Climate in 2053:
The Future in our Hands

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Shaping the Future: The World in 2053, Universiteit Hasselt, 27-5-2013

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

Outline

- **Introduction:**
  - **Climate Change**
  - **What is the IPCC?**

- **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**

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Introduction

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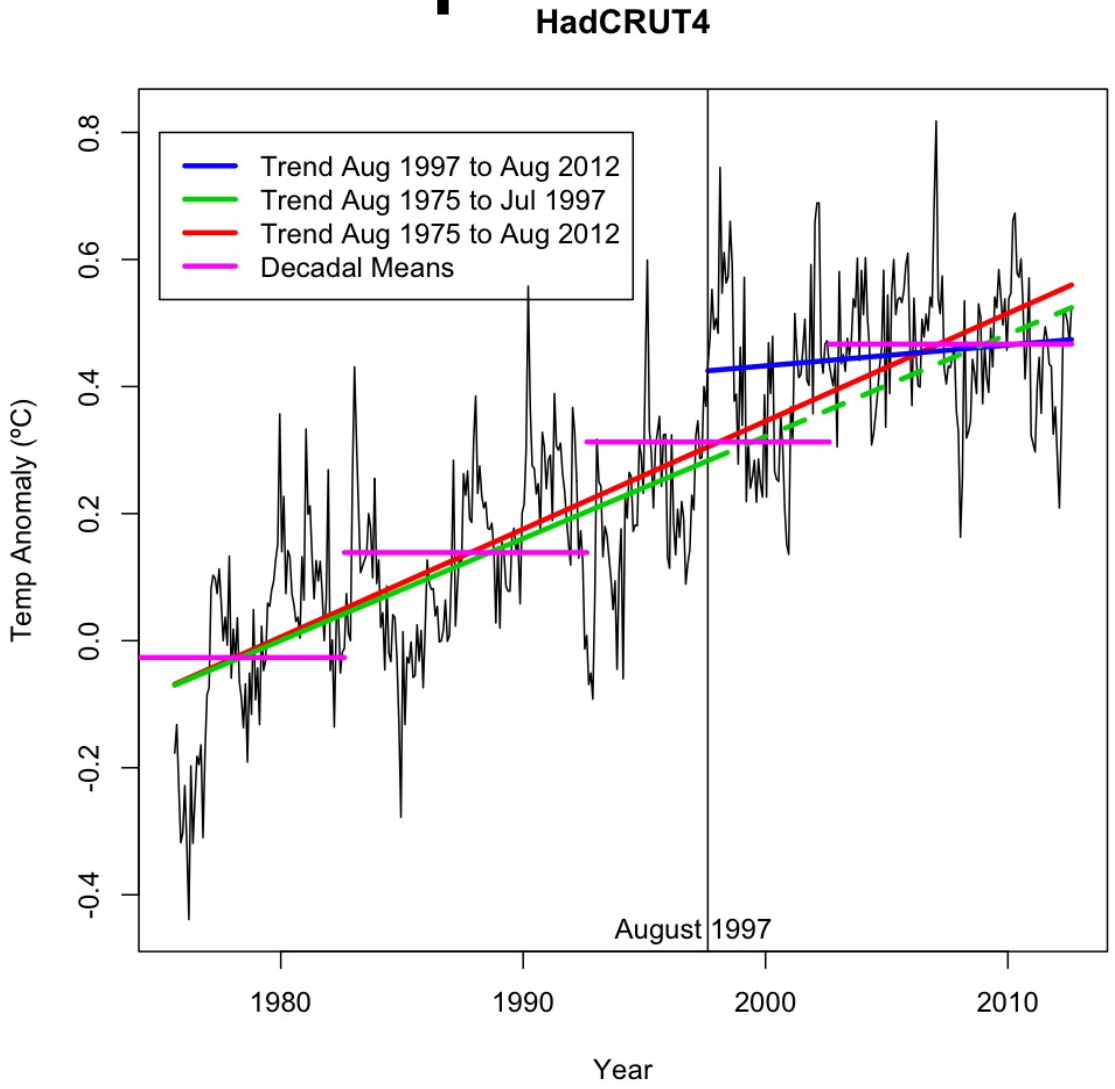
Ce réchauffement se poursuit: chaque décennie est environ 0.15°C plus chaude que la précédente



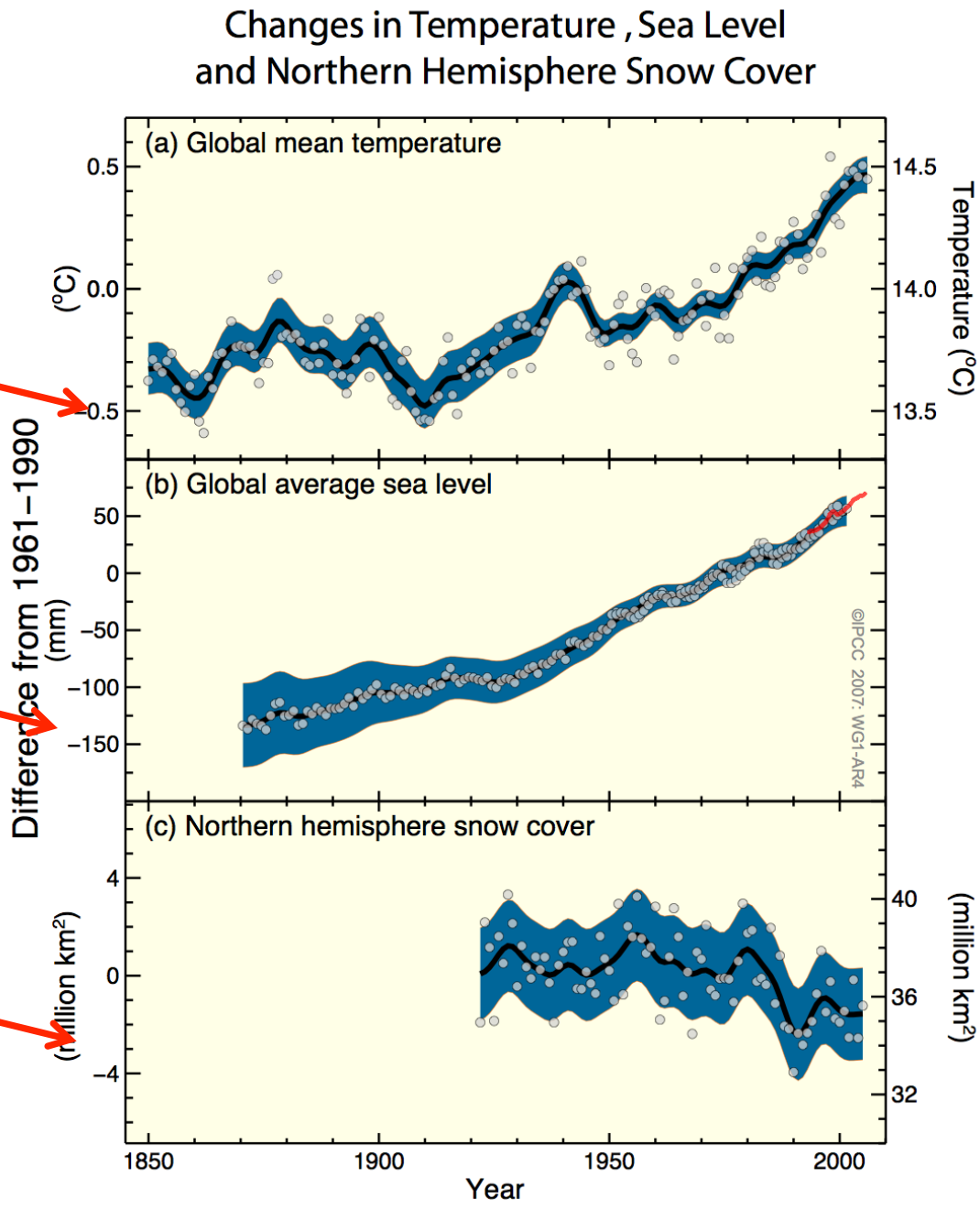
http://www.realclimate.org/index.php/archives/2012/11/short-term-trends-another-proxy-fight/

Warming is Unequivocal

Rising atmospheric temperature

Rising sea level

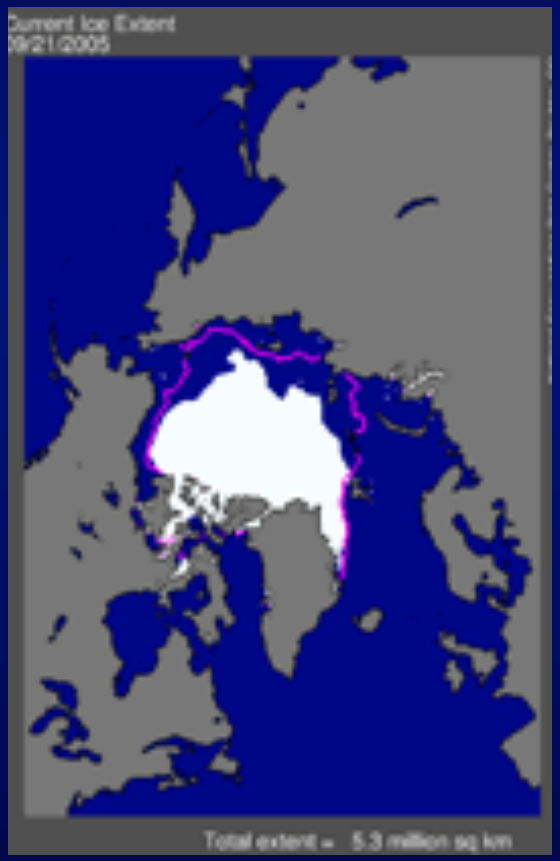
Reductions in NH snow cover



Extension of the Arctic ice cap

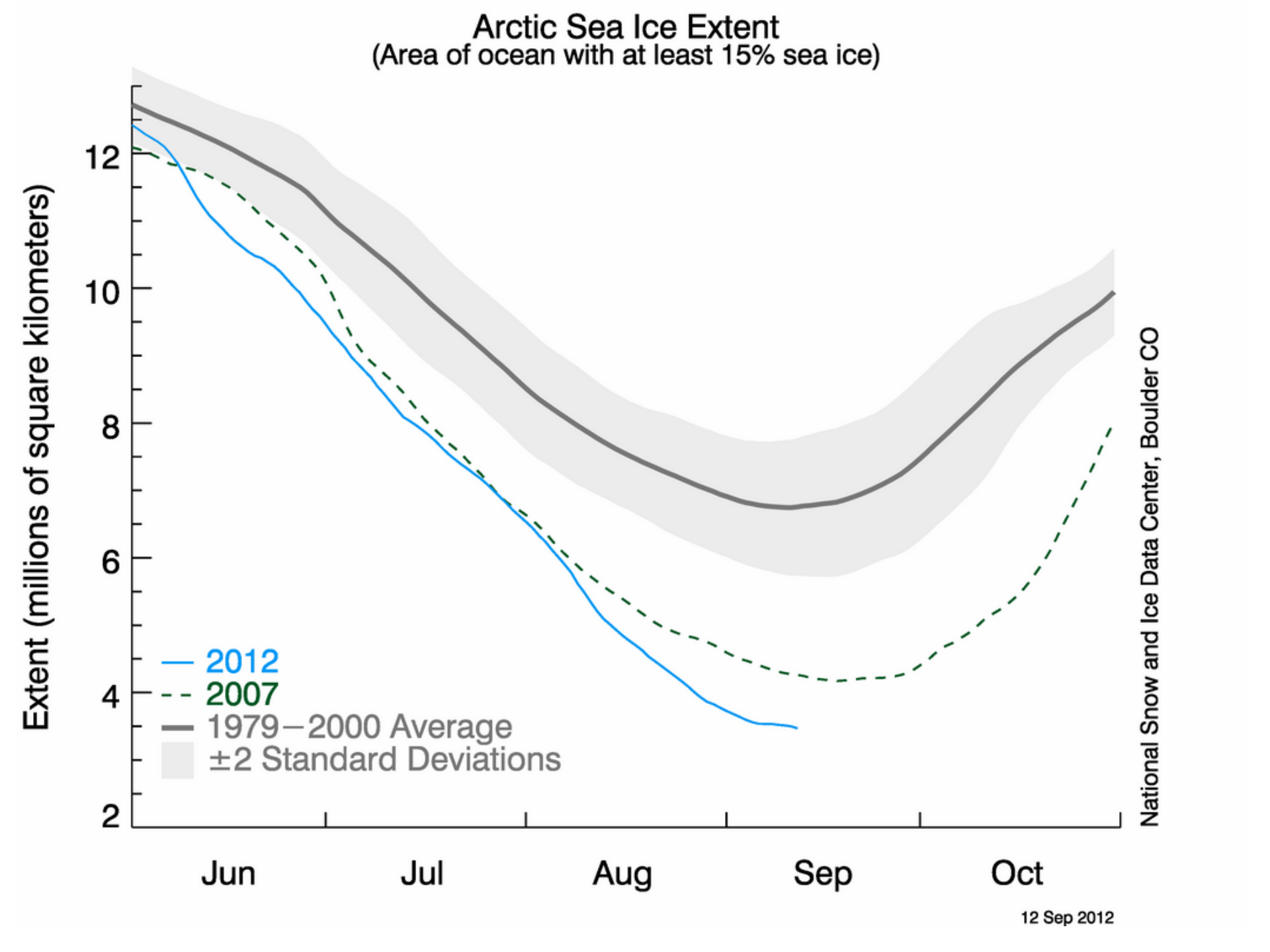
September 1979

September 2005

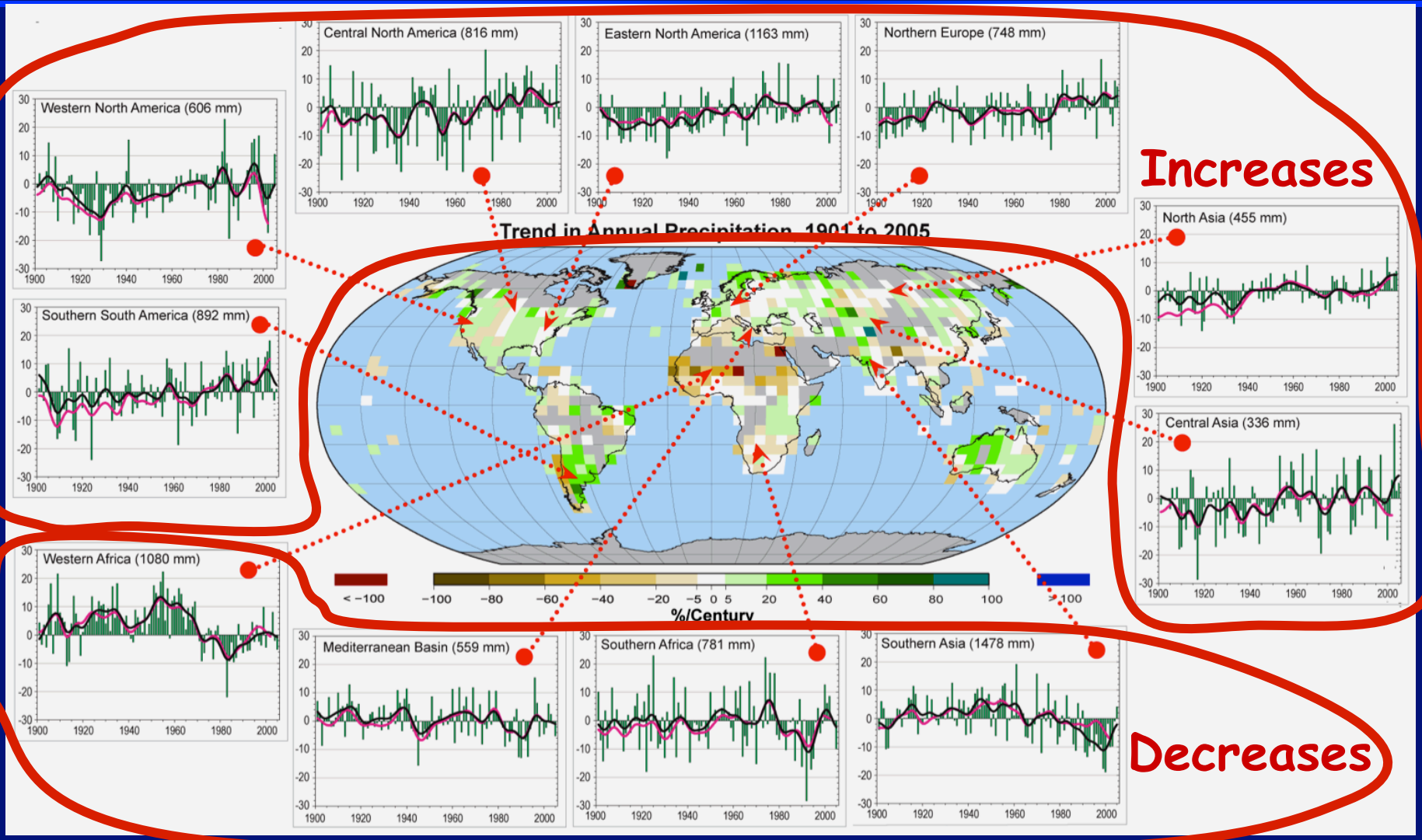


September 2007

The pink line indicates the average ice cap extension since 1979

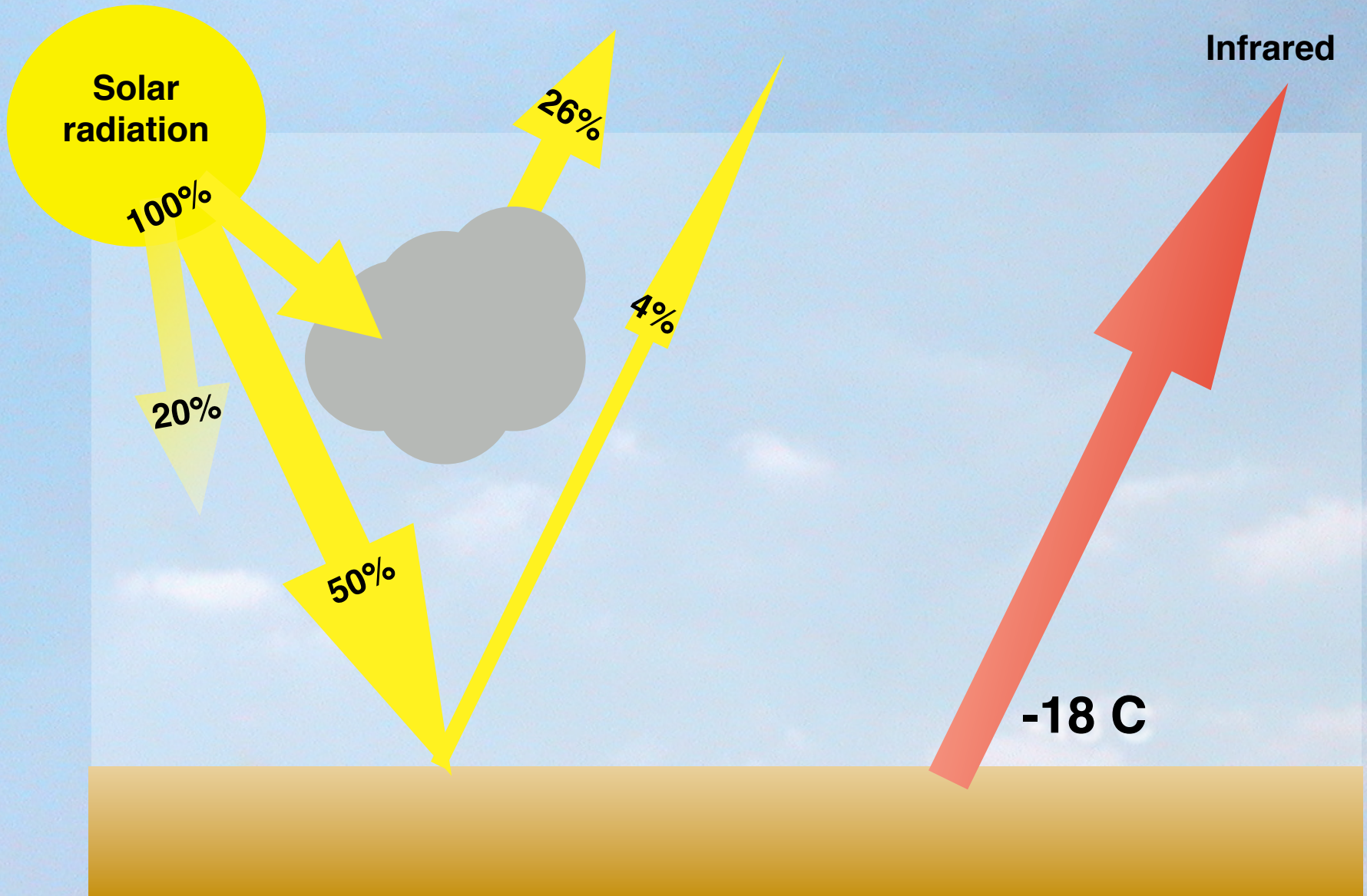

Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)
Extent (millions of square kilometers)
12
10
8
6
4
2
2012
2007
1979–2000 Average
±2 Standard Deviations
Jun
Jul
Aug
Sep
Oct
National Snow and Ice Data Center, Boulder CO
12 Sep 2012

Land precipitation is changing significantly over broad areas

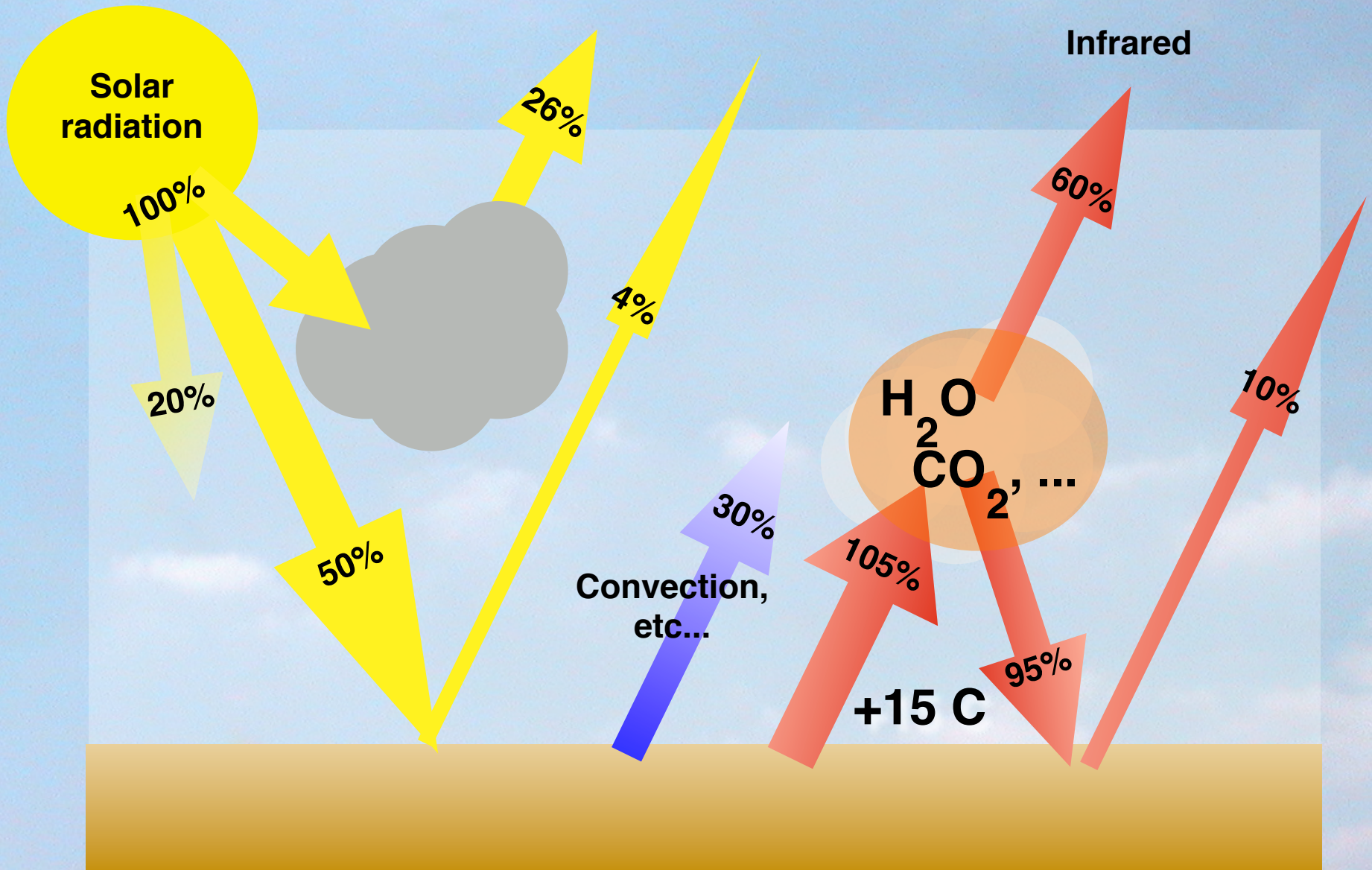


Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

Energy cycle without greenhouse effect



Energy cycle *with* greenhouse effect



Quantité de CO_2 émise par unité d'énergie consommée

Combustibles	kg CO_2 / Gigajoule
Charbon	95
Gasoil	74
Essence	69
LPG	63
Gaz naturel	56

Source : VITO (1991)

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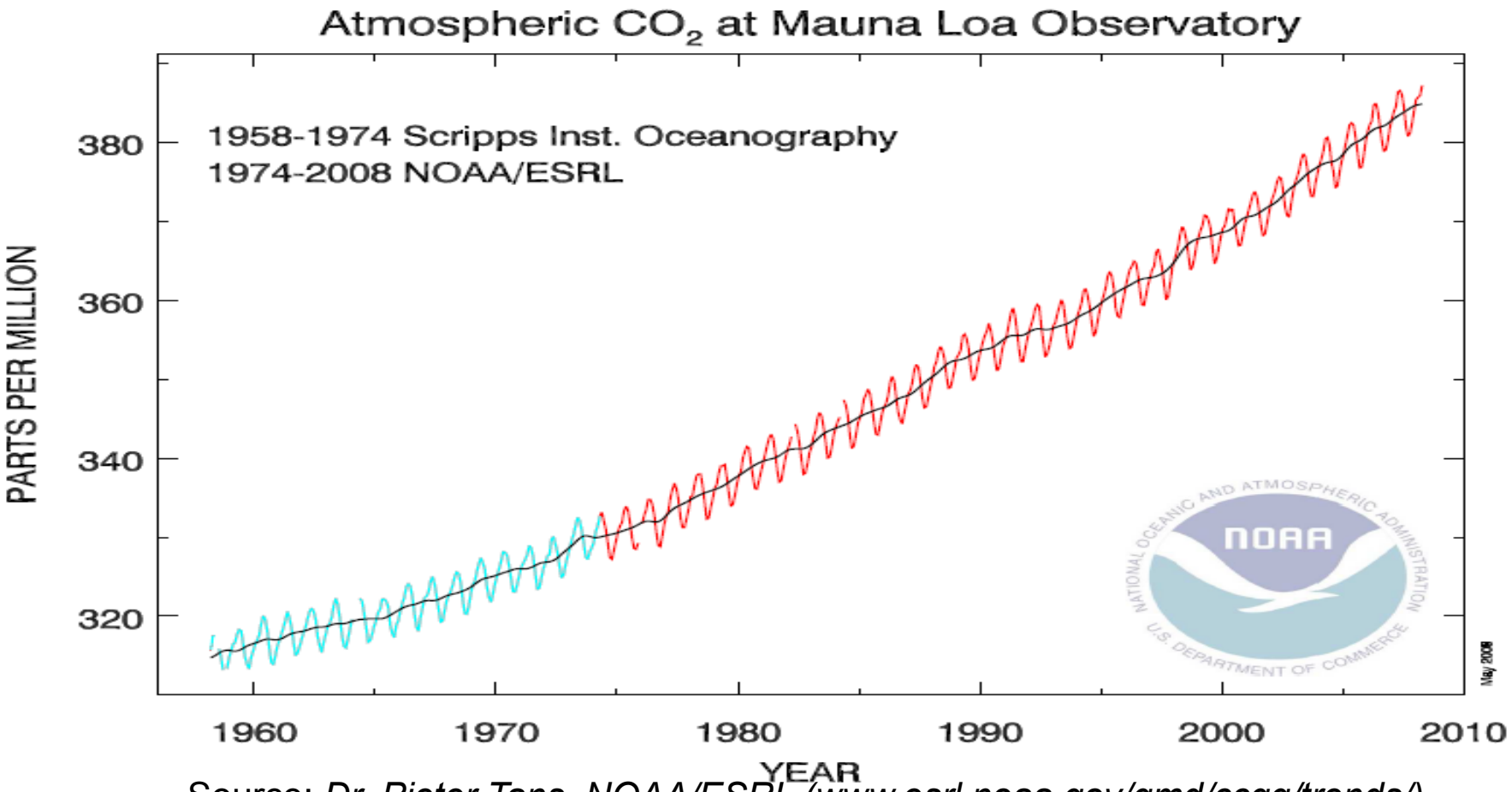
CO_2 concentration measured at Mauna Loa (3400 m)



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

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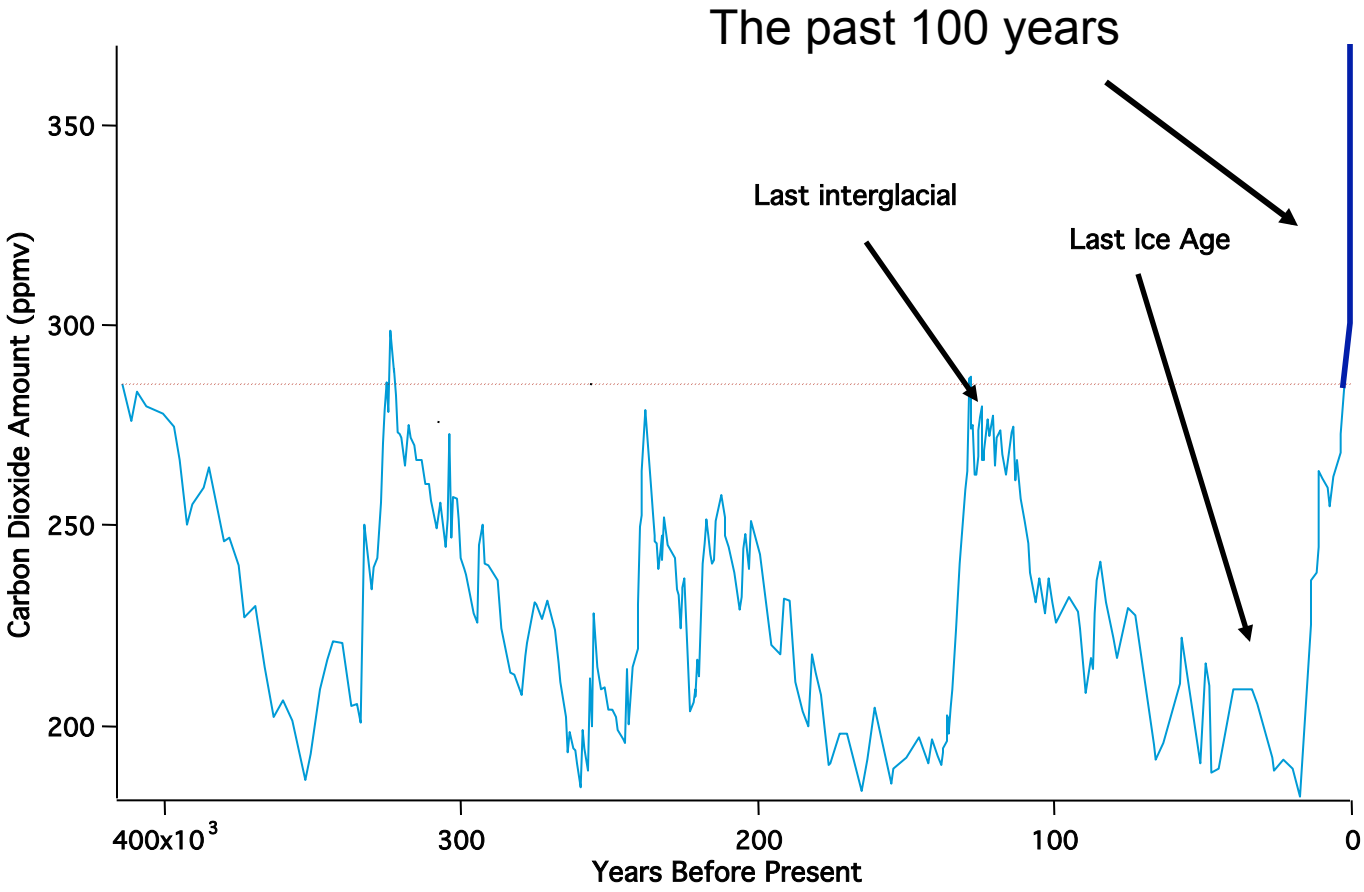
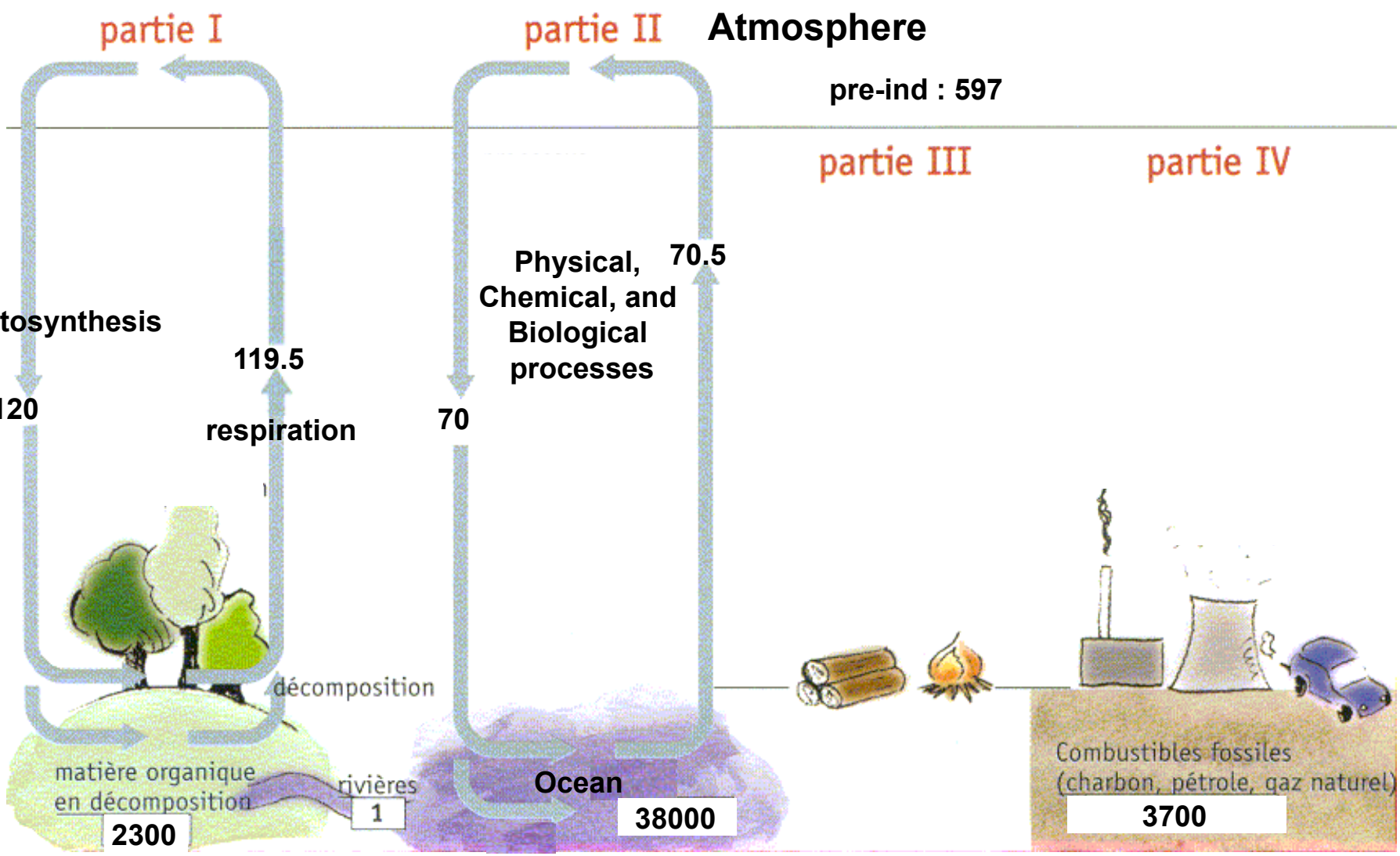
Some information about carbon dioxide changes through four past ice ages (from ice cores), and in the modern era (from global data)



Ice ages are 'forced' by earth's orbital clock….

It is well established that there is more carbon dioxide in the atmosphere today than there has been in at least 650,000 years. **(Figure by S. Solomon)**

Carbon cycle



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

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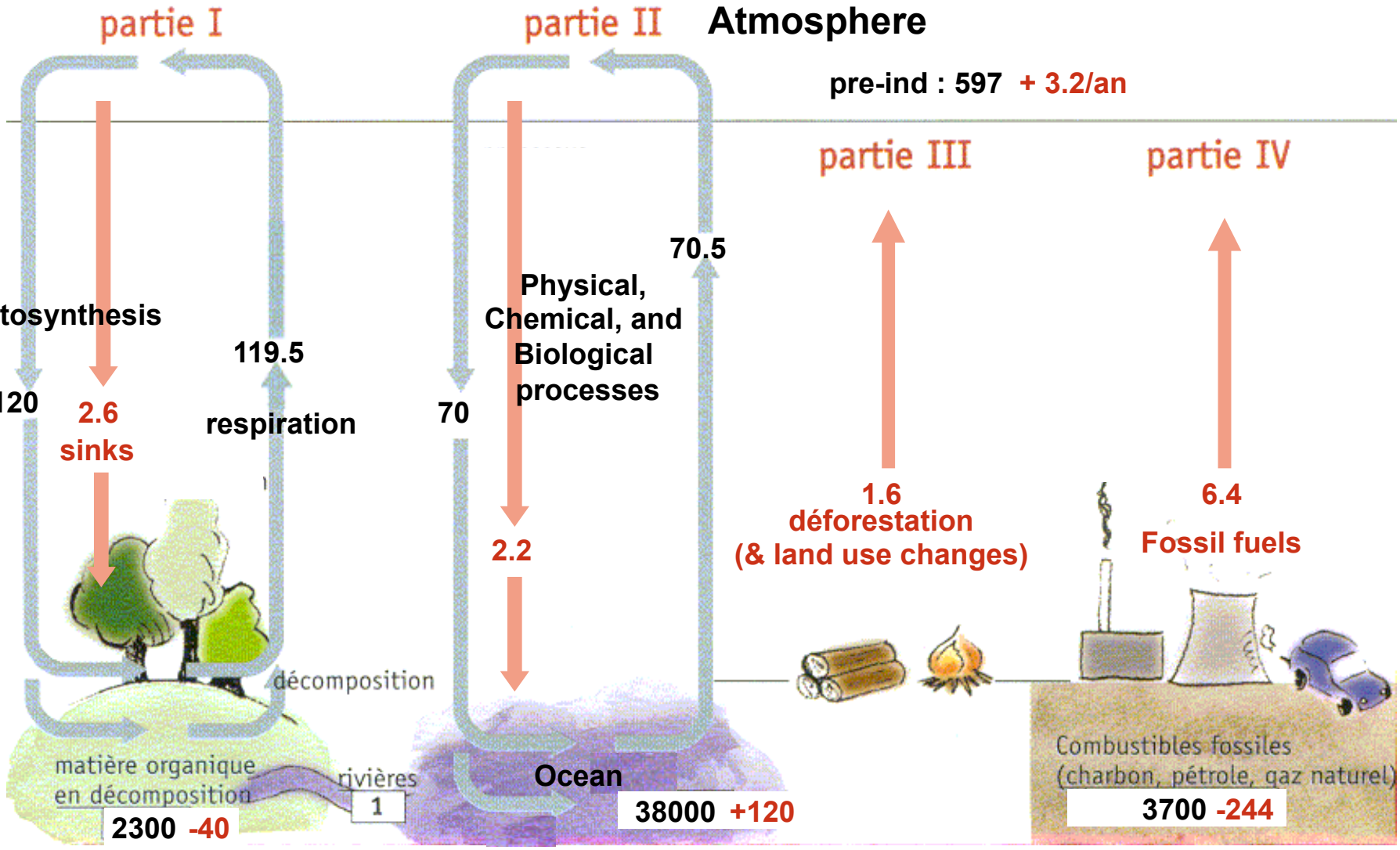
Carbon cycle



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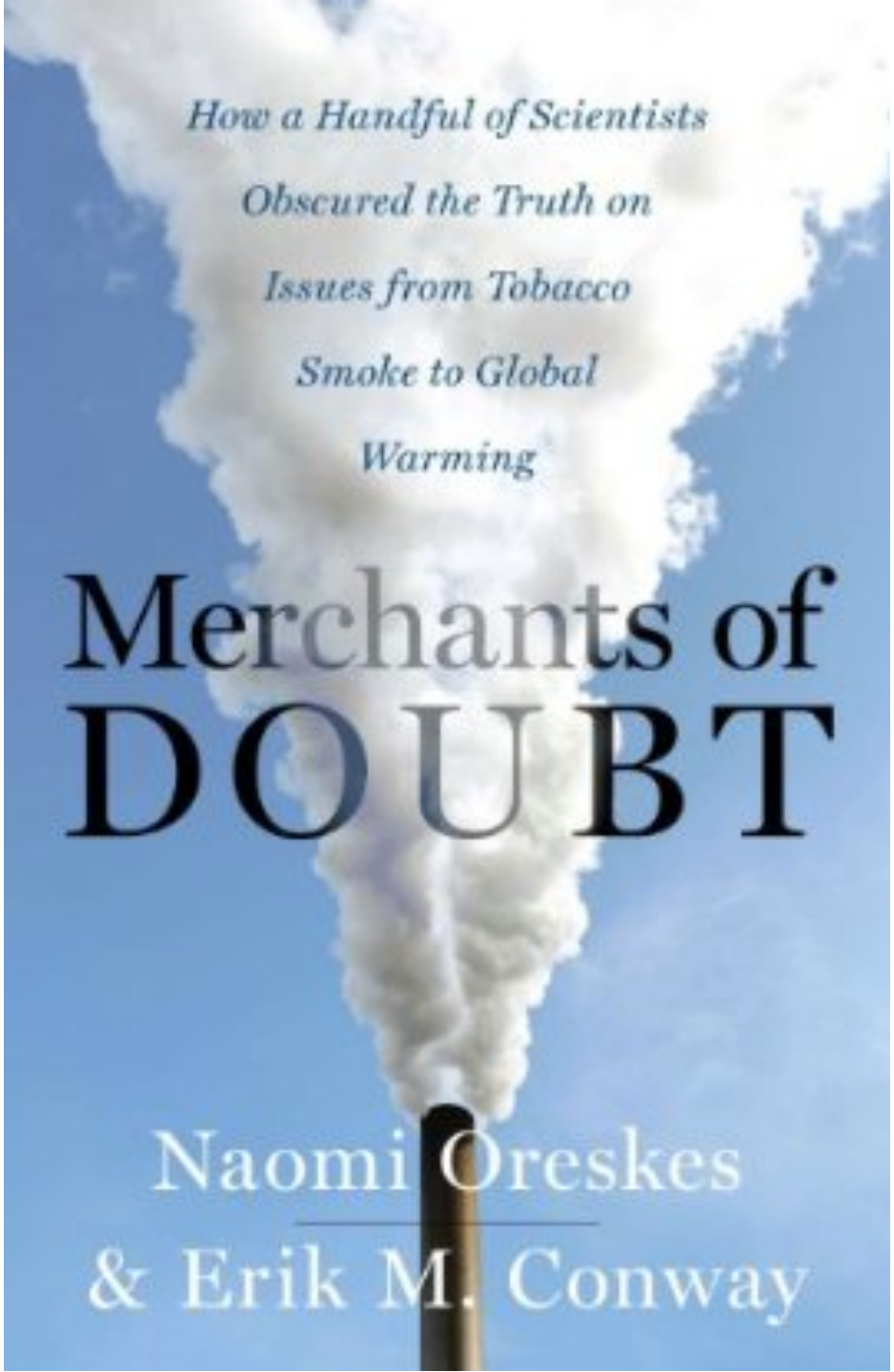
How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming
Merchants of DOUBT
Naomi Oreskes
& Erik M. Conway

How does IPCC work?

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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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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

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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

IPCC Working Group I: climatology

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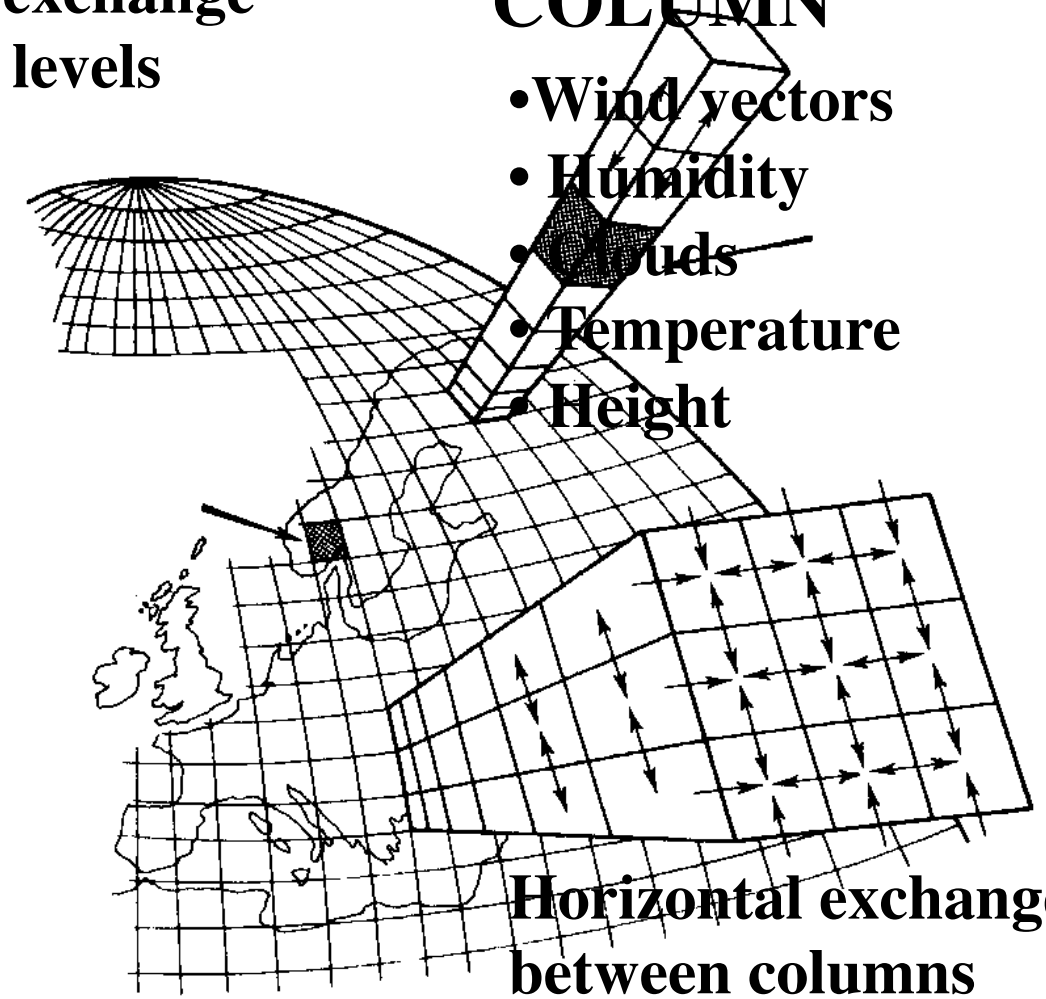
A climate model:

Vertical exchange between levels

IN THE ATMOSPHERIC COLUMN

- Wind vectors
- Humidity
- Clouds
- Temperature
- Height



AT THE SURFACE

- Ground temperature
- Water and energy fluxes

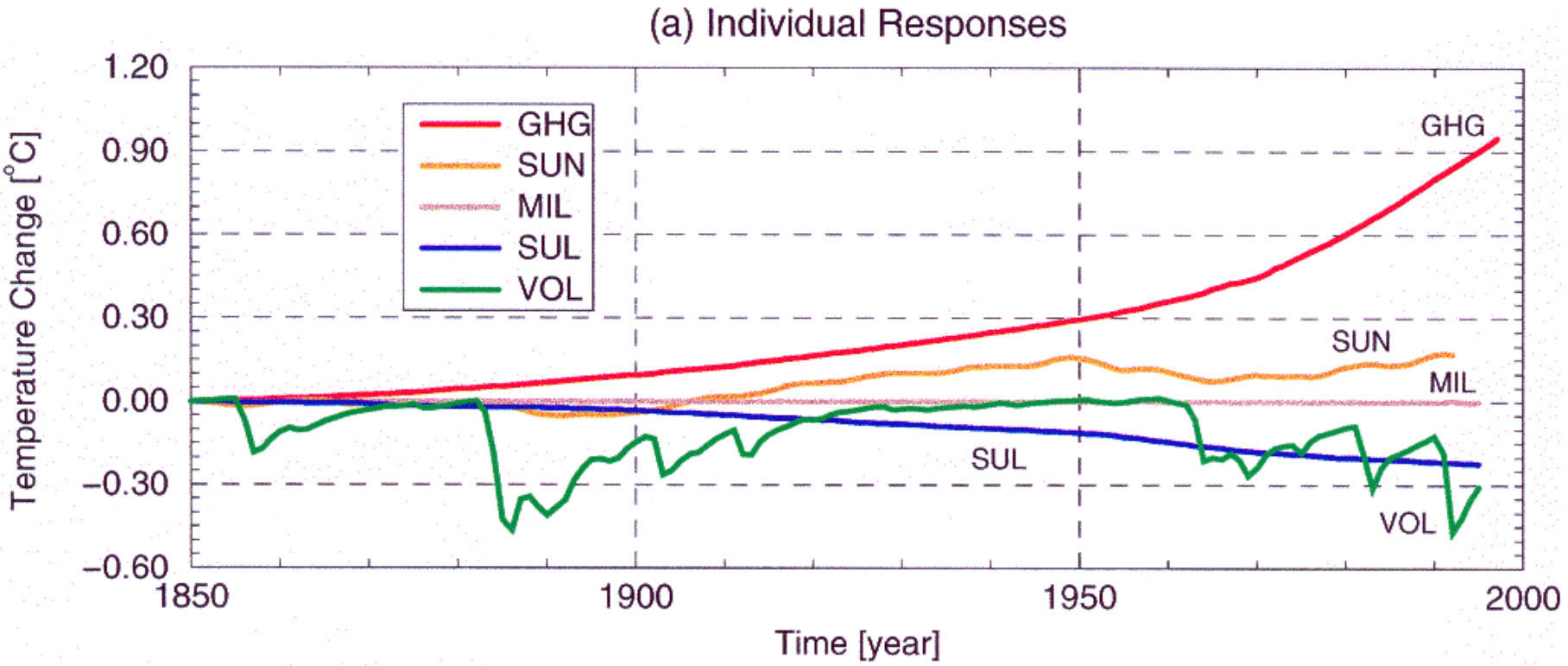
Horizontal exchange between columns

Time step ~ 30 minutes

Grid spacing ~ 3°x 3°

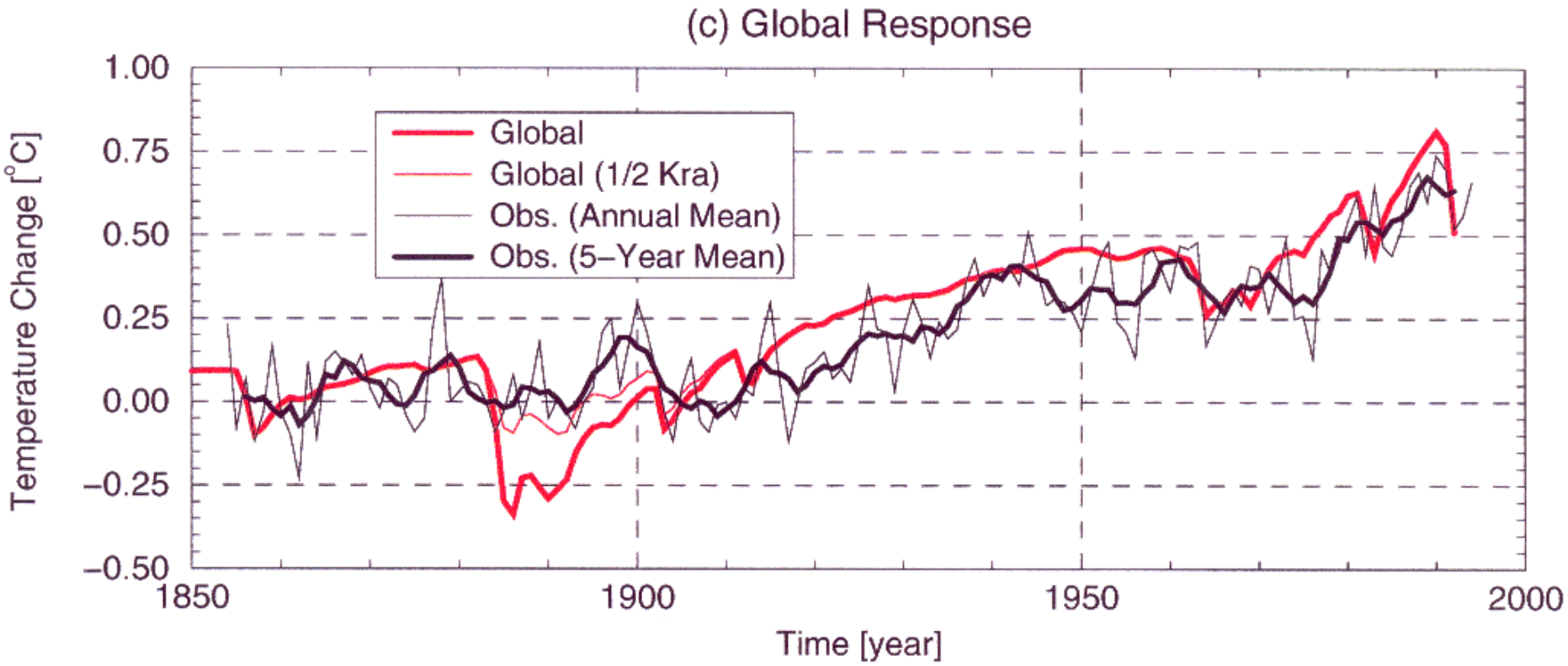
Source: McGuffie & Henderson-Sellers (1997)

Separate effect of different factors in the 2-dimensional climate model at UCL



Bertrand et al. 2001

Combined effect of all factors in the 2-dimensional climate model at UCL

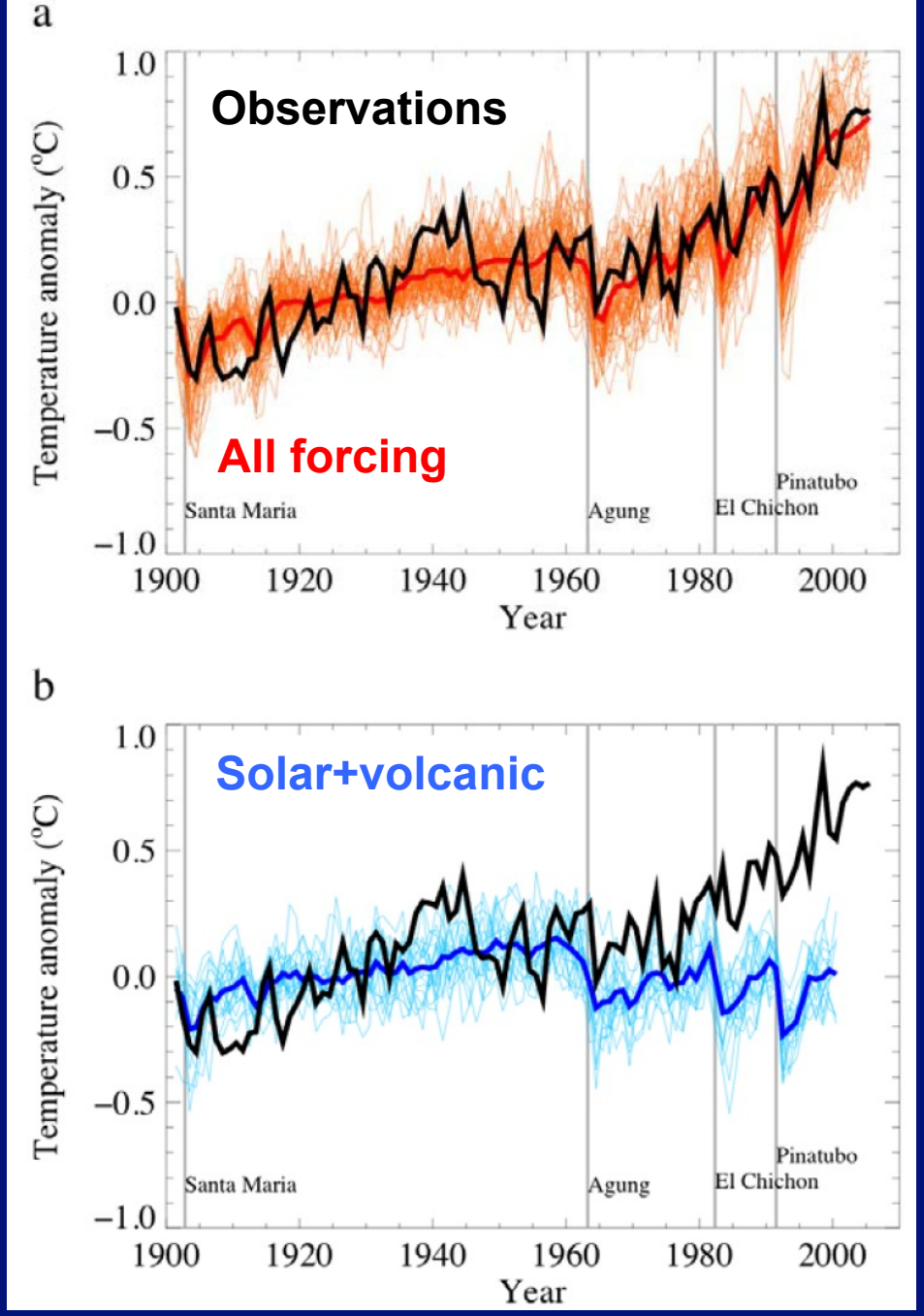


Bertrand et al. 2001

Attribution

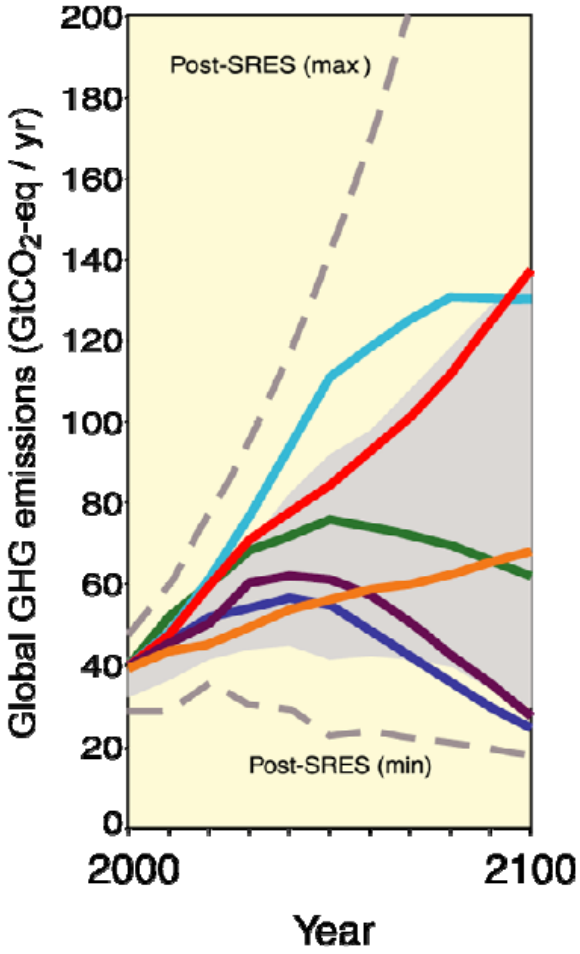
Are observed changes consistent with expected responses to natural forcings?

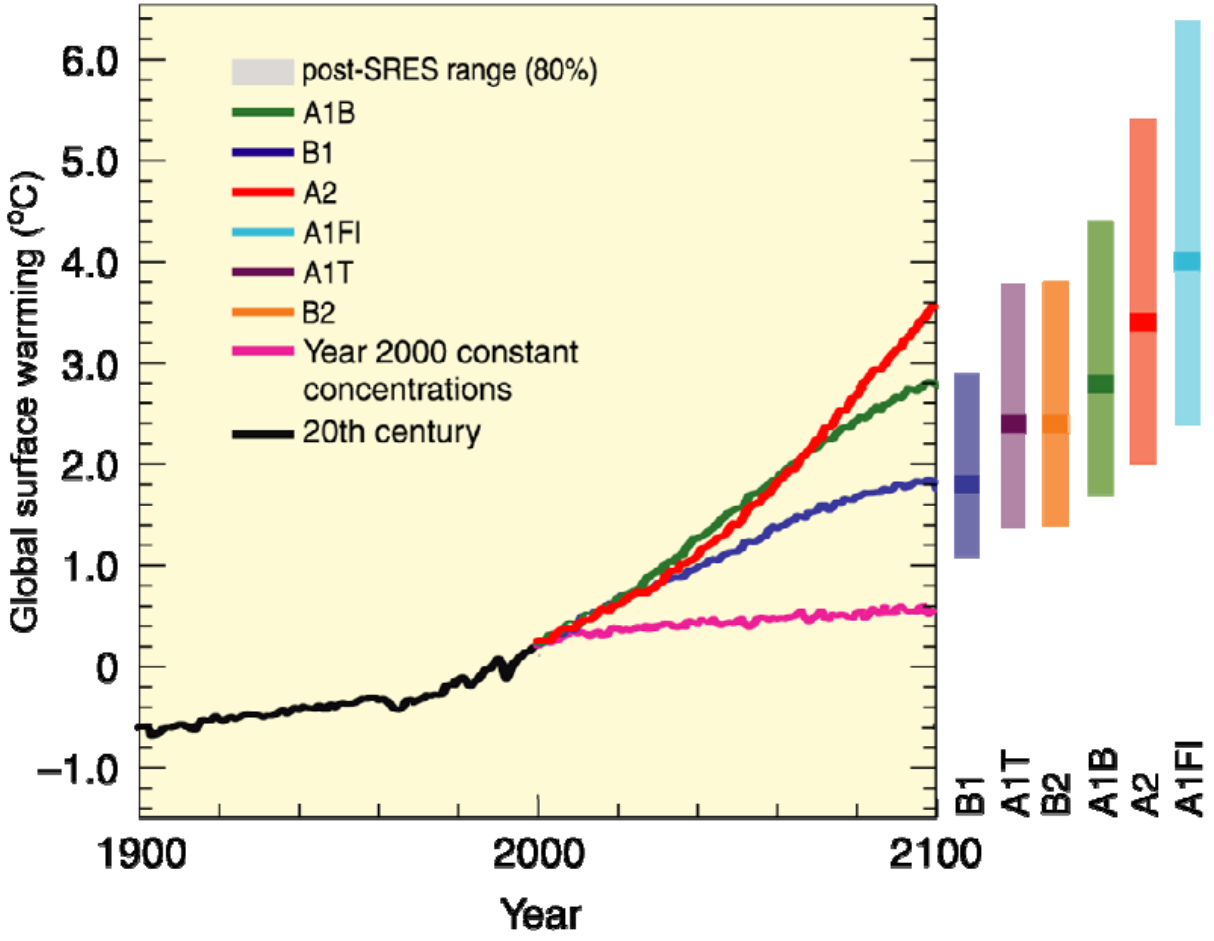
IPCC (2007):
"Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases."



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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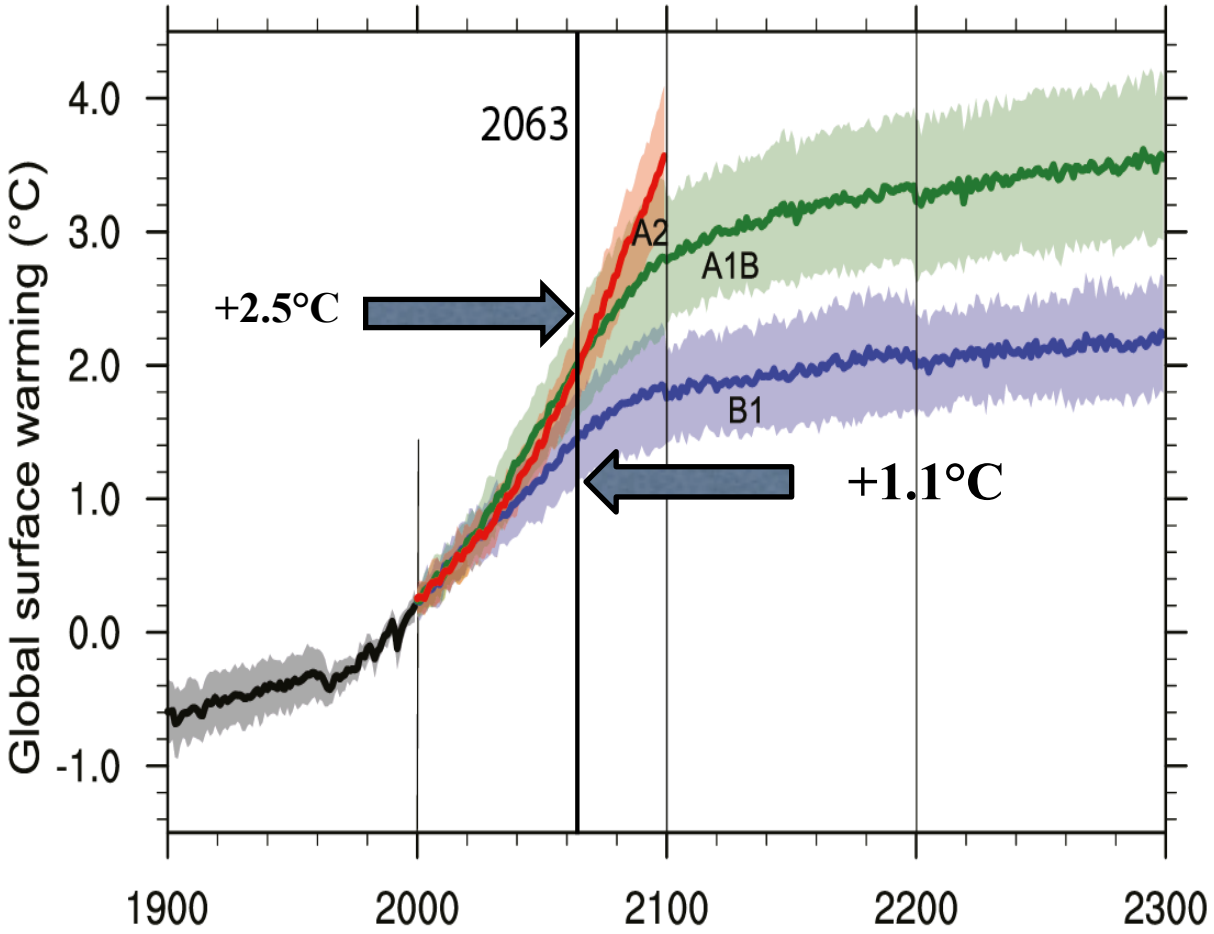
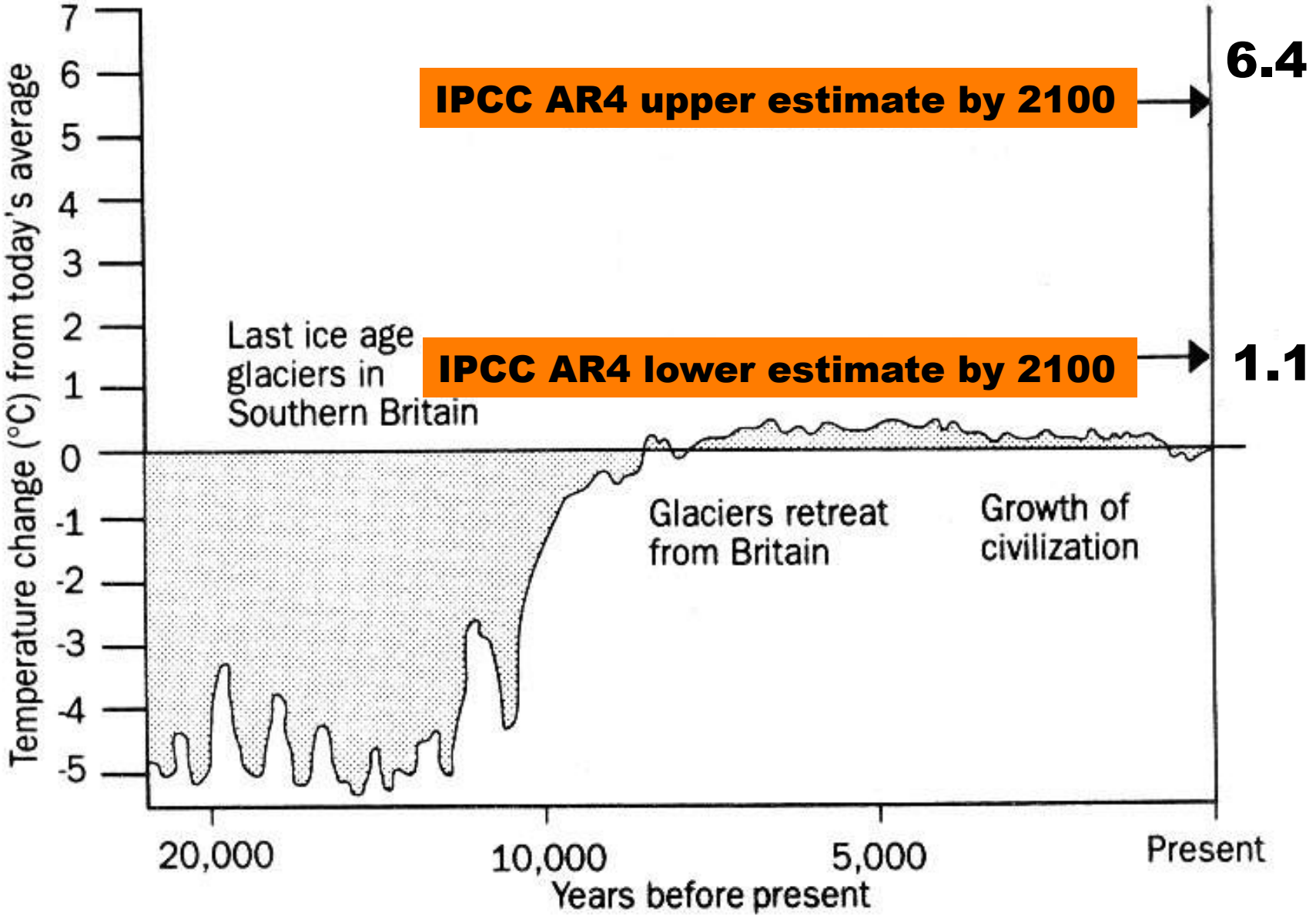
2063: Température moyenne planétaire en surface



NB: écart par rapport à la moyenne 1980-1999

Remarque : la gamme de scenarios ne couvre pas toutes les possibilités envisageables.

Source: IPCC, 4e rapport d'évaluation, 2007



Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July1988

18-20000 years ago (Last Glacial Maximum)

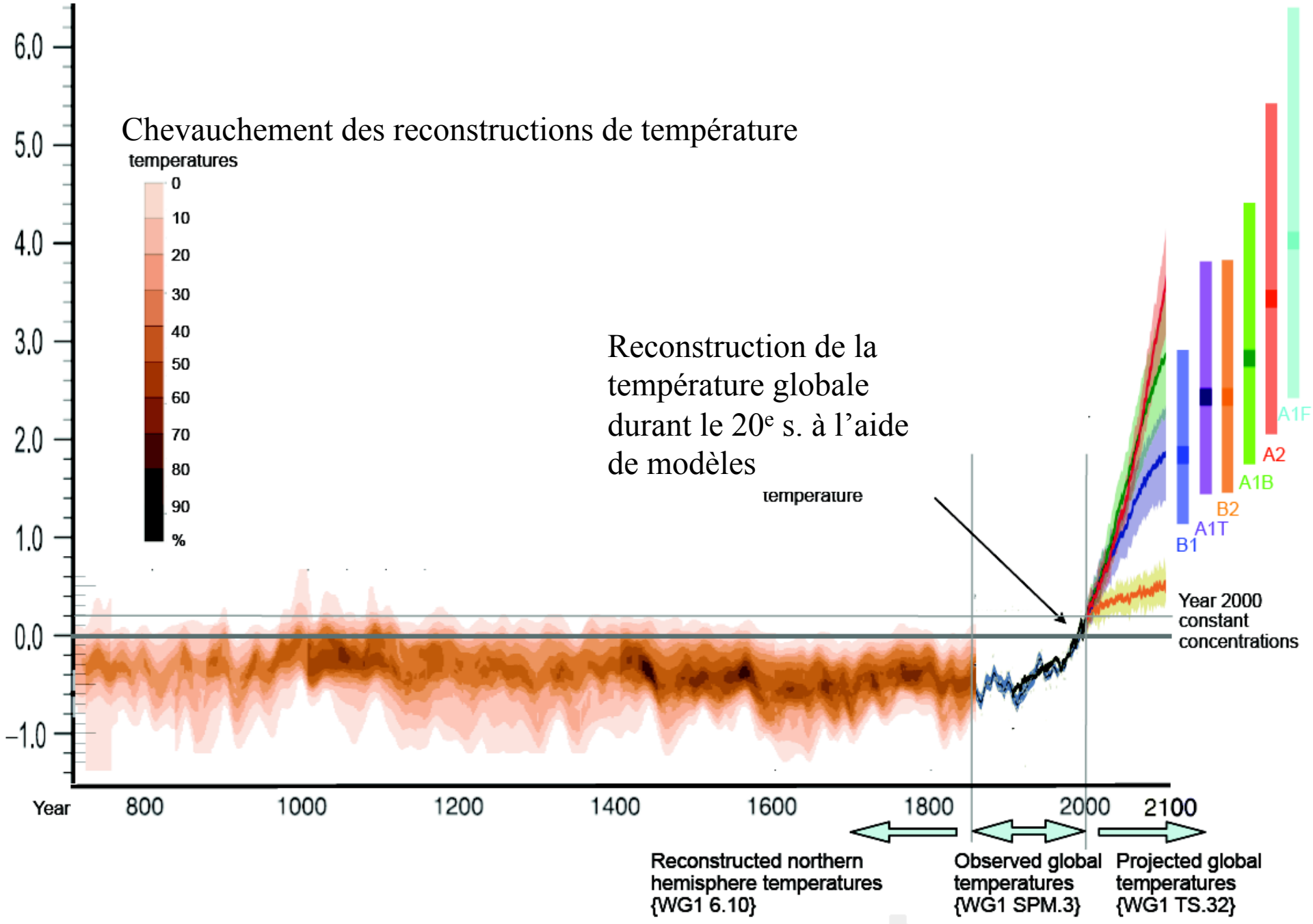
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

Today, with +4-5°C globally

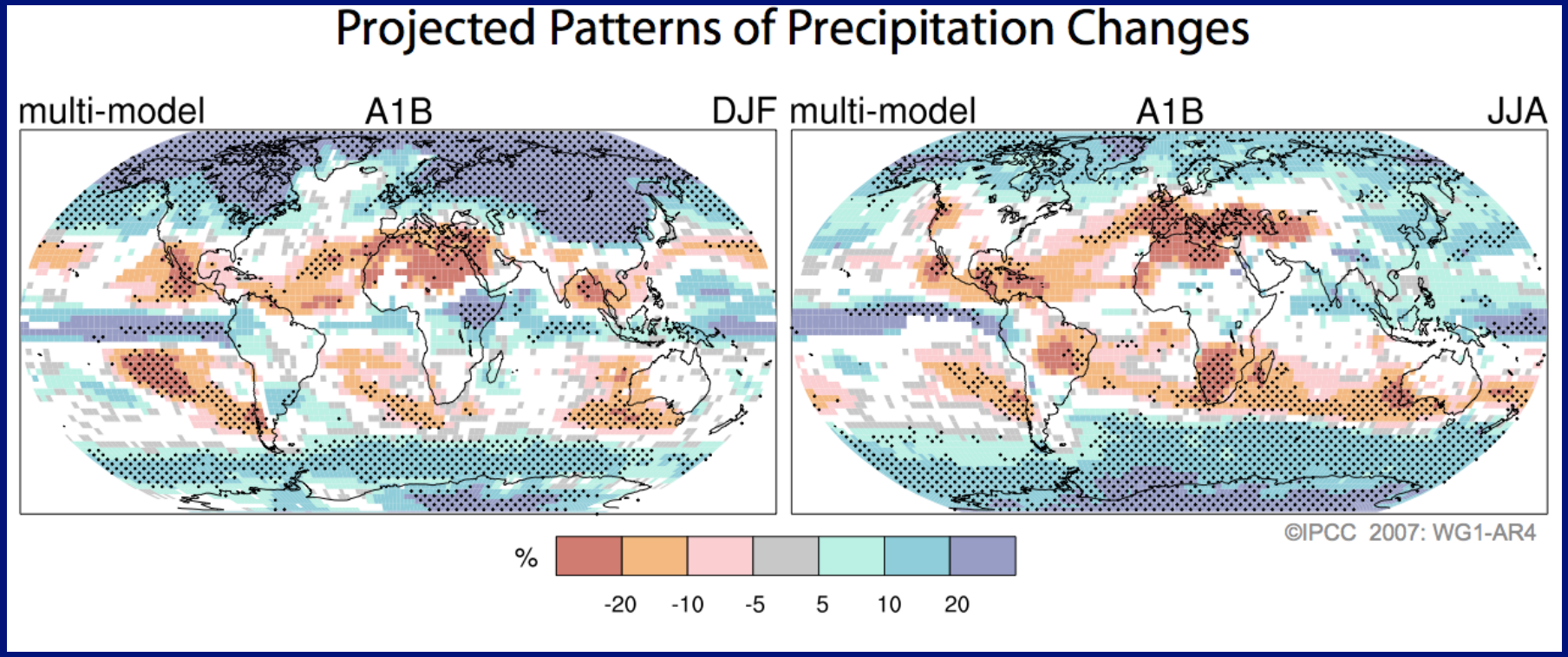
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

Anomalies de la température en surface par rapport à 1980-1999

Source: GIEC, 4AR

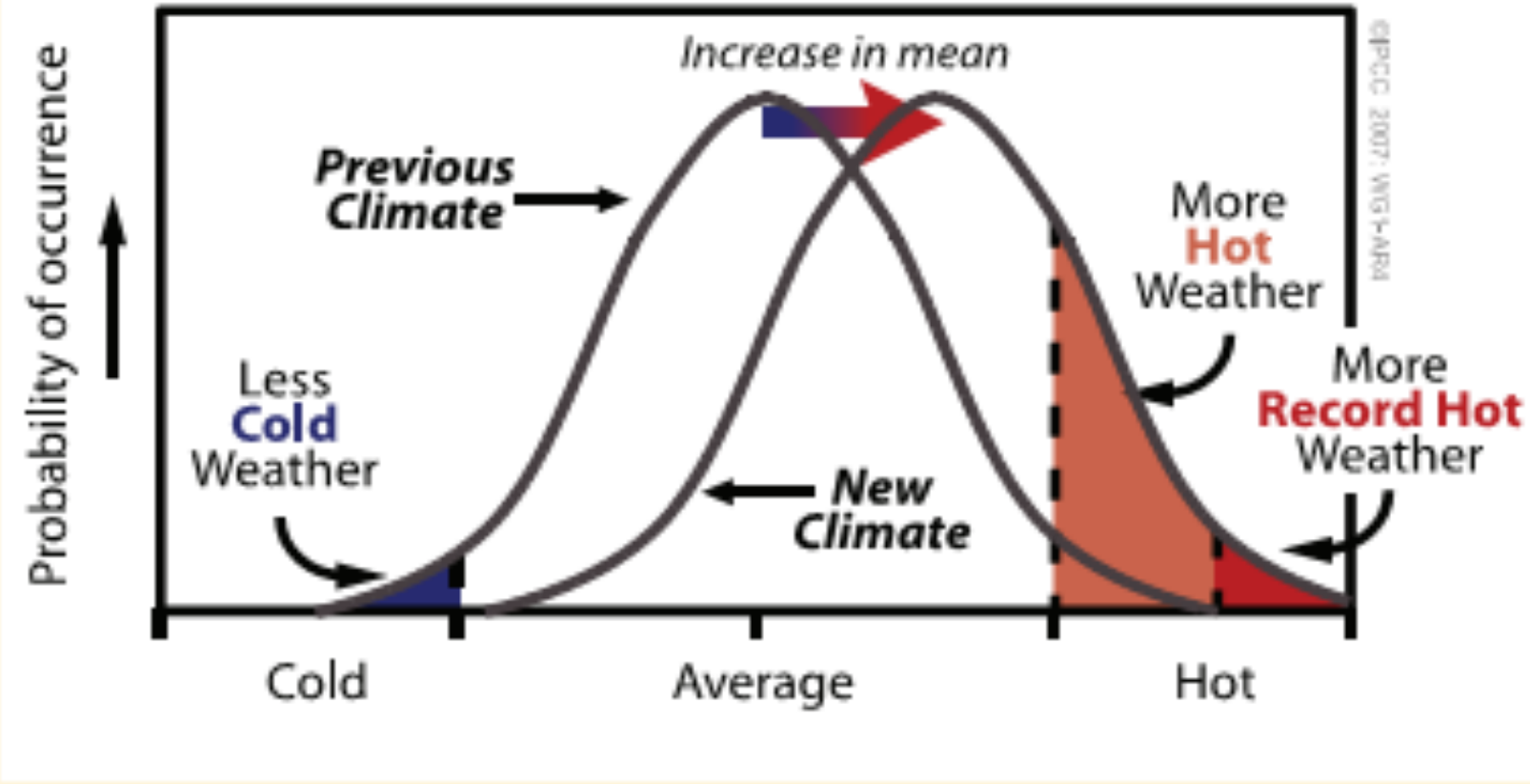


Projections of Future Changes in Climate
(A1B in 2100)



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

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%

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

IPCC Working Group II: Impacts, Vulnerability, and adaptation

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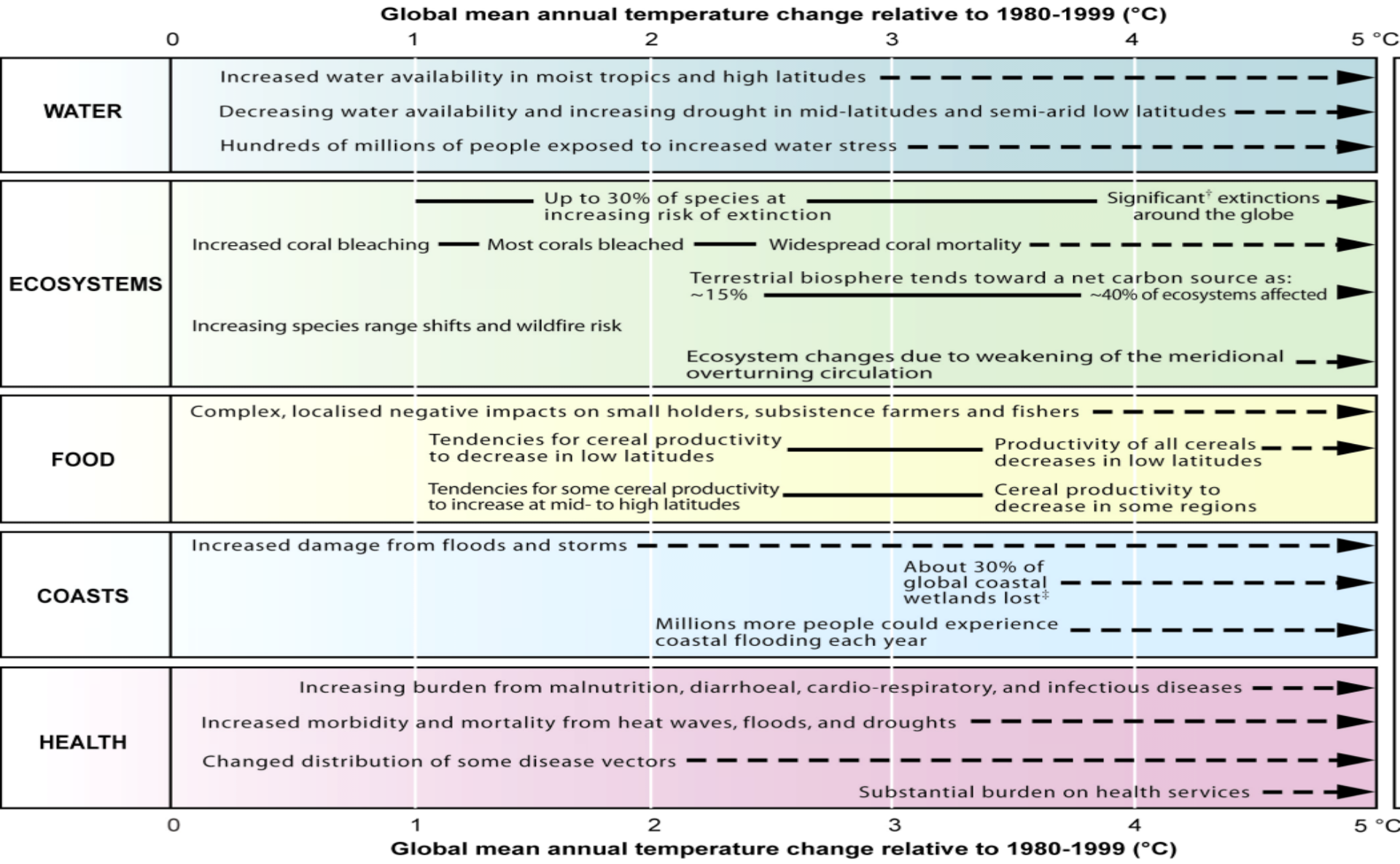
Figure SPM.2. Key impacts as a function of increasing global average temperature change

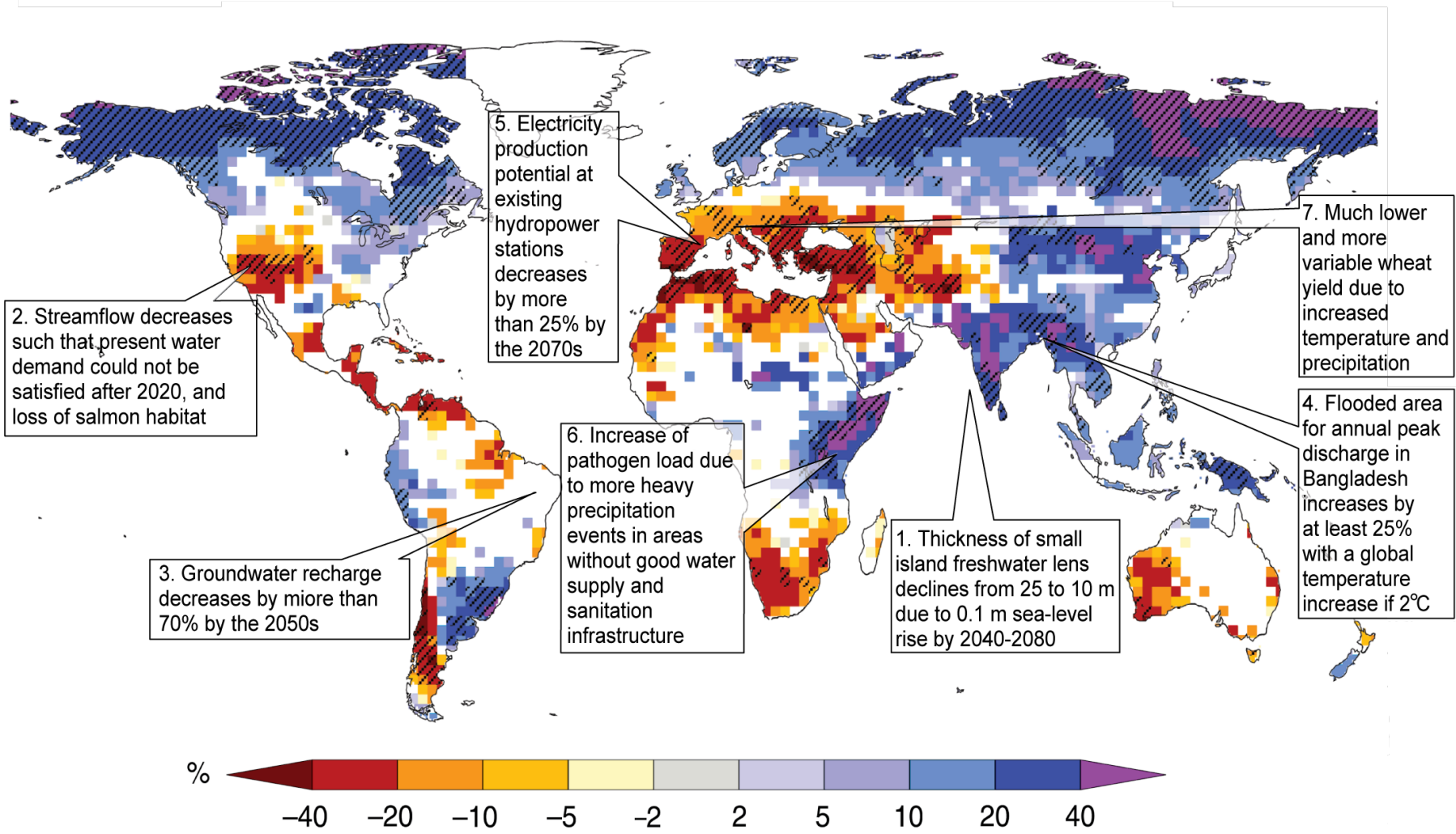
(Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)



† Significant is defined here as more than 40%.

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

WMO UNEP

More heavy precipitation and more droughts….

More heavy precipitation and more droughts….

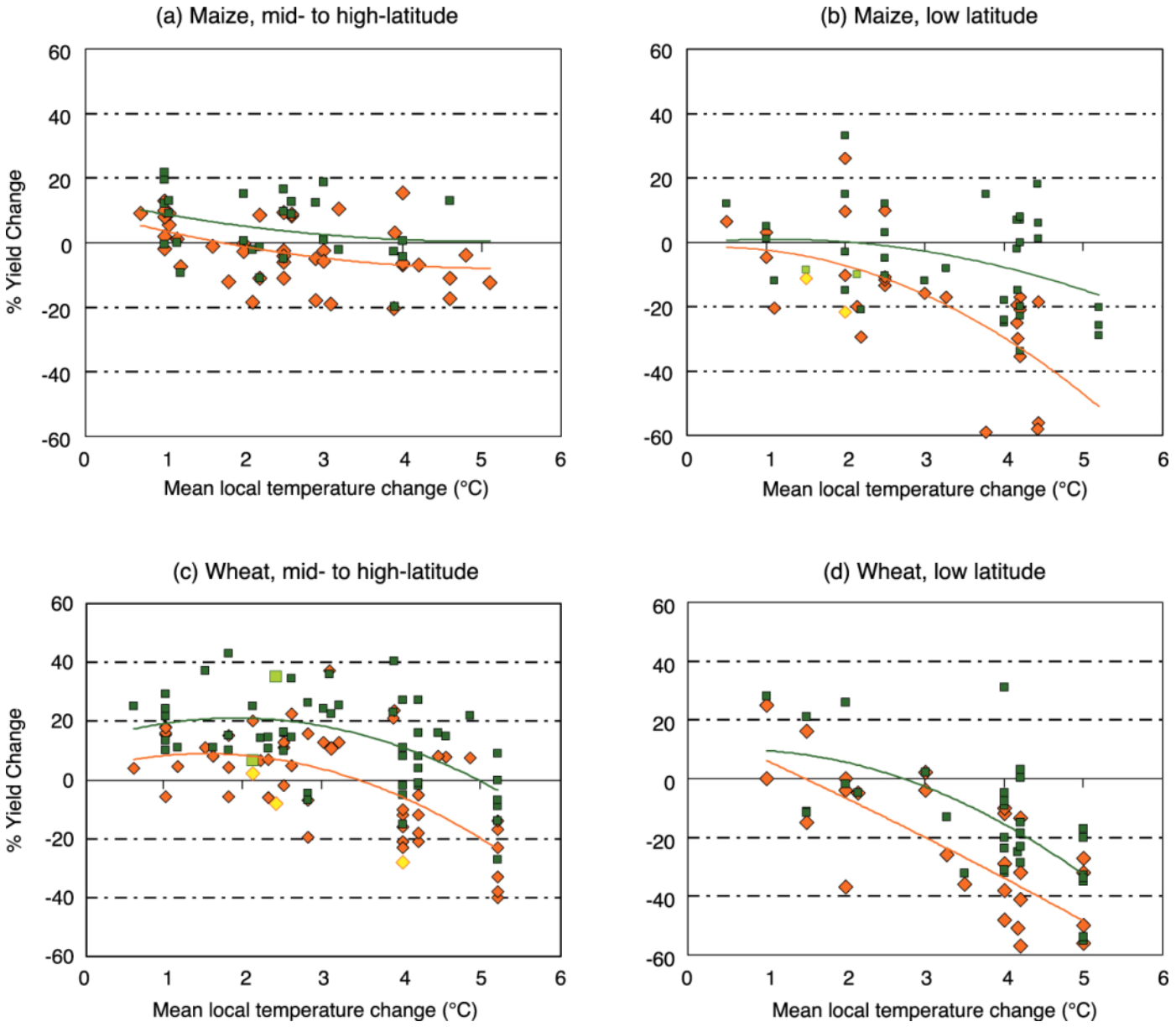
20% - 30% of plants and animals species likely at "increased risk of extinction"

if ΔT = 2°C - 3°C (above pre-industrial temperature)

WMO

UNEP

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



WMO

UNEP

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)

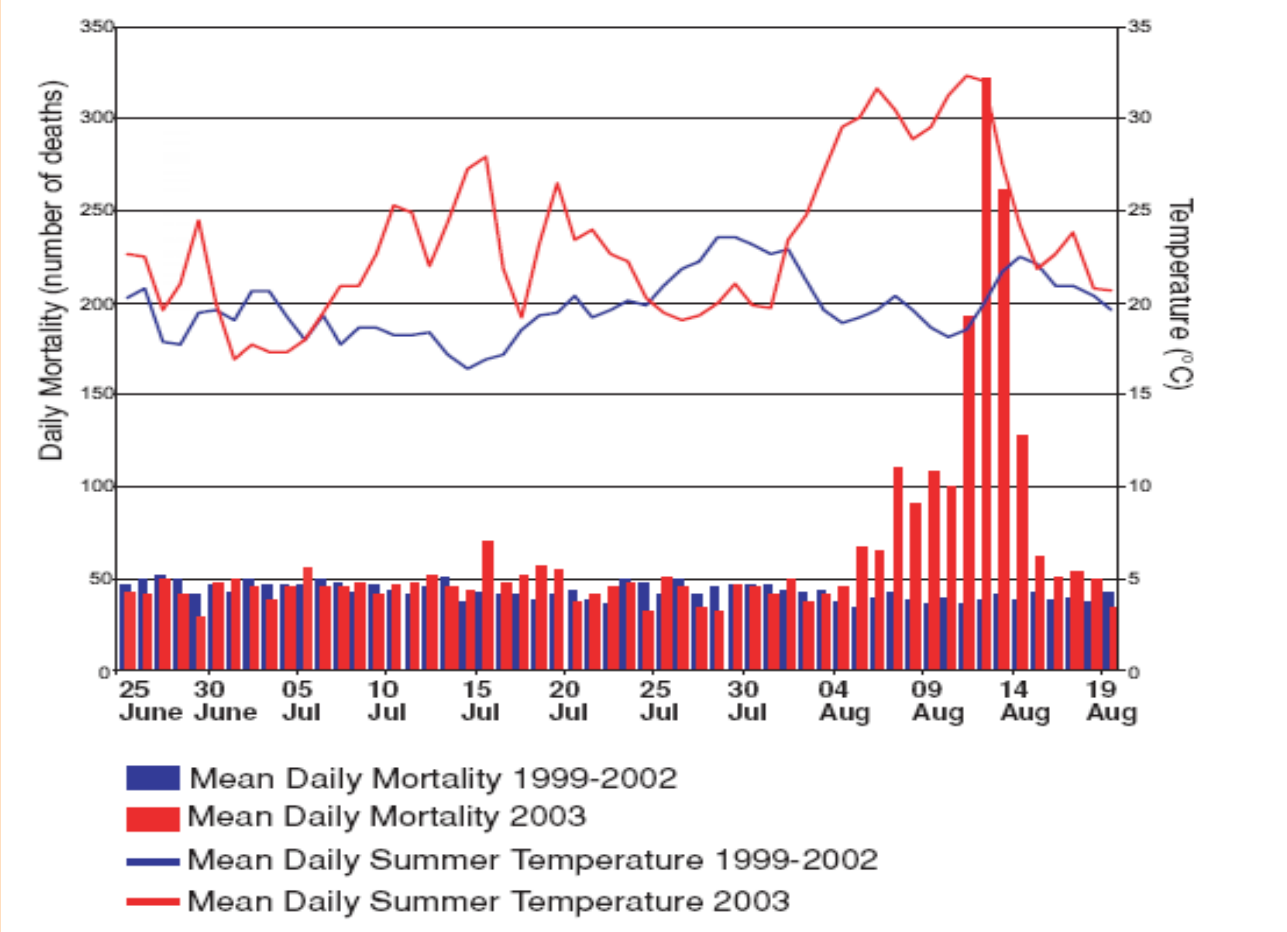
With 8 metre sea-level rise: 3700 km^2 below sea-level in Belgium

(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)

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



WMO

UNEP

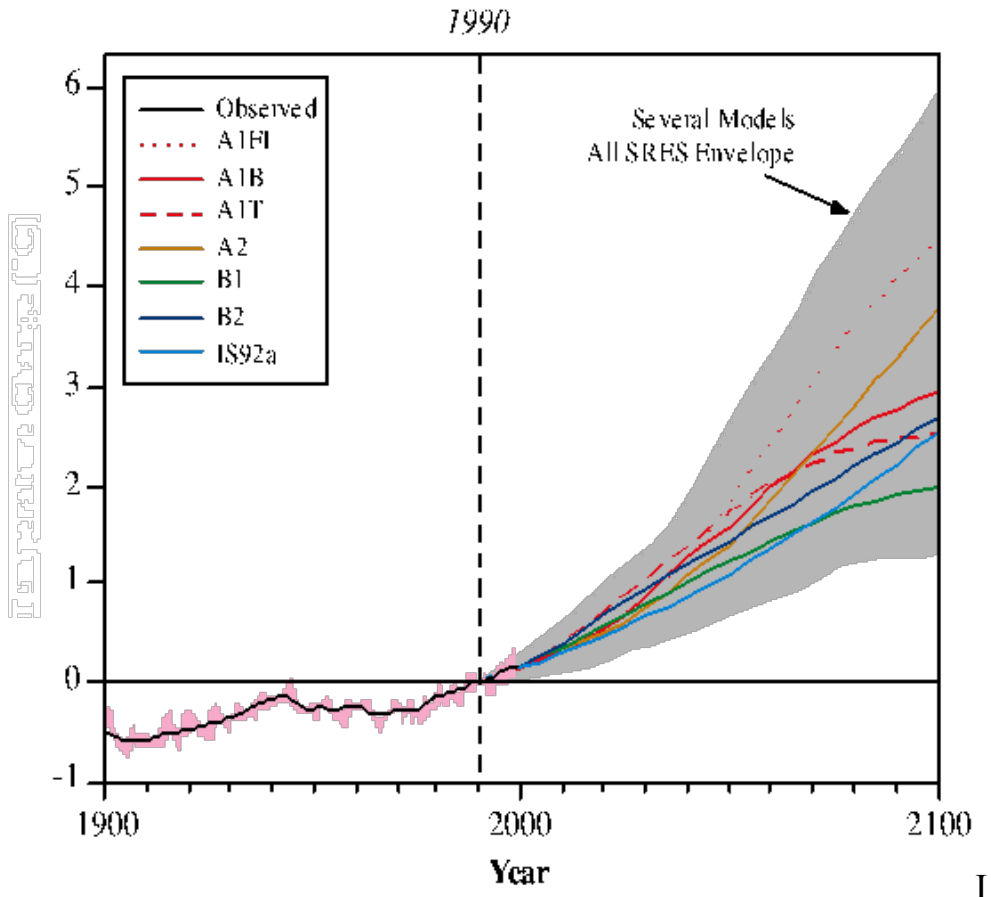
Regions most affected

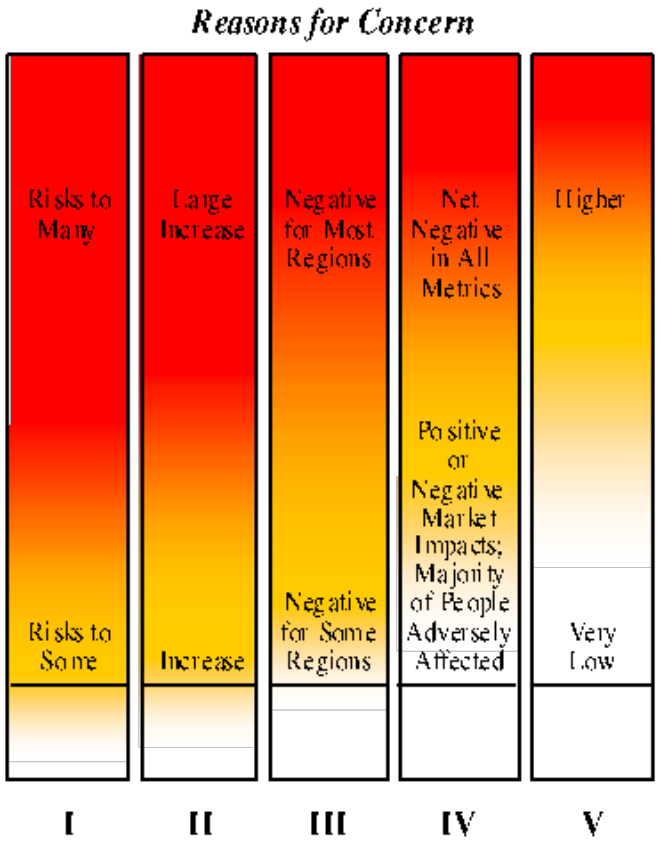
- The Arctic
- Sub-Saharan Africa
- Small islands
- Large megadeltas

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

- The poor
- Young children
- The elderly

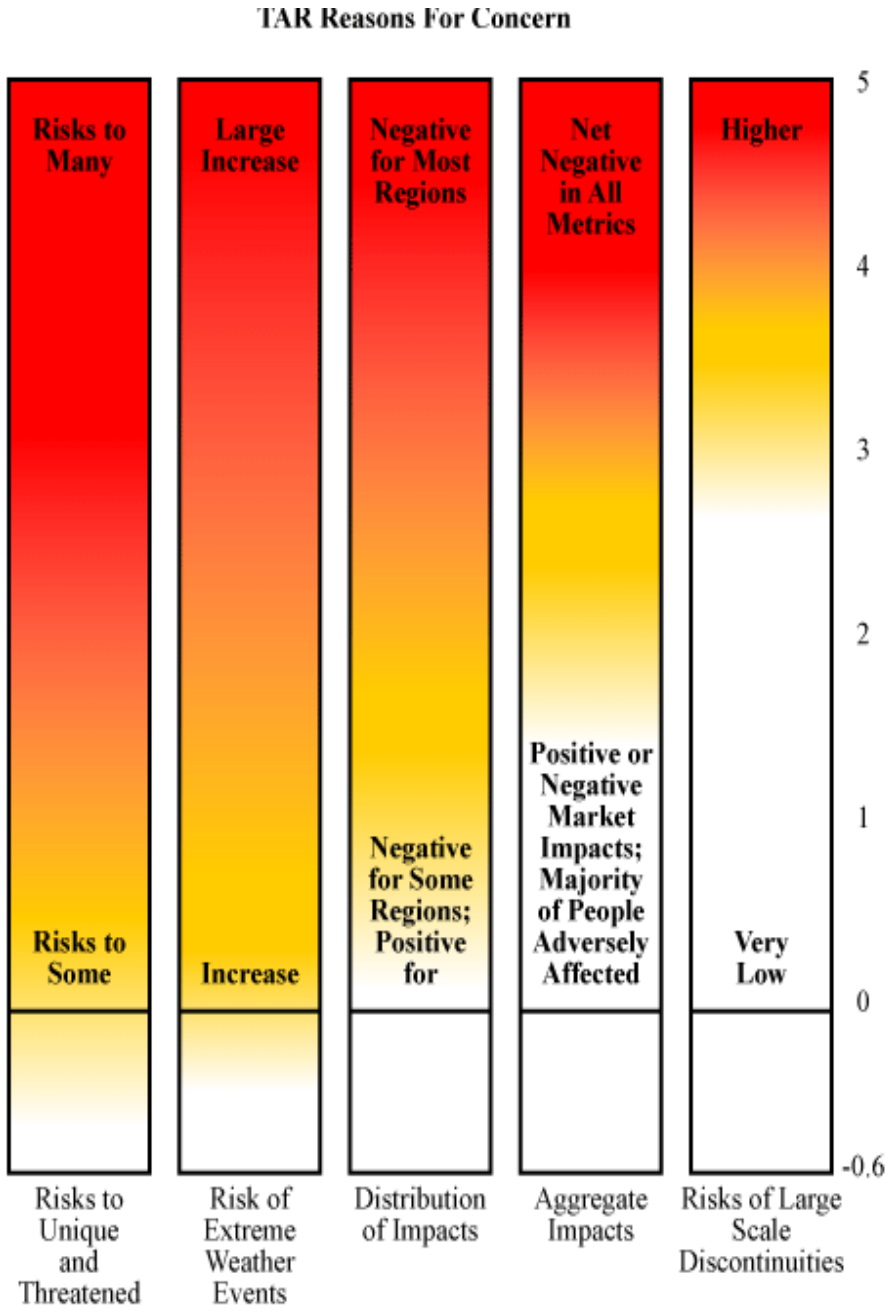
Reasons for Concern

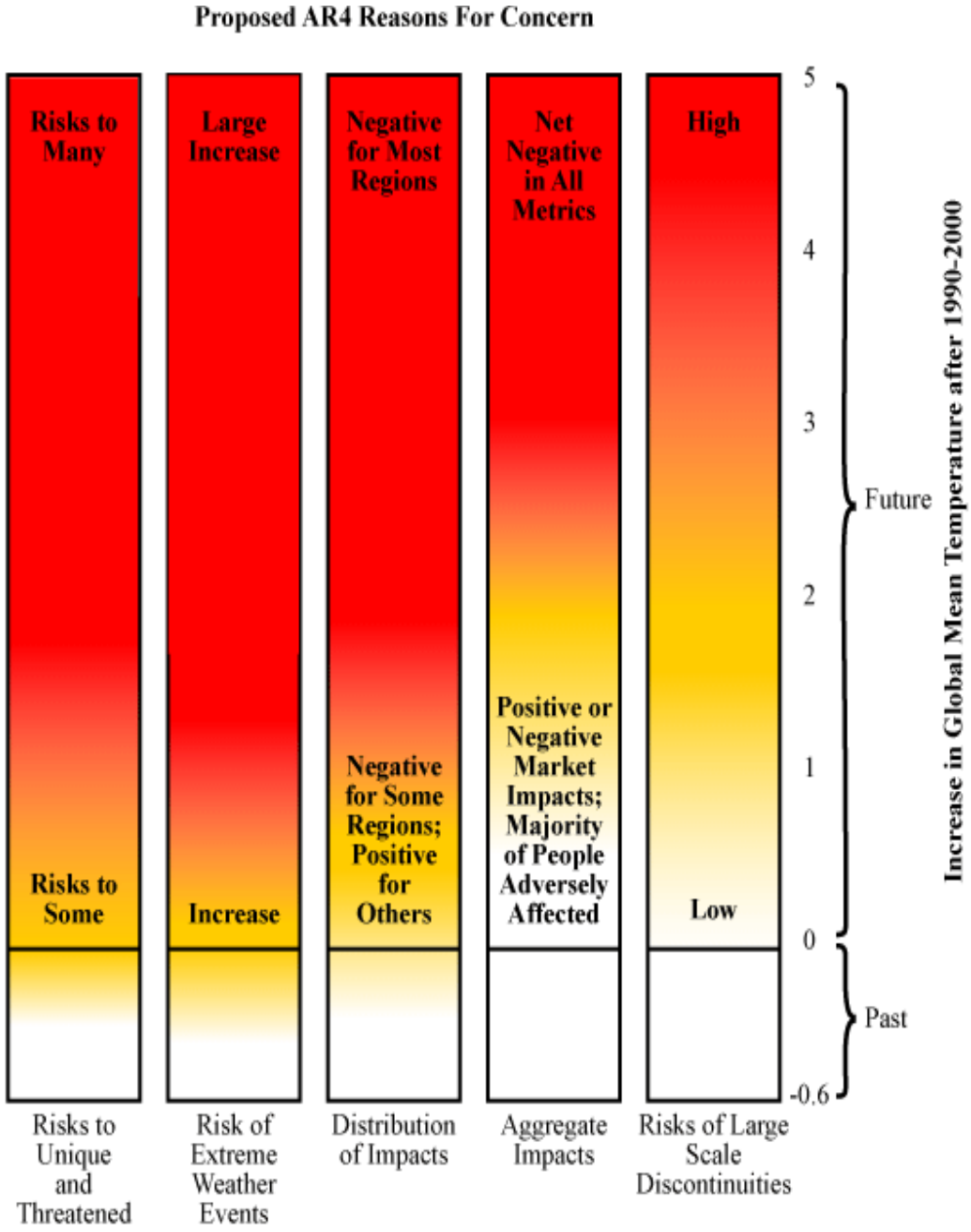




I Risks to unique and threatened systems
II Risks from extreme climate events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from large-scale discontinuities

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

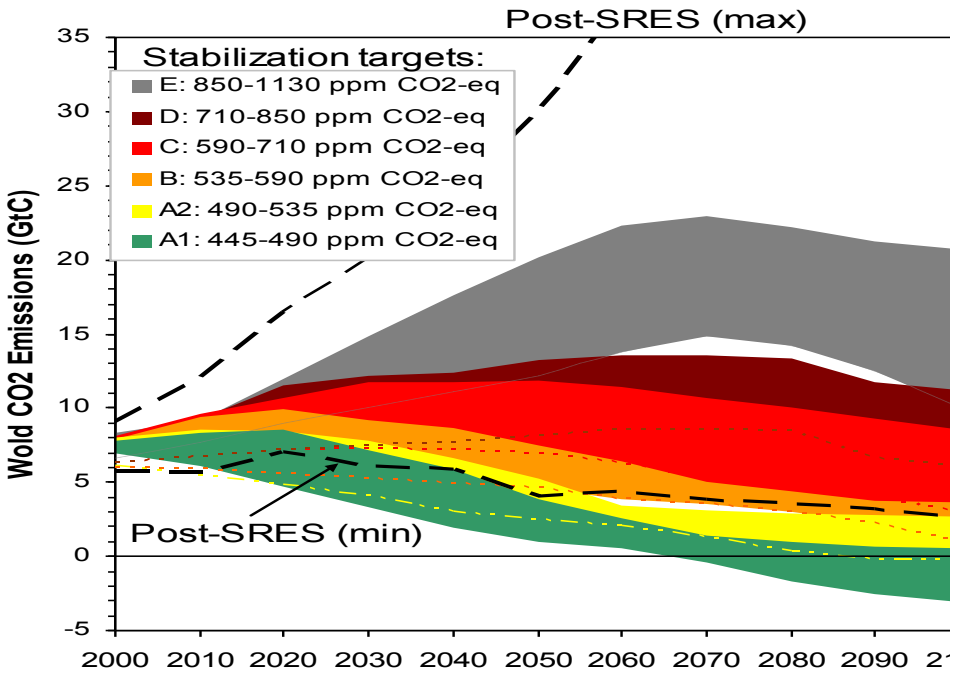

Proposed AR4 Reasons For Concern
Risks to Many
Risks to Some
Large Increase
Increase
Negative for Most Regions
Negative for Some Regions; Positive for Others
Net Negative in All Metrics
Positive or Negative Market Impacts; Majority of People Adversely Affected
High
Low
5
4
3
2
1
0
-0.6
Future
Past
Increase 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

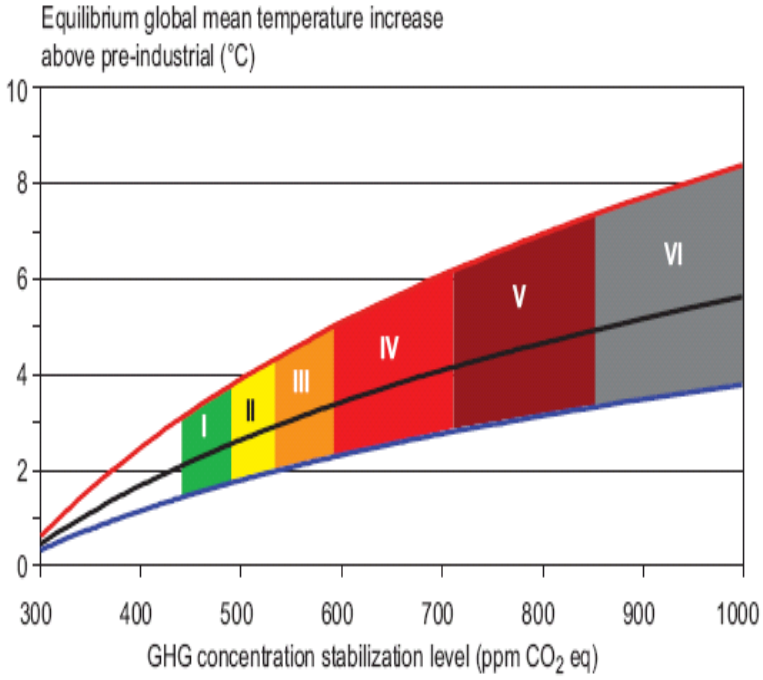
Adaptation will be necessary to address unavoidable impacts, but there are limits and costs

What does IPCC tell us on mitigation?

- WG3: Mitigation

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





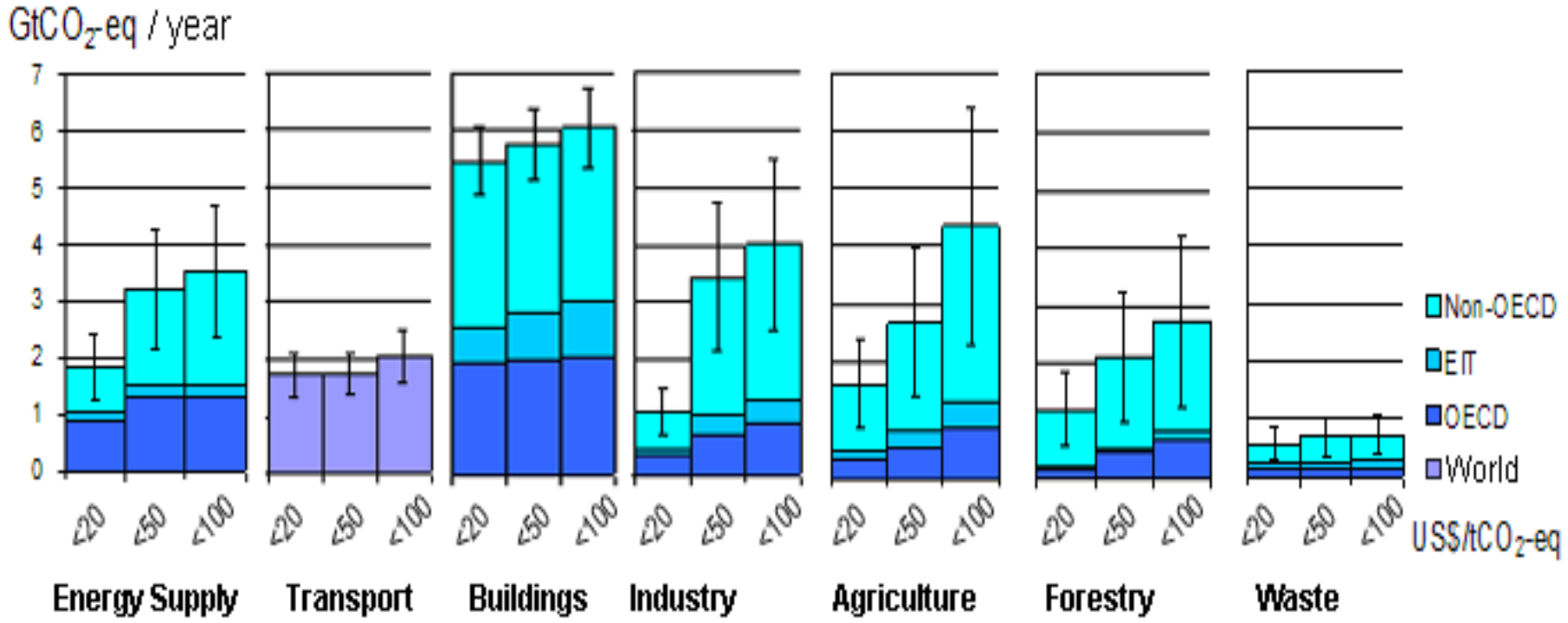
Multigas and CO2 only studies combined

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 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

All sectors and regions have the potential to contribute by 2030



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

Role of Technology, following IPCC AR4

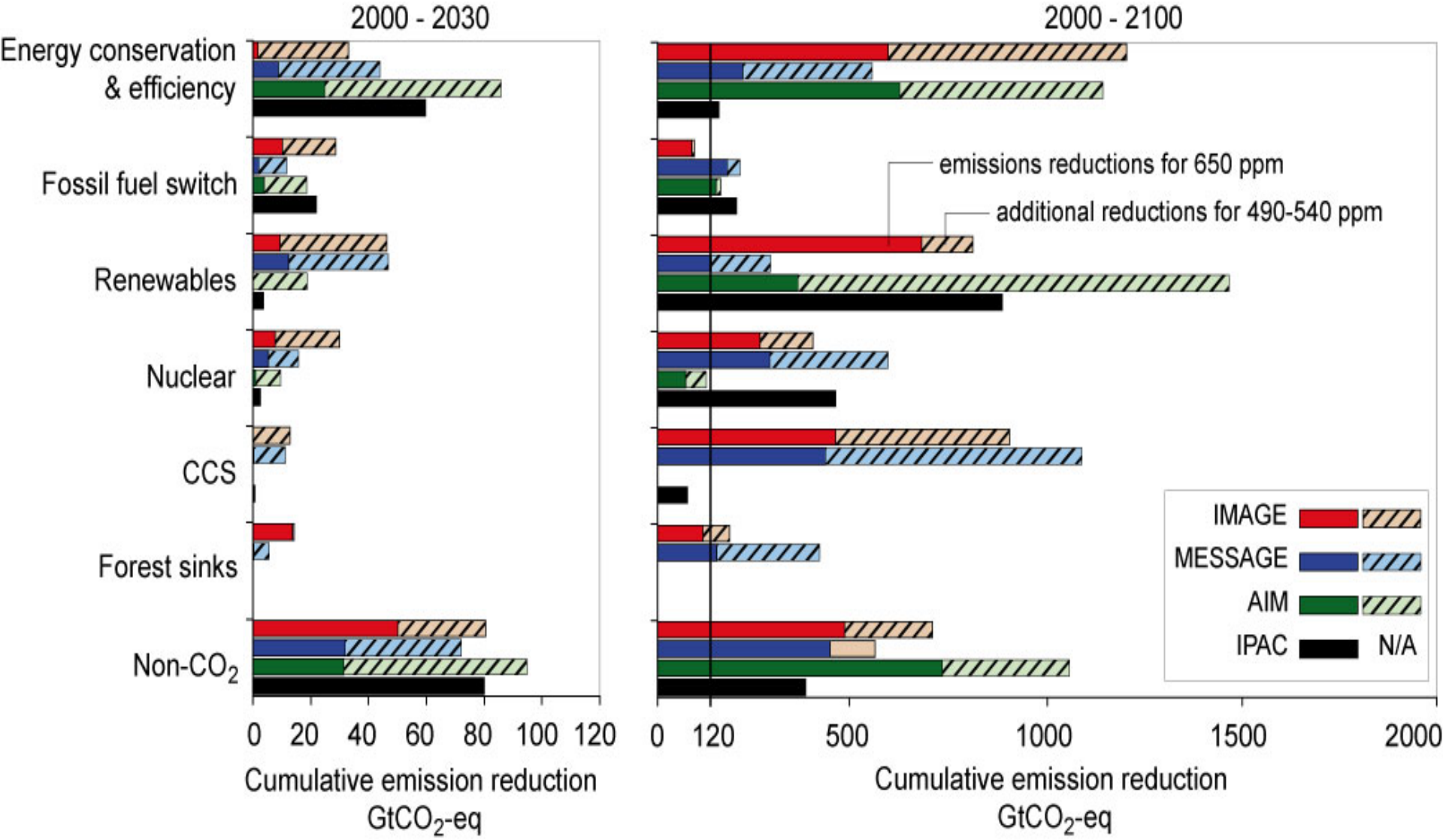
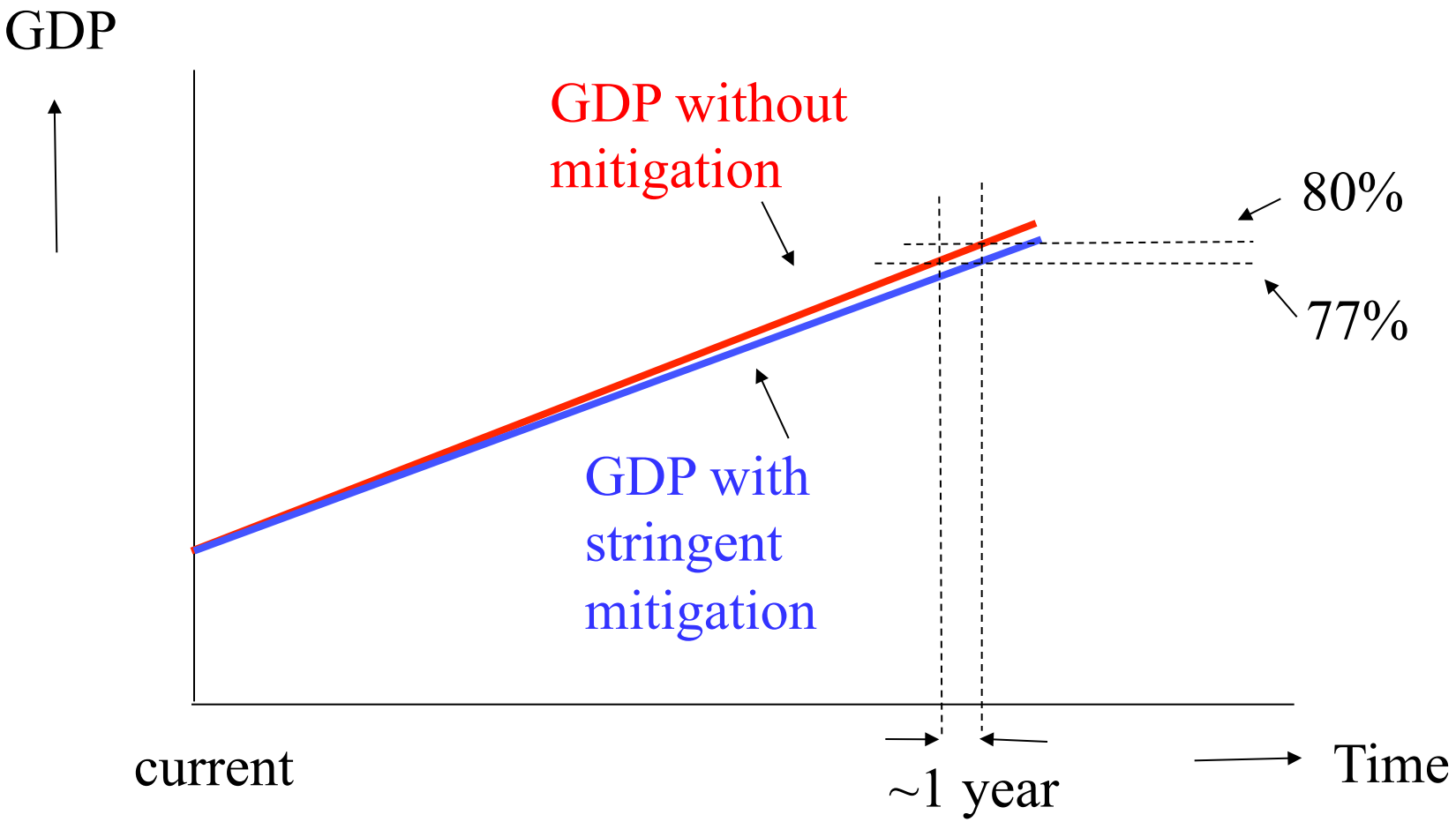
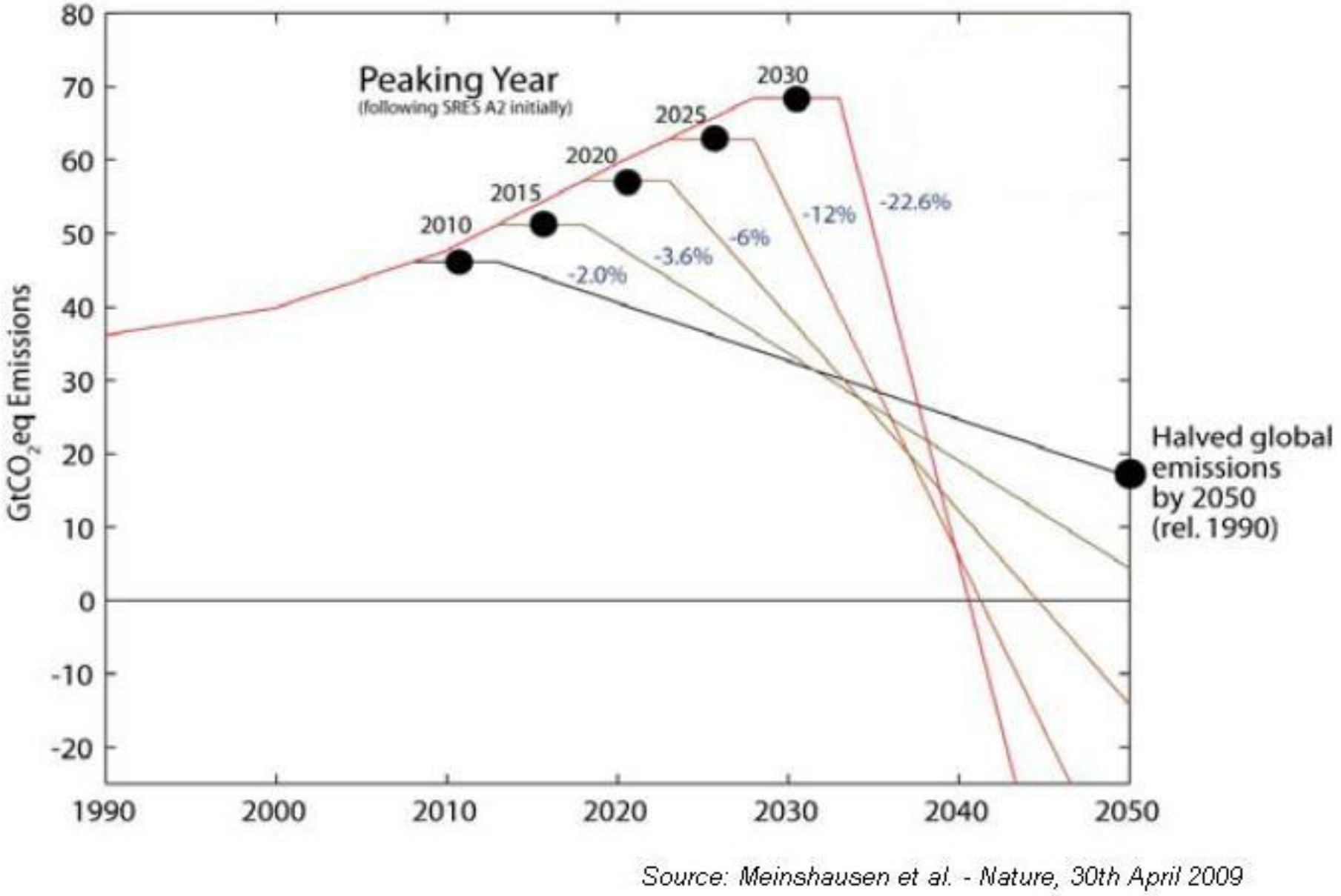


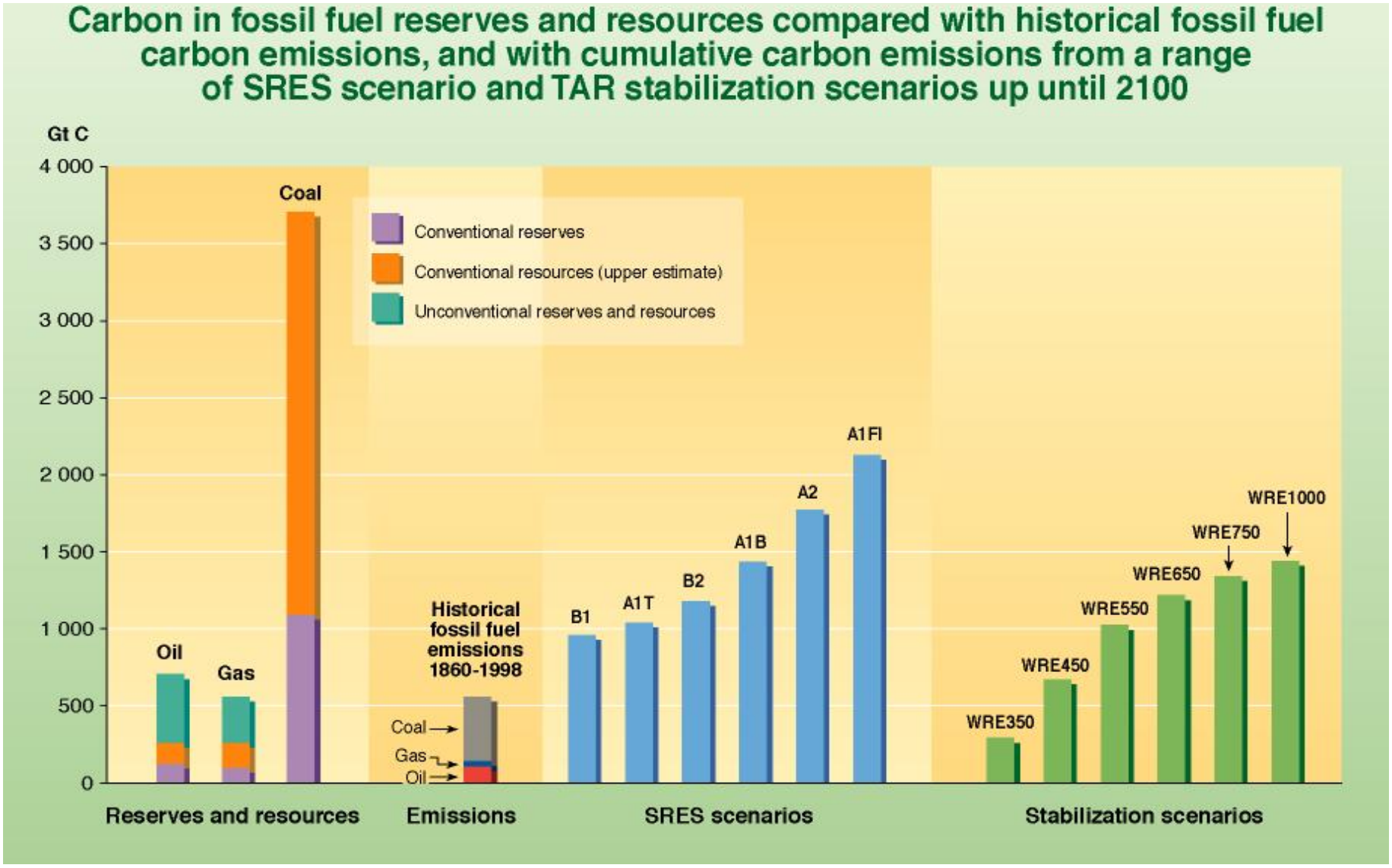
Illustration of cost numbers



The more we wait, the more difficult it will be



Source: Meinshausen et al. - Nature, 30th April 2009



Source: IPCC (2001)

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.'***

Useful links:

- www.ipcc.ch : IPCC
- www.climate.be/vanyp : my slides and other documents
- www.climate.be/desintox : answers to skeptics
- www.skepticalscience.com : idem

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Het Belang Van Limburg (25-26 mei 2013)

CANARY PETE

OPINIE



Foto J. Delcorde (UCL)

Peter Wittoeck (Dienst Klimaatverandering FOD Leefmilieu)
Prof. Jean-Pascal van Ypersele (UCL, vice-voorzitter IPCC)

Nú beslissen is besparen

Omschakelen niet onmogelijk

Onlangs stelde het meetstation op Mauna Loa (Hawaï) vast dat de CO_2-concentratie de drempel van 400 ppm overschreden is. De aarde heeft sinds het pliocentijdvak - ruim 3 miljoen jaren geleden - geen dergelijke concentraties meer gekend. Een hopeloze zaak?

Deze grens van 400 ppm (parts per million/deeltjes per miljoen) mag dan misschien symbolisch lijken, de effecten van klimaatverandering zijn dat veel minder: stijgende zeewaterniveaus, krachtigere cyclonen, intensere regenval of grotere periodes van droogte, verschuivingen in de verspreidingsgebieden van soorten (bv. kabeljauw in onze Noordzee)… met alle gevolgen van dien: bedreigde voedselzekerheid, tekort aan drinkwater, klimaatvluchtelingen, de verspreiding van ziekten...

Wetenschappers geven daarom al jaren aan dat de CO_2-concentratie in de atmosfeer op termijn - en liefst zo snel mogelijk - teruggebracht moet worden tot 350 ppm, om de stijging van de gemiddelde temperatuur op aarde te rekenen vanaf de start van de industriële revolutie beneden de 2°C te houden.

Deze 2°C-doelstelling werd door de internationale gemeenschap erkend tijdens de VN-klimaattoppen van Kopenhagen (2009) en Cancún (2010), maar vertaalde zich nog onvoldoende in concrete actie. Wat de landen individueel hebben beloofd te zullen doen, volstaat niet, zoals de laatste jaren werd aangetoond door de zgn. *gap reports* van het Milieuprogramma van de VN (UNEP) en eind vorig jaar ook nog door de Wereldbank. Die kondigde een temperatuurstijging van 4°C aan als er niet meer inspanningen worden geleverd om de uitstoot van broeikasgassen en CO_2 te reduceren.

> Op één generatie moet onze maatschappij omschakelen van een systeem dat draait op fossiele brandstoffen naar een koolstofarme maatschappij.

Om de 2°C-doelstelling te halen, zijn drastische reducties van de uitstoot van broeikasgassen nodig, met wereldwijd minstens 50% tegen 2050 (t.o.v. 1990). Voor geïndustrialiseerde landen zoals België komt dit neer op reducties van liefst 80 à 95%! Op één generatie tijd zal onze maatschappij dus moeten omschakelen van een systeem dat nu nog grotendeels draait op fossiele brandstoffen naar een maatschappij die 'koolstofarm' zal moeten zijn.

TE DUUR?

Dat is geen sinecure, maar zeker niet onmogelijk. De technische oplossingen bestaan: het gebruik van hernieuwbare energiebronnen, het verhogen van de energie-efficiëntie van gebouwen en apparaten, de keuze van milieuvriendelijke transportmiddelen of een aangepast mobiliteits- en voedingsgedrag (minder vlees). Het VN-panel van klimaatexperten IPCC (Intergovernmental Panel on Climate Change) heeft dat bevestigd en zal hier in zijn volgende rapport dieper op ingaan.

Sommigen zullen beweren dat een dergelijke ommezwaai niet betaalbaar is. Dat klopt niet: er zijn talloze studies die aantonen dat zo'n omschakeling weliswaar belangrijke investeringen zal vergen, maar ook dat deze tegelijk onze afhankelijkheid van buitenlandse energie zal doen verminderen, onze energiefactuur zal doen dalen, 'groene jobs' zal creëren, innovatie zal aanwakkeren en zo het concurrentievermogen van onze bedrijven zal verhogen, de volksgezondheid ten goede zal komen, onze steden veel leefbaarder zal maken… Deze investeringen zullen minder duur uitvallen dan de gevolgen van onbeperkte klimaatverandering, maar hoe langer we wachten, hoe hoger deze zullen zijn. De tijd dringt dus.

BIJKOMEND

Succesverhalen bestaan: op tien jaar tijd leerde iedereen de CO_2-uitstoot van zijn wagen kennen, de nieuwe wegenbelasting - gebaseerd op o.m. CO_2-uitstoot - stuurt de keuze van de bedrijfswagens in de richting van de zuinigere motoren, terwijl zonnepanelen, condensatieketels, hoogrendementsbeglazing en isolatiematerialen op korte tijd een sterke opgang hebben gekend.

Het beleid heeft daarin een belangrijke rol gespeeld, maar heeft nog een weg te gaan. Daarom ondersteunen onze parlementsleden een reductie van 30% van de emissies van de Europese Unie tegen 2020 en verdedigt België dat de kostprijs die voor de uitstoot van broeikasgassen wordt betaald hoog genoeg moet zijn, dat de inspanningen die wereldwijd moeten gebeuren op een rechtvaardige manier moeten verdeeld worden en dat de armste en meest kwetsbare landen voldoende steun moeten krijgen van de rijkere landen.

Ook in België werden inspanningen gedaan en ons land zal door de inzet van internationale kredieten zijn Kyoto-doelstelling voor de jaren 2008 tot 2012 waarschijnlijk wel halen. Maar zoals de Europese Commissie vorig jaar nog en het Federaal Planbureau eerder deze maand vaststelden hun de economische vooruitzichten voor 2013-2018, zijn bijkomende inspanningen nodig als we de meer ambitieuze doelstellingen voor het jaar 2020 of voor 2050 willen realiseren.

Net als alle andere landen van de wereld heeft België zich binnen de Verenigde Naties ertoe geëngageerd om zijn economie op het traject van een koolstofarme economie te zetten. Om daarin te slagen zullen we een echte toekomstvisie moeten ontwikkelen en nú de beslissingen nemen die ervoor kunnen zorgen dat onze kinderen niet zullen moeten terugkijken naar de generatie van hun ouders die wel wist wat er moest gebeuren, maar te weinig ondernam om het roer op tijd om te gooien!