Climate Science and the Hidden Message in the IPCC 5th Assessment Report (AR5)

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#ClimateJustice2015 Conference,

Maynooth, 23 June 2015

Thanks to the Belgian Federal Science Policy Office (BELSPO) and the Ministry of Foreign Affairs, and to my team at the Université catholique de Louvain for their support

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A poem to start:

« In the end, we conserve only what we love.
We will love only what we understand.
We will understand only what we are taught.»

(*Baba Dioum*, Senegalese poet)

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Why the IPCC ?

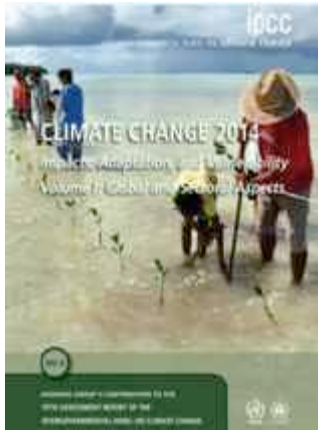
Established by WMO and UNEP in 1988

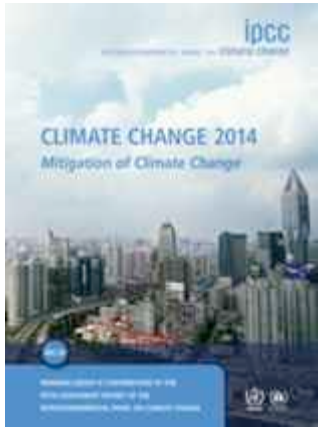
to provide policy-makers with an objective source of information about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options (adaptation & mitigation).

WMO=World Meteorological Organizatior

UNEP= United Nations Environment Programme





What is happening in the climate system?

What are the risks?

What can be done?

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Key messages from IPCC AR5

- Human influence on the climate system is clear
- Continued emissions of greenhouse gases will increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems
- While climate change is a threat to sustainable development, there are many opportunities to integrate mitigation, adaptation, and the pursuit of other societal objectives
- Humanity has the means to limit climate change and build a more sustainable and resilient future

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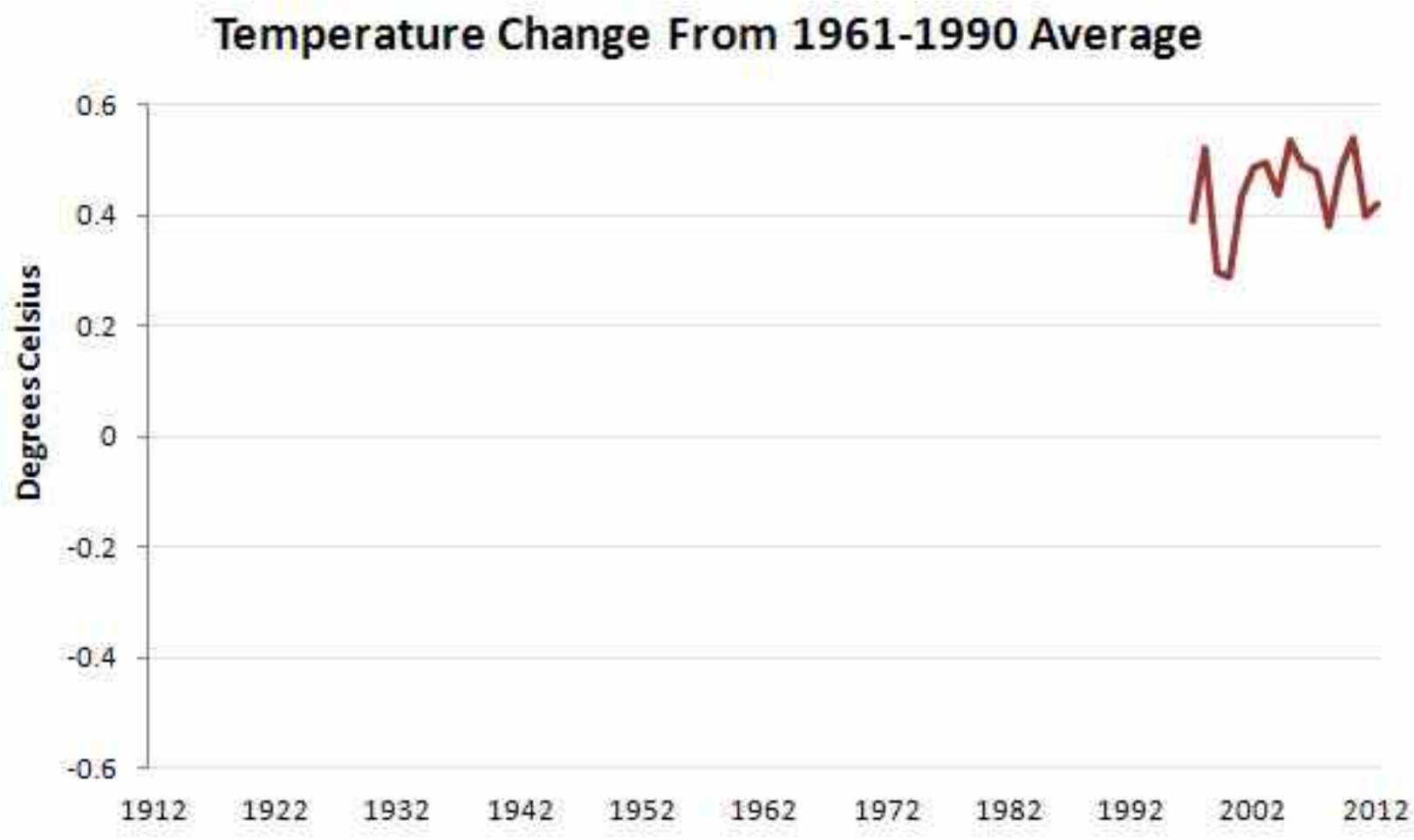
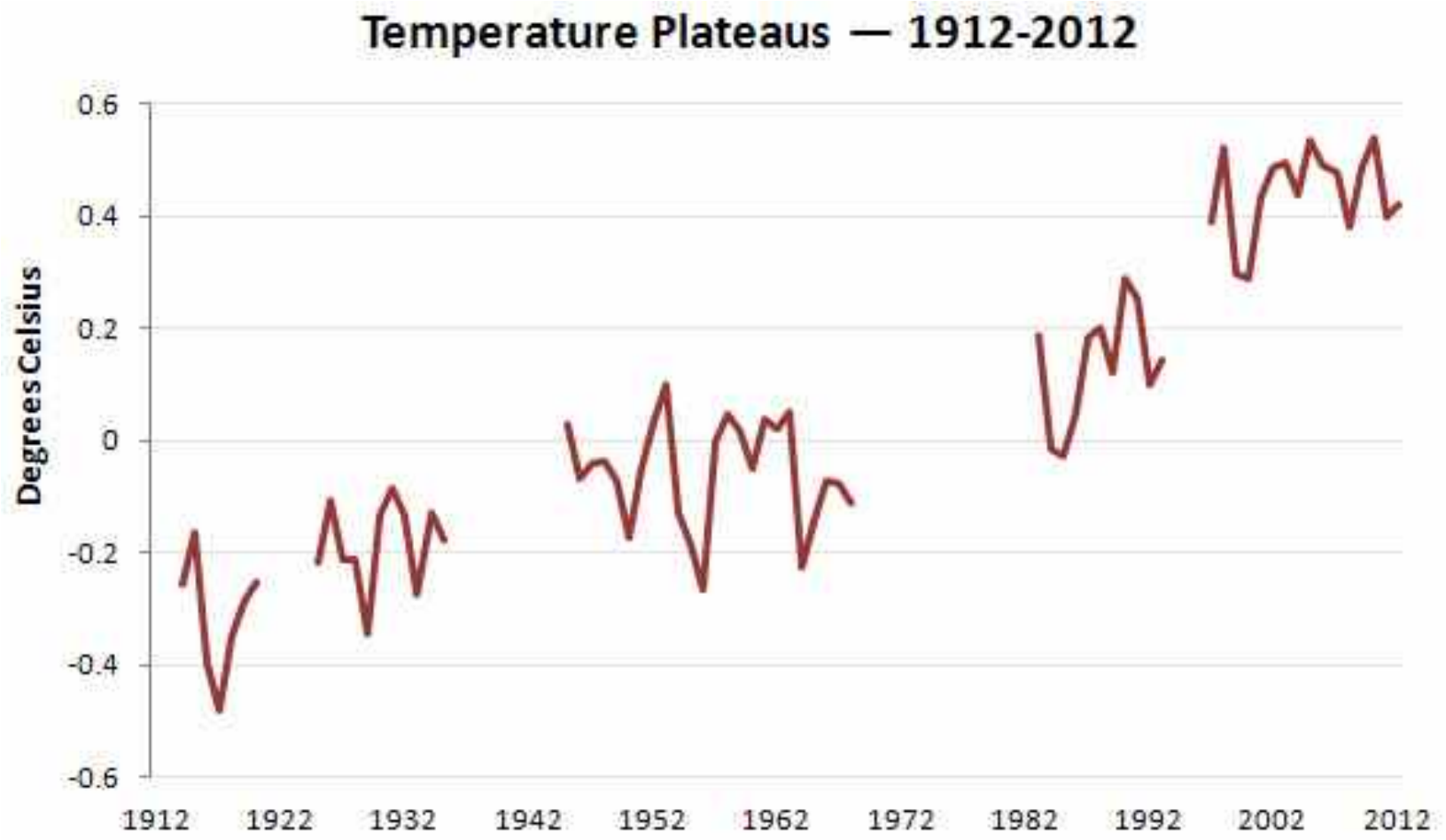


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



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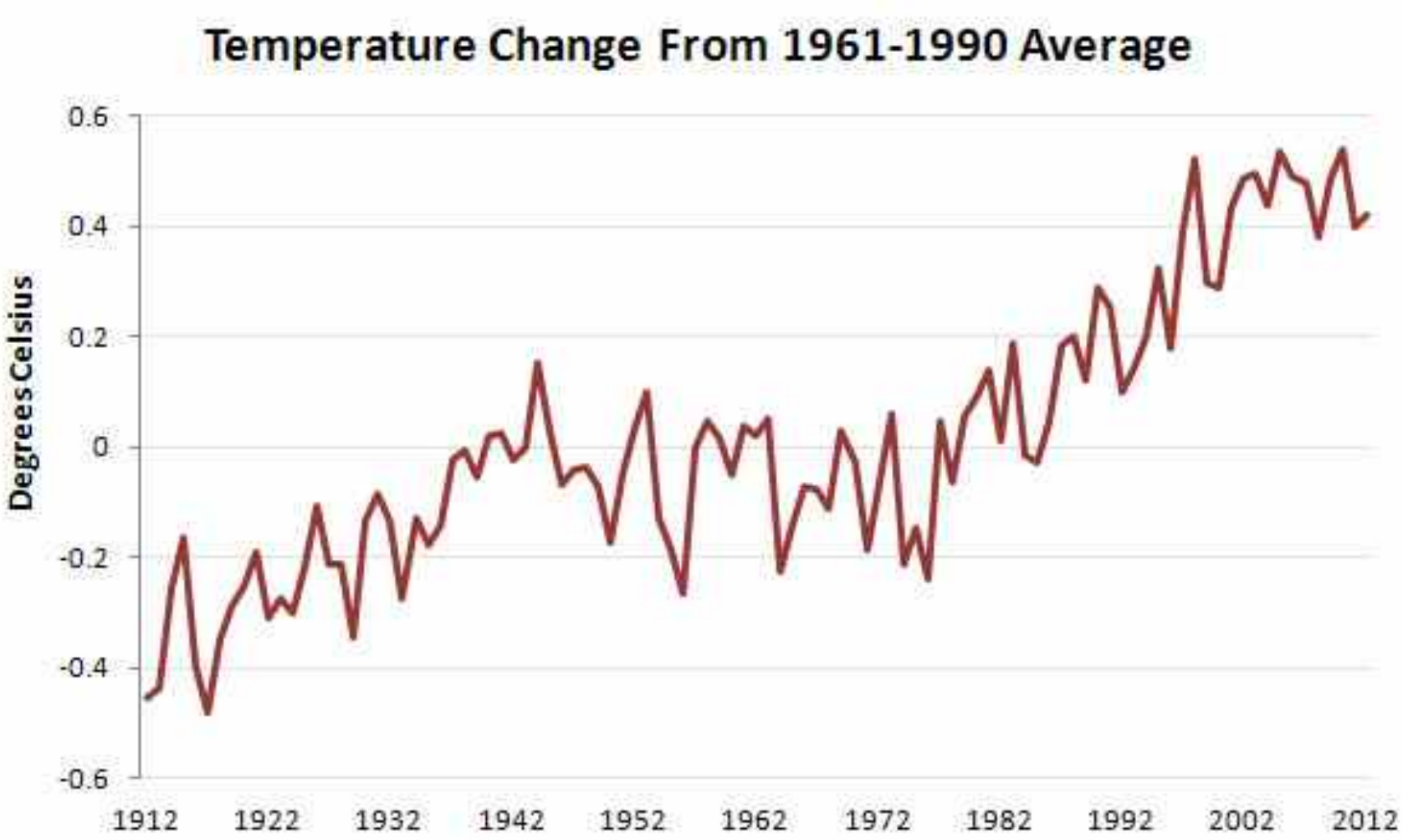

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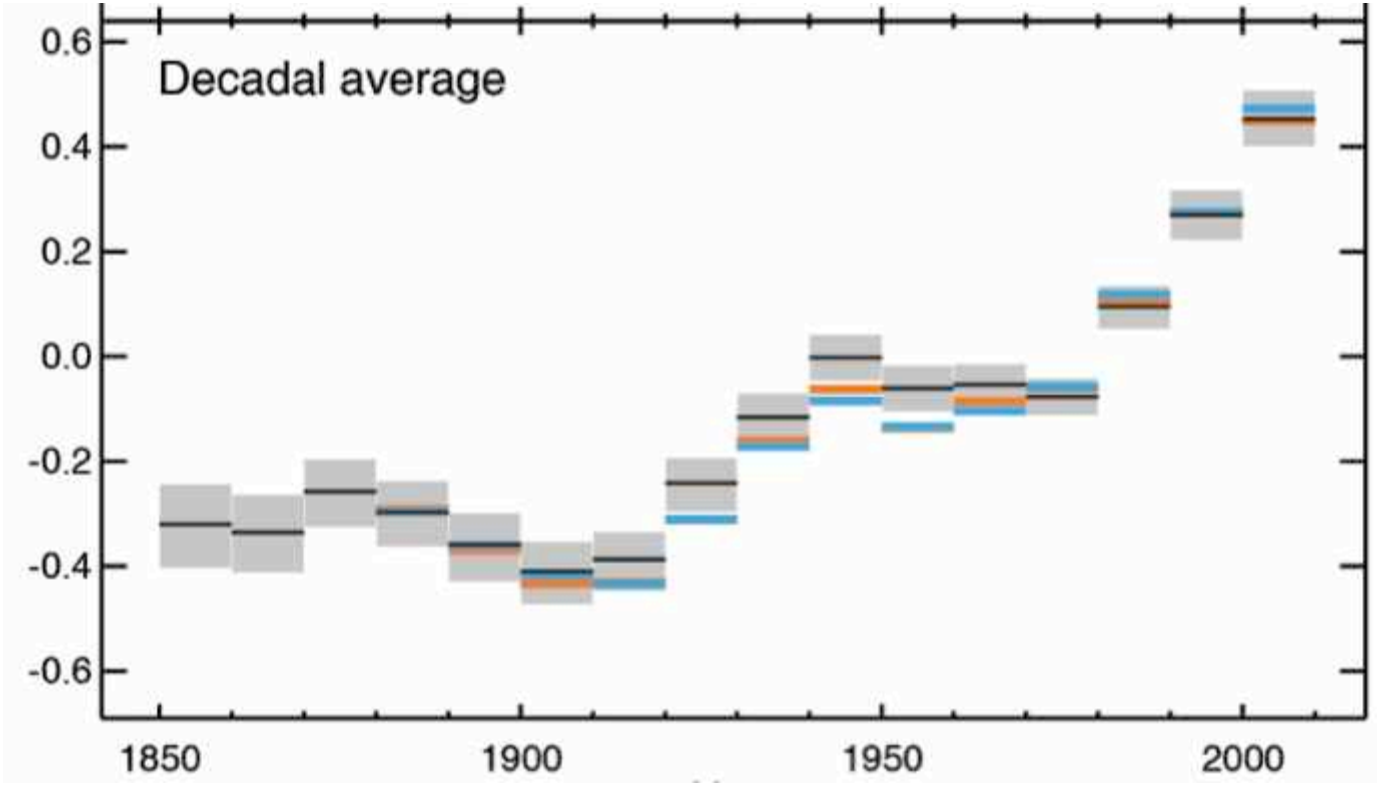


(IPCC 2013, Fig. SPM.1a)

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*).

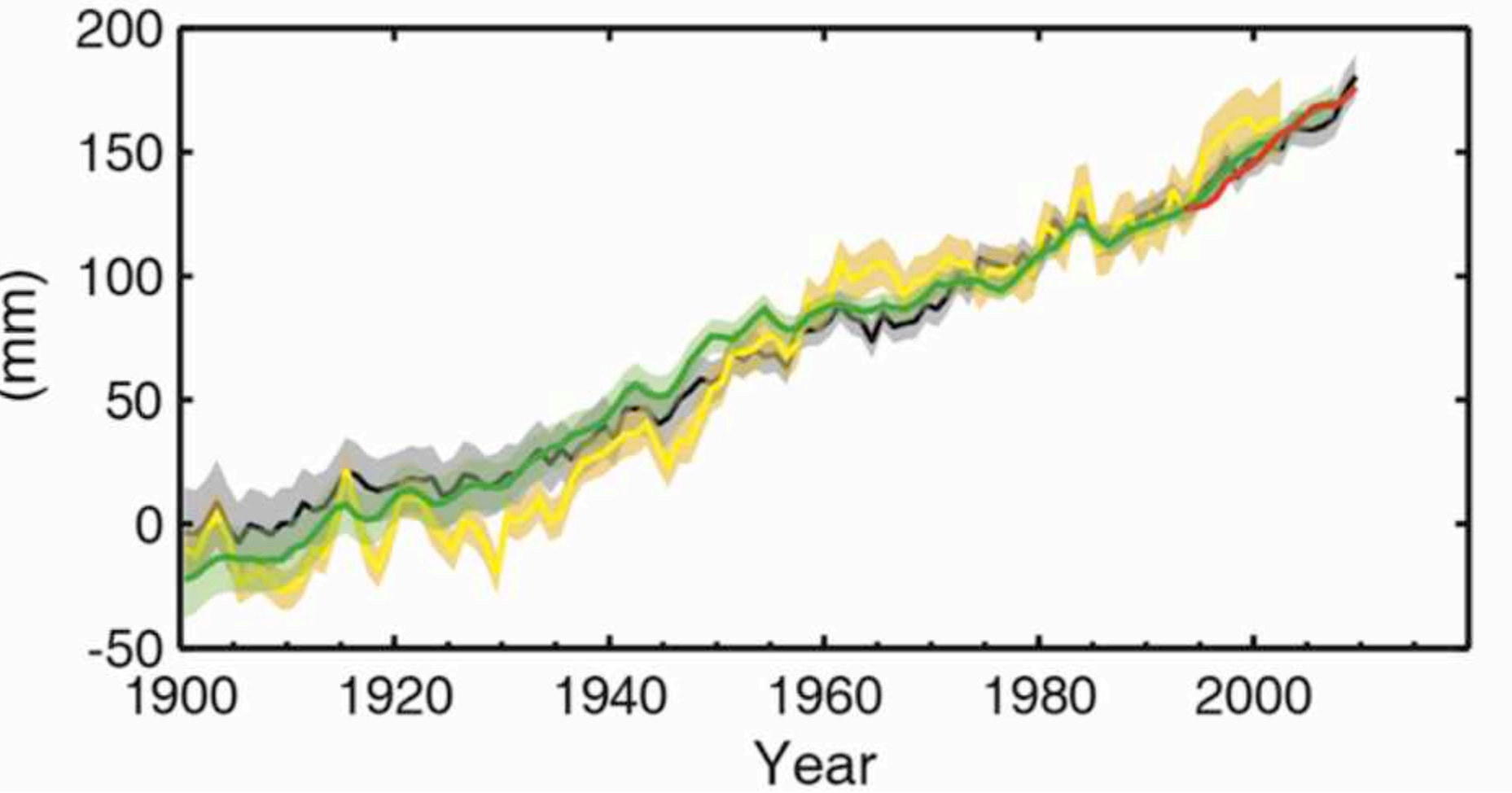
Plateau Glacier (1961)
(Alaska)

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)

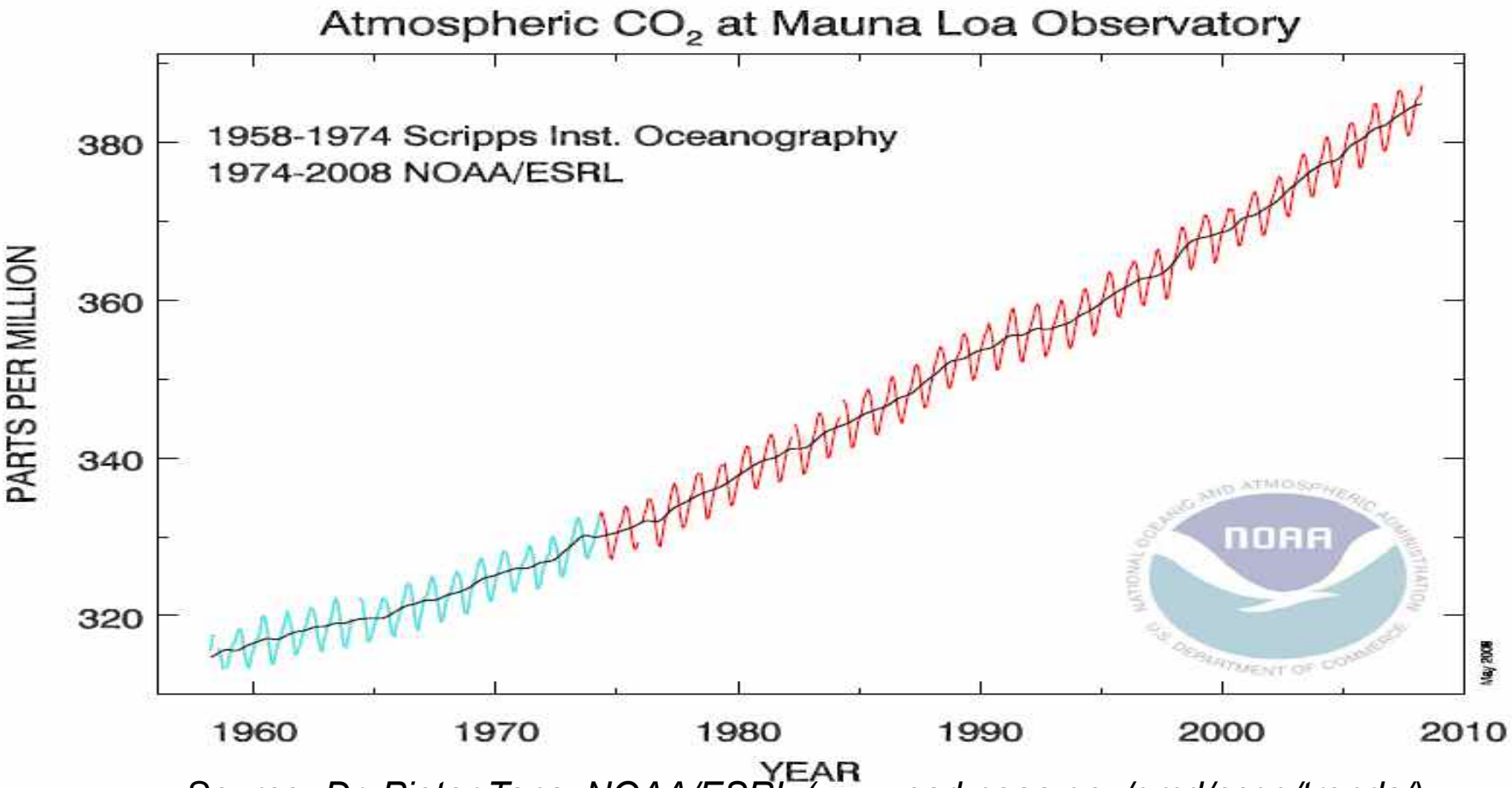
http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Change in average sea-level change



AR5 WGI SPM - Approved version / subject to final copyedit

CO_2 concentration measured at Mauna Loa (3400 m)



Source: *Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)*

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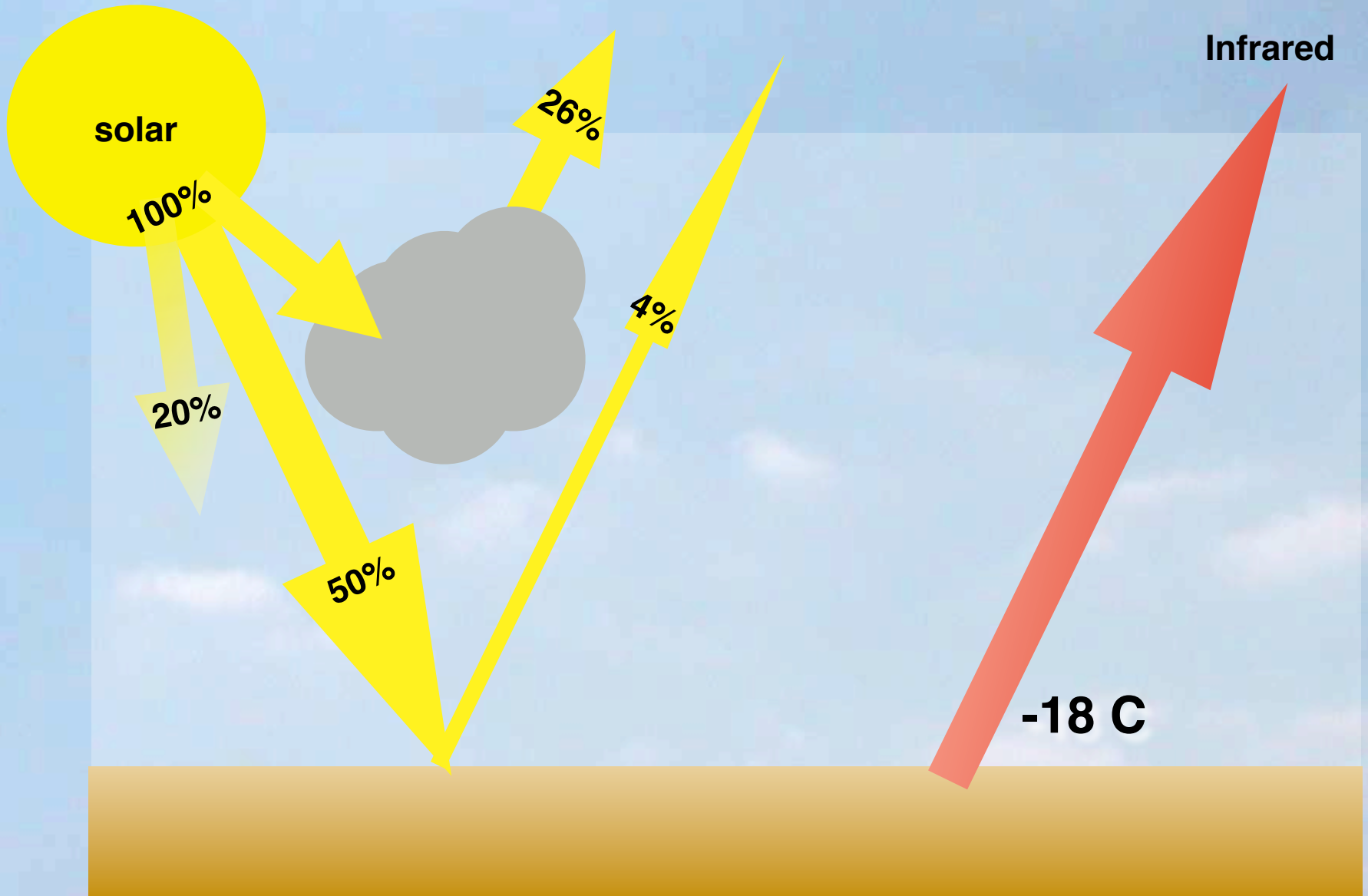
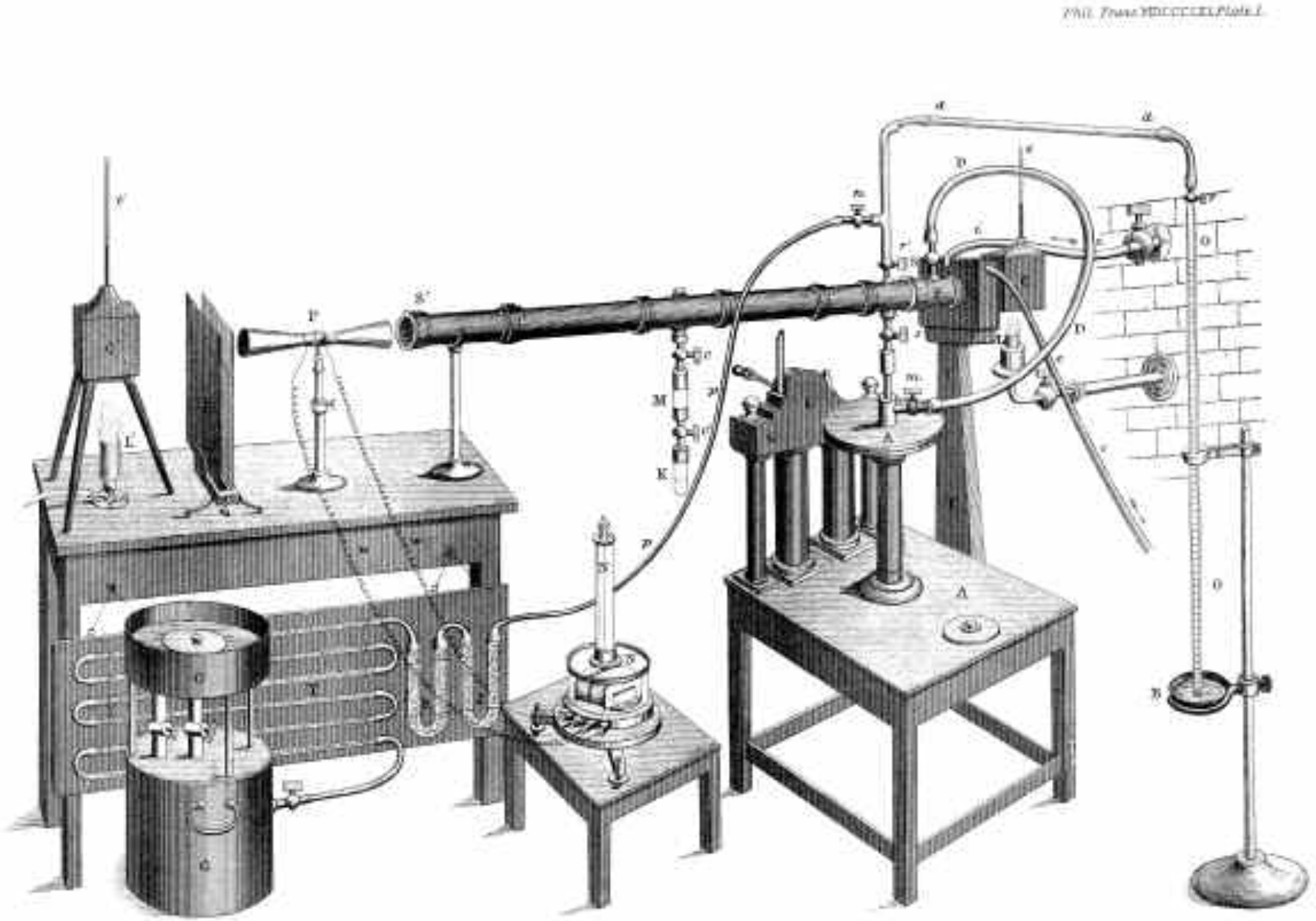
Atmospheric concentrations of CO_2

The concentrations of CO_2 have increased to levels unprecedented in at least the last 800,000 years.

Without Greenhouse Effect





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

With Greenhouse Effect

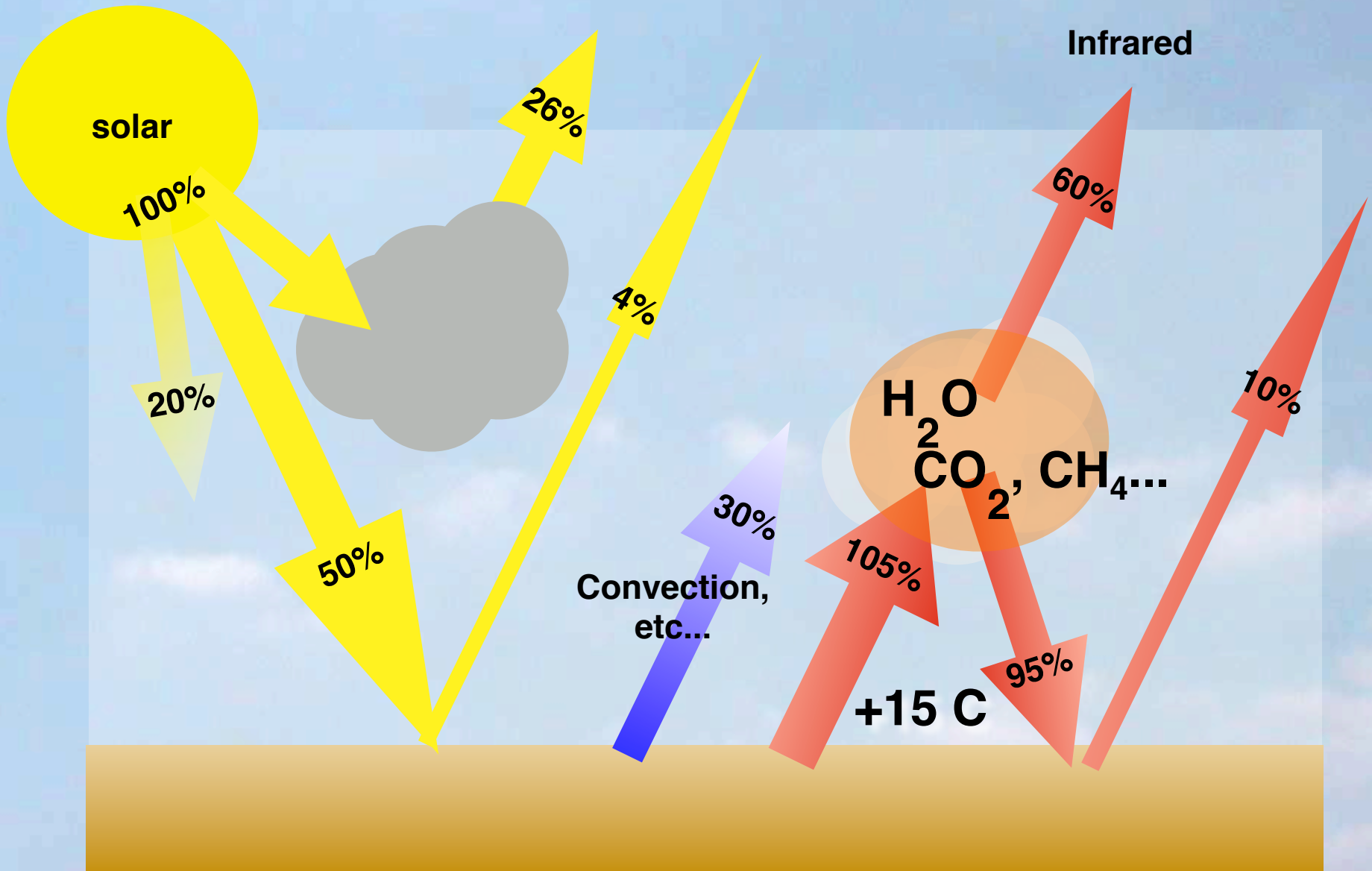
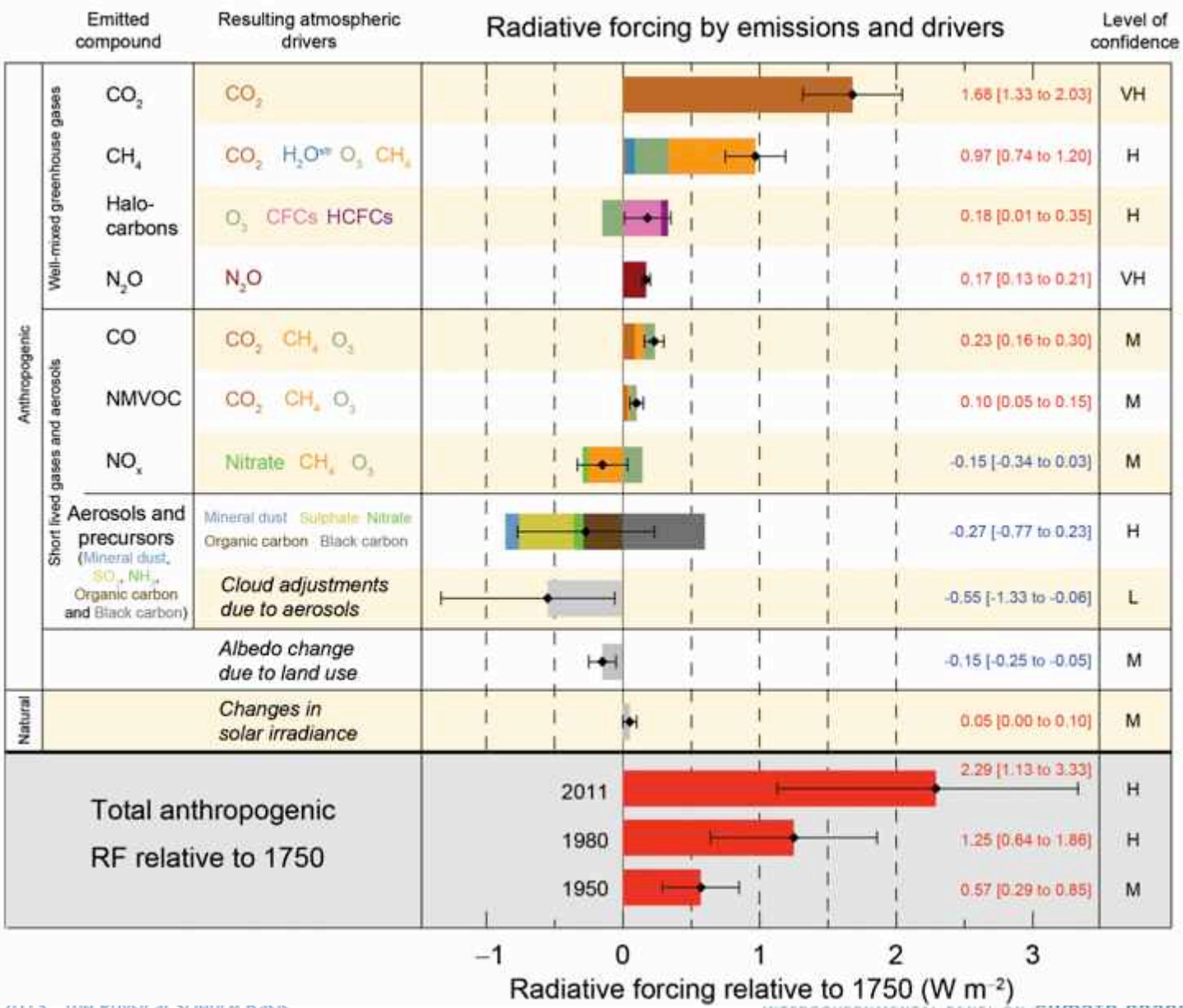


Figure SPM.5

Radiative forcing estimates in 2011 relative to 1750



Methane

The concentration of CH4 has increased by a factor of 2.5 since pre- industrial times, from 722 [697 to 747] ppb in 1750 to 1803 [1799 to 1807] ppb in 2011. There is *very high confidence* that the atmospheric CH4 increase during the Industrial Era is caused by anthropogenic activities.

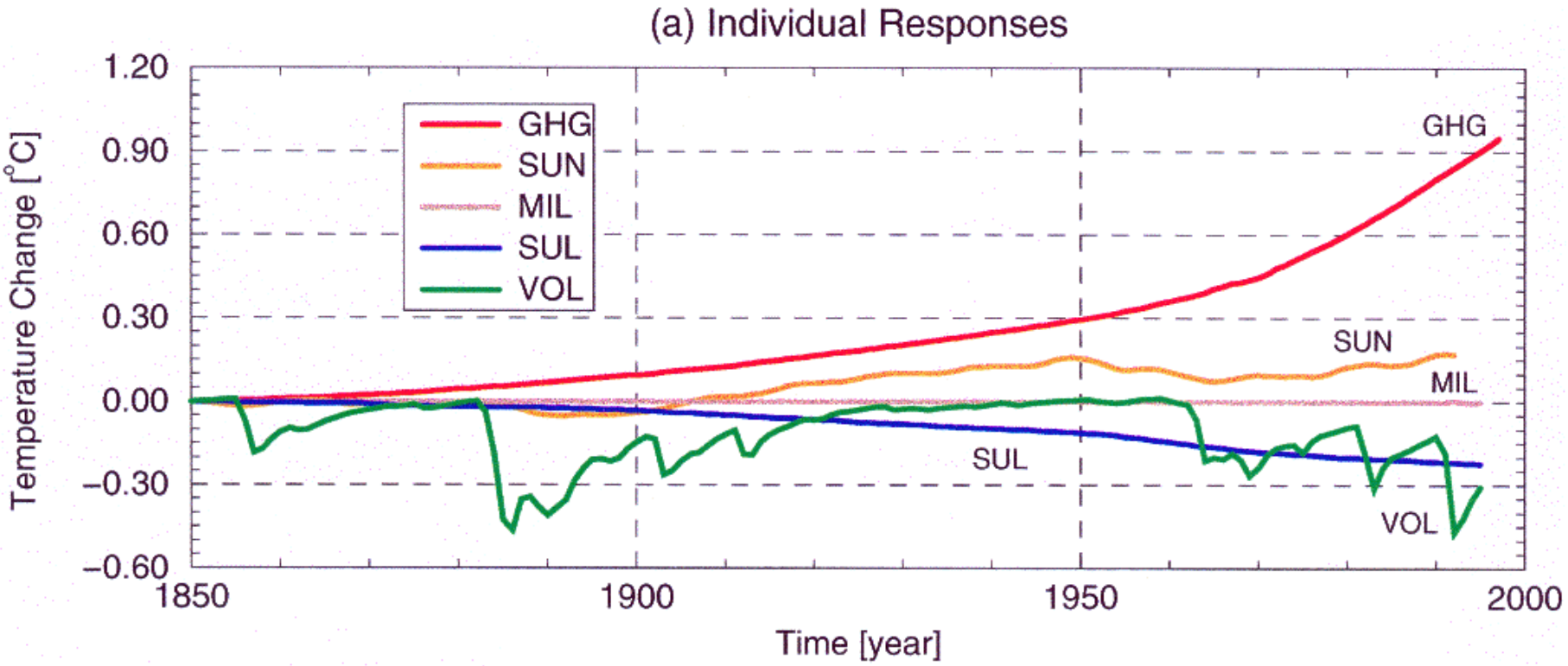
IPCC, AR5, WG I, TS, p. 52

Methane

The massive increase in the number of ruminants, the emissions from fossil fuel extraction and use, the expansion of rice paddy agriculture and the emissions from landfills and waste are the dominant anthropogenic CH4 sources. Anthropogenic emissions account for 50 to 65% of total emissions..

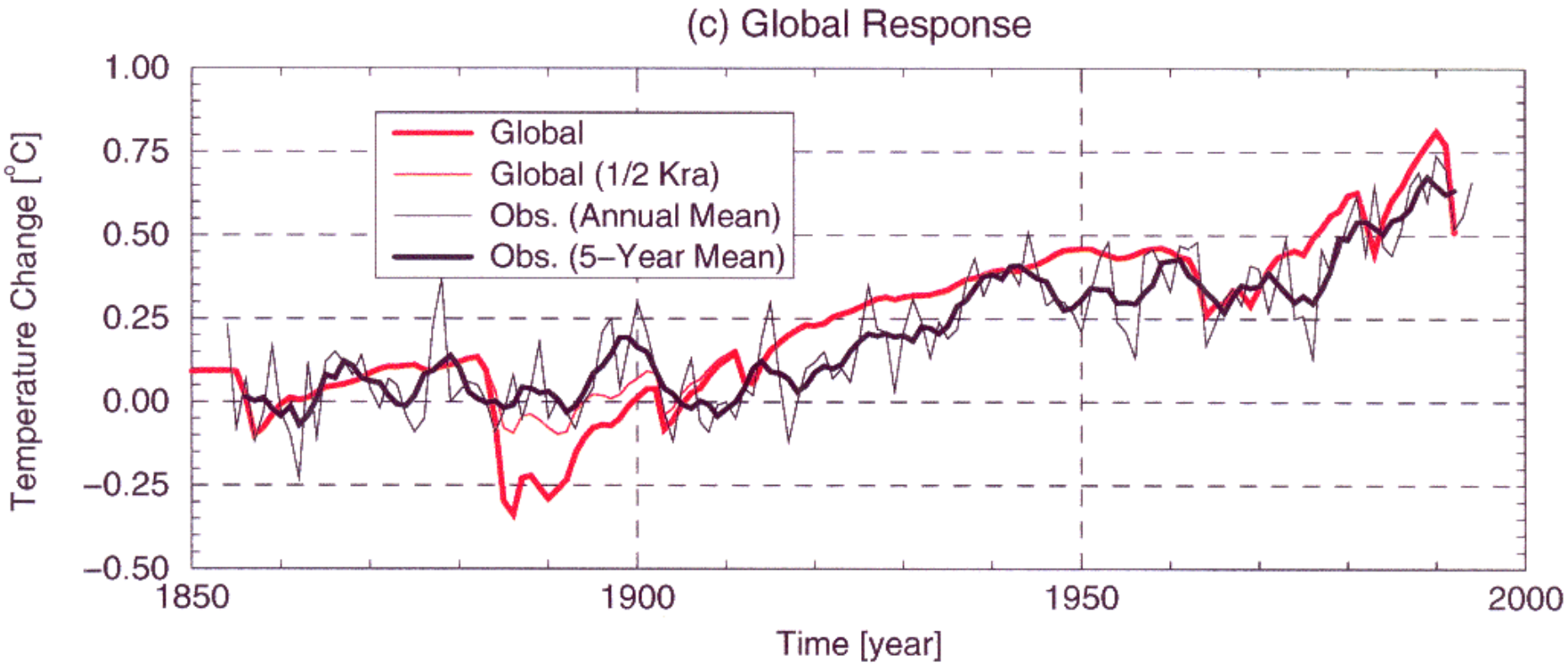
IPCC, AR5, WG I, TS, p. 52

Separate effect of different factors in the 2-dimensional climate model at UCL



Bertrand et al. 2001

Combined effect of all factors in the 2-dimensional climate model at UCL



Bertrand et al. 2001

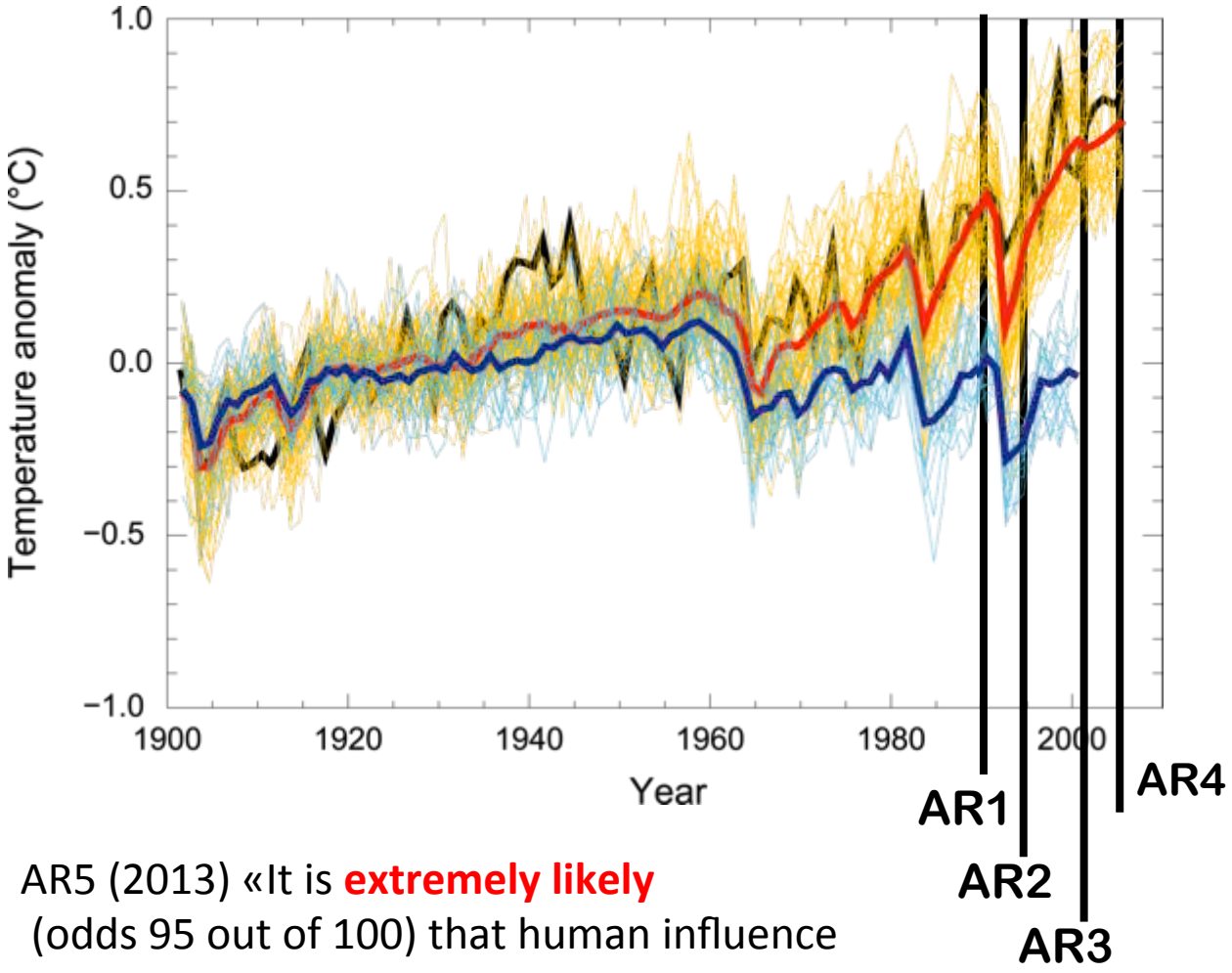
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

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

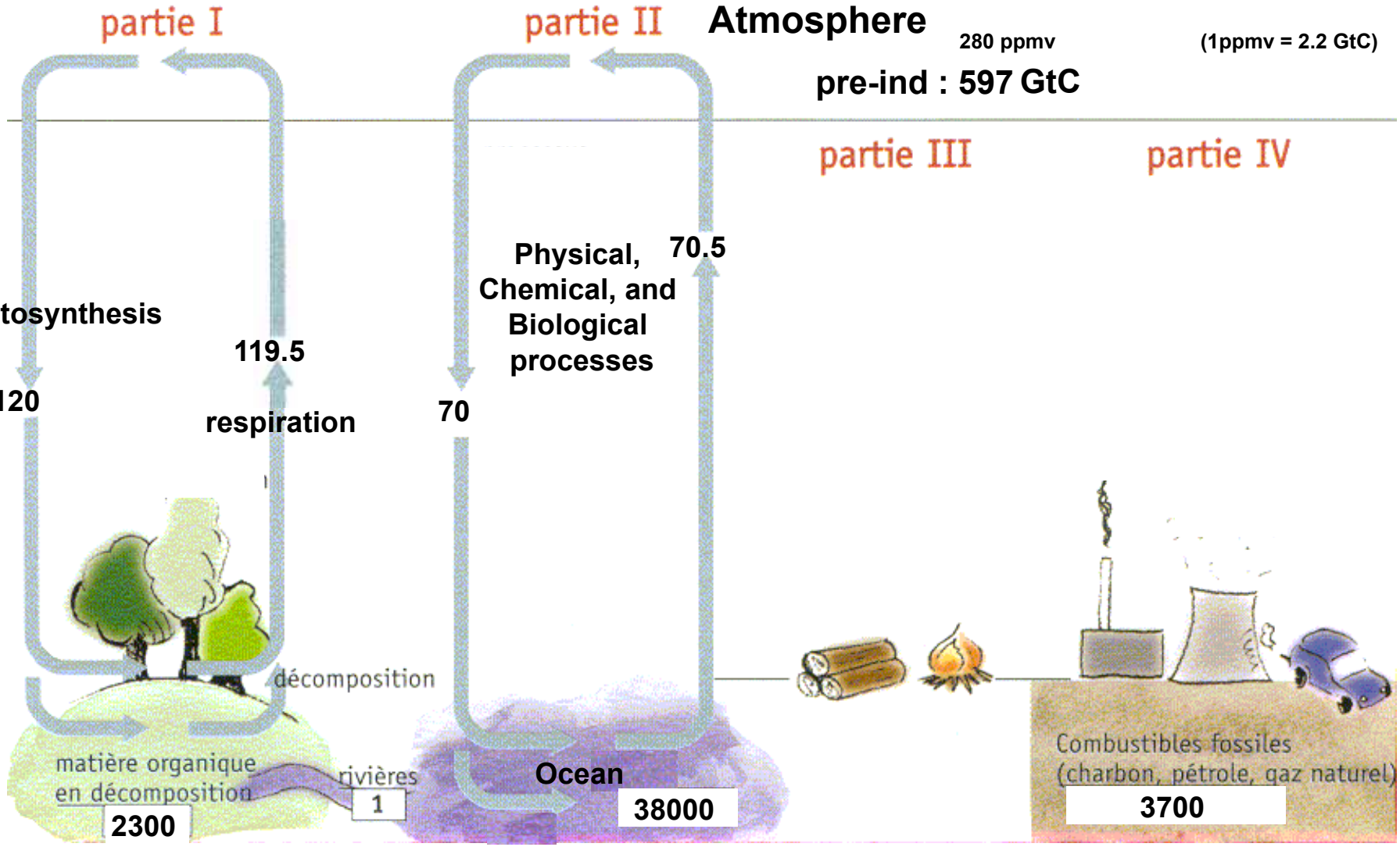
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

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… »

Carbon cycle: unperturbed fluxes

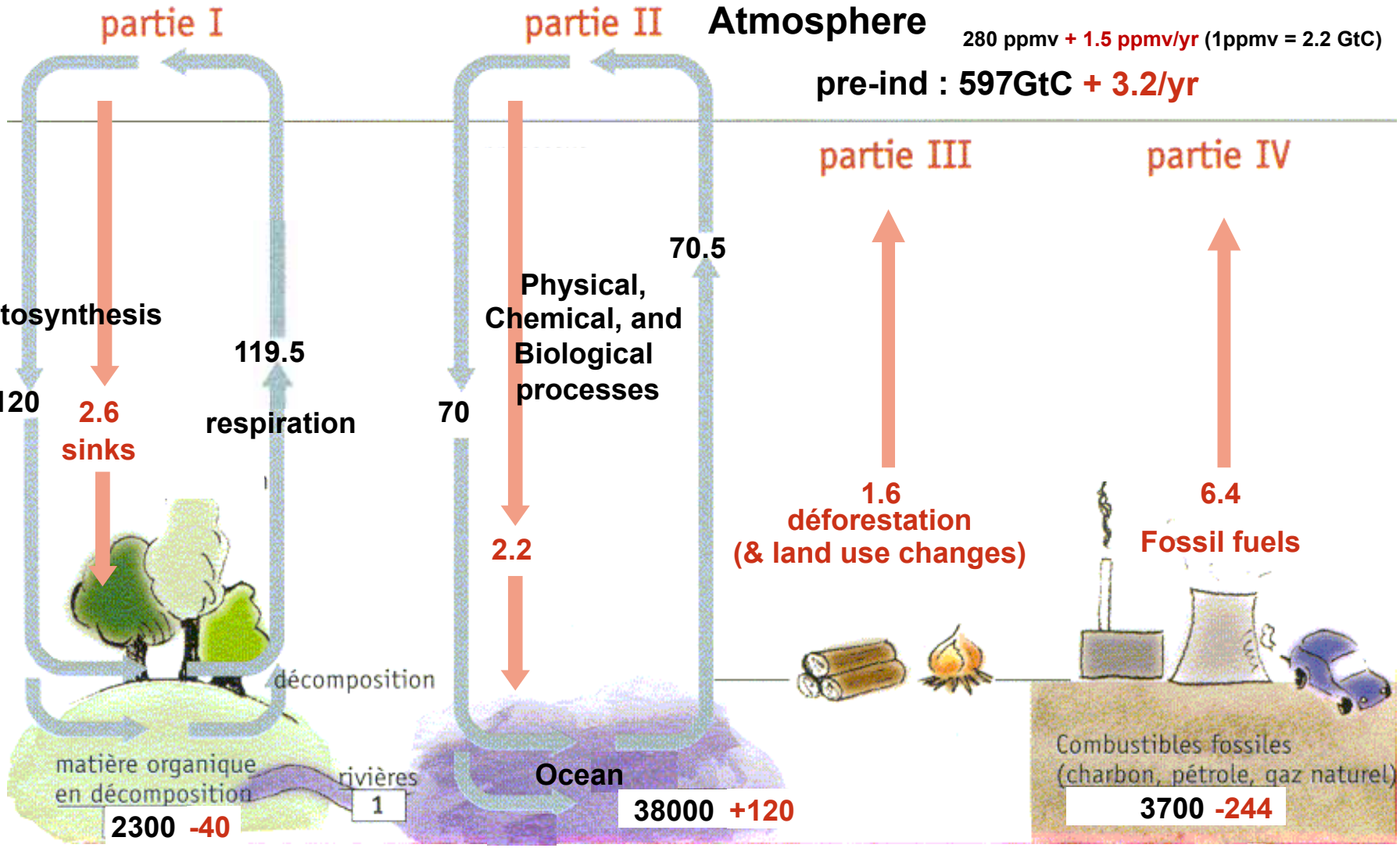


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

vanyp@climate.be

Carbon cycle: perturbed by human activities

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



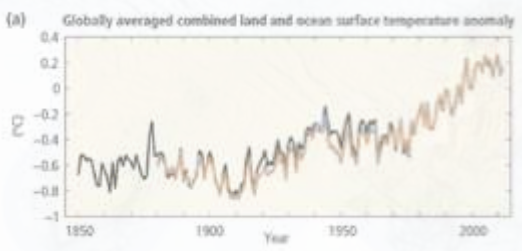
Units: GtC (billions tons of carbon) or GtC/year

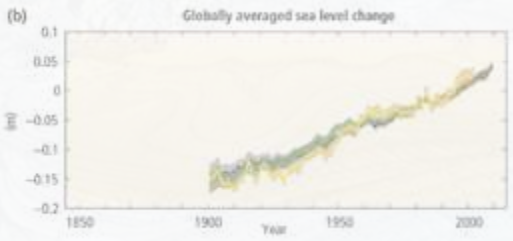
Stocks!

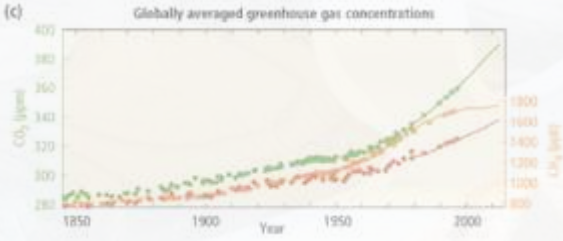
vanyp@climate.be

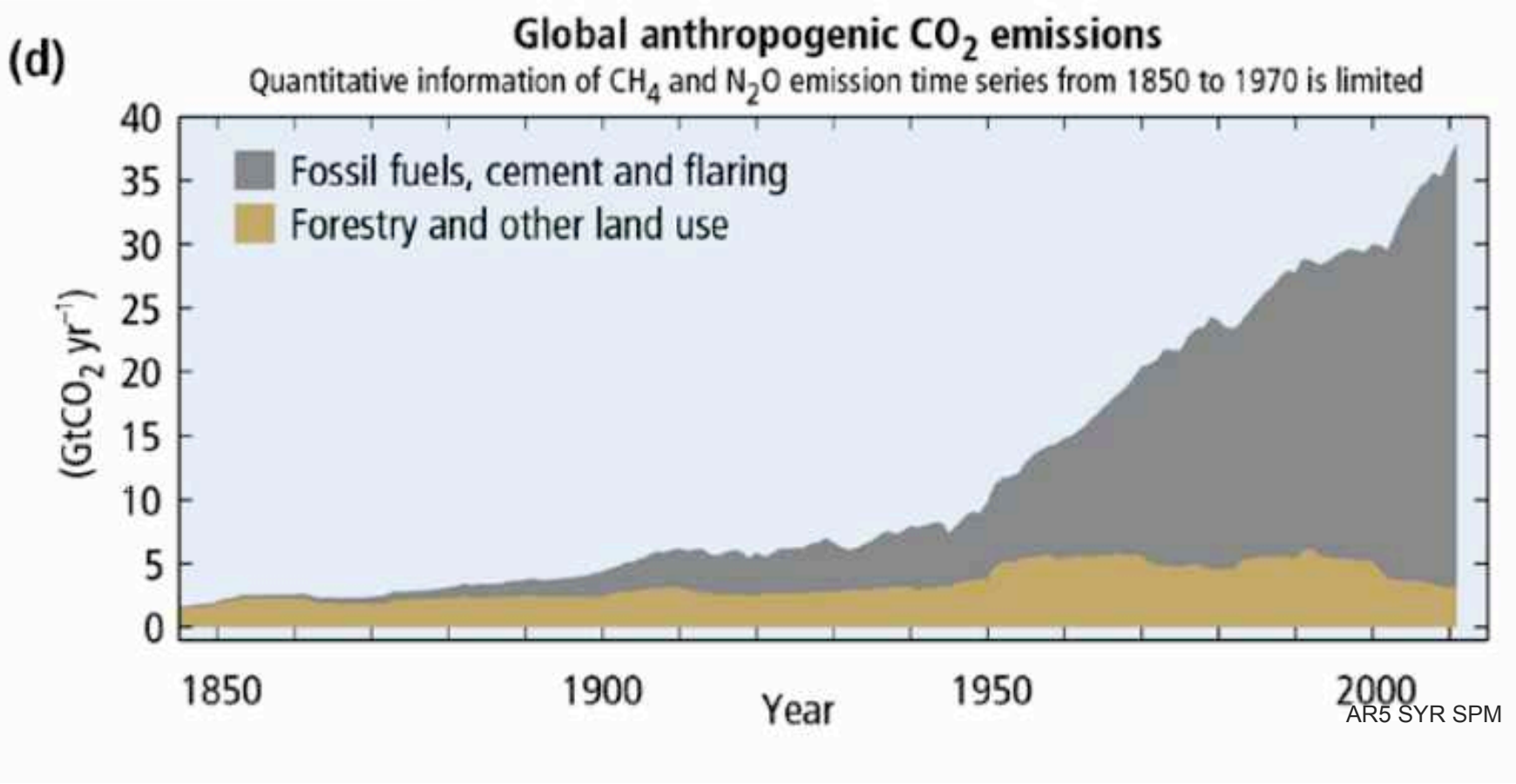
The carbon cycle is policy-relevant

- **CO_2 accumulates in the atmosphere as long as human emissions are larger than the natural absorption capacity**
- **Historical emissions from developed countries therefore matter for a long time**
- **As warming is function of cumulated emissions, the carbon « space » is narrowing fast (to stay under 1.5 or 2°C warming)**


(a)
Globally averaged combined land and ocean surface temperature anomaly
°C
Year


(b)
Globally averaged sea level change
Year


(c)
Globally averaged greenhouse gas concentrations
Year


(d)
Global anthropogenic CO_2 emissions
Quantitative information of CH_4 and N_2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
$(GtCO_2\ yr^{-1})$
40
35
30
25
20
15
10
5
0
1850
1900
1950
2000
Year

AR5 SYR SPM

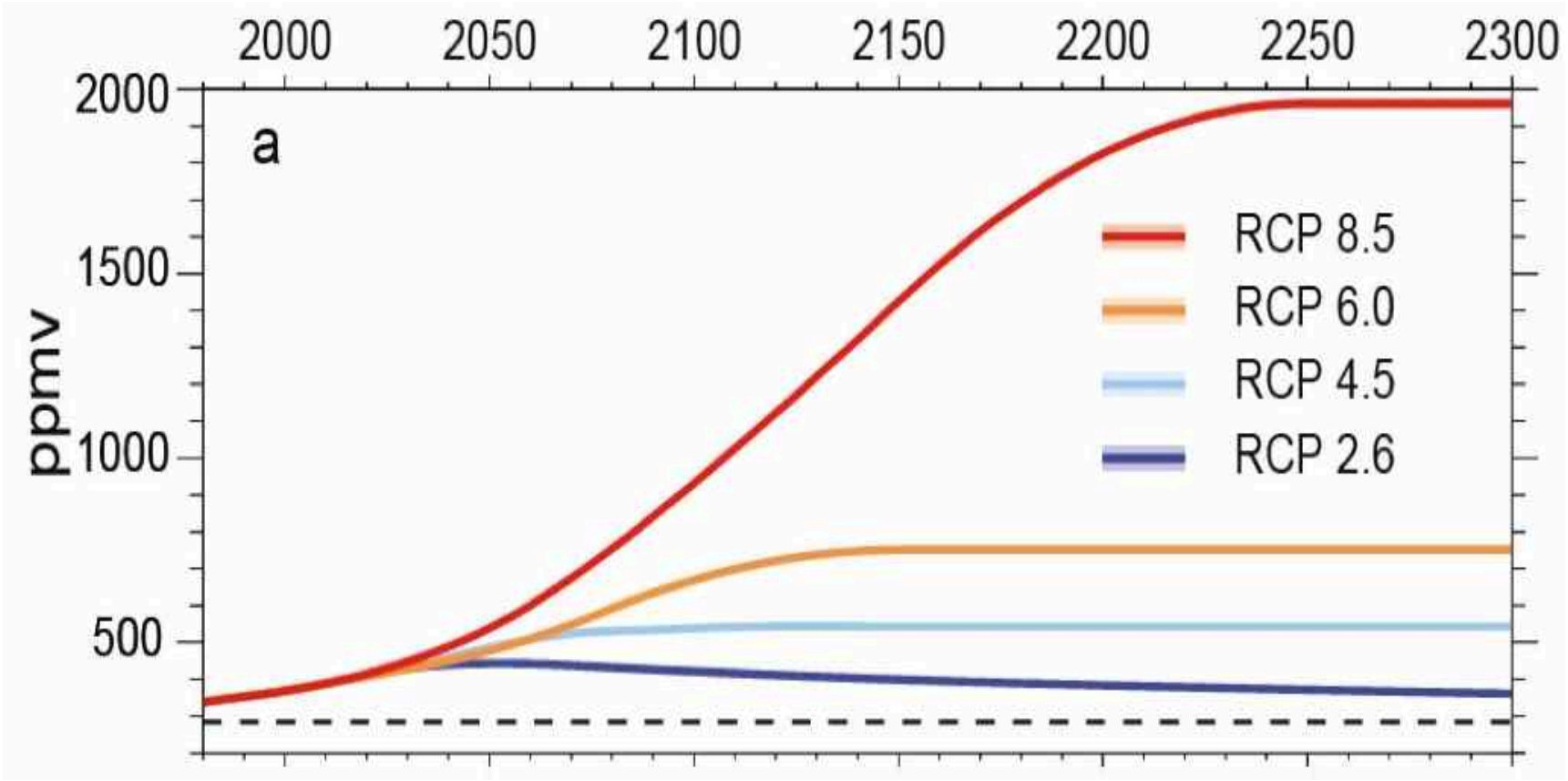
Sources of emissions

Energy production remains the primary driver of GHG emissions

2010 GHG emissions

AR5 WGIII SPM

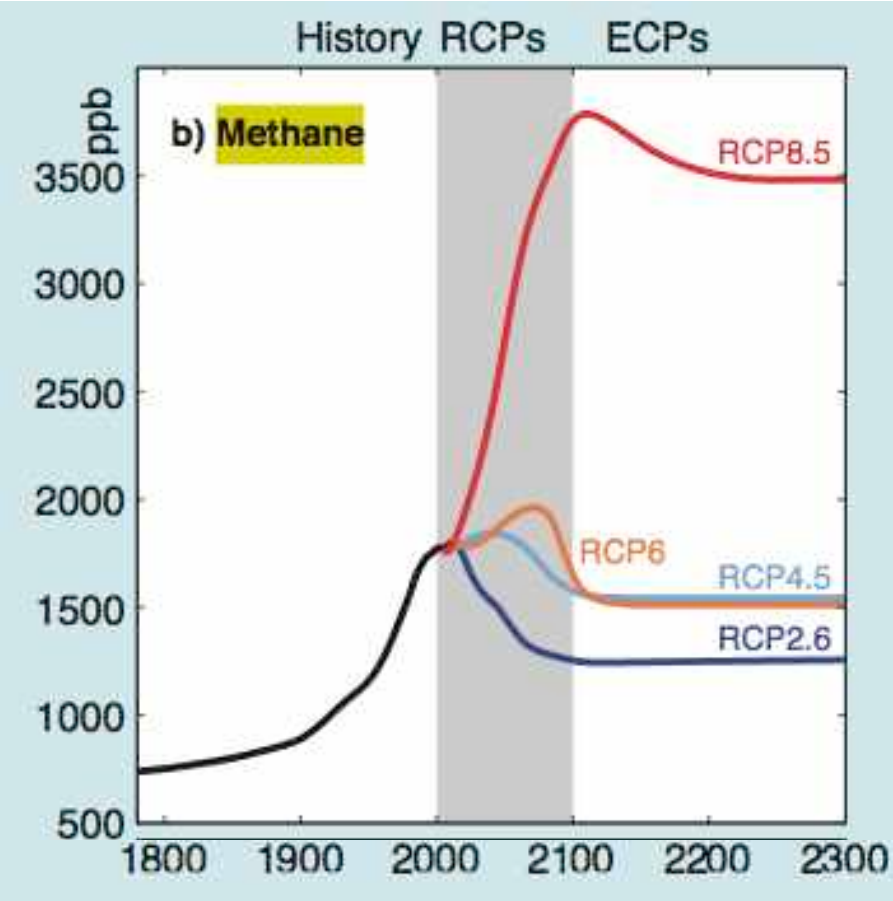
RCP Scenarios: Atmospheric CO_2 concentration



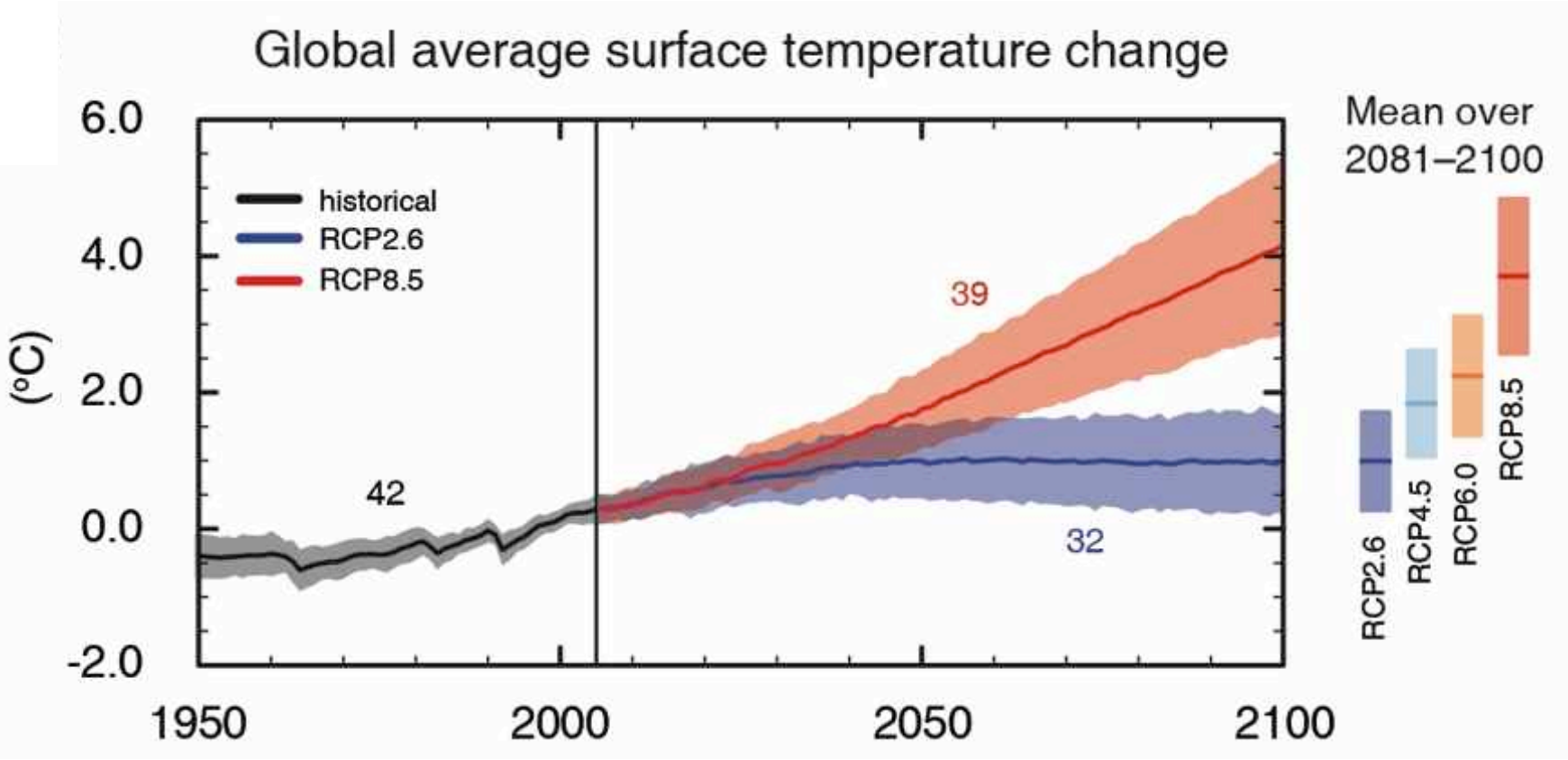
Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

AR5, chapter 12. WGI

Concentrations of CH4 following the 4 RCPs and their extensions (ECP) to 2300



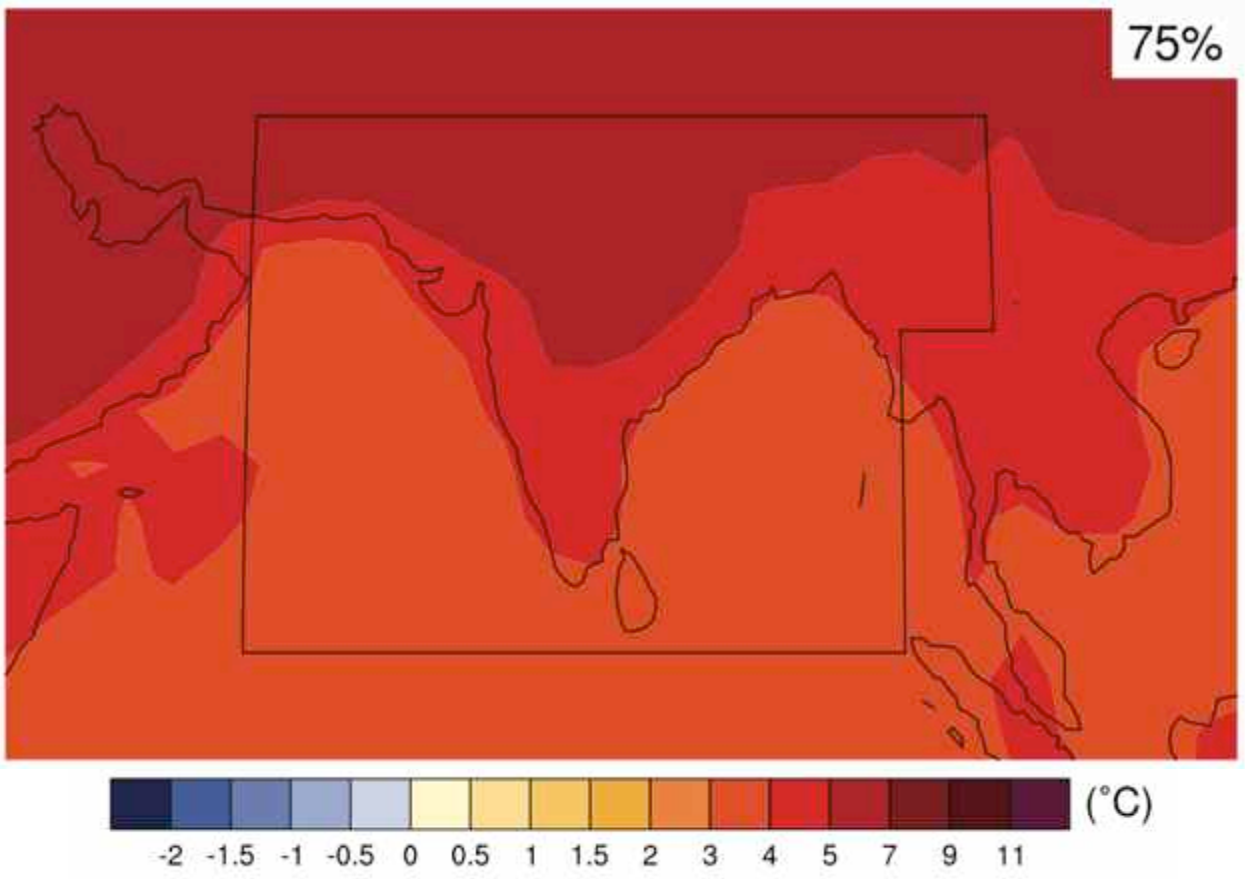
IPCC, AR5, WG I, Chap. 1, p.148



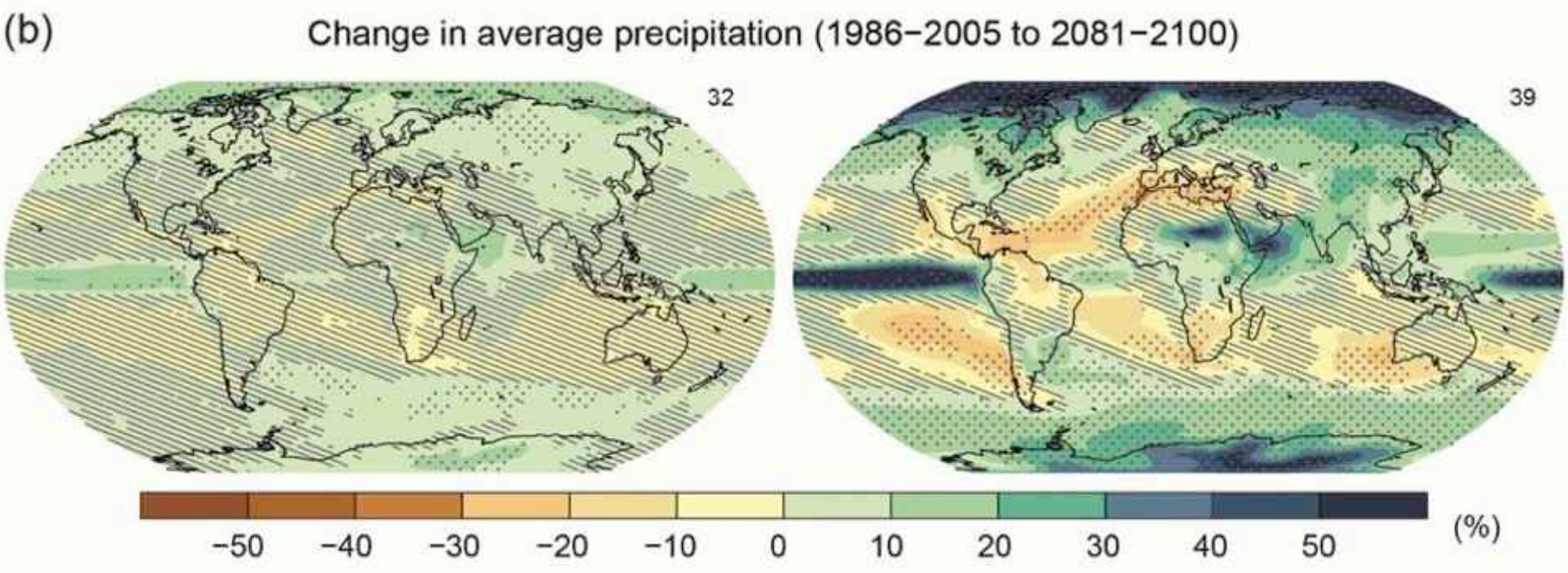
(IPCC 2013, Fig. SPM.7a)

Only the lowest (RCP2.6) scenario maintains the global surface temperature increase above the pre-industrial level to less than 2°C with at least 66% probability

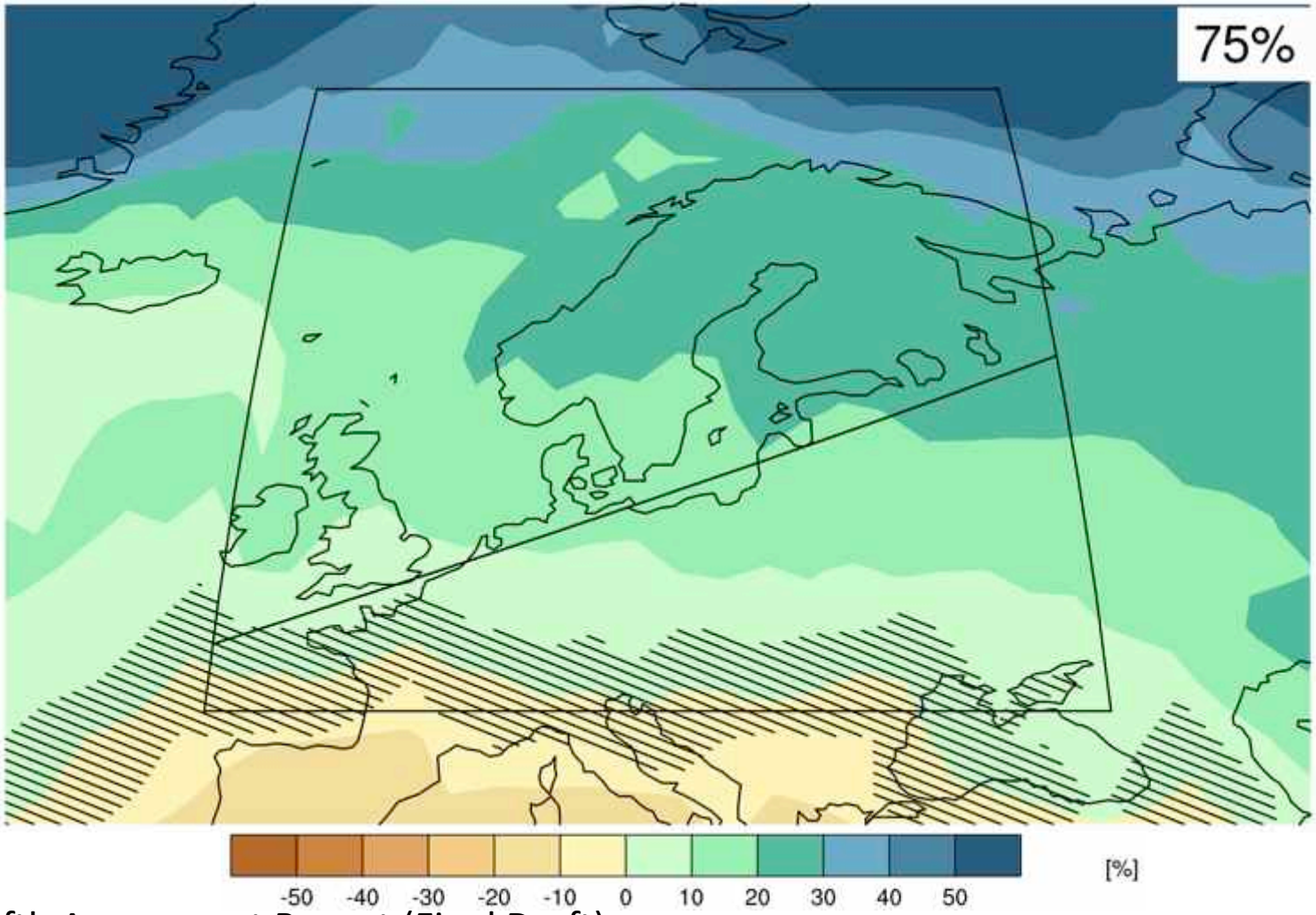
Maps of temperature changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario



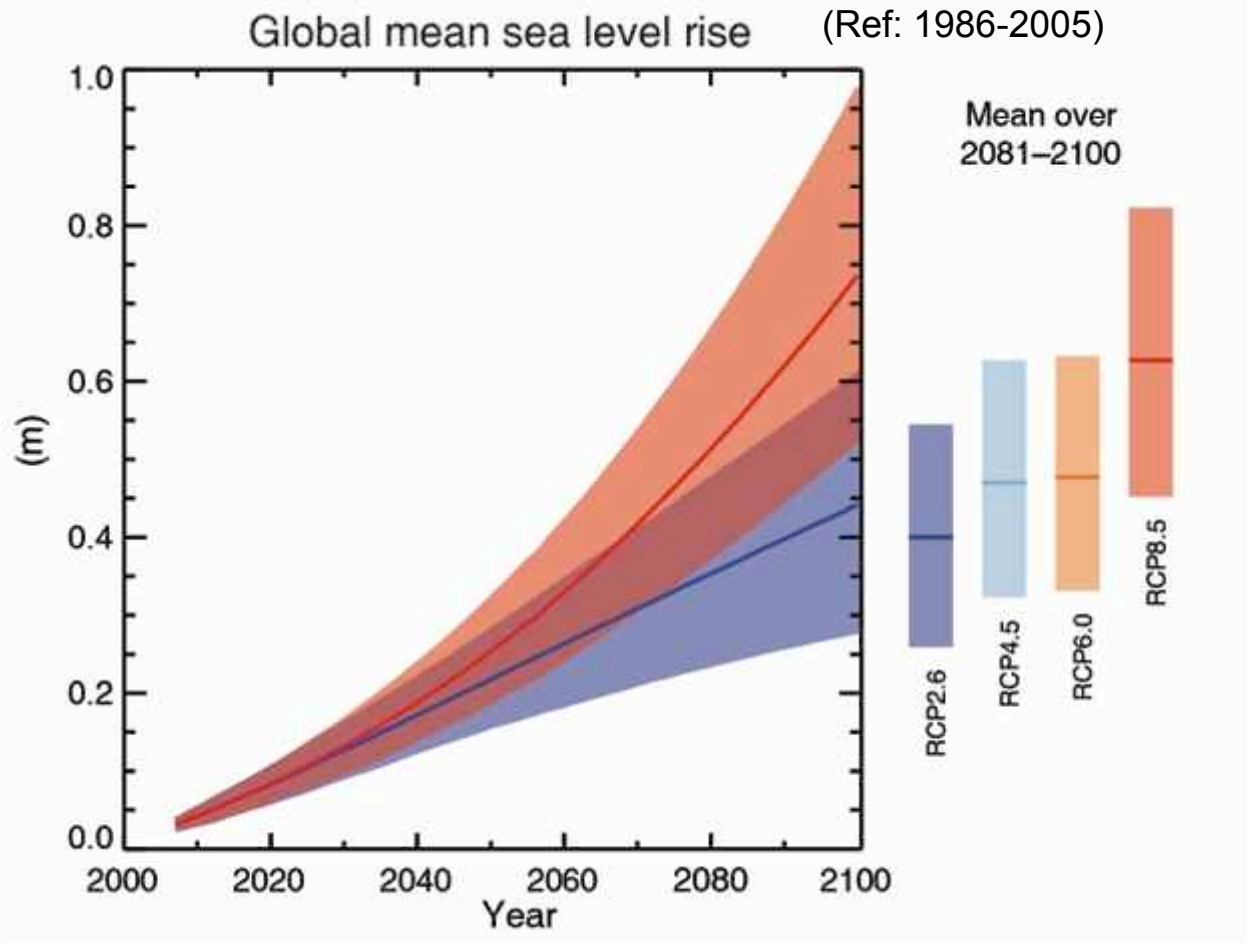
Projections de l'évolution du total des pluies



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)



(IPCC 2013, Fig. SPM.9)

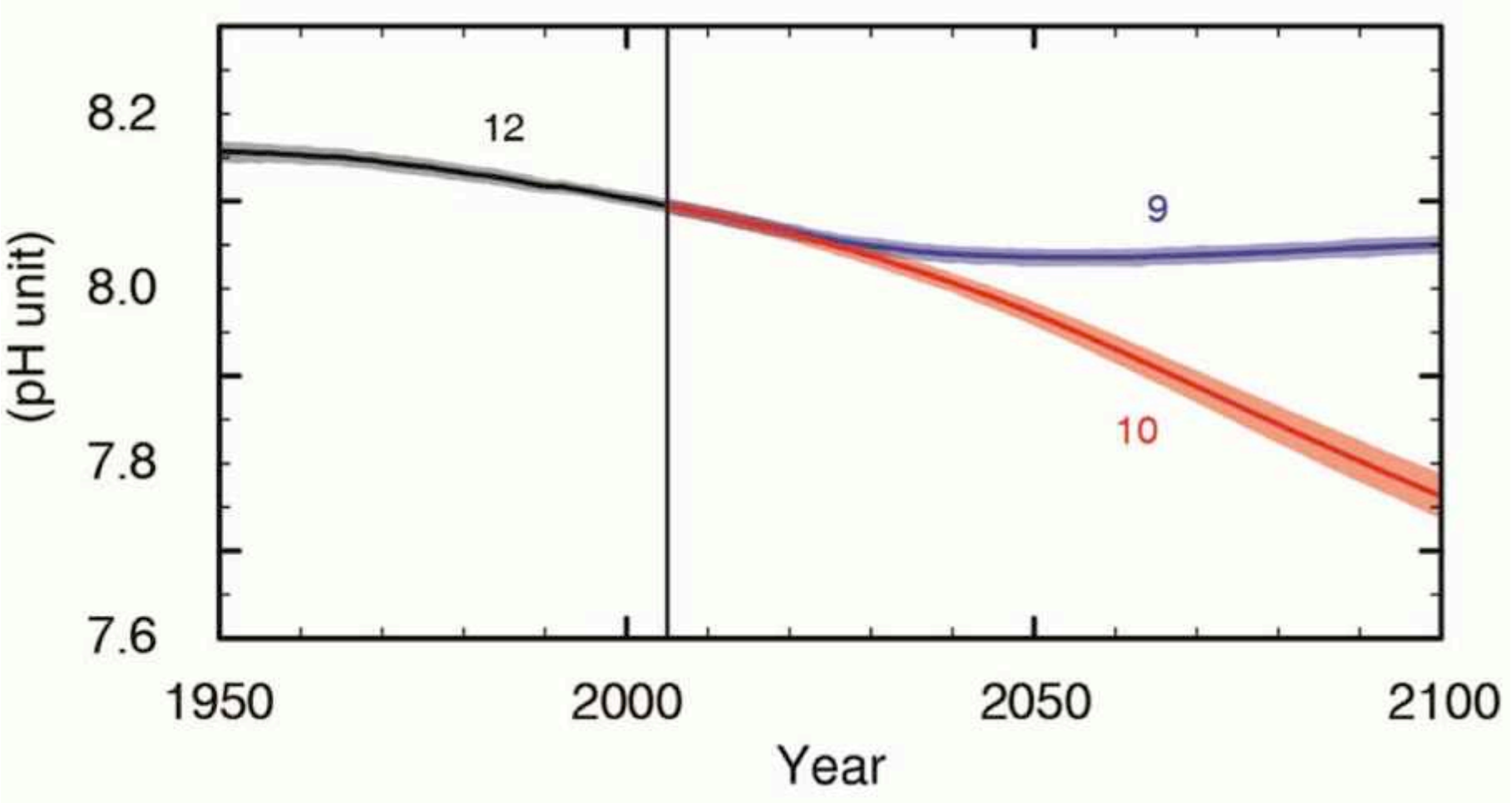
Sea level due to continue to increase

Effects of a 1 m Sea-Level Rise in the Nile Delta (>10 million people live at less than 1 m a.s.l.)

(Time 2001)

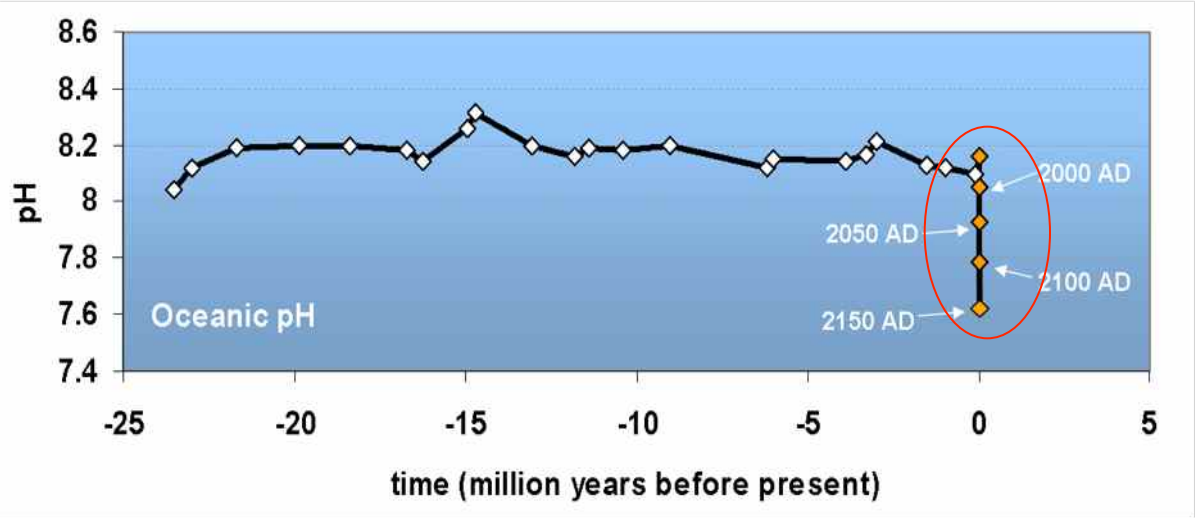
Global ocean surface pH (projections)

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**

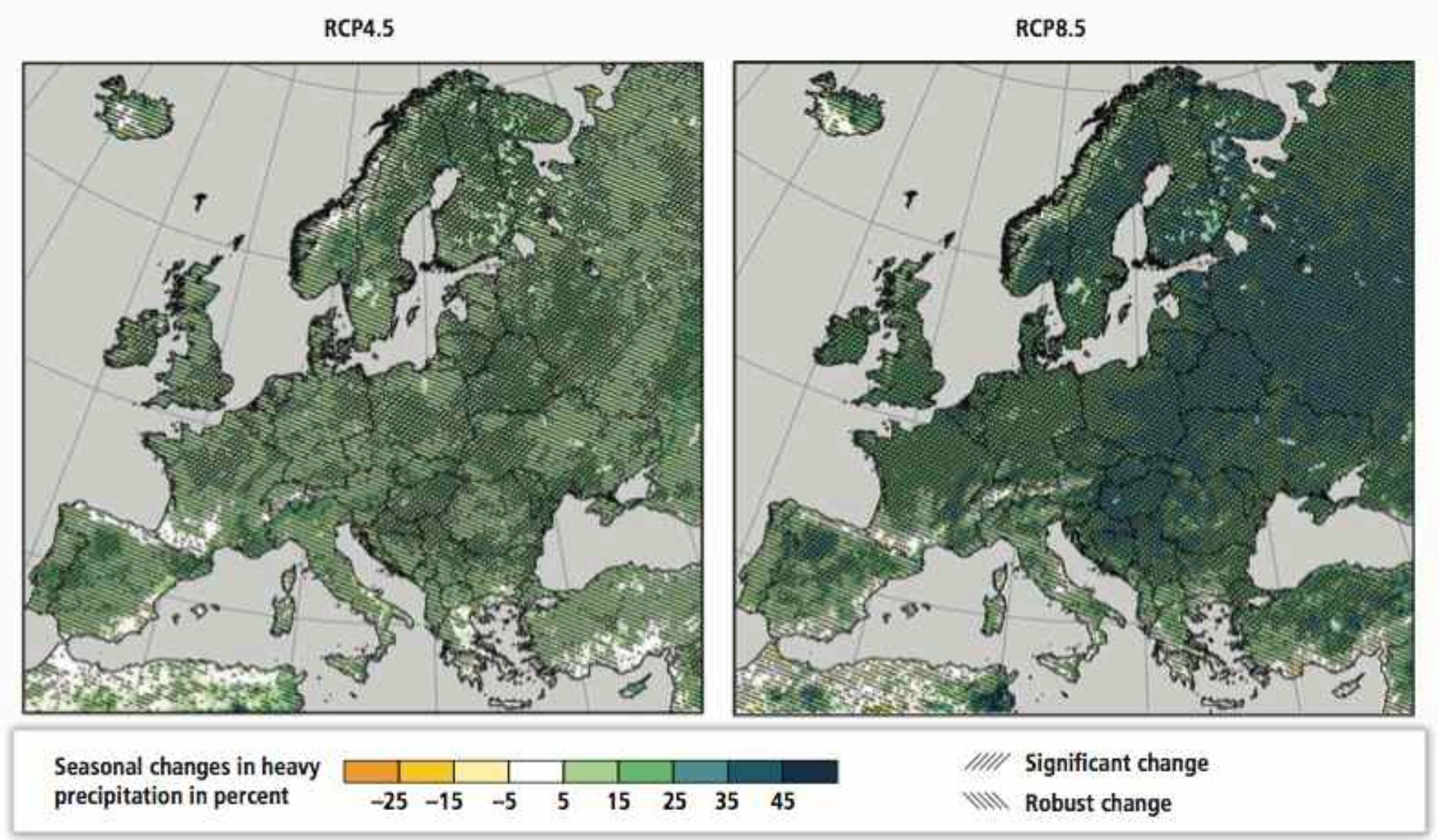
Turley et al. 2006

Slide courtesy of Carol Turley, PML

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

DJF seasonal changes in heavy precipitation (%), 2071-2100 compared to 1971-2000



IPCC, AR5, WG II, Chap. 23, p. 1277

National Assessments

In Kenya, a study by the Stockholm Environment Institute (SEI) estimated the economics of climate change under a range of scenarios and estimated that, **by 2050, more than 300,000 people could be flooded per year under a high-emissions scenario**.

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IPCC, AR5, WG II, Chap. 14, p. 852

Impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries (but the poor are more vulnerable everywhere)




AR5 WGII SPM

Risk = Hazard x Vulnerability x Exposure (Katrina flood victim)

AP Photo - Lisa Krantz (http://lisakrantz.com/hurricane-katrina/zspbn1k4cn17phidupe4f9x5t1mzdr)

Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

AR5 WGII SPM

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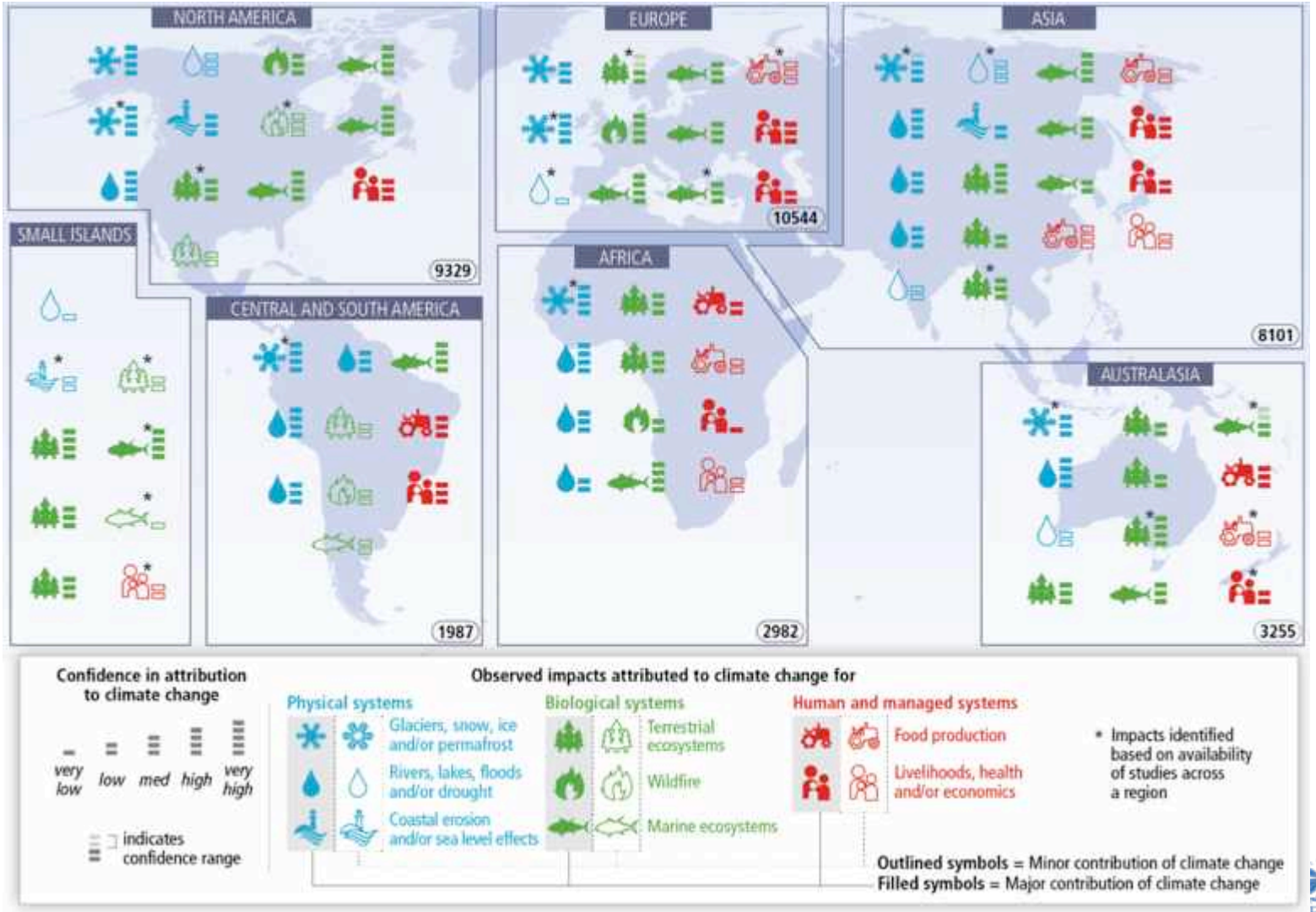
Widespread impacts attributed to climate change based on the available scientific literature since literature since the AR4



IPCC, AR5, SYR, SPM 4


ADAPTATION IS
ALREADY OCCURRING
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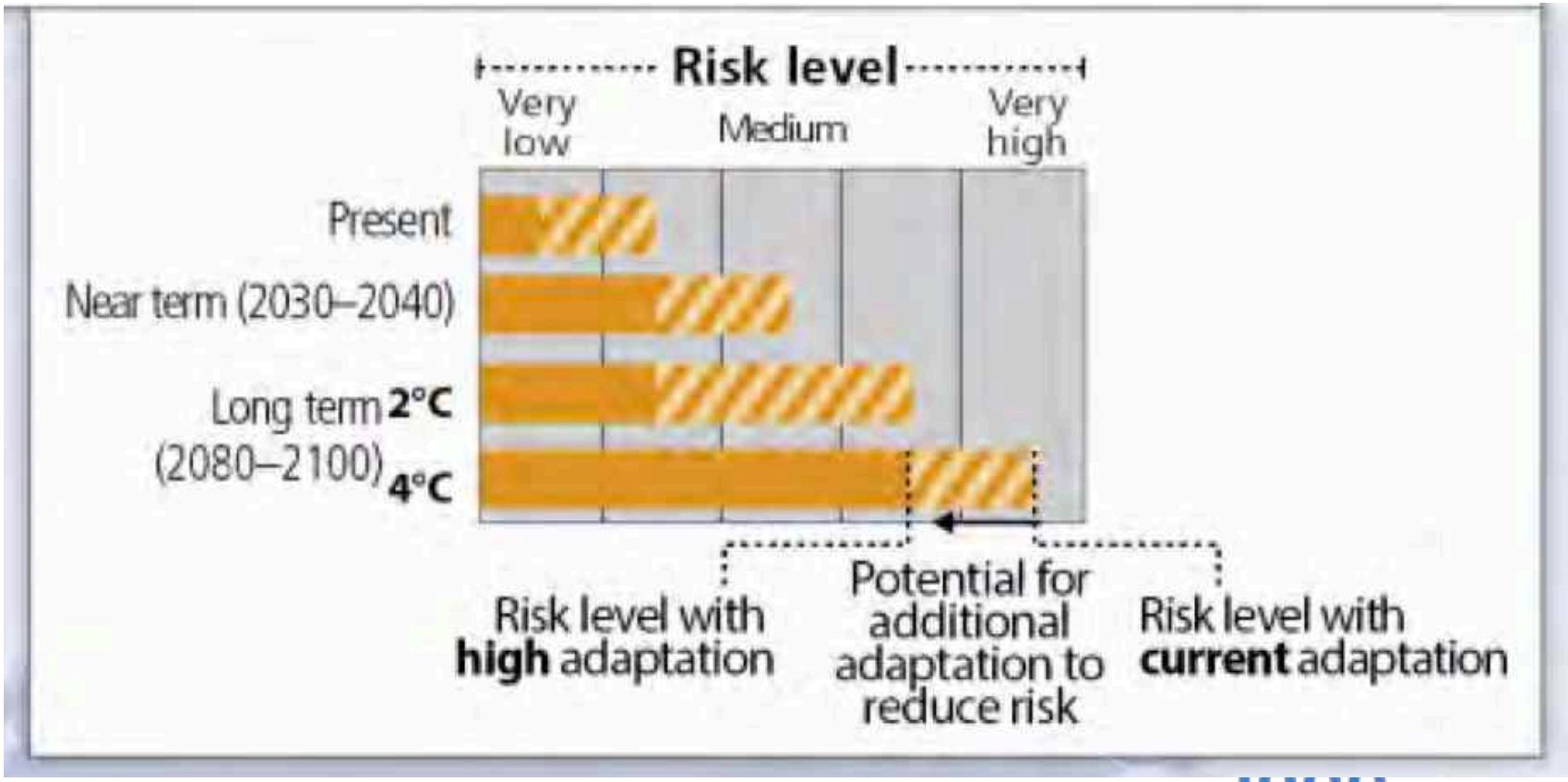
Flood risk adaptation in Bangladesh (example): cyclone shelters, awareness raising, forecasting and warning

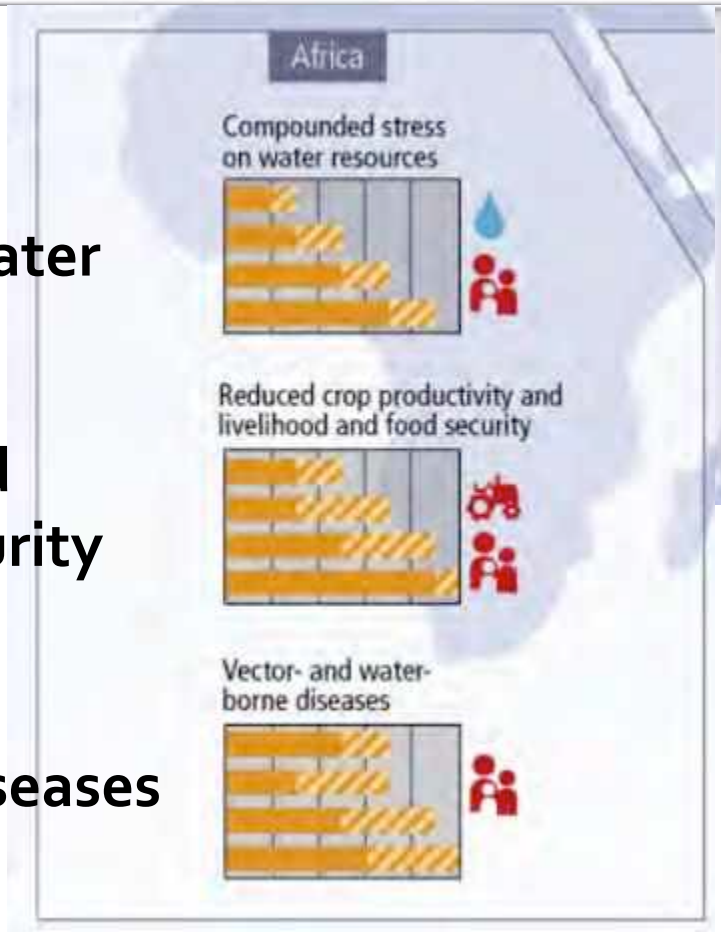
photo: Dr Thorsten Klose/German Red Cross (2010), evaluation of the Community Based Disaster Preparedness Programme run by the Red Cross in1996-2002

Regional key risks and potential for risk reduction through adaptation



IPCC, AR5, SPM, Figure SPM.8

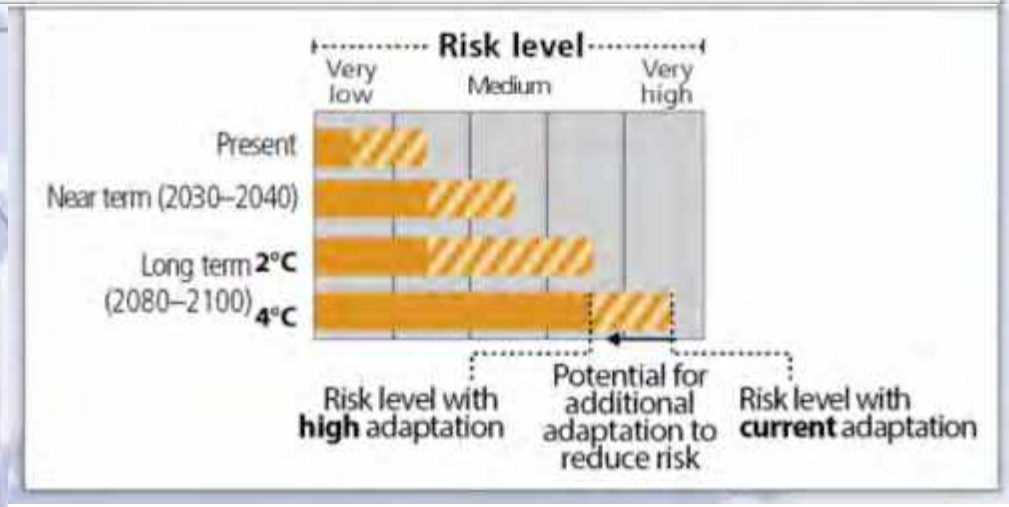
Regional key risks and risk reduction through adaptation



Water

Food security

Diseases



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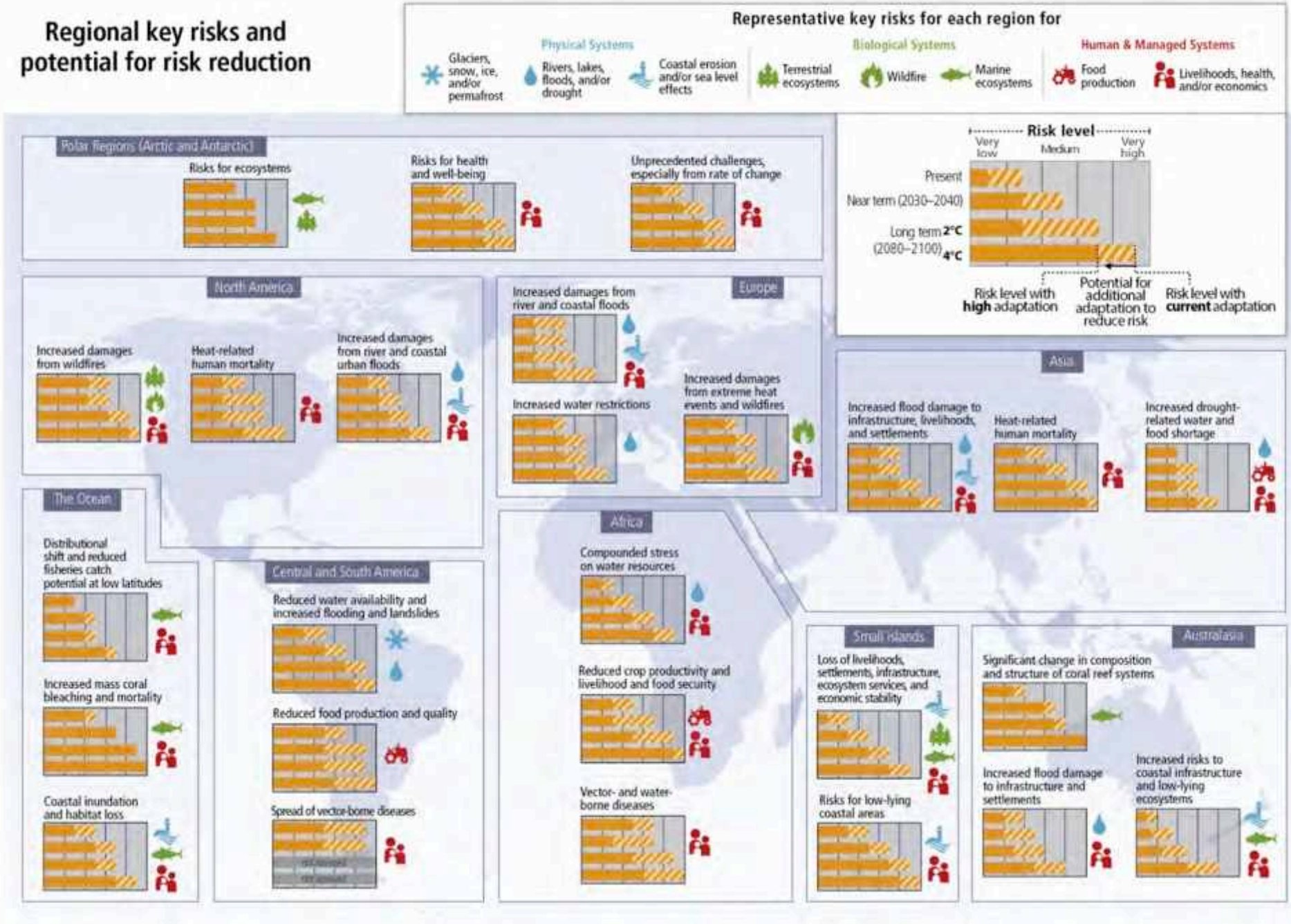
Regional key risks and potential for risk reduction



IPCC, AR5, SPM, Figure SPM.8


RISKS OF
CLIMATE CHANGE
INCREASE
WITH CONTINUED
HIGH EMISSIONS
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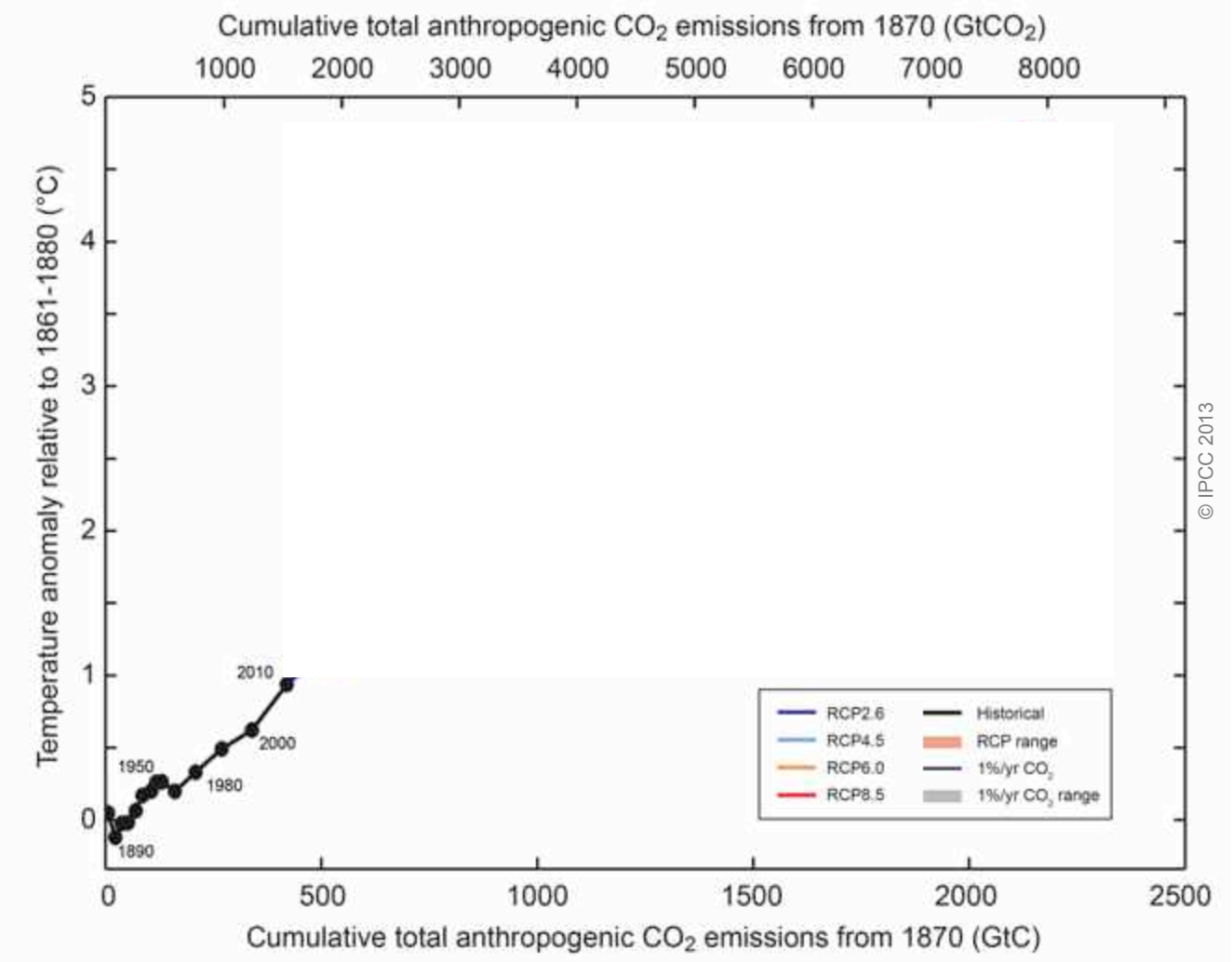


Fig. SPM.10

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

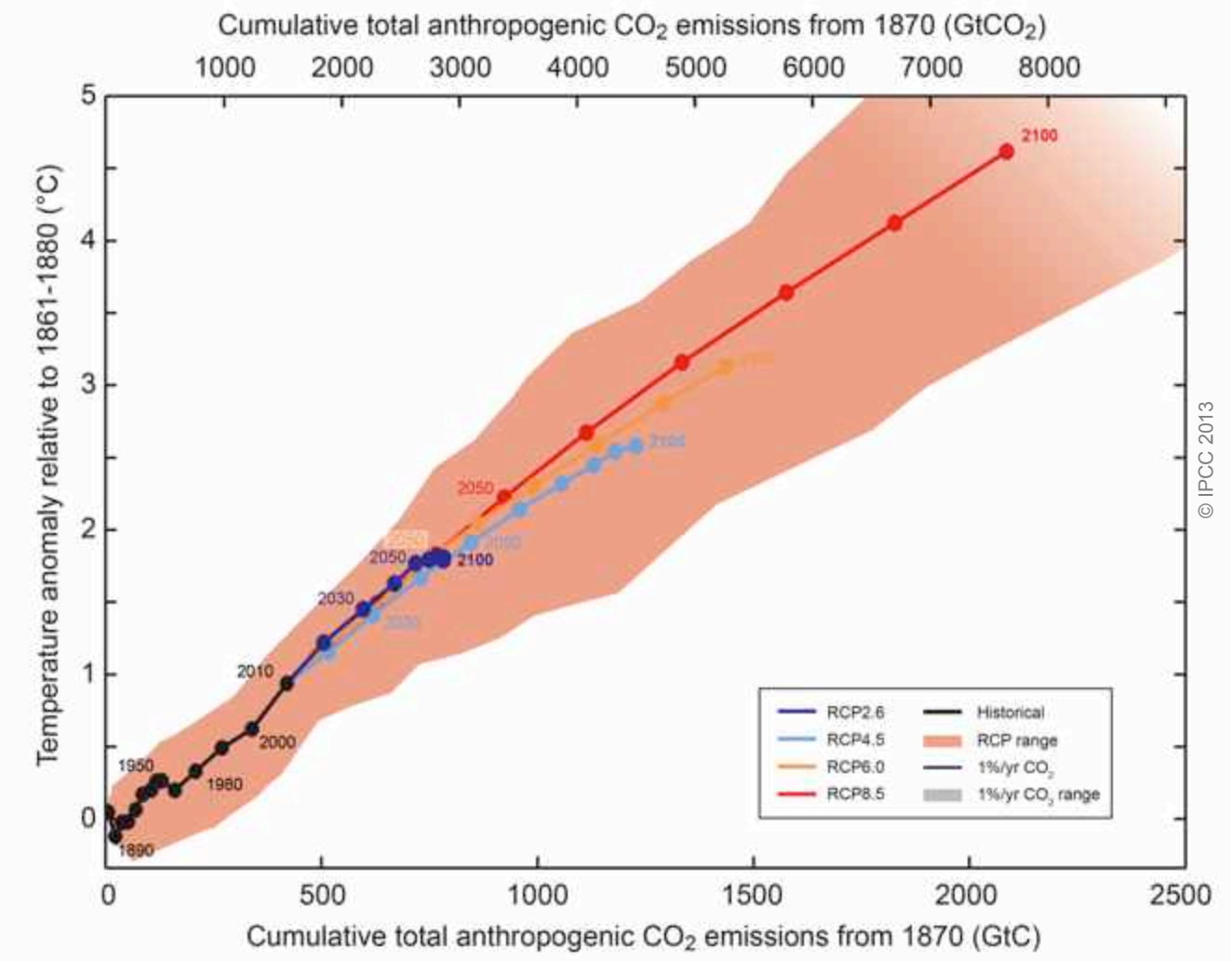
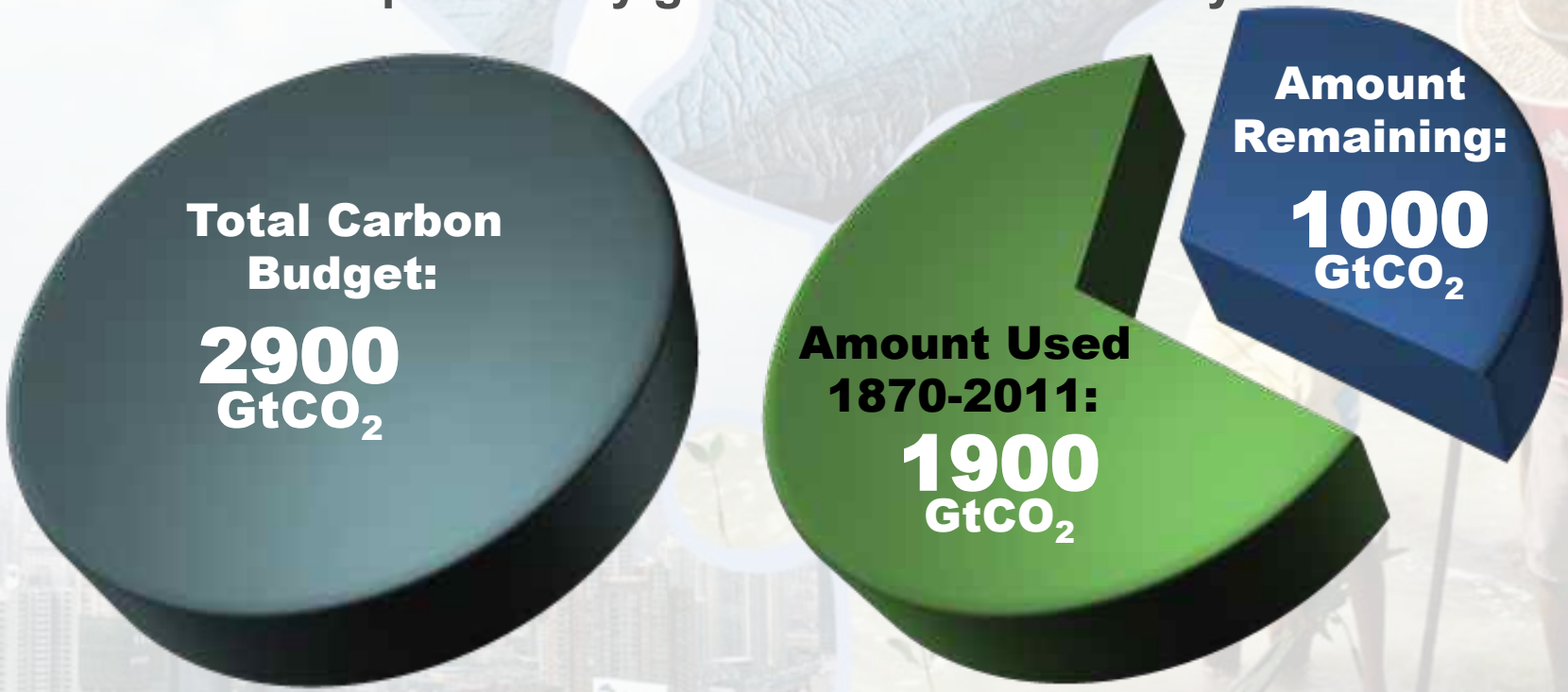


Fig. SPM.10

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

The window for action is rapidly closing

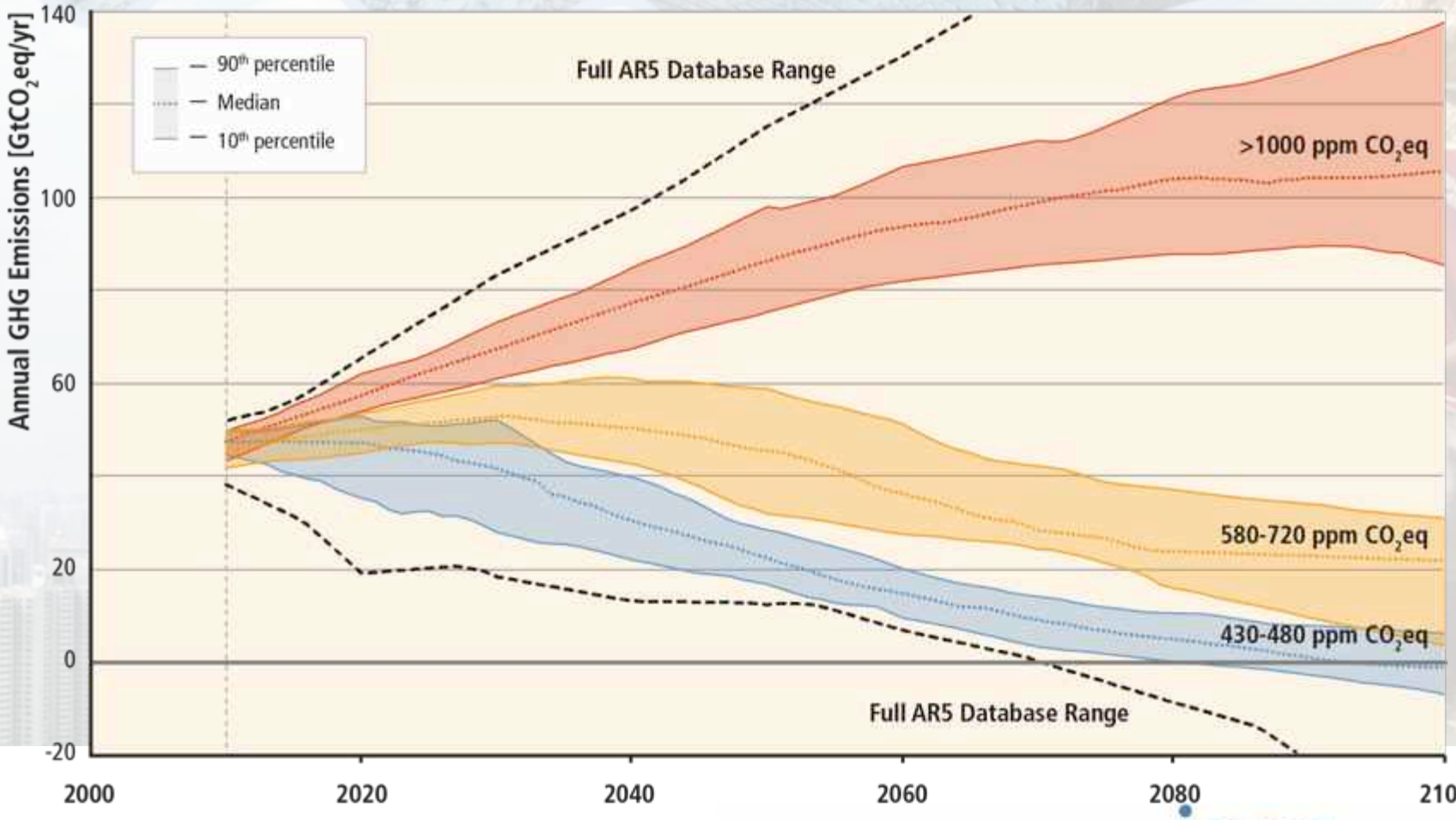
65% of the carbon budget compatible with a 2°C goal is already used
NB: this is with a probability greater than 66% to stay below 2°C



NB: Emissions in 2011: 38 GtCO2/yr

AR5 WGI SPM

Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

AR5 WGIII SPM

IPCC AR5 Synthesis Report

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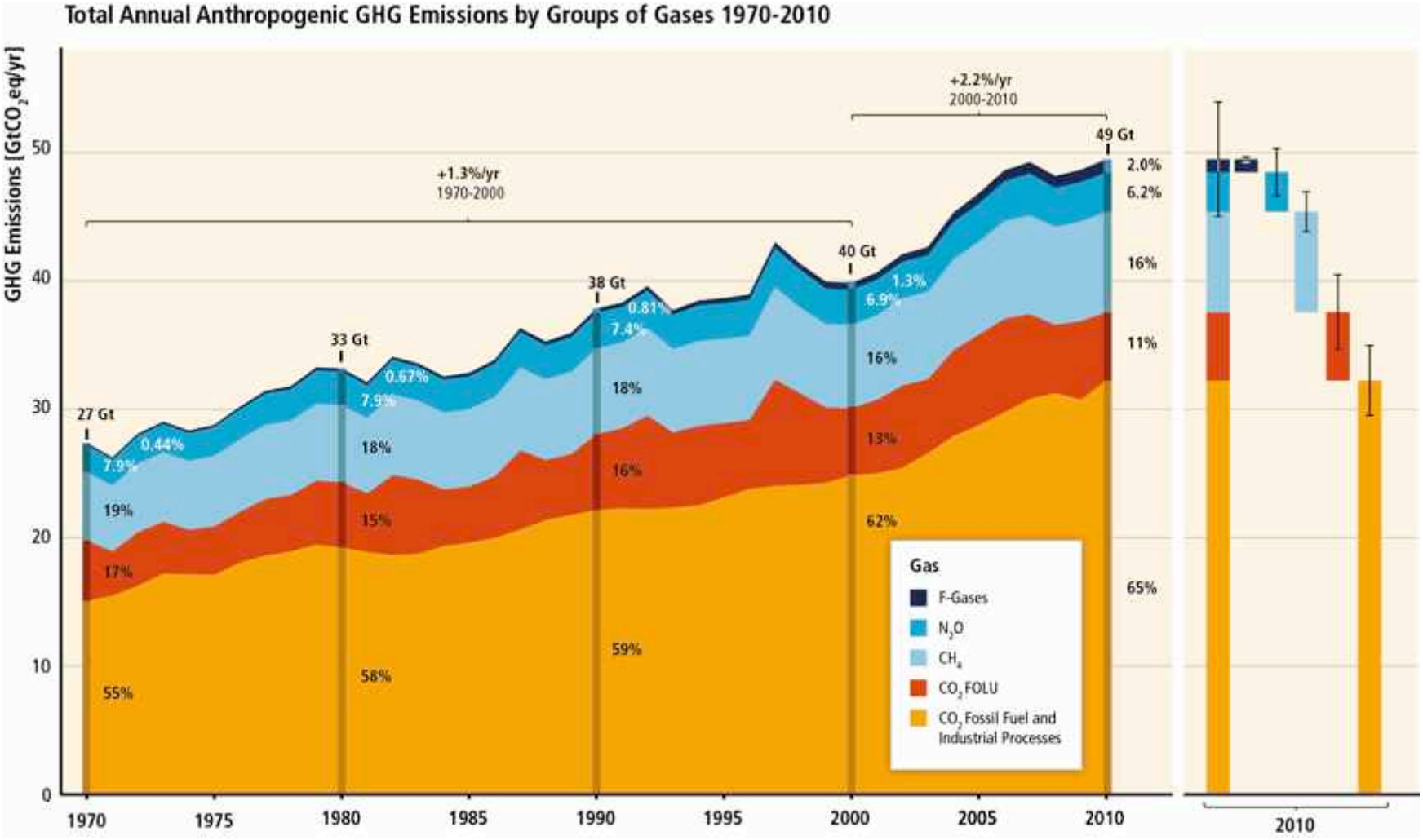
GHG emissions accelerate despite reduction efforts. Most emission growth is CO_2 from fossil fuel combustion and industrial processes.



Working Group III contribution to the
IPCC Fifth Assessment Report

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Mitigation Measures

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today
- But worldwide investment in **research** in support of GHG mitigation is small…

Improved carbon sinks

- **Reduced deforestation** and improved forest management and planting of new forests
- **Bio-energy with carbon capture and storage**

Lifestyle and behavioural changes

AR5 WGIII SPM

Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **Many scenario studies confirm that *it is technically and economically feasible to keep the warming below 2°C*, with more than 66% probability ("likely chance").** This would imply limiting atmospheric concentrations to 450 ppm CO_2-eq by 2100.
- **Such scenarios** for an above 66% chance of staying below 2°C **imply reducing by 40 to 70% global GHG emissions compared to 2010 by mid-century, and reach zero or negative emissions by 2100.**

Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **These scenarios are characterized by rapid improvements of energy efficiency and a near quadrupling of the share of low-carbon energy supply (renewables, nuclear, fossil and bioenergy with CCS), so that it reaches 60% by 2050.**
- **Keeping global temperature increase below 1.5°C would require even lower atmospheric concentrations (<430 ppm CO_2eq) to have a little more than 50% chance.** There are not many scenario studies available that can deliver such results, **requiring even faster reductions** in the medium term, indicating how difficult this is.

Ambitious Mitigation Is Affordable

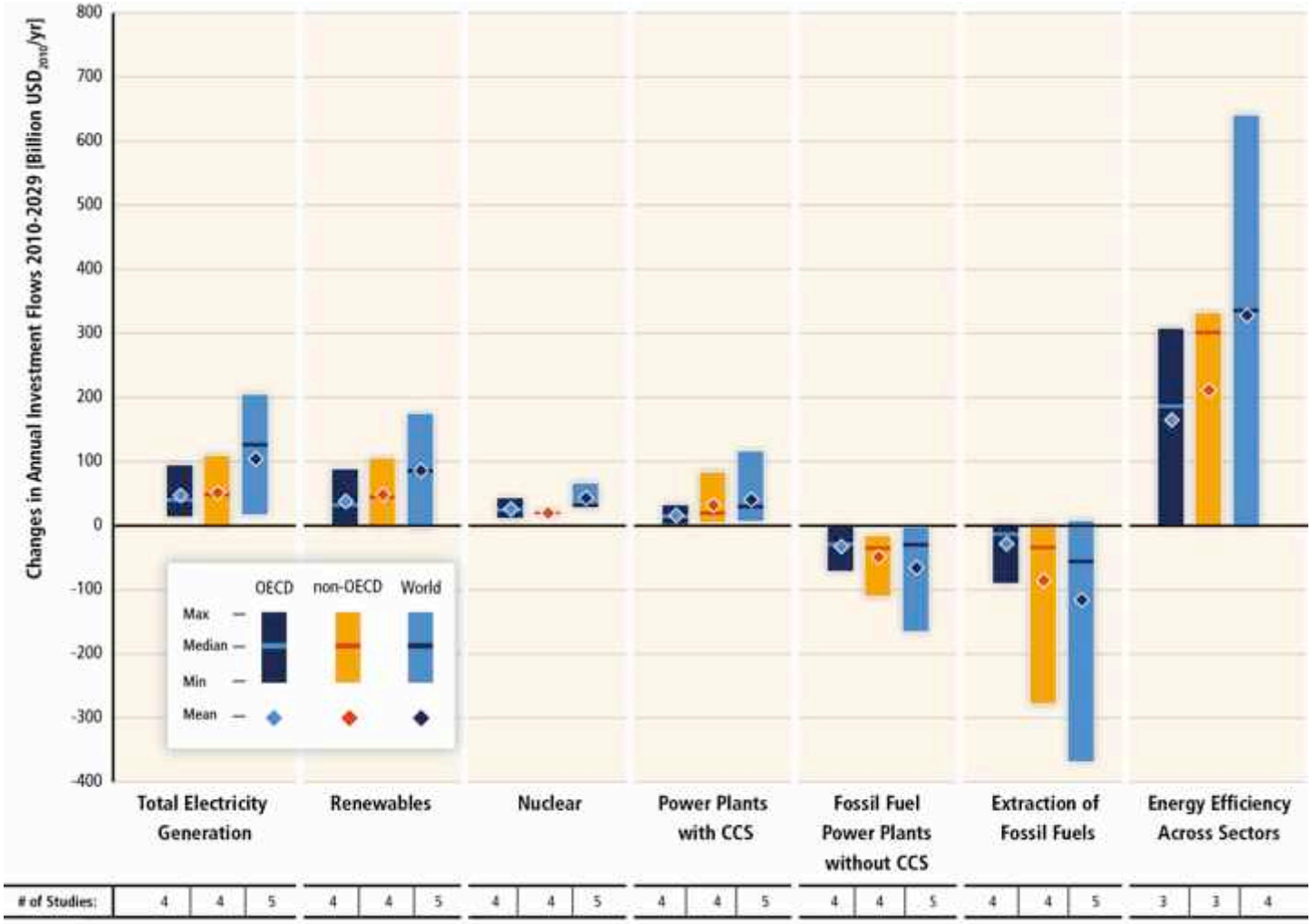
- ➜ Economic growth reduced by ~ 0.06%
  (BAU growth 1.6 - 3%/year)
- ➜ This translates into delayed and not forgone growth
- ➜ Estimated cost does not account for the benefits of reduced climate change
- ➜ Unmitigated climate change would create increasing risks to economic growth and efforts to eradicate poverty

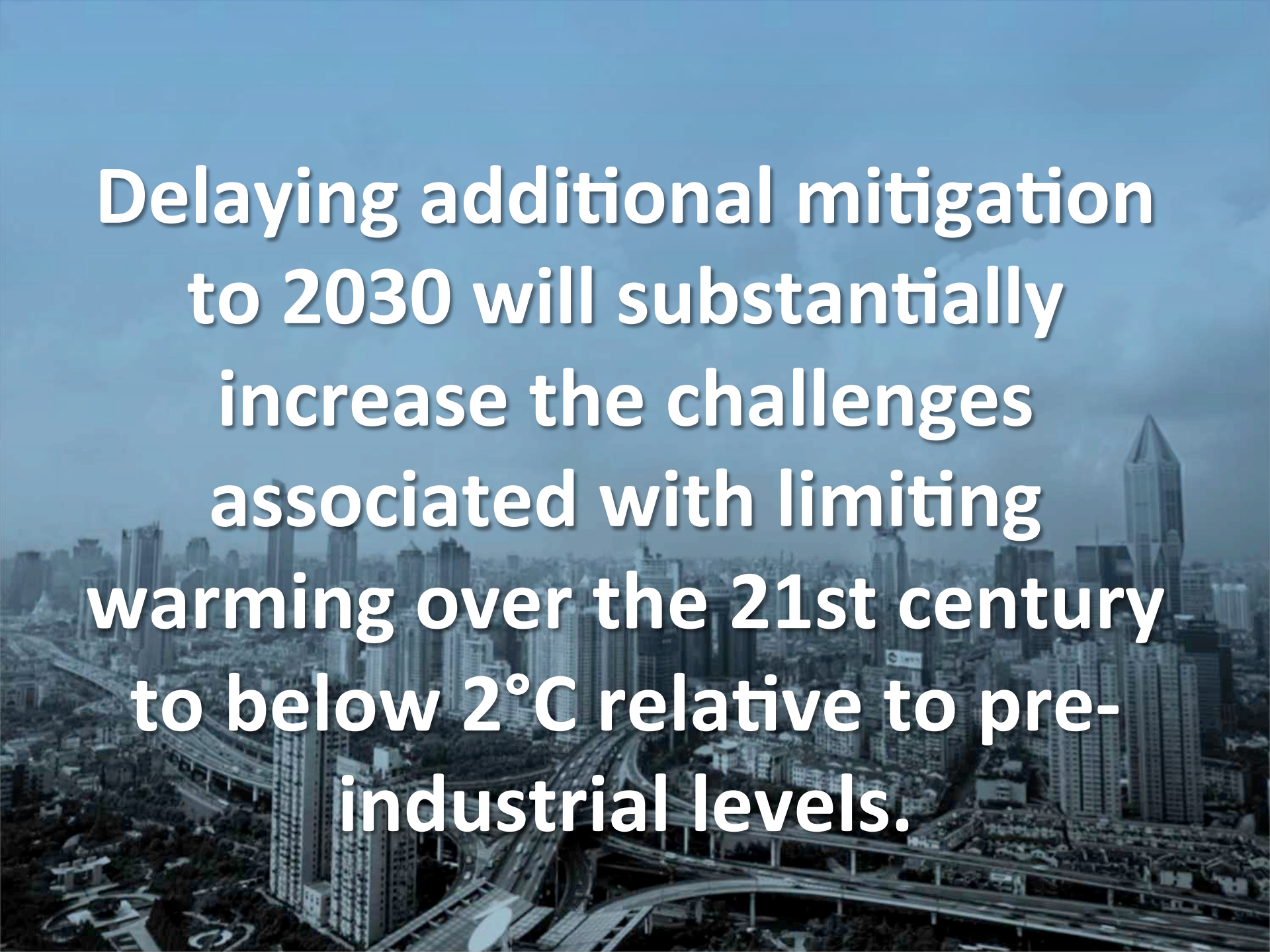
AR5 WGI SPM, AR5 WGII SPM

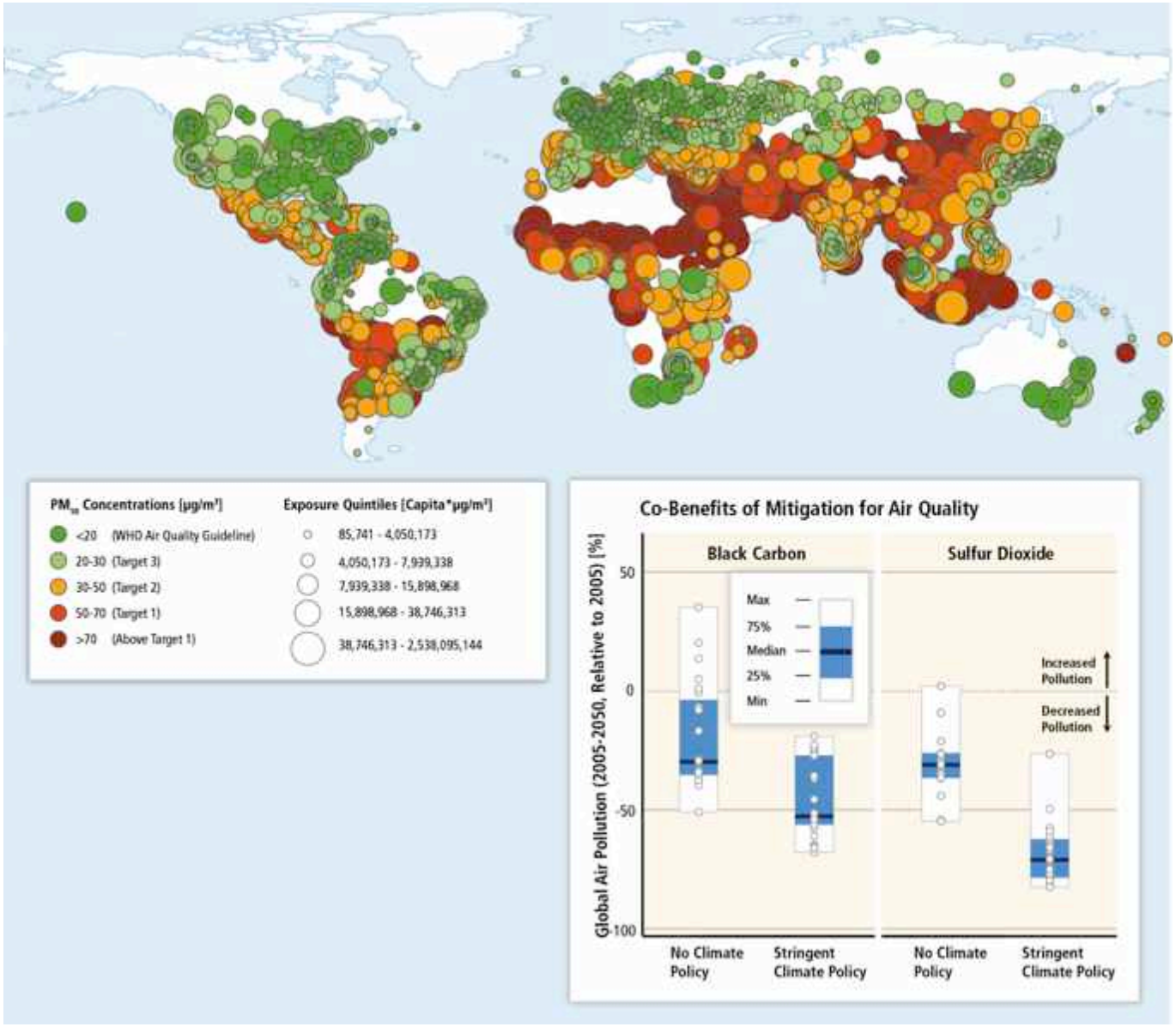
- **Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy (quadrupling from 2010 to 2050 for the scenario limiting warming below 2°C)**

- **Substantial reductions in emissions would require large changes in investment patterns e.g., from 2010 to 2029, in billions US dollars/year:**
  (mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)
- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**

Substantial reductions in emissions would require large changes in investment patterns.




Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels.



Mitigation can result in large co-benefits for human health and other societal goals.

- **Sustainable development and equity provide a basis for assessing climate policies and highlight the need for addressing the risks of climate change**

- **Issues of equity, justice, and fairness arise with respect to mitigation and adaptation**

Historical Responsibility

International cooperation on climate change involves ethical considerations, including equitable effort-sharing.

These questions include how much overall mitigation is needed to avoid **'dangerous interference with the climate system'**, how the effort or **cost of mitigating climate change should be shared among countries** and between the present and future, how to account for such factors as **historical responsibility for GHG emissions**, and how to choose among alternative policies for mitigation and adaptation. Ethical issues of well- being, **justice**, fairness, and rights are all involved.

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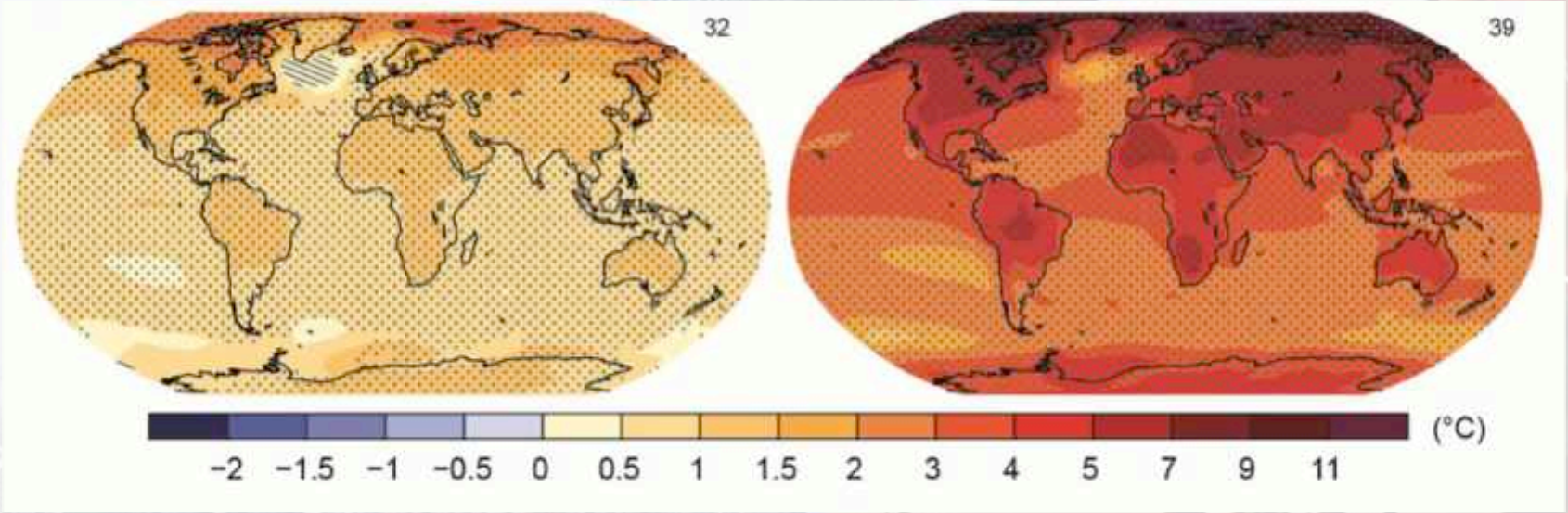
IPCC, AR5, WG III, TS, p. 39

The Choices we Make Will Create Different Outcomes (and affect prospects for effective adaptation)

With substantial mitigation

Without additional mitigation



Change in average surface temperature (1986–2005 to 2081–2100)

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Please…

- **Participate to the next IPCC Assessment (as authors or expert reviewers)(Tip: know your IPCC Focal point)**
- **Think about the children and their future in a warm climate**

Jean-Pascal van Ypersele
(vanyp@climate.be)

Let us think about the future of these children from Machakos in a warming climate

Photo: @JPvanYpersele, during the #CBA9 conference field trips, Kenya, April 2015

The Hidden Message:

- **If it's possible and not enough happens, what is lacking?**
- **Political will, at the appropriate scale**

Useful links:

- www.ipcc.ch : IPCC (reports and videos)
- www.climate.be/vanyp : my slides and my candidature for the IPCC Chair position
- www.skepticalscience.com: excellent responses to contrarians arguments
- **On Twitter: @JPvanYpersele and @IPCC_CH**