Air Pollution Levels at Copenhagen Airport estimated by measurements and Nested Regional Eulerian, Local Gaussian Plume and CFD Models

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Outline

- Background
- Method
  - Three one-way nested models
    (regional DEHM, local OML and MISKAM)
  - Emission inventories
- Results
- Conclusions

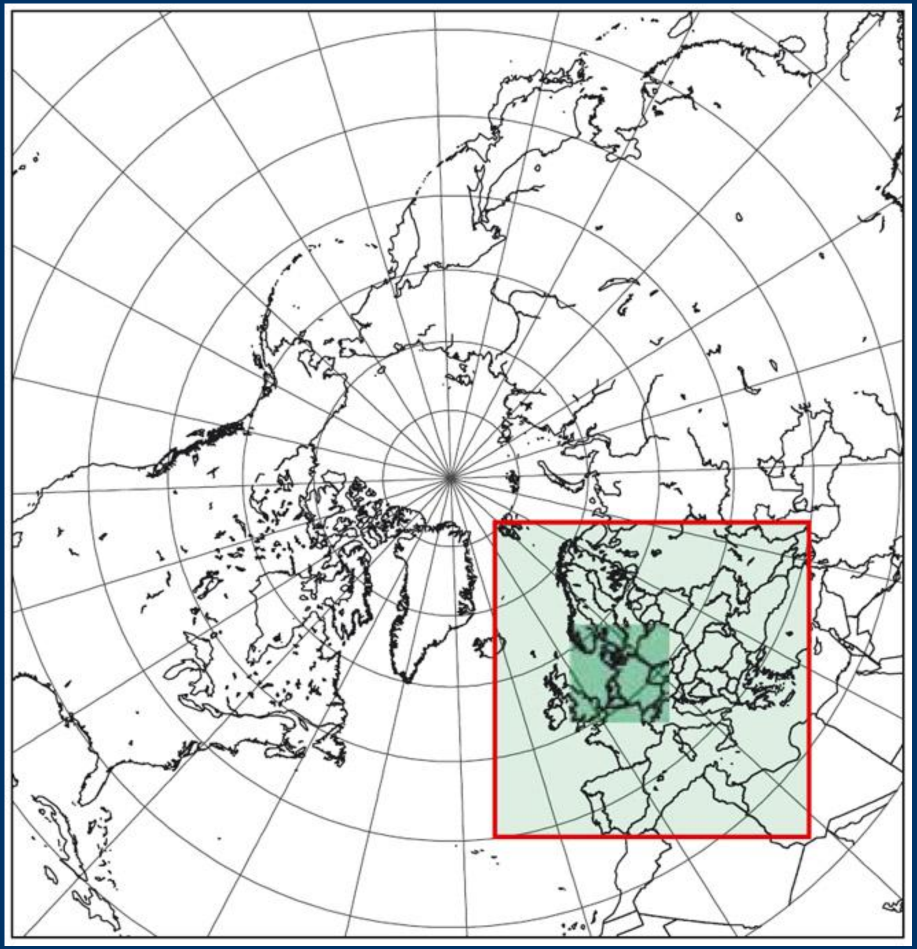
Background

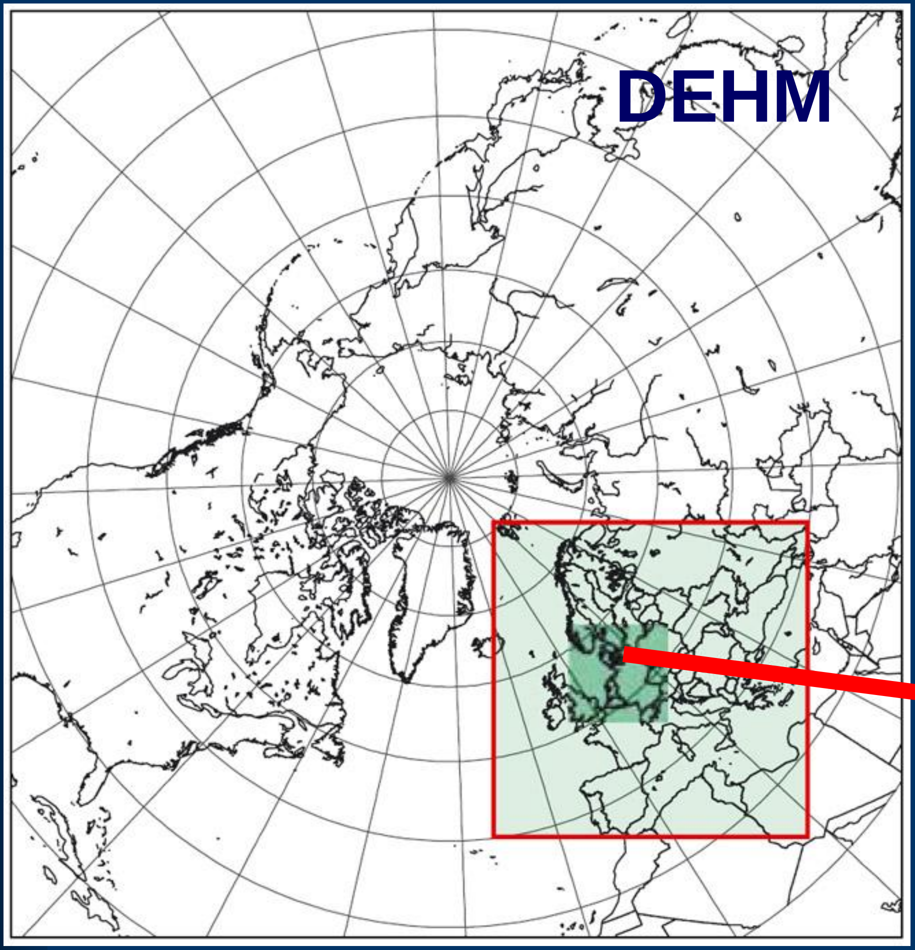
- Possible work-related health problem in the airport
- Focus on the apron
- Measurements and dispersion modelling for 2010
- Limit values
- Point out possible major sources
  => reduction strategy
- Several air pollutants measured,
  but only NO_X and NO_2 are presented here

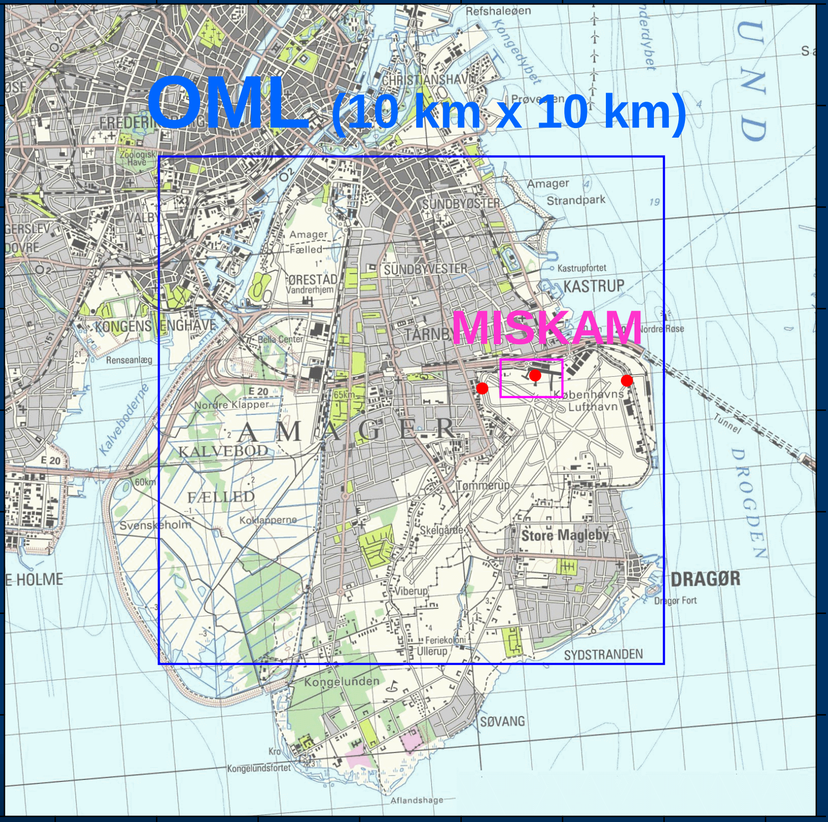
DEHM (Danish Eulerian Hemispheric Model)

- Horizontal grid size:
  - 150 km x 150 km
  - 50 km x 50 km
  - 5,6 km x 5,6 km

- 3D chemical transport model
  - Transport and dispersion
  - Chemical reactions
  - Wet and dry deposition



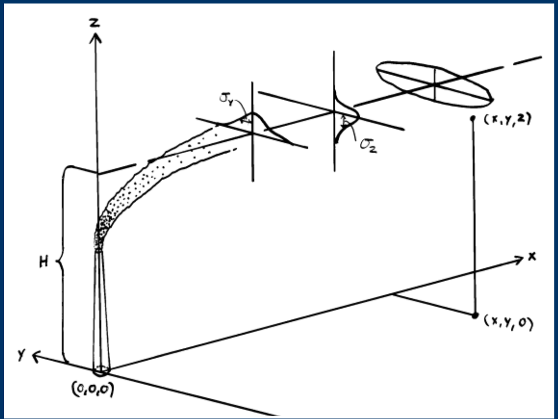

DEHM


OML (10 km x 10 km)
MISKAM
AMAGER
KALVEBOD
FÆLLED
KASTRUP
DRAGØR
Store Magleby
SUNDBYØSTER
SUNDBYVESTER
ØRESTAD
CHRISTIANSHAVN
KONGENS ENGHAVE
Københavns Lufthavn
SYDSTRANDEN
SØVANG
Kongelunden
Tømmerup
Viberup
Skelgårde
Amager Strandpark
Amager Fælled
Refshaleøen
Nordre Klapper
Svenskeholm
DROGDEN

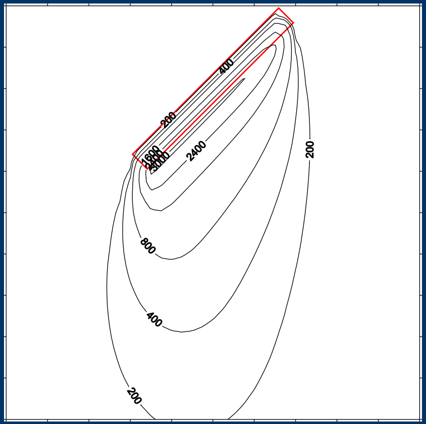
The OML model

Gaussian plume model

- Point sources
  - Plume rise
  - Building effects
- Area sources
- Disp. continuous function of hourly u*, L, z_0, H_{mix}
- Hourly conc.
- Chemical scheme for NO-NO_2-O_3 as in OSPM



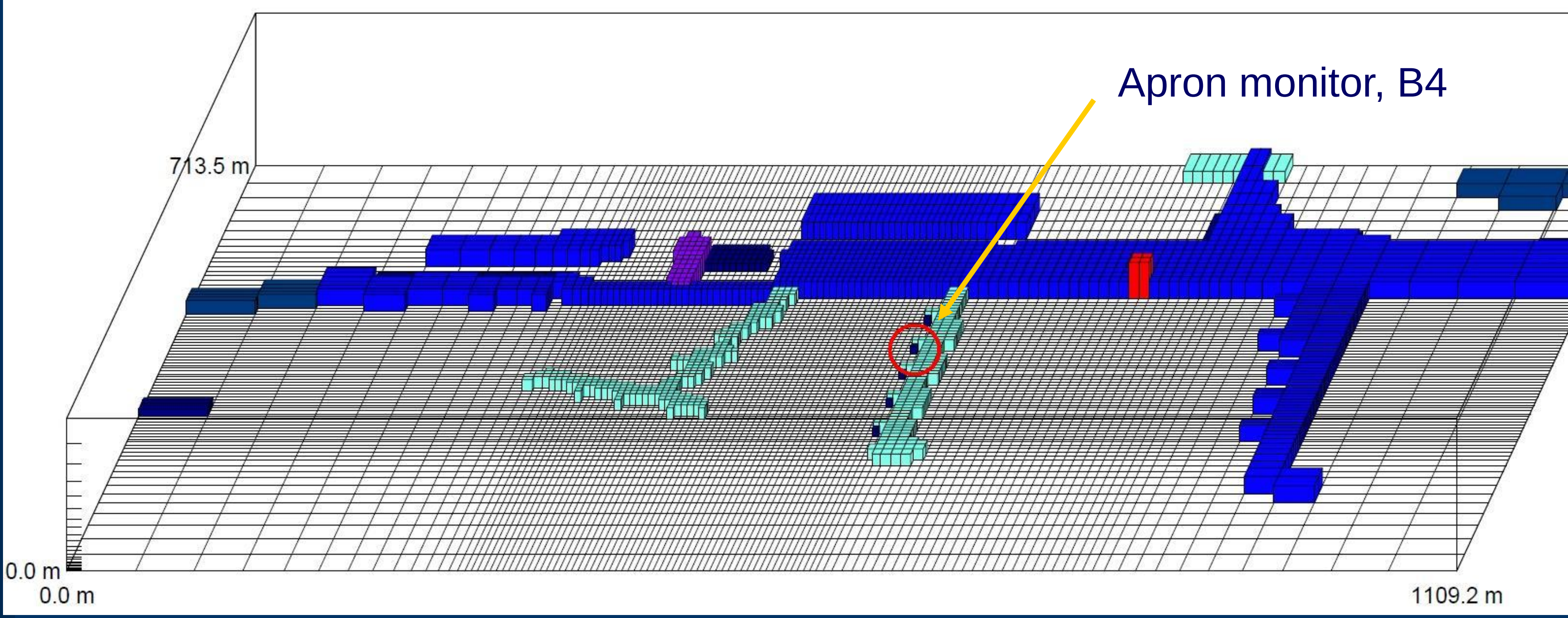
Point source



Area source

Building effects

MISKAM



- **CFD model**
- **Grid size in centre: 5 m x 5 m**

Emission inventories

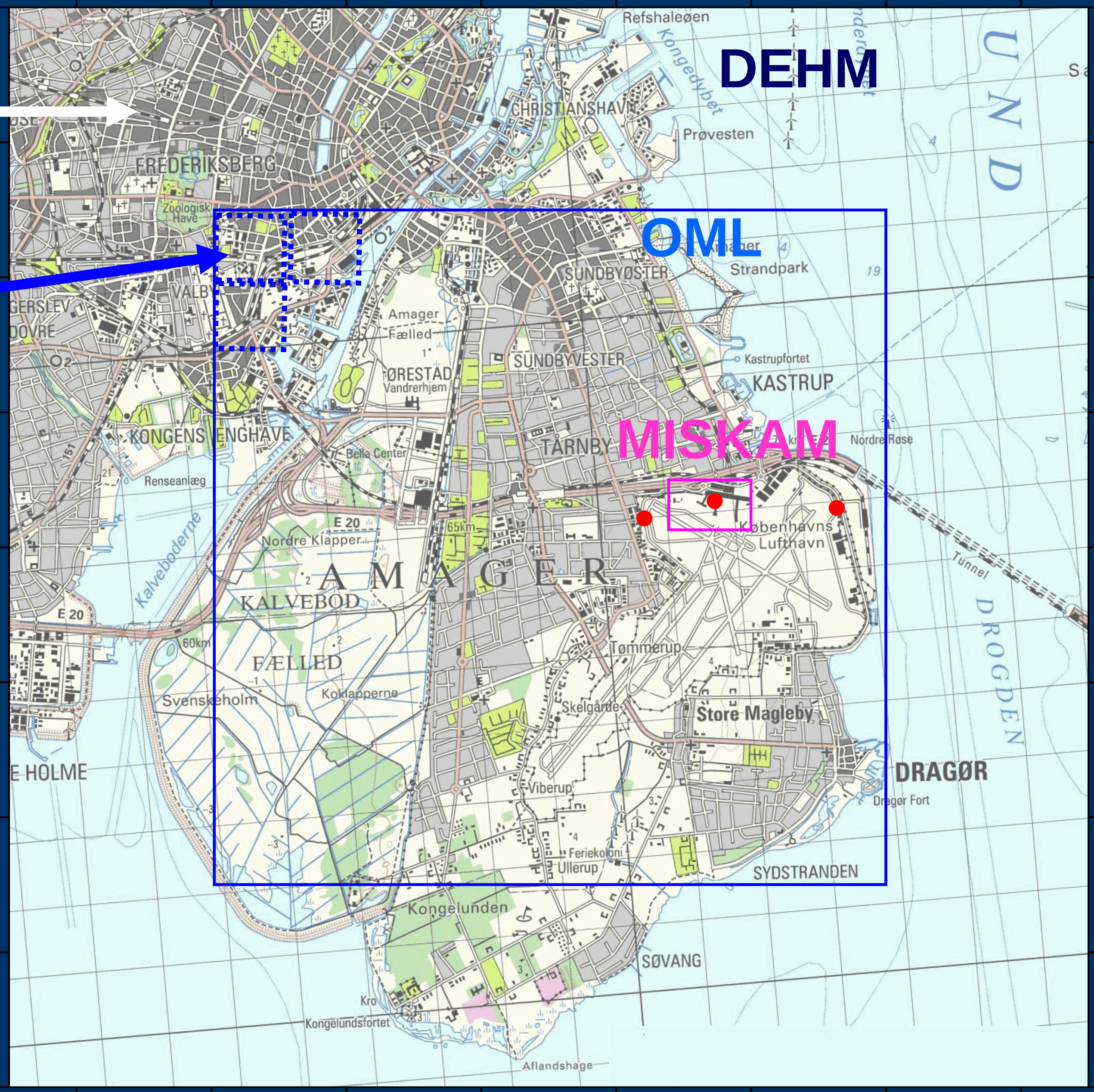
- **The airport: A very detailed emission inventory**
- **Danish road traffic: Danish road database (**Jensen et al., 2009**)**
- **Other Danish sources:** 1km x 1km **inventory (**Plejdrup et al., 2011**)**
- **European sources: EMEP inventory**
- **Hemisphere sources:** EDGAR2000 and GEIA
- **SNAP categories (Selected Nomenclature for Air Pollution; ETC/AEM – CITEPA, 1996): combustion , industries, transport, waste, agriculture, etc.**

DEHM:
5.6 km x 5.6 km

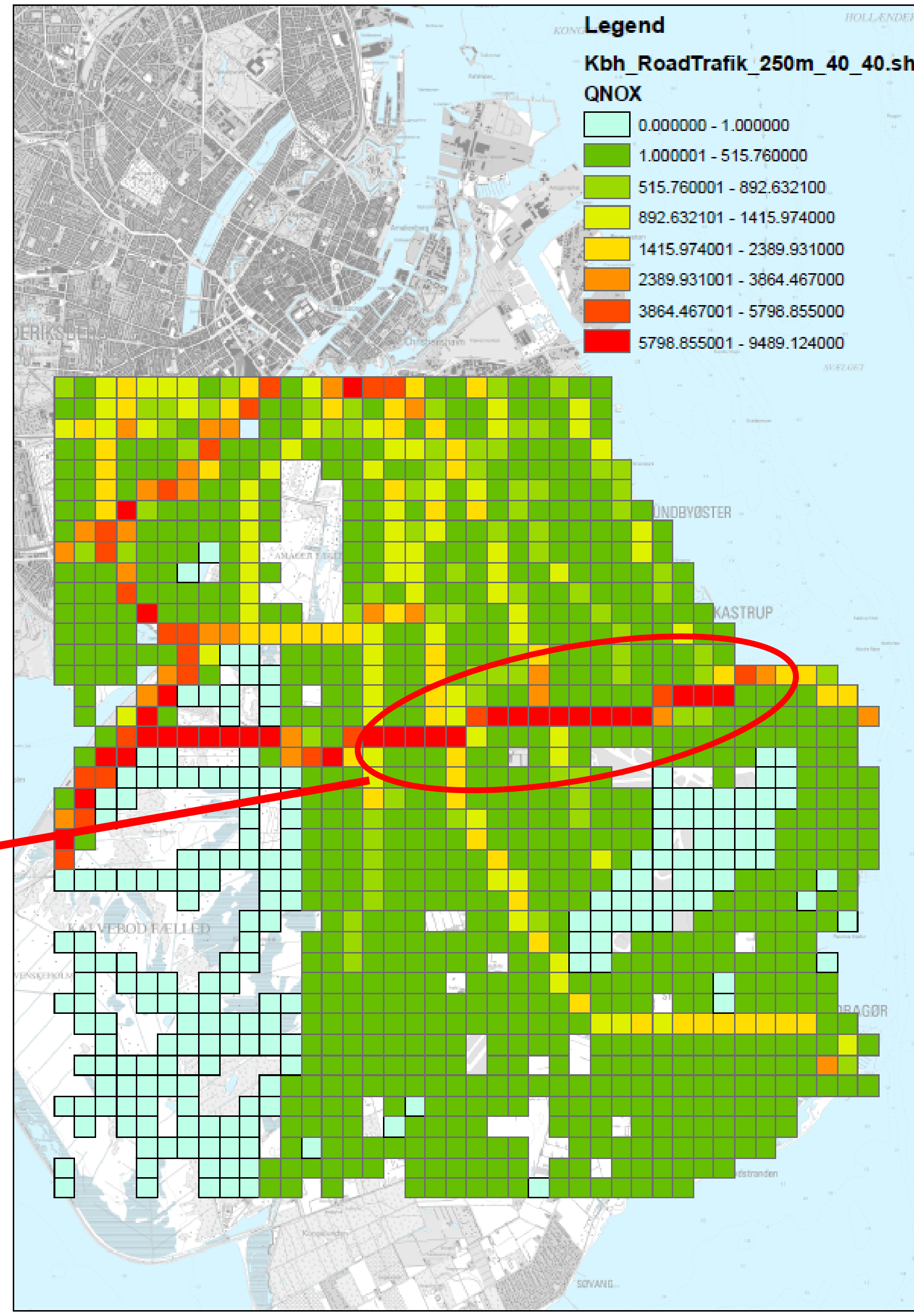
OML non-vehicle emission:
1 km x 1 km

OML domain:
10 km x 10 km

MISKAM domain:
1100 m x 700 m



Traffic emission grid
250 m x 250 m,
used in OML



50 m x 50 m

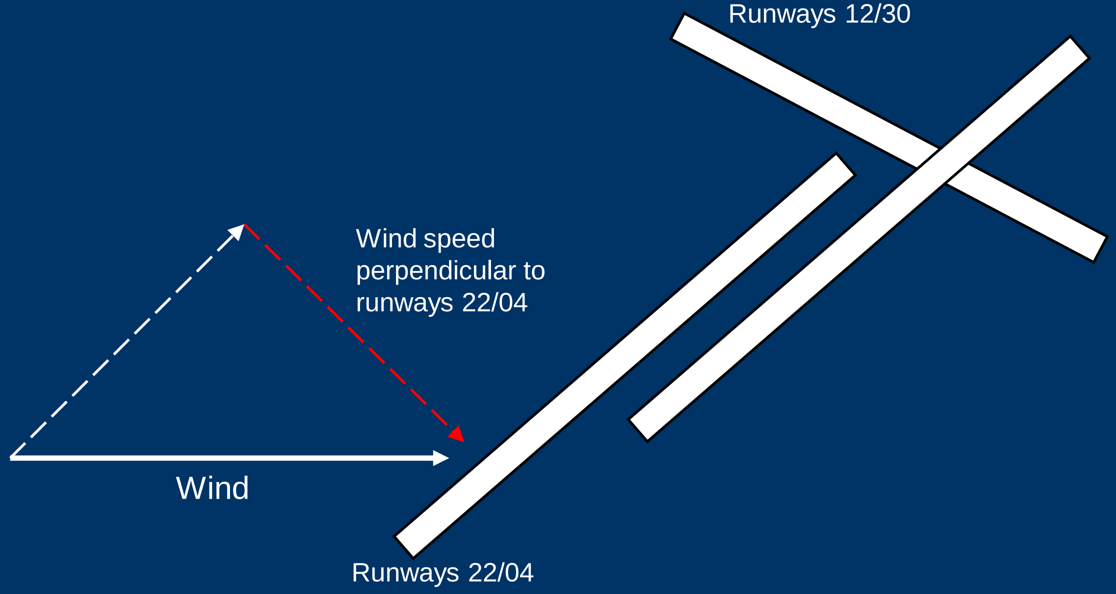
Airport emission inventory

- Based on flight operations for 4 typical days with use of 4 possible runways
- Aircraft emission divided into taxi, take-off, climb-out, approach and landing
- Databases:
  - ICAO (Intern. Civil Aviation Org.) emissions
  - LASPORT (LASat for airports, Janicke 2010) fuel consumption
- Source categories
  - Aircraft main engines
  - APU (auxiliary power units)
  - Handling equipment
  - Vehicle traffic inside the airport

Choice of one of four emission days / runways

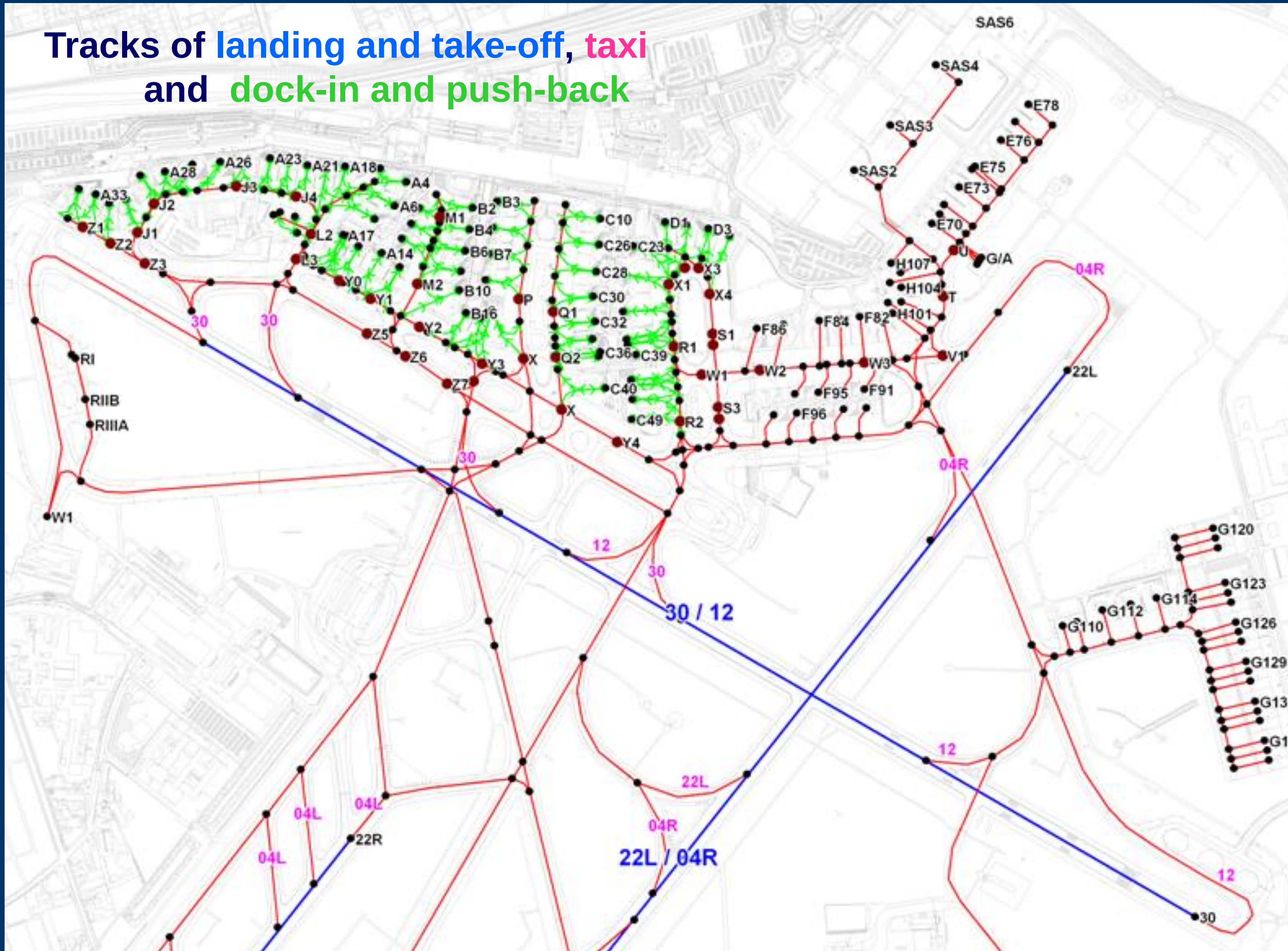
4 typical days/runways:

- 22 L+R
- 04 L+R
- 12
- 30



Choice determined by
wind speed and direction
for the current hour

Tracks of landing and take-off, taxi and dock-in and push-back

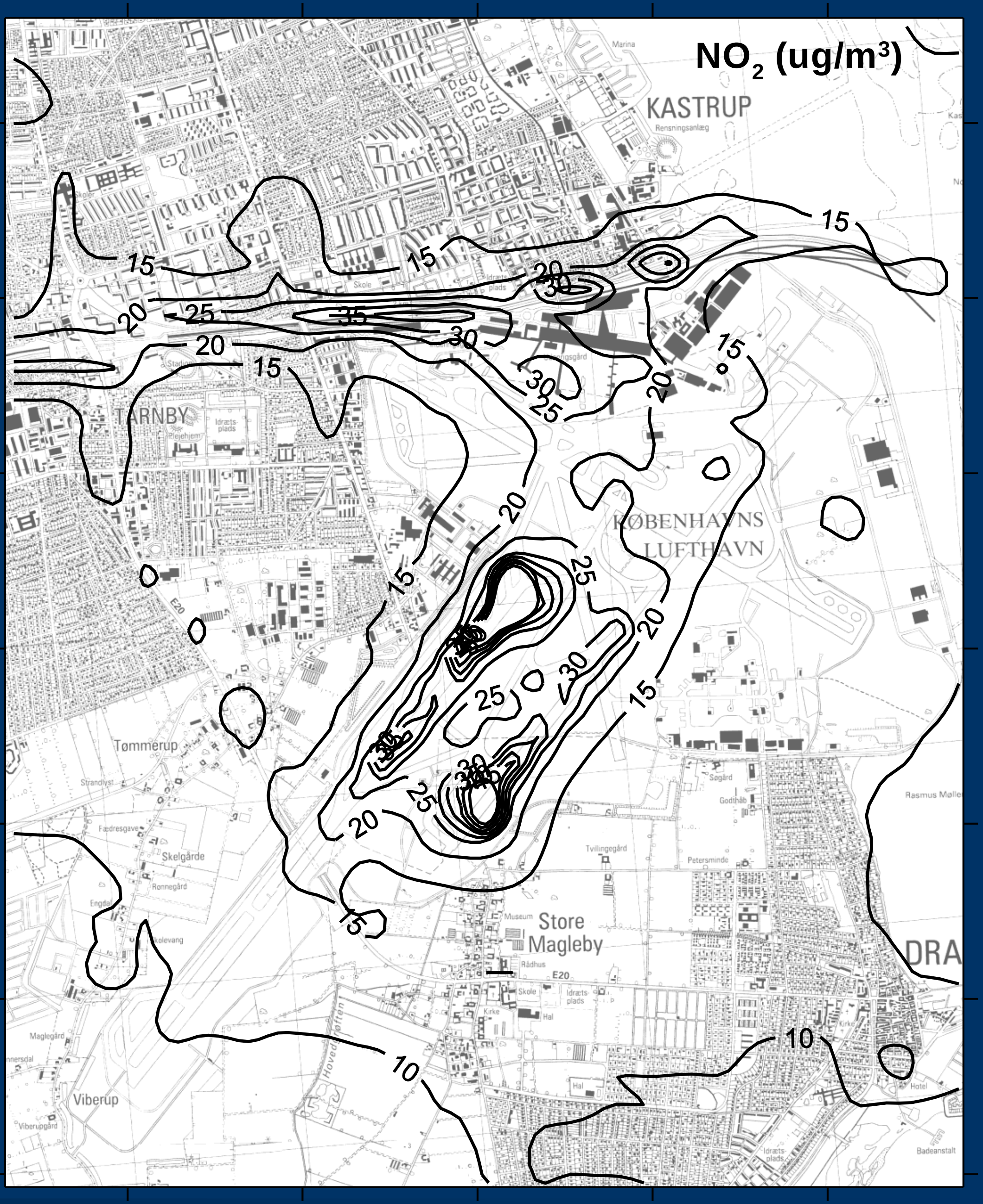


NO_x emission at the apron

Results

OML

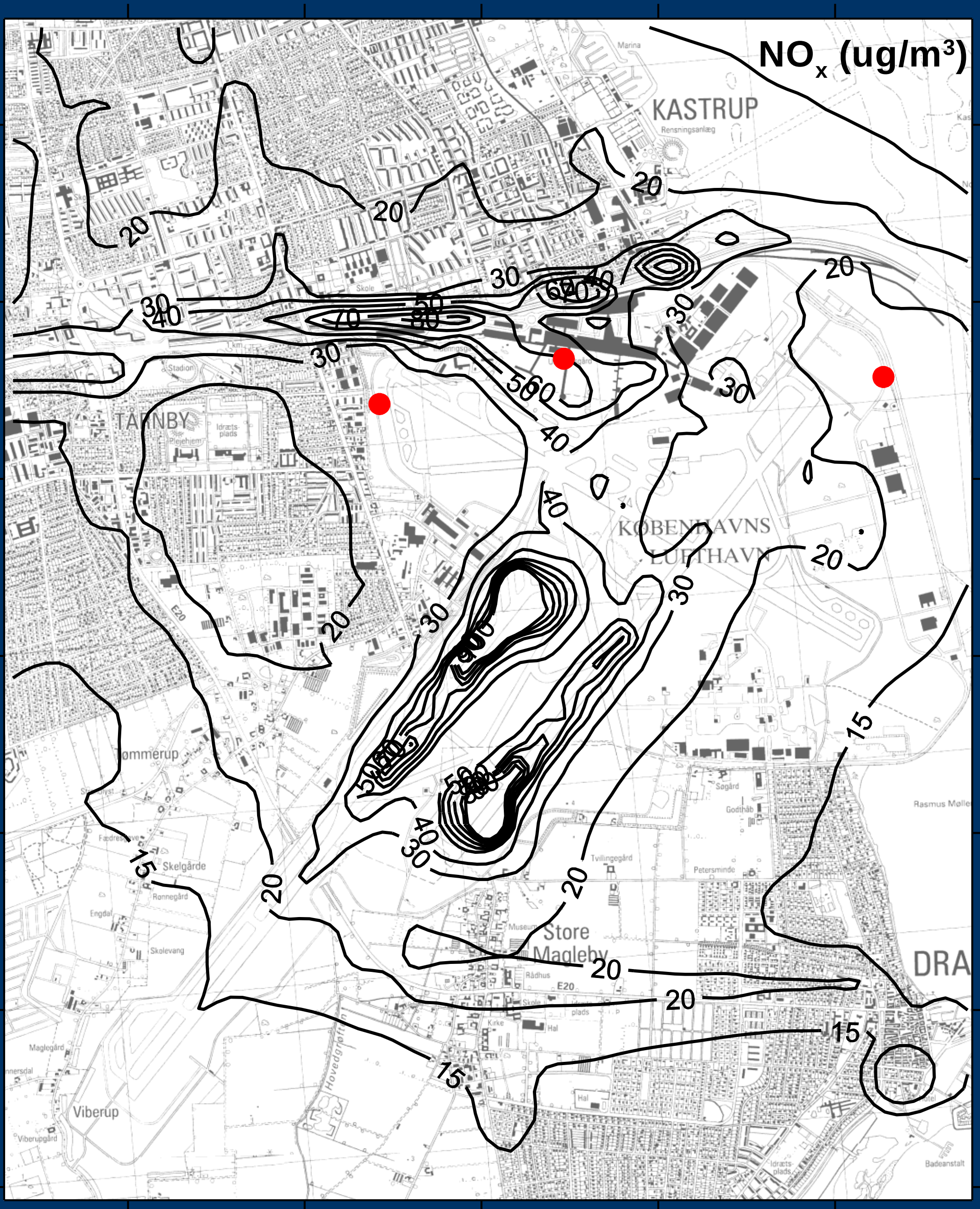
Yearly NO_2



Results

OML

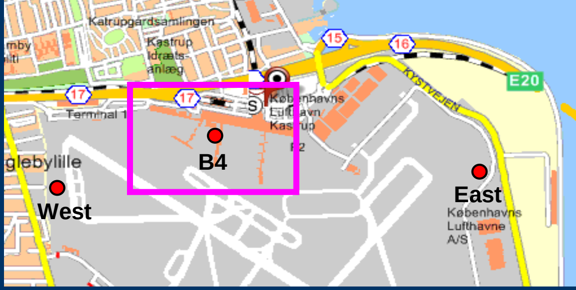
Yearly NO_x

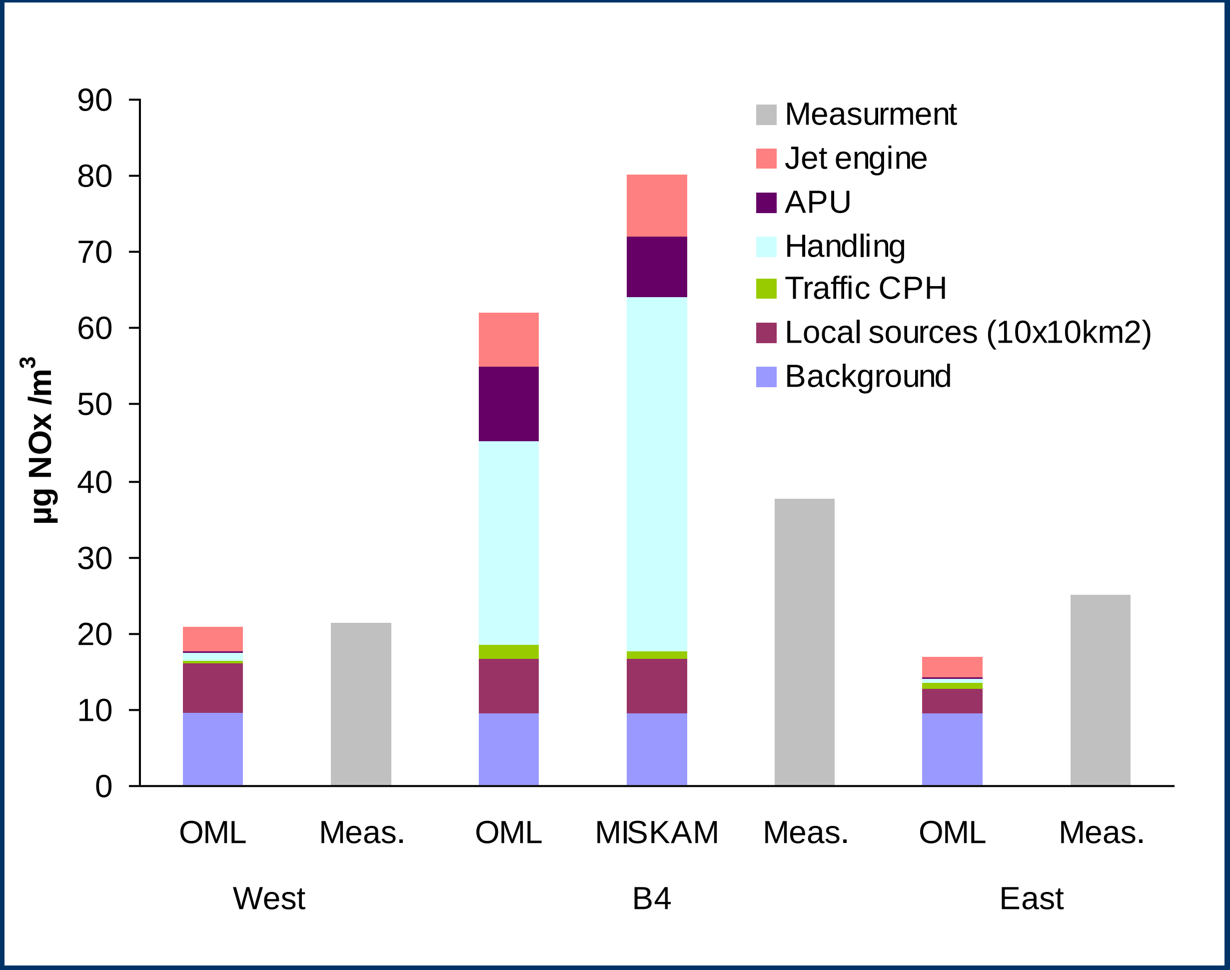


Source categories

- Background (regional from DEHM)
- Local sources (10 km x 10 km) outside airport
- Aircraft main engines
- APU (auxiliary power units)
- Handling equipment
- Vehicle traffic inside the airport

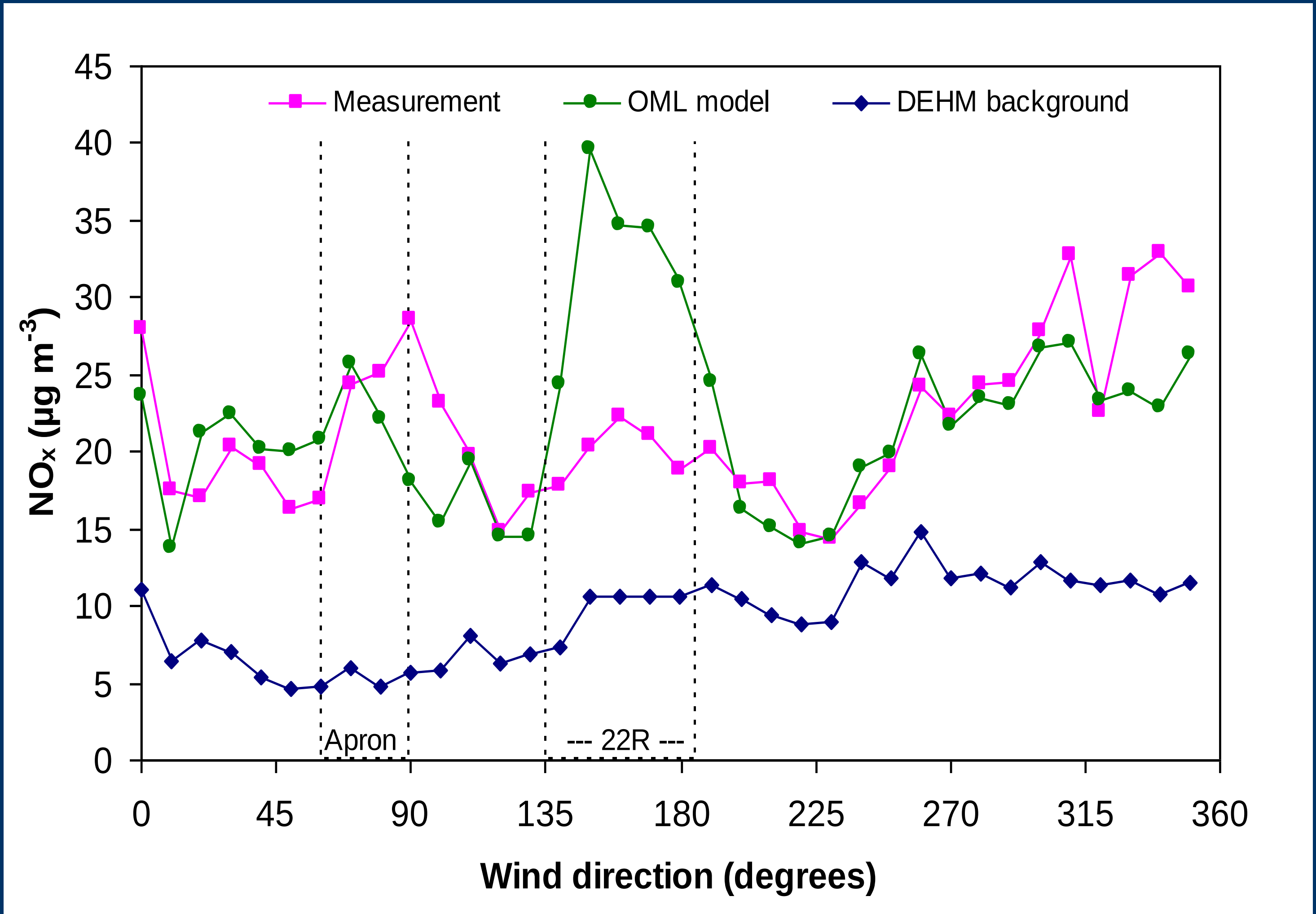
NO_x, 2010

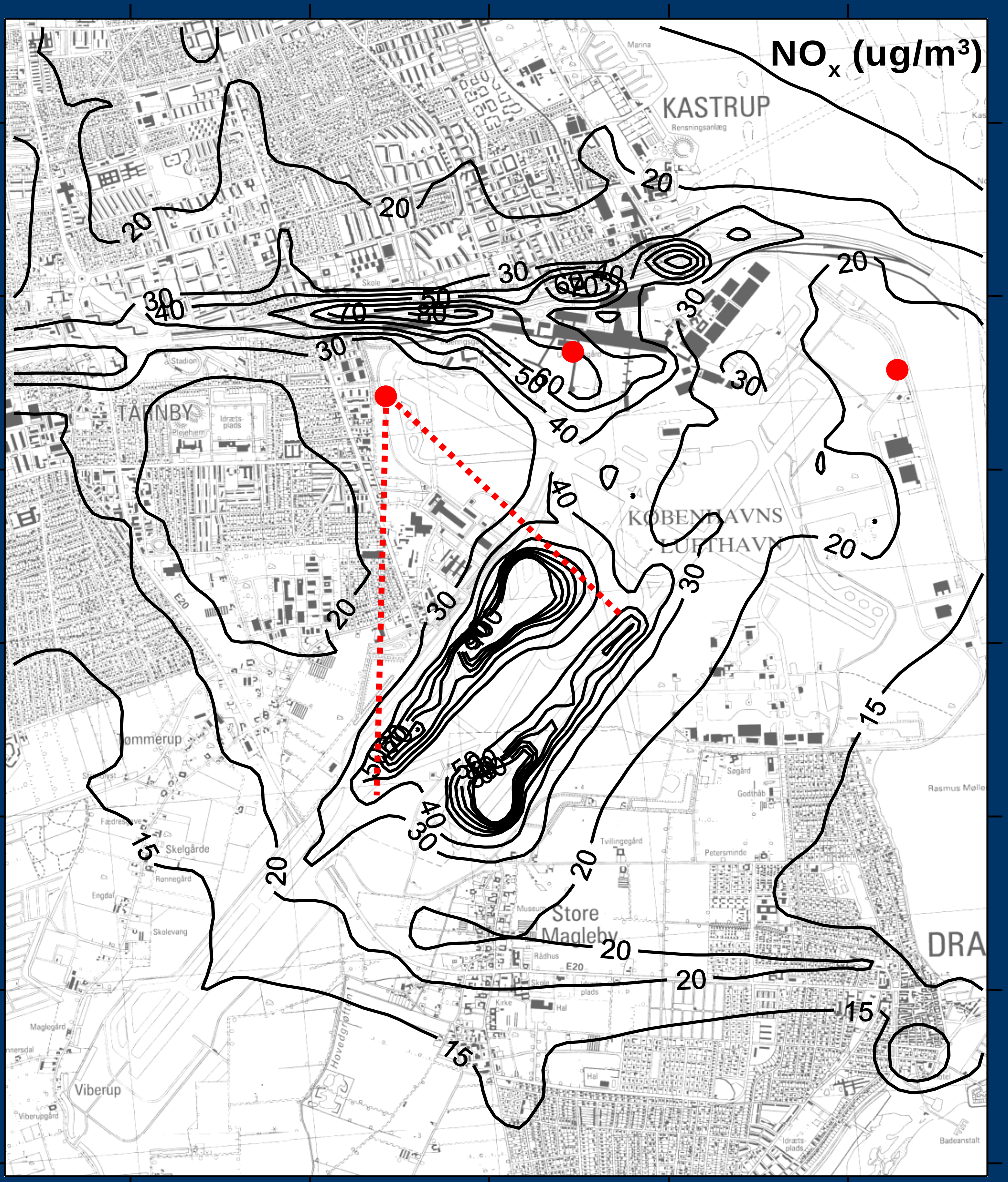




Model differences:
-grid size
-time variation
-atm. stability

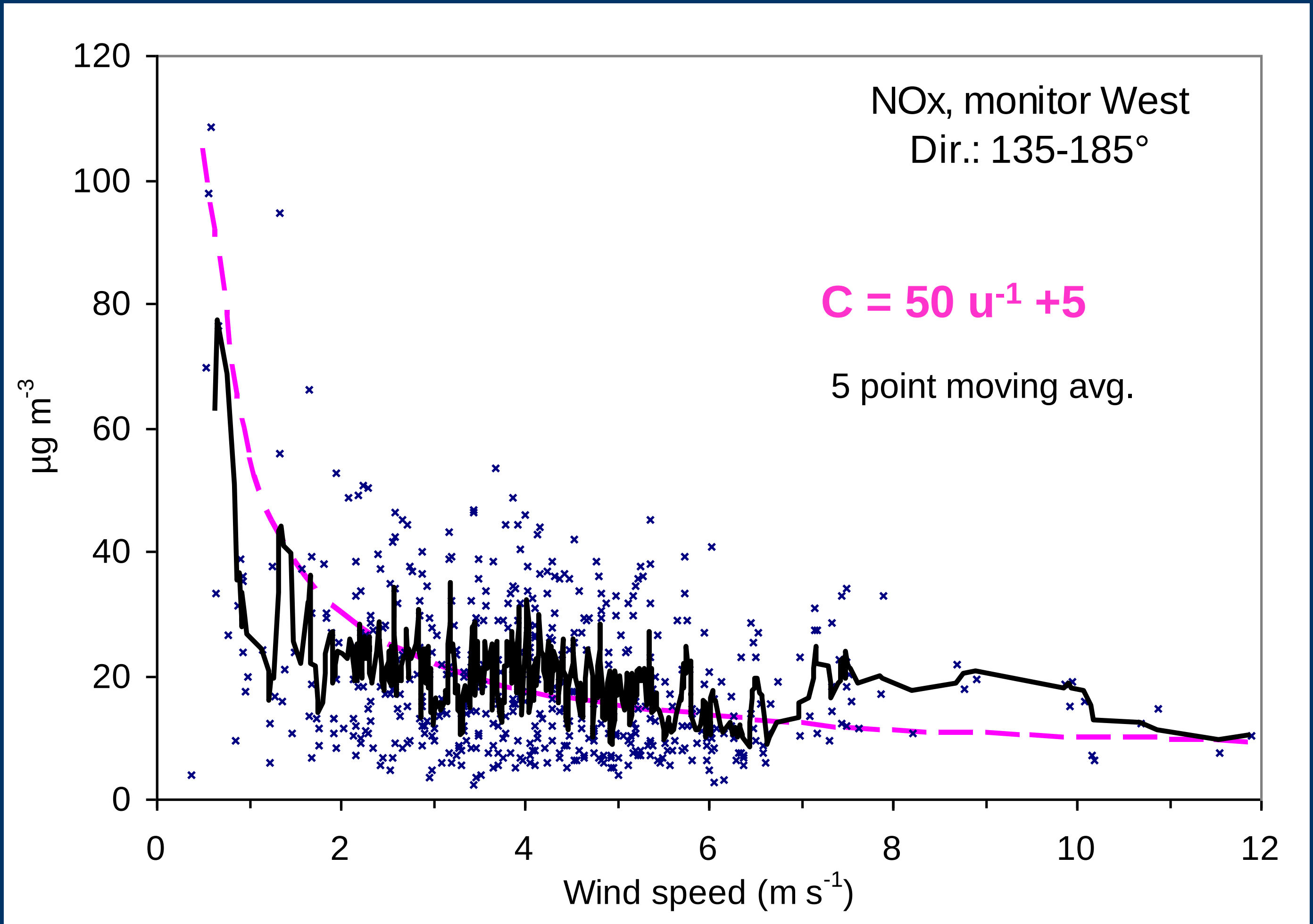
Station West



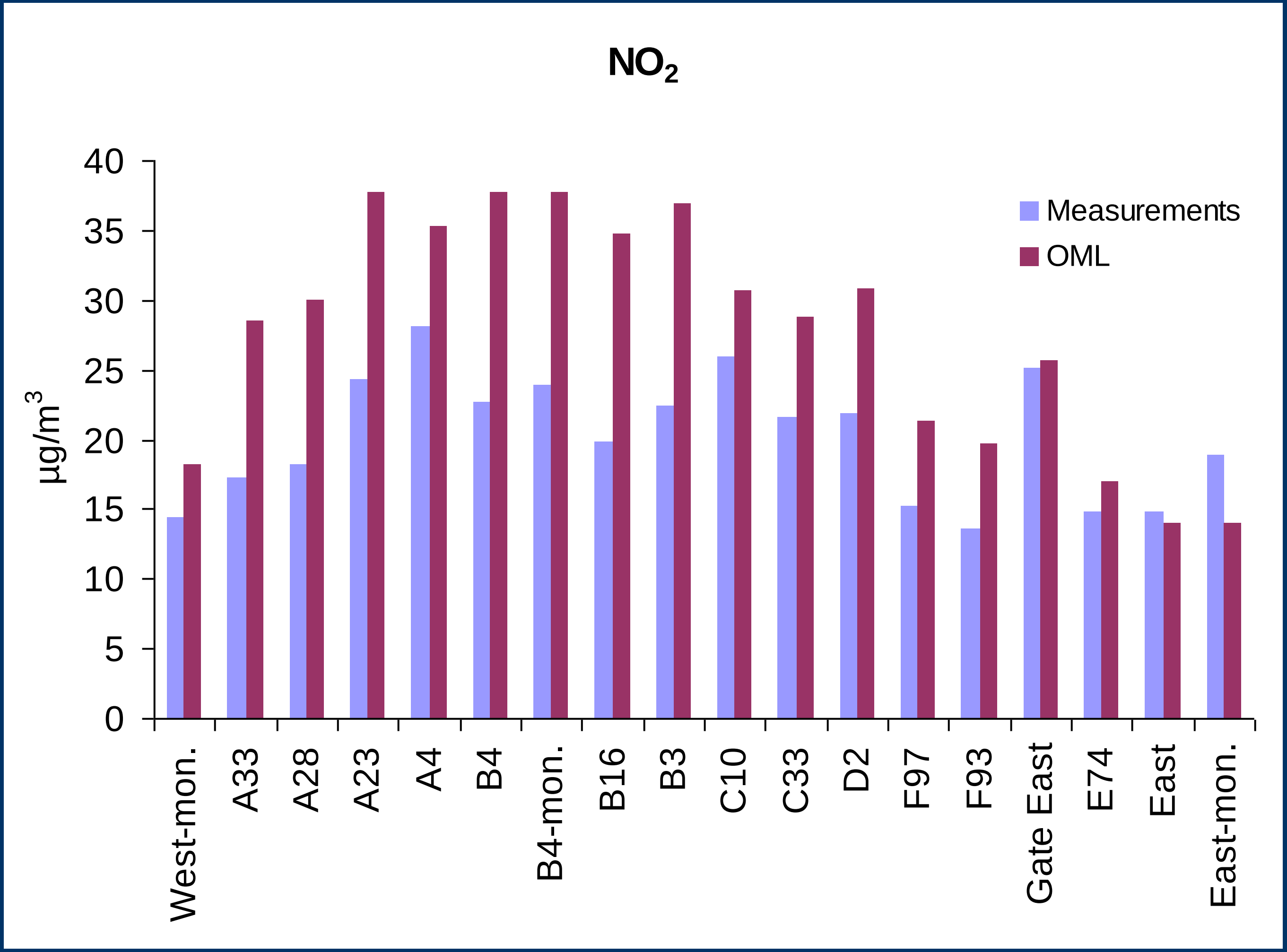


Direction 135-185 towards part of runway 22R with major emissions

Measurements



5 weeks campaign with passive samplers mainly at the apron



Conclusions

- The relative geographical distribution of the emission at the apron is reproduced well
- The NO_x level at the apron is overestimated probably due to too high emission from handling equipment
- The levels at the remote monitors are modelled well
- Plume rise of aircraft main engines and APU must be accounted for in future studies in order to determine if aircraft emissions are too high