Scottish Air Quality Mapping – a devolved model

AEA

Modelling & mapping of NO_X, NO_2 and PM_{10} for 2009, and projections for 2010, 2015 & 2020

Justin Lingard – March 2011

Outline

Overview

Modelling and mapping method

Model results for NO_X and PM_{10}

- Base year = 2009
- Forward projections for 2010, 2015 and 2020

Scottish air quality modelling

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Policy advice to the Scottish Government

- Brings together information from ambient measurements, emission inventories and models

Modelling approach

- GIS-based model

Outputs and reporting

- Mapping current concentrations
- Baseline & scenario based projections
- Health impact assessment for scenarios

Basis for this approach

- Established, peer-reviewed approach used by Defra for modelling, mapping and reporting AQO pollutant concentrations in the UK to the Commission
- Modelling approach meets DQO set by the Commission

Method

General modelling approach

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Maps built up from many layers, e.g.,

- Regional (interpolated from rural measurements)
- Point sources modelled using dispersion model
- Area sources modelled using a dispersion kernel approach
- Roadside increment model

Scottish meteorology (RAF Leuchars)

1 km grid resolutions + major urban road links

Seperate approaches for large and small point sources:

- Large point sources of primary pollutant emissions (>200 tonne per annum, modelled using emissions estimates from the NAEI & dispersion kernel)
- Small point sources of primary pollutant emissions (<200 tonne per annum, modelled using emissions estimates from the NAEI & the small points model)

Point source emissions come from SEPA database

Pollutant specific considerations

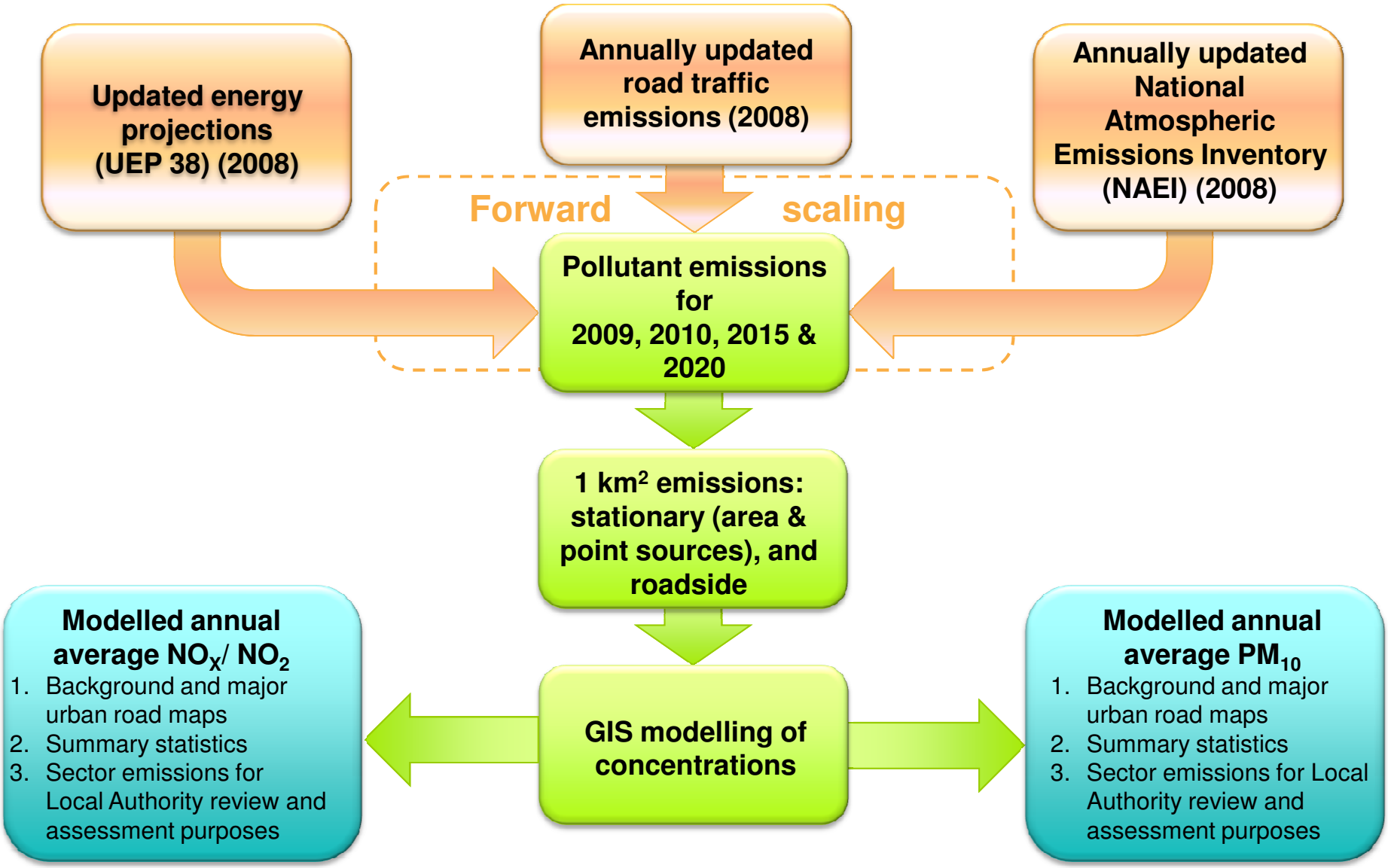
PM_{10}: components not included in National Emissions

- Regional primary particles (from results from the TRACK model and emissions estimates from the NAEI and EMEP)
- Secondary inorganic aerosol (derived by interpolation and scaling of measurements of SO_4, NO_3 and NH_4 at rural sites)
- Secondary organic aerosol (semi-volatile organic compounds formed by the oxidation of non-methane volatile organic compounds. Estimates derived from results from the ELMO model)
- Iron and calcium rich dusts (estimated from a combination of measurements made in Birmingham and surrogate variables for the spatial distribution of the emission associated with these dusts)
- Sea salt (derived by interpolation and scaling of measurements of chloride at rural sites)

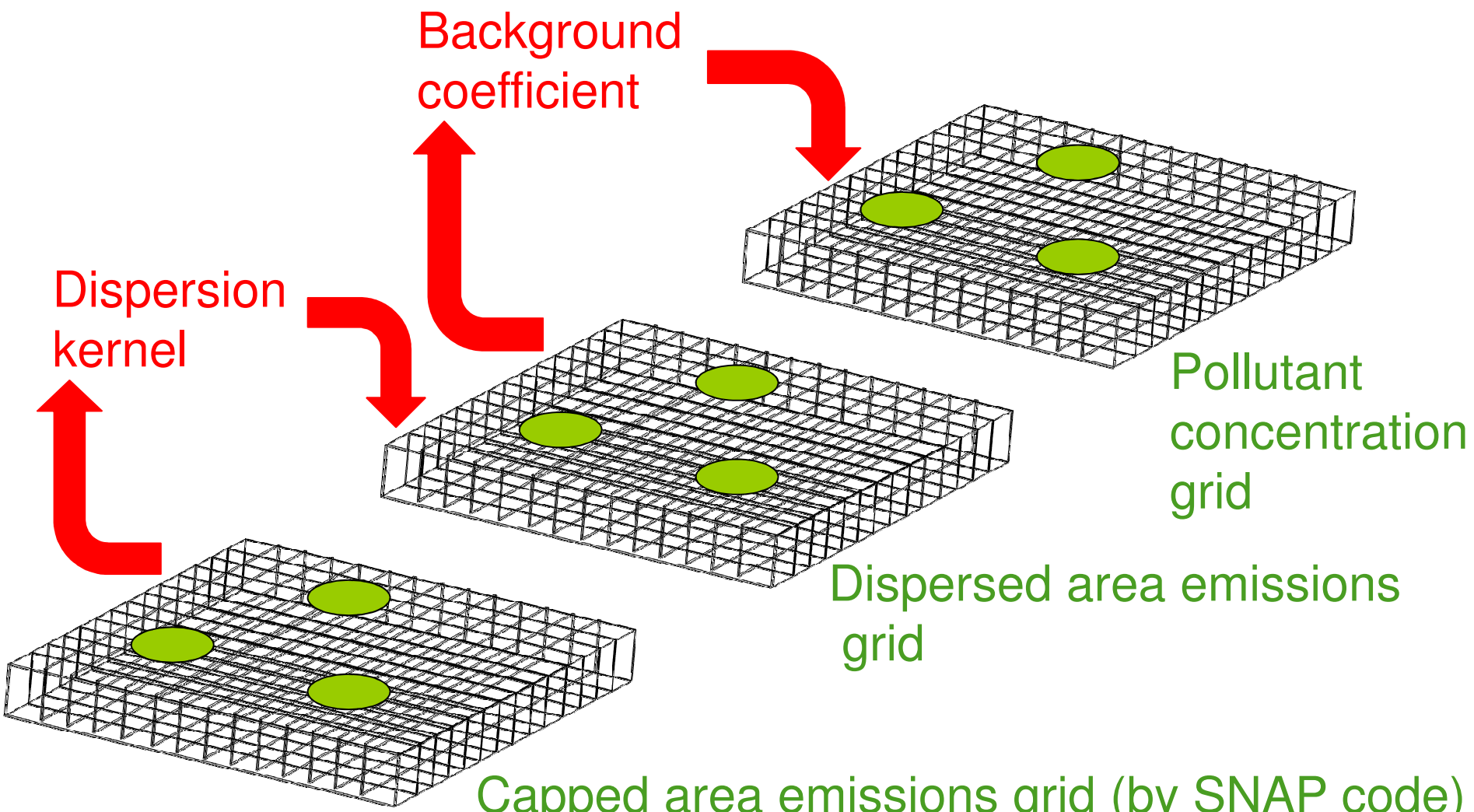
NO_X/NO_2

- NO_2 calculated from NO_X using 'oxidant partitioning model' developed by Mike Jenkins (2004a &b)

Modelling inputs and outputs



Background primary pollutant emissions



Area sources

Area sources (by sector) of primary pollutant emissions estimates from the NAEI

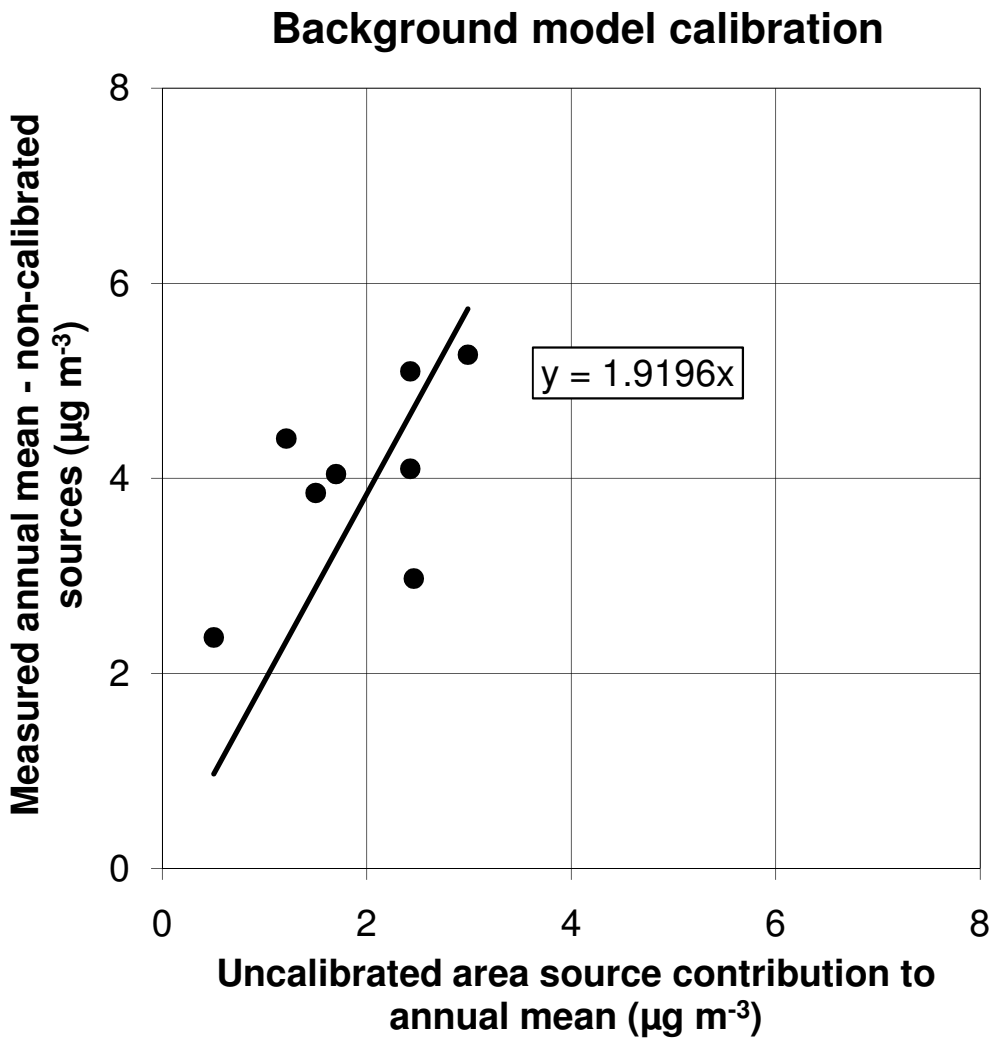
Dispersion kernel applied, emissions capped where necessary

Total background emissions = Σ(Area sources emissions) + Σ(Point source emissions) + Σ(Any other emissions [pollutant specific])

Primary pollutant emissions converted to a concentration

Modelled total background concentration compared against background automatic monitoring data from the SAQN to derive background coefficient

Area sources



Roadside model

Increment model approach: Roadside concentration = Σ(Background concentration) + Σ(Roadside increment)

Roadside increment pollutant specific

NO_X = primary emissions from road traffic

PM_{10} = primary emissions from road traffic + btw

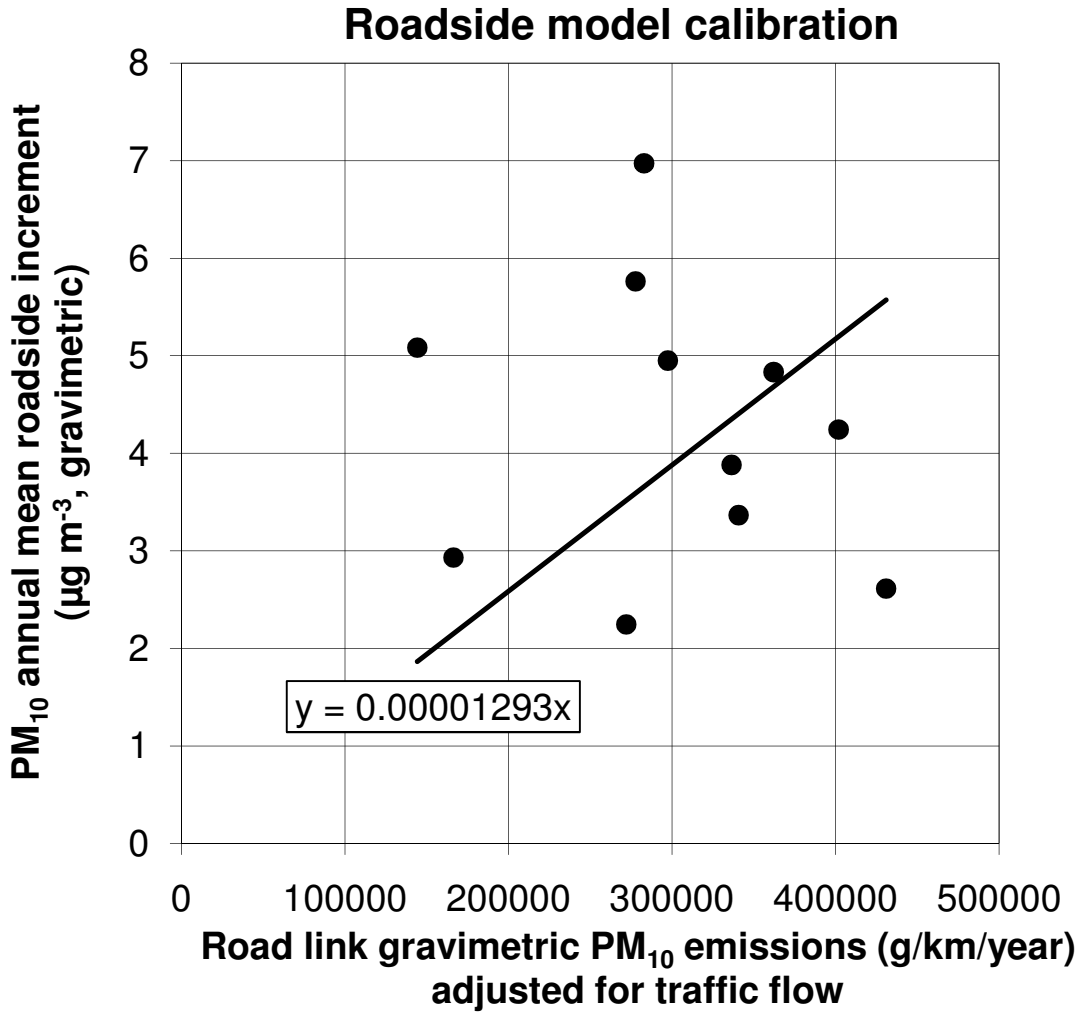
Dispersion kernel applied, emissions capped where necessary

Primary emissions calculated on the basis of vehicle flows at censusid points in close proximity to roadside monitoring sites in SAQN

Primary pollutant emissions converted to a concentration

Modelled total roadside concentration compared against roadside automatic monitoring data from the SAQN to derive roadside coefficient

Roadside model



Changes for 2009

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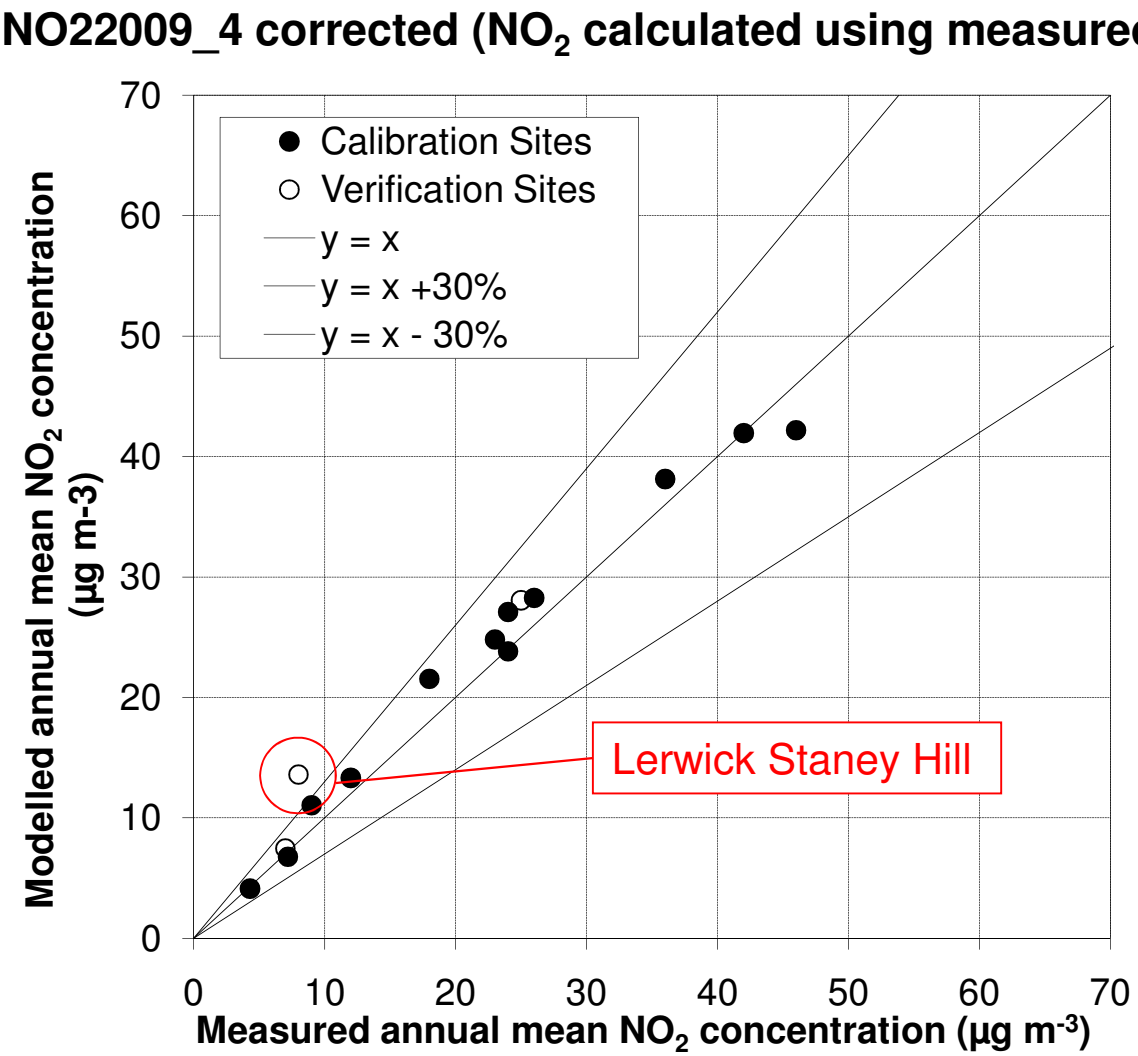
Modifications since last year...

- **Use of verification sites**
  - **Types and number of sites which are verification sites**

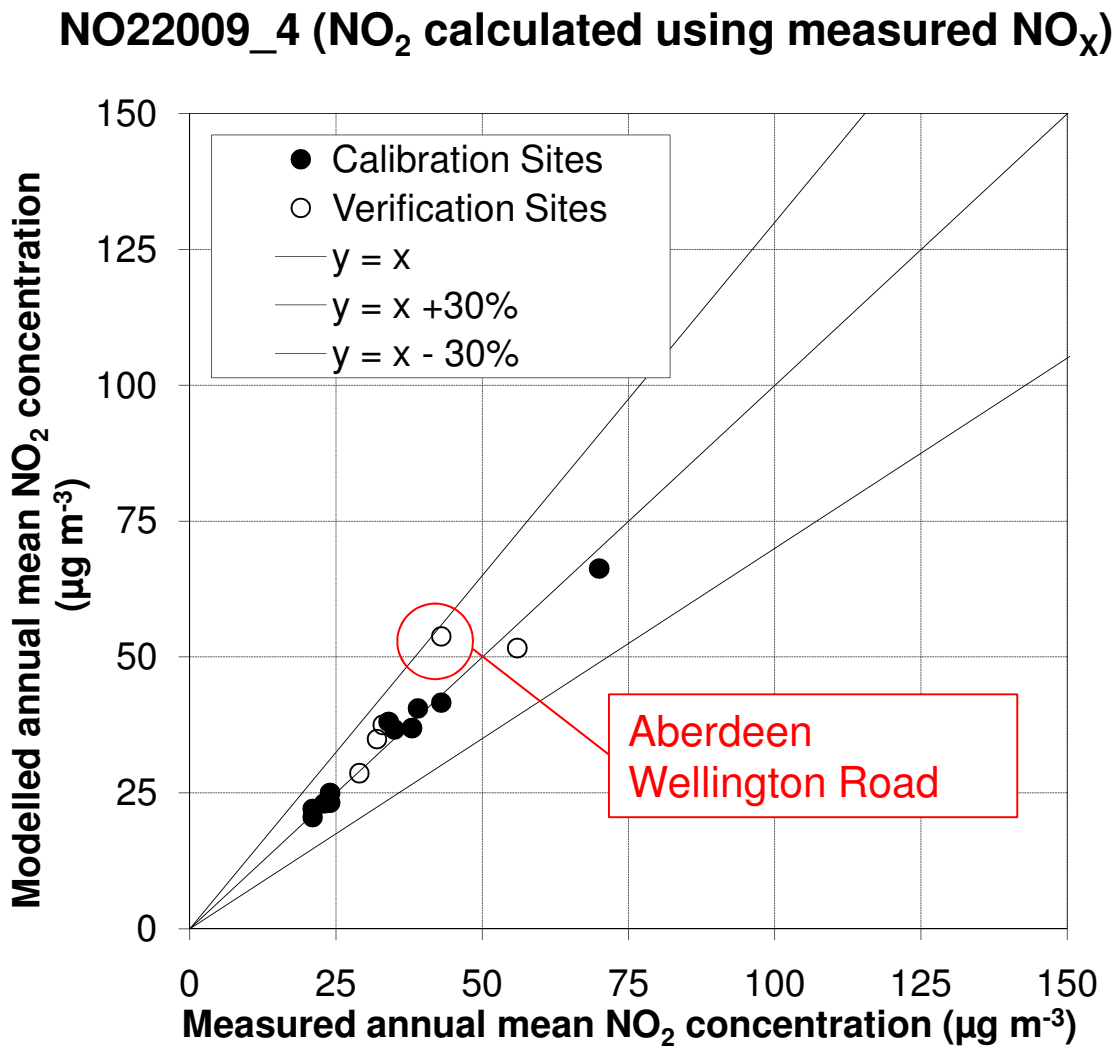
Results

NO_2

Background comparison



Roadside comparison



2009 annual mean background NO_2

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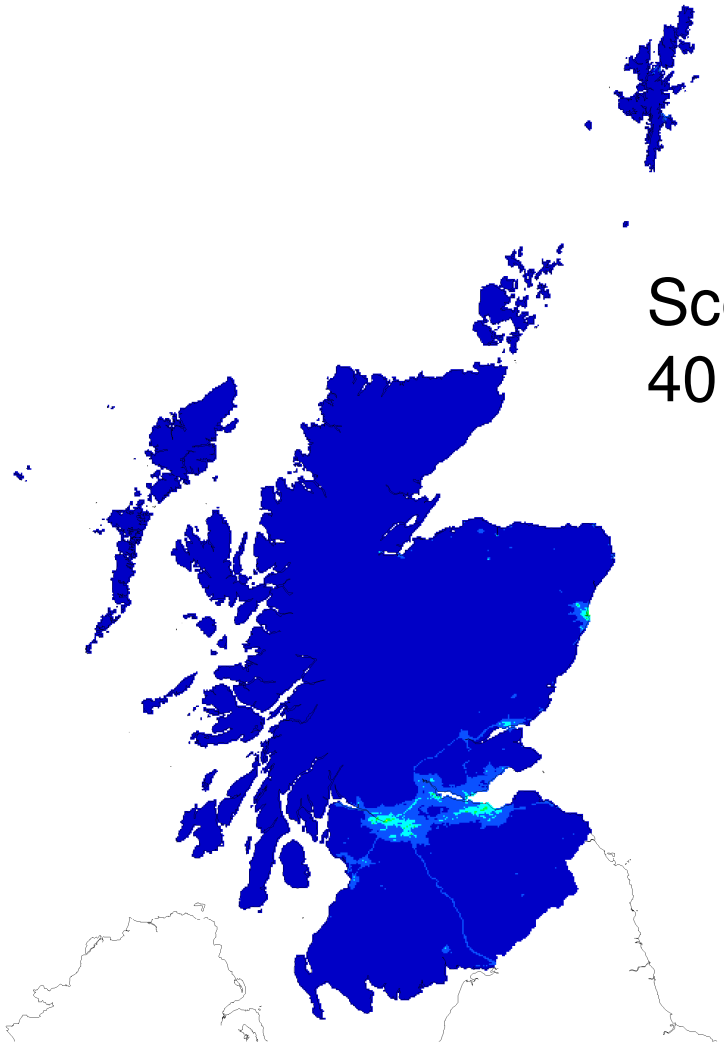
($\mu g\ m^{-3}$)

- BELOW 10
- 10 - 20
- 20 - 30
- 30 -40
- 40 - 46
- 46 - 60
- ABOVE 60



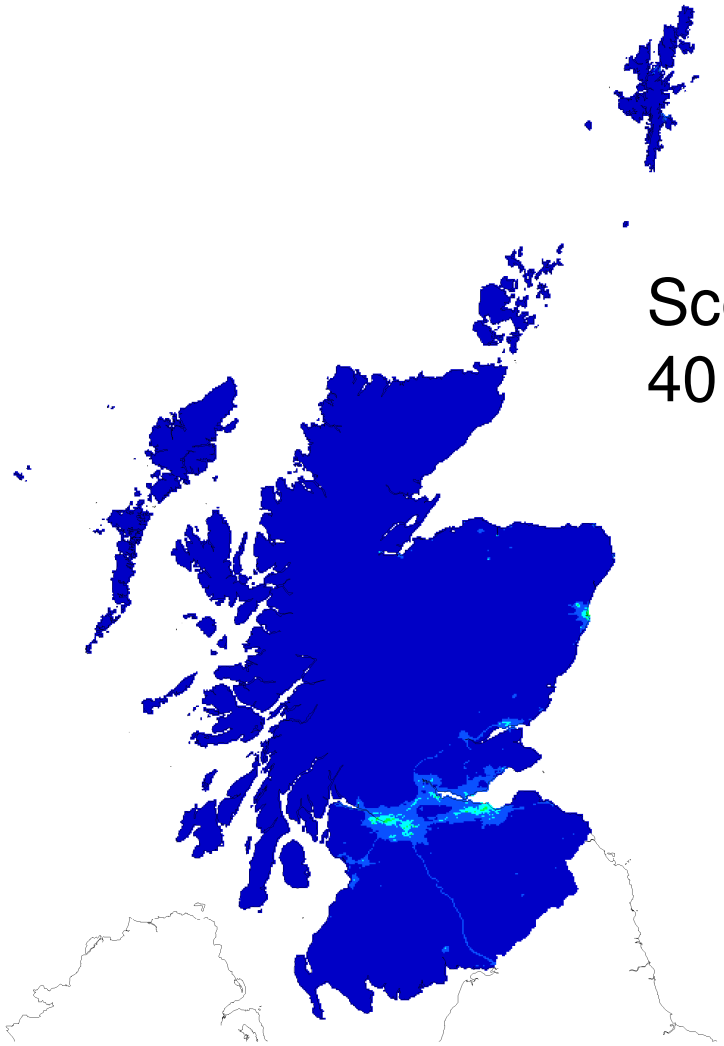
Scottish AQO for NO_2:
40 $\mu g\ m^{-3}$ (annual mean)

2010 annual mean background NO_2

AEA

($\mu g\ m^{-3}$)

- BELOW 10
- 10 - 20
- 20 - 30
- 30 -40
- 40 - 46
- 46 - 60
- ABOVE 60



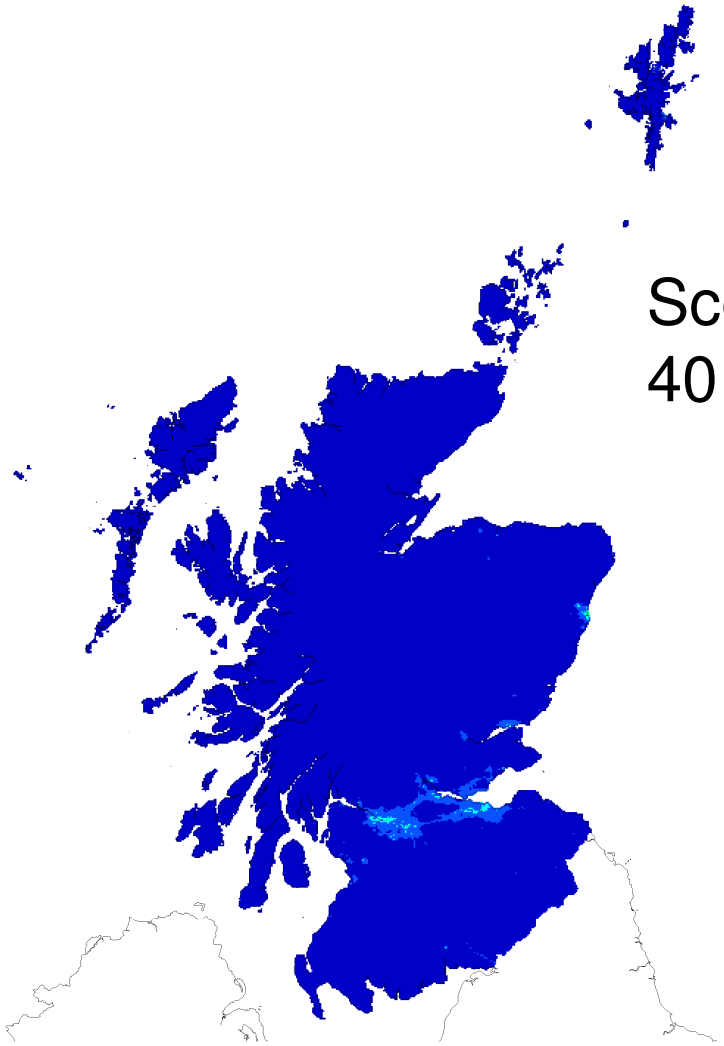
Scottish AQO for NO_2:
40 $\mu g\ m^{-3}$ (annual mean)

2015 annual mean background NO_2

AEA

($\mu g\ m^{-3}$)

- BELOW 10
- 10 - 20
- 20 - 30
- 30 -40
- 40 - 46
- 46 - 60
- ABOVE 60



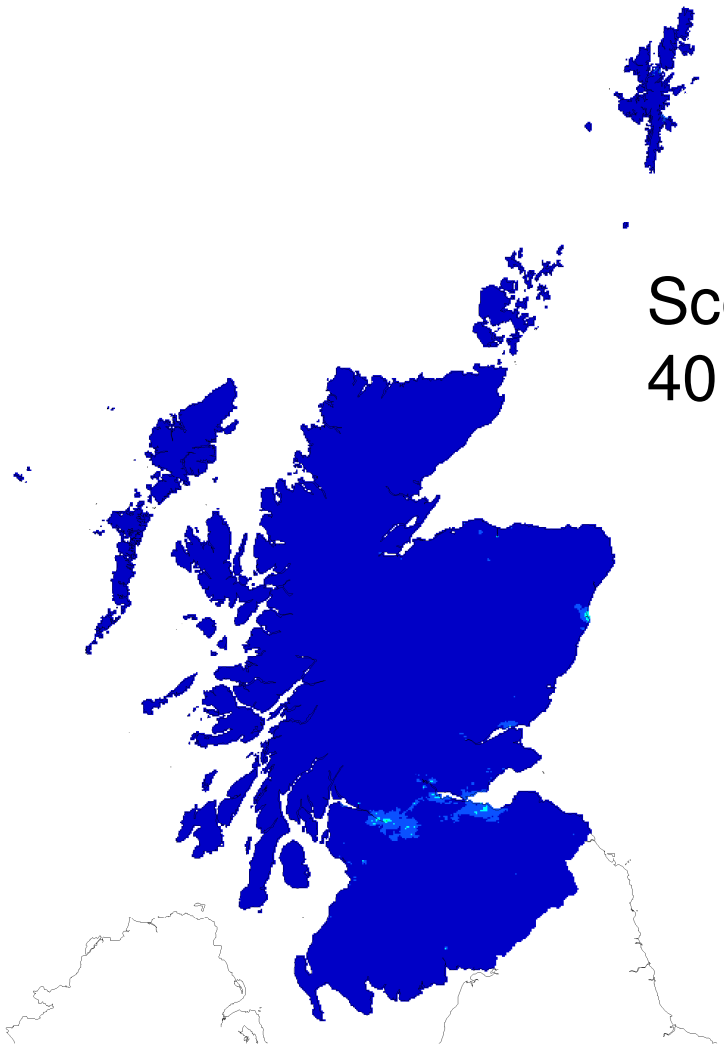
Scottish AQO for NO_2:
40 $\mu g\ m^{-3}$ (annual mean)

2020 annual mean background NO_2

AEA

($\mu g\ m^{-3}$)

- BELOW 10
- 10 - 20
- 20 - 30
- 30 -40
- 40 - 46
- 46 - 60
- ABOVE 60



Scottish AQO for NO_2:
40 $\mu g\ m^{-3}$ (annual mean)

2009 annual mean roadside NO_2

AEA

($\mu g\ m^{-3}$)

- BELOW 10
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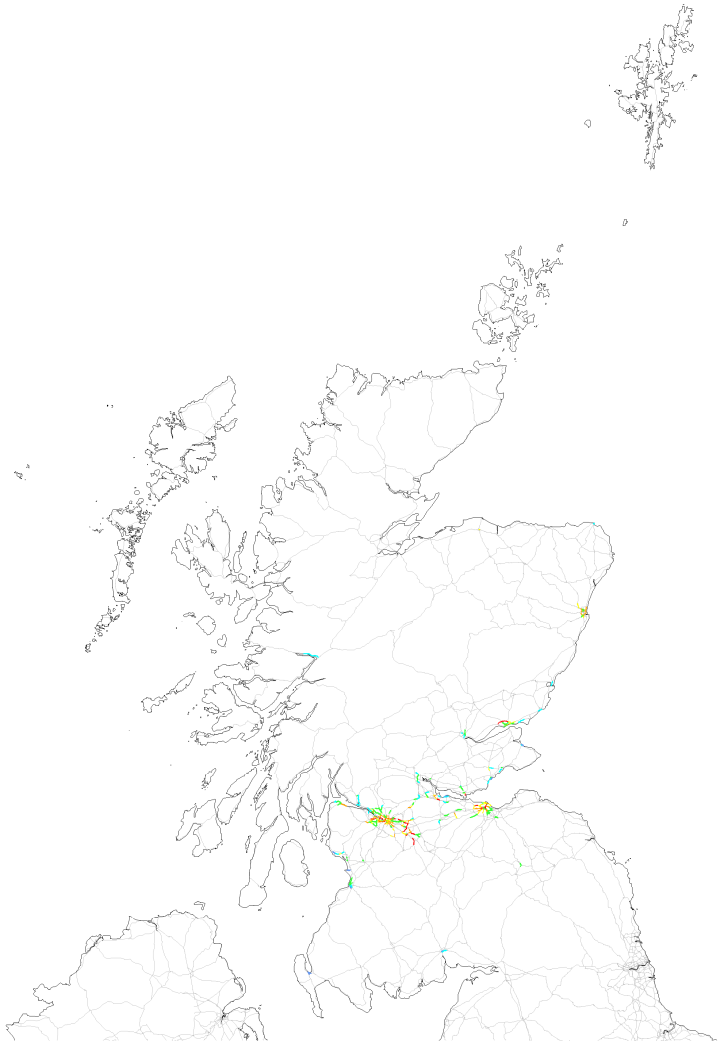
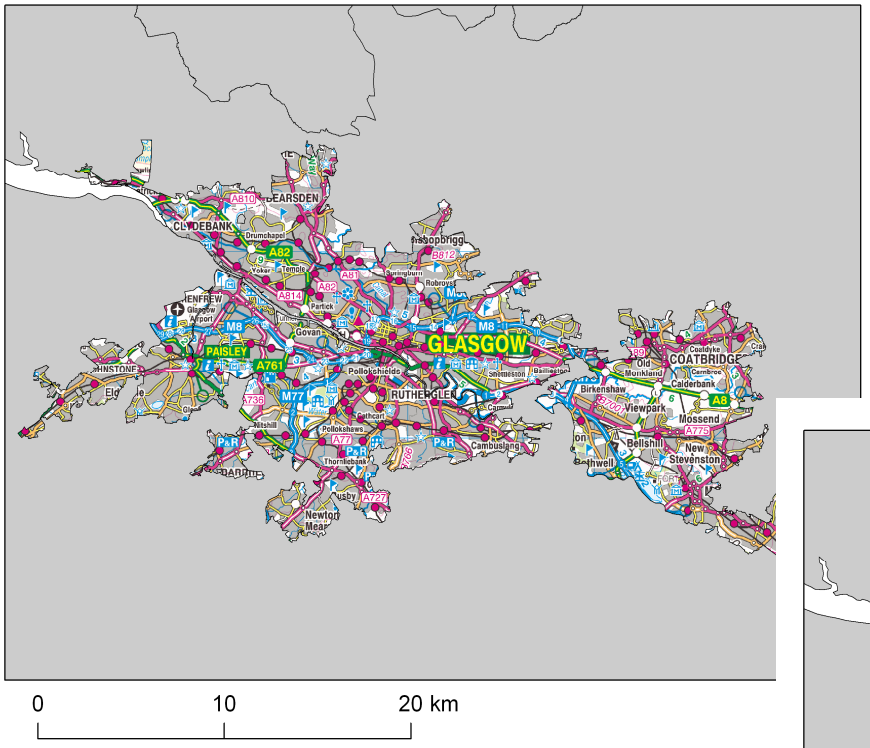
- ABOVE 60

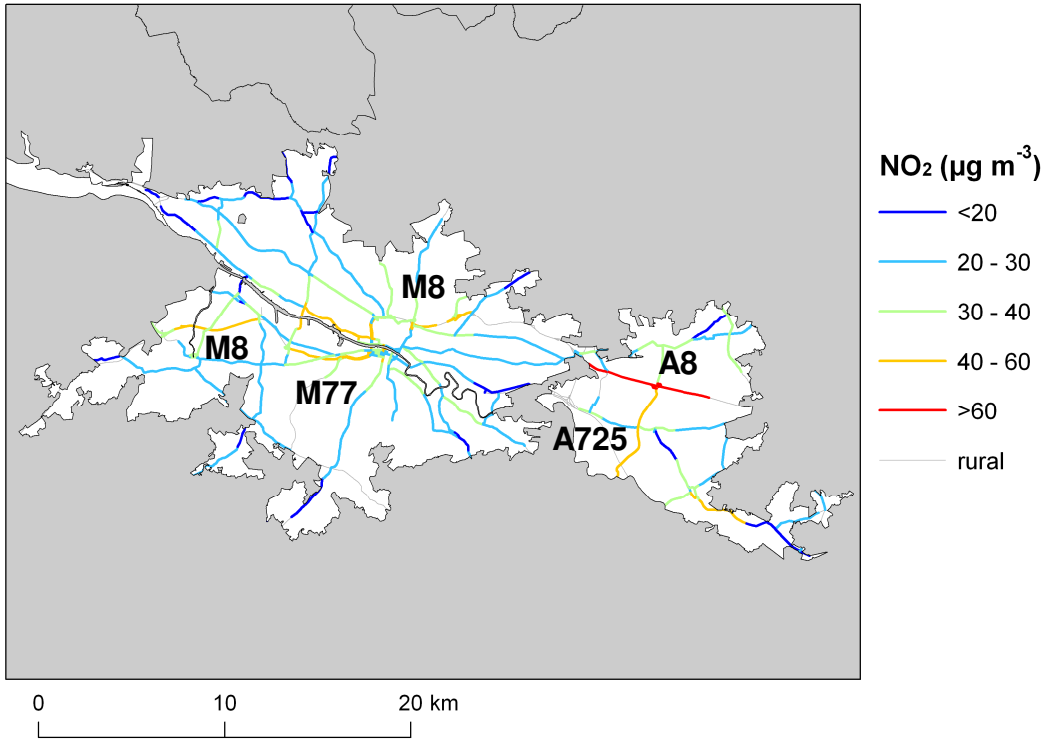


2009 annual mean roadside NO_2: Glasgow



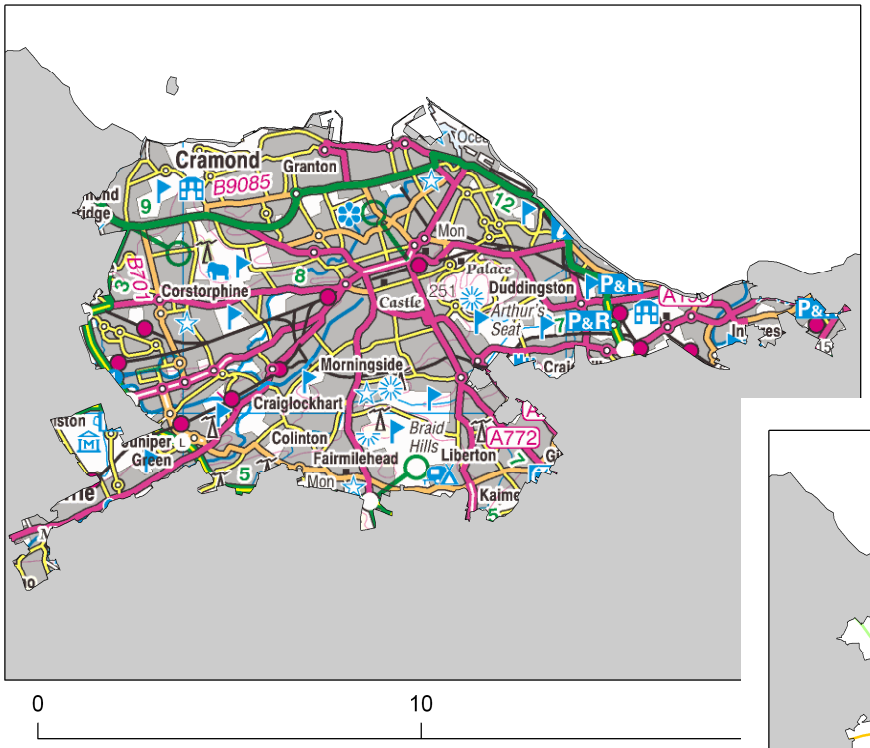
Glasgow

Only major roads in built-up areas are included in the assessment



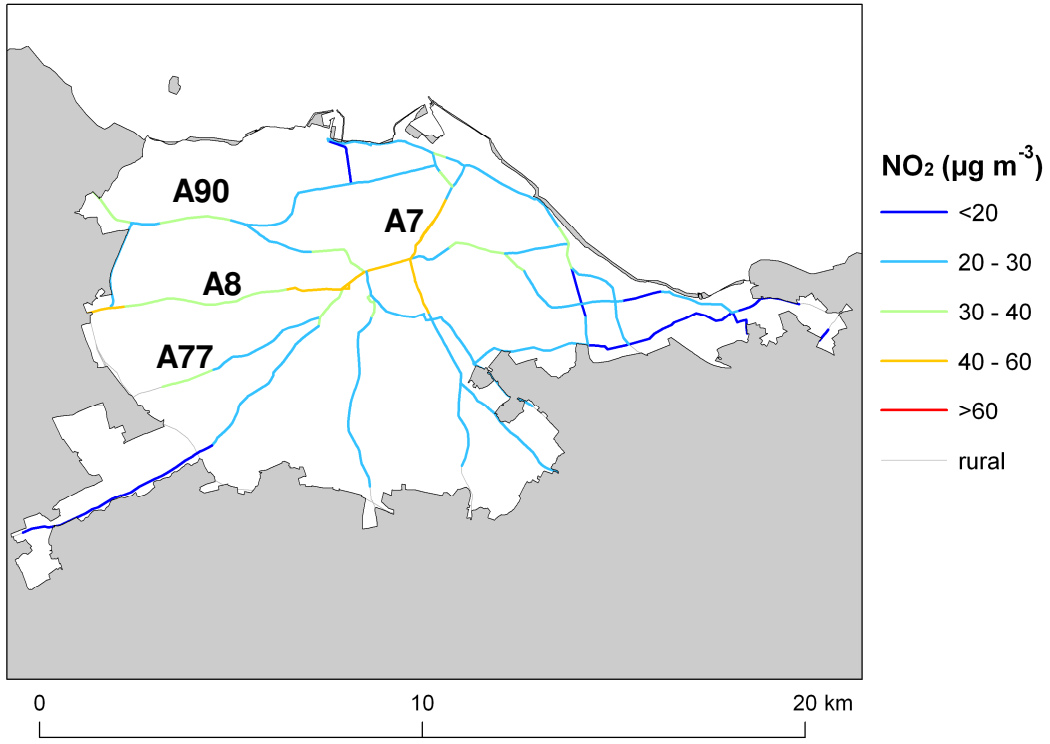
Scottish AQO for NO_2:
40 µg m^{-3} (annual mean)

2009 annual mean roadside NO_2: Edinburgh



Edinburgh

Only major roads in built-up areas are included in the assessment



Scottish AQO for NO_2:
40 µg m^{-3} (annual mean)

2009 summary: background & roadside NO_2

Year	Total area (km^2)	Total population exposed
2009	1	1547
2010	0	0
2015	0	0
2020	0	0

Year	Road links	Road length (km)
2009	255	401
2010	147	229
2015	37	69
2020	0	0

Modelled and projected results show a progressive decrease in exceedences of the Scottish AQO for background & roadside NO_2 between 2009 and 2020

PM_{10}

2009 annual mean background PM_{10}

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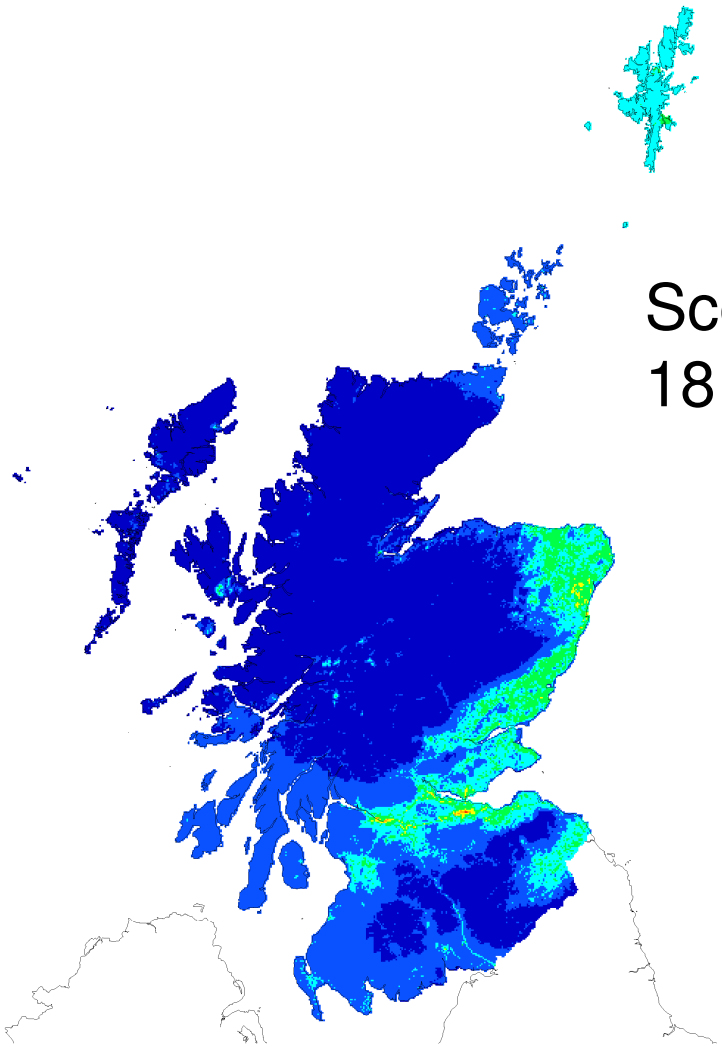
($\mu g\ m^{-3}$)

- BELOW 8
- 8 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- ABOVE 20



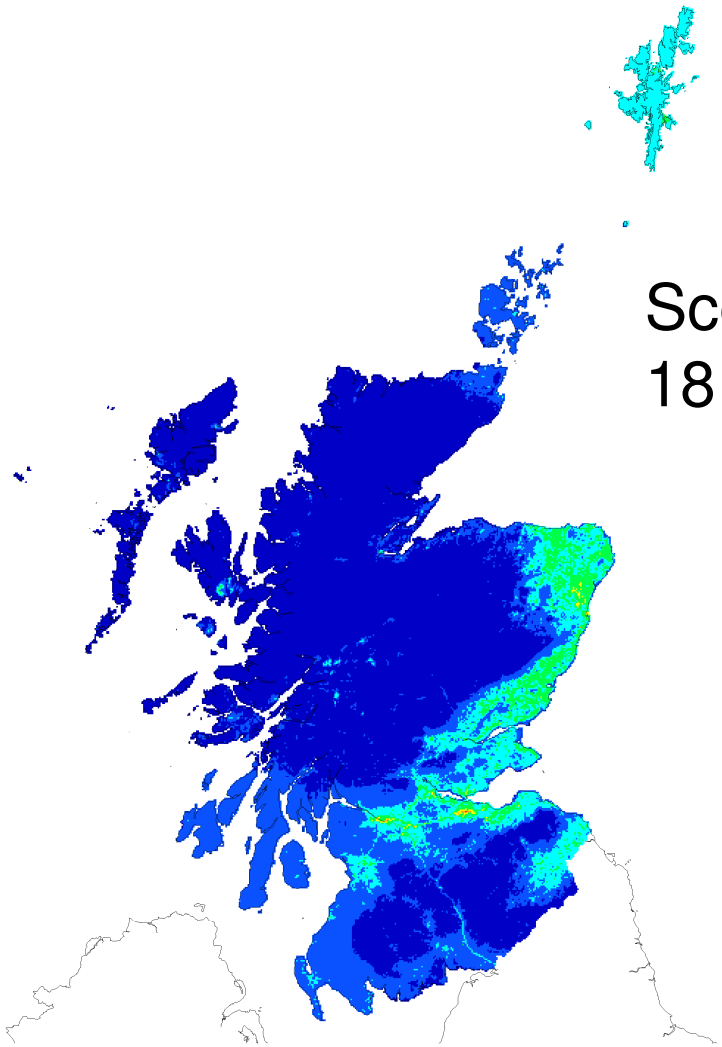
Scottish AQO for PM_{10}:
18 $\mu g\ m^{-3}$ (annual mean)

2010 annual mean background PM_{10}

AEA

($\mu g\ m^{-3}$)

- BELOW 8
- 8 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- ABOVE 20



Scottish AQO for PM_{10}:
18 $\mu g\ m^{-3}$ (annual mean)

2015 annual mean background PM_{10}

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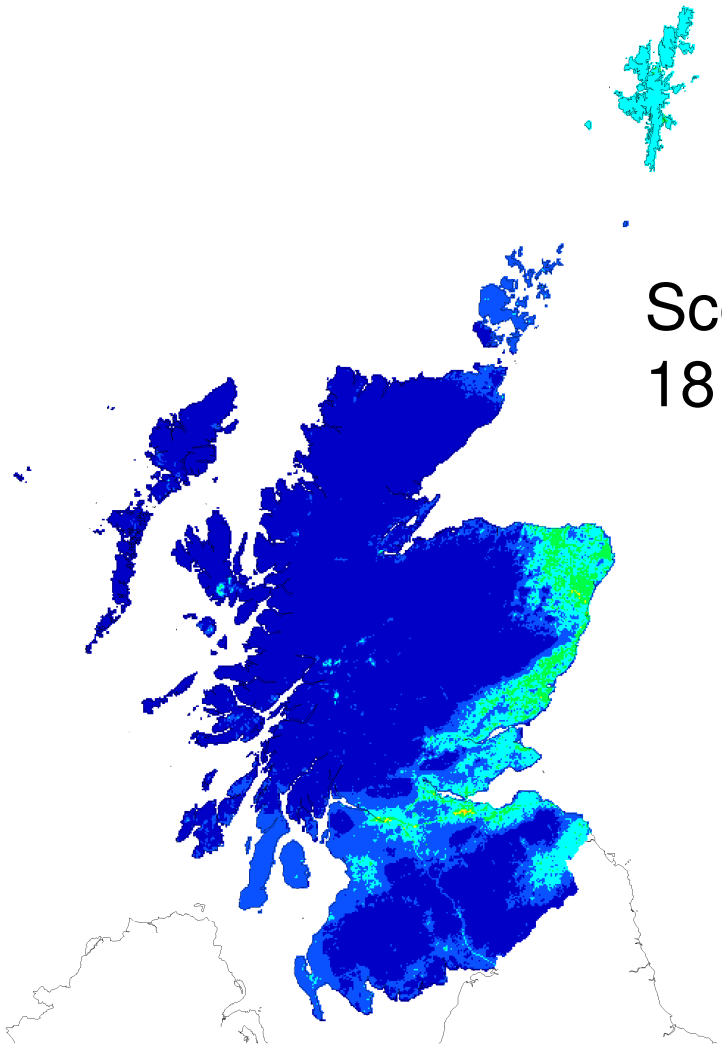

Scottish AQO for PM_{10}:
18 $\mu g\ m^{-3}$ (annual mean)

2020 annual mean background PM_{10}

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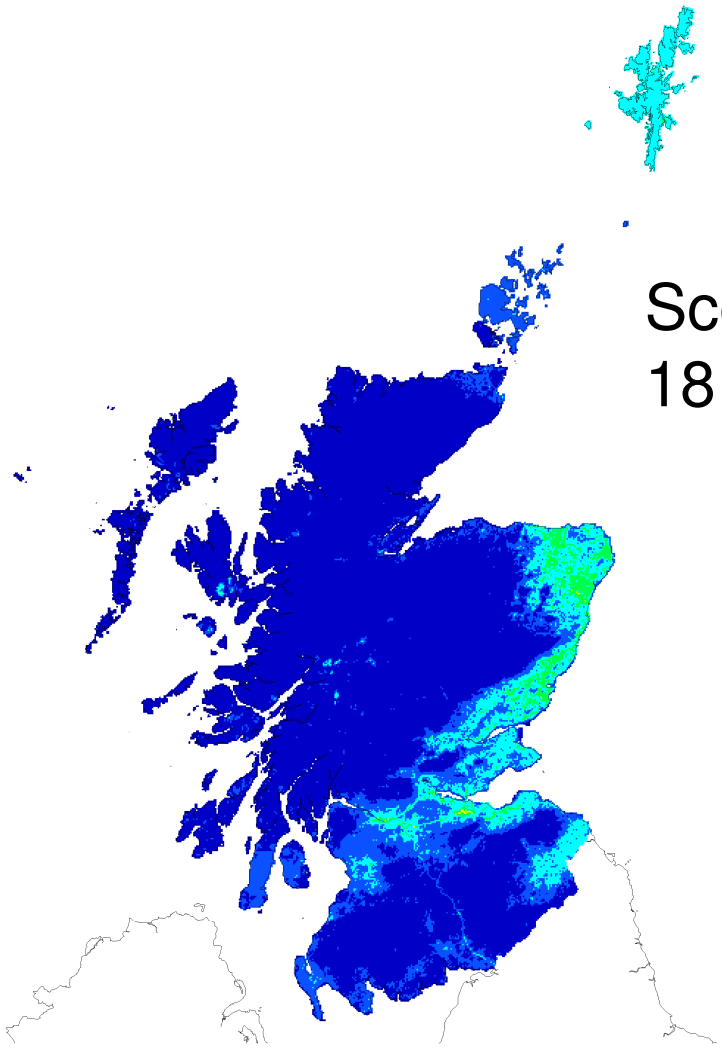

Scottish AQO for PM_{10}:
18 $\mu g\ m^{-3}$ (annual mean)

2009 annual mean roadside PM_{10}

AEA

($\mu g\ m^{-3}$)

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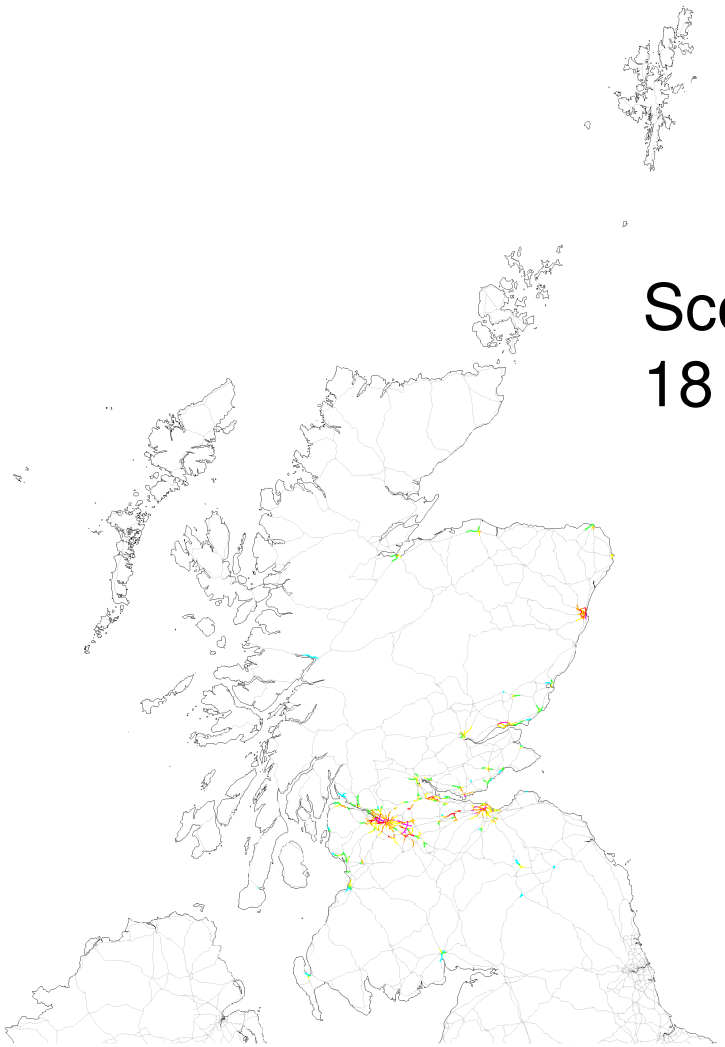
- 18 - 20
- ABOVE 20



Scottish AQO for PM_{10}:
18 $\mu g\ m^{-3}$ (annual mean)

2009 summary: background & roadside PM_{10}

AEA

Year	Total area (km^2)	Total population exposed
2009	2	114
2010	1	29
2015	0	0
2020	0	0

Year	Road links	Road length (km)
2009	133	179
2010	Not calculated	Not calculated
2015	Not calculated	Not calculated
2020	Not calculated	Not calculated

Modelled and projected results show a progressive decrease in exceedences of the Scottish AQO for background PM_{10} between 2009 and 2020

Summary

Scottish background and roadside maps of:

- NO_2
- PM_{10} for 2009 for the SG

Provide ability to predict exceedences of Scottish Air Quality objectives

Forward projections for 2010, 2015 and 2020 for the SG

- Projections dependent on the scaling factors applied

Data for Local Authority Review and Assessment purposes

Data and reports

- Scottish background NO_2 and PM_{10} maps for 2009, 2010, 2015 are now available on the SAQD, see: http://www.scottishairquality.co.uk/maps.php
- Background map data (disaggregated by emission) sector now available for Local Authority review and Assessment purposes, see: http://www.scottishairquality.co.uk/maps.php?n_action=data
- Scottish air quality modelling for 2008 and projected concentrations for 2010, 2015 and 2010: annual mean PM_{10}, NO_X and NO_2 published on SAQD, see: http://www.scottishairquality.co.uk/documents/reports2/296100915_ScottishAQmapping2008_Issue1.pdf
- Scottish air quality modelling for 2009 and projected concentrations for 2010, 2015 and 2010: annual mean NO_X, NO_2 and PM_{10} will be published in the coming months

Any questions

2008 summary: background & roadside NO_2

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Year	Total area (km^2)	Total population exposed
2008	0	0
2010	0	0
2015	0	0
2020	0	0

Year	Road links	Road length (km)
2008	80	123
2010	40	65
2015	2	5
2020	0	0

2008 summary: background & roadside PM_{10}

AEA

Year	Total area (km^2)	Total population exposed
2008	1	29
2010	0	0
2015	0	0
2020	0	0

Year	Road links	Road length (km)
2008	101	128
2010	Not calculated	Not calculated
2015	Not calculated	Not calculated
2020	Not calculated	Not calculated