Development of Air Quality in Copenhagen

Slovakian delegation, June 2025

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DCE – Danish Centre for Environment and Energy

Aarhus University, Denmark

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Why is Aarhus University doing routine monitoring?

Miljøstyrelsens Luftforureningslaboratorium - originally part of the Danish EPA under the Ministry for the Environment

2007 - Reform of the governmental sectoral research institutions moved these institutions out of the ministry

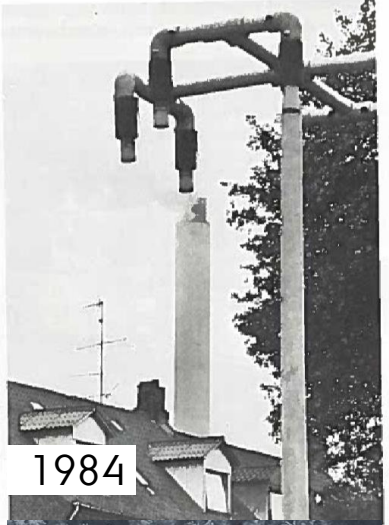
Today part of Aarhus University

Large framework contract with Ministry for the Environment on research based advising of the Danish governemt

Department of Environmental Science

DCE – Danish Centre for Environment and Energy

Valuable synergy between research, public advice and monitoring



Unique organization of the Danish Air Quality Monitoring

6 million people and 42.000 km^2

One single national air quality monitoring program:

EU
National
EMEP

One single institution carries out all the tasks relevant for the air quality monitoring

Emission inventories
Measurements
Modelling

DCE – Danish Centre for Environment and Energy at Aarhus University

Daily management, measurements and modelling
National data host and responsible for reporting
National reference laboratory

Ministry of Environment has the overall responsibility

Aim of the monitoring program

- Fullfill Denmarks national and international requirements for air quality monitoring – **EU, national needs and international conventions**
- Determine state and development of air quality in relation to human health and assess compliance with limit values
- Determine state and development of air quality in relation to impact on ecosystems and aquatic environment
- Document the impact of reduction measures on air quality
- Determine state and development for the health effects of air pollution

Integration of measurements and model calculations

Aim:

Status – concentration and deposition

Long-term trends

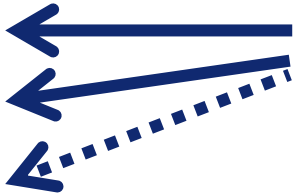
Source assessment

Forecast of air quality

Health impacts

Regulation of industrial emissions (stack heights)

Regulation of emissions from livestock production



Methods:

Measurements

Validation

Model calculations

Integration of measurements and model calculations

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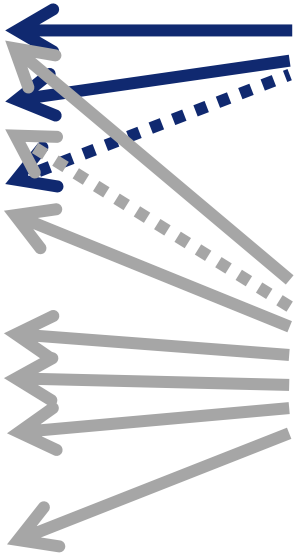

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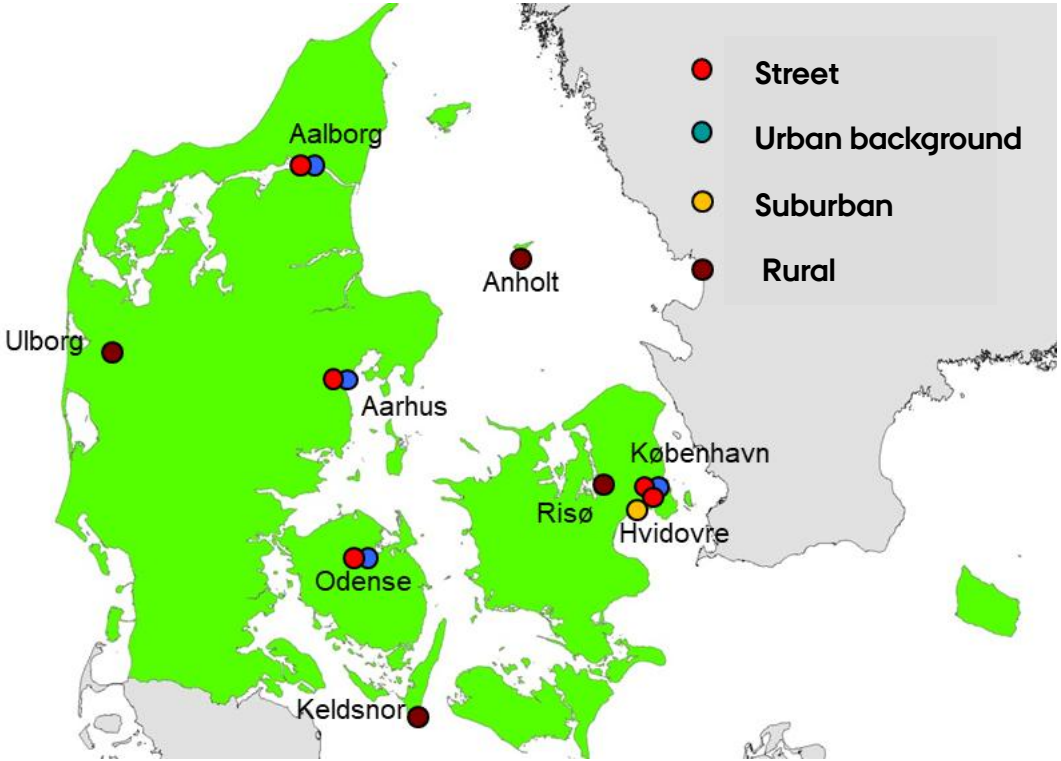
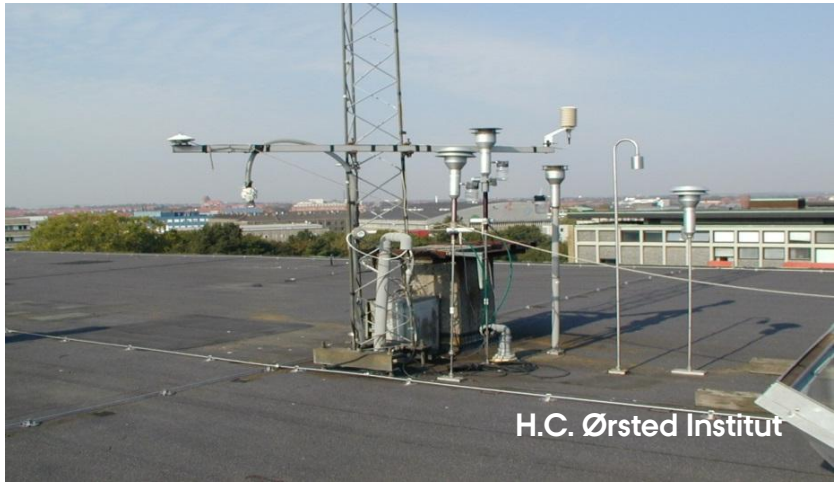
Danish national measurement program




H.C. Andersens Boulevard


H.C. Ørsted Institut


Risø


Hvidovre

Measurements

EU's reference measurement methods for particulate matter, nitrogen dioxide, ozone, carbon monoxide and sulphur dioxide

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DCE – DANISH CENTRE FOR ENVIRONMENT AND ENERGY

Parameters covered by measurements

Particulate matter ($PM_{2.5}$, PM_{10}, particle number concentration (UFP), size distribution, chemical composition)

Nitogen oxides, ammonia and particulate nitrogen

Sulphur dioxide and sulphate

Ozone

Inorganic ions in particulate matter

Elemental carbon and organic carbon

Polyaromatic hydrocarbons (Benzo[a]pyrene)

Heavy metals

Benzene and other volatile organic compounds

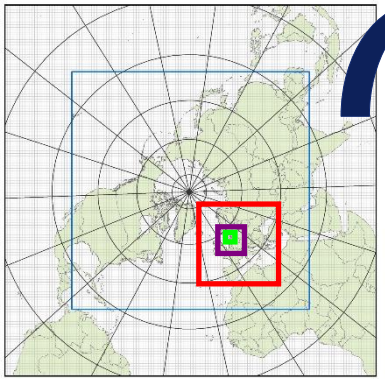
Pesticides (prosulfocarb)

Deposition of nitrogen, sulphur, heavy metals, polyaromatic compounds, and pesticides

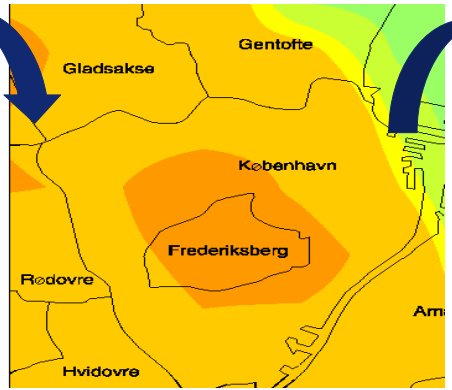
Precipation

Model calculations in the monitoring program

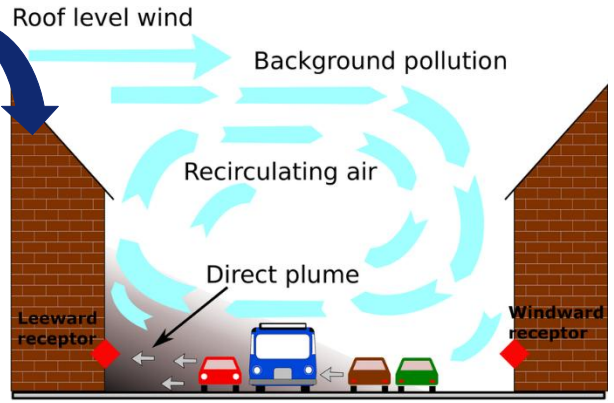
Regional model - DEHM



Urban background model - UBM



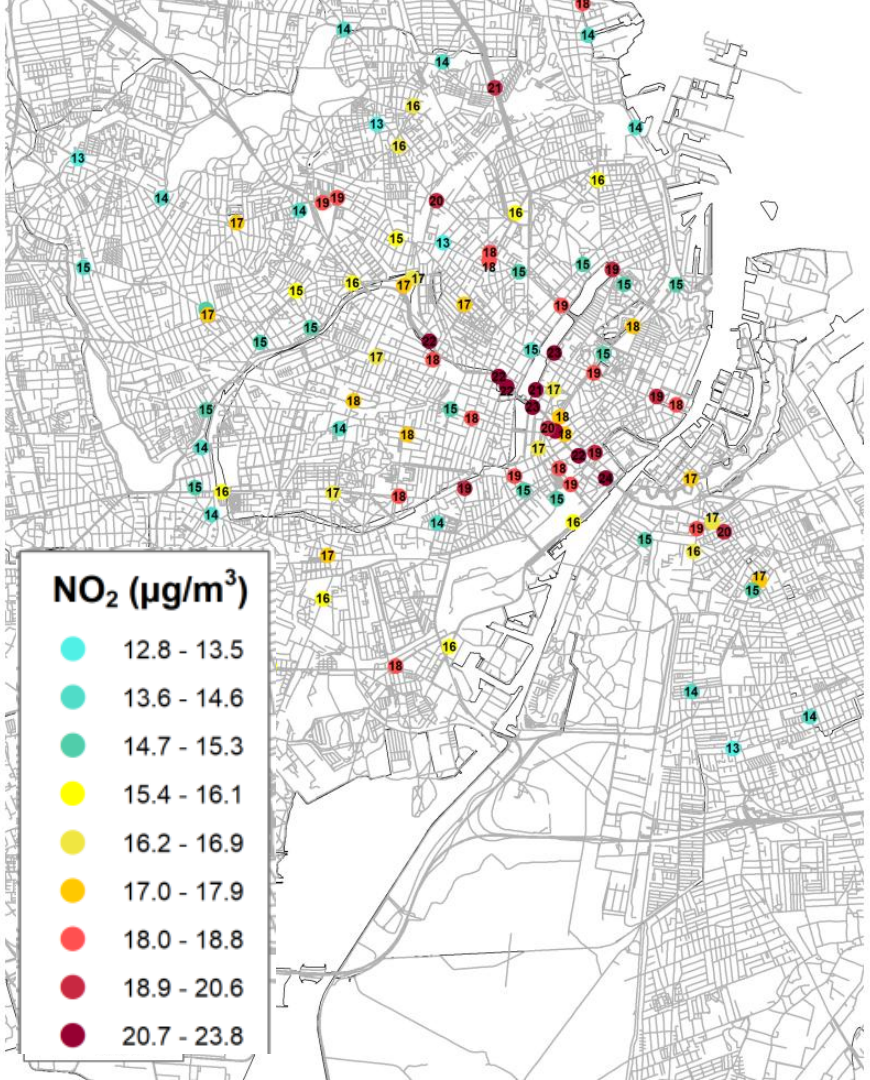
Street canyon model - OSPM



Emissions, meteorological data, chemical and physical processes, deposition of air pollutants

OSPM is coupled to at GIS-system that makes it possivle to carry out automatic calculations for millions of adresses

Model calculations of annual average for NO_2 in 2023



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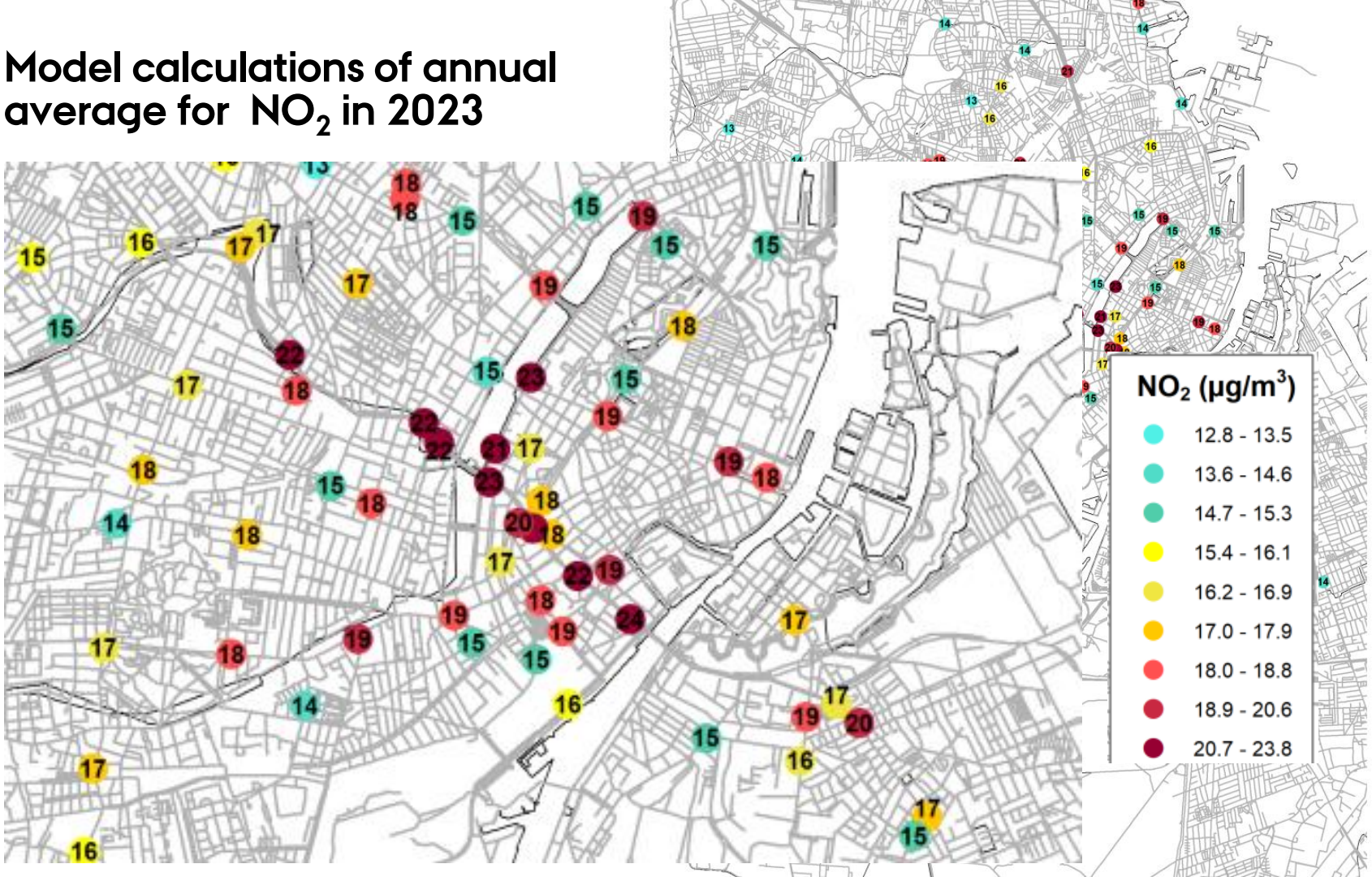
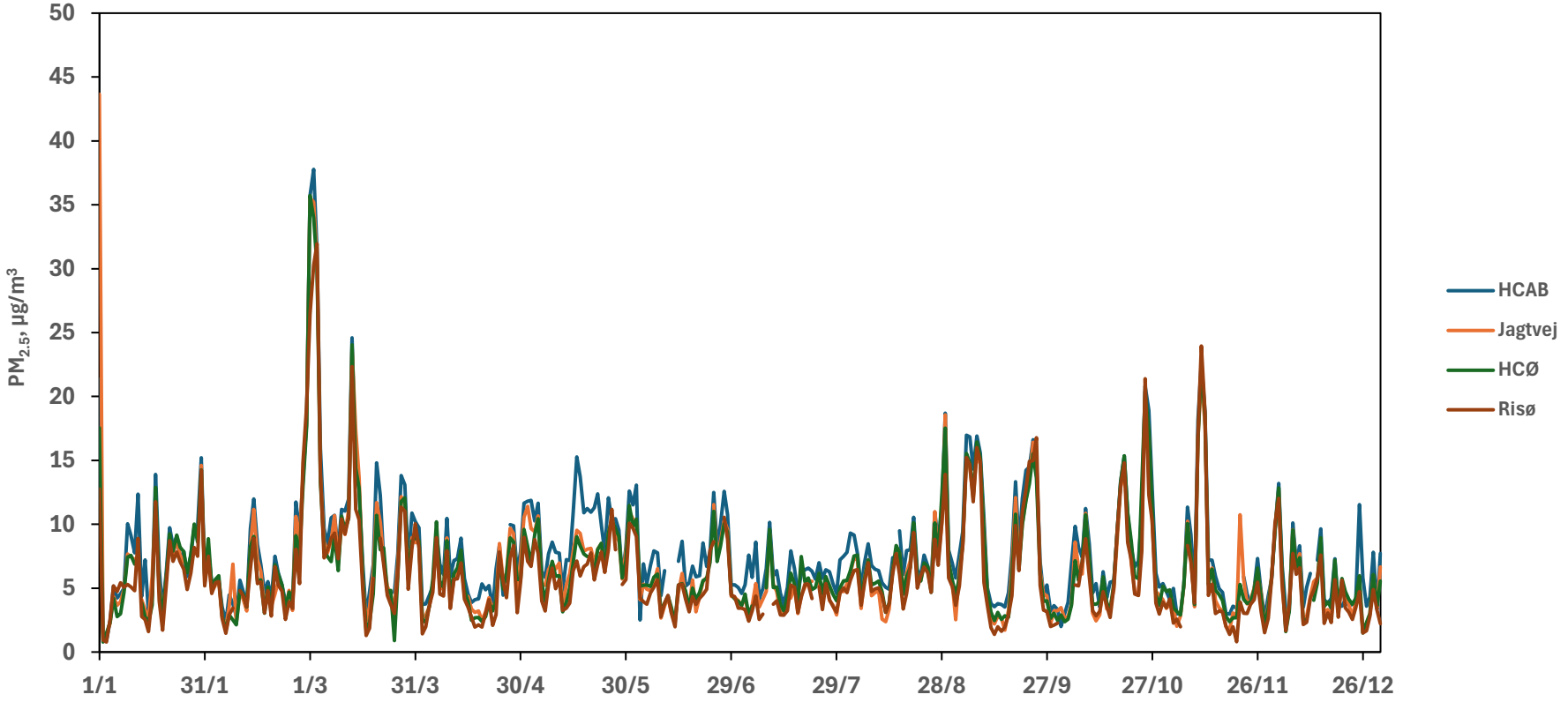


Examples of results: Diurnal averages of $PM_{2.5}$ in 2024



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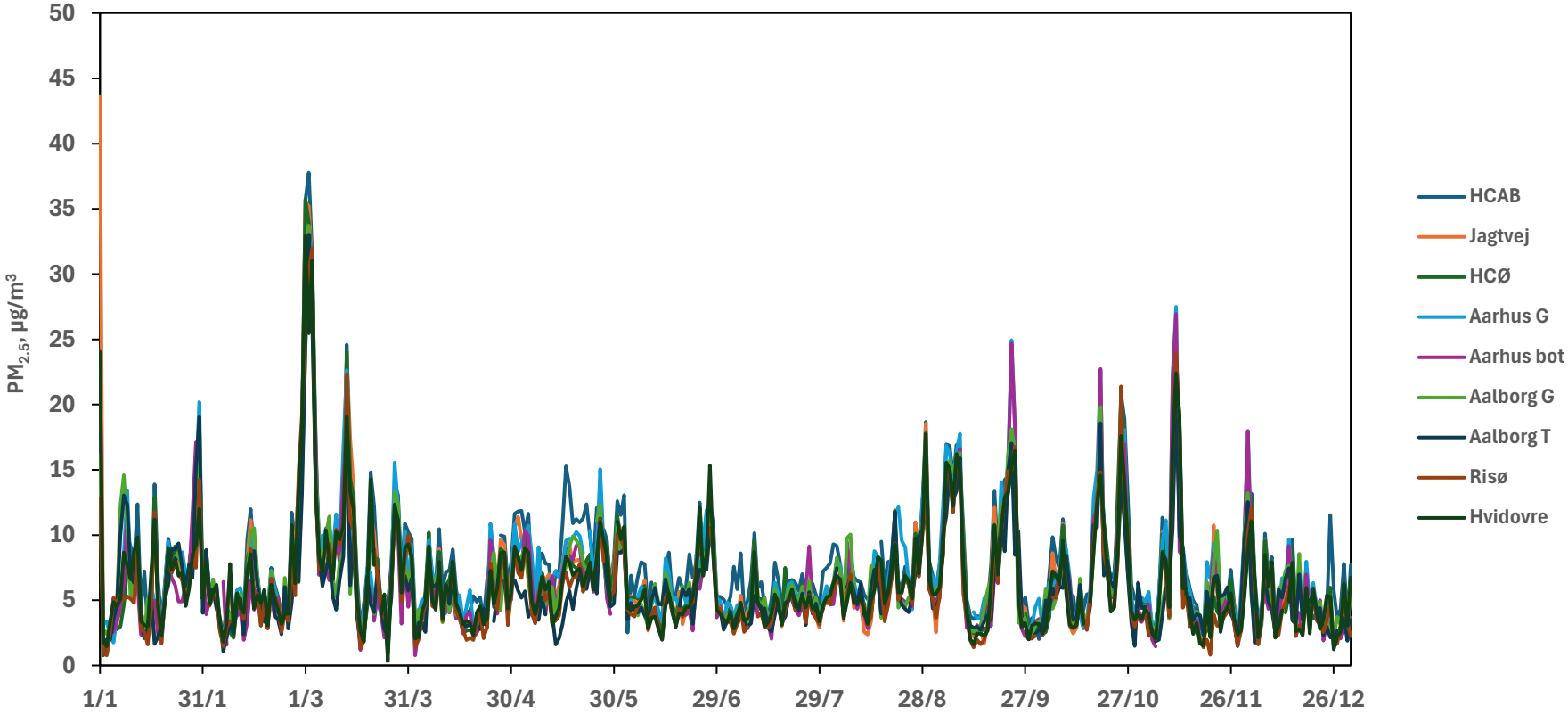
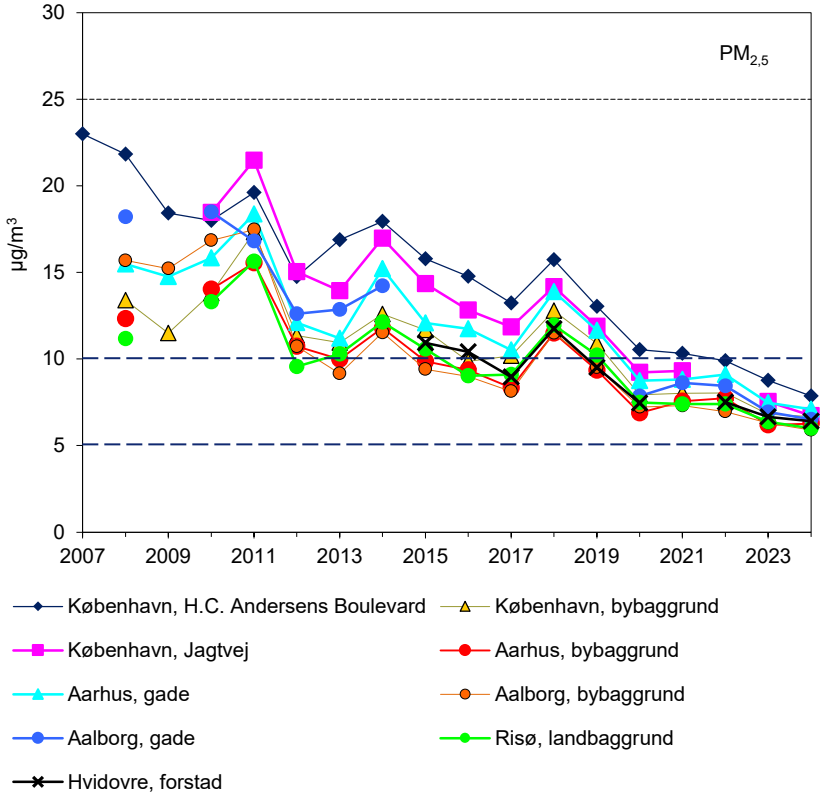
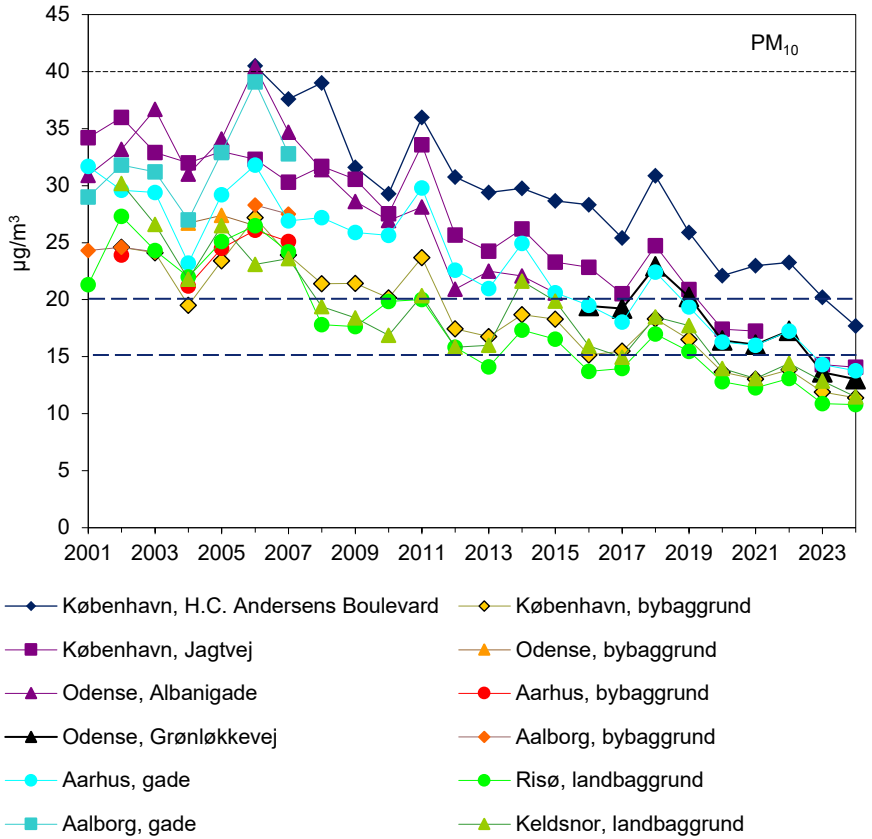
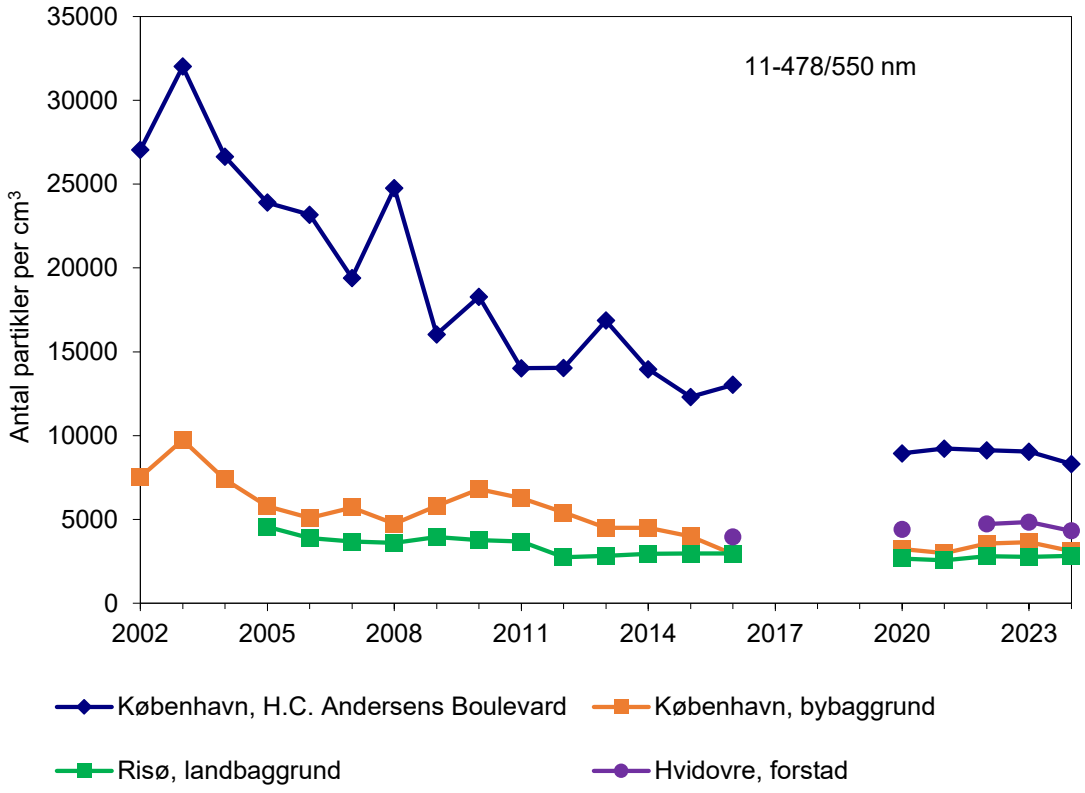


Examples of long-term trends: Particulate matter

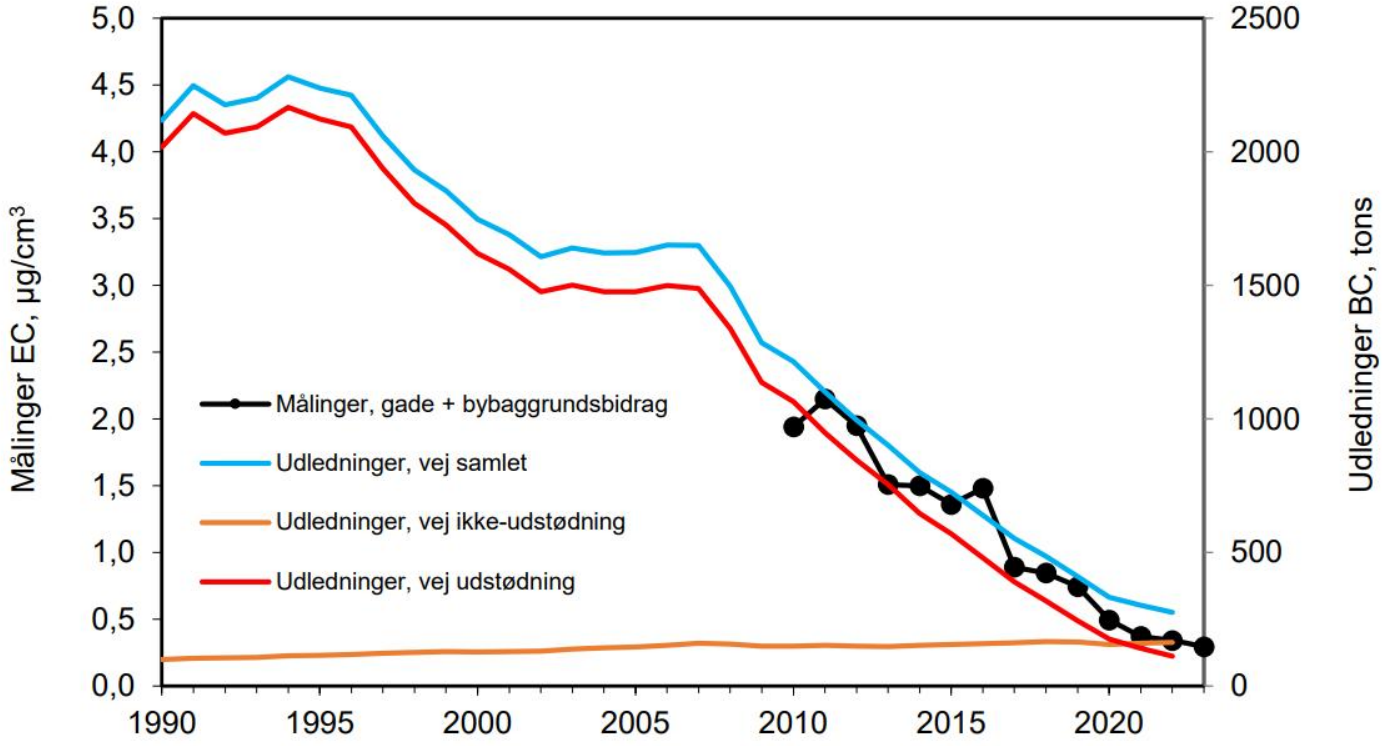




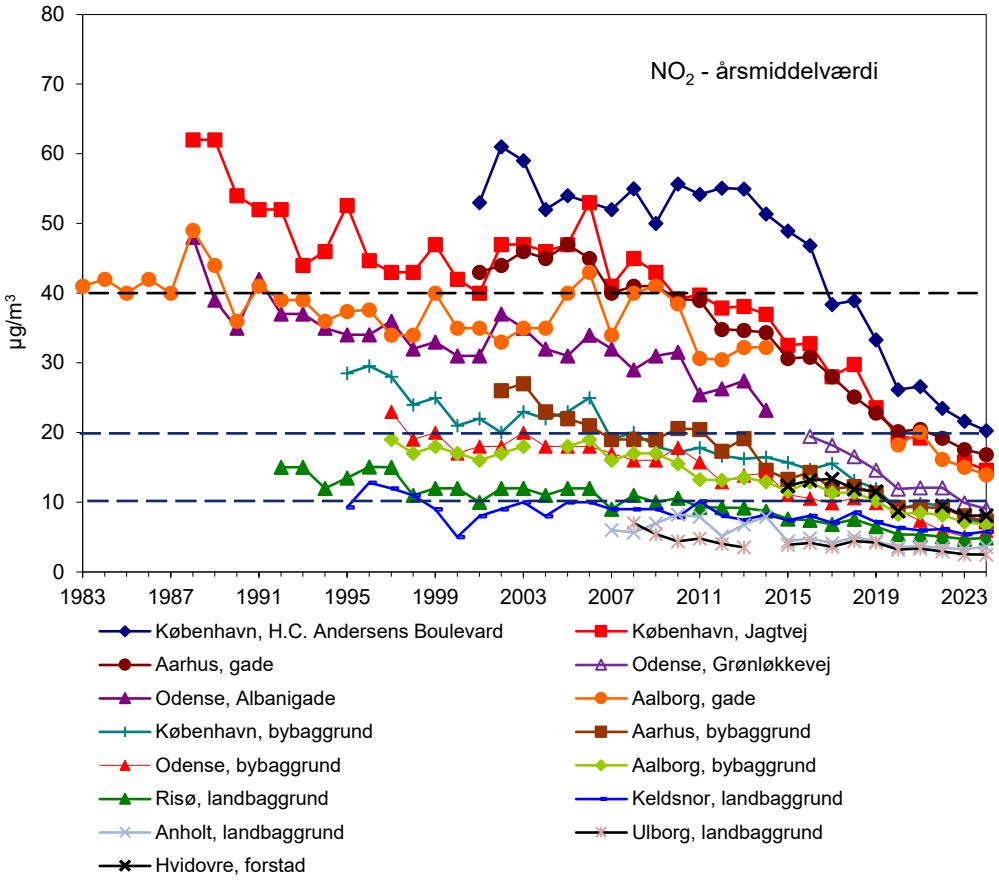
Ultrafine particles – particle number per cm^3



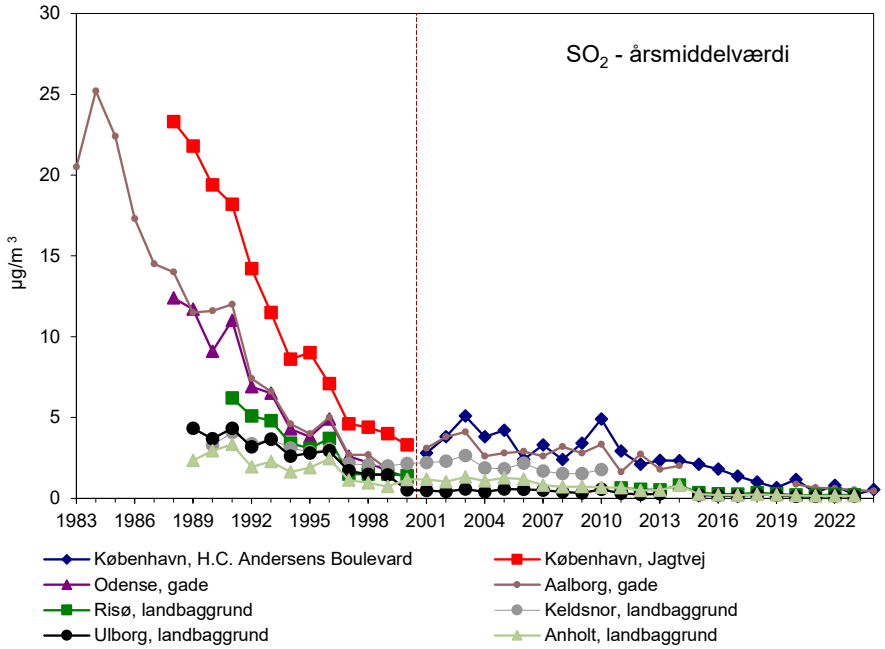
Elementary carbon (≈Black carbon)



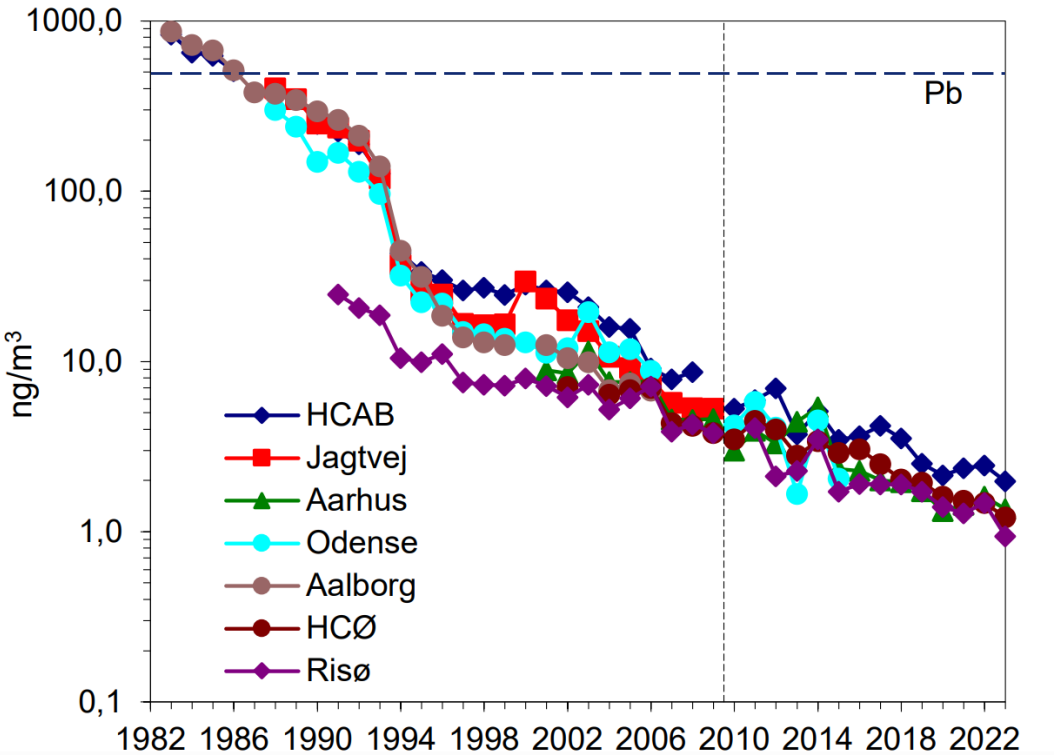
Examples of long-term trends: Nitrogen dioxide



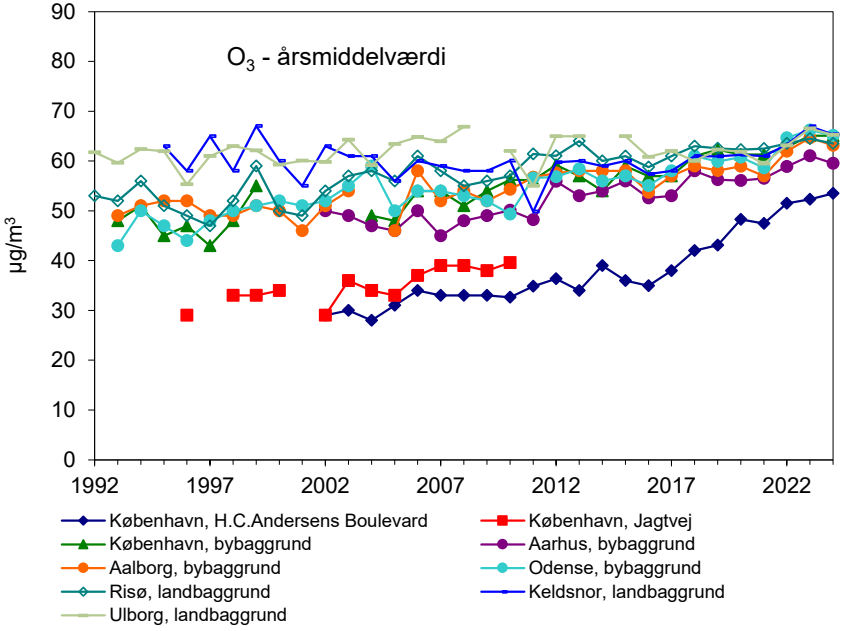
Examples of long-term trends: Sulphur dioxide

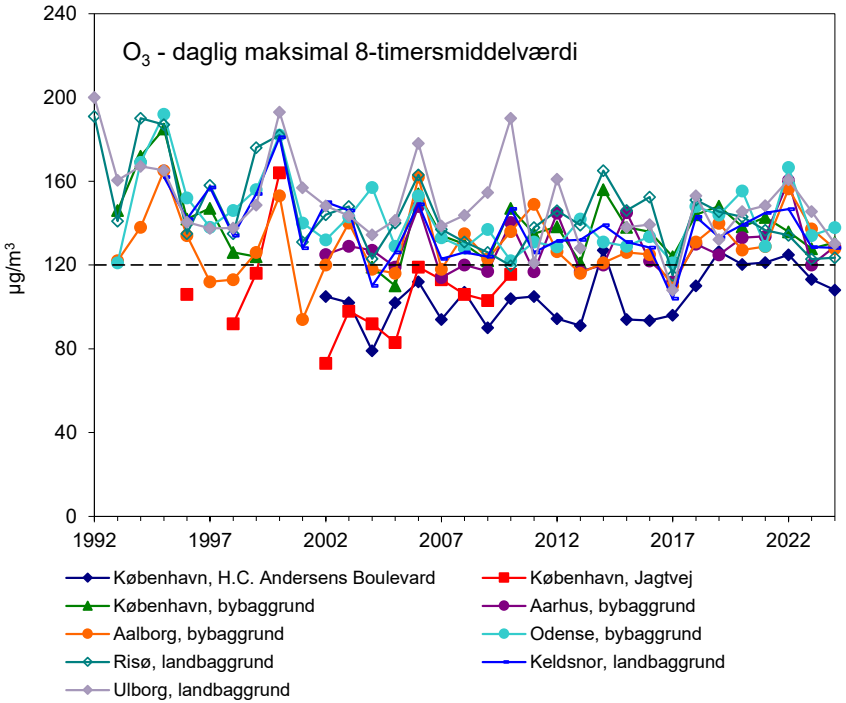


Heavy metals - Lead

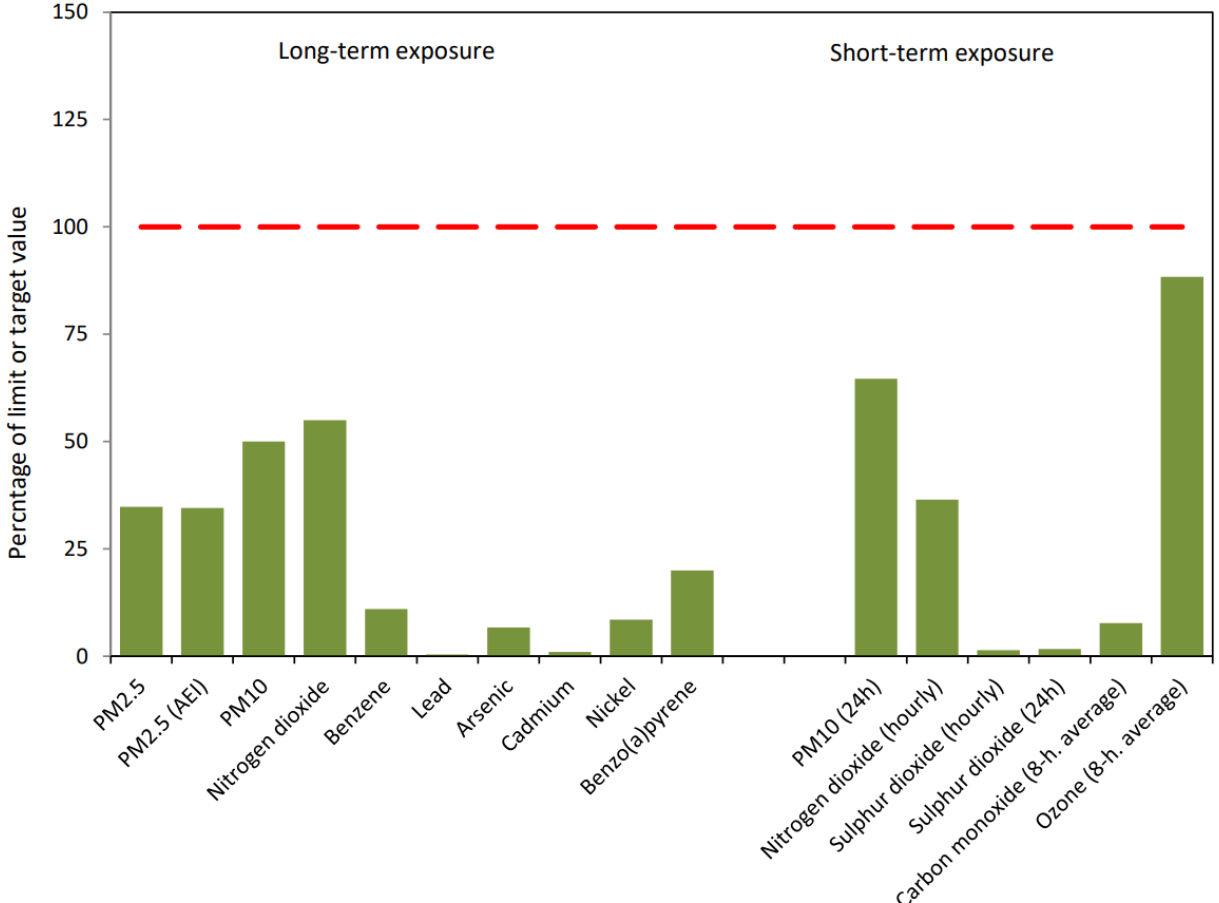


Examples of long-term trends: Ozone





Danish air quality relative to “old” EU limit and target values



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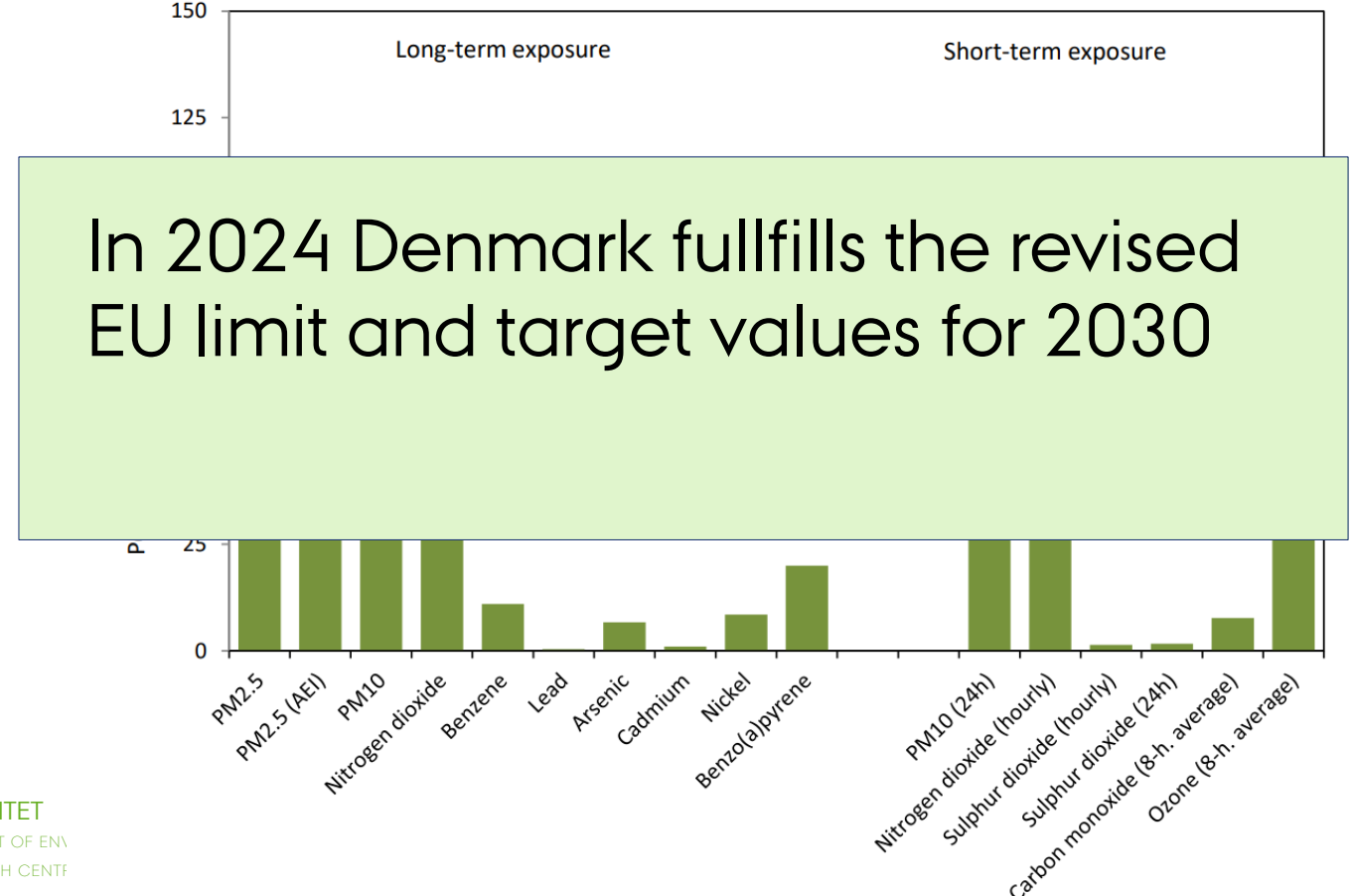
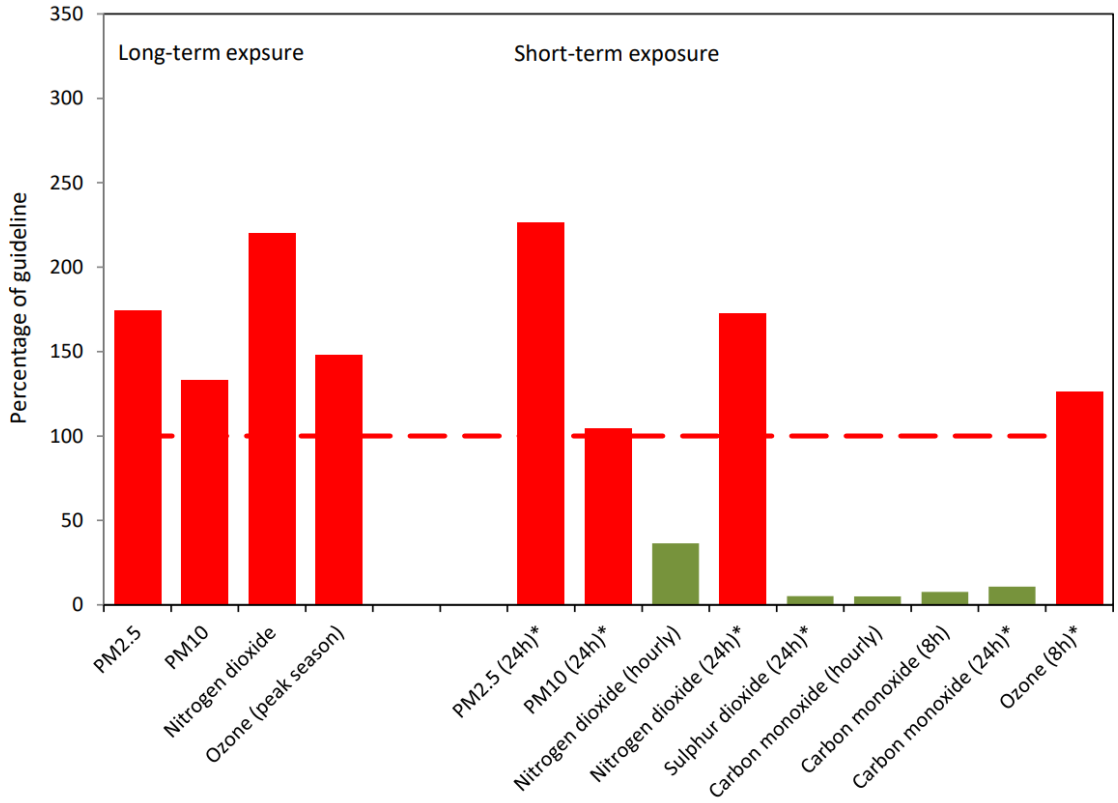
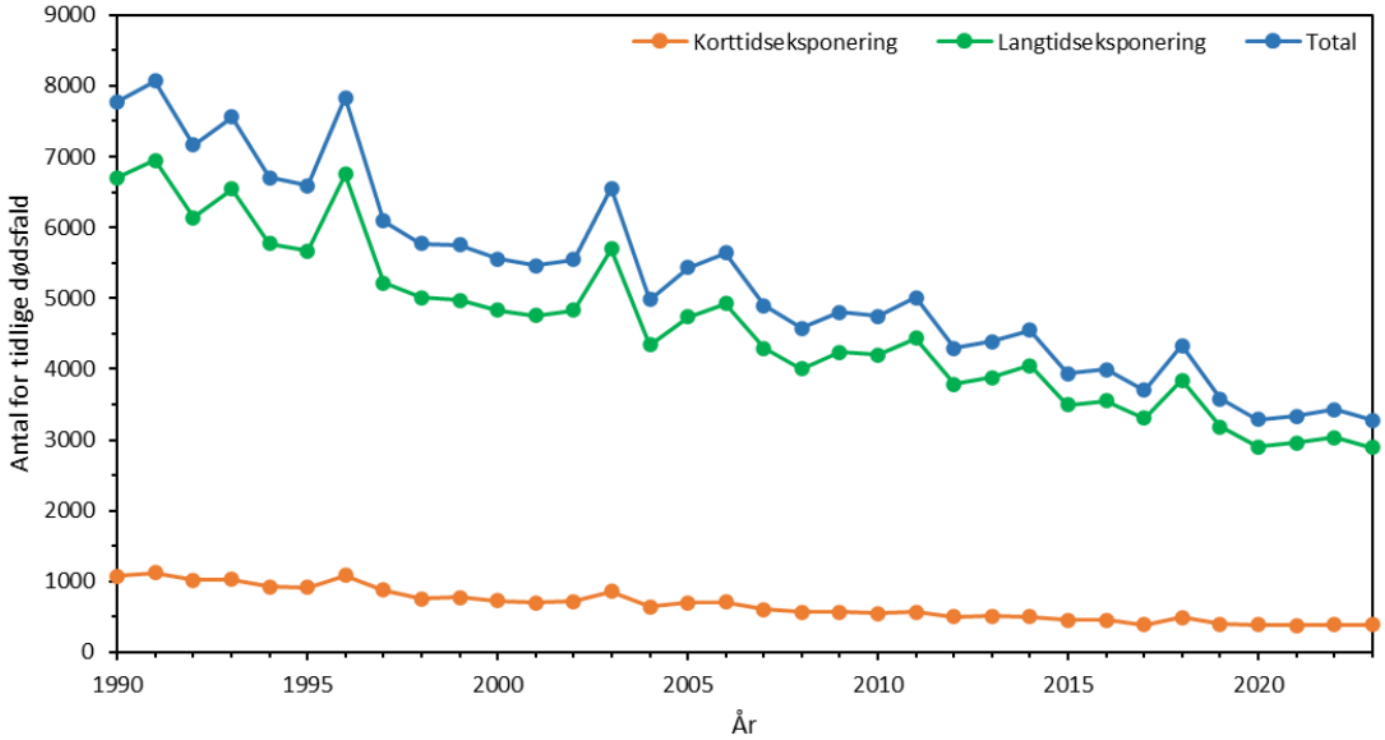


In 2024 Denmark fullfills the revised EU limit and target values for 2030

Relative to WHO guidelines from 2021



Trend in health impacts in Denmark



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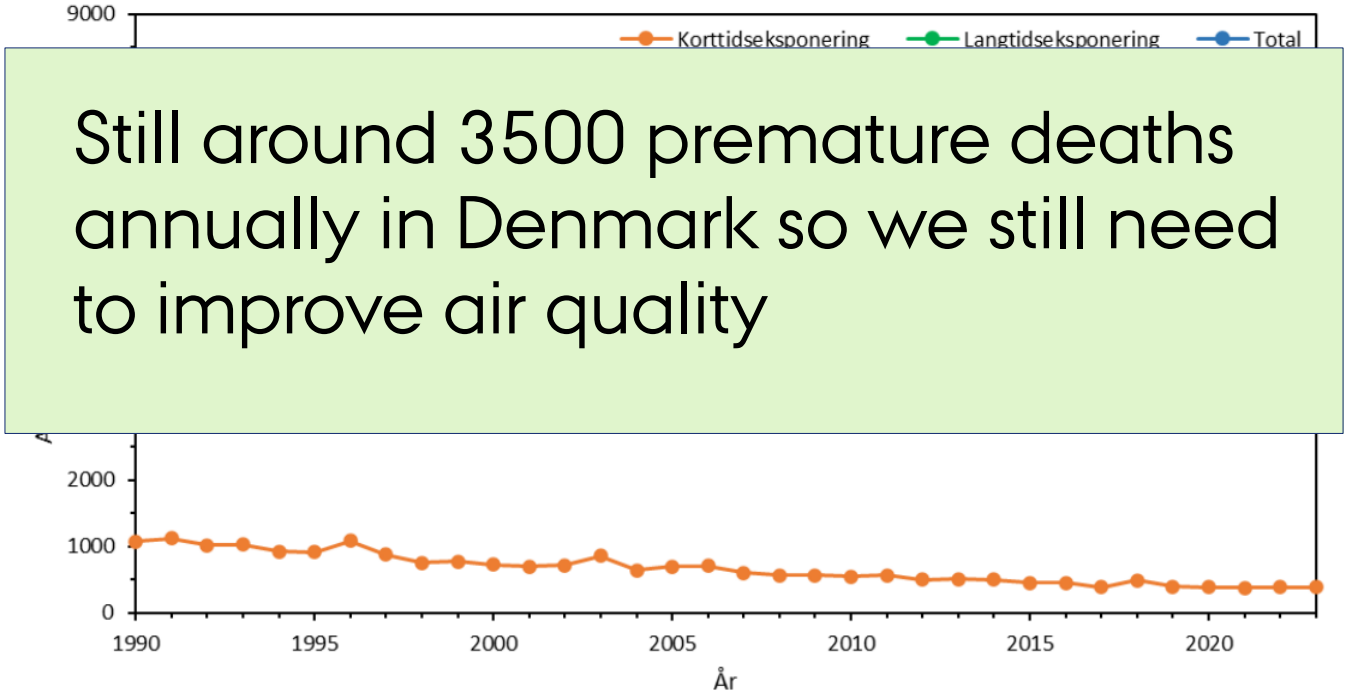

Still around 3500 premature deaths annually in Denmark so we still need to improve air quality