UNCERTAINTIES IN CLIMATE CHANGE PREDICTIONS

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CLIMATE CHANGE DEPENDS UPON:

• How man-made emissions grow
  – population, GDP, energy use, technology...
• How sensitive the climate system is to emissions
  – how much concentrations change
  – what forcing effect this has
  – what climate change this produces
  – we can estimate this only with climate models
UNCERTAINTIES IN CLIMATE PREDICTIONS

- Emissions uncertainty
- “Science” uncertainty
- Natural variability

CO₂ in SRES EMISSIONS SCENARIOS

- **A1FI**
- **A2**
- **B1**
- **B2**

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<th>A1FI</th>
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GLOBAL TEMPERATURE RISE

Start to diverge from mid-century

UNCERTAINTY IN CO₂ CONCENTRATIONS

Hadley Centre for Climate Prediction and Research
CHANGE IN DJF PRECIPITATION (%)  
2080s - present, SRES A2, 3-member initial condition ensemble

GLOBAL PRECIPITATION CHANGE  
due to A2 emissions, predicted by 9 climate models

Source: IPCC, 2001
CHANGE IN GLOBAL PRECIPITATION
HadCM3 under a range of emissions scenarios

±25%

% CHANGE IN WINTER PRECIPITATION
2080s, A2
### SEA LEVEL RISE REGIONAL VARIATIONS

Low clouds reflect sunlight but trap little infra-red radiation; They act to cool climate

High clouds reflect sunlight but also trap infra-red radiation; They act to warm climate

Global warming may change the characteristics of clouds, and thus alter their current net cooling effect; this could exert a powerful feedback on climate change.
PROBABILITY PREDICTIONS

- Generate X (50 - 1000) climate models by varying parametrisations within plausible limits
- Make simulation (1900-2100) with each model
- Assess credibility of each model based on current climatology and 1900-2000 simulation
- Weight prediction (2000-2100) according to model credibility
- Use X runs to generate pdf of a specific change
- pdf can be used direct in risk analyses
- next: do this with other climate models
PROBABILISTIC CLIMATE PREDICTIONS

X CLIMATE MODELS

- ATMOSPHERE + CLOUDS
- LAND AND VEGETATION
- CARBON CYCLE
- OCEAN CIRCULATION
- ETC.

Probability

2050s Paris summer rainfall

RESOLUTION OF CLIMATE SCENARIOS


300km grid 50km grid

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SIMULATION OF A TROPICAL CYCLONE in the PRECIS regional climate model

Global climate model

Regional climate model

REGIONAL MODEL PREDICTIONS OF CHANGE IN WINTER PRECIP BY 2080s

Both RCMs driven by Hadley Centre HadCM3 GCM
EMISSIONS AND CONCENTRATIONS OF CO₂
from unmitigated and stabilising emission scenarios

GLOBAL AVERAGE TEMPERATURE RISE
from unmitigated and stabilising emission scenarios
CROP YIELD changes from the present day to the 2080s

Potential change in cereal yields (%)

-10 - -20
-6 - -10
-2.5 - -5
0 - 2.5
2.5 - 0
5 - 2.5
10 - 5

Unmitigated emissions

Stabilisation of CO₂ at 750 ppm
Stabilisation of CO₂ at 550 ppm

ANNUAL NUMBER OF PEOPLE FLOODED with no climate change and under three emissions scenarios

University of Middlesex

HadCM2

Hadley Centre for Climate Prediction and Research
CHANGES IN STORED CARBON 1860-2100

- Soil carbon
- Vegetation carbon

Hadley Centre coupled climate carbon-cycle model

EFFECT ON CO2 CONCENTRATION OF CARBON CYCLE FEEDBACK

Met Office / Hadley Centre

- with carbon cycle
- without carbon cycle
EFFECT ON LAND TEMPERATURES OF CARBON CYCLE FEEDBACK

Impact of carbon cycle feedbacks on CO$_2$ concentrations (WRE550)
Cumulative emissions consistent with WRE550 CO$_2$ concentration scenario

Impact of carbon cycle feedbacks on stabilisation level
SUMMARY: HANDLING UNCERTAINTIES IN CLIMATE CHANGE PREDICTIONS

- Emissions uncertainty
  - first half C21: uncertainty small ∴ ignore
  - beyond: “scope” using range of SRES scenarios
- Science uncertainty
  - larger than SRES emissions uncertainty
  - initially: use a range of climate model results (“calibrated” using 1990-2000 simulations)
  - soon: probability predictions
- Natural variability
  - quantify via initial condition ensemble