Developments of ADMS

Presented by

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Outline

- ADMS3/ADMS4
- ADMS-Urban/ADMS-Roads
- ADMS-Airport

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…after ADMS 3?

- What applications do you currently use ADMS for?
- Which model options are most/least popular? Which pollutants are of most/least interest?
- What scientific capabilities would you like to see in ADMS?
- What other features would you like to see?
- Other issues?

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Process

- User Group Meeting session, June 2003
- Feedback from helpdesk, training etc
- Own ideas
- New scientific information, validation
- Wrote to users in April 2004 seeking views

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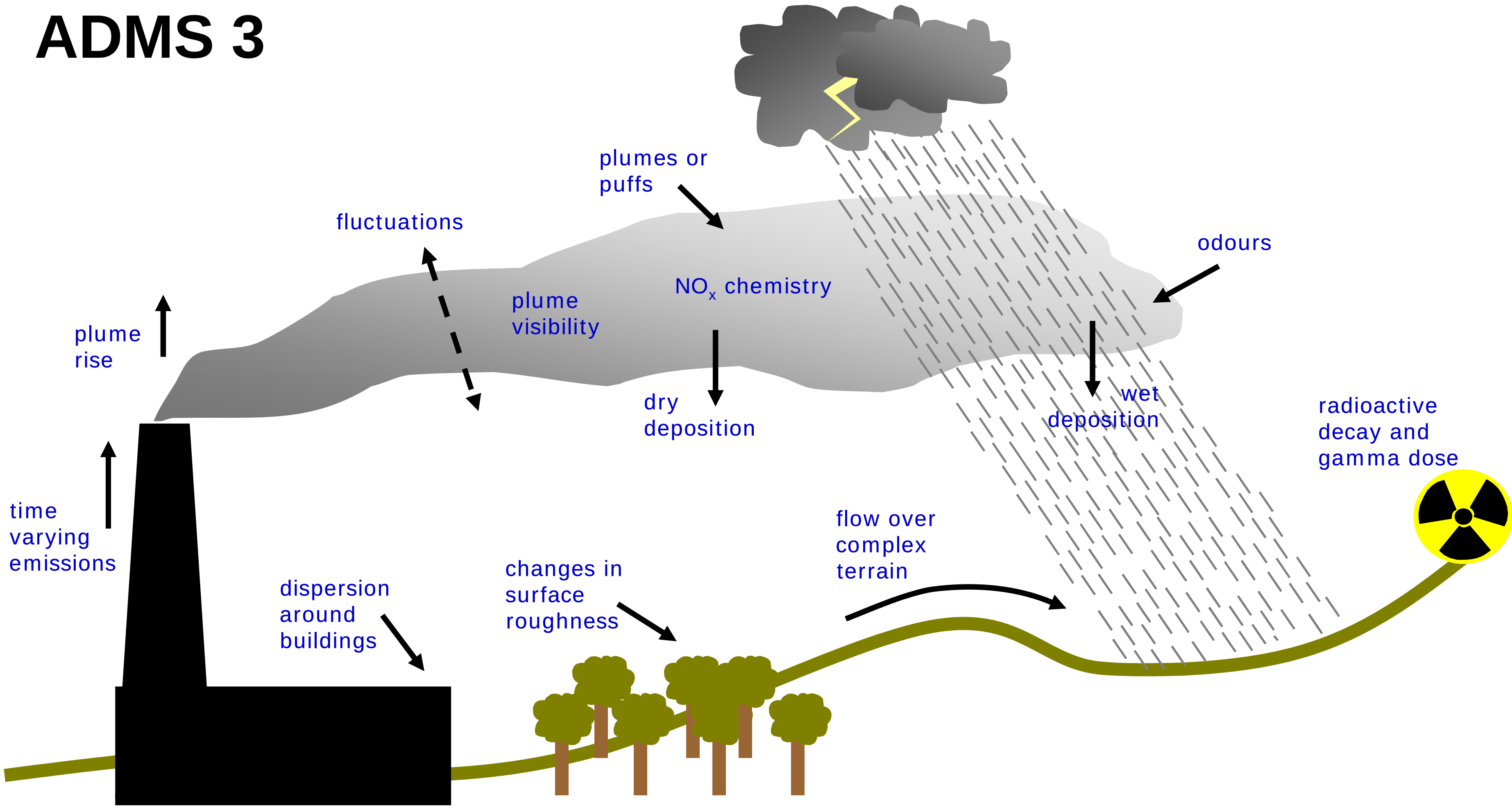
Current Features of ADMS 3



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Meteorology

Issues -

- Decreasing number of surface met sites
- Quality control of meteorological data
- Use of met model for ‘met data input’
- Future weather - climate change

Developments -

- Allowance for input of vertical profiles
- Allow use of mesoscale model 3D fields and CFD output (building module)

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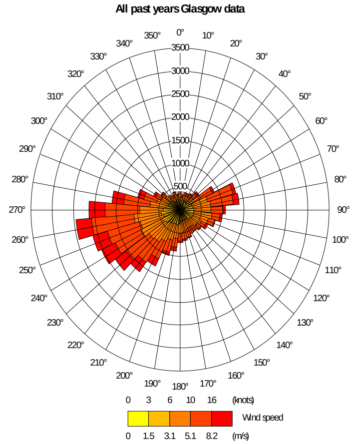

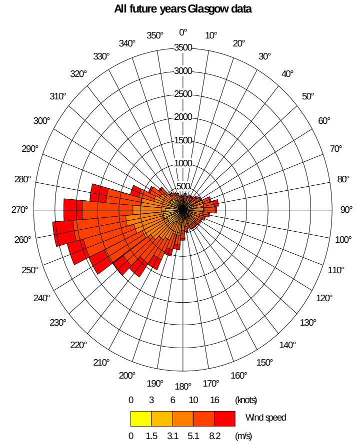

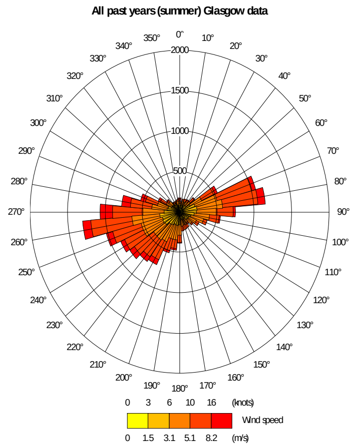

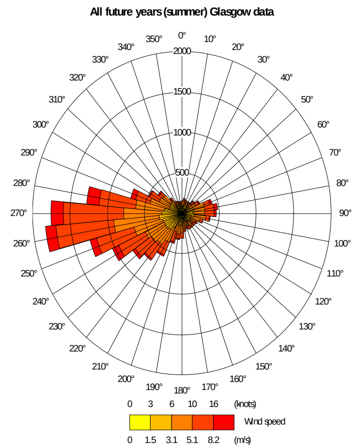

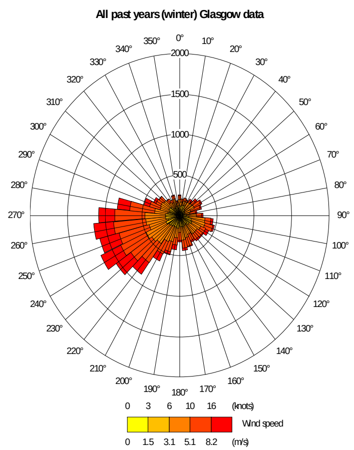

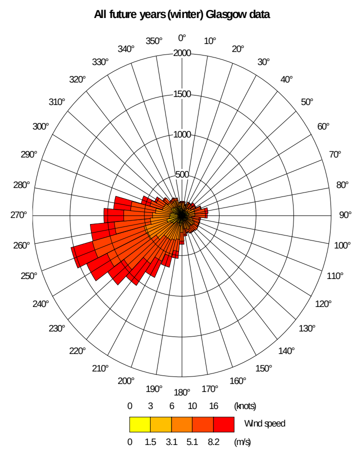

Climate Change

Wind roses for Glasgow under the current and future climate scenarios. All year, summer, and winter roses are presented. For each scenario, the results are for the four years combined.

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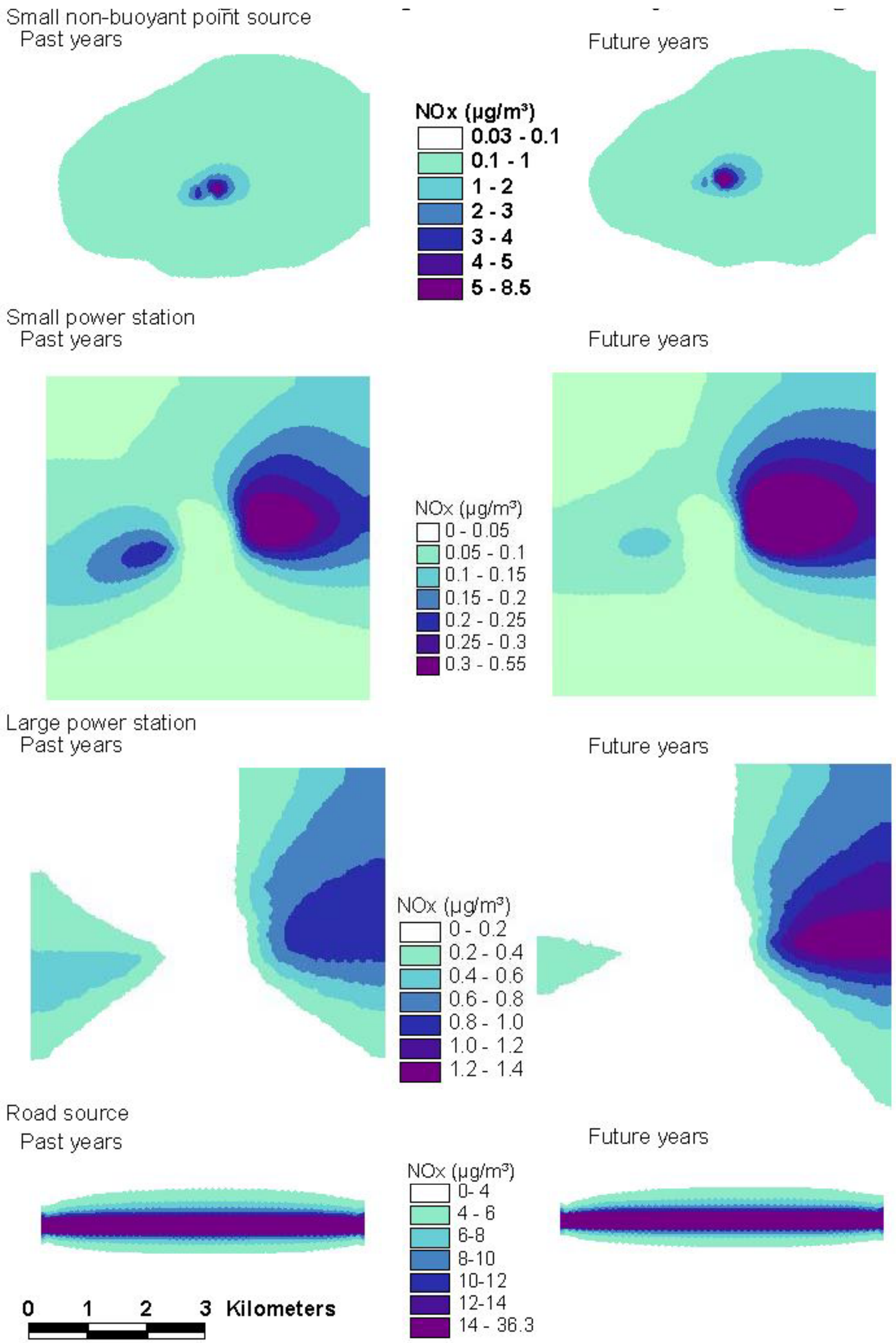

Climate Change

Long term average of NO_x for past (1971, 1976, 1981, 1986) and future years (2071, 2076, 2081, 2086) calculated using ADMS 3.2 (point sources) and ADMS-Urban (road source) with Glasgow meteorological data. Note the scale bar does not relate to the large power station plot which covers 16×16km; all other plots are 6×6km and do relate to the scale bar.

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Calculated changes in spatial maxima of various NO_x concentration statistics: Glasgow met data

		Annual average (µg/m³)	Maximum hourly average (µg/m³)	99.8th percentile of hourly average (µg/m³)	99th percentile of hourly average (µg/m³)	98th percentile of hourly average (µg/m³)
Small point	Past	6.82	405.83	141.92	59.89	49.91
	Future	8.53	341.66	144.82	62.22	52.20
	% change	25.07	-15.81	2.04	3.89	4.59
Small power station	Past	0.41	12.81	6.66	5.22	4.44
	Future	0.55	12.35	6.81	5.59	4.78
	% change	34.15	-3.59	2.25	7.09	7.66
Large power station	Past	0.98	89.40	47.19	30.71	18.71
	Future	1.36	88.53	49.71	36.07	25.92
	% change	38.78	-0.97	5.34	17.45	38.54
Road	Past	36.34	883.19	702.99	491.45	393.97
	Future	33.65	868.49	668.37	470.18	363.13
	% change	-7.40	-1.66	-4.92	-4.33	-7.83

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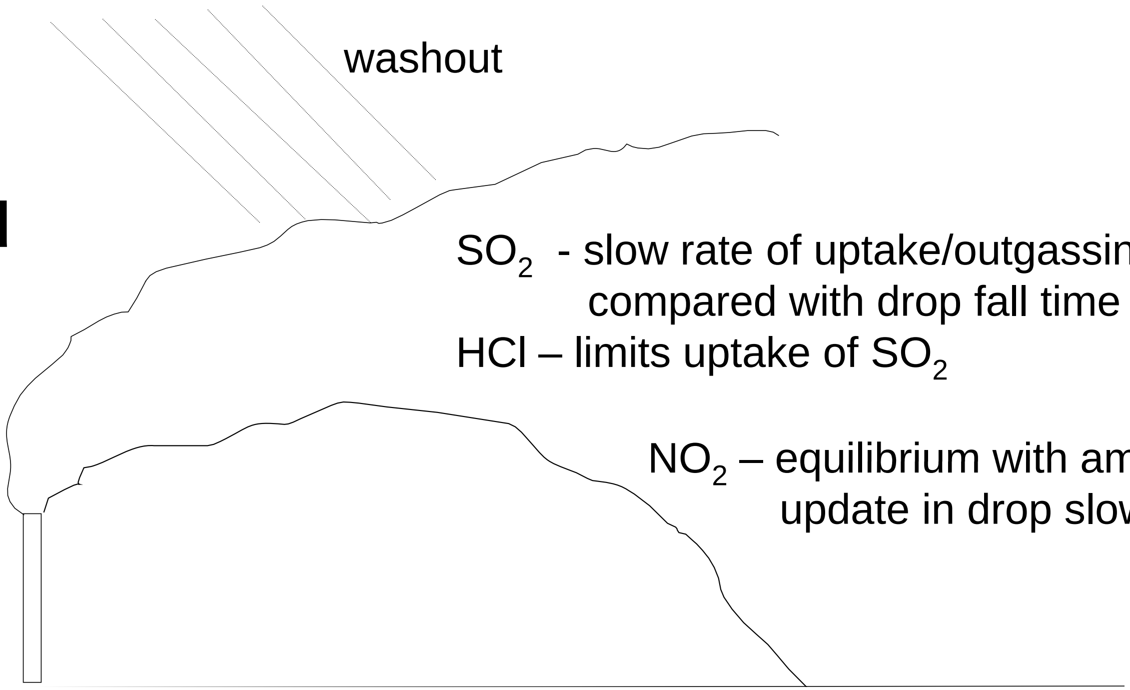
Wet Deposition

Current Formation

$$F_{wet} = \int_0^\infty \Lambda C dz$$

Washout coefficient $\Lambda = AP^B$ P precipitation rate

Falling Drop Method (JEP)

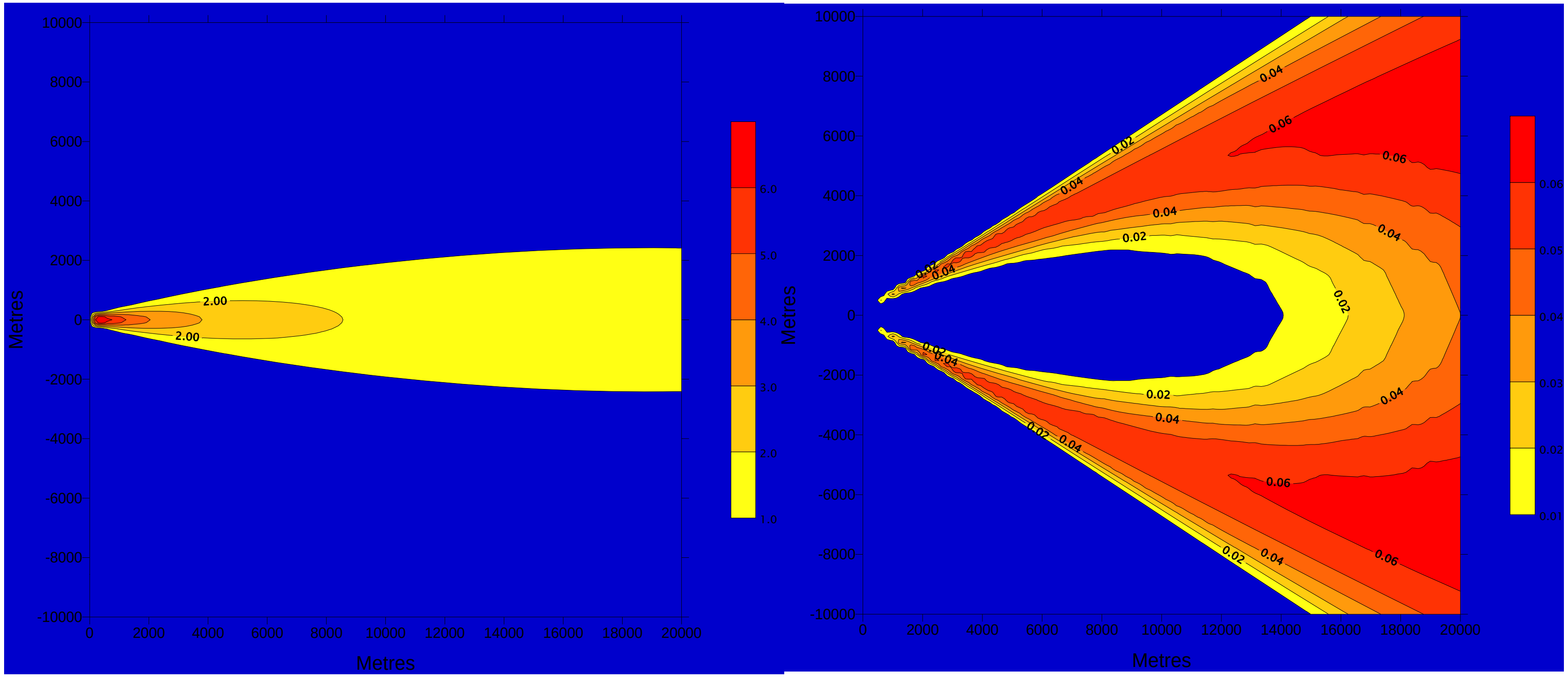


SO_2 - slow rate of uptake/outgassing compared with drop fall time

HCl – limits uptake of SO_2

NO_2 – equilibrium with ambient concentration update in drop slow – little deposition

$S0_2$ wet deposition



SO_2 wet deposition, stable met conditions a) pH limiting washout coefficient method, b) falling drop method NOTE THESE PLOTS USE DIFFERENT SCALES

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Dry Deposition

Current model -

- Dry deposition velocity
  either specified or
  calculated in terms of specified surface roughness and calculated aerodynamic and laminar sub-layer resistance for each hour

Model development -

- Express surface resistance in terms of stomatal, leaf surface and soil resistance (Smith et al Atmos Env. **34**)
- Depends on land use category, solar radiation, surface roughness
- Diurnal and seasonal variations

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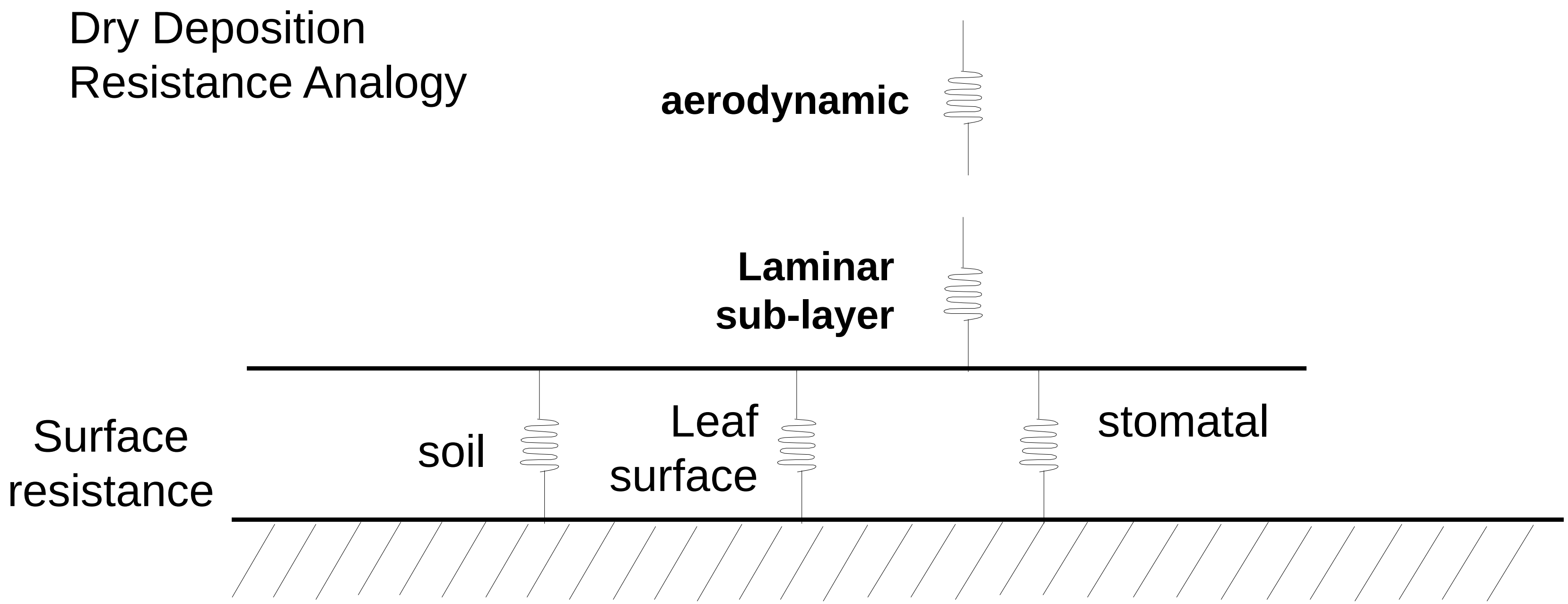
Dry Deposition

Land use category - several vegetation types, canopy height, leaf area index, stomatal response



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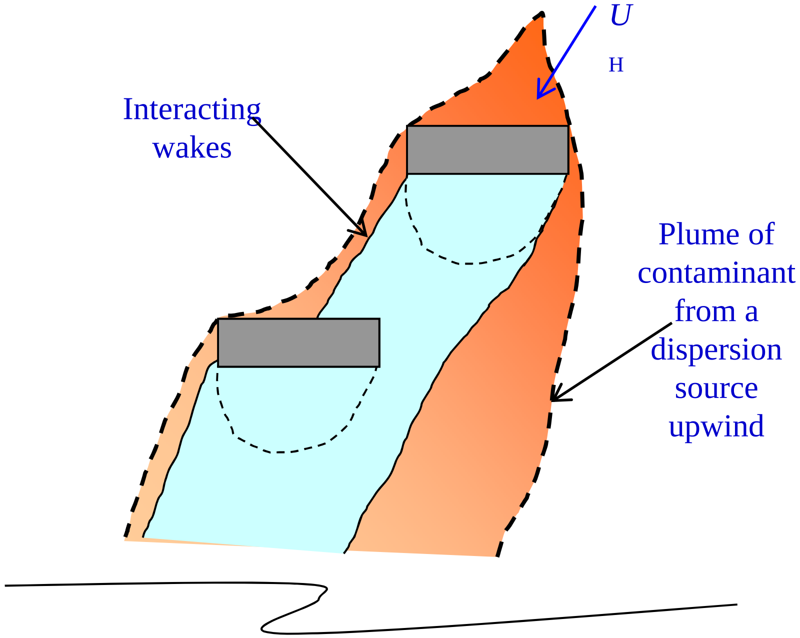
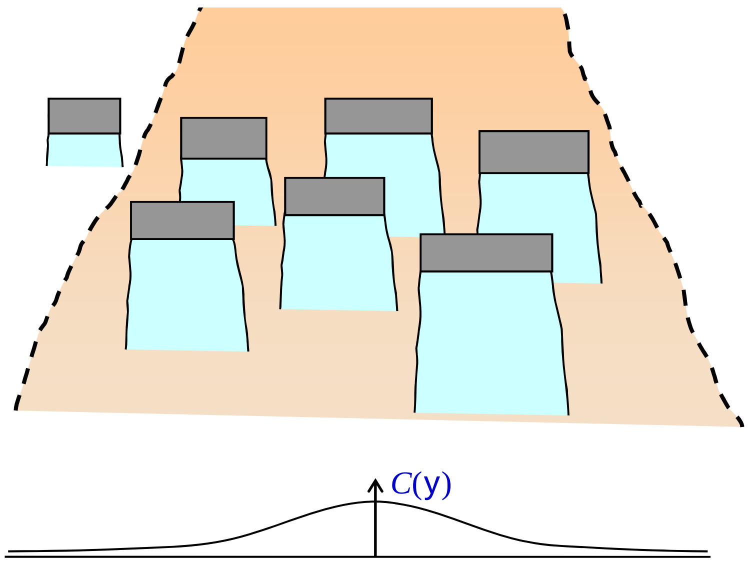
Multiple Buildings





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Marine boundary layers

- Surface roughness, wind and wave parameters are co-dependent
  - high waves should be modelled by a high value of surface roughness
- Calculation of the surface sensible heat flux over the sea is different from over land due to the difference in latent heat flux

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Marine boundary layers

- Surface roughness and wind profile parameterisation, used by ECMWF (the European Centre for Medium-Range Weather Forecasting)

$$z_0 = \alpha_m \frac{\nu}{u_*} + \alpha_{Ch} \cdot \frac{u_*^2}{g}$$

- Surface layer heat flux parameterisation for surface sensible heat flux and latent heat flux (ECMWF)

$$F_{\theta_0} = \frac{-c_p \rho \kappa^2 (\theta(z) - \theta_0) u(z)}{\left[\ln\left(\frac{z+z_{0H}}{z_{0H}}\right) - \psi_H\left(\frac{z+z_{0H}}{L_{MO}}\right)\right]\left[\ln\left(\frac{z+z_0}{z_0}\right) - \psi\left(\frac{z+z_0}{L_{MO}}\right)\right]}$$

$$\lambda E = \frac{-\lambda \rho \kappa (q(z) - q_{sat\,0}) u(z)}{\left[\ln\left(\frac{z+z_{0q}}{z_{0q}}\right) - \psi_q\left(\frac{z+z_{0q}}{L_{MO}}\right)\right]\left[\ln\left(\frac{z+z_0}{z_0}\right) - \psi\left(\frac{z+z_0}{L_{MO}}\right)\right]}$$

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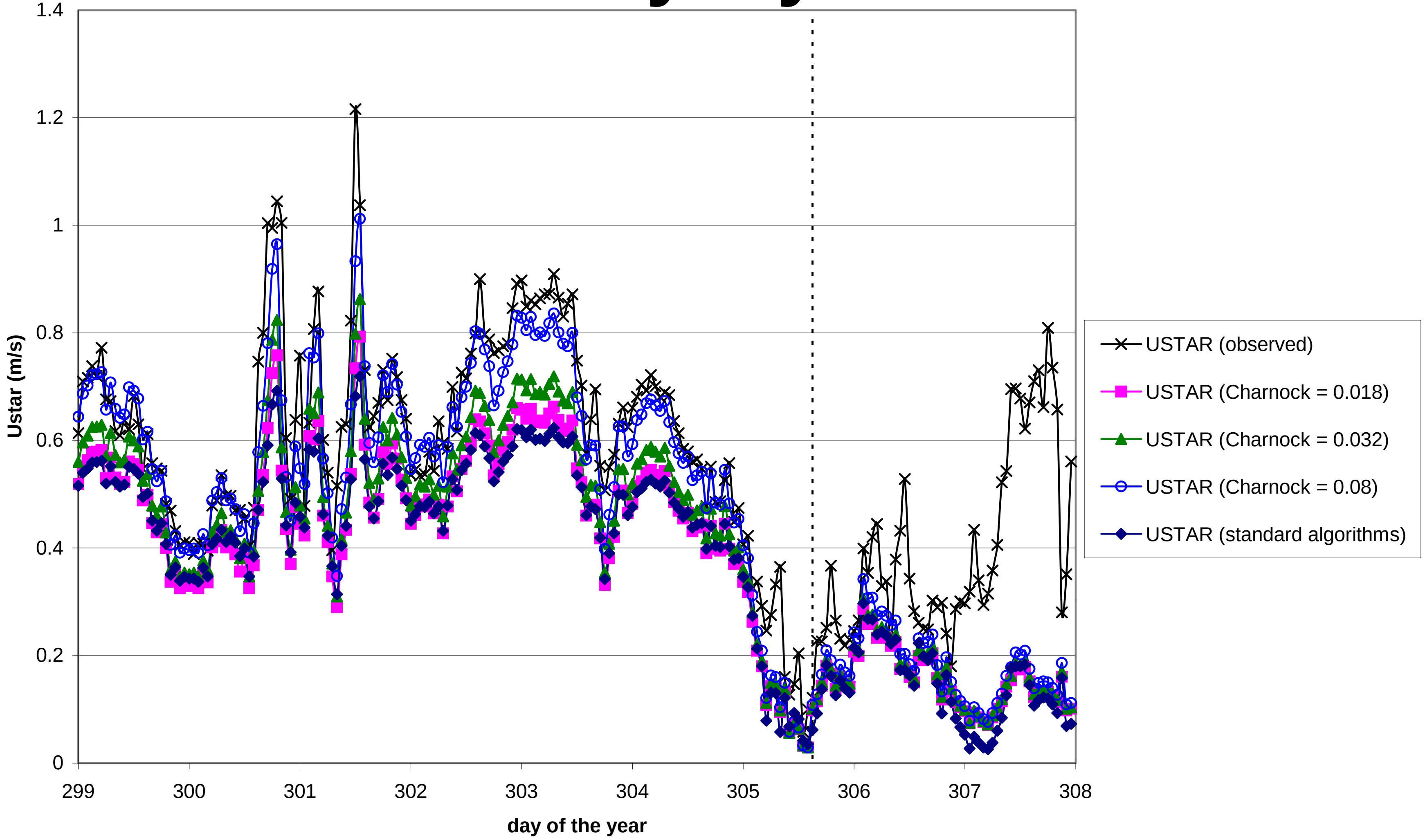
Marine boundary layers: u*



Time series of predicted and observed values of (m/s) at Christiansø. The time at which the wind direction switched from south-westerly to northerly/easterly (and hence off-shore) is shown by a dotted line

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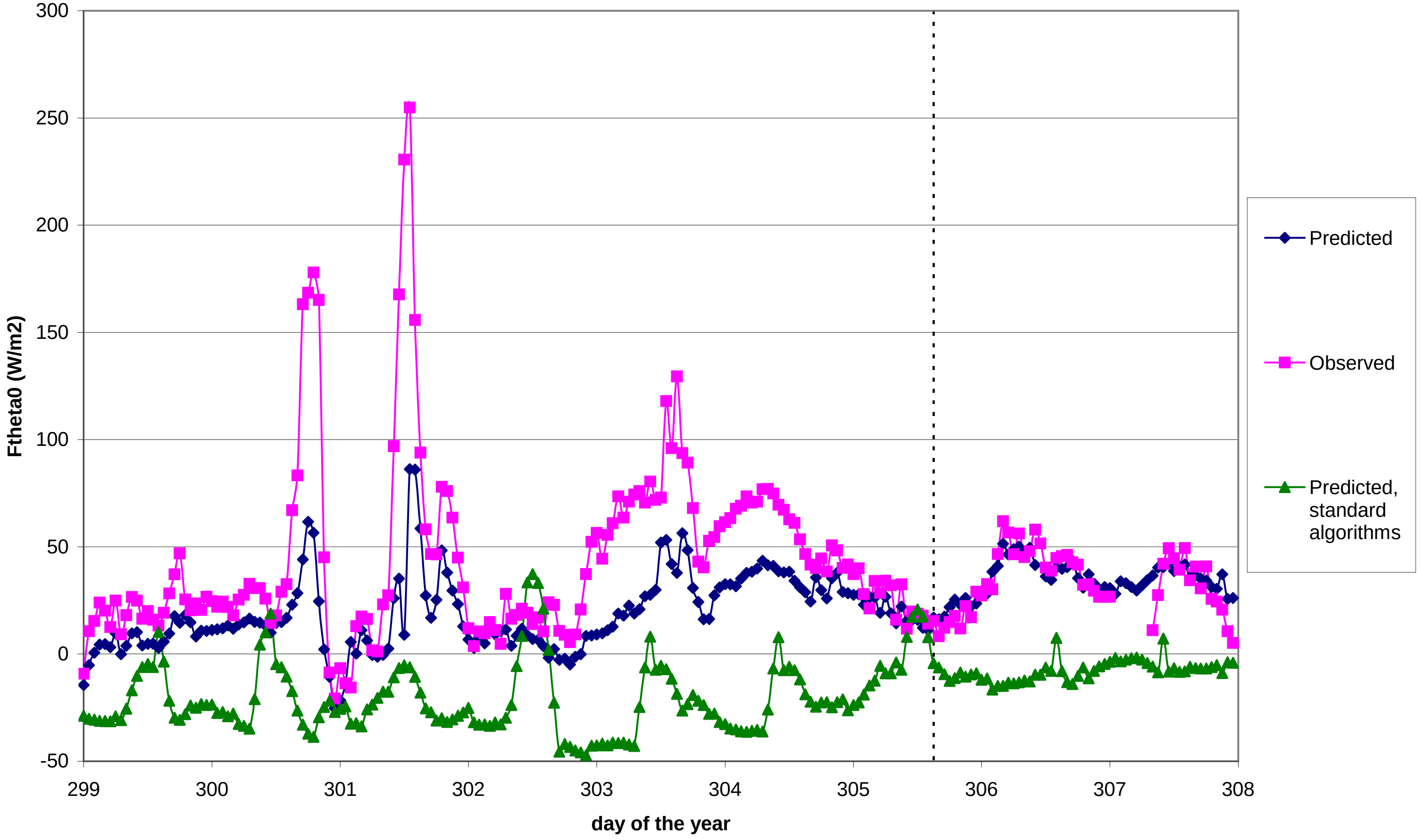
Marine boundary layers: Heat Flux $F_{\theta 0}$



Time series of predicted and observed values of sensible heat flux (W/m^2) at Christiansø. The time at which the wind direction switched from south-westerly to northerly/easterly (and hence off-shore) is shown by a dotted line.

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ADMS-Urban

ADMS-Roads

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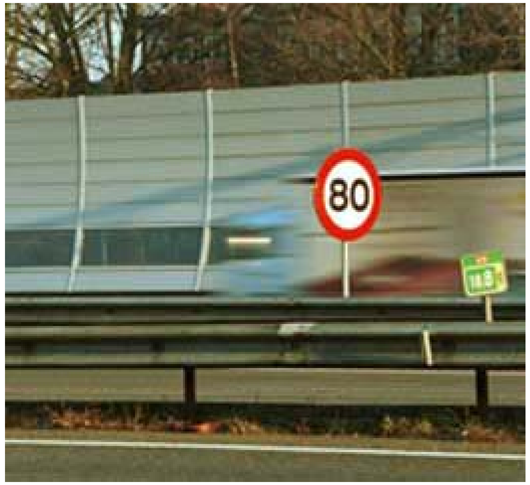
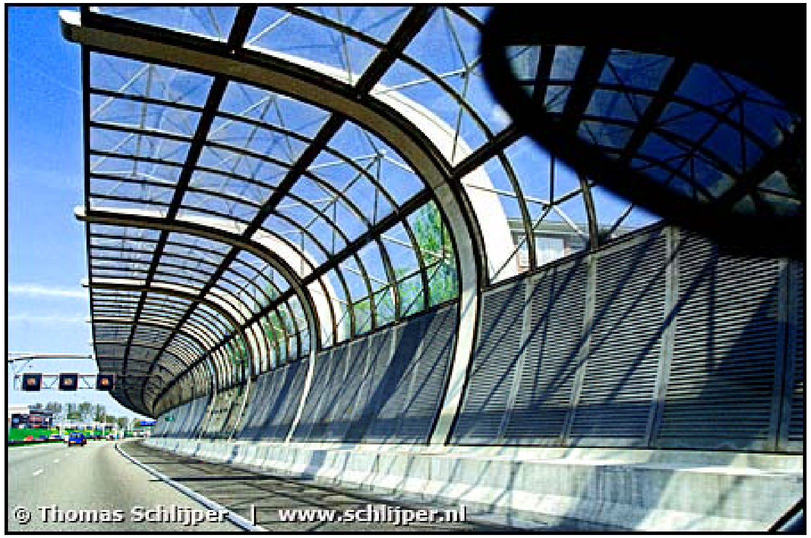
Noise barriers





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Modelling noise barriers

- **Noise barriers common in mainland Europe**
- **Effects of noise barriers on pollution of interest – particularly in residential areas**
- **Looked at results from TNO Traffic model**
- **Modelled noise barriers explicitly in ADMS 3**
- **Derived an empirical algorithm that relates the *noise barrier height* to the height of a *representative elevated line source***

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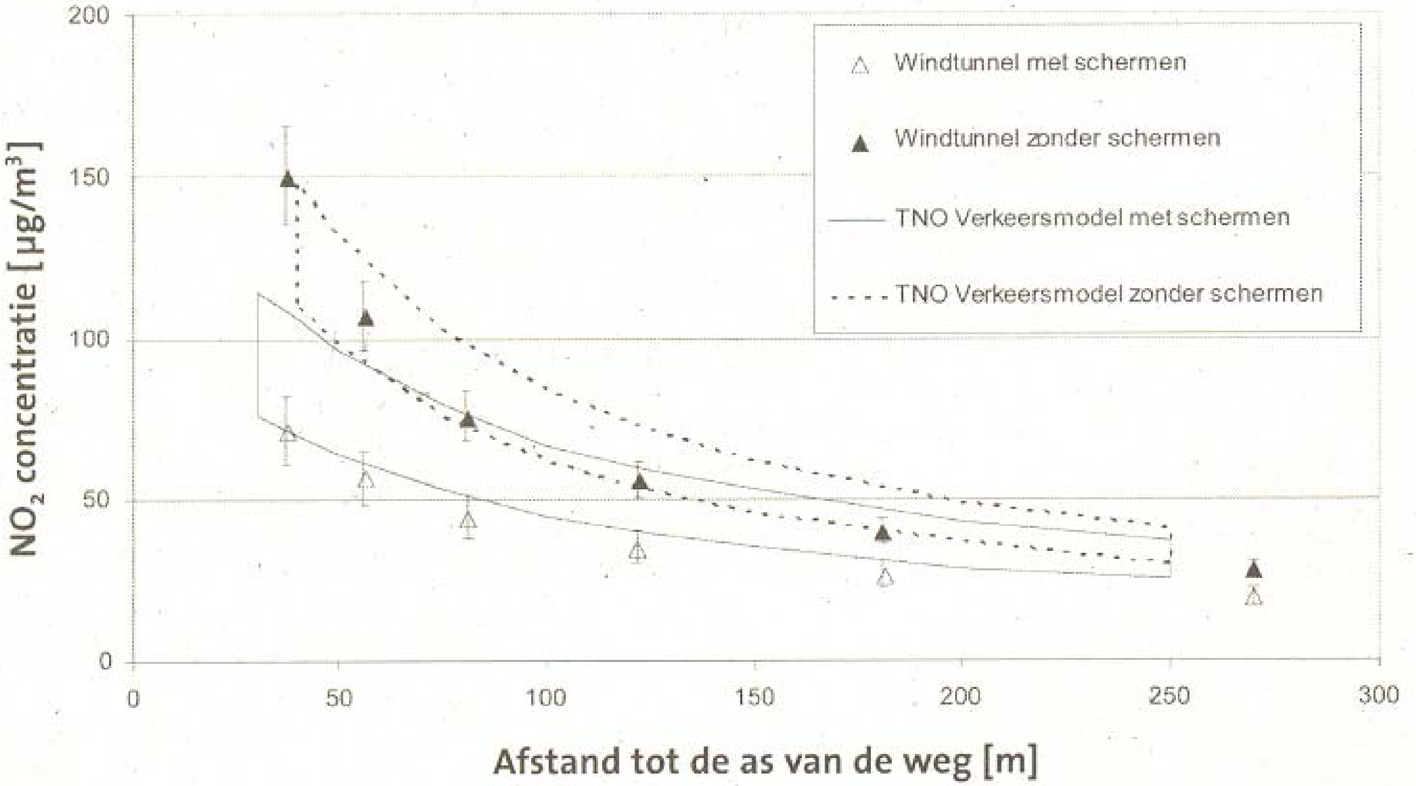
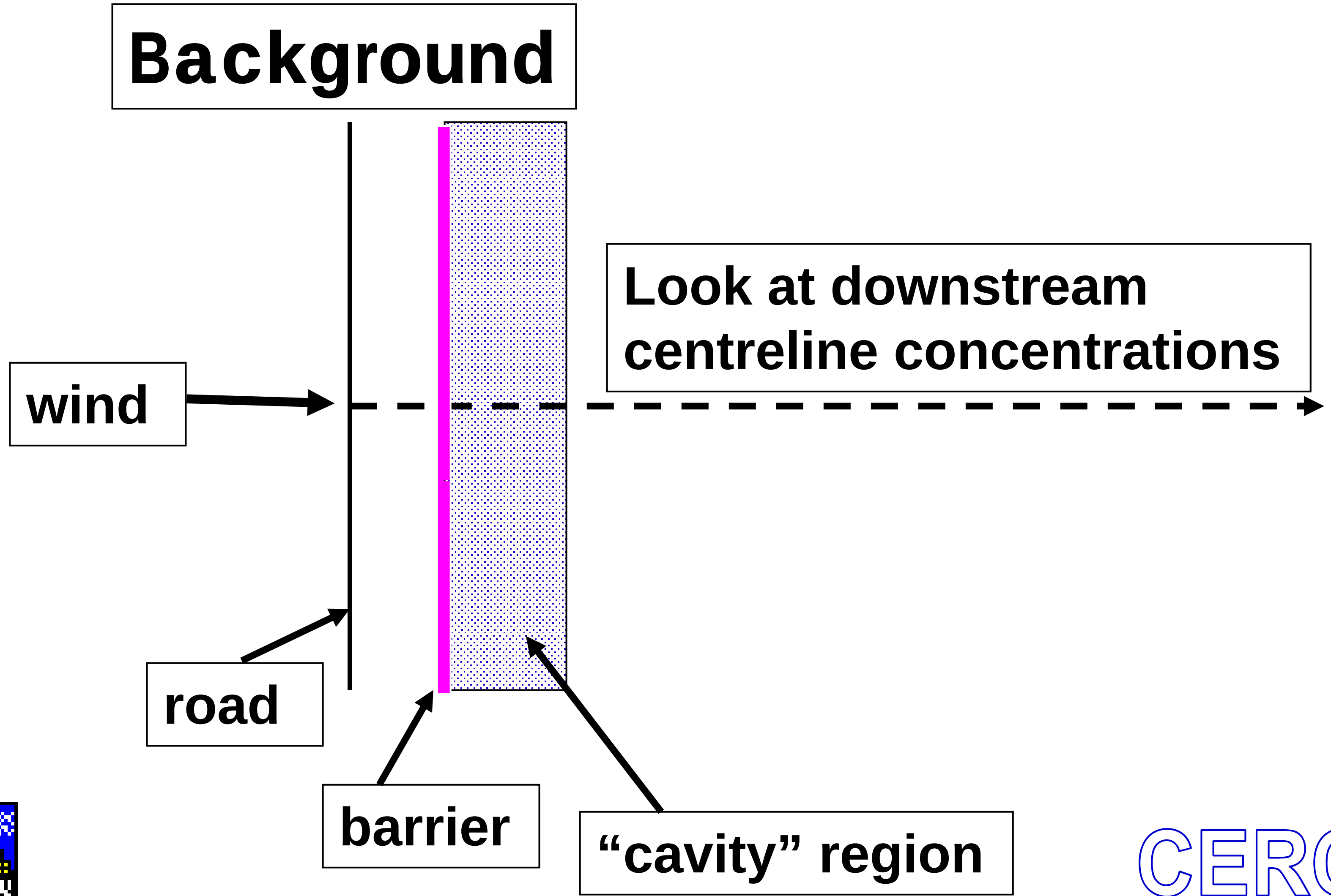
Modelling noise barriers

Figuur 2
Gemeten en berekende NO_x-concentratiebijdragen bij loodrechte aanstroming van de A13 in het open veld bij de aanwezigheid van schermen.



Modelling noise barriers



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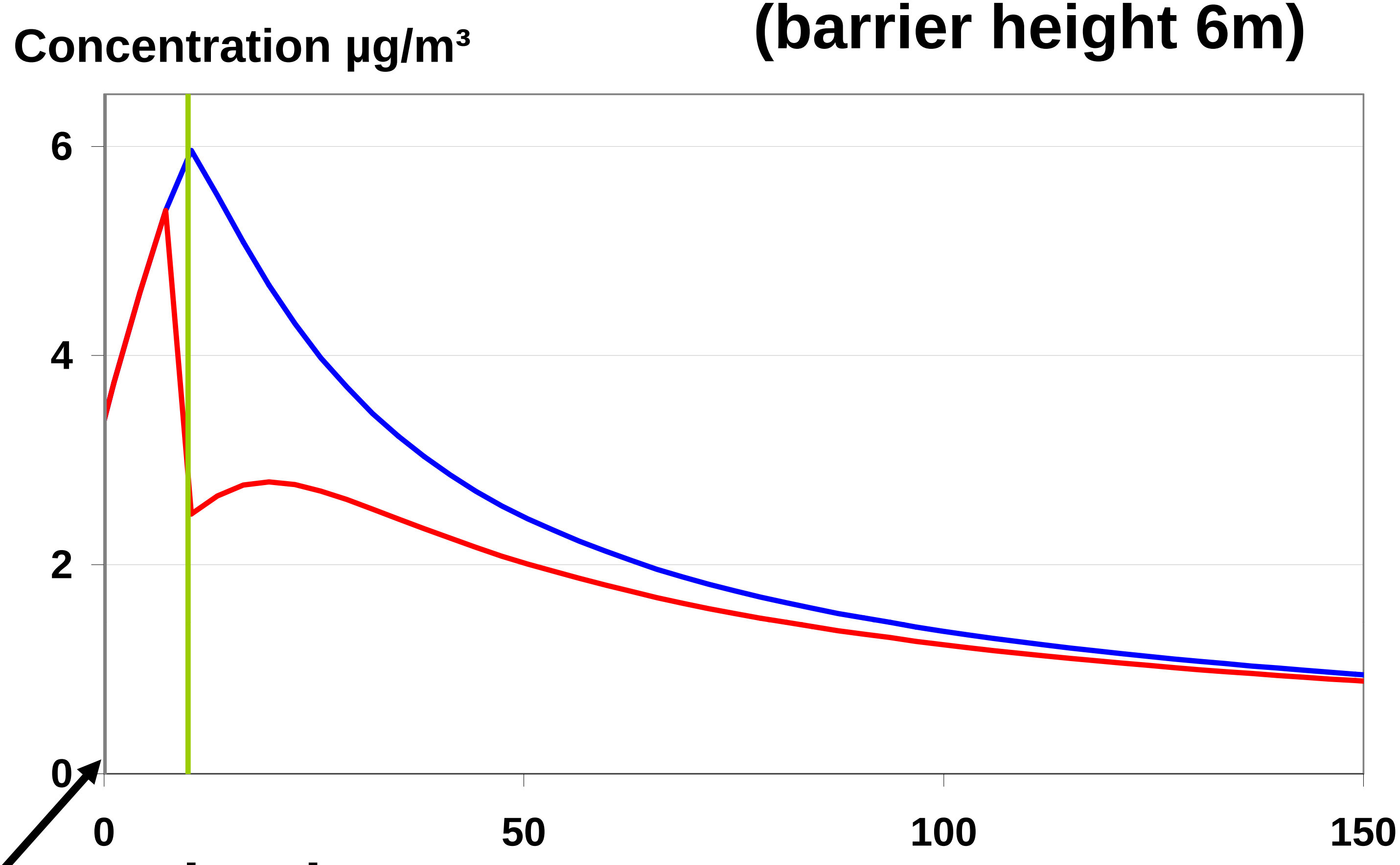
Modelling noise barriers

ADMS – Urban results (barrier height 6m)



road at x=0

barrier at x=10m

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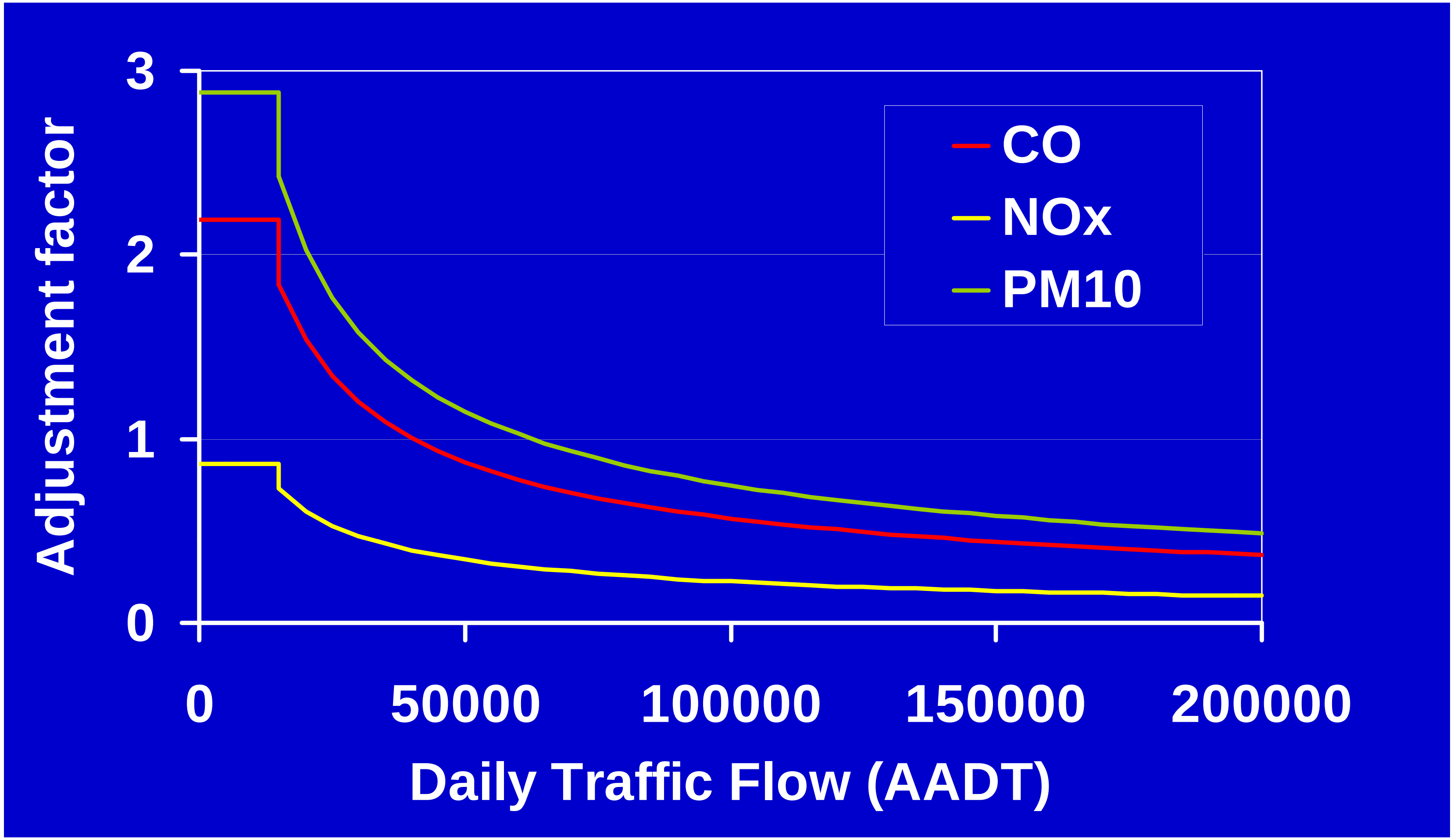
Background
UK Design Manual for Roads and Bridges (DMRB)



Initial mixing near vehicles (ADMS-Roads, ADMS-Urban)

Assumes an initial mixing height – 1m.

Ignores different exhaust locations on LGV's and exhaust buoyancy effects – dependent on wind speed/vehicle speed.

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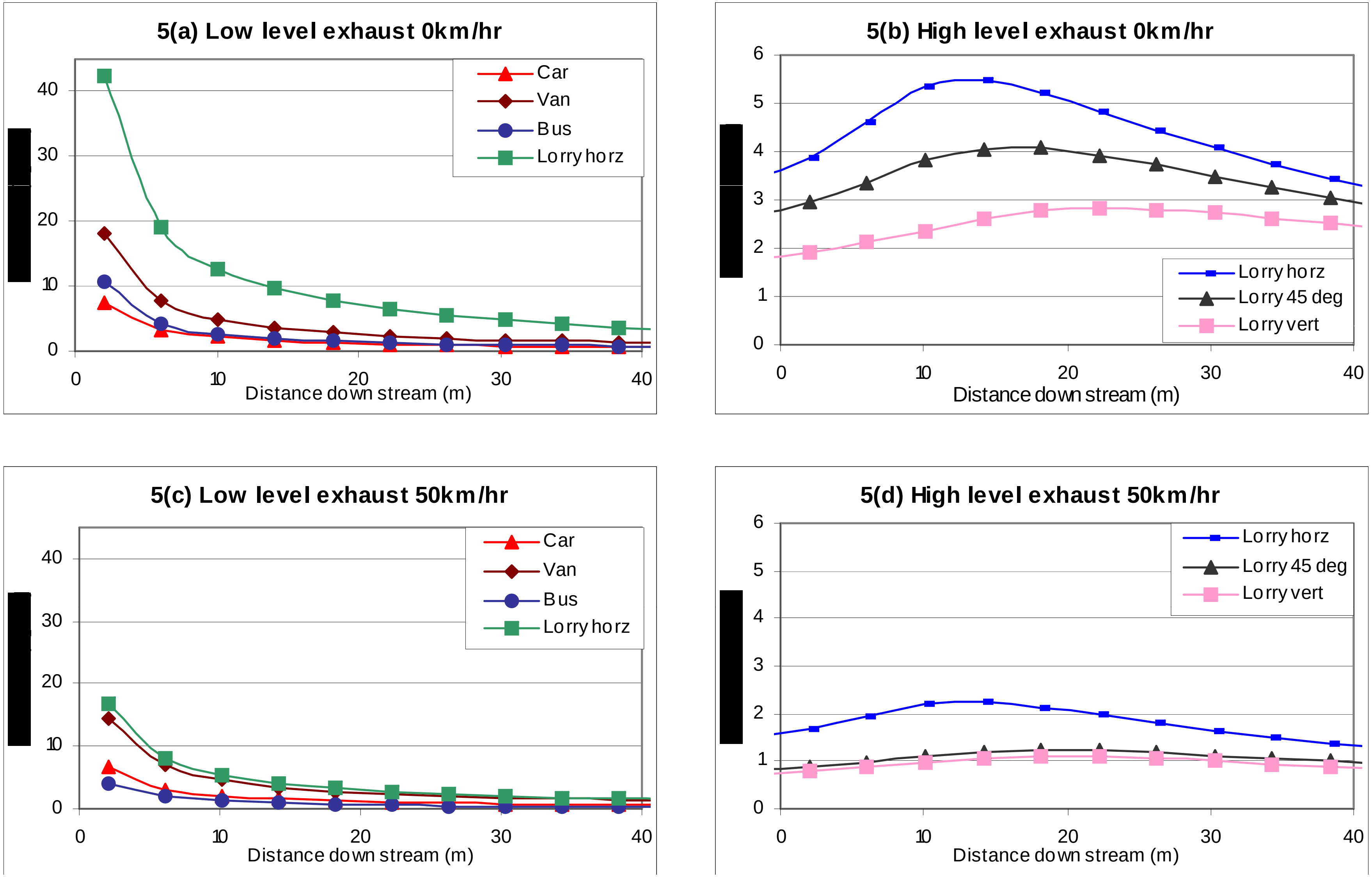
Annual average concentrations for each vehicle type over a range of speeds



New parameterisation

- dependent on vehicle speed, wind speed
- for HGV's also exhaust location

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ADMS-Airport(1)

ADMS-Airport is an extension of ADMS-Urban designed to model pollutant concentrations in the neighbourhood on an airport. It includes all features of ADMS-Urban including the following:

Allowance for up to 6000 sources: road (1500, each with upto 50 vertices), industrial (1500), area sources (3000)

•Fully integrated street canyon model based on Danish OSPM model/noise barriers

•Local and regional NO_x chemistry calculation (NO, NO_2 and O_3)

•Based on current understanding of atmospheric boundary layer - characterised by the height of the boundary layer and the Monin-Obukhov length

•A meteorological pre-processor – flexible input

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ADMS-Airport(2)

•Integrated with GIS and Emissions Database. Output via GIS includes high resolution pollutant concentration maps

•'Local' ADMS dispersion model nested in trajectory model

•ADMS-Urban has been used in many major cities: London, Birmingham, Manchester, Budapest, Beijing, Shanghai, San Diego, Rome, Bologna, Lyon, Dublin etc

•ADMS-Urban has been used for many airports across the UK and Ireland (also ADMS 3)

•*ADMS-Airport is ADMS-Urban plus the ADMS 3 jet model modified to account of moving jet sources for aircraft take-off roll and also additional input options*

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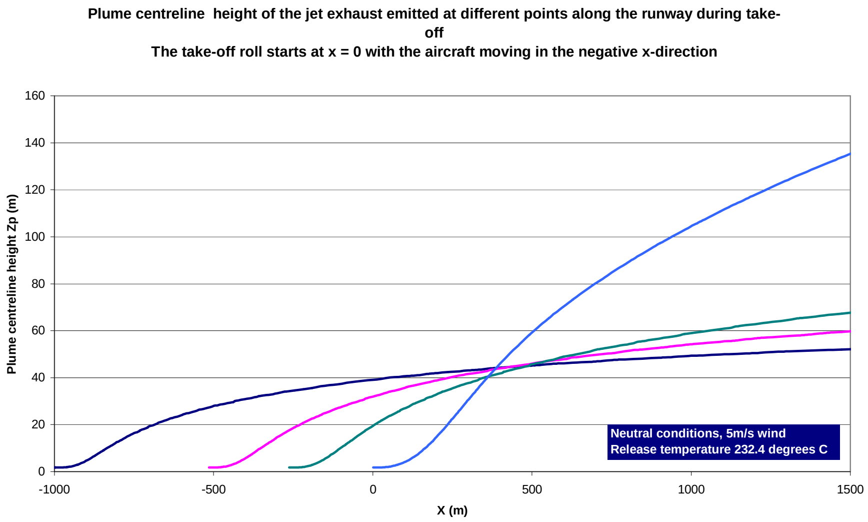
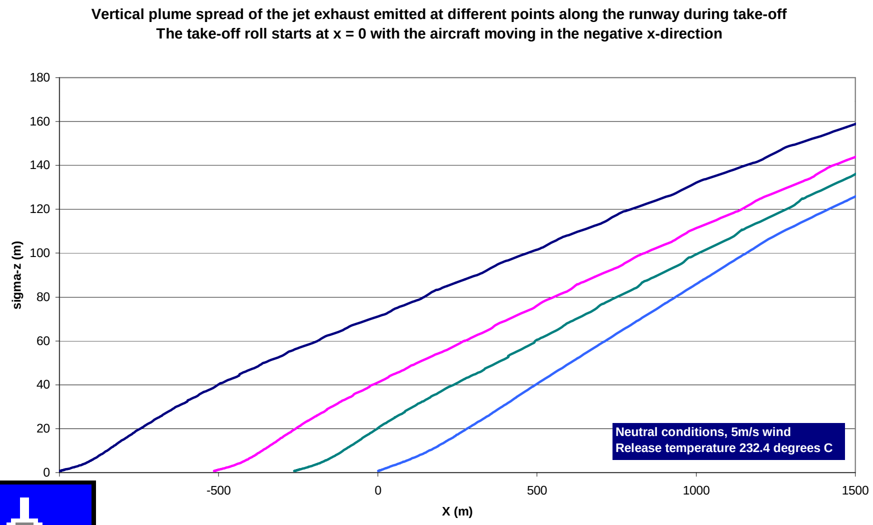
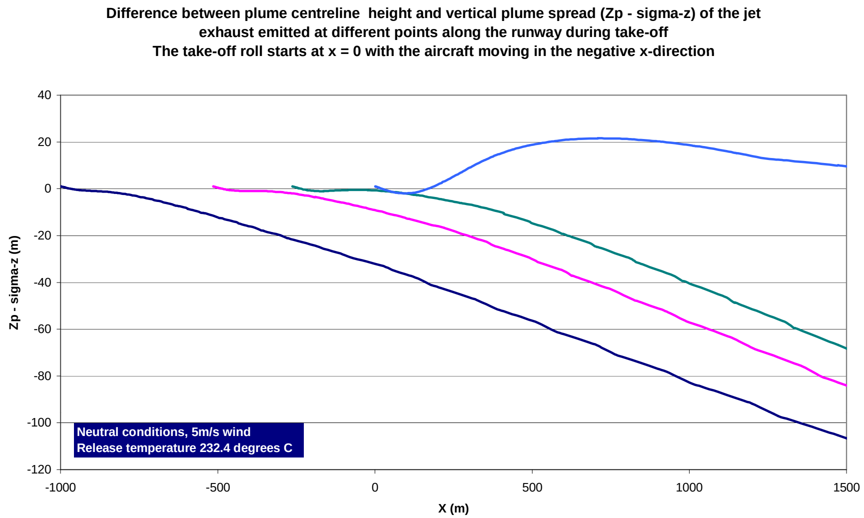
Neutral met conditions, plume trajectory (z_p) (top), vertical spread (σ_z) (middle) and z_p - σ_z (bottom)







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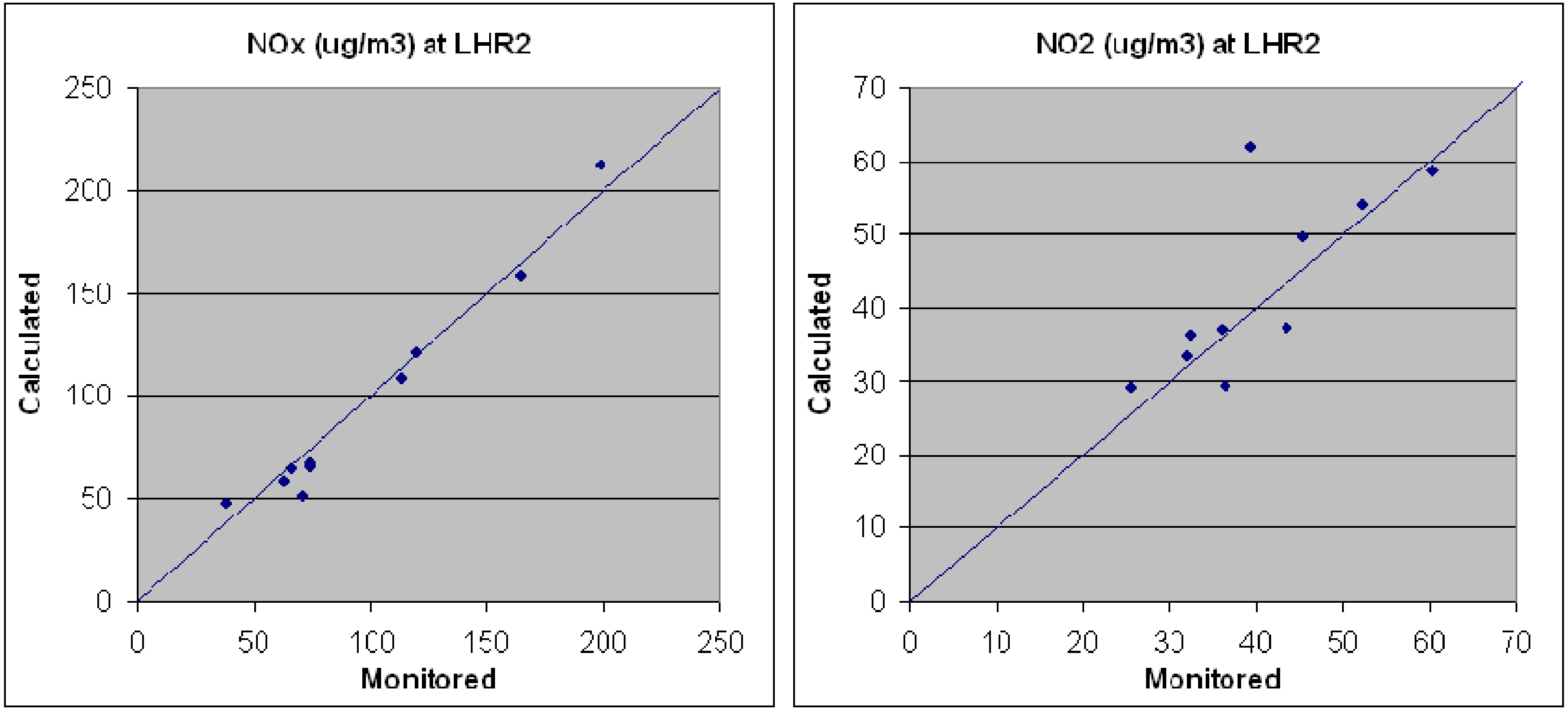
Scatter plot of monitored and ADMS-Airport calculated concentrations of NO_X (left) and NO_2 (right).



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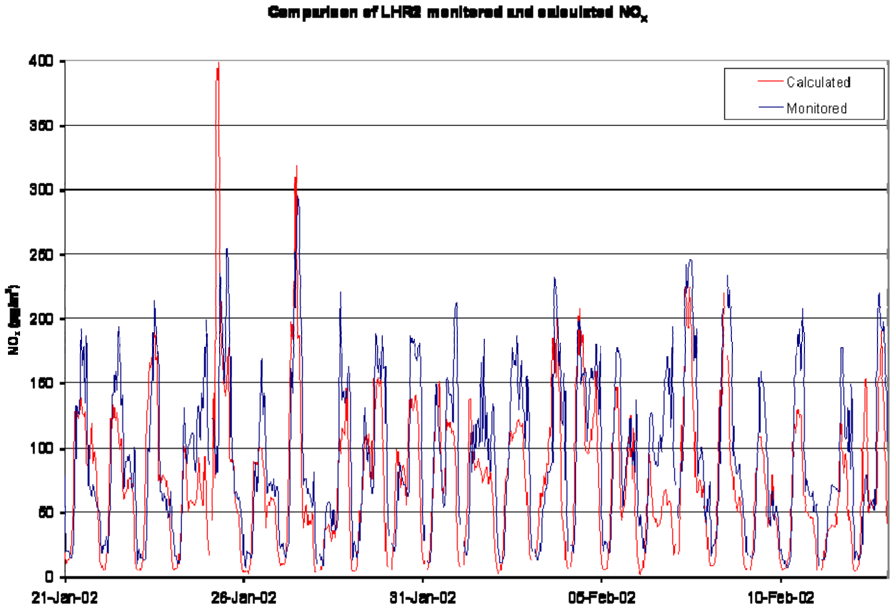
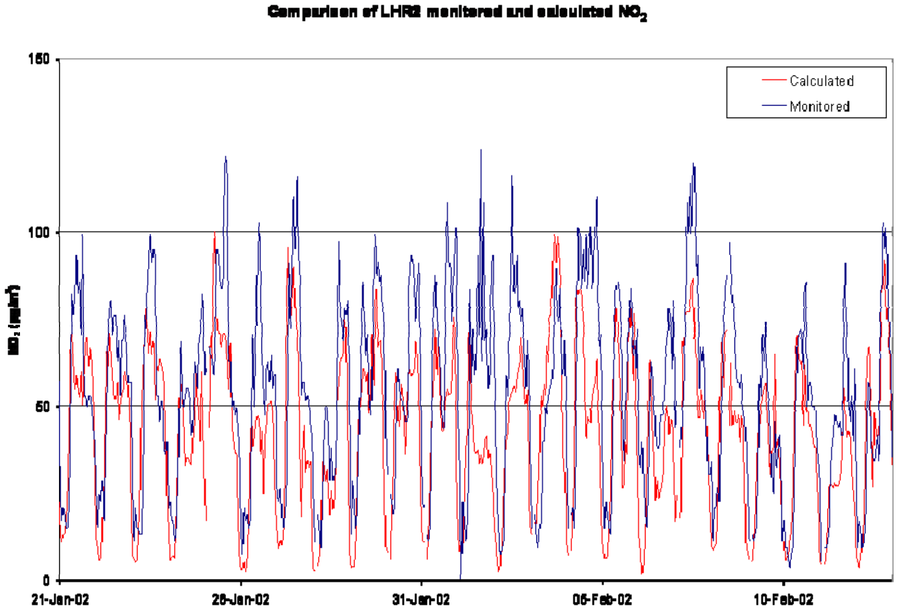
Time series of monitored and calculated NO_X (top) and NO_2 (bottom) in $\mu g/m^3$ at LHR2





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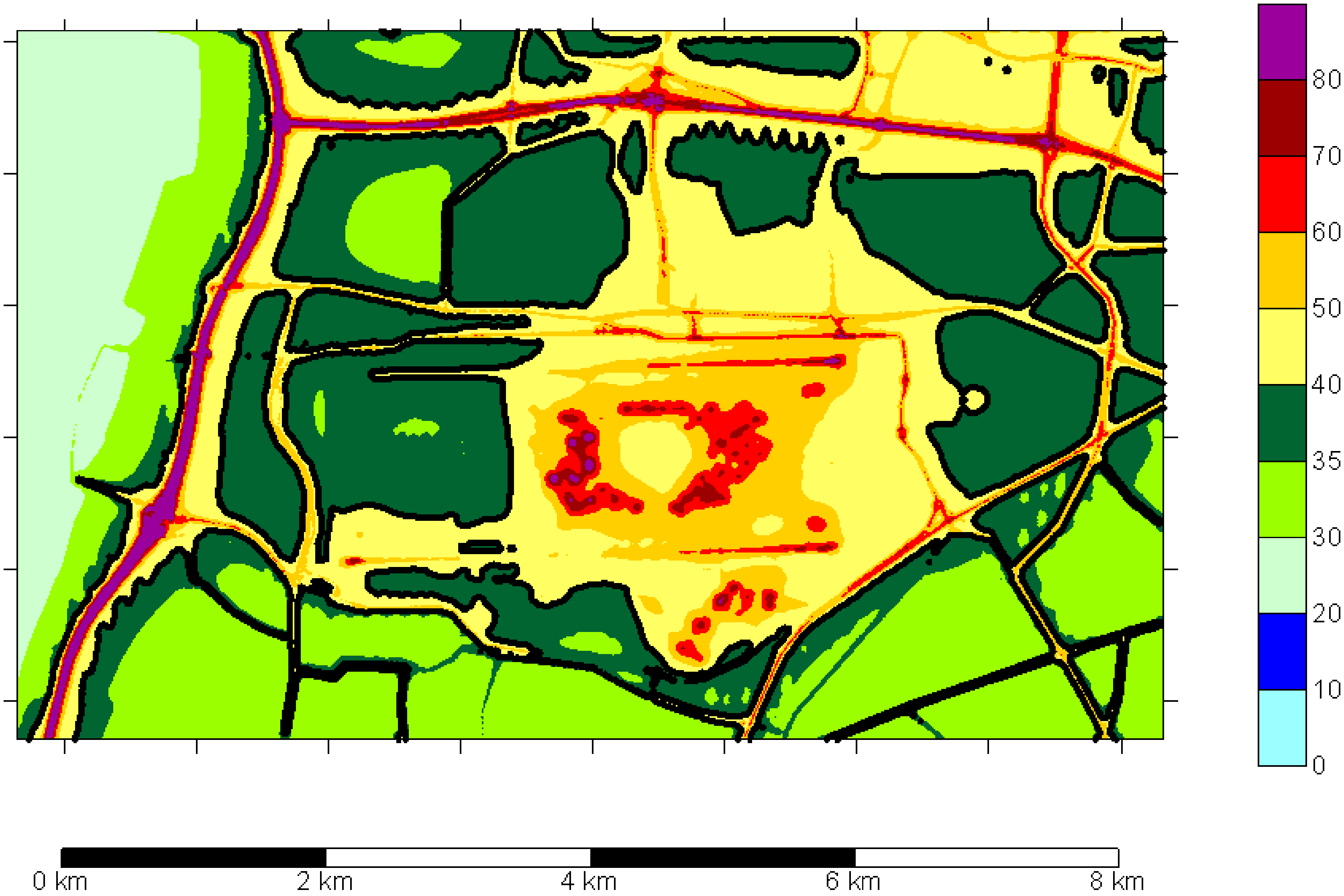
Annual Average NO2 Concentration ($\mu g/m^3$) Heathrow



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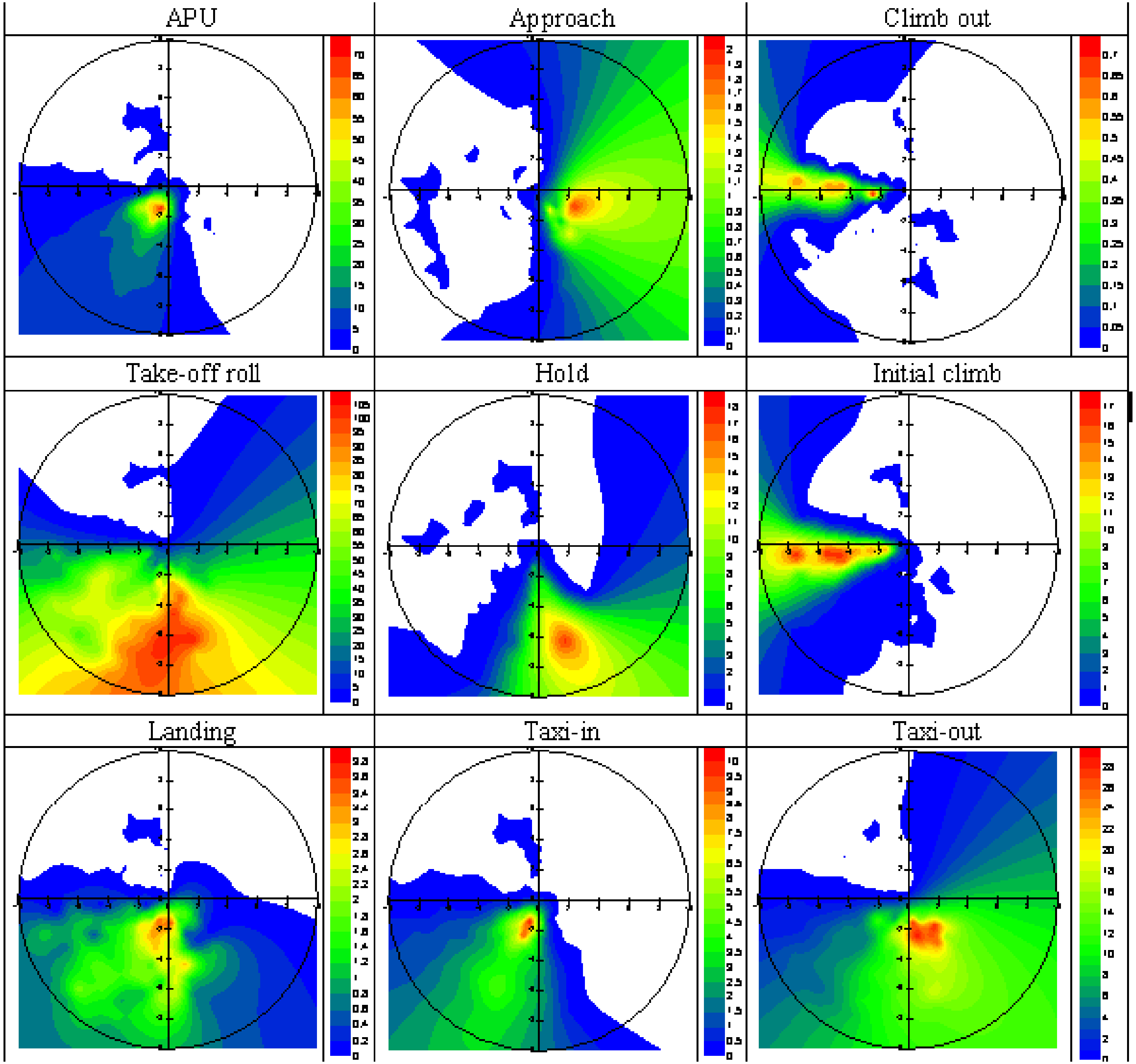

Examples of Polar Plots for Heathrow sources

Powerful diagnostic tool

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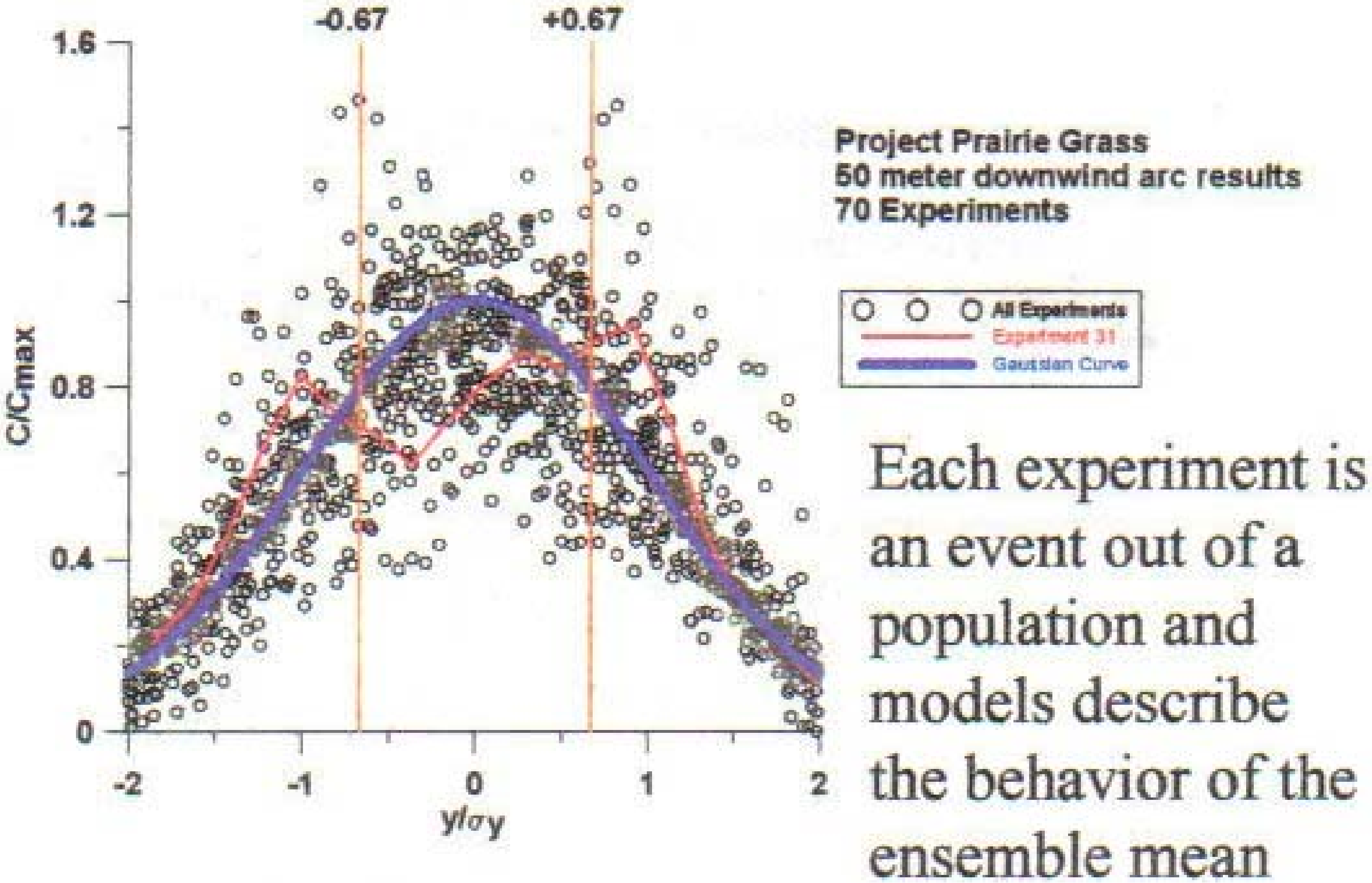
Validation



Arcwise maximum – Harmonisation Meetings etc

Near centreline concentrations ASTM methodology

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Conclusions

ADMS 3

Meteorology - Input, boundary layer structure, Dry and Wet Deposition

Building Effects, Climate change

ADMS-Urban, ADMS-Roads

Initial mixing, Noise barriers

ADMS-Airports

Jet Model for Aircraft Engine Sources

Input -- PM2.5

Validation, diagnostic techniques

Acknowledgements

DEFRA, Met Office, RWE plus many others

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