

Climate Change, IPCC, and our Future on Planet Earth



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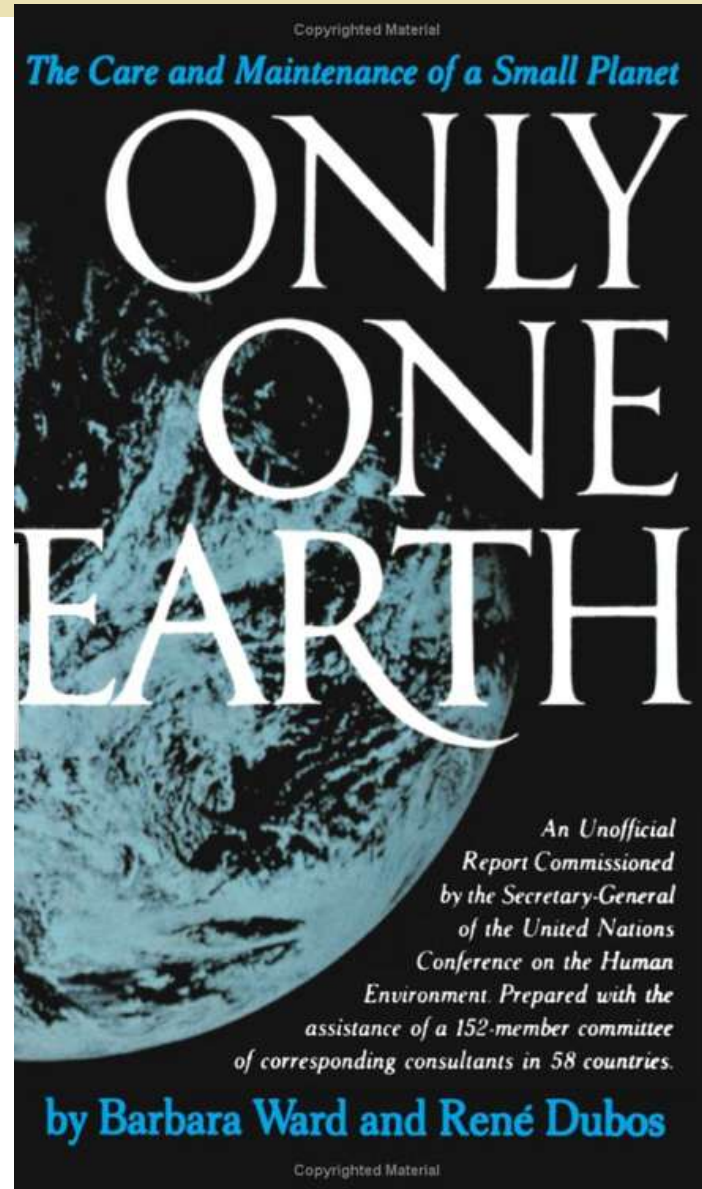
Harvard Club of Belgium, Brussels, 30-3-2011

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

Already 39 years!

- It was well before the establishment of the IPCC, in 1988
- Didn't we lose some time?

Introduction



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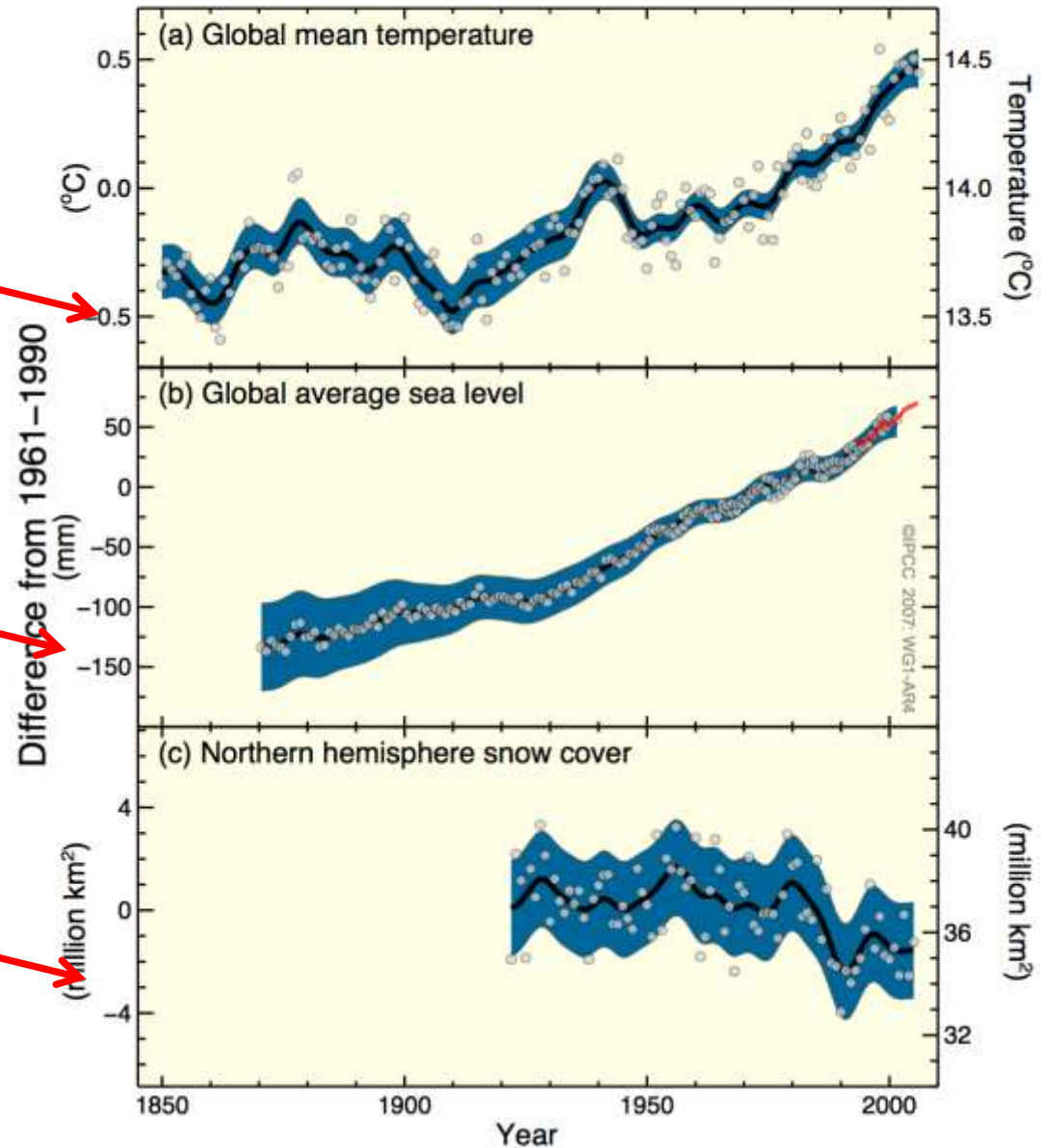
Warming is Unequivocal

Rising atmospheric temperature

Rising sea level

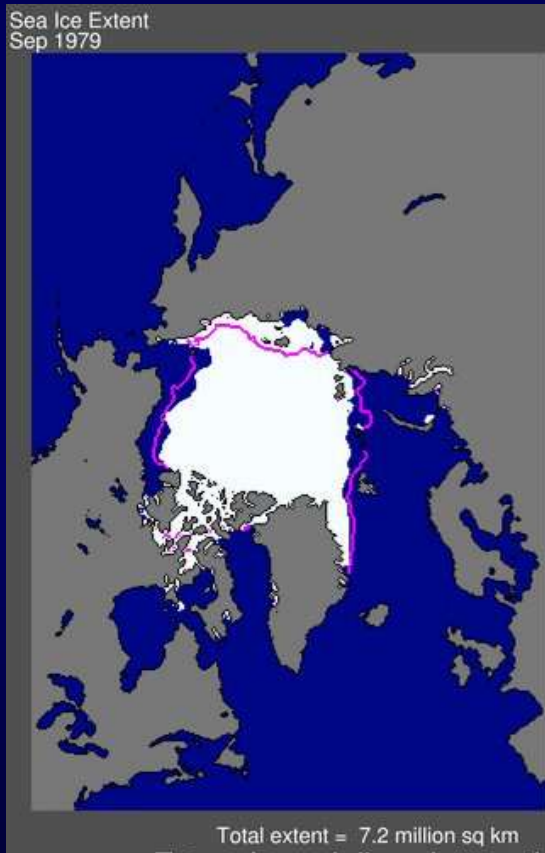
Reductions in NH snow cover

Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

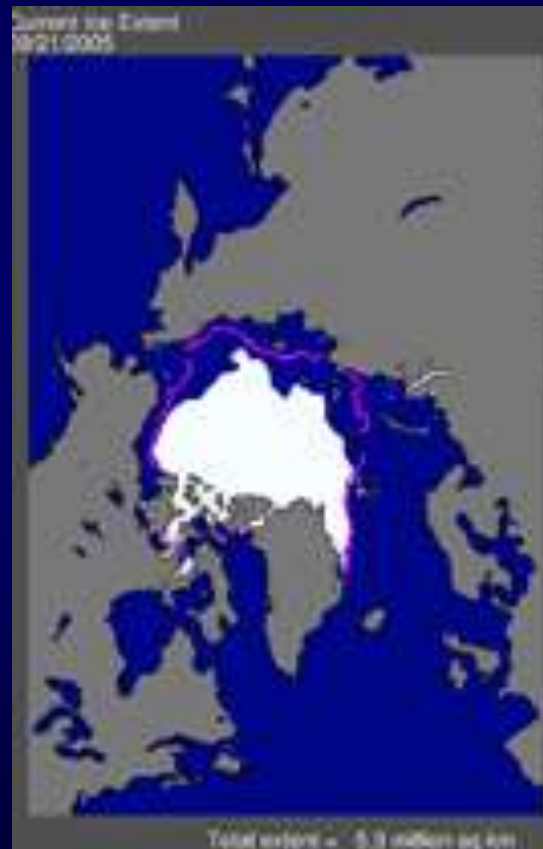


Extension of the Arctic ice cap

September 1979



September 2005

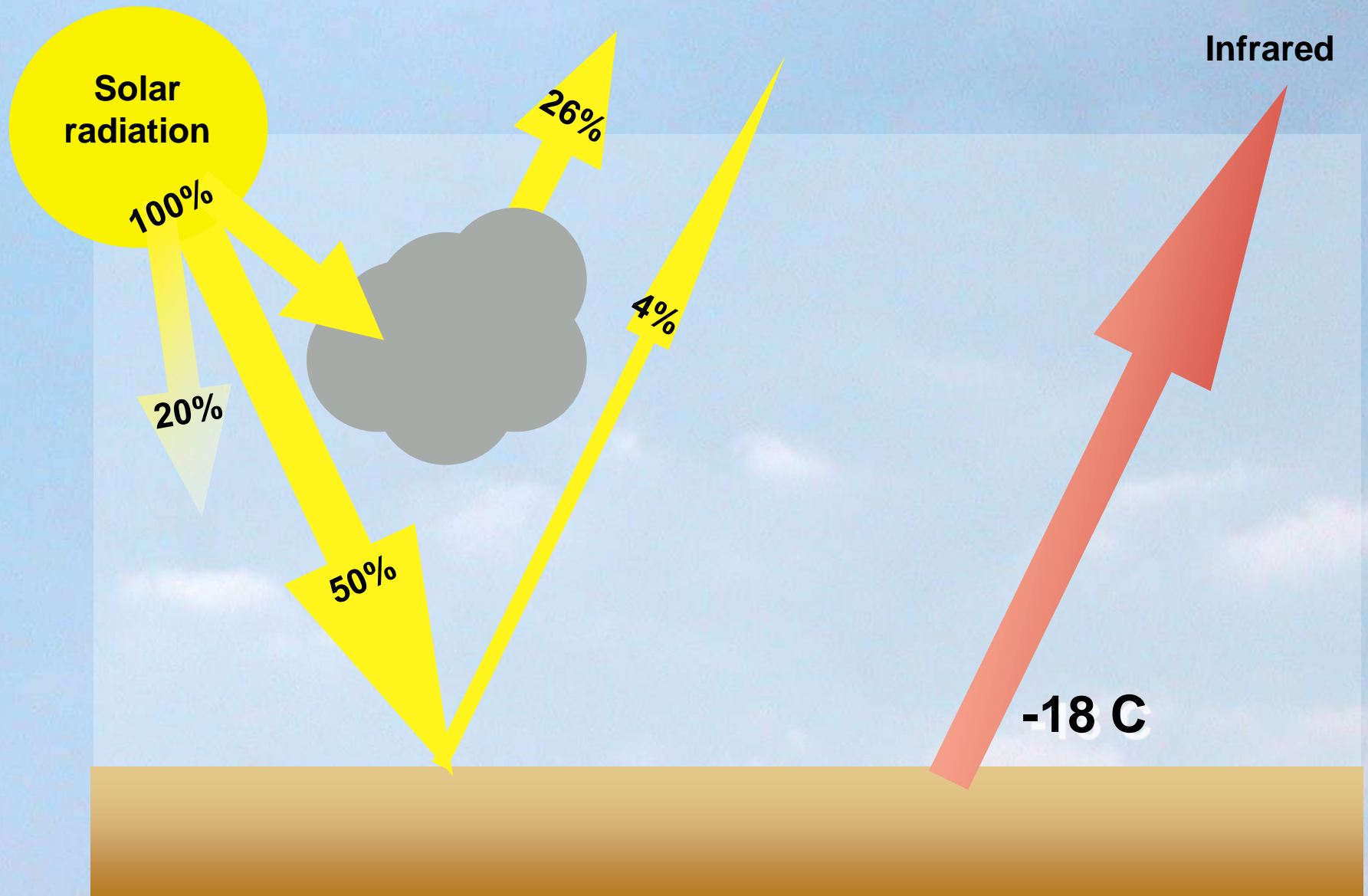


September 2007

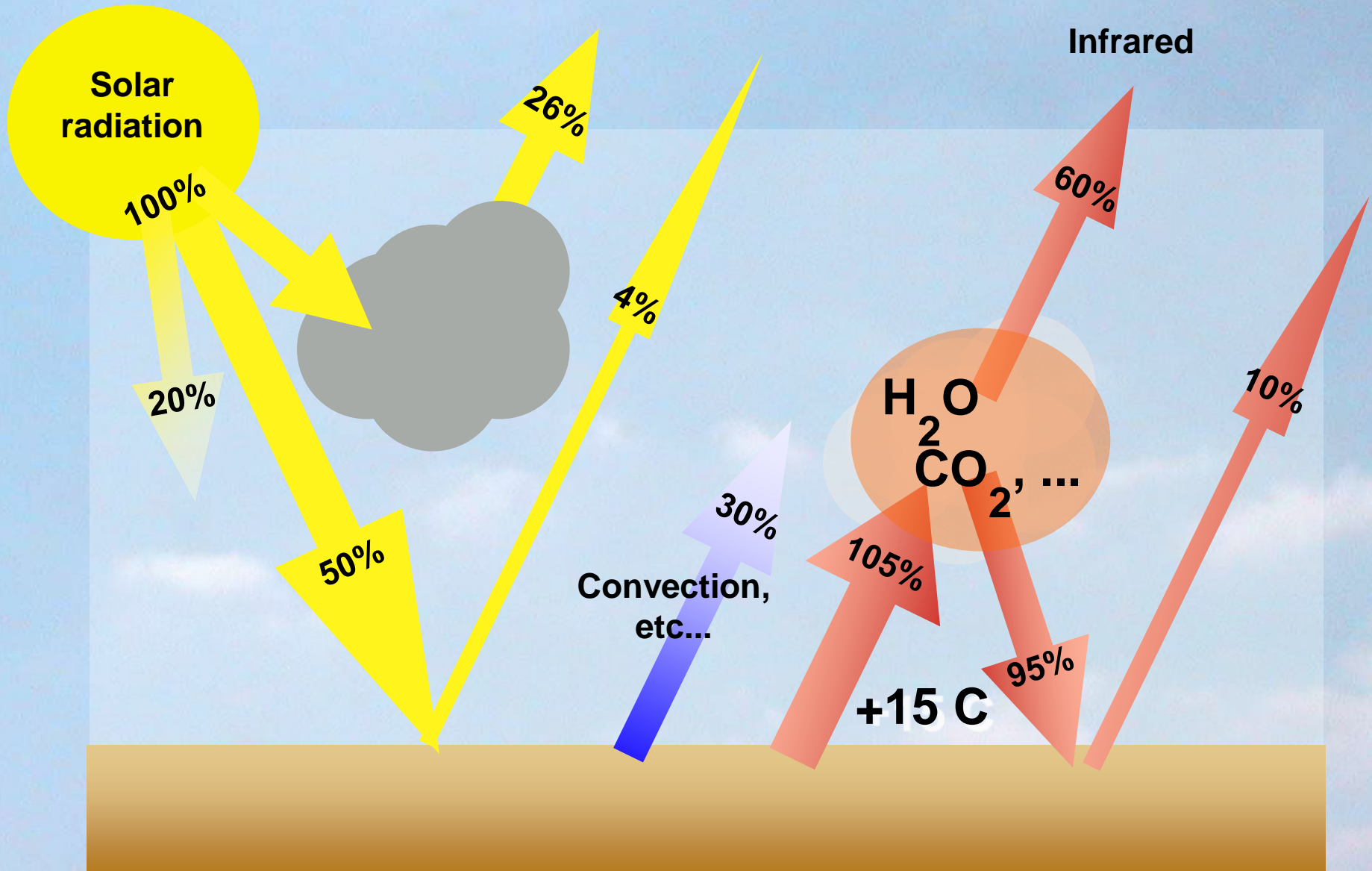


The pink line indicates the average ice cap extension since 1979

Energy cycle without greenhouse effect

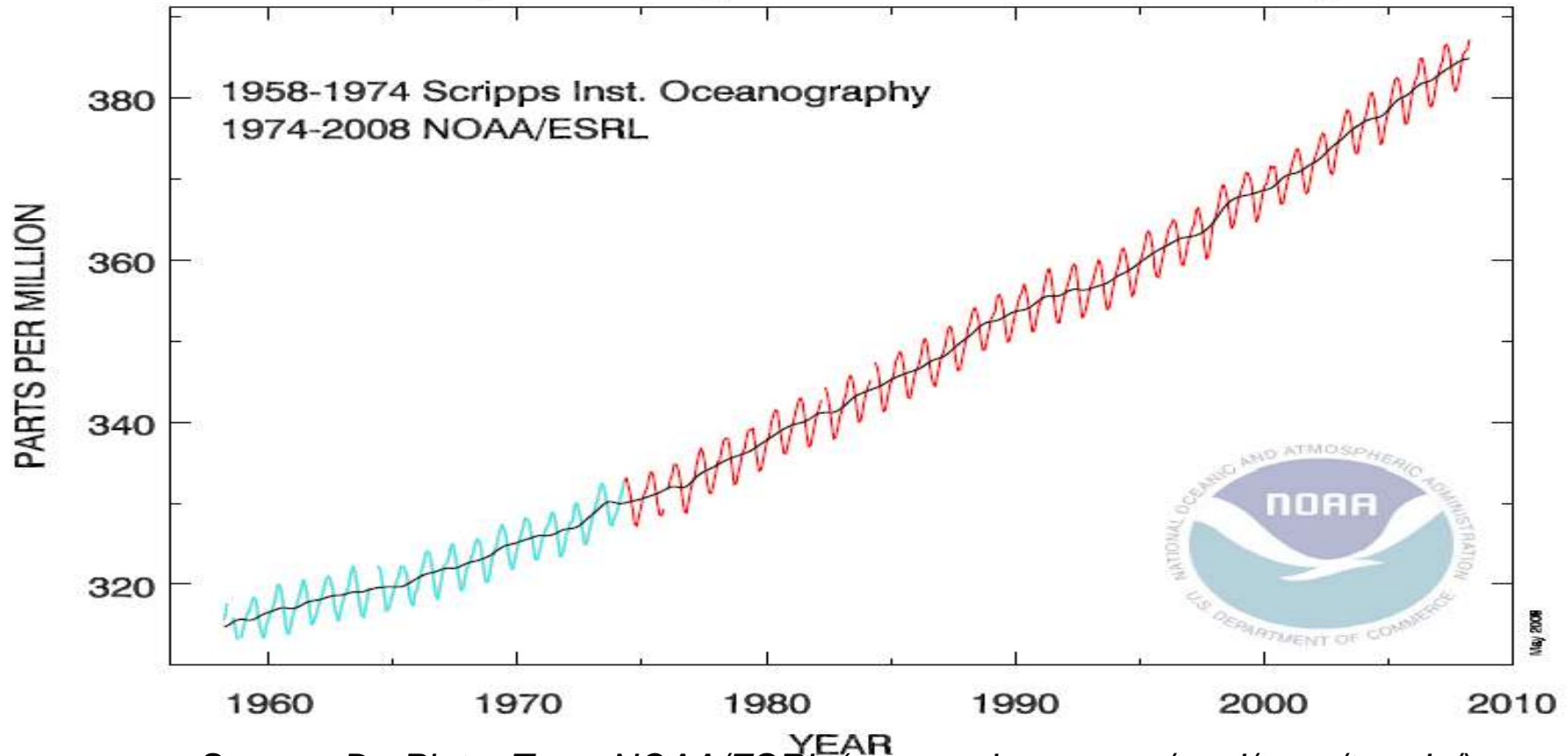


Energy cycle *with* greenhouse effect



CO₂ concentration measured at Mauna Loa (3400 m)

Atmospheric CO₂ at Mauna Loa Observatory



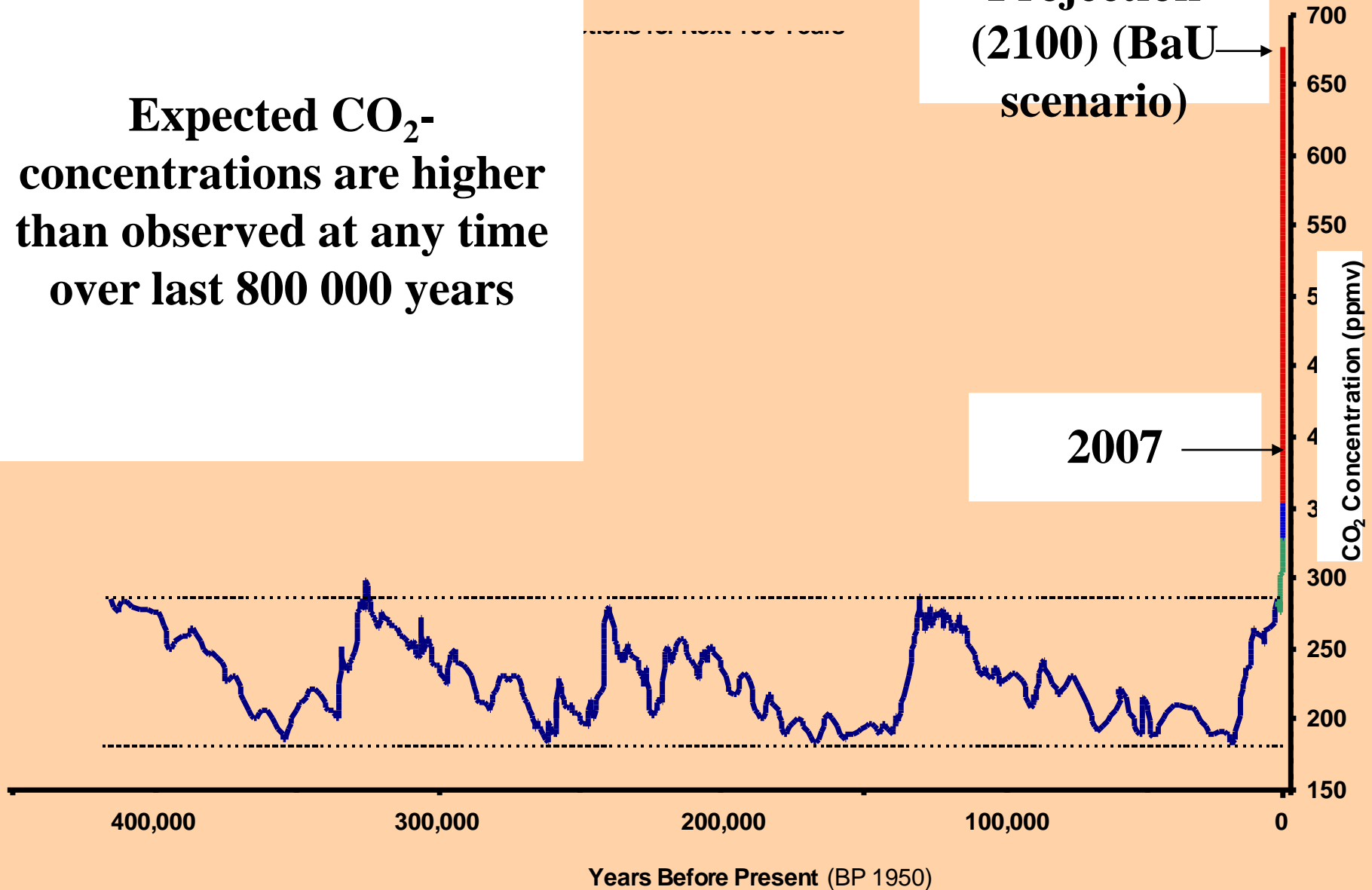
Source: Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)

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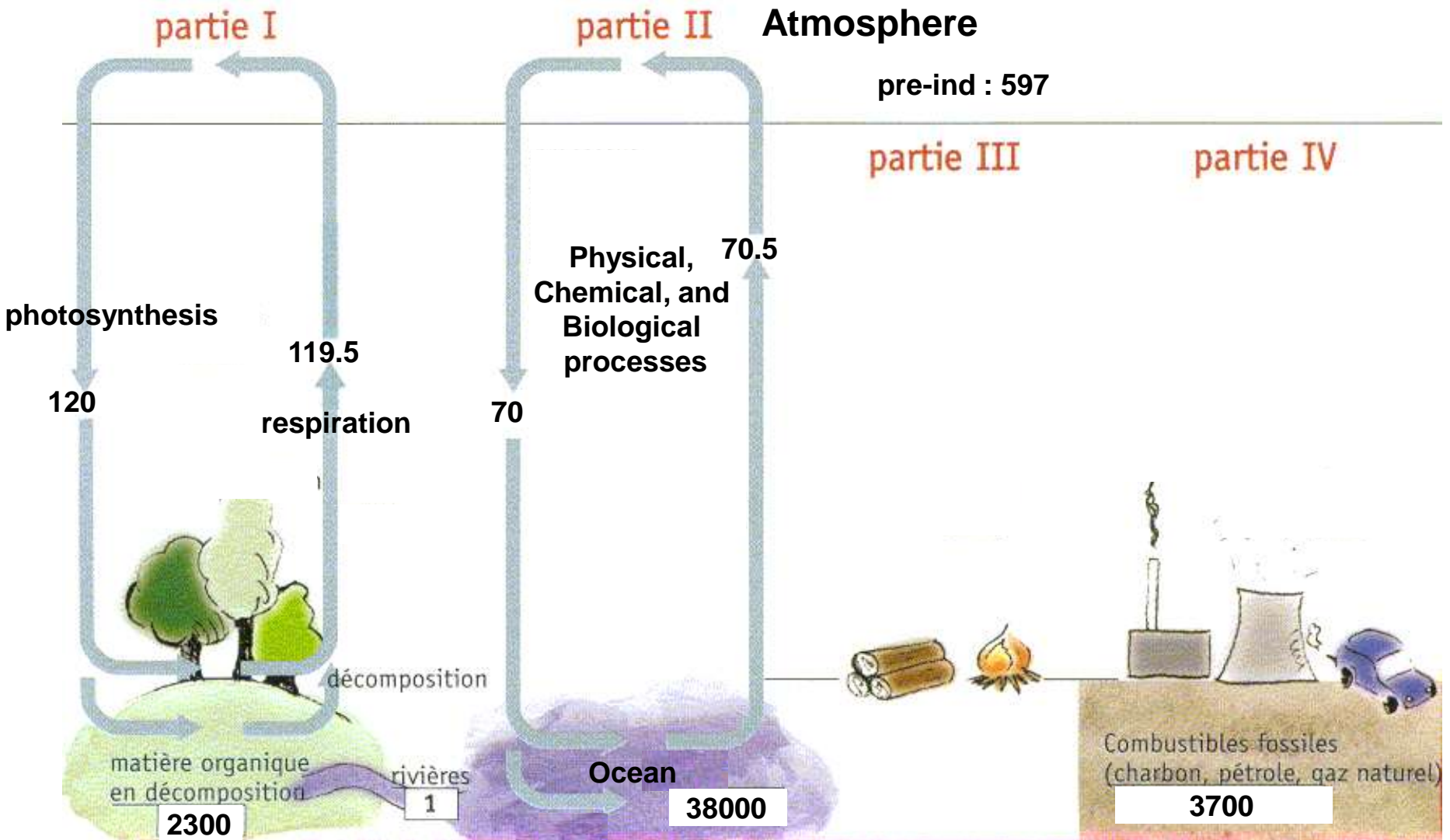
**Expected CO₂-
concentrations are higher
than observed at any time
over last 800 000 years**

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

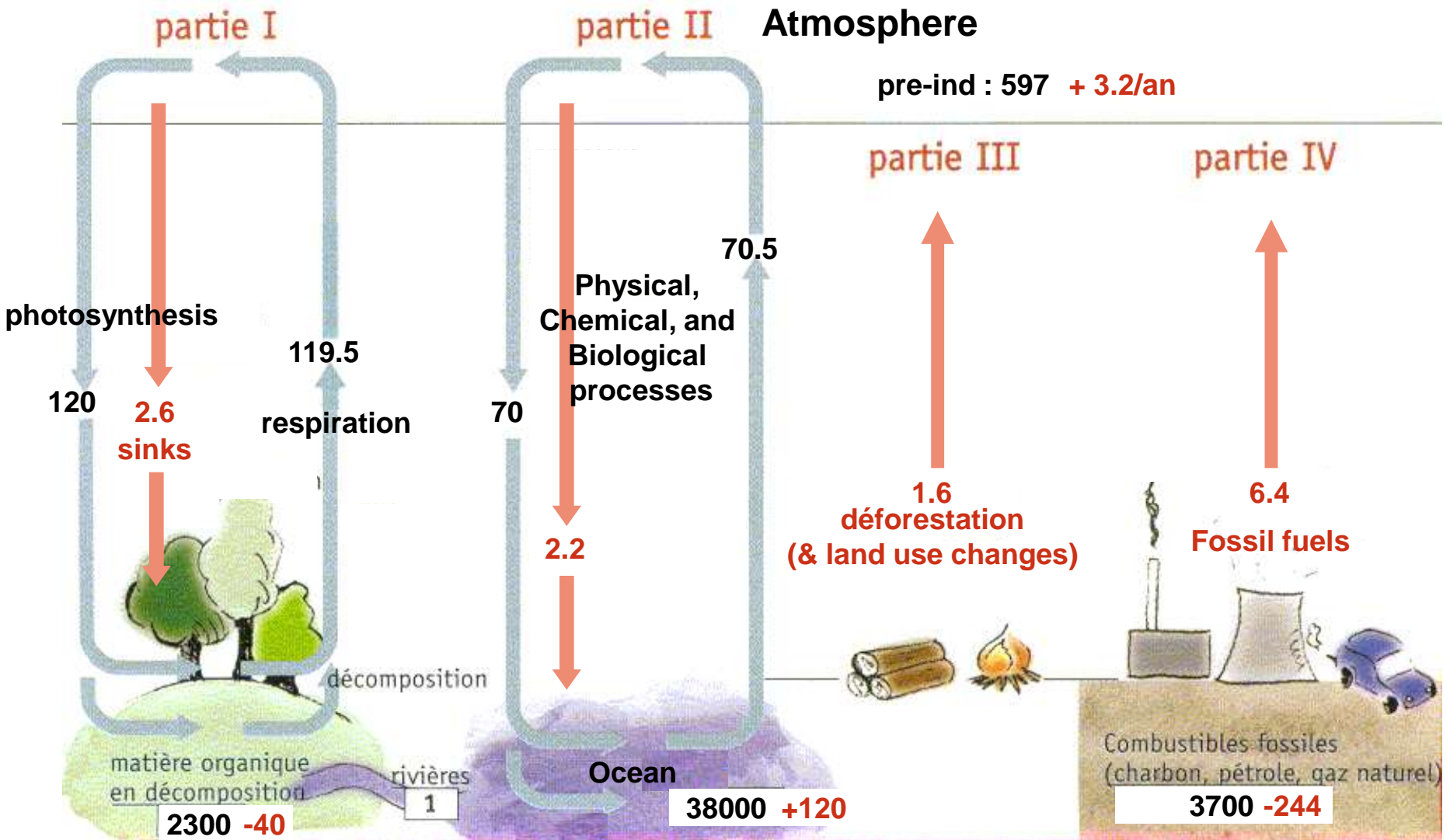
2007



Carbon cycle

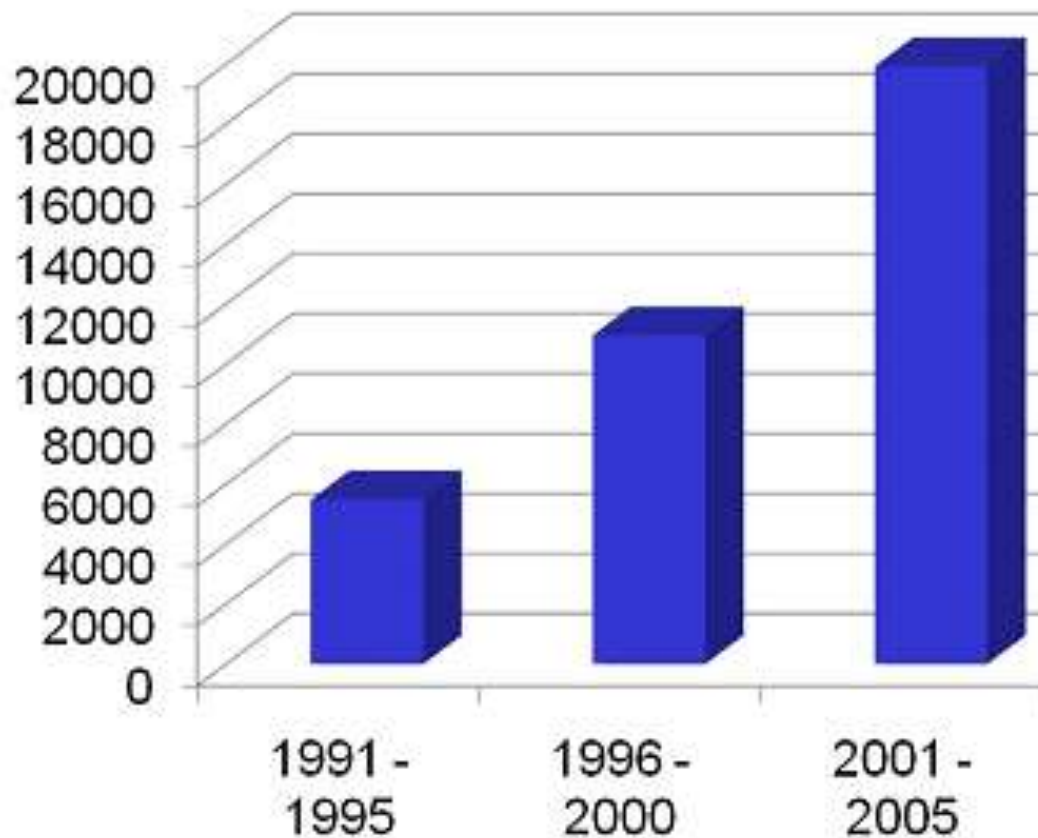


Carbon cycle



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

Number of papers published on climate change



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>


Role of IPCC



"The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature."

(source: www.ipcc.ch)

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IPCC Reports are
policy-relevant,
NOT
policy-prescriptive

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IPCC Structure



⌘ 3 Working Groups, 1 Task Force

⌘ WG1: Physical basis for climate change

⌘ WG2: Impacts, adaptation & vulnerability

⌘ WG3: Mitigation (emission reductions)

⌘ TF: Emission inventories (methodologies)

IPCC writing cycle (4 years, 2500 scientists)

- ⌘ Plenary decides table of content of reports
- ⌘ Bureau appoints world-class scientists as authors, based on publication record
- ⌘ Authors assess all scientific literature
- ⌘ *Draft* – Expert **review** (+ Review editors)
- ⌘ *Draft 2 (+ Draft 1 Summary for Policy Makers (SPM))* – Combined expert/government **review**
- ⌘ *Draft 3 (+ Draft 2 SPM)* – Government **review** of SPM
- ⌘ Approval Plenary (interaction authors – governments) – *SPM and full report*

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

Completed IPCC Reports

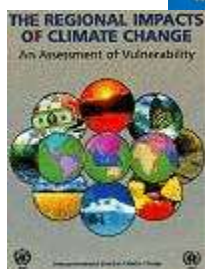
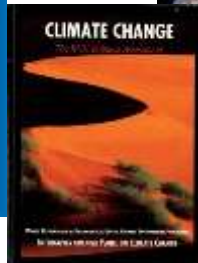
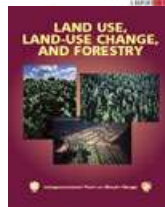
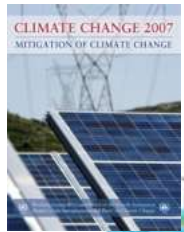
4 Assessment Reports (1990, 1995, 2001, 2007)

1992 Supplementary Report and 1994 Special Report

7 Special Reports (1997, 1999, 2000, 2005)

Guidelines for National GHG Inventories, Good Practice Guidance (1995-2006)

6 Technical Papers (1996-2008)





⌘ IPCC Working Group I: climatology

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Key points from the WG1 IPCC AR4 Report

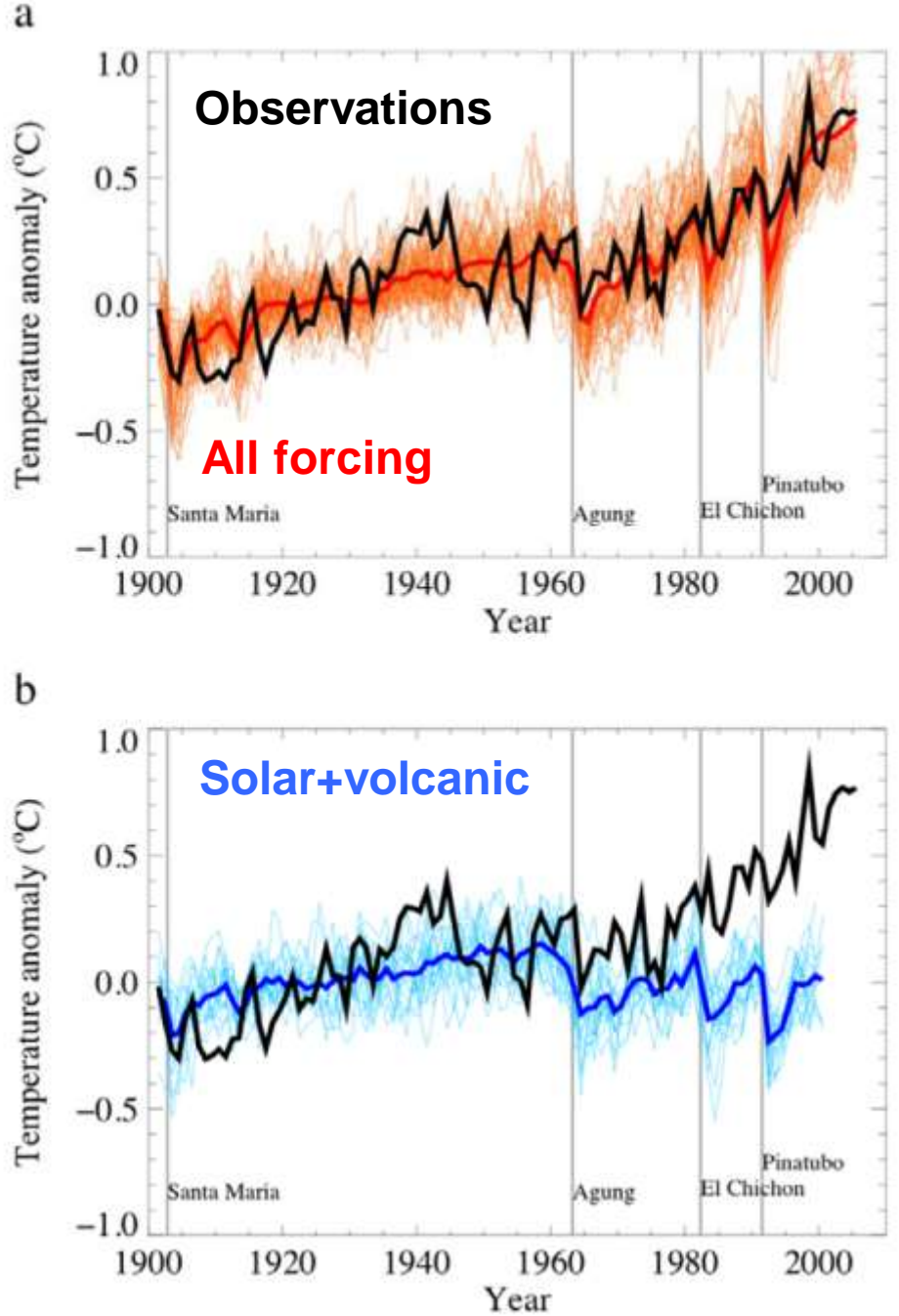


- ⌘ **Warming of the climate system is unequivocal**
- ⌘ **Very high confidence that net effect of human activities since 1750 = warming**
- ⌘ **Last 50 years likely to be highest temperature in at least last 1300 yrs**
- ⌘ **Most of this warming is very likely due to increase in human greenhouse gases**
- ⌘ **Without emission reduction policies, global temperature could increase by 1.1 to 6.4°C, or even higher in 2100 compared to 1990**
- ⌘ **Sea level could increase by 18 to 59 cm, or more**
- ⌘ **Frequency/intensity of several extreme phenomena due to increase (ex: heat waves, droughts, floods, ...)**

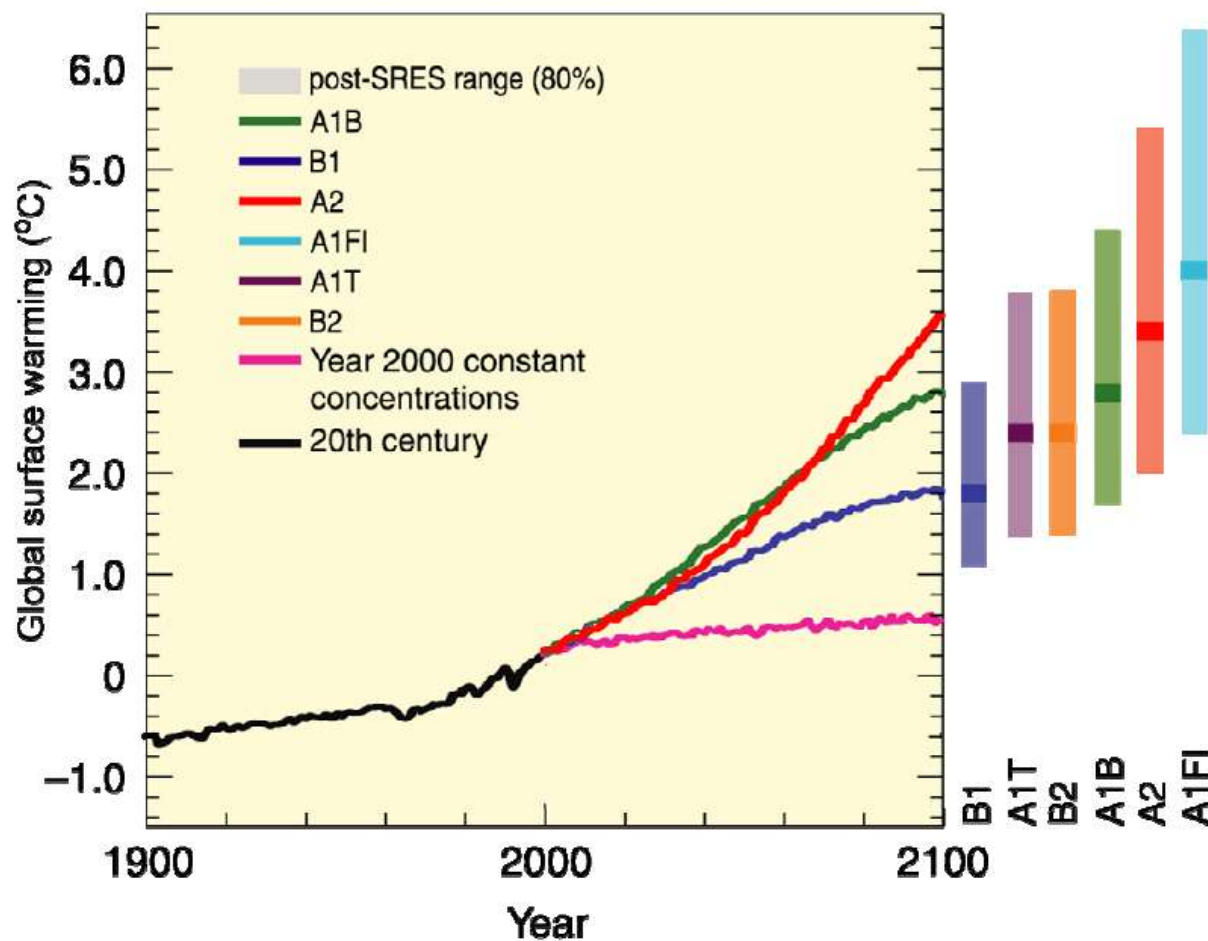
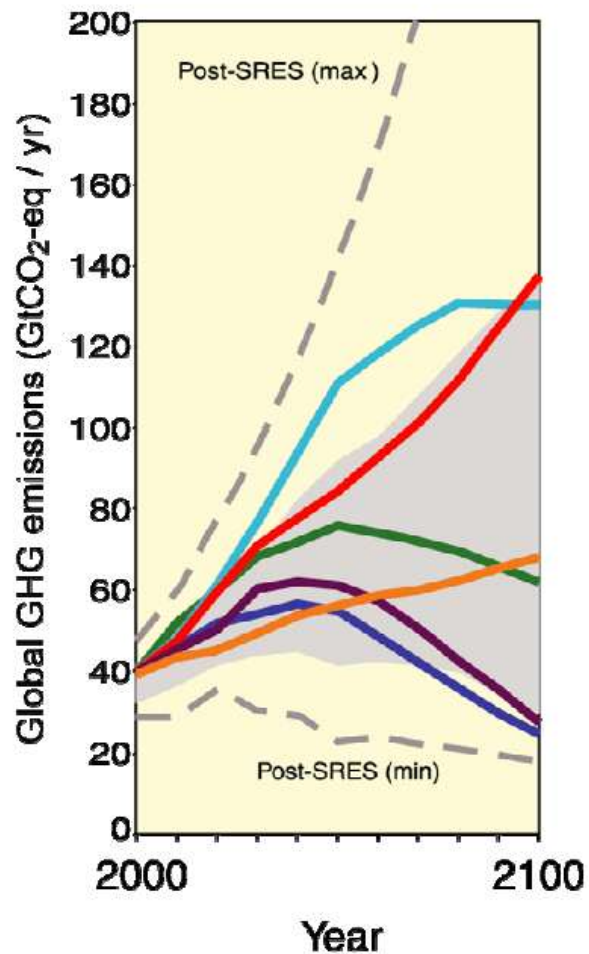
Attribution

Are observed changes consistent with expected responses to natural forcings?

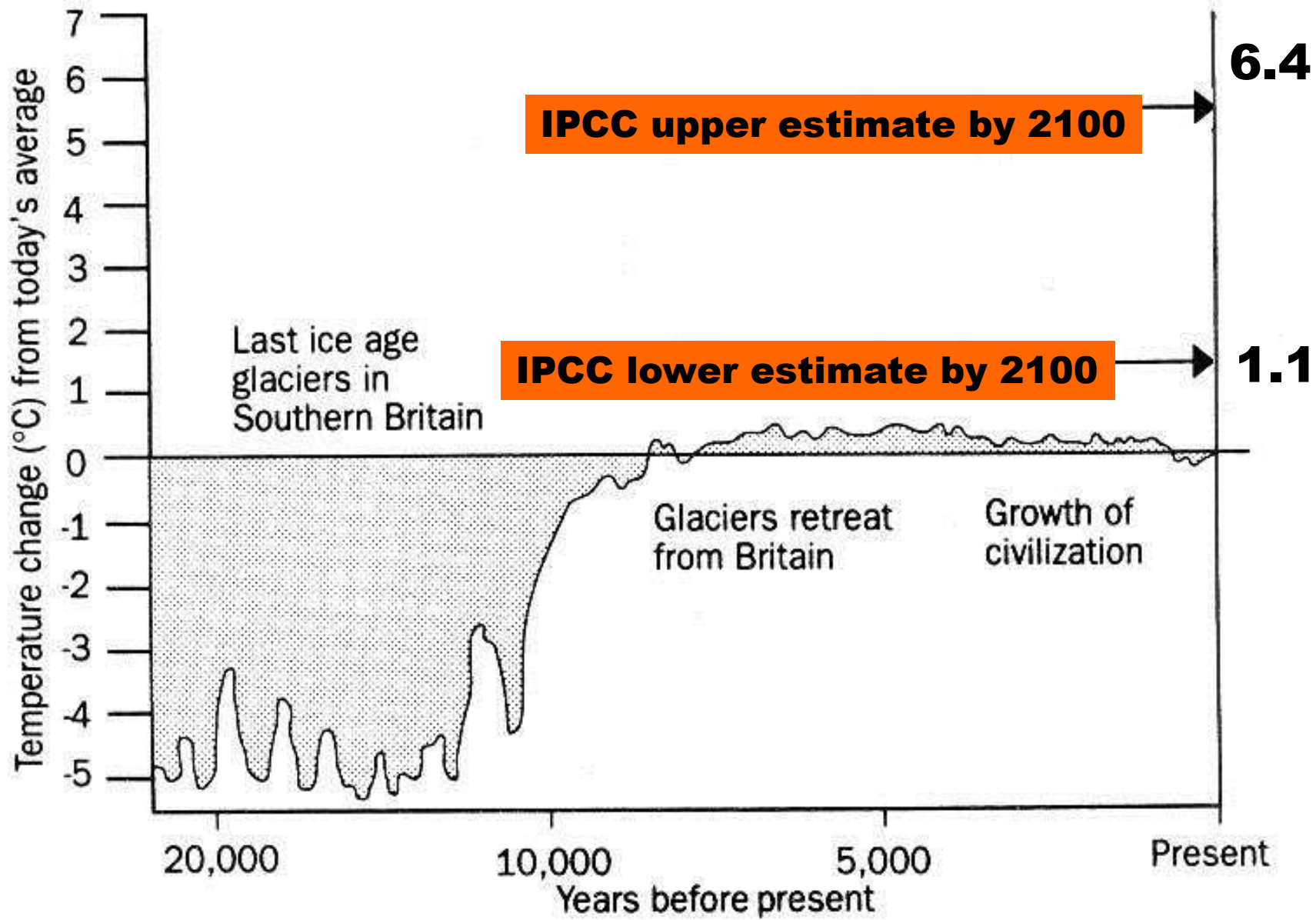
IPCC (2007):
“Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases.”



Climate projections without mitigation

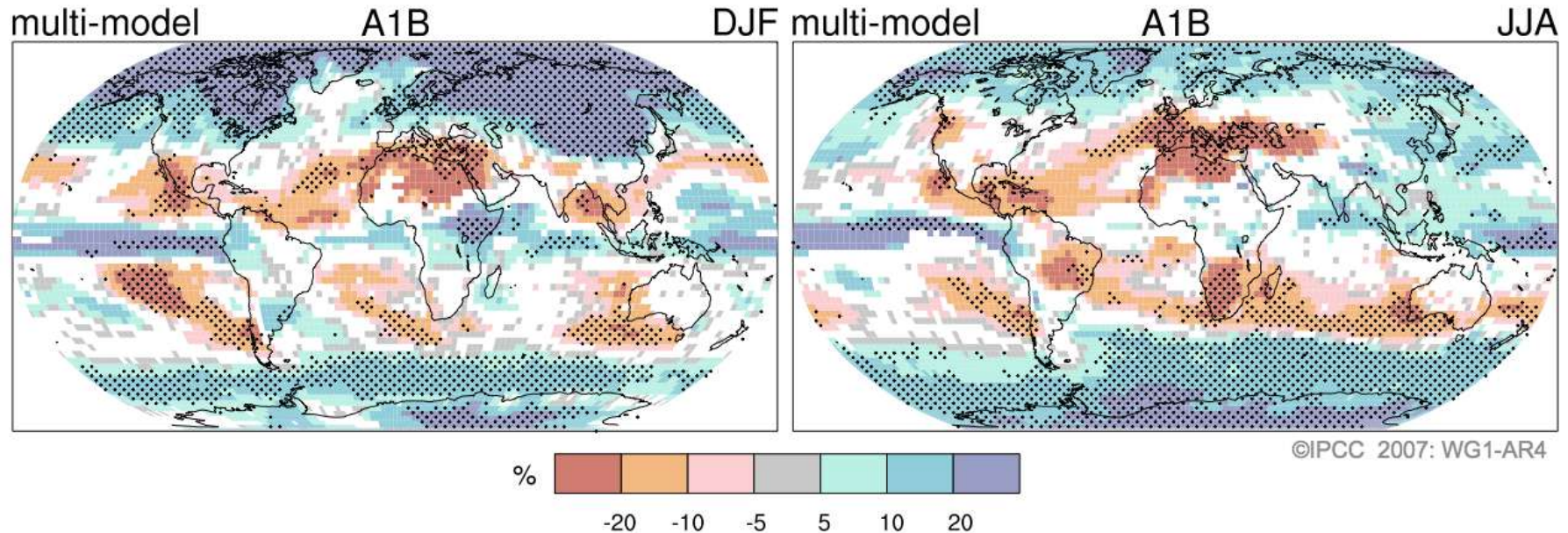


NB: écart par rapport à la moyenne 1980-1999



Projections of Future Changes in Climate

Projected Patterns of Precipitation Changes



Brand new in AR4: Drying in much of the subtropics, more rain in higher latitudes, continuing the broad pattern of rainfall changes already observed.

More heavy precipitation and more droughts....



More heavy precipitation and more droughts....



Climate change and extremes

(IPCC AR4 WG1)

Post 1960

21th century

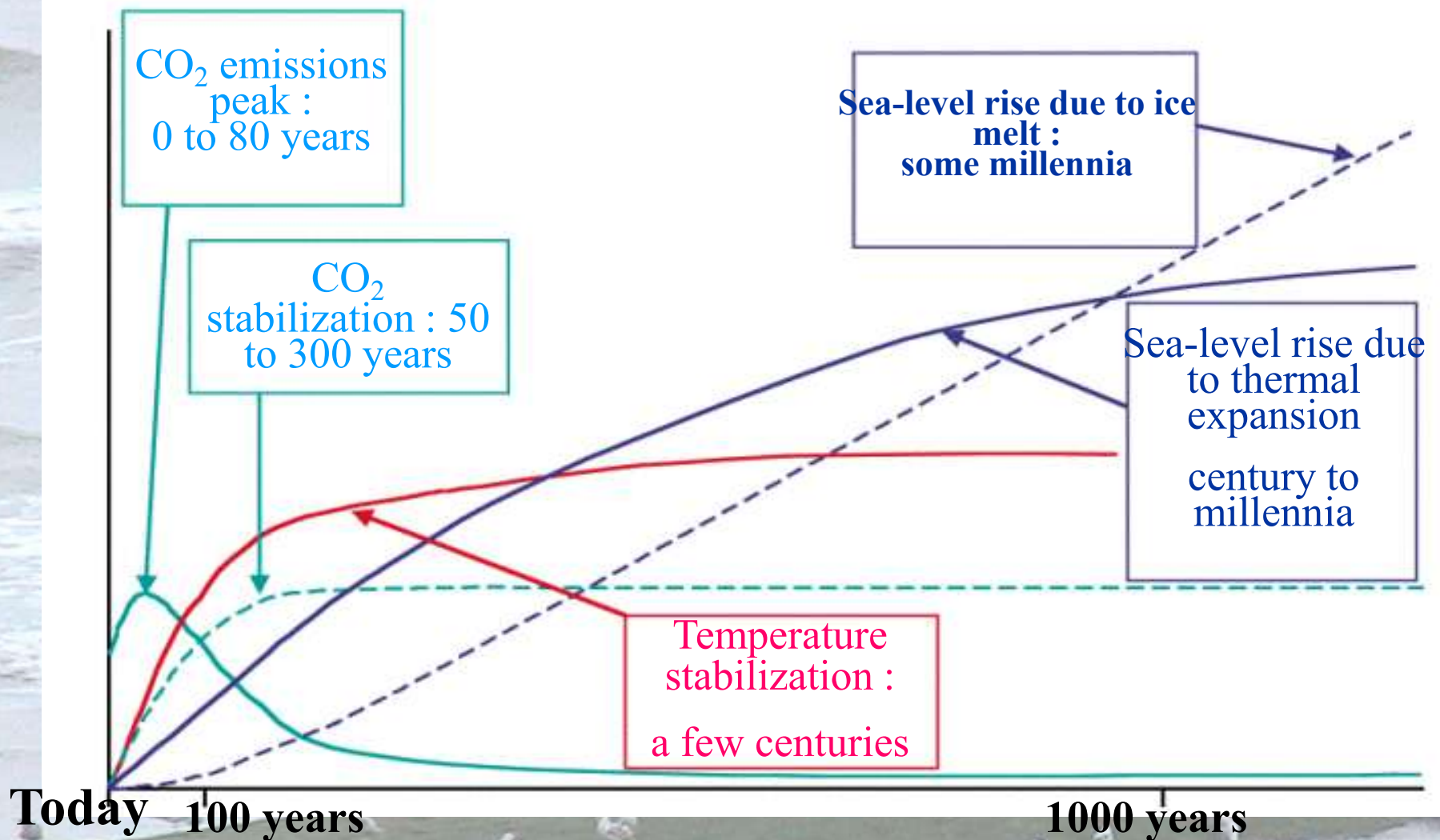
Phenomenon ^a and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend ^b	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most 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%

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

Significant inertia exists in the climate system

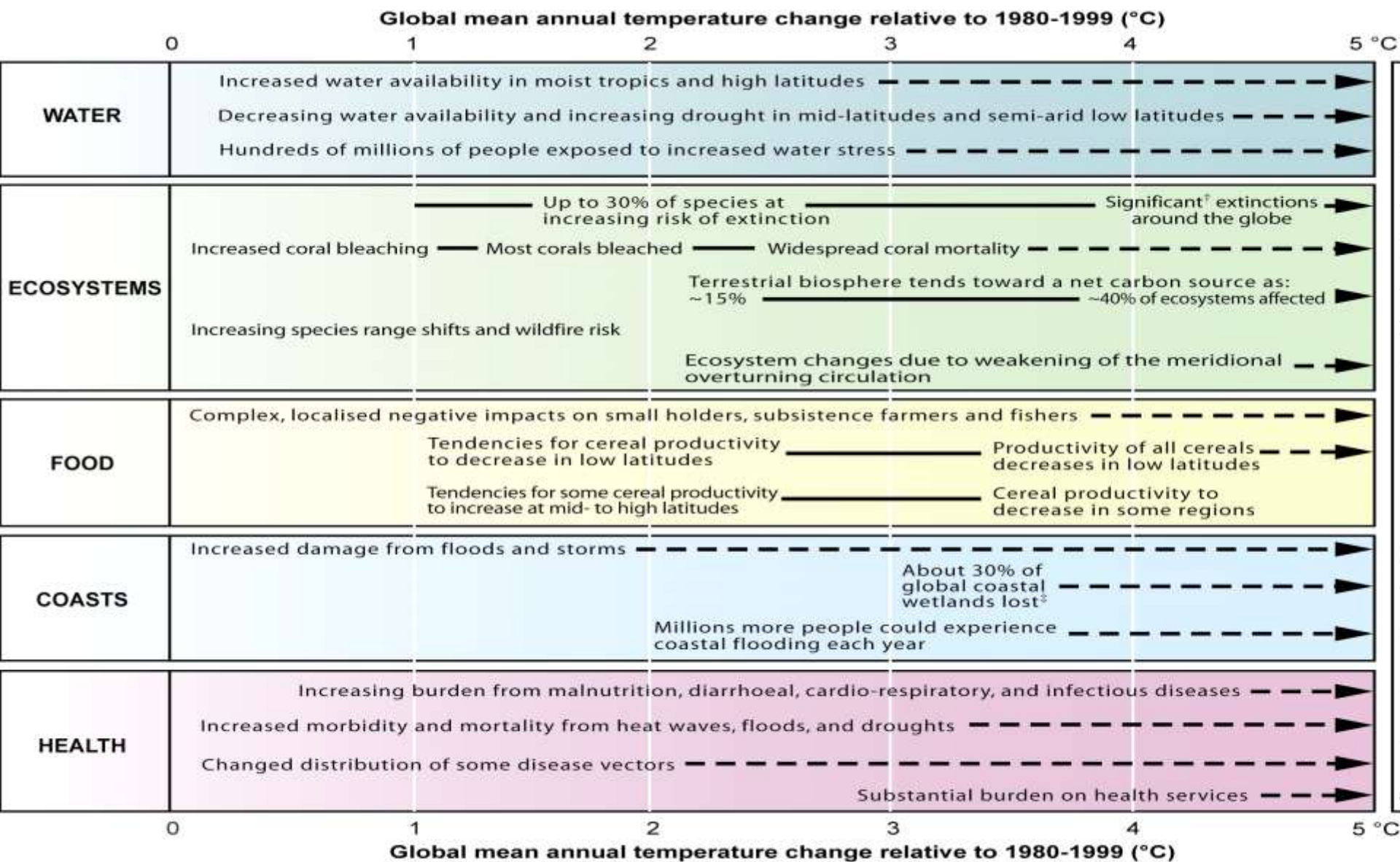




⌘ IPCC Working Group II: Impacts, Vulnerability, and Adaptation

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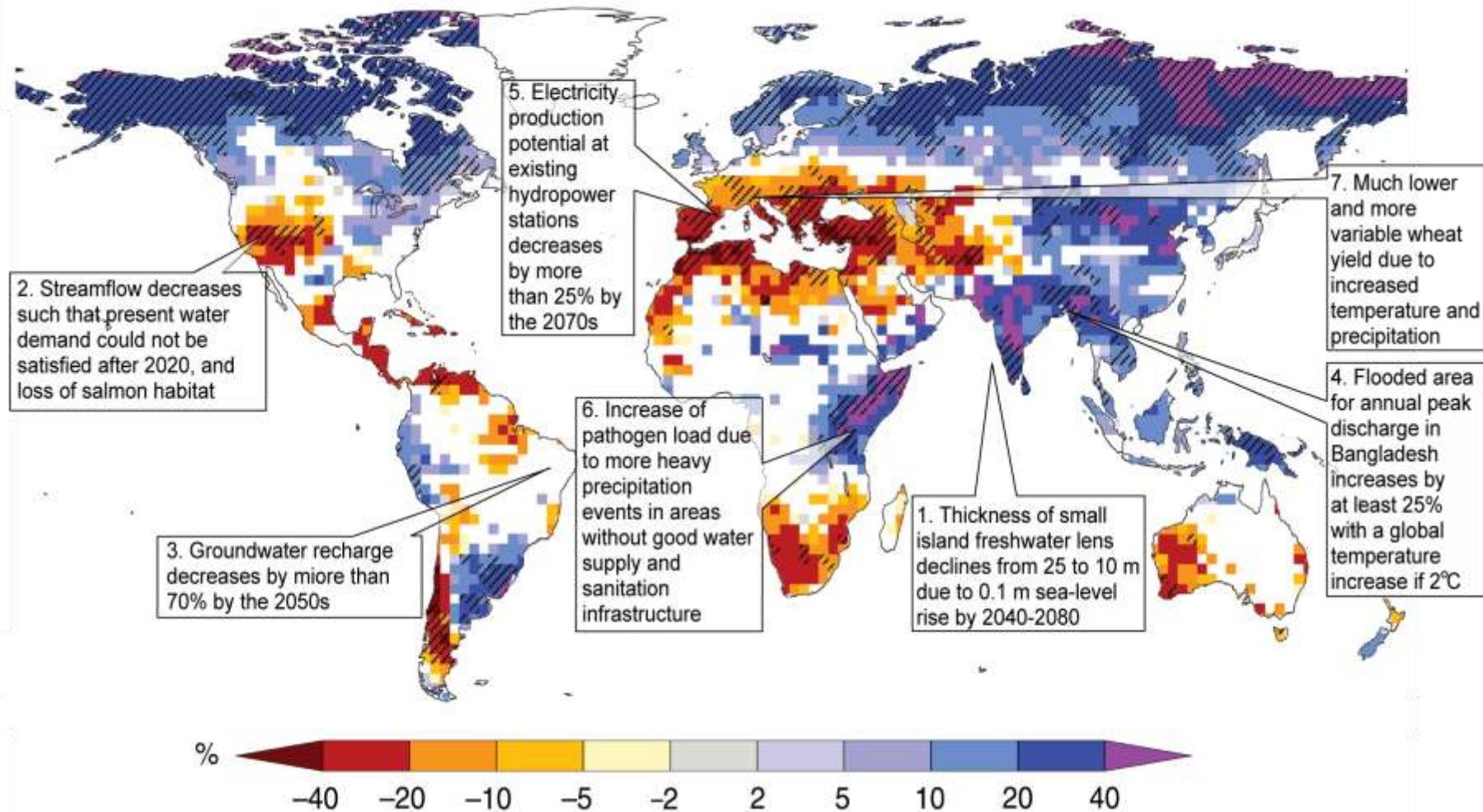
Figure SPM.2. Key impacts as a function of increasing global average temperature change
 (Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)



† Significant is defined here as more than 40%.

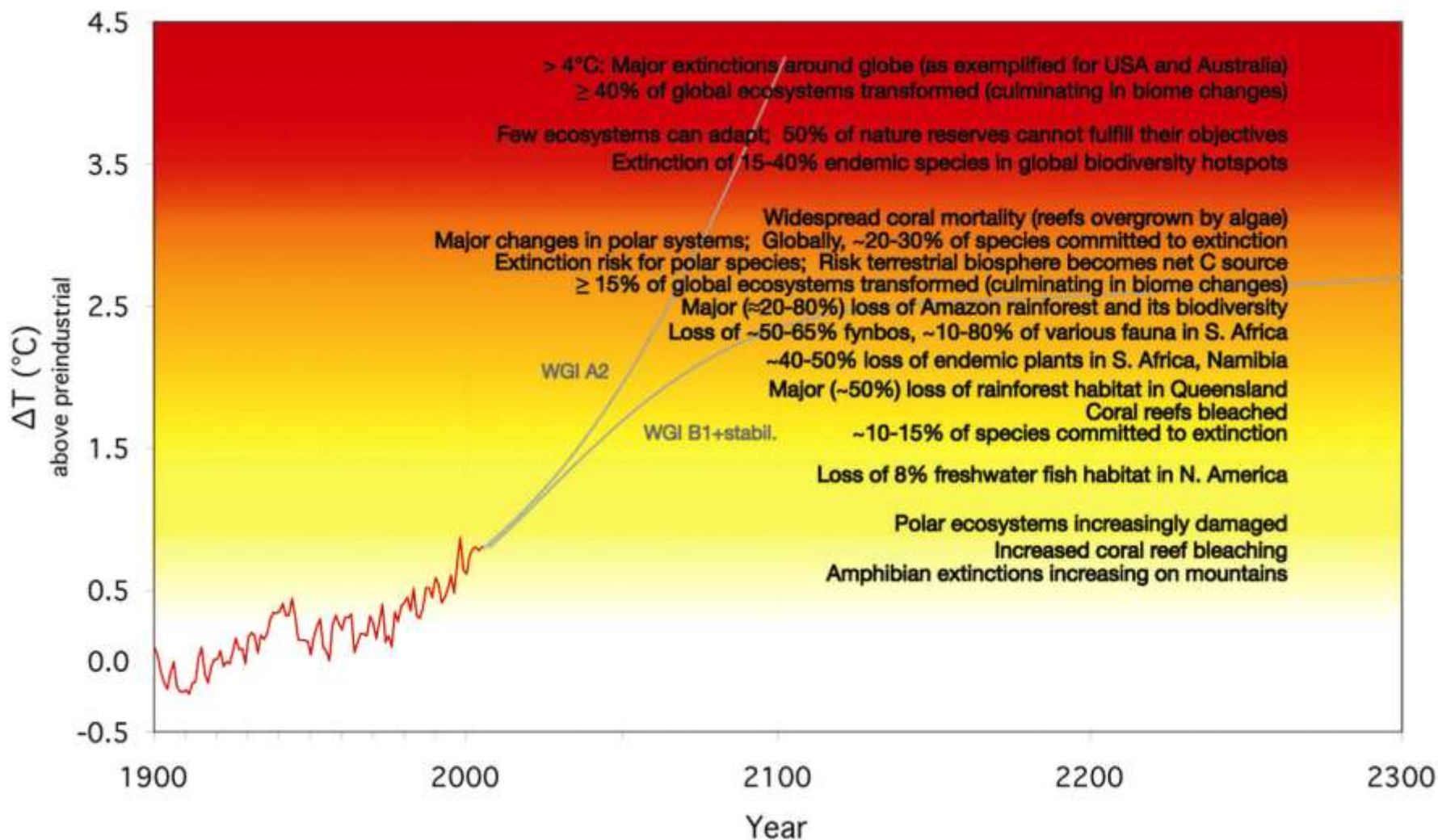
‡ Based on average rate of sea level rise of 4.2 mm/year from

Water at the end of the 21st century for SRES A1B



TP Figure 3.4: Ensemble mean change of annual runoff, in percent, between present (1980-1999) and 2090-2099 for the SRES A1B emissions scenario (based on Milly et al., 2005).

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



Biodiversité (+)

- Evolution, selon une projection climatique, de la zone où le climat convient au hêtre [de beuk]

Présent



2 x CO₂



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

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

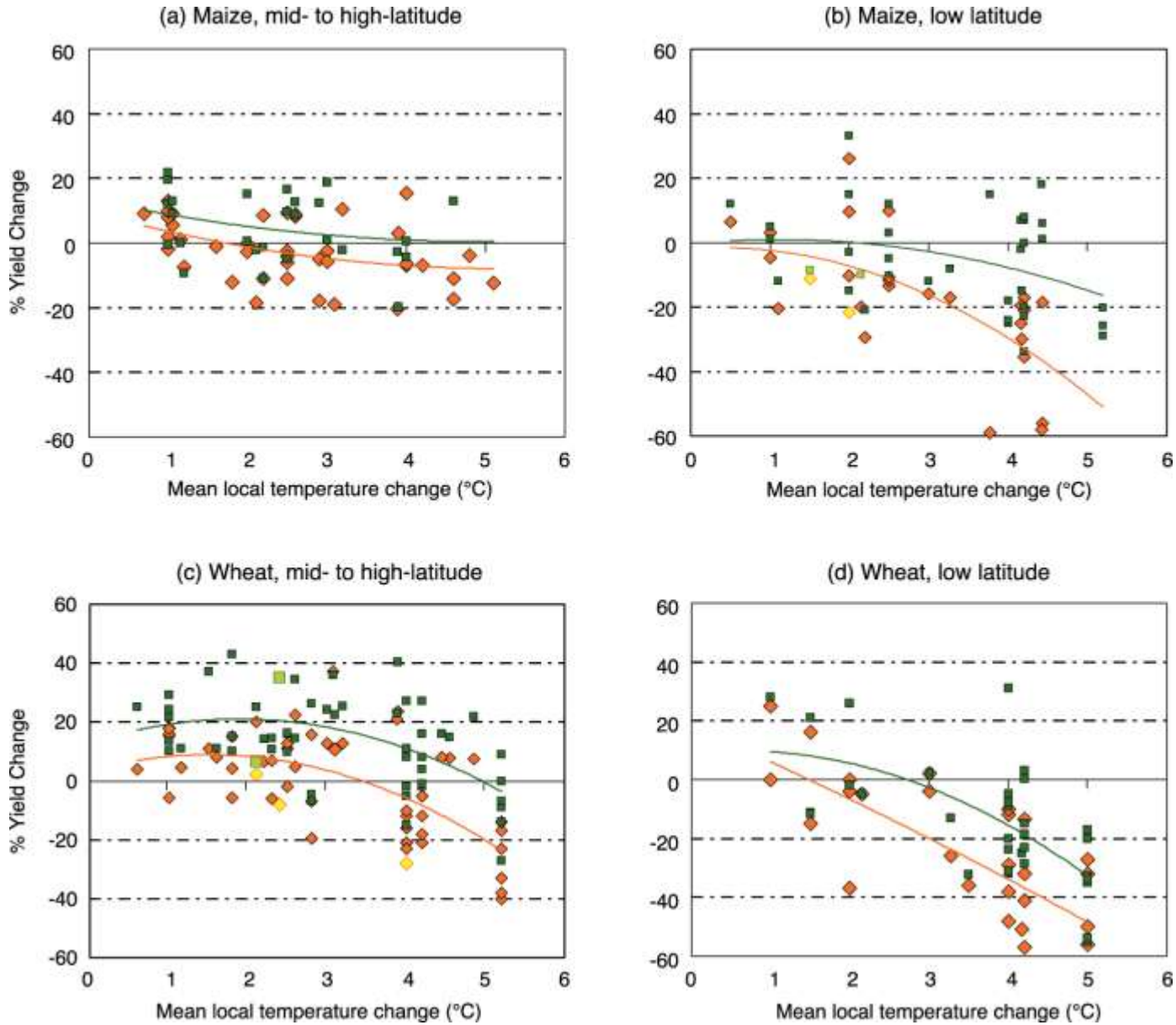


WMO



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)**



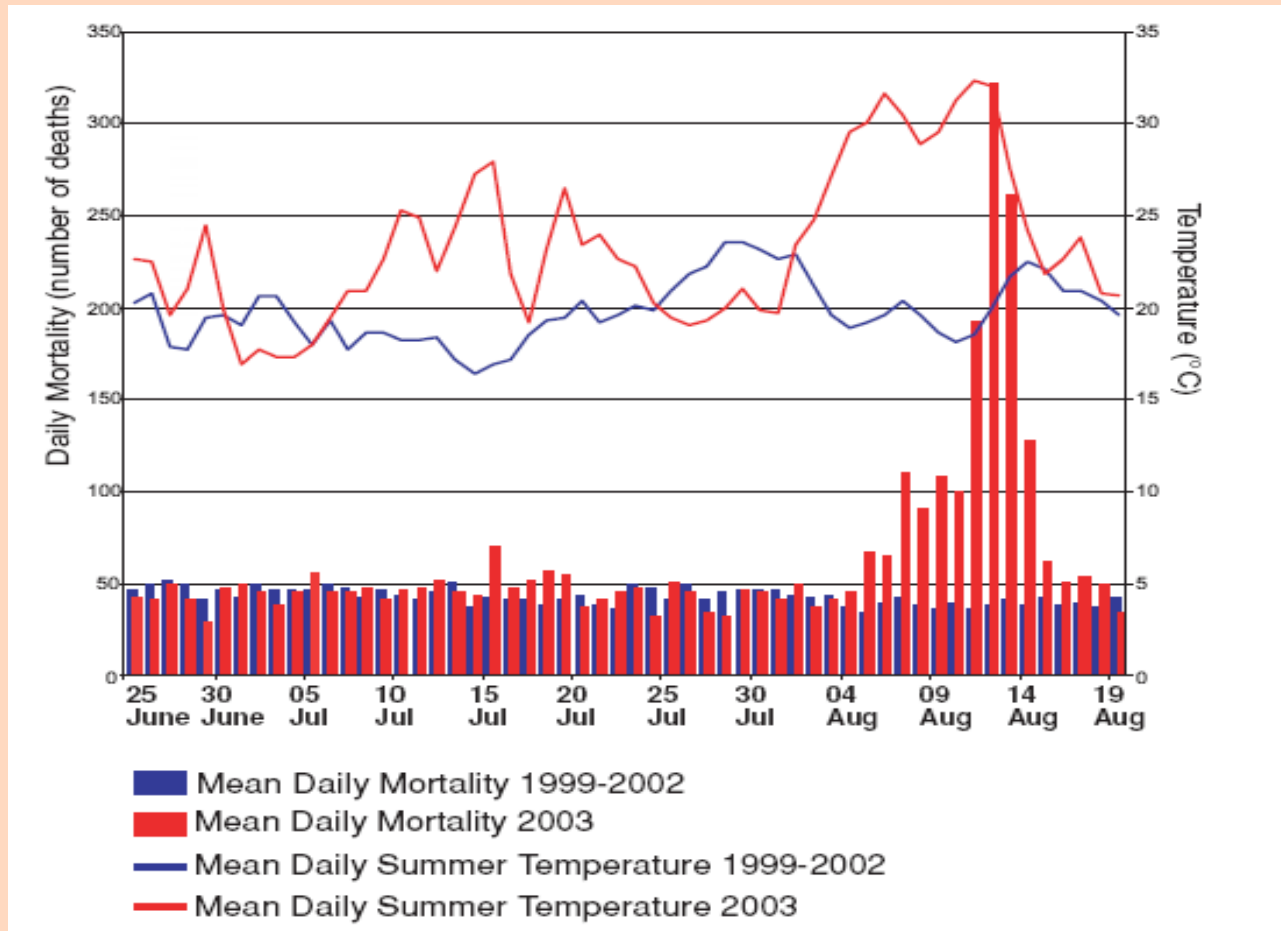
Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

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)



Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **For the first time, wide ranging impacts of changes in current climate have been documented in Europe**
 - retreat of glaciers, lengthening of growing season, shift of species, heat wave in 2003, ...
- **Climate-related hazards will mostly increase, although changes will vary geographically**
 - More winter floods in maritime regions, snowmelt-related floods in Central and E. Europe, flash floods throughout Europe.
 - Coastal flooding related to increasing storminess and sea level rise is likely to threaten up to 2.5 million additional people annually.
 - Some impacts may be positive, as in reduced risk of extreme cold events. However, on balance, health risks are very likely to increase.



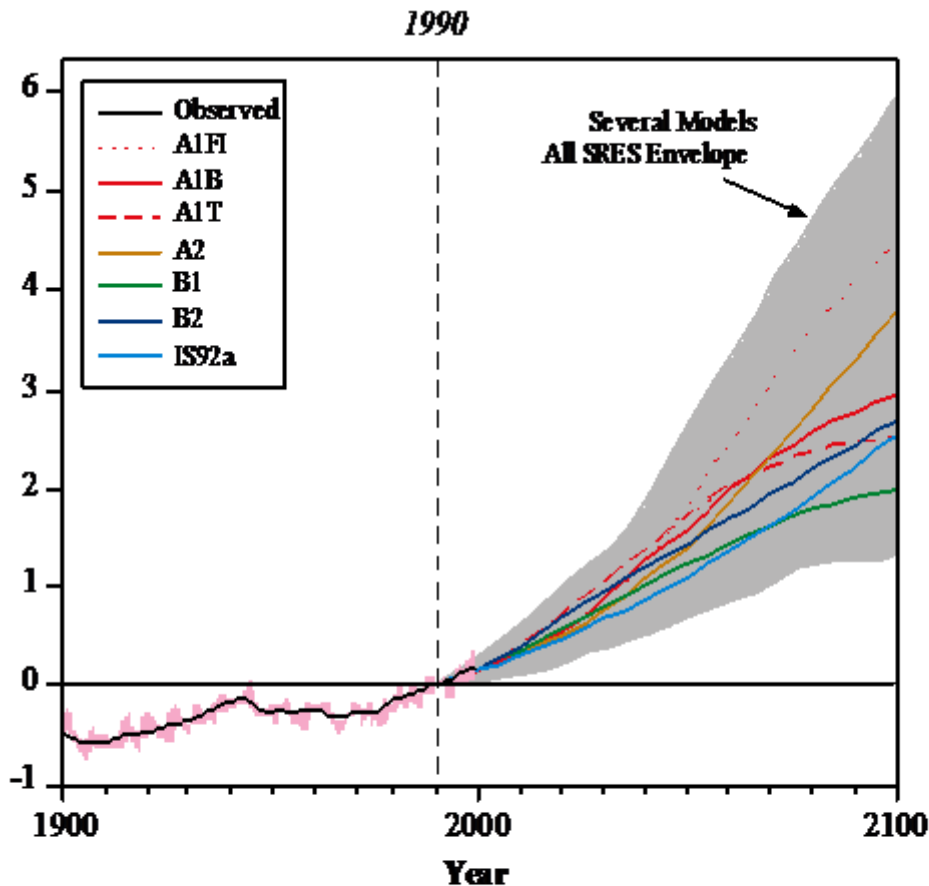
Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **It is anticipated that Europe's natural (eco)systems and biodiversity will be substantially affected by climate change. The great majority of organisms and ecosystems are likely to have difficulty in adapting to climate change.**
 - **A large percentage of the European flora is likely to become vulnerable, endangered, or committed to extinction by the end of this century.**
 - **Options for adaptation are likely to be limited for many organisms and ecosystems.**
 - **Low-lying, geologically-subsiding coasts are likely to be unable to adapt to sea-level rise.**
 - **New sites for conservation may be needed.**

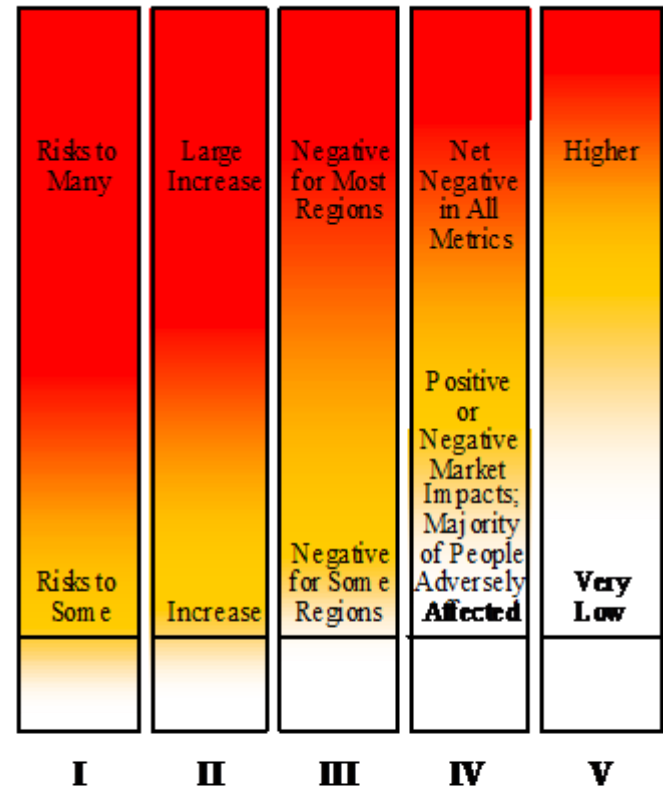
Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **Climate change is estimated to pose challenges to many European economic sectors and alter the distribution of economic activity.**
 - **Agriculture will have to cope with increasing water demand for irrigation in S. Europe.**
 - **Peak electricity demand is likely to shift in some locations from winter to summer.**
 - **Winter tourism in mountain regions is anticipated to face reduced snow cover.**

Reasons for Concern



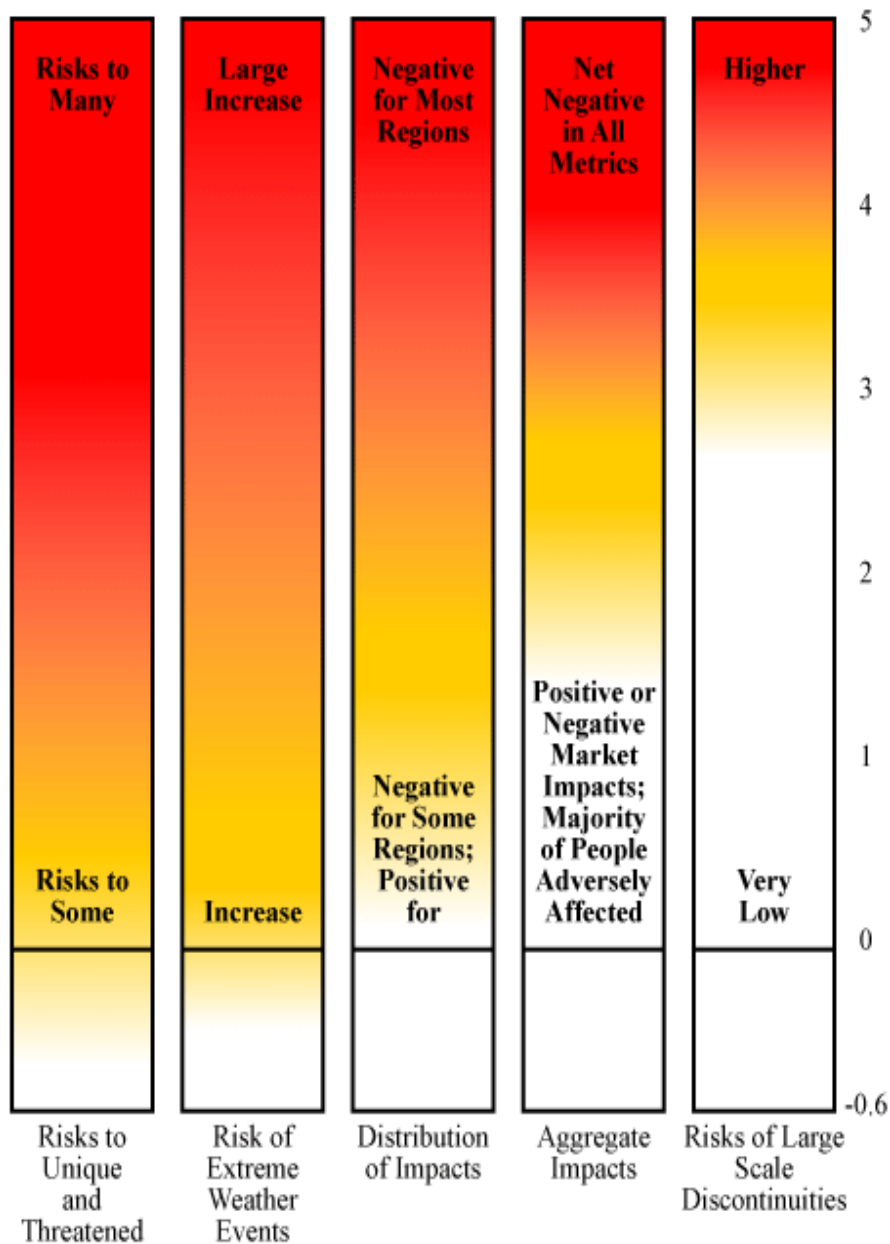
Reasons for Concern



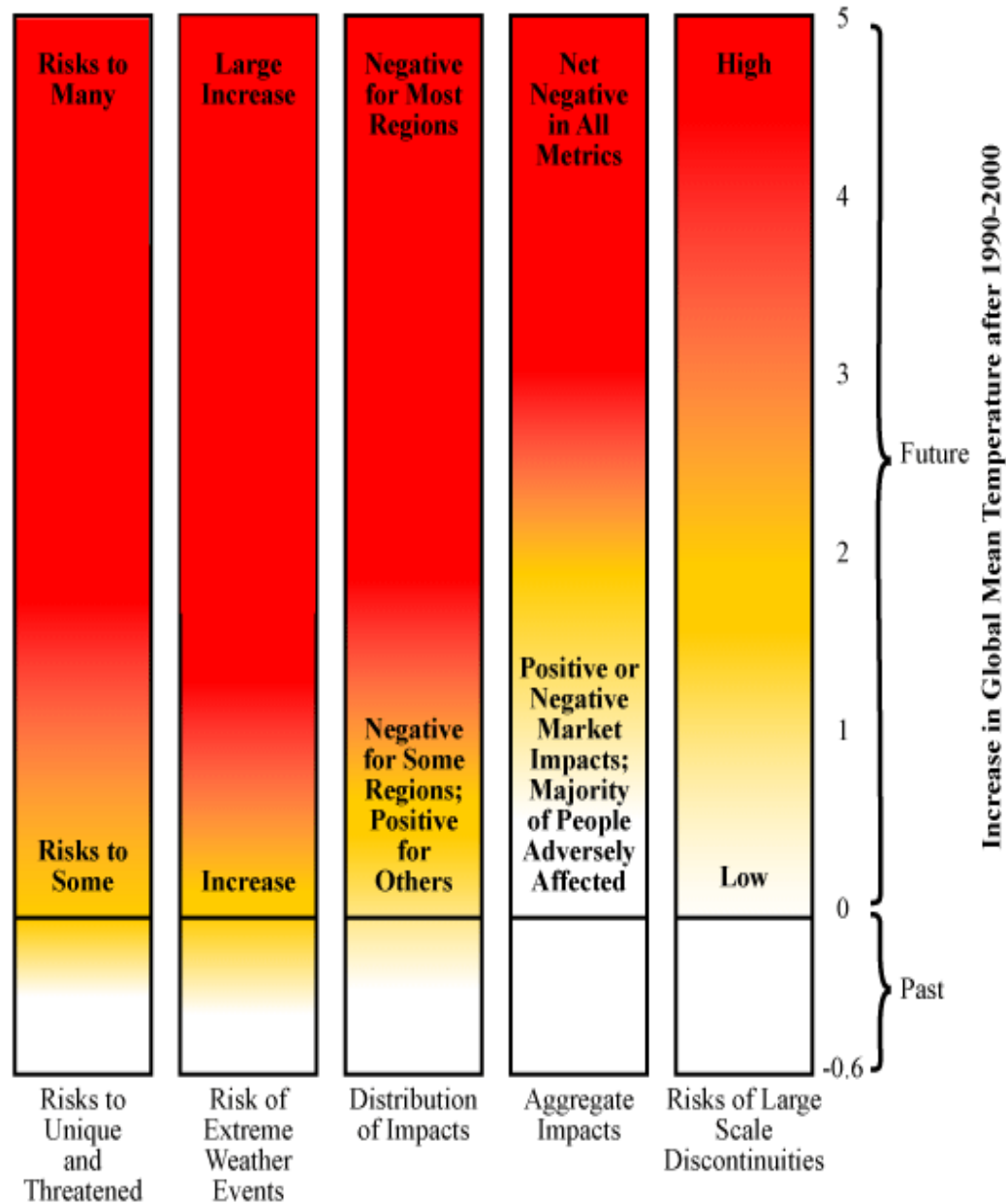
- I Risks to unique and threatened systems
- II Risks from extreme climate events
- III Distribution of Impacts
- IV Aggregate Impacts
- V Risks from large-scale discontinuities

Source: IPCC TAR WG2 (2001)

TAR Reasons For Concern



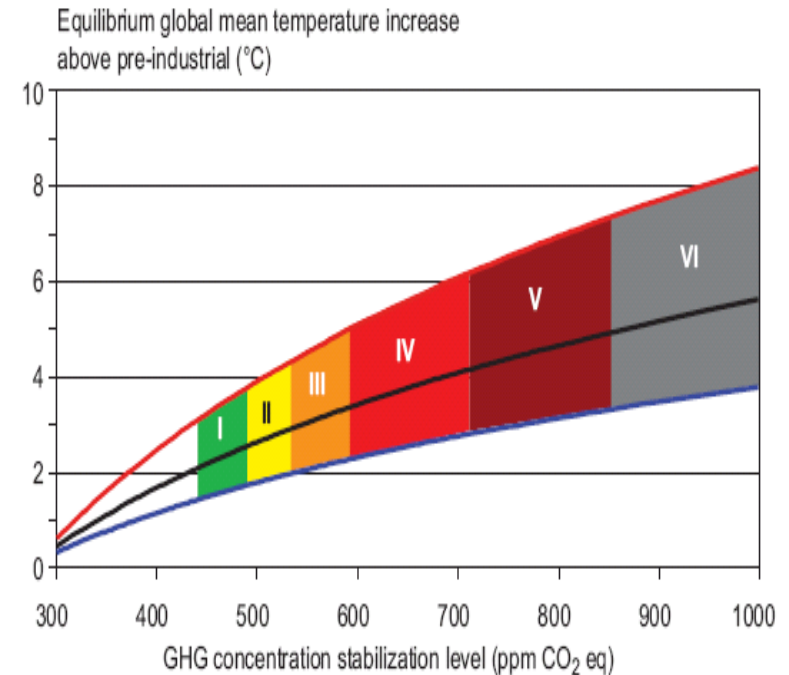
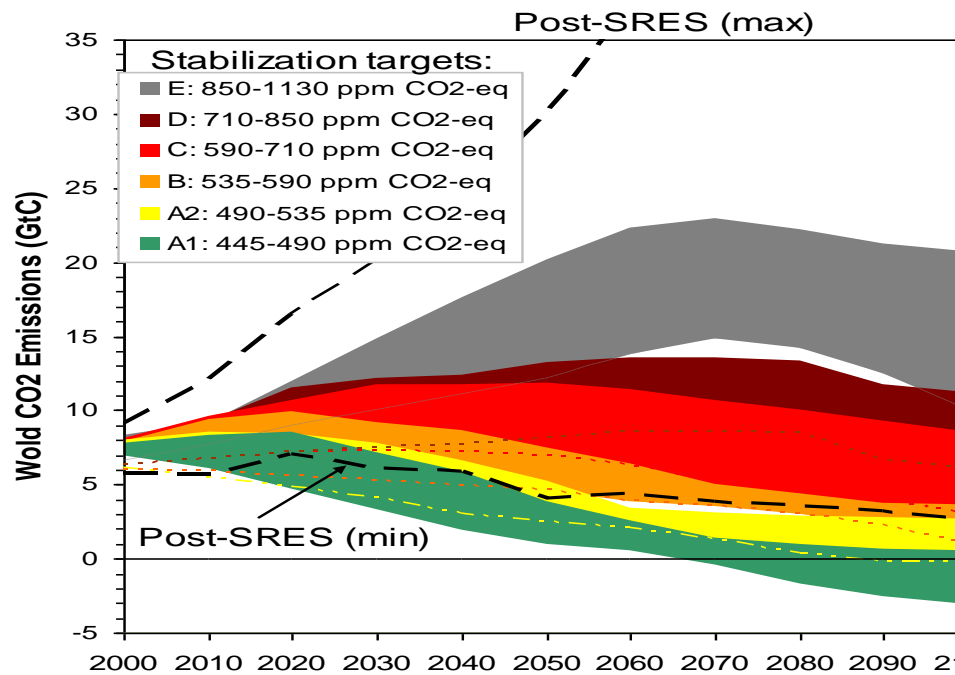
Proposed AR4 Reasons For Concern



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

Long term mitigation (after 2030)

- The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter
- Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

Stab level (ppm CO ₂ -eq)	Global Mean temp. increase at equilibrium (°C)	Year CO ₂ needs to peak	Reduction in 2050 compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

Contribution of Working Group III to the Fourth Assessment Report of the IPCC,

⌘ Chapter 13, page 776:

Box 13.7 The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group^a

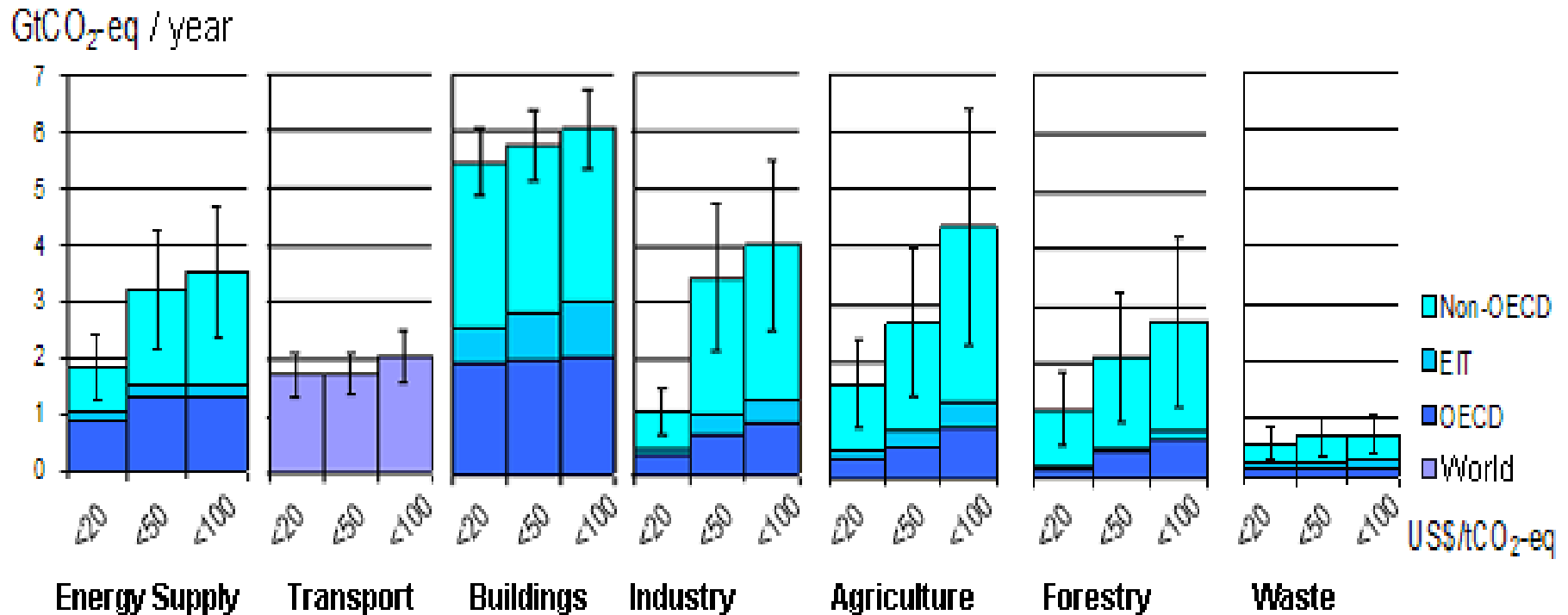
Scenario category	Region	2020	2050
<i>A-450 ppm CO₂-eq^b</i>	Annex I	-25% to -40%	-80% to -95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
<i>B-550 ppm CO₂-eq</i>	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
<i>C-650 ppm CO₂-eq</i>	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

Notes:

- ^a The aggregate range is based on multiple approaches to apportion emissions between regions (contraction and convergence, multistage, Triptych and intensity targets, among others). Each approach makes different assumptions about the pathway, specific national efforts and other variables. Additional extreme cases – in which Annex I undertakes all reductions, or non-Annex I undertakes all reductions – are not included. The ranges presented here do not imply political feasibility, nor do the results reflect cost variances.
- ^b Only the studies aiming at stabilization at 450 ppm CO₂-eq assume a (temporary) overshoot of about 50 ppm (See Den Elzen and Meinshausen, 2006).

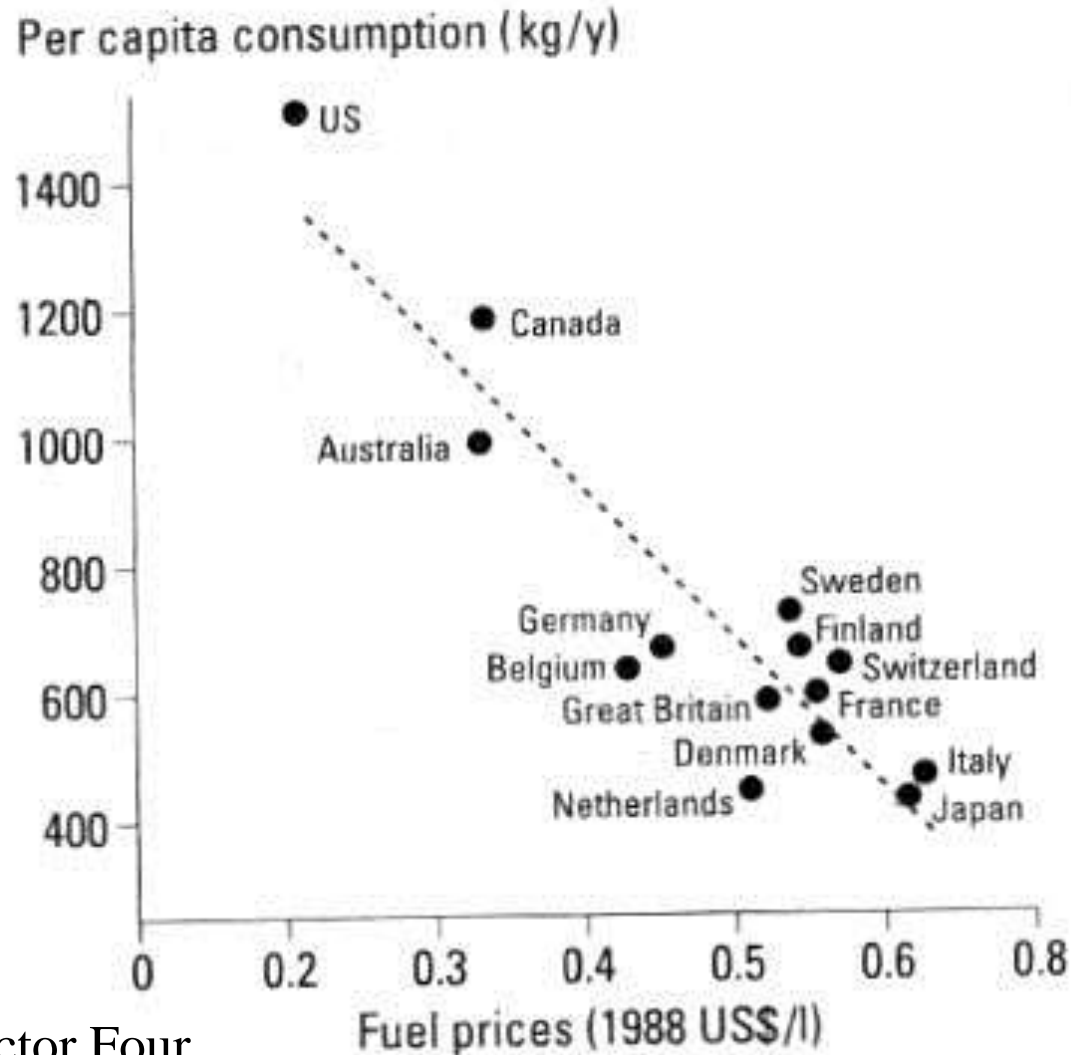
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All sectors and regions have the potential to contribute by 2030



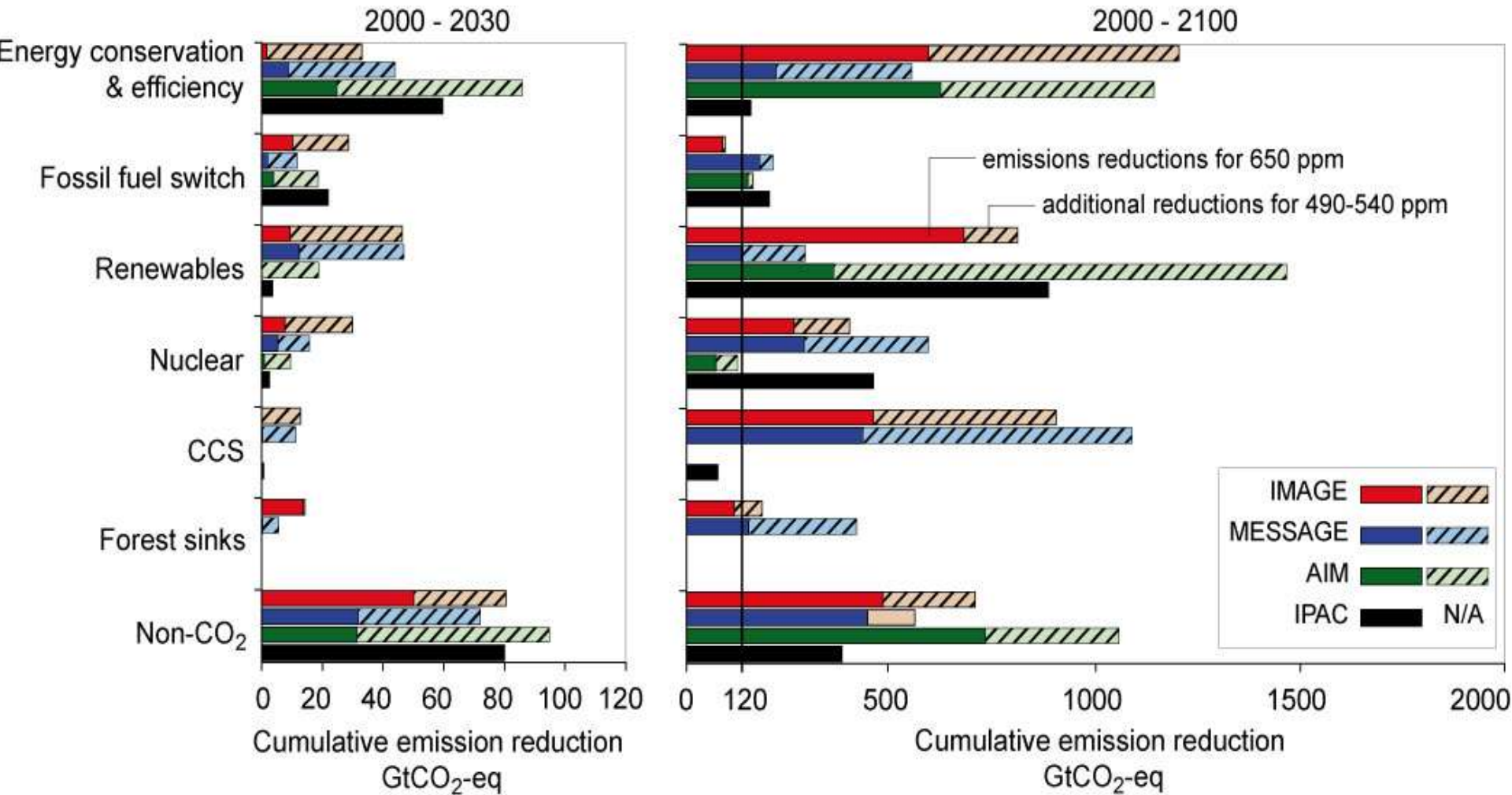
Note: estimates do not include non-technical options, such as lifestyle changes.

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 radars 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)

This choice...

- **... is our choice, it is the choice which each one among us will make in the next months and the next years, where she/he can act**
- **This choice needs to be a conscious one, and not a choice made by default, so that nobody feels obliged starting again this talk in 39 years**

This choice...

- ... can be a *profitable* one, and I will let you decide which one of A or B is the most profitable (and satisfying) in the long term

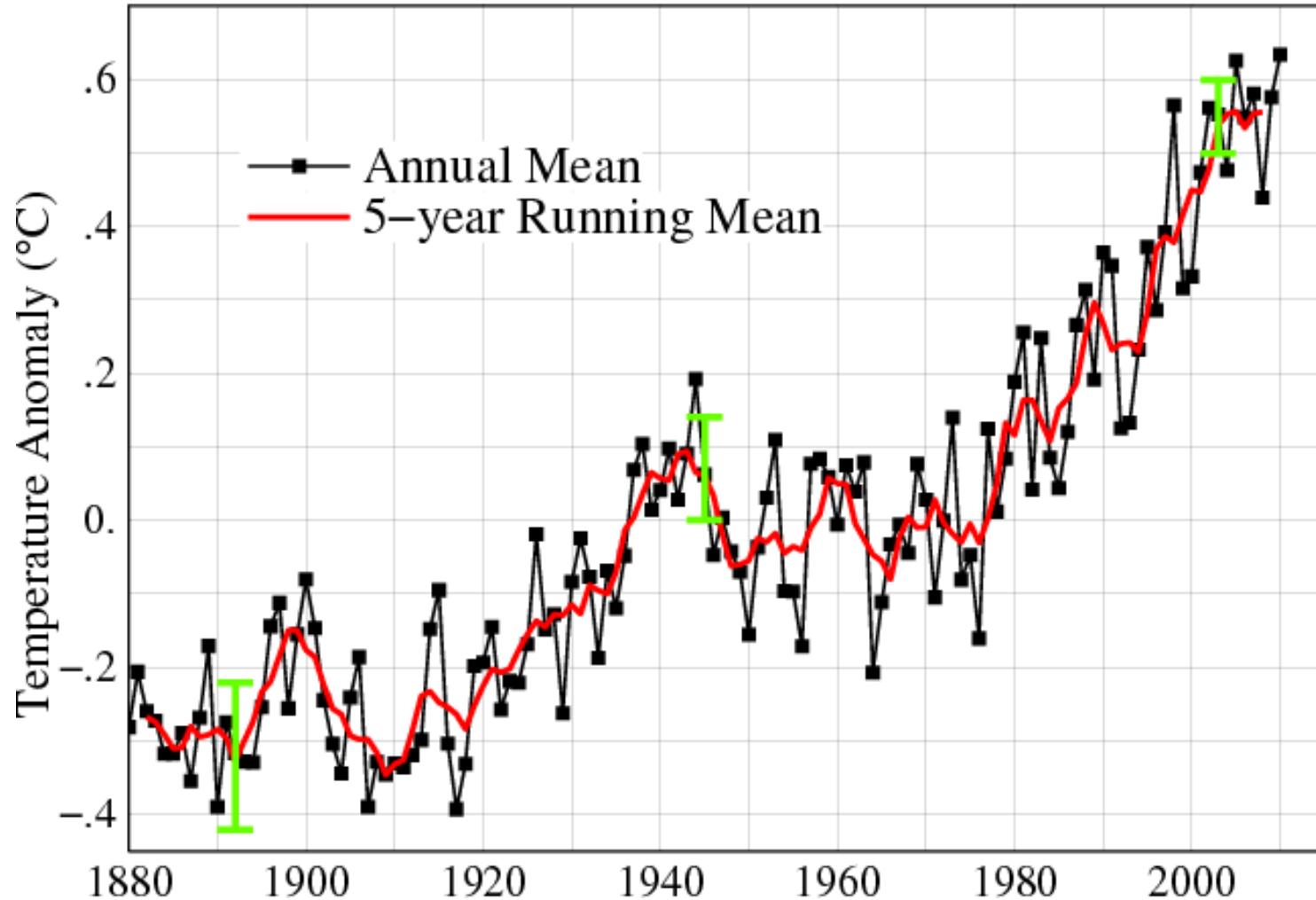
What did « The Economist » say in 1990 already?

- **“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

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

⌘ Please also Google « Harvard climate
change project »