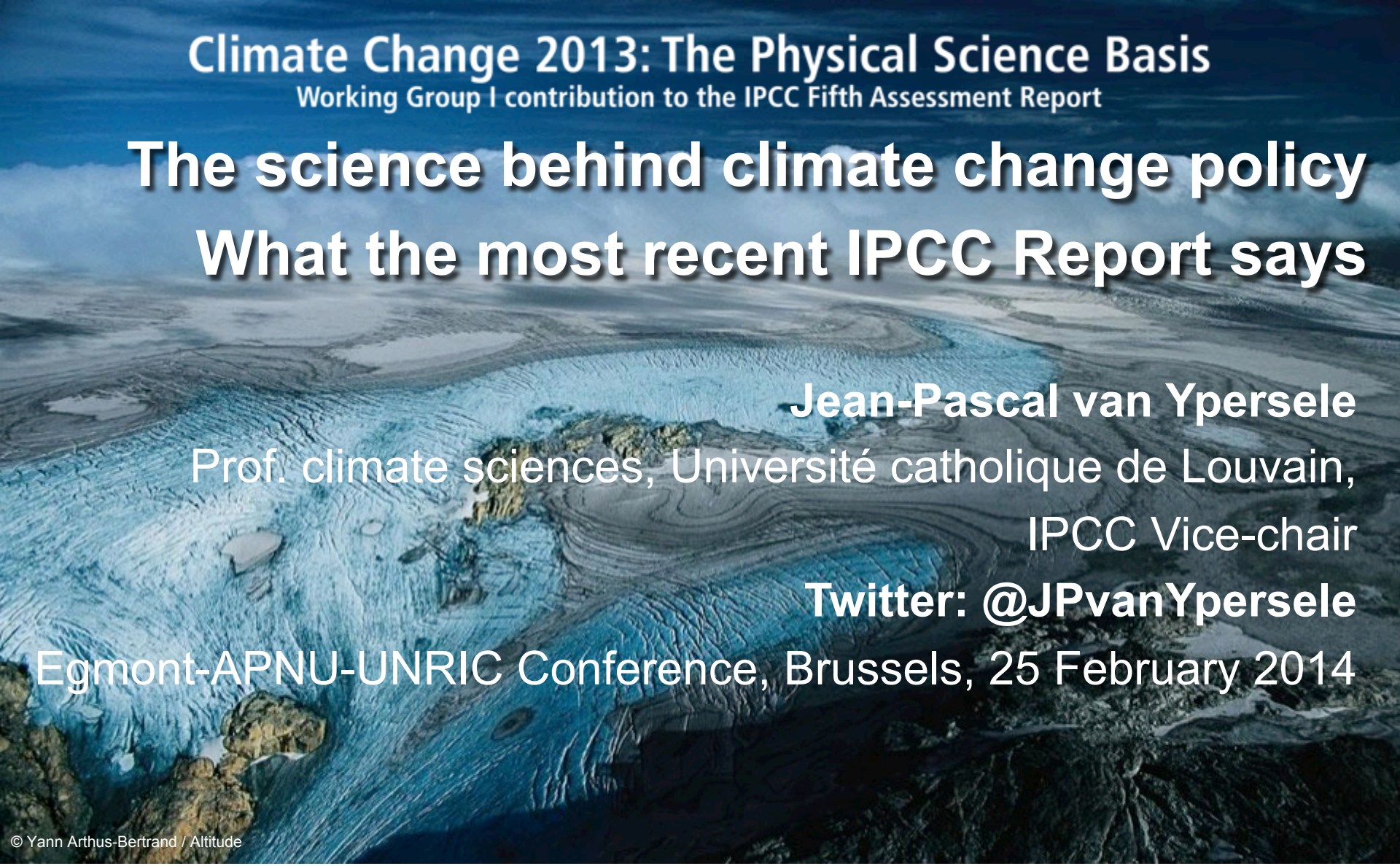


The science behind climate change policy
What the most recent IPCC Report says

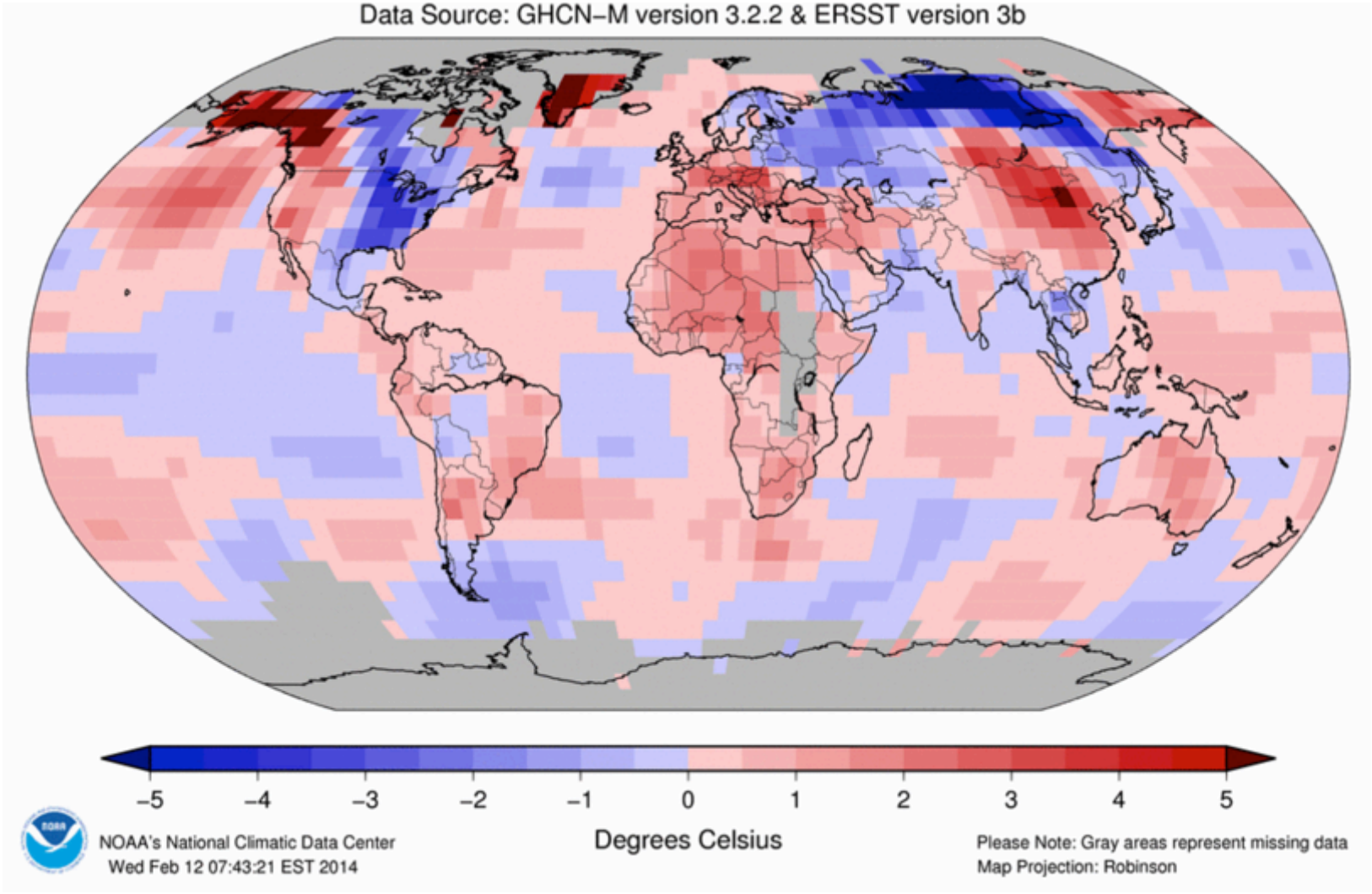
Jean-Pascal van Ypersele
Prof. climate sciences, Université catholique de Louvain,
IPCC Vice-chair
Twitter: @JPvanYpersele

Egmont-APNU-UNRIC Conference, Brussels, 25 February 2014

Thanks to the Belgian Federal Science Policy Office (BELSPO) for their support,
to IPCC WGI for some of the slides, and to Dr Philippe Marbaix & Dr Bruna Gaino for their help

Land & Ocean Temperature Departure from Average Jan 2014

(with respect to a 1981–2010 base period)



http://www.ncdc.noaa.gov/sotc/service/global/map-percentile-mntp/201401.gif

More heavy precipitation and more droughts….

More heavy precipitation and more droughts….

Why the IPCC ?

Established by WMO and UNEP in 1988

to provide policy-makers with an objective source of information about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options.

WMO=World Meteorological Organization

UNEP= United Nations Environment Programme

IPCC Reports are policy-relevant, NOT policy-prescriptive

Jean-Pascal van Ypersele
(vanypersele@astr.ucl.ac.be)

IPCC writing cycle (5 years, 2500 scientists)

- **Plenary decides table of content of reports**
- **Bureau appoints world-class scientists as authors, based on publication record**
- **Authors assess all scientific literature**
- ***Draft* – Expert review (+ Review editors)**
- ***Draft 2 (+ Draft 1 Summary for Policy Makers (SPM)* – Combined expert/government review**
- ***Draft 3 (+ Draft 2 SPM)*– Government review of SPM**
- **Approval Plenary (interaction authors – governments) – *SPM and full report***
- ***NB: the scientists have the last word!***

Jean-Pascal van Ypersele
(vanypersele@astr.ucl.ac.be)

Completed IPCC Reports

5 Assessment Reports *(1990,1995, 2001, 2007, 2013-14)*

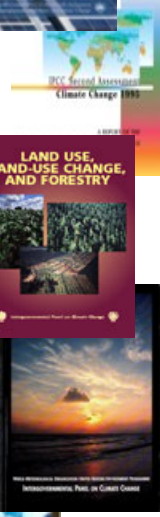
1992 Supplementary Report and 1994 Special Report

8 Special Reports *(1997,1999, 2000, 2005, 2011)*

Guidelines for National GHG Inventories, Good Practice Guidanc

(1995-2006)

6 Technical Papers *(1996-2008)*



Key SPM Messages

19 Headlines

on less than 2 Pages

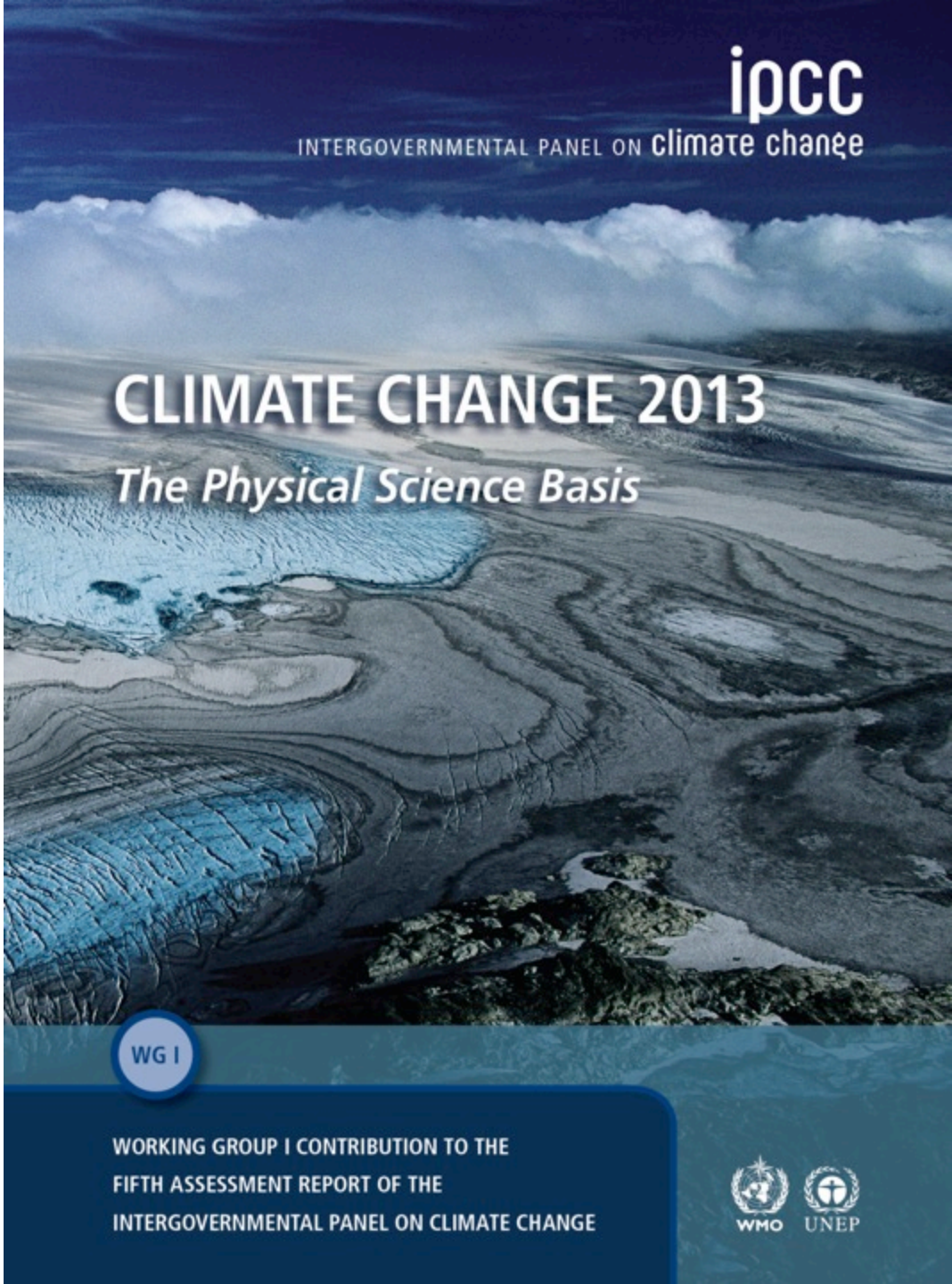
Summary for Policymakers
~14,000 Words

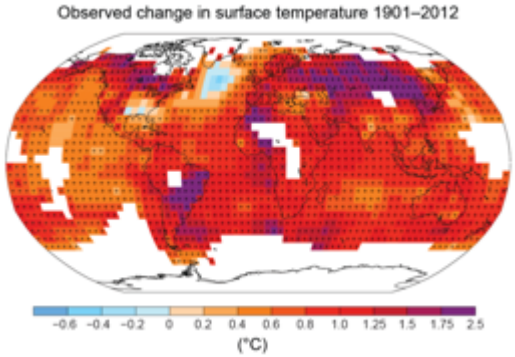
14 Chapters
Atlas of Regional Projections

54,677 Review Comments
by 1089 Experts

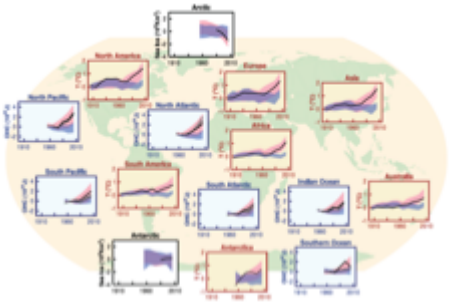
2010: 259 Scientists Selected

2009: WGI Outline Approved

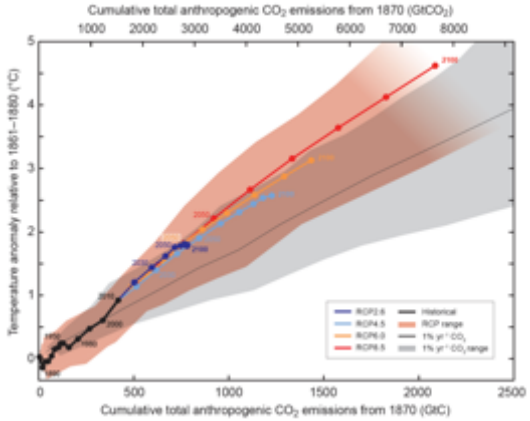




Warming of the climate system is unequivocal, [...]

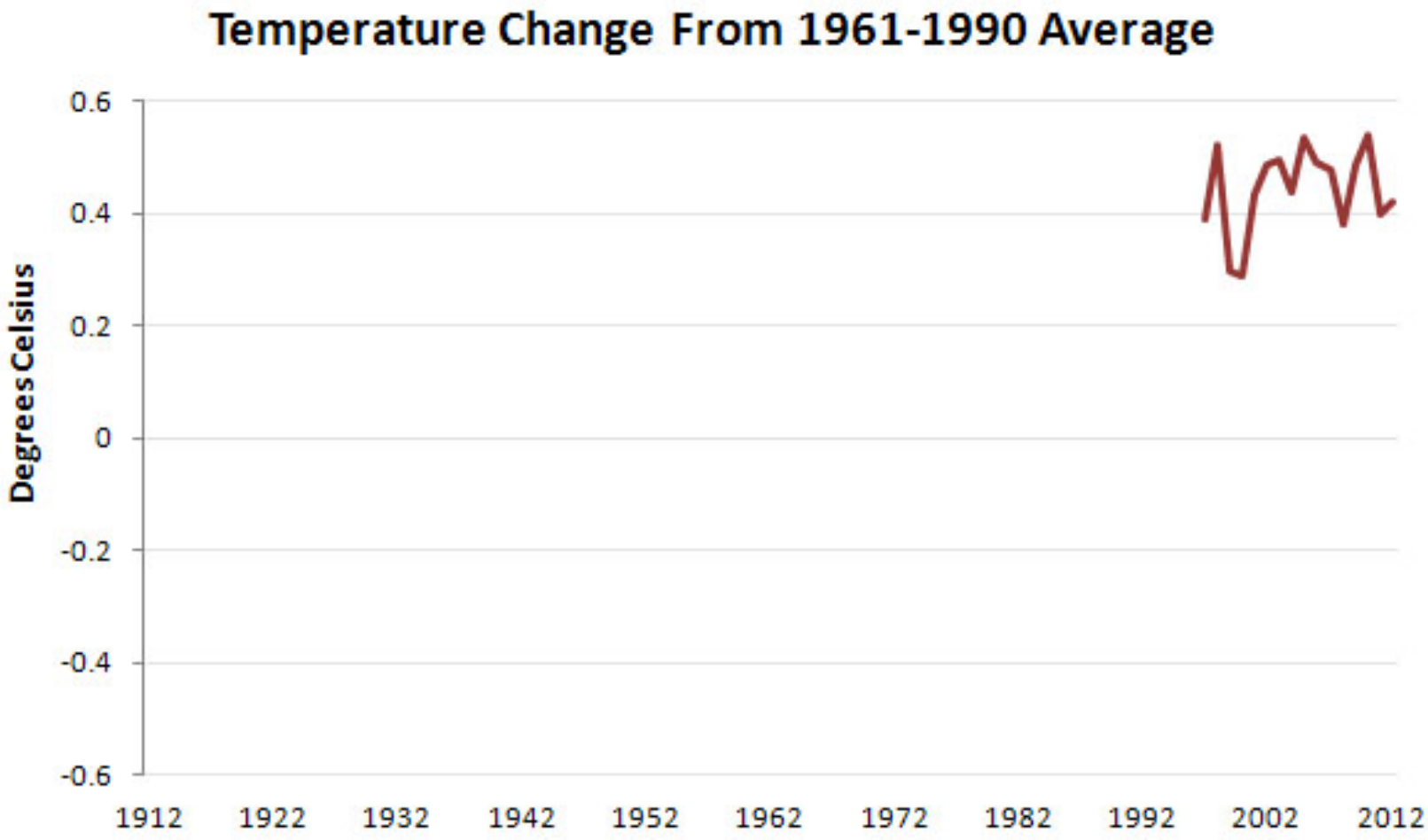


Human influence on the climate system is clear.



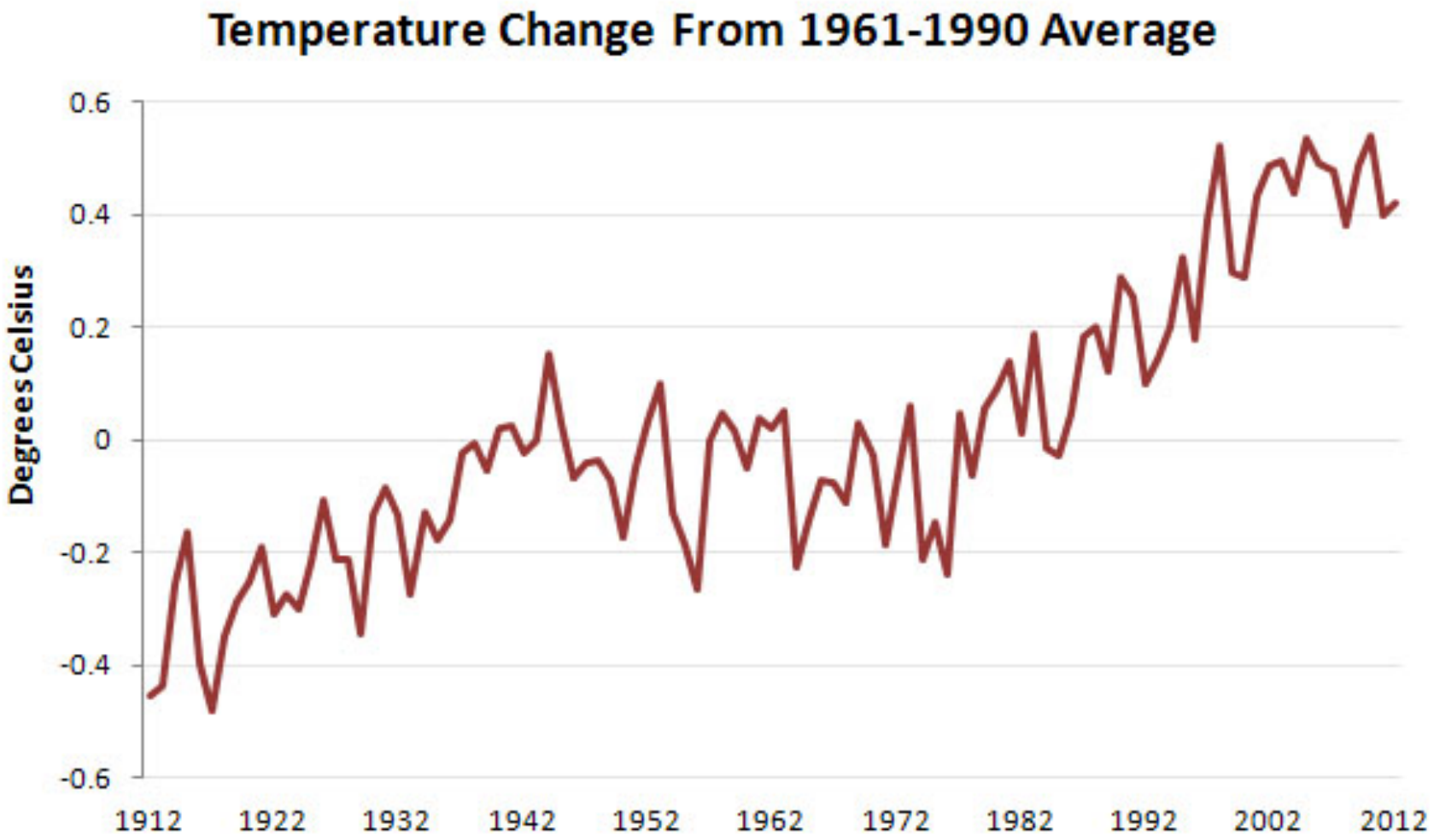
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

Lying With Statistics, Global Warming Edition



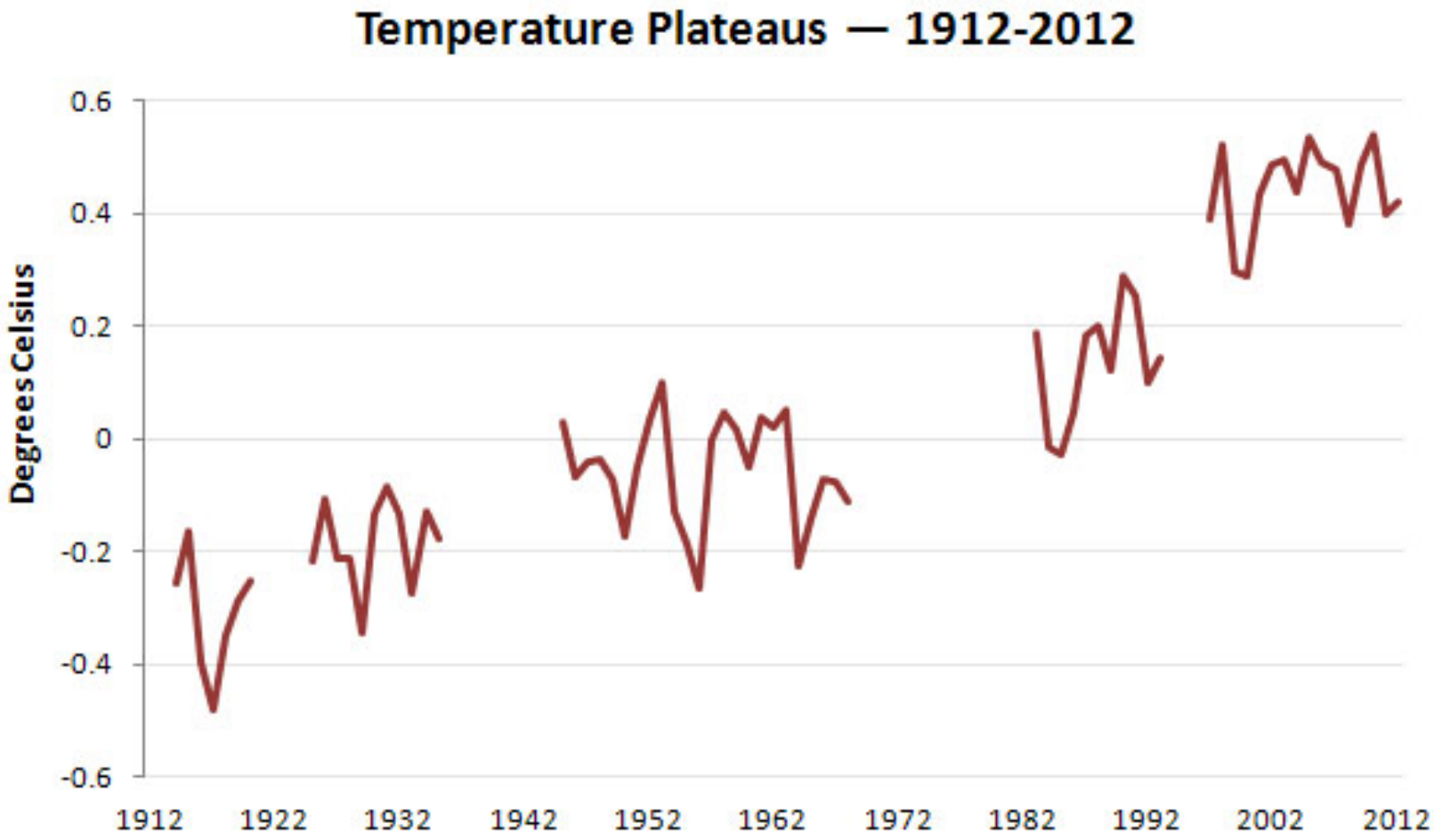
http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition

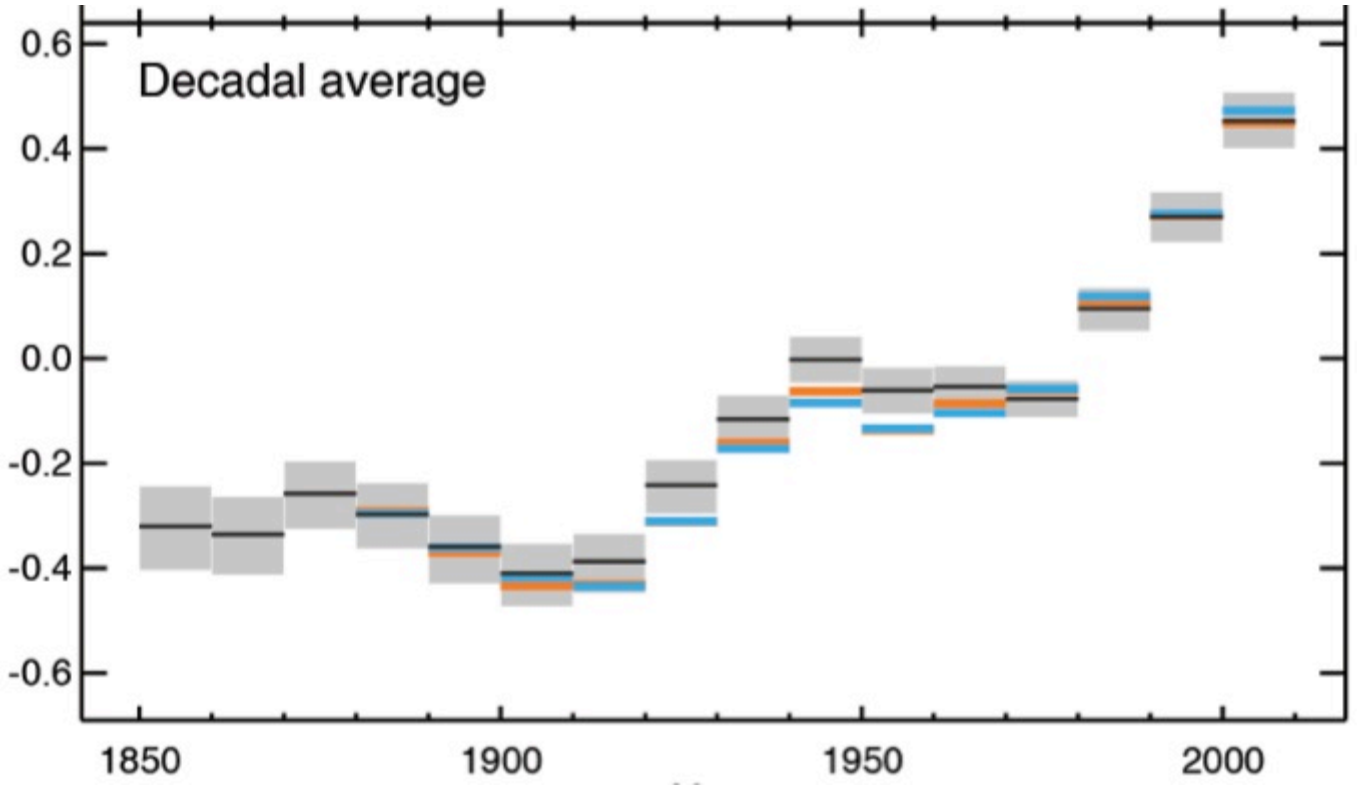


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition



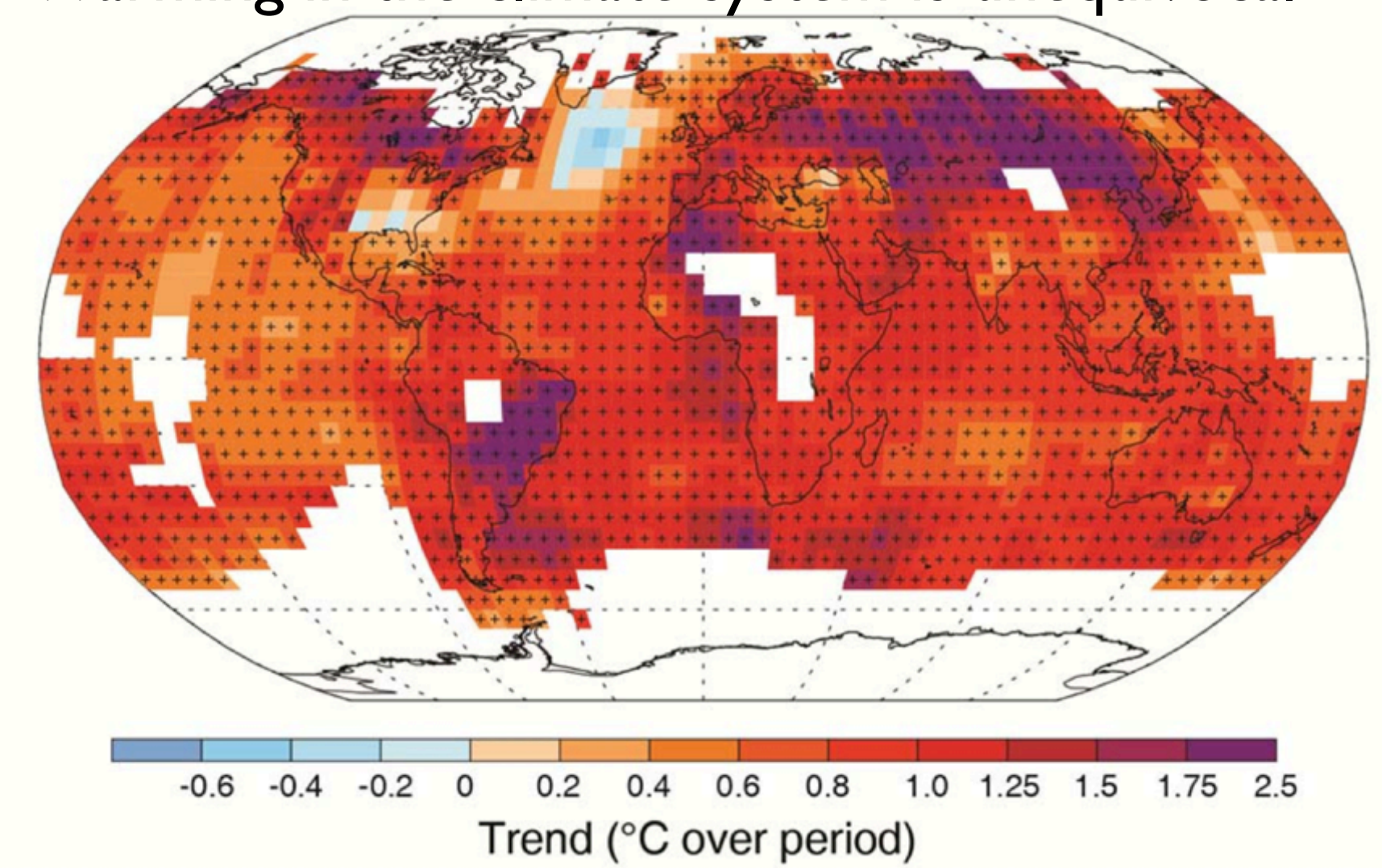
(IPCC 2013, Fig. SPM.1a)

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

In the Northern Hemisphere, 1983–2012 was *likely* the warmest 30-year period of the last 1400 years (*medium confidence*).

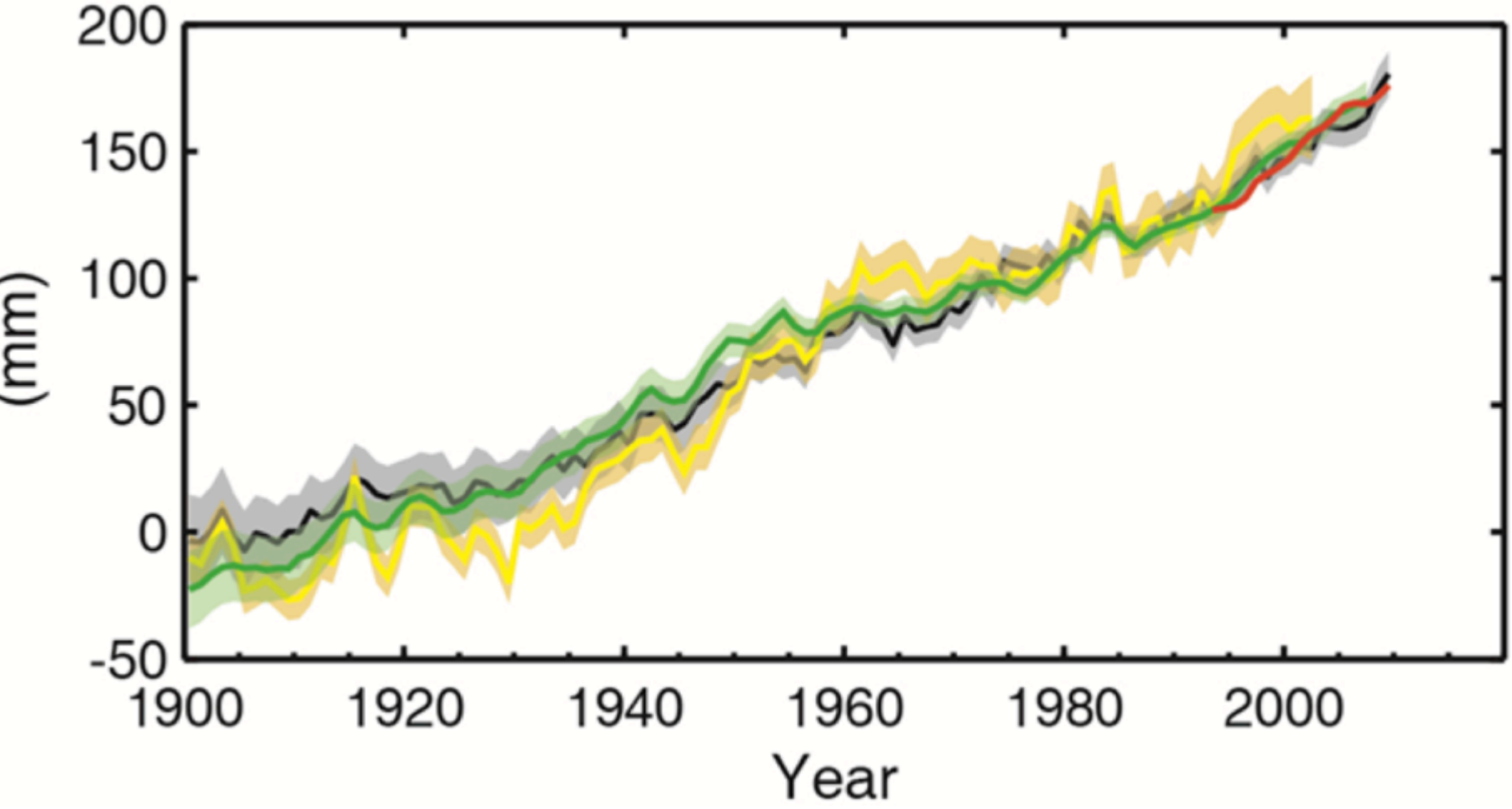
Change in average surface temperature 1901-2012

Warming in the climate system is unequivocal



AR5 WGI SPM - Approved version / subject to final copyedit

Change in average sea-level change



AR5 WGI SPM - Approved version / subject to final copyedit

Muir Glacier and Inlet (1895) (Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Muir Glacier and Inlet (2005) (Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

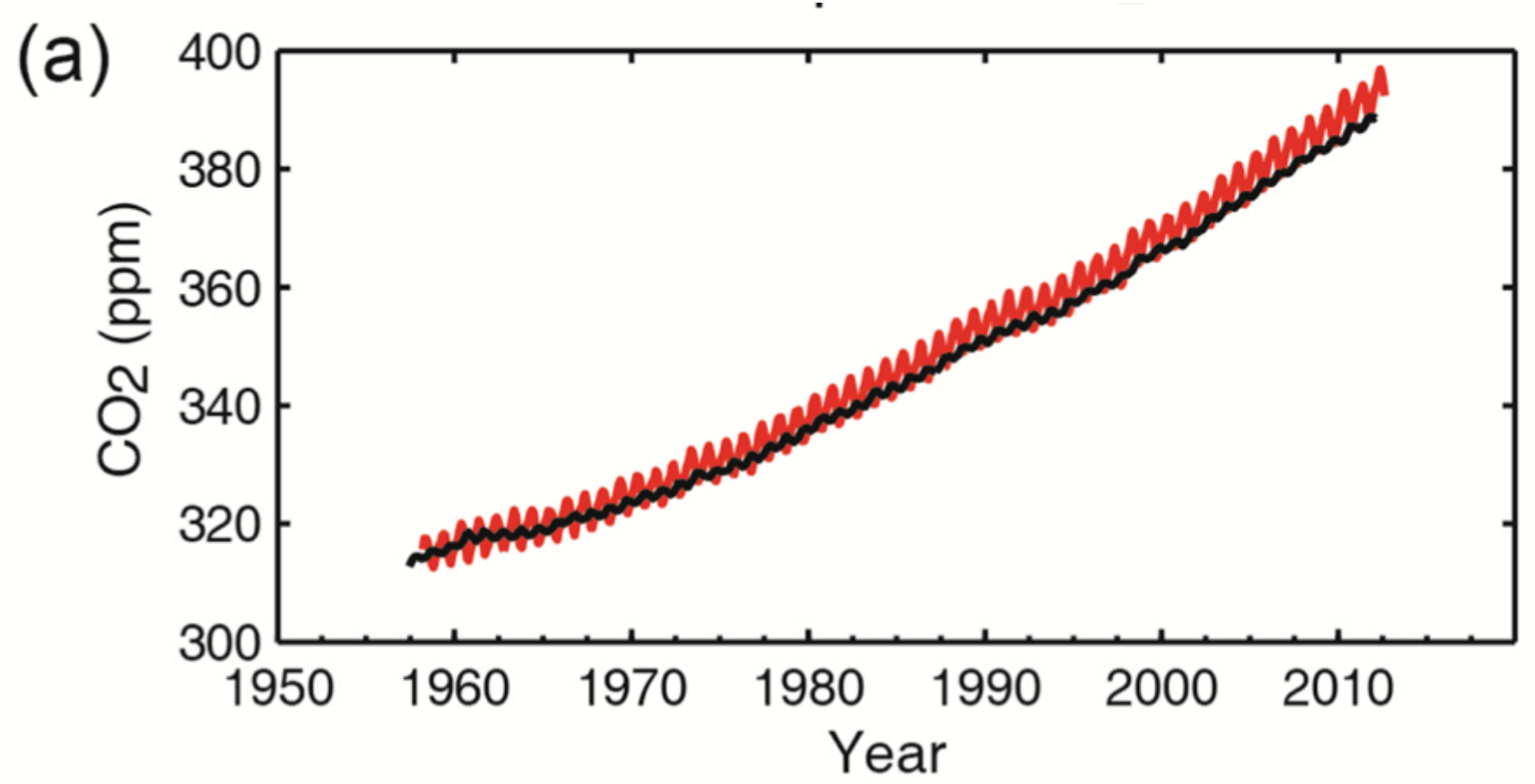
Plateau Glacier (1961)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

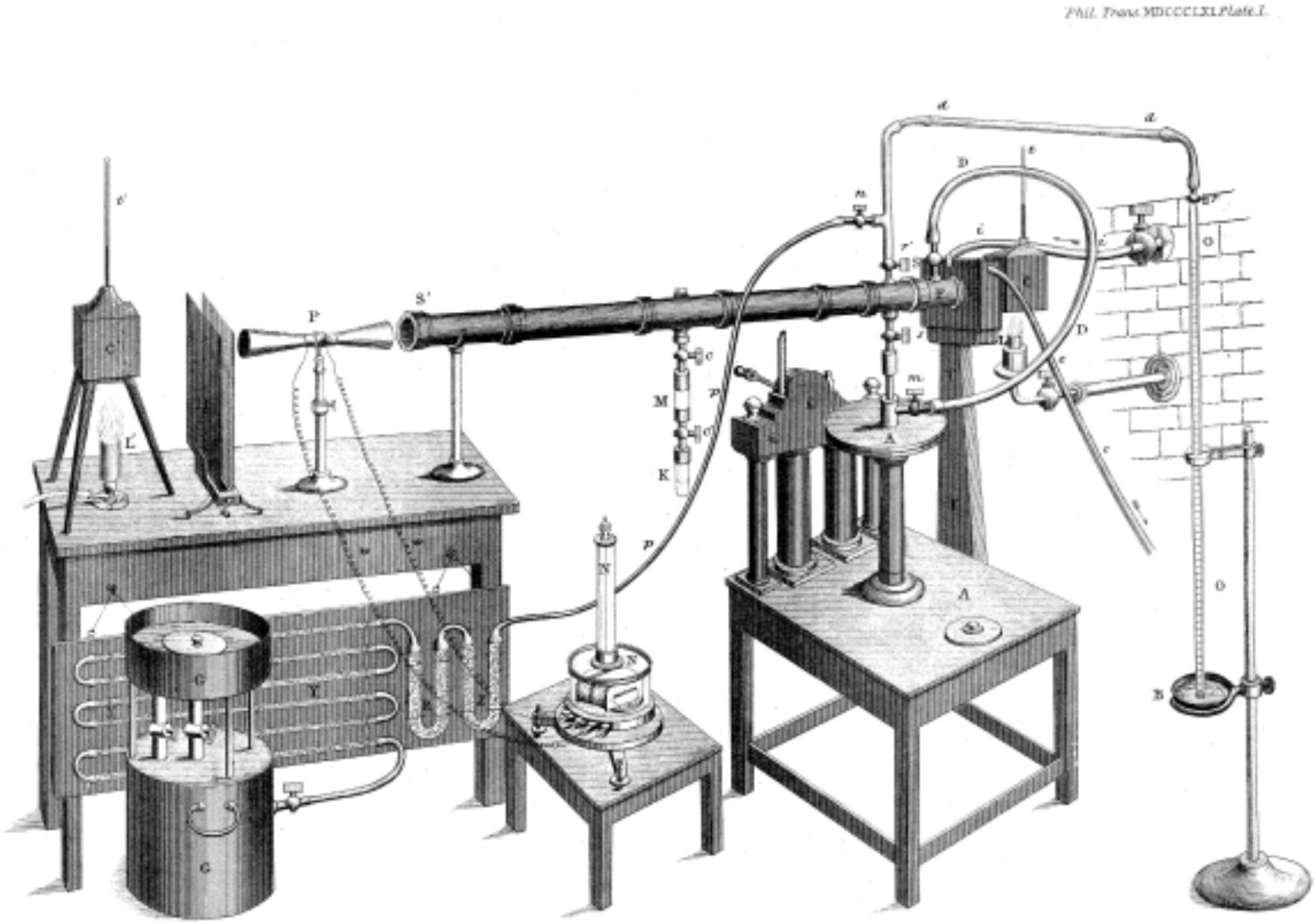
Plateau Glacier (2003)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Atmospheric CO_2 concentration

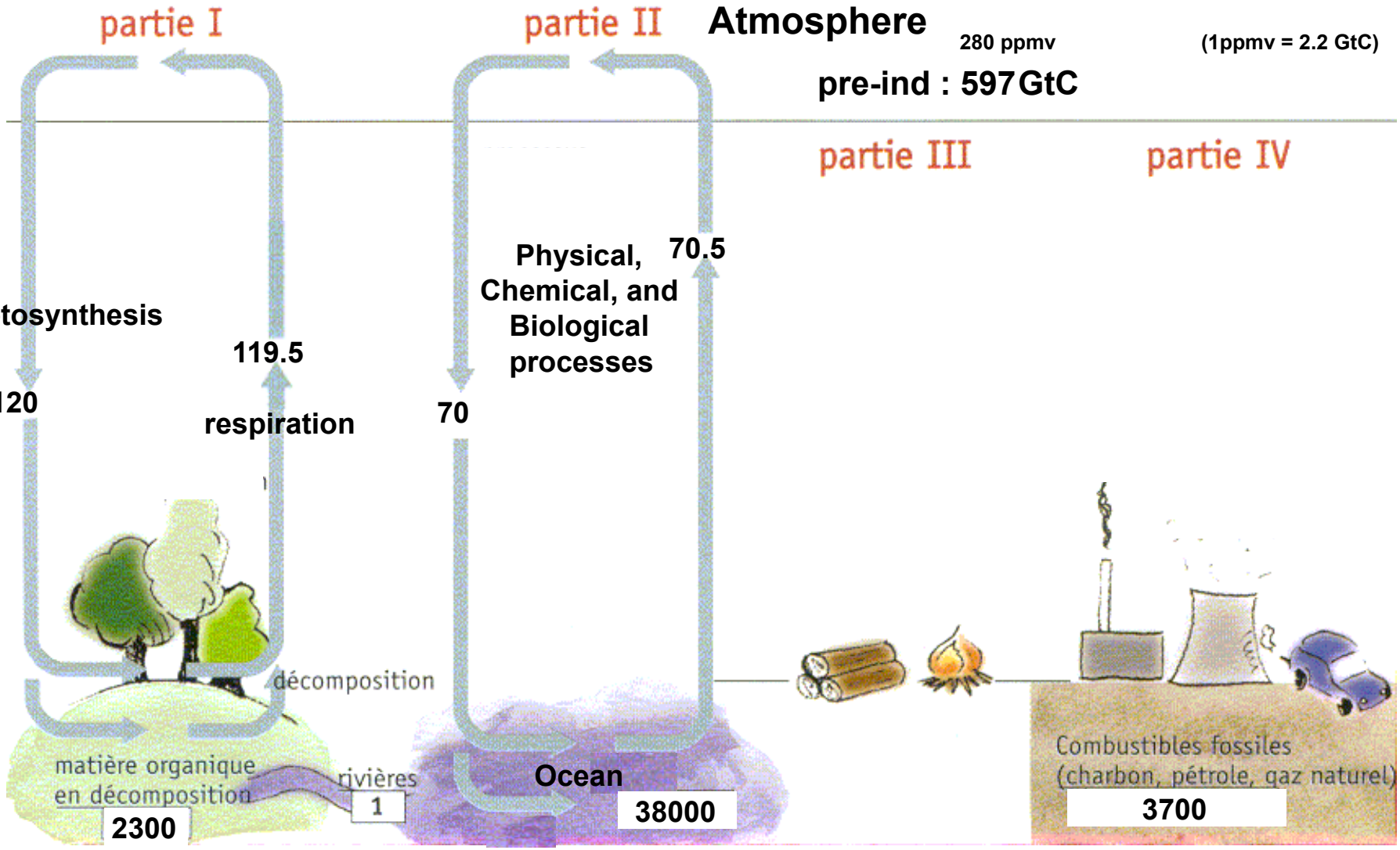


AR5 WGI SPM - Approved version / subject to final copyedit



Tyndall (1861) mesure l'absorption du rayonnement par les gaz

Carbon cycle: unperturbed fluxes

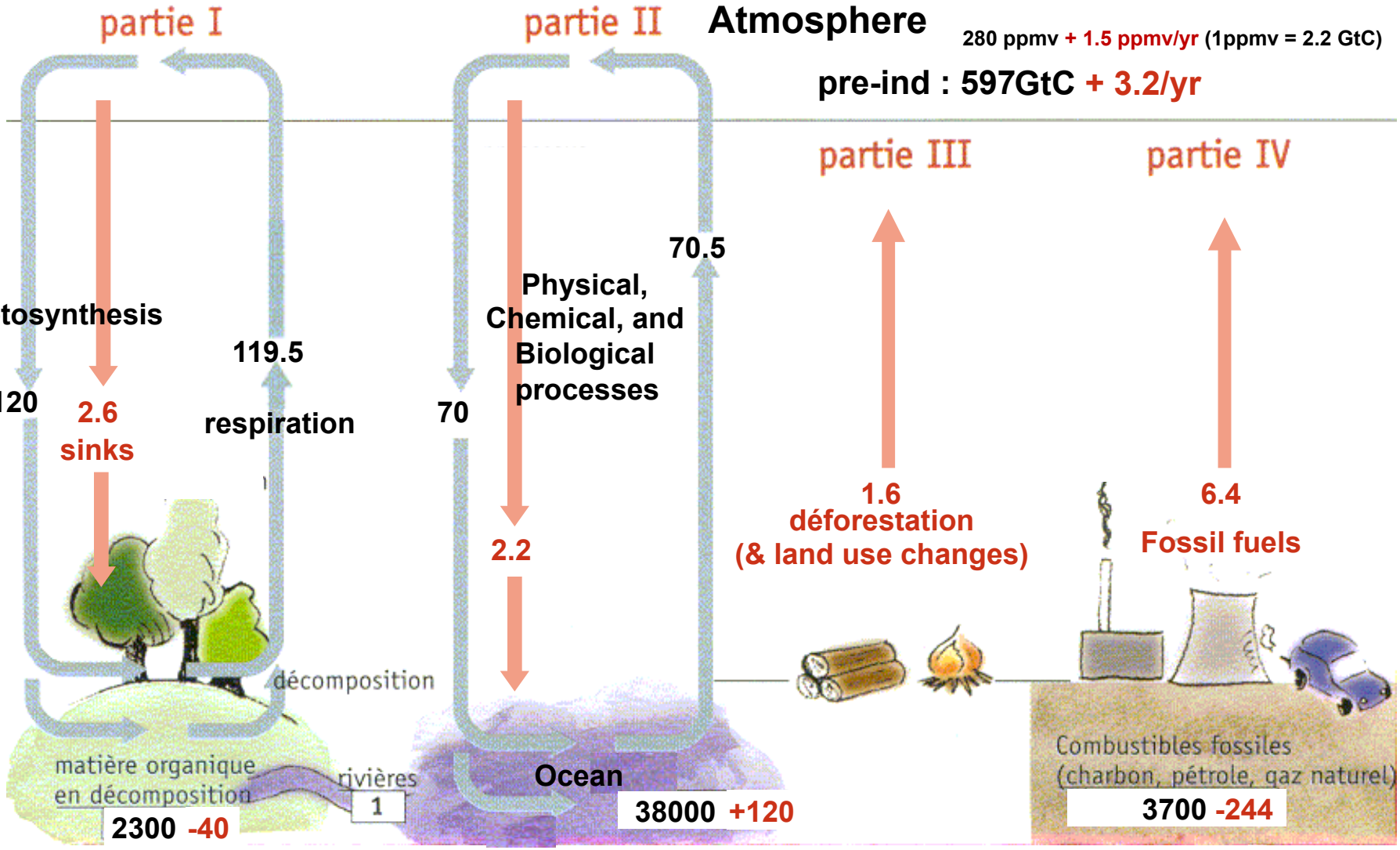


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

vanyp@climate.be

Carbon cycle: perturbed by human activities

(numbers for the decade 1990-1999s, based on IPCC AR4)

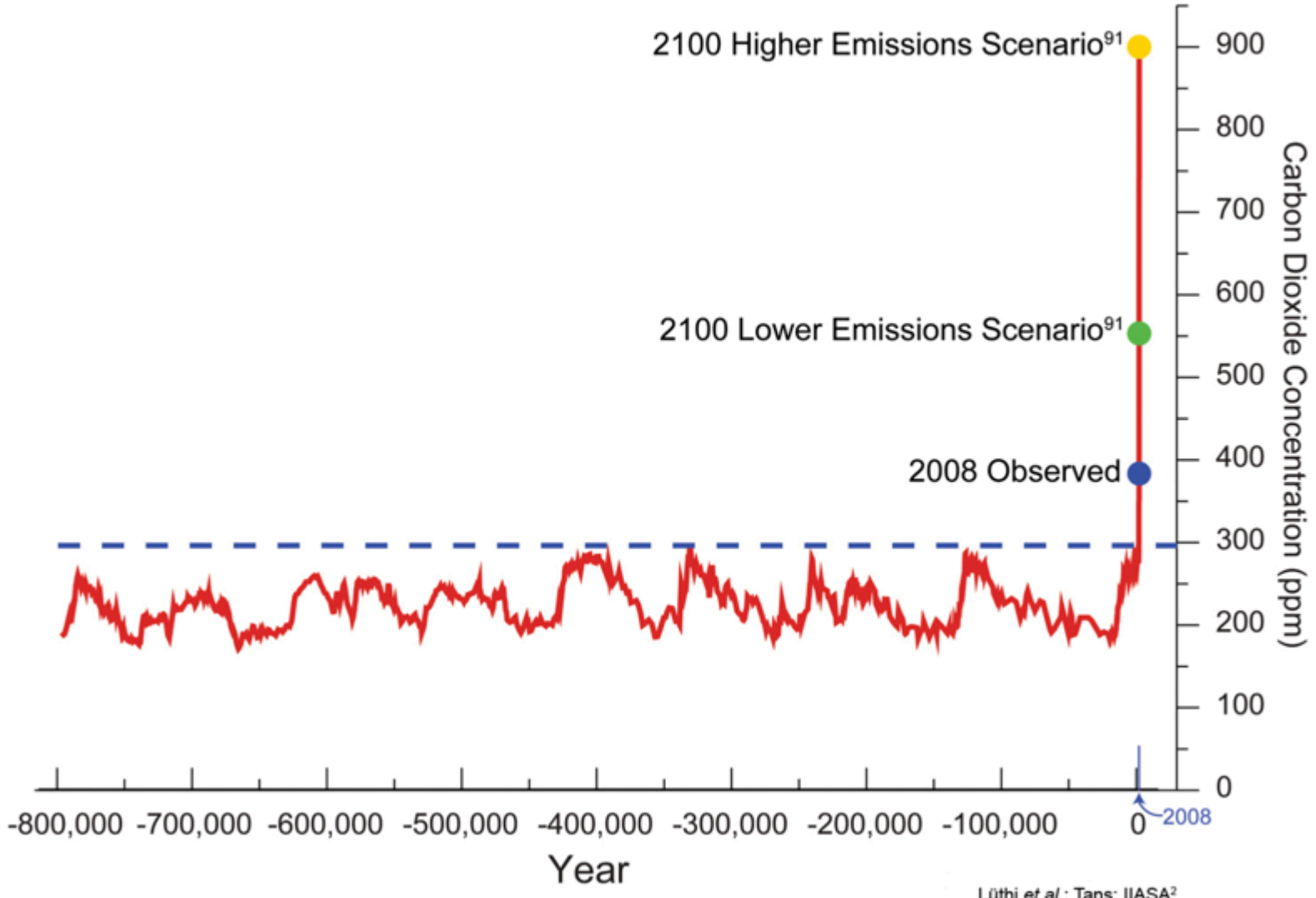


Units: GtC (billions tons of carbon) or GtC/year

Stocks!

vanyp@climate.be

Atmospheric CO_2 over the last 800000 years



U.S. Global Change Research Program:Lüthi *et al.*; Tans; IIASA2

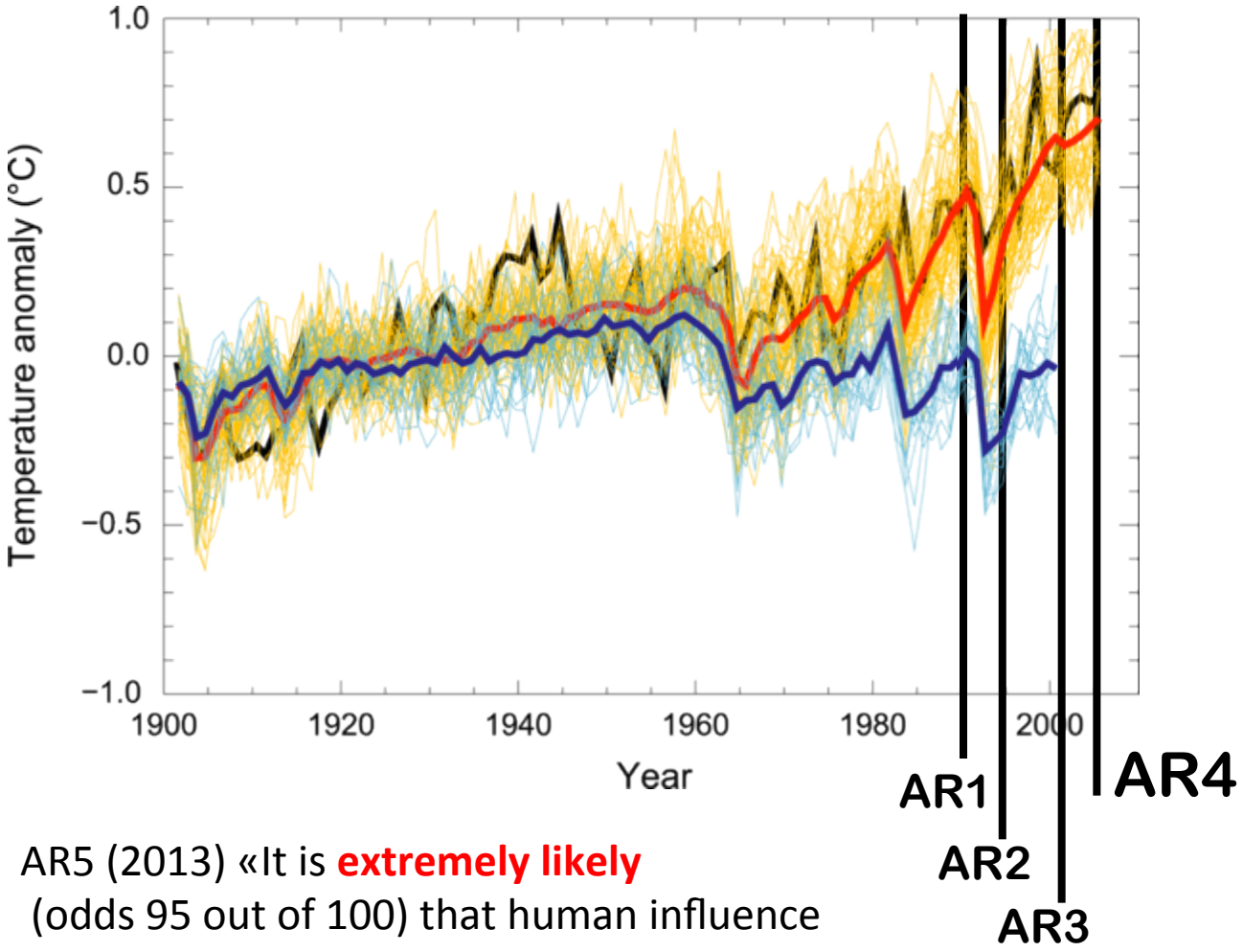
A Progression of Understanding: Greater and Greater Certainty in Attribution

AR1 (1990): "unequivocal detection not likely for a decade"

AR2 (1995): "balance of evidence suggests **discernible** human influence"

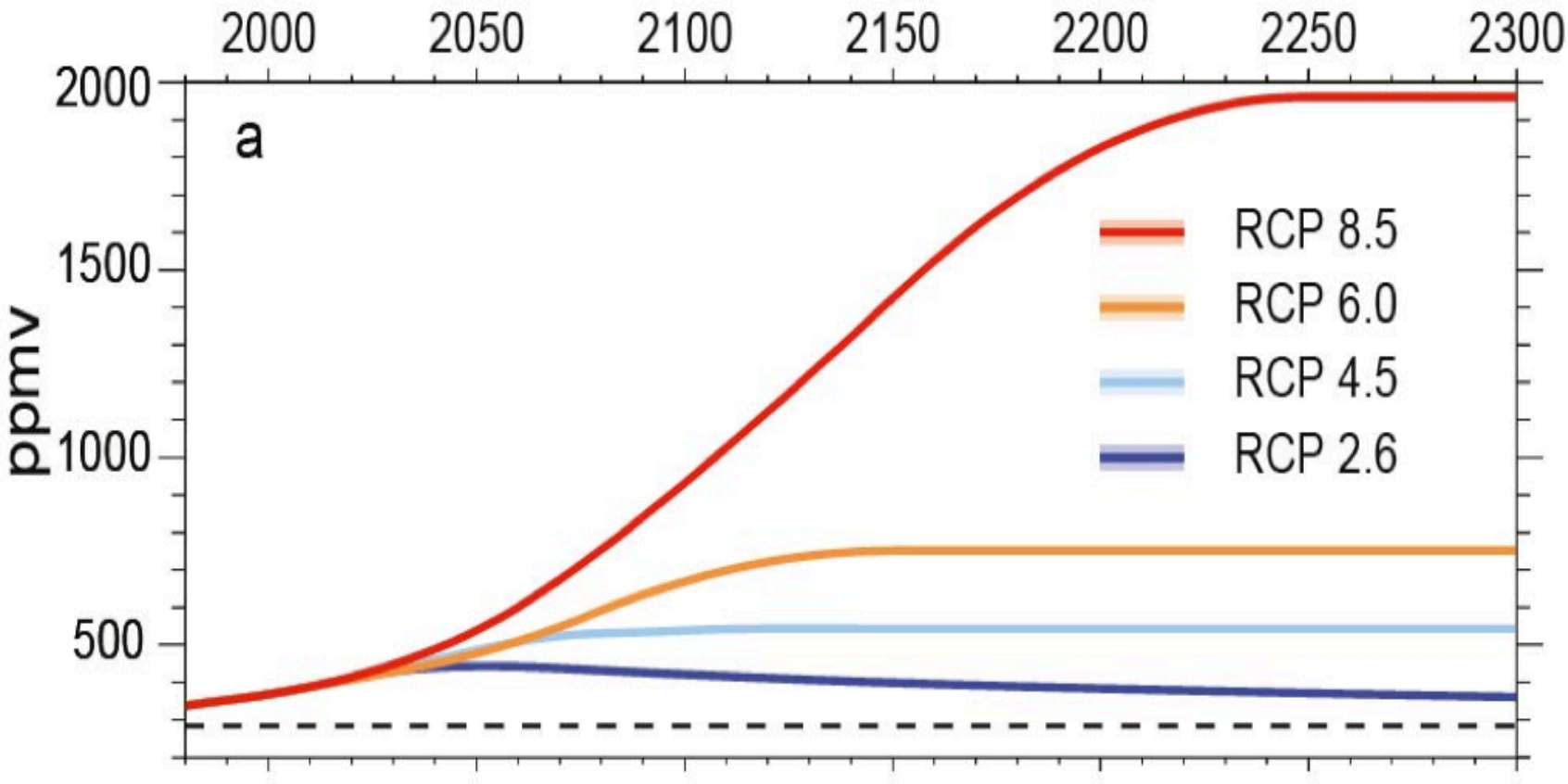
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

AR4 (2007): "most of the warming is **very likely** (odds 9 out of 10) due to greenhouse gases"



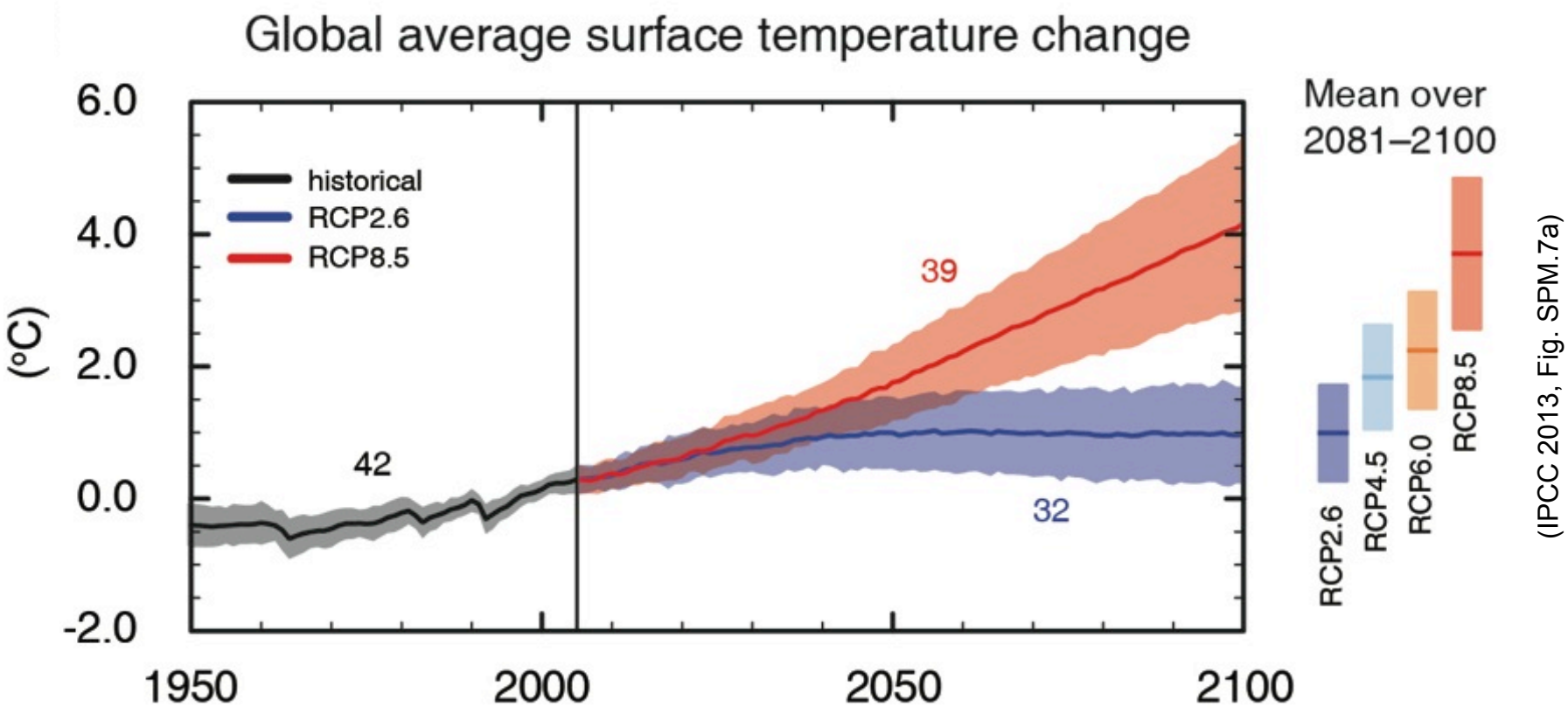
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

RCP Scenarios: Atmospheric CO_2 concentration



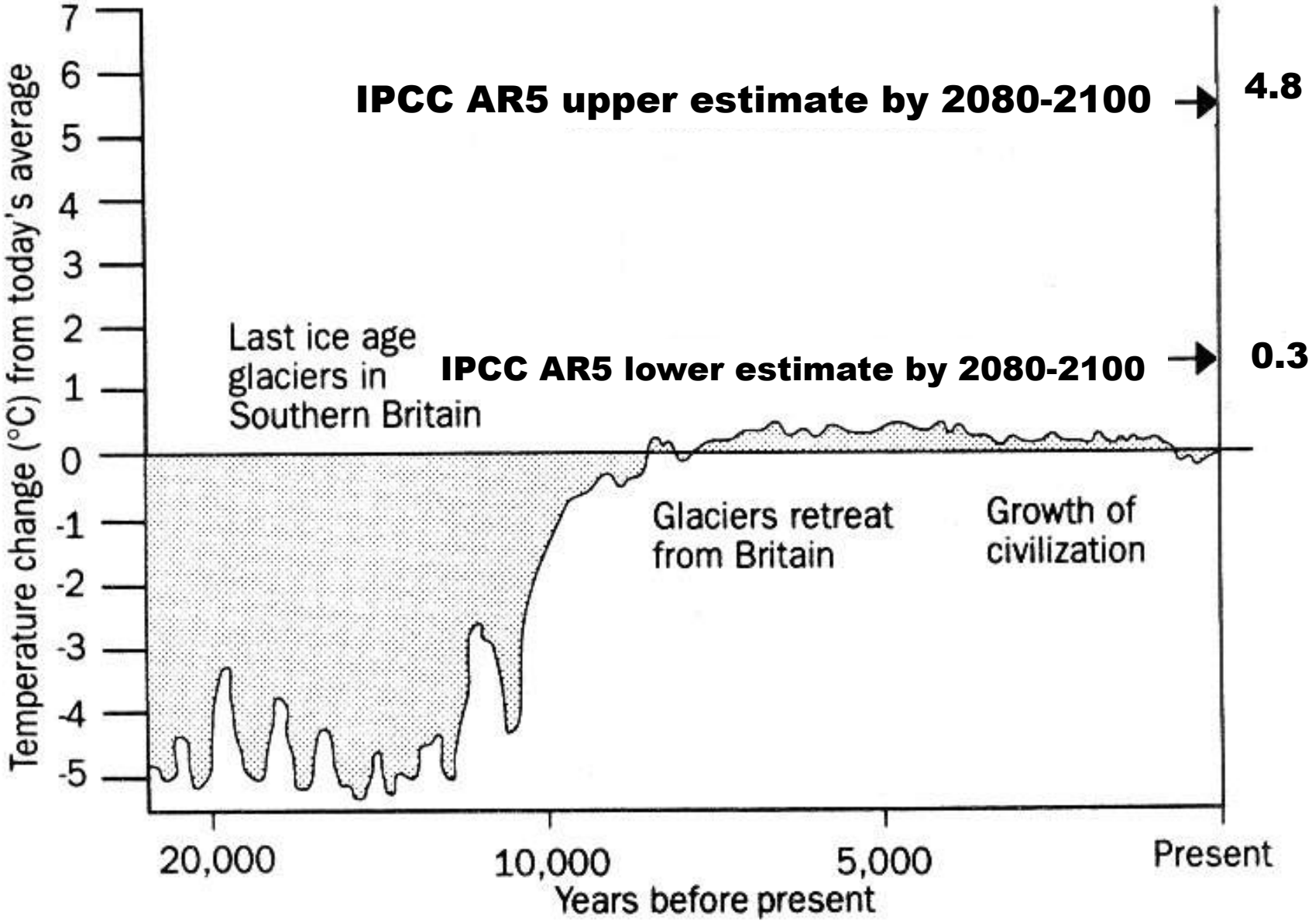
Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

AR5, chapter 12. WGI- Adopted version / subject to final copyedit



(IPCC 2013, Fig. SPM.7a)

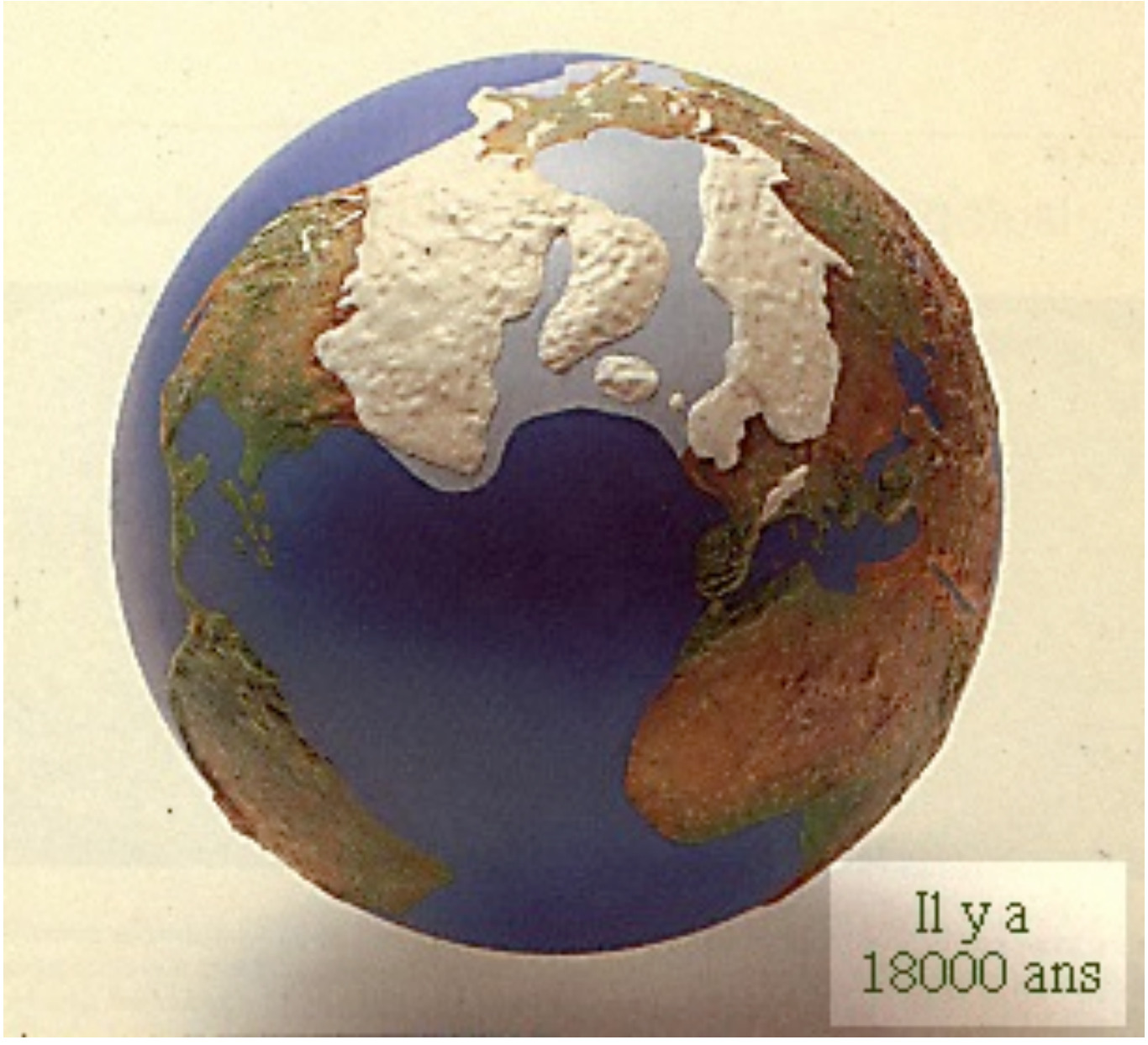
Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 for all scenarios



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

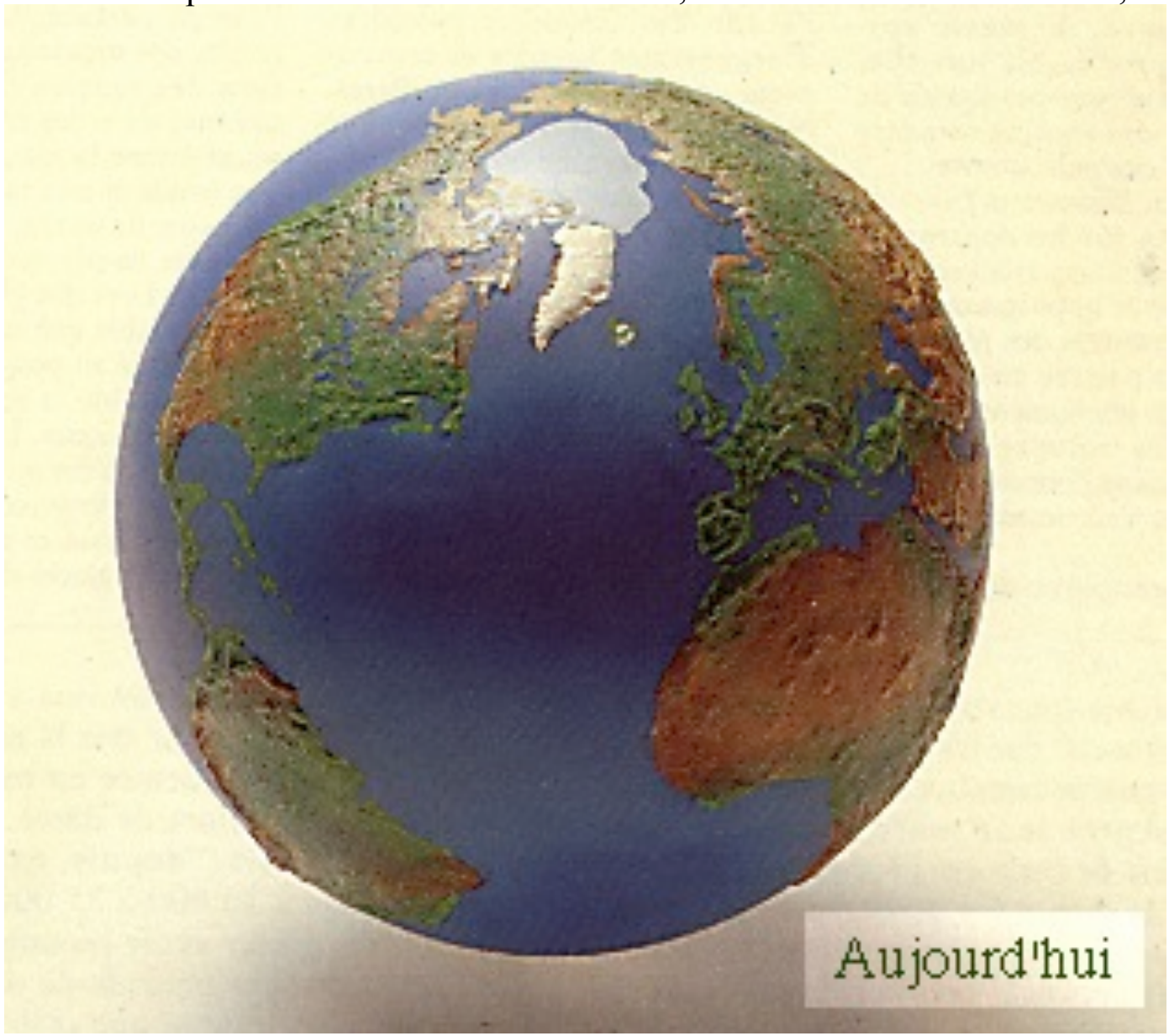
18-20000 years ago (Last Glacial Maximum)

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

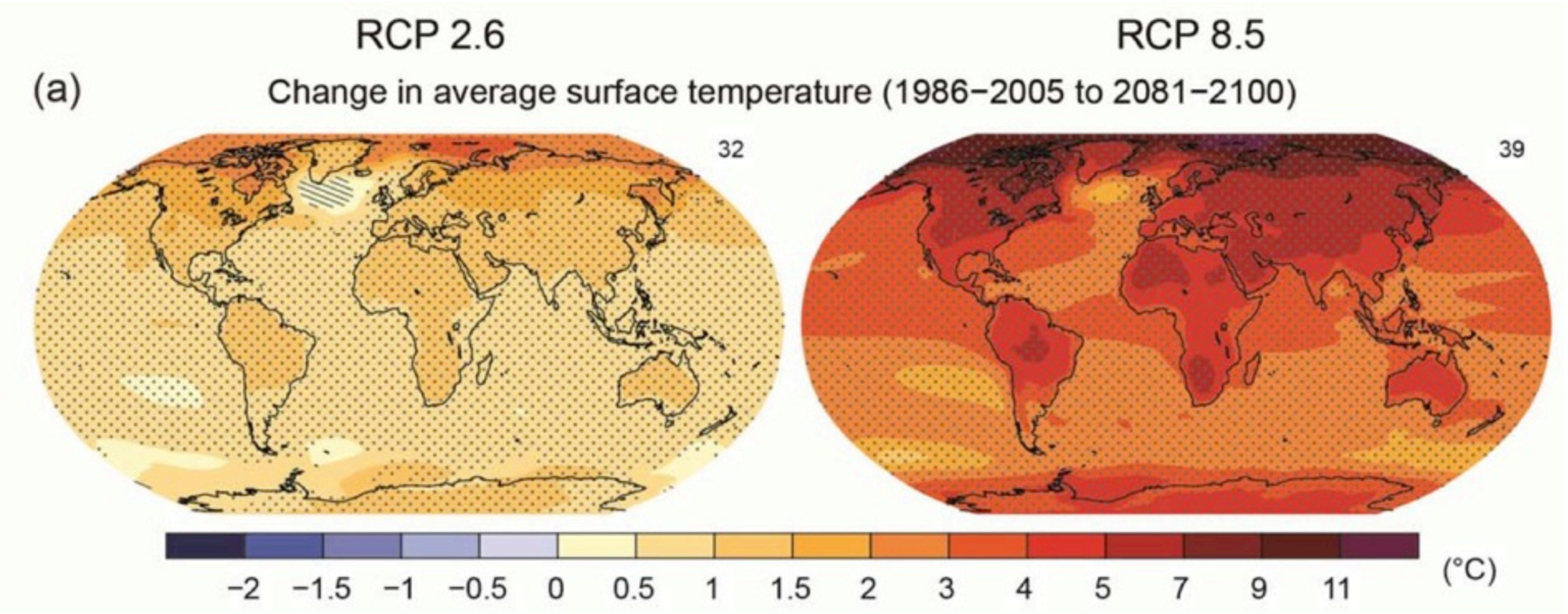


Today, with +4-5°C globally

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



Surface temperature projections



AR5 WGI SPM - Approved version / subject to final copyedit

Since 1950, extreme hot days and heavy precipitation have become more common

There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes

Extreme weather and climate events

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warmer and/or more frequent hot days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warm spells/heat waves. Frequency and/or duration increases over most land areas	***Medium confidence*** on a global scale Likely in large parts of Europe, Asia and Australia	***Likely***	Not formally assessed	***Very likely***
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	*Likely more land areas with increases than decreases*	***Medium confidence***	*Likely* over many land areas	***Very likely*** over most of the mid-latitude land masses and over wet tropical regions
Increases in intensity and/or duration of drought	***Low confidence*** on a global scale Likely changes in some regions	***Low confidence***	*Low confidence*	***Likely*** *(medium confidence)* on a regional to global scale
Increases in intense tropical cyclone activity	***Low confidence*** in long term (centennial) changes Virtually certain in North Atlantic since 1970	***Low confidence***	*Low confidence*	***More likely than not*** in the Western North Pacific and North Atlantic
Increased incidence and/or magnitude of extreme high sea level	*Likely* (since 1970)	***Likely***	*Likely*	***Very likely***

IPCC, AR5, Table SPM.1

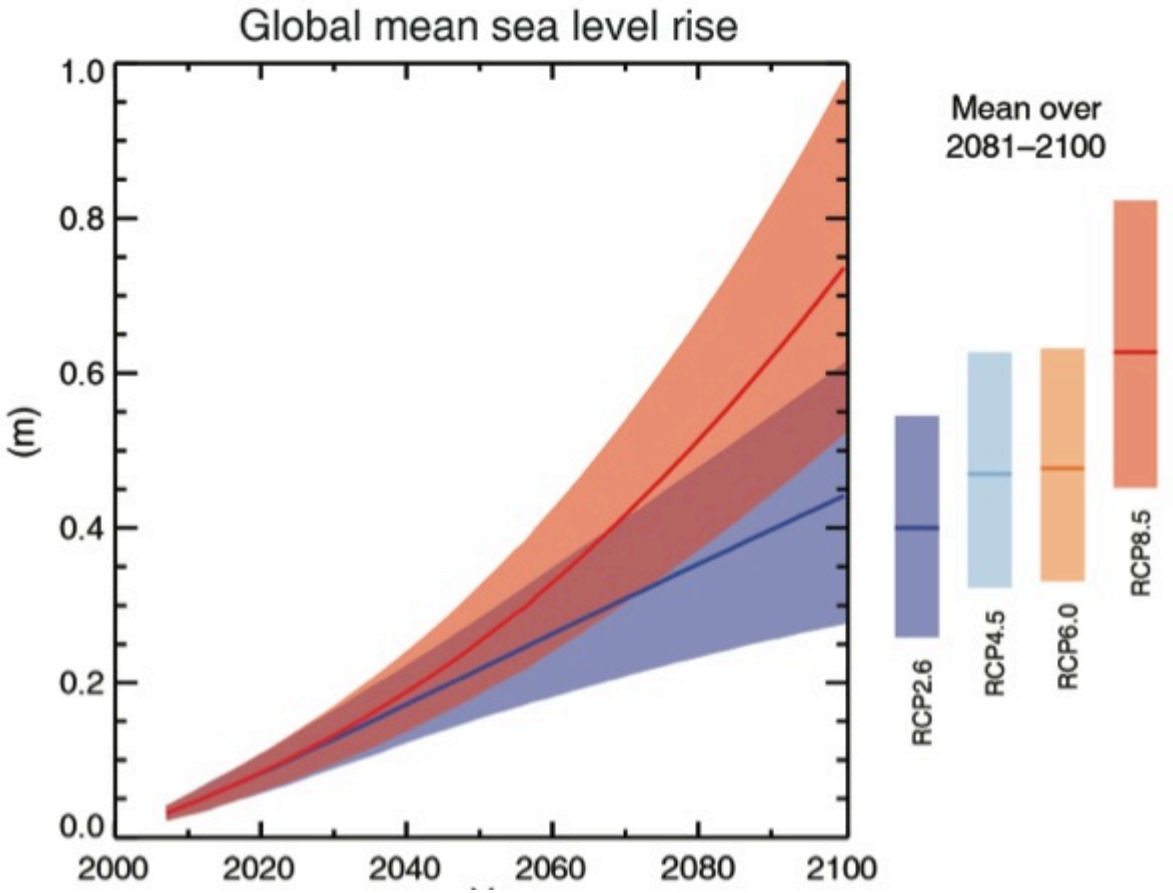


Fig. SPM.9

RCP2.6 (2081-2100), *likely* range: **26 to 55 cm**

RCP8.5 (in 2100), *likely* range: **52 to 98 cm**

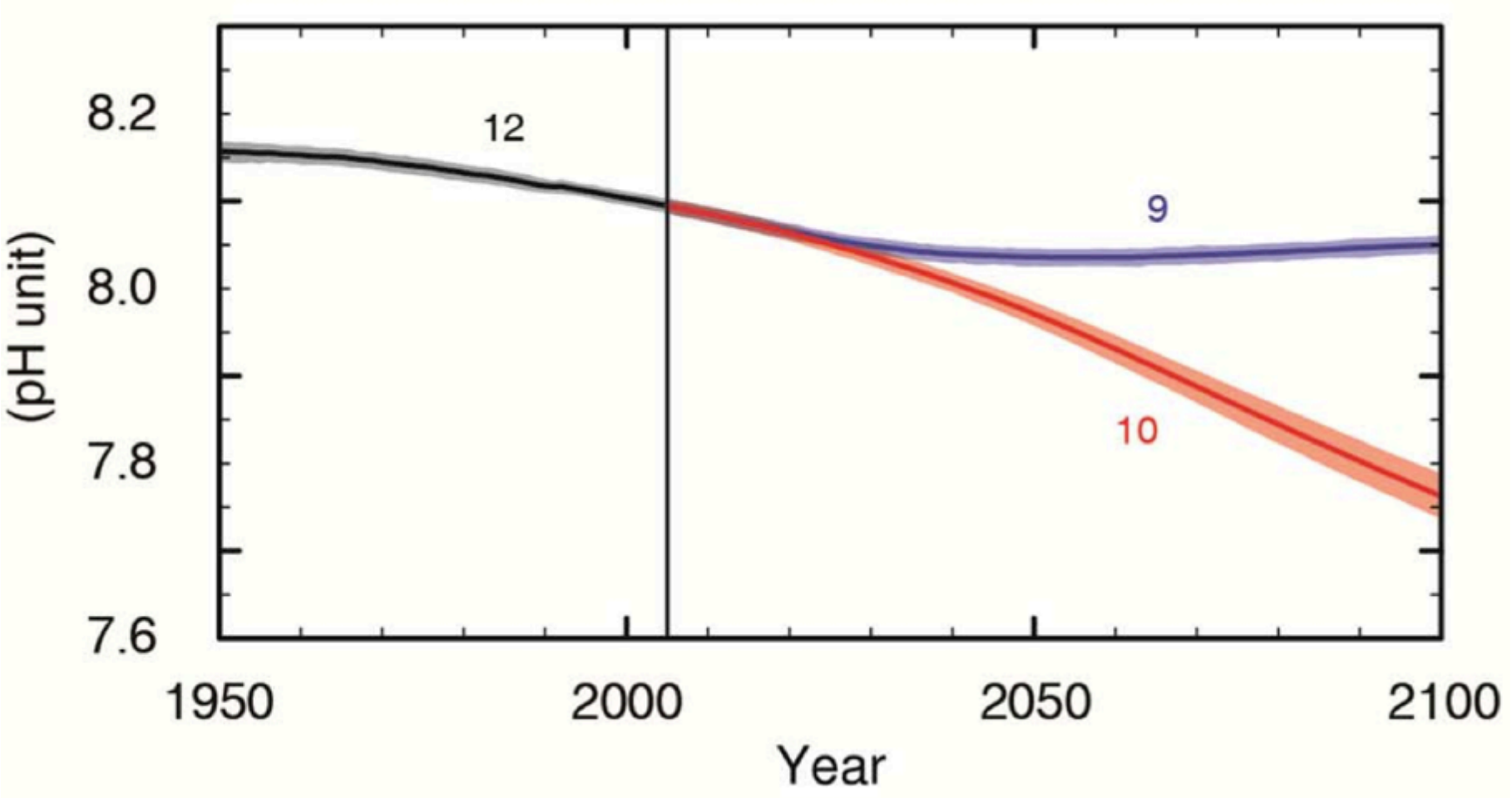
(Reference level: 1986-2005)

Effects on Nile delta: 10 M people above 1m

(Time 2001)

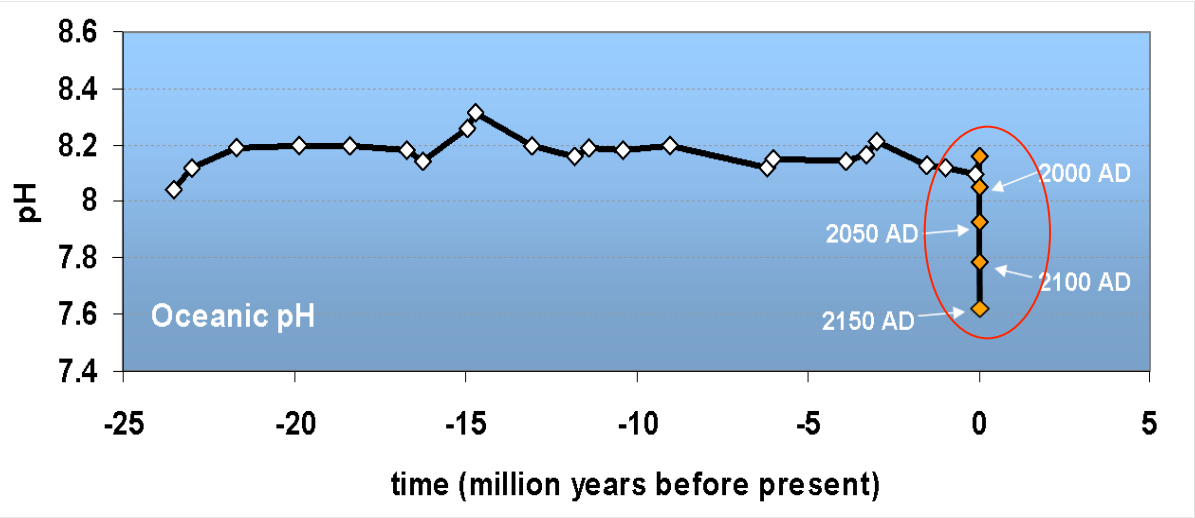
Global ocean surface pH (projections)

Ocean Acidification, for RCP 8.5 (orange) & RCP2.6 (blue)



Oceans are Acidifying Fast…

Changes in pH over the last 25 million years



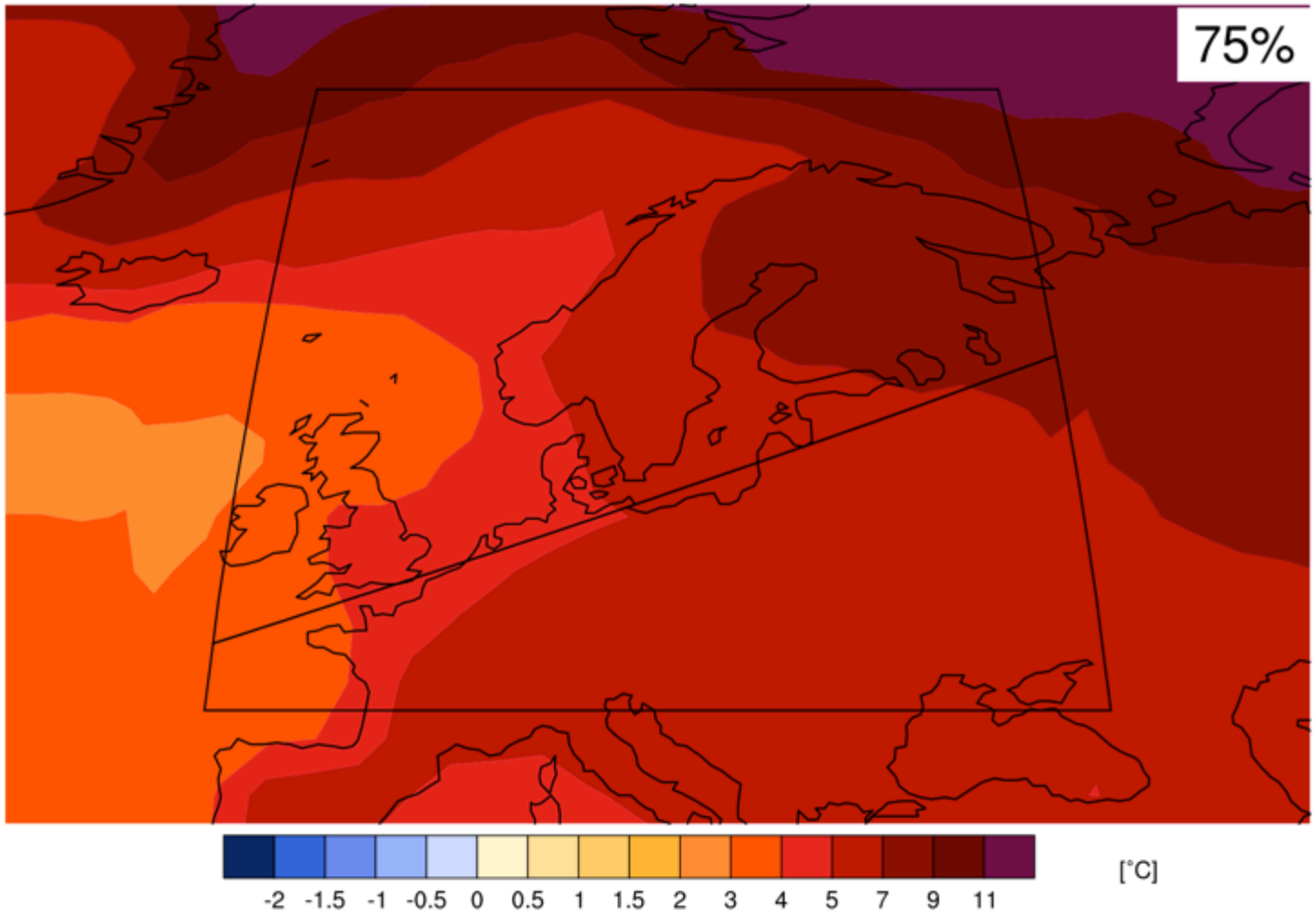
"Today is a rare event in the history of the World"

- **It is happening now, at a speed and to a level not experienced by marine organisms for about 60 million years**
- **Mass extinctions linked to previous ocean acidification events**
- **Takes 10,000's of years to recover**

Turley et al. 2006

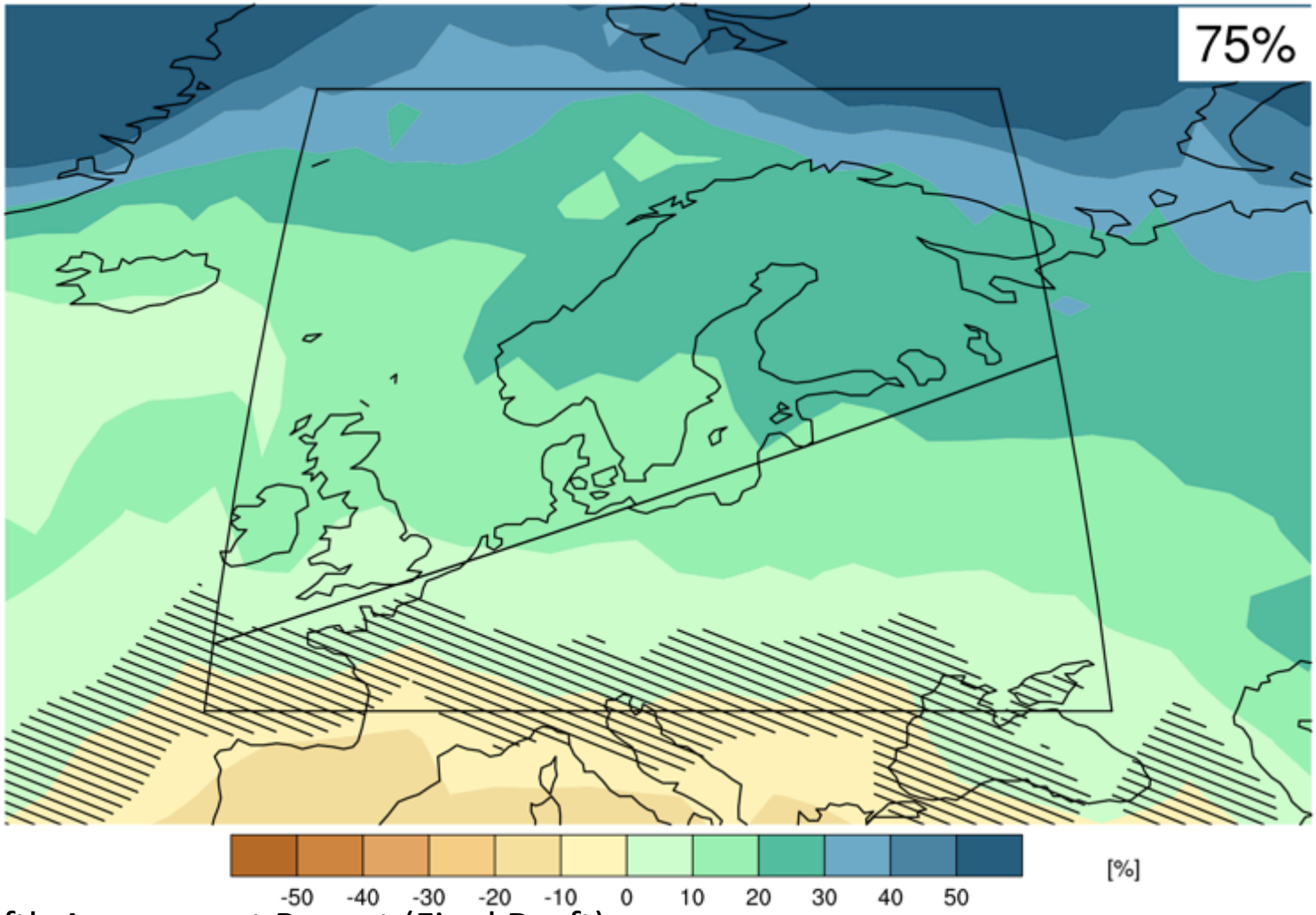
Slide courtesy of Carol Turley, PML

North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



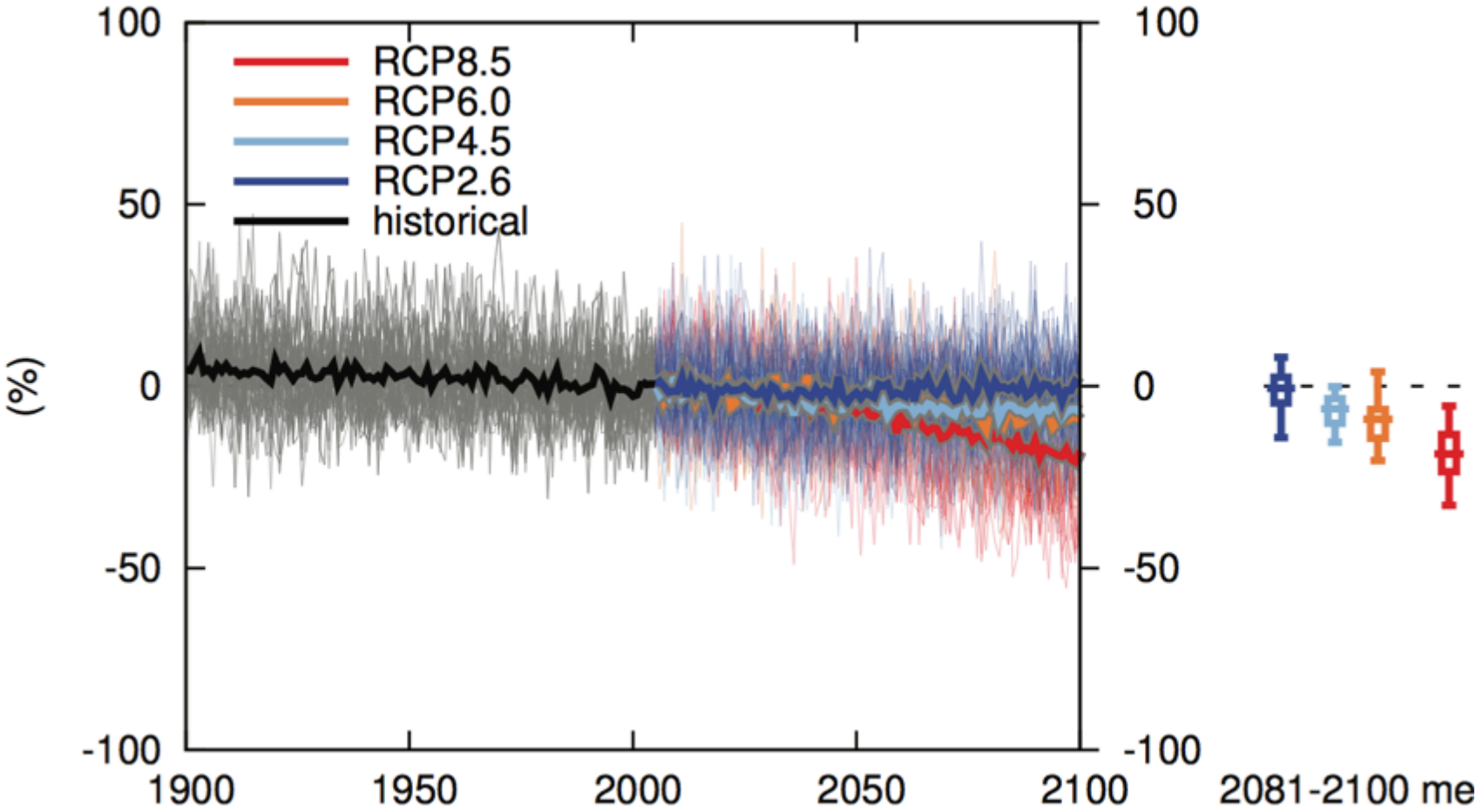
IPCC WG1 Fifth Assessment Report (Final Draft)

North Europe - Map of precipitation changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



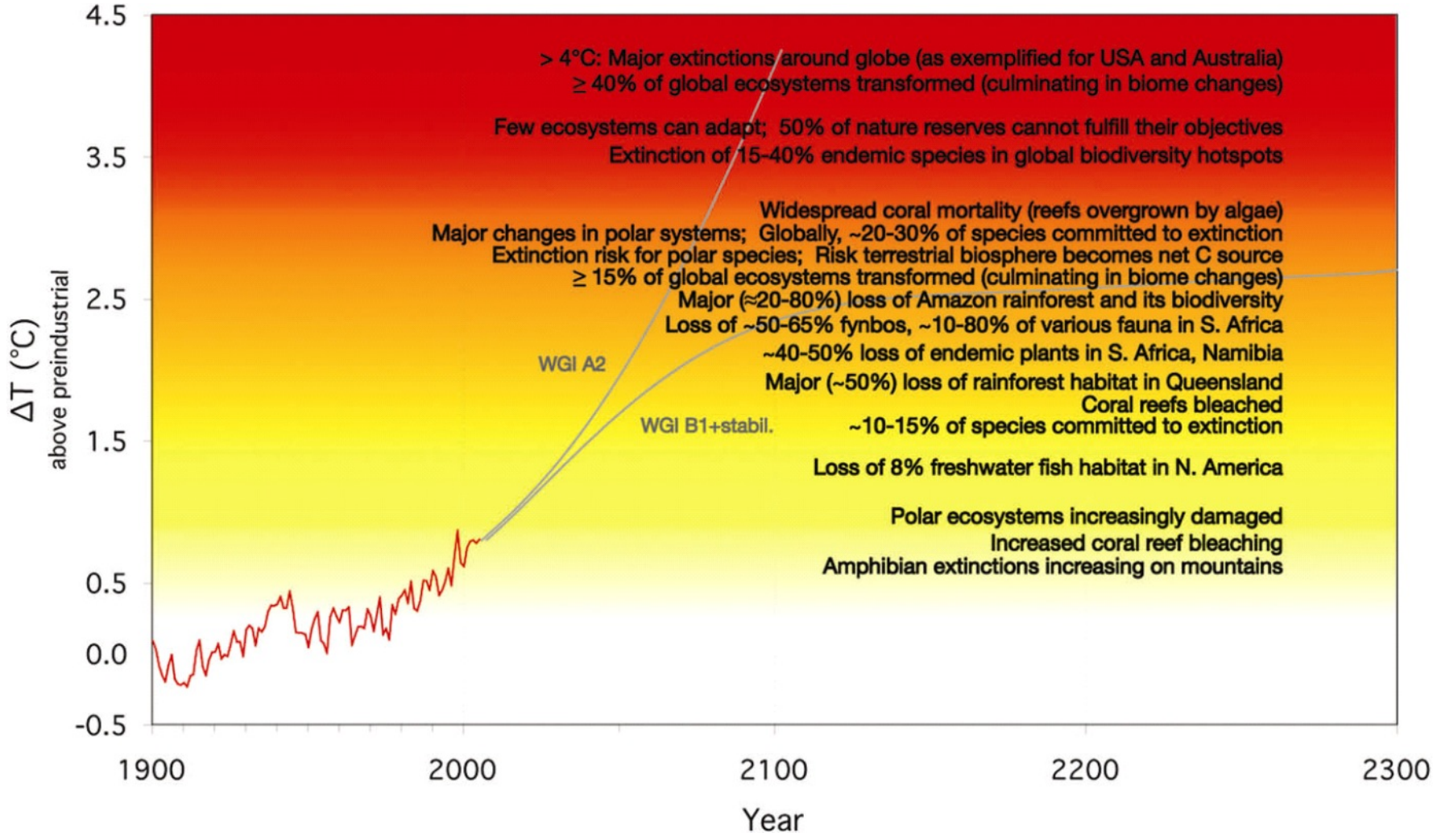
IPCC WG1 Fifth Assessment Report (Final Draft)

Precipitation change South Europe/ Mediterranean annual



IPCC WG1 Fifth Assessment Report-Atlas of Global and Regional Climate Projections (Final Draft)

Figure TS.6. Projected risks due to critical climate change impacts on ecosystems



WMO

UNEP

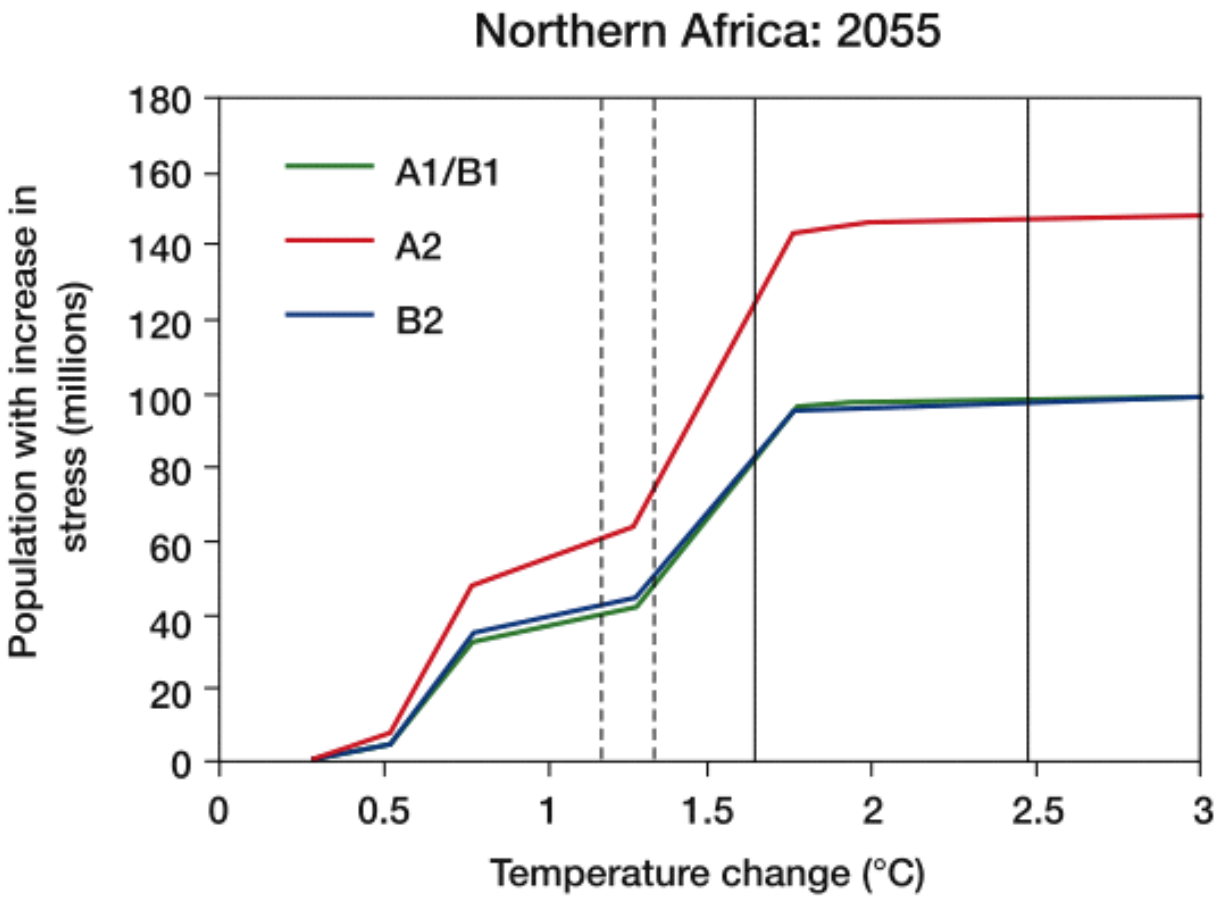
20% - 30% of plants and animals species likely at "increased risk of extinction"

if ΔT 2.0°C - 3.0°C (above pre-industrial temperature)

WMO

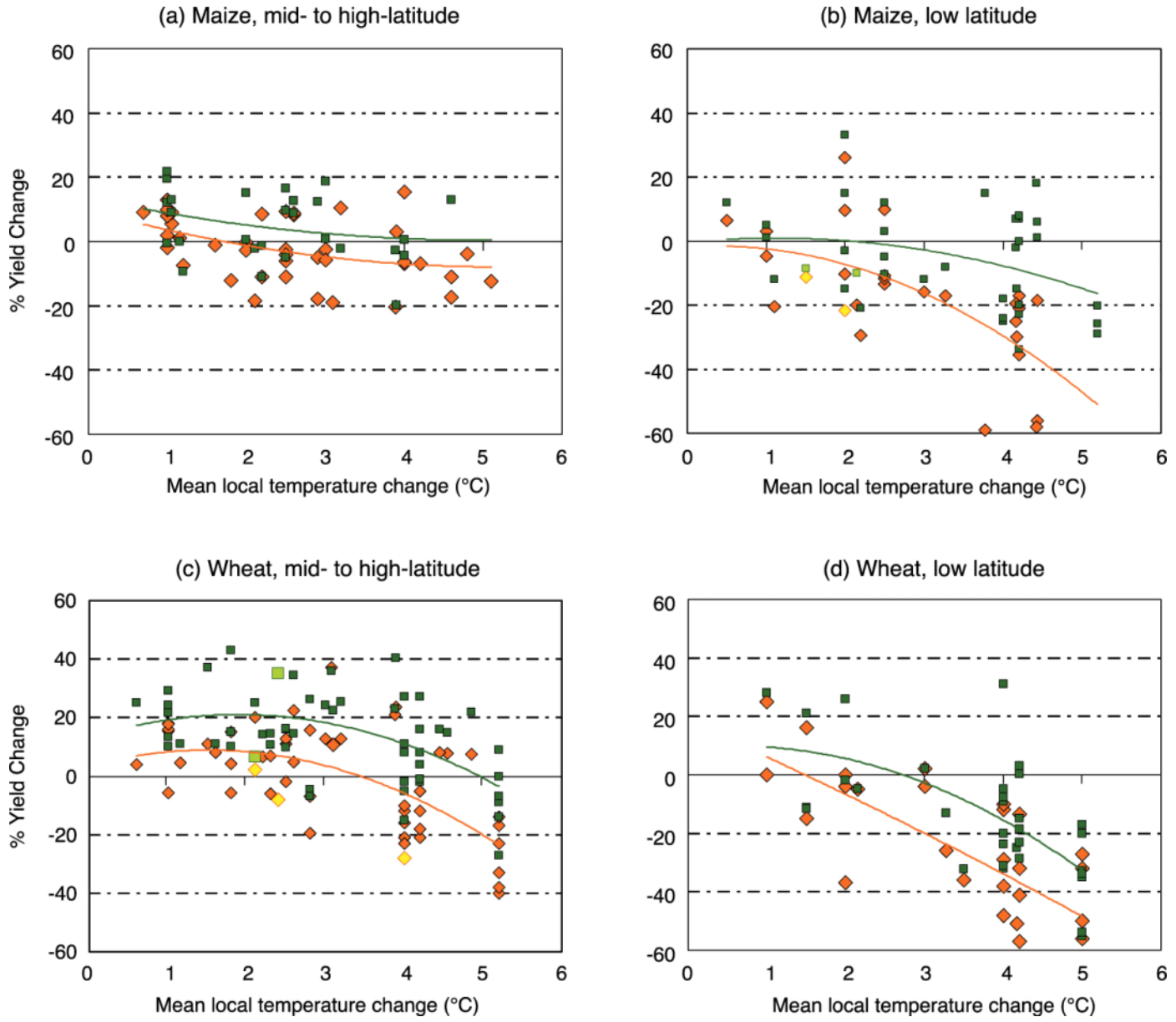
UNEP

Number of people (millions) with an increase in water stress



Source: IPCC AR4 (2007), WGII, Ch.9.4.1

AR4 Figure TS.7. Sensitivity of cereal yield to climate change



WMO

UNEP

Regions most affected

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

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

- The poor
- Young children
- The elderly

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of 'multiple stresses', occurring at various levels, and low adaptive capacity (high confidence).**
- (…) and this vulnerability is exacerbated by existing developmental challenges (…) These in turn have contributed to Africa's weak adaptive capacity, increasing the continent's vulnerability to projected climate change.

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **African farmers have developed several adaptation options to cope with current climate variability, but such adaptations may not be sufficient for future changes of climate (high confidence).**
- Human or societal adaptive capacity, identified as being low for Africa in the TAR, is now better understood (…) However, such advances in the science of adaptation to climate change and variability (…), show that these adaptations may be insufficient to cope with future changes of climate.

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Agricultural production and food security (including access to food) in many African countries and regions are likely to be severely compromised by climate change and climate variability (high confidence).**
- A number of countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will be likely to reduce the length of growing season as well as force large regions of marginal agriculture out of production. Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected. This would adversely affect food security in the continent.

WMO

UNEP

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Climate change will aggravate the water stress currently faced by some countries, while some countries that currently do not experience water stress will become at risk of water stress (very high confidence).**
- Climate change and variability are likely to impose additional pressures on water availability, water accessibility and water demand in Africa.

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- Even without climate change, several countries in Africa, particularly in northern Africa, will exceed the limits of their economically usable land-based water resources before 2025. About 25% of Africa's population (about 200 million people) currently experience high water stress.
- The population at risk of increased water stress in Africa is projected to be between 75-250 million and 350-600 million people by the 2020s and 2050s, respectively.

WMO

UNEP

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Changes in a variety of ecosystems are already being detected, particularly in southern African ecosystems, at a faster rate than anticipated (very high confidence).**
- Climate change, interacting with human drivers such as deforestation and forest fires, are a threat to Africa's forest ecosystems. Changes in grasslands and marine ecosystems are also noticeable. It is estimated that, by the 2080s, the proportion of arid and semi-arid lands in Africa is likely to increase by 5-8%. Climate change impacts on Africa's ecosystems will probably have a negative effect on tourism as, according to one study, between 25 and 40% of mammal species in national parks in sub-Saharan Africa will become endangered.

WMO

UNEP

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Climate variability and change could result in low-lying lands being inundated, with resultant impacts on coastal settlements (high confidence).**
- Climate variability and change, coupled with human-induced changes, may also affect ecosystems e.g., mangroves and coral reefs, with additional consequences for fisheries and tourism.

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Human health, already compromised by a range of factors, could be further negatively impacted by climate change and climate variability, e.g., malaria in southern Africa and the East African highlands (high confidence).**
- It is likely that climate change will alter the ecology of some disease vectors in Africa, and consequently the spatial and temporal transmission of such diseases. Most assessments of health have concentrated on malaria and there are still debates on the attribution of malaria resurgence in some African areas.

WMO

UNEP

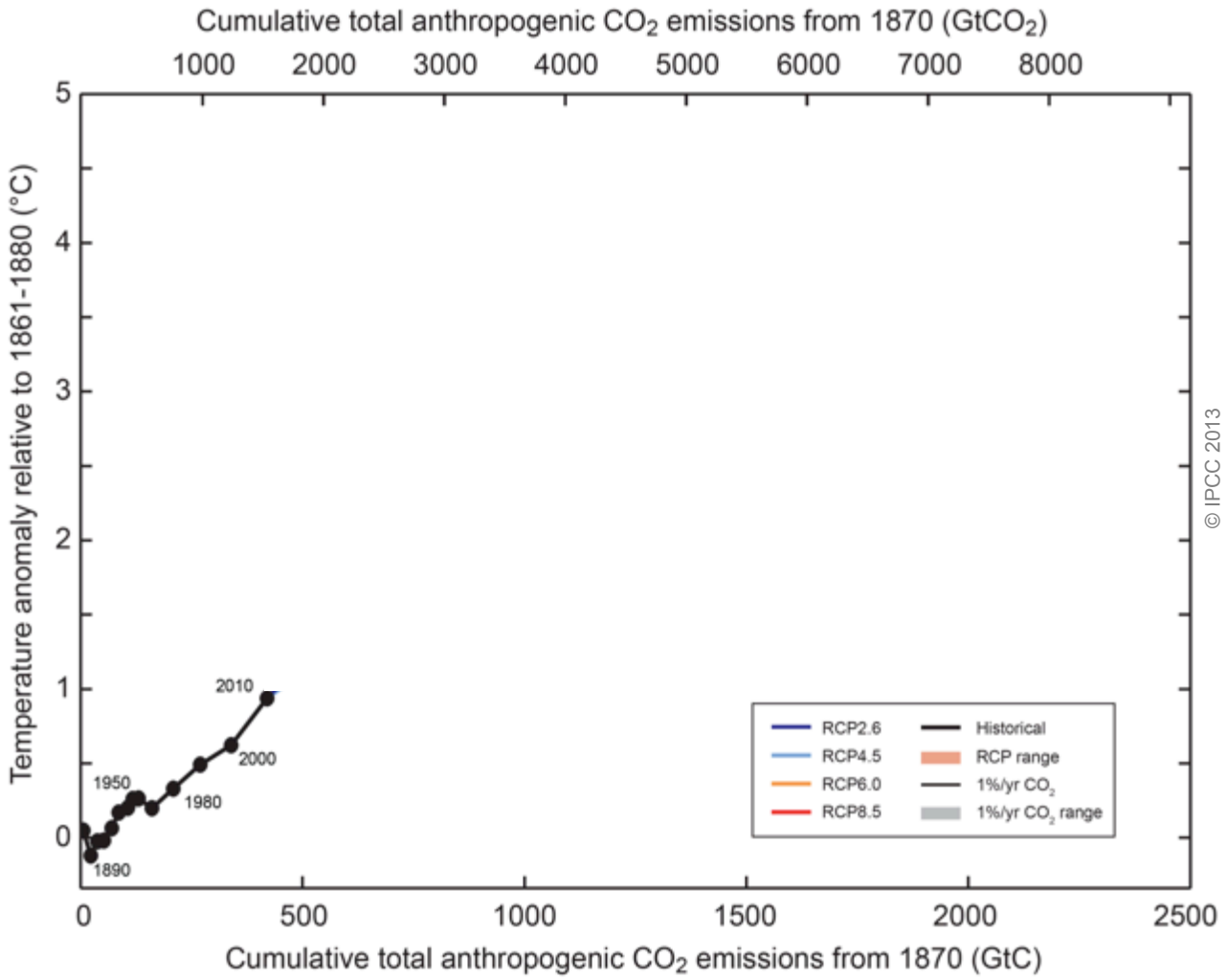


Fig. SPM.10

Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond.

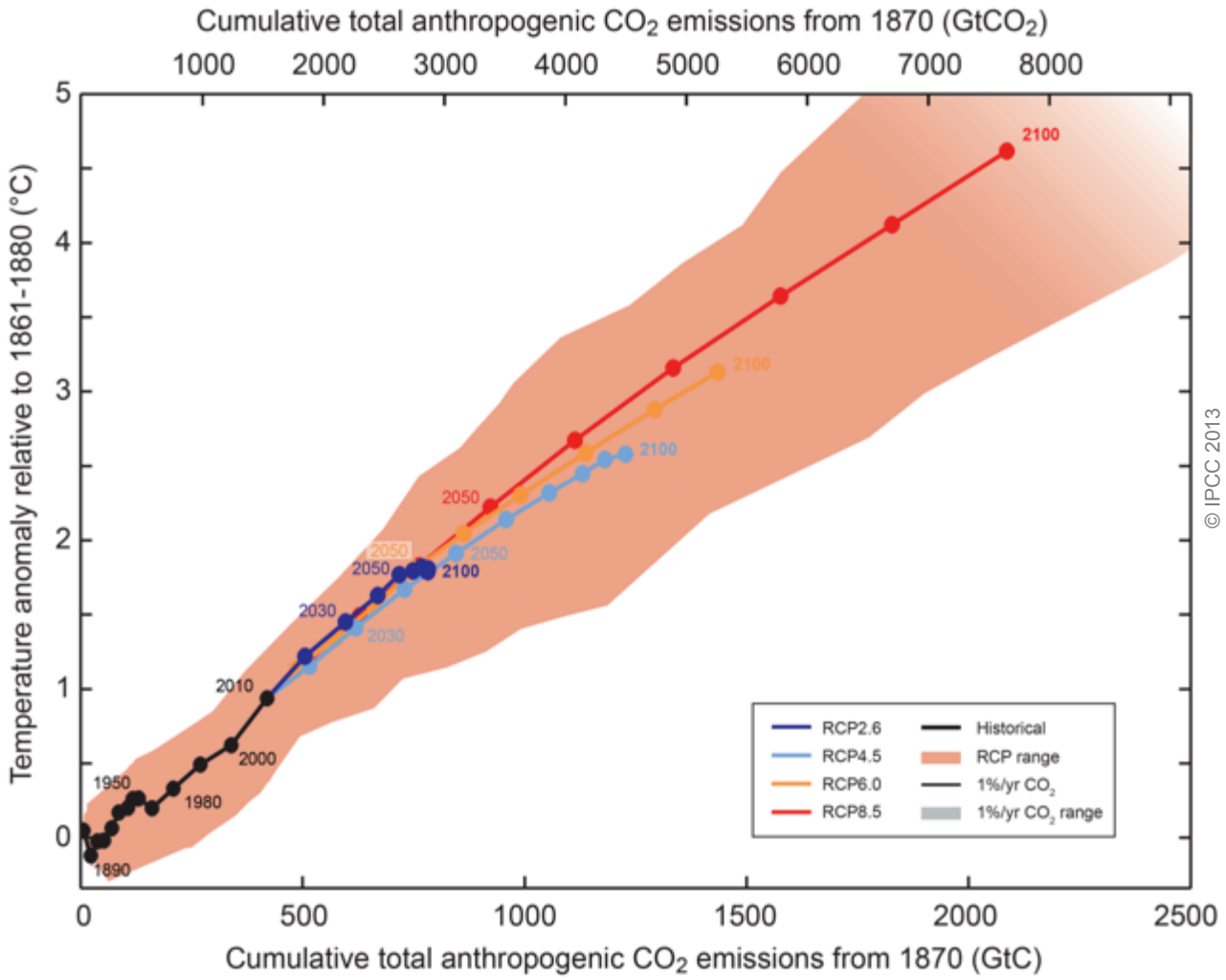
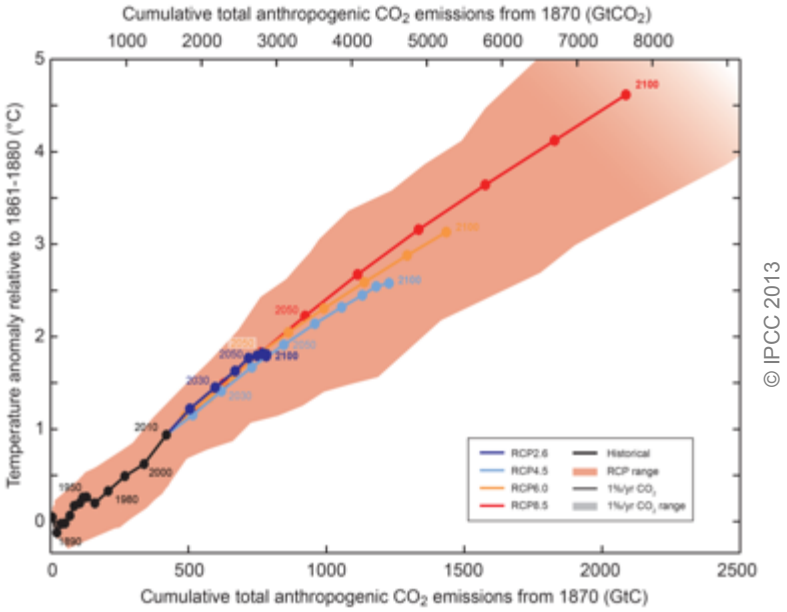


Fig. SPM.10

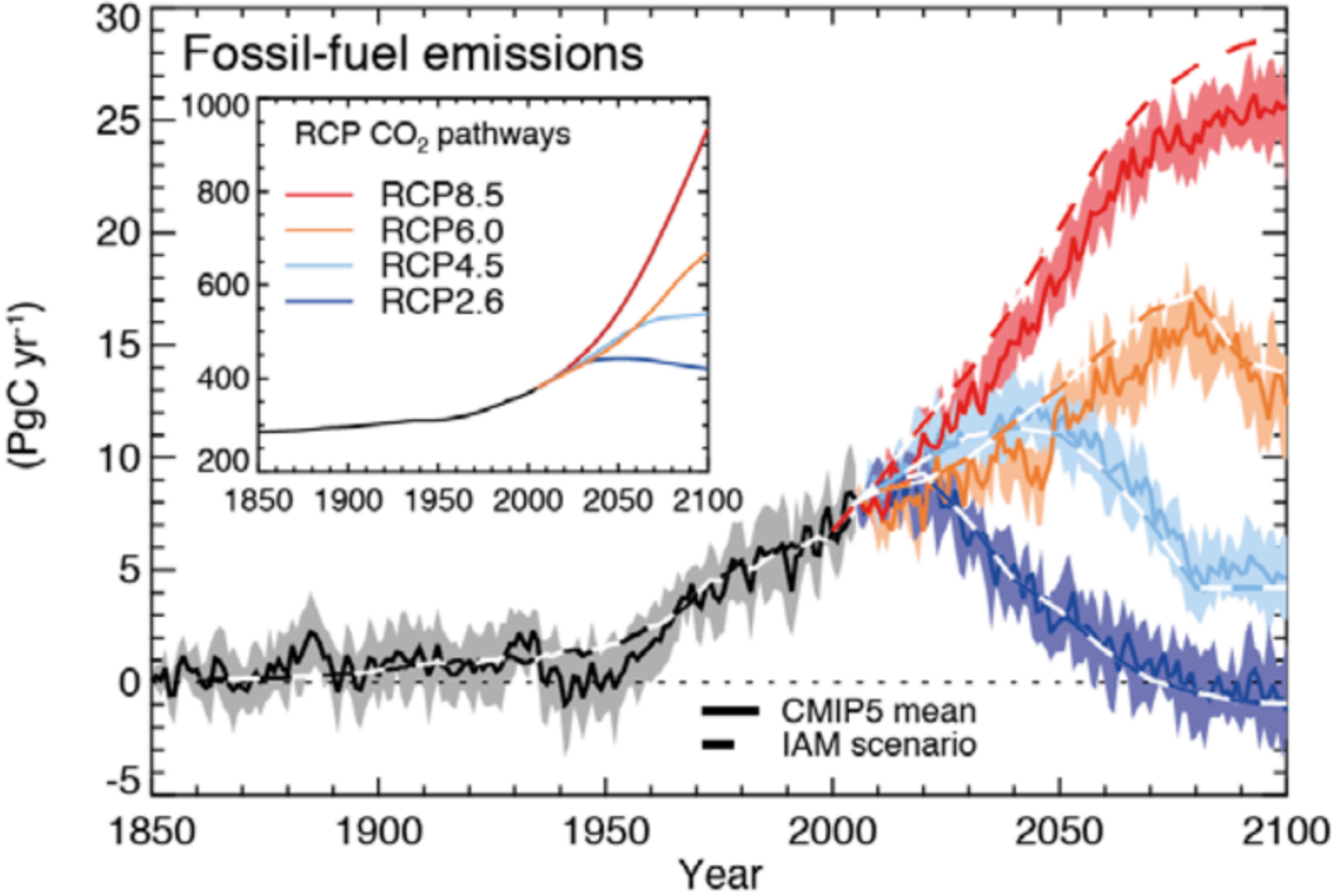
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.



Limiting warming to *likely* less than 2°C since 1861-1880 requires cumulative CO_2 emissions to stay below 1000 GtC. Until 2011, over 50% of this amount has been emitted.

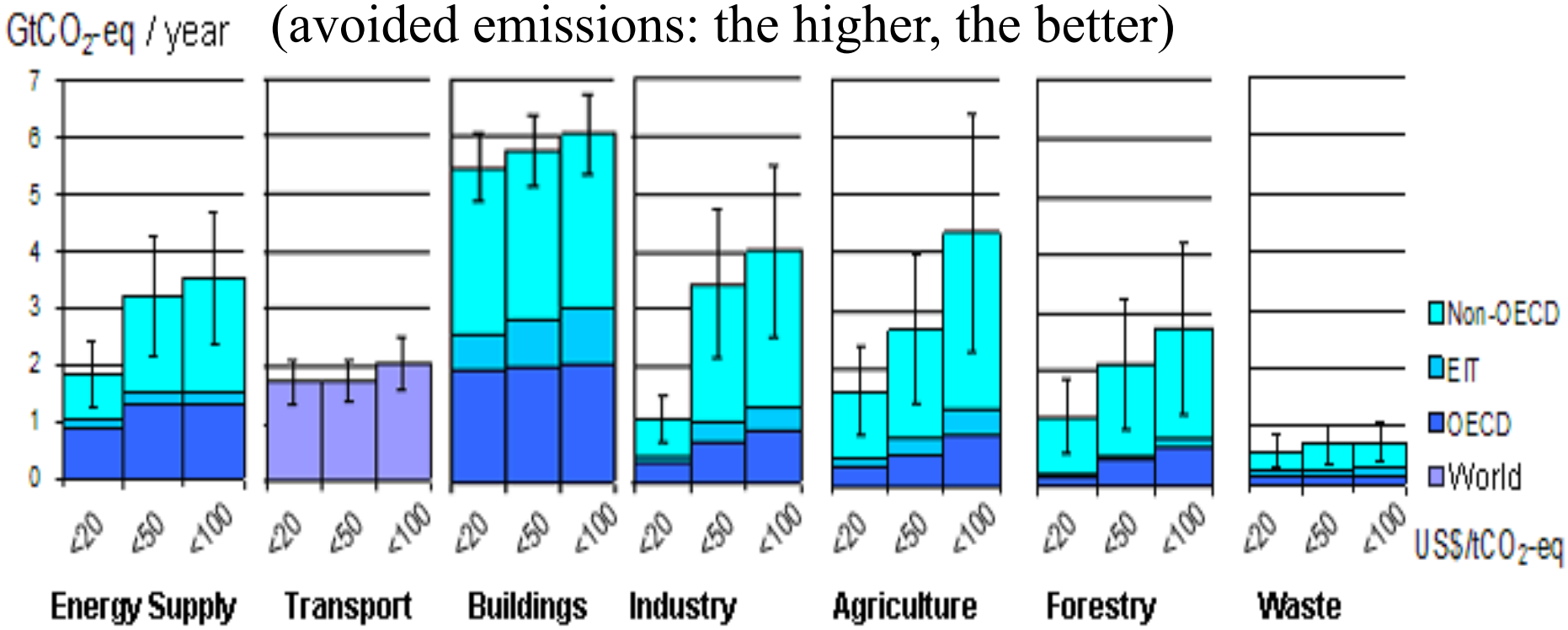
Accounting for other forcings, the upper amount of cumulative CO_2 emissions is 800 GtC; over 60% have been emitted by 2011.

Compatible fossil fuel emissions simulated by the CMIP5 models for the four RCP scenarios



AR5 WGI TS – Approved version/subject to final copy edit

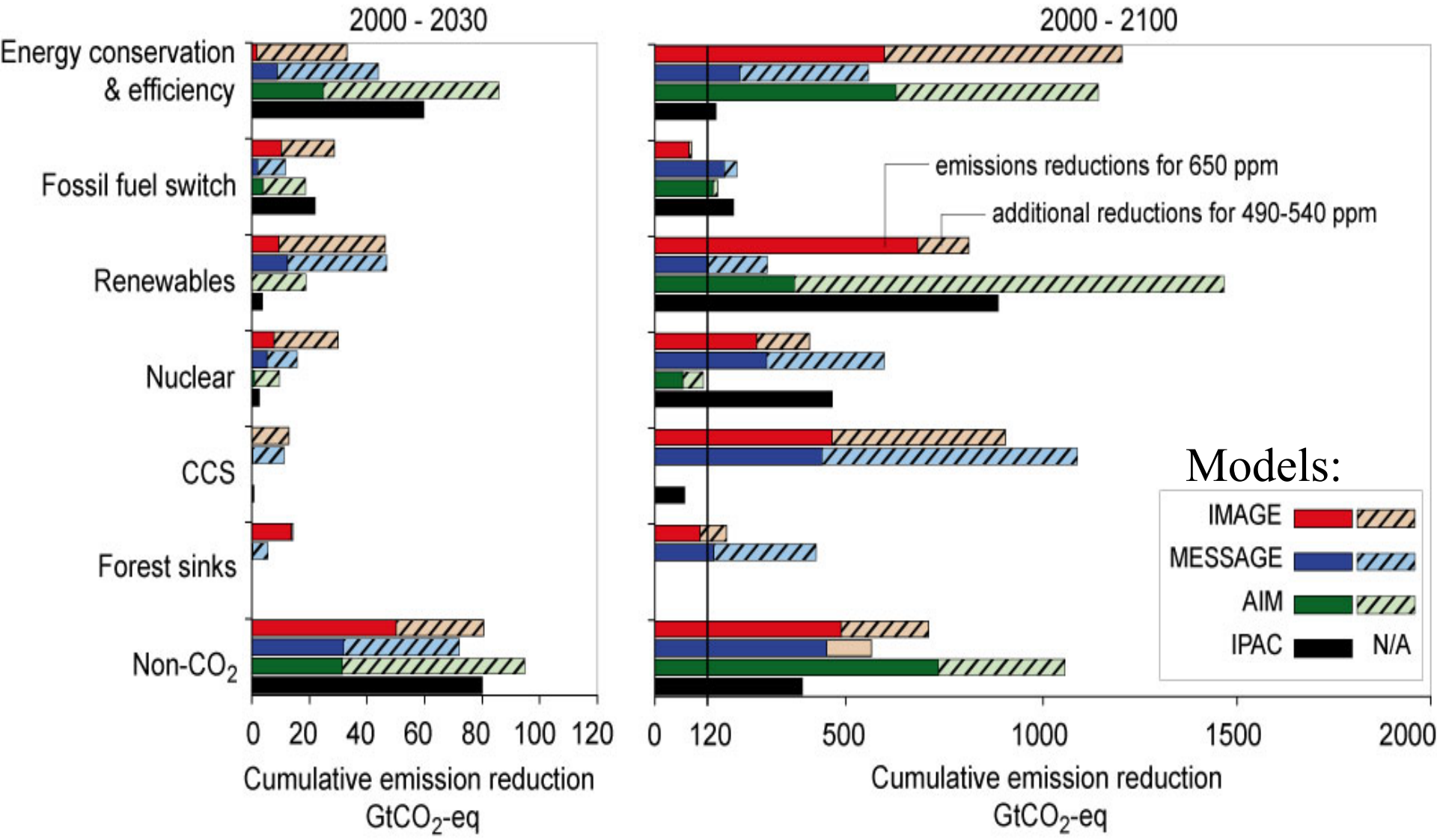
All sectors and regions have the potential to contribute by 2030



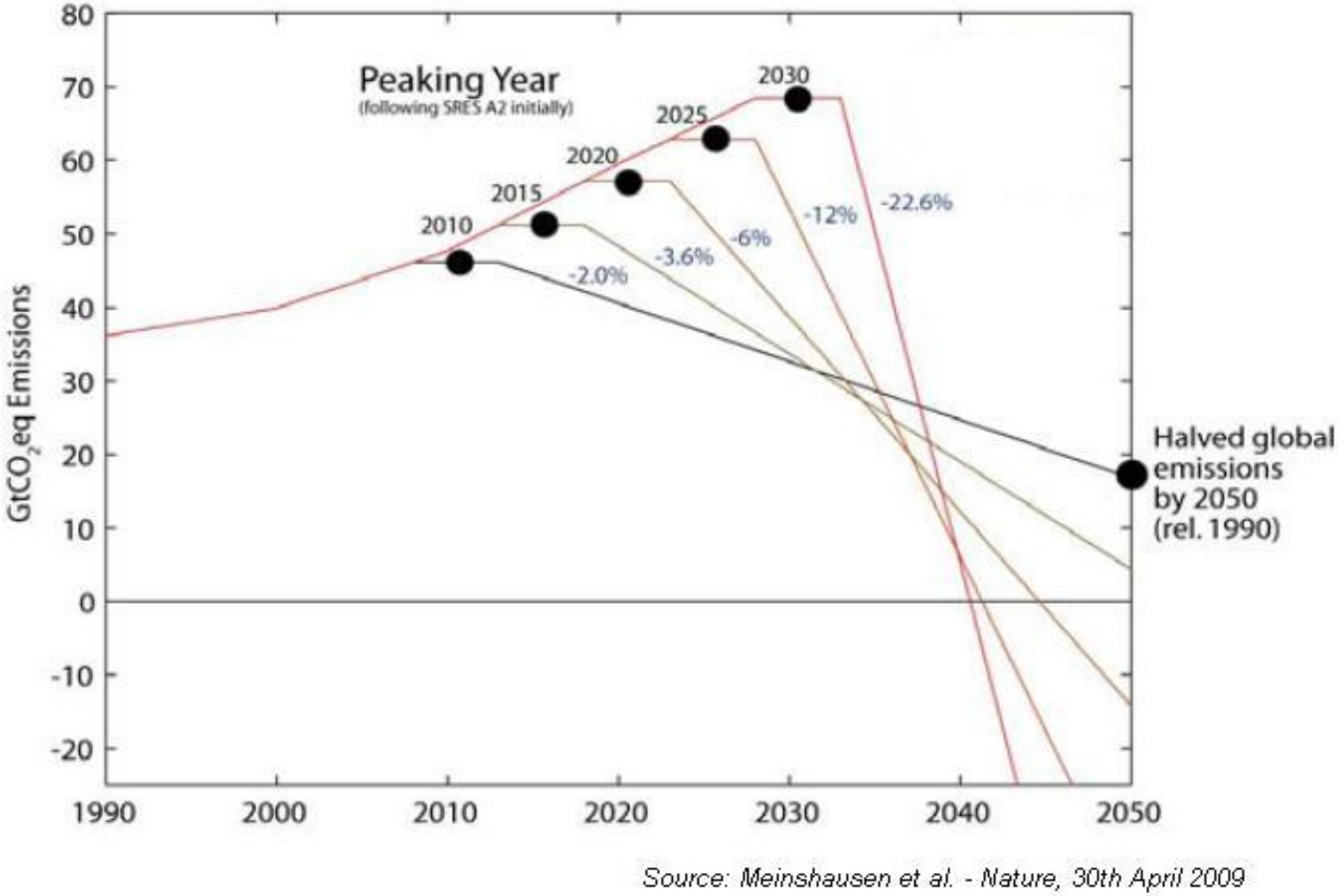
IPCC AR4 (2007)

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

Role of Technology, following IPCC AR4



The more we wait, the more difficult it will be



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

Useful links:

- www.ipcc.ch : IPCC
- www.climatechange2013.org : IPCC WGI AR5
- www.climate.be/vanyp : my slides and other documents
- www.skepticalscience.com: excellent responses to contrarians arguments
- **On Twitter: @JPvanYpersele**

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