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Adventures in Risk

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Institute of Actuaries of Australia

THE ECONOMICS OF CLIMATE CHANGE – THE STERN REVIEW

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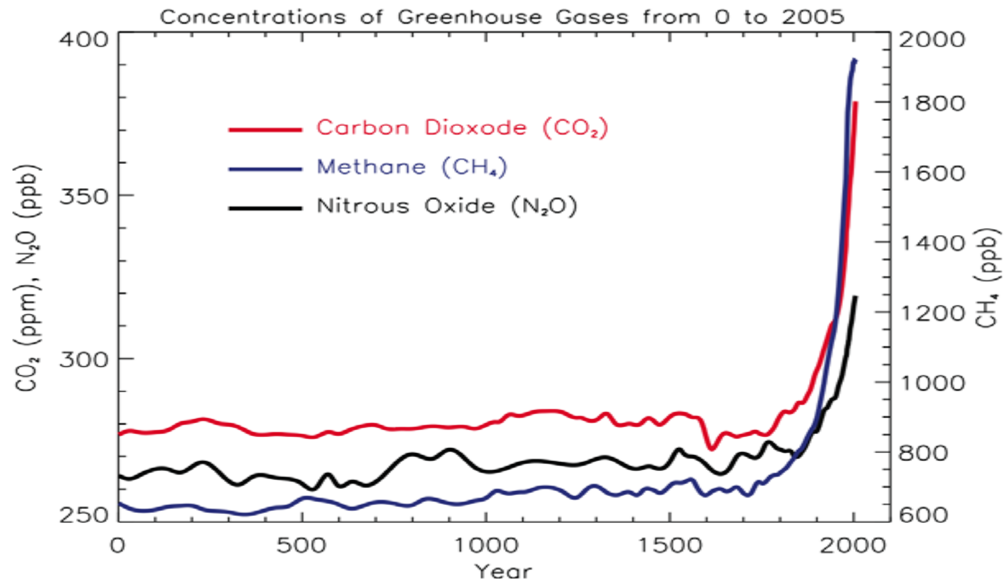
The Stern Review

- Climate change predictions
- Methods of modelling of impacts
- Results for business as usual (BAU)
- Results with stabilisation
- Social cost of carbon
- Criticisms of methods/assumptions
- Discussion

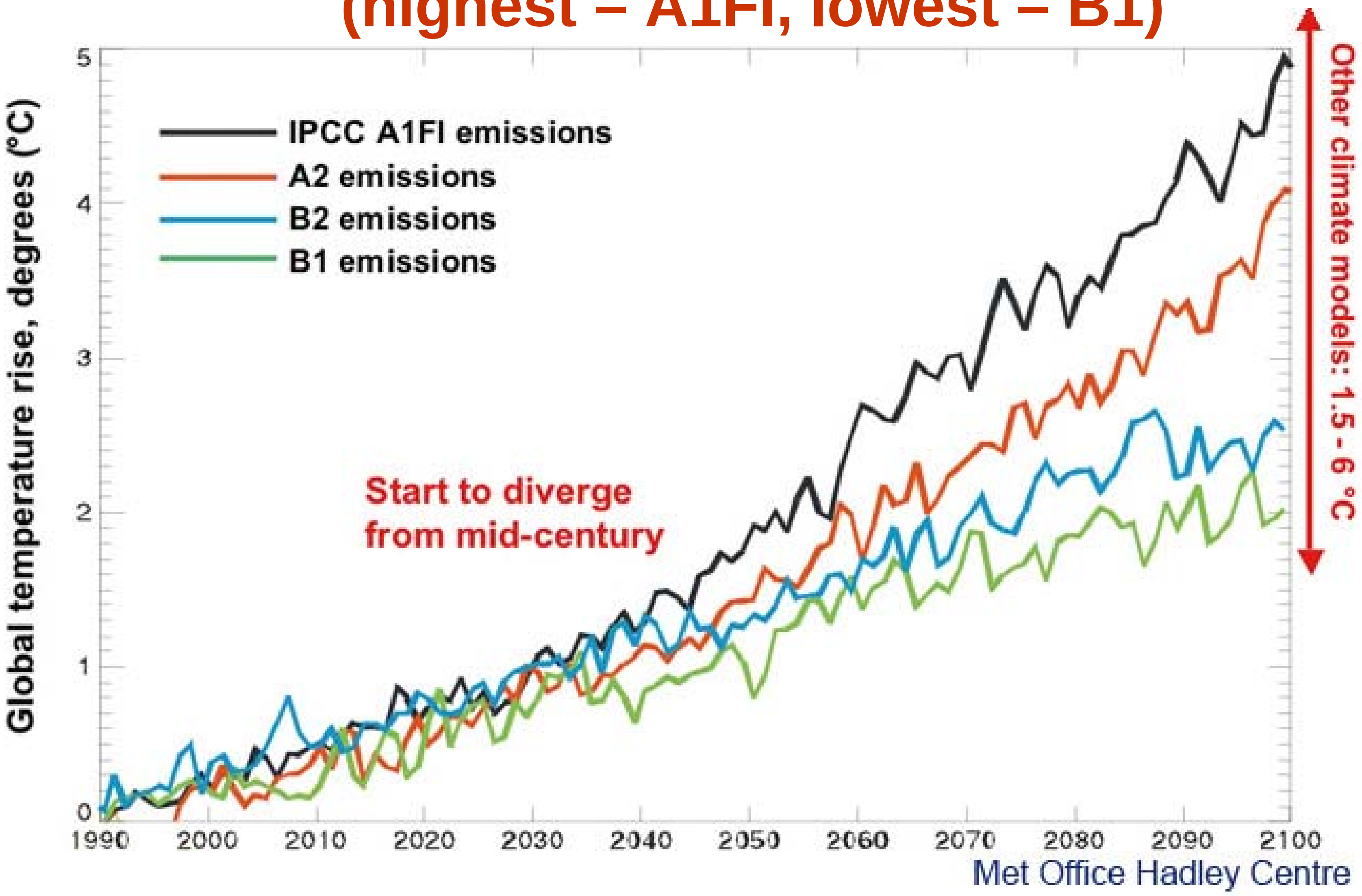
Current levels of the main GHGs



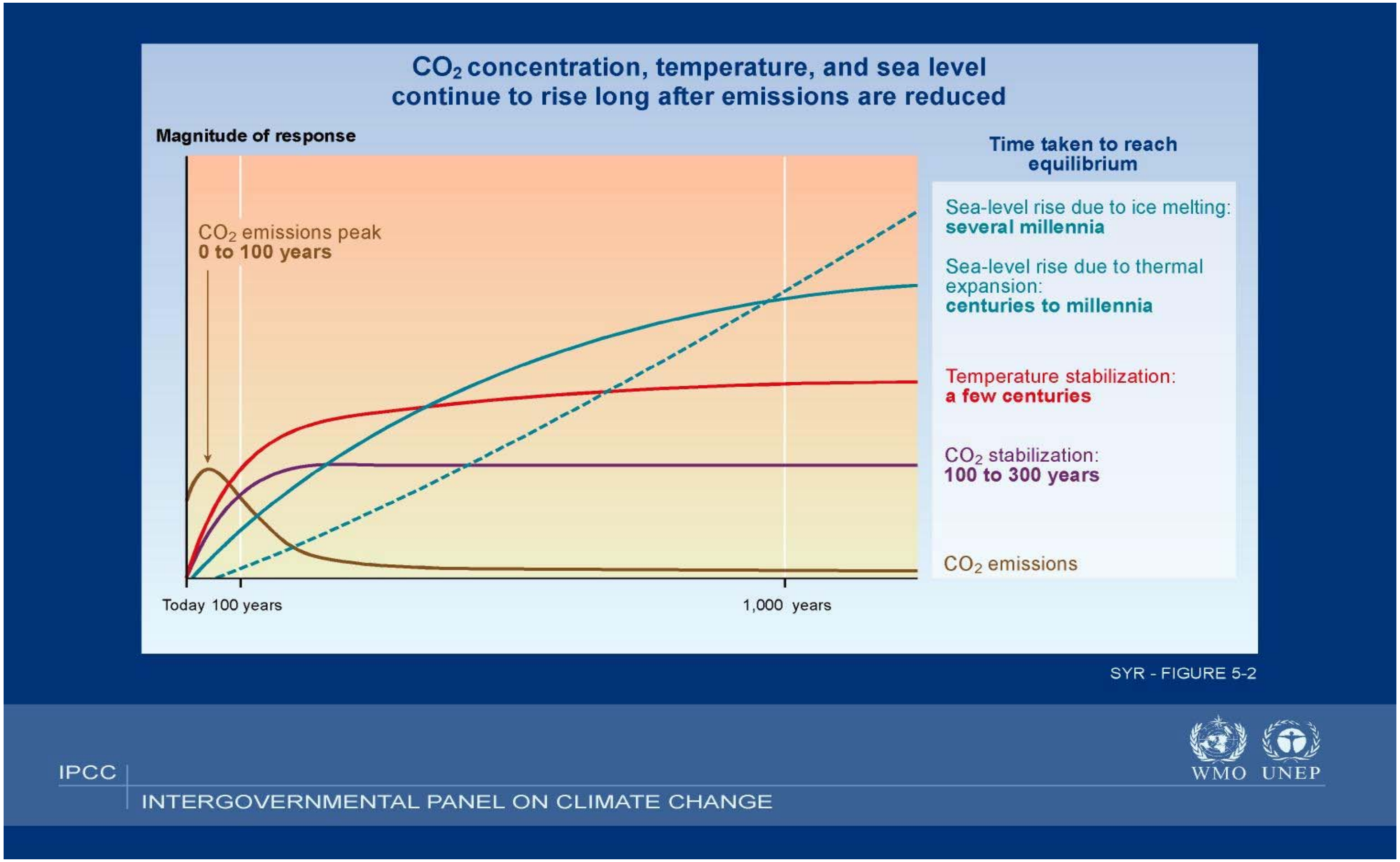
FAQ 2.1, Figure 1

The atmospheric concentration of CO_2 is currently at about 382ppm. It is increasing by around 2ppm per year. Including other GHGs (ie. methane, nitrous oxide etc) the atmospheric concentration of CO_2-e is currently at about 430ppm. It is increasing by around 2.5ppm per year. Source IPCC

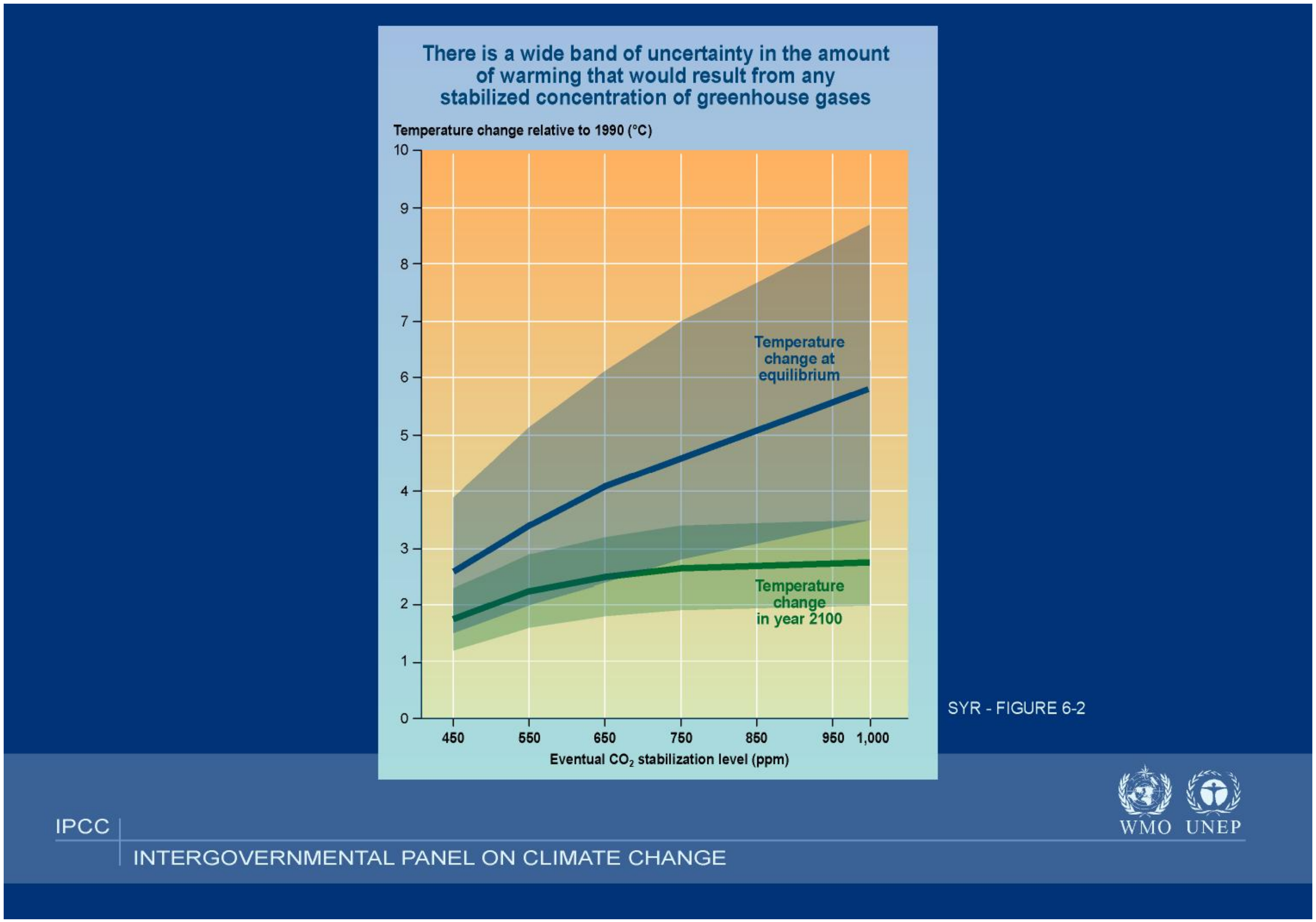
Projected Changes in Global Average Temperature to 2100 under Different IPCC Emissions Scenarios (highest – A1FI, lowest – B1)



Inertia in emissions impacts



Predictions of Temperature Increases

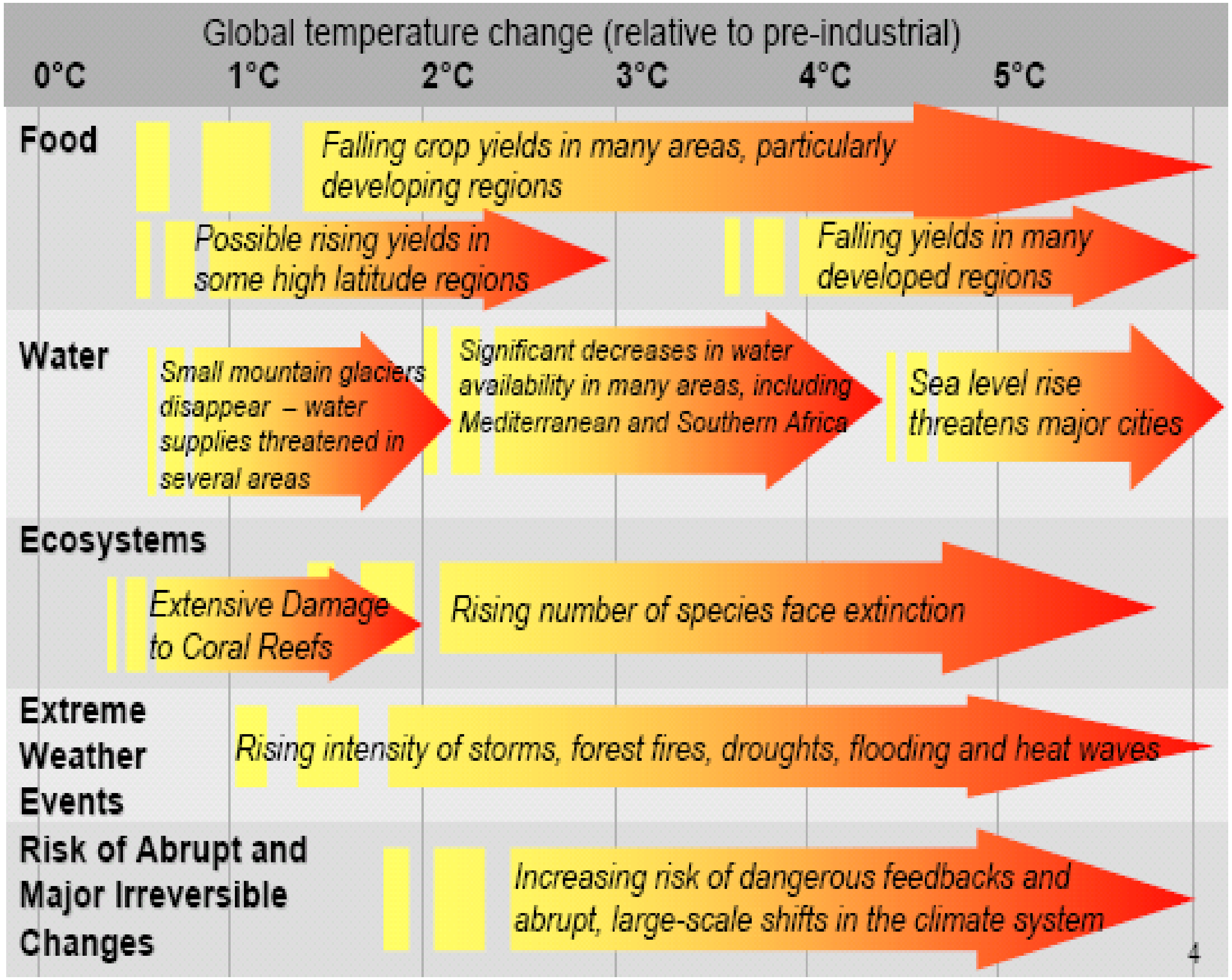


Types of analysis undertaken

1. Descriptive (disaggregated) techniques
2. Economic models of costs of:
   - Business as usual (BAU)
   - Emissions reduction
   - Adaptation
3. Social cost of carbon (or CO_2)

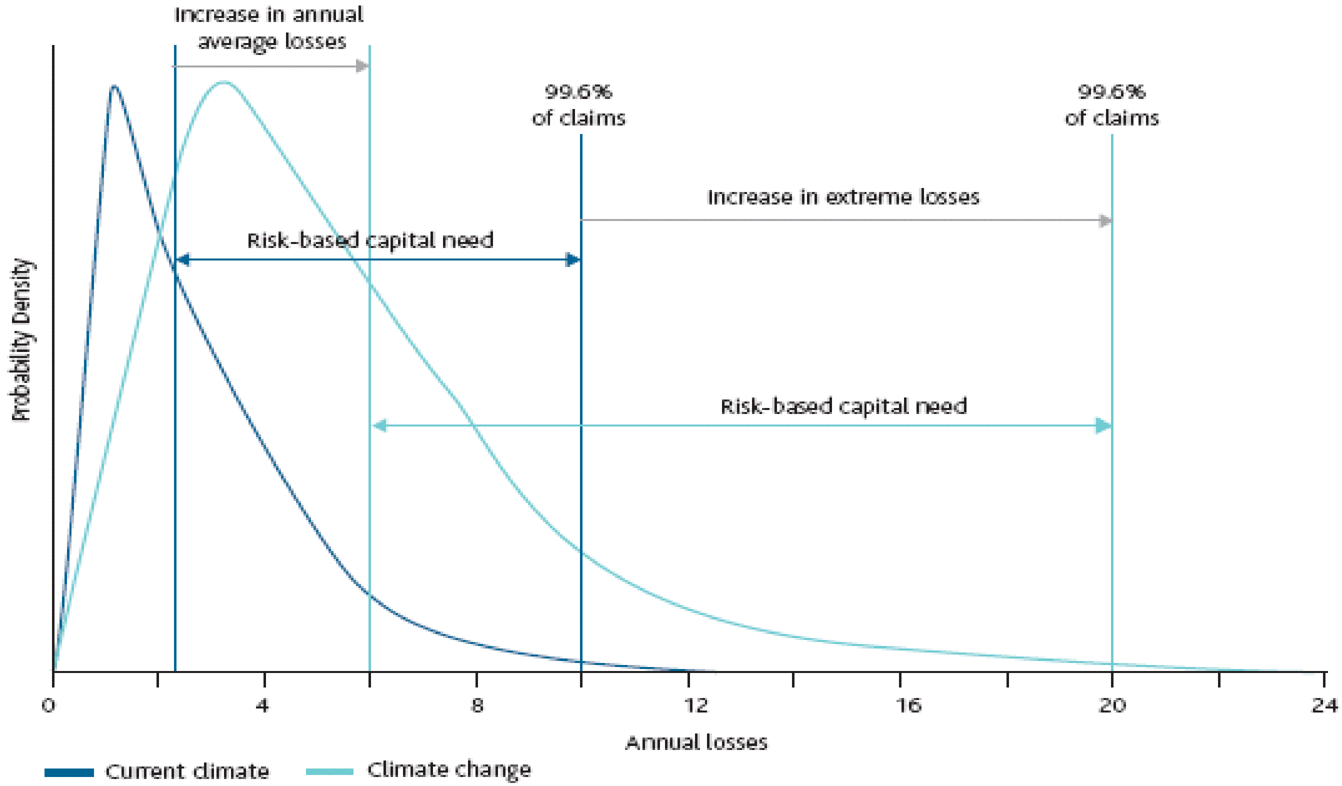
1. Disaggregated Techniques

Projected Impacts of Climate Change



Insurance capital requirements

Figure 9.1 Impact of climate change on probability loss distribution and implications for risk capital requirements

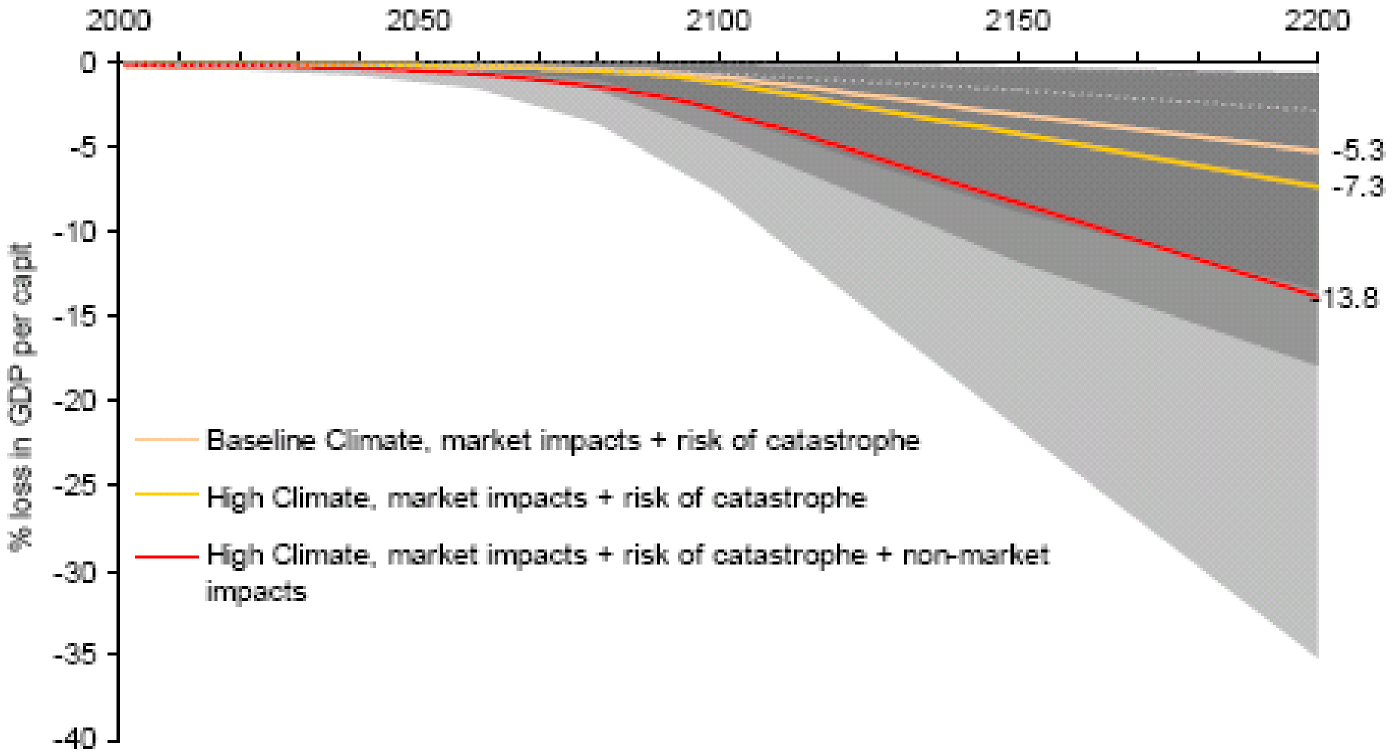


Source: Association of British Insurers, 2005

2. Economic models - scope

- Most comprehensive study so far
- Timescale more than 200 years
- Stochastic allowance for uncertainty
- Covers market and non-market impacts and risks from extreme weather events.
- Additional dynamic feedbacks

Possible Range of impacts



Global loss of income from climate change

Source: Stern Review

Valuation assumptions

- Consumption without climate change grows by g, population by 0.6% pa to 2200 then stable
- Climate change impacts on incomes are projected stochastically (1,000 model runs)
- Consumption paths converted to utilities (measure of welfare)
- $U_t = C_t^{1-\eta} / (1-\eta)$, or $U_t = C_0^{1-\eta} / (1-\eta) * (1+g)^{t/(1-\eta)}$
- if $\eta = 1$, $U_t = \ln(C_t)$
- η is elasticity of marginal utility, set $\eta = 1$

Valuation assumptions cont'd

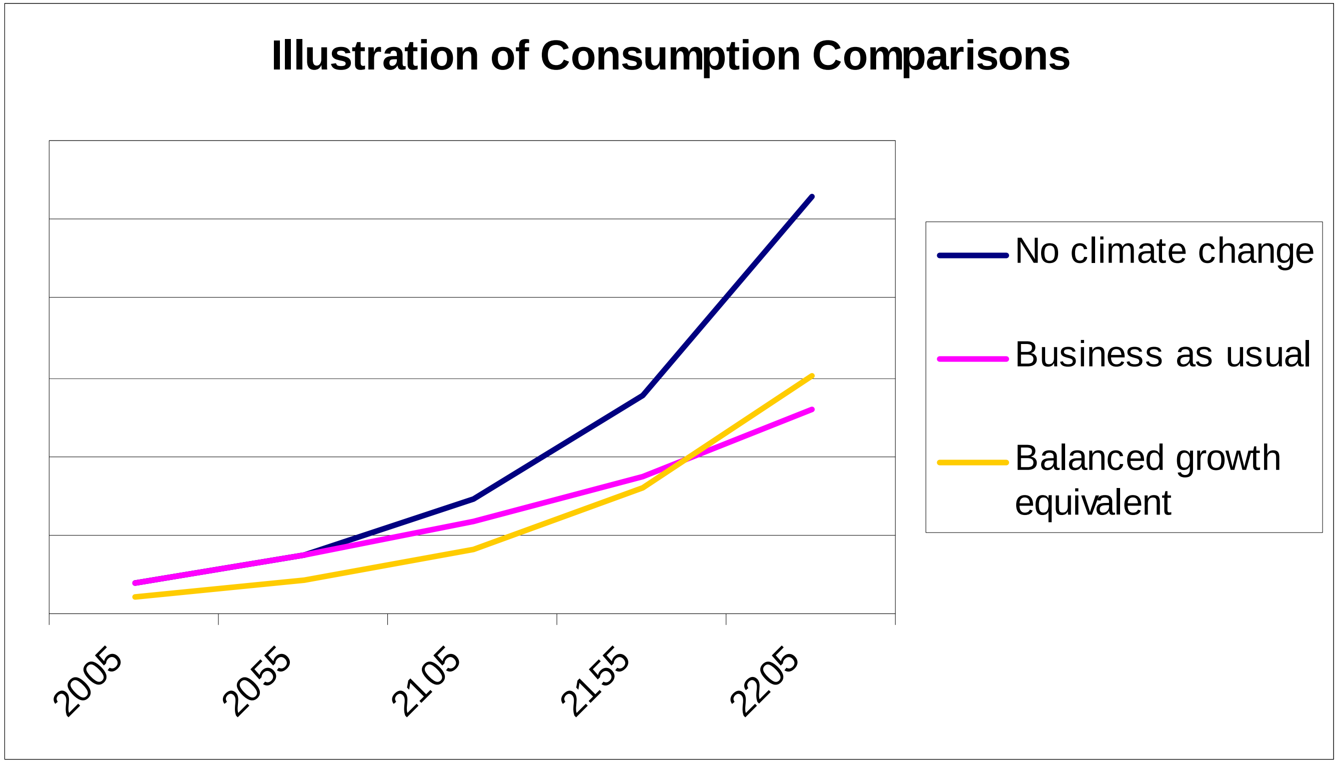
- Pure time preference rate, δ (0.1% pa)
  - no discount of welfare of future generations
  - chance of extinction
- Shadow discount rate = $\delta + \eta * g$

  \- growth (g) initially 2% pa (developed), 4% pa (Asia), reduces to 1.3% pa in long term

  \- long term shadow discount rate is 1.4% pa.

Valuation method

- How much consumption would be given up now to get the same total stream of utilities



Business as usual results

- Losses in per capita consumption “now and forever”

Scenario		Balanced growth equivalent (%)		
Climate	**Economic**	**Mean**	**5th percentile**	**95th percentile**
Baseline	**Market impacts**	**2.1**	**0.3**	**5.9**
	Market + catastrophe	**5.0**	**0.6**	**12.3**
	Market+cat+ non-market	**10.9**	**2.2**	**27.4**
High climate	**Market+cat+ non-market**	**14.4**	**2.7**	**32.6**

Increase in global temperature (relative to pre-industrial levels) for different stabilisation levels (expressed as CO_2 equivalent).

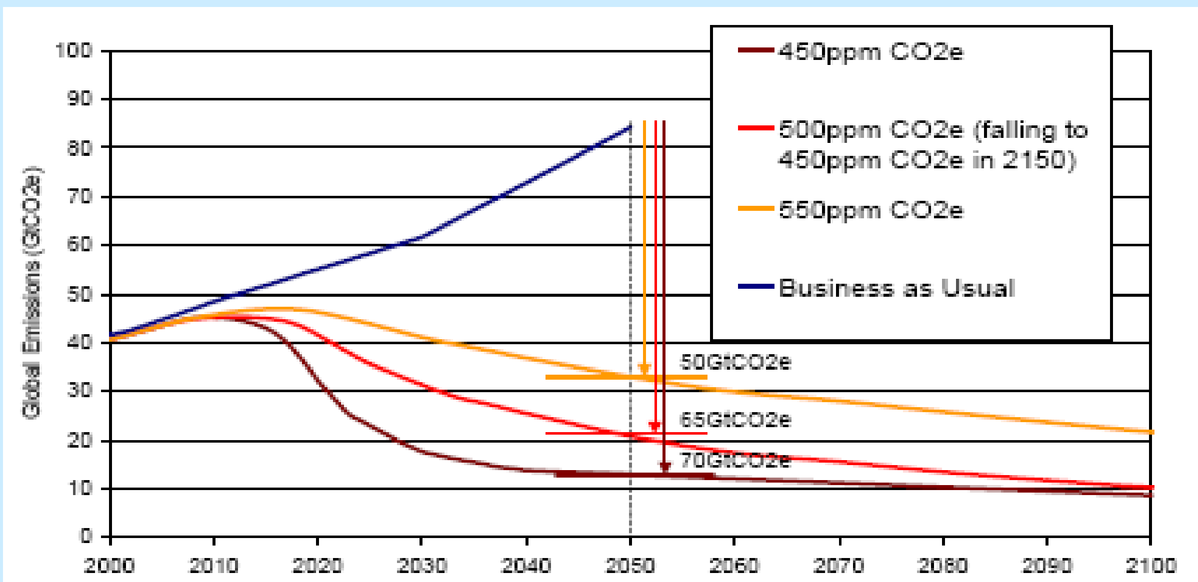
	Temperature change by 2100 (relative to pre-industrial)		Temperature change at equilibrium (relative to pre-industrial)	
Stabilisation Level (CO_2 equivalent)	Temperature change - based on IPCC 2001 climate models	Temperature change - based on 2004 Hadley Centre ensembles	Temperature change - based on IPCC 2001 climate models	Temperature change - based on 2004 Hadley Centre ensembles
400ppm	1.2° - 2.5°C	1.6° - 2.8°C	0.8° - 2.4°C	1.3° - 2.8°C
450ppm	1.3° - 2.7°C	1.8° - 3.0°C	1.0° - 3.1°C	1.7° - 3.7°C
550ppm	1.5° - 3.2°C	2.2° - 3.6°C	1.5° - 4.4°C	2.4° - 5.3°C

Source: Based on den Elzen and Meinhausen (2005). From Stern Review

BAU emissions and stabilisation trajectories

Figure 8.4 BAU emissions and stabilisation trajectories for 450 - 550 ppm CO_2e

The figure below shows illustrative pathways to stabilise greenhouse gas levels between 450 ppm and 550 ppm CO_2e. The blue line shows a business as usual (BAU) trajectory. The size of the mitigation gap is demonstrated for 2050. To stabilise at 450 ppm CO_2e (without overshooting) emissions must be more than 85% below BAU by 2050. Stabilisation at 550 ppm CO_2e would require emissions to be reduced by 60 – 65% below BAU. Table 8.2 gives the reductions relative to 2005 levels.



Source: http://www.hm-treasury.gov.uk/media/9/1/Chapter_8_The_Challenge_of_Stabilisation.pdf

Costs of emissions reduction

- Meta-analysis of model simulations
- To stabilise concentrations at 550ppm over period to 2100 is
  - Average cost 1.0% pa gross world product
  - Range of costs –2% (gains) to 5% GWP
- Similar to costs estimated for Australia by Allen Consulting for the Business Roundtable on CC
- Climate change cost still 1.1% “now and forever”
- Therefore, 1% cost of abatement measures will reduce cost from 10.9% to 1% of consumption “now and forever”

3. Social Cost of Carbon

- Value at a point in time of the future losses in welfare caused by the emission of one additional tonne of CO_2
- Result dependent on assumed future path of emissions, current concentration, discount rate, etc
- Used to compare with cost of abatement (emission permit prices)
- If SCC is higher than abatement cost then economically positive to invest in abatement
- Provides a bottom up assessment of costs/benefits of emissions reduction

SCC results

- Stern has calculated current cost of \$US85 per tonne CO_2e under BAU
- Compared with cost of \$US30 per tonne under stabilisation at 550 ppm CO_2e
- Results are dependent on assumptions so other calculations (eg W. Nordhaus) are much lower - a source of criticisms

Criticisms of assumptions

- High proportion of costs relate to post 2200
- Imply a very high rate of saving (or early investment in abatement measures)
- Better to invest in improving developing economies than in climate change action (or pay compensation in future for damages!)
- BUT will delay of action increase risk of severe & irreversible damages?

Some results of sensitivity testing

- Changes in Baseline cost of 10.9% now and forever
  - If δ = 1%, cost reduces to 4%
  - If η = 2, cost reduces to 3.4%
  - If results weighted by population instead of income, cost increases by 25% or more
  - If assume greater convexity of damage function, cost increases to 14.2%

Quotations

- Brad DeLong (Prof. of Economics, U.C. Berkeley)

"investments in controlling global warming are not risk-increasing but risk-reducing ones; they are more like buying insurance than like speculating on unproven technologies. The appropriate hurdle rate is thus lower, not higher, than for sure things".

- Stern Review report

"In many ways, the science has progressed further than the economics"

- John Quiggin (Prof. of Economics, Uni of Qld)

"*Economists can help to define the issues, but it is unlikely that economics can provide the final answer"*

Economic Modelling in Australia

There are a number of parties that model the economic impacts of climate change in Australia. These include:

- ABARE
- Treasury (for the government)
- Professor Ross Garnaut (for the Labor party)

  The Review will examine the impacts of climate change on the Australian economy, and recommend medium to long-term policies and policy frameworks to improve the prospects for sustainable prosperity. It will draw upon the significant expertise within Australia on climate change matters and place Australian policy in an international context. His web site says where appropriate, he will also be seeking submissions on specialist subject areas.

  He plans to hold a public forum in Sydney during Oct/Nov 2007 on Financial services and climate change

- Business Roundtable on Climate Change (Allen Consulting)

Questions / Comments / Ideas?

- Opportunities for actuaries
  - Insurance
  - Risk management
  - Design/management of trading schemes
  - Adaptation strategies