The Effect of Climate Change on the Local Dispersion of Air Pollutants

Andrew Malby[1], Roger Timmis[2] and Duncan Whyatt[1]

[1] Lancaster Environment Centre, Lancaster University, UK
[2] Air Science Manager, Environment Agency, UK

Environment Agency

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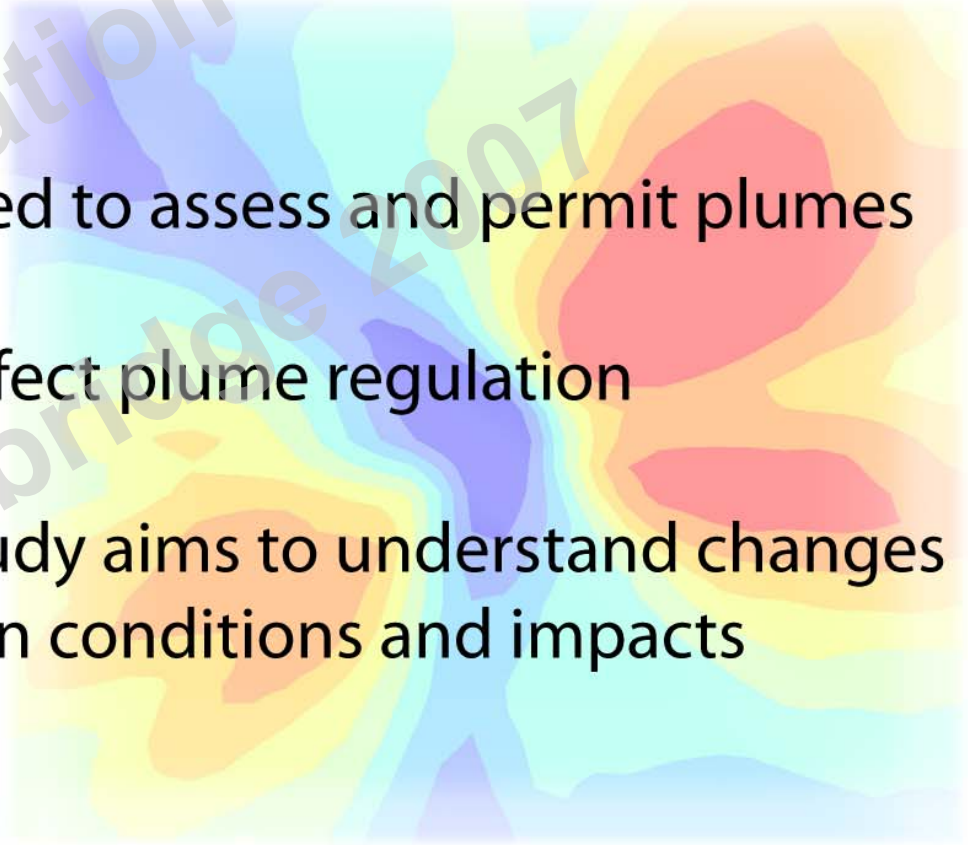
Introduction

- The Environment Agency regulate a range of major industrial sources
- Dispersion modelling used to assess and permit plumes
- Climate change might affect plume regulation
- Limited literature: this study aims to understand changes in frequency of dispersion conditions and impacts



The Effect of Climate Change on the Local Dispersion of Air Pollutants

- Key topics

  1. How can we identify if climate change will affect high-impact plume dispersion conditions?

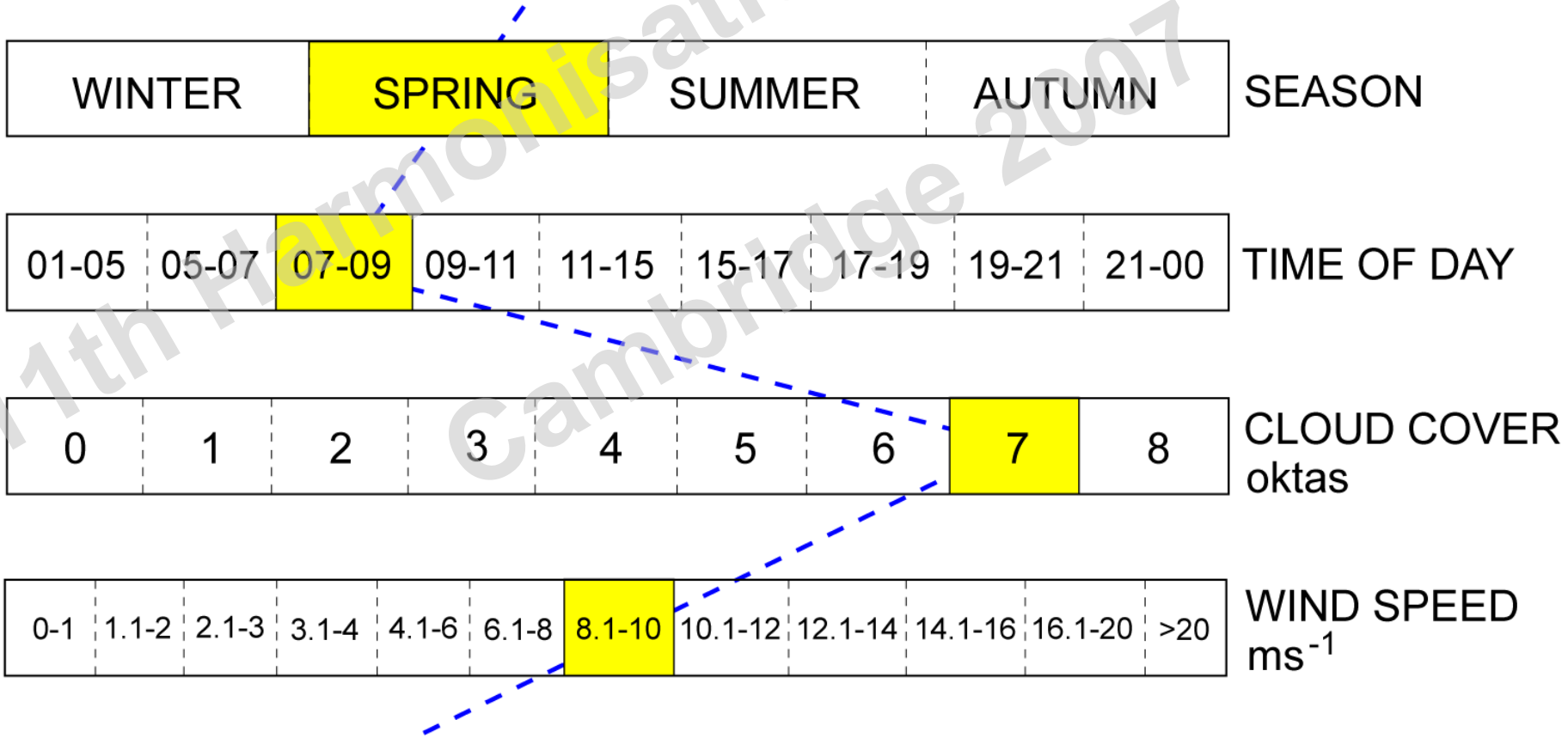
  2. GCMs: Can we use them to predict high-impact dispersion conditions?

  3. What does climate change mean for different industrial sources and receptors?

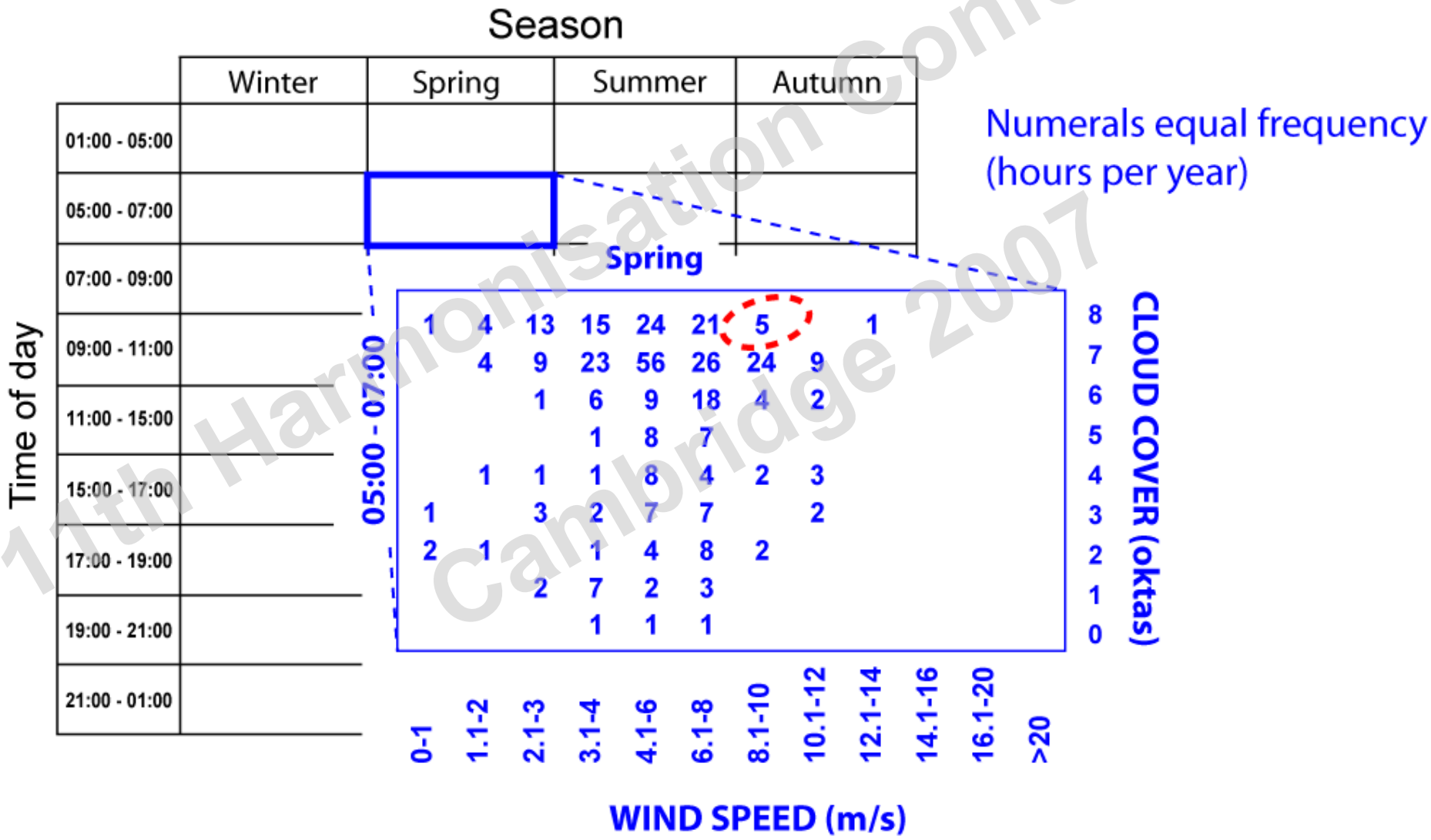
- Conclusions

1. How can we identify if climate change will affect high-impact plume-dispersion conditions?

- Dispersion calendar: Simple typing and counting scheme using 4 simple observables
- Typing related to atmospheric stability classes, e.g. Pasquill-Gifford

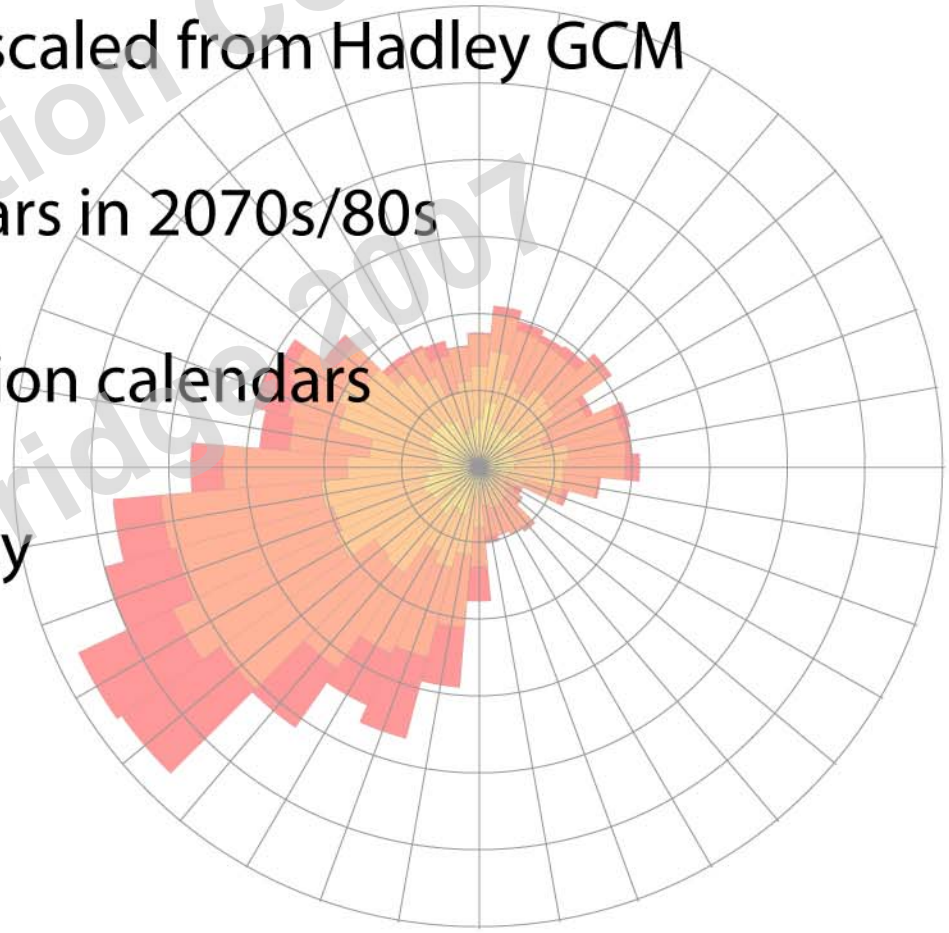


Dispersion Calendar: Temporal and met sub-divisions



2. GCMs: Can we use them to predict high-impact dispersion conditions?

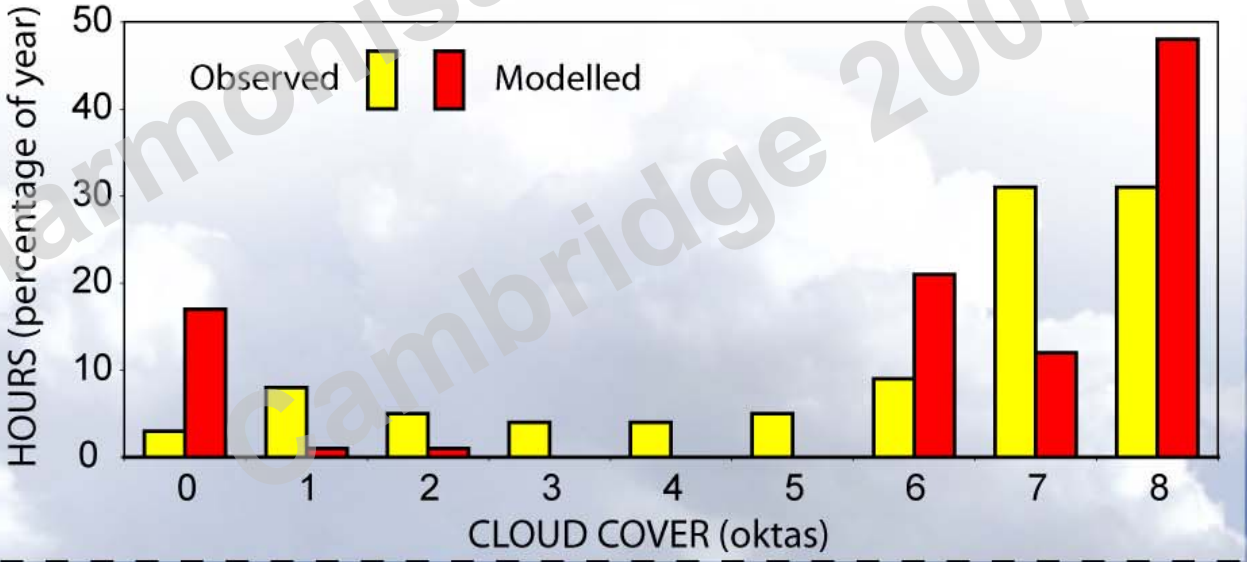
- Hourly meteorology downscaled from Hadley GCM
- 4 years in 1970s/80s v. 4 years in 2070s/80s
- Compare 2 x 4 year dispersion calendars
- Test for change in frequency



2. GCMs: continued…

- Only marginal changes in frequency of dispersion conditions
- Changes comparable to that expected from random variation (only 1 in 20 conditions change)

- Dispersion calendar confirms unrealistic simulation of cloud cover



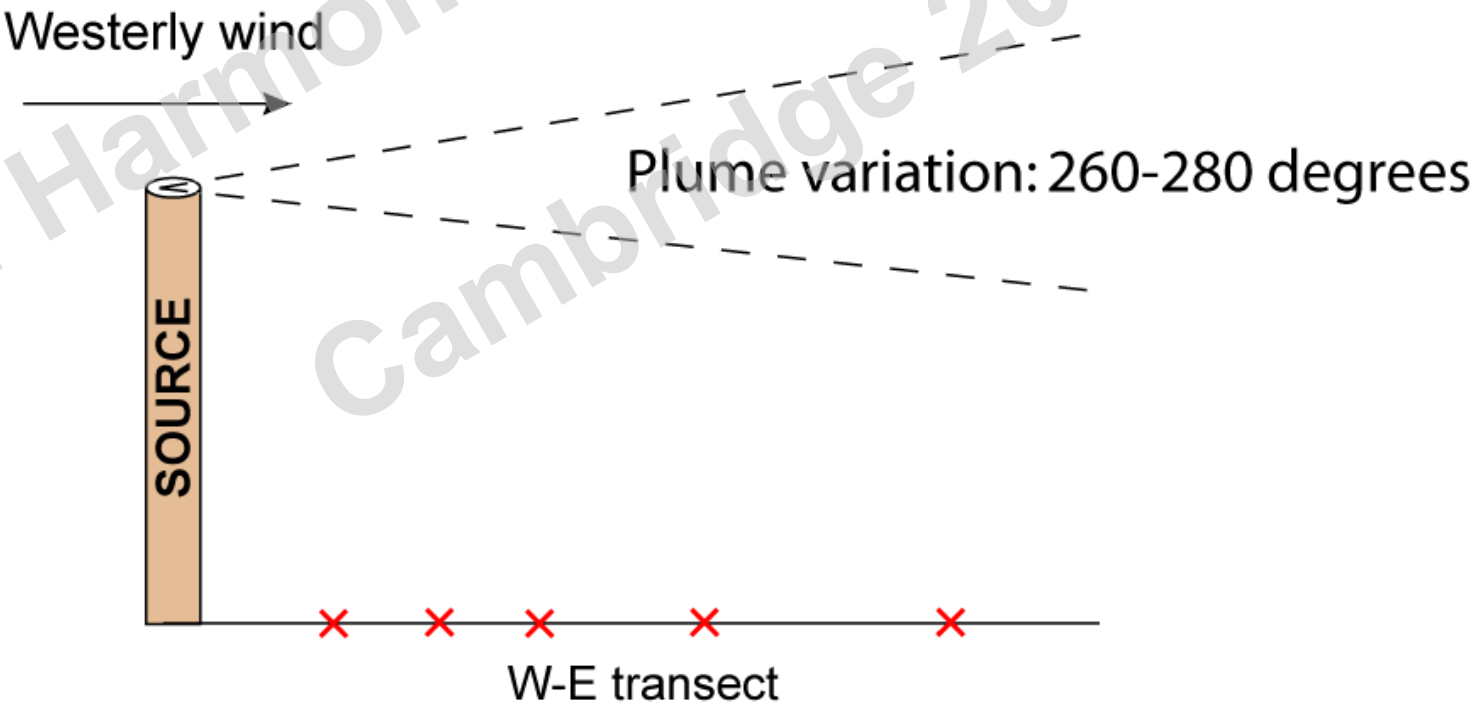
- Used historical met comparison as alternative, to develop climate change-plume assessment

2. GCMs: continued… Alternative historical comparison

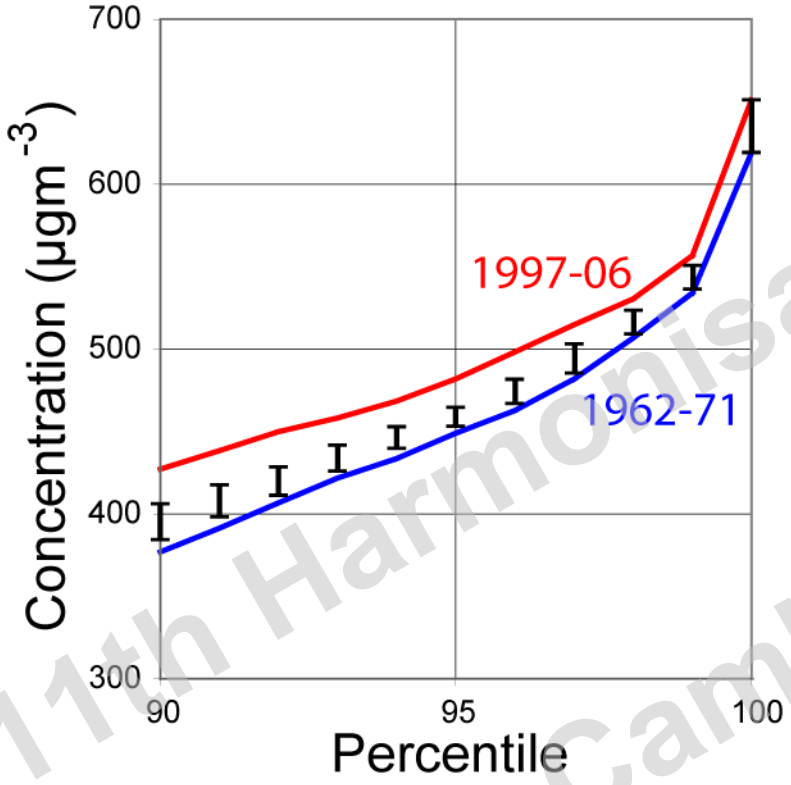
- Hourly, observed meteorology from Met-Office surface station
- Compare two decades/calendars of contrasting climate:
  - 1962-71 v. 1997-06
- Many conditions changed frequency between decades (on average, 1 in 5 conditions change)
- Dispersion conditions: past changes in frequency are greater than predicted under climate change (?)

3. What does climate change mean for different sources and receptors?

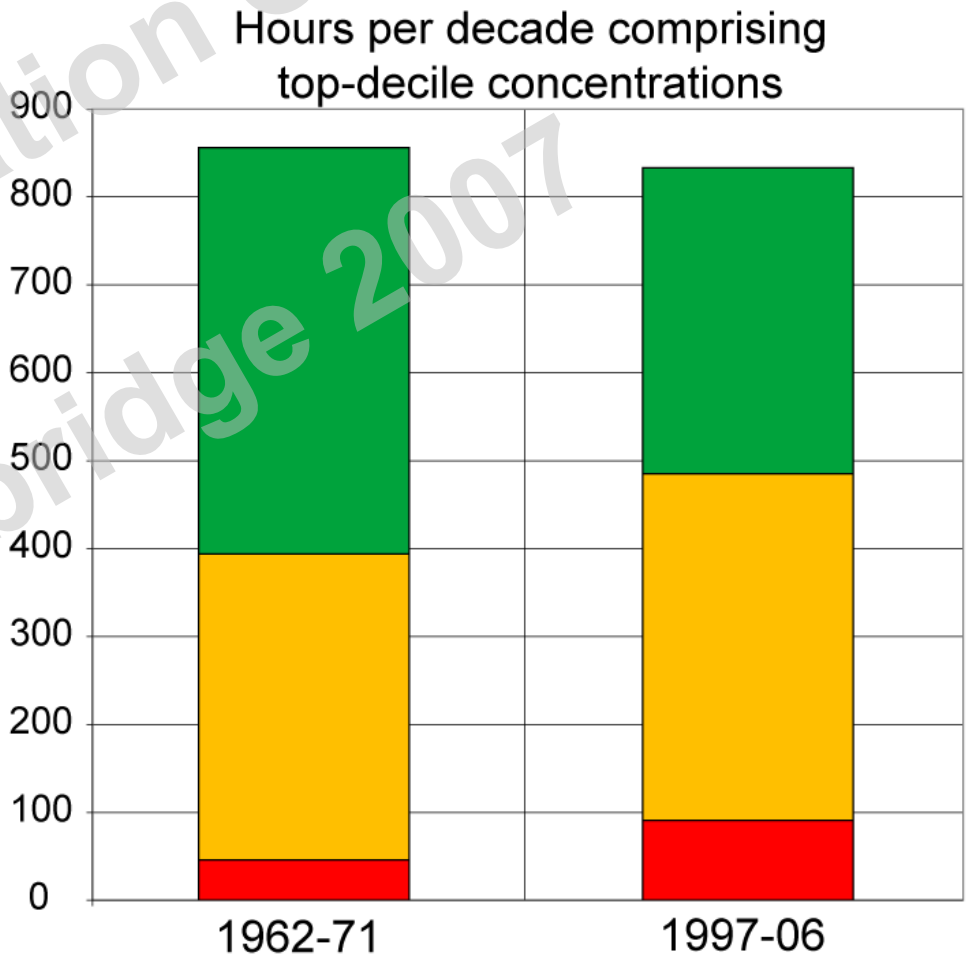
- Climate change = 1962-71 v. 1997-06 plus bootstrapping to test significance
- Range of sources and receptor distances (inert gas; ADMS)
- Focus on high (⩾90th) percentiles



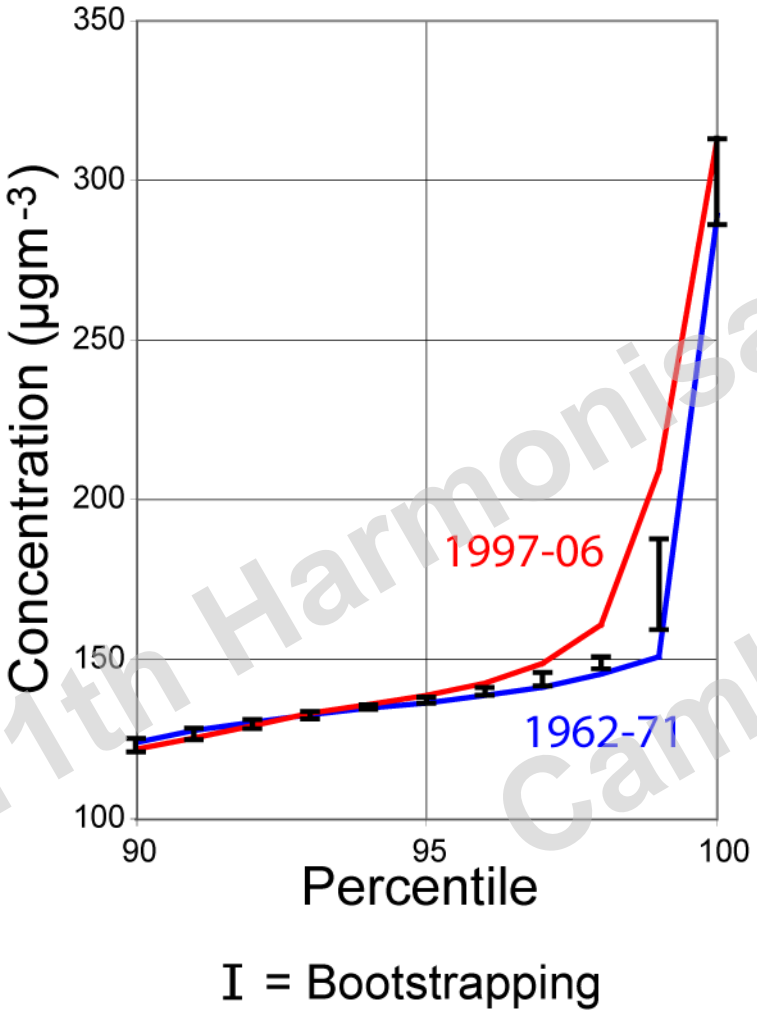
500m from low (40m) stack: 1962-71 v. 1997-06

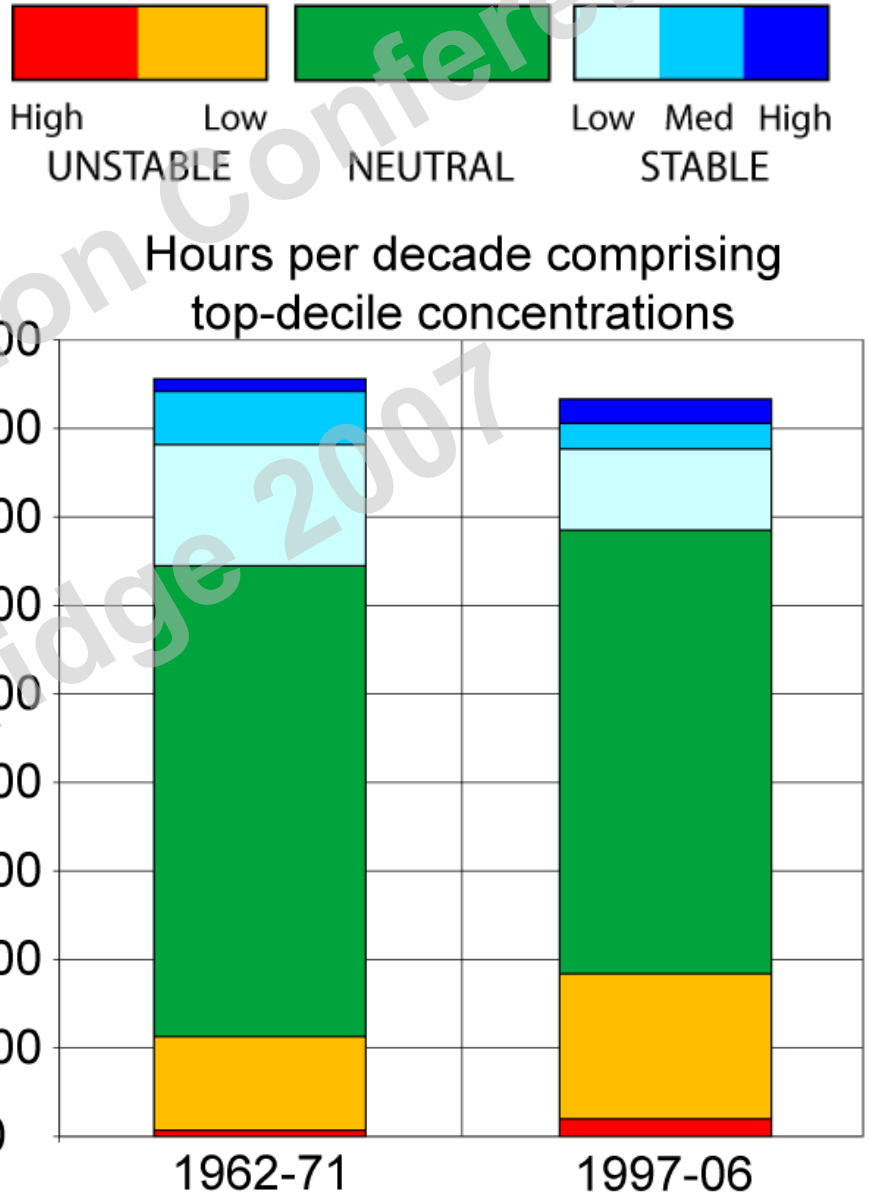


I = Bootstrapping



2000m from low (40m) stack: 1962-71 v. 1997-06





Conclusions

1. How can we identify if climate change will affect high-impact plume dispersion conditions?

- A new typing and counting scheme, the Dispersion Calendar
- Systematic comparison of dispersion regimes
- Auditable tracking of links between dispersion climate change and plume impacts/air quality

Conclusions

2. GCM's: Can we use them to predict high-impact future dispersion conditions?

- Limited attempt at using GCMs for dispersion comparison
- We would ideally have a longer time-series to compare, e.g. 2 decades
- Methods for longer GCM comparisons developed using historical met
- [Cloud cover is inaccurate and the broader literature suggests that future wind projections are highly uncertain]

Conclusions

3. What does climate change mean for different industrial sources and receptors?

- Effect of climate change on plume-impacts varies markedly with release height and receptor distance
- Dispersion calendar method allows modellers to link changes in climate, dispersion and plume impacts

Acknowledgements

- David Thomson, Met Office for ADMS format GCM met data
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- BADC for access to Met Office observations surface data