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Climate Change Detection and Scenarios: Re-examining the Evidence

By

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At

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Any discussion on climate change must address the following:

- Geophysical aspects
- Socio-economic aspects
- Political implications
- A scenario based approach to assess developments in the future

Hence, science needs to be interpreted within a socio-economic/political framework

What does the science tell us?

- The earth is warming
- Precipitation patterns have changed
- There are other impacts of climate change
- Climate change has equity implications
- Climate change will affect sustainable development

Climate change: is it for real?

It is likely that -

- Globally 1990s was the warmest decade of the millennium and 1998 the warmest year
- The number of hot days have ↑while cold days and frost ↓ in all land areas during the 20th century
- Continental precipitation has ↑ by 5-10% over the 20th century although it may have ↓ in some regions
- Frequency and severity of droughts have ↑ particularly in Asia and Africa

Climate change: is it for real? (contd.)

It is likely that--

- Non polar glaciers have retreated during the 20th century
- Artic sea ice extent decreased by 10 to 15% and thickness decreased by 40%
- Snow cover has ↓ in areas by 10% since 1960
- Coral reef bleaching

A peep into the future

On running the AOGCM (complex numerical models)

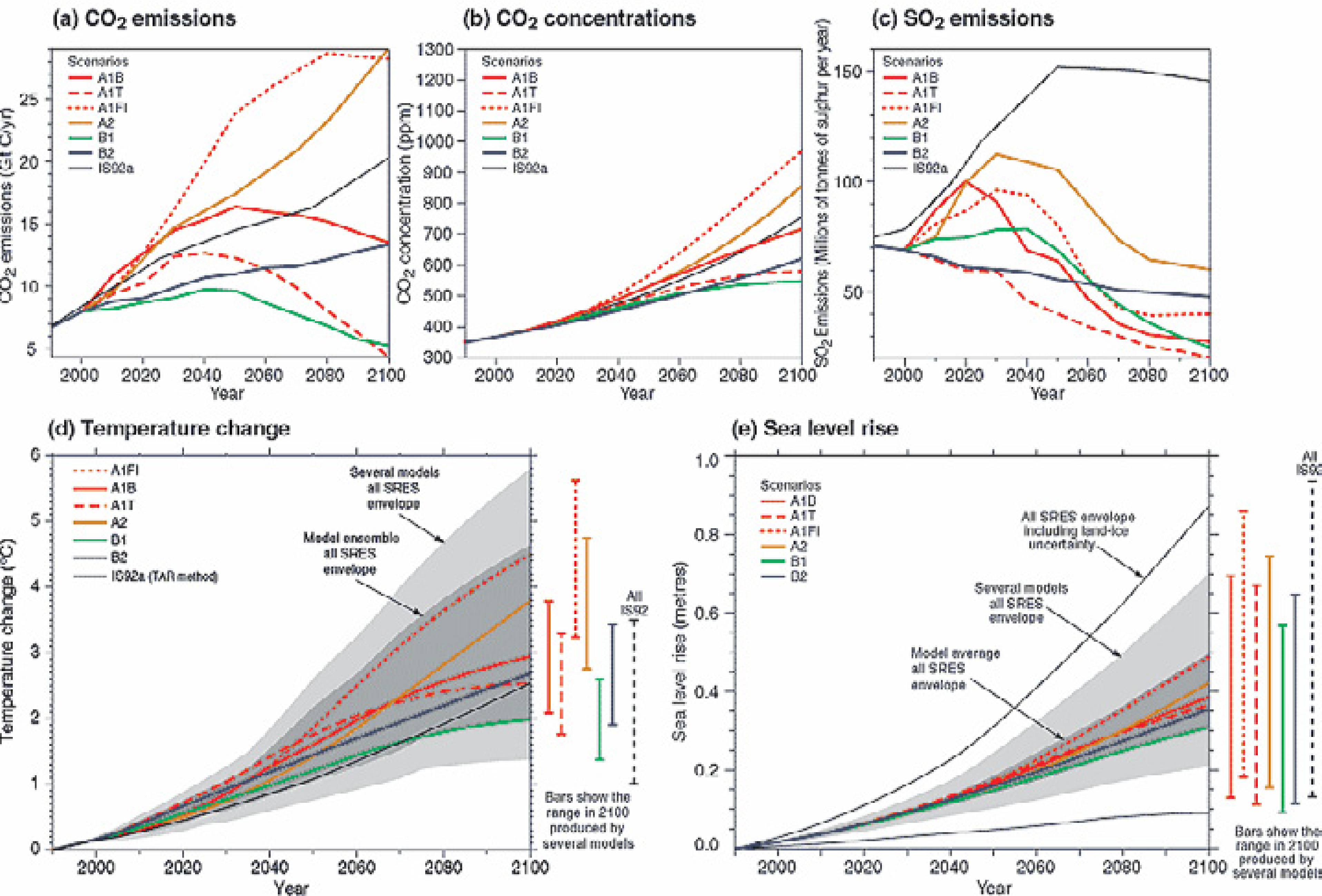
The global averaged surface temperature is projected to increase by 1.4 to 5.8 ^{o}C over the period 1990-2100

Increases in winter temperature are likely to be more, particularly in the northern latitudes

Globally averaged water vapour, evaporation and precipitation are projected to increase, although regionally the effects could vary

Source: IPCC TAR

The global climate of the 21st century



IPCC Scenarios

- These emission scenarios are from the Special Report on Emission Scenarios (SRES)

- Criticism of IPCC scenarios:
  - Market exchange rates (MER) vs. purchasing power parity (PPP)
  - Projections for developing regions improbably high
  - SRES did not use statistical expertise or involve economic ministries

Emission Scenarios: the real facts

- The SRES reviews existing literature, most of which is MER based, from the World Bank, IEA and USDoE.
- Scenarios of GDP growth are typically expressed as MER (the preferred measure for GDP growth, as opposed to PPP which is a preferred measure for assessing differences in economic welfare).
- IPCC scenarios include PPP-based scenarios
- Contrary to claims, IPCC scenarios are consistent with historical data, including that from 1990 to 2000, and with the most recent near term (up to 2020) projections of other agencies.
- Long-term emissions are based on multiple, interdependent driving forces, and not just economic growth. There is a need to look beyond GDP.

Historical per capita PPP growth rates for past 100 years and for the four SRES world regions across the scenarios

10^9 PPP$1980	1870	1985	Factor	%/yr
UK	59.0	510.9	8.7	1.9
USA	61.7	2947.1	47.8	3.4
Canada	4.9	306.8	62.1	3.7
Japan	17.2	1202.2	69.8	3.8
SRES range	(B2, B1, A1-Message)	1990-2100		
OECD90			3.6—7.6	1.2—1.9
REF			6.2—13.2	1.7—2.4
ASIA			18.9—39.1	2.7—3.4
ALM			17.1—43.7	2.6—3.5

Source: Kausel, 1985, SRES, 2000

Detecting the anthropogenic signal

There is a growing body of evidence that human activities are responsible for the change in the climate system

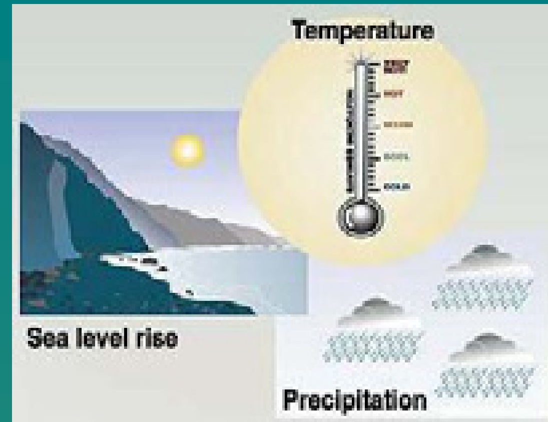
The warming over the past hundred years is unlikely to be due to internal variability of the climate system alone

The estimated rate and magnitude of global warming due to increasing concentrations of greenhouse gases alone are comparable with or larger than observed warming

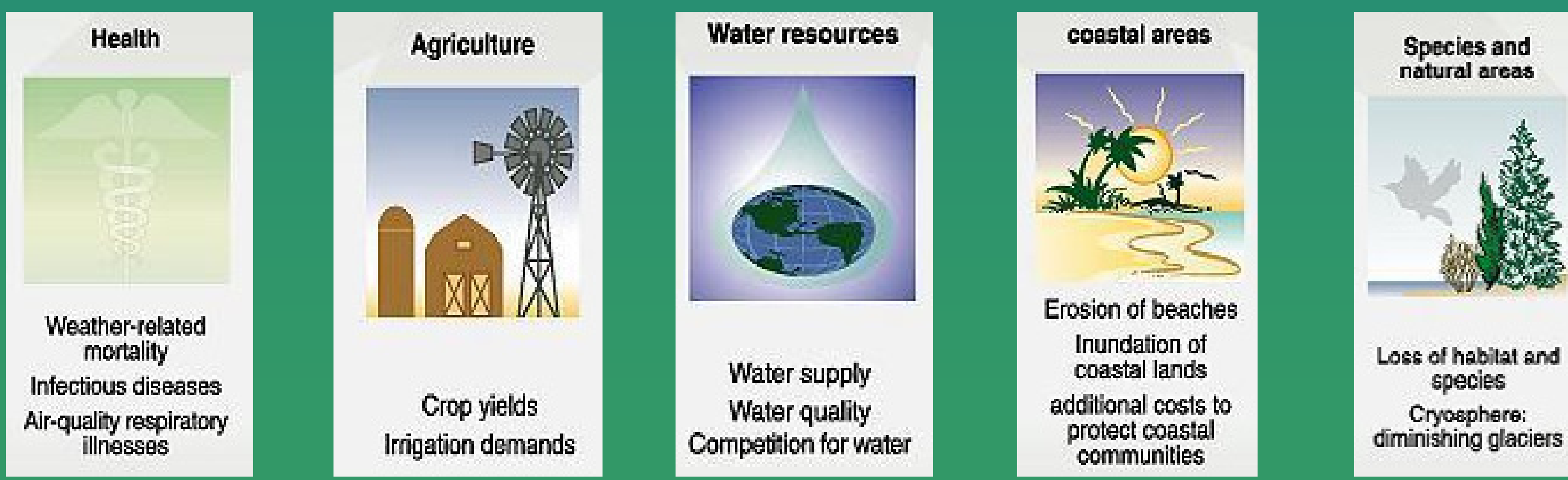
There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.

Source: IPCC, TAR

Source: GRID Arendal



Impacts



Instances of possible singular events

- Breakdown of the thermohaline circulation
- Disintegration of the West Antarctic ice sheet
- Shift in mean climate towards an El Nino like state
- Runaway carbon dynamics - reduced sink capacity, release of methane from hydrates, carbon from permafrost
- Rearrangement of biome distribution

Such events can overwhelm our response strategies

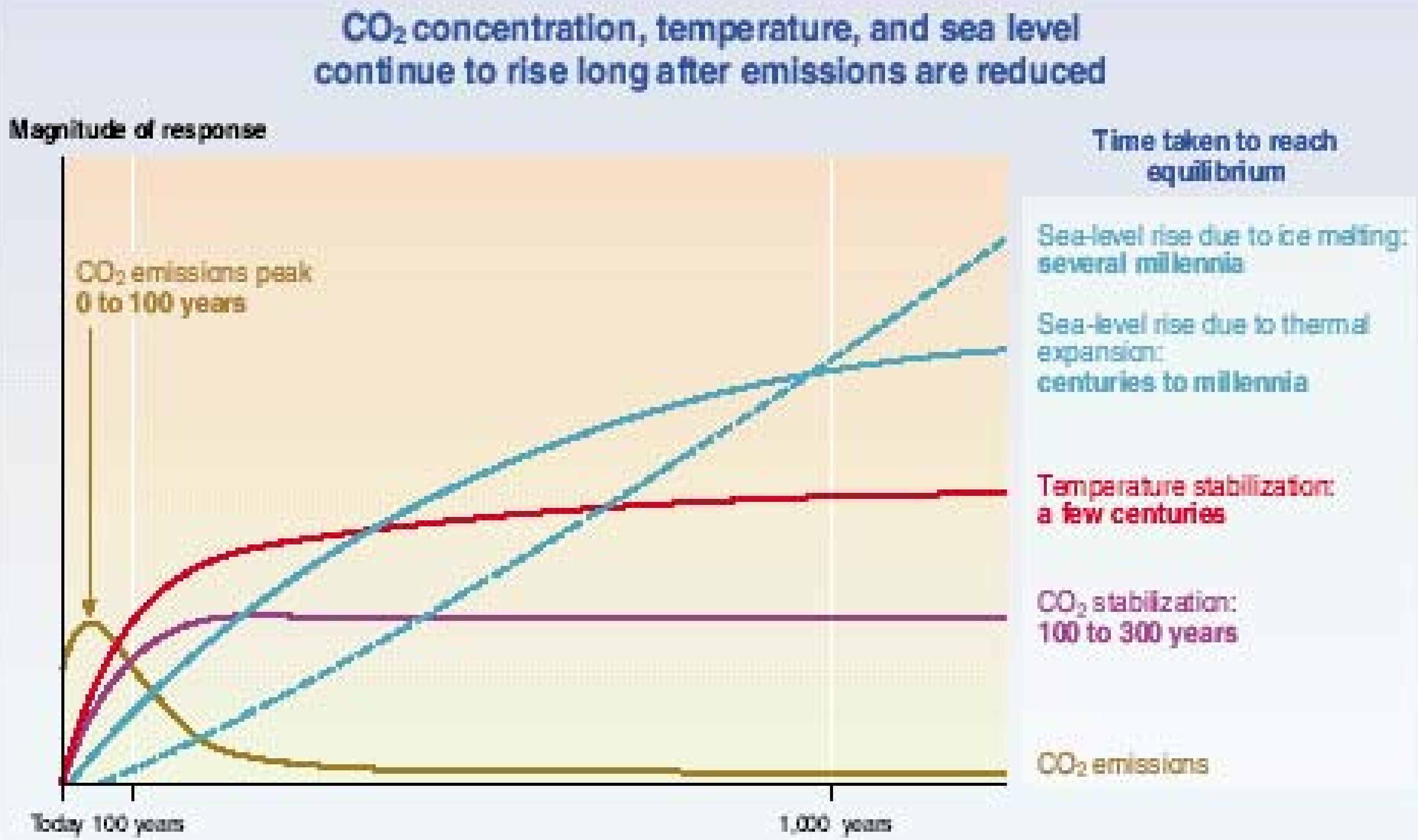
Extreme events & impacts

- The duration, location, frequency, and intensity of extreme weather and climate events are likely to very likely to change, and would result in mostly adverse impacts on biophysical systems.
- More hot days and heat waves and fewer cold and frost days are very likely over nearly all land areas.
- The amplitude and frequency of extreme precipitation events is very likely to increase over many areas
- High resolution modeling studies suggest that over some areas the peak wind intensity of tropical cyclones is likely to increase

Extreme events & impacts (contd.)

- Greenhouse gas forcing in the 21st century could set in motion large-scale, high-impact, non-linear, and potentially abrupt changes in physical and biological systems over the coming decades to millennia, with a wide range of associated likelihoods.
- Most models project a weakening of the ocean thermohaline circulation, which leads to a reduction of the heat transport into high latitudes of Europe
- The Greenland ice sheet is likely to lose mass during the 21st century and contribute a few centimeters to sea-level rise

Adaptation - an immediate necessity



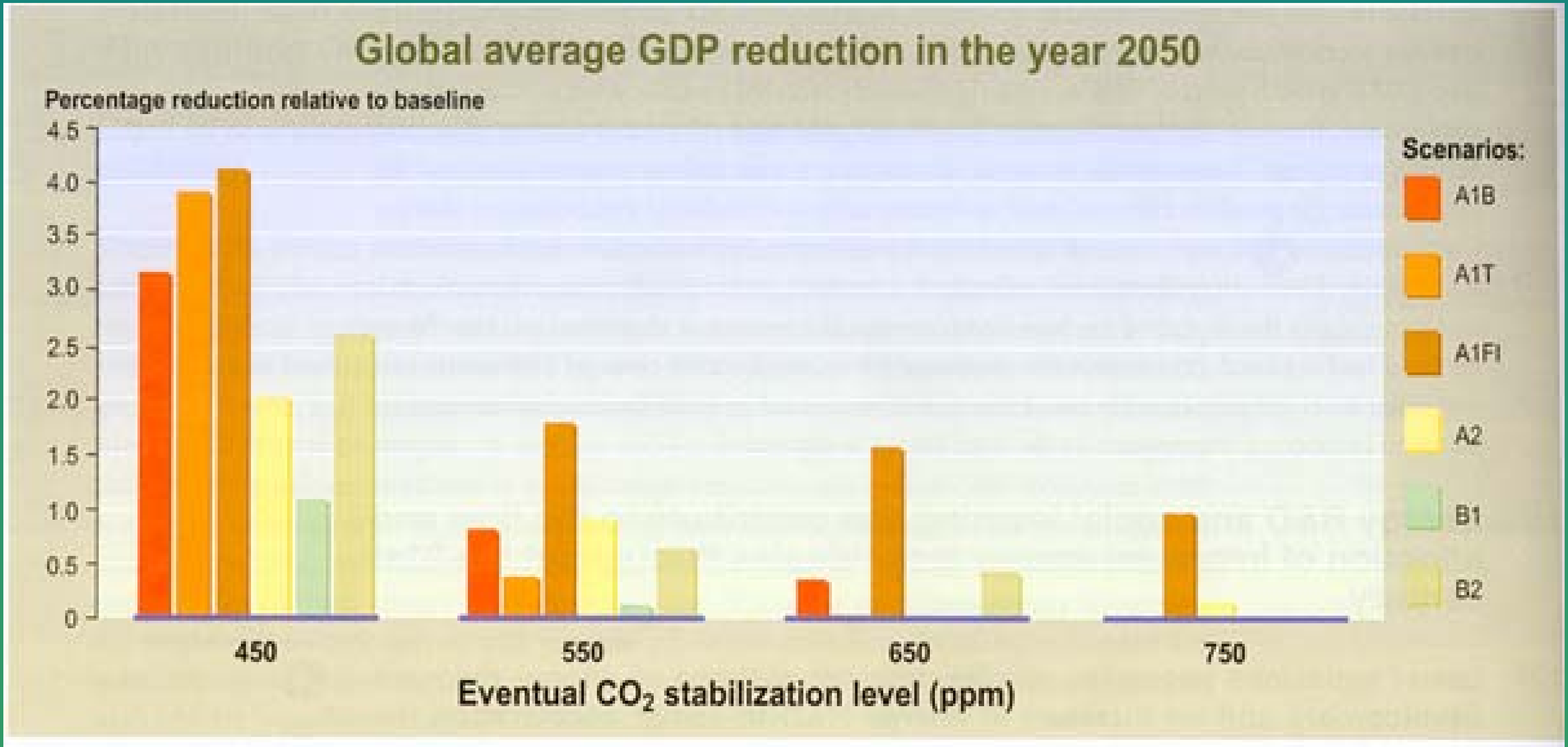
Need for Climate Cooperation

- Inertia and the possibility of irreversibility in the interacting climate, ecological and socio-economic systems are the main reasons why anticipatory adaptation and mitigation are beneficial.
- Successful implementation of GHG mitigation options would need to overcome technical, economic, political, cultural, social, behavioral and/or institutional barriers.
- National responses to climate change can be more effective if deployed as a portfolio of policy instruments to limit or reduce net emissions; exchange of knowledge useful.
- Technology development and deployment are important components of cost-effective stabilisation, and are universally relevant.

Technological Options for Reducing Net CO_2

- Reducing energy consumption, by increasing the efficiency of energy conversion and/or utilisation
- Switching to less carbon intensive fuels, for example natural gas instead of coal
- Increasing the use of renewable energy sources or nuclear energy each of which emits little or no net CO_2
- Sequestering CO_2 by enhancing biological absorption capacity in forests and soils
- Capturing and storing CO_2, chemically or physically

Global GDP Reductions Caused by Mitigation Activities (2050)



Source: IPCC Synthesis Report

Approach to climate change mitigation

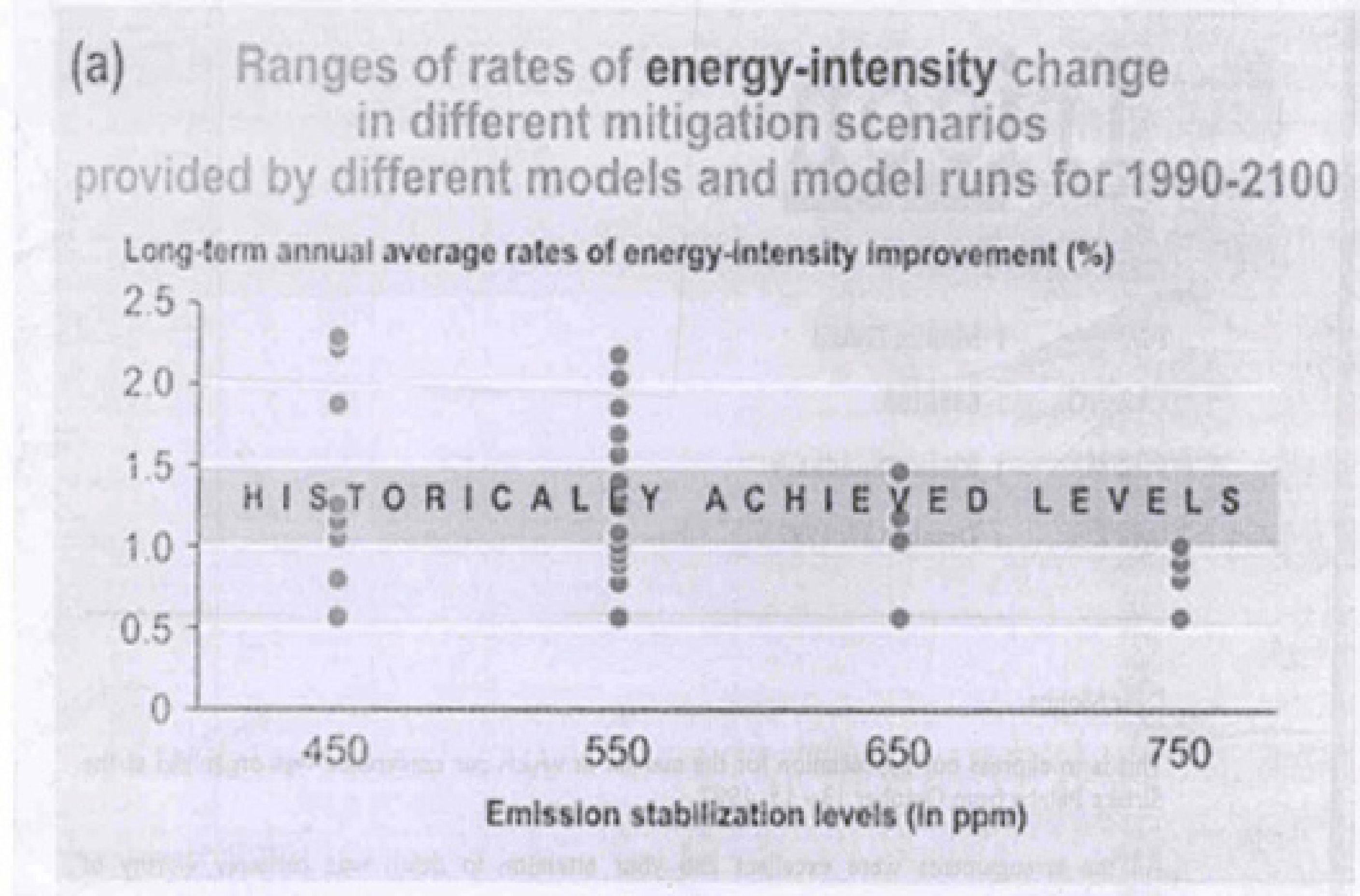
Using the Kaya Identity

CO_2 emissions = GDP * Energy Intensity * Carbon Intensity

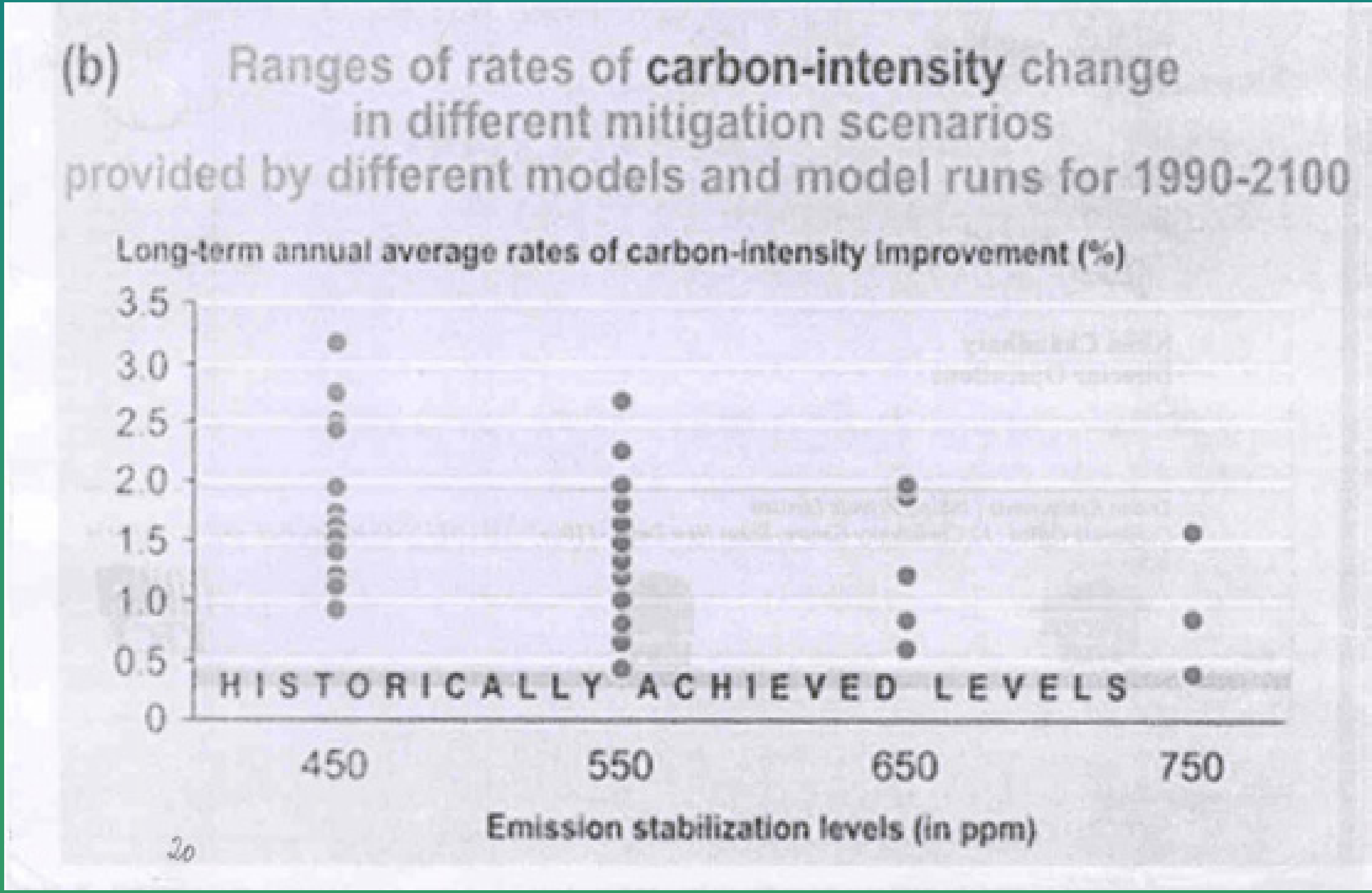
Reduction in Energy intensity → Reduced end use demand, increased efficiency (tech change)

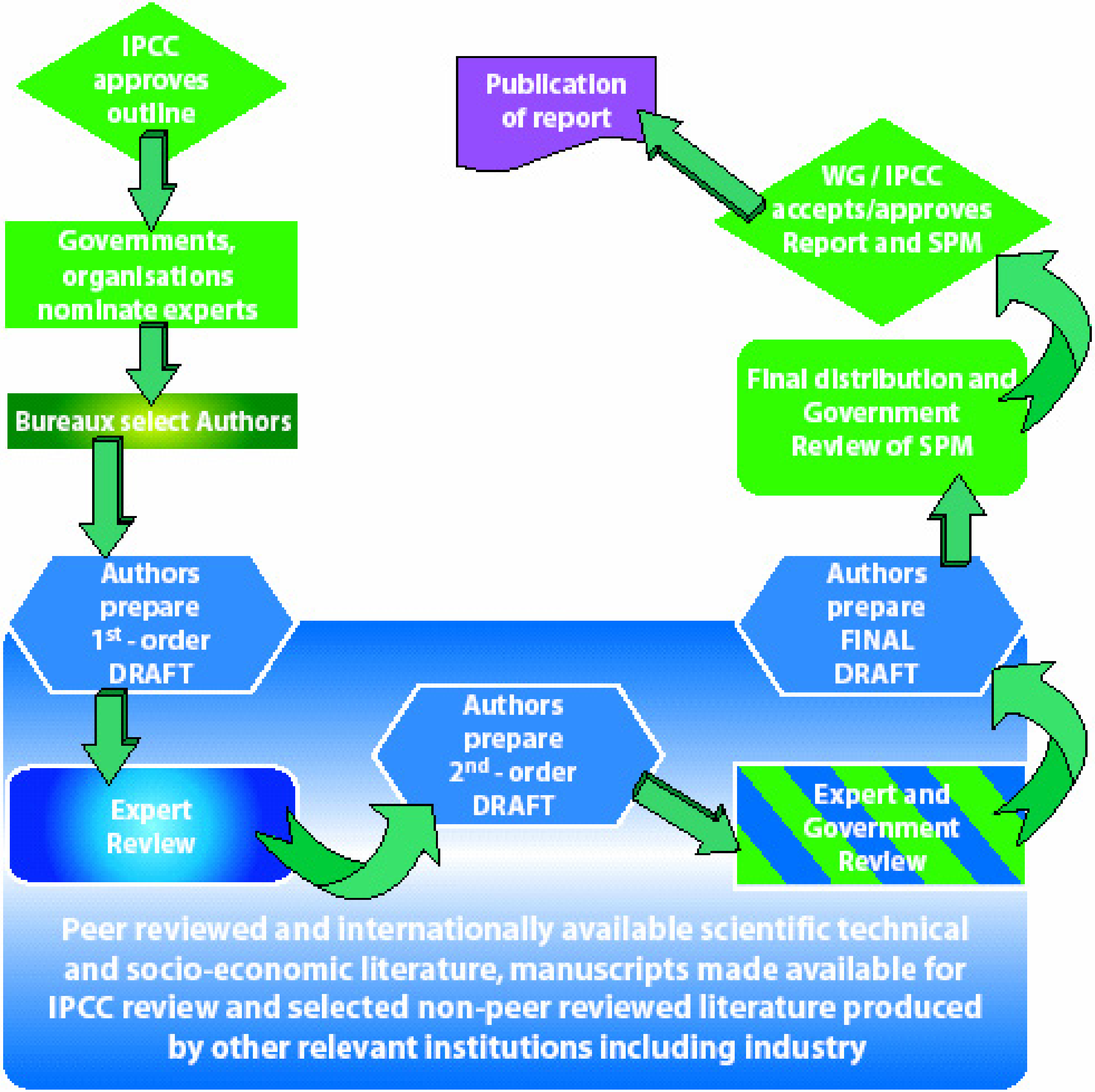
Reduction in net C intensity → Shift towards renewables,Hydrogen economy and fuel cells, C sequestration

Acceleration of energy system change



Acceleration of energy system change

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Authors prepare 2nd - order DRAFT
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Publication of report
Peer reviewed and internationally available scientific technical and socio-economic literature, manuscripts made available for IPCC review and selected non-peer reviewed literature produced by other relevant institutions including industry