

Climate Change: Challenges and Opportunities



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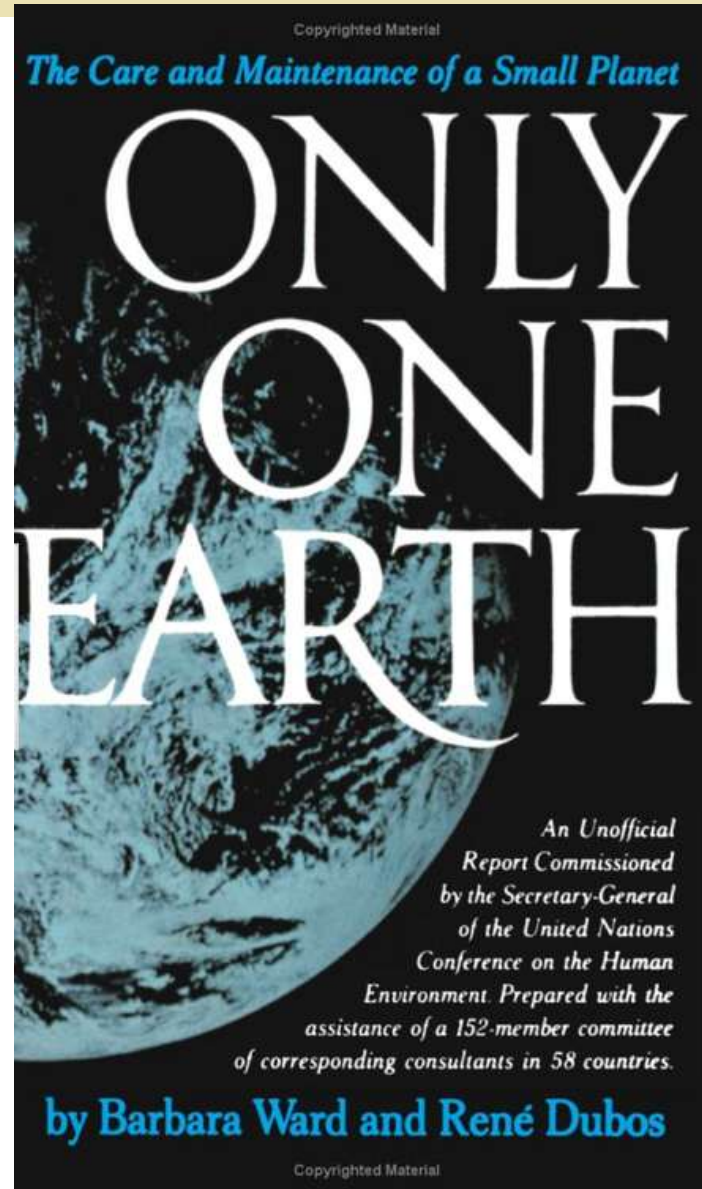
University of Malta, 12-4-2011

**NB: The support of the Belgian Science Policy
Office is gratefully acknowledged**

Only one Earth

“... The sum of all likely fossil-fuel demands in the early decades of the [21st] century might ... greatly increase the emission of carbon dioxide into the atmosphere and by doing so bring up average surface temperature uncomfortably close to that rise of 2° C which might set in motion the long-term warming up of the planet.”

B. Ward & R. Dubos, 1972



B. Ward & R. Dubos,
*Only one Earth: the Care and
Maintenance of a Small Planet,*
New York, London:

W W Norton & Company, (1972) 1983

IMPLICATIONS OF EXPECTED CLIMATIC CHANGES ON THE ISLAND OF MALTA

« Possible adverse effects from predicted climatic changes affecting Malta could occur because the « greenhouse effect » (...). Changes in the global atmosphere may occur even sooner than some scientists have predicted and are mainly the result of man's industrial activities and the scant regard he has at times paid to the effects resulting from his intimate interactions with the environment. »

Introduction



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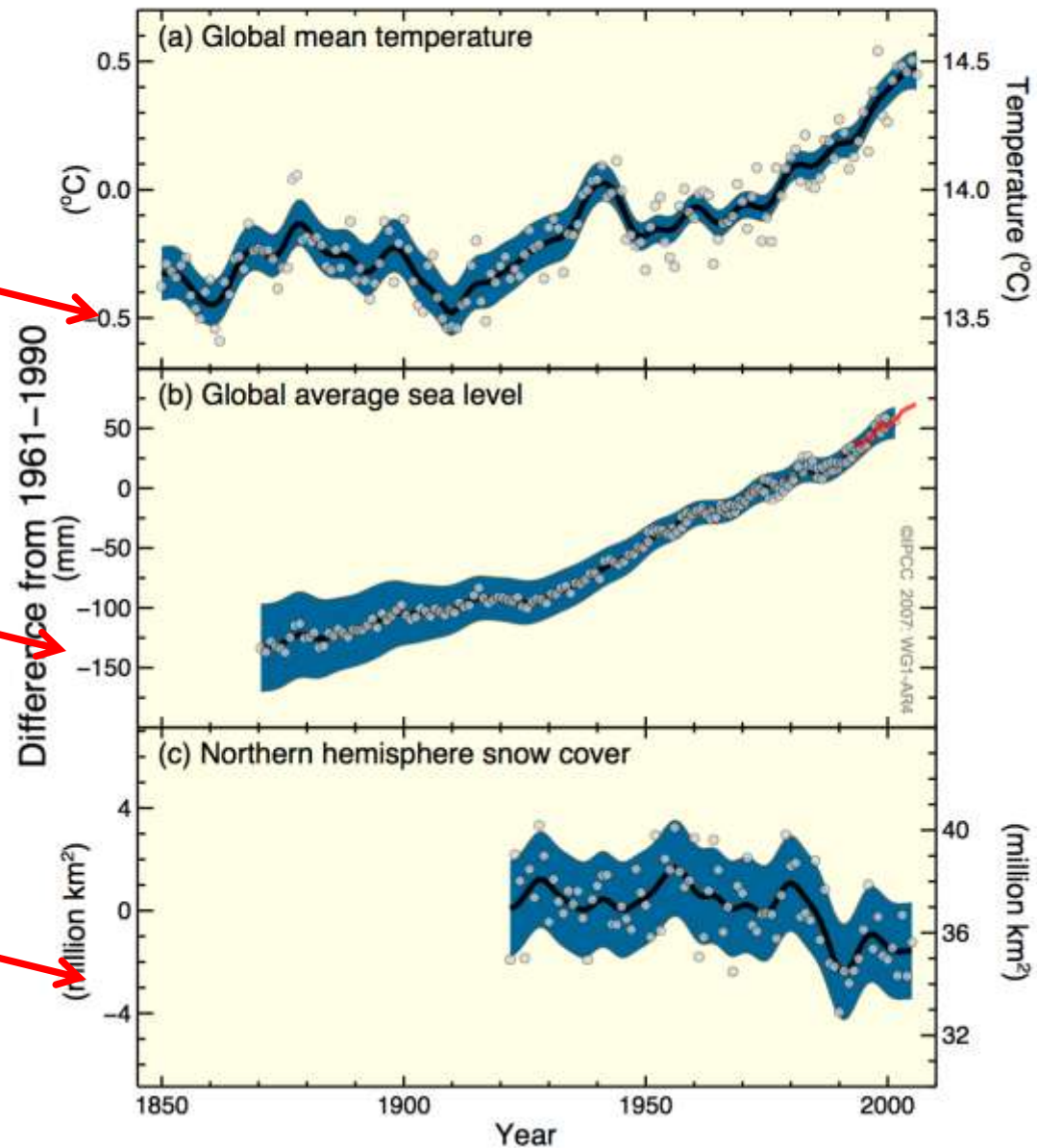
Warming is Unequivocal

Rising atmospheric temperature

Rising sea level

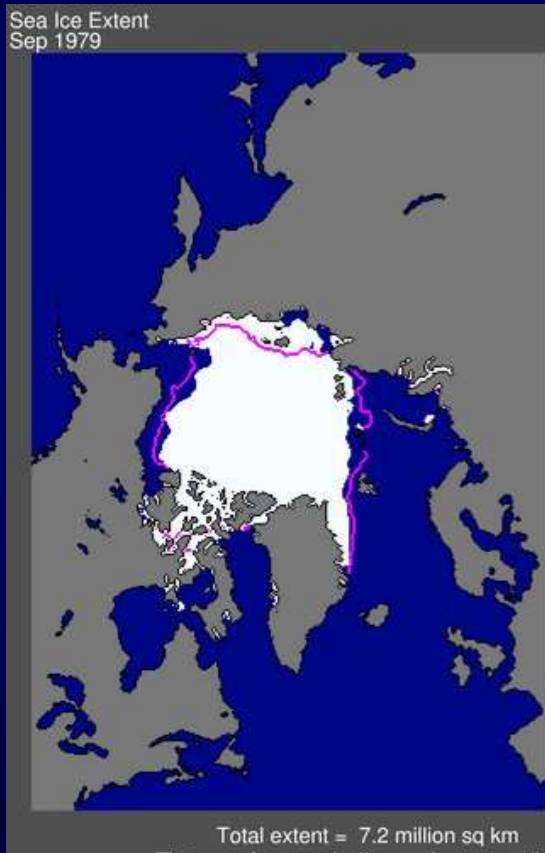
Reductions in NH snow cover

Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

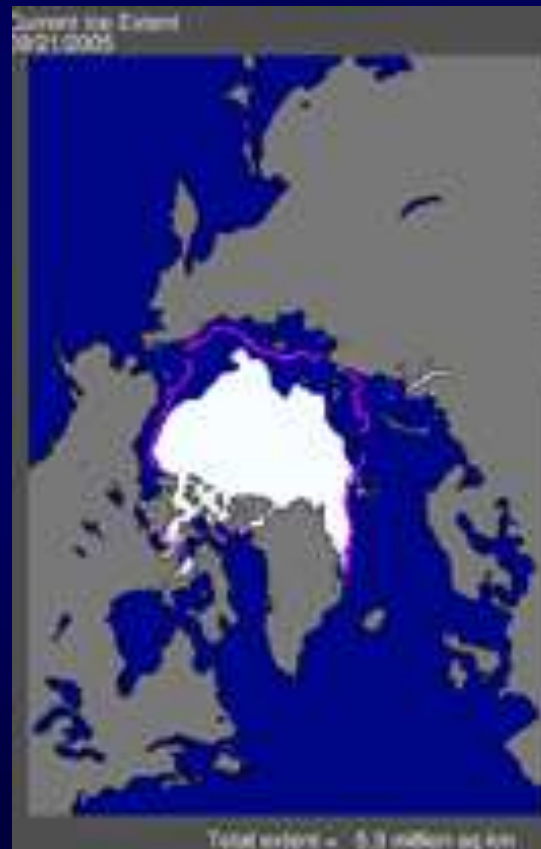


Extension of the Arctic ice cap

September 1979



September 2005

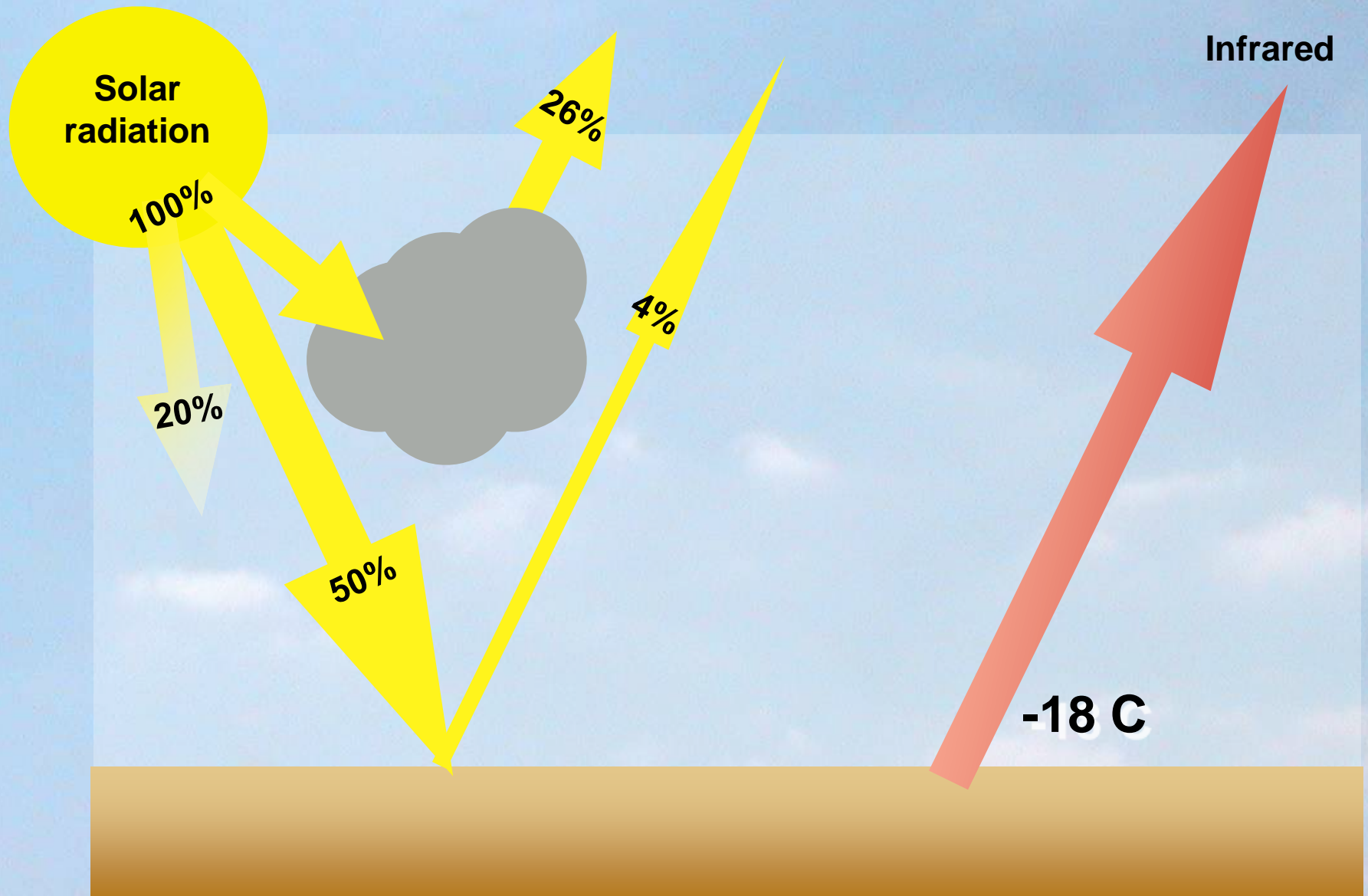


September 2007

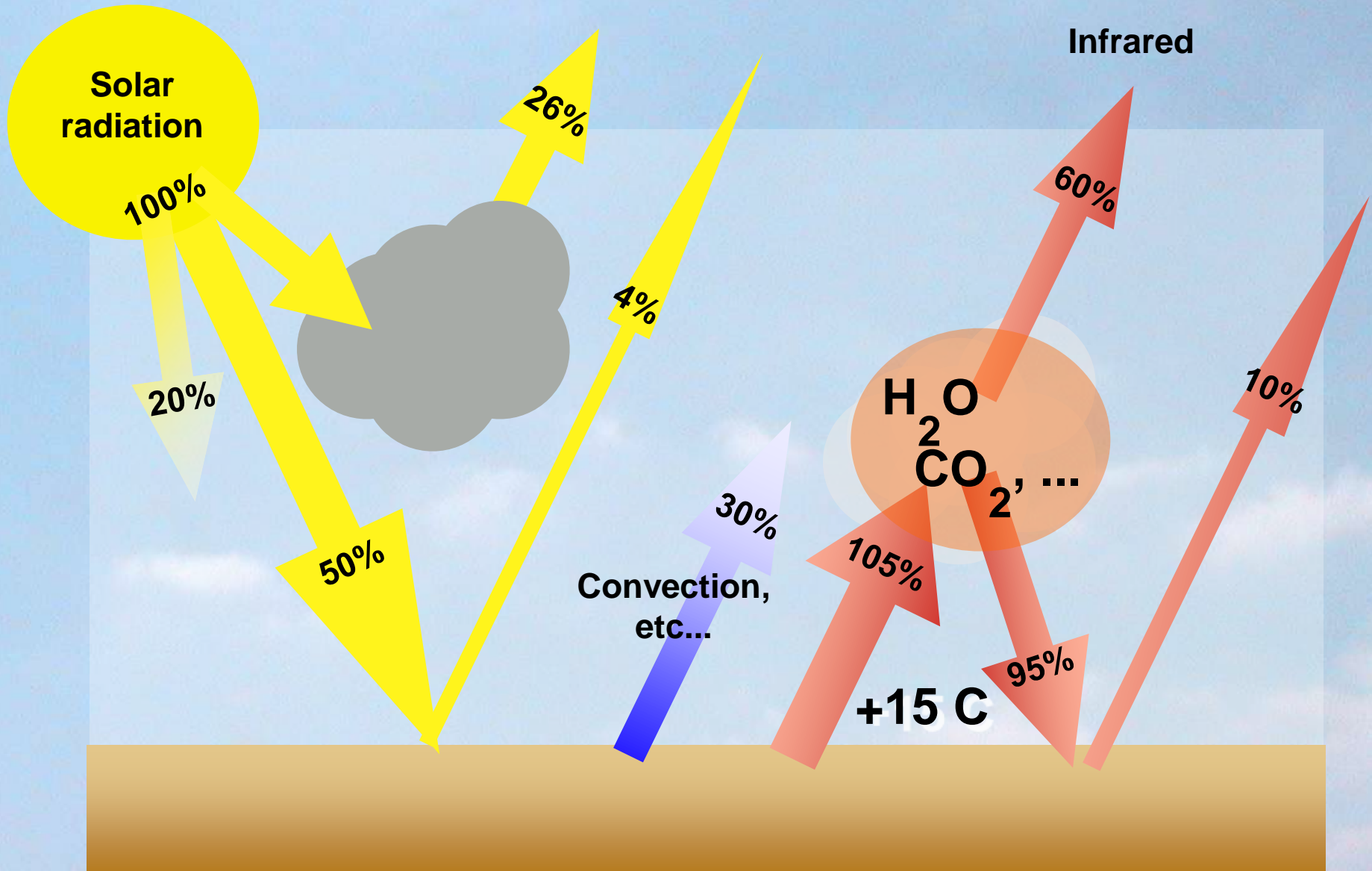


The pink line indicates the average ice cap extension since 1979

Energy cycle without greenhouse effect

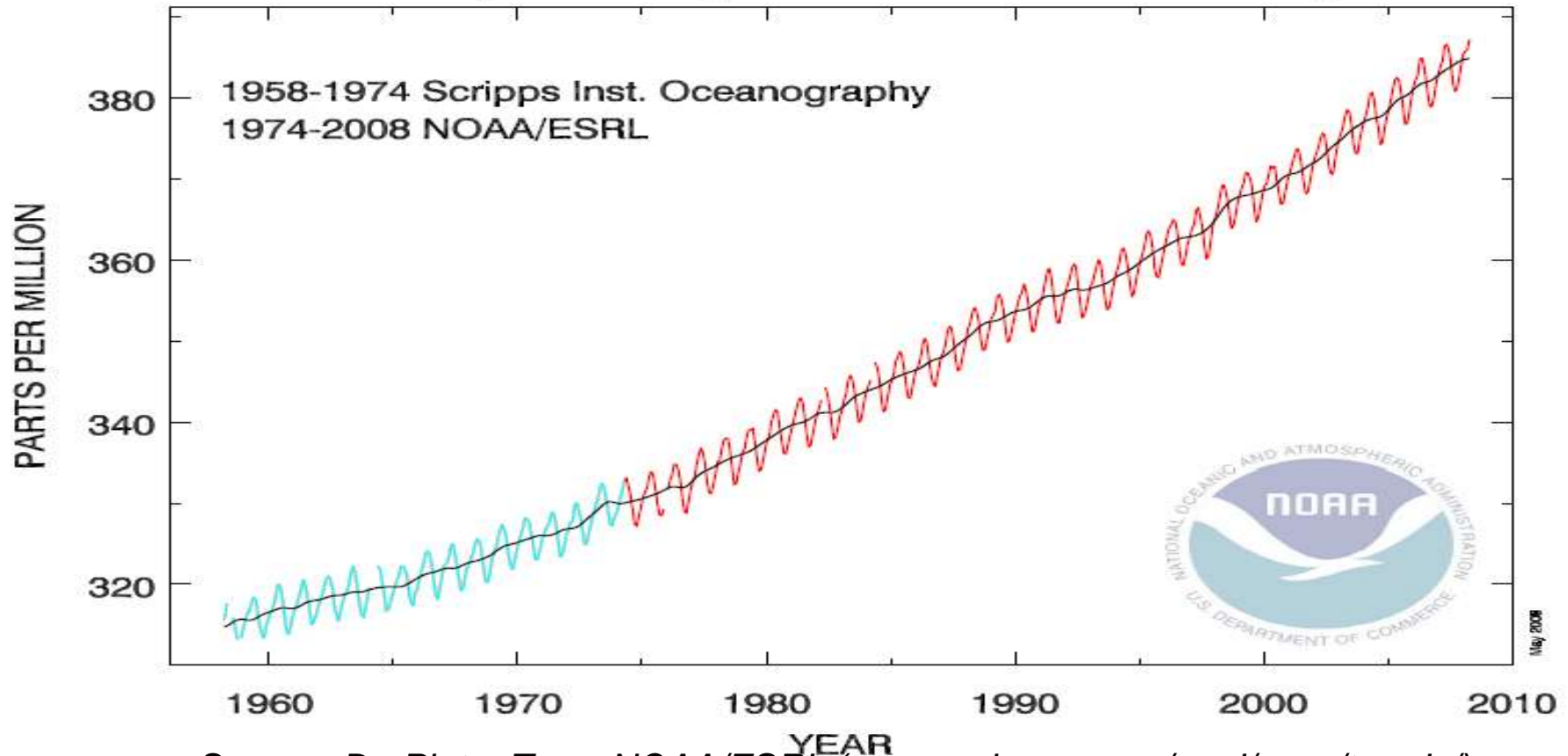


Energy cycle *with* greenhouse effect



CO₂ concentration measured at Mauna Loa (3400 m)

Atmospheric CO₂ at Mauna Loa Observatory



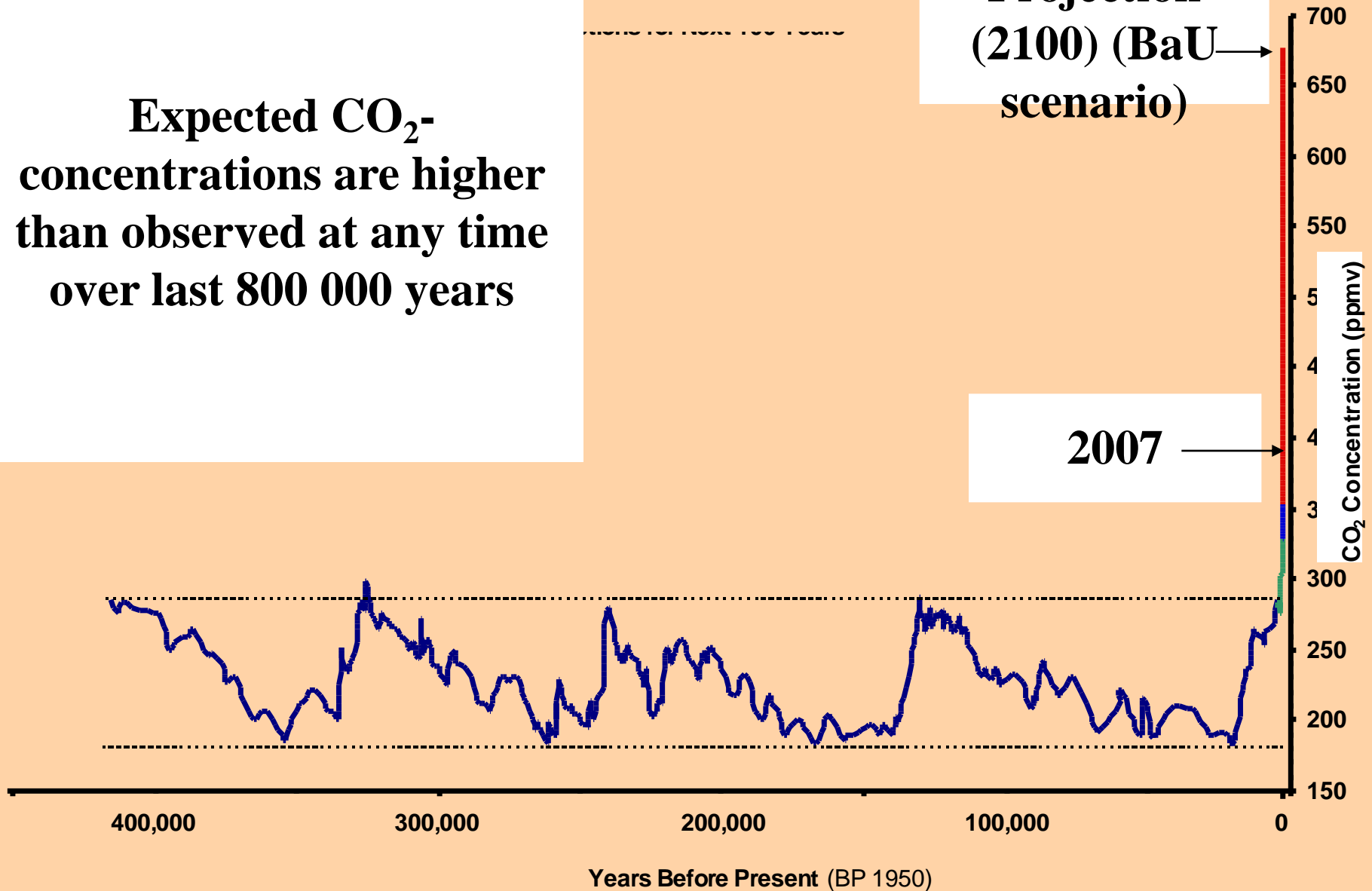
Source: Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)

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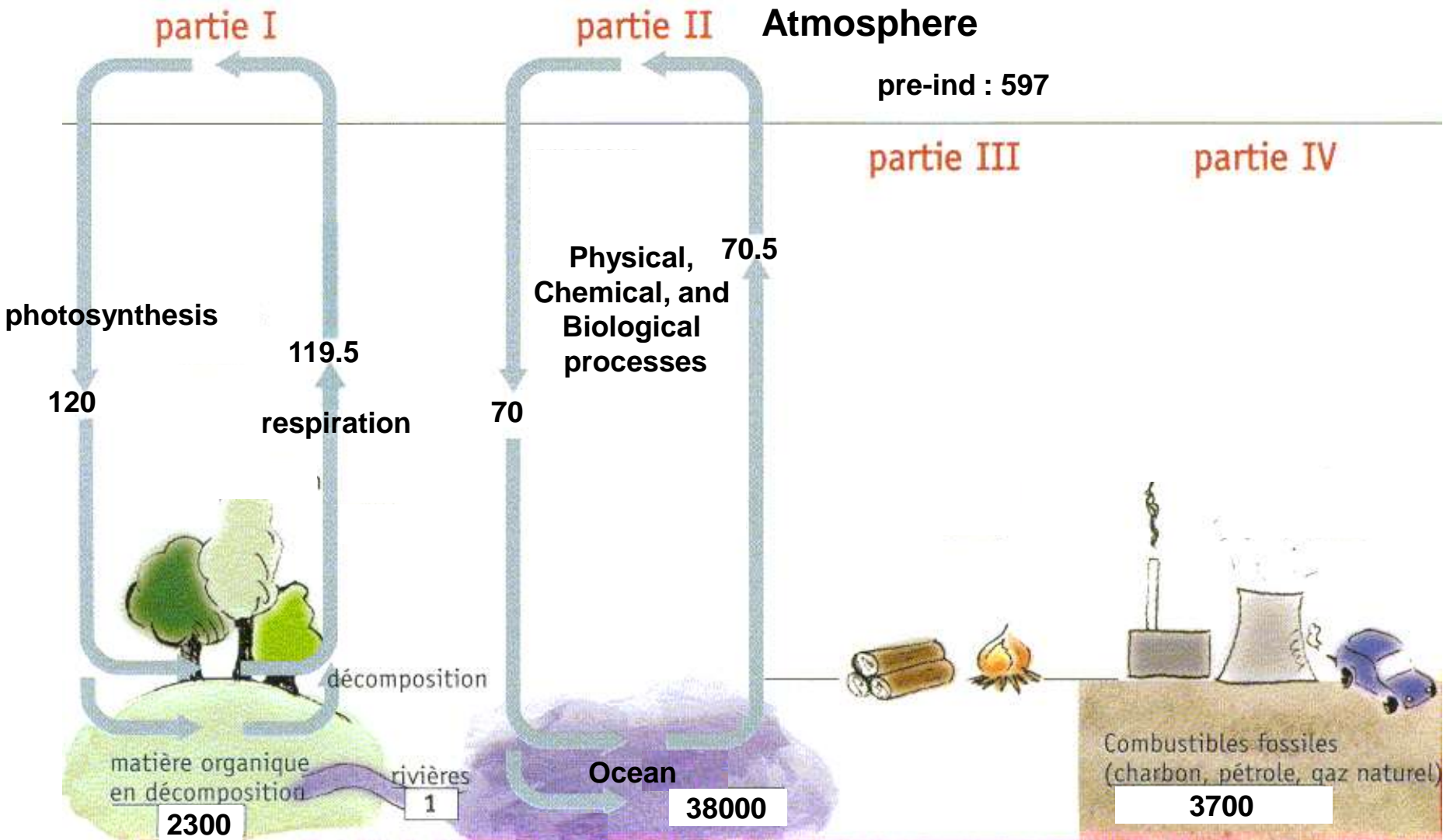
**Expected CO₂-
concentrations are higher
than observed at any time
over last 800 000 years**

**Projection
(2100) (BaU
scenario)**

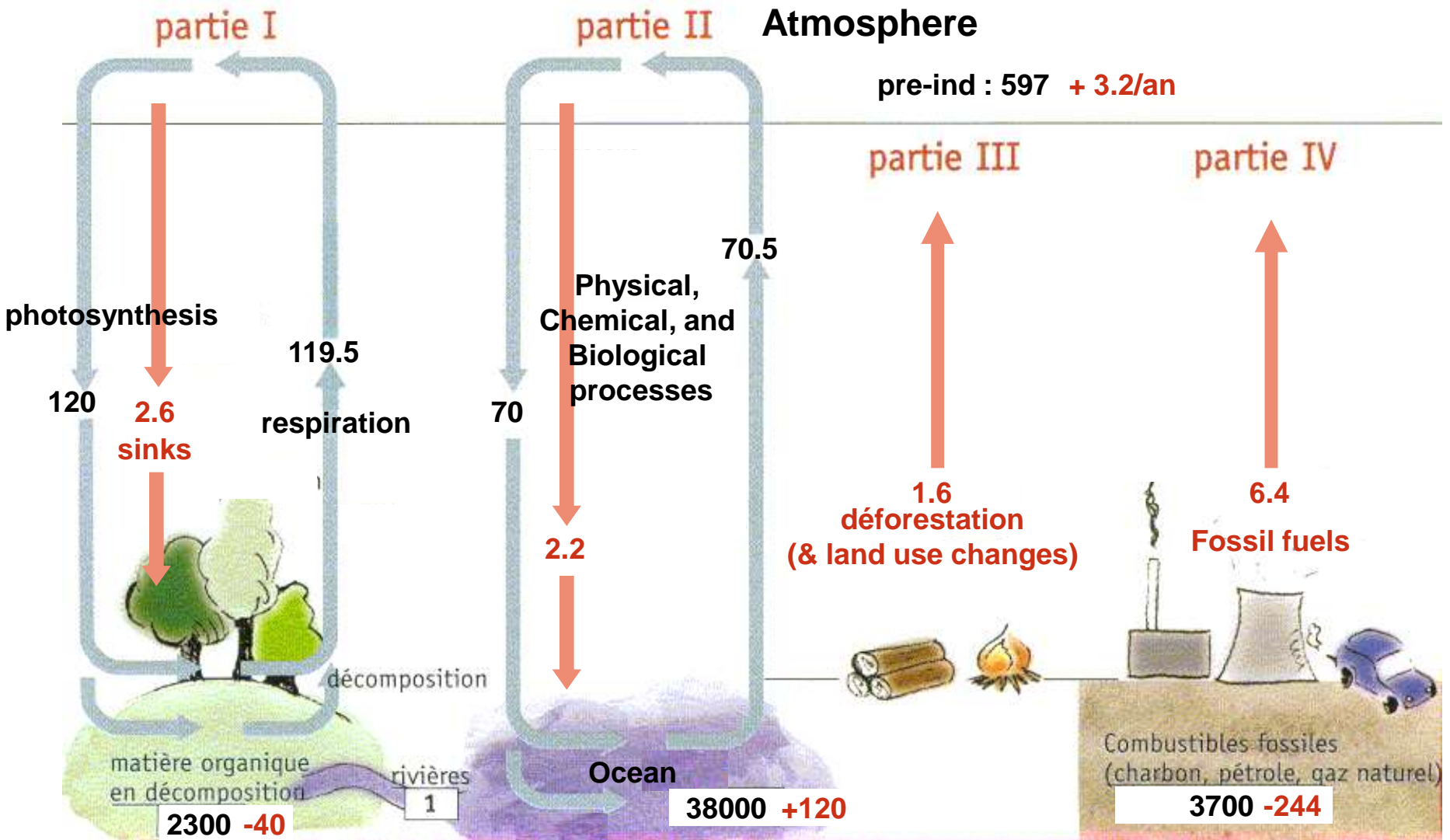
2007



Carbon cycle

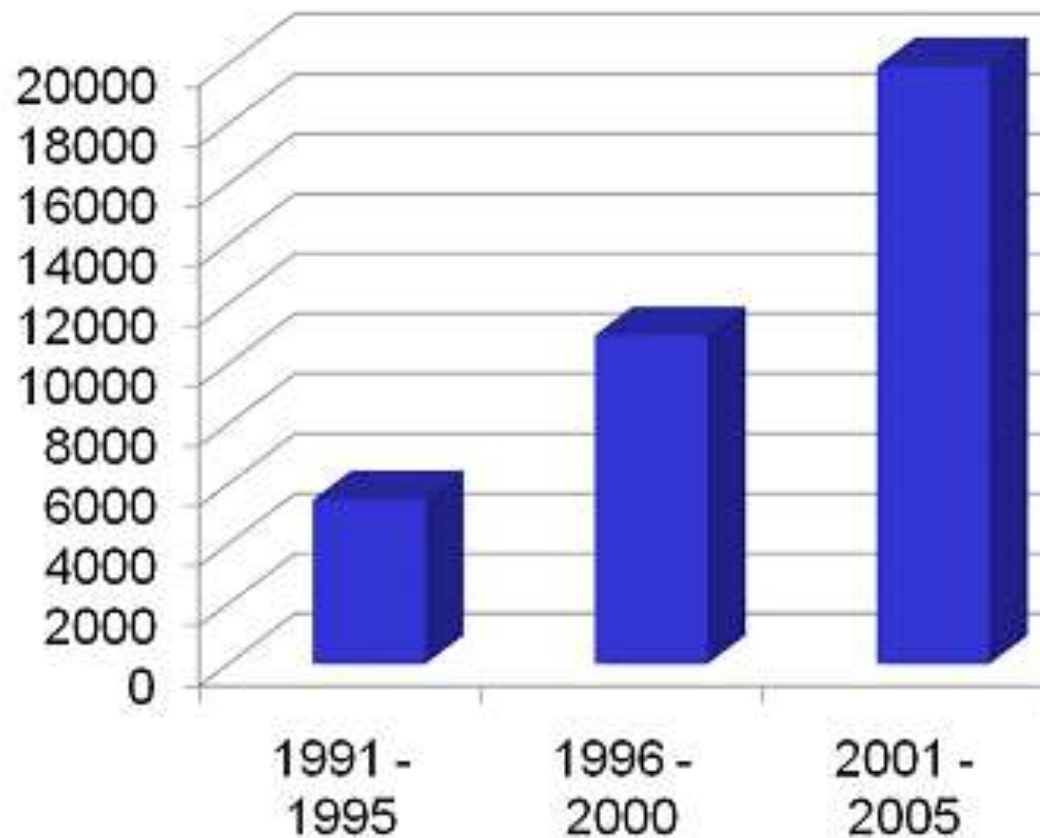


Carbon cycle



Units: GtC (billions tons of carbon) or GtC/year

Number of papers published on climate change



Why the IPCC ?

Established by WMO and UNEP in 1988


to provide **policy-makers** with an **objective source of information** about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options.



What is the IPCC (GIEC in French) ?

- ⌘ IPCC : Intergovernmental Panel on Climate Change
- ⌘ Created by World Meteorological Organisation (WMO) & United Nations Environment Programme (UNEP) in 1988
- ⌘ Mandate : assess the science of climate change, impacts and adaptation, mitigation options
- ⌘ Publishes consensus reports (1990, 1996, 2001, 2007) (Cambridge University Press)
Advises Climate Change Convention
- ⌘ Nobel Peace prize (2007)
- ⌘ Web : <http://www.ipcc.ch>



IPCC Reports are
policy-relevant,
NOT
policy-prescriptive

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The IPCC Fourth Assessment Report (2007)

+130 countries

around 450 lead authors

around 800 contributing authors

+2500 scientific expert reviewers

+18000 peer-reviewed publications cited

+90000 comments from experts and Governments

Next IPCC Report
(published 9 May 2011)

**Special Report on Renewable
Energy Sources and Climate
Change Mitigation**



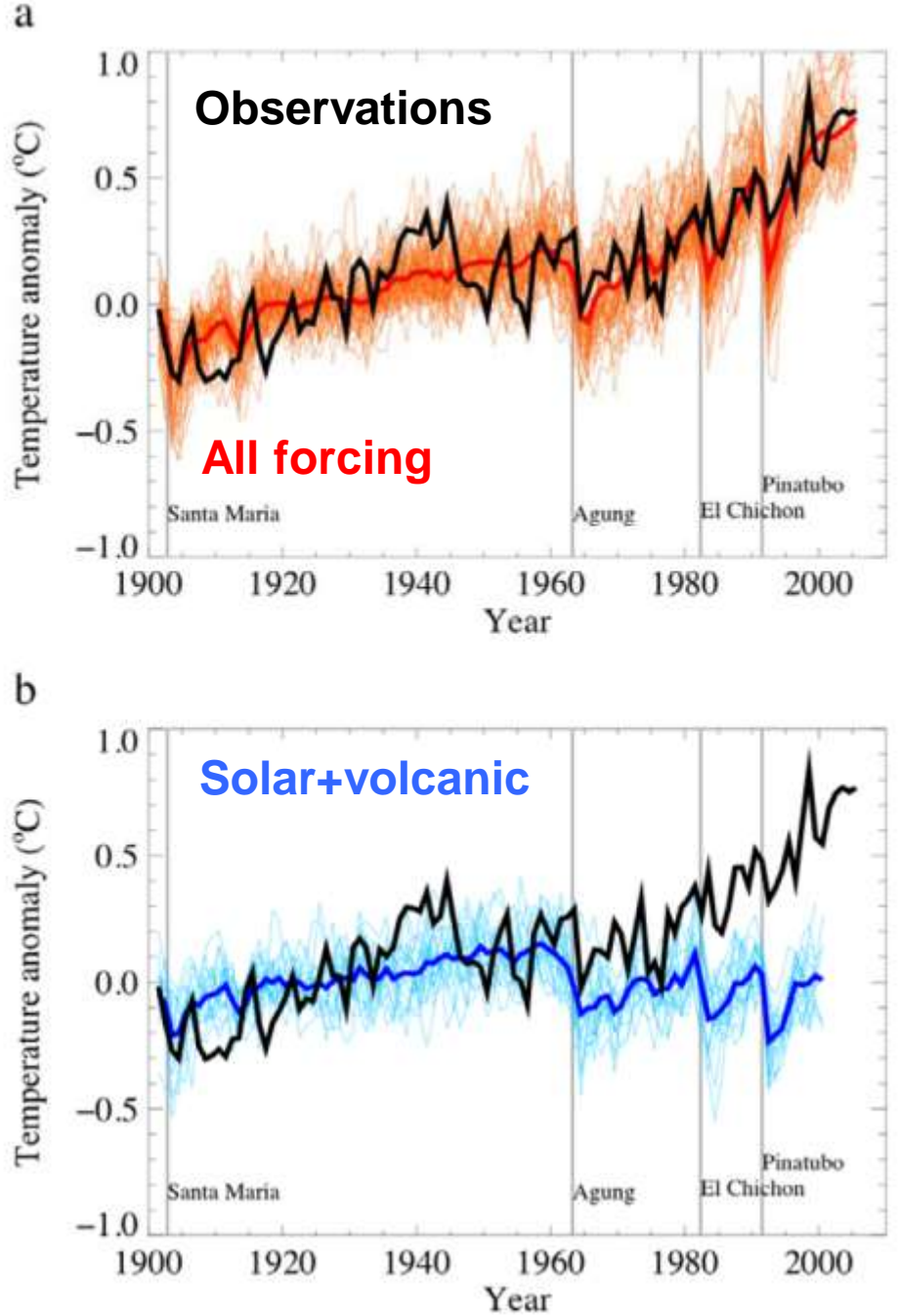
⌘ IPCC Working Group I: climatology

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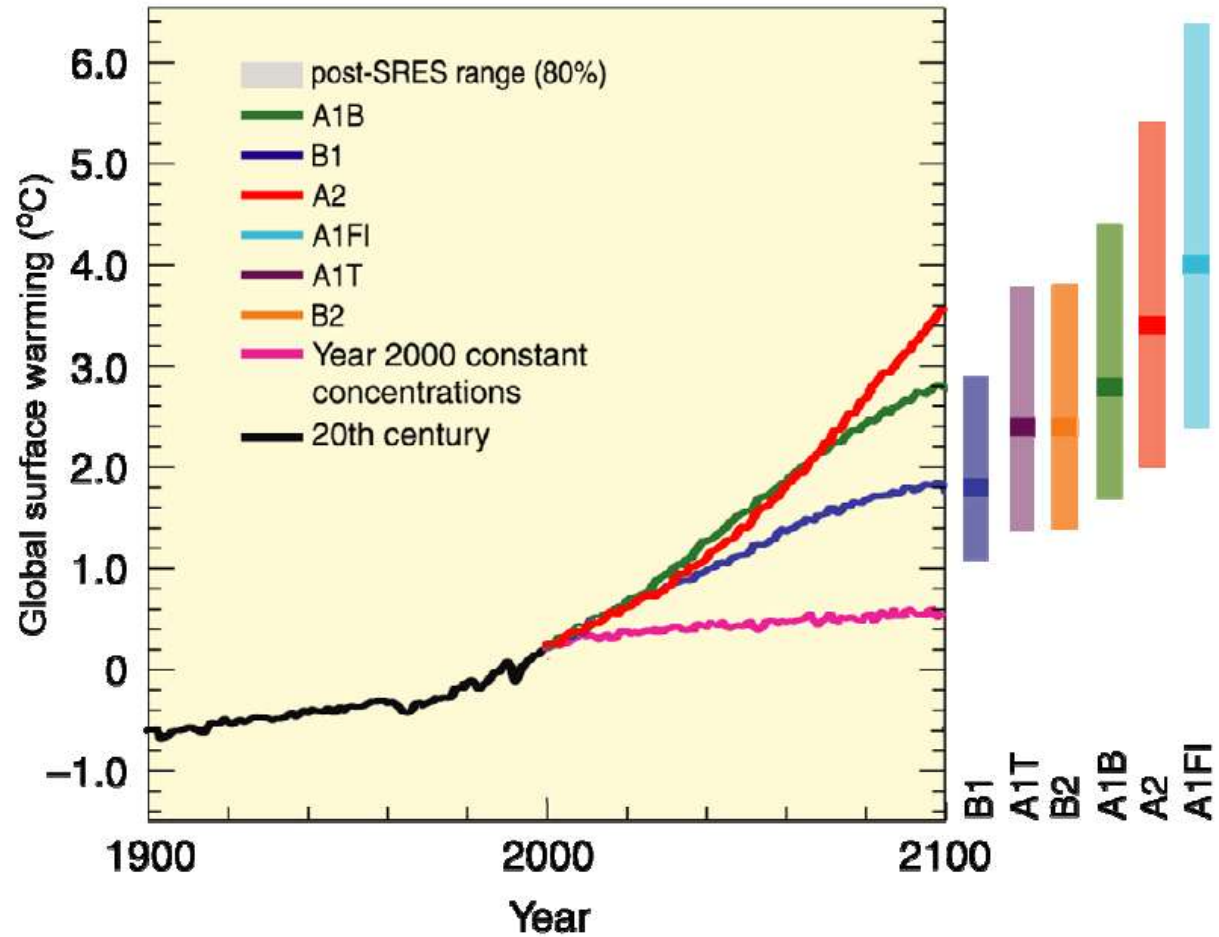
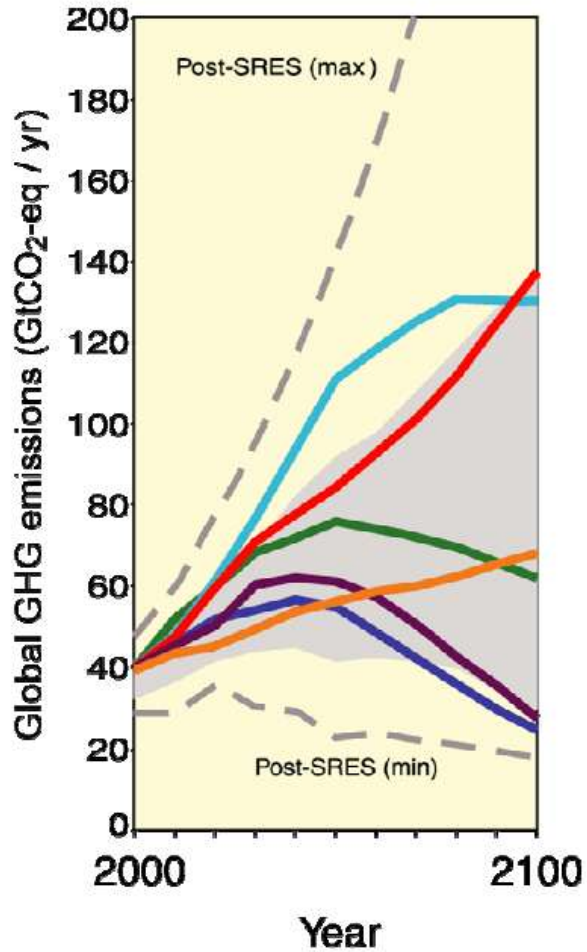
Attribution

Are observed changes consistent with expected responses to natural forcings?

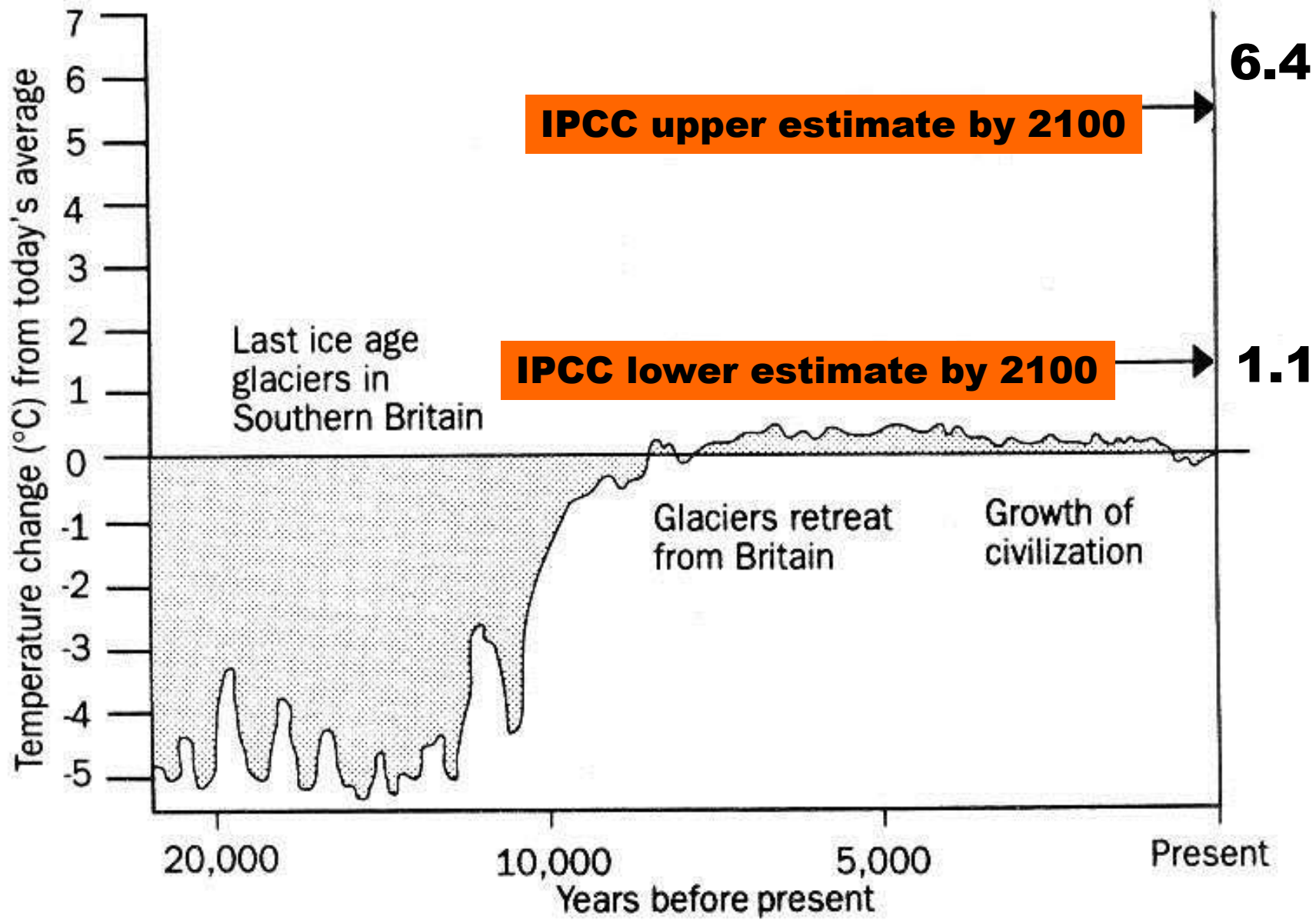
IPCC (2007):
“Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases.”



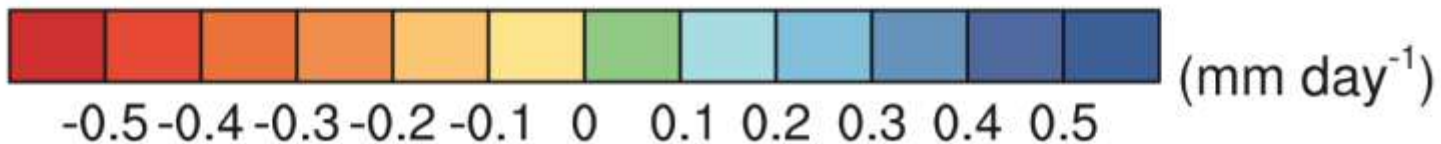
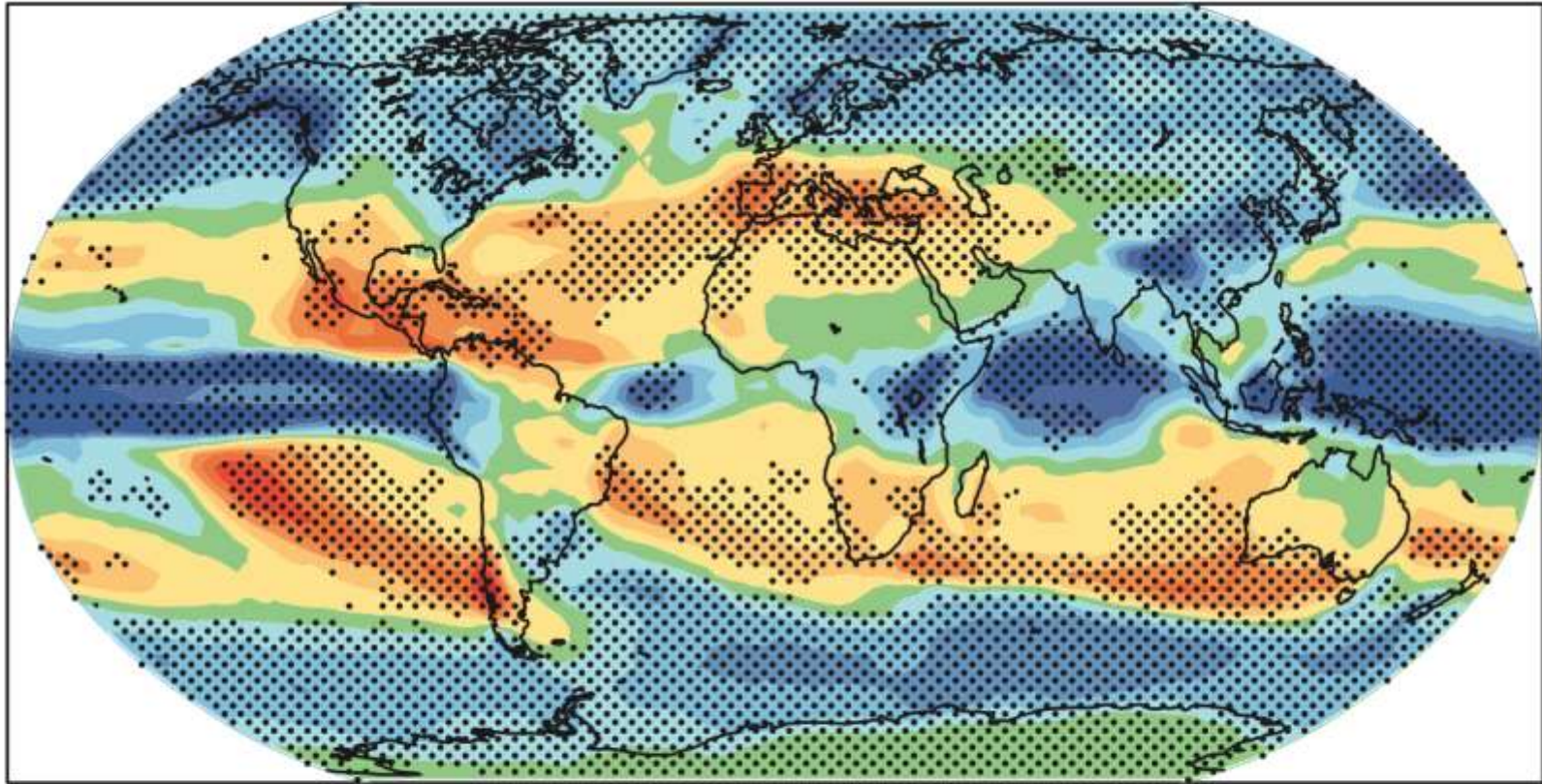
Climate projections without mitigation



NB: écart par rapport à la moyenne 1980-1999



Multi-model mean changes in precipitation (mm/day) (2090 relative to 1990, A1B scenario)



Projected regional change over the 21st century

- Seasonally, the largest warming is *likely* to be in northern Europe in winter and in the **Mediterranean area** in summer
- Annual precipitation is *very likely* to increase in most of northern Europe and decrease in most of the **Mediterranean area**
- The annual number of precipitation days is *very likely* to decrease in the Mediterranean area
- Risk of summer drought is *likely* to increase in central Europe and in the **Mediterranean area**

More heavy precipitation and more droughts....



More heavy precipitation and more droughts....



Climate change and extremes

(IPCC AR4 WG1)

Post 1960

21th century

Phenomenon ^a and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend ^b	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	<i>Very likely^c</i>	<i>Likely^d</i>	<i>Virtually certain^d</i>
Warmer and more frequent hot days and nights over most land areas	<i>Very likely^e</i>	<i>Likely (nights)^d</i>	<i>Virtually certain^d</i>
Warm spells / heat waves. Frequency increases over most land areas	<i>Likely</i>	<i>More likely than not^f</i>	<i>Very likely</i>
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	<i>Likely</i>	<i>More likely than not^f</i>	<i>Very likely</i>
Area affected by droughts increases	<i>Likely in many regions since 1970s</i>	<i>More likely than not</i>	<i>Likely</i>
Intense tropical cyclone activity increases	<i>Likely in some regions since 1970</i>	<i>More likely than not^f</i>	<i>Likely</i>
Increased incidence of extreme high sea level (excludes tsunamis) ^g	<i>Likely</i>	<i>More likely than not^{f, h}</i>	<i>Likelyⁱ</i>

Virtually certain > 99%, very likely > 90%, likely > 66%, more likely than not > 50%

What if the Gulf Stream is affected?

- Based on current model simulations, it is *very likely* that the **meridional overturning circulation (MOC) of the Atlantic Ocean** will slow down during the 21st century.
 - **longer term changes not assessed with confidence**
- **Temperatures in the Atlantic** region are projected to **increase** despite such changes due to the much larger warming associated with projected increases of greenhouse gases.

Ice sheet melting

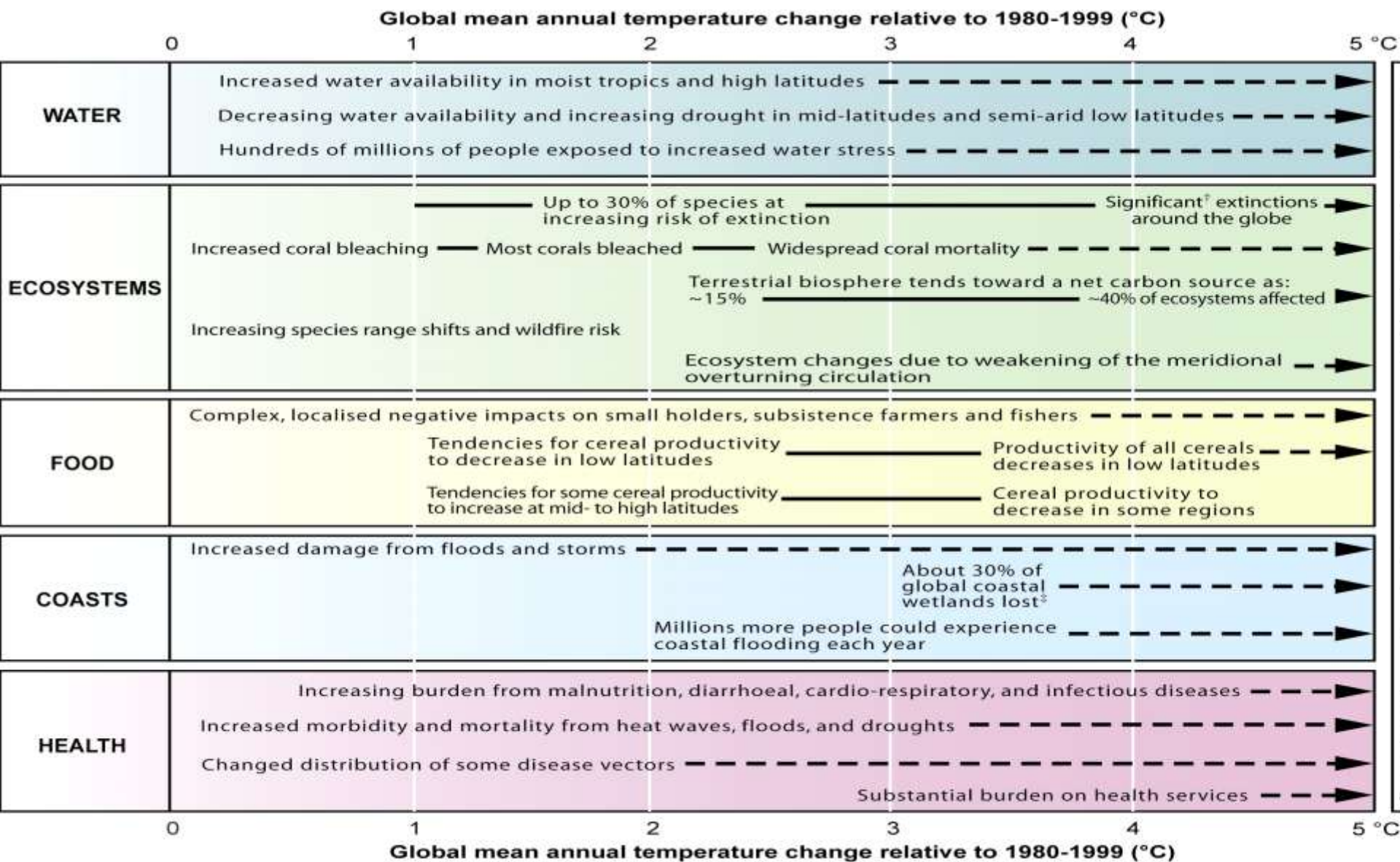
- Melting of the Greenland ice sheet
 - Total melting would cause 7 m SLR contribution
- Melting of the West Antarctic Ice Sheet
 - Total melting would cause 5 m SLR contribution
- Warming of 1 – 4°C over present-day temperatures would lead to partial melting over centuries to millennia



⌘ IPCC Working Group II: Impacts, Vulnerability, and Adaptation

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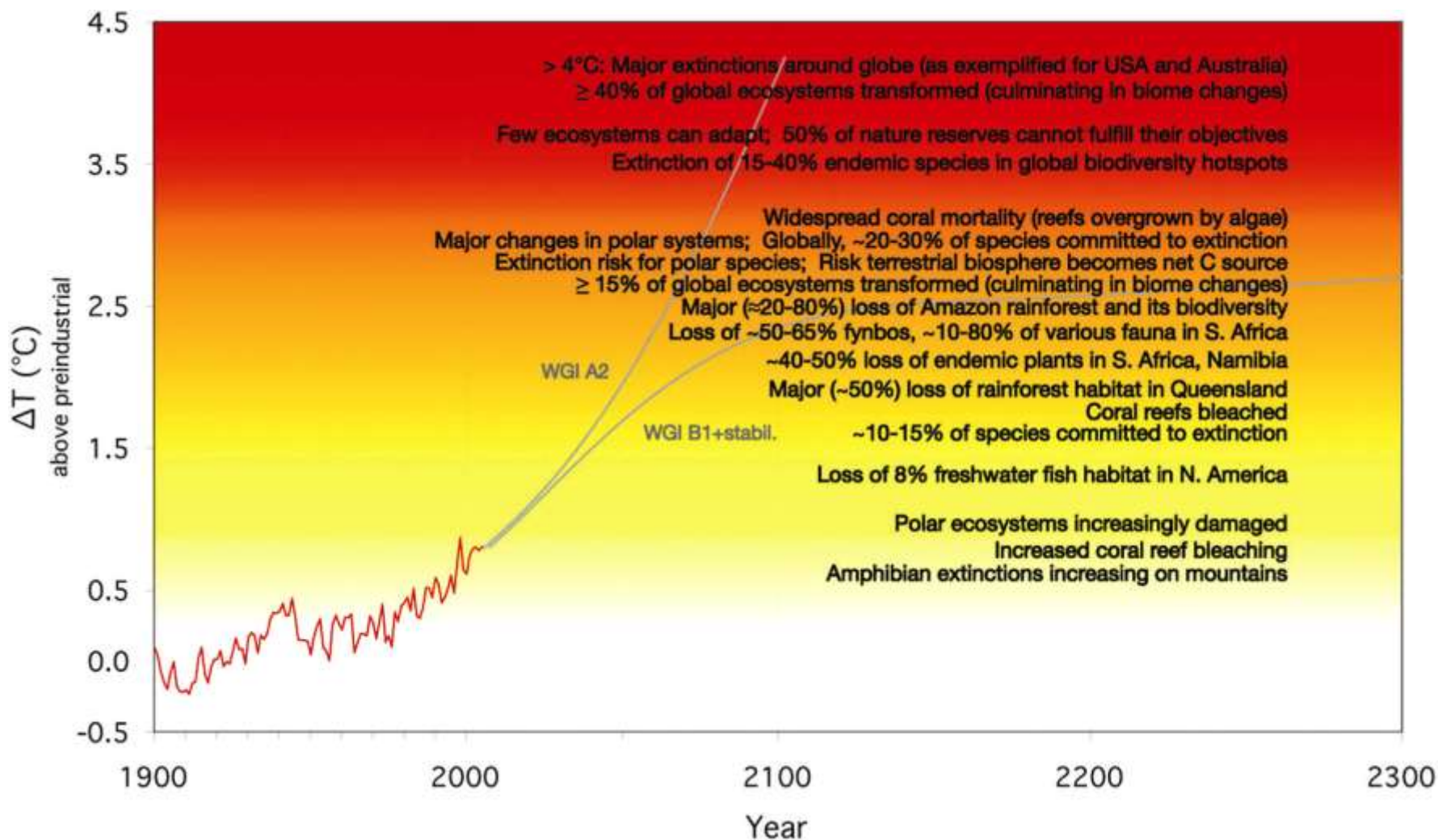
Figure SPM.2. Key impacts as a function of increasing global average temperature change
 (Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)



† Significant is defined here as more than 40%.

‡ Based on average rate of sea level rise of 4.2 mm/year from

Figure TS.6. Projected risks due to critical climate change impacts on ecosystems



**20% - 30% of plants
and animals species
likely at “increased
risk of extinction”**

**if ΔT 1.5°C - 2.5°C
(above 1990 temperature)**

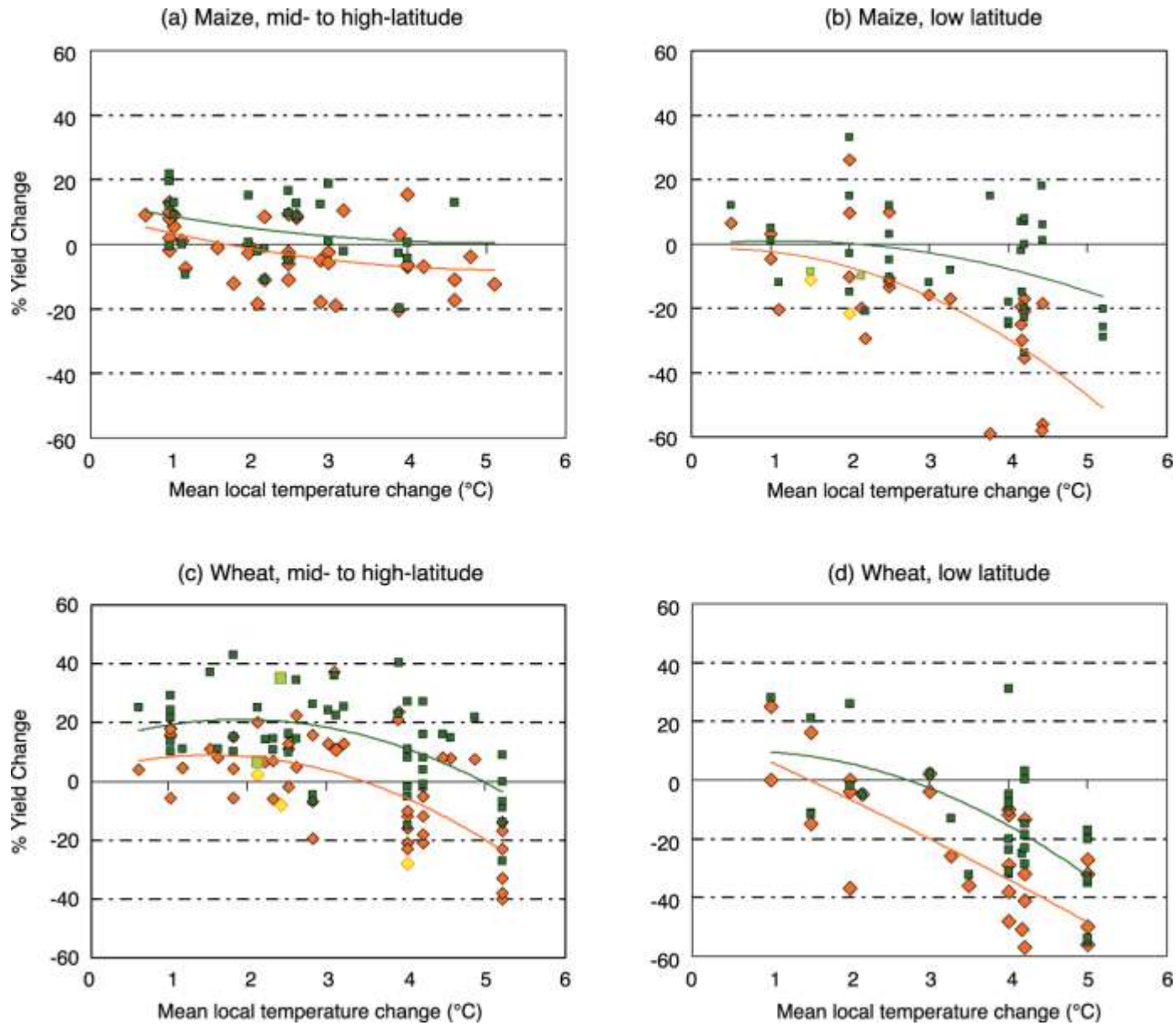


WMO



UNEP

Figure TS.7. Sensitivity of cereal yield to climate change



Effects on Nile delta: 10 M people above 1m



(Time 2001)

**With 1 metre sea-level rise: 63000 ha below sea-level in Belgium (likely in 22nd century, not impossible in 21st century)
(NB: flooded area depends on protection)**



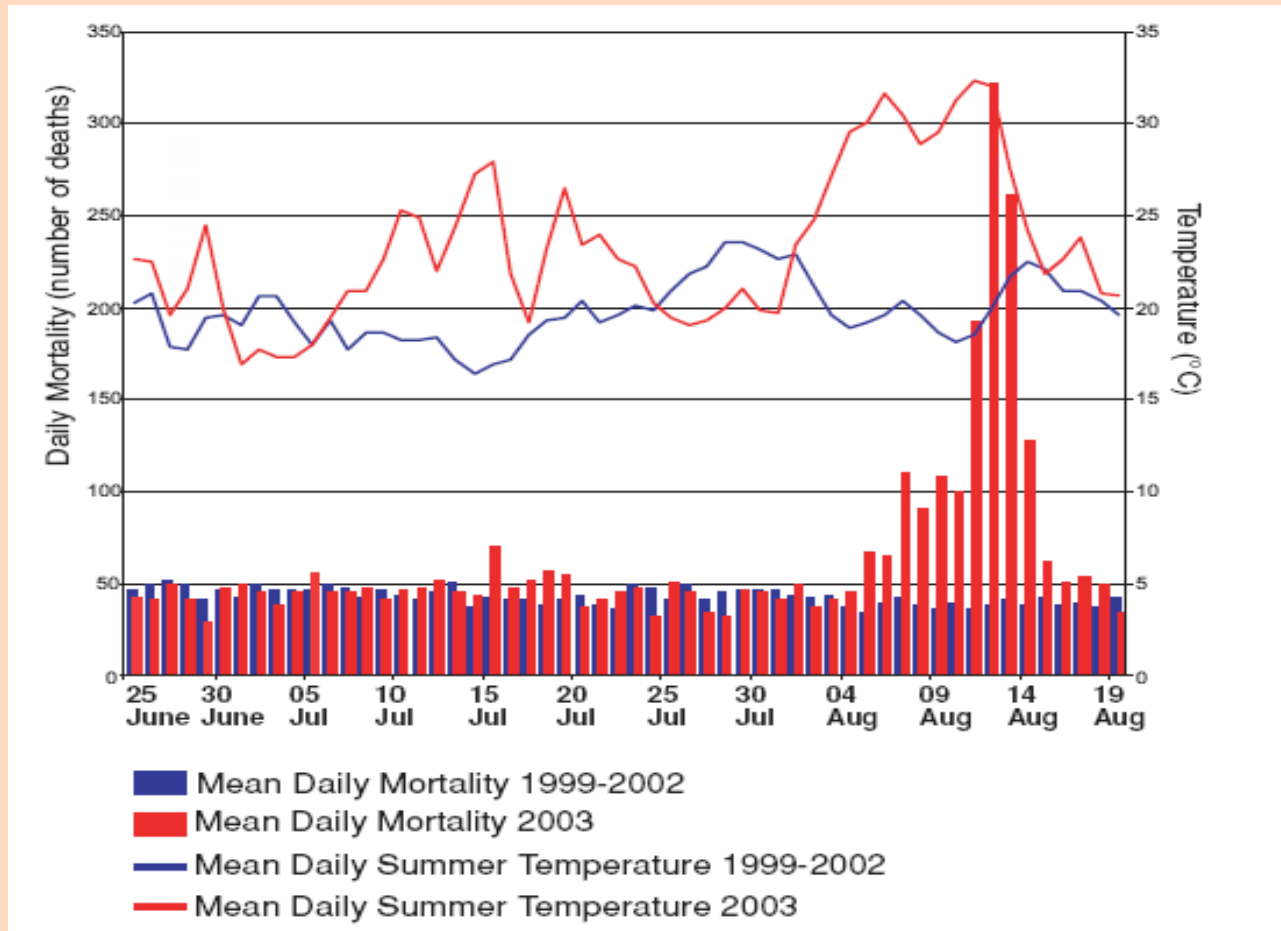
Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

With 8 metre sea-level rise: 3700 km² below sea-level in Belgium
(very possible in year 3000)
(NB: flooded area depends on protection)



Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

Daily mortality in Paris (summer 2003) (IPCC AR4 Ch 8)



Mediterranean ecosystems: Key vulnerabilities (1)

Threats from desertification were projected due to expansion of adjacent semi-arid and arid systems under relatively minor warming and drying scenarios

Warming and drying trends are likely to induce substantial species-range shifts, and imply a need for migration rates that will exceed the capacity of many endemic species

Mediterranean ecosystems: Key vulnerabilities (2)

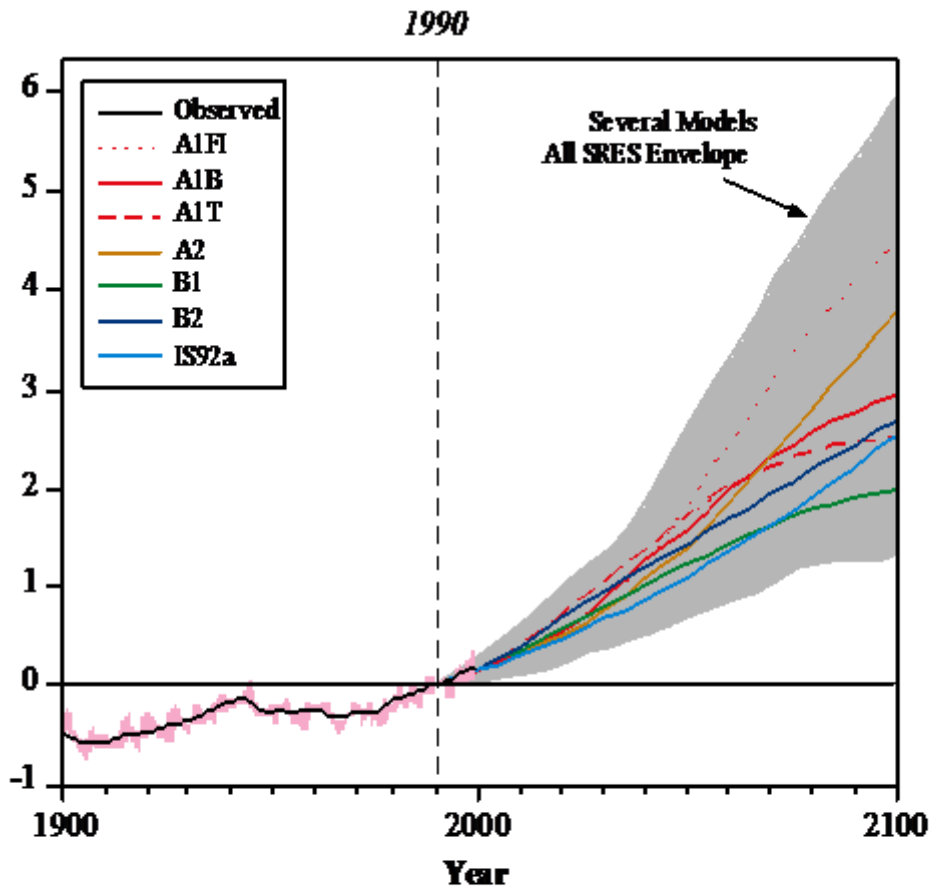
Vegetation structural change driven by dominant, common or invasive species may also threaten rare species.

Overall, a loss of biodiversity and carbon sequestration services may be realised over much of these regions.

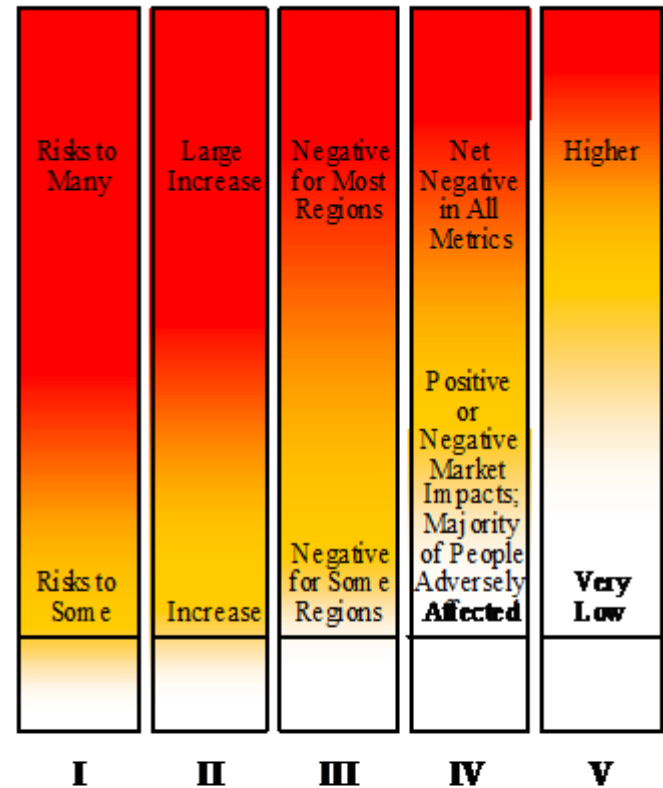
Key hotspots of societal vulnerability in coastal zones: Mediterranean

- Coastal areas subject to multiple natural and human-induced stresses, such as subsidence or declining natural defences
- Coastal areas with tourist-based economies where major adverse effects on tourism are likely

Reasons for Concern



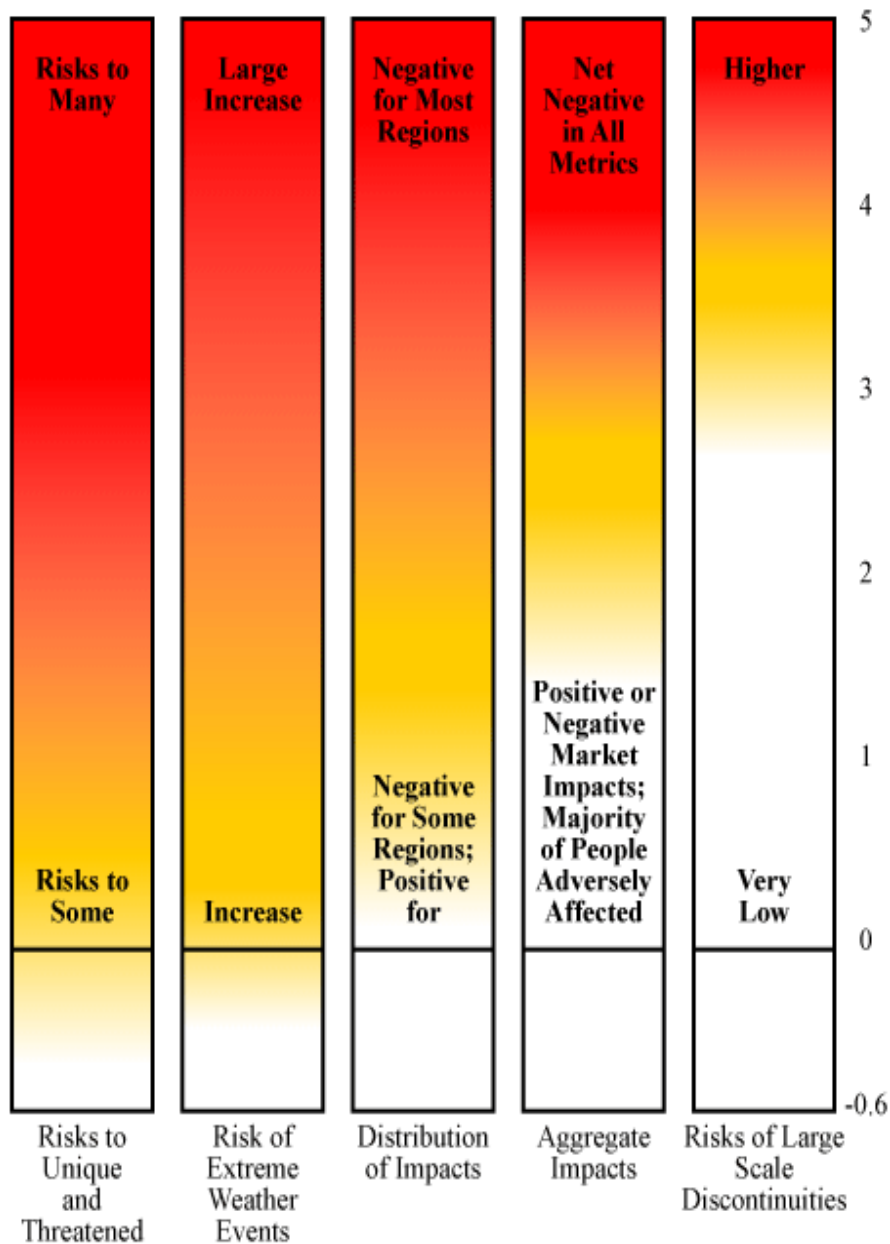
Reasons for Concern



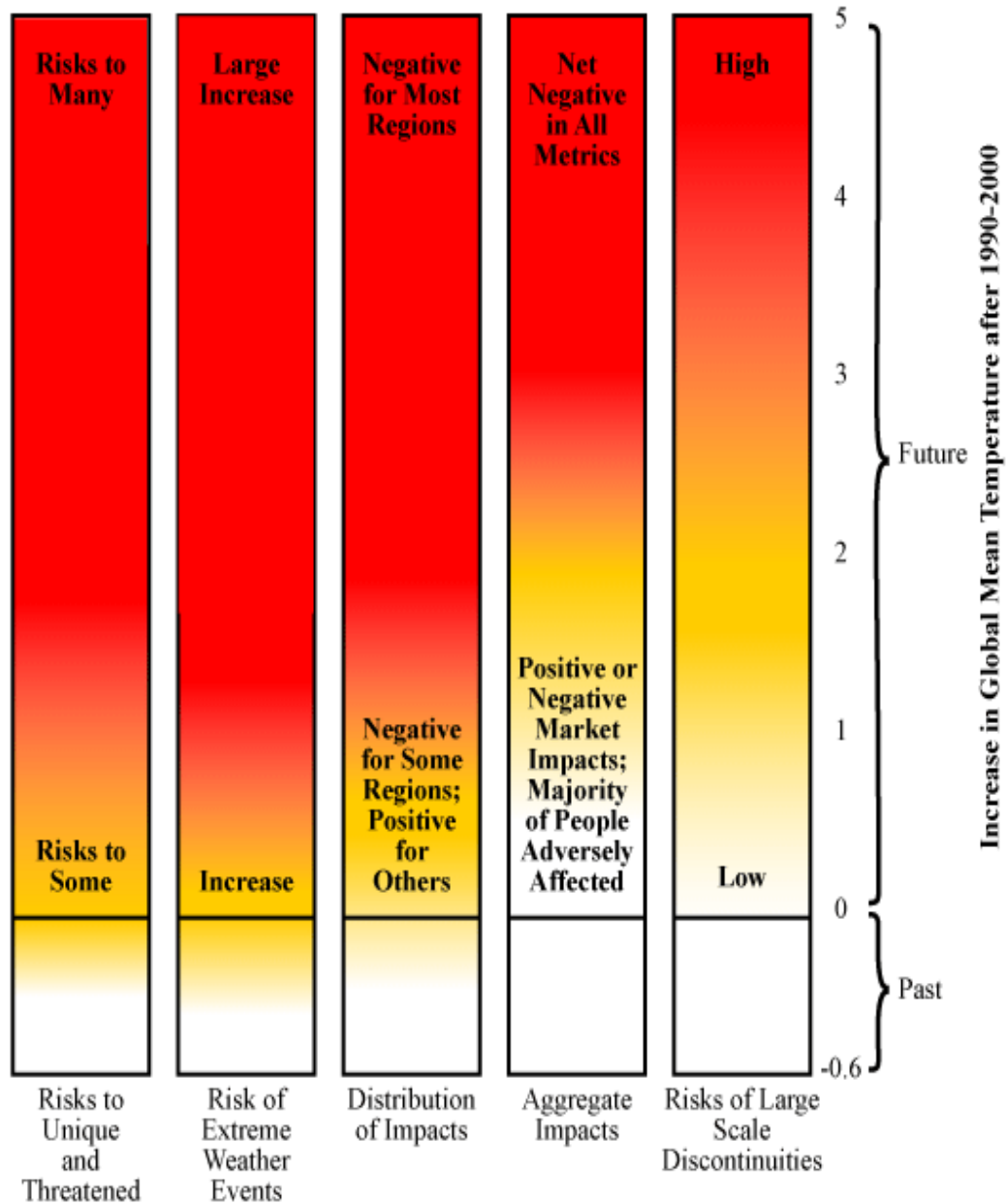
- I Risks to unique and threatened systems
- II Risks from extreme climate events
- III Distribution of Impacts
- IV Aggregate Impacts
- V Risks from large-scale discontinuities

Source: IPCC TAR WG2 (2001)

TAR Reasons For Concern



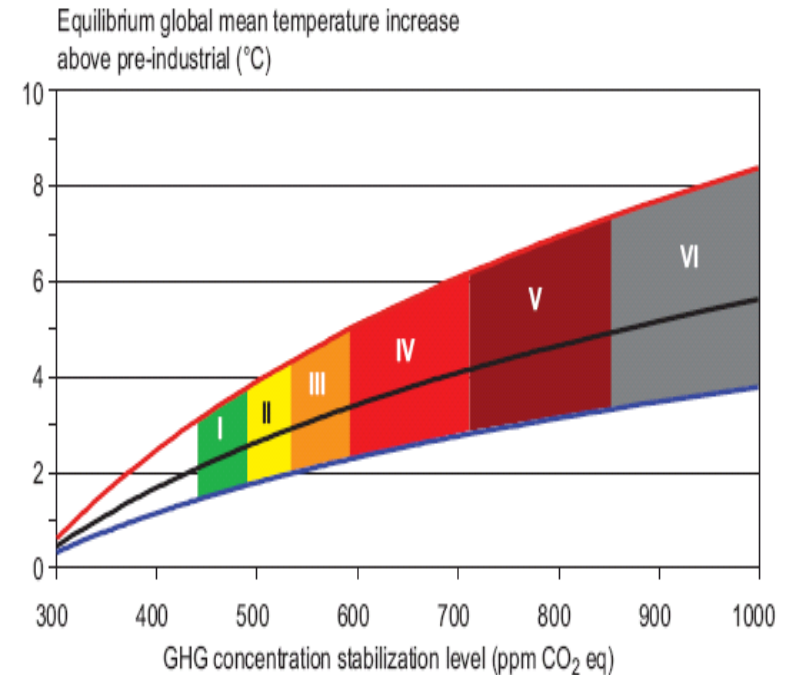
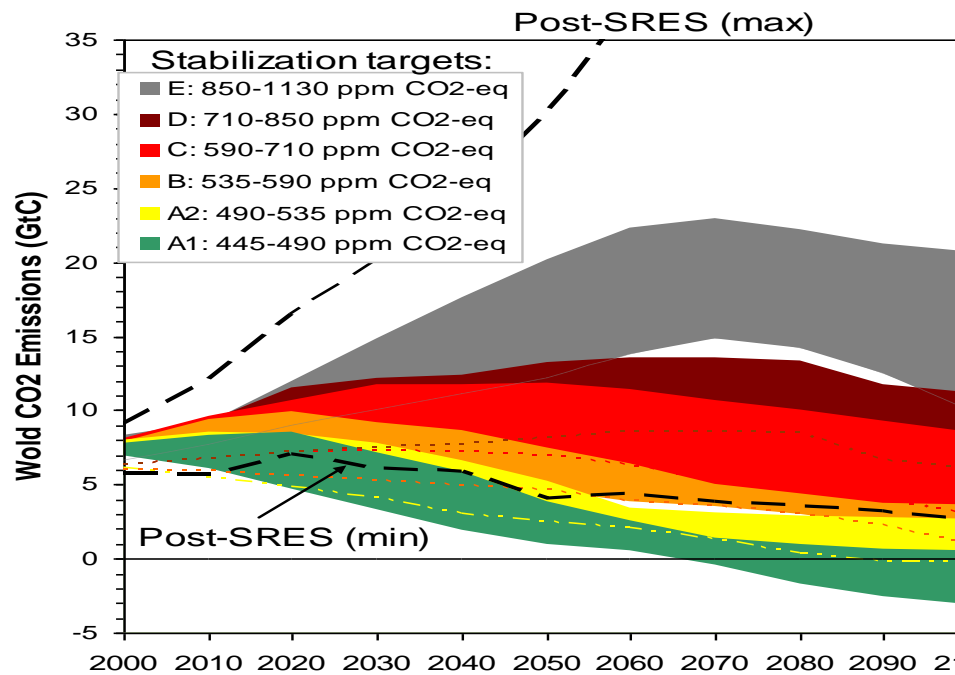
Proposed AR4 Reasons For Concern



What does IPCC tell us on mitigation?

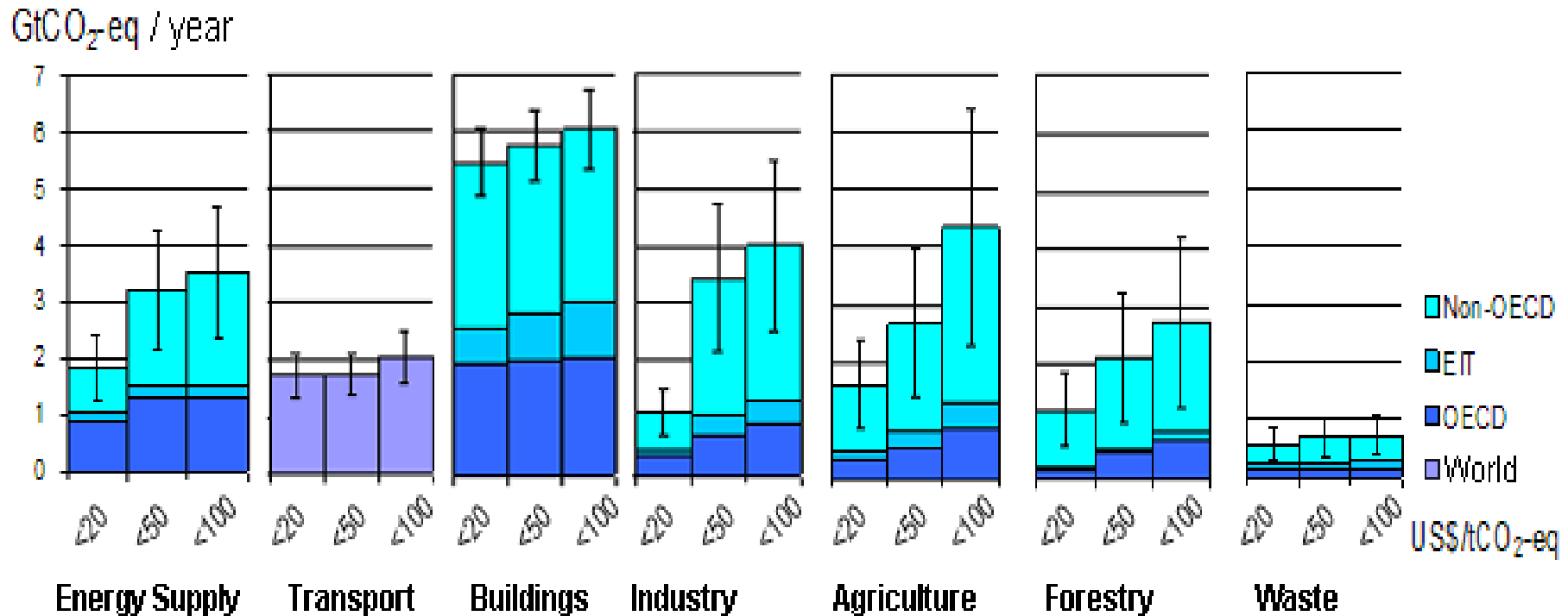
⌘ WG3: Mitigation

The lower the stabilisation level the earlier global emissions have to go down



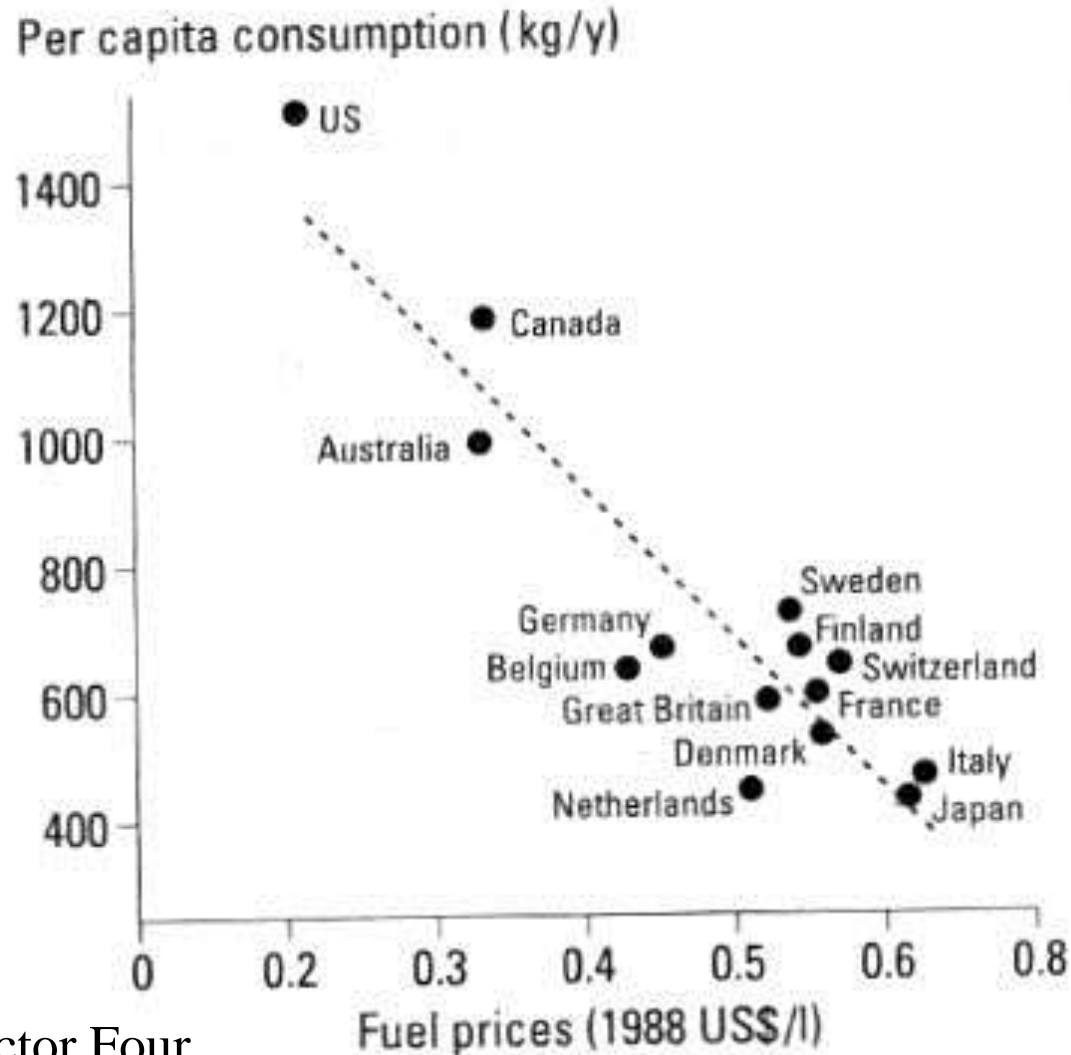
Multigas and CO₂ only studies combined

All sectors and regions have the potential to contribute by 2030



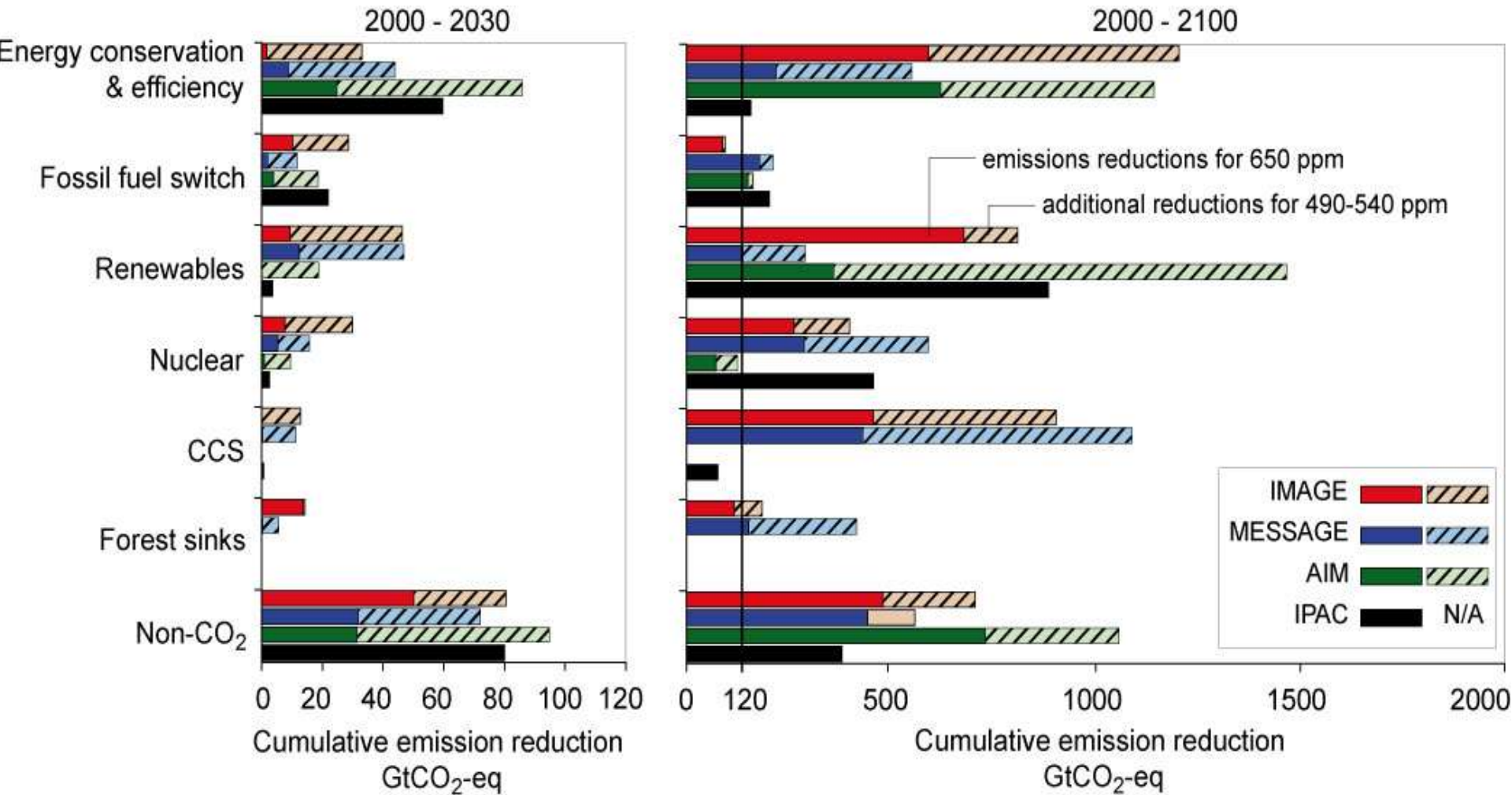
Note: estimates do not include non-technical options, such as lifestyle changes.

The pricing of carbon is effective: Negative correlation between fuel price and consumption



Source: Factor Four

Role of Technology, following IPCC AR4



Choice A...

- ... is privileging the short-term and amounts to being as clever as the ostrich hiding her head in the sand
- ... is like continuing to dance in the Titanic ballroom, while unaware of the approaching collision

Choice B

- Here, humanity pays more attention to the IPCC and to scientists who work on the subject
- Humanity uses the IPCC reports like radar antennas combined with GPS systems, which at the same time make it possible to anticipate the obstacle and to find an alternate way
- NB: Radars and GPS which missed on Titanic
- Humanity sees the beauty and the fragility of the branch on which we are all seated

Choice B

- Humanity understands that the Sun provides us each **hour** the same quantity of energy as what humanity consumes in total in one **year**
- Visionary leaders and actors at all levels see the opportunities offered by a long-term and **sustainable vision**, including in **profitability** (among other reasons because non-renewable energy and other natural resources will become more costly; **being super-efficient** means being **more competitive** as well)

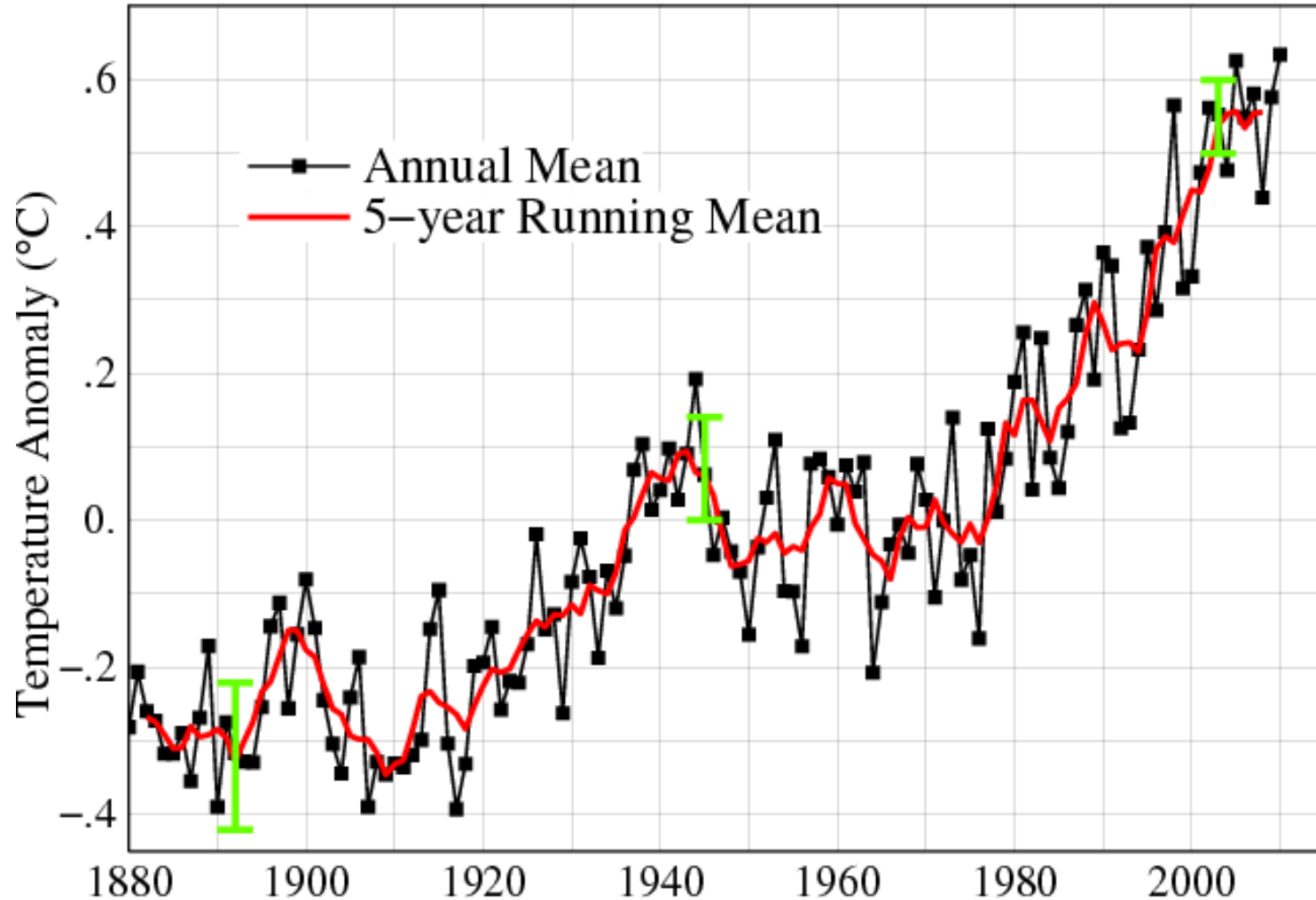
What did « The Economist » say in 1990 already?

- **“Being dirty has lots of costs: being greener than the competition may have many advantages”**
- **“For far-sighted companies, the environment may turn out to be the biggest opportunity for enterprise and invention the industrial world has seen.”**

(Frances Cairncross, The Economist, 8 September 1990)

Warming has not « stopped »: Global (land & ocean) mean surface temperature change from NASA GISS until 2010

Global Land–Ocean Temperature Index



Source: NASA GISS

A wise man said this at a recent UN climate conference:



⌘ ...The Zen practice of breaking through mental boundaries provides a good theme for the days ahead when negotiators would have to break through the tendency to consider the short-term costs while neglecting the long-term economic opportunities. (*Michael Zammit Cutajar, Kyoto, 1997*)

Jean-Pascal van Ypersele
(vanypers@astr.ucl.ac.be)

Let us break the mental barriers Michael Zammit Cutajar mentioned in Kyoto in 1997, because we only have one of these...



Painting by the Maltese artist Luciano Micallef

This painting commemorates the 20th anniversary of when Malta proposed the concept of 'conservation of climate as part of the common concern of mankind' in the UN General Assembly

Useful links:



⌘ www.ipcc.ch : IPCC

⌘ www.unfccc.int : Climate Convention

⌘ www.skepticalscience.com: answers to
« skeptics »

⌘ www.climate.be/vanyp : my slides and
other documents