



Climate Change and Air Quality

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- Introduction
- Effects of climate change on:
 - Chemistry
 - Transport
 - Emissions and deposition
- Effects of air quality on climate change
- Summary

Introduction

Importance of climate change

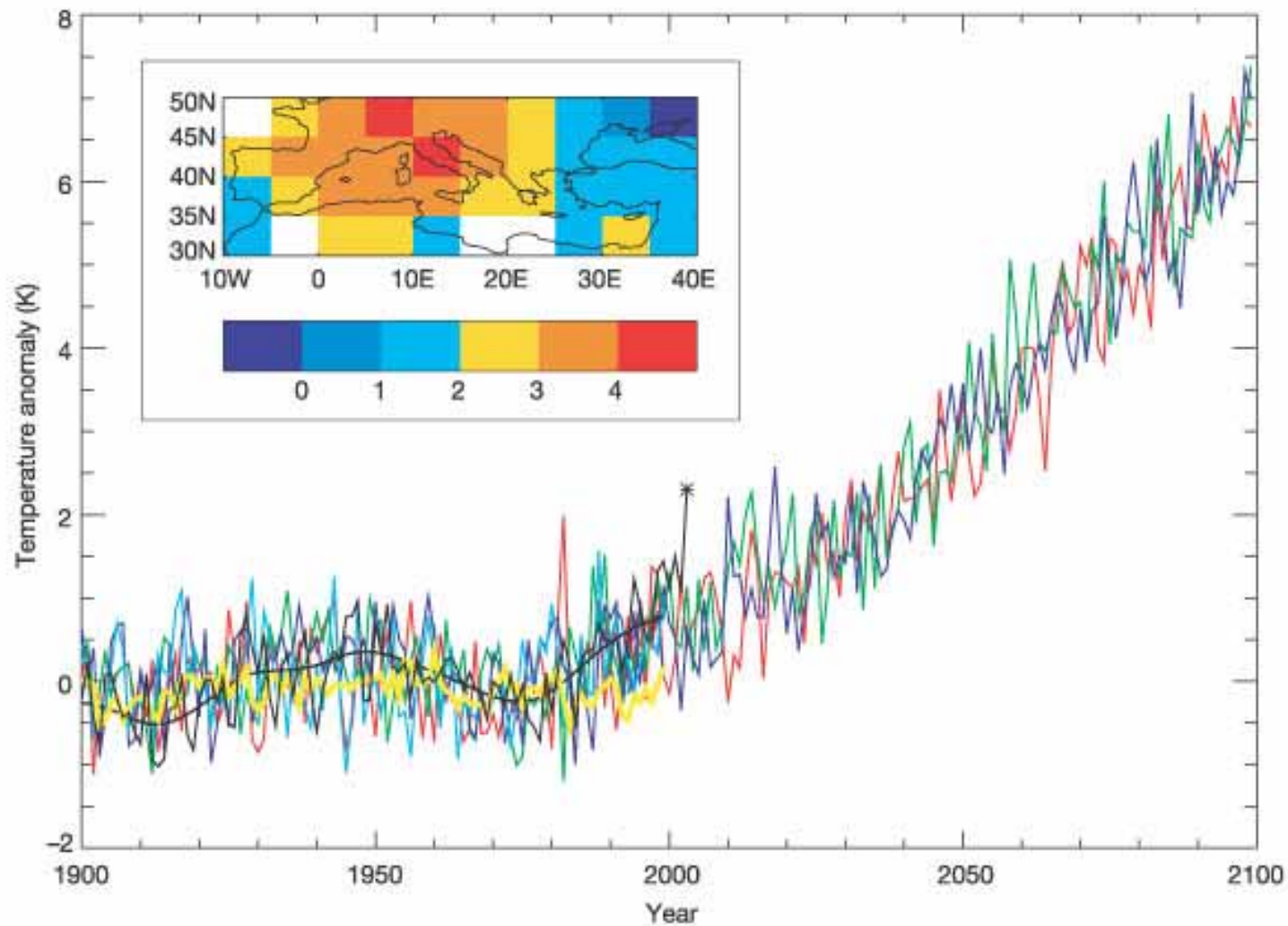


- Contract (CPEA7) with DEFRA AEQ division to provide scientific advice on the impacts of climate change on air quality.

- Co-operation with Air Quality Expert Group for report on “Air Quality and Climate change”

- Climate change is not just about temperature change, there are also changes in:
 - Humidity (specific)
 - Clouds and precipitation
 - Winds
 - others...

Predicted climate change



Stott et al. Nature, December 2004

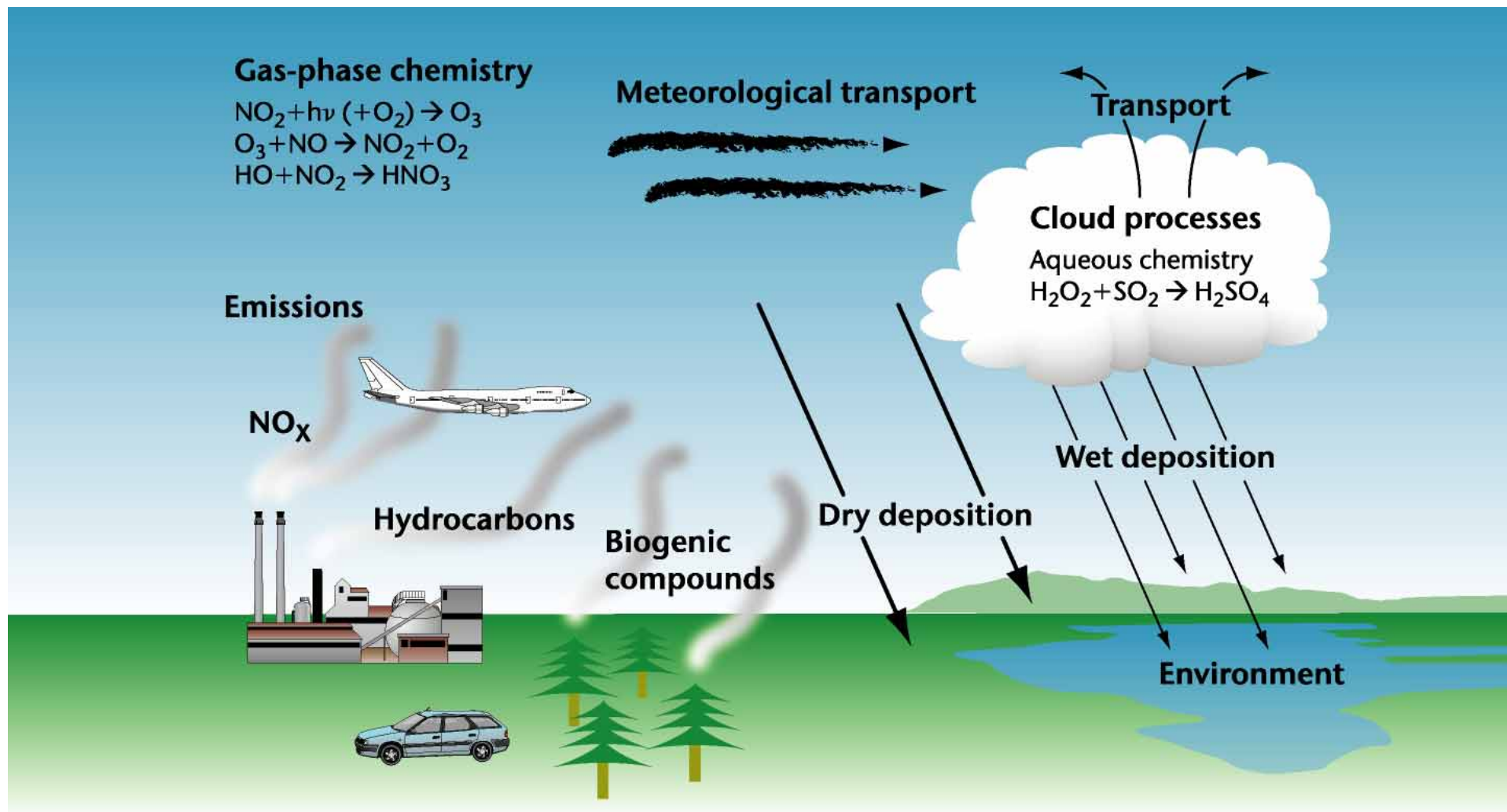
How climate affects air quality



- Air quality is affected by many factors
 - Emissions – temperature dependence
 - Transport – winds
 - Chemistry – temperature and humidity
 - Deposition – precipitation
- All these are in turn affected by a changing climate
- The impact of air quality on people and plants will be affected by the climate too

- Focus on ozone:
 - Damaging to human health, and to crop yields
 - **Produced by:** Oxidation of hydrocarbons in presence of NO_x
 - **Destroyed by:** UV light in presence of water, and deposition
- Ozone will change in future
 - Changes in emissions of man-made pollutants (hydrocarbons and NO_x)
 - Changes in climate
- Increased humidity (water vapour)→
 - Destruction of ozone
- Increased tropospheric temperature→
 - Decomposition of PAN – releases NO_x

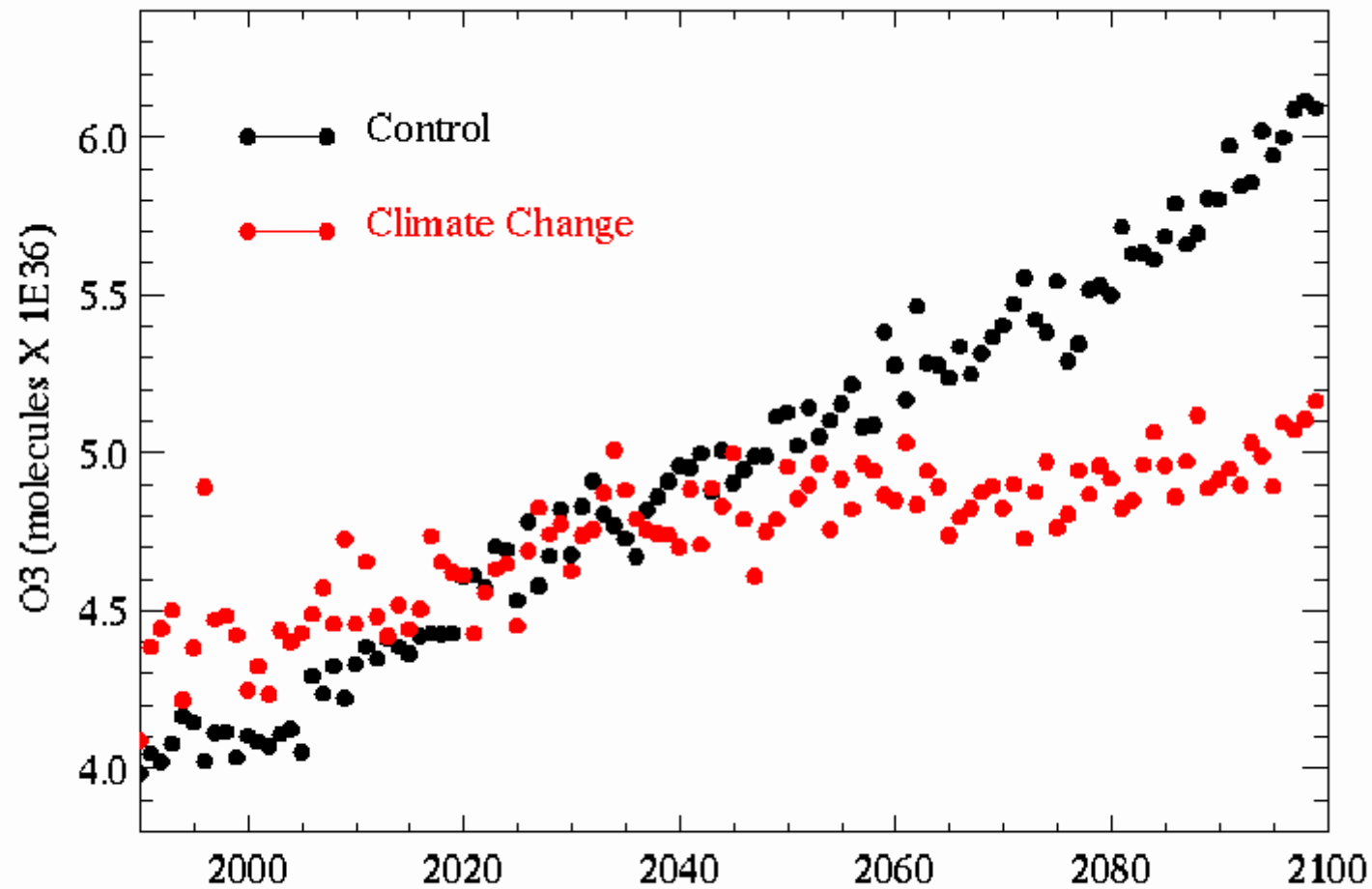
Modelling atmospheric chemistry



Tropospheric Ozone. July Inventory



Decrease in tropospheric ozone in climate change case, due to increase in humidity



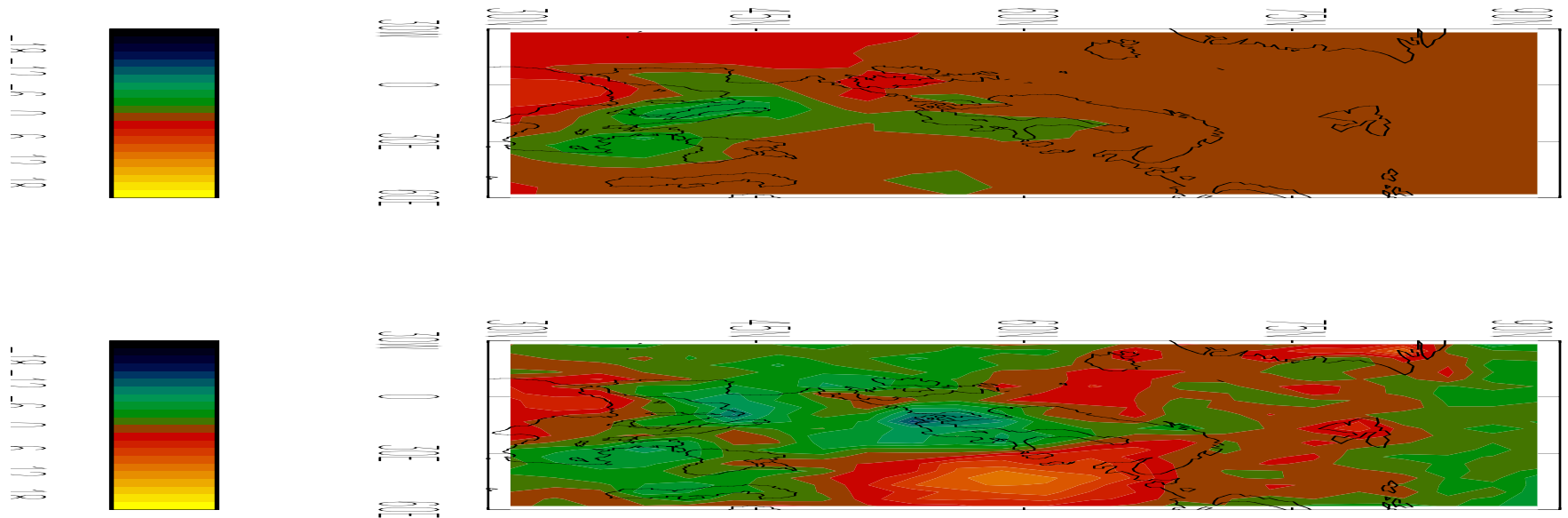
Johnson et al. GRL 2001

Climate change by 2030: July surface ozone



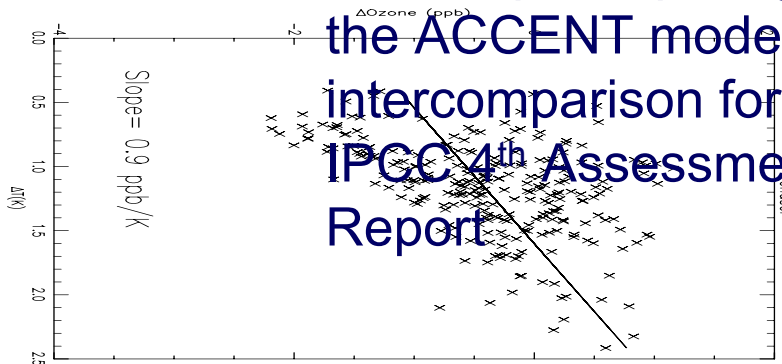
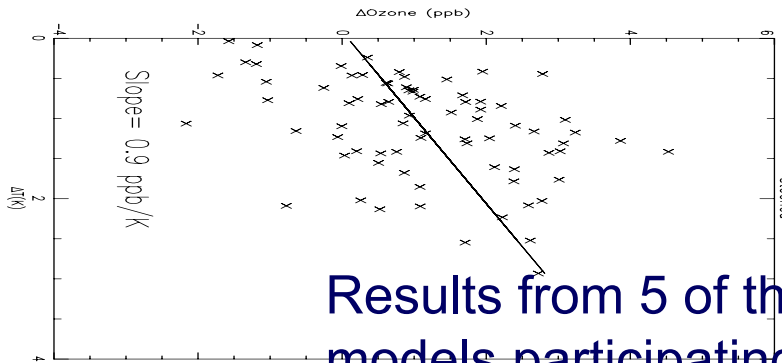
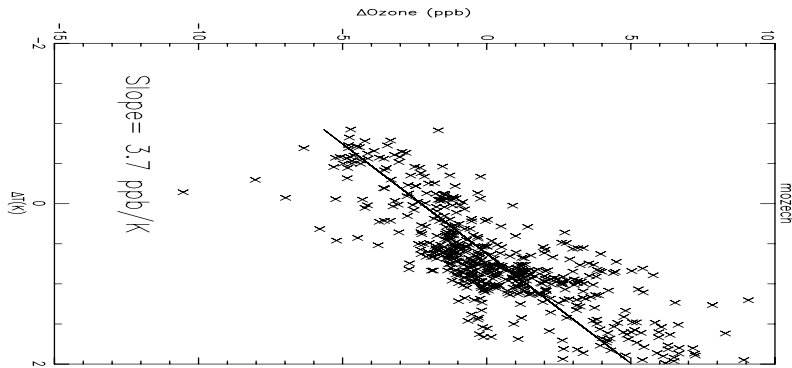
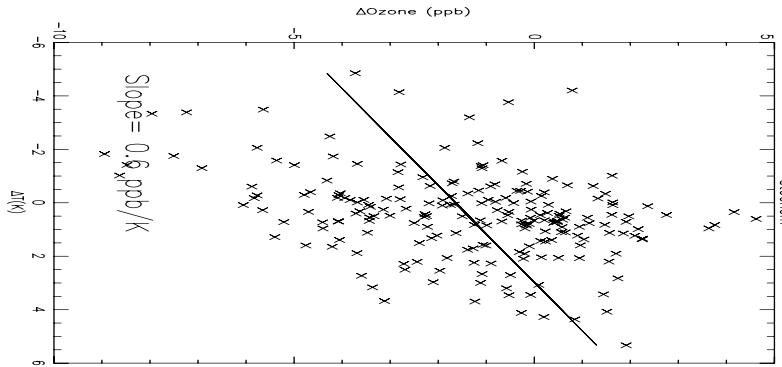
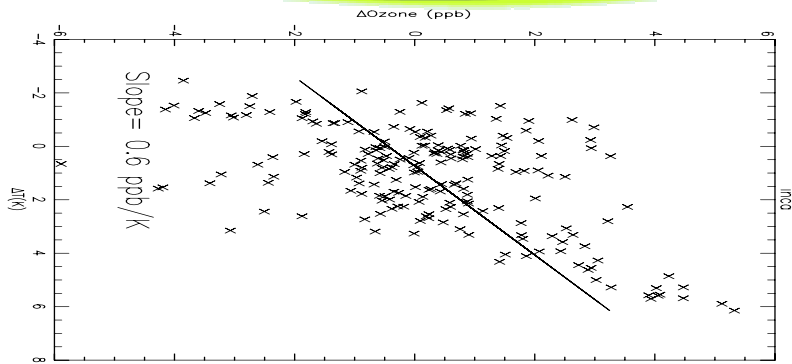
Changes in man-made emissions only

Changes in emissions and climate change



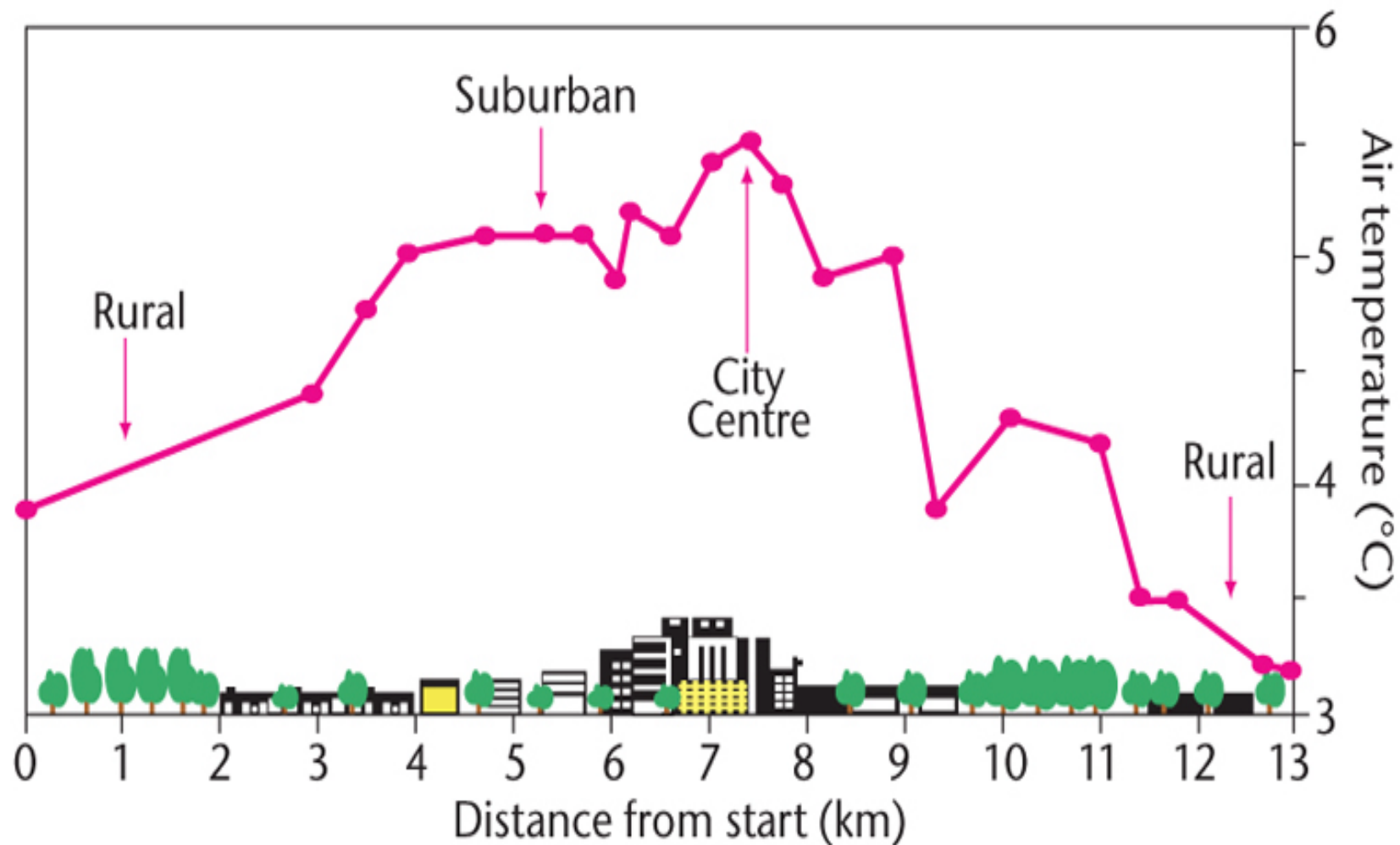
• Prediction of future ozone wrong unless we include climate change

Correlation between ΔO_3 and ΔT



Results from 5 of the models participating in the ACCENT model intercomparison for the IPCC 4th Assessment Report

Urban areas are warmer than countryside

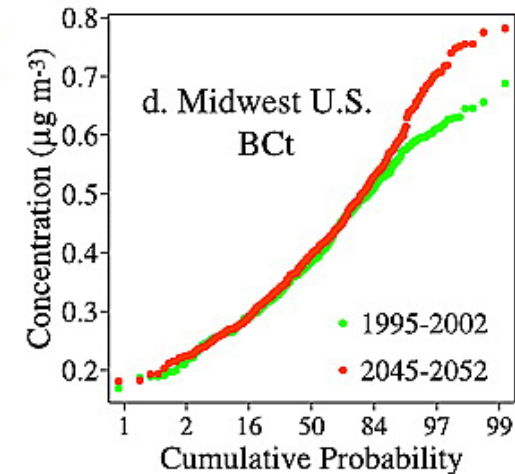
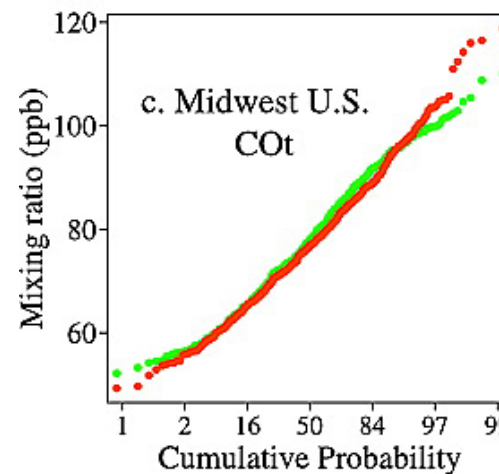
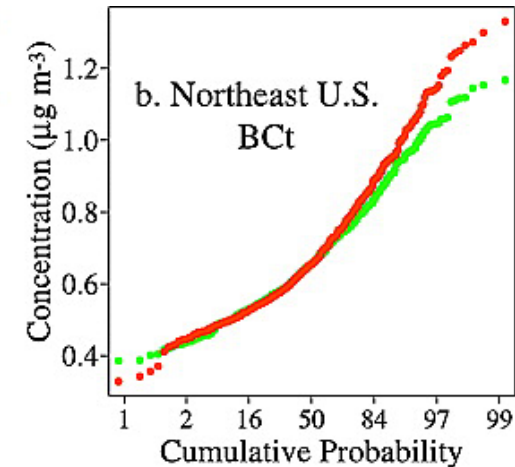
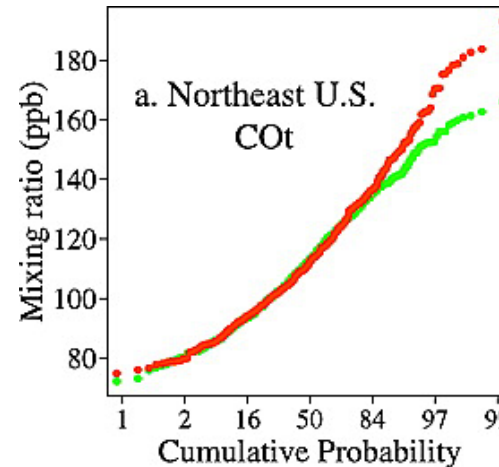


- Climate change can impact on the likelihood of pollution events e.g.
 - The number and strengths of summer highs
 - The number and duration of calm winter days

Effect of climate change on transport



- No chemistry – sources and sinks unchanged
- Mean concentrations the same
- Higher chance of extreme concentrations



■ Emissions

- Anthropogenic
- Wild fires – soil moisture
- Lightning – convective clouds
- Vegetation and soils – temperature, sunlight

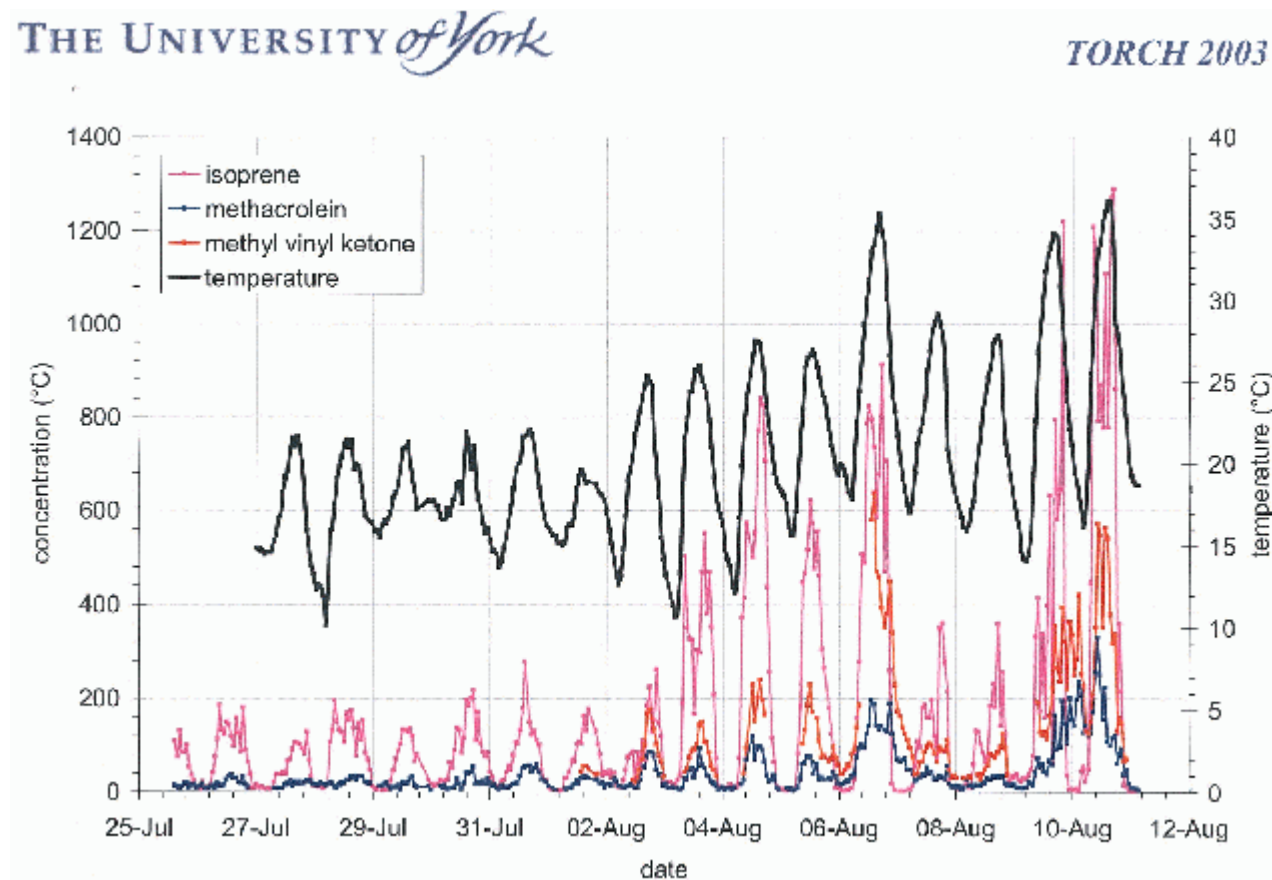
■ Deposition

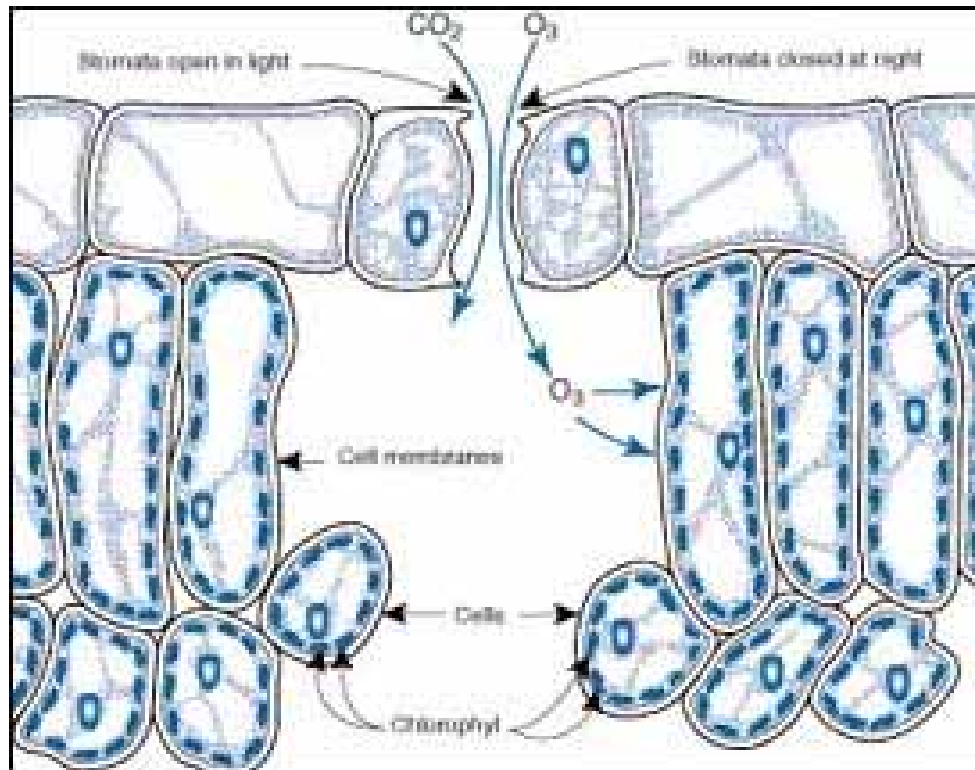
- Removal by precipitation
- Removal at the surface – vegetation and soils

Climate effects on emissions



- Increasing temperature increases hydrocarbon emissions from vegetation e.g. isoprene



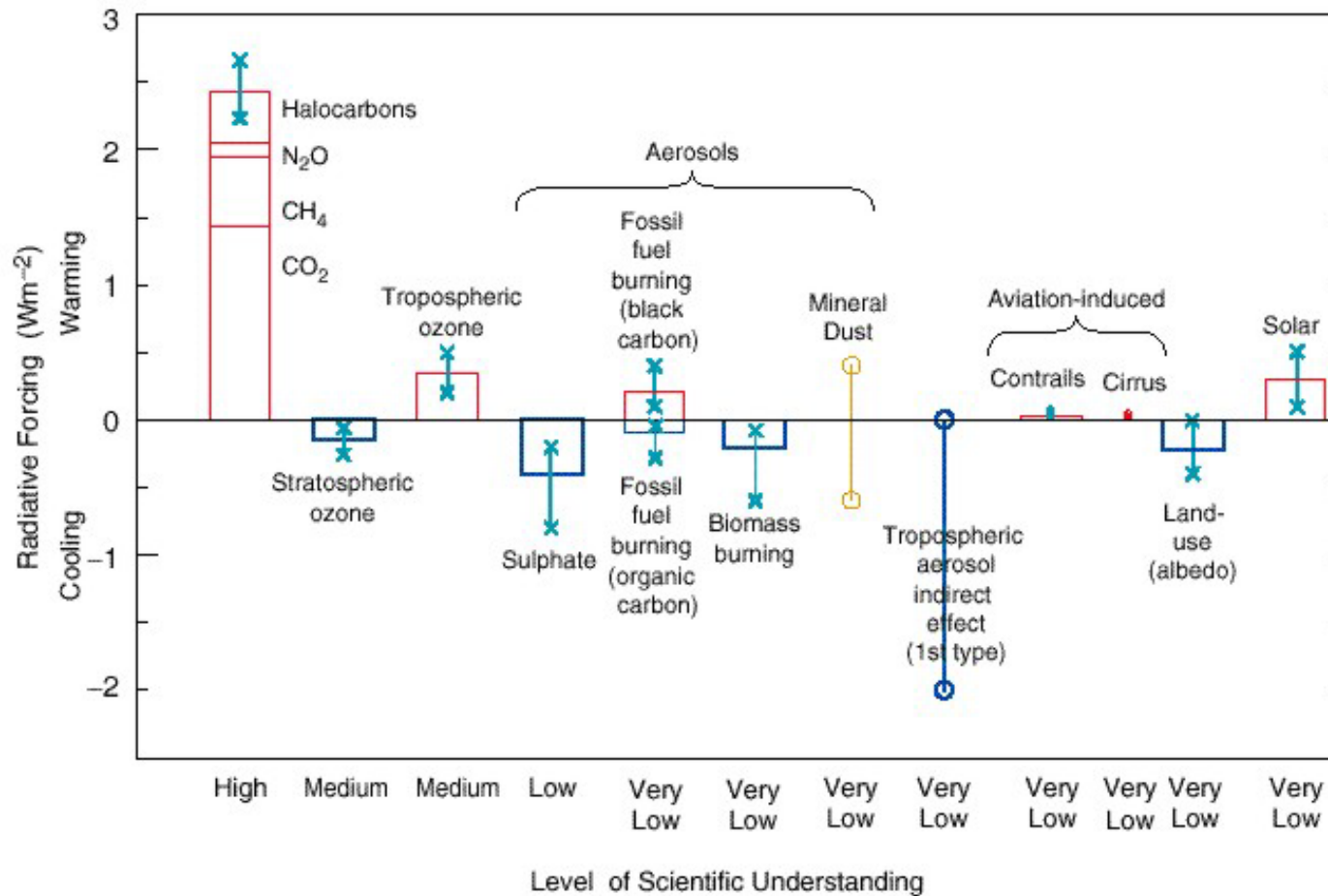


Courtesy Gro Torsdahl

- Ozone causes damage internally after passing through stomata
- Stomatal opening depends on climate conditions
- Ability of air pollution to damage plants is affected by climate

- Some gaseous pollutants are greenhouse gases – ozone, methane, NO_2
- Aerosol (particulate) pollutants can cool the planet by reflecting sunlight – sulphate, nitrate
- or warm the planet by absorbing sunlight – soot, organic carbon, dust
- These are all affected by climate \Rightarrow feedback!

Global-mean Radiative Forcing since pre-Industrial Times



From IPCC (2001)

- Increased humidity reduces tropospheric background ozone
- Increased temperature increases local ozone production – which wins?
- Need to look at impact on biospheric emissions/deposition
- Changes in transport could be important
- Effect of climate change is likely to increase air pollution – similar order of magnitude to emissions changes
- Still large uncertainties