The Economics of Climate Change

Chris Taylor
Visiting Fellow, Grantham Research Institute, London School of Economics
Senior Economist, Department of Energy and Climate Change, UK

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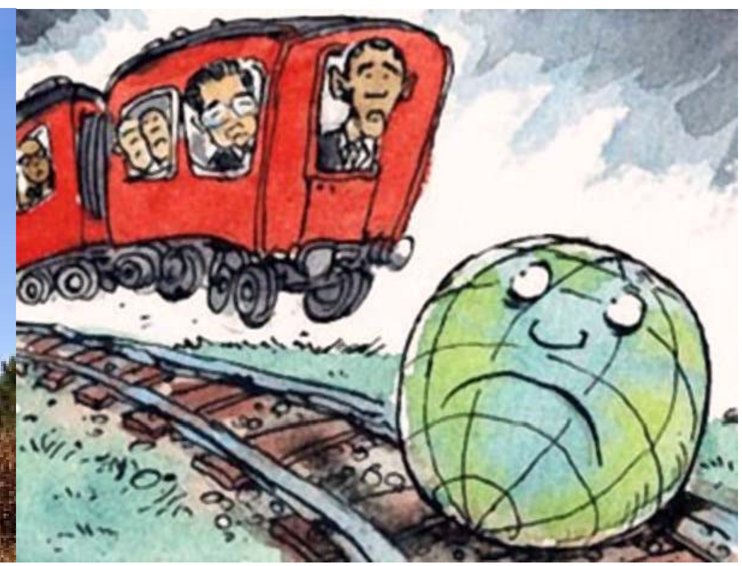


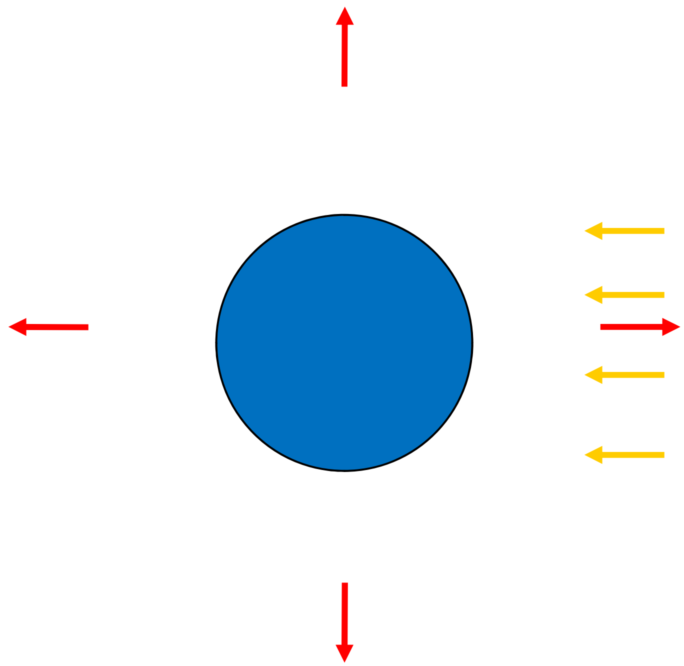
Structure of the presentation

1. Basic science
2. Climate impacts and risks
3. Modelling and valuing these impacts
4. Mitigation costs
5. Mitigation policy
6. Adaptation
7. Collective action
8. Discounting
9. Conclusions

Common arguments for why you should not care about climate change

i. Science is not credible – the world is not warming
ii. The impacts will be small
iii. It is in the future and we care less about that
iv. It is cheaper to adapt than mitigate
v. Too expensive to act now
vi. Other bigger priorities
vii. No point acting as other countries are not acting/will not act
viii. It is other countries that should be acting

Basic Science



"Greenhouse" gases absorb heat acting as a blanket around earth. Without them the surface temperature would be 33°C cooler.

(water vapour) carbon dioxide, methane,…

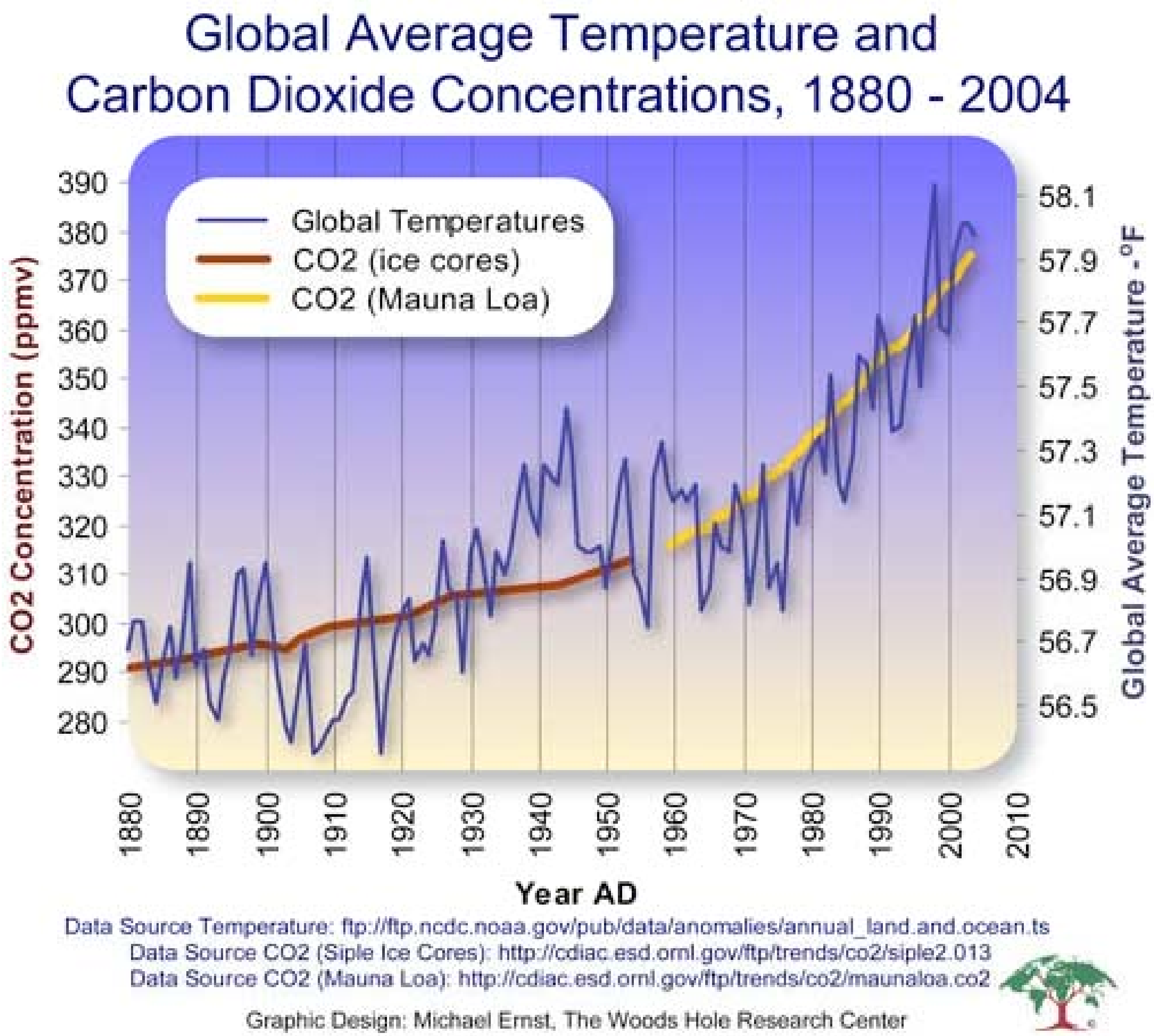
Fourier (1827), Tyndall (1861)

More greenhouse gases:

less heat lost

global warming

In 1896 Nobel Prize-winning Swedish chemist Svante Arrhenius calculated what would happen if the amount of CO_2 in the atmosphere were doubled. He estimated it would lead to an average global surface temperature increase of 2 °C. This is consistent with modern predictions (althogh feebacks suggest that this is a low estimate with 3 degrees more likely).



Current levels:

392ppm in 2011

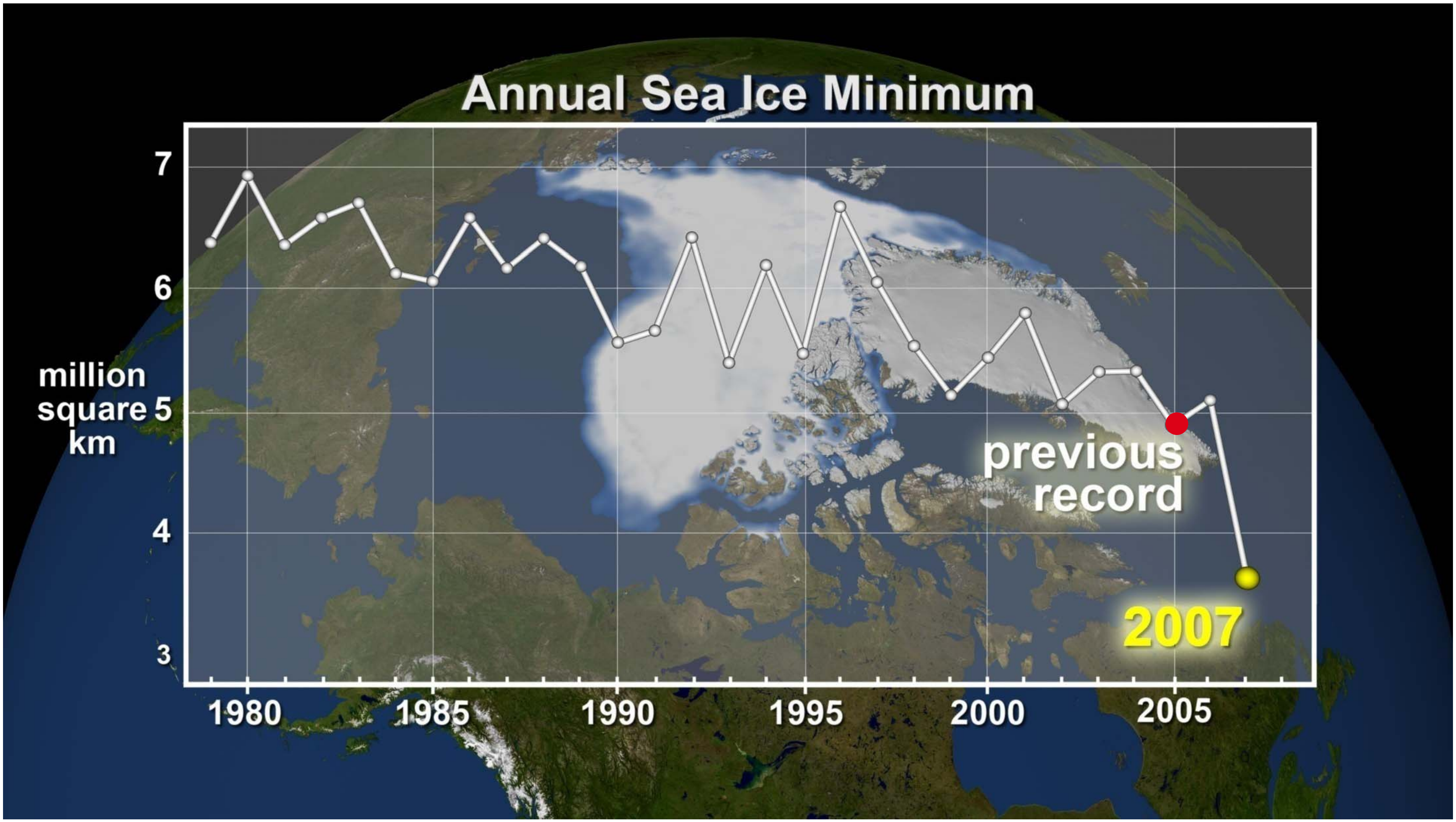
Last 400,000 years

Ice age:

180-210ppm

Inter-glacial:

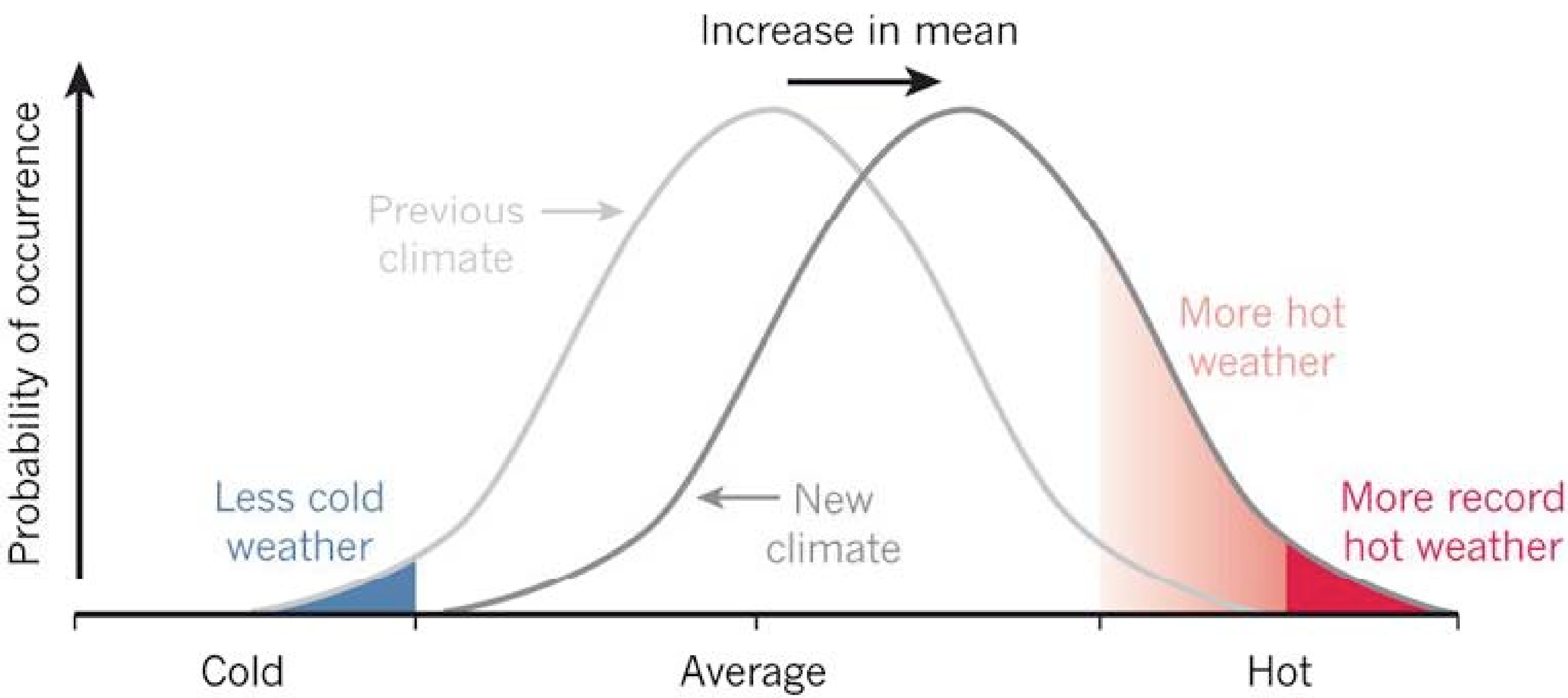
280-300ppm



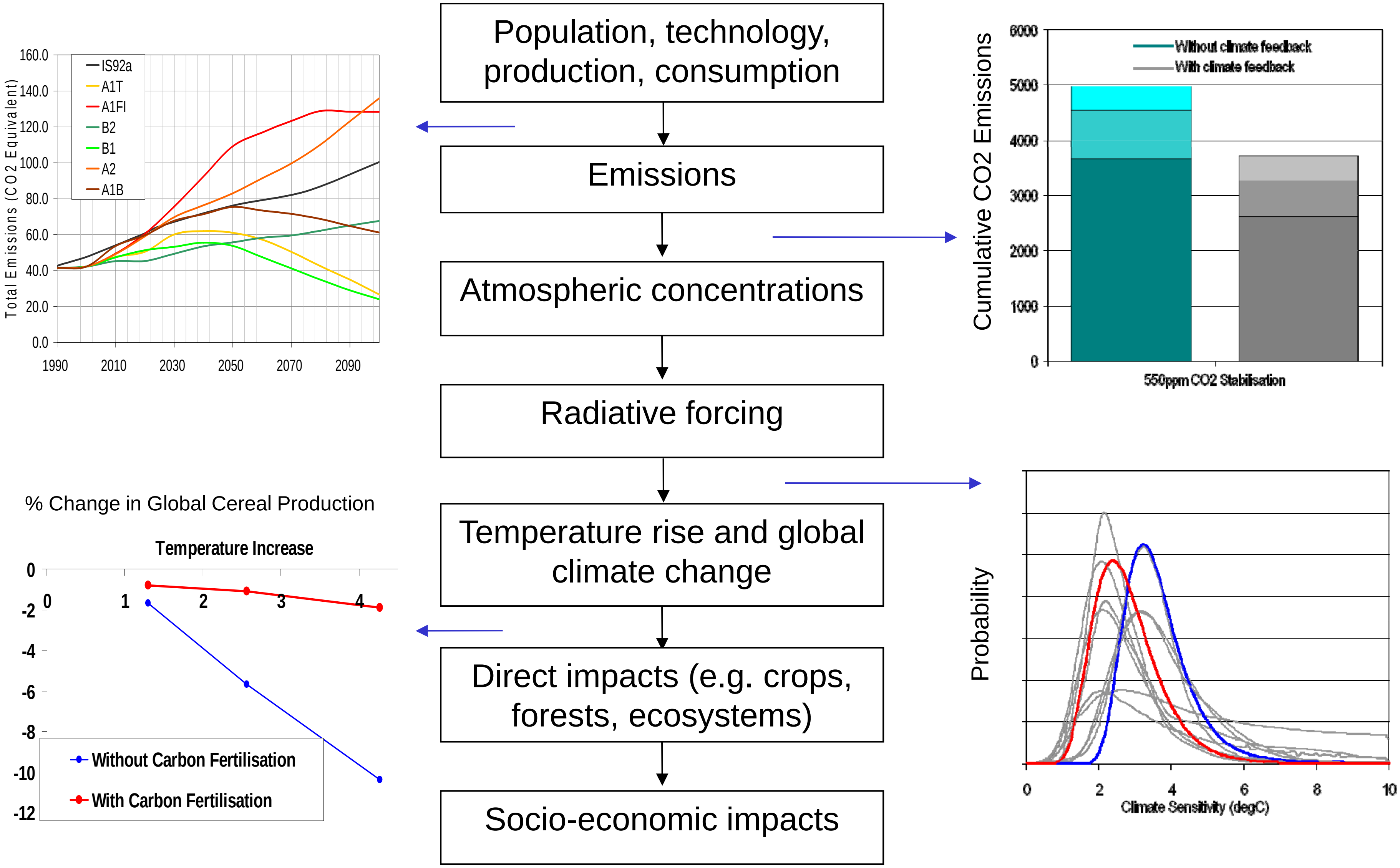
Annual Sea Ice Minimum
7
6
million square km
5
4
3
1980
1985
1990
1995
2000
2005
previous record
2007

CLIMATE SHIFT

Extreme weather events — here, very hot or cold temperatures — are rare. But a small rise in the average temperature through greenhouse warming (right-hand curve) can radically increase their frequency. Attribution research tries to quantify this effect for specific events.

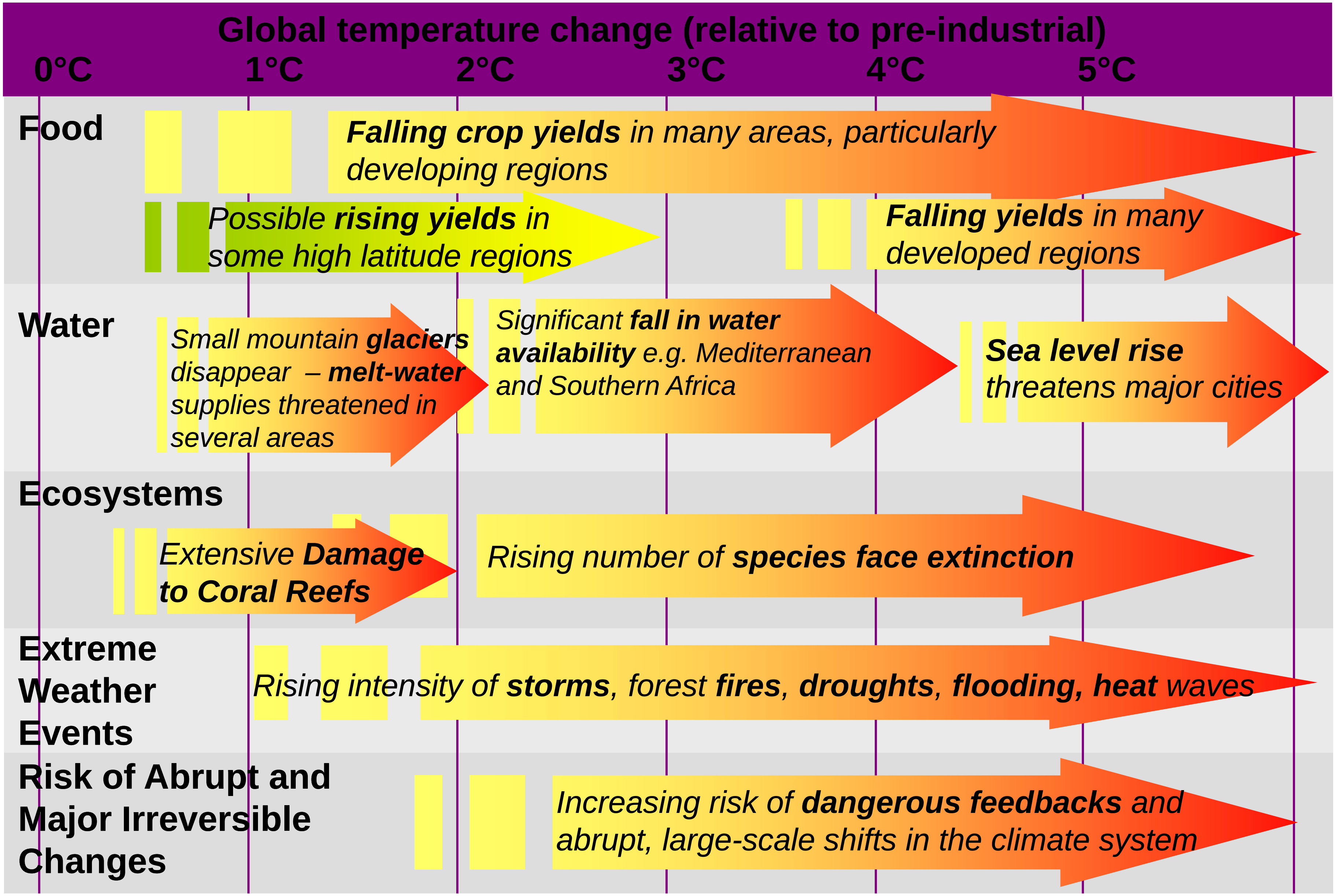


Working with Uncertainty

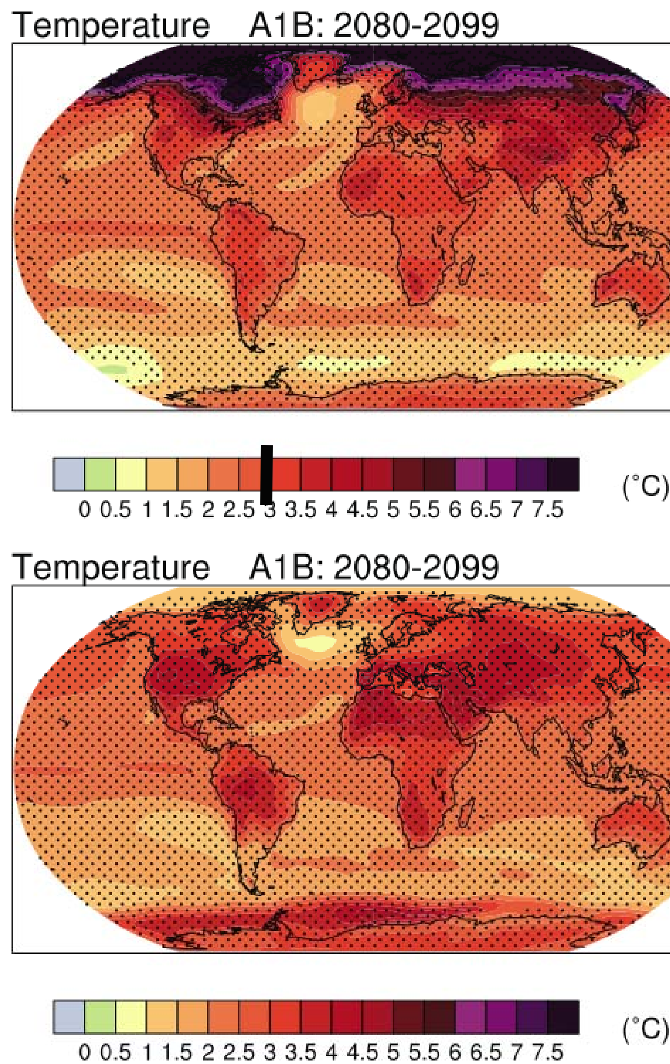


Climate impacts and risk

Projected impacts of climate change

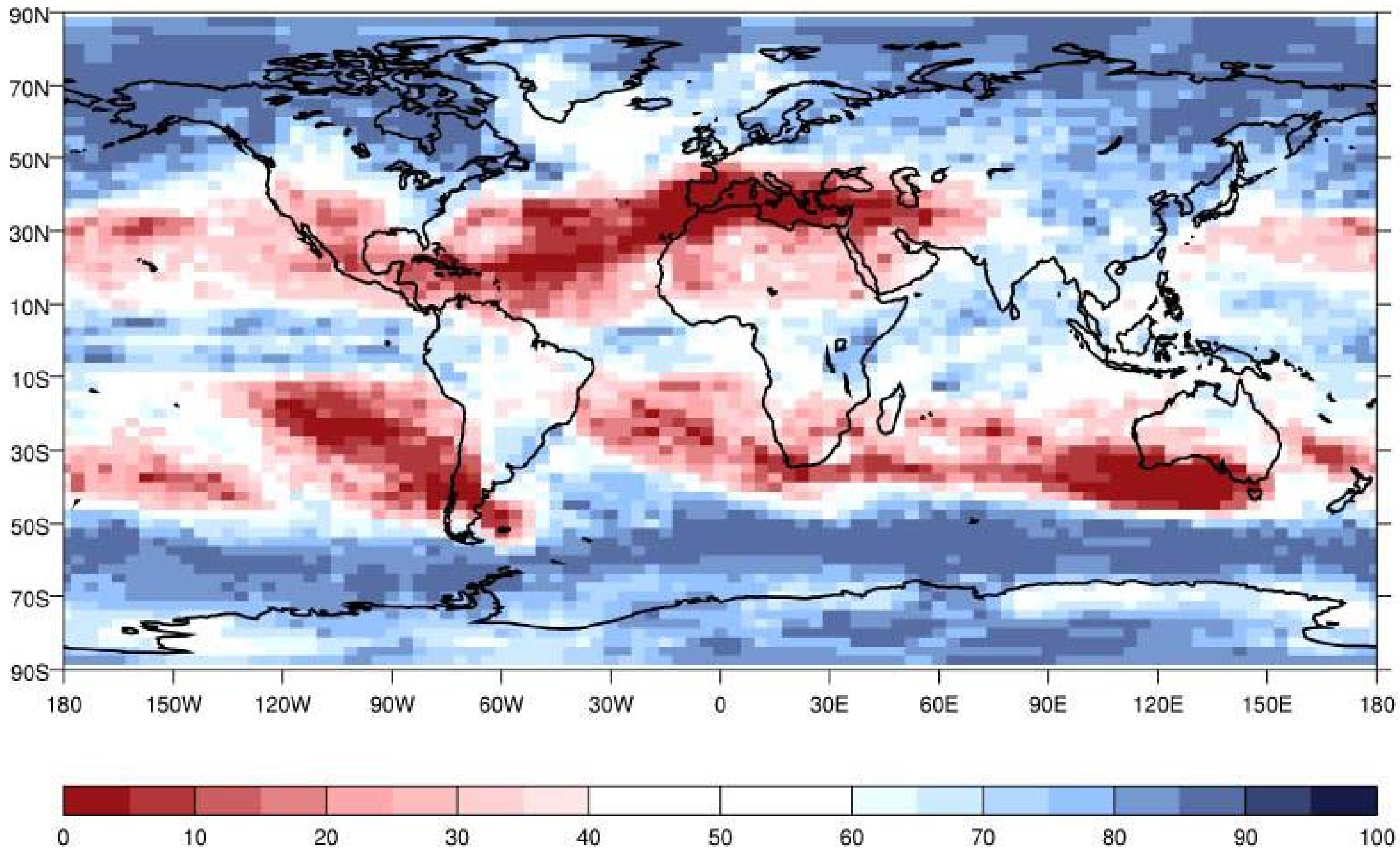


Surface Temperature Projections 2090s relative to 1980-99

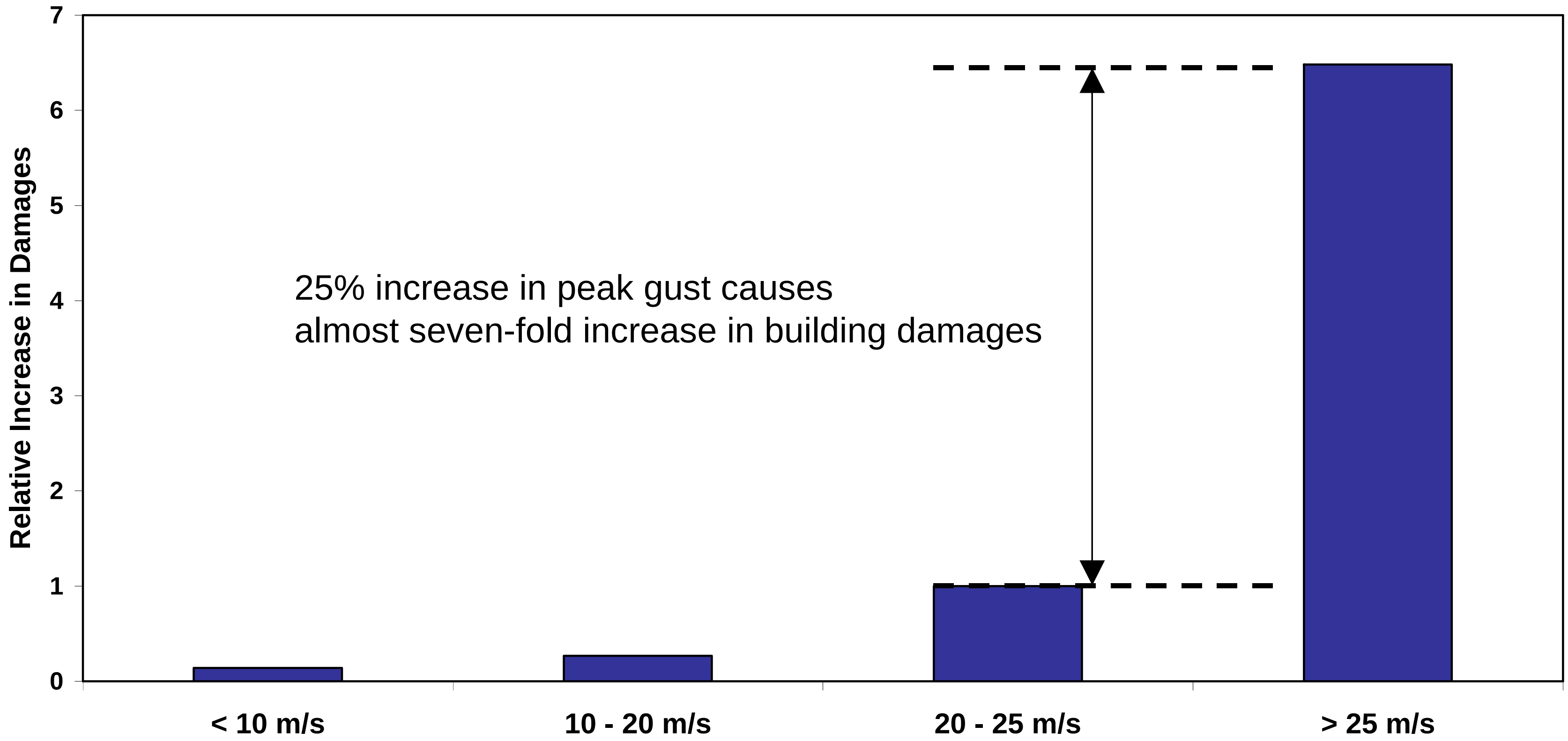


IPCC (2007

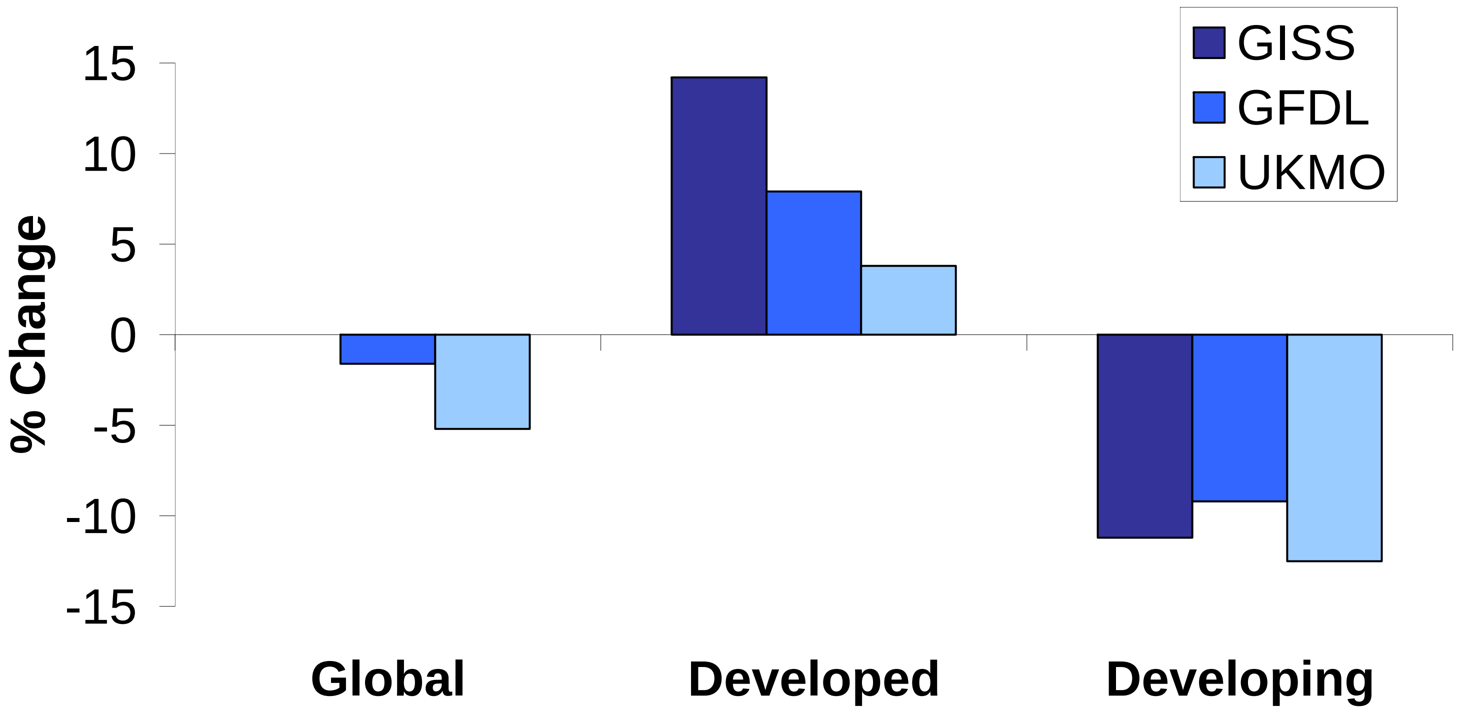
What's the impact on rainfall?



What's the impact on hurricane damages?



What's the impact on cereal production?



Changes in cereal production for a doubling of carbon dioxide levels (roughly equivalent to 3degC in the models used), simulated with three climate models.

The work assumed a strong fertilisation effect (possibly optimistic), farm-level adaptation in developing countries and some economy-wide adaptation in developed countries.

The debate before the Stern Review

- Scientists warning of catastrophic risks of climate change and advocating strong mitigation.
- (Most) Economists arguing a much more cautious approach to mitigation – postponing action and risking high levels of warming.

The Stern Review changed the debate with an appraisal of the risks and policy prescription that was closer to the scientists.

This led to a big debate on why this analysis had different conclusions..

What is the economics of climate change and how does it depend on the science?

Analytic foundations:

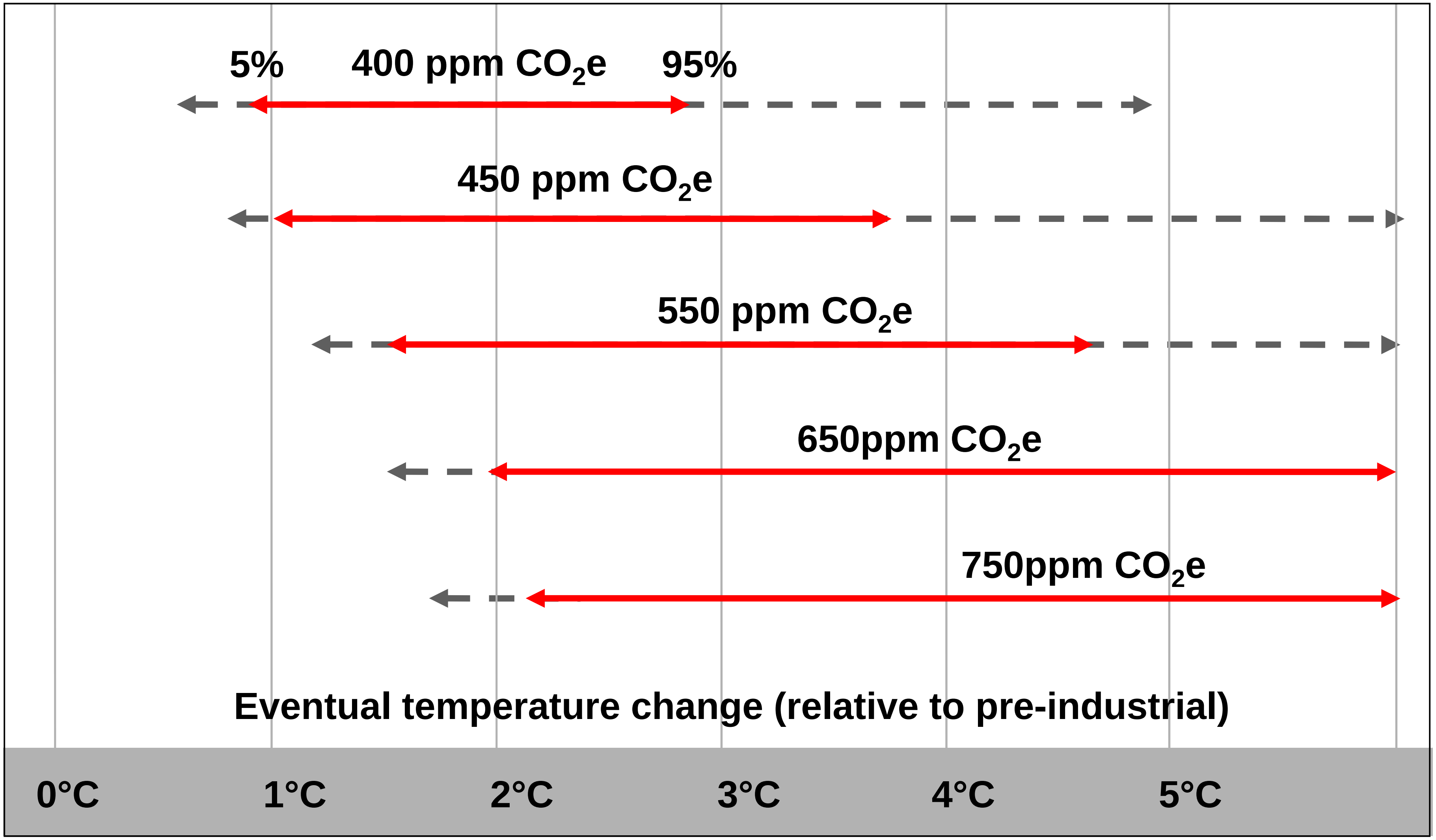
Climate change is an externality with a difference:

- Global
- Long-term
- Uncertain
- Potentially large and irreversible

Hence key roles in the Stern Review of:

i. Economics of Risk
ii. Ethics
iii. International Action

Stabilisation and Commitment to Warming



Likelihood (in %) of exceeding a temperature increase at equilibrium

Stabilisation Level (ppm $C0_2e$)	2°C	3°C	4°C	5°C	6°C	7°C
450	78	50	34	21	0	0
500	96	61	45	32	1	0
550	99	69	53	41	2	1
650	100	94	66	53	9	4
750	100	99	82	62	22	9

Source: Hadley Centre: From Murphy et al. 2004

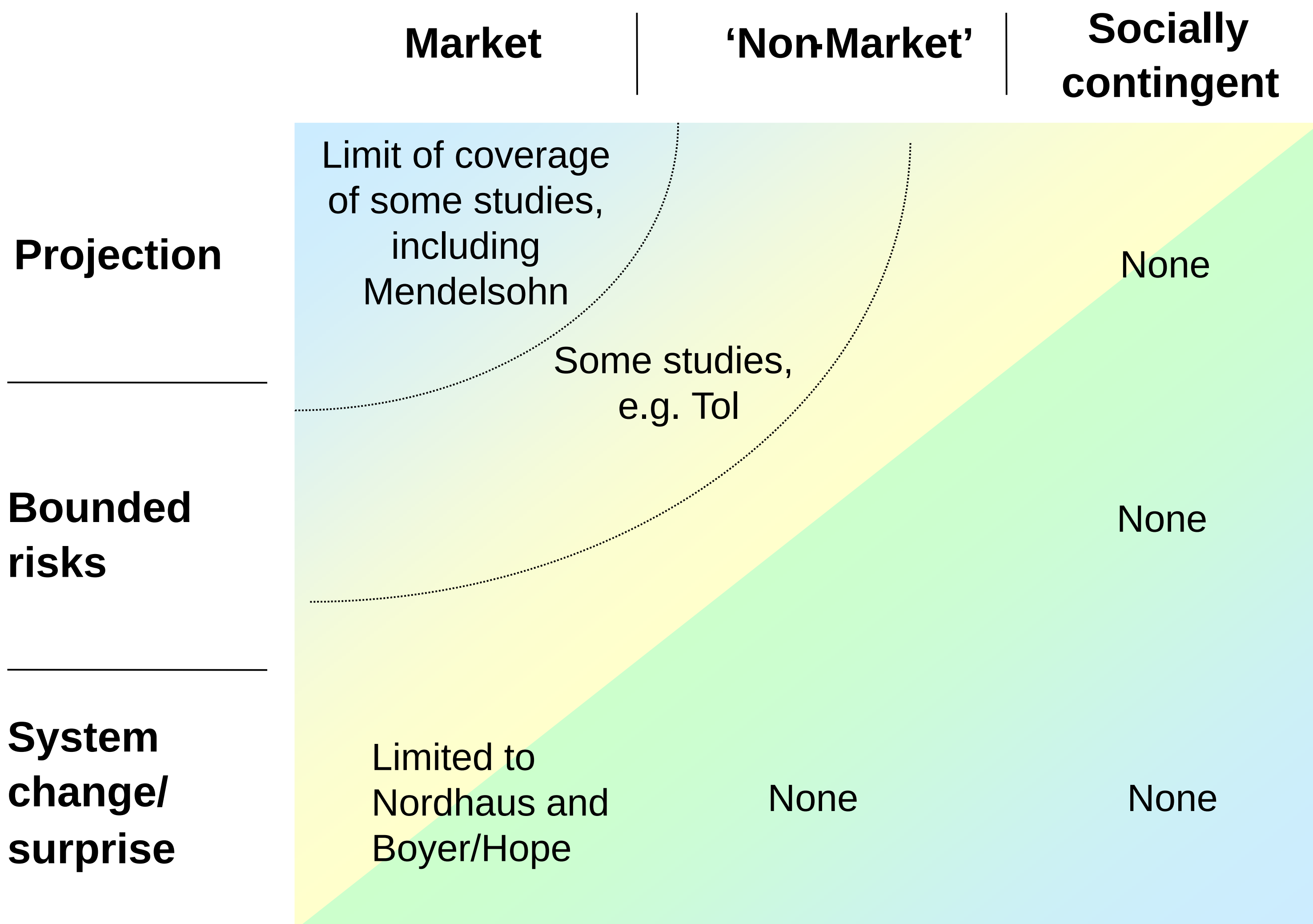
- Those who argue e.g. for stabilisation levels of 650ppm $CO2_e$ and above are accepting very big risks of a transformation of the planet
- Figures similar to IPCC AR4 (no probabilities in TAR) and show greater risk than Stern Review
- Important omitted risks

Possible consequences of 5°C+ (I)

- Would transform planet; way outside human experience; most recent warm period was 3 million years ago and this was 2-3°C above pre-industrial
- Likely increase in extreme events around the world (storms, floods, droughts etc.)
- Collapse of Greenland ice-sheet and likely West Antarctica sheet;
- Eventual sea-level rise likely to be more than ten metres, major threat of inundation of world's costal cities and low-lying areas (Bangladesh, Florida)

Possible consequences of 5°C+ (II)

- Disappearance of snows and glaciers from Himalayas leading to major disruption of rivers serving most populous nations on earth
- Collapse of Amazon forest
- Likely extinction of majority of earth's species
- Major movements of population and thus massive world conflict
- Strong regional and seasonal differences



Models only have partial coverage of impacts

Values in the literature are a sub-total of impacts

Source: Watkiss, Downing *et al*. (2005)

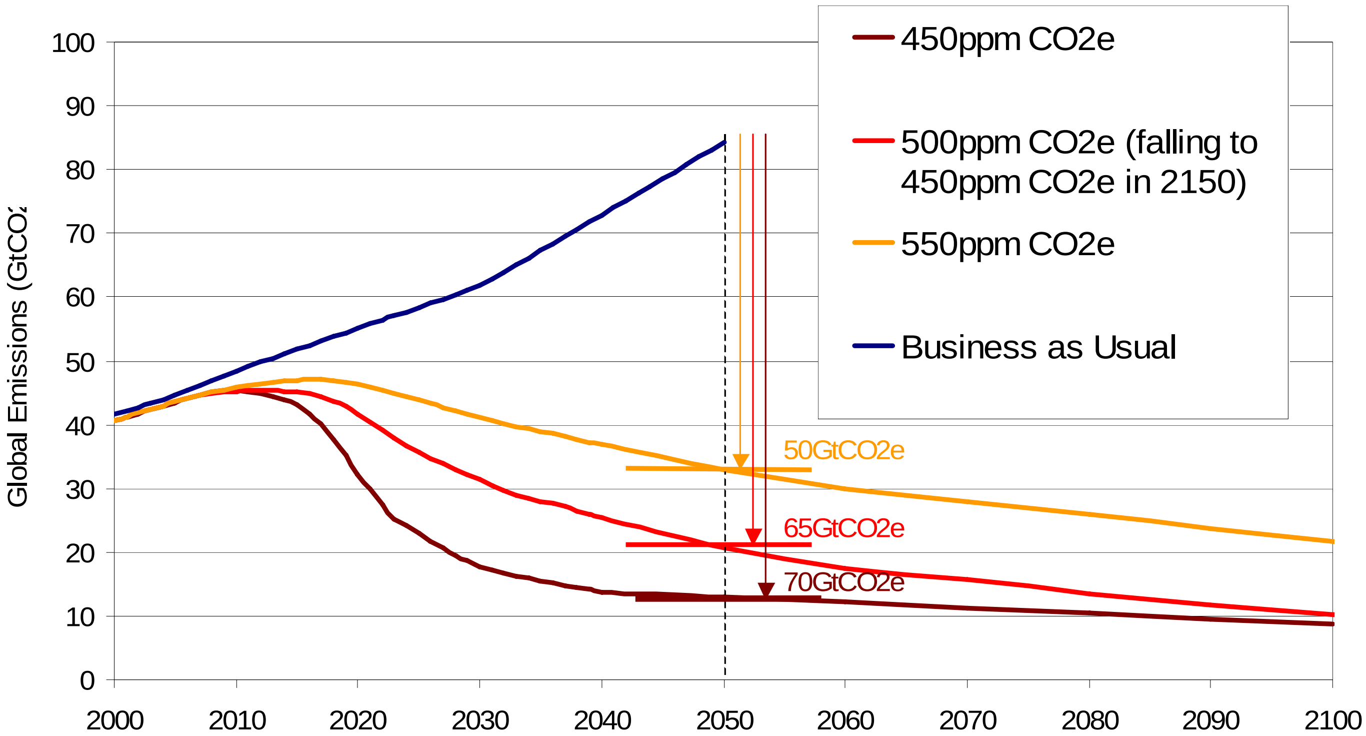
Aggregate Impacts Matrix

- Essential to take account of **risk and uncertainty**
- Models do **not** provide **precise** forecasts
- Assumptions on **discounting, risk aversion and equity** affect the results

	Market impacts	Broad impacts
Baseline climate	5% (0-12%)	11% (2-27%)
High climate	7% (1-17%)	14% (3-32%)

Rough estimate of equity weighting: 20%

Economics of Stabilisation



Stabilising below 450ppm CO_2e would require emissions to peak by 2010 with 6-10% p.a. decline thereafter.

If emissions peak in 2020, we can stabilise below 550ppm CO_2e if we achieve annual declines of 1 – 2.5% afterwards

MITIGATION COSTS

STERN review
ON THE ECONOMICS OF CLIMATE CHANGE

Estimating Costs of Mitigation

Expected cost of cutting emissions consistent with 550ppm CO2e stabilisation trajectory averages 1% of GDP per year.

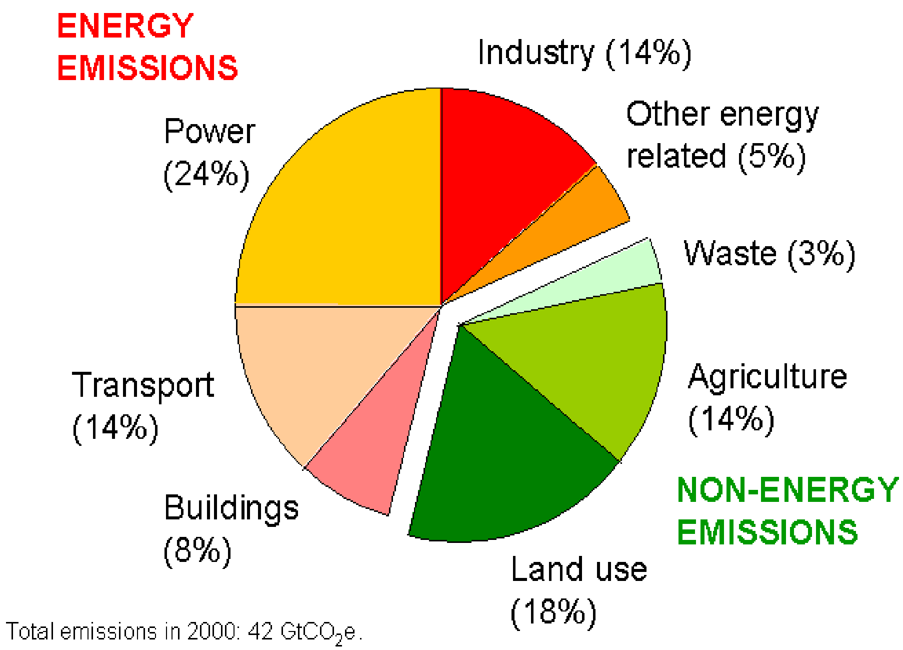
- Macroeconomic models: 1% of GDP in 2050, in range +/- 3%.
- Resource cost: 1% of GDP in 2050, in range –1% to +3.5%.

Costs will not be evenly distributed:

- Competitiveness impacts can be reduced by acting together.
- New markets will be created. Investment in low-carbon electricity sources could be worth over $500bn a year by 2050.

Strong mitigation is fully consistent with the aspirations for growth and development in poor and rich countries.

Strategies for Emission Reduction



Four ways to cut emissions:

- reducing demand
- improving efficiency
- lower-carbon technologies
- non-energy emissions

Average Cost of Reducing Fossil Fuel Emissions to 18 GtCO2 in 2050

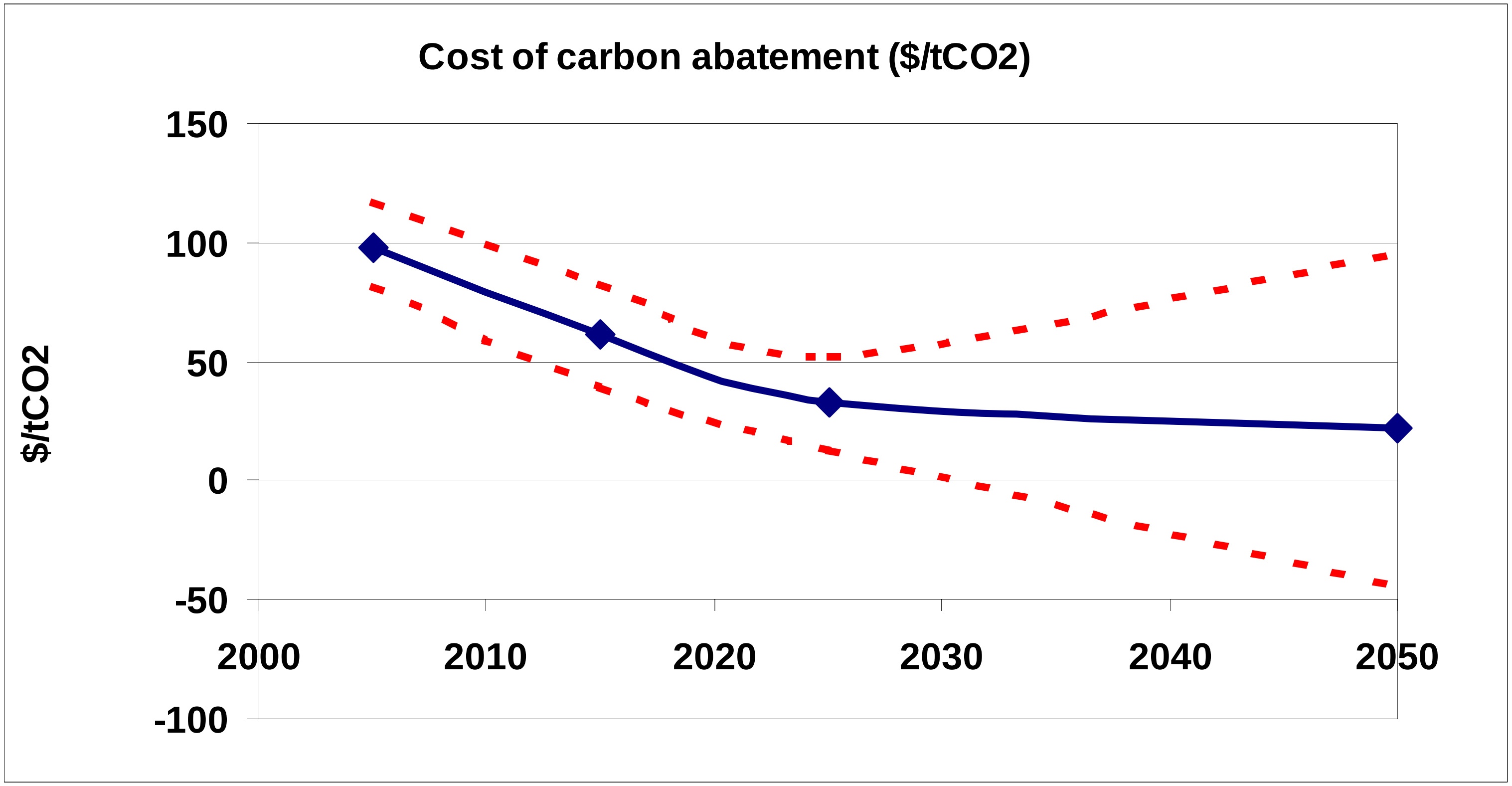


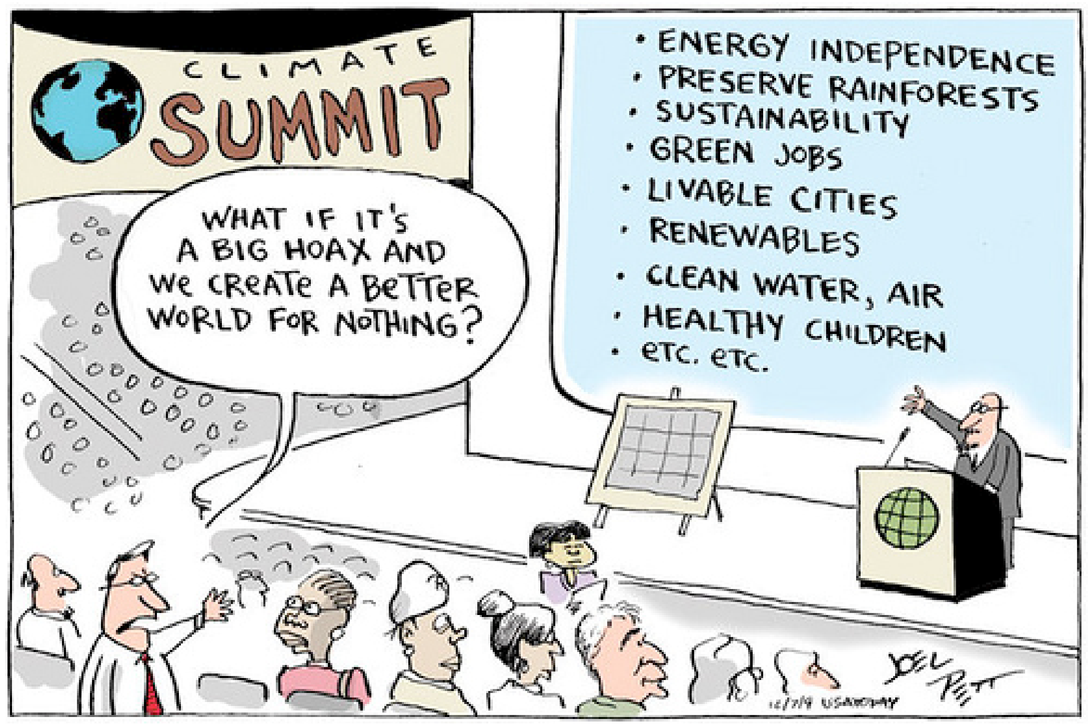
Table 9.1 Annual total costs of reducing fossil fuel emissions to 18 $GtCO_2$ in 2050			
	2015	2025	2050
Average cost of abatement, $/t CO_2	61	33	22
Emissions Abated $GtCO_2$ (relative to emissions in BAU)	2.2	10.7	42.6
Total cost of abatement, $ billion per year:	134	349	930

Structure of argument on mitigation objectives

- Risks of going above 5°C increase (or even 4°C) are very severe. Would induce, e.g., major movements of population and thus massive conflict
- On basis of implied probabilities of temperature increase, dangerous to go beyond 550ppm CO_2e
- Cuts of 30-50% by 2050 required for target of stabilisation range 550- 500ppm CO_2e
- Cost of action to get in range looks acceptable relative to reduction of risks and damages avoided
- Some aggregate formal modelling useful to inform damage estimates but loses key detail, sensitive to assumptions and implausible for optimisation analysis

Some big potential co-benefits

- Resource efficiency – competitiveness, energy independence
- Reduced exposure to fossil fuel price volatility (and high prices)
- Local environmental and health
- Innovation spillovers
- Biodiversity



MITIGATION POLICY

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ON THE ECONOMICS OF CLIMATE CHANGE

Key principles of policy

Climate change policy:

– Carbon pricing

– R,D&D

– Related market failures and behavioural change

Consistency with other policy goals – growth and energy security

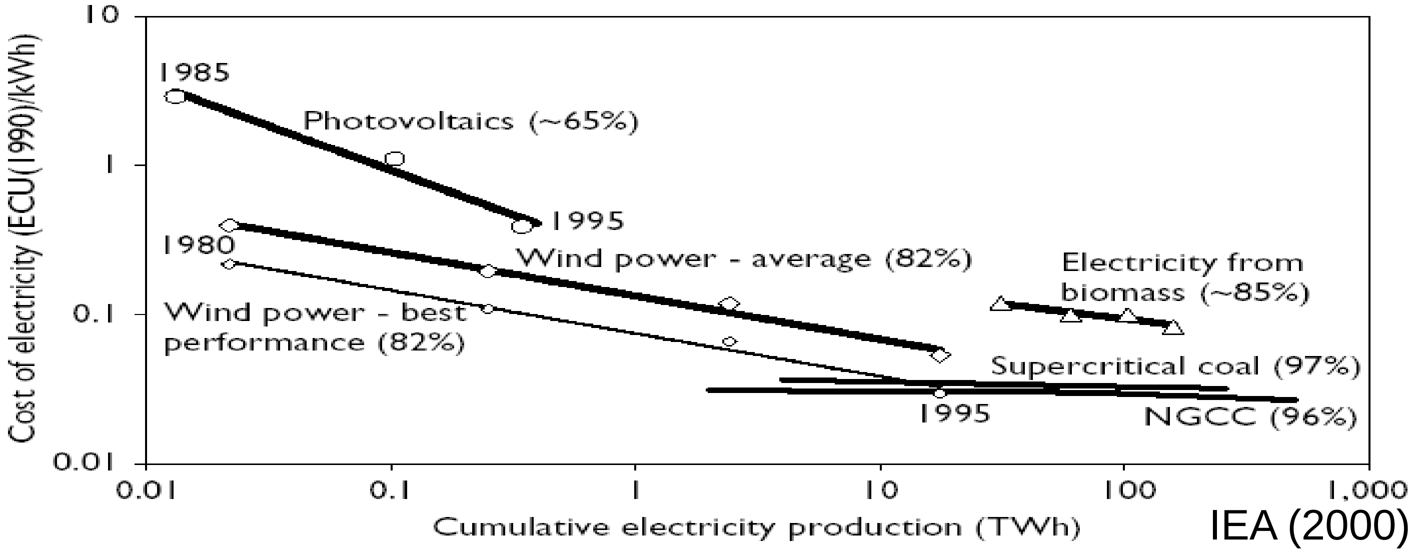
How can users face their carbon price?

3 ways:

- Carbon taxation
- Regulation (especially for energy efficiency)
- Emissions trading (e.g. EU ETS)

Stern is not prescriptive about choice of policy instrument. They can all play valuable roles. Countries will find some instruments more suitable than others.

Technology needs more than a carbon price



IEA (2000)

One element of technology policy is public funding to support innovation in new technologies.

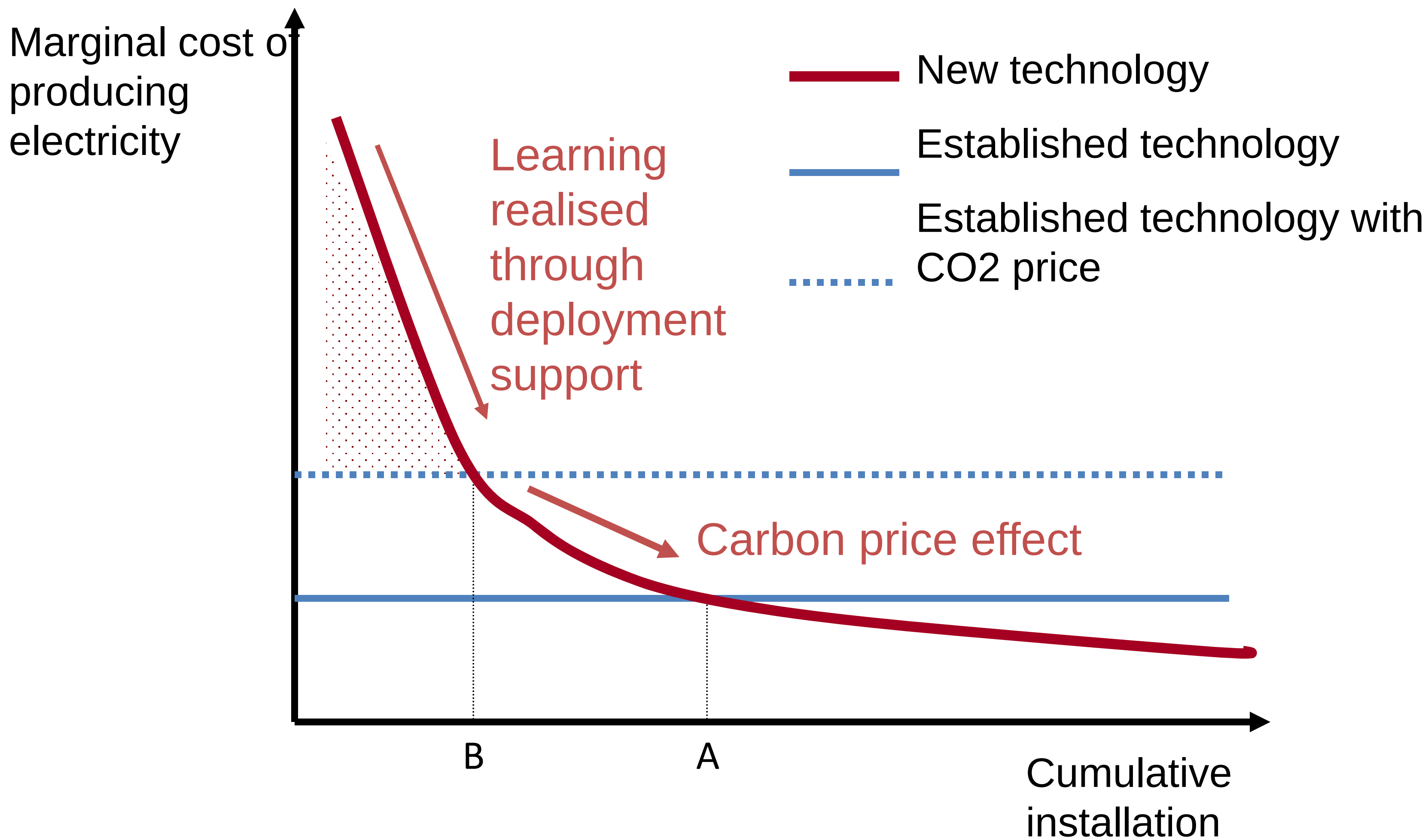
The Review suggests that:

– Global public energy R&D funding should double, to around $20 bn

– Deployment incentives should increase 2 to 5 times, from current level of $34 bn

Promising developments: Pholtovoltaics (new material); cellulosic biofules; 'nanostorage'….

Interaction between policy instruments



Beyond pricing and technology

- **Regulation** has several important economic roles: supporting implicit prices for carbon, accelerating technology, overcoming other barriers.

- **Information** important to help people make sound decisions.

- Promote a **shared understanding of responsible behaviour** across all societies – beyond sticks and carrots

ADAPTATION

STERN
review
ON THE ECONOMICS
OF CLIMATE CHANGE

Threats

- Developing countries are particularly vulnerable to impacts of climate variability

- Climate change will threaten all aspects of the development agenda

  » Income poverty and hunger

  » Direct and indirect health effects

  » Dislocation, migration and conflict

  » Some effects already here

Opportunities

- Opportunities for adaptation
- Opportunities for low carbon development
- Opportunities to improve land use and reduce deforestation
- Opportunities to shape international co-operation

Adaptation and development

- Development key to adaptation: enhances resilience and increases capacity
- Adaptation to current climate variability reduces costs of natural disasters
- Adaptation requires economy-wide planning and regional co-operation
  - » Leadership and co-ordination is essential: key role for Heads of Government, Finance and Economic Ministries

– Mistake to separate adaptation and development either in analysis or funding: this issue concerns development in a more hostile climate

International support for adaptation

- Link between development and adaptation has implications for ODA scale and focus
- Equity requires assistance from rich countries as main source of climate problem
- This strengthens still further argument for delivery on aid commitments
- UNFCCC process and funds essential to support capacity-building and prioritisation
- Additional ODA flows will be a bigger source of funding for adaptation and development
- Adaptation must be part of post-2015 development goals and funding

Global opportunities for adaptation

•International action also has a key role in supporting global public goods for adaptation

- Forecasting climate and weather
- Disaster response
- More resilient crop varieties
- Technologies for water conservation and irrigation
- New methods to combat land degradation
- Prevention and treatment of malaria and other water- and vector- borne diseases

Collective Action: The Emissions Gap Report

Are the Copenhagen Accord pledges sufficient to limit global warming to 2° C or 1.5° C?

www.unep.org/publications/ebooks/emissionsgapreport

2 degrees or not 2 degrees – that is the question

The Copenhagen Accord

Copenhagen
December, 2009

✓ **A goal …**
Staying below an increase of 2 degrees Celsius (1.5^{0} C)

✓ **A means to get there …**
Country pledges to control emissions (pegged to 2020)

✓ **Is there a gap between …**
What we are aiming for … Where we are heading ?

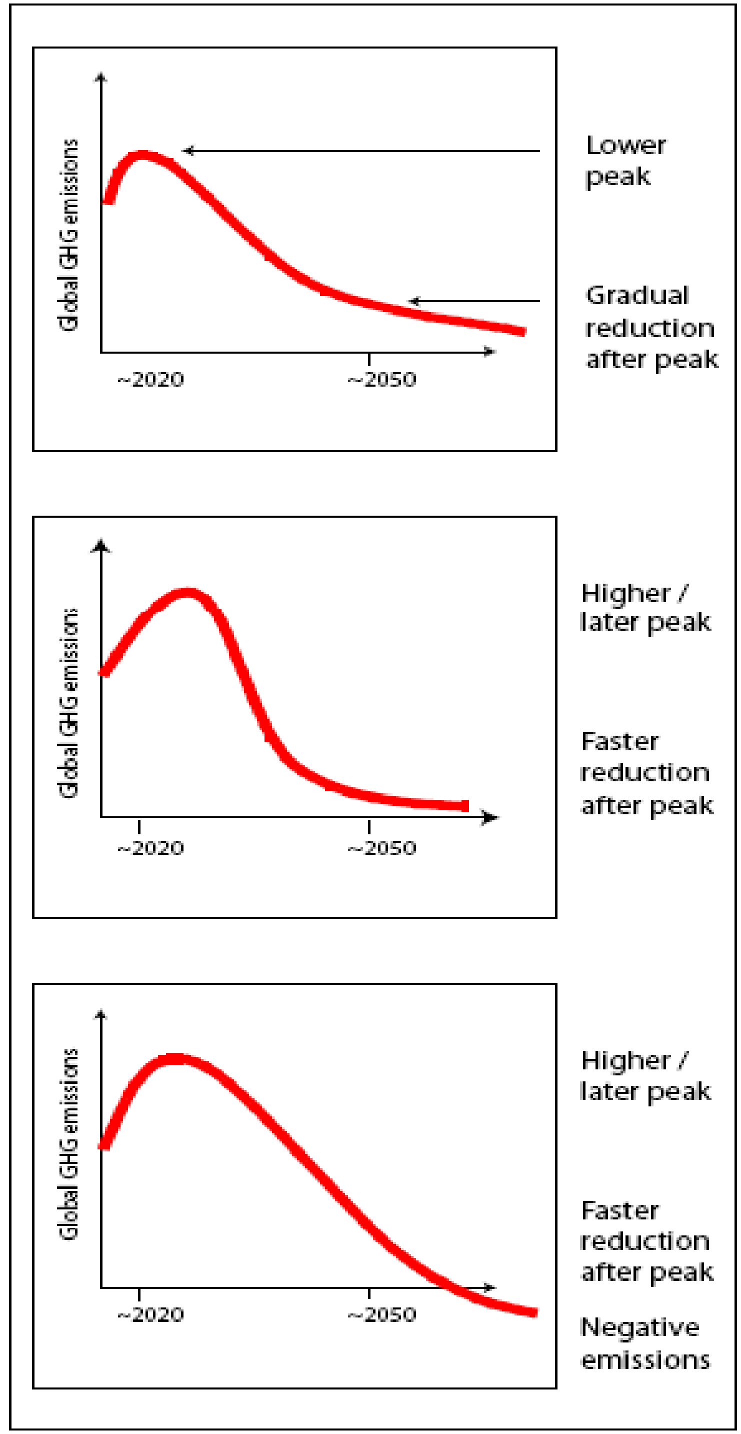
Photo: http://gogreenindia.co.in/blog/wp-content/uploads/2010/09/official-white-house-photo-at-cop15-copenhagen-usa-india-brazil-south-africa-china.jpg

1. What are we aiming for?

1. Meeting a temperature target with a given probability depends largely on *cumulative* emissions

2. Different pathways correspond to same cumulative emissions

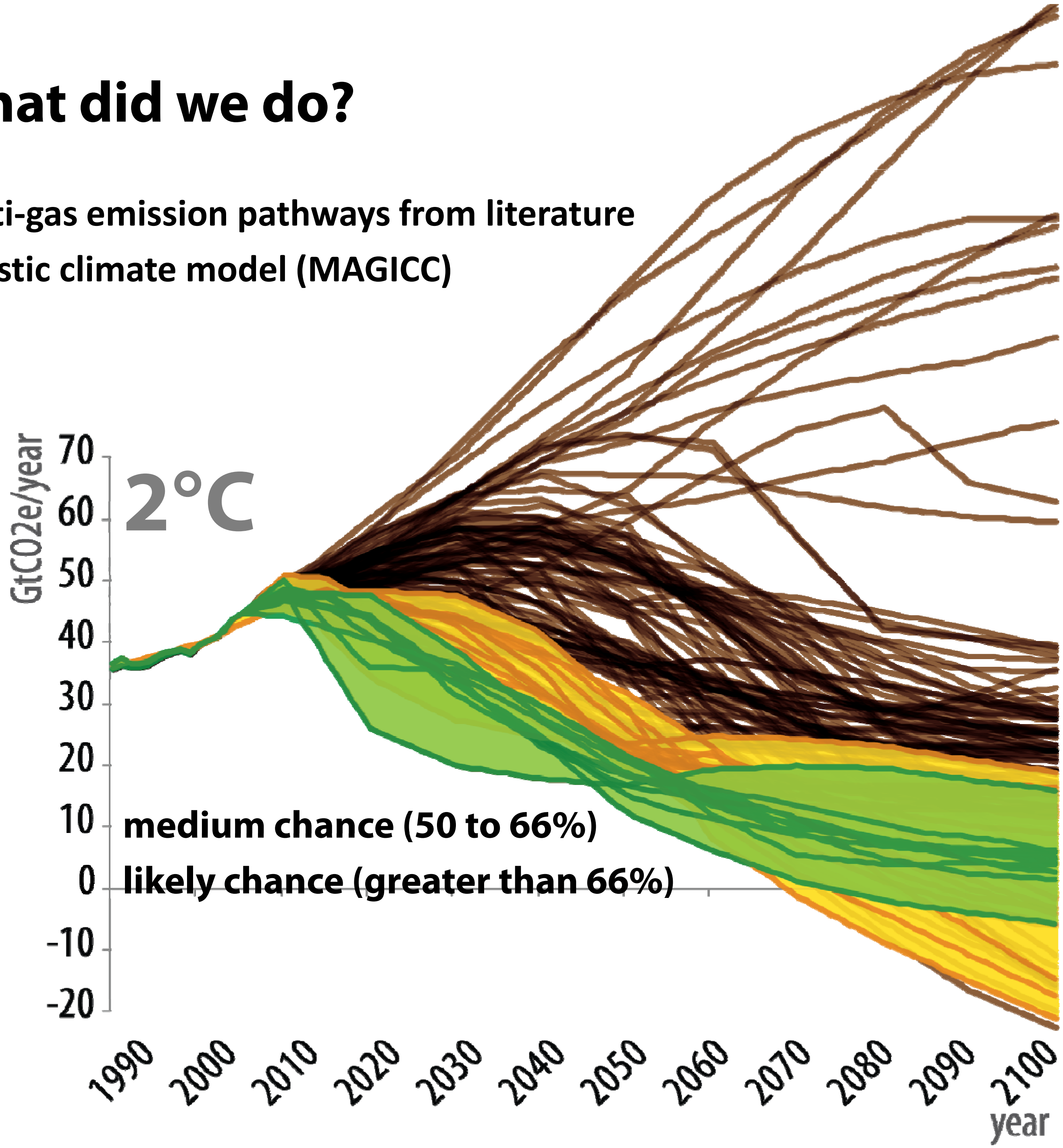
Behind the lines is a huge amount of science that has significant uncertainties.



What did we do?

IAM multi-gas emission pathways from literature

Probabilistic climate model (MAGICC)



UNEP thanks Joeri Rogelj (ETHZ) for graphics

UNEP

Emission levels consistent with 1.5°C and 2°C?

KEY MESSAGES:

general characteristics (20th to 80th percentile)

peak:

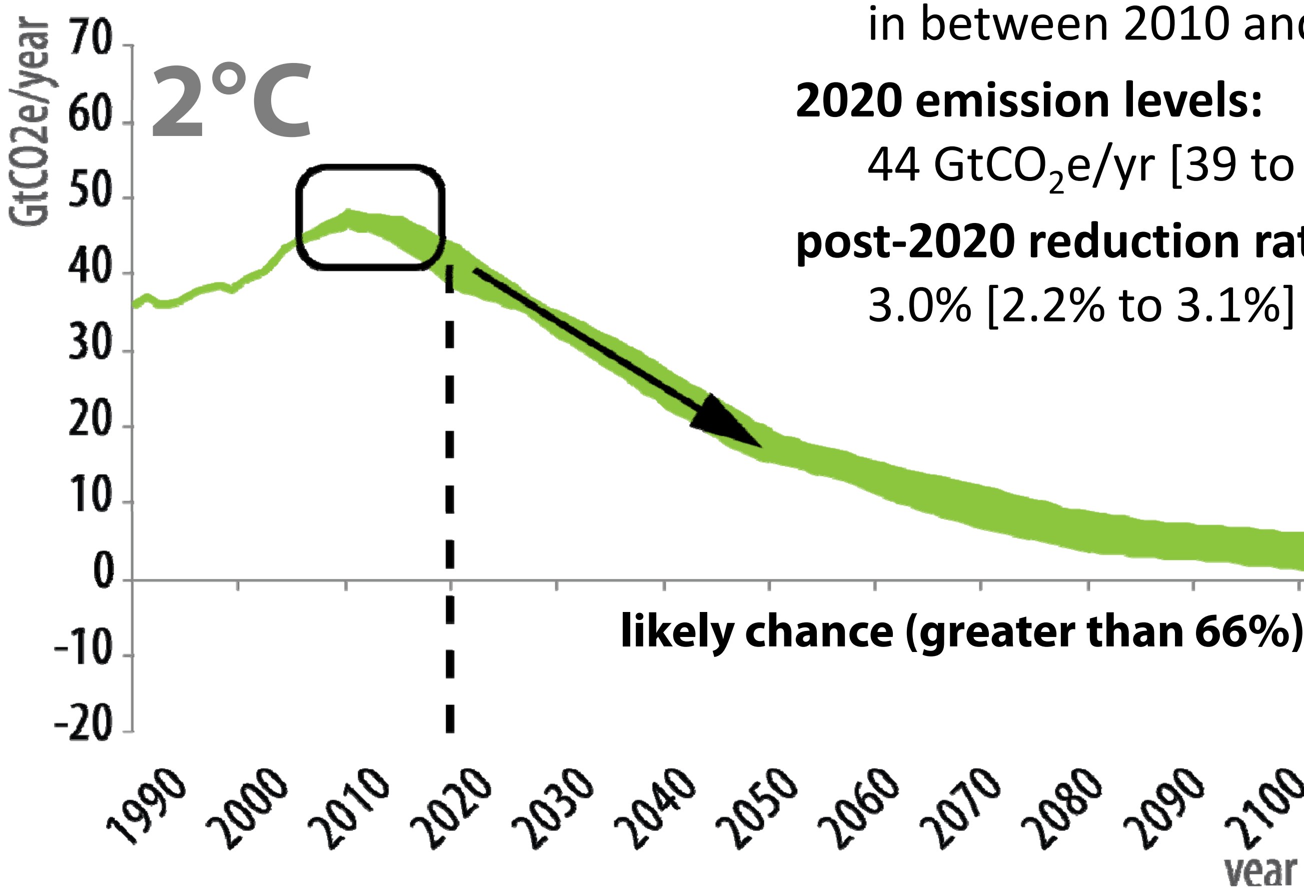
in between 2010 and 2020

2020 emission levels:

44 $GtCO_2e$/yr [39 to 44]

post-2020 reduction rate:

3.0% [2.2% to 3.1%]



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