# Modelling health benefits of 40 years of air pollution control policies in the UK

London Smog event in 2014 - http://www.thetimes.co.uk/tto/environment/article4053987.ece


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# Highlights

- Models can simulate effects of emissions changes on  long-term air quality trends
- Emission reductions have reduced health impacts of UK air pollution since 1970
- Attributable $PM_{2.5}$ and $NO_2$ mortality have declined by 56% and 44%  over 40 years
- Ozone attributable respiratory mortality increased by 17% over the same period

https://iopscience.iop.org/article/10.1088/1748-9326/ab1542

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Modelling public health improvements as a result of air pollution control policies in the UK over four decades – 1970 to 2010

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Abstract

In much of the industrialised world, policy interventions to address the challenges of wide-spread air pollution as resulting from development and economic progress in the 2nd half of the 20th century have overall led to reductions in air pollution levels and related health effects since the 1970s. While overall improvements towards reducing health effects from ambient air pollution are recorded, comprehensive and consistent assessments of the long-term impact of policy interventions are still scarce. In this paper, we conduct a model assessment over a 40 year period of air pollution in the UK. In order to correct for the short and longer term variability of meteorological factors contributing to trends in ambient concentrations of priority air pollutants (nitrogen dioxide, sulphur dioxide, fine particulate matter and ozone), we use a fixed meteorological year for all model simulations. Hence, the modelled changes in air pollutant concentrations and related health effects are solely a function of

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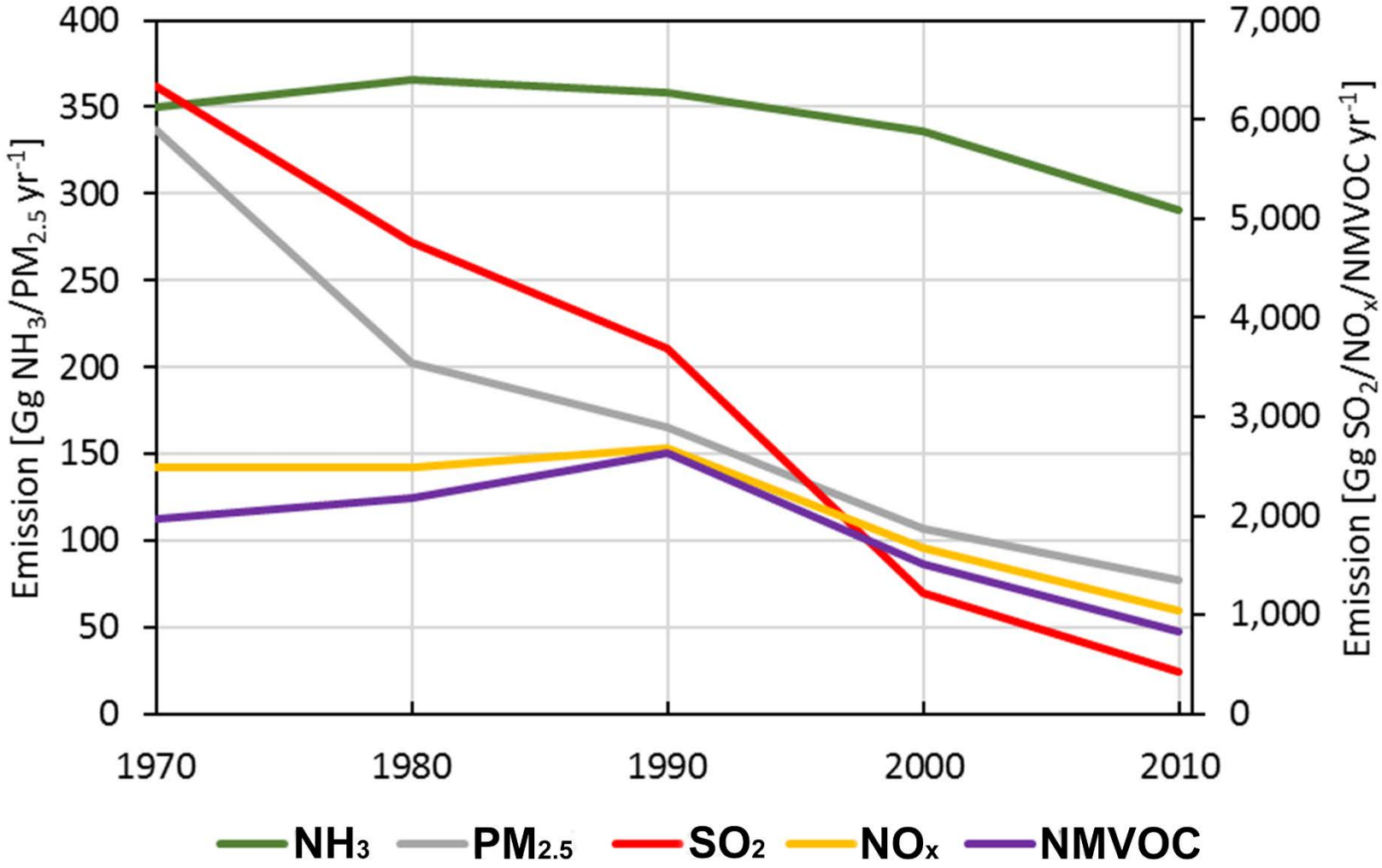
# Emissions of key air pollutants from 1970-2010

- Early policies focused on $SO_2$ emissions and stationary sources
- $NO_x$ emissions increased with vehicle numbers until early 1990s, then declined as a result of policies introducing more stringent limit values for vehicles
- $PM_{2.5}$ declined throughout, while $NH_3$ only modest reduction

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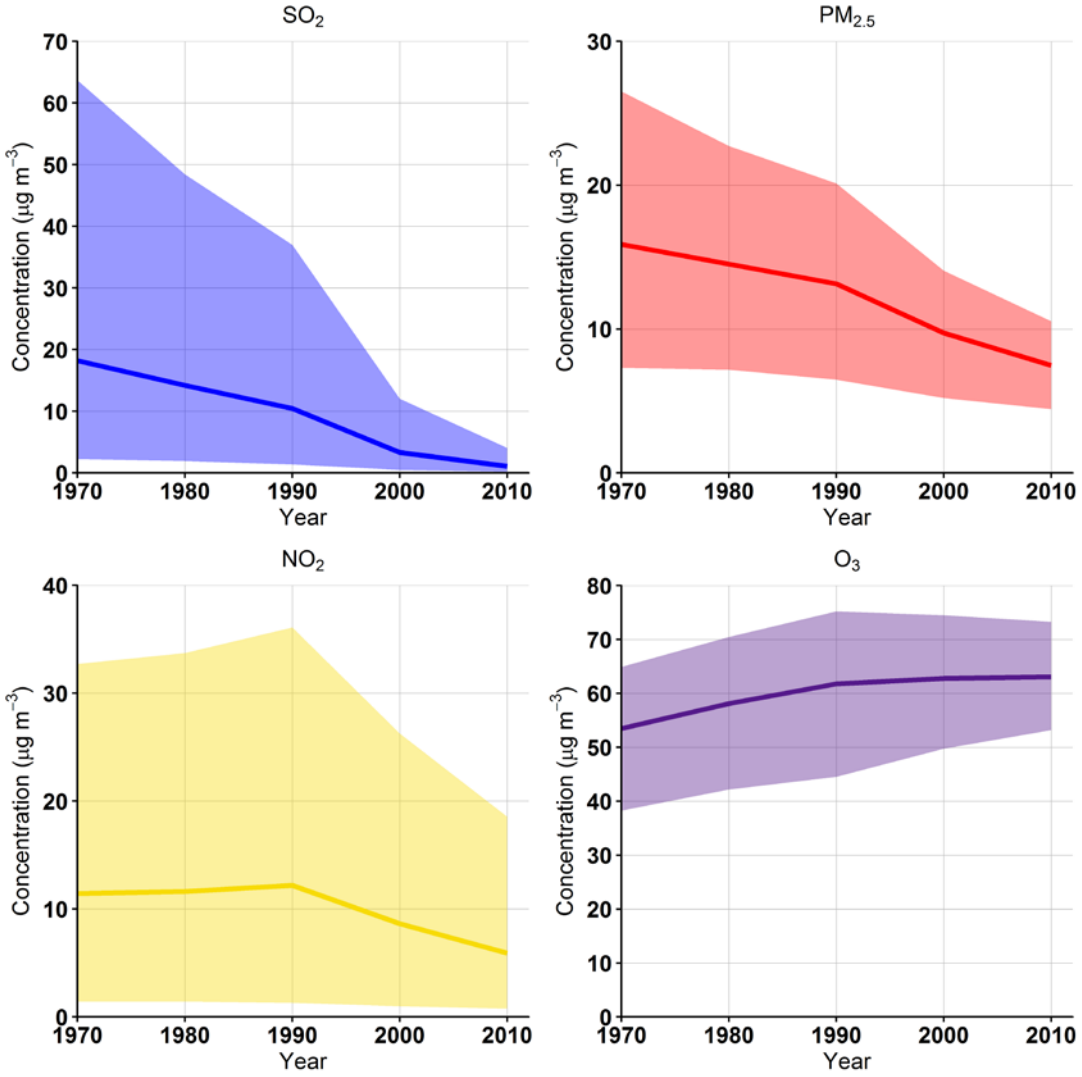
# Air pollutant concentrations modelled over 40 years




- Applied one consistent meteorological year to all model runs
- Changes in emissions drive concentration changes
- 1st and 99th confidence interval boundaries and average concentration levels shown for 10 year time steps

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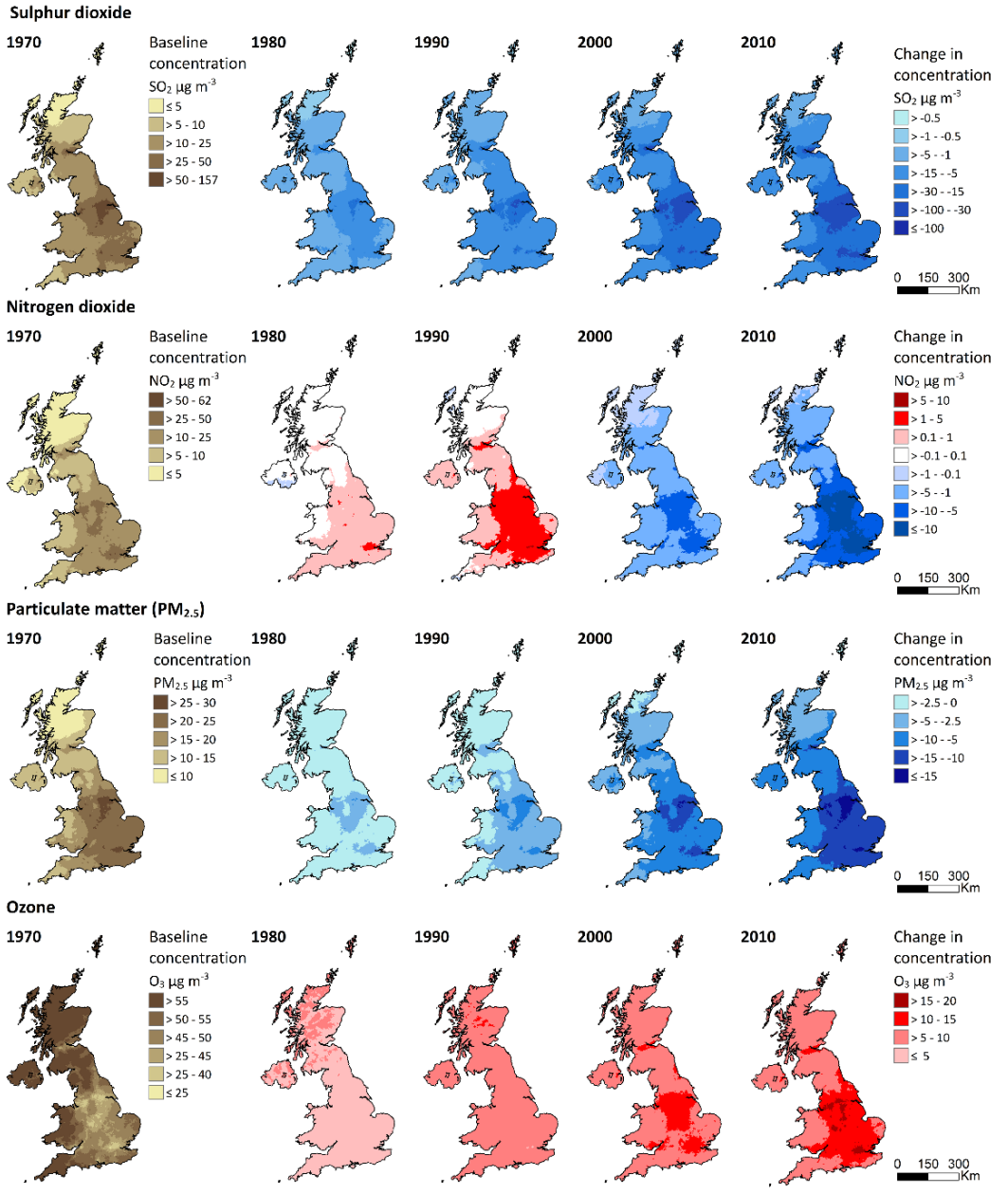
# Concentrations and pop-weighted concentrations

- Mapped time series of annual average concentration changes over the study period for $SO_2$, $NO_2$, $PM_{2.5}$ and $O_3$.
- The left panel (1970) depicts concentrations in the base year, with the remaining maps in each row illustrating the absolute change in concentrations in µg $m^{-3}$.
- **Blue** indicates decreases and **red** indicates increases compared to the baseline 1970

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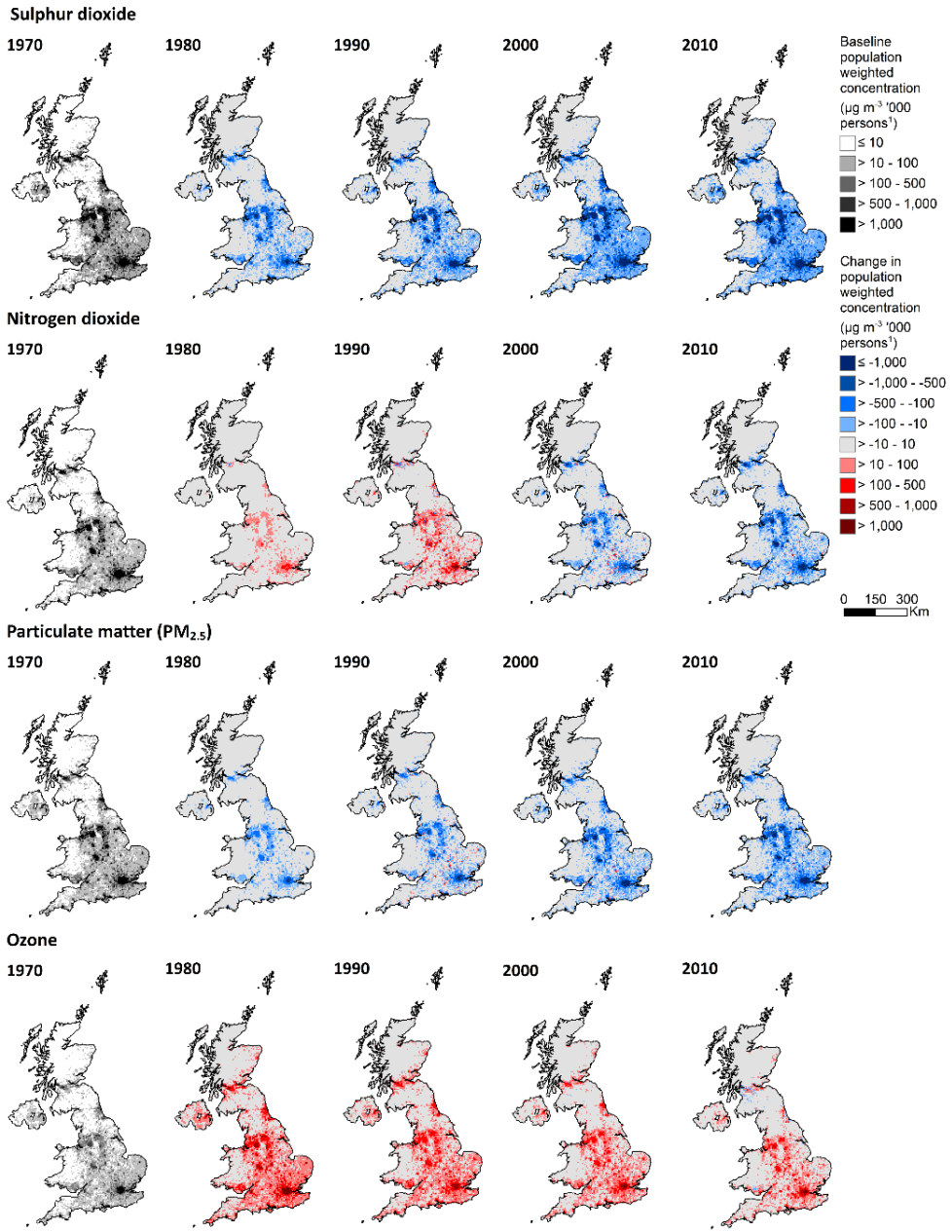
# Concentrations and pop-weighted concentrations




- Mapped time series of population-weighted concentration changes over the study period to illustrate changes in population exposure to $SO_2$, $NO_2$, $PM_{2.5}$ and $O_3$.
- The left panel (1970) depicts concentrations in the base year, with the remaining maps in each row illustrating the absolute change in concentrations in µg $m^{-3}$ × 1,000 persons.
- **Blue** indicates decreases and **red** indicates increases compared to the baseline 1970.

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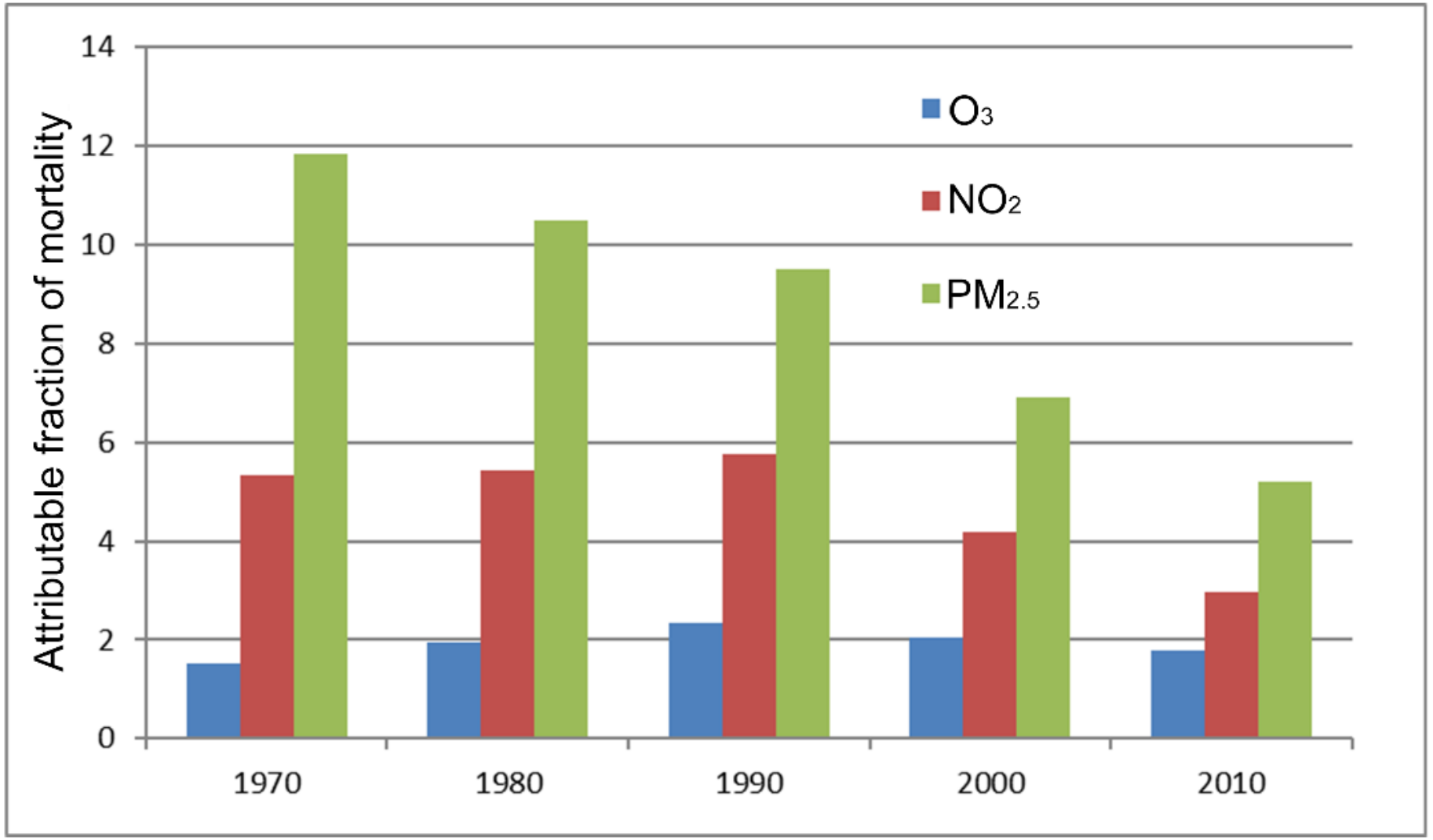
# Changes in attributable mortality in the UK

Population-weighted UK average attributable fraction of mortality for $O_3$ (blue), $NO_2$ (red) and $PM_{2.5}$ (green) for 1970, 1980, 1990, 2000 and 2010

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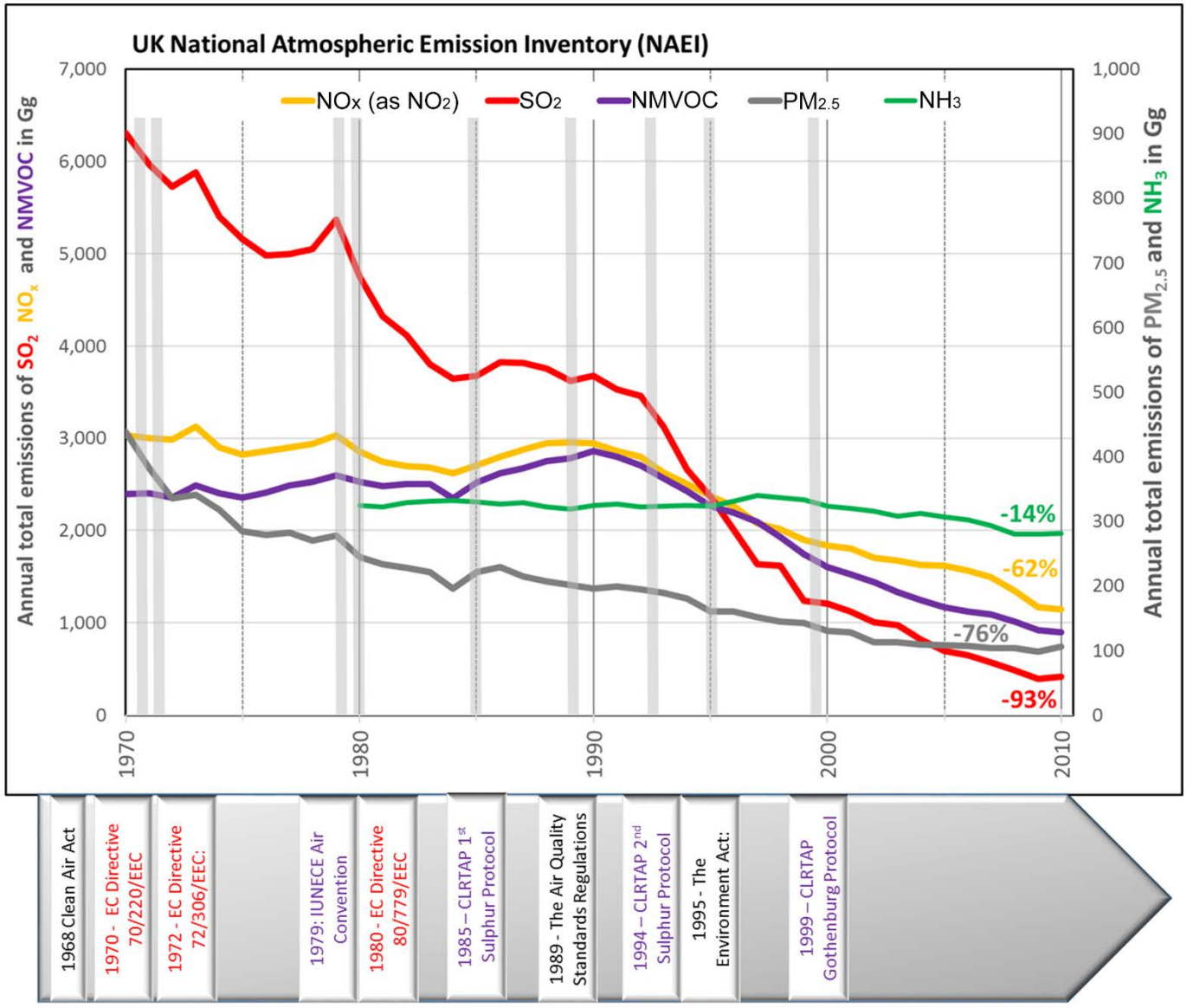
# Emission control policies

Timeline of emission changes (based on the UK NAEI) from 1970 to 2010, and of the coming into force of selected air quality legislation in a UK (**black**), EU (**red**) and UNECE Air Convention (**purple**) context.




*Percentage values show changes in emissions in 2010 with respect to those in 1970 (in 1980 for $NH_3$)*

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# Caveats & Limitations

- Attributable mortality calculated for individual pollutants – but what about the effect of multiple exposures?
- We did not investigate the impact of individual policies
- Modelling at 10 year time steps will miss some more subtle changes over time (see final graph on emission changes)
- 5 km x 5 km spatial resolution may not capture the spatial variability of concentrations and exposure in sufficient detail

# Conclusions & Outlook

- Value of ex-post assessment in identifying positive messages and assessing effects of emission control policies
- Long time horizon and removing meteorological variability allows review of *public health effects changes* resulting from *Δemissions*

***What next?***

- *Extending analysis to higher spatio-temporal resolution*
- *Public health burden of combine exposure to all regulated pollutants*
- *Should we look at our skills at projecting the impacts of future emission control policies?*