Introdução às Alterações Climáticas no contexto do Desenvolvimento Sustentável

FILIPE DUARTE SANTOS

SIM – Laboratório de Sistemas, Instrumentação e Modelação em Ciências e Tecnologias do Ambiente e do Espaço
FCUL – Faculdade de Ciências da Universidade de Lisboa
www.sim.ul.pt

Formação em Alterações Climáticas no Contexto dos Recursos Hídricos

AESABESP

São Paulo, 7 a 8 de Agosto de 2012

A Grande Aceleração

Desde o final da 2ª Guerra Mundial regista-se um crescimento muito pronunciado da população humana, da actividade económica, da produção e do consumo, do uso de recursos renováveis e não-renováveis, do transporte, dos fluxos de comunicação e informação, do conhecimento científico e das aplicações tecnológicas. Alguns autores designam este período de crescimento por "A Grande Aceleração" (Hibbard, 2007)

- A população humana aumentou 10 vezes nos últimos 3 séculos e por um factor de 4 no século XX, atingindo actualmente cerca de 6700 milhões. É muito provável que atinja cerca de 9200 milhões em 2050.

- A área urbana global cresceu por um factor de 10 no século XX. Actualmente cerca de metade da população mundial habita em cidades.

- No século XX a produção industrial cresceu por um factor de 40 e a utilização de energia por um factor de 16;

- Aproximadamente 50% da superfície terrestre está modificada pela acção humana;

- No século XX o consumo de água aumentou por um factor de 9. Actualmente é de 800 m^3 por ano e per capita: 65% para a agricultura; 25% para a indústria e cerca de 10% para consumo doméstico.

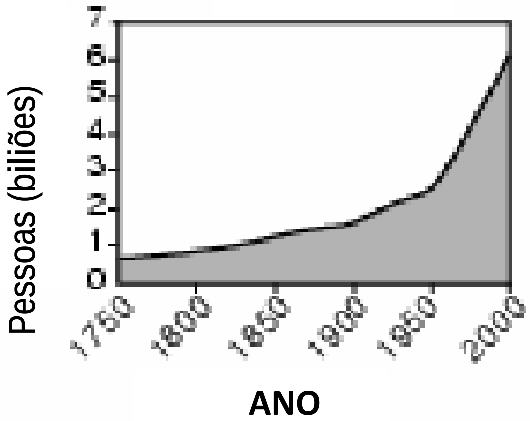
- Aumento da poluição do ar, da água e dos solos;

- Perda de biodiversidade: o ritmo actual de extinções é cerca de 100 a 10 000 vezes superior (valor mais provável 1000) ao pré-humano, que era de, aproximadamente, uma espécie por 10^6 espécies por ano (E.O. Wilson);

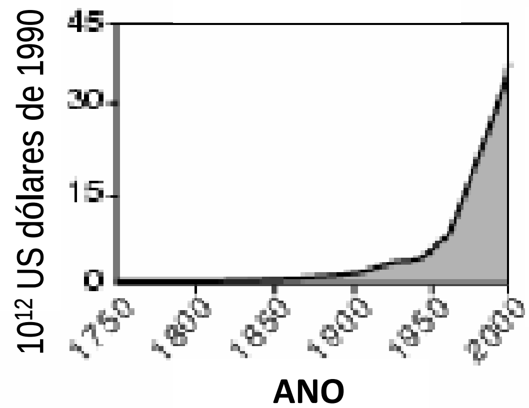
As actividades humanas exercem actualmente uma interferência significativa sobre os sistemas terrestres à escala global, como por exemplo, o sistema climático. Iniciou-se uma nova época que P. Crutzen e E.F. Stoermer designam por **Antropocénica.**

A GRANDE ACELERAÇÃO

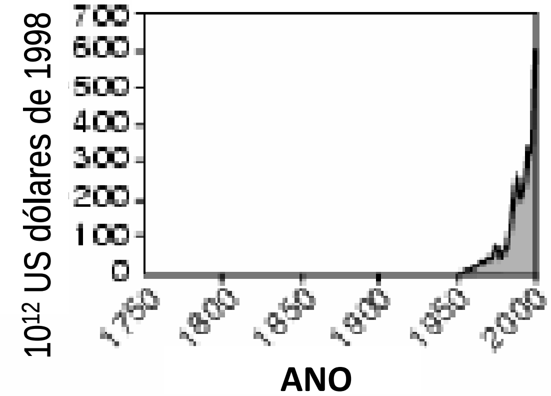
População



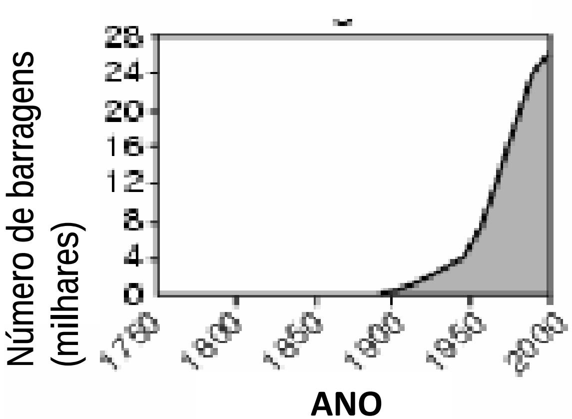
PIB Mundial



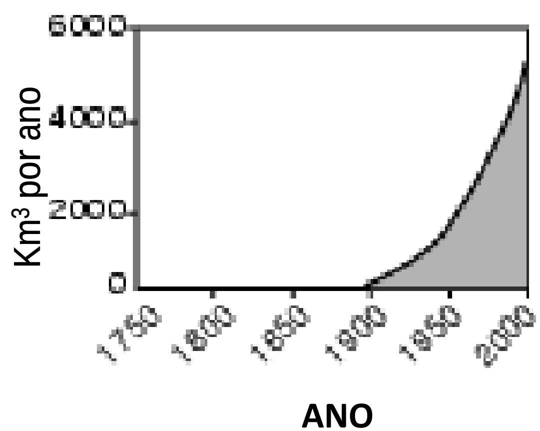
Investimento Estrangeiro Directo



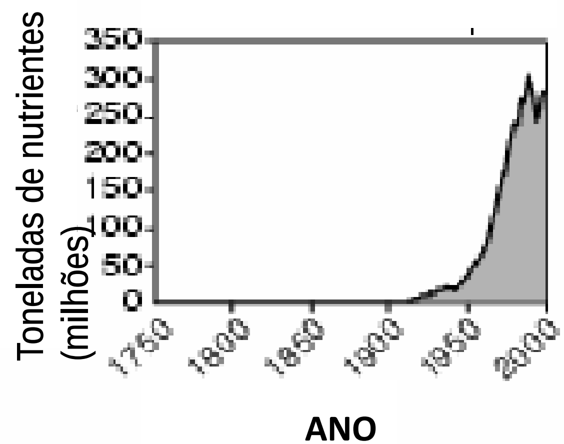
Barragens nos Rios



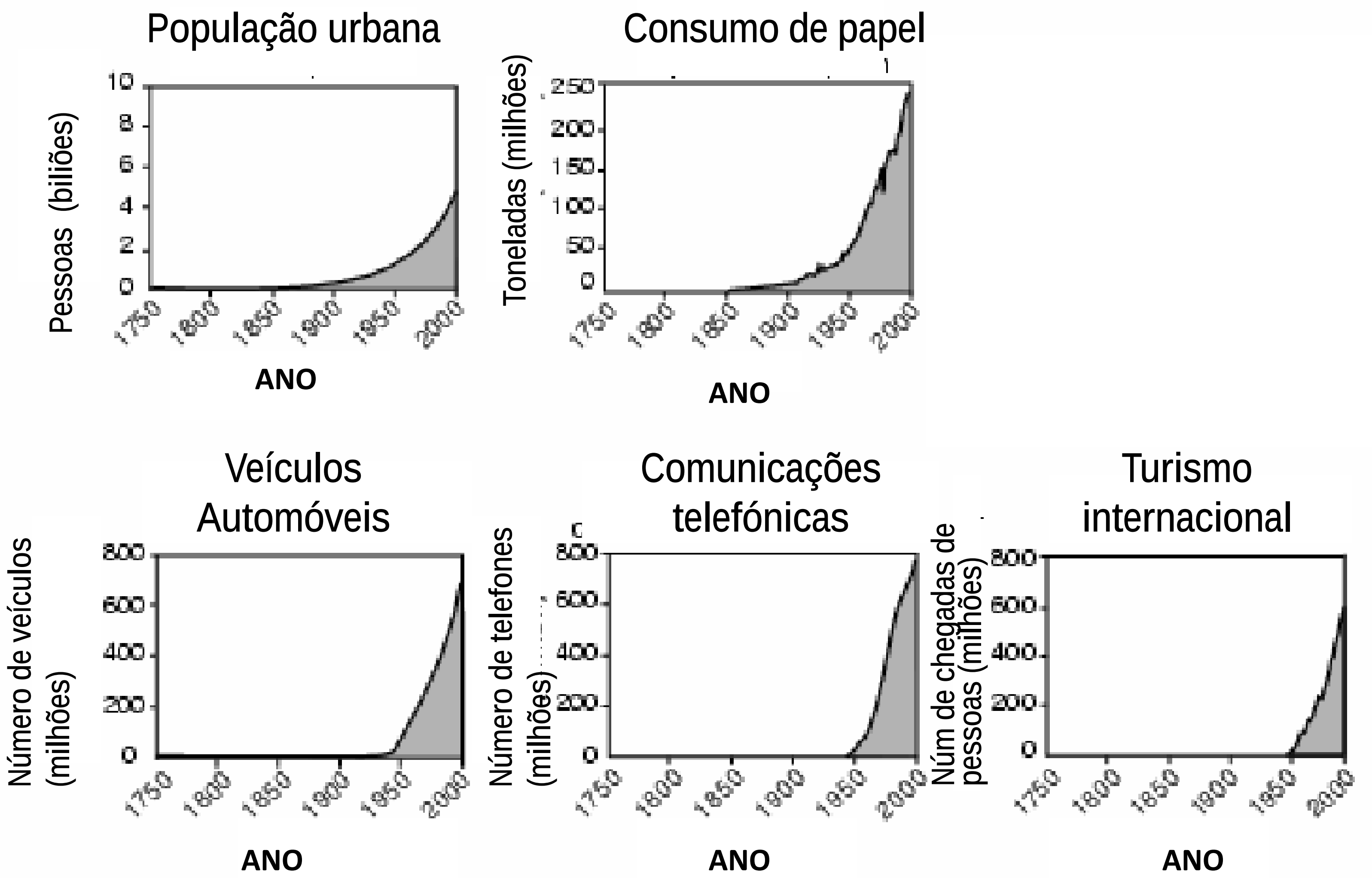
Uso mundial de Água



Consumo de Fertilizantes



A GRANDE ACELERAÇÃO



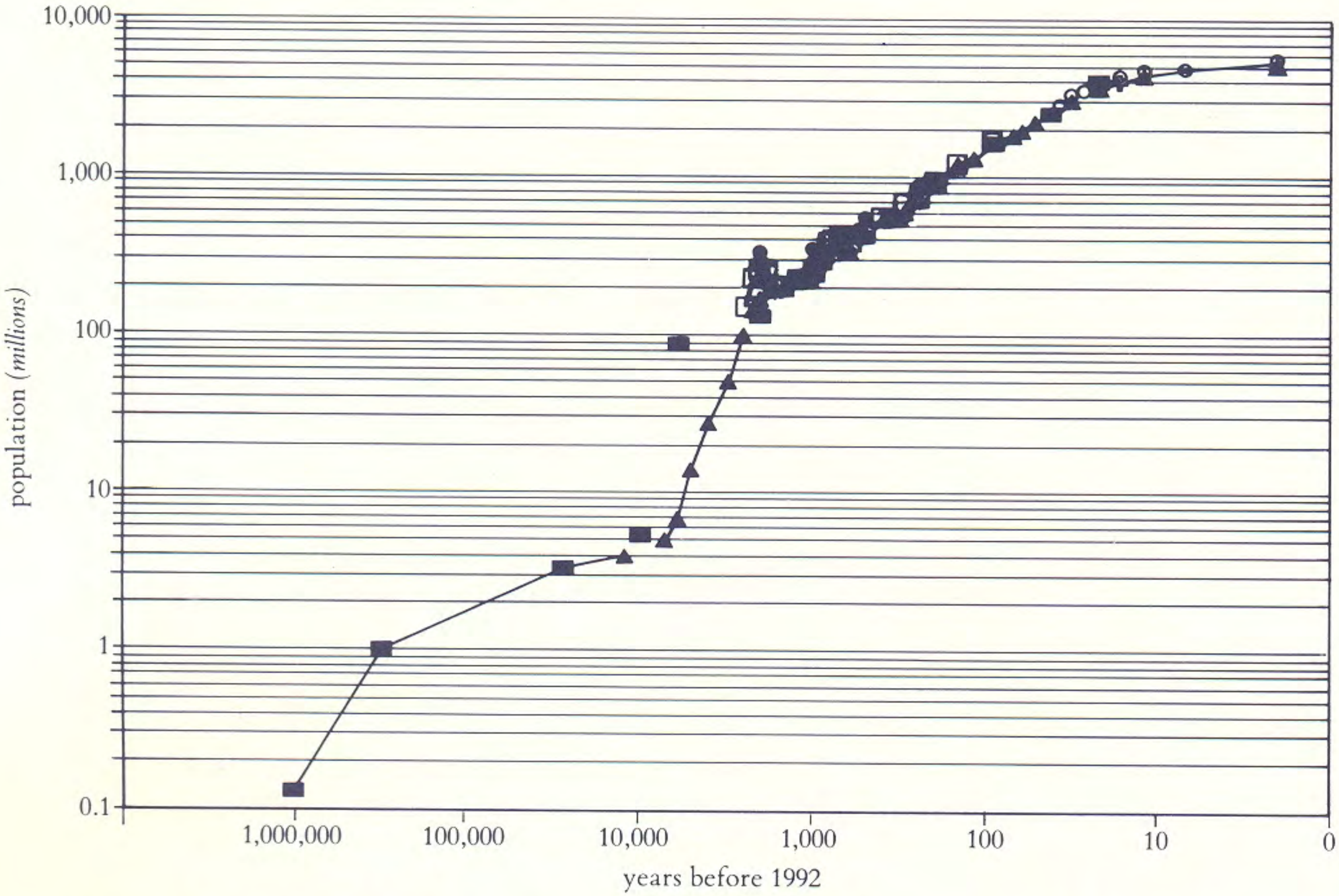


FIGURE 5.14 World population history for the last million years, with the number of years before 1992 and population size both plotted on logarithmic scales. Different symbols represent estimates from different sources. SOURCE OF DATA: Appendix 2

Source: Joel E. Cohen, 1995

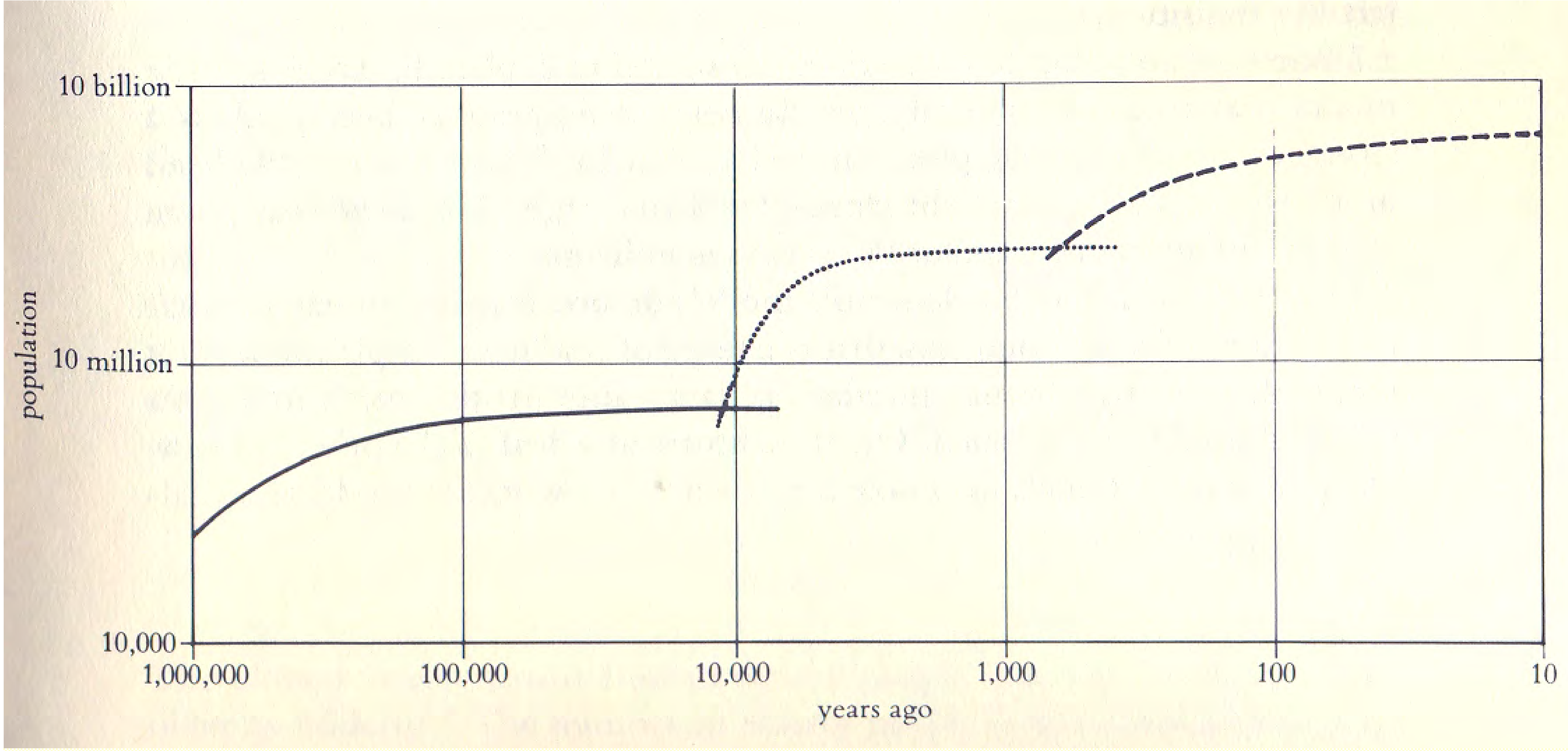
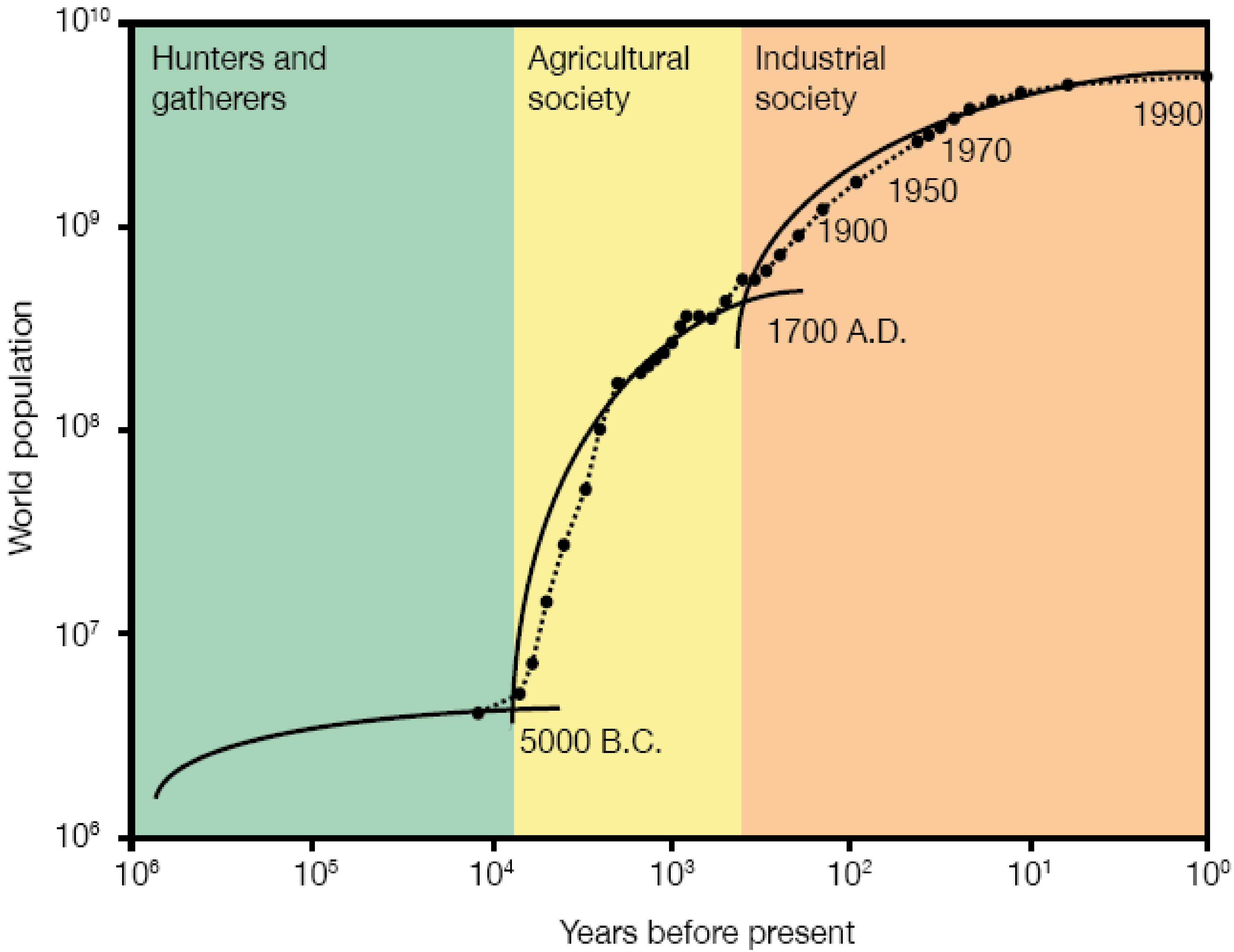


Figure 5.13 – Deevey's schema of world population history for the last million years, with the number of years before the present population size both plotted of logarithmic scales. Source: Deevey (1960, p. 198)



Hunters and gatherers
Agricultural society
Industrial society
1990
1970
1950
1900
1700 A.D.
5000 B.C.
World population
10^{10}
10^9
10^8
10^7
10^6
10^6
10^5
10^4
10^3
10^2
10^1
10^0
Years before present

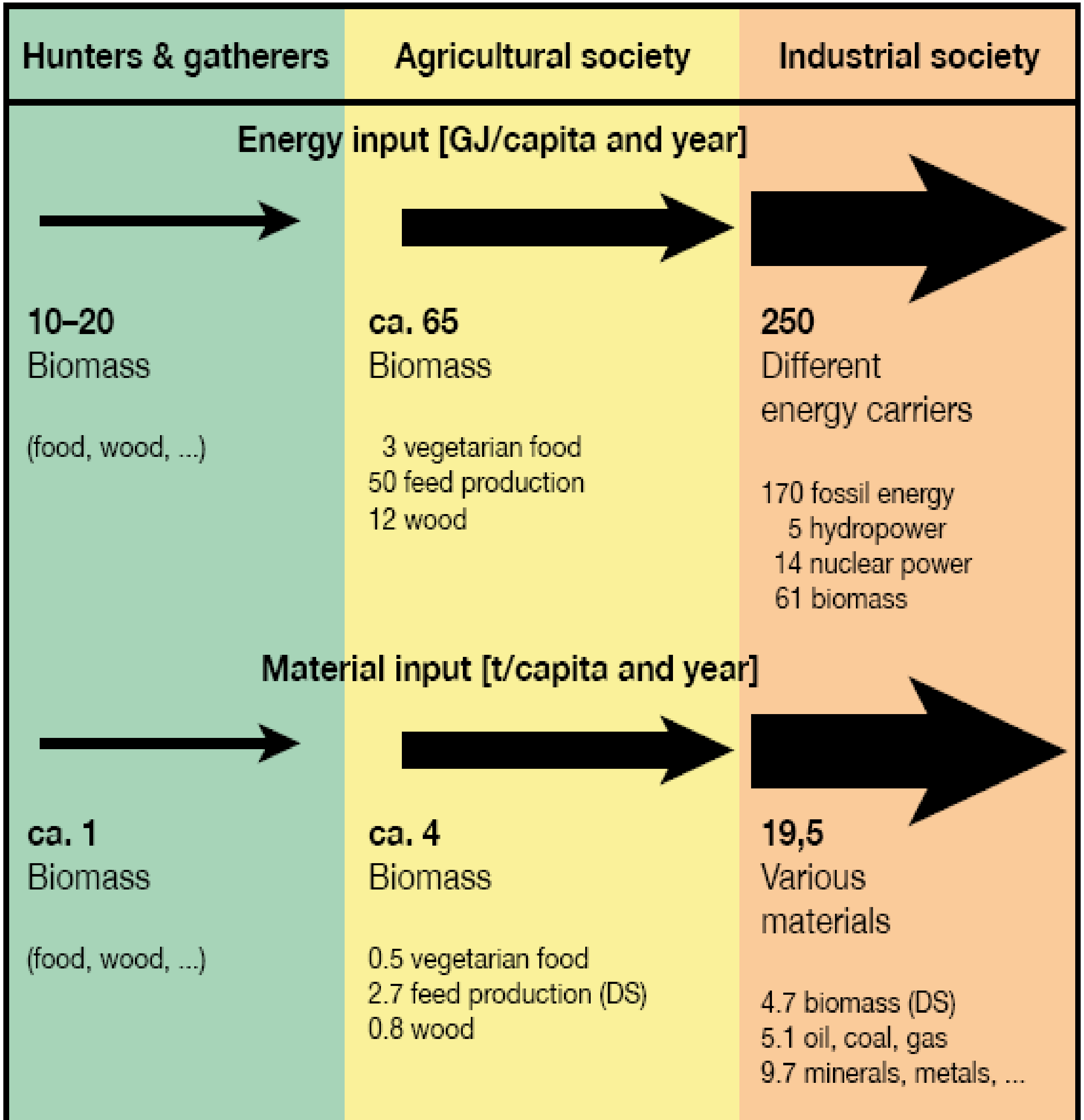


Figure 3.2-1

Growing energy input in gigajoule (GJ) per capita per year, and material input in t per capita per year in the wake of the Neolithic and Industrial Revolutions in industrialised countries (estimated). DS = tonnage stated as dry substance. Source: based on Fischer-Kowalski and Haberl, 1998

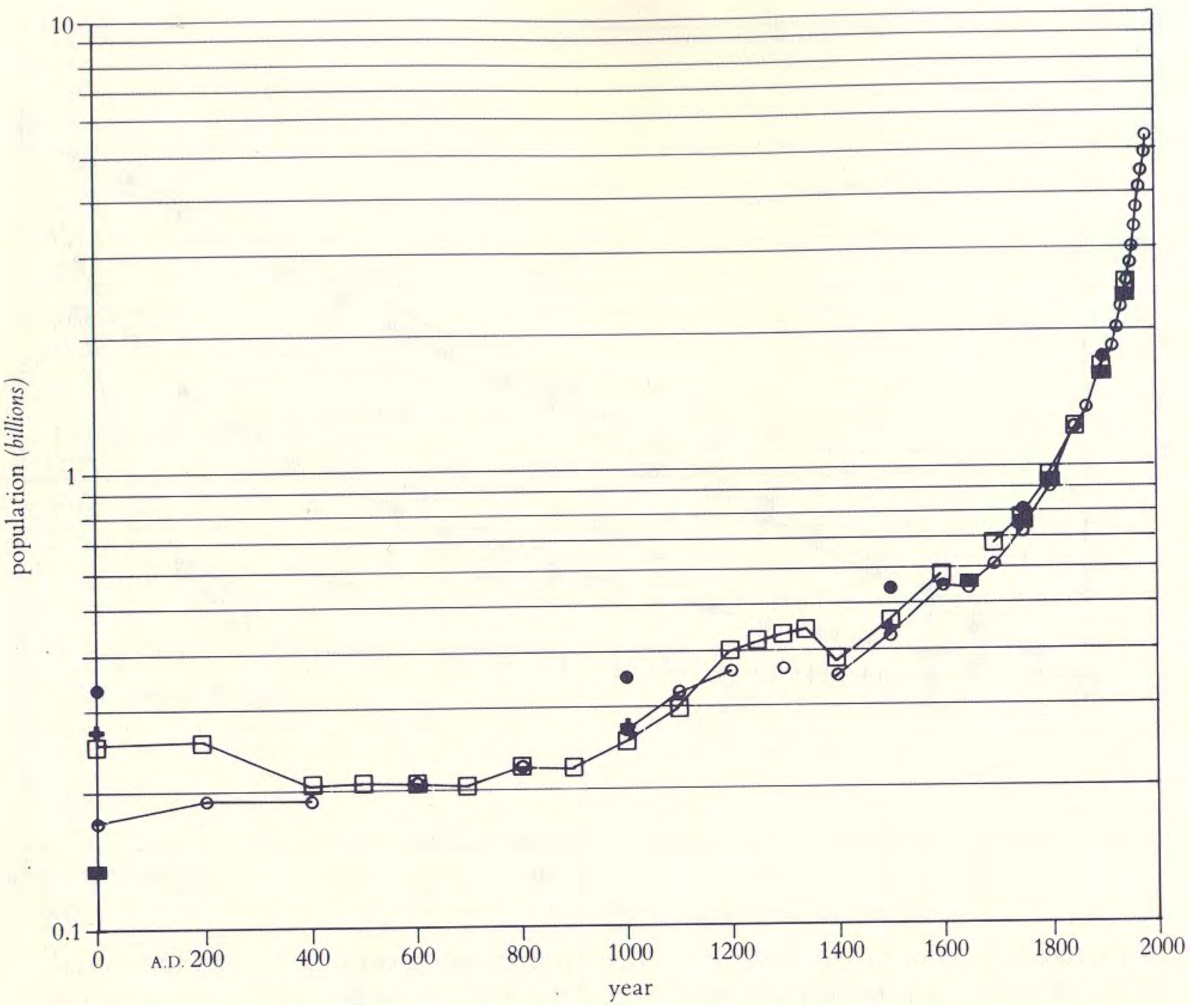
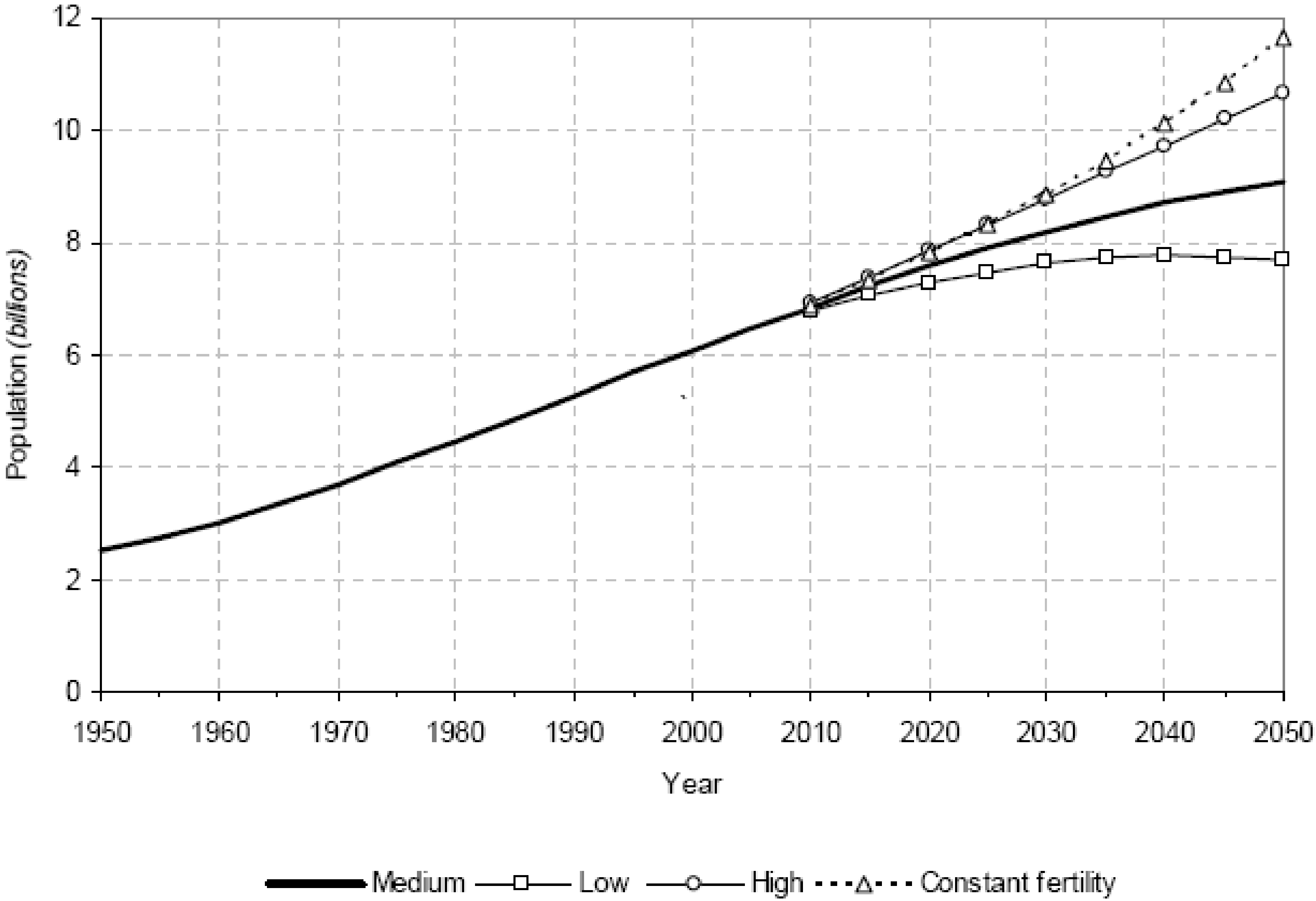


FIGURE 5.12 World population history for the last two millennia, with population plotted on a logarithmic scale. Different symbols represent estimates from different sources. SOURCE OF DATA: Appendix 2

Source: Joel E. Cohen, 1995

Figure 1. Population of the world, 1950-2050, by projection variants



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2005). *World Population Prospects: The 2004 Revision. Highlights*. New York: United Nations.

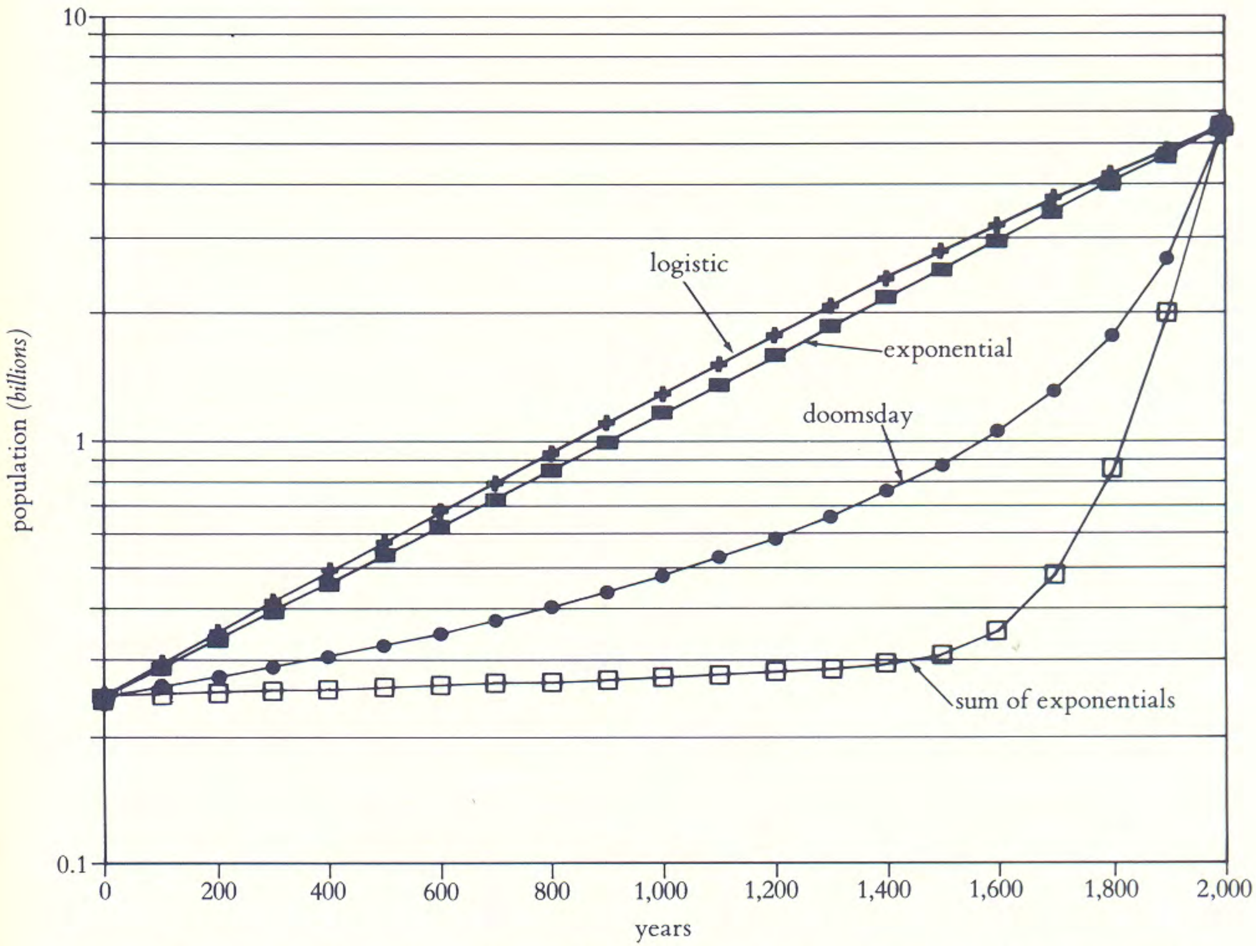
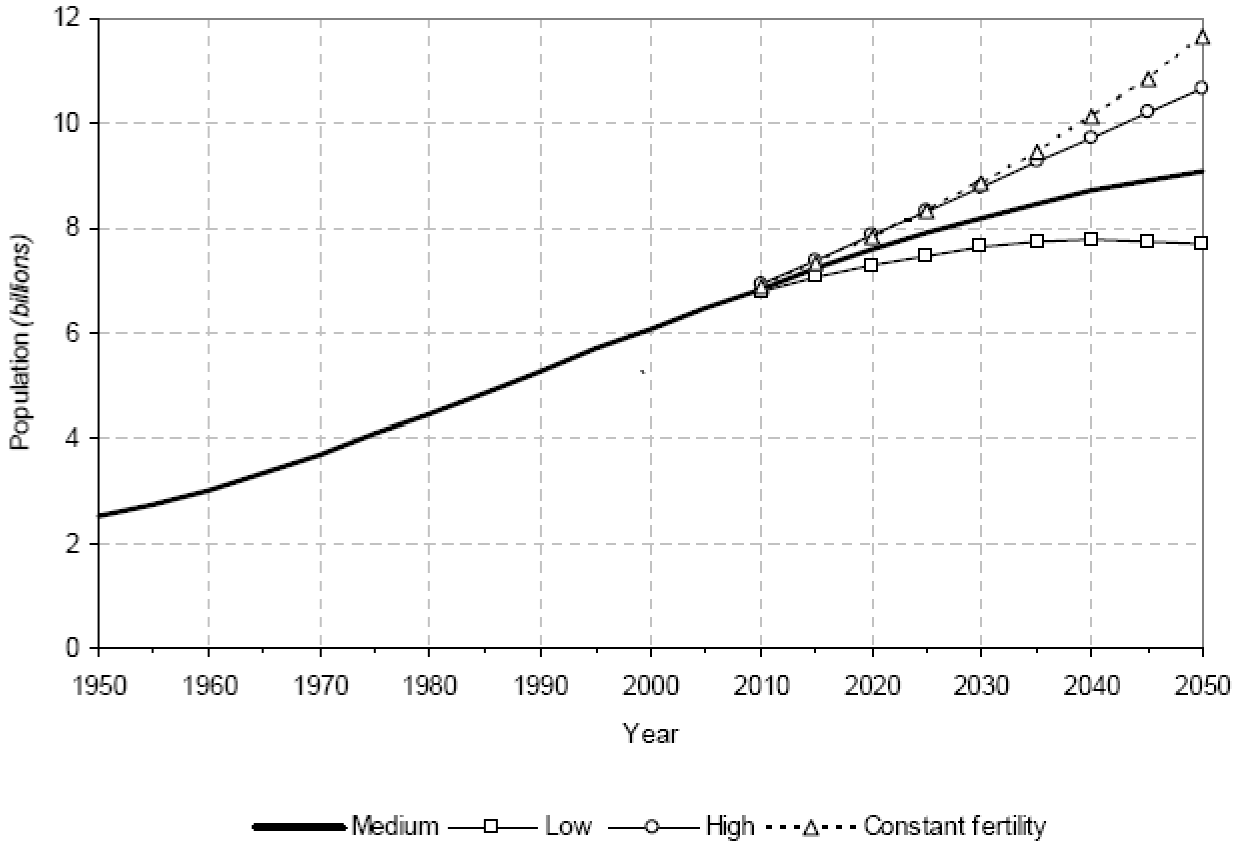


FIGURE 5.11 Four hypothetical populations growing according to the exponential (solid rectangles), logistic (+ symbols), doomsday (• symbols) and sum-of-exponential (open squares) models. Population size is plotted on a logarithmic scale.

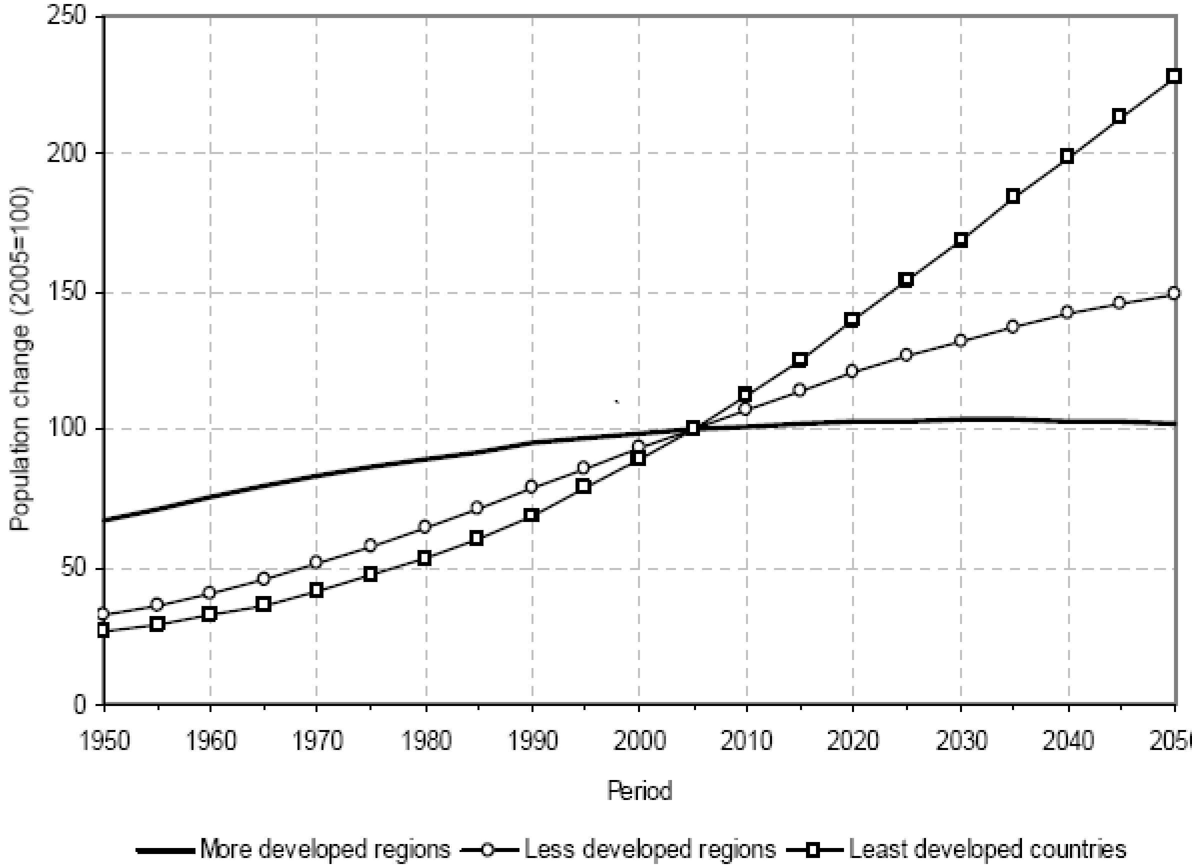
Source: Joel E. Cohen, 1995

Figure 1. Population of the world, 1950-2050, by projection variants

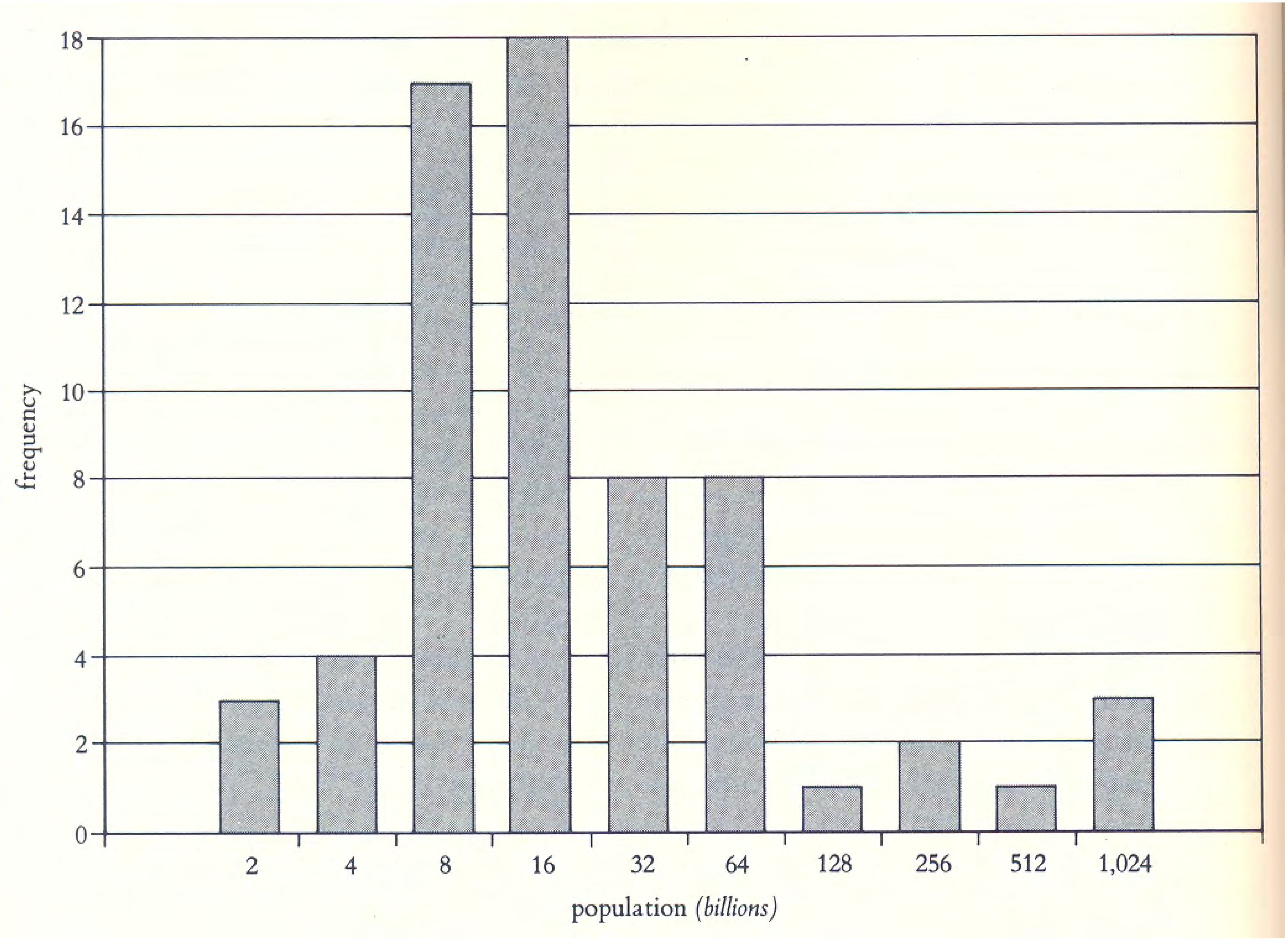


Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2005). *World Population Prospects: The 2004 Revision. Highlights*. New York: United Nations.

Figure 2. Population dynamics by development groups, 1950-2050



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2005). *World Population Prospects: The 2004 Revision. Highlights*. New York: United Nations.



Frequency distribute of estimates of how many people the Earth can support

Source: Joel E. Cohen, 1995

- As iniquidades de desenvolvimento são cada vez maiores. A razão entre o PIB per capita dos países mais ricos e mais pobres está a aumentar assustadoramente: em 1820 era de 7, aumentou para 11 em 1910, 30 em 1960 e 74 em 1997.

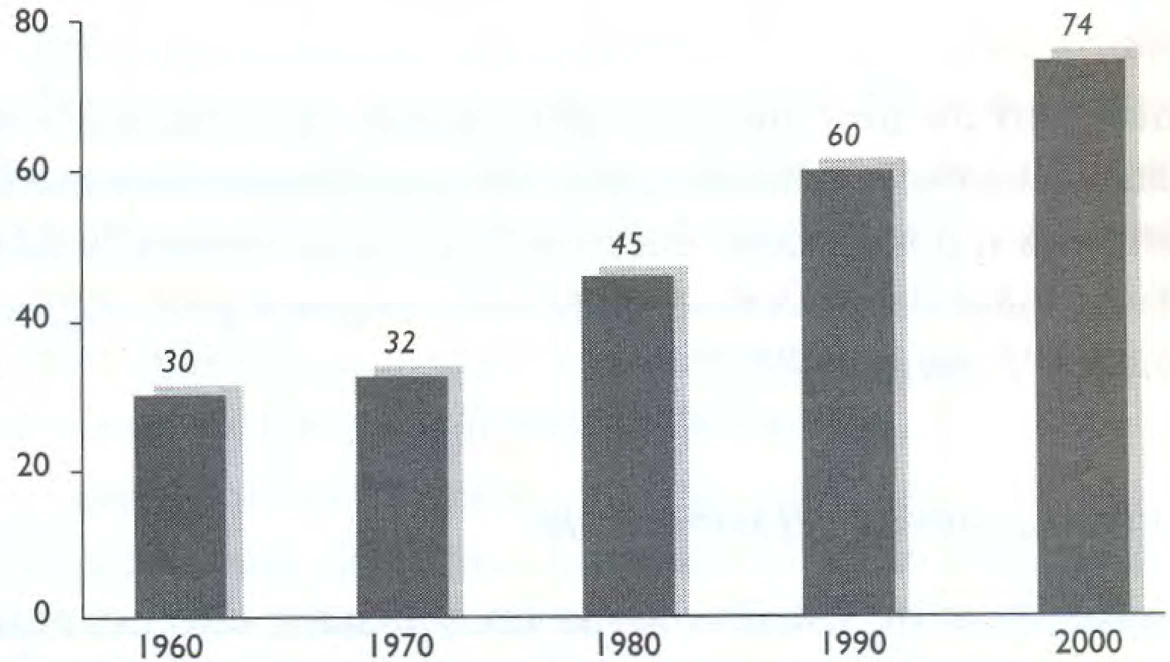
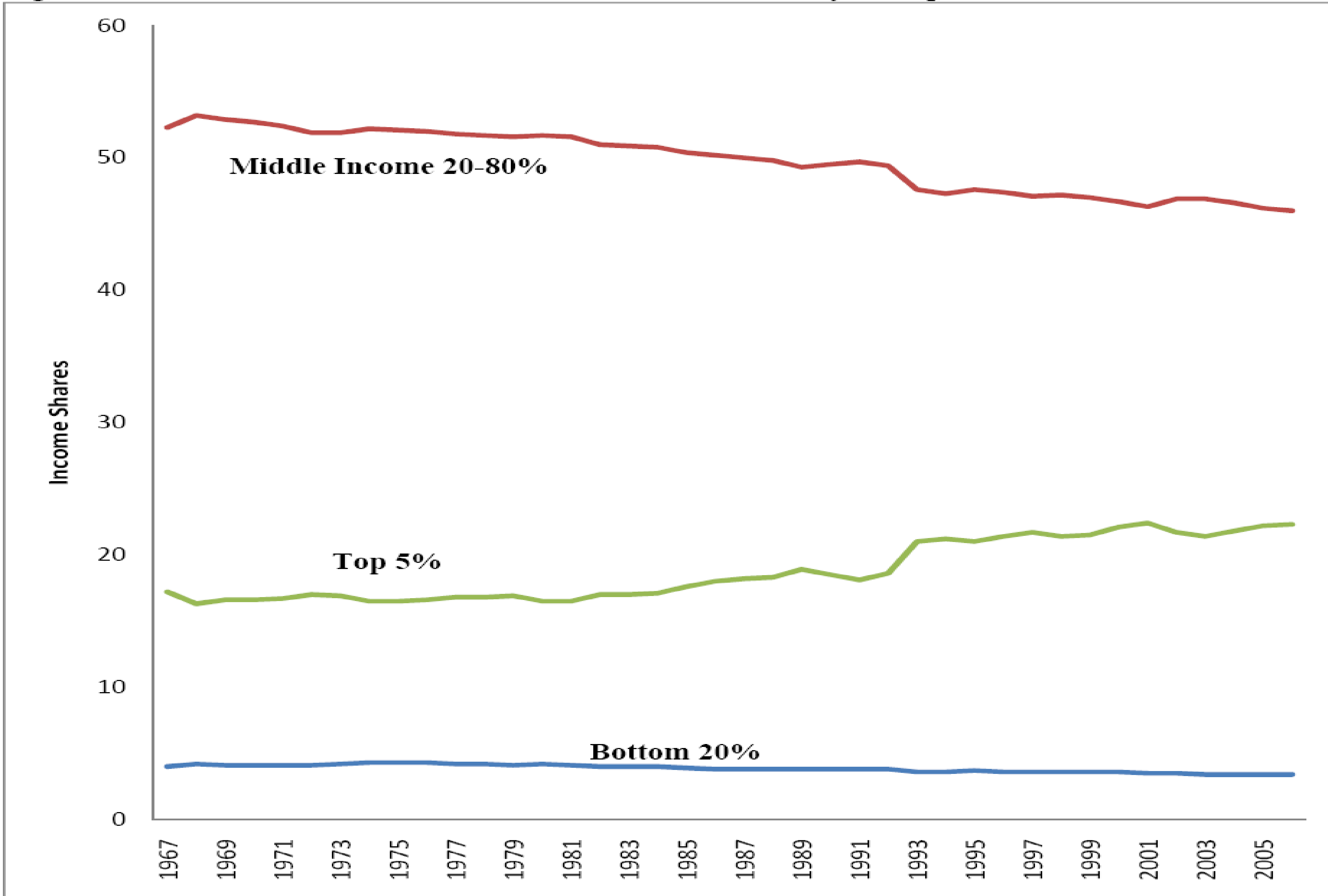


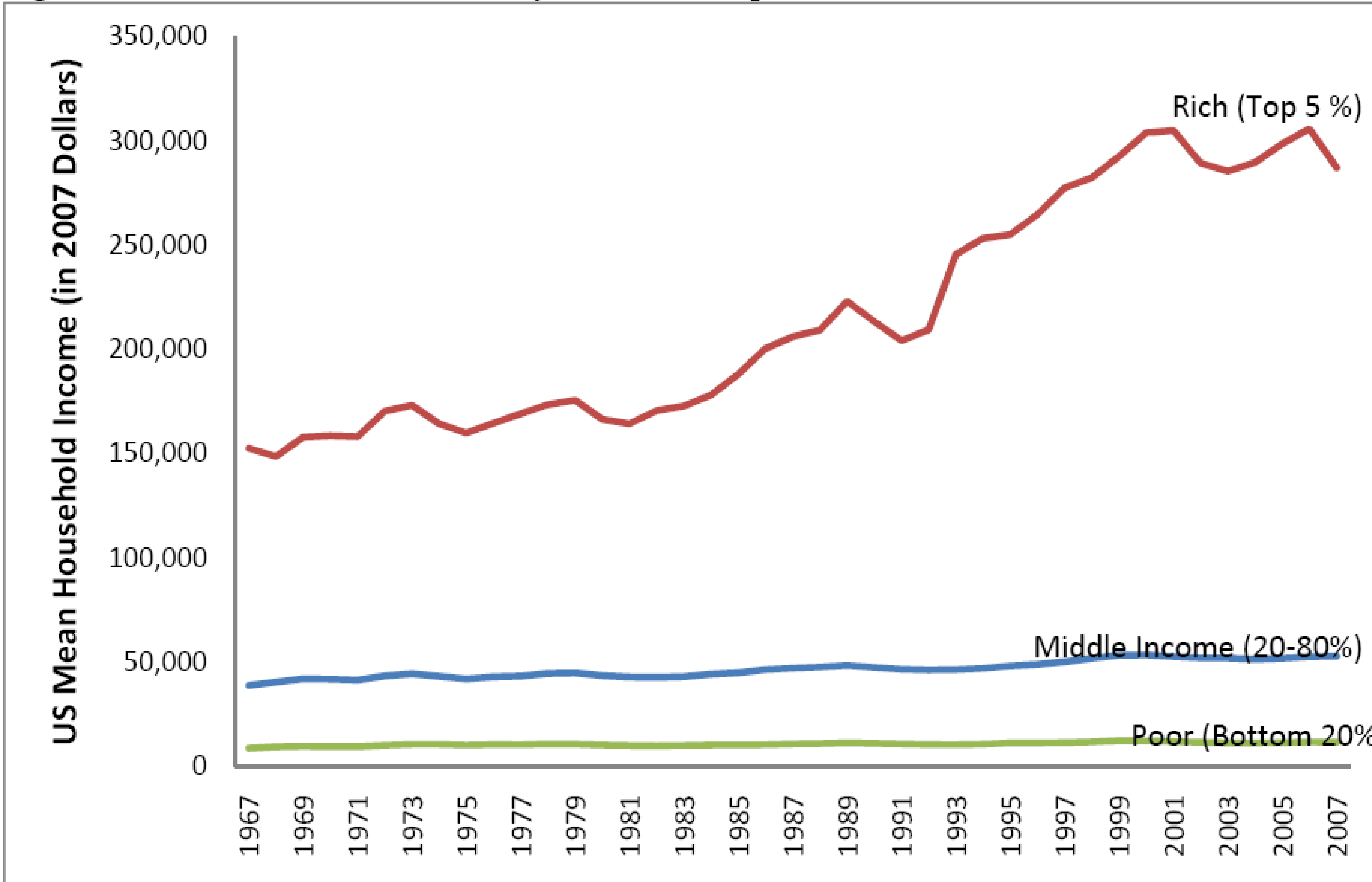
Figure 6.3. Accroissement des inégalités de richesse depuis 1950. Rapport des revenus cumulés des 10 % les plus riches sur les 10 % les plus pauvres (UNDP, *Human Development Reports*).

Figure 9: Income Distribution in the USA: Income Shares by Groups



Source: US Census Bureau

Figure 11: Real Household income by Income Groups in the USA



Source: US Census Bureau

Table 7-9 Large differences in levels of poverty (per cent)

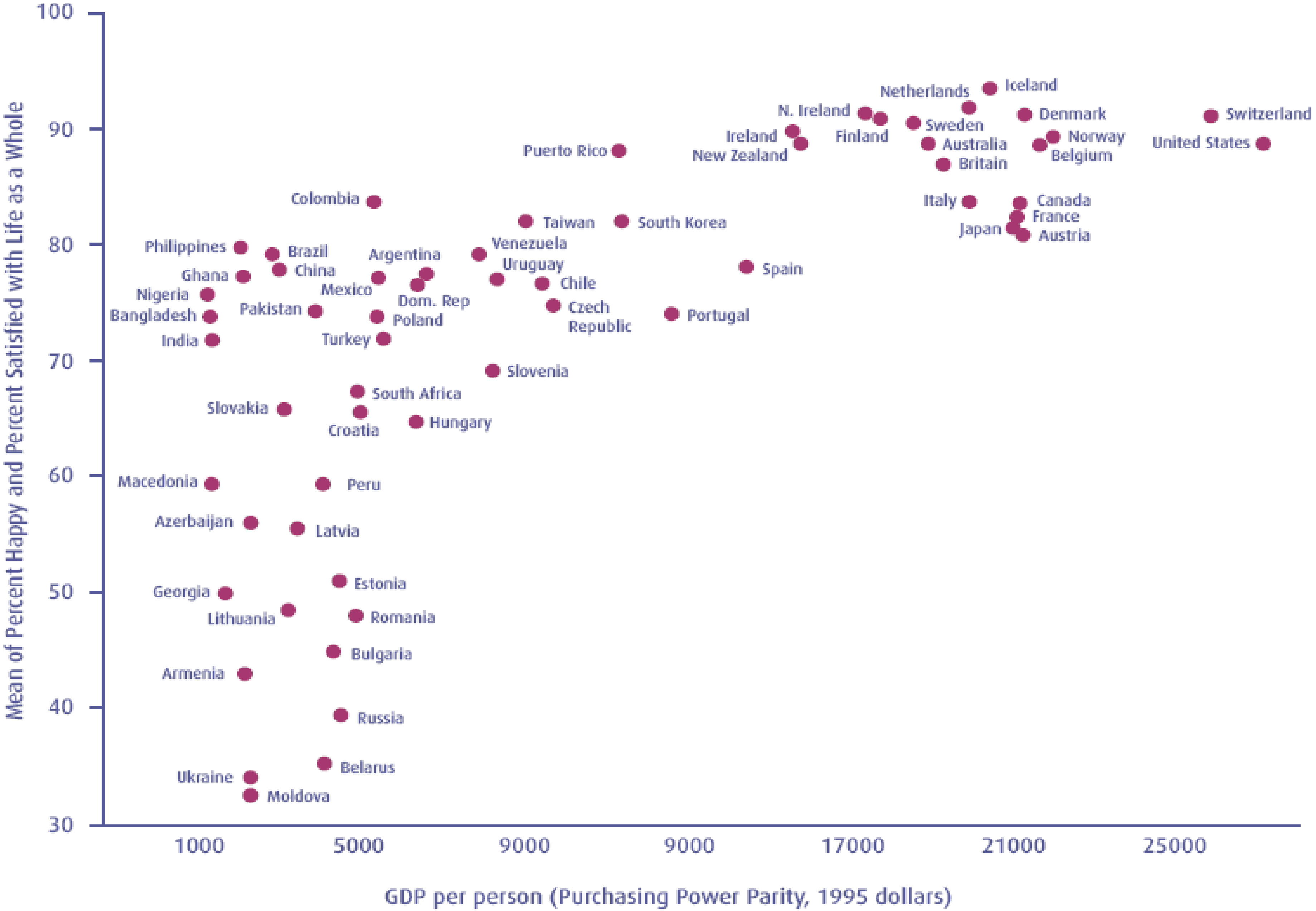
Developing countries	HPI-1
Five countries with the lowest levels of poverty	
Barbados	2.5
Uruguay	3.6
Chile	4.1
Cost Rica	4.4
Cuba	5.0
Five countries with the highest levels of poverty	
Zimbabwe	52.0
Mali	55.1
Ethiopia	56.0
Burkina Faso	58.6
Niger	61.8
Developed countries	**HPI-2**
Five countries with the lowest levels of poverty	
Sweden	6.5
Norway	7.2
Finland	8.4
Netherlands	8.4
Denmark	9.1
Five countries with the highest levels of poverty	
Belgium	12.4
Australia	12.9
UK	14.8
Ireland	15.3
USA	15.8

HPI – The Human Poverty Index (per cent) includes income and other factors, such as life span and illiteracy. The HPI is defined differently for developing and developed countries.

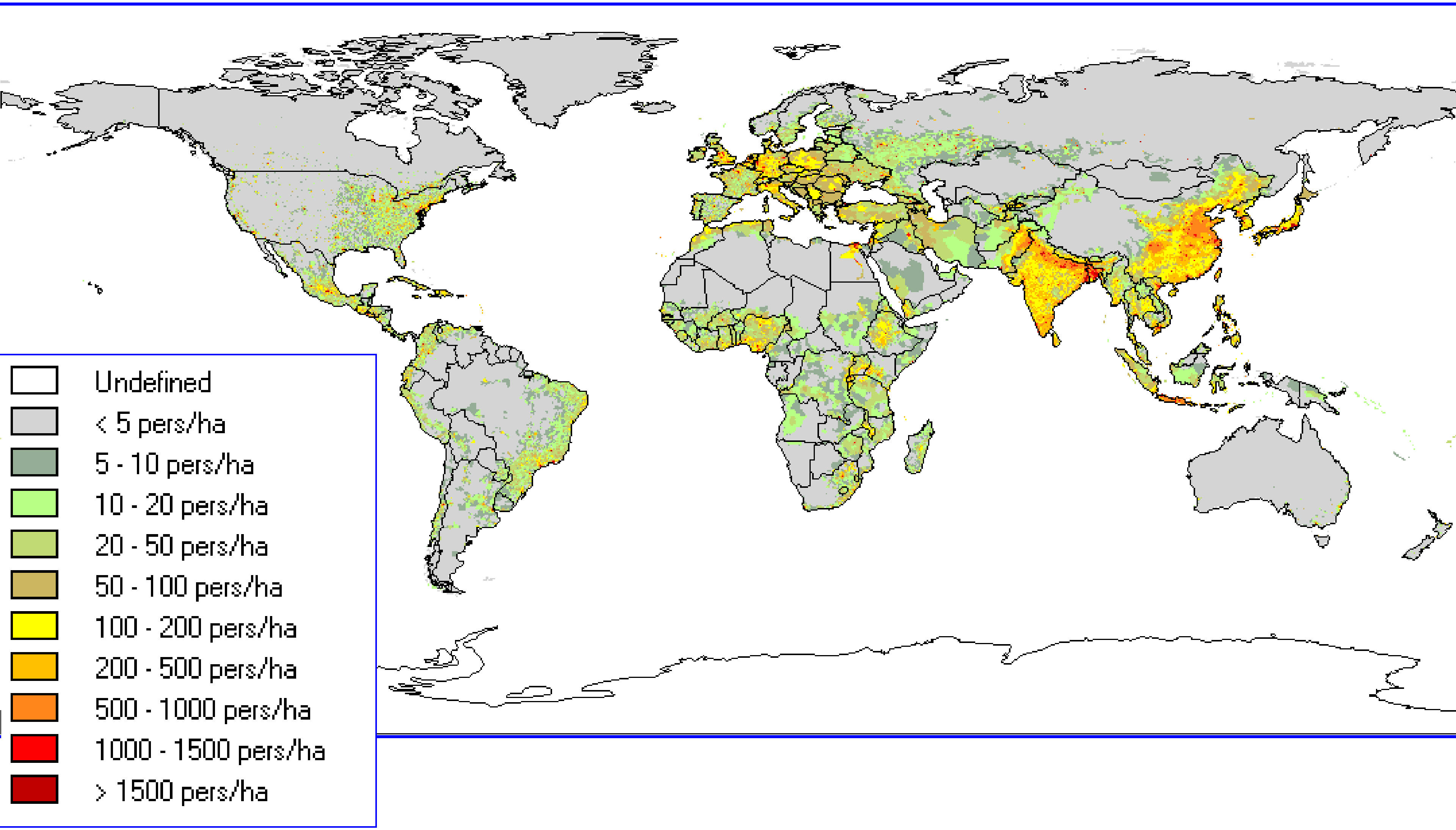
Example: Only 2.5 per cent of the population in Barbados live in poverty, but the figure is 61.8 per cent in Niger. Only 6.5 per cent of the population in Sweden live in poverty, but 15.8 per cent in the USA.

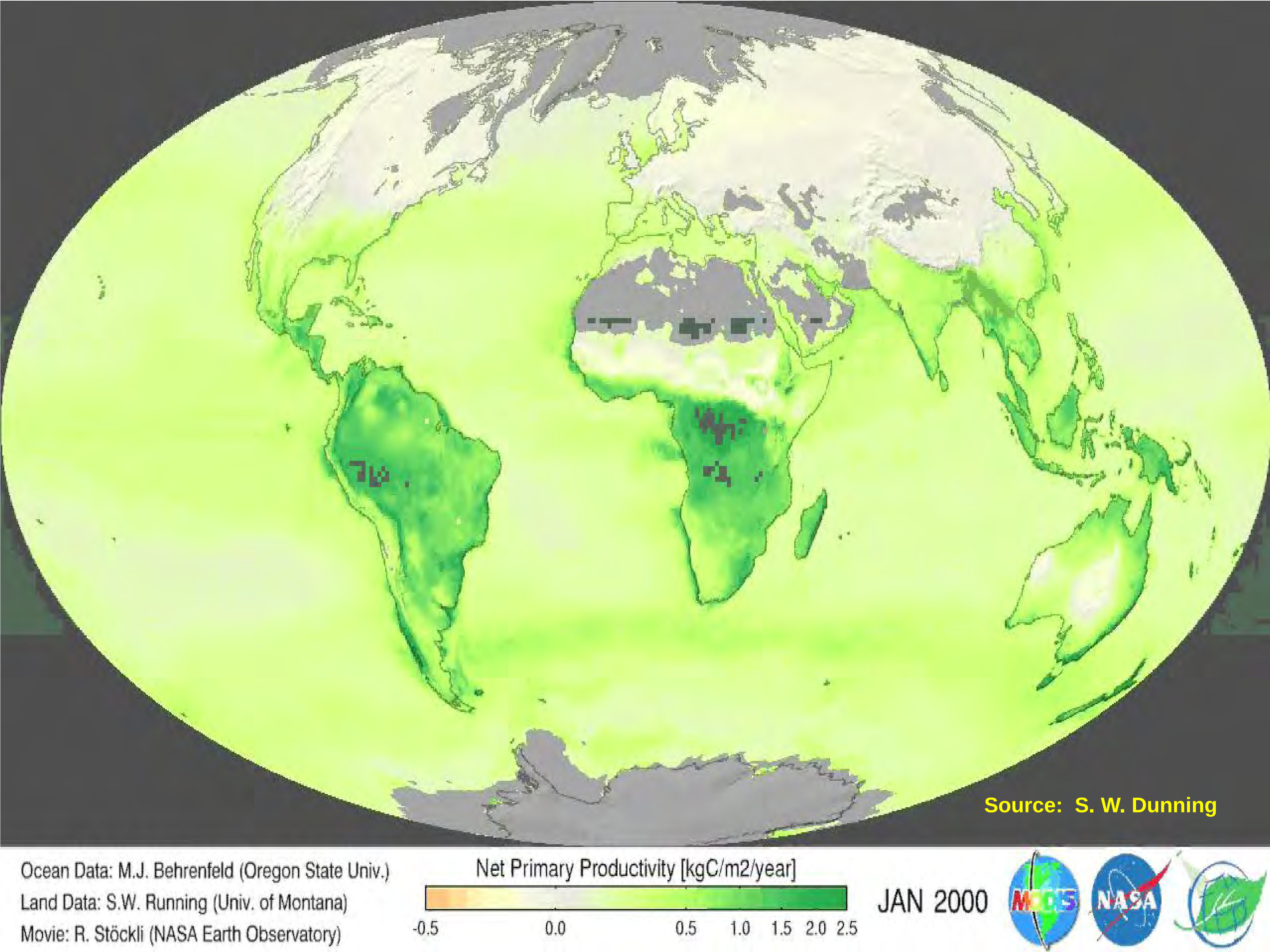
Source: UNDP 2003

Figure 6 **Happiness and average annual income**[15]



Densidade demográfica em 1995 com uma resolução espacial de 2.5 arc-min latitude/longitude (CIESIN)

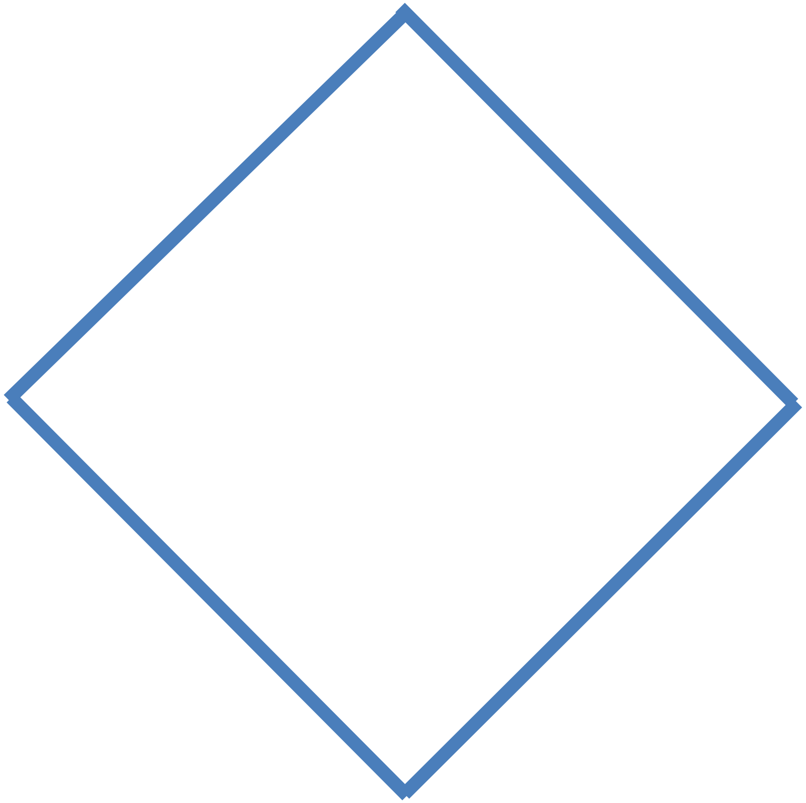



Source: S. W. Dunning
Ocean Data: M.J. Behrenfeld (Oregon State Univ.)
Land Data: S.W. Running (Univ. of Montana)
Movie: R. Stöckli (NASA Earth Observatory)
Net Primary Productivity [kgC/m2/year]
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
JAN 2000
MODIS
NASA

Quadrado da Insustentabilidade

Desigualdades e Iniquidades de Desenvolvimento
Pobreza extrema e severa

Segurança Alimentar, escassez de água, perda de biodiversidade



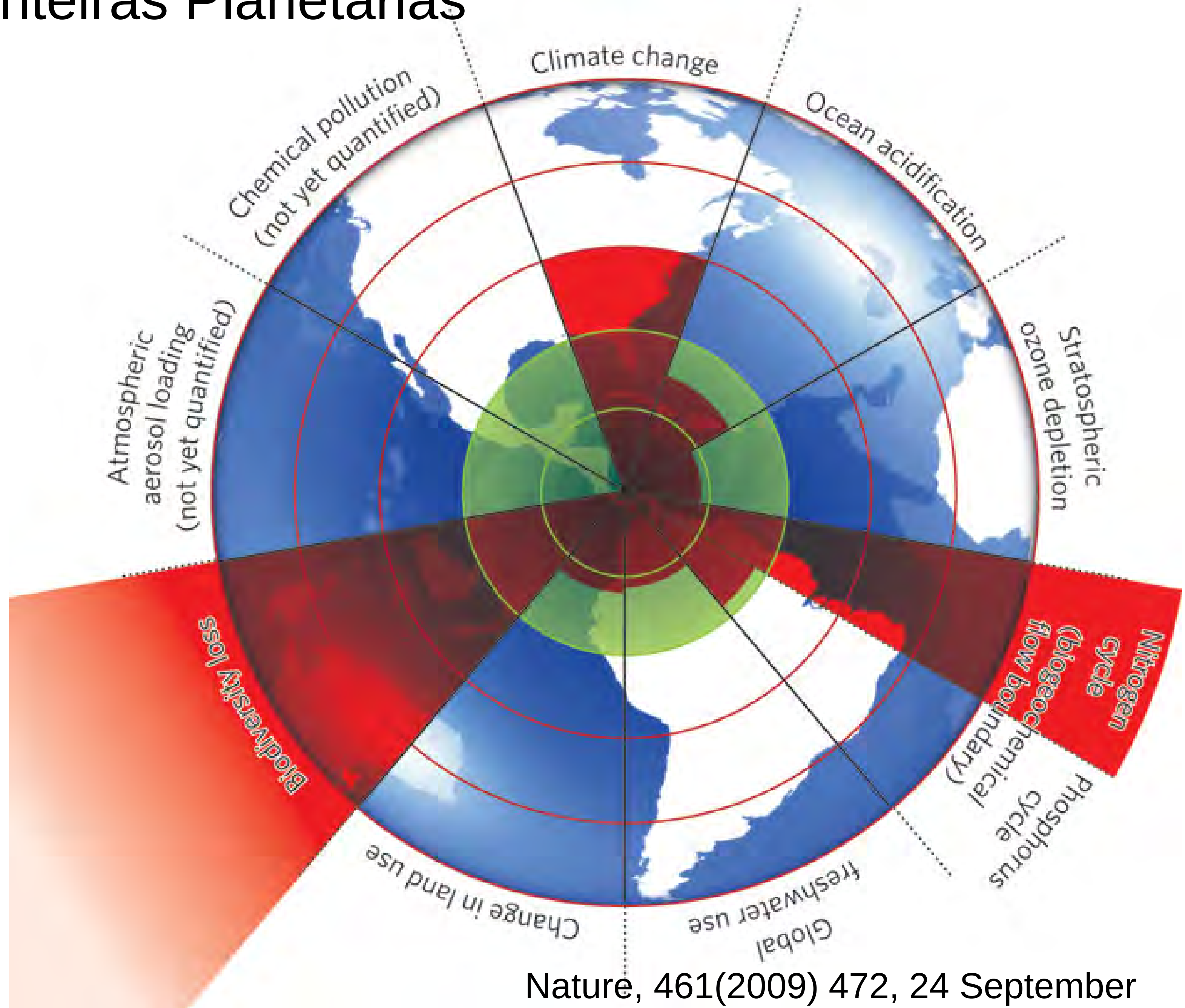
Sustentabilidade dos sistemas de Energia

Alterações Climáticas

1 – Os 4 factores de insustentabilidade estão fortemente interligados e interdependentes

2 – Não é possível atingir o desenvolvimento sustentável sem procurar resolver os 4 desafios de forma integrada
e simultânea

Fronteiras Planetarias



Nature, 461(2009) 472, 24 September

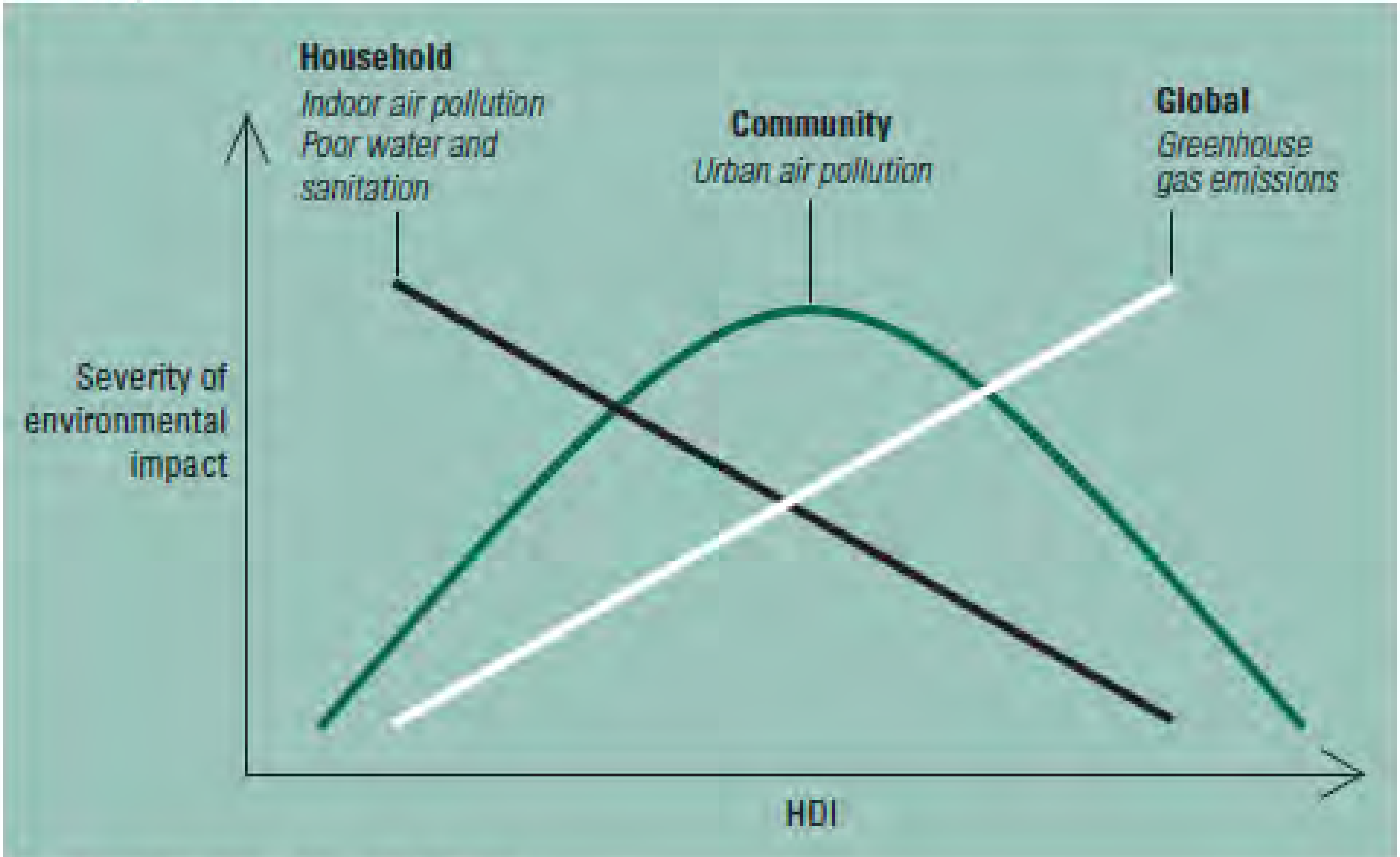
PLANETARY BOUNDARIES

Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	(ii) Change in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number of species per million species per year)	10	>100	0.1–1
Nitrogen cycle (part of a boundary with the phosphorus cycle)	Amount of N_2 removed from the atmosphere for human use (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions of tonnes per year)	11	8.5–9.5	-1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis		To be determined	
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof		To be determined	

Boundaries for processes in red have been crossed. Data sources: ref. 10 and supplementary information

FIGURE 2.3

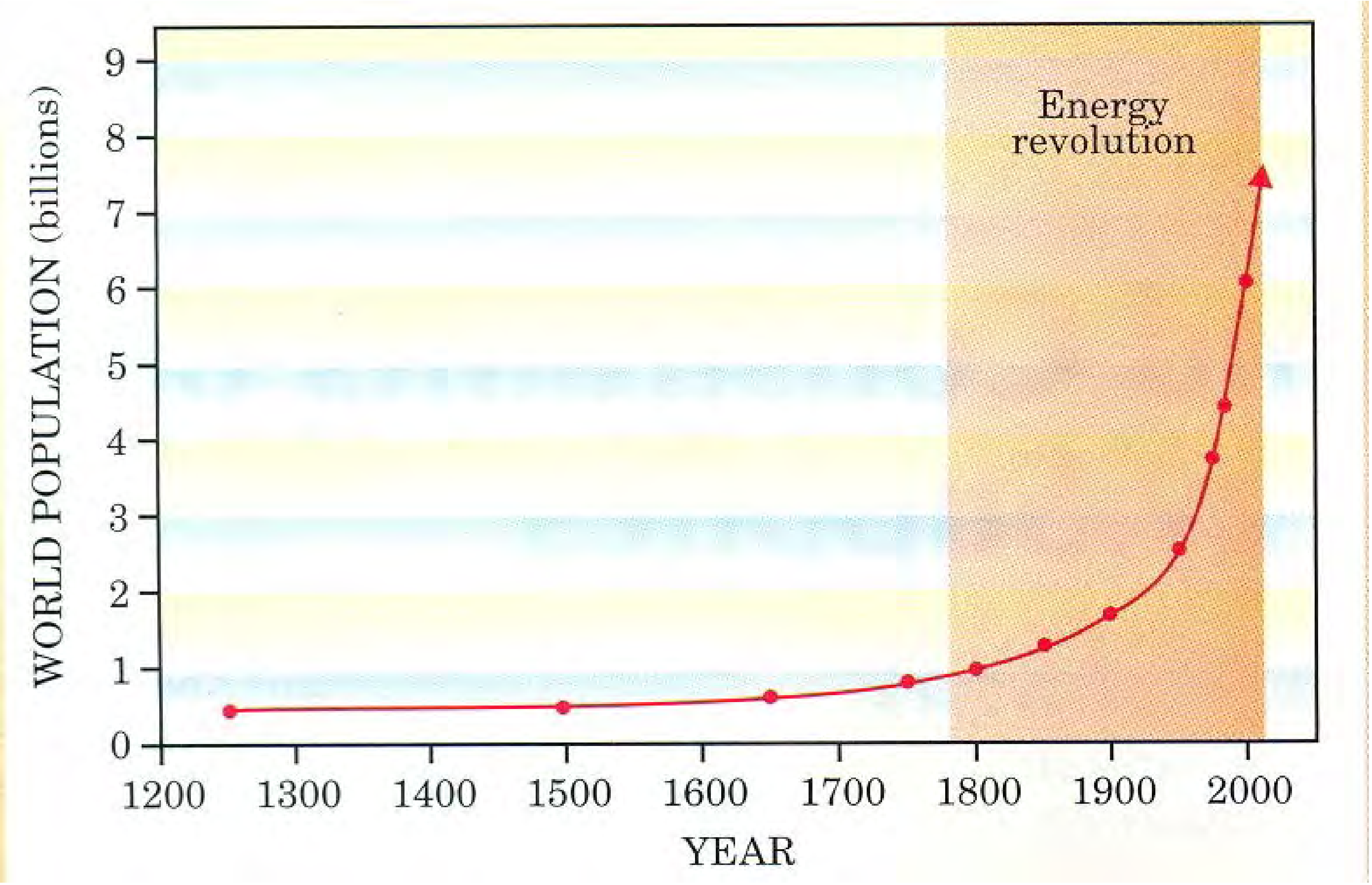
Patterns of risk change: environmental transitions and human development



Source: Based on Hughes, Kuhn and others (2011).

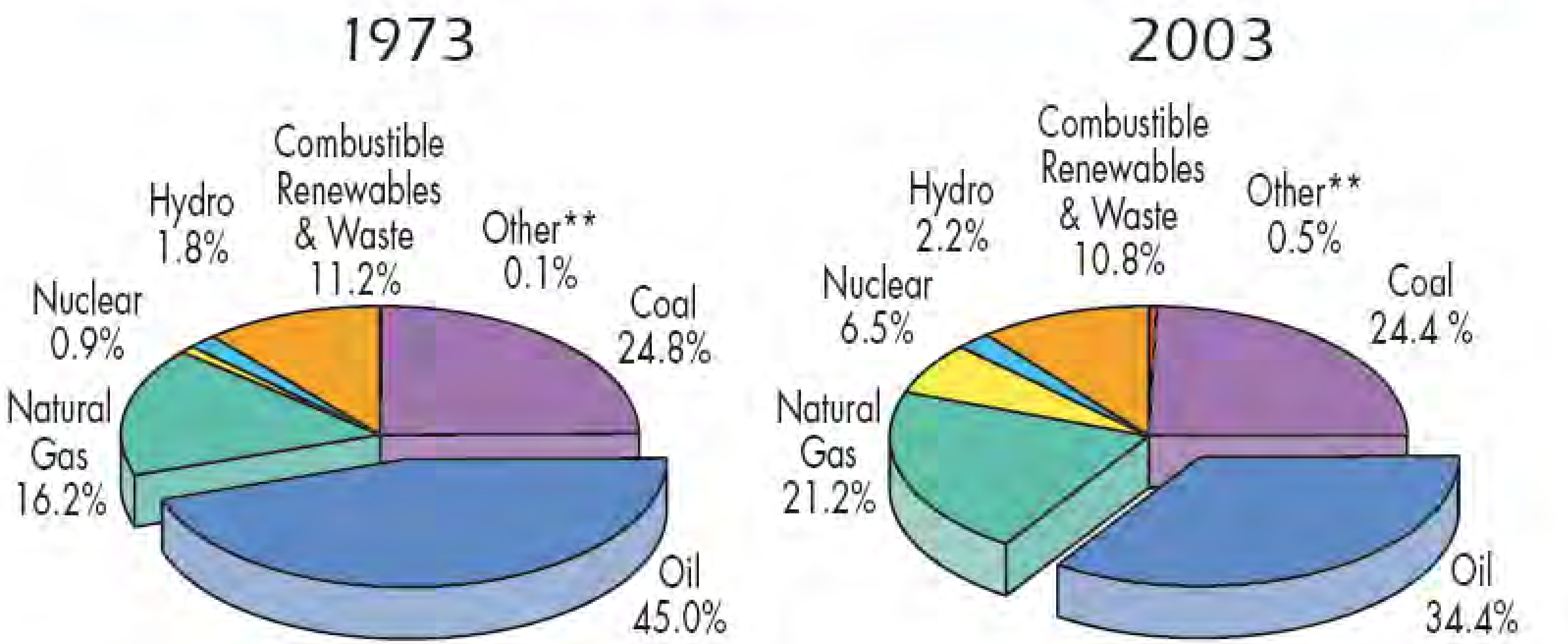
ENERGIA

Revolução Energética



Fonte, P. Weiss, 2004

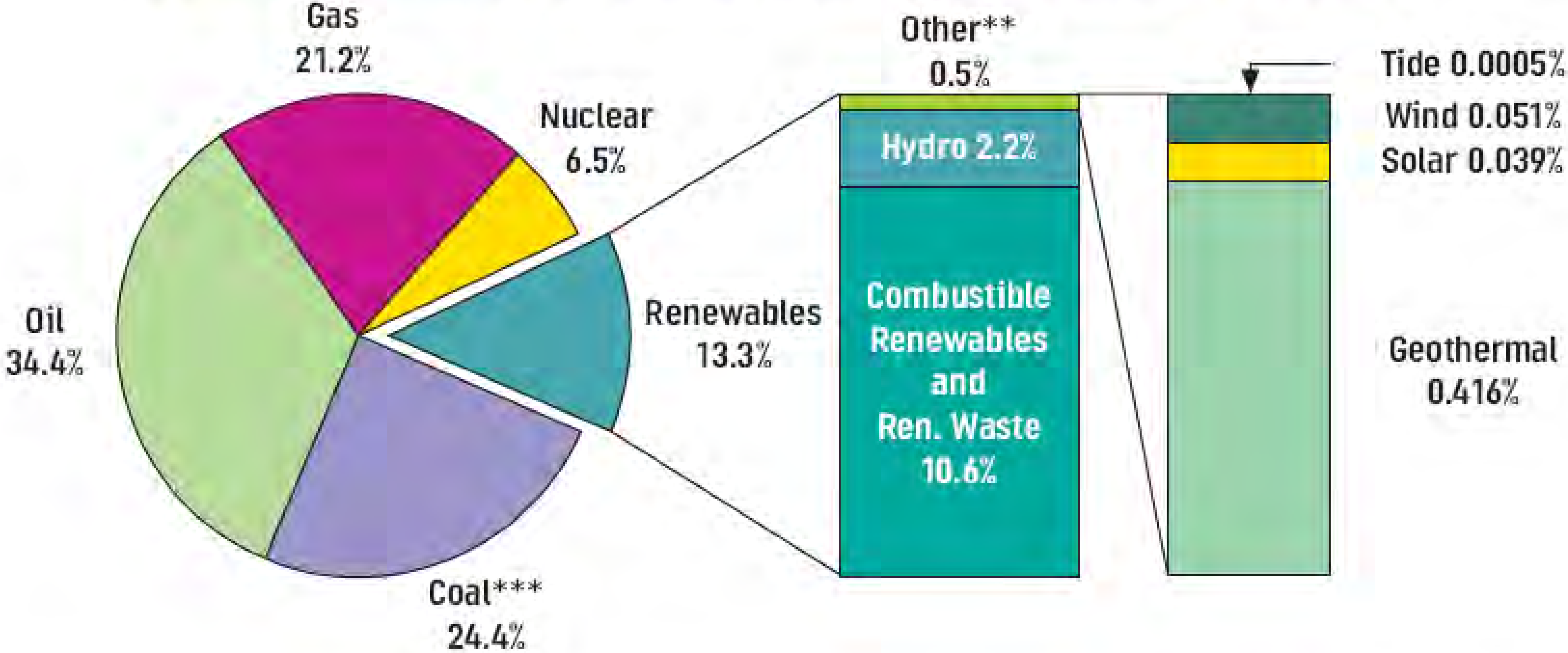
1973 and 2003 Fuel Shares of TPES*



6 034 Mtoe **10 579 Mtoe**

**Excludes international marine bunkers and electricity trade.*
***Other includes geothermal, solar, wind, heat, etc.*

2003 Fuel Shares of World Total Primary Energy Supply*



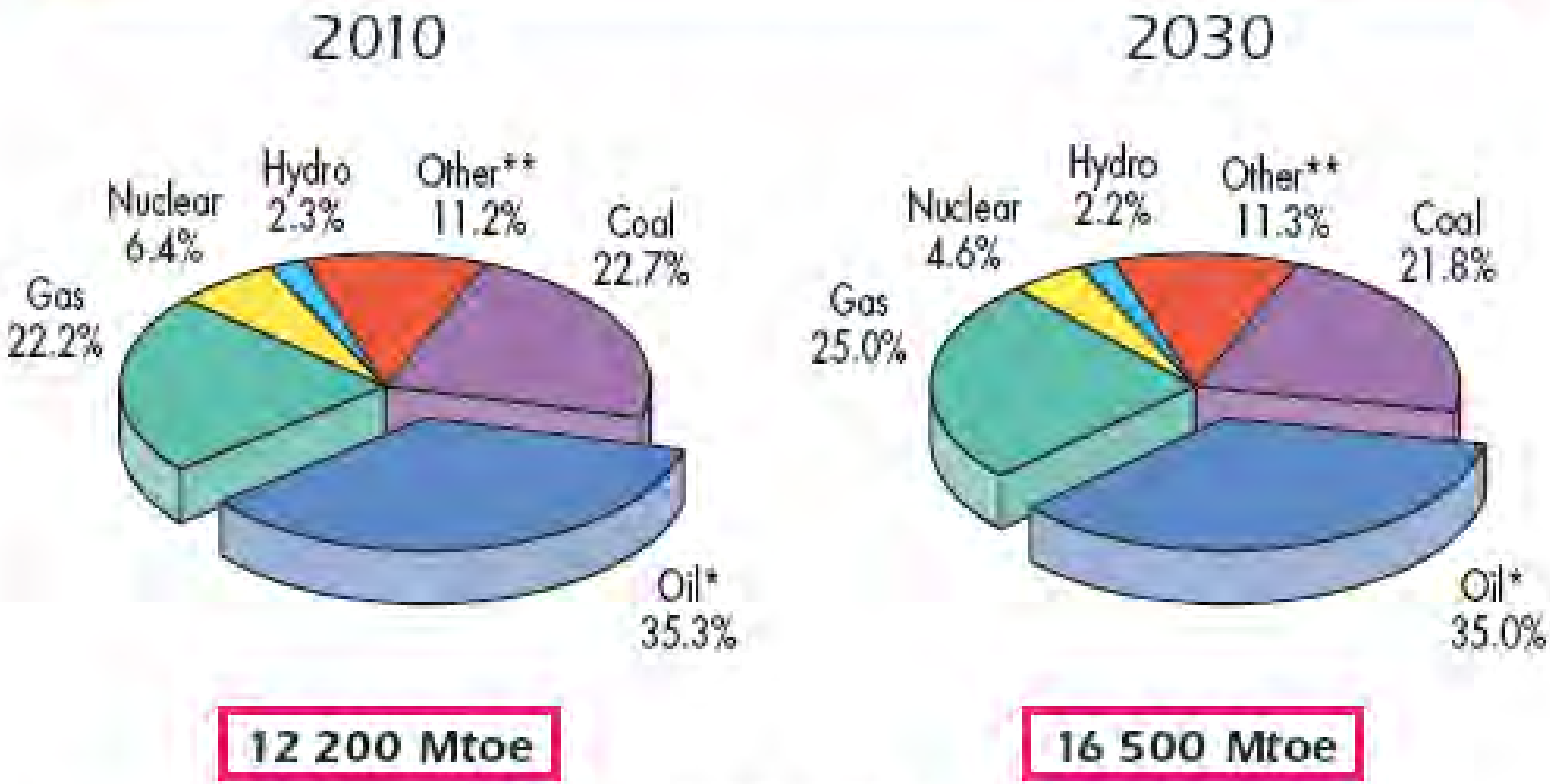
* TPES is calculated using the IEA conventions (physical energy content methodology). It includes international marine bunkers and excludes electricity/heat trade. The figures include both commercial and non-commercial energy.

** Geothermal, solar, wind, tide/wave/ocean.

*** Includes non-renewable waste.

Source: IEA Energy Statistics

Fuel Shares of TPES* in 2010 and 2030



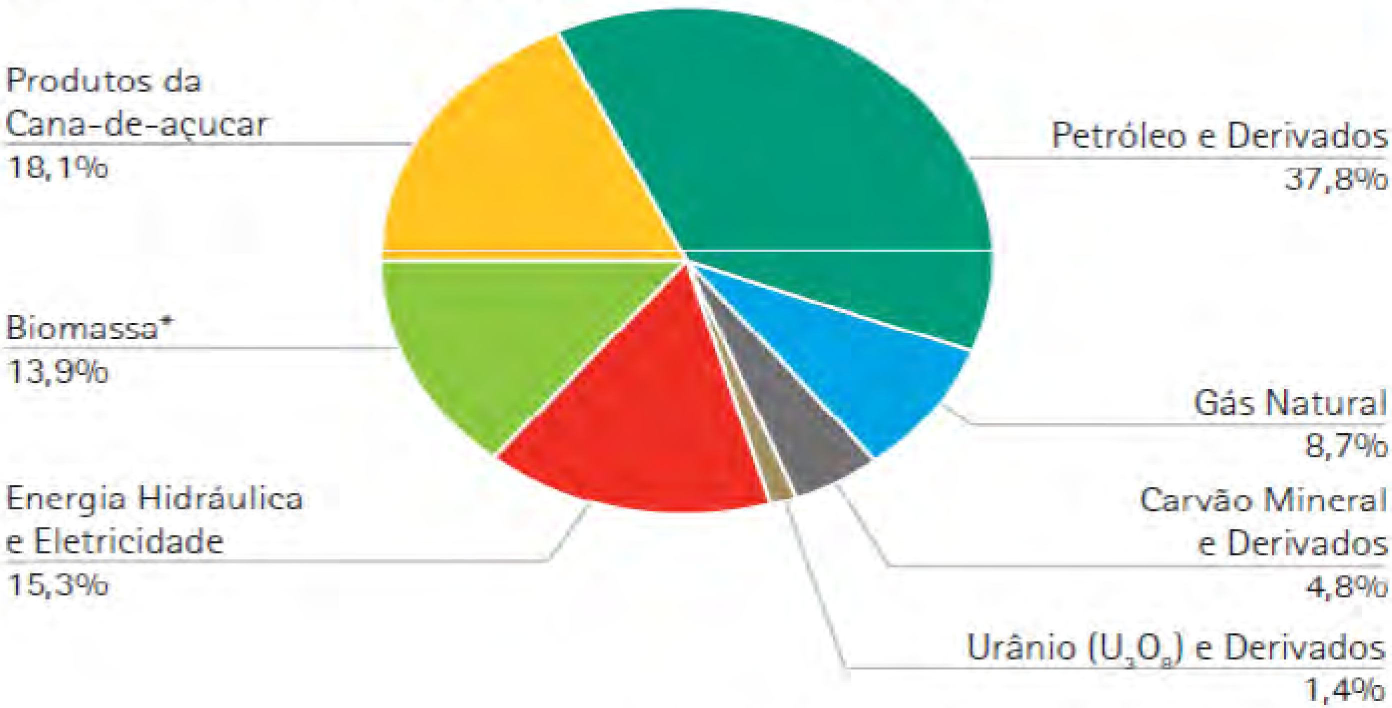
* Includes bunkers.

** Other includes combustible renewables & waste, geothermal, solar, wind, tide, etc

Fonte: AIE

A Matriz Energética Brasileira

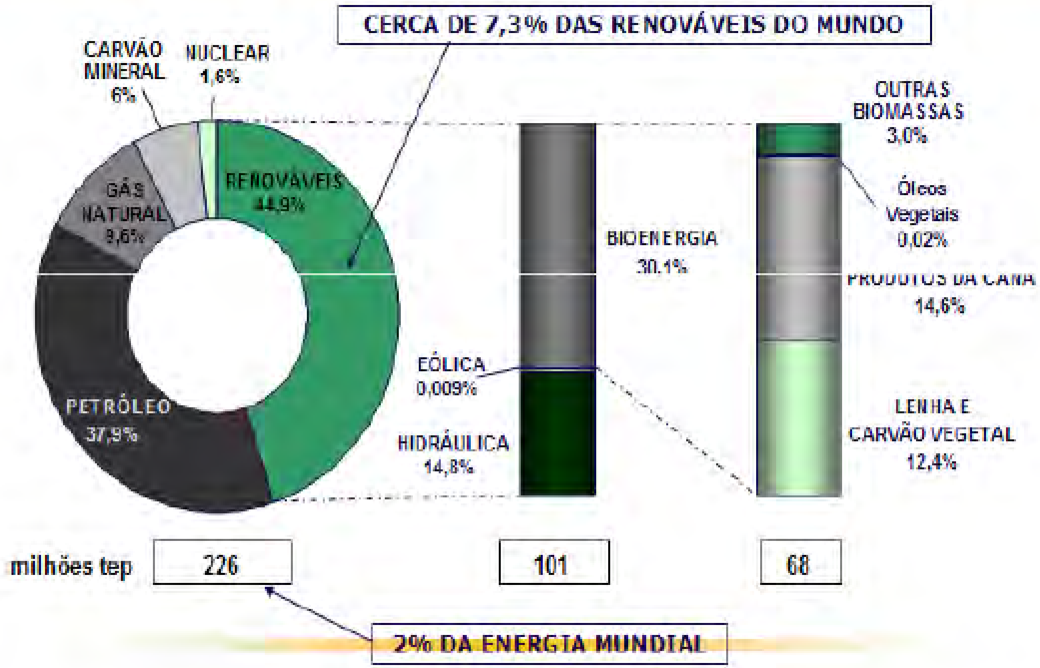
Oferta Interna de Energia - Brasil (2009)



Fonte: Balanço Energético Nacional - BEN

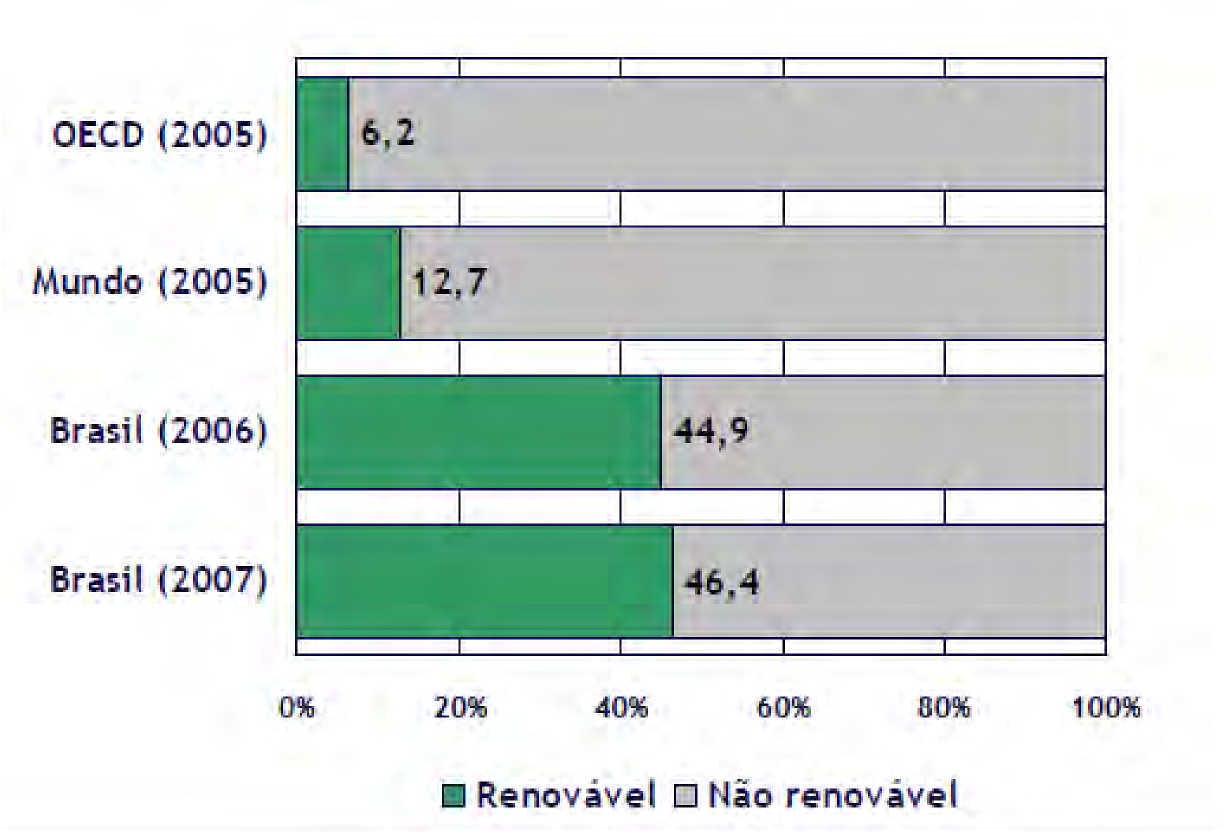
Nota: *Inclui lenha, carvão vegetal e outras renováveis

A Matriz Energética Brasileira



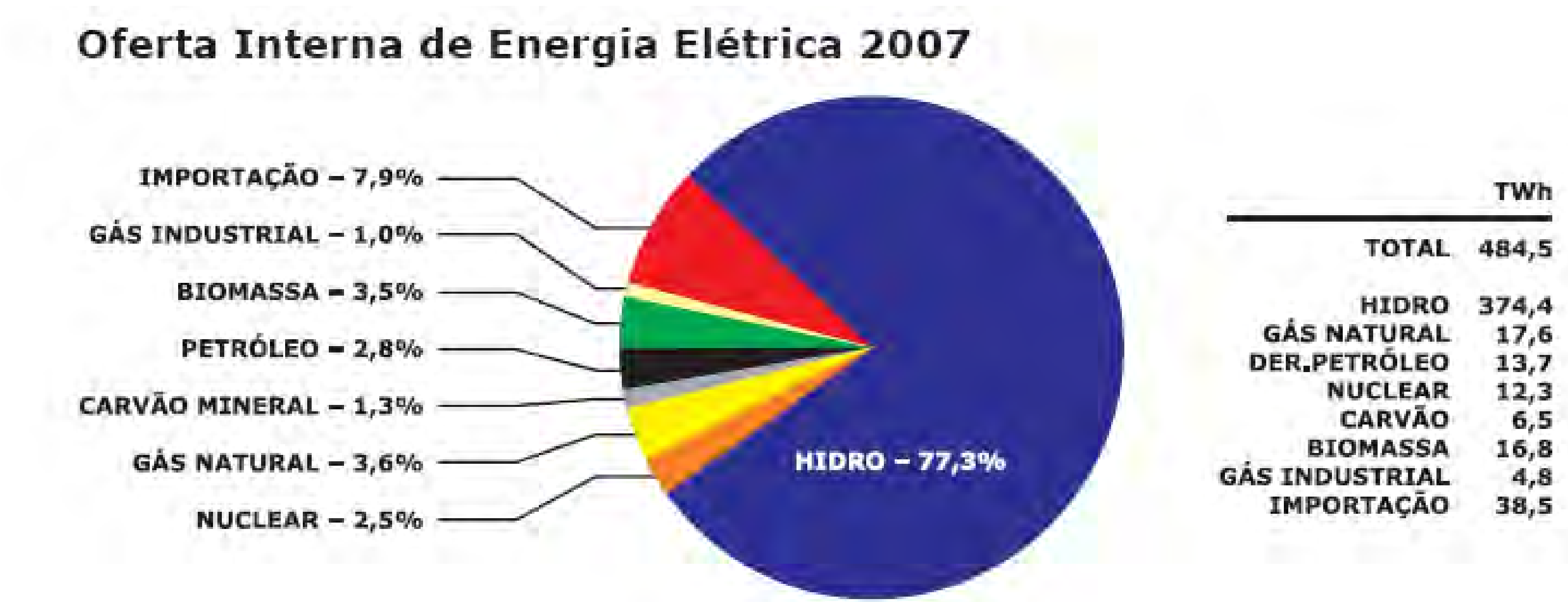
Fonte: MME

O Diferencial Brasil

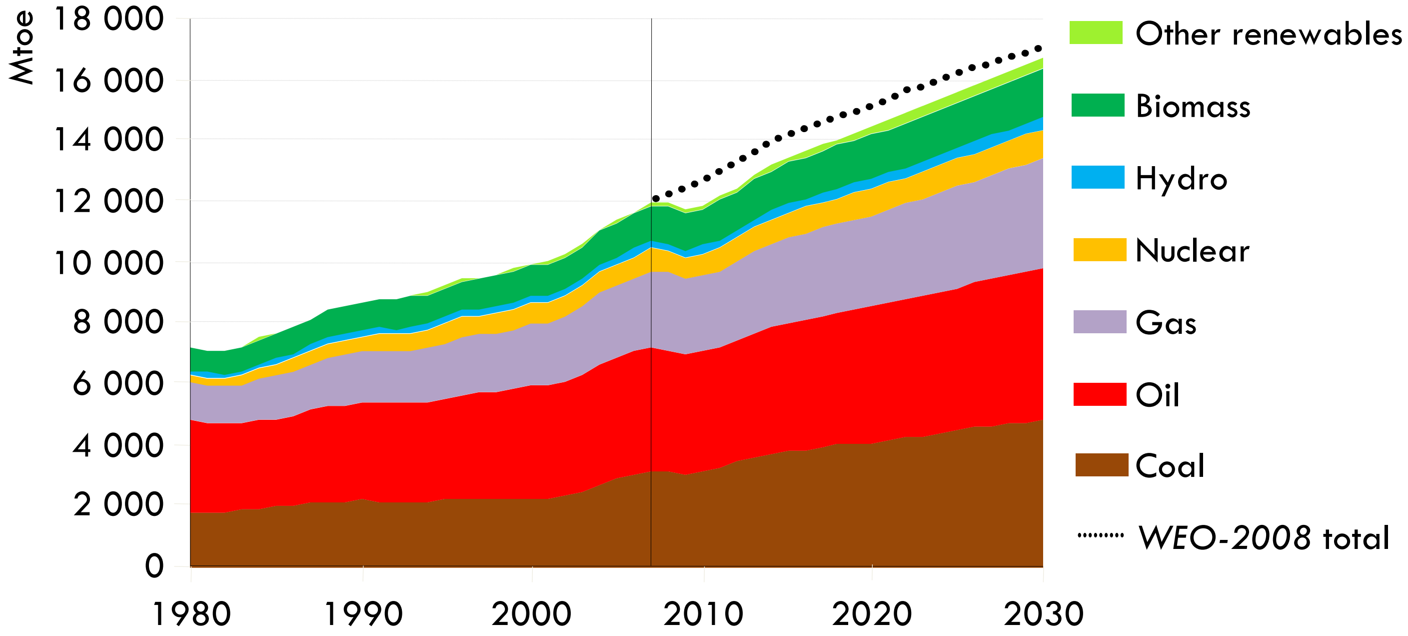


2. Renováveis

Buscar manter elevada a participação de energia renovável na matriz elétrica, preservando posição de destaque que o Brasil sempre ocupou no cenário internacional

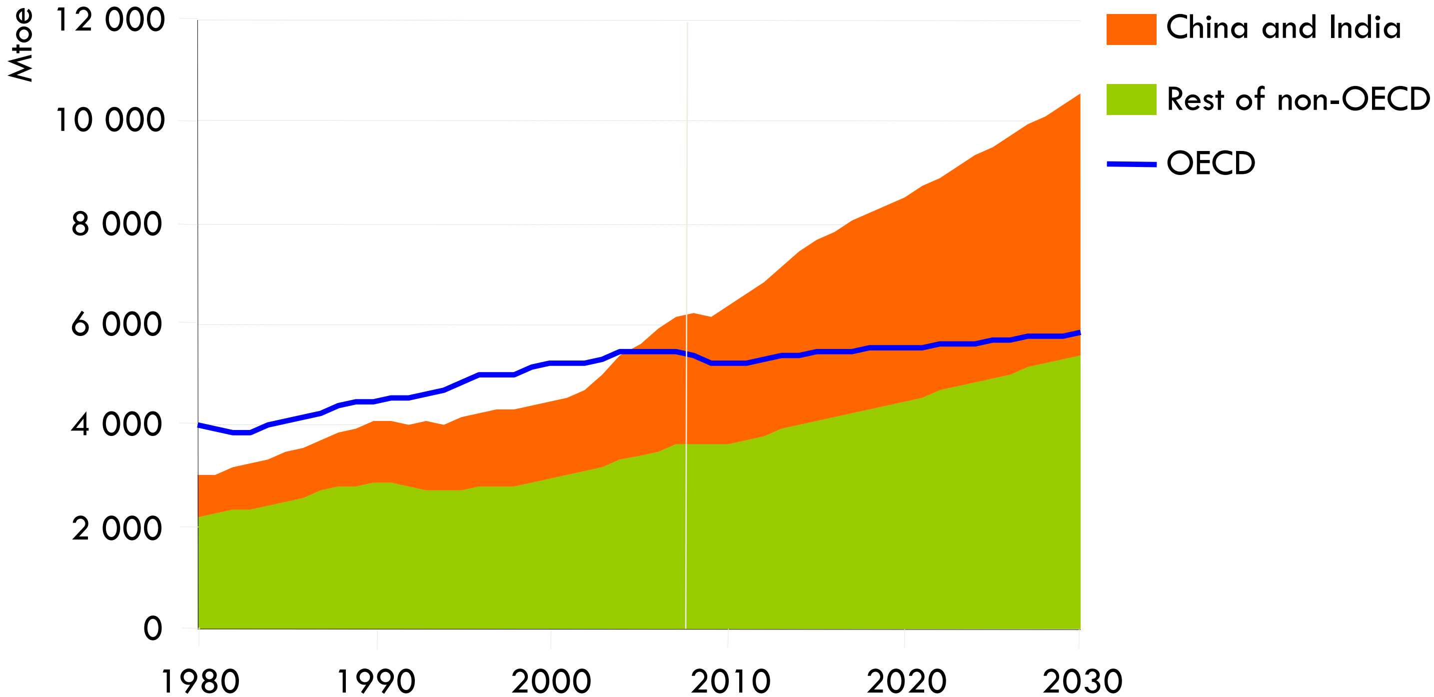


Procura mundial de energia primária por tipo de fonte no cenário de referência da AIE



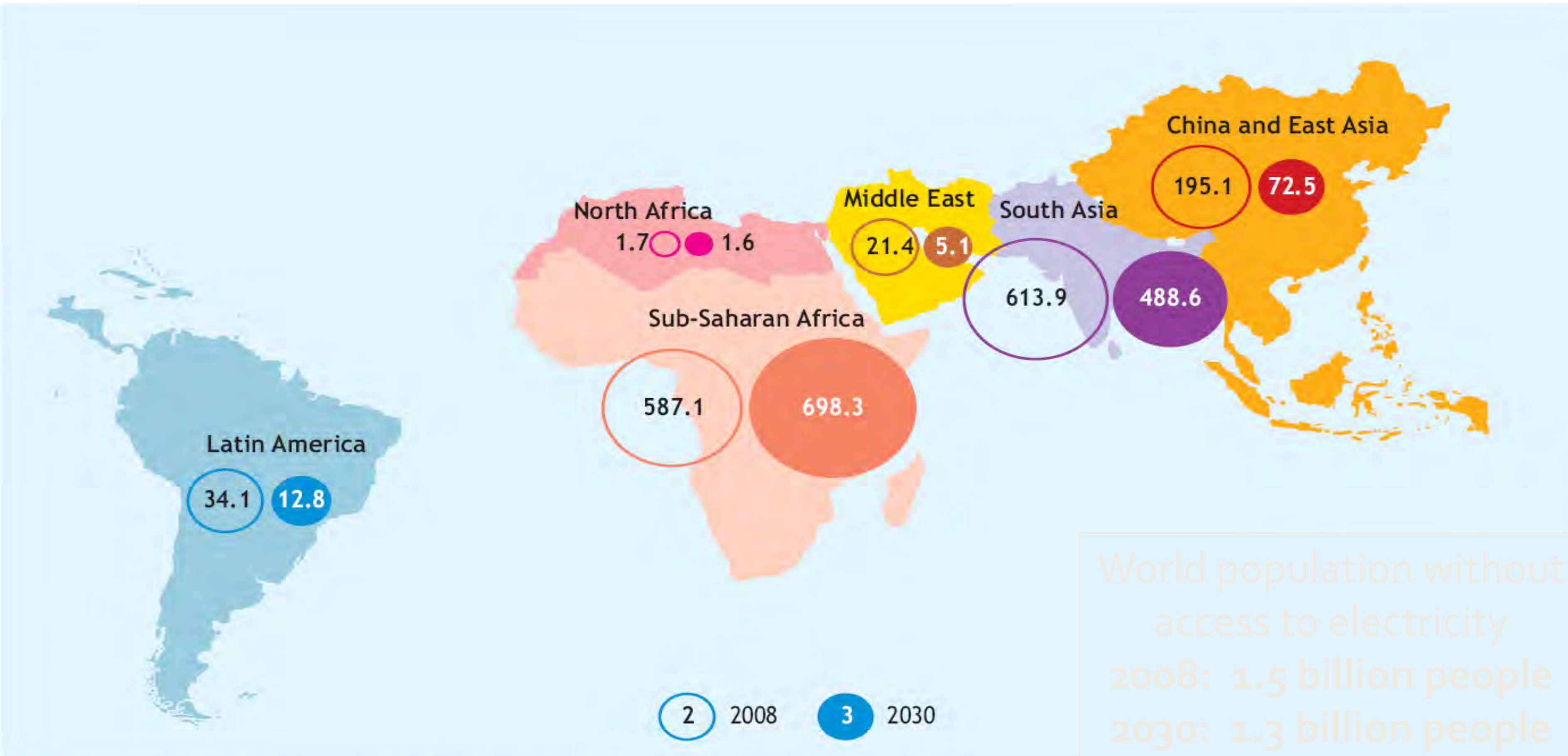
•Global demand grows by 40% between 2007 and 2030,
•with coal use rising most in absolute terms

Procura mundial de energia primária no cenário de referência da AIE



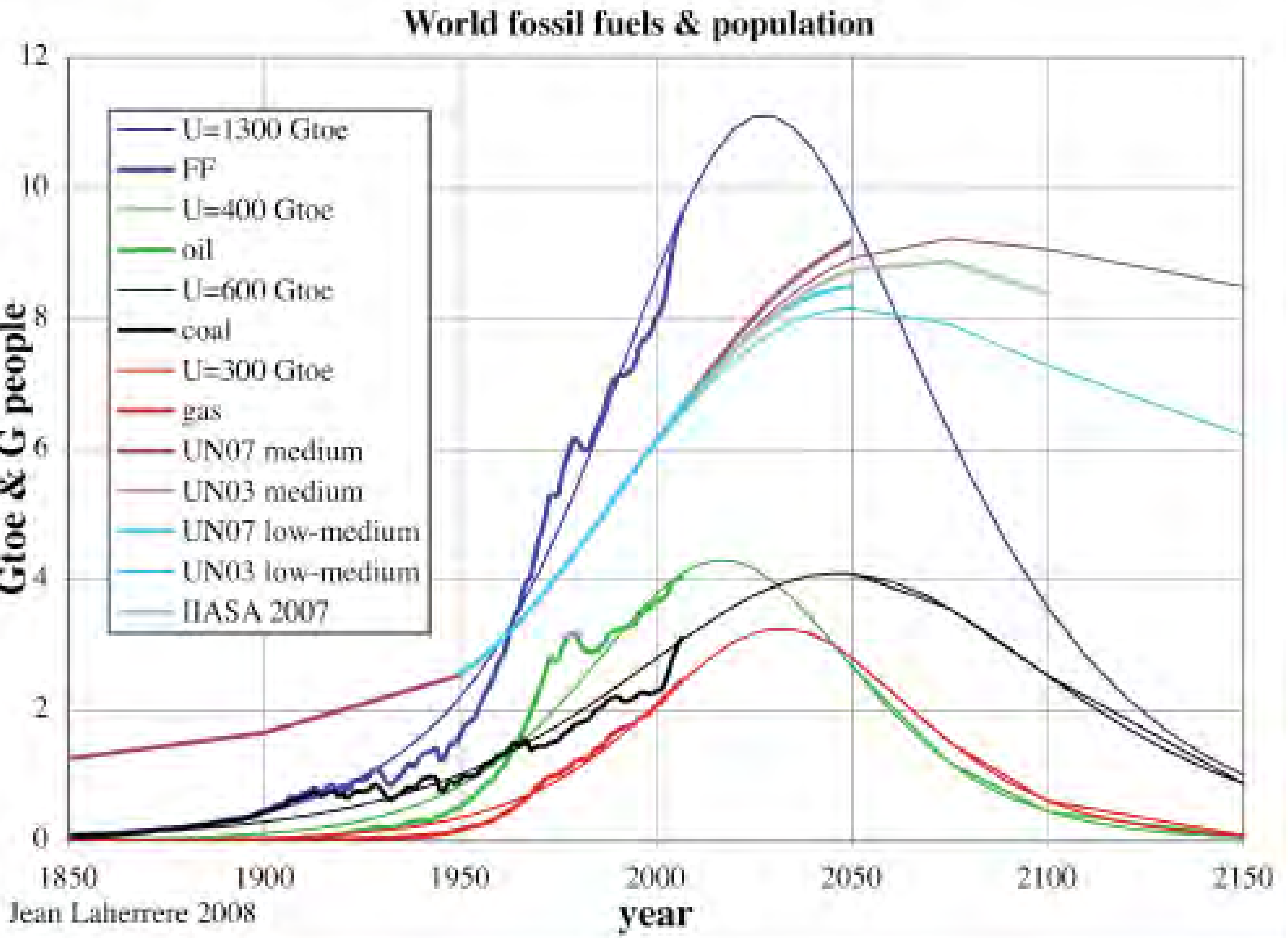
•Non-OECD countries account for 93% of the increase in global demand
•between 2007 & 2030, driven largely by China & India

Numero de pessoas sem acesso a electricidade em 2008 e 2030 no cenário de referência da AIE



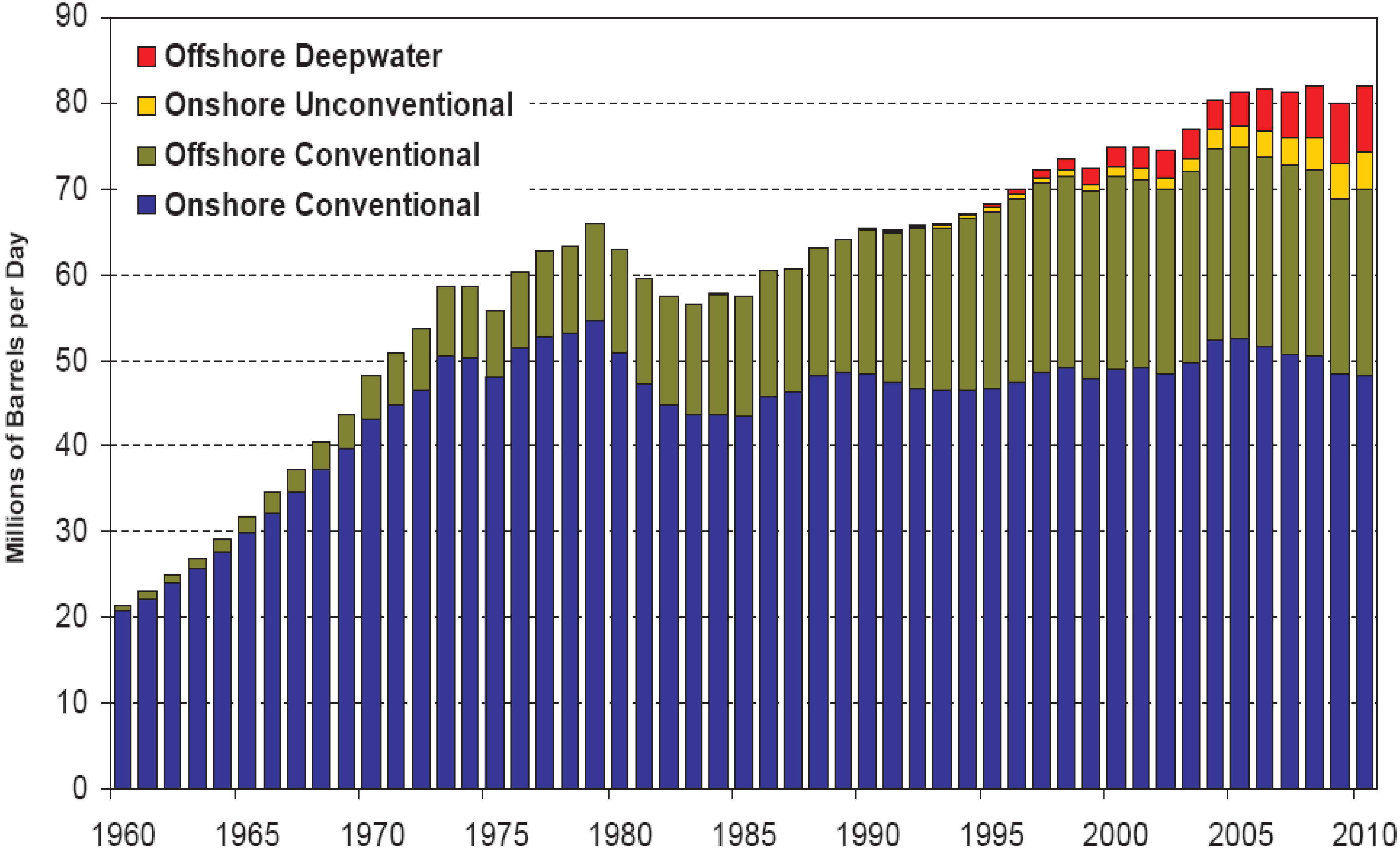
The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

$35 billion per year more investment than in the Reference Scenario would be needed to 2030 – equivalent to just 5% of global power-sector investment – to ensure universal access



World fossil fuels & population
12
10
8
6
4
2
0
Gtoe & G people
U=1300 Gtoe
FF
U=400 Gtoe
oil
U=600 Gtoe
coal
U=300 Gtoe
gas
UN07 medium
UN03 medium
UN07 low-medium
UN03 low-medium
IIASA 2007
1850
1900
1950
2000
2050
2100
2150
year
Jean Laherrere 2008

Global Oil Production – Onshore and Offshore, Conventional and Unconventional



Source: Energyfiles, Energy Information Administration, BP Statistical Review of World Energy, Wood Mackenzie *As of 12/31/10*

Extreme Energy – Energia Extrema

Unconvencional oil – Petróleo Não Convencional

Oil sands – Areias betuminosas (Canadá)
Tight oil – Xistos petrolíferos (Dakota do Norte, EUA)
Offshore deepwater – Offshore muito profundo

Unconventional gas – Gás Não Convencional

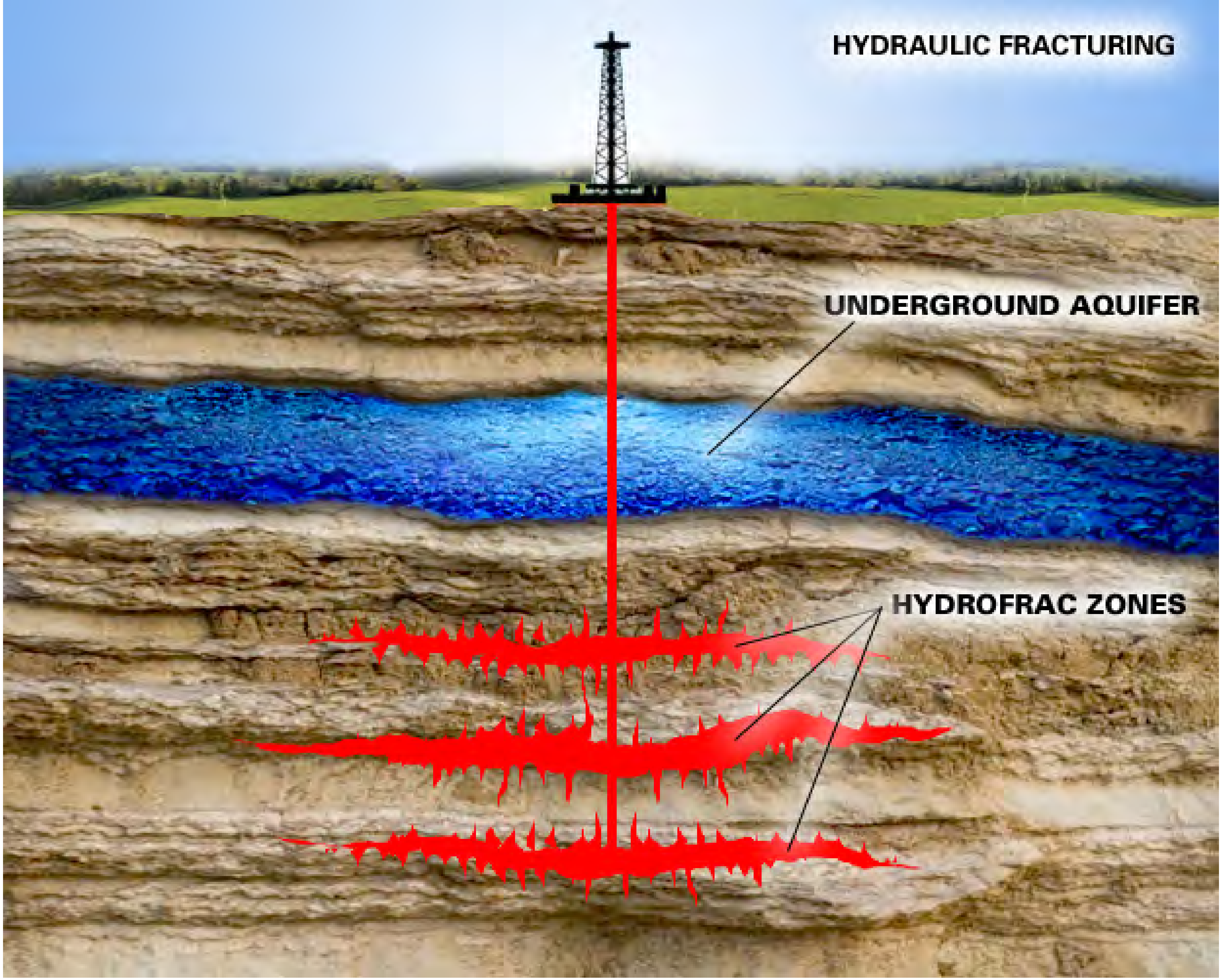
Shale gas – Gás de xisto (EUA)

AREIAS BETUMINOSAS

Alberta Tar Sands © Garth Lenz


119
116
110

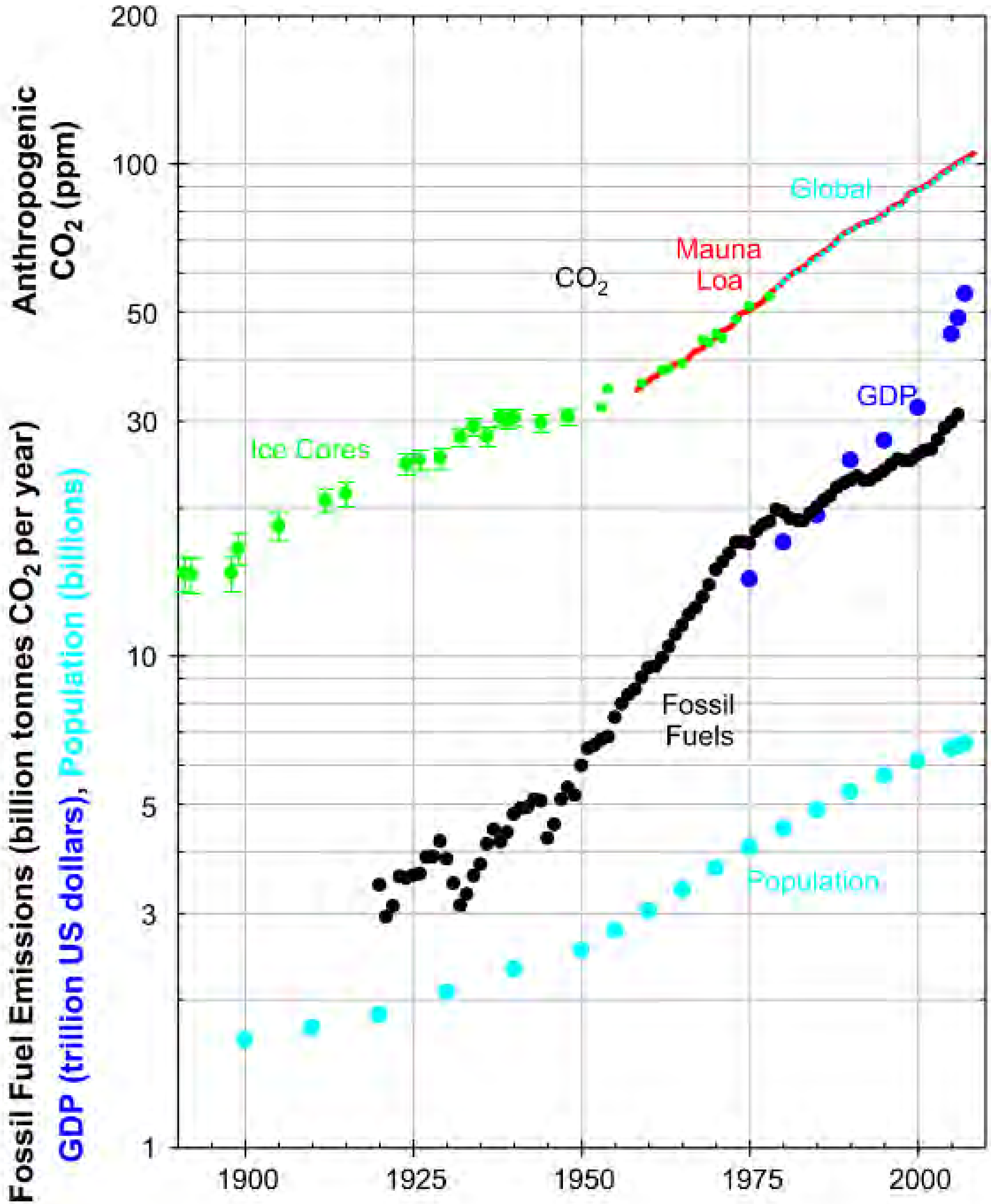
Gás de xisto: Emissões de gases com efeito de estufa comparáveis ao do carvão quando se contabilizam as emissões de metano durante O processo de exploração


HYDRAULIC FRACTURING
UNDERGROUND AQUIFER
HYDROFRAC ZONES

GÀS DE XISTO


© June 2008, WVSORO
www.wvsoro.org

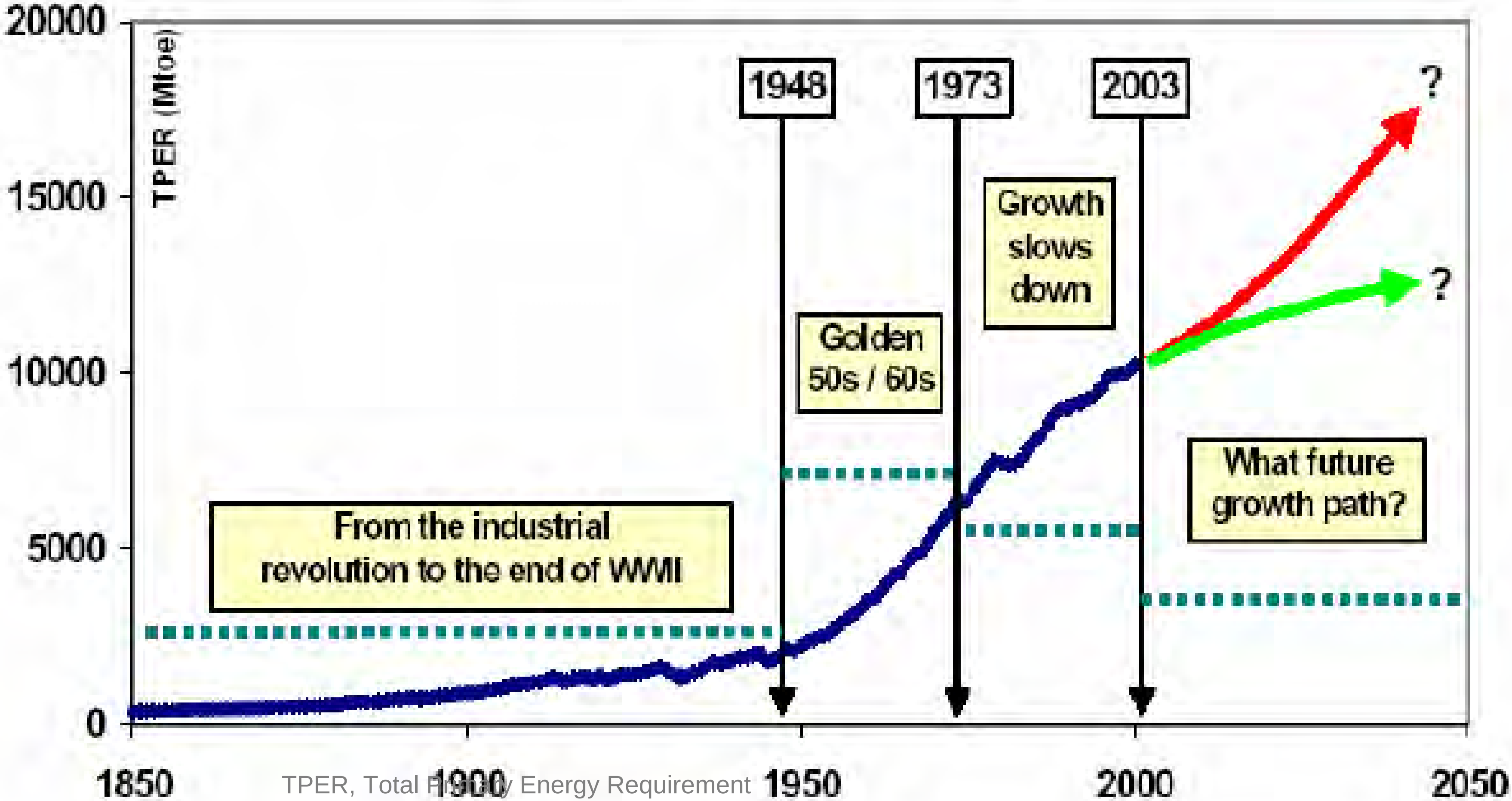
Anthropogenic atmospheric carbon dioxide, fossil fuel emissions, world gross domestic product (GDP), and world population for the past century. Carbon dioxide data from Antarctic ice cores (green points), Mauna Loa Observatory (red curve), and the global network (blue dots).



http://www.noaanews.noaa.gov/stories2009/20090421_carbon.html

Fonte: NOOA, April 2009

Energy demand and GDP
(over time)



TPER, Total Primary Energy Requirement

Source: *Drivers of the Energy Scene*, World Energy Council (2003)

Table 4.1-3
Potential emissions as a consequence of the use of fossil reserves and resources. Also illustrated is their potential for endangering the 2 °C guard rail. This risk is expressed as the factor by which, assuming complete exhaustion of the respective reserves and resources, the resultant CO_2 emissions would exceed the 750 Gt CO_2 budget permissible from fossil sources until 2050 (Box 1.1-1). The figures refer to CO_2 alone, other greenhouse gases have not been taken into account. They are based on the values in Table 4.1-2.
Source: based on Table 4.1-1 and GEA, 2011

	Historical production up to 2008	Production in 2008	Reserves	Resources	Further occurences	Total: reserves, resources and further occurences	Factor by which these emissions alone exceed the 2 °C emissions budget
	[Gt CO_2]	[Gt CO_2]	[Gt CO_2]	[Gt CO_2]	[Gt CO_2]	[Gt CO_2]	
Conventional oil	505	13	494	386	–	880	1
Unconventional oil	39	2	295	2,637	3,646	6,577	9
Conventional gas	194	7	343	459	27,977	28,778	38
Unconventional gas	15	1	3,987	5,300	–	9,287	12
Coal	666	14	1,970	41,277	–	43,247	58
Total fossil fuels	1,419	37	7,088	50,060	31,622	88,770	118

Água

- A Terra é o “Planeta Azul”, o único onde existe água em abundância no estado líquido;

- Foi esta característica que permitiu o aparecimento de vida na Terra há 4100 a 3900 milhões de anos;

- A água é um recurso renovável que o ciclo hidrológico, movido pela energia solar, disponibiliza continuamente.

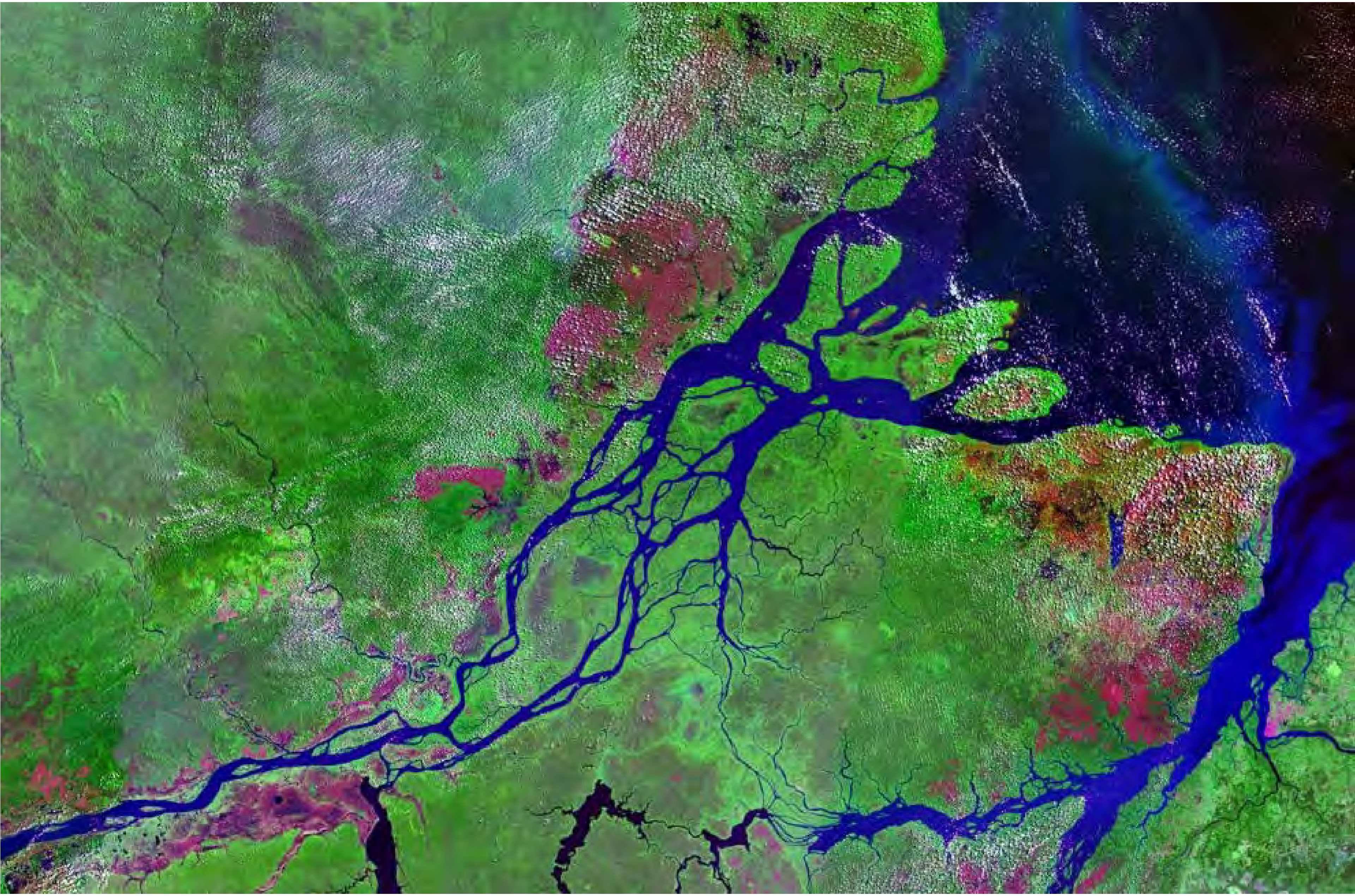
- Reserva total do planeta 1,4 X 10^9 Km^3

  Água salgada 97,5%

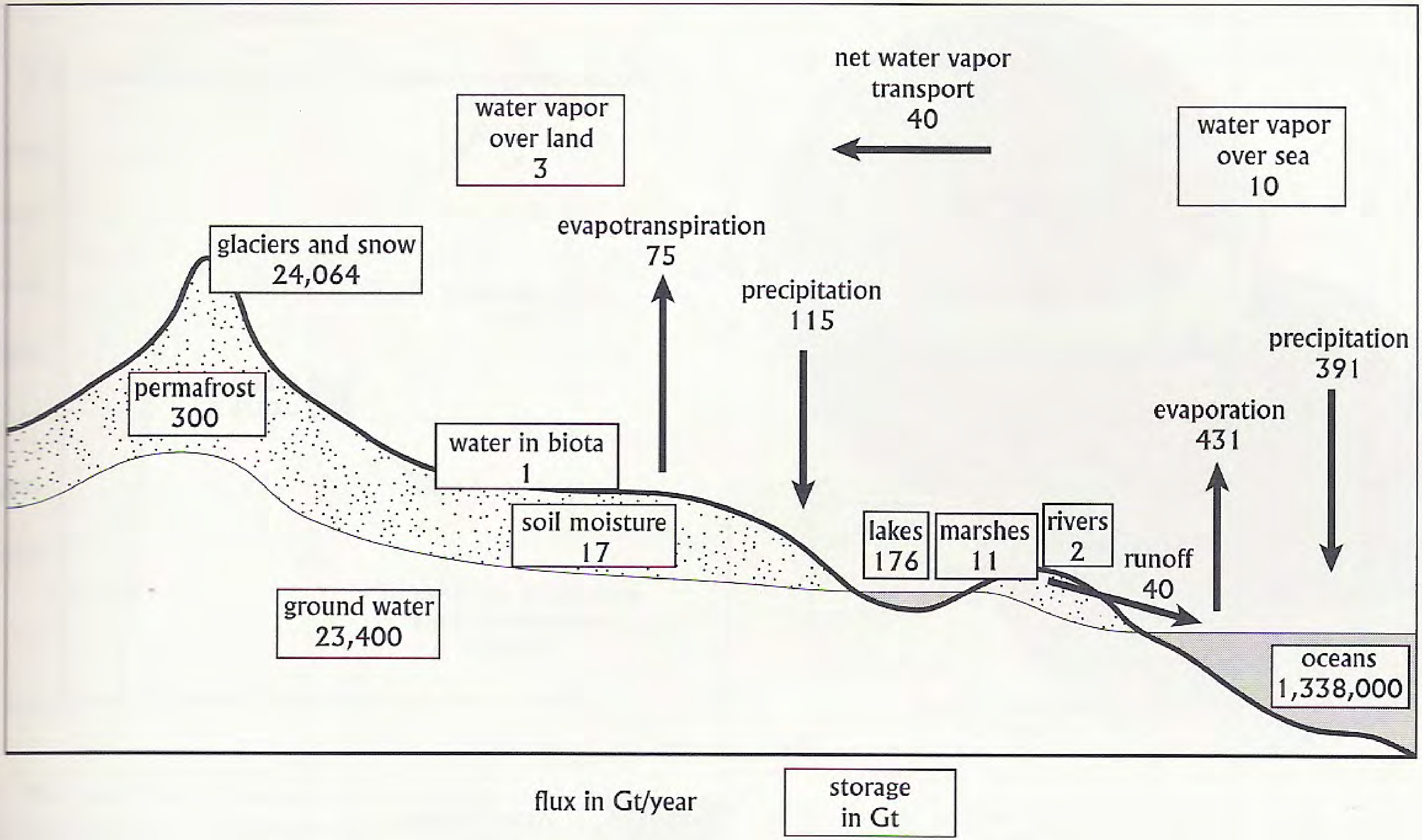
  Água doce 2,5%

Principais reservatórios de água doce do ciclo hidrológico

	Volume (1 000 Km^3)	**Percentagem do Total**
Águas subterrâneas	10 530	30.1
Humidade dos solos	16,5	0.05
Glaciares e cobertura permanente de neve	24 064	68.7
Camada do solo permanentemente gelado (“permafrost”)	300	0.86
Lagos	91	0.26
Zonas Húmidas	11.5	0.03
Rios	2.1	0.006
Biota	1.1	0.003
Vapor de água atmosférico	12.9	0.04
Total	35 029	100



Região da Foz do Amazonas



Annual global flows of the Earth’s water cycle; the totals (in Gt/year) are from Oki (1999)

- Escoamento total anual dos continentes para os oceanos é de 40 000 Km^3, cerca de 2/3 sob a forma de cheias. Regularmente utilizáveis actualmente são apenas 14 000 Km^3 o que corresponde a uma capitação média anual superior a 2 000 m^3, valor que é plenamente suficiente

- Problema está nas profundas assimetrias espaciais da precipitação entre diferentes regiões do globo e temporais ao longo do ano

- Cerca de 1100 milhões de pessoas não têm acesso a água comprovadamente potável;
- Cerca de 2600 milhões de pessoas não têm casas de banho ou outras formas de saneamento básico;
- Mais de 5 milhões de pessoas morrem por ano devido a doenças provocadas pela poluição das águas de consumo corrente, ou seja, cerca de 10 vezes o número anual médio de vítimas de guerras e conflitos armados recentes.

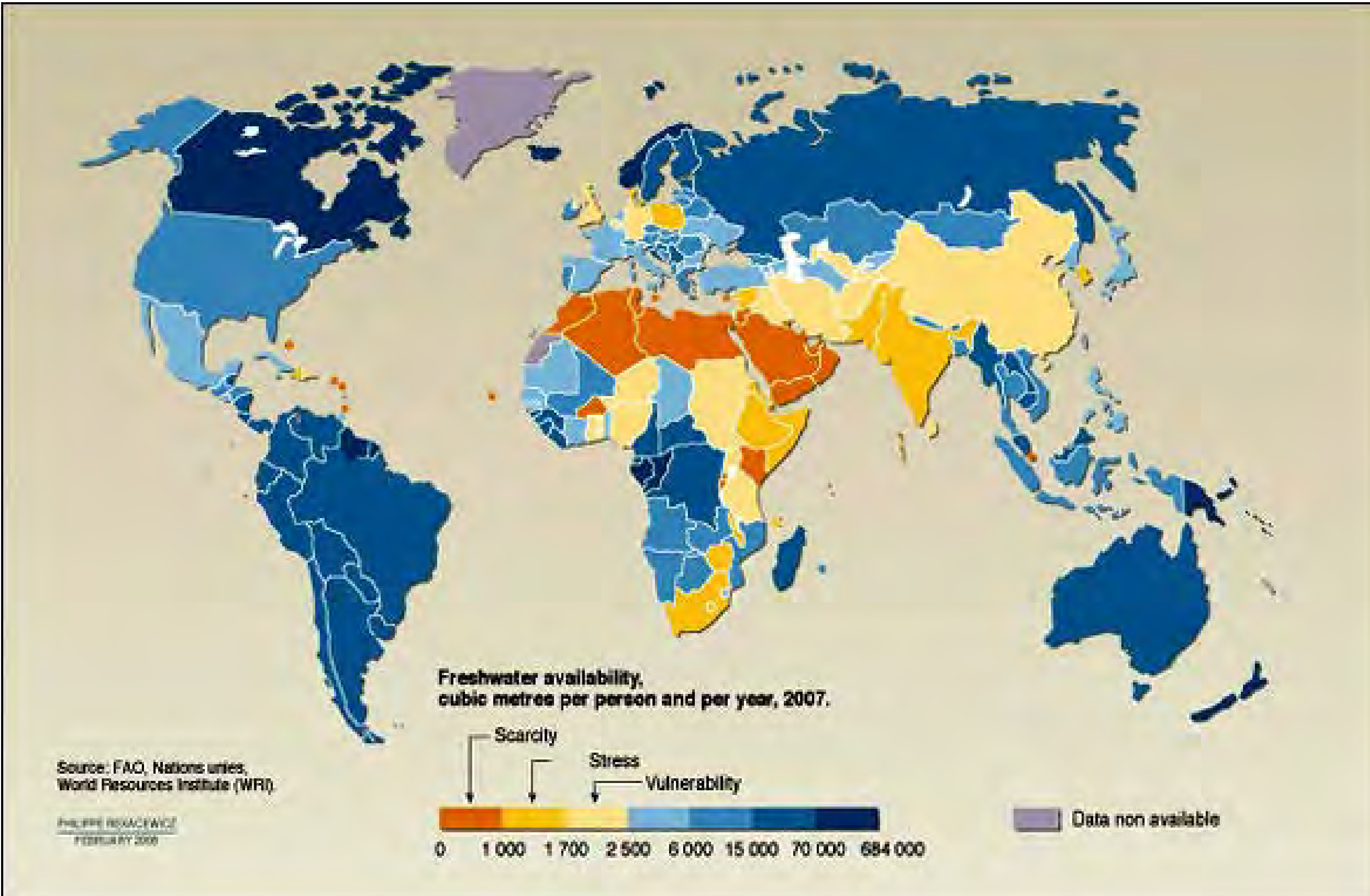
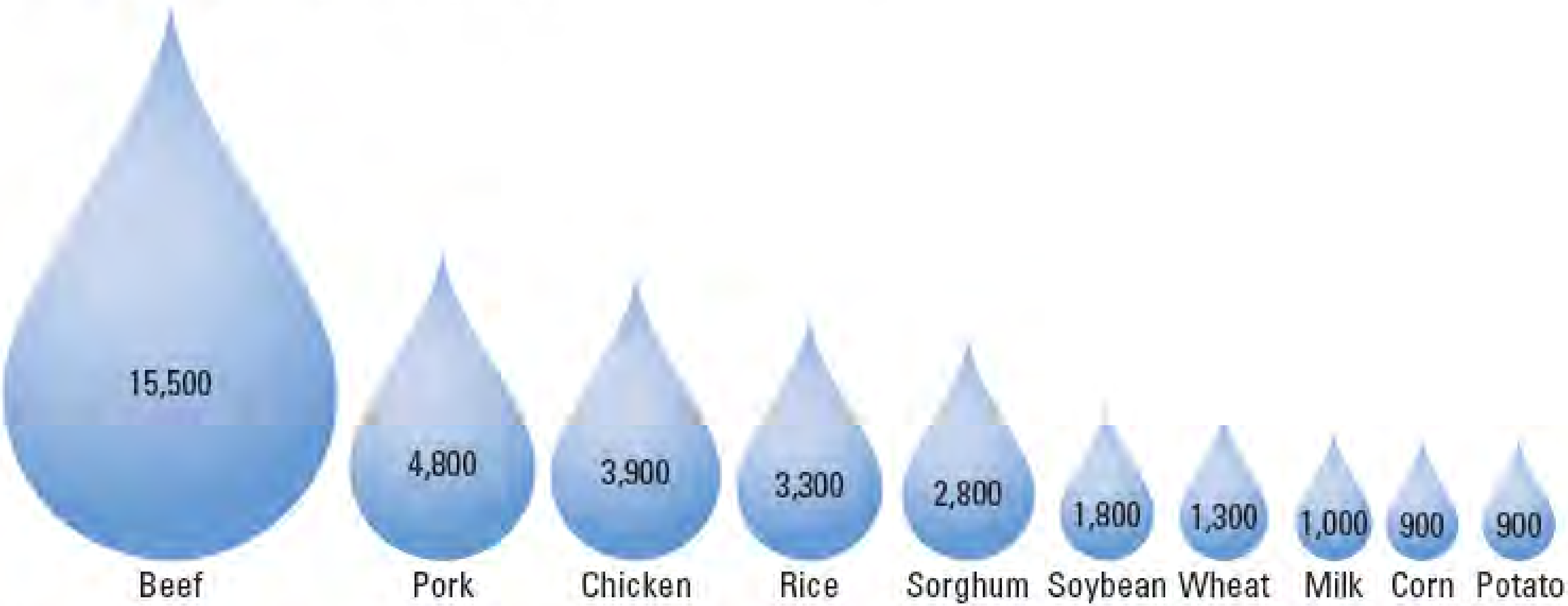

Freshwater availability,
cubic metree per person and per year, 2007.
Scarcity
Stress
Vulnerability
0
1 000
1 700
2 500
6 000
15 000
70 000
684 000
Data non available
Source: FAO, Nations unies,
World Resources Institute (WRI).

Figure 3.3 Meat is much more water intensive than major crops
(liters of water per kilogram of product)



Source: Waterfootprint (https://www.waterfootprint.org), accessed May 15, 2009; Gleick 2008.

Note: Chart shows liters of water needed to produce one kilogram of product or one liter of milk. Water use for beef production refers only to intensive production system.

Desertificação

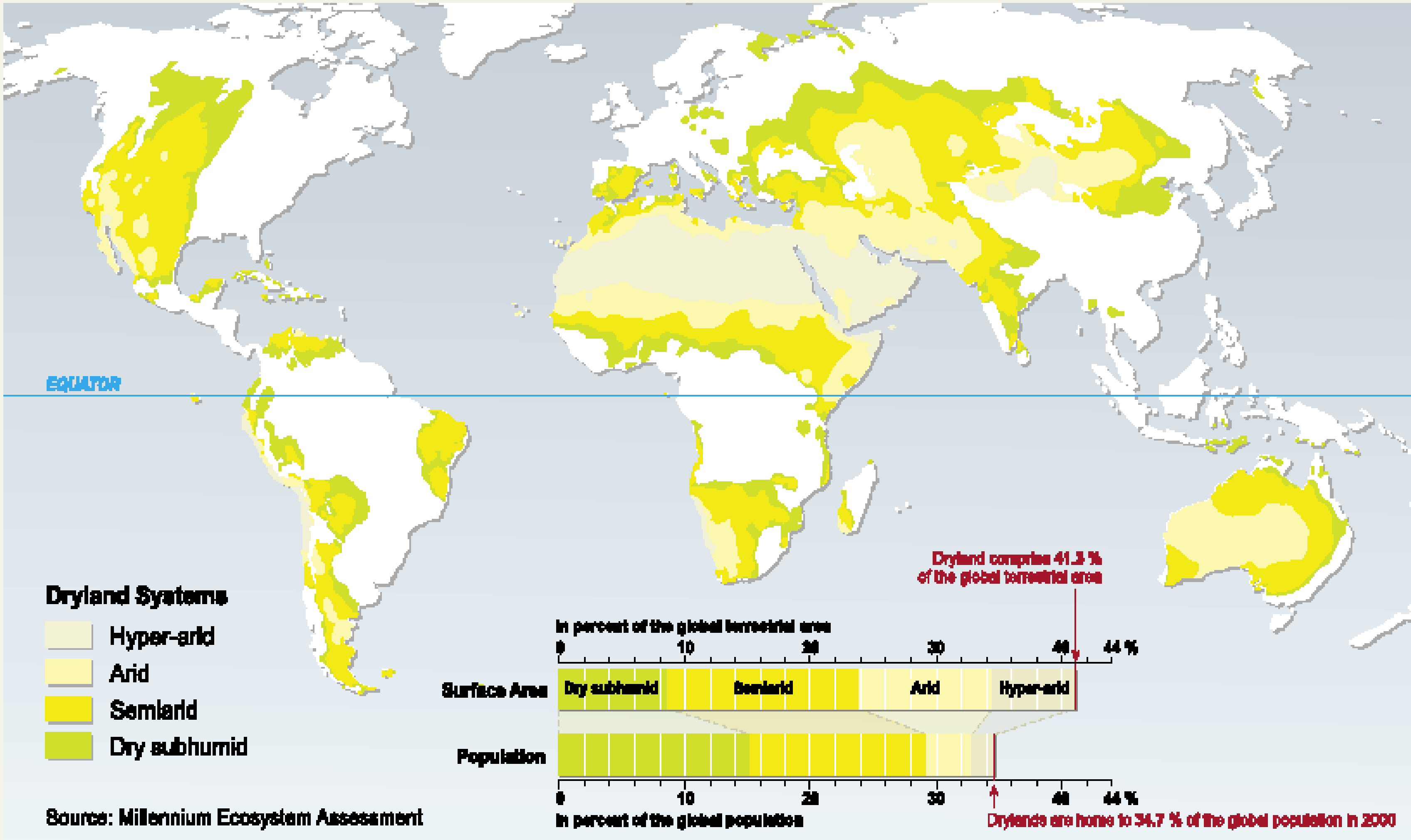
- Cerca de 41,3% da superfície terrestre emersa são terras sub-húmidas secas, semi-áridas, áridas e hiper-áridas (desertos), designados por “terras secas” ou “drylands”.

- Nas “Terras secas” habitam 2250 milhões de pessoas, ou seja, cerca de 34,7% da população mundial;

- Nas “Terras secas” a produção agrícola e florestal e outros serviços dos ecossistemas estão limitados pela escassez de água.

Present-day Drylands and Their Categories

Drylands include all terrestrial regions where the production of crops, forage, wood and other ecosystem services are limited by water. Formally, the definition encompasses all lands where the climate is classified as dry subhumid, semiarid, arid or hyper-arid. This classification is based on Aridity Index values†.



† The long-term mean of the ratio of an area's mean annual precipitation to its mean annual potential evapotranspiration is the Aridity Index (AI).

Notes: The map is based on data from UNEP Geo Data Portal (http://geodata.grid.unep.ch/). Global area based on Digital Chart of the World data (147,573,196.6 square km); Data presented in the graph are from the MA core database for the year 2000.

- Desertificação é a degradação dos solos nas terras áridas, semi-áridas e sub-húmidas secas;

- A desertificação atinge actualmente cerca de 10 a 20% da área total das regiões áridas, semi-áridas e sub-húmidas secas e constitui um dos mais graves problemas ambientais de âmbito global devido à relação estreita entre a degradação dos solos e a produção alimentar.

Biodiversidade

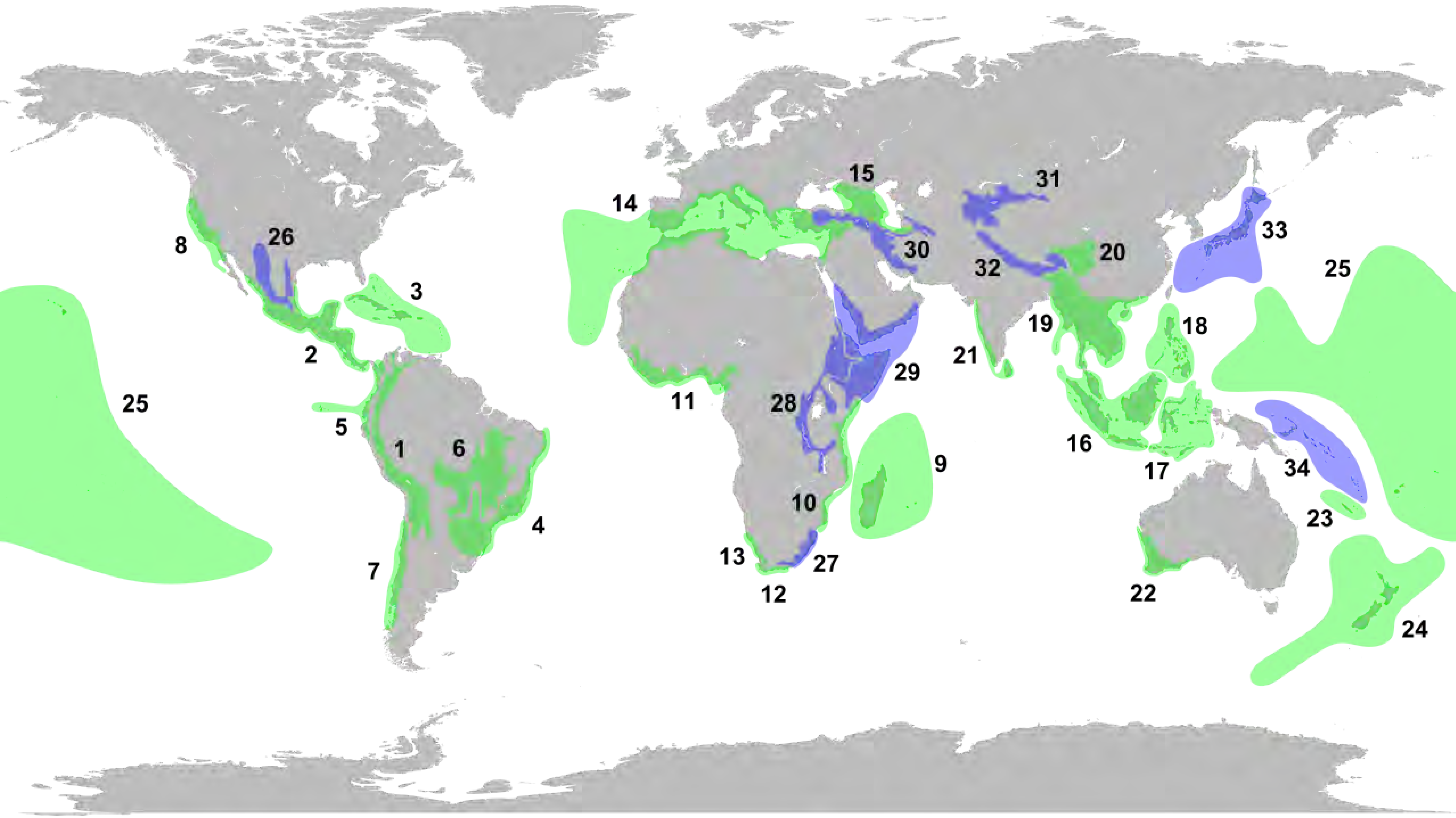
- A biodiversidade de uma região é a totalidade dos seus genes, espécies e ecossistemas;

- Os ecossistemas naturais providenciam à humanidade um vasto e diversificado conjunto de serviços essenciais à vida: ciclo do carbono, equilíbrio do oxigénio atmosférico; geração, manutenção e fertilidade dos solos; novos medicamentos; valores educativos, culturais, estéticos e éticos, etc.

- É possível que se esteja na 6ª extinção maciça de espécies, esta com origem nas actividades humanas;

- Foram identificadas e descritas cientificamente cerca de 1,75 milhões de espécies, mas é provável que o número total seja muito maior, da ordem de 14 milhões;

- A actual taxa de extinção de espécies é superior por um factor de 100 a 10 000, à taxa natural de extinção livre da interferência antropogénica, cujo valor é da ordem de 1 espécie por milhão e por ano.



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Desflorestação

- Desde o surgimento da agricultura, há cerca de 10 000 anos, a área florestal global reduziu-se da ordem de 20% a 25%.

- As florestas tropicais húmidas, apesar de cobrirem apenas cerca de 6% da superfície terrestre, constituem o habitat de mais de 50% e possivelmente 90% das espécies da fauna e flora do nosso planeta.

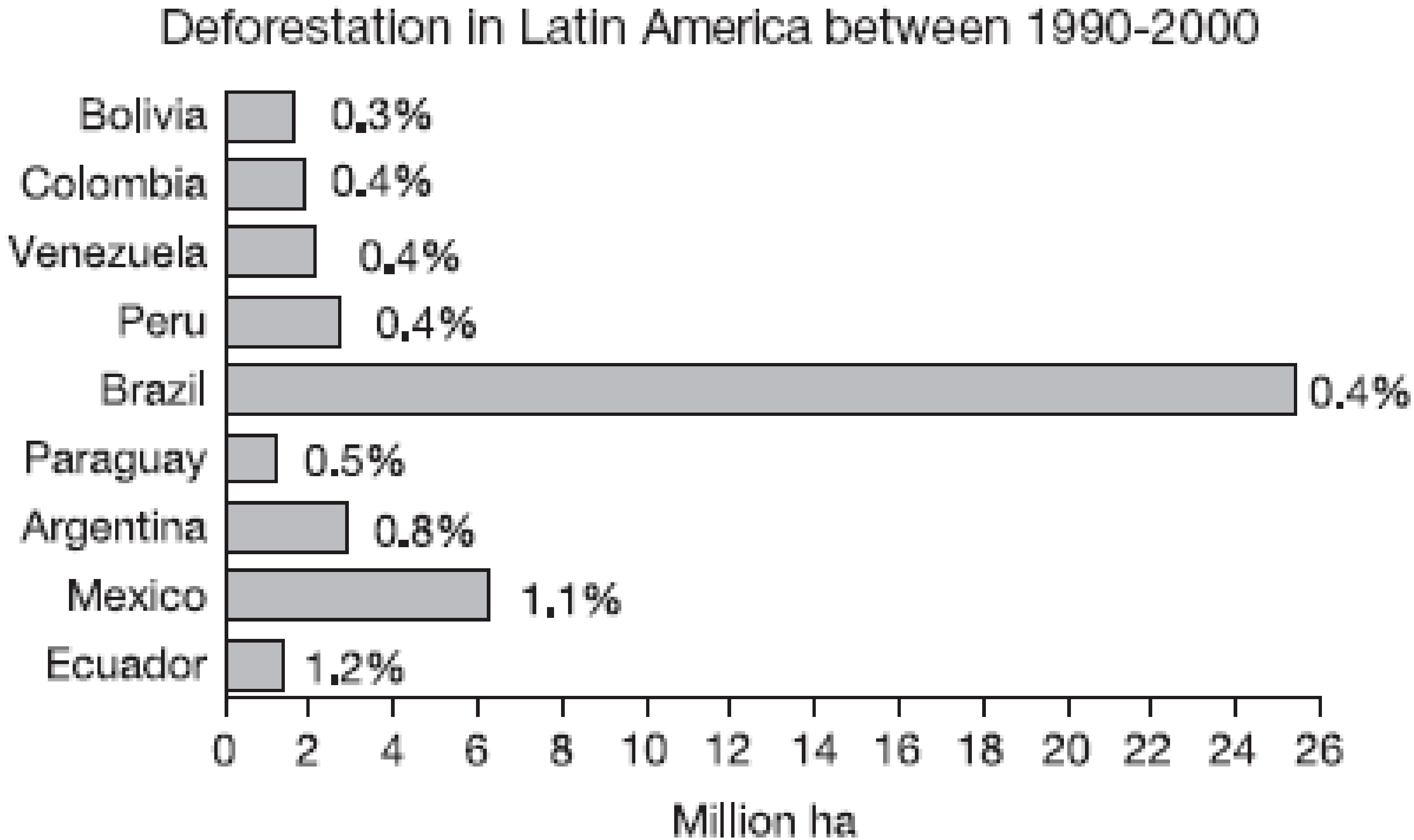
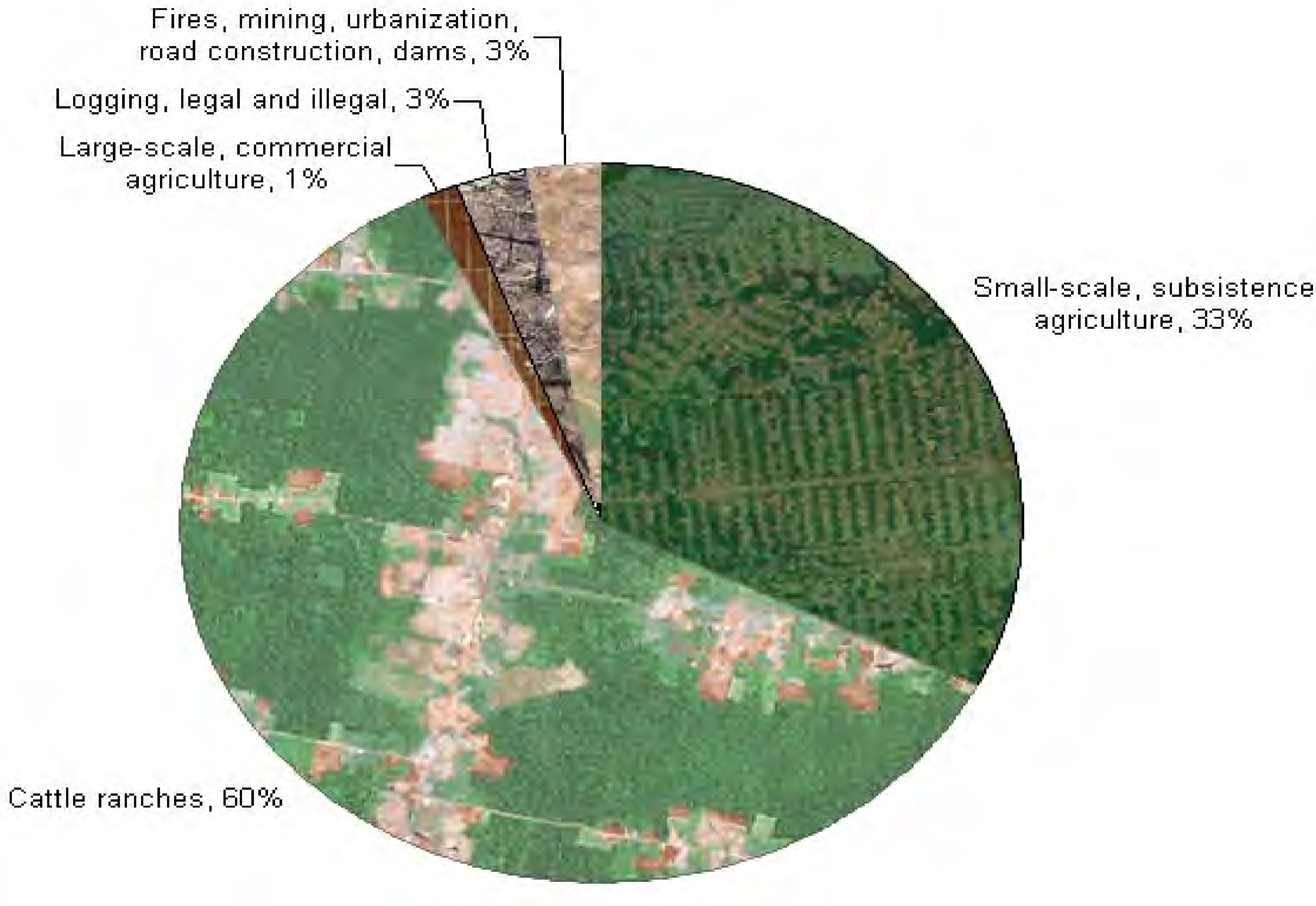


Figure 13.2. *Total deforestation in Latin America (Mha) between 1990 and 2000. Number indicates deforestation rate (%/yr) for each country. Based on FAO (2001a).*

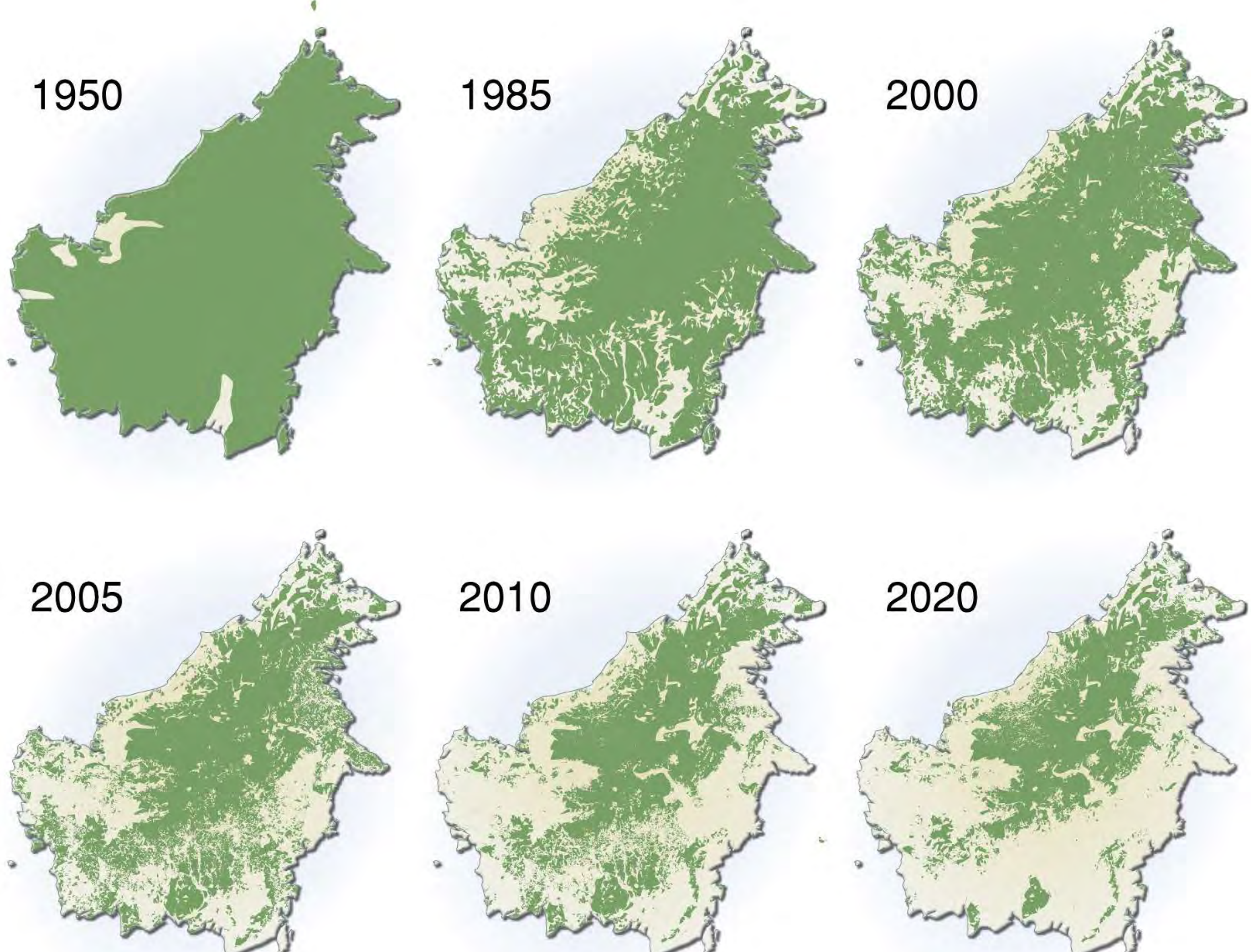
Fonte, IPCC

- As florestas das zonas temperadas da América do Norte e da Eurásia estabilizaram ou estão a crescer enquanto que as florestas tropicais continuam em declínio acentuado;
- De acordo com várias estimativas, a manutenção do actual ritmo de desflorestação da floresta tropical húmida irá conduzir à sua extinção nos próximos 100 anos;
- Cerca de 15% a 25% das actuais emissões globais de CO_2 para a atmosfera resultam da desflorestação.

Causes of Deforestation in the Amazon, 2000-2005



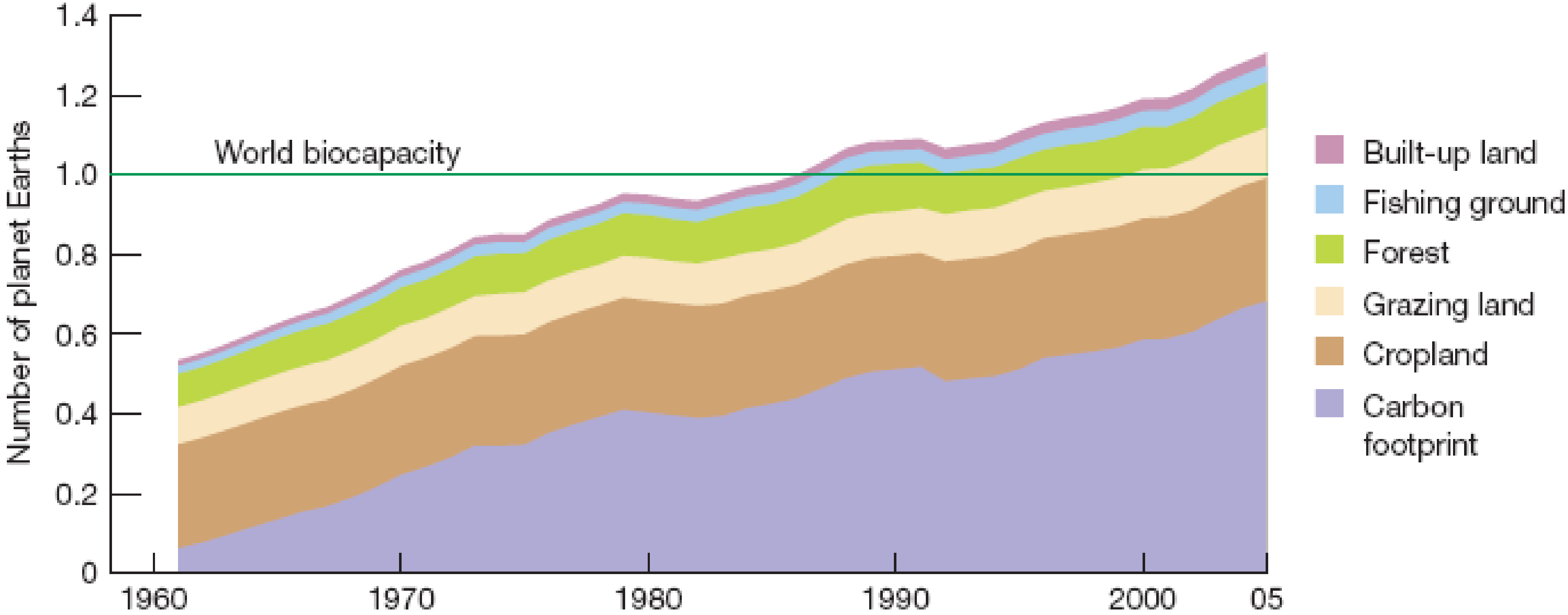
Deforestation in Amazonia, seen from satellite. The roads in the forest follow a typical "fishbone" pattern



Extent of deforestation in Borneo 1950-2005, and projection towards 2020. The tropical lowland and highland forests of Borneo, including vast expanses of rainforest, have decreased rapidly after the end of the second world war. Forests are burned, logged and clear, and commonly replaced with agricultural land, built-up areas or palm oil plantations. These areas represent habitat for species, such as Orangutan and elephants

RECURSOS NATURAIS

Pegada Ecológica da Humanidade



A procura por parte da Humanidade dos recursos naturais renováveis excede a capacidade regenerativa do planeta em cerca de 30% actualmente

Source: WWF, Living Planet Report 2008

Pre-recession (2000-2008) Global NNR Scarcity Summary

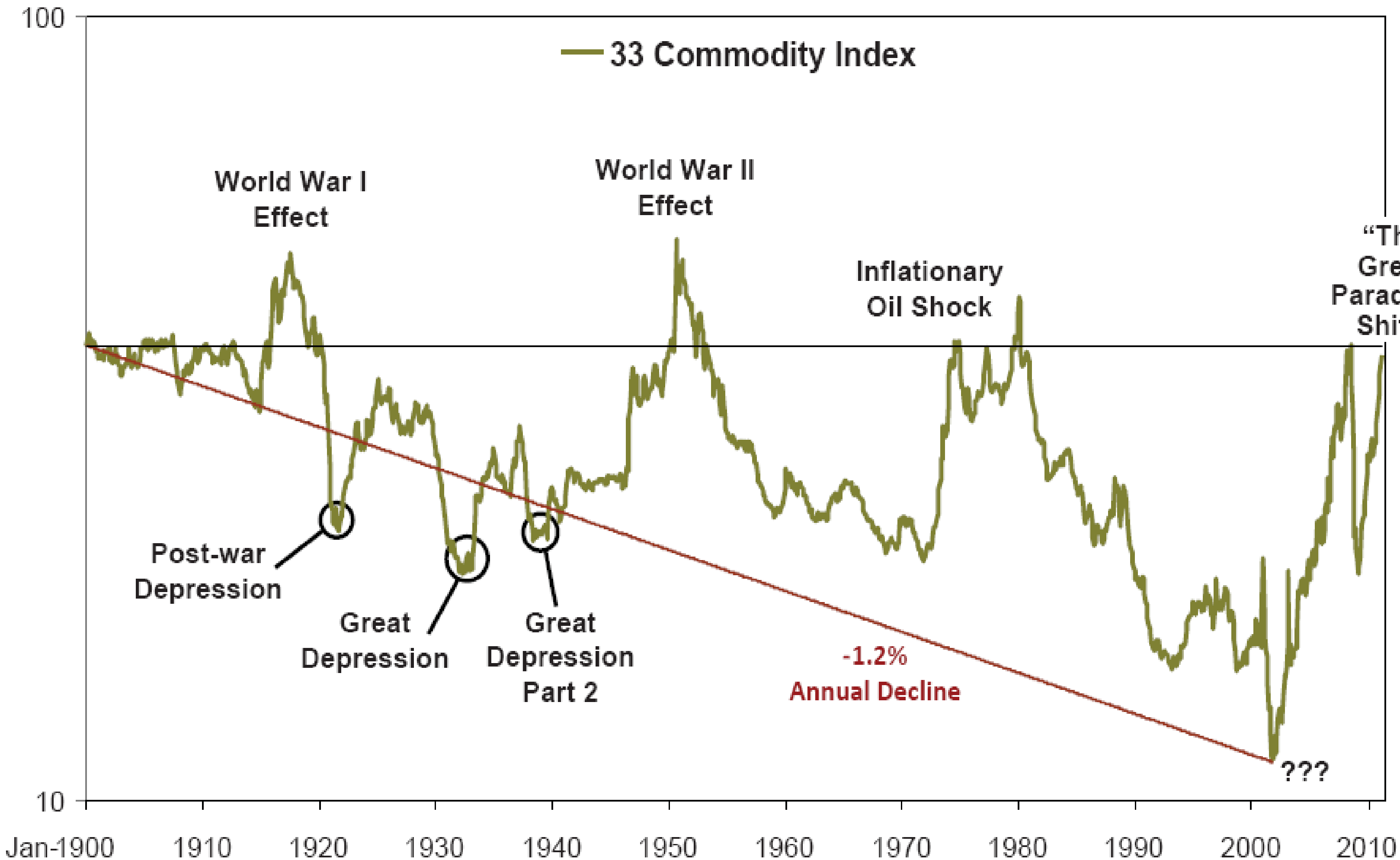
Extremely Scarce (6)	Very Scarce (21)	Moderately Scarce (22)	Marginally Scarce (1)	Not Scarce (7)
Bromine	Aluminum	Antimony	PGM	Arsenic
Gold	Bauxite	Beryllium		Barite
Mercury	Cadmium	Bismuth		Boron
Tantalum	Cement	Coal		Diamond
Tellurium	Chromium	Cobalt		Garnet
Thallium	Copper	Gallium		Lithium
	Fluorspar	Germanium		Niobium
	Magnesium Compounds	Graphite		
	Molybdenum	Gypsum		
	Natural Gas	Indium		
	Nickel	Iron Ore		
	Nitrogen (Ammonia)	Lead		
	Oil	Lime		
	Phosphate Rock	Manganese		
	Potash	Salt		
	REM	Silicon		
	Rhenium	Silver		
	Selenium	Soda Ash		
	Strontium	Tin		
	Sulfur	Vanadium		
	Tungsten	Zinc		
		Zirconium		

Fonte: Energy Bulletin, 2010

Permanent Global NNR Supply Shortfall (by 2030) Probability Summary

Nearly Certain Probability (5)	Very High Probability (8)	High Probability (10)	Low Probability (3)
Cadmium	Cobalt	Chromium	Bauxite
Gold	Lead	Coal	REM
Mercury	Molybdenum	Copper	Tin
Tellurium	PGM	Indium	
Tungsten	Phosphate Rock	Iron Ore	
	Silver	Lithium	
	Titanium	Magnesium Compounds	
	Zinc	Natural Gas	
		Nickel	
		Oil	
		Phosphate Rock	

GMO Commodity Index: The Great Paradigm Shift



Note: The GMO commodity index is an index comprised of the following 33 commodities, equally weighted at initiation: aluminum, coal, coconut oil, coffee, copper, corn, cotton, diammonium phosphate, flaxseed, gold, iron ore, jute, lard, lead, natural gas, nickel, oil, palladium, palm oil, pepper, platinum, plywood, rubber, silver, sorghum, soybeans, sugar, tin, tobacco, uranium, wheat, wool, zinc.

Source: GMO   As of 2/28/11

Exhibit E1

Commodity prices have increased sharply since 2000, erasing all the declines of the 20th century

MGI Commodity Price Index (years 1999–2001 = 100)[1]

1 See the methodology appendix for details of the MGI Commodity Price Index.

2 2011 prices are based on average of the first eight months of 2011.

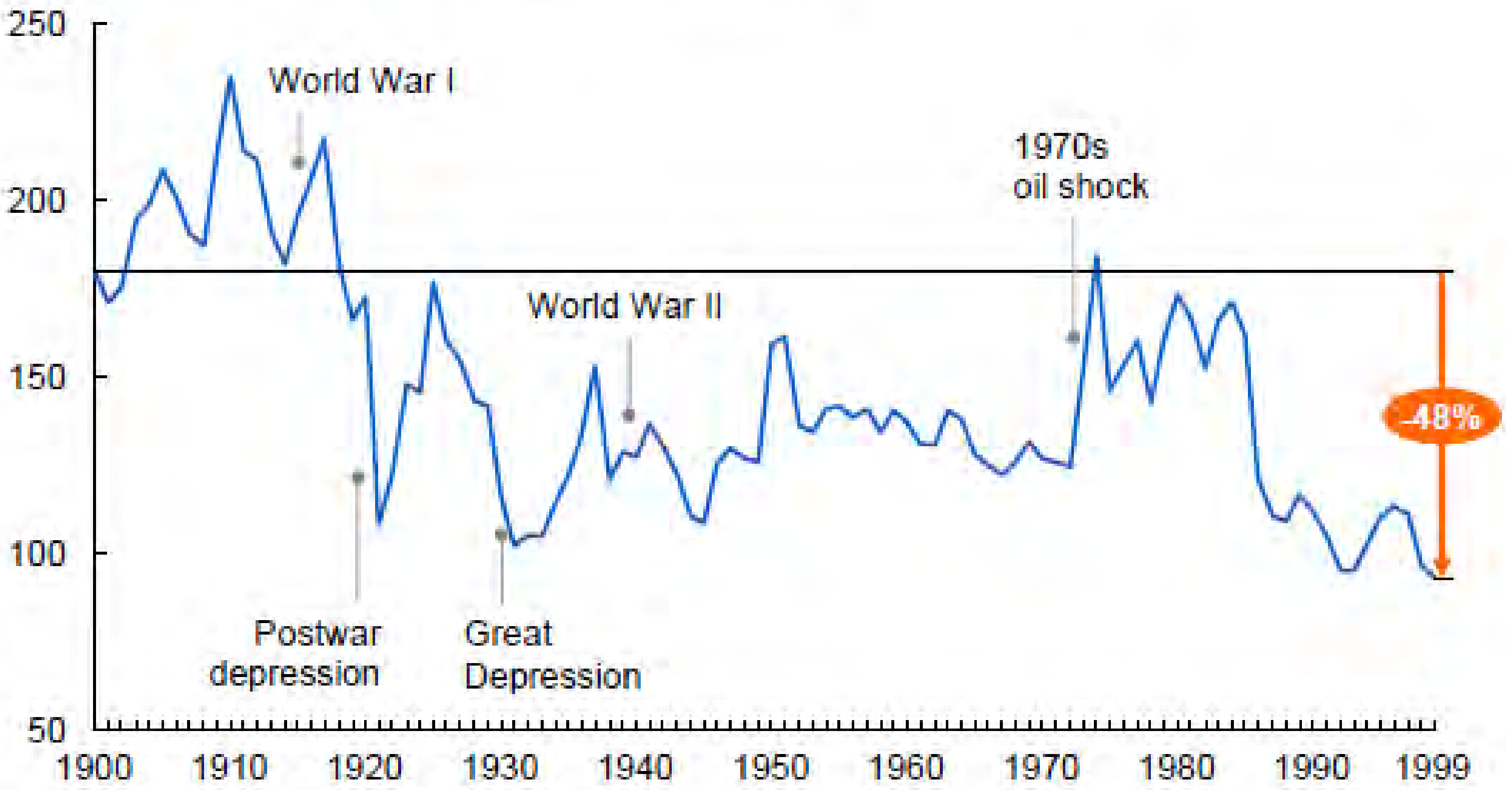
SOURCE: Grilli and Yang; Stephan Pfaffenzeller; World Bank; International Monetary Fund (IMF); Organisation for Economic Co-operation and Development (OECD); UN Food and Agriculture Organization (FAO); UN Comtrade; McKinsey analysis

Resource Revolution, McKinsey, 2011

Exhibit 1

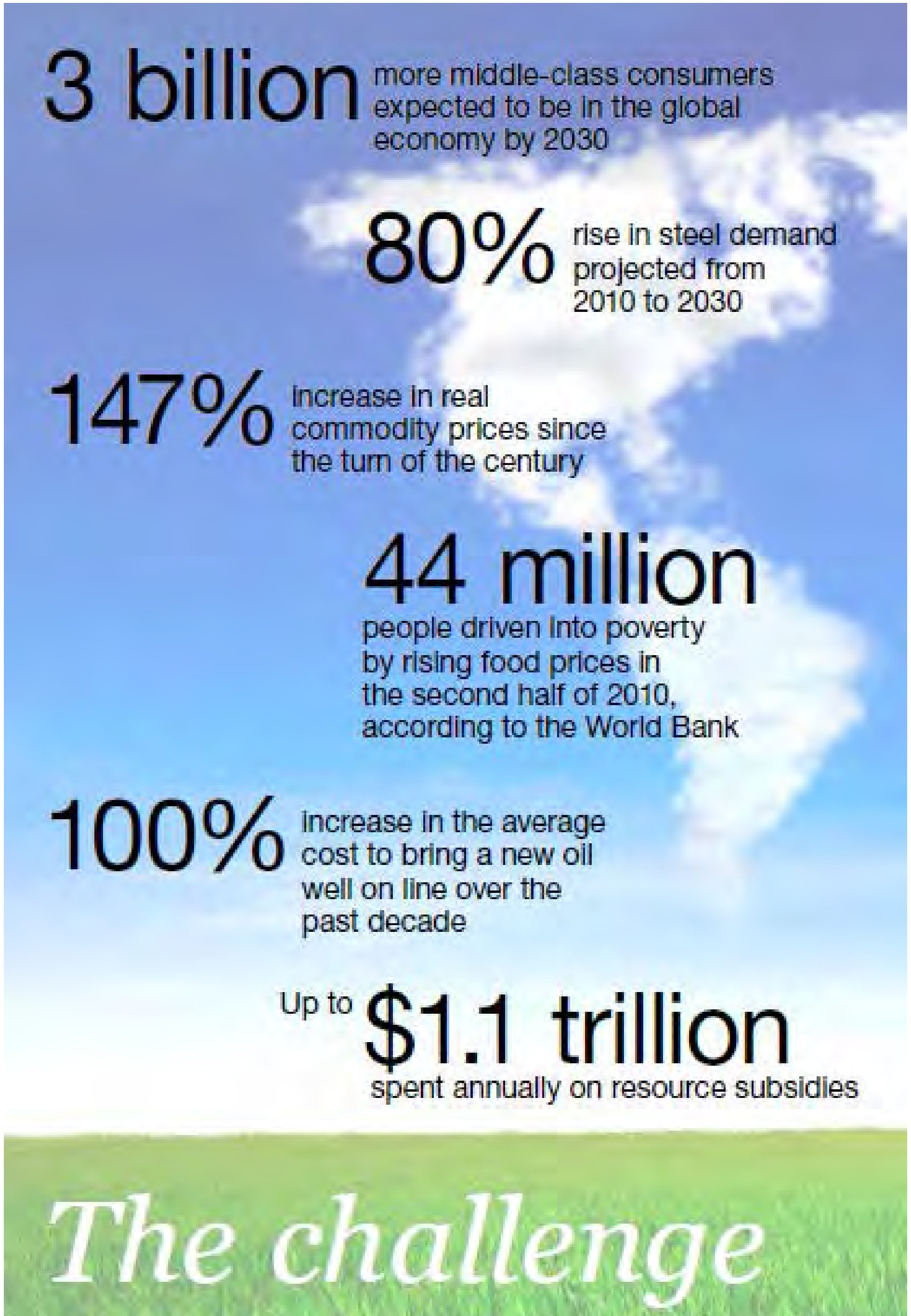
Average commodity prices have fallen by almost 50 percent over the past century

MGI Commodity Price Index (years 1999–2001 = 100)[1]



1 See our methodology appendix for details of the MGI Commodity Price Index.

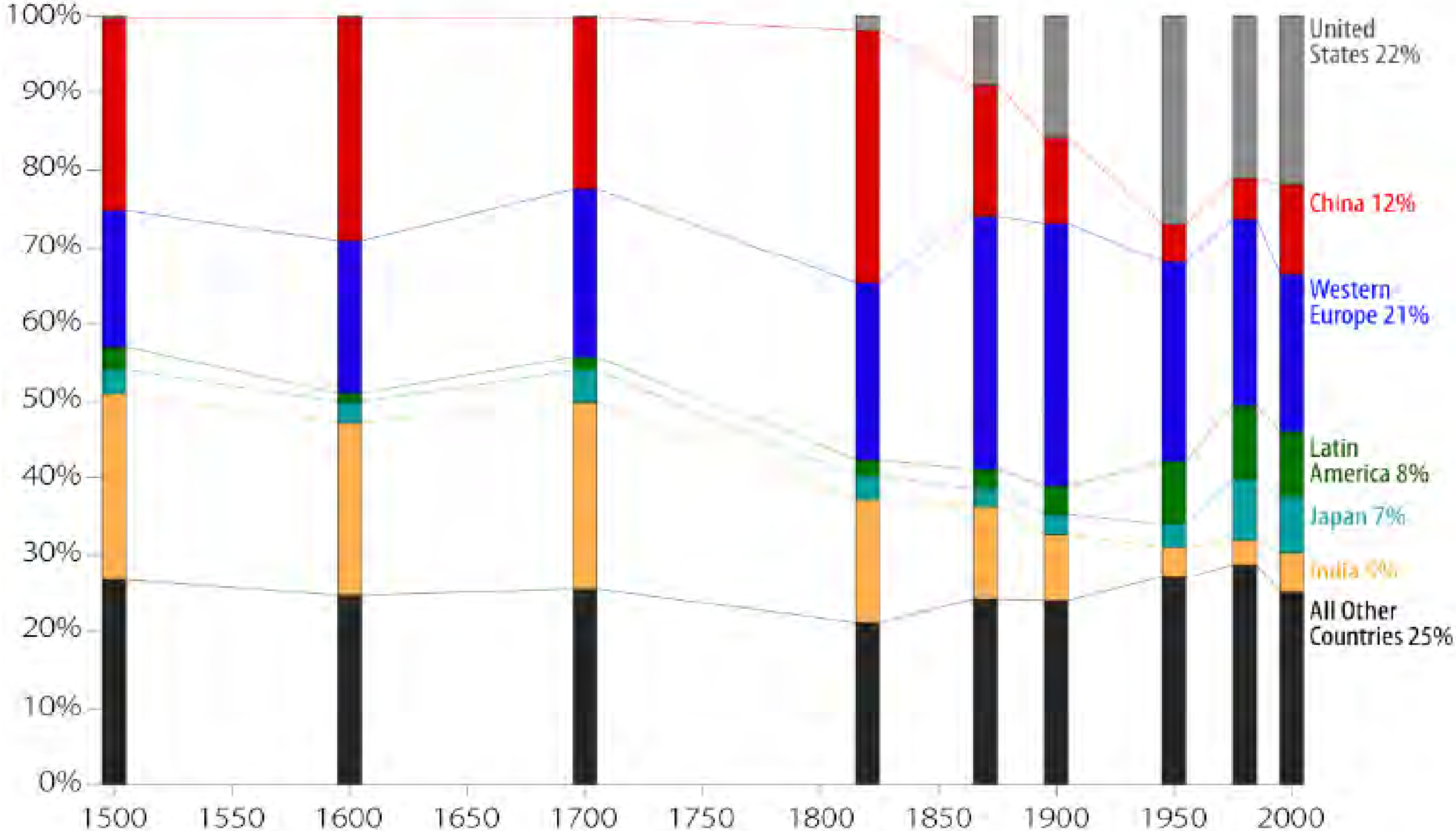
SOURCE: Grilli and Yang; Pfaffenzeller; World Bank; IMF; OECD statistics; FAO; UN Comtrade; McKinsey analysis



Resource Revolution
McKinsey, 2011

Percentage of World GDP (last 500 years)

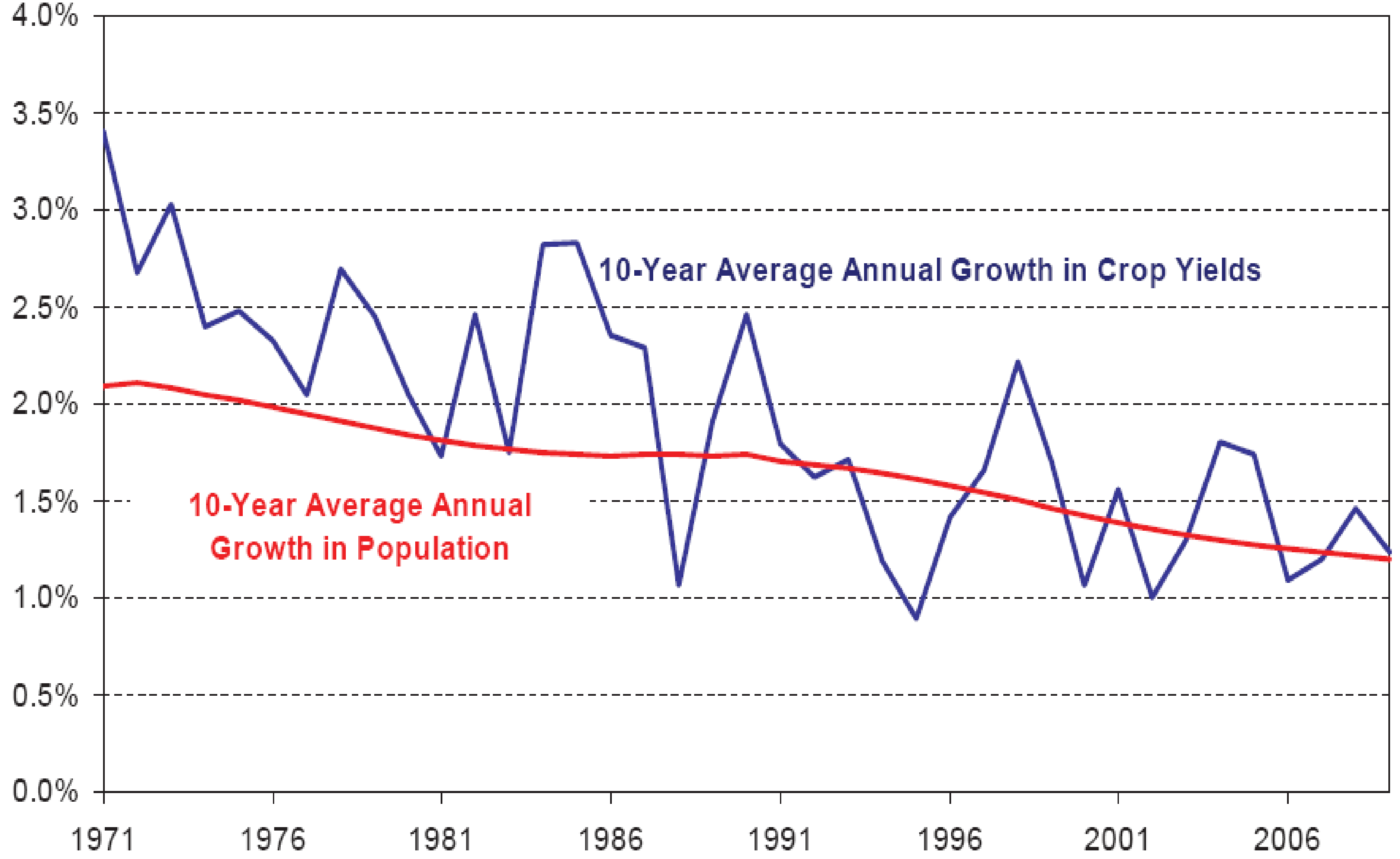
China, India, Japan, Latin America, Western Europe, and United States



Source: Angus Maddison, University of Groningen

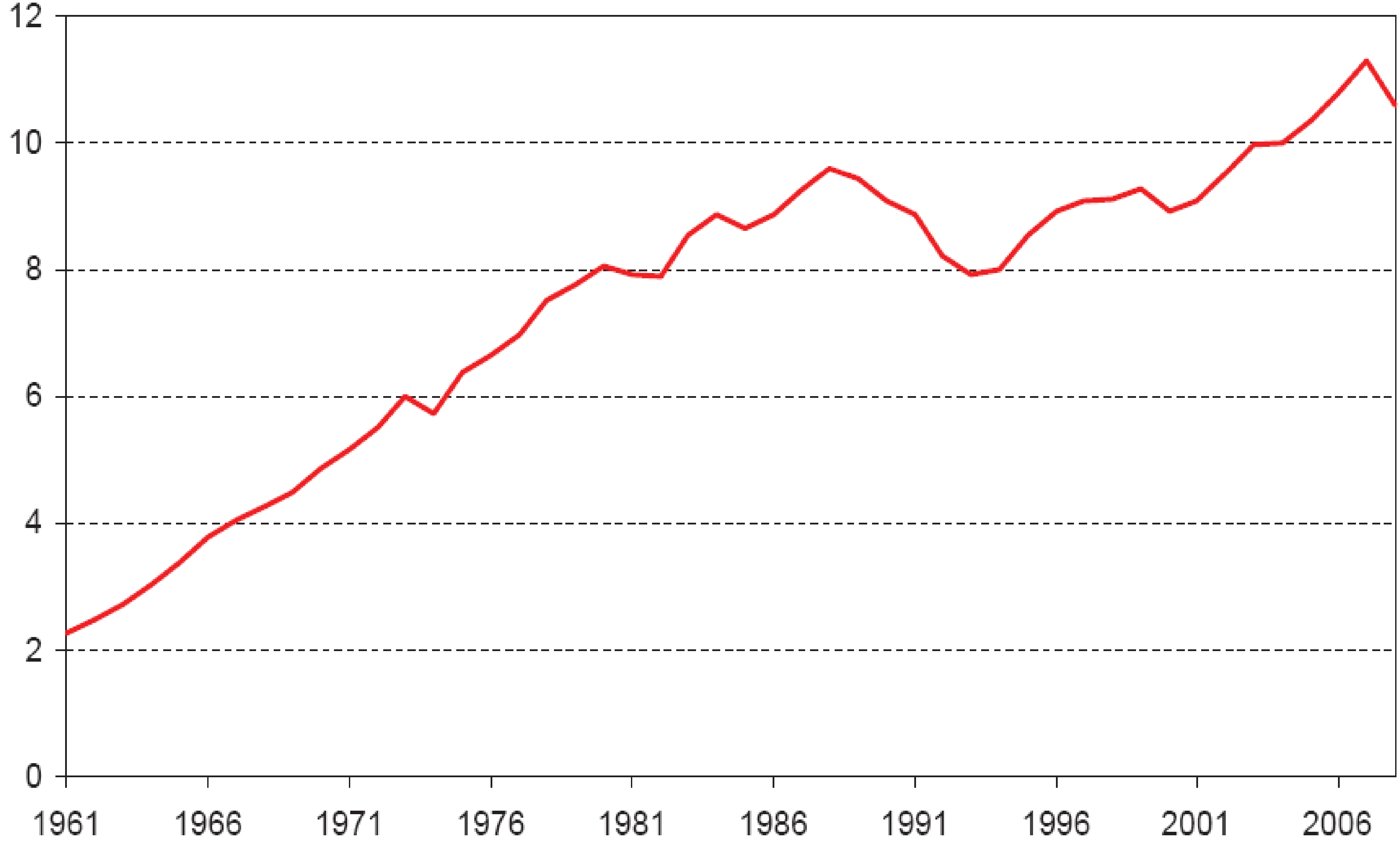
SEGURANÇA ALIMENTAR

10-Year Average Annual Growth in Crop Yields



Source: Food and Agriculture Organization of the United Nations   As of 12/31/09

Tons of Fertilizer Used Annually (per sq km of cropland)



Source: Food and Agriculture Organization of the United Nations *As of 12/31/08*

World food prices reach new historic peak

03-02-2011

3.4 percent surge in January - FAO updates Food Price Index3 February 2011, Rome - World food prices surged to a new historic peak in January, for the seventh consecutive month, according to the http://www.fao.org/worldfoodsituation/FoodPricesIndex/en/ a commodity basket that regularly tracks monthly changes in global food prices.

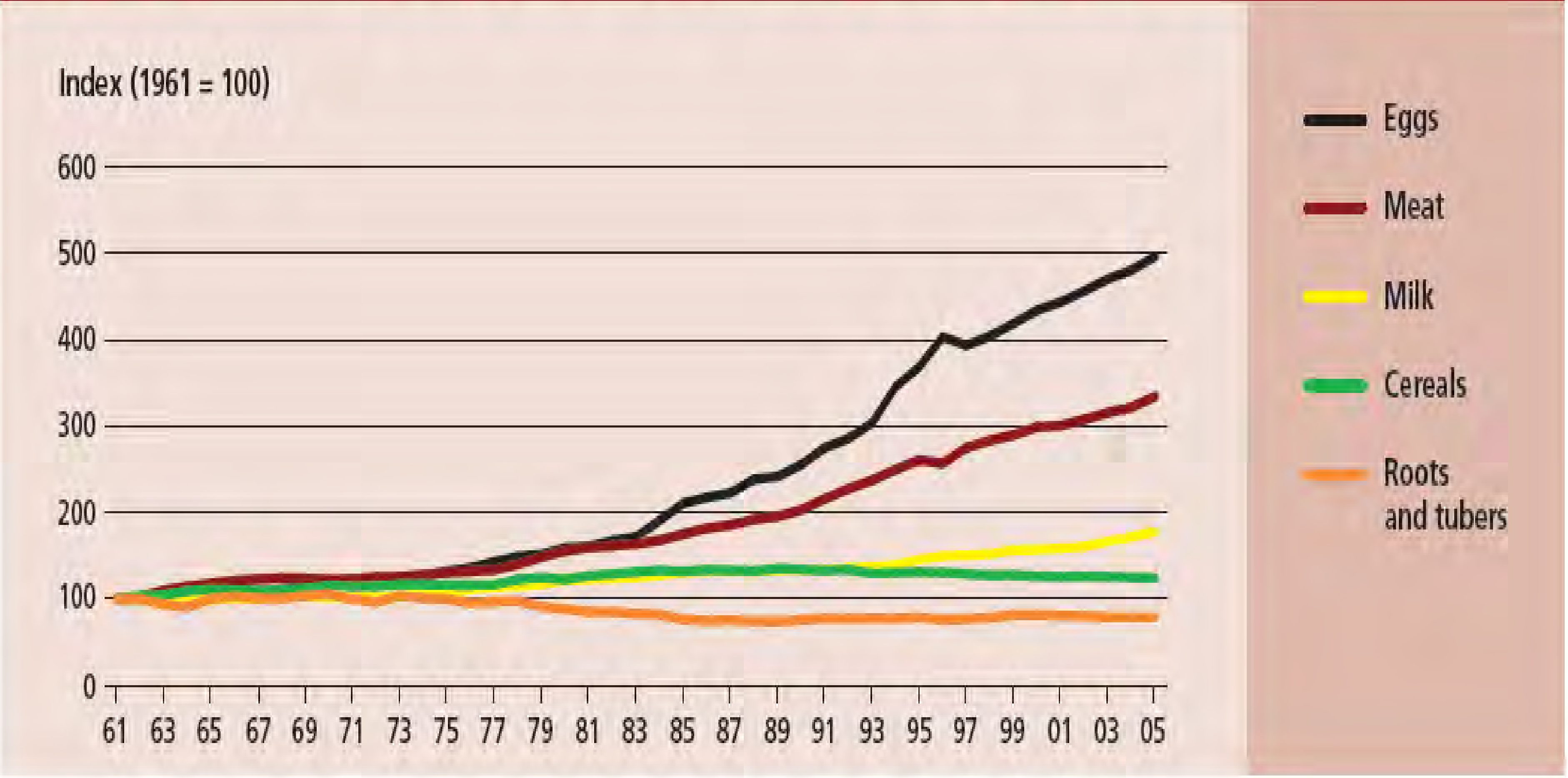
"The new figures clearly show that the upward pressure on world food prices is not abating," said FAO economist and grains expert Abdolreza Abbassian. "These high prices are likely to persist in the months to come. High food prices are of major concern especially for low-income food deficit countries that may face problems in financing food imports and for poor households which spend a large share of their income on food."

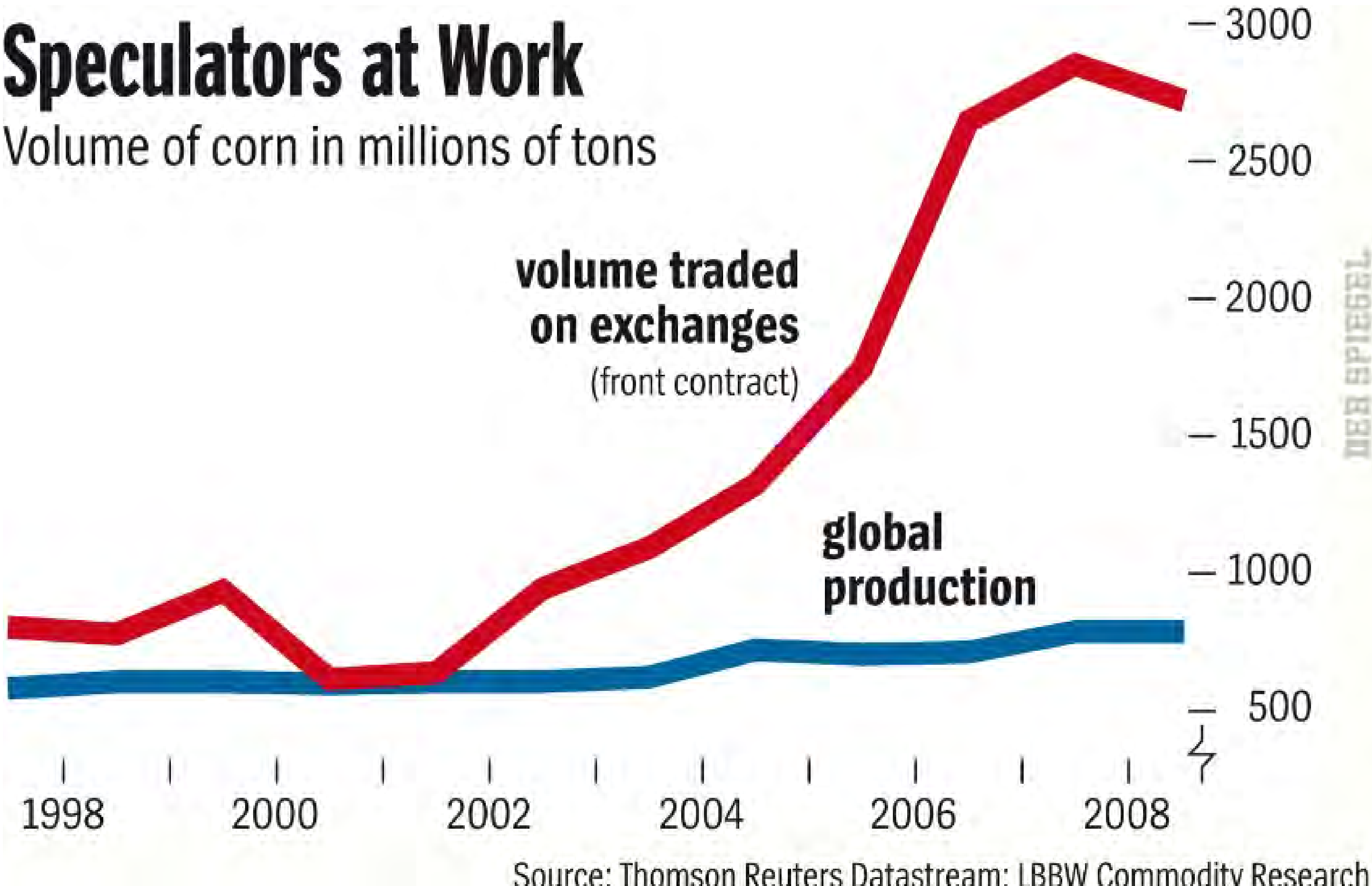
"The only encouraging factor so far stems from a number of countries, where - due to good harvests - domestic prices of some of the food staples remain low compared to world prices," Abbassian added.

Why food prices are rising

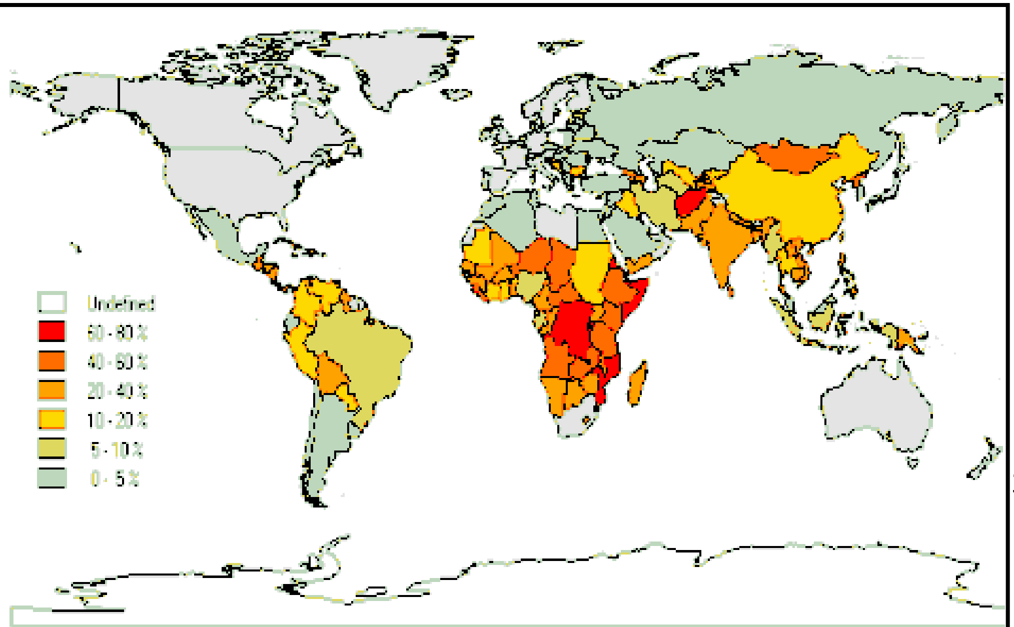
- Climate change, which leads to droughts, floods and storm, and thus to crop failures;
- The cultivation of biofuels, which takes valuable farmland out of food production;
- The global population, which is growing too fast for agricultural production to keep up;
- The emerging economies China and India, whose citizens are consuming greater quantities of higher quality food;
- The rising price of oil, which makes it more expensive to produce and ship food products;
- The rise in meat consumption, which means that more grain is needed for animal feed;
- Decades of neglecting agriculture, especially in hunger-prone regions.

Per capita consumption of major food items in developing countries, 1961–2005




Speculators at Work
Volume of corn in millions of tons
volume traded
on exchanges
(front contract)
global
production
3000
2500
2000
1500
1000
500
1998
2000
2002
2004
2006
2008
Source: Thomson Reuters Datastream; LBBW Commodity Research

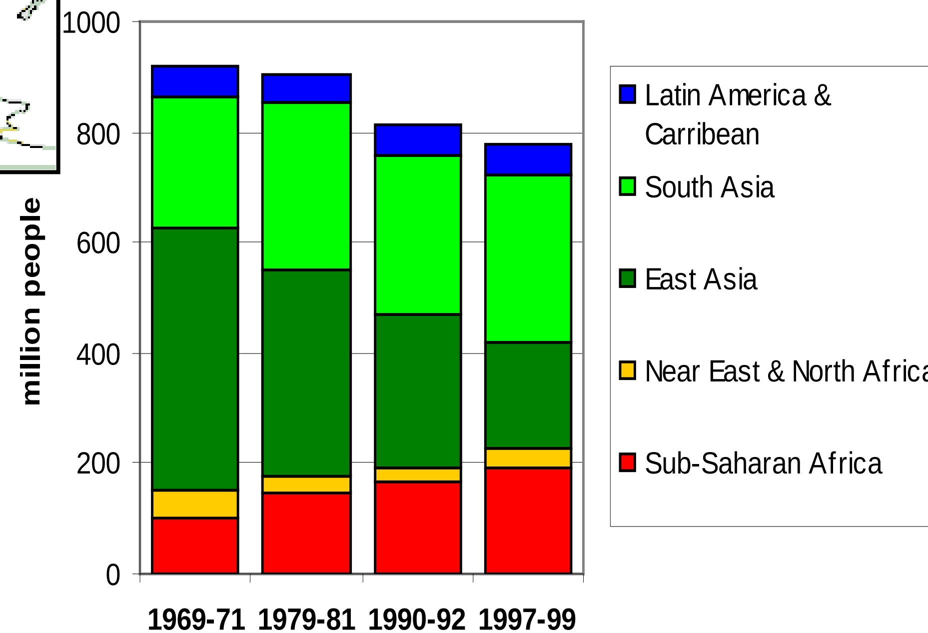
Hunger in a World of Plenty



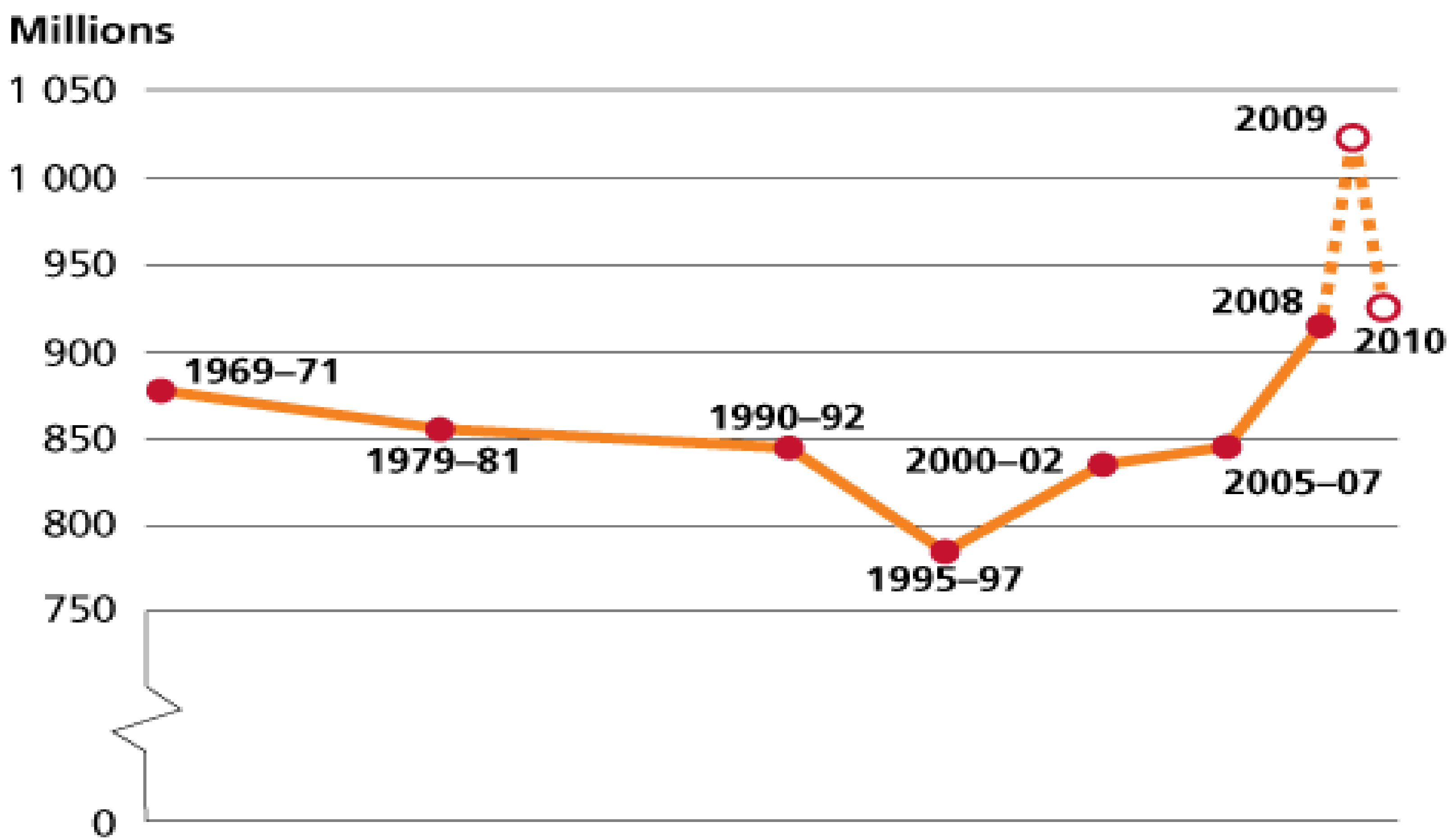
World Food Summits
1974, 1996, 2002

MDGs 2000

34 Years of Failure to Deliver

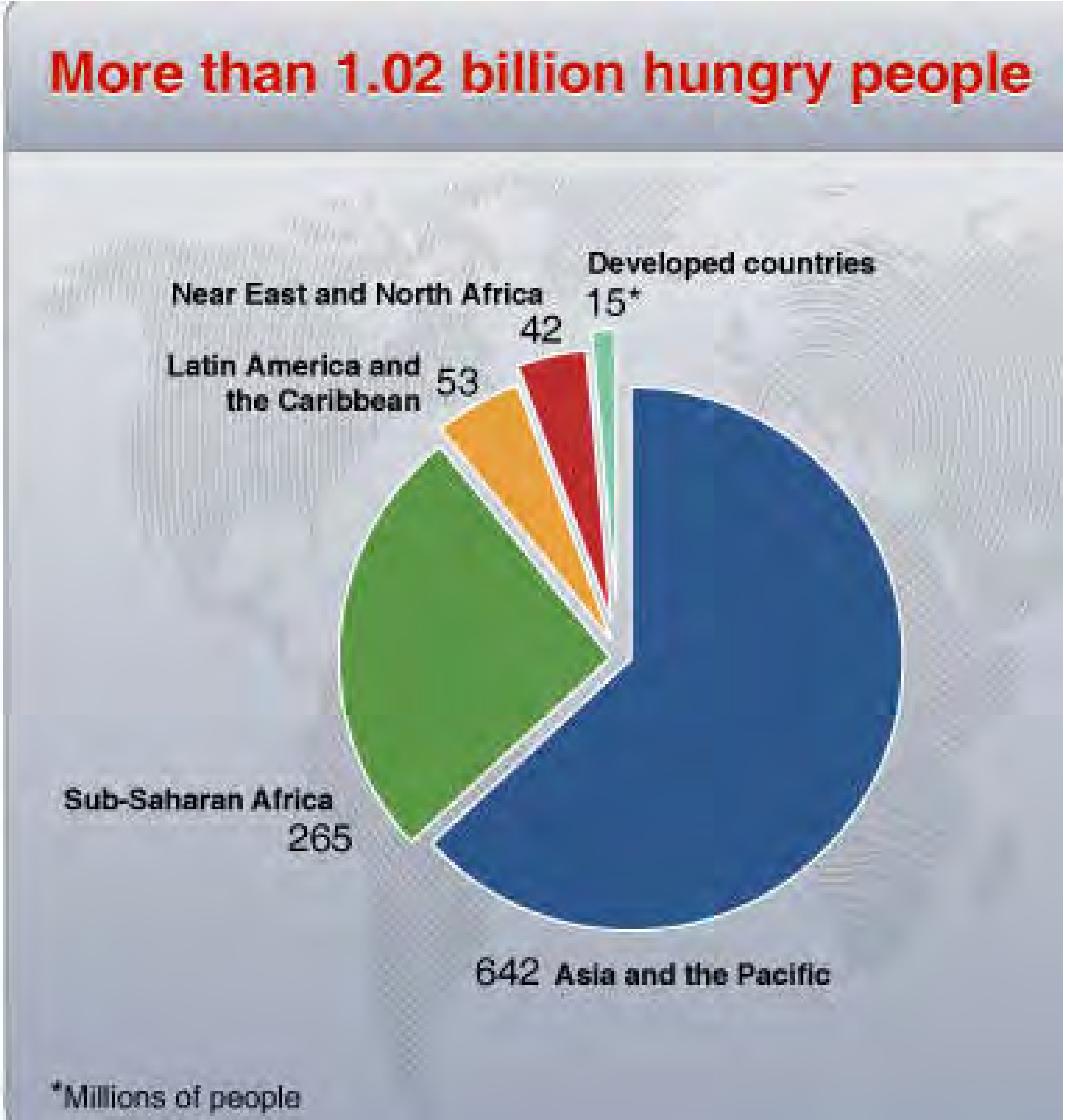


The debilitating pain of hunger: Not Just Numbers but real Faces and Voices

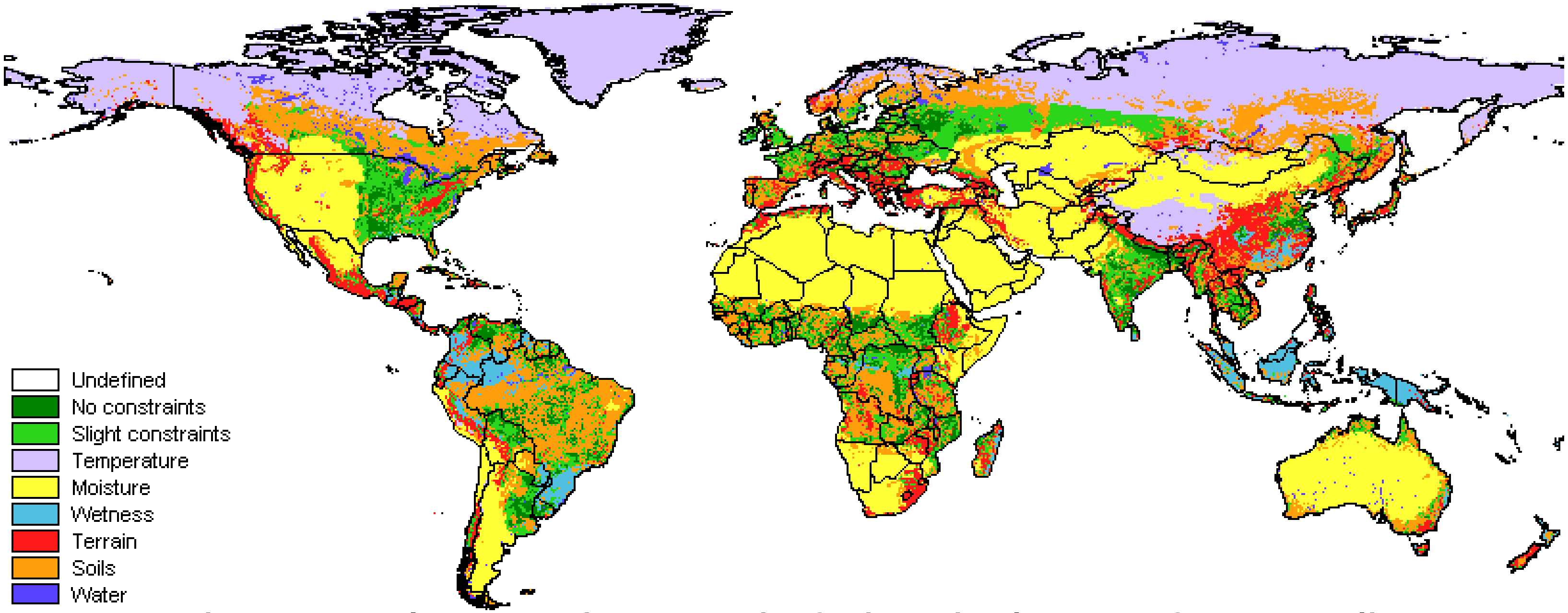


Note: Figures for 2009 and 2010 are estimated by FAO with input from the United States Department of Agriculture, Economic Research Service. Full details of the methodology are provided in the technical background notes (available at www.fao.org/publication/sofi/en/).

Source: FAO.

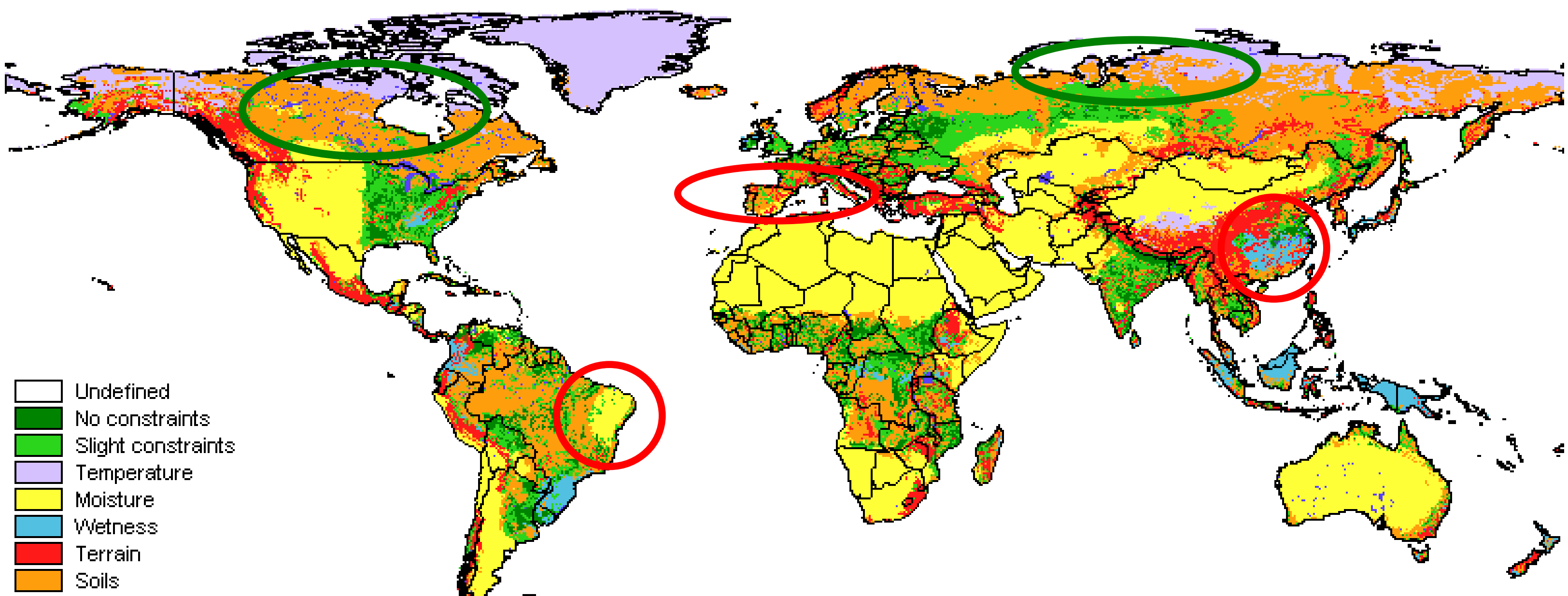


More than 1.02 billion hungry people
Developed countries
15*
Near East and North Africa
42
Latin America and
the Caribbean
53
Sub-Saharan Africa
265
642 Asia and the Pacific
*Millions of people



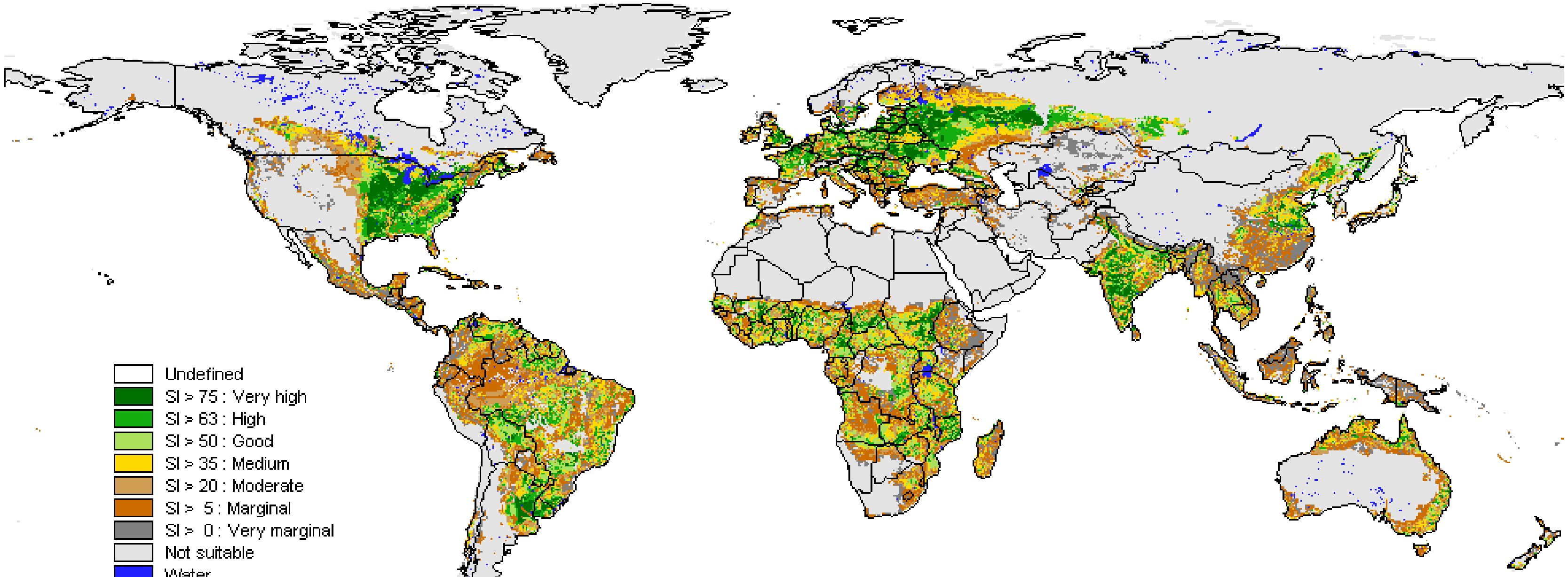
3.7

Environmental constraints to rain-fed agriculture, reference climate 1961-90



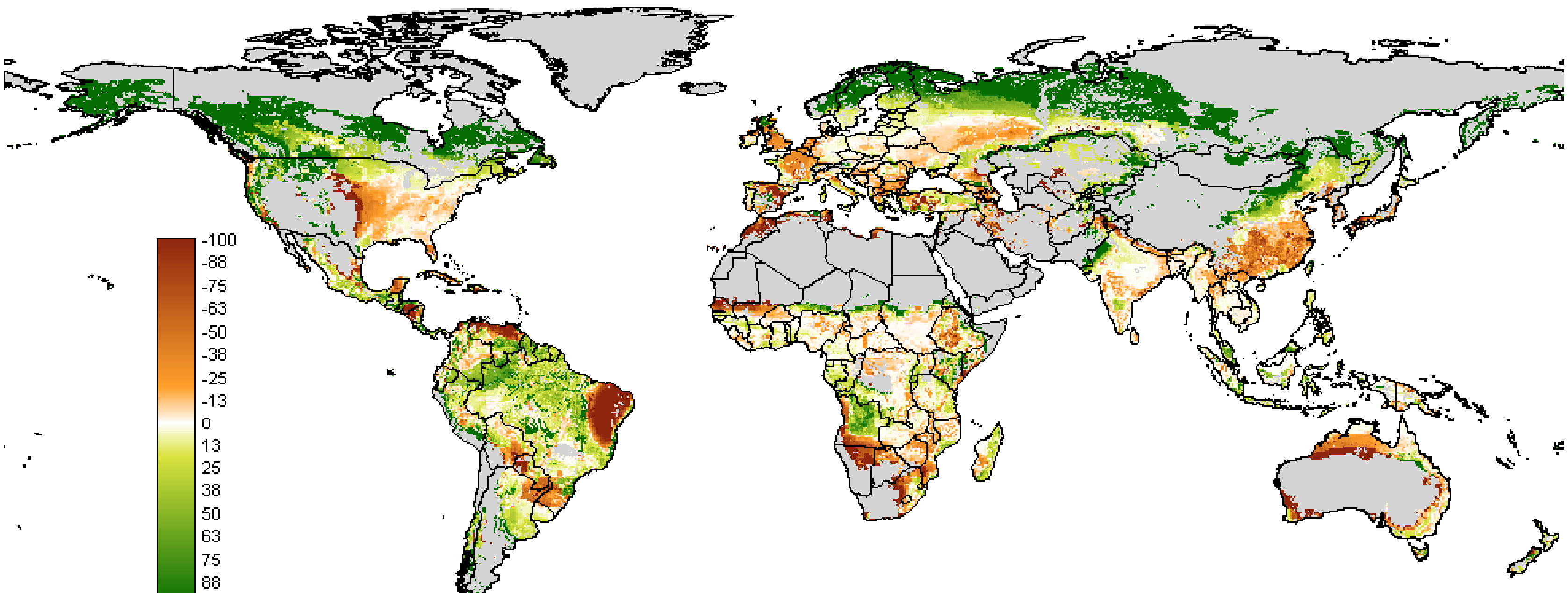
3.8

Environmental constraints to rain-fed agriculture, HadCM3-A1FI 2080s



3.12a

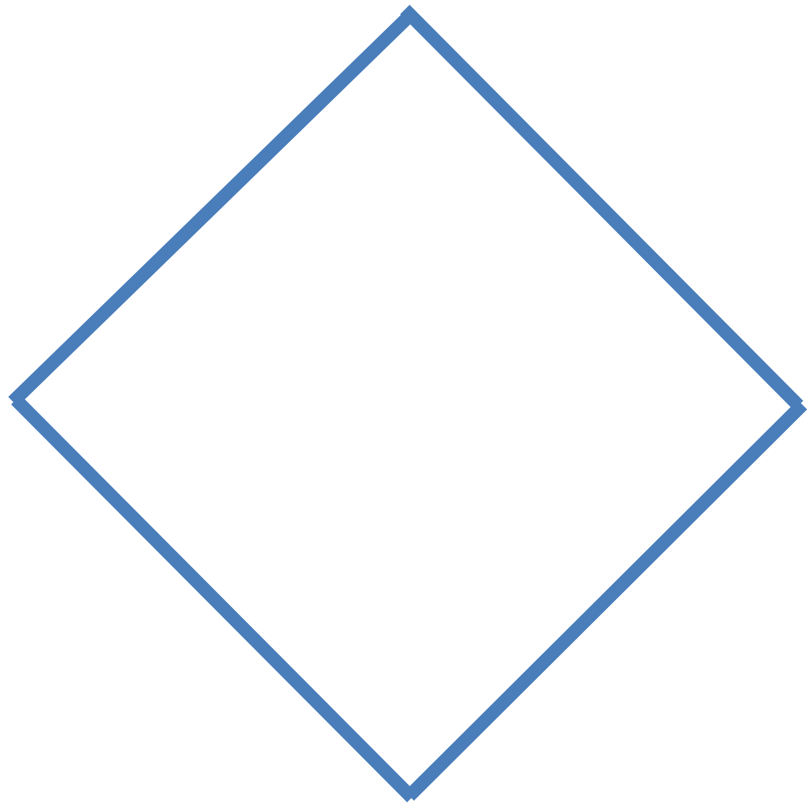
Suitability for rain-fed cereals, reference climate 1961-90.



3.12b

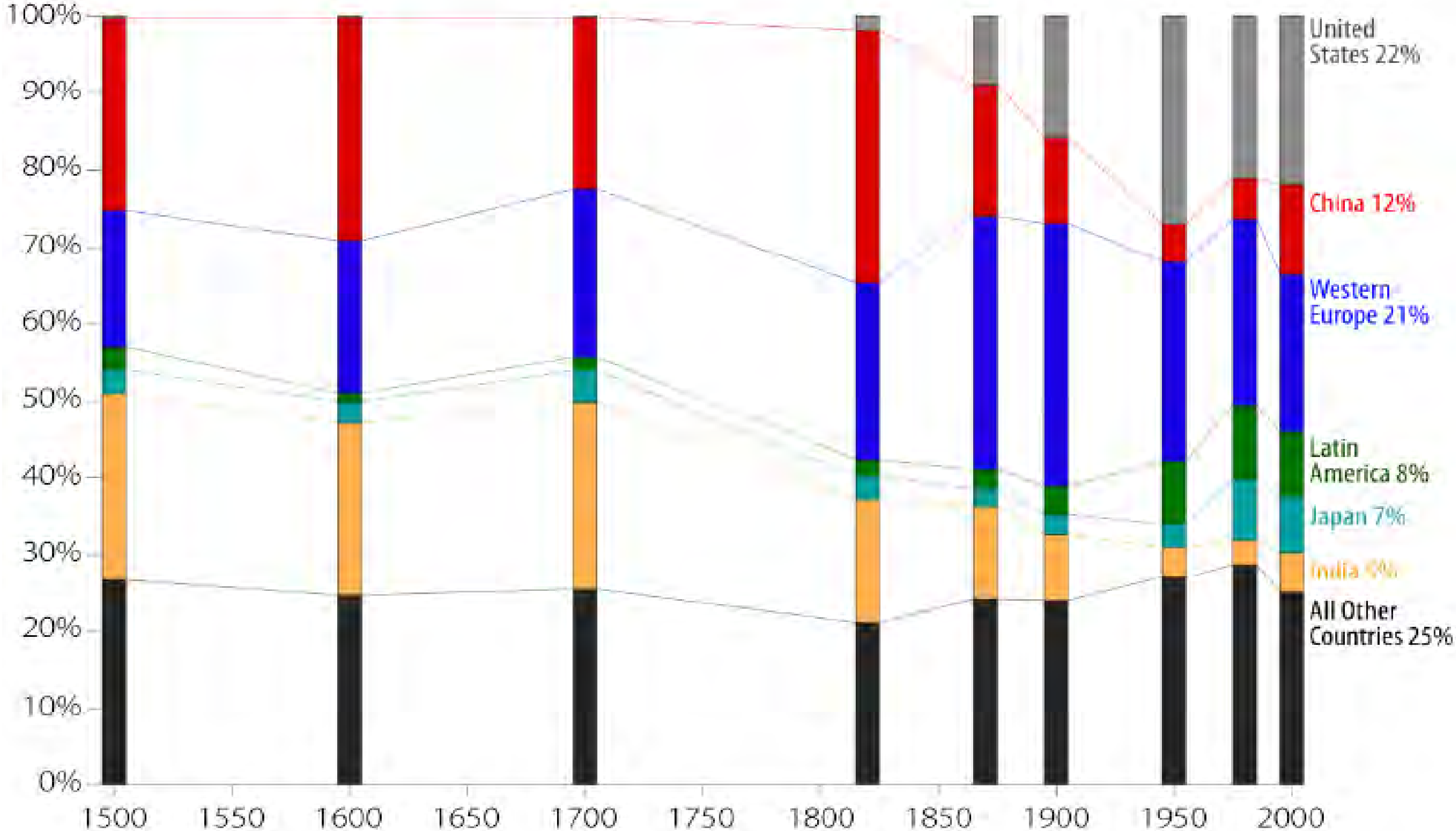
Change in suitability for rain-fed cereals, HadCM3-A1FI, 2080s

Quadrado da Insustentabilidade

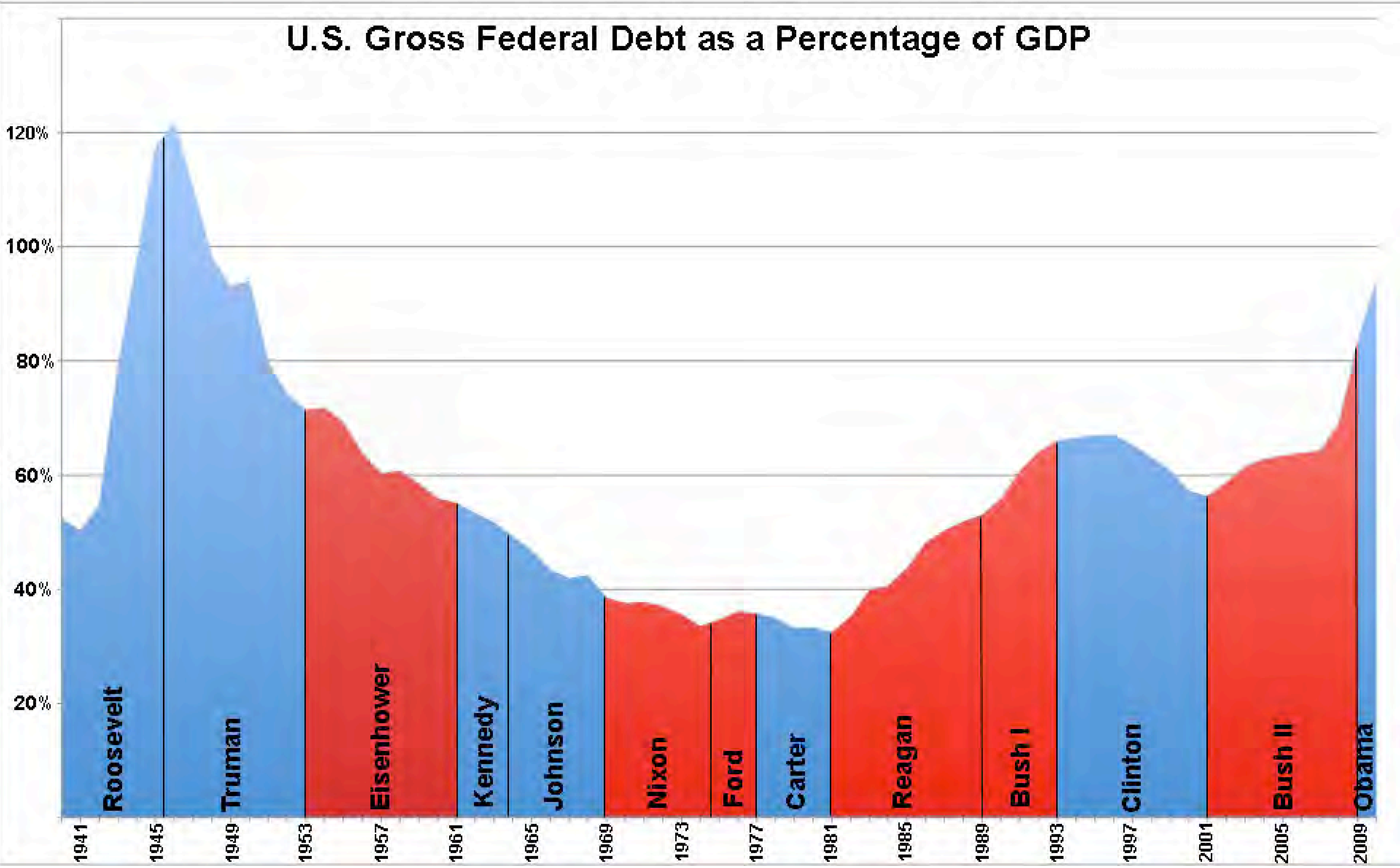


Percentage of World GDP (last 500 years)

China, India, Japan, Latin America, Western Europe, and United States

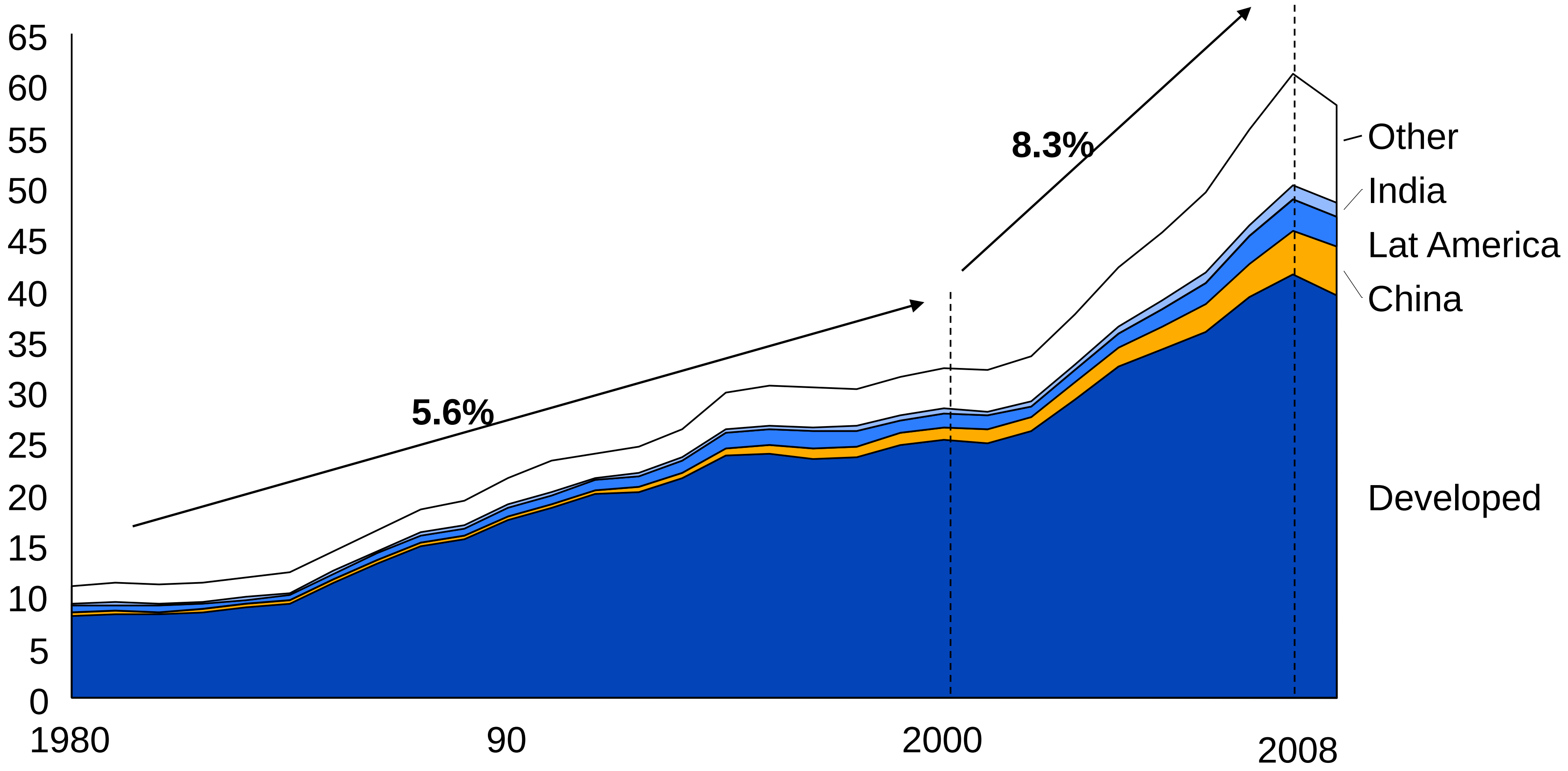


Source: Angus Maddison, University of Groningen


U.S. Gross Federal Debt as a Percentage of GDP
120%
100%
80%
60%
40%
20%
Roosevelt
Truman
Eisenhower
Kennedy
Johnson
Nixon
Ford
Carter
Reagan
Bush I
Clinton
Bush II
Obama
1941
1945
1949
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009

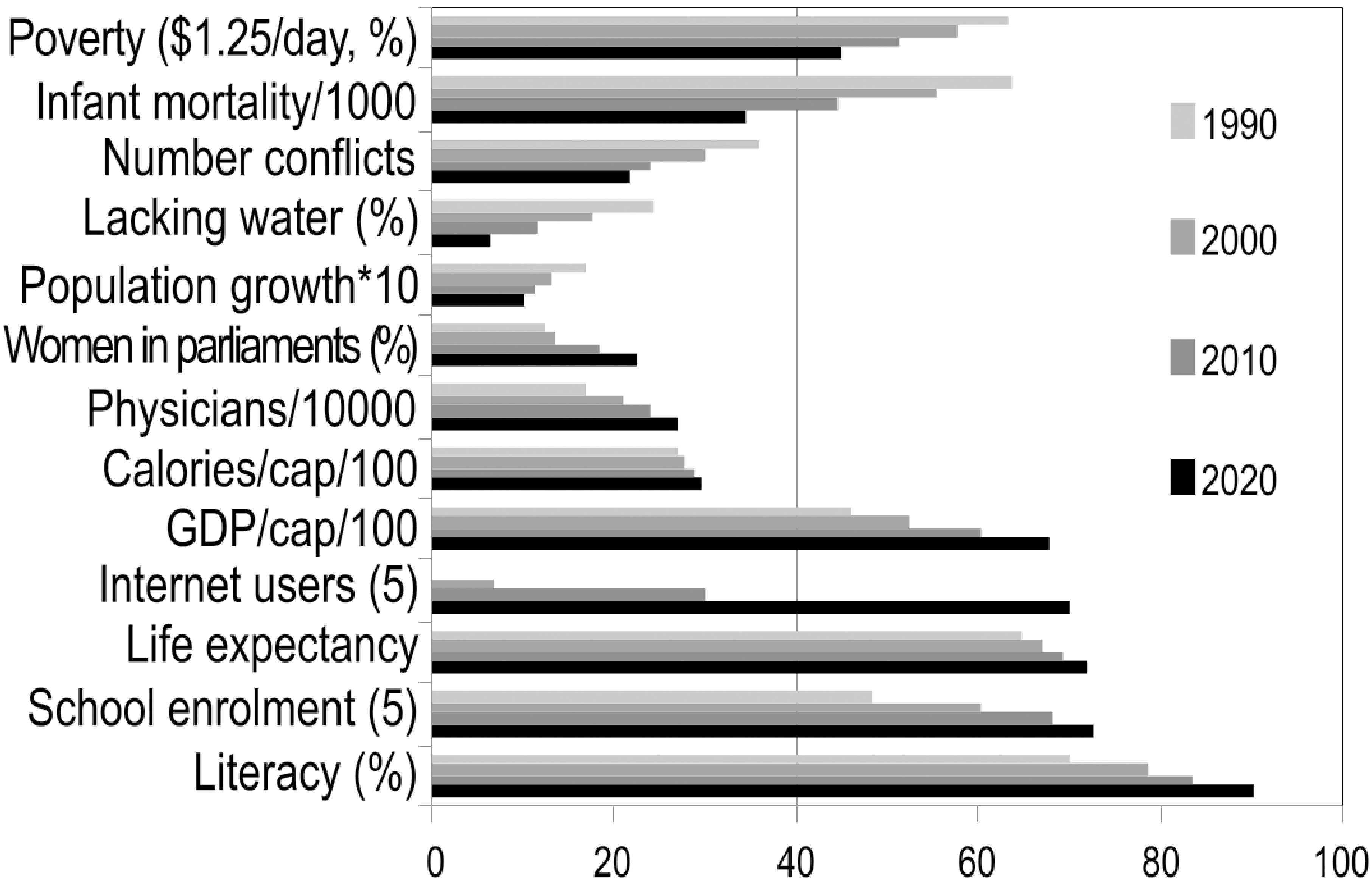
A crisis like no other – World GDP fell for the first time in the last 30 years

Evolution of world GDP
10^6 million dollars



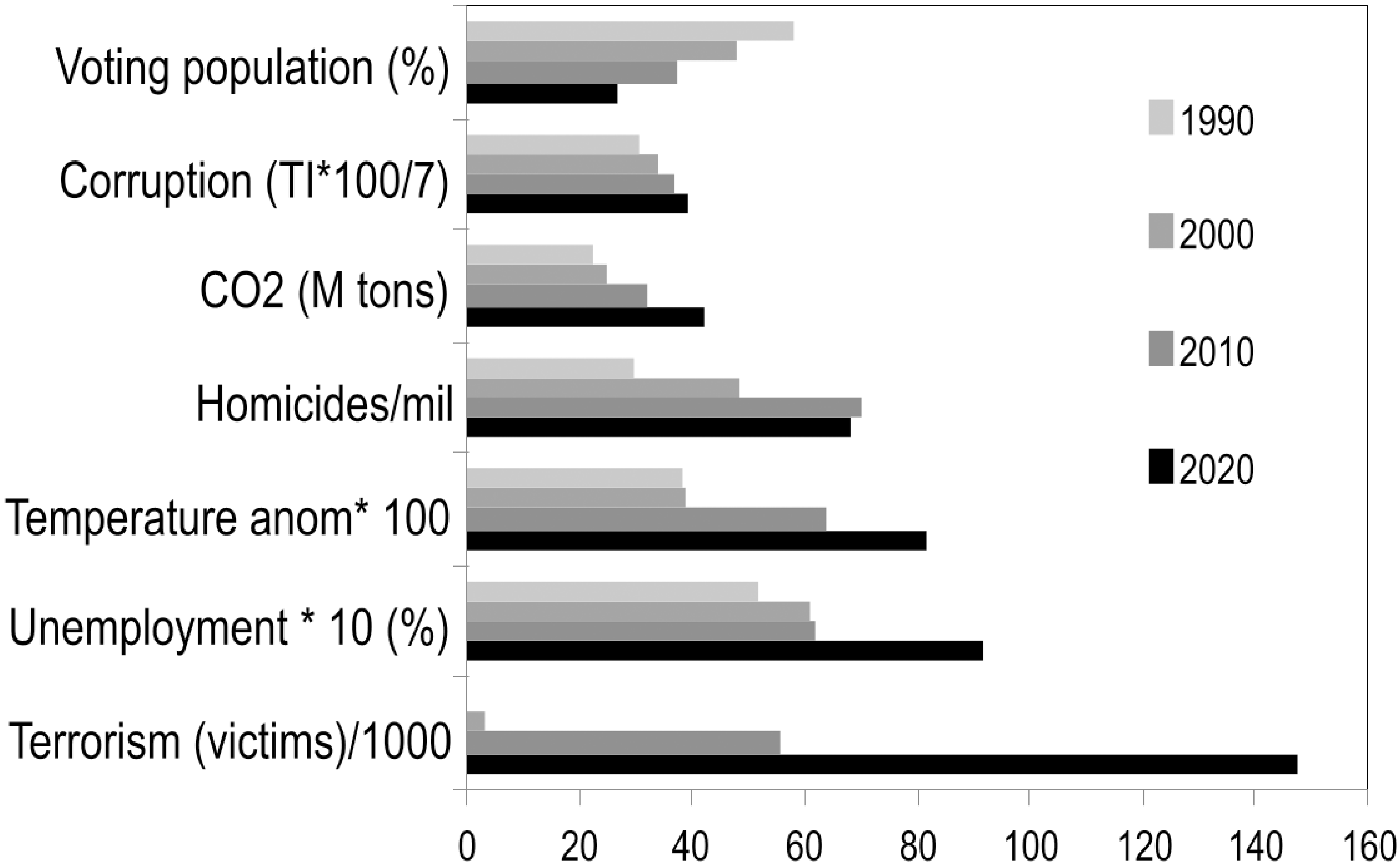
Source: Global Insights

Where we are improving

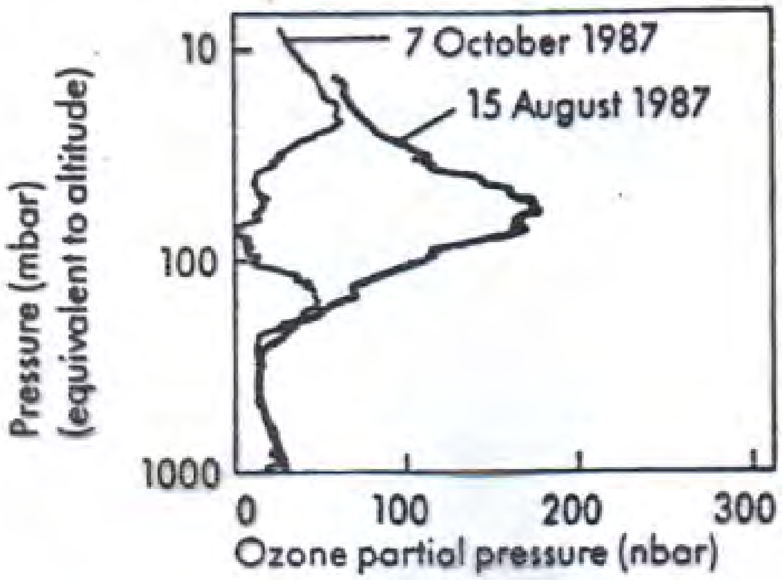


UN Millennium Project, 2010

Where we are not improving



UN Millennium Project, 2010



On 15 August 1987, the total ozone measured above Halley Bay was 296 Dobson units; on 7 October, at the same site, it was 128 Dobson units. Balloon measurements showed that all of the ozone at an altitude of 16.5 kilometres (corresponding to a pressure of just under 100 mbar) had gone. On 15 August, at an altitude where the pressure was 70 mbar (16.5 km), ozone made up just over one-millionth of the atmosphere; on 7 October, at the same altitude, it was undetectable.
(Figure supplied by Joe Farman)

1mbar = 10^{-3} bar = 100 Nm^{-2} = 100 Pa

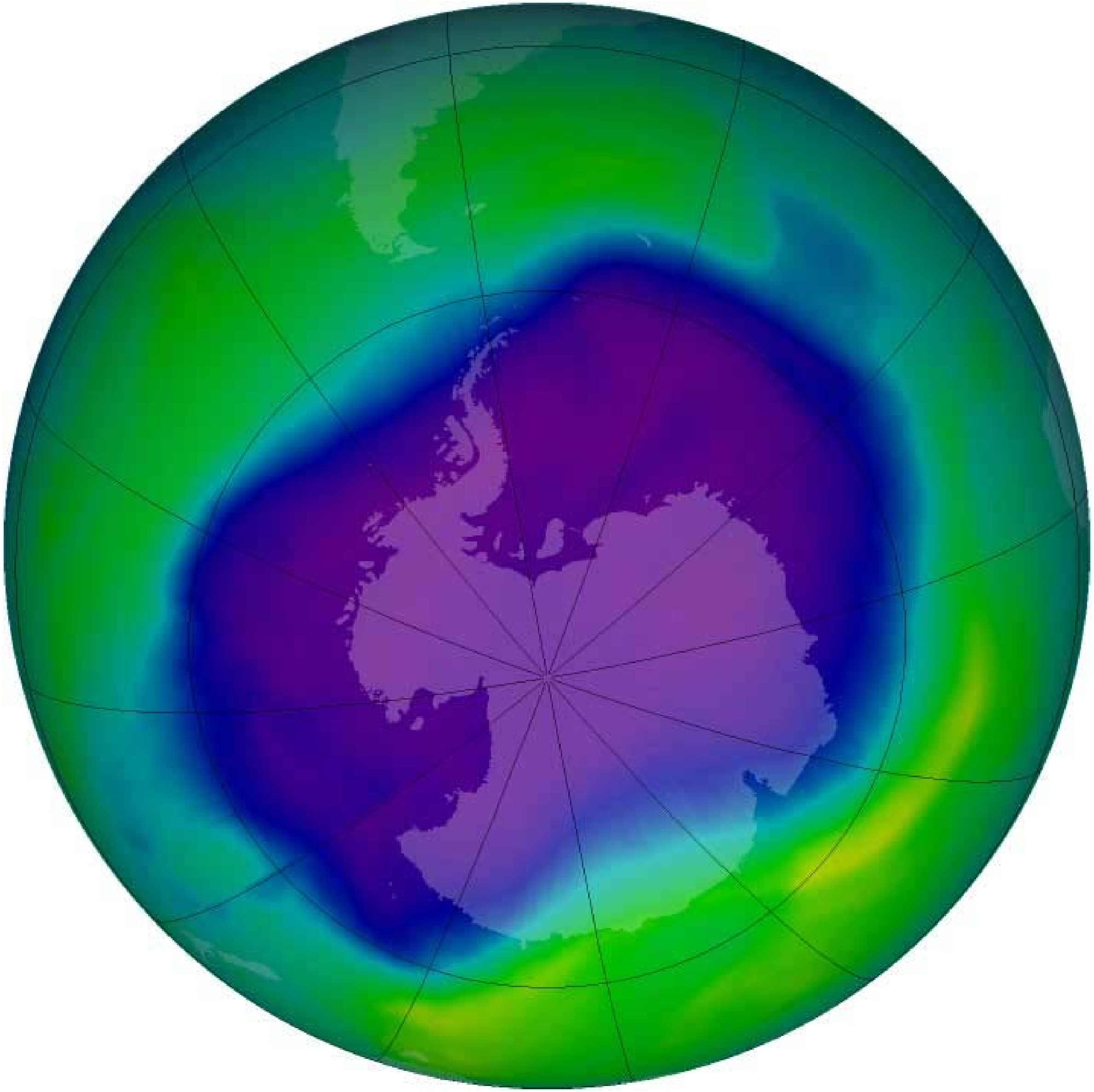
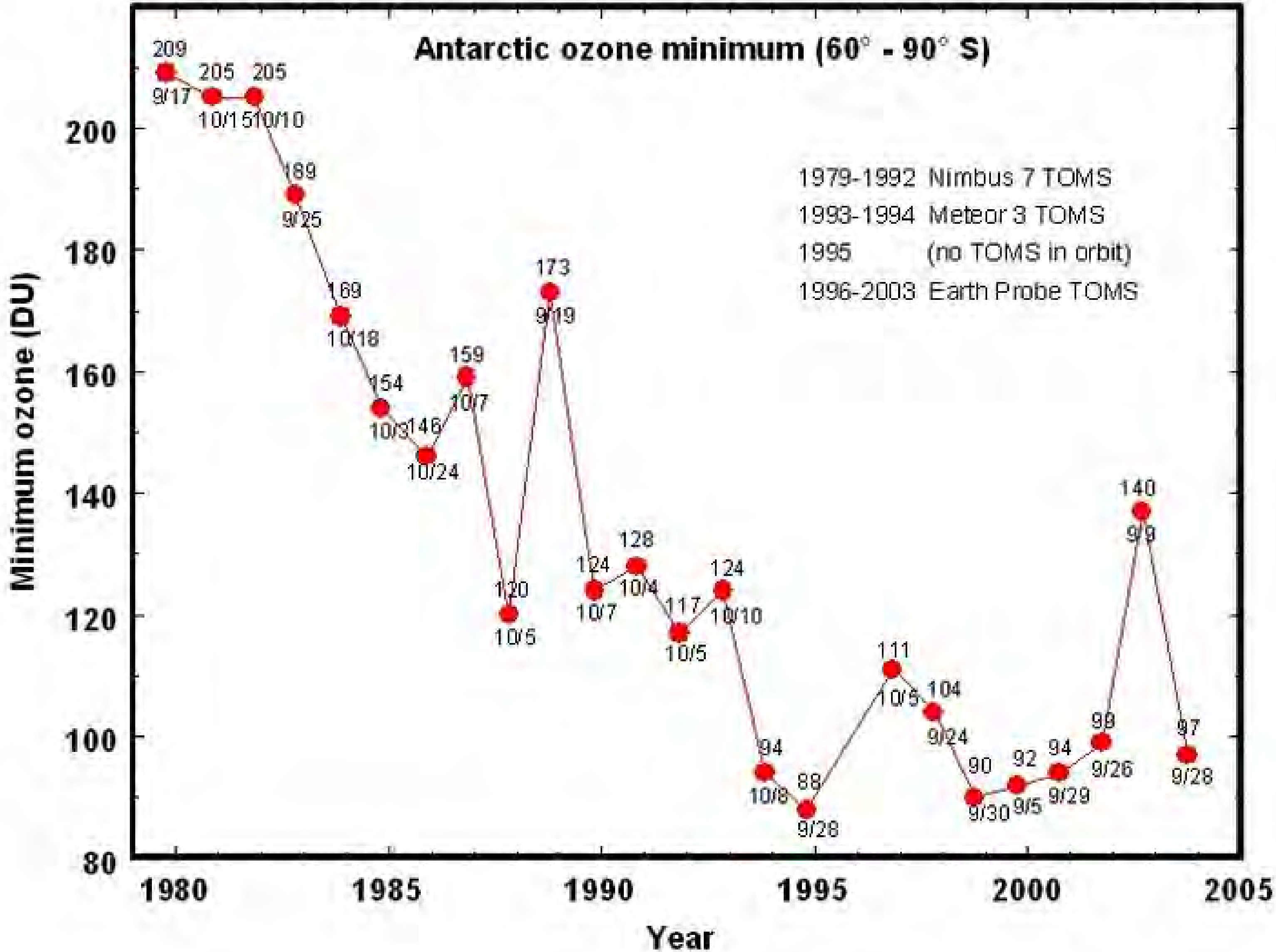


Image of the largest Antarctic ozone hole ever recorded (Sep. 2006).

Nuvens estratosféricas polares



Lowest value of ozone measured by TOMS each year in the ozone hole

Decrescimento do Ozono estratosférico

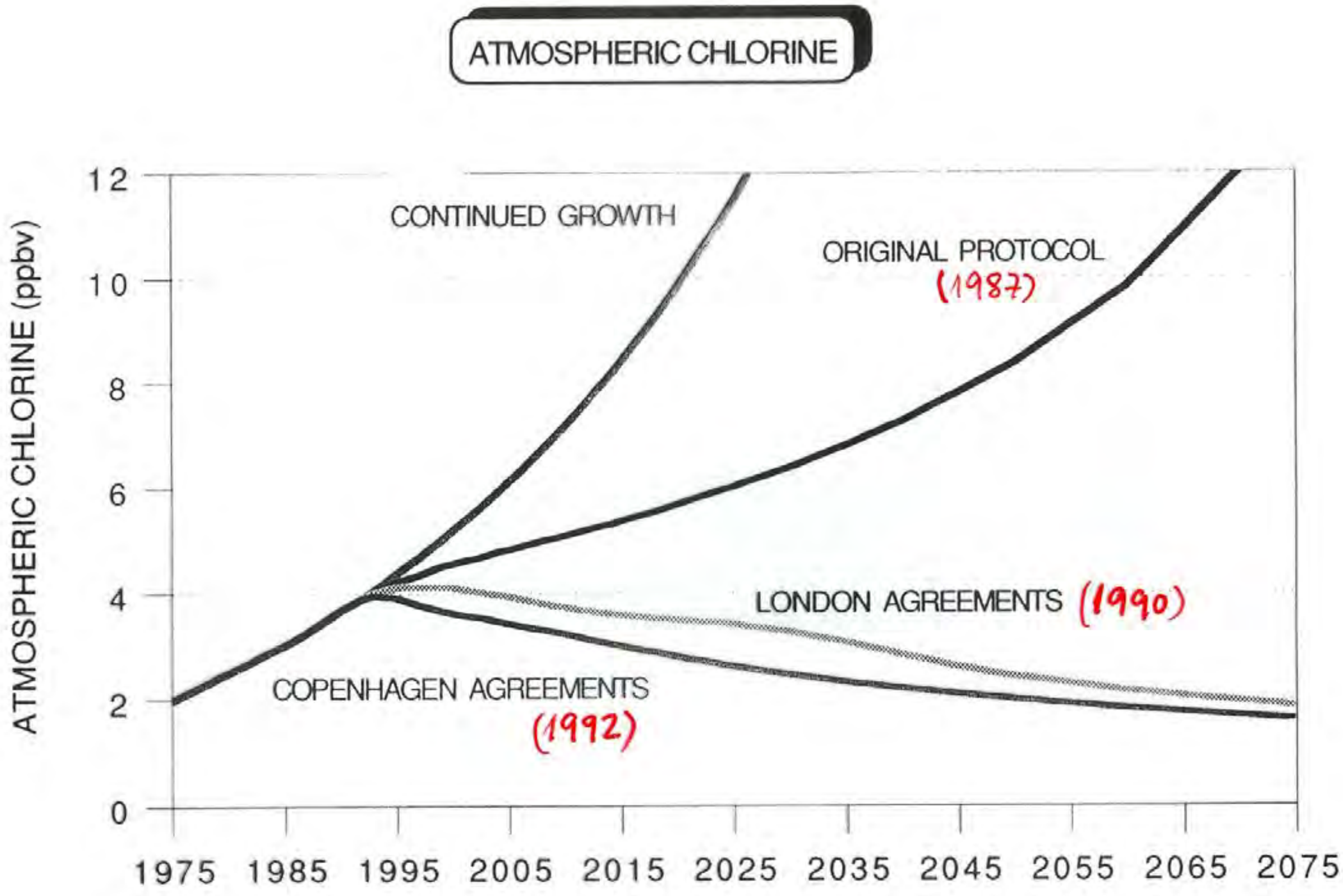
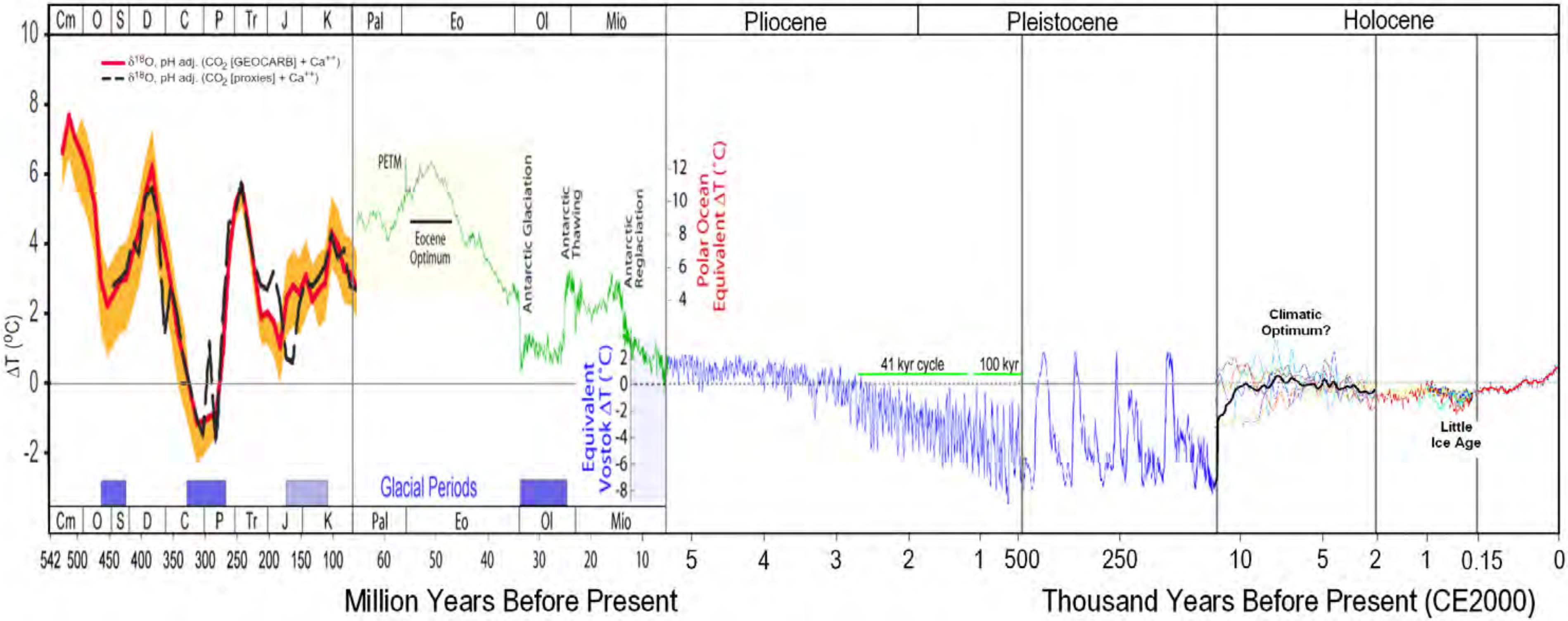
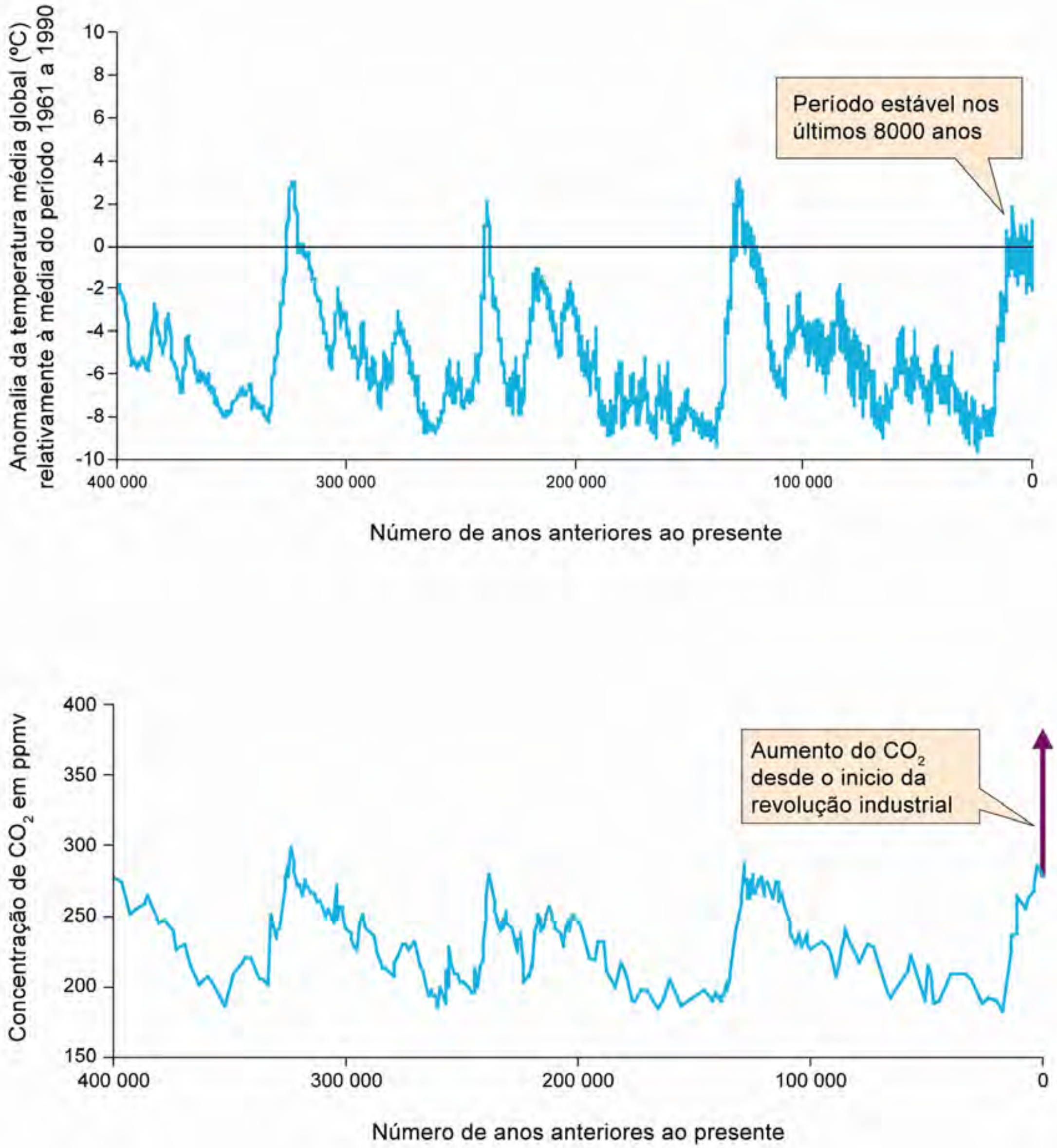


Figure 1. Projected Concentrations of Atmospheric Chlorine.

Source: DuPont Fluorochemicals,
M.J. Prather, personal communication

Temperature of Planet Earth





Reconstituição da evolução da temperatura média global da baixa atmosfera, representada por meio da anomalia relativamente à média do período de 1961 a 1990, e da concentração atmosférica do CO2 nos últimos 400 000 anos (Petit, 1999). Figura adaptada de EEA, 2004. Repare-se na correlação que se observa entre os dois registos. O aumento da concentração do CO2 a partir da revolução industrial e até ao presente está indicado por um vector aproximadamente vertical devido à escala de tempo utilizada na figura

Fonte, Petit et al., 1999

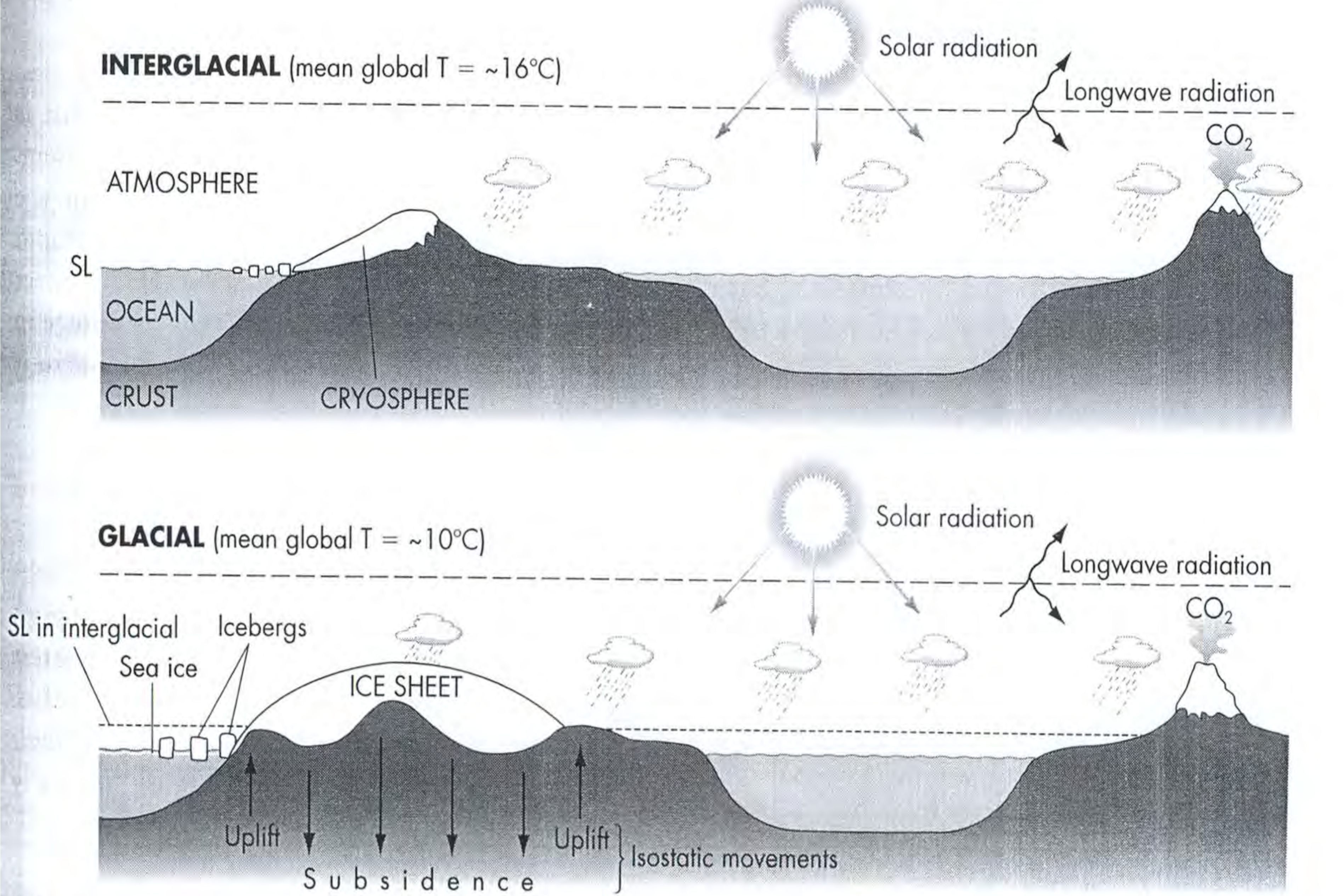


Figure 2.7 A comparison of the Earth's climate system during interglacial and glacial intervals.

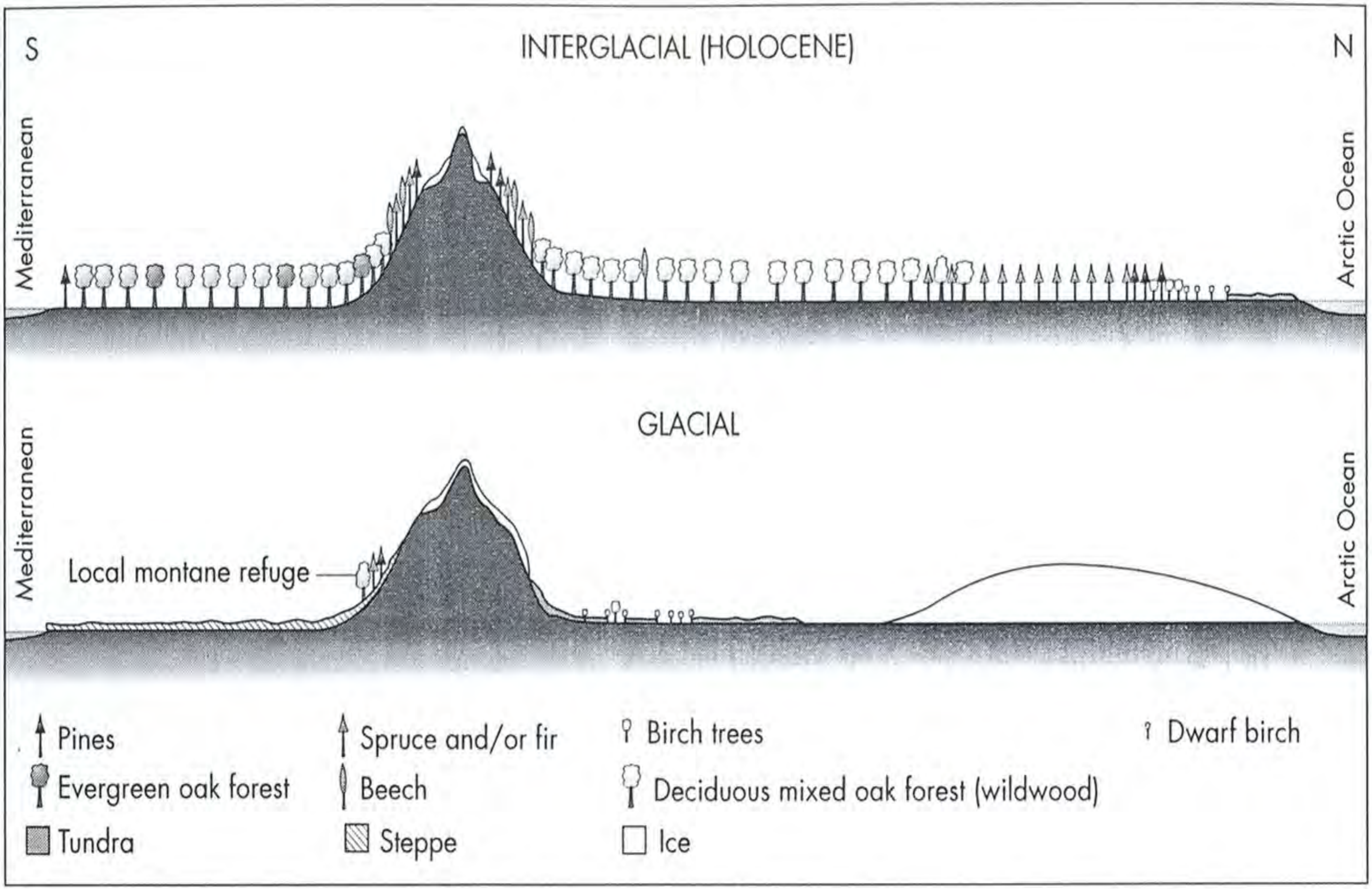
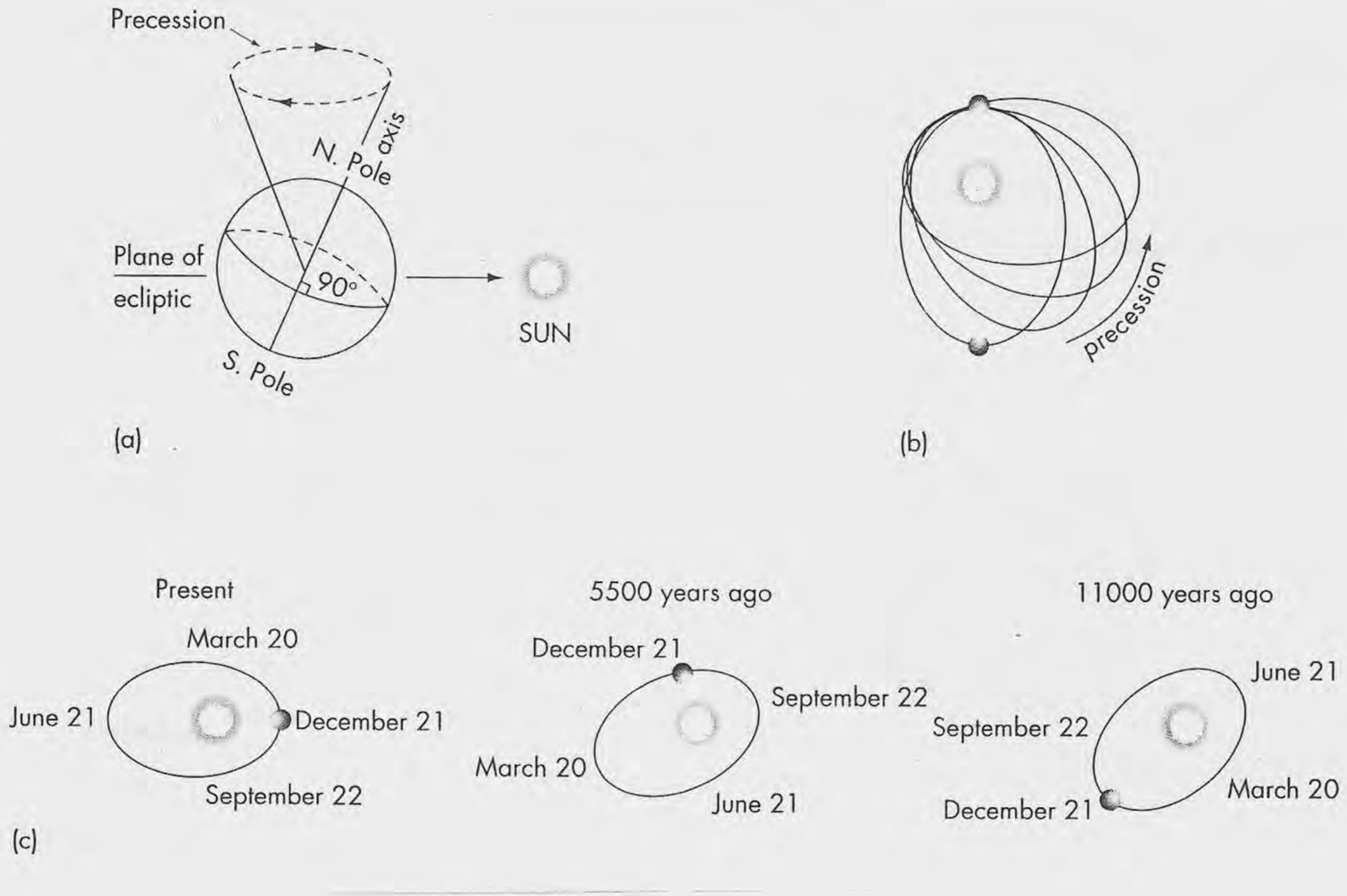
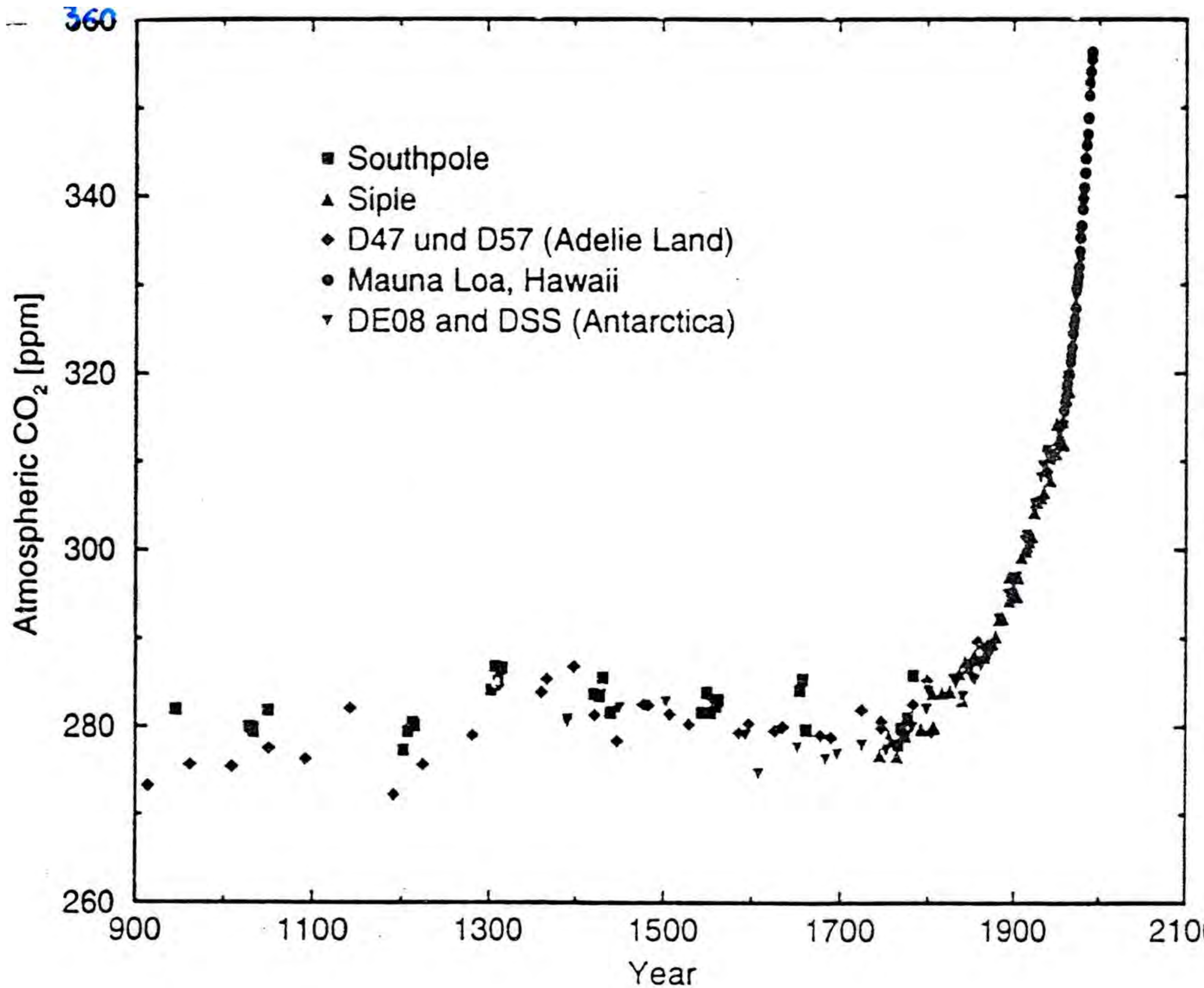


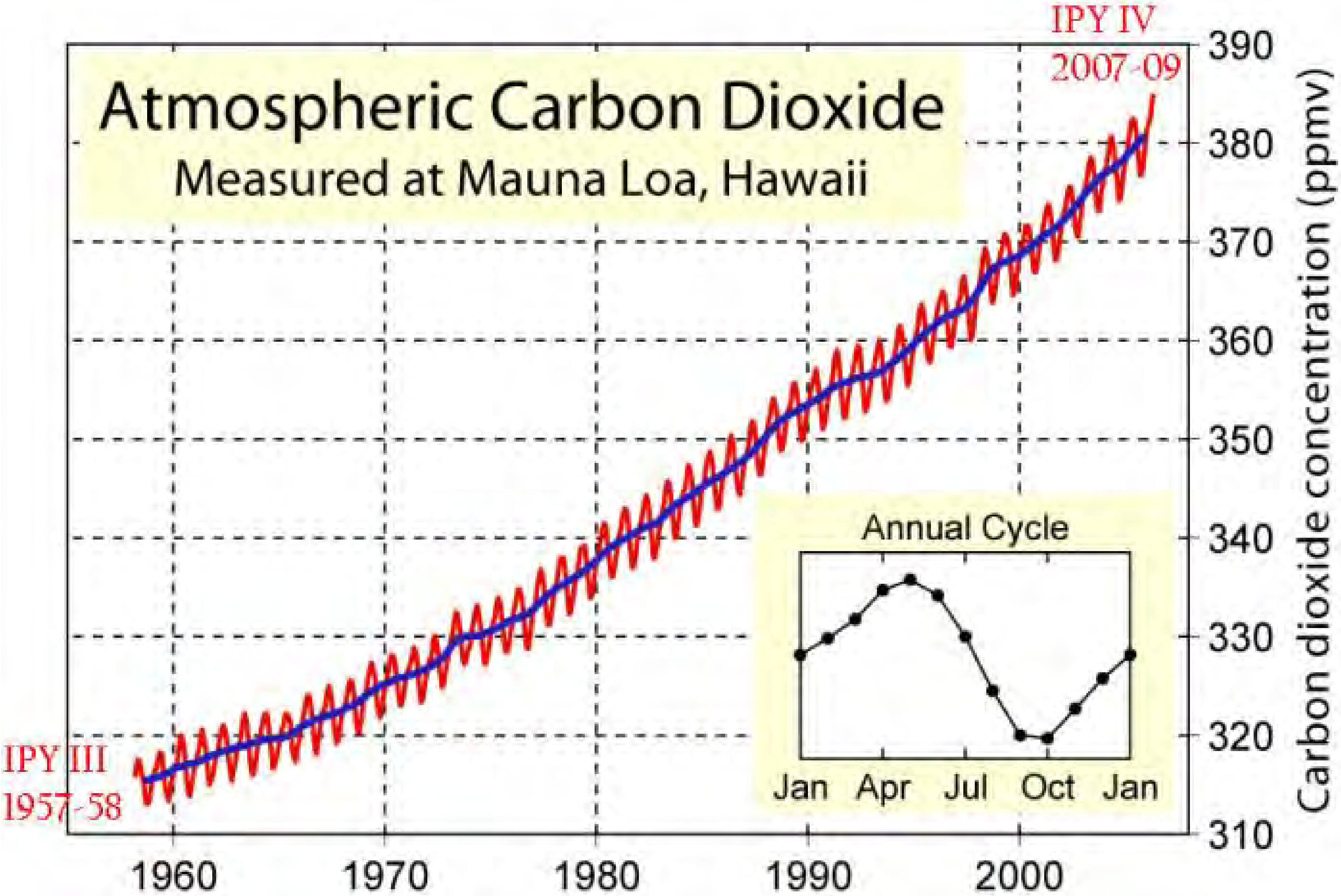
Figure 8.7 Diagrams showing the vegetation cover of Europe during glacial maxima and interglacials.

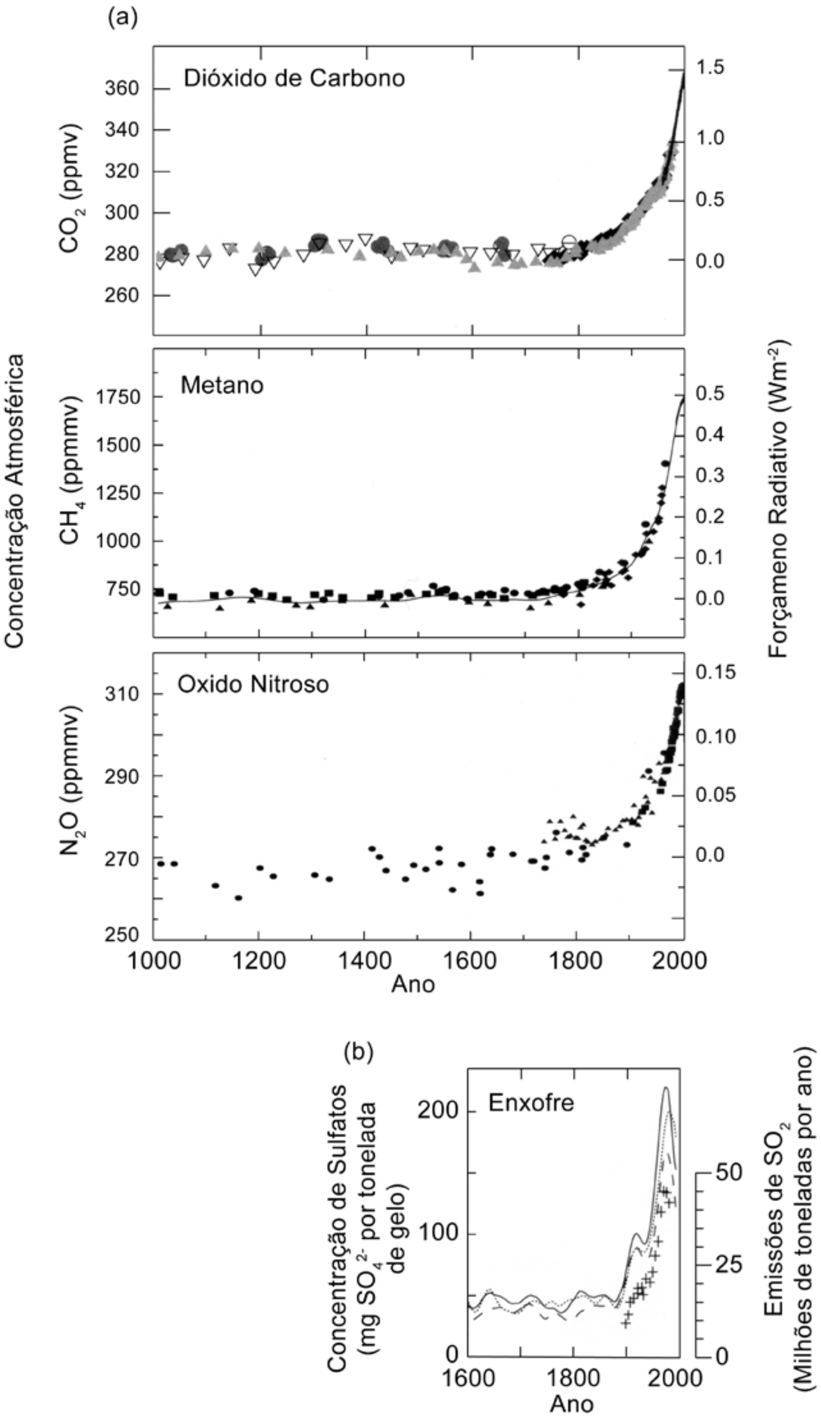


From R.C. Wilson et al., 2000


Southpole
Sipie
D47 und D57 (Adelie Land)
Mauna Loa, Hawaii
DE08 and DSS (Antarctica)
Atmospheric CO_2 [ppm]
360
340
320
300
280
260
900
1100
1300
1500
1700
1900
2100
Year

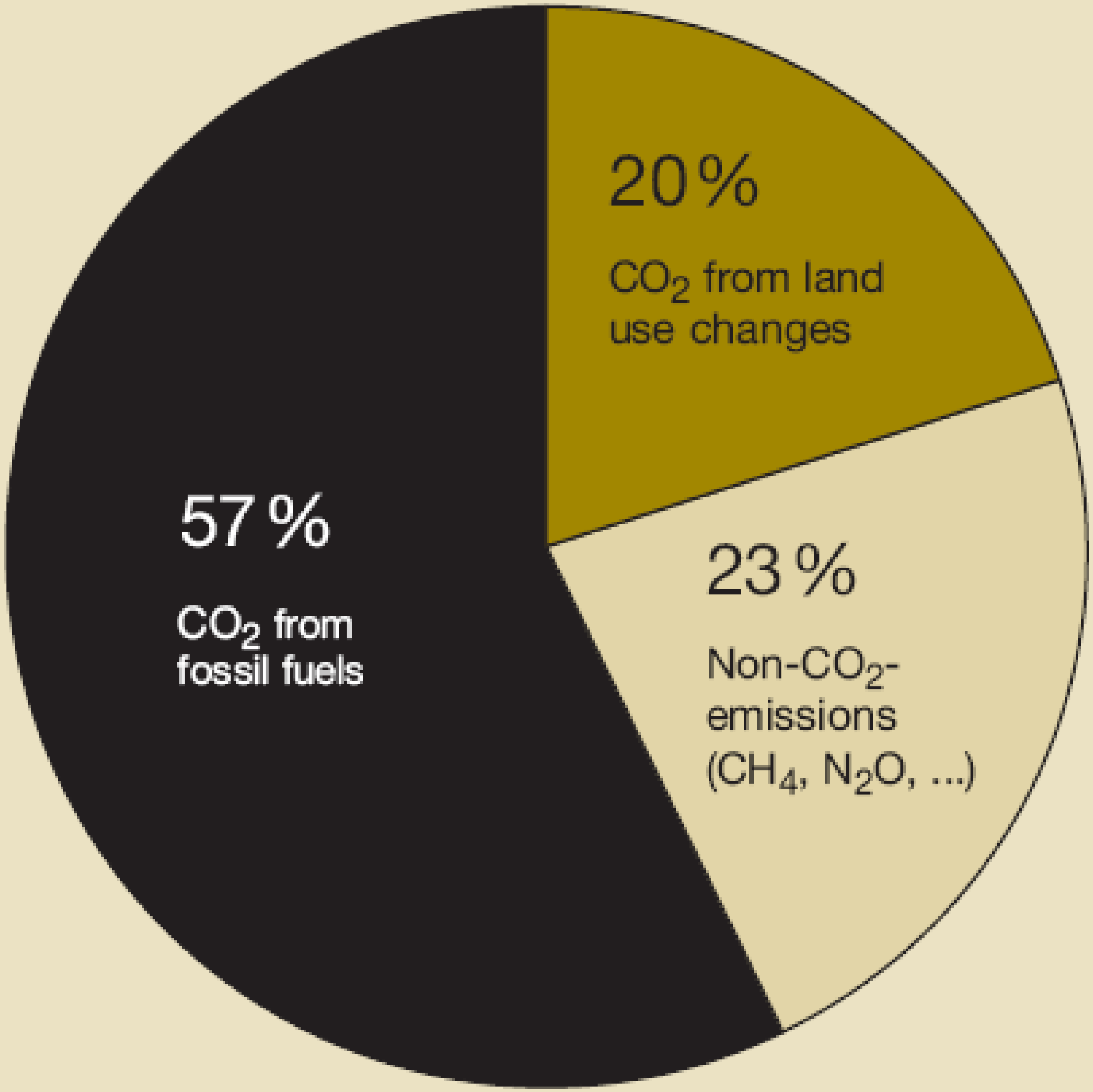
Fonte, IPCC


Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
IPY IV
2007-09
IPY III
1957-58
Carbon dioxide concentration (ppmv)
390
380
370
360
350
340
330
320
310
1960
1970
1980
1990
2000
Annual Cycle
Jan
Apr
Jul
Oct
Jan



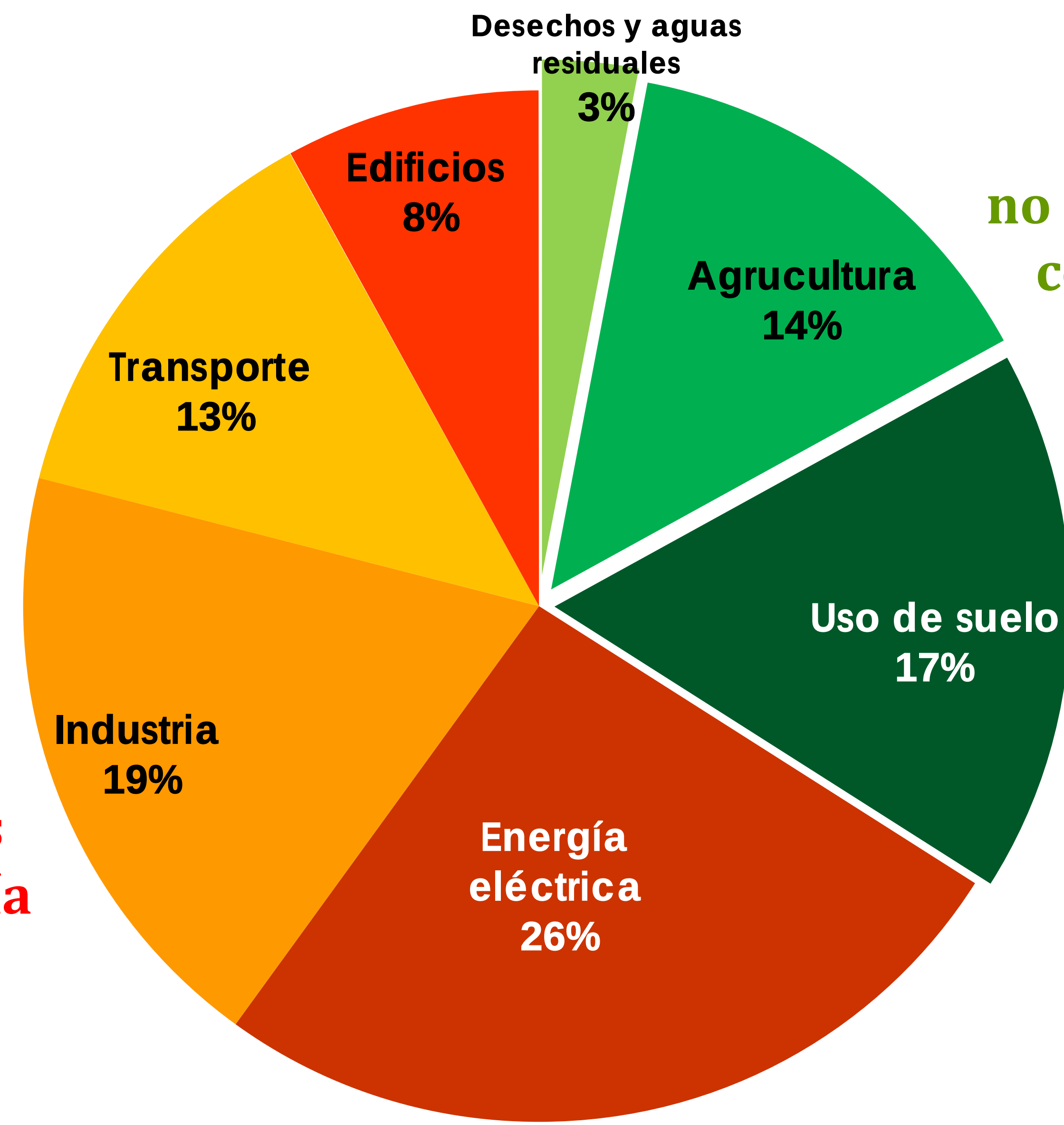
Evolução das concentrações de vários componentes da atmosfera (IPCC, 2001a). (a) Concentrações de três dos principais gases com efeito de estufa (GEE), com emissões antropogénicas – CO2, CH4 e N2O – nos últimos 1 000 anos. Dados obtidos a partir de furos nos gelos da Antárctica e Gronelândia e de observações directas nas últimas décadas (indicada por uma linha no caso do CO2). No gráfico relativo ao CH4 a curva representa a média global. O forçamento radiativo provocado pela presença destes gases na atmosfera está representado à direita. No caso do CH4 e N2O a concentração está representada em partes por milhar de milhão em volume (ppmmv). (b) Concentrações de sulfatos obtidas a partir de furos nos gelos da Gronelândia em três locais (curvas) e emissões totais de SO2 na Europa e nos Estados Unidos da América (indicadas com +).

Fonte, IPCC



Rough breakdown of global greenhouse gas emissions in 2004.
Source: WBGU, based on IPCC, 2007c

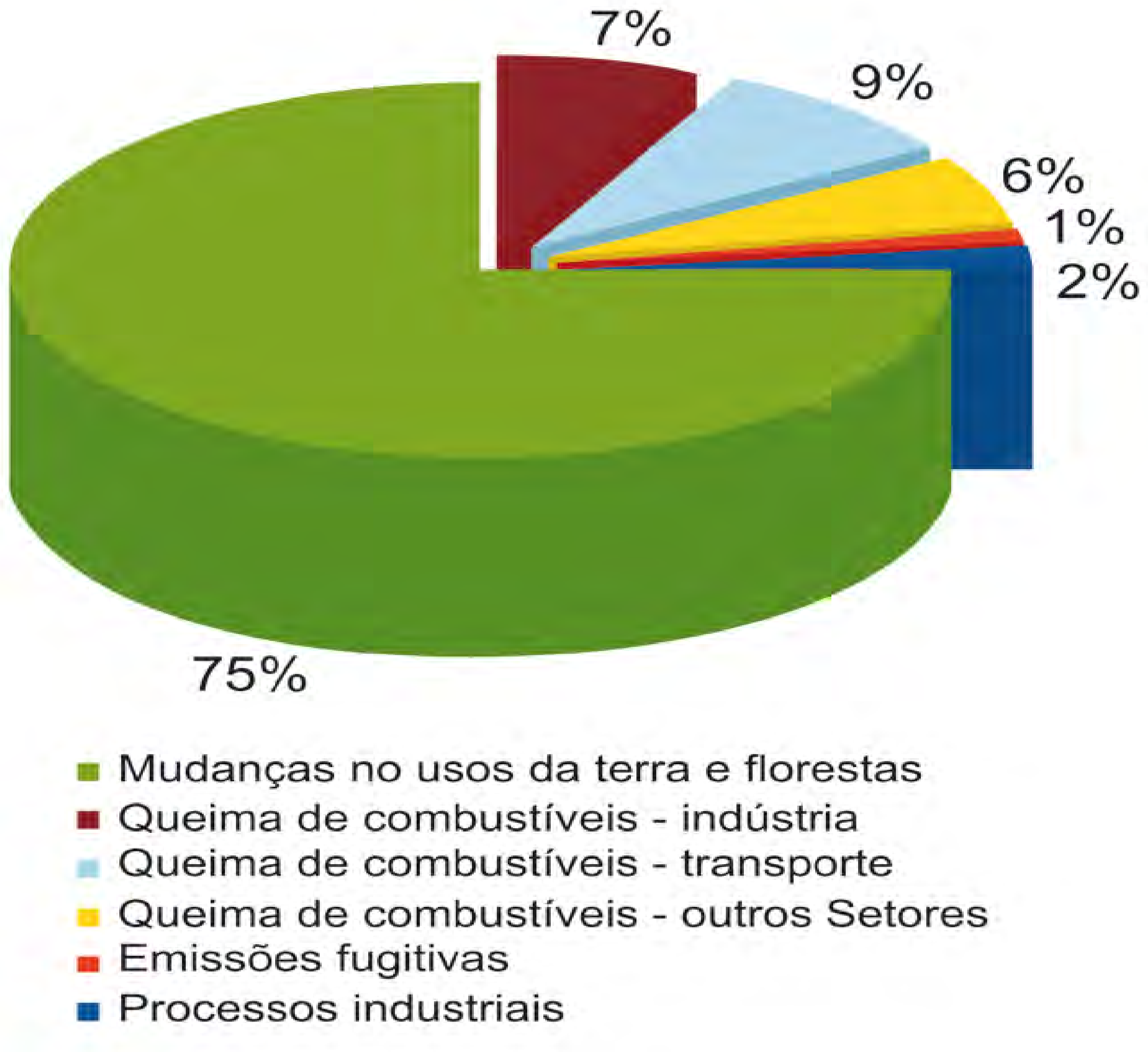
Emissões de GEE por sector 2007

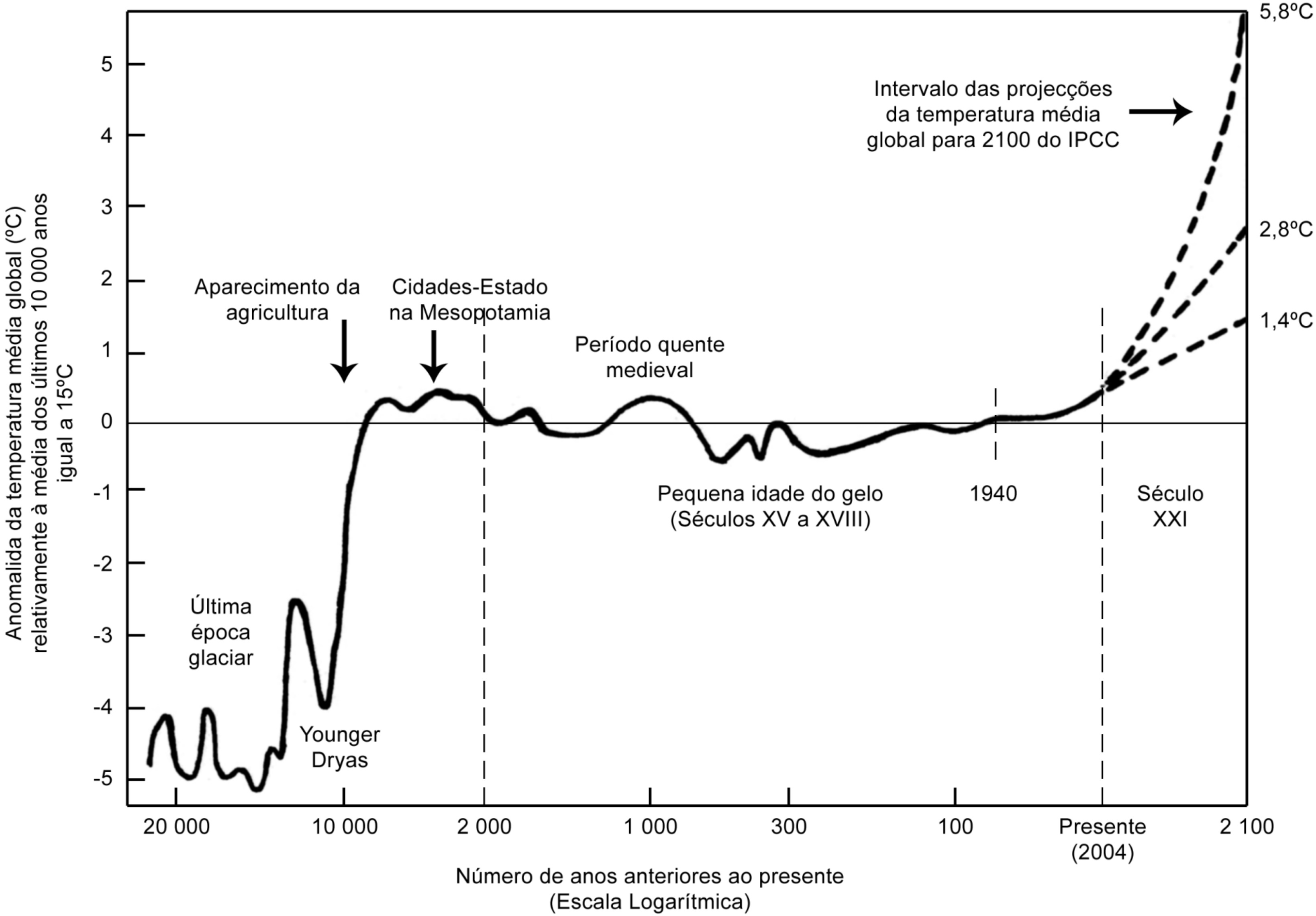


Emisiones no relacionadas con la energía

Emisiones relacionadas con la energía

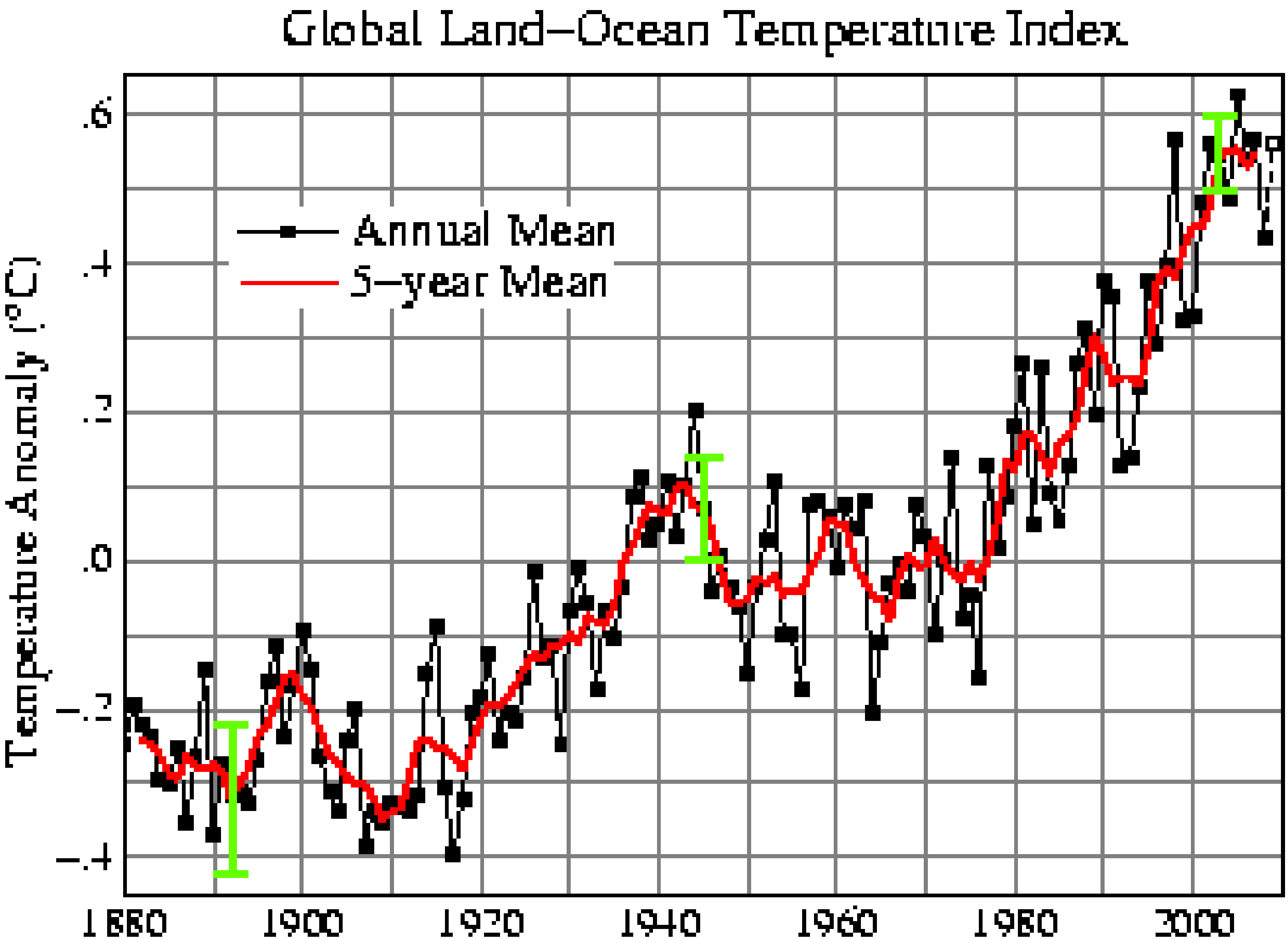
Emisiones Brasileiras de CO_2



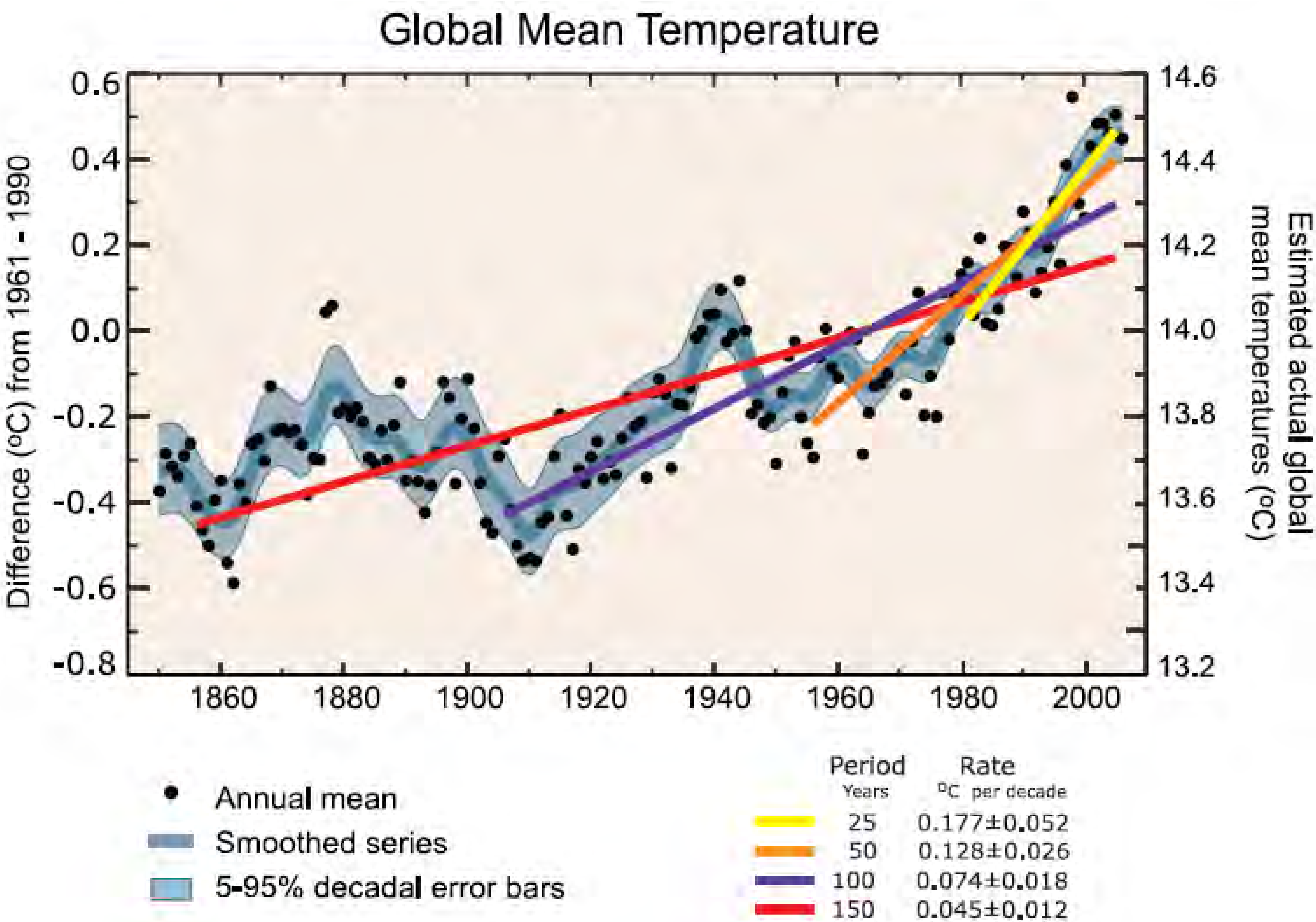


Anomalida da temperatura média global (ºC) relativamente à média dos últimos 10 000 anos igual a 15ºC
5
4
3
2
1
0
-1
-2
-3
-4
-5
5,8ºC
2,8ºC
1,4ºC
Intervalo das projecções da temperatura média global para 2100 do IPCC
Aparecimento da agricultura
Cidades-Estado na Mesopotamia
Período quente medieval
Pequena idade do gelo (Séculos XV a XVIII)
1940
Século XXI
Última época glaciar
Younger Dryas
20 000
10 000
2 000
1 000
300
100
Presente (2004)
2 100
Número de anos anteriores ao presente (Escala Logarítmica)

Fonte, SIAM



Global Land–Ocean Temperature Index
Annual Mean
5–year Mean
Temperature Anomaly (°C)
.6
.4
.2
.0
–.2
–.4
1880
1900
1920
1940
1960
1980
2000

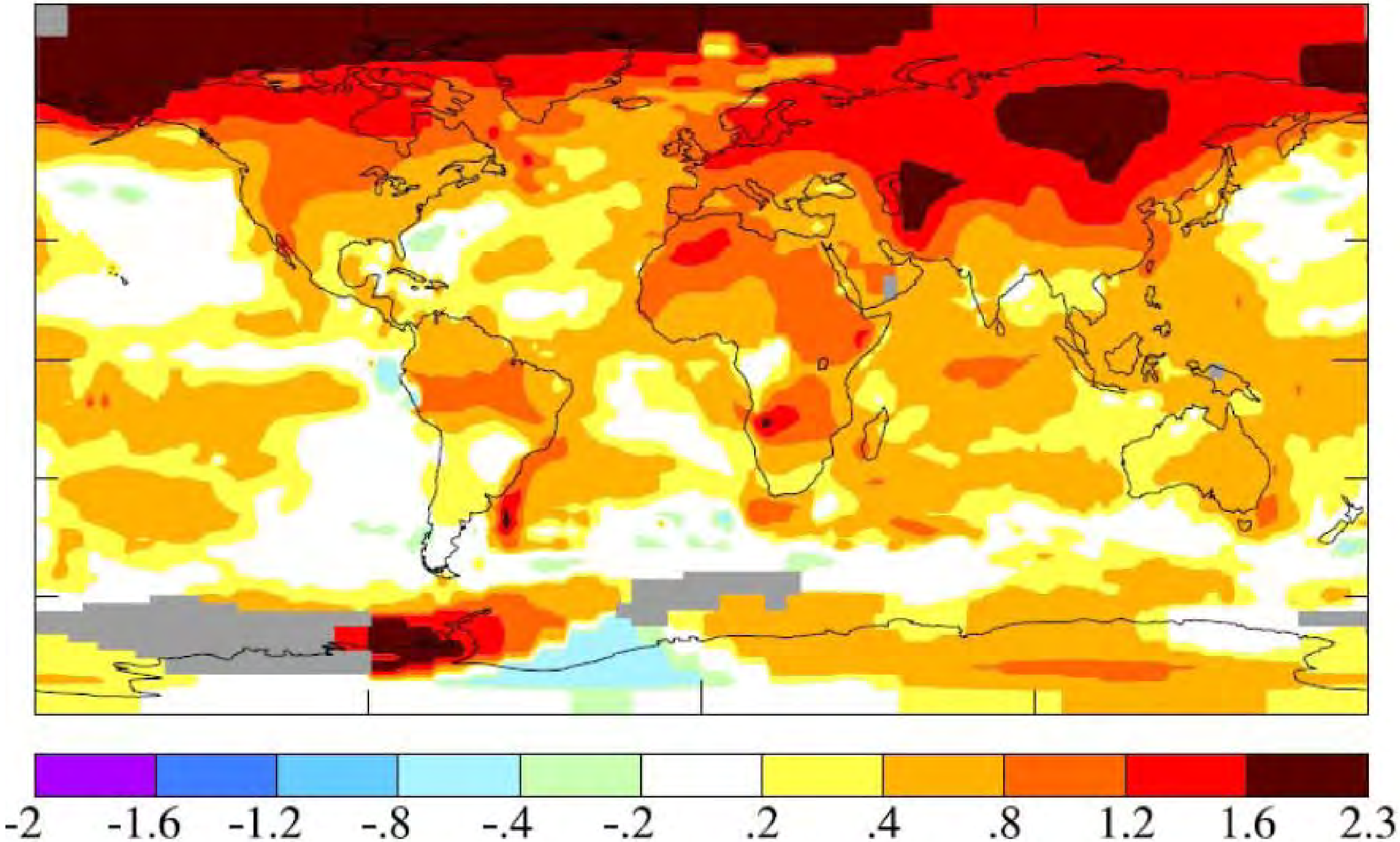


Global Mean Temperature
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
Difference (°C) from 1961 - 1990
14.6
14.4
14.2
14.0
13.8
13.6
13.4
13.2
Estimated actual global mean temperatures (°C)
1860
1880
1900
1920
1940
1960
1980
2000
Annual mean
Smoothed series
5-95% decadal error bars
Period Years
Rate °C per decade
25 0.177±0.052
50 0.128±0.026
100 0.074±0.018
150 0.045±0.012

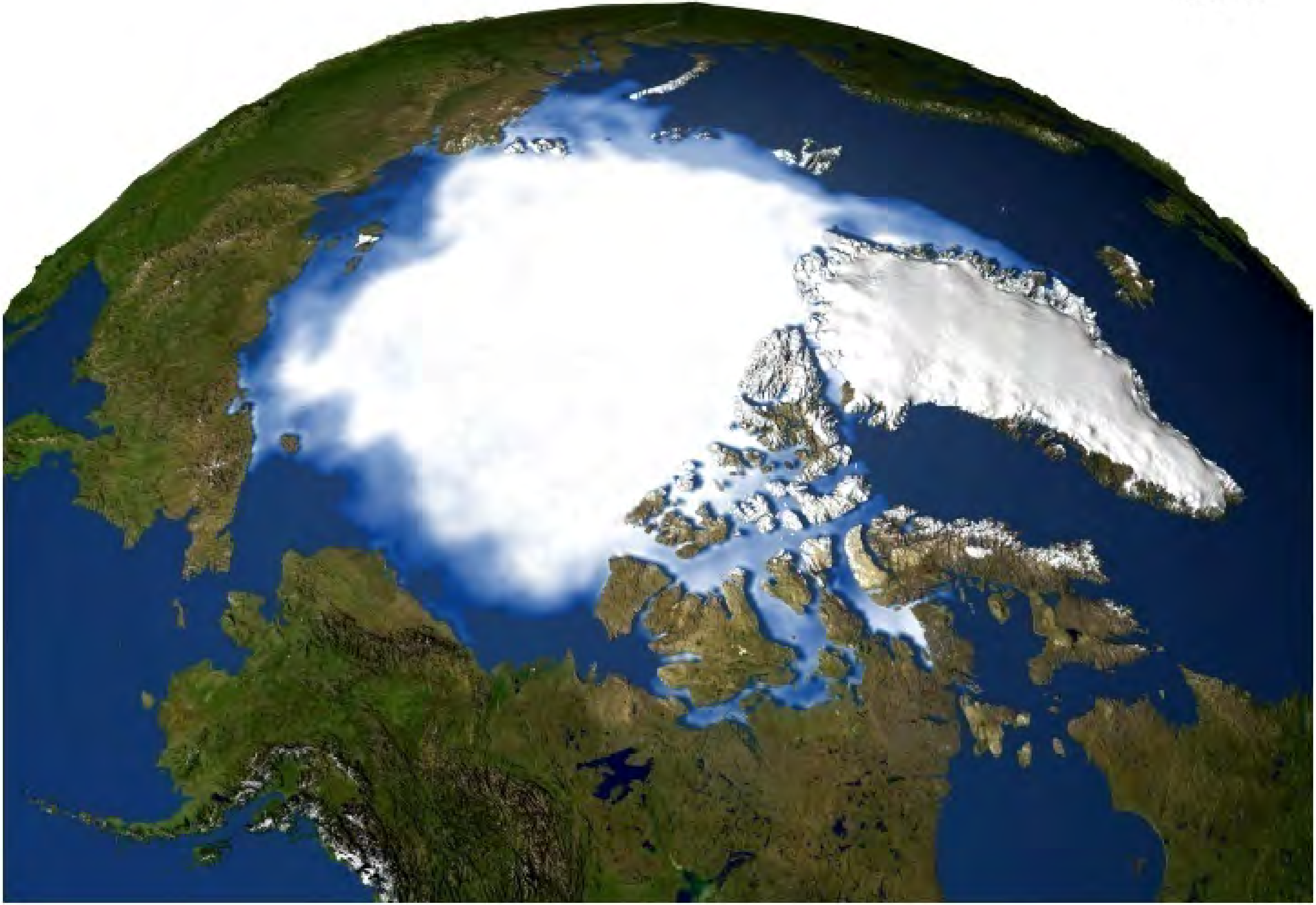
Fonte, IPCC

Variação da Temperatura Média Global à Superfície

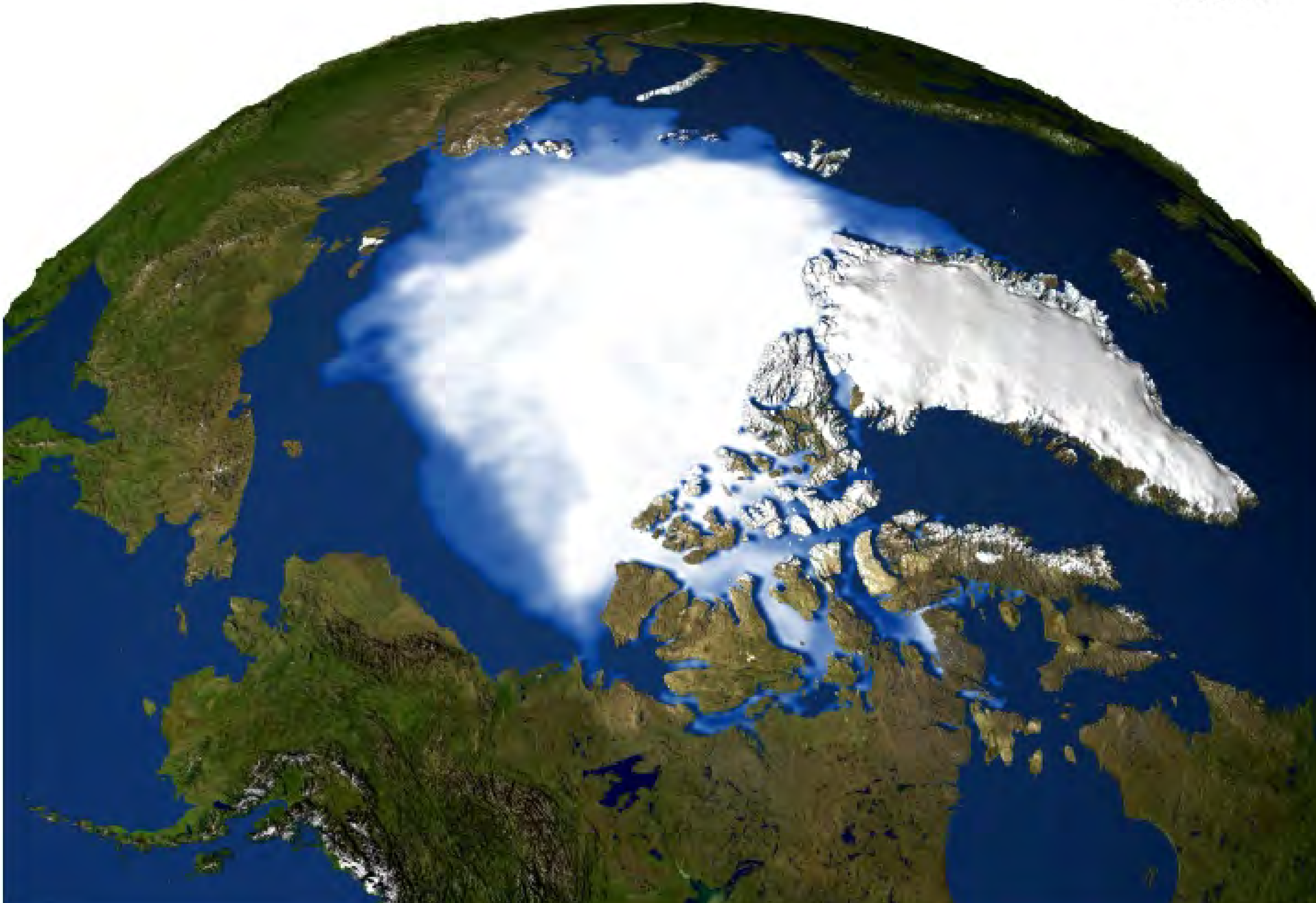
Média 2001-2007 em relação 1951-80 (+0,54º C)



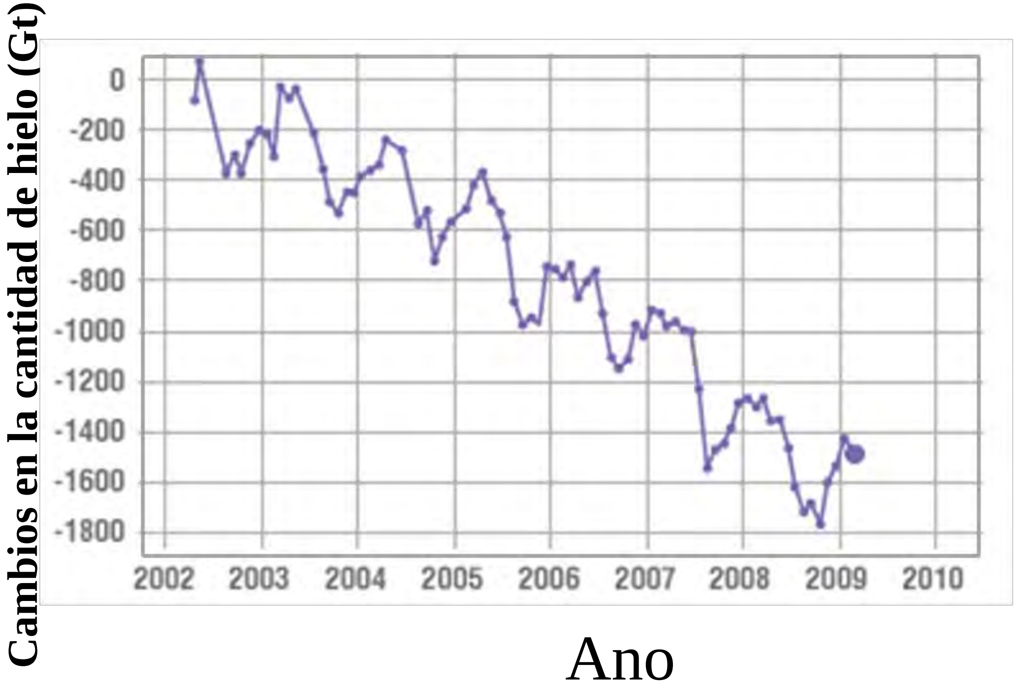
1979



2005



Redução do Gelo Oceânico no Ártico



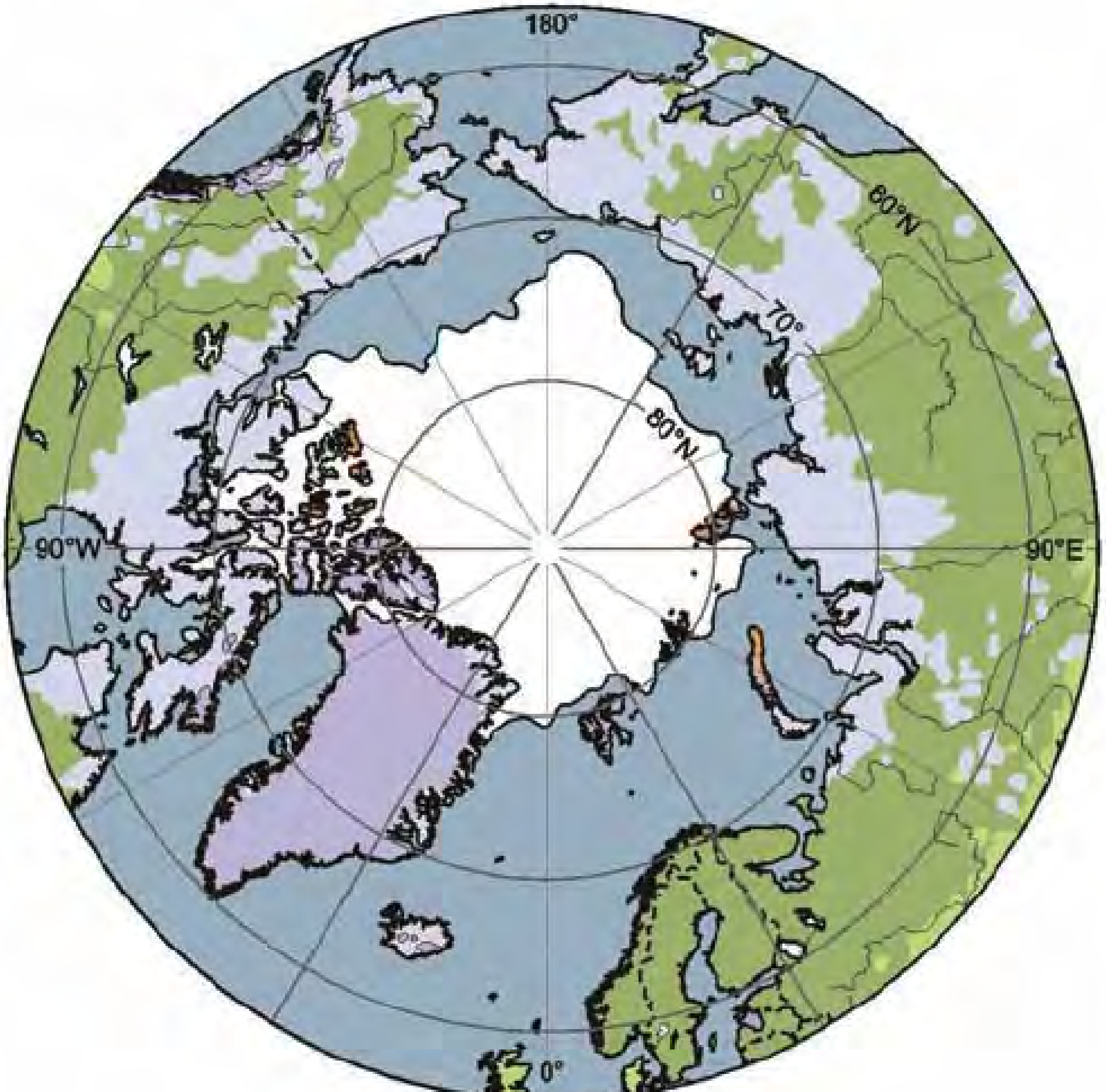
Fonte: NASA -University of California Irvine. 2010.

Sea level is rising faster than predicted

Surface melt on Greenland ice sheet descending into moulin, a vertical shaft carrying the water to base of ice sheet.

Source: Roger Braithwaite

Current Arctic Conditions



Projected Arctic Conditions

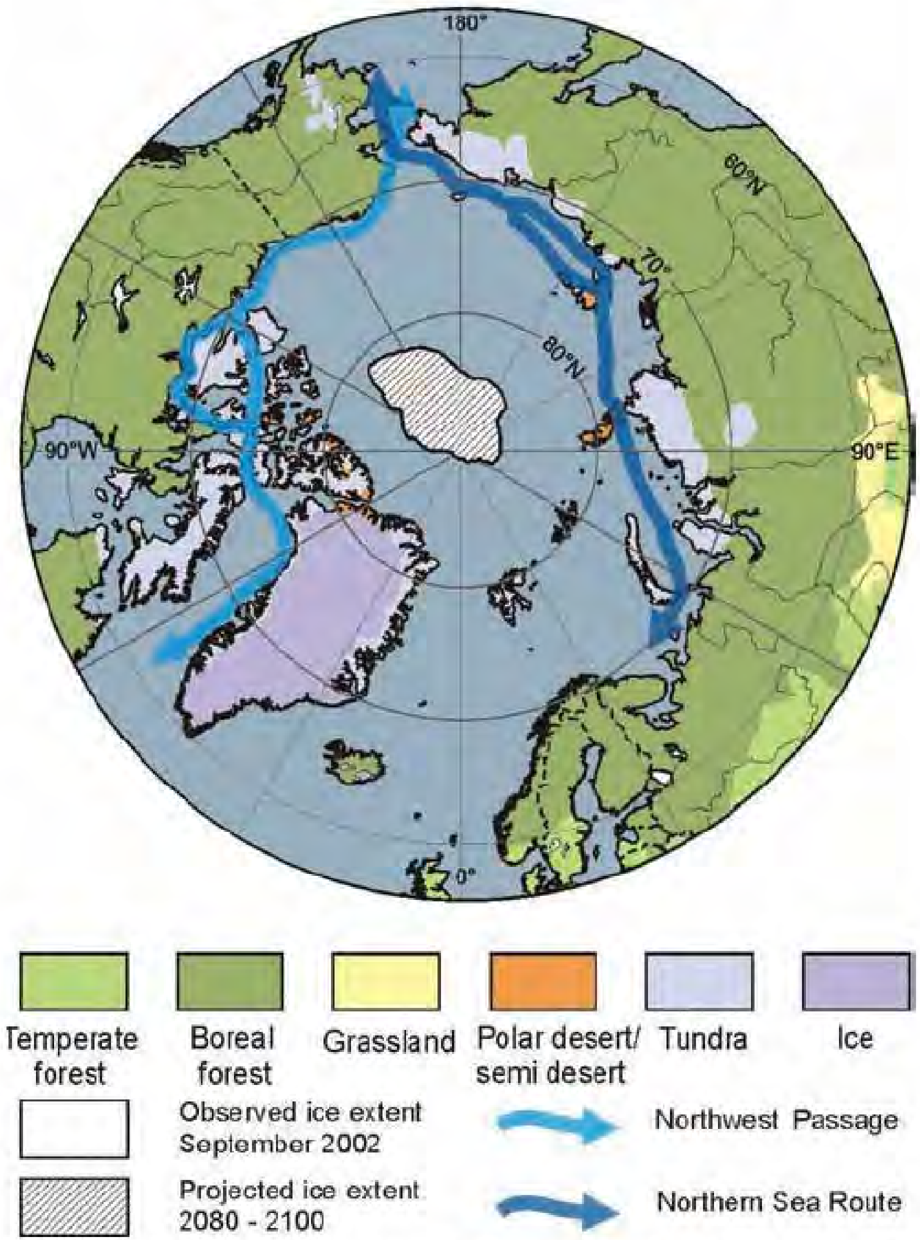


Figure TS.16. *Vegetation of the Arctic and neighbouring regions. Top: present-day, based on floristic surveys. Bottom: modelled for 2090-2100 under the IS92a emissions scenario. [F15.2]*

Sea level is rising faster than predicted

Surface melt on Greenland ice sheet descending into moulin, a vertical shaft carrying the water to base of ice sheet.

Source: Roger Braithwaite


1985
2002
© GARY BRAASCH


Pasterze Glacier 1875


Pasterze Glacier (site), Austria
© 2004 Gary Braasch

1940

1982

1998

2002

2005

Evolution of the Chacaltaya Glacier in Bolivia

Source: Photographs by B. Francou and E. Ramirez and archive photographs

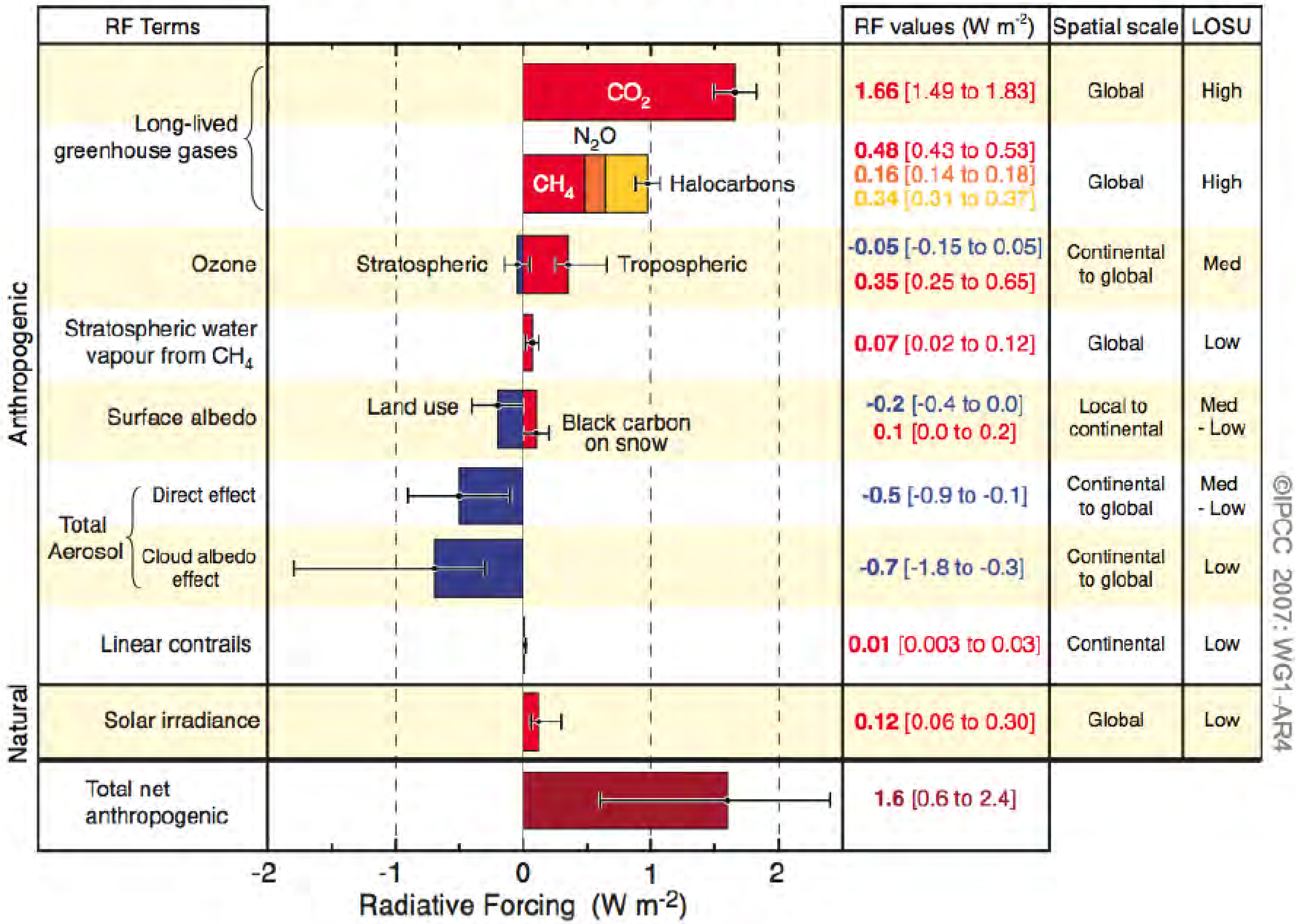
Table 13.3. *Glacier retreat trends.*

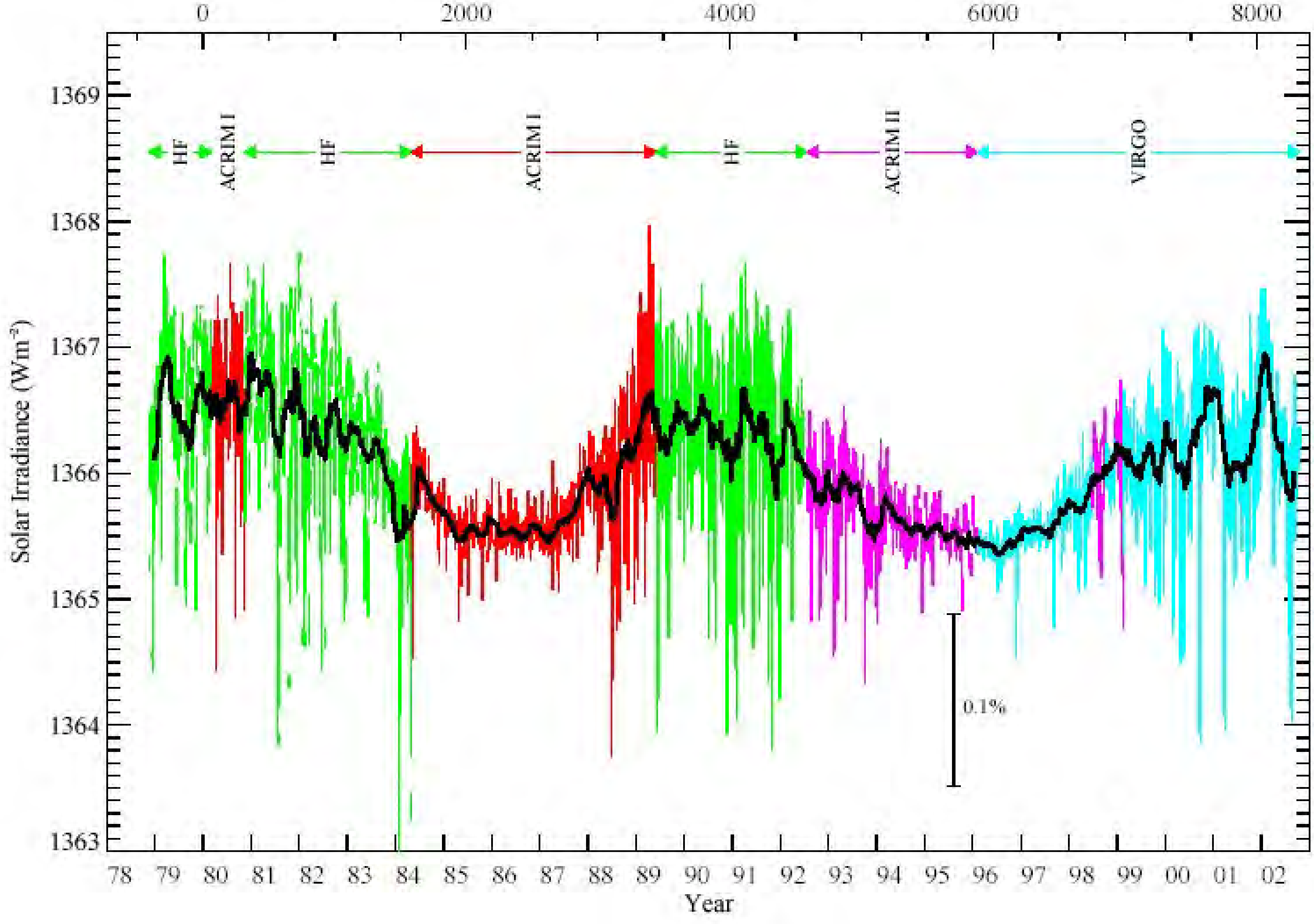
Glaciers/Period	Changes/Impacts
Peru[a, b] Last 35 years	22% reduction in glacier total area; reduction of 12% in freshwater in the coastal zone (where 60% of the country's population live). Estimated water loss almost 7,000 Mm^3
Peru[c] Last 30 years	Reduction up to 80% of glacier surface from small ranges; loss of 188 Mm^3 in water reserves during the last 50 years.
Colombia[d] 1990-2000	82% reduction in glaciers, showing a linear withdrawal of the ice of 10-15 m/yr; under the current climate trends, Colombia's glaciers will disappear completely within the next 100 years.
Ecuador[e] 1956-1998	There has been a gradual decline glacier length; reduction of water supply for irrigation, clean water supply for the city of Quito, and hydropower generation for the cities of La Paz and Lima.
Bolivia[f] Since mid-1990s	Chacaltaya glacier has lost half of its surface and two-thirds of its volume and could disappear by 2010. Total loss of tourism and skiing.
Bolivia[f] Since 1991	Zongo glacier has lost 9.4% of its surface area and could disappear by 2045-2050; serious problems in agriculture, sustainability of 'bofedales'[1] and impacts in terms of socio-economics for the rural populations.
Bolivia[f] Since 1940	Charquini glacier has lost 47.4% of its surface area.

[a]Vásquez, 2004; [b]Mark and Seltzer, 2003; [c]NC-Perú, 2001; [d]NC-Colombia, 2001; [e]NC-Ecuador, 2000; [f]Francou et al., 2003.

Fonte, IPCC

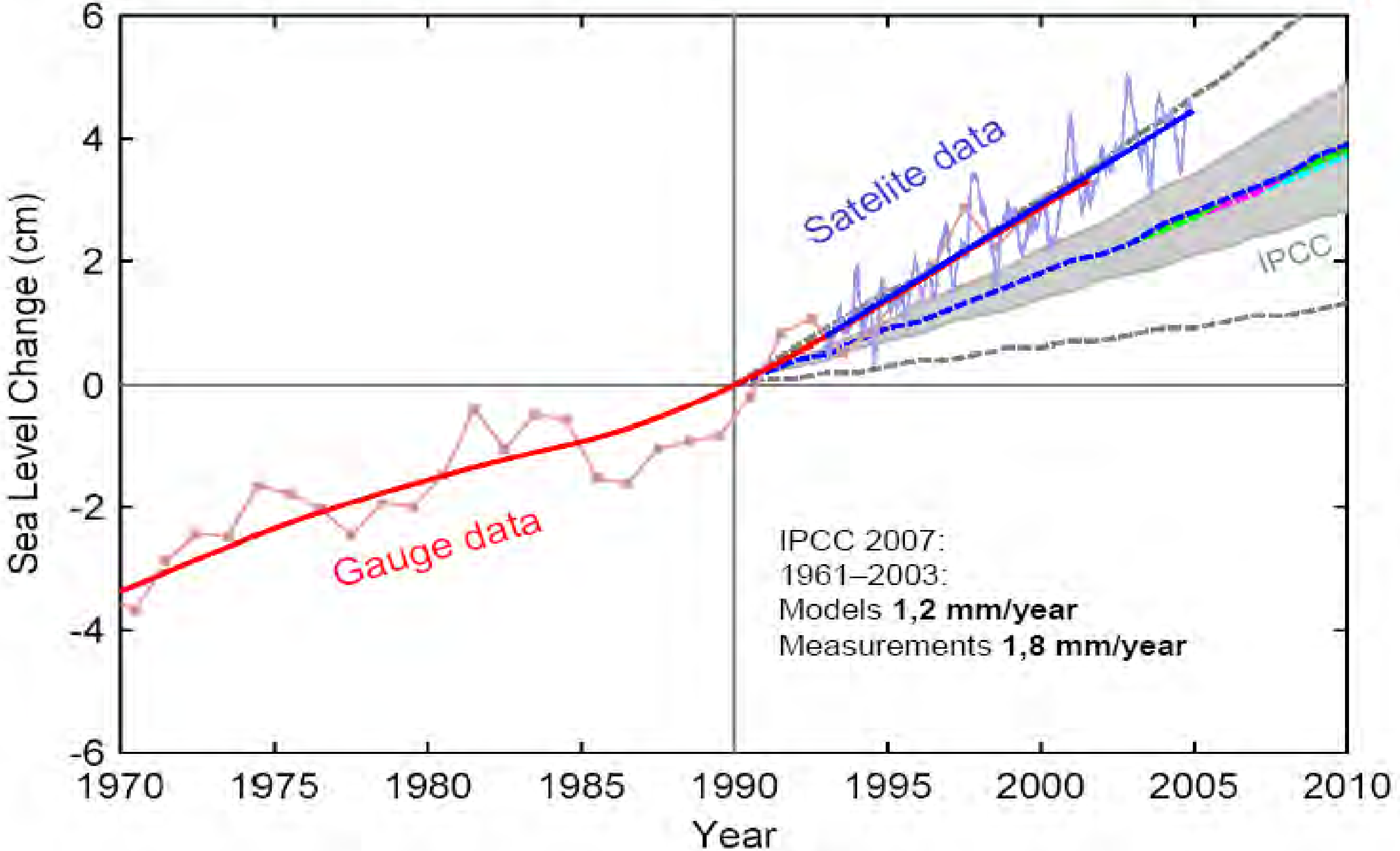
Radiative Forcing Components



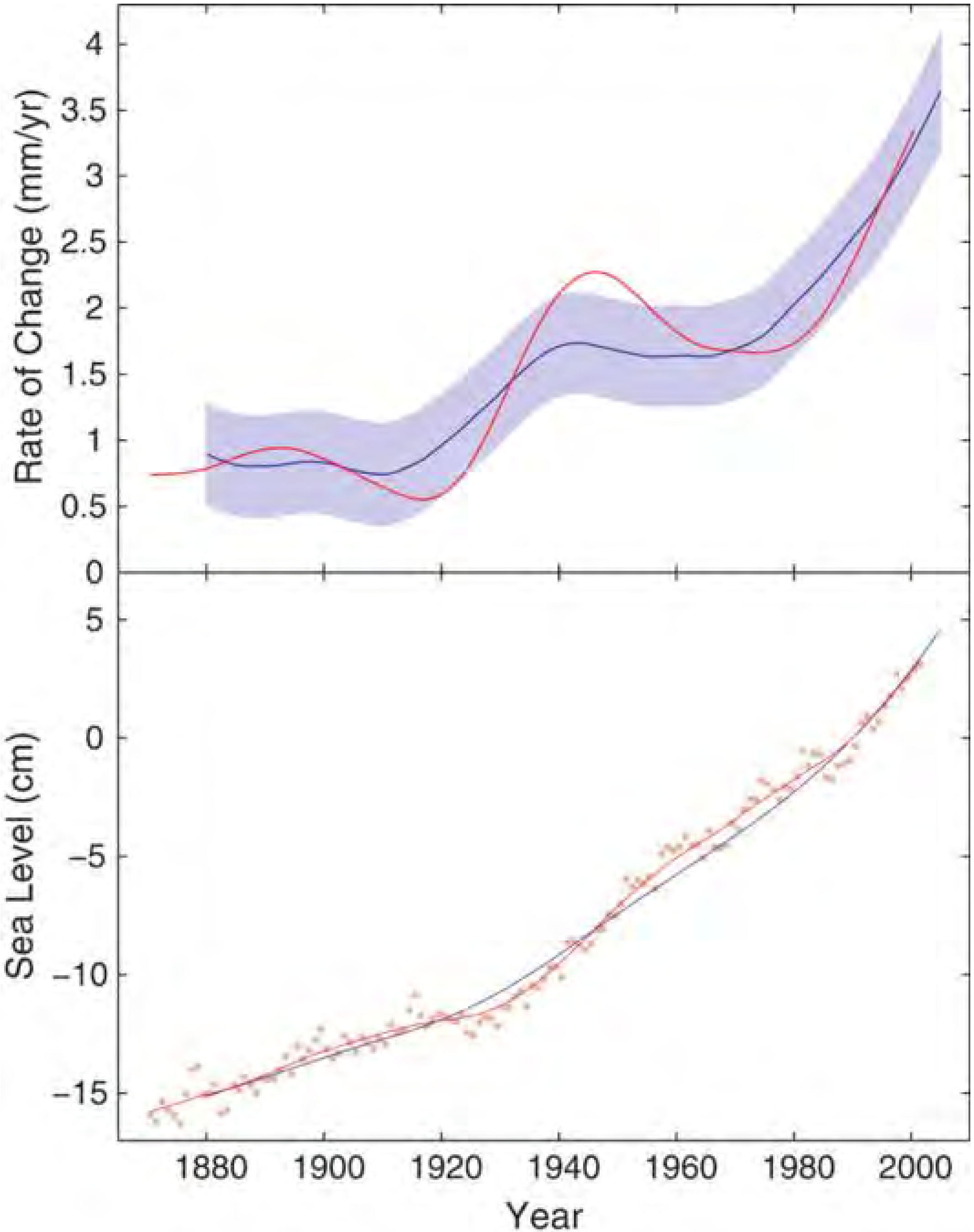


Solar Constant Variations1978-2003

Observed and modelled sea level rise



Rahmstorf, Cazenave, Church, Hansen, Keeling, Parker and Somerville (Science, 2008)

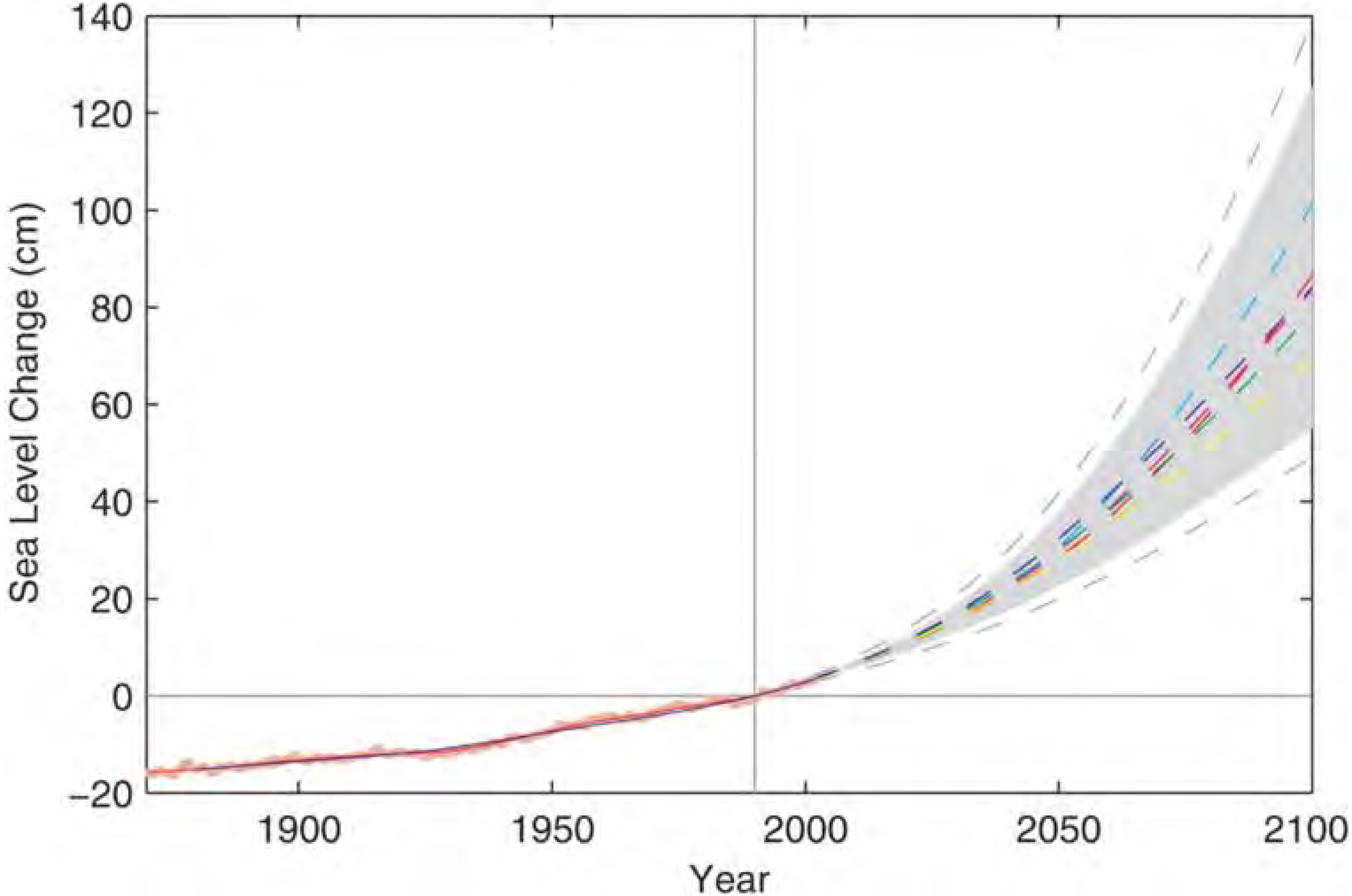


Rahmstorf, 2007


1999
2004
© GARY BRAASCH

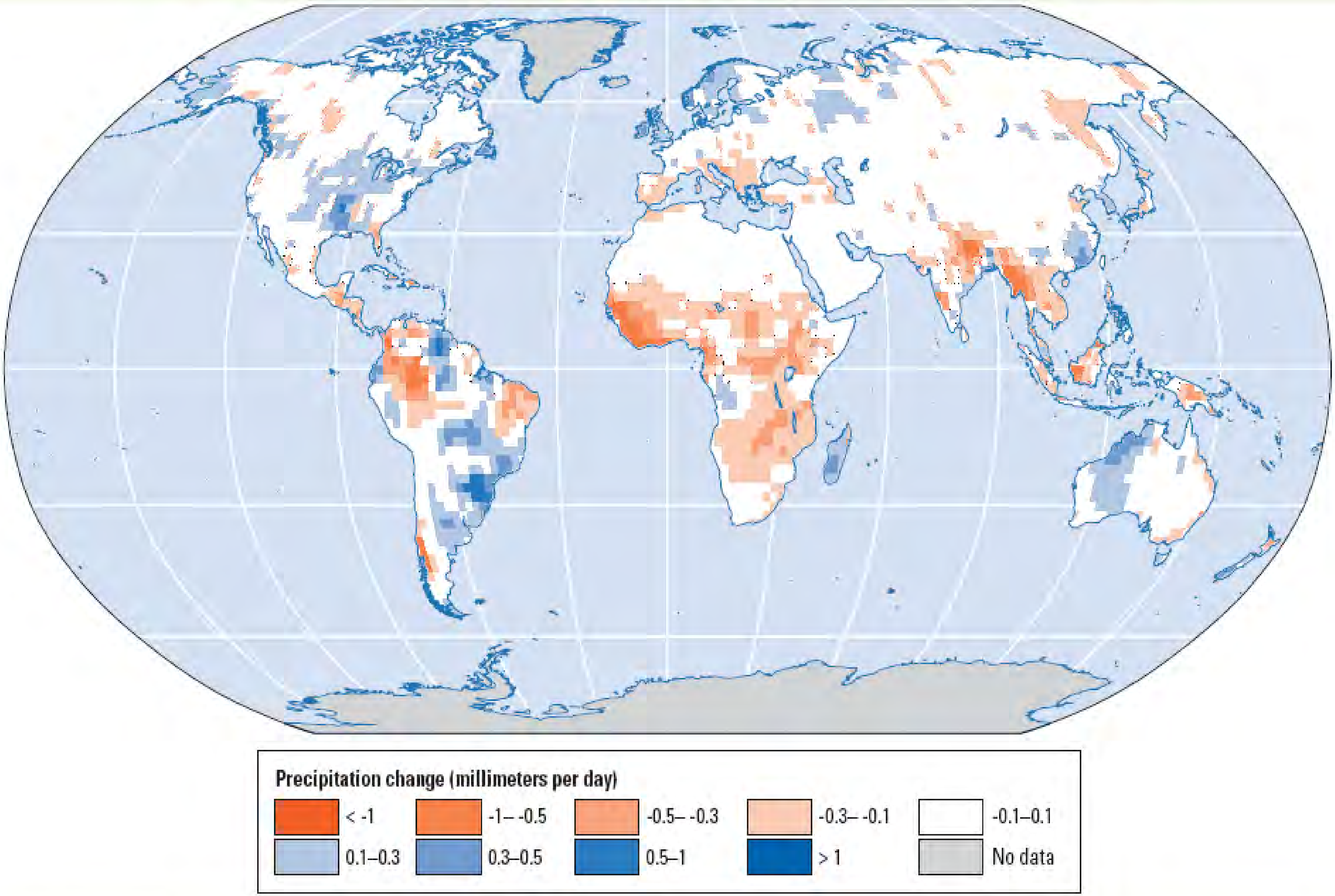

Cape Hatteras Beach Erosion • © 2004 Gary Braasch

Funafuti, Tuvalu, main island of nation only 4 meters high in So. Pacific, threatened by sea level rise. © 2005 Gary Braasch



Rahmstorf, 2007

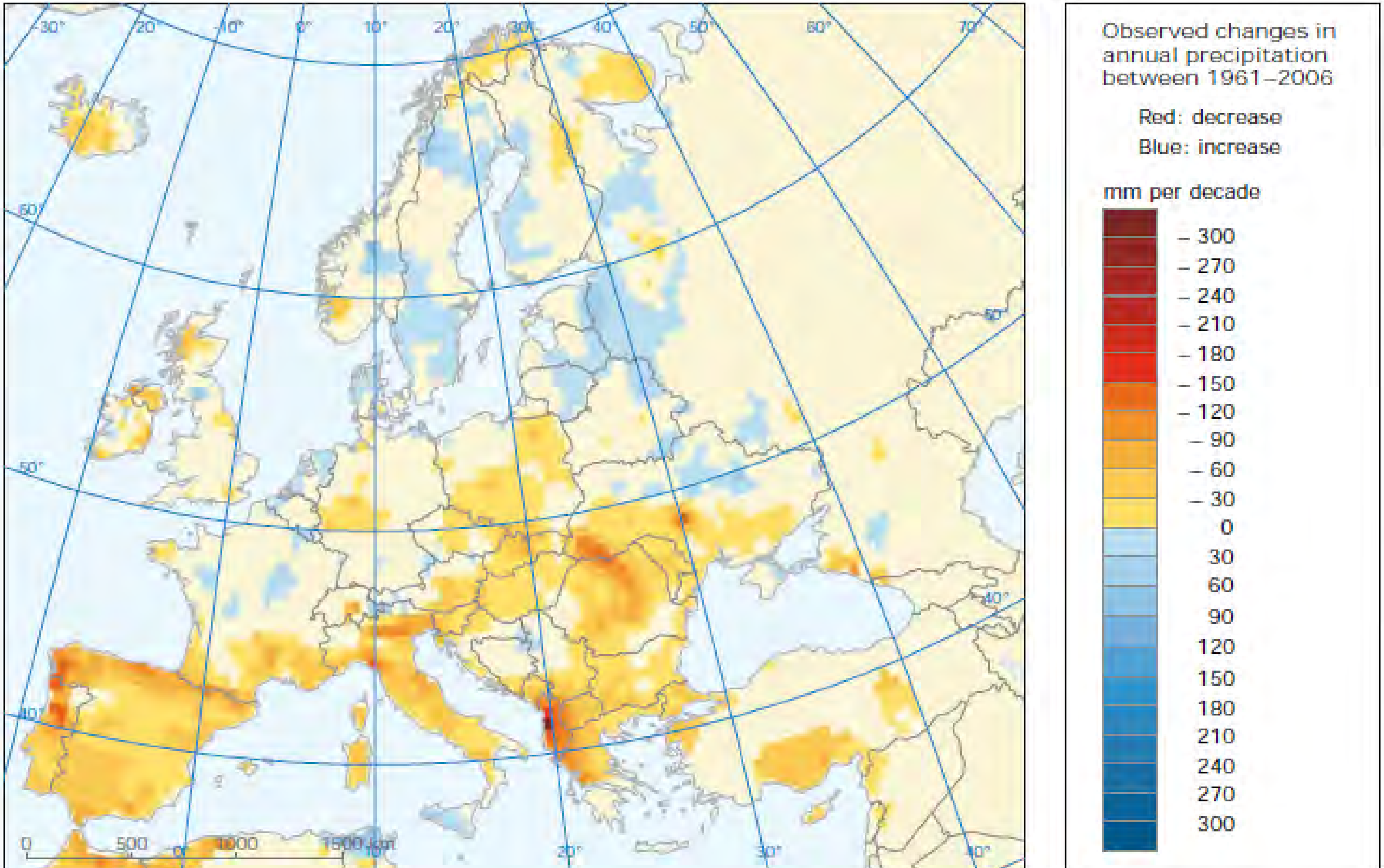
b. Precipitation



Source: Goddard Institute for Space Studies, http://data.giss.nasa.gov/cgi-bin/precipcru/do_PRCmap.py?type=1&mean_gen=0112&year1=1980&year2=2000&base1=1951&base2=1980 (accessed May 2009).

Note: Yellow denotes increased in precipitation in millimeters a day; blue denotes decreases from 1980 to present compared with the previous three decades. Drying has been greatest in continental interiors, while rainfall has become more intense in many coastal areas. The changing geographic distribution of rainfall has serious implications for agriculture.

Map 5.4 Observed changes in annual precipitation 1961–2006



Note: Data are in mm per decade, blue means an increase, red a decrease. The observations indicate that large decadal scale variability in precipitation amount is superposed on the long time scale trends described above. This variability is partly related to the decadal scale variability in atmospheric circulation anomalies (see Box 5.1). Calculating trends over shorter time periods may therefore lead to different results.

Source: The climate dataset is from the EU-FP6 project ENSEMBLES (http://www.ensembles-eu.org) and the data providers in the ECA&D project (http://eca.knmi.nl).

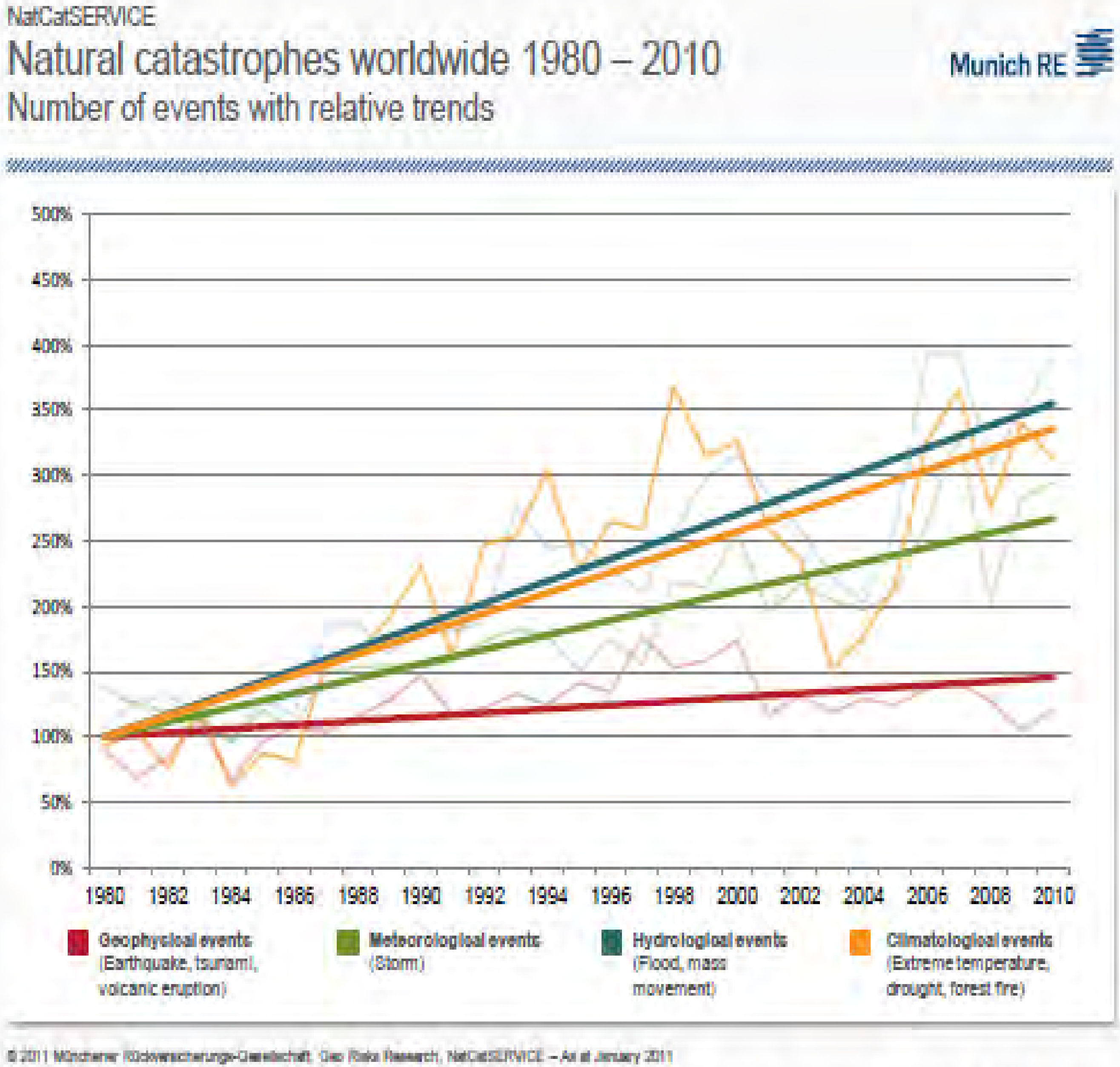


Fig. 1: Relative trends of loss relevant natural extreme events of the different perils

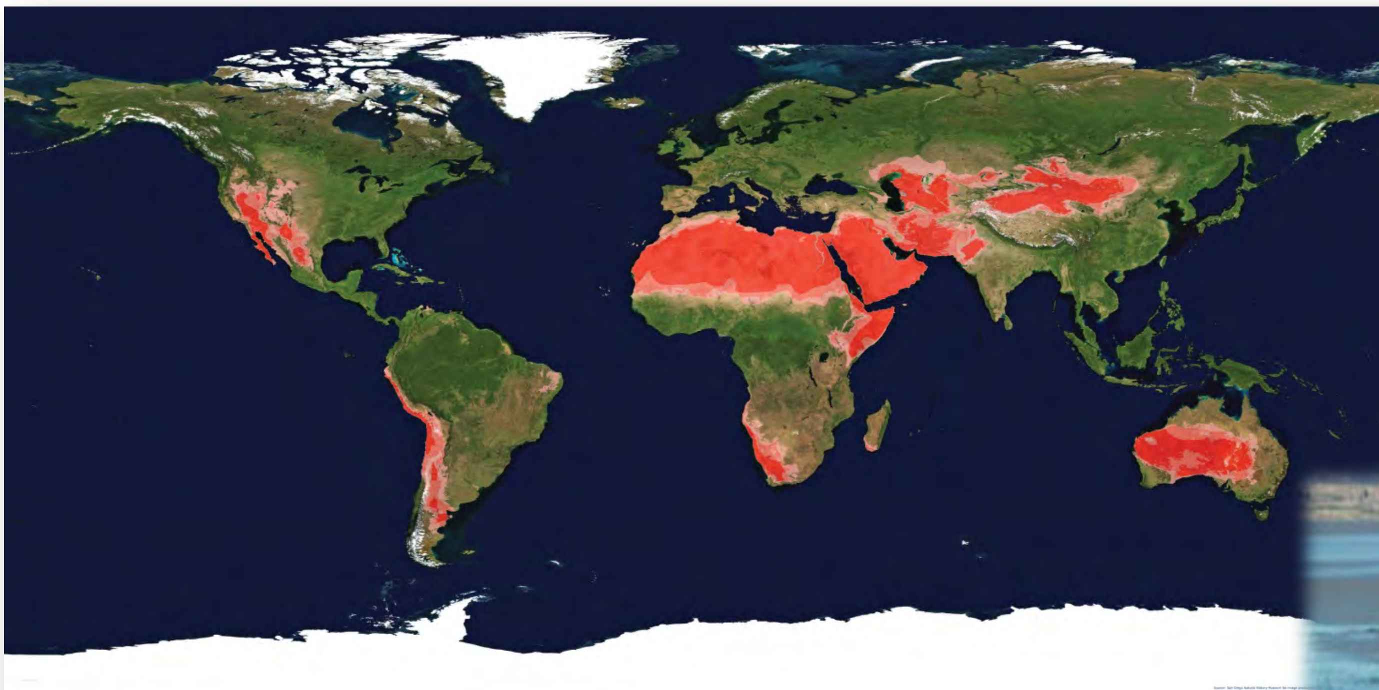
Droughts

About 400,000,000 people live under extreme drought conditions

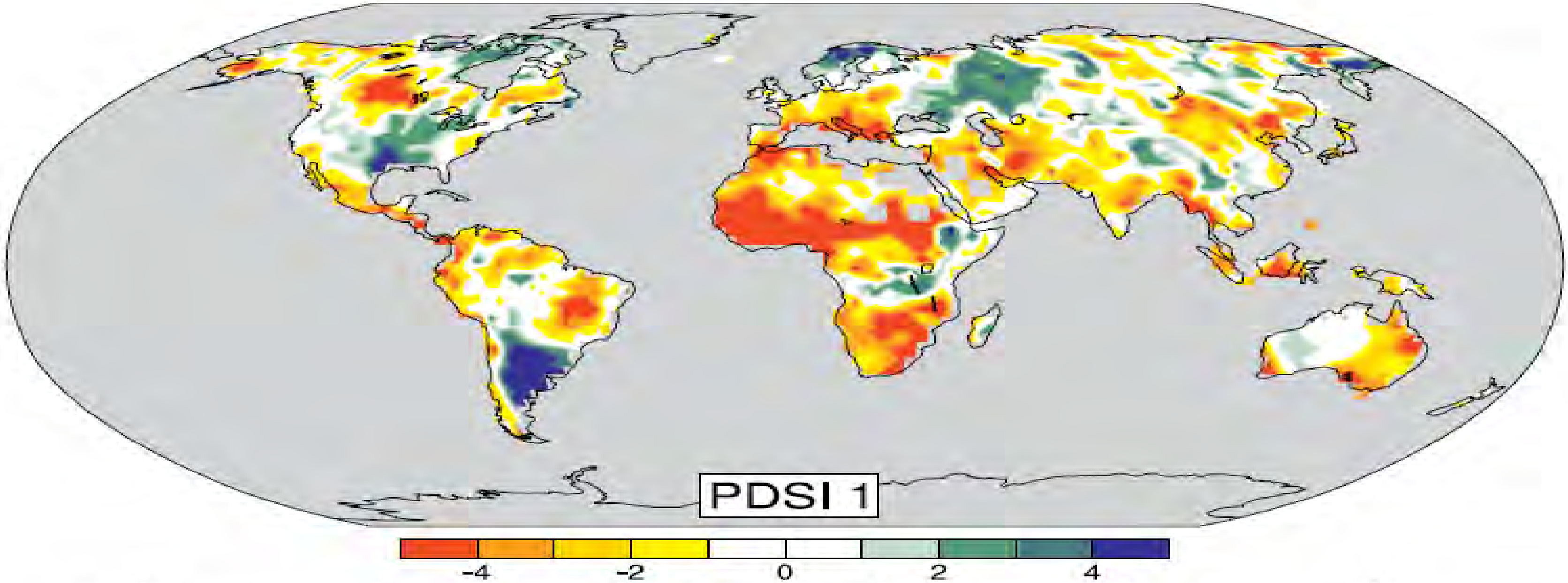
Land considered "very dry" at global level:

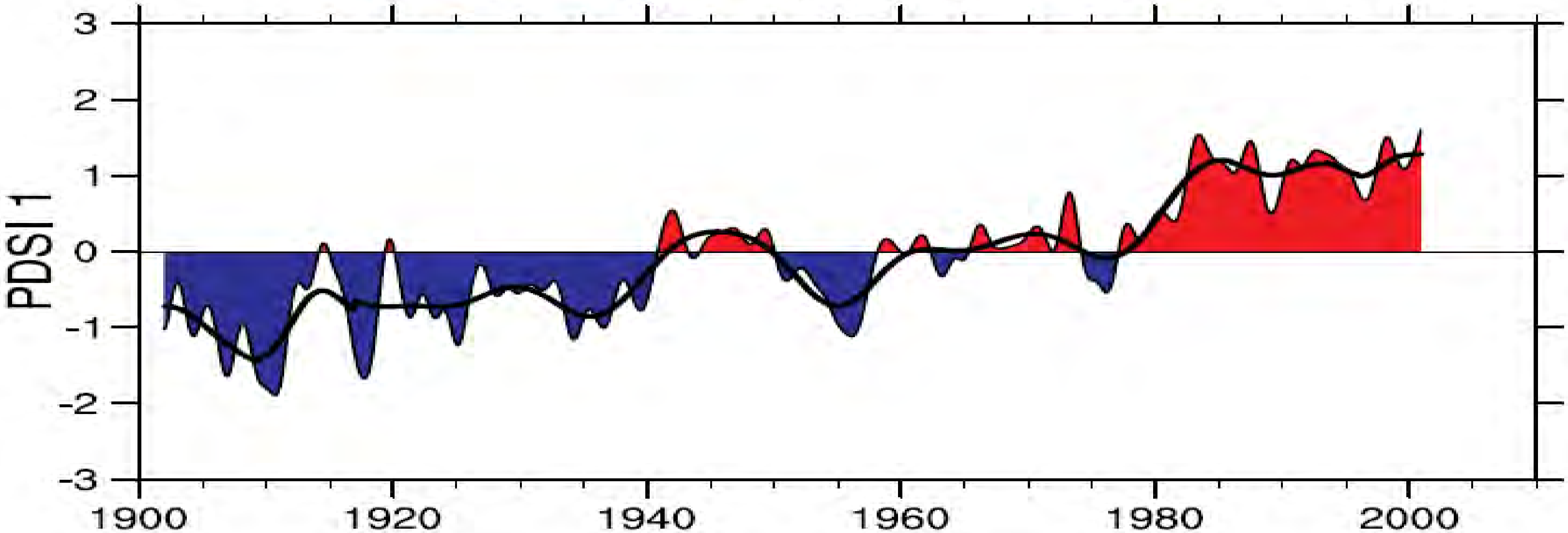
15% em 1970

38% em2010



Drought severity index is increasing





IPCC, 2007

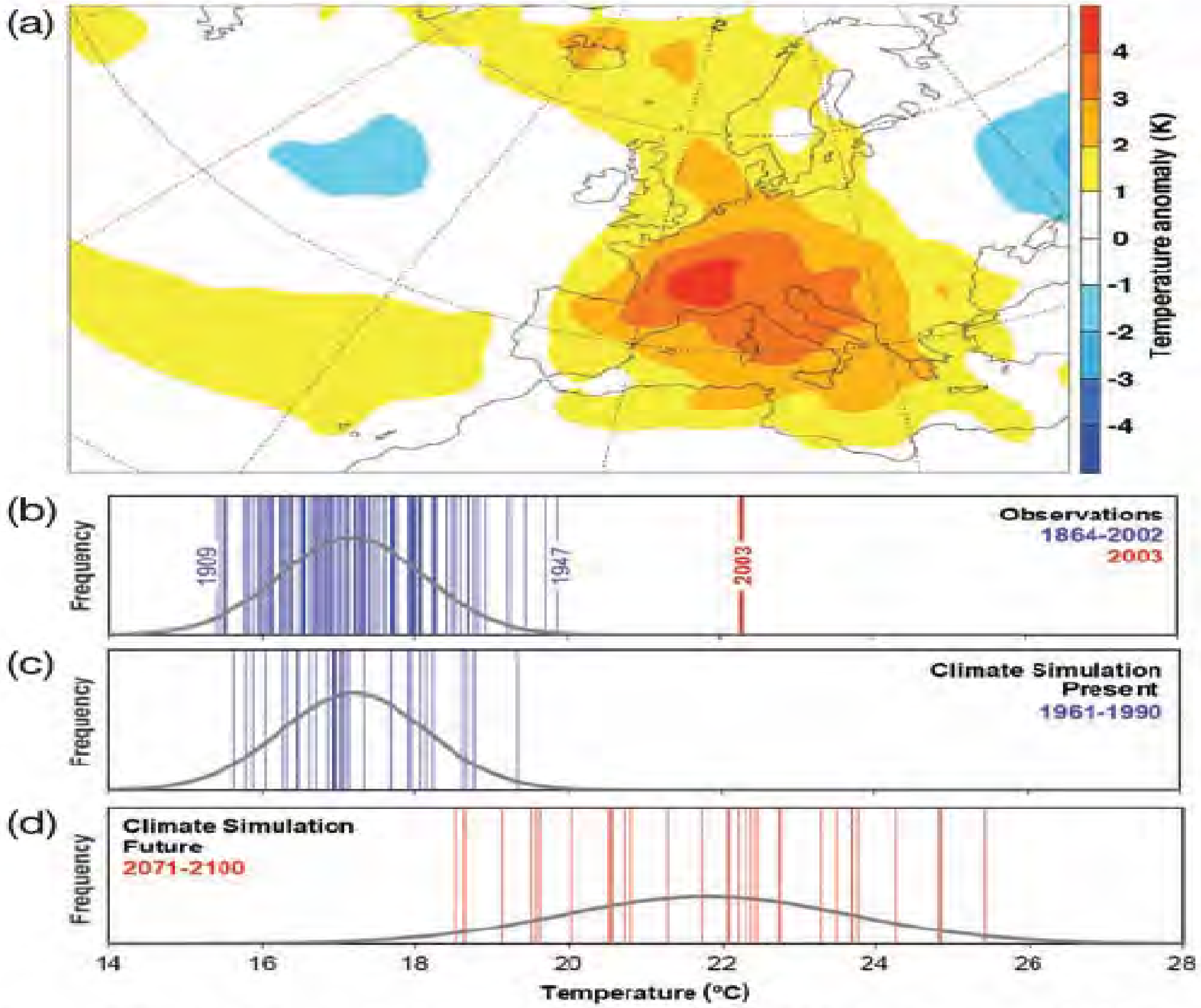


Figure TS.13. *Characteristics of the summer 2003 heatwave: (a) JJA temperature anomaly with respect to 1961-1990; (b-d) June, July, August temperatures for Switzerland; (b) observed during 1864-2003; (c) simulated using a regional climate model for the period 1961-1990; (d) simulated for 2071-2100 under the SRES A2 scenario. The vertical bars in panels (b-d) represent mean summer surface temperature for each year of the time period considered; the fitted Gaussian distribution is indicated in black. Reprinted by permission from Macmillan Publishers Ltd. [Nature] (Schär et al., 2004), copyright 2004, [F12.4].*

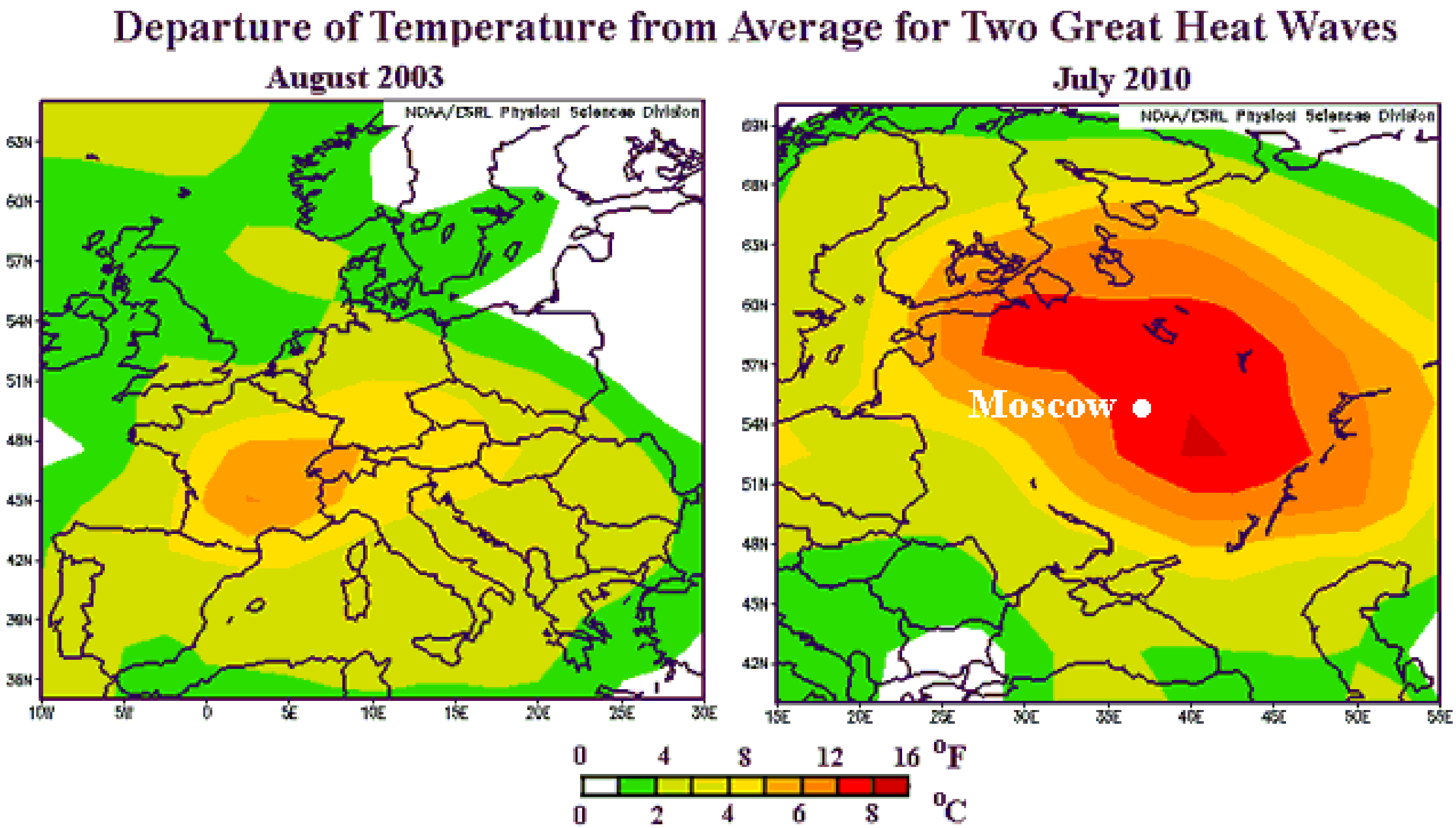
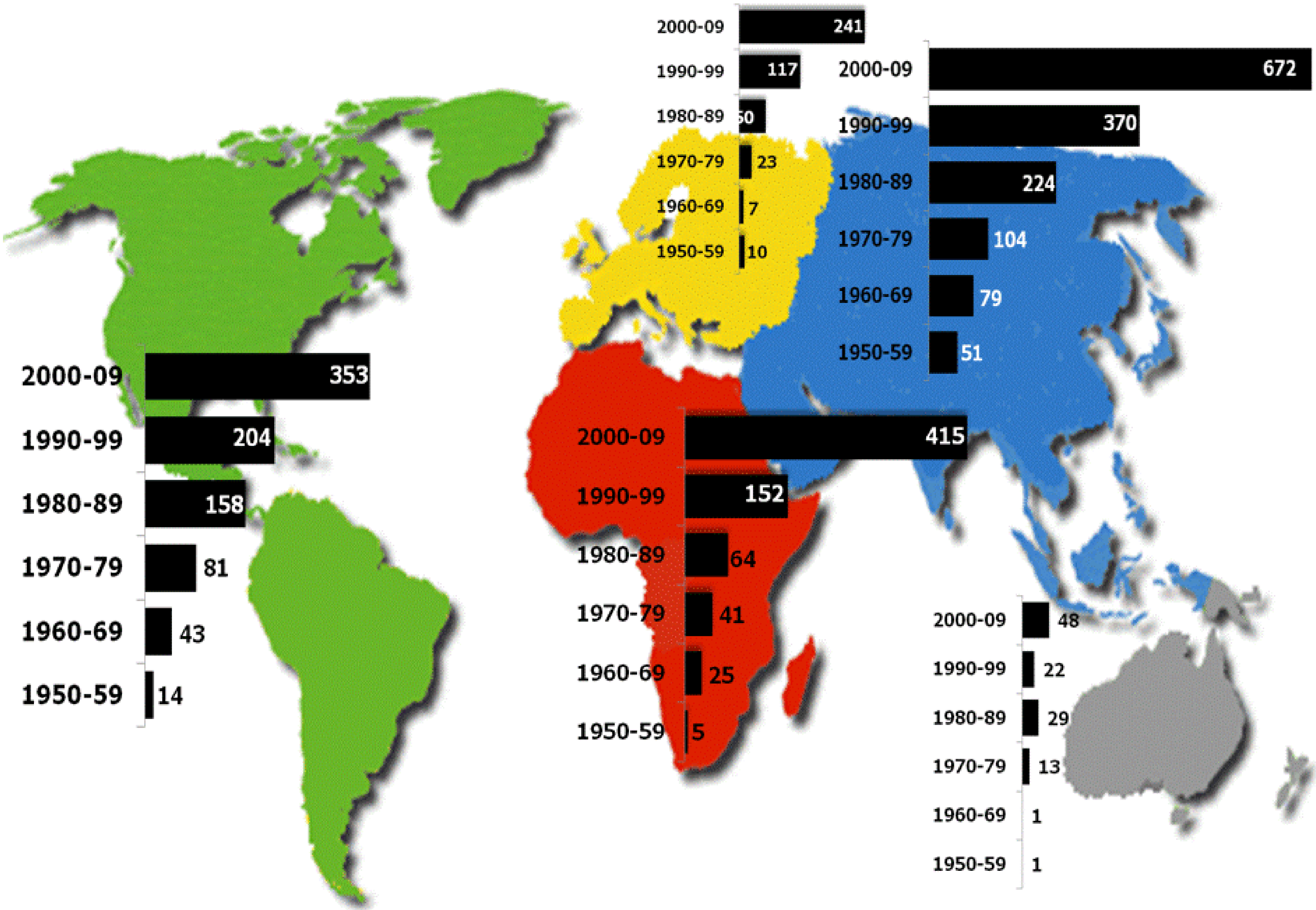
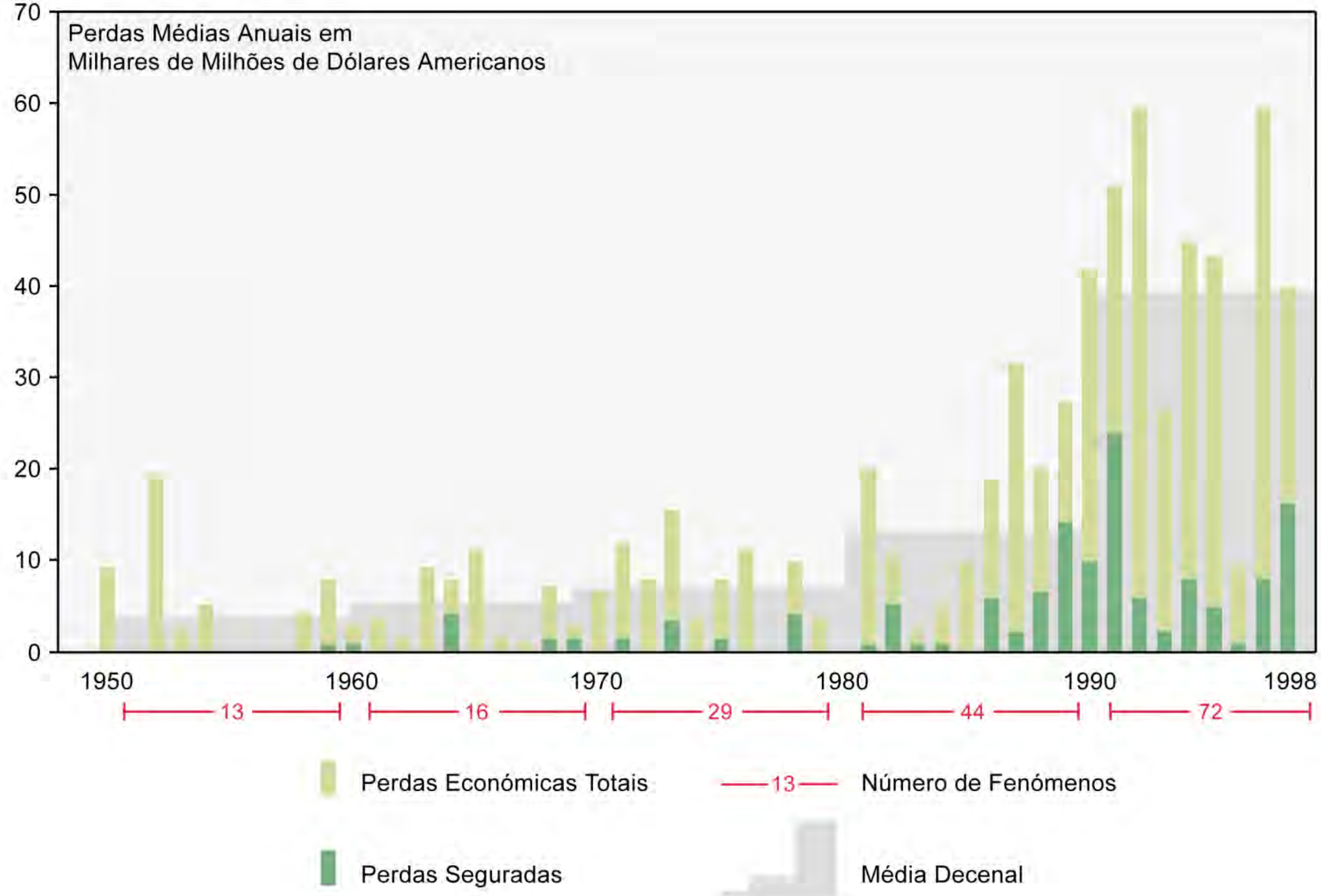


Figure 1. A comparison of August temperatures, the peak of the great European heat wave of 2003 (left) with July temperatures from the Great Russian Heat Wave of 2010 (right) reveals that this year's heat wave is more intense and covers a wider area of Europe.

Inundações 1950-2009



Fuente: The international disaster data base. Center for Research on Epidemiology of Disasters. 2010.


Perdas Médias Anuais em
Milhares de Milhões de Dólares Americanos
70
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
1998
13
16
29
44
72
Perdas Económicas Totais
Número de Fenómenos
Perdas Seguradas
Média Decenal

Fonte, IPCC

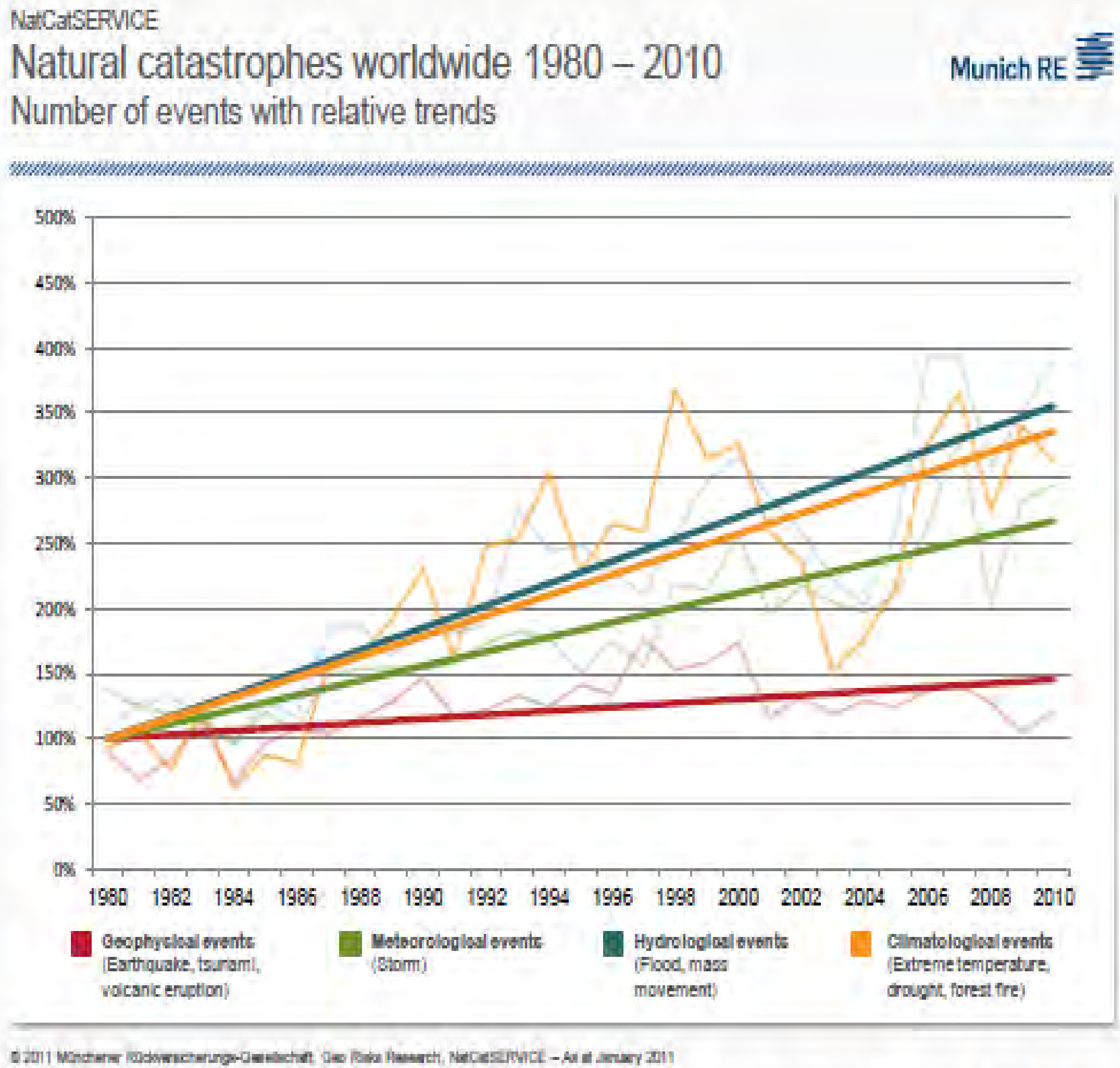
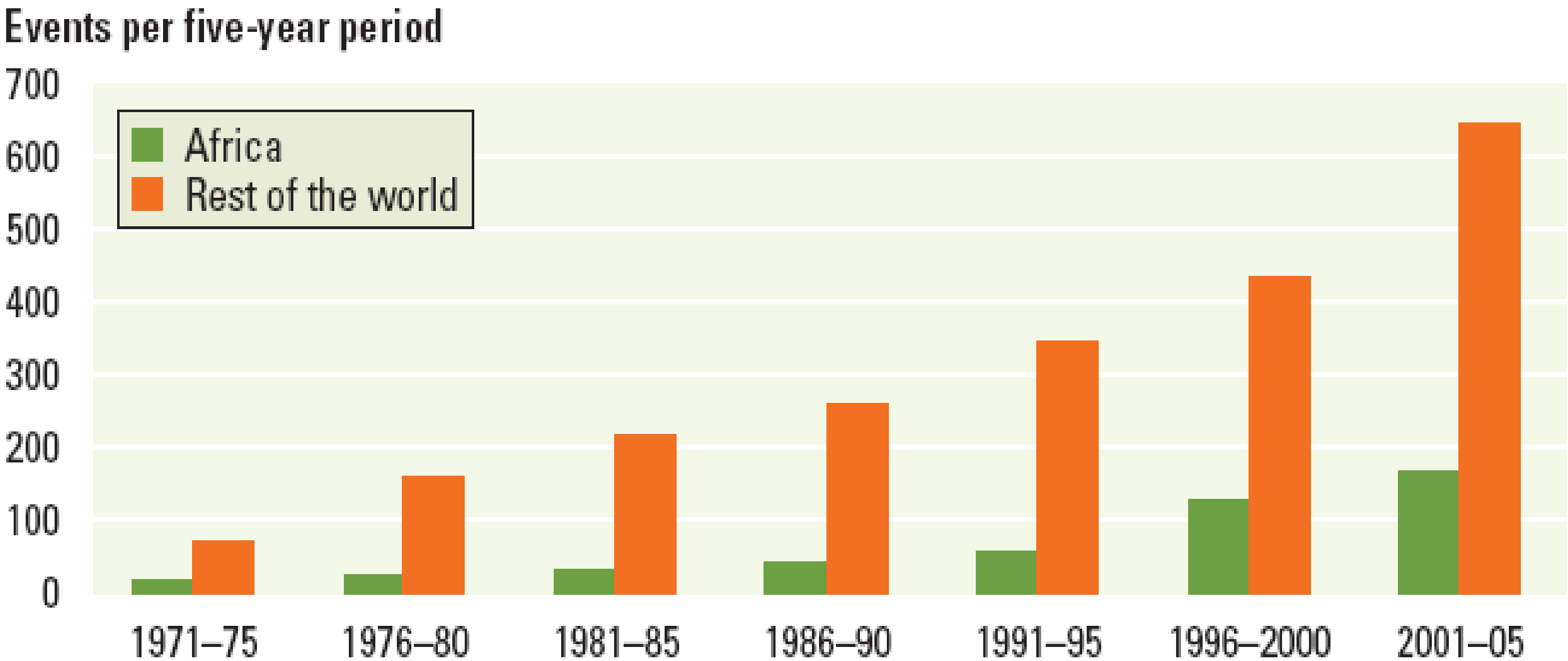


Fig. 1: Relative trends of loss relevant natural extreme events of the different perils

Figure 2.2 Floods are increasing, even in drought-prone Africa



Source: WDR team analysis from CRED 2009.
Note: Flood events are increasing everywhere but particularly in Africa, with new regions being exposed to flooding and with less recovery time between events. Reporting of events may have improved since the 1970s, but this is not the main cause of rising numbers of reported floods, because the frequency of other disaster events in Africa, such as droughts and earthquakes, has not shown a similar increase.

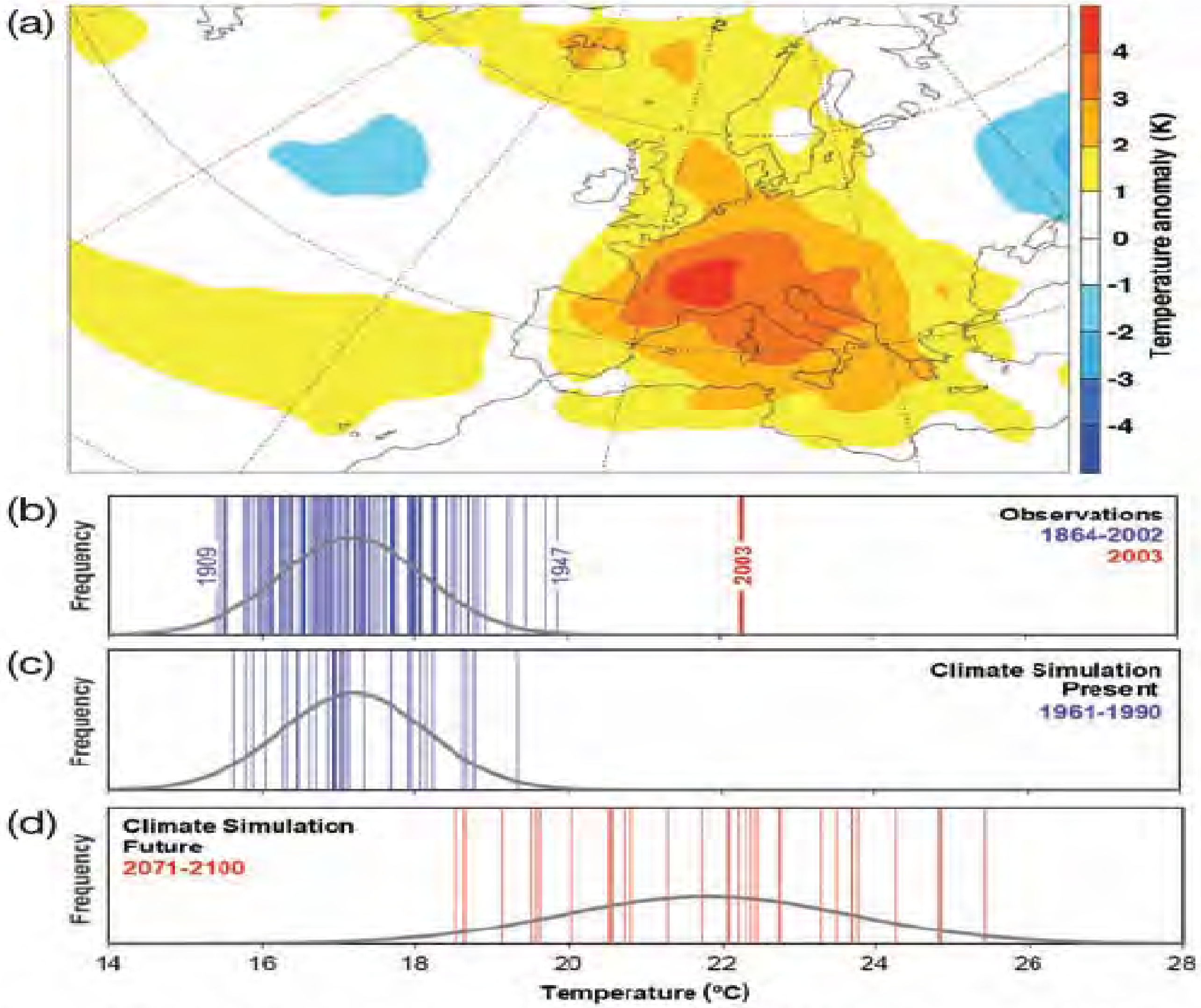


Figure TS.13. *Characteristics of the summer 2003 heatwave: (a) JJA temperature anomaly with respect to 1961-1990; (b-d) June, July, August temperatures for Switzerland; (b) observed during 1864-2003; (c) simulated using a regional climate model for the period 1961-1990; (d) simulated for 2071-2100 under the SRES A2 scenario. The vertical bars in panels (b-d) represent mean summer surface temperature for each year of the time period considered; the fitted Gaussian distribution is indicated in black. Reprinted by permission from Macmillan Publishers Ltd. [Nature] (Schär et al., 2004), copyright 2004, [F12.4].*

The Elbe between Bitterfeld and Eilenburg, Germany 2002

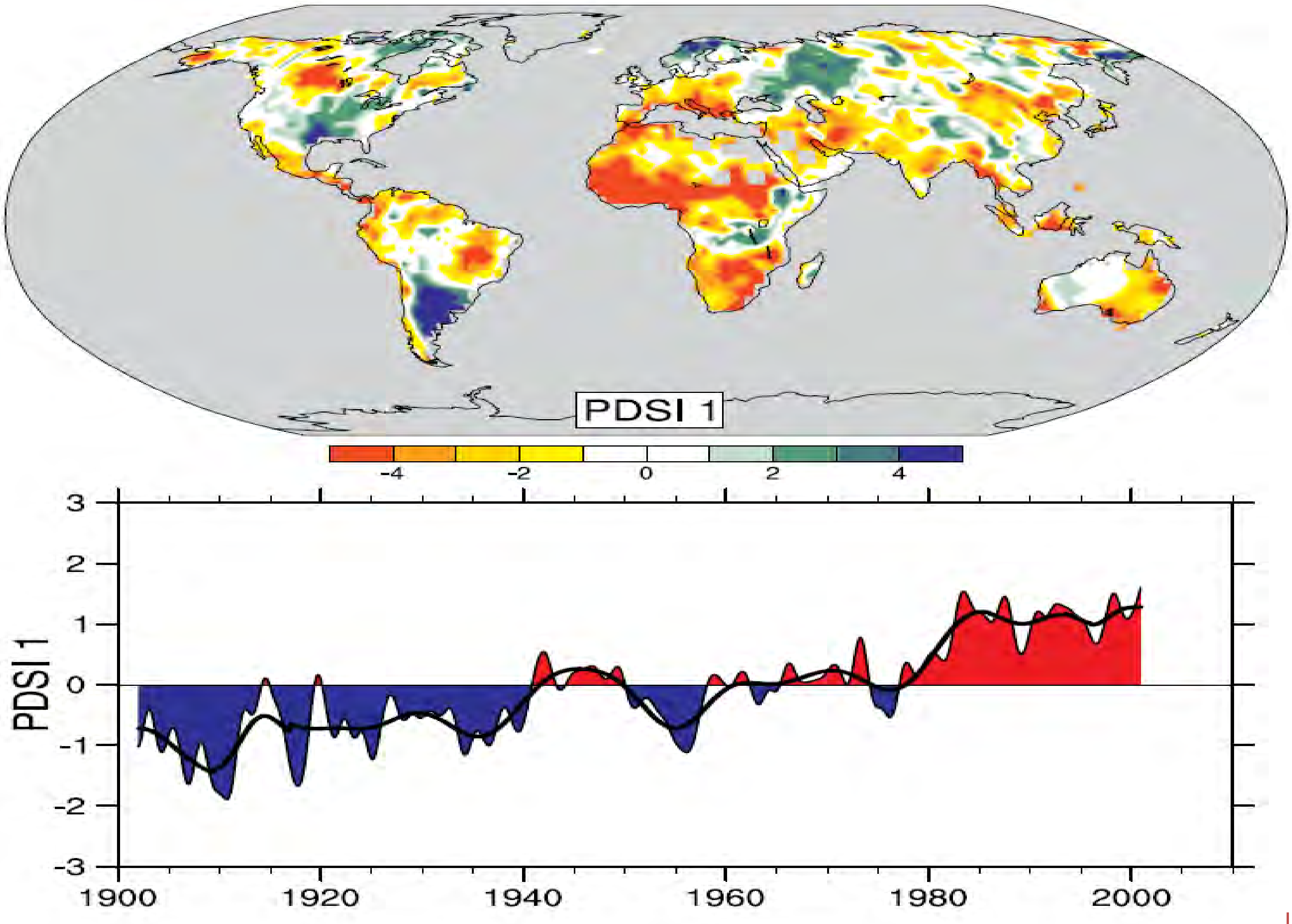
Ilha da Madeira, 20 de Fevereiro de 2010

Ilha da Madeira, 20 de Fevereiro de 2010

Ilha da Madeira, 20 de Fevereiro de 2010

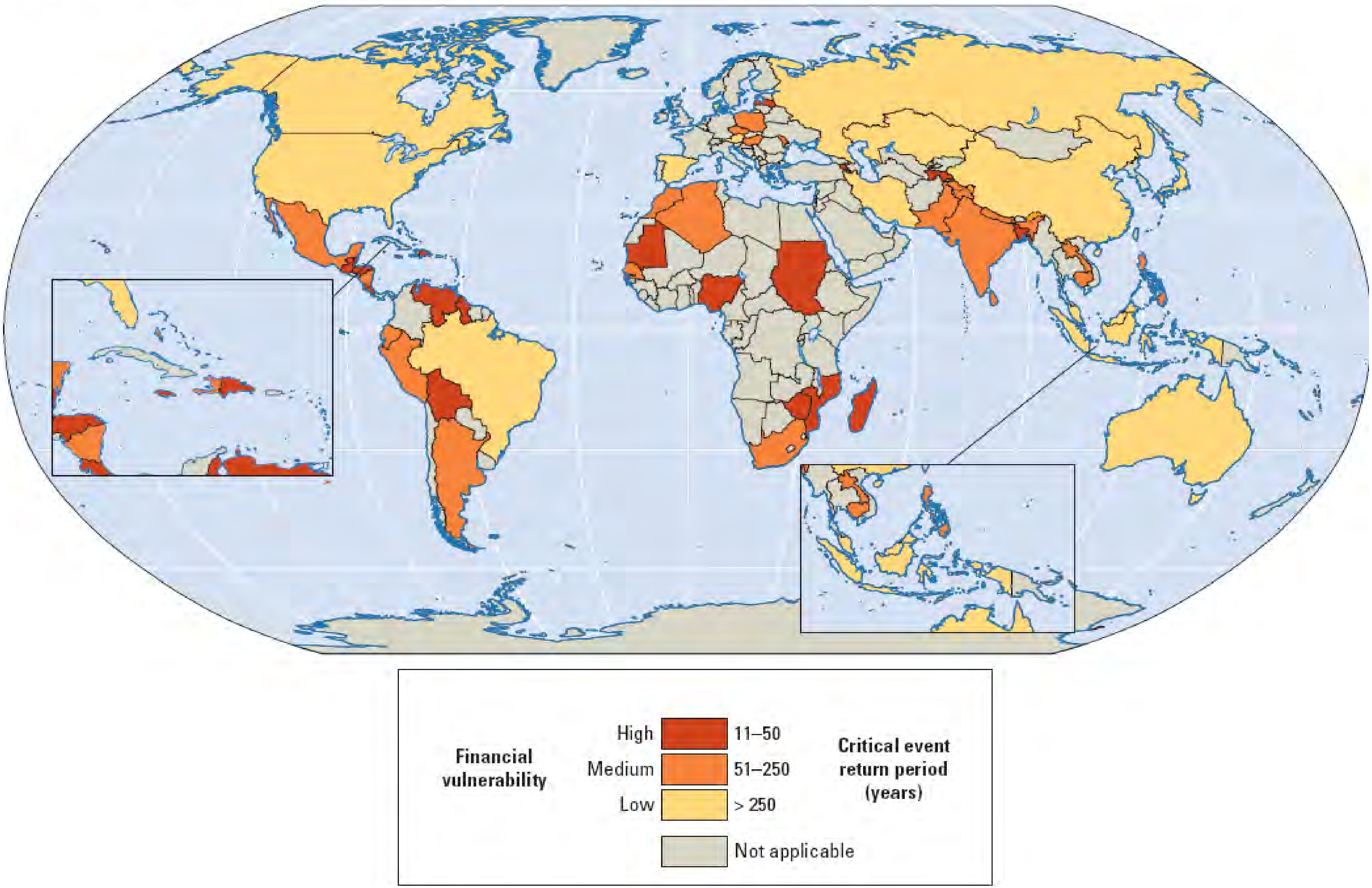
Bangladesh

Drought severity index is increasing



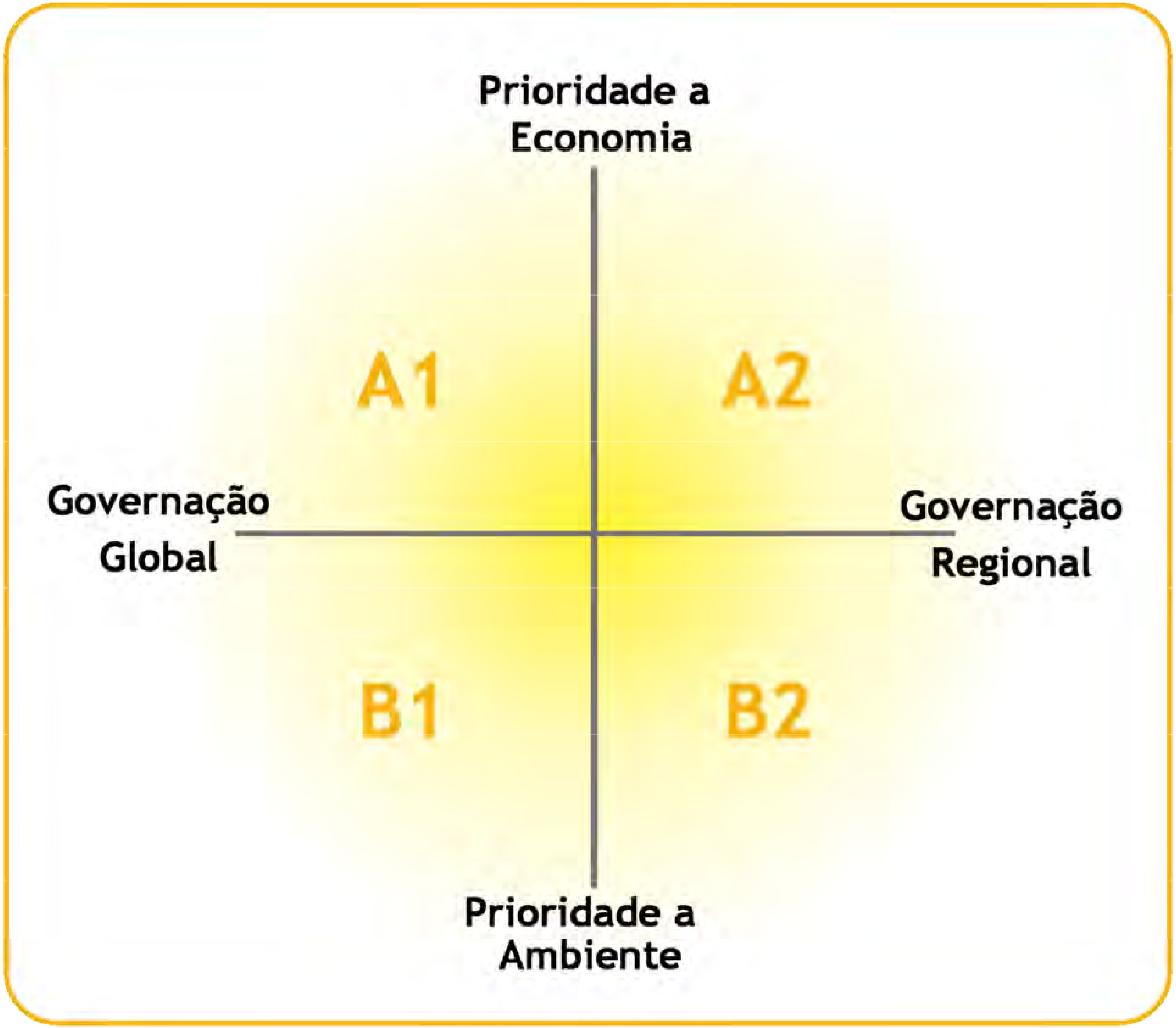
IPCC, 2007

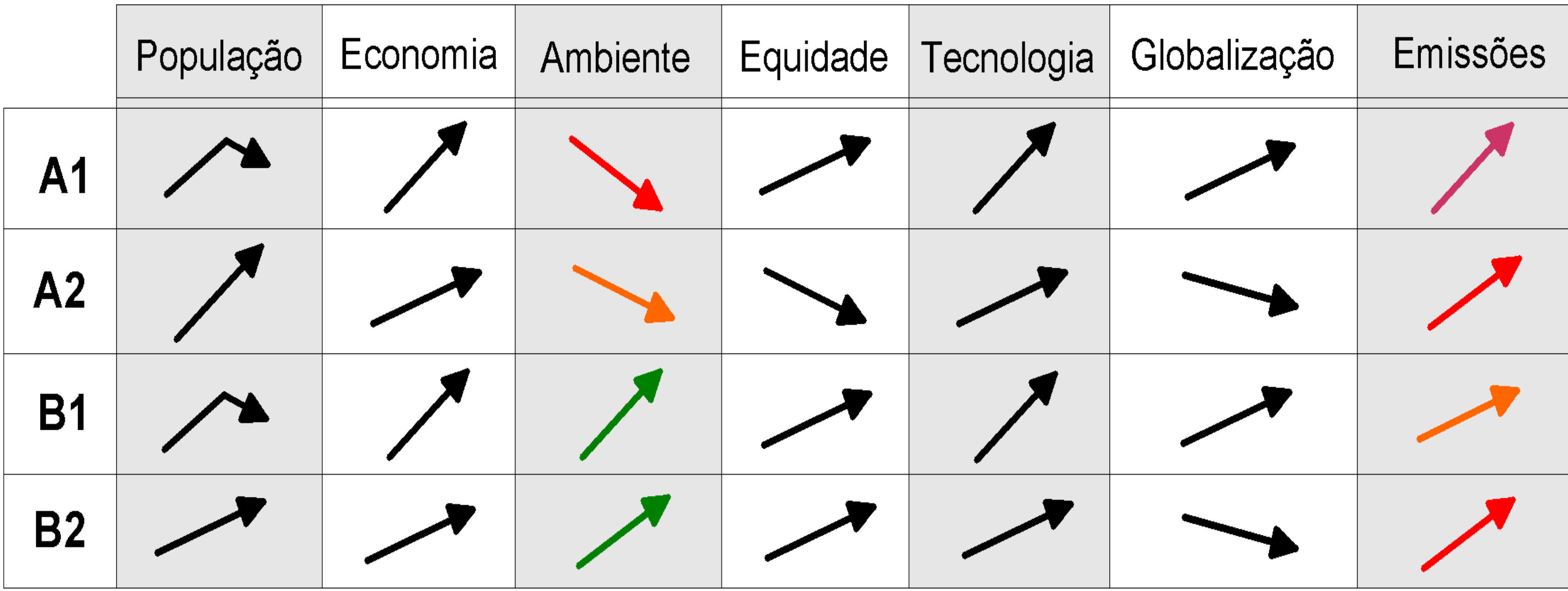
Map 2.5 Small and poor countries are financially vulnerable to extreme weather events



Source: Mechler and others 2009.

Note: The map shows degree to which countries are nancially vulnerable to floods and storms. For example, in countries shaded dark red a severe weather event that would exceed the public sector's nancial ability to restore damaged infrastructure and continue with development as planned is expected about once every 11 to 50 years (an annual probability of 2–10 percent). The high nancial vulnerability of small economies underscores the need for nancial contingency planning to increase governments' resilience against future disasters. Only the 74 most disaster-prone countries that experienced direct losses of at least 1 percent of GDP due to floods, storms, and droughts during the past 30 years were included in the analysis.


Prioridade a
Economia
A1
A2
Governação
Global
Governação
Regional
B1
B2
Prioridade a
Ambiente


População
Economia
Ambiente
Equidade
Tecnologia
Globalização
Emissões
A1
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B1
B2

5th Assessment Report

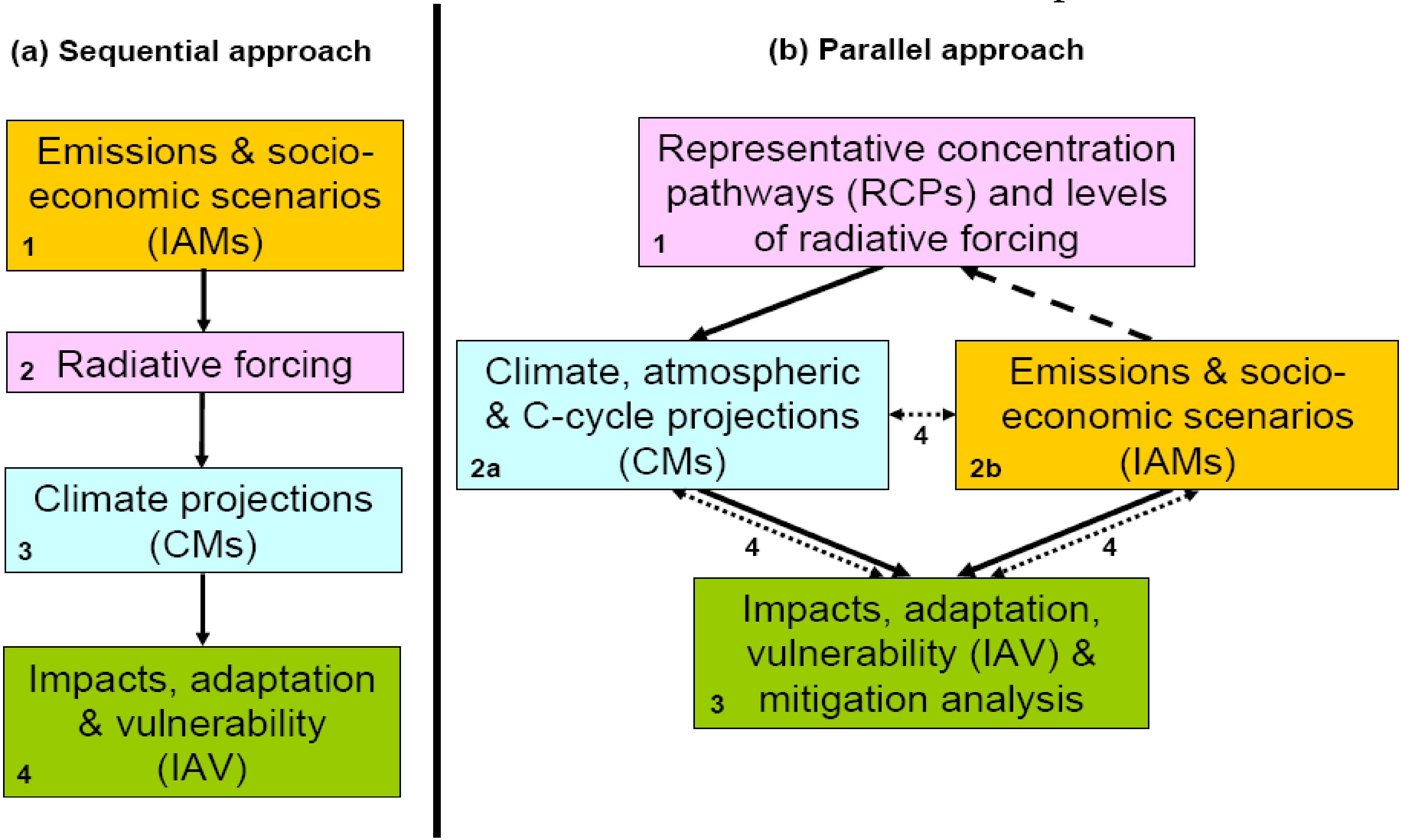


Figure 1. Approaches to the development of global scenarios: (a) previous *sequential* approach; (b) proposed *parallel* approach. Numbers indicate analytical steps (2a and 2b proceed concurrently). Arrows indicate transfers of information (solid), selection of RCPs (dashed), and integration of information and feedbacks (dotted).

The anticipated time line for the production of these five products is depicted in Figure 2.

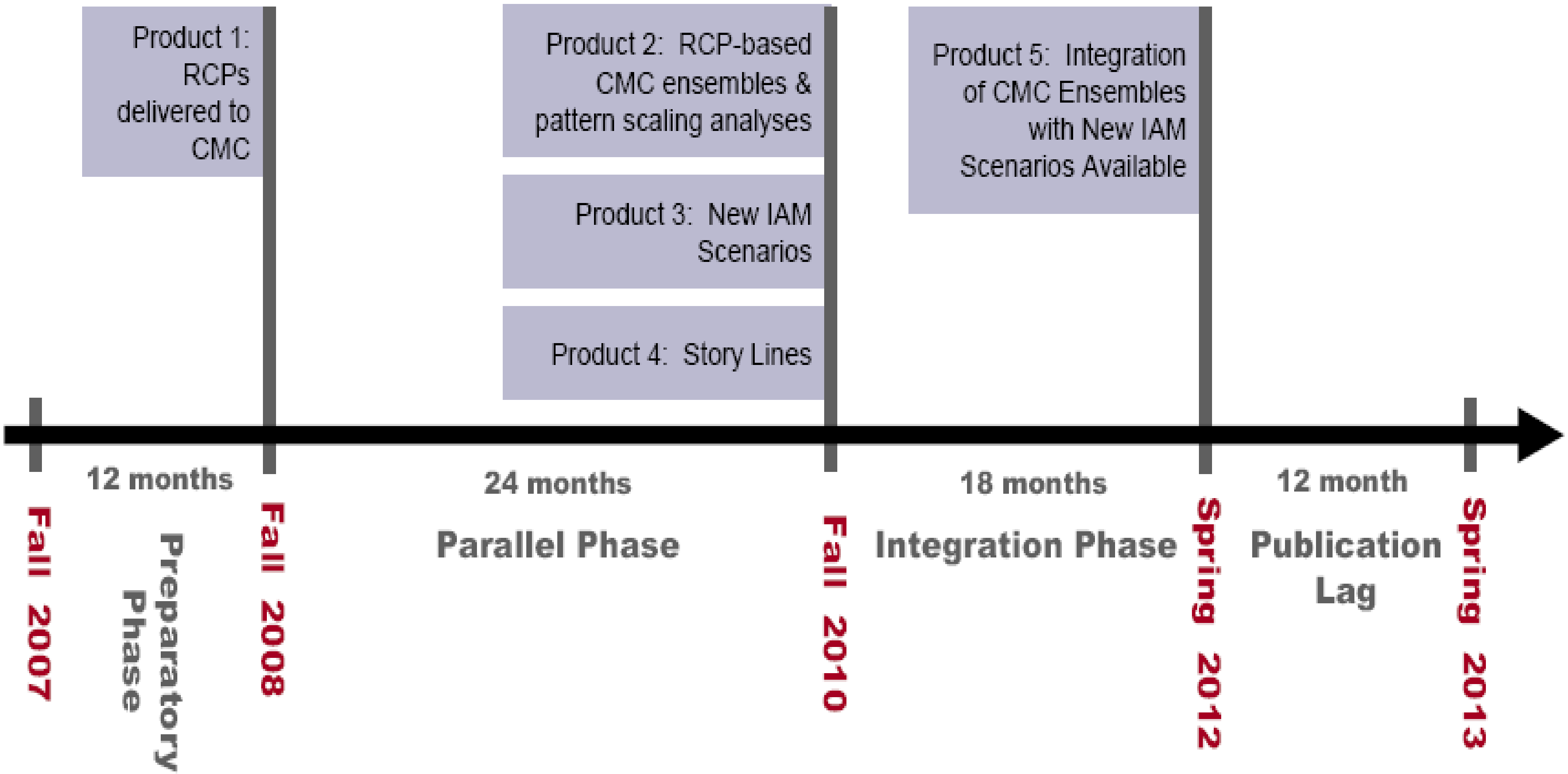
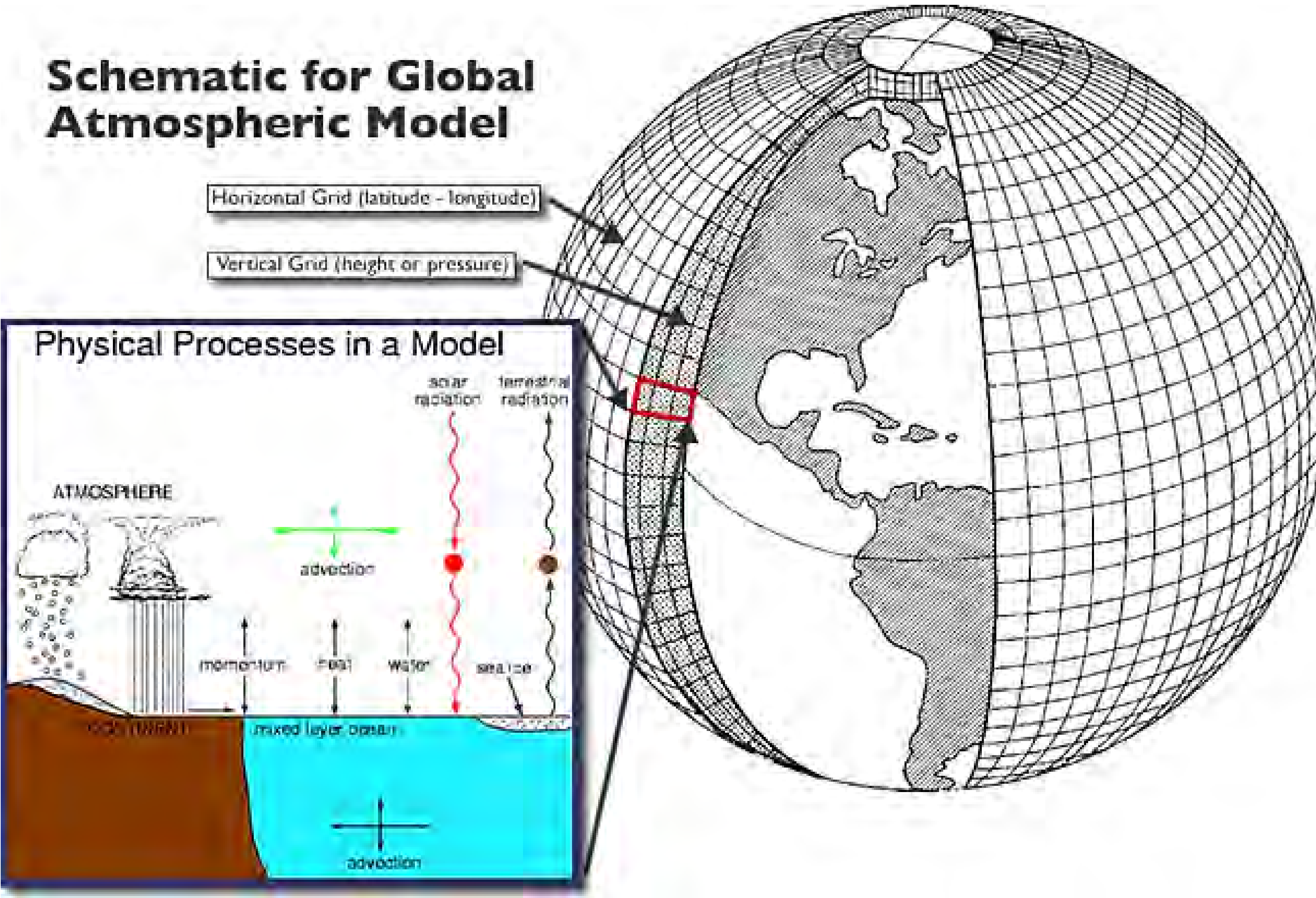
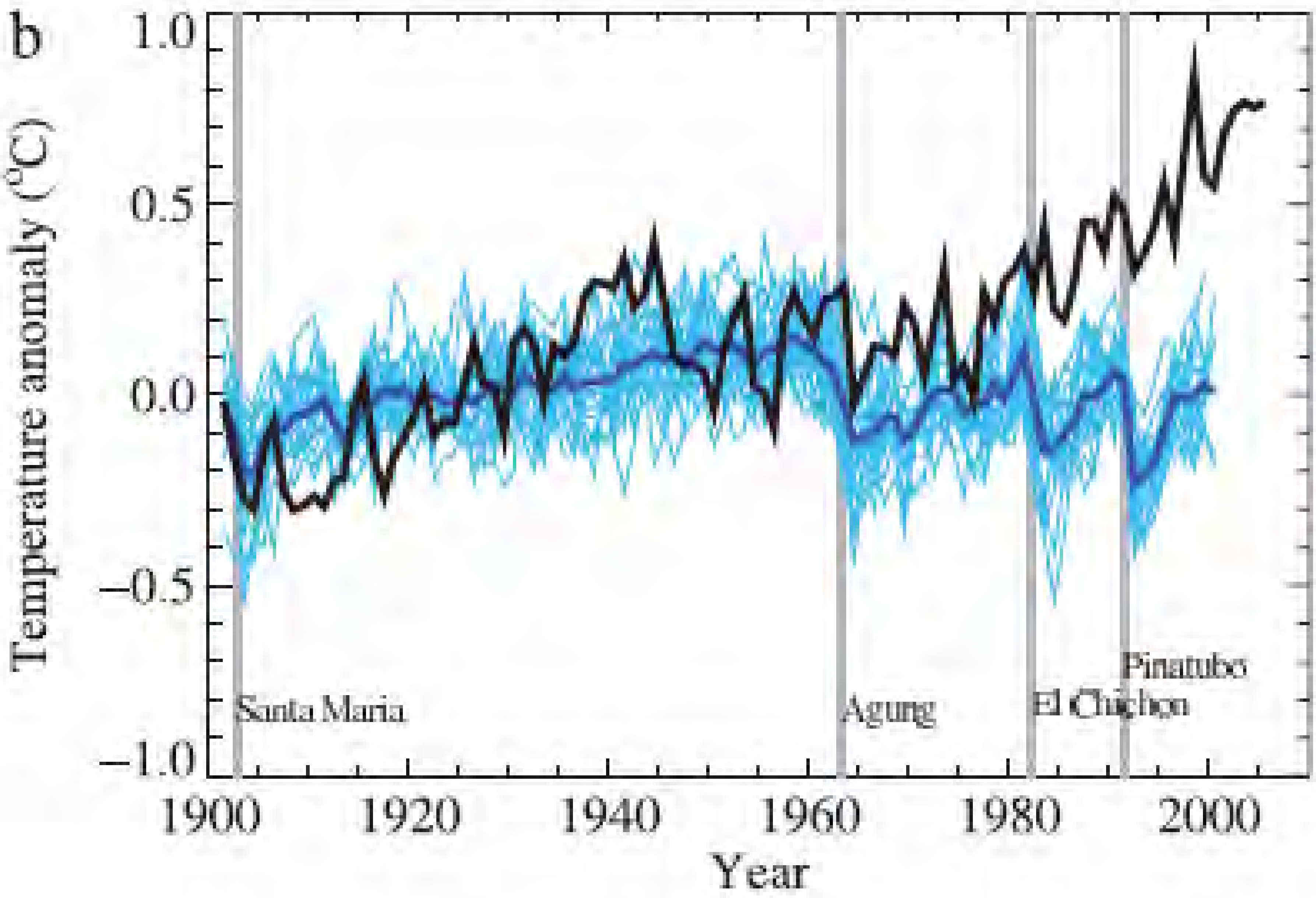


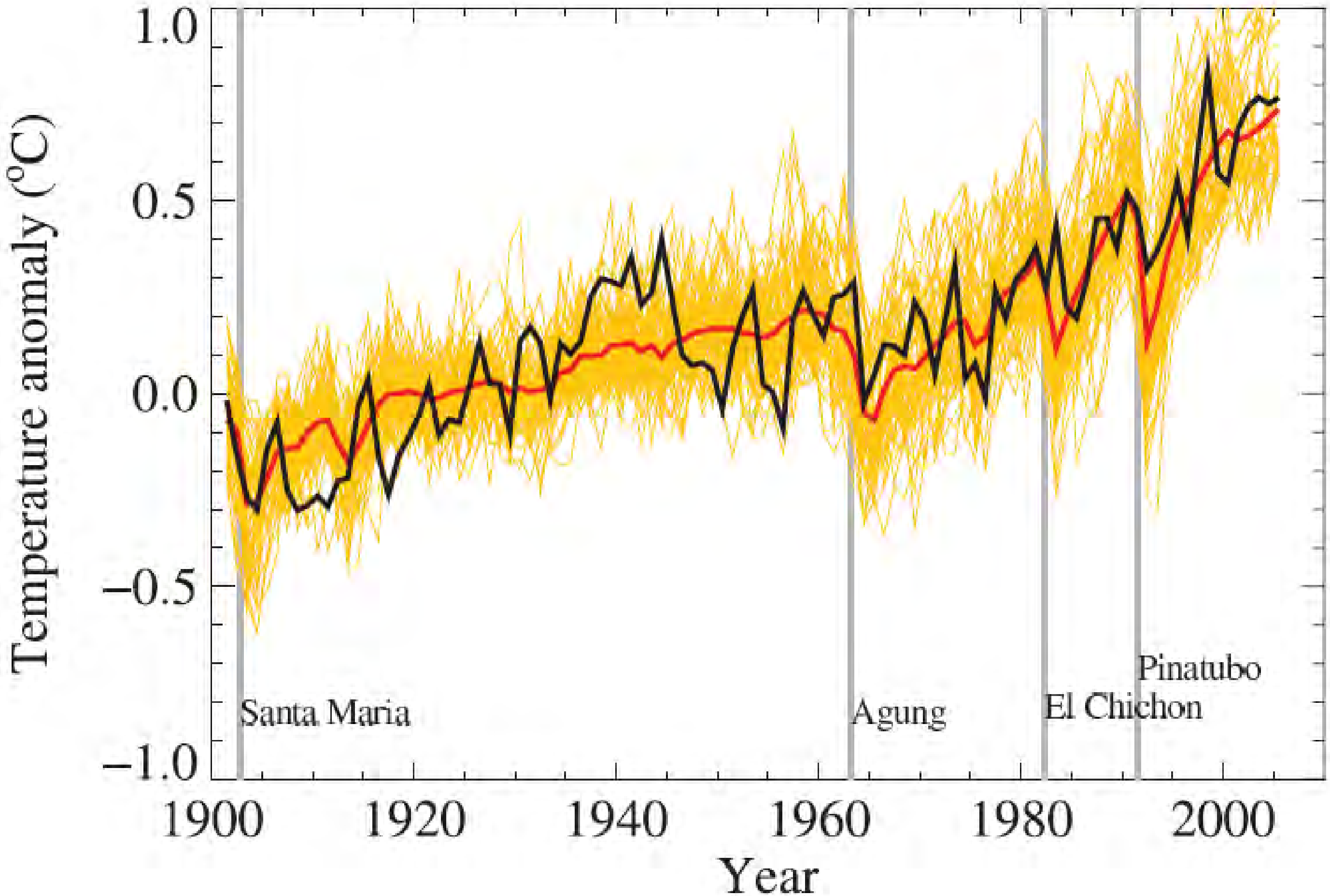
Figure 2. Timeline of key scenario development products (CMC = climate modeling community).



Schematic for Global Atmospheric Model
Horizontal Grid (latitude - longitude)
Vertical Grid (height or pressure)
Physical Processes in a Model
solar radiation
terrestrial radiation
ATMOSPHERE
advection
momentum
heat
water
sea ice
mixed layer ocean
advection

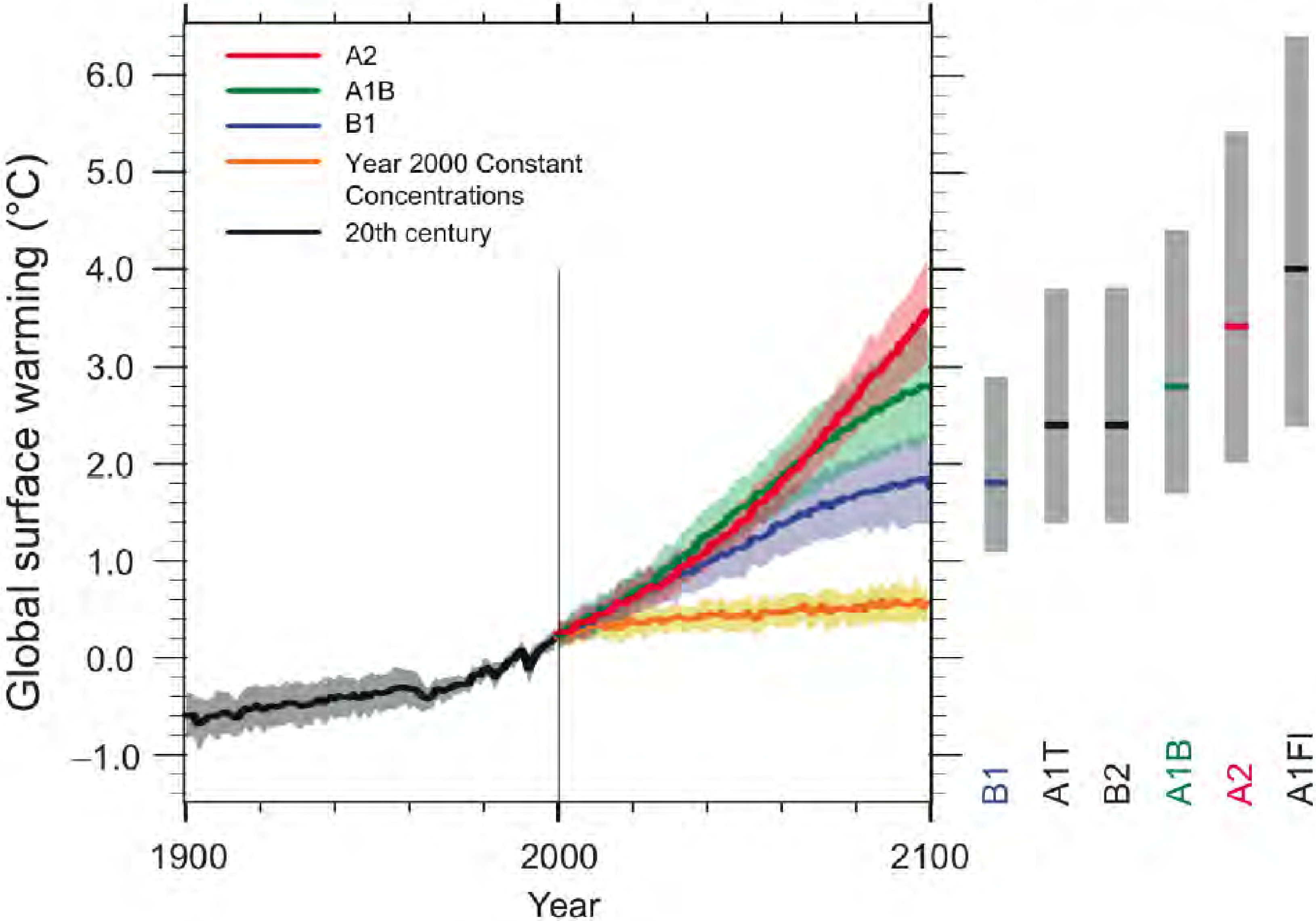


b
Temperature anomaly (°C)
1.0
0.5
0.0
−0.5
−1.0
Santa Maria
Agung
El Chichon
Pinatubo
1900
1920
1940
1960
1980
2000
Year



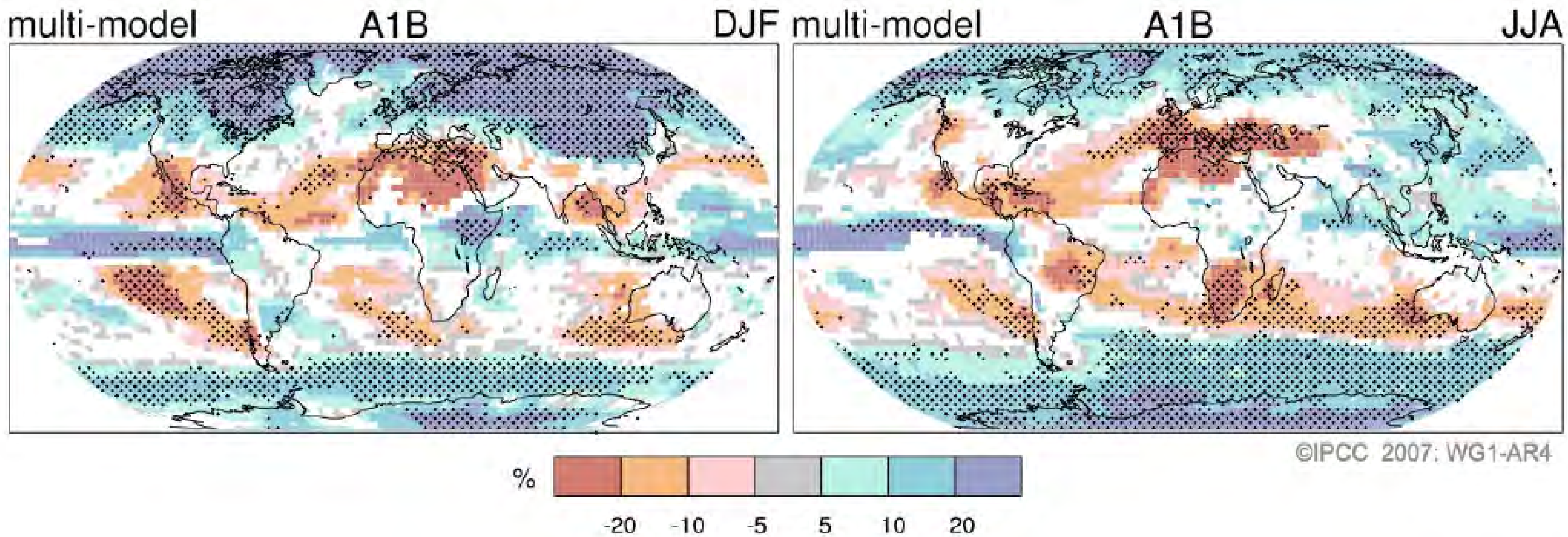
FAQ 8.1, Figure 1. *Global mean near-surface temperatures over the 20th century from observations (black) and as obtained from 58 simulations produced by 14 different climate models driven by both natural and human-caused factors that influence climate (yellow). The mean of all these runs is also shown (thick red line). Temperature anomalies are shown relative to the 1901 to 1950 mean. Vertical grey lines indicate the timing of major volcanic eruptions. (Figure adapted from Chapter 9, Figure 9.5. Refer to corresponding caption for further details.)*

Multi-model Averages and Assessed Ranges for Surface Warming



Source, IPCC

Projected Patterns of Precipitation Changes



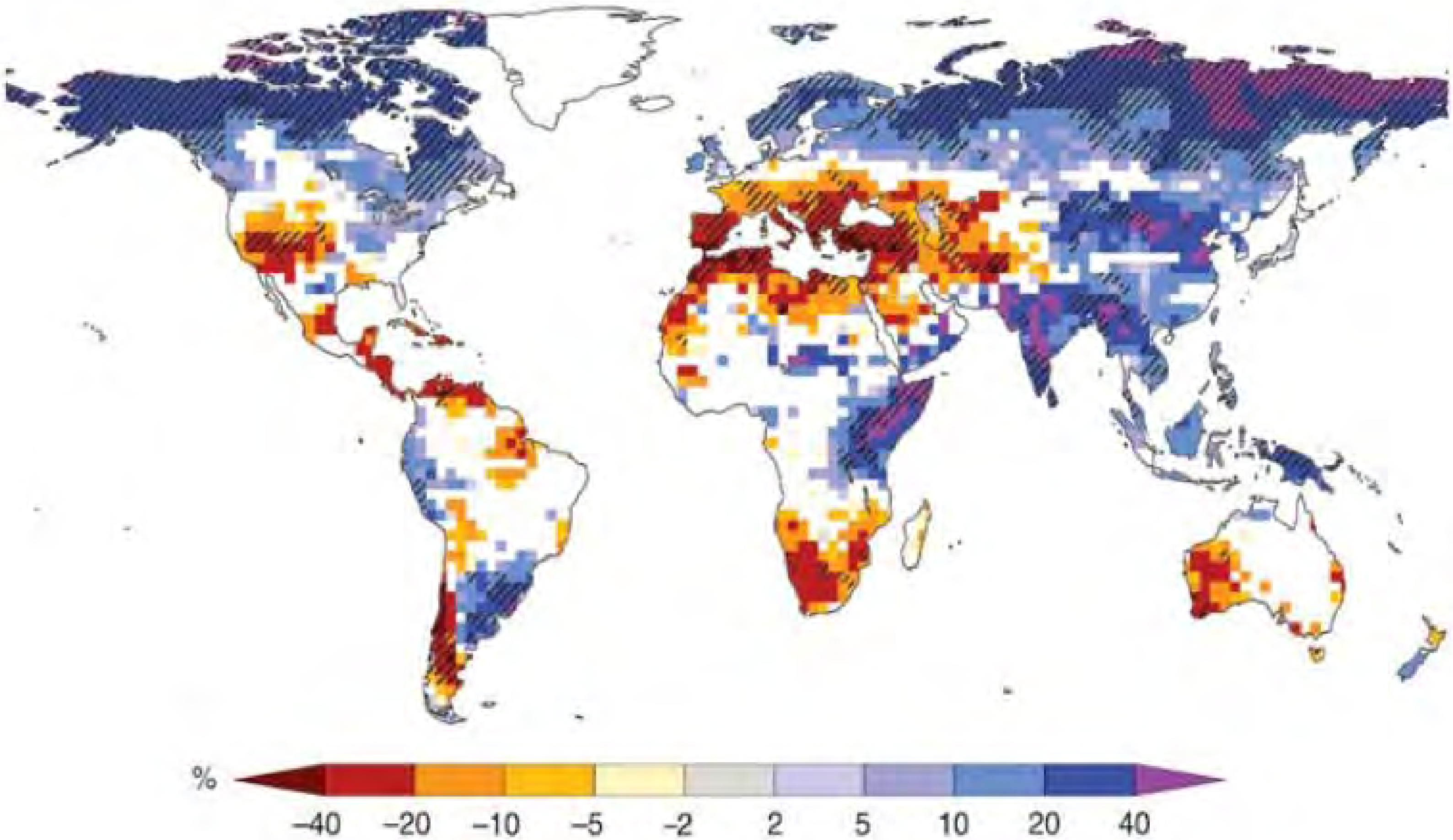


***Figure 2.10:** Large-scale relative changes in annual runoff for the period 2090–2099, relative to 1980–1999. White areas are where less than 66% of the ensemble of 12 models agree on the sign of change, and hatched areas are where more than 90% of models agree on the sign of change (Milly et al., 2005). [Based on SYR Figure 3.5 and WGII Figure 3.4]*

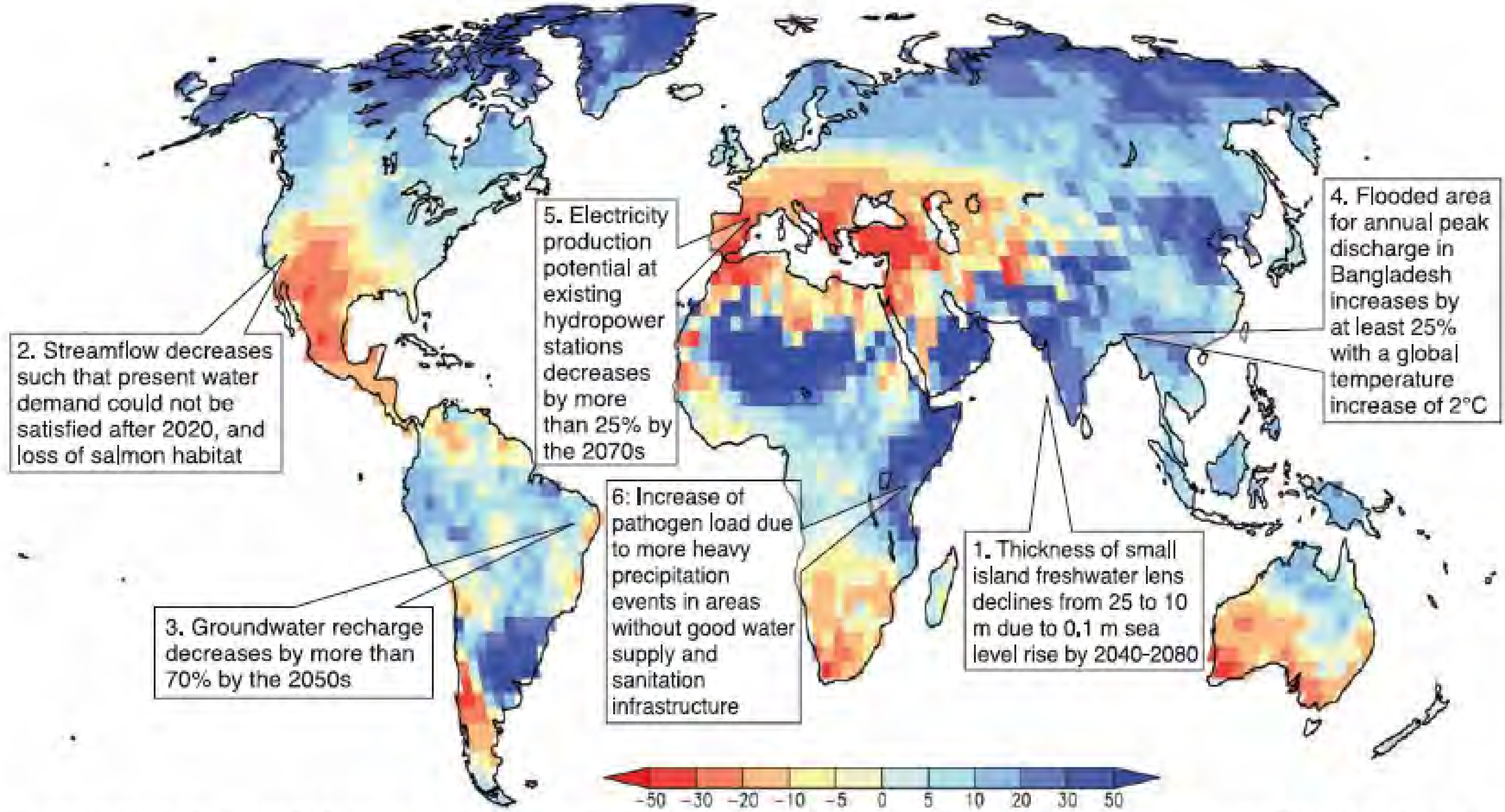
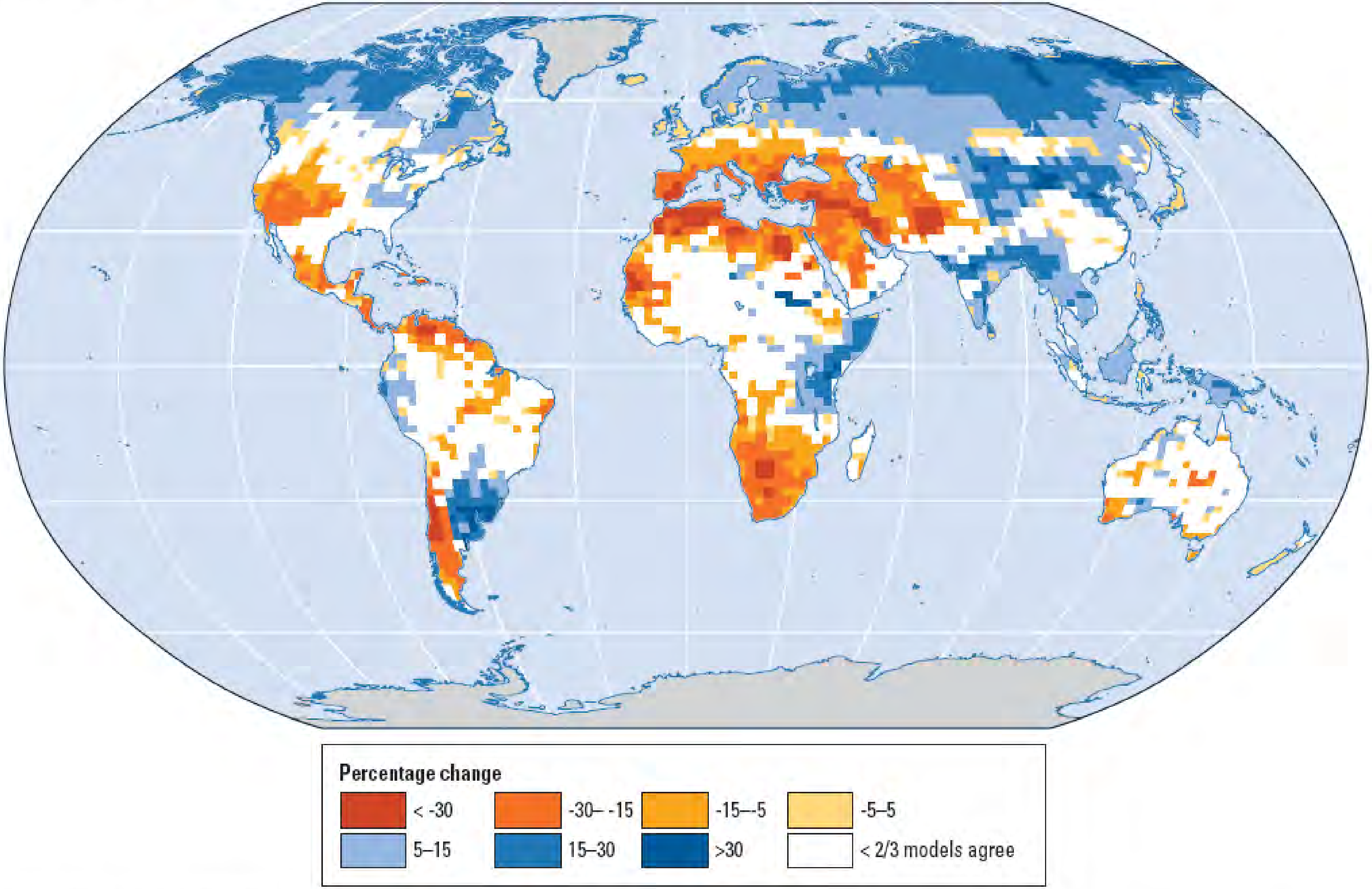


Figure 3.8. *Illustrative map of future climate change impacts on freshwater which are a threat to the sustainable development of the affected regions. 1: Bobba et al. (2000), 2: Barnett et al. (2004), 3: Döll and Flörke (2005), 4: Mirza et al. (2003) 5: Lehner et al. (2005a) 6: Kistemann et al. (2002). Background map: Ensemble mean change of annual runoff, in percent, between present (1981 to 2000) and 2081 to 2100 for the SRES A1B emissions scenario (after Nohara et al., 2006).*

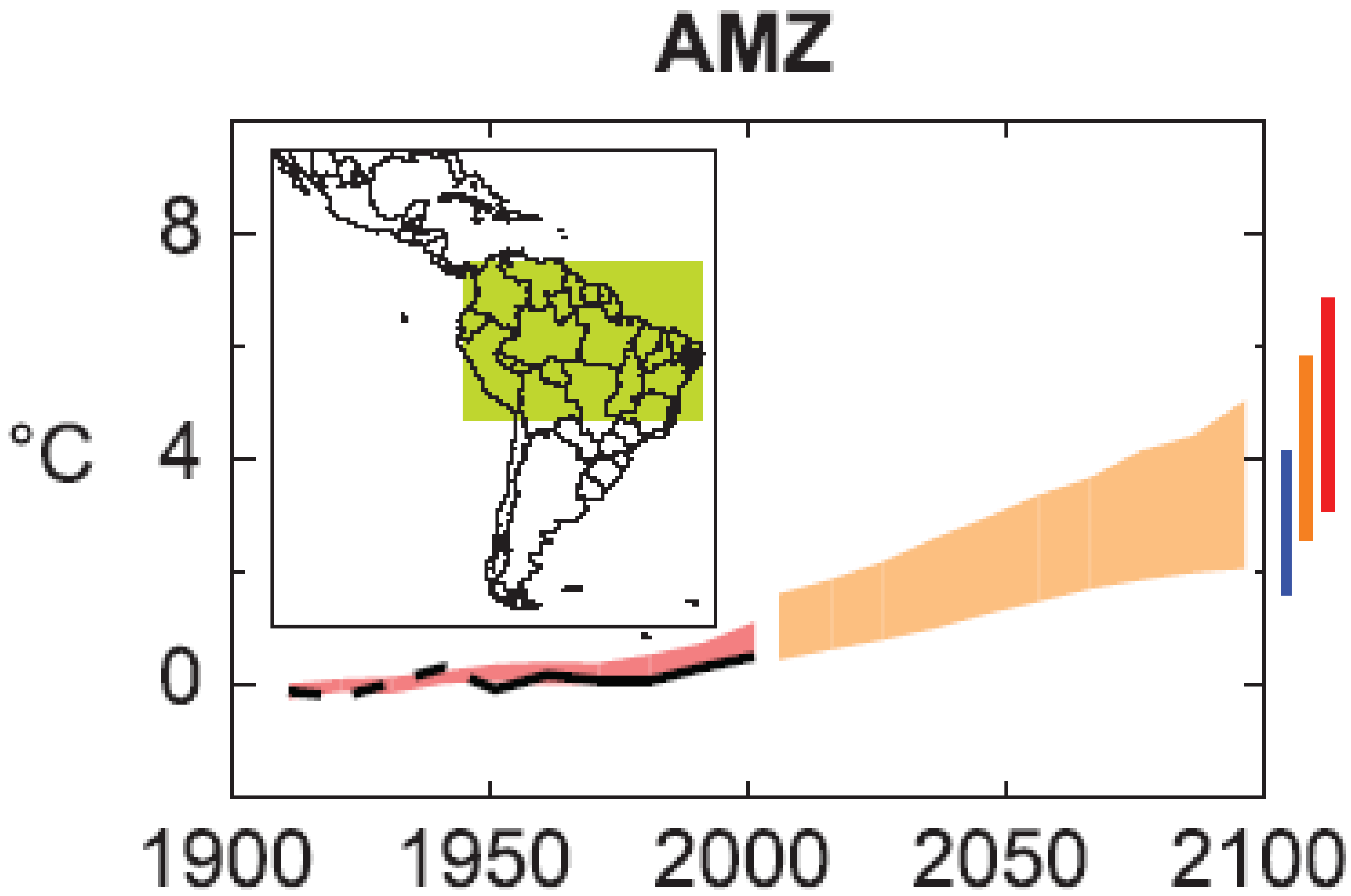
Fonte, IPCC

Map 3.1 Water availability is projected to change dramatically by the middle of the 21st century in many parts of the world.



Source: Milly and others 2008; Milly, Dunne, and Vecchia 2005.

Note: The colors note percentage changes in annual runoff values (based on the median of 12 global climate models using the IPCC SRES A1B scenario) from 2041 to 2060 compared with 1900 to 1970. The white denotes areas where less than two-thirds of the models agree on whether runoff will increase or decrease. Runoff is equal to precipitation minus evaporation, but the values shown here are annual averages, which could mask seasonal variability in precipitation such as an increase in both floods and droughts.



Fonte, IPCC

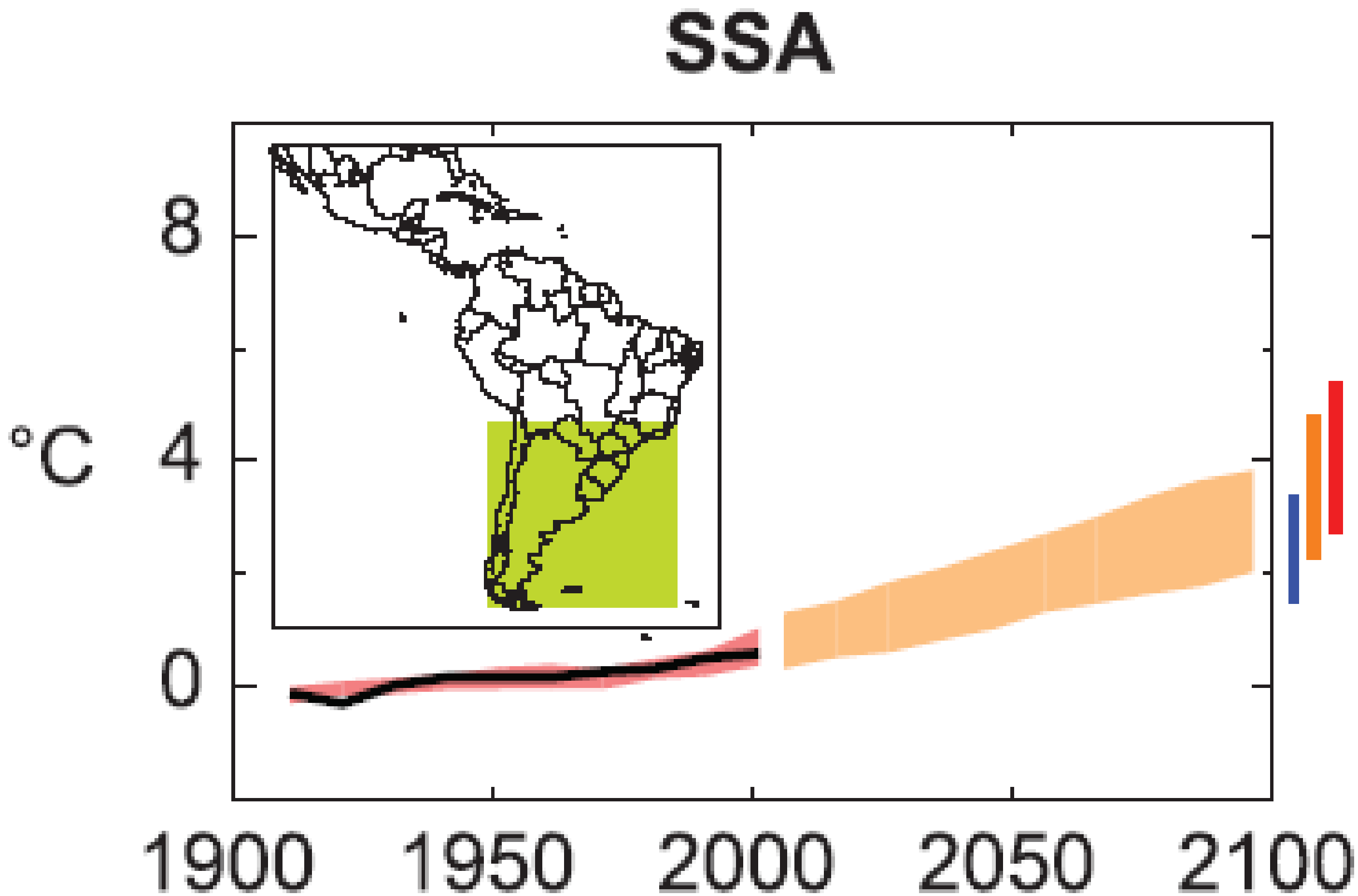
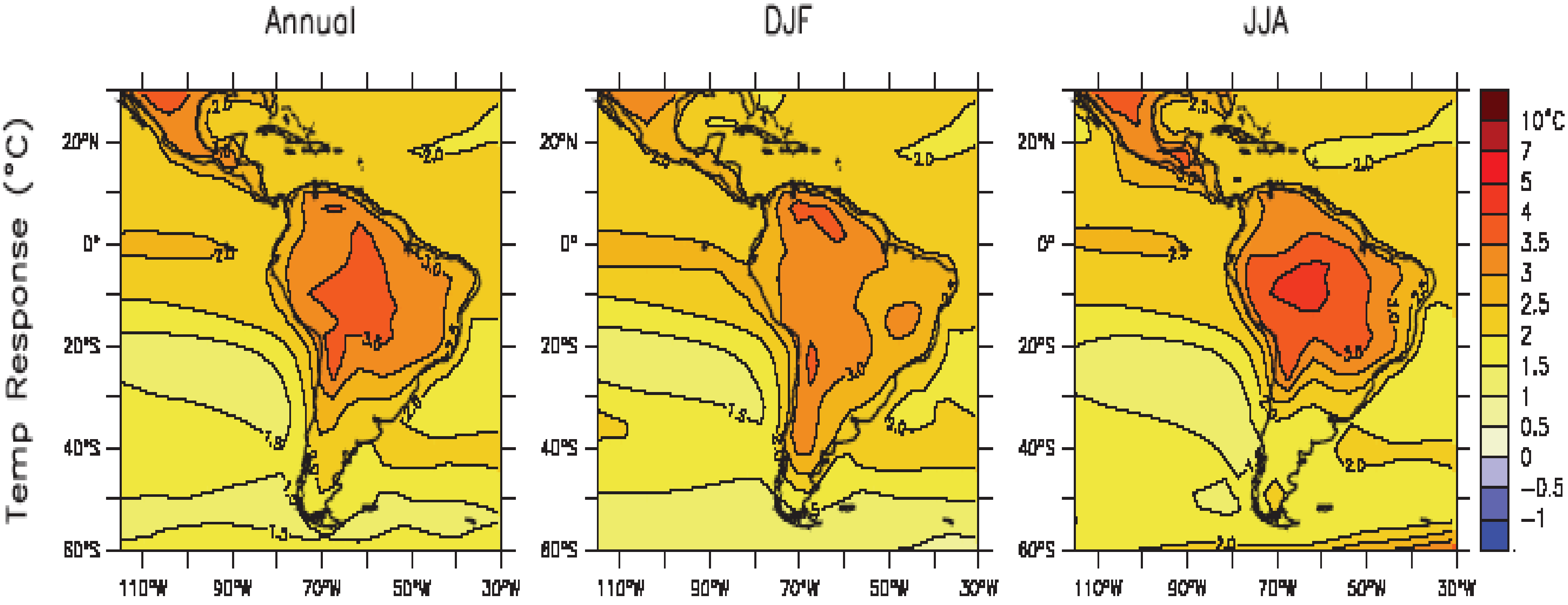


Figure 11.14. *Temperature anomalies with respect to 1901 to 1950 for three Central and South American land regions for 1906 to 2005 (black line) and as simulated (red envelope) by MMD models incorporating known forcings; and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue), the A1B scenario (orange) and the A2 scenario (red). The black line is dashed where observations are present for less than 50% of the area in the decade concerned. More details on the construction of these figures are given in Box 11.1 and Section 11.1.2.*

Fonte, IPCC



Annual
DJF
JJA
Temp Response (°C)
20°N
0°
20°S
40°S
60°S
110°W
90°W
70°W
50°W
30°W
10°C
7
5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1

Fonte, IPCC

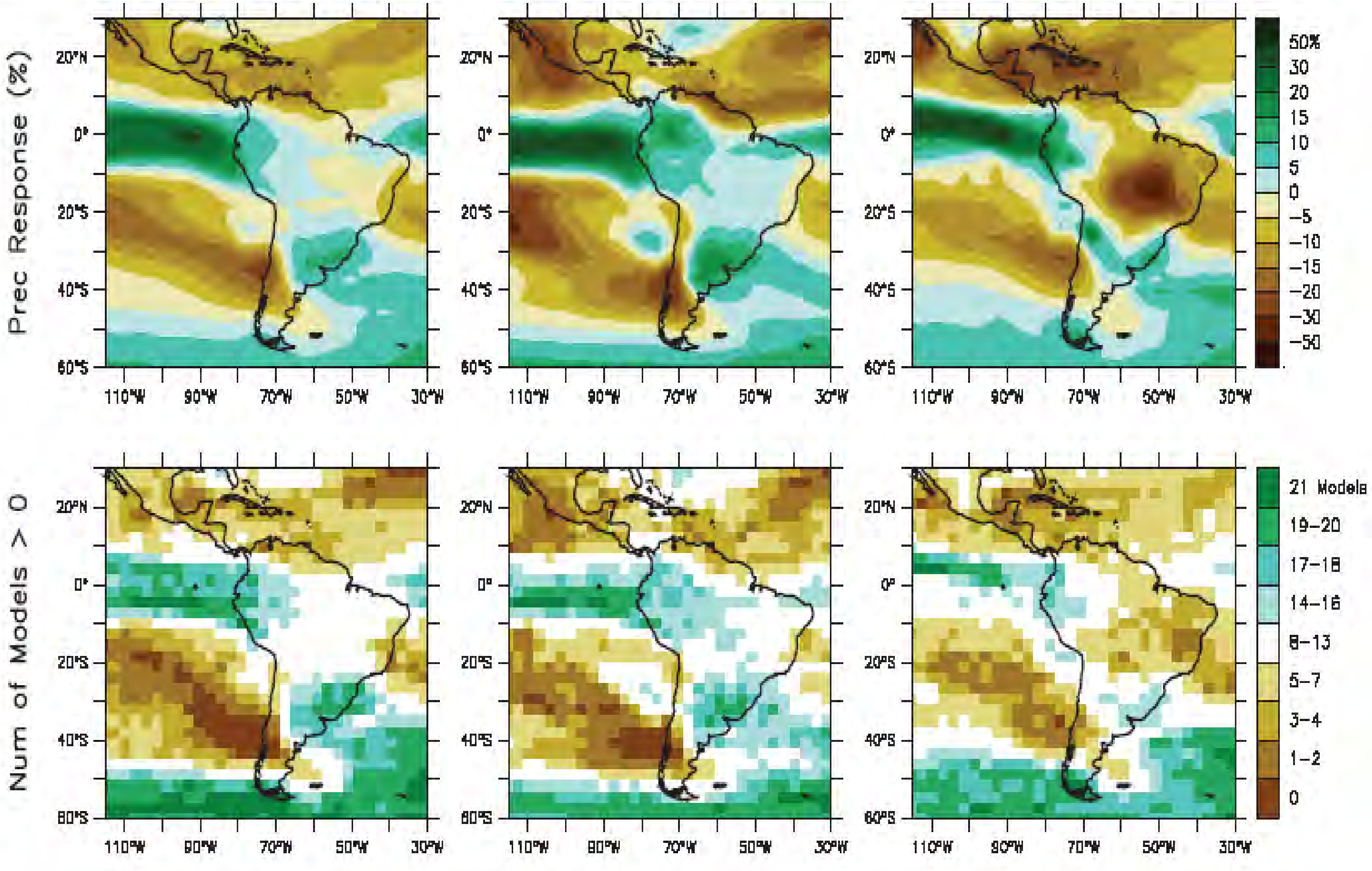


Figure 11.15. *Temperature and precipitation changes over Central and South America from the MMD-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation.*

Fonte, IPCC

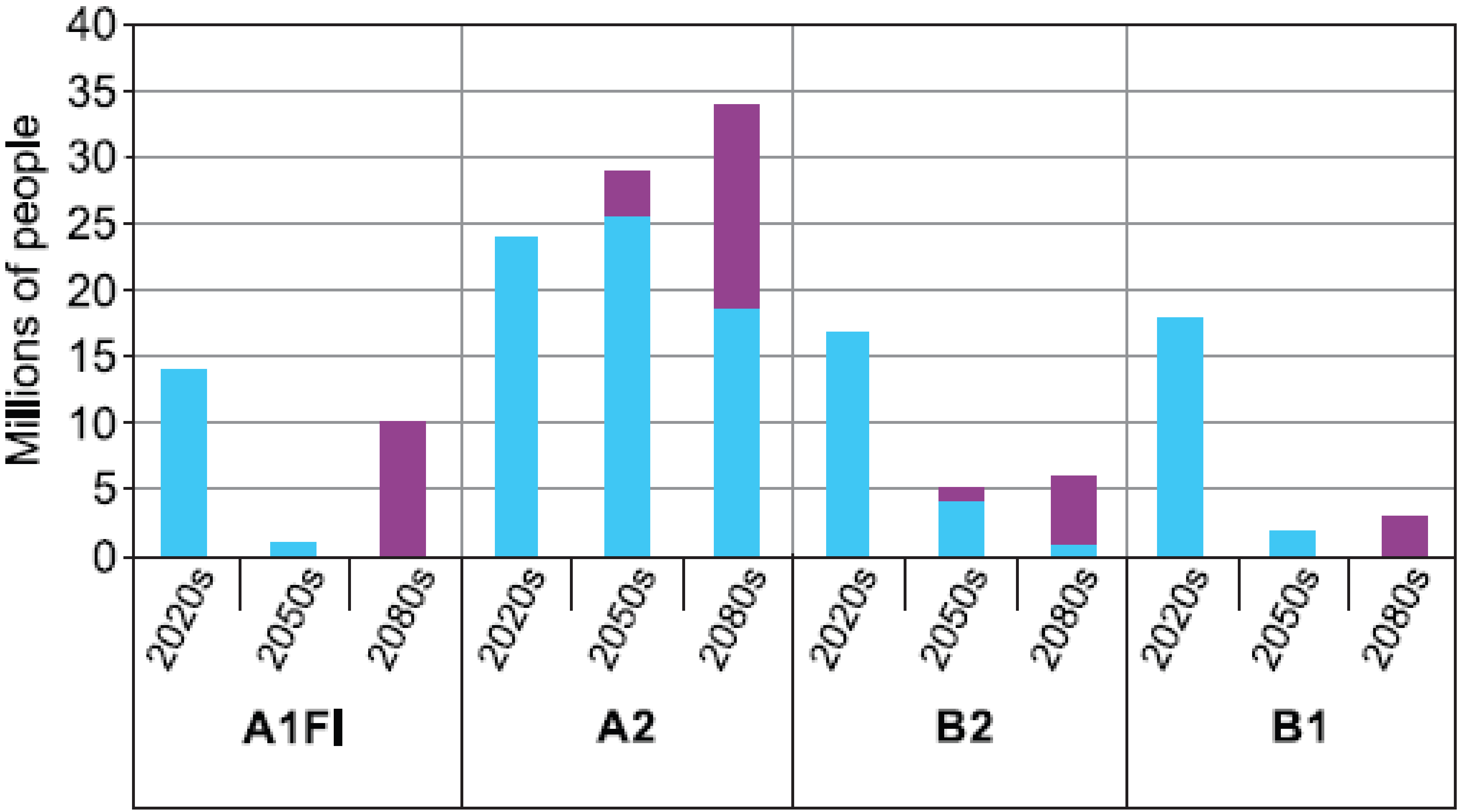


Figure TS.18. *Results from a recent study showing estimated millions of people per annum at risk globally from coastal flooding. Blue bars: numbers at risk without sea-level rise; purple bars: numbers at risk with sea-level rise. [T6.6]*

Figure TS.8. *Relative vulnerability of coastal deltas as indicated by estimates of the population potentially displaced by current sea-level trends to 2050 (extreme >1 million; high 1 million to 50,000; medium 50,000 to 5,000) [B6.3]. Climate change would exacerbate these impacts.*

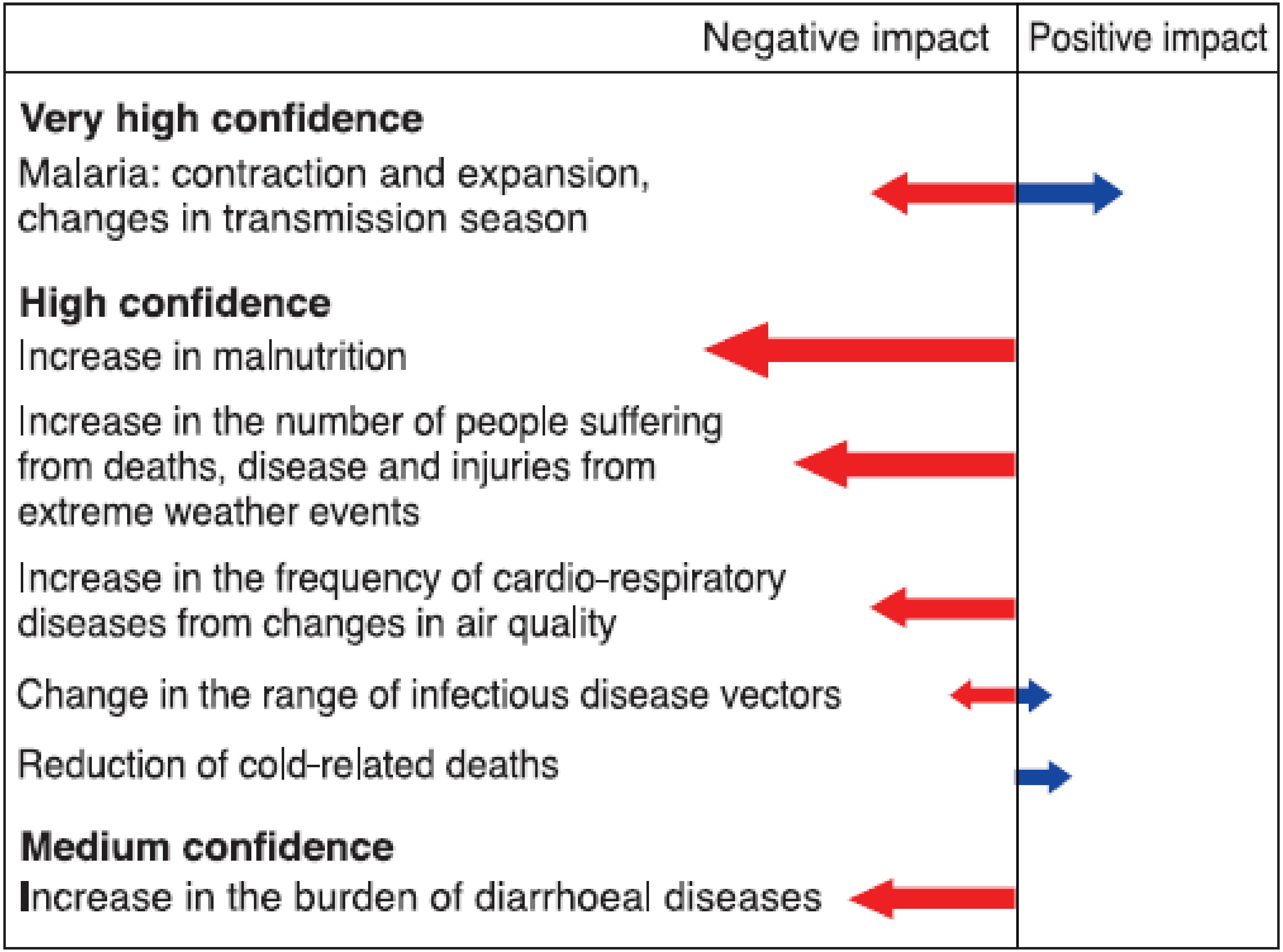
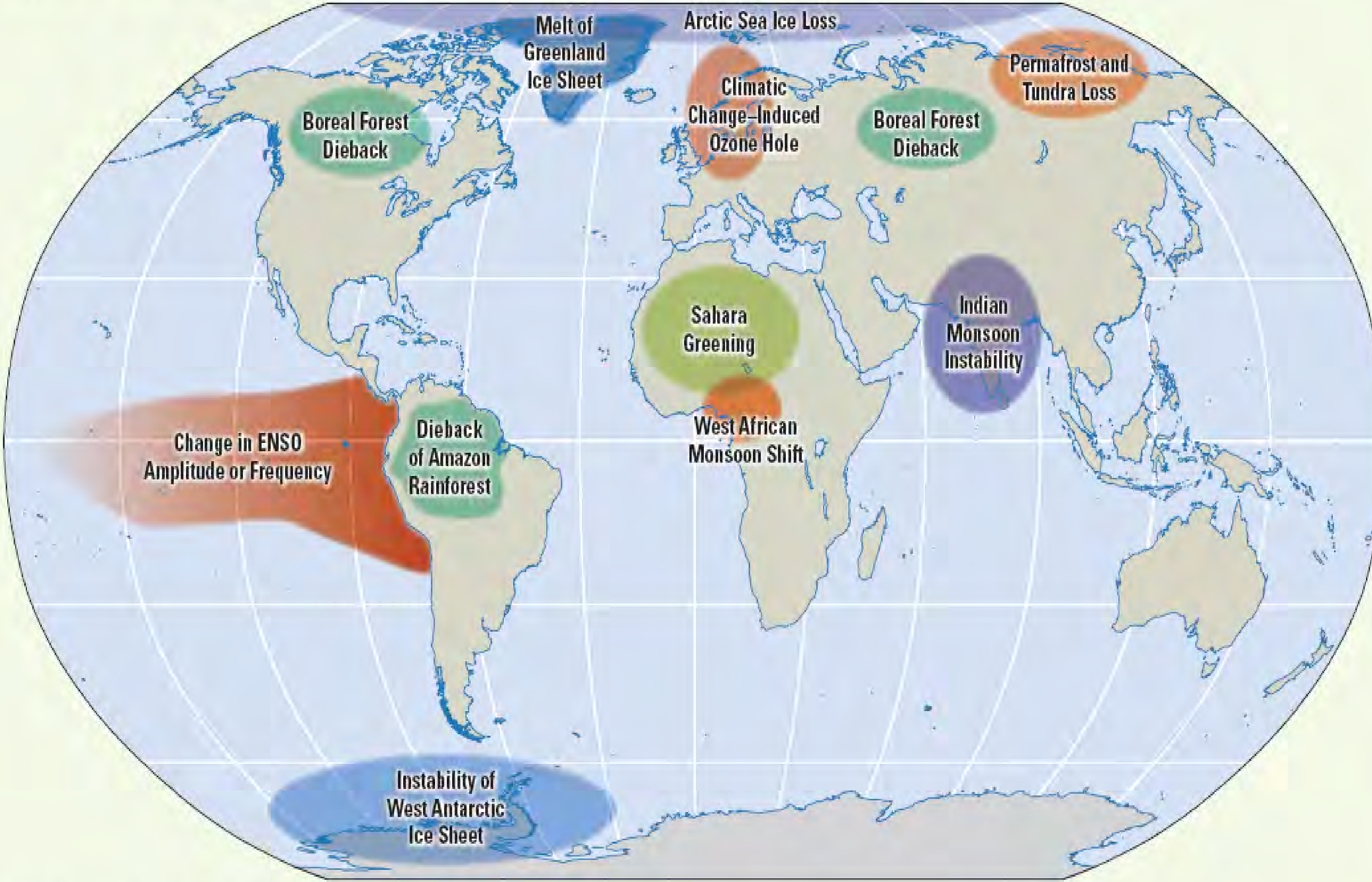


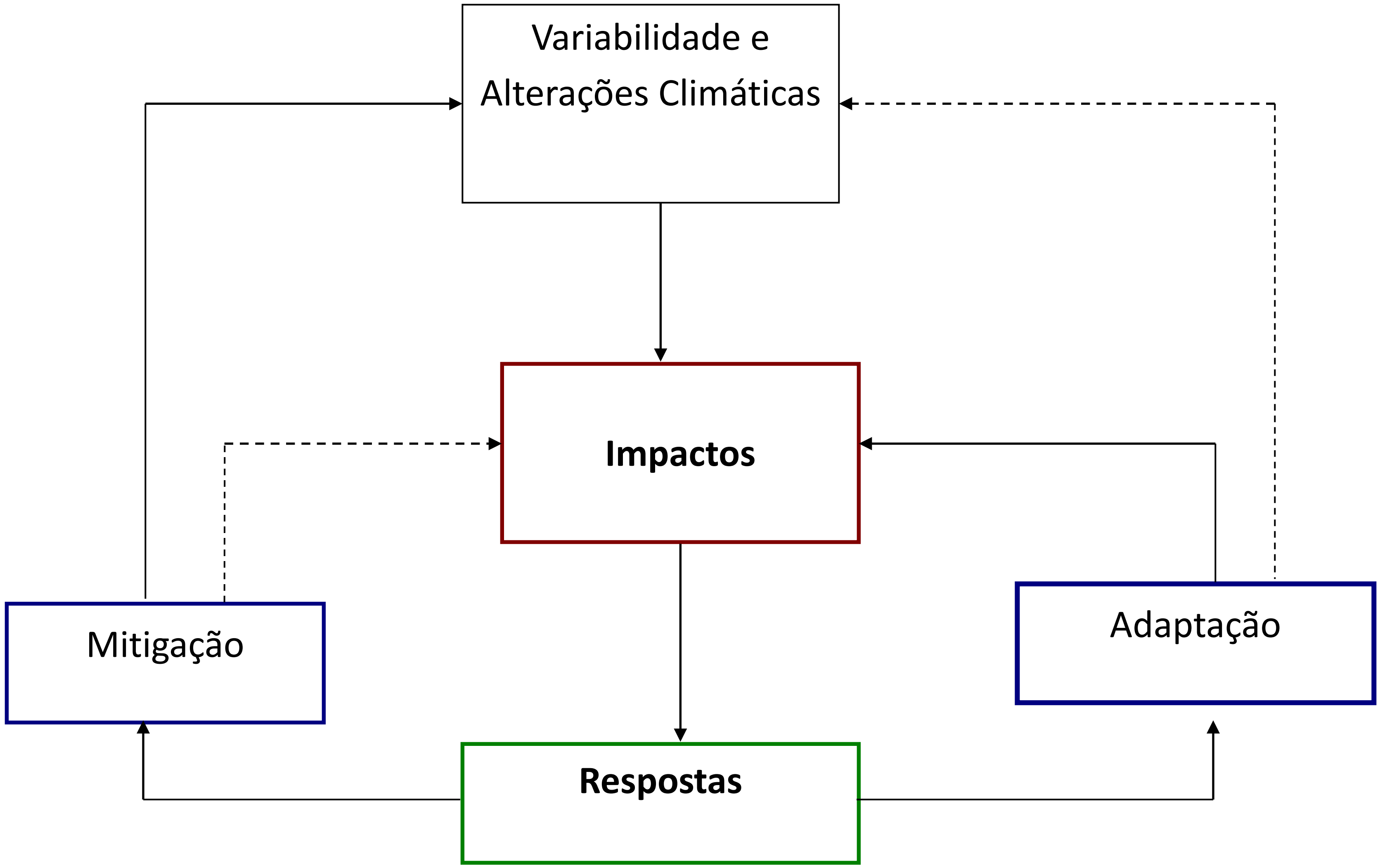
Figure TS.9. *Direction and magnitude of change of selected health impacts of climate change.*

Map FA.2 Potential tipping elements in the climate system: Global distribution



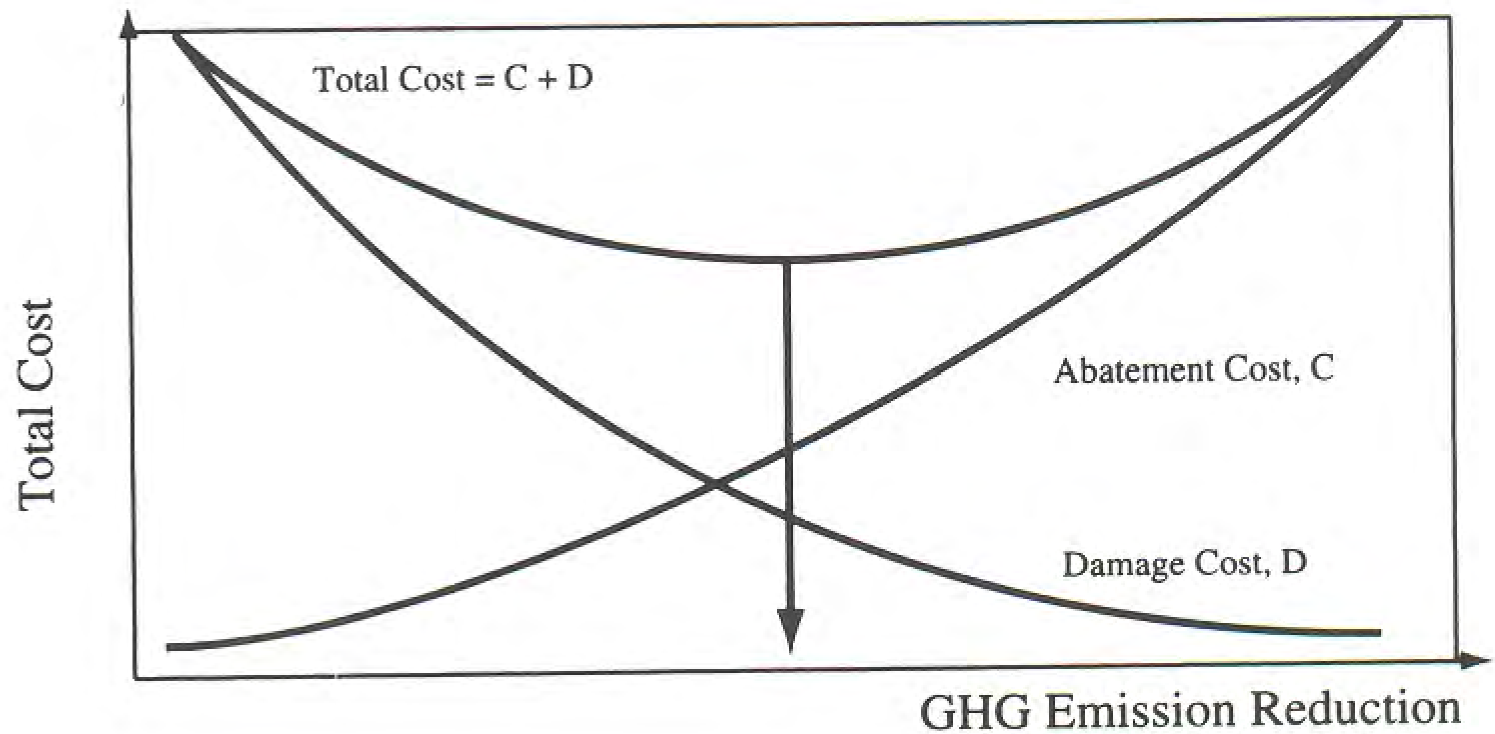
Source: Adapted from Lenton and others 2008.

Note: Several regional-scale features of the climate system have tipping points, meaning that a small climate perturbation at a critical point could trigger an abrupt or irreversible shift in the system These could be triggered this century depending on the pace and magnitude of climate change.



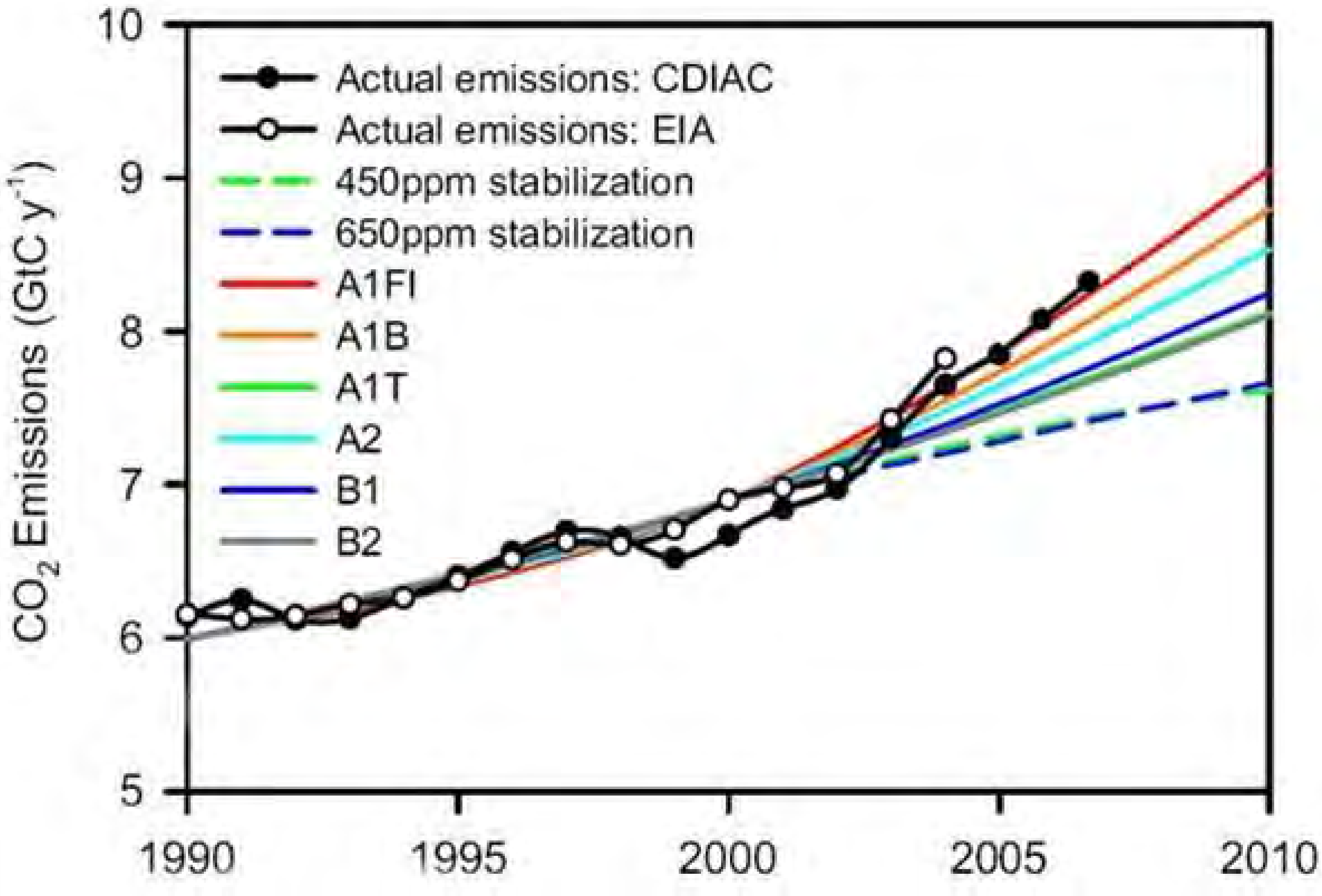
Efeitos directos ou retroacção

Efeitos indirectos

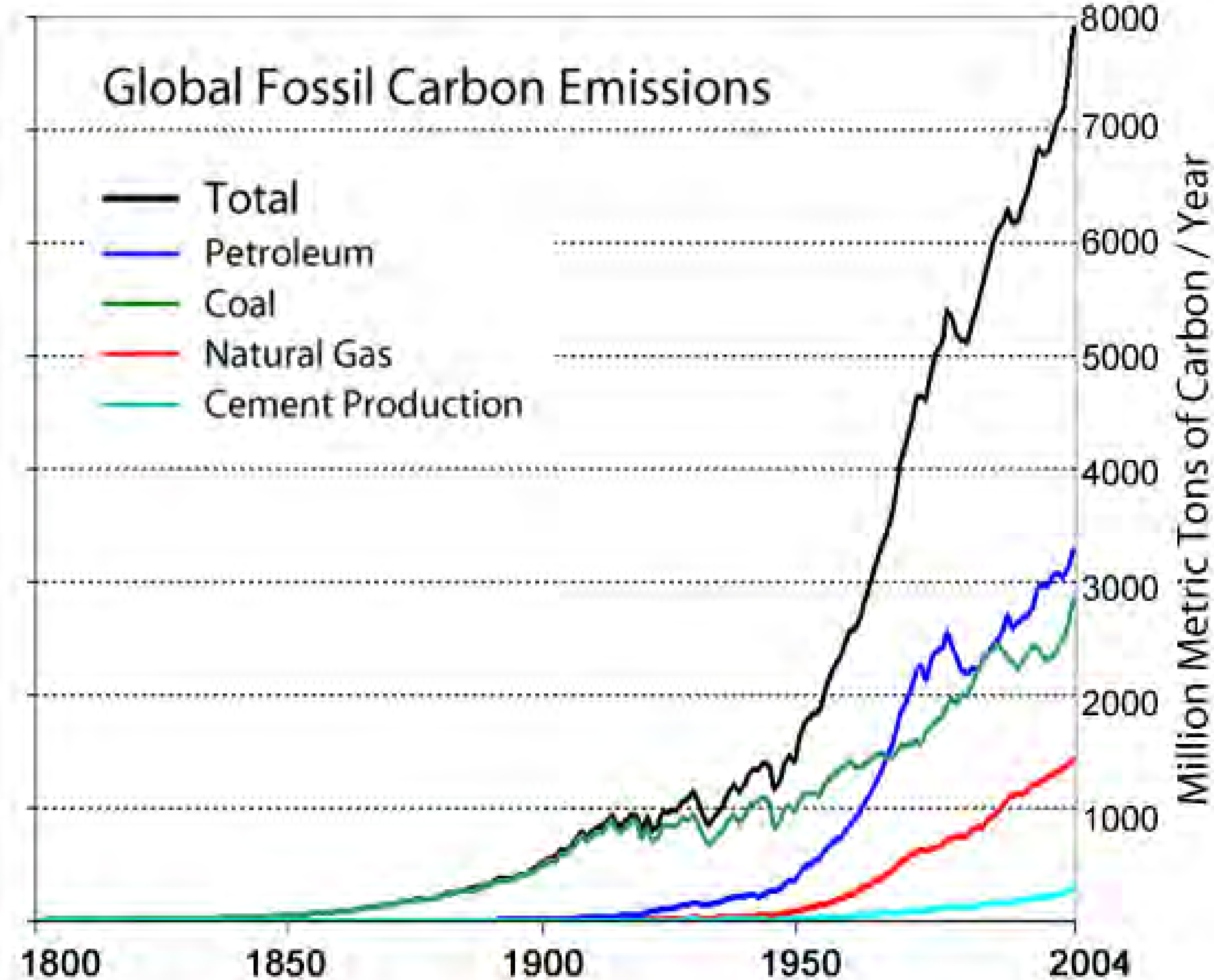


Source, J. Houghton, 1994

As emissões anuais recentes de gases com efeito de efeito de estufa são próximas dos cenários mais gravosos do IPCC

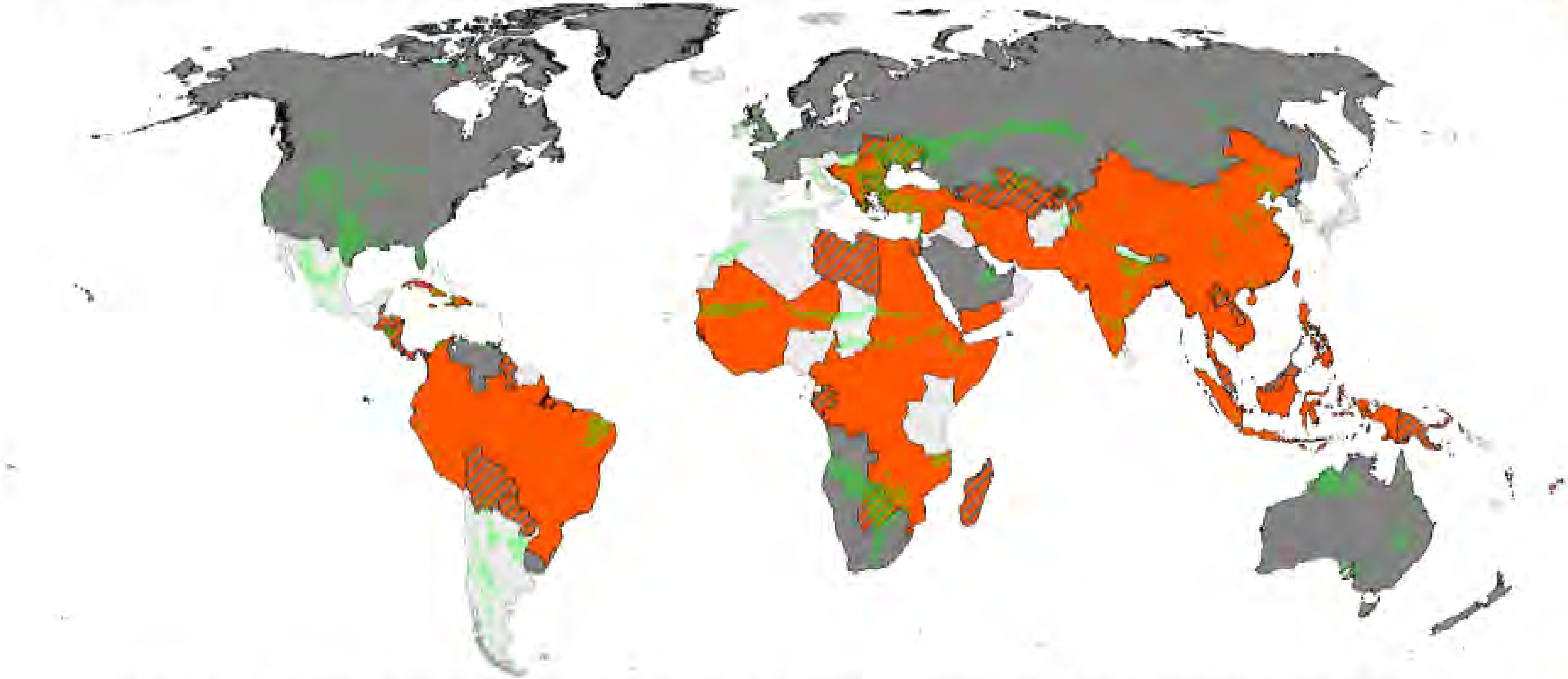


Journal reference: *Proceedings of the National Academy of Sciences* (DOI: 10.1073/pnas.0700609104)



Marland et al, 2007

Vulnerability vs. emissions



Highest vulnerability towards climate change vs. largest CO_2 emissions (from fossil fuel combustion and cement production, and including land use change, kg C per person and year from 1950 - 2003)

- Highest social and / or agro-economic vulnerability
- Areas with highest ecological vulnerability
- Largest per capita CO_2 emitters
- Largest per capita CO_2 emitters, and highest social and / or agro-economic vulnerability

Source, W. Cramer, 2007

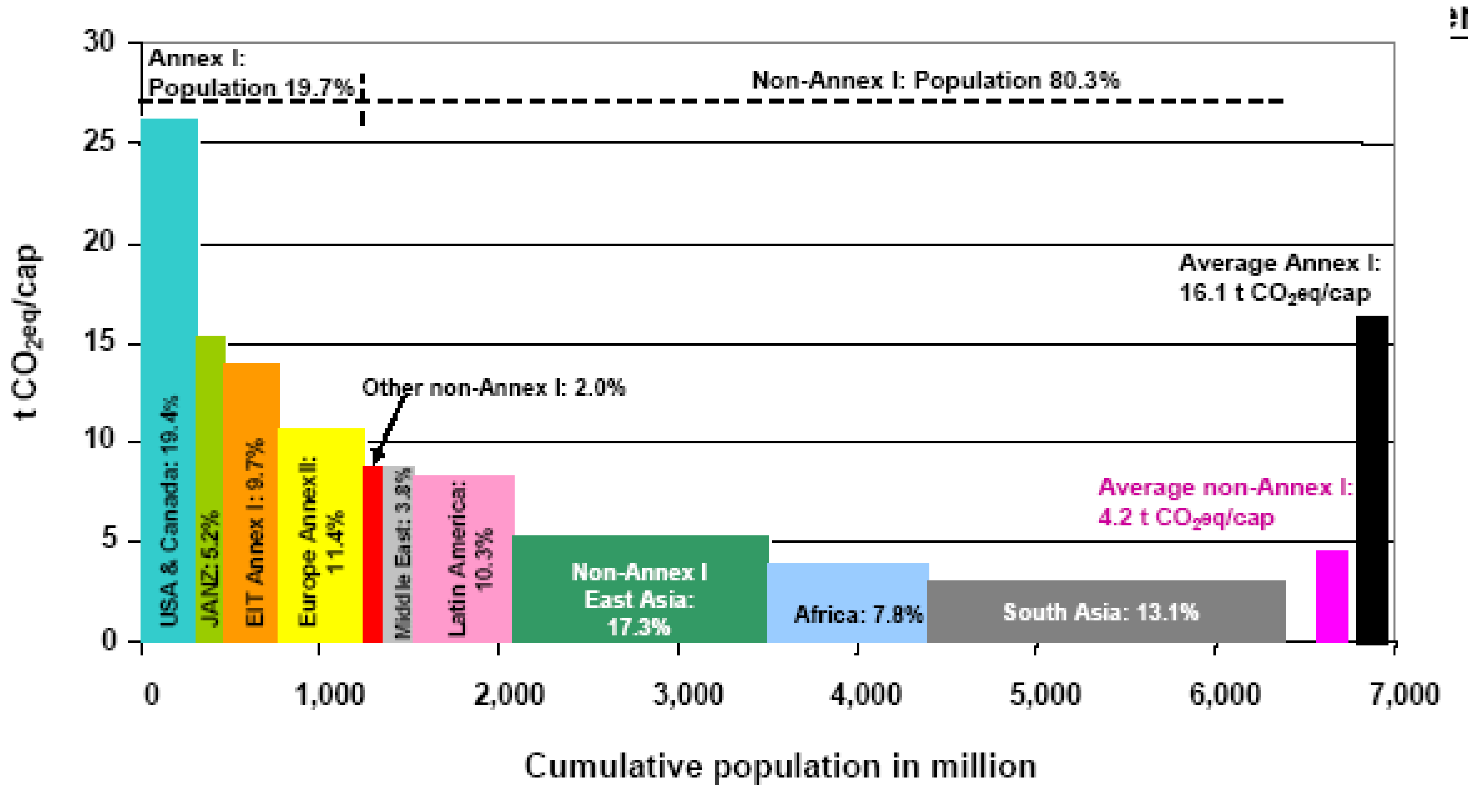
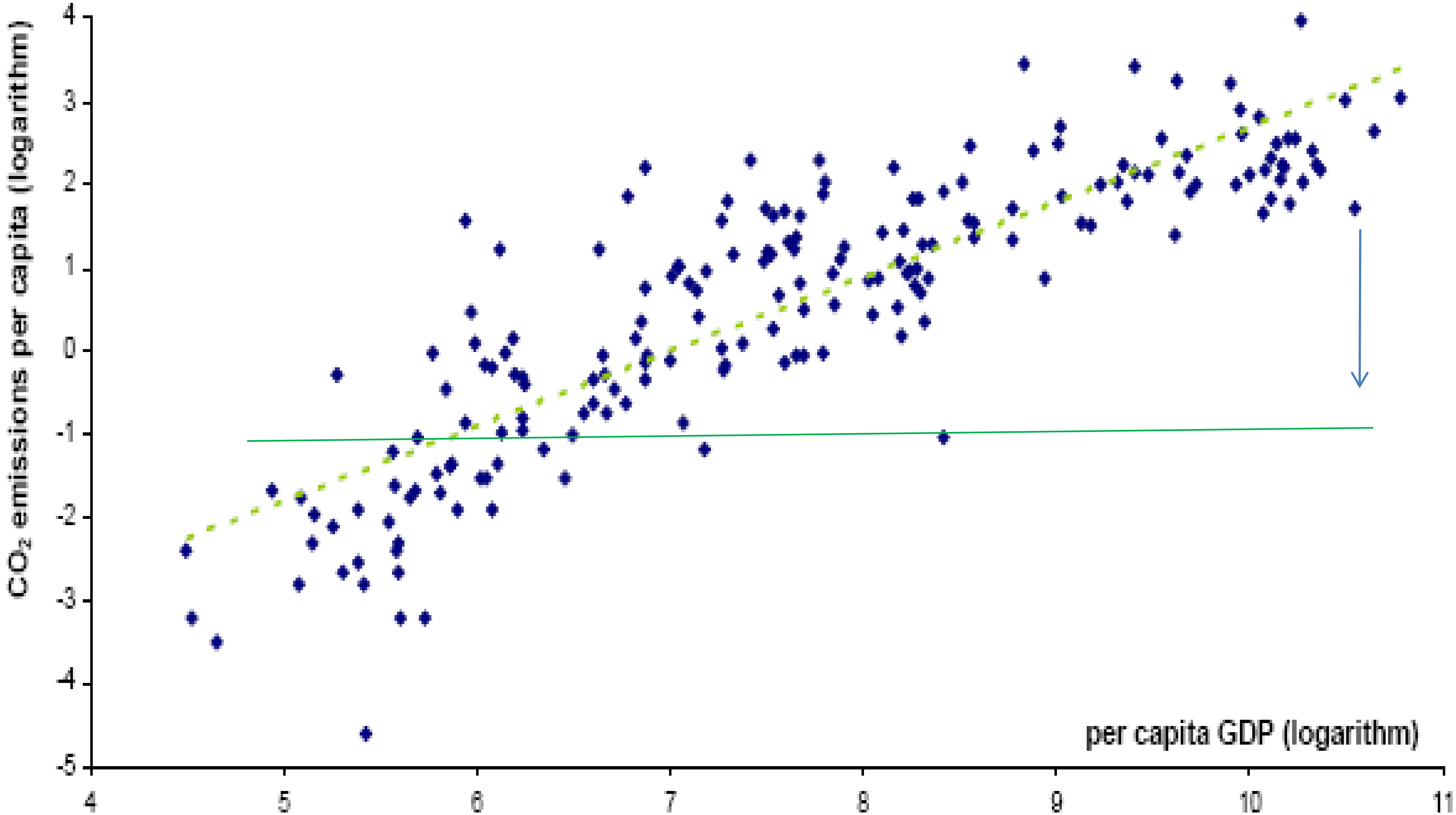


***Figure SPM 3a**: Year 2004 distribution of regional per capita GHG emissions (all Kyoto gases, including those from land-use) over the population of different country groupings. The percentages in the bars indicate a regions share in global GHG emissions [Figure 1.4a].*

Fonte, IPCC

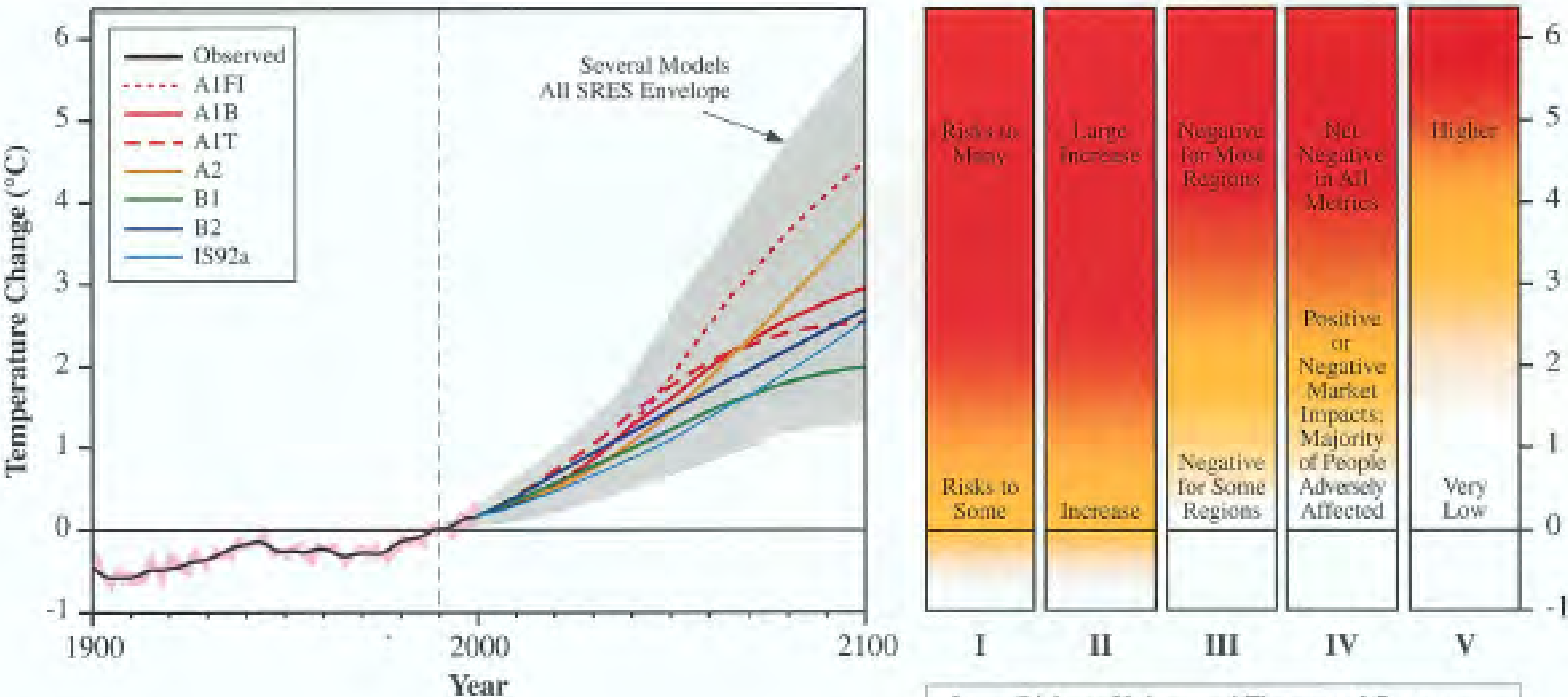
Figure 3 – CO_2 emissions per capita according to per capita GDP in the world in 2002.



A 1% increase in GDP per capita leads to an estimated increase of about 0.9% in emissions per capita. The fact that the emissions figure is less than1% indicates that emissions increase at a slower pace than economic growth.

Source: World Bank.

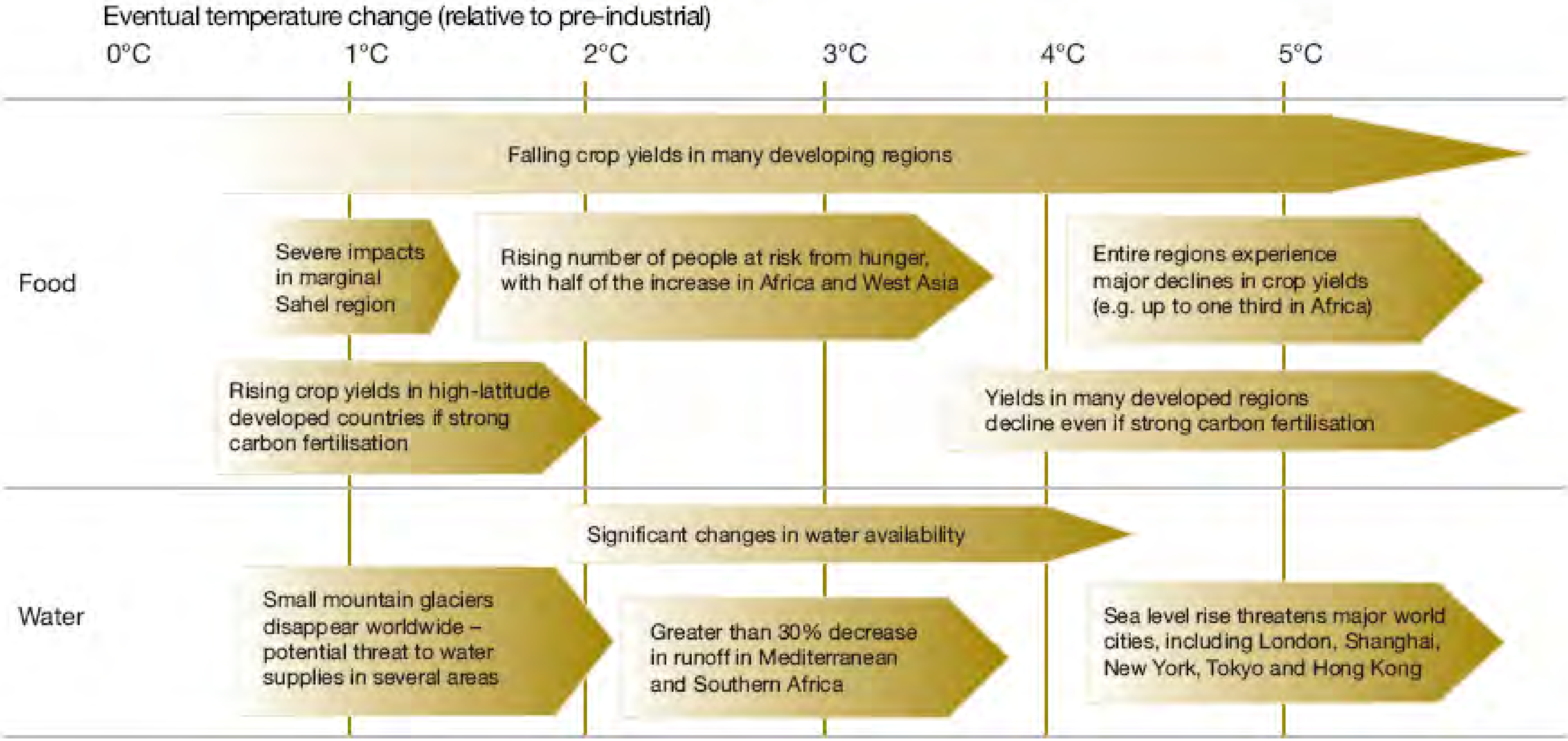
Global "reasons for concern"



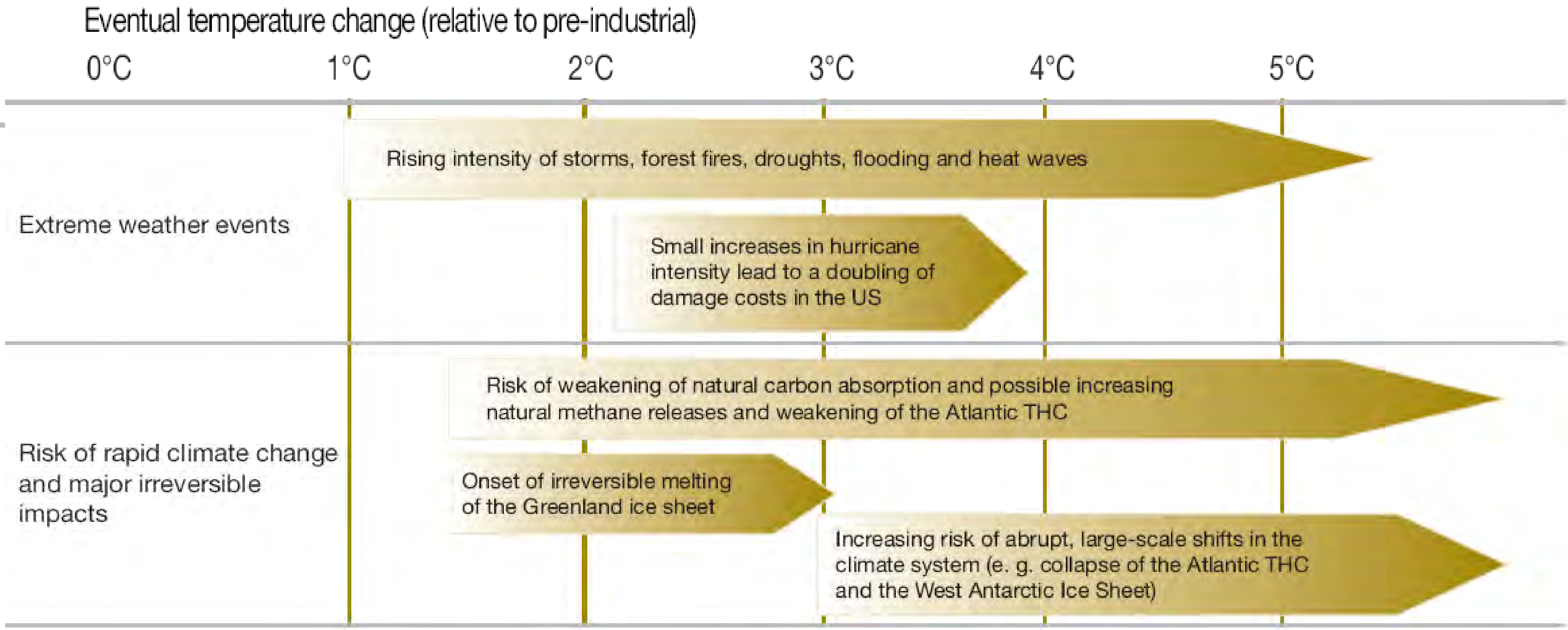
I Risks to Unique and Threatened Systems
II Risks from Extreme Climate Events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from Future Large-Scale Discontinuities

Source: Smith et al 2001, TAR IPCC WG II

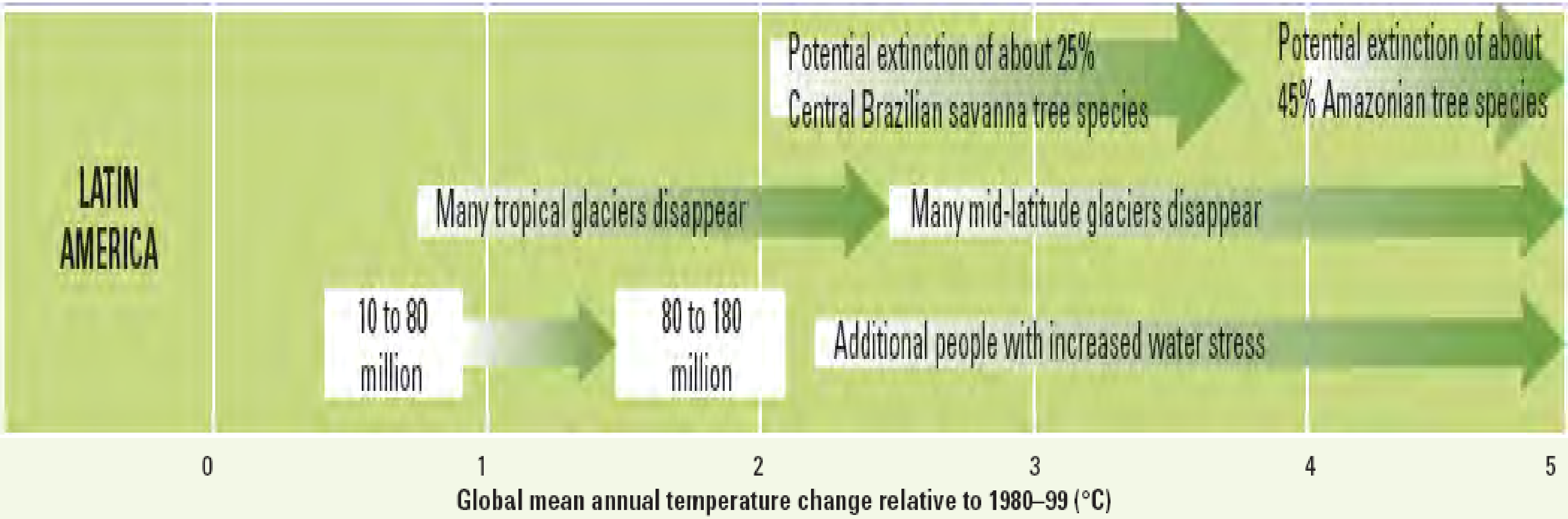
Climate change as a driver of social destabilization and threat to international security



Climate change as a driver of social destabilization and threat to international security

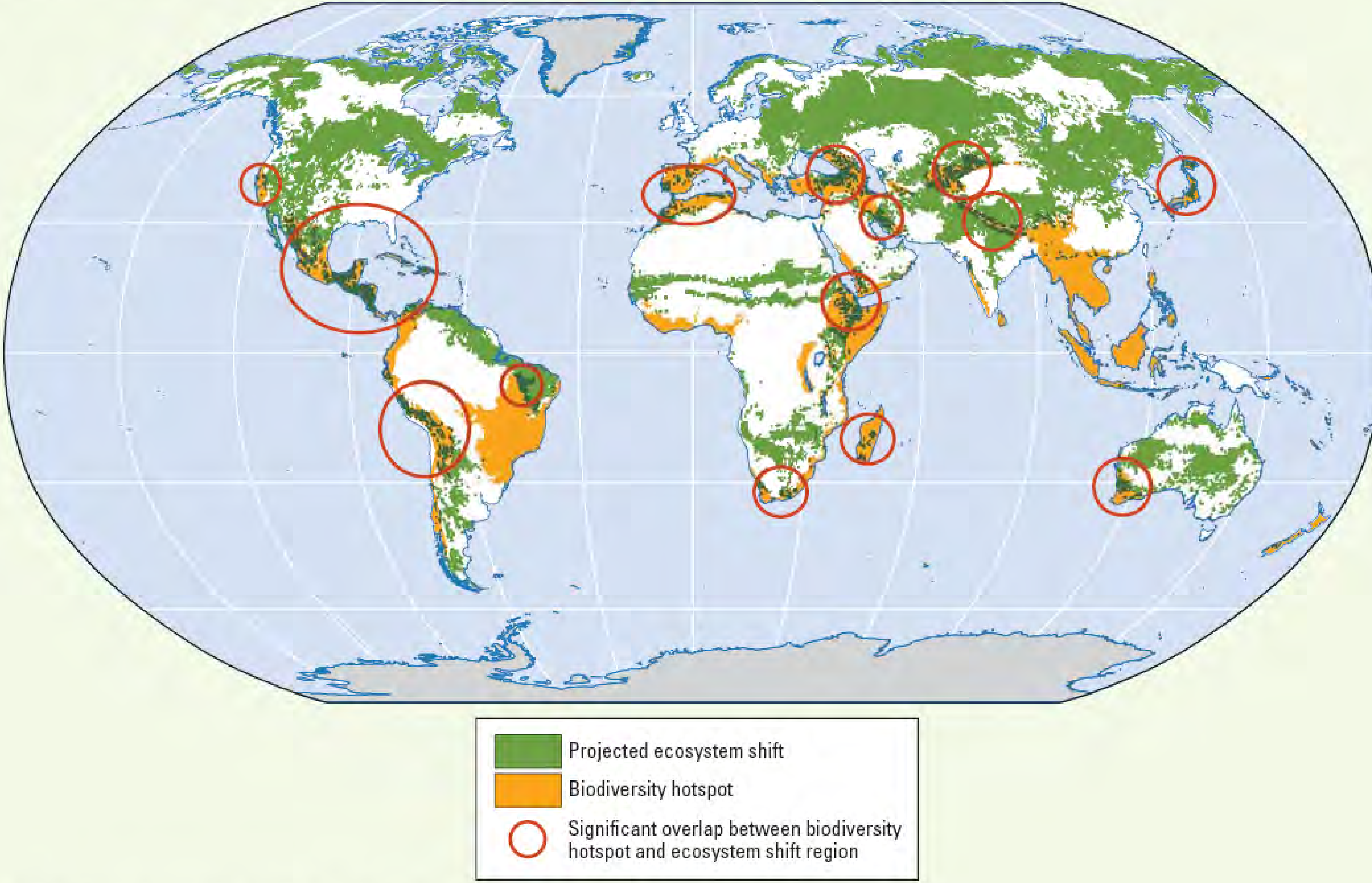


Consequences of climate change for ecosystems and economic sectors at different levels of warming.
Source: Stern, 2006



Source: Adapted from Parry and others 2007.

Map FB.1 While many of the projected ecosystem changes are in boreal or desert areas that are not biodiversity hotspots, there are still substantial areas of overlap and concern

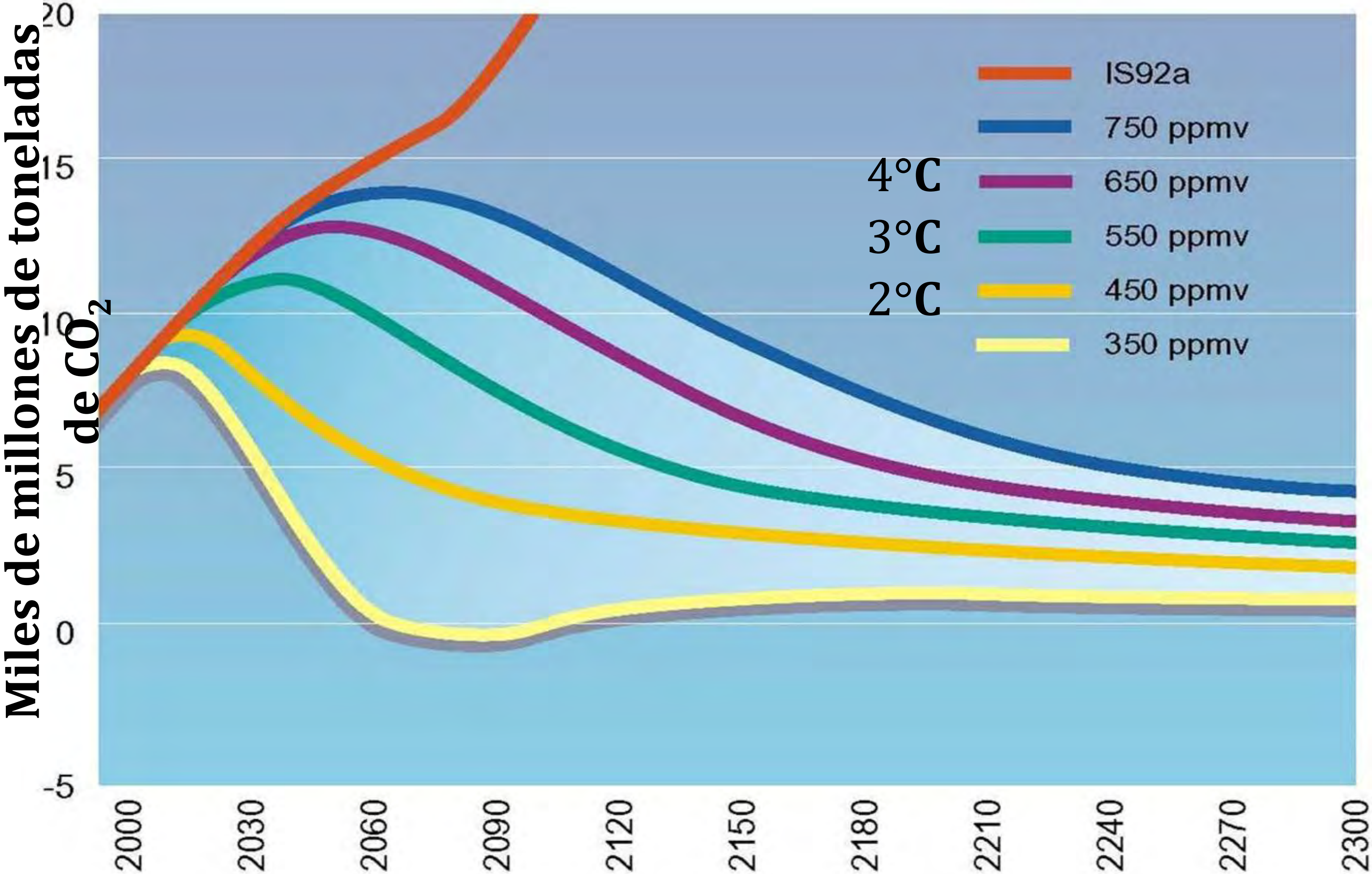


Source: WDR team based on Myers and others (2000) and Fischlin and others (2007).

Note: The figure shows the overlap between biodiversity hotspots (Conservation International and Myers and others 2000) and the projected changes in terrestrial ecosystems by 2100 relative to the year 2000, as presented by the Intergovernmental Panel on Climate Change in Fischlin and others (2007), figure 4.3 (a), p. 238. The changes should be taken as only indicative of the range of possible ecosystem changes and include gains or losses of forest cover, grassland, shrub- and woodland, herbaceous cover, and desert amelioration.

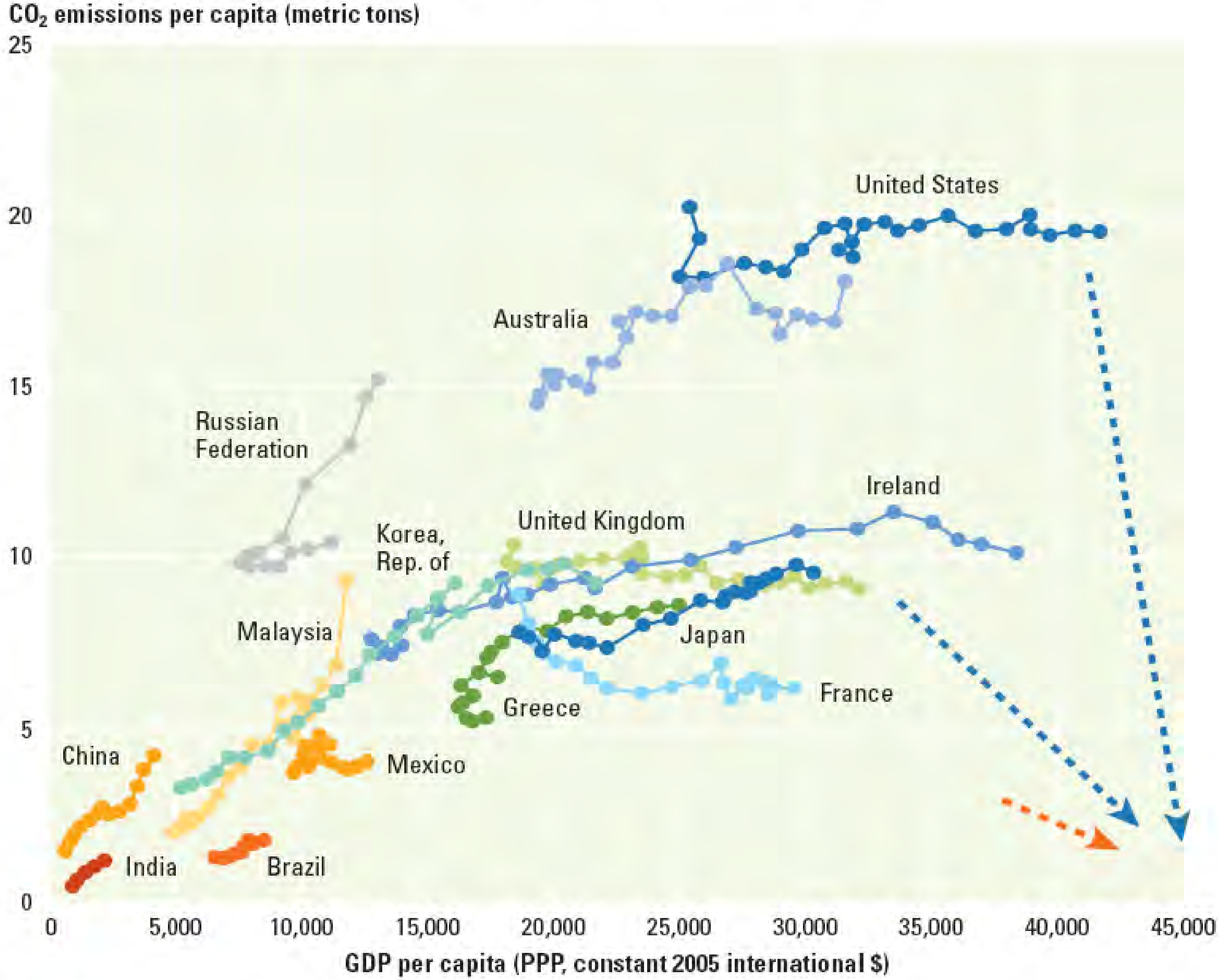
Trajectórias das emissões de CO_2e

(2005 = 380 ppmv)



Fuente: Stern Review; World Resources Institute

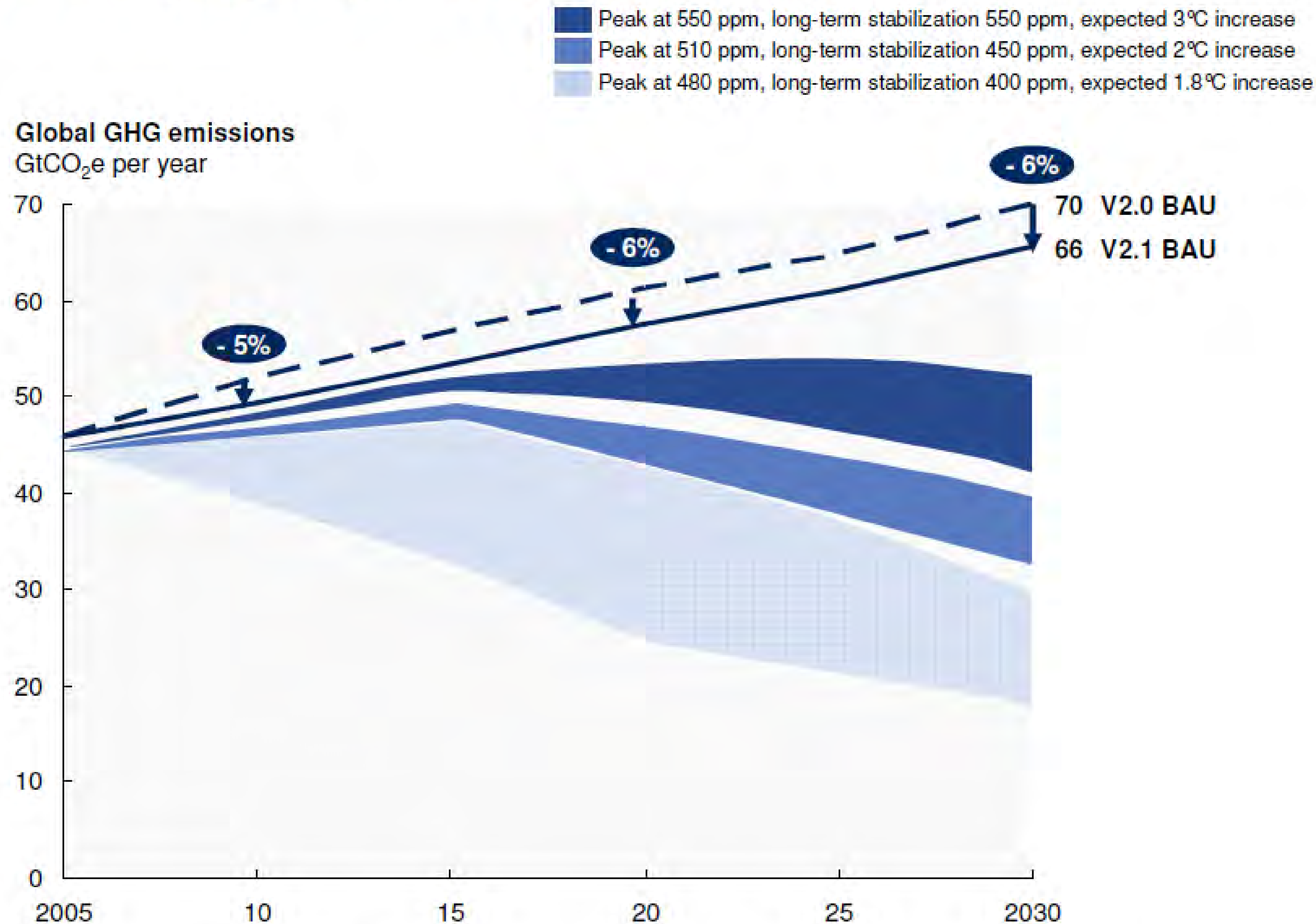
Figure 4.6 Where the world needs to go: energy-related CO_2 emissions per capita



Source: Adapted from NRC 2008, based on data from World Bank 2008e.

Note: Emissions and GDP per capita are from 1980 to 2005.

Business-as-usual (BAU) comparisons between V2.0 and V2.1



Note: As a reference, 1990 total emissions were 36 $GtCO_2e$.
Source: Global GHG Abatement Cost Curve v2.0, v2.1; IEA; US EPA; Houghton; IPCC; OECD; den Elzen; Meinshausen; van Vuuren

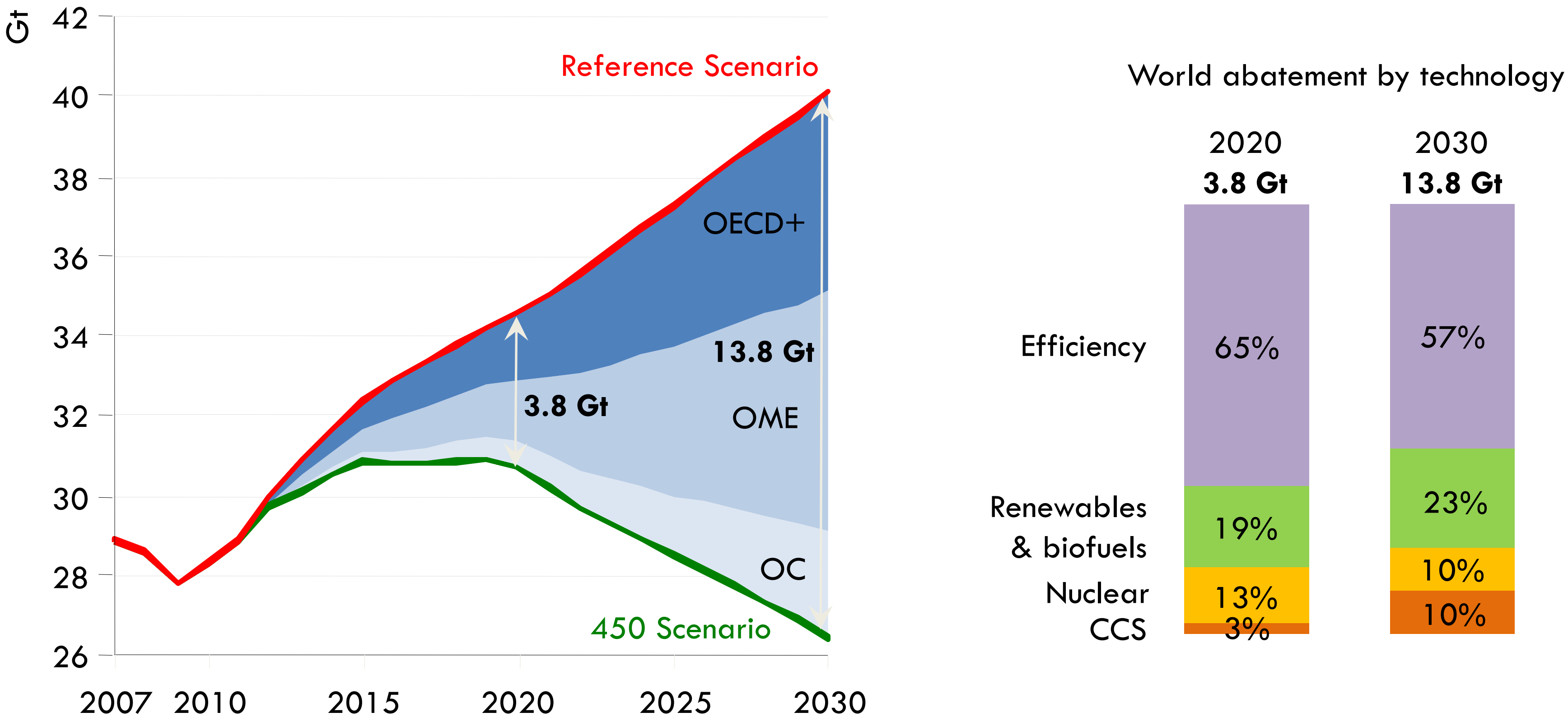
Figure 3.4 Intensive beef production is a heavy producer of greenhouse gas emissions

Food item (1 kg)	Emissions (kg CO_2e)	Driving distance equivalent
Wheat	0.80	3.6 km
Potato	0.24	1.2 km
Chicken	4.60	22.7 km
Pork	6.40	31.6 km
Beef	16.00	79.1 km

Source: Williams, Audsley, and Sandars 2006.

Note: The figure shows CO_2 equivalent emissions in kilograms resulting from the production (in an industrial country) of 1 kilogram of a specific product. The car and road image conveys the number of kilometers one must drive in a gasoline-powered car averaging 11.5 kilometers a liter to produce the given amount of CO_2e emissions. For example, producing 1 kilogram of beef and driving 79.1 kilometers both result in 16 kilograms of emissions.

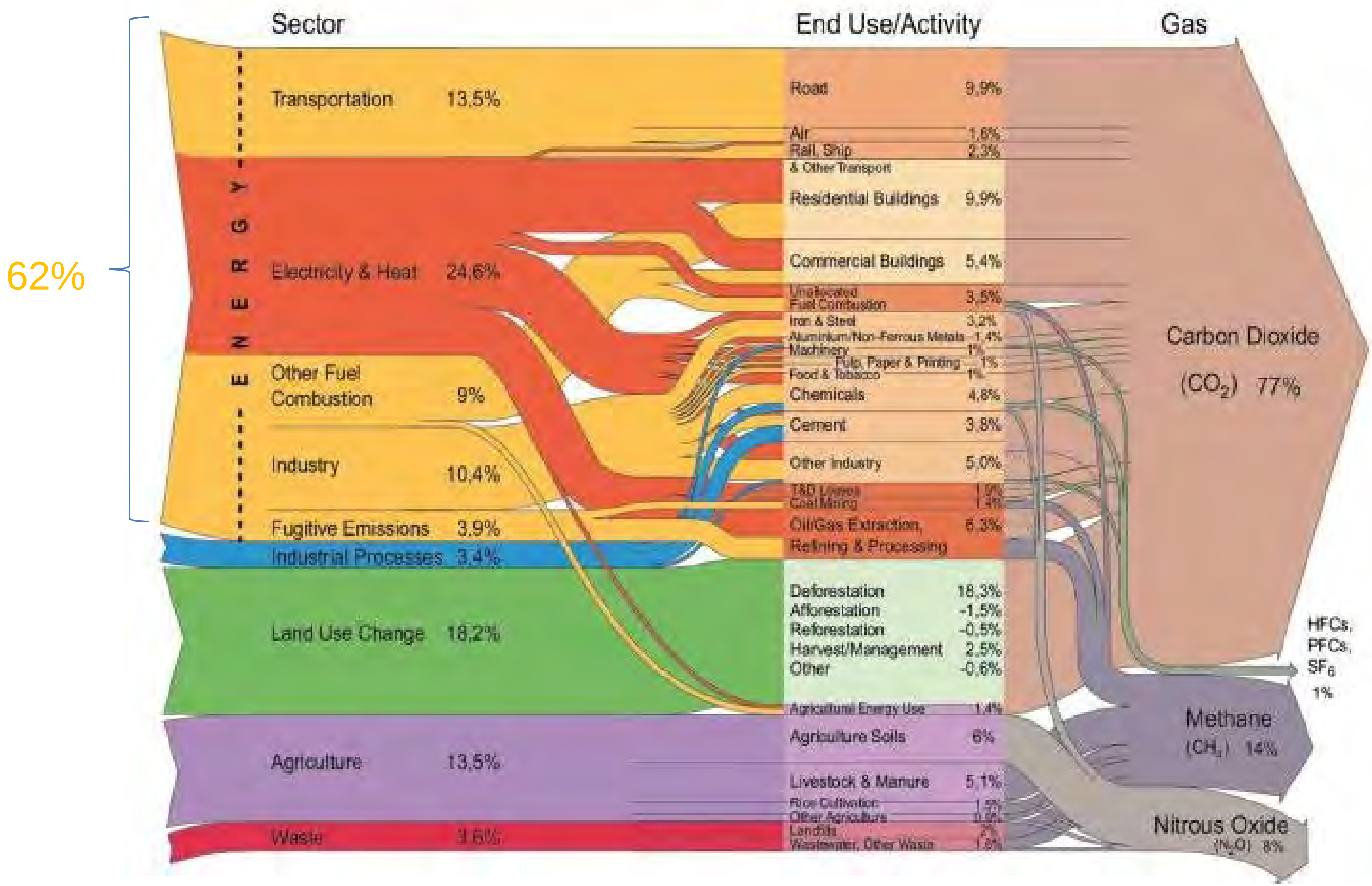
Redução das Emissões Globais de CO_2 do Sector da Energia no Cenário de 450 ppmv



Fonte:AIE

•An additional $10.5 trillion of investment is needed in total in the 450 Scenario, with measures to boost energy efficiency accounting for most of the abatement through to 2030

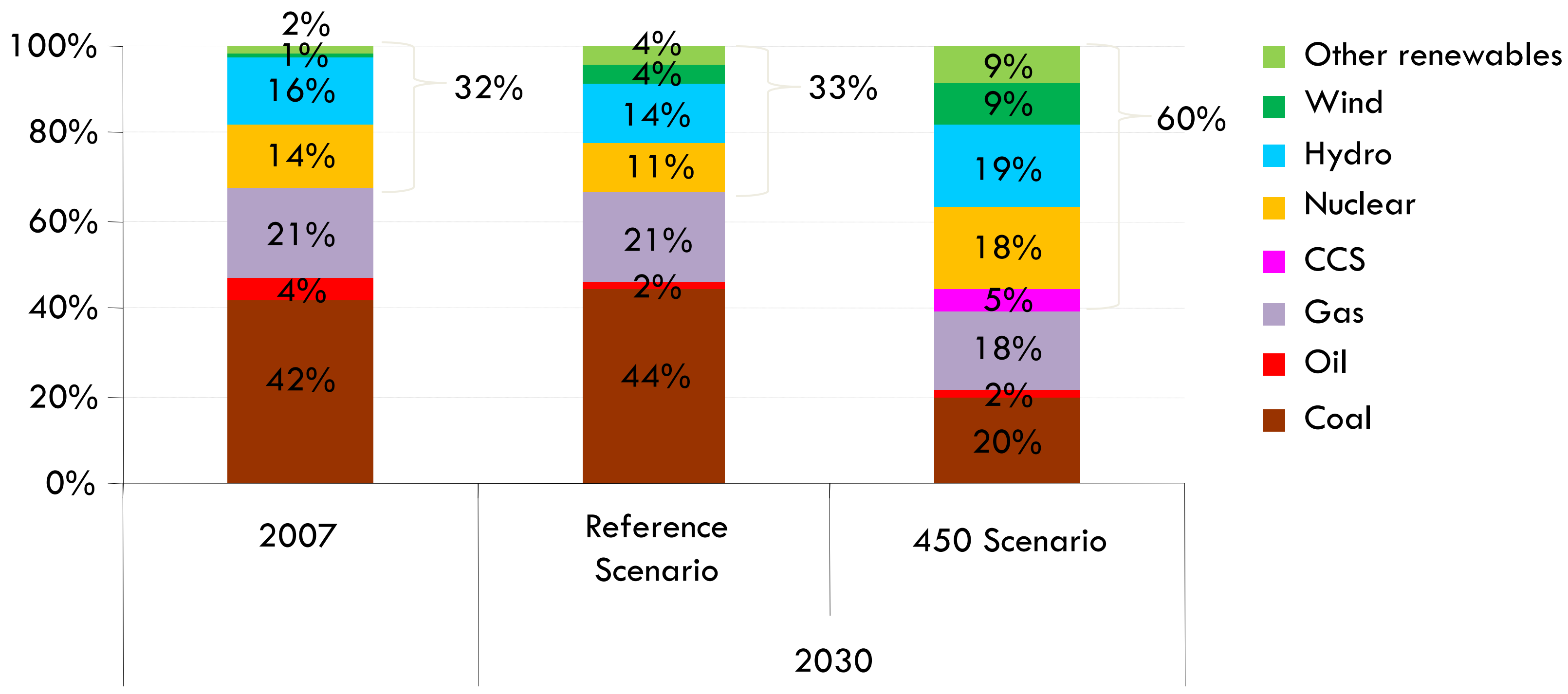
World Greenhouse gas emissions by sector



All data is for 2000. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41 755 $MtCO_2$ equivalent. Land use change includes both emissions and absorptions. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

Source: World Resources Institute, Climate Analysis Indicator Tool (CAIT), Navigating the Numbers: Greenhouse Gas Data and International Climate Policy, December 2005; Intergovernmental Panel on Climate Change, 1996 (data for 2000).

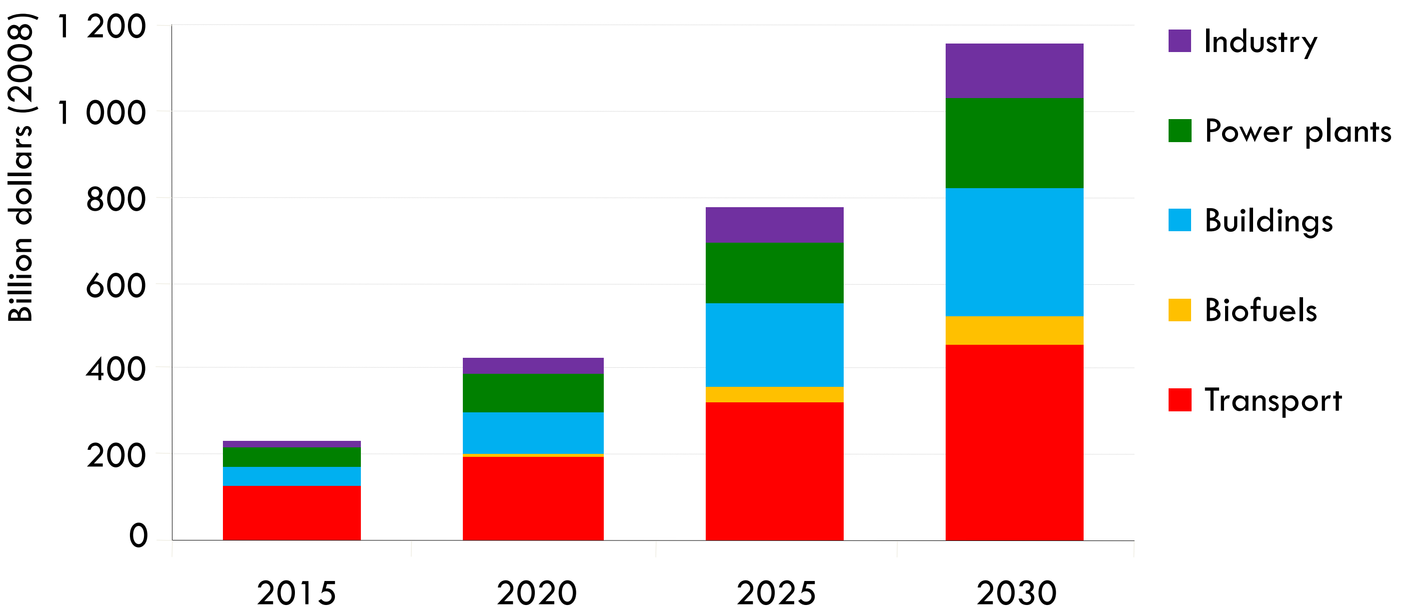
Percentagem de Tecnologias de Carbono-Zero ou Baixo na Geração de Electricidade no Cenário de 450 ppmv



Fonte: AIE

•In the 450 Scenario, low- & zero-carbon technologies account for 60% of world
•electricity generation by 2030, up from 32% today

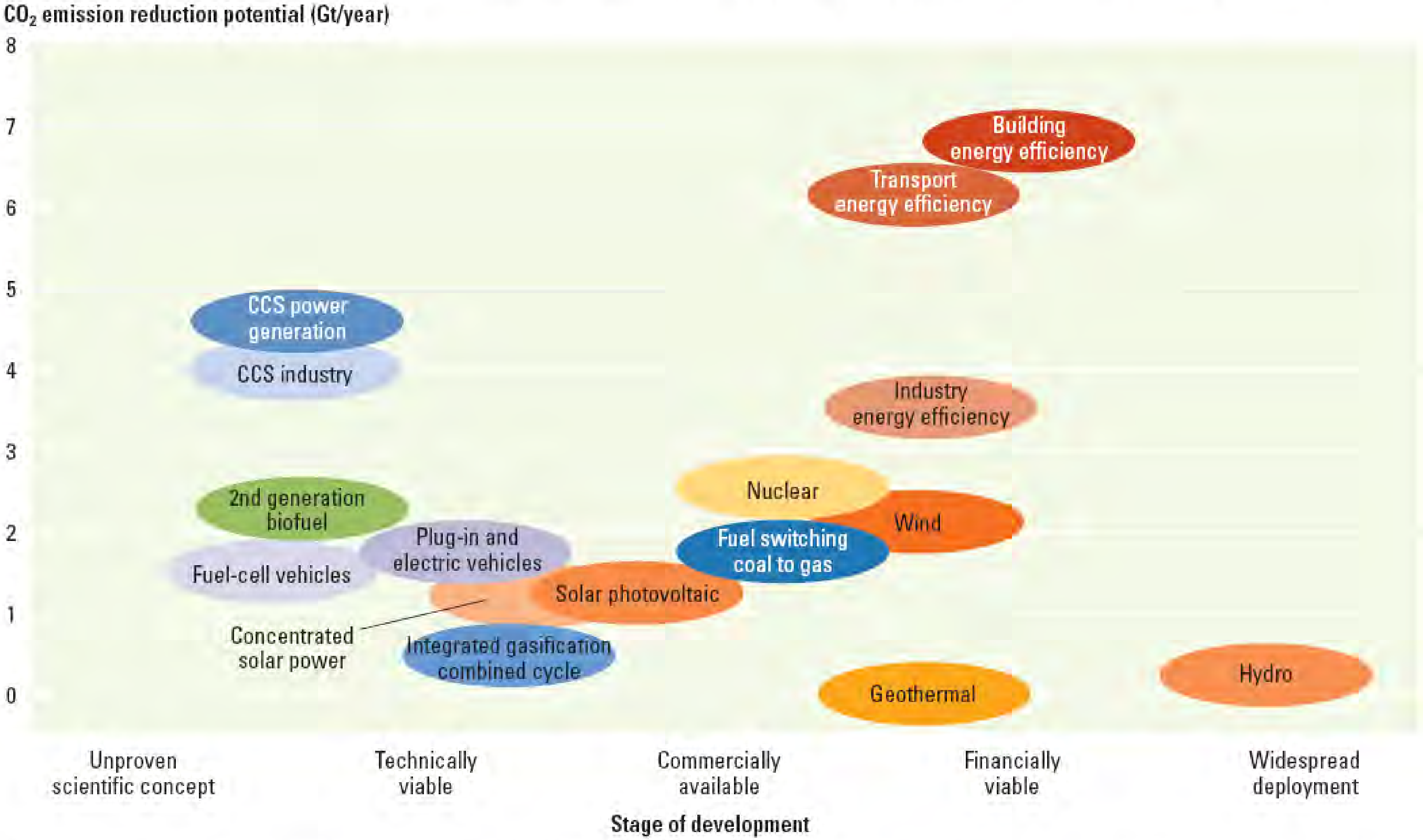
Quanto Custa?
Investimento Adicional no Cenário de 450 ppmv Relativamente ao Cenário de Referência



Fonte: AIE

• *$10.5 trillion of additional investment is needed in the 450 Scenario in the period 2010-2030 compared with the Reference Scenario, costing 0.5% of GDP in 2020 & 1.1% of GDP in 2030*

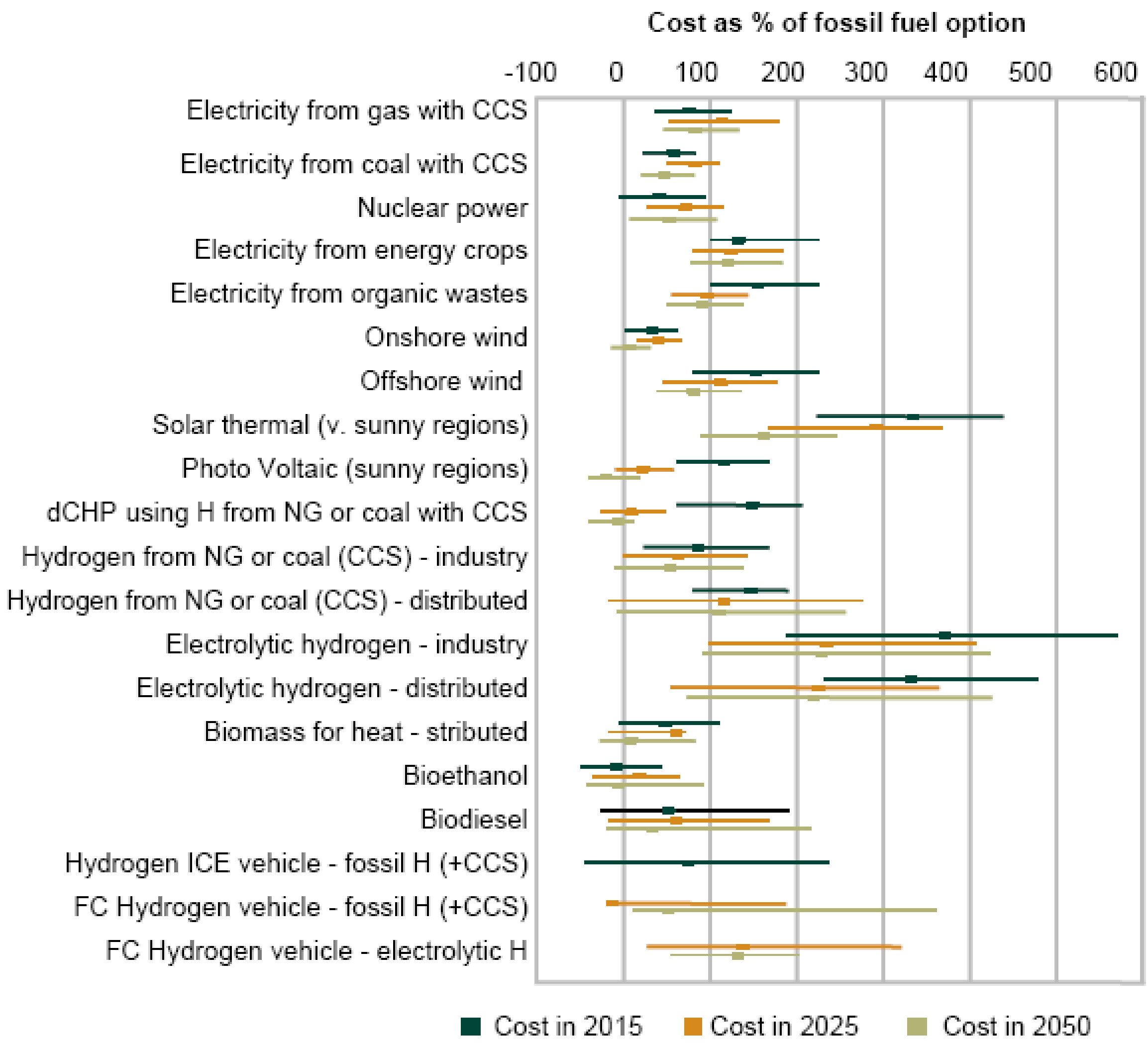
Figure 4.11 The goal is to push low-carbon technologies from unproven concept to widespread deployment and to higher emission reductions



Source: WDR team, based on data from World Bank 2008a and IEA 2008a (mitigation potential from IEA Blue Scenario in 2050).

Note: See table 4.4 for detailed definitions of technology development stage. A given technology group can be progressing through different stages at the same time but in different country settings and at different scales. Wind, for example, is already cost competitive with gas-fired power plants in most of the United States (Wiser and Bolinger 2008). But in China and India wind may be economically but not financially viable against coal-fired power plants. So for clean technologies to be adopted in more places and at larger scales, they must move from the top to bottom in table 4.4.

Figure 22. Unit costs of energy technologies: proportion of fossil-fuel alternative, 2015, 2025 and 2050



Source: Anderson, D. (2006).

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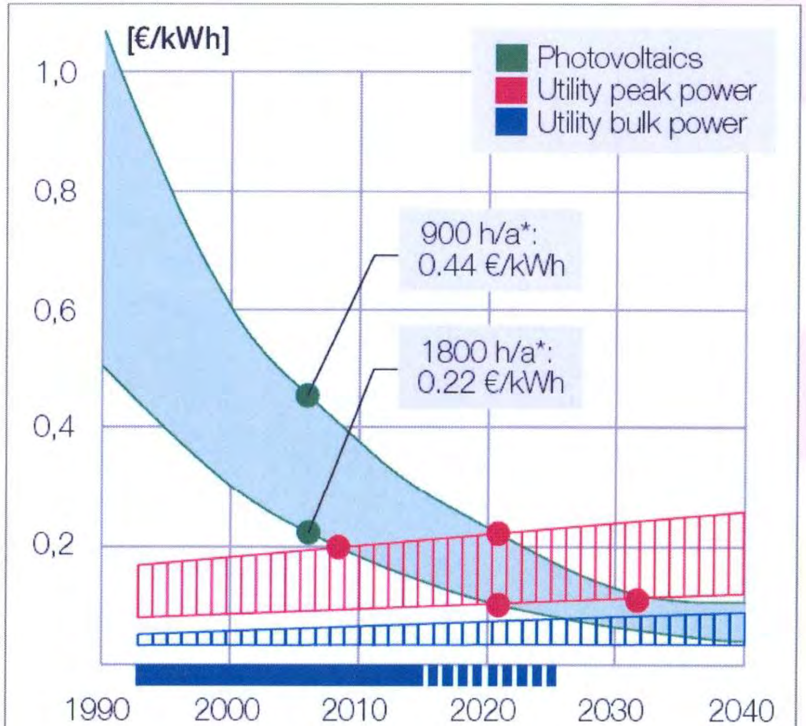
[53] *See Barker, T. et al. (2002).*

General Outlook



*h/a: Hours of sun per annum
900 h/a corresponds to northern countries of Europe
1800 h/a corresponds to southern countries of Europe

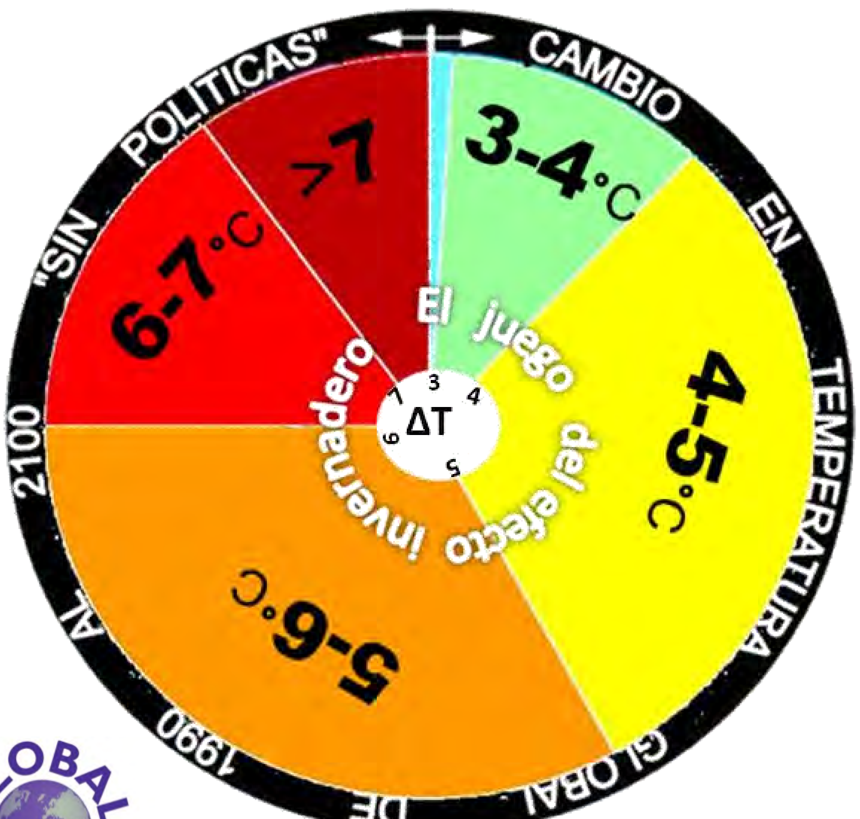
Note: The blue band indicates that market support programmes will be necessary until about 2020 in some markets.

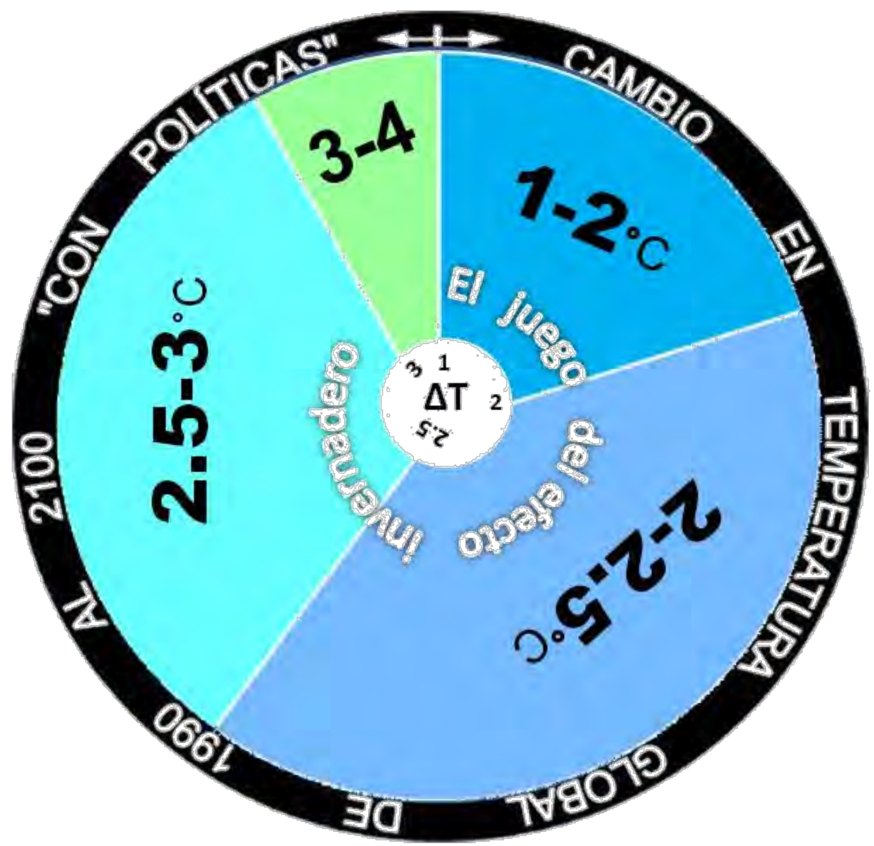
Lidar com a incerteza em políticas climáticas

Sem Políticas climáticas

Estabilização do CO_2 em 550ppm:

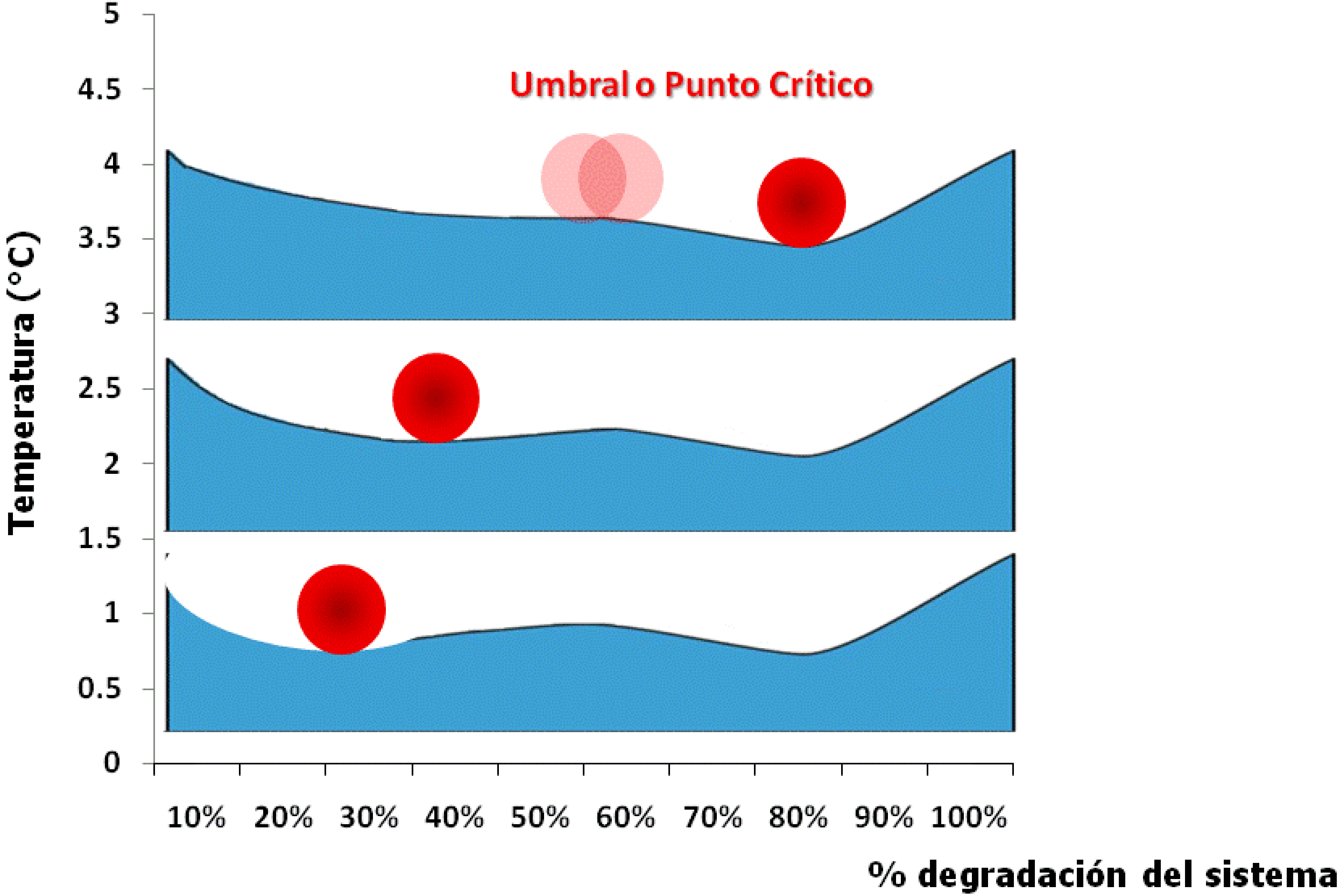
Uma nova roda com políticas





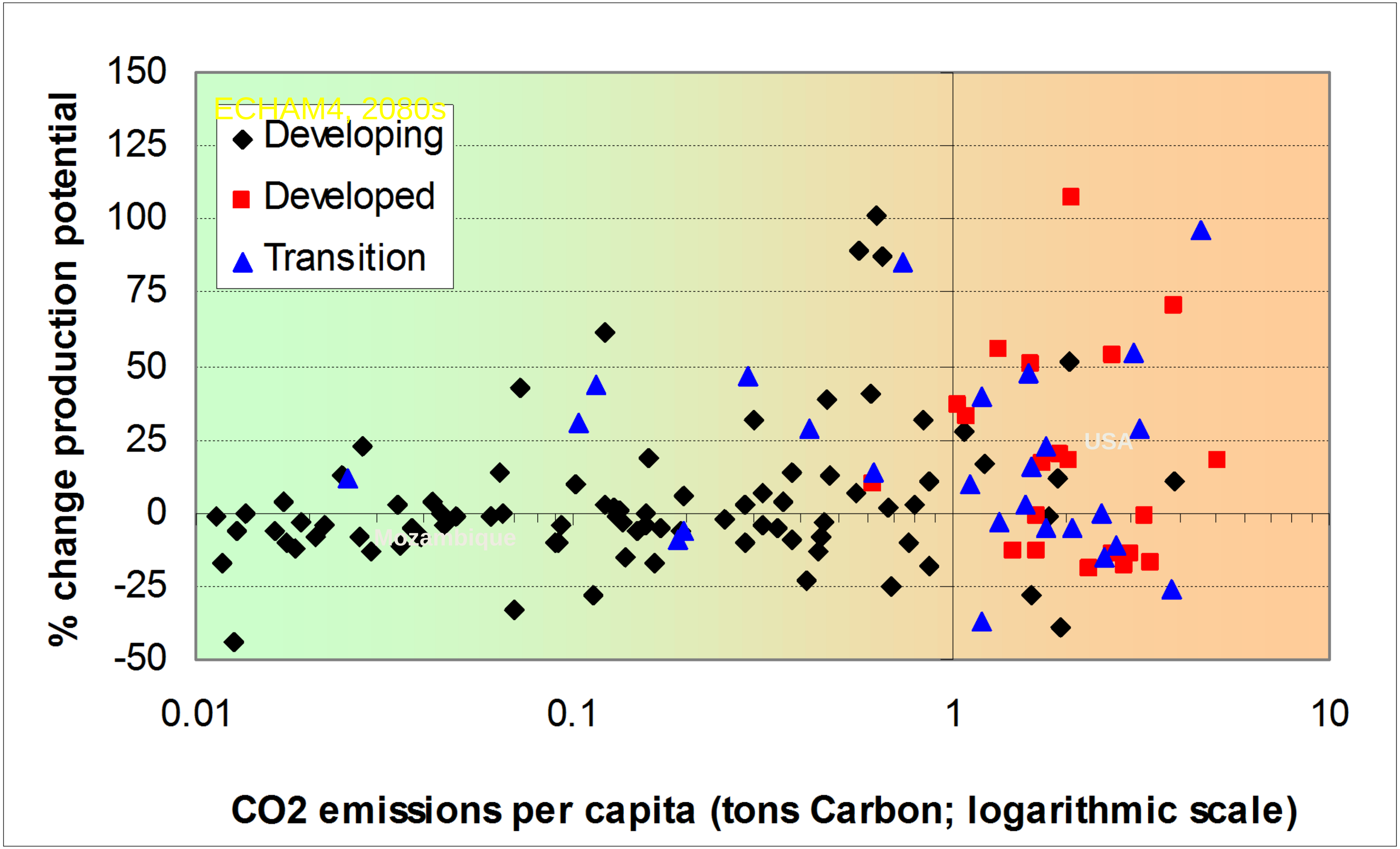
Fuente: MIT, 2009

Pontos críticos
na interferência sobre o sistema climático



Fuente: Lenton et al. Tipping elements in the Earth's climate system *Proc Natl Acad Sci USA*, 2008

Impactos das alterações climáticas na produção agrícola



Emissões acumuladas desde 1950: 75% dos países desenvolvidos e 25% dos países em desenvolvimentos

Medidas de Adaptação

Procura de Recursos Hídricos

1. Aumento da eficiência no uso da água por meio da reciclagem;
2. Redução da procura de água para irrigação por meio de alterações na:
   a) Calendarização das culturas
   b) Composição e variedade dos cultivares;
   c) Métodos de irrigação
   d) Área de plantio
3. Redução da procura de água para irrigação por importação de produtos agrícolas, ou seja, água virtual e optimização à escala global.

Procura de Recursos Hídricos (cont.)

4. Promoção das práticas locais indígenas de uso sustentável da água
5. Melhor uso dos mercados da água para redistribuição da procura no sentido dos usos mais indispensáveis e sustentáveis;
6. Melhor uso de incentivos económicos e financeiros, incluindo a contagem e valorização para encorajar a conservação da água.

Obrigado pela Atenção

Figure 2.1: Annual Growth Rates from 1990 to 2005 vs. Income Level in 1990

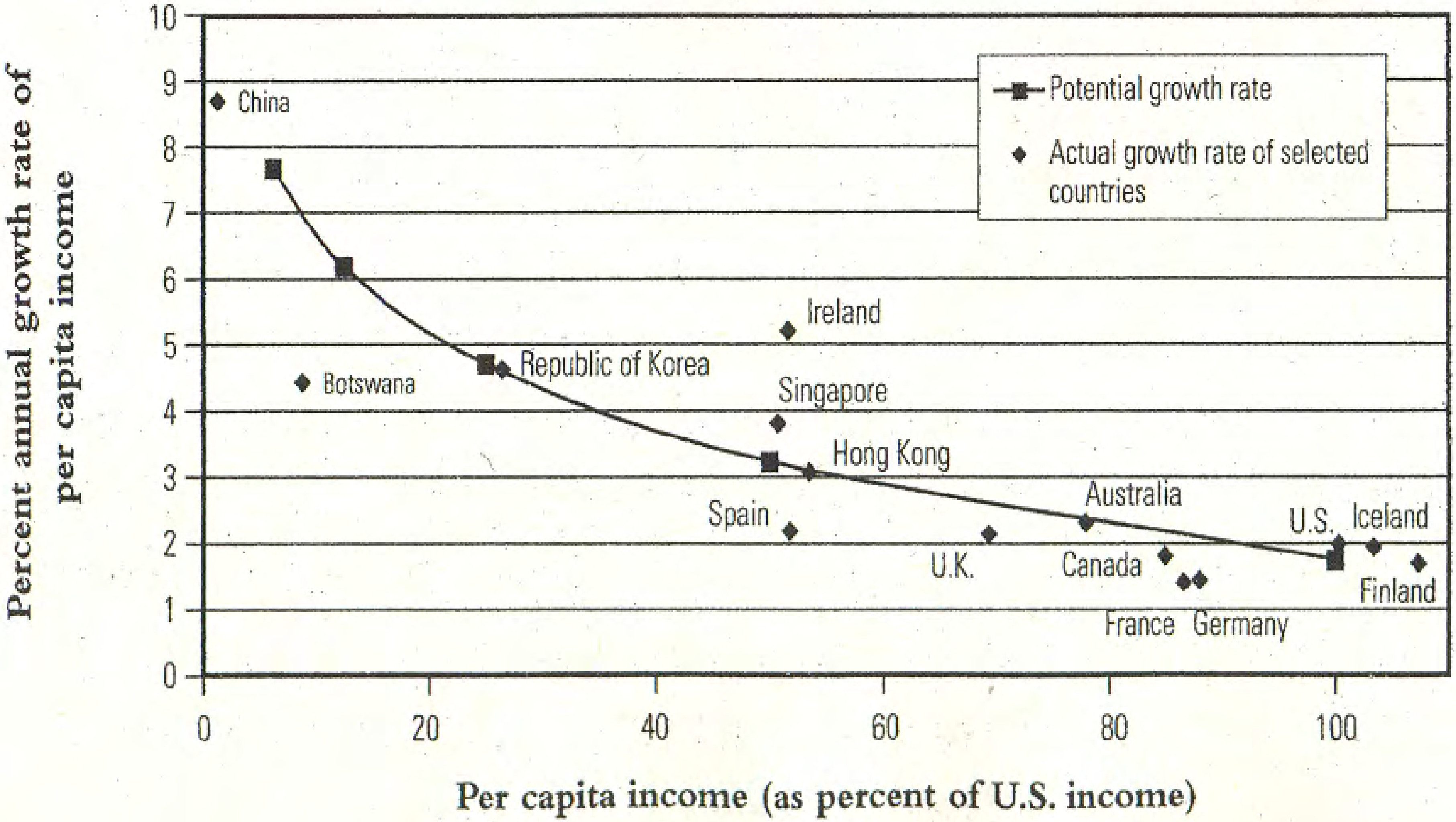
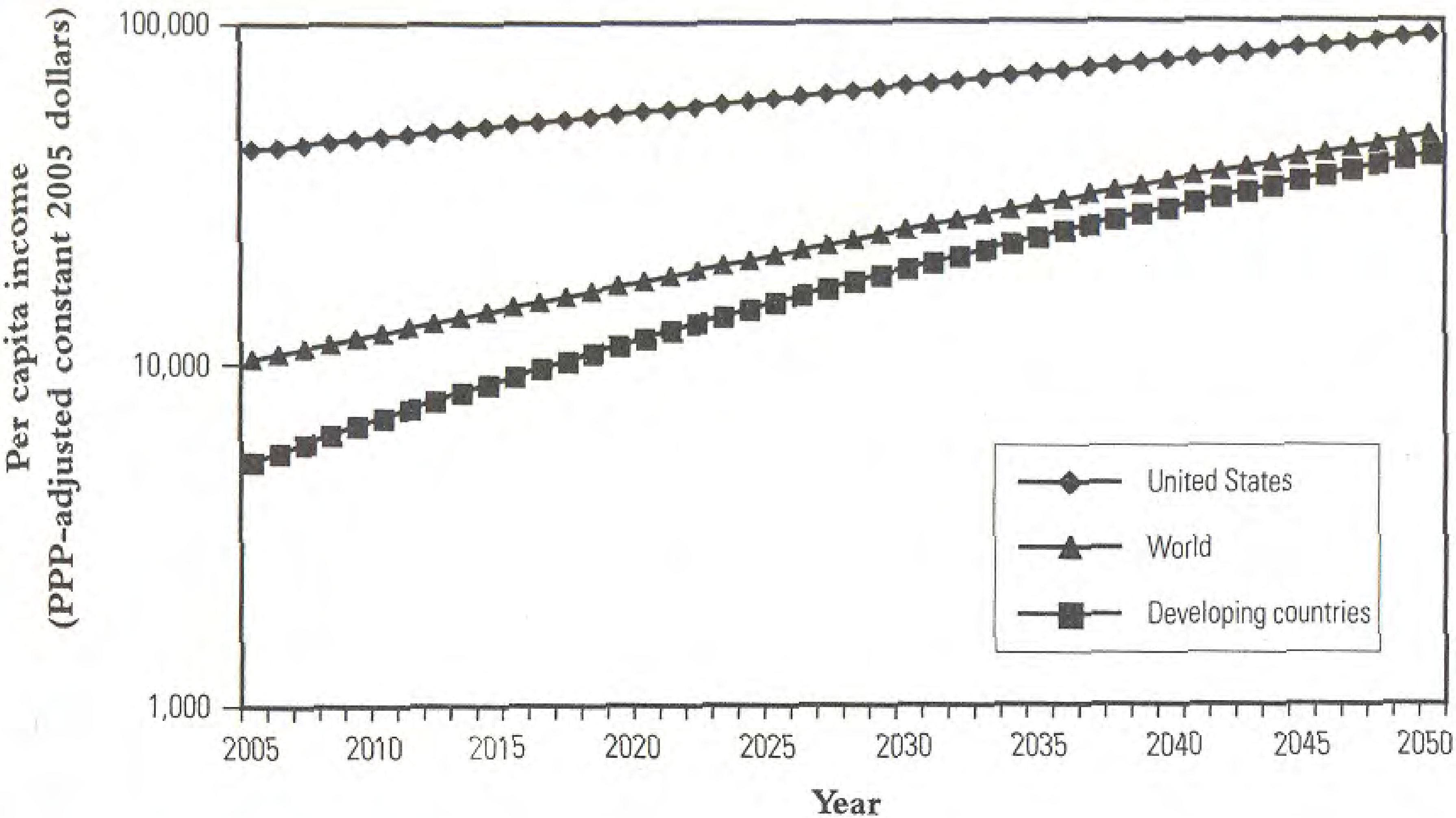


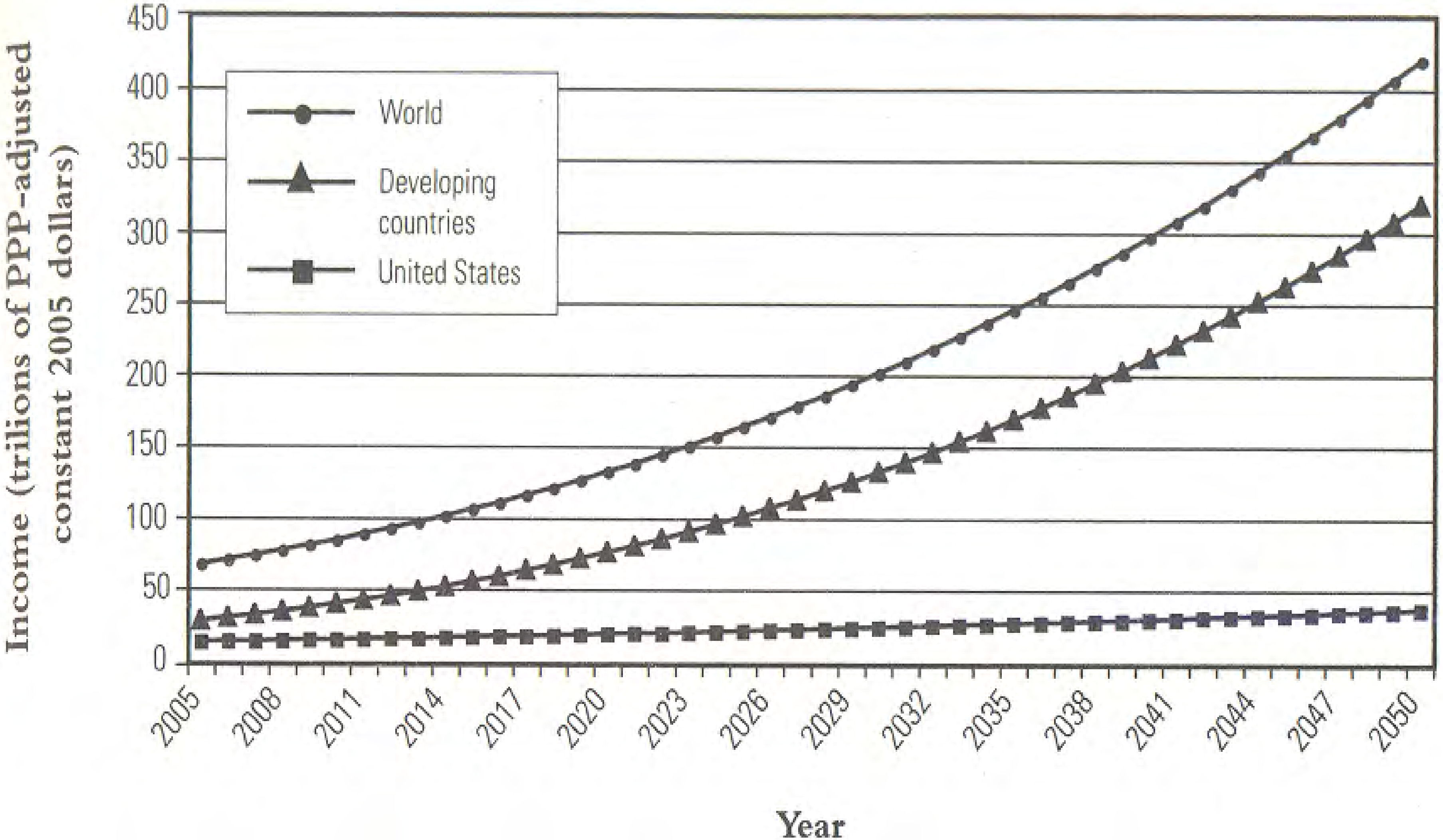
Figure 2.2(a): The Convergence of Global Income per Capita through 2050



Source: Calculated using data from World Bank (2007)

Note: Vertical axis on logarithmic scale. Income is measured in purchasing power parity (PPP) to adjust for difference in price levels across countries.

Figure 2.2(b): World Product through 2050



Source: Calculated using data from World Bank (2007)