

Atmosphere and Local Environment

Defra's Atmospheric Modelling Capacity

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Outline



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- ▶ Current modelling capacity
- ▶ Defra's modelling review
- ▶ Defra's modelling intercomparison exercise and protocol
- ▶ How do the protocols produced by the USEPA & Defra's compare?
- ▶ Future modelling capacity

Current modelling capacity



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- ▶ Defra uses models for a number of purposes
 - ▷ Meeting the requirements of national and EU legislation
 - ▷ Policy analysis
 - ▷ Furthering scientific understanding
 - ▷ Answering short-term questions

Meeting legislative requirements



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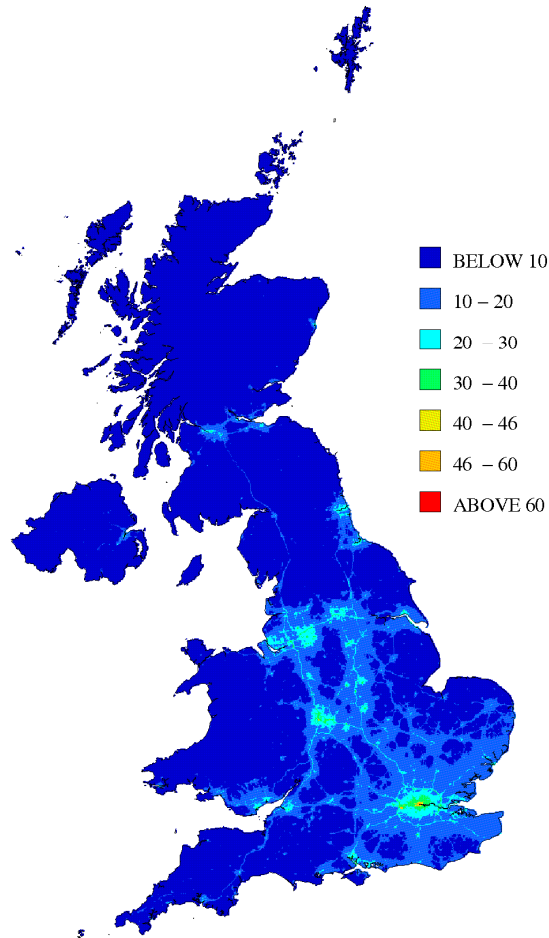
- ▶ Air Quality Strategy for England, Scotland Wales and Northern Ireland
- ▶ Ambient Air Quality Directive (2008/50/EC) and 4th Daughter Directive (2004/107/EC)
- ▶ Convention on Long Range Transboundary Air Pollution and Protocols



Meeting legislative requirements



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Annual mean NO₂ for 2008

Pollution Climate Mapping

- ▶ Annual national-scale modelling of pollutants for EU reporting to supplement measurements (PM₁₀, PM_{2.5}, NO_x, NO₂, SO₂, CO, benzene, PAHs (specifically BaP), heavy metals (As, Cd, Ni, Pb))

- ▶ Projections of key pollutants

Community Multi-Scale Air Quality (CMAQ) Model

- ▶ Air quality forecasts

Policy analysis support



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Explicitly modelled predictions of BAU and policy scenario

▶ Ambient concentrations, exceedences and health statistics for AQD pollutants

- ▷ Scenario analysis using PCM
- ▷ Projections of ozone concentrations using Ozone Source Receptor Model (OSRM) – human health

▶ Impacts on ecosystems

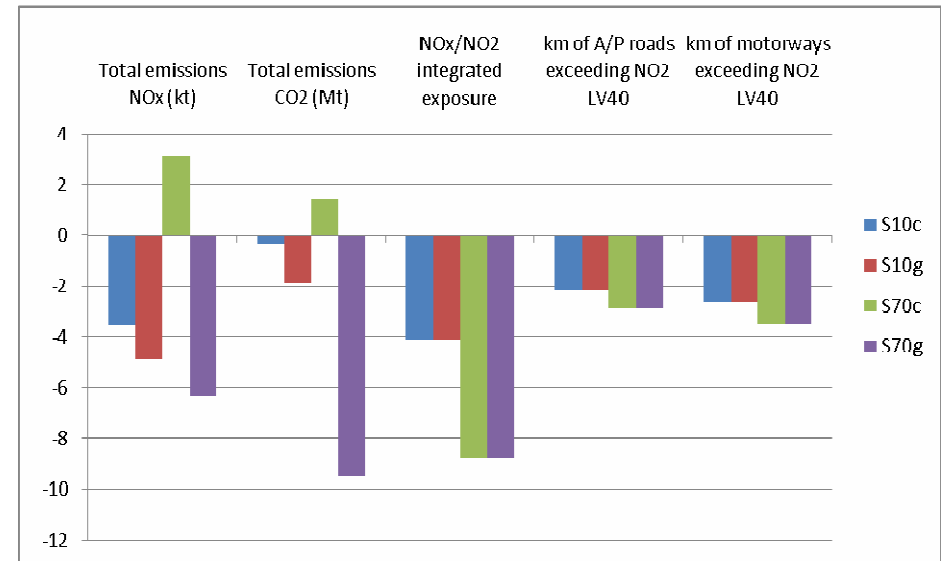
- ▷ Projections of deposition of pollutants leading to acidification and eutrophication using Fine Resolution Atmospheric Multi-pollutant Exchange (FRAME) model - calculation of exceedence of critical loads
- ▷ OSRM – ozone impacts on ecosystems

Policy analysis support

Screening and optimisation tools for policy scenario testing

► UK Integrated Assessment Model (UKIAM)

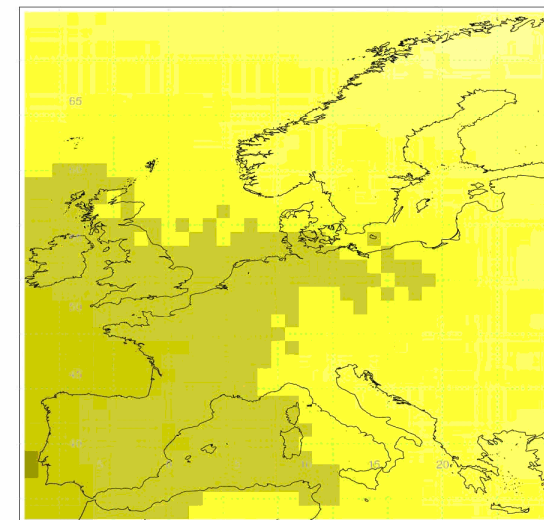
- ▷ FRAME
- ▷ BRUTAL



Change in emissions, integrated exposure and road-kilometres exceeding limit values for the four electric vehicle scenarios relative to the 2020 baseline scenario.

Furthering understanding

- ▶ Research on how changing the atmosphere affects transport and concentrations of pollution
 - ▷ Importance of different sources
 - ▷ Impacts of changing emissions
 - ▷ Impacts of climate change



PM10 concentration (micrograms per cubic metre)

2.50e-04	7.50e-04	2.50e-03	7.50e-03	2.50e-02	7.50e-02
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NAME modelled annual mean PM₁₀ concentration resulting from US emissions, in $\mu\text{g}/\text{m}^3$.

Development of new tools



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- ▶ European Monitoring & Evaluation Programme Model Developed for the UK (EMEP4UK)
 - ▷ Developed to improve deposition modelling capacity
- ▶ CMAQ – looking to explore possibilities
- ▶ Ozone Flux modelling
- ▶ Model development

Modelling Review



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- ▶ Defra currently reviewing all of the modelling undertaken in the department.
- ▶ Air quality models are included in the Science Advisory Council (SAC) Review
- ▶ Review contracts on the processes of how modelling are development and maintained for Defra use.
- ▶ Our review is for AQ models only.

Air Quality Modelling Review



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- ▶ Review current modelling capacity
- ▶ How current policy requirements are being met by contract outputs
- ▶ Identify gaps in policy requirements, any models being used which are not fit for purpose
- ▶ To highlight likely future policy requirements
- ▶ To investigate options available to Defra
- ▶ To summarise and provide prioritised short term and long term recommendations.

Modelling Review



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- ▶ **Modelling Steering Group Appointed:**
 - ▷ Four independent scientists, chaired by Marin Williams
- ▶ **Inputs:**
 - ▷ Defra's policy needs from modelling
 - ▷ Summary of current Defra modelling
 - ▷ Initial results from intercomparison exercise
- ▶ **Report due March 2011**
- ▶ **Recommendations taken forward 2011/2012**

Modelling Intercomparison Protocol



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- ▶ Protocol developed in 2009, to provide advice to Defra's contractors concerning 'best practice' for air quality model evaluation
- ▶ Provide a common method for model evaluation across our contracts
- ▶ Protocol sets out methodology for Intercomparison Exercise

How do our Protocols Compare?

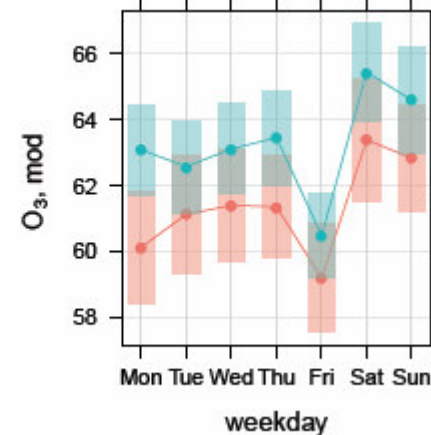
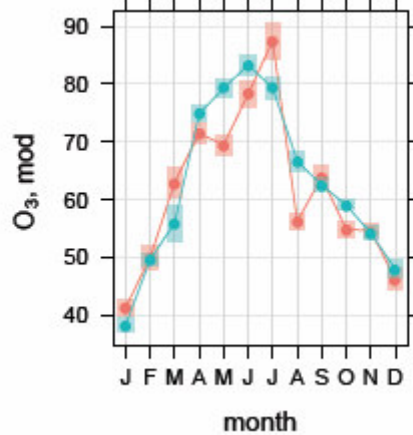
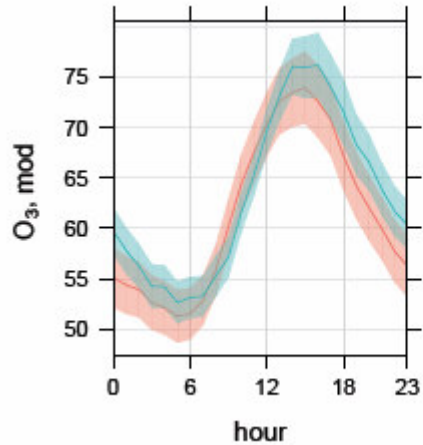
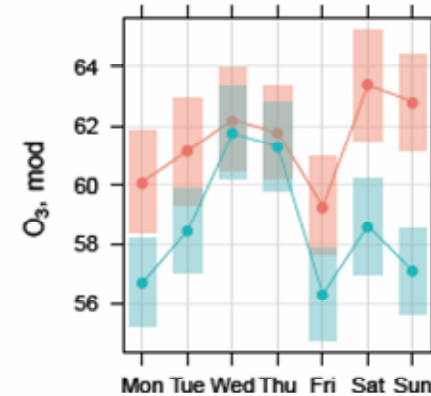
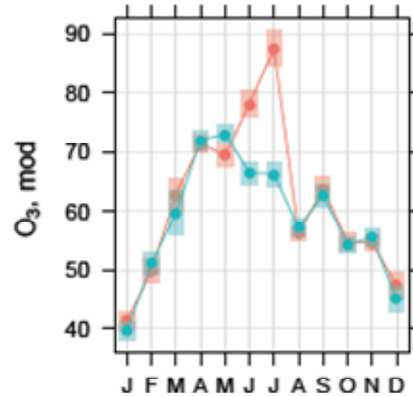
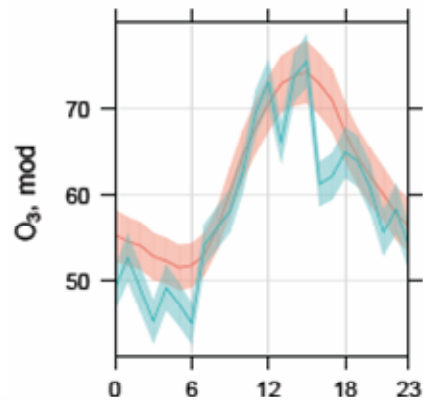


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Defra Protocol	USEPA Framework ¹
Provides specific guidance for <ul style="list-style-type: none">• Ground-level ozone• Acidification & eutrophication• Urban air quality	Provides guidance for photochemical modelling systems
A number of scales	Regional-scale
<ul style="list-style-type: none">• Operational Evaluation• Diagnostic Evaluation• Probabilistic Evaluation• Scientific Evaluation	<ul style="list-style-type: none">• Operational Evaluation• Diagnostic Evaluation• Probabilistic Evaluation• Dynamic Evaluation

¹Dennis et al., 2010

Evaluation using the Protocol



■ O₃
■ mod

Temporal variation of modelled and observed O₃ hourly concentrations at Lullington Heath Using the EMEP4UK (Top) and NAME (Bottom) model.

Modelling Intercomparison Exercise



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- ▶ Additional evidence for review
- ▶ Contractors, Consultants and Researchers
- ▶ 12 models, 30 modellers
- ▶ No funding provided
- ▶ Modellers to submit data using specific templates and questionnaires
- ▶ Templates are used to produce standardised reports using Openair software

Modelling Intercomparison Exercise



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- ▶ Unique approach
- ▶ Interactive/open/transparent process
- ▶ Providing the modellers with the tools required to carry out model evaluation
- ▶ One key advantage is that it is then possible to understand the model processes in much greater depth than a straightforward comparison would allow.

Intercomparison Exercise Groups



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Urban modelling of NO₂ & PM₁₀
(Annual Means, London, 2008)

- ADMS
- CMAQ/ADMS
- ERG Tool Kit
- PCM
- UKIAM/BRUTAL

Regional & Transboundary Pollution incl. O₃
(Hourly Predictions, 15 O₃ sites, 2006)

- CMAQ
- CMAQ/ADMS
- EMEP4UK
- NAME
- OSRM
- PTM
- UKCA

Deposition – inc. Acidification
(Annual Means, All rural sites, 2003)

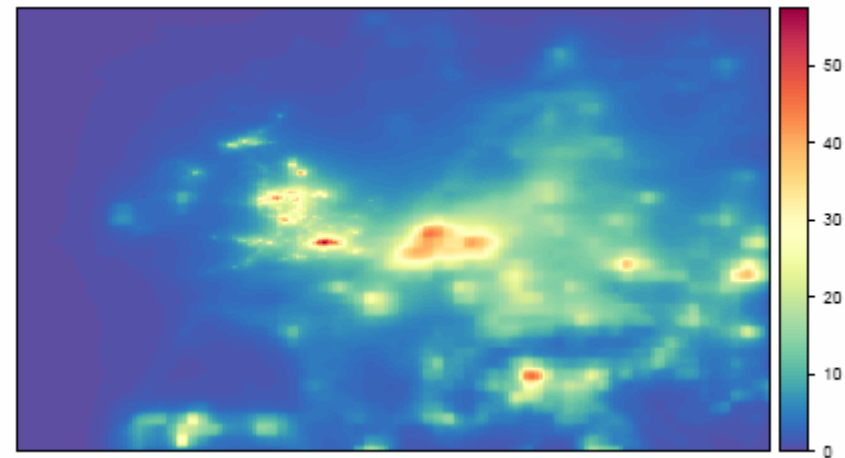
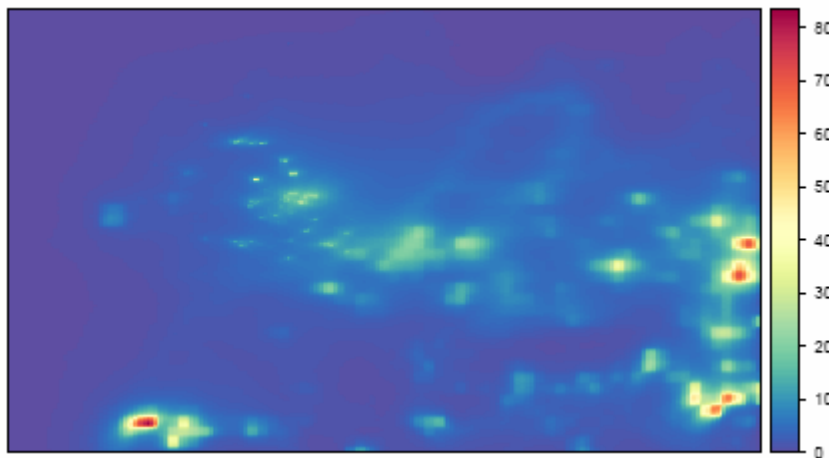
- CMAQ
- CMAQ/ADMS
- EMEP4UK
- FRAME
- NAME
- HARM

Intercomparison Exercise Timetable



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- ▶ Data & Questionnaires submitted: 3rd Dec 2010
- ▶ Reports sent to modellers: 17th Dec 2010
- ▶ Three modelling discussion meetings: 27th-28th Jan 2011



Dep'n Spatial Outputs: Annual mean SO₂ & NO₂ concentrations NAME model

Future Modelling Capacity



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- ▶ Awaiting recommendations from the SAC-modelling review and our modelling review.
- ▶ Currently collaborating with the EA to develop CMAQ to assist with UK policy decisions.
- ▶ Continue the Model Intercomparison Exercise