Integrated Assessment for Air Quality in the UK

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Overview

The UK Integrated Assessment Modelling

Scenario Definition
- Fleet Composition
- Traffic Flows
- Country Emissions
- Shipping Emissions
- Total UK Emissions
- Sector Emissions
- Abatement Measures

Model Component
- ASAM
  - European Emissions
  - Imported Contributions (AQ, Deposition, Ozone)
  - Traffic Emissions
- UKIAM (5x5km)
  - Traffic Projections
- UKIAM (1x1km)
  - Imported PM/NOx
  - Non-road Contribution
- BRUTAL (Emissions)
- BRUTAL (Concentrations)

Model Outputs
- Critical Load Exceedance
- Ozone Damage
- PM$_{10}$, PM$_{2.5}$, BC, SIA, SOA, Dusts
- Full Source-Apportionment
- Health Impacts (Regional & London)
- Urban AQ (PM, NO$_2$) LV exceedance

Key Datasets
- Road Network
- COPERT SDEF’s
- EMEP S-R Relationships
- FRAME S-R Relationships
- Critical Loads SSSI, SAC, SPA


Key components and data

UK National Atmospheric Emissions Inventory

- Current emissions and future projections of SO$_2$, NO$_x$, NH$_3$, PM$_{10}$ & PM$_{2.5}$, VOCs based on UK energy, transport and agricultural data

- Spatial mapping on 1 km x 1 km grid for ~100 source categories modelled in UKIAM

- Plus detailed mapping of road transport emissions built up road by road across the UK road network according to vehicle mix and traffic flow (BRUTAL sub-model)
Key components and data

Abatement options and Costs: Multi-Pollutant Measures database (MPMD)

- Data base of >600 technical measures to reduce emissions
- Abatement costs and multi-pollutant effects of implementation
- Basis for the generation of scenarios for emission reduction and their cost
- Exploratory scenarios, e.g. “What if black C and diesel PM are considered more important in relation to public health than total PM$_{2.5}$ mass?”
Key components and data

Atmospheric chemistry transport models FRAME and EMEP4UK providing source-receptor relationships:

**SO\textsubscript{x}** dry deposition from point source

**NO\textsubscript{y}** dry deposition from international shipping

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**FRAME** is a Lagrangian model that simulates an air column moving along straight-line trajectories.

**EMEP4UK** simulates atmospheric chemistry transport processes using real meteorology. [http://www.emep4uk.ceh.ac.uk/](http://www.emep4uk.ceh.ac.uk/)

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Outputs & Results

Modelling and mapping of pollutant concentrations and deposition:

- Taking into account long-range transport of secondary inorganic aerosols (ammonium sulphates and -nitrates) and S and N deposition
- Local scale NOₓ/NO₂ and primary PM₂.₅
- Using source contributions derived by different models (FRAME, EMEP4UK, EMEP) to identify imported contributions from outside the UK, including international shipping
- Local scale: Gaussian PPM and road-side increments (ADMS)

UKIAM map of background NO₂ concentrations to calculate human exposure and health impacts
Outputs & Results

Protection of natural ecosystems
e.g. effects of eutrophication on SSSIs/NATURA 2000 sites due to nitrogen deposition

Distribution of SSSIs and protectability index from green = “protected” to red at “very high risk”

Critical level for ammonia:
1 μg m⁻³: lichens & bryophytes
3 μg m⁻³: higher plants [2-4]

Source: FRAME calculations


Outputs & Results

Calculation of benefits, particularly to human health:

- Reduction in exposure of UK population to ambient PM$_{2.5}$ and NO$_2$ concentrations

- Incorporating recent evidence from WHO Health Risks of Air Pollution in Europe (HRAPIE) study and Committee on the Medical Effects of Air Pollutants (COMEAP) on health effects of NO$_2$ (comparable importance with PM$_{2.5}$)

- Estimating a total of $\sim$40,000-50,000 premature deaths in the UK due to air pollution effects

- Monetised health benefits of reductions in exposure of UK population
In the analysis for AQEG\# of current mitigation scenarios, NH$_3$ and primary PM$_{2.5}$ emission control were found to be equally effective, but for the 2030 scenario, primary PM$_{2.5}$ control yields higher reductions due to less SO$_2$ and NO$_x$ being available to form secondary inorganic aerosols with ammonia (taking into account population-weighted concentrations):


\#UK Air Quality Expert Group