

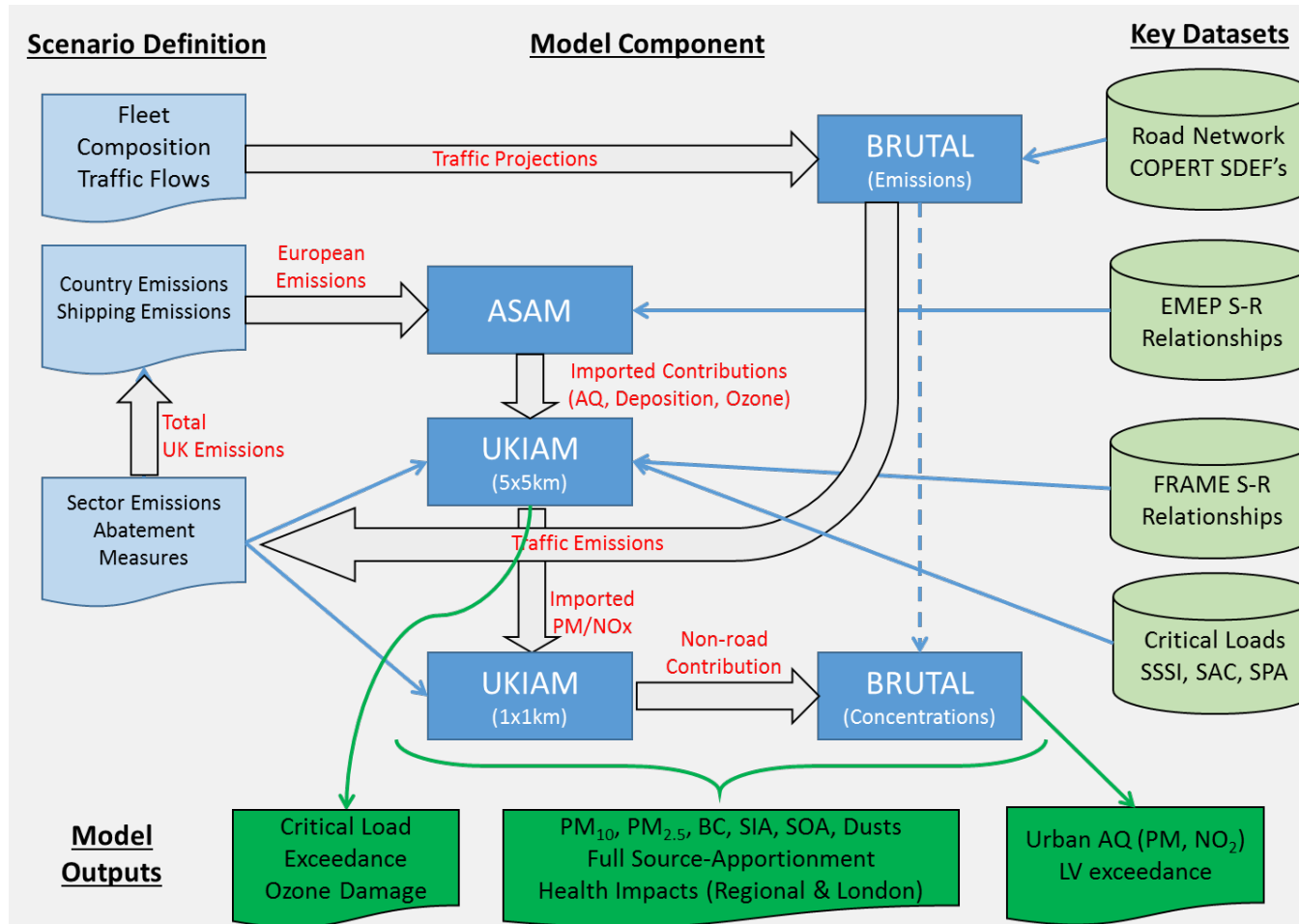
# *Integrated Assessment for Air Quality in the UK*

*Stefan Reis, Helen ApSimon, Tim Oxley, Tony Dore, Chris Green, Christopher Conolly, Tom Misselbrook, Mike Holland, Massimo Vieno, Melanie Hobson, Gina Mills, Rachel Beck et al.*

1. Overview
2. Key components & data
3. Outputs & results

# Overview

## The UK Integrated Assessment Modelling



Oxley T, Dore AJ, ApSimon H, Hall J, Kryza M (2013) Modelling future impacts of air pollution using the multi-scale UK Integrated Assessment Model (UKIAM). *Environment International* 61,17-35

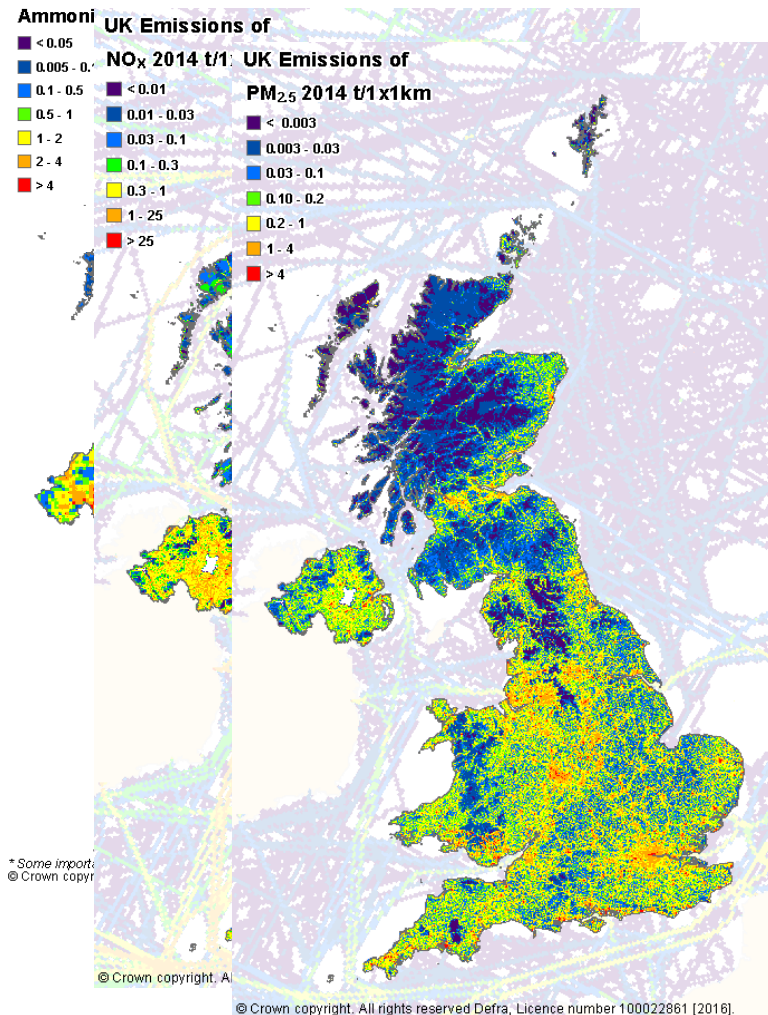
Oxley, T, ApSimon, HM, Dore, CJ, Sutton, M, Hall, J, Heywood, E, Gonzales del Campo, T and Warren, Rachel (2004) *The UK Integrated Assessment Model, UKIAM: A National Scale Approach to the Analysis of Strategies for Abatement of Atmospheric Pollutants Under the Convention on Long-Range Transboundary Air Pollution. Integrated Assessment*, 4 (4), 236-249

# Key components and data

## UK National Atmospheric Emissions Inventory

- Current emissions and future projections of  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{NH}_3$ ,  $\text{PM}_{10}$  &  $\text{PM}_{2.5}$ , 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)

UK Emissions of



# Key components and data

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

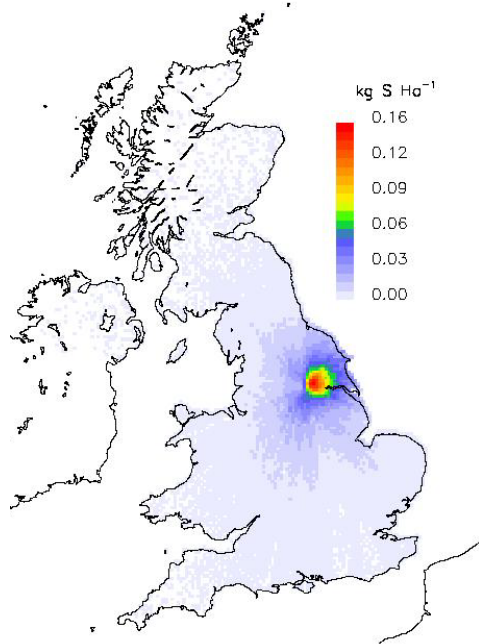
- ❑ Data base of >600 technical measures to reduce emissions
- ❑ Abatement costs and multi-pollutant effects of implementation
- ❑ Basis for the generation of scenarios for emission reduction and their cost
- ❑ Exploratory scenarios, e.g. *“What if black C and diesel PM are considered more important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



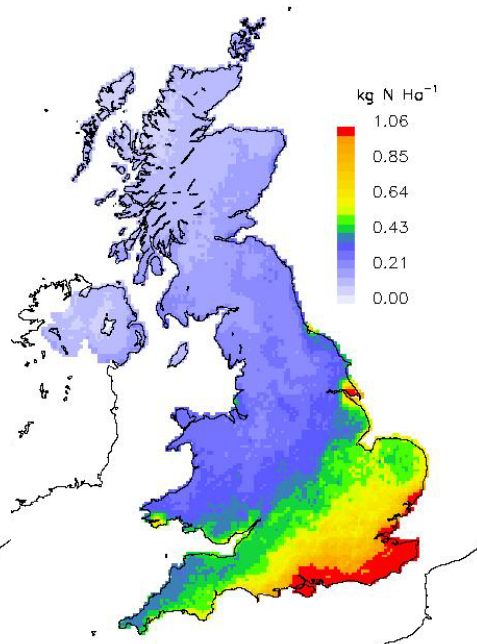
# Key components and data

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

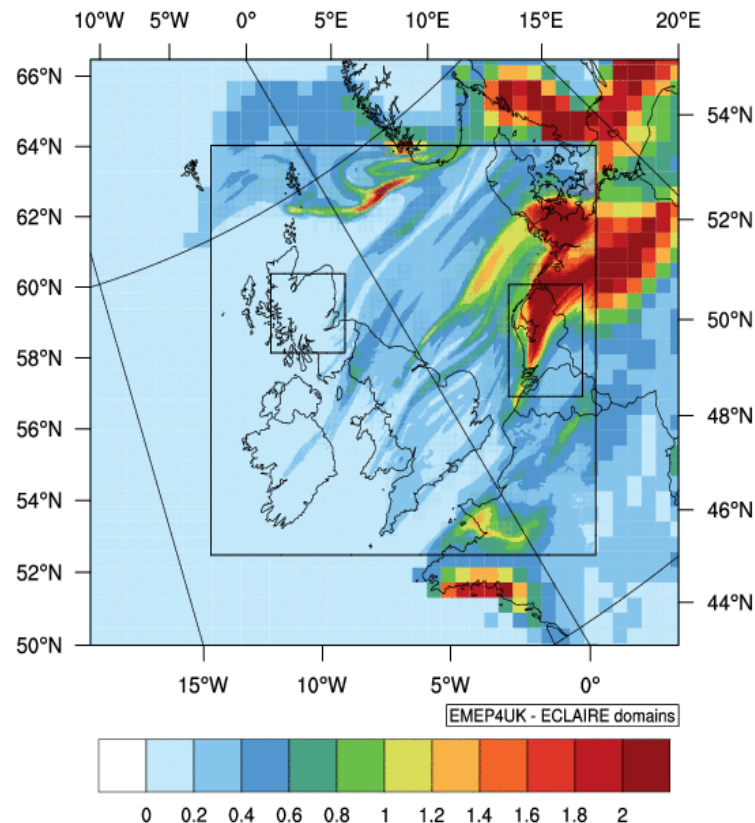
$\text{SO}_x$  dry deposition  
from point source



$\text{NO}_y$  dry deposition from  
international shipping



Regional scale surface concentrations of sulphate particulate  
matter for 2008 (in  $\mu\text{g m}^{-3}$ )



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

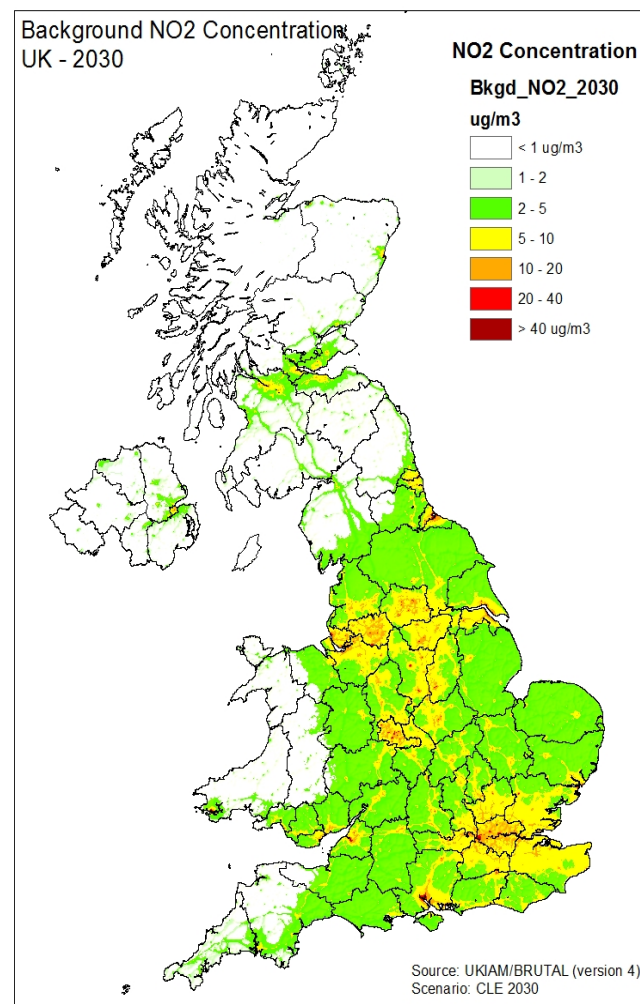
EMEP4UK simulates atmospheric chemistry  
transport processes using real meteorology.

<http://www.emep4uk.ceh.ac.uk/>

# 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  $\text{NO}_x/\text{NO}_2$  and primary  $\text{PM}_{2.5}$
- 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)

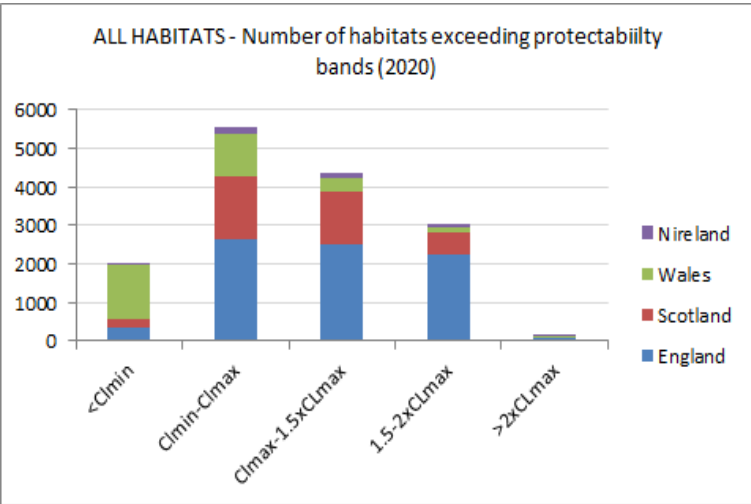
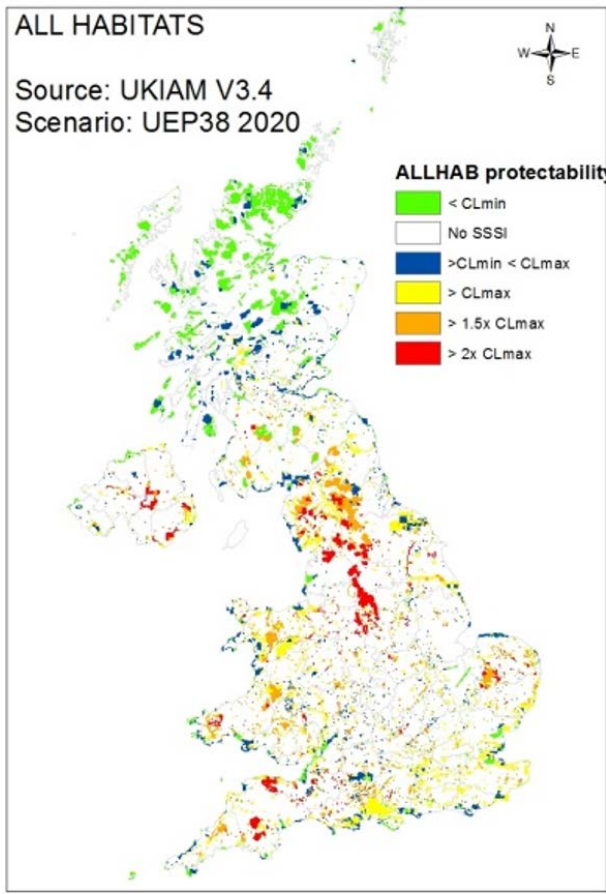


UKIAM map of background NO<sub>2</sub> concentrations to calculate human exposure and health impacts

# Outputs & Results

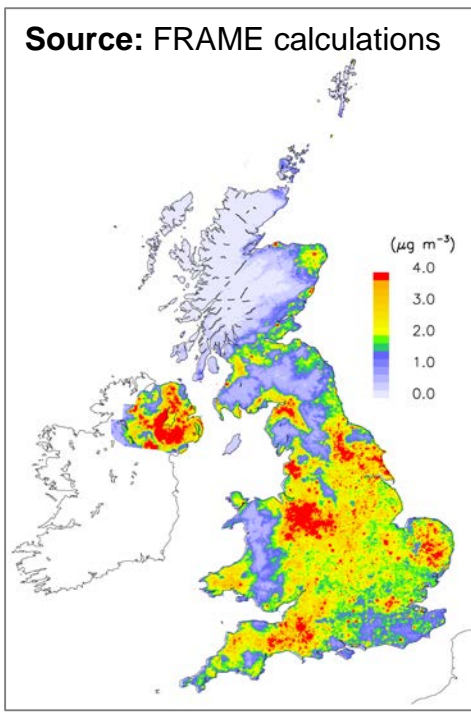
## Protection of natural ecosystems

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



Oxley T, ApSimon H, Hall J (2013) Application of a protectability index to assess habitat eutrophication in designated areas. MODSIM Conference Paper.

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

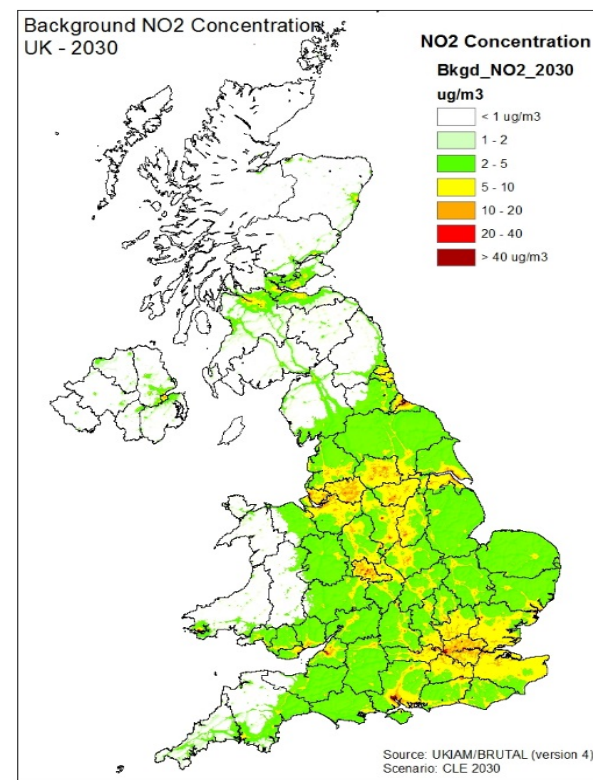


**Critical level for ammonia:**  
**1  $\mu\text{g m}^{-3}$ :** lichens & bryophytes  
**3  $\mu\text{g m}^{-3}$ :** higher plants [2-4]

# Outputs & Results

## Calculation of benefits, particularly to human health:

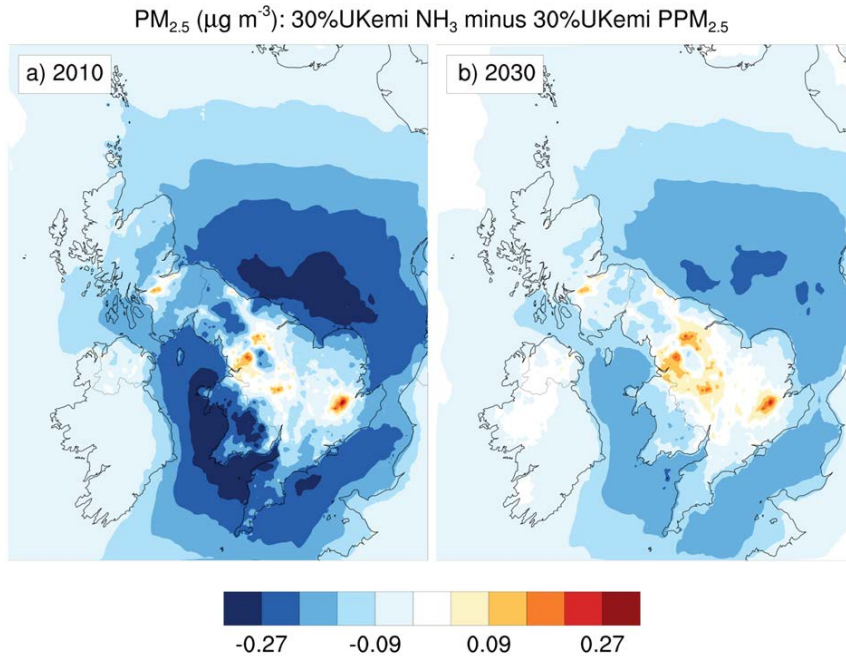
- ❑ Reduction in **exposure of UK population** to ambient  $\text{PM}_{2.5}$  and  $\text{NO}_2$  concentrations
- ❑ Incorporating recent evidence from WHO Health Risks of Air Pollution in Europe (HRAPIE) study and Committee on the Medical Effects of Air Pollutants (COMEAP) on health effects of  $\text{NO}_2$  (comparable importance with  $\text{PM}_{2.5}$ )
- ❑ Estimating a total of **~40,000-50,000 premature deaths** in the UK due to air pollution effects
- ❑ Monetised health benefits of reductions in exposure of UK population





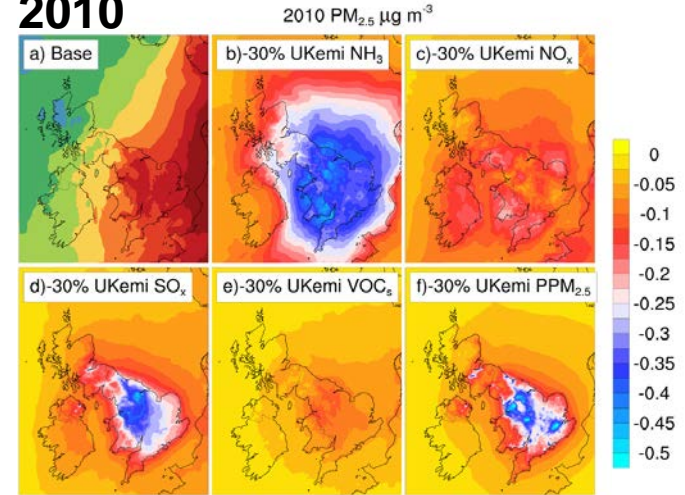
# Case study: EMEP4UK scenario evaluation

In the analysis for AQEG<sup>#</sup> of current mitigation scenarios, NH<sub>3</sub> and primary PM<sub>2.5</sub> emission control were found to be equally effective, but for the 2030 scenario, primary PM<sub>2.5</sub> control yields higher reductions due to less SO<sub>2</sub> and NO<sub>x</sub> being available to form secondary inorganic aerosols with ammonia (*taking into account population-weighted concentrations*):



#UK Air Quality Expert Group

2010



2030

