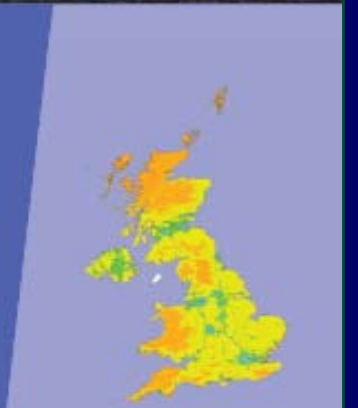
AIR QUALITY EXPERT GROUP

# Ozone in the United Kingdom

Prepared for:
Department for Environment, Food and Rural Affairs;
Scottish Executive; Welsh Assembly Government; and
Department of the Environment in Northern Ireland



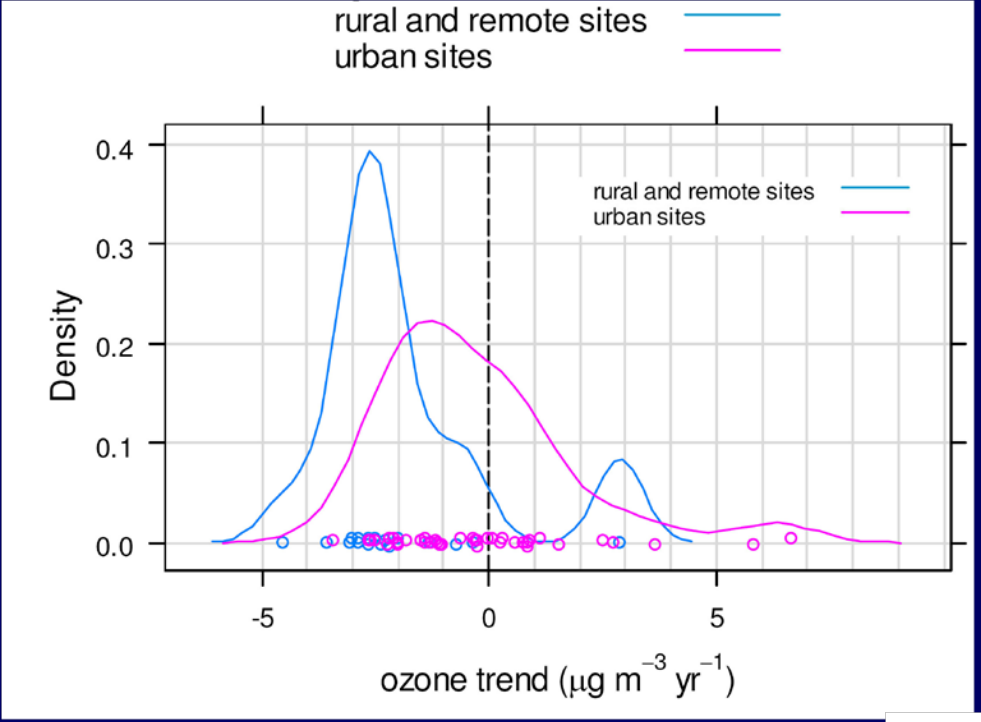
Presentation by
Professor Mike Pilling

# Format

- Defra posed 8 questions relating to ozone
- Response to each as a separate chapter, each comprising
  - A short answer, typically one short paragraph.
  - A detailed answer.
  - Supporting evidence
  - Recommendations
- Questions and short answer gathered in Executive Summary

- Eighth questions asked about progress since 1997 Photochemical Oxidants Review Group report. Progress, especially relating to monitoring and interpretation, but with further work needed

- Appendices (e.g. emissions of ozone precursors)



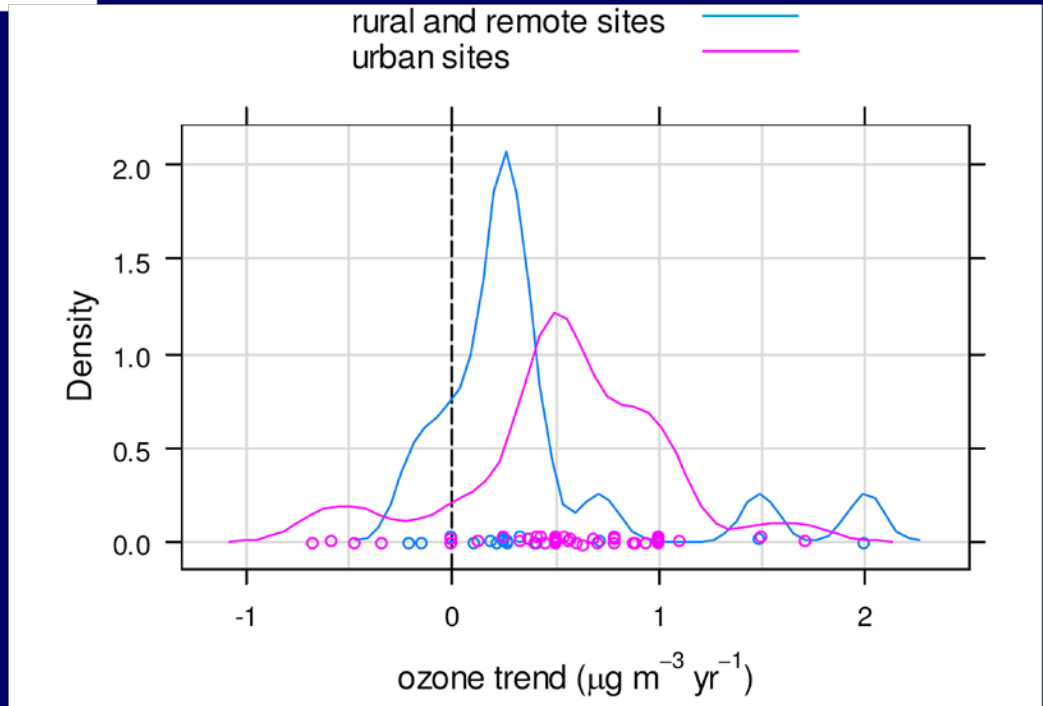

# Temporal trends and spatial distributions

Distributions of ozone trends at 18 rural and 45 urban sites (to 2005)

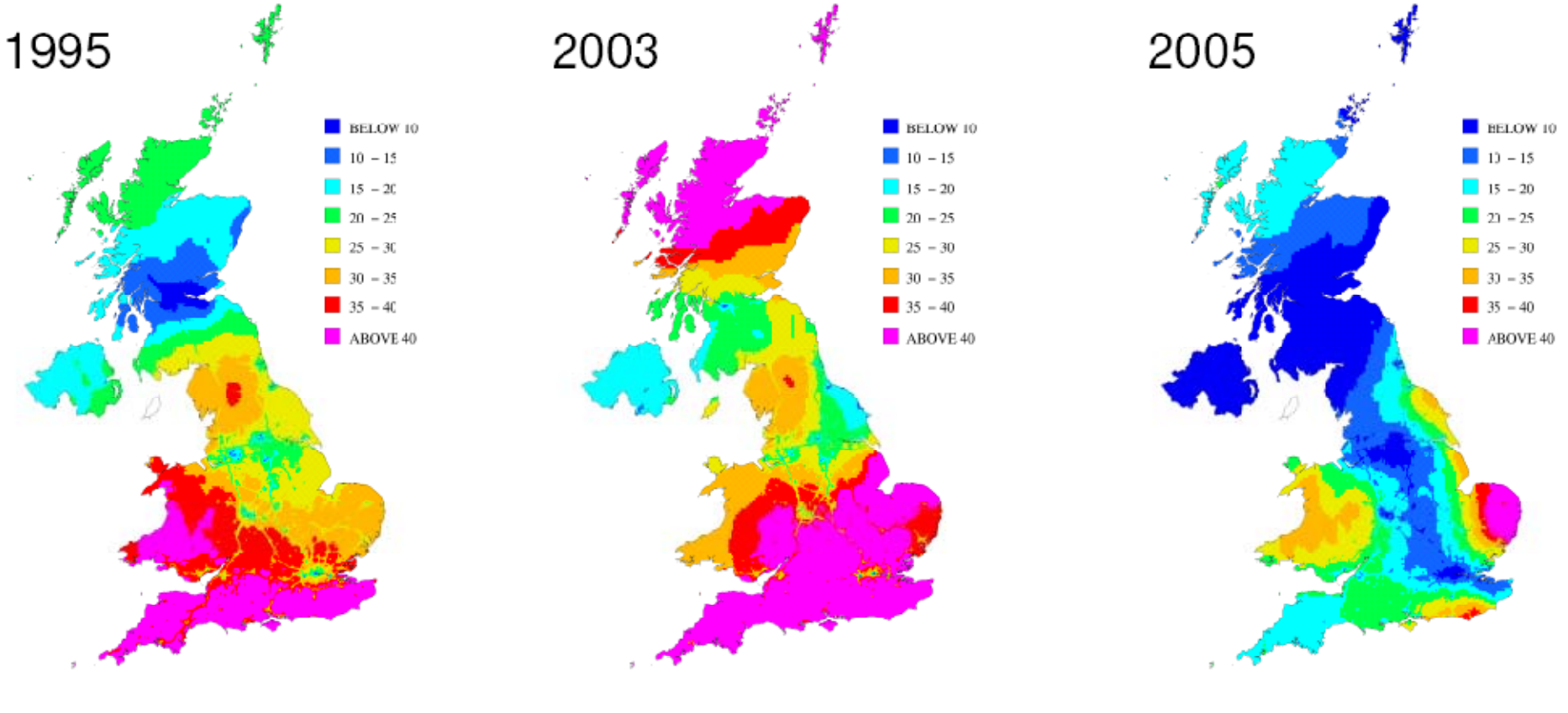
99.9th percentile of the hourly mean ozone concentration

Annual mean ozone concentration

- Annual mean ozone concⁿs generally increased over last 10 years in urban areas. Less marked in rural areas.
- Reductions in European region emissions have led to reductions in peak ozone at rural sites

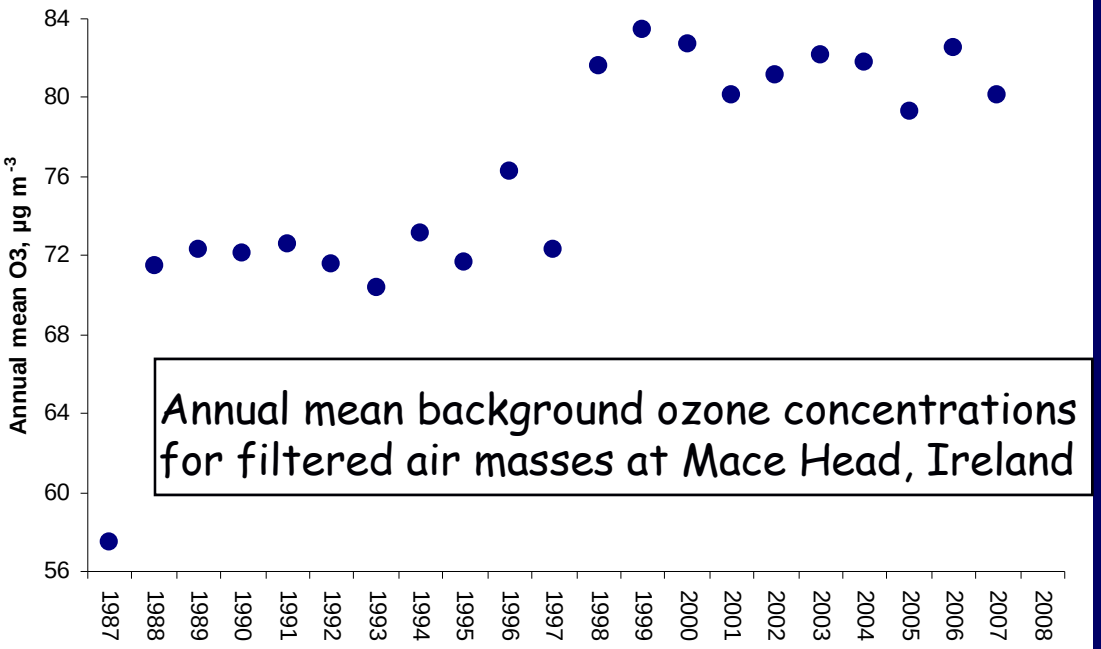


# Spatial distributions
# Inter-annual variability – dependence on meteorology




(e) Number of days with maximum 8-hour running mean ozone concentration greater than 100 μg $m^{-3}$

# Trends in background ozone concentrations



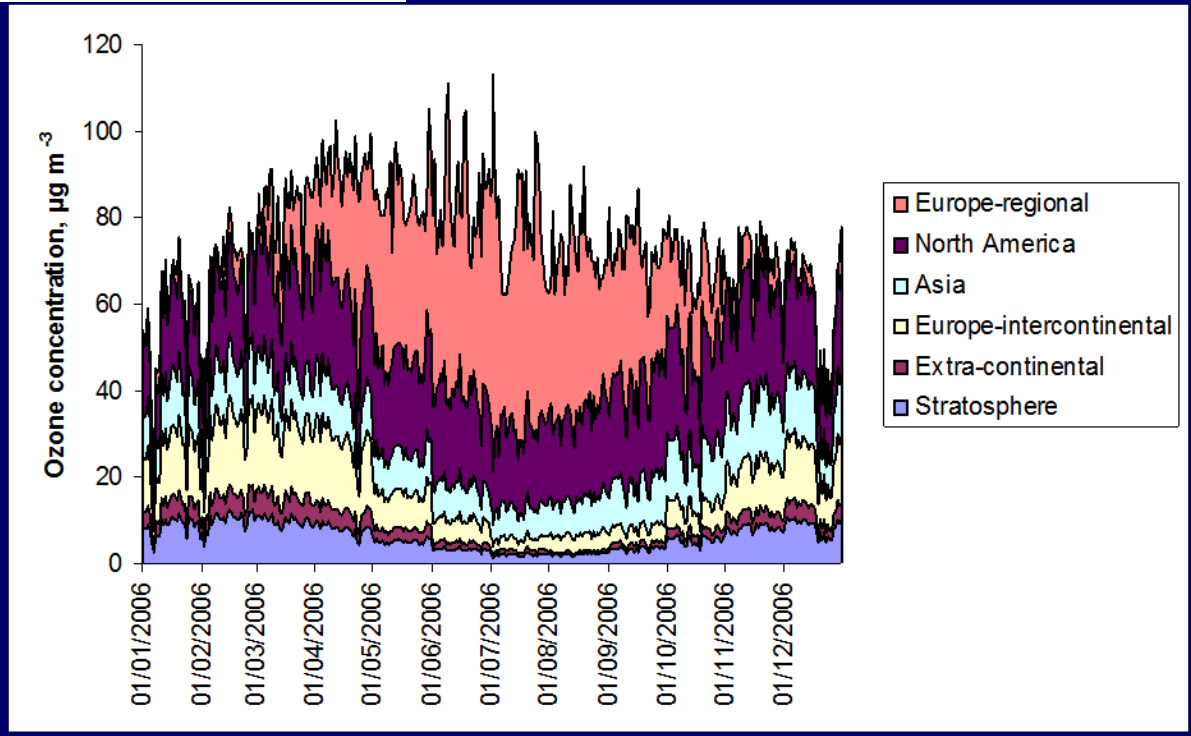

Annual mean background ozone concentrations for filtered air masses at Mace Head, Ireland

Modelled source attribution, site in S. England, 2006

Background ozone concentration appears to have increased by ~ 10 µg $m^{-3}$ per decade over last 20 – 30 years

(Accent)

Fairly level at Mace Head 2000- 2006

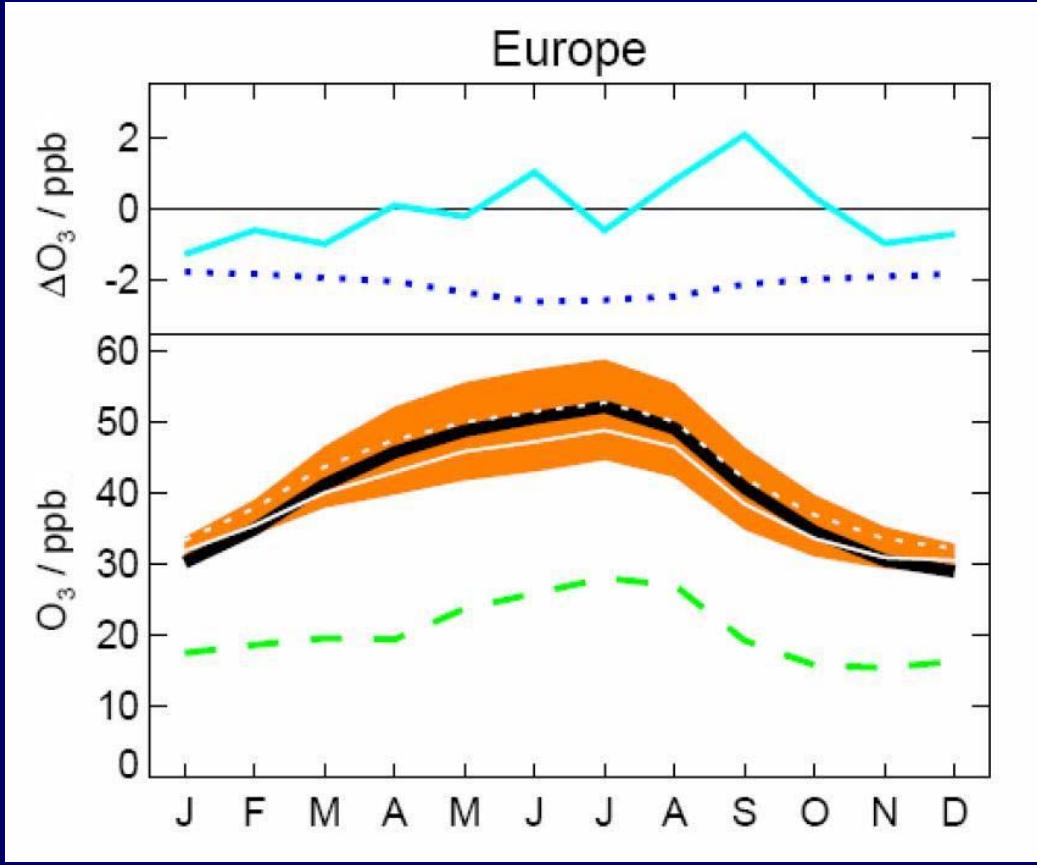


# Short term impacts of climate change (to 2030)

Not known with confidence

Small compared with change in anthropogenic emissions in Europe and NH of ozone precursors

Climate change may have greater impact on future peak episodic ozone



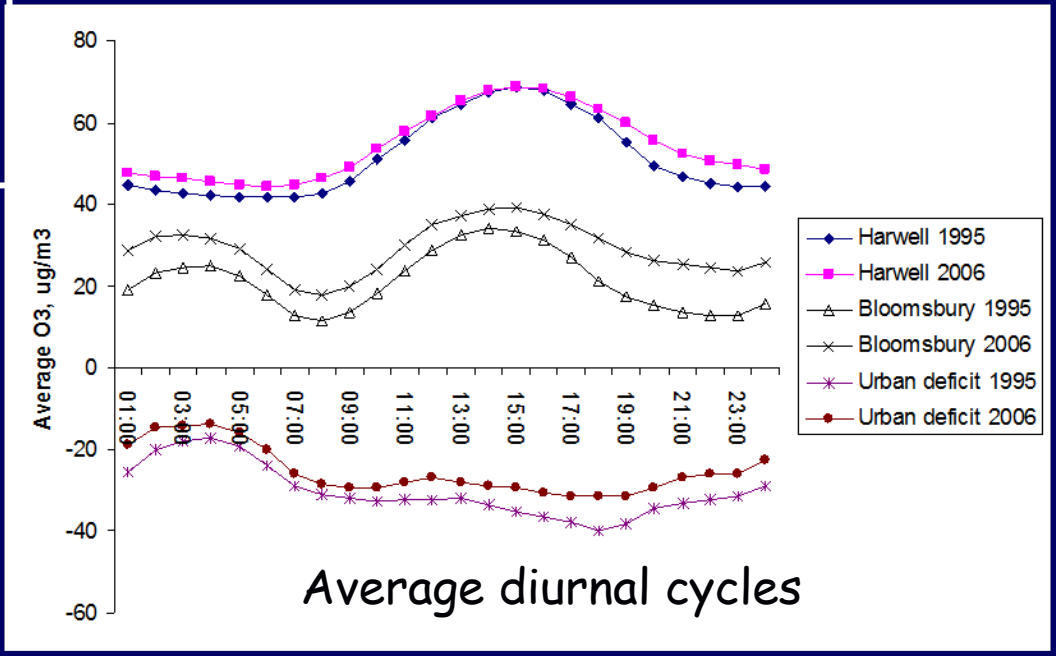

Seasonal cycle in future surface ozone averaged over Europe.
Green dashed – pre-industrial; Black – 2000
White – 2050; Orange – range of different models
Upper panel – cyan – change in ozone 2000 - 2050
Including climate change and projected emissions
Dotted blue – $CH_4$ fixed at 2000 levels
(From Royal Society Report)

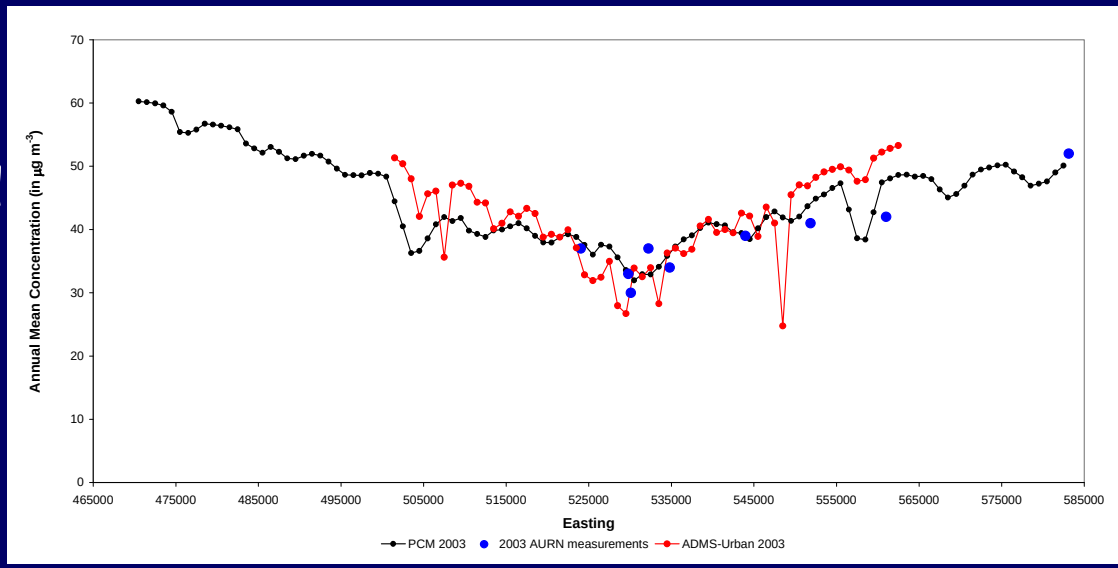
# Likely future trends in urban ozone concentrations

Urban ozone expected to rise over next two decades and tend to concentrations in surrounding rural areas.

Driven by reduction in emissions through vehicle controls and reduction in removal of urban ozone by NO.

Urban ozone will also respond to changes in surrounding rural concentrations driven by changes in background ozone, which arfe  driven by changes on a hemispheric scale.




Transects across London. Annual mean, modelled and measured.

# Uncertainties in ozone modelling

Need better understanding of:

-Influence of spatial and temporal resolution.

- representations of chemical mechanisms

- Relative importance of anthropogenic and biogenic sources of ozone precursors

-Uncertainties

- Monks report to Defra

  - Use Eulerian framework

  - Robust coupling between speciated emissions inventories and chemical schemes

  - Importance of model evaluation and intercomparison; links to observations

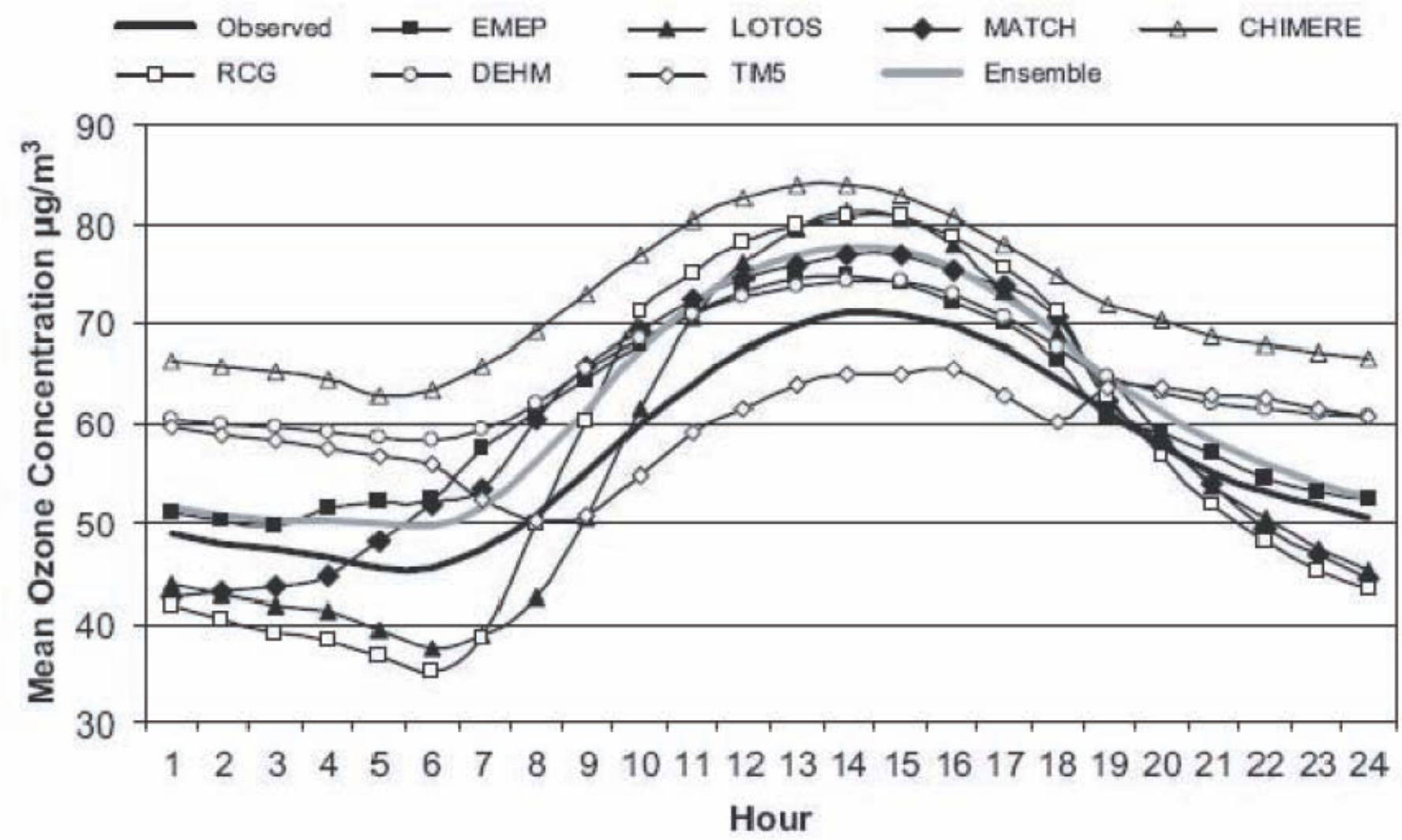



**Figure 6.1** Yearly mean diurnal cycle of ozone from a number of regional air quality models compared to observations (van Loon *et al.*, 2007) (reprinted with permission from Elsevier).

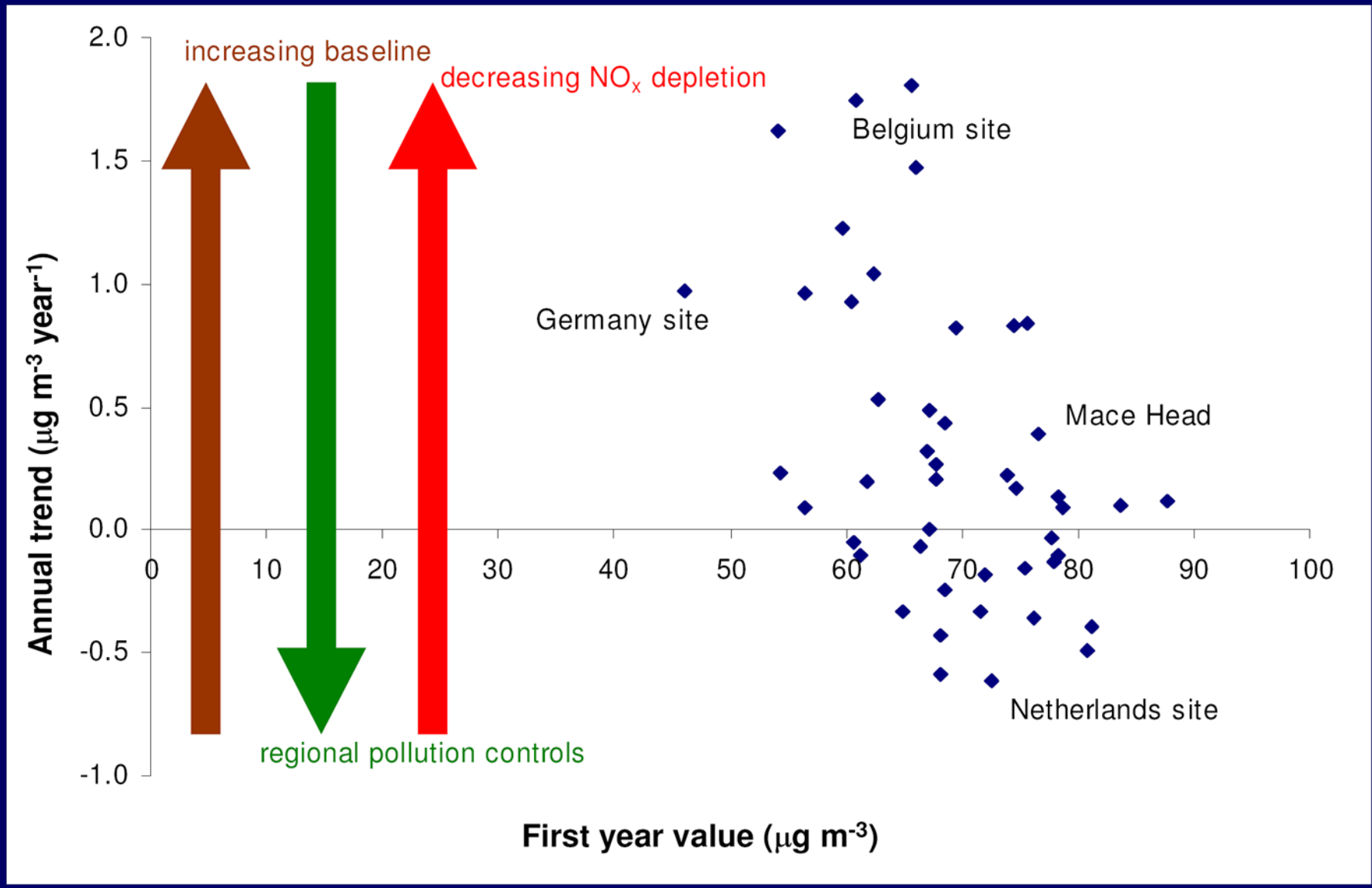
# Impact of European emissions on ozone in the UK

- Integrated assessment modelling for CAFÉ – UK ozone (based on SOMO35 and AOT40) likely to remain steady in foreseeable future.
- Focus in CAFÉ on PM and eutrophication rather than ozone – hence $NO_x$ reduction scenarios favoured.
- Projected VOC reductions, e.g. solvent emissions, implemented in CAFÉ background.
- Metrics used by CAFÉ are heavily damped in Atlantic seaboard countries by influence of NH background ozone concentrations

# Control options for reduction of exposure to ozone in the UK

- Effective control depends on UK, European and, increasingly, Northern Hemisphere reductions in ozone precursors.
- Control of VOCs almost always leads to improvements in ozone and reductions in population exposure. Future importance of biogenic VOC emissions
- $CH_4$ mitigation is a cost effective strategy at a global scale, for both air quality and climate change.
- CO emission reductions can also reduce ozone.
- NOx reductions are more complex, because of the disbenefit in urban areas. Reduction in NOx from shipping emissions would be beneficial to annual and summertime mean ozone in W Europe.

A scatter plot of the trends in the annual average daily maximum 8-hour mean ozone concentrations observed at 46 EMEP rural sites over the period 1990-2002 plotted against the initial 1990 value of the ozone metric



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