Annual Defra AEQ Modelling Meeting

Dispersion Modelling of Air Pollution in Urban Areas in the UK (Phase 2)

Cambridge Environmental Research Consultants
Presented by David Carruthers

9 March 2007

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Aims and Objectives

- Provide a baseline assessment of current and future levels of PM_{10}, $PM_{2.5}$, NO_x, O_3 as inputs to policy formulation, review of AQS, implementation/ review of EU AQ directives.
- Selection of urban areas with emphasis on London.
- Analysis of impacts of policy scenarios on future levels of pollutant concentration.
- Contribute expertise to project for sustainable development of Heathrow (PSDH) and ensure London modelling takes account of Heathrow emissions.
- Compare output of dispersion modelling with netcen modelling.

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Modelling Framework and Approach

- Advanced gaussian type model ADMS nested within a trajectory model.
- All source types treated explicitly or aggregated as required.
- Treatment of street canyons (based on OSPM approach).
- Chemical scheme GRS; now linked to CBM IV scheme (or other schemes) as required.
- Calculates concentration hour by hour for long or short term statistics.
- Treats all AQS pollutants and others in self consistent manner as required.
- Input data includes emission data, topographical data including buildings data, hourly sequential meteorological and rural background concentration data.

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Modelling Framework and Approach cont'd

- Input/Output through GIS and EMIT (Emissions inventory toolkit).
- Model has been used extensively in many cities across the world.
- Input for this study (London).
  - LAEI (2001, 2002, 2003)
  - Sequential met data for Heathrow Airport (2001, 2002, 2003)
  - Background concentration data from rural AURN sites
  - Forward projections for background concentration based on EMEP and UK projections and (for PM) source speciation

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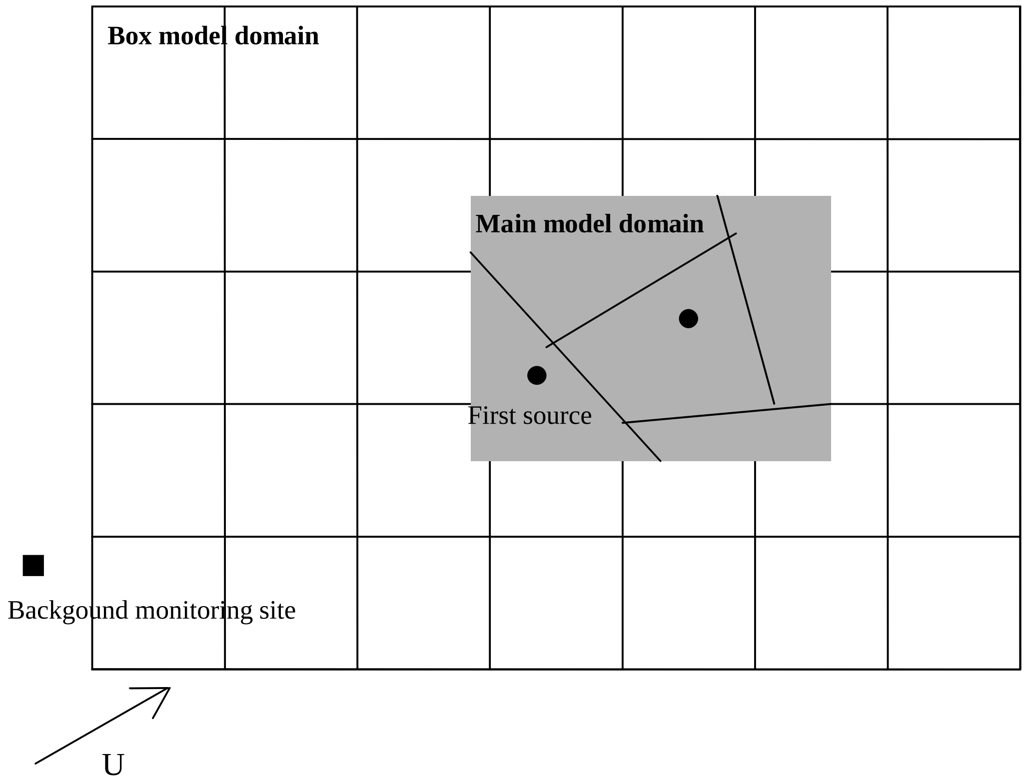
Local and Regional Scales



- ADMS model nested with large, area-wide trajectory model

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Summary of Model Runs

- Modelled NO_2, O_3, PM_{10} & $PM_{2.5}$ for London for 2001, 2010 & 2020
- Source apportionment for NO_x, PM_{10} & $PM_{2.5}$
- Modelled impact of policy Measure Q
- Investigated impact of
    - Increased primary NO_2 emissions
    - Increased background O_3 concentrations
- Local impact of climate change
- Impact of vehicle exhaust location on initial dispersion

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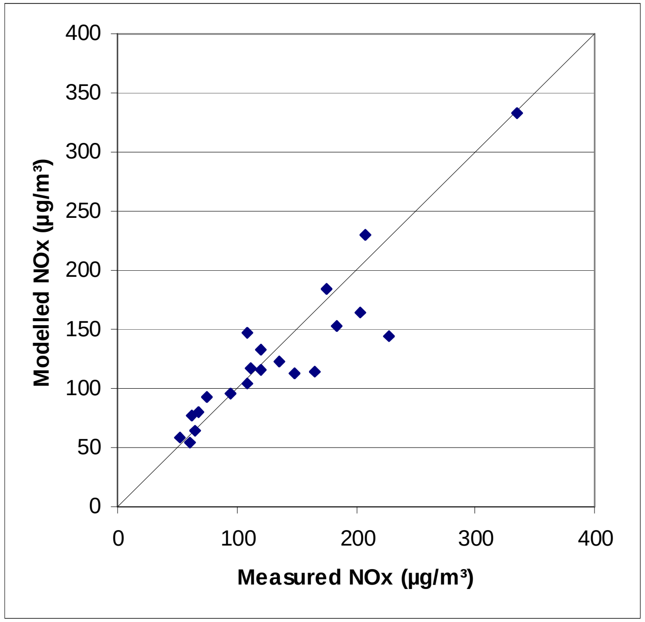
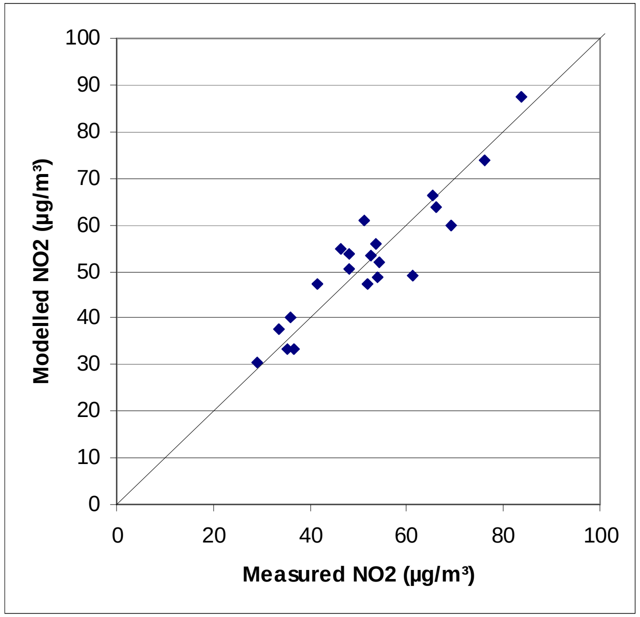
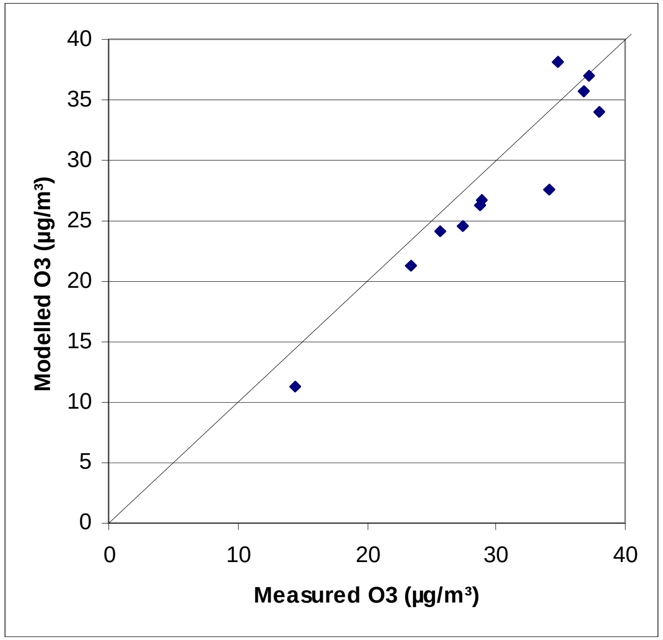
Model verification at AURN Sites – Annual Means NO_x, NO_2, O_3







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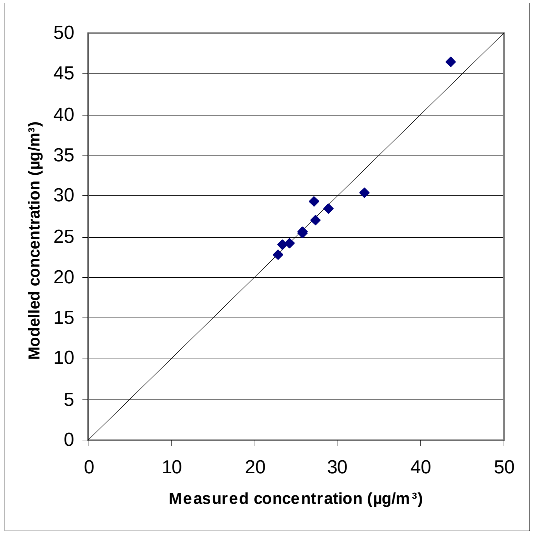
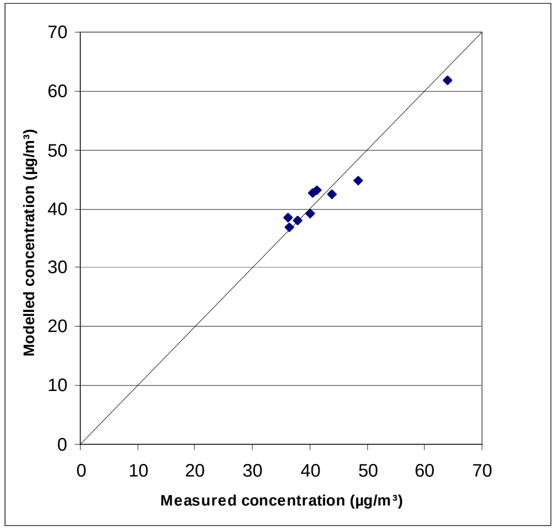
Model verification at AURN Sites – PM_{10} & $PM_{2.5}$

PM_{10}



Annual Mean



90.4th percentile

$PM_{2.5}$

	Measured	Modelled
Marylebone Road	32.0	32.8
Bloomsbury	17.1	19.2

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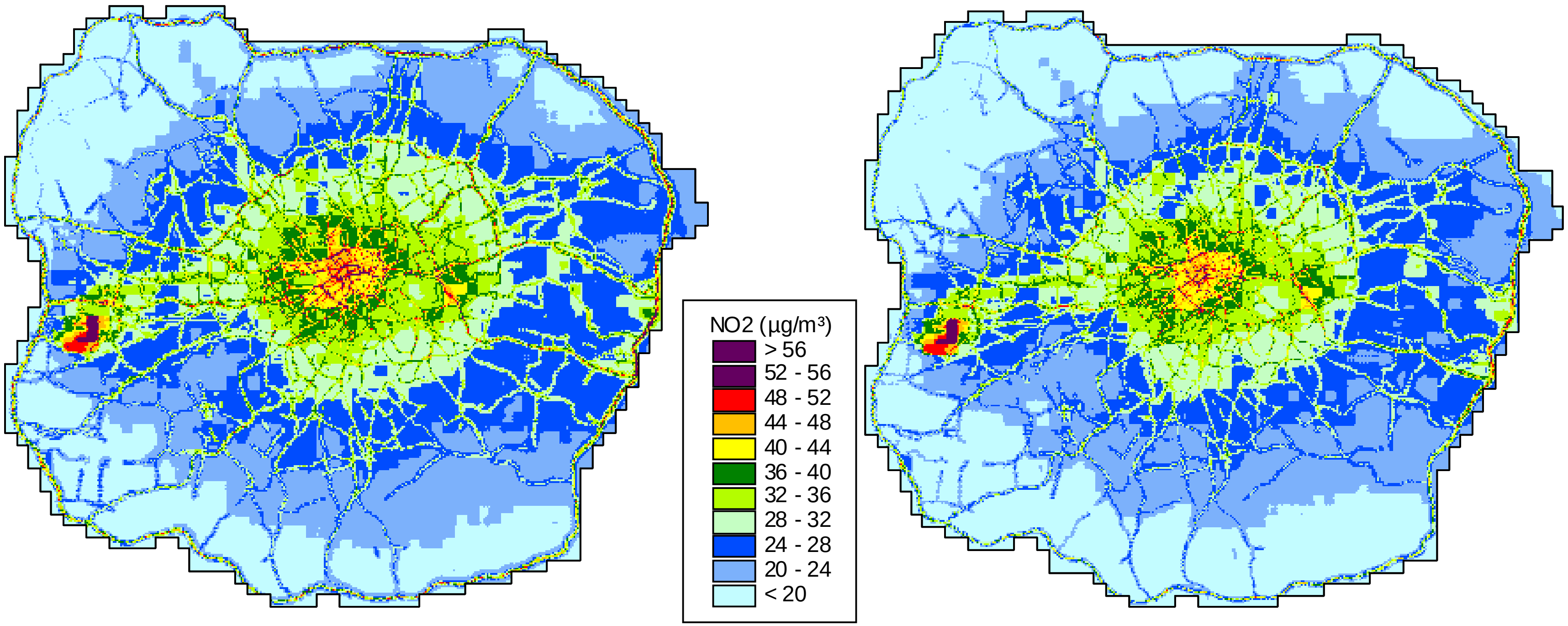
Impact of Measure Q on annual average NO_2 concentrations 2020



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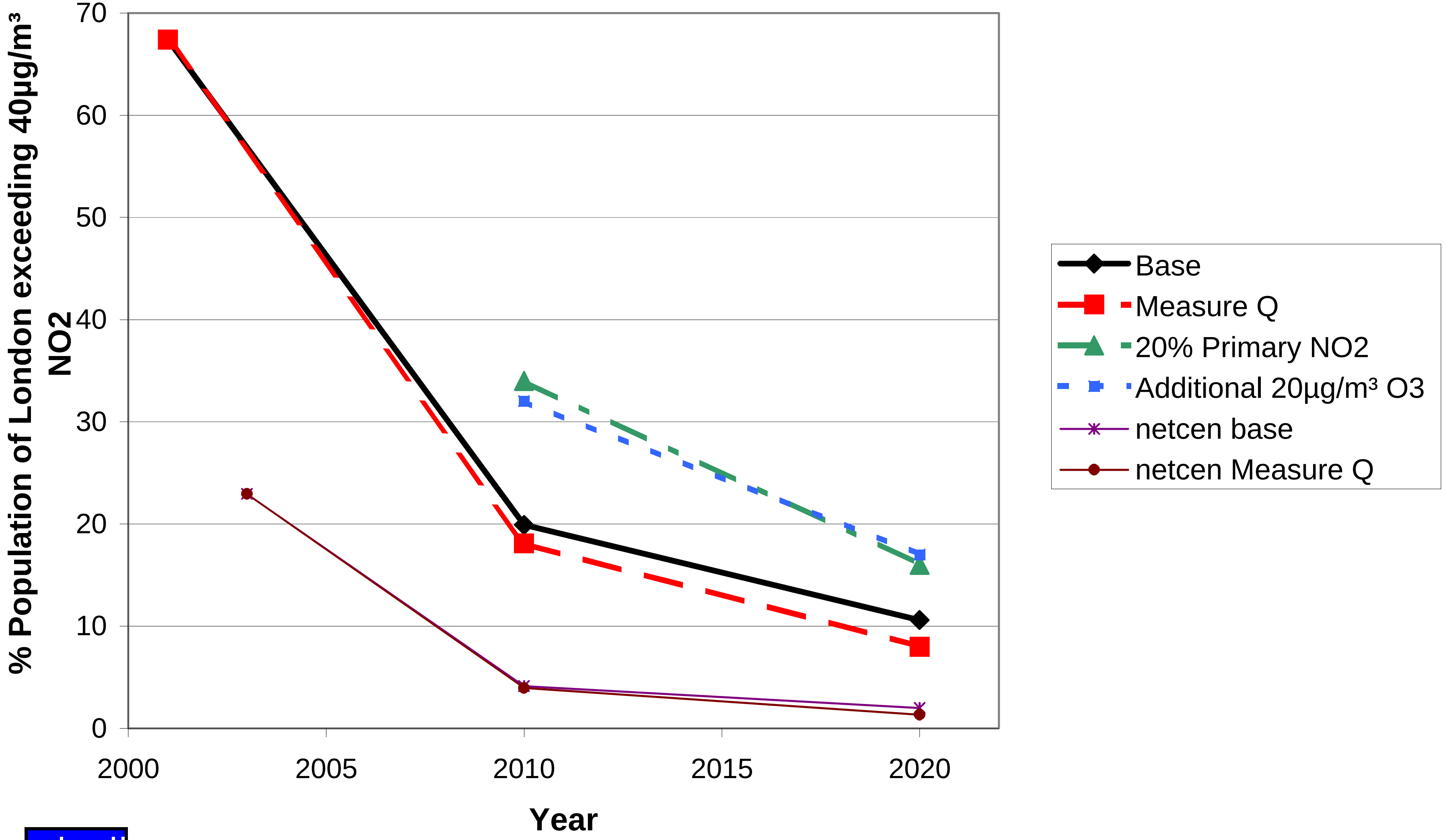
Population of London exceeding 40µg/m³ NO_2



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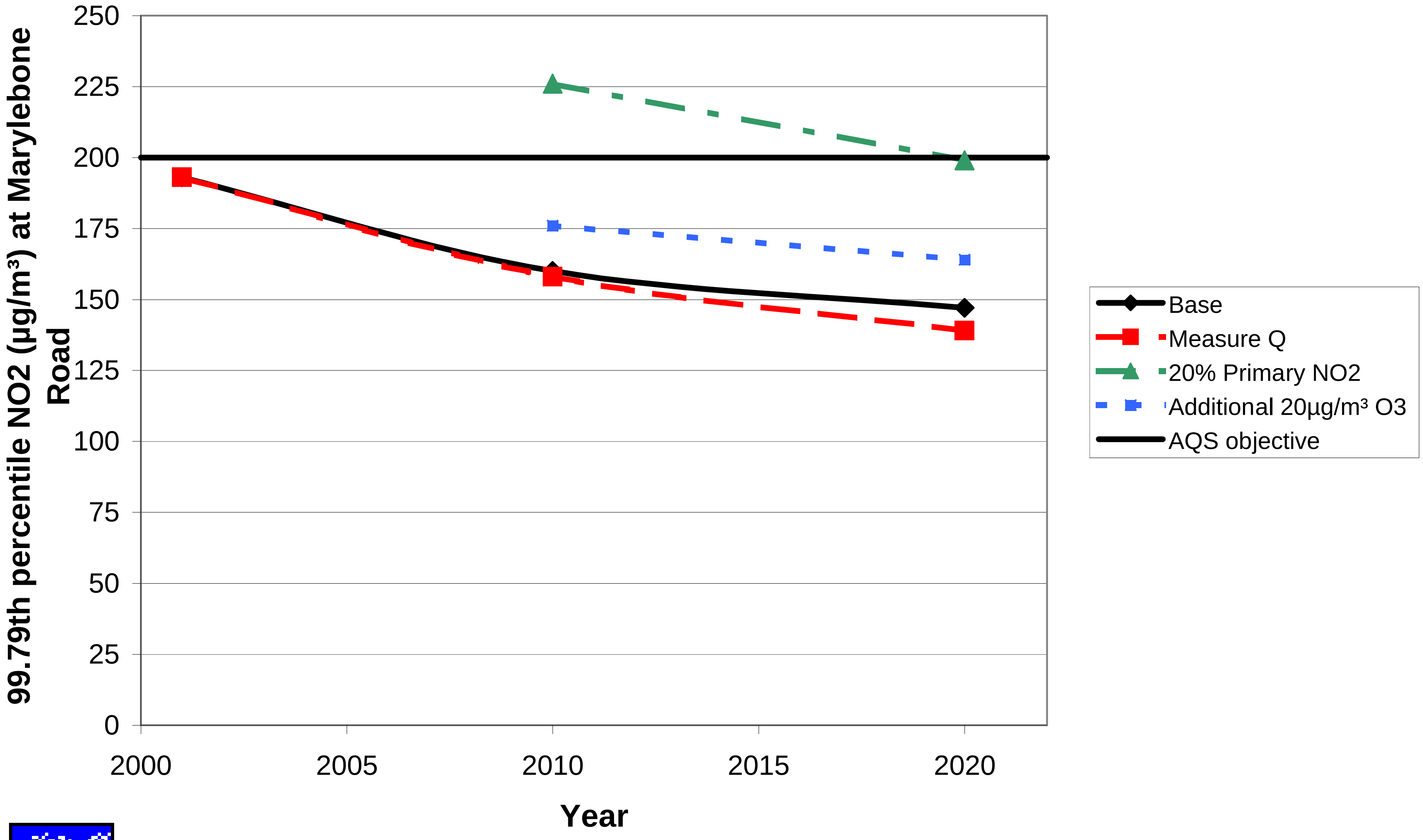
99.79th percentile of hourly average NO_2 concentrations at Marylebone Road



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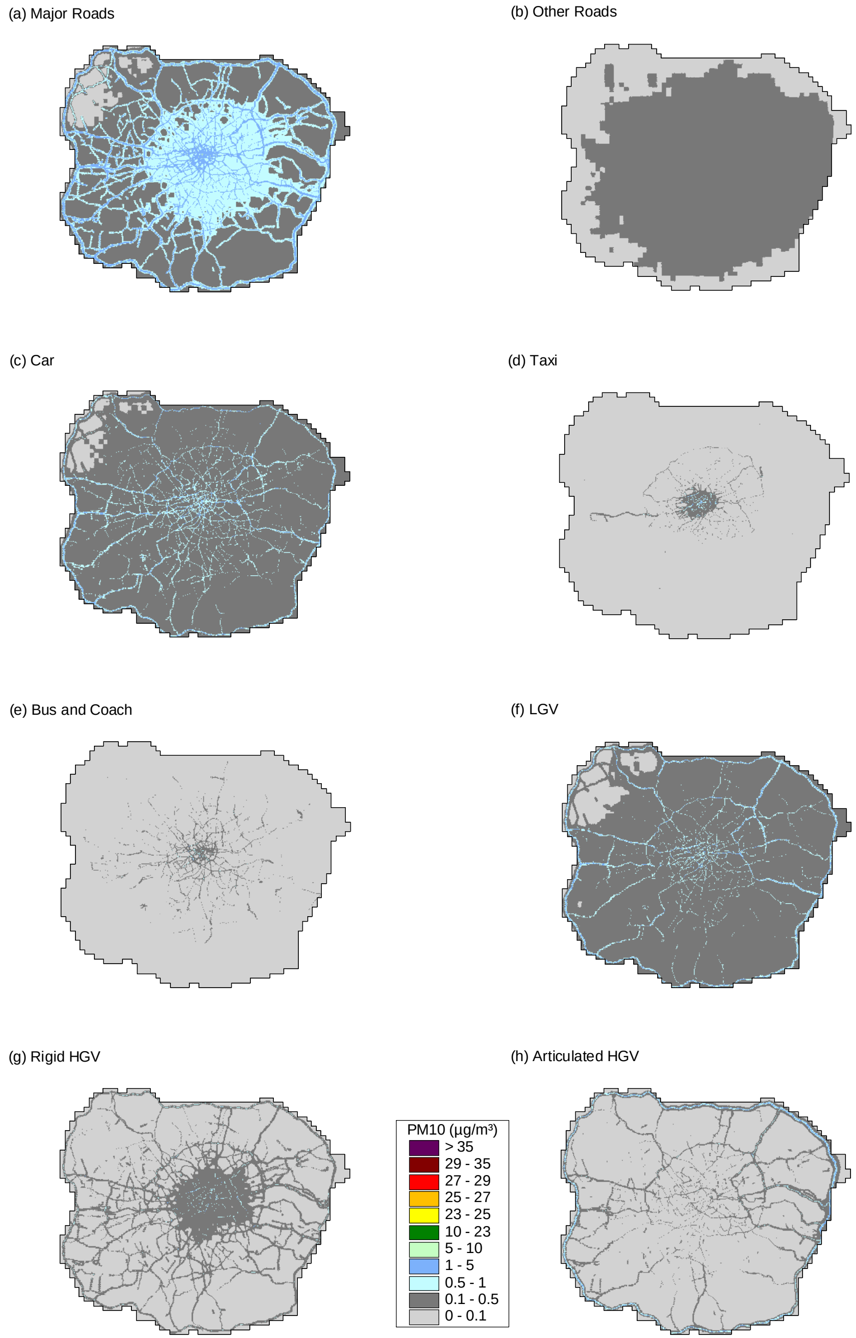
Source apportionment of PM_{10} from vehicle exhaust emissions 2010



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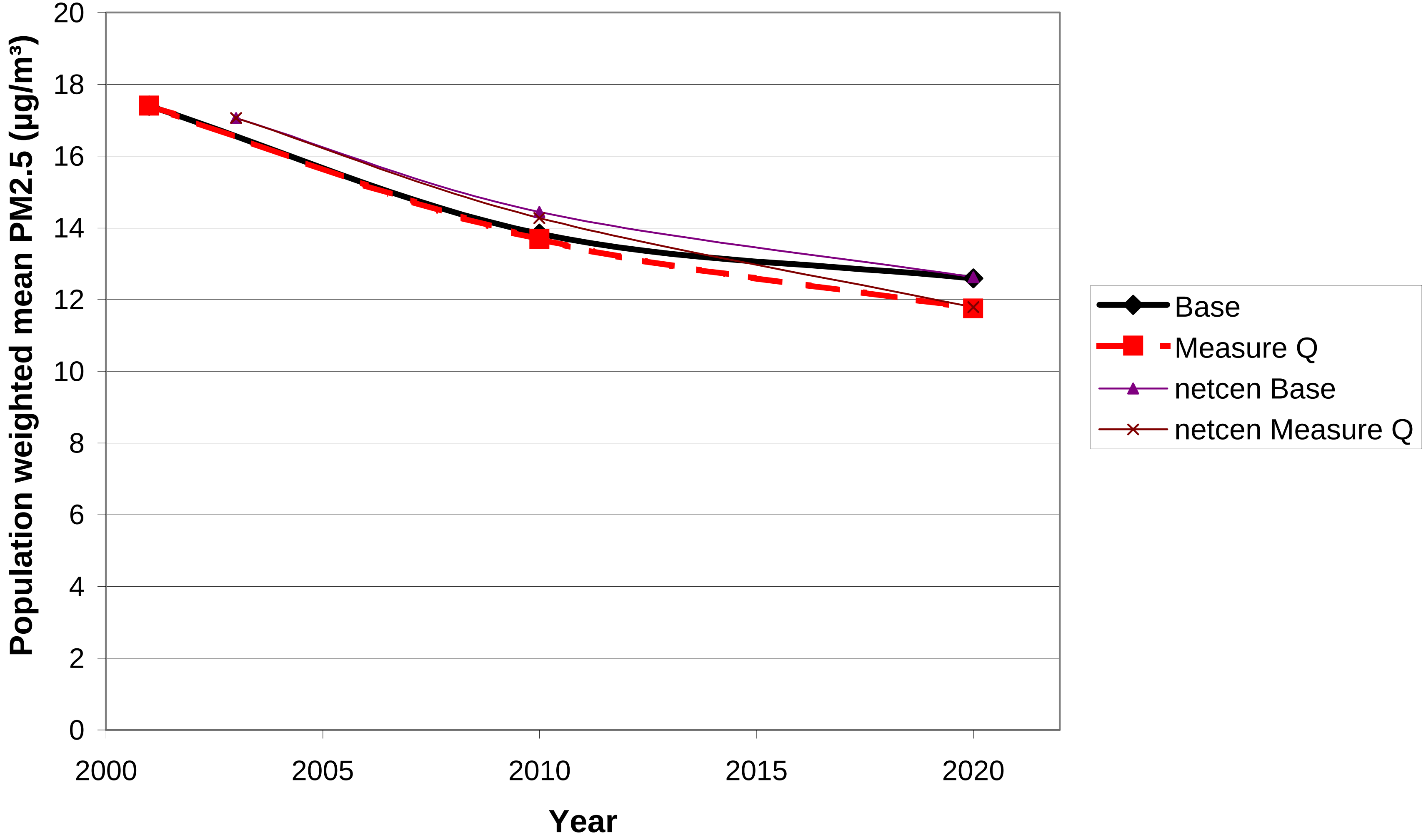
Population weighted mean $PM_{2.5}$ concentrations



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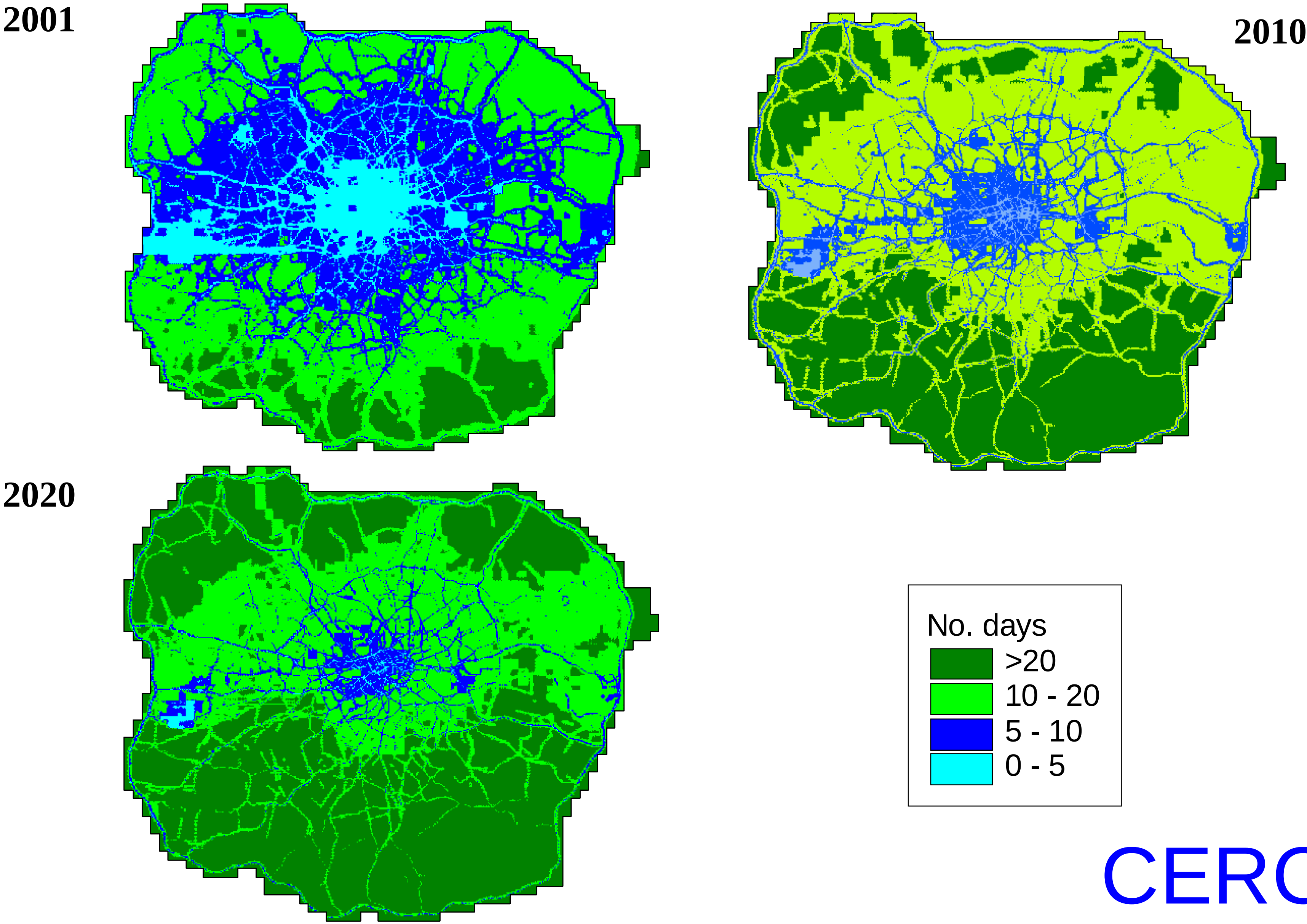
Number days in which the 8 hour maximum concentration exceeds 100µg/m^3 – Base case



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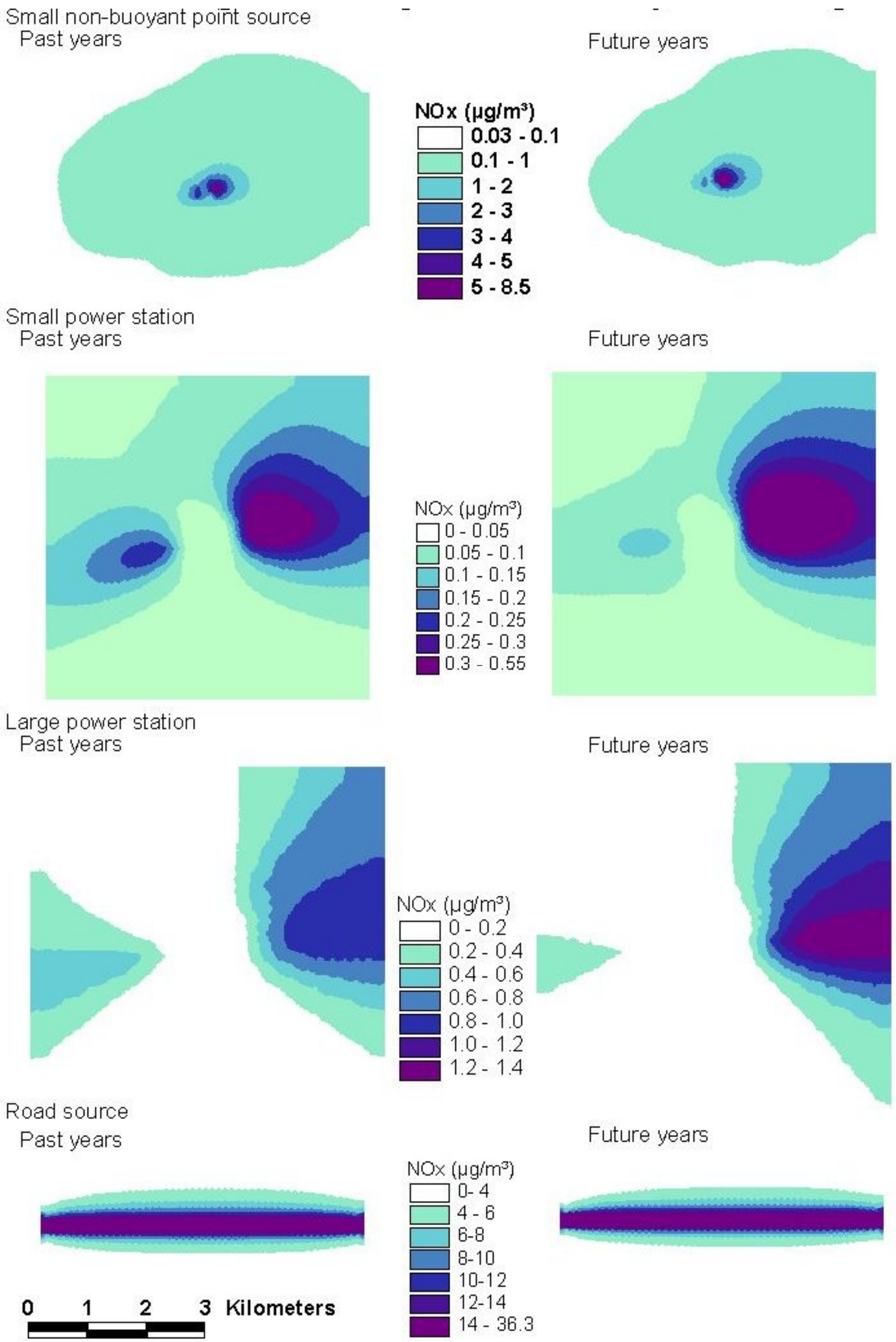

Climate Change

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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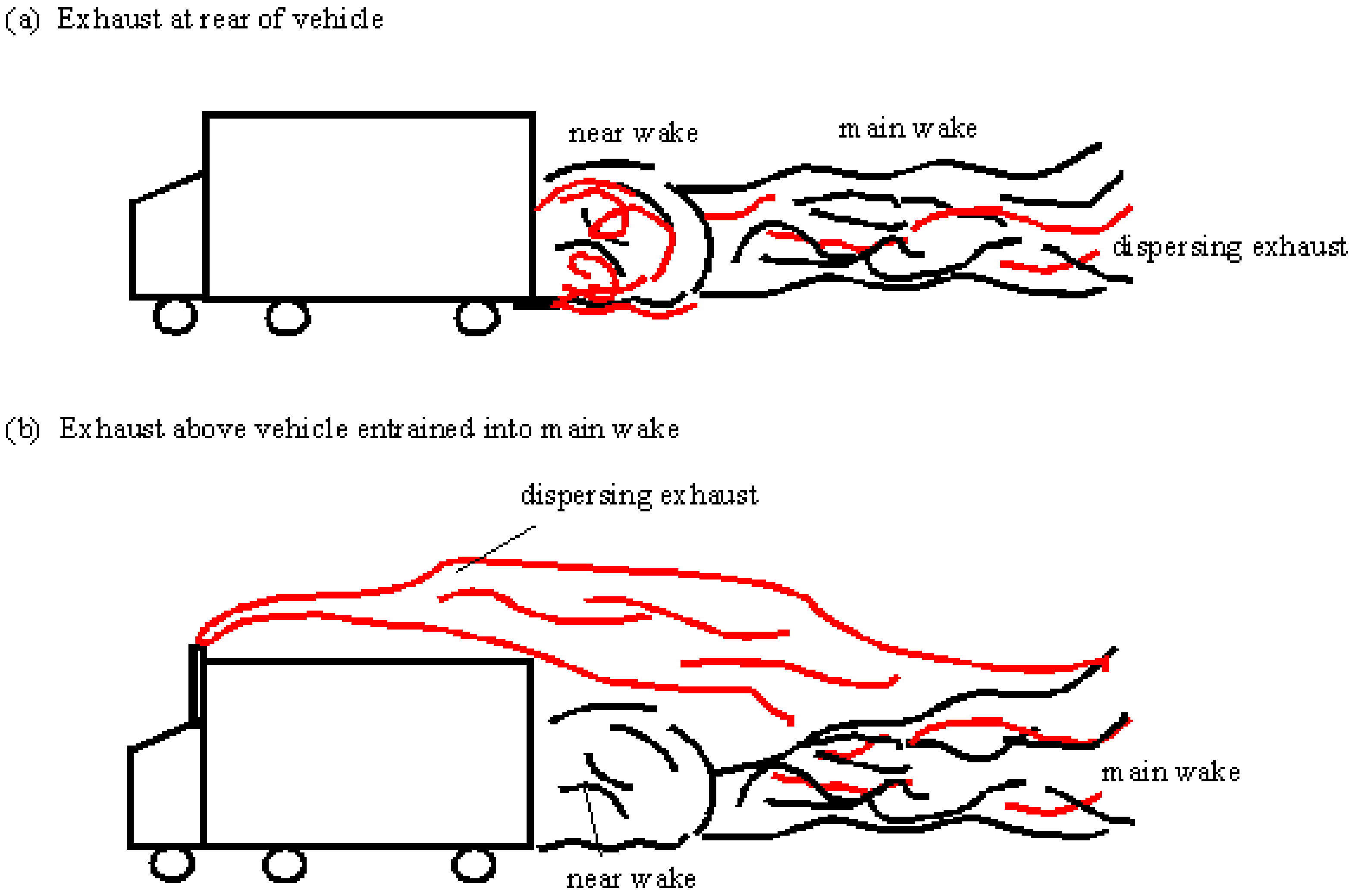

Dispersing vehicle exhaust

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Conclusions

- Project completed December 2006. Aims and objectives substantially achieved.

- NO_2 annual mean objective exceeded in London up to 2020 even with mitigation options.
- As urban NO_x decreases O_3 increases except for the peak values.
- A decrease of 15% of the $PM_{2.5}$ population weighted mean difficult to achieve even with mitigation options (measure Q).
- Elevated exhausts on HGVs can decrease local impact by up to a factor of 10.
- Increased frequency of hot spells due to climate change are likely to reverse decline in peak O_3 levels.
- Modelled results show strong sensitivity to forward projections of Background O_3 and PM and percentage of primary NO_2.

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Opportunities for future (5-10 years) related research

Key concerns at local/urban/ regional scales

NO_2 mainly close to roads

O_3 regional and increasingly in urban areas

PM_{10}, $PM_{2.5}$ close to roads (primary) and regional (secondary)

ADMS-Urban has local scale small capabilities not exploited:

- Can allow for variation of percentage of primary NO_2 and resuspension on street by street basis - vehicle category/numbers.
- Near field dispersion effects eg exhaust location.

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Opportunities for future (5-10 years) related research cont’d

Regional/Links to Local Scale

- Projections of rural background for use in ADMS-Urban (and other models) simple.
- Benefit from regional model with full chemistry eg MM5/CMAQ, NAME(?) to cover all of Europe and set up to be able to take account of different mitigation scenarios.
- ADMS-Urban easily nested in a mesoscale model system (eg forecasting in PROMOTE).
- Such a system would provide fully consistent approach covering both regional and local scales as required.

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