

Validation of newest developments within the Operational Street Pollution Model (OSPM)

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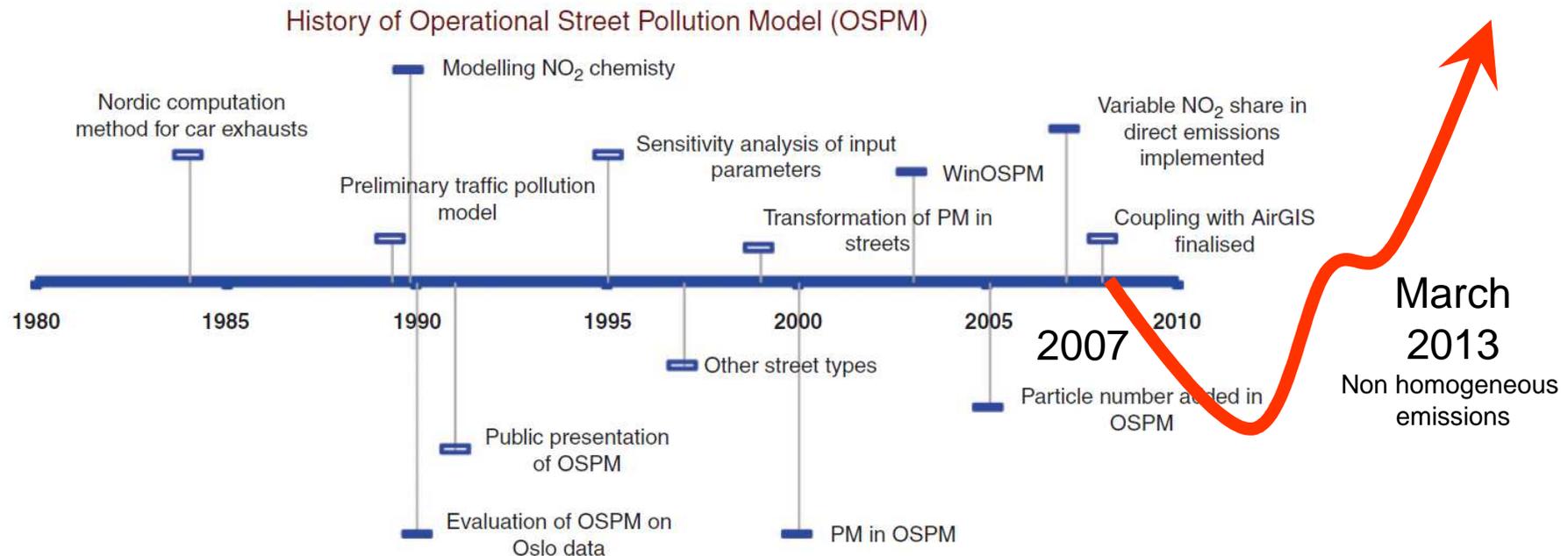
Outline

- › **The OSPM model**
- › **Changes / Updates in OSPM**
- › **Validation**
- › **Application of OSPM for “Air Quality at your Street” for all addresses in Denmark**
- › **Conclusion**

Comments on OSPM (1/2)

- > **OSPM slightly older than Harmo conference (25+ years!) Developed at NERI by Berkowicz and Hertel since 1988**
- > **Applied and validated many places worldwide**
- > **Part of several AQM systems**

K. E. Kakosimos et al.



Comments on OSPM (2/2)

> **Parameterised model**

> **Based on physics**

> **Direct plume**

> **Traffic produced turbulence**

> **Recirculation**

> **How to re-estimate the parameters?**

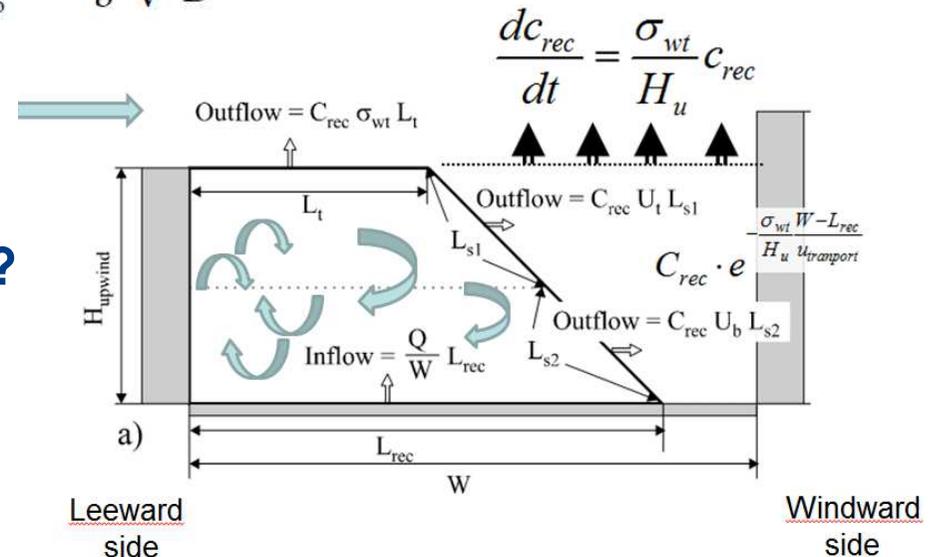
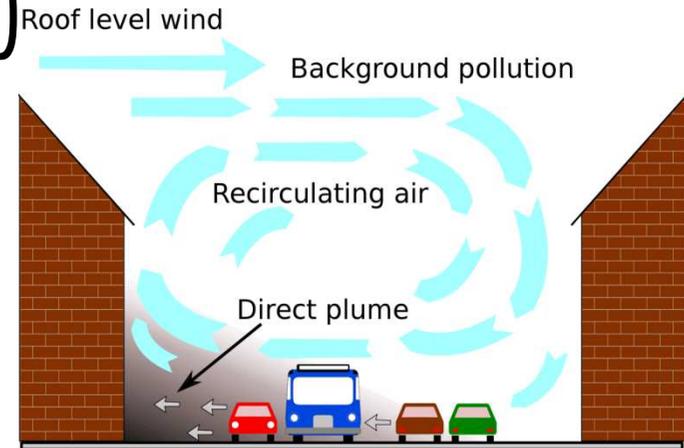
> "Ruwims" constant(s) 0.1 0.3 ...

> (-> talk on Thursday)

$$\sigma_z(x) = \sigma_w \frac{x}{u_b} + h_o$$

$$\sigma_w = \left((\alpha u_b)^2 + \sigma_{wo}^2 \right)^{1/2}$$

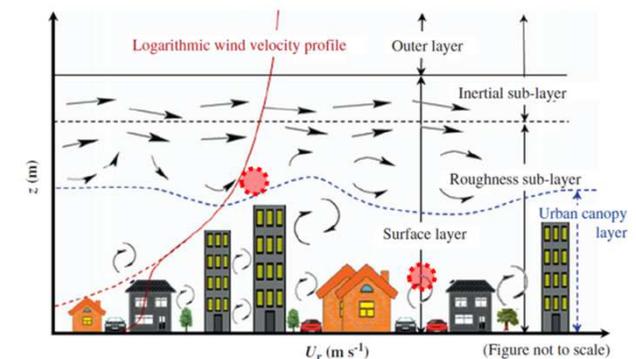
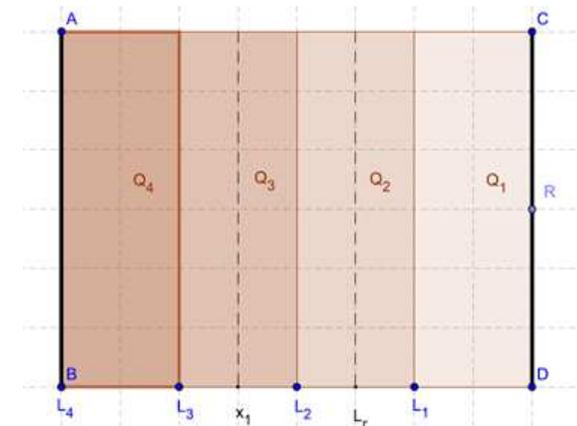
$$\sigma_{wo}^2 = b^2 V^2 D$$



OSPM - Present changes / updates

Short-term issues (urgent and “need to have”)

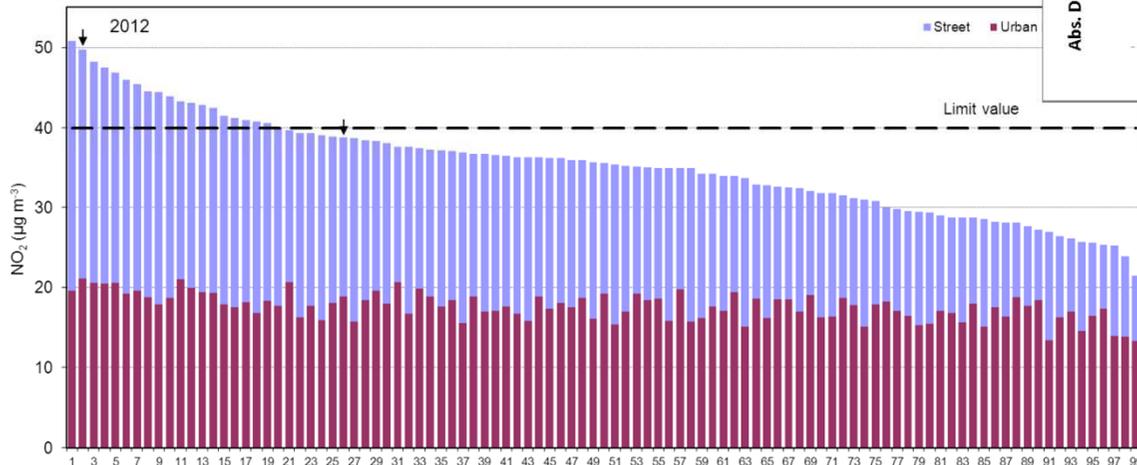
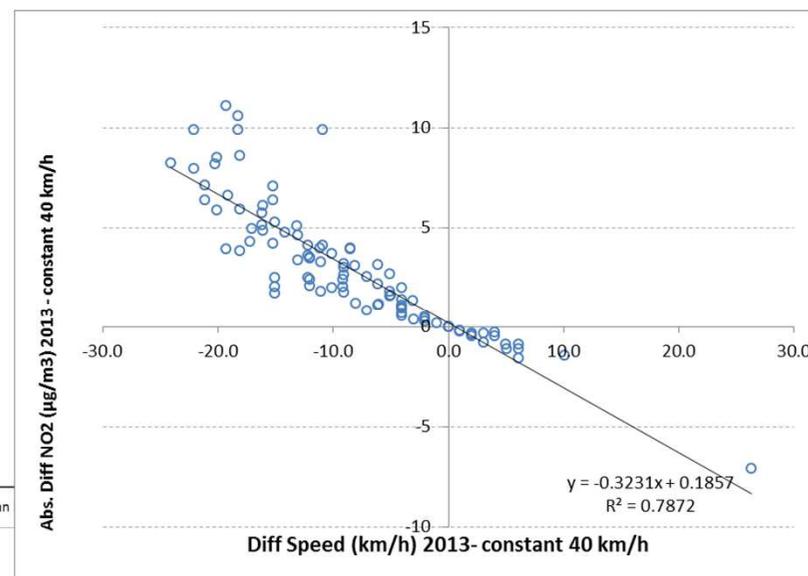
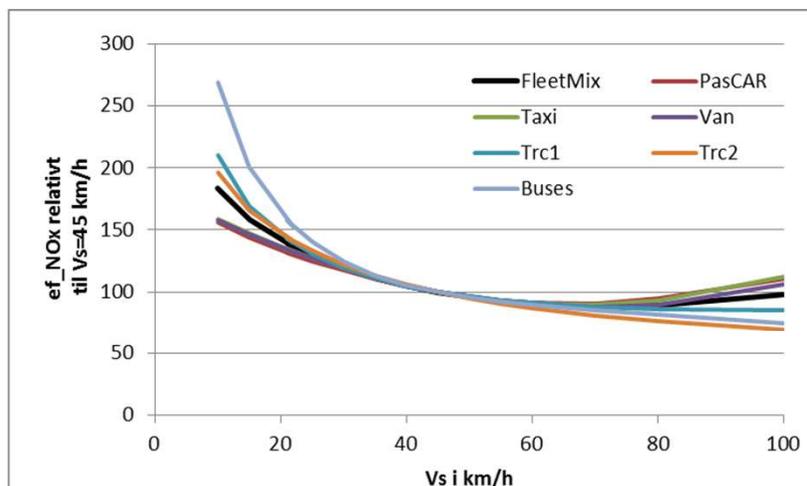
- > General building height definition,
 - > defined by OSPM for streets with many exceptions
 - > **DONE (-> Air Quality 2014)**
- > Asymmetric streets - **DONE -> Air Quality 2014, Paper on way**
- > NO_2 fits well while NO_x is underestimated
 - > Chemistry?! Or Parameter estimation -> **talk on Thursday**
- > $U_{\text{roof}} / U_{\text{mast}}$ - ratio ; parameter ‘fRoof’
 - > changed from 0.82 to 0.4 when switching to COPERT emis.
 - > Develop a ‘sub’ model to put this on more solid ground
- > Are our travel speeds / emission factors right?
 - > Change from now 40..50 km/h to 20...30 km/h
 - > Double penalty: a) +++ emissions b) --- TPT



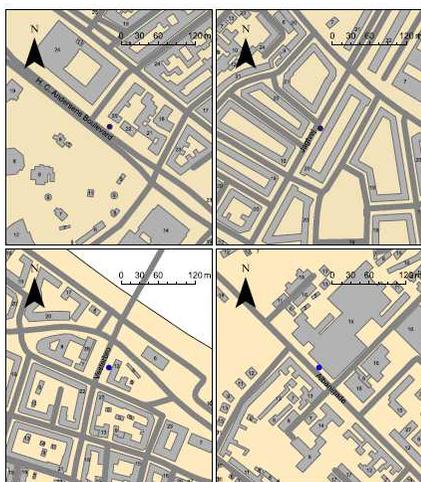
(Figure not to scale)

Change of traffic speed

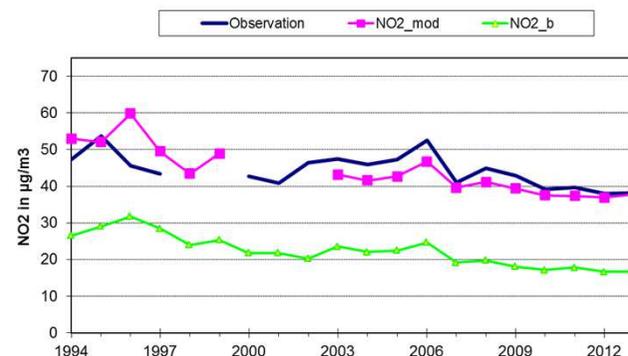
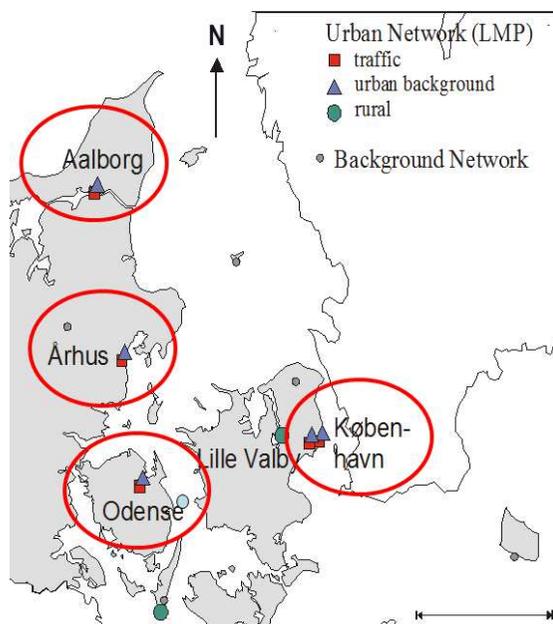
> New data based on GIS-based "SpeedMap"



Validation



- > Using 5 street stations in DK
- > Correlation usually high 0.7–0.8
- > Focus on reducing the bias
 - > Typical bias at street level +/-20% for NO₂



- > Future
 - > More streets (SE, UK)
 - > Re-estimate several parameters in OSPM

Air Quality at your street

> Background

- > Citizens have great interest in information about air quality where they live, work, and their kids to kindergarten or school
- > Authorities also want to get information about AQ in relation to urban planning or complains
- > Used in epidemiological studies

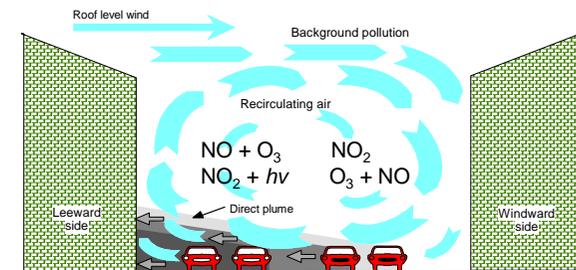
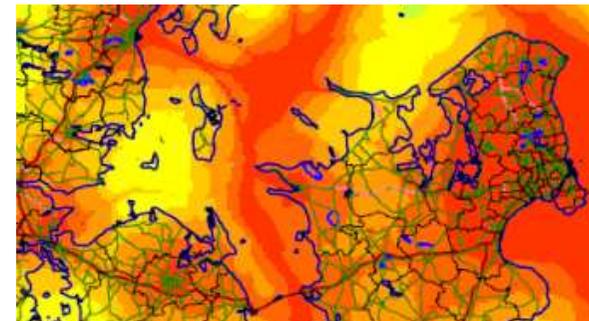
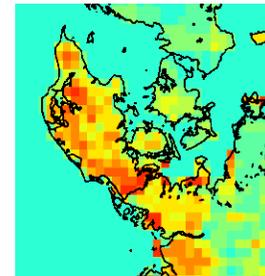
> Screeningtool

- > Working with national datasets
- > might give 'outliers' at specific locations



AQ models

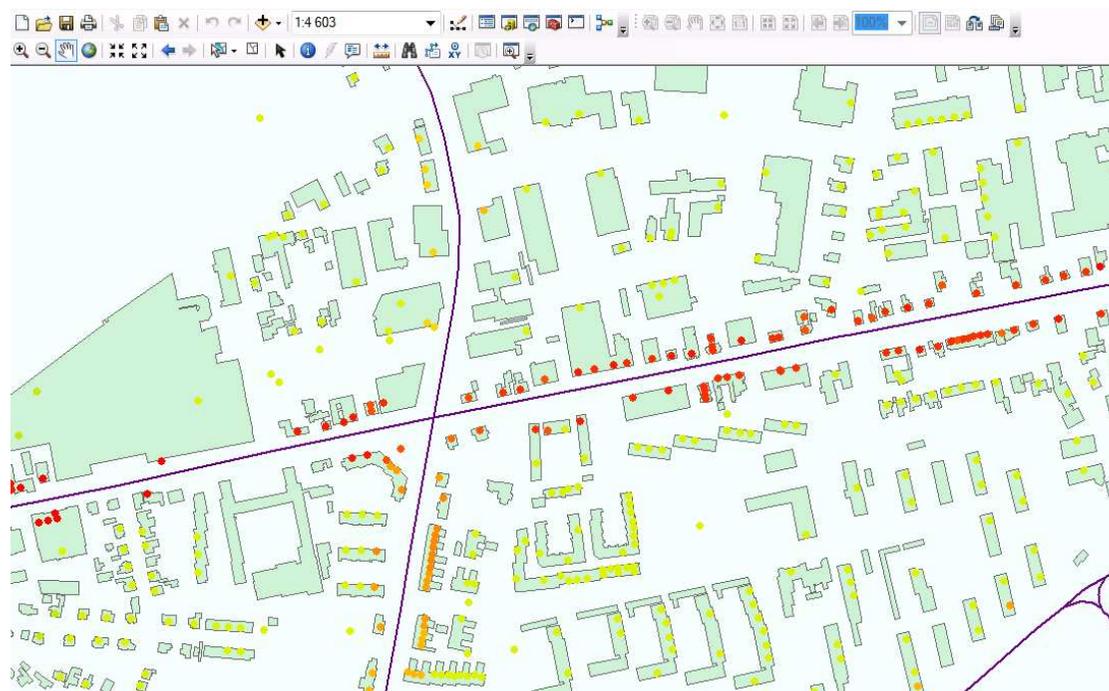
- › **Regional background concentrations**
 - › DEHM (Danish Eulerian Hemispheric Model)
 - › Adjusted for PM mass closure
 - › Geographic resolution 5,6 km x 5,6 km in DK
- › **Urban background concentrations**
 - › Urban Background Model (UBM)
 - › Coupled to DEHM in one hour time step
 - › Geographic resolution 1km x 1km
 - › New: all SNAP emission sectors
- › **Street concentrations**
 - › OSPM (Operational Street Pollution Model)
 - › AirGIS (automatic generation of input data to OSPM about traffic and buildings)
 - › Geographic resolution: address level





Preprocessing of data

- > National traffic model
- > Building footprints + heights
- > National address data
- > AirGIS script to generate



Example of large discrepancy in Aalborg



- > **Street geometry at measuring station at Aalborg**
- > **AirGIS model estimates street width to 21 m due to two small buildings**
- > **Width of 41 m is more representative**
- > **Modelled concentrations become too high**

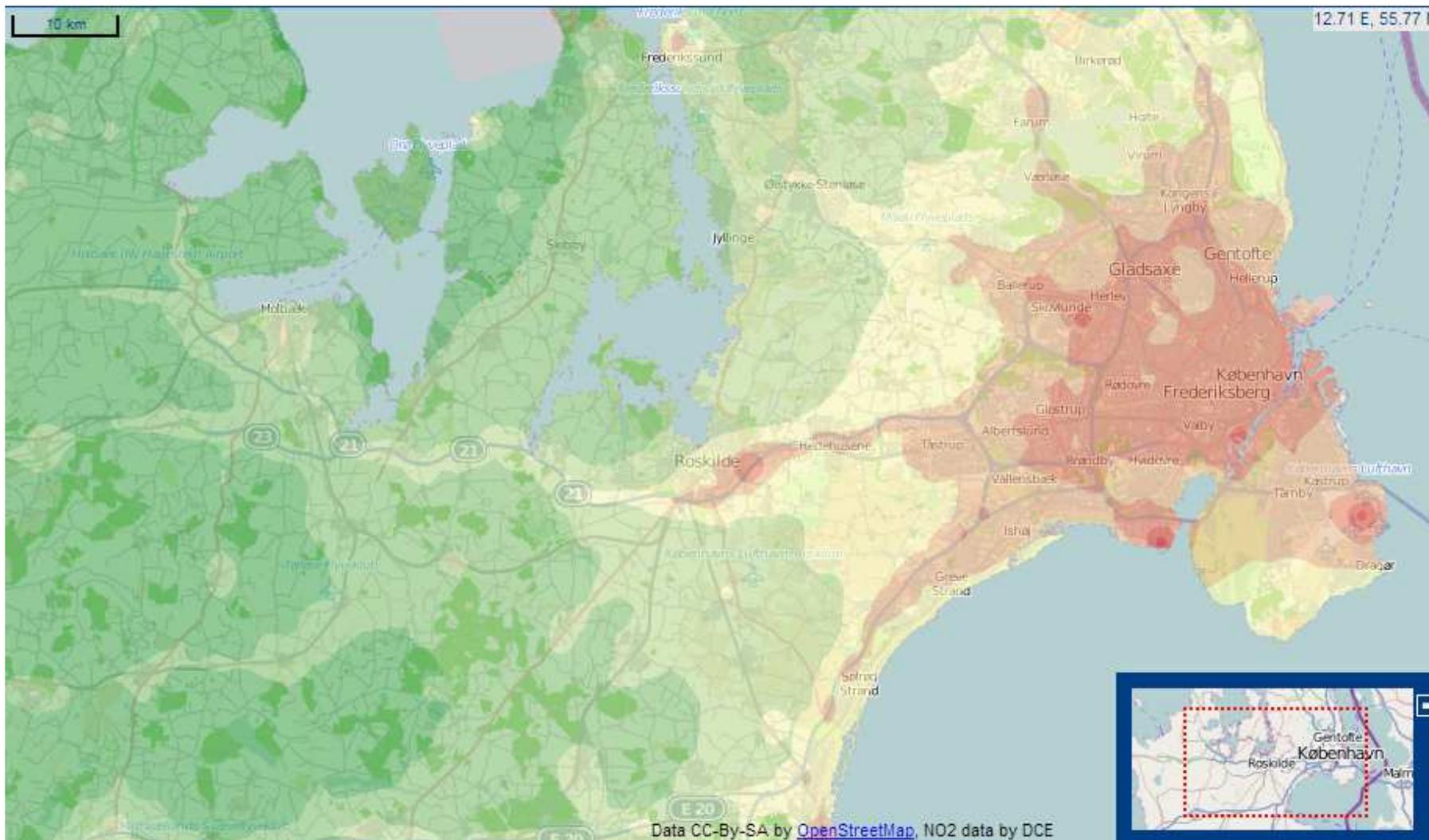
User interface in GeoExt

The screenshot displays the GeoExt user interface for Aarhus University. The top header features the Aarhus University logo and the text 'AARHUS UNIVERSITET DCE - NATIONALT CENTER FOR MILJØ OG ENERGI'. The interface is divided into several panels:

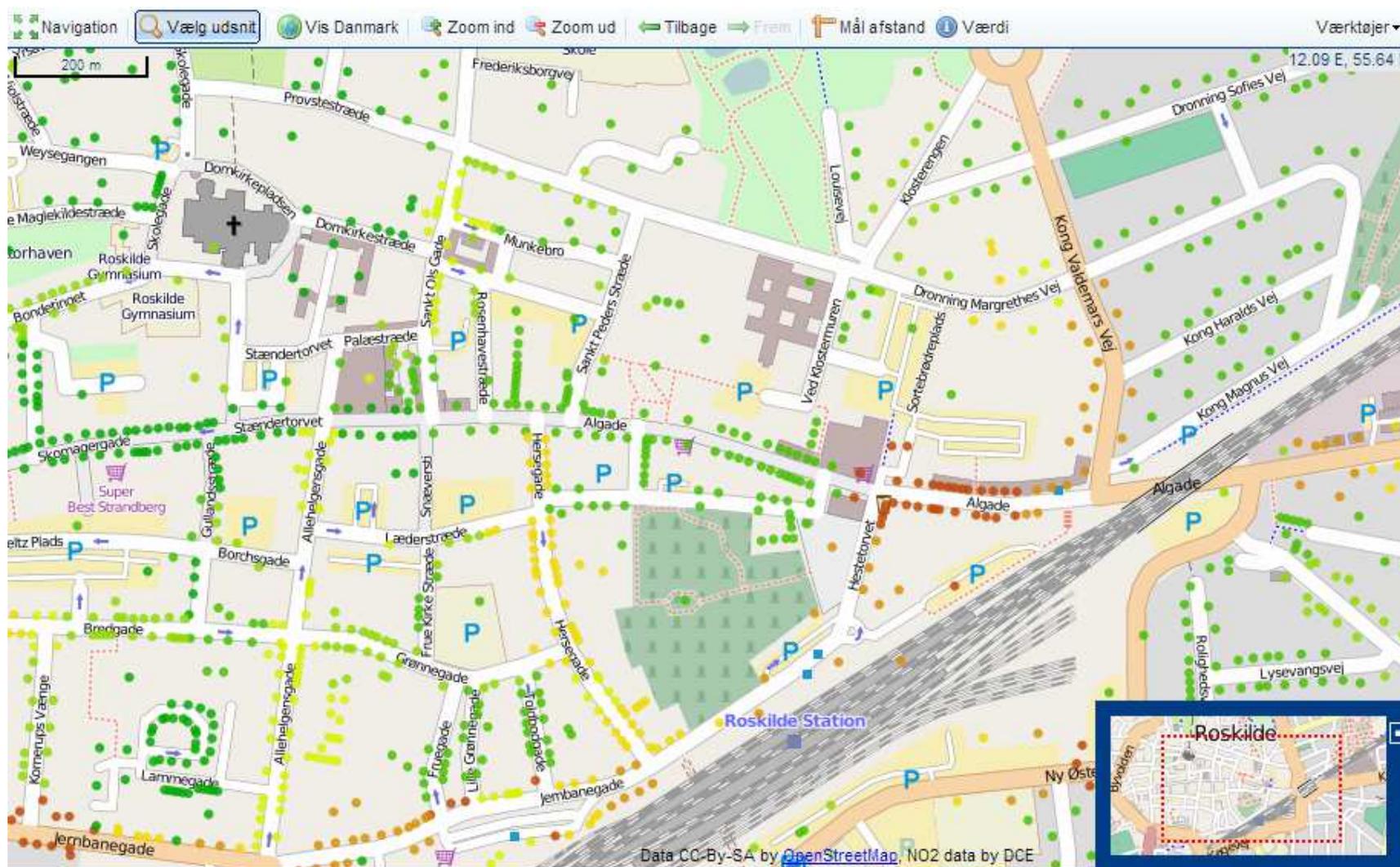
- Datalag (Left Panel):** Contains a 'Baggrundskort' section with options for Google Hybrid, Google Satellite, and OpenStreetMap. Below it, the 'Luftforurening i 2012' section has checkboxes for NO₂ (kvælstofdioxid), PM_{2.5} (partikler < 2,5 µm), and PM₁₀ (partikler < 10 µm).
- Navigation (Top Bar):** Includes tools for 'Navigation', 'Vælg udsnit', 'Vis Danmark', 'Zoom ind', 'Zoom ud', 'Tilbage', 'Frem', 'Mål afstand', and 'Værdi'. A scale bar shows 100 km.
- Map (Center):** Displays a map of Denmark with NO₂ pollution data for 2012. The map shows various regions and cities, with NO₂ concentrations indicated by color gradients. A small inset map shows the location of Denmark within Europe.
- Info (Right Panel):** Titled 'Signaturforklaring', it lists various map features and symbols, including: Motorvej, Motortrafikvej, Hovedvej (primær- og sekundær-), Uasfalteret vej, Hjulspor, Sti, Ridesti, Cykelsti, Gangsti, Jernbane, Undergrundsbane, Letbane og sporvogn, Kabelvogn og stolelift, Landingsbane og taxibane, Lufthavnsforplads og terminal, Administrativ grænse, Skov, Golfbane, Park, Boligområde, Seværdighed, Fæddel og eng, Detailhandelsområde, Industriområde, Erhvervsområde, Hede, and Sø og reservoir.

At the bottom of the interface, there is a search bar labeled 'Indtast adresse (gadenavn husnummer kommunenavn)' and a data attribution: 'Data CC-BY-SA by OpenStreetMap, NO2 data by DCE'.

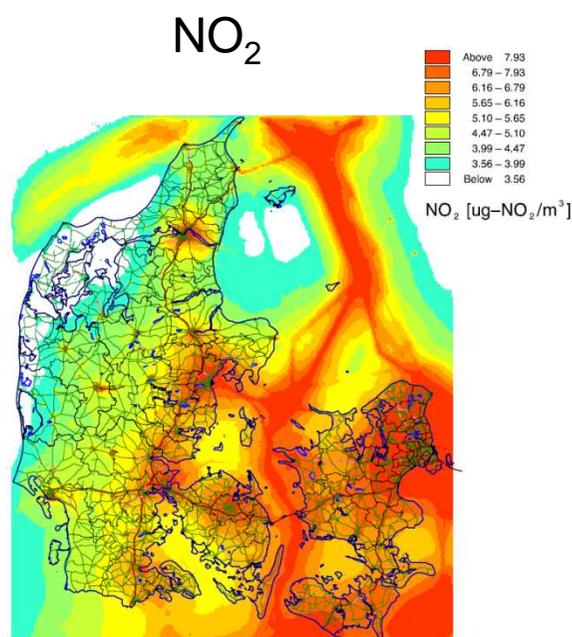
Urban background concentrations of NO₂



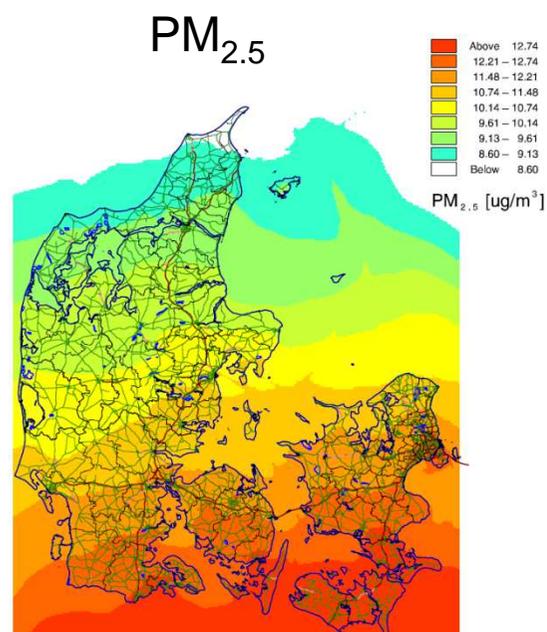
Street concentrations of NO₂



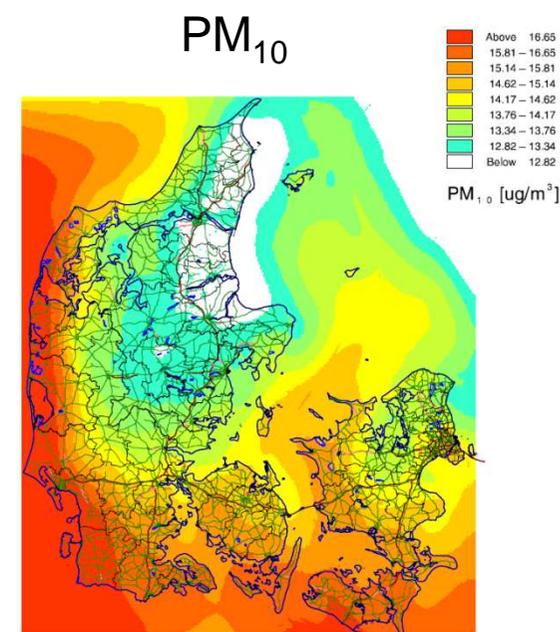
Urban background variations



- › Traffic sources and ships emissions clearly visible



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



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

Discussion of uncertainties and limitations

- › **generalised road network – if not edited – make unrepresentative street geometry**
- › **AQ at ‘background addresses’ in cities outside LTM road network can be underestimated**
- › **input data about traffic and interpretation of street geometry may not be representative**
- › **direct contribution from motorways is underestimated**
- › **AQ close to or exceeding limit values should be interpreted with caution due to uncertainty and requires more scrutiny of input data**

Conclusion

- › **OSPM has been further developed and coupled with a revised version of the urban background model.**
- › **satisfying performance when evaluated with measurements**
- › **Air Quality at Your Street gives in general a fairly accurate picture of air quality and its geographic variation and relative difference between areas**
- › **– but may be very wrong at single addresses**

Future work on OSPM

Long-term (“Nice to have” – wish list)

- > **More validation for Non-standard streets**
 - > Qatar HCAB Hong Kong ... LA
- > **buildings in different distances**
- > **variable receptor position**
 - > Horizontal positioning of the receptor point
 - > Height dependence
- > **street crossings**
- > **calculate the influence of the nearby road network**

Thank you for your attention

> **Acknowledgement:**

- > Funding e.g. Danish EPA, various EU projects, Qatar Foundation, DCE – Danish Centre for Environment and Energy under Aarhus University
- > Technical University of Denmark (DTU Transport) provided traffic data from the Danish National Traffic Model (LTM)
- > Danish Road Directorate provided data on travel speeds