ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

DUWIS
Departement
Umweltwissenschaften

Climate Change and Its Impacts On Humankind

Andreas Fischlin

Senior coordinating lead author of chapter on ecosystems of the Fourth Assessment Report of IPCC «Climate Change 2007» Working Group II

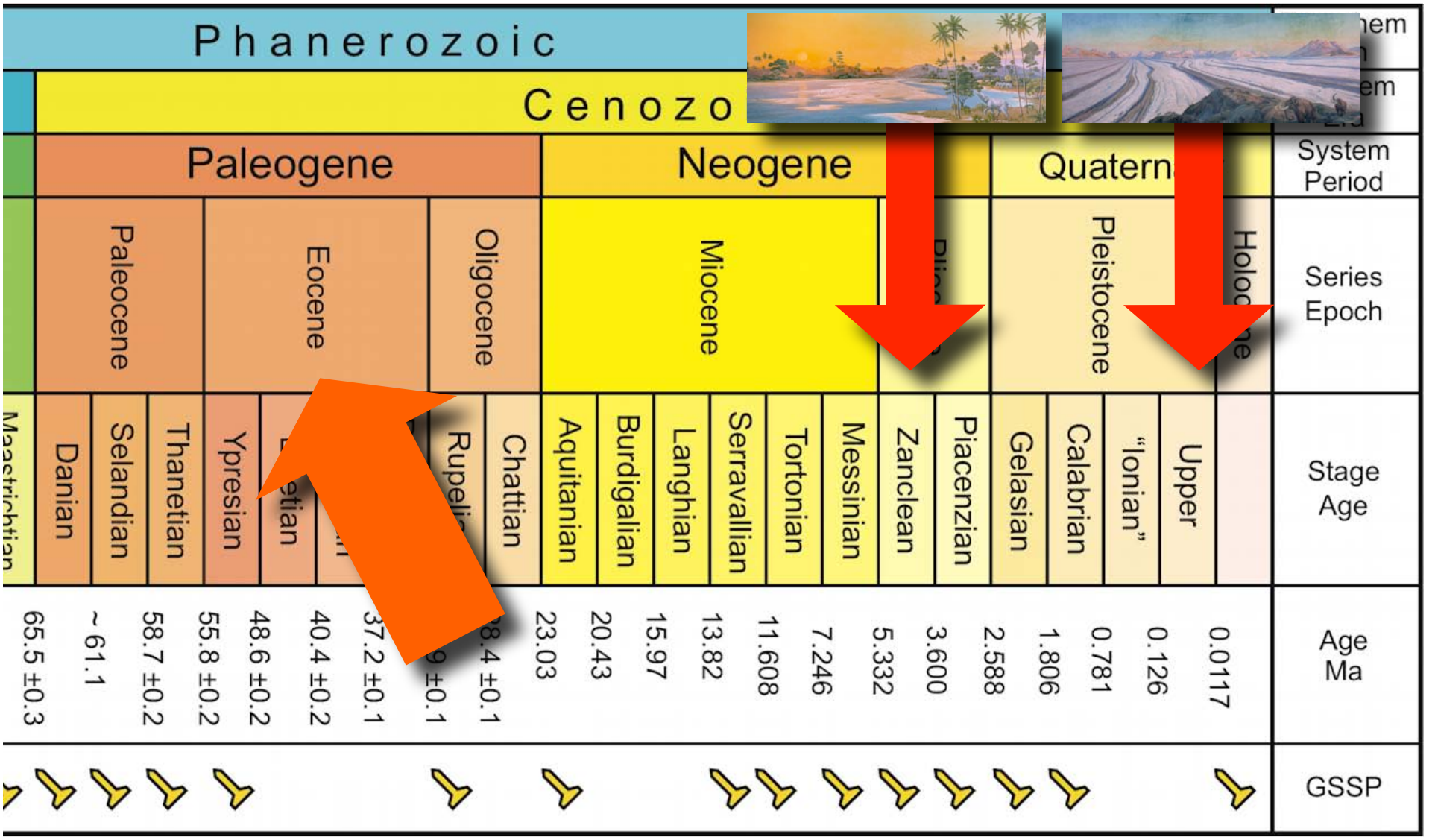
Summary:

- Climate is important
- Climate change is real and human made
- Climate change can impact all sectors, including human health
- Climate change poses huge challenges:
  - Climate change effects are delayed
  - Impacts are uneven, geographically and socially
- It matters a great deal whether and how we solve the climate change challenge!

Climate Is
Important!

Lucerne ~4-23 Ma BP (Miocene)
Lucerne 18’000 a BP (>LGM)

Context of Past Epochs



ICS International Commission on Stratigraphy

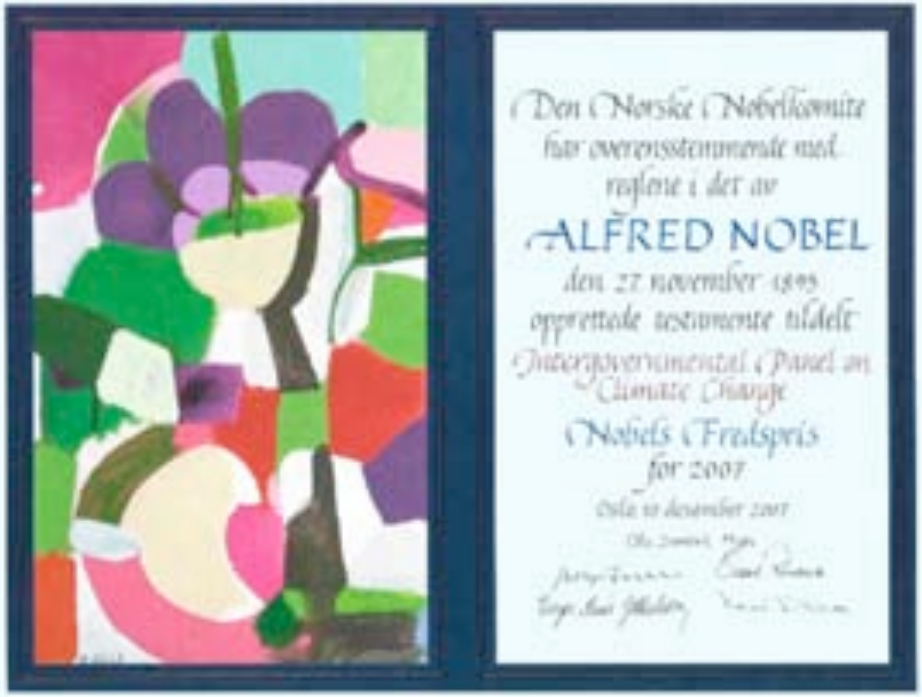
Global Standard Section and Point (GSSP)

www.stratigraphy.org/

On IPCC

Intergovernmental Panel on Climate Change

Nobel Peace Prize 2007 for IPCC



WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

PRESENTED TO

ANDREAS FISCHLIN

FOR CONTRIBUTING TO THE AWARD OF THE

NOBEL PEACE PRIZE

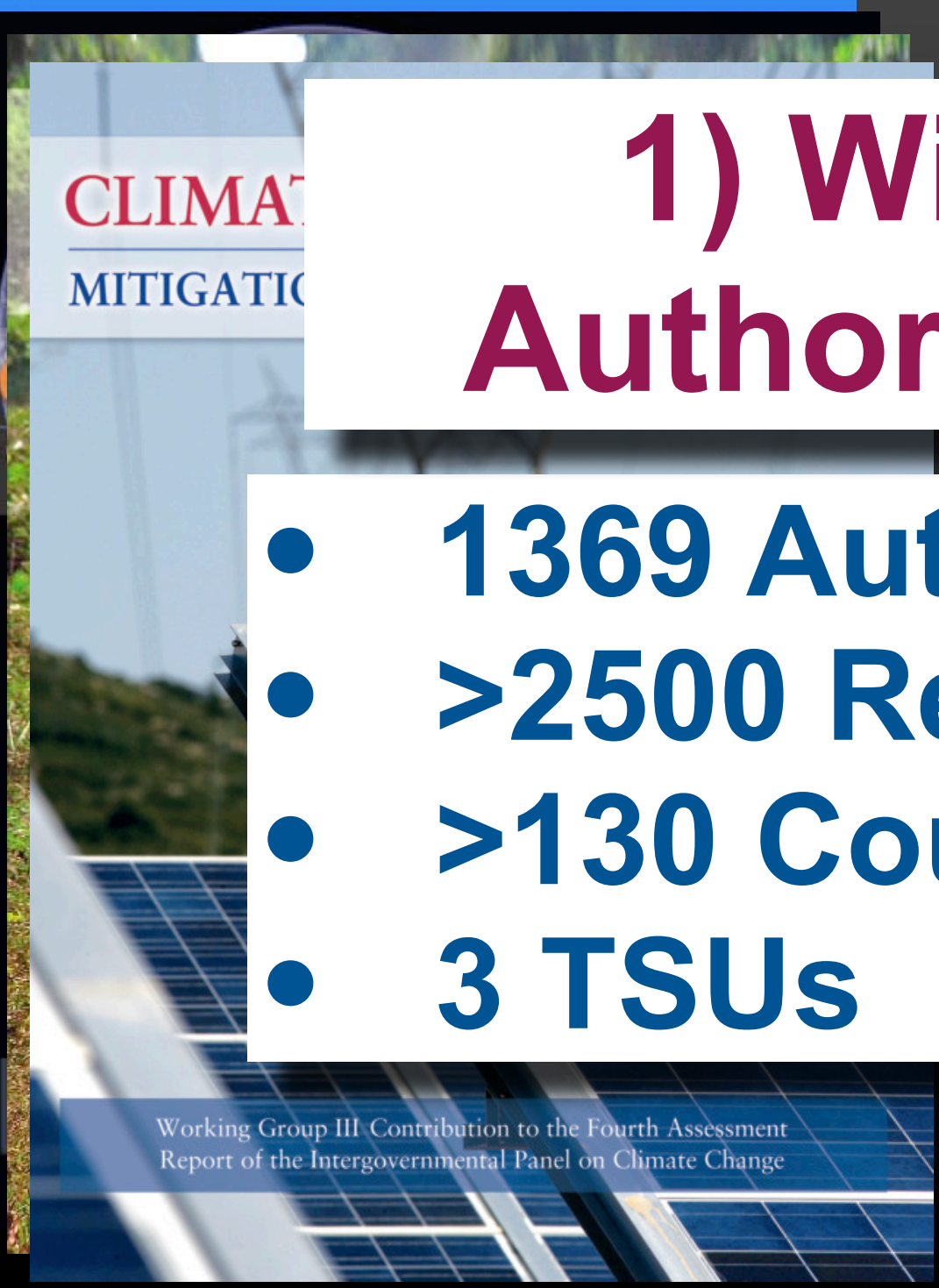
FOR 2007 TO THE IPCC

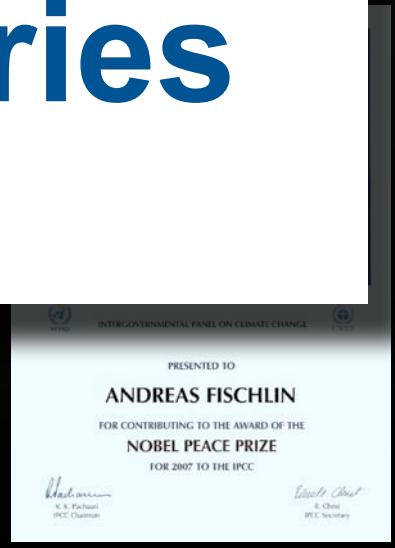
R. K. Pachauri
IPCC Chairman

R. Christ
IPCC Secretary

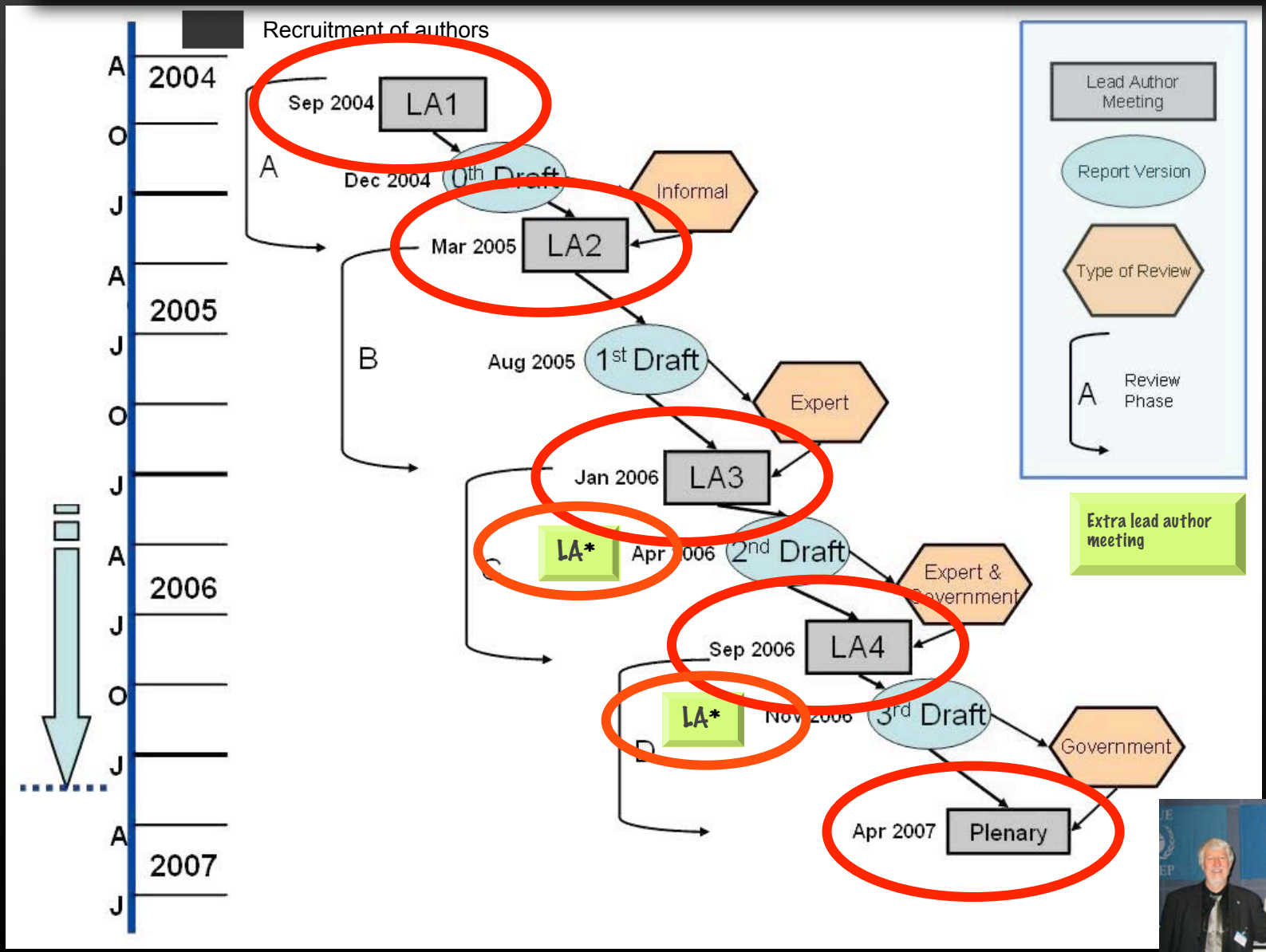
1) Wide Authorship

- 1369 Authors
- >2500 Reviewers
- >130 Countries
- 3 TSUs





2) Transparent



IPCC Key Points

- Governments need information
- IPCC formed 1988 under auspices of the UN
- Has to provide assessments of science of climate change
- Scientific community contributes widely and on a voluntary basis (fluctuation 75% TAR->AR4)
- Substance of IPCC reports in hands of scientists

Impressions From Kyoto 1 ...

IPCC Key Points

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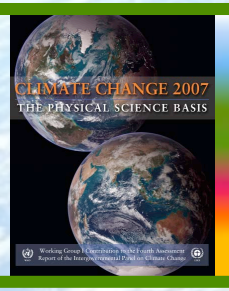
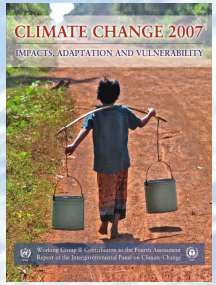
IPCC Assessment Report 4

The Voice of Science

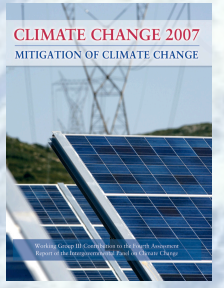
Anthropogenic climate change is real



Unmitigated climate change would cause major impacts



A drastic climate change is still avoidable



IPCC Assessment Report 4

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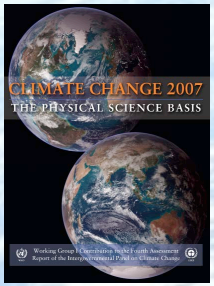

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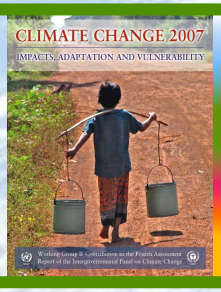

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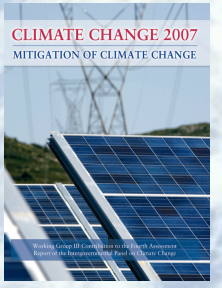

IPCC Assessment Report 4

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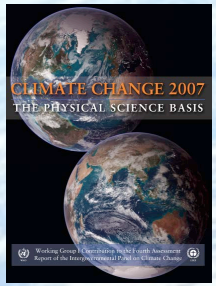
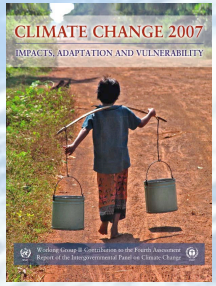


Unmitigated climate change would cause major impacts



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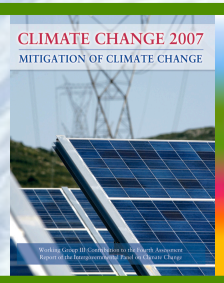

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Anthrop change

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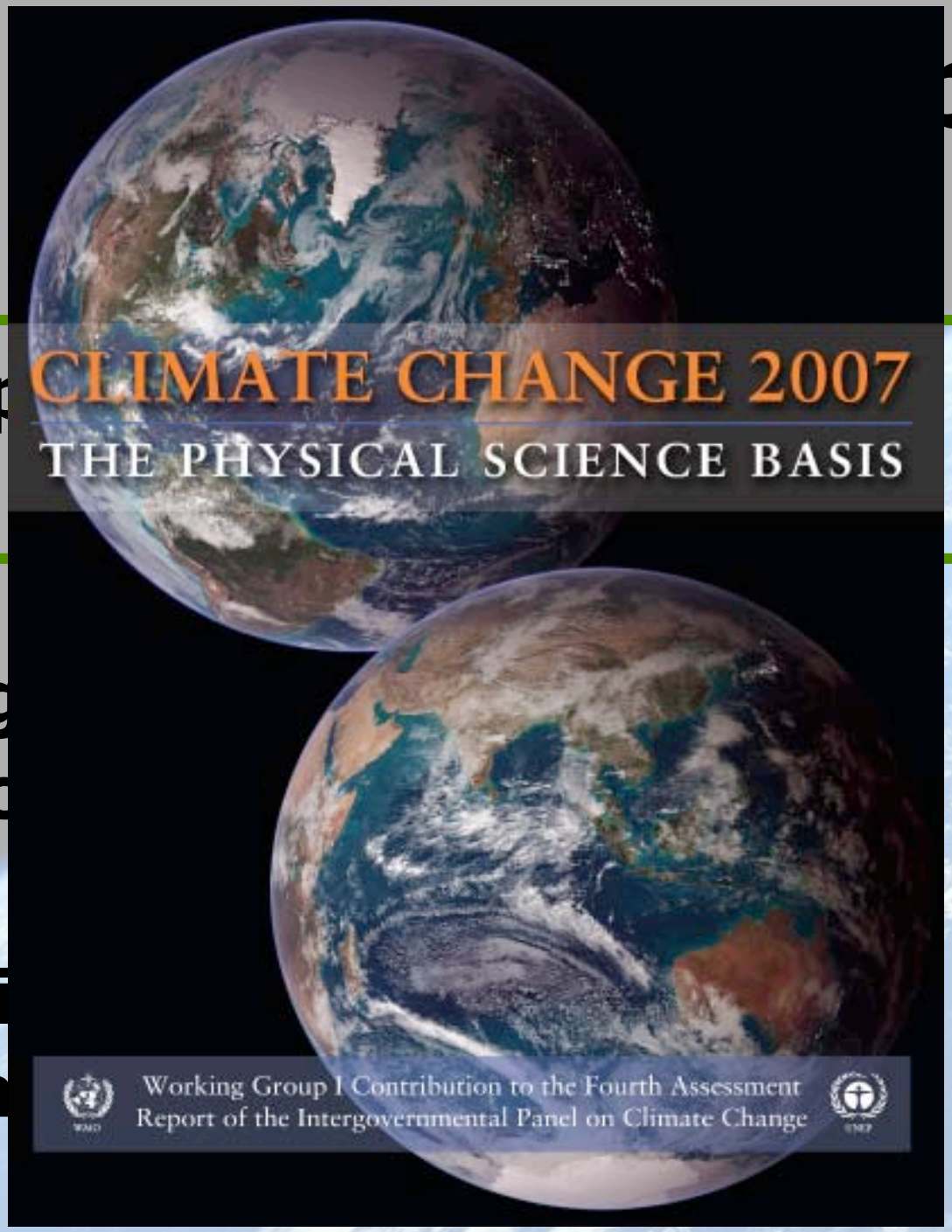
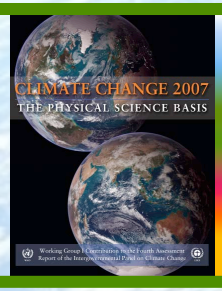
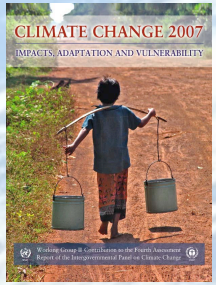
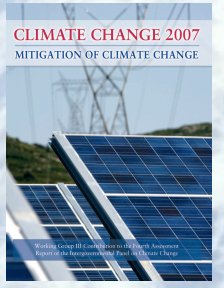


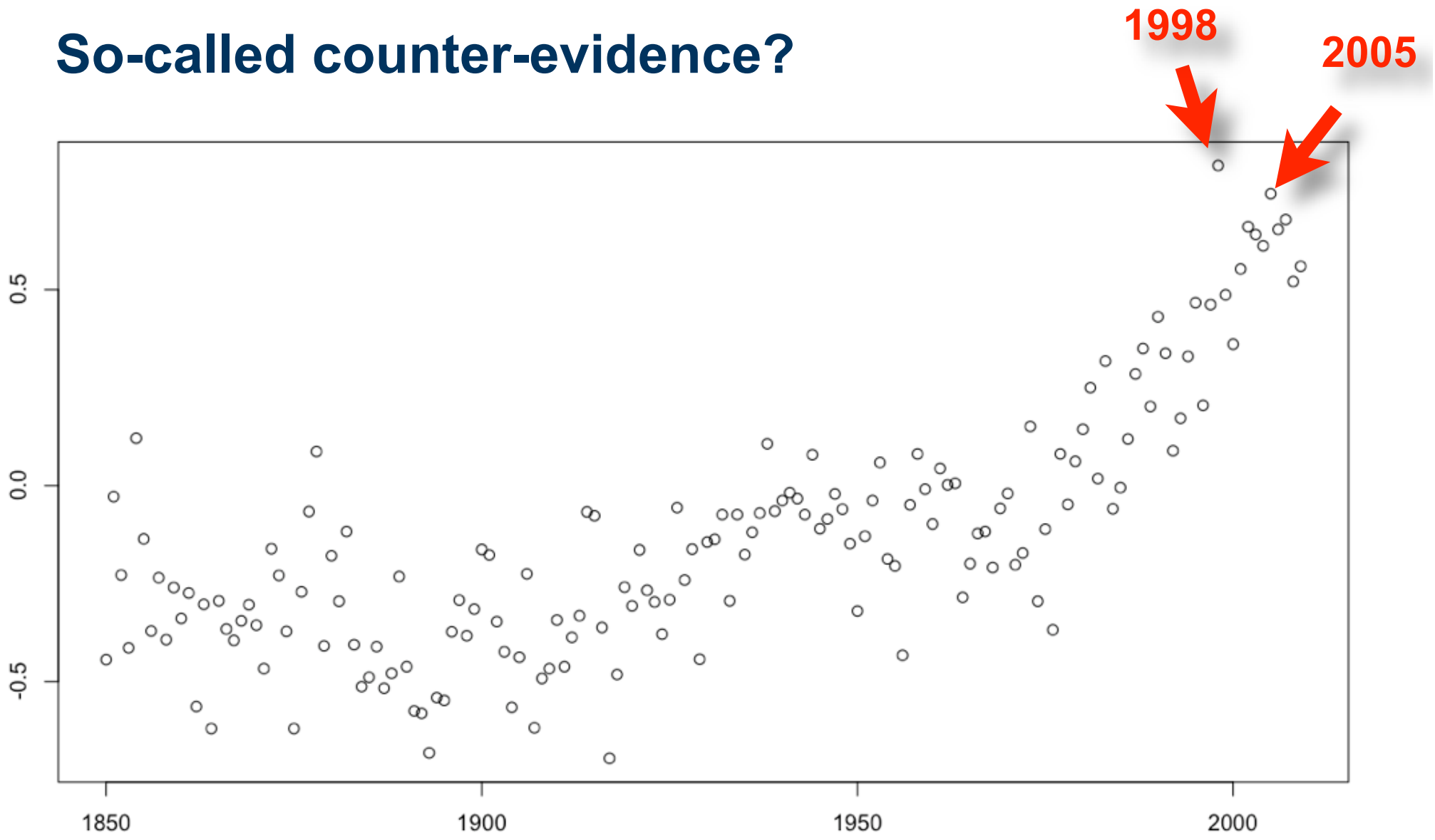






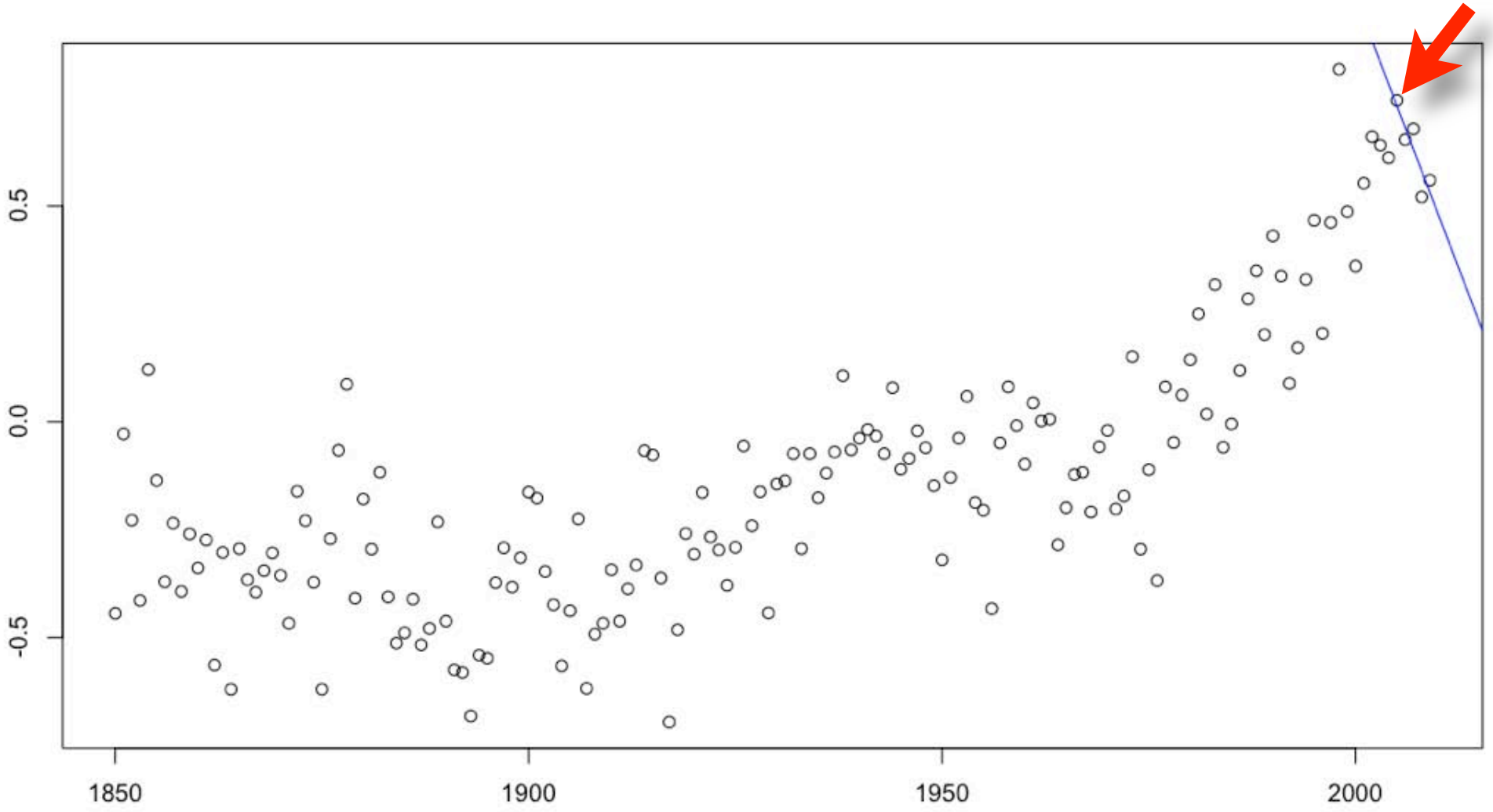
Does Climate Change?

So-called counter-evidence?



So-called counter-evidence?

2005



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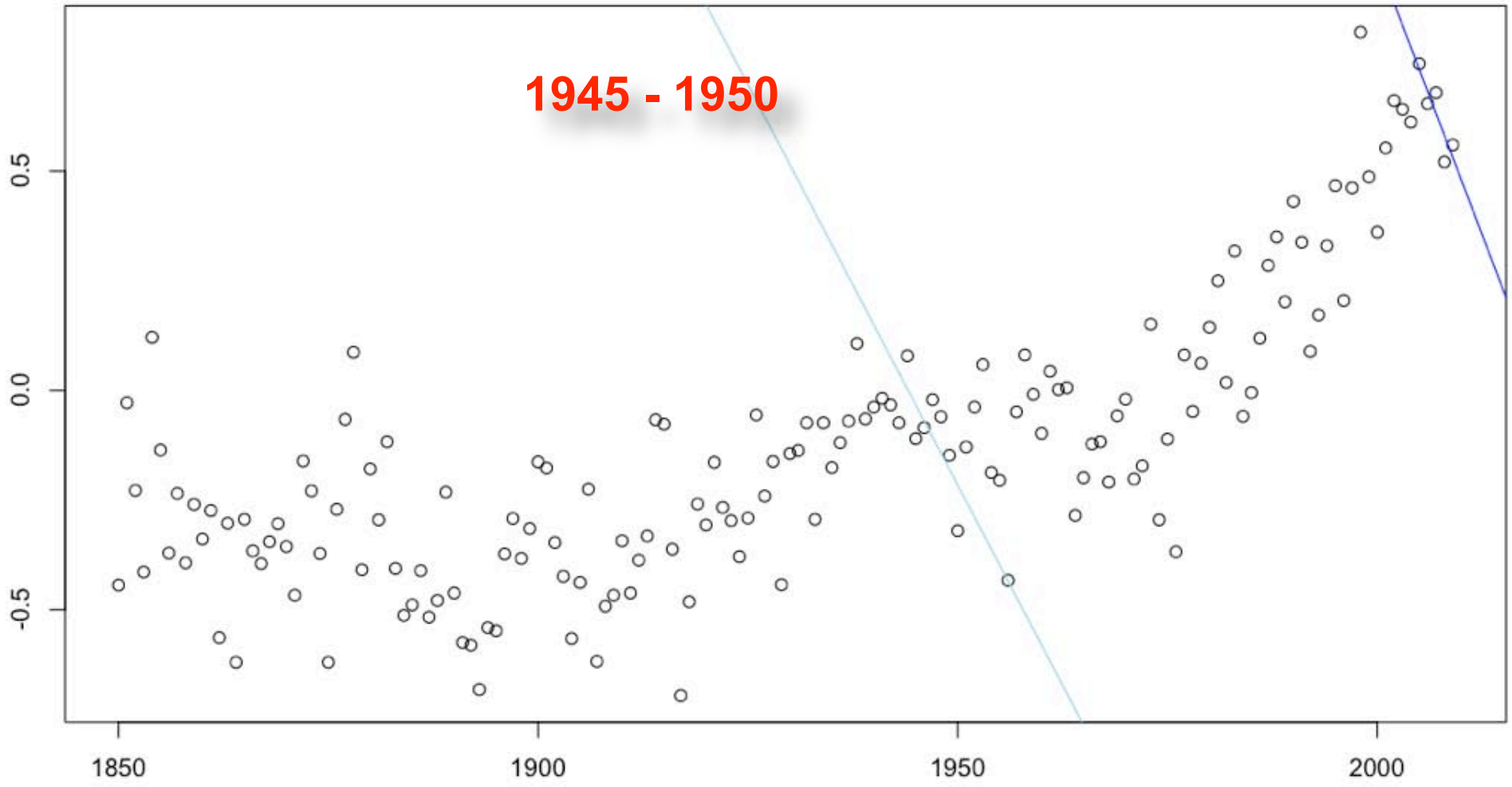

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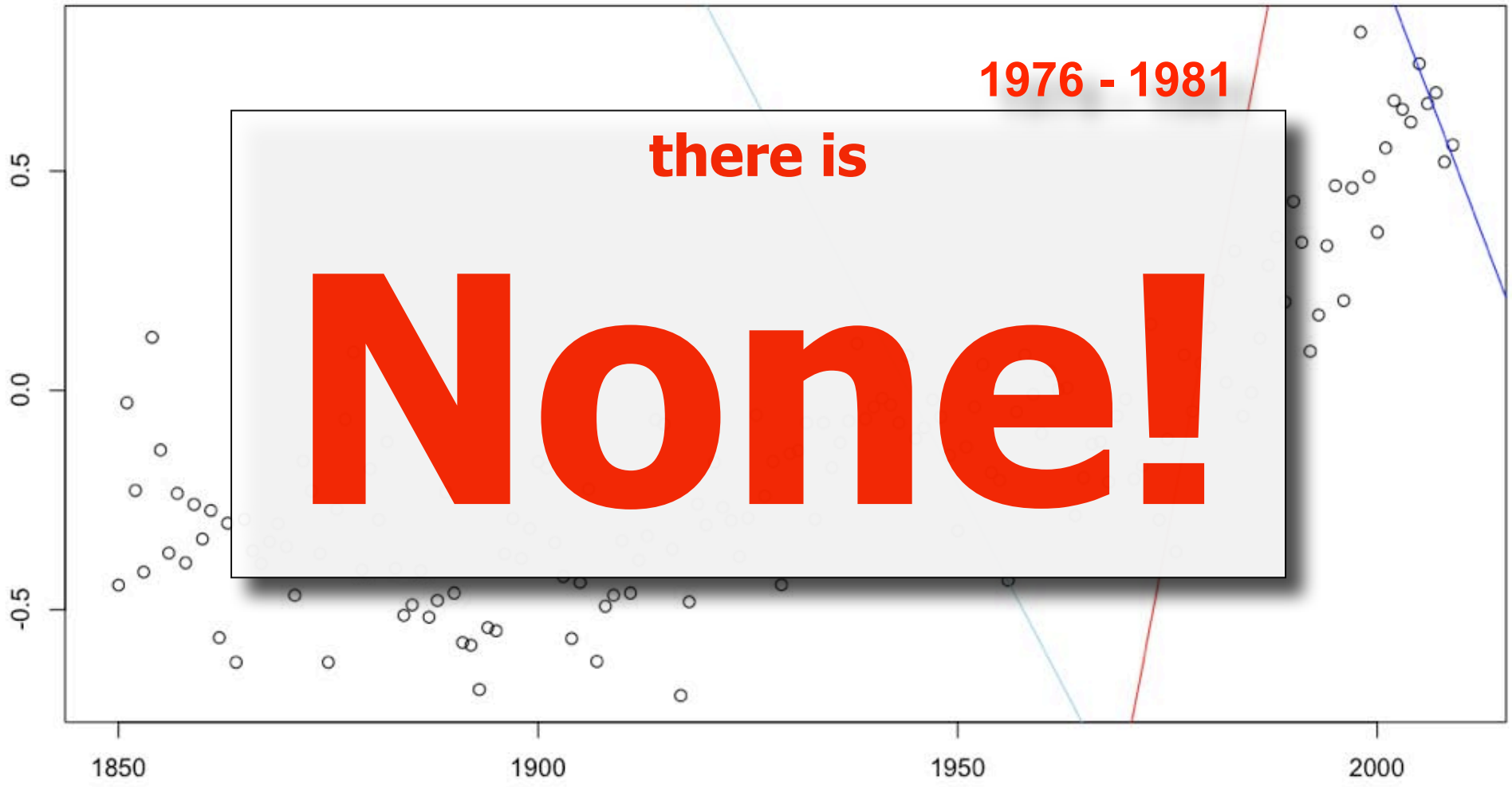
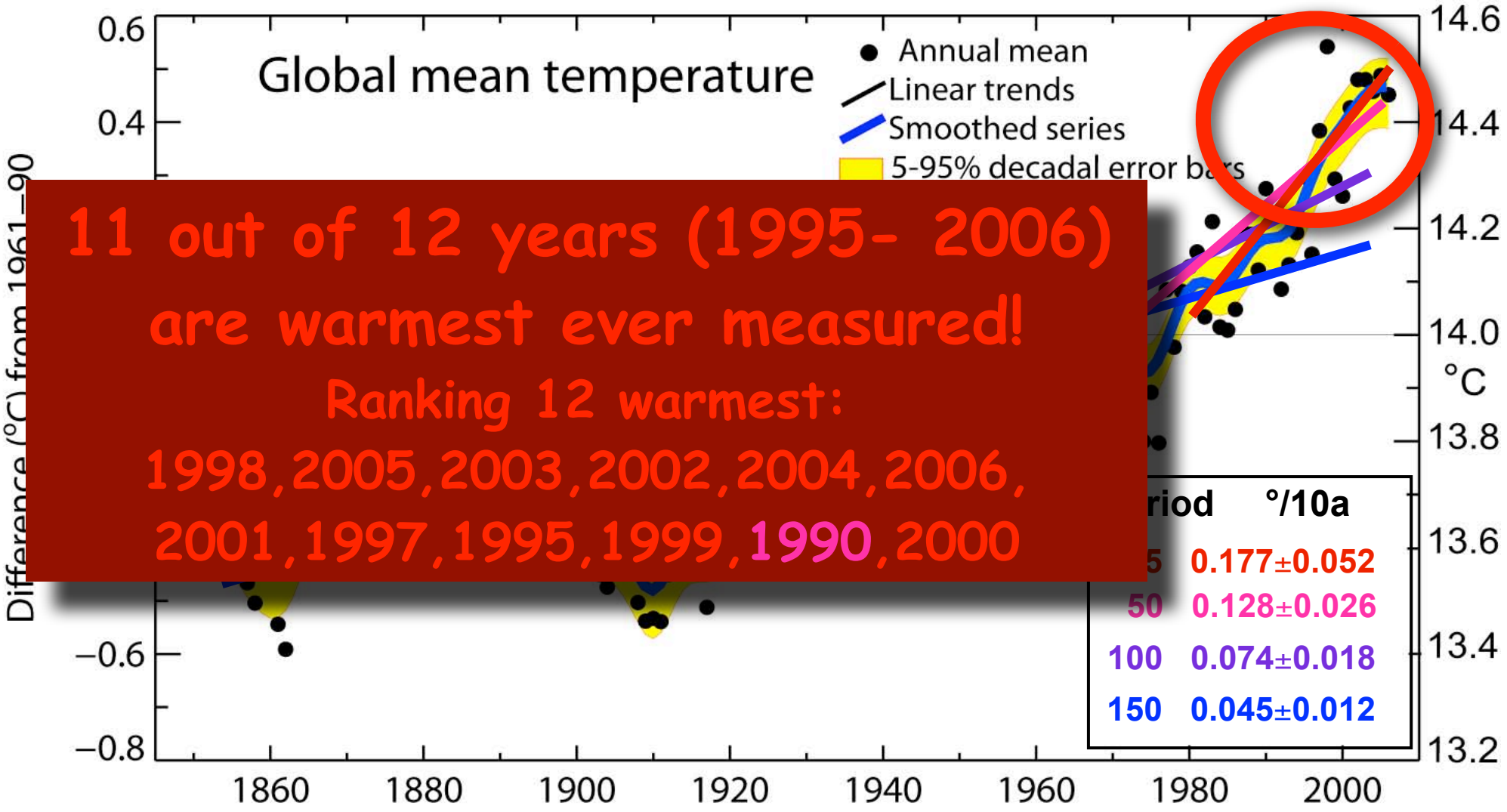


Observed Temperatures

After Figure TS.6 (IPCC, 2007b.
Technical Summary (TS) WGI)



Observed Temperatures

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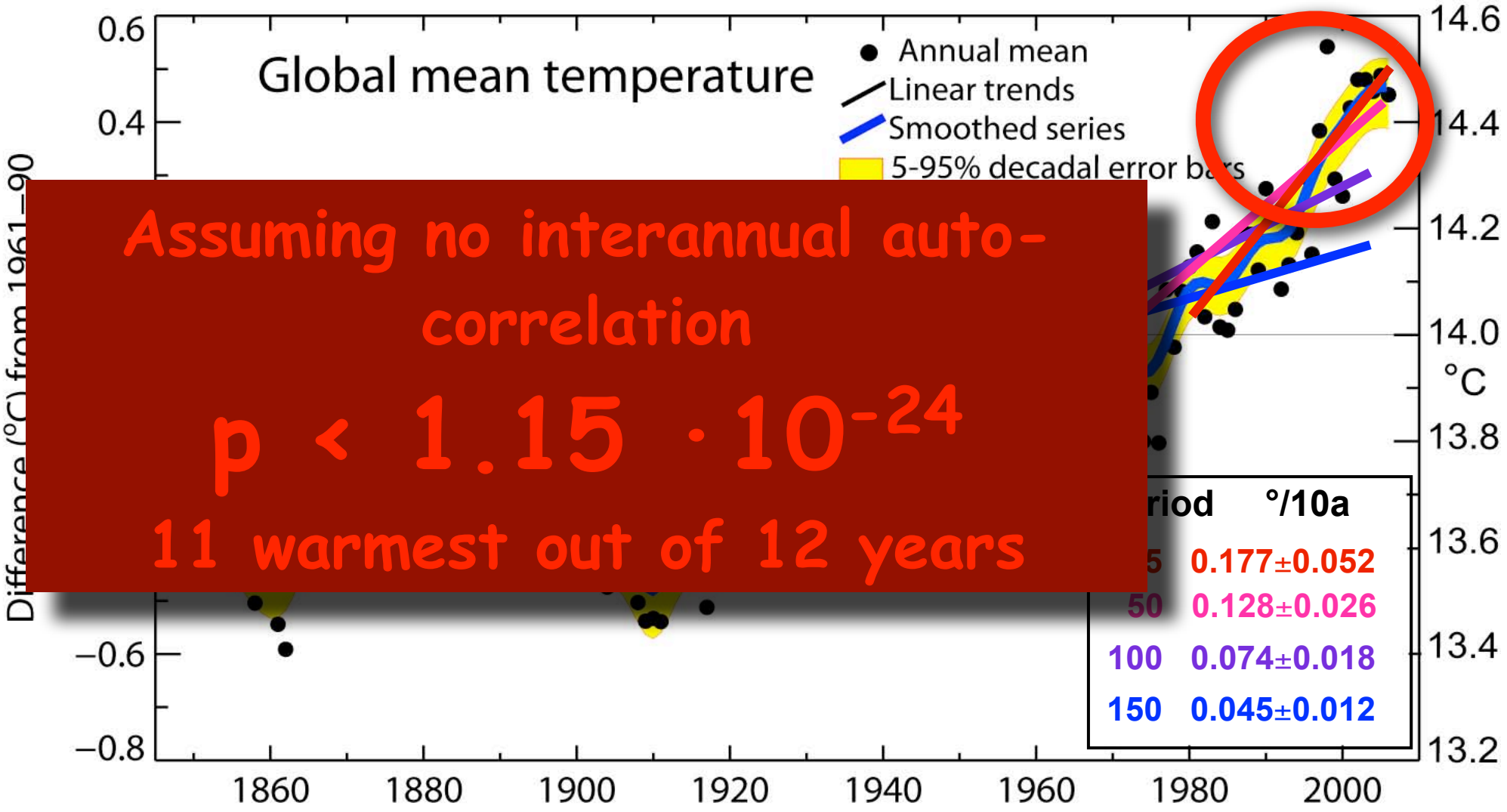

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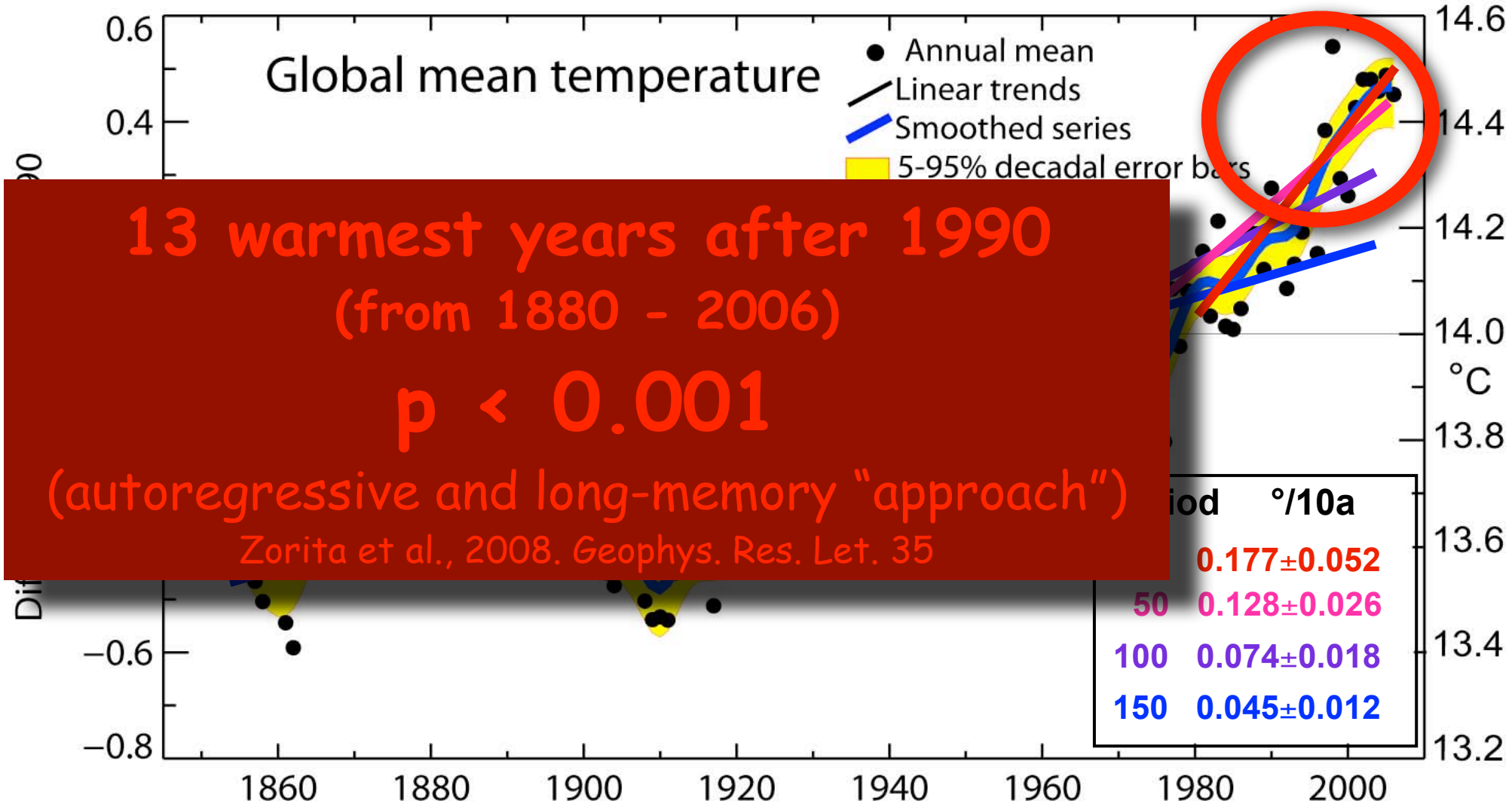
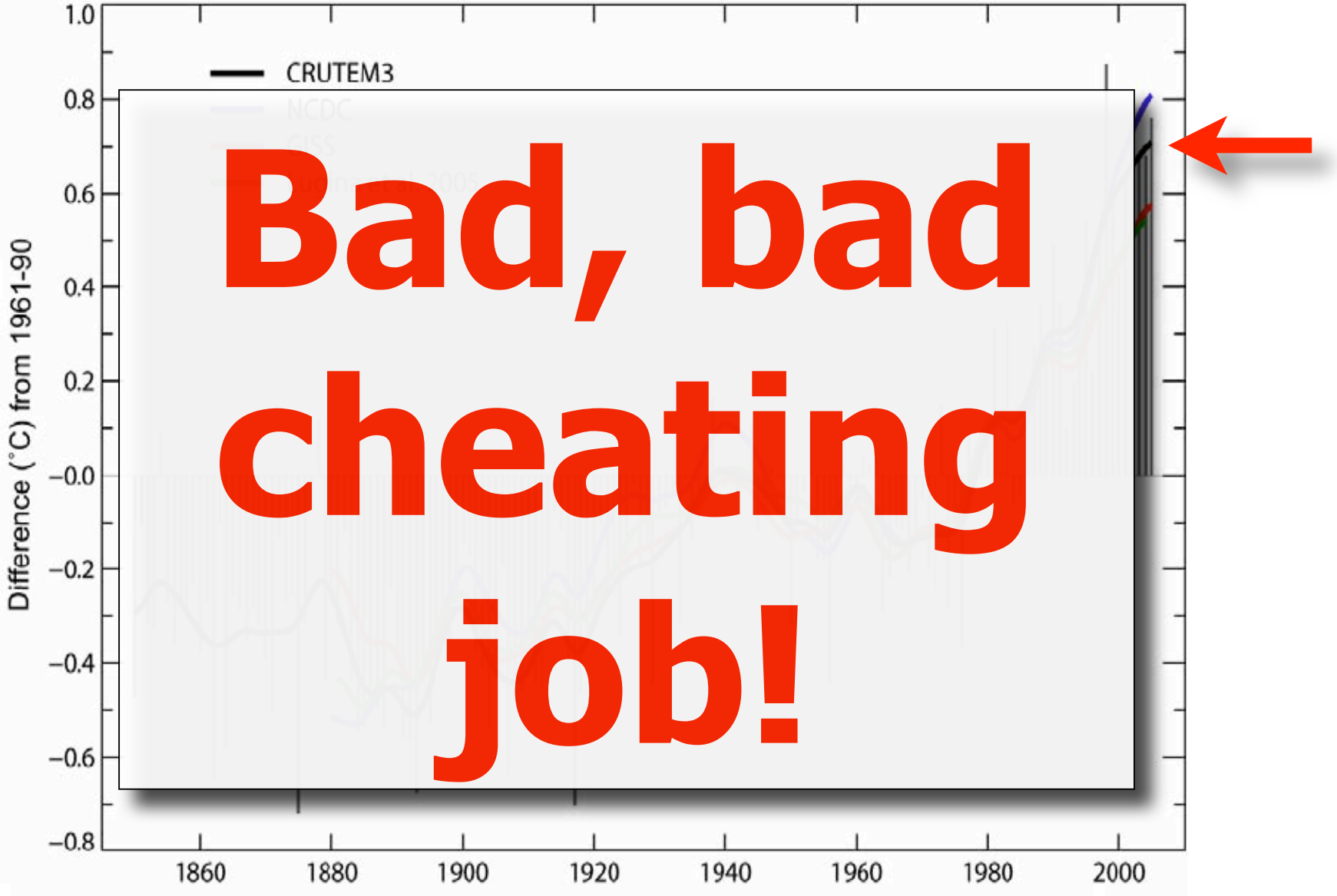
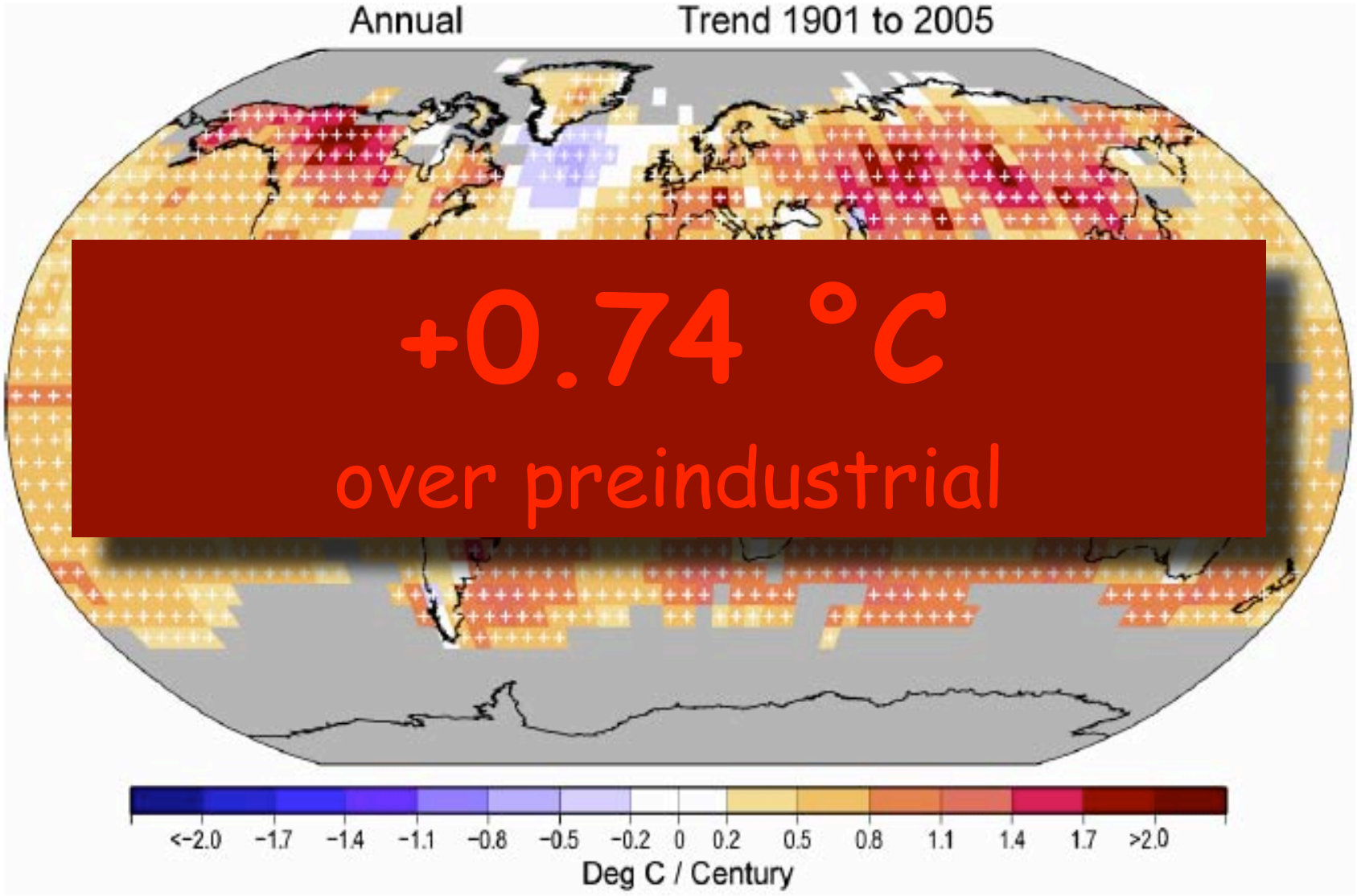


IPCC used several Temperature Records



Trenberth et al., 2007. IPCC WGI AR4

Unequivocal Warming



Trenberth et al., 2007. IPCC WGI AR4

Global vs. Local Warming:

+0

Global

(IPCC)

preindustrial to present

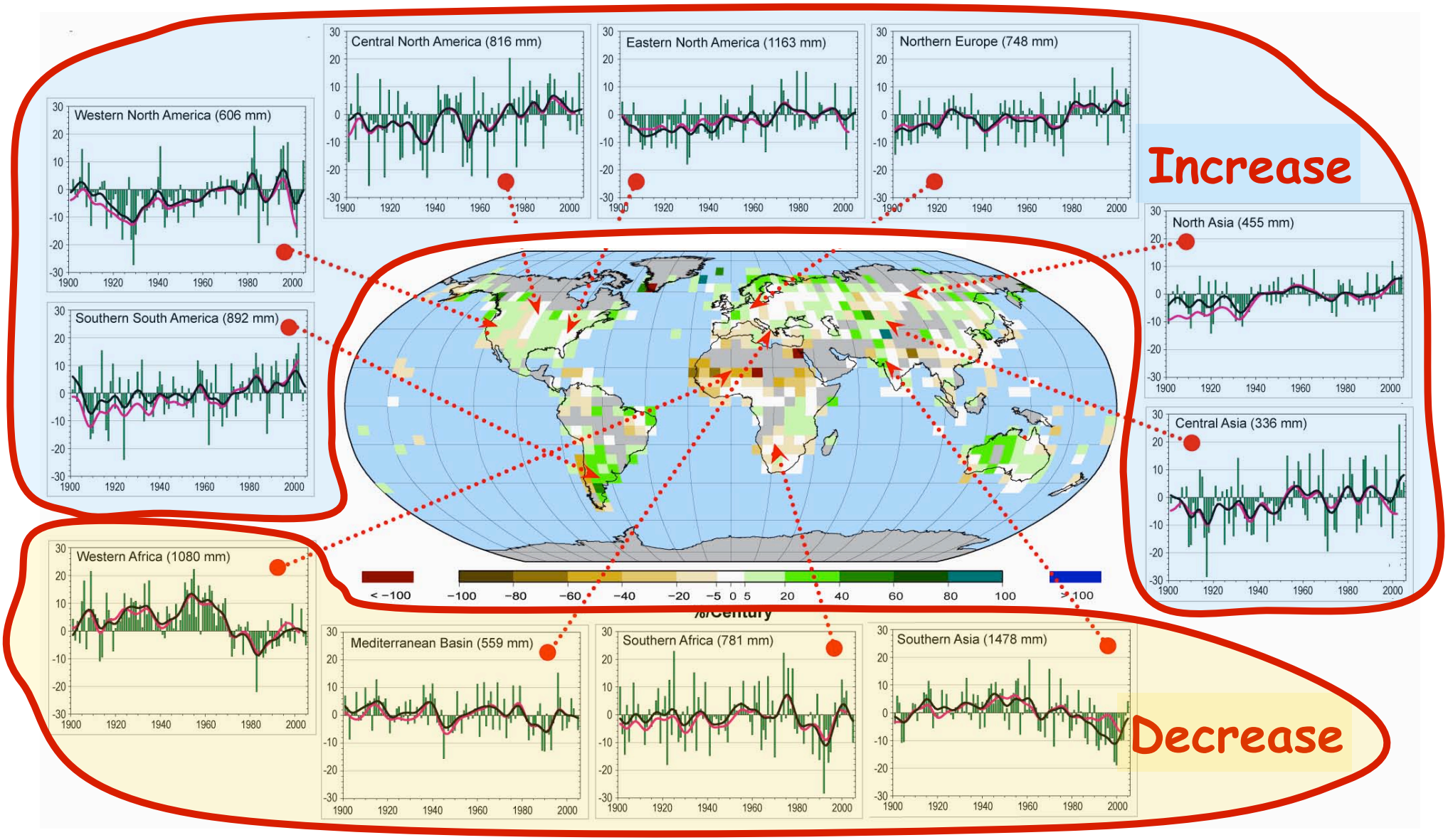
In Switzerland twice as much warming!

+1

Switzerland

(MeteoSchweiz)

Changes in Precipitation (1900-2005)

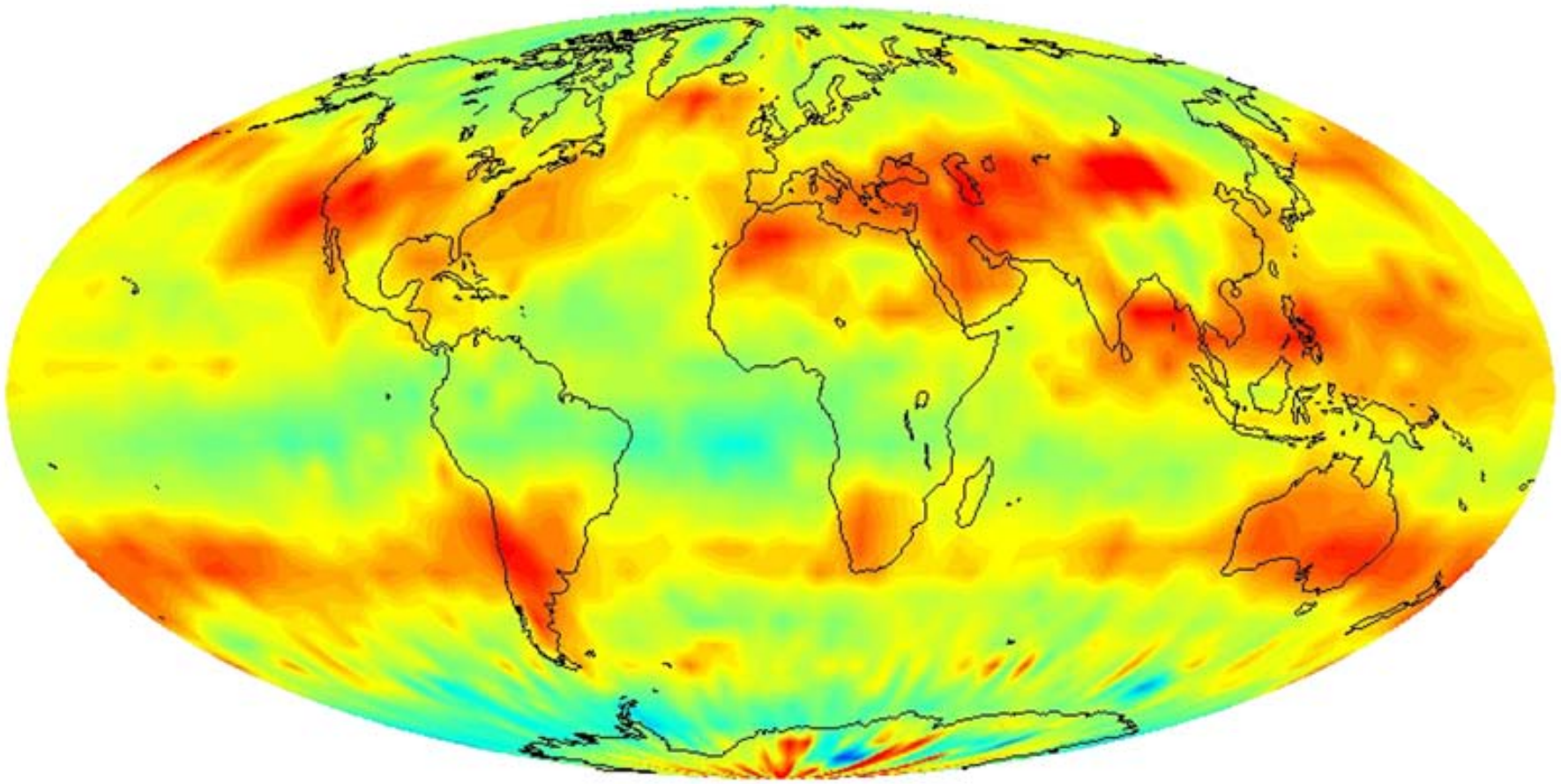


Smoothed anomalies (%) over continents

After Figure 3.14 (Trenberth *et al.*, 2007. IPCC WGI)

Human Made?

Ex. CO_2



AIRS (Atmospheric Infrared Sounder) **July 2008 CO2 (ppmv)**

Greenhouse Gases

CO_2	Fossil fuels, Deforestation (Land use change)
CH_4	Livestocks, Landfills, Rice cultivation, Gas pipe leakages
N_2O	Fertilisation
CFCs a.o.	Heat pumps, cleaning etc.

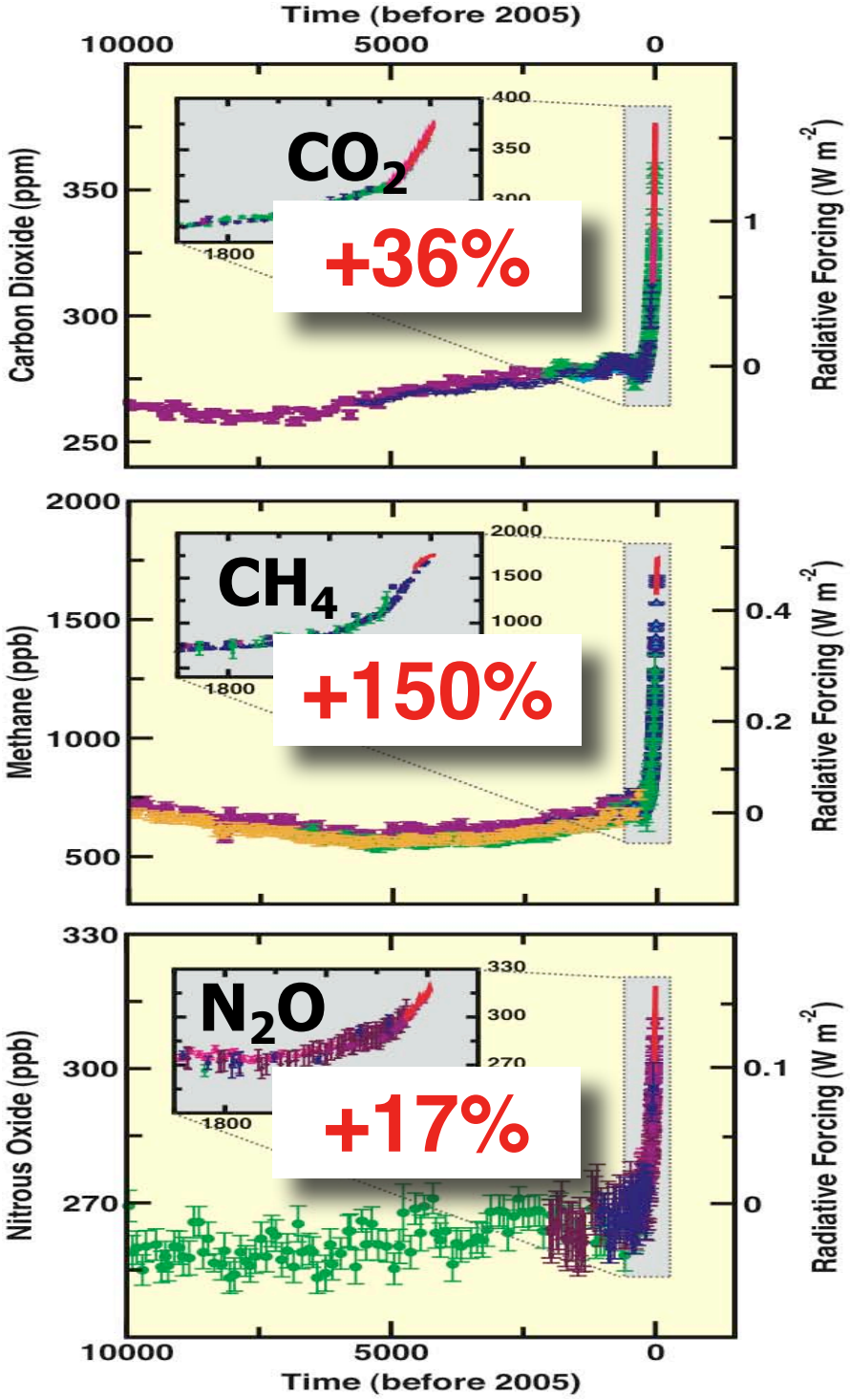
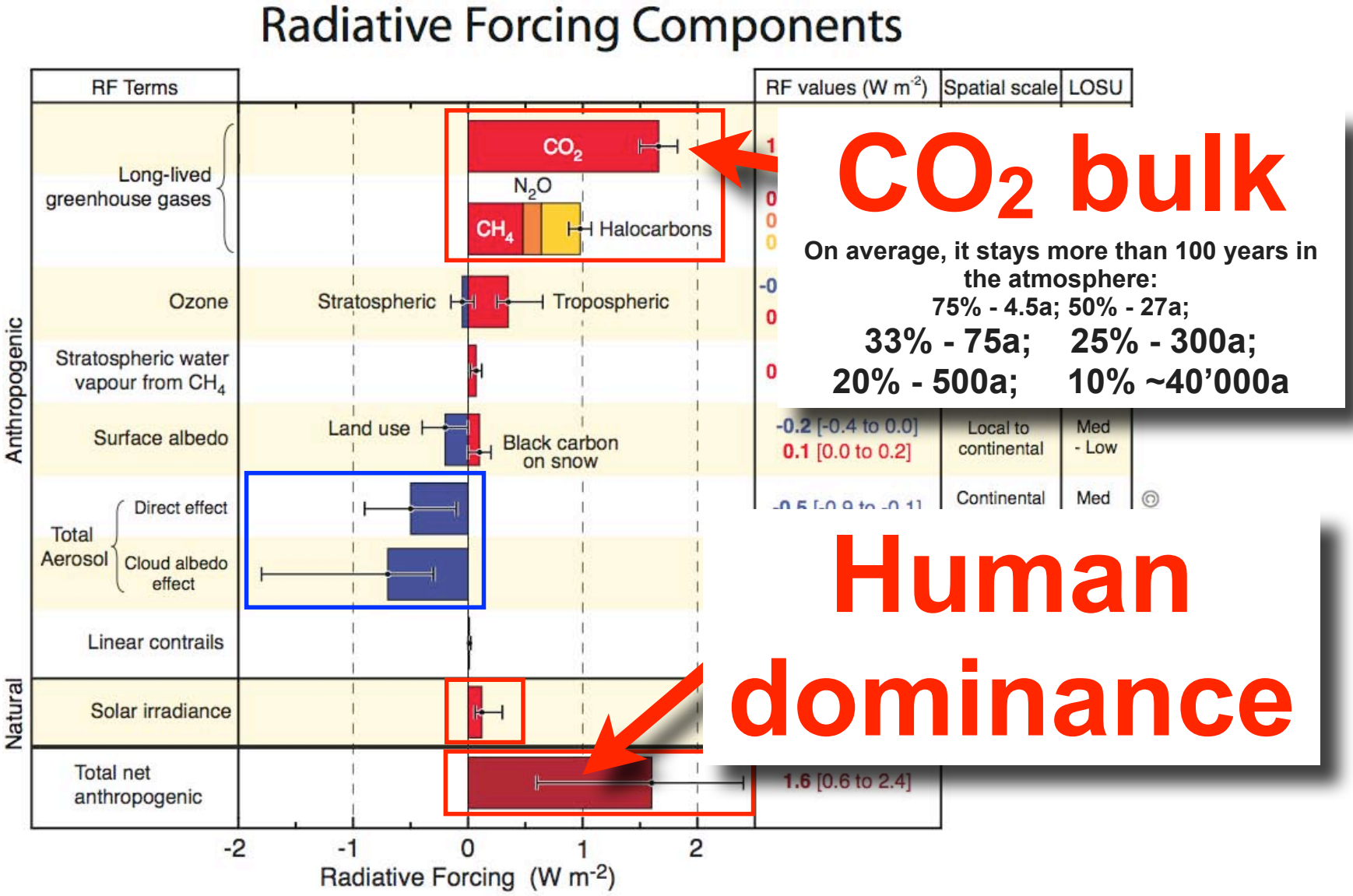


Figure SPM.1 (IPCC, 2007a. Summary for Policy Makers (SPM) WGI)

Human and Natural Drivers of Climate Change



CO_2 bulk

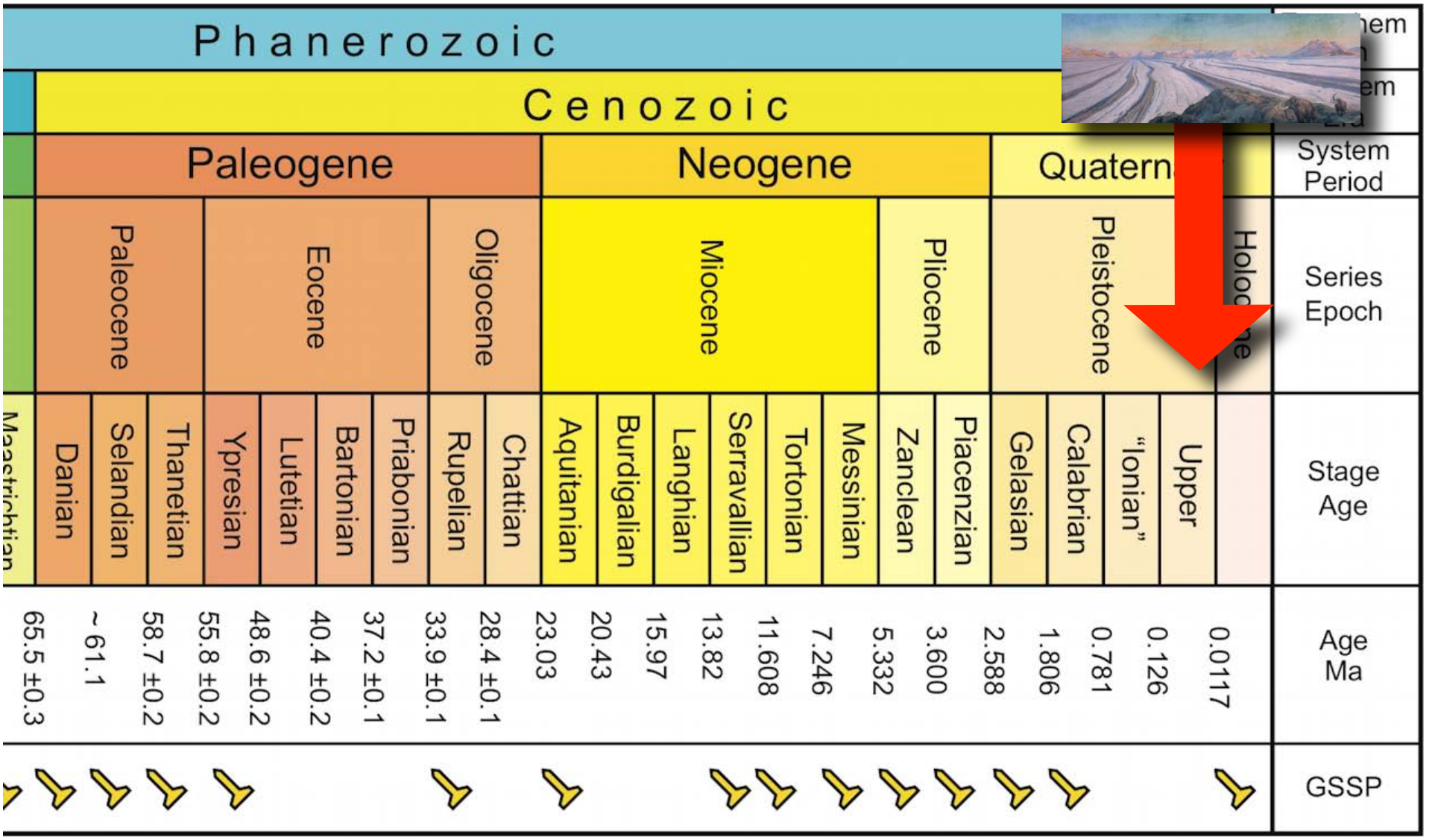
On average, it stays more than 100 years in the atmosphere:
75% - 4.5a; 50% - 27a;
33% - 75a; 25% - 300a;
20% - 500a; 10% ~40'000a

Human dominance

Figure SPM.2 (IPCC, 2007a. Summary for Policy Makers (SPM) WGI)

Past Climate Change?

Context of Past Epochs



ICS International Commission on Stratigraphy

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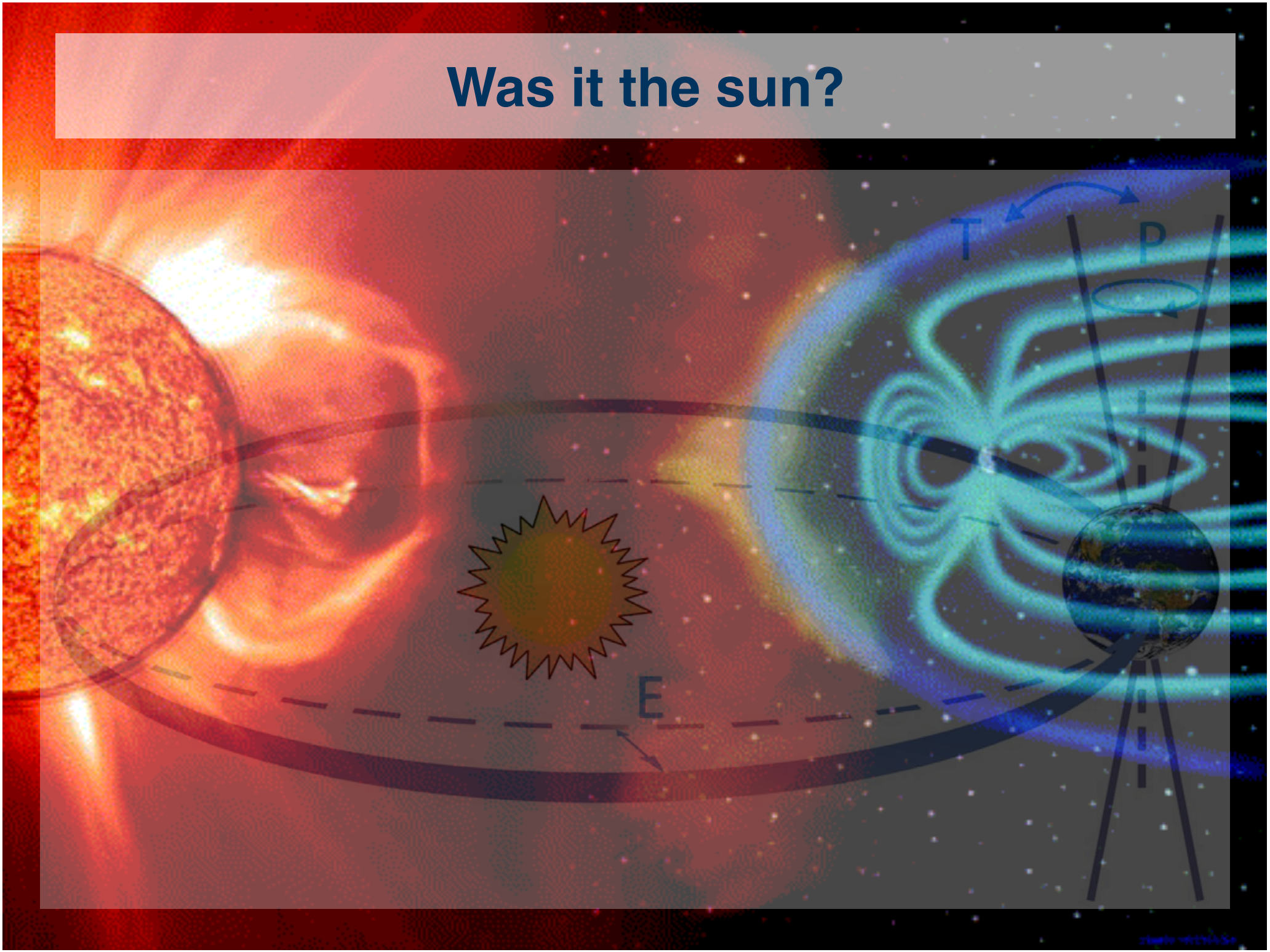
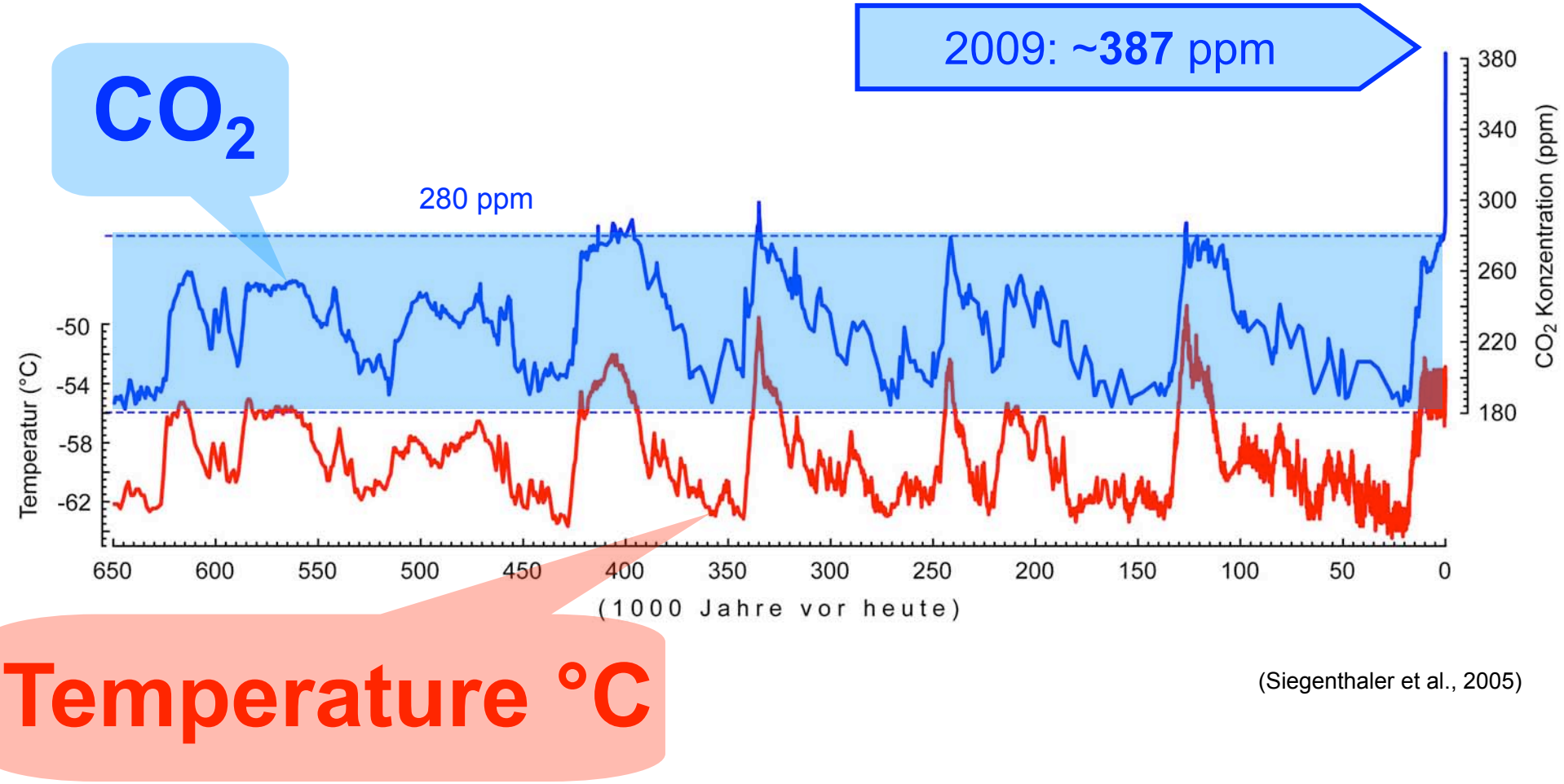
Was it the sun?

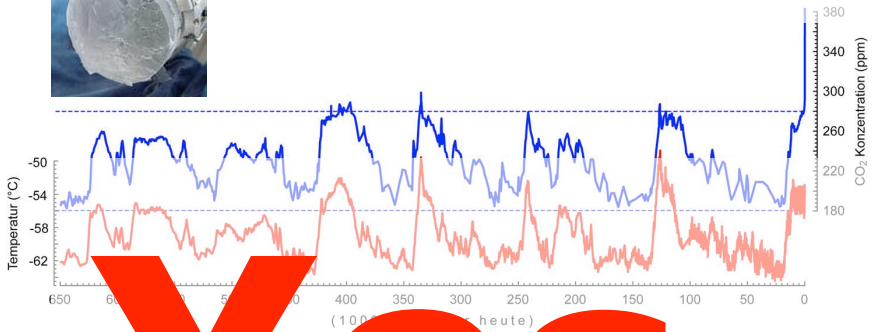


Evidence from the past: 650’000 a BP (ice cores)

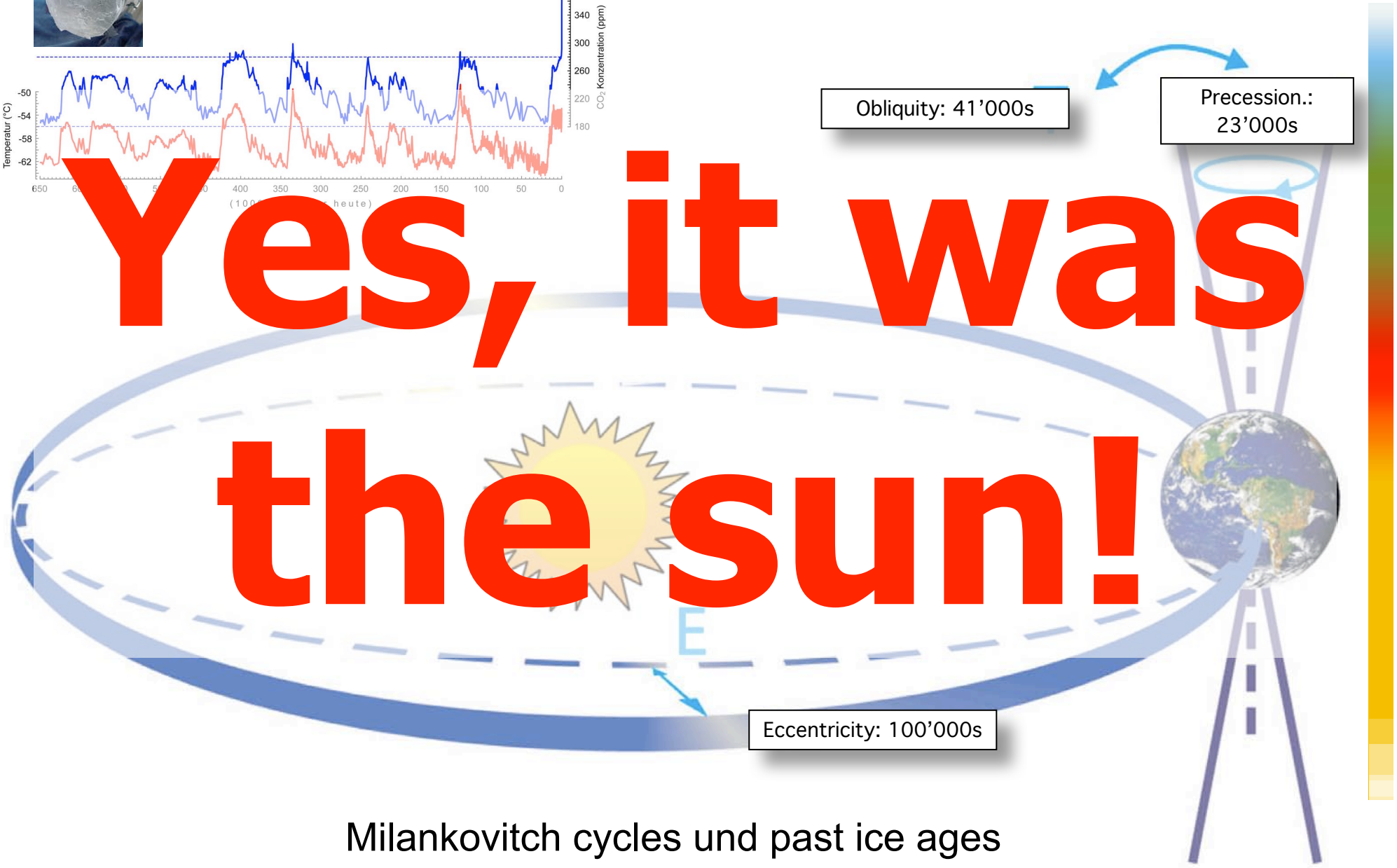


(Siegenthaler et al., 2005)

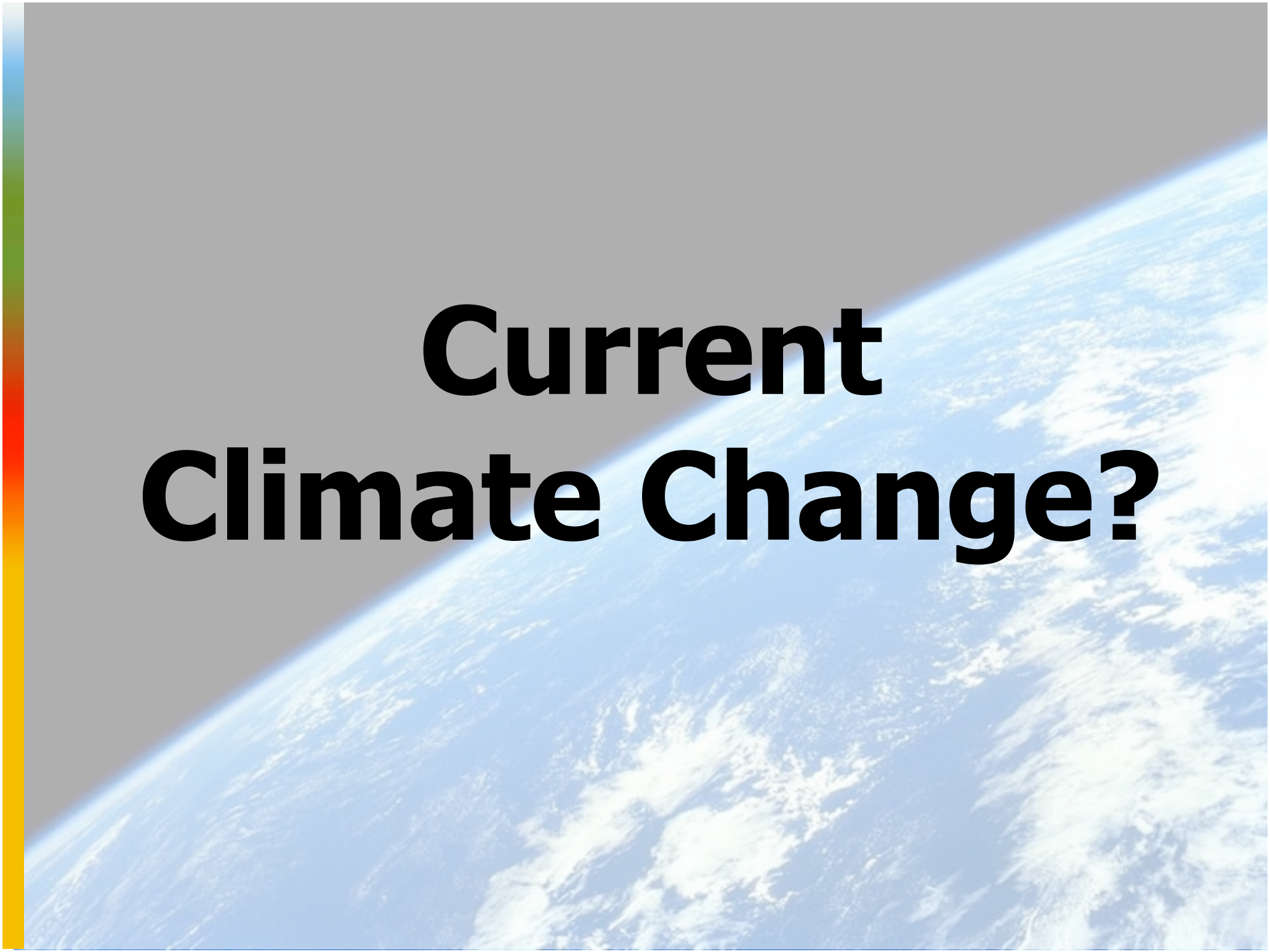
Past Climate Changes



Yes, it was the sun!



Milankovitch cycles und past ice ages


Current
Climate Change?

Is it now also the sun?

Do We Humans Cause It?

Future Changes?

Warming Over Present Levels

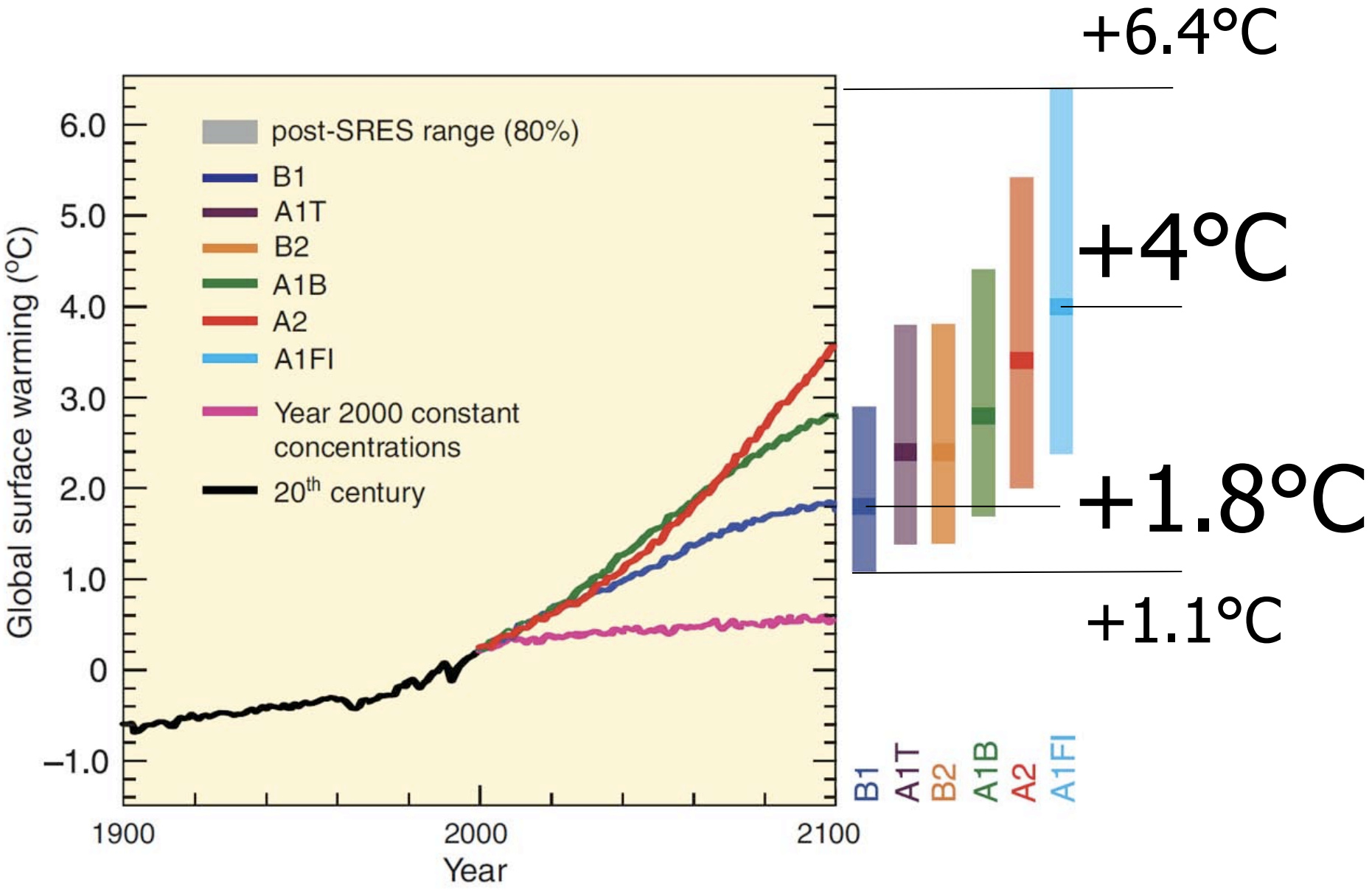


Figure SPM.5: Multi-model global averages of surface warming (relative to 1980–1999) for the scenarios (IPCC, 2007. Summary for Policy Makers WGI)

Δ T (SST Annual Means)

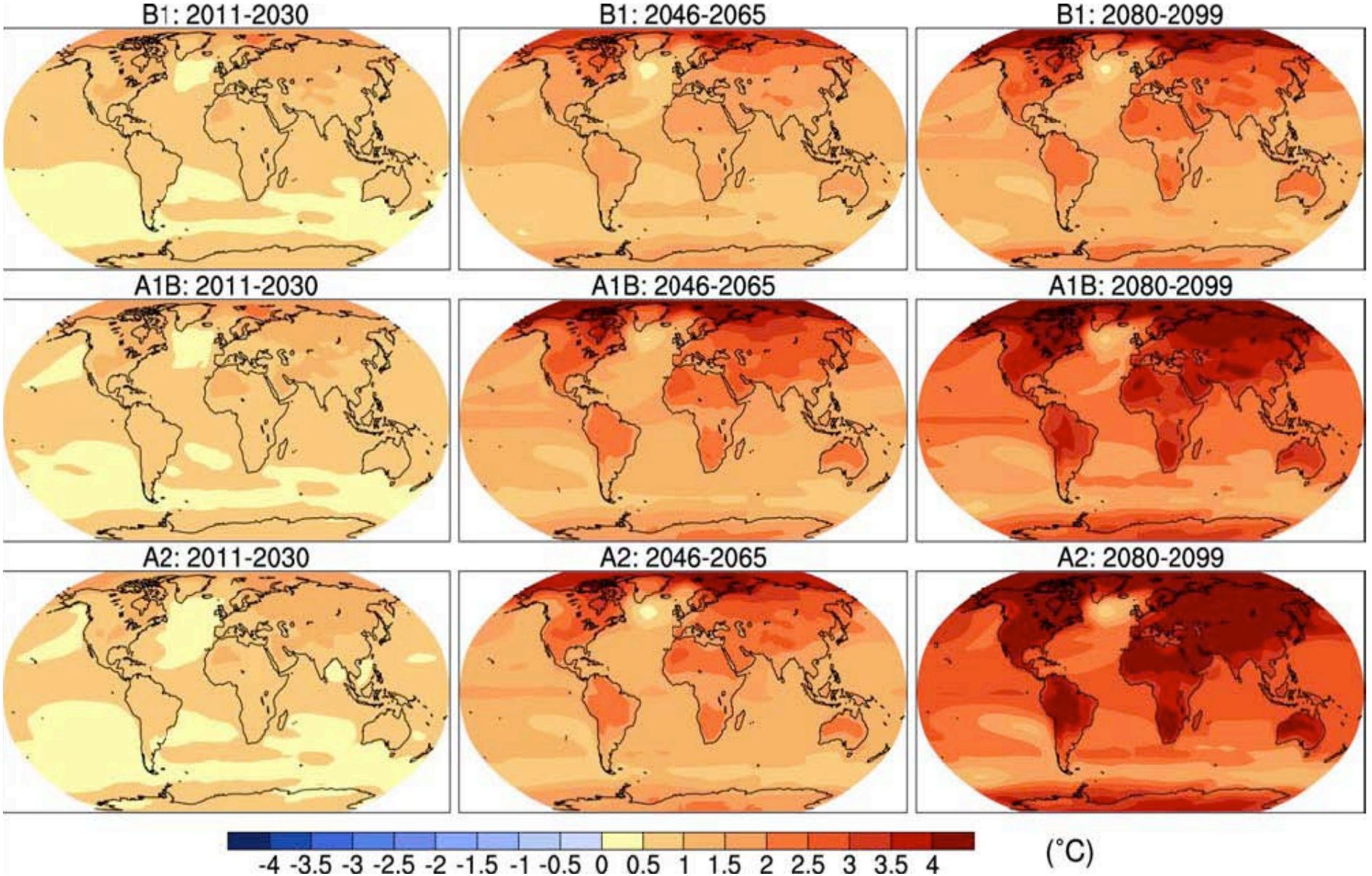
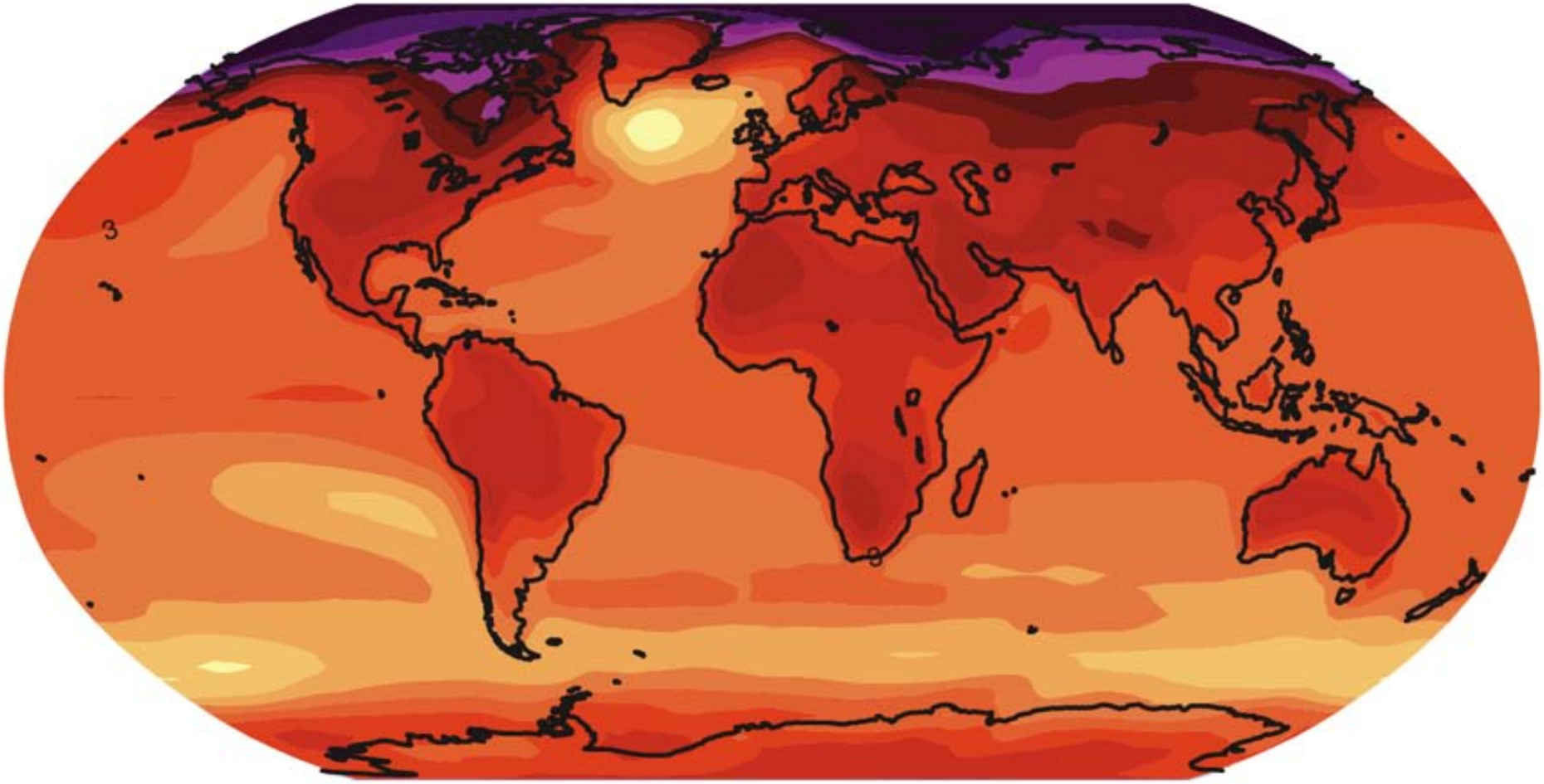


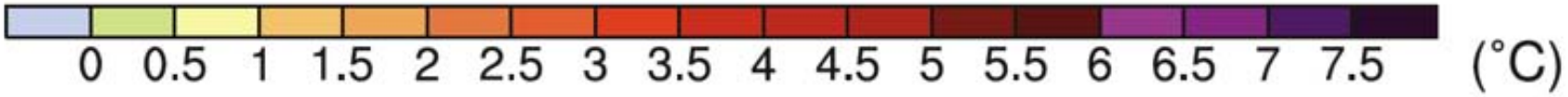
Figure 10.8: Projected surface temperature changes - multimodel means (Meehl *et al.*, 2007. IPCC WGI)

Warming Unevenly Distributed

(IPCC A2 SRES ~2100)



IPCC, 2007. SPM WG I



Is climate change real? Human made? Dangerous?

Yes!

IPCC ort 4

Anthro
change

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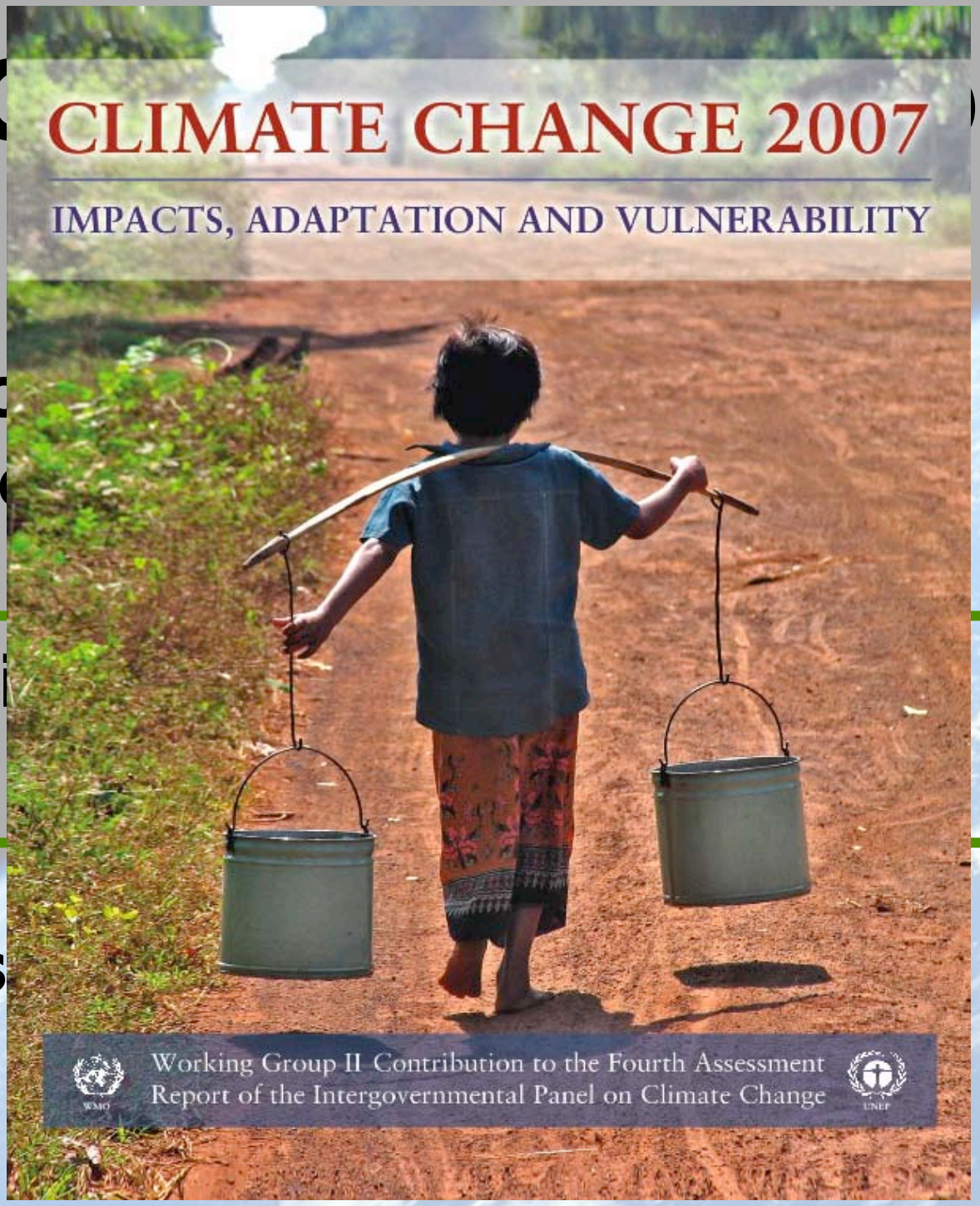
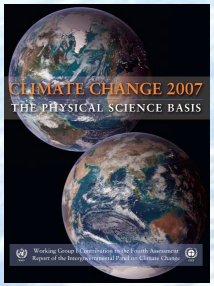
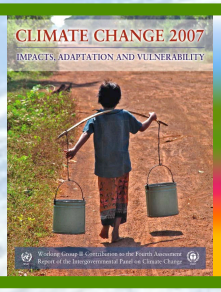
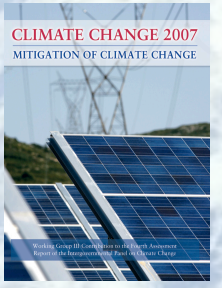
is still



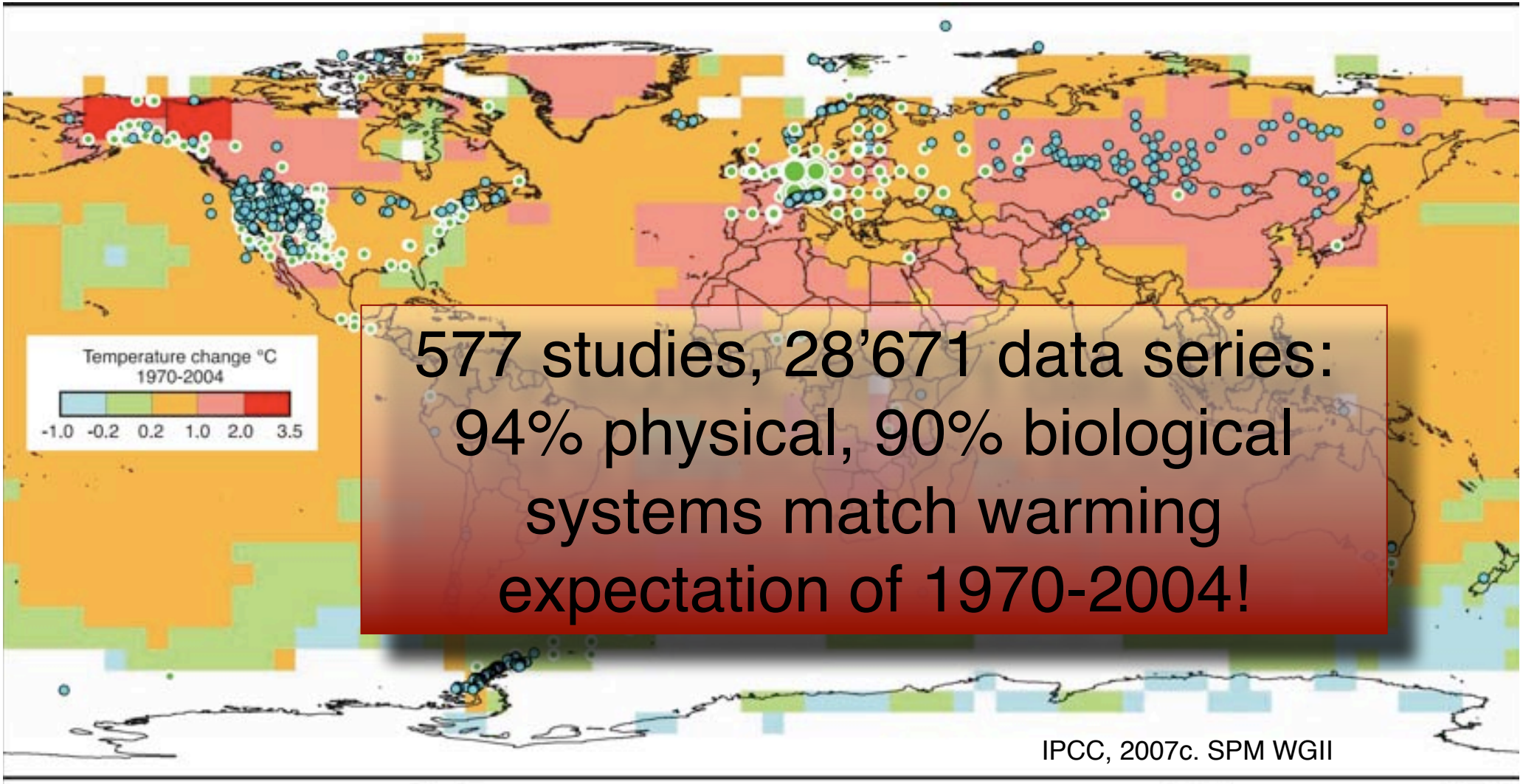






Any Impacts?

Since 1970 observed impacts on physical and biological systems



577 studies, 28'671 data series:
94% physical, 90% biological systems match warming expectation of 1970-2004!

IPCC, 2007c. SPM WGII

NAM		LA		EUR (28,115)		AFR		AS		ANZ		PR*		TER (28,586)		MFW**		GLO (28,671)	
355	455	53	5	119		5	2	106	8	6	0	120	24	764		1	85	765	
94%	92%	98%	100%	94%	89%	100%	100%	96%	100%	100%	–	91%	100%	94%	90%	100%	99%	94%	90%

Muir Glacier, USA, 13.Aug.1941

Muir Glacier, USA, 31.Aug.2004

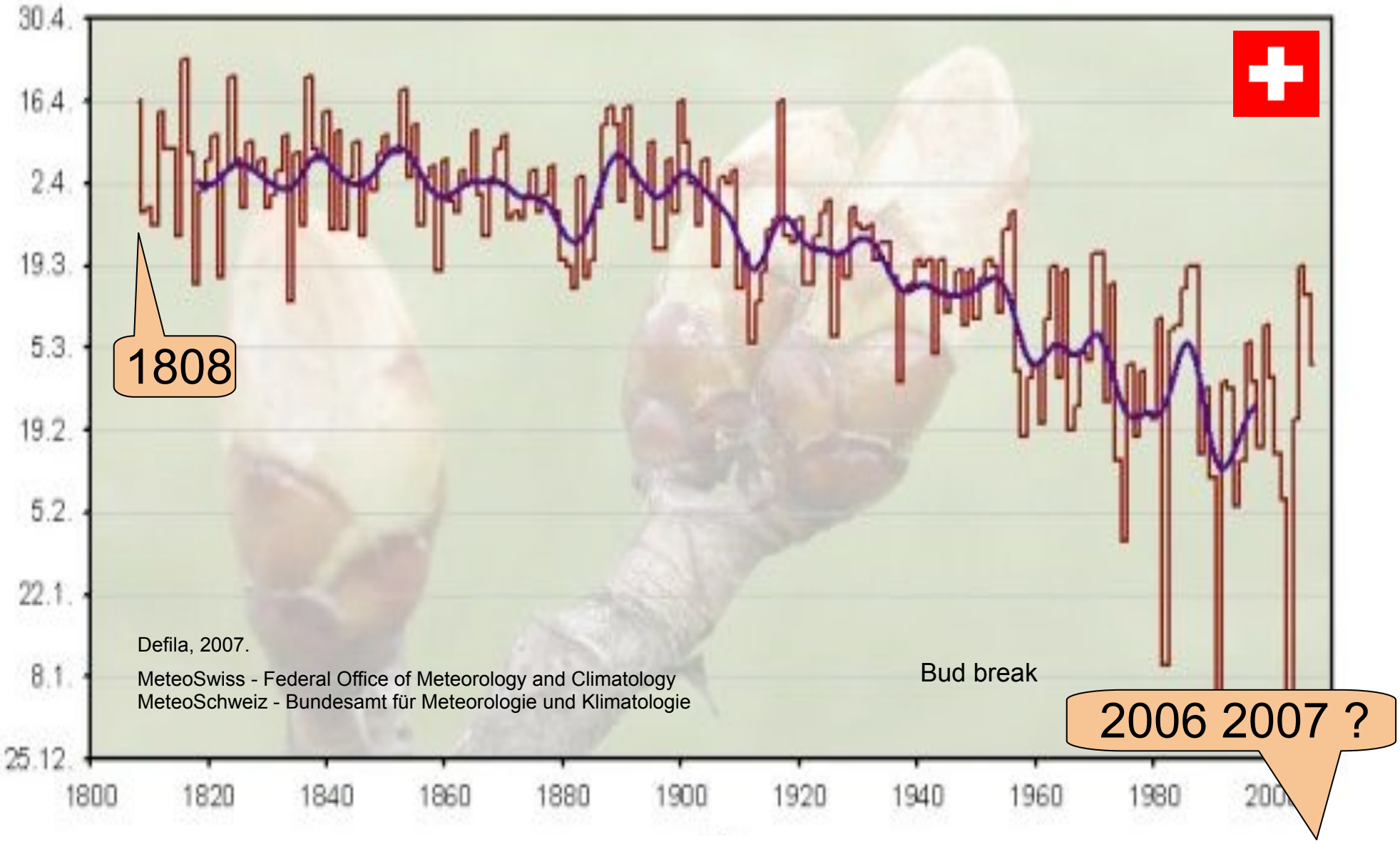
Morteratsch
glacier

Thawing of Permafrost and Glacier Retreat

Thawing of Permafrost and Glacier Retreat

MVFD
© AP

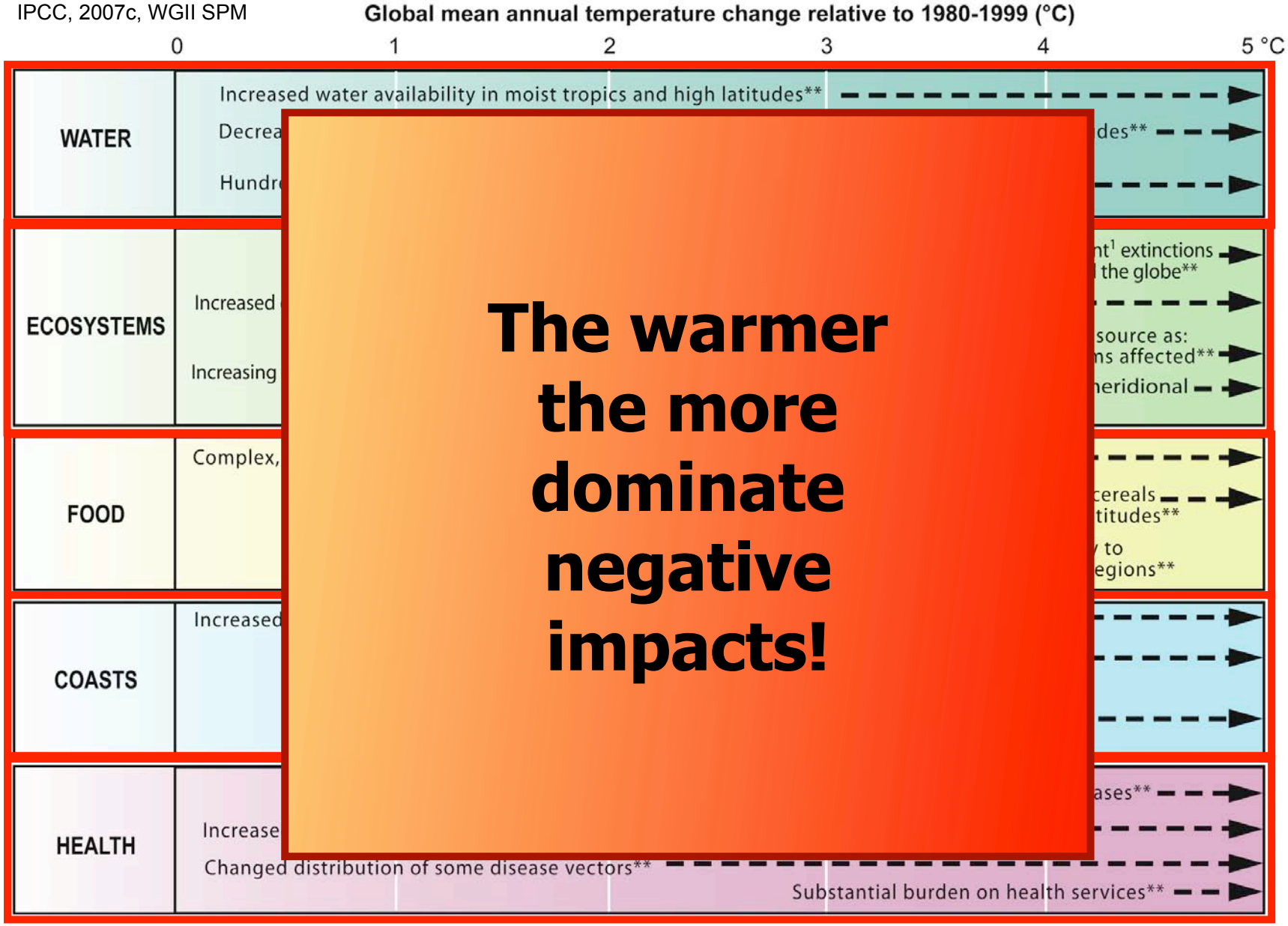
Biological Systems - E.g. Phenology



Future Climate Change Impacts?

Global Warming Affects All Sectors

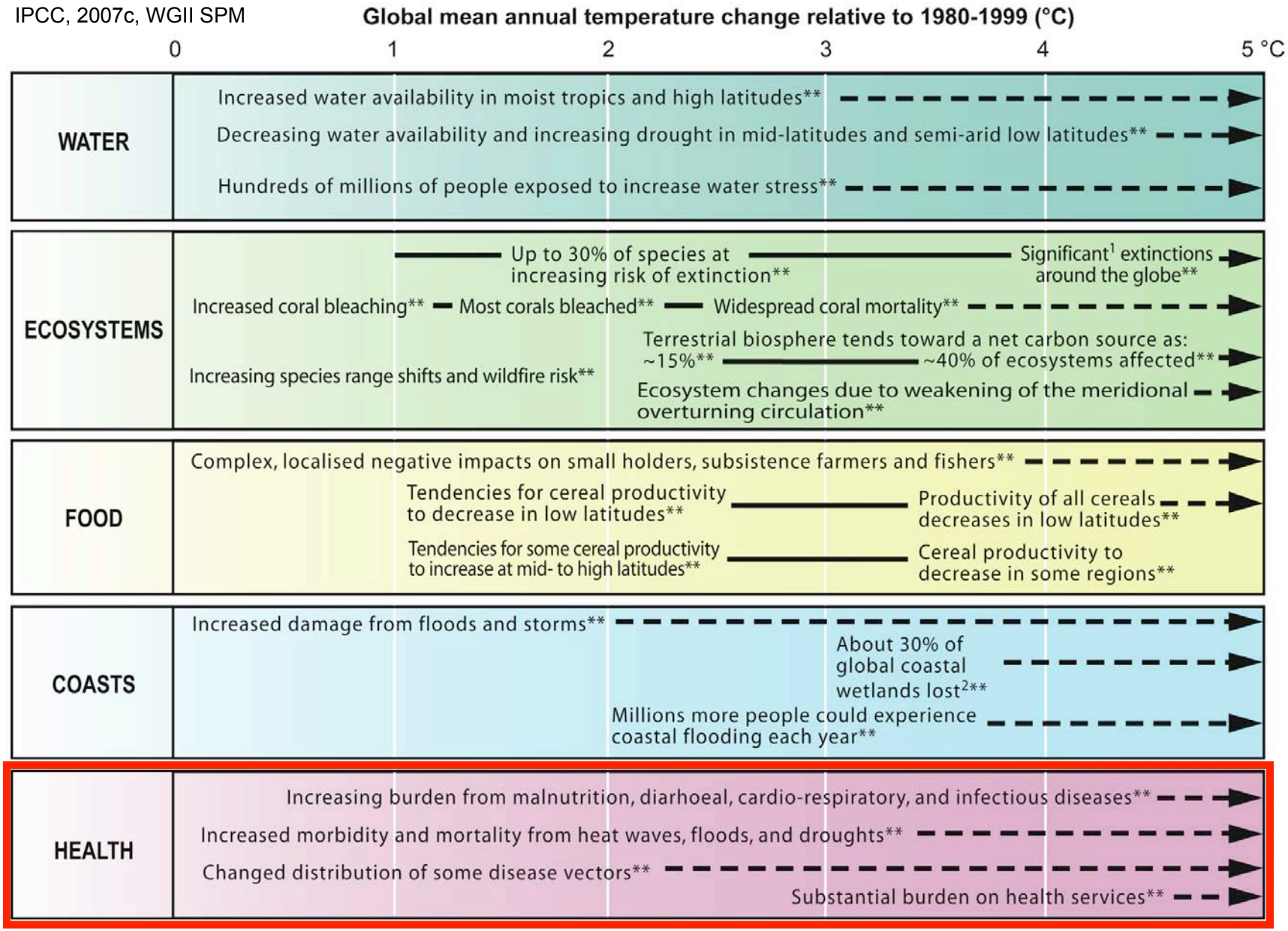
IPCC, 2007c, WGII SPM



The warmer the more dominate negative impacts!

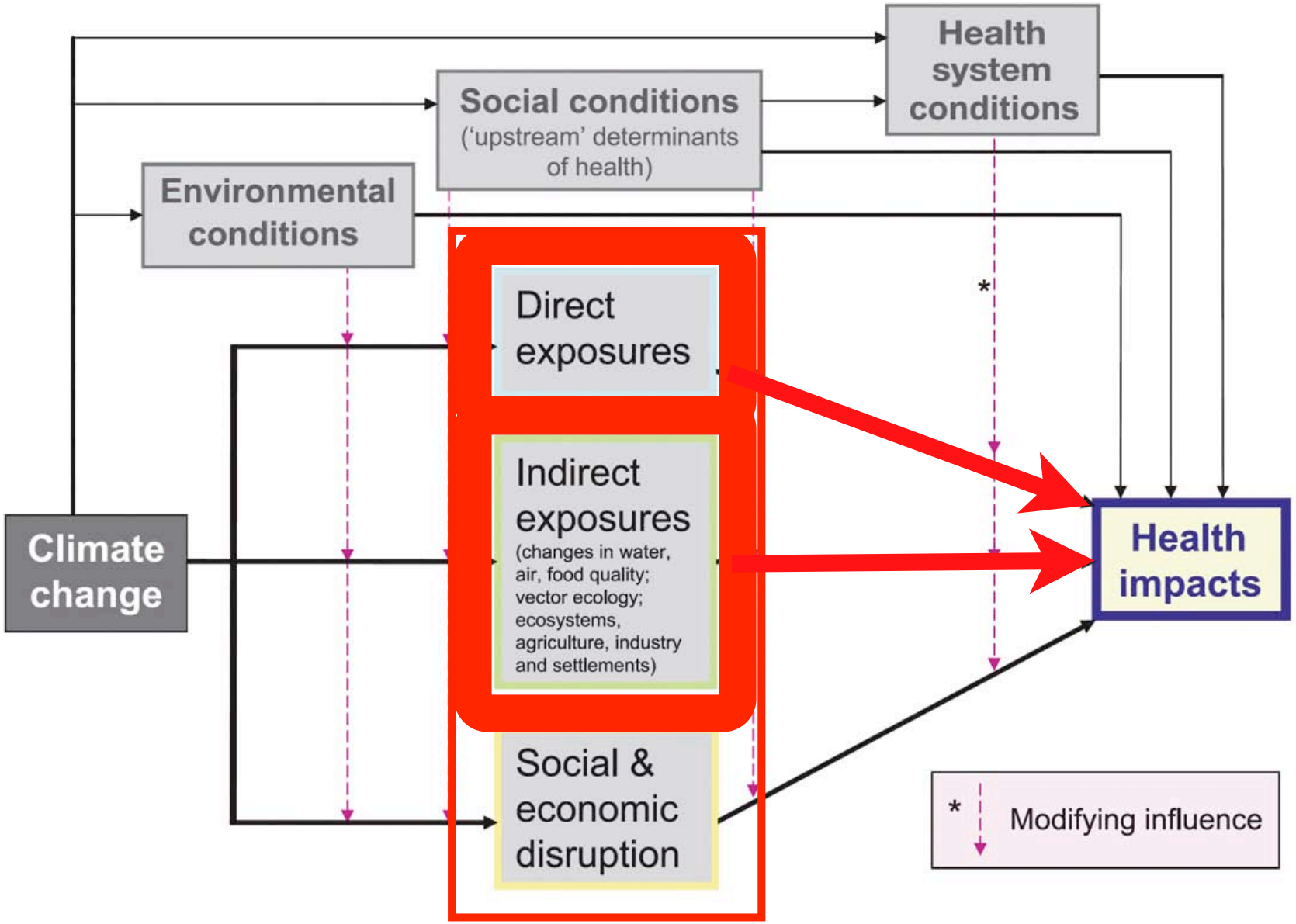
Global Warming Affects All Sectors

IPCC, 2007c, WGII SPM



Human
Health?

How Climate Change Affects Health



Confalonieri et al., 2007. Health. IPCC AR4 WGII, Fig. 8.1

Health Impacts Summary

- Large differences (regional, social)
- Likely Millions affected
- Child growth affected by malnutrition => health consequences (incl. adult)
- Injuries, deaths, illnesses due to heat waves, floods, storms, fires (yet less cold victims)
- Cardio-respiratory morbidity and mortality incl. O_3 diseases and diarrhoeal diseases
- Changes for vector transmitted diseases (Malaria, Dengue, Filariasis, Schistosomiasis)

Water
Earth
Fire
Air

Water

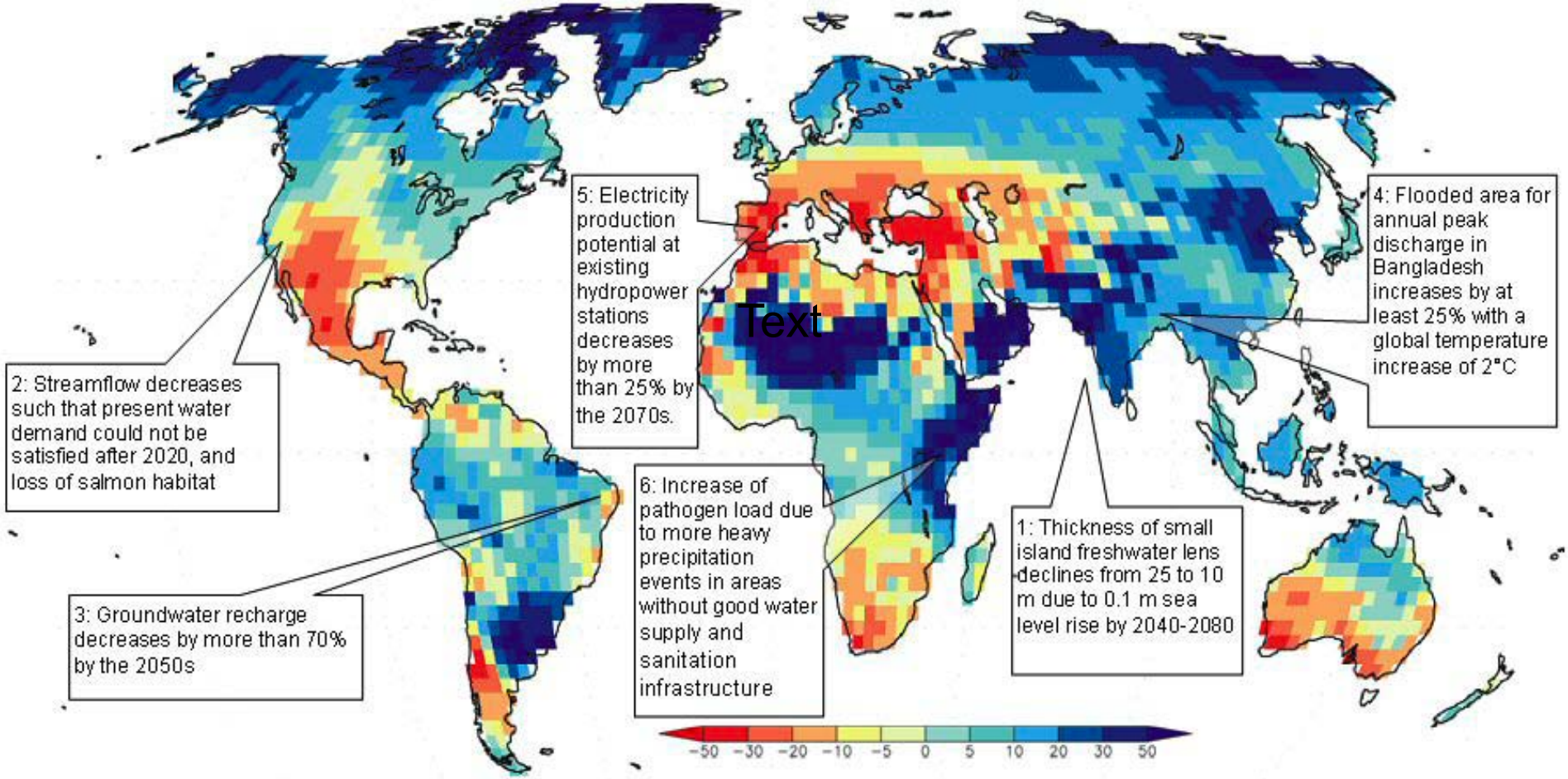
Töss 2003

Foto Christoph Schär

Quelle: Fotoagentur Hug, Barberêche

Freshwater Supply and Climate Change

IPCC SRES A1B



Adger et al, 2007 - Kundzewicz & Mata, 2007 - IPCC AR4

Precipitation Changes (Summer)

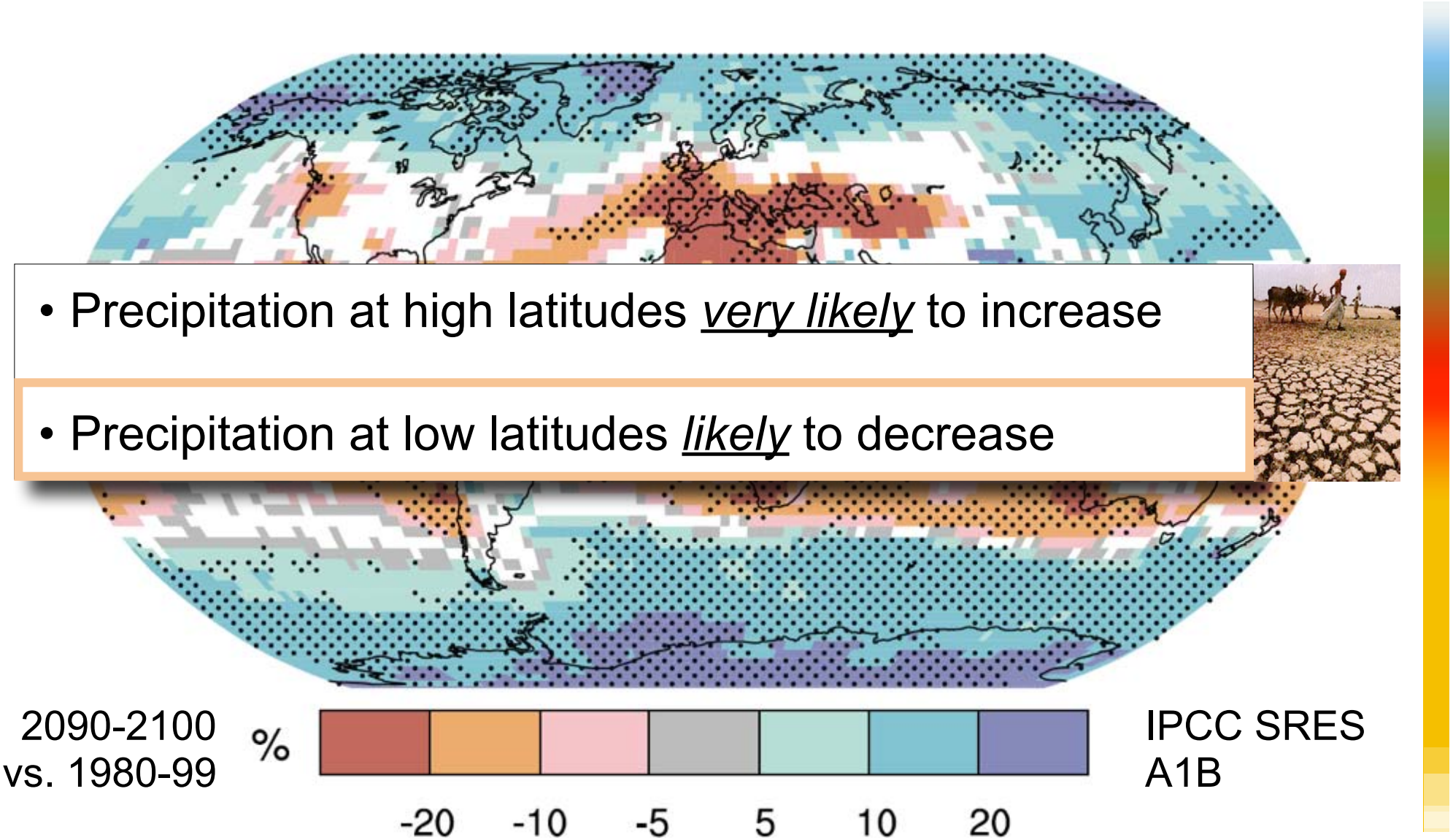
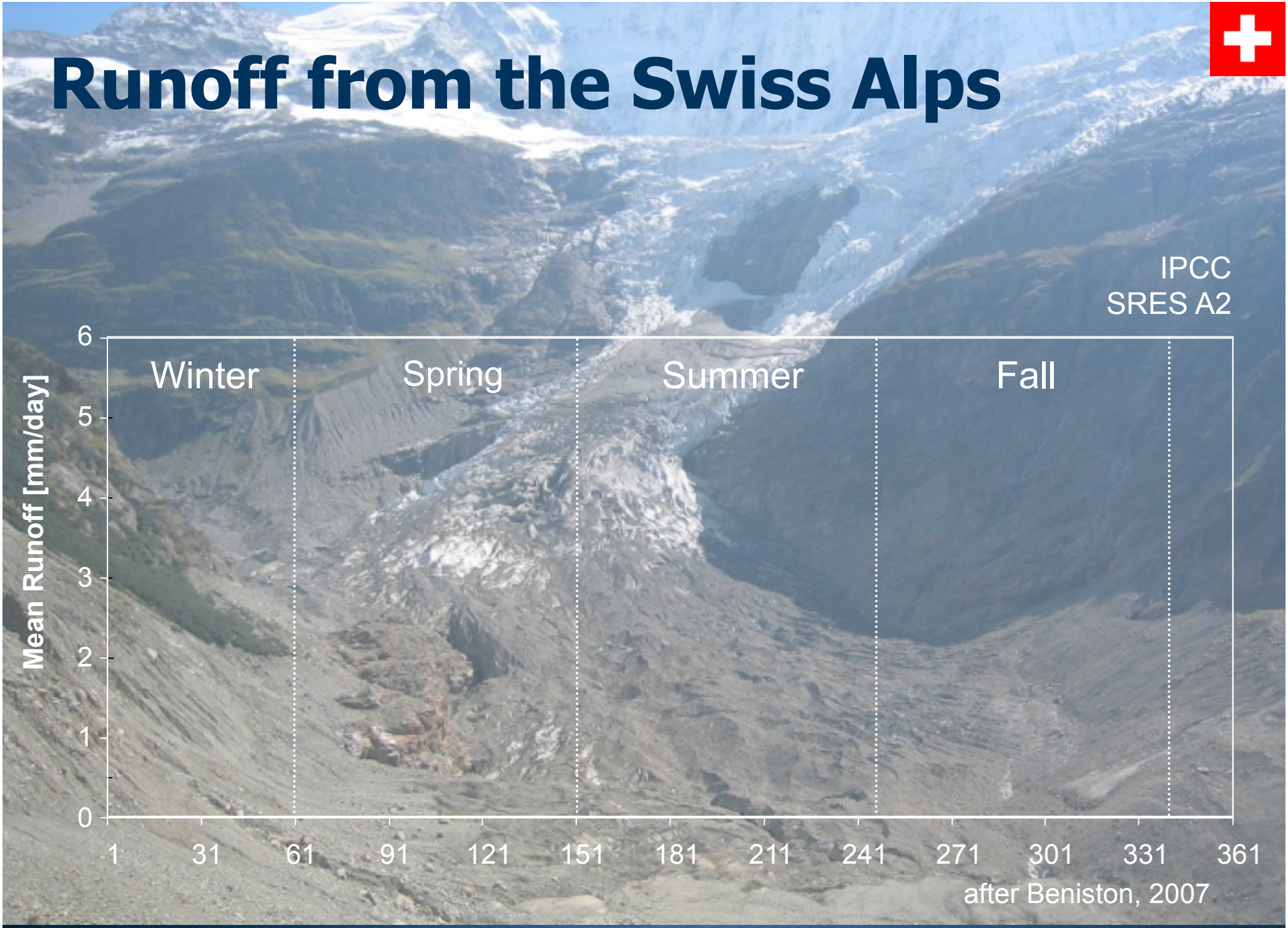
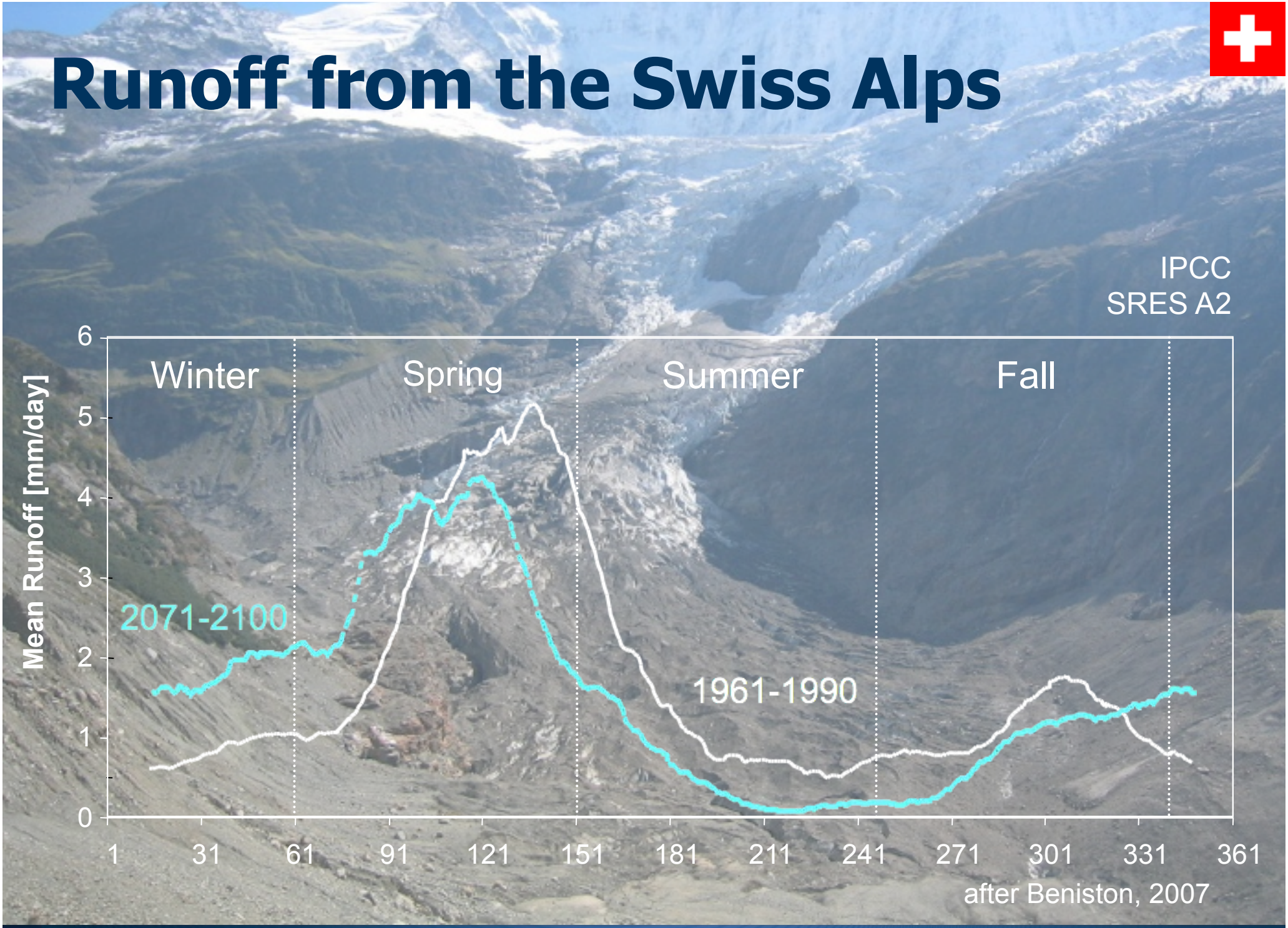


Figure SPM.7: Relative changes in precipitation 2090-2099 vs. 1980-1999 (IPCC, 2007a. SPM WGI)

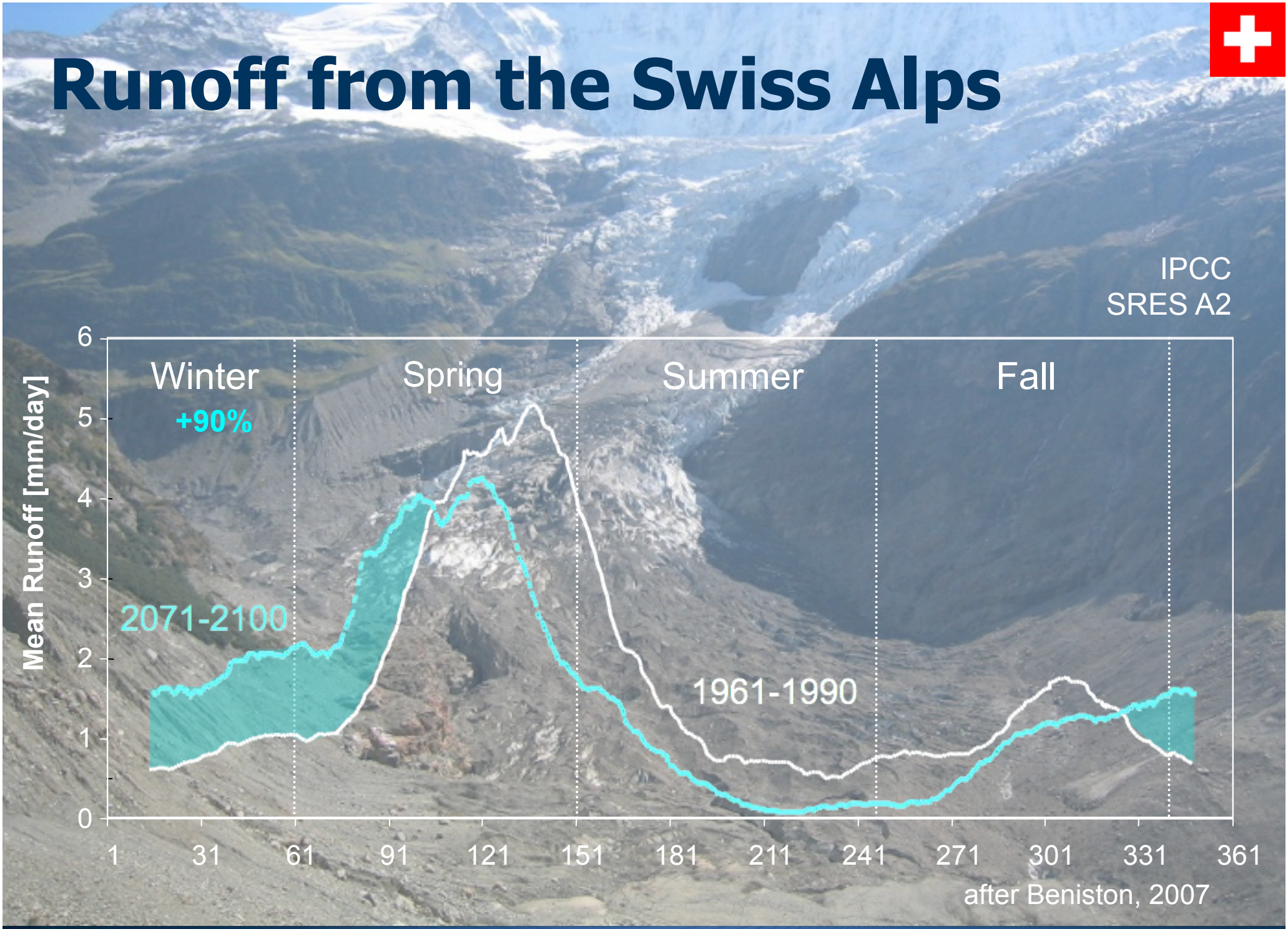
Runoff from the Swiss Alps



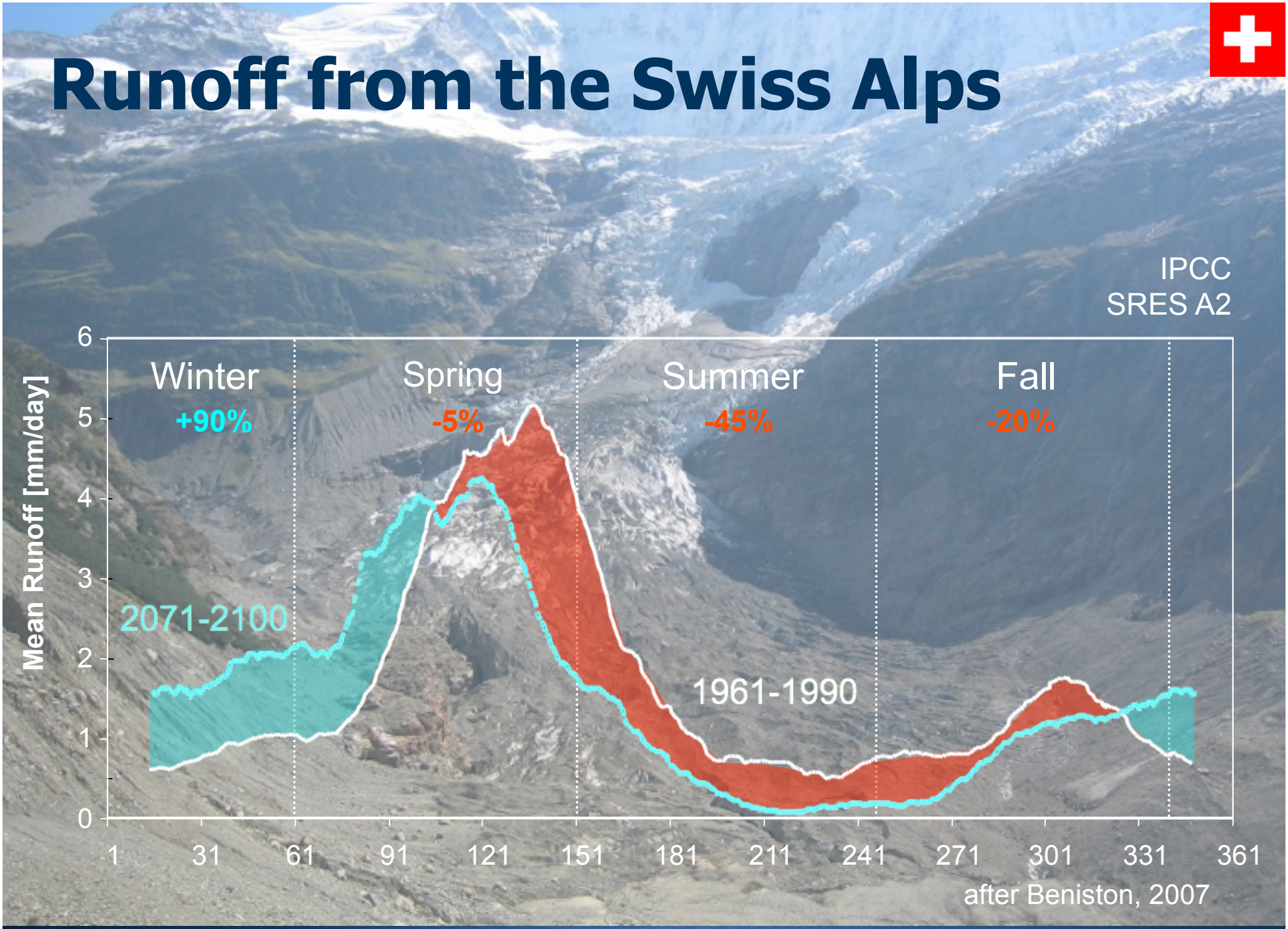
Runoff from the Swiss Alps



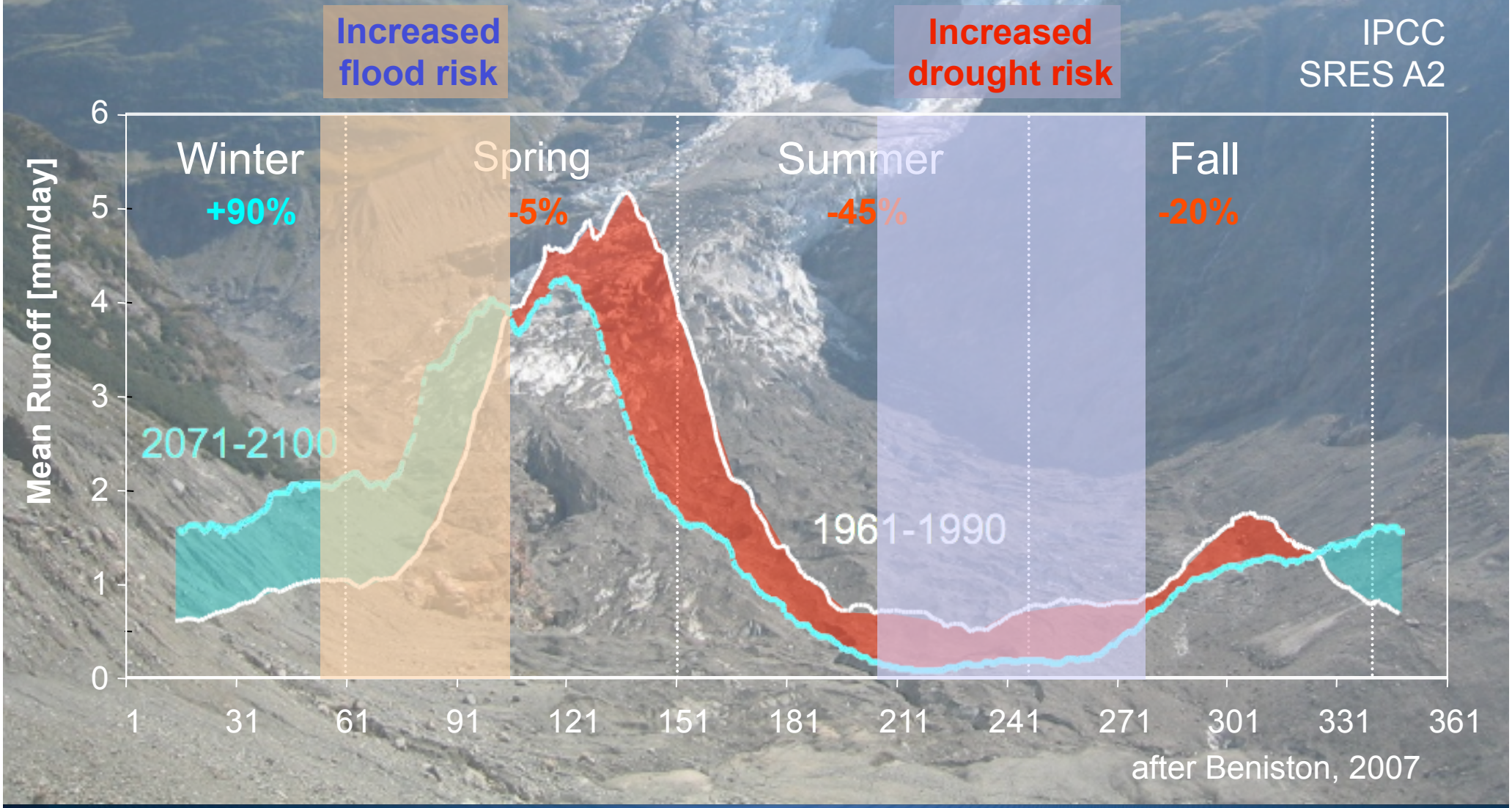
Runoff from the Swiss Alps



Runoff from the Swiss Alps

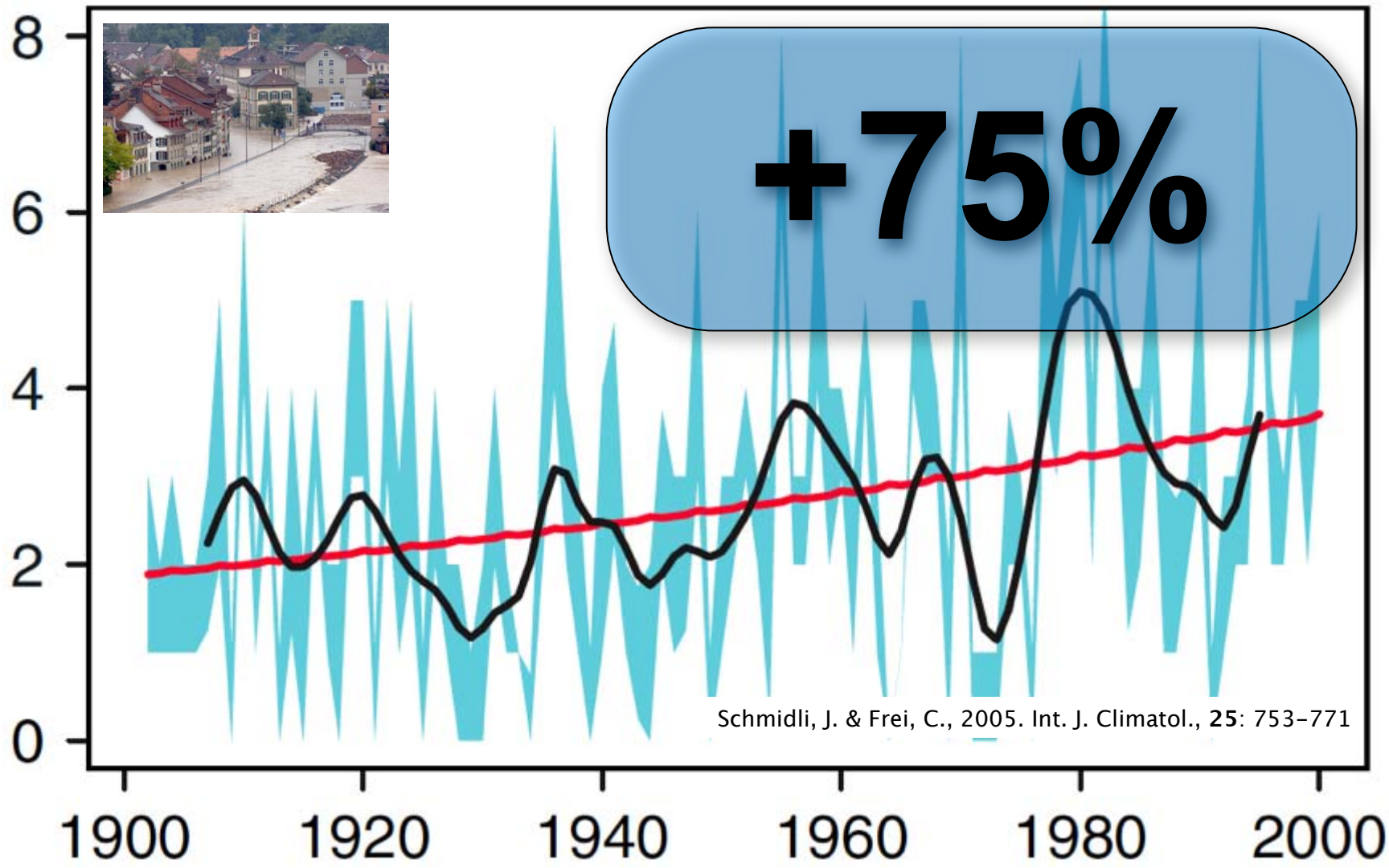


Runoff from the Swiss Alps



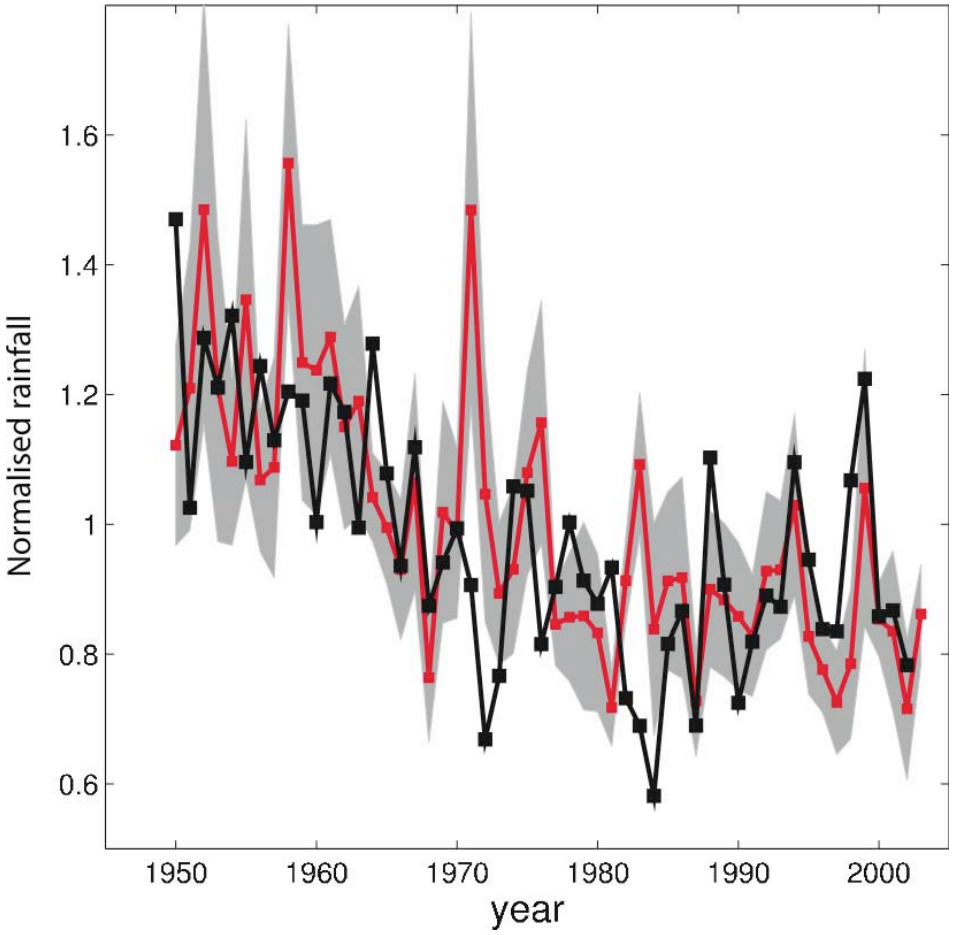
Heavy Precipitation Events

Winter



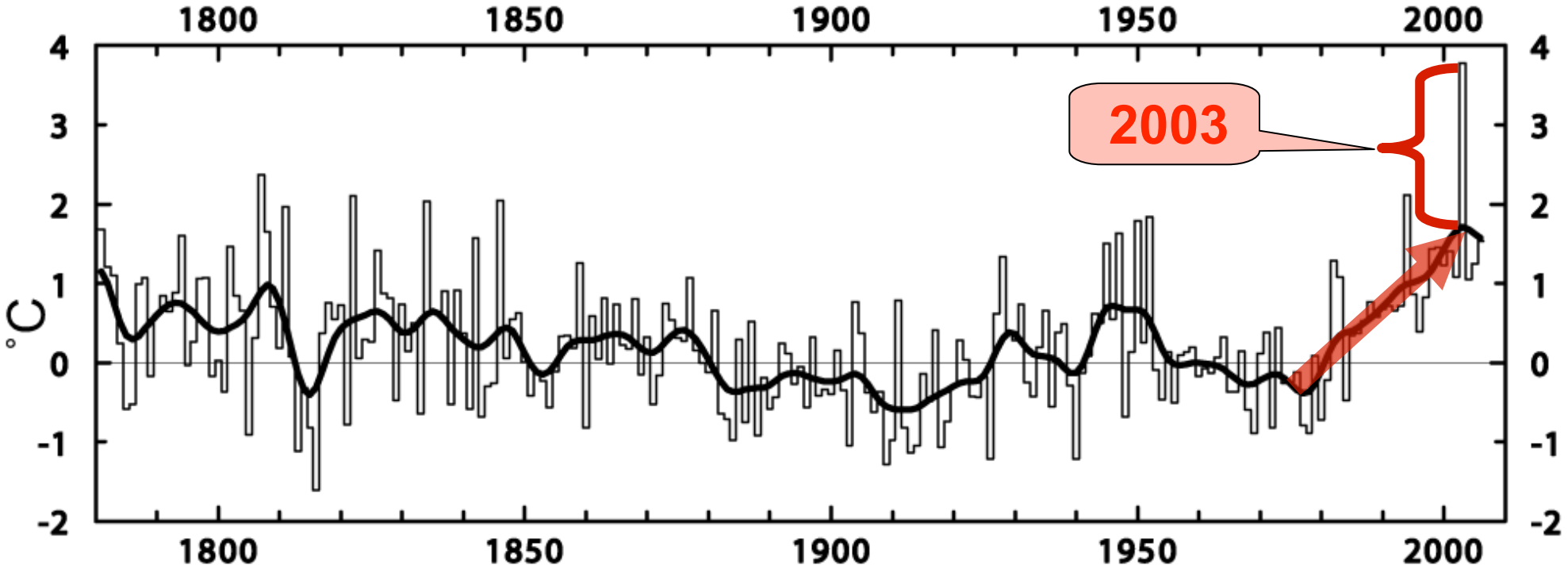
A World of Drought

- Many dry areas are getting drier as soils dry out
- Observed sea surface temperature (SST) and links to the pattern of rain in Africa?
- SSTs and Sahelian rainfall have varied in the past
- Some studies suggest links now to the widespread ocean SST trends and global warming



Sahelian rainfall decline shown by many climate models

More Heat Spells - European Trends



Anomalies from mean summer temperatures (JJA)

Changes In Extremes - R, Drought

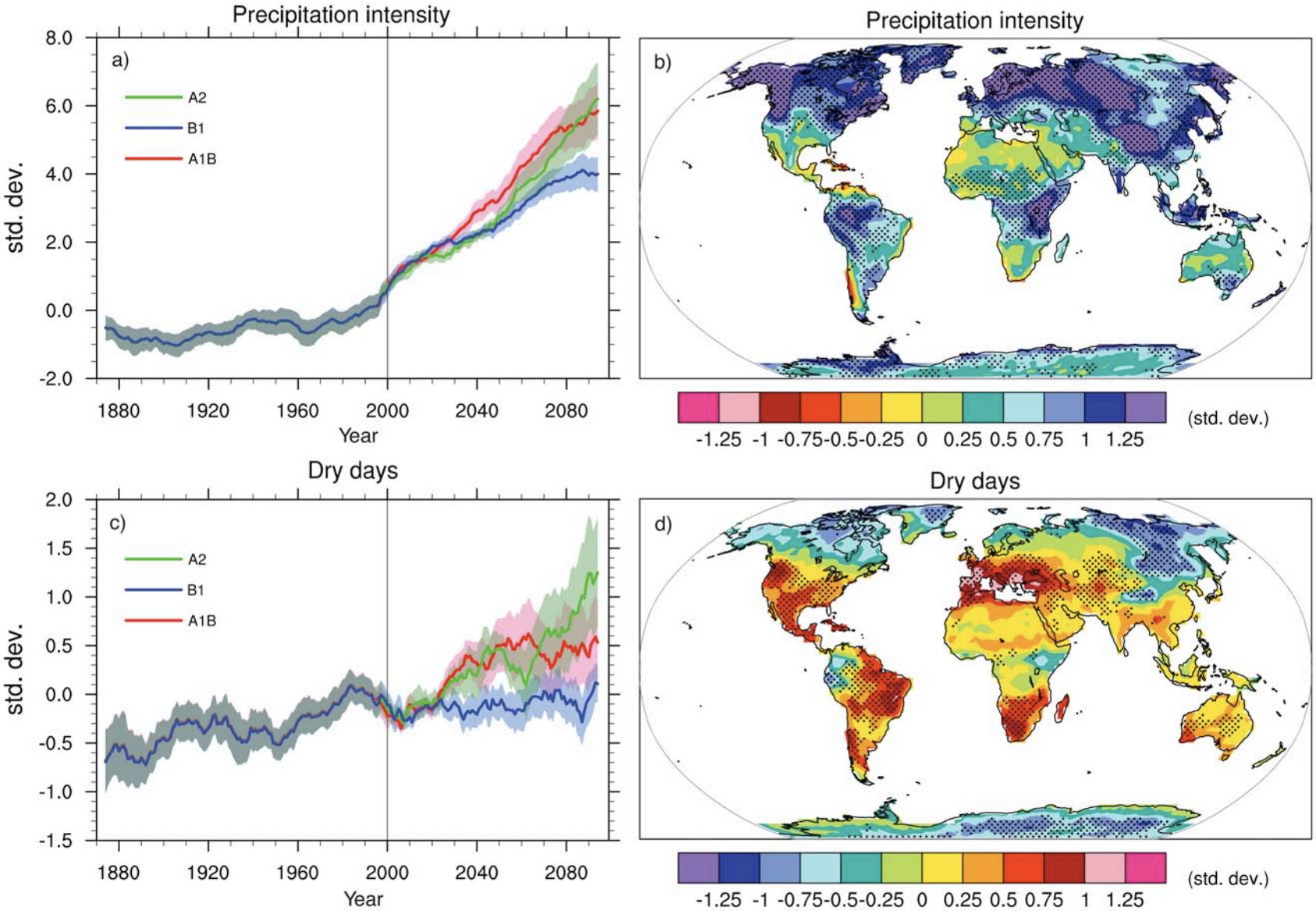
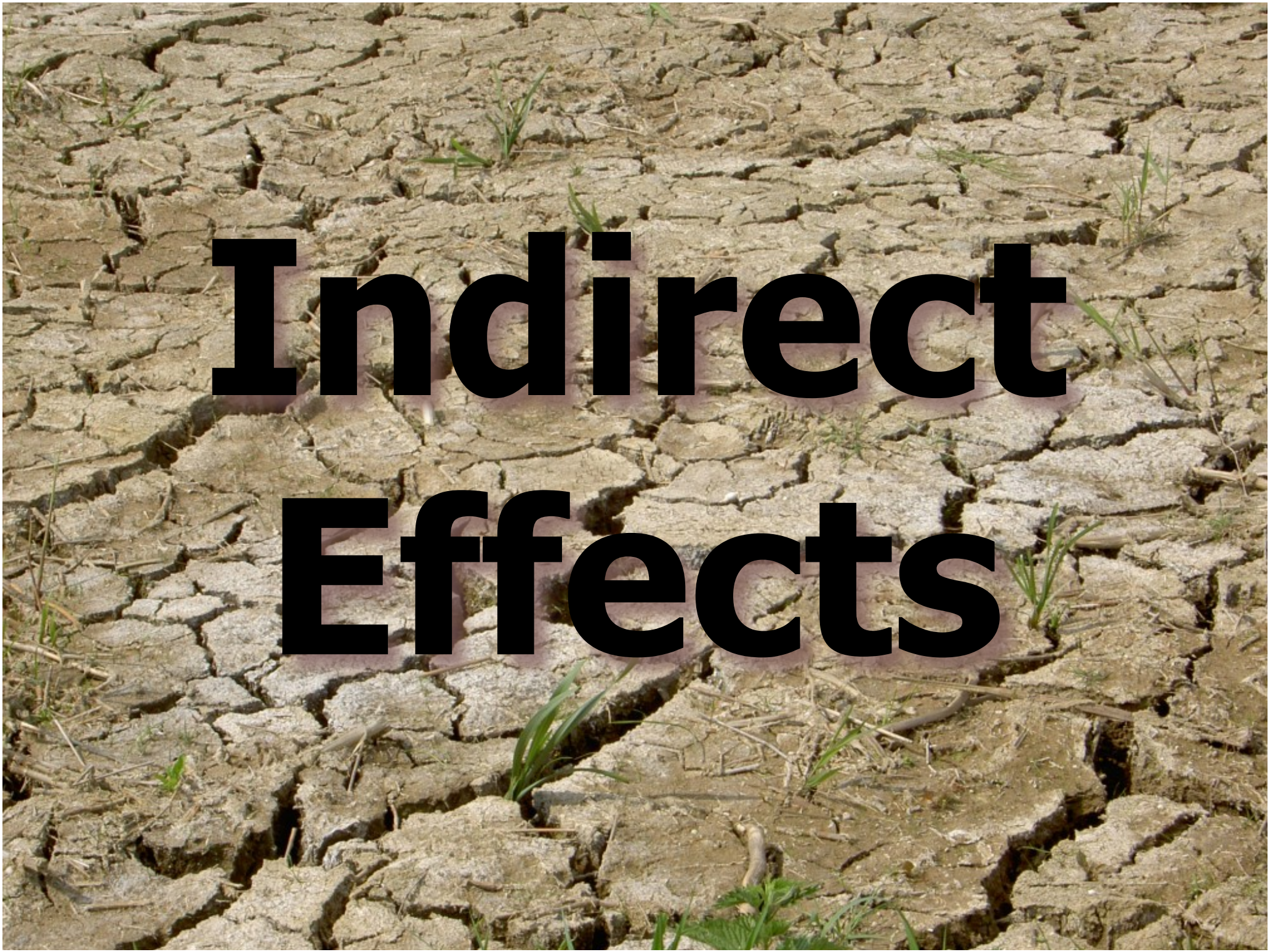
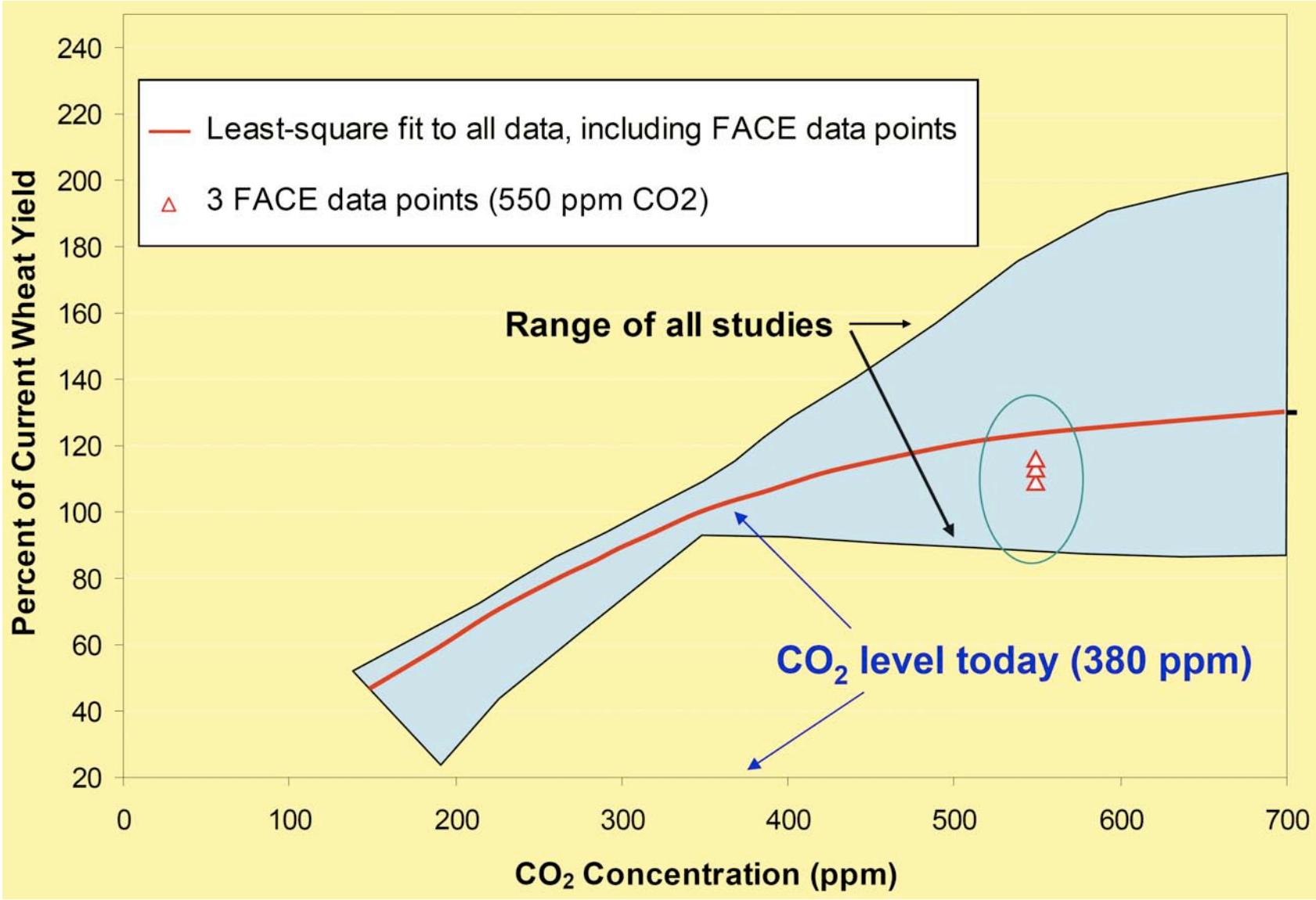


Figure 10.18:Multi-model projections of changes in extremes (Meehl et al., 2007. IPCC WGI)


Indirect
Effects

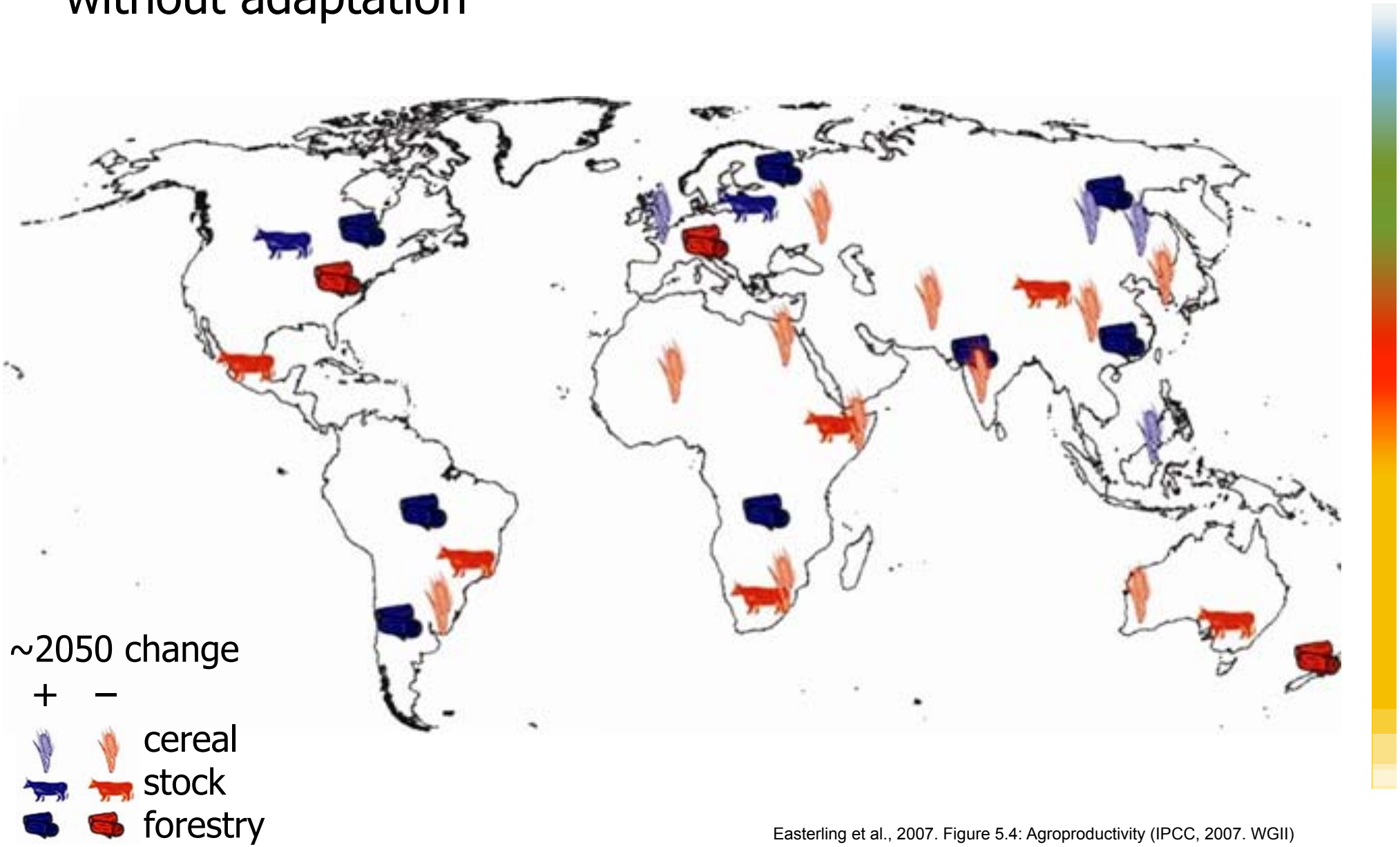
Food:
Quantity and Quality

Agricultural Yields and CO_2-fertilisation



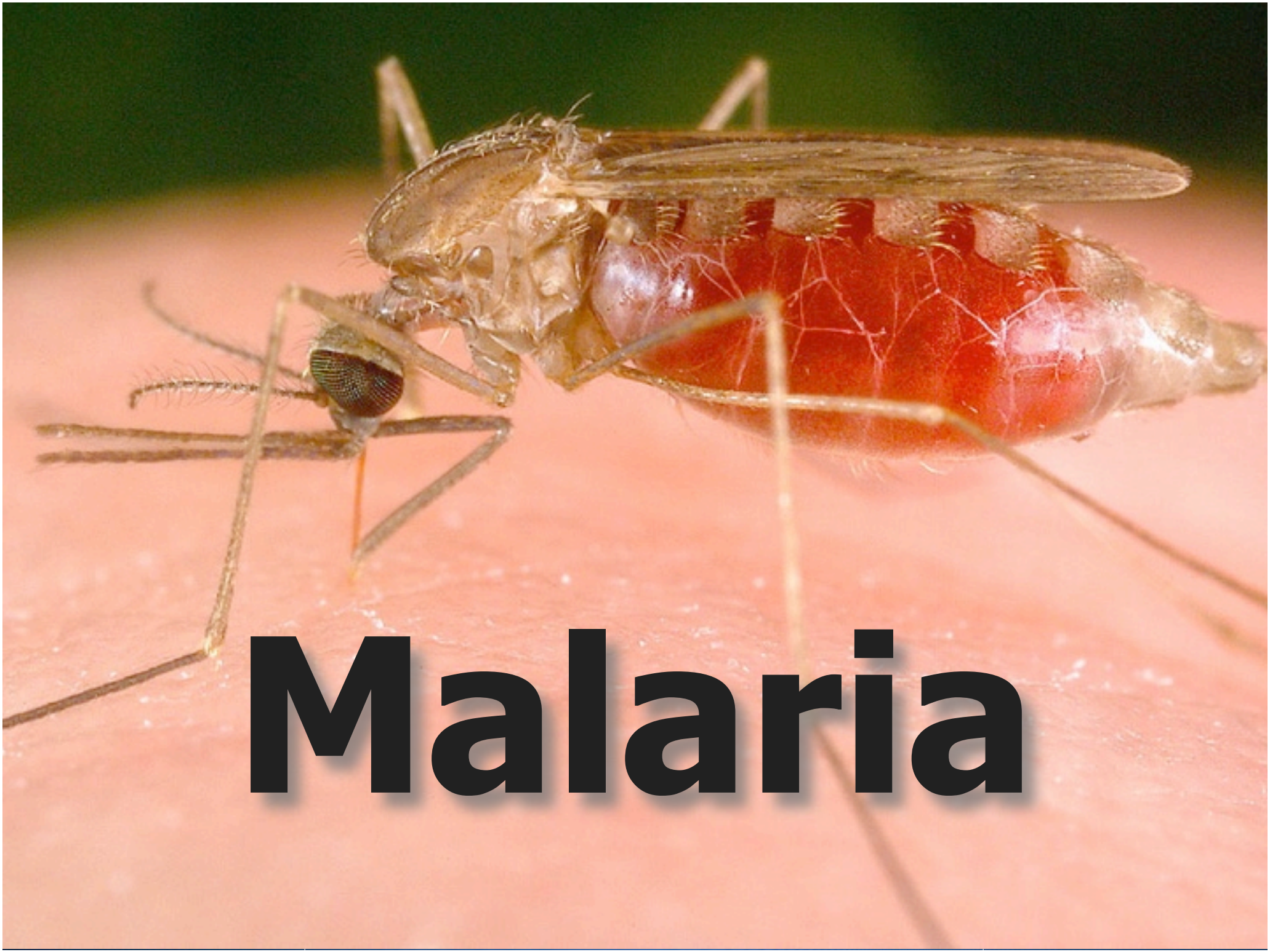
Agroproductivity by 2050

without adaptation



Easterling et al., 2007. Figure 5.4: Agroproductivity (IPCC, 2007. WGII)

Animal
borne
Diseases



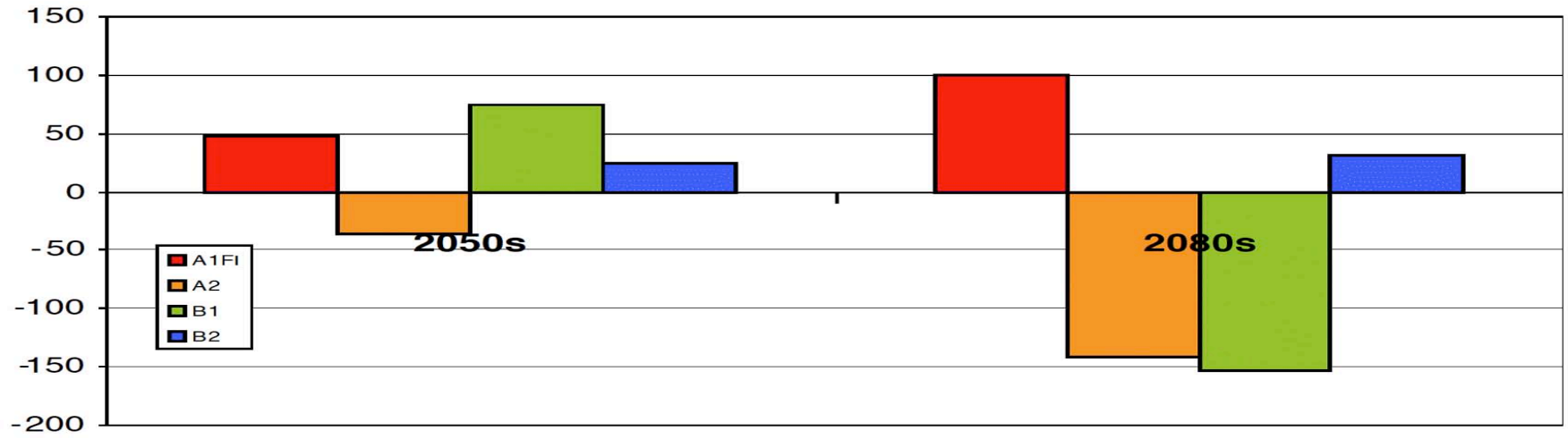
Malaria

People at Risk of Malaria ~2080

Table 2
Additional population at risk of malaria by WHO region by 2080s (millions)

van Lieshout et al., 2004. Global Environ. Change

	A1FI		A2		B1		B2	
	>3	>1	>3	>1	>3	>1	>3	>1
West Africa AFR_D	−46	−13	−35	−11	−25	−1	−8	−2
Sub-Saharan Africa AFR_E	49	44	53	56	21	38	51	67
North America AMR_A	−15	9	−46	33	−9	15	11	13
Latin America AMR_B	−92	−21	−169	−40	−29	16	−49	14
W. South America AMR_D	−19	−5	−42	−7	−12	2	−17	1
West Asia EMR_B	0	39	0	62	0	34	0	20
West Asia EMR_D	23	140	16	237	−2	100	62	139
Western Europe EUR_A	−1	7	−1	22	−1	4	0	33
Central Europe EUR_B	−1	19	−1	33	−1	25	−1	15
Eastern Europe and CIS EUR_C	1	−12	1	−13	1	−2	1	−14
South East Asia SEAR_B	0	0	−1	0	0	0	0	0
South Asia SEAR_D	102	7	−77	13	−104	6	−35	9
Australasia WPR_A	17	1	17	1	13	1	9	1
East Asia WPR_B	82	12	143	29	−6	11	7	12
World	100	227	−141	416	−153	250	31	307



Fires

Moscow 2010 - An example of what is ahead of Russia (and others)

RUSSIA

Fire-plagued Russians say they breathe as long as they don't inhale

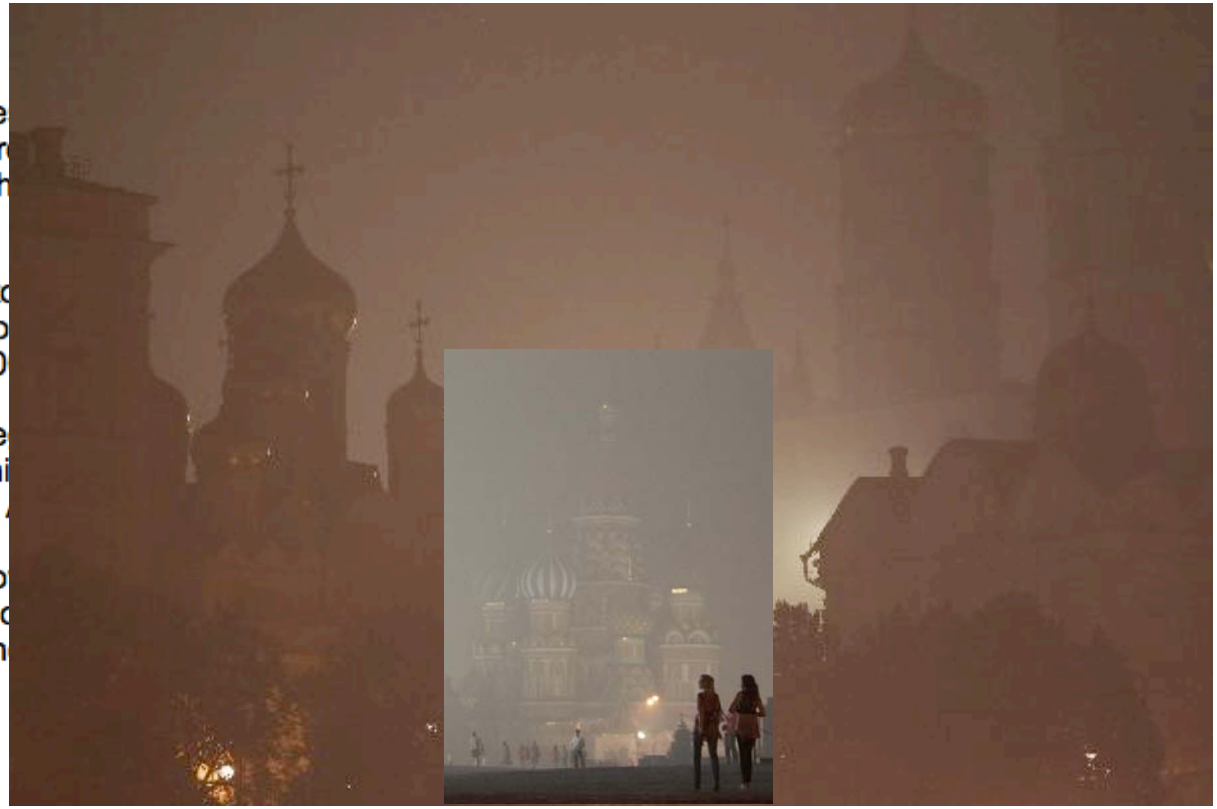
05.08.2010, 17.49

MOSCOW, August 5 (Itar-Tass) -- Forest fire
burning peat leaves no chance for a gulp of fr
increasingly angry about the authorities, wh
situation.

The death toll from the disasters has risen to
constituent territories of Russia. According to
different parts of the country measured 188,50

Of the 24 peat fires 13 are in the Moscow Re
choking smog more than anybody else. In thi
roads visibility was no more than 100 meters.

In some areas of the city the quality of air pro
Region – four-five times the tolerance limit. Fo
two or three packs of cigarettes over several h
possible, and to wear wet masks outdoors.



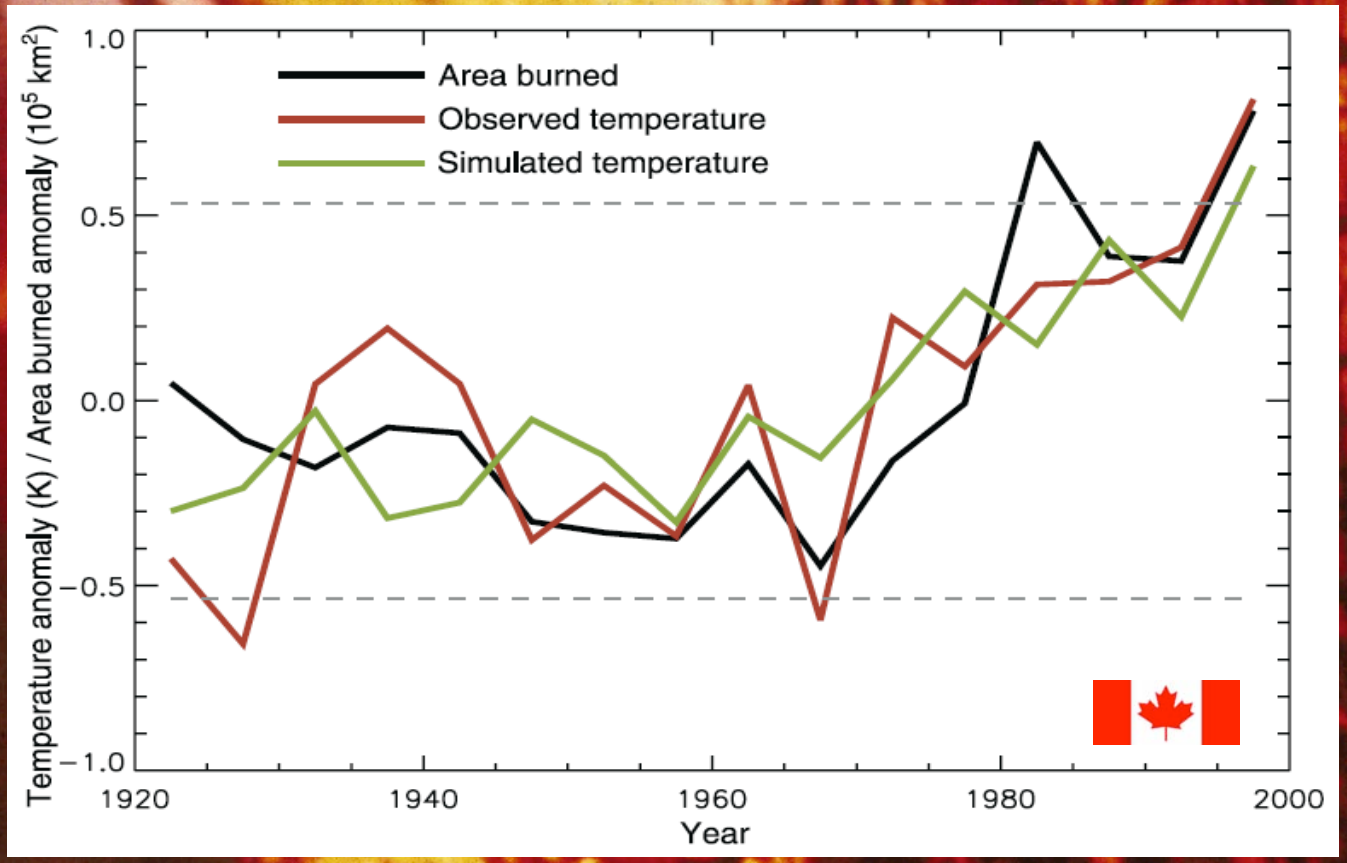
Observed Trends of Increasing Fire Prevalence

mostly in boreal and subtropical zones

Section 4.4.5 (Fischlin *et al.*, 2007. IPCC WGII)

Observed Trends of Increasing Fire Prevalence

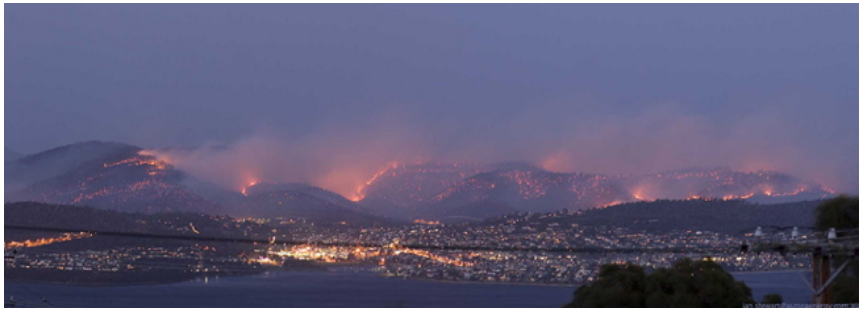
mostly in boreal and subtropical zones



Section 4.4.5 (Fischlin *et al.*, 2007. IPCC WGII)

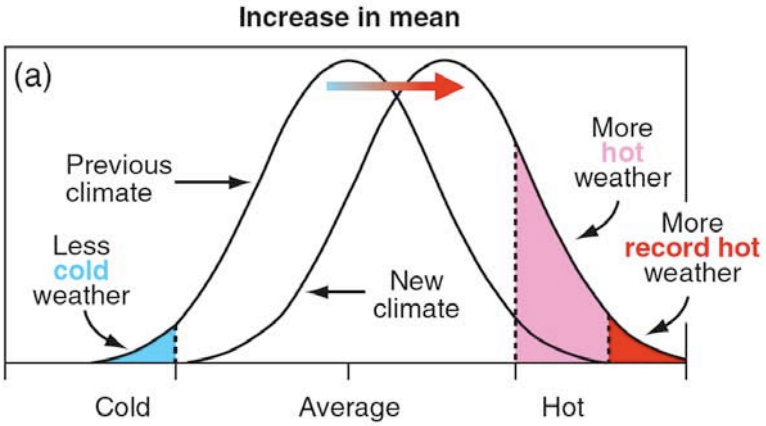
Storms

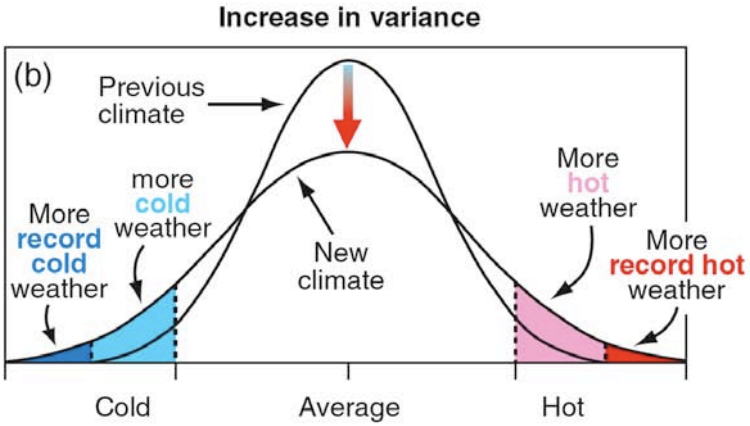
Floods, Storms, Fires and Other Extreme Events Cause Injuries and Deaths (direct exposure)

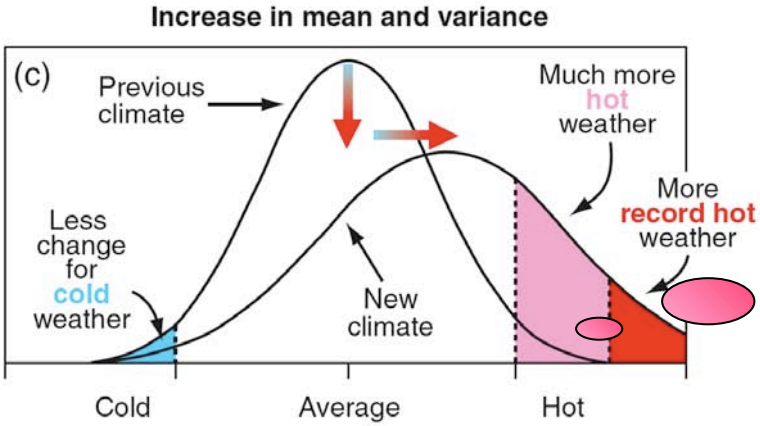


Tempera-
ture

Frequency of Extreme Events







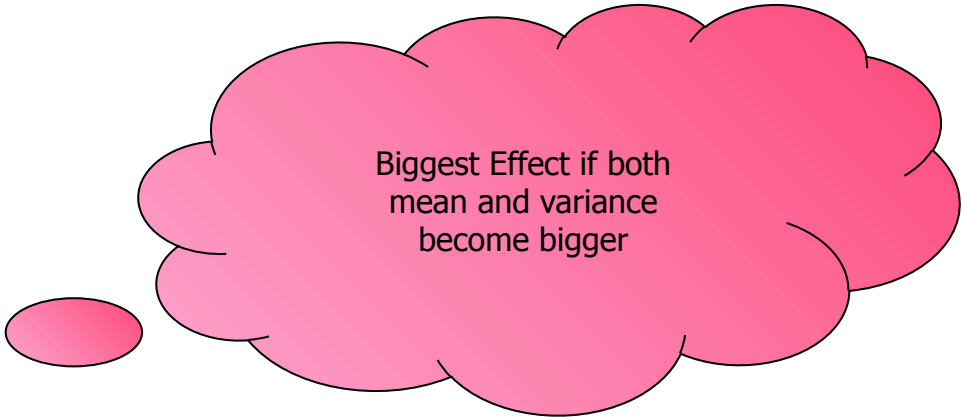
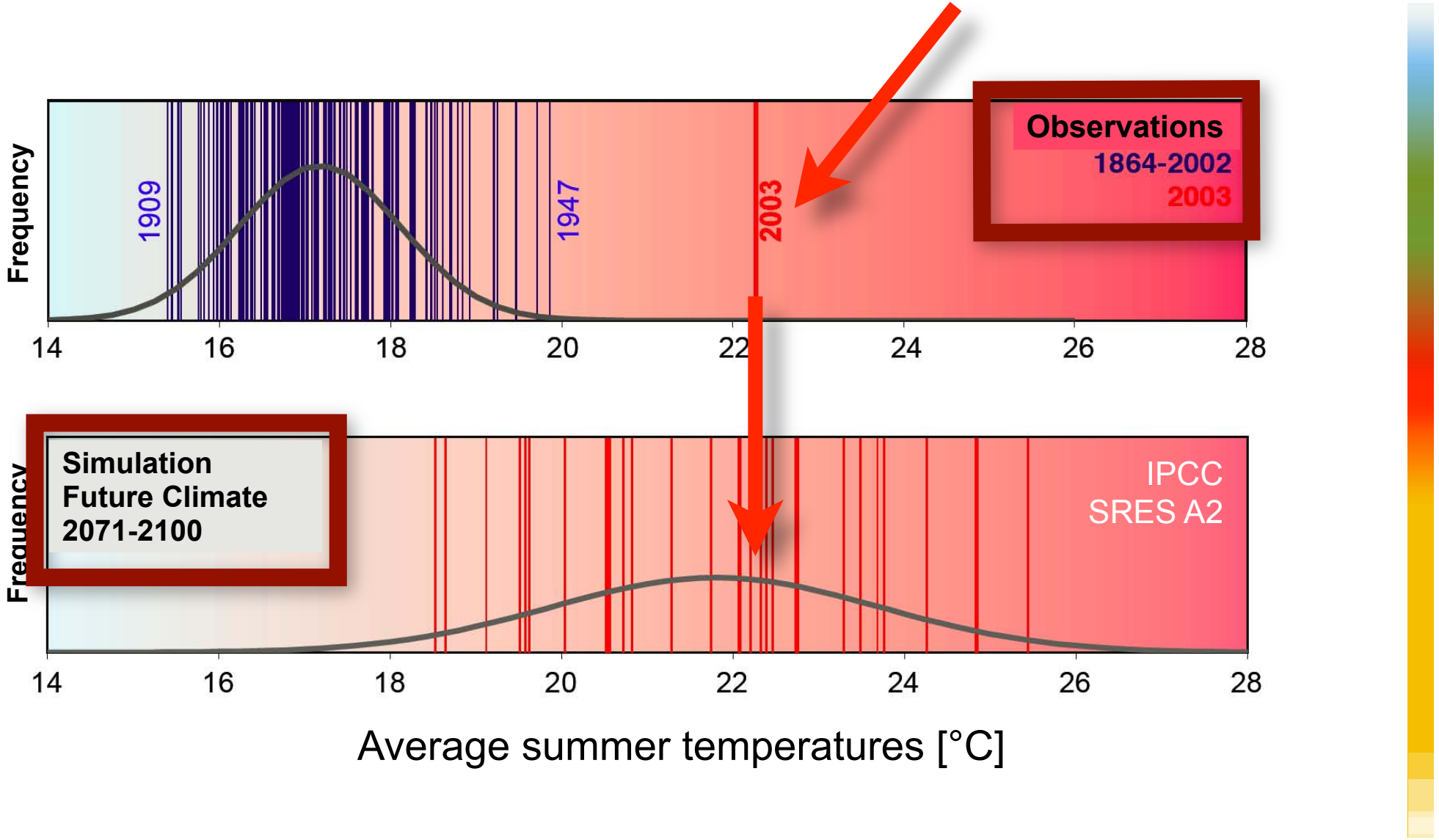


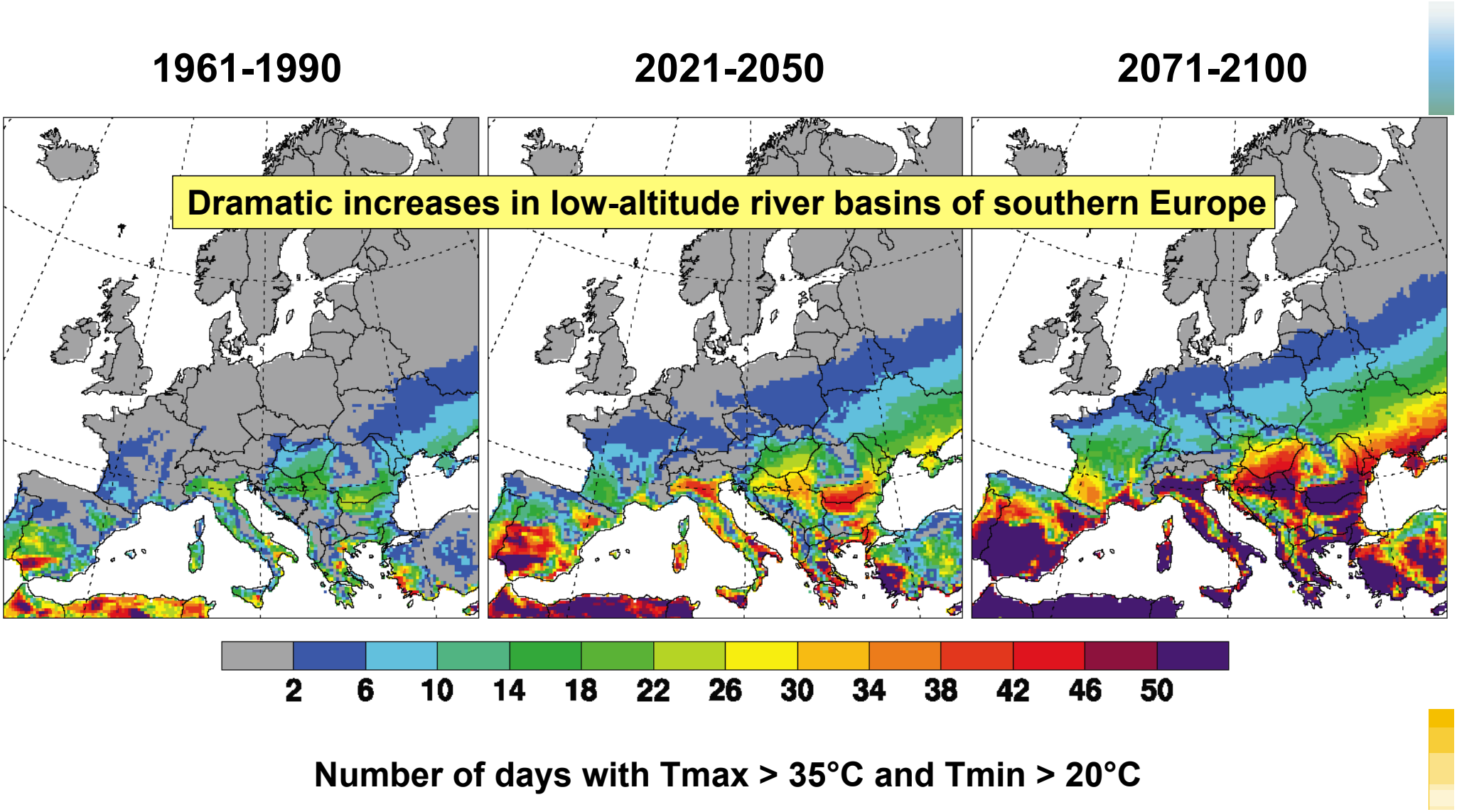
Fig. 2.32, Folland et al., 2001. IPCC WGI TAR

Frequency of Extreme Temperatures



Alcamo et al., 2007. Regional chapter: Europe. IPCC WGII (after Schär et al., 2004)

Heat Days and Tropical Nights



(Fischer & Schär, 2009, ENSEMBLES, submitted, mean of 5 models)

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

DUWIS
Departement
Umweltwissenschaften

Prevalence of Heat Stress

Number of days with apparent temperature ≥ 42°C
(large heat stroke risk with extended exposure)

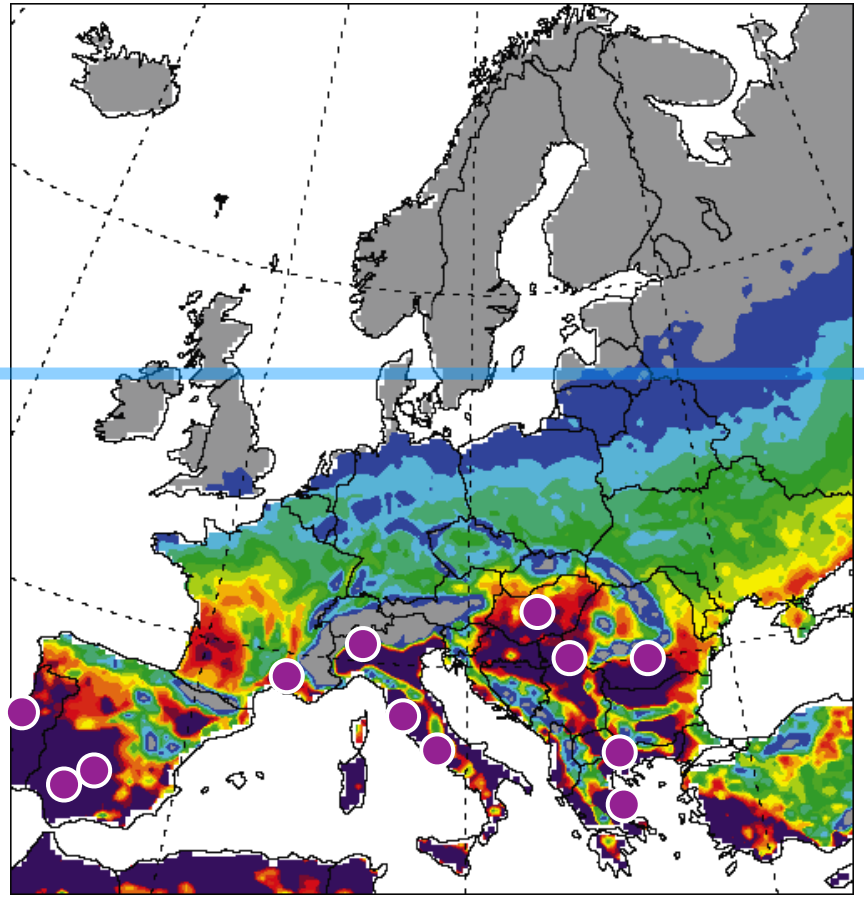
Particularly Impacted River Basins:

Tagus
Ebro
Rhone
Po
Tiber
Danube
etc.

+3.2°

2071-2100

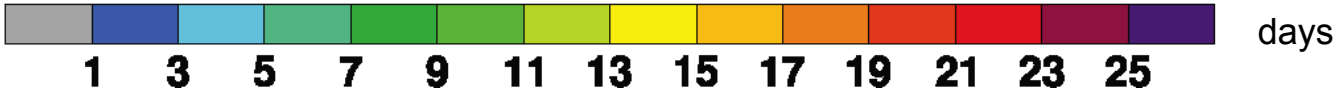
Apparent temperature (heat index > 90) based on T and air humidity



Impacted Cities:

Lisbon
Seville
Cordoba
Marseille
Milan
Roma
Napels
Budapest
Belgrade
Bucharest
Thessaloniki
Athens
etc.

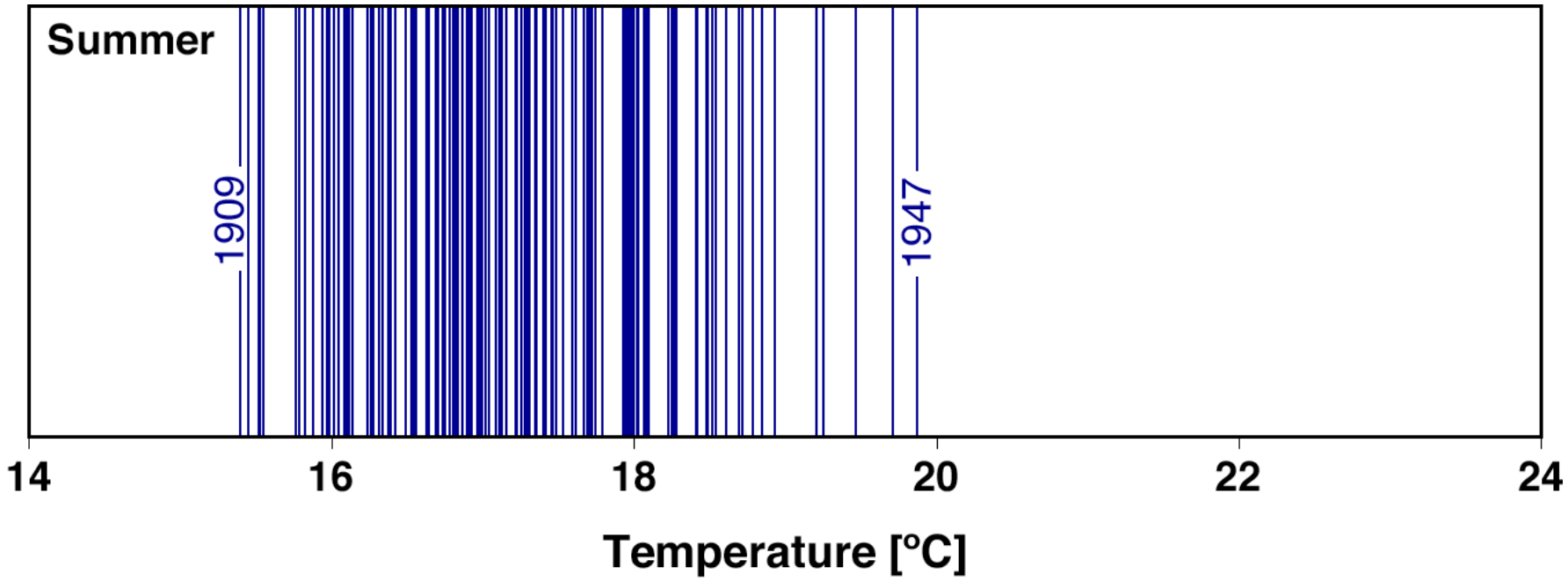
+3°



(Fischer & Schär 2009, mean of 5 ENSEMBLES models)

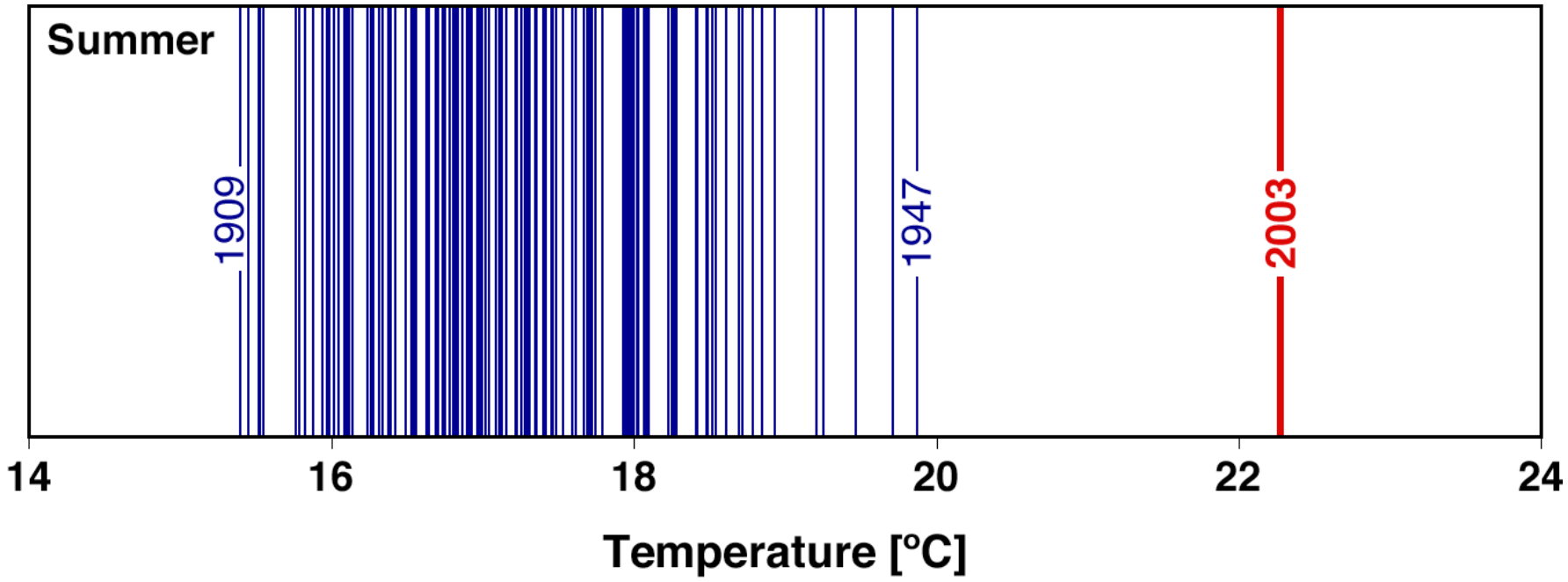
Swiss Temperature Series 1864-2002

Average of 4 Stations: Zürich, Basel, Berne, Geneva



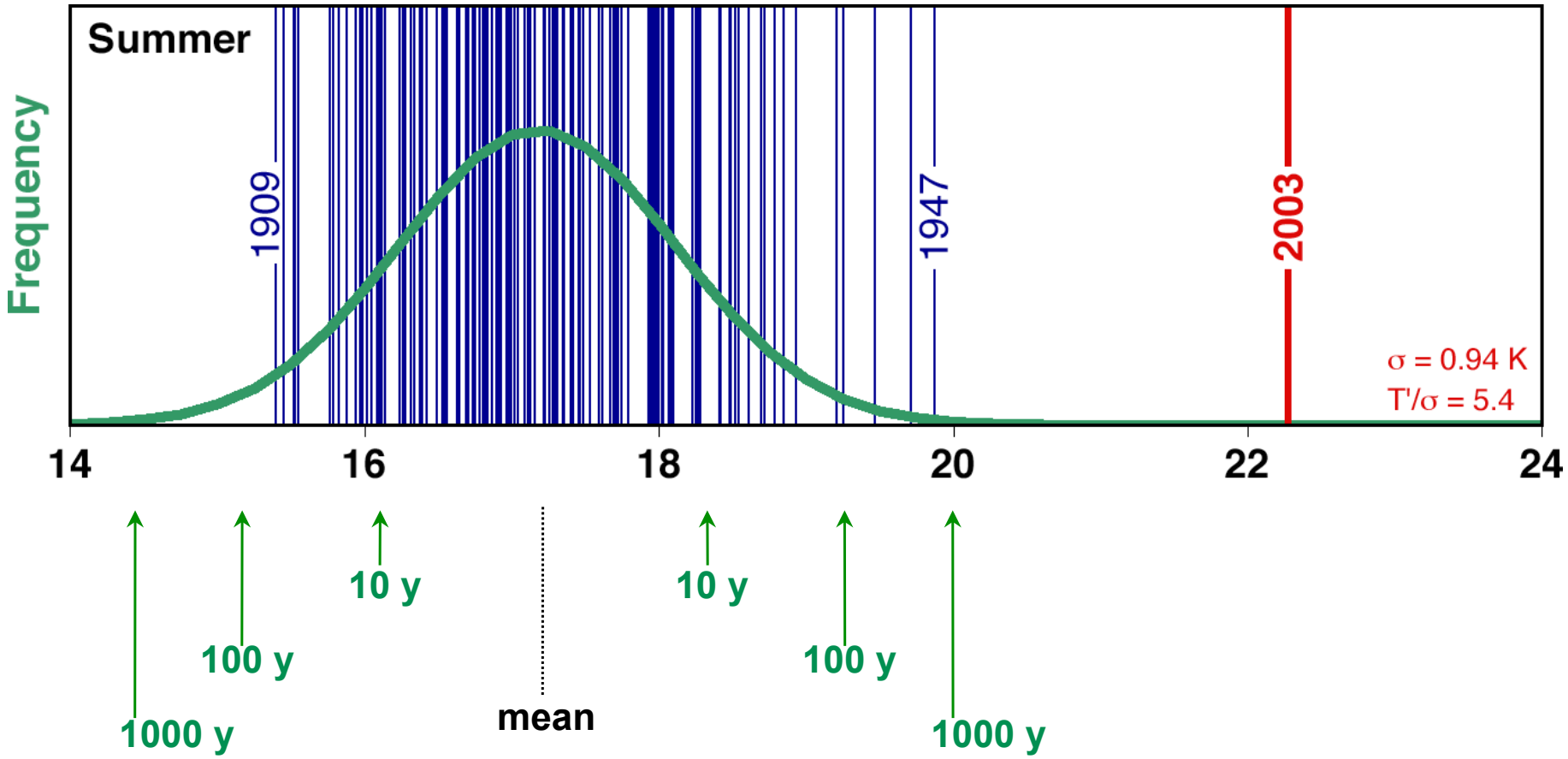
Swiss Temperature Series 1864-2003

Average of 4 Stations: Zürich, Basel, Berne, Geneva

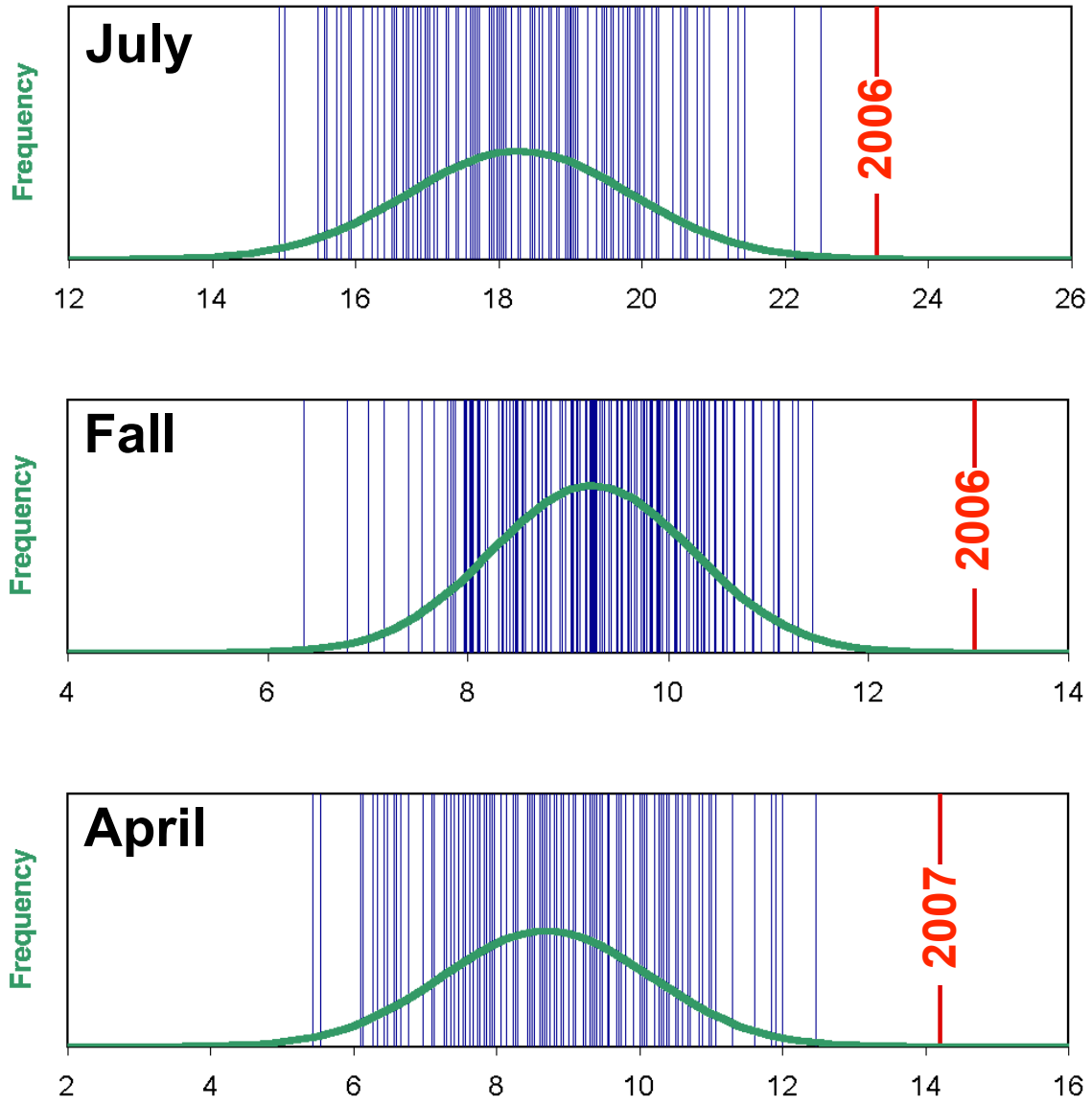


Swiss Temperature Series 1864-2003

Average of 4 Stations: Zürich, Basel, Berne, Geneva

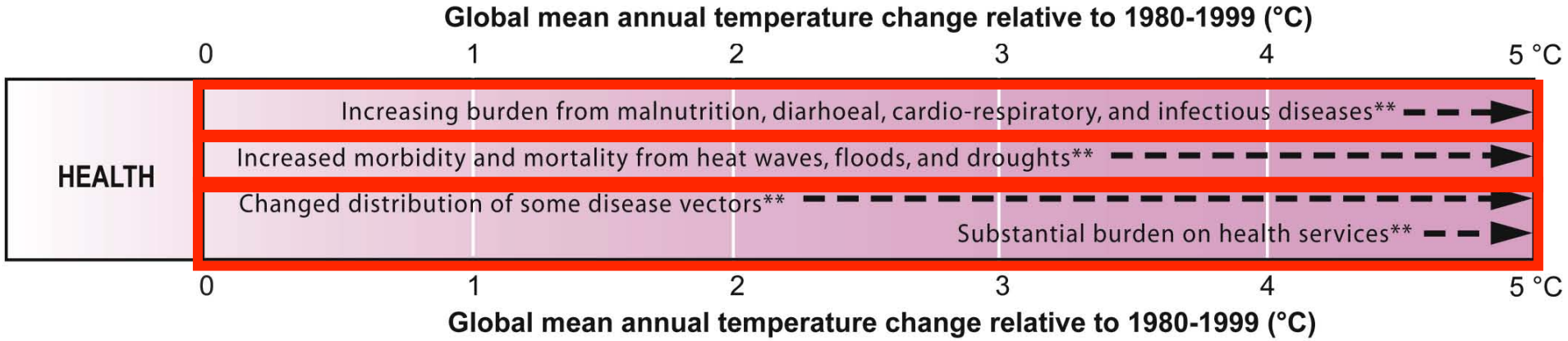


Other Swiss Temperatures Breaking Records



Summary

Impacts on Human Health



The warmer, the more negative the impacts!

From Figure SPM.2

(IPCC, 2007. Summary for Policy Makers by Working Group II AR4 IPCC)

Future Impacts?

Plenty!

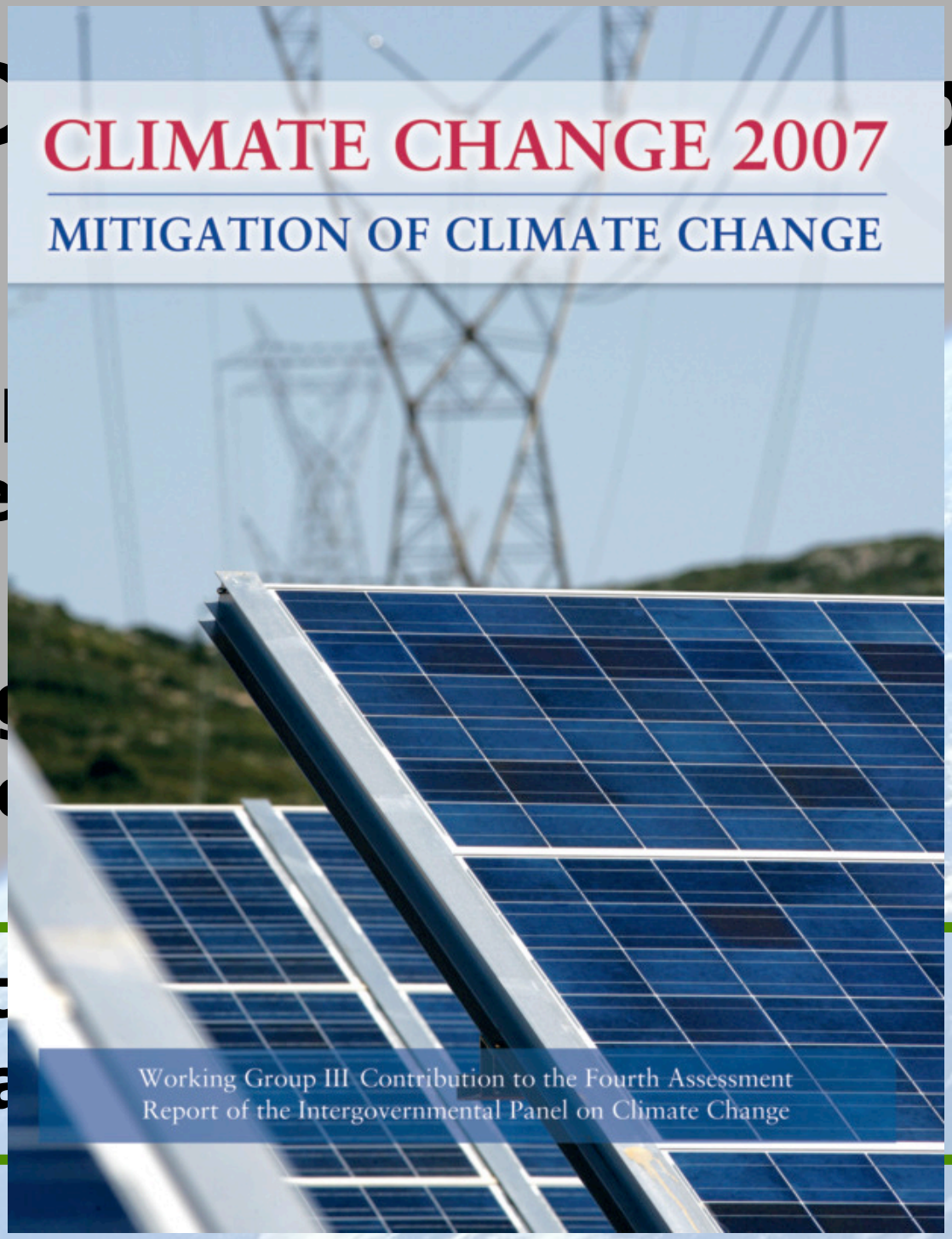
Including some fatal ones!

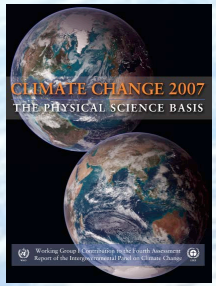
IPCC ort 4

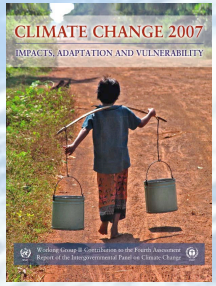
Anthro
change

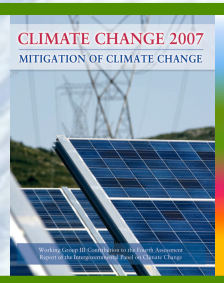
Unmiti
would

A drast
is still a









What Can Be Done?

Adaptation

AND

Mitigation

Warming Over Present Levels

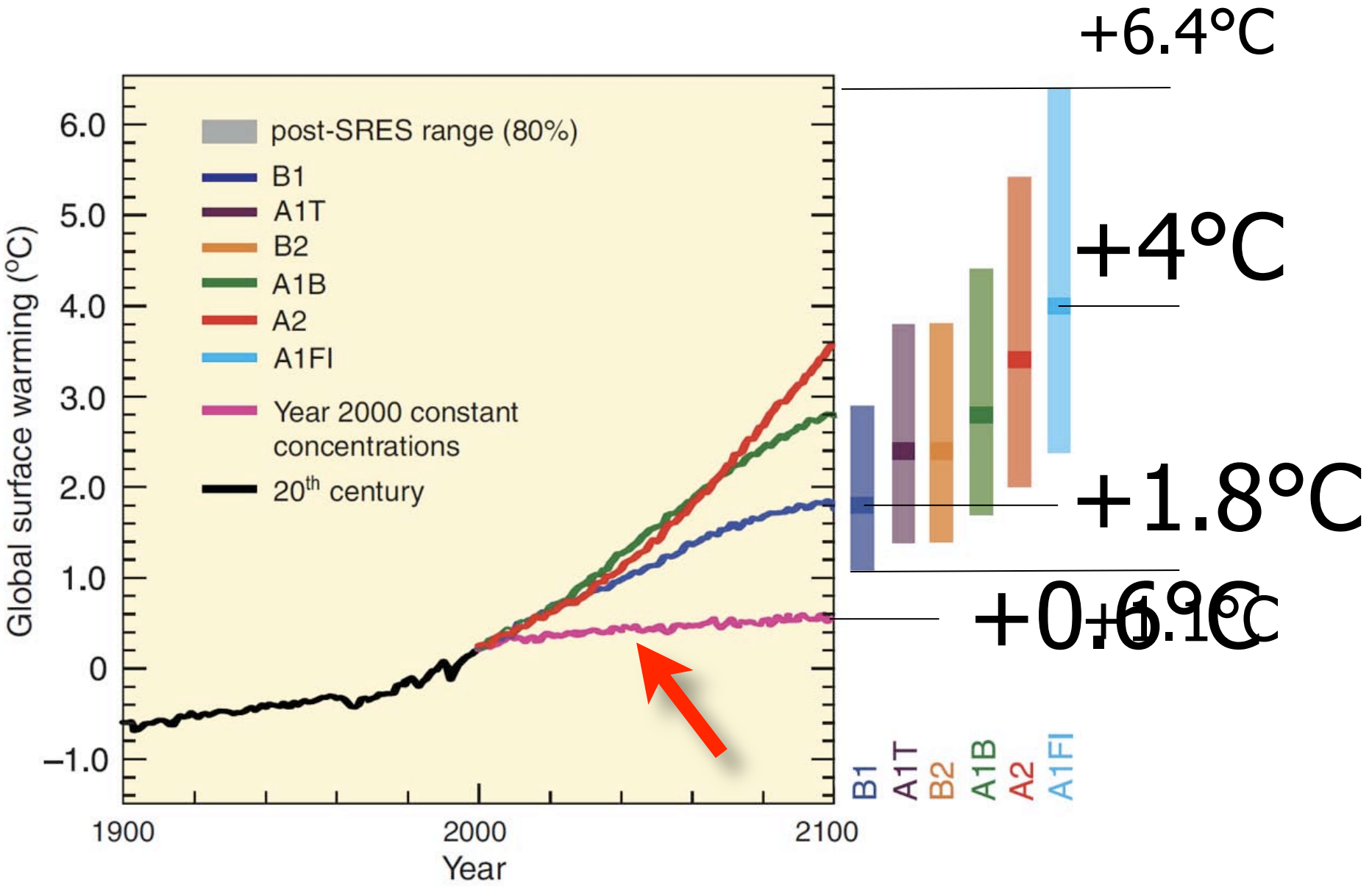


Figure SPM.5: Multi-model global averages of surface warming (relative to 1980–1999) for the scenarios (IPCC, 2007. Summary for Policy Makers WGI)

Warming Over Present Levels

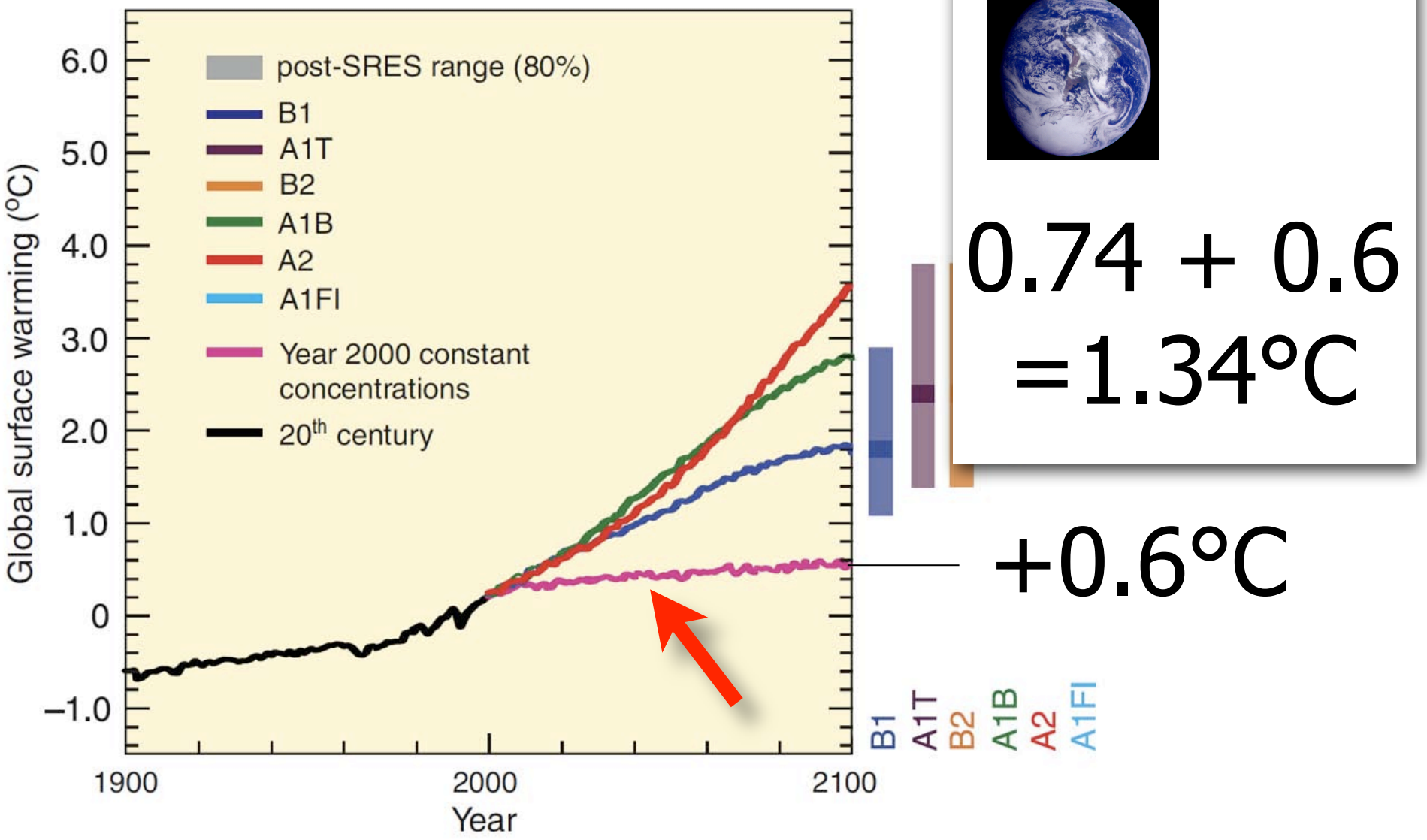


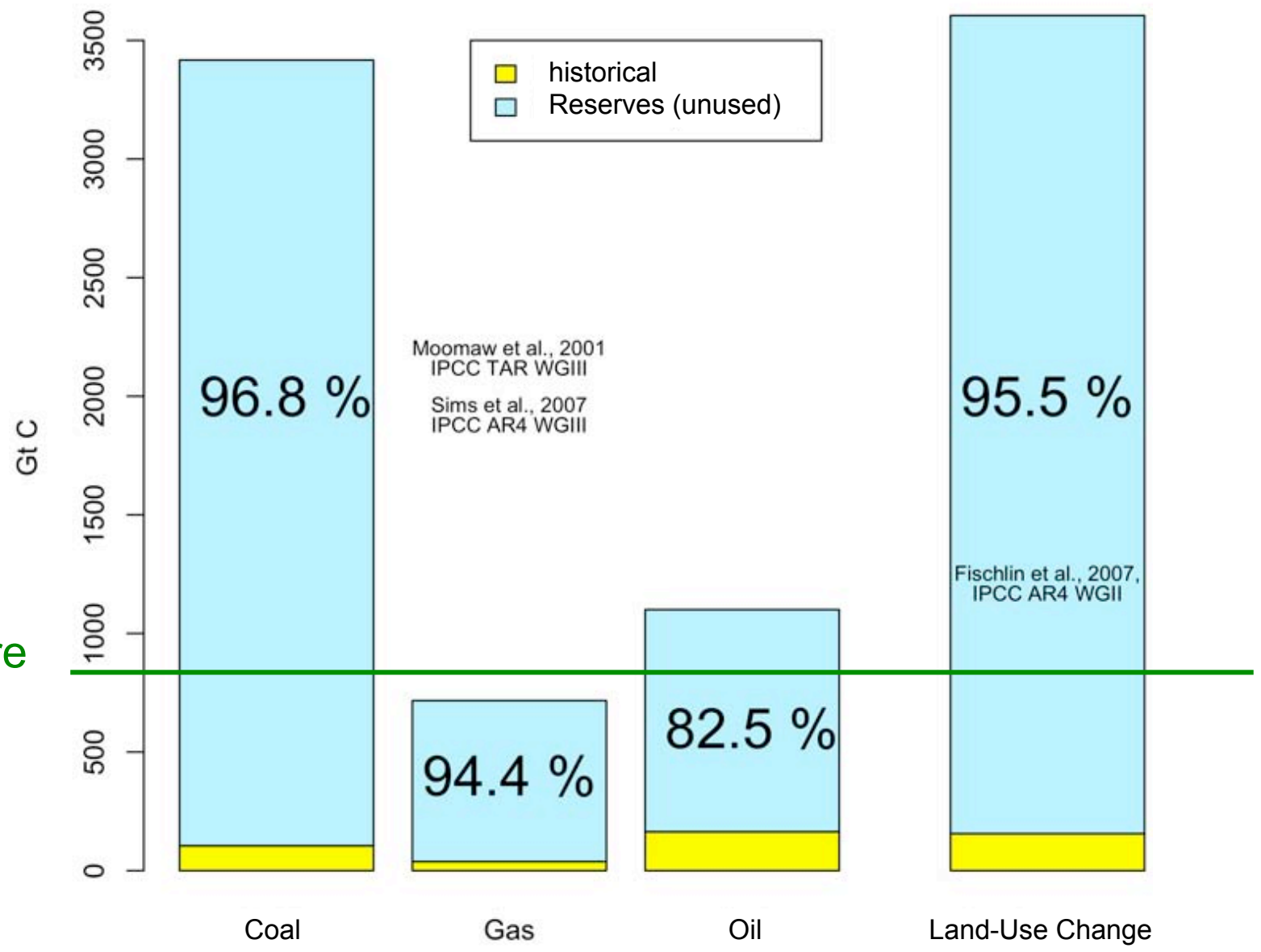
Figure SPM.5: Multi-model global averages of surface warming (relative to 1980–1999) for the scenarios (IPCC, 2007. Summary for Policy Makers WGI)

Adaptation

AND

Mitigation

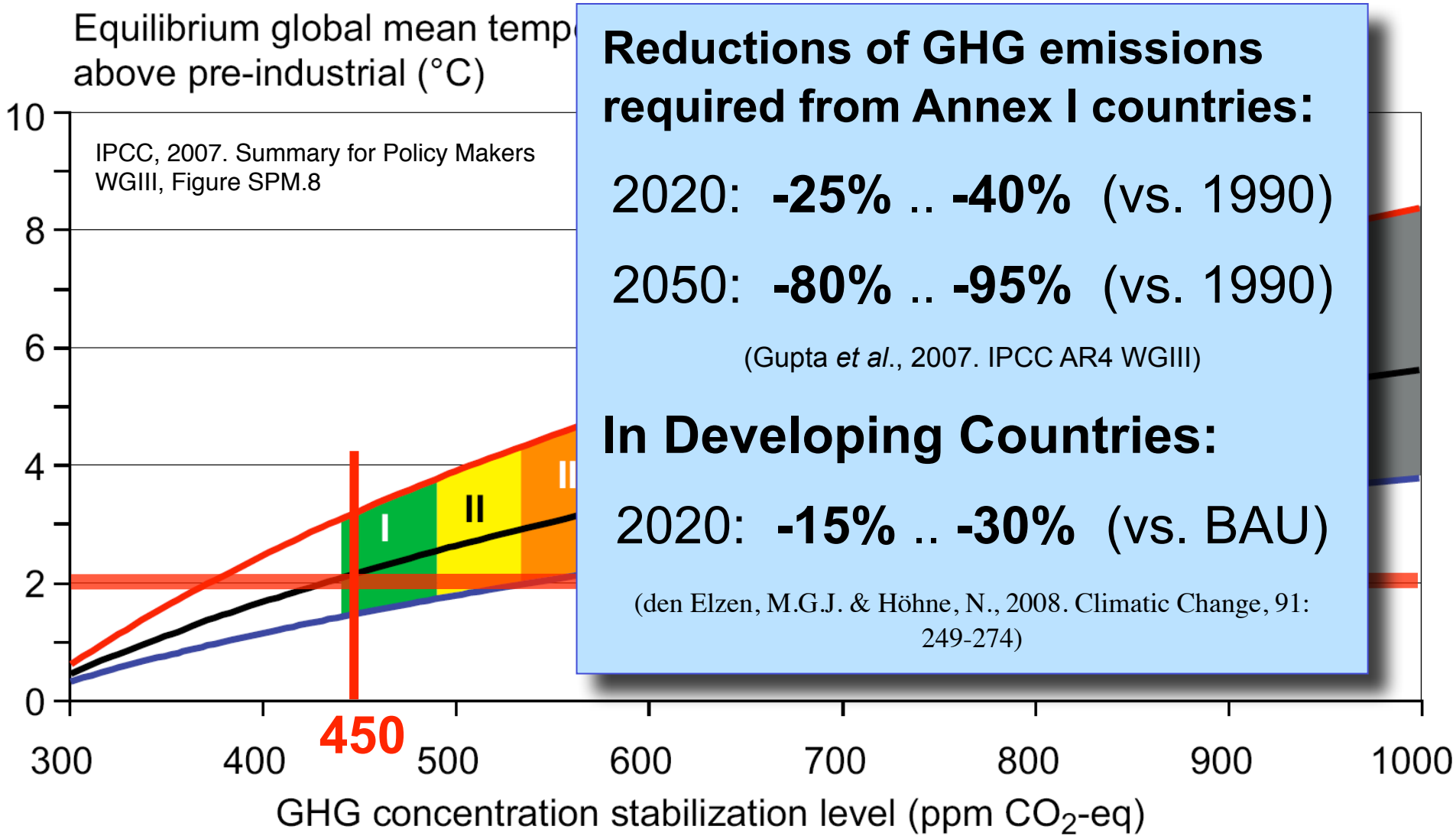
Fossil Fuels (world)



Current atmosphere 777 GtC

Need We
Mitigate?
By How Much?

Max 2°C ?



Reductions of GHG emissions required from Annex I countries:

2020: **-25%** .. **-40%** (vs. 1990)

2050: **-80%** .. **-95%** (vs. 1990)

(Gupta *et al.*, 2007. IPCC AR4 WGIII)

In Developing Countries:

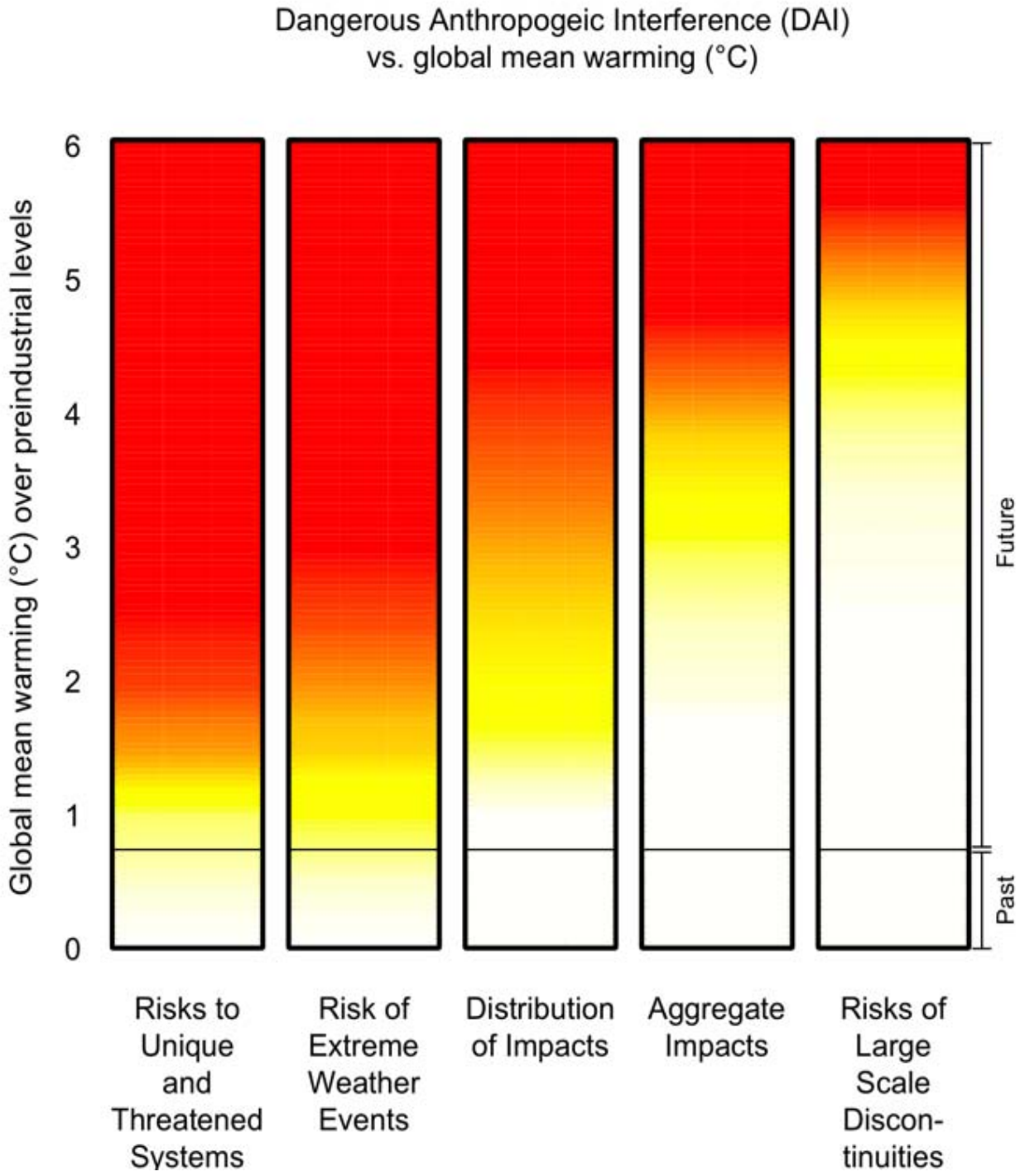
2020: **-15%** .. **-30%** (vs. BAU)

(den Elzen, M.G.J. & Höhne, N., 2008. Climatic Change, 91: 249-274)

Figure SPM.8: Global warming and GHG stabilization levels (IPCC, 2007. Summary for Policy Makers WGIII)

Reasons of Concern

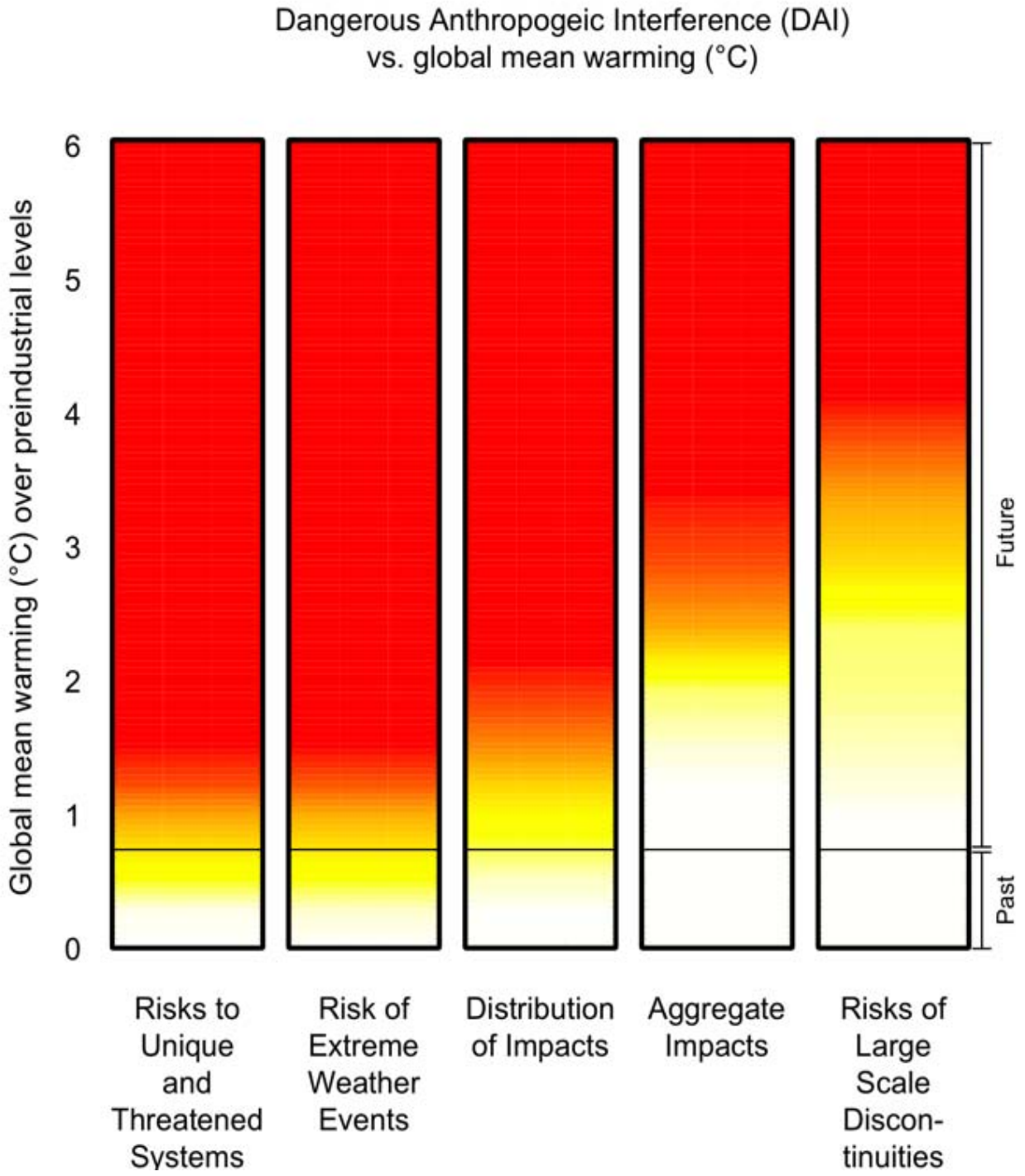
Know-ledge **TAR 2001**



Smith et al., 2009. PNAS u. Fischlin, 2009

Reasons of Concern

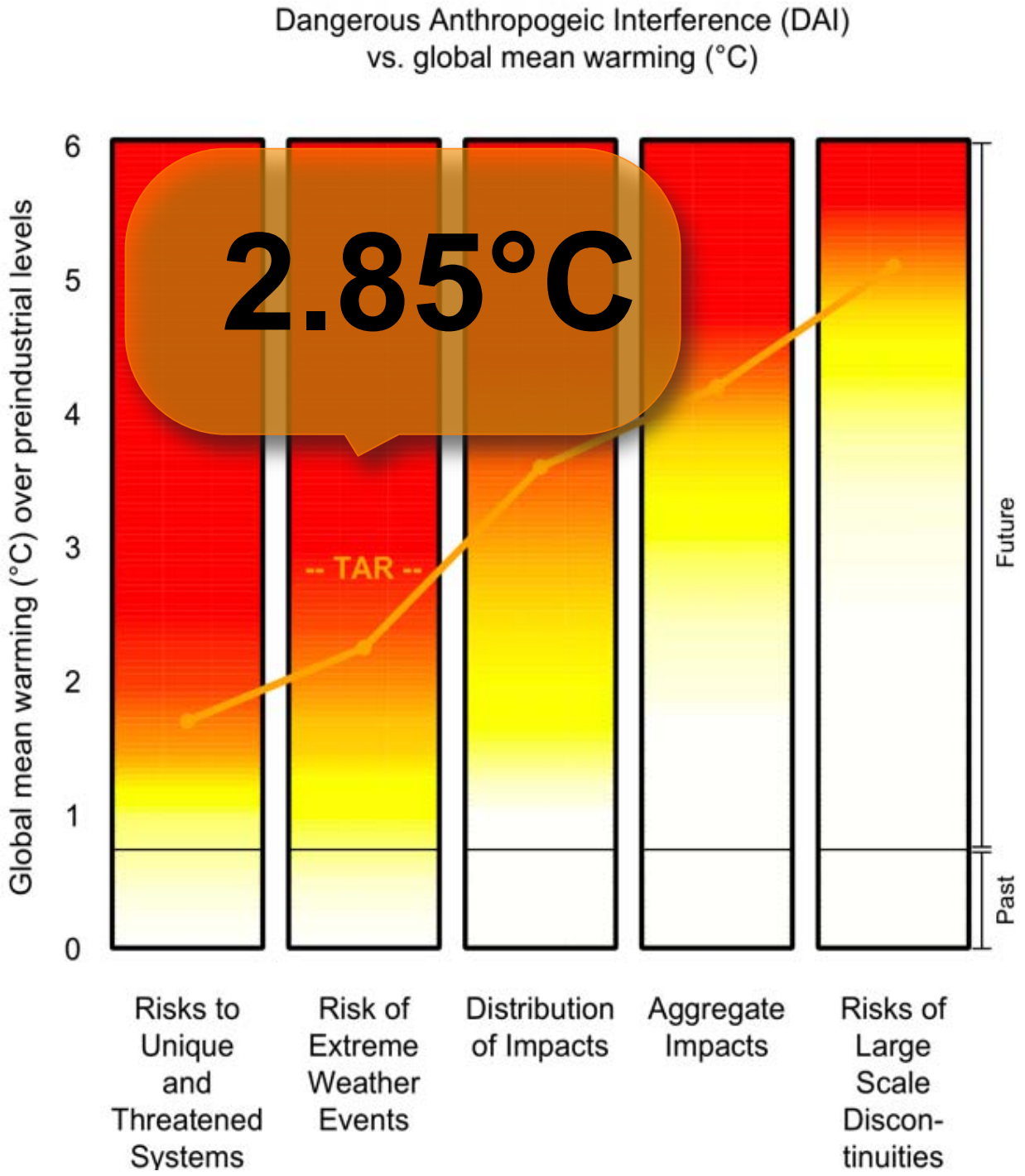
Know-ledge **AR4 2007**



Smith et al., 2009. PNAS u. Fischlin, 2009

Reasons of Concern

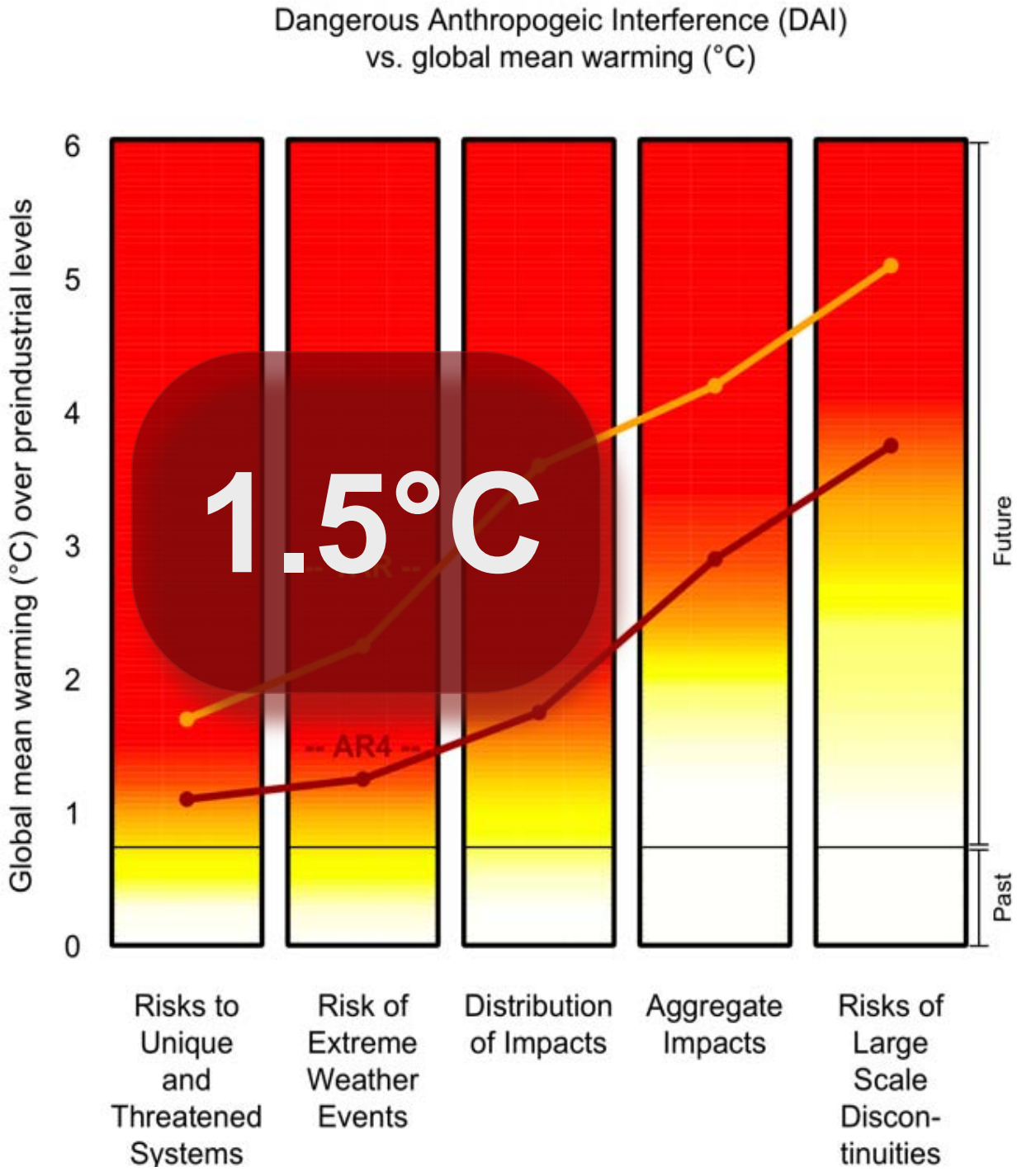
Know-ledge **TAR 2001**



Smith et al., 2009. PNAS u. Fischlin, 2009

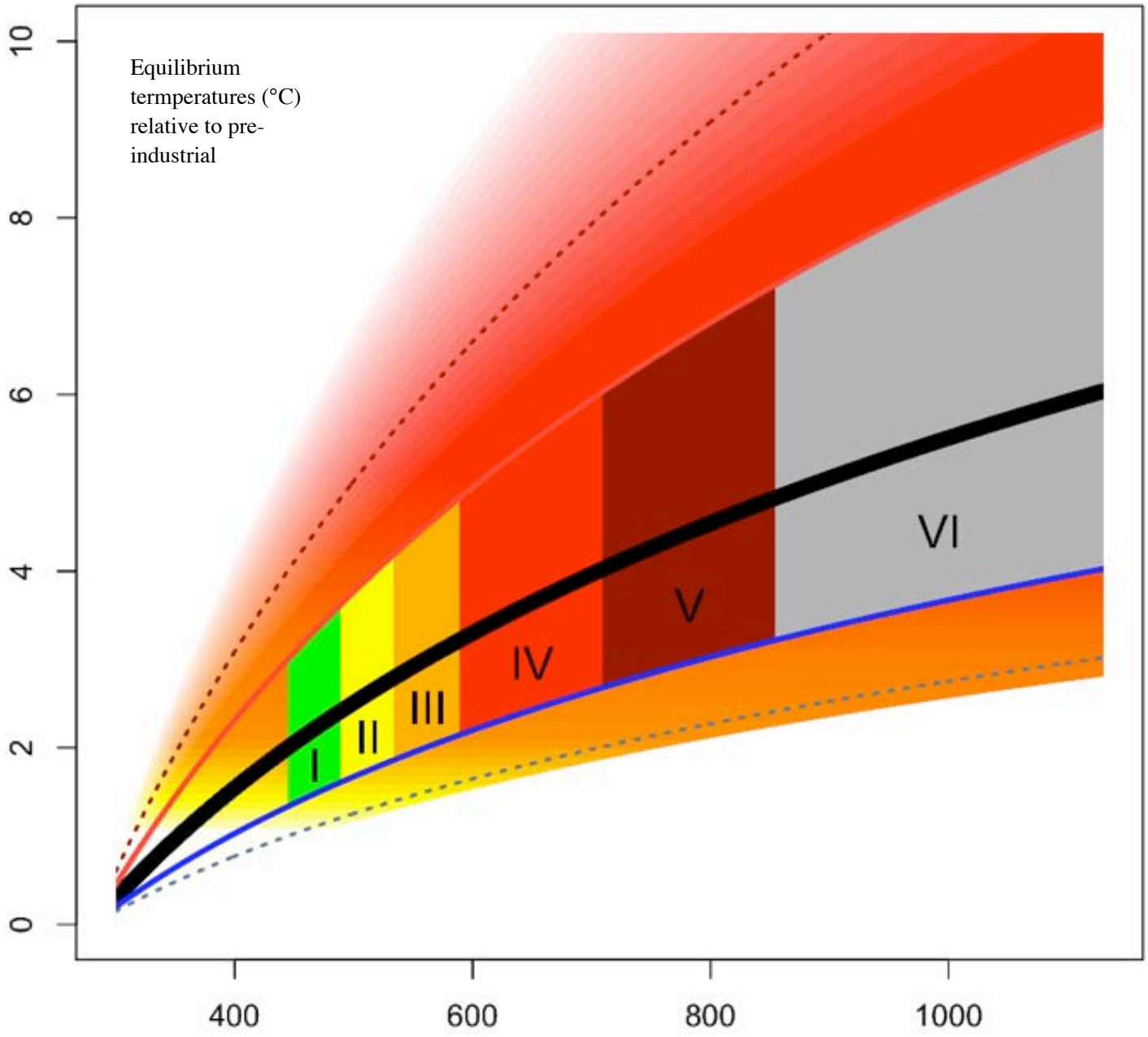
Reasons of Concern

Know-ledge **AR4 2007**



Fischlin, A., 2009. GAIA, **18**: 193–199

Safety Mar-gins?



Fischlin, 2009. GAIA, 18: 193-199

Need We Mitigate? By How Much?

Yes! A Lot!

No, since ...

Global CO_2 Emissions

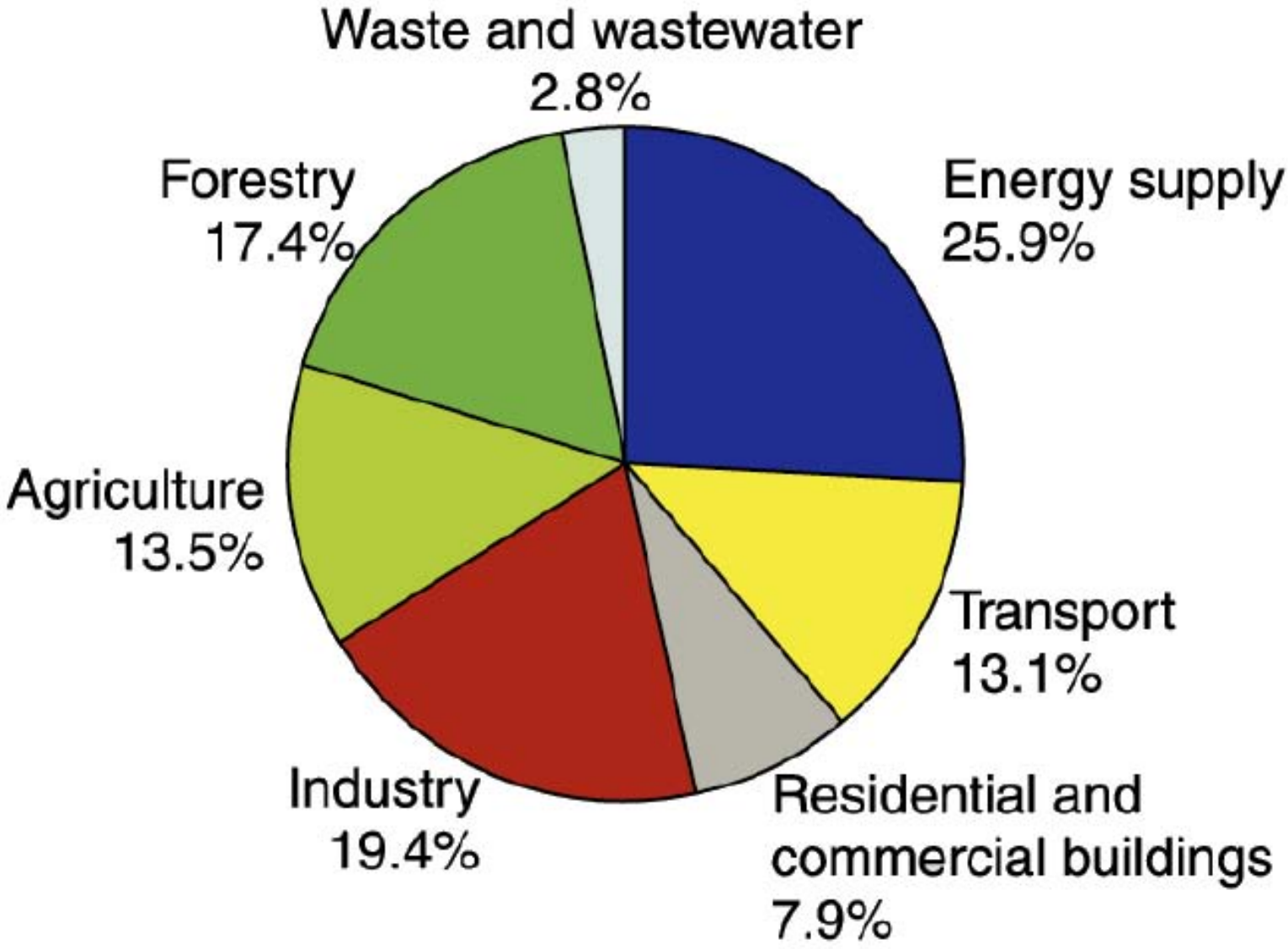
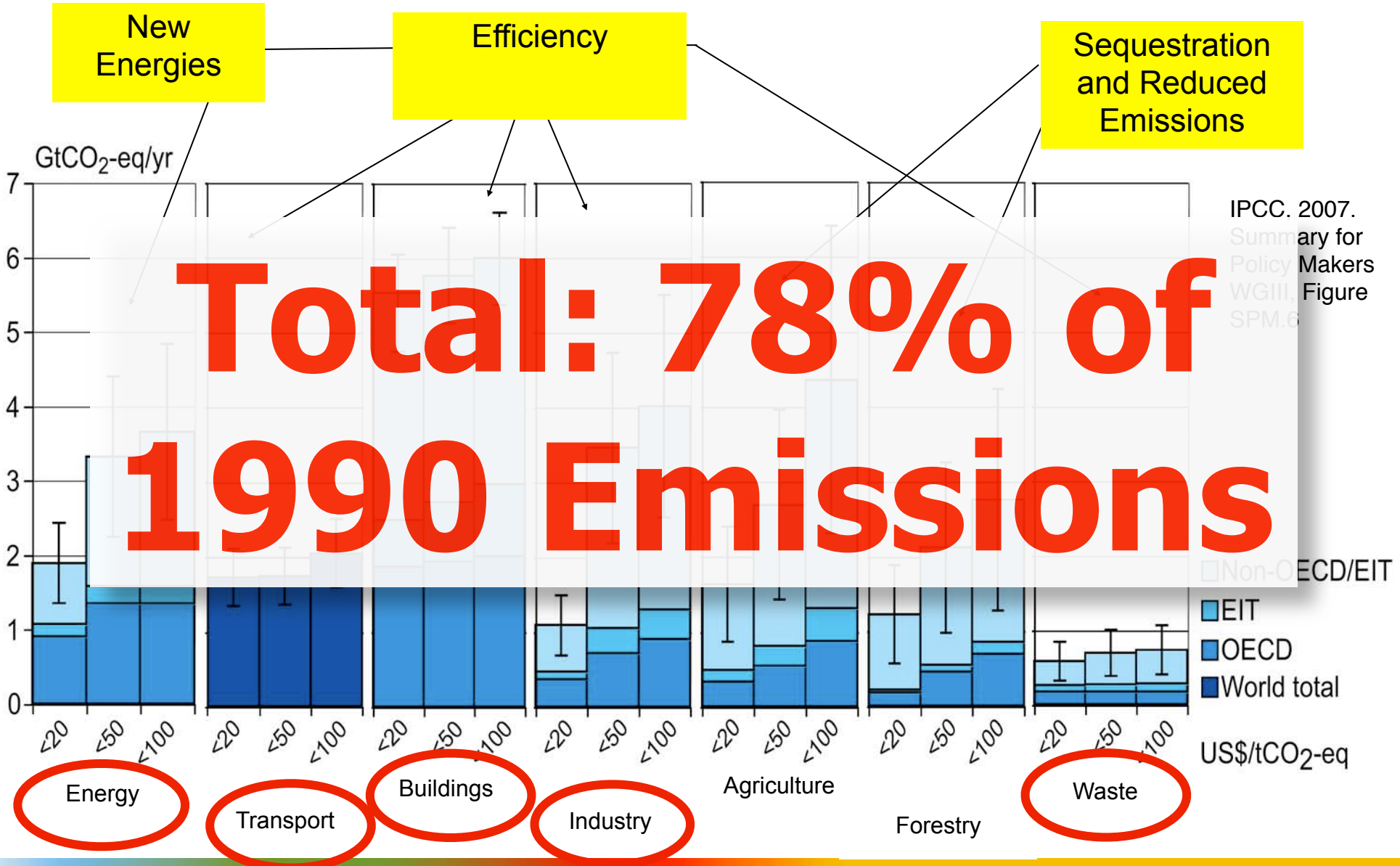
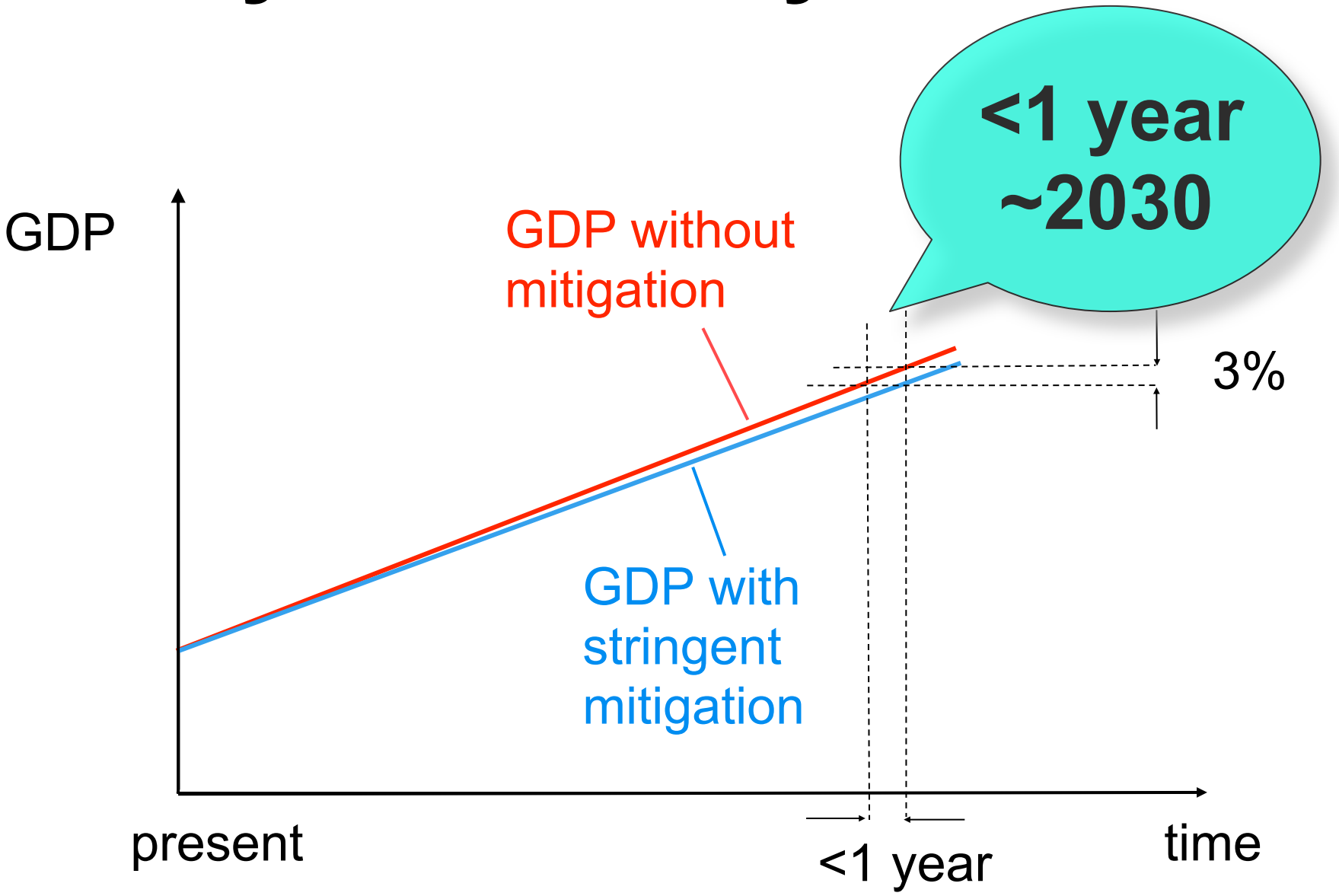


Figure SPM.3: GHG emissions in 2004 by sectors [CO_2-eq]. IPCC, 2007. WGIII SPM.

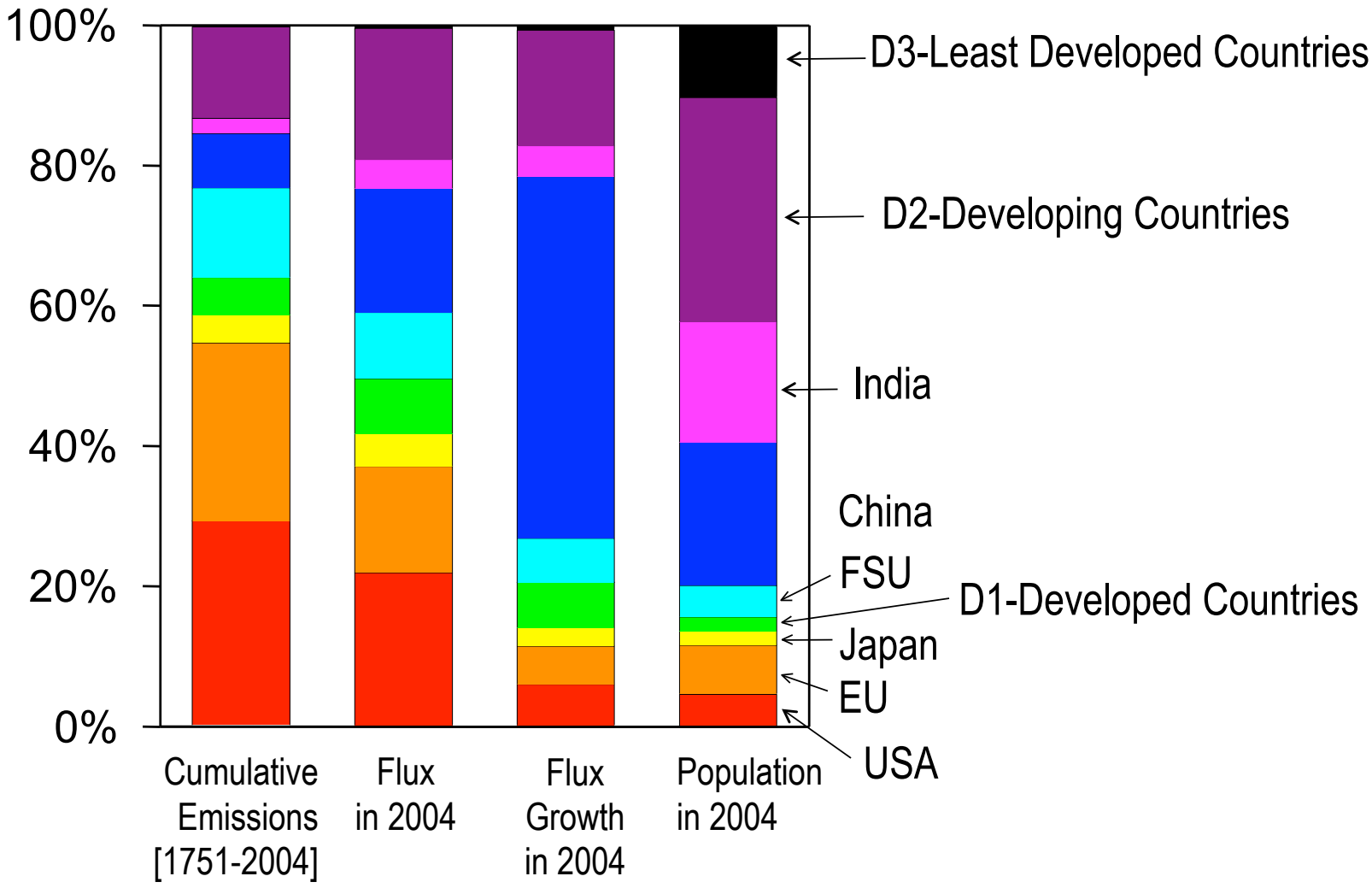
High Technical and Ecomonic Reduction Potentials by 2030es



Really Too Costly?



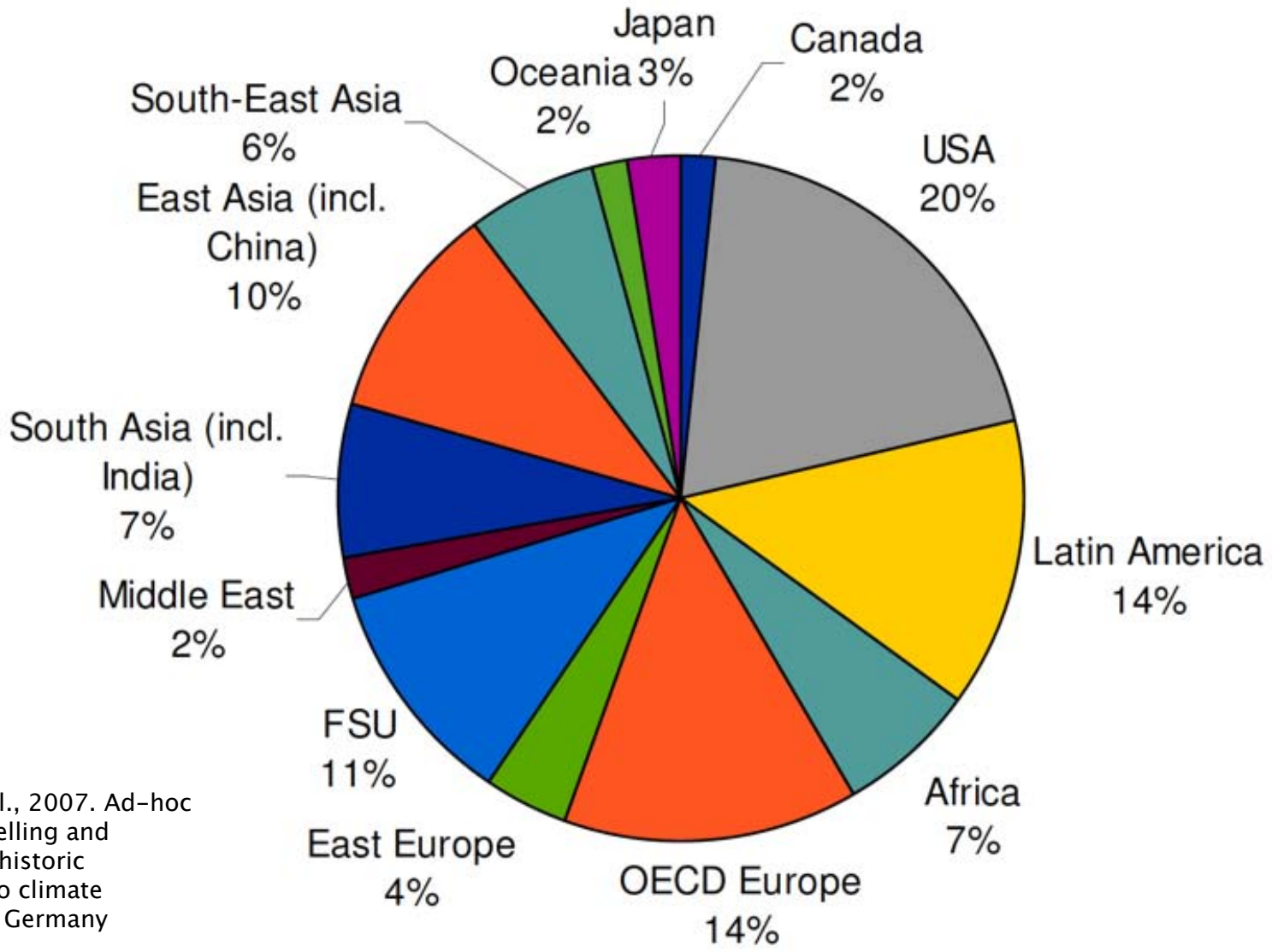
National & Regional Share of Fossil Fuel Emissions



Raupach et al. 2007, PNAS

Responsibilities

for Composition of Atmosphere in 2000



Höhne, N., et al., 2007. Ad-hoc group for modelling and assessment of historic contributions to climate change, Ecofys Germany

Per Capita Emissions

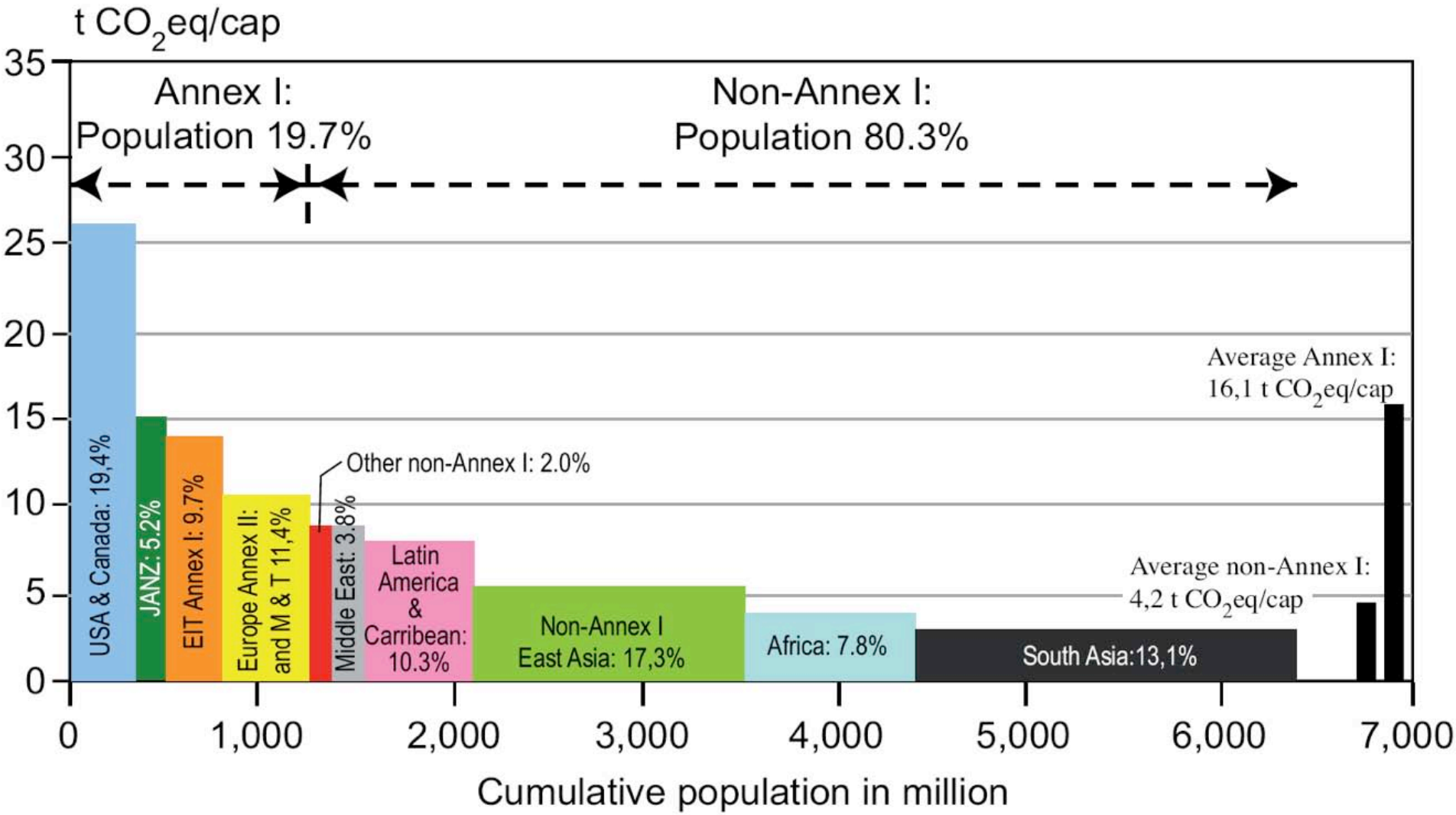


Fig. SPM.3a: Per capita GHG emissions (all Kyoto gases, including LULUCF). IPCC, 2007. SPM WG III

Summary:

- Climate is important
- Climate change is real and human made
- Climate change can impact all sectors, including human health
- Climate change poses huge challenges:
  - Climate change effects are delayed
  - Impacts are uneven, geographically and socially
- It matters a great deal whether and how we solve the climate change challenge!

Thanks for your attention!

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