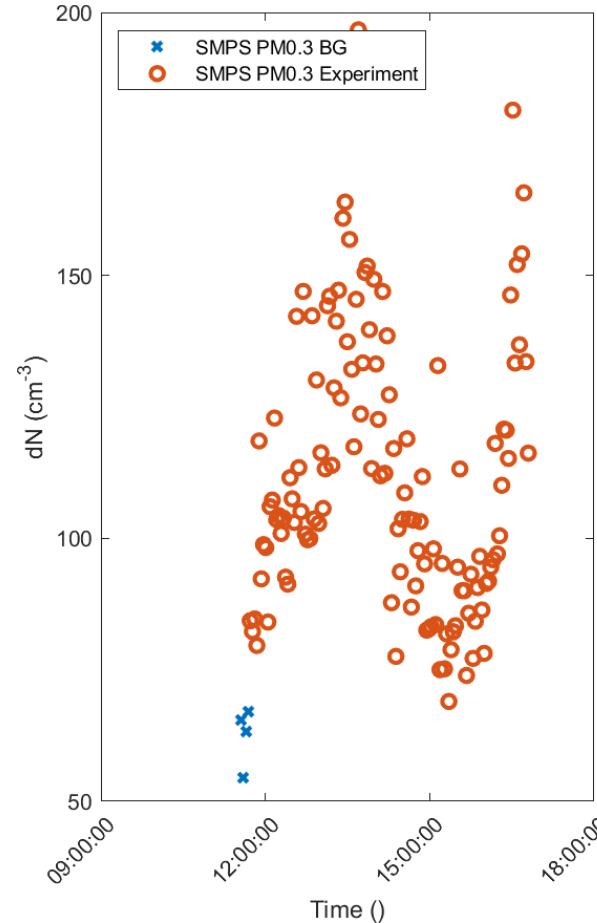
Tire wear particle emission experiment



Slow motion - Courtesy Vilhelm Malmborg, Lund University

Brake emissions

- Low metallic brake pin, pin-on-disc (particles ≤ 300 nm)

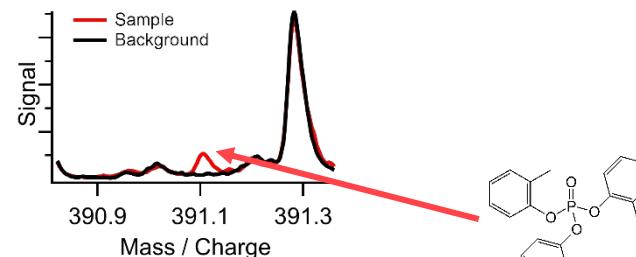


Courtesy Vilhelm Malmborg, Lund University

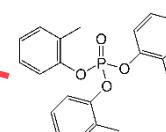
Aviation plumes



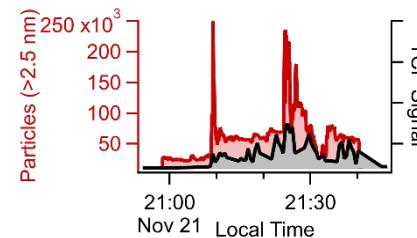
Sampled direct aircraft emissions



Identified aircraft oil particle emissions:
Tricresyl phosphate (TCP)

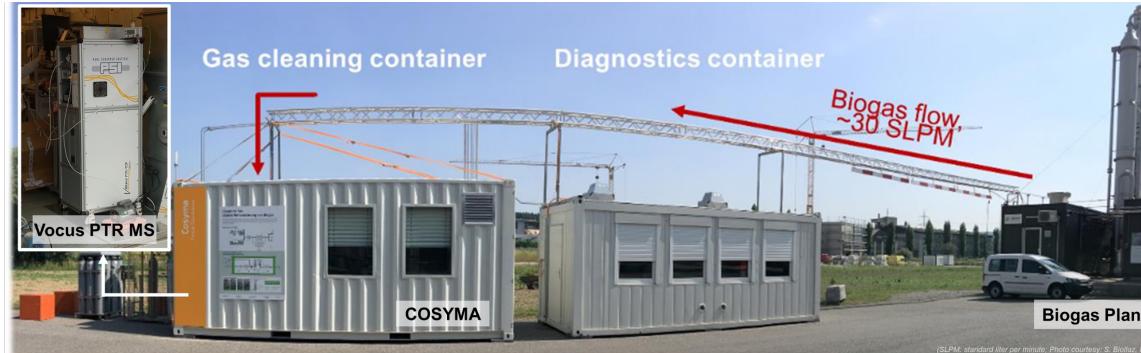


Sampling ambient aircraft emissions

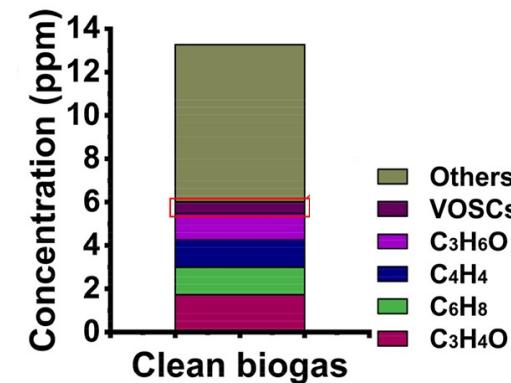
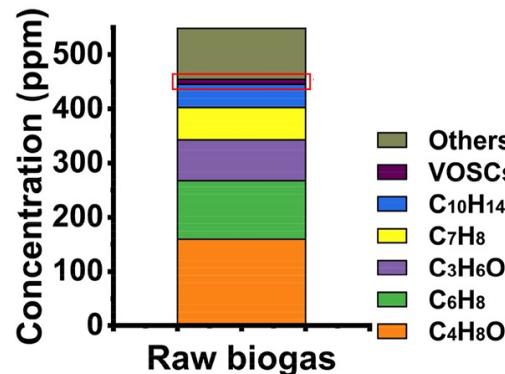


Observe aircraft oil particles in ambient air during aircraft pass-over

Biogas as a way forward: tracking down contaminants



(SLPM: standard liter per minute. Photo courtesy: S. Bodmer, PSI)





Air pollution maps
for single emission



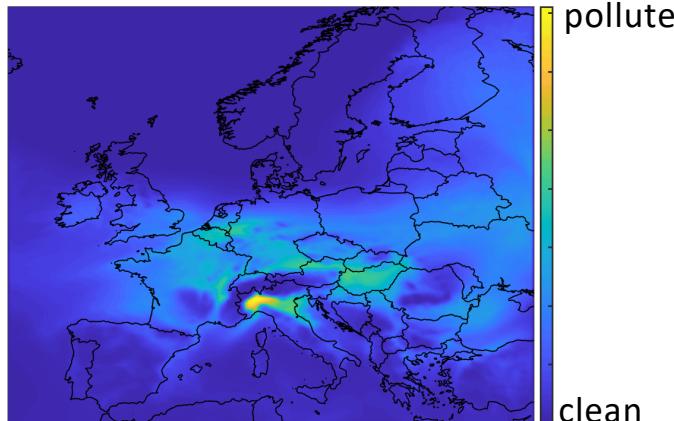
Source-specific
toxicity of particle



Health effects
in populations



better air

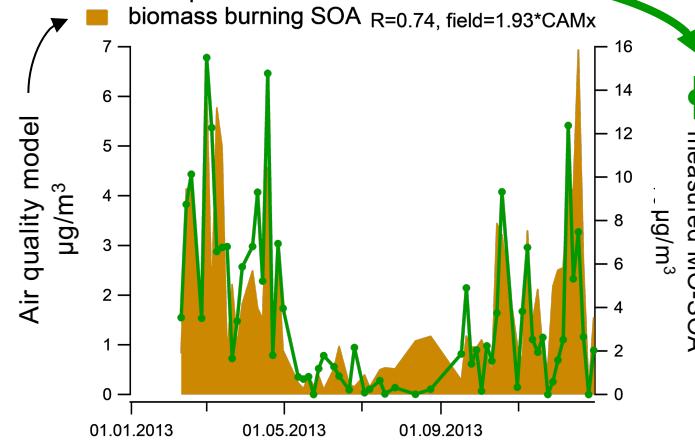
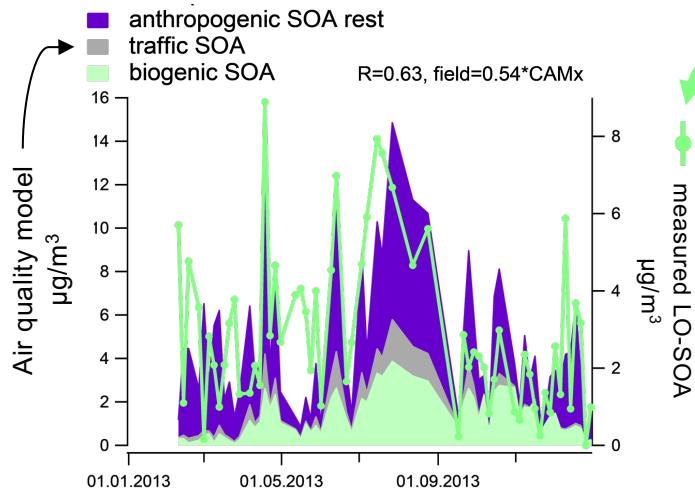
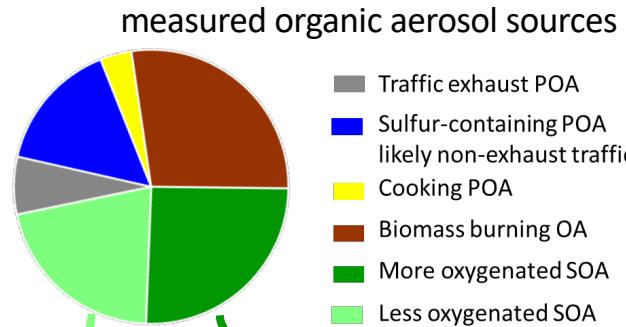


New unprecedented PSI database for
chemical air quality observations for
model validations and developments

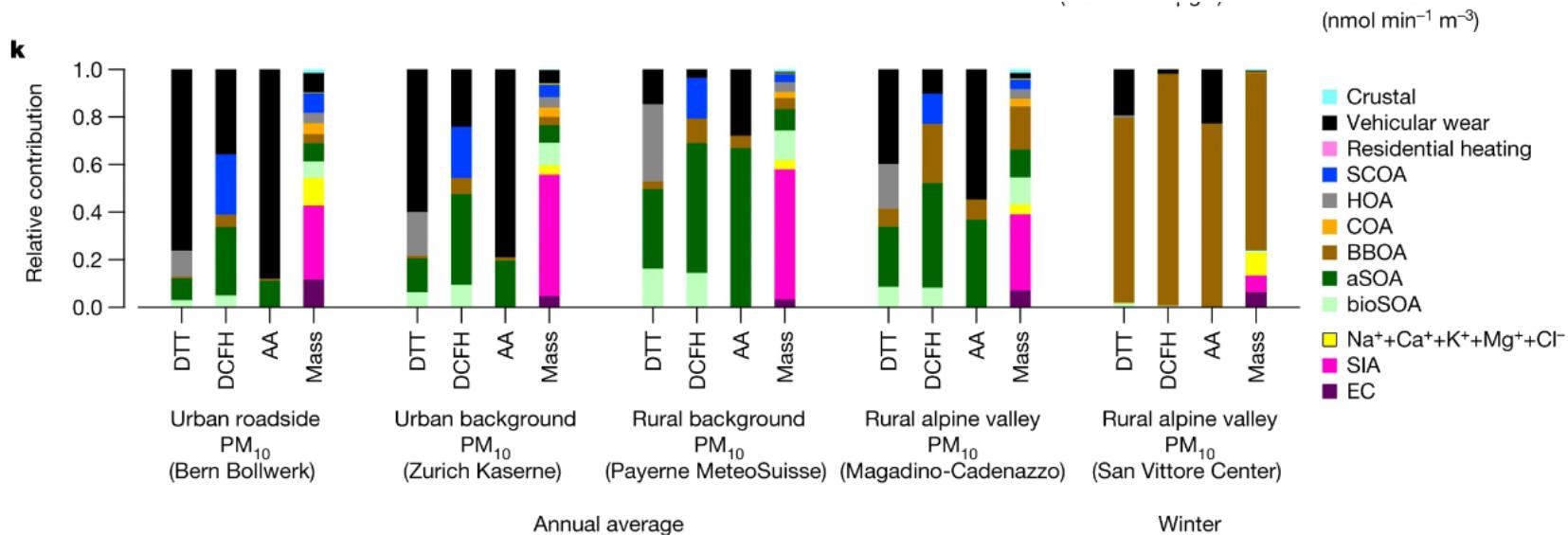
>200 sites; >500k data points
AURORA project

Improved source understanding of organic aerosol in Milano

- Organic aerosol contributes ~50% to particulate matter (PM_{10})



Aerosol health effects: Oxidative potential of individual particle components



Take-home messages

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 - Alternative fuels will become more important
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My thanks go to

- PSI and especially the LAC
- Former colleagues at Stockholm University
- Collaborators
- Funding agencies

