

# LTLS – Atmosphere Reconstructing past N (and S) deposition in the UK & future projections



Photo - Shutterstock

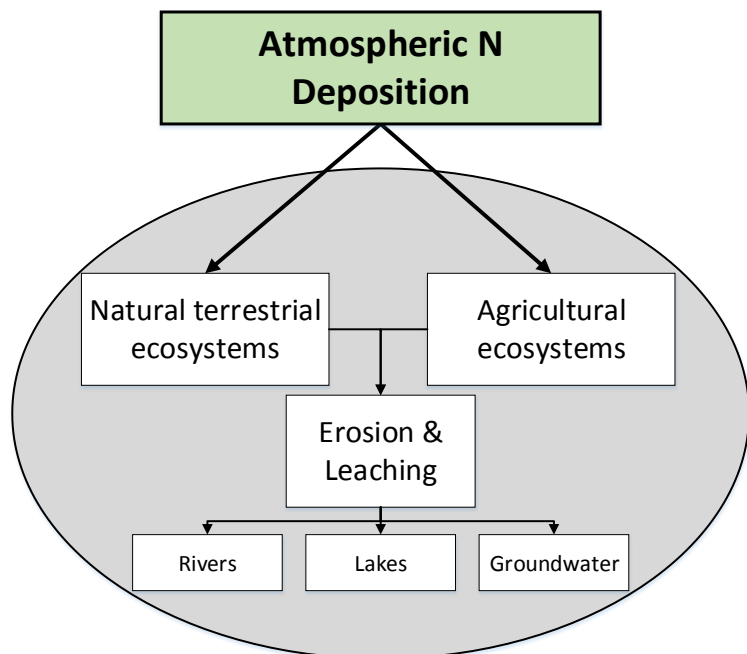
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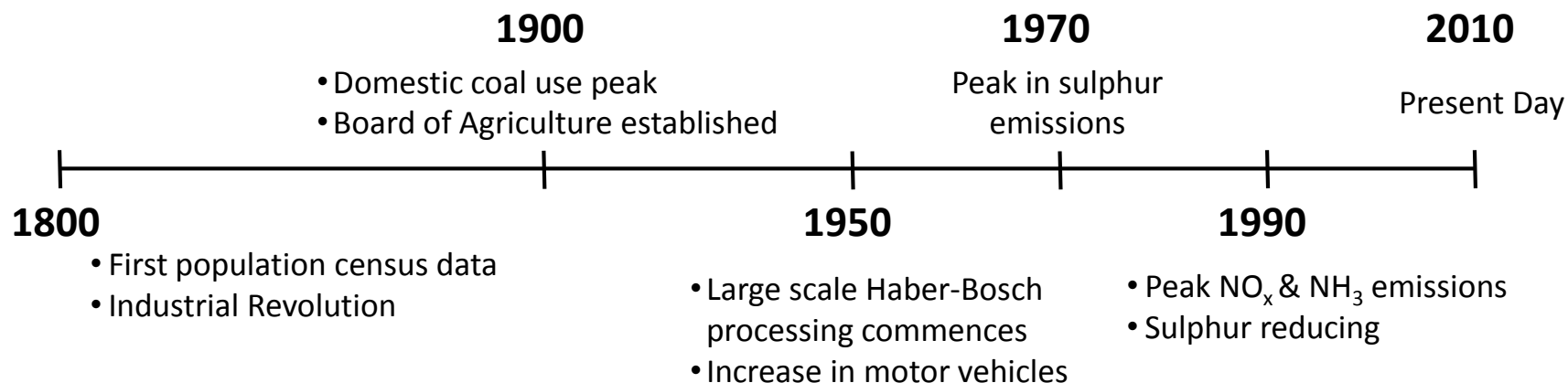
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# Introduction – Atmospheric component



## Key tasks

- Historic emissions – quantify sources, source data & model spatial distribution
- Model time series of emissions & deposition
- UK focus & European background
- Analyse & interpret data ←
- Publish results & collaborate on further work
- Publish data



# 200+ years of history – emission sources

## Research historical source activity:

- Books
- Reports
- Gov't records
- Papers
- Statistics



## Estimate emissions based on:

- NAEI emissions
- Source populations (human & livestock)
- Fuel inputs
- Known/estimated emission factors

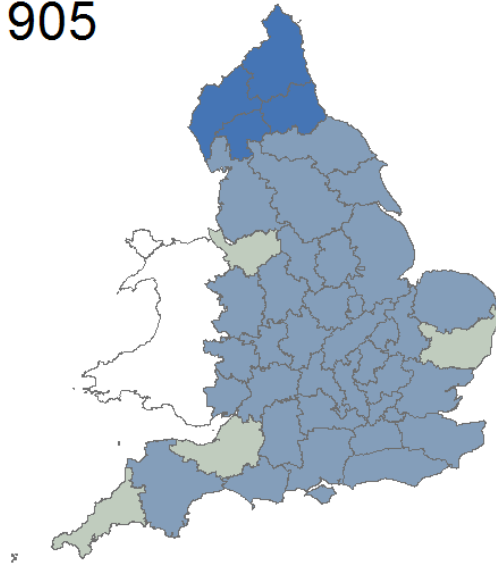


## Spatial distribution of emissions:

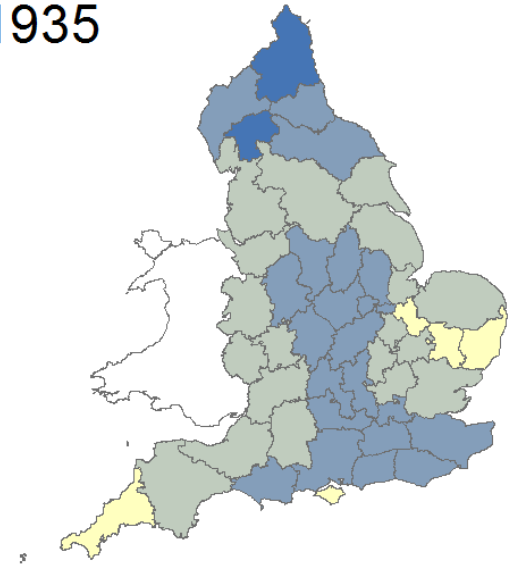
- Records
- Proxy data
- Scaling
- Weighting

# Pig density (county level)

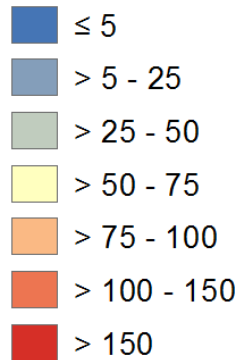
1905



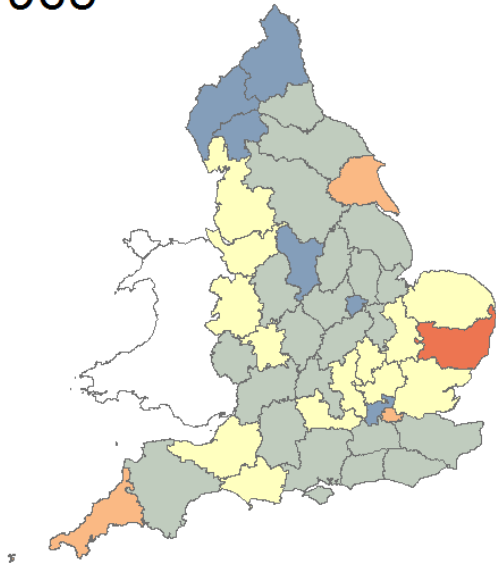
1935



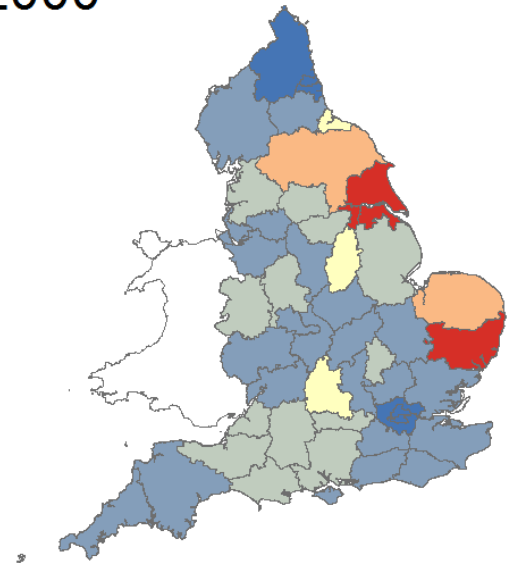
Total Pigs km<sup>-1</sup>



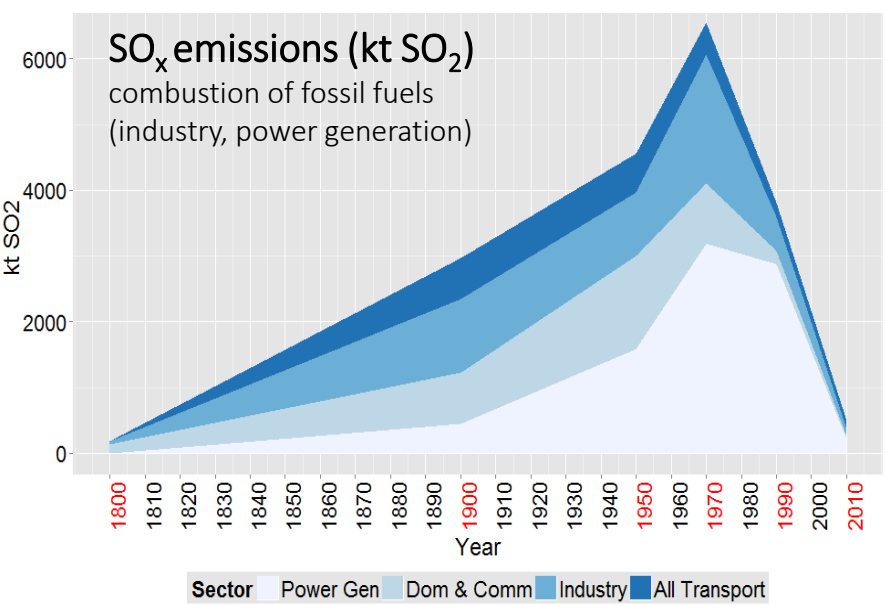
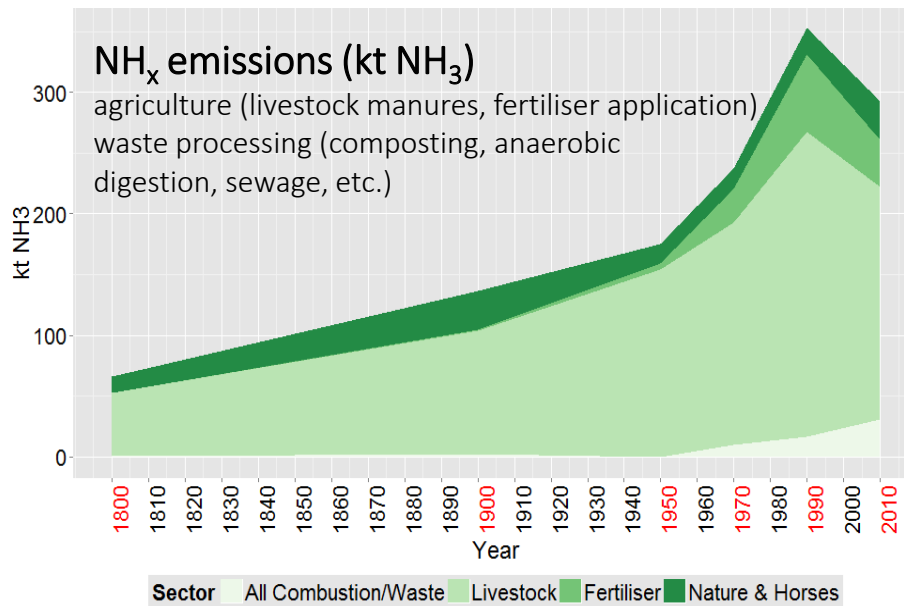
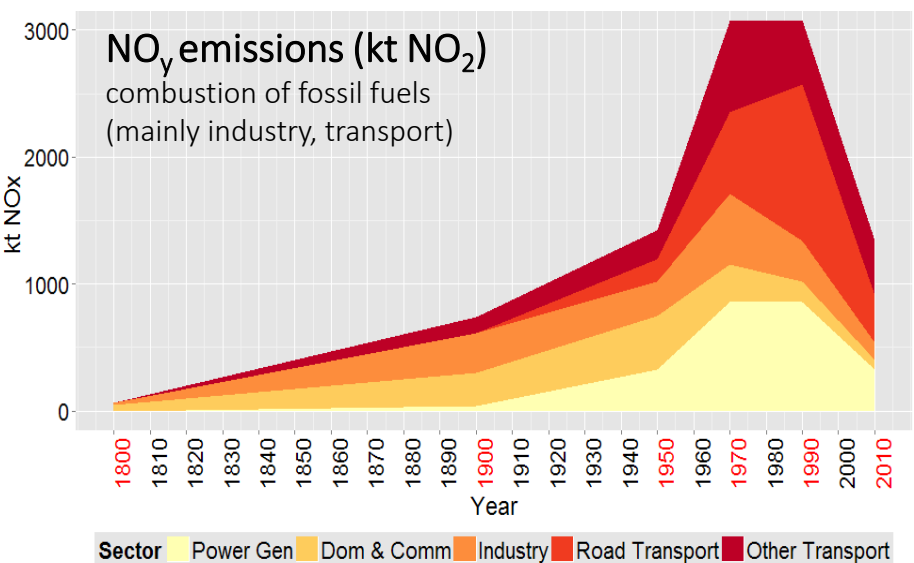
1965



2000



# Historic emission trends 1800-2010



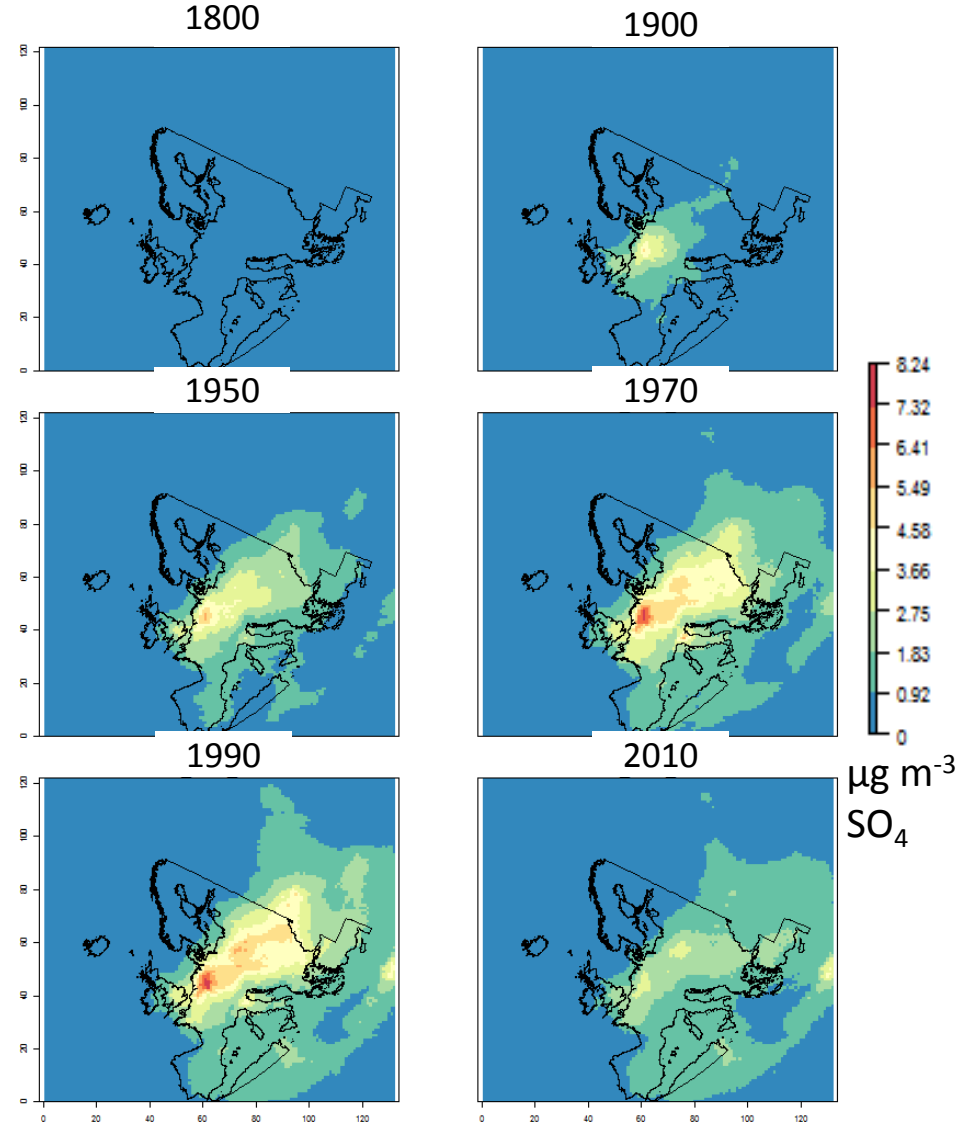
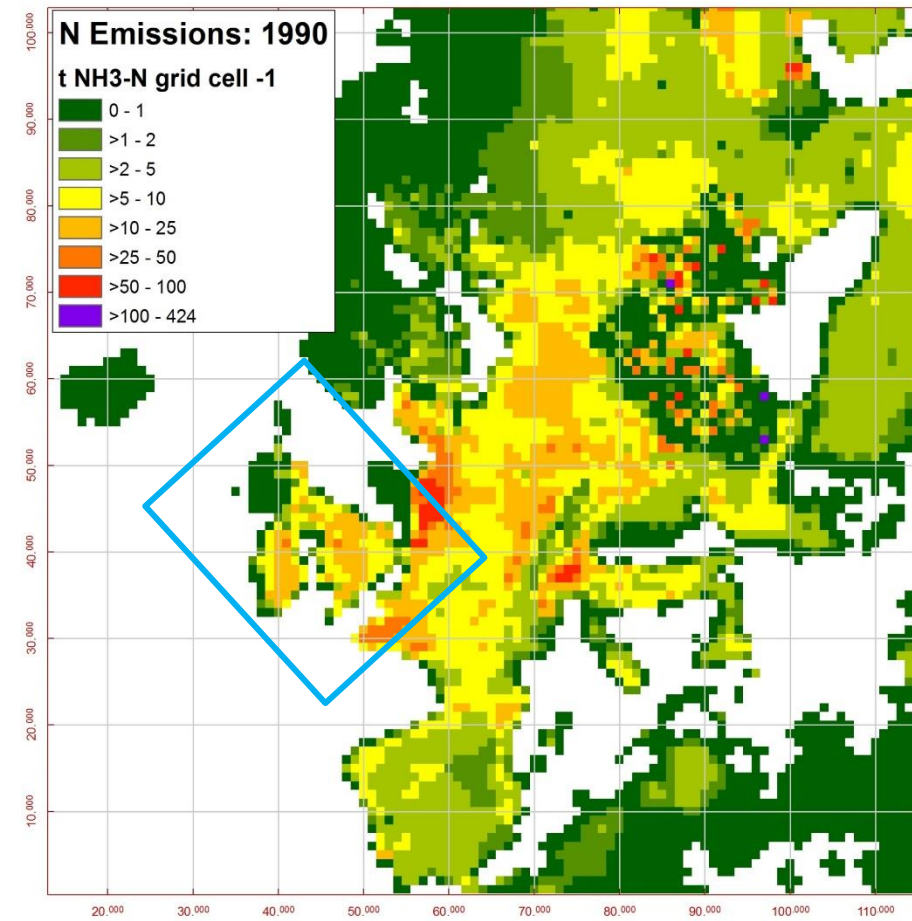
SO<sub>2</sub> important for atmospheric chemistry/deposition processes



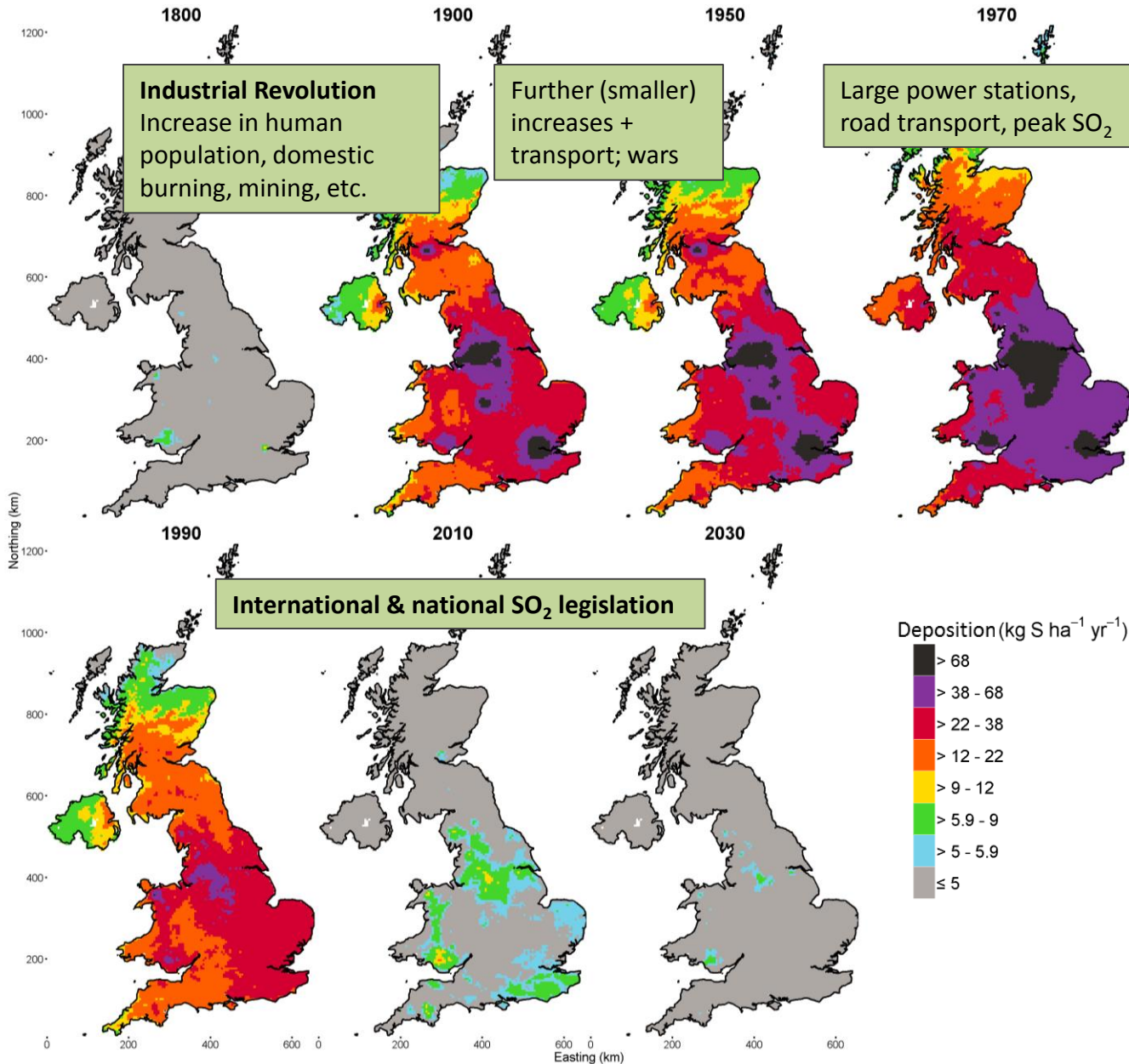
# European background & deposition modelling

## Fine Resolution Atmospheric Multi-pollutant Exchange (FRAME) model

Creating boundary conditions for a  
5km FRAME-UK simulation



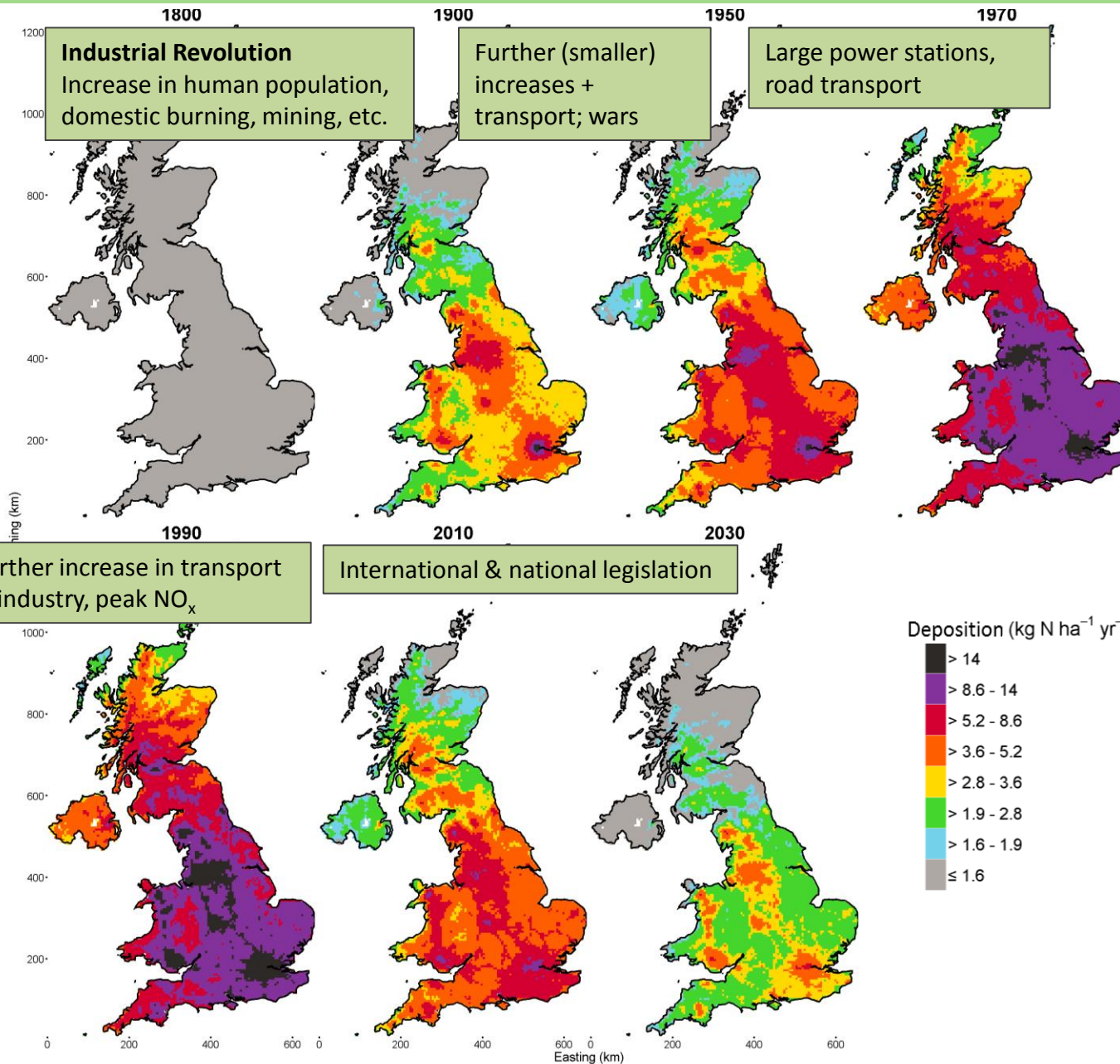
# Sulphur deposition 1800-2030







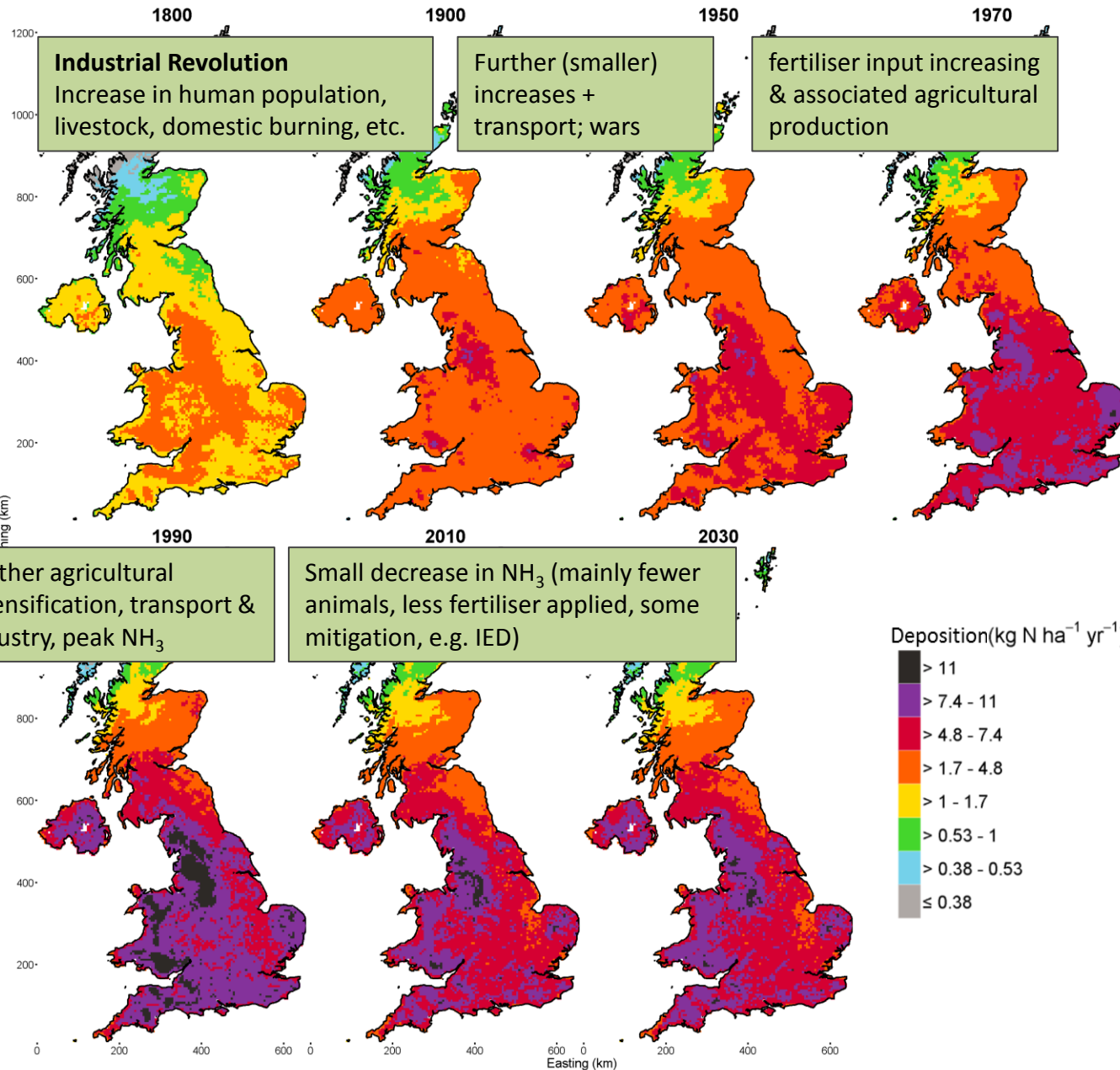
# Oxidised N deposition 1800-2030



## Main sources:

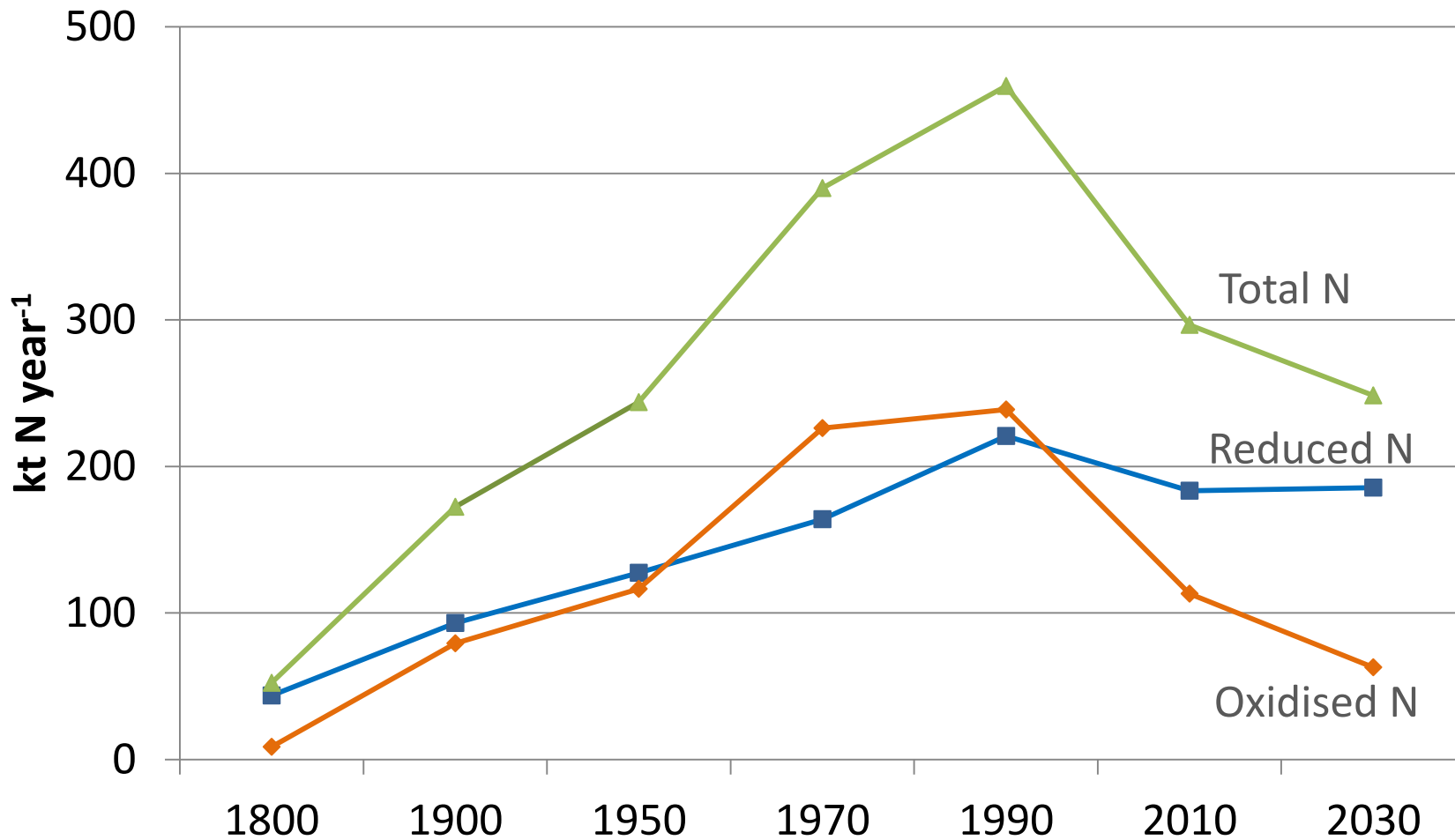
- Combustion
- Motorised transport
- Industry

# Reduced N deposition 1800-2030

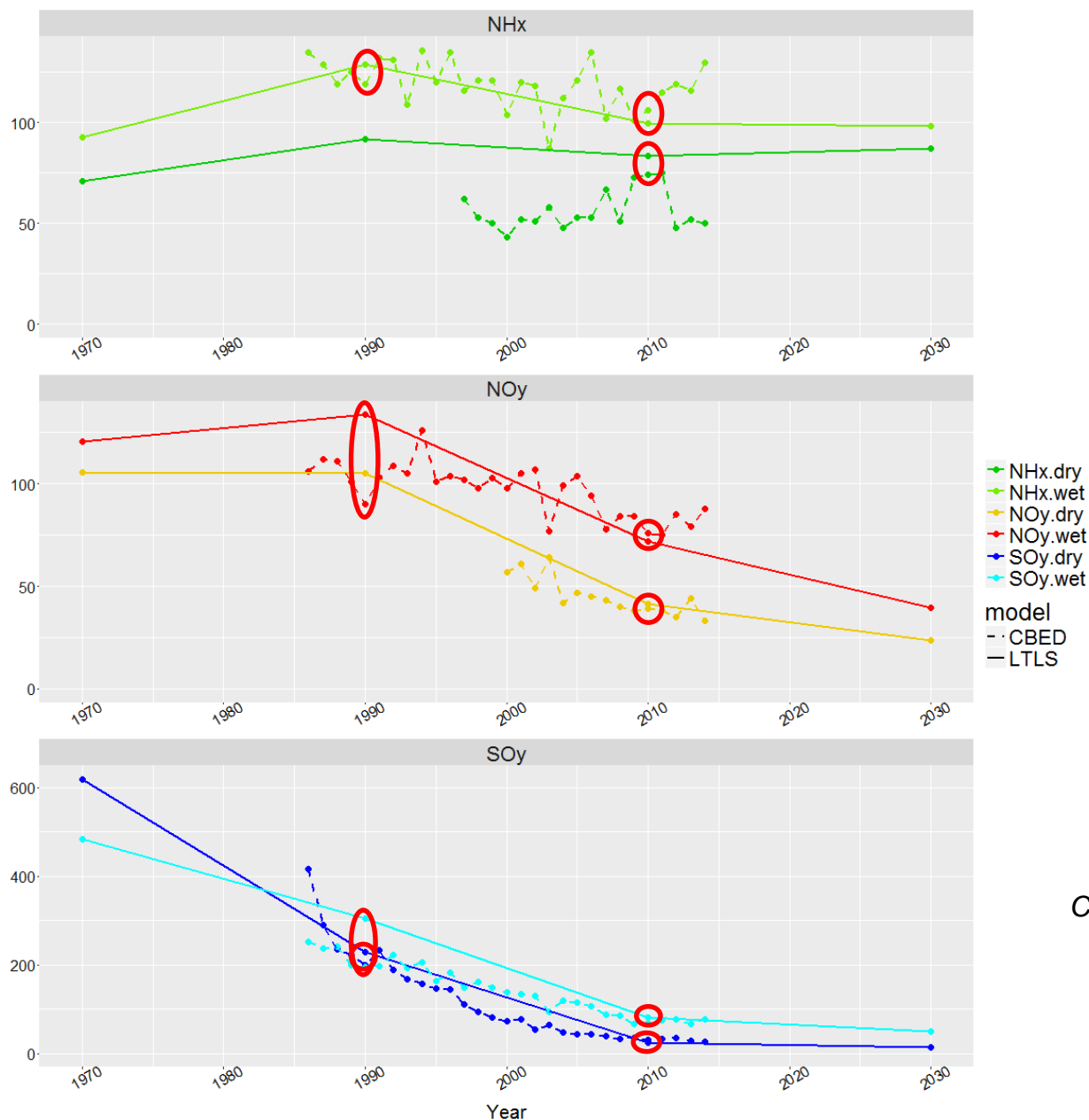


**Main source:**  
Agriculture  
(livestock & fertilisers)

# Temporal trends in N deposition 1800-2030



# Comparison with measurement-based data



CBED model, R. Smith et al.,  
CEH Edinburgh



# Conclusions

- **N & S deposition** increased hugely during 19/20<sup>th</sup> centuries
- **S deposition** – emission reductions a big policy success!
- Recent considerable decreases (since ~1990) in total N deposition mainly due to **NO<sub>x</sub> emission reductions** following international legislation (e.g. combustion plants, catalytic converters). Partial success story, in progress.
- **Reduced N (ammonia)** now largest source of N deposition, largely unchanged & predicted to remain stable
- Changing spatial patterns and composition of N deposition

# Acknowledgements

## Online datasets:

Vision of Britain, Edina Agricultural Census, Defra UK National Atmospheric Emissions Inventory

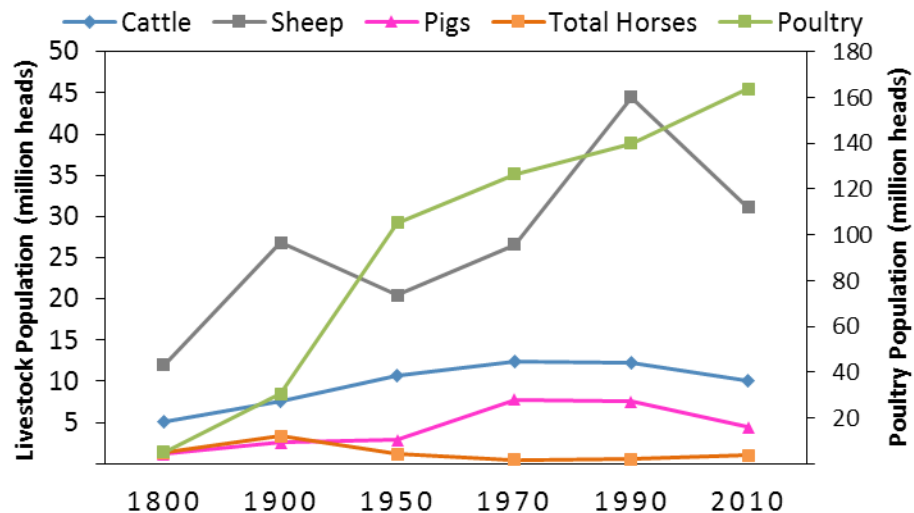
## Contributions:

David Simpson (Norwegian Meteorological Institute & Chalmers University of Technology)

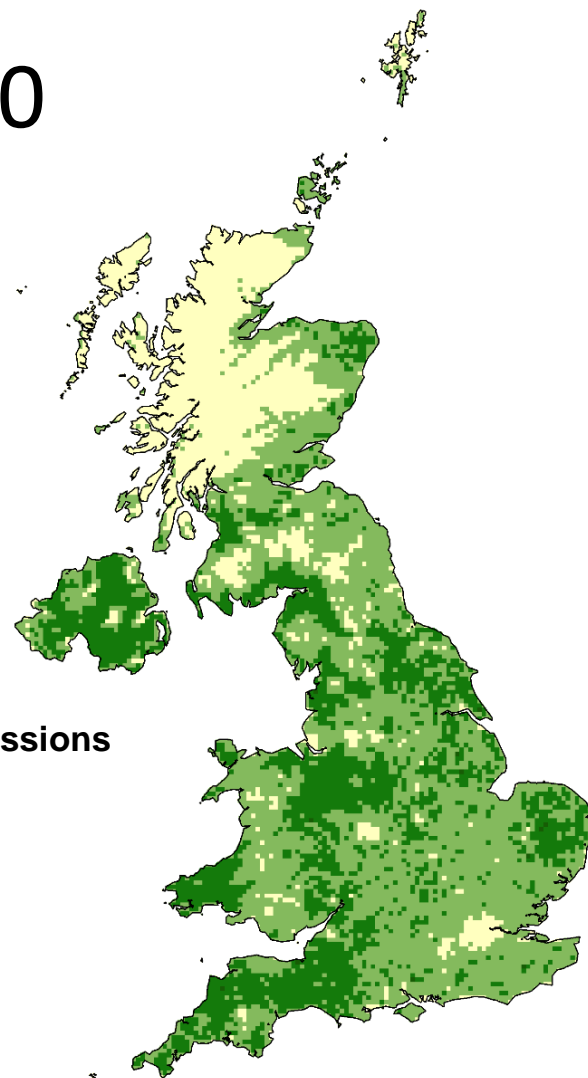
Maciej Kryza (University of Wroclaw)

# Agricultural ammonia emissions

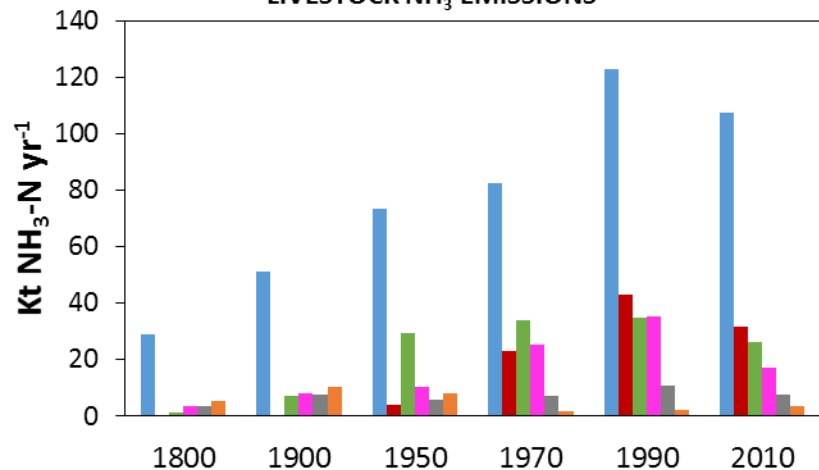
## LIVESTOCK POPULATIONS



# 2010

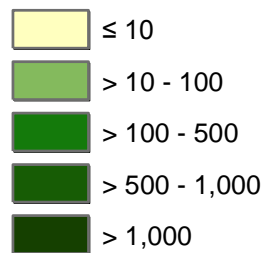


## LIVESTOCK NH<sub>3</sub> EMISSIONS



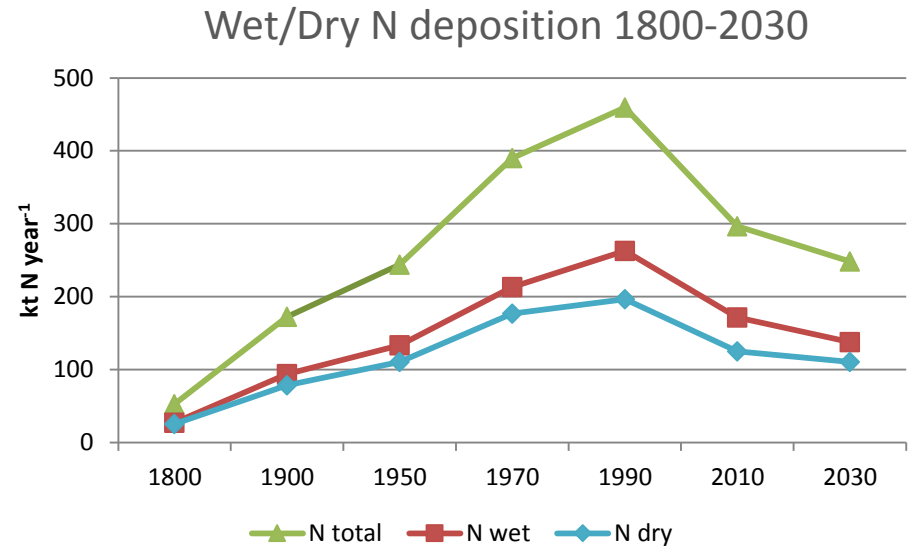
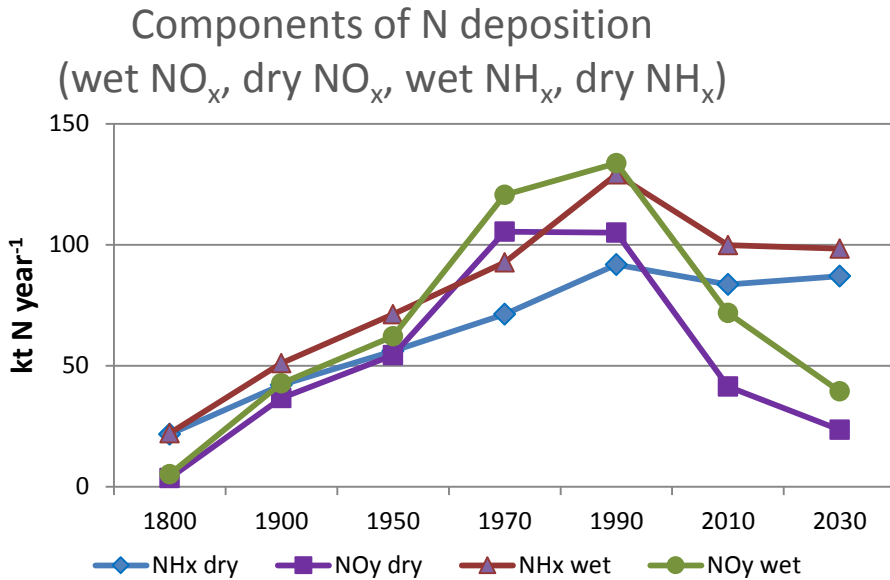
## Agricultural NH<sub>3</sub> Emissions

kg NH<sub>3</sub>-N ha<sup>-1</sup> yr<sup>-1</sup>

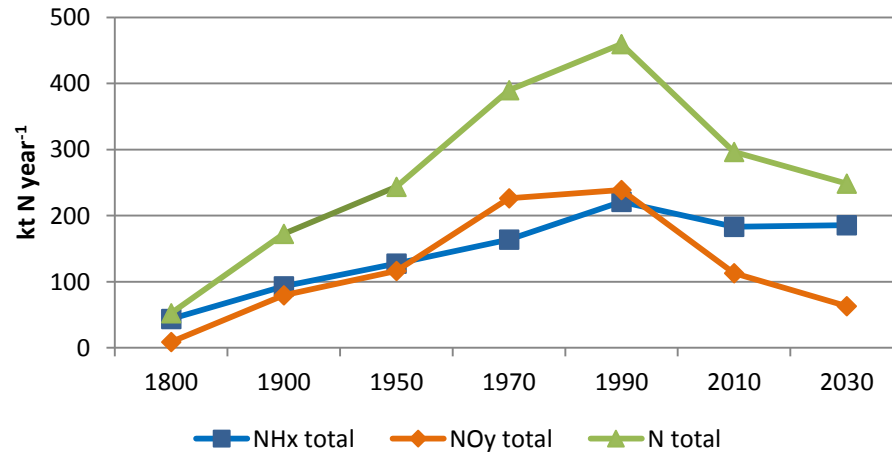


- Cattle
- Poultry
- Sheep
- Fertiliser
- Pigs
- Agricultural Horses

# Analysis of N deposition components



## Oxidised/reduced N deposition 1800-2030





# Components of N Deposition (1970)

## Oxidised nitrogen



Wet Deposition



Dry Deposition

N Deposition

kg N ha<sup>-1</sup> yr<sup>-1</sup>

≤ 2.5

> 2.5 - 5

> 5 - 10

> 10 - 15

> 15 - 25

> 25

## Reduced nitrogen



Wet Deposition



Dry Deposition

## Total N Deposition

Grid square average deposition estimates  
(i.e. taking account of land cover)