

# ***Climate Change: Challenges and Opportunities after COP21***

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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 Organization

UNEP= United Nations Environment Programme

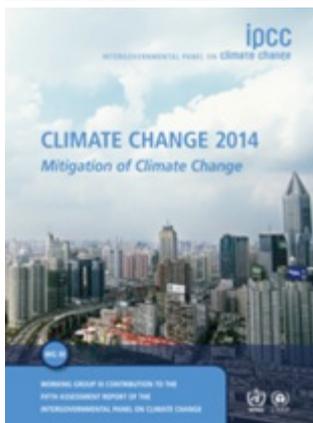




**What is happening in the climate system?**



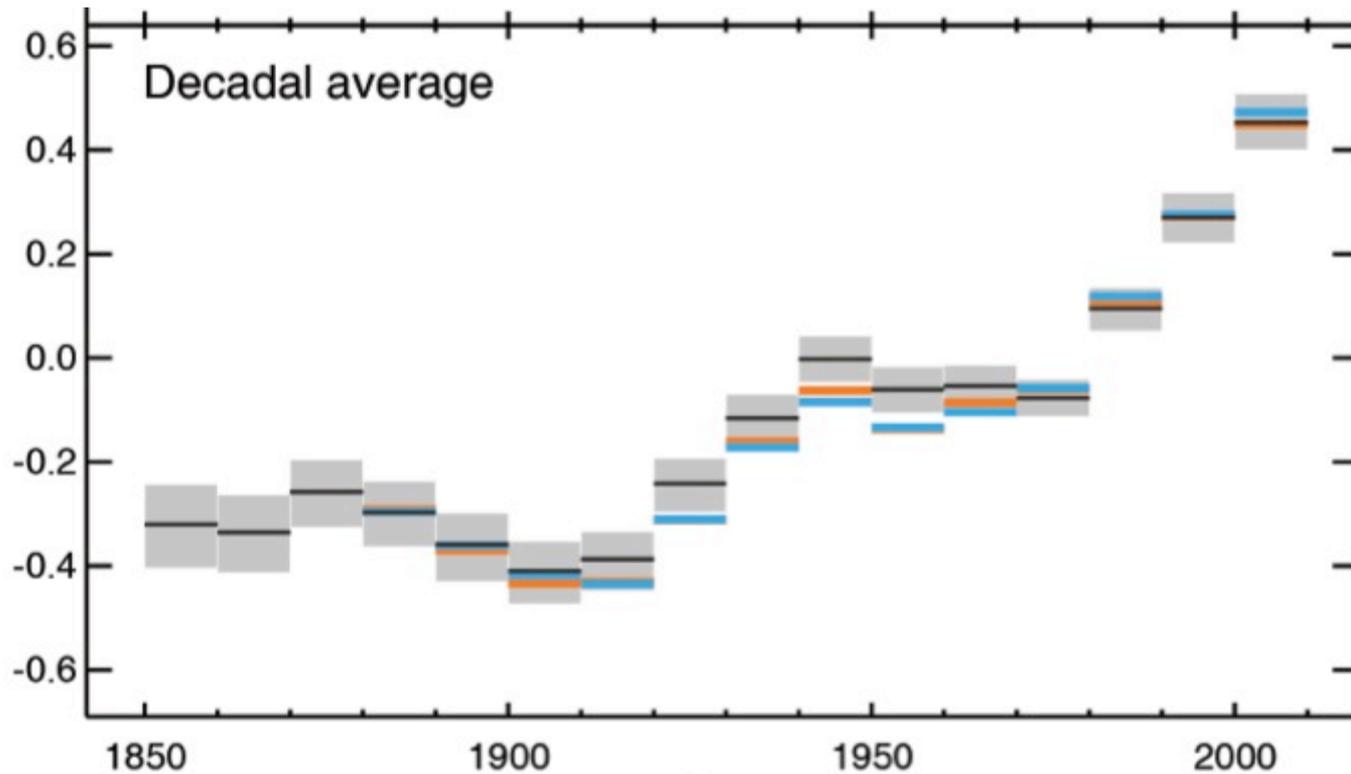
**What are the risks?**



**What can be done?**

# 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**



**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)



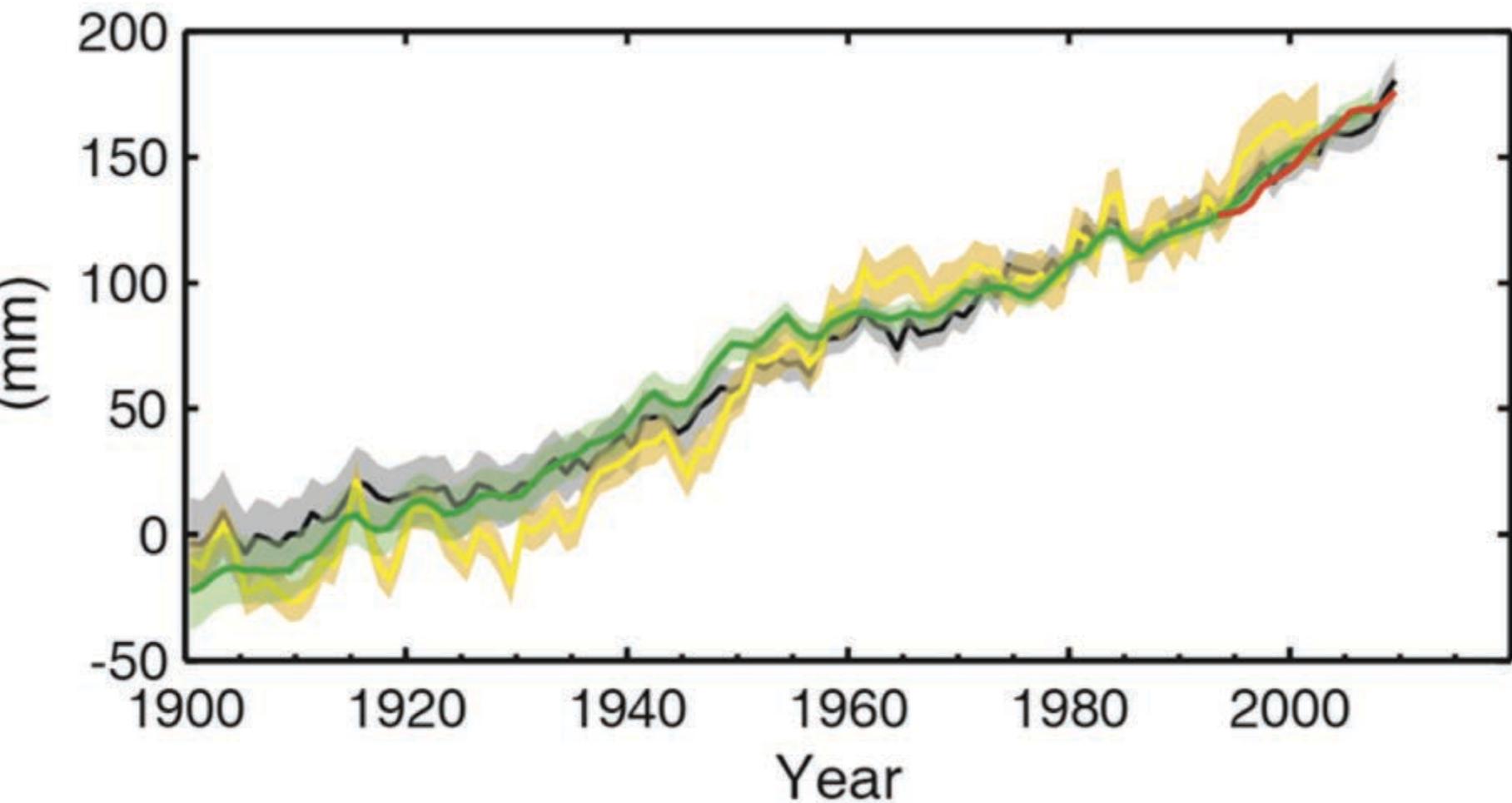
[http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm\\_ven=Email&cm\\_cat=ENVIRONMENT\\_us\\_share](http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share)

# Plateau Glacier (2003) (Alaska)

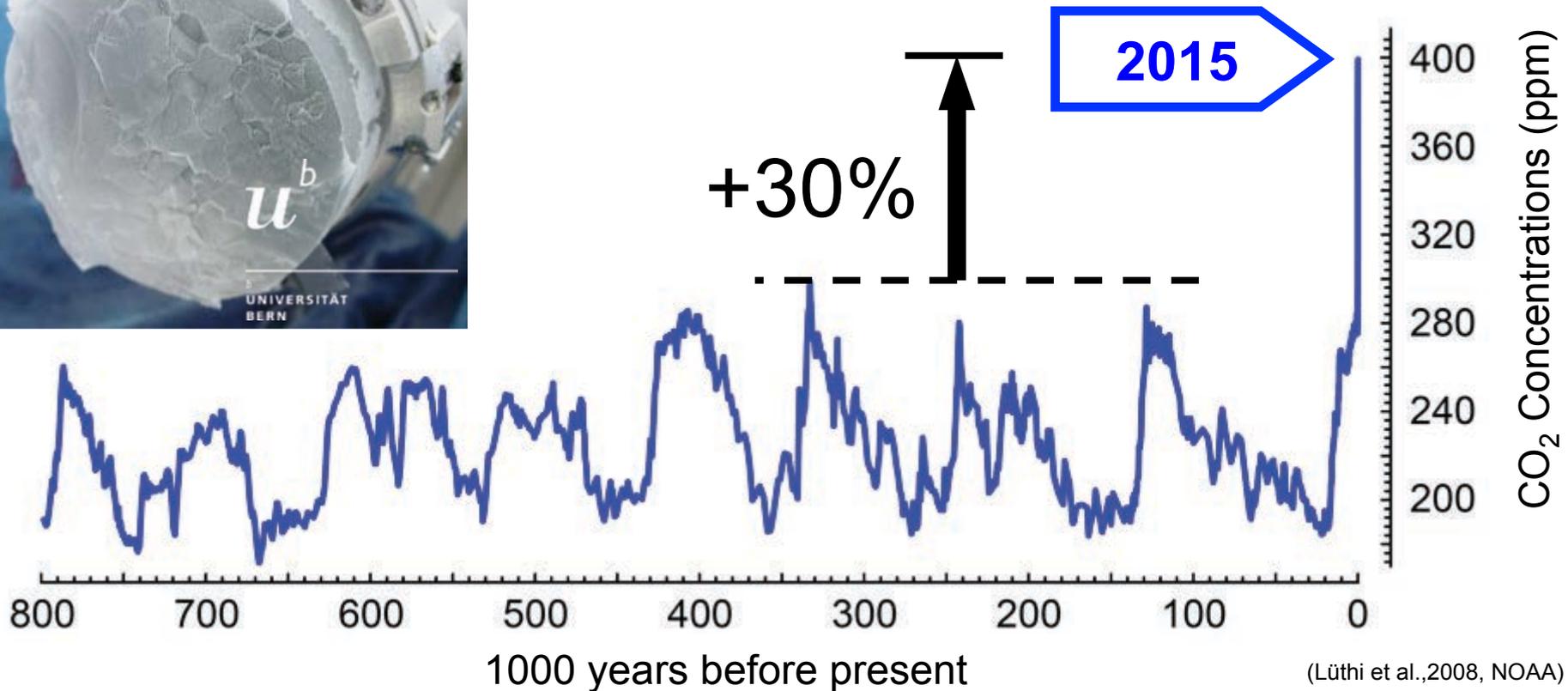


[http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm\\_ven=Email&cm\\_cat=ENVIRONMENT\\_us\\_share](http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share)

# Change in average sea-level change

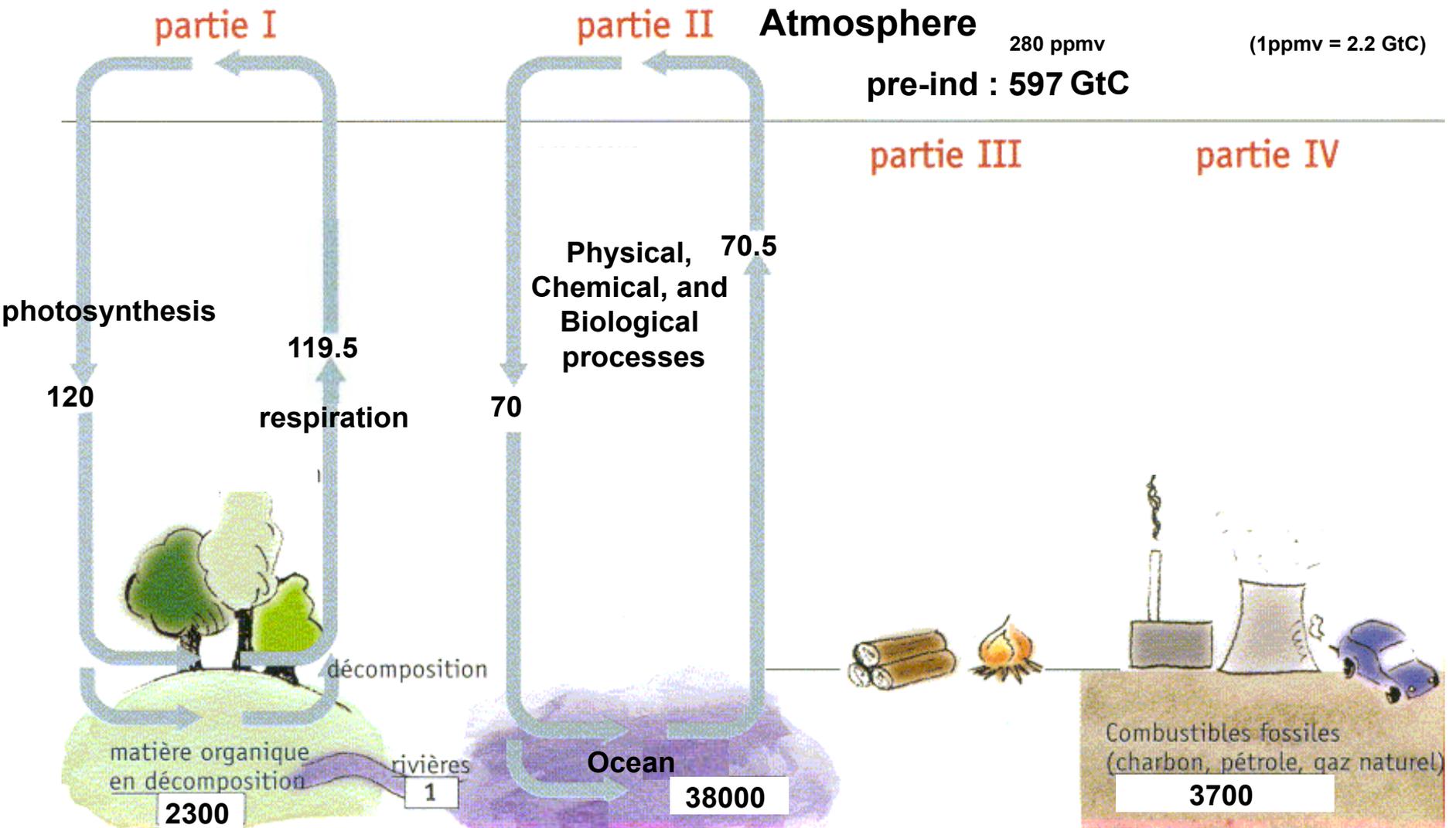


# Atmospheric concentrations of CO<sub>2</sub>



**The concentrations of CO<sub>2</sub> have increased to levels unprecedented in at least the last 800,000 years.**

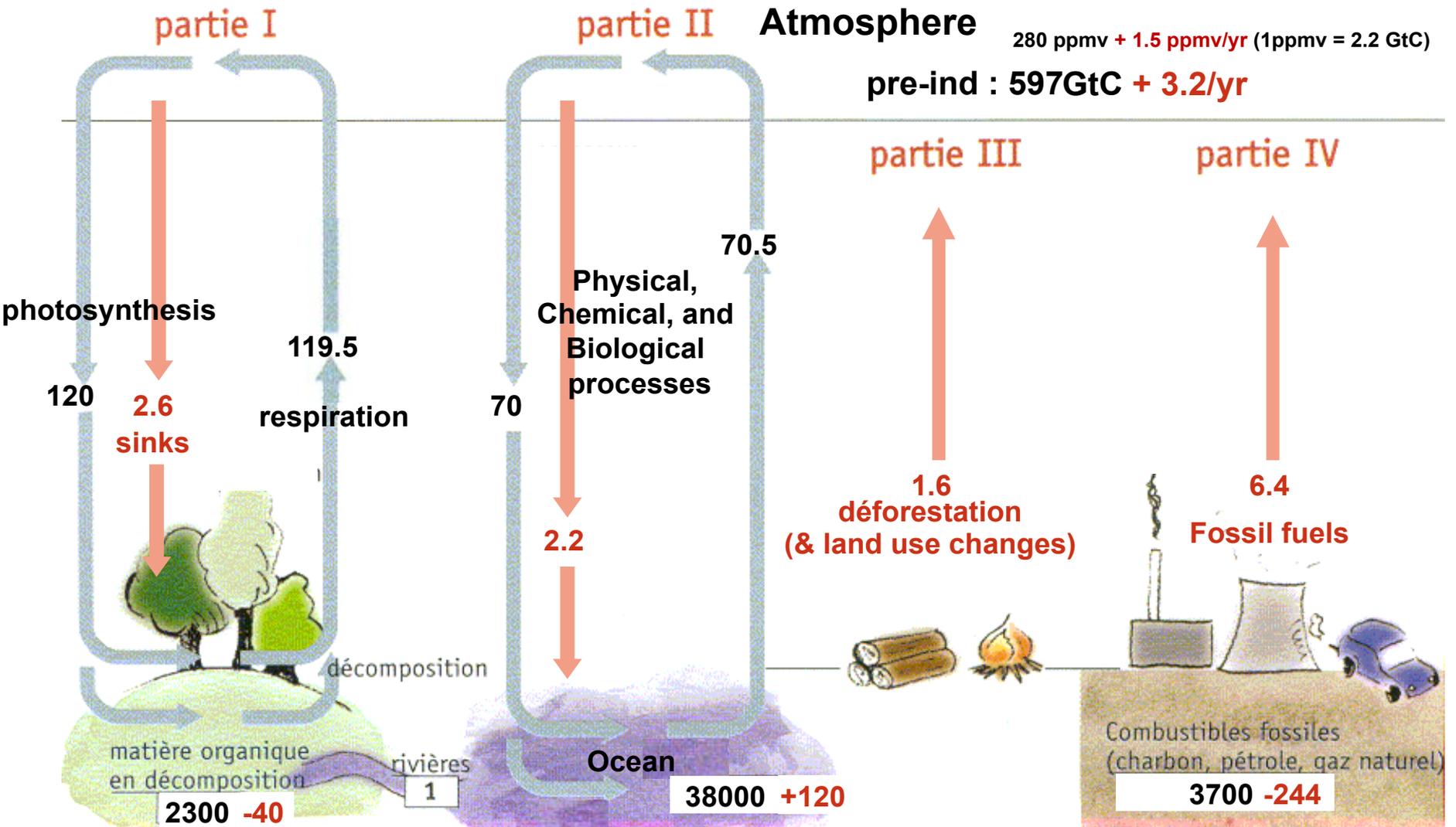
# Carbon cycle: unperturbed fluxes



Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get GtCO<sub>2</sub>)

# Carbon cycle: perturbed by human activities

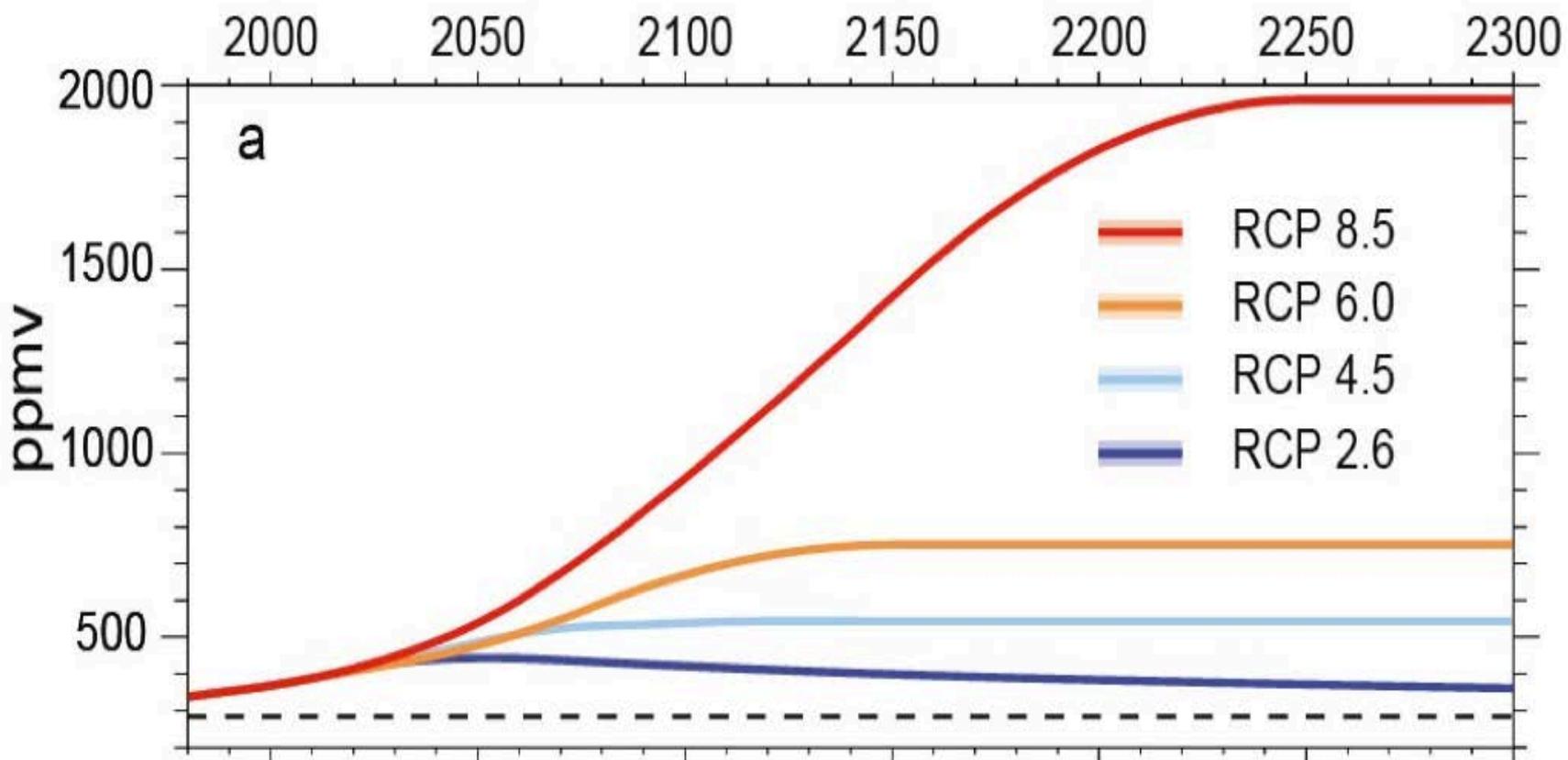
(numbers for the decade 1990-1999s, based on IPCC AR4)



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

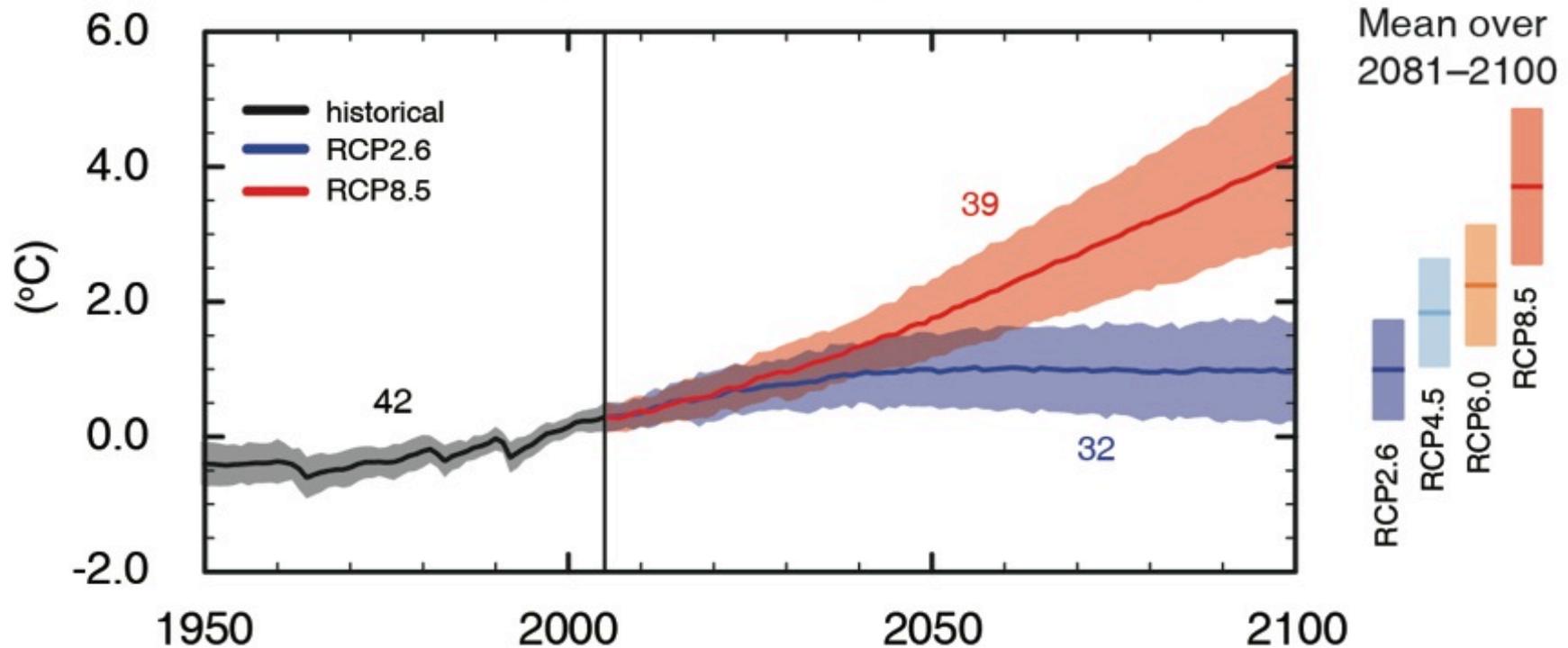
Stocks!

# RCP Scenarios: Atmospheric CO<sub>2</sub> concentration



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

## Global average surface temperature change

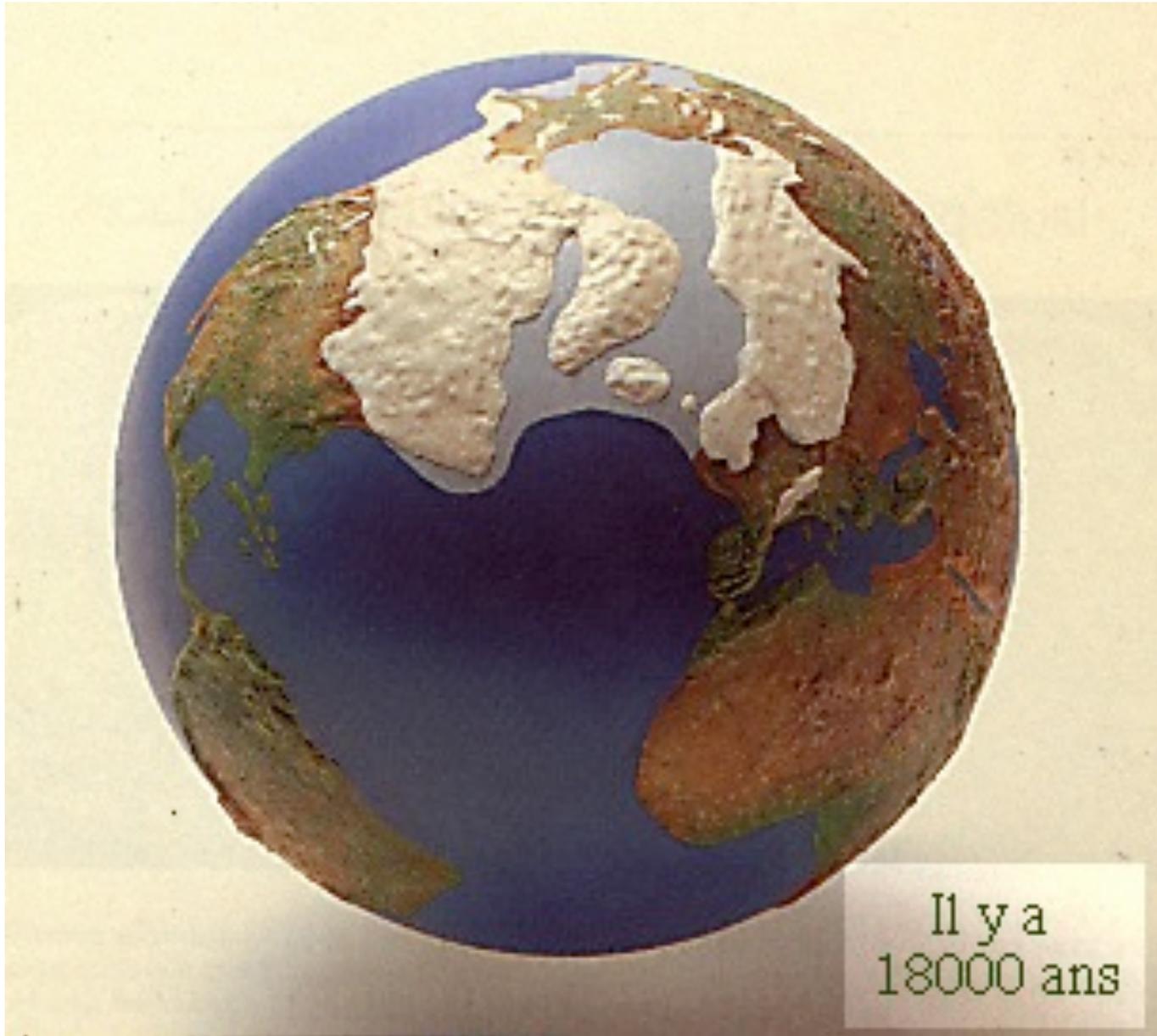


(IPCC 2013, Fig. SPM.7a)

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

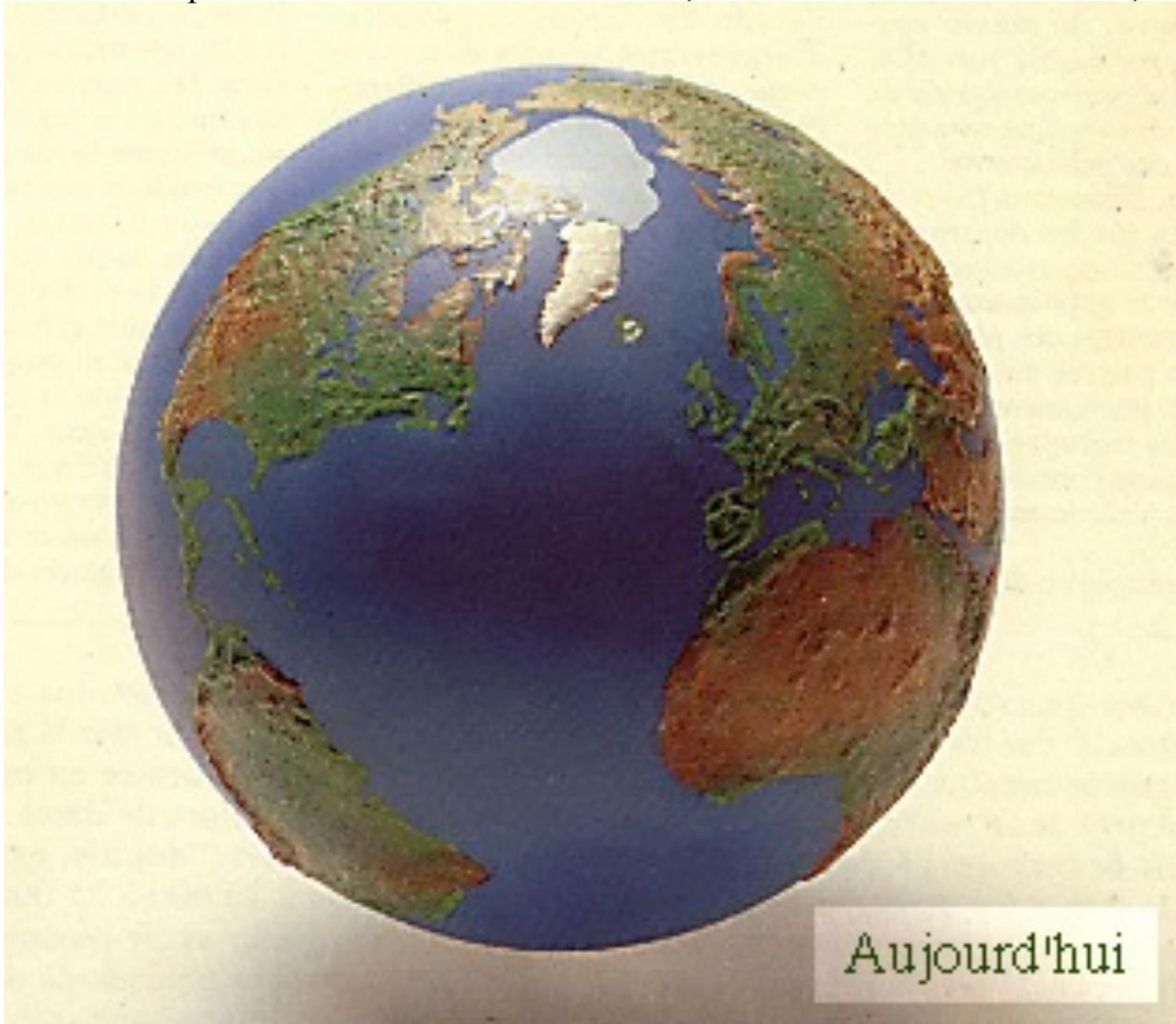
# 18-20000 years ago (Last Glacial Maximum)

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

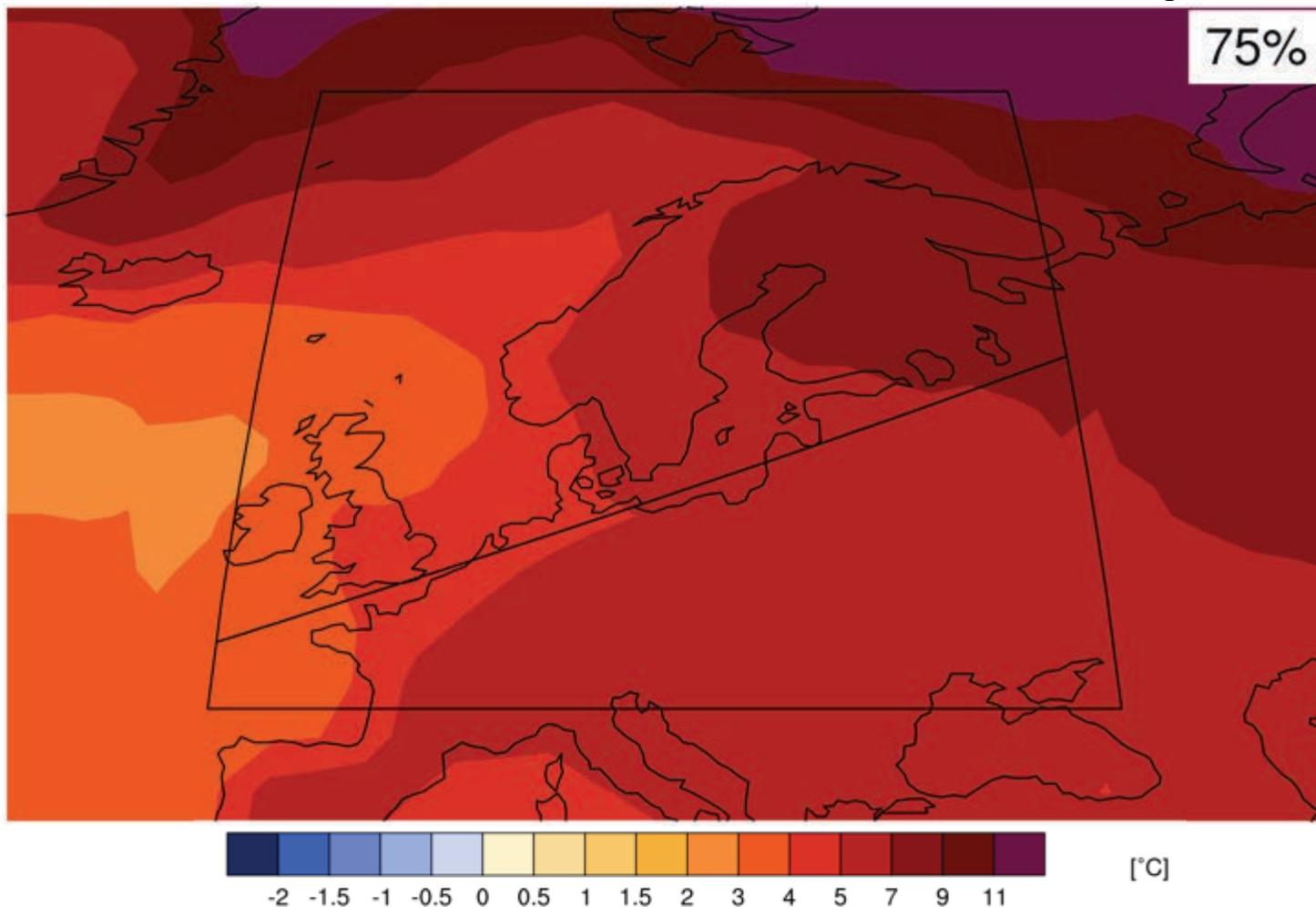


# Today, with +4-5°C globally

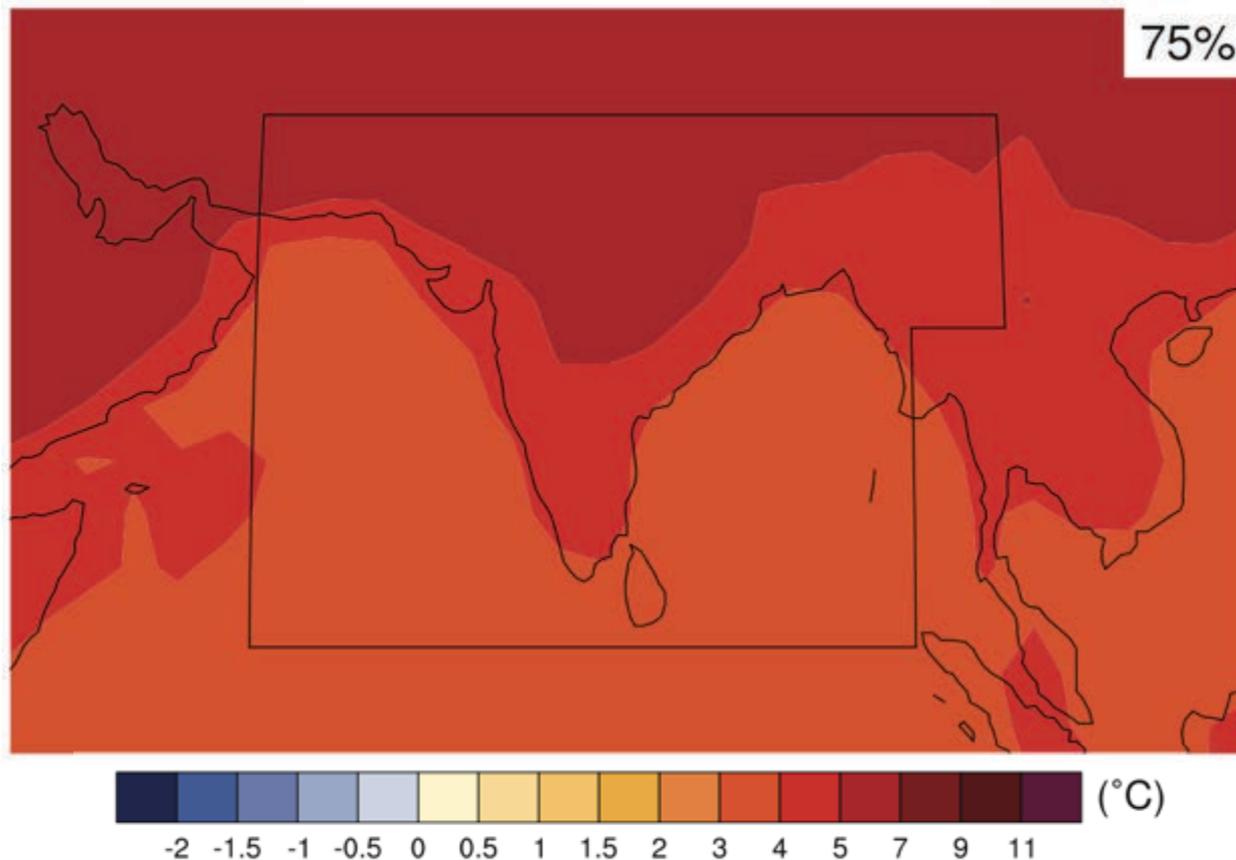
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.



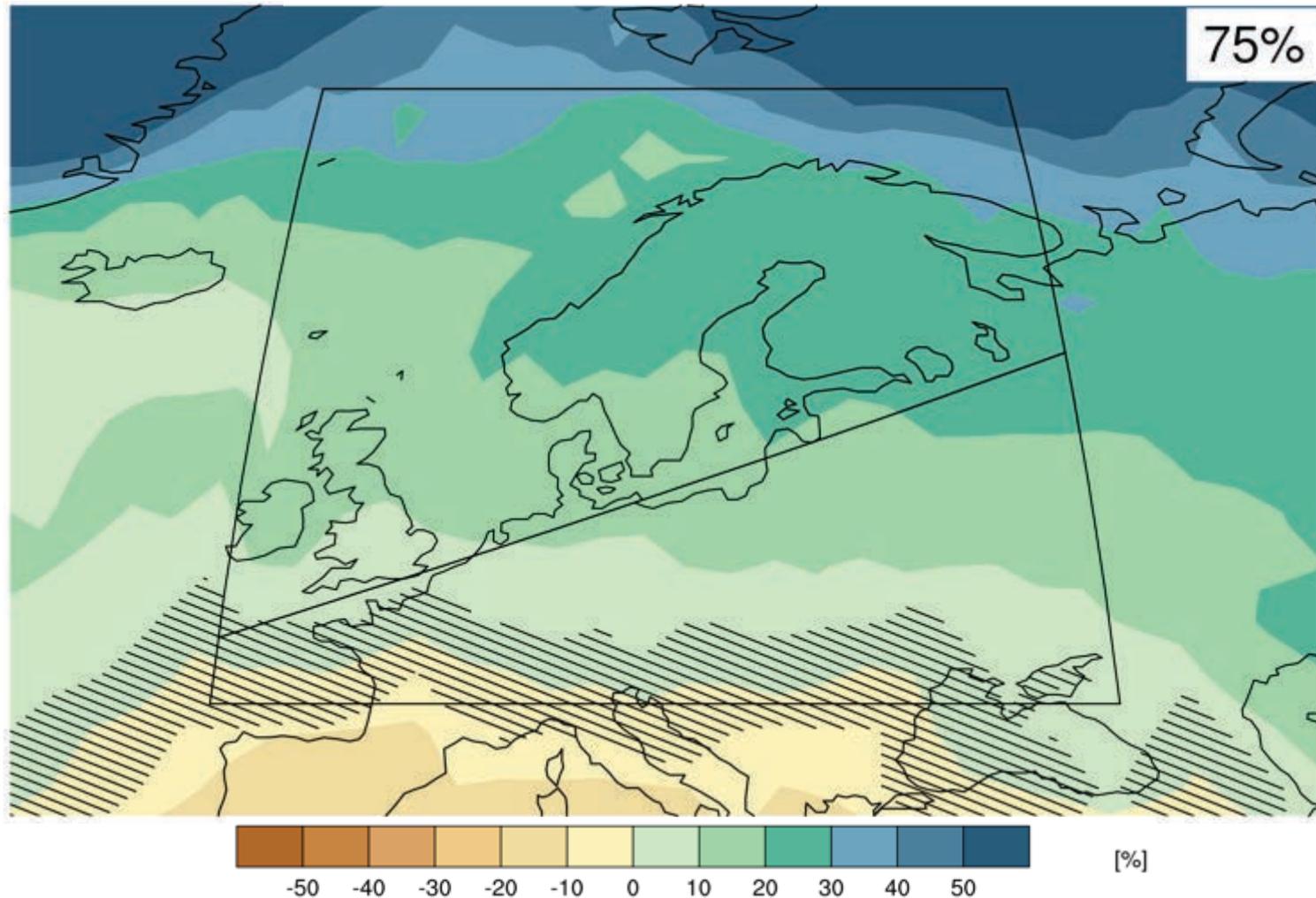
# North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)

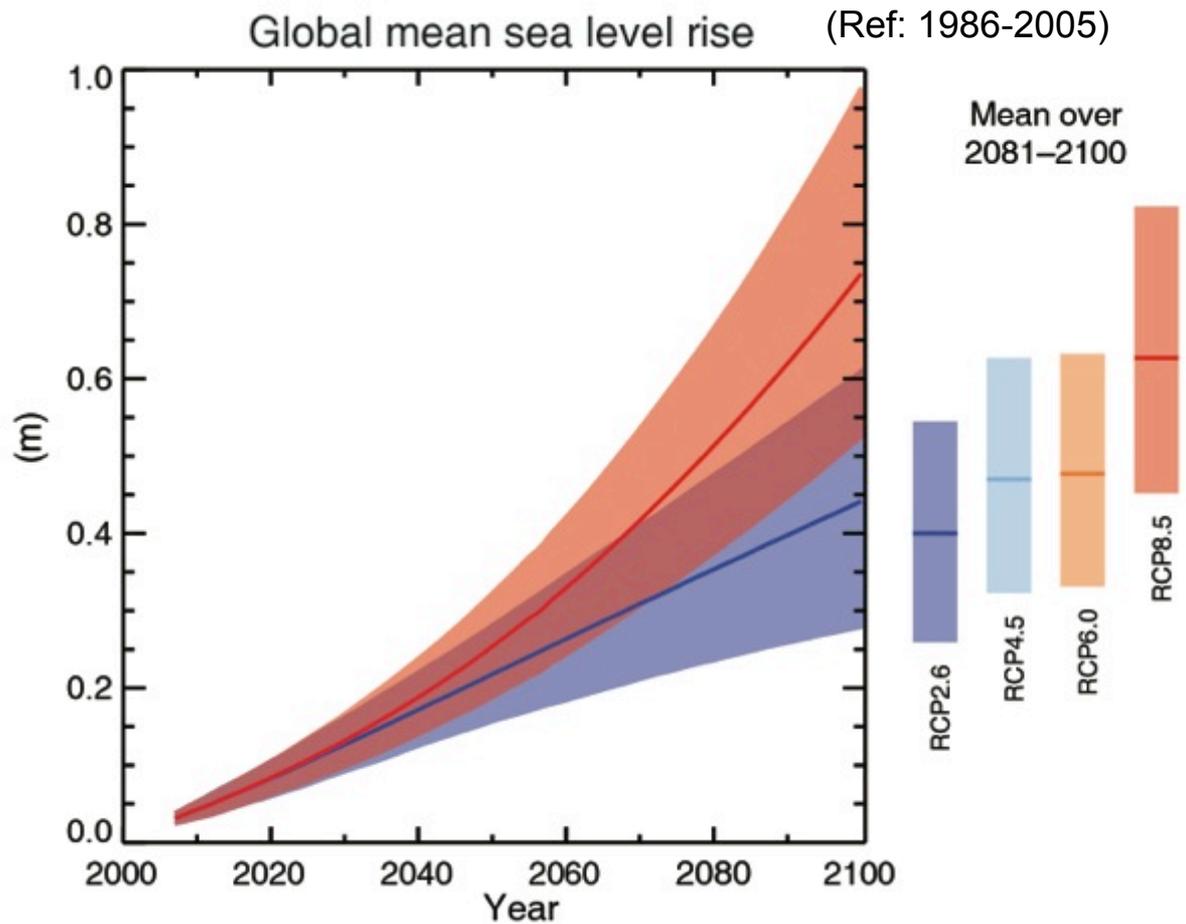


# Maps of temperature changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario



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





(IPCC 2013, Fig. SPM.9)

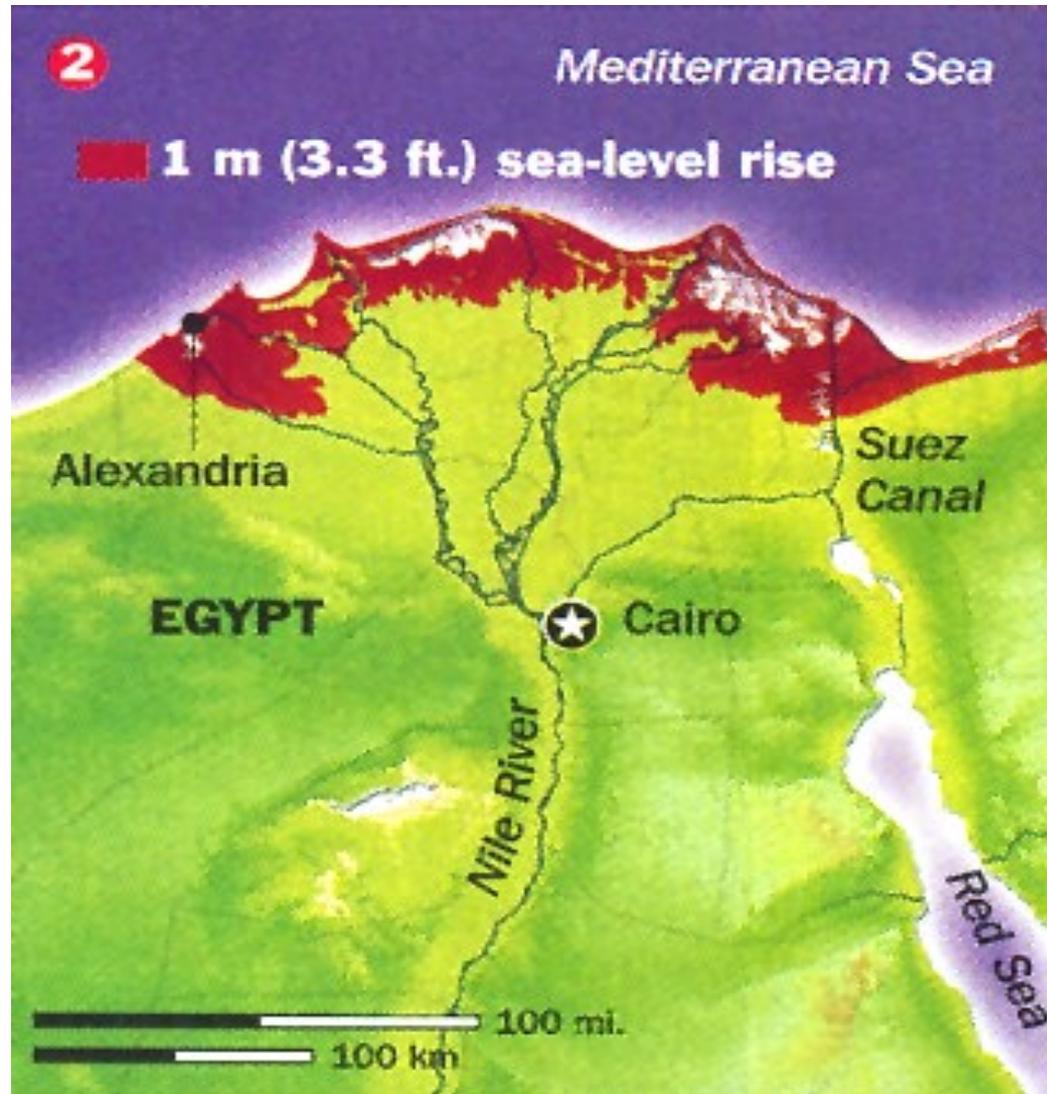
Sea level due to continue to increase

**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](http://www.climate.be/impacts)

# Effets sur le Delta du Nil, où vivent plus de 10 millions de personnes à moins d'1 m d'altitude



(Time 2001)

# 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)**



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



# Potential Impacts of Climate Change



Food and water shortages



Increased displacement of people



Increased poverty

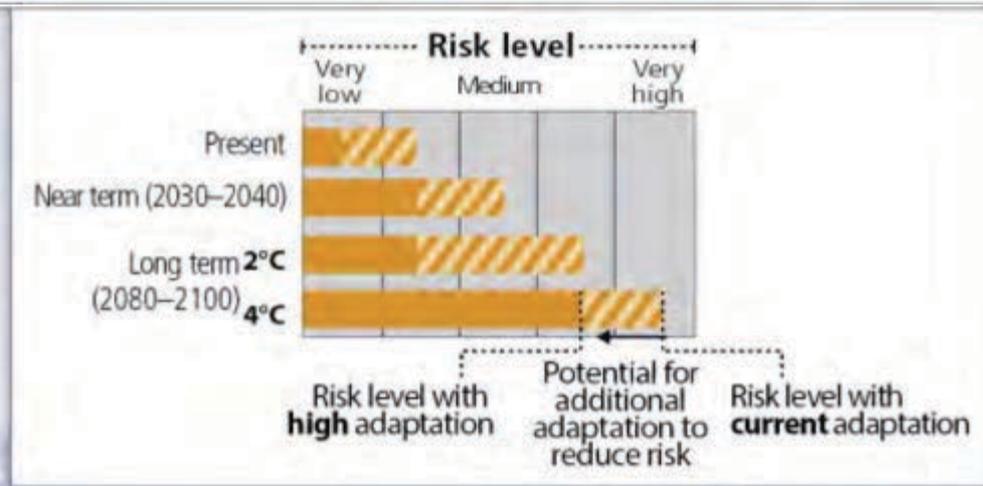
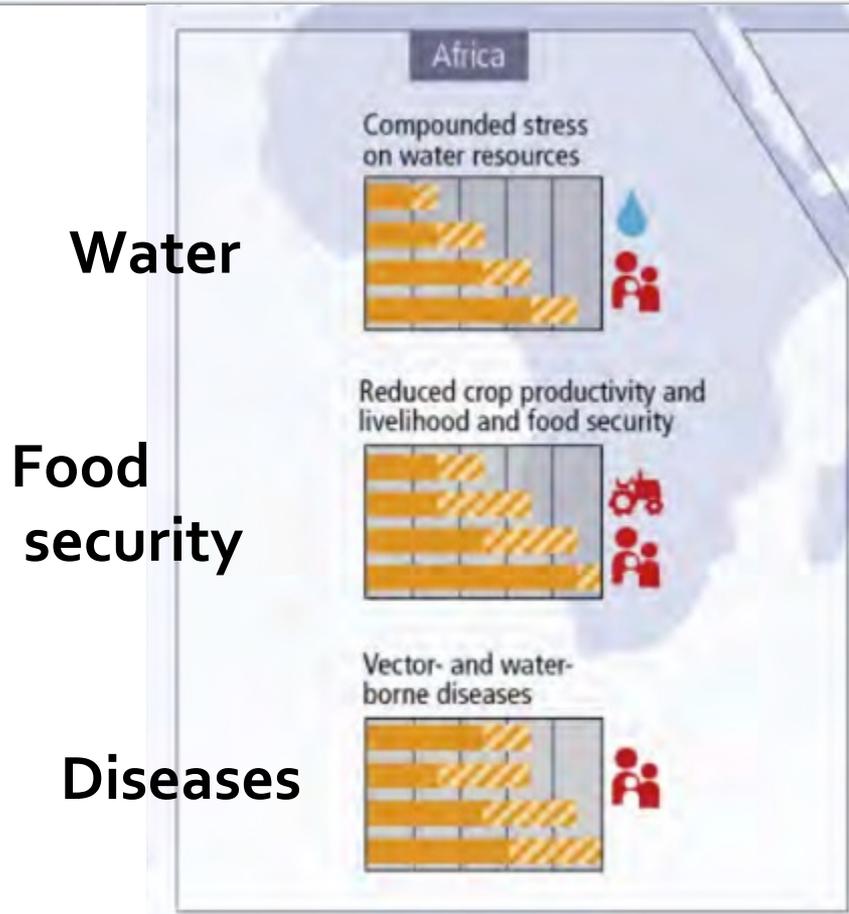
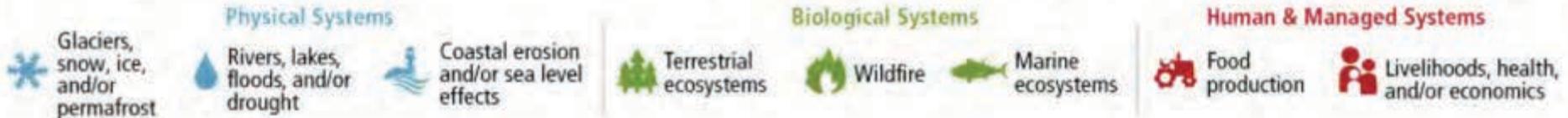


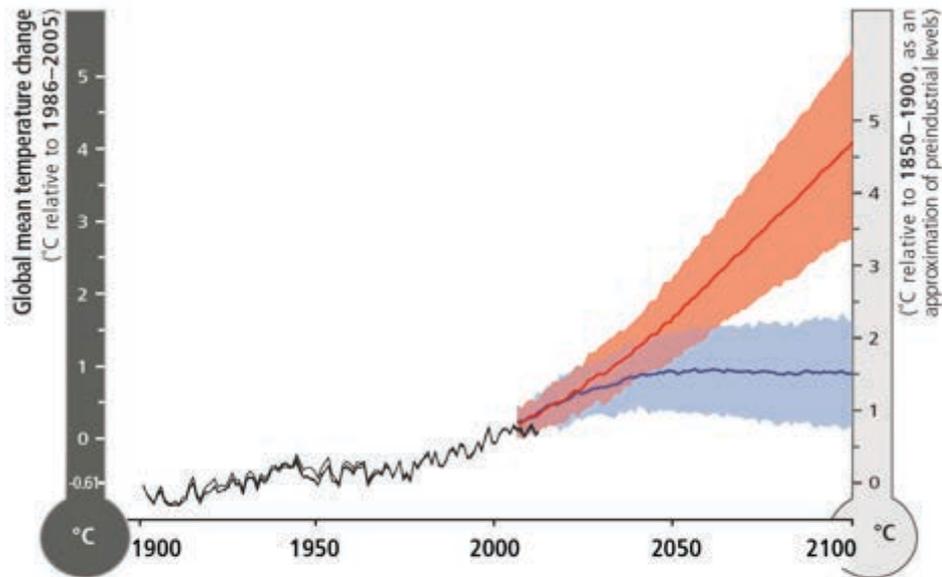
Coastal flooding

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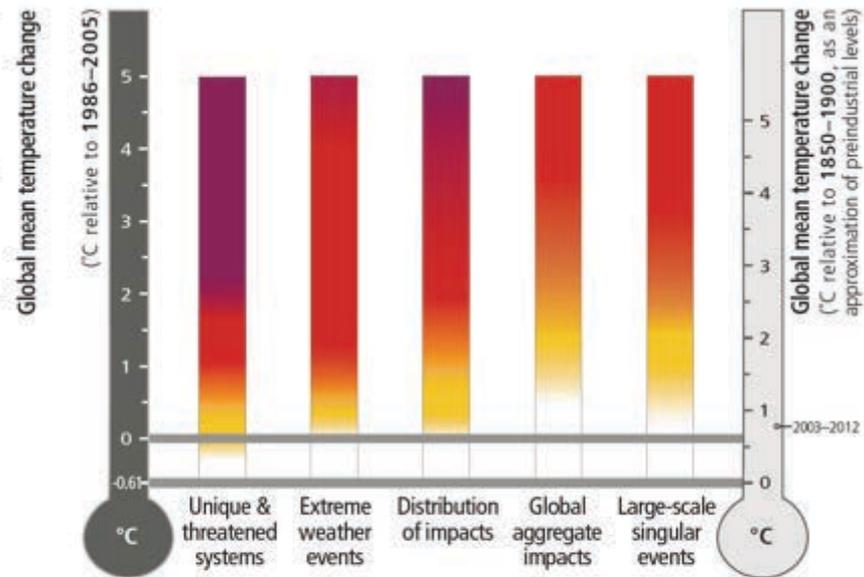
# Regional key risks and risk reduction through adaptation: Africa

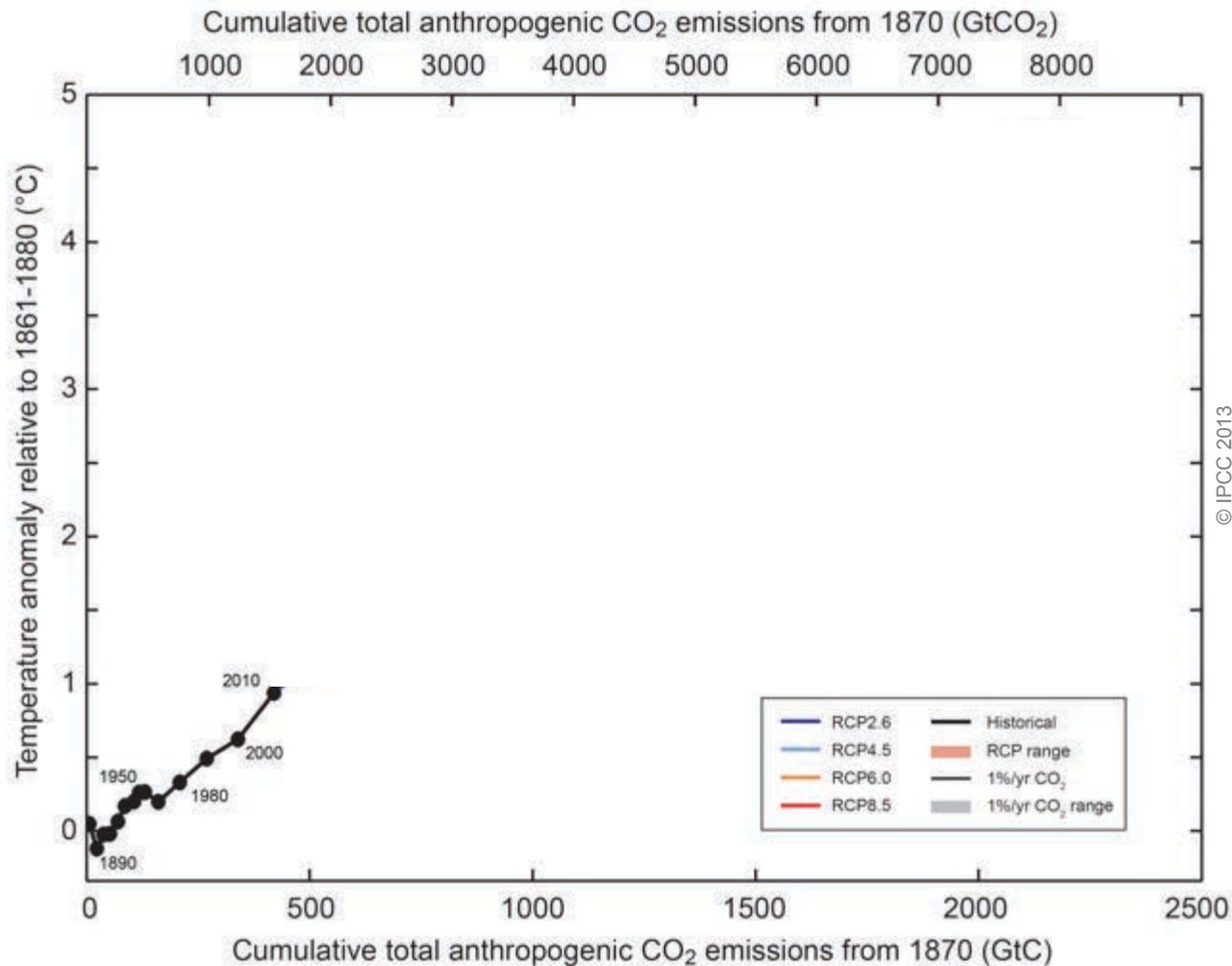
Representative key risks for each region for





- Observed
- RCP8.5 (a high-emission scenario)
- Overlap
- RCP2.6 (a low-emission mitigation scenario)





© IPCC 2013

Fig. SPM.10

Cumulative emissions of CO<sub>2</sub> largely determine global mean surface warming by the late 21st century and beyond.

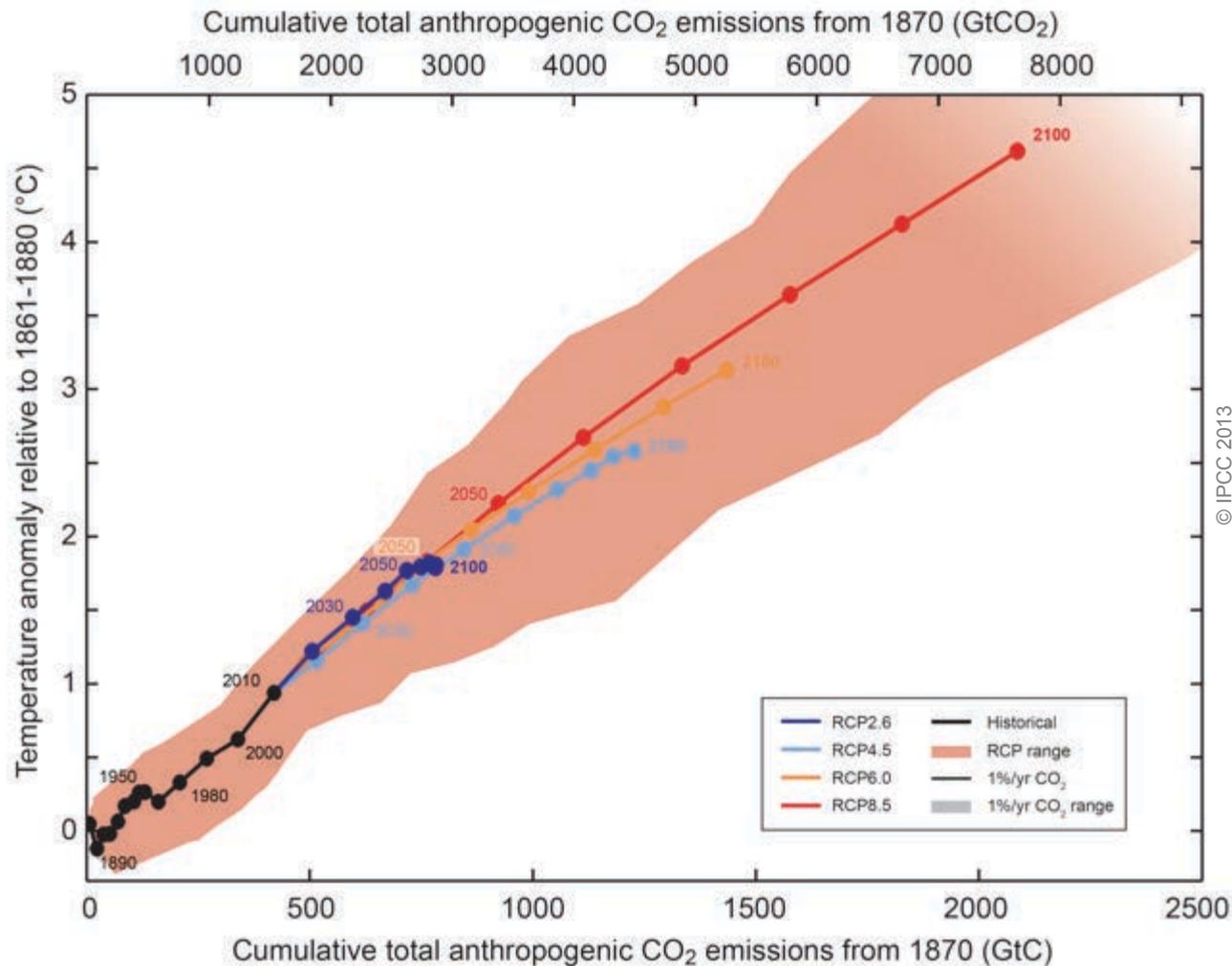
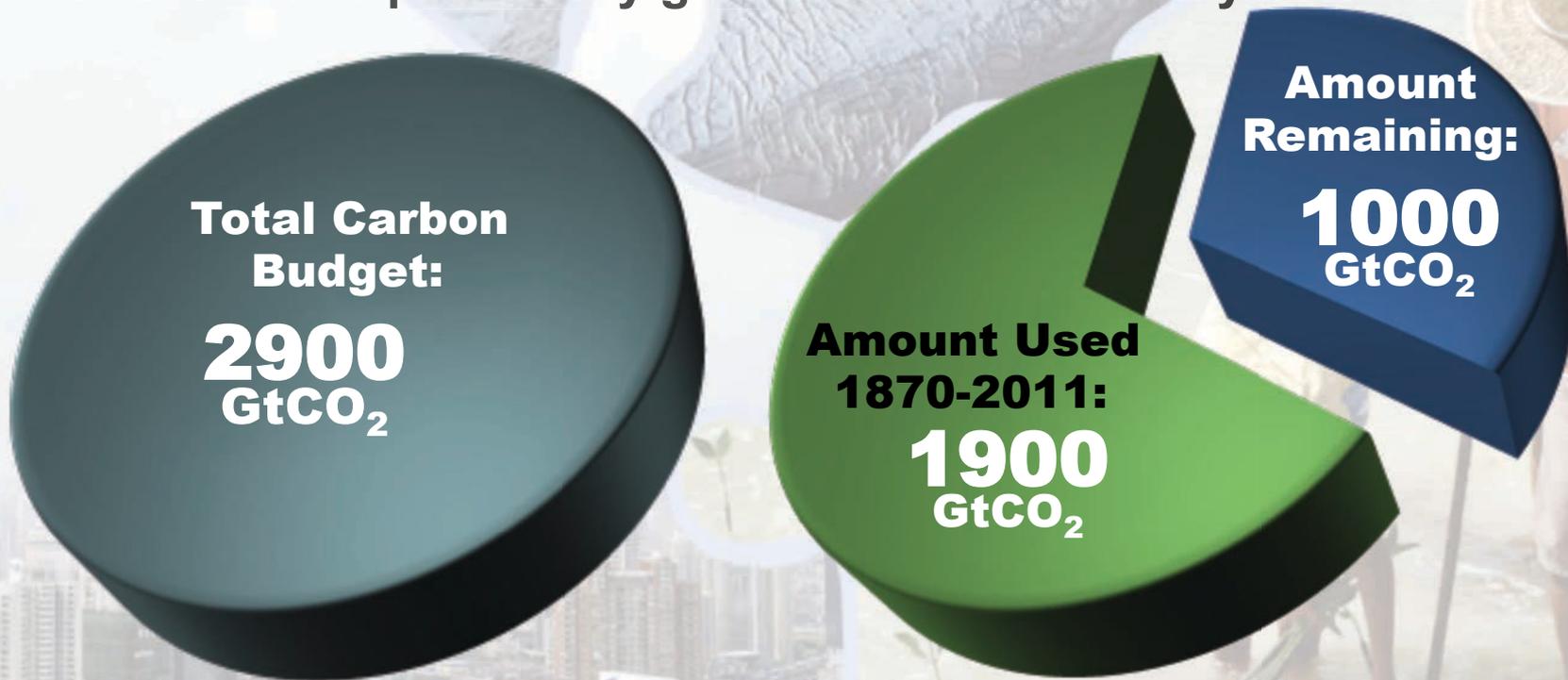


Fig. SPM.10

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 GtCO<sub>2</sub>/yr**

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# Can temperature rise still be kept below 1.5 or 2°C (over the 21<sup>st</sup> 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<sub>2</sub>-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 21<sup>st</sup> 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<sub>2</sub>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

# Paris Agreement

- Article 2:
  - ◆ (...) to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:
    - ▶ Holding the increase in the global average temperature to **well below 2 °C** above pre-industrial levels and to **pursue efforts** to limit the temperature increase to **1.5 °C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
    - ▶ **Increasing the ability to adapt** (...) and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
    - ▶ Making **finance flows consistent** with a pathway towards low greenhouse gas emissions and climate-resilient development

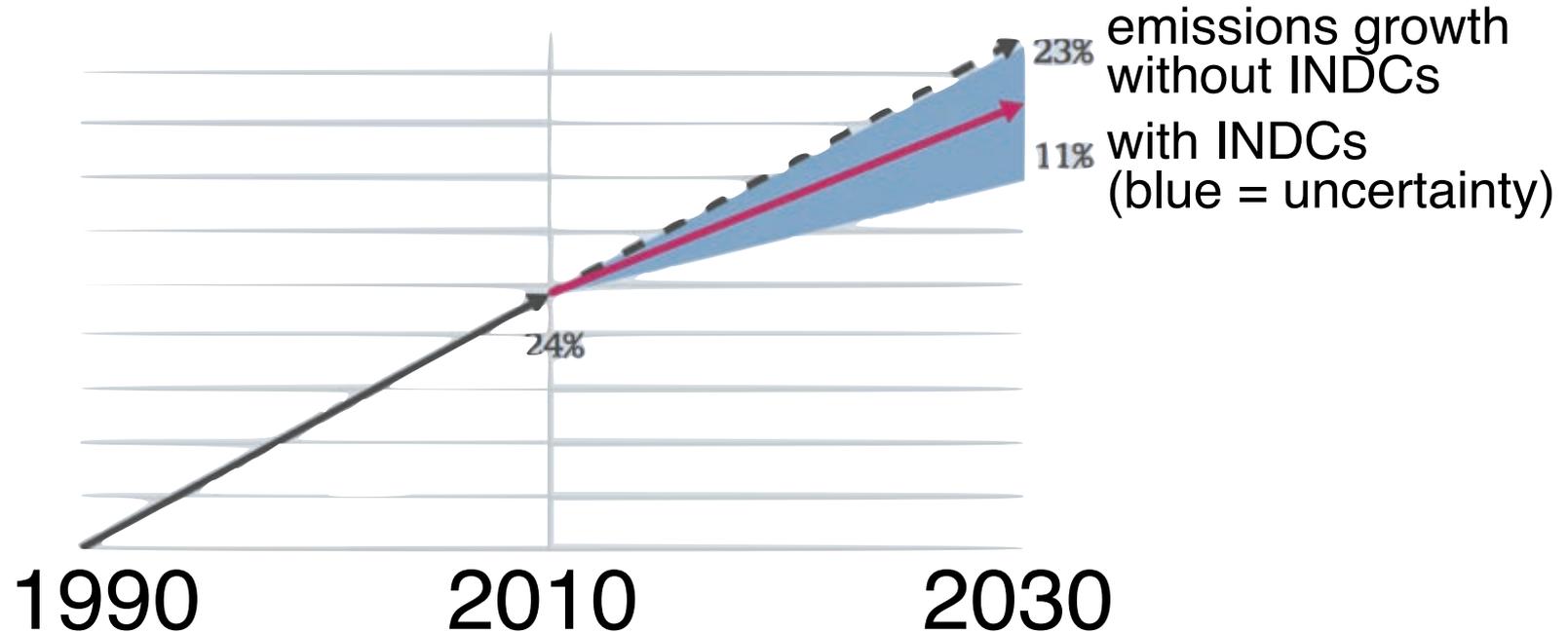
# Paris Agreement

- Article 4:
  - ♦ 1. (...) Parties aim to reach **global peaking** of greenhouse gas emissions **as soon as possible**, recognizing that **peaking will take longer for developing country Parties**,
  - ♦ and to undertake **rapid reductions thereafter in accordance with best available science**,
  - ♦ so as to achieve a **balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty
  - ♦ 3. **Each Party's successive nationally determined contribution will represent a progression(...)**

# Paris Agreement

- Article 4 (cont.):
  - ◆ 4. Developed country Parties should continue taking the lead by undertaking economy-wide absolute emission reduction targets.
  - ◆ Developing country Parties should continue enhancing their mitigation efforts, and are encouraged to move over time towards economy-wide emission reduction or limitation targets in the light of different national circumstances.
  - ◆ **Each Party shall communicate a nationally determined contribution every five years**
  - ◆ Parties shall take into consideration in the implementation of this Agreement the concerns of Parties with economies most affected by the impacts of response measures, particularly developing country Parties.

# INDCs: UNFCCC's Synthesis Report



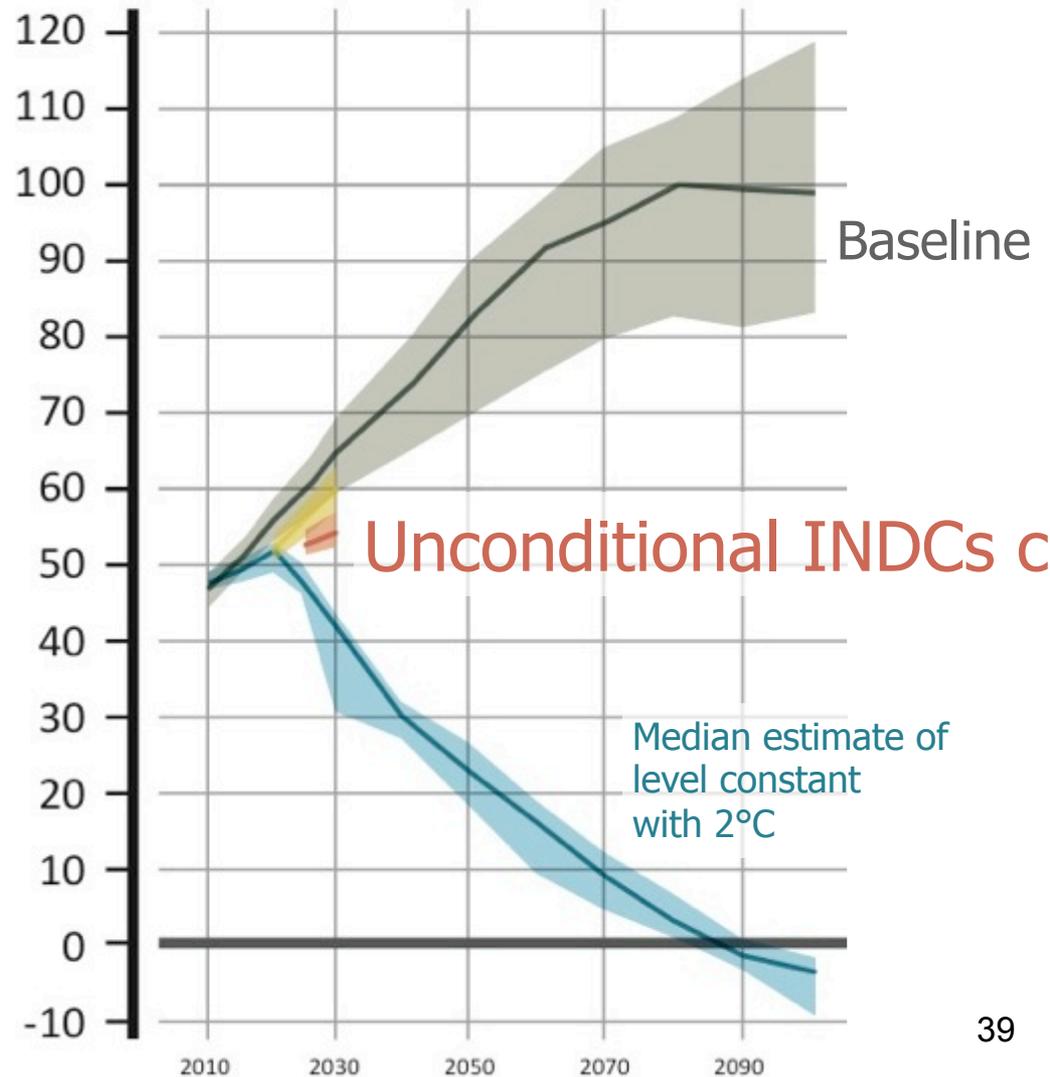
- Slow down of emissions growth due to INDCs:
  - ♦ With the INDCs, emissions are expected to equal ~54% by 2025 and 75% by 2050 of the « carbon budget » since 2011 that would be consistent with 66% chances of  $< 2^{\circ}\text{C}$

Source : UNFCCC, october 2015  
[http://unfccc.int/focus/indc\\_portal/items/9240.php](http://unfccc.int/focus/indc_portal/items/9240.php)

# Intended Nationally Determined Contributions (INDCs)

- UN emissions gap report

Annual Global Total Greenhouse Gas Emissions (GtCO<sub>2</sub>e)



- **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:**

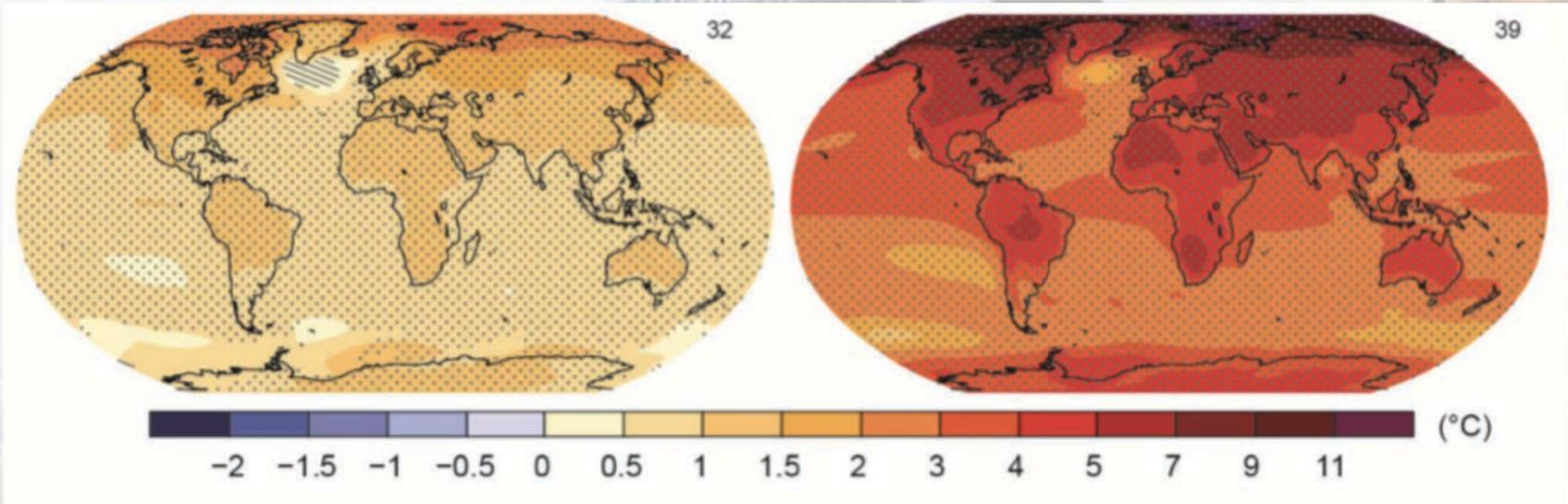
(mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)

- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**

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

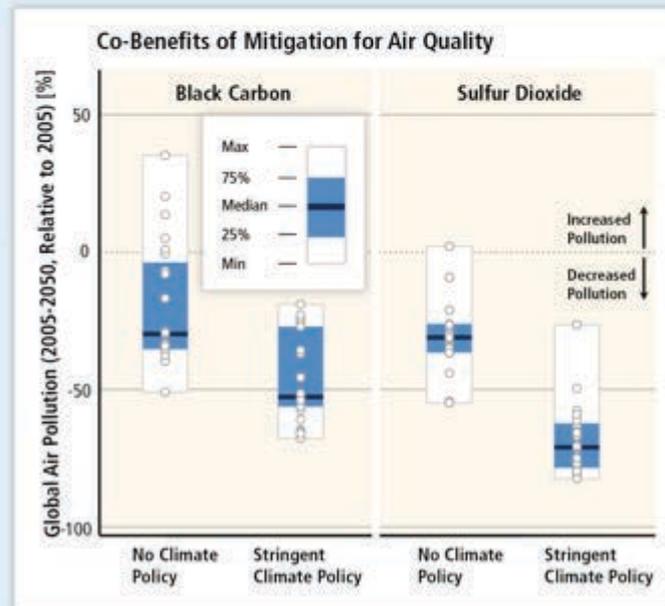
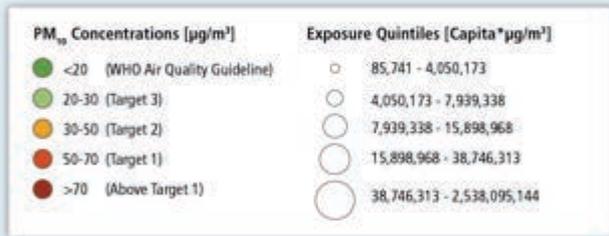
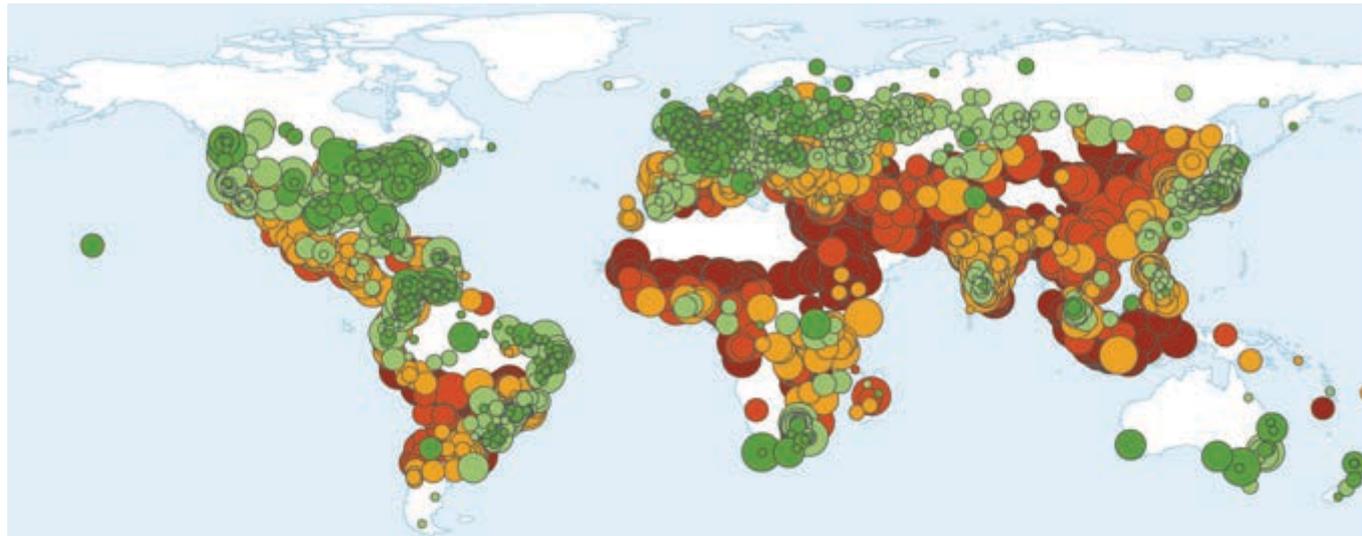
With substantial mitigation

Without additional mitigation



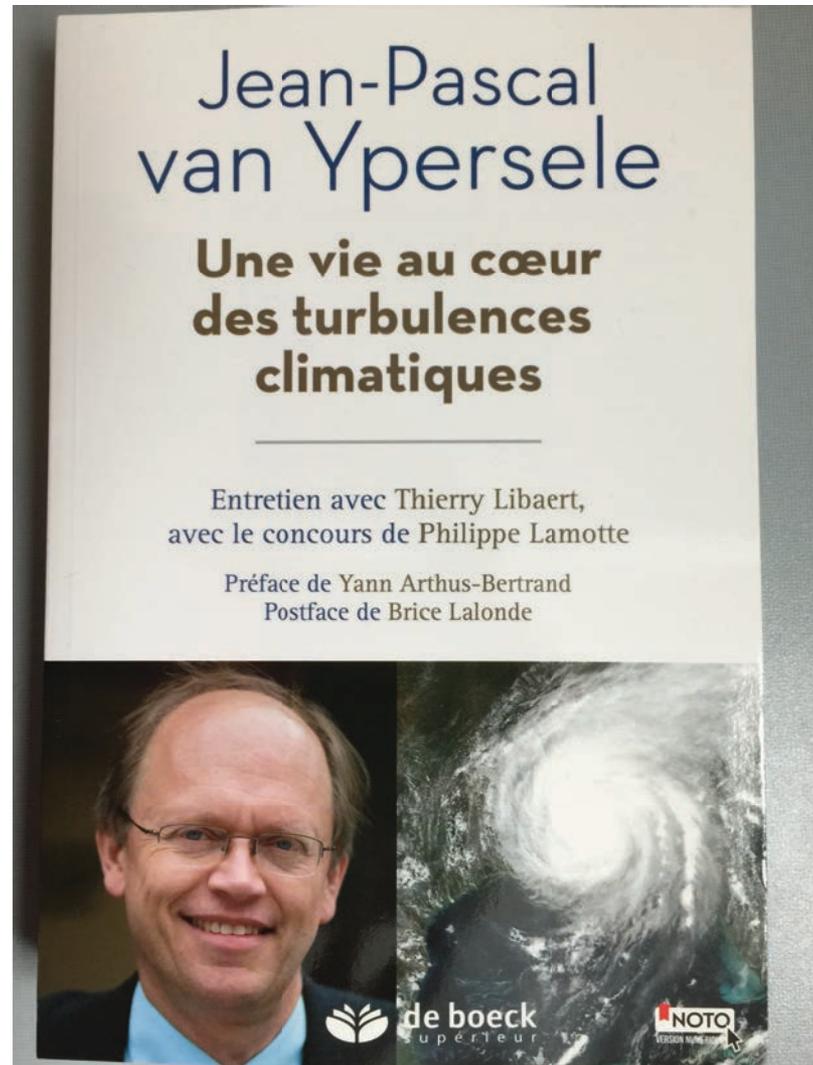
Change in average surface temperature (1986–2005 to 2081–2100)

AR5 WGI SPM



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

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supérieur,  
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# Useful links:

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