

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

COST Action TD1105

**WGs & MC Meeting at SOFIA (BG), 16-18 December 2015**

***New Sensing Technologies for Indoor Air Quality Monitoring:  
Trends and Challenges***

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

**Assessing the air pollution distribution in a busy street of Copenhagen in the further development of a street pollution model**



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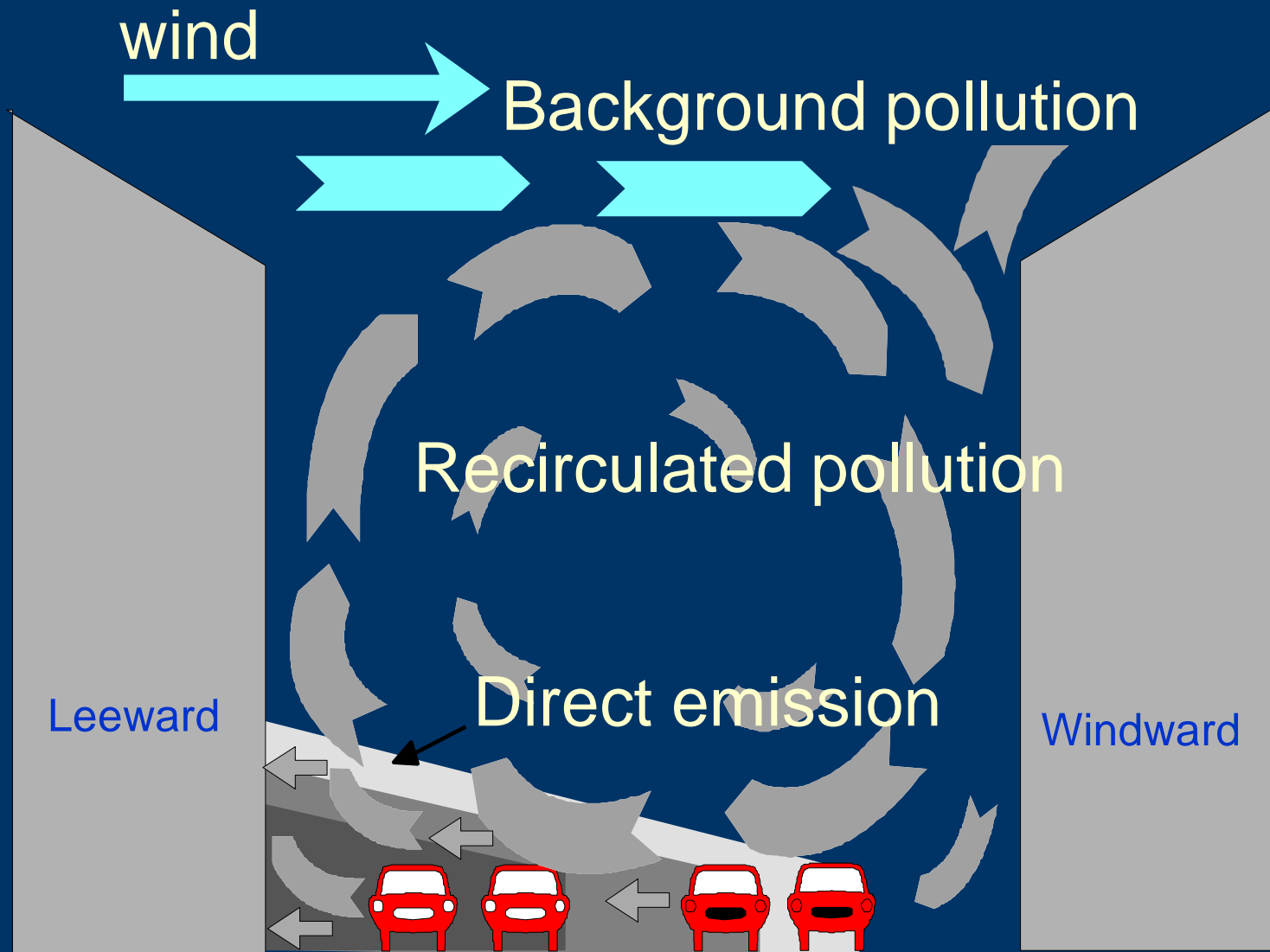
 **cost**  
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



# Aim of study at H.C. Andersens Boulevard

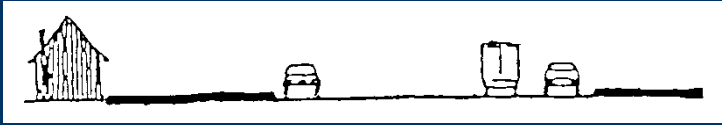
- Further develop Street Poll. Model (OSPM)
- Provide spatial data for testing the model
- Explain concentration jump at CPH street
  
- Focus on: non-street canyons, inhomogeneous emissions,  $\text{NO}_x/\text{NO}_2$

# The Operational Street Pollution Model (OSPM)



# Most data from Street Canyons (D)

A



B



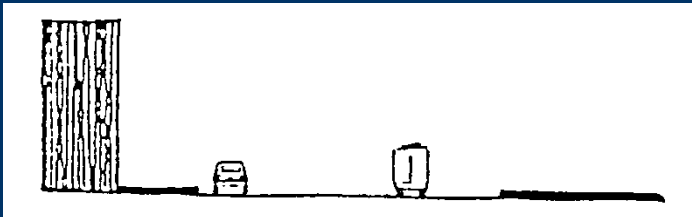
C



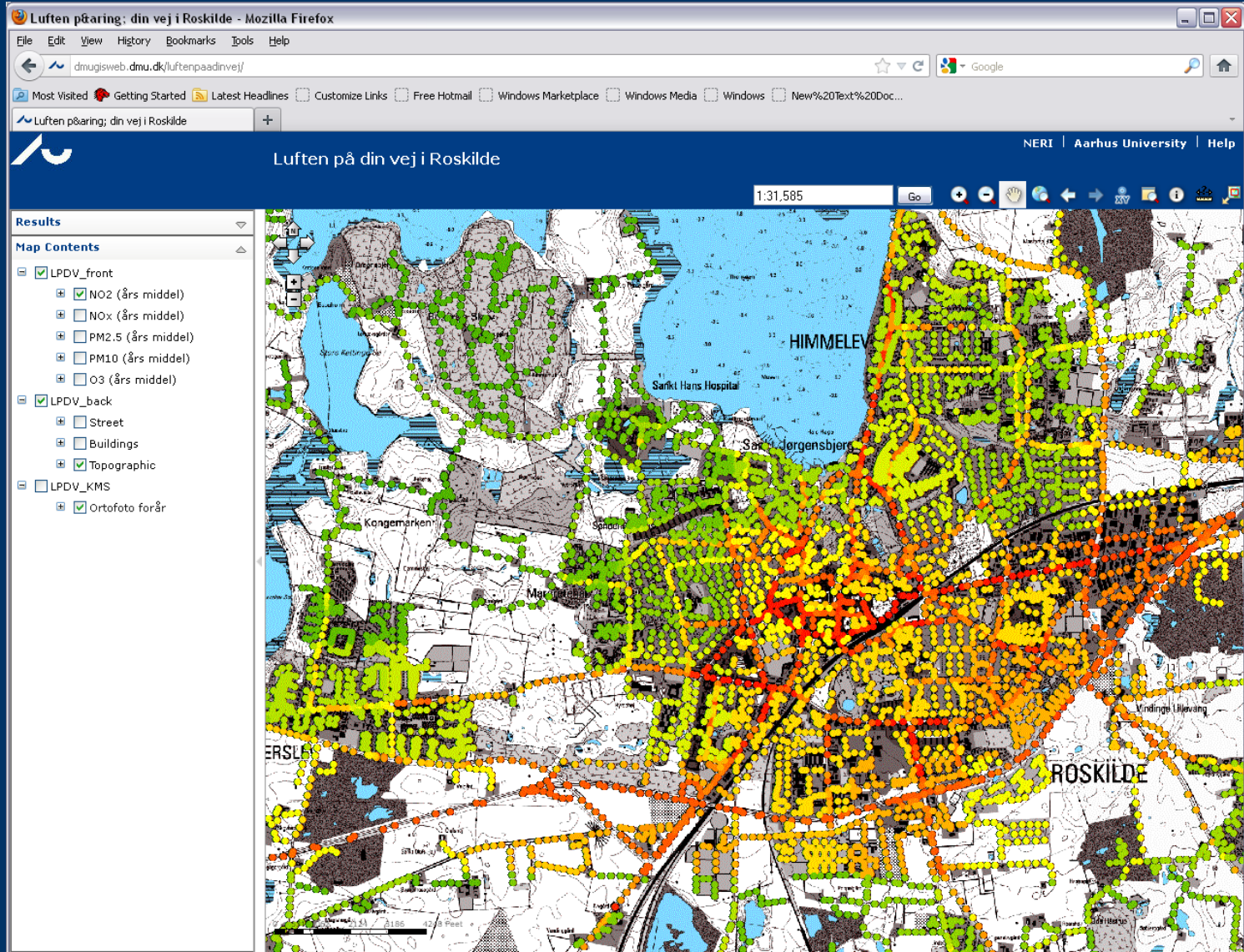
D



E



# Mapping performed for all Danish addresses

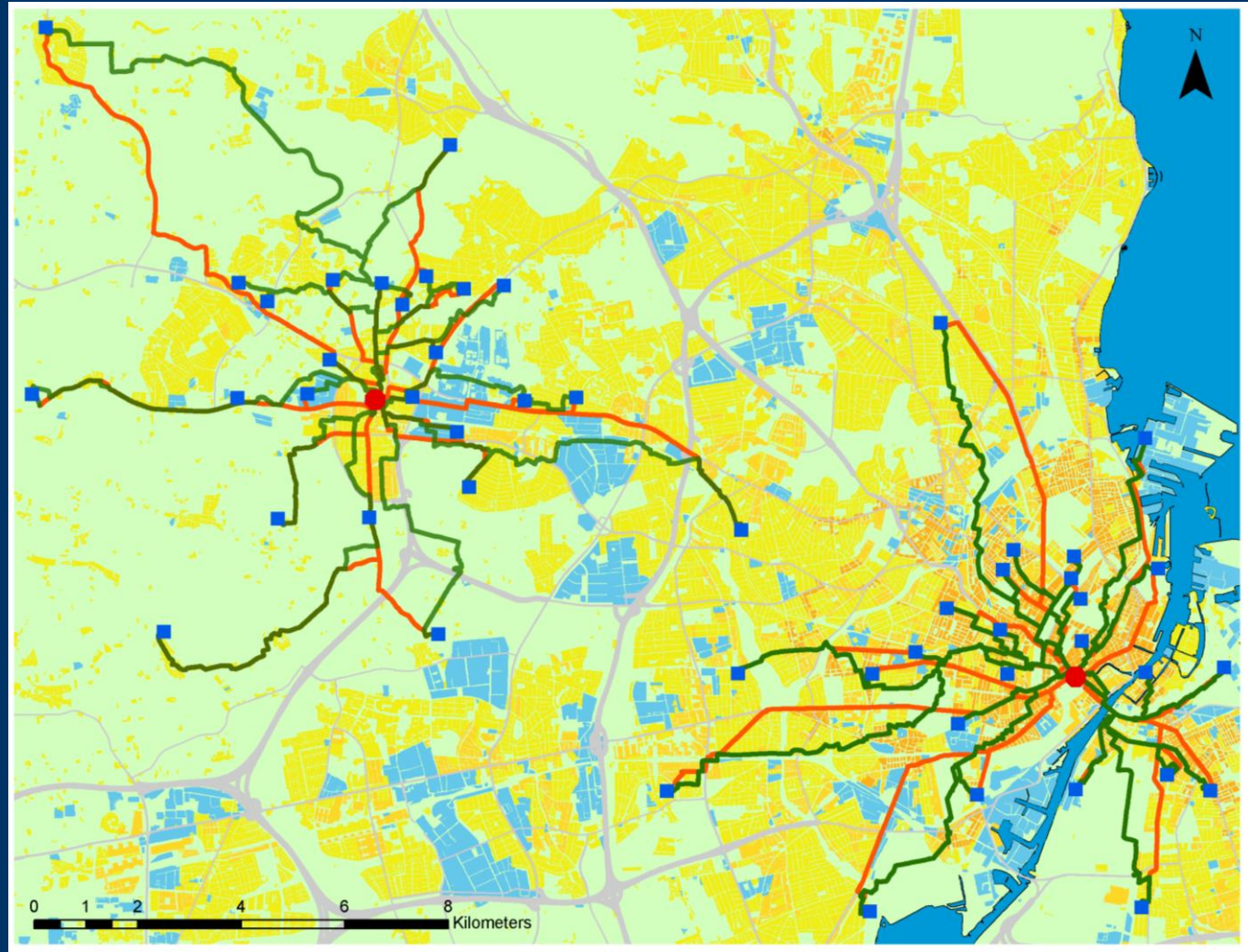


# Application of AirGIS/OSPM for exposure study

Exposure  
bicycling  
home & work  
shortest &  
cleanest

## Legend

- Workplace
- Homes
- Green routes
- Direct routes
- Highway
- Expressway
- Major Road
- Land
- Ocean



# Long term effects Danish studies

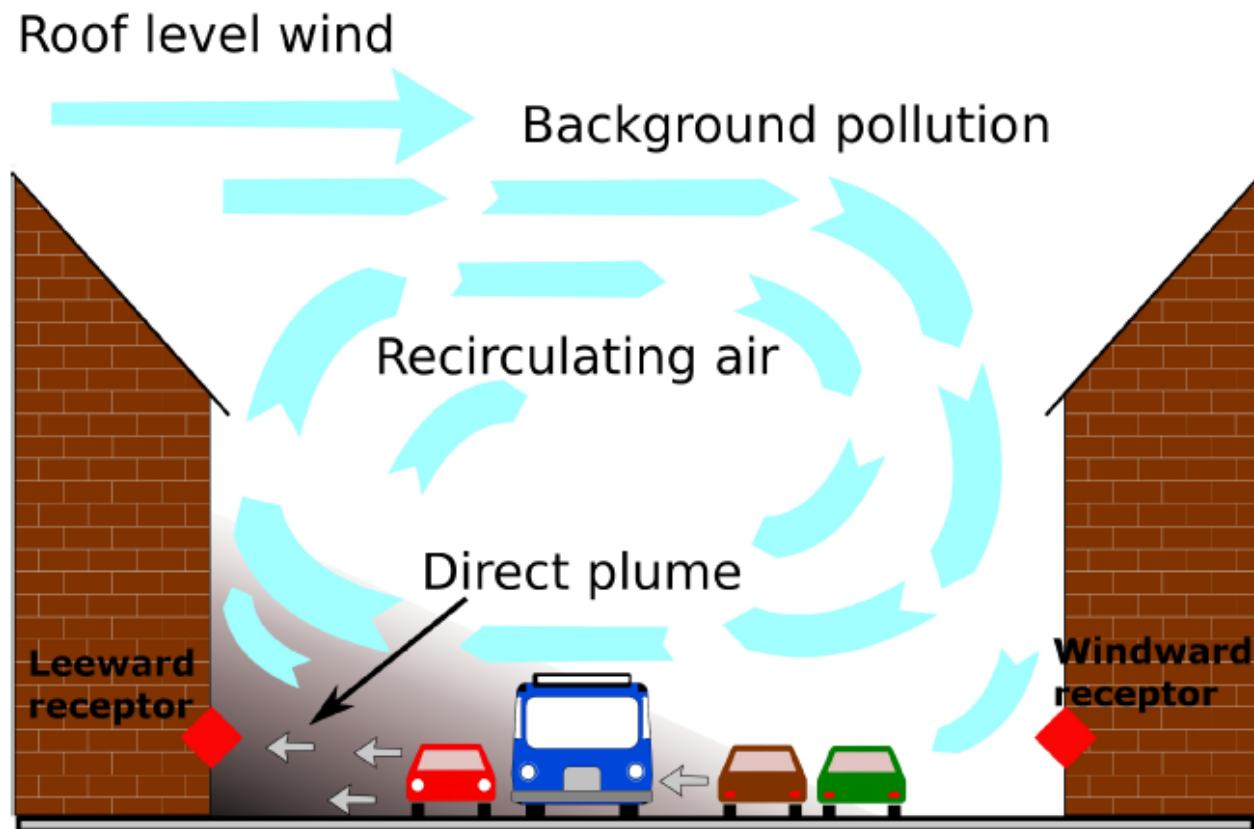
	NO <sub>2</sub> per 10 µg/m <sup>3</sup>	NO <sub>x</sub>
<b><u>Mortality</u></b>		
<b>Total</b>	8 % (CI: 1 - 14 %)	
<b>Cardiovascular illness</b>	16 % (CI: 3 - 31 %)	
<b>Ischemic</b>	8 % (CI: -11 - 30 %)	
<b>Stroke</b>	9 % (CI: -17 - 42 %)	
<b><u>Incidents/hospital admission</u></b>		
<b>Cardiovascular illness</b>		
<b>Stroke, all</b>	5 % (CI: -1 - 11 %) per 43 % increase in NO <sub>2</sub>	
<b>Stroke, fatal</b>	22 % (CI: 0 - 50 %) per 43 % increase in NO <sub>2</sub>	
<b>Airways disease</b>		
<b>COPD</b>	8 % (CI: 2 - 14 %) per 6 µg/m <sup>3</sup>	5 % (CI: 1 - 10 %) per 12 µg/m <sup>3</sup>
<b>Asthma (elderly)</b>	12 % (CI: 4 - 22 %) per 6 µg/m <sup>3</sup>	
<b>Lung cancer</b>		9 % (CI: -21-51 %) & 37% (CI: 6-76 %) per 100 µg/m <sup>3</sup>

# The use of OSPM world-wide





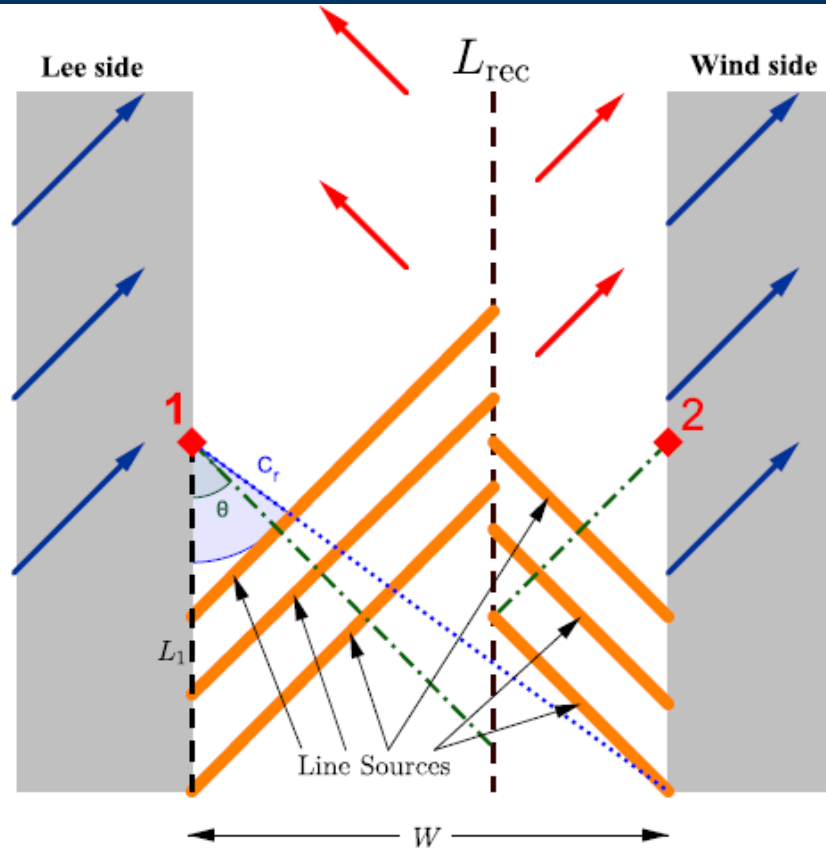
# Basic principle of OSPM



$$C = QC^* + C_{bg} \quad (1)$$

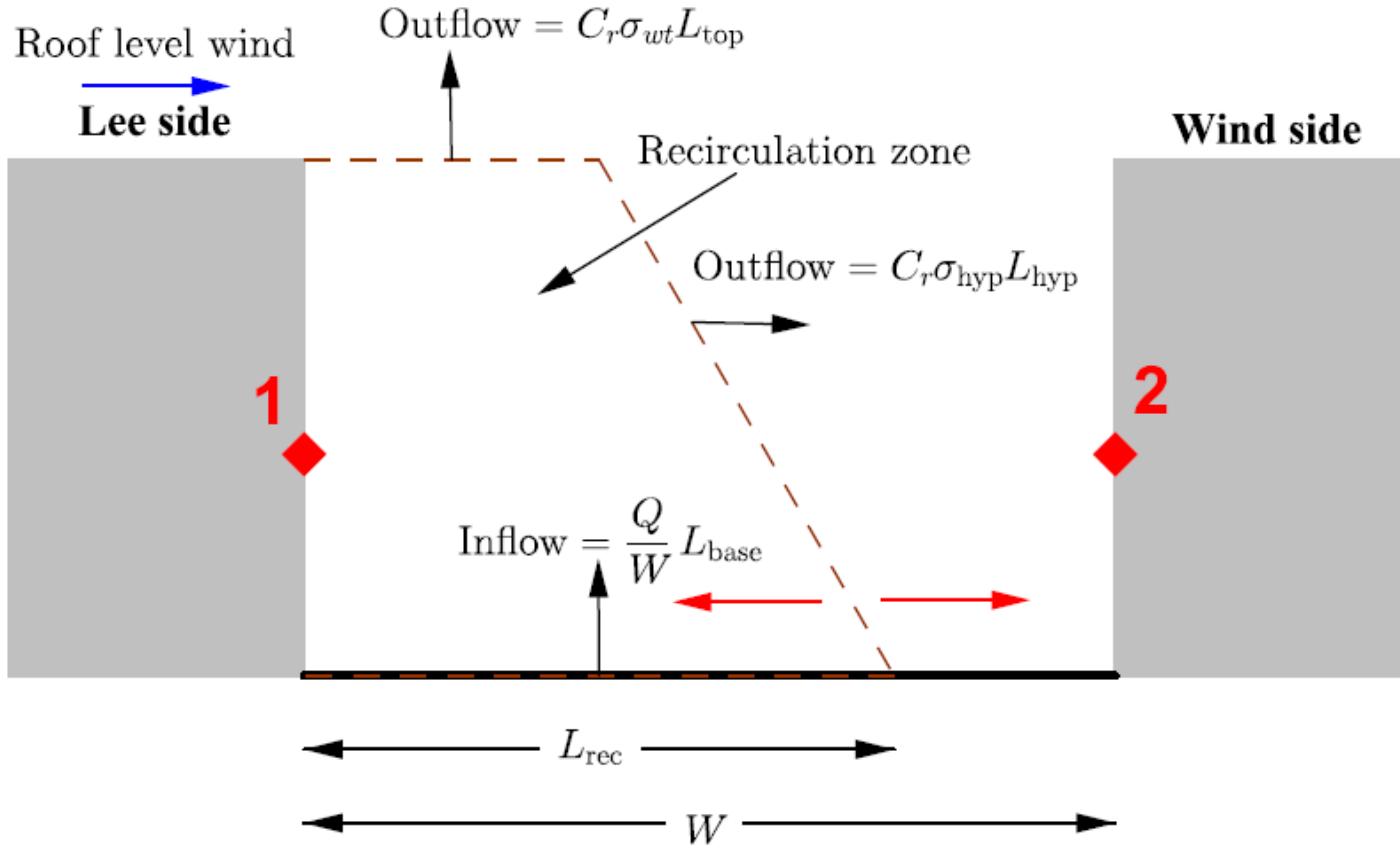
$$C^* = C_{dir} + C_{rec} \quad (2)$$

# Direct contribution



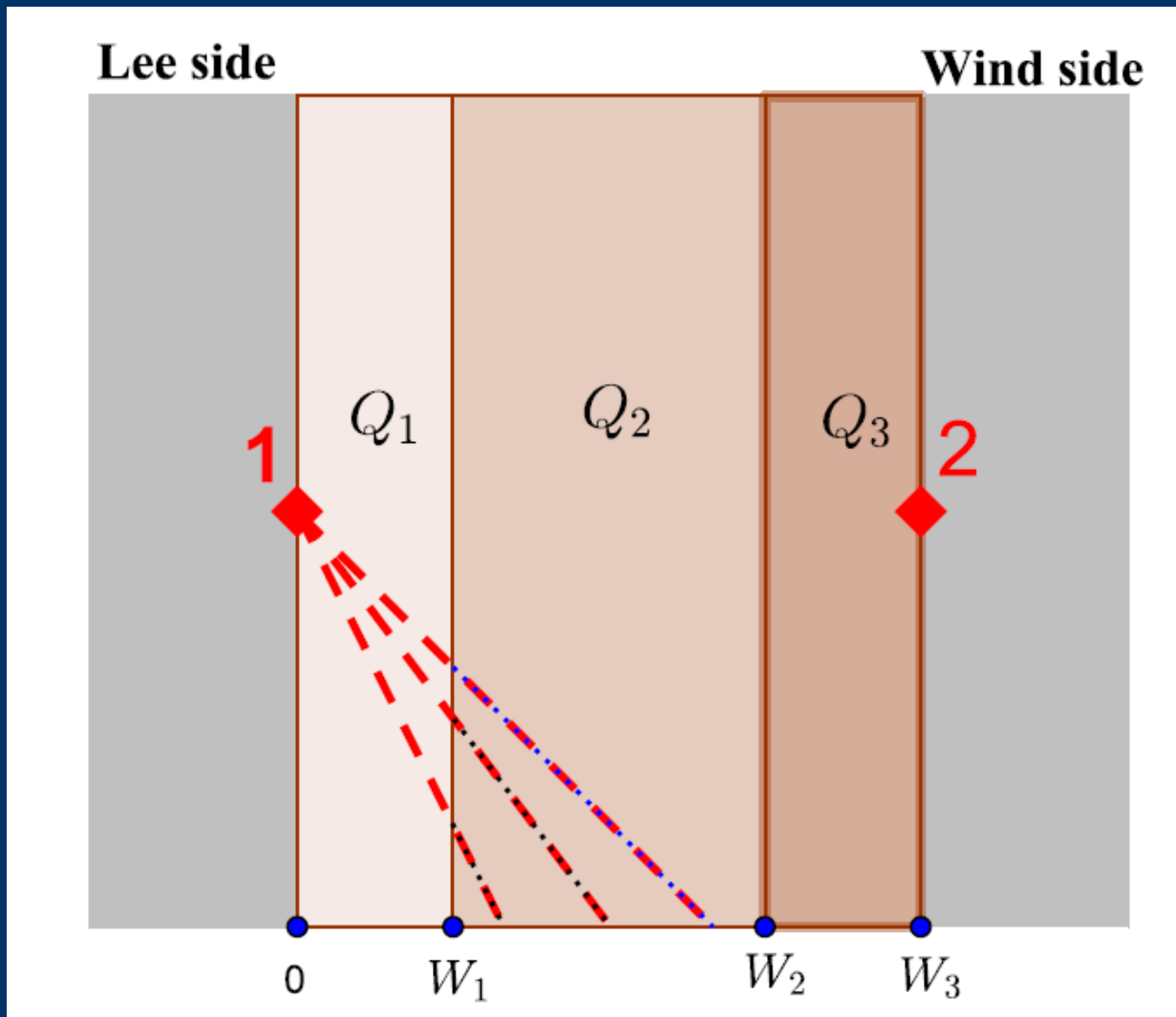
$$C_{\text{dir}} = \sqrt{\frac{2}{\pi}} \frac{Q}{W \sigma_w} \ln \left( \frac{x_{\text{end}} \frac{\sigma_w}{u_b} + h_0}{h_0} \right) \quad (3)$$

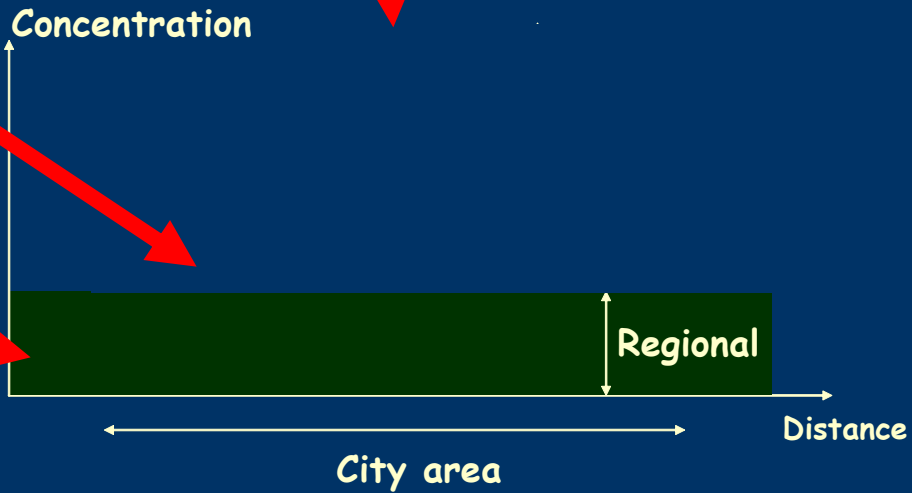
# Recirculation zone



$$C_r = \frac{\frac{Q}{W} L_{base}}{\sigma_{wt} L_{top} + \sigma_{hyp} L_{hyp}} \quad (4)$$

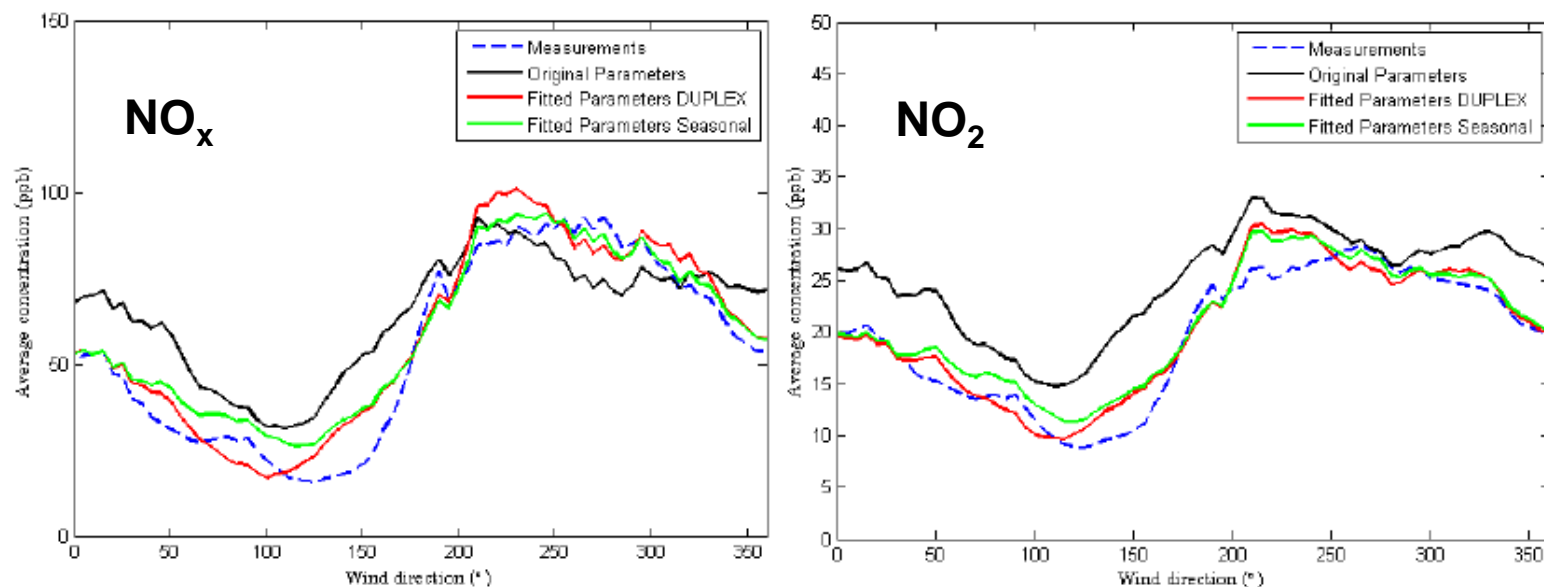
# Inhomogeneous emissions





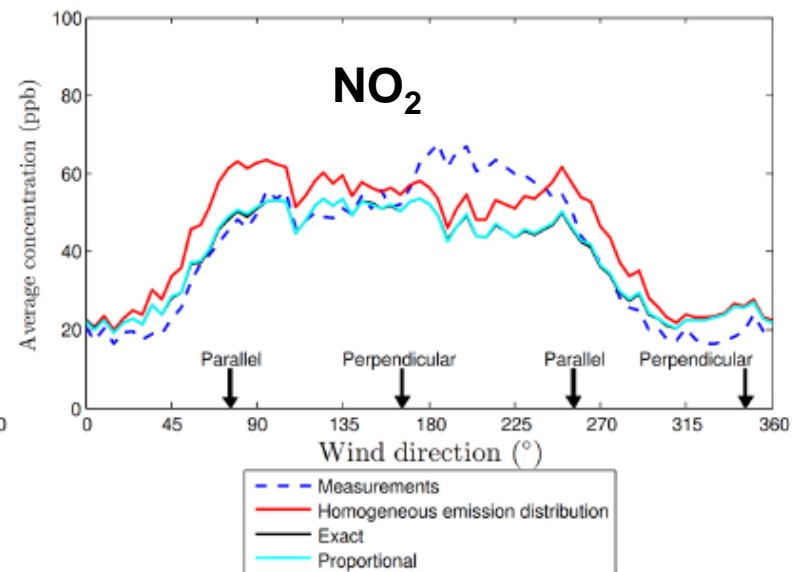
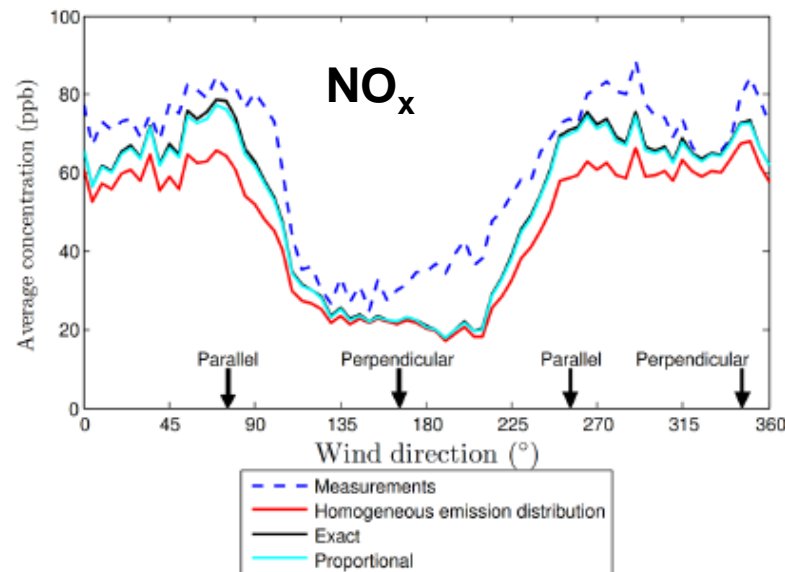
# Wind direction dependency: testing inhomogeneous emission description DK

Validation of estimated parameters – Wind direction plot: Albanigade, Odense



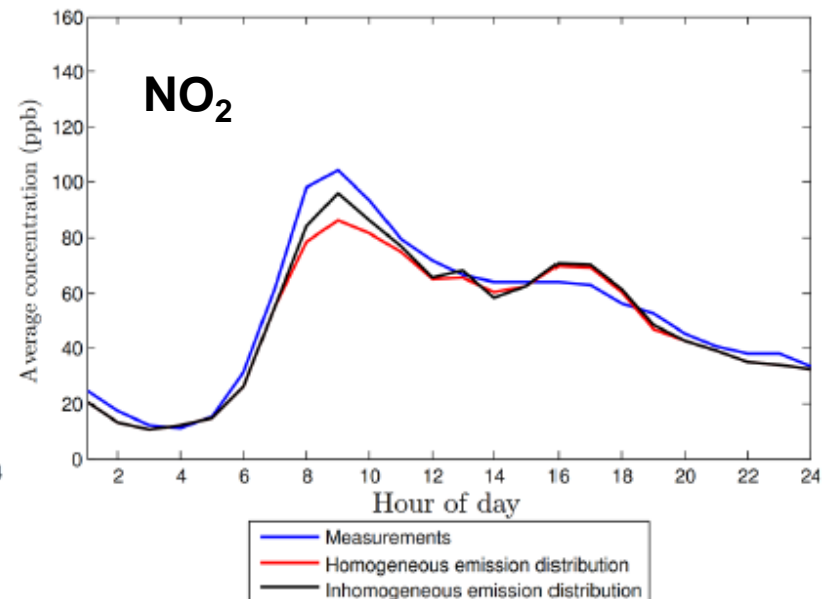
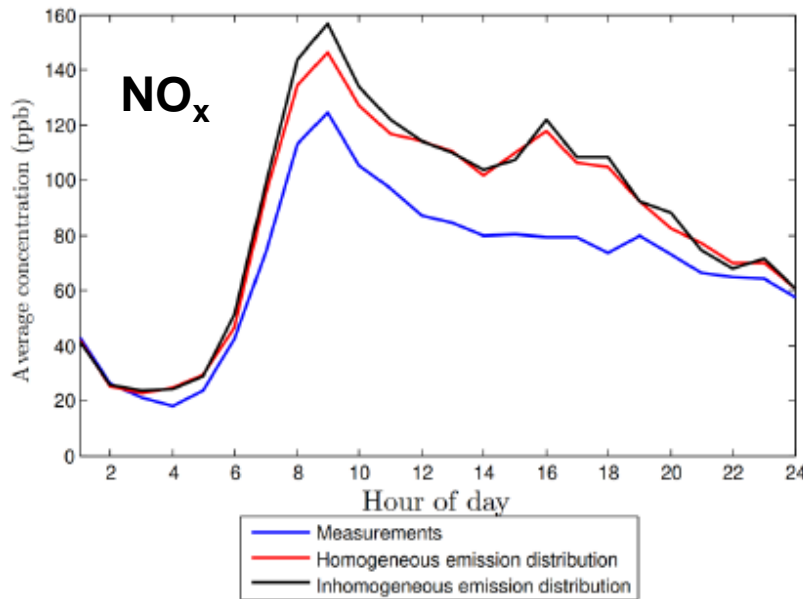
# Wind direction dependency: Testing inhomogeneous emissions Swedish street

Hornsgatan:



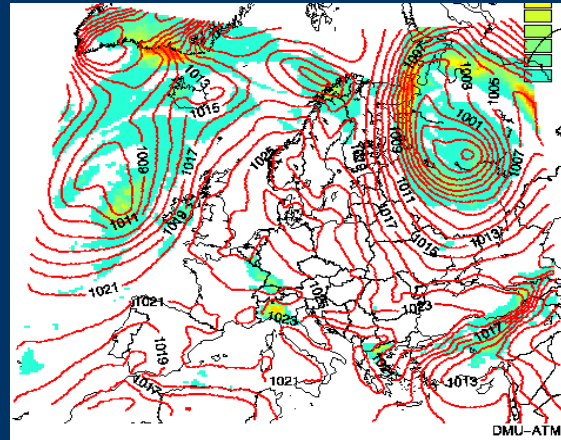
# Diurnal variation: Testing inhomogeneous emissions DK

Jagtvej:

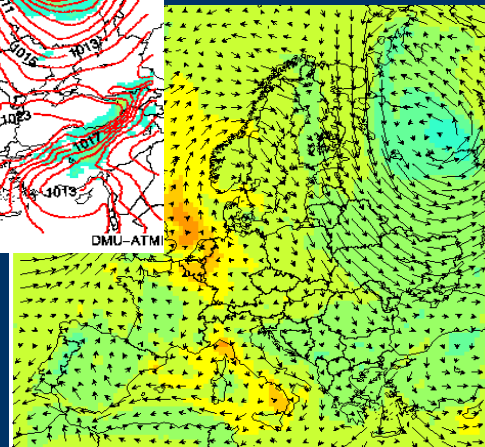




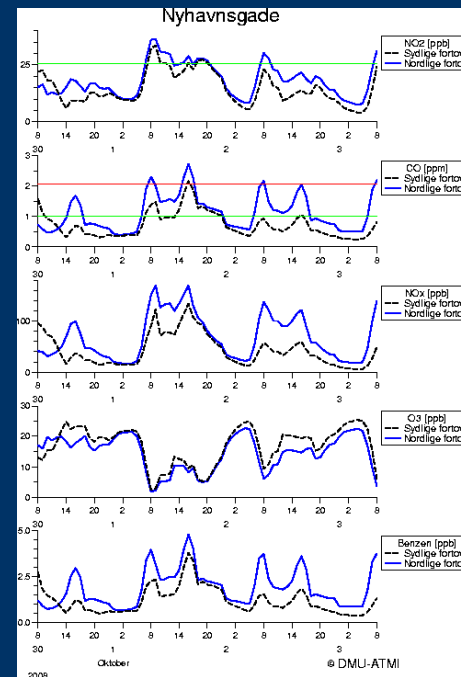
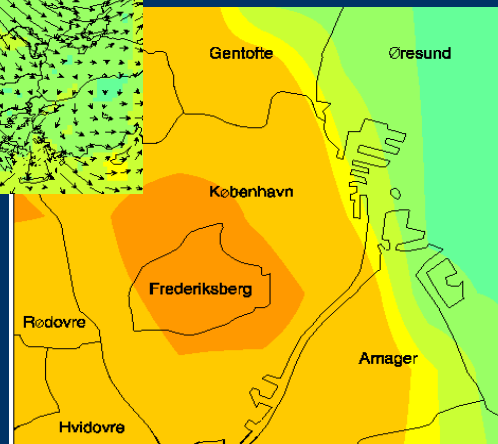
# Coupled models in the THOR system



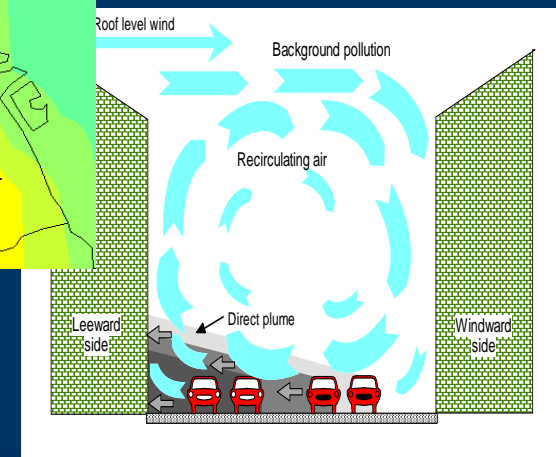
Long-range transport



Urban scale

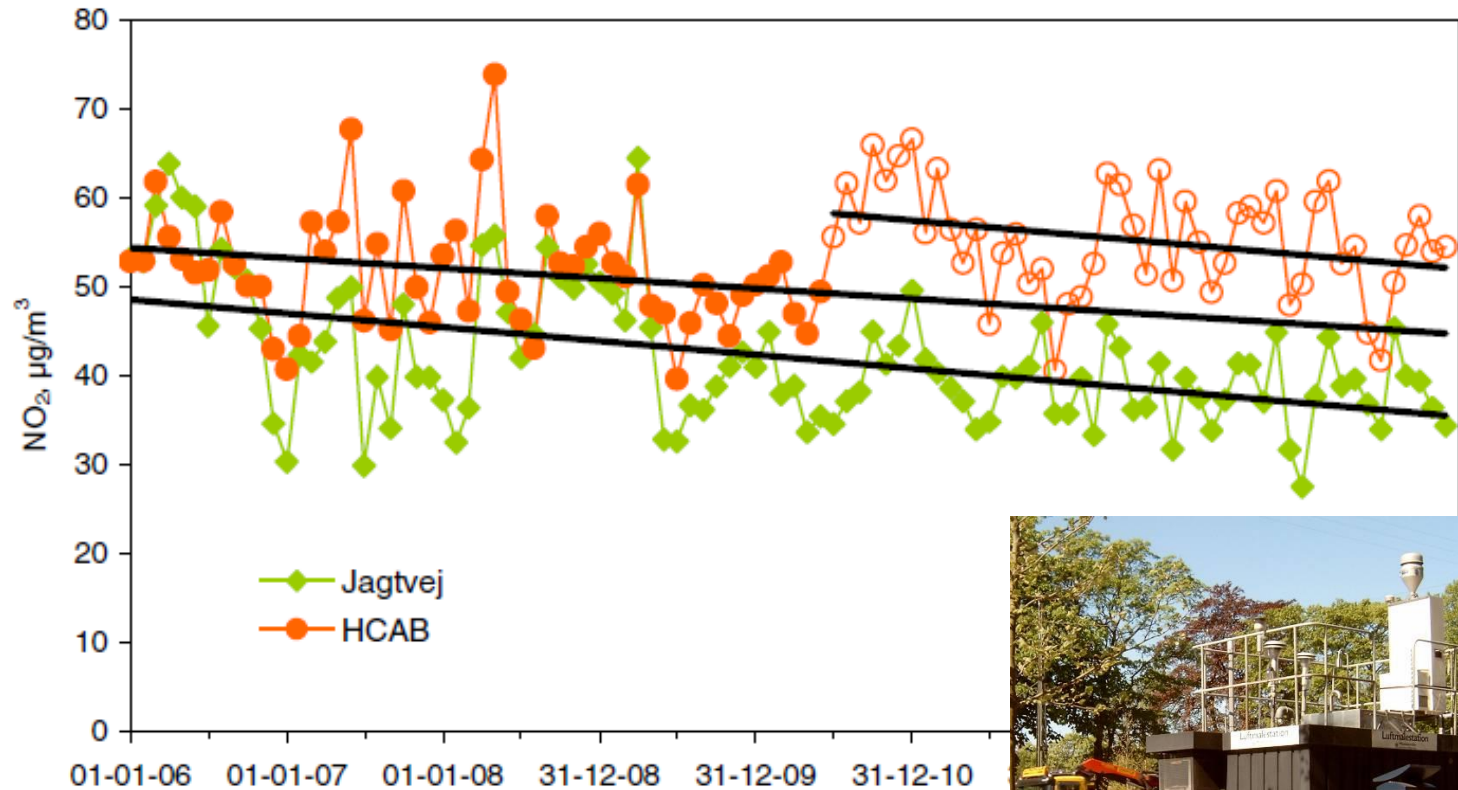


Street level

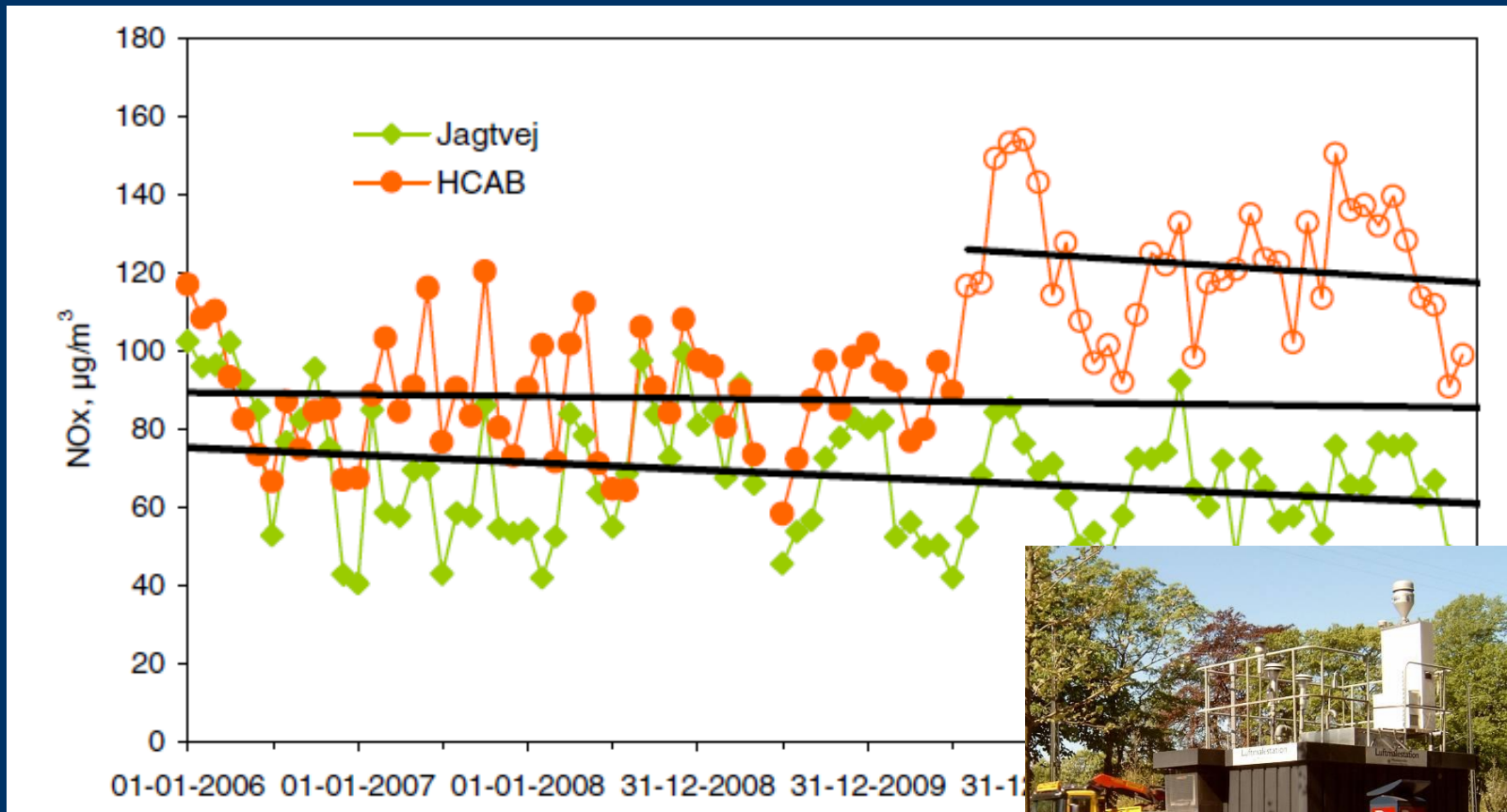


Performs 3-days prognoses of Air Quality 4 times a day

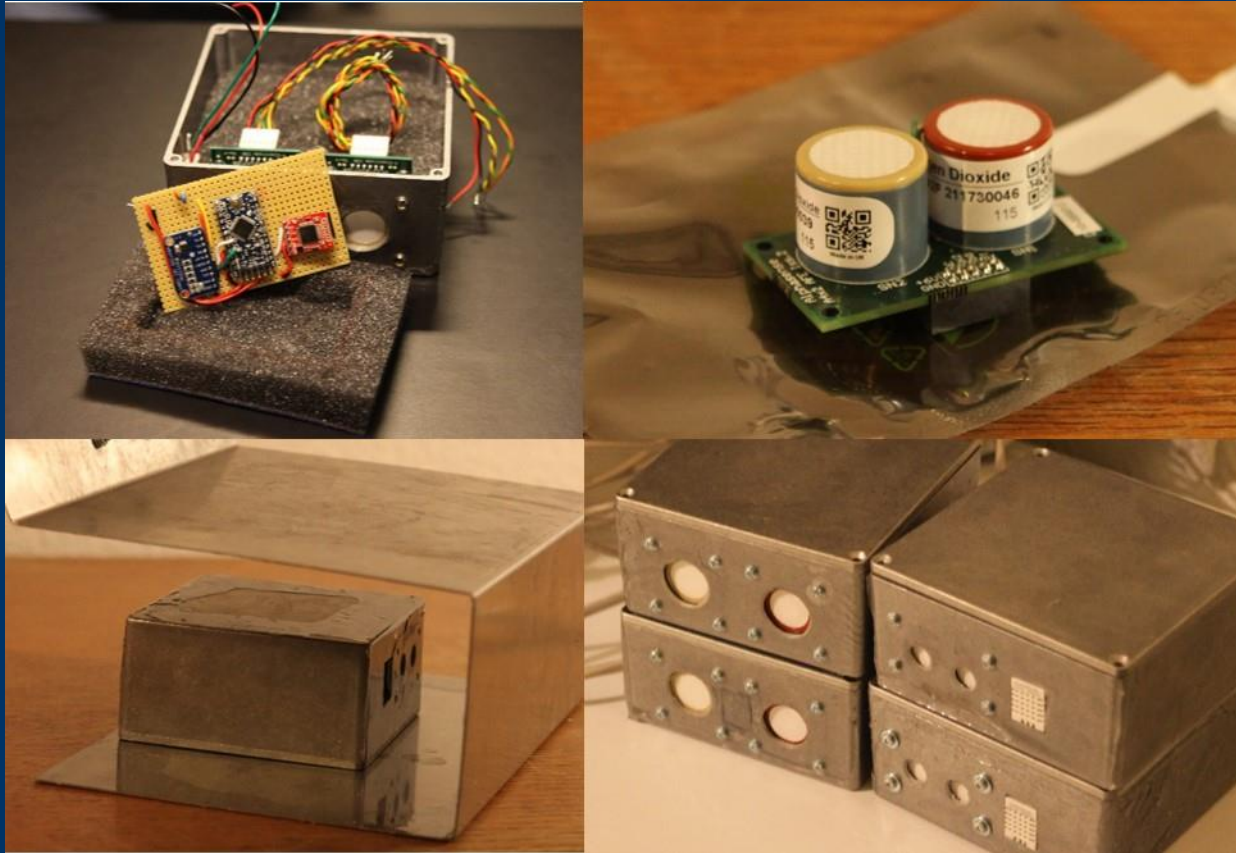
# Trend at H.C. Andersens Boulevard



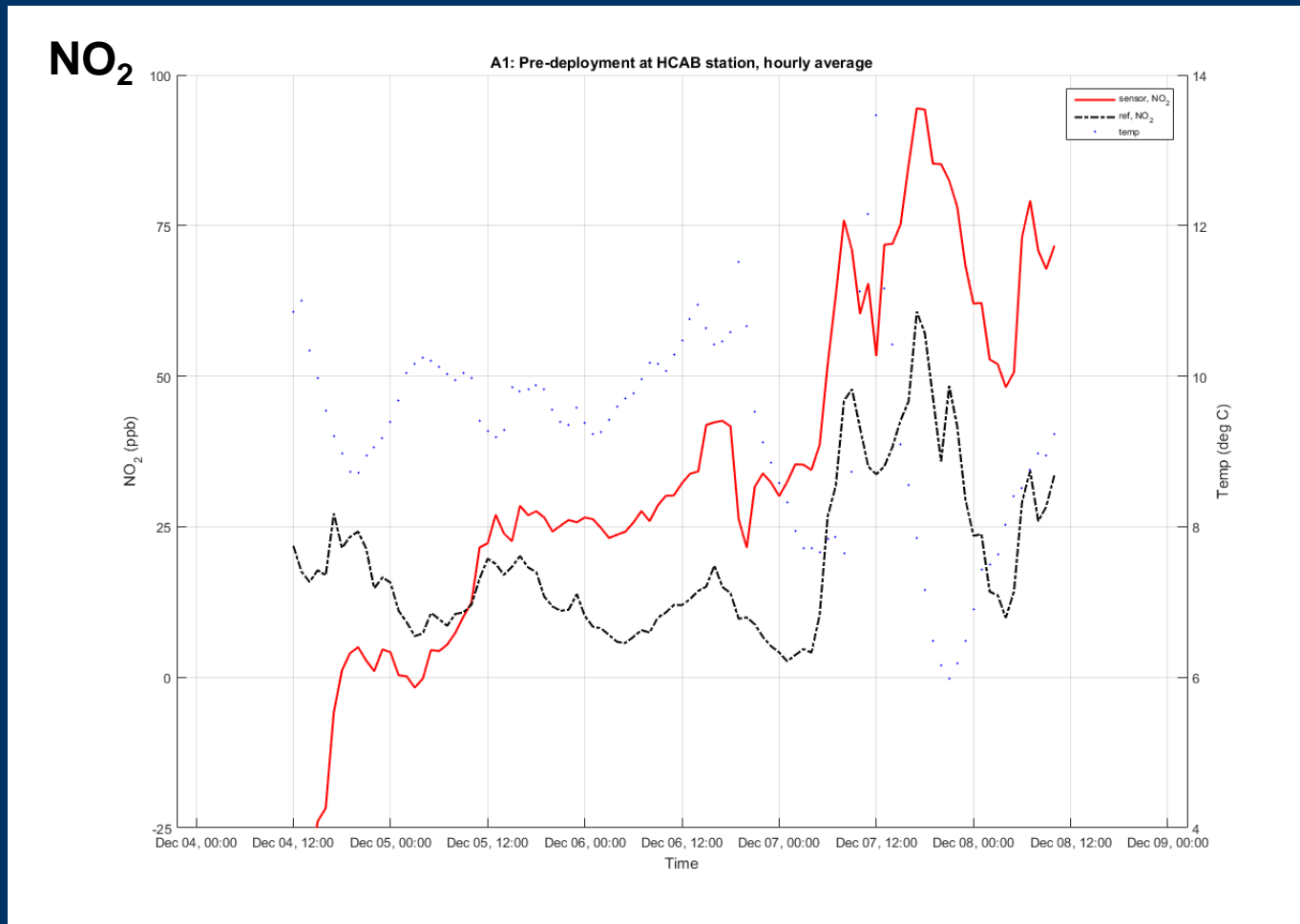
# Trend at H.C. Andersens Boulevard



# NO2 and O3 sensors from Alphasense



# Test of electro-chemical sensors from Alphasense at H.C. Andersens Boulevard - still in ongoing within MSc project



# Radiello NO<sub>2</sub> passive samplers



# At Tivoli: 3x light poles + 2 x on Tivoli fence



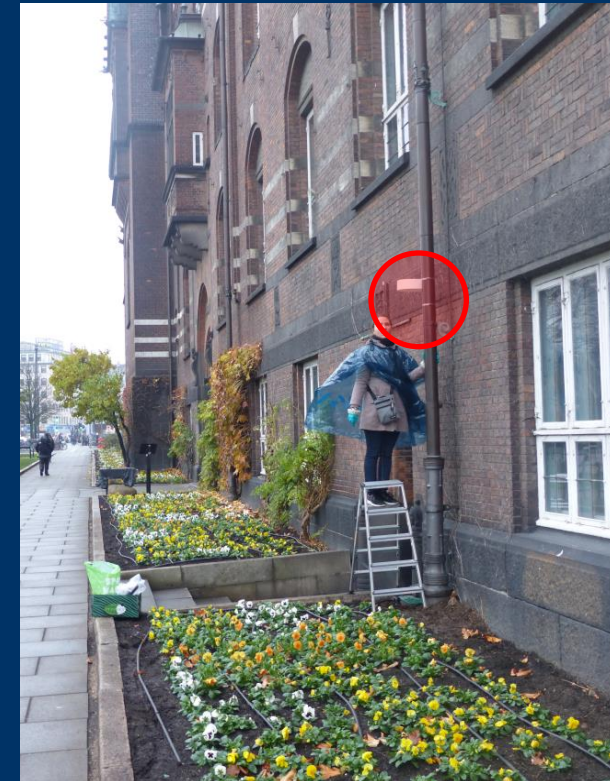
# At Mayor house: 4x light poles + 2 x on facade

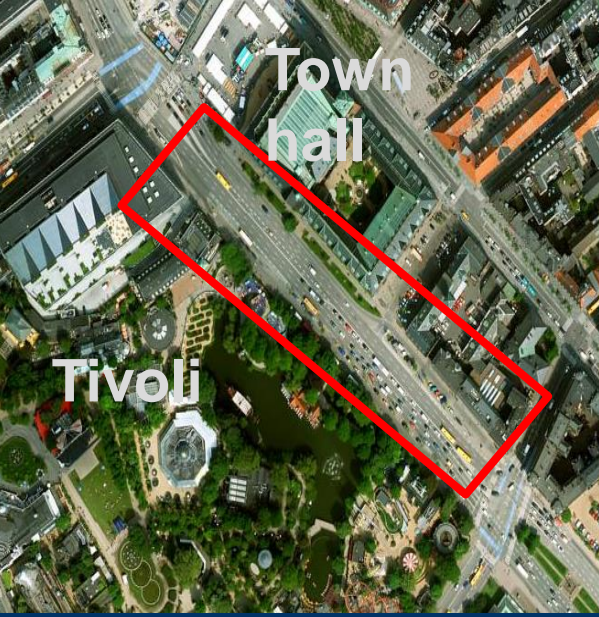




# Crossing & Mayor house

TD1105 EuNetAir Workshop 15-18 December 2015 in Sofia, Bulgaria

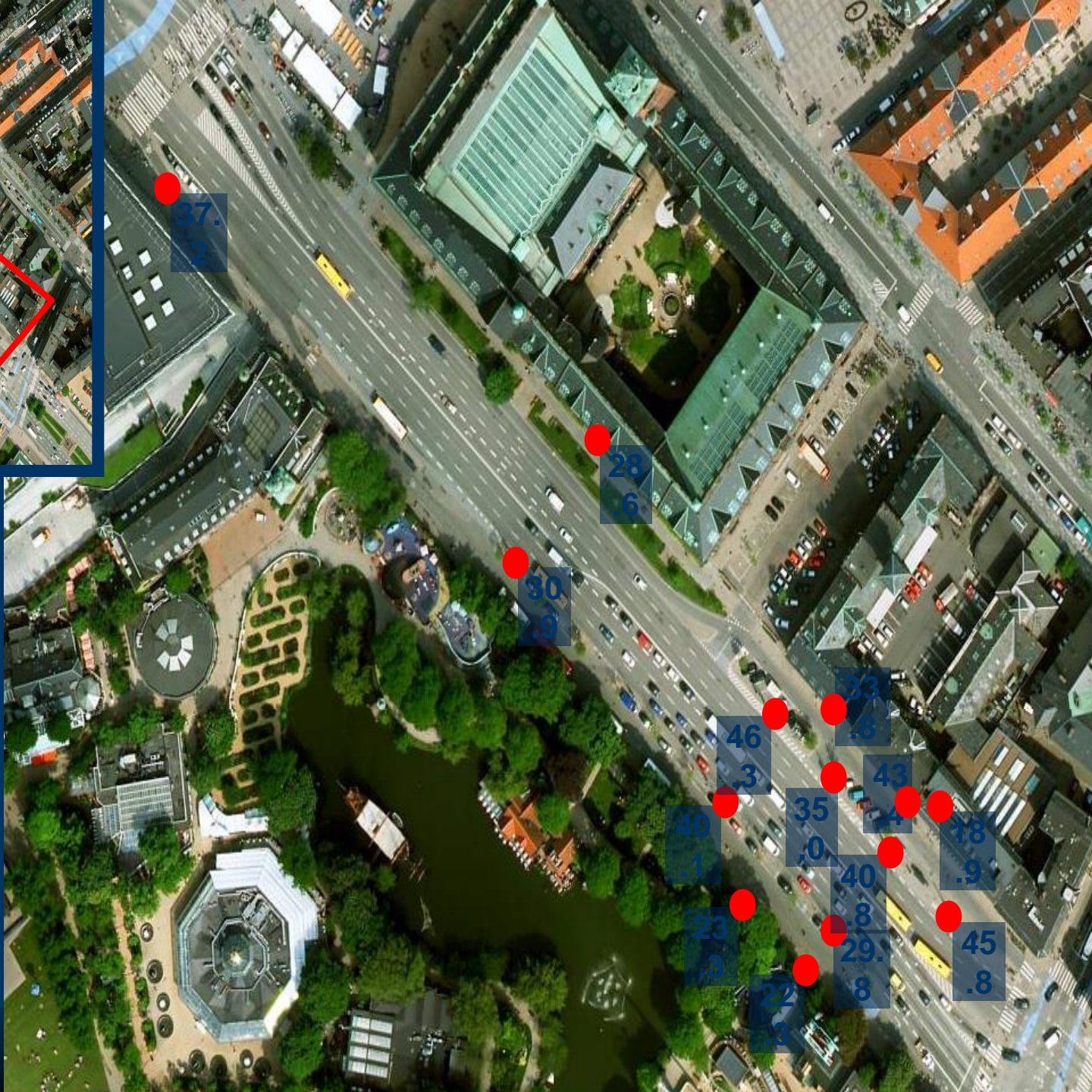


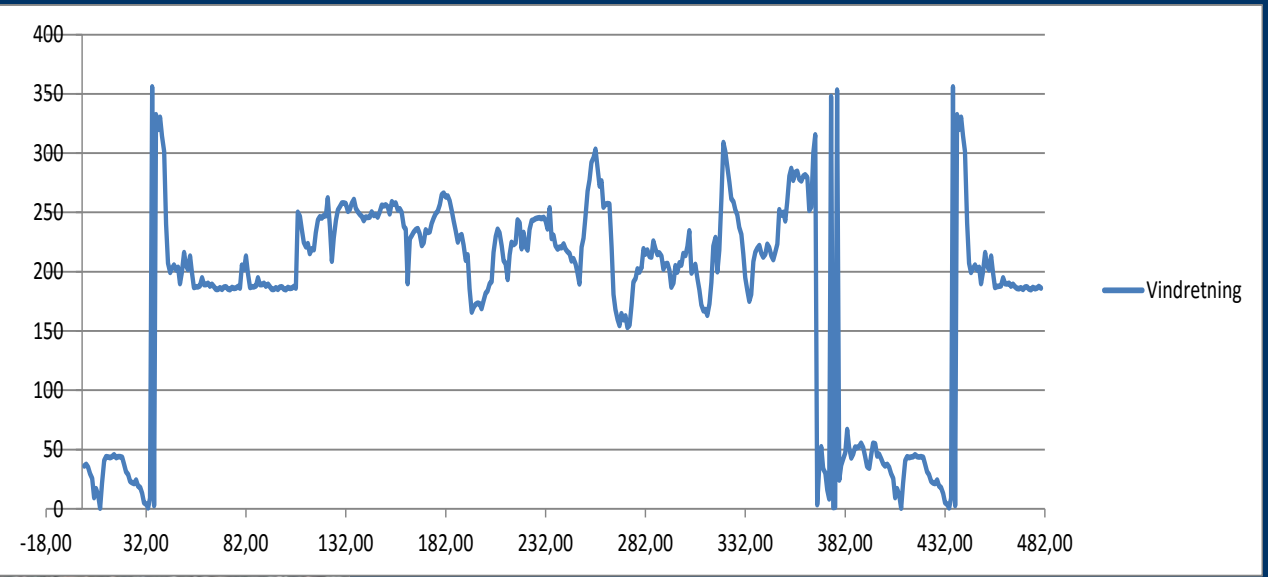


Mean value  
of first &  
second  
campaign

Correction  
factor: 2.1

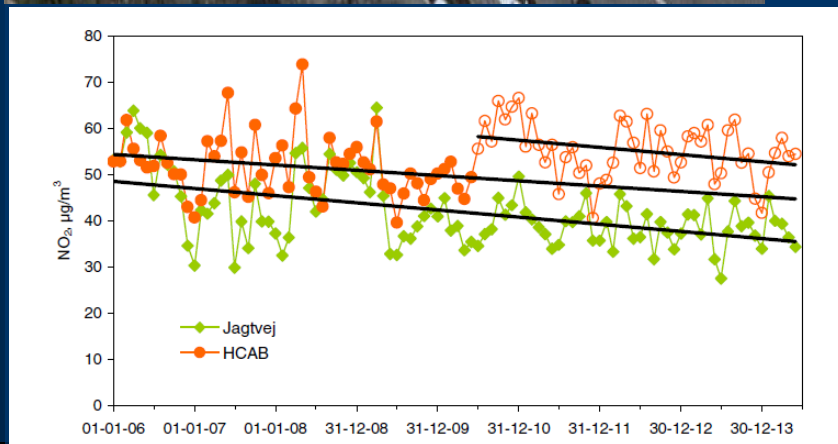
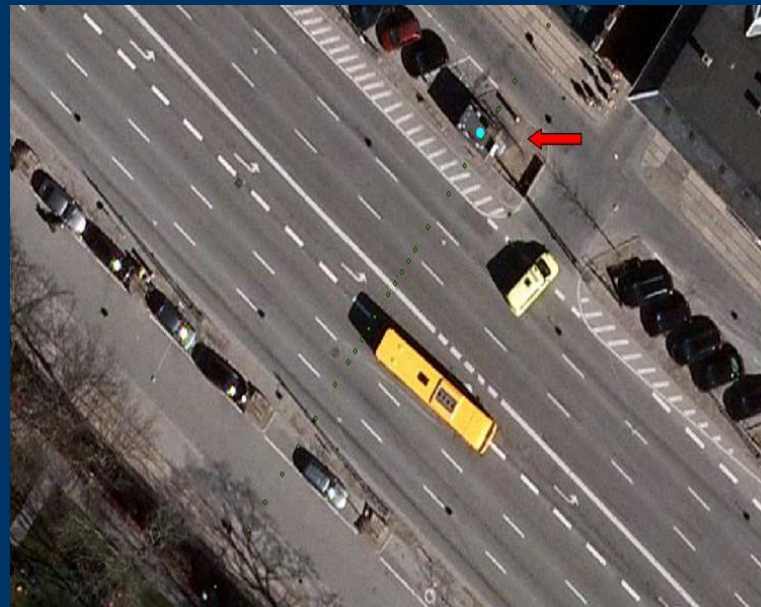
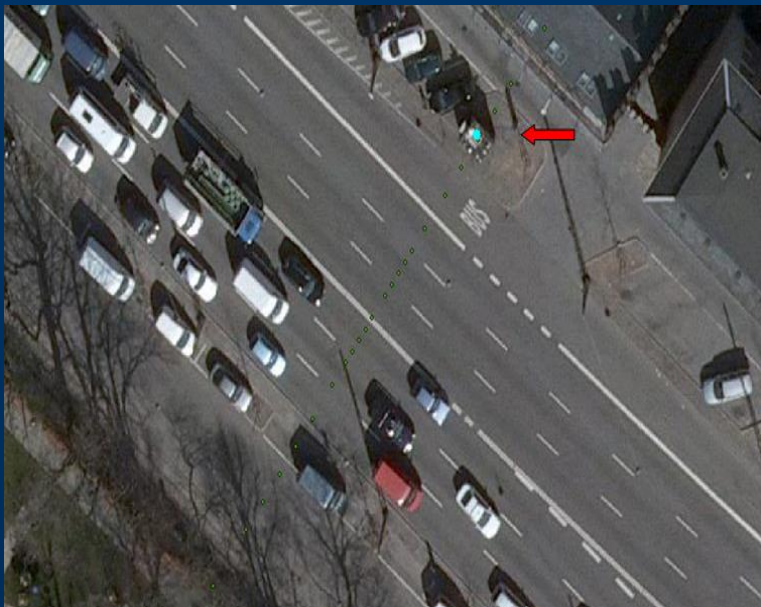
Units:  $\mu\text{g}$   
 $\text{NO}_2 / \text{m}^3$





Wind from amusement park Tivoli give low concentrations

# Traffic lanes before and after new bus lane at H.C. Andersens Boulevard



# Traffic lanes before and after new bus lane at H.C. Andersens Boulevard



## Conclusions:

- Need spatial distribution data in urban areas
- Both single streets and street networks
- Various low-cost sensors applicable
- Changed traffic lanes strongly affect levels
- Street pollution models are strong tools but still need further refinements

Ottosen, T.-B., Ketzel, M., Skov, H., Hertel, O., Brandt, J., Kakosimos, K., 2015. Analysis of the Impact of Inhomogeneous Emissions in a Semi-Parameterized Street Canyon Model. *Geosci. Model Dev.*, 8(10), 3231-3245, <http://dx.doi.org/10.5194/gmd-8-3231-2015>, [www.geosci-model-dev.net/8/3231/2015/](http://www.geosci-model-dev.net/8/3231/2015/)

Ottosen, T.-B., Ketzel, M., Skov, H., Hertel, O., Brandt, J., Kakosimos, K., 2016. A parameter Estimation and Identifiability Analysis Methodology Applied to a Street Canyon Air Pollution Model. Submitted for publication in *Environmental Modelling & Software*. Under review