NERC Macro Nutrient Cycles LTLS Long term trends in UK N deposition

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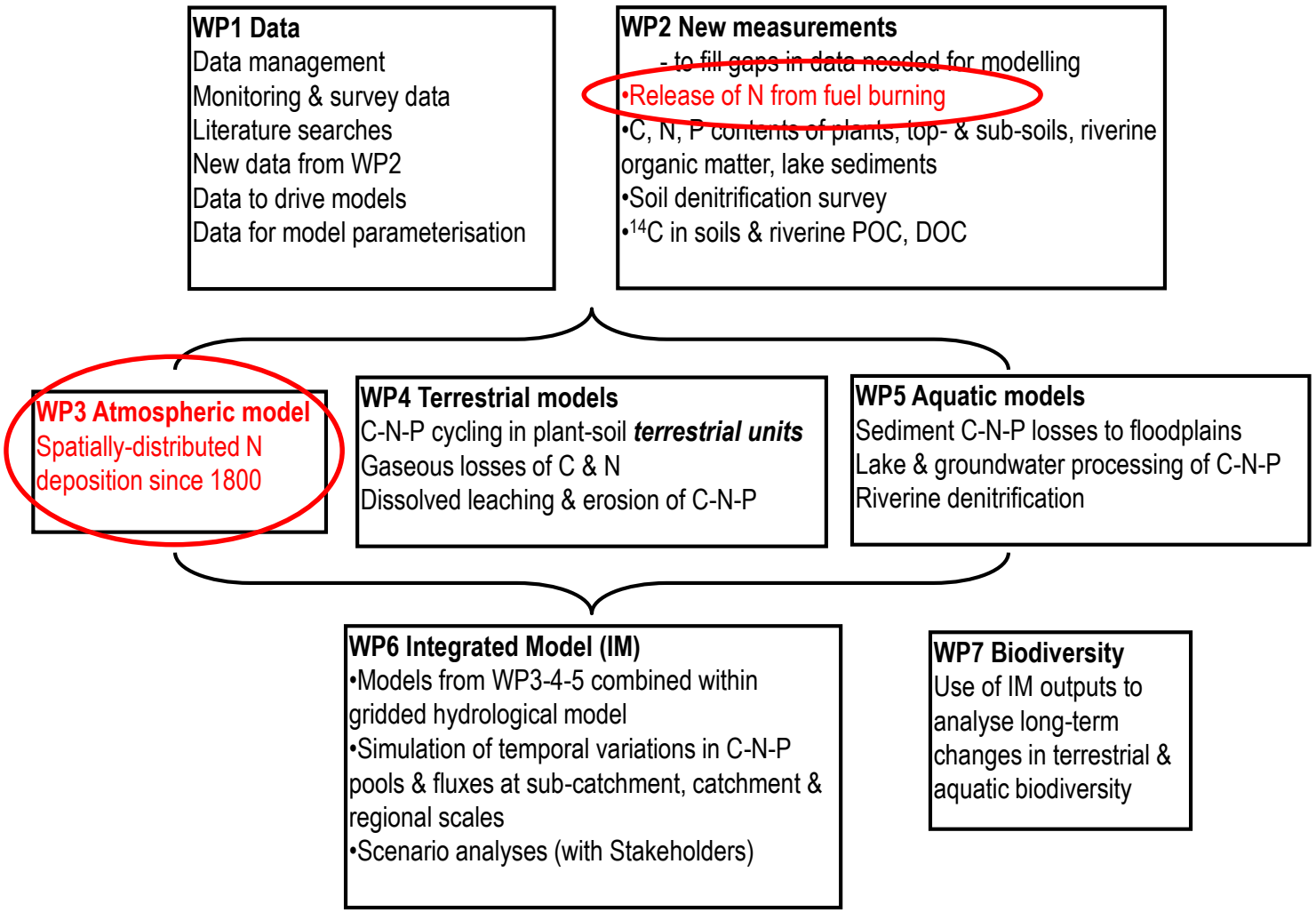
Atmospheric component of LTLS



UK historic N deposition 1800-2010

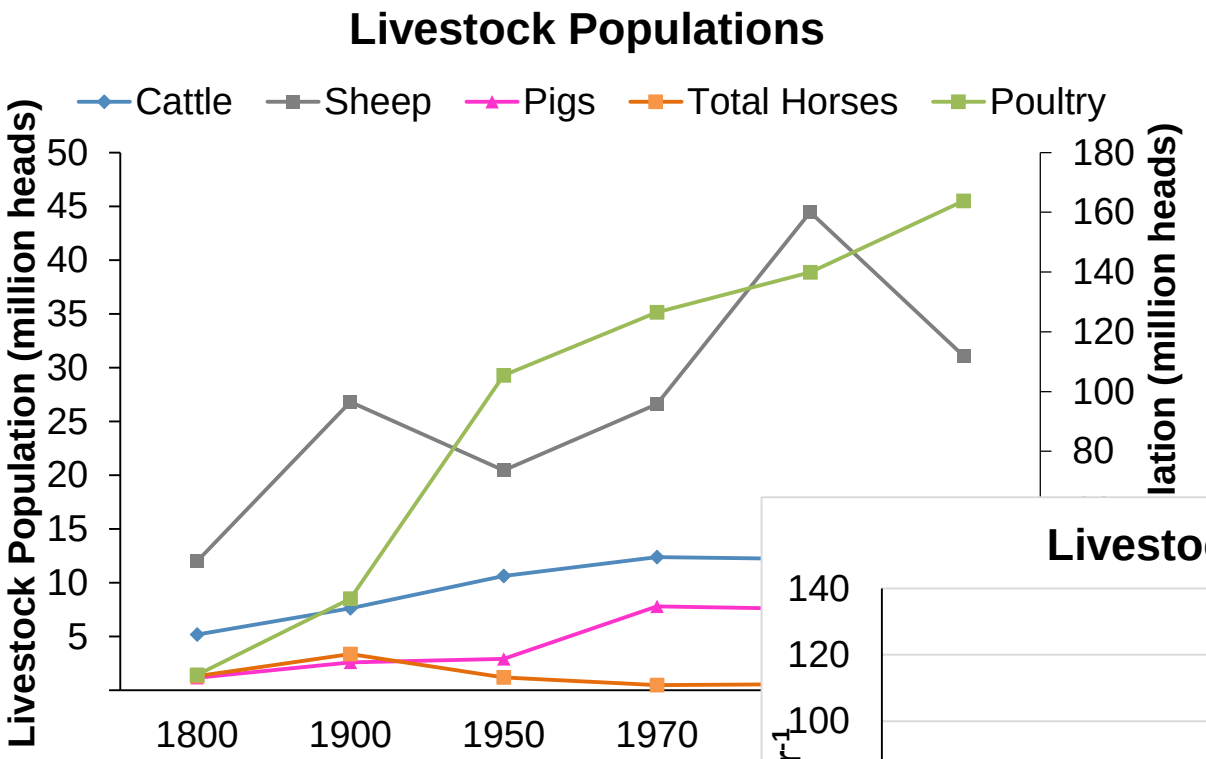
Aims/objectives

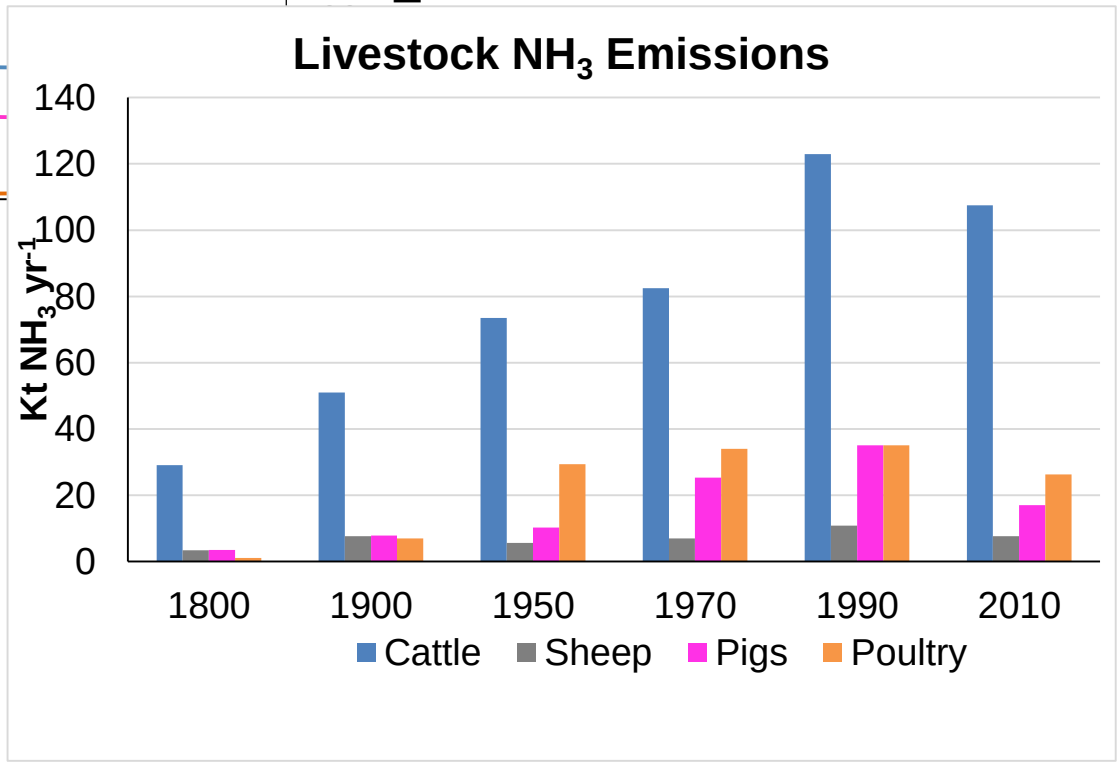
- Reconstruction of N deposition timeline/spatial distribution (5 km)
- 6 time slices: 2010-1990-1970-1950-1900-1800

Tasks/methodology

- Research into historical trends of **emission sources** (activity data, spatial distributions, emission factors)
- Finding, analysing and combining **large amounts of data** (e.g. historic human population, agricultural livestock & crops, fertiliser application, agricultural practice, land cover, road/rail transport, shipping, coal mining, power generation, domestic fuel use, industry, landfill, sewage, town gas, ...)
- **Measurements** to quantify emissions from domestic fuel burning
- Atmospheric **emission & deposition modelling (NARSES, AENEID, FRAME) and mapping**

Agricultural NH_3 emissions





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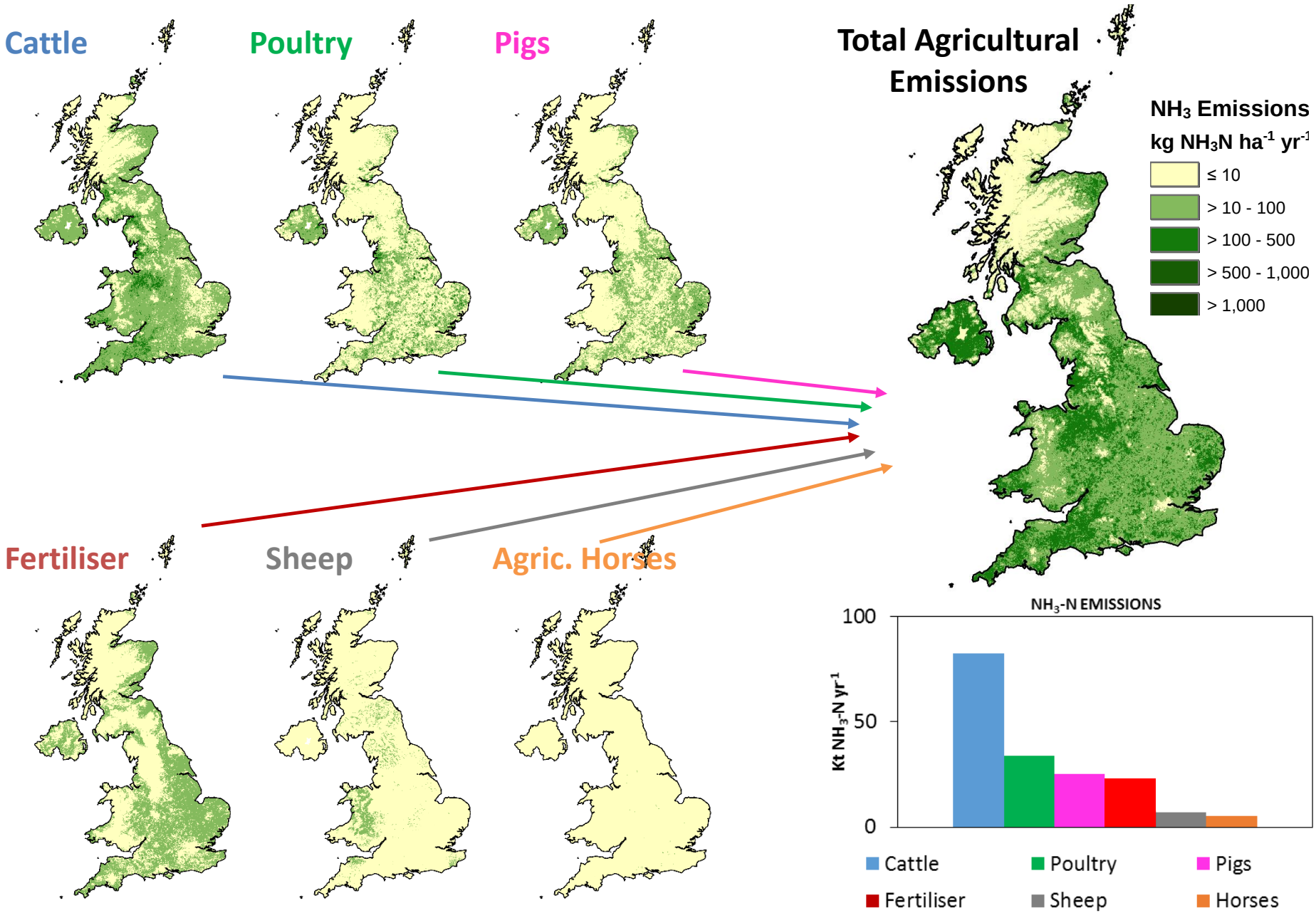
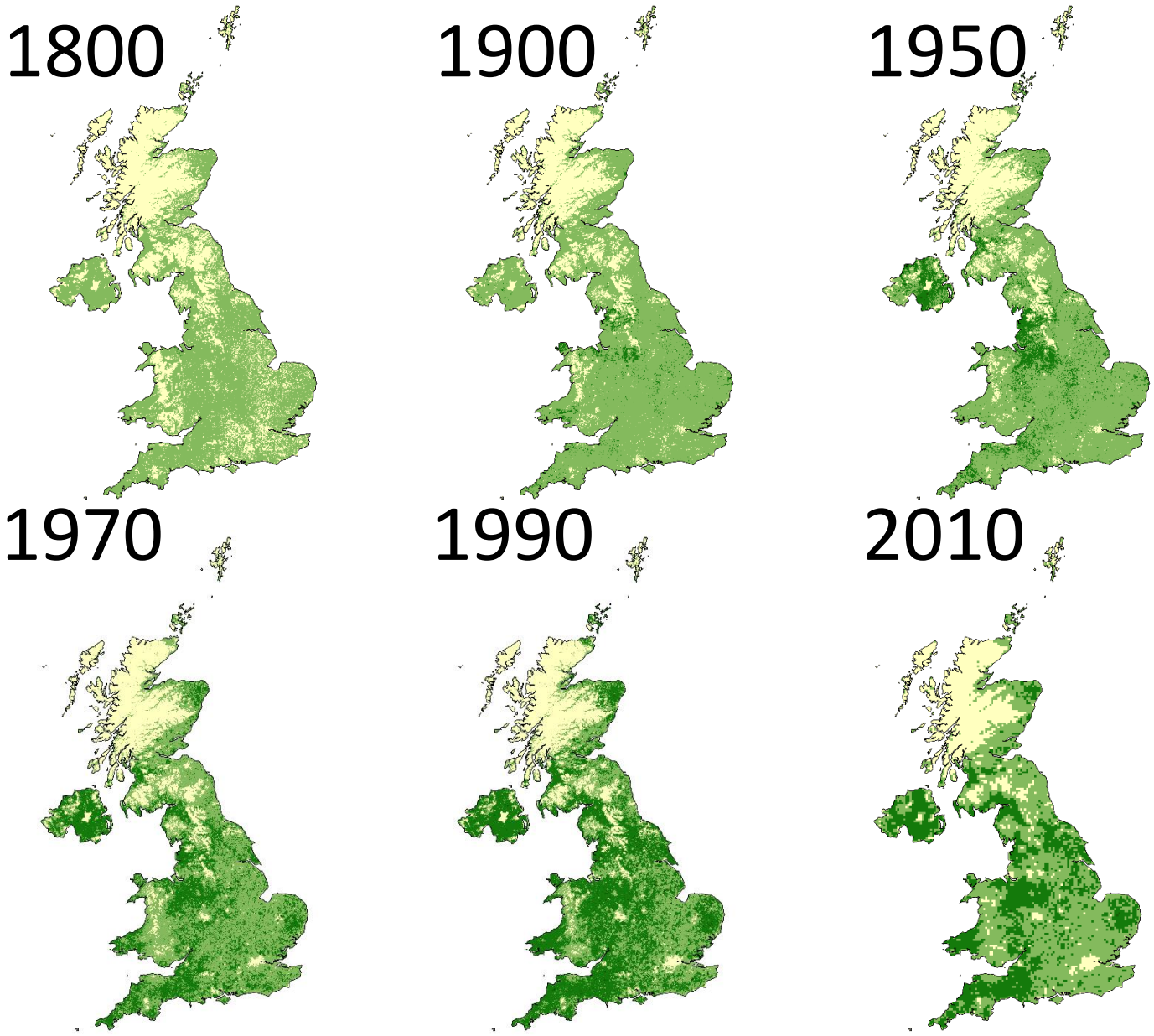
Agricultural NH_3 emissions (1970)



Agricultural NH_3 Emissions



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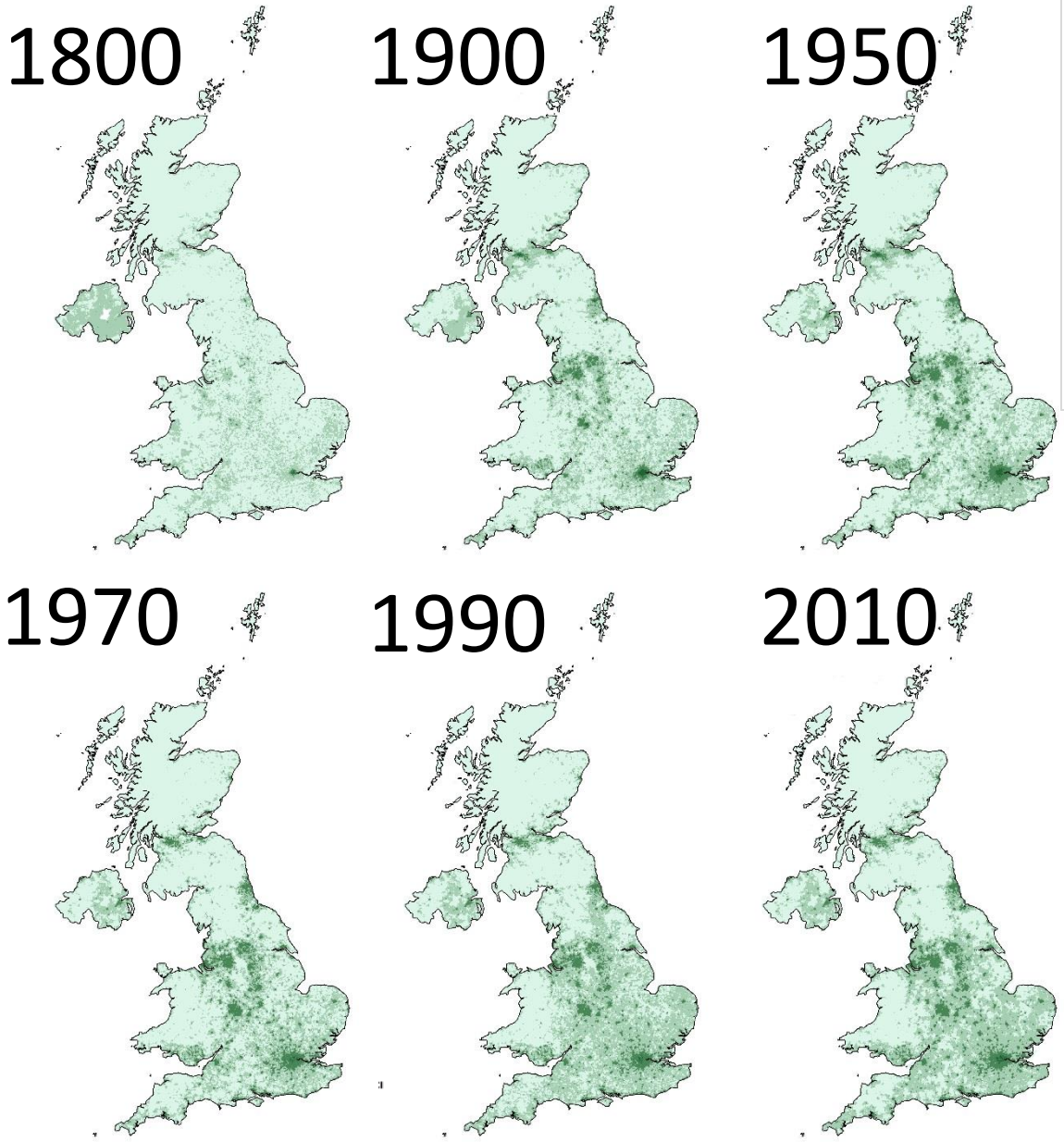
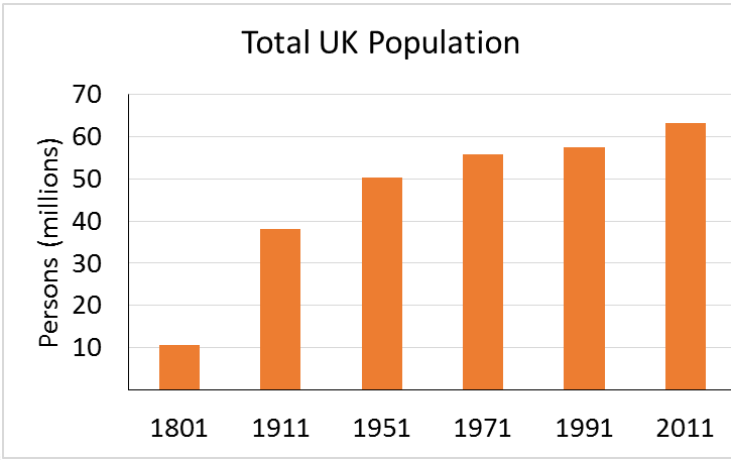
Human population density





Population Density

Persons km^{-2}

- ≤ 50
- > 50 - 500
- > 500 - 1,000
- > 1,000 - 10,000
- > 10,000

N

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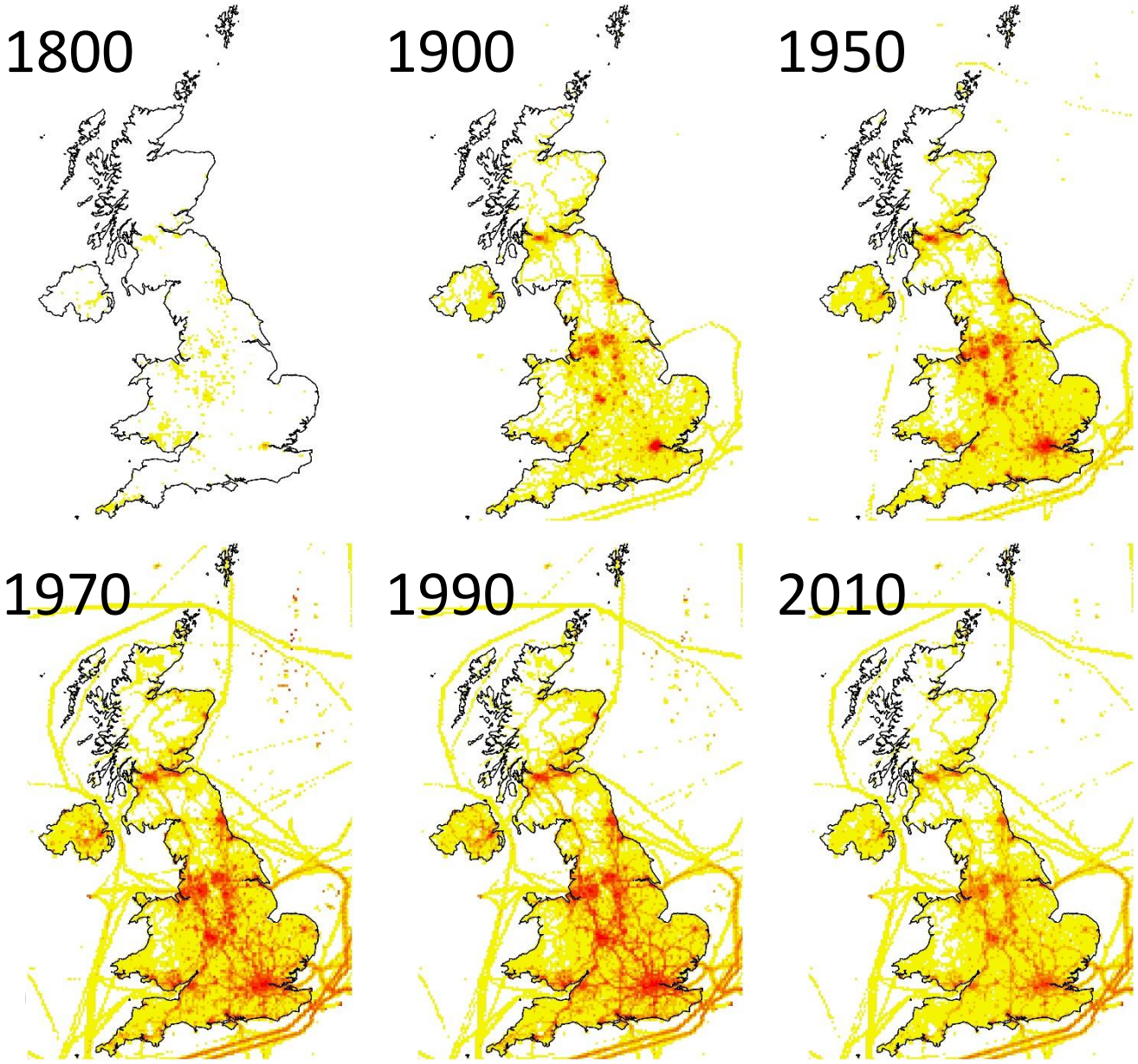
Total NO_x Emissions



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How much N is emitted from domestic solid fuel burning?

Fire Experiment – Dec 2014:

low-temperature domestic combustion, traditional burning practices/fuels

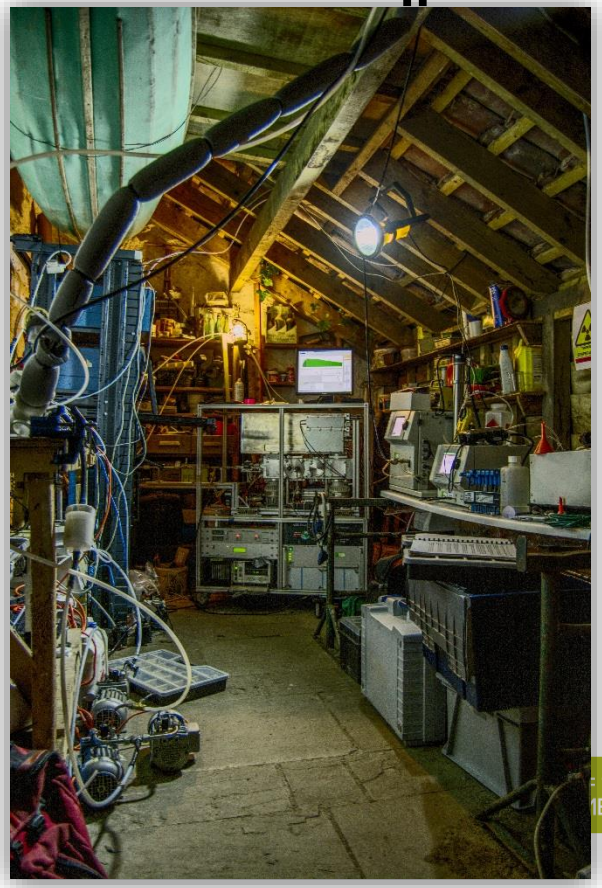
2.5g NO_x kg^{-1} coal
[0.004 g NH_3 kg^{-1} coal]

Output:
emission per kg fuel

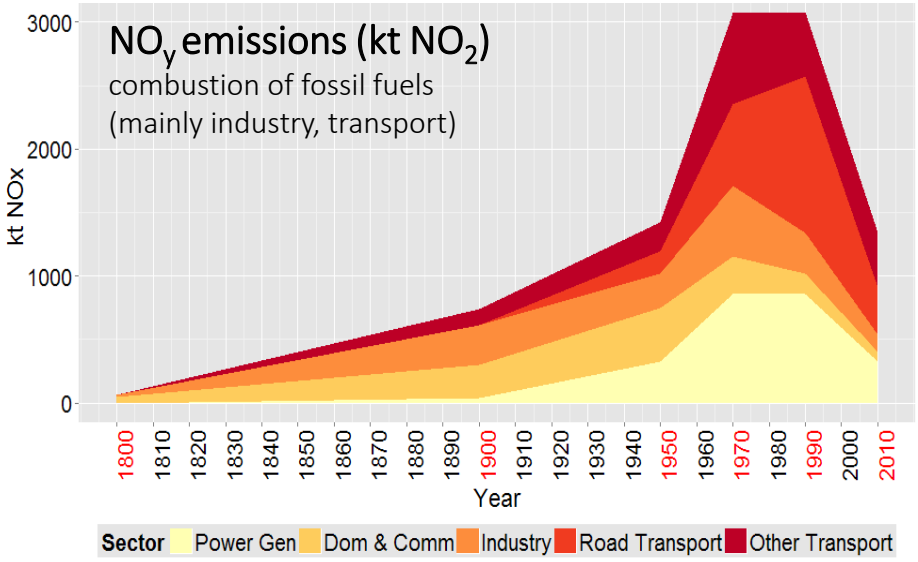
Gas Phase
CO_2, CO, NO_x, SO_2, HCN, NH_3…

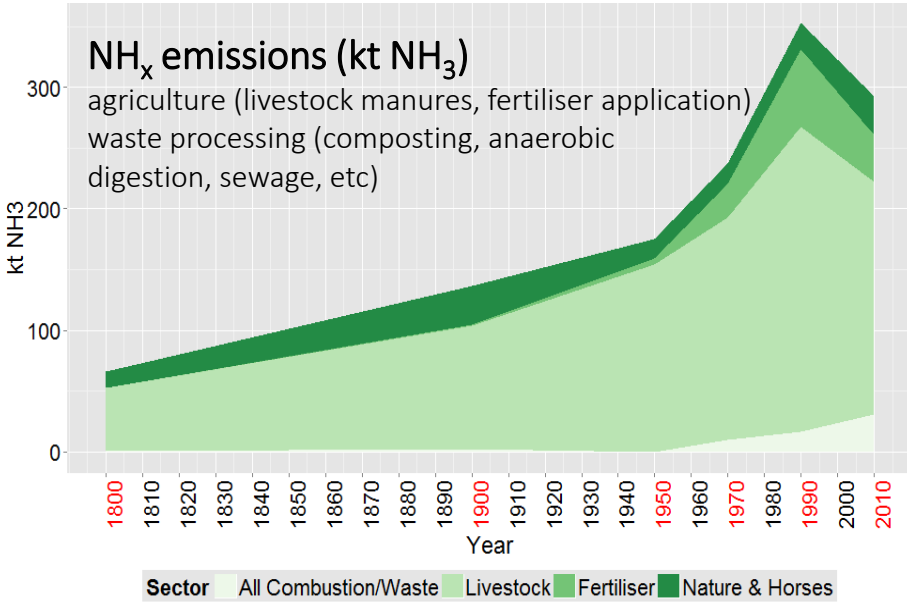
Aerosol Phase
Org, NO_3^-, NH_4^+, SO_4^{2-}, Cl^-

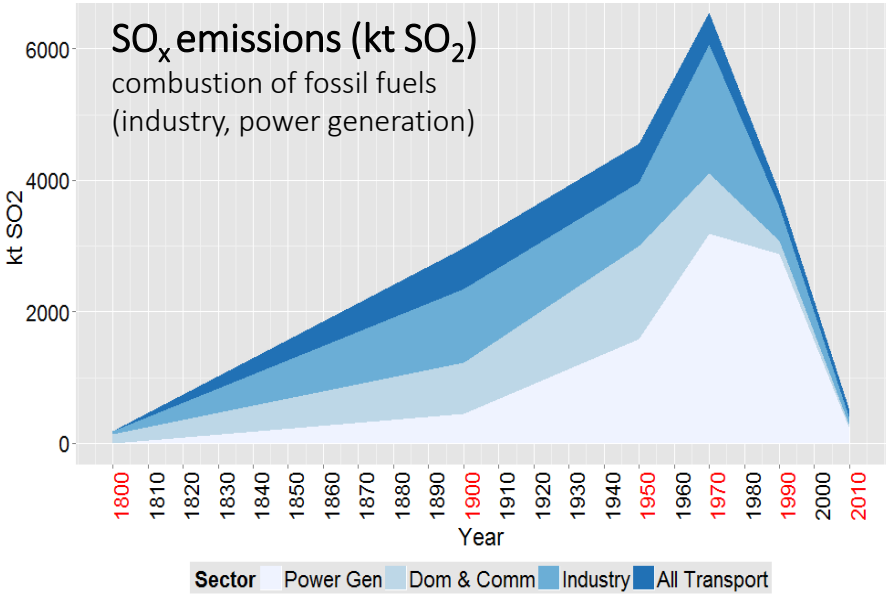
Fuels
Wood
Peat
Coal



Historic emission trends 1800-2010







SO_2 important for atmospheric chemistry/deposition processes

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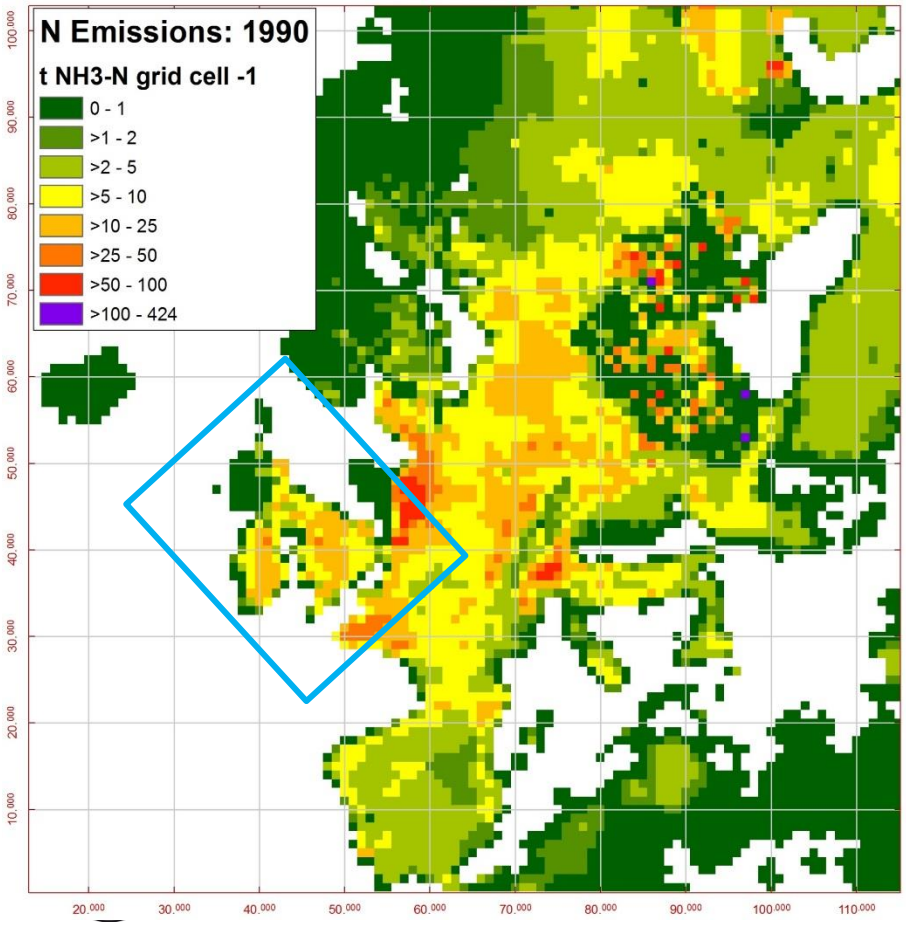
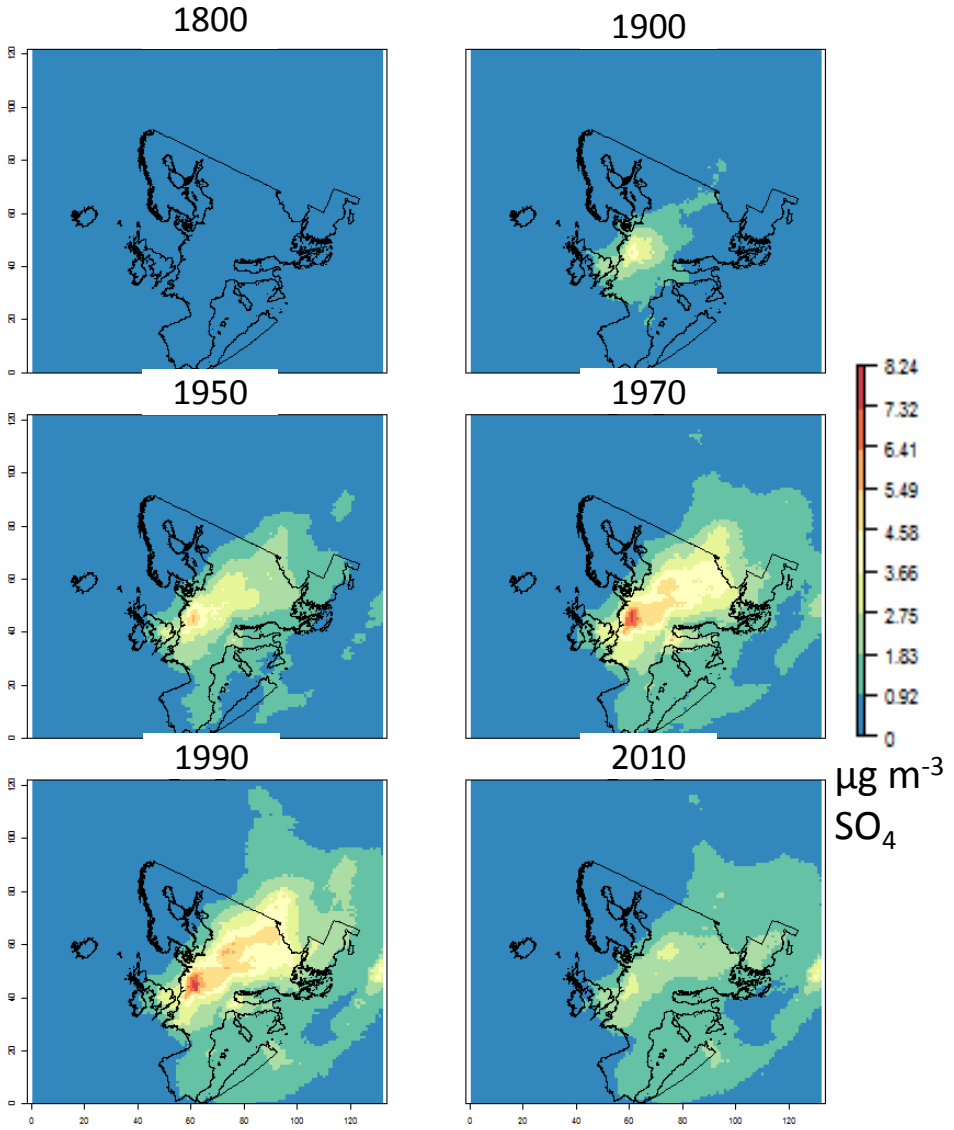
FRAME – European to UK emissions

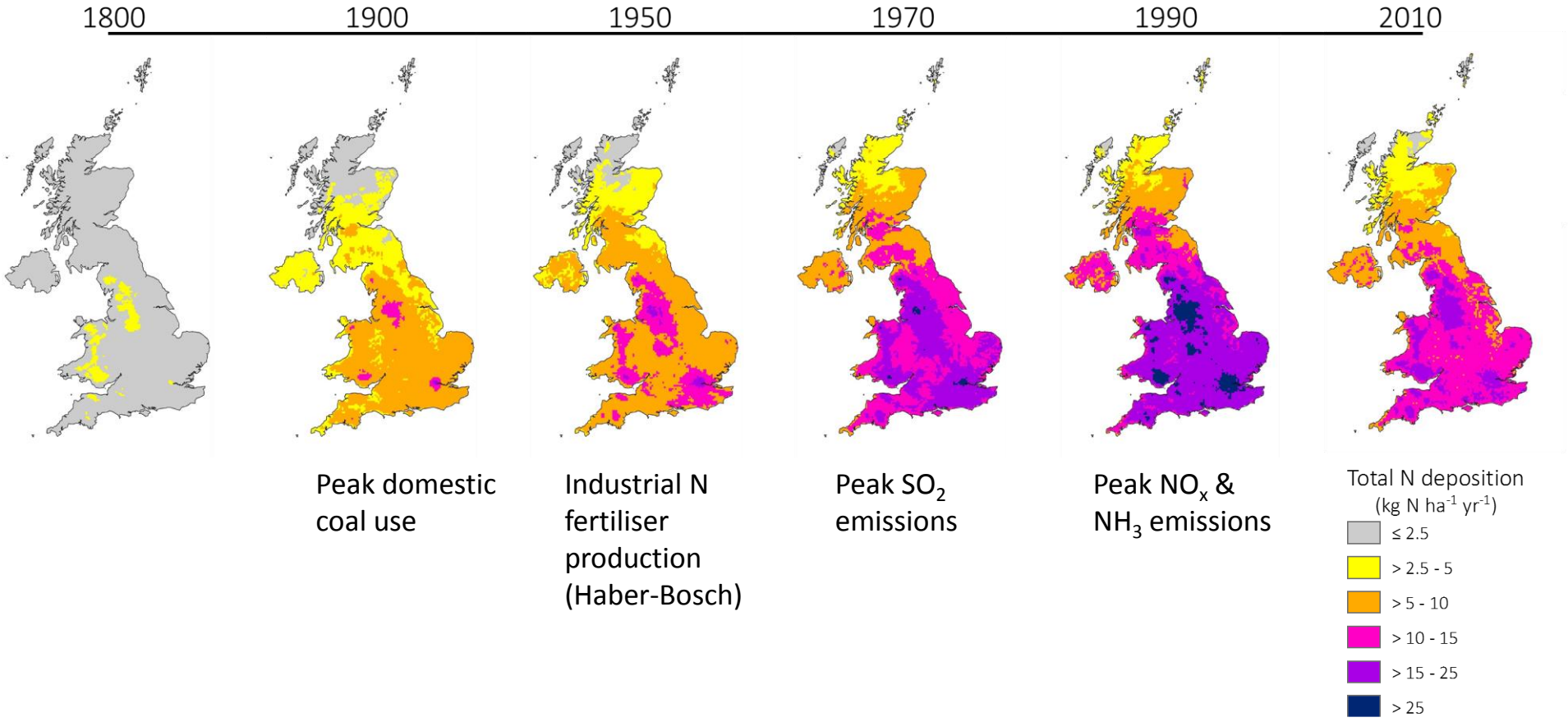
Fine Resolution Atmospheric Multi-pollutant Exchange (FRAME) model

Generates boundary conditions for a 5km FRAME-UK simulation





N deposition timeline 1800-2010



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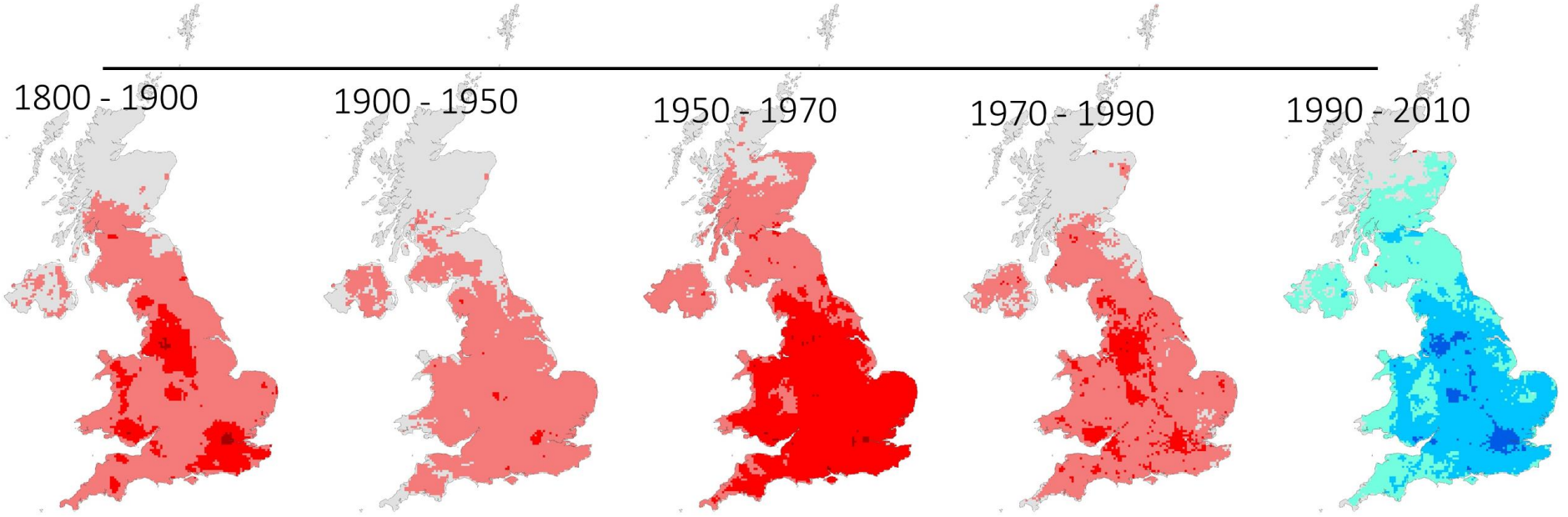
Changes in N deposition 1800-2010



Increase in human population, livestock, domestic burning, mining

Further (smaller) increases + transport; wars

Large power stations, road transport, fertiliser input increasing, peak SO_2

Further agricultural intensification, transport & industry, peak NO_x & NH_3

International SO_2 & NO_x legislation, small decrease in NH_3 (mainly fewer animals, less fertiliser)

Change in N deposition

(kg N ha^{-1})

- > 10 - 23.8
- > 5 - 10
- > 2 - 5
- > -2 - 2
- > -5 - -2
- > -10 - -5
- -19.6 - -10

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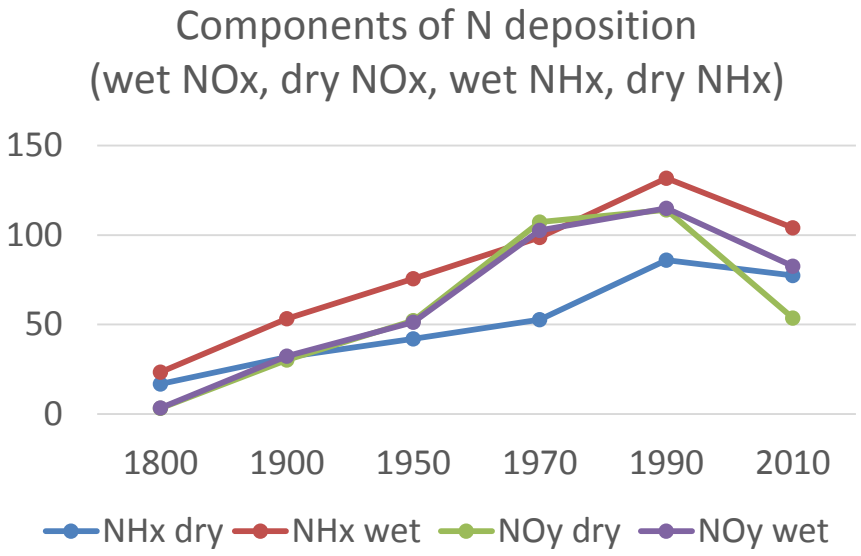
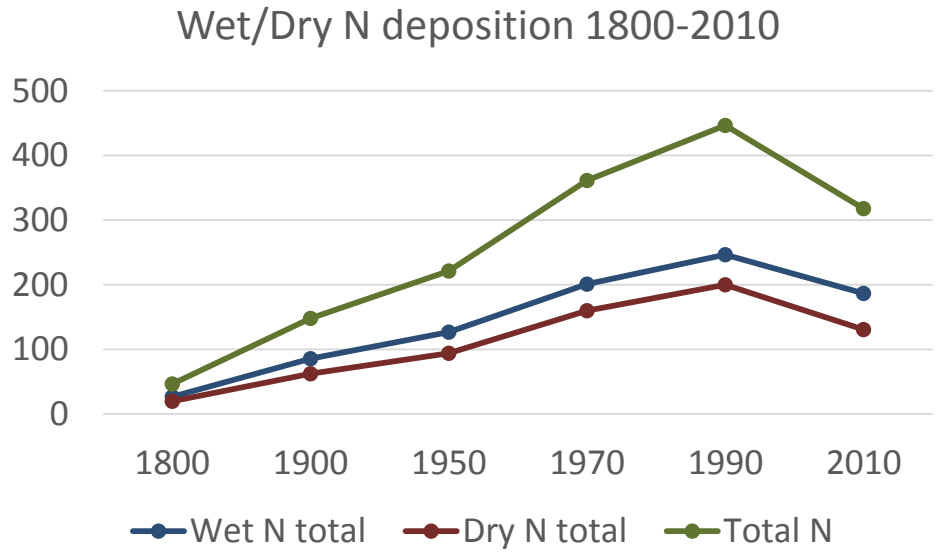
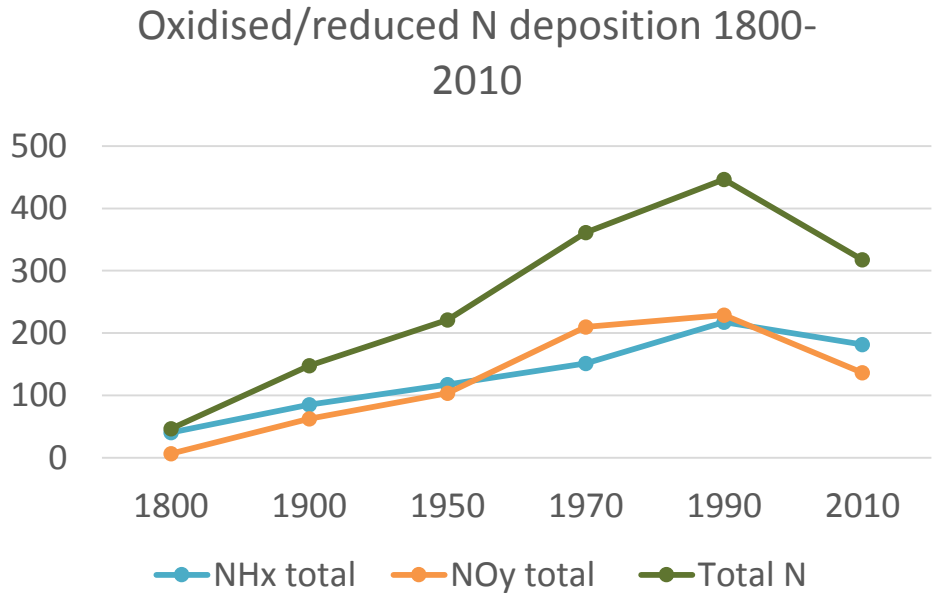
Analysis of N deposition components







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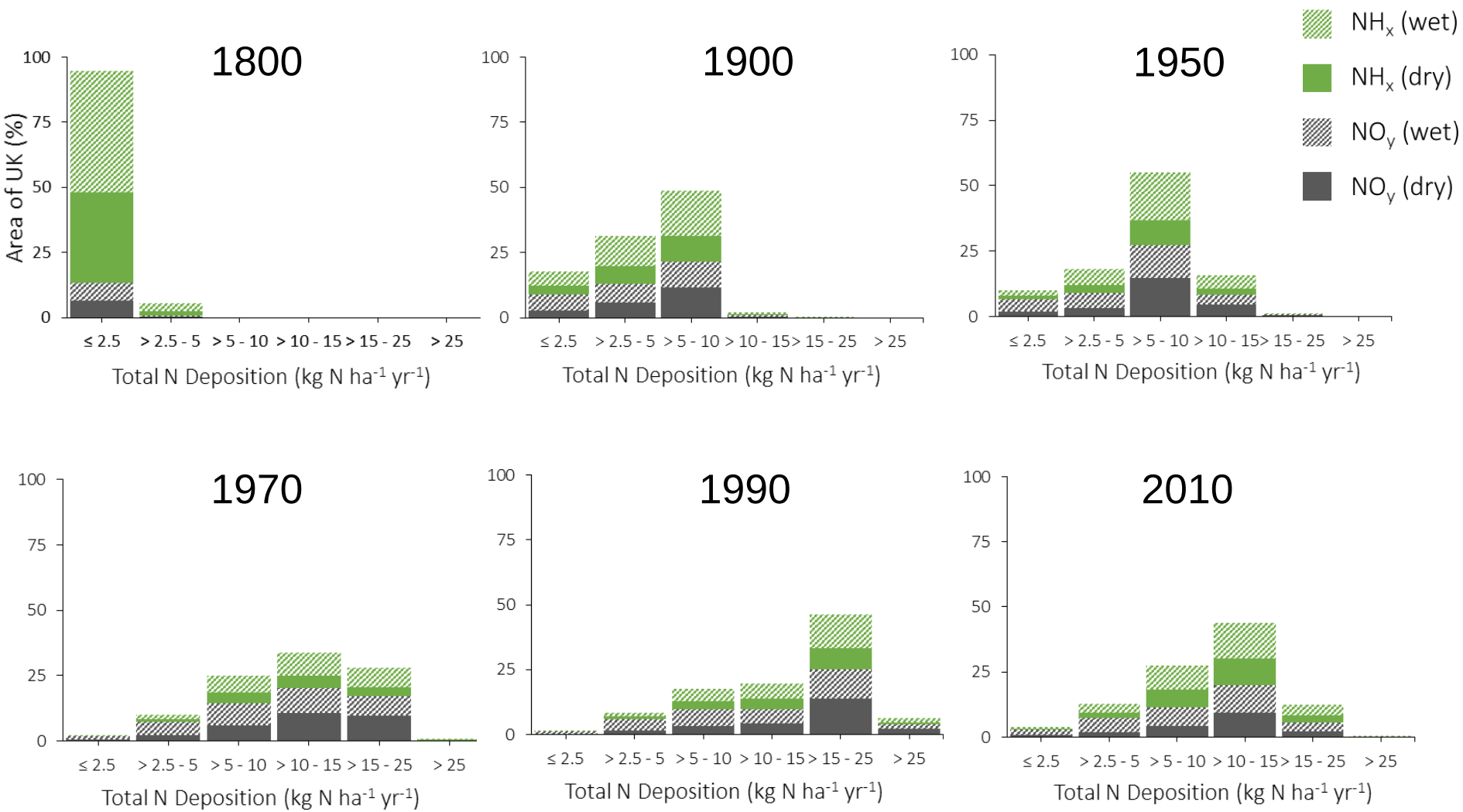
N deposition components 1800-2010



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Conclusions

- N deposition increased substantially between 1800-1990
- Recent decreases (since 1990) in N deposition mainly due to NO_x emission reductions following international legislation (combustion plants, catalytic converters)
- Changing spatial patterns and composition of N deposition

Acknowledgements

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