

# European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

## Final Meeting at PRAGUE (CZ), 5-7 October 2016

### *New Sensing Technologies for Air Quality Monitoring*

Action Start date: 01/07/2012 - Action End date: 15/11/2016 - EXTENSION: 15/11/2016

## Air Quality at Your Street - Public Assessable Digital Maps of Air Pollution from Traffic in Denmark



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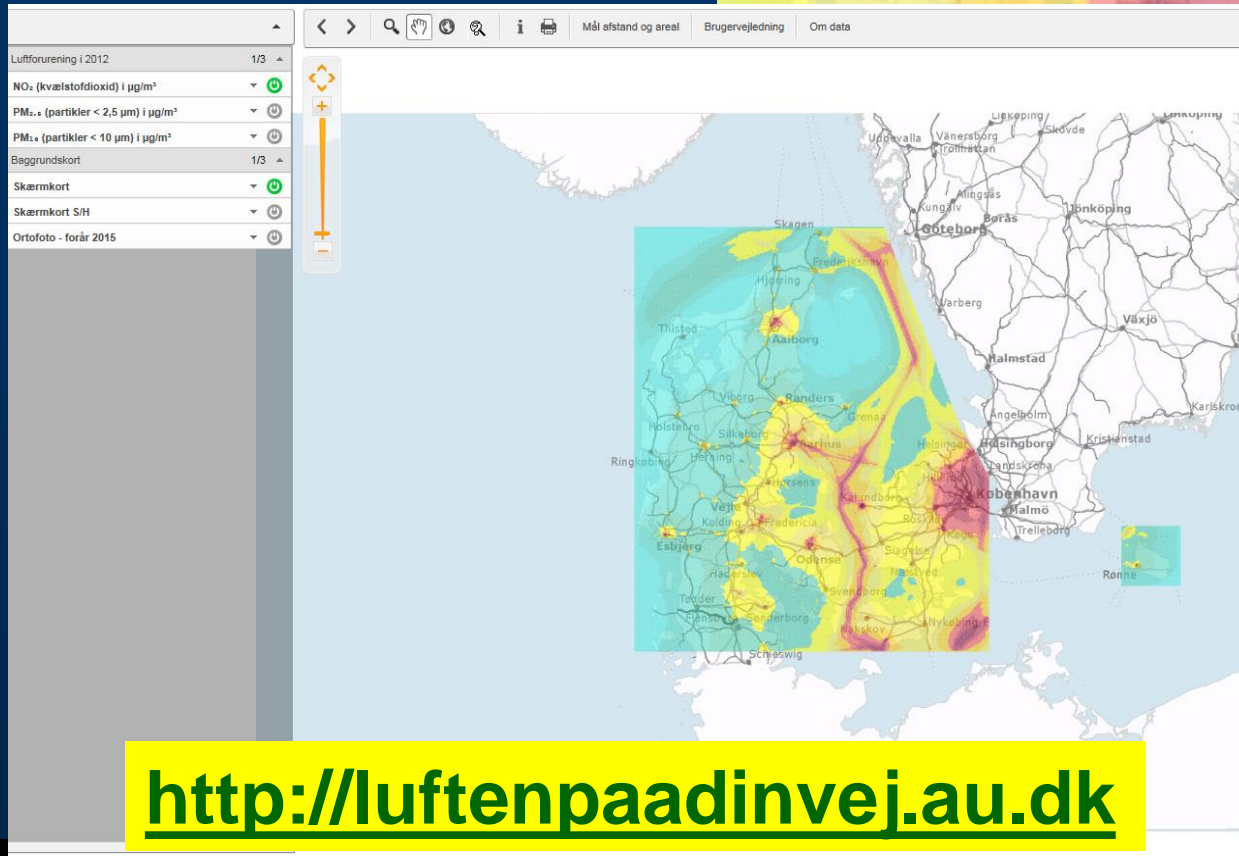
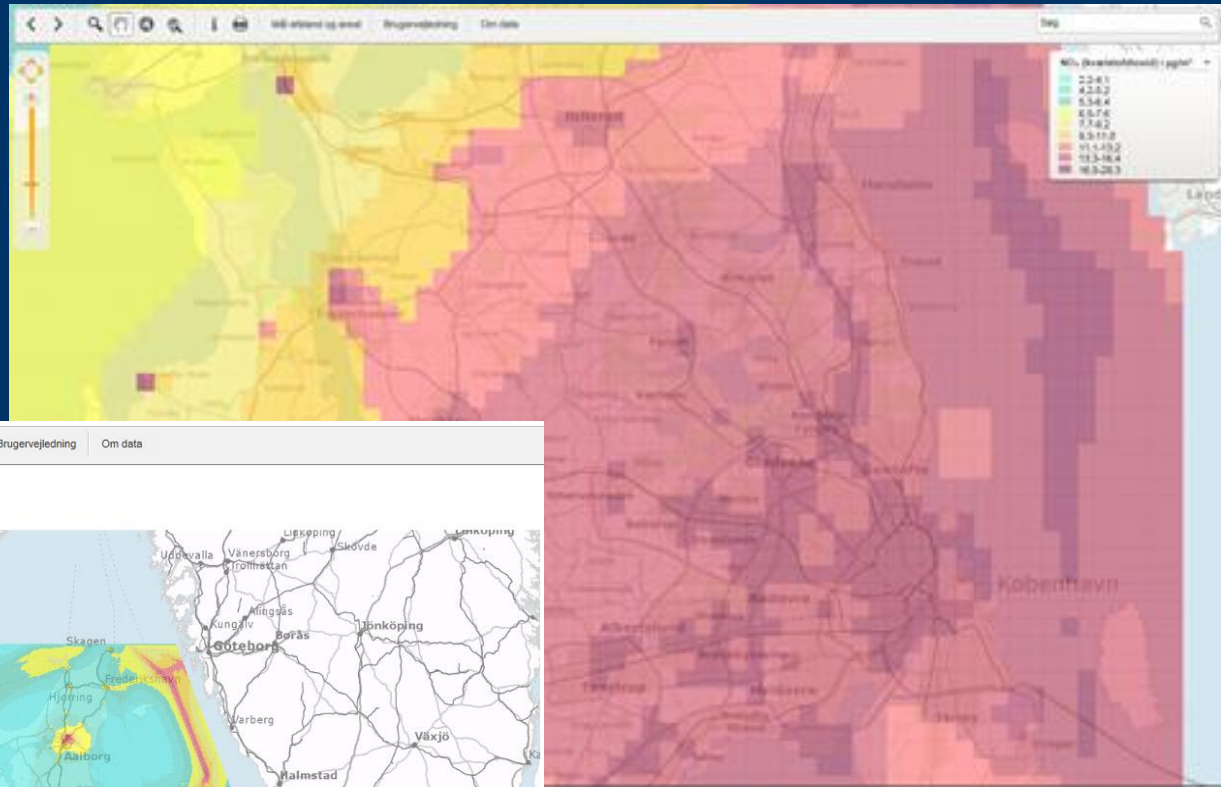
 **cost**  
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



Air at you road: <http://lufttenpaadinvej.dk>

- Online since 1. September 2016
- Received massive interest within a week
- Many calls from worried citizens
- Affect house costs
- Modelled data verified to extent possible
- Still many challenges and need further validation

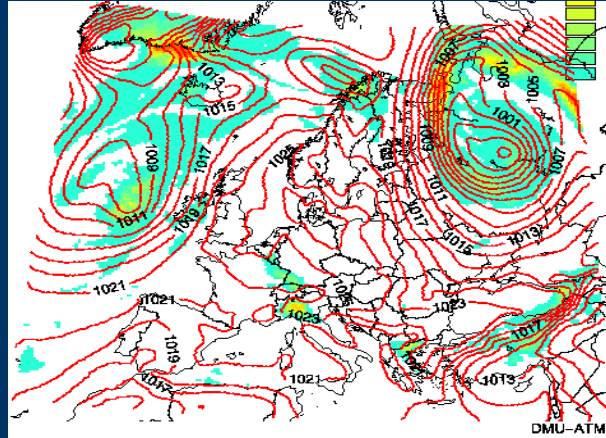
2.4 million addresses  
in Denmark for the  
year 2012



<http://luftenpaadinvej.au.dk>

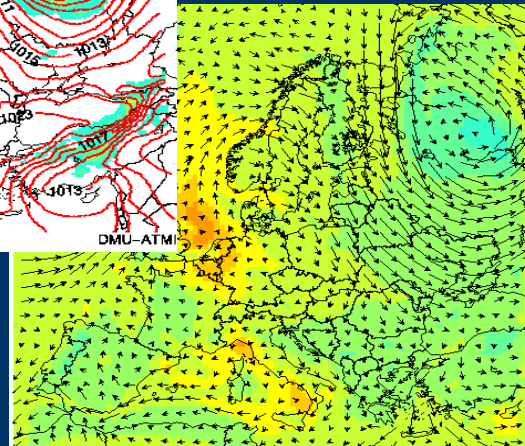
Up to 15,000  
simultaneous  
visits on the  
homepage

# Coupled models in the THOR system

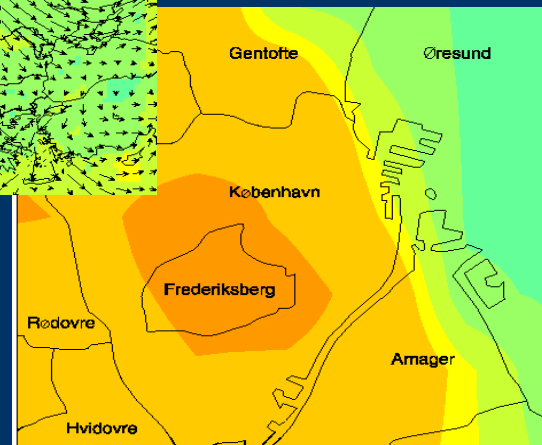


Weather

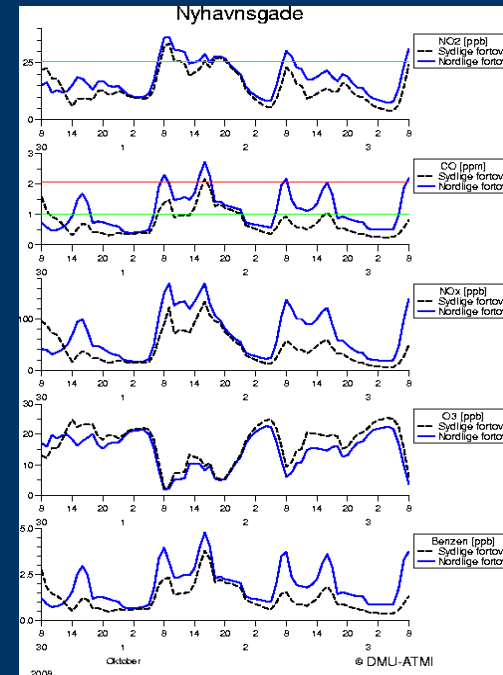
Long-range transport



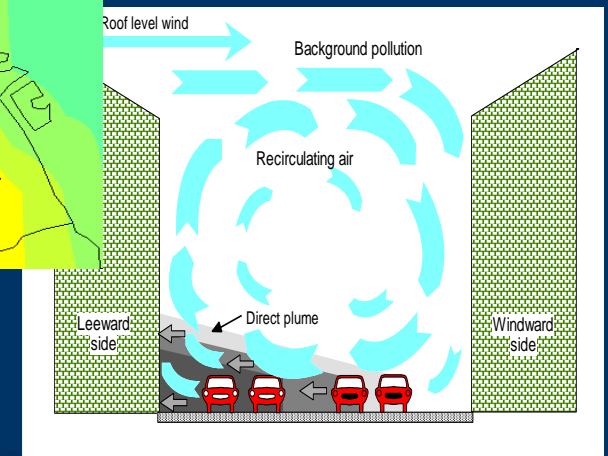
Urban scale



Street level



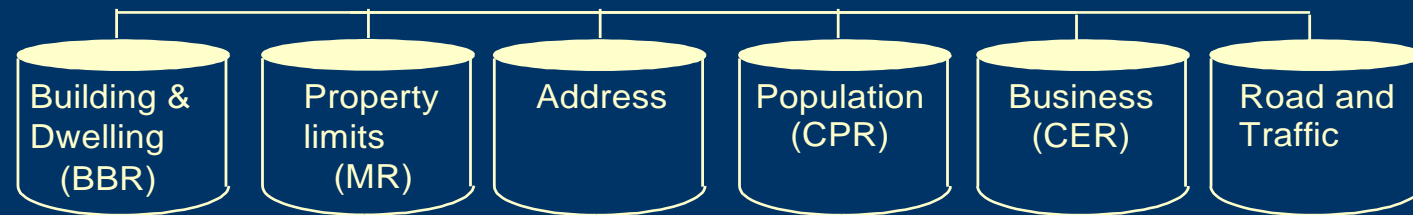
Performs 3-days prognoses of Air Quality 4 times a day



# The AirGIS system

Determination of street configuration data from digital maps & databases:

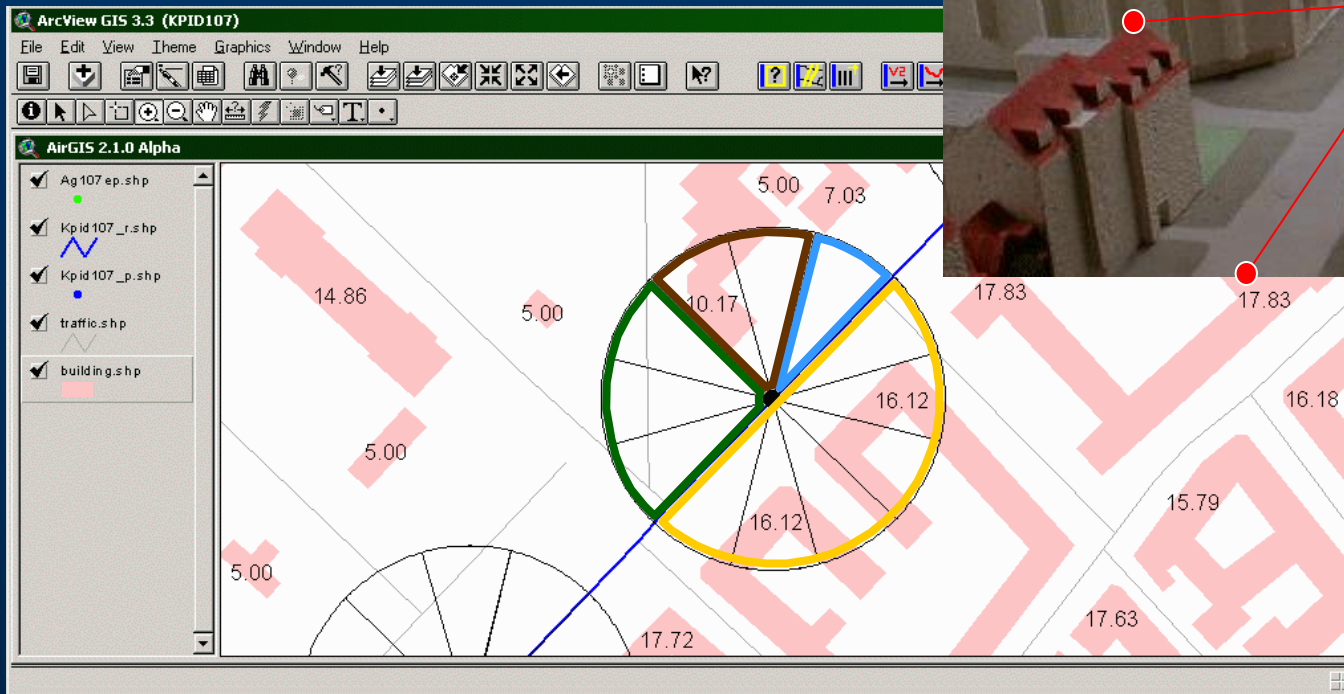
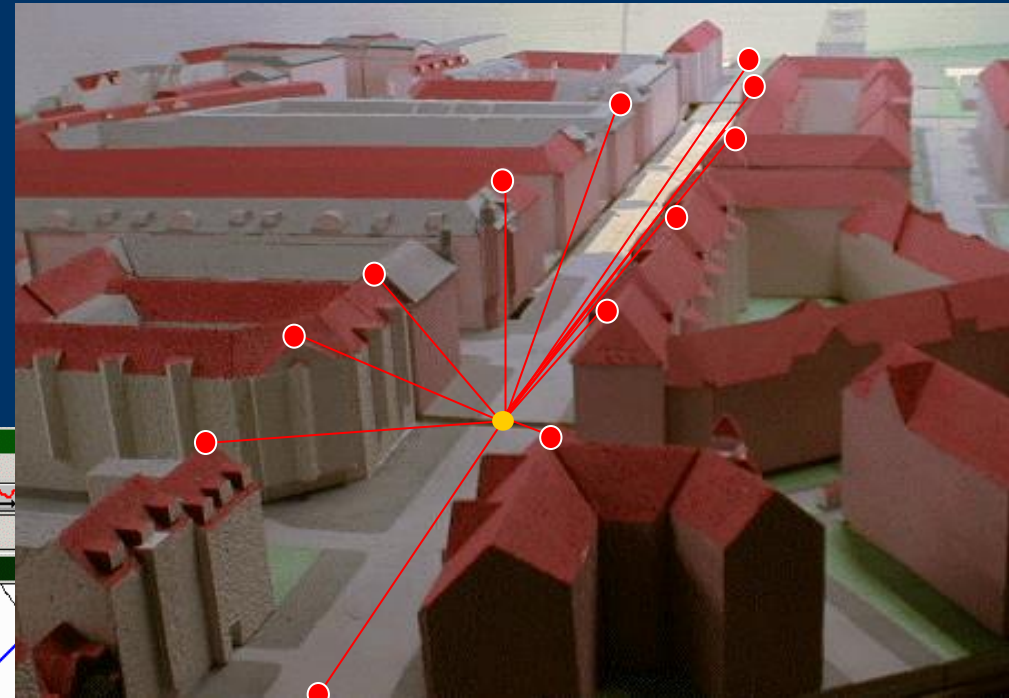
1. Building height
2. Building height in sectors
3. Average height of buildings
4. Distance building facade to road centre line
5. Street orientation
6. Width of carriageway



National and local databases

# AirGIS automatic generation street configuration

Performed previously calculations for the entire nutrition, cancer, health cohort of 50.000 people & 200.000 addresses



# THOR-AirPAS

- Integrated air pollution assessment system
- User-friendly graphical interface to:
  - Regional air quality data (DEHM)
  - Emission data (SPREAD)
  - Modelling of urban background air quality (UBM)
  - Modelling of street air quality (OSPM)
- Applied pilot cities in Eastern Europe

**THOR-AirPAS Air Pollution Assessment System**  
Setup for Denmark Funen, years 2000 - 2012

**DEHM - Regional background and meteorology**  
Open DEHM files in TextPad DEHM file: AGO\_hovoty\_Danmark\_opt.dat

**SPREAD - Urban Emissions**  
Show Transport Emi. Transport emissions: Funen\_Transport.csv  
Show Area Emi. Other area emissions: Funen\_Area.csv  
Show Point Emi. Point source emissions: Funen\_Point.csv

**UBM - Urban Background Model**  
Grid or Rec. val: Calculate for whole grid  
Edit Rec. val  
Run UBM  
StartDate: 01-01-2000 00h  
EndDate: 31-12-2000 23h  
RunName: Funen\_Example  
FolderName: Funen\_v4  
Export of UBM Emissions (Sum of Transport and Area or Point including Scaling)  
Export (T.+A.) as polygon shape Open in TextPad  
Export Point Emi. as shape file  
Export of UBM concentration results (averages only)  
Export as GIS-polygon shp file Open in TextPad  
Export as GIS-point shp file

**OSPM - Operational Street Pollution model**  
OSPM Project Name: OSPMProject\_Funen\_Example.osp  
ProjPathName (as in UBM): Funen\_v4  
StreetName: High street  
Height (m): 25  
Width (m): 20  
Orientation (deg): 111  
Daily Traffic (veh/day): 2200  
Vehicle Speed (km/h): 31  
Start OSPM with selected options  
Export data from OSPM\_Results  
Show OSPM result sheet Export as GIS-point shp file

# Impact assessments of policy measures

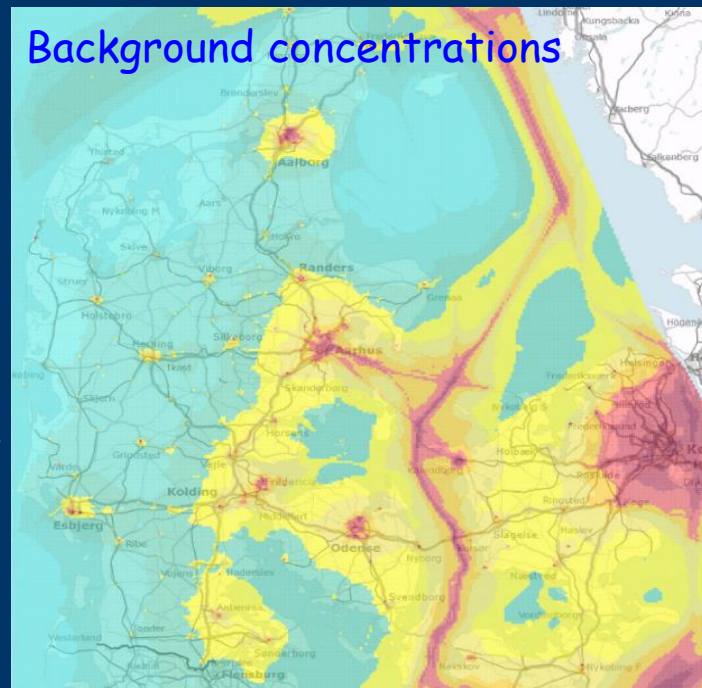
- Low Emission Zones
- Traffic management
- Road pricing
- Toll ring
- SCRT on urban buses



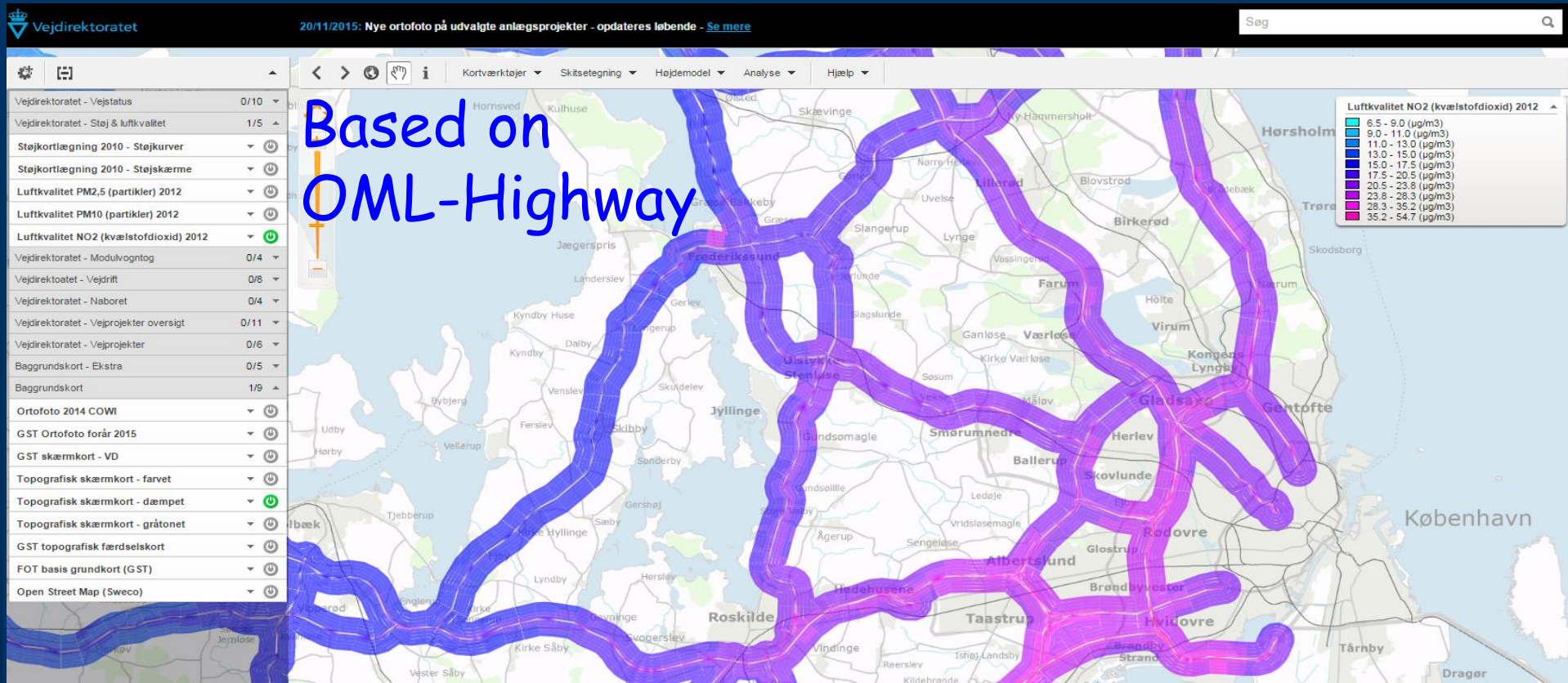


# Air Quality at Your street

- Easy tool for AQ at all DK addr.
- Focus geo variation & relative diff.
- Popular interpret. health risk
- Short description: models, data etc.
- NOVANA provides official statement on exceedances



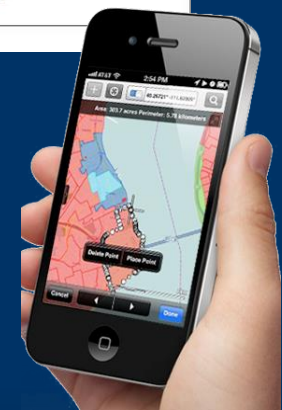
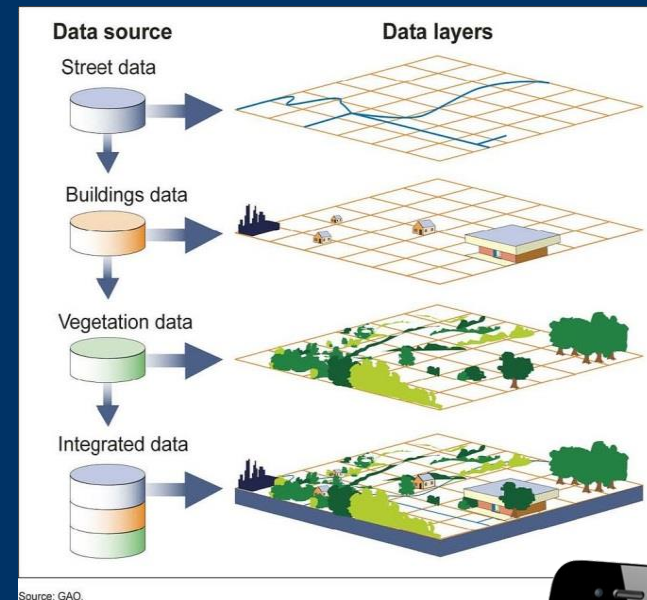
# Air Quality of NO<sub>2</sub> along State Roads in DK



Website of Danish Road Directorate:  
<http://webkort.vd.dk/spatialmap>

# Supporting tools and data

- Computers & internet
- GIS and web-GIS
- Geo-coded national datasets
  - CPR
  - BBR
  - Building footprints
  - Address
  - DEM (DK elevation model)
  - Traffic
  - etc.
- Smartphones & apps



# Input data for Denmark

- Emission data
  - 1x1 km<sup>2</sup> national emission inventory based on geographic variables (SPREAD)
- GIS road network from national traffic model (LTM) navteq road network DTU Transport
- Travel speed from SpeedMap DK Road Directorate
- GIS building polygons with building height estimations based on National Elevation Model
- GIS national address database

# OSPM & background addresses

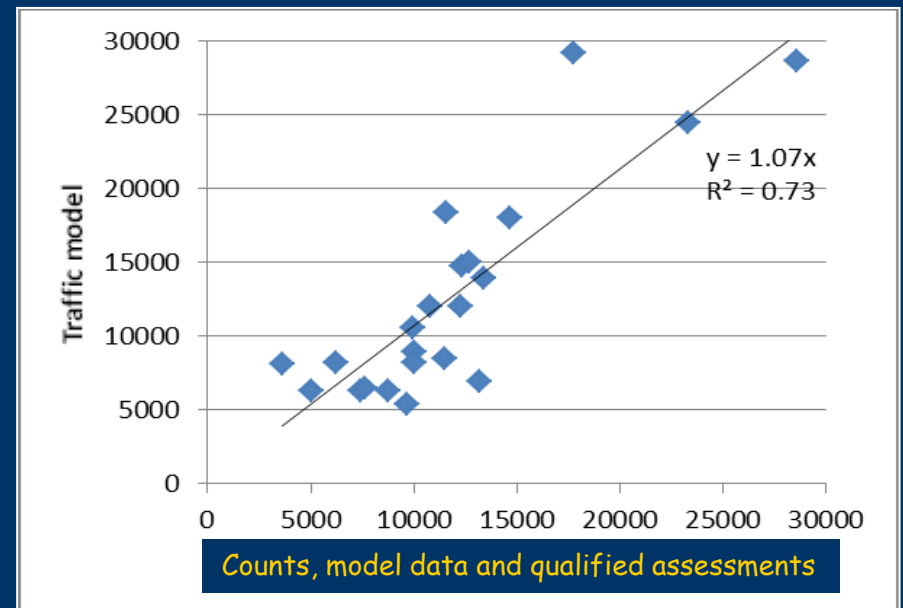
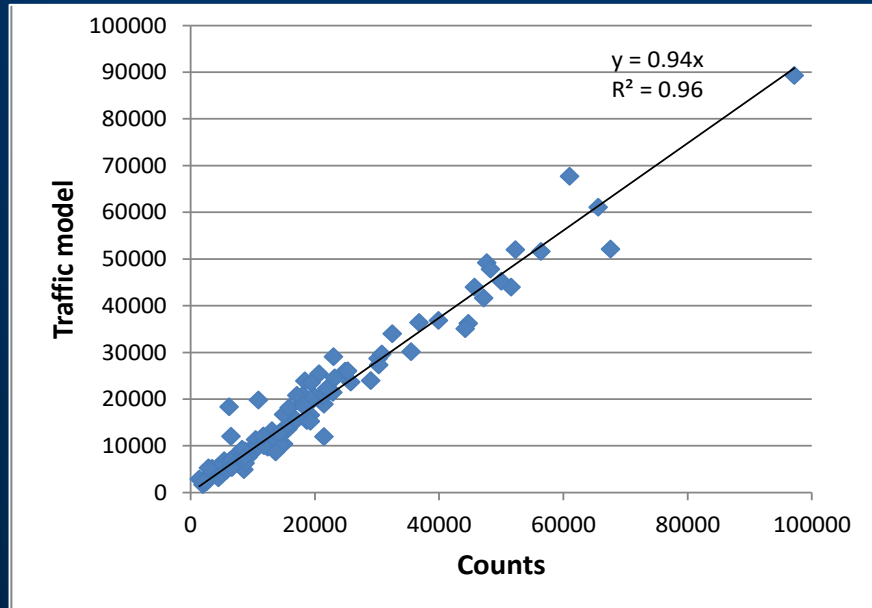
- Addr. within 34 m of road links & >500 AADT - OSPM calcs
- In total 201,036 addr.
- Other addresses considered urban background (2.1 mill.)



# Evaluation of modelled traffic data

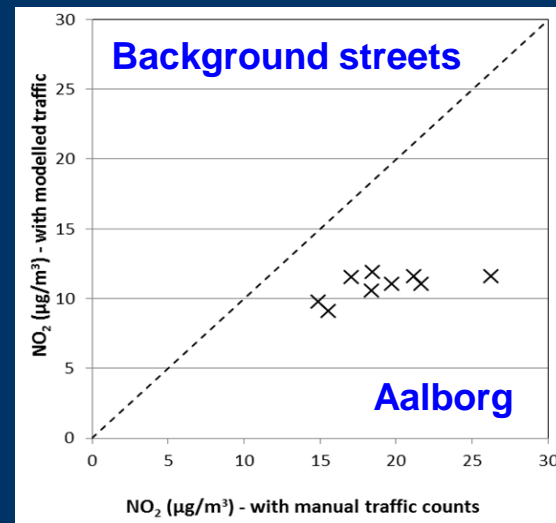
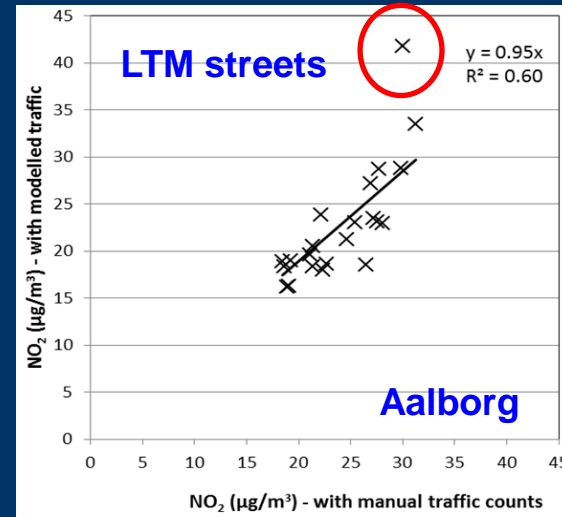
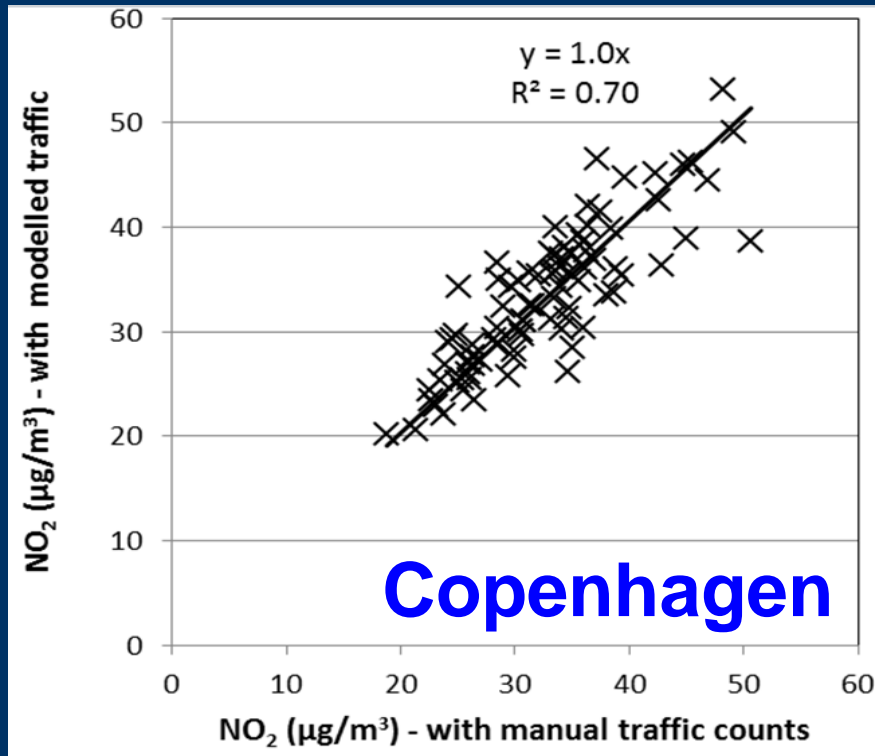
Copenhagen (109 counted)

Aalborg (22 "counted")



Poor corr. modelled & counted heavy-duty vehicles.  
Therefore default values:  
4.5% for urban streets & 10% for highways.

# NO<sub>2</sub> with modelled and counted traffic



# Model vs. NOVANA PM measurements

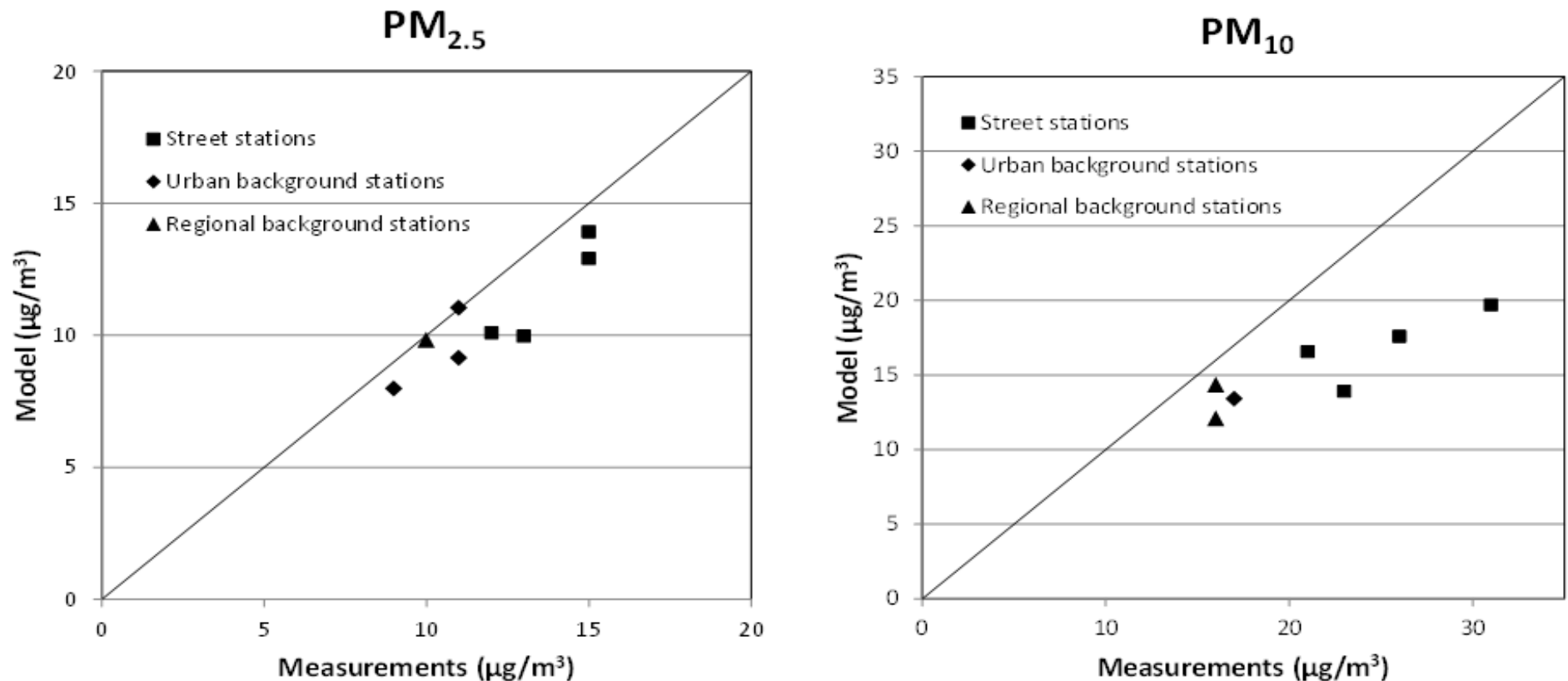
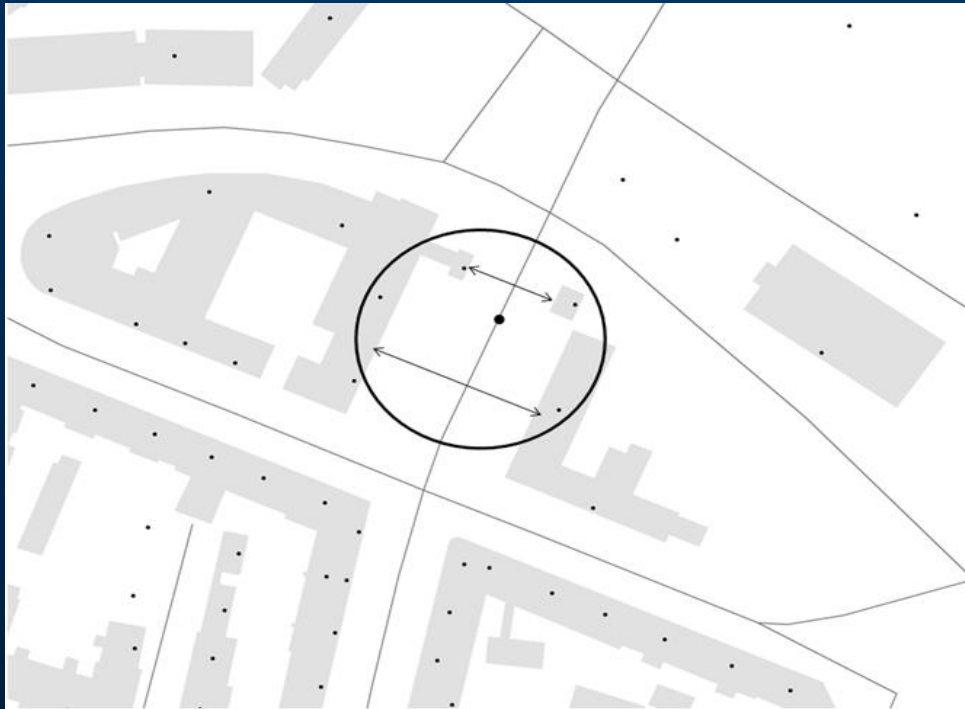


Figure 3 Comparison of annual mean values of model results and observations for PM<sub>2.5</sub> (left panel) and PM<sub>10</sub> (right panel) for fixed monitoring stations under the Danish Air Quality Monitoring Programme for the year 2012. The 1:1 line is also shown.



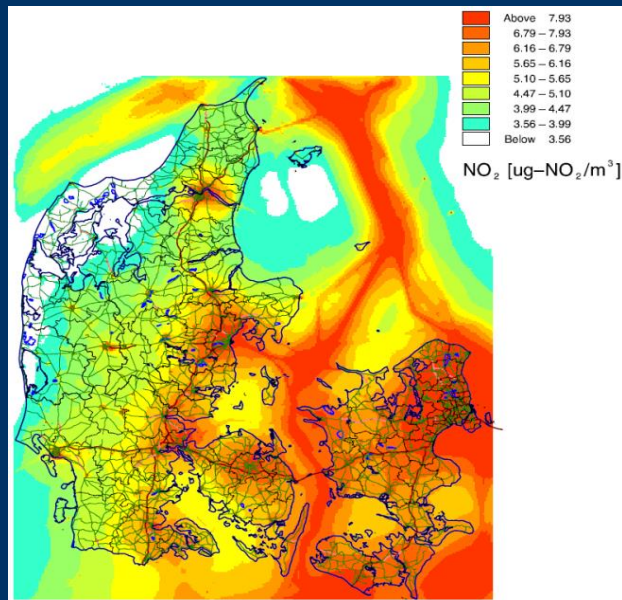
# Example of large discrepancy in Aalborg



- › Street geometry at measuring station in Aalborg
- › AirGIS estimates street width 21 m due to 2 small buildings
- › Width of 41 m is more repres.
- › Modelled become too high

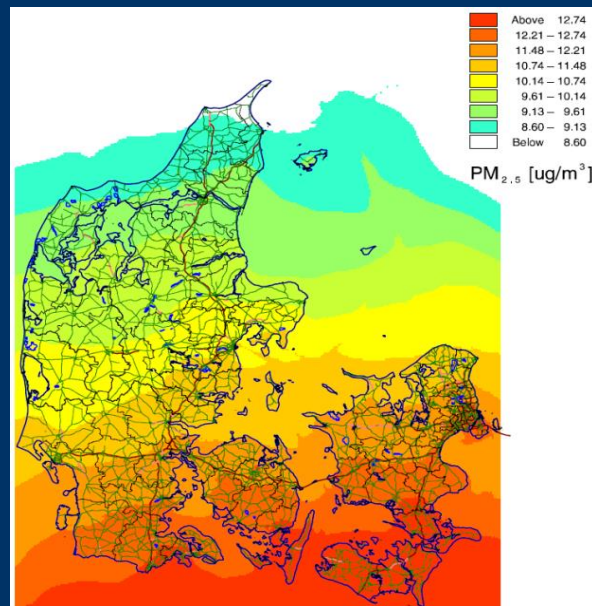
# Urban background variations

## NO<sub>2</sub>



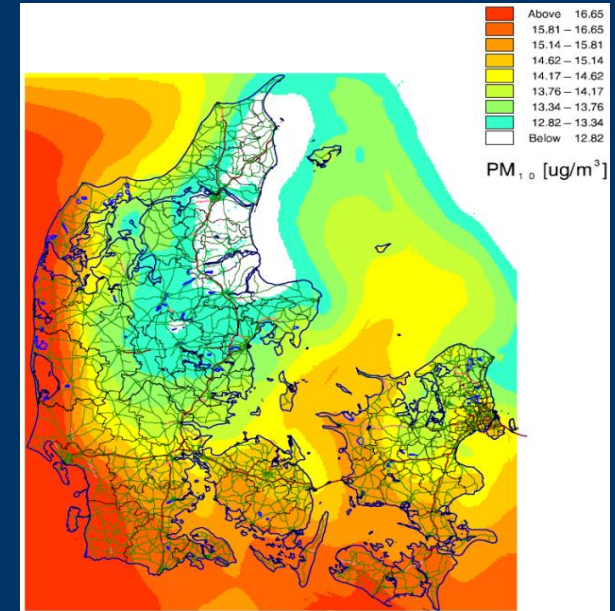
- › Traffic sources and ships emissions clearly visible

## PM<sub>2.5</sub>



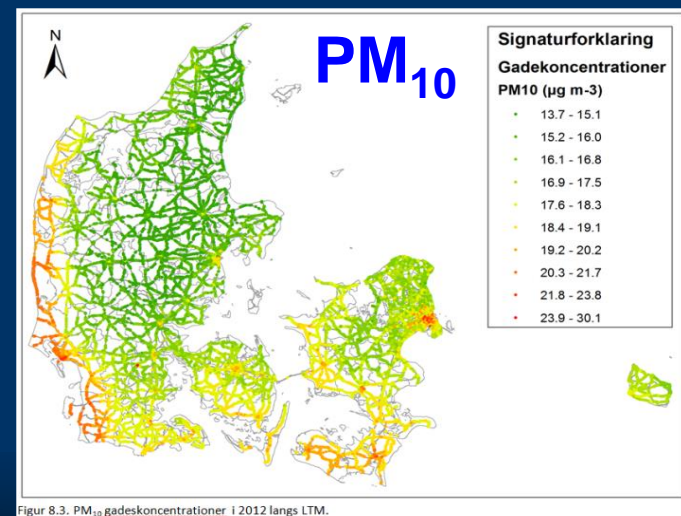
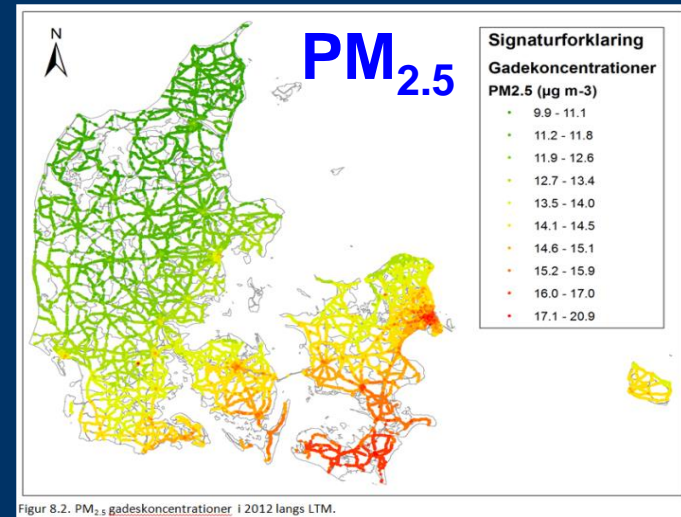
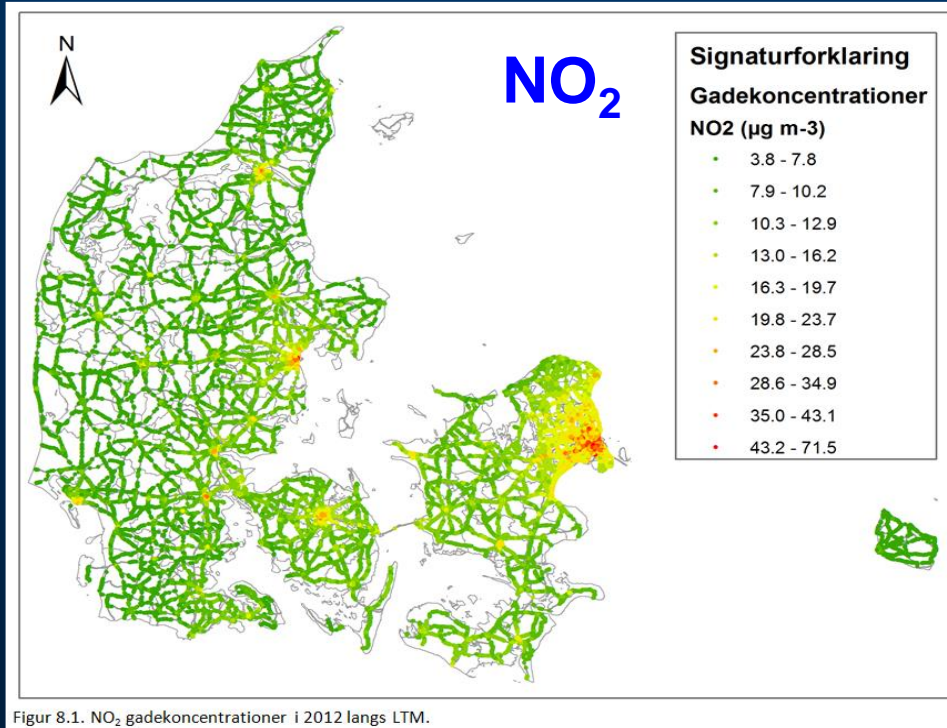
- › Dominated by long-rang and local sources hardly visible. Gradient from south.

## PM<sub>10</sub>



- › Dominated by long-rang and local sources hardly visible. Sea salt visible.

# Geografic variation at address level

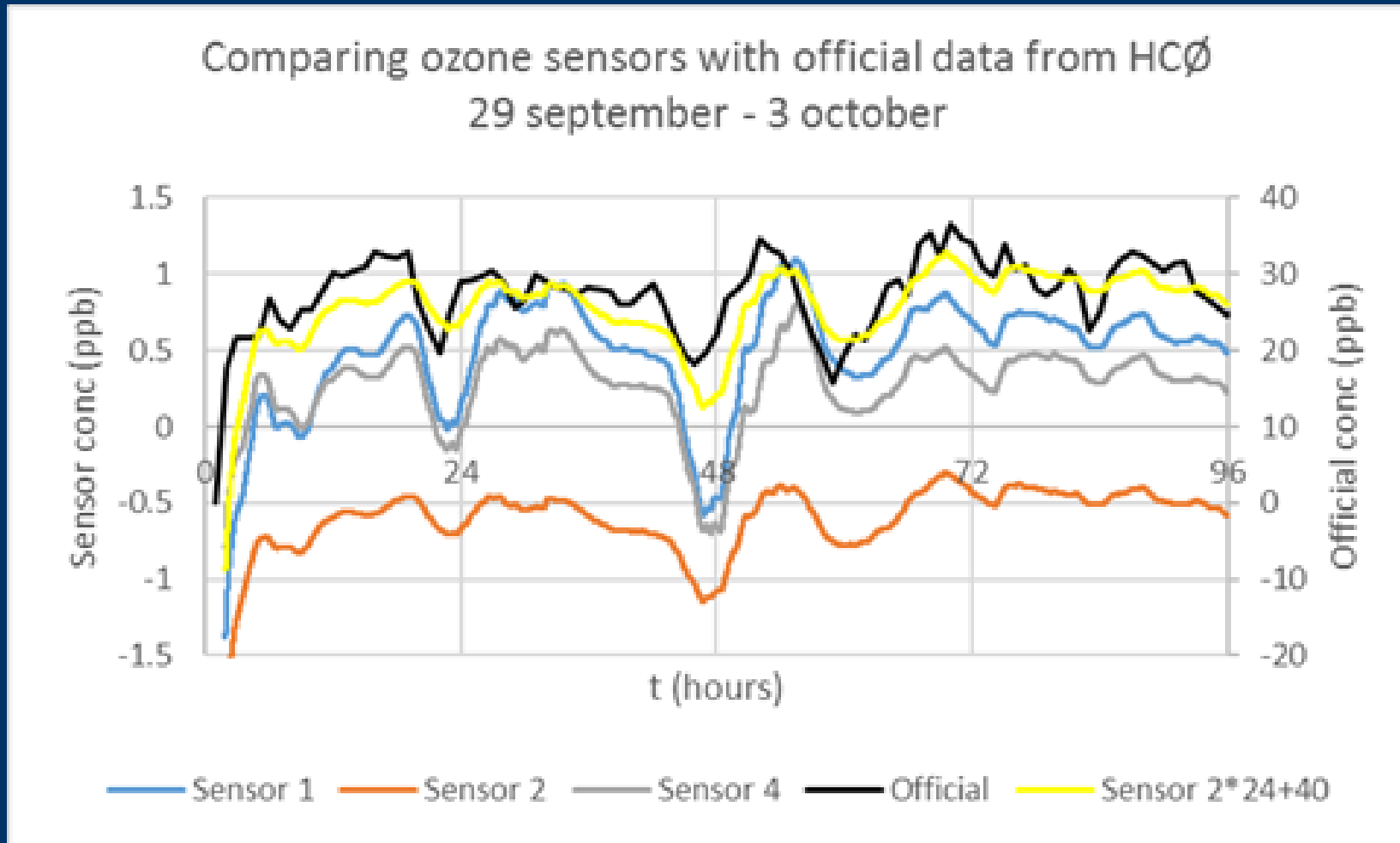


# Indicative NO<sub>2</sub> exceedances in 2012



- Modelled indicative exceedances in Copenhagen area, and few streets in Aarhus and Aalborg
- Good correlation between location of modelled exceedances in NOVANA and Air Quality at your street
- Modelled exceedances in Aalborg due to too high AADT and truck share in traffic model (and street geometry at measuring station)

# One option for validation is use of low-cost sensors



Collaboration prof. Ole John Nielsen CPH U & 3 MScs

# Discussion of uncertainties and limitations

- generalised road network - if not edited - make unrepresentative street geometry
- City 'background addresses' outside LTM can be underestimated
- input data for traffic & street geometry may not be representative
- default values for heavy-duty vehicles
- contribution from motorways is underestimated
- Inventory for PM from wood stoves uncertain
- Interpret. of close to or exceeding limit values requires more scrutiny of input data

## Conclusions:

- AQ at your street provide spatial distr. in urban areas
- Substantial interest from public and press
- Different AP have different distributions & sources
- Still substantial uncertainties: street geometry, traffic data
- Low-cost sensors may provide validation data
- Street pollution models are strong tools but still need further refinements