Climate change and low carbon cities: the IPCC case for action

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What is the IPCC?

- **IPCC : Intergovernmental Panel on Climate Change (GIEC in French)**
- **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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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

What does IPCC tell us about climate science?

- WG1: 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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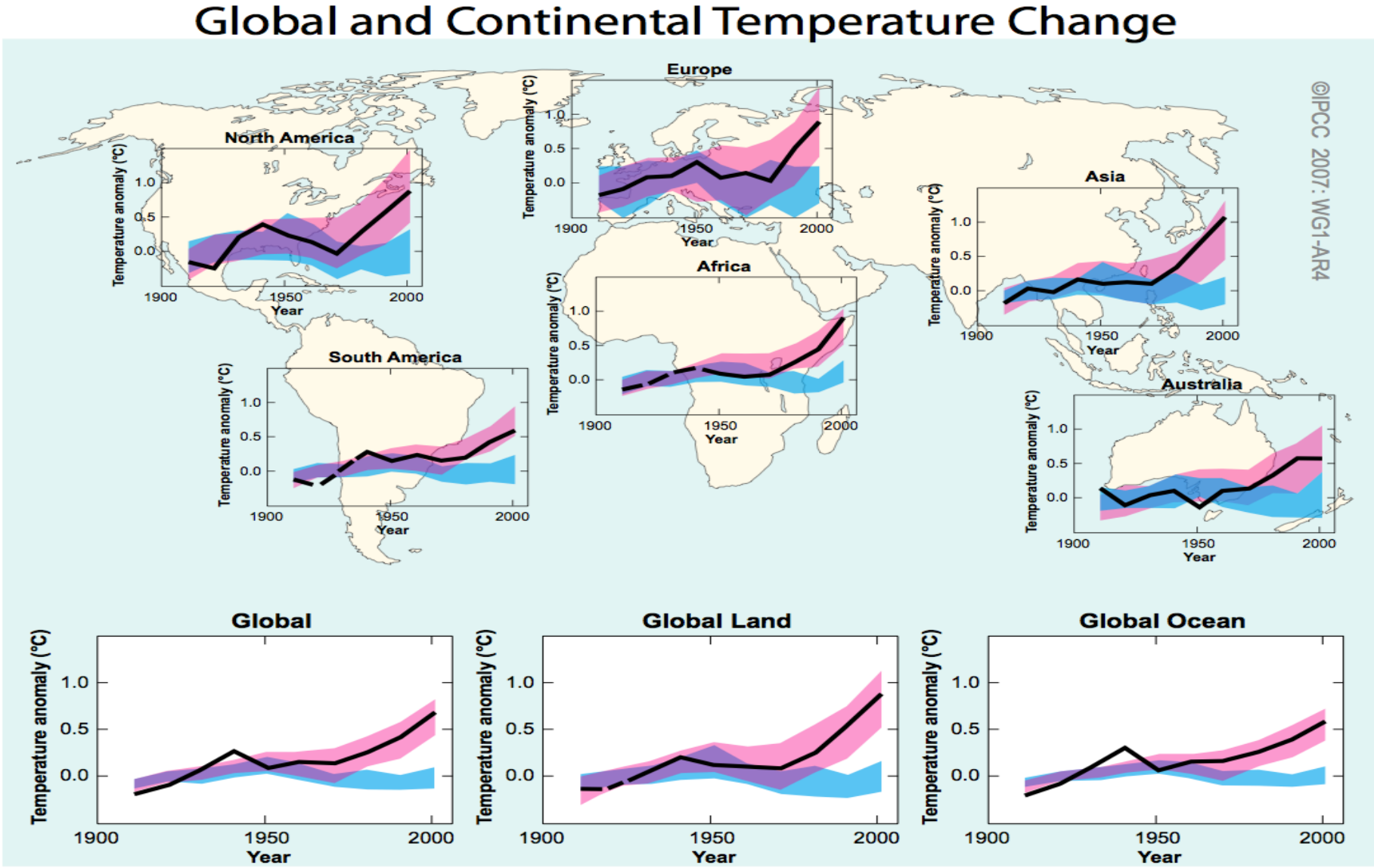
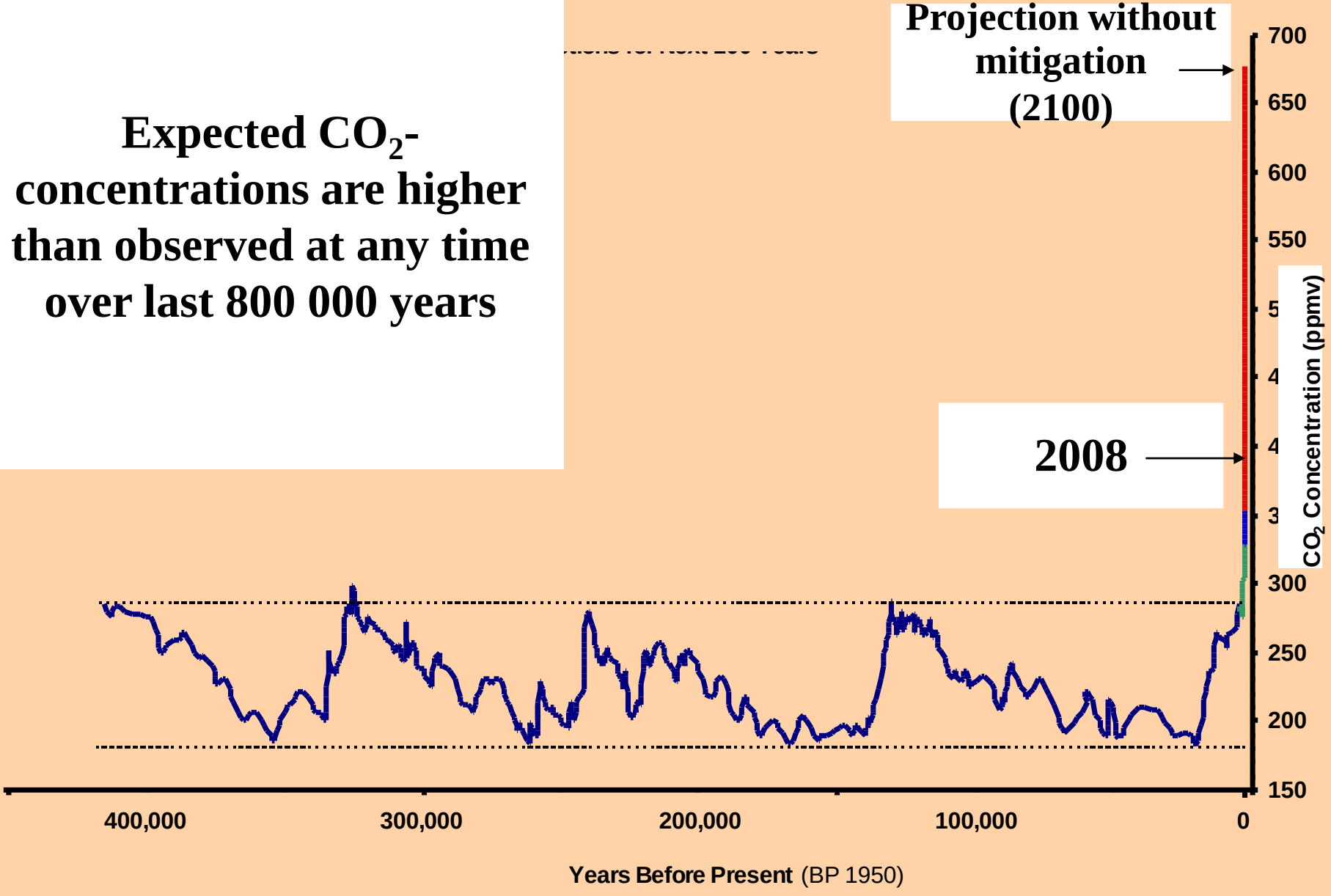
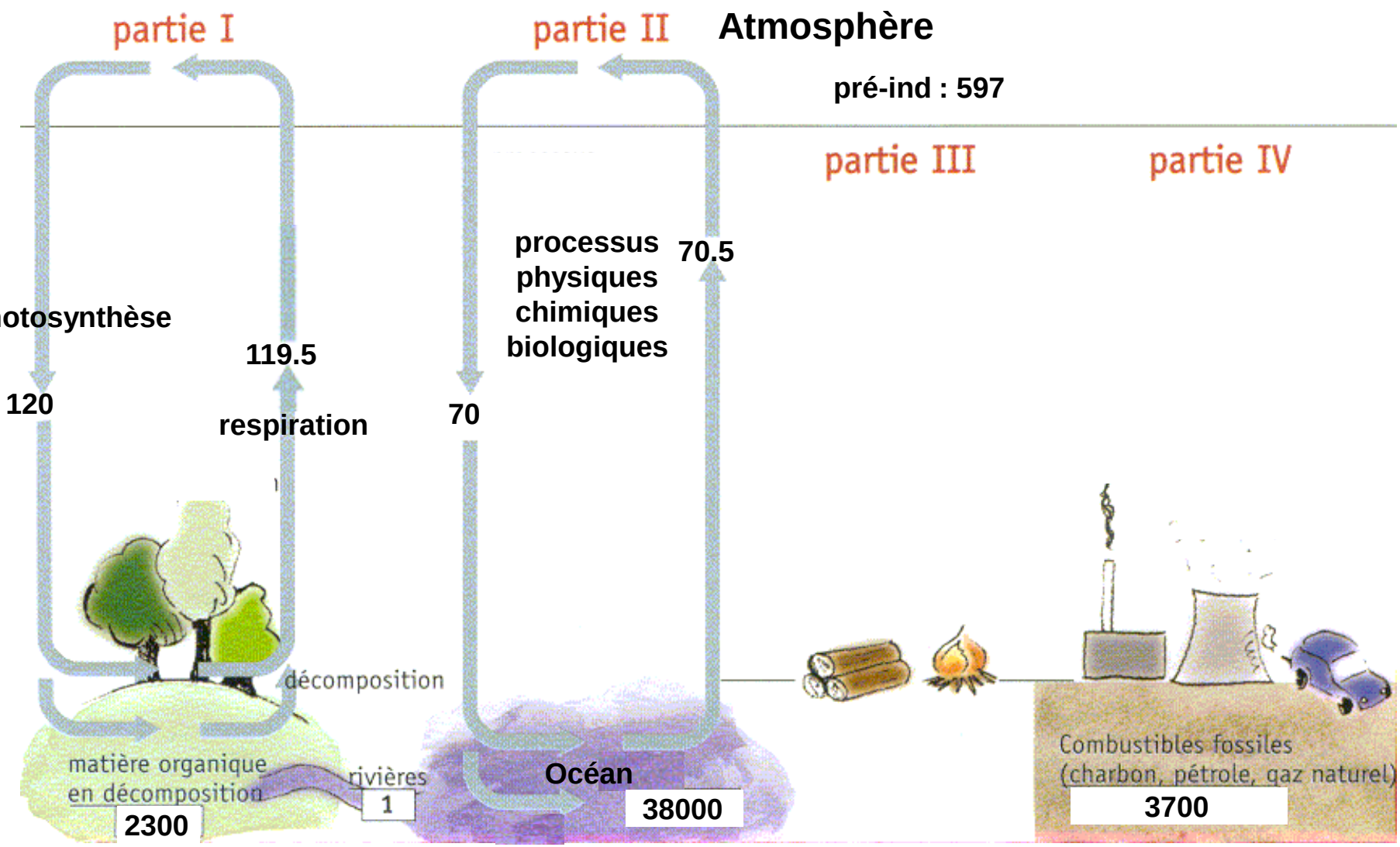
Understanding and Attributing Climate Change



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



Cycle du carbone



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

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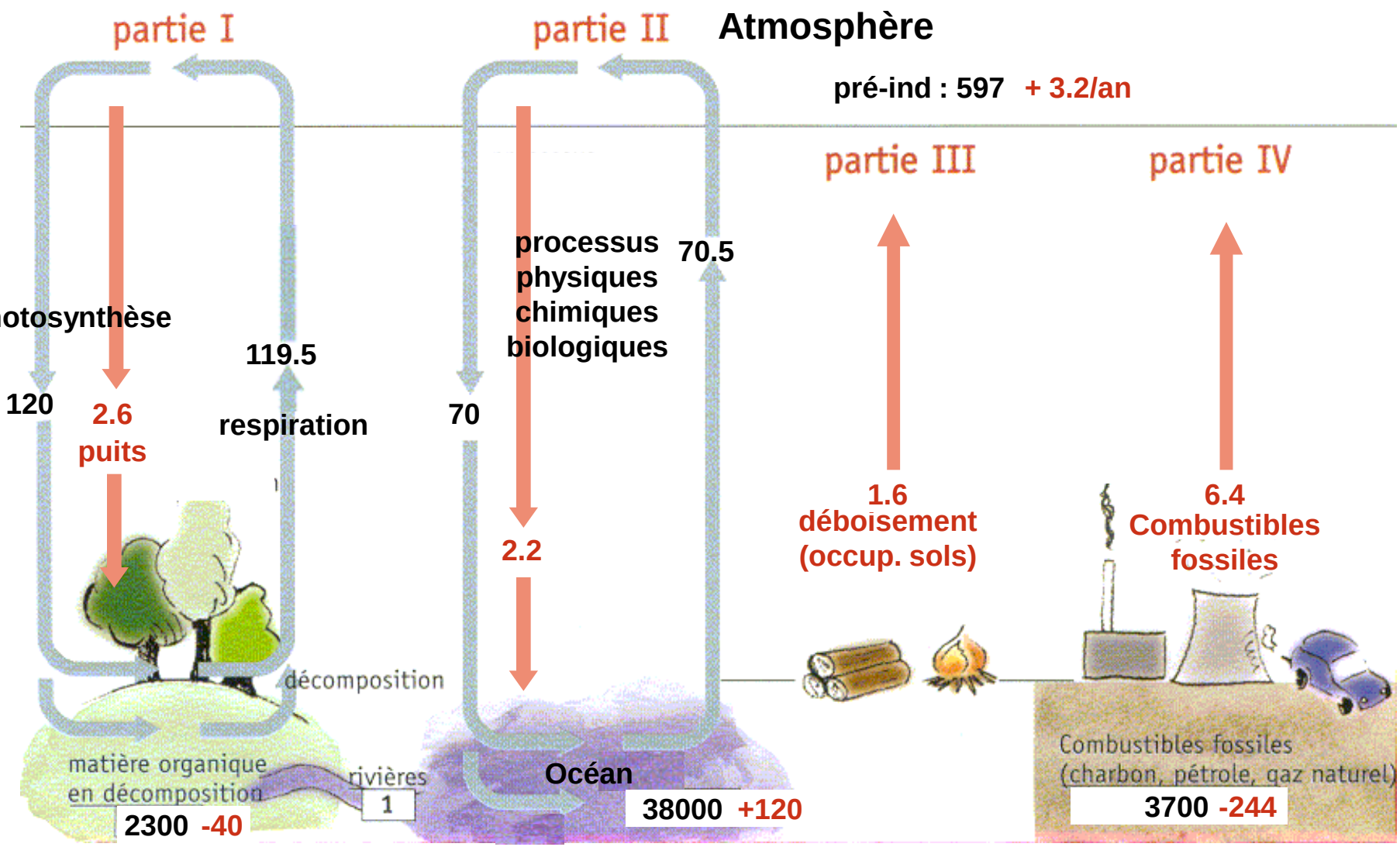
Cycle du carbone



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

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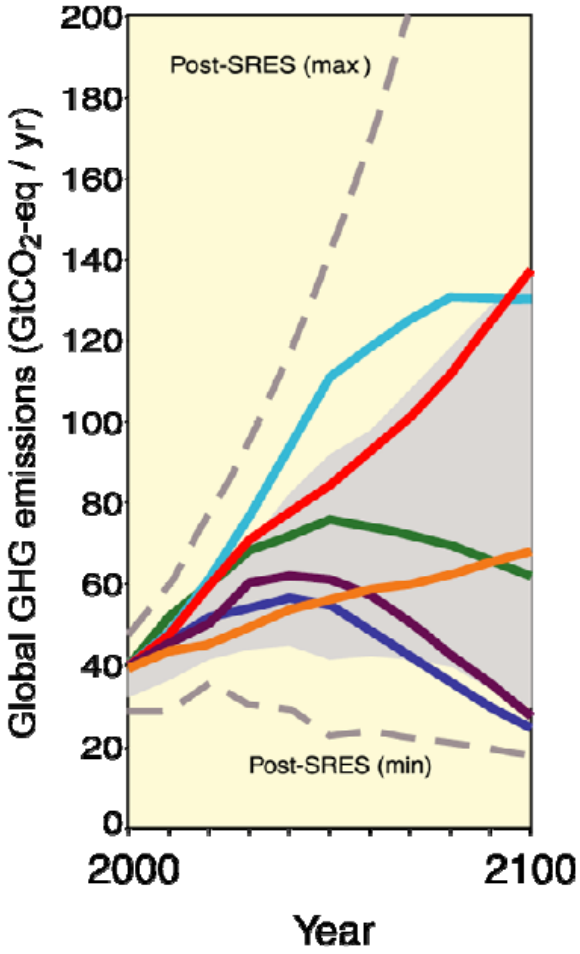
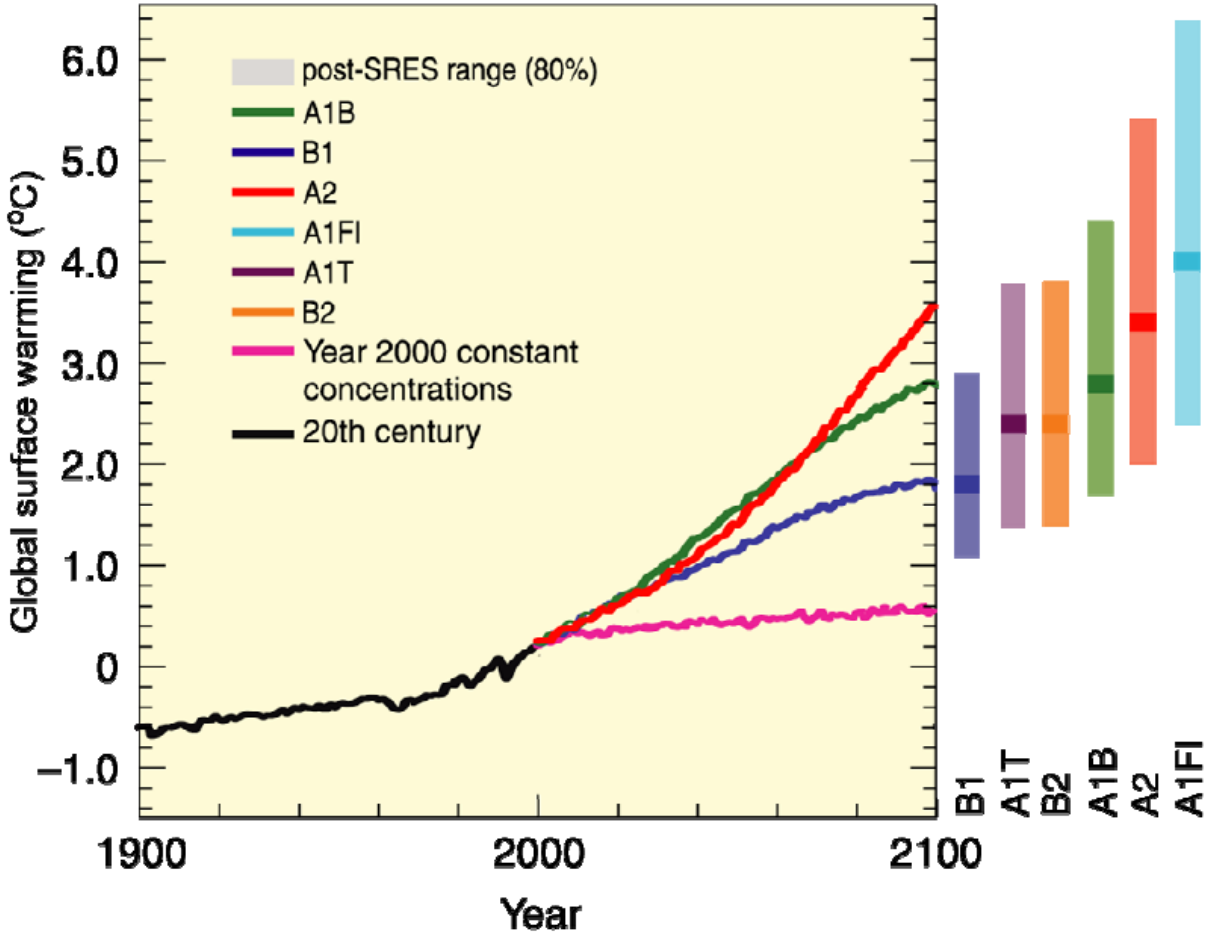
Source: IPCC, AR4 (2007)

Climate projections without mitigation





NB: écart par rapport à la moyenne 1980-1999

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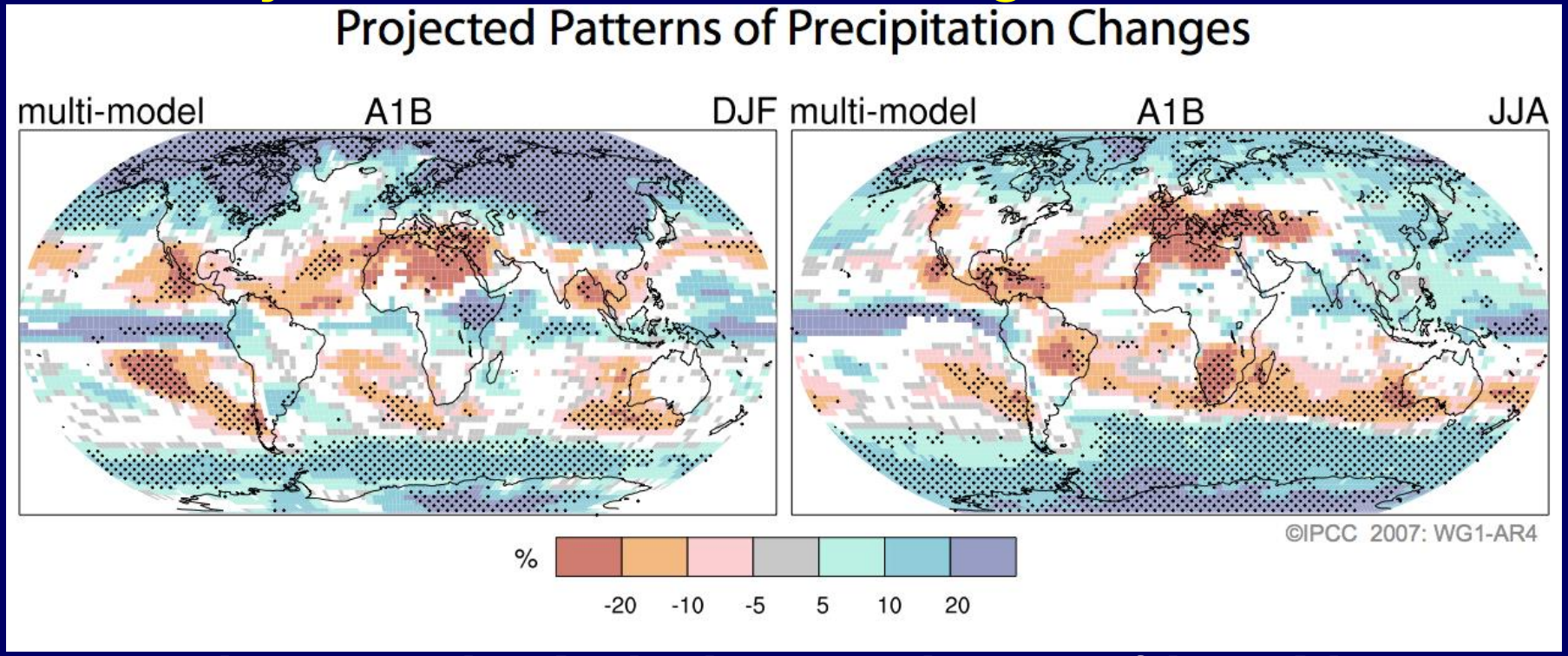
Projections of Future Changes in Climate



Changes are plotted only where more than 66% of the models agree on the sign of the change. The stippling indicates areas where more than 90% of the models agree on the sign of the change.

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

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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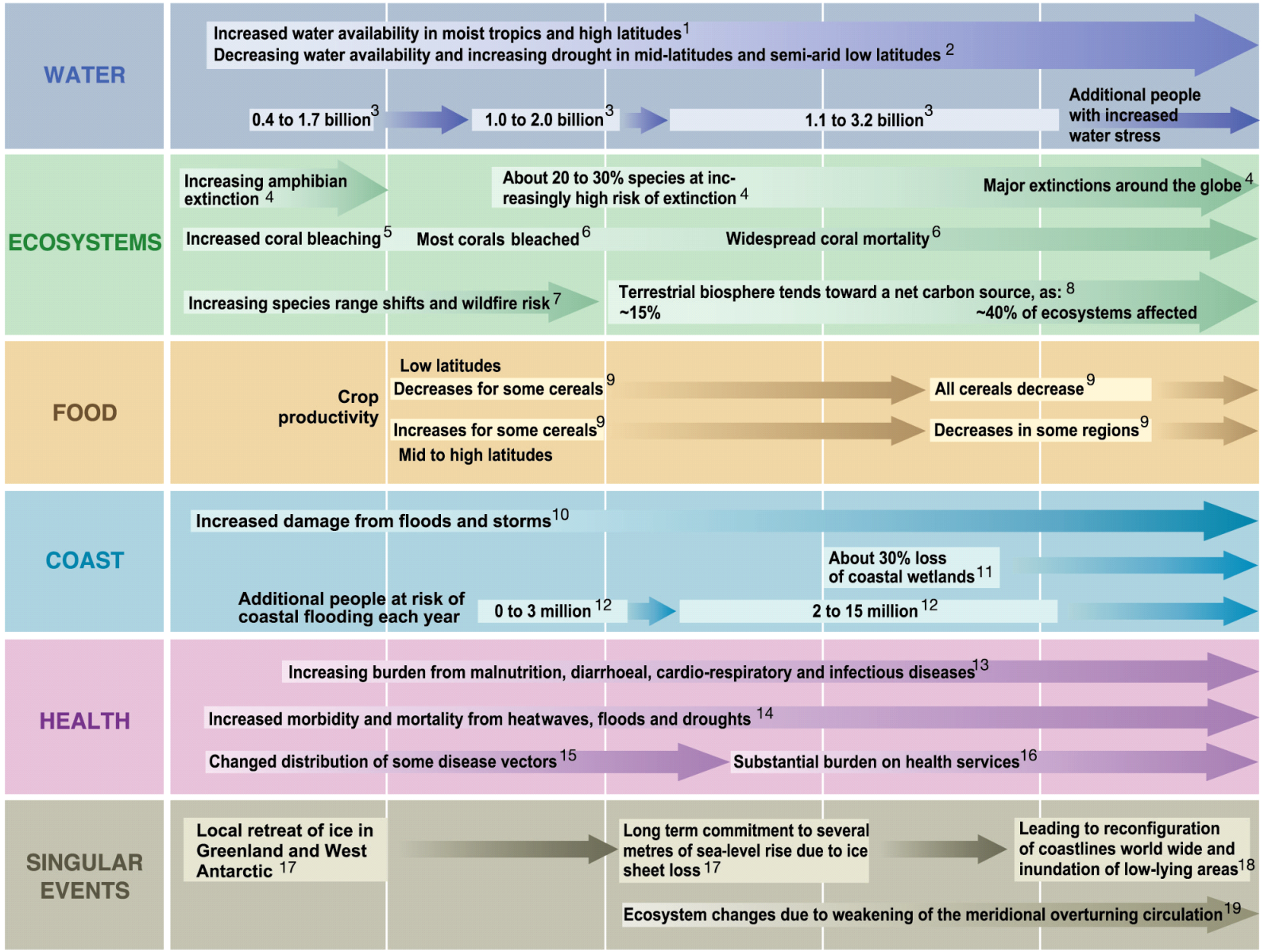
Table TS.3. (lower) Examples of global impacts projected for changes in climate (and sea level and atmospheric CO_2 where relevant)



Source: IPCC WGII AR4

SECTORS

Water: Water supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions supplied by meltwater from major mountain ranges, where more than one-sixth of the world population currently lives.

Ecosystems: ~20-30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C.

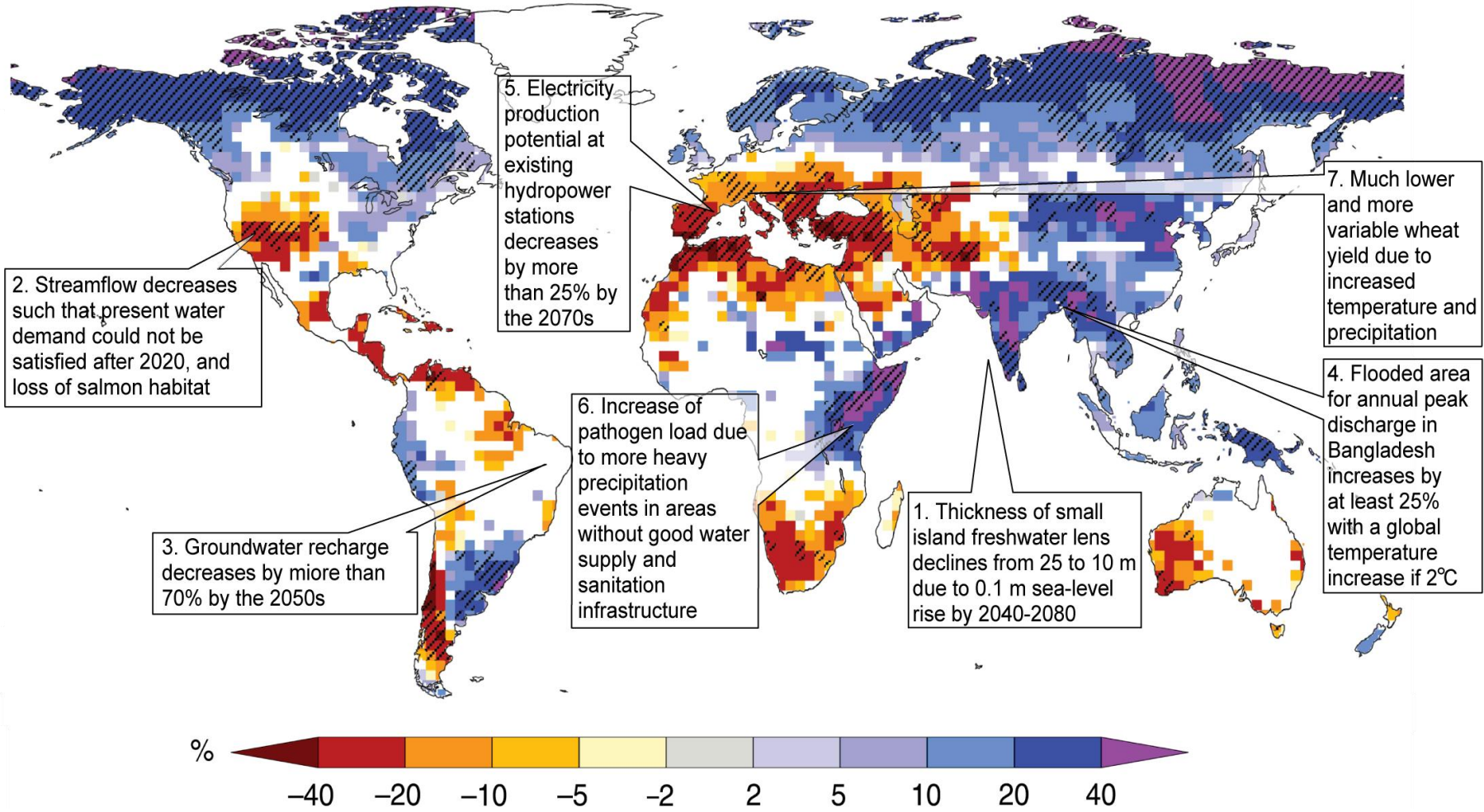
Food: At lower latitudes, crop productivity is projected to decrease for even small local temperature increases (1-2°C). At higher latitudes crop productivity is projected to increase for temperature increases of 1-3°C, then decrease beyond that.

Coasts: Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s.

Industry, Settlement and Society: The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanisation is occurring.

Human Health: Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity.

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

REGIONS

Africa: By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change.

Asia: Projected crop yields could increase up to 20% in E and SE Asia while they could decrease up to 30% in C and S Asia by the mid-21st century.

Australia and New Zealand: Significant biodiversity loss is projected to occur by 2020 in some ecologically-rich sites including the Great Barrier Reef and Queensland Wet Tropics.

Europe: Initially, climate change is projected to bring benefits to Northern Europe (reduced energy demand for heating, crop and forest growth increases) whilst Southern Europe is expected to experience increased heat waves, wildfires and reduced crop productivity.

Latin America: By mid-century, climate change is projected to lead to the gradual replacement of tropical forest by savanna in eastern Amazonia.

North America: Cities currently experiencing heat waves will experience many more in the future with adverse health impacts.

Polar Regions: Climate change is projected to impact natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators.

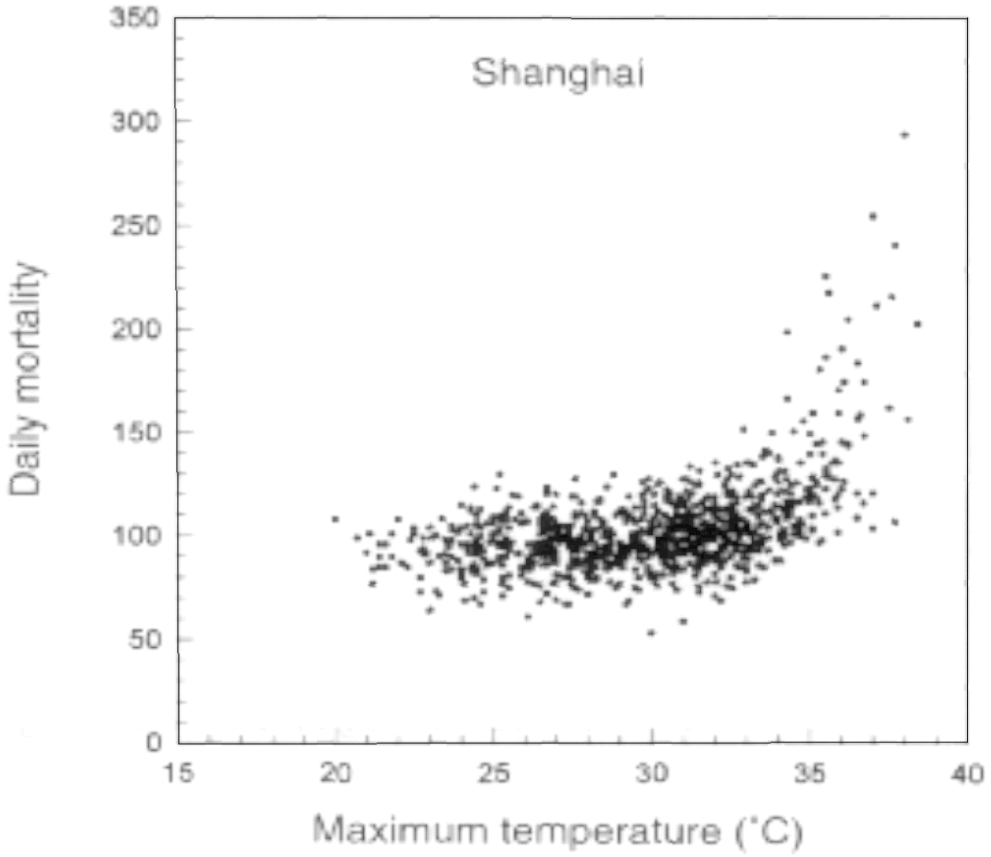
Small Islands: Deterioration in coastal conditions e.g., through beach erosion and coral bleaching is expected to affect local resources e.g., fisheries and tourism.

Asia: key impacts

(Source: IPCC AR4 WGII Chapter 10)

- By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
- Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.
- Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

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



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Africa

(Source: IPCC AR4 WGII Chapter 9)

- By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change.
- By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition.
- Towards the end of the 21st century, projected sea level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5 to 10% of GDP.
- By 2080, an increase of 5 to 8% of arid and semi-arid land in Africa is projected under a range of climate scenarios

Effects on Nile delta: 10 M people above 1m

(Time 2001)

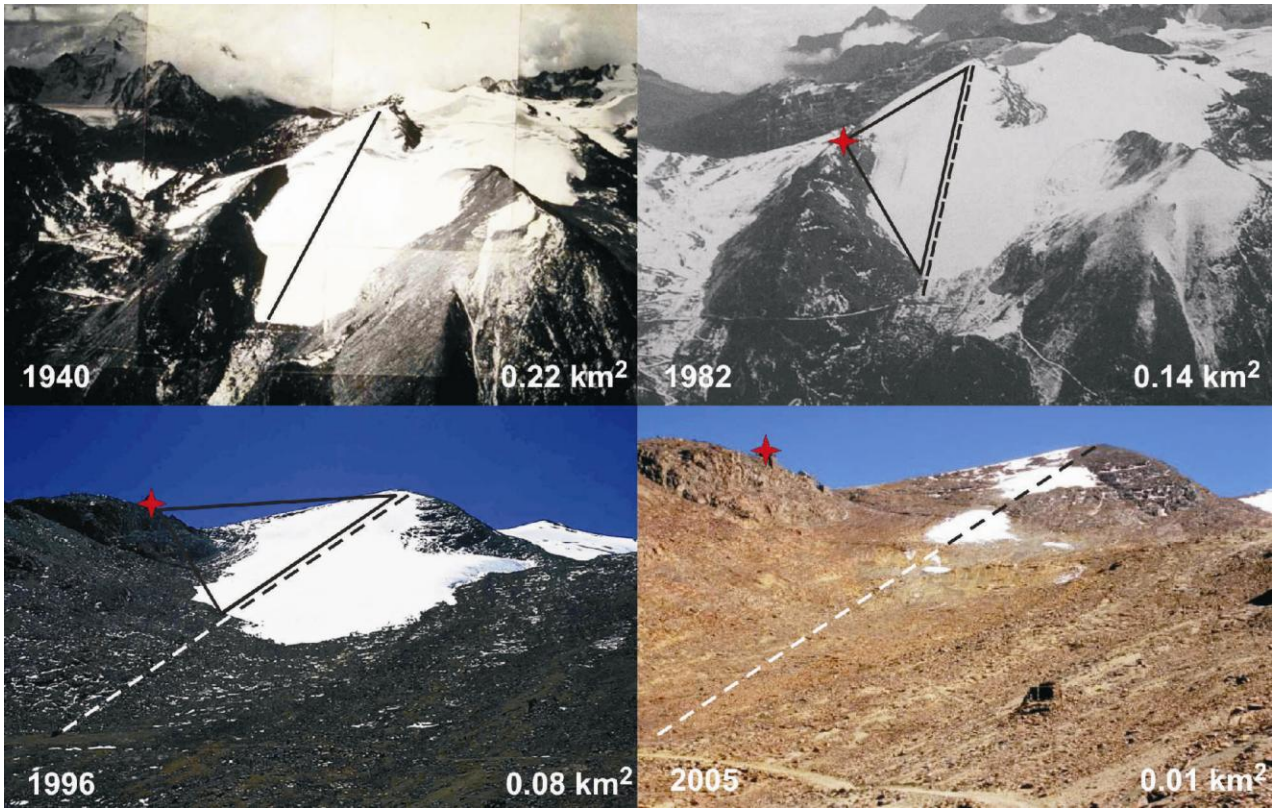
Latin America

(Source: IPCC AR4 WGII Chapter 13)

- By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semiarid vegetation will tend to be replaced by arid-land vegetation.
- There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America.
- Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase (*medium confidence*).
- Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.

The Chacaltaya glacier and ski-lift, Bolivia

Skiing was no longer possible after 2004



WMO

UNEP

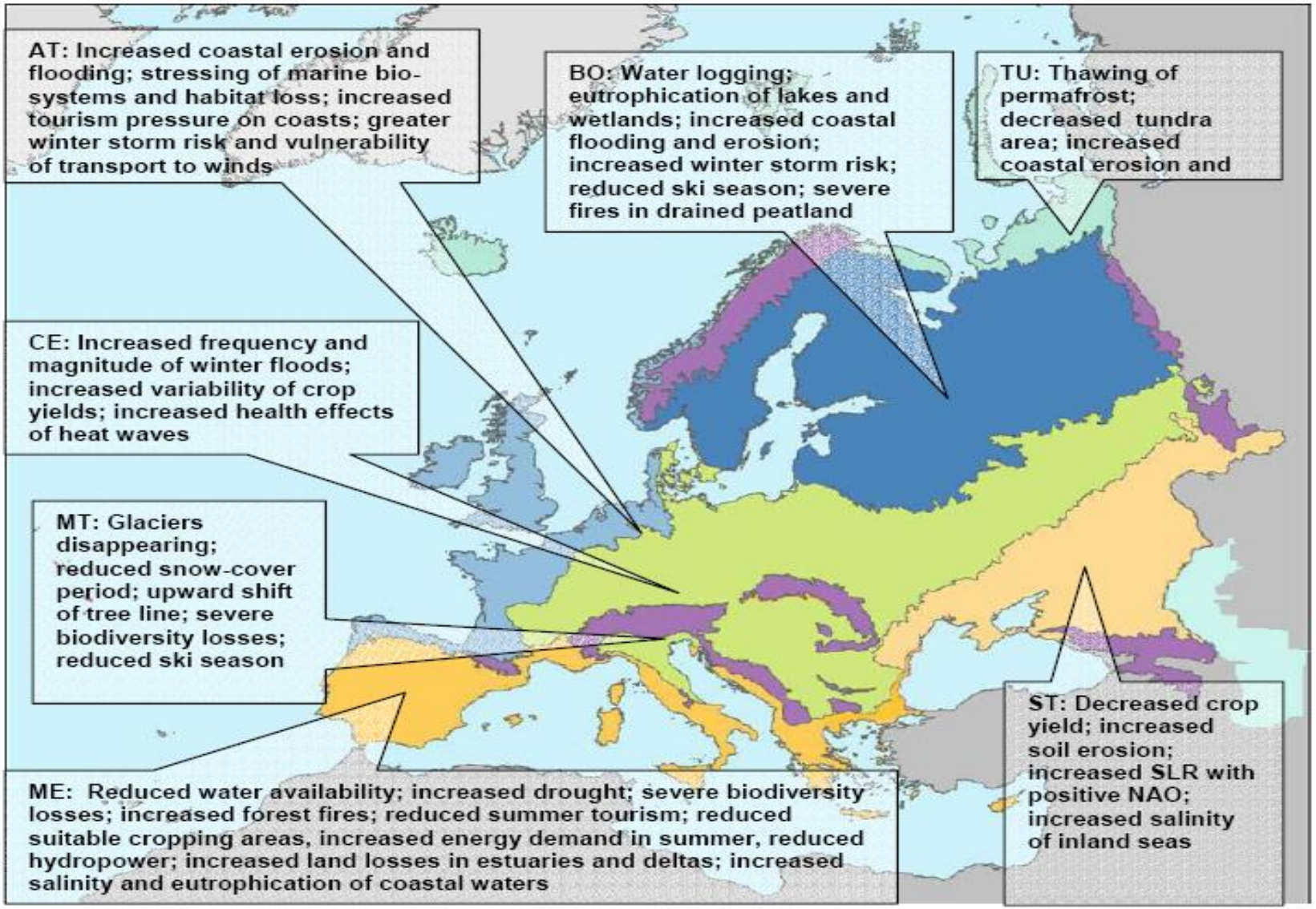


Figure 12.3: *Key vulnerabilities of European systems and sectors to climate change during the 21st century for the main biogeographic regions of Europe (EEA 2004a): TU (Tundra, pale turquoise); BO (Boreal, dark blue); AT (Atlantic, light blue); CE (Central, green [includes the Pannonian Region]); MT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

Some regions will be more affected than others

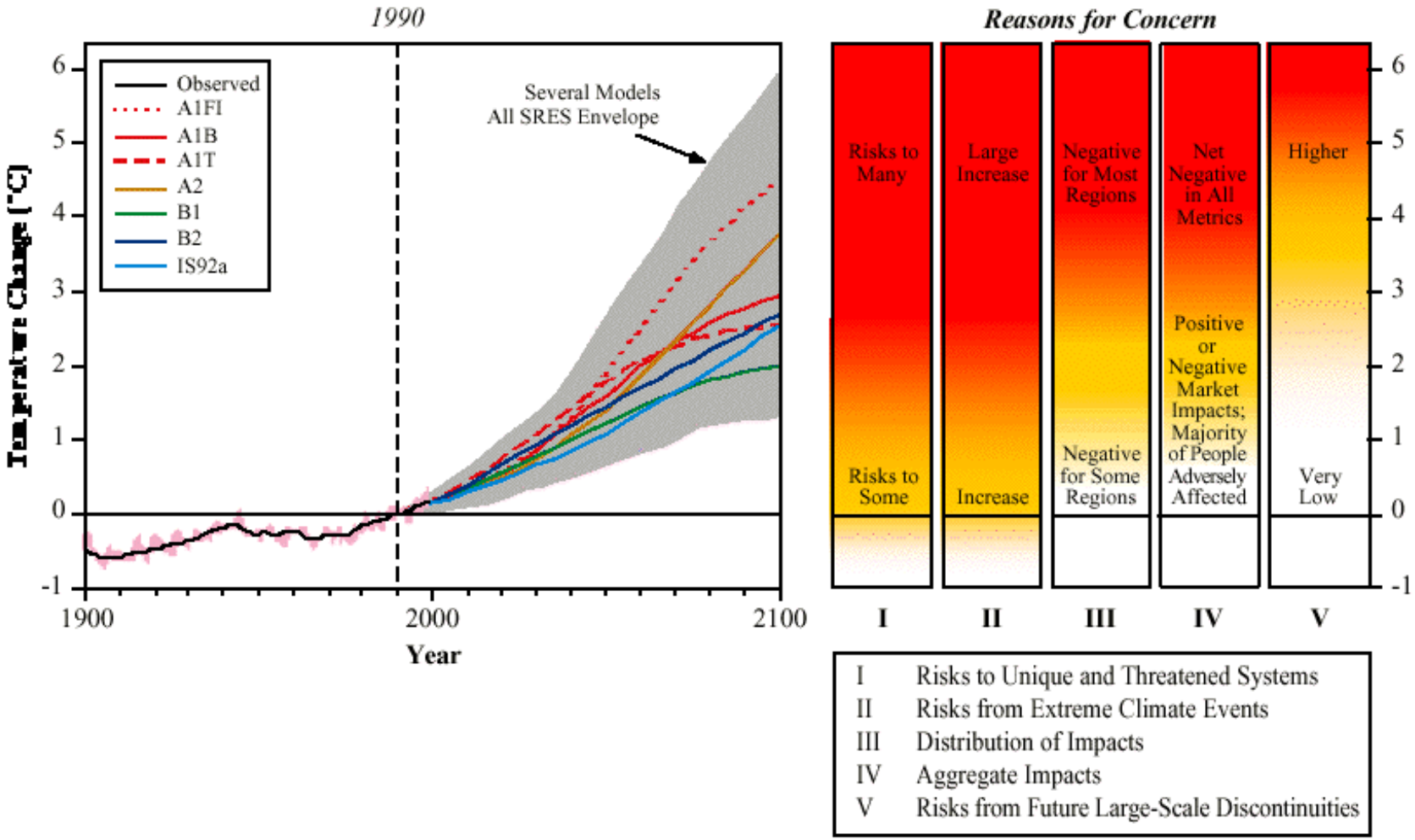
- The Arctic
- Sub-Saharan Africa
- Small islands
- Megadeltas

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

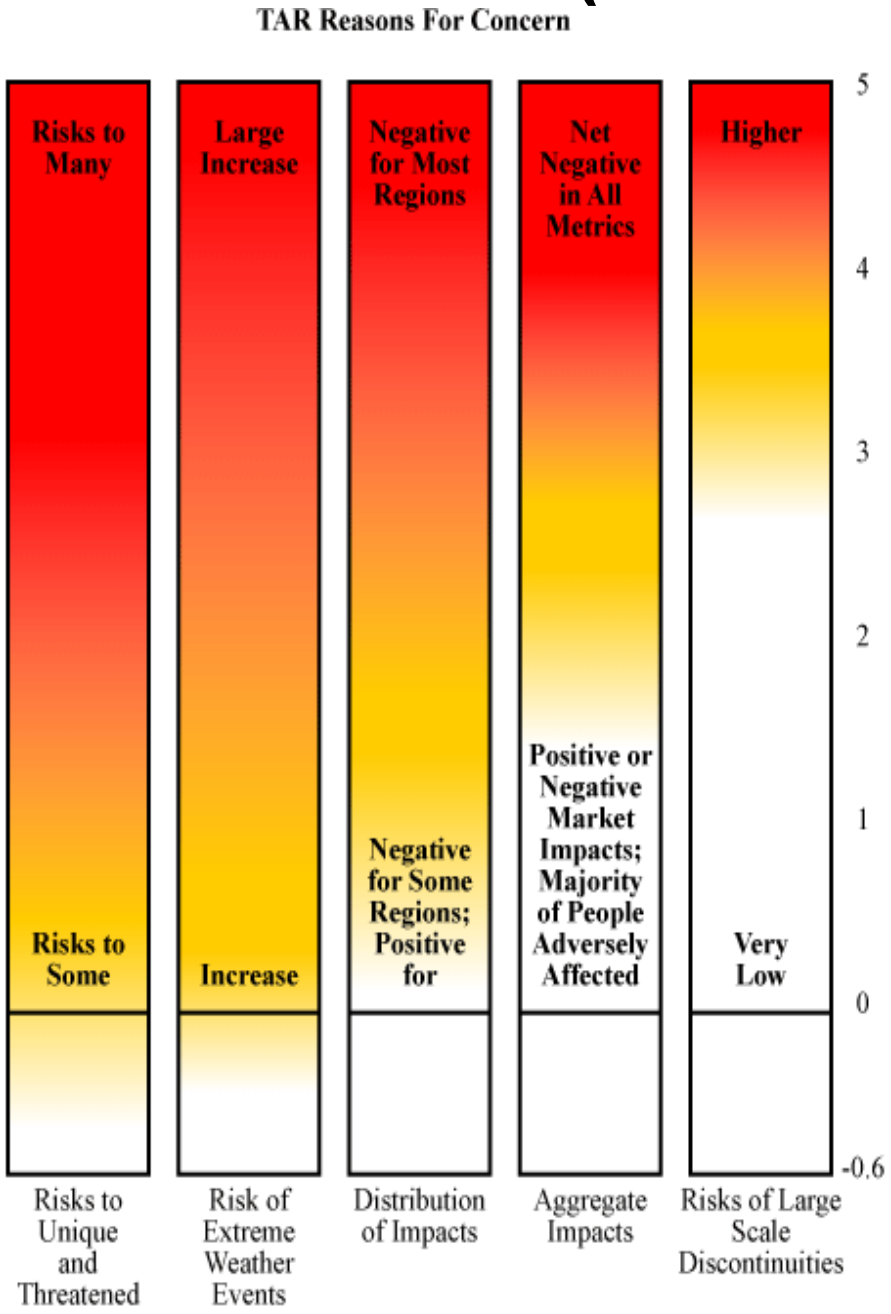
- The poor
- Young children
- The elderly

Adaptation will be necessary to address unavoidable impacts

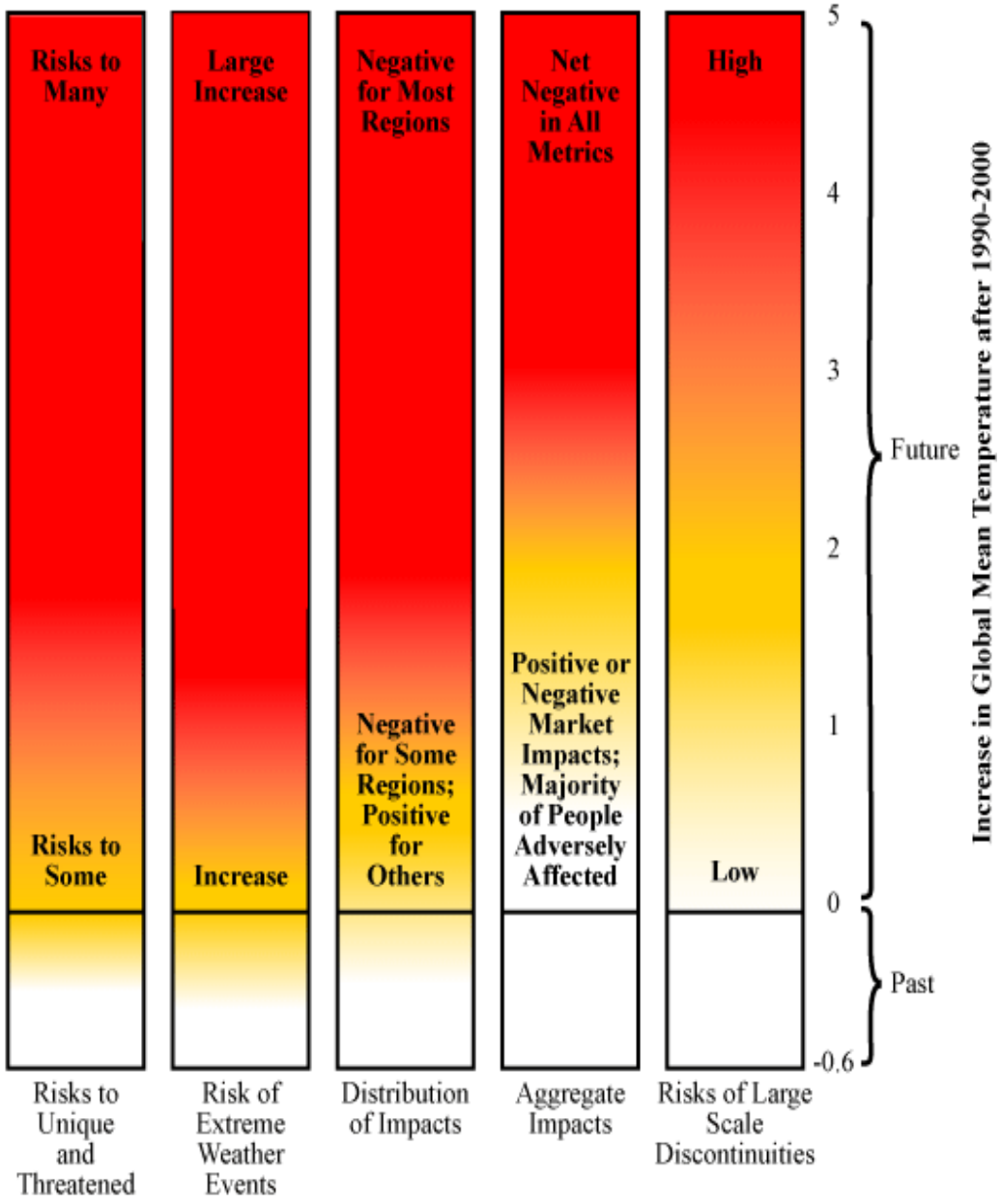
IPCC 2001:


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)



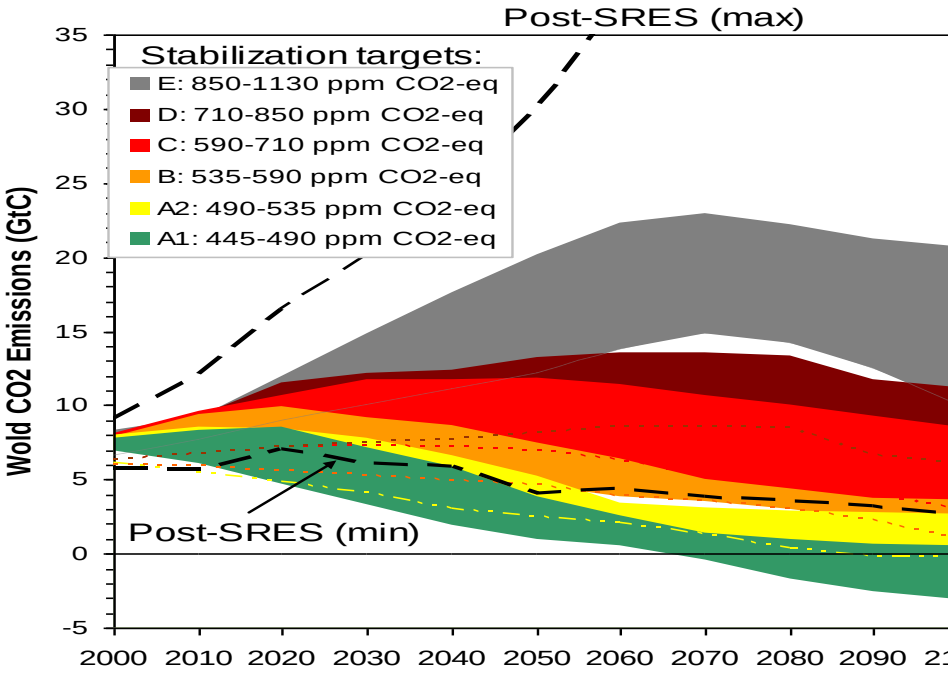
Reasons for concern (Smith et al, 2009, PNAS, based on AR4-2007)



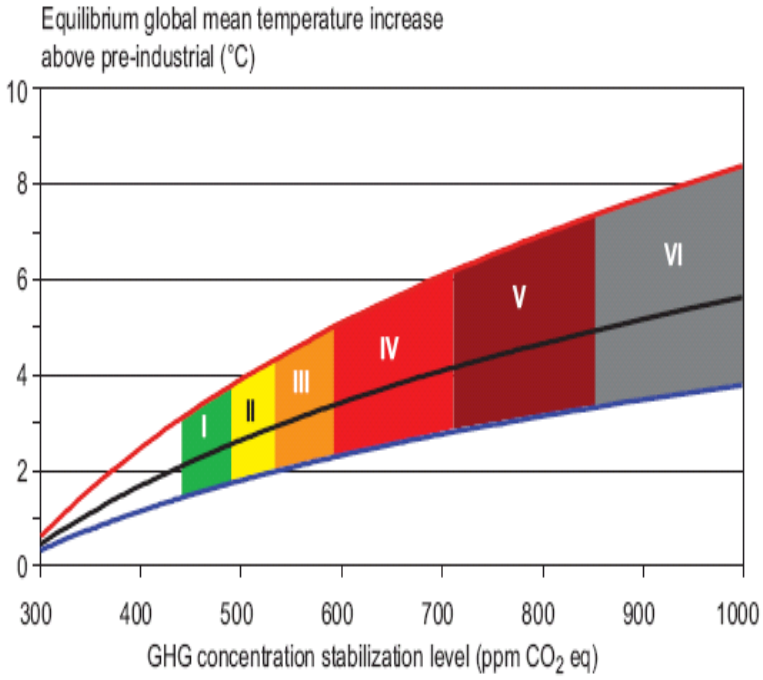
What does IPCC tell us on mitigation?

- WG3: Mitigation

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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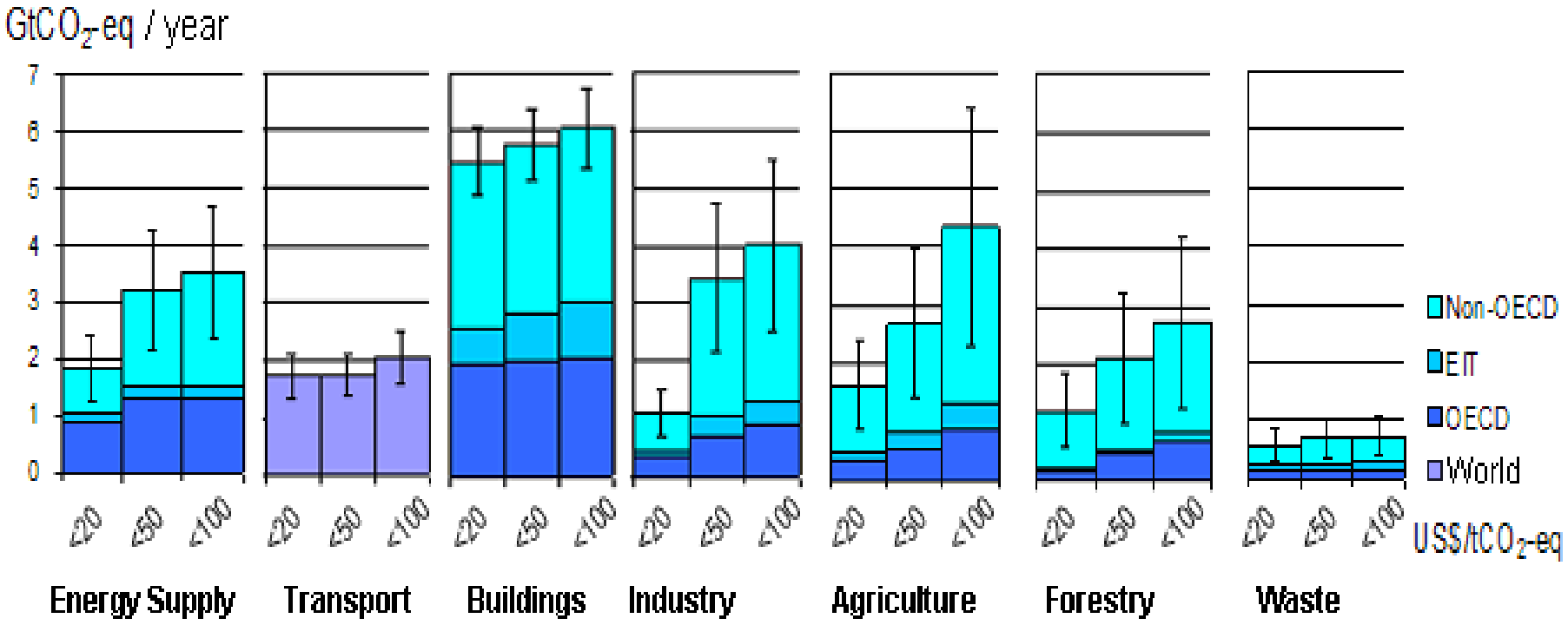
All sectors and regions have the potential to contribute by 2030



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

How can emissions be reduced?

Sector	**(Selected) Key mitigation technologies and practices currently commercially available.**
Transport	More fuel efficient vehicles; hybrid vehicles; biofuels; modal shifts from road transport to rail and **public transport systems**; cycling, walking; **land-use planning**
Buildings	Efficient lighting; efficient appliances and airco; improved insulation ; solar heating and cooling; alternatives for fluorinated gases in insulation and aplliances

Examples of policies which have shown good results (IPCC 2007)

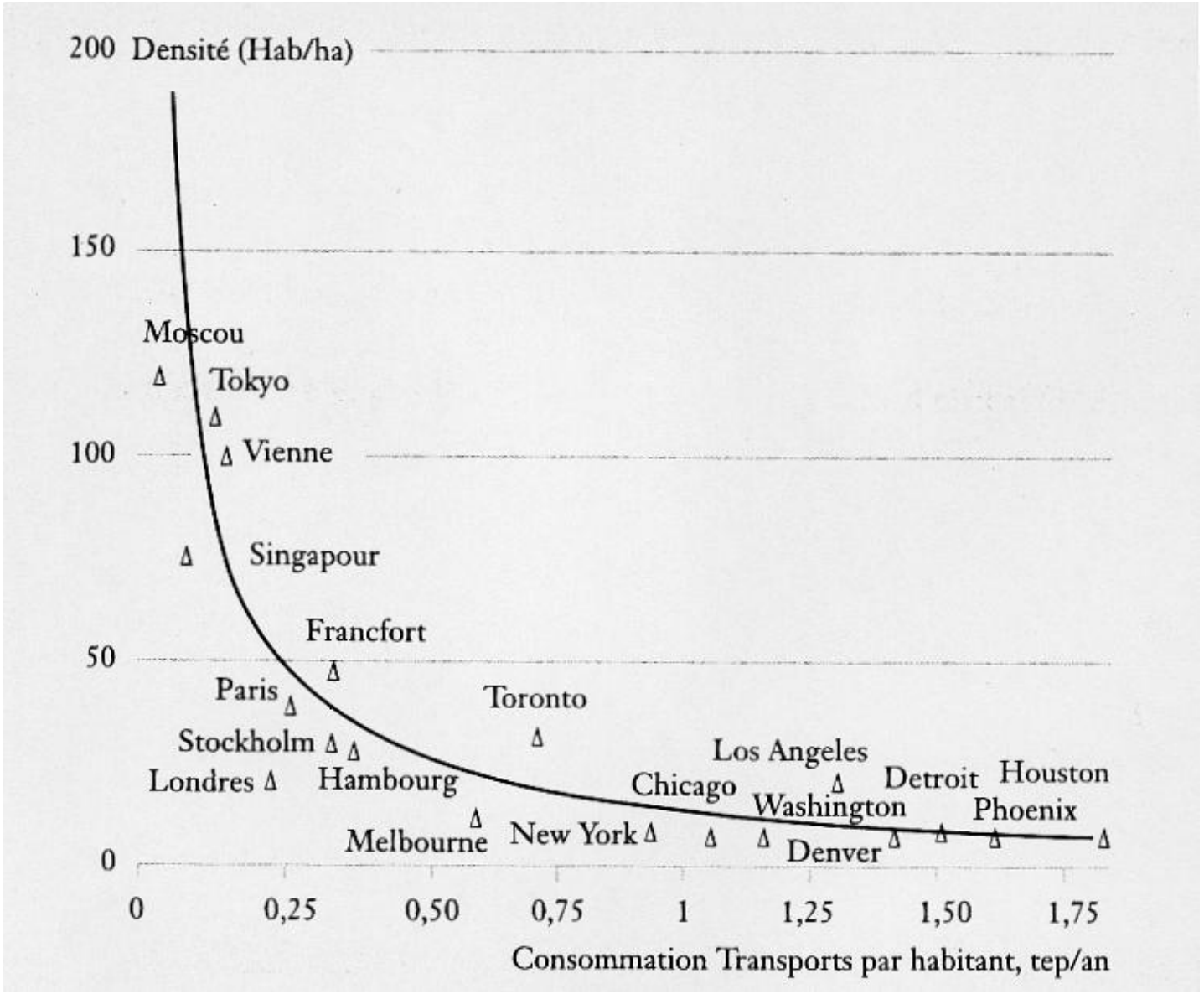
Sector	**Policies[1], measures and instruments shown to be environmentally effective**	**Key constraints or opportunities**
Transport	Mandatory fuel economy, biofuel blending and CO_2 standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
	Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
	Influence mobility needs through **land use regulations, and infrastructure planning**	Particularly appropriate for countries that are building up their transportation systems
	Investment in **attractive public transport facilities** and non-motorised forms of transport	

[1] Public RD&D investment in low emission technologies have proven to be effective in all sectors.

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

Influence of urban density on energy use in transport



Source: Dessus B. (1999). « Energie un défi planétaire ». Débats Belin.

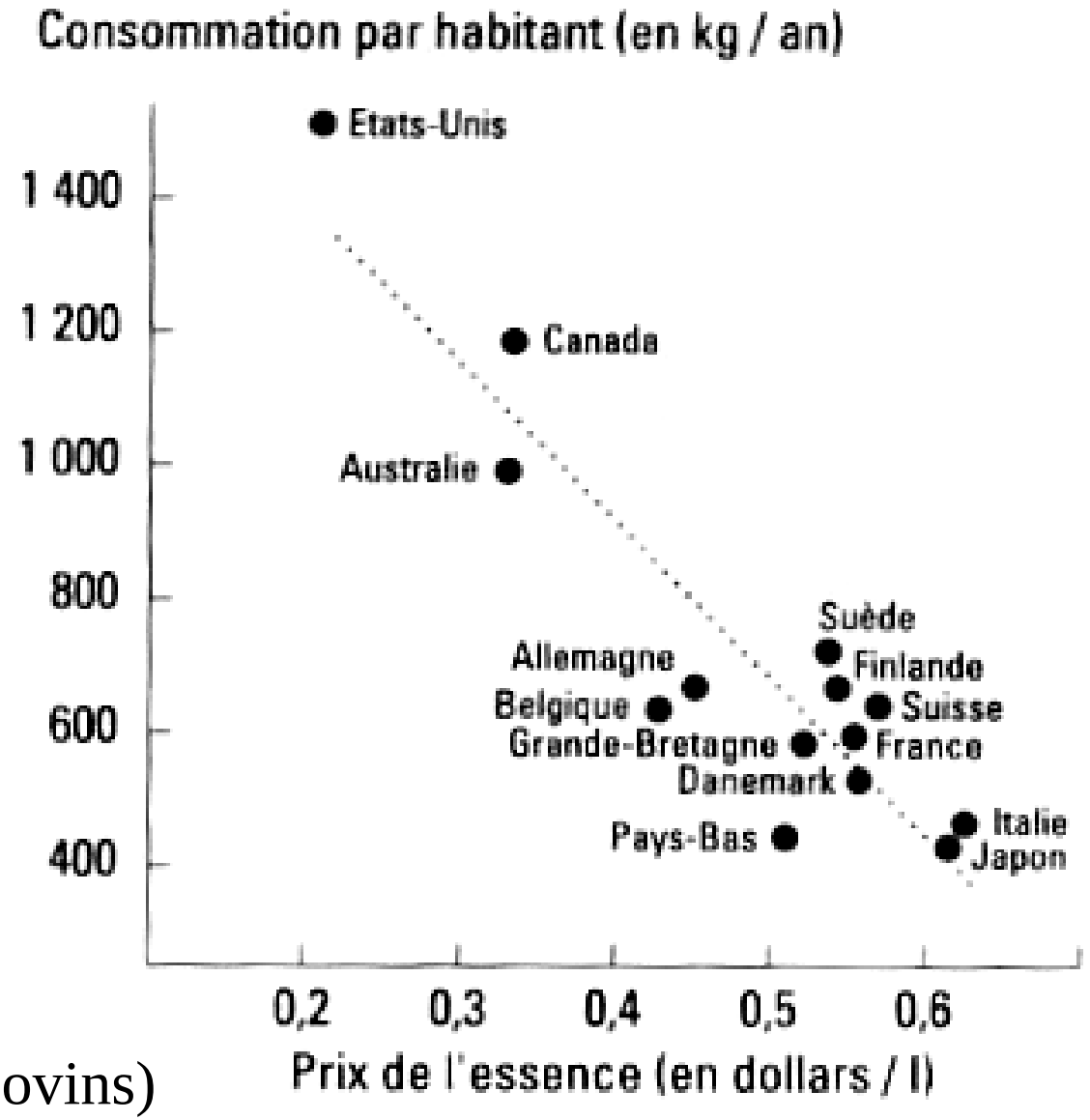
The importance of a "price of carbon"

- **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)

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”).

What is in store before Copenhagen?

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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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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 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
- We have to fight inertia, which is particularly large in infrastructure
- Urban and regional planning has a key role to play

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Useful links:

- www.ipcc.ch : IPCC
- www.climate.be/JCM: interactive climate model
- www.climate.be/vanyp : many of my slides

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