Climate Change Stabilisation:

A review of policies, perspectives and problems

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UNFCCC

- *The ultimate objective of this Convention……. is to achieve…...* ***stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system****.*
- But
- What changes constitute dangerous anthropogenic interference (to ecosystems, food production, and economies)?
- The uncertainty in climate sensitivity
    - the change in global mean temperature from a doubling of the pre-industrial concentration of atmospheric CO_2

Stabilisation

- From this broad concept, stabilisation usually expressed either as:
  - A level of temperature change
  - A level of CO_2 eq. ppm concentration
  - A reduction target in terms of GHG emissions.

  But note sometimes there is often confusion on metrics

  - Global temperature increase expressed, either as :
    - above pre-industrial levels (note 0.6℃ already oc curred in the 20th century),
    - or relative to 1980-1999 , or relative to 1961-1990
  - Atmospheric CO_2 concentrations,
    - either CO_2 in ppm or CO_2 equiv. in ppm

Table 1. *Proposed temperature and/or CO_2 concentration thresholds for "dangerous anthropogenic interference".*

Source	Global Mean Temperature Change (°C)[a]	Atmospheric CO_2 Stabilisation Level (ppmv)	Non-CO_2 Gases?[b]
Azar and Rodhe (1997)[12]	1.4	375	
Climate Options for the Long-Term (2002)[13]	1.5	450	
Climate Taskforce (2005)[14]	1.4	400	●
Environmental Systems Analysis Group (2005)[15]	0.9		
European Climate Forum (2004)[16]	1.9 [c]		
European Union (1996)[17]	1.4	550	
Hansen et al. (2005)[18]	1.0	475	
Klimatkommittén (2000)[19]		550	●
Mastrandrea and Schneider (2004)[20]	2.9[d]		
O'Neill and Oppenheimer (2002)[21]	2.0	450	
Rijsberman and Swart (1990) [22]	1.4		
Royal Commission on Environmental Pollution (2003)[23]		550	
Wissenschaftlicher Beirat der Bundesregierung (1995)[24]	1.3		
Wissenschaftlicher Beirat der Bundesregierung (2003)[25]	1.4		
Average	**1.5**	**475**	

[a]Relative to 1990, assuming 0.6°C of warming occurred between the industrial revolution and 1990
[b]Stabilisation targets include non-CO_2 gases on a CO_2-equivalent basis
[c]"Critical limits" estimated as 1.4-2.5°C; midpoint of this range used here
[d]Median estimate of the threshold for "dangerous anthropogenic interference"

Jones and Preston, 2006

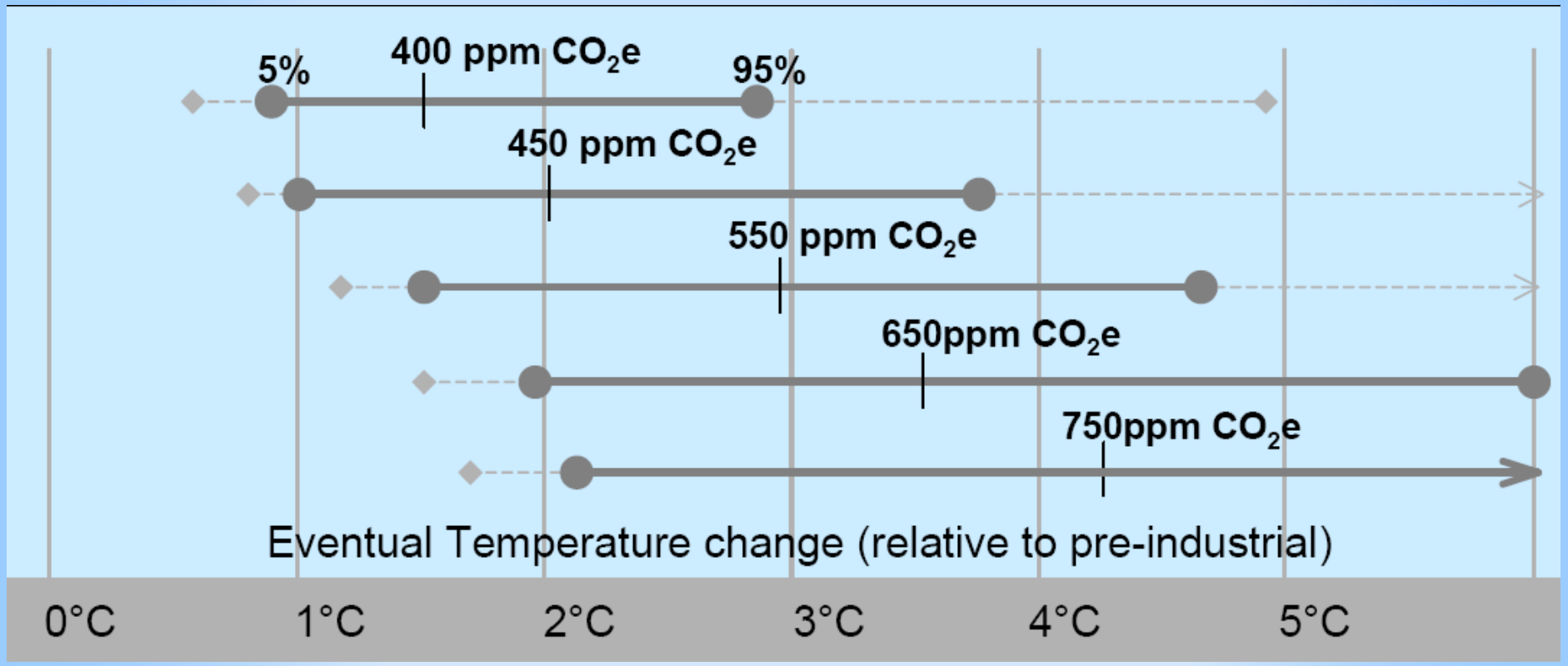
The European Union

- The European Council (1996: 2004; 2005) set out a stabilization aim
  - To limit global temperature increase to 2°C above pre-industrial levels to avoid severe impacts globally. (with 0.6°C current, effectively 1.4℃ from now)
- European Commission 2007 Communication, *Limiting Global Climate Change to 2 degrees Celsius*,
  - *By 2050 global GHG emissions must be reduced by up to 50 % compared to 1990, implying reductions in developed countries of 60-80 % (Peak 2025)*
  - *Require atmospheric concentrations of GHG to remain well below 550 ppmv CO_2 eq. By stabilising long-term concentrations at around 450 ppmv CO_2 eq. there is a 50 % chance of (of achieving 2°C).*
- The target is not based on a detailed consideration of costs and benefits or a CBA

Stern Review

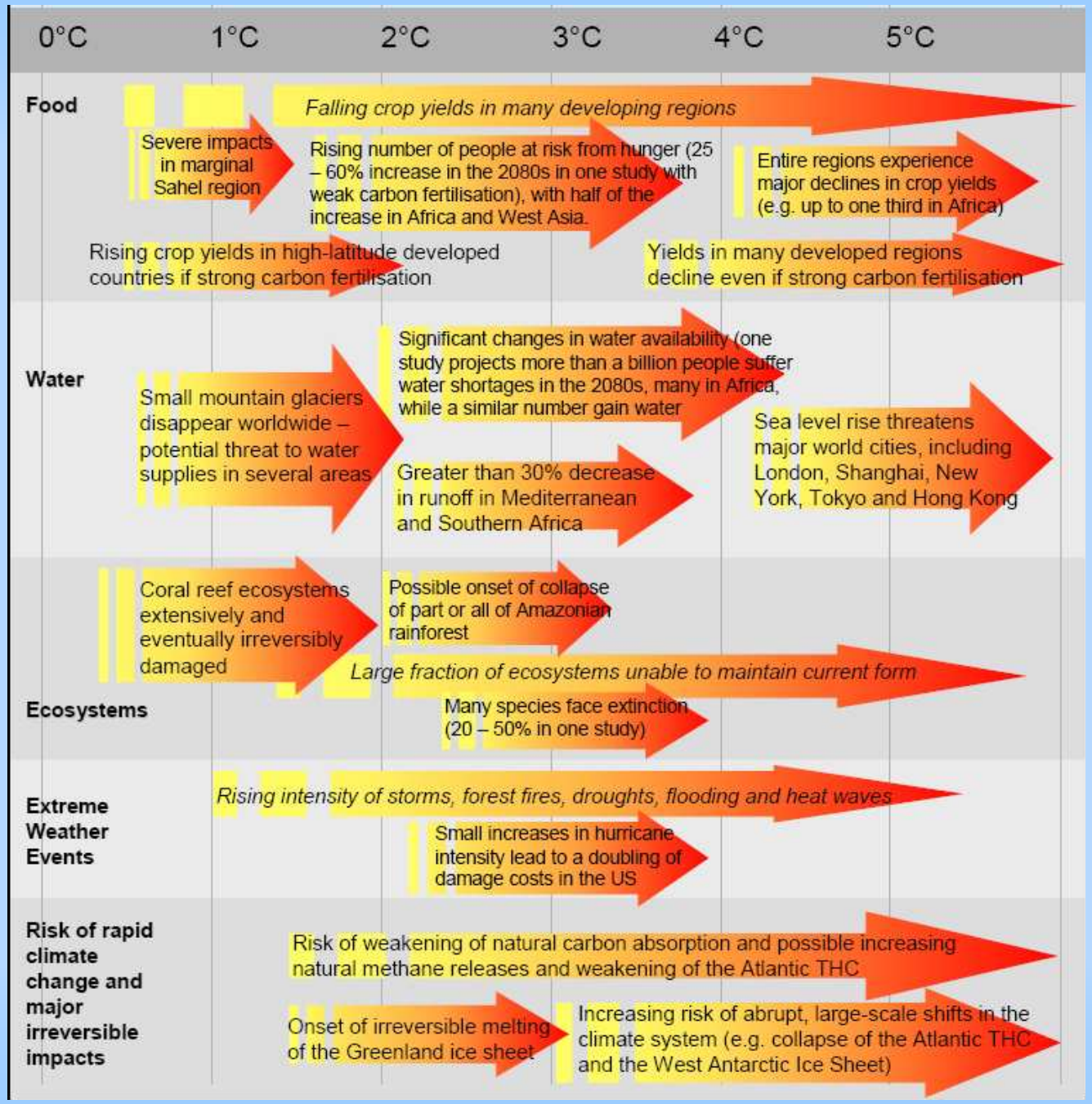
- Stabilisation of GHG gas in range 450-550ppm CO_2e. Though highlights 500-550 ppm
  - 550ppm CO_2e require global emissions to be 25% below current levels by 2050.
  - For 450ppm CO_2e, without overshooting, need to peak in next 10 years and 70% below current levels by 2050. Already almost out of reach
- Anything higher would substantially increase the risks of very harmful impacts while reducing the expected costs of mitigation by comparatively little.
- Lower end of this range would mean the costs of mitigation would be likely to rise rapidly.
- Anything lower would certainly impose very high adjustment costs in the near term for small gains and might not even be feasible.
- Stern does not do CBA, but broad brush comparison of costs (1%) and benefits (5-20%),
  - Does look at marginal social costs of different trajectories - if the target were between 450- 550ppm CO2e, then the social cost of carbon would start in the region of $25-30 per tonne of CO2 – around one third of the level if the world stays with BAU ($85).

Stern



500 to 550 implies 2.5 to 3C, i.e. 2 C from today (50%)

Based on climate sensitivity with Ensemble run
vertical line indicates the mean of the 50th percentile point and line the 5 – 95% .
The dashed lines show the 5 - 95% range based on eleven recent studies.


0°C
1°C
2°C
3°C
4°C
5°C
Food
Falling crop yields in many developing regions
Severe impacts in marginal Sahel region
Rising number of people at risk from hunger (25 – 60% increase in the 2080s in one study with weak carbon fertilisation), with half of the increase in Africa and West Asia.
Entire regions experience major declines in crop yields (e.g. up to one third in Africa)
Rising crop yields in high-latitude developed countries if strong carbon fertilisation
Yields in many developed regions decline even if strong carbon fertilisation
Water
Small mountain glaciers disappear worldwide – potential threat to water supplies in several areas
Significant changes in water availability (one study projects more than a billion people suffer water shortages in the 2080s, many in Africa, while a similar number gain water
Greater than 30% decrease in runoff in Mediterranean and Southern Africa
Sea level rise threatens major world cities, including London, Shanghai, New York, Tokyo and Hong Kong
Ecosystems
Coral reef ecosystems extensively and eventually irreversibly damaged
Possible onset of collapse of part or all of Amazonian rainforest
Large fraction of ecosystems unable to maintain current form
Many species face extinction (20 – 50% in one study)
Extreme Weather Events
Rising intensity of storms, forest fires, droughts, flooding and heat waves
Small increases in hurricane intensity lead to a doubling of damage costs in the US
Risk of rapid climate change and major irreversible impacts
Risk of weakening of natural carbon absorption and possible increasing natural methane releases and weakening of the Atlantic THC
Onset of irreversible melting of the Greenland ice sheet
Increasing risk of abrupt, large-scale shifts in the climate system (e.g. collapse of the Atlantic THC and the West Antarctic Ice Sheet)

IPCC AR4, WGII

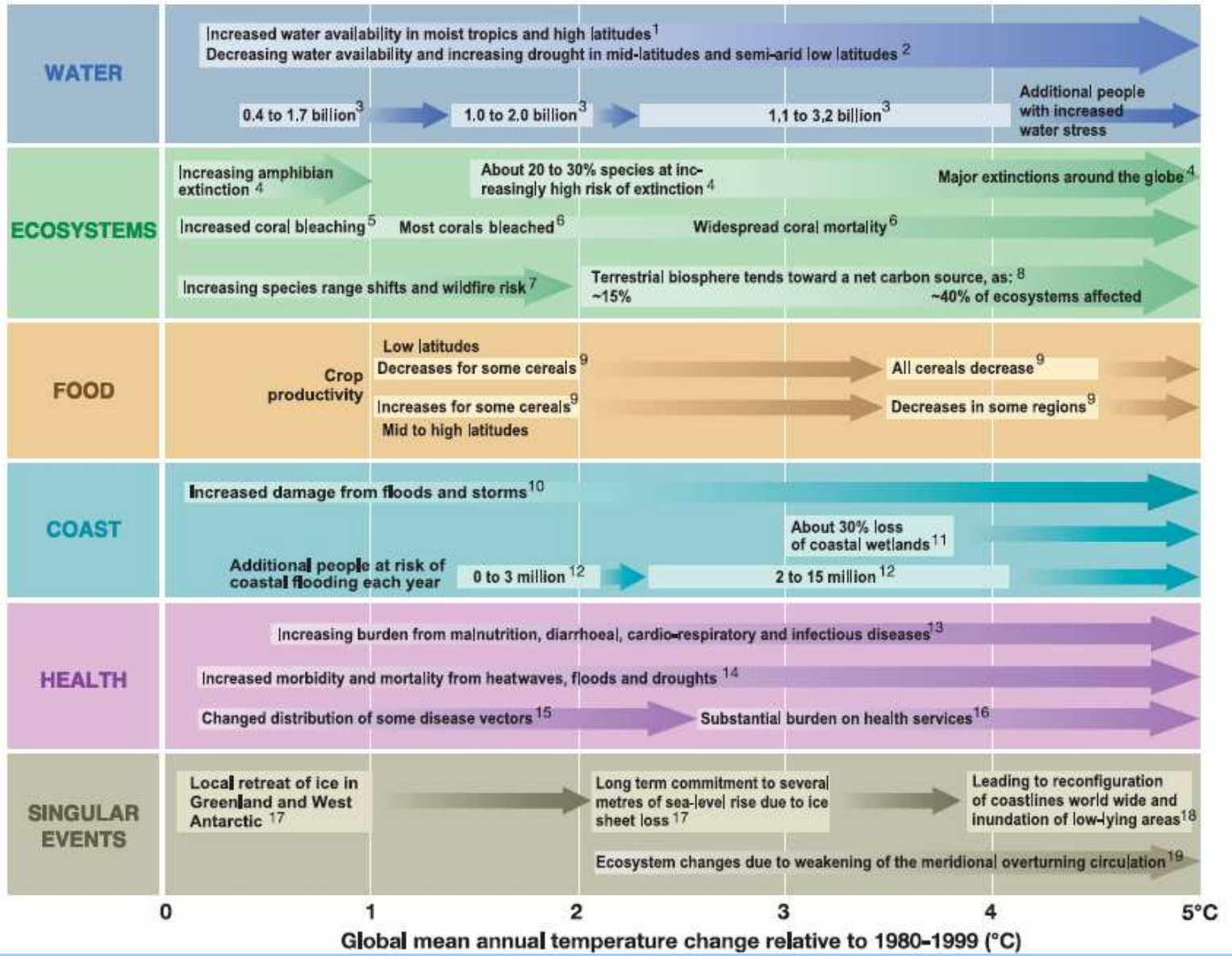
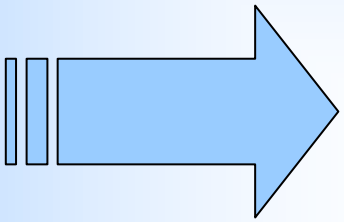


Table TS3, note benchmarked to 1980 - 1999

Stabilisation objectives and perspectives

- The decision is, at most, only partly scientific. It is dependent on the decision making approach, and ethical and moral perspectives…. Following interviews

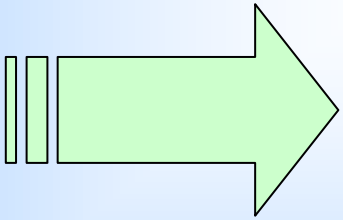
Economic framework



Economic Costs and benefits (cost benefit analysis)
- Note uncertainty on parameters/perspectives (Watkiss et al)

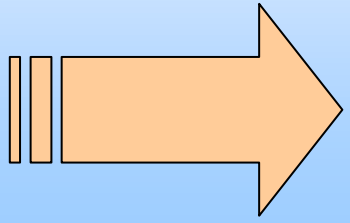
a) Conventional (descriptive)
b) Concerned global view (prescriptive)
c) Wider framework

Environmental (risk) framework



Risk approach to standard and major events, including tolerable windows (cost-effectiveness analysis)
- Risk analysis
- Pre-cautionary (tipping points, major ecological function

Social framework



Social practice methods/social learning
- Human well-being and social indicators
- Inequality and distributional effects
- Health, settlement and welfare, values, beliefs, cultural dimensions, as well as development issues

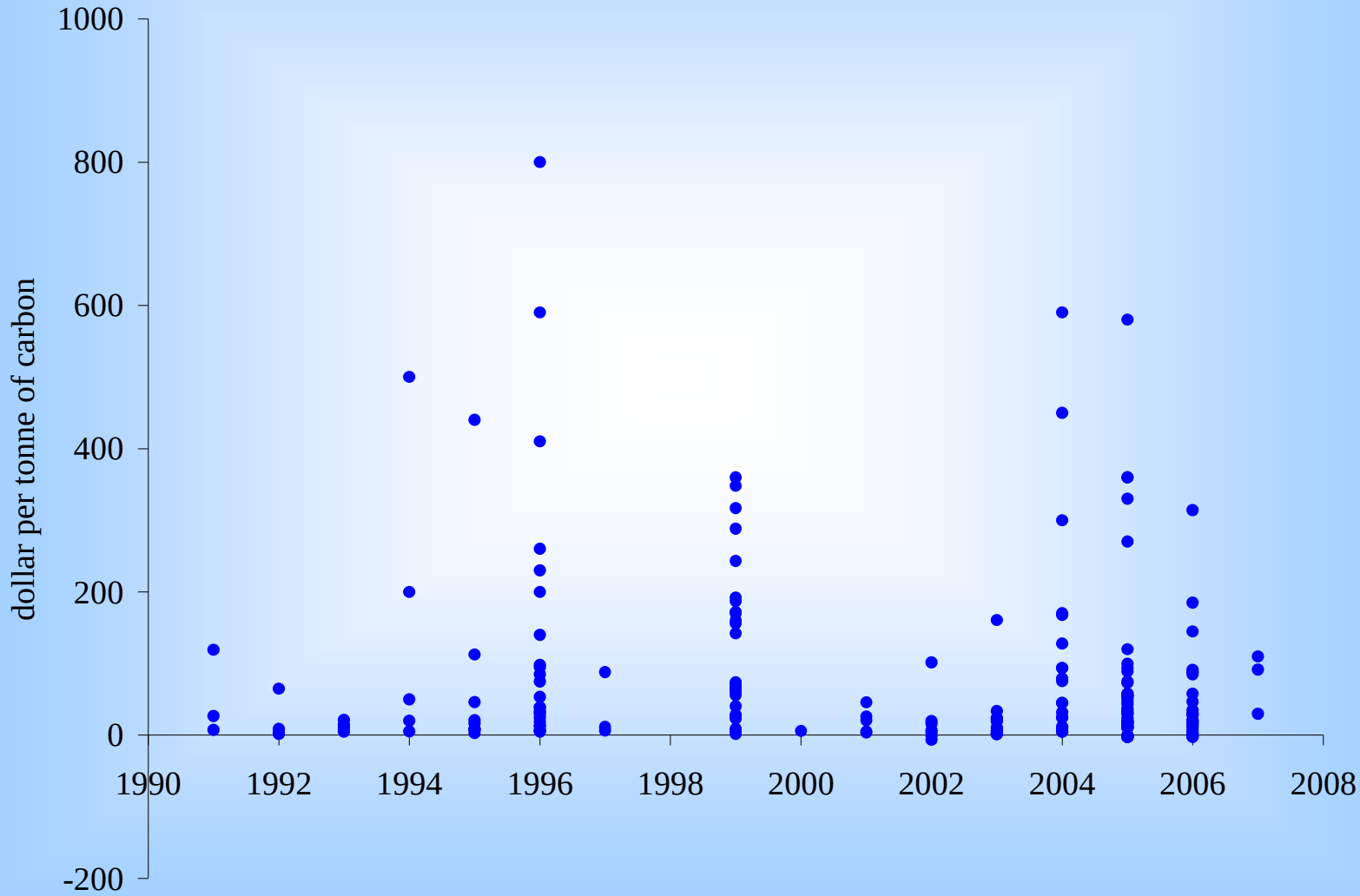
So how should we set stabilisation objectives?

- Stakeholders (for the 3 perspectives) have fundamentally different views
  - They will therefore come to different conclusions (on stabilisation level)
  - Value judgements of individuals within a framework are usually fixed – someone with a strong social perspective will not (ever) be convinced by the economics
- It is not possible to come up with a single framework (that everyone supports)
- The key is to regard the decision making frameworks as complements
- (this is acceptable (indeed necessary) while there are large evidence gaps)

An Economic Approach – Social Costs

- Economic costs of climate change occurring
- Also known as ‘costs of inaction’, or social costs of climate change
- Most useful the marginal social cost (MSC), or social cost of carbon
  - net present value of climate change impacts over the next 100 years (or longer) of one additional tonne of carbon emitted to the atmosphere today. It is the marginal global damage costs of carbon emissions.
  - Generally, more recent MSC values are lower, because they include adaptation

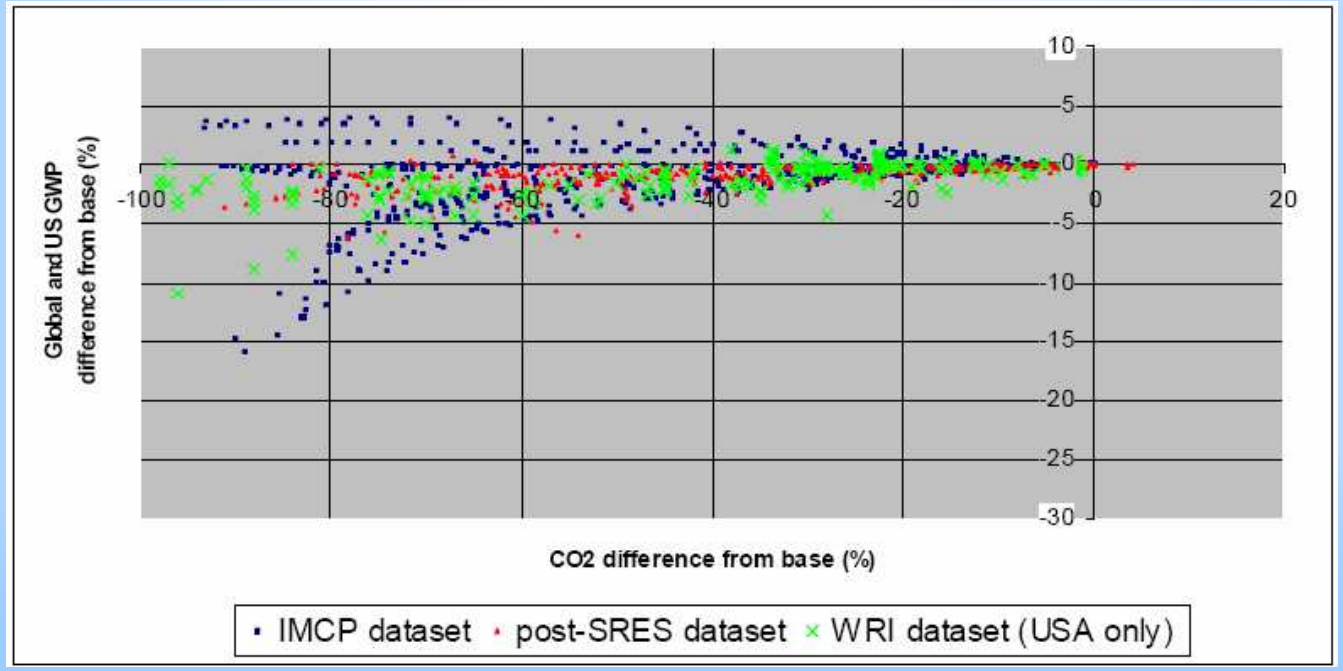
Marginal Social Costs



Tol, 2007. update of Tol, 2005

Comparing to the marginal abatement costs

- Wide variation in the literature on marginal abatement costs (>1 Order Mag.)
- Stern: Trajectory to stabilisation at ~ 500-550ppm CO_2e clustered in the range of –2% to 5% of GDP, with an average around 1% of GDP to 2050
- Even this implies MAC higher than most MSC estimates. MAC of aggressive stabilisation scenarios towards the EU 2 degrees target much higher



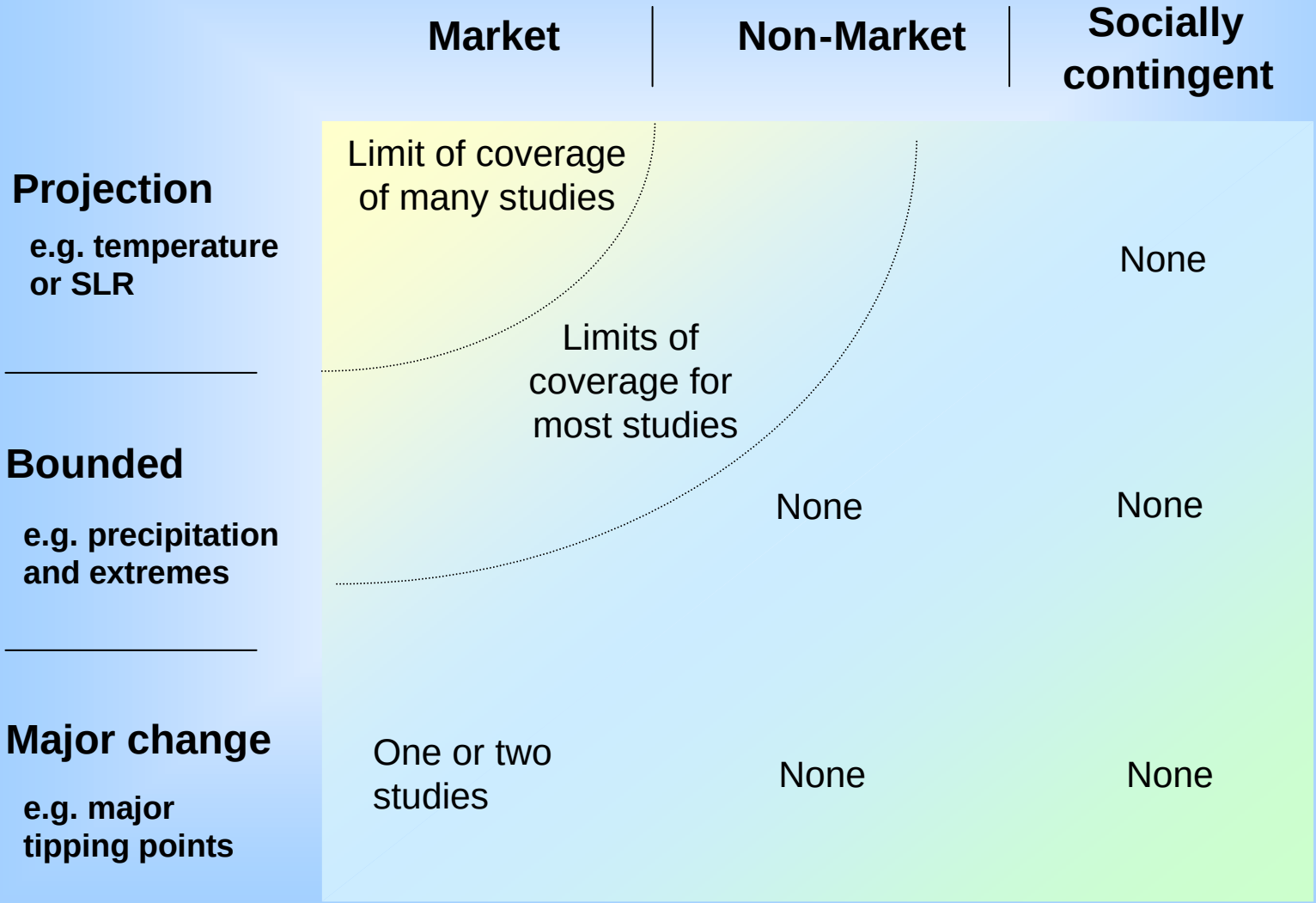
Barker et al, 2006

But MSC only includes what we can model

Uncertainty in Predicting Climate Change ↓	Uncertainty in Valuation →			
		Market	**Non Market**	**(Socially Contingent)**
	Projection (average temp sea level rise)	Coastal protection Loss of dryland Energy (heating/cooling)	Heat stress Loss of wetland	Regional costs Investment
	Bounded Risks (e.g. reg. prec., floods, storms)	Agriculture Water Variability (drought, flood, storms)	Ecosystem change Biodiversity Loss of life Secondary social effects	Comparative advantage & market structures
	System change & surprises (e.g. major events)	Above, plus Significant loss of land and resources Non- marginal effects	Higher order social effects Regional collapse Irreversible losses	Regional collapse

Source: Tom Downing and Paul Watkiss, 2003

We know that numbers likely to be a sub-total



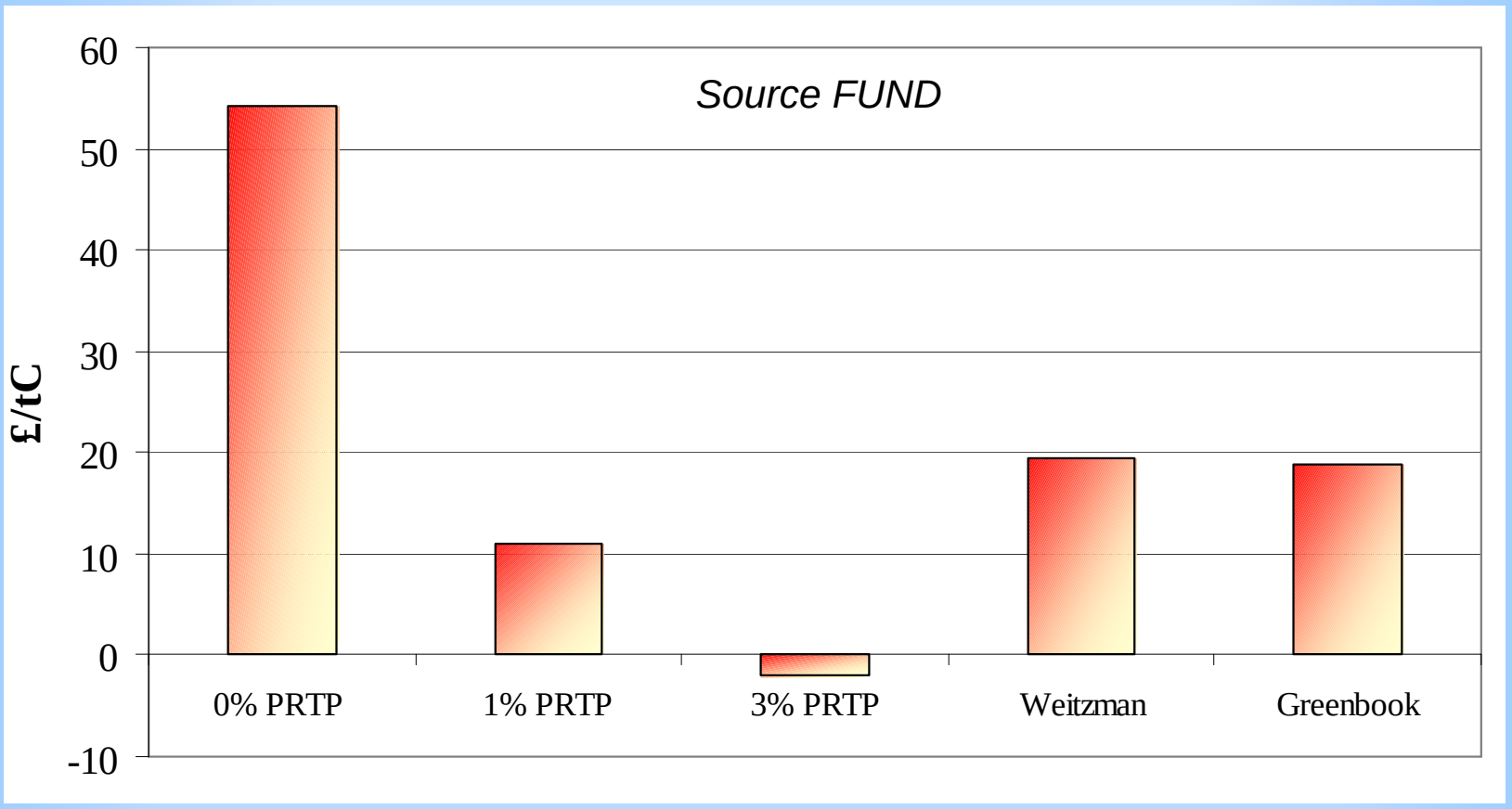
Missing elements will include positives and negatives, but more likely to be negative

Source: Watkiss et al, 2006

Values are determined by parameter choice

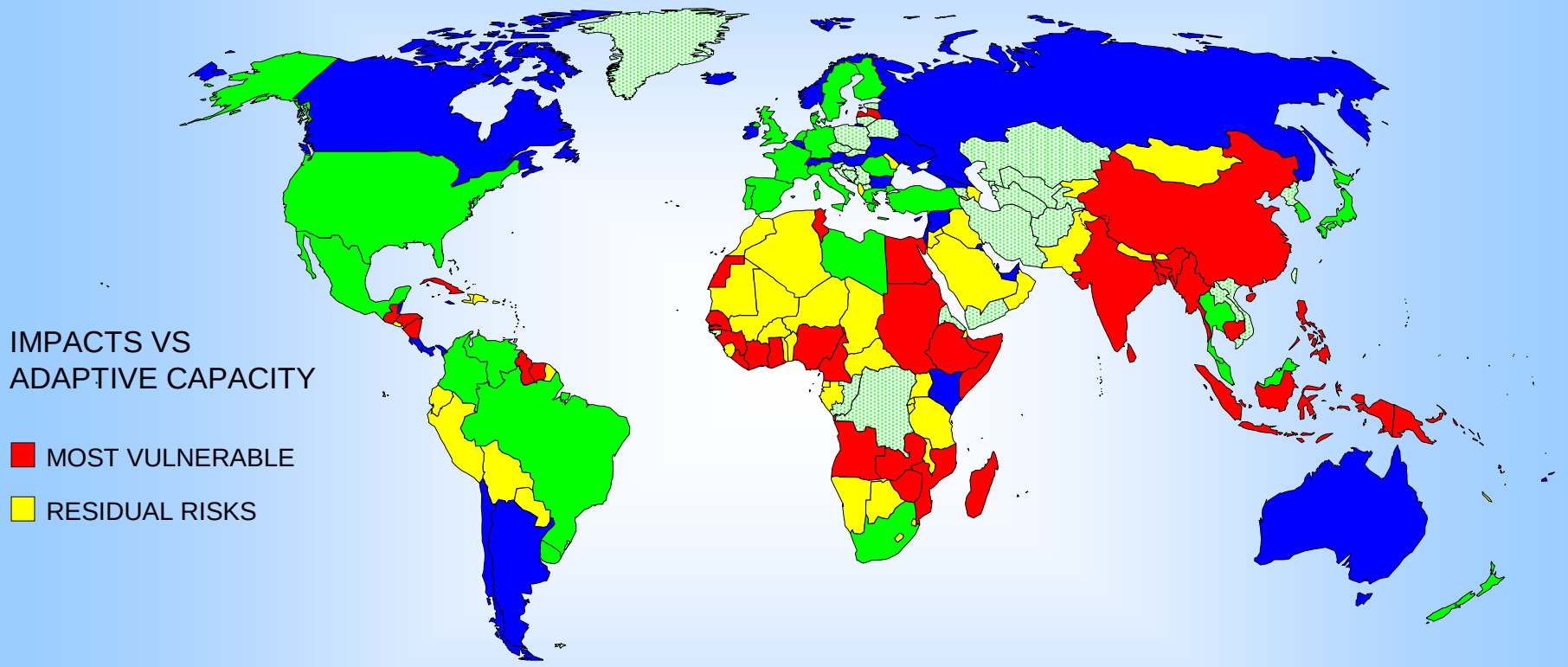
- Discounting
- Equity
- Uncertainty / Risk Aversion (central or probabilistic, tails)
  - Parameter choice is subjective – different perspectives lead to different assumptions / values
- Note also varies with trajectory we are on, and period of emission

Discounting



(Stern used 0.1% PRTP)

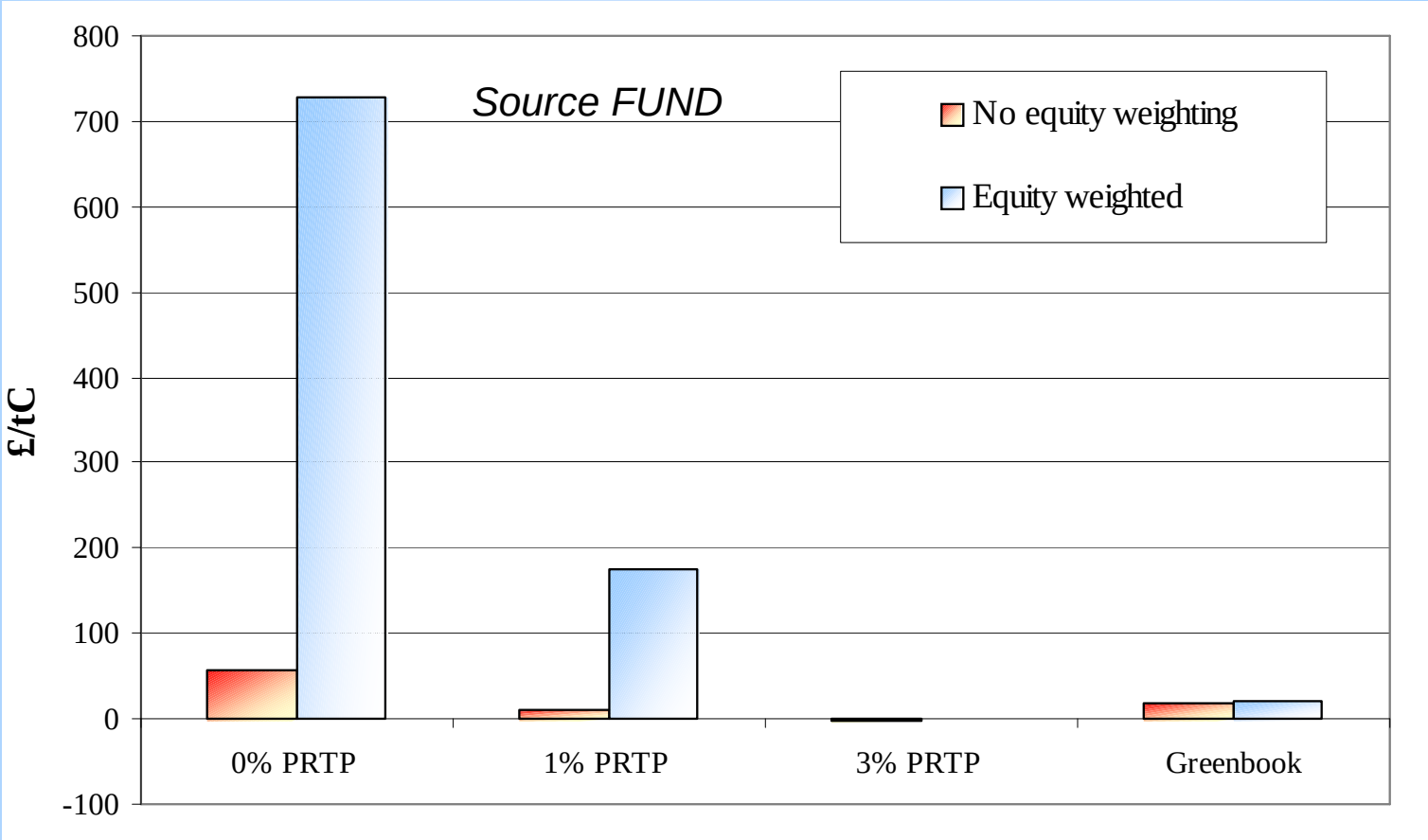
Equity – Distributional Effects



- Poorer countries likely to be net losers, as more vulnerable
  - climate-sensitive activities, close to tolerances, poorly prepared to adapt

How adjust impacts in regions (equity weighting)

The Effect of Equity Weighting

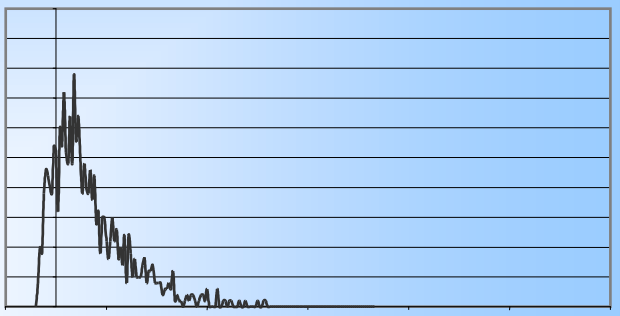


Stern used ad hoc weighting.

BUT considering equity leads to inconsistency with other policy, We do not apply these types of equity weights to other international issues (e.g. trade, aid)

Risk - Statistical Reporting

- Uncertainty (Monte Carlo) is strongly skewed
  - Mean is higher than median or best guess



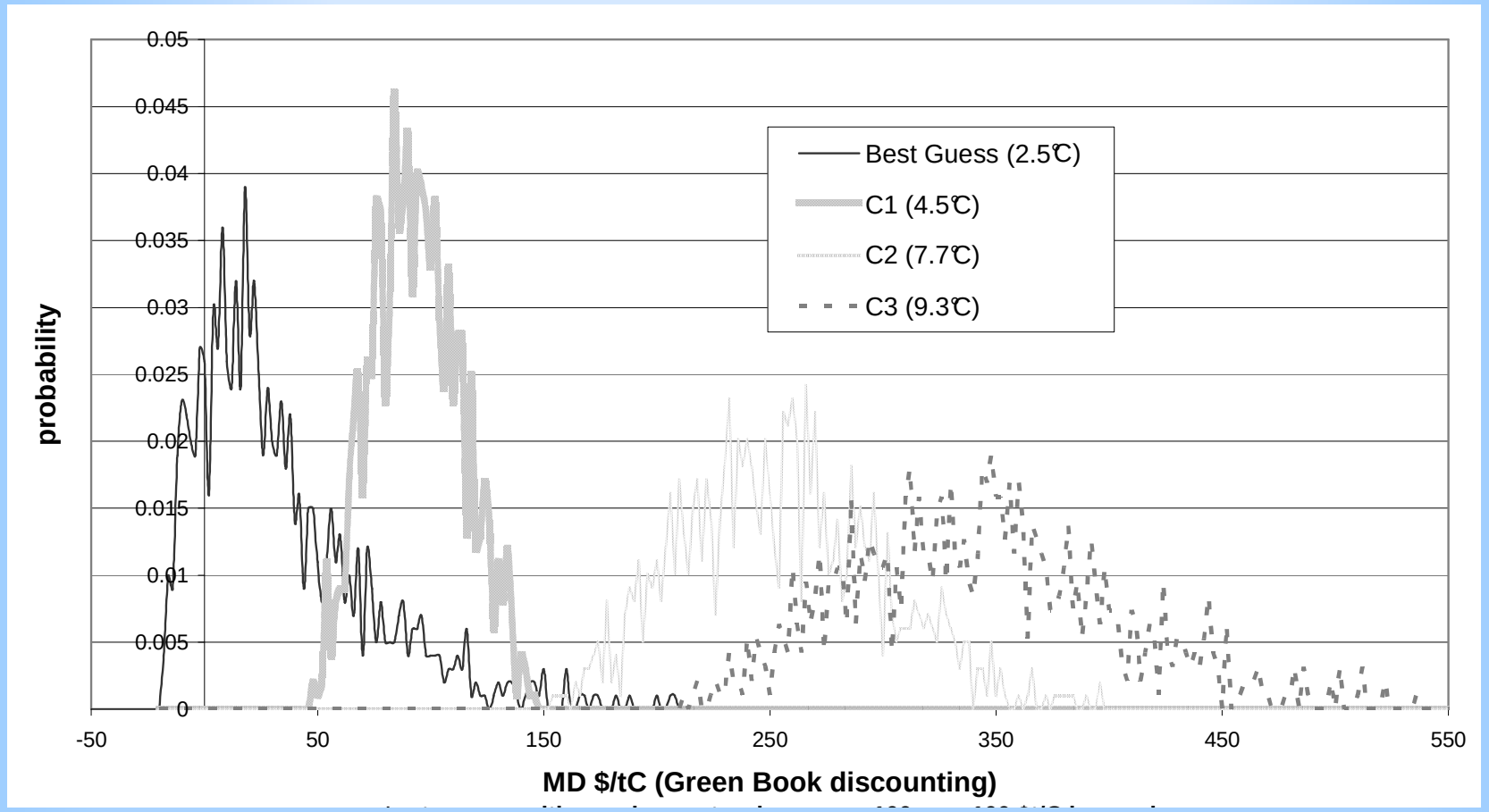
Climate sensitivity

- Previous values = 2.5°C; input to Monte Carlo = 1.5 to 4.5°C
- New IPCC 2007 WG1 = range 2 to 4.5°C with a best estimate of 3°C

Emerging discussion of deep uncertainty and economics for extreme tail probabilities (Weitzman, 2007)

(unknown scale (climate sensitivity) has the potential to dominate expected-utility cost-benefit calculations, and so conventional Monte Carlo simulation is misleading)

Climate Sensitivity



Ceronsky (2004).

So which parameters to use (1)

- Given current state of economic analysis (and IAMs)
- If one adopts a conventional marginal economic appraisal perspective (desc.)
  - Standard discount rates (4% SRTP in Europe = 2% PRTP)
  - No equity weighting
  - Standard approach to risk – median values (or best guess)
- Gives a low value – can't justify any current stabilisation targets (even 550)

GHG	Model	Study	Price year	Statistical metric	Discount	Equity	Value
CO2	FUND	MethodEx 250 yr	€2005	median	1% PRTP	SS	2.0
CO2	FUND	NEEDS	€2005	median	1% PRTP	SS	4.3

So which parameters to use (2)

- If one adopts a different decision perspective (e.g. benign global dictator, concerned global policy maker), prescriptive
  - Low discount rates (declining PTRP?)
  - Consideration of equity weights
  - Risk aversion – mean values and risk aversion
- Higher values - may be able to justify modest stabilisation (e.g. 550ppm), but are considering climate change is special - and can't justify ambitious stabilisation

GHG	Model	Study	Price year	Statistical metric	Discount	Equity	Value
CO2	FUND	MethodEx 250 yr	€2005	5% trim. Mean	1% PRTP	EW	25.7
CO2	FUND	MethodEx 250 yr	€2005	1% trim. Mean	1% PRTP	EW	49.6

Is Climate Change Special?

Interviews 2 years ago – wide range of views (yes and no)

2 years on – some individual thoughts……

- Global perspective (not national) - unusual but not exceptional (e.g. Montreal)
- Long-life times - unusual but not exceptional
- Potentially a non-marginal change – exceptional
- Duty of care/human rights (DC) – unusual but other issues have these aspects
- Distribution – involves very severe distributional and inequality issues
- Sustainability – involves very unusual levels of substitution (weak sust.)
- Risk – very unusual (e.g. tail)

Adaptation

- Mitigation vs. Adaptation
- Theoretically, there is an optimal point which considers the optimal balance of mitigation and adaptation, vs. the costs of business as usual
- Good studies to illustrate (e.g. Bosello)
- However, until we have better data on climate sensitivity, and have completed the risk matrix, very difficult to do this
- Something that will need to be explored as evidence improves
- Is an urgent need to progress information on the costs and benefits of adaptation

Reflections

- The economics of climate change policy should be considered when thinking of stabilisation. However, existing stabilisation policy does not pass a cost benefit test with available economic information and conventional decision parameters
- To justify (modest) stabilisation, need to adopt a number of prescriptive parameter inputs, that effectively assume climate change is a special case
- But studies of risk / precautionary perspectives and/ or social perspectives almost all advocate ambitious stabilisation
- Implicitly, they argue that the economic components of the rest of the risk matrix provides the benefits to justify ambitious stabilisation levels
- We need to fill the matrix !

Summary

- There is no consensus, only individual viewpoints !
- The lack of information precludes setting a long-term stabilisation target with confidence – some of the literature recognises this and therefore advocates short-term action (and research to provide better information) …
  - but which path?....given the risks a higher of short-term ambition might be warranted
- Economics has an essential role in decision making of stabilisation, but is partial until we fill the matrix. The economics of climate change is a key research priority
- Other decisions frameworks are useful as complements, but we should recognise that they involve implicit decisions (e.g. implicitly using low discount rates, equity weights)
- Emerging view that Stern was probably right, but for the wrong reasons, i.e. should start now on stabilisation path….
  - maybe this is a little unfair…..Stern may well have been right for the right reasons (but not necessarily the right analysis)