IPCC and the eleventh hour of climate politics (Or what does the IPCC really say ahead of the Cancún conference?)

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Outline

- Introduction:
  - What is the IPCC?
  - Climate Change
- What does IPCC tell us about the challenge and opportunities of climate change?
  - IPCC Group 1: climatology
  - IPCC Group 2: impacts, vulnerability, & adaptation
  - IPCC Group 3: mitigation
- Conclusion before Cancún

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Introduction

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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.

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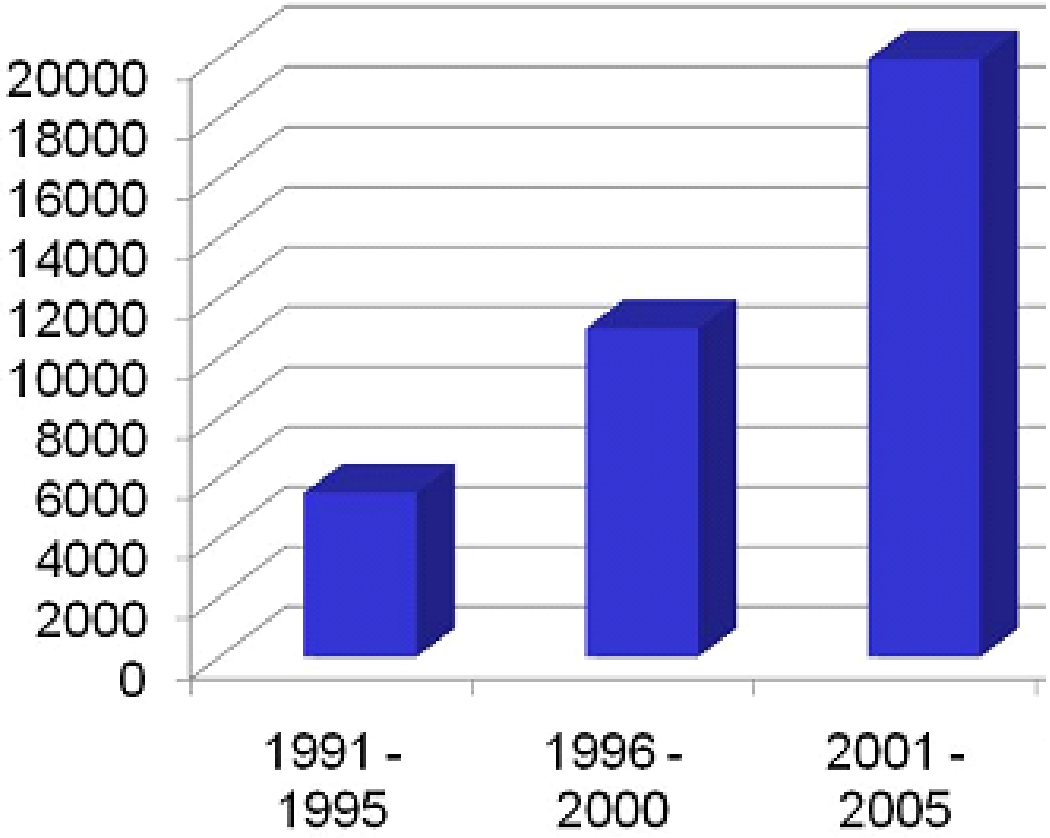
Number of papers published on climate change



Mandate of the IPCC

"The General Assembly […] endorses action of the World Meteorological Organisation and the United Nations Environment Programme in jointly establishing an Intergovernmental Panel on Climate Change to provide **international coordinated scientific assessments** of the magnitude, timing and potential environmental and socio-economic impact of climate change and realistic response strategies […]."

United Nations General Assembly
43rd session resolution, 6th December 1988

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)

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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*

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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

Completed IPCC Reports

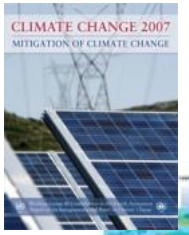
4 Assessment Reports *(1990,1995, 2001, 2007)*

1992 Supplementary Report and 1994 Special Report

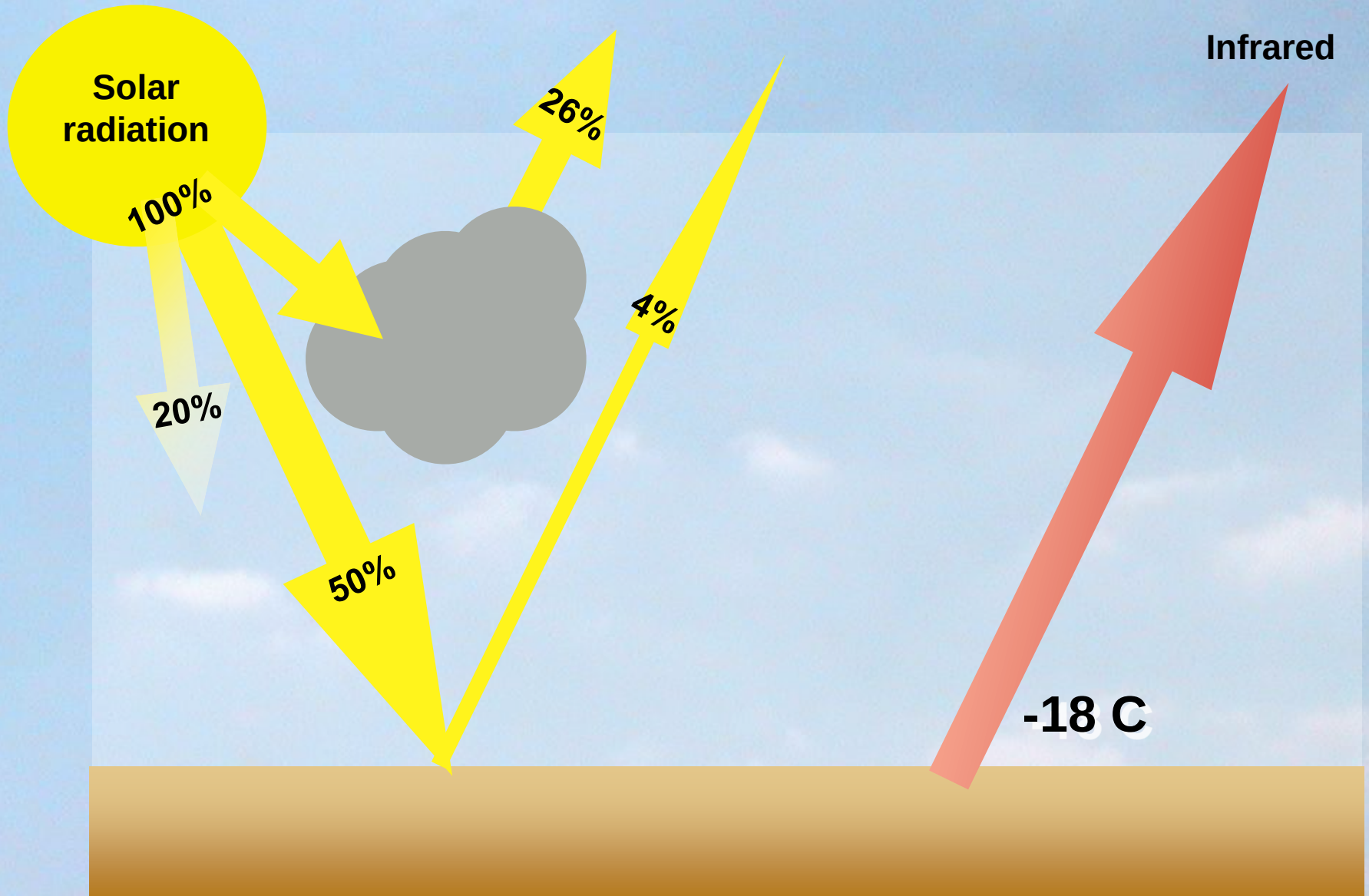
7 Special Reports *(1997,1999, 2000, 2005)*

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

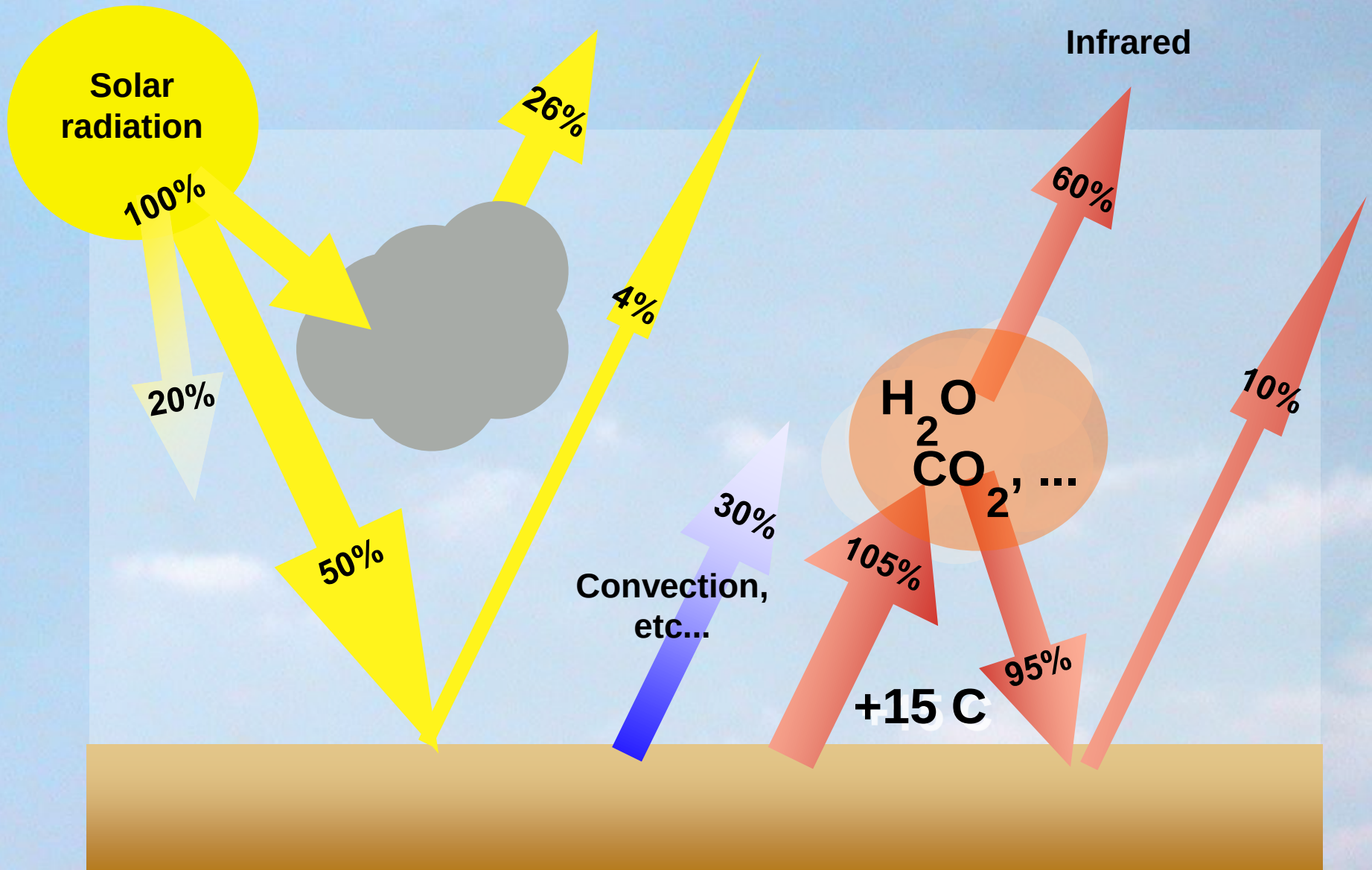
6 Technical Papers *(1996-2008)*



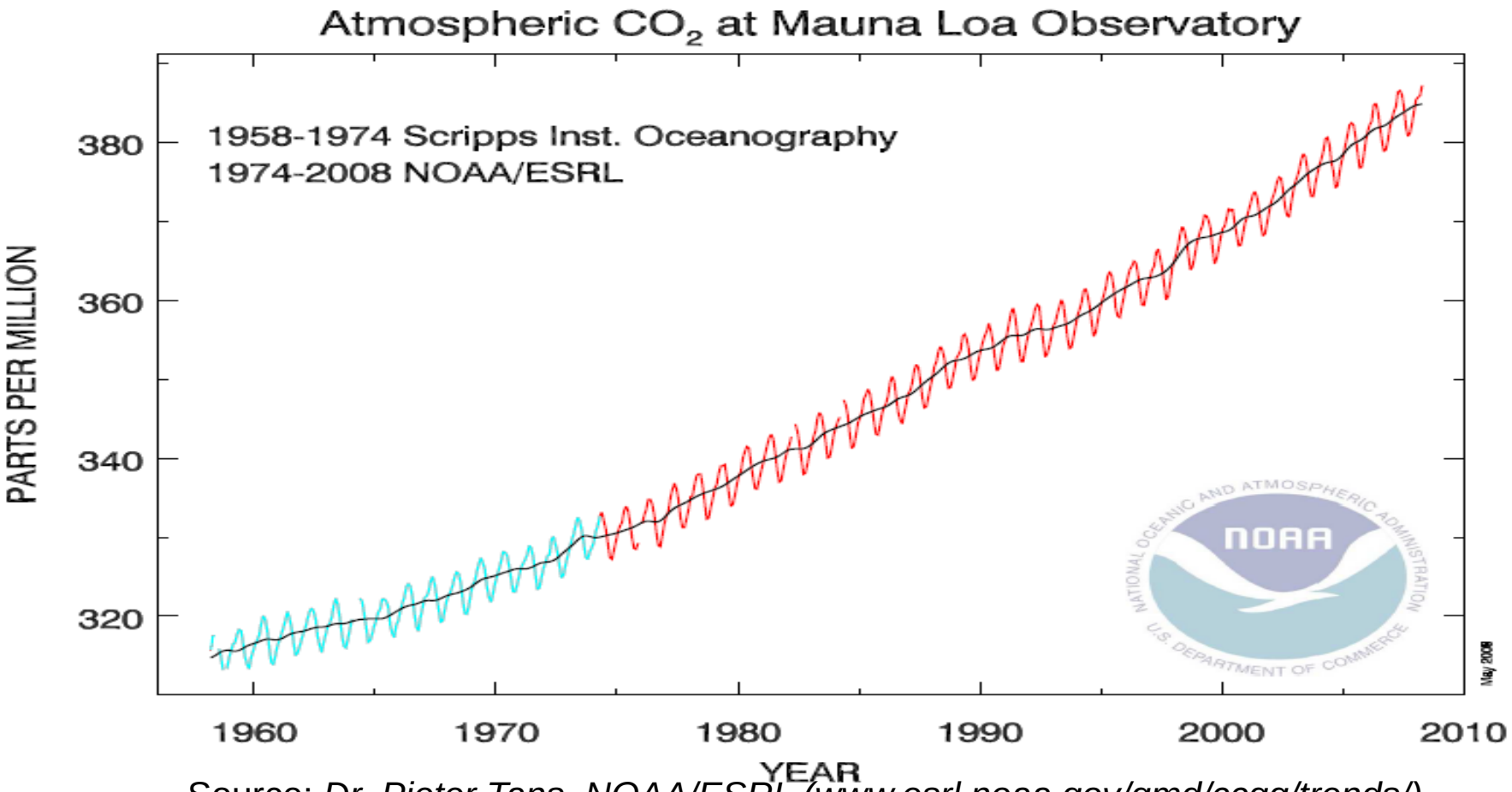
Energy cycle without greenhouse effect



Energy cycle *with* greenhouse effect



CO_2 concentration measured at Mauna Loa (3400 m)



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

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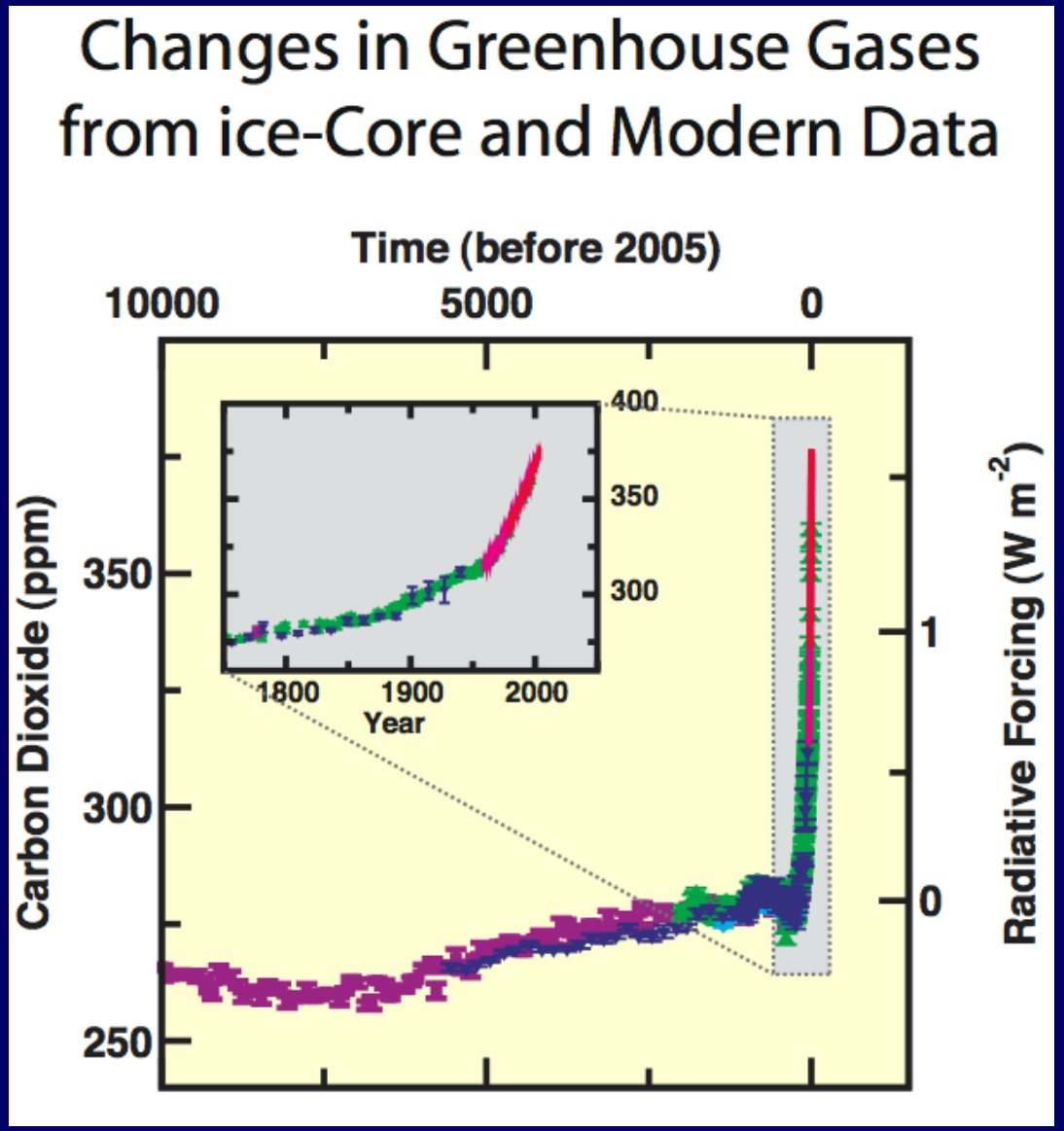
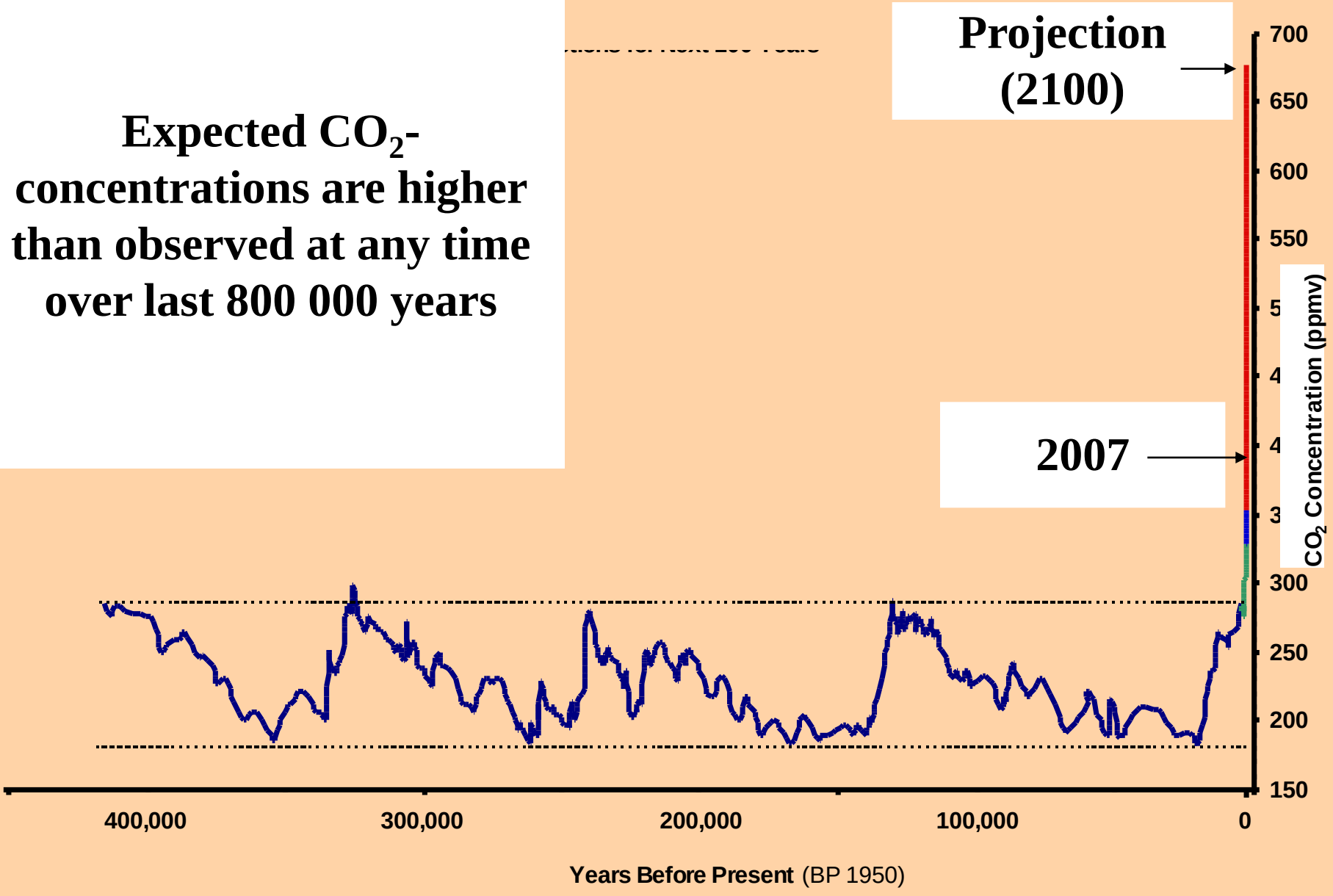
Human and Natural Drivers of Climate Change: Unprecedented

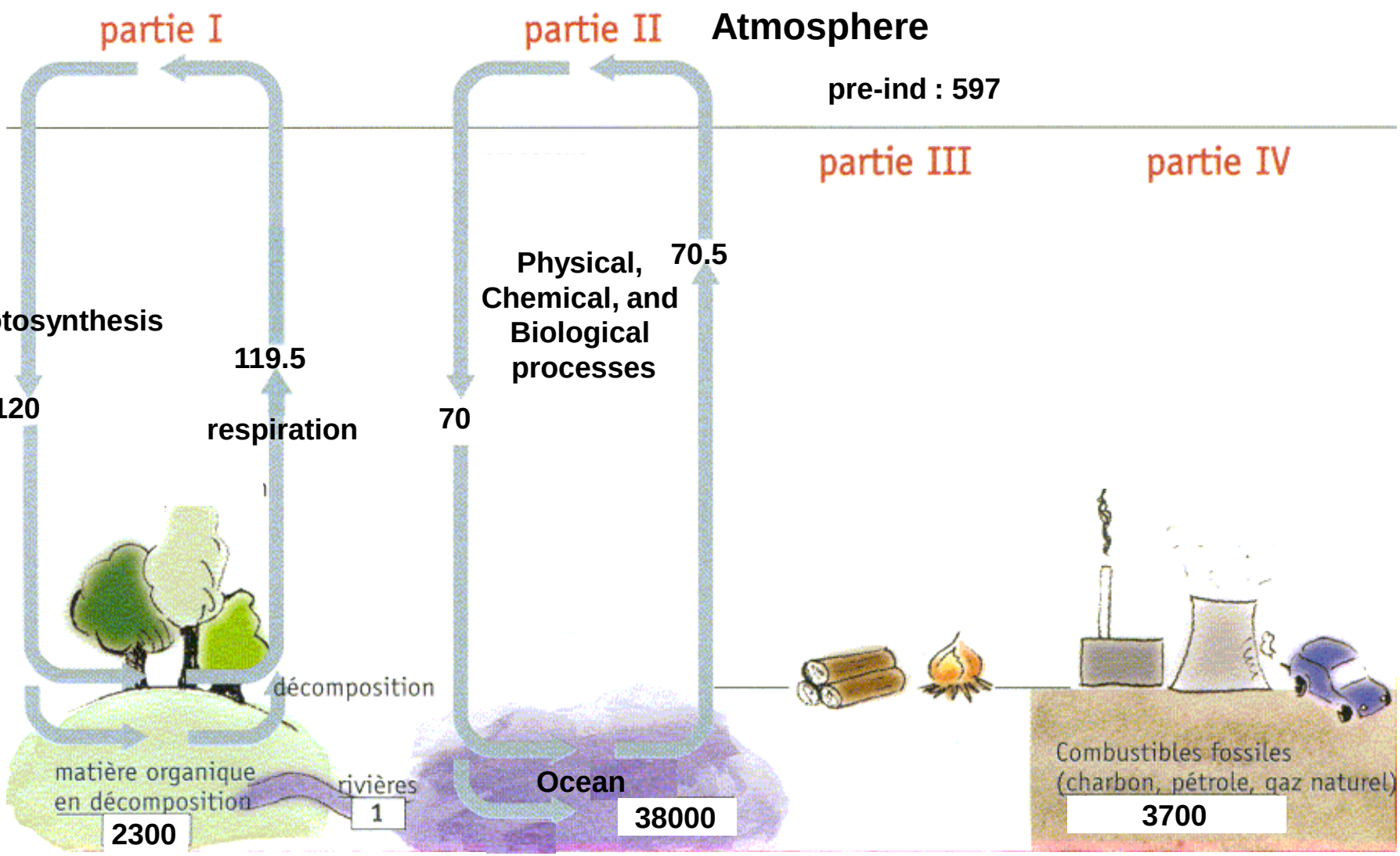
- Dramatic rise in the industrial era
- Largest growth rate of CO2 seen over the last ten years (1995-2005) than in any decade at least since direct measurements began (1960).



Expected CO_2-concentrations are higher than observed at any time over last 800 000 years



Carbon cycle



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

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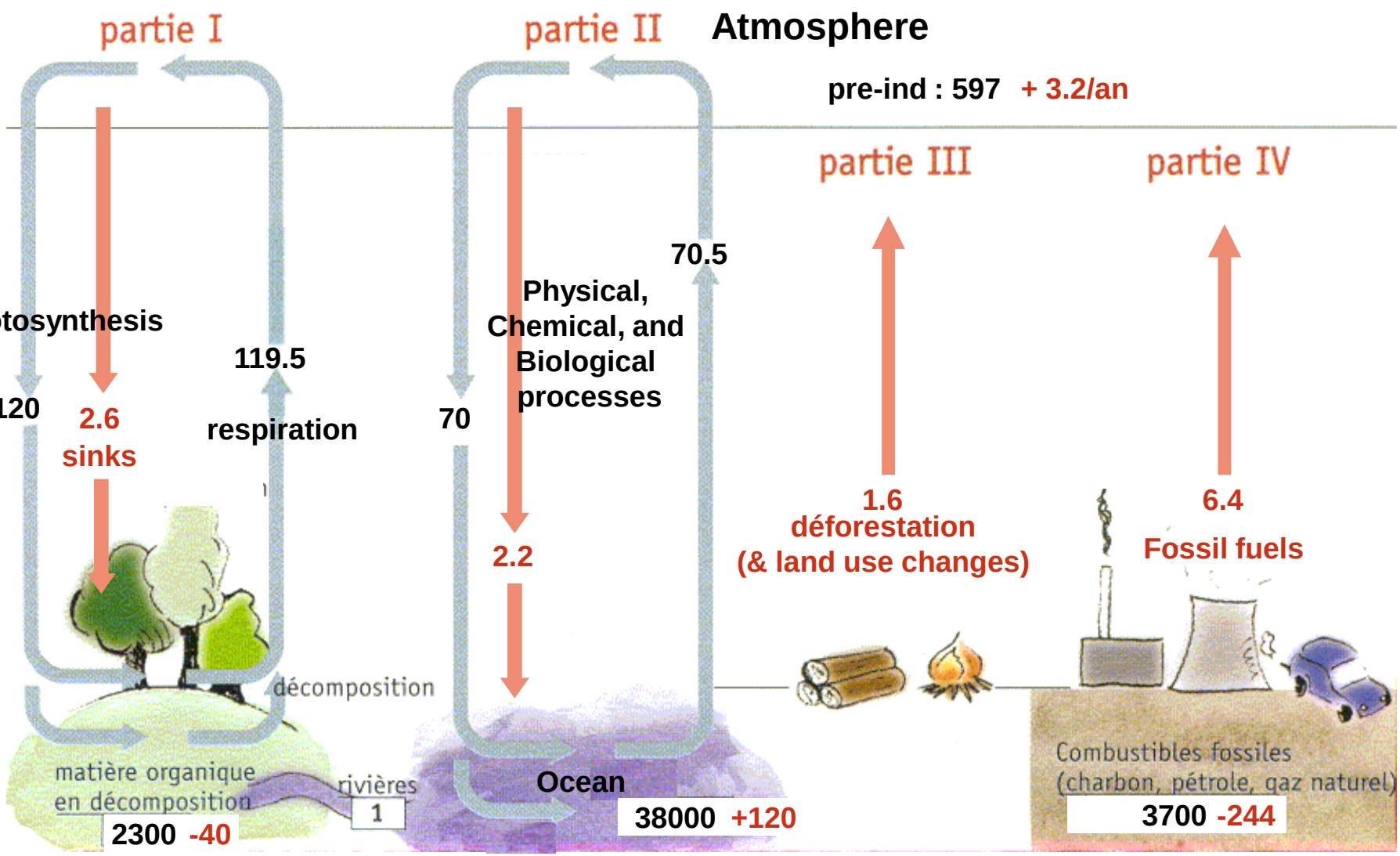
Carbon cycle



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

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⌘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, …)

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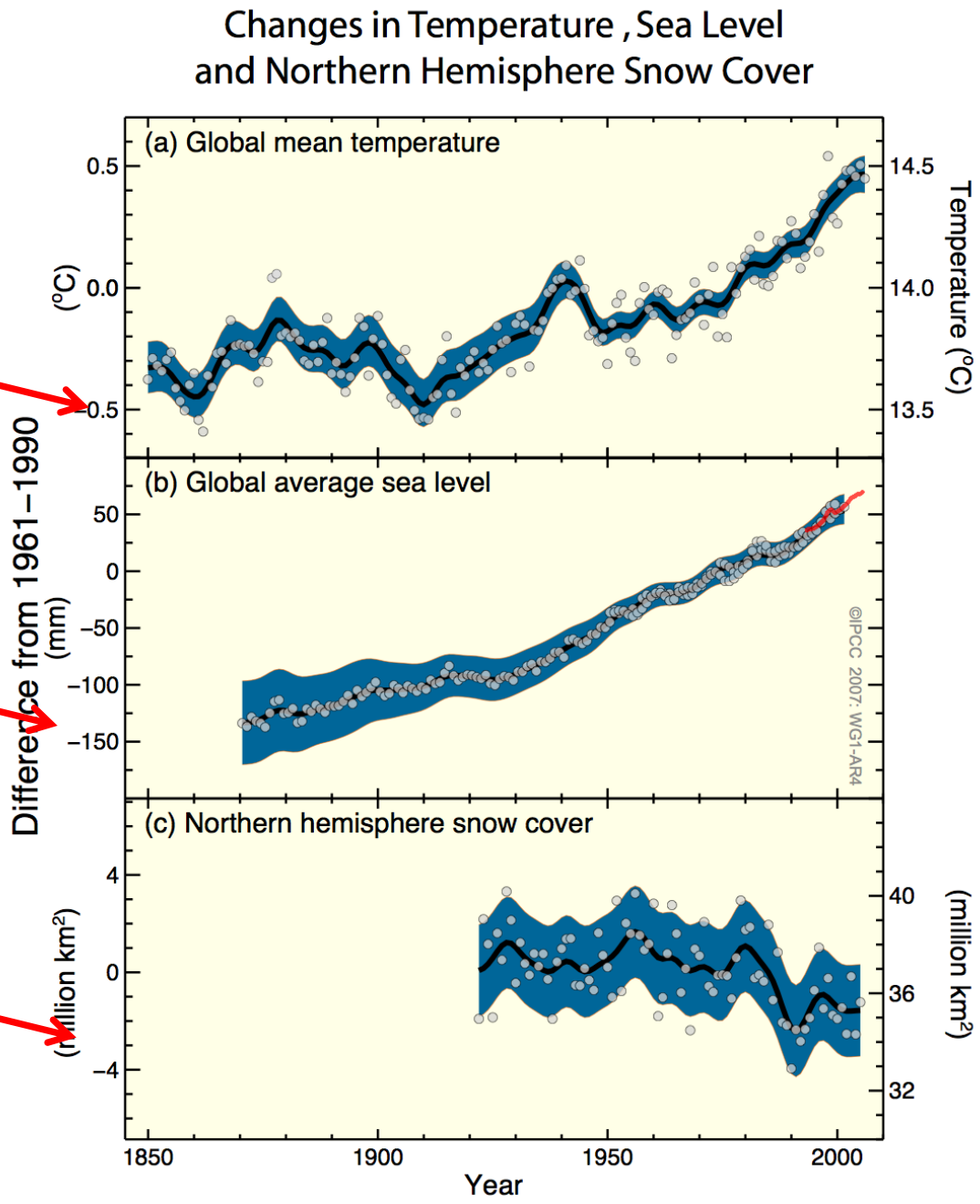
Warming is Unequivocal

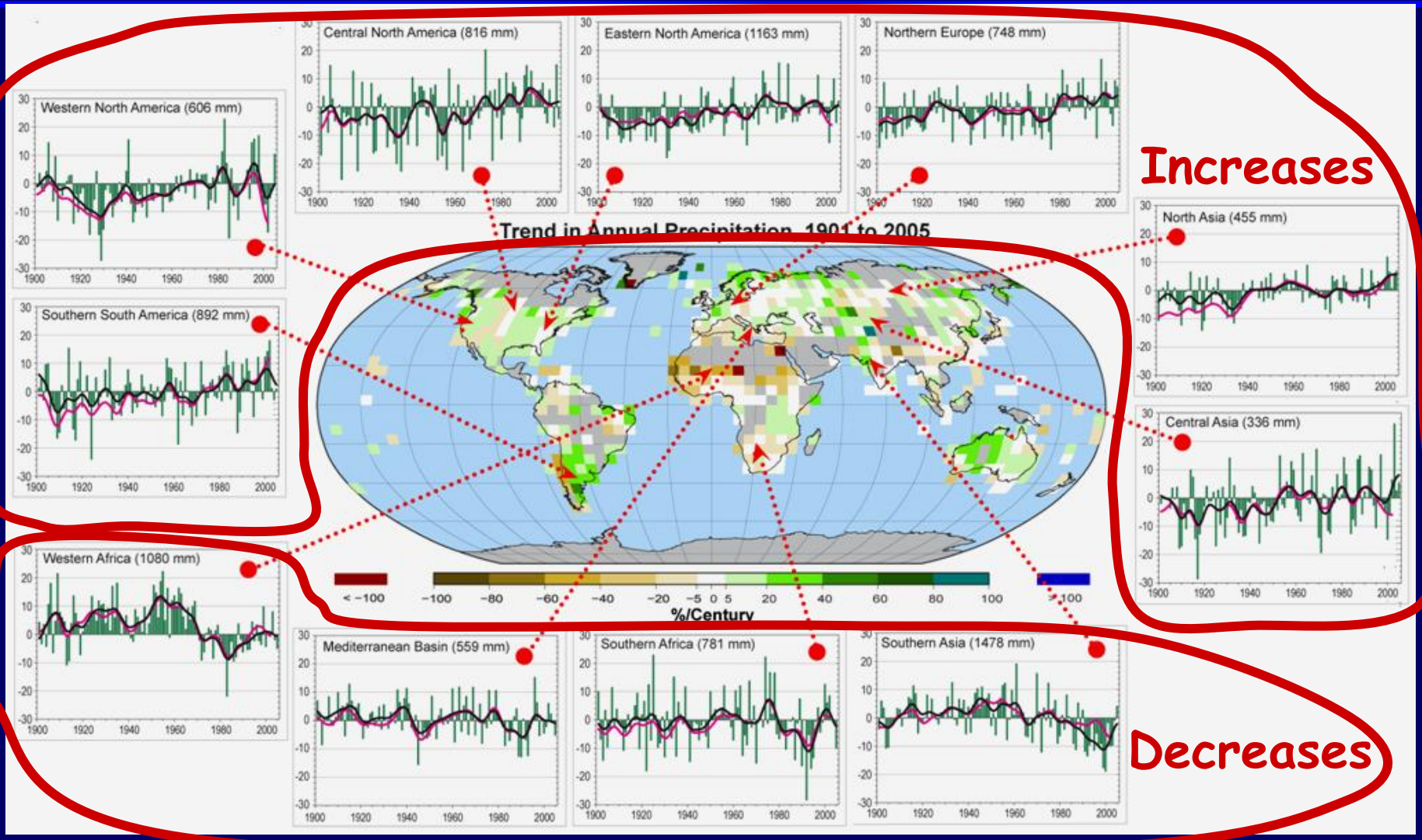
Rising atmospheric temperature

Rising sea level

Reductions in NH snow cover

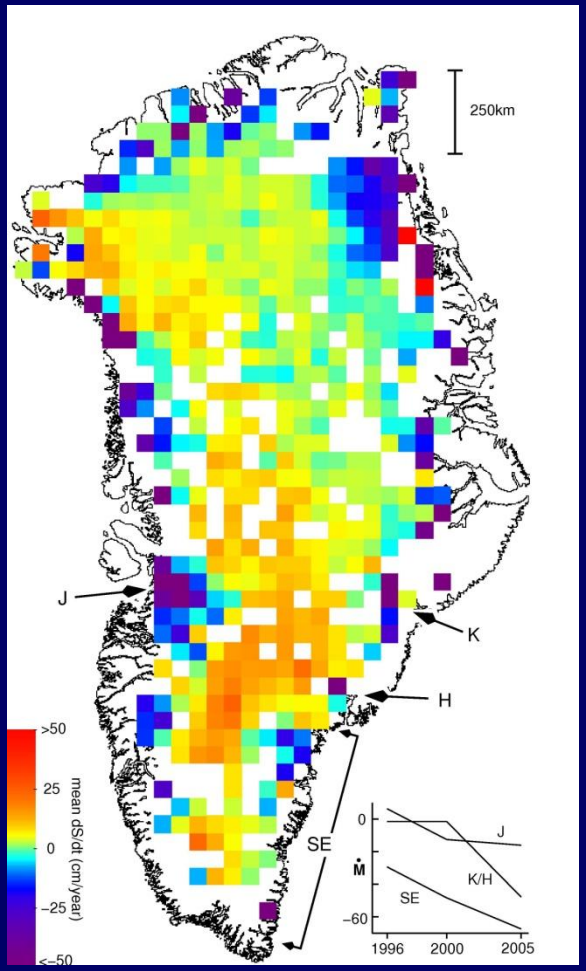


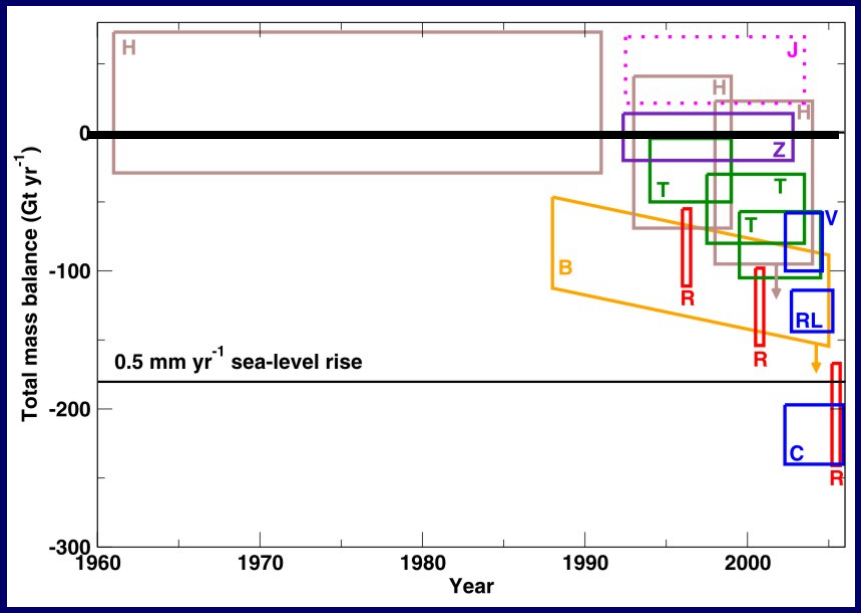
Land precipitation is changing significantly over broad areas



Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

Greenland and Antarctic ice sheets are shrinking





Greenland mass loss is increasing
Loss: glacier discharge, melting

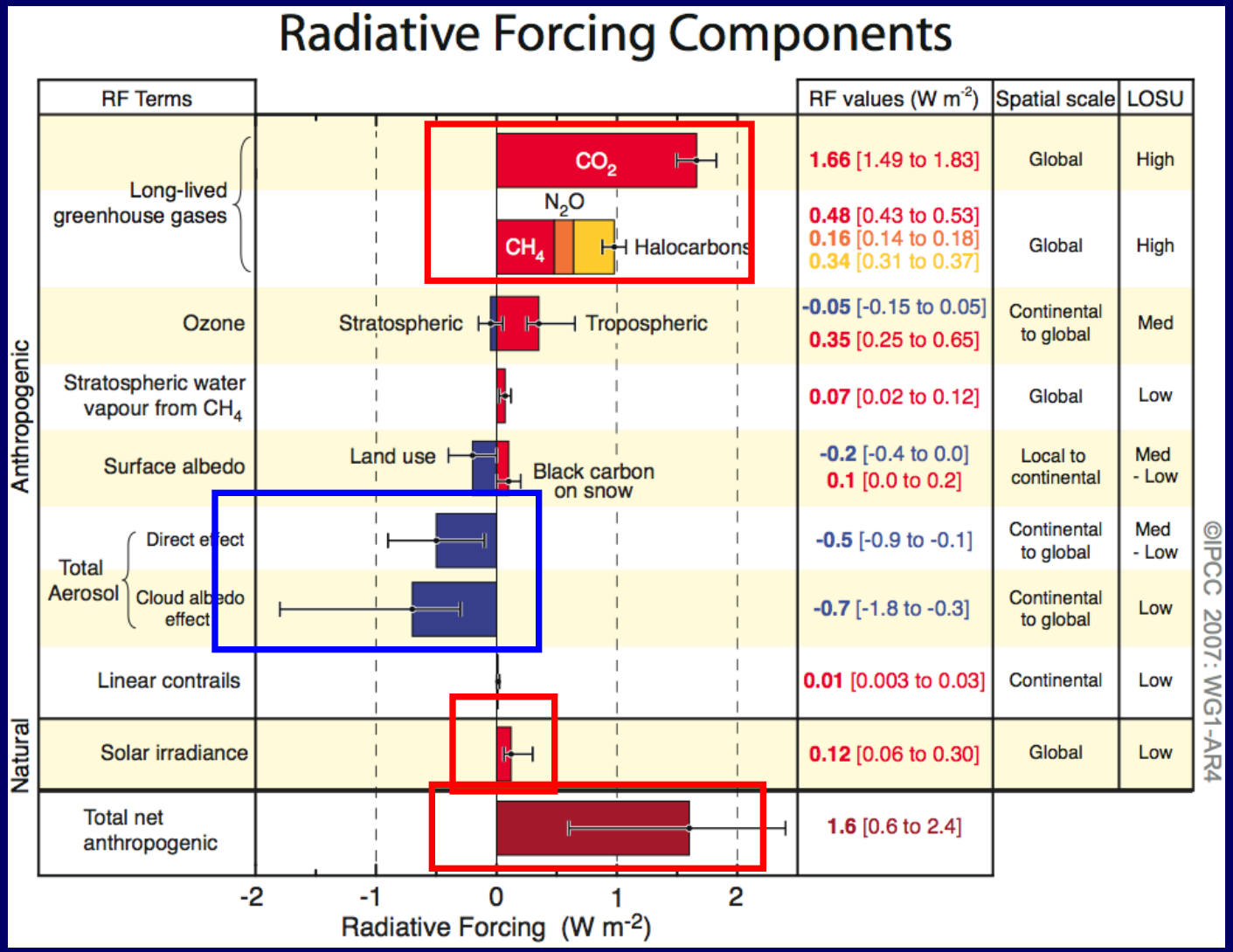
Greenland gains mass in the interior, but loses more at the margins

Human and Natural Drivers of Climate Change

Major improvements in understanding forcing compared to IPCC (2001).

Now we have more confidence about “drivers”.

1.6 W m^{-2} warms like 1.6 Christmas tree lights over every m^2 on Earth.

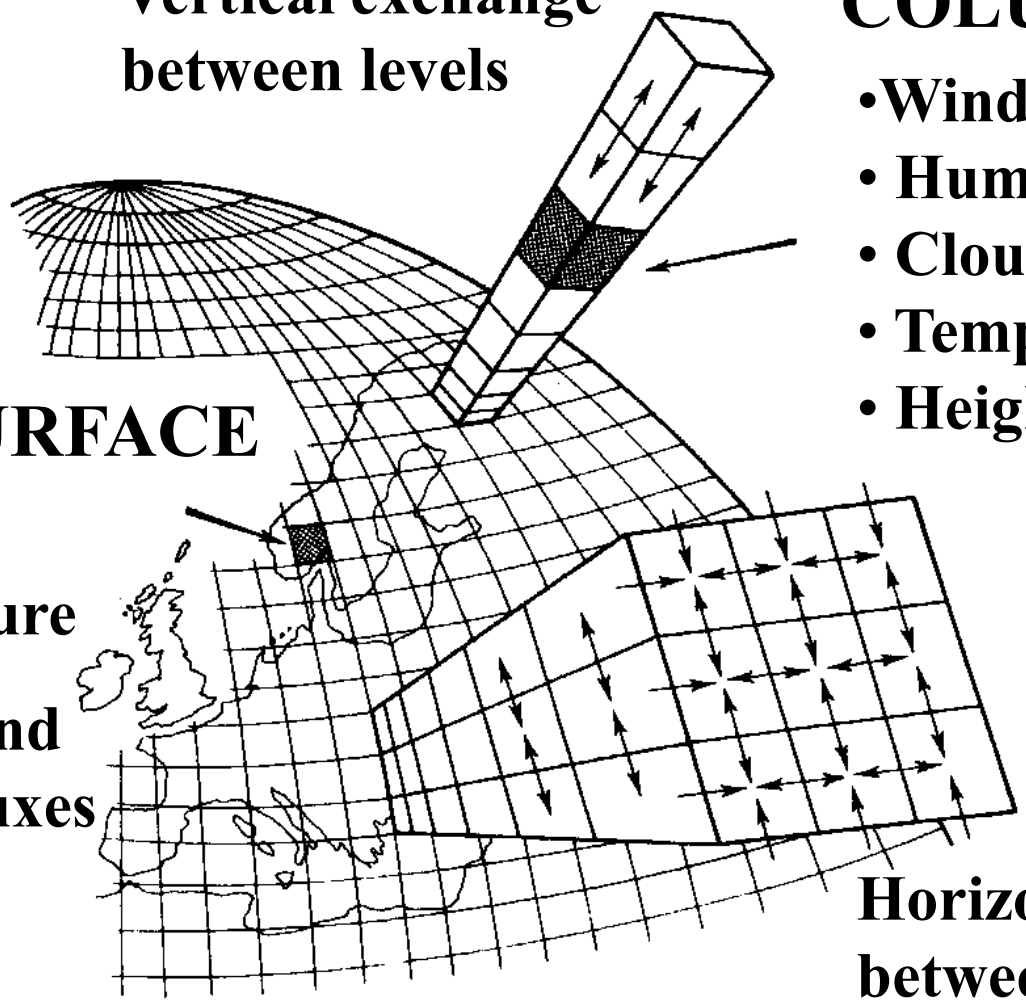


A climate model:

IN THE ATMOSPHERIC COLUMN

- Wind vectors
- Humidity
- Clouds
- Temperature
- Height

Vertical exchange between levels



AT THE SURFACE

- Ground temperature
- Water and energy fluxes

Horizontal exchange between columns

Time step ~ 30 minutes

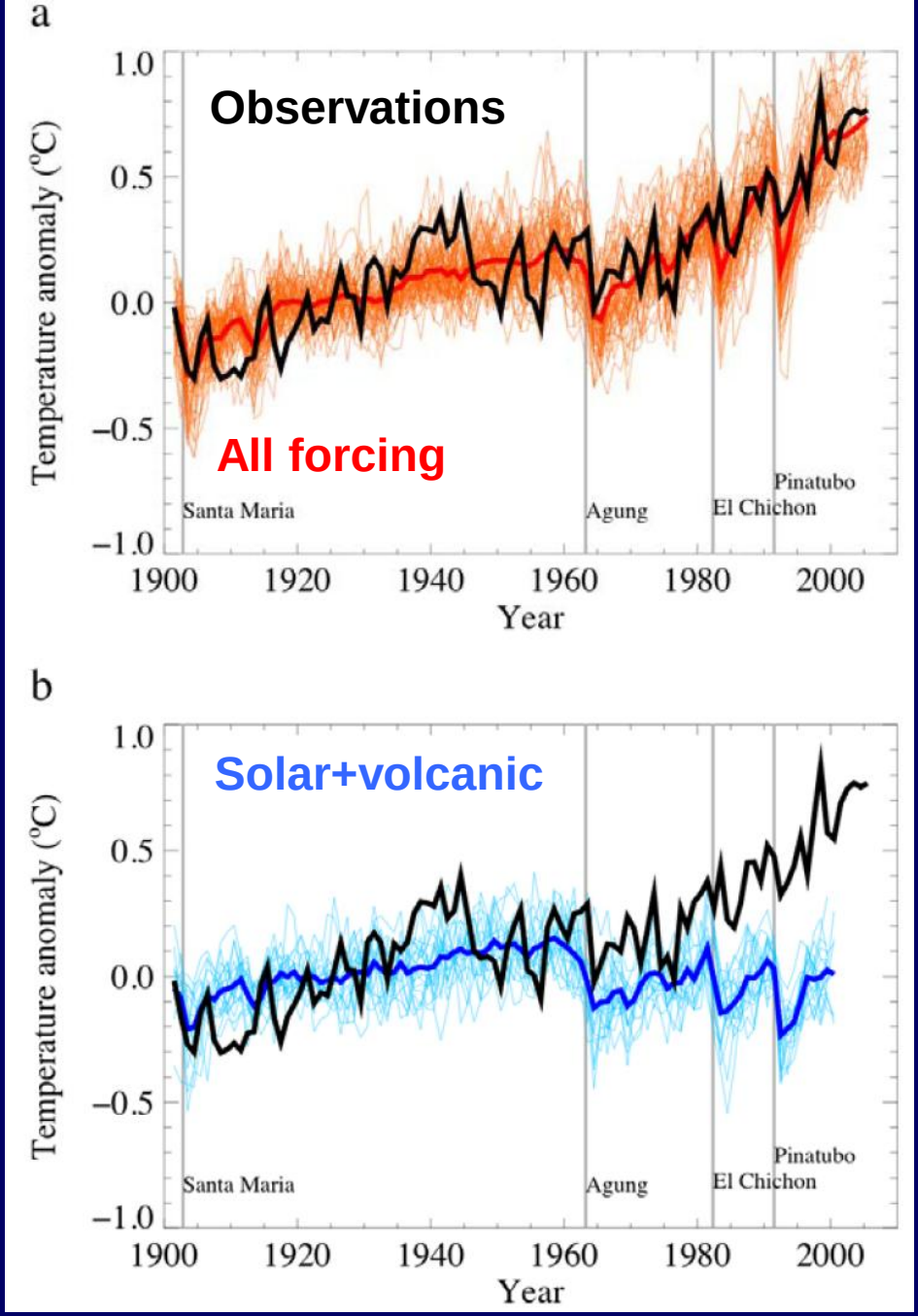
Grid spacing ~ 3°x 3°

Source: McGuffie & Henderson-Sellers (1997)

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."



Understanding and Attributing Climate Change

- **Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (>90%) due to the observed increase in anthropogenic greenhouse gas concentrations.**

- **This is an advance since the TAR's conclusion that "most of the observed warming over the last 50 years is likely (>66%) to have been due to the increase in greenhouse gas concentrations".** .

The IPCC WG1 Sequence……

IPCC (1990) Broad overview of climate change science, discussion of uncertainties and evidence for warming.

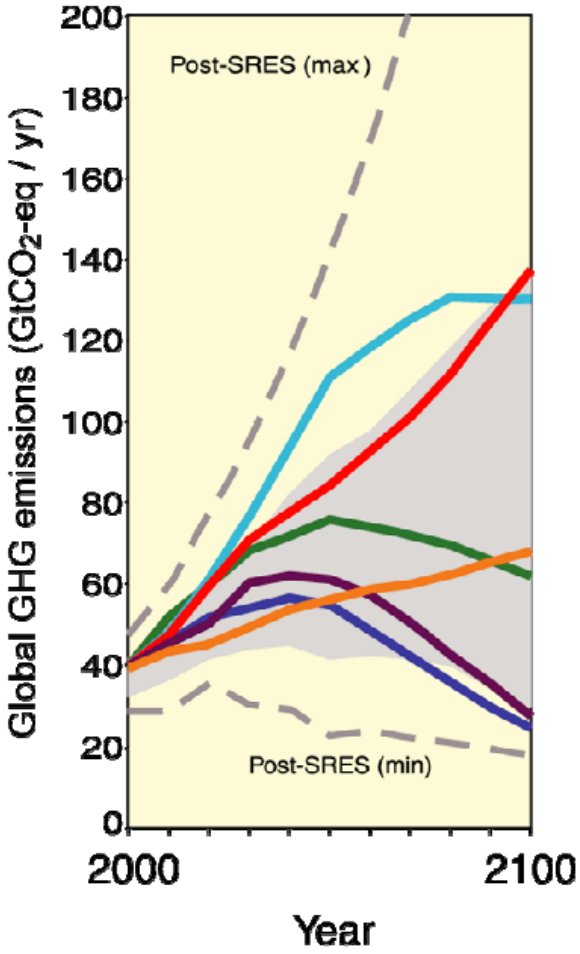
IPCC (1995) “The balance of evidence suggests a discernible human influence on global climate.”

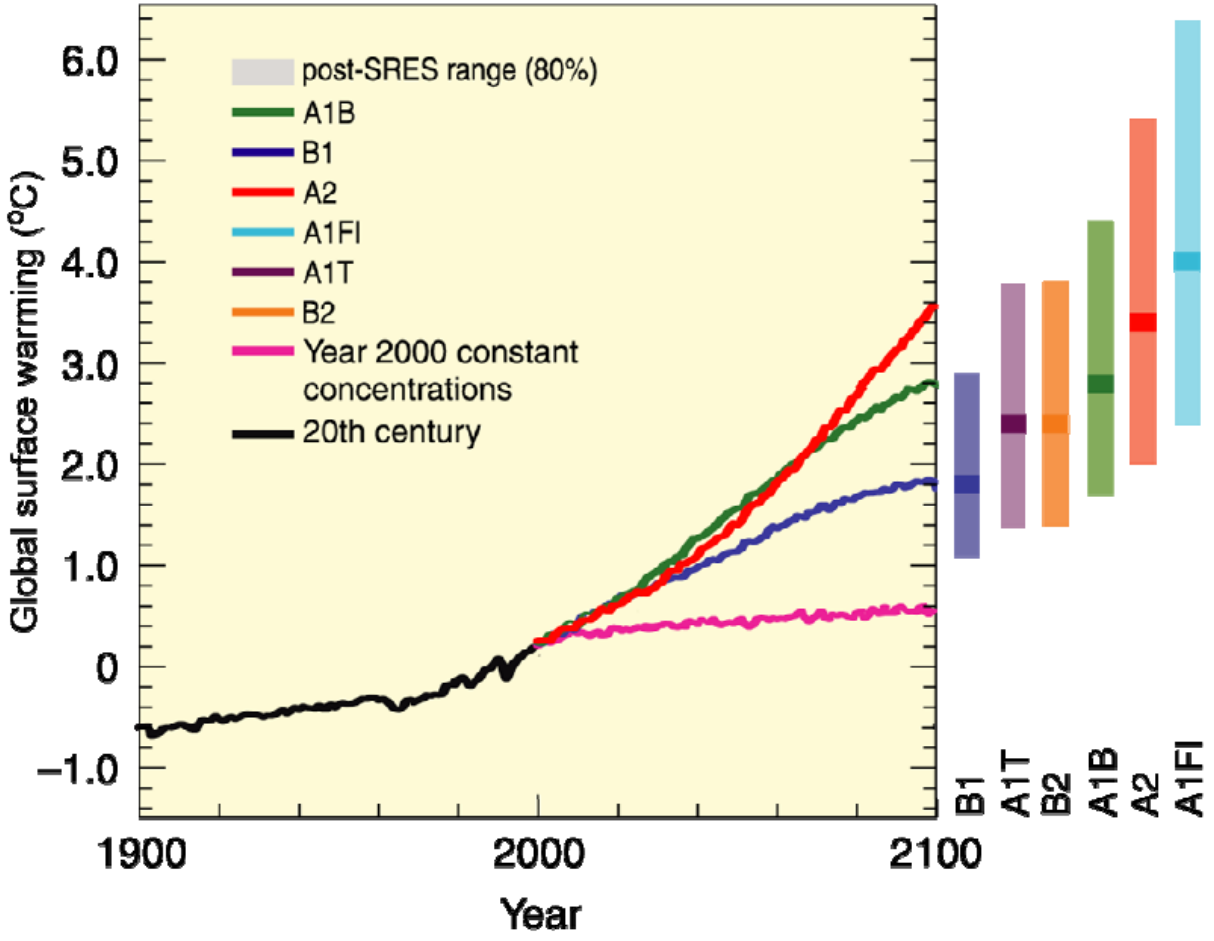
IPCC (2001) “Most of the warming of the past 50 years is likely (>66%) to be attributable to human activities.”

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.”

Source: IPCC, AR4 (2007)

Climate projections without mitigation





NB: écart par rapport à la moyenne 1980-1999

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Projected globally averaged surface warming and sea level rise at the end of the 21st century (IPCC WG1 AR4)

	Temperature Change (°C at 2090-2099 relative to 1980-1999) [a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
Case	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations [c]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

NB: add 0.5°C to get pre-industrial reference

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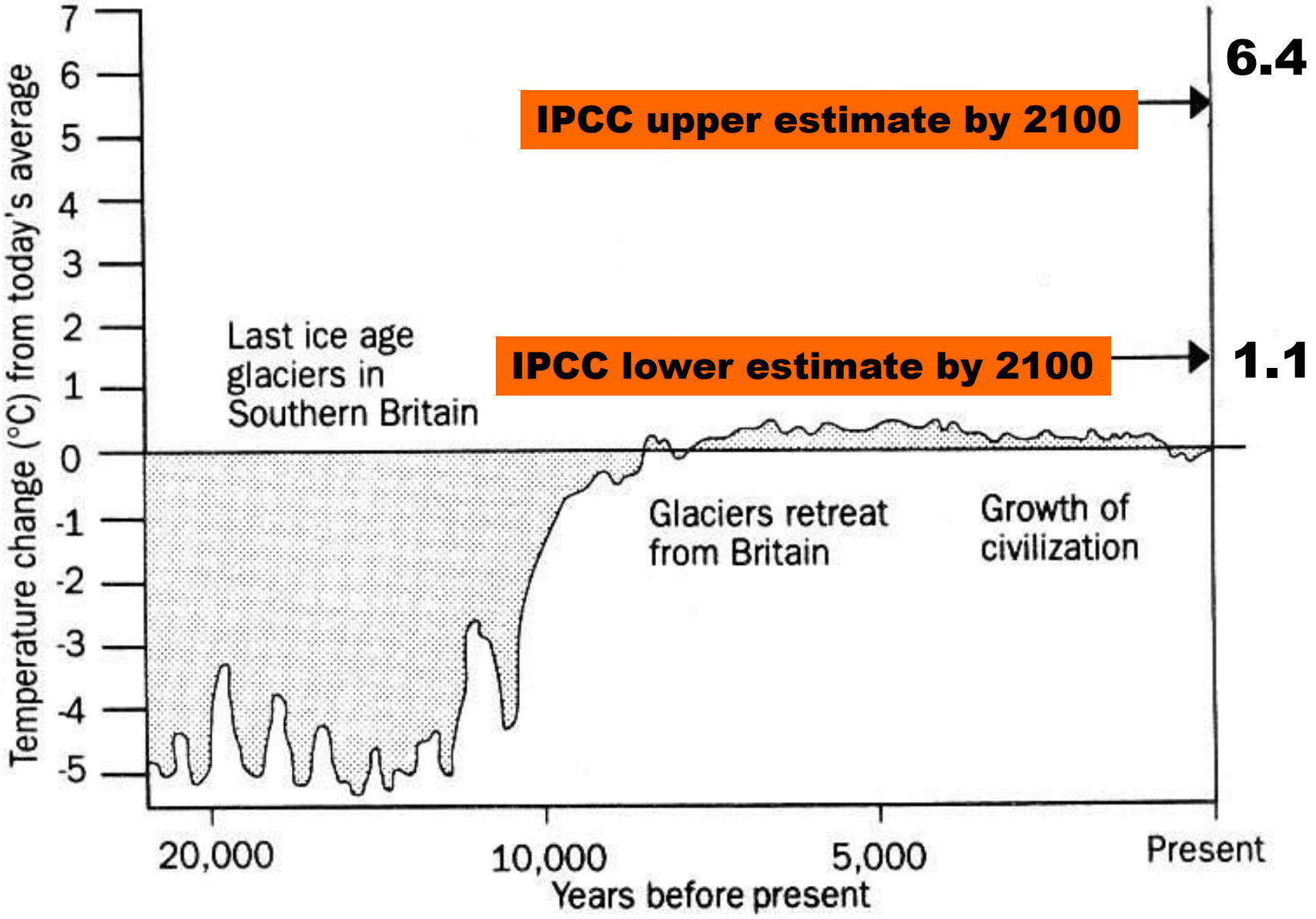
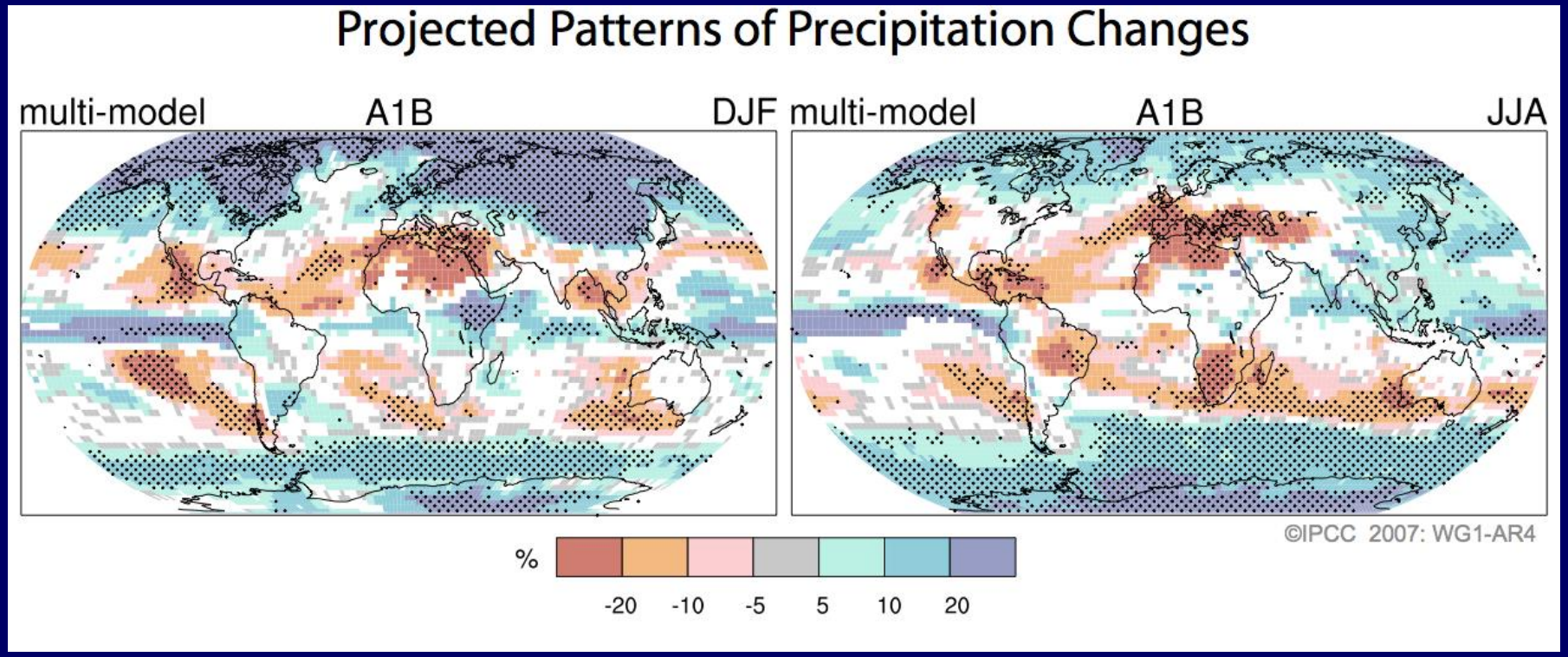

6.4
IPCC upper estimate by 2100
IPCC lower estimate by 2100
1.1
Last ice age glaciers in Southern Britain
Glaciers retreat from Britain
Growth of civilization
Temperature change (°C) from today's average
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
20,000
10,000
5,000
Present
Years before present

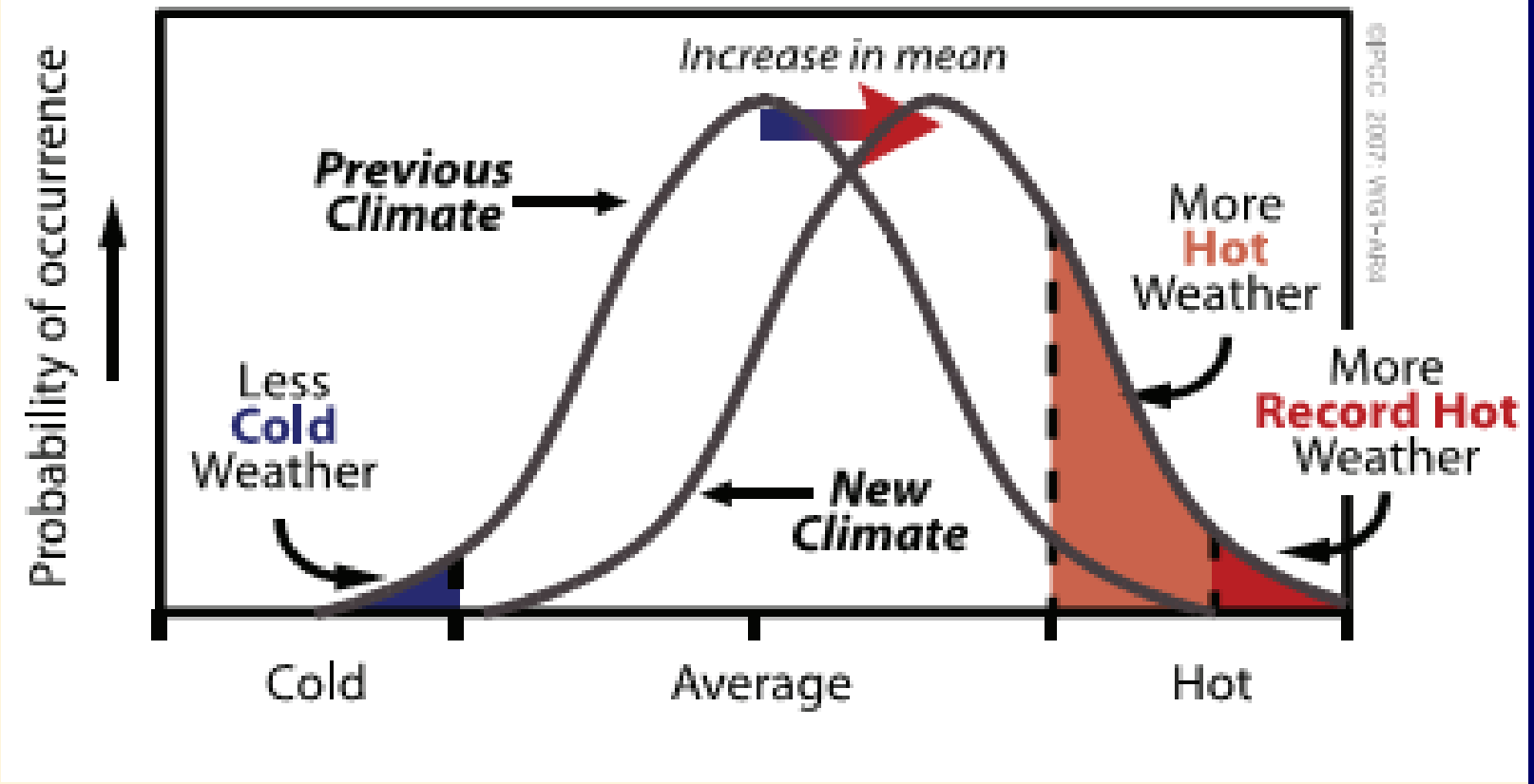
Projections of Future Changes in Climate



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….

Changes in average produce changes in probability of extremes



Box TS.5, Figure 1. *Schematic showing the effect on extreme temperatures when the mean temperature increases, for a normal temperature distribution.*

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	*Very likely* [c]	*Likely* [d]	*Virtually certain* [d]
Warmer and more frequent hot days and nights over most land areas	*Very likely* [e]	*Likely (nights)* [d]	*Virtually certain* [d]
Warm spells / heat waves. Frequency increases over most land areas	*Likely*	*More likely than not* [f]	*Very likely*
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	*Likely*	*More likely than not* [f]	*Very likely*
Area affected by droughts increases	*Likely* in many regions since 1970s	*More likely than not*	*Likely*
Intense tropical cyclone activity increases	*Likely* in some regions since 1970	*More likely than not* [f]	*Likely*
Increased incidence of extreme high sea level (excludes tsunamis) [g]	*Likely*	*More likely than not* [f, h]	*Likely* [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

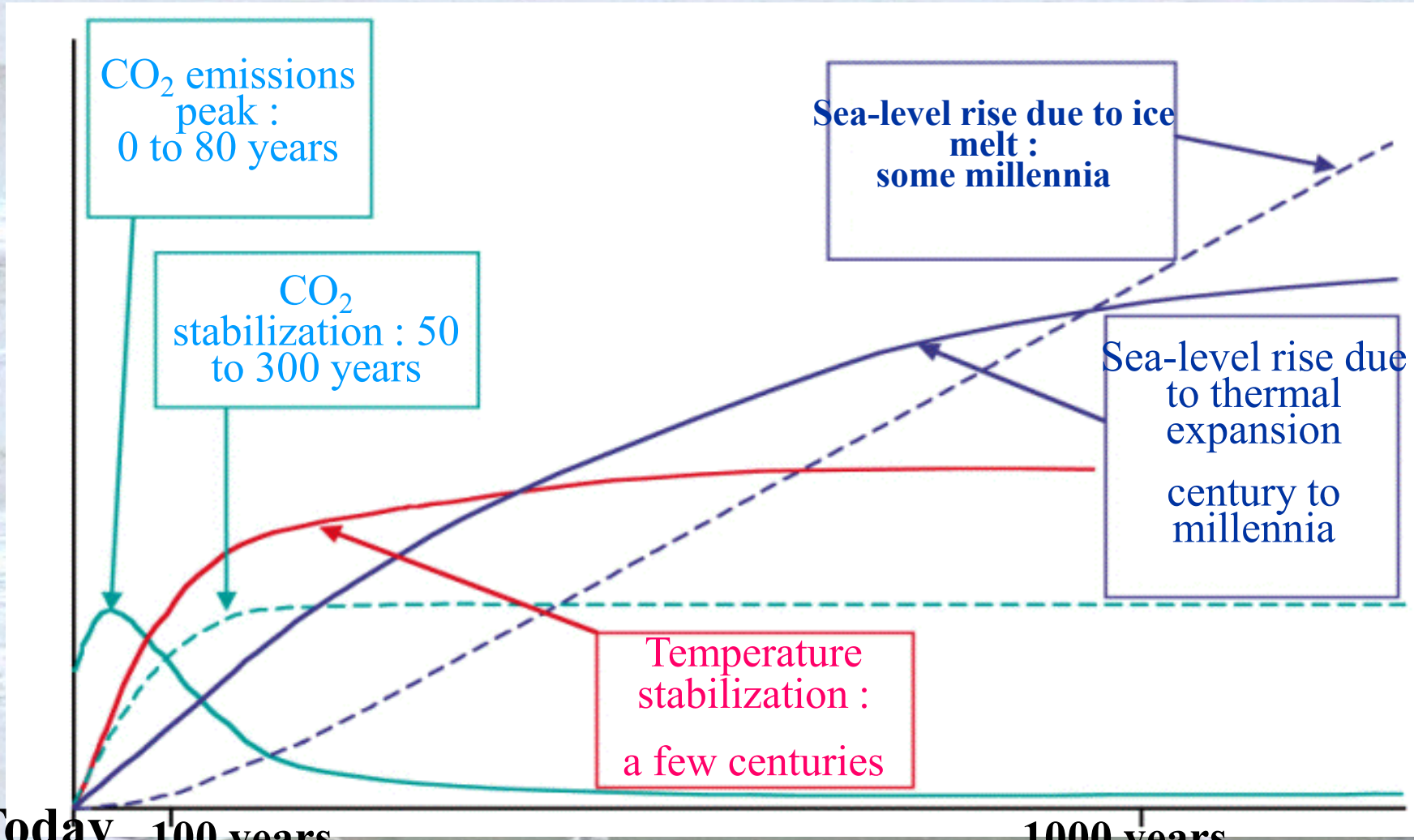
- Melting of the Greenland ice sheet
  - Total melting would cause 7 m SLR contribution
- Melting of the West Antarctic Ice Sheet
  - Total melting would cause 5 m SLR contribution
- Warming of 1 – 4^{o}C over present-day temperatures would lead to partial melting over centuries to millennia

Projections of Future Changes in Climate

- **Anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.**

- **Temperatures in excess of 1.9 to 4.6°C warmer than pre-industrial sustained for millennia…eventual melt of the Greenland ice sheet. Would raise sea level by 7 m. Comparable to 125,000 years ago.**

Significant inertia exists in the climate system



Source: IPCC (2001

IPCC Working Group II: Impacts, Vulnerability, and adaptation

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Following addressed by WG II:

- Impacts observed so far

- Future scenarios
- Impacts on sectors:
  - Water
  - Ecosystems
  - Agriculture, forestry, fisheries
  - Coasts
  - Settlements and industry
  - Health

WMO

UNEP

Following addressed (cont.):

- Impacts on regions:
  - Africa, Asia, Australia and New Zealand, Latin America, North America, Polar regions, Small islands, and
  - Europe (including the Alps)

- Adaptation practices
- Adaptation vs. mitigation
- Key vulnerabilities
- Sustainability

WMO

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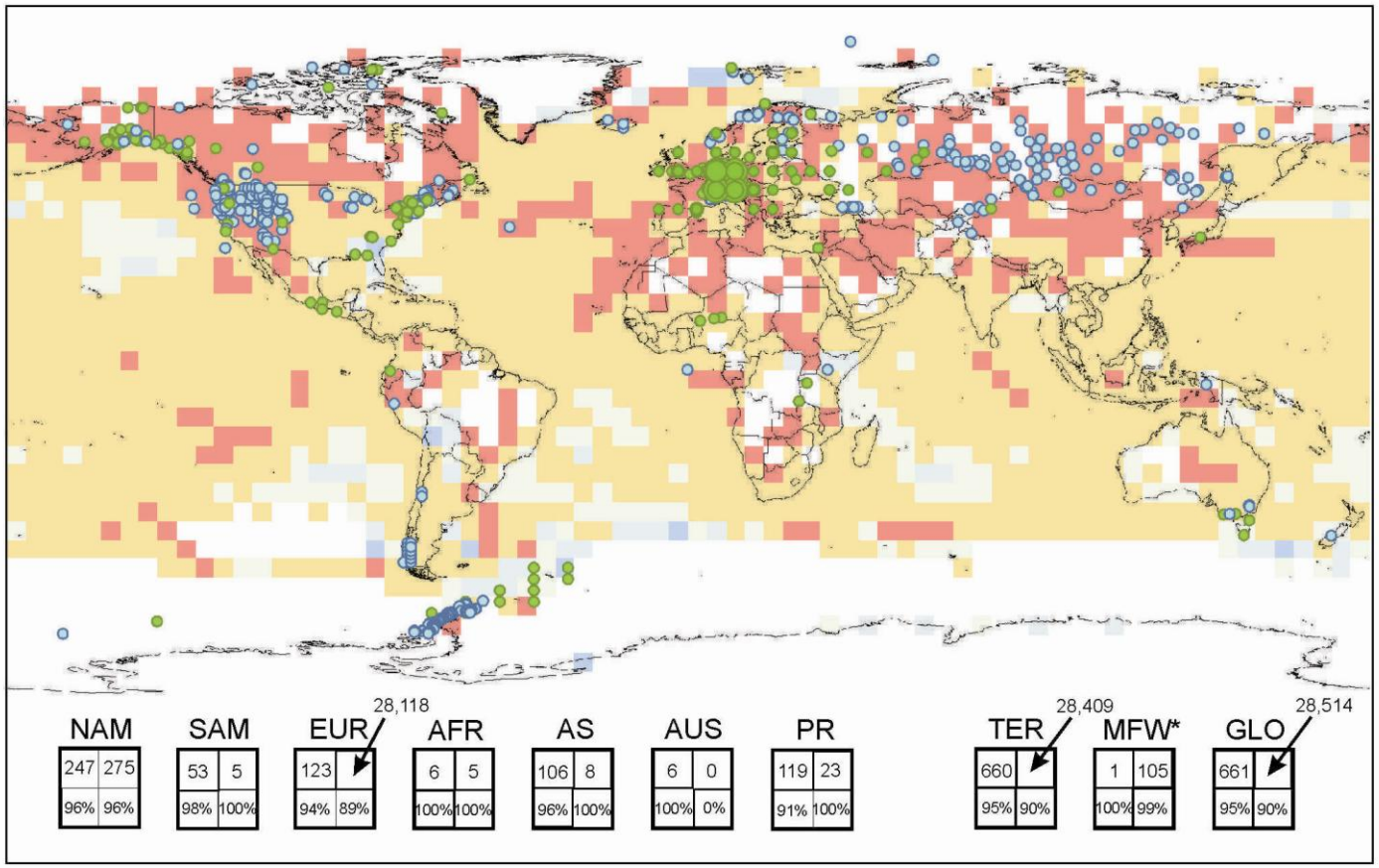
Temperature changes since 1970 and observed changes in physical and biological systems



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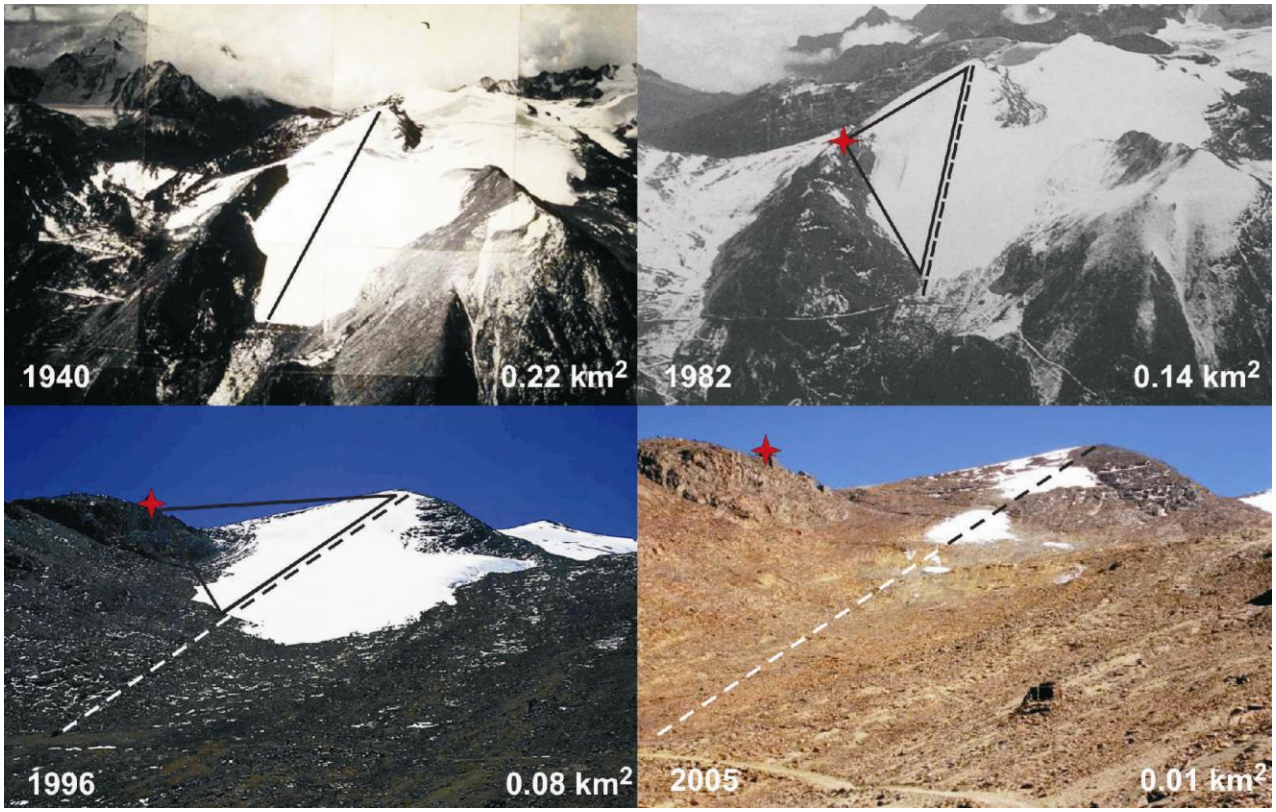
The Chacaltaya glacier and ski-lift, Bolivia

Skiing was no longer possible after 2004 (also important effect on water resources!)



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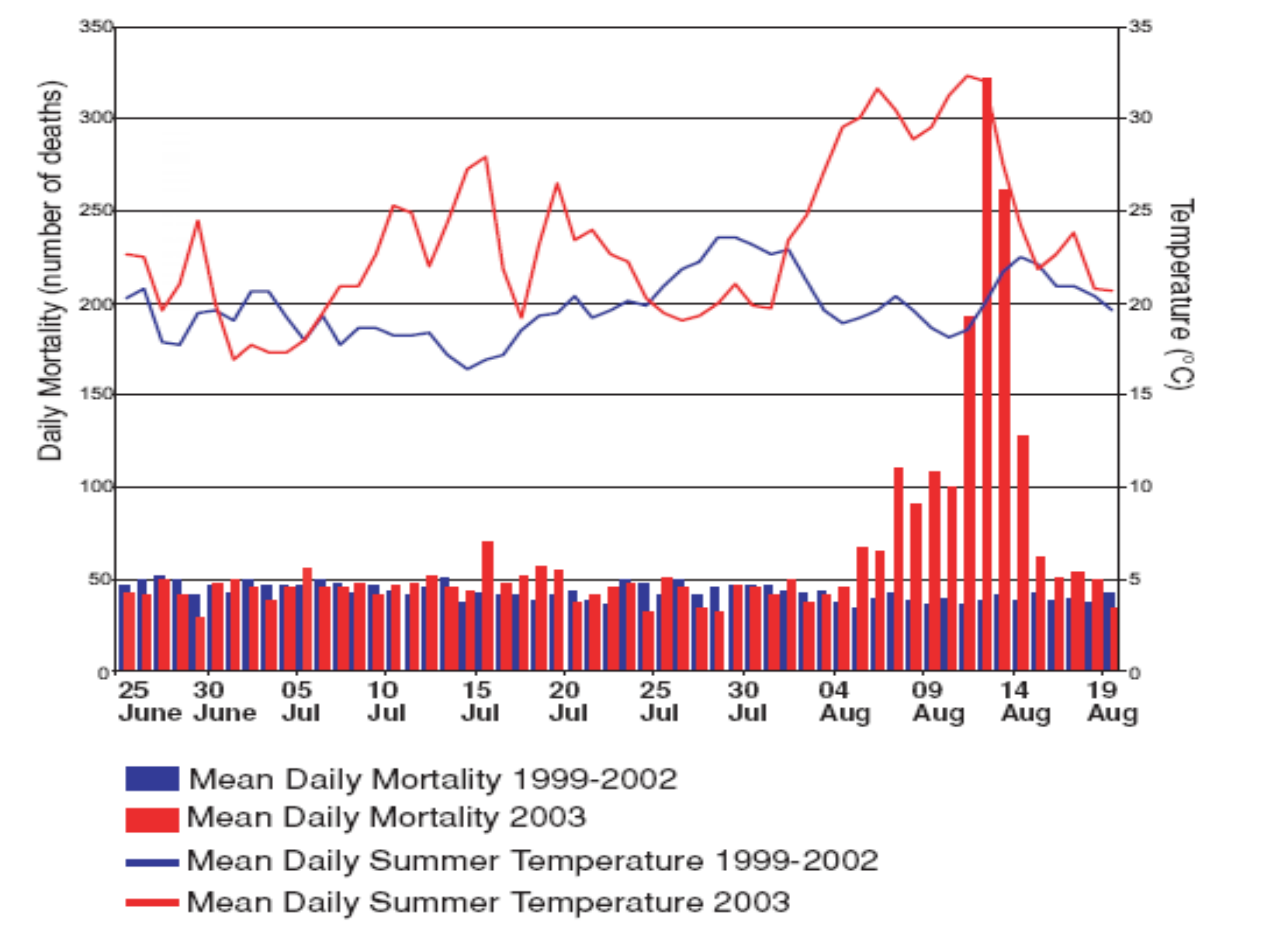
Daily mortality in Paris (summer 2003) (IPCC AR4 Ch 8)



WMO

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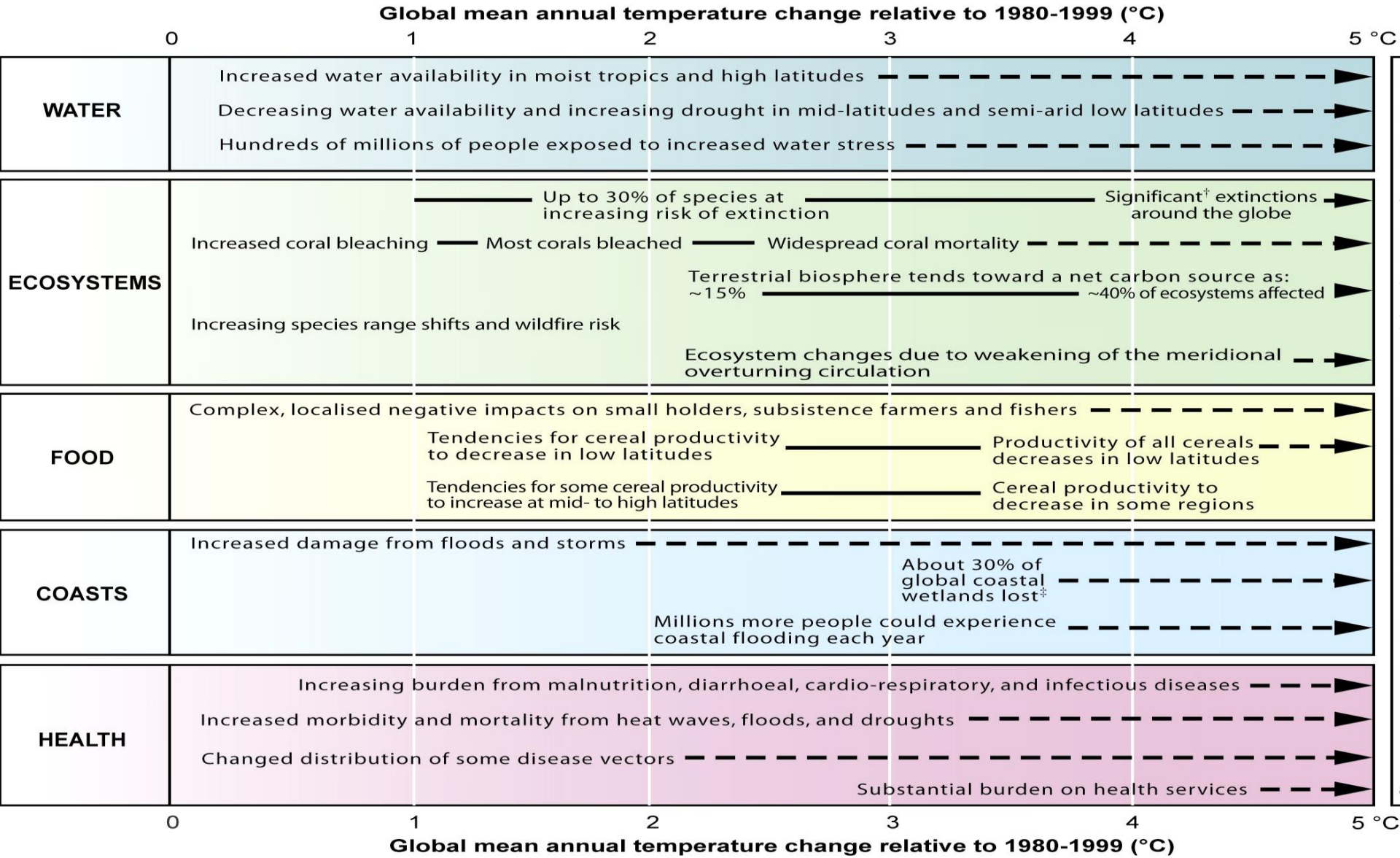
Figure SPM.2. Key impacts as a function of increasing global average temperature change

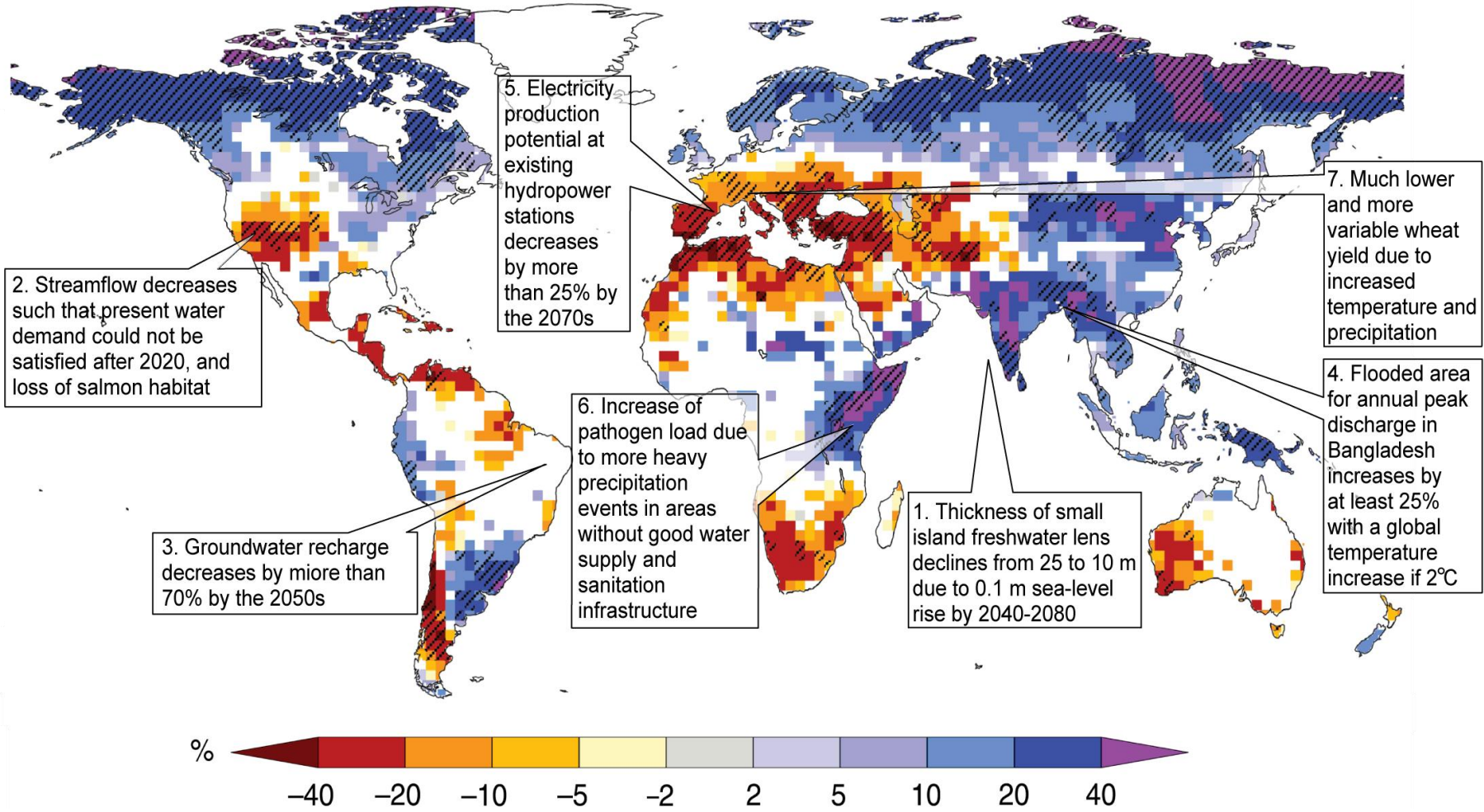
(Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)



† Significant is defined here as more than 40%.

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

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).

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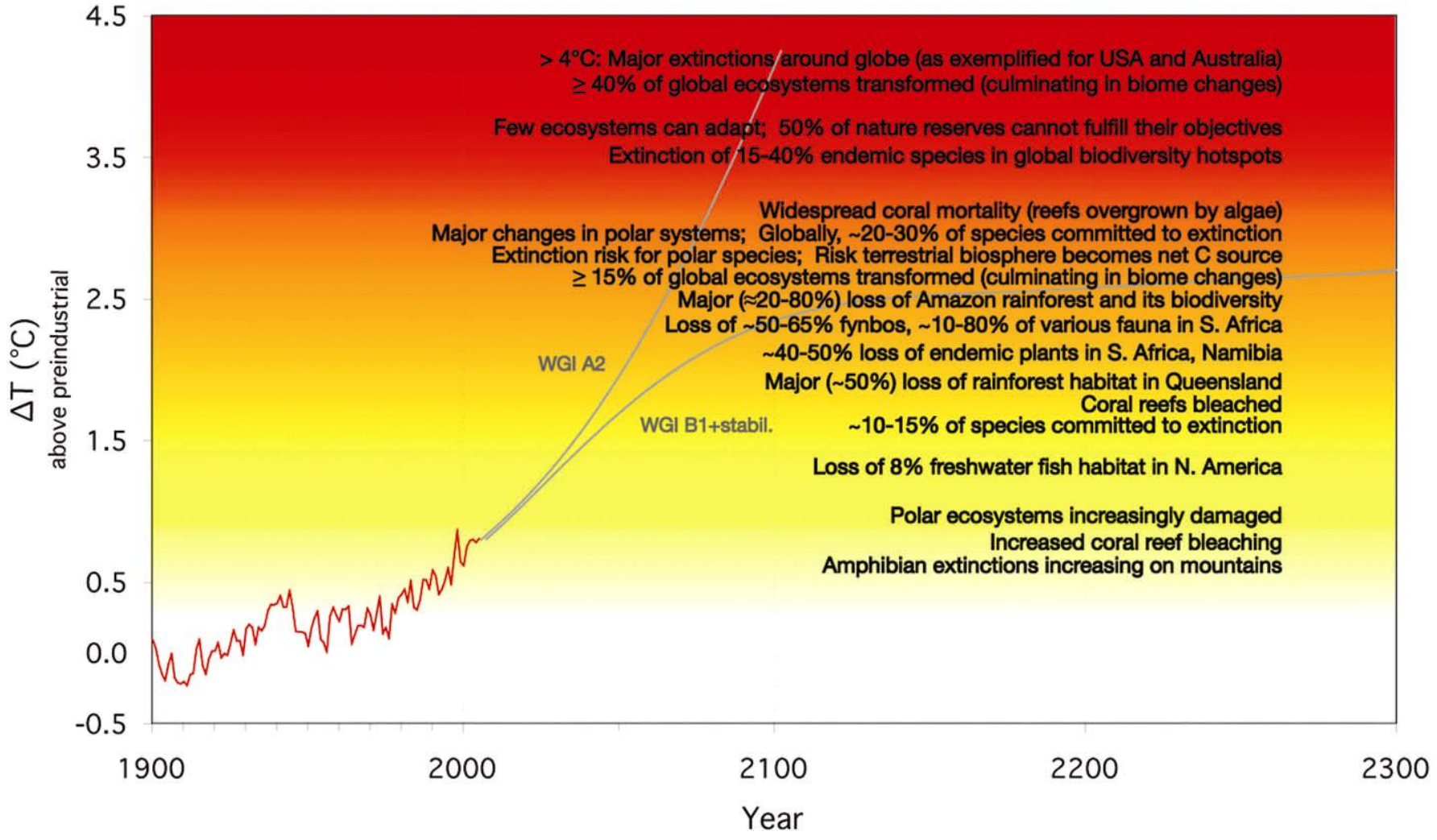
Figure TS.6. Projected risks due to critical climate change impacts on ecosystems



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20% - 30% of plants and animals species likely at "increased risk of extinction"

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

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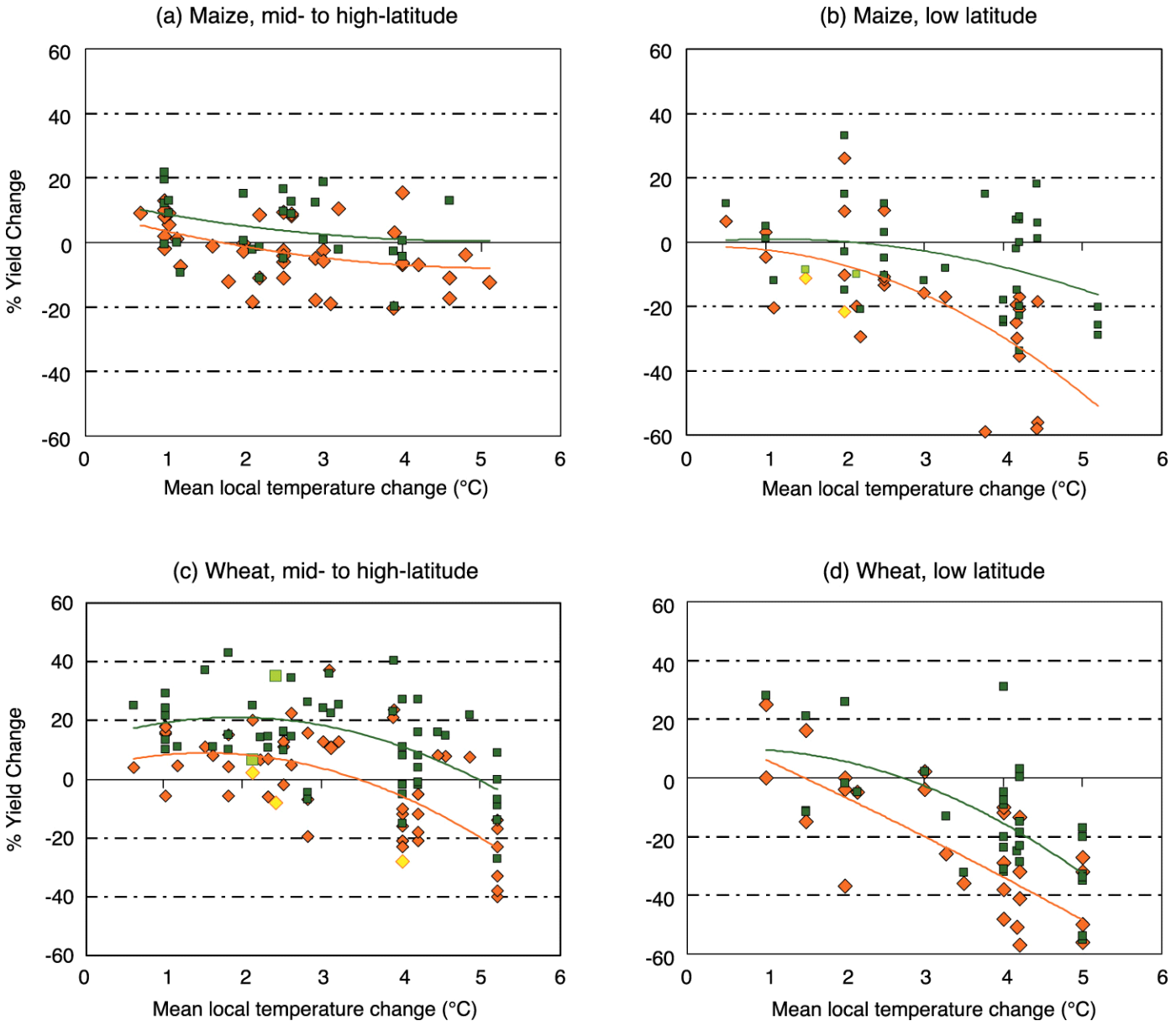
Figure TS.7. Sensitivity of cereal yield to climate change



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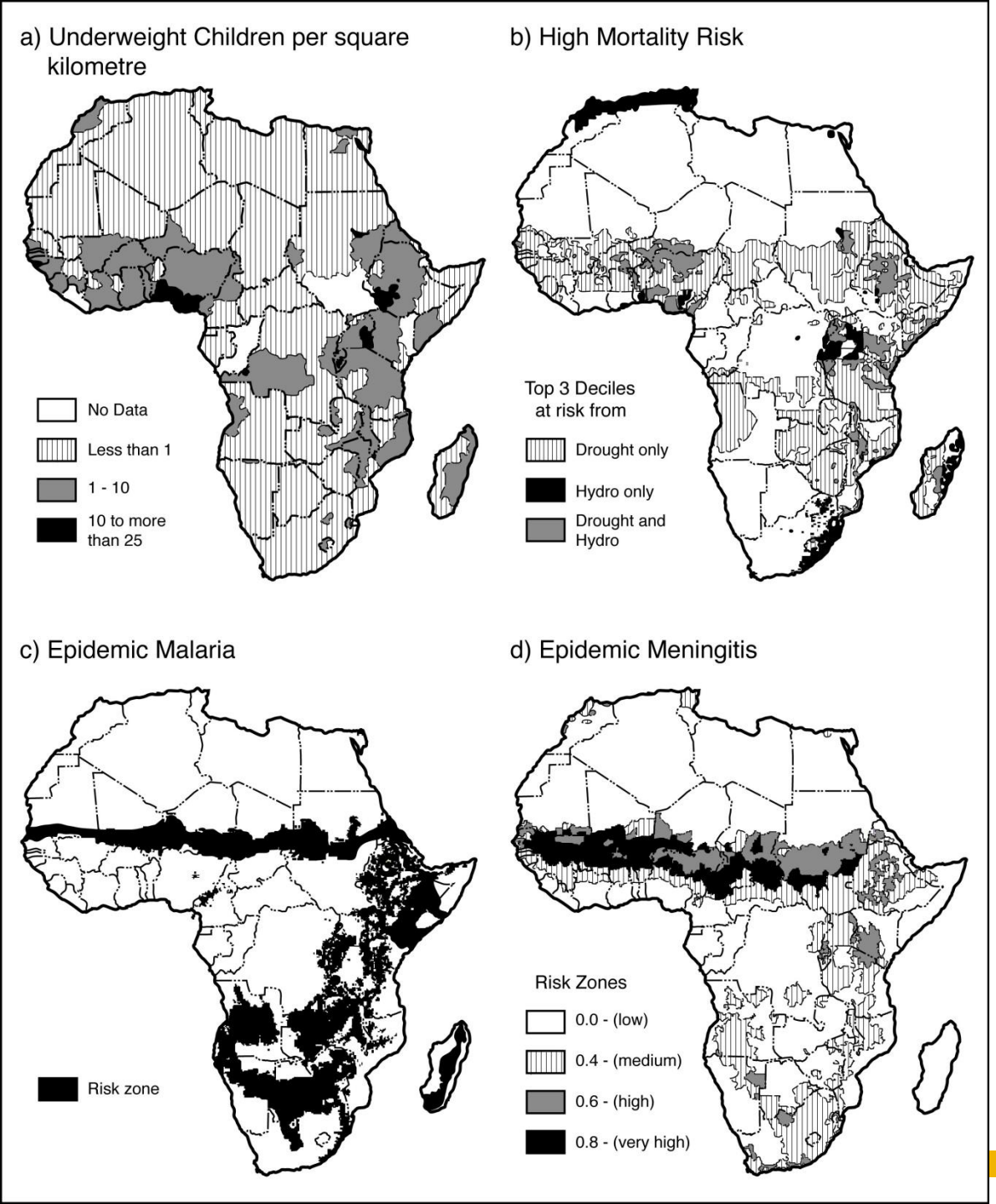
Effects on Nile delta: 10 M people above 1m

(Time 2001)



Vulnerability to climate change can be made worse by the presence of other stresses:

Multiple stresses in Africa (Ch 9)

UNEP

Developing countries are the most vulnerable to climate change (from IPCC TAR)

- **Impacts are worse** - already more flood and drought prone and a large share of the economy is in climate sensitive sectors
- **Lower capacity to adapt** because of a lack of financial, institutional and technological capacity and access to knowledge
- **Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons within countries**, exacerbating inequities in health status and access to adequate food, clean water and other resources.
- **Net market sector effects are expected to be negative in most developing countries**

Regions most affected

- The Arctic
- Sub-Saharan Africa
- Small islands
- Large megadeltas

WMO

UNEP

In all regions, there are some areas and communities which are particularly vulnerable

- The poor
- Young children
- The elderly

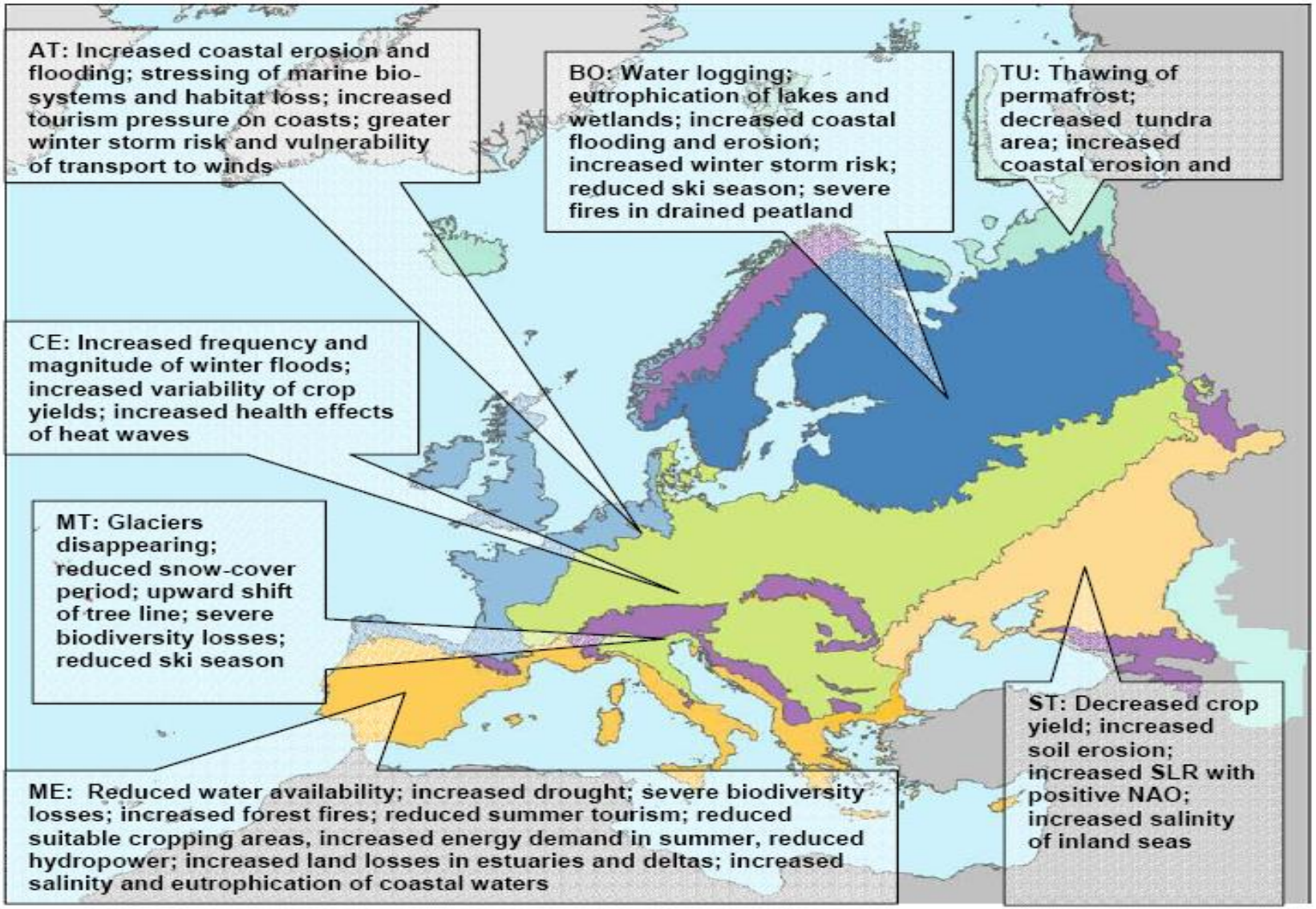


Figure 12.3: *Key vulnerabilities of European systems and sectors to climate change during the 21st century for the main biogeographic regions of Europe (EEA 2004a): TU (Tundra, pale turquoise); BO (Boreal, dark blue); AT (Atlantic, light blue); CE (Central, green [includes the Pannonian Region]); MT (Mountains, purple); ME (Mediterranean, orange [includes the Black Sea region]); ST (Steppe, cream); SLR (sea-level raise); NAO (North Atlantic Oscillation).*

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.

WMO

UNEP

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.**

WMO

UNEP

Terrestrial Ecosystems in Europe

- Greatest impacts on
  - –arctic regions
  - –moisture-limited ecosystems of southern and eastern Europe
  - –mediterranean

WMO

UNEP

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.**

Key Vulnerabilities

WMO

UNEP

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 km^2 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)

Agarwal et al., 1999

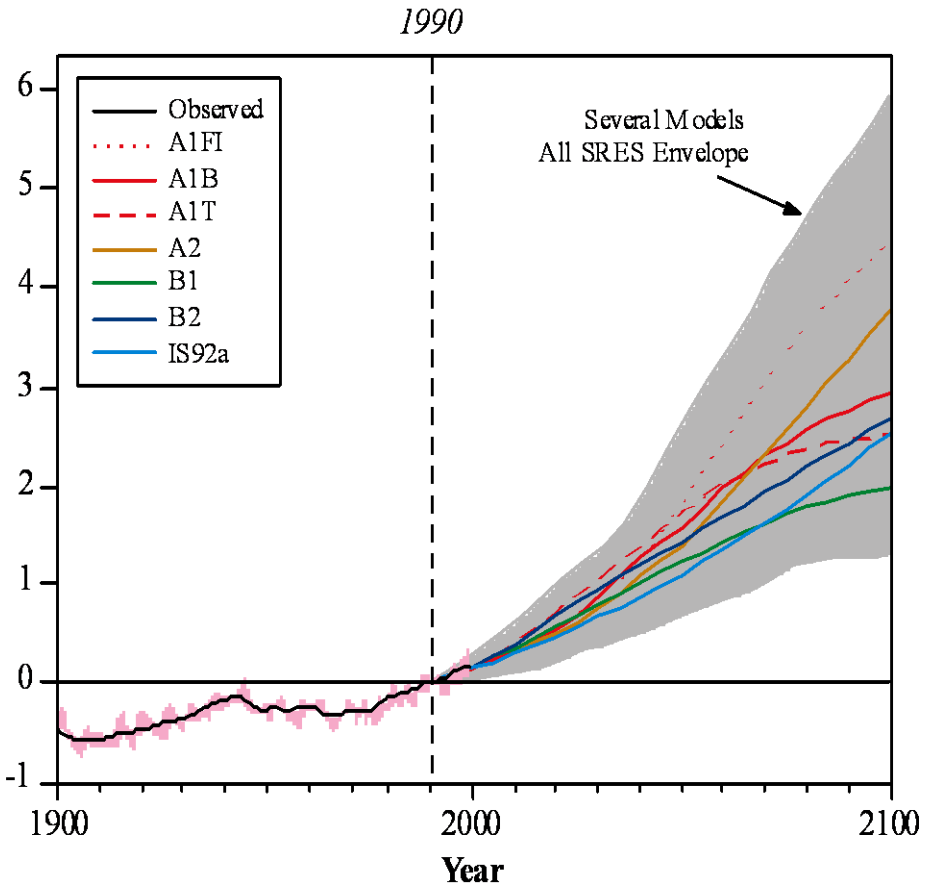
Adaptation will be necessary to address unavoidable impacts

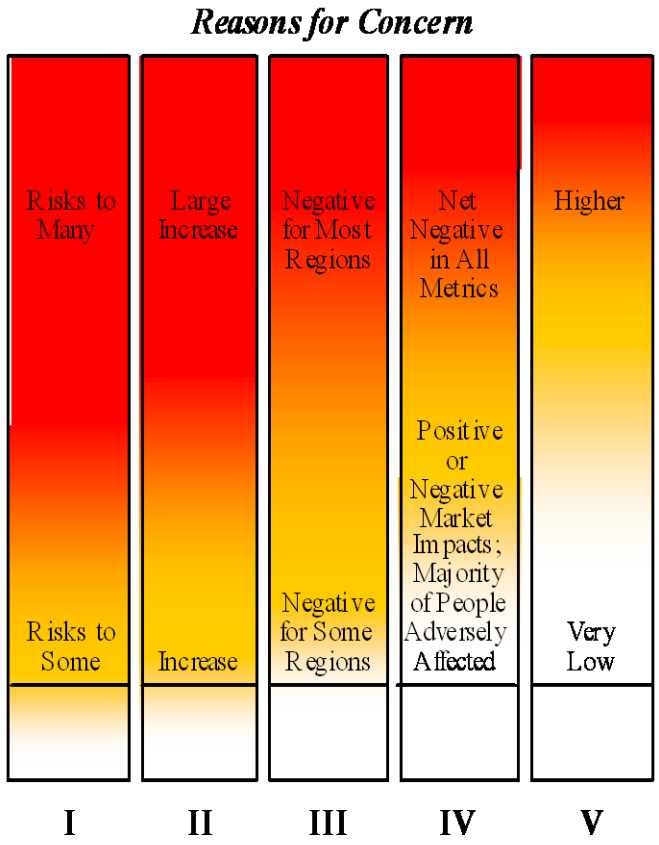
Adaptation/Mitigation

(not verbatim)

- Some adaptation is occurring now, faces limitations and barriers
- Other stresses can exacerbate vulnerability
- Vulnerability depends also on development paths
- Sustainable development can reduce vulnerability
- Mitigation can reduce, delay or avoid impacts

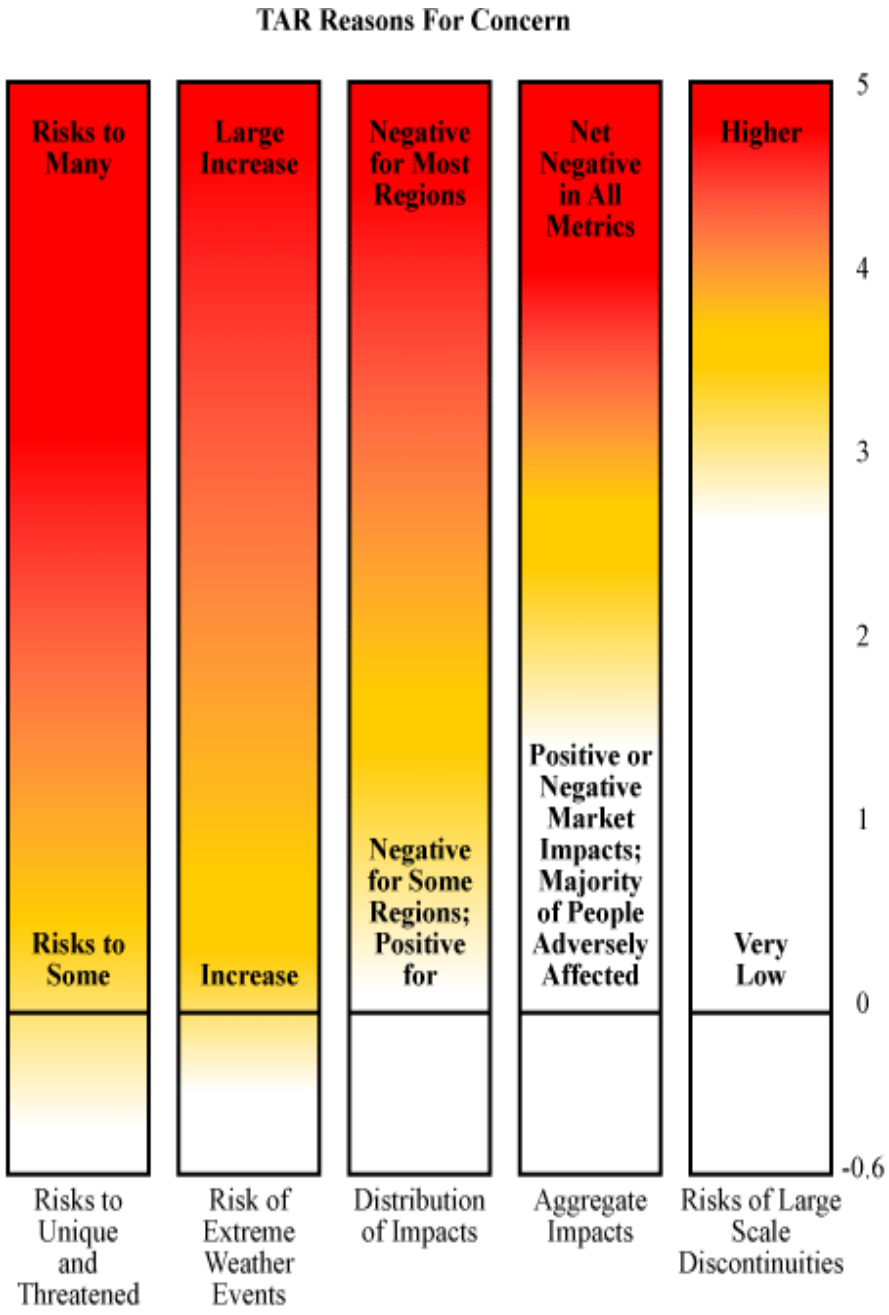
Reasons for Concern

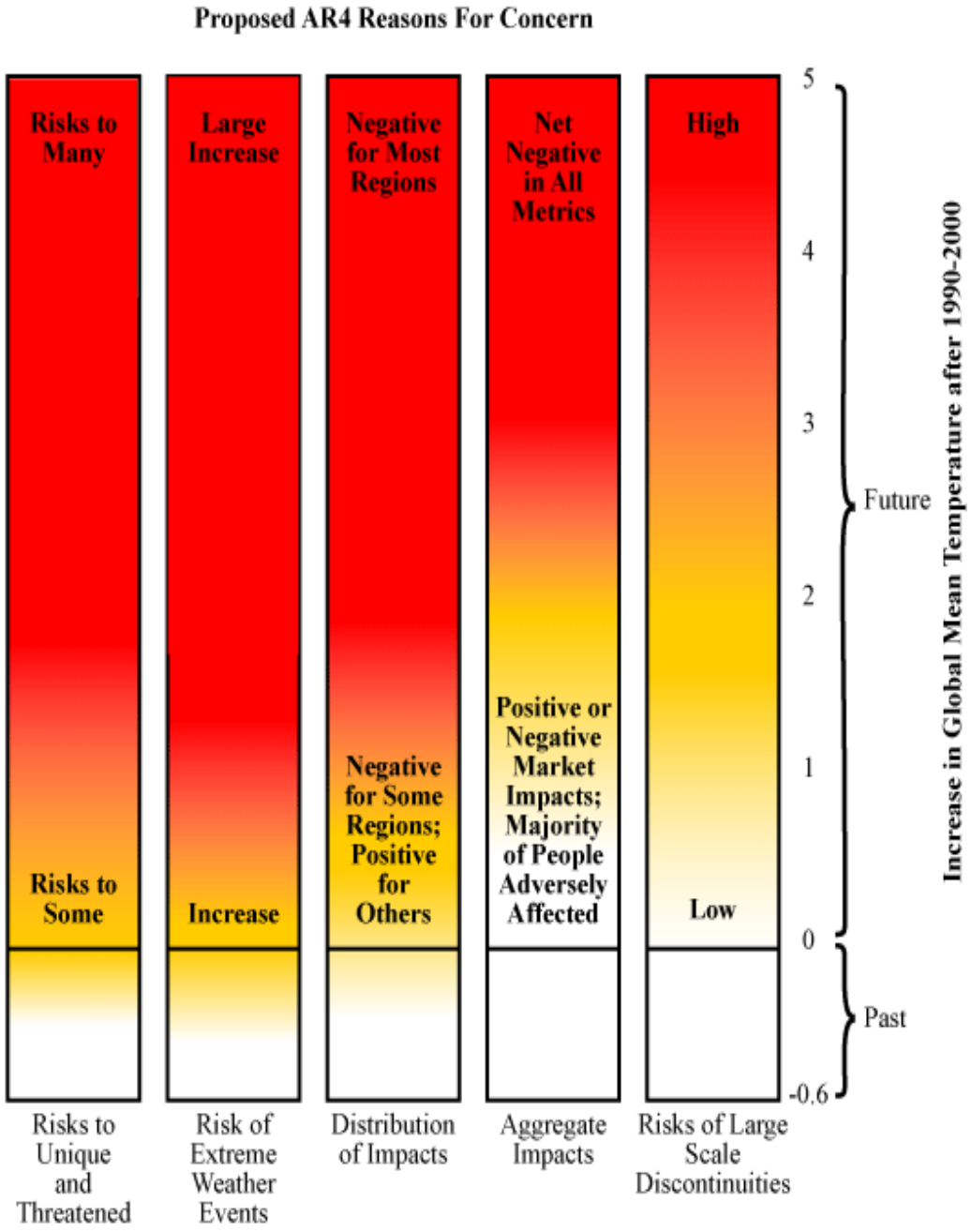




I Risks to unique and threatened systems
II Risks from extreme climate events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from large-scale discontinuities

Source: IPCC TAR WG2 (2001)


TAR Reasons For Concern
Risks to Many
Risks to Some
Large Increase
Increase
Negative for Most Regions
Negative for Some Regions; Positive for
Net Negative in All Metrics
Positive or Negative Market Impacts; Majority of People Adversely Affected
Higher
Very Low
5
4
3
2
1
0
-0.6
Risks to Unique and Threatened
Risk of Extreme Weather Events
Distribution of Impacts
Aggregate Impacts
Risks of Large Scale Discontinuities


Proposed AR4 Reasons For Concern
Risks to Many
Risks to Some
Large Increase
Increase
Negative for Most Regions
Negative for Some Regions; Positive for Others
Net Negative in All Metrics
Positive or Negative Market Impacts; Majority of People Adversely Affected
High
Low
5
4
3
2
1
0
-0.6
Future
Past
Increase in Global Mean Temperature after 1990-2000
Risks to Unique and Threatened
Risk of Extreme Weather Events
Distribution of Impacts
Aggregate Impacts
Risks of Large Scale Discontinuities

What does IPCC tell us on mitigation?

- WG3: Mitigation

Jean-Pascal van Ypersele
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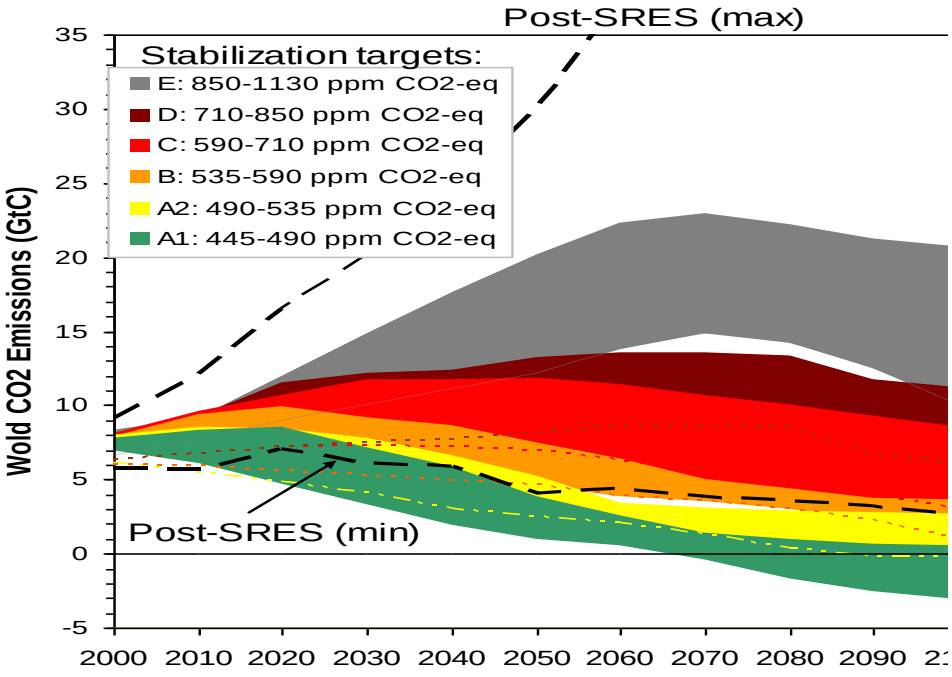
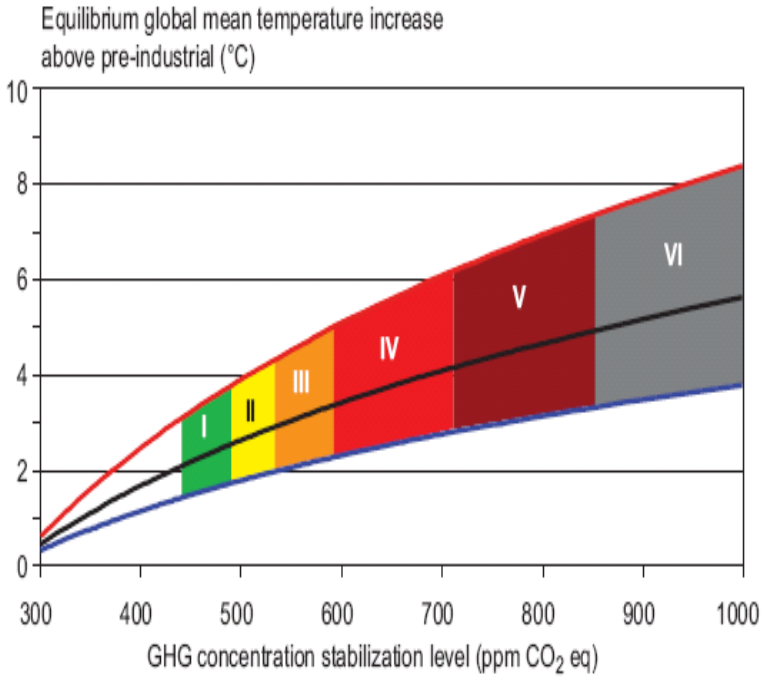
The lower the stabilisation level the earlier global emissions have to go down



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 CO2-eq)	Global Mean temp. increase at equilibrium (°C)	Year CO2 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
A-450 ppm CO_2-eq[b]	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
B-550 ppm CO_2-eq	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
C-650 ppm CO_2-eq	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 CO_2-eq assume a (temporary) overshoot of about 50 ppm (See Den Elzen and Meinshausen, 2006).

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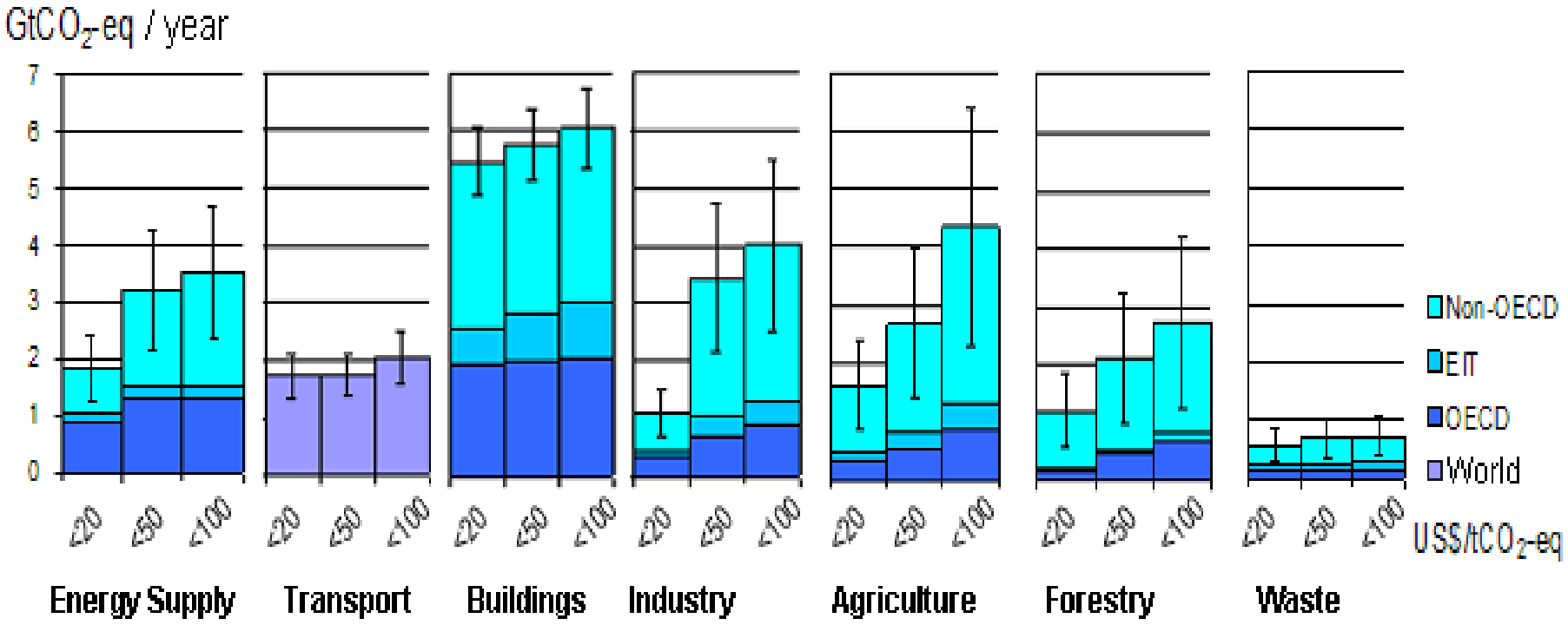
All sectors and regions have the potential to contribute by 2030



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

John Holdren, Past-President of the American Association for the Advancement of Science, now President Obama's science adviser

- ***'We basically have three choices – mitigation, adaptation, and suffering.***
- ***We're going to do some of each. The question is what the mix is going to be.***
- ***The more mitigation we do, the less adaptation will be required, and the less suffering there will be.'***

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Useful links:

- www.ipcc.ch : IPCC
- www.unfccc.int : Climate Convention
- www.climate.be/JCM: interactive climate model
- www.climate.be/vanyp : my slides and other documents

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