A few things a climate scientist would like to tell policymakers ahead of Copenhagen

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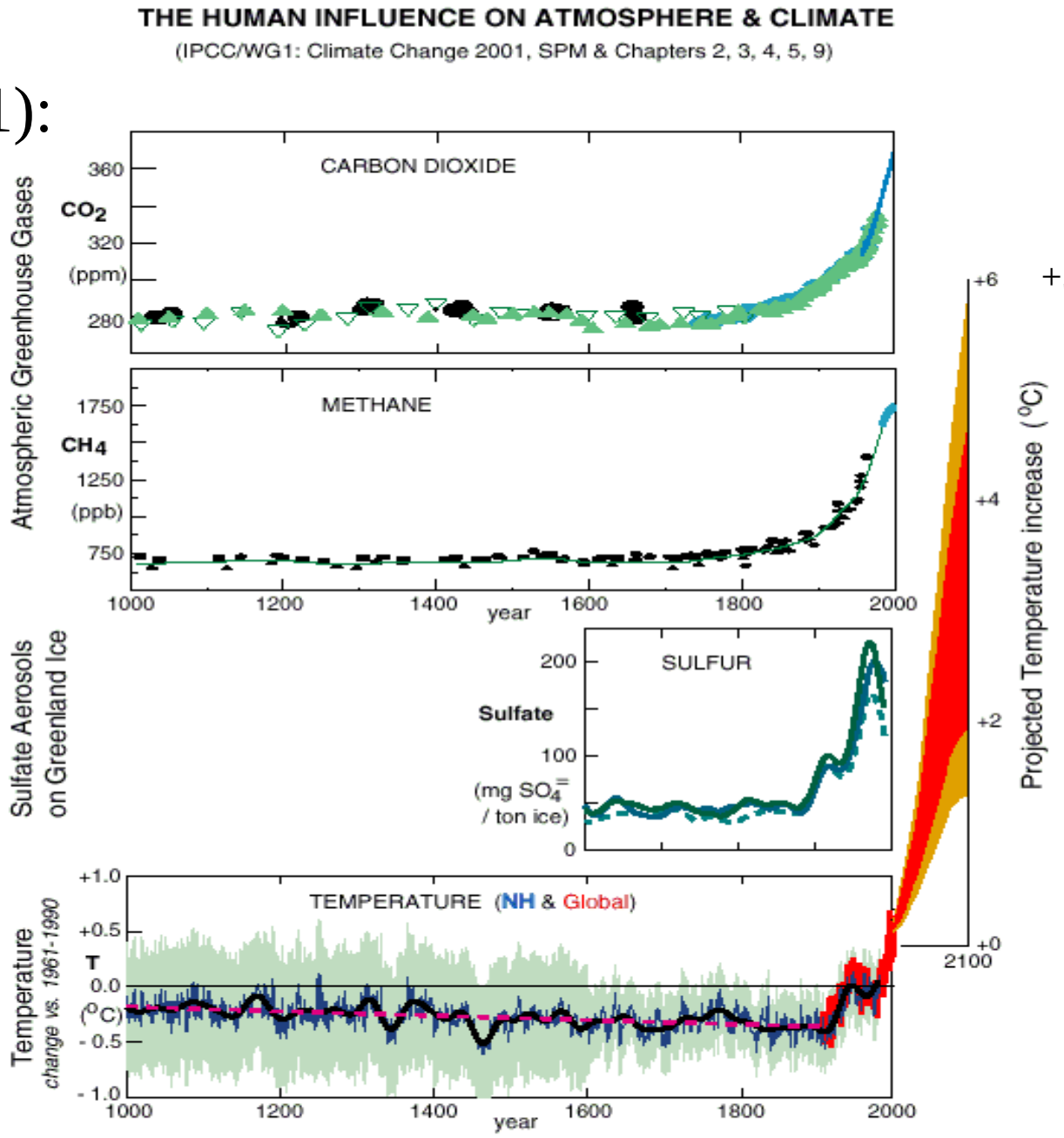
Dublin, 24-11-2009

NB. The support from the Belgian Science Policy Office is gratefully acknowledged

IPCC

TAR (2001):



AR4:

+6.4 C

+1.1 C

Outline

- IPCC = best source of information
- The climate change (CC) problem is real
- The problem is serious
- Deep emissions reductions are needed
- So is adaptation, particularly, but not only in developing countries
- Elements of solutions are at hand
- Technology is important, but not sufficient
- Change is affordable, and offers co-benefits
- The economic crisis could offer opportunities to tackle CC: orient the stimulus packages
- A deal in Copenhagen is essential

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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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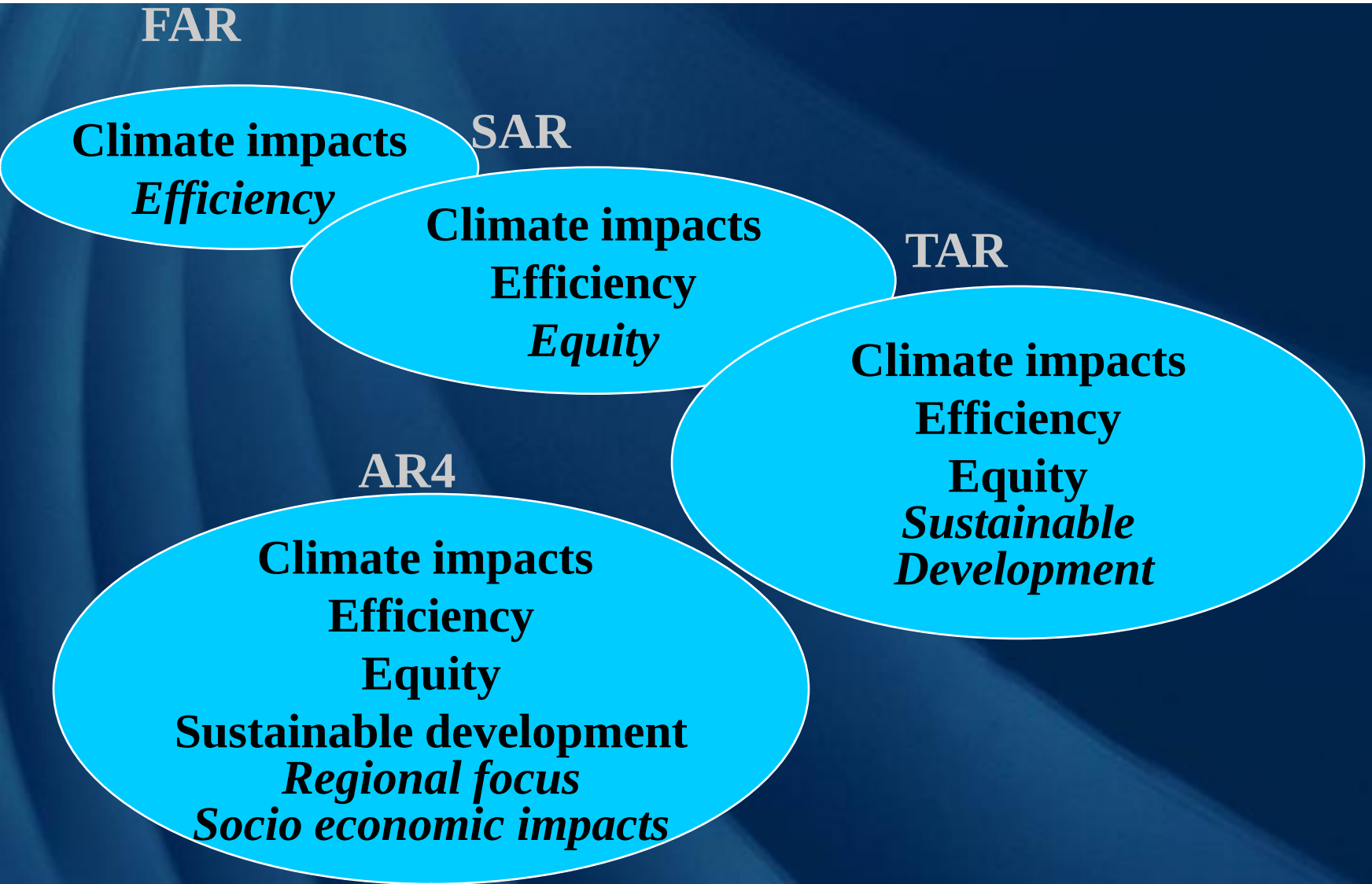
Role of IPCC

"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)

IPCC Reports are policy-relevant, NOT policy-prescriptive

The evolving perspective - IPCC Assessments



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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2500+ SCIENTIFIC EXPERT REVIEWERS
800+ CONTRIBUTING AUTHORS AND
450+ LEAD AUTHORS FROM
130+ COUNTRIES
6 YEARS WORK
1 REPORT

2007

The assessments carried out by the IPCC have influenced global action on an unprecedented scale

1. First Assessment Report (1990) had a major impact in defining the content of the **UNFCCC**

2. The Second Assessment Report (1996) was largely influential in defining the provisions of the **Kyoto Protocol**

3. The Third Assessment Report (2001) focused attention on the **impacts** of climate change and the need for **adaptation**

4. The Fourth Assessment Report (2007) is creating a strong basis for a **post Kyoto Protocol** agreement

Bali: COP Decision about IPCC AR4 (Decision 5/CP.13)

- The Conference of the Parties,
- 1. Welcomes the Fourth Assessment Report of the Intergovernmental Panel on ClimateChange;
- 2. Expresses its appreciation and gratitude to all those involved in the preparation of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change for their excellent work;
- 3. Recognizes that the Fourth Assessment Report represents the most comprehensive and authoritative assessment of climate change to date, providing an integrated scientific, technical and socio-economic perspective on relevant issues;

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Bali action plan (december 2007)

- ***The Conference of the Parties***,
- ***(…) Responding*** **to the findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change that warming of the climate system is unequivocal, and that delay in reducing emissions significantly constrains opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts,**
- ***Recognizing*** **that deep cuts in global emissions will be required to achieve the ultimate objective of the Convention and emphasizing the urgency (NOTE 1) to address climate change as indicated in the Fourth Assessment Report of the IPCC,**
- **1. *Decides* to launch a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision at its fifteenth session, by addressing, inter alia: …**
- **Note 1: Contribution of Working Group III to the Fourth Assessment Report of the IPCC, Technical Summary, pages 39 and 90, and Chapter 13, page 776.**

⌘Latest science

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Key messages from the IPCC WG1 Report (1)

- **Certain:**
  - Emissions resulting from **human activities are substantially increasing** the atmospheric concentrations of the **greenhouse gases**: CO2, CH4, CFC, and N2O
- Calculated **with confidence**:
  - Under the business as usual scenario, **temperature will increase by about 3°C by 2100** (uncertainty range: 2 to 5°C), and **sea level will increase by 60 cm** (uncertainty range: 30 to 100 cm)

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Key messages from the IPCC WG1 Report (2)

- With an increase in the mean temperature, **episodes of high temperature** will most likely become **more frequent**
- Rapid changes in climate will change the composition of ecosystems; **some species** will be unable to adapt fast enough and **will become extinct**.
- Long-lived gases (**CO2**, N2O and CFCs) **would require immediate reduction** in emissions from human activities **of over 60% to stabilise their concentration at today's levels**.

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Oops…

- … this was from the IPCC **first** assessment report, published 19 years ago (1990)

- Was anybody really listening?

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What does IPCC (really) tell us about climate science?

- WG1: climatology

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Key points from the WG1 IPCC AR4 Report (2007)

- 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 (90%) 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, by 2100
- Frequency/intensity of several extreme phenomena due to increase (ex: heat waves, droughts, floods, …)

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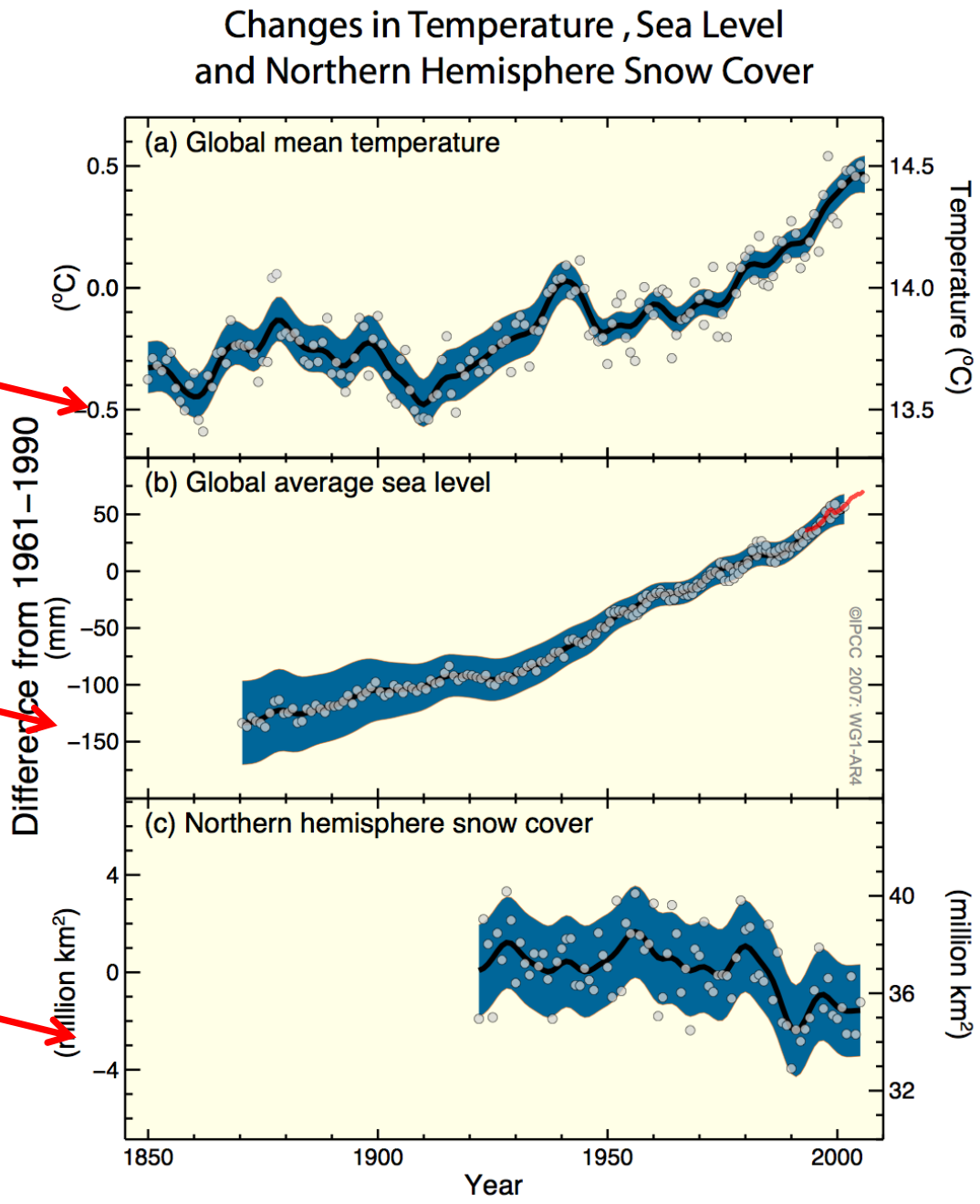
Warming is Unequivocal

Rising atmospheric temperature

Rising sea level

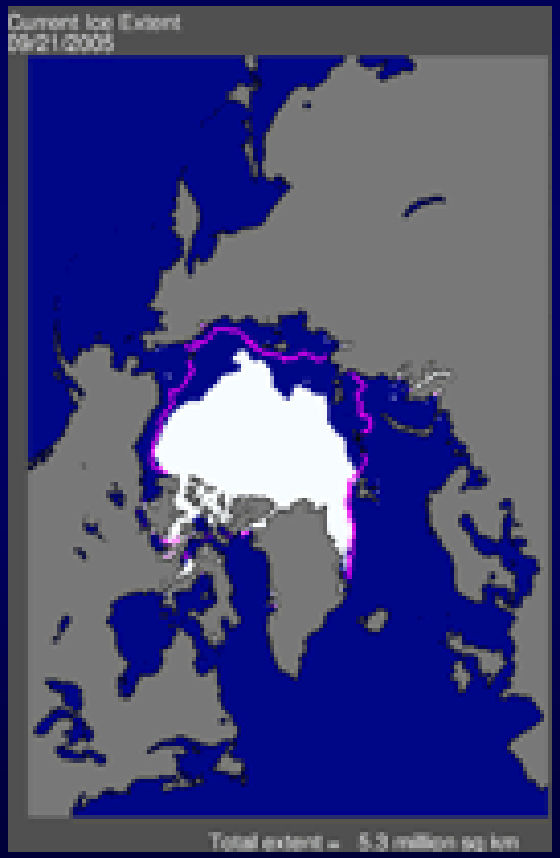
Reductions in NH snow cover



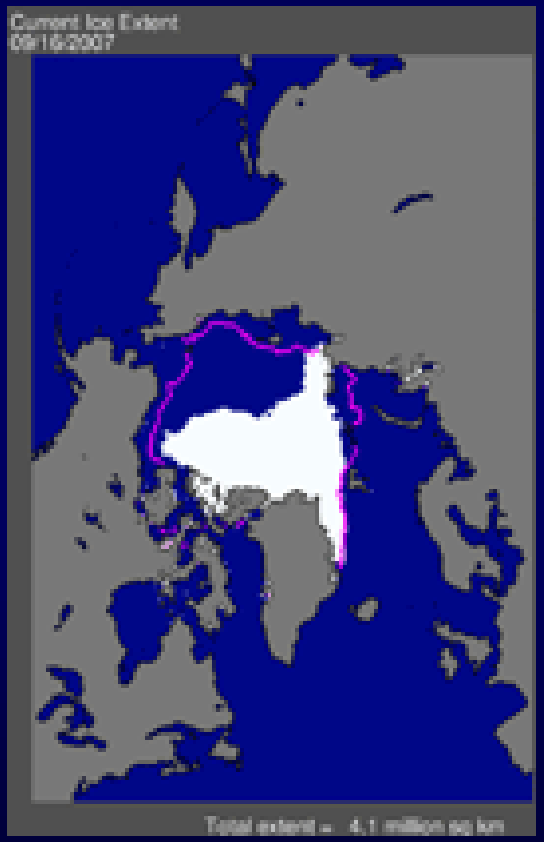
Extension of the Arctic ice cap

September 1979

September 2005

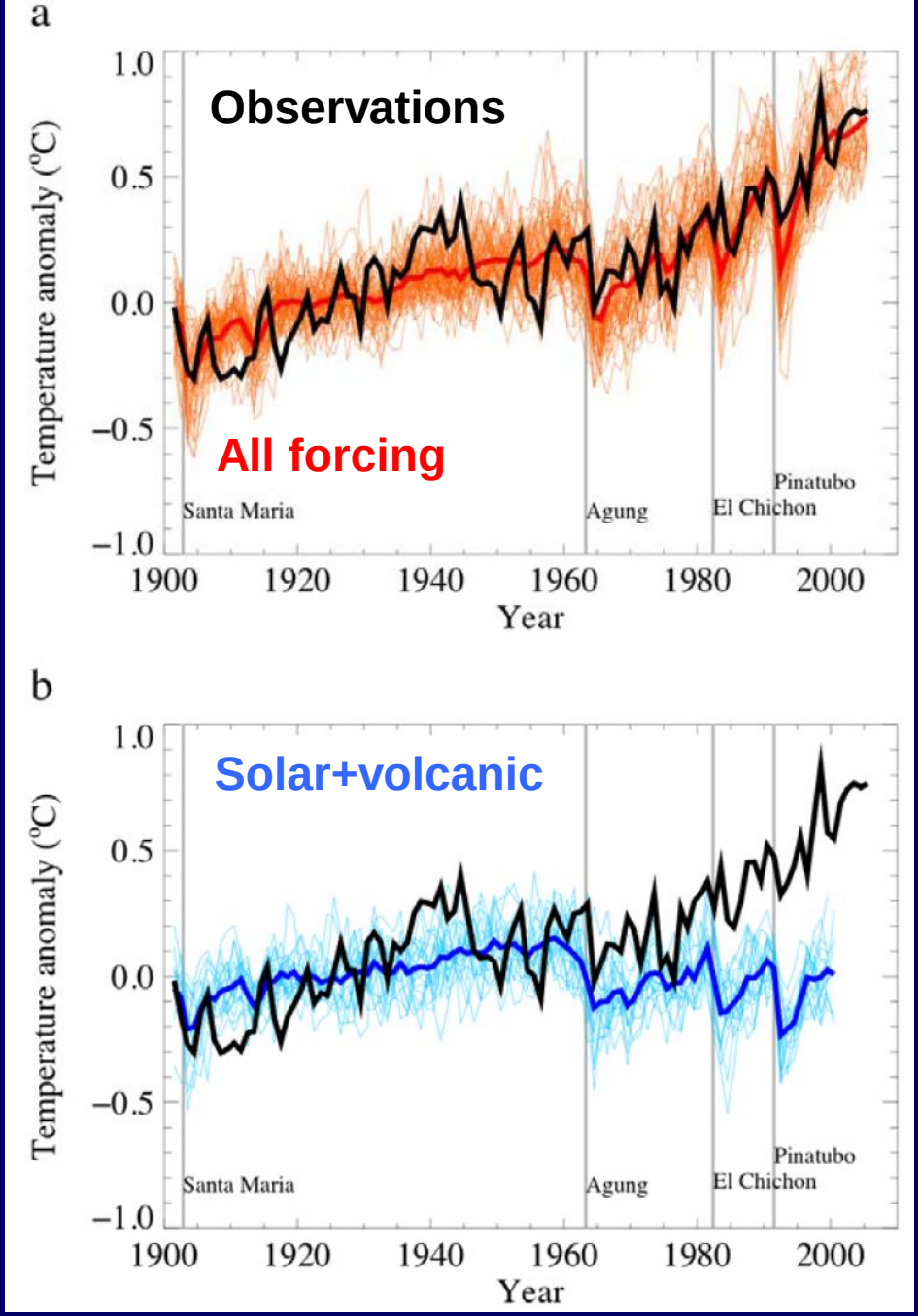


September 2007



The pink line indicates the average ice cap extension since 1979

Attribution



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."

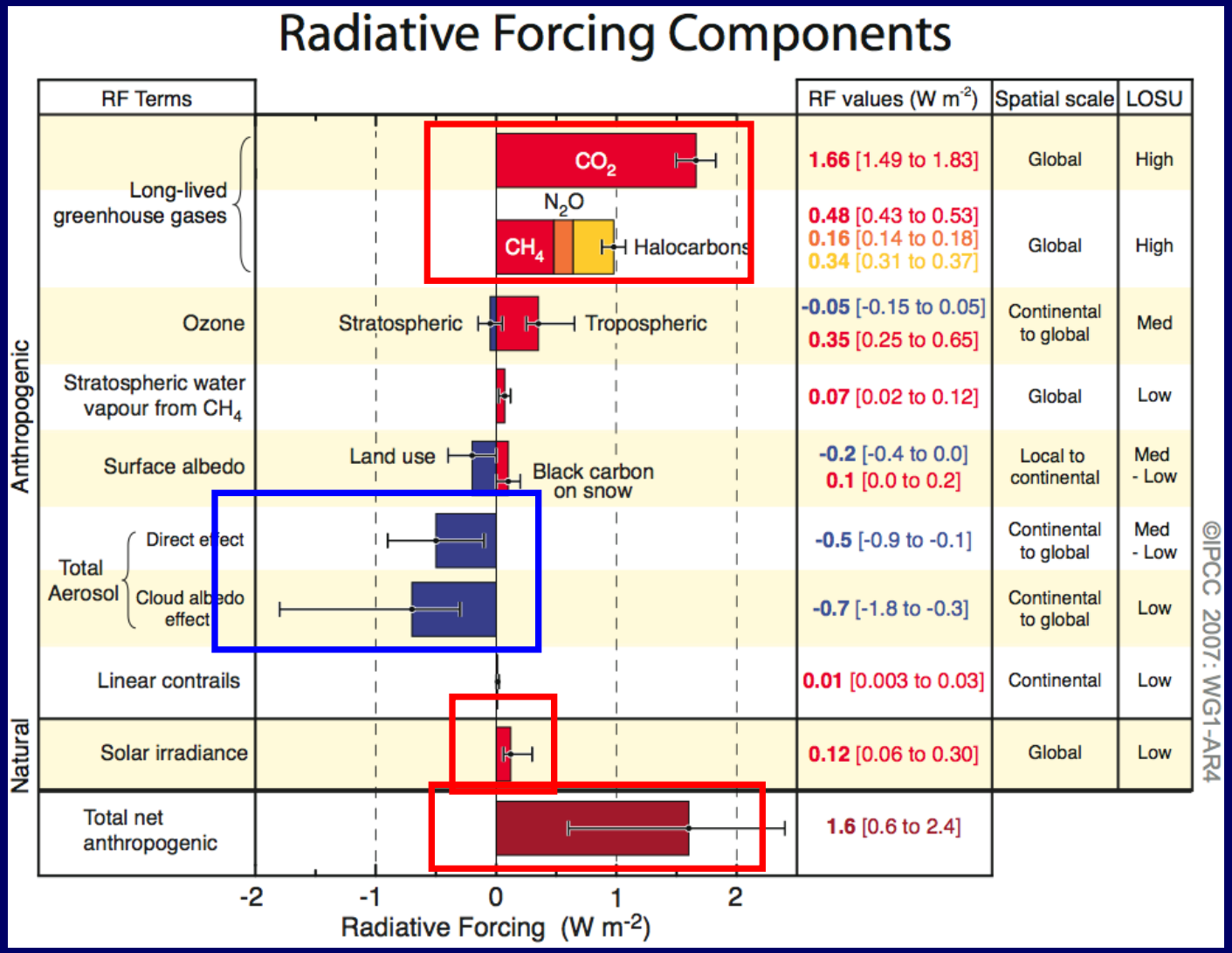
IPCC (2007) "Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases."

Human and Natural Drivers of Climate Change

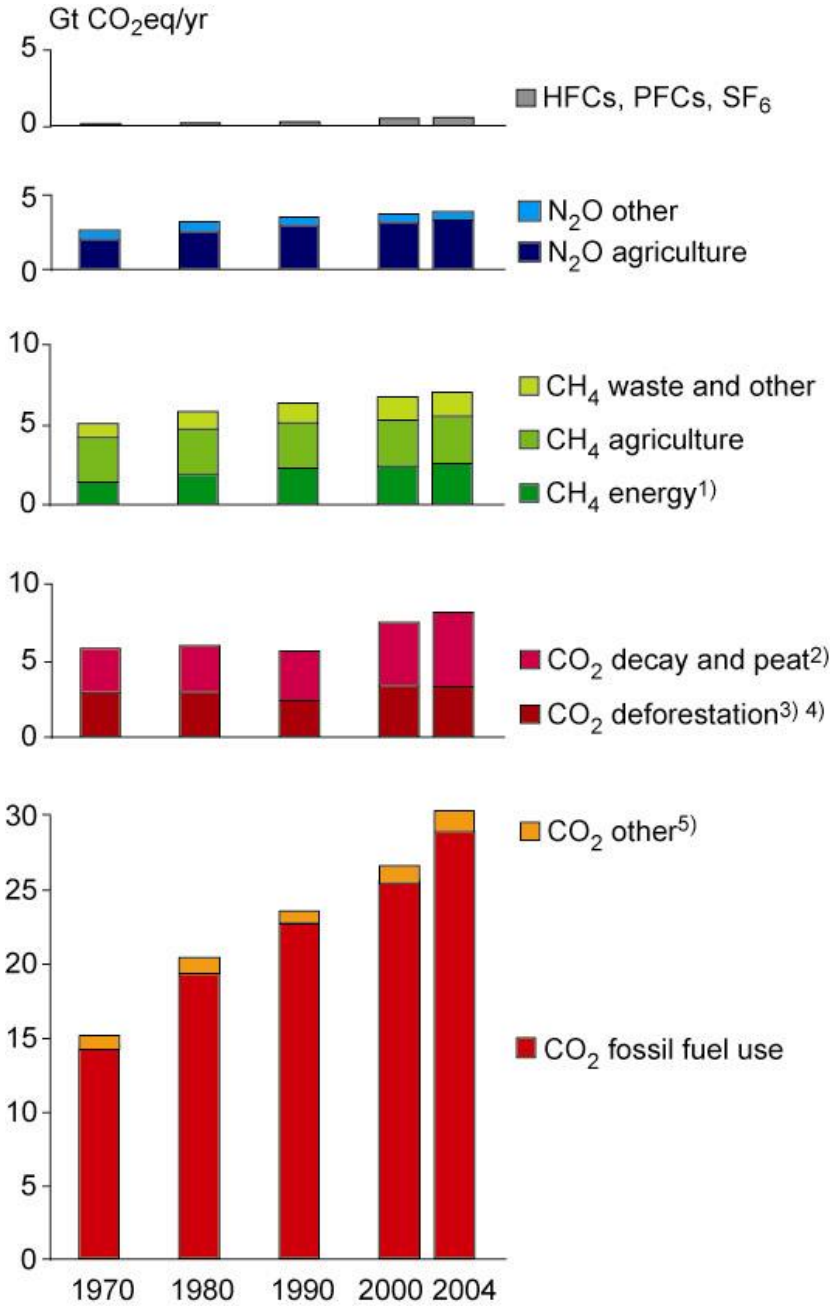
Major improvements in understanding forcing compared to IPCC (2001).

Now we have more confidence about “drivers”.

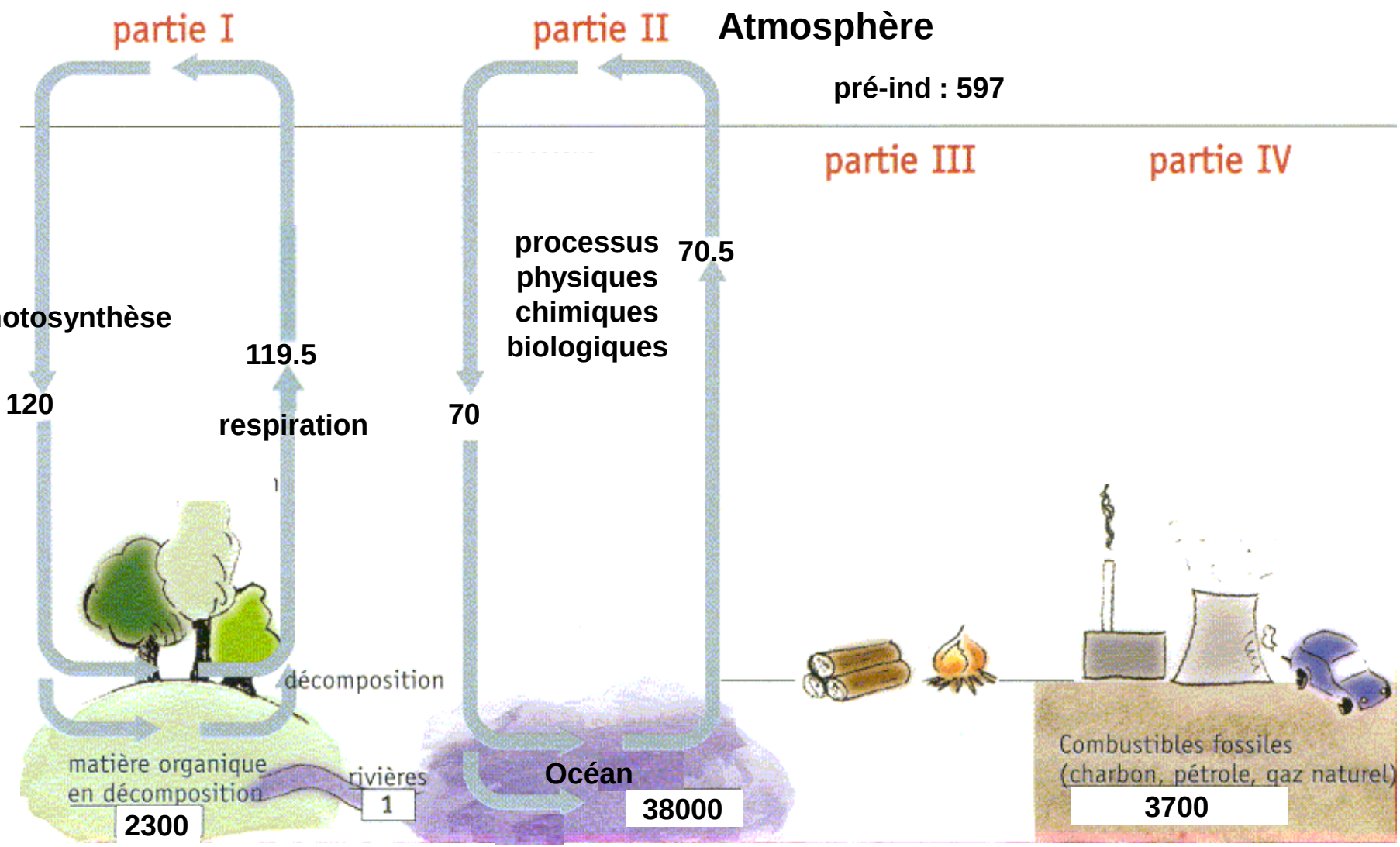
1.6 W m^{-2} warms like 1.6 Christmas tree lights over every m^2 on Earth.



Carbon dioxide is the largest contributor



Cycle du carbone



Unités: GtC (milliards de tonnes de carbone) ou GtC/an

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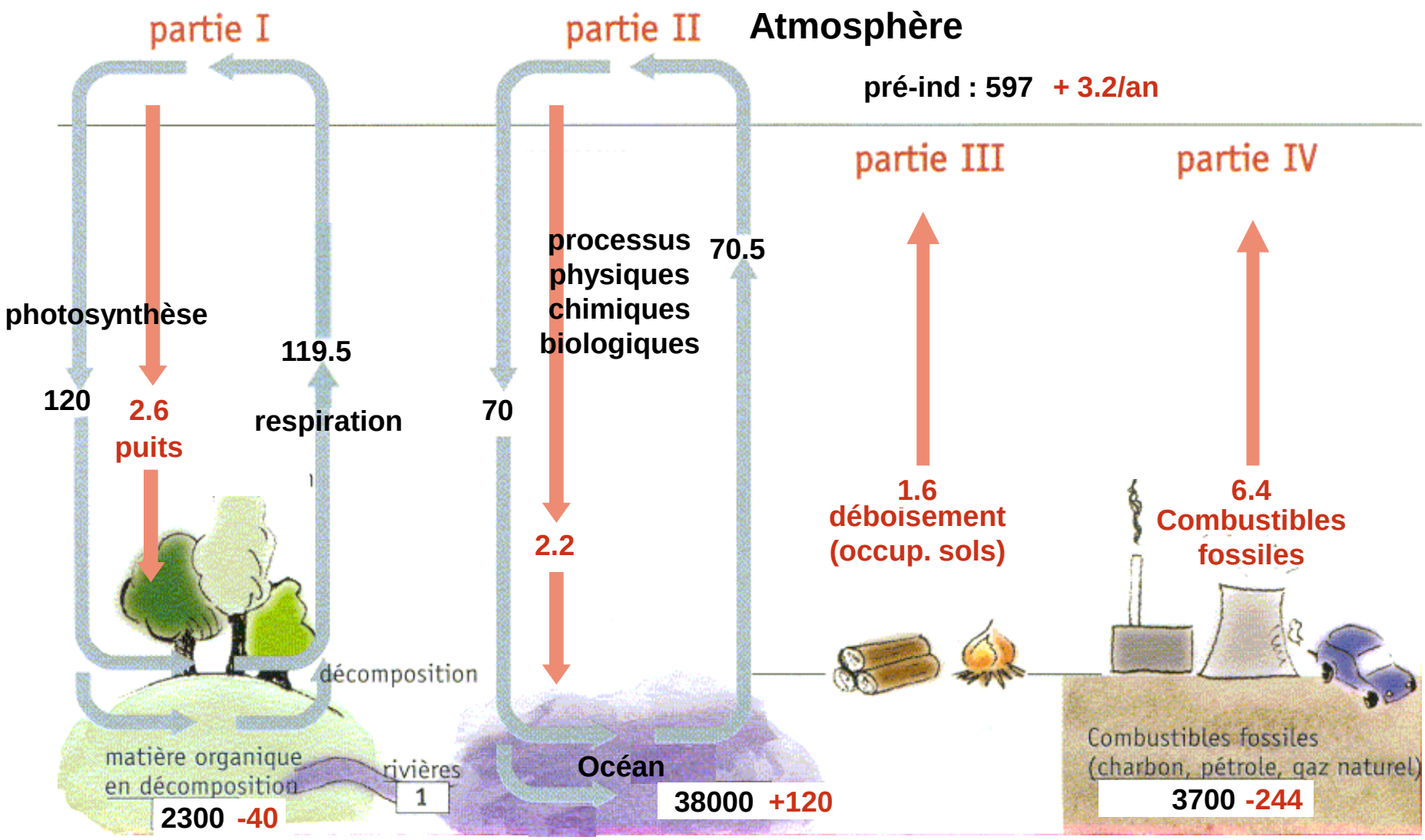
Cycle du carbone



Unités: GtC (milliards de tonnes de carbone) ou GtC/an

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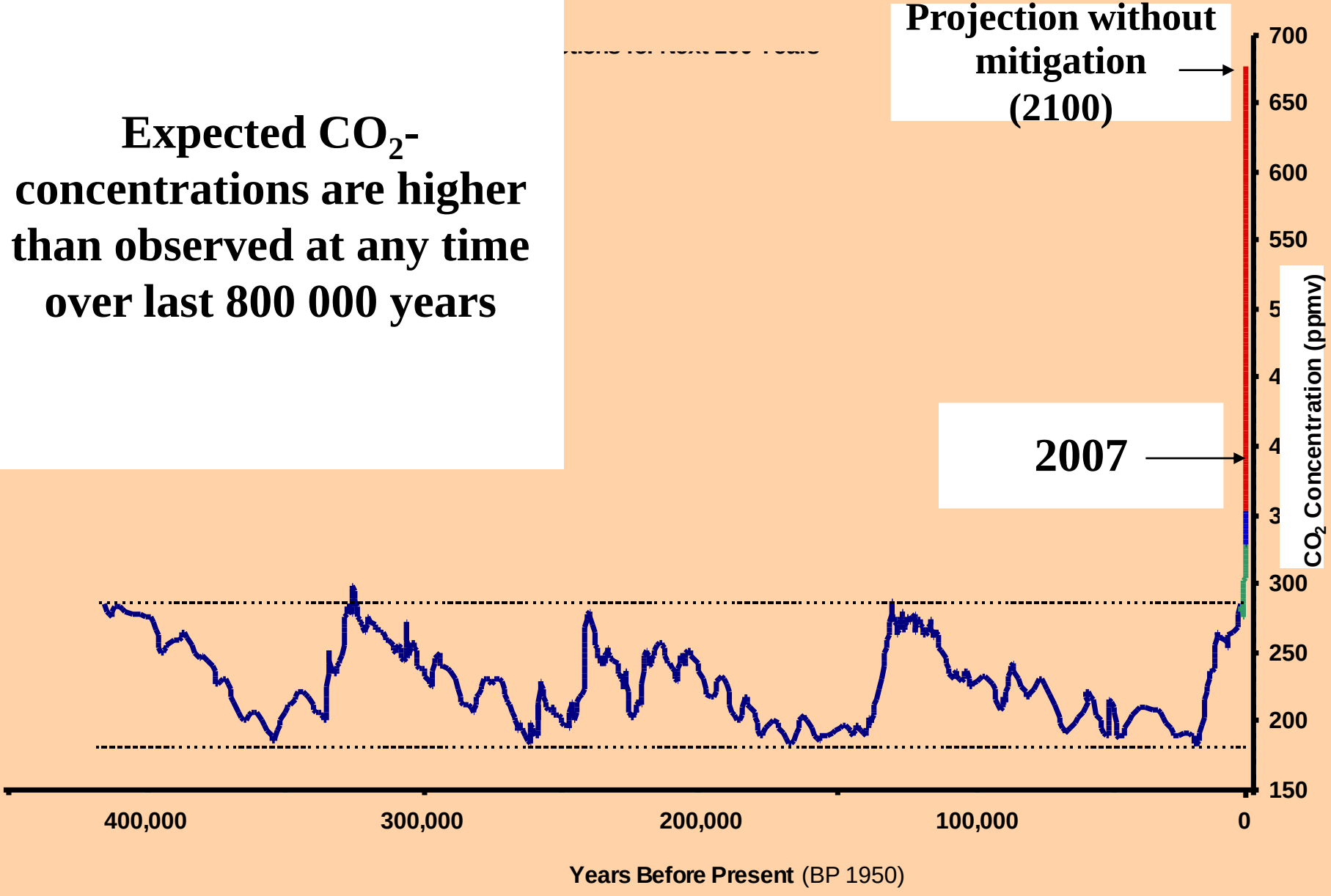
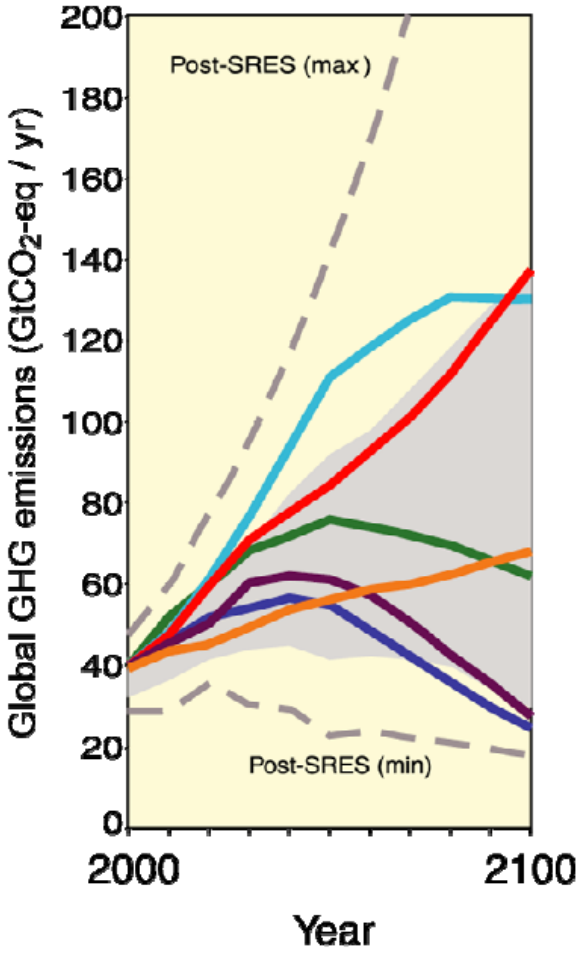
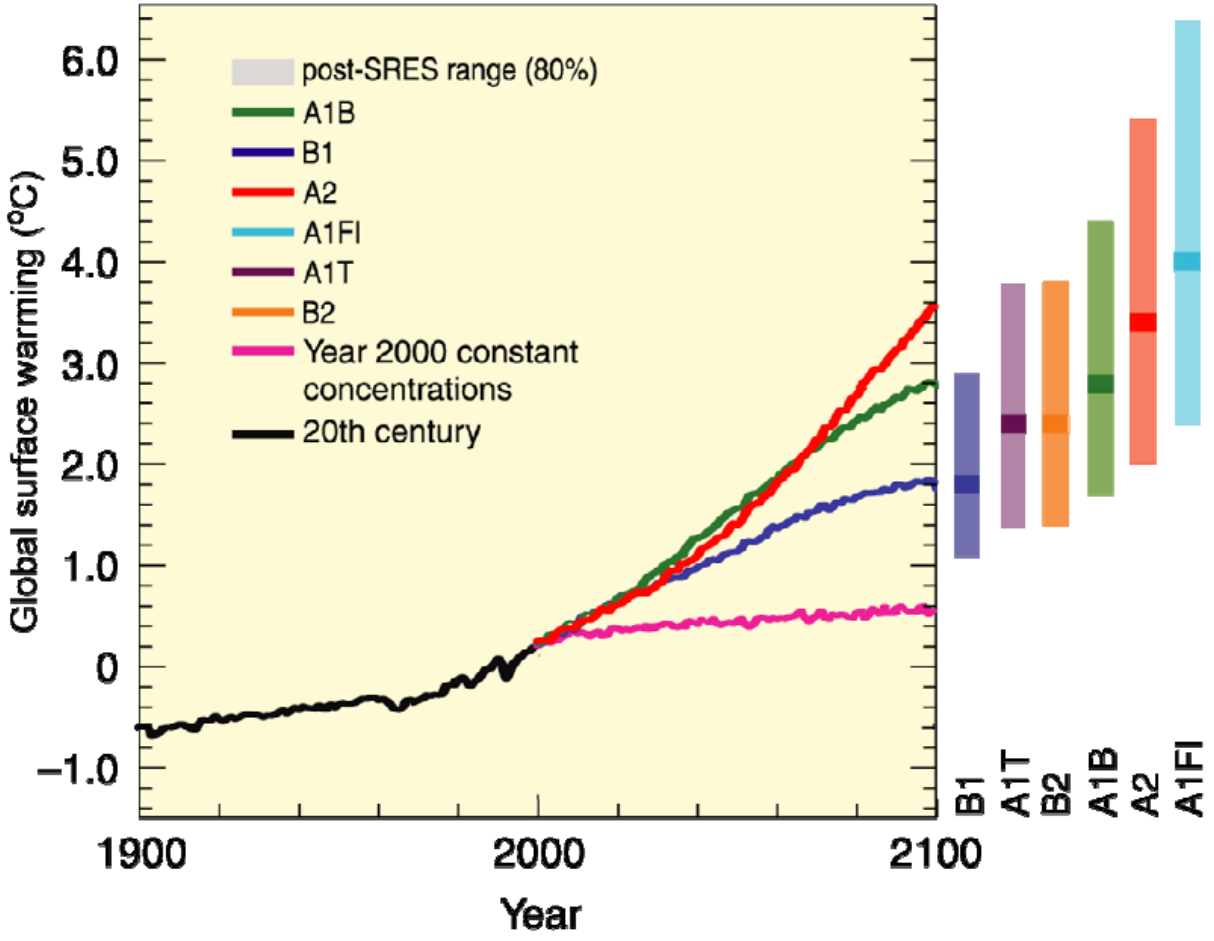
Expected CO_2-concentrations are higher than observed at any time over last 800 000 years



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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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 does IPCC tell us about impacts and adaptation?

- WG2: Impacts, Vulnerability, and adaptation

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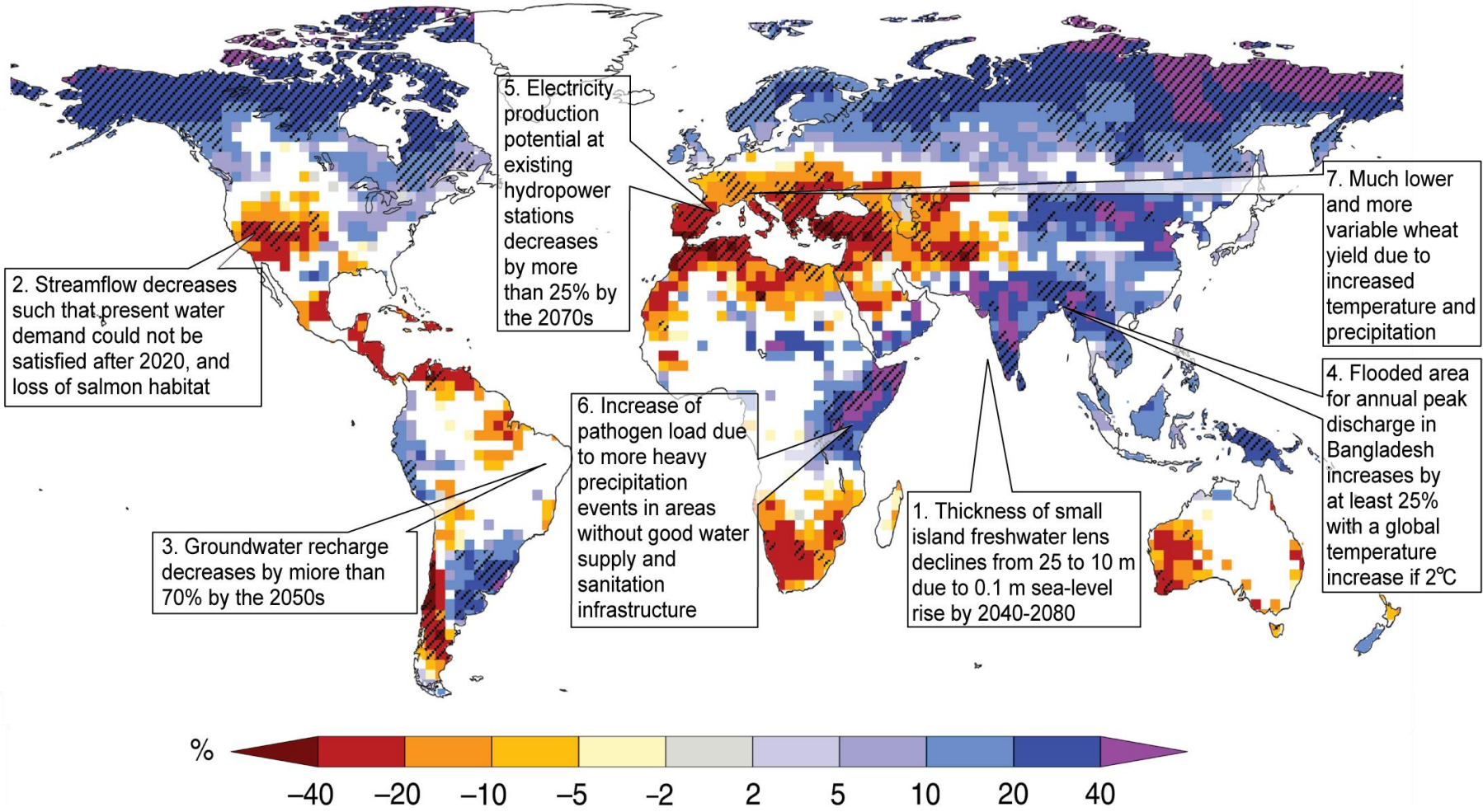
More heavy precipitation and more droughts….

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

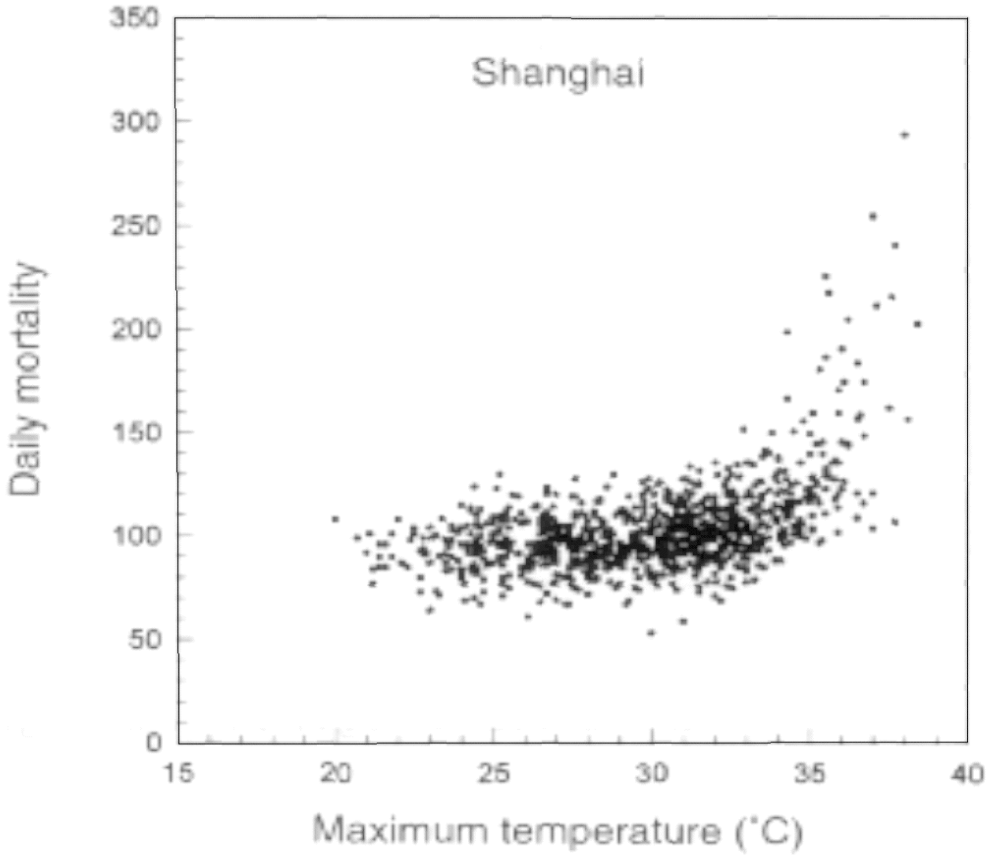


TP Figure 3.4: Ensemble mean change of annual runoff, in percent, between present (1980-1999) and 2090-2099 for the SRES A1B emissions scenario (based on Milly et al., 2005).

WMO

UNEP

Relationship between maximum temperature and mortality in Shanghai, China, 1980-89



Référence : ClLIMATE CHANGE AND HUMAN HEALTH, 1996

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Effects on Nile delta: 10 M people above 1m

(Time 2001)

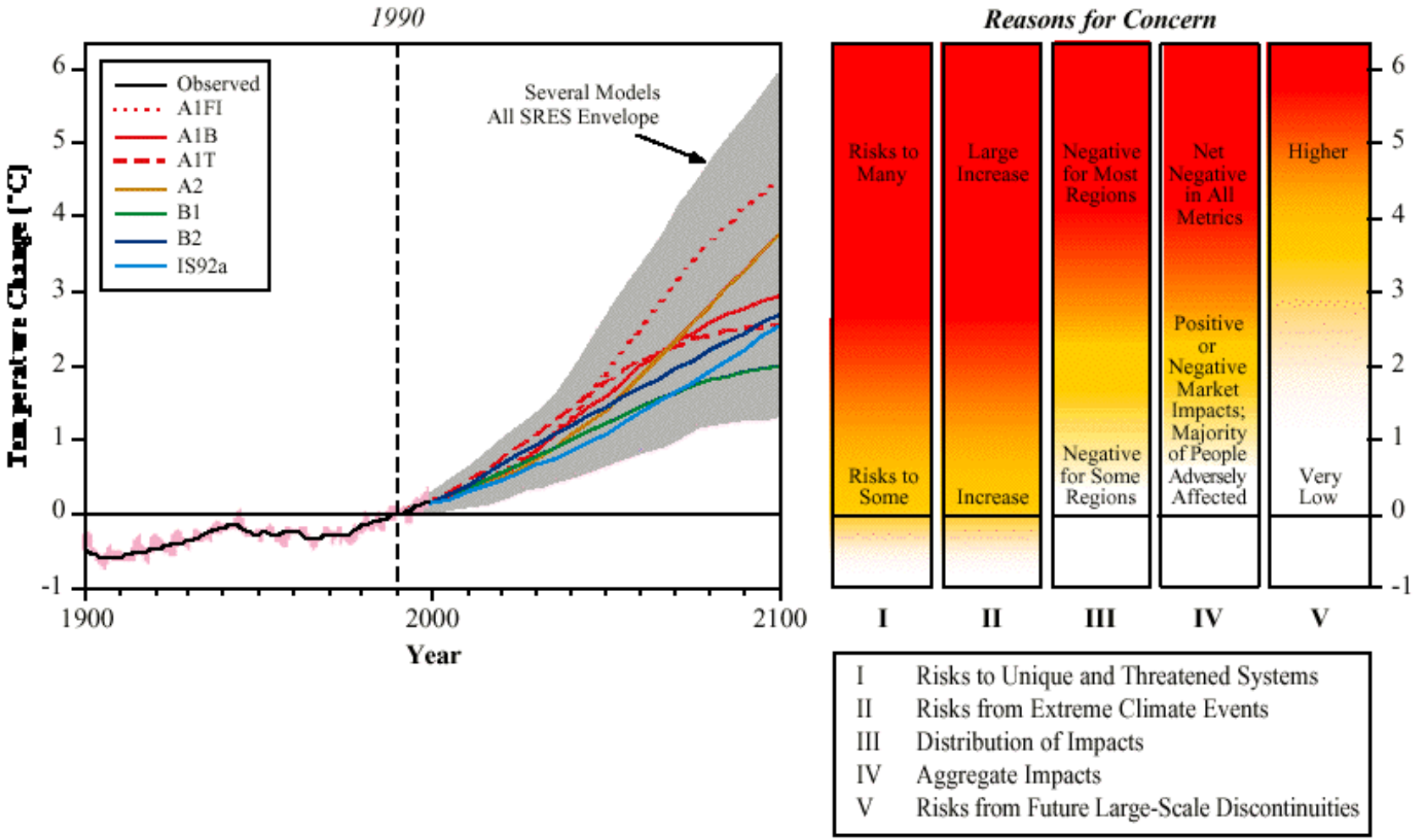
20% - 30% of plants and animals species at increased risk of extinction

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

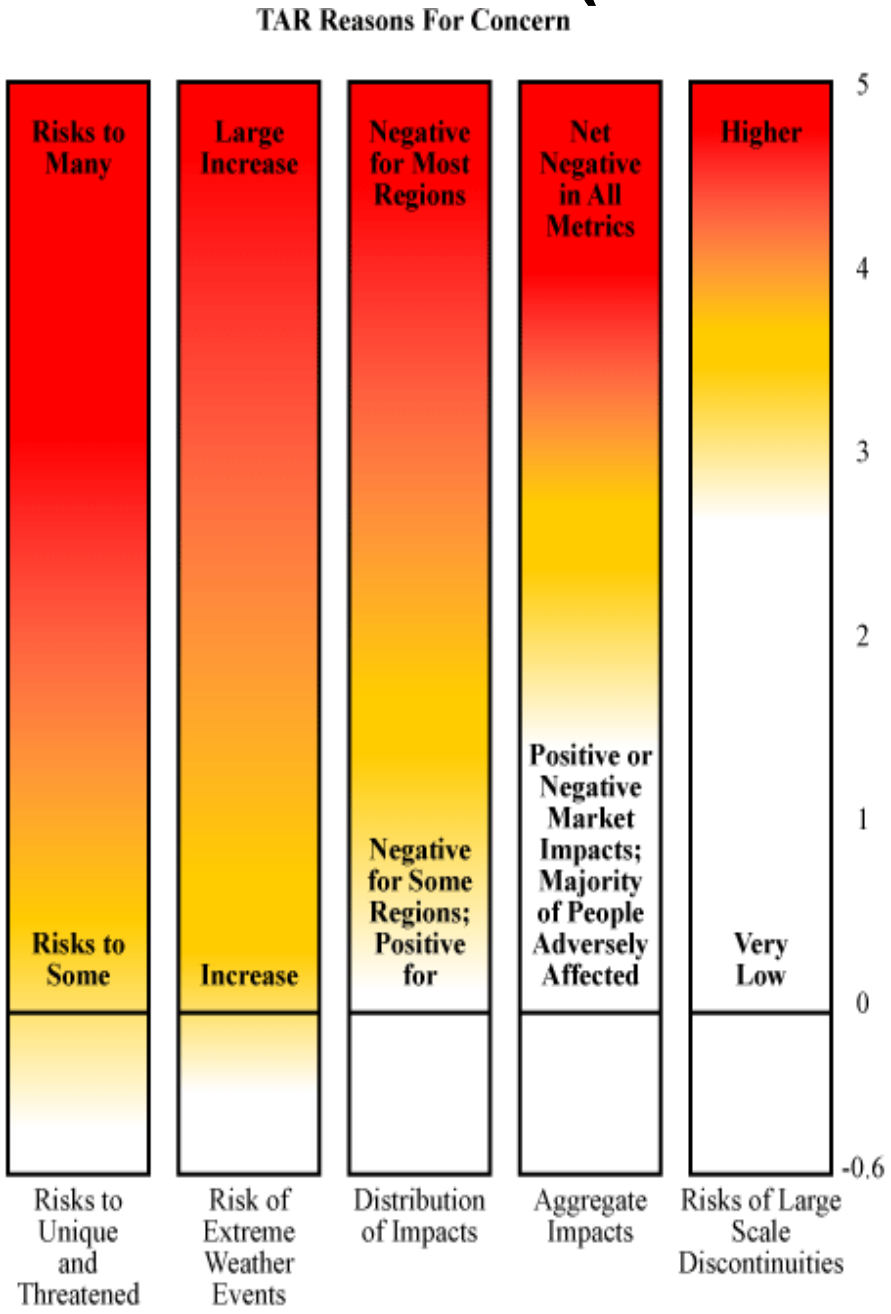
WMO

UNEP

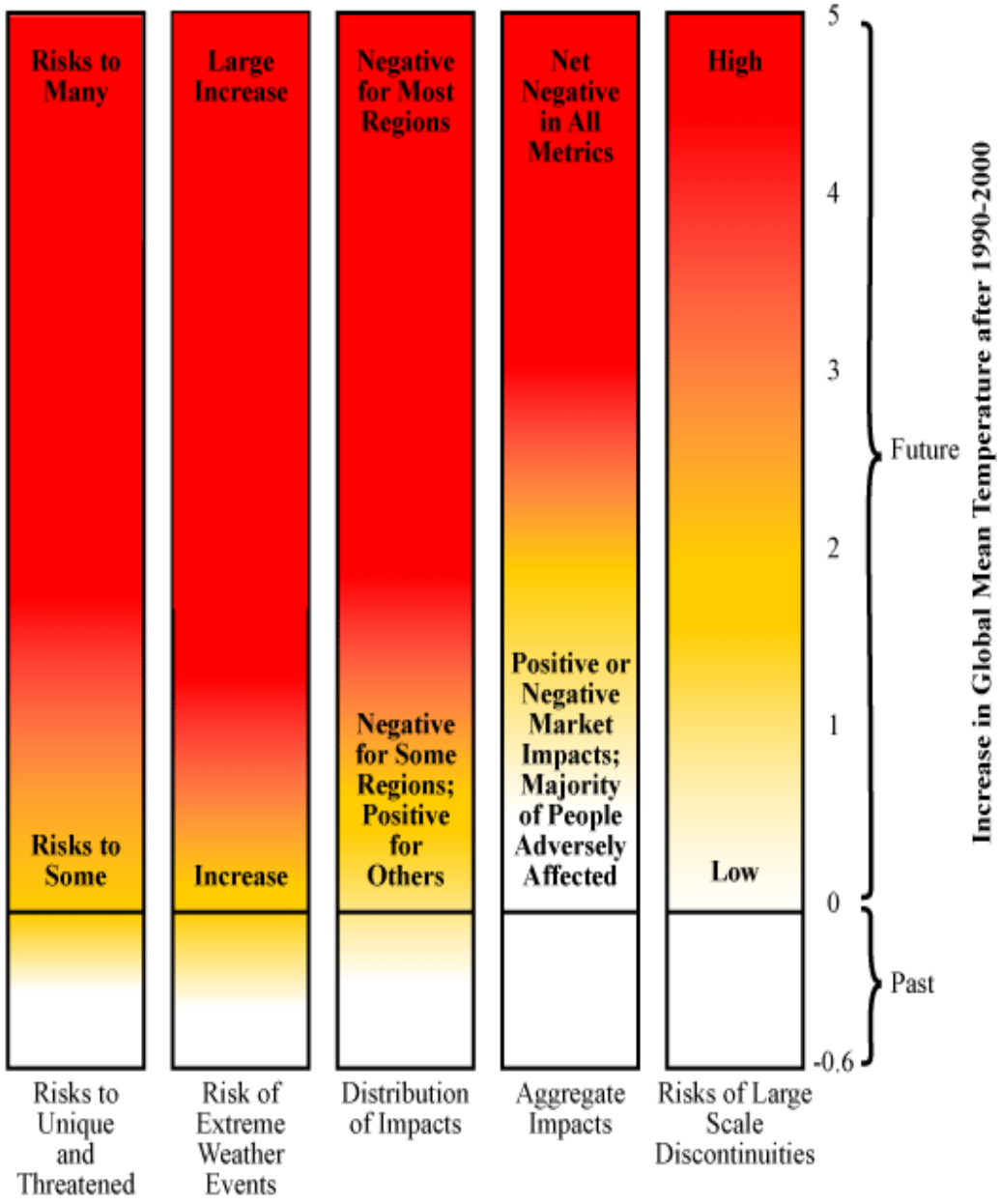
IPCC 2001:


1990
Observed
A1FI
A1B
A1T
A2
B1
B2
IS92a
Several Models
All SRES Envelope
Temperature Change (°C)
6
5
4
3
2
1
0
-1
1900
2000
2100
Year
Reasons for Concern
Risks to Many
Risks to Some
Large Increase
Increase
Negative for Most Regions
Negative for Some Regions
Net Negative in All Metrics
Positive or Negative Market Impacts; Majority of People Adversely Affected
Higher
Very Low
I
II
III
IV
V
I Risks to Unique and Threatened Systems
II Risks from Extreme Climate Events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from Future Large-Scale Discontinuities

Reasons for concern (TAR-2001)



Reasons for concern (Smith et al, 2009, PNAS, based on AR4-2007)



What does IPCC tell us on mitigation?

- WG3: Mitigation

Stabilisation levels and equilibrium global mean temperatures

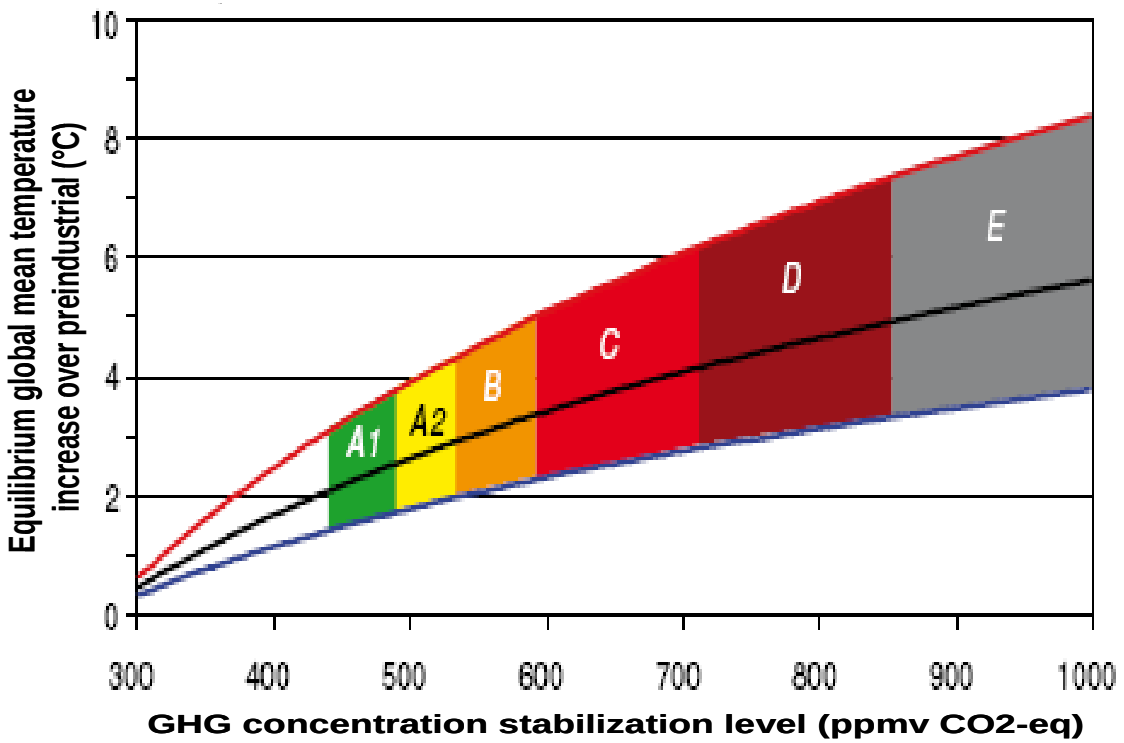
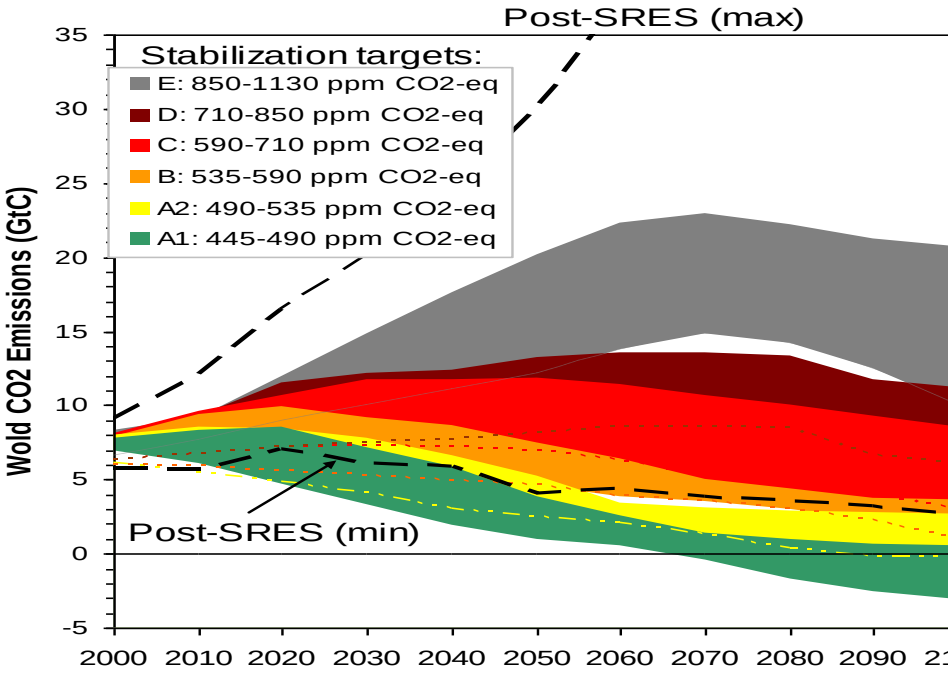
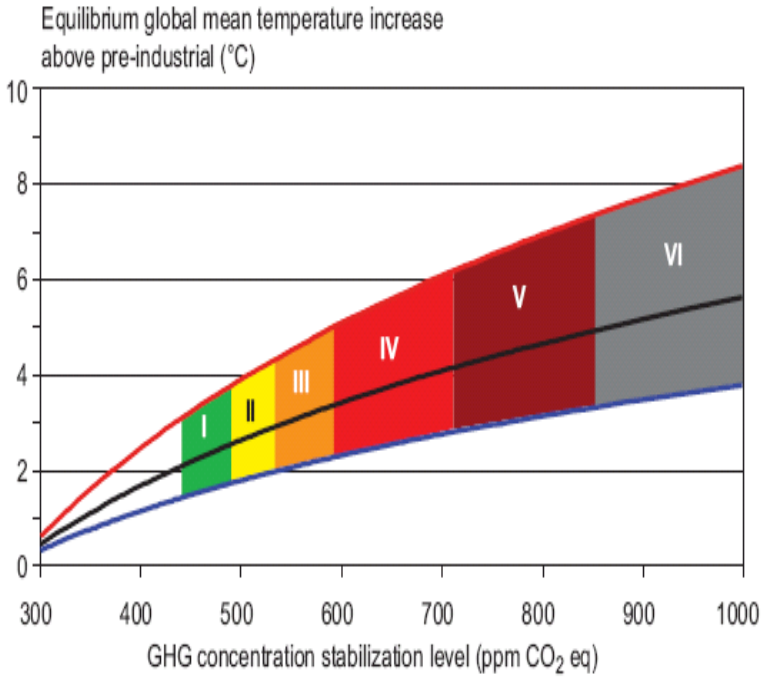


***Figure SPM 8**: Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3 ℃ (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5 ℃ (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2 ℃ (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories. The data are drawn from AR4 WGI, Chapter 10.8.*

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



Multigas and CO2 only studies combined



Long term mitigation (after 2030)

⌘IPCC WGIII Technical Summary, page 39:

- 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

Test yourself effect of different scenarios and uncertainties with the Java Climate Model:

- www.climate.be/JCM: interactive climate model developed by Dr. Ben Matthews (Université catholique de Louvain, Belgium), with support from Belgian Science Policy Office.

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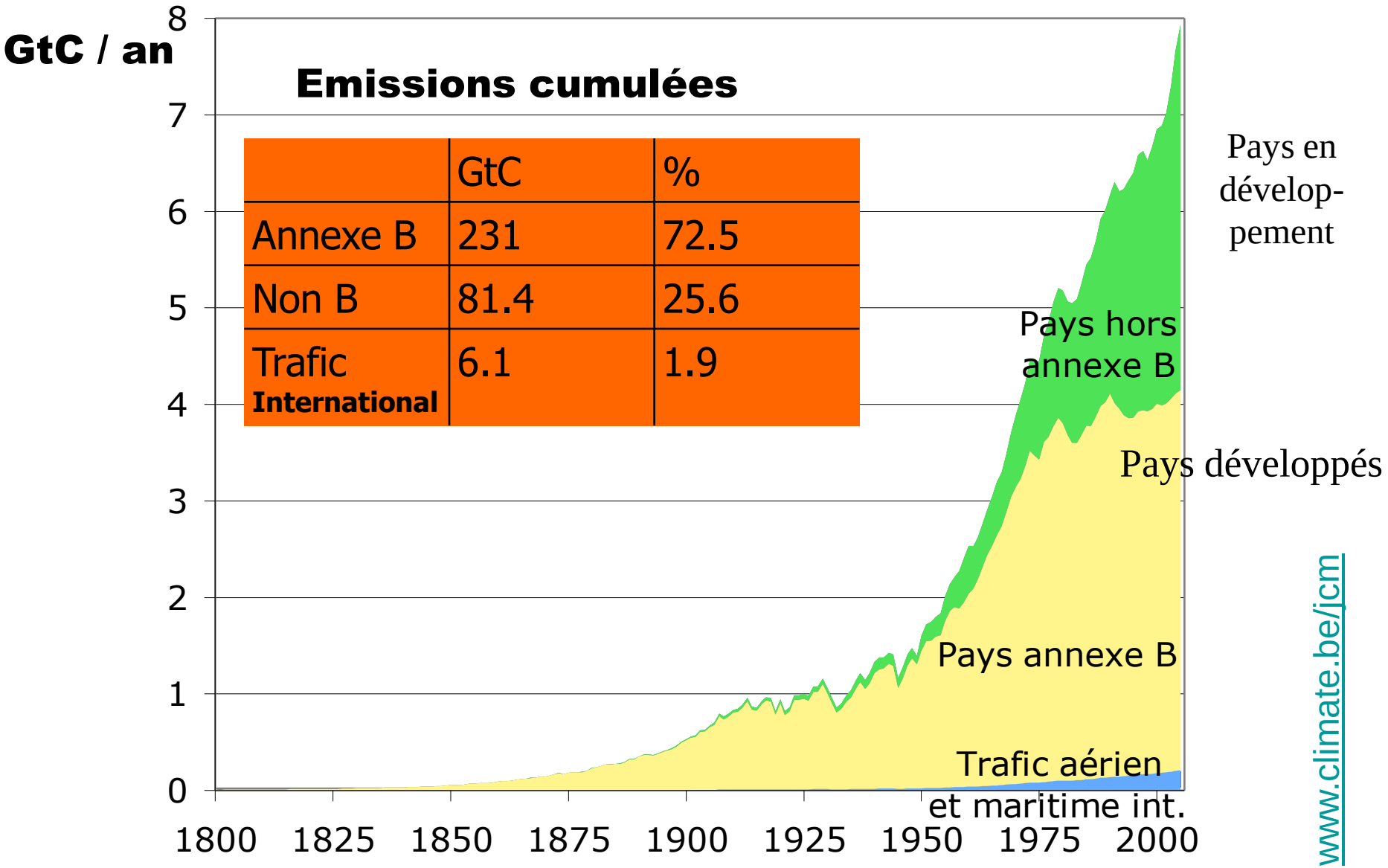
Not always easy
to assume responsibility…

Assuming responsibility…

Emissions historiques : CO_2 (fossil fuel)



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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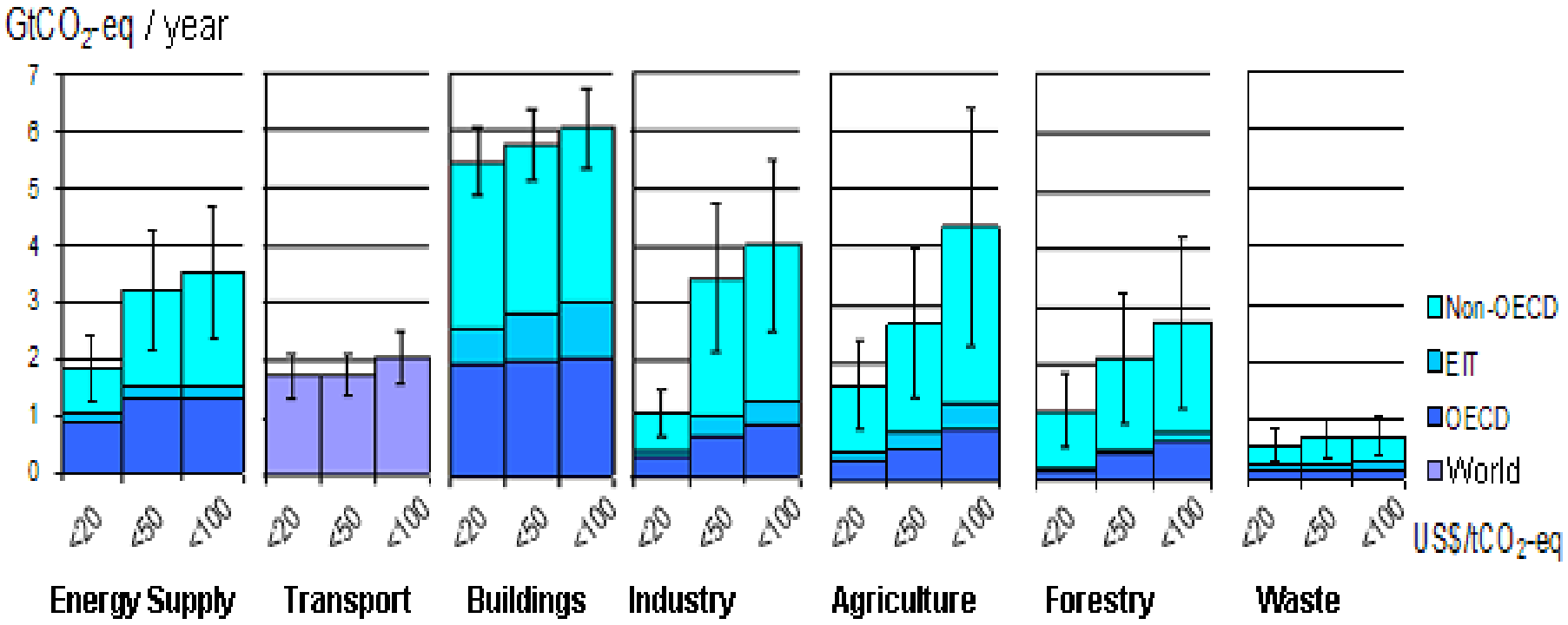
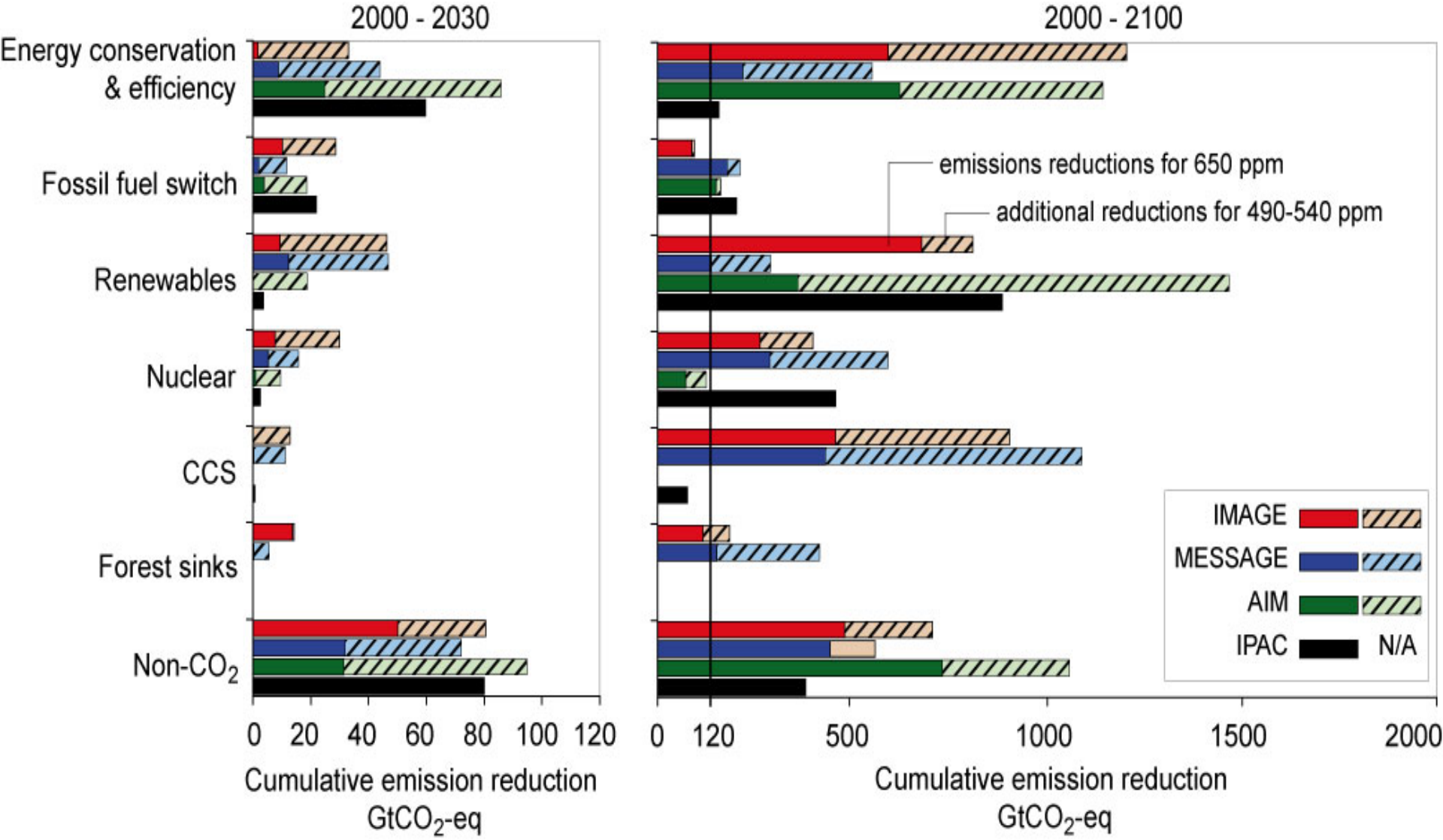
All sectors and regions have the potential to contribute by 2030



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

Role of Technology, following IPCC AR4



Changes in lifestyle and behaviour patterns can contribute to climate change mitigation

- Changes in occupant behaviour, cultural patterns and consumer choice in buildings.
- Reduction of car usage and efficient driving style, in relation to **urban planning and availability of public transport**
- Staff training, reward systems, regular feedback and documentation of existing practices in industrial organizations

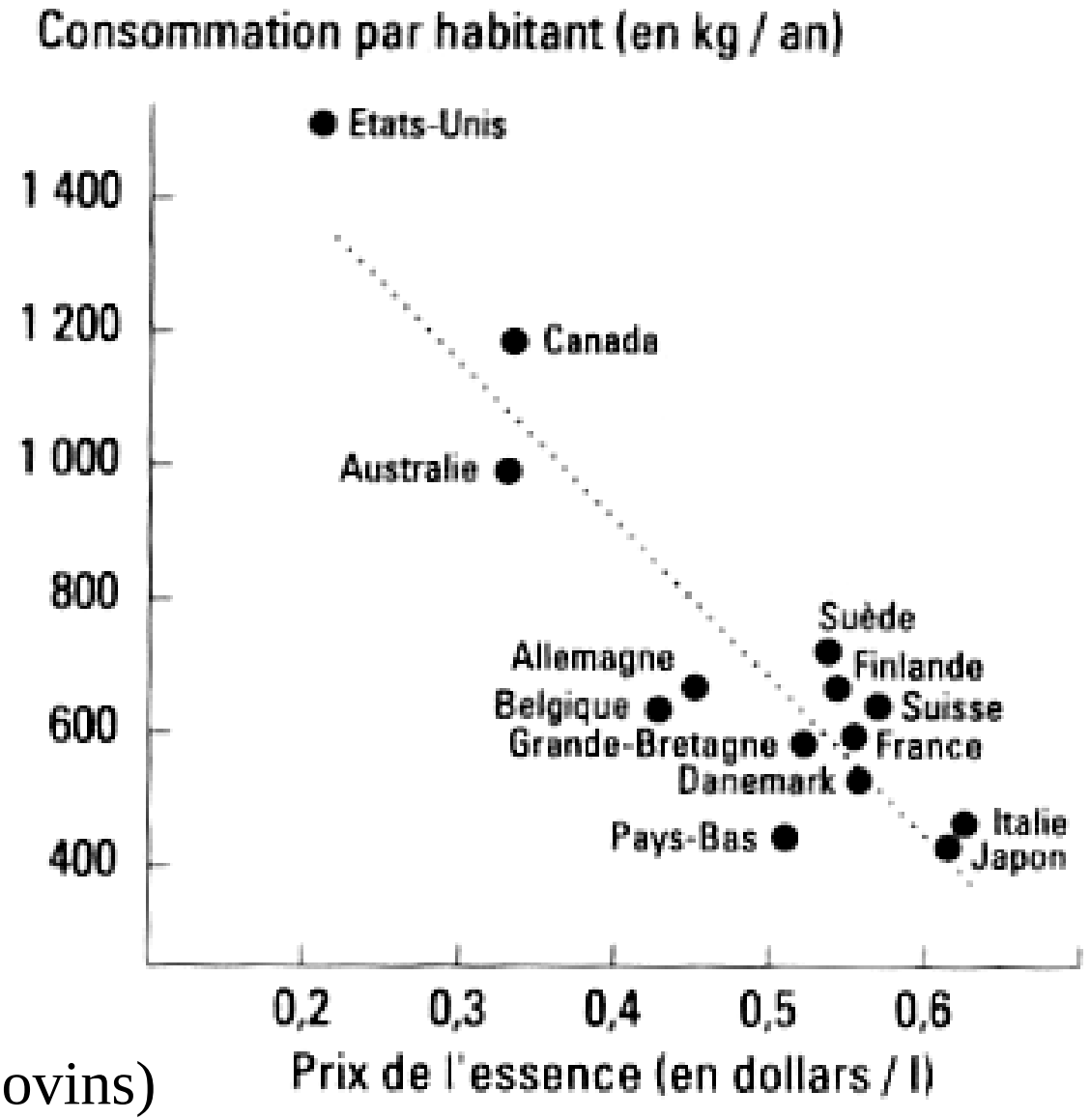
The importance of a "price of carbon"

- **Policies that provide a real or implicit price of carbon could create incentives for producers and consumers to significantly invest in low-GHG products, technologies and processes.**
- **Such policies could include economic instruments, government funding and regulation**
- **For stabilisation at around 550 ppm CO_{2eq} carbon prices should reach 20-80 US$/t$CO_{2eq}$ by 2030 (5-65 if "induced technological change" happens)**
- **At these carbon prices large shifts of investments into low carbon technologies can be expected**
- **For stabilisation at around 450 ppm CO_{2eq} carbon prices should reach 100-200 US$/t$CO_{2eq}$ by 2030 (multiply by 25 for a tonne of CH_4)**

What does US$ 100/ tCO2eq mean?

- Crude oil: ~US$ 50/ barrel
- Gasoline: ~24 US cent/ litre (1 US$/gallon)
- Electricity:
  - from coal fired plant: ~10 US cent/kWh
  - from gas fired plant: ~3 US cent/kWh

Correlation fuel price/consumption



(Source: Lovins)

What are the macro-economic costs in **2030**?

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[1] (%)	Range of GDP reduction [2] (%)	Reduction of average annual GDP growth rates [3] (percentage points)
590-710	0.2	-0.6 – 1.2	< 0.06
535-590	0.6	0.2 – 2.5	<0.1
445-535[4]	Not available	< 3	< 0.12

[1] This is global GDP based market exchange rates.
[2] The median and the 10th and 90th percentile range of the analyzed data are given.
[3] The calculation of the reduction of the annual growth rate is based on the average reduction during the period till 2030 that would result in the indicated GDP decrease in 2030.
[4] The number of studies that report GDP results is relatively small and they generally use low baselines.

There are also co-benefits of mitigation

- Near–term health benefits from **reduced air pollution** may offset a substantial fraction of mitigation costs
- Mitigation can also be positive for: energy security, balance of trade improvement, provision of modern energy services to rural areas and employment

BUT

- Mitigation in one country or group of countries could lead to higher emissions elsewhere (“carbon leakage”) or effects on the economy (“spill-over effects”).

In the text that was on the table in Bangkok (October 2009) (FCCC/AWG-LCA/2009/INF.2):

- I.31 [To this end, [developed country parties]…, as a group, [shall][should][reduce their [domestic] GHG emissions][deeply cut their GHG emissions]: (a)[By at least 25-40][By 25-40] [By more than 25-40] [In the order of 30] [By at least 40] [By 45] [By at least 45]% from 1990 levels by [2017] [2020], through domestic and international efforts]…

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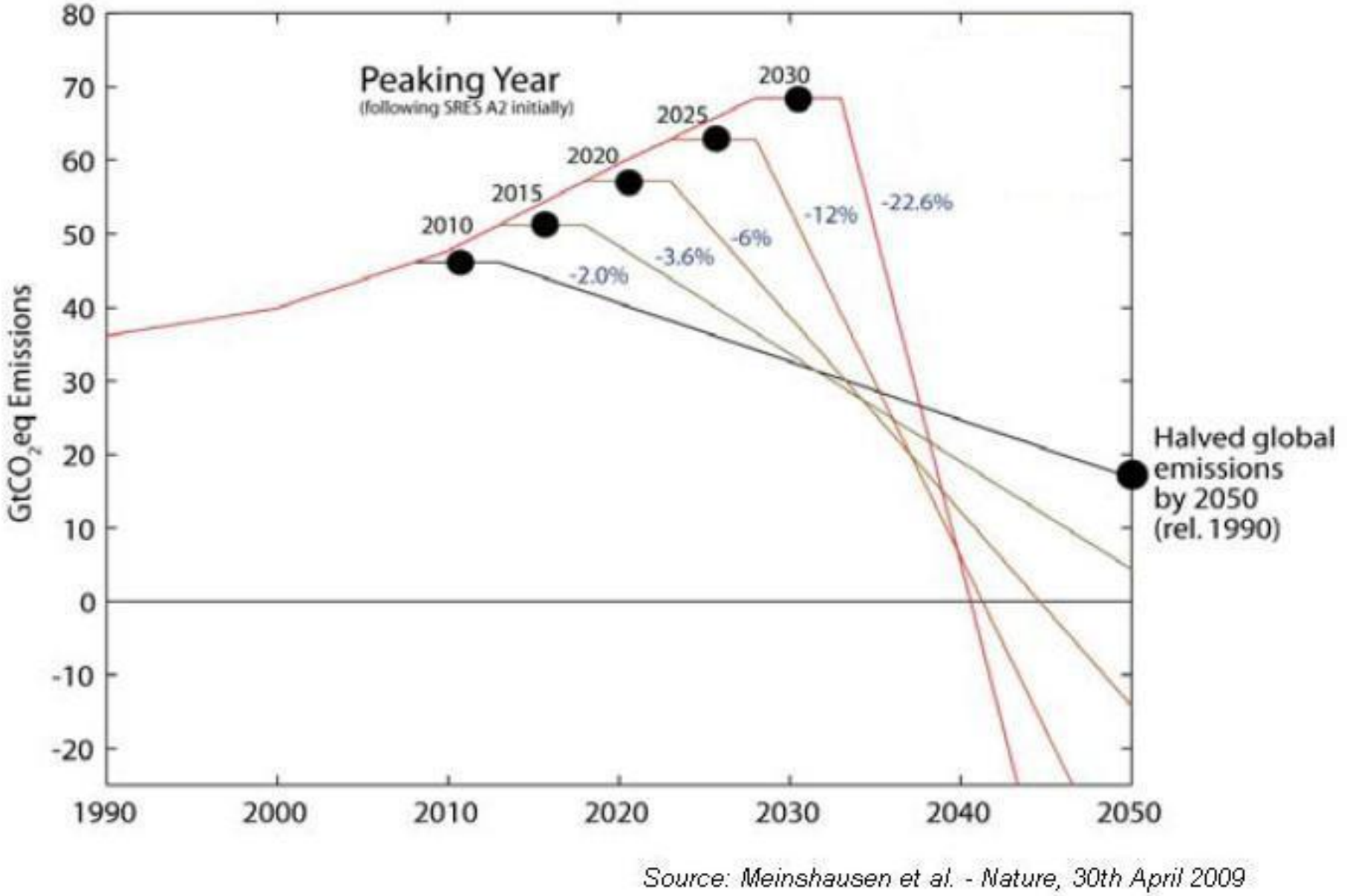

Source: Meinshausen et al. - Nature, 30th April 2009

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Conclusion

- **The Earth is heading towards a climate no human has ever known: we need to adapt**
- **Significant risks are assessed to be occurring for lower temp. increase than assessed earlier: adaptation (and money) is needed**
- **Adaptation has limits and costs: we need to prevent excessive warming (mitigation)**
- **Annex I reductions of 25-40% (1990-2020), and global emissions becoming NEGATIVE around 2070 deliver increase under 2°C only IF we are very lucky: the challenge is much bigger than assessed earlier**

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Conclusion

- We are heading towards strong constraints on GHG emissions, in all sectors
- Coherence between different policies (energy, environment, trade, transport, industry, …) is essential, and offers many opportunities
- Costs can be limited, if there is much international collaboration
- Those who will be bold will be winners
- Where there is a will, there is a way

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Web sites…

- www.ipcc.ch : IPCC full reports and SPM
- www.climate.be/jcm Interactive model (developed at UCL with support of Belgian Science Policy Office)
- www.climate.be/vanyp: my web page with many of my slides