Climate Change: a Formidable Challenge, but also an Opportunity

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World efficiency, The Shift event, Paris, 13 October 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

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?

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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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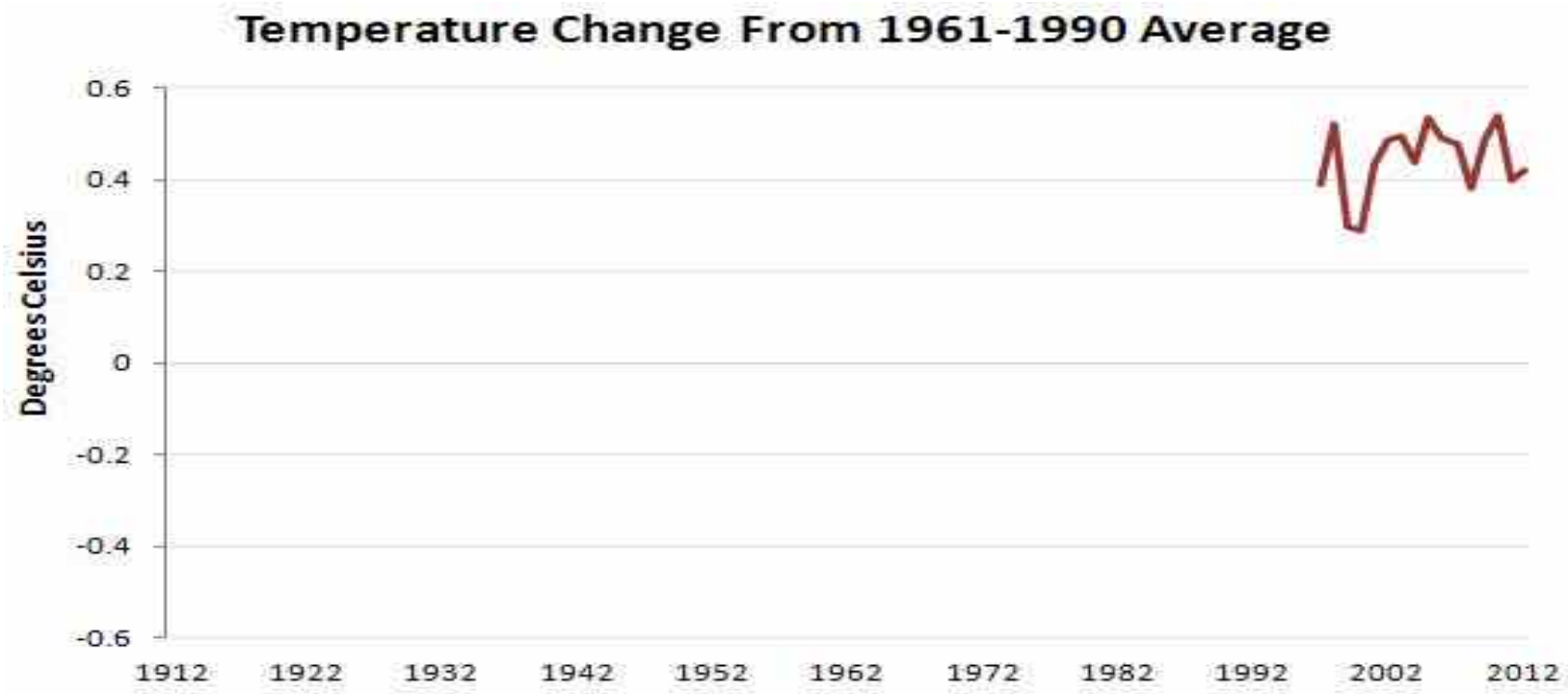
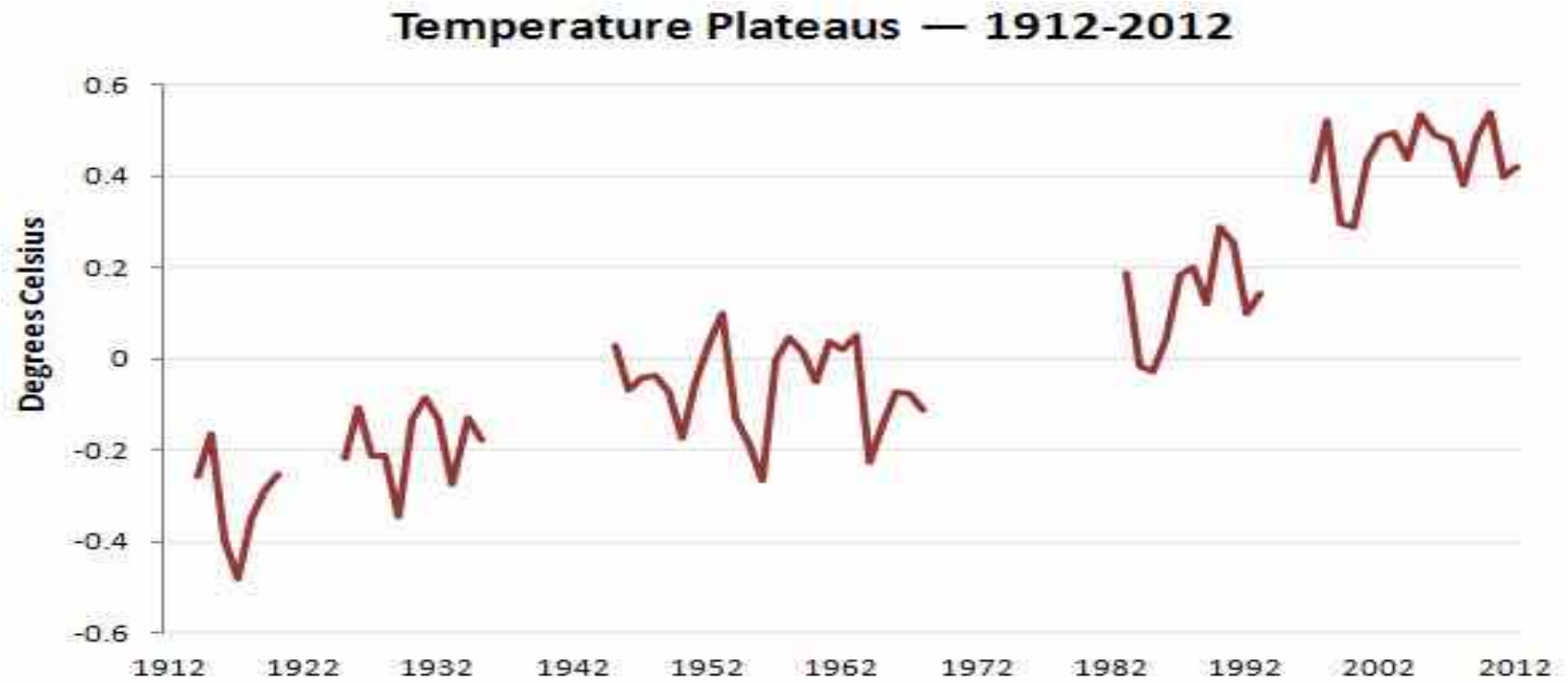


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



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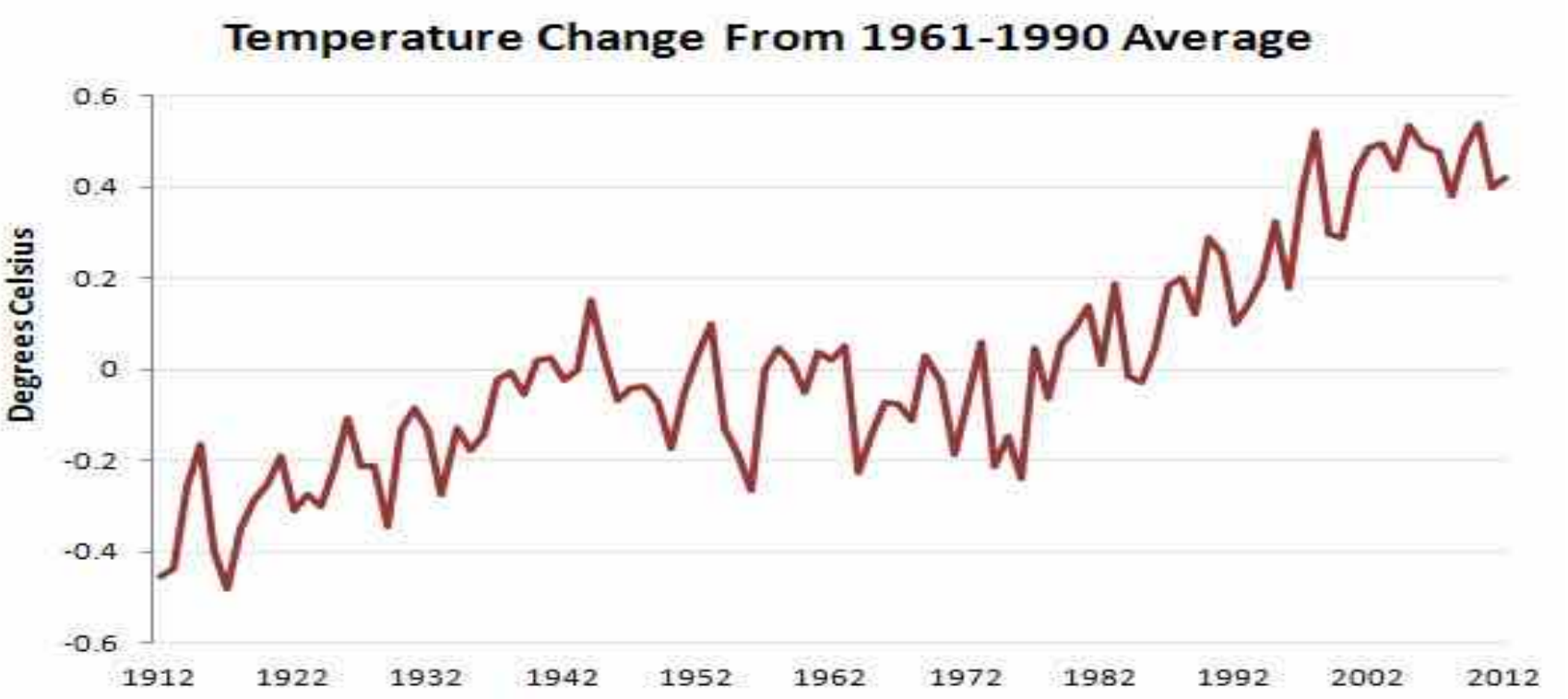

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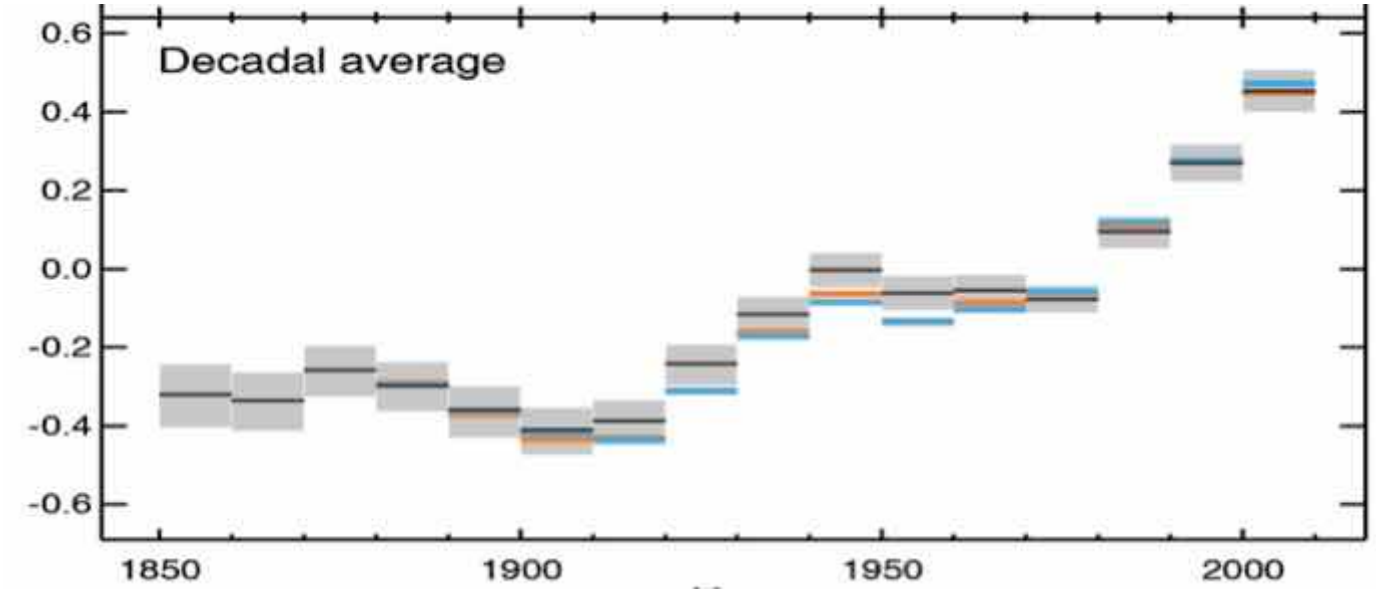


(IPCC 2013, Fig. SPM.1a)

Chacune des trois dernières décennies a été successivement plus chaude à la surface de la Terre que toutes les décennies précédentes depuis 1850

Dans l'hémisphère nord, la période 1983–2012 a probablement été la période de 30 ans la plus chaude des 1400 dernières années (degré de confiance moyen).

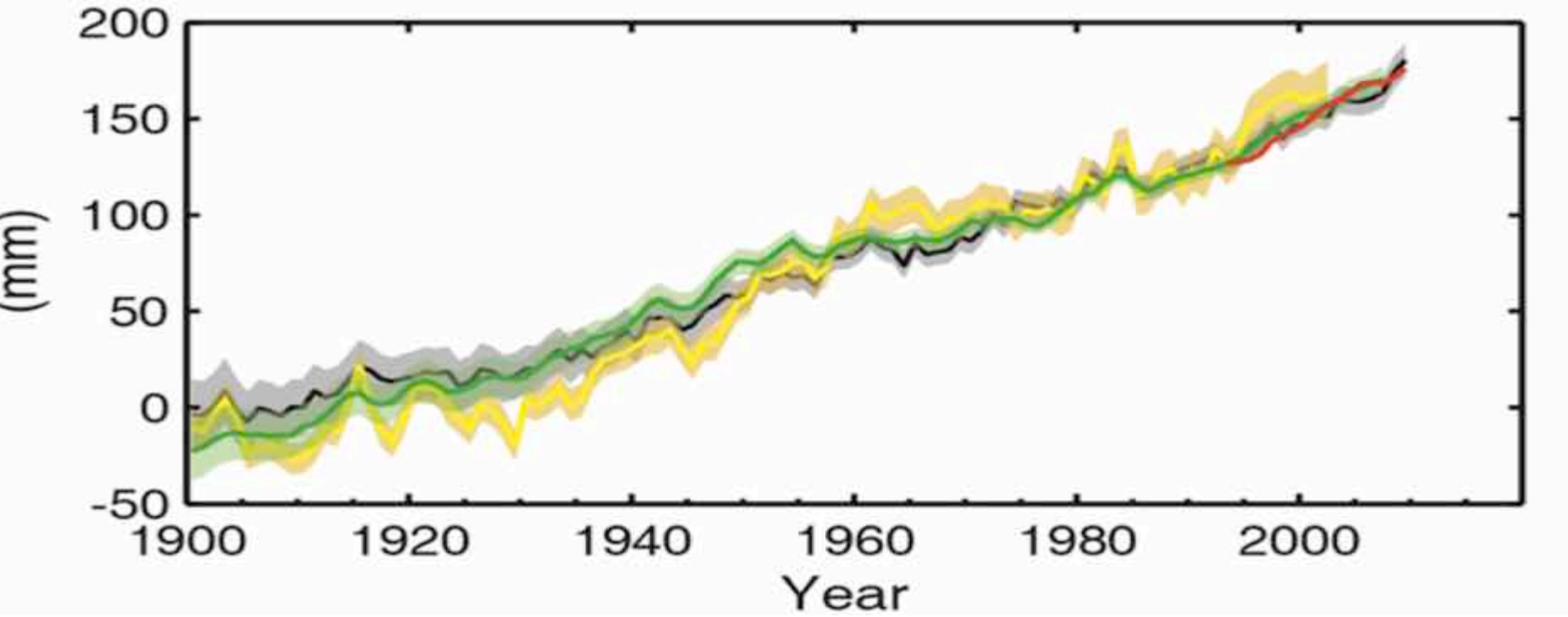
Plateau Glacier (1961)
(Alaska)

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

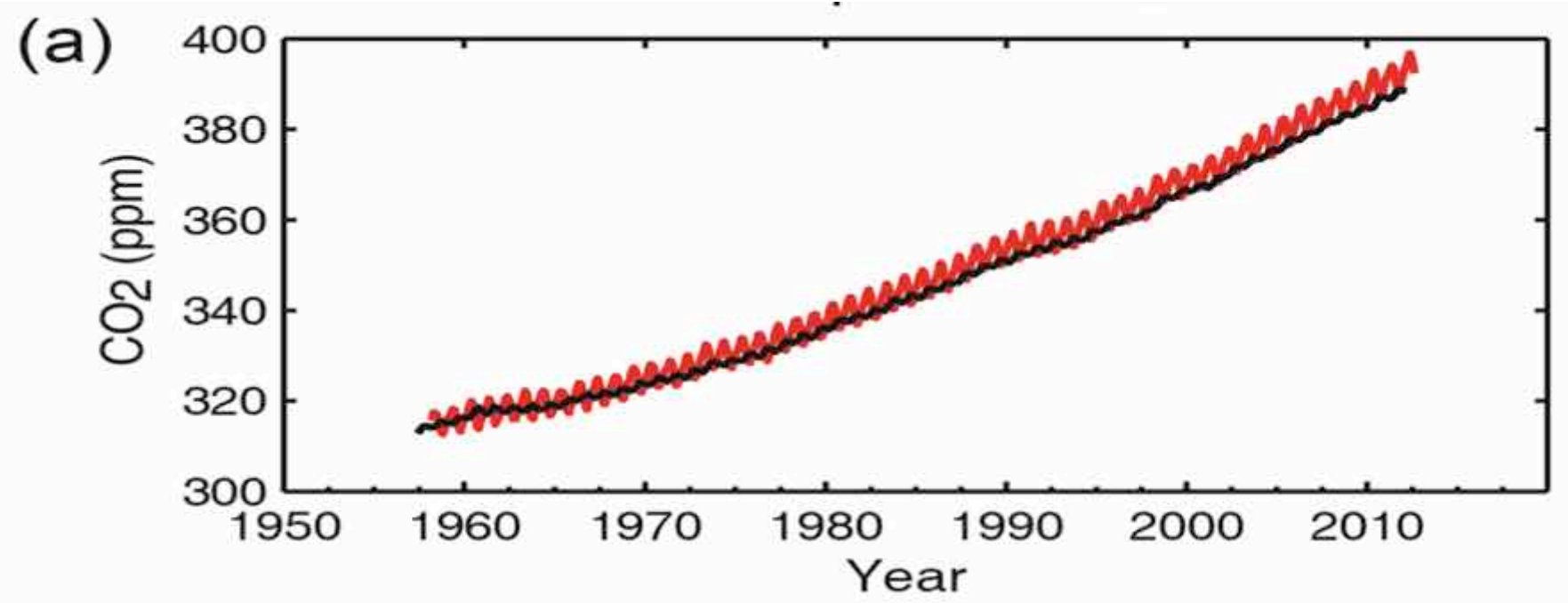
Plateau Glacier (2003)
(Alaska)

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

Evolution du niveau moyen des mers



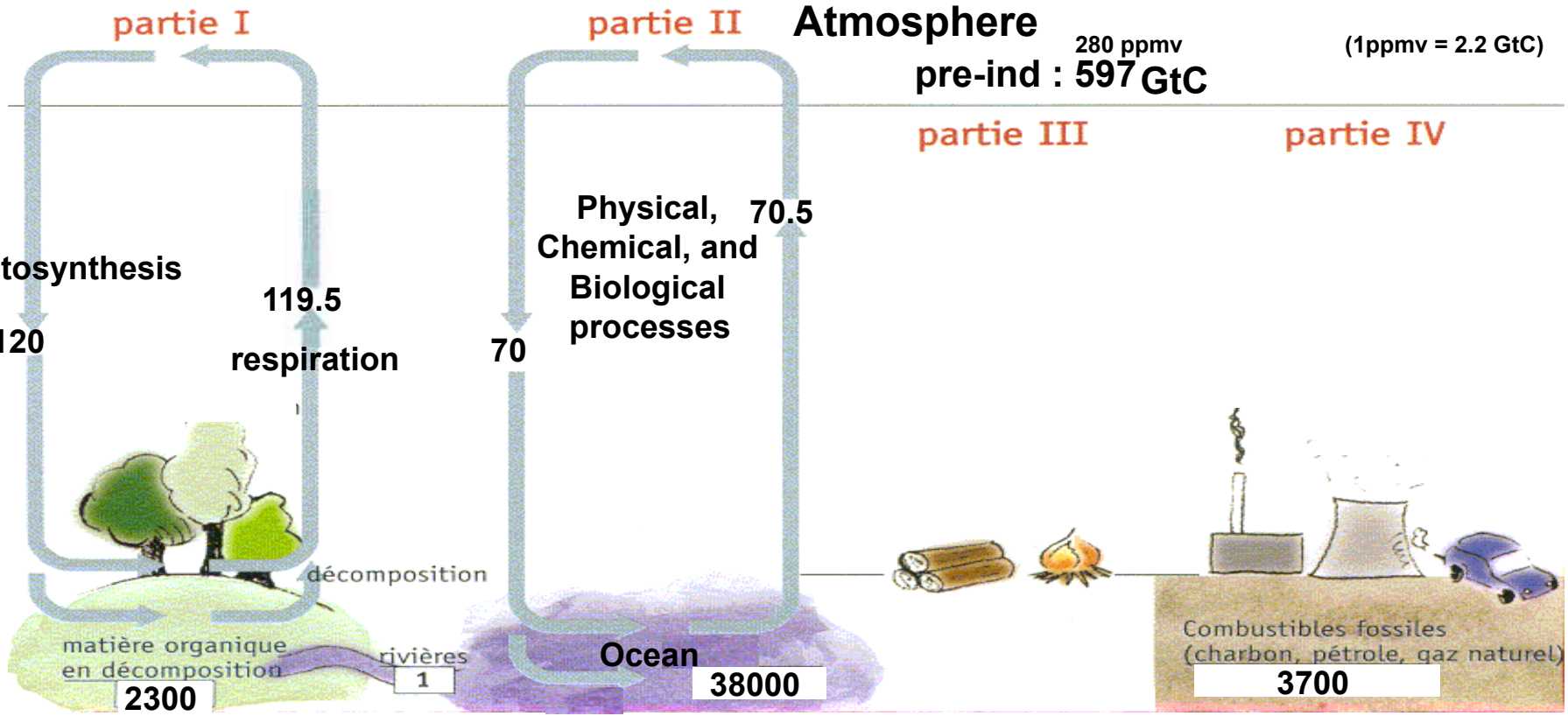
Concentration atmosphérique en CO_2



(Lüthi et al.,2008, NOAA)

Les concentrations atmosphériques en dioxyde de carbone (CO_2) ont augmenté jusqu'à des niveaux sans précédent au cours des 800 000 dernières années

Carbon cycle: unperturbed fluxes

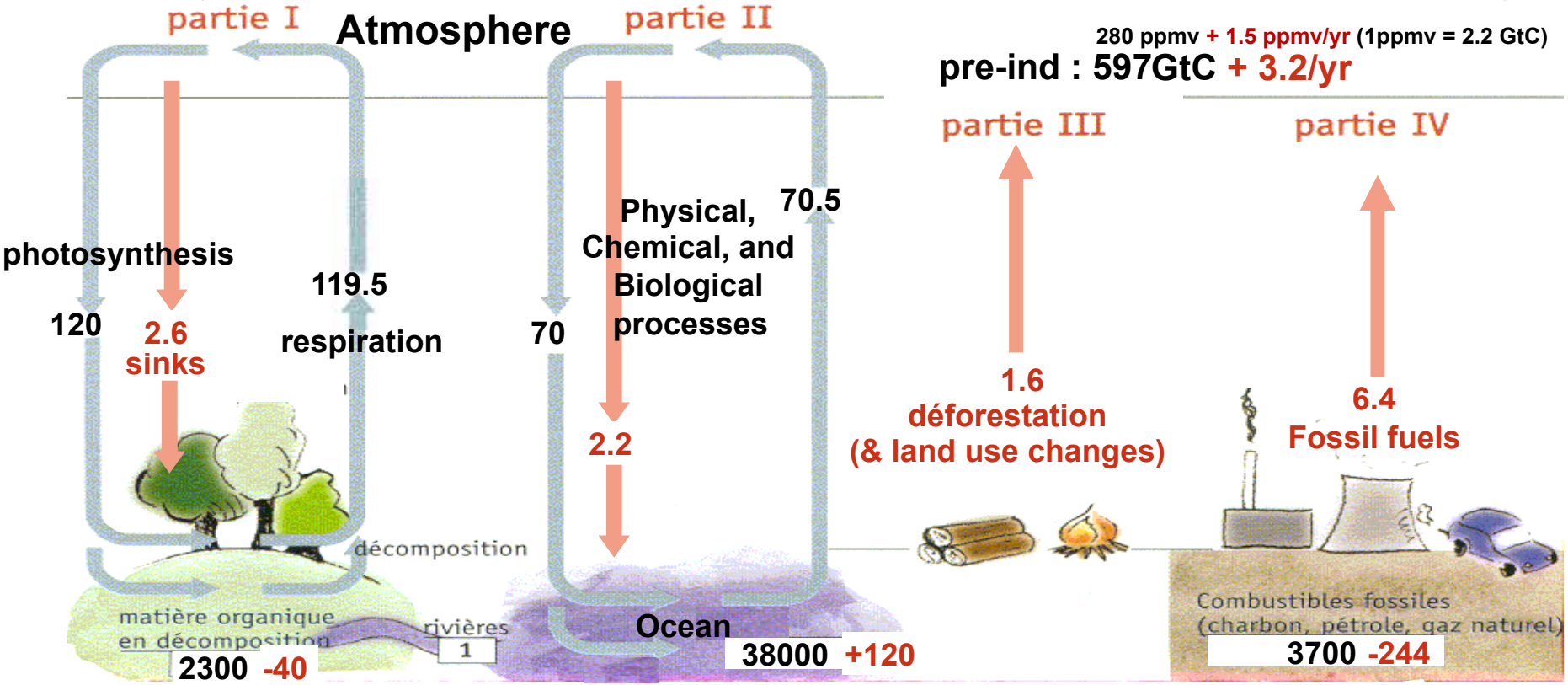


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

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!

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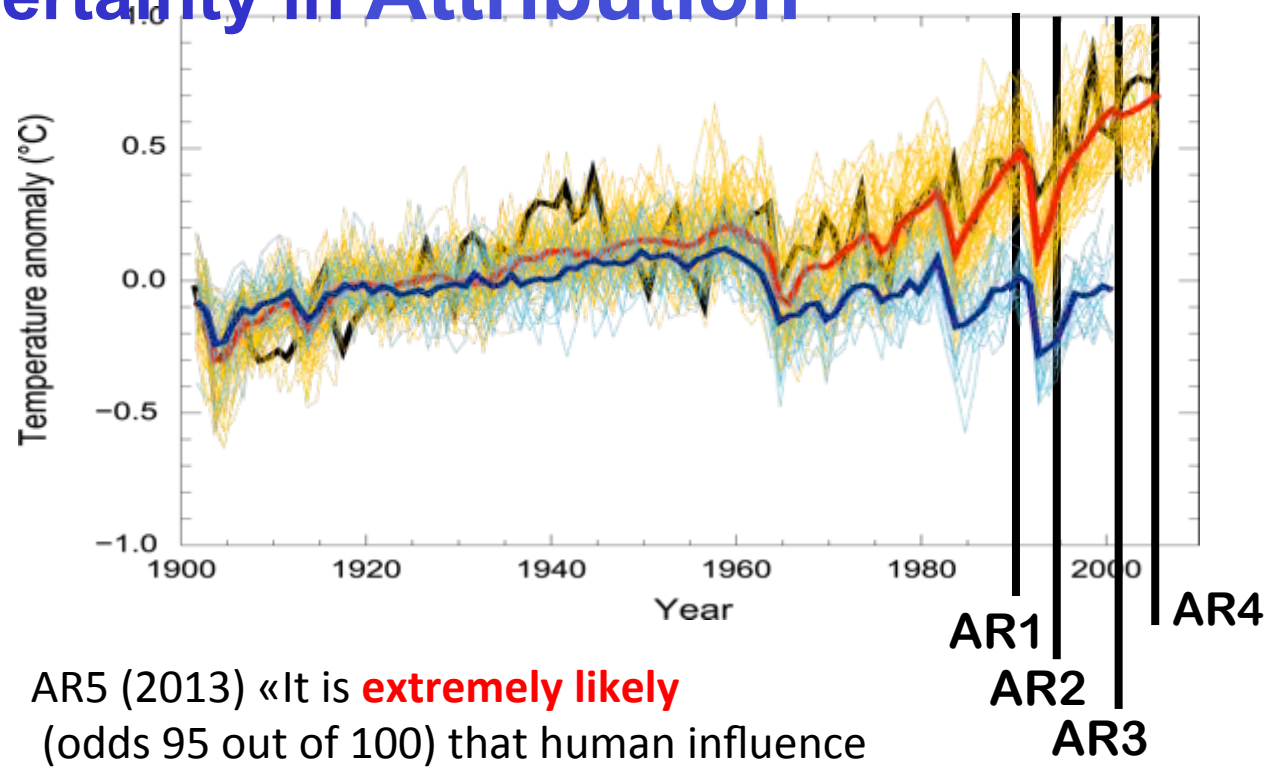
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

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

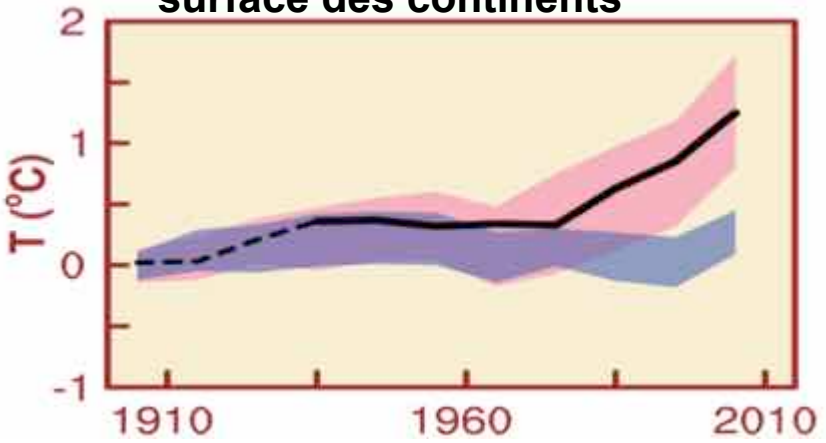
AR3 (2001): “most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities”

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

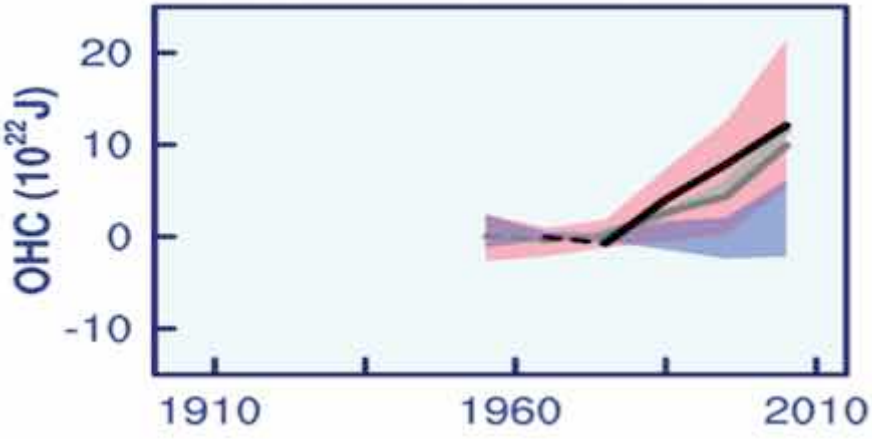


AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

Température moyenne surface des continents



Contenu thermique des océans



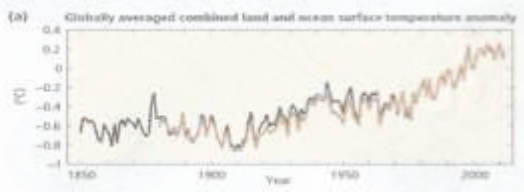
(IPCC 2013, Fig. SPM.6)

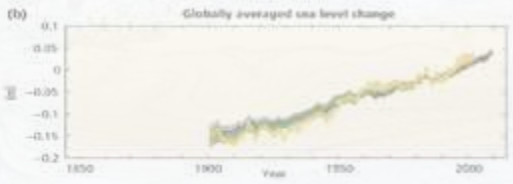
Noir: observations

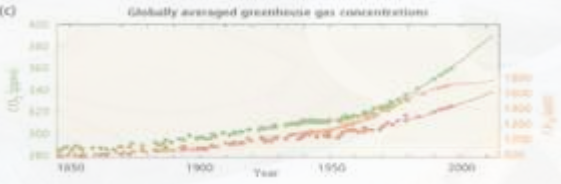
Bleu: simulations avec seuls facteurs naturels

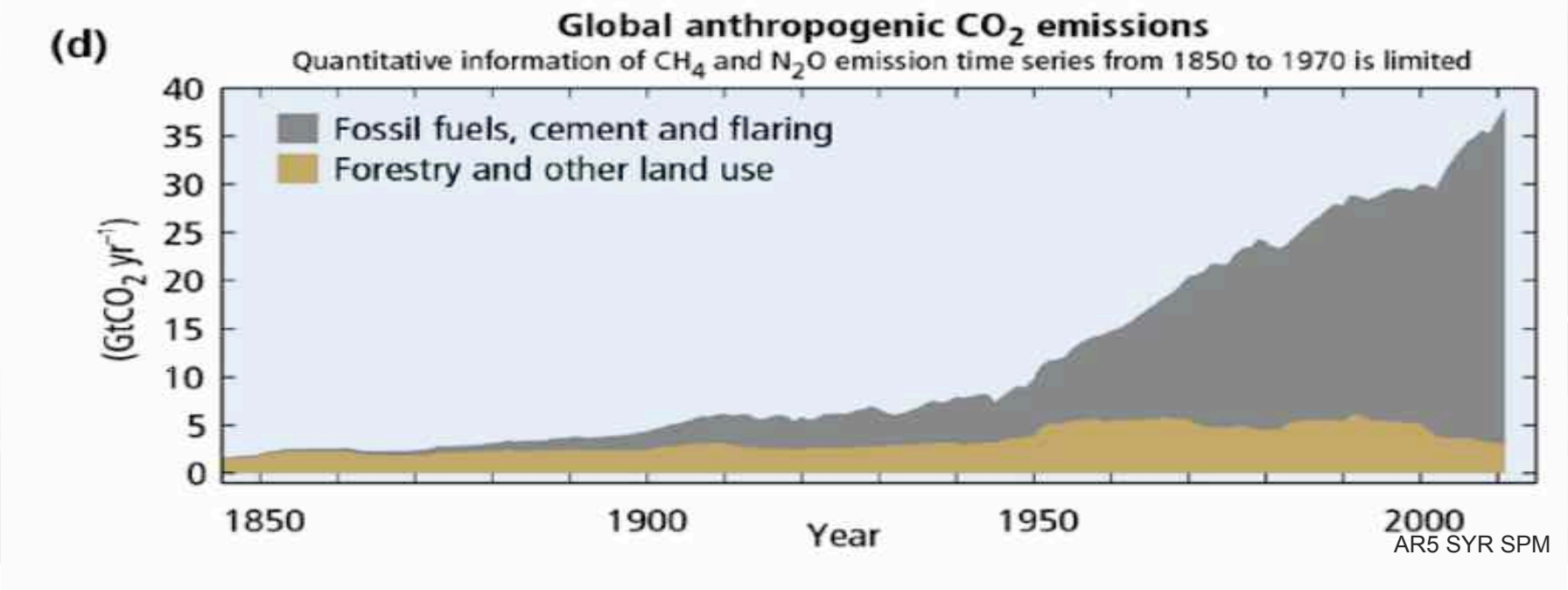
Rose: simulations avec facteurs naturels & humains

L'influence humaine sur le système climatique est sans équivoque; Il est *extrêmement probable* (95%) que l'influence humaine a été la cause principale du réchauffement depuis le milieu du 20ème siècle


(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
1850
1900
Year
1950
2000


(b)
Globally averaged sea level change
1850
1900
Year
1950
2000


(c)
Globally averaged greenhouse gas concentrations
1850
1900
Year
1950
2000


(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
Year
1950
2000

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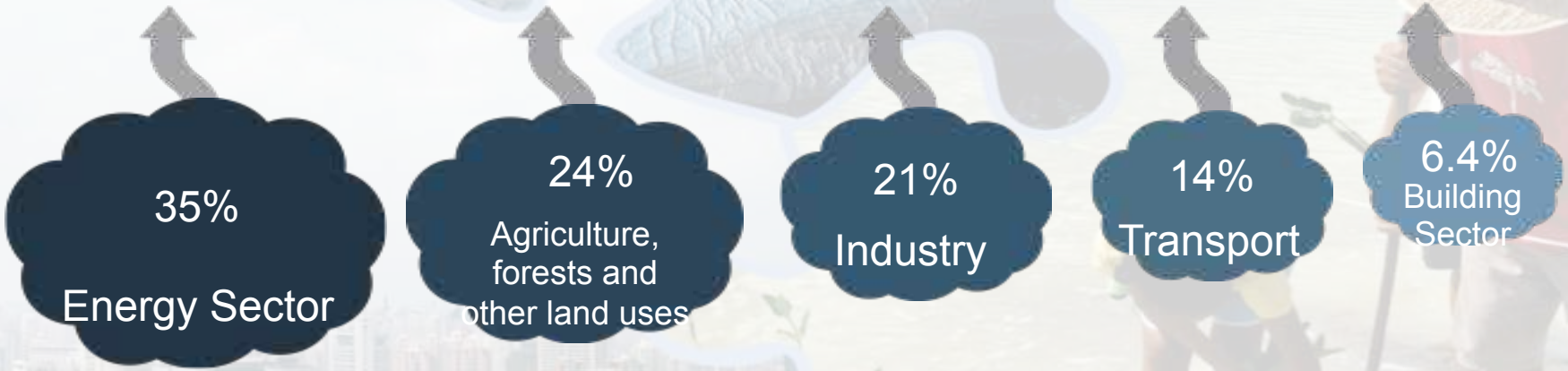
Sources of emissions

Energy production remains the primary driver of GHG emissions



2010 GHG emissions

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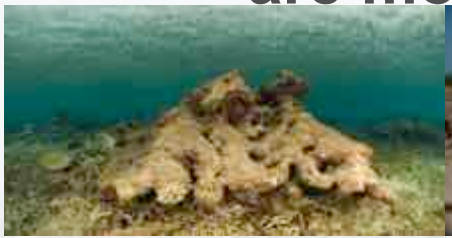
Since 1950, extreme hot days and heavy precipitation have become more common

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

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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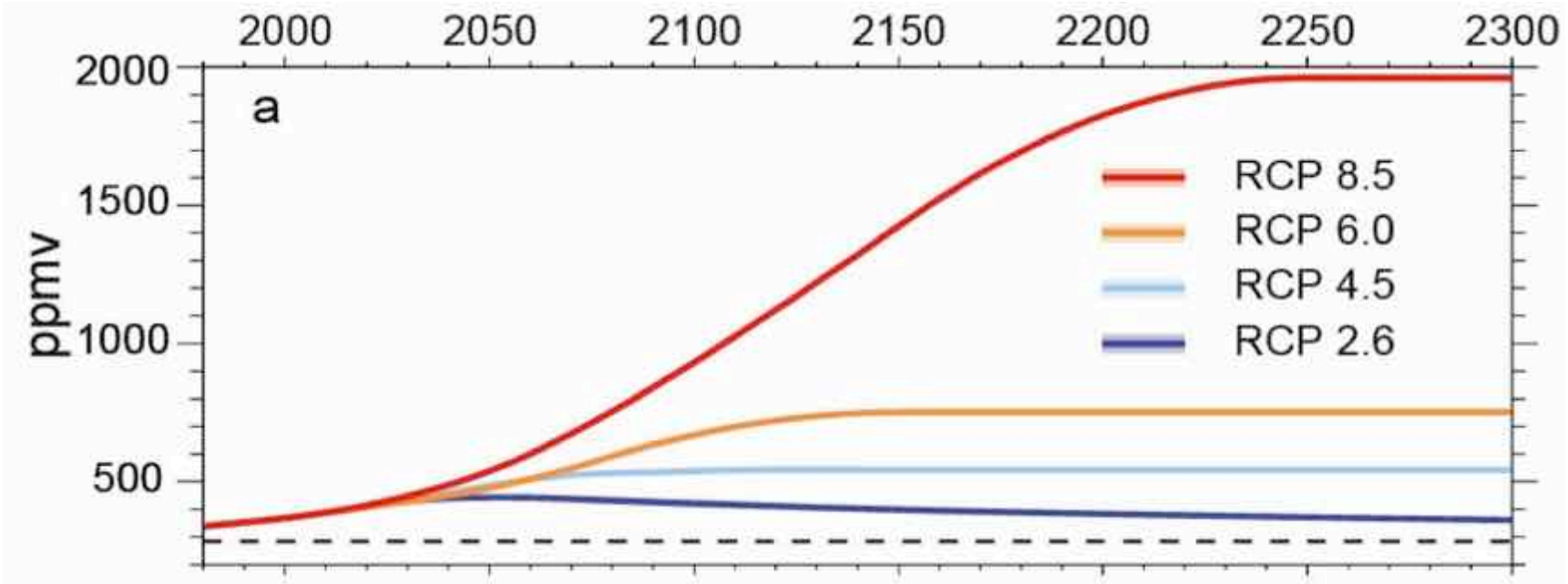
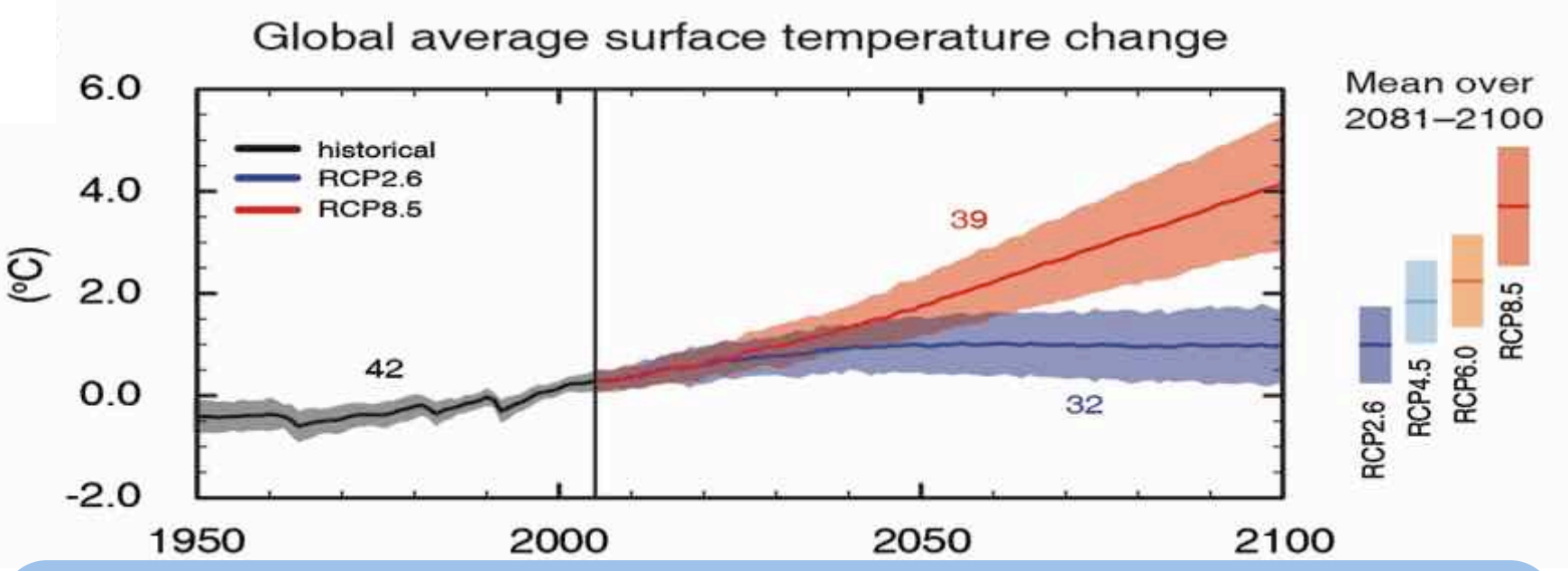
RCP Scenarios: Atmospheric CO_2 concentration



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

AR5, chapter 12. WGI

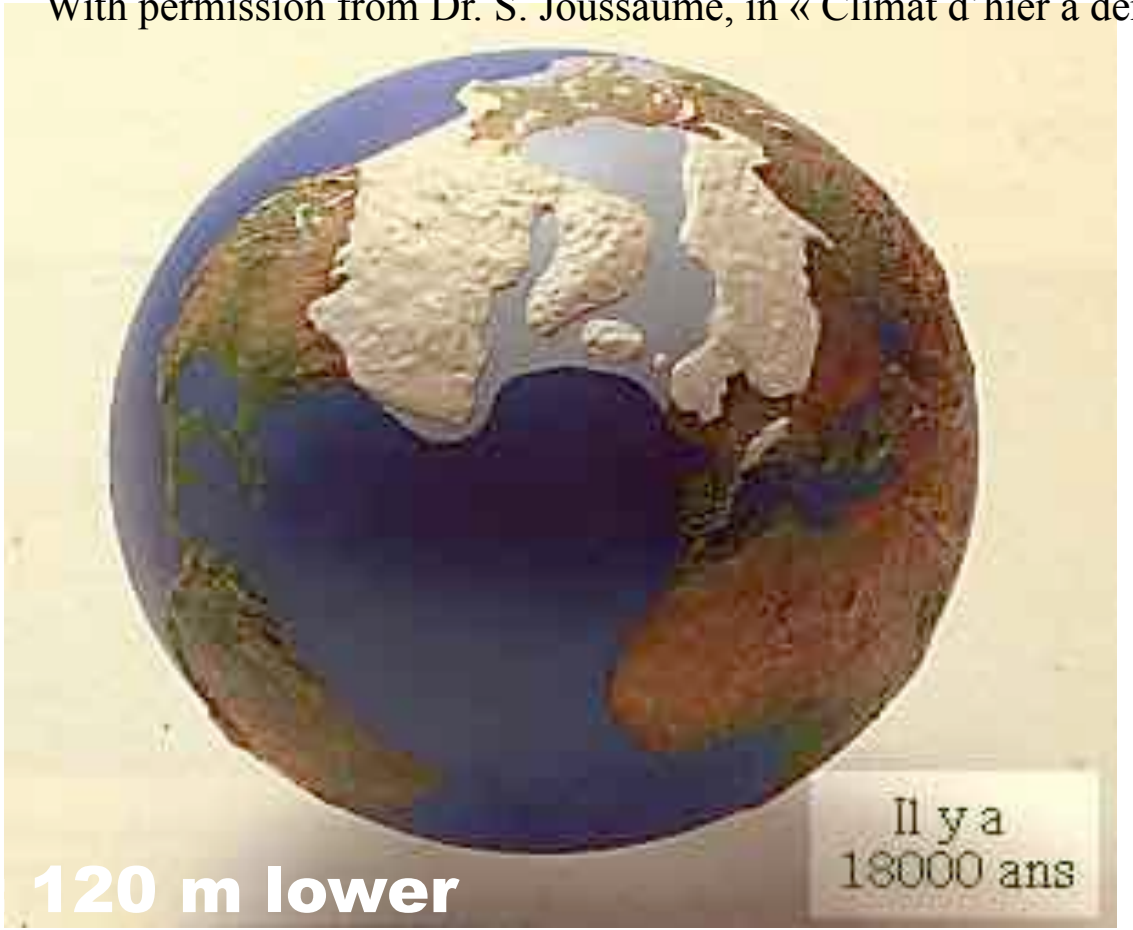


(IPCC 2013, Fig. SPM.7a)

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

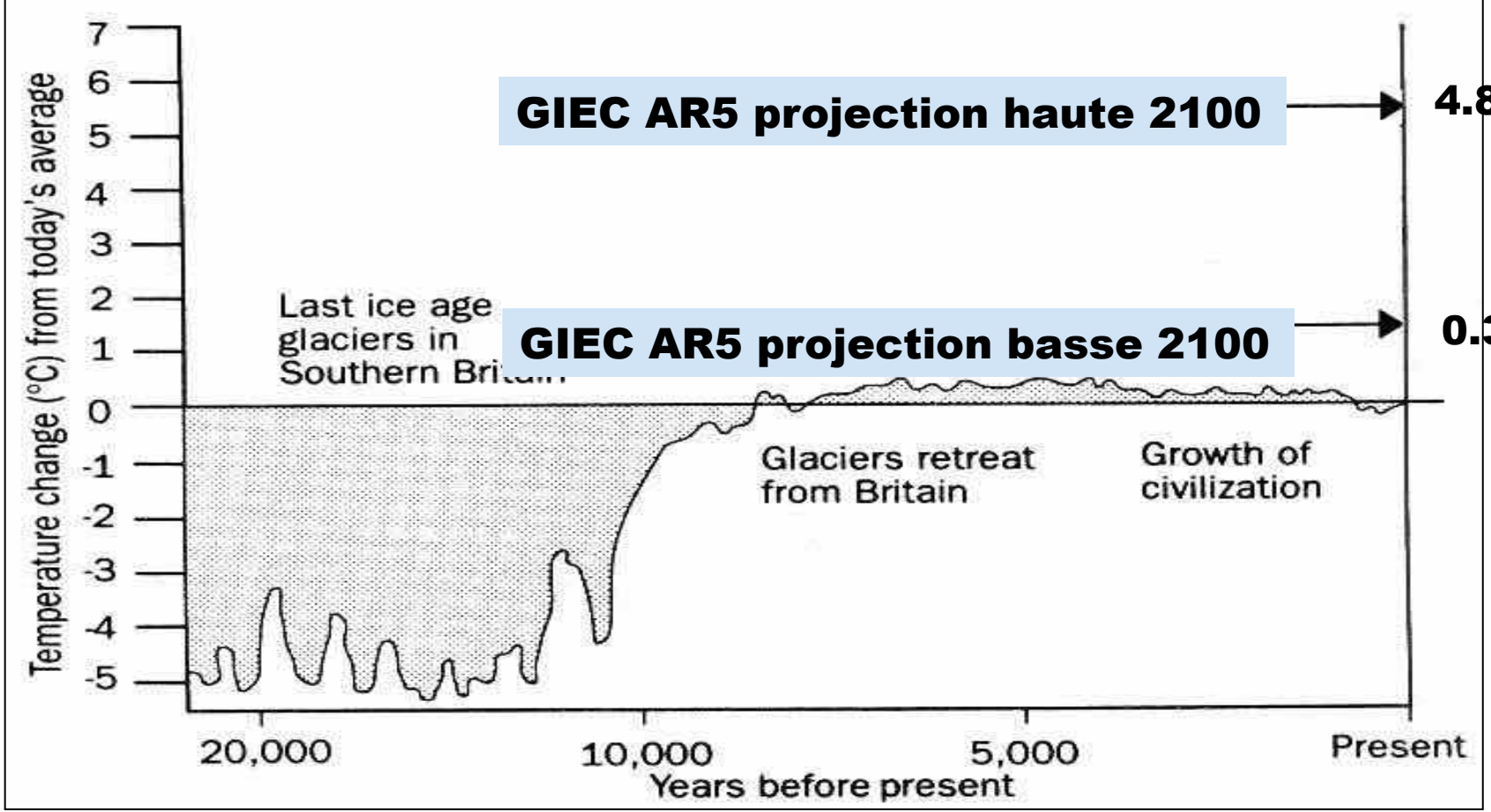
18-20000 years ago (Last Glacial Maximum)

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



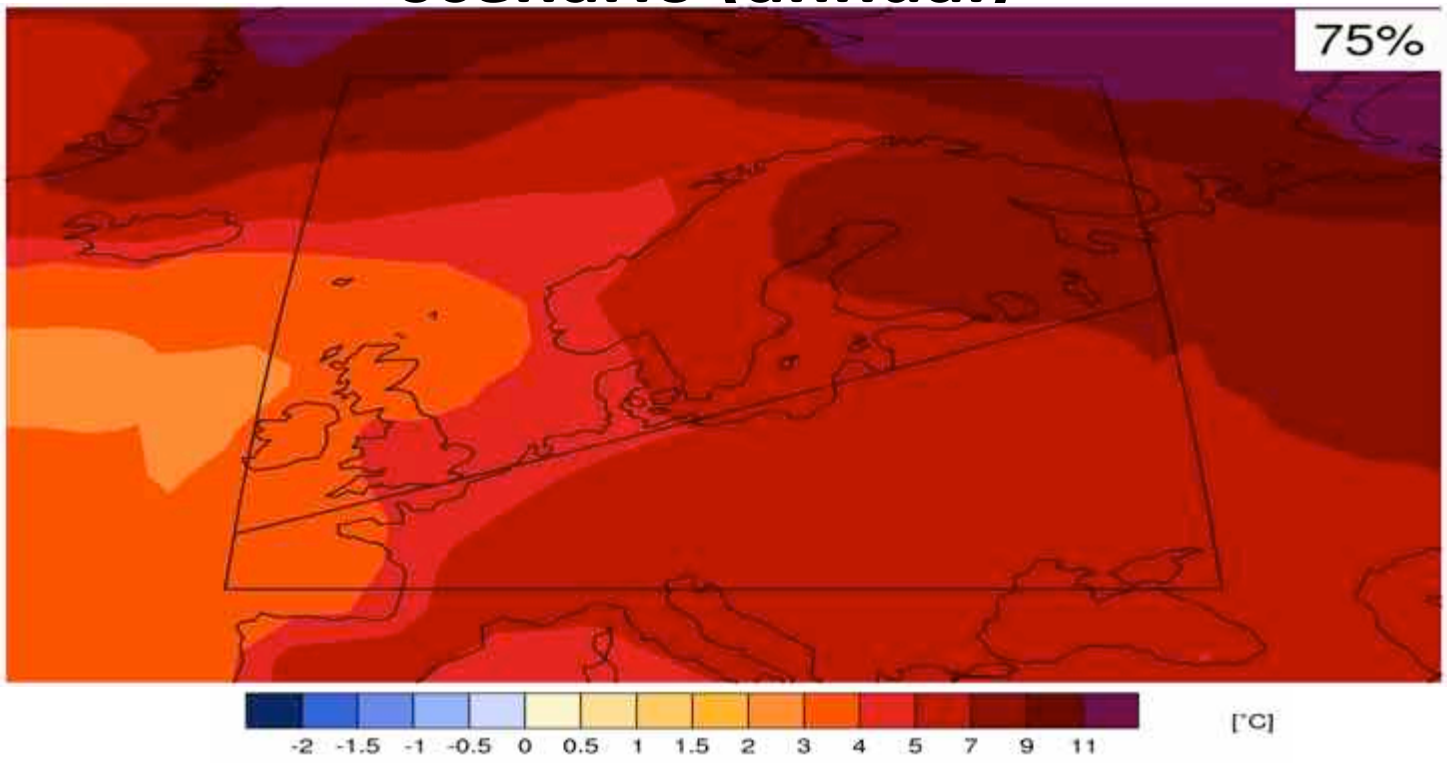
Today, with +4-5°C globally

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



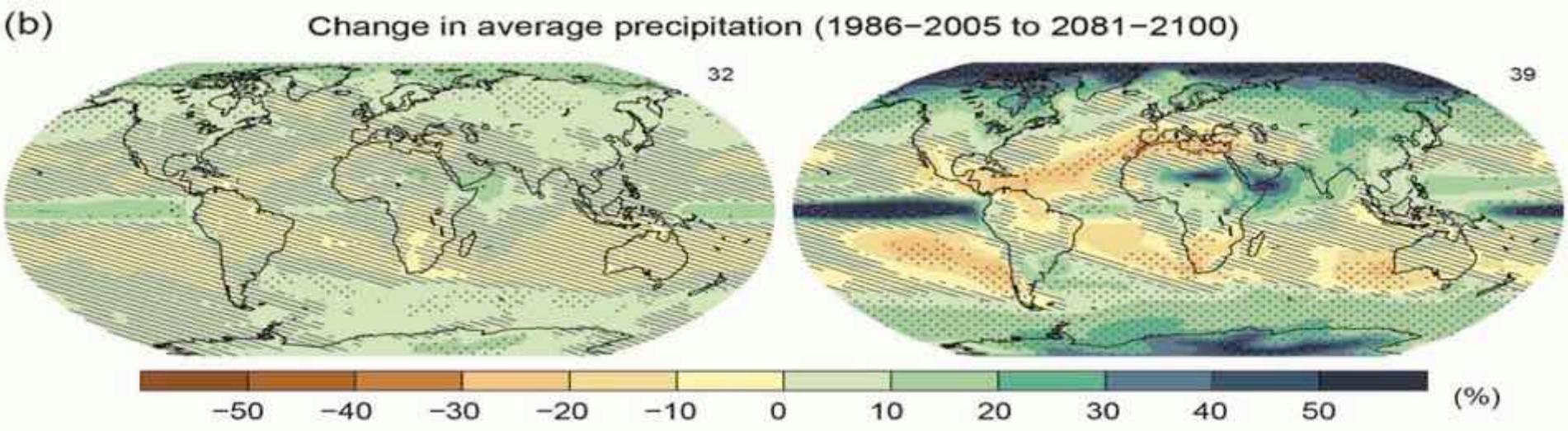
Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July1988

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

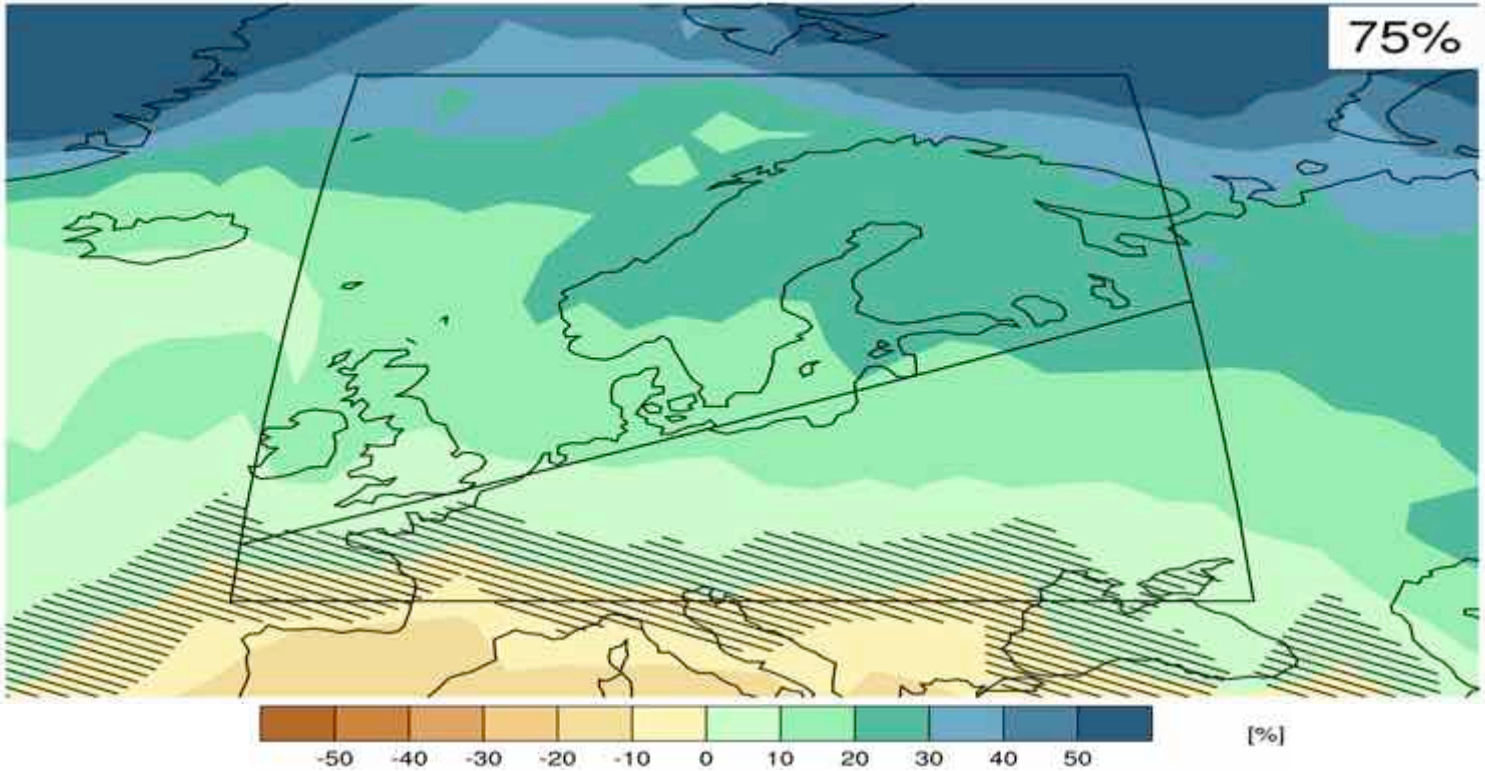


IPCC WG1 Fifth Assessment Report (Final Draft)

Projections of Annual Precipitation



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



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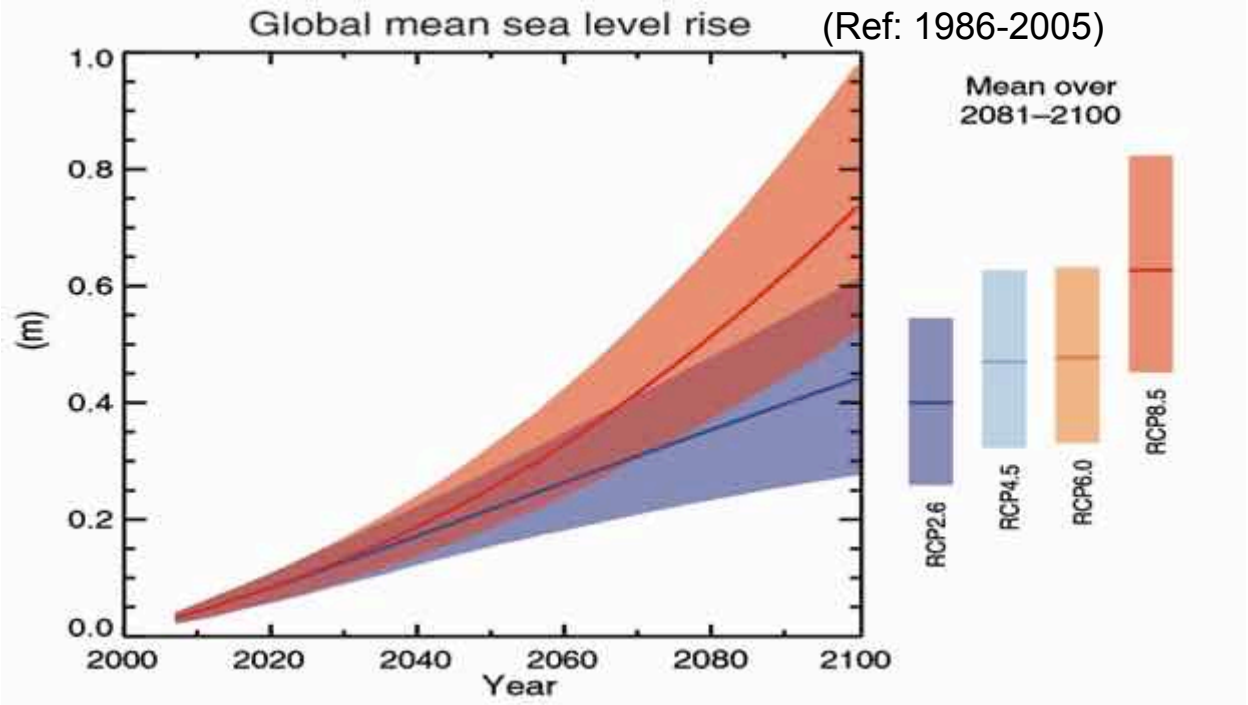
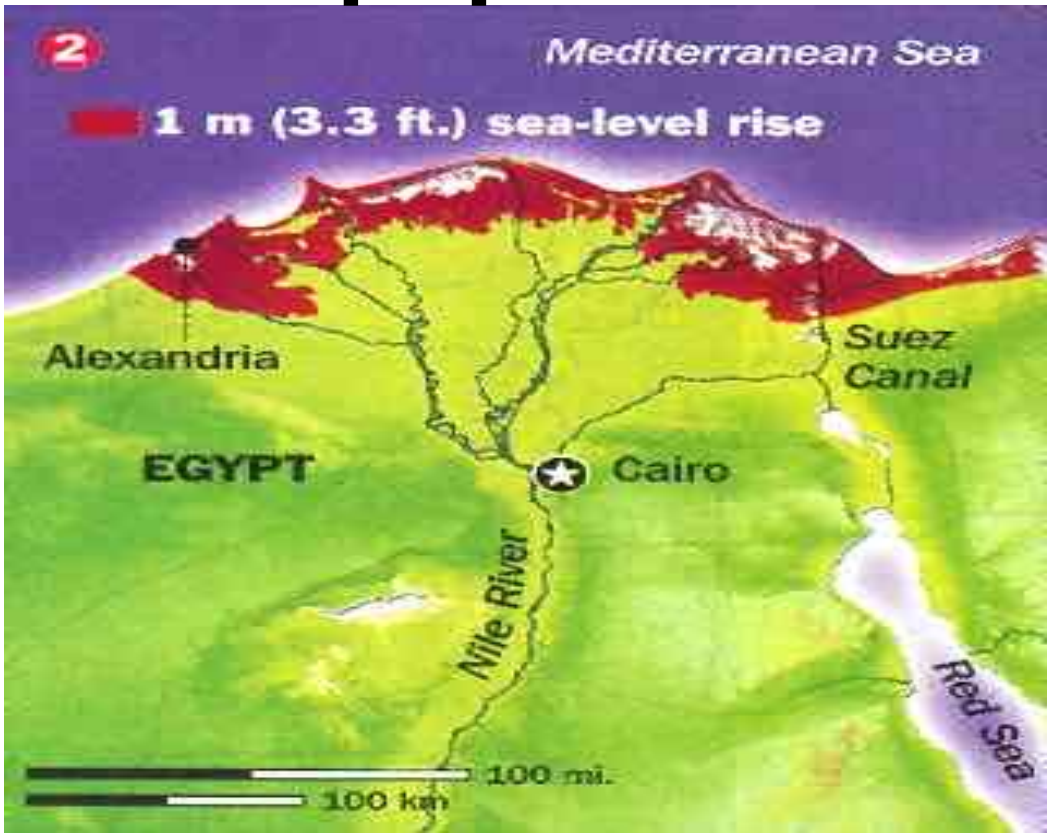


(IPCC 2013, Fig. SPM.9)

Sealevel will continue to increase

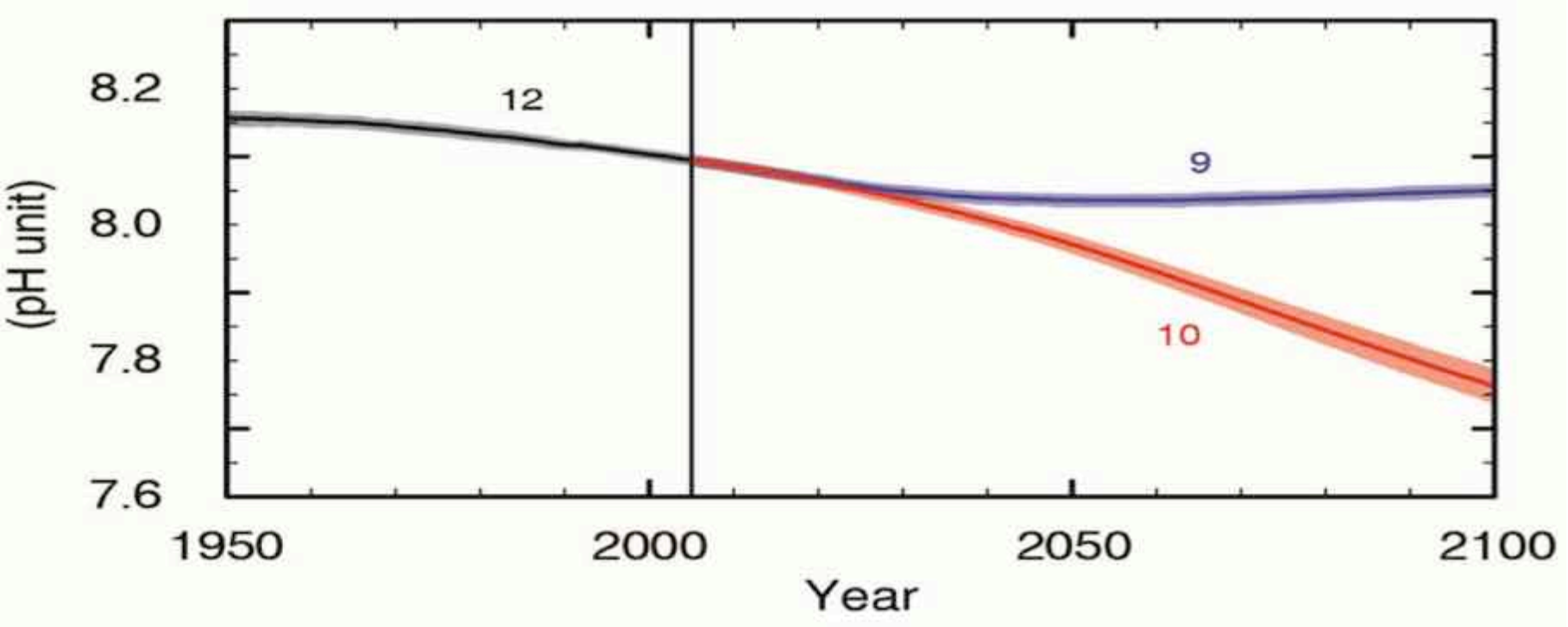
Nile Delta: red zone = less than 1 m above sealevel, 10 M people in 2000



(Time 2001)

Global ocean surface pH (projections)

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



Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

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ADAPTATION IS
ALREADY OCCURRING
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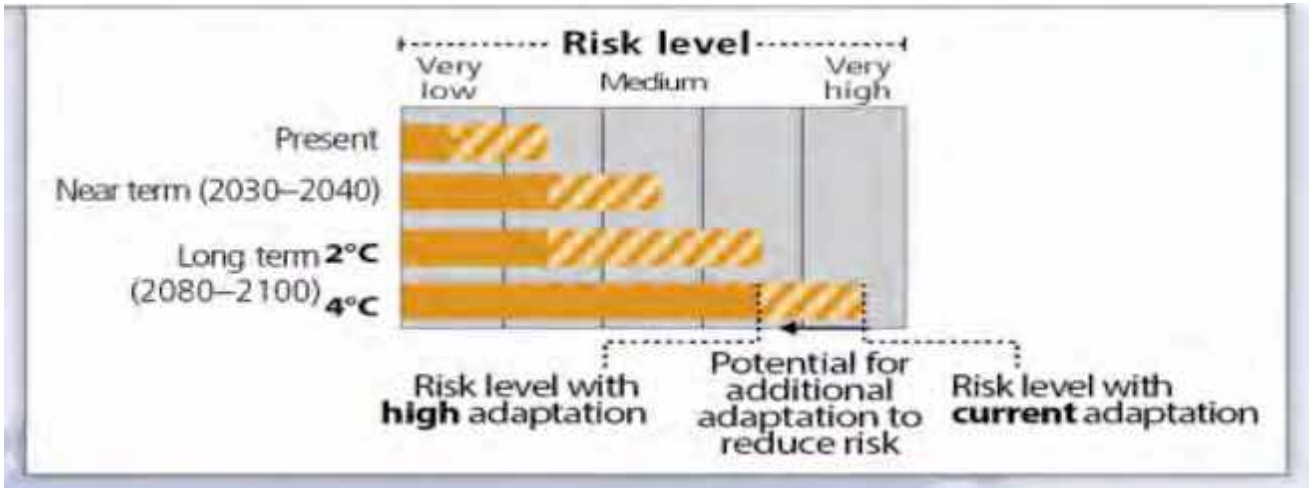
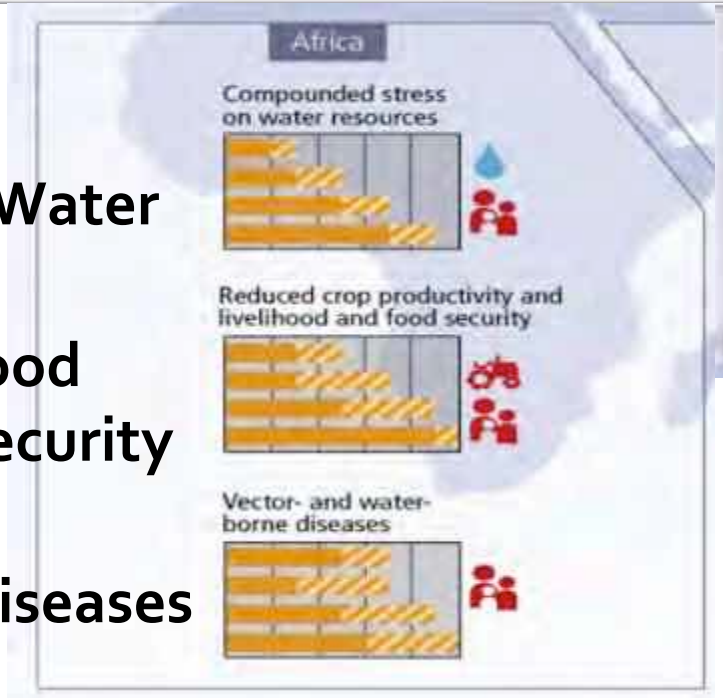
Regional key risks and potential for risk reduction through adaptation



IPCC, AR5, SPM, Figure SPM.8

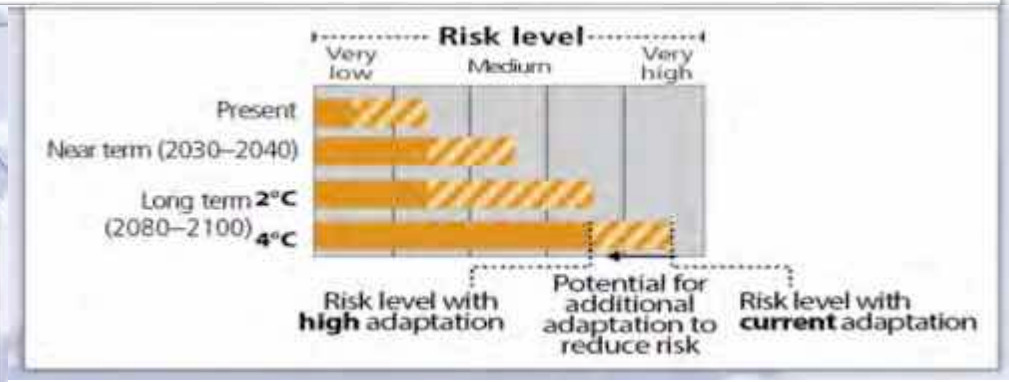
Regional key risks and risk reduction through adaptation



Water

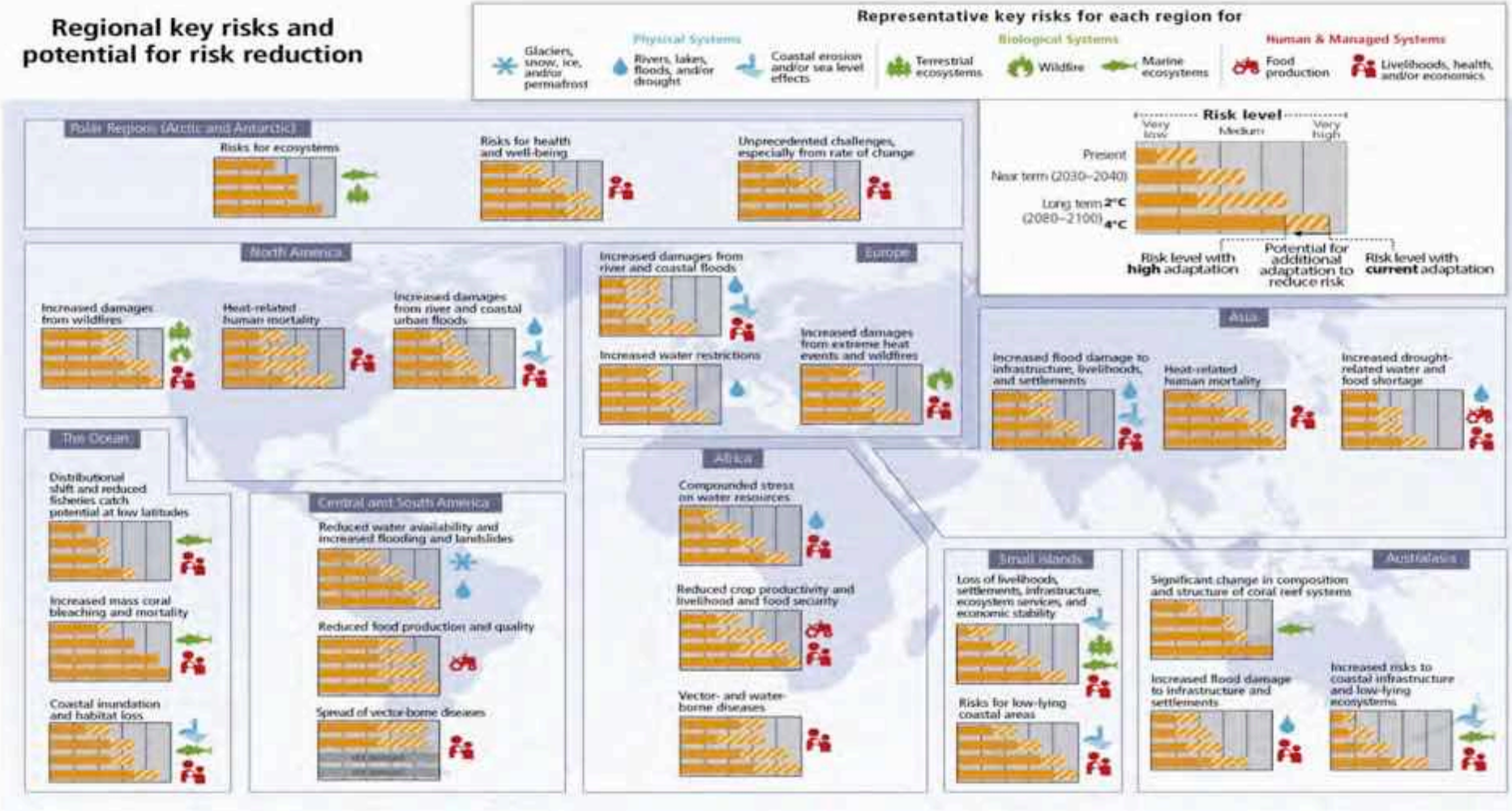
Food security

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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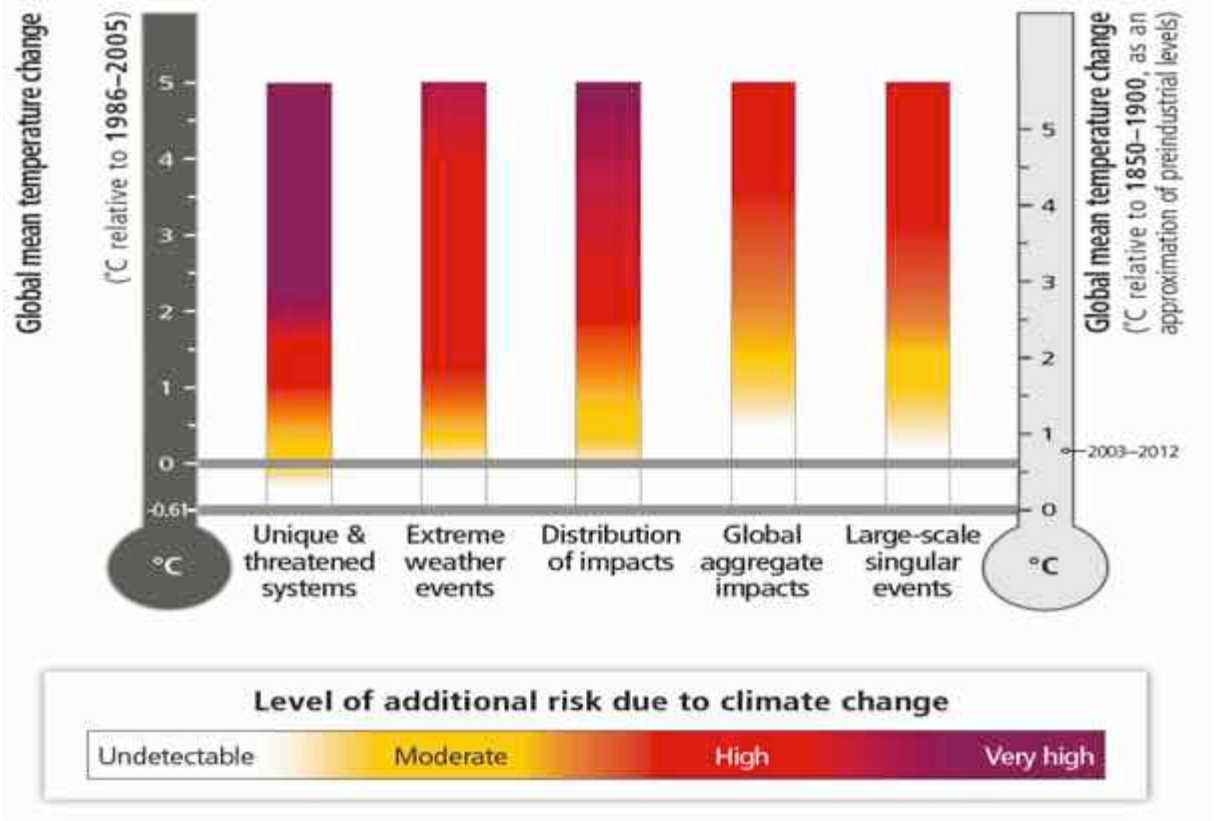
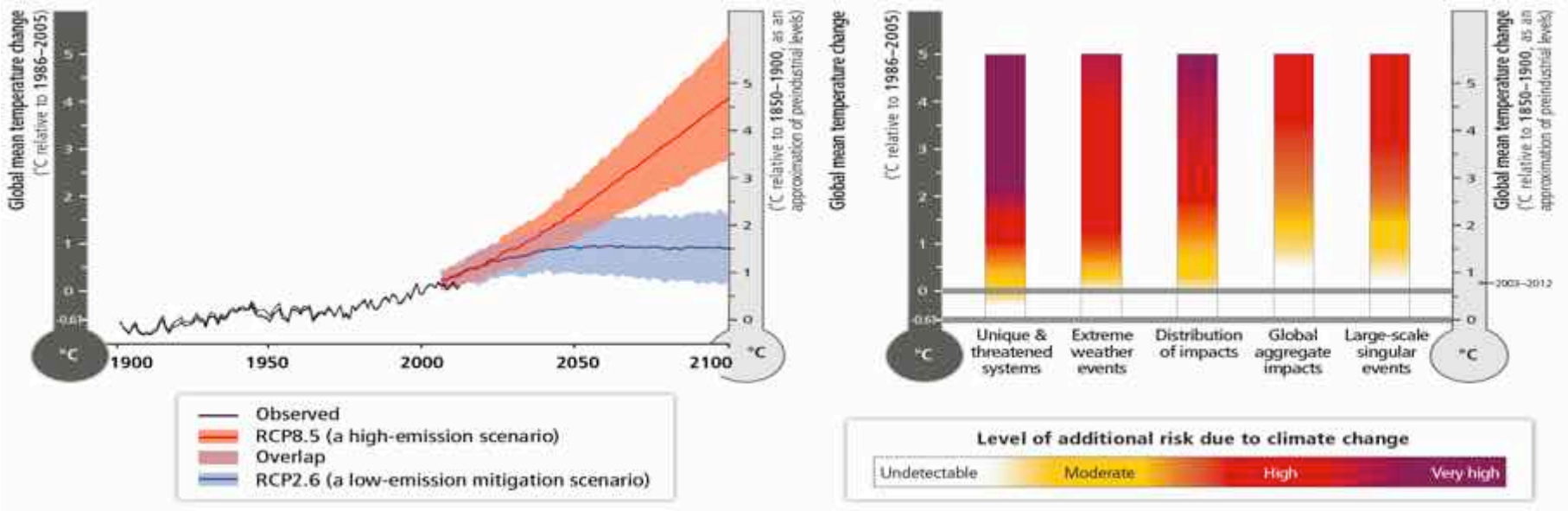


AR5, WGII, Box SPM.1 Figure 1



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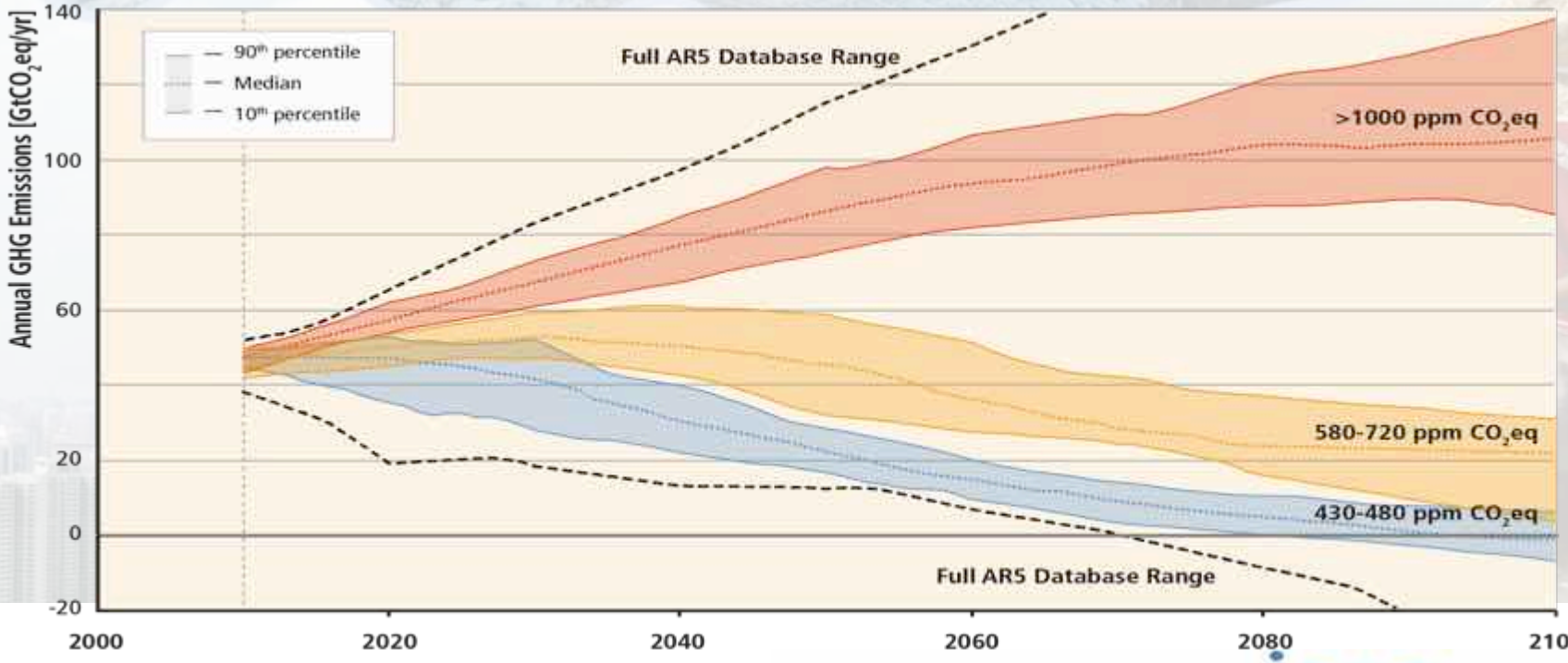
INTERGOVERNMENTAL PANEL ON climate change

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



Based on Figure 6.7

IPCC AR5 Synthesis Report

AR5 WGIII SPM

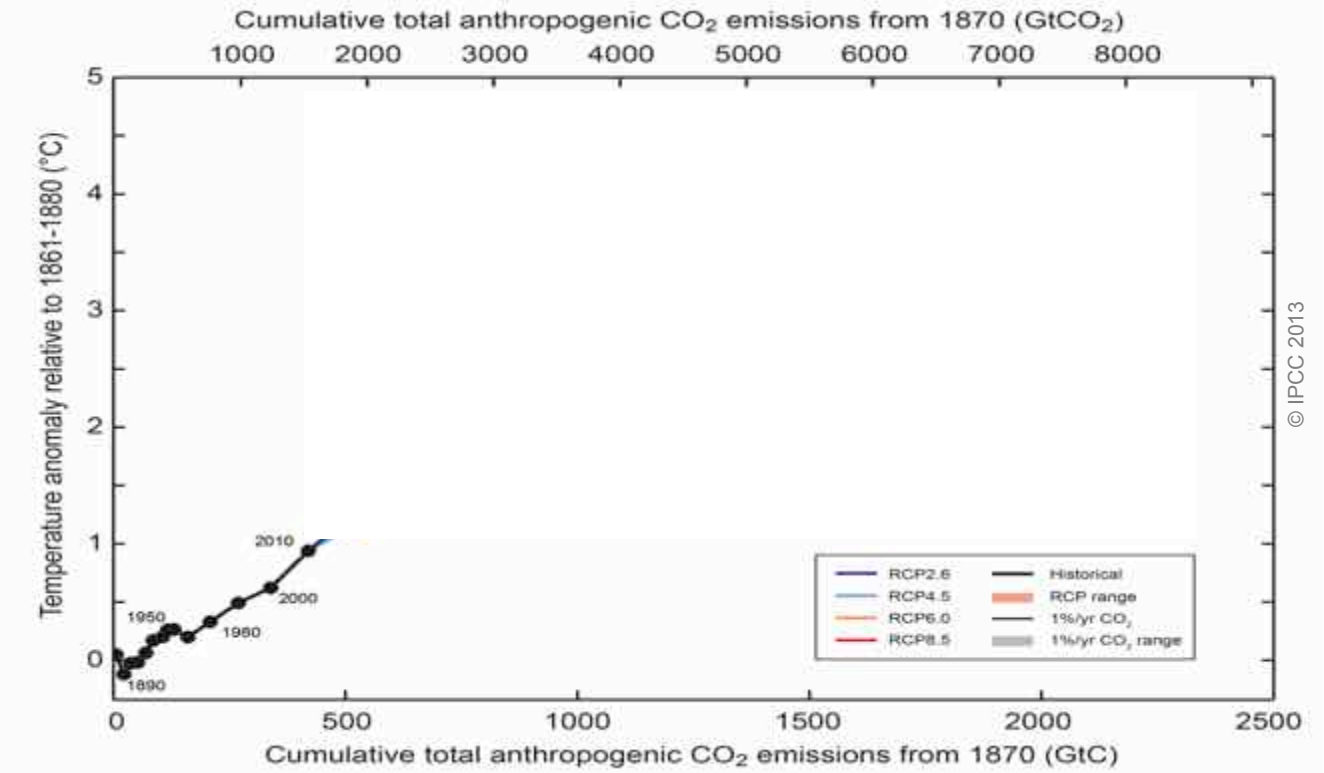


Fig. SPM.10

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

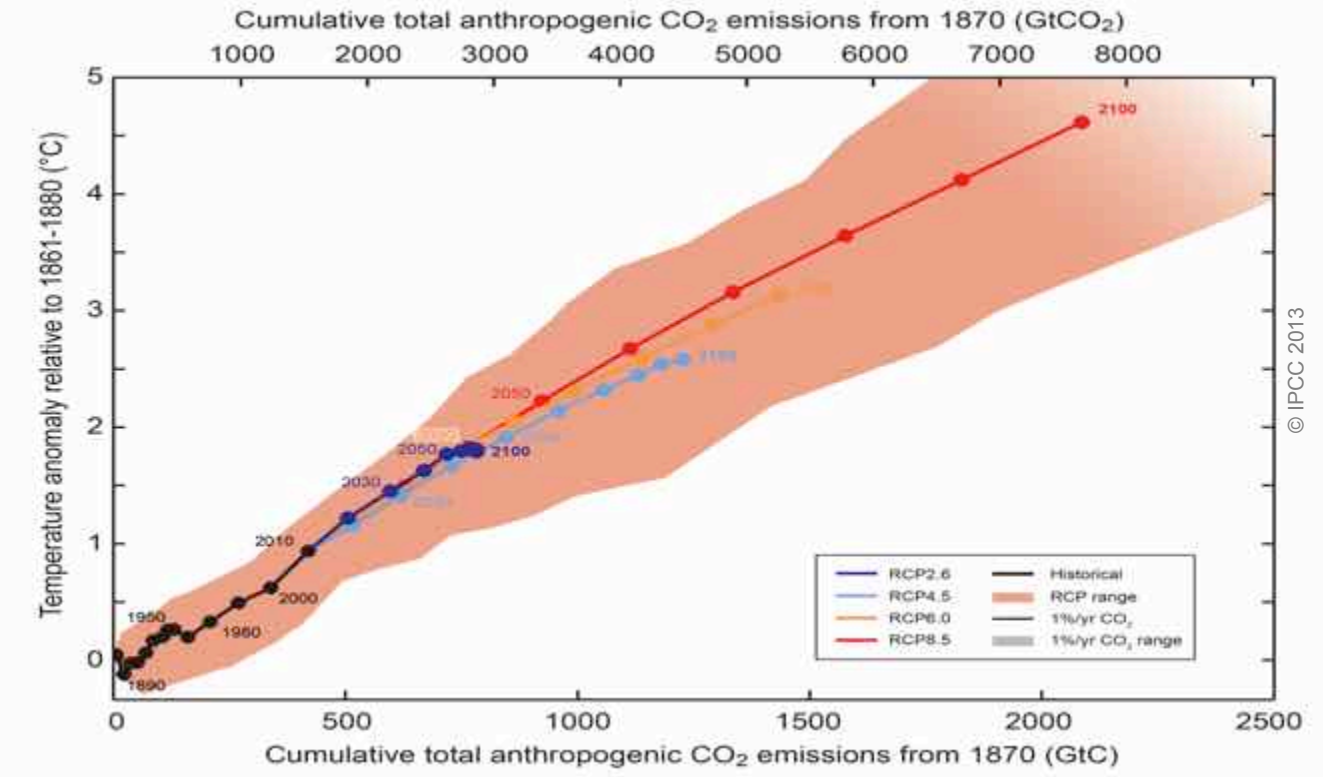


Fig. SPM.10

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

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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

Mitigation Measures

More **efficient use of energy**

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today

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.

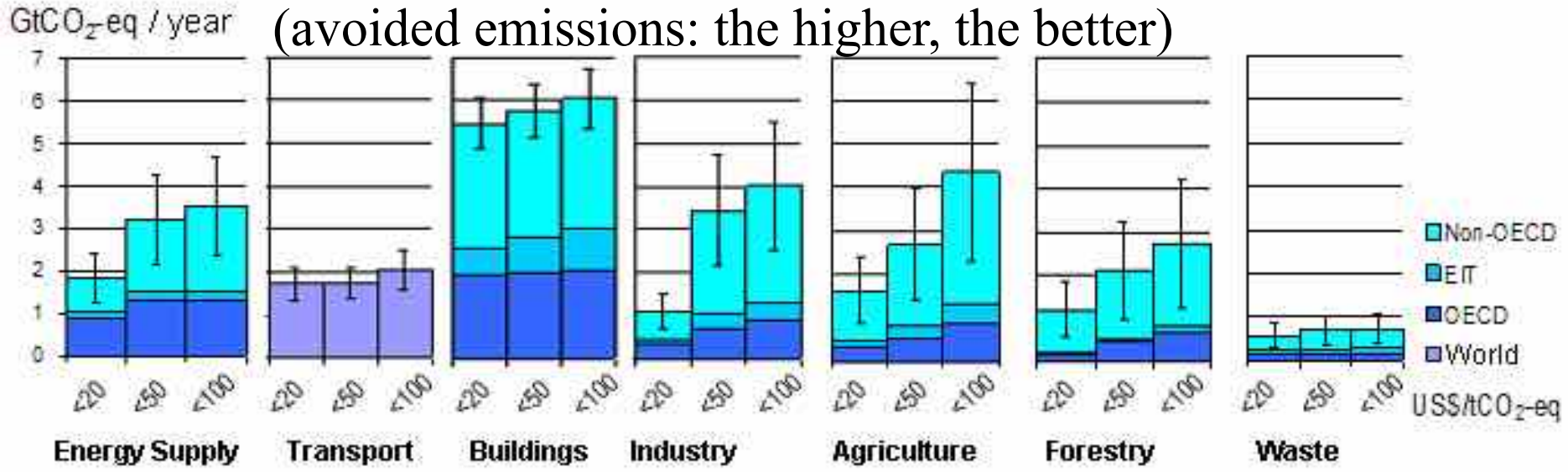
Ambitious Mitigation Is Affordable

- ➜ 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

All sectors and regions have the potential to contribute by 2030

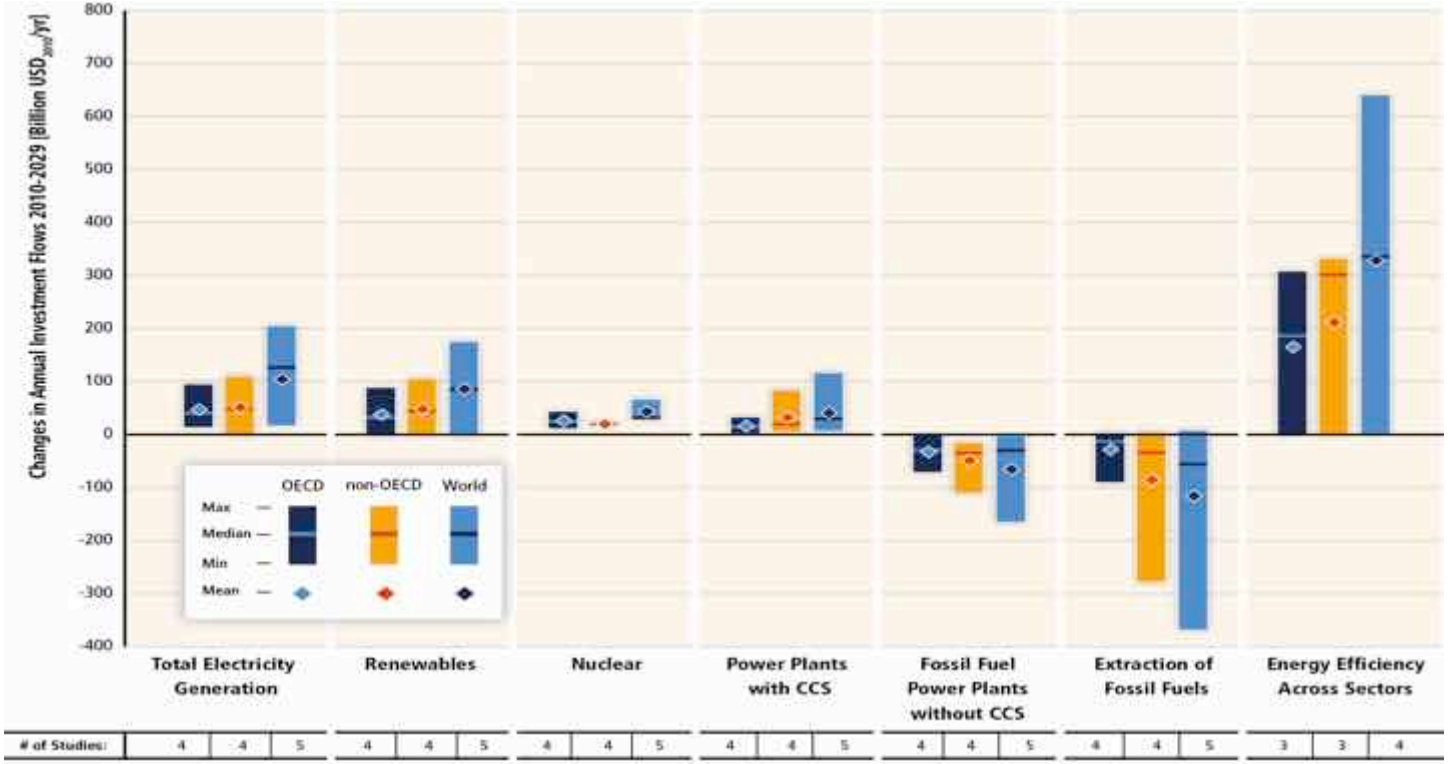
(avoided emissions: the higher, the better)



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.



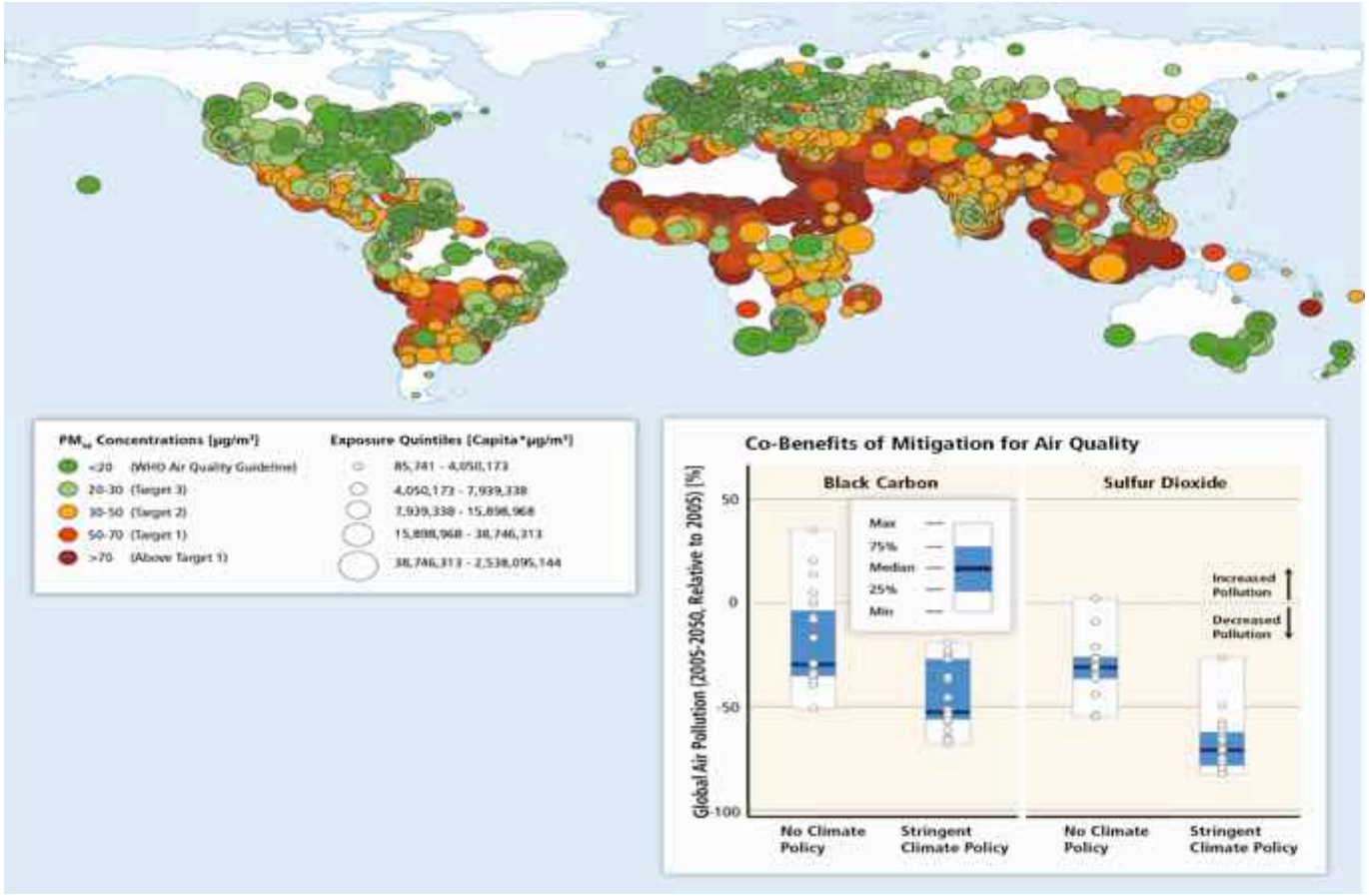
- **Des réductions substantielles d'émissions requièrent des changements importants des flux d'investissement; ex: de 2010 à 2029, en milliards de dollars US par an** (chiffres moyens arrondis, IPCC AR5 WGIII Fig SPM 9)
- **efficacité énergétique: +330**
- **renouvelables: + 90**
- **centrales électr. avec CCS: + 40**
- **nucléaire: + 40**
- **centrales électr. sans CCS: - 60**
- **extraction de comb. fossiles: - 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.

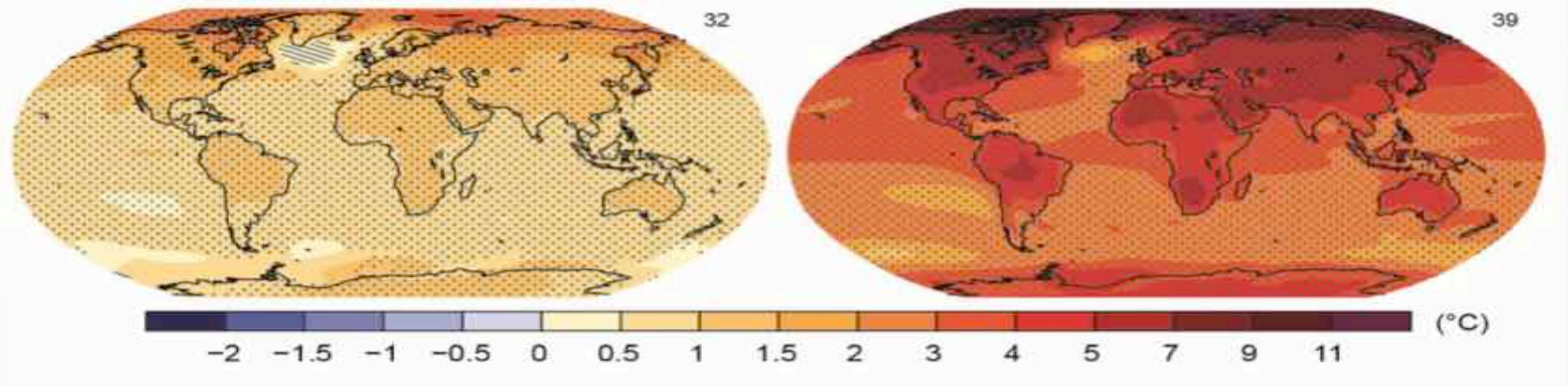


Mitigation can result in large co-benefits for human health and other societal goals.

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

With substantial mitigation

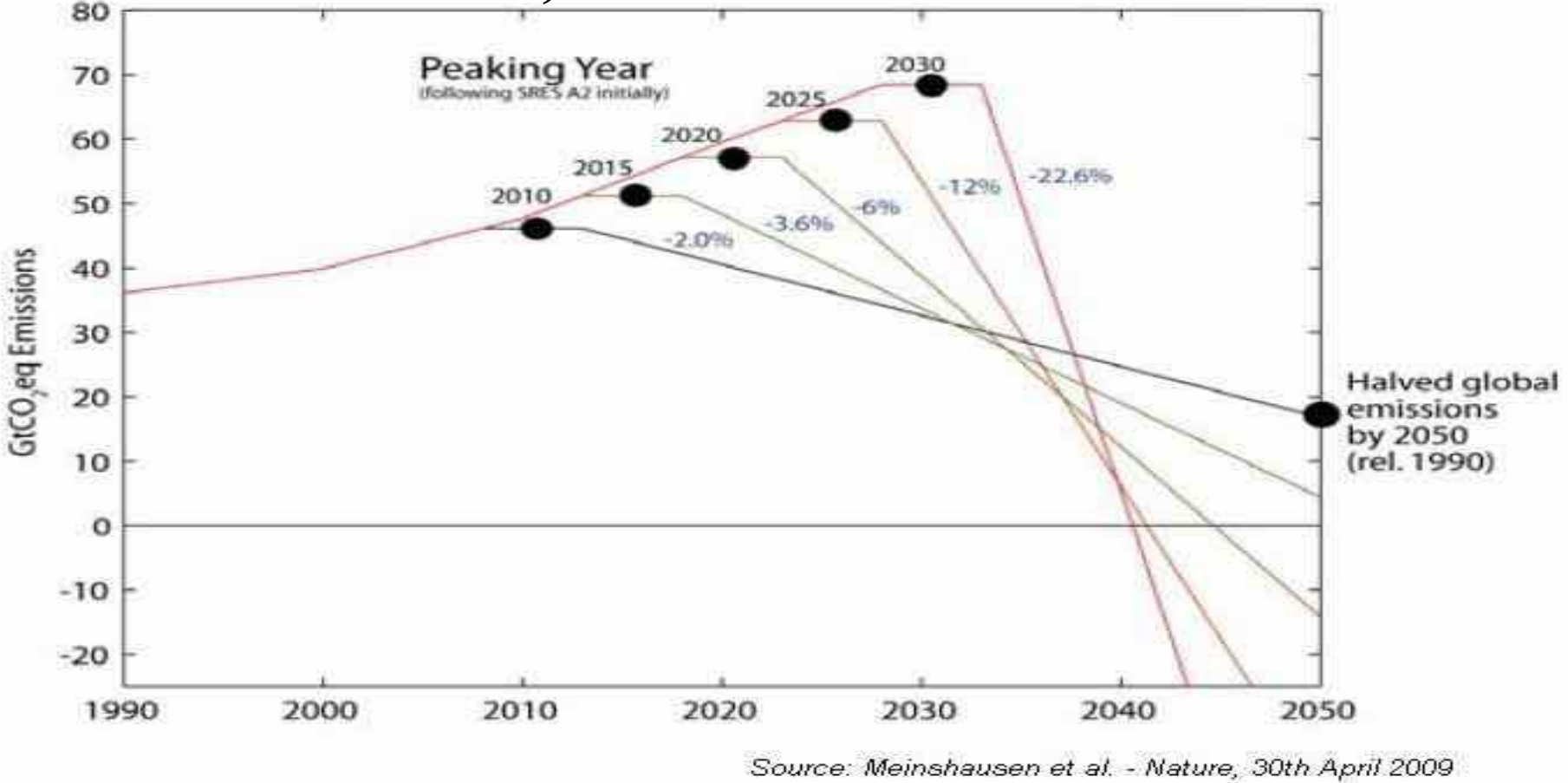
Without additional mitigation



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

AR5 WGI SPM

The more we wait, the more difficult it will be



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

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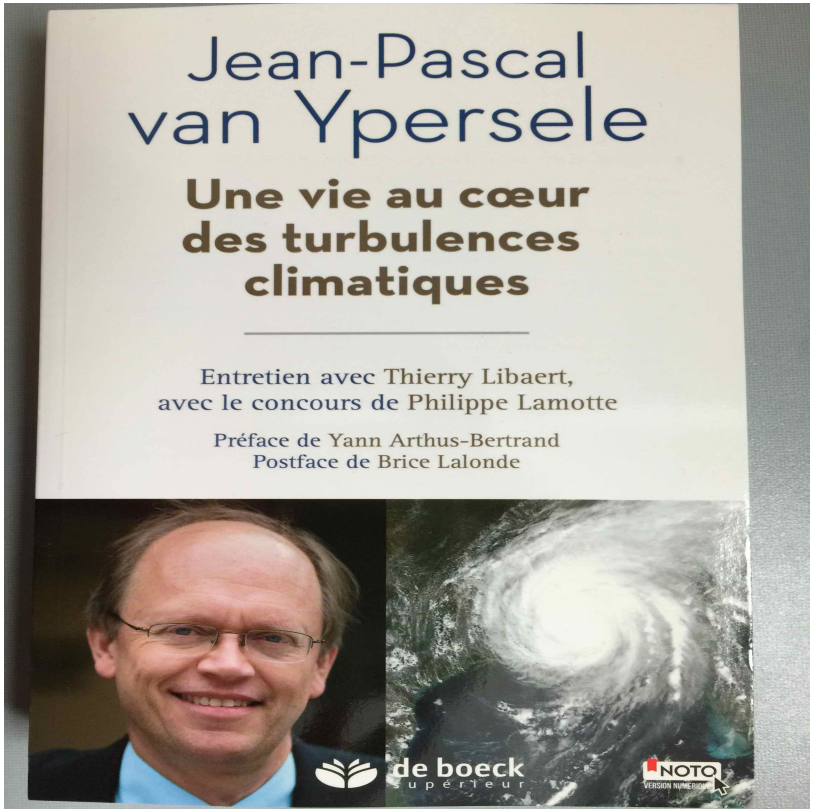

Useful links:

- 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**

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