Department
for Environment
Food & Rural Affairs

RICARDO-AEA

Theory meets reality:

Use of AQ models to meet every day regulatory obligations

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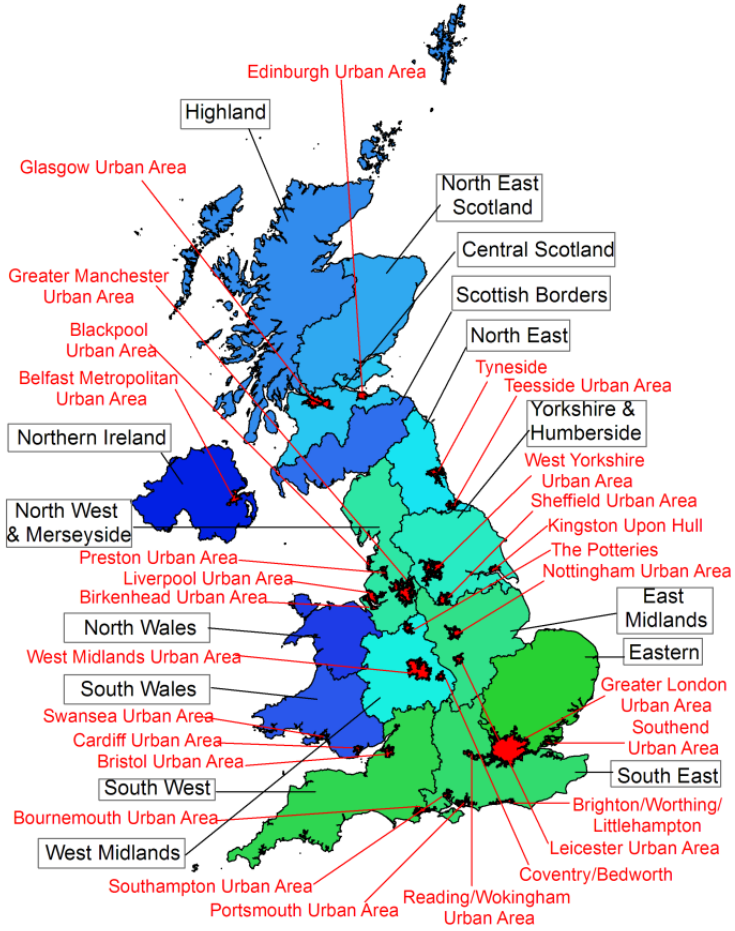
The use of air quality models within the UK annual compliance assessment

- Overall approach
- Benefits
- Limitations
- PCM GIS-based models
- Examples from the 2011 UK compliance assessment
- Implications of using models



Overall approach to Compliance Assessment

- Annual air quality assessment against the limit and target values (AQD 2008/50/EC and DD4 2004/107/EC)
  - For the whole of the UK, assessment is carried out by centrally
  - The assessment of compliance in each zone is based on a combination of measurements and model results
    - Assessment thresholds have been set in Annex II of the AQD and are at levels lower than the limit values
    - Above upper assessment threshold: fixed measurements supplemented by modelling
    - Between upper and lower assessment thresholds: a combination of fixed measurements and modelling
    - Below the lower assessment threshold: modelling is sufficient

Overall approach to Compliance Assessment

- Annual air quality assessment against the limit and target values
  - The assessment is based on the higher of the maximum measured and maximum modelled in each zone
  - The models used need to provide results relevant to the assessment requirements in Annex III of the AQD
    - Highest concentration in the zone. Typically at traffic locations but not including locations where the public do not have access and not including junctions
    - Urban background locations. Representative of exposure of the general population: typically representative of several square km

Benefits

- Model results can cover the whole of the Member State at locations relevant for assessment
- Reduced requirement for fixed monitoring and therefore reduced cost
- Models can also be used to provide other information required for air quality management:
  - Spatial extent of exceedance
  - Source apportionment
  - Baseline projections
  - Impacts of measures
  - All consistent with the compliance assessment

Limitations

- Additional uncertainties associated with using models
  - Inputs (emission inventories, met data)
  - Model formulations (transport, dispersion, chemistry)
  - Model results cannot have lower uncertainties than the measurements!
- Availability of input data including emission inventory maps
  - ~ 1 km for urban background sources
  - Individual roads for traffic locations

PCM GIS-based models

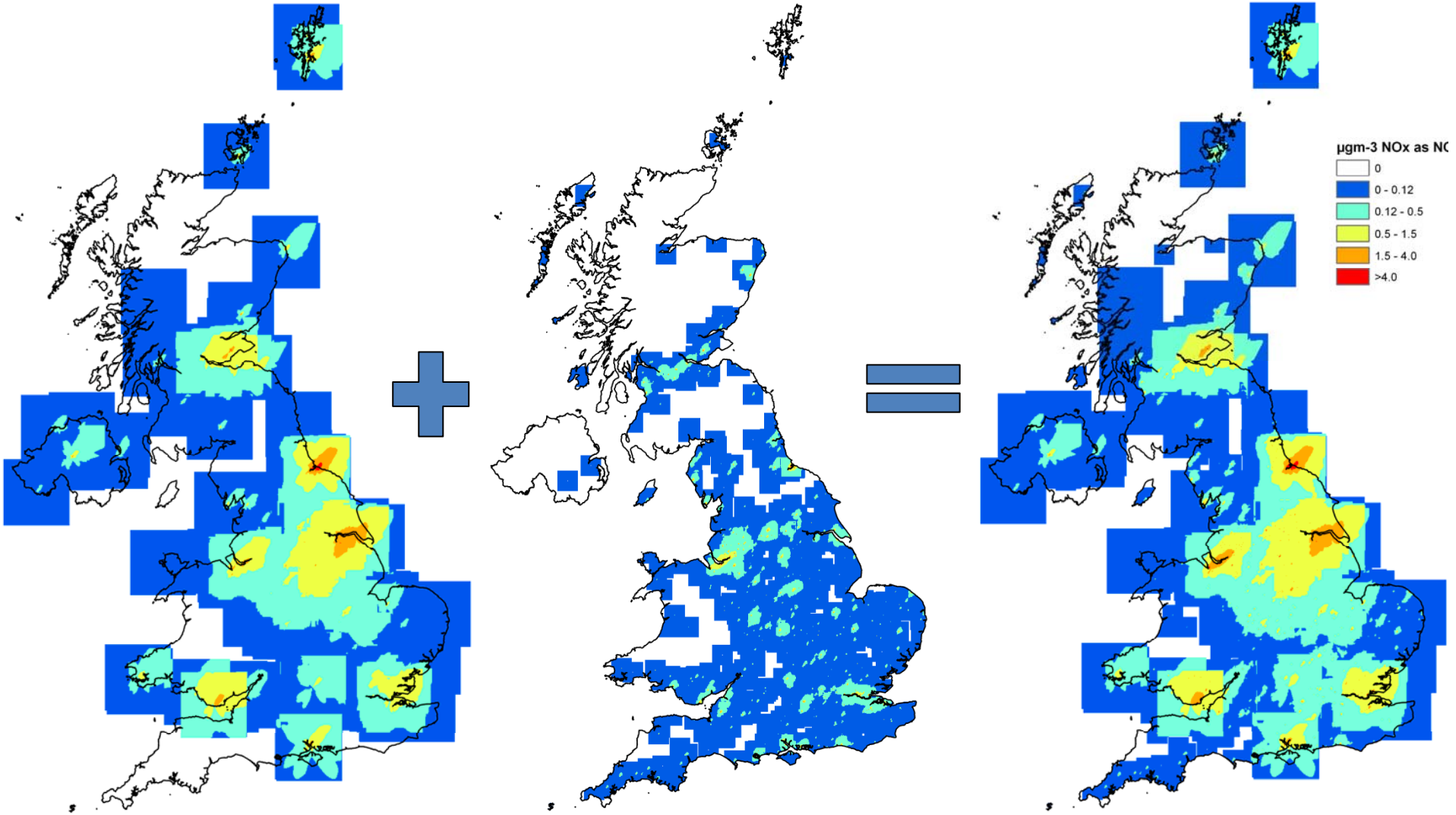
- Pollutants
  - AQD: SO_2, NO_x, NO_2, PM_{10}, $PM_{2.5}$, Pb, C_6H_6, O_3
  - DD4: BaP, As, Cd, Ni
- Annual mean maps built up from many layers
  - Regional (interpolated from rural measurements)
  - Point sources modelled using dispersion model
  - Area sources modelled using a dispersion kernel approach
  - Roadside increment model

PCM GIS-based models

- Calibrated using automatic monitoring data from the AURN
- 1 km grid resolutions + ~9000 urban major road links
- NO_2 calculated from NO_X using 'oxidant partitioning model'

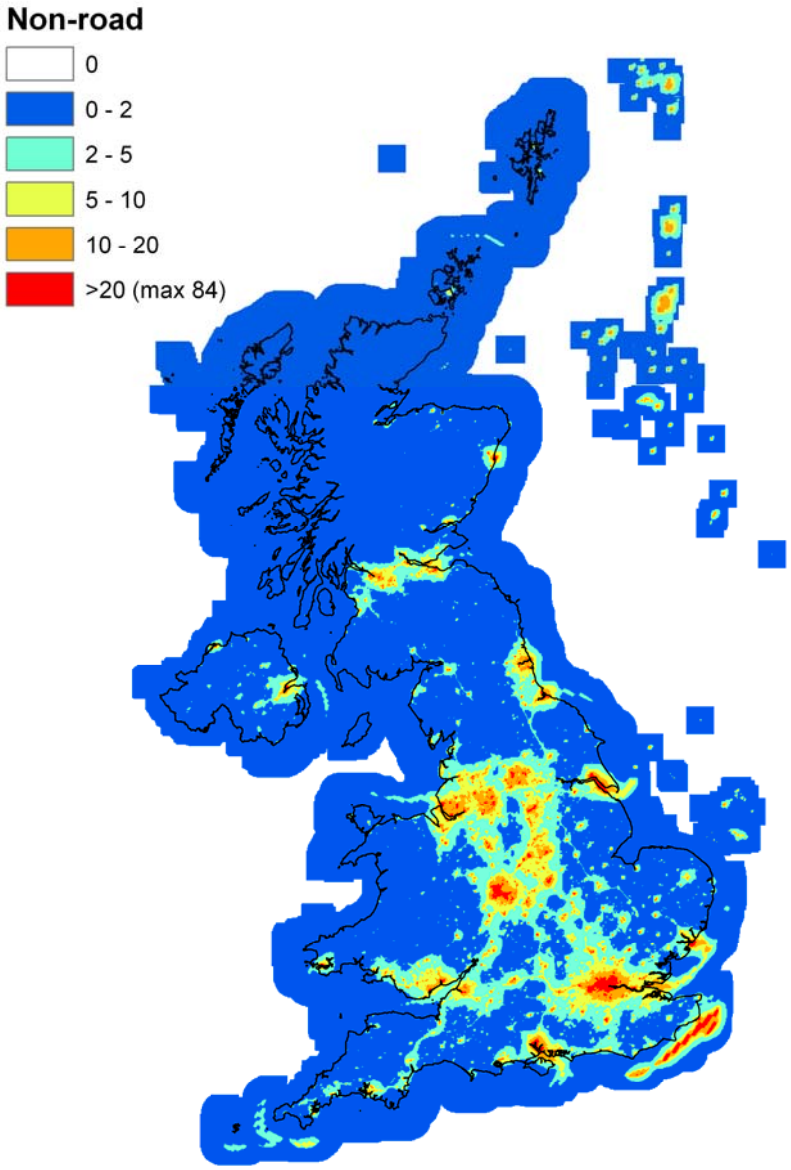
- Many similarities between 'gaseous' and 'particle' models, and some differences
- Particle model (PM_{10}, $PM_{2.5}$, As, Cd, Ni, Pb) components such as re-suspension consistent with each other and other components are consistent with the gaseous models

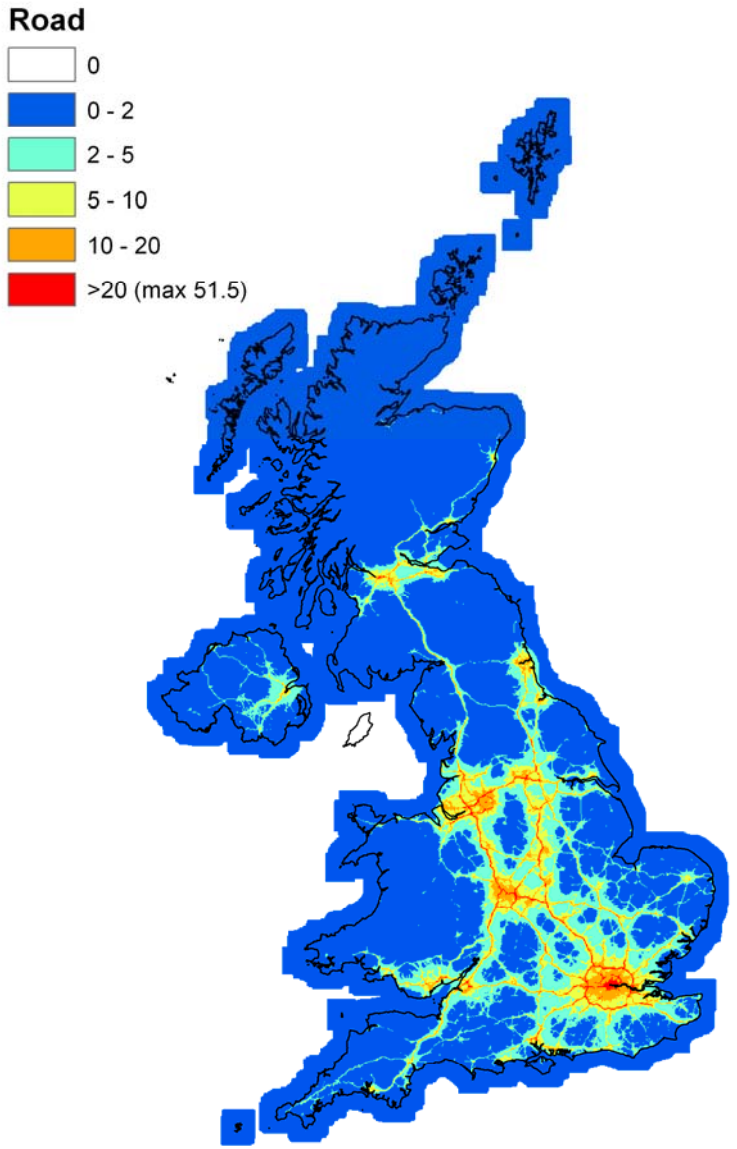
NO_x: Point sources



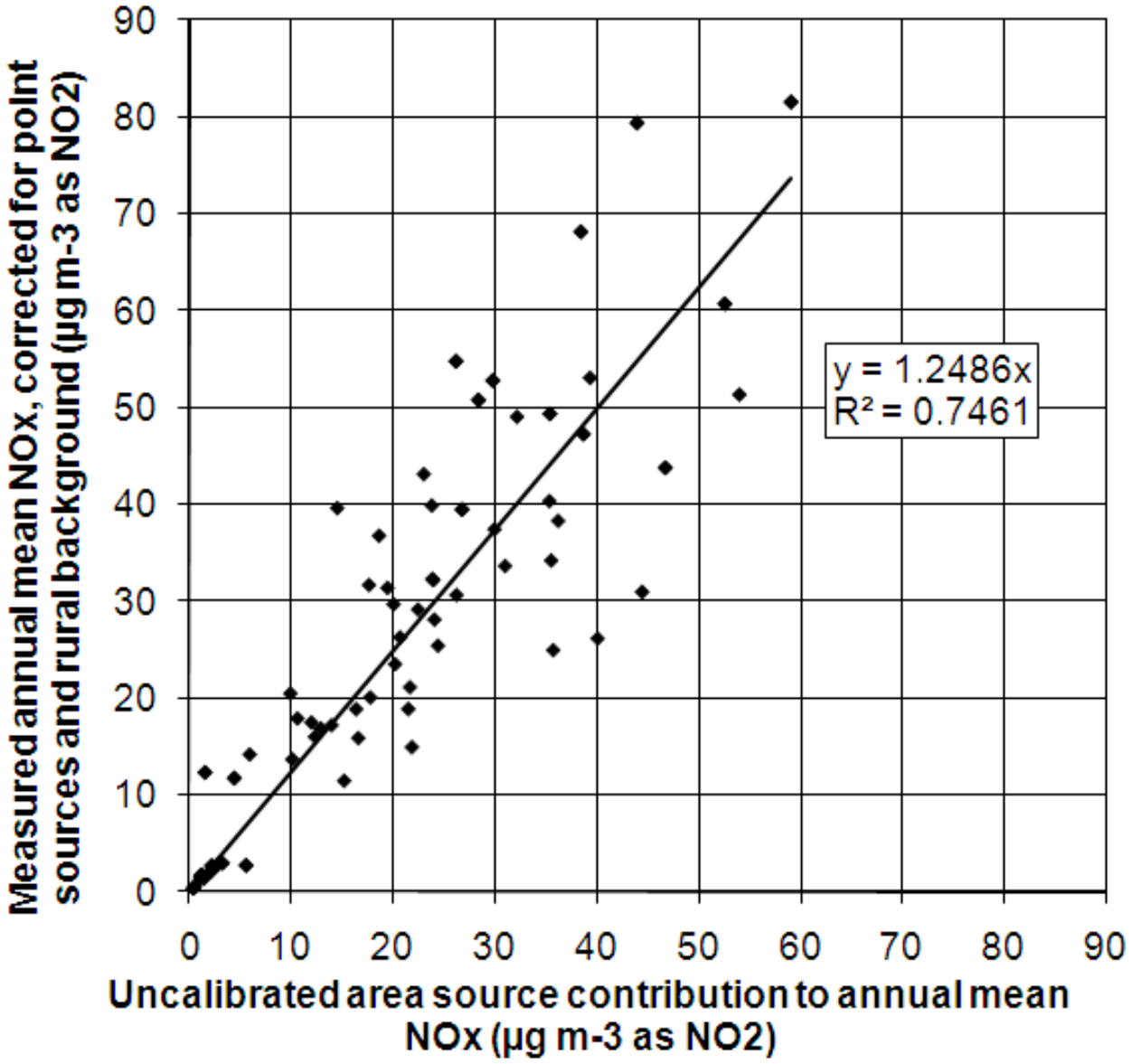
- Large points modelled explicitly Small points using a kernel approach

NO_x: Area sources

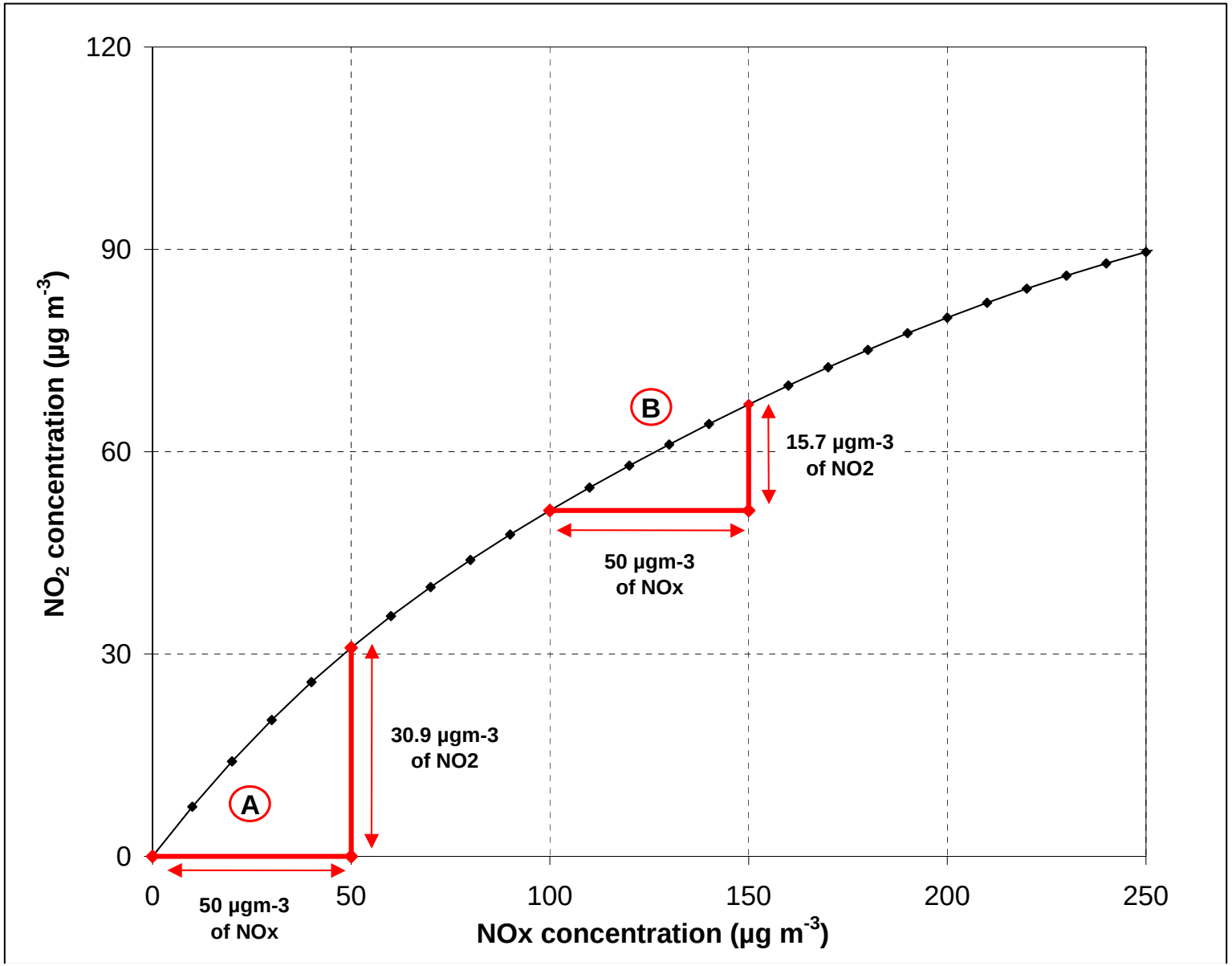




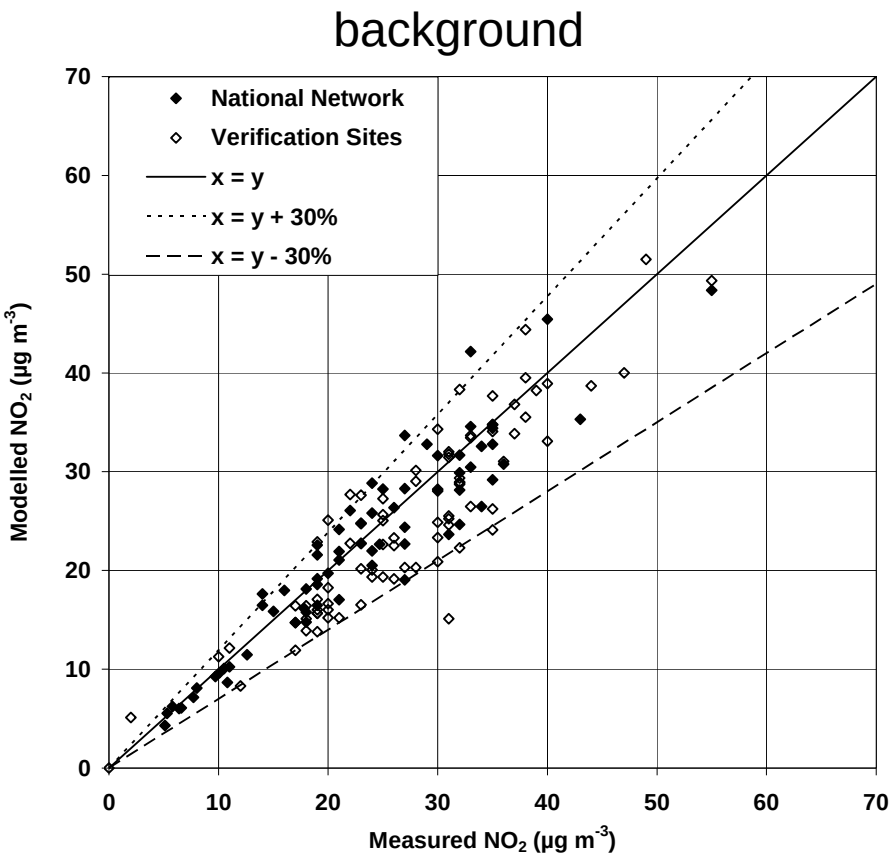
NO_x Area sources: calibration of model

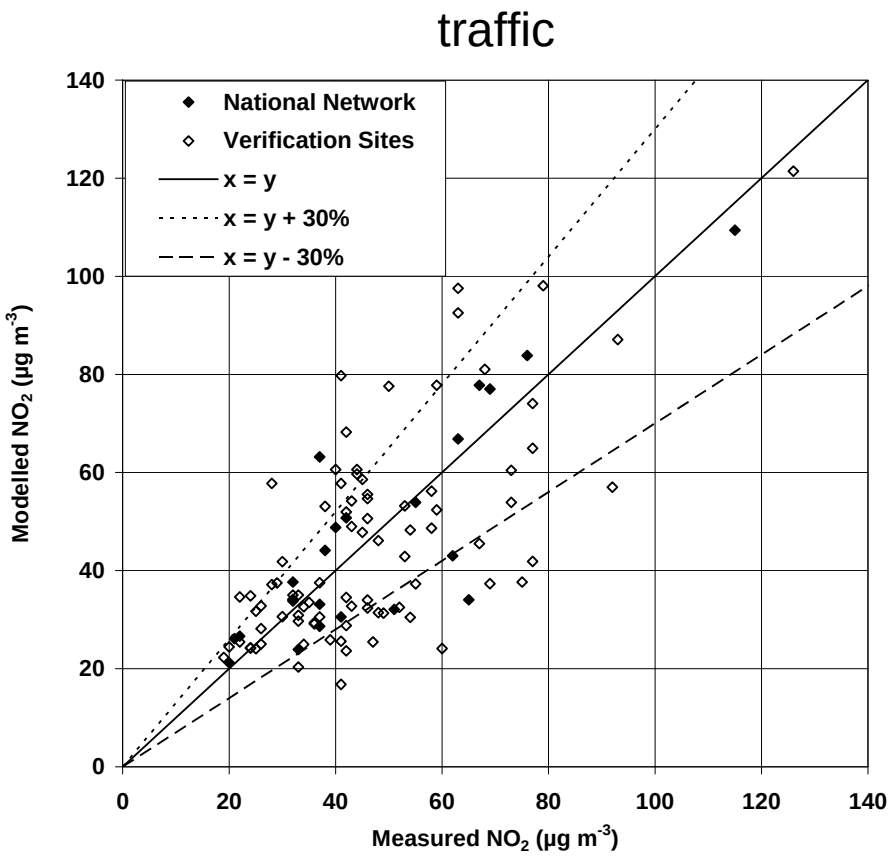


NO_2: accounting for chemistry

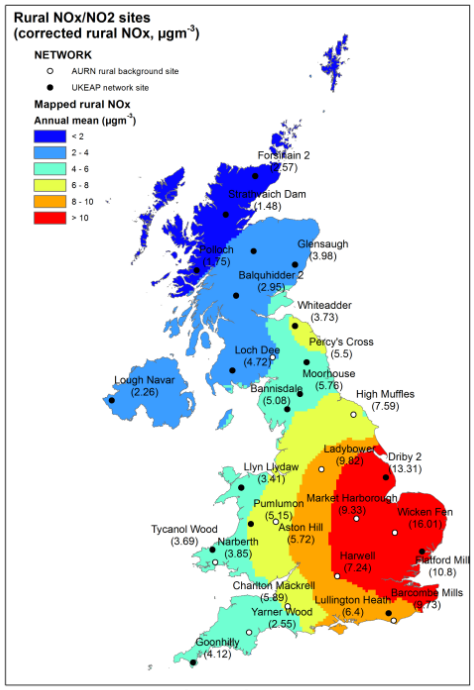


NO_2. Verification of models

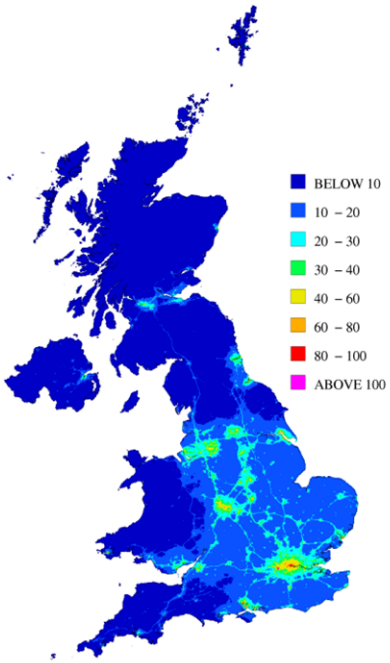




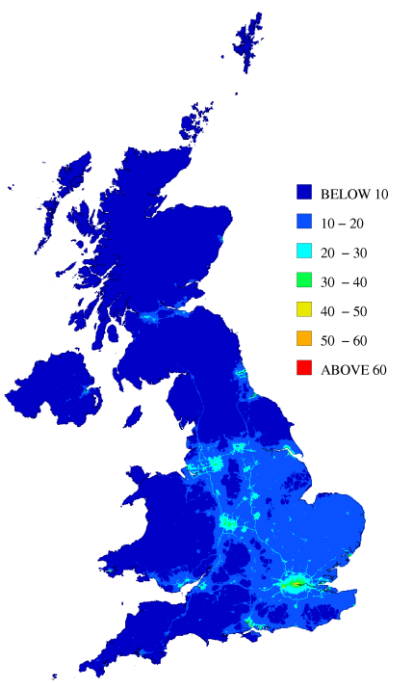
NO_x and NO_2 in 2011



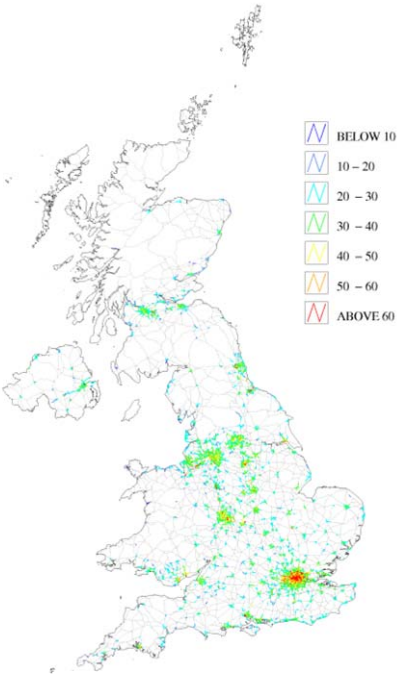
Regional NO_x



Background NO_x



Background NO_2

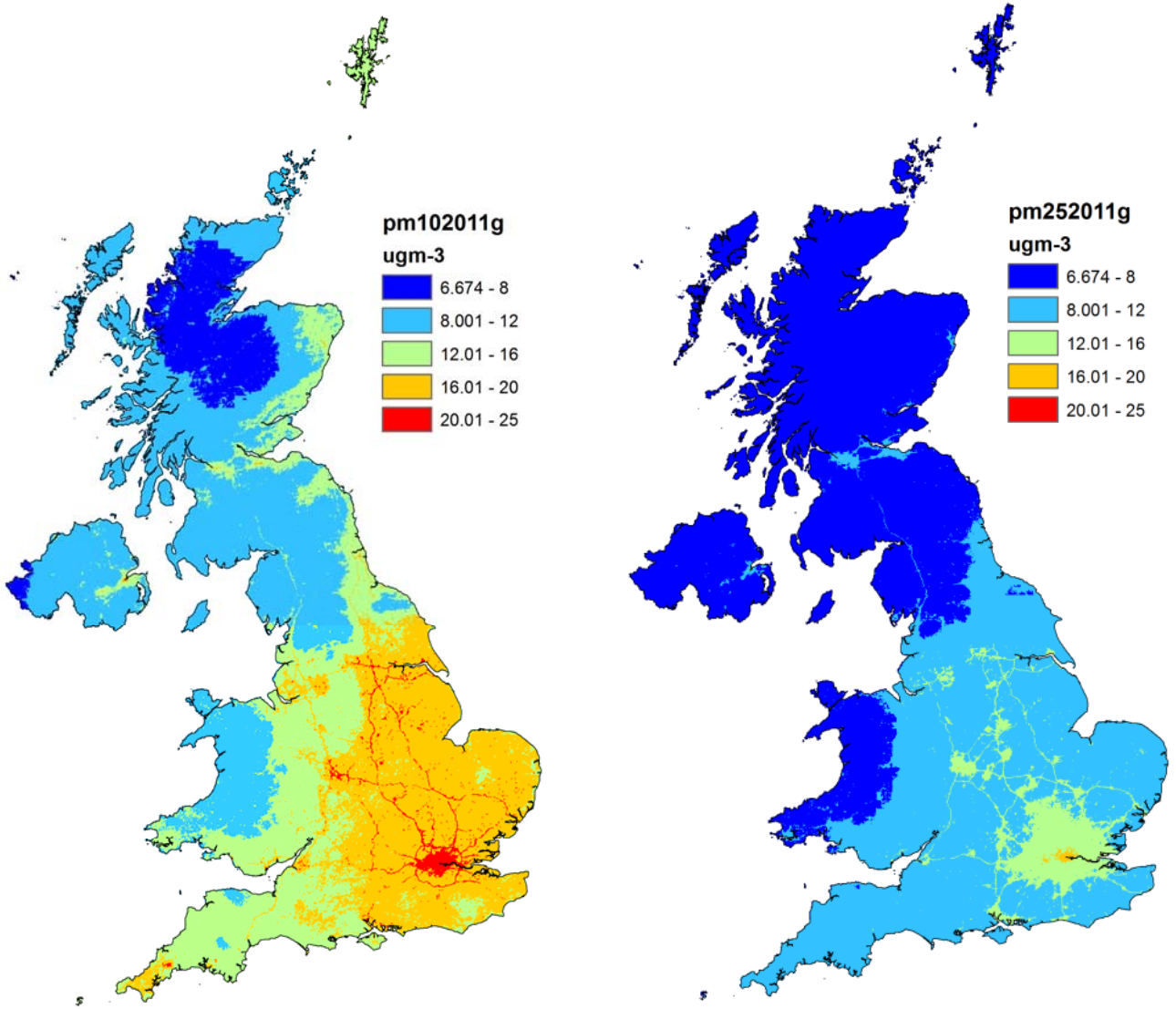


Roadside NO_2

NO_x and NO_2 in 2011

- Results of the air quality assessment for the annual mean limit value for 43 UK zones
  - Measured exceedance in eight zones
  - Modelled exceedance in a further 32 zones

PM_{10} and $PM_{2.5}$ in 2011



PM_{10} and $PM_{2.5}$ in 2011

- Results of the air quality assessment for 43 UK zones
  - PM_{10}: Modelled exceedance of 24-hour limit value in one zone (after subtraction of natural contribution) but time extension in place until 10 June 2011
  - $PM_{2.5}$: No exceedances of target or limit value

Other pollutants in 2011

- Results of the air quality assessment for 43 UK zones
  - Fully compliant with limit and target values for SO_2, Pb, C_6H_6, CO, As, Cd
  - Fully compliant with target values for O_3, 31 measured and 12 modelled zones exceeding for 8-hour mean, two measured and one modelled zone for AOT40 long term objectives
  - One measured and one modelled zone exceeding for target value for Ni
  - Two measured and five modelled zones exceeding for target value for BaP

Implications of using models

- Model results will include the maximum concentration in relevant locations across the whole zone
- Monitoring networks may not include the maximum location for practical or other reasons
- We have completed some calculations to explore the likely impact of including modelling

Implications of using models

- 2011 Compliance assessment for annual mean NO_2 (percentages in exceedance)
  - Germany: 36% of stations, 61% of zones
  - France: 10% of stations, 36% of zones
  - Italy: 19% of stations, 35% of zones
  - UK: 13% of stations
    - 19% of zones (monitoring only)
    - 30% of zones (estimate if UK had 150 monitoring stations)
    - 60% of zones (estimate if UK had 500 monitoring stations)
    - 93% of zones (as reporting, including model results for ~9000 roads)

The use of air quality models within the UK annual compliance assessment

- Benefits
  - Model results can cover the whole of the Member State or smaller areas if required
  - Reduced requirement for fixed monitoring
  - Models can also be used to provide other information required for air quality management (extent of exceedance, source apportionment, projections, impact of measures)
- Limitations
  - Additional uncertainties associated with using models
  - Availability of input data including emission inventory maps
- Implications of using models
  - Monitoring networks may not include the maximum location
  - Use of models may tend to increase the proportion of zones with reported exceedances