# In Paris for a Climate Accord: It is Still Time to Act!

## *An Overview Based on the IPCC Fifth Assessment Report (AR5)*

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**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**

# Why the IPCC ?

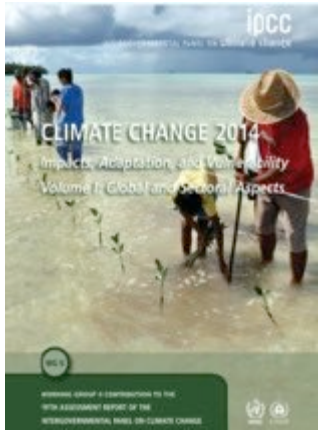
## Established by WMO and UNEP in 1988

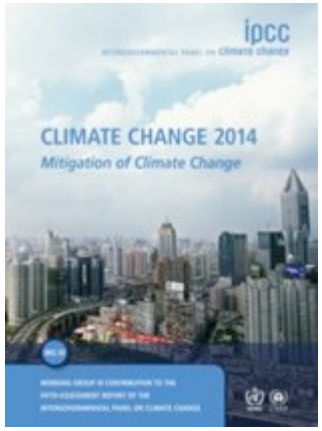
to provide **policy-makers** with an **objective source of information** about

- 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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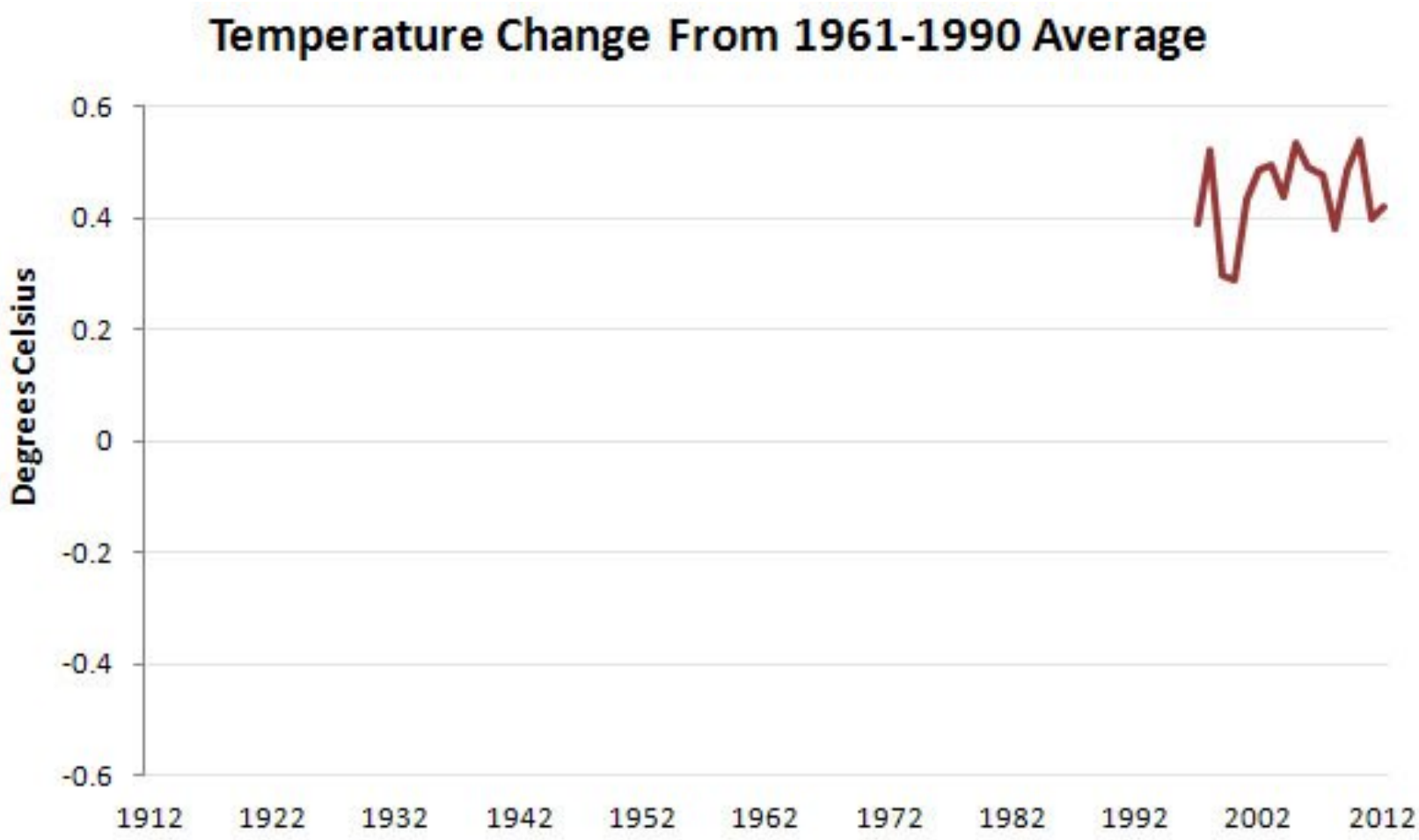
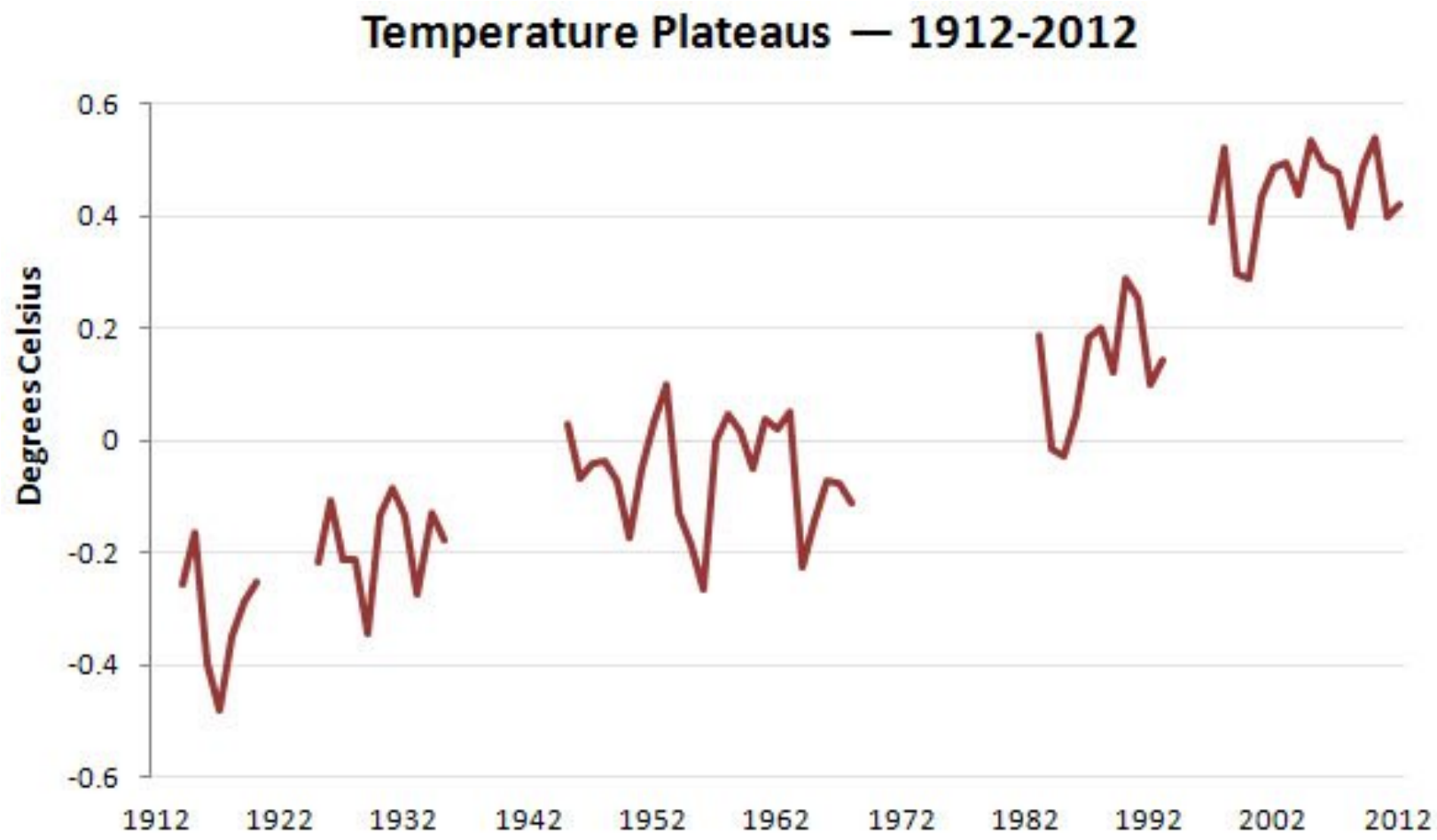
# Key messages from IPCC AR5

- 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




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

# Lying With Statistics, Global Warming Edition

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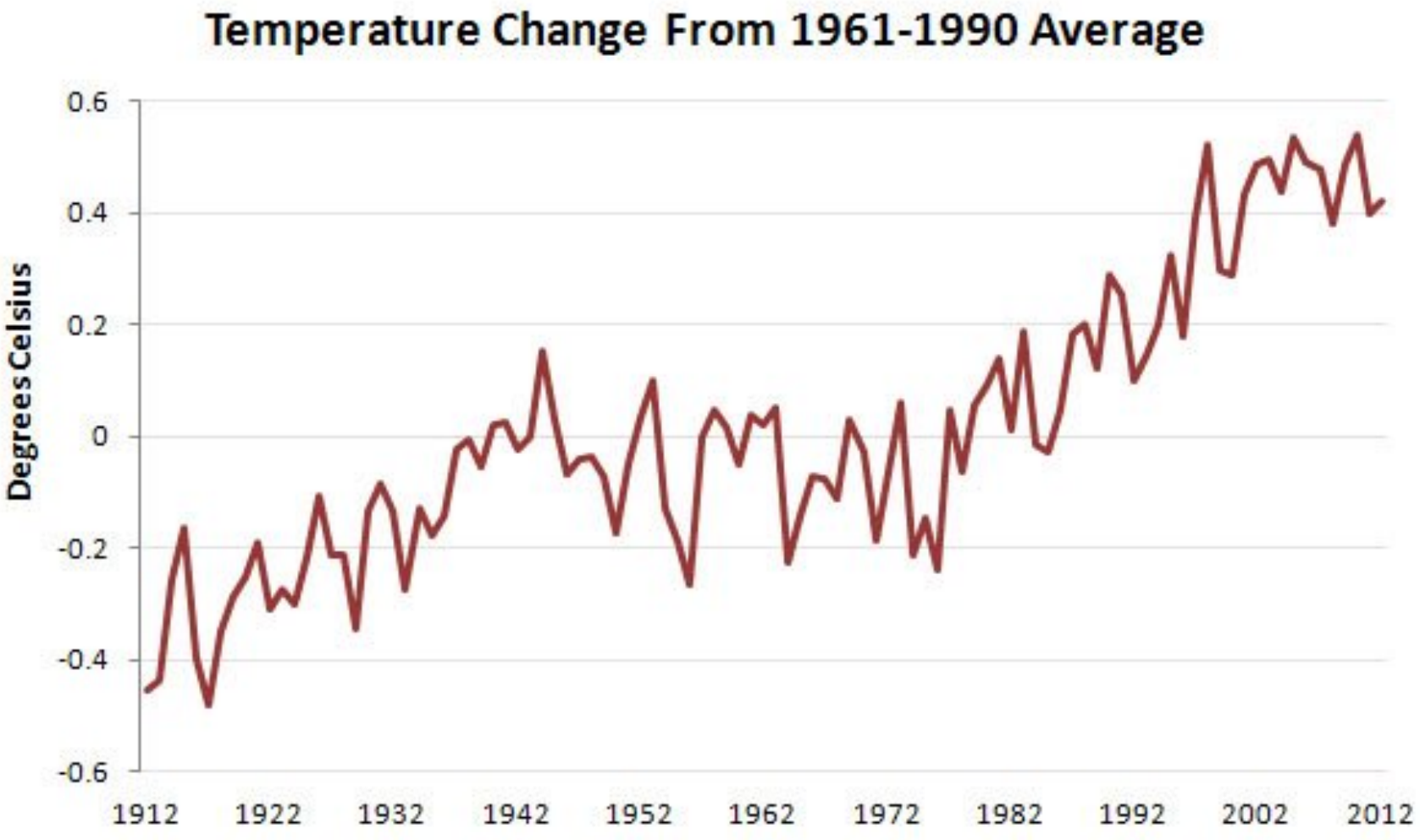


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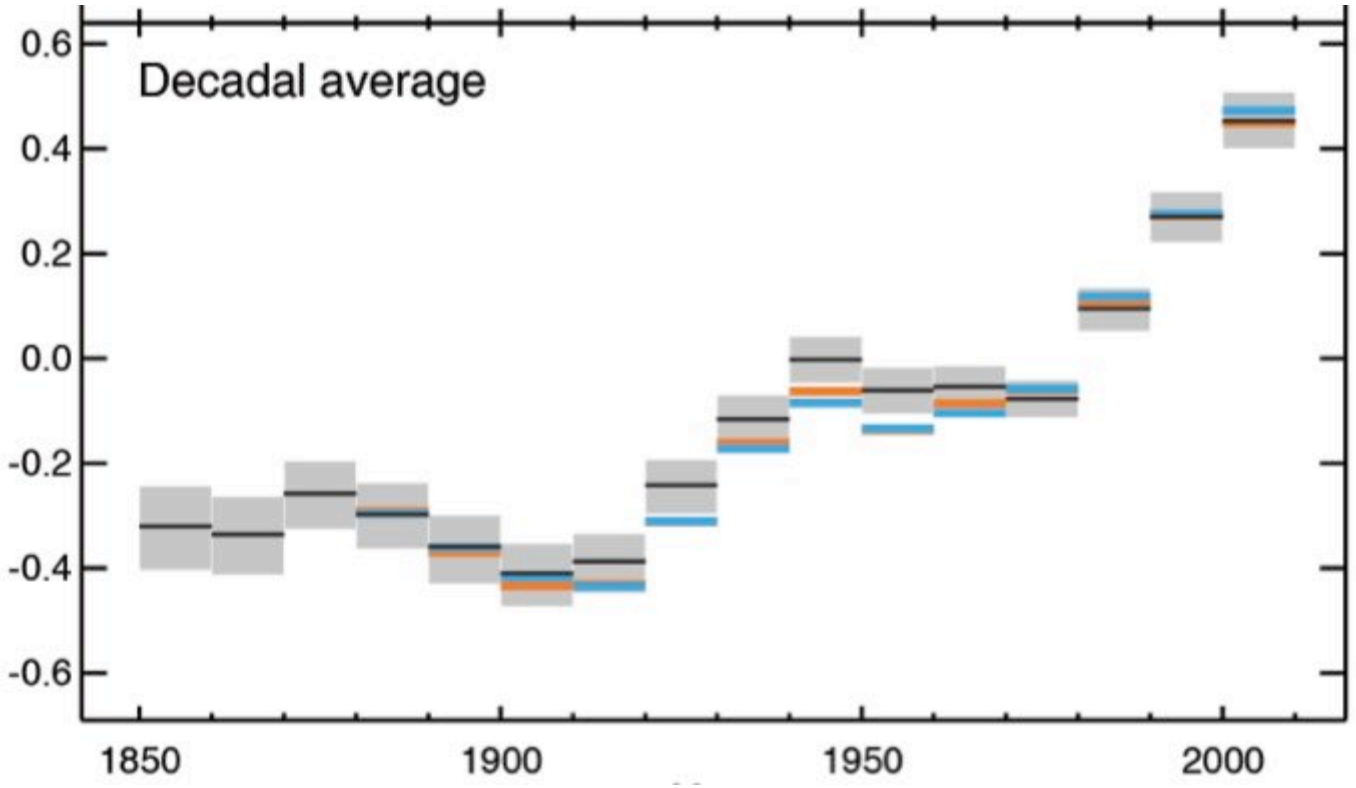
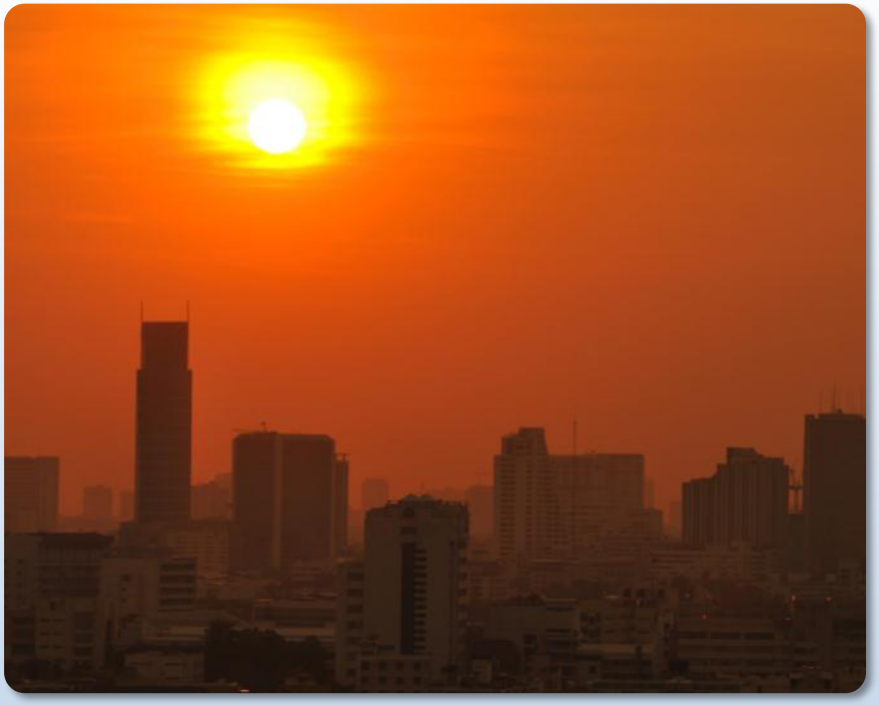



(IPCC 2013, Fig. SPM.1a)

**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*).

# 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

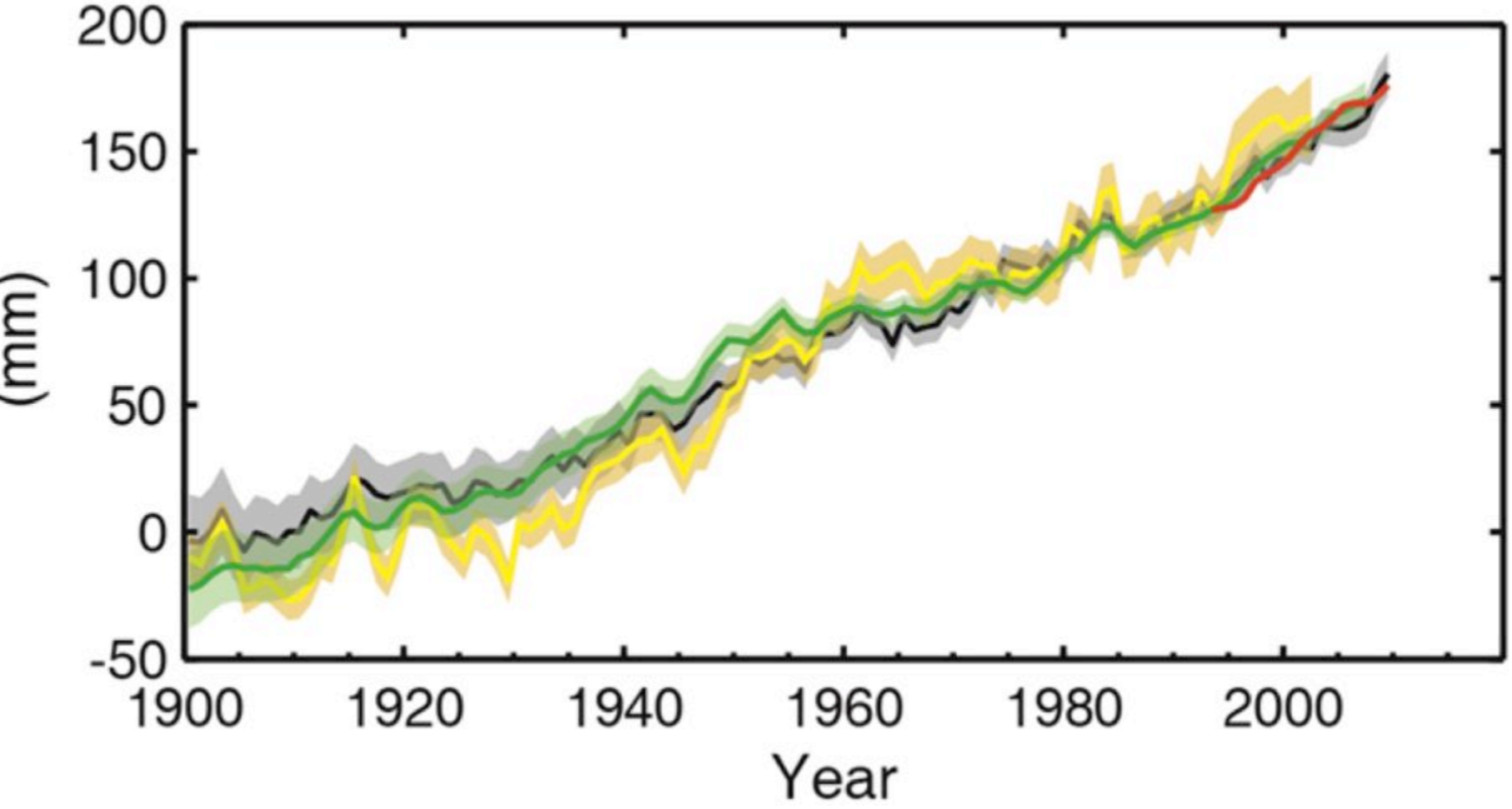
# Plateau Glacier (1961)
# (Alaska)

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

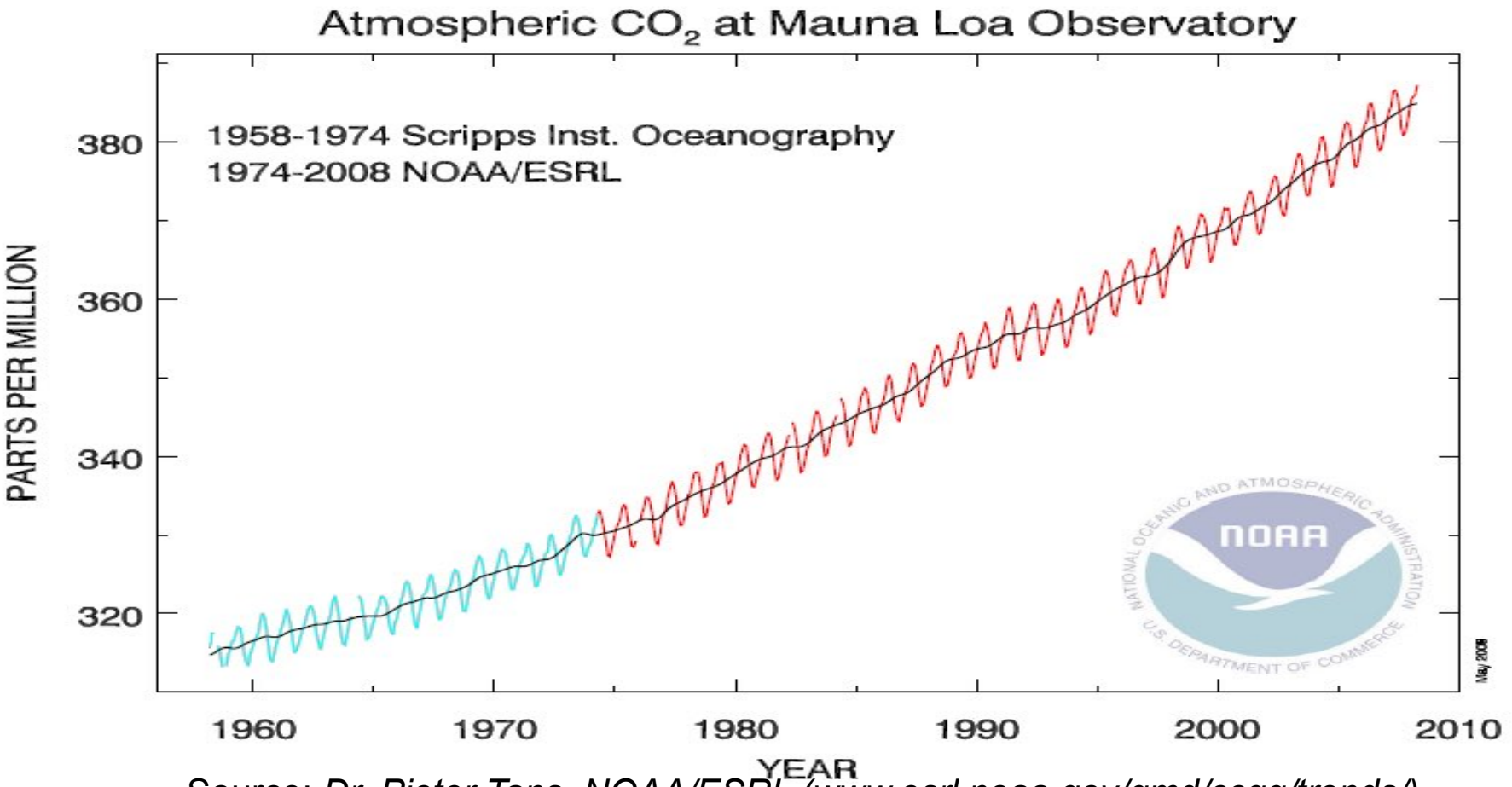
# Plateau Glacier (2003)
# (Alaska)

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



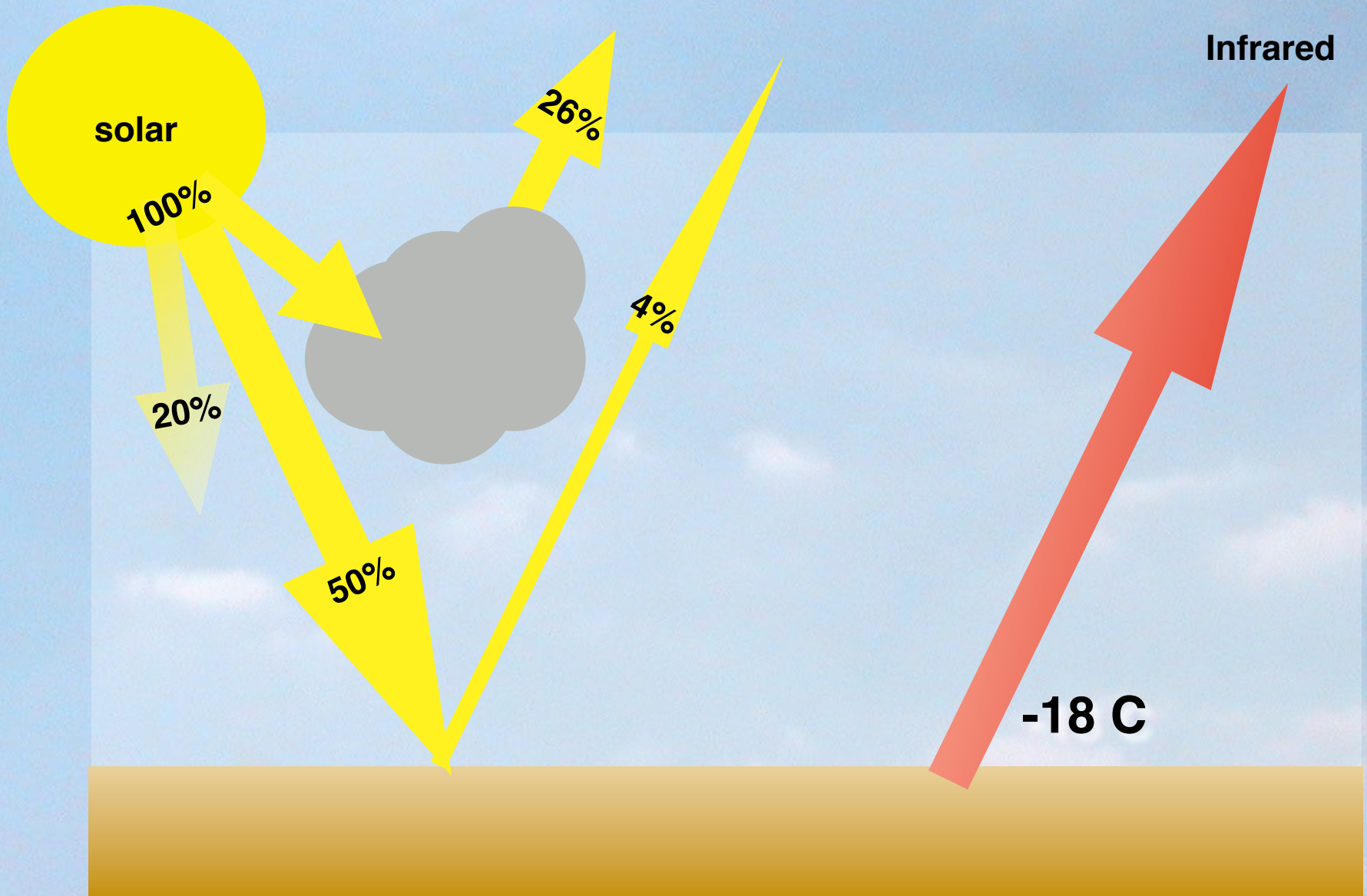
# $CO_2$ concentration measured at Mauna Loa (3400 m)

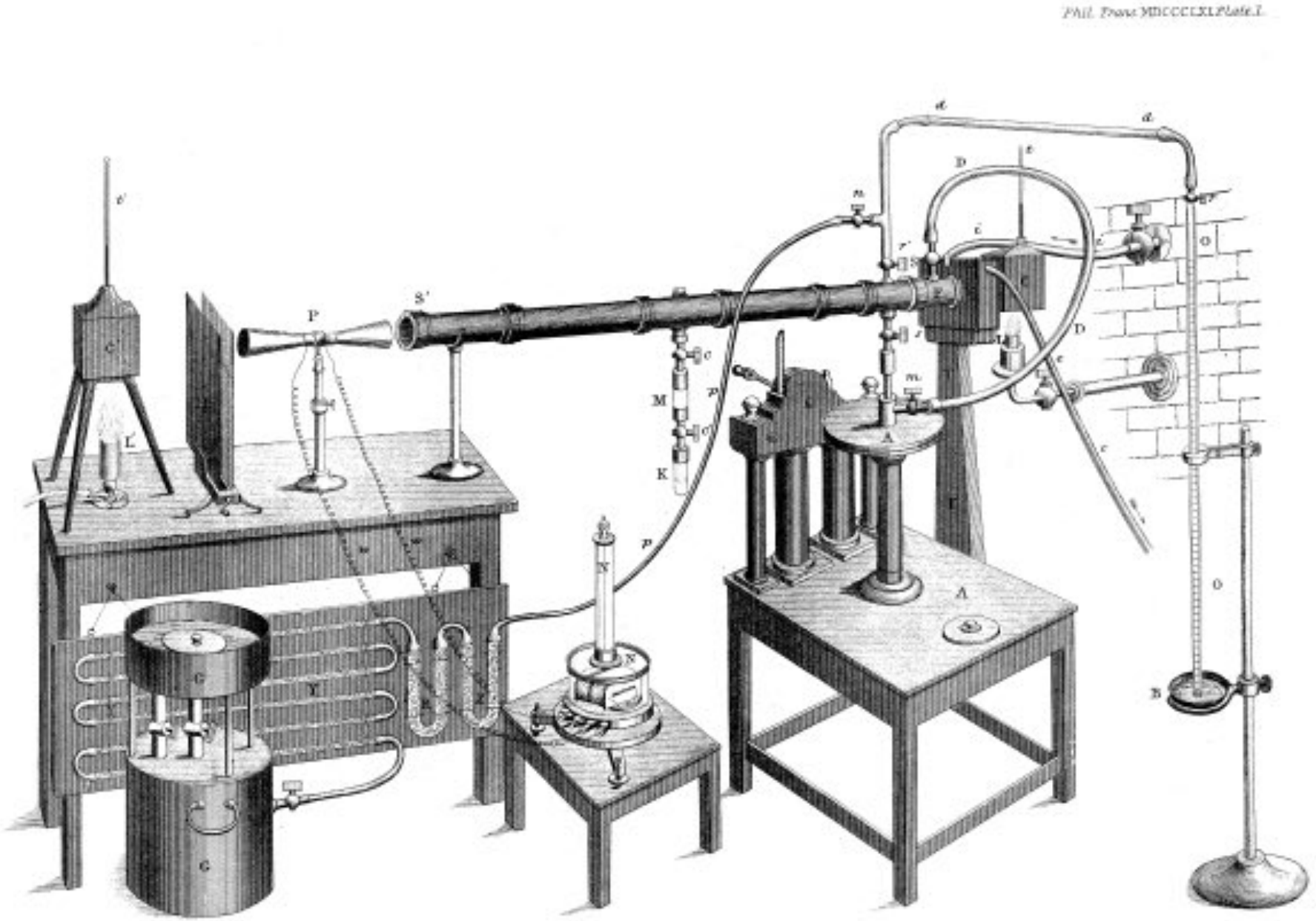



Source: *Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)*

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

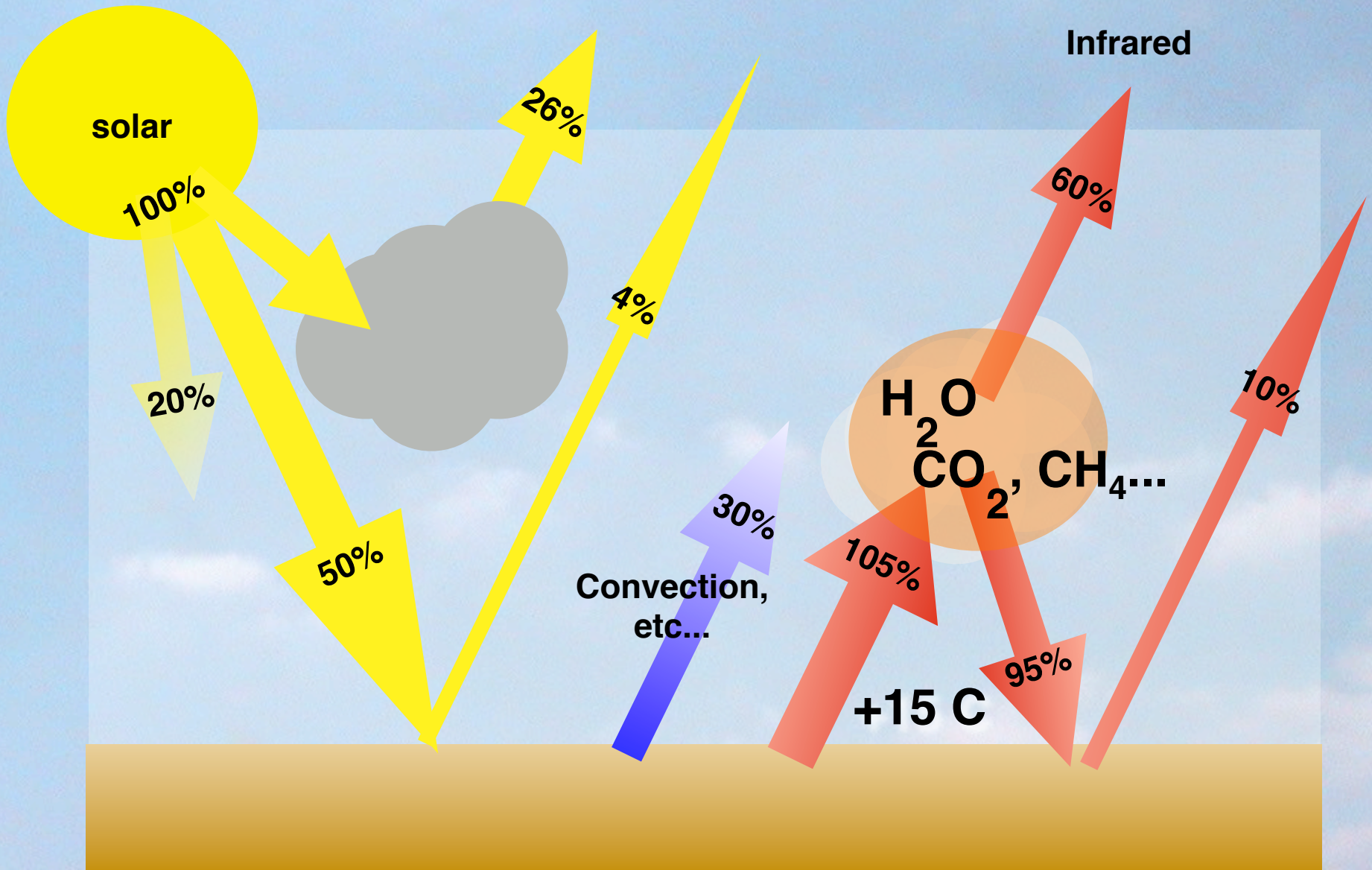
# Without Greenhouse Effect






**Tyndall (1861) measures radiation absorption by gases**

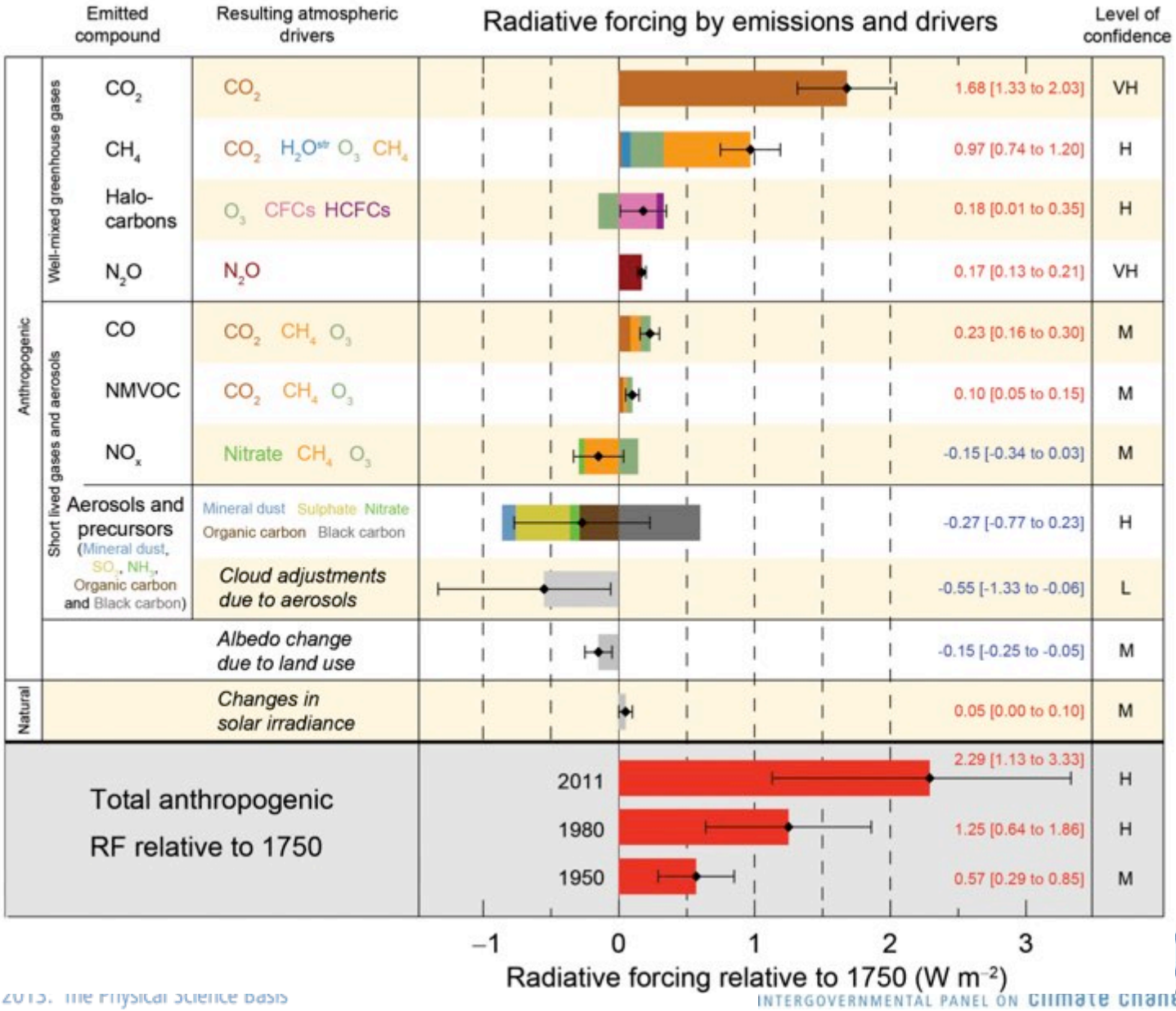
# With Greenhouse Effect



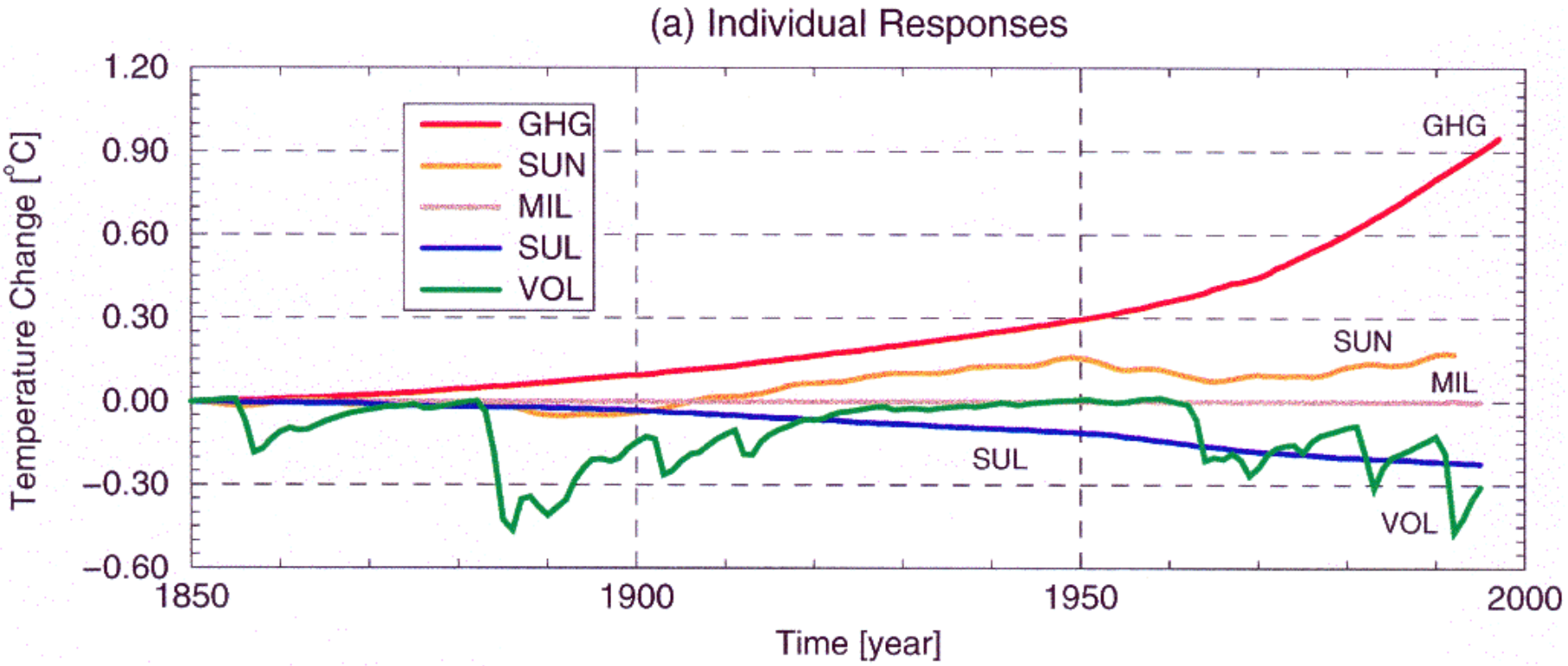
# Figure SPM.5

Radiative forcing estimates in 2011 relative to 1750



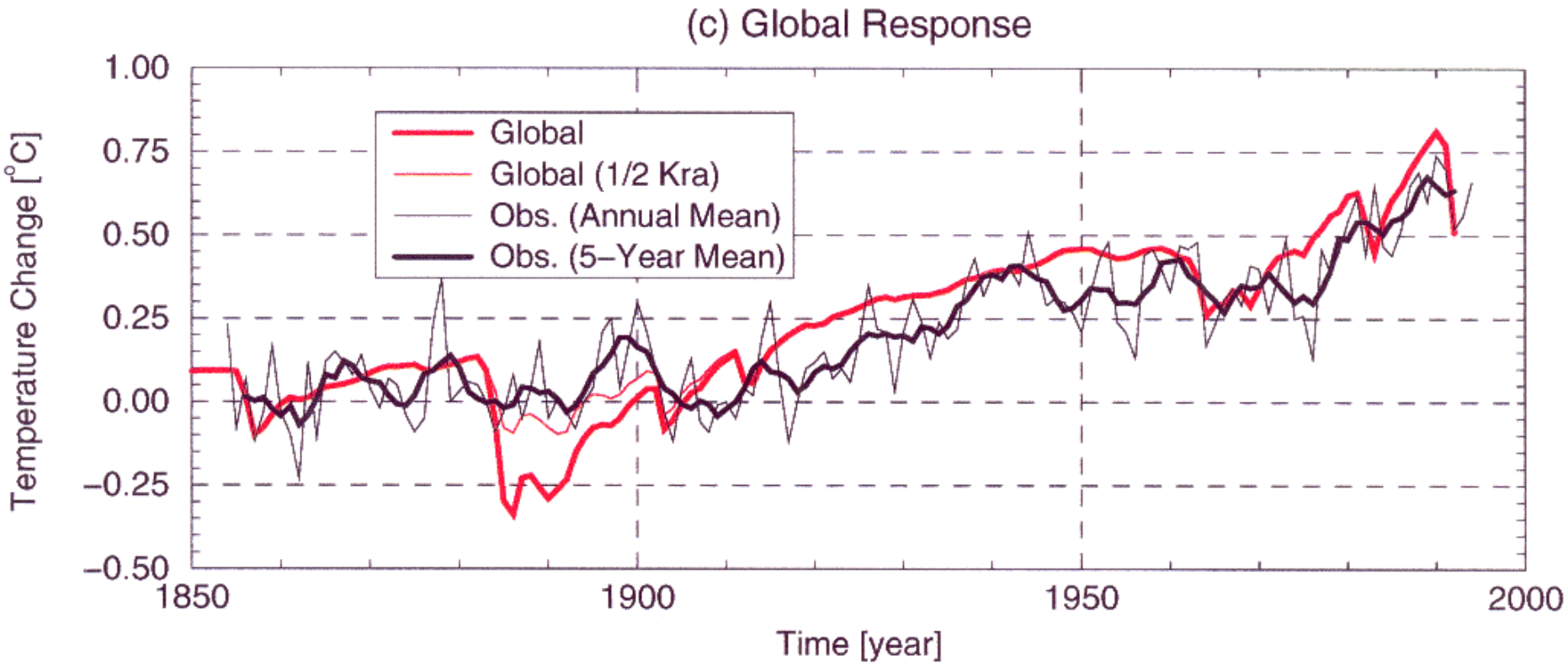


# Separate effect of different factors in the 2-dimensional climate model at Univ. cath. Louvain




Bertrand et al. 2001

# Combined effect of all factors in the 2-dimensional climate model at Univ. cath. Louvain




Bertrand et al. 2001

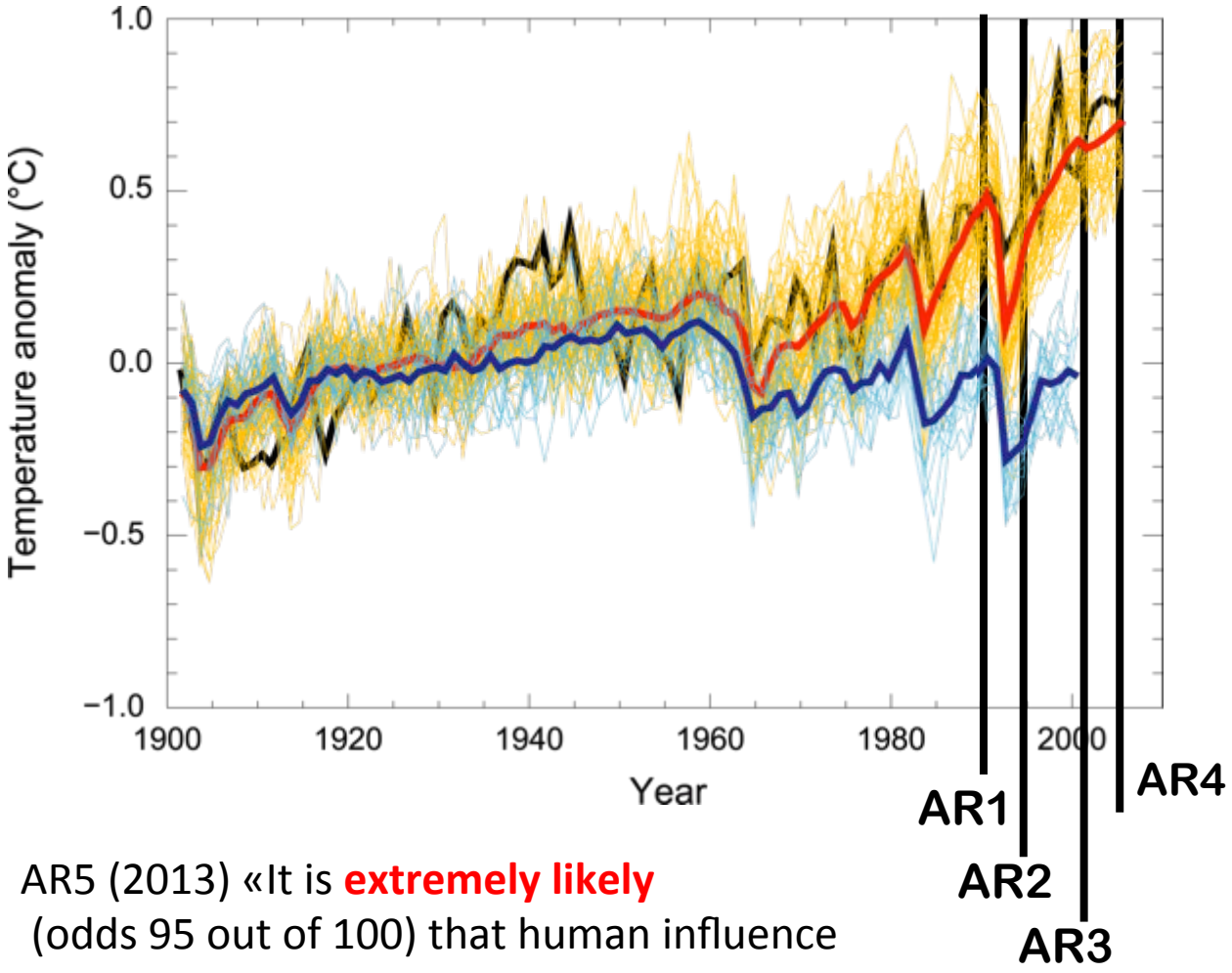
# A Progression of Understanding: Greater and Greater Certainty in Attribution

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

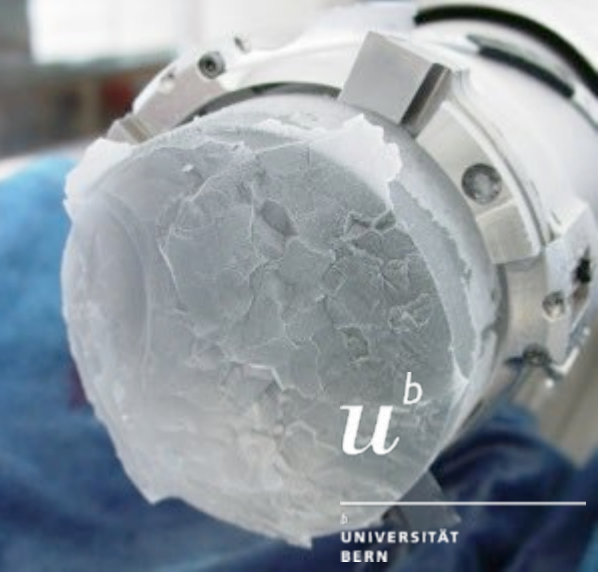
AR2 (1995): "balance of evidence suggests **discernible** human influence"

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… »



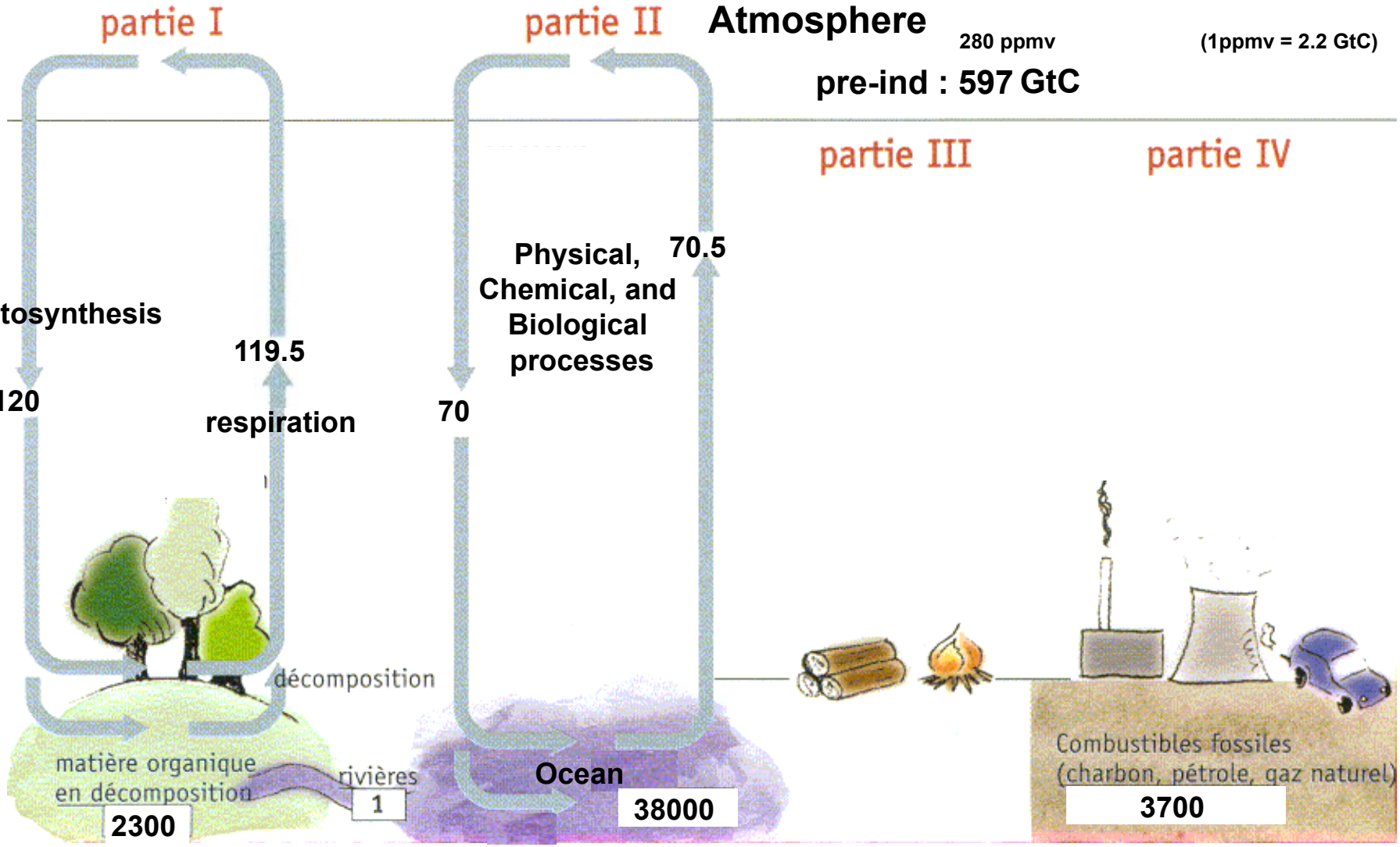

# Atmospheric concentrations of $CO_2$




(Lüthi et al.,2008, NOAA)

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

# Carbon cycle: unperturbed fluxes

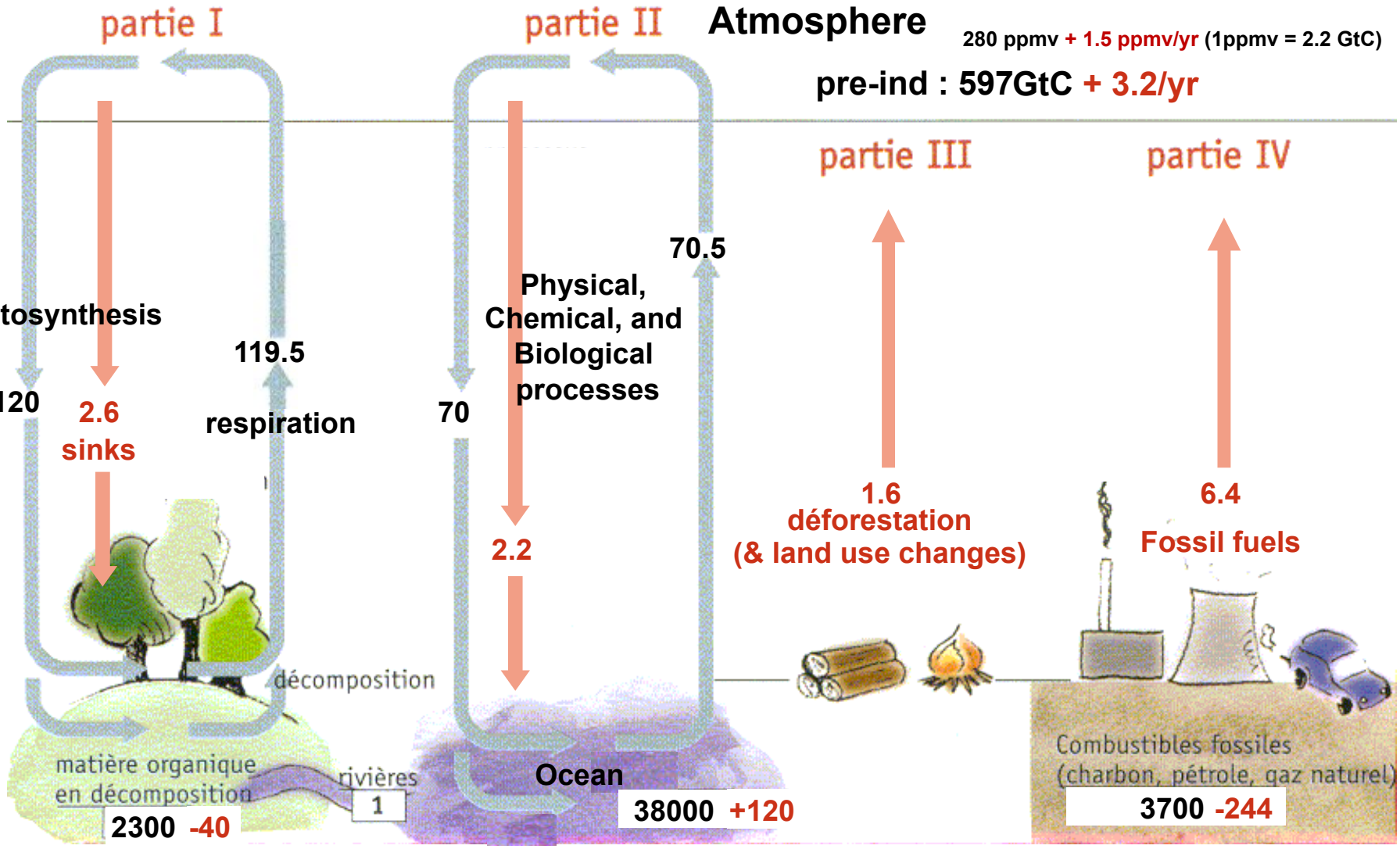



**Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)**

vanyp@climate.be

# Carbon cycle: perturbed by human activities

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



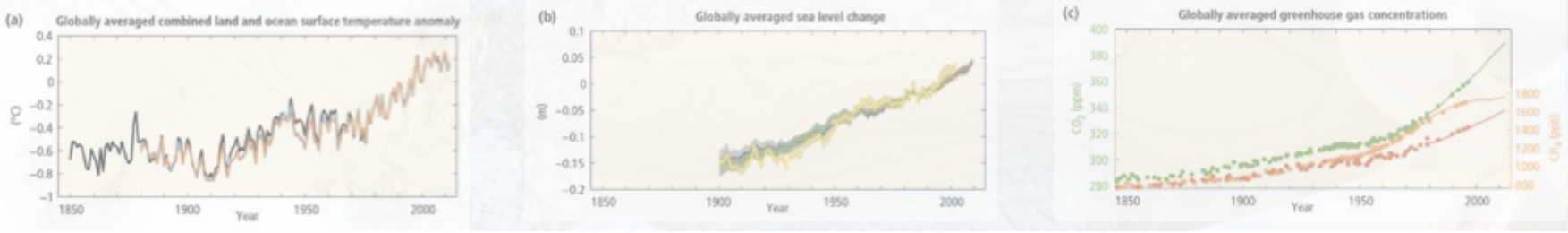

Units: GtC (billions tons of carbon) or GtC/year

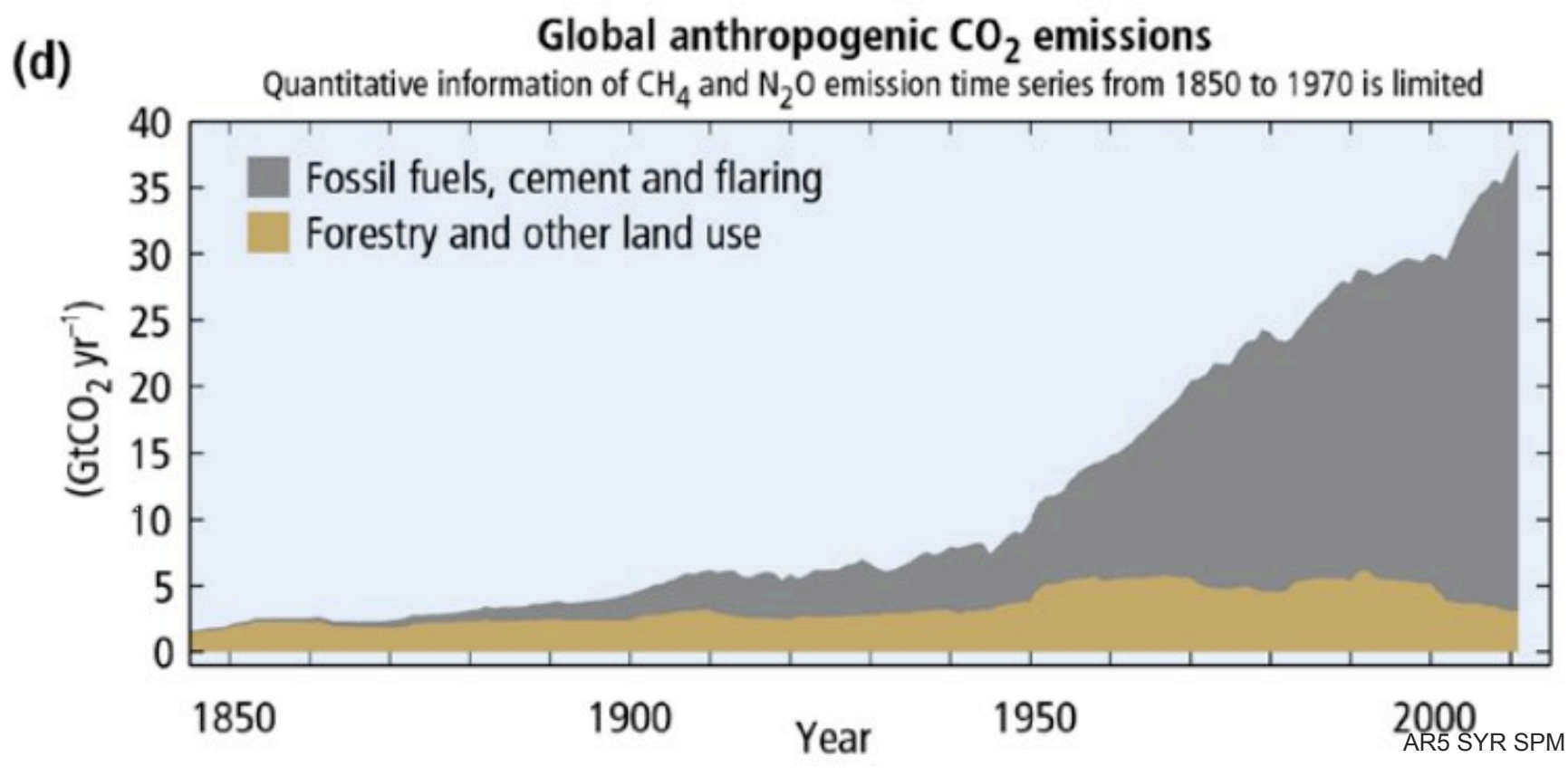
Stocks!

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)**




AR5 SYR SPM

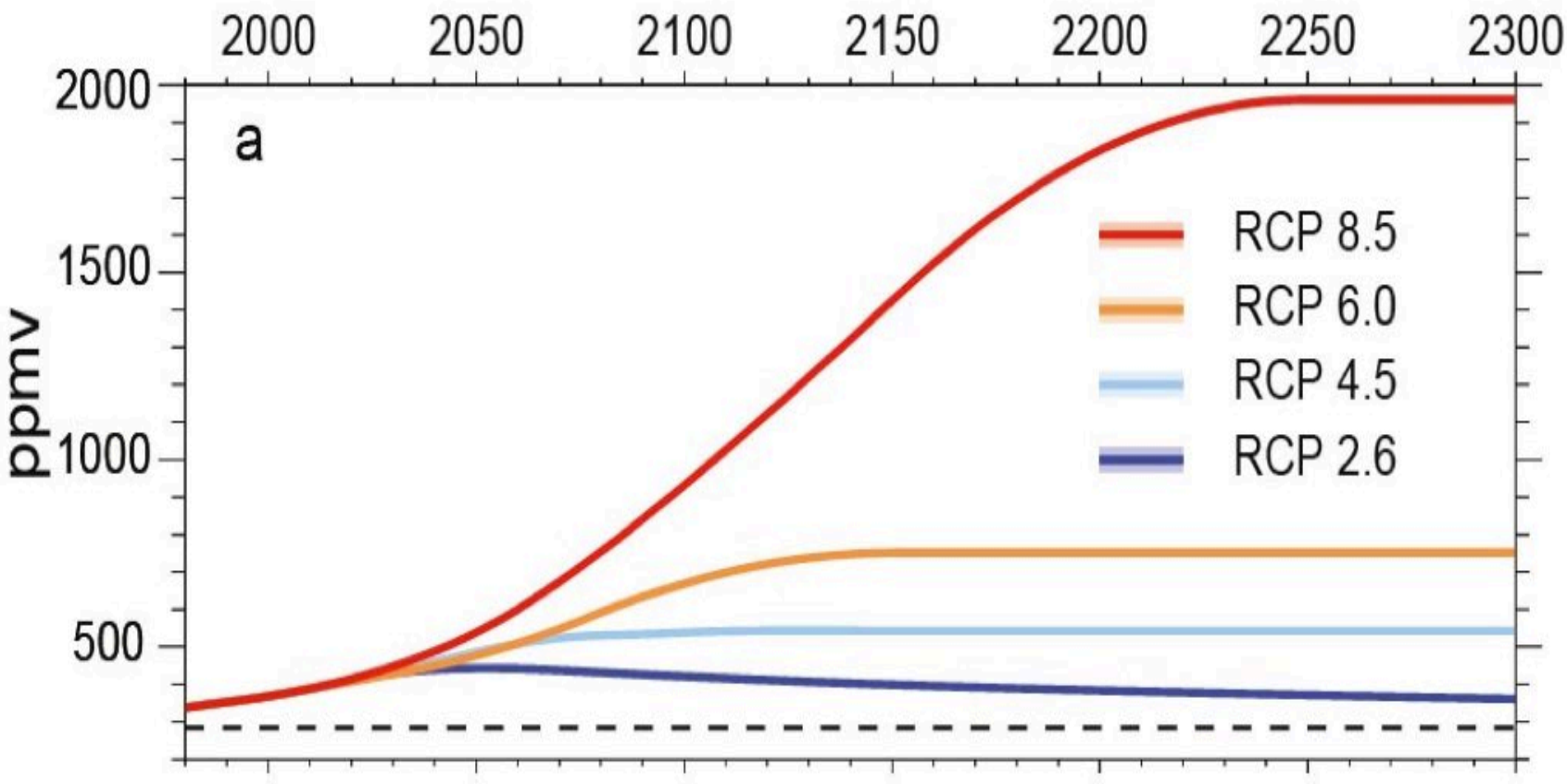
# Sources of emissions

## Energy production remains the primary driver of GHG emissions


2010 GHG emissions

AR5 WGIII SPM

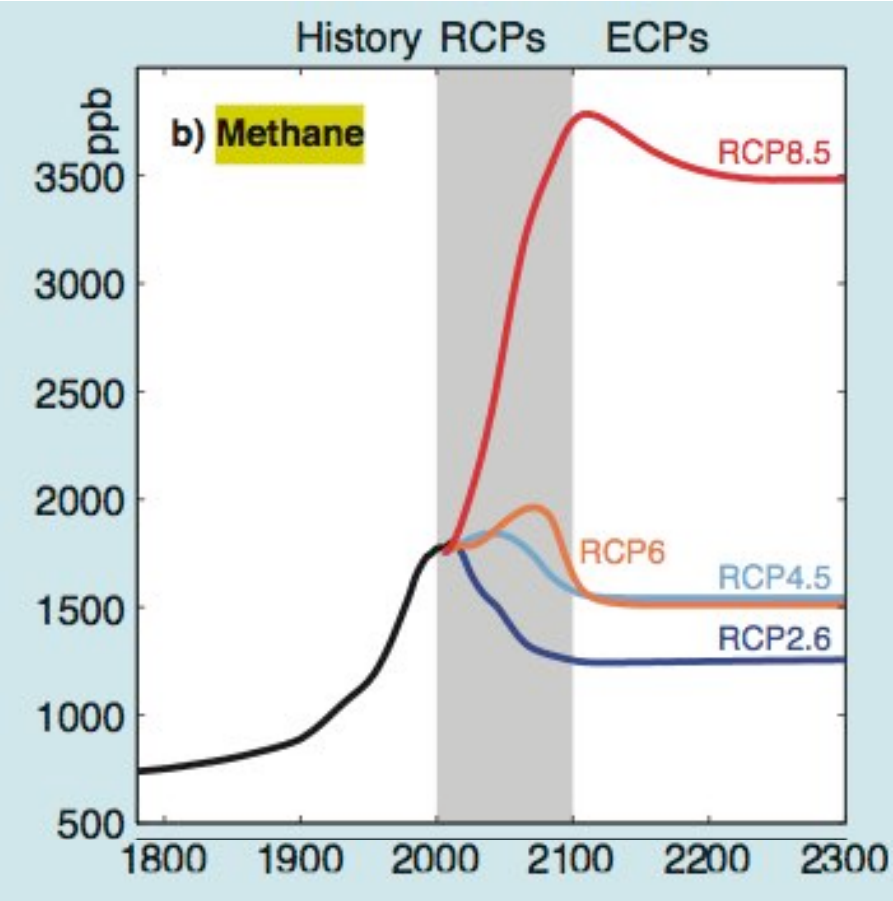
# RCP Scenarios: Atmospheric $CO_2$ concentration



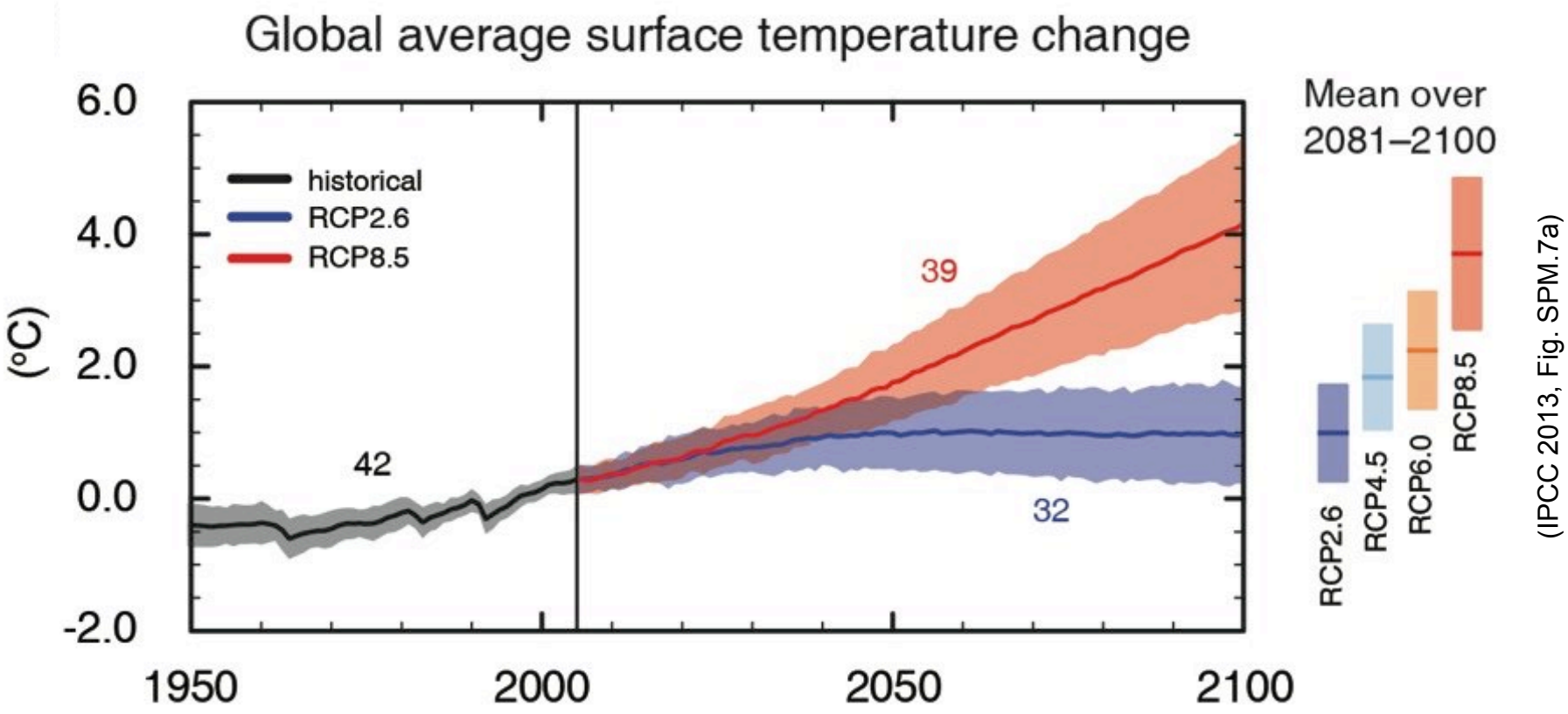

Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

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

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




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

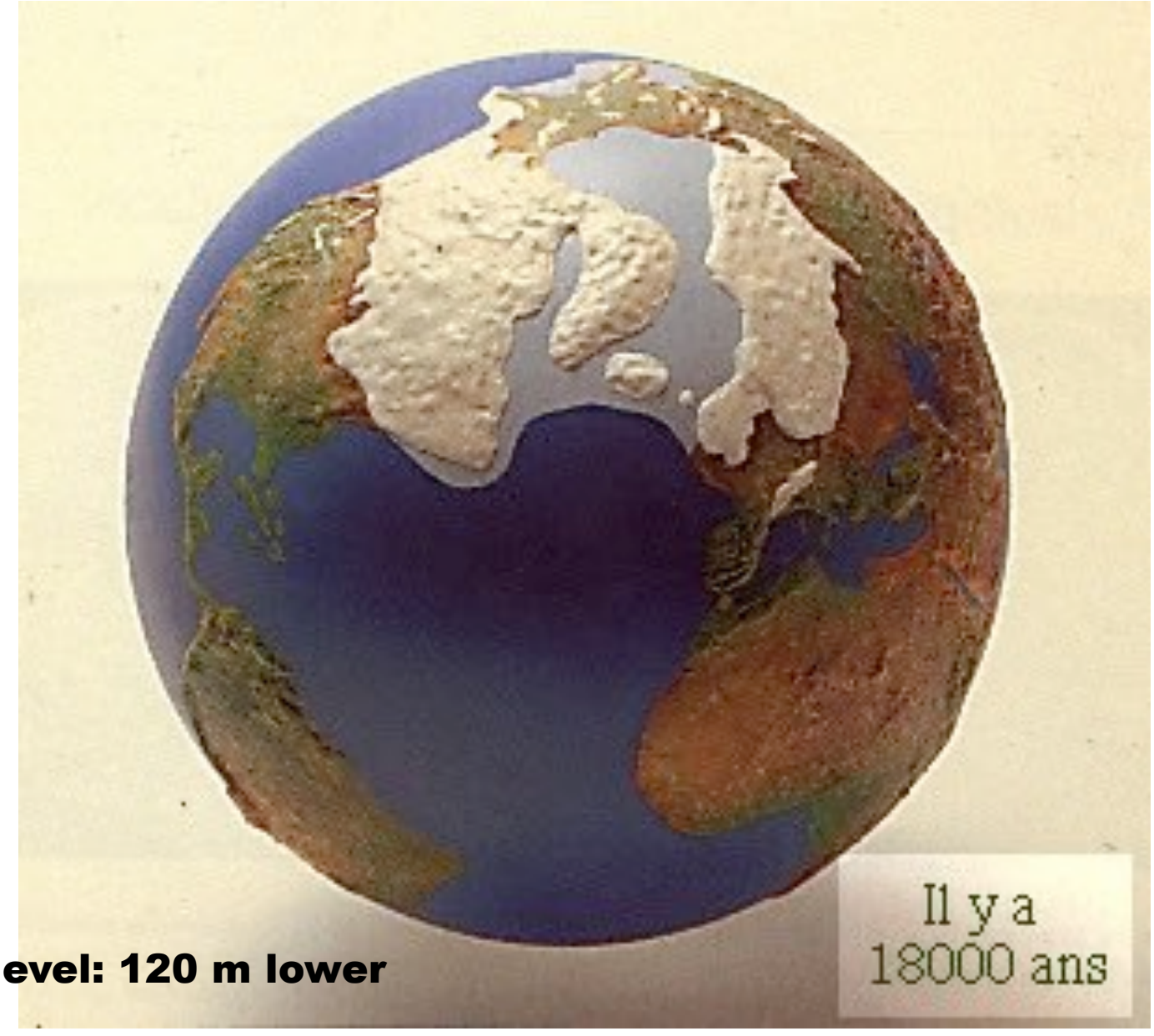



(IPCC 2013, Fig. SPM.7a)

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

# 18-20000 years ago (Last Glacial Maximum)

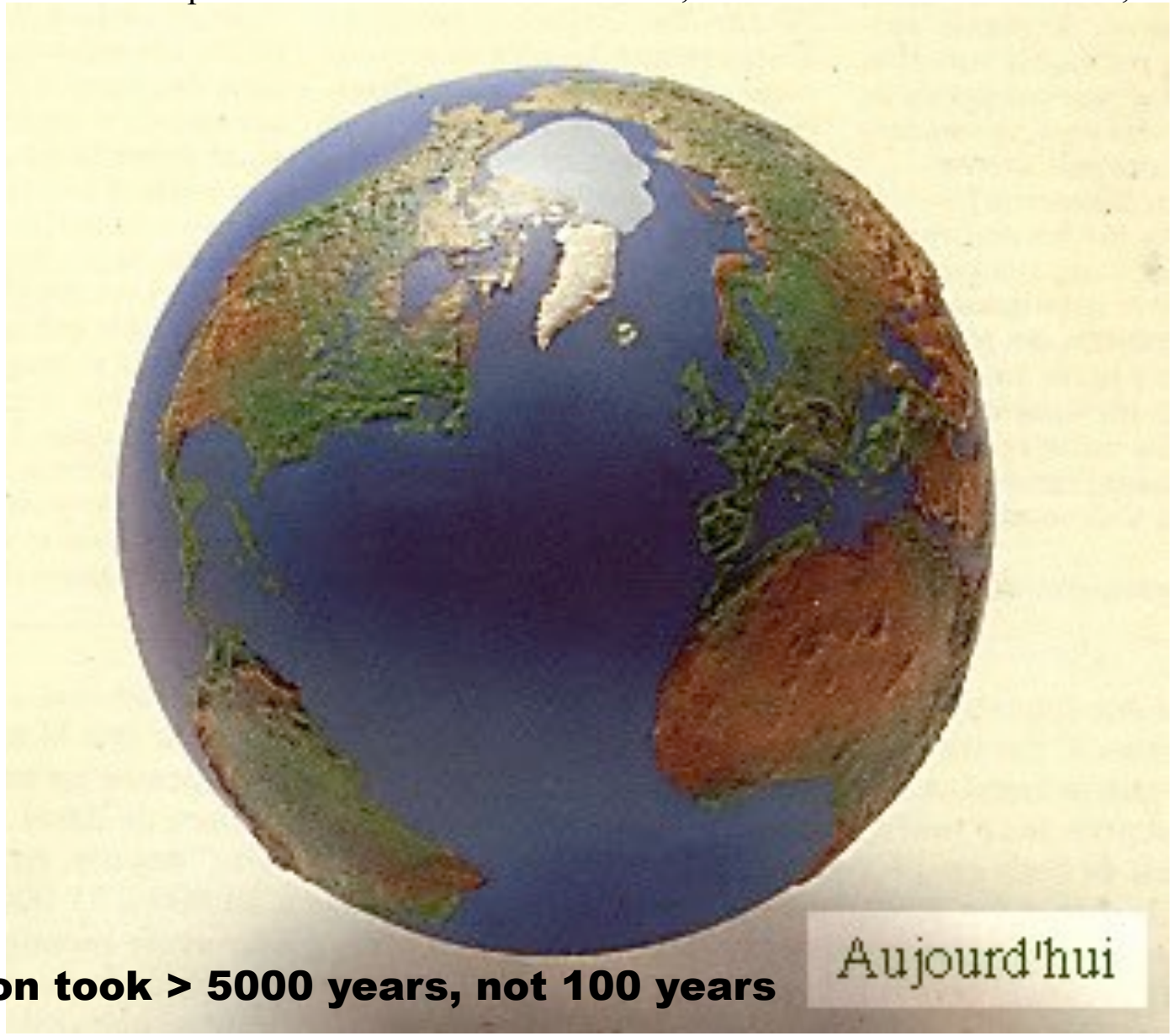
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.




**Sea level: 120 m lower**

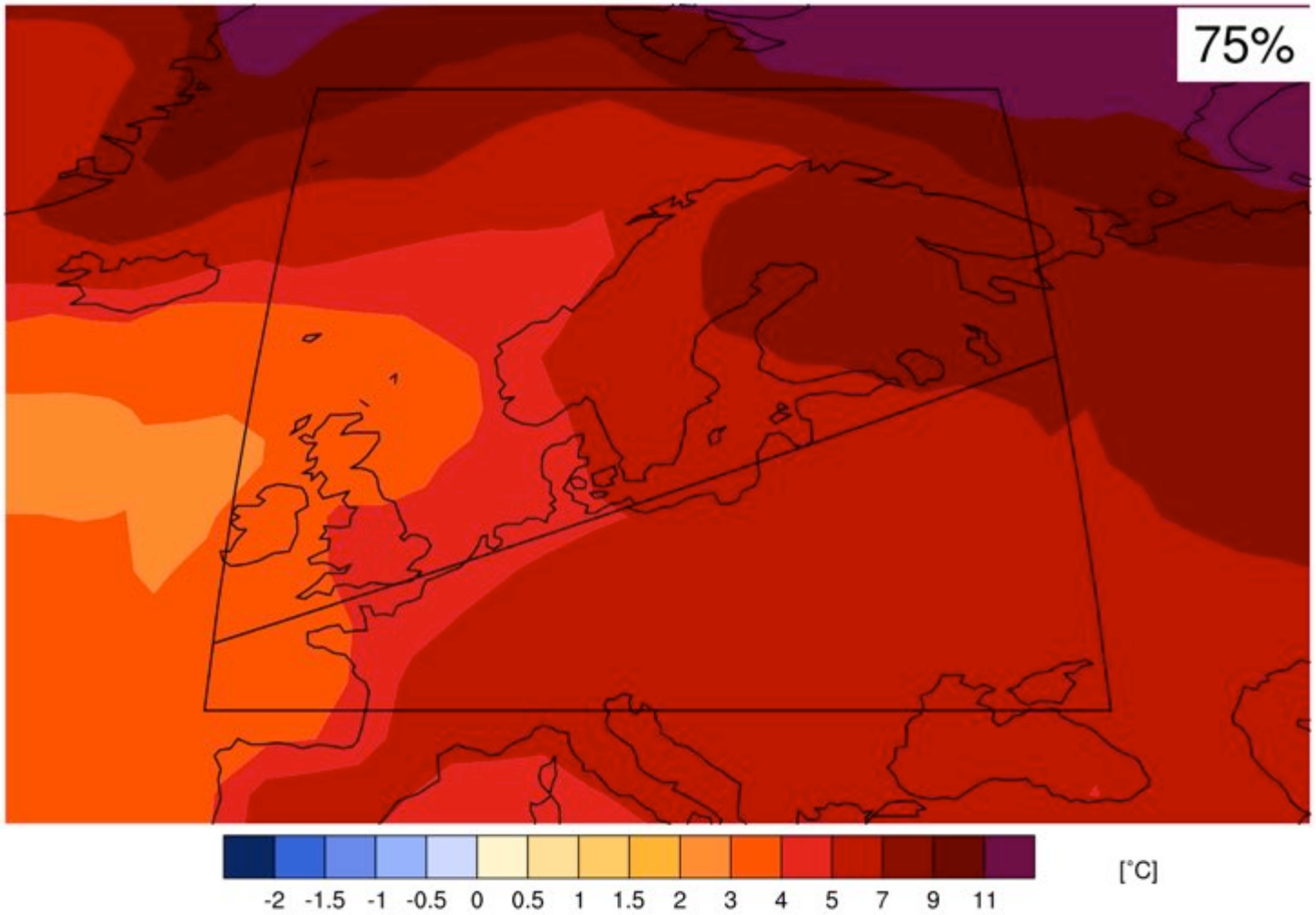
# Today, with +4-5°C globally

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



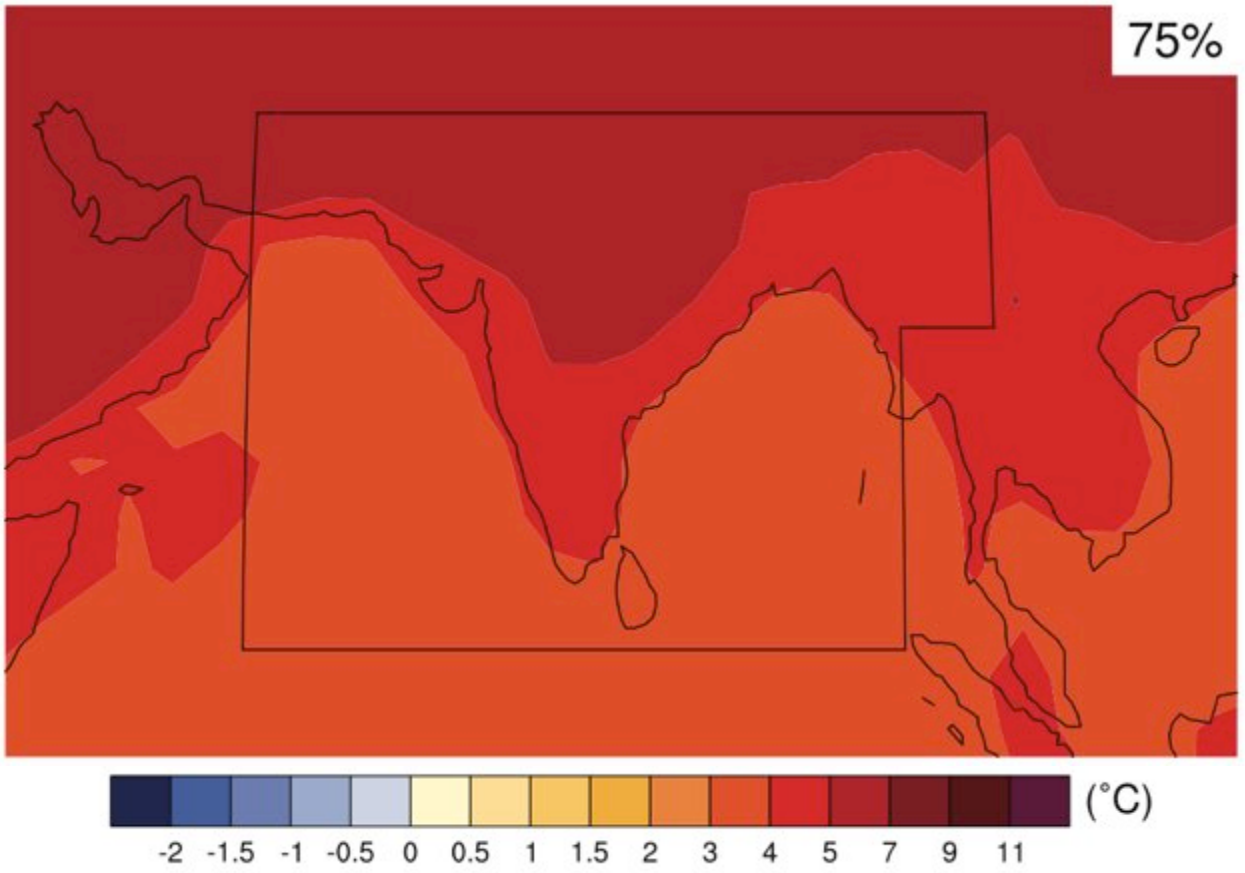

**Transition took > 5000 years, not 100 years**

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



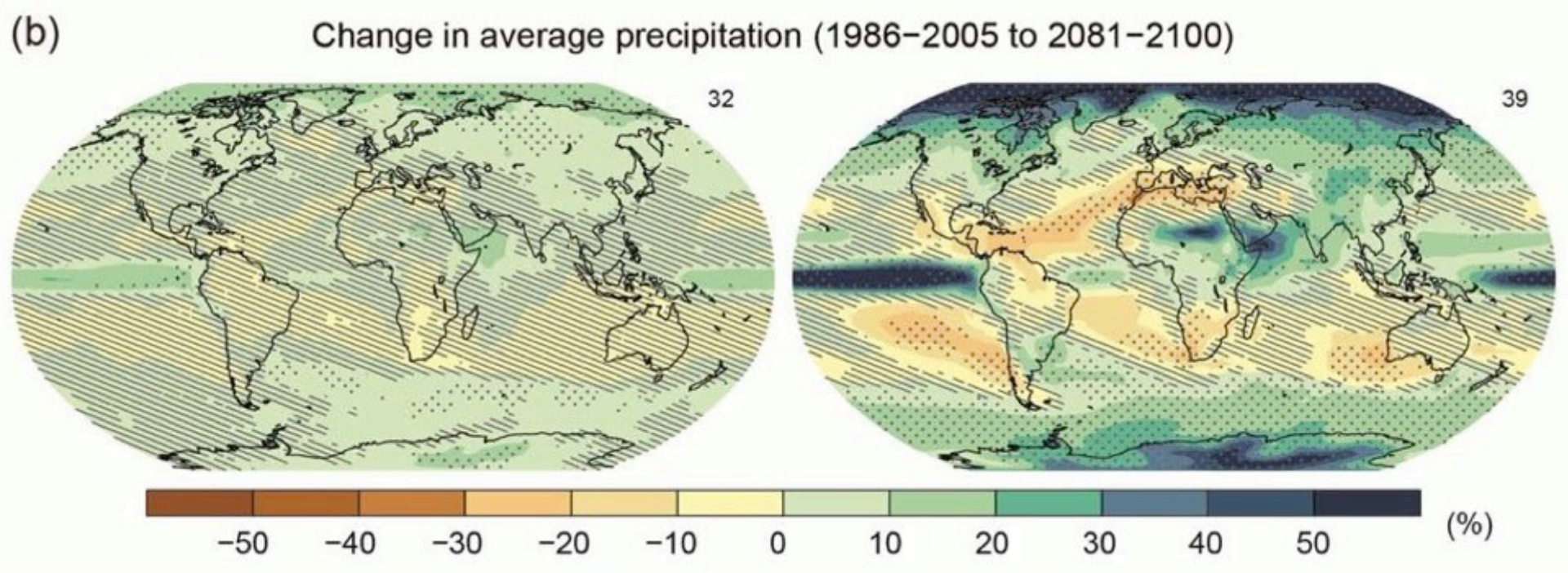

IPCC WG1 Fifth Assessment Report (Final Draft)

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

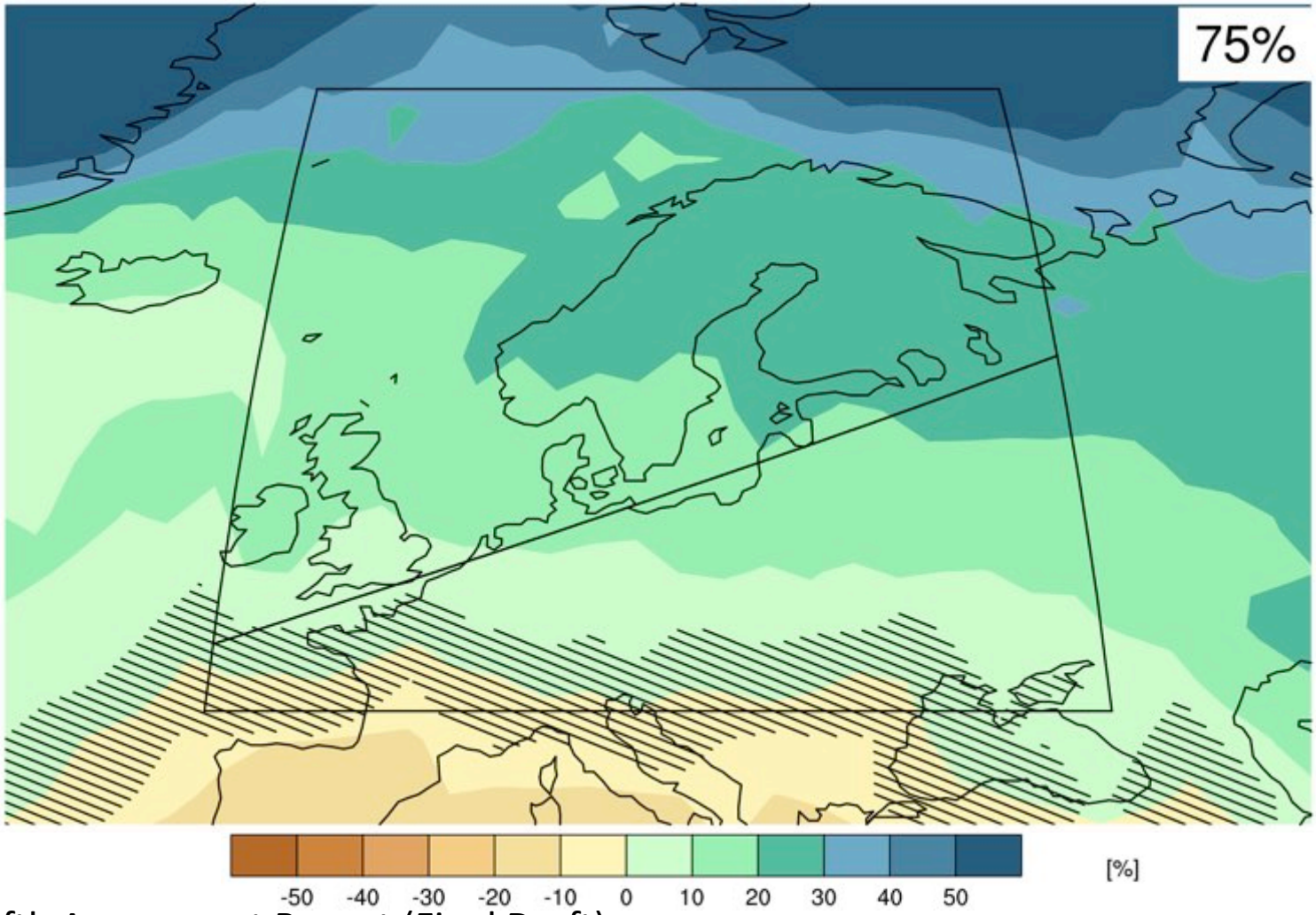



IPCC, WGI, Annex I: Atlas of Global and Regional Climate Projections Supplementary Material RCP8.5

# Annual rainfall projections



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

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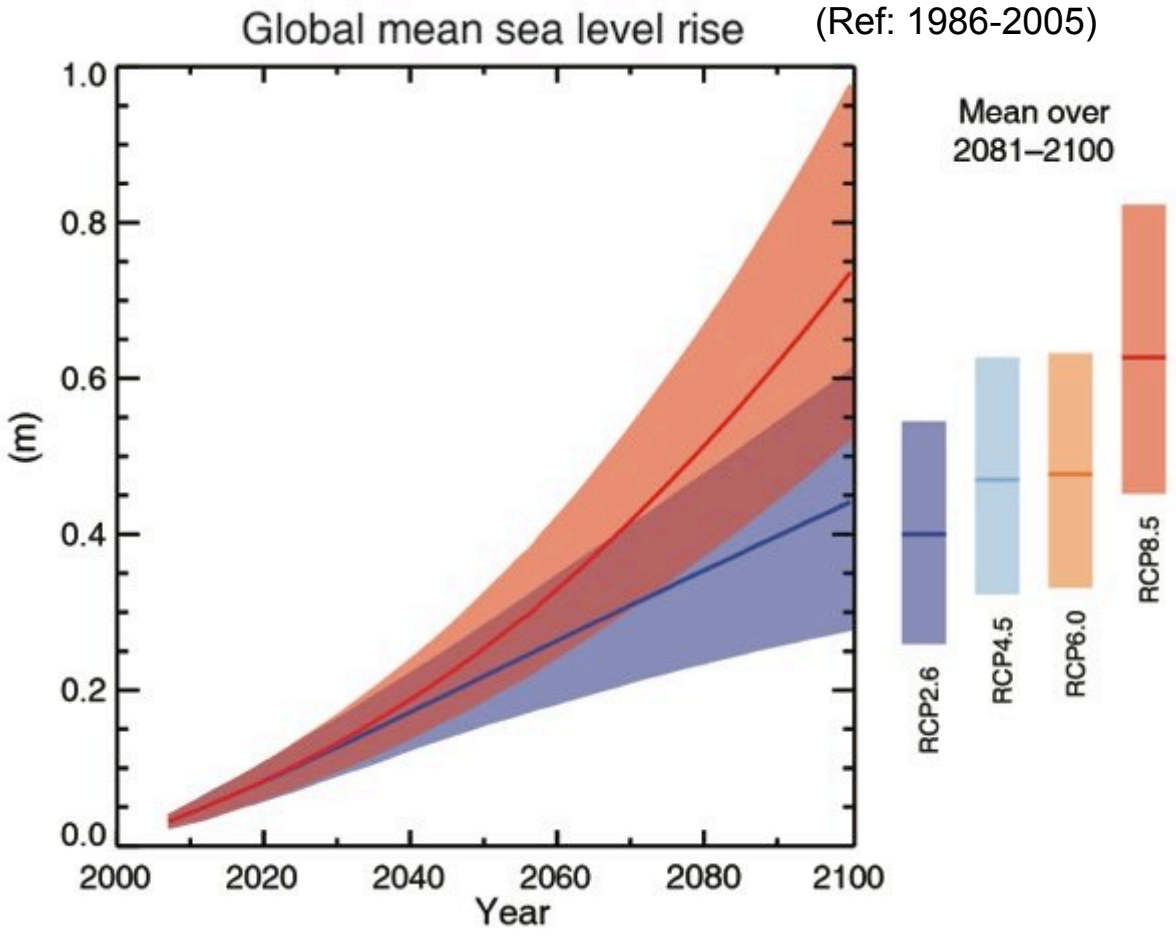



(IPCC 2013, Fig. SPM.9)

# Sea level due to continue to increase

# With 1 metre sea-level rise: 63000 ha below sea-level in Belgium (likely in 22nd century, not impossible in 21st century)

## (NB: flooded area depends on protection)


Source: J.P. van Ypersele et P. Marbaix (2004) See www.climate.be/impacts

# Effects on Nile Delta, where more than 10 million people live at less than 1 metre above sea level

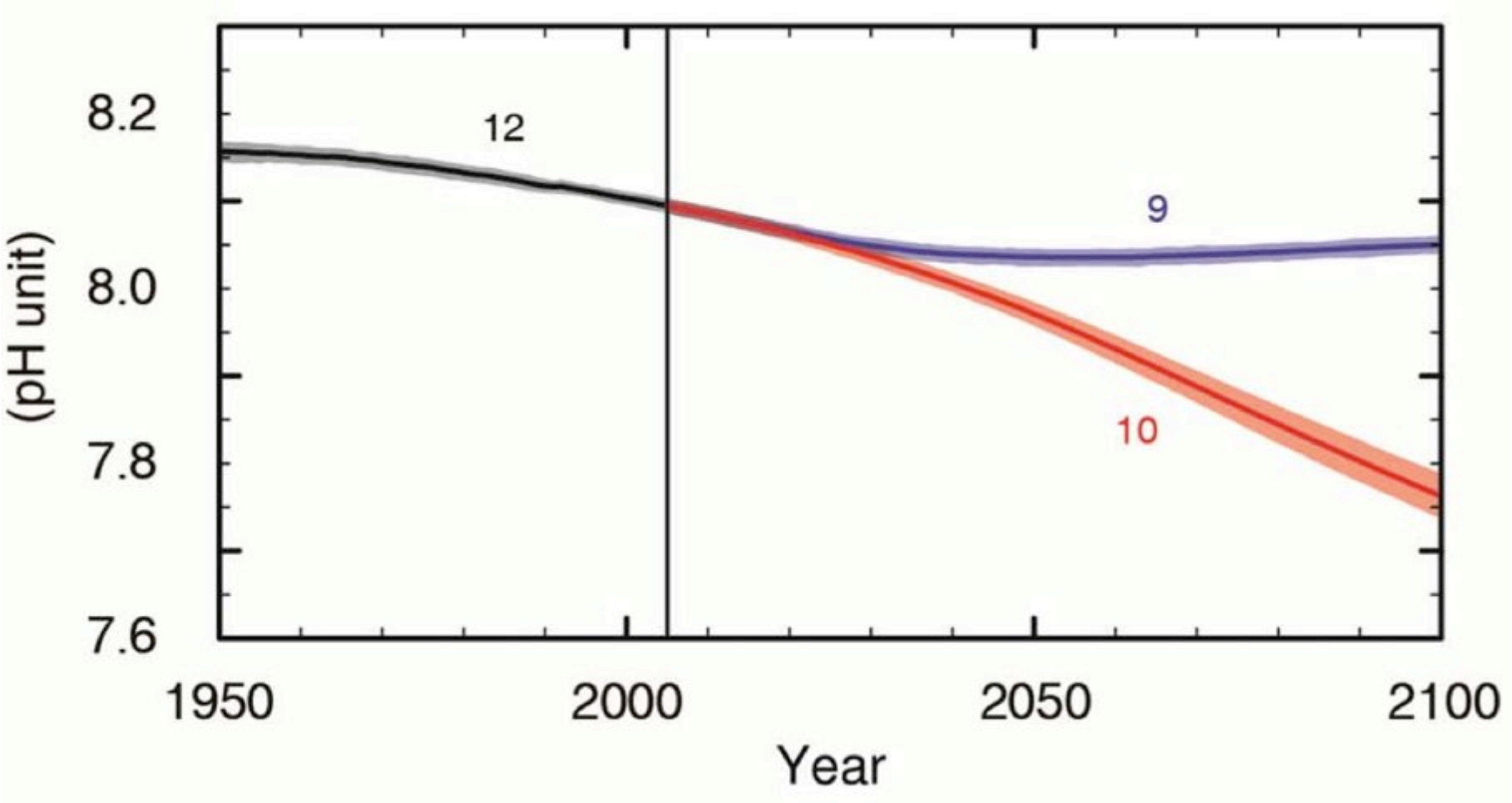

(Time 2001)

# With 8 metre sea-level rise: 3700 km$^2$ below sea-level in Belgium (very possible in year 3000) (NB: flooded area depends on protection)


Source: J.P. van Ypersele et P. Marbaix (2004) See www.climate.be/impacts

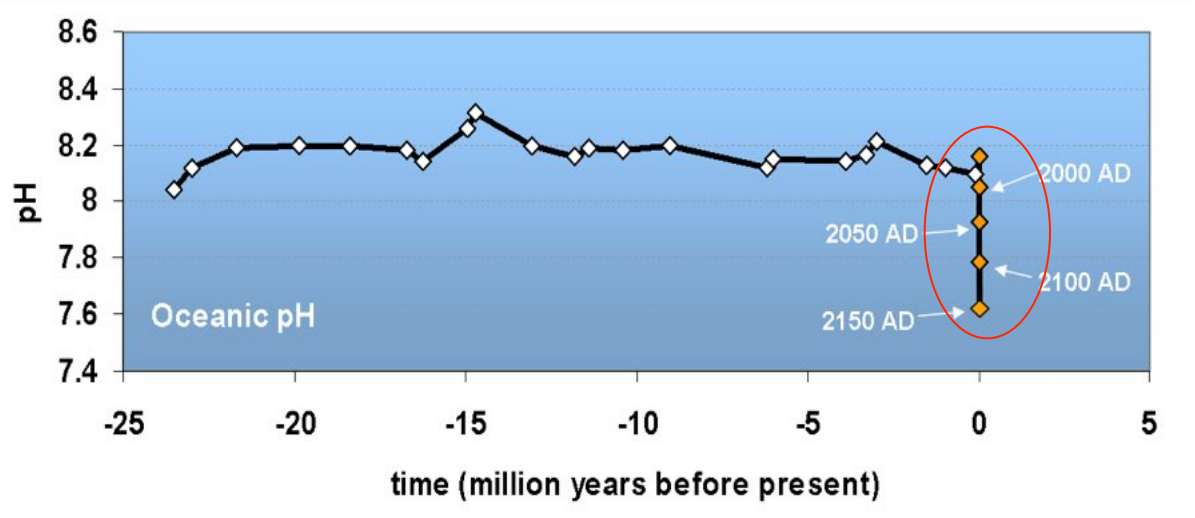
# Global ocean surface pH (projections)

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



# Oceans are Acidifying Fast …….

**Changes in pH over the last 25 million years**



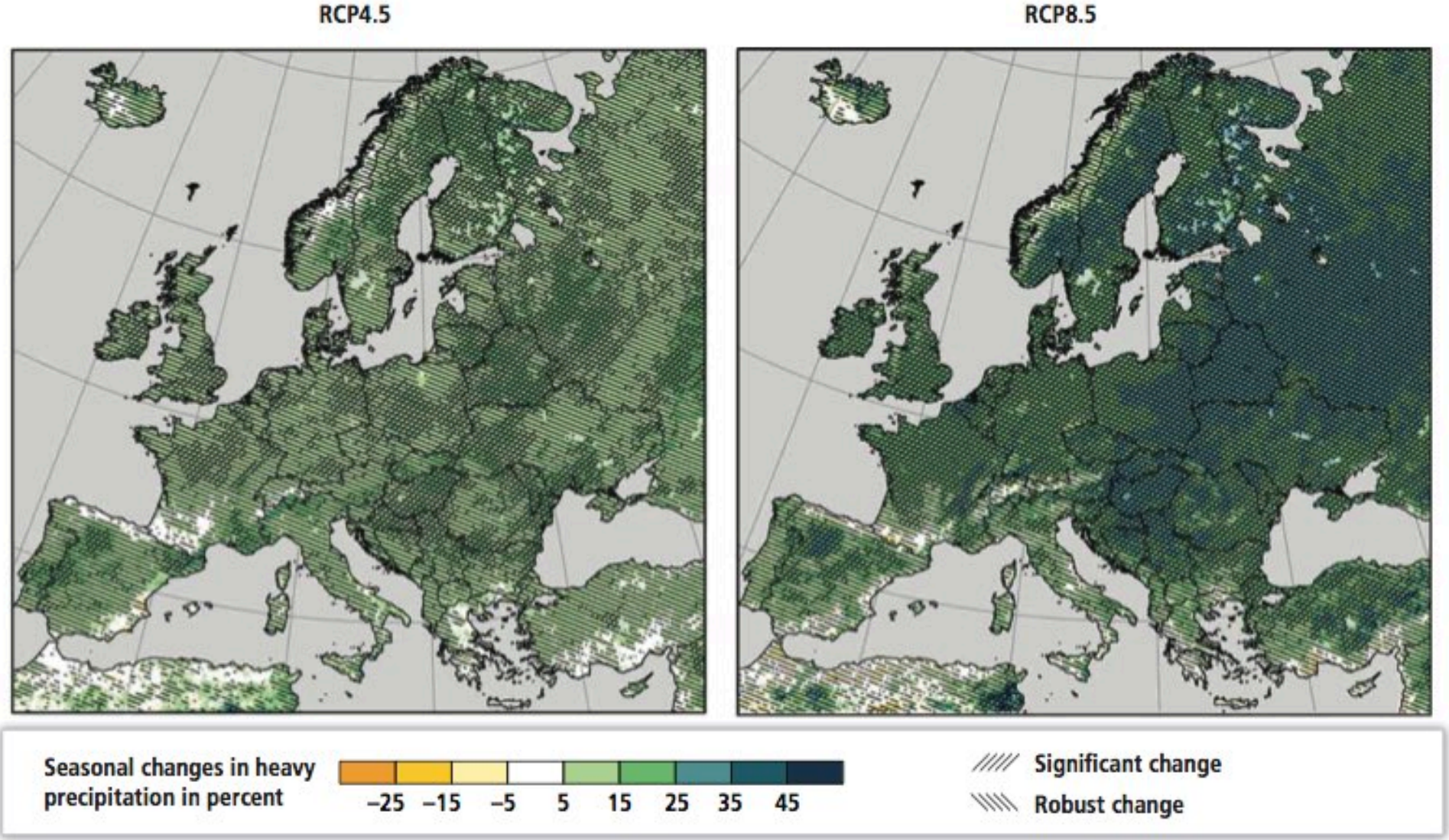

"Today is a rare event in the history of the World"

- **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

# 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


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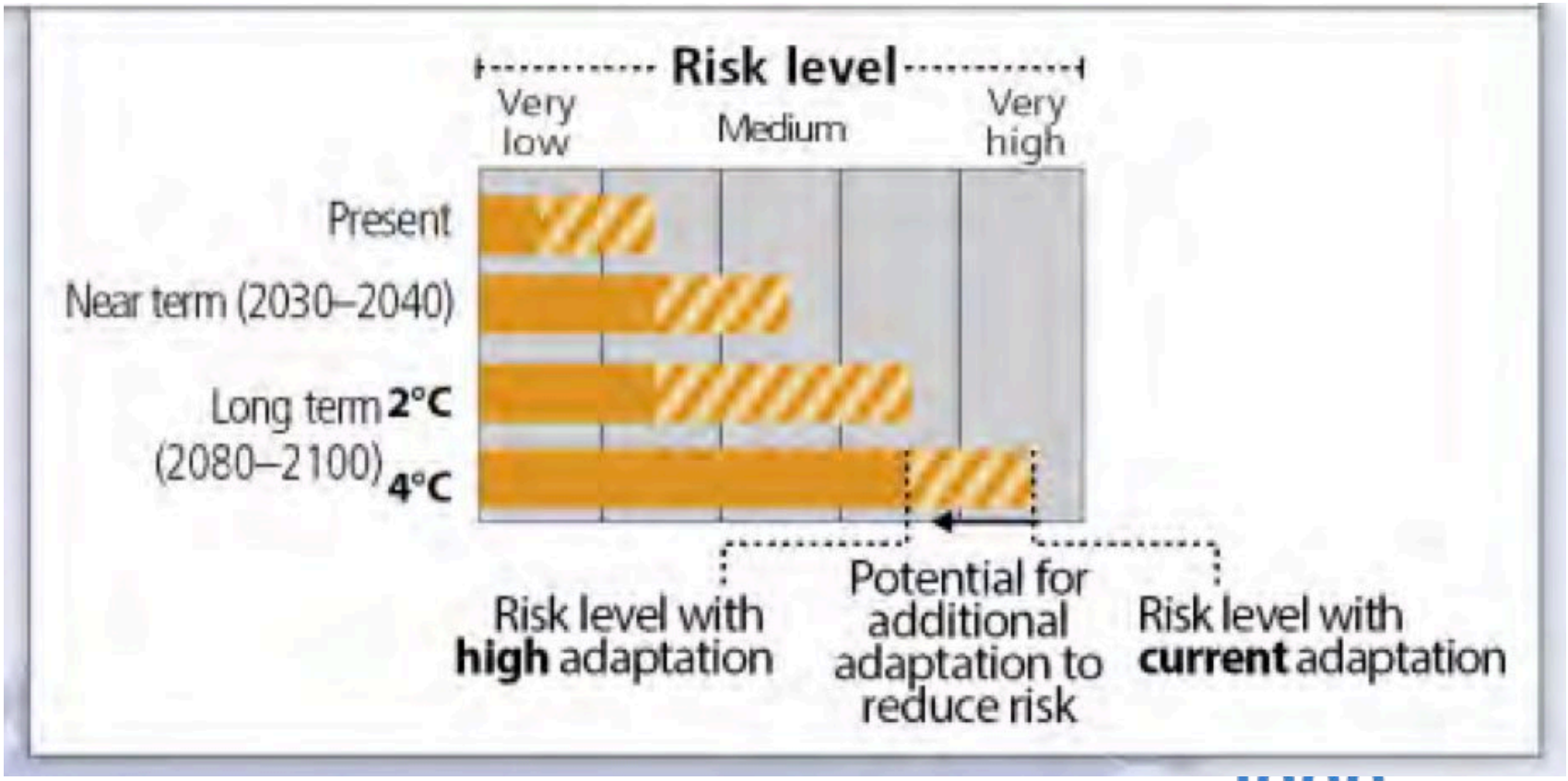
# Flood risk adaptation in Bangladesh (example): cyclone shelters, awareness raising, forecasting and warning

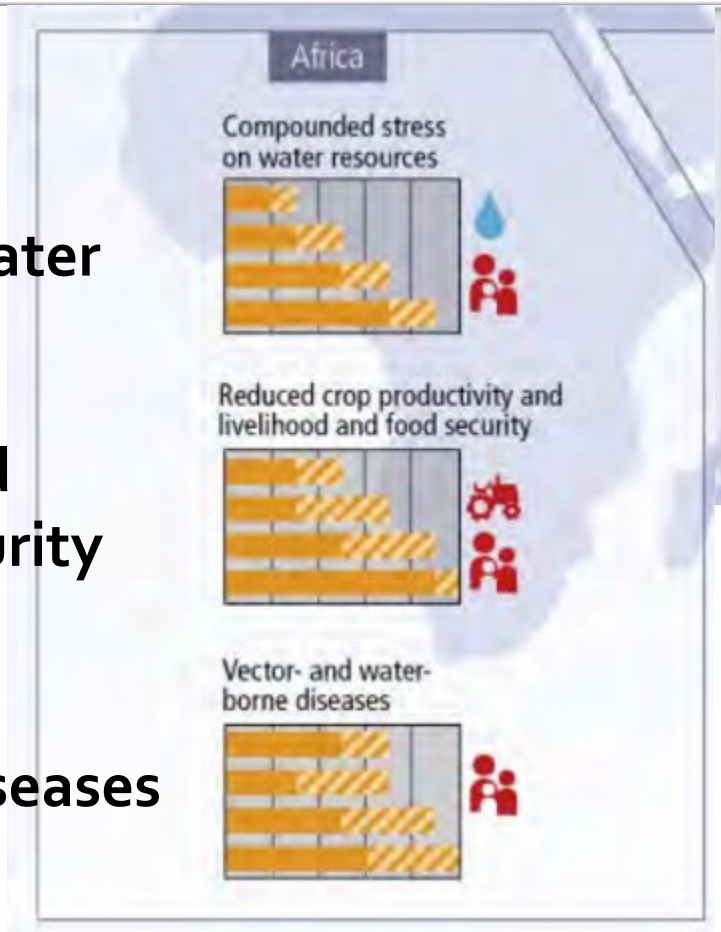
photo: Dr Thorsten Klose/German Red Cross (2010), evaluation of the Community Based Disaster Preparedness Programme run by the Red Cross in1996-2002

# Regional key risks and potential for risk reduction through adaptation


IPCC, AR5, SPM, Figure SPM.8

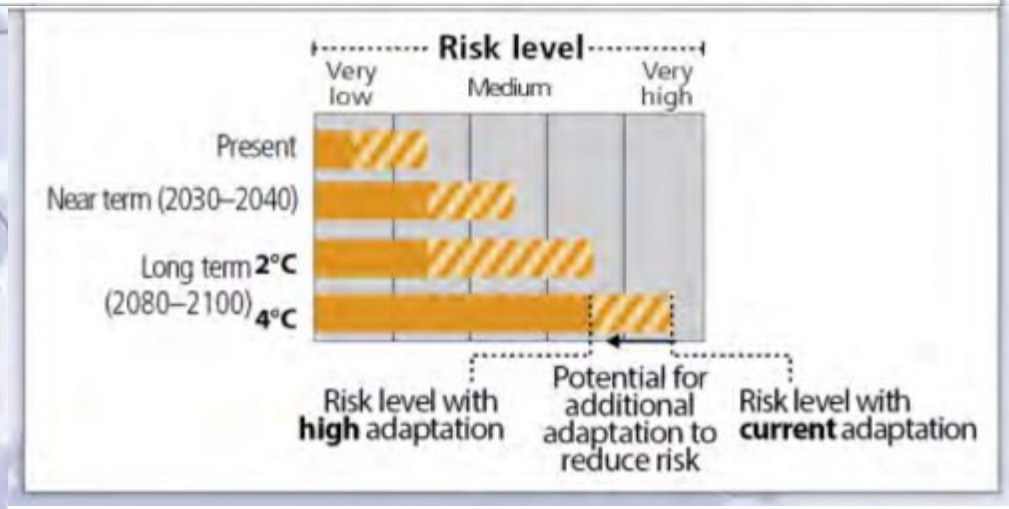
# Regional key risks and risk reduction through adaptation


Water

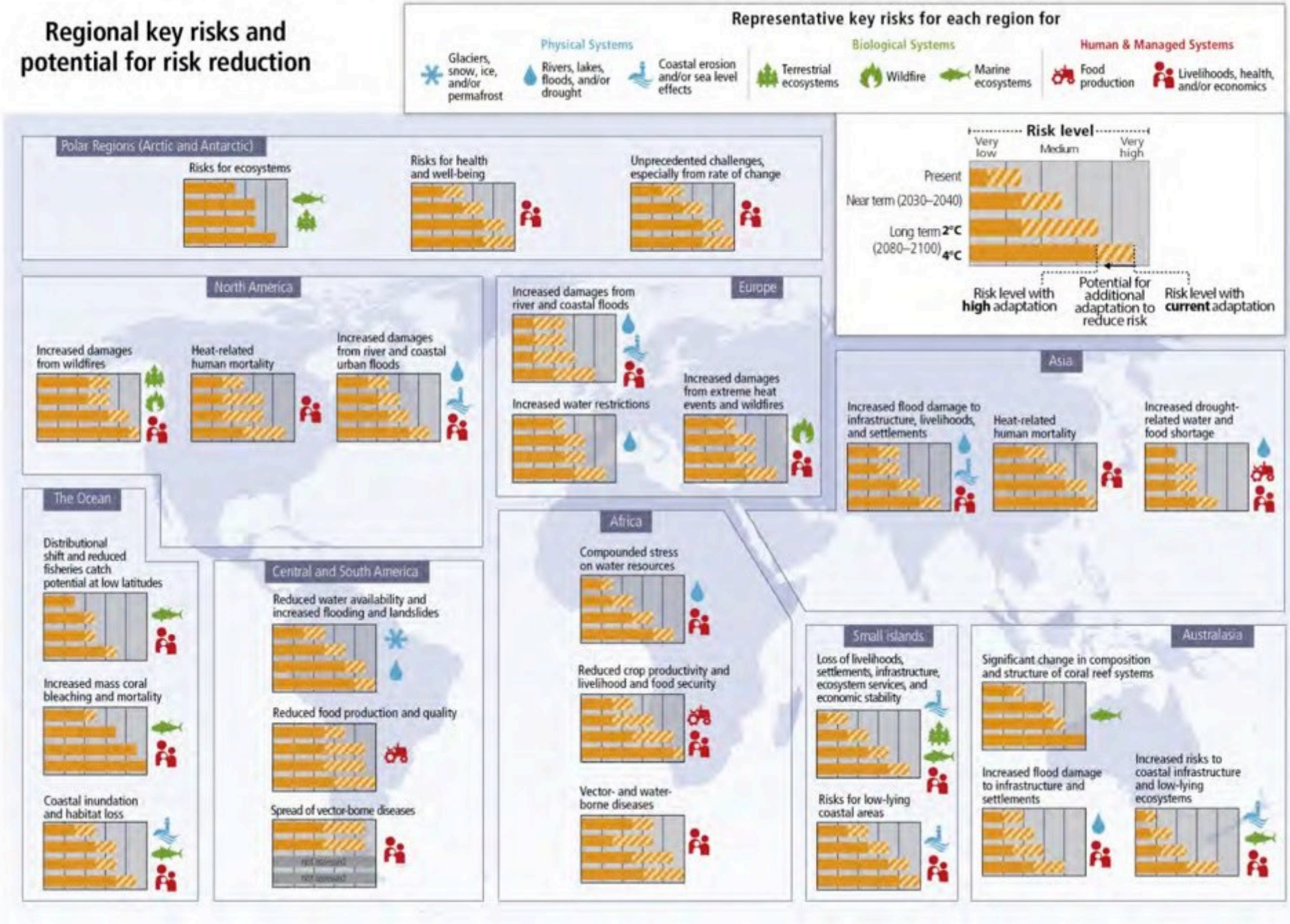
Food security

Diseases




IPCC, AR5, SPM, Figure SPM.8

# 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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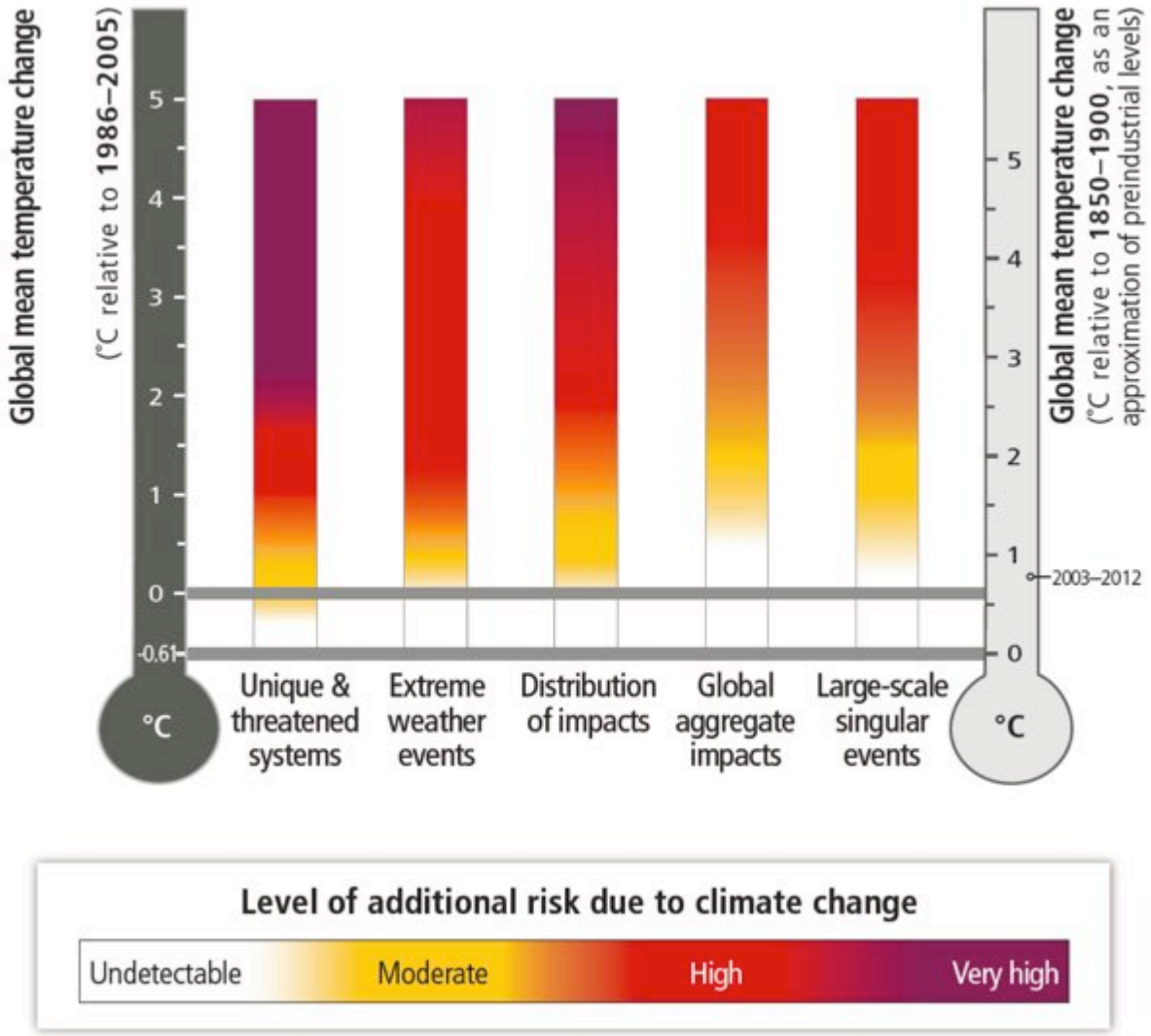
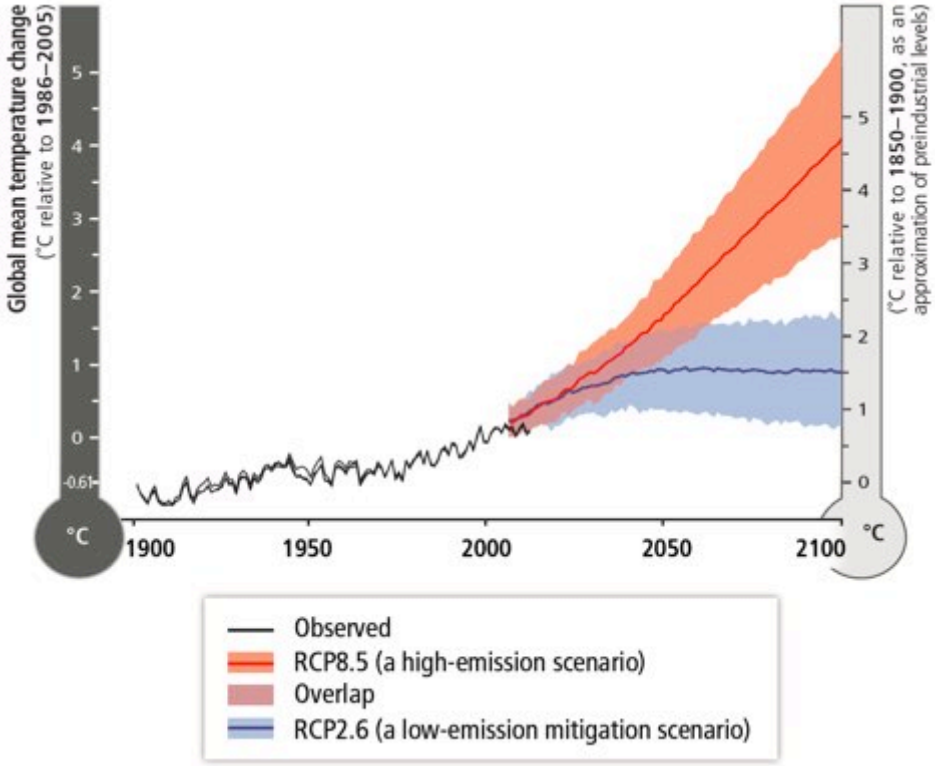
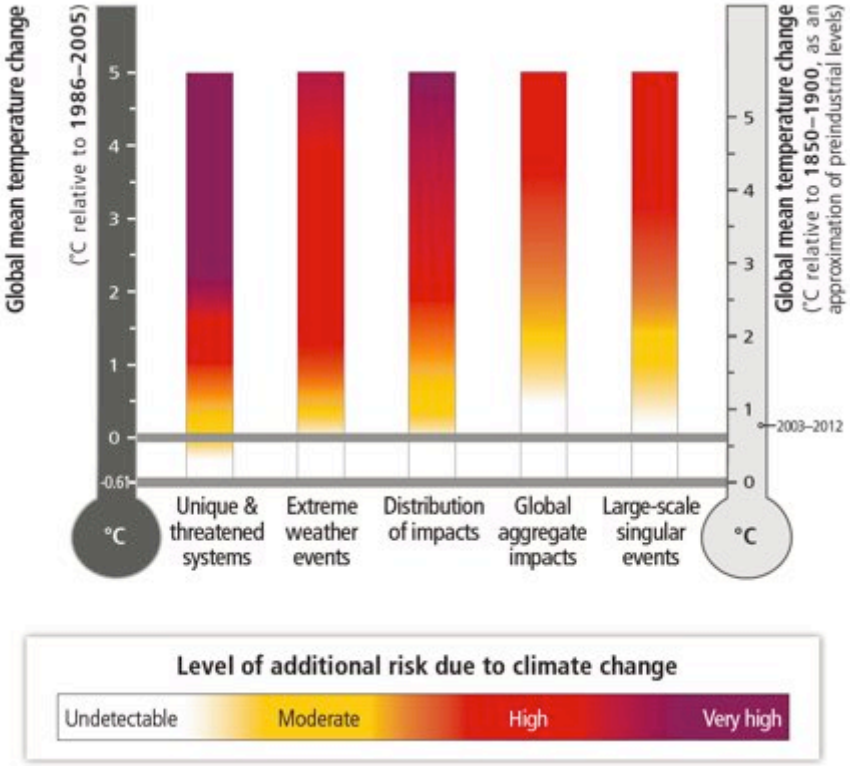



AR5, WGII, Box SPM.1 Figure 1

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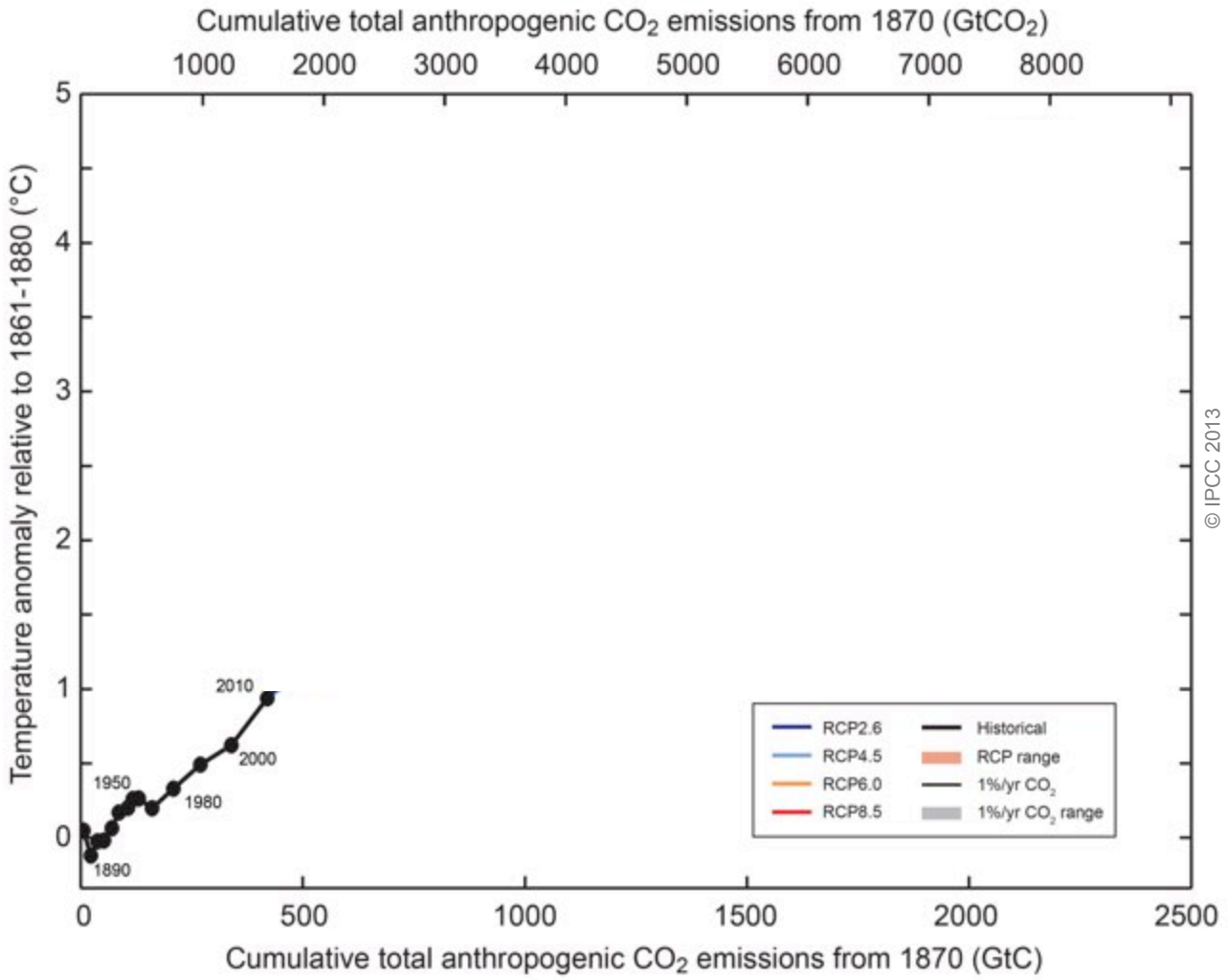



Fig. SPM.10

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

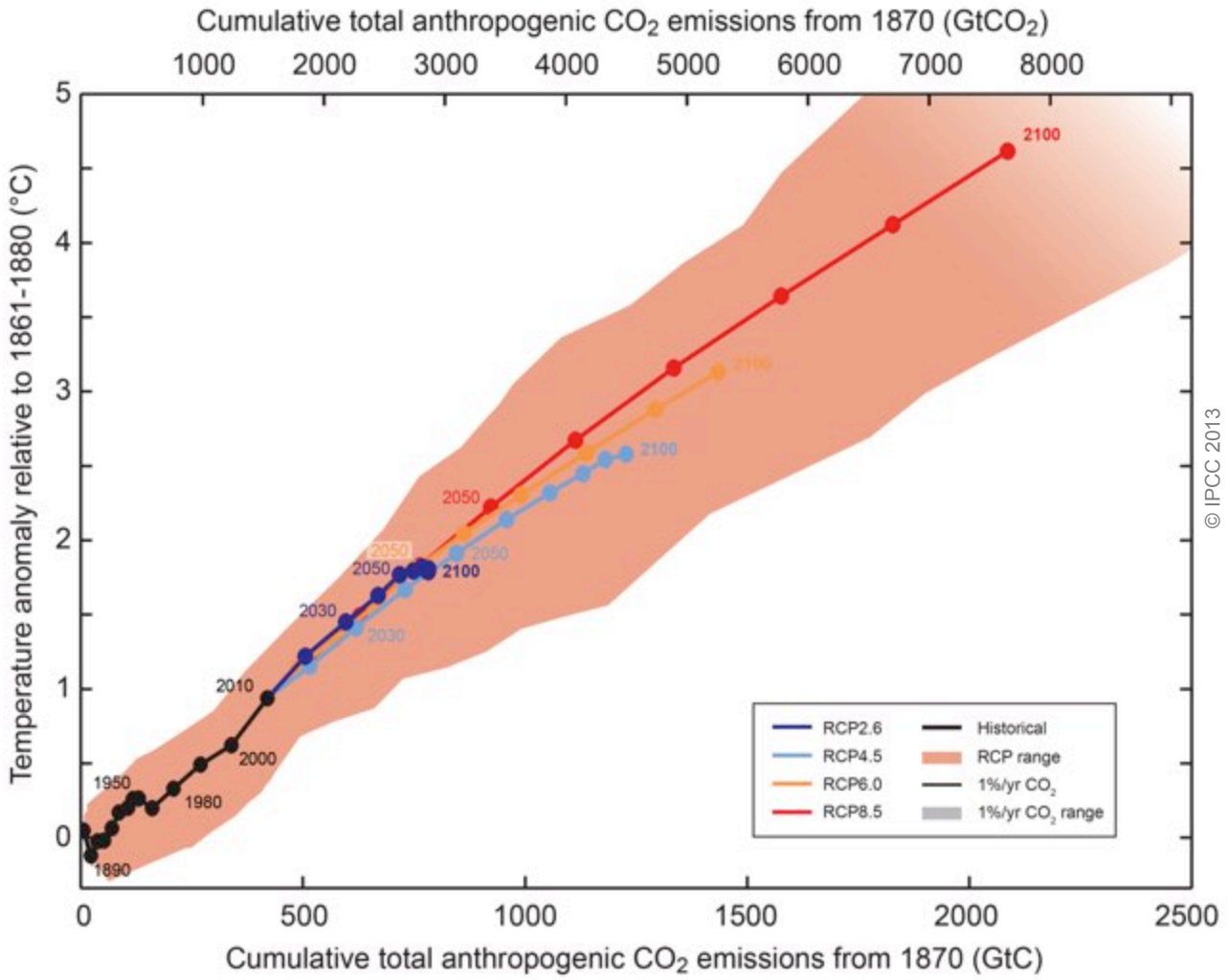
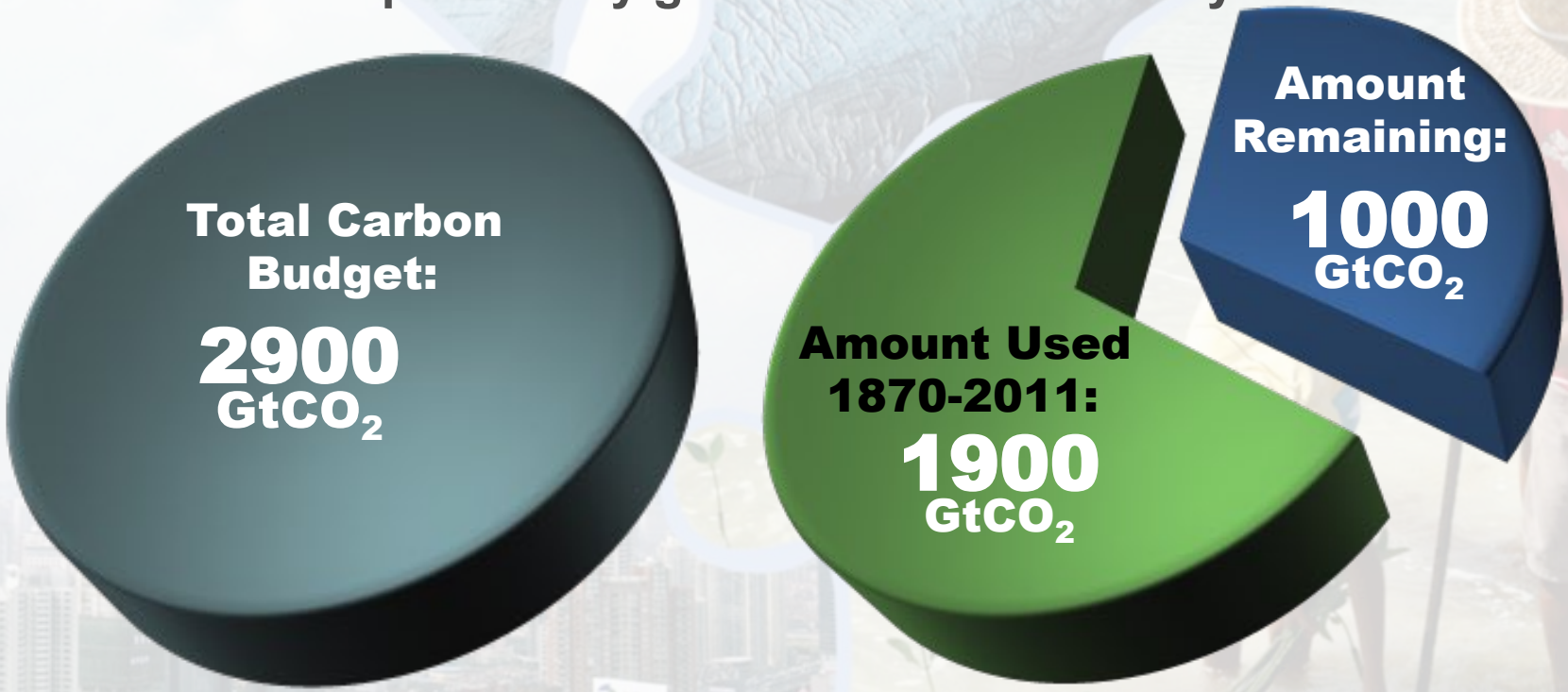



Fig. SPM.10

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

# 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. Ethical analysis can identify the different ethical principles that underlie different viewpoints, and distinguish correct from incorrect ethical reasoning.

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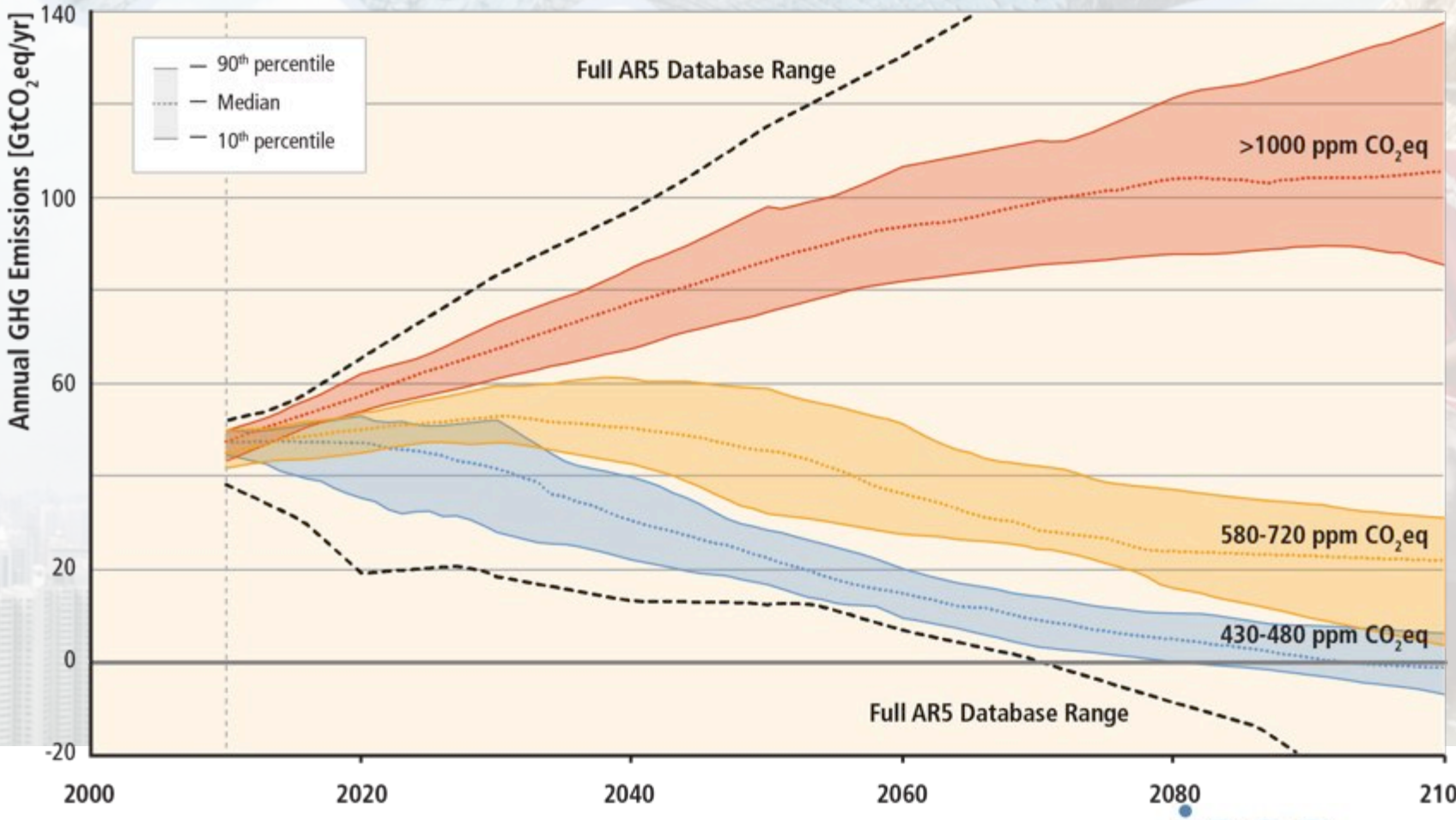
IPCC, AR5, WG III, TS, p. 39

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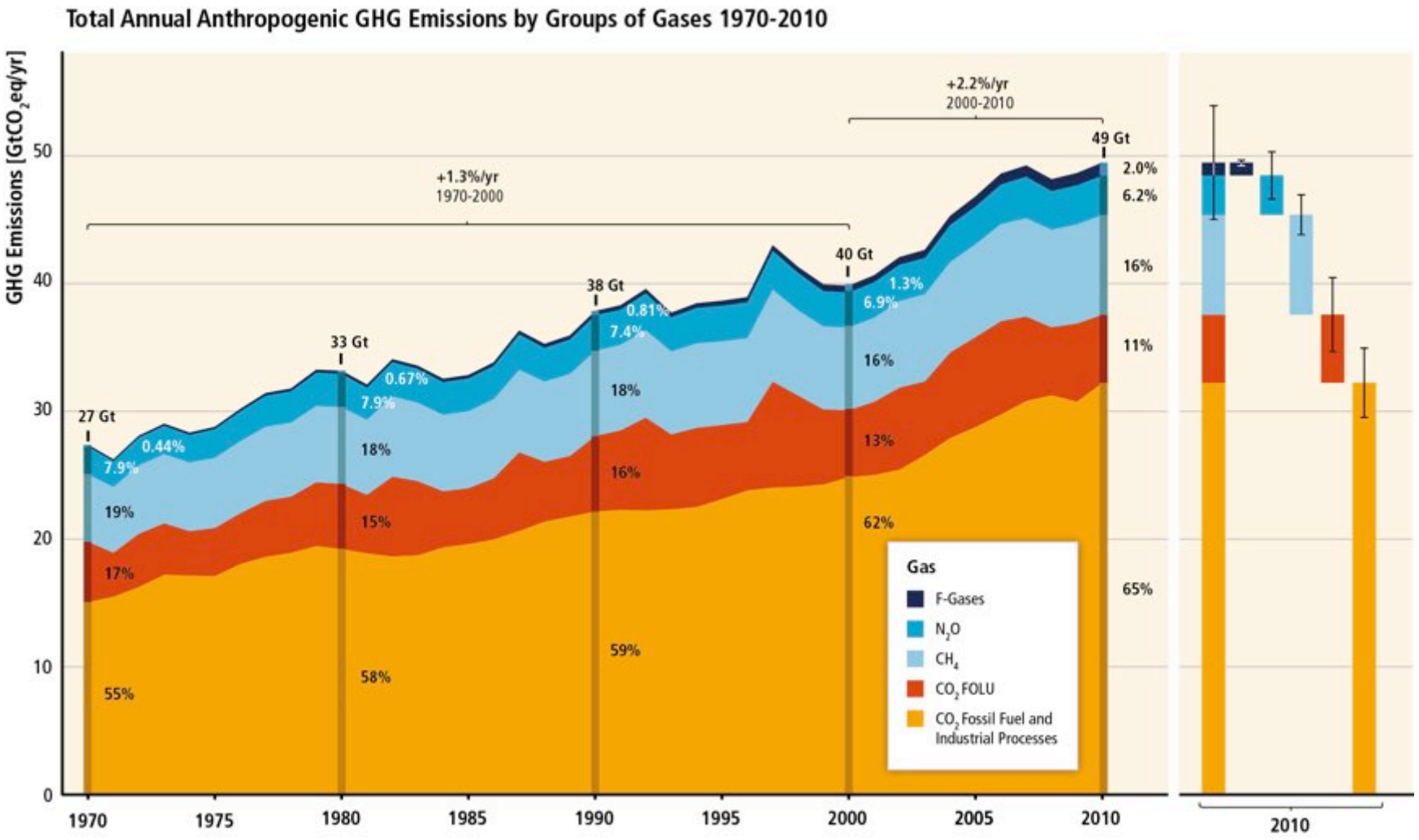
# GHG emissions accelerate despite reduction efforts. Most emission growth is $CO_2$ from fossil fuel combustion and industrial processes.




Working Group III contribution to the
IPCC Fifth Assessment Report

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# Limiting Temperature Increase to 2˚C

**Measures exist to achieve the substantial emissions reductions required to limit likely warming to 2°C**

**A combination of adaptation and substantial, sustained reductions in greenhouse gas emissions can limit climate change risks**

**Implementing reductions in greenhouse gas emissions poses substantial technological, economic, social, and institutional challenges**

**But delaying mitigation will substantially increase the challenges associated with limiting warming to 2°C**

AR5 WGI SPM, AR5 WGII SPM,AR5 WGIII SPM



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# 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 $CO_2$eq) 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.

# 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**

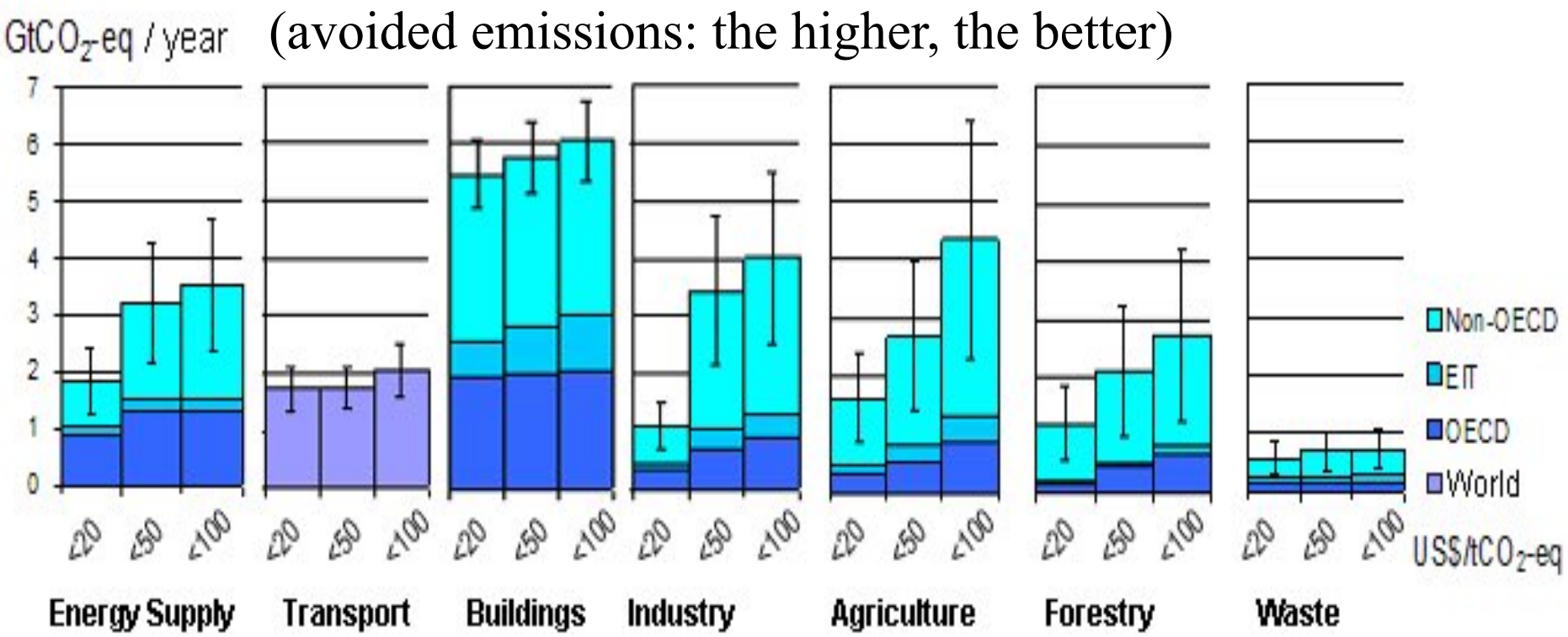
- **Reduced deforestation** and improved forest management and planting of new forests
- **Bio-energy with carbon capture and storage**

Lifestyle and behavioural changes

AR5 WGIII SPM

- **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)**

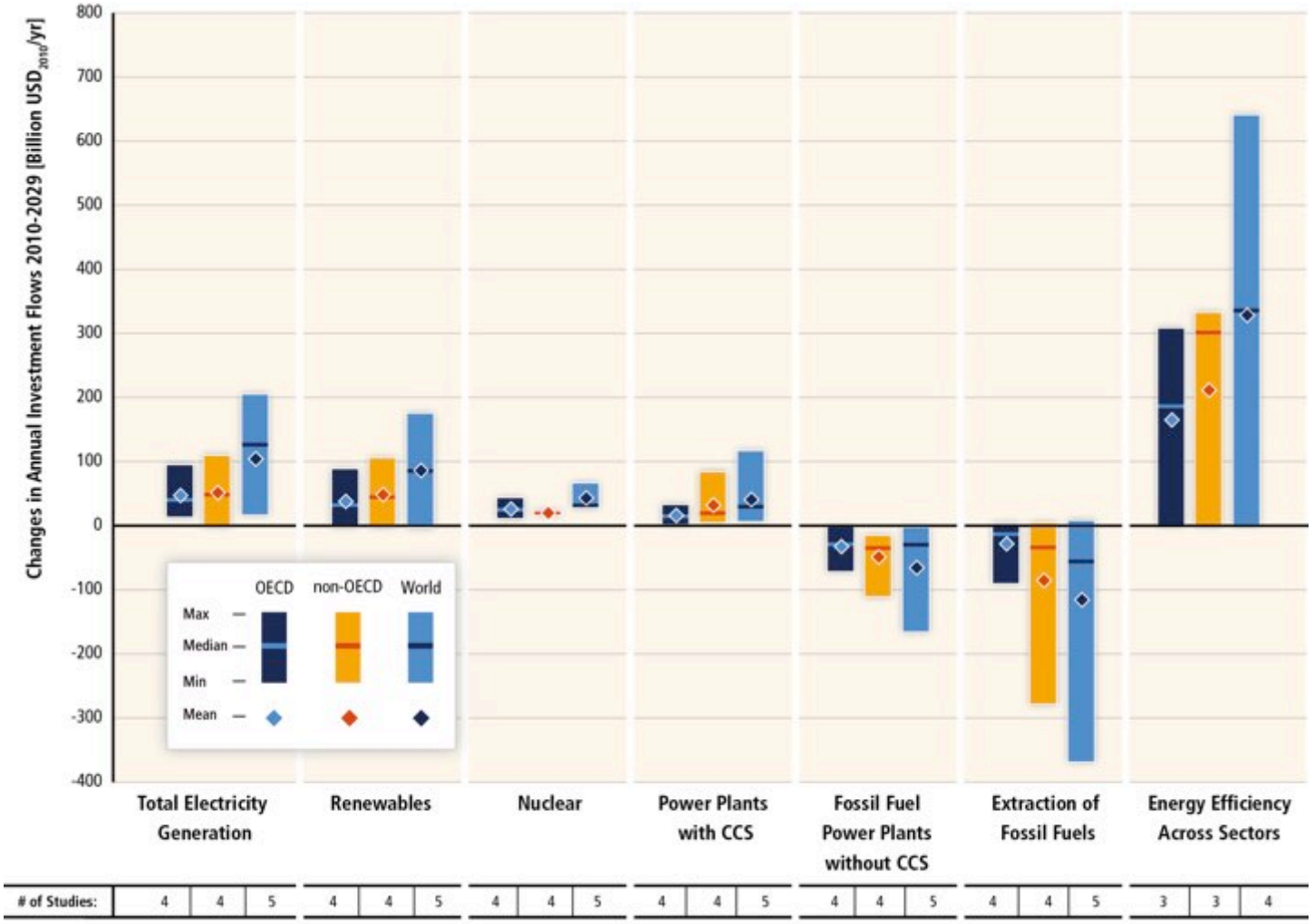
# All sectors and regions have the potential to contribute by 2030




IPCC AR4 (2007)

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

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



- **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**

# Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

- **Sector-specific policies** have been more widely used than economy-wide policies.
- **Regulatory approaches and information** measures are widely used, and are often environmentally effective.
- Since AR4, **cap and trade** systems for GHGs have been established in a number of countries and regions.
- In some countries, **tax-based policies** specifically aimed at reducing GHG emissions–alongside technology and other policies–have helped to weaken the link between GHG emissions and GDP
- The **reduction of subsidies** for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context.

# Effective mitigation will not be achieved if individual agents advance their own interests independently.

- Existing and proposed **international climate change cooperation** arrangements vary in their focus and degree of centralization and coordination.
- Issues of **equity, justice, and fairness** arise with respect to mitigation and adaptation.
- Climate policy may be informed by a consideration of a diverse array of risks and uncertainties, some of which are difficult to measure, notably events that are of low probability but which would have a significant impact if they occur.

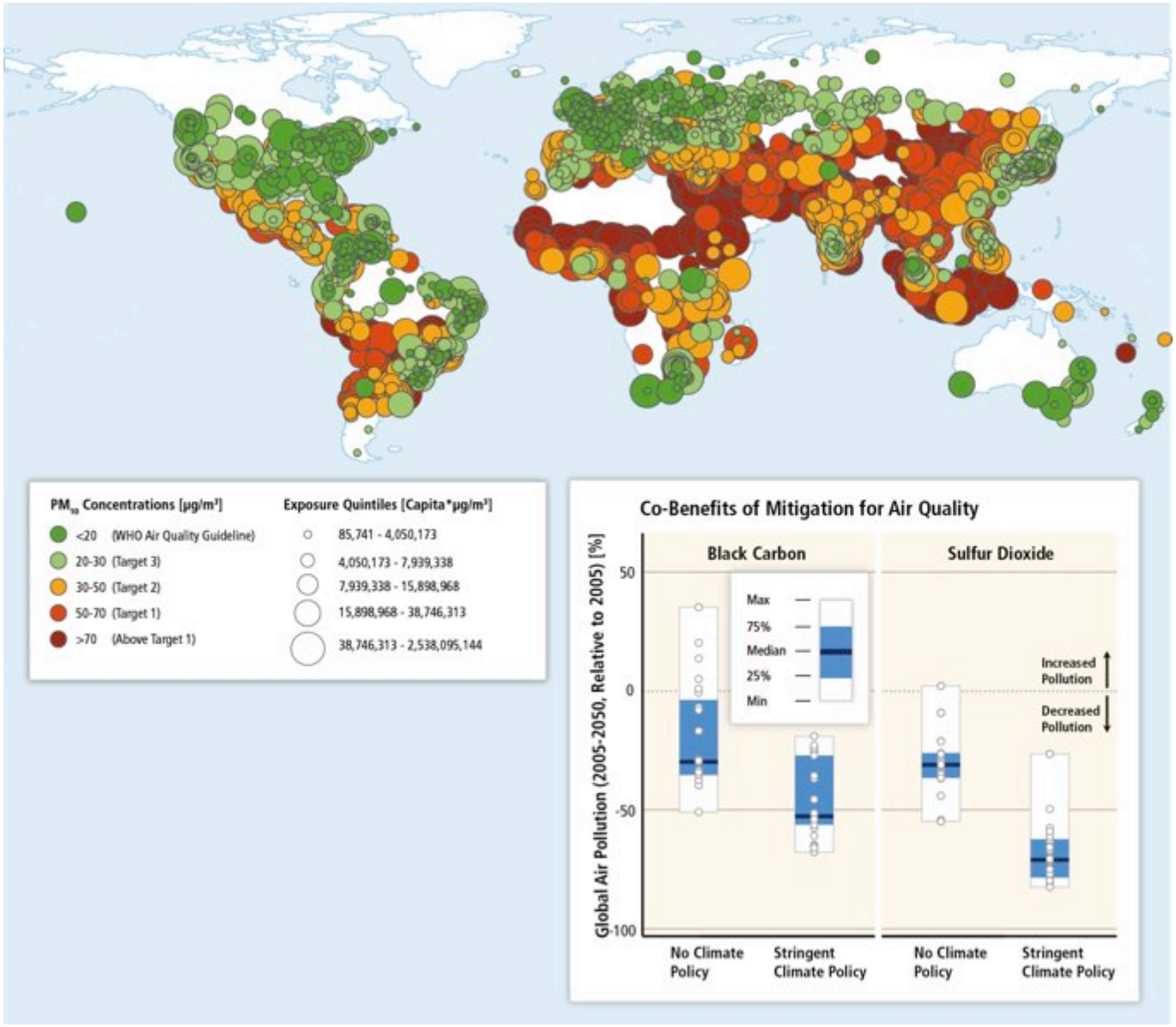
# Ambitious Mitigation Is Affordable

- ➜ 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


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.

**NB: Ambition *before* 2020 is essential as well (lock-in & entrainment effects)**







**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**

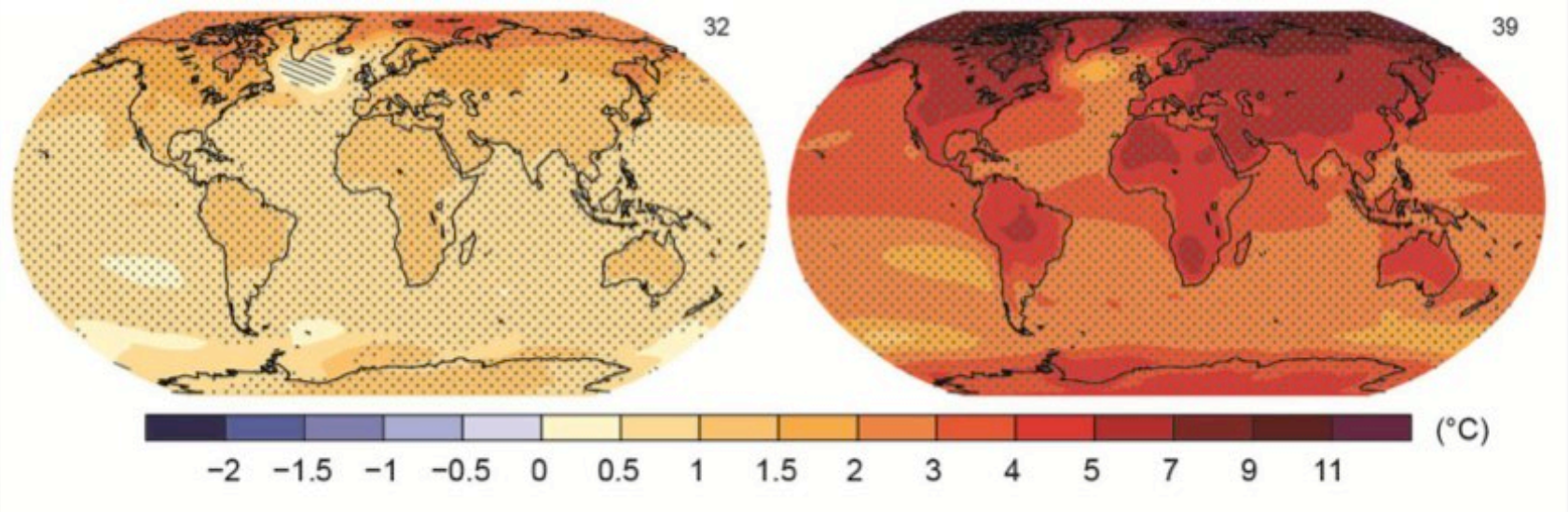
- **Issues of equity, justice, and fairness arise with respect to mitigation and adaptation**

AR5, WGIII, SPM

# The Choices Humanity Makes Will Create Different Outcomes (and affect prospects for effective adaptation)

With substantial mitigation

Without additional mitigation



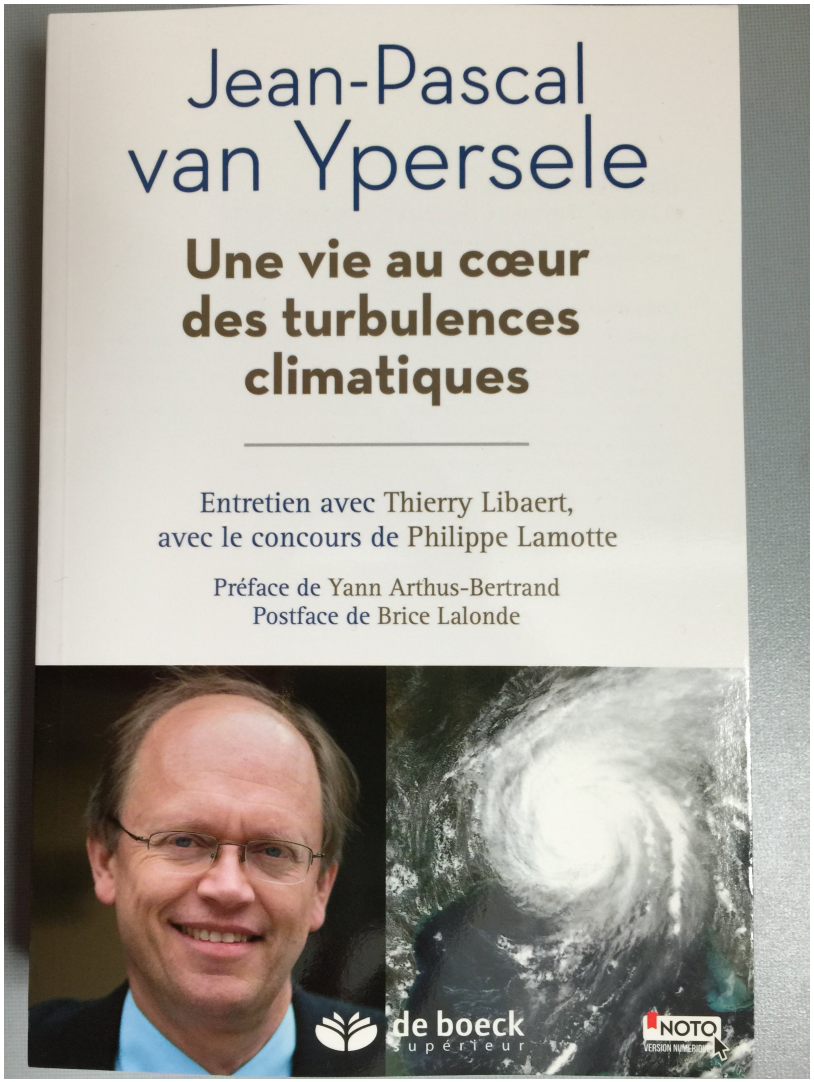

Change in average surface temperature (1986–2005 to 2081–2100)

AR5 WGI SPM

# The Hidden IPCC Message:

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

**If you read French:**
**Publié chez De Boeck supérieur,**
**octobre 2015**



# Useful links:

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