

***Climate change: a challenge for the
21st Century, but also a business
responsibility, and an opportunity***

Jean-Pascal van Ypersele

(Université catholique de Louvain)

Former IPCC Vice-Chair (2008-2015)

Twitter: @JPvanYpersele

EDF Luminus, Brussels, 27 June 2016

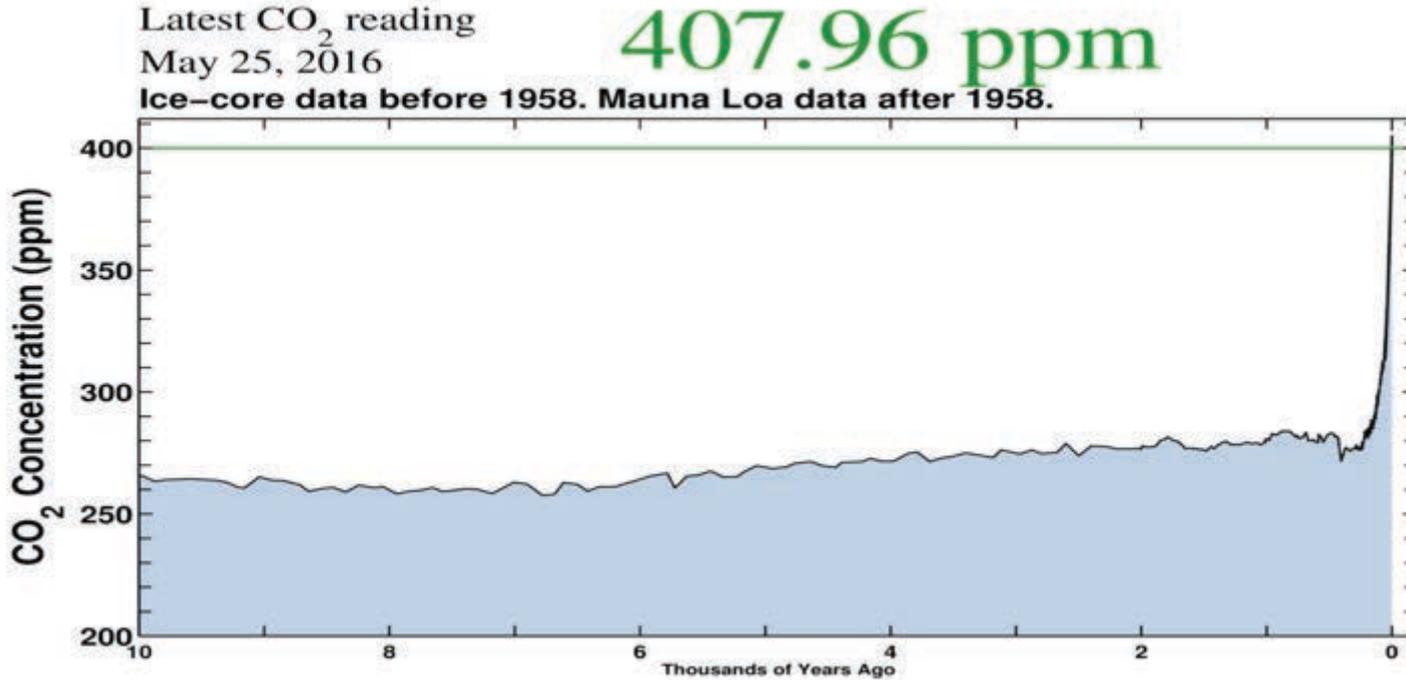
**Thanks to my team at the Université catholique de Louvain for their support,
and to Geert Fremout (Federal Climate Section) for slides about COP21**

Chamonix, June 2016



Jean-Pascal van Ypersele
(@JPvanYpersele)

CO₂ Concentration, 25 May 2016 (Keeling curve)



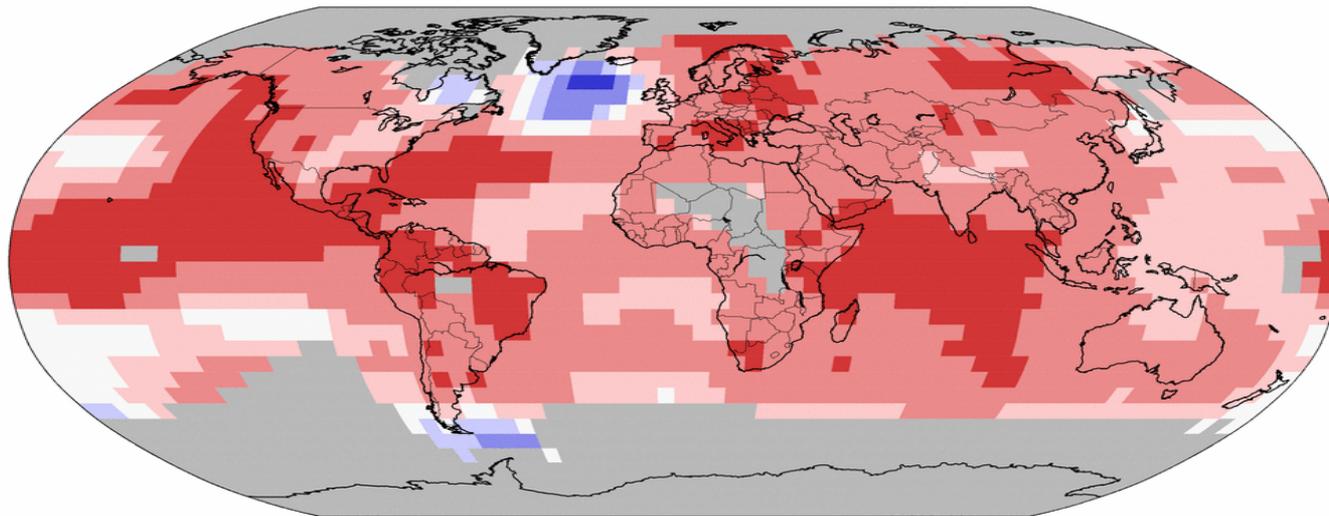
Source: scripps.ucsd.edu/programs/keelingcurve/

2015= warmest year since 1880

Land & Ocean Temperature Percentiles Jan–Dec 2015

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0




Record
Coldest


Much
Cooler than
Average


Cooler than
Average


Near
Average


Warmer than
Average


Much
Warmer than
Average


Record
Warmest



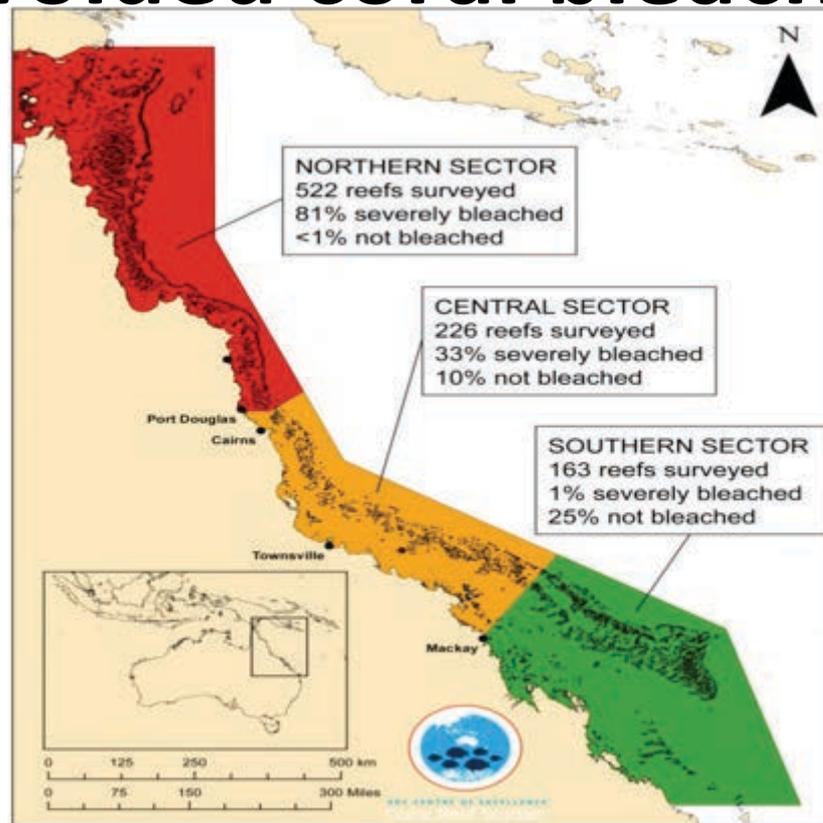
Wed Jan 13 12:15:02 EST 2016

Coral reefs are dying



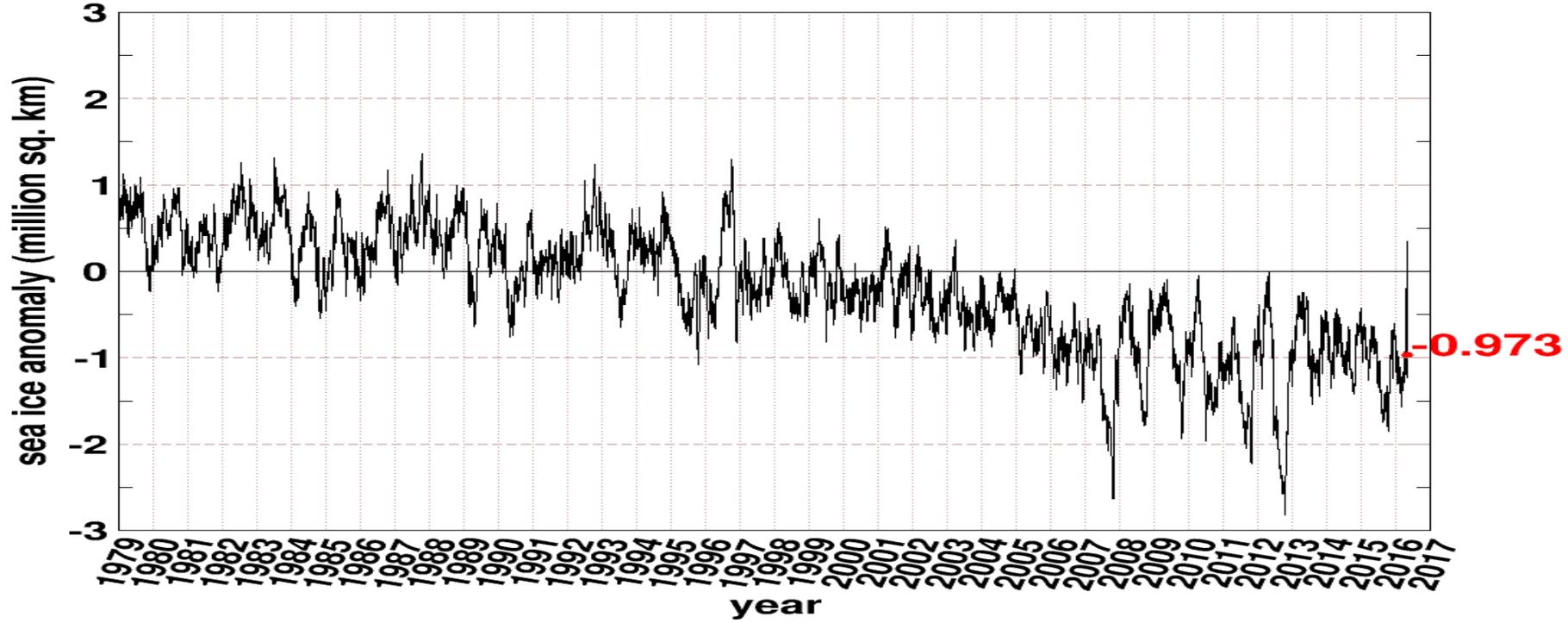
American Samoa (from www.globalcoralbleaching.org)

Only 7% of the Great Barrier Reef has avoided coral bleaching



Arctic Sea Ice Cover

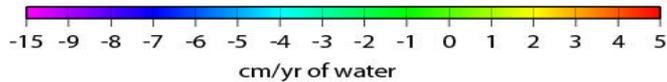
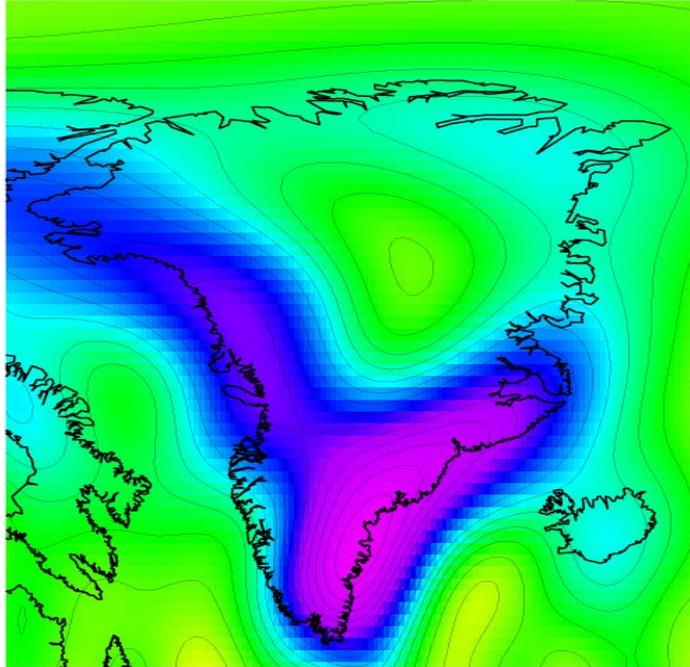
Northern Hemisphere Sea Ice Anomaly
Anomaly from 1979-2008 mean



Greenland Ice Mass Loss 2002-2009

Derived From NASA GRACE Gravity Mission

Greenland

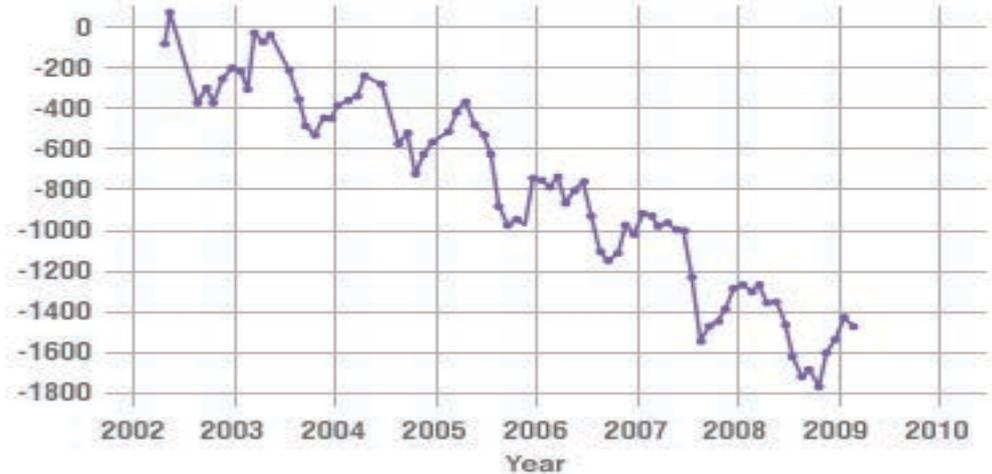


J. Wahr, U. Colorado

GREENLAND MASS VARIATION SINCE 2002

Data source: Ice mass measurement by NASA's Grace satellites.

Change in Ice Mass Loss Gigatons



Velicogna, Geophysical Research Letters, 2009

•Contributes to sea level rise

B. Holt - JPL

Scale Of Flooding Across Europe



Six weeks worth of rain has fallen in three days over parts of France



The Louvre and Musee d'Orsay in Paris evacuated their vaults



In Germany, many residents weren't prepared for the mass flooding as the rain pelted down



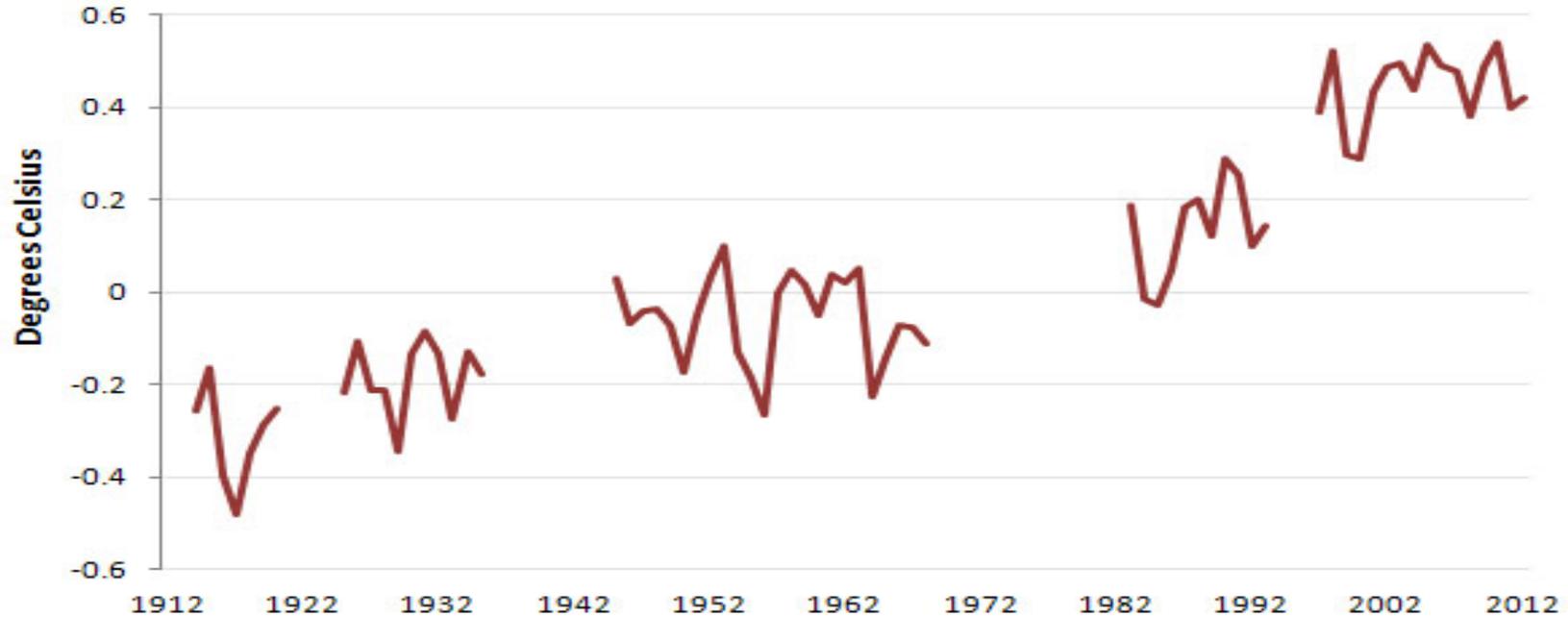
Temperature Change From 1961-1990 Average



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

Lying With Statistics, Global Warming Edition

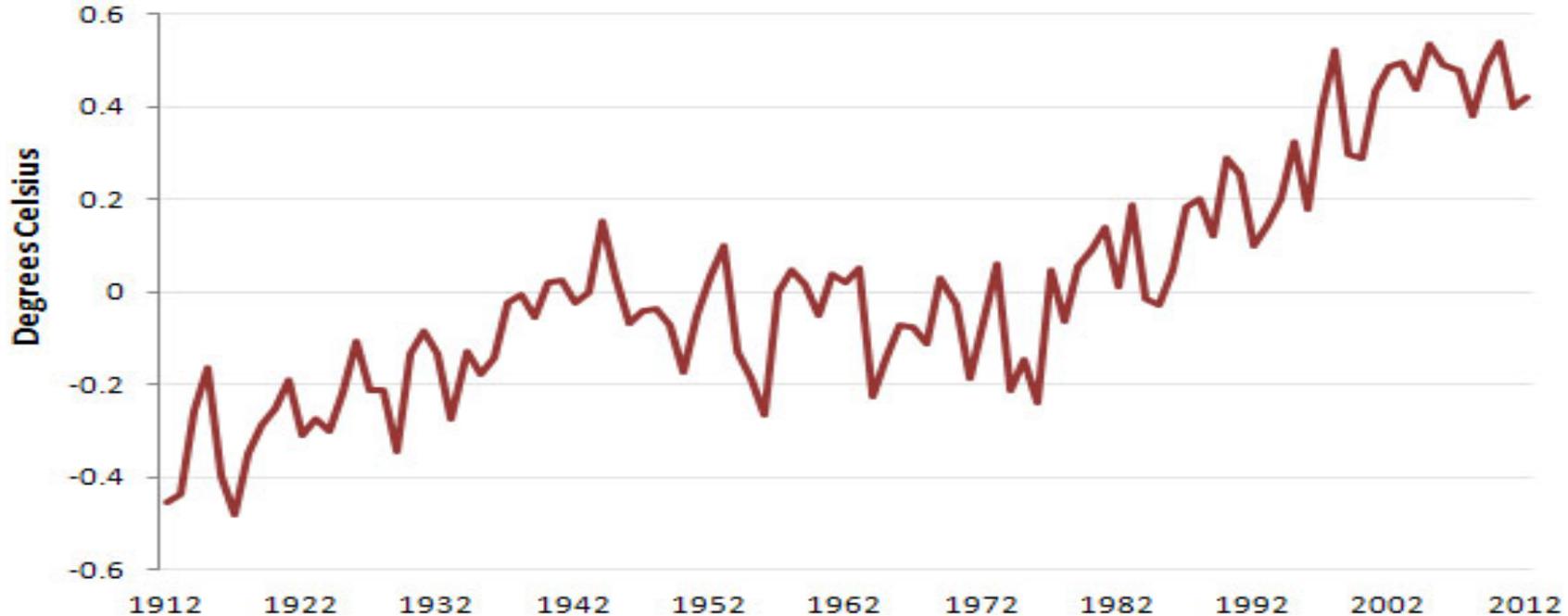
Temperature Plateaus — 1912-2012



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

Lying With Statistics, Global Warming Edition

Temperature Change From 1961-1990 Average



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

Why the IPCC ?

Established by WMO and UNEP in 1988

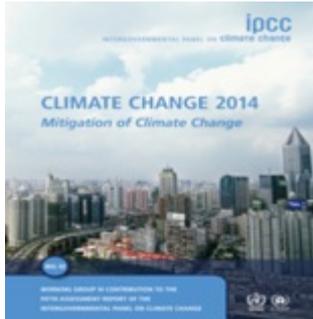
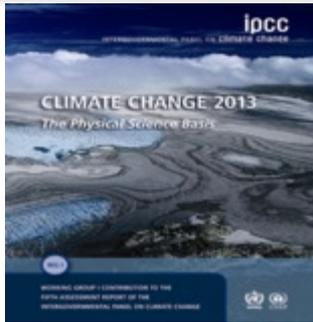
to provide **policy-makers** with an **objective source of information** about

- 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?

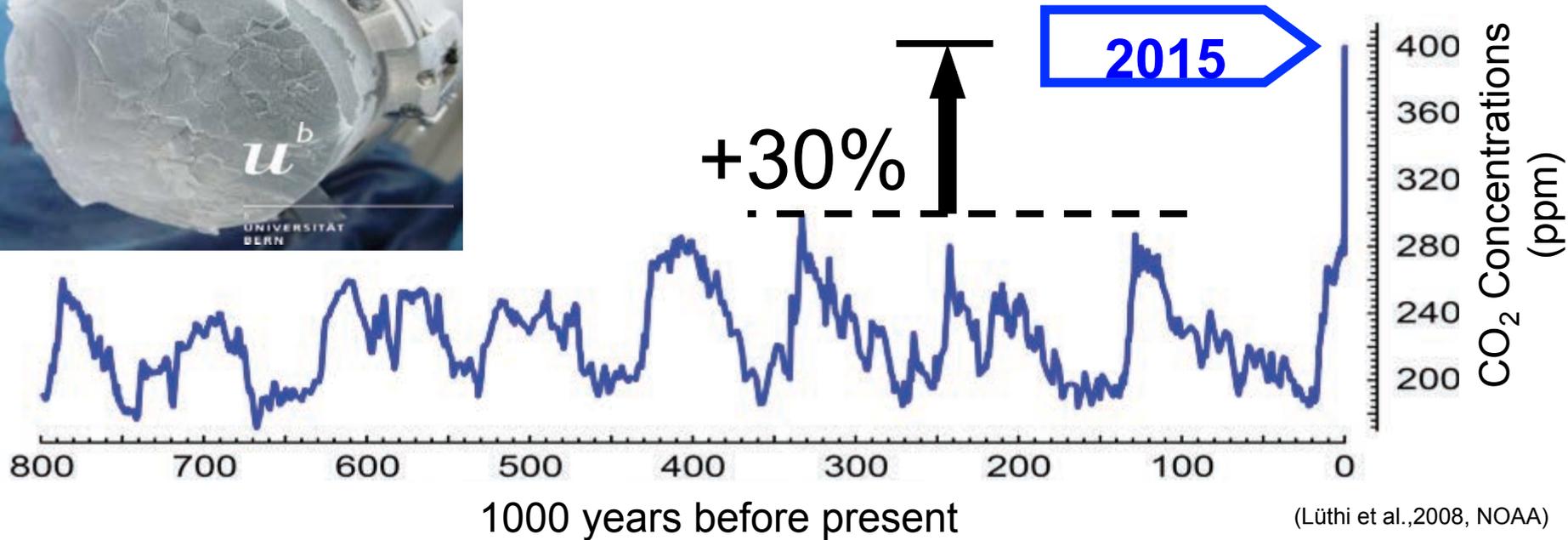
What can be done?

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**



Atmospheric concentrations of CO₂



The concentrations of CO₂ have increased to levels unprecedented in at least the last 800,000 years.

A Progression of Understanding: Greater and Greater Certainty in Attribution

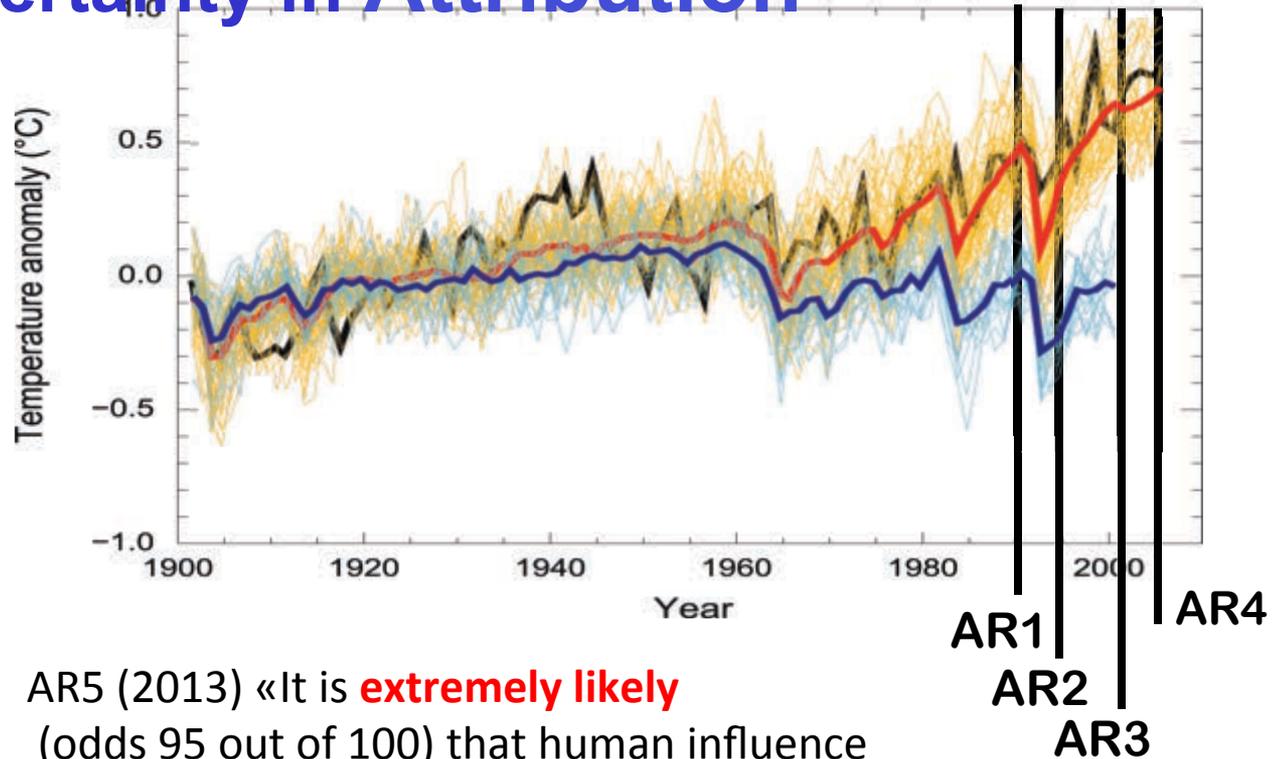
AR1 (1990): “unequivocal detection not likely for a decade”

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

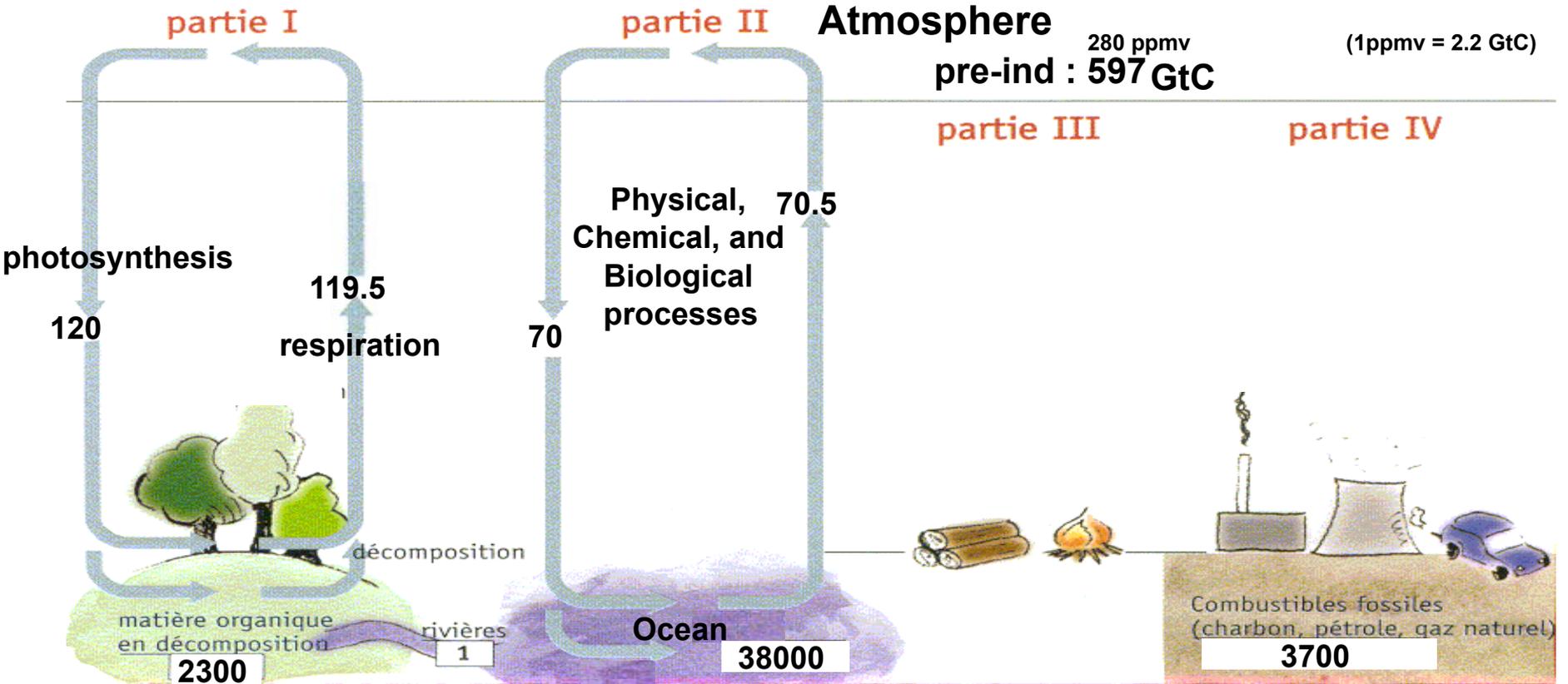
AR3 (2001): “most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities”

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... »



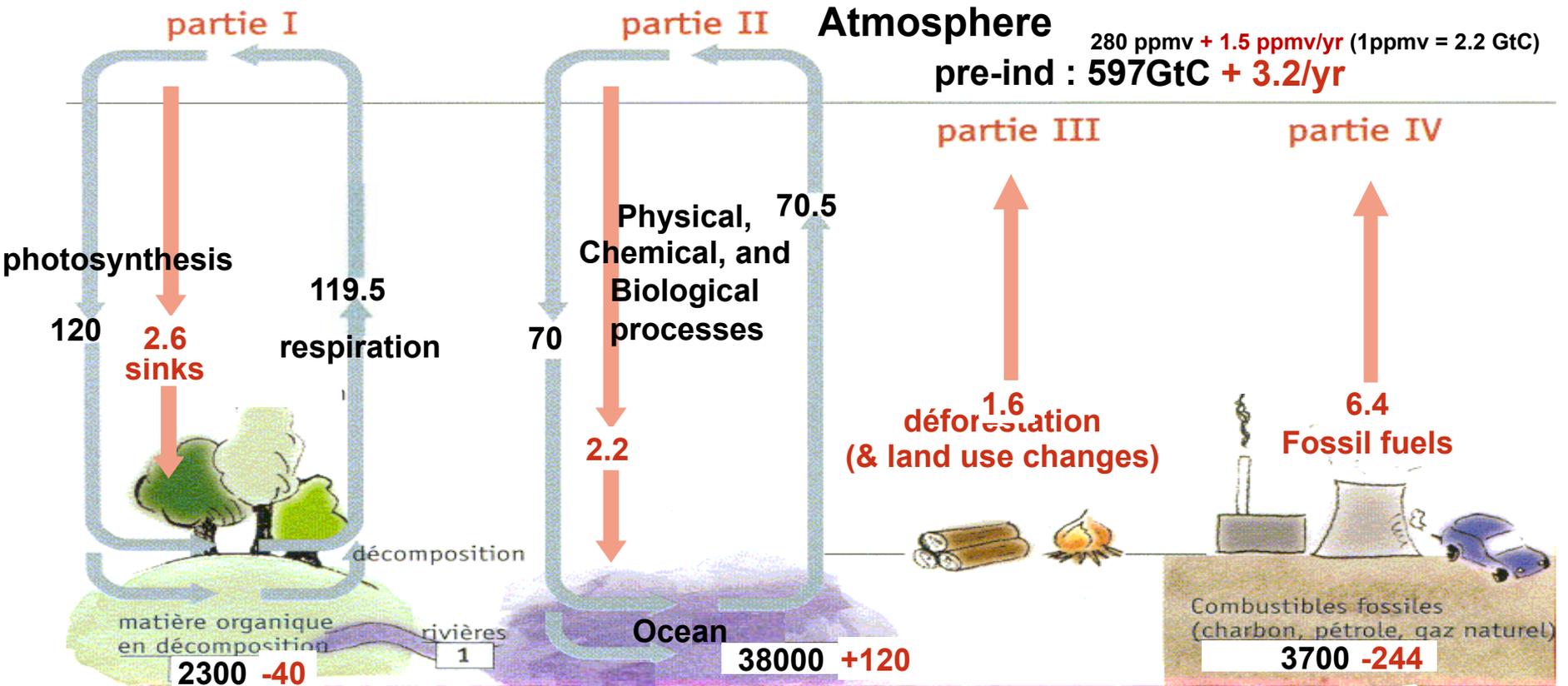
Carbon cycle: unperturbed fluxes



Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get GtCO₂)

Carbon cycle: perturbed by human activities

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



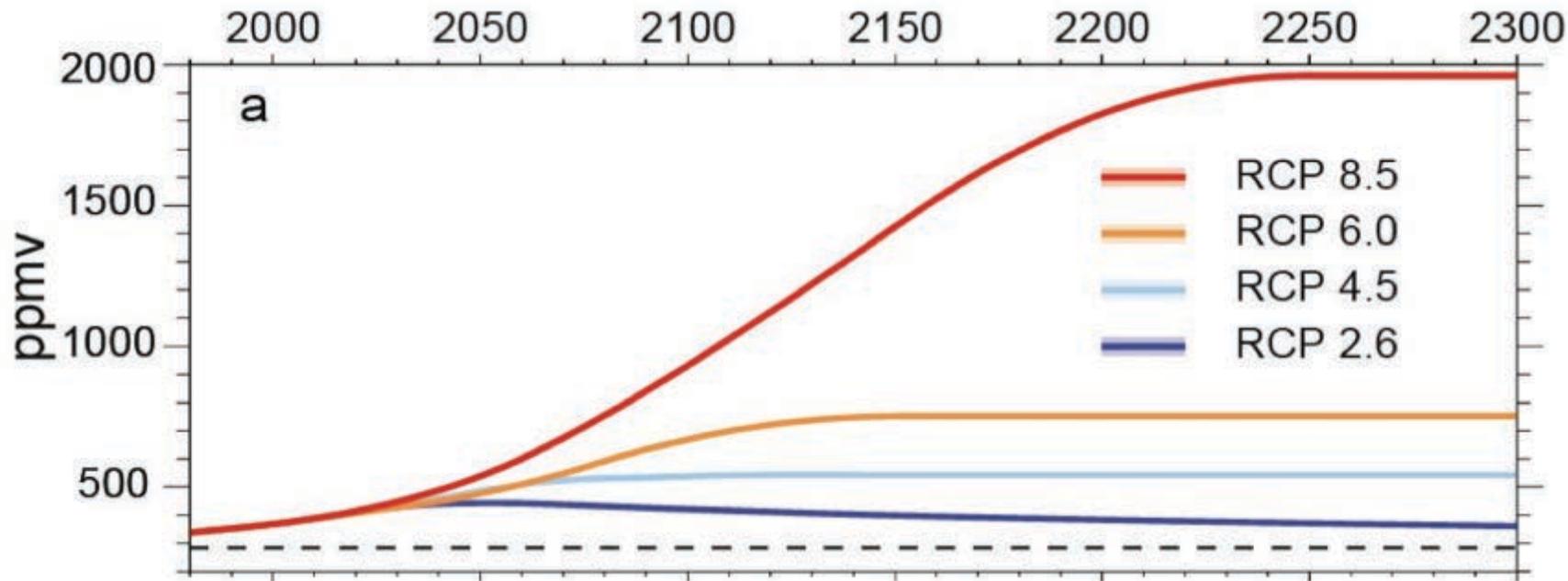
Units: GtC (billions tons of carbon) or GtC/year

Stocks!

The carbon cycle is policy-relevant

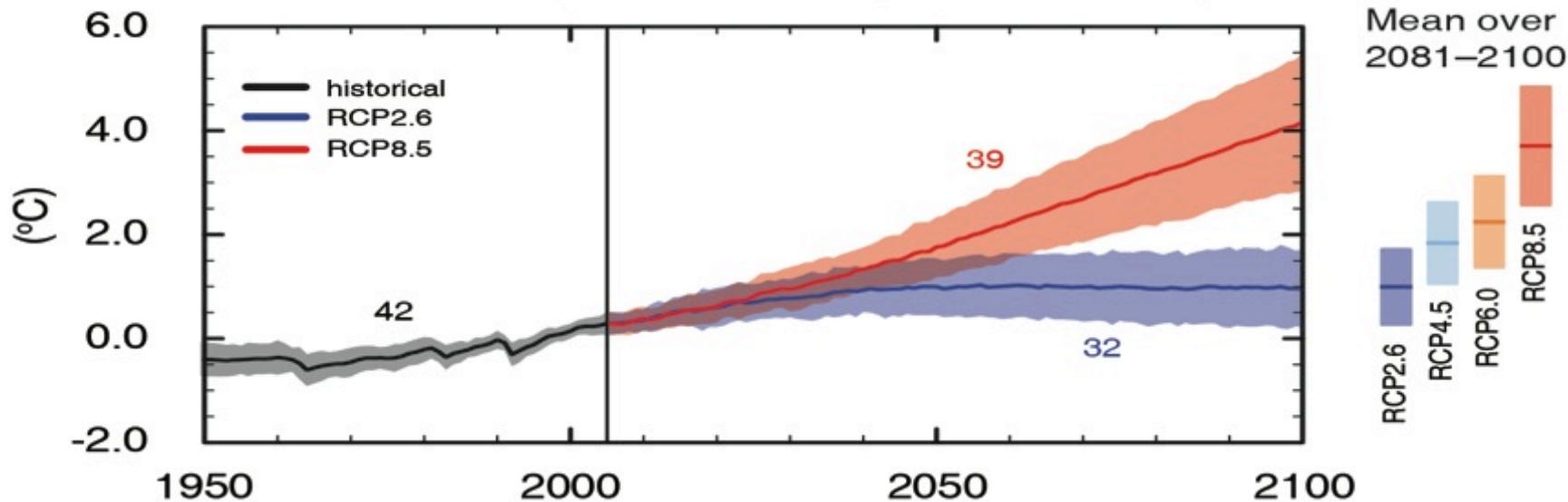
- CO₂ accumulates in the atmosphere as long as human emissions are larger than the natural absorption capacity**
- Historical emissions from developed countries therefore matter for a long time**
- As warming is function of cumulated emissions, the carbon « space » is narrowing fast (to stay under 1.5 or 2°C warming)**

RCP Scenarios: Atmospheric CO₂ 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)

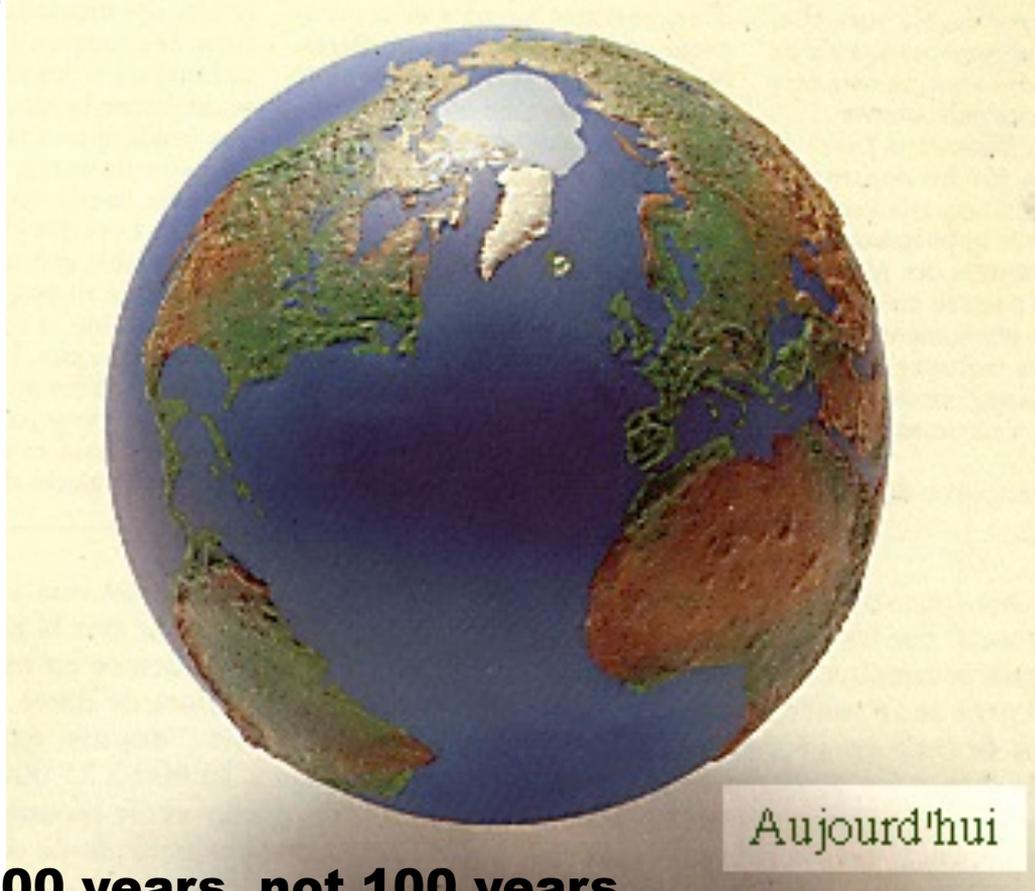
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.



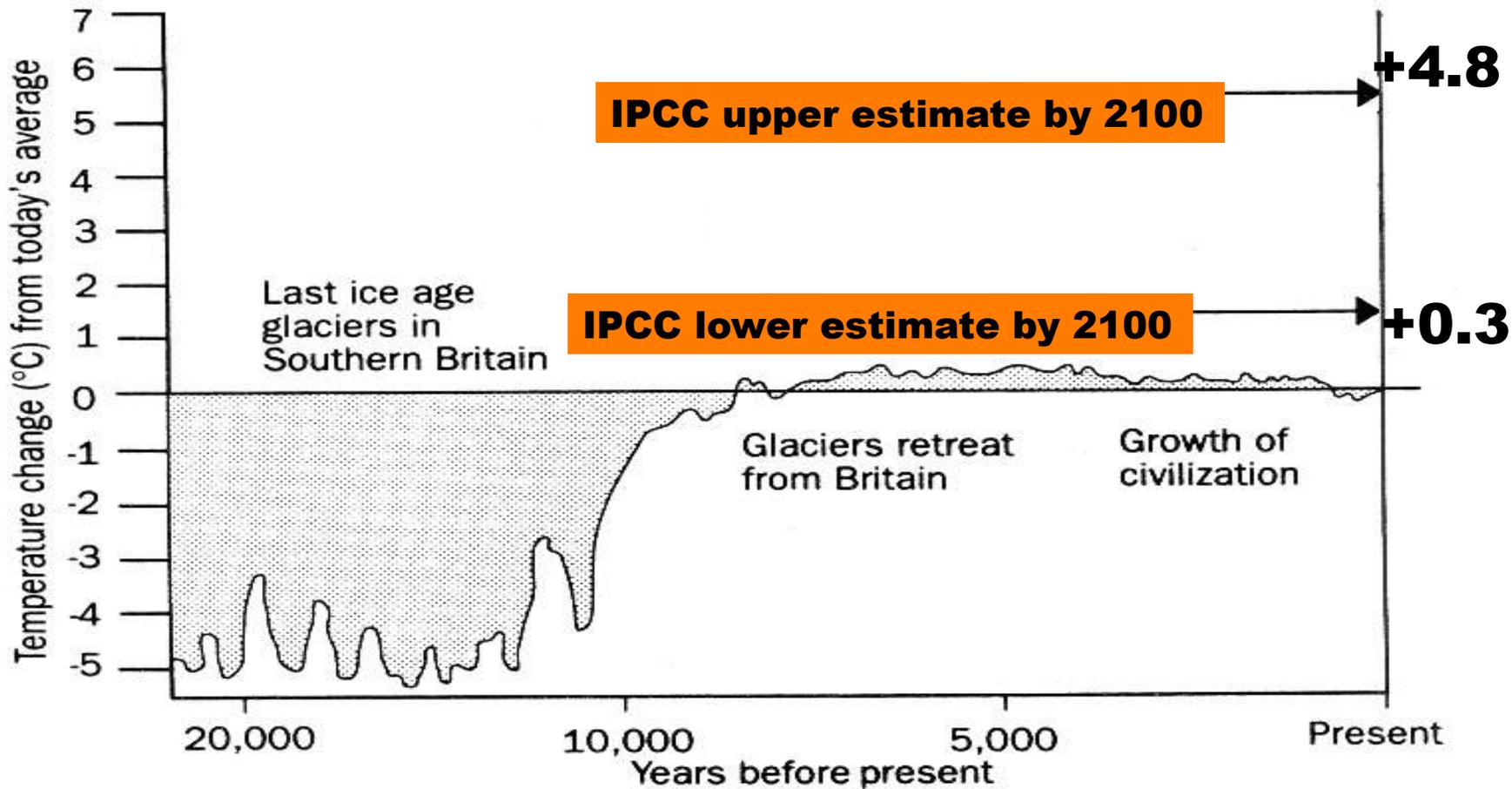
Sea level: 120 m lower

Today, with +4-5°C globally

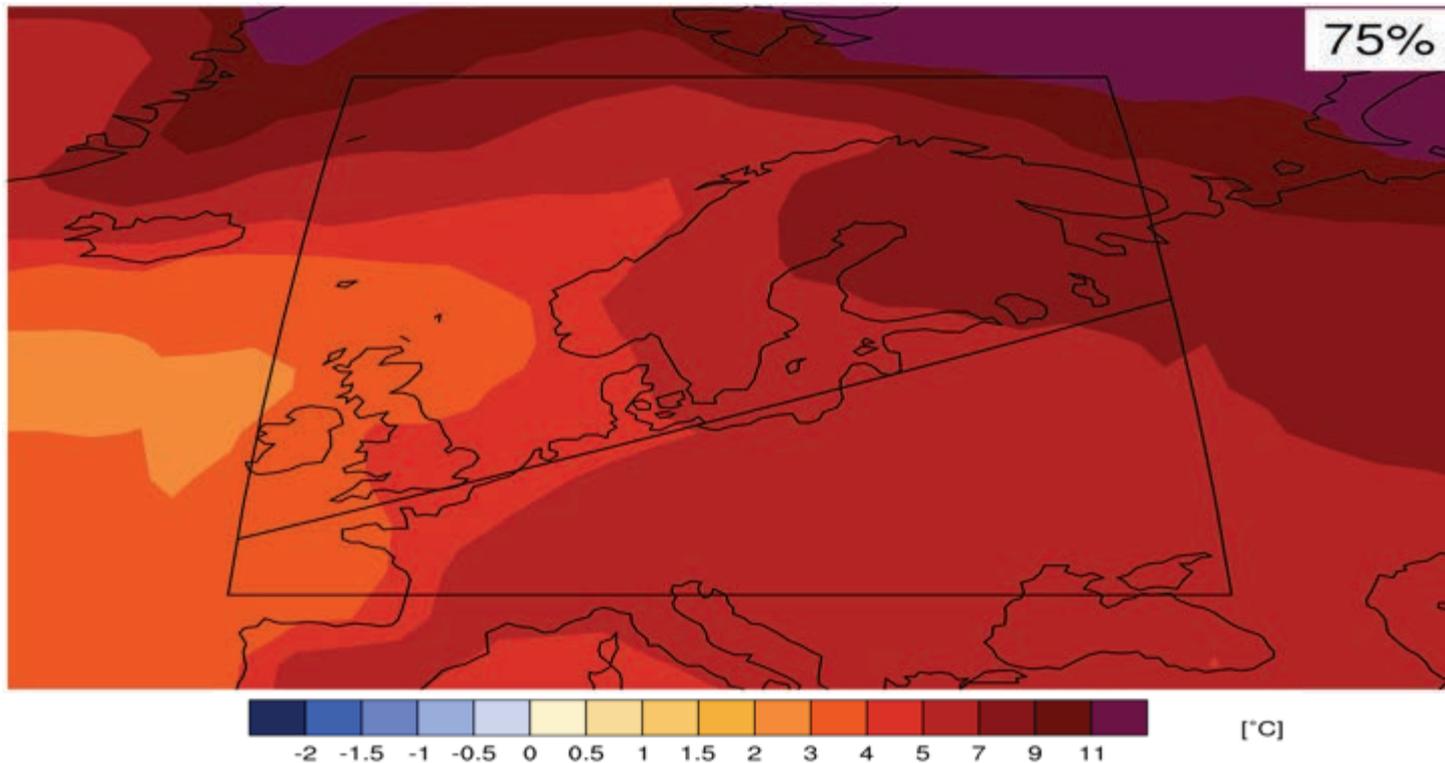
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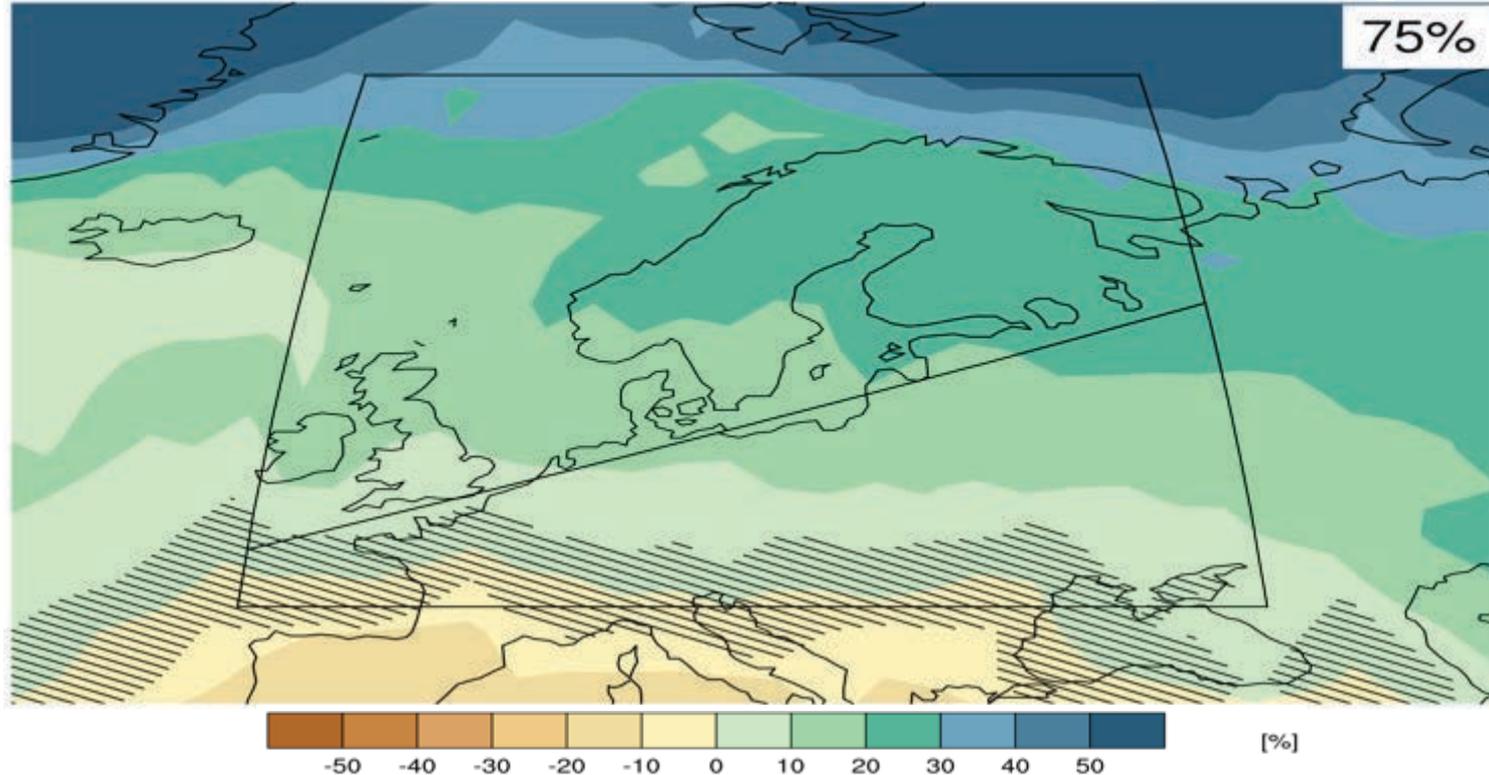
Transition took 4000 years, not 100 years

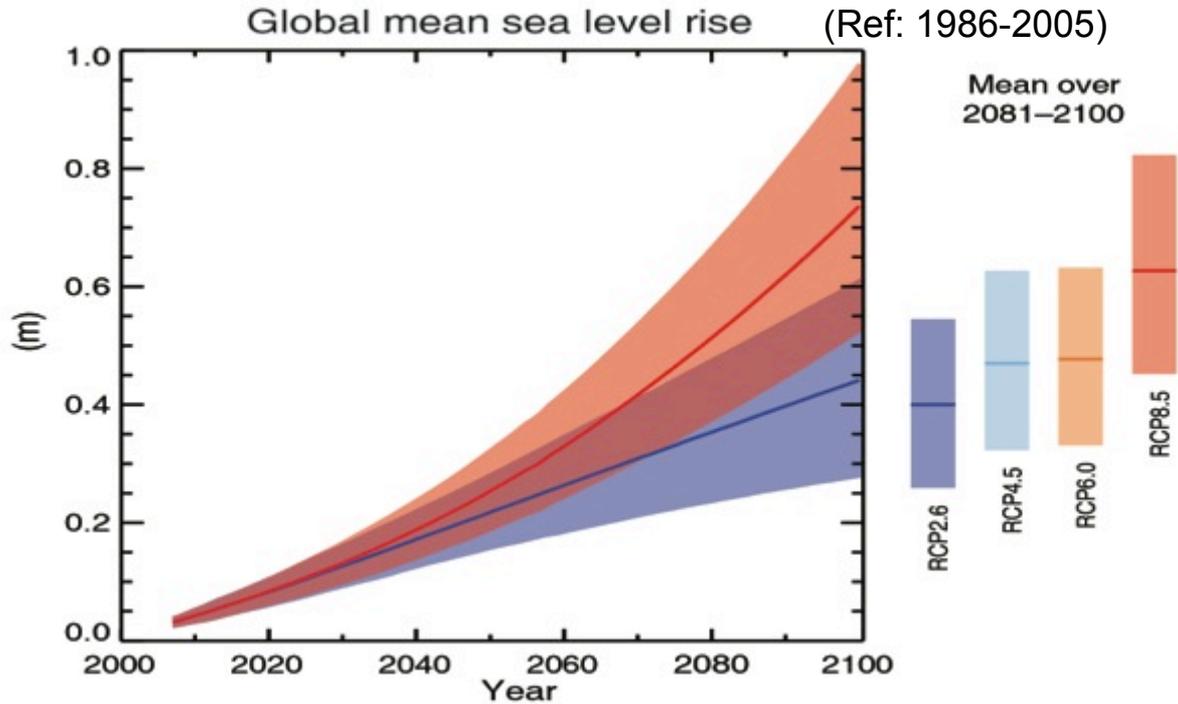


North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



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)



Source: J.P. van Ypersele et P. Marbaix (2004) See 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)

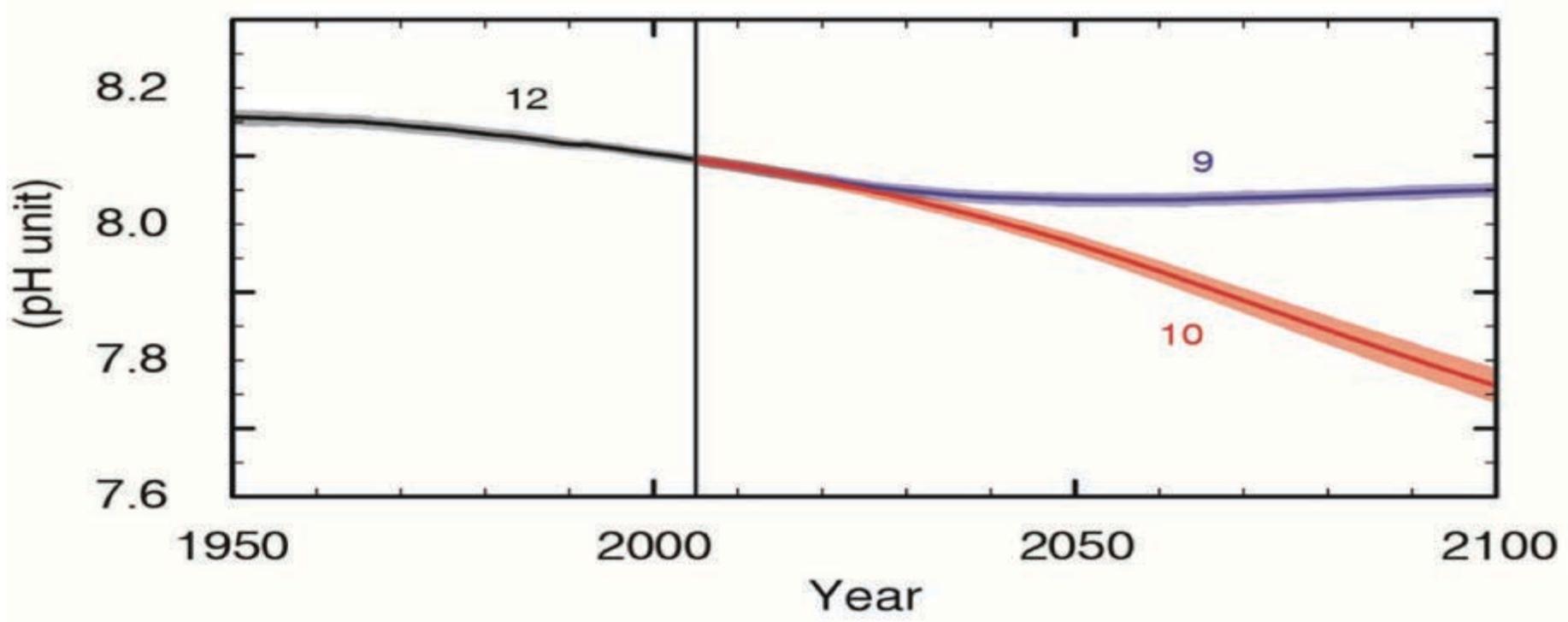
With 8 metre sea-level rise: 3700 km² below sea-level in Belgium (very possible in year 3000)



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

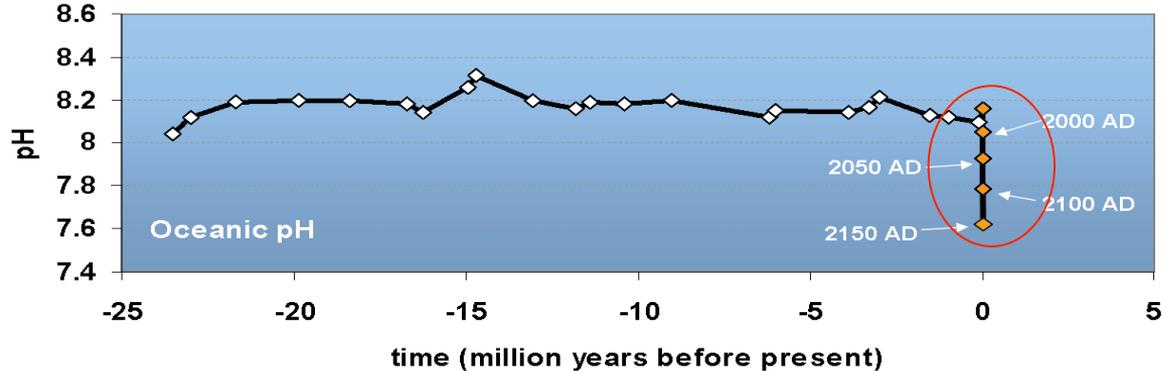
Global ocean surface pH (projections)

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

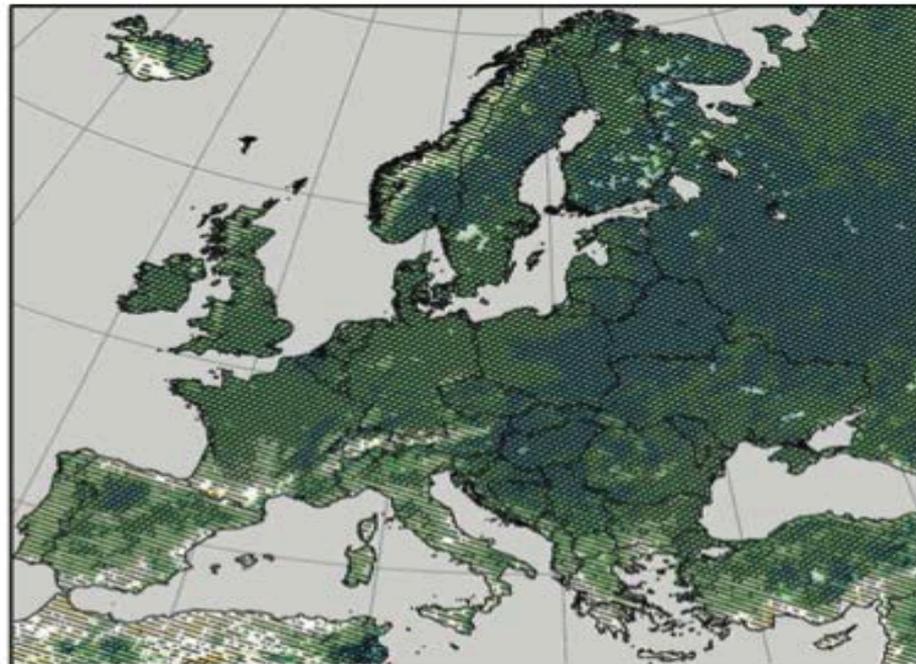
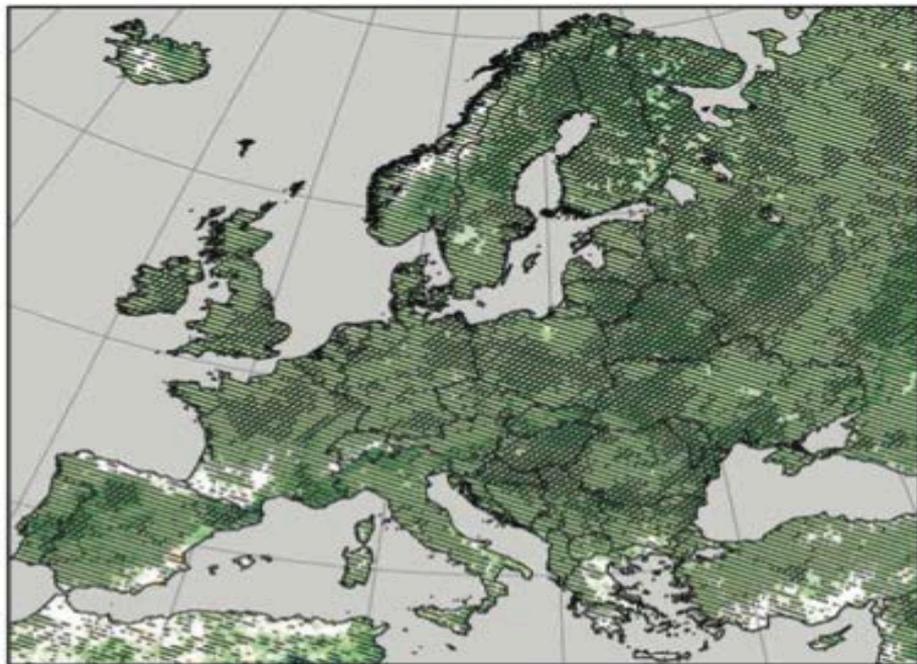
Turley et al. 2006

Slide courtesy of Carol Turley, PML

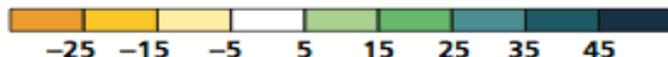
DJF seasonal changes in heavy precipitation (%), 2071-2100 compared to 1971-2000

RCP4.5

RCP8.5



Seasonal changes in heavy
precipitation in percent



//// Significant change
\\\\ Robust change

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>)

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 in 1996-2002

Regional key risks and risk reduction through adaptation

Representative key risks for each region for

Physical Systems

Glaciers, snow, ice, and/or permafrost

Rivers, lakes, floods, and/or drought

Coastal erosion and/or sea level effects

Biological Systems

Terrestrial ecosystems

Wildfire

Marine ecosystems

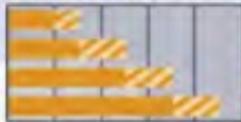
Human & Managed Systems

Food production

Livelihoods, health, and/or economics

Africa

Compounded stress on water resources



Reduced crop productivity and livelihood and food security



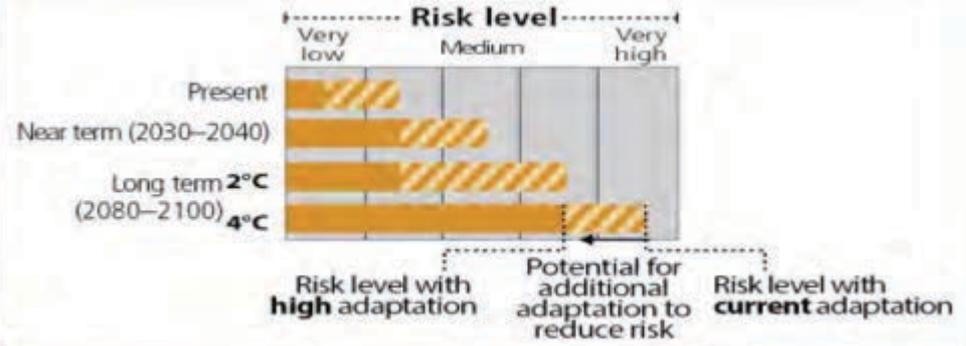
Vector- and water-borne diseases



Water

Food security

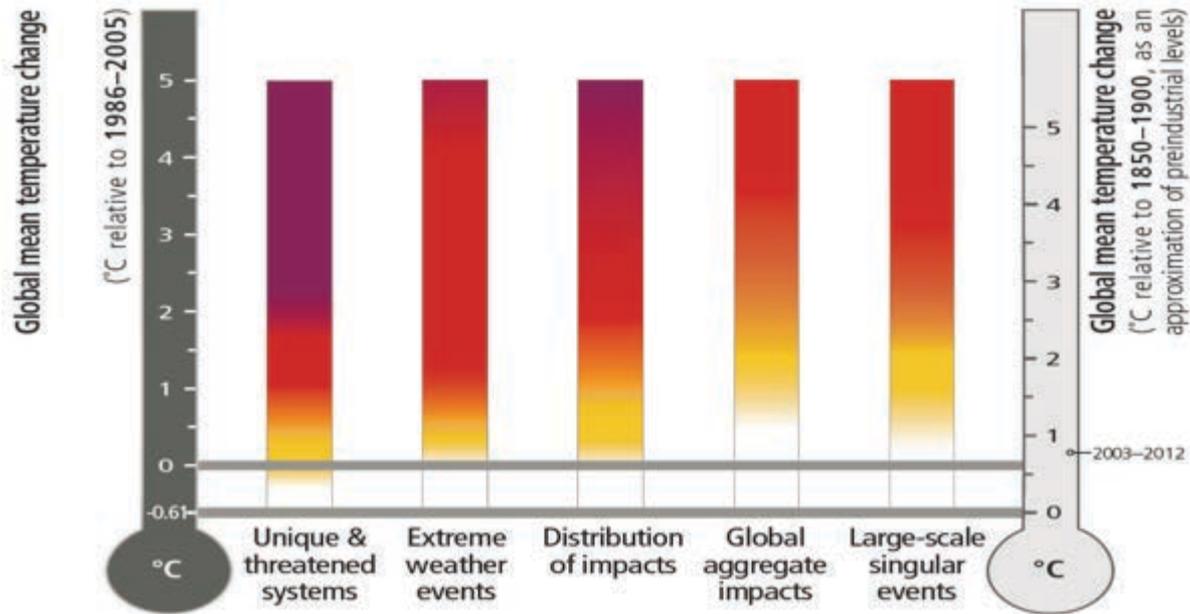
Diseases

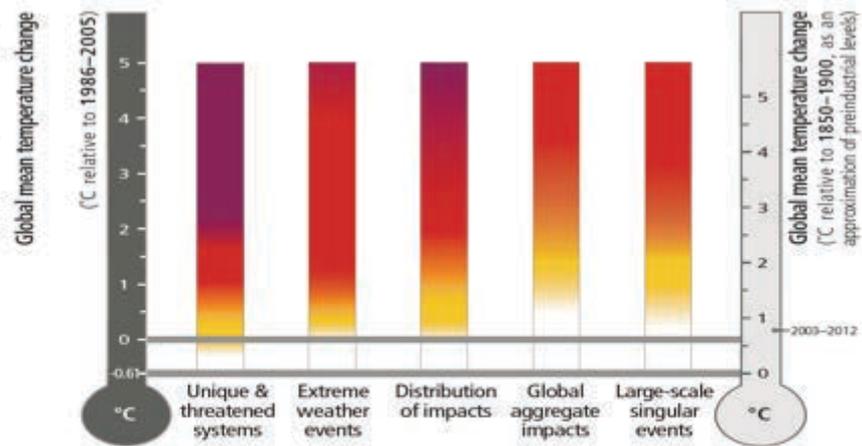
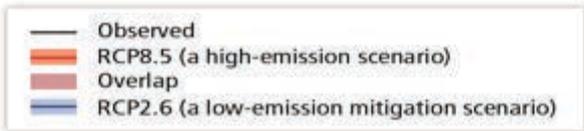
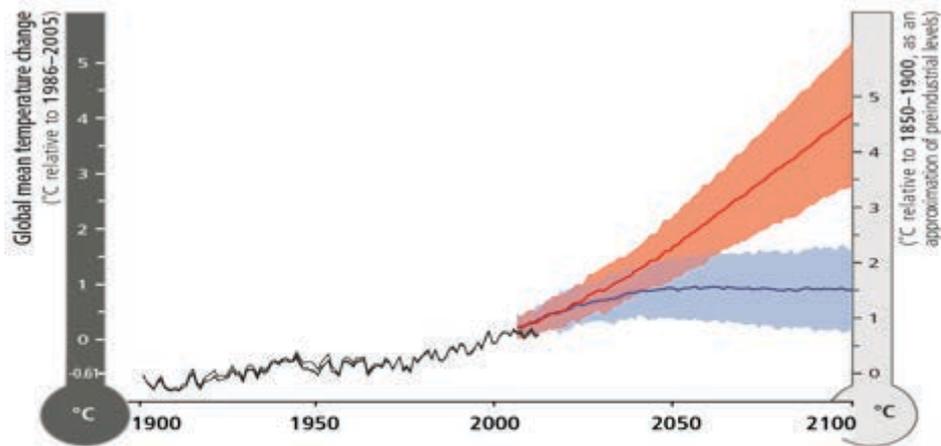


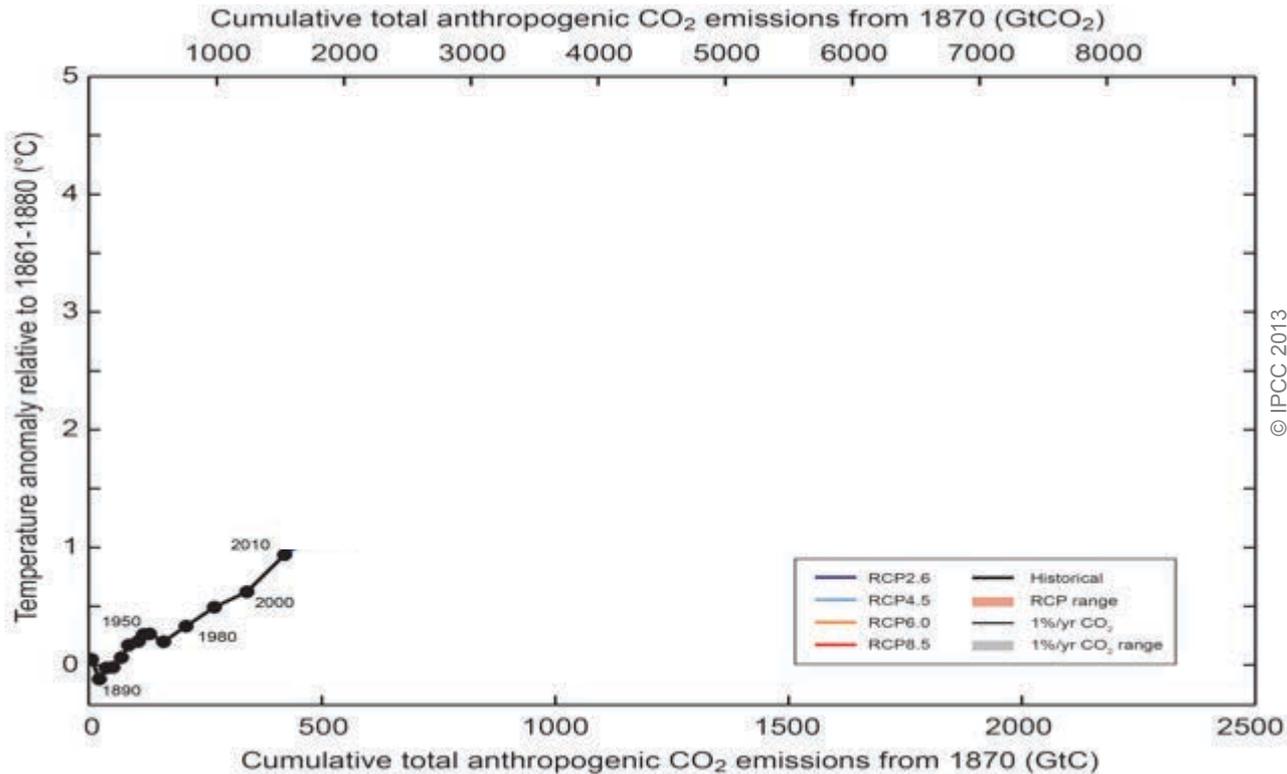
ipcc

INTERGOVERNMENTAL PANEL ON climate change





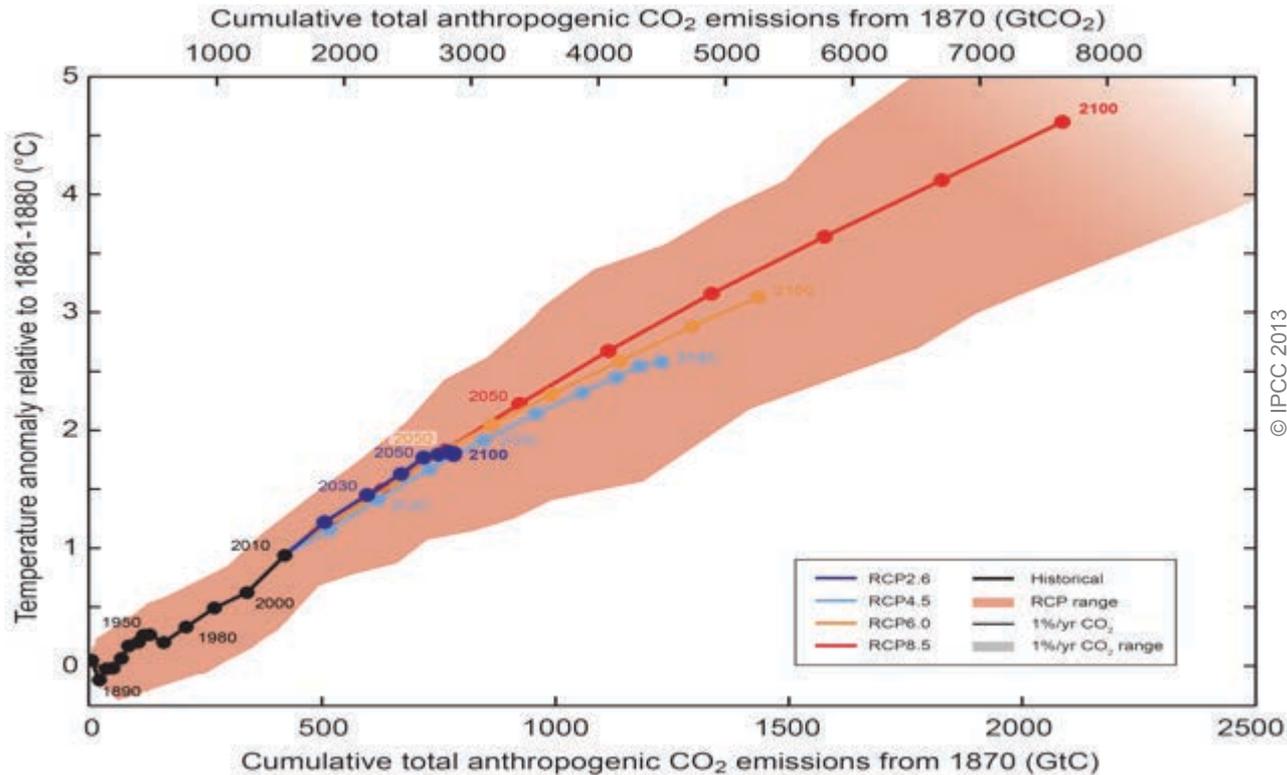




© IPCC 2013

Fig. SPM.10

Cumulative emissions of CO₂ largely determine global mean surface warming by the late 21st century and beyond.



© IPCC 2013

Fig. SPM.10

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

The window for action is rapidly closing

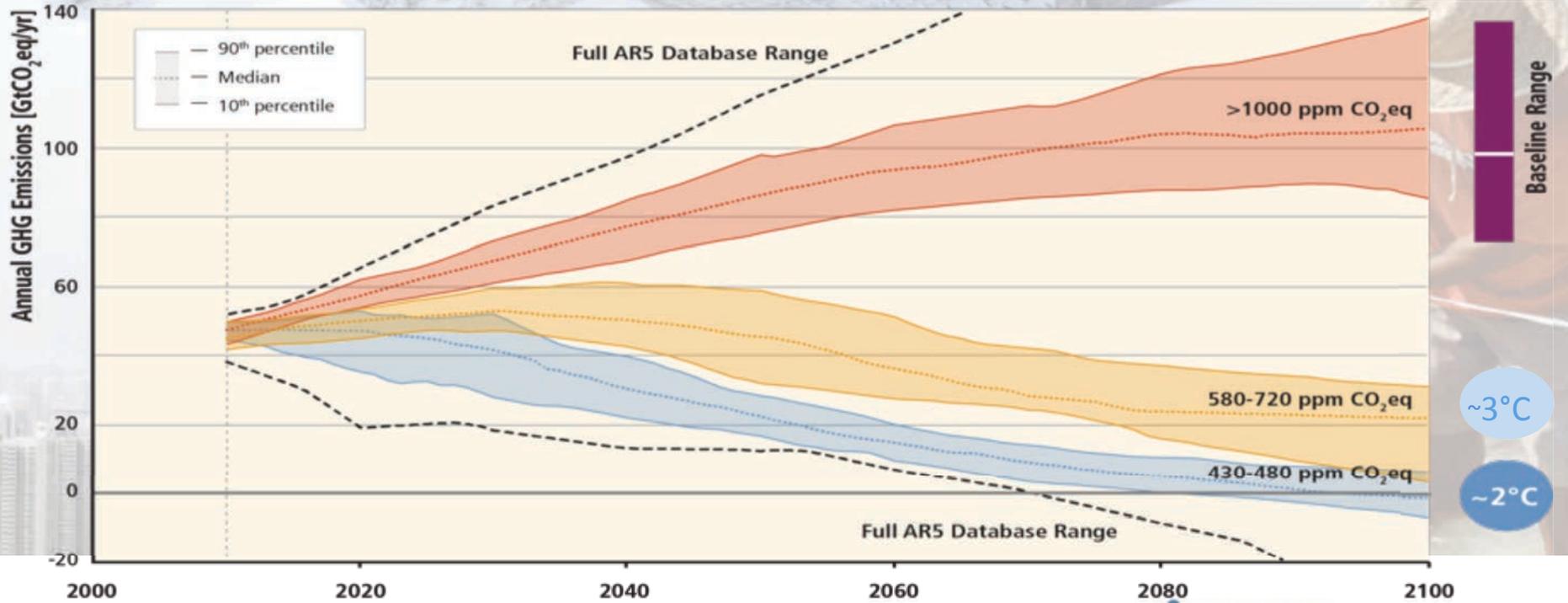
65% of the carbon budget compatible with a 2°C goal is already used
NB: this is with a probability greater than 66% to stay below 2°C



NB: Emissions in 2011: 38 GtCO₂/yr

AR5 WGI SPM

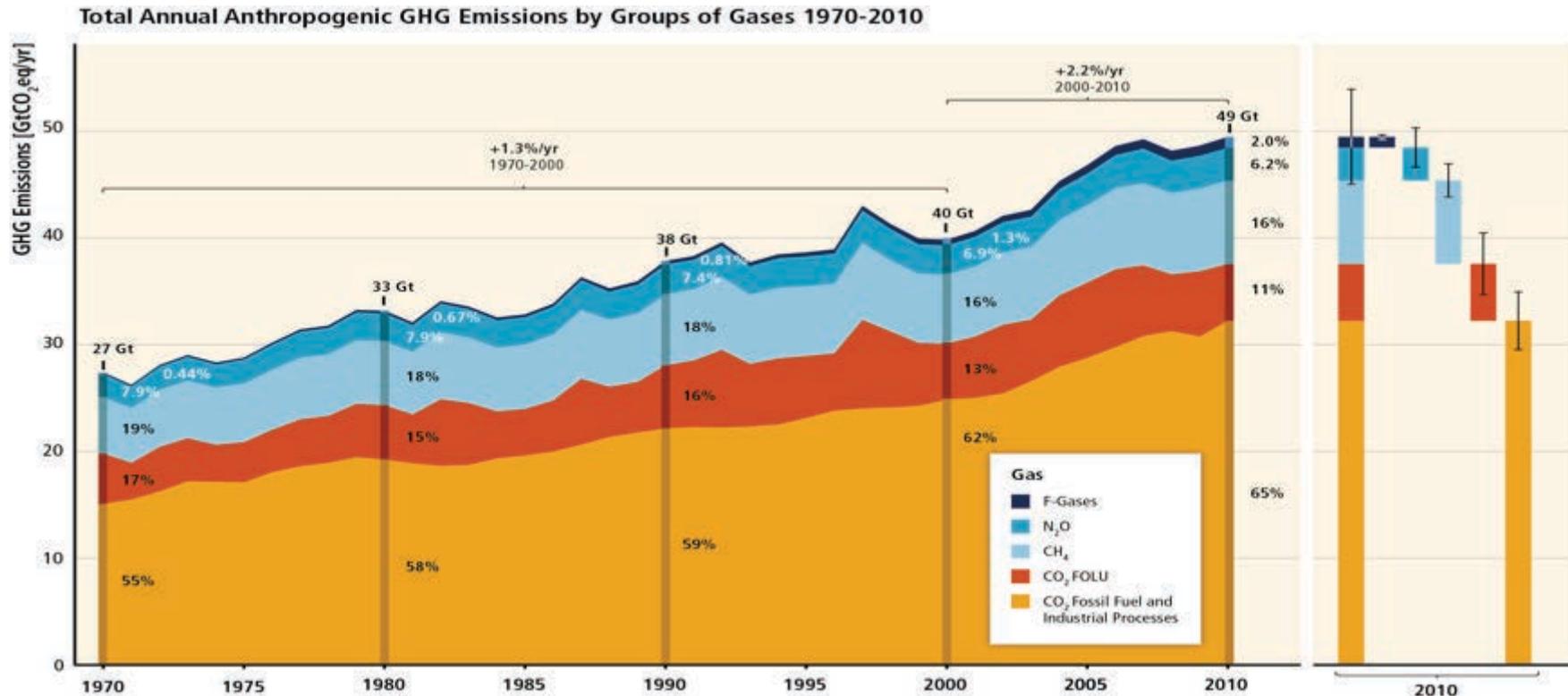
Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

IPCC AR5 Synthesis Report

GHG emissions accelerate despite reduction efforts. Most emission growth is CO₂ from fossil fuel combustion and industrial processes.



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 CO₂-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 CO₂eq) 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

Chamonix,
June 2016

Technology matters, but is not enough



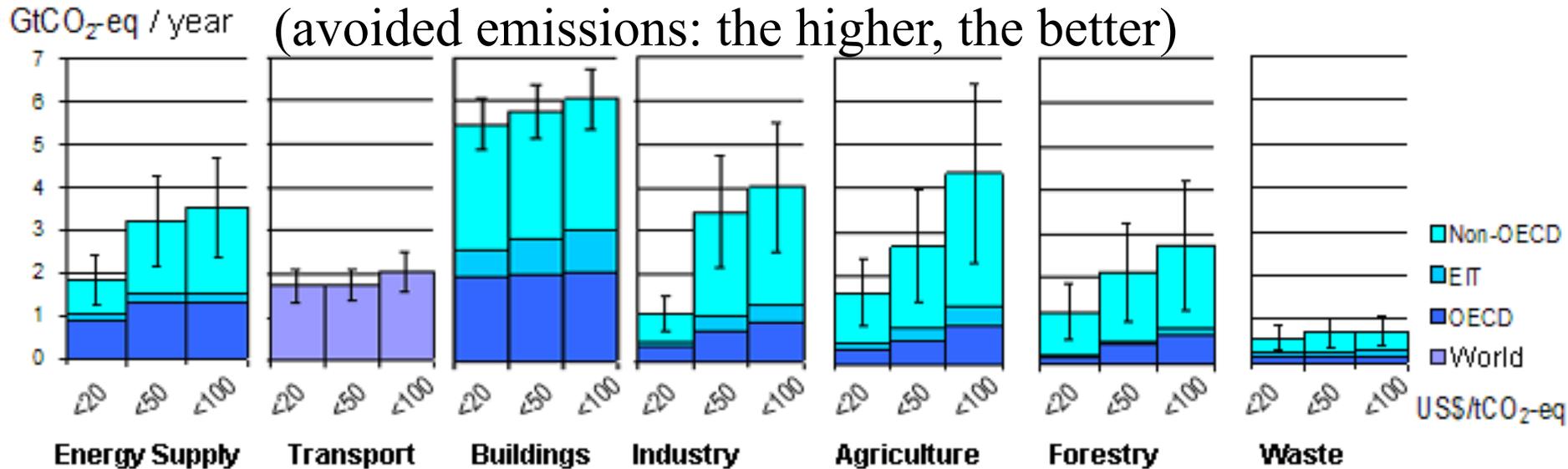
Jean-Pascal van Ypersele
(@JPvanYpersele)

Chamonix,
June 2016



Jean-Pascal van Ypersele
(@JPvanYpersele)

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 e.g., from 2010 to 2029, in billions US dollars/year:** (mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)

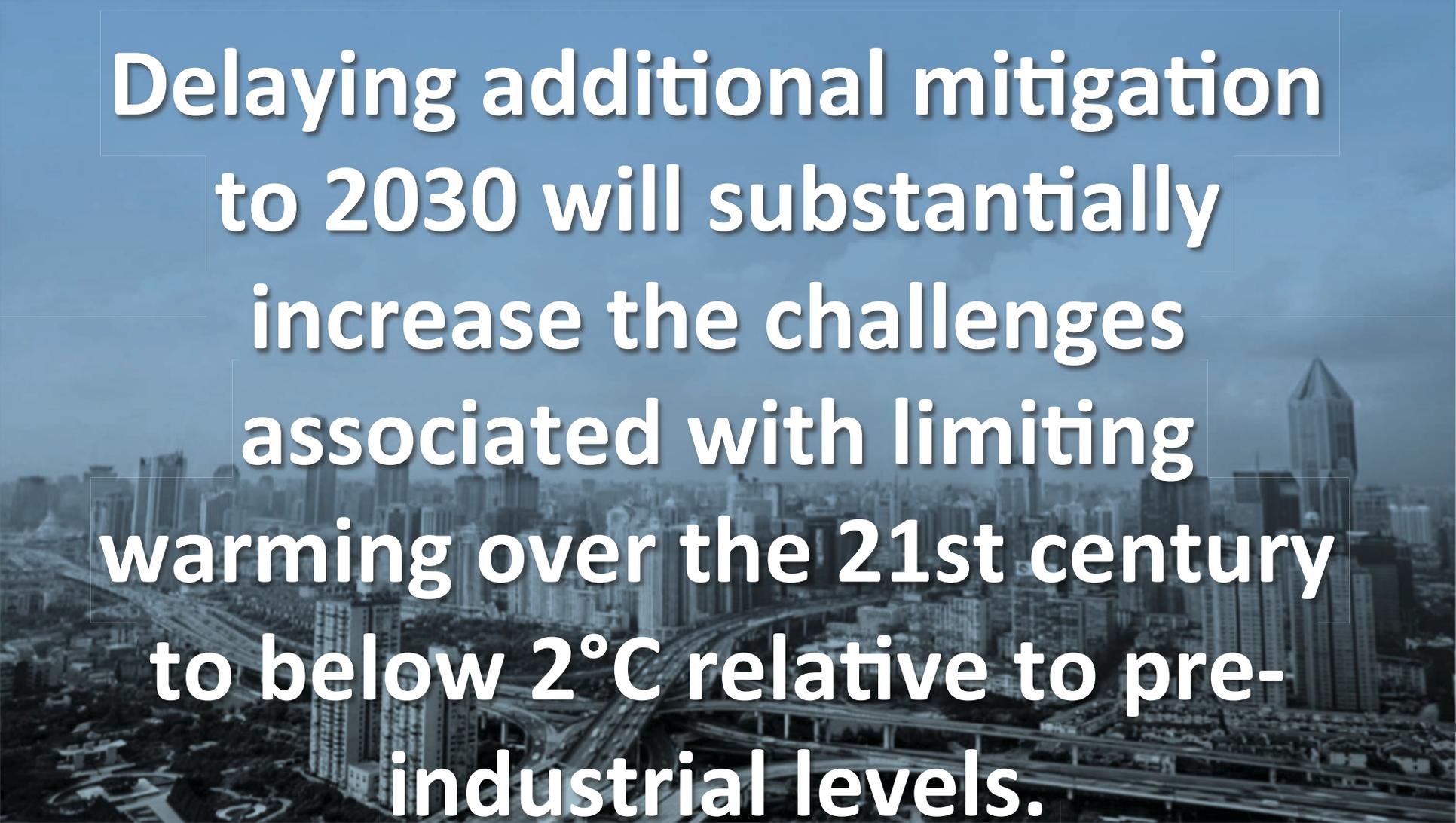
- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**

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

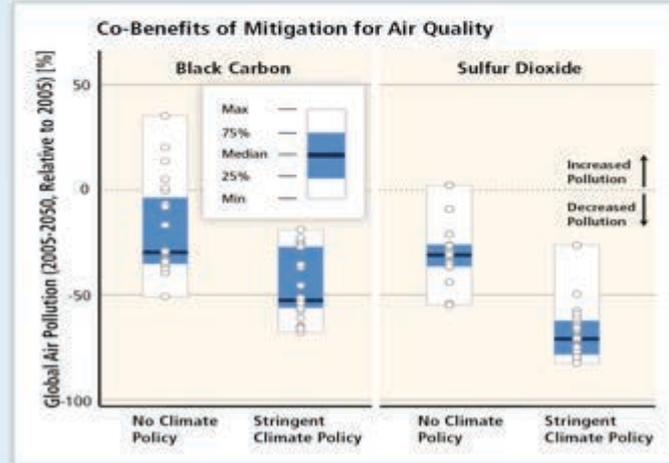
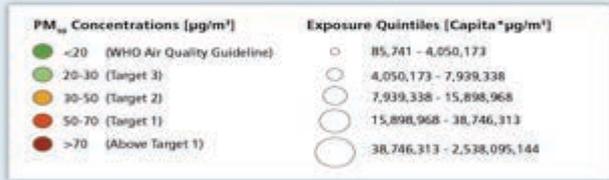
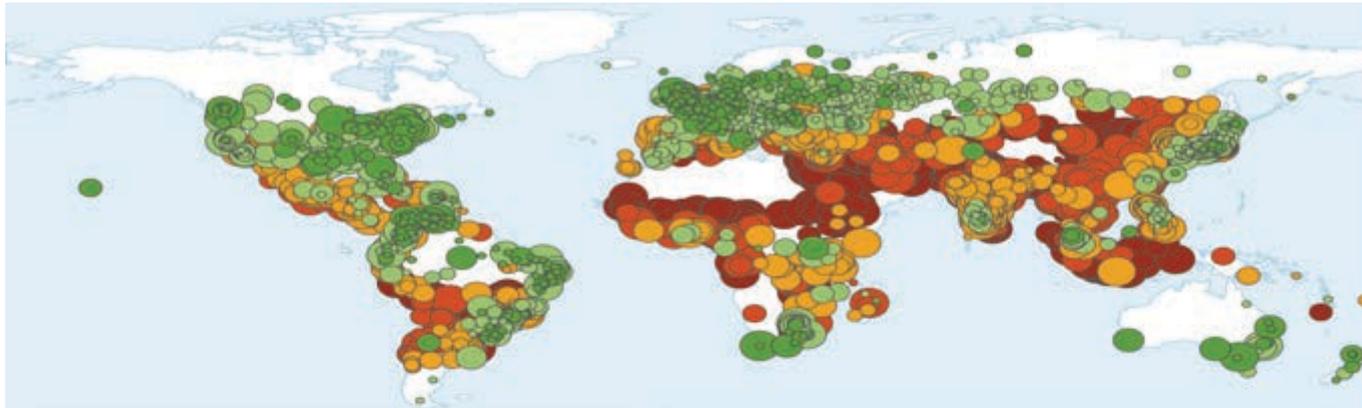
- **Sector-specific policies** have been more widely used than economy-wide policies.
- **Regulatory approaches and information** measures are widely used, and are often environmentally effective.
- Since AR4, **cap and trade** systems for GHGs have been established in a number of countries and regions.
- 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.

An aerial photograph of a city skyline, likely Hong Kong, featuring a complex highway interchange and numerous high-rise buildings. The image is overlaid with a semi-transparent blue filter.

**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.**

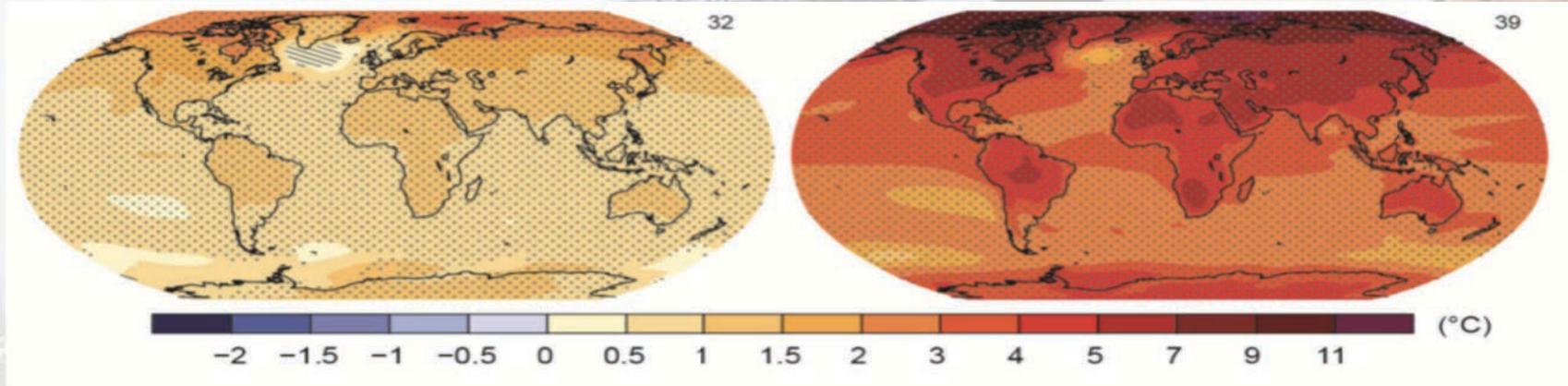


Mitigation can result in large co-benefits for human health and other societal goals.

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***

Chamonix,
June 2016

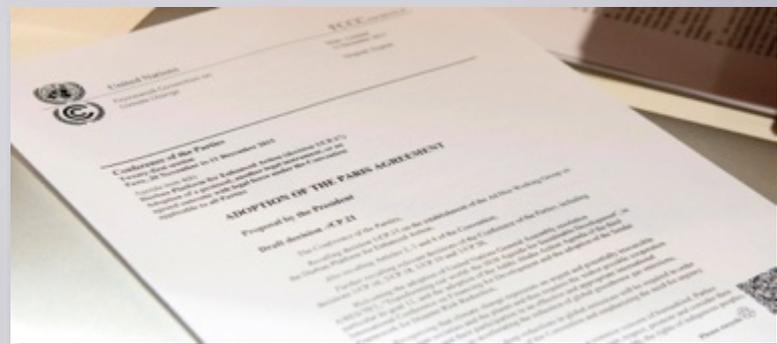
A common purpose, coordination, cooperation, risk management



Sur les Changements Climatiques 2015

COP21/CMP11

Paris, France





- **196 Parties**
- **150 Heads of State and Govt**
- **36.276 participants**

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;

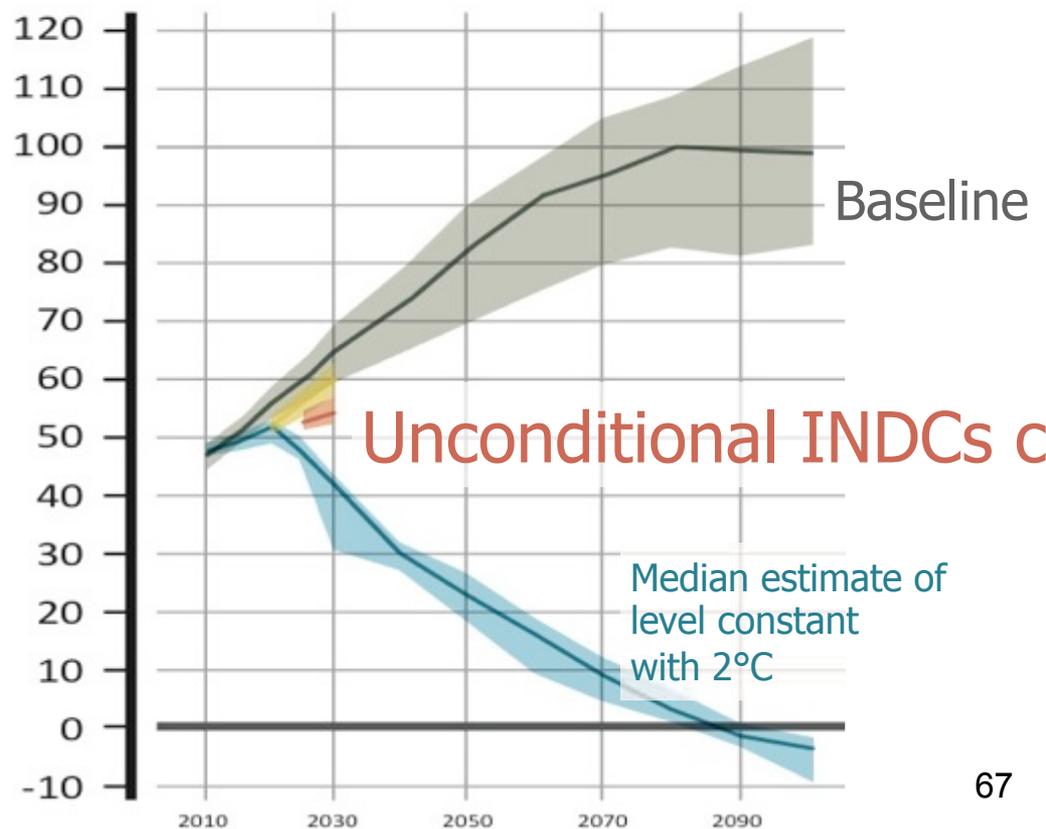
Paris Agreement

- 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

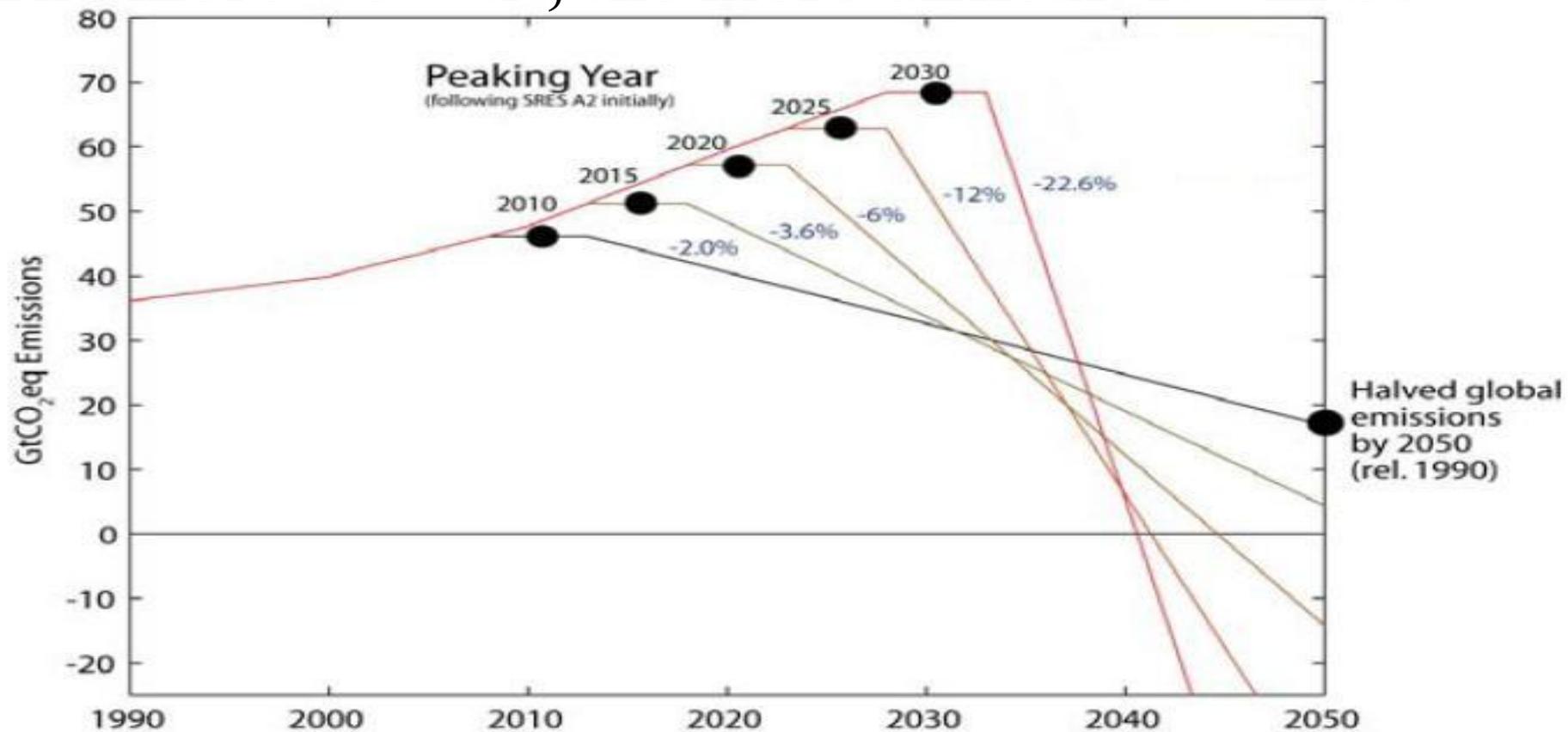
Intended Nationally Determined Contributions (INDCs)

- UN emissions gap report

Annual Global Total Greenhouse Gas Emissions (GtCO₂e)



The more we wait, the more difficult it will be



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

“Getting 196 Countries To Agree On Climate Change Was The Easy Part. Now comes the real work.”

(C. Figueres, World Economic Forum 2016, Davos)

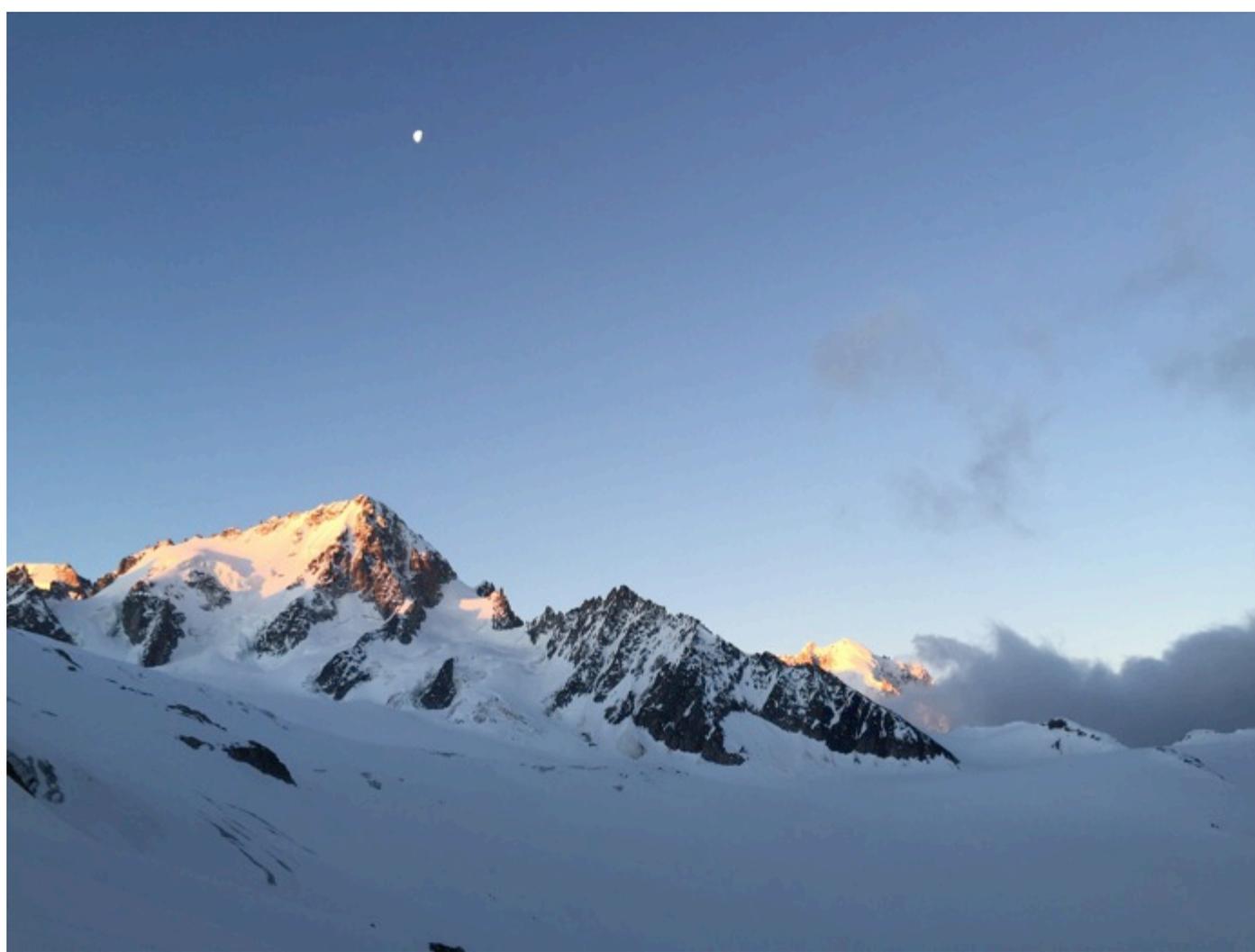


I try to be coherent...



**Chamonix,
June 2016**

Efforts deliver



Jean-Pascal van Ypersele
(@JPvanYpersele)

**Chamonix,
June 2016**

**The sky is blue when above the clouds which obscure the Sun
for those who remain in the valley**



Jean-Pascal van Ypersele
(@JPvanYpersele)

Chamonix, June 2016; The future is full of opportunities



Jean-Pascal van Ypersele
(@JPvanYpersele)

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**

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

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