Climate Change and Global Growth: A New Framework for Policy

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Structure of the Presentation

1. The problems
   - mitigation: holding warming to less than 2ºC requires 450 ppm CO2e stabilisation; this is no longer achievable
   - adaptation: current methods give inadequate basis for policy (IPCC AR4 has warming at 1.4ºC-6.4ºC by 2100)
2. The current framework – uncertainty and long run equilibrium concepts contribute to the problems
3. Towards a new framework – focusing on medium term dynamics with allowance for new knowledge/technology
4. Putting empirical and operational flesh on this framework
5. Future research requirements for the new framework

1. The problems

- The mitigation impasse
  - ‘dangerous warming’ is greater than 2ºC (a premise here)
  - holding warming to <2ºC with 50% probability requires CO2e stabilisation at 450 ppm (eg IPCC AR4)
  - given the current global growth path, stabilisation at 450 ppm is not in practice achievable
- The adaptation problem
  - adaptation planning requires reliable regional warming projections and risk assessment
  - IPCC AR4 concludes that global warming by 2100 could be between 1.1º C and 6.4º C

Estimates of equilibrium global warming, for given GHG stabilisation levels

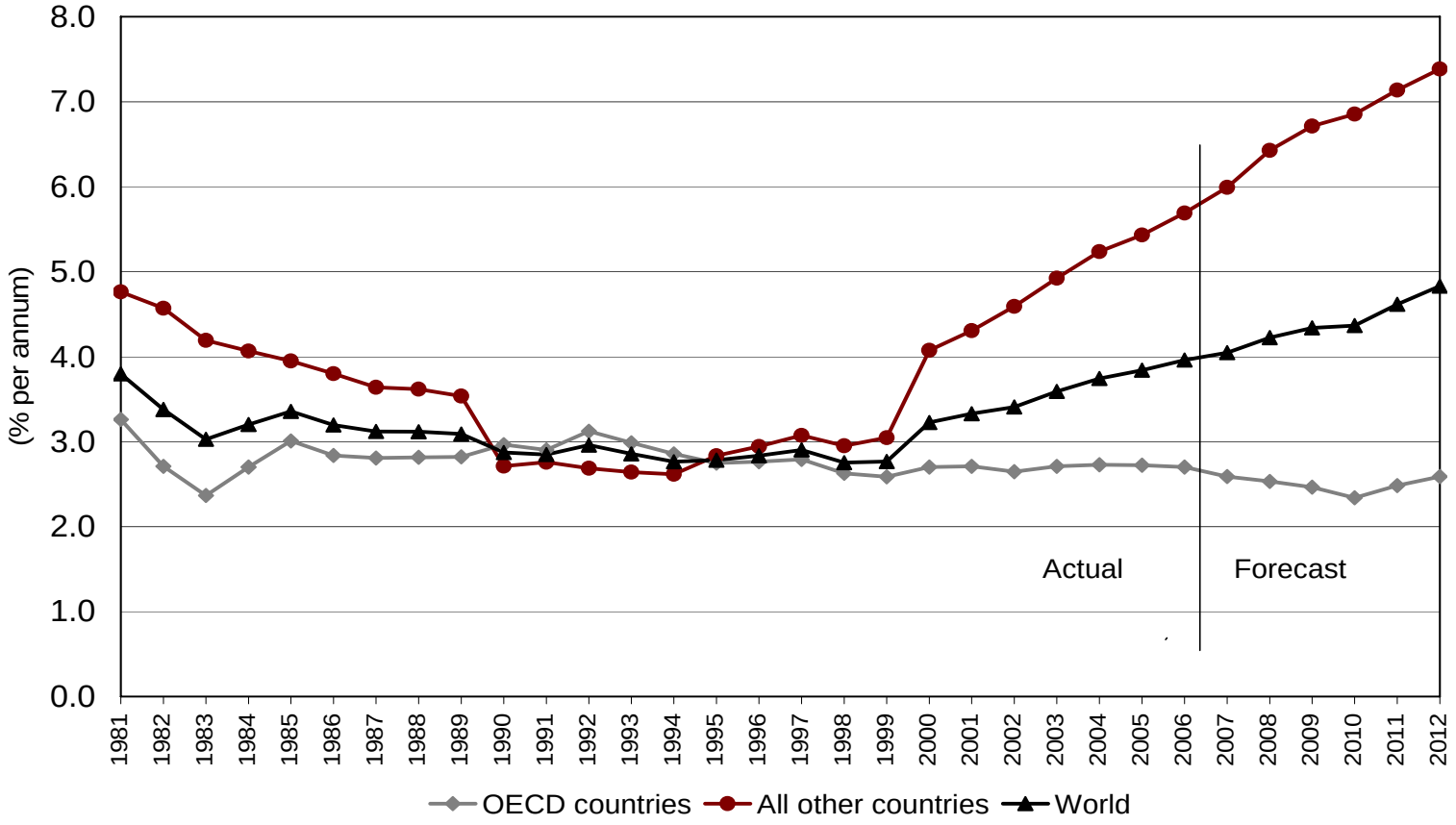
Global warming	**Equilibrium CO_2-e level, ppm**				
	350	**450**	**550**	**650**	**750**
	Equilibrium global mean surface warming (relative to pre-industrial levels, ^{o}C				
Best estimate	1.0	2.1	2.9	3.6	4.3
Very likely above	0.5	1.0	1.5	1.8	2.1
Likely in the range	0.6-1.4	1.4-3.1	1.9-4.4	2.4-5.5	2.8-6.4

Source: IPPC, Fourth Assessment Report, WGI, Table TS.5.

The new global growth path

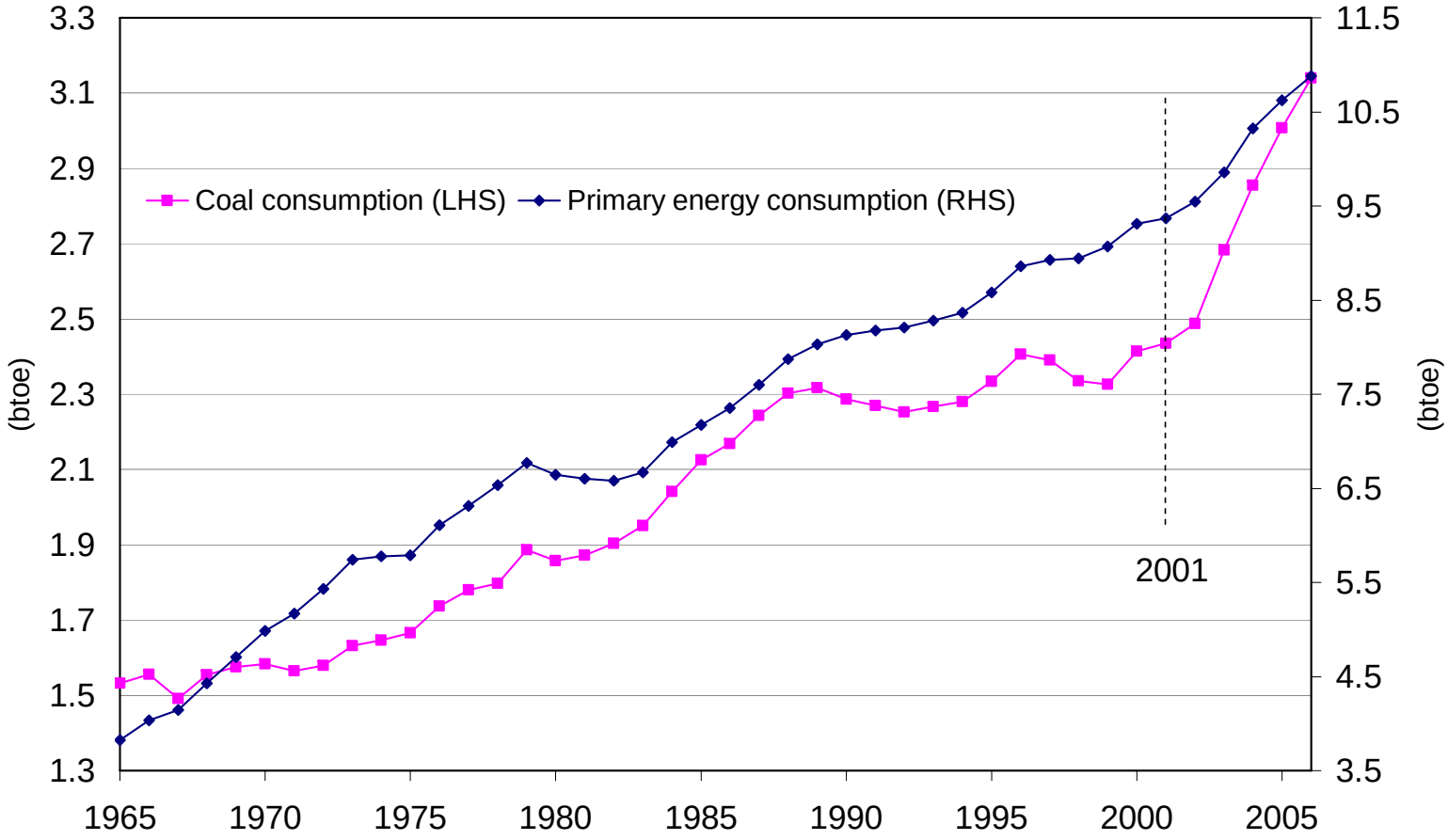
- Global growth has accelerated in the past decade, driven by the developing countries, especially China and India
- This growth is energy and coal intensive, and likely to continue
- Realistic projections of energy use and CO2 emissions from fuel combustion to 2030 are above any of the SRES marker scenarios, including A1FI
- Other emissions of GHGs are higher than anticipated in the SRES scenarios, and will in part reflect this global growth

Long-term growth in GDP in the OECD and non-OECD areas, 1982–2012 (ten-year moving average annual growth in GDP, at ppp prices)



Source: IMF (2007) World Economic Outlook, Washington DC.

Global primary energy consumption and coal consumption, 1965–2006

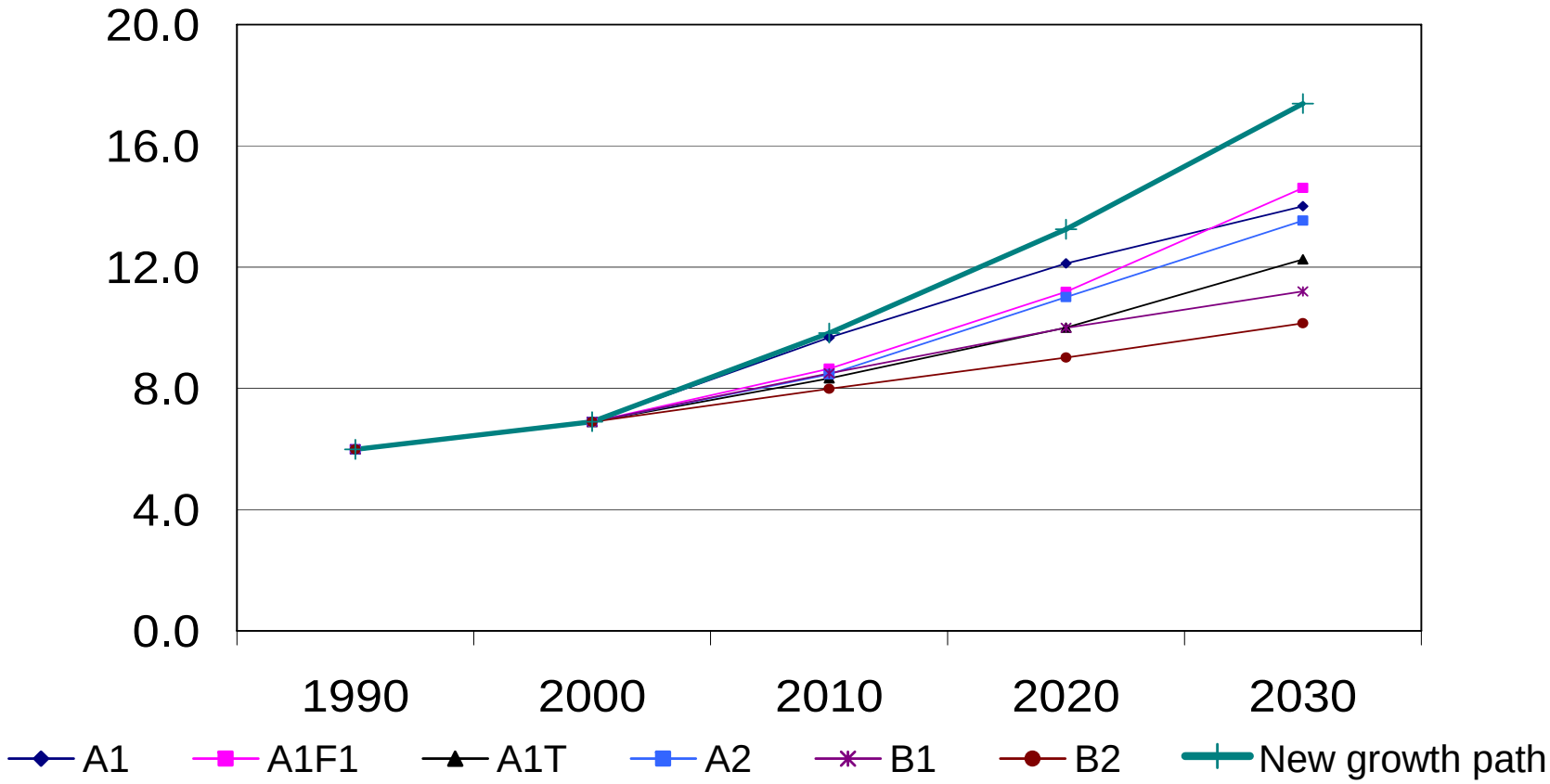


Source: British Petroleum (BP) (2007) Statistical Review of World Energy 2007, London.

Implications of the new growth path for GHG emissions and atmospheric concentrations

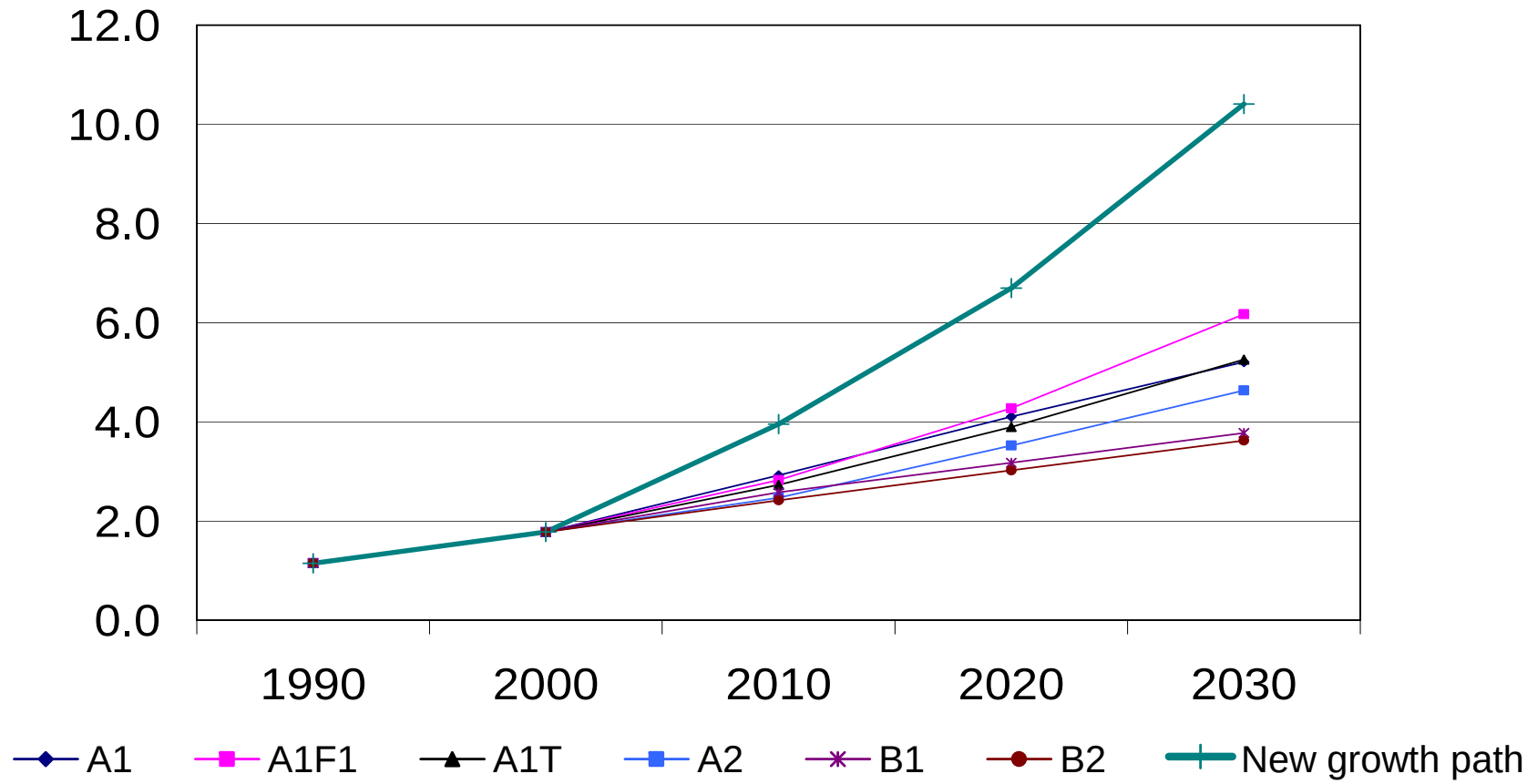
- To explore the implications of the new growth path it is necessary to
  - develop a reference case projections of CO2 emissions from fuel combustion to 2030
  - make assumptions about the path of other emissions
  - develop paths for emissions after 2030 (here minimum emissions paths, from different times)
  - explore CO2-e concentrations and temperatures in a small climate model (here MAGGIC)
- This was done in Sheehan, Jones et al.
- Even with a minimum emissions path from 2010 atmospheric GHG concentrations approach 600 ppm.

CO_2 emissions from fuel combustion and cement production, SRES scenarios and new growth path projection to 2030, world (GtC)



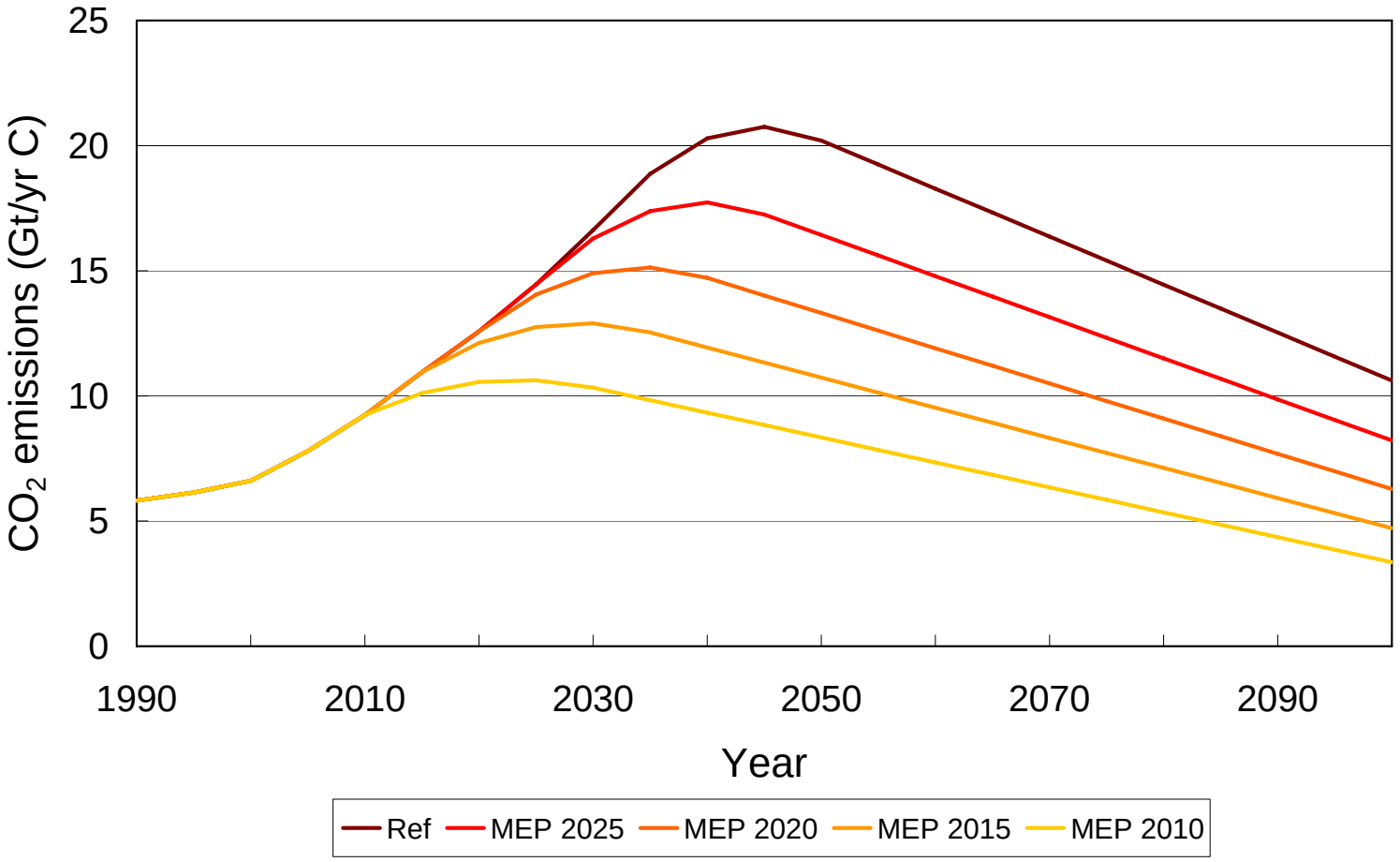
Sources: Nakiçenovic and Swart (2000), Sheehan, Jones et al. (forthcoming 2008). Global Environmental Change.

CO_2 emissions from fuel combustion and cement production, SRES scenarios and new growth path projection to 2030, Asia (GtC)



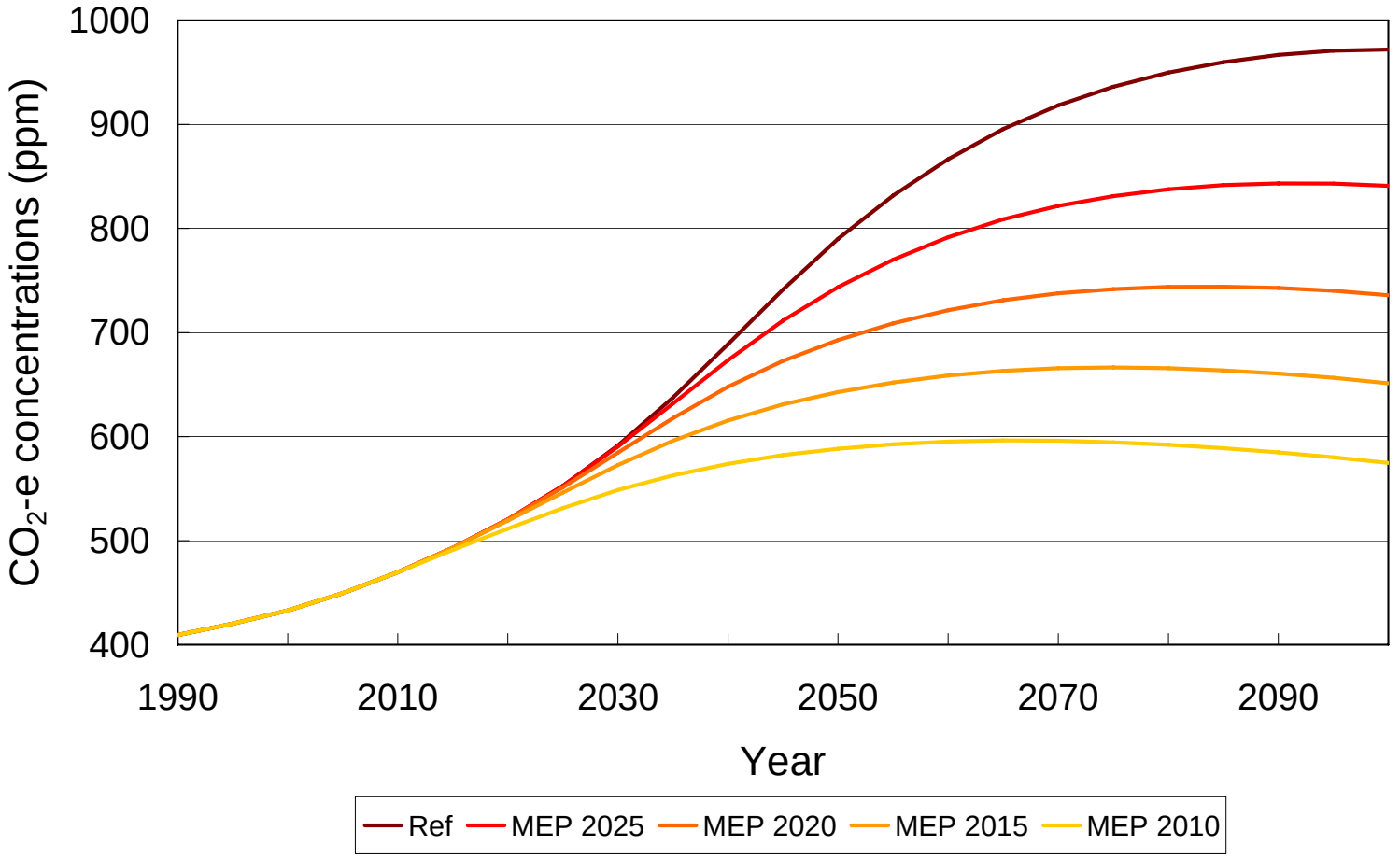
Sources: Nakiçenovic and Swart (2000), Sheehan, Jones et al. (2008).

CO_2 emissions for alternative paths



Source: Sheehan, Jones et al. (2008).

CO_2-e concentrations for alternative paths



Source: Sheehan, Jones et al. (2008).

Implications for emission reductions to achieve given stabilisation levels

- The estimate of required emissions reductions to achieve given stabilisation levels in AR4, and widely debated at Bali, rely on a range of scenarios within the SRES marker set
- The range shown correspond to the 15th to 85th percentile distribution of 177 post TAR scenarios
- As a result, they are unreliable guides to the extent and distribution of the emission reductions necessary to achieve given stabilisation targets

Estimates of required emissions reductions, for given levels of GHG stabilisation and equilibrium global warming, in IPCC AR4

	Equilibrium CO_2-e level (ppm)			
	445-490	**490-535**	**535-590**	**590-710**
Global mean warming (best estimate)	2.0-2.4	2.4-2.8	2.8-3.2	3.2-4.0
Peaking year for global CO_2 emissions	2000-15	2000-20	2010-30	2020-60
Change in global CO_2 emissions over 2000-50 (% of 2000 emissions)	-85 to -50	-60 to -30	-30 to +5	+10 to +60

Source: IPPC, Fourth Assessment Report, WGIII, Table TS.2.

The problems

- The mitigation impasse
  - ‘dangerous warming’ is greater than 2ºC (a premise here)
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  - given the current global growth path, stabilisation at 450 ppm is not in practice achievable
- The adaptation problem
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2. The current policy framework

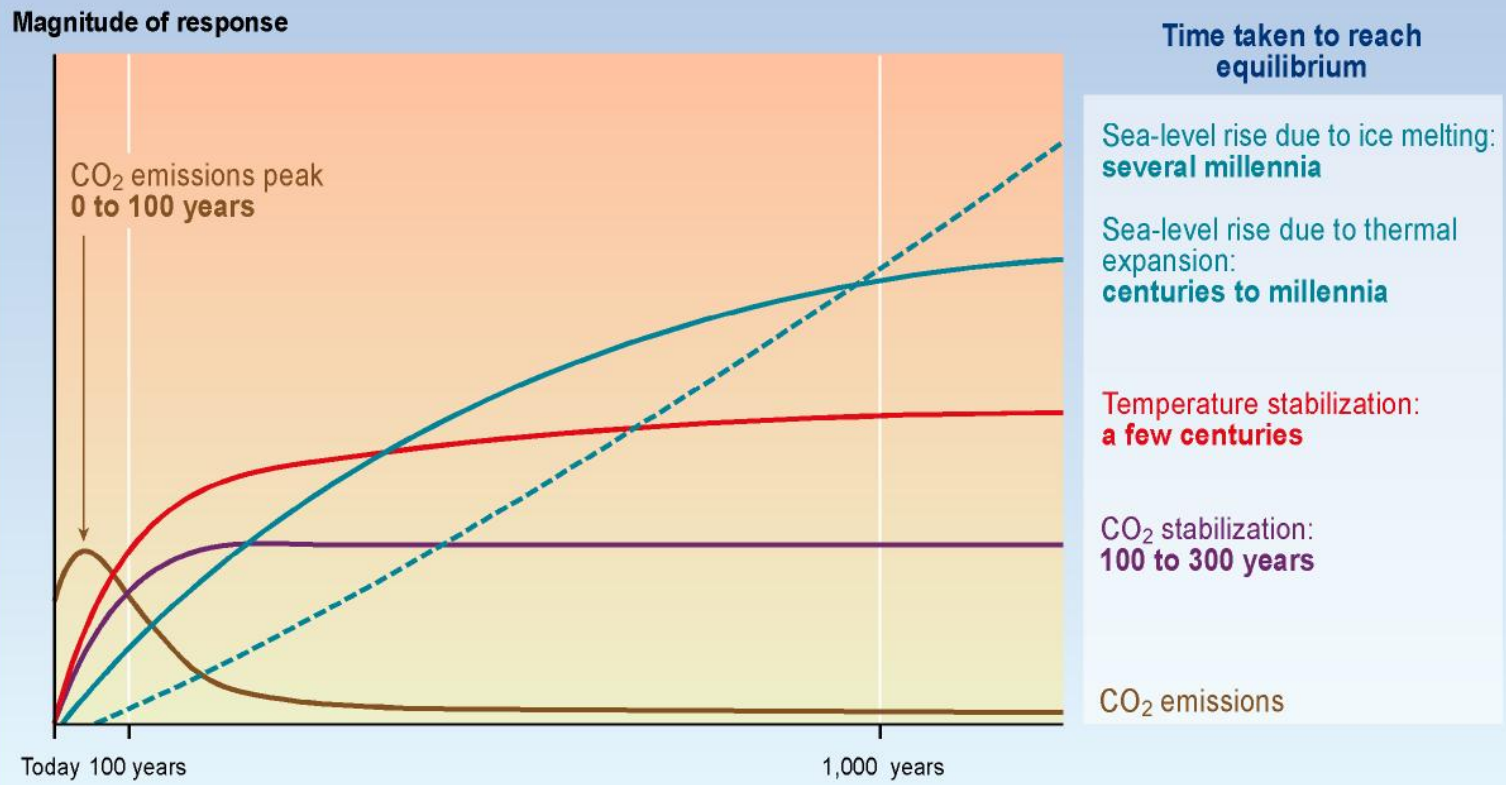
Three broad areas of uncertainty:

- the evolution of global economies and societies, and hence the level of emissions;
- the warming implications of a given emissions path; and
- the available technologies, both medium and long term

Key long run equilibrium concepts used to define the current framework:

- the CO2-e stabilisation level;
- the long run equilibrium temperature increase; and
- climate sensitivity (the increase in equilibrium global temperature resulting from a doubling of CO2-e concentration levels)

CO_2 concentration, temperature, and sea level continue to rise long after emissions are reduced



SYR - FIGURE 5-2

Application of the current framework

- Scenarios (no assigned probabilities) to cover range of societal/emissions uncertainties
- Range of values for climate sensitivity (used in simple models or implicit in multiple runs of large models) to generate probability distribution about warming for given concentration path
- Wide distribution range for predicted warming to eg 2100
- Focus on CO2-e stabilisation level (eg 450 ppm) as proximate policy target, to give reasonable probability of achieving 2ºC warming target

Problems with the current framework

- Existing scenario set is out of date; short run emission paths are now critical for climate outcomes
- Climate sensitivity (the ratio of two long run equilibrium concepts out of the range of experience) is inherently uncertain, especially at the upper end
- Hence link between proximate and ultimate targets (CO2-e stabilisation and warming) is uncertain
- No allowance in current policy settings for improved future knowledge of climate variables or of emergence of new technologies
- It does not work
  - stabilisation level for <2ºC warming is not achievable
  - does not give an adequate basis for mitigation policy

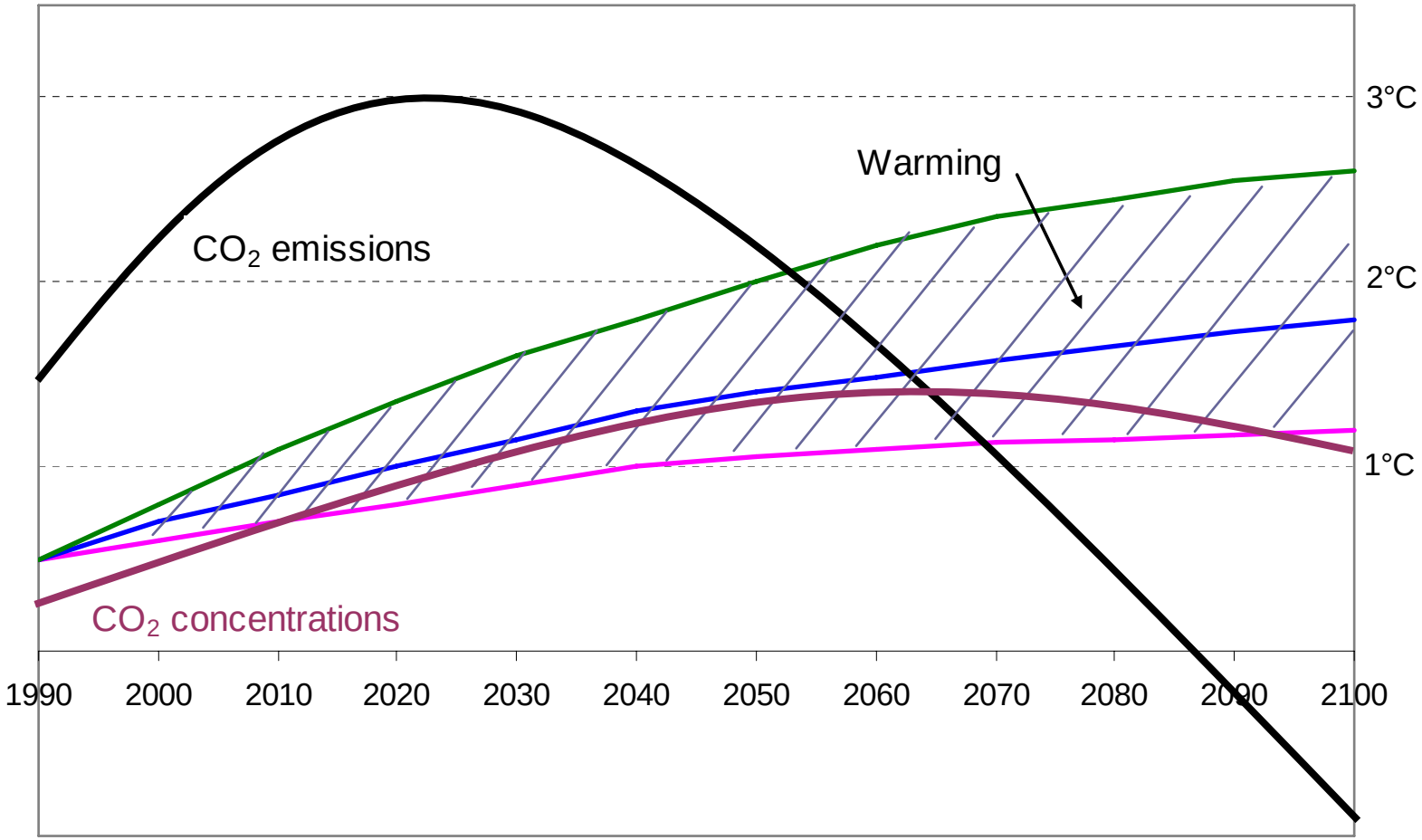
3. Towards a new framework

We need a new framework that addresses these deficiencies:

- based on best projection of medium term emissions
- focuses on ultimate target (warming) for the period of effective knowledge and action
- allows for adjustment of targets as new knowledge is gained and for future technological capabilities
- preserves the possibility of <2°C peak warming and provides more definitive guidance about likely warming and risks

Is such a framework possible?

The nature of the control problem - I



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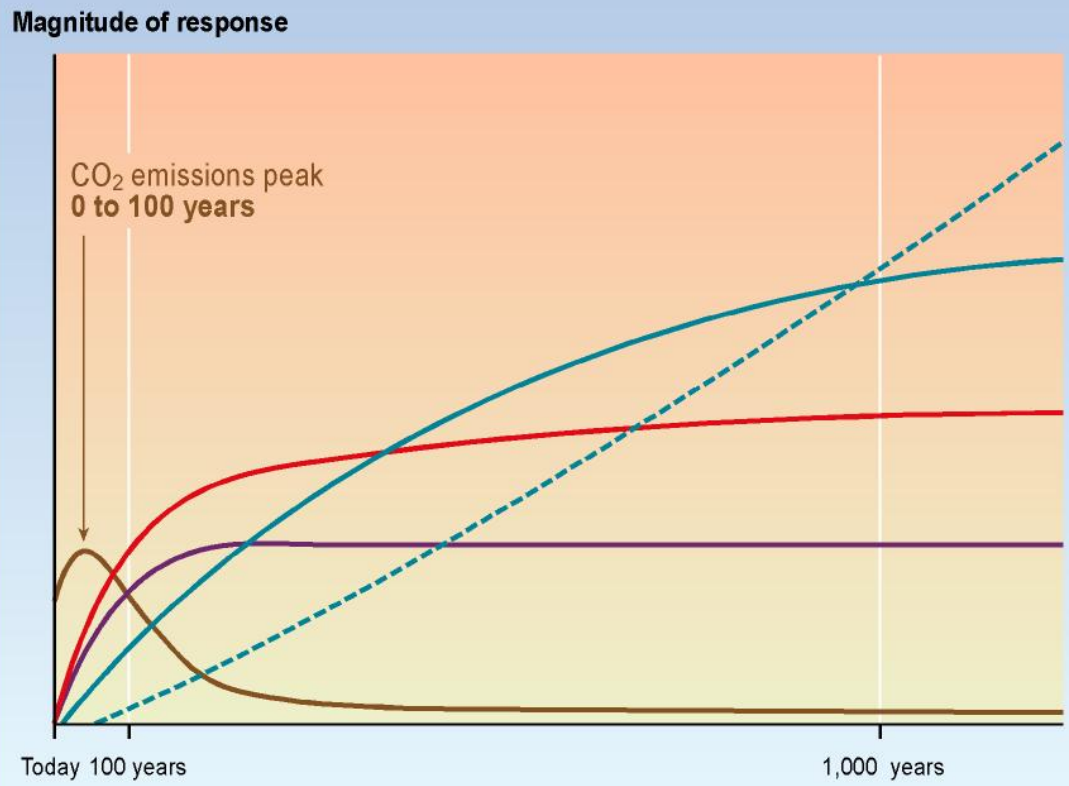


SYR - FIGURE 5-2

The nature of the control problem - II

Rather than thinking about long run equilibrium concepts (IPCC Chart) we should focus on the medium term dynamics (previous chart), accepting that knowledge and technologies will be much different beyond say 2030

Hence the task is to find:

- the achievable CO2-e emissions path to say 2050 and 2100 and
- the implied CO2-e concentration path

that will:

- will provide a good probability of holding peak warming within the 2ºC limit
- hold warming up to say 2030 and 2050 within the 2ºC limit and

Higher emissions now requires lower emissions later

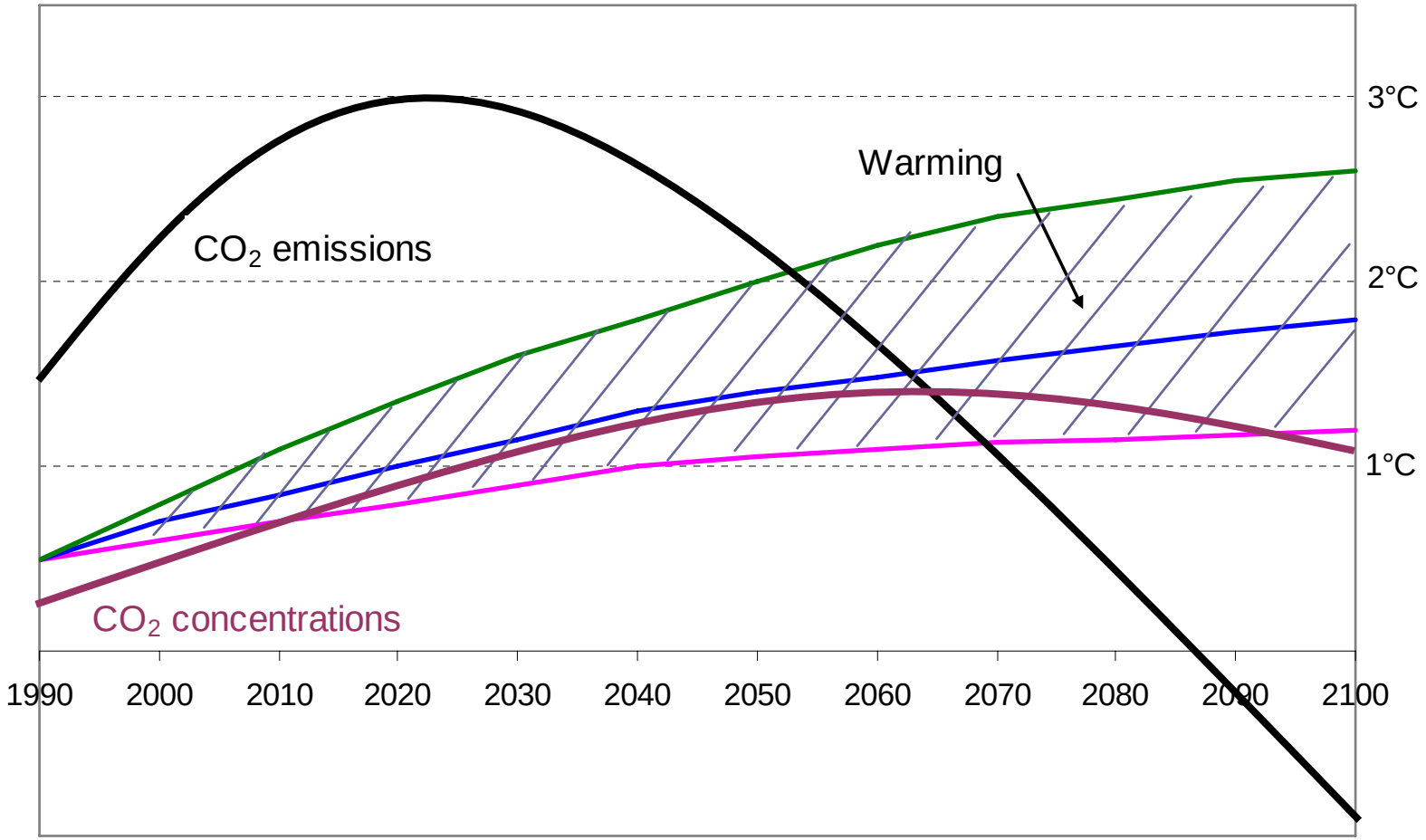
Looking at the 21st century dynamics with a view to holding peak warming to 2ºC (relative to pre-industrial) it is clear that:

- there has to be a trade off between higher emissions now, under the new global growth path, and low emissions later; and hence
- to hold peak warming to 2ºC, zero or negative emissions globally will probably be necessary by 2100

Four elements of a potential new framework, based on medium term dynamics

- A commitment to zero or negative global emissions by 2100
- Intermediate warming targets (say for 2020, 2030 and 2050) consistent with holding peak warming to <2ºC
- An achievable CO2-e emissions path to say 2050 consistent with current economic trends and peak warming to <2ºC
- Methods of measuring impact risk on a global and regional basis consistent with these intermediate warming targets

The nature of the control problem - I

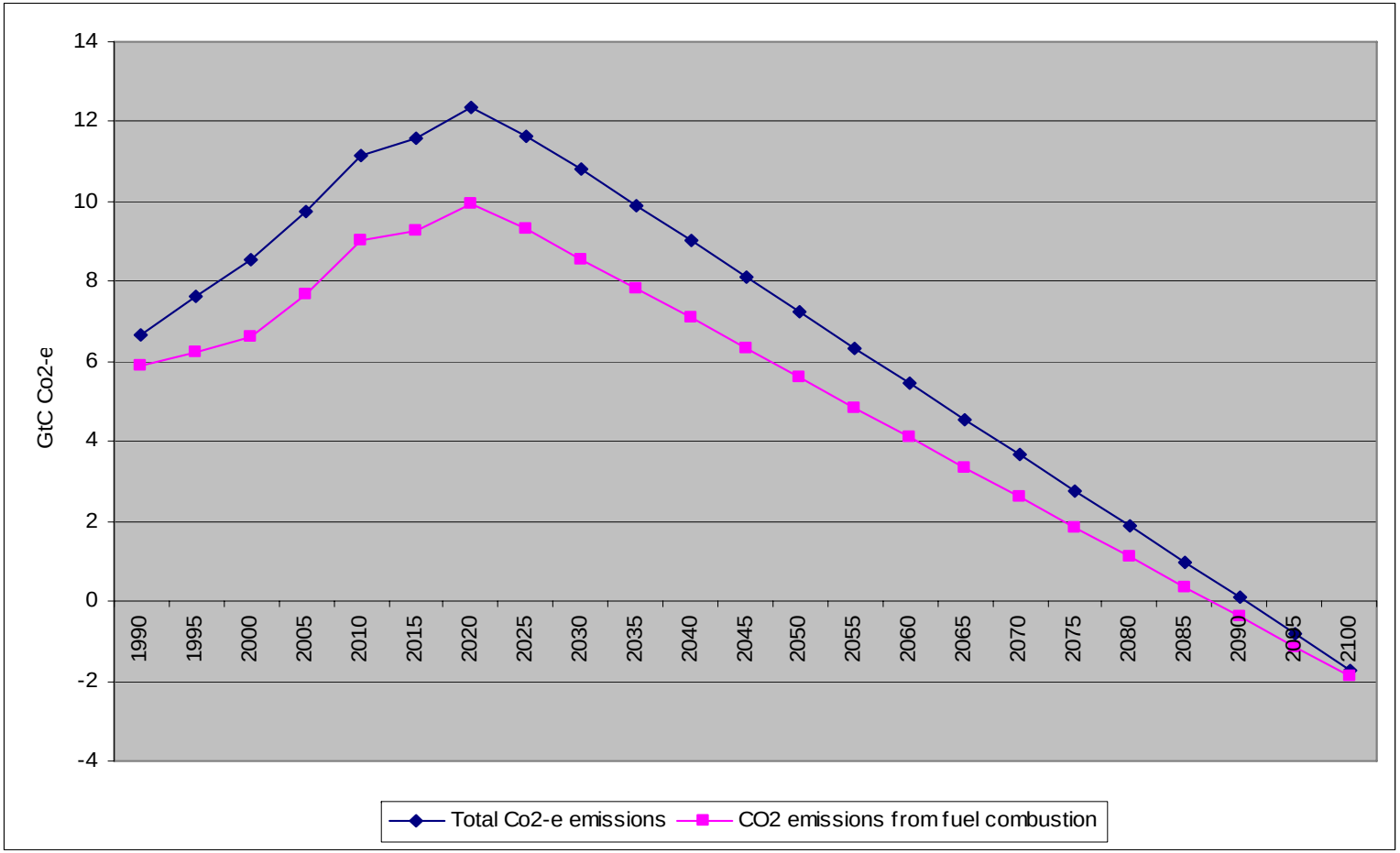


4. Some empirical specifications – is such a framework viable?

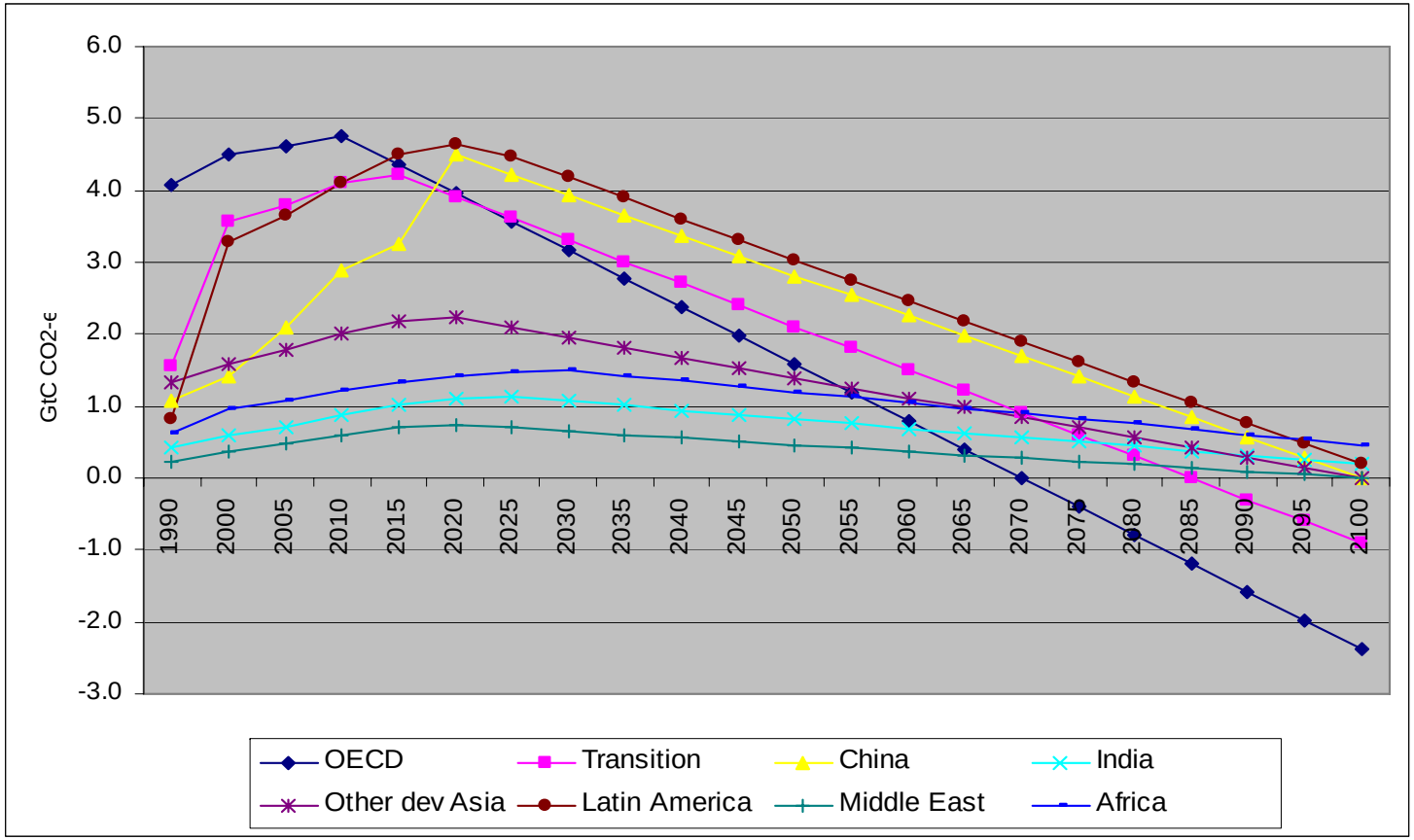
As a preliminary test, the following has been undertaken:

- construction of a preliminary unchanged policy projection to 2030 for all GHGs, consistent with the new growth path;
- construction of two paths starting from that path:
  - one broadly consistent after 2030 with A1FI, and
  - one a minimum emissions path (MEP) after 2010
- the MEP is based on a range of assumptions about date of peaking of emissions and rate of decline:
  - for OECD peaking in 2010, out to 2030 for Africa
  - for OECD reduction to zero over 60 years, and continuing
  - for Africa reduction to zero over 100 years
- simulation of the results using a small climate model, MAGICC

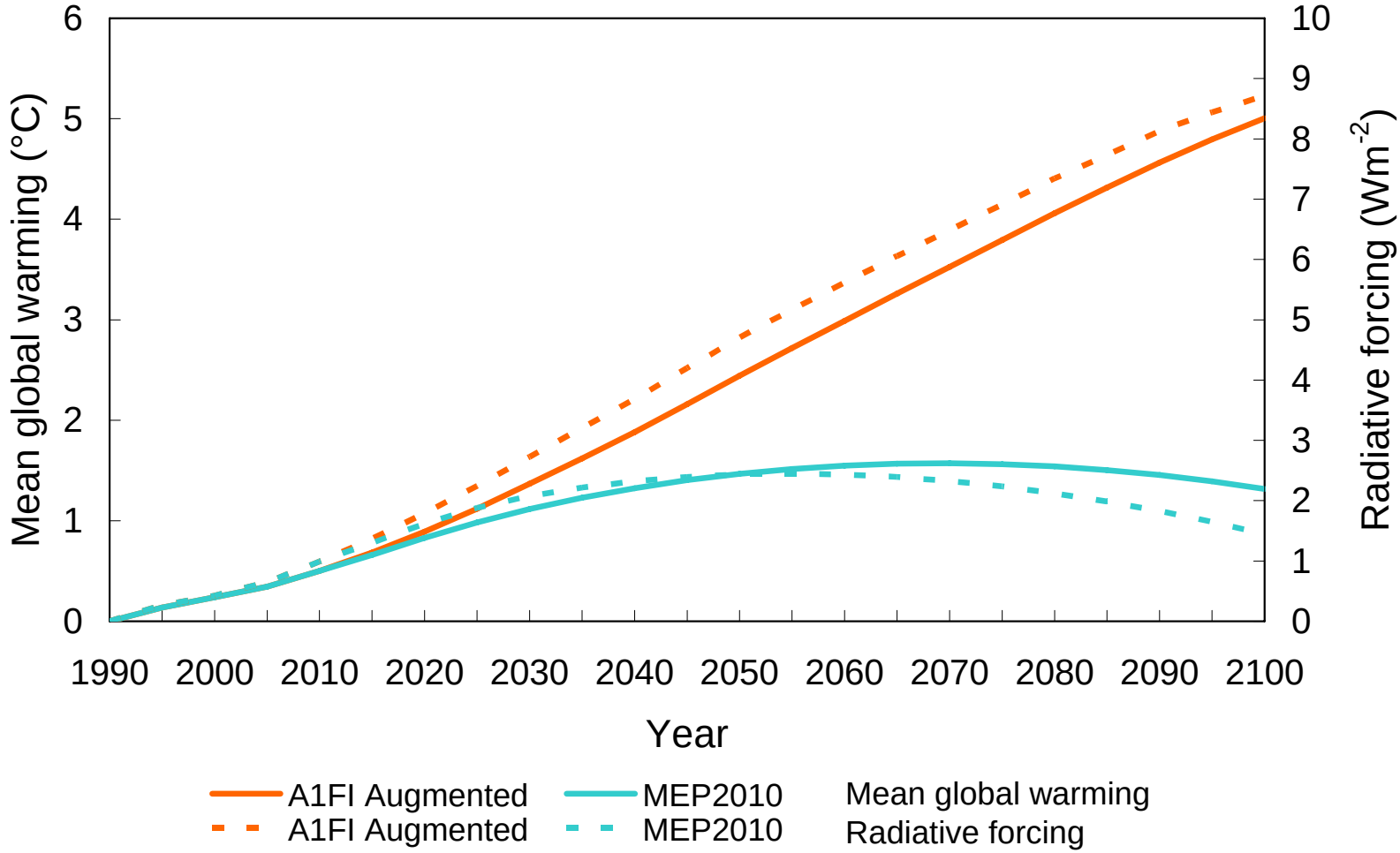
GHG emissions - the MEP 2010 path



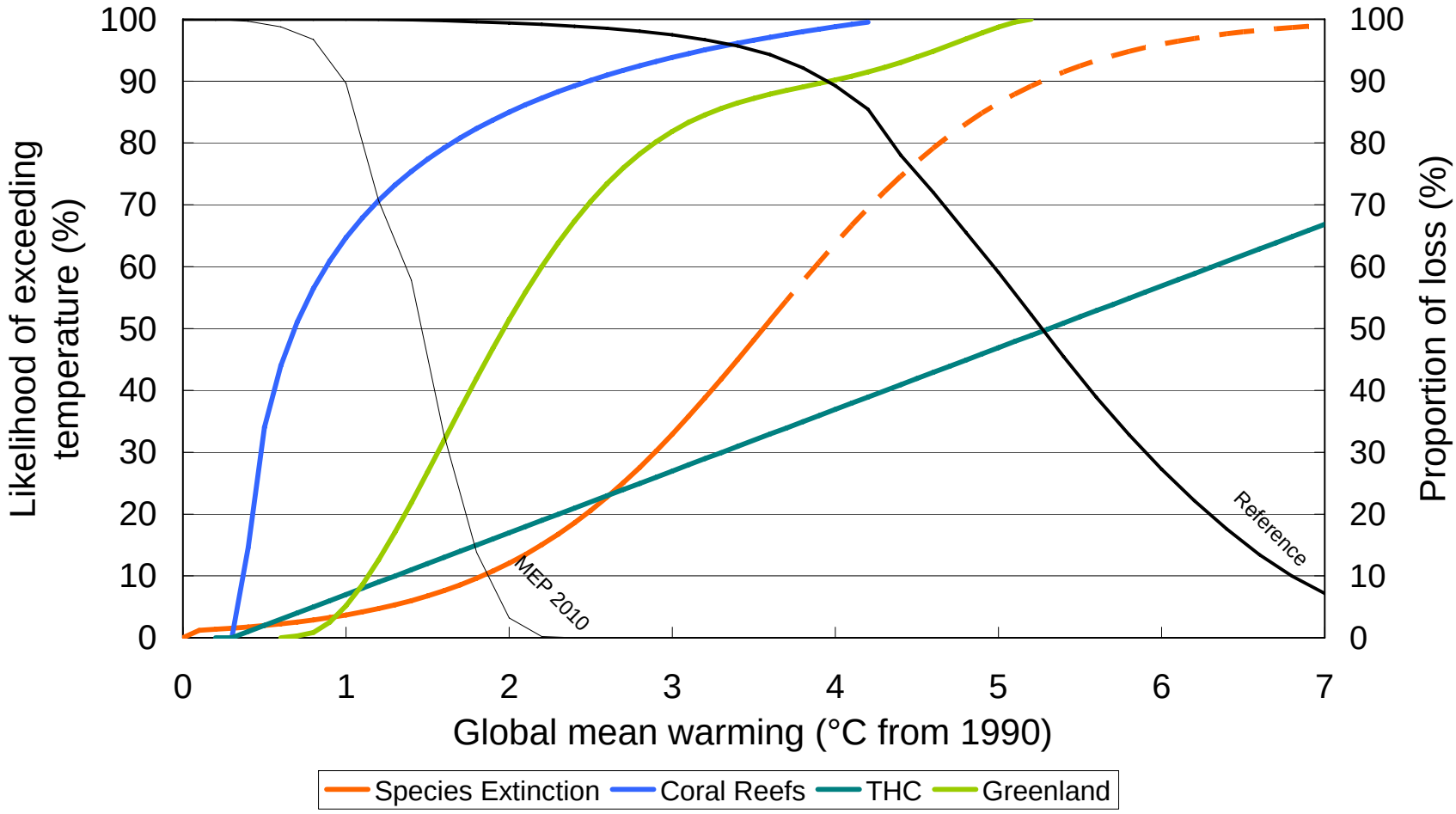
Distribution of GHG emissions by region – MEP 2010 path



Estimated global warming to 2030: A1FI and MEP 2010 paths (based on climate sensitivity of 3.0)



Key impact risks for the augmented A1FI and the MEP paths



Some conclusions about the potential viability of the new framework

- Based on a sensitivity of 3.0, the MEP 2010 may be able to achieve peak warming of <2ºC, but a range of probabilities based on other values are necessary
- More definitive ways of identifying medium term warming are necessary, such as:
  - development of models based on versions of transient climate sensitivity (the marginal warming rate)
  - analysis of multiple runs with large climate models
- The MEP 2010 warming path substantial reduces the probability of serious damage, except for coral reefs

5. Research requirements for testing and using a new framework

Much needs to be done to test whether such a framework is viable, and to make it operational. These things include the development of:

- an authoritative GHG emissions projection to 2030, together with an improved ability to analyse the responsiveness of this path to policy and technology changes, by region
- better ways of predicting the human impact on warming over the medium term
- a better understanding of external impacts on warming (solar irradiance, volcanoes) and of internal variability, in terms of predicting warming
- a better understanding of the potential impact of new technologies, both in the medium and long term

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