# Climate change, long-term observations, and IPCC

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**IPCC Vice-Chair**
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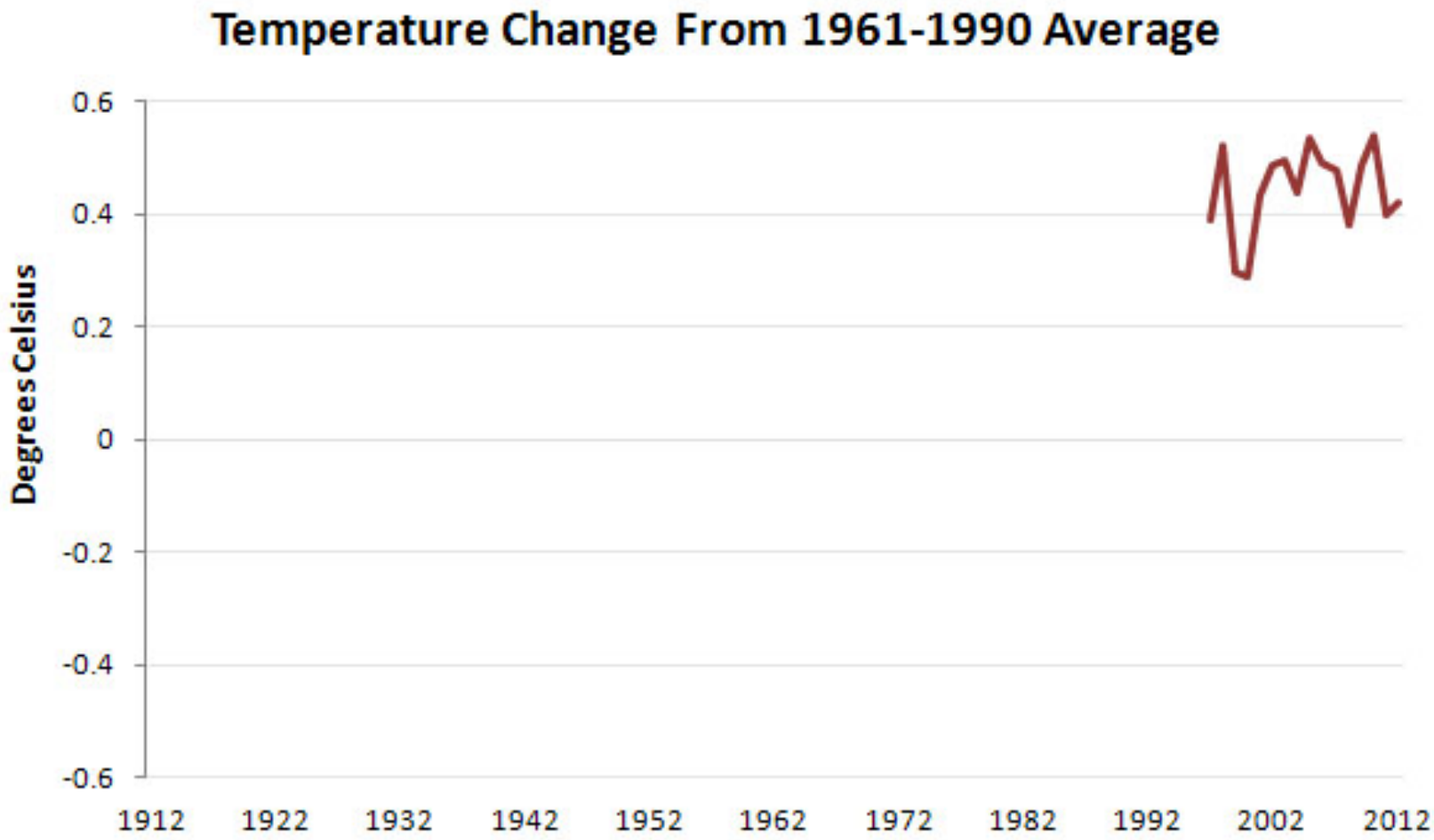
NORS/NDACC/GAW Workshop
BELSPO, Brussels, 6 November 2014

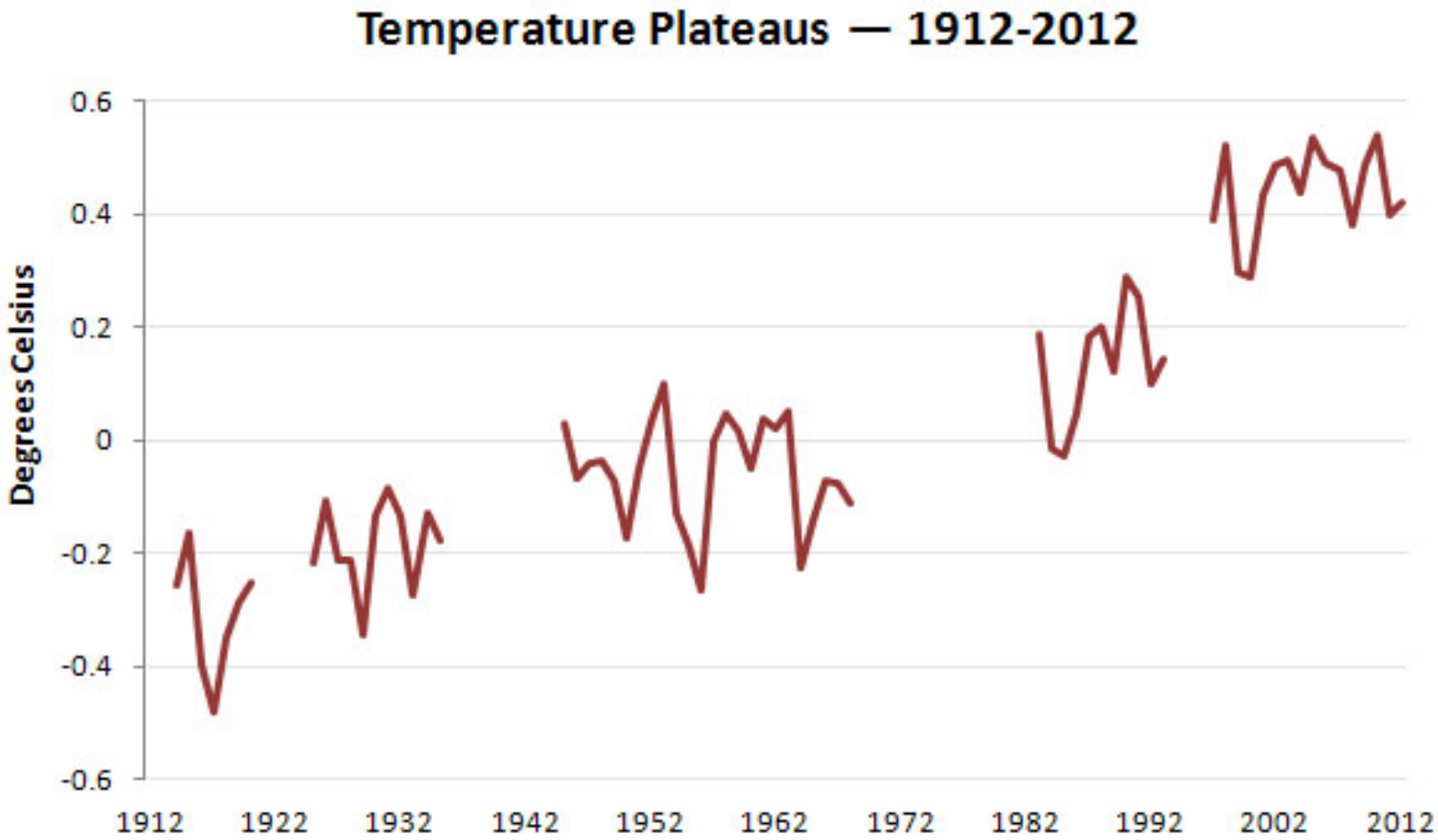
IPCC AR5 Synthesis Report

**Thanks to the Belgian Federal Science Policy Office (BELSPO) for its support**




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

# Lying With Statistics, Global Warming Edition

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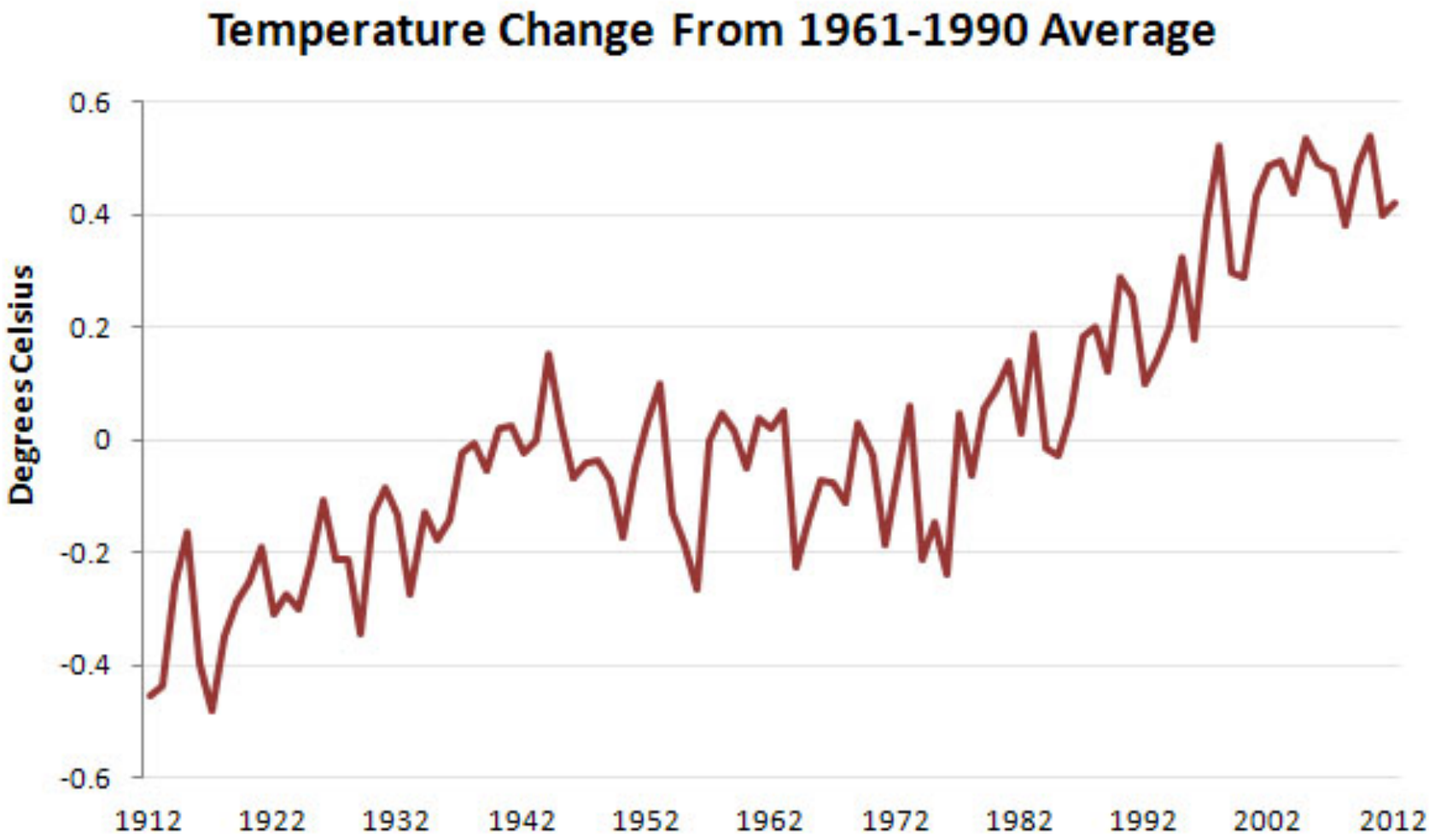


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

# 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 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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WMO UNEP


**WG I (Physical science basis): 209 lead authors, 2014 pages, 54.677 review comments**


**WG II (Impacts, Adaptation, and Vulnerability): 243 lead authors, 2500 pages, 50.492 review comments**


**WG III (Mitigation of Climate Change): 235 coordinating and lead authors, 2000 pages, 38.315 review comments**

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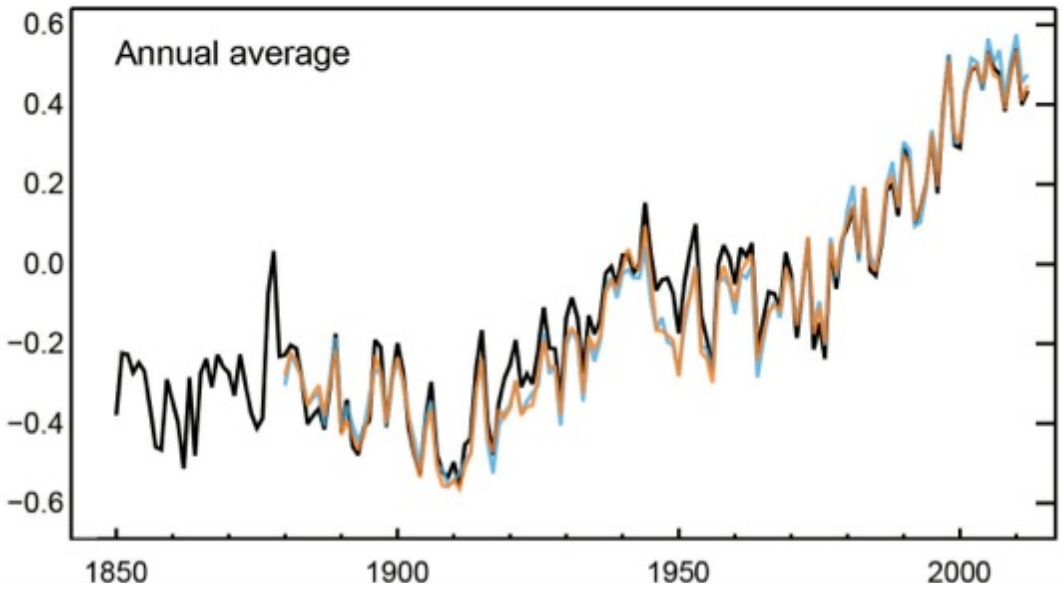
# Key Messages

- ➜ **Human influence on the climate system is clear**
- ➜ **The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts**
- ➜ **We have the means to limit climate change and build a more prosperous, sustainable future**

AR5 WGI SPM, AR5 WGII SPM, AR5 WGIII SPM

# Humans are changing the climate

**It is extremely likely that we are the dominant cause of warming since the mid-20th century**

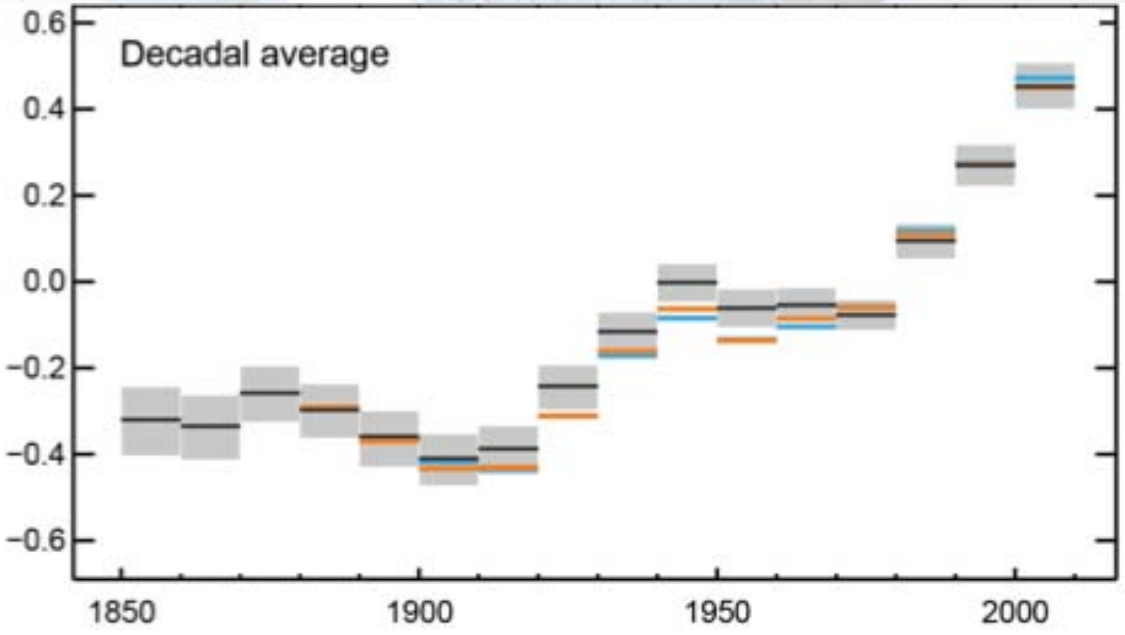



Globally averaged combined land and ocean surface temperatures

AR5 WGI SPM

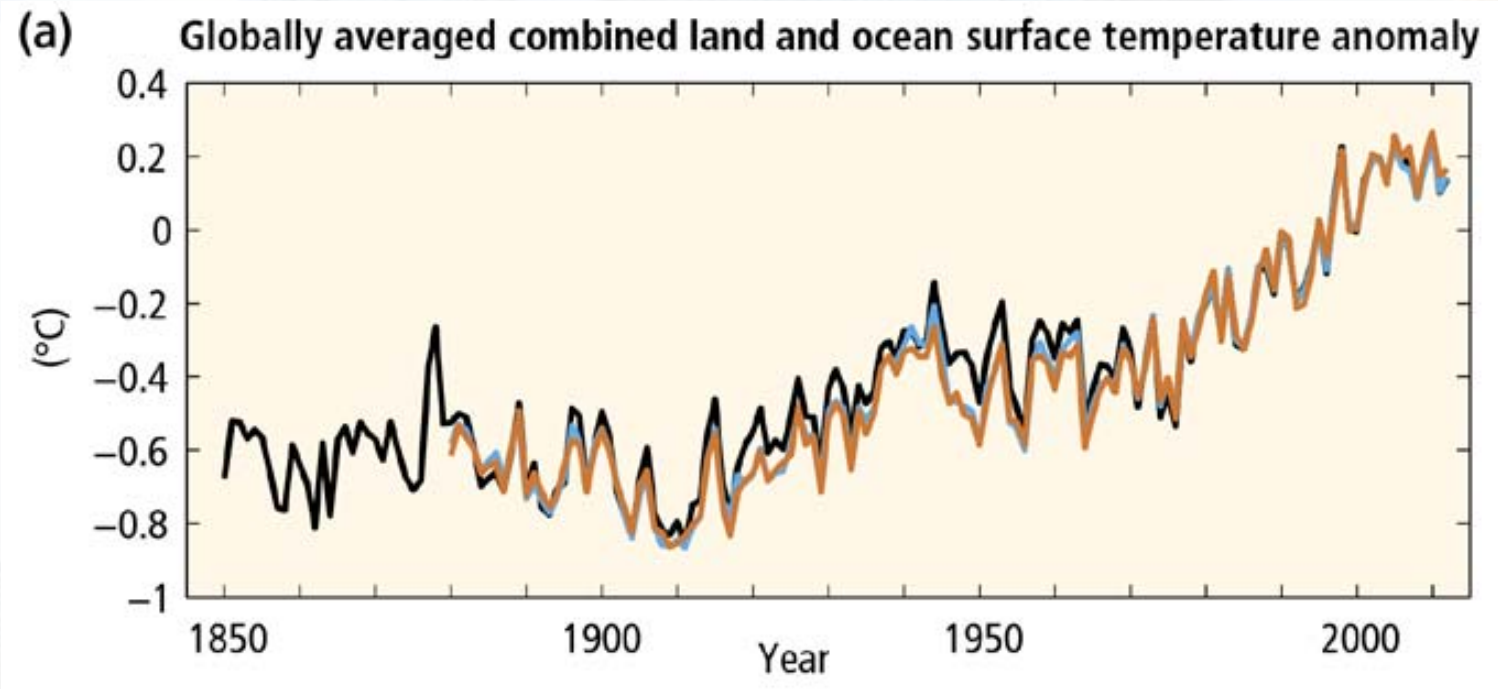
# Temperatures continue to rise

**Each of the past 3 decades has been successively warmer than the preceding decades since 1850**

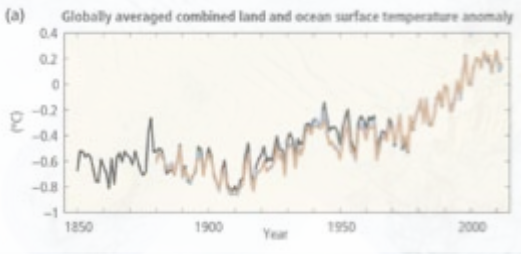



Globally averaged combined land and ocean surface temperatures

AR5 WGI SPM


(a)
Globally averaged combined land and ocean surface temperature anomaly
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
(°C)
1850
1900
1950
2000
Year

AR5 SYR SPM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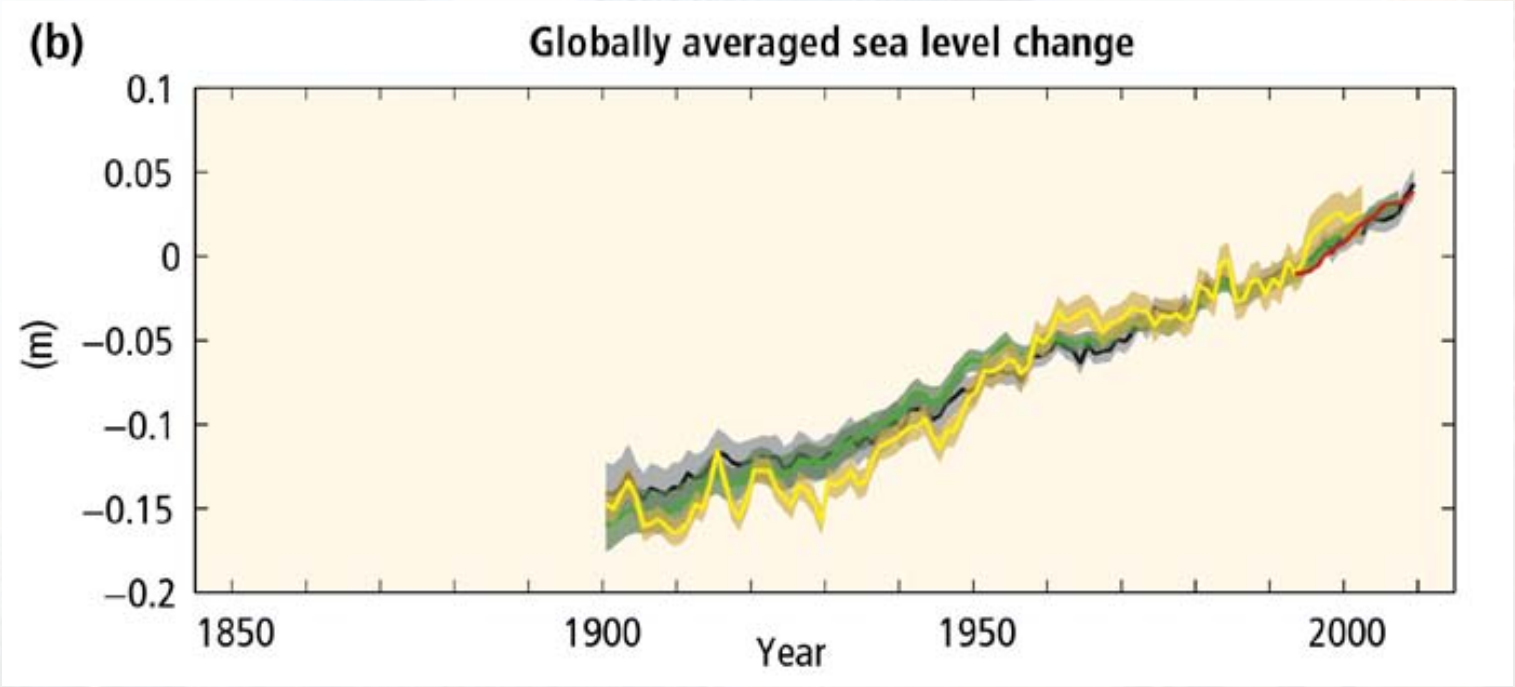
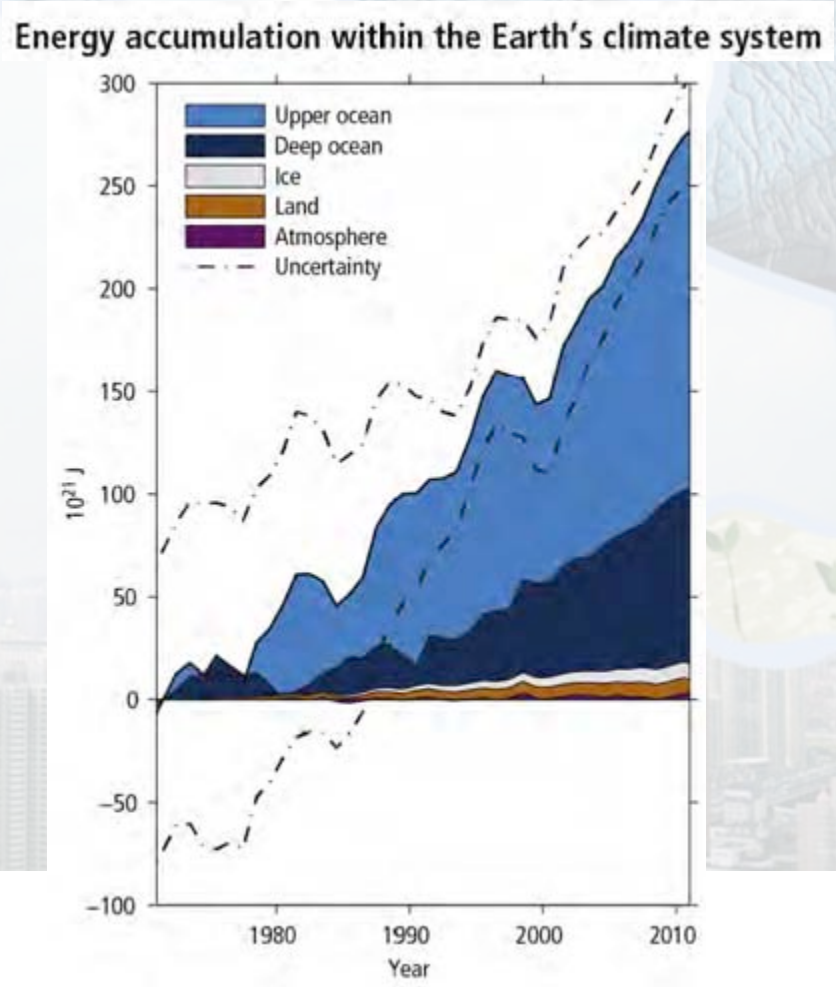

(b)
Globally averaged sea level change
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
(m)
1850
1900
Year
1950
2000

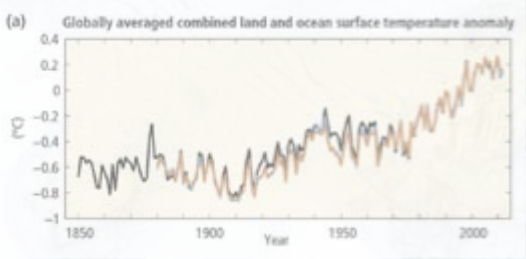
AR5 SYR SPM

# Oceans absorb most of the heat




- More than 90% of the energy accumulating in the climate system between 1971 and 2010 has accumulated in the ocean
- Land temperatures remain at historic highs while ocean temperatures continue to climb

AR5 SYR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−0.2
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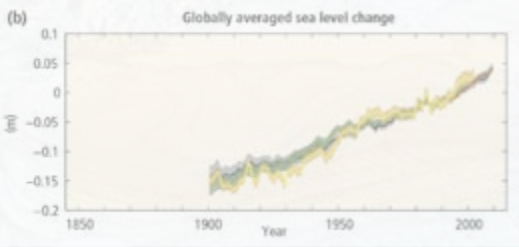
−0.6
−0.8
−1
1850
1900
Year
1950
2000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0.05
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1850
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Year
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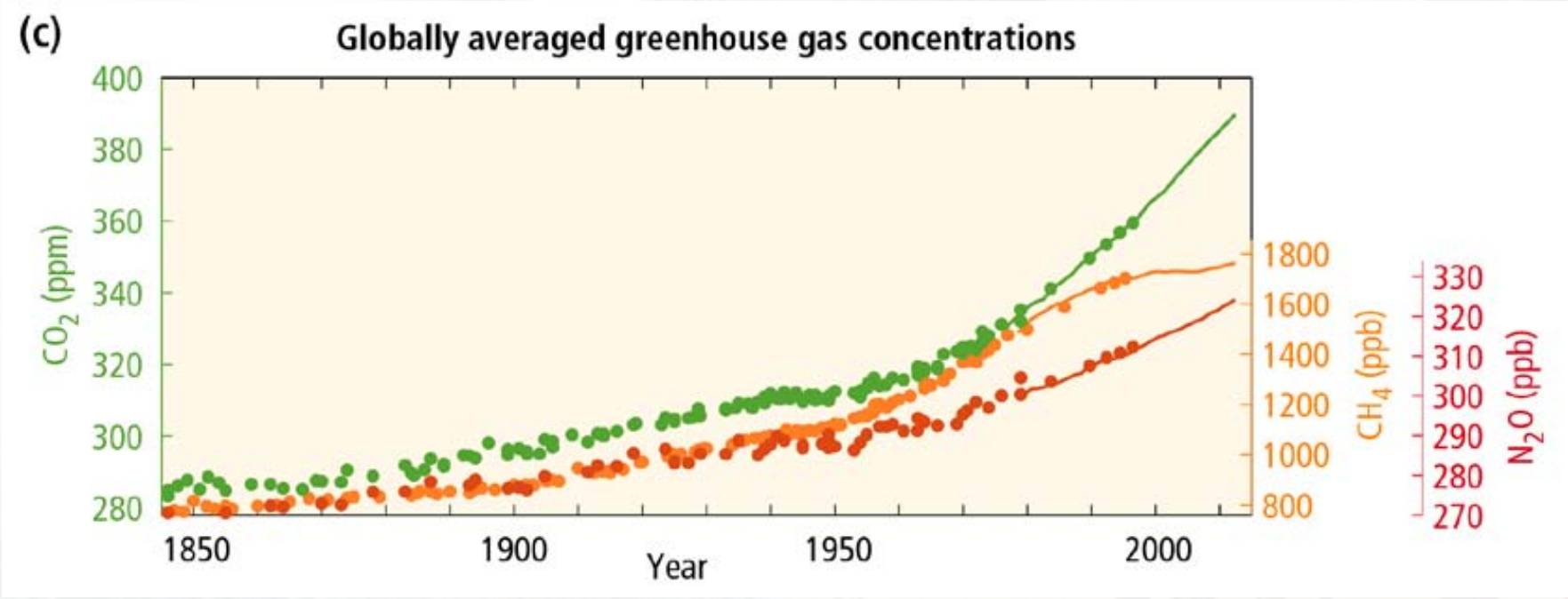
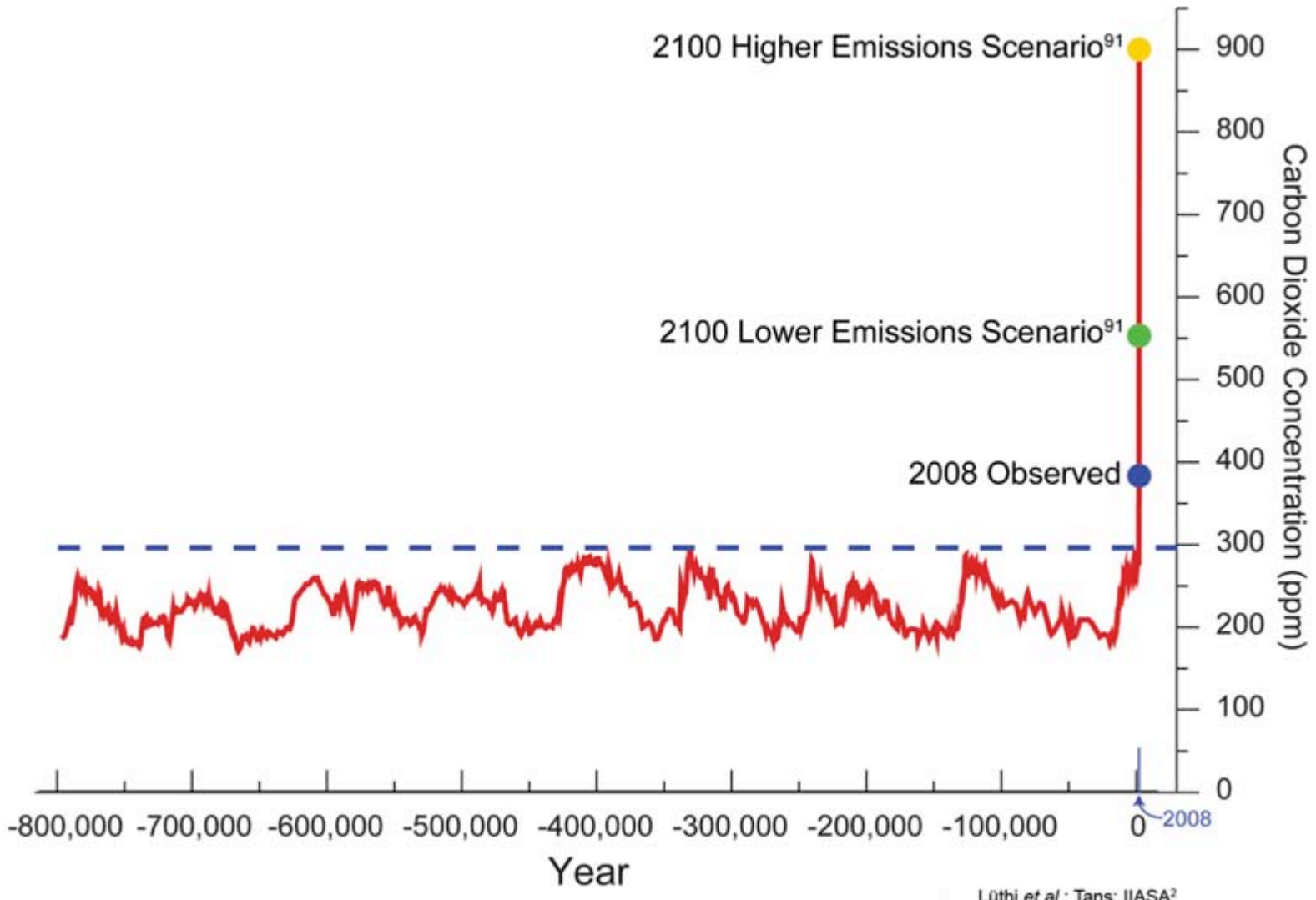
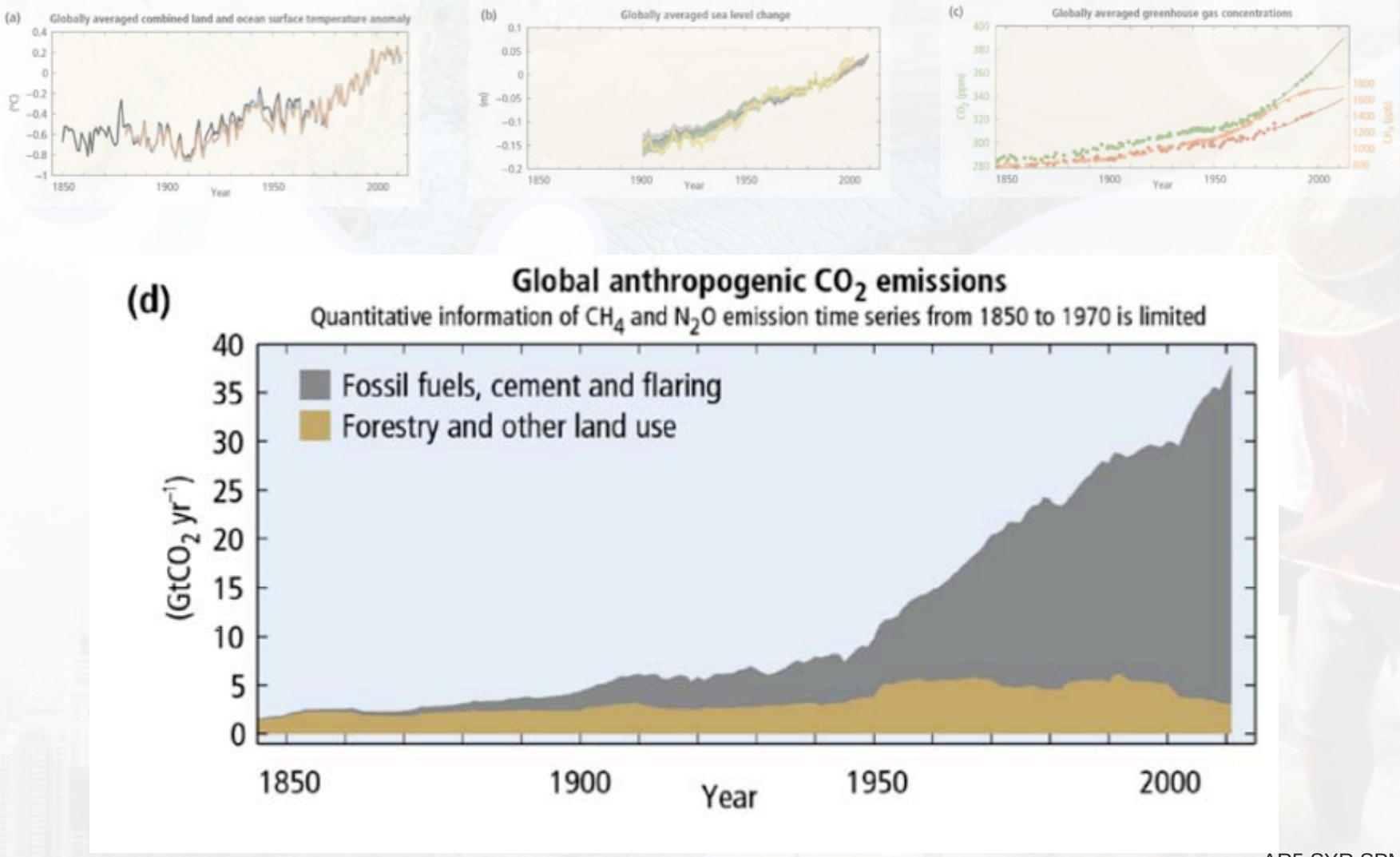

(c)
Globally averaged greenhouse gas concentrations
CO2 (ppm)
400
380
360
340
320
300
280
CH4 (ppb)
1800
1600
1400
1200
1000
800
N2O (ppb)
330
320
310
300
290
280
270
1850
1900
Year
1950
2000

AR5 SYR SPM

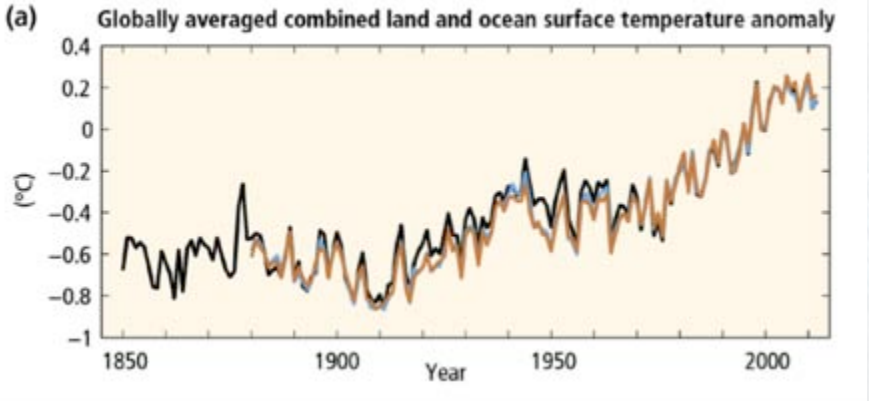
# Atmospheric $CO_2$ over the last 800000 years




U.S. Global Change Research Program:Lüthi *et al.*; Tans; IIASA2


(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
Year
(b)
Globally averaged sea level change
(m)
Year
(c)
Globally averaged greenhouse gas concentrations
Year
(d)
Global anthropogenic $CO_2$ emissions
Quantitative information of $CH_4$ and $N_2O$ emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
$(GtCO_2\ yr^{-1})$
Year

AR5 SYR SPM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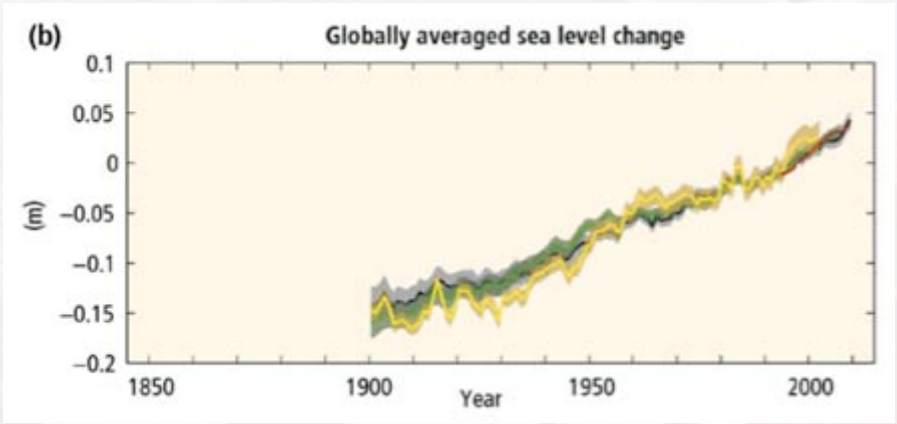
1850
1900
1950
2000
Year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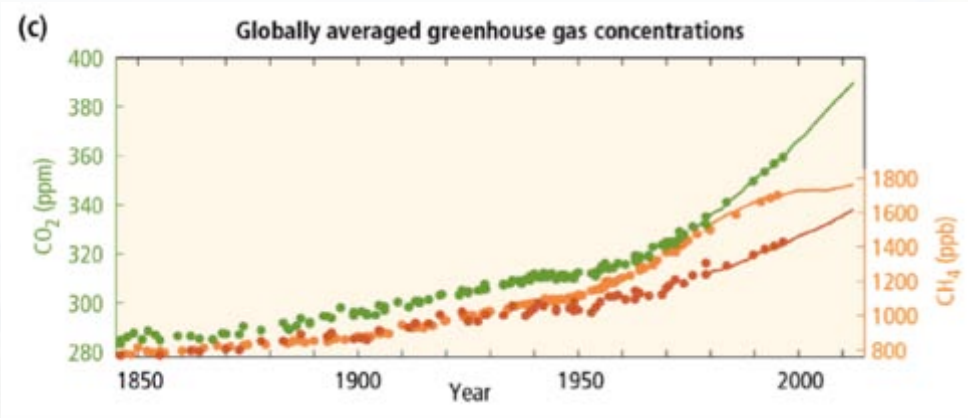
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Globally averaged greenhouse gas concentrations
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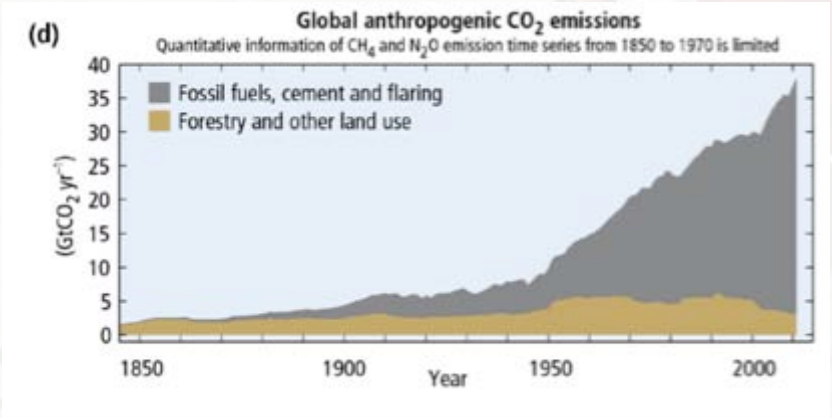
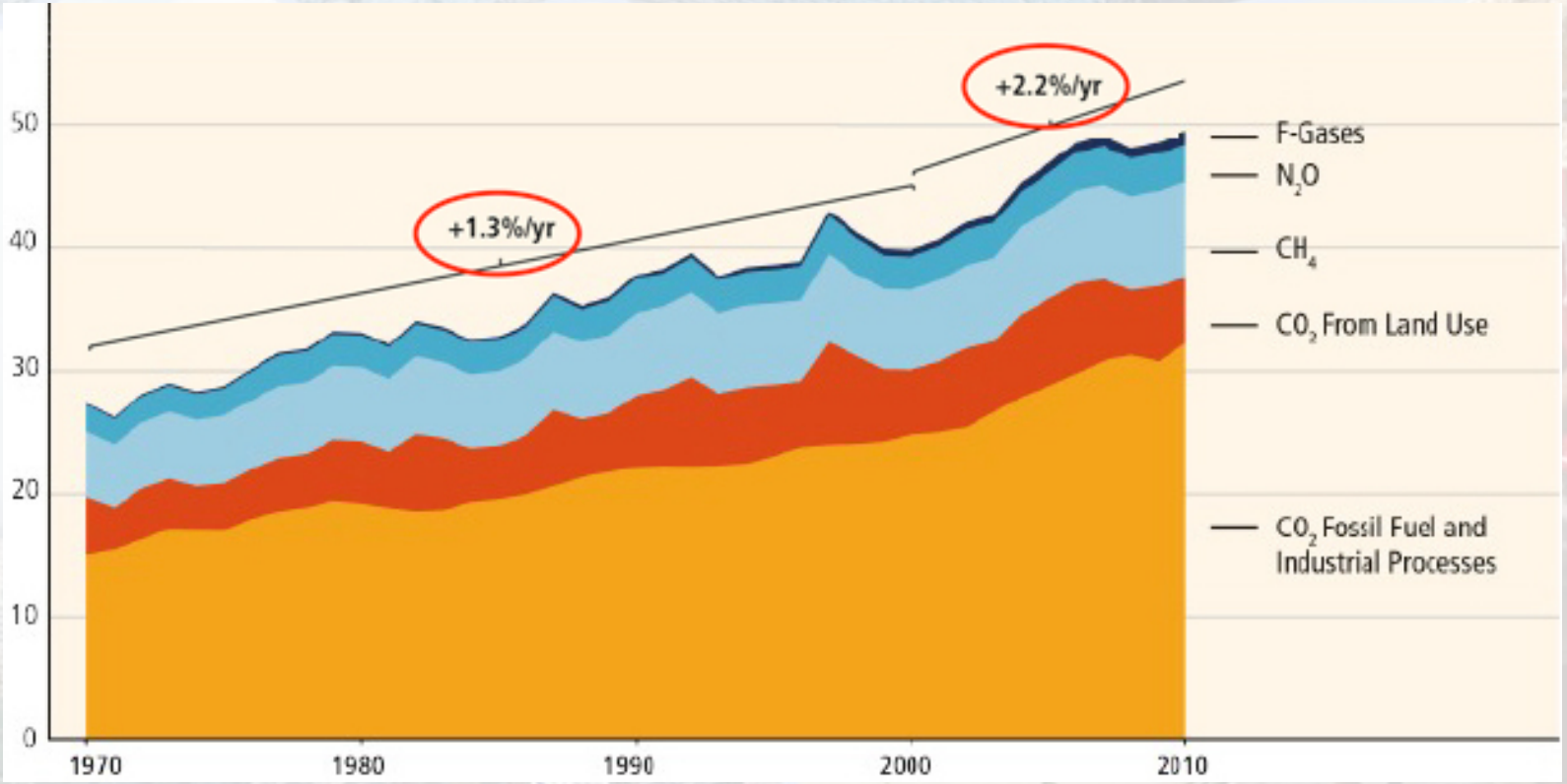
1900
1950
2000
Year


(d)
Global anthropogenic CO2 emissions
Quantitative information of CH4 and N2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
40
35
30
25
20
15
10
5
0
(GtCO2 yr−1)
1850
1900
1950
2000
Year

AR5 SYR SPM

# GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades

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# Some of the changes in extreme weather and climate events observed since about 1950 have been linked to human influence

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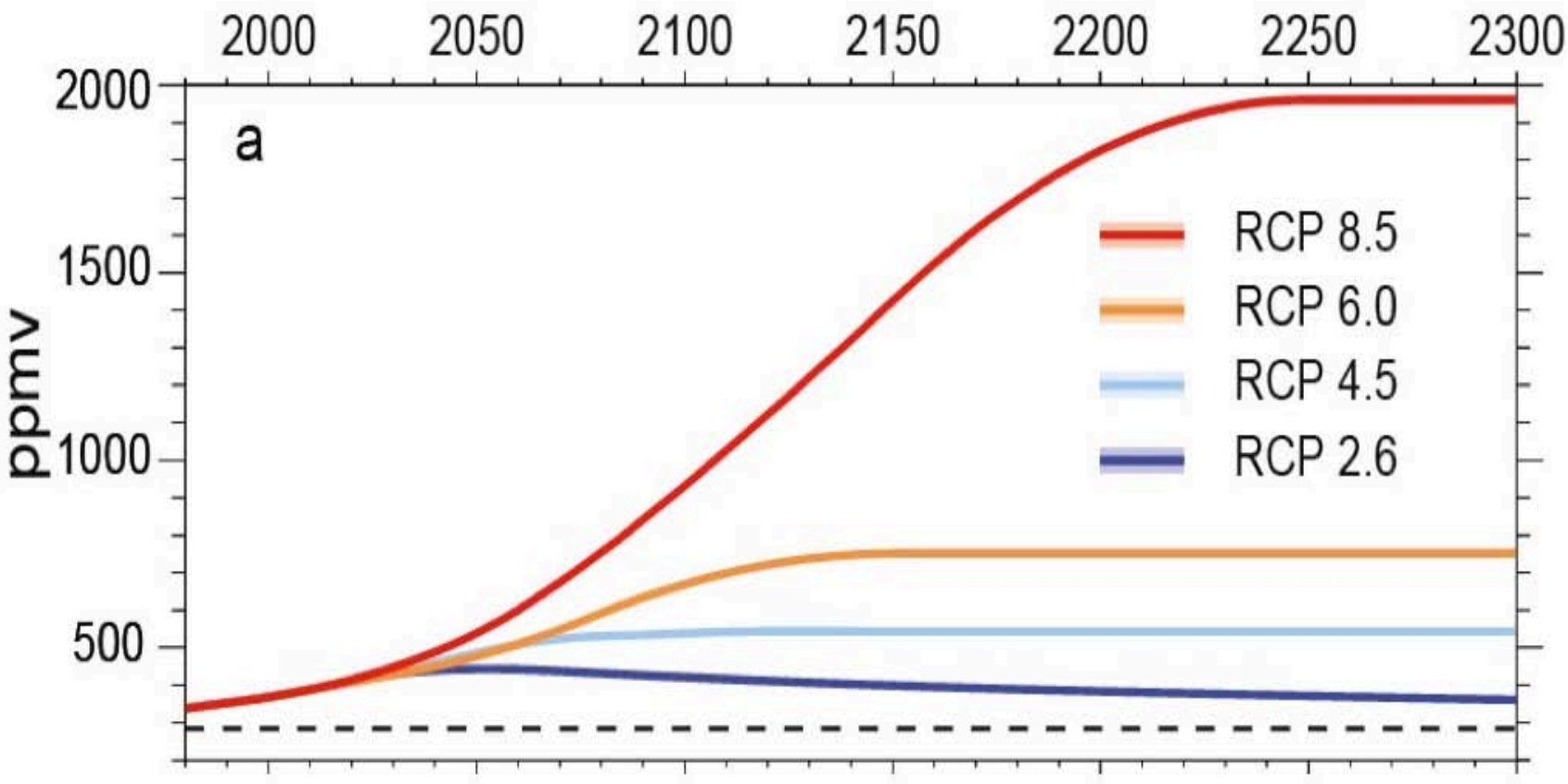
# Impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries



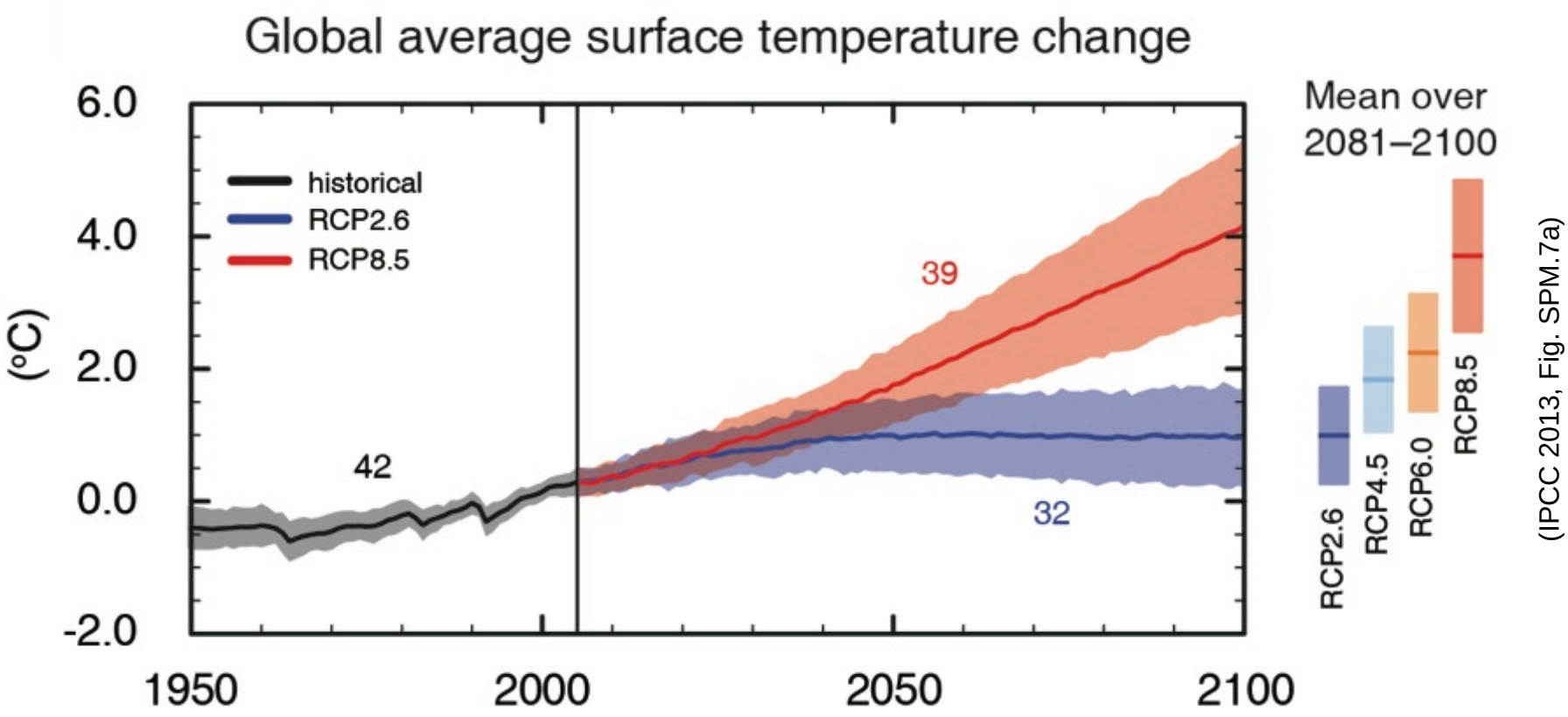

AR5 WGII SPM

# RCP Scenarios: Atmospheric $CO_2$ concentration




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

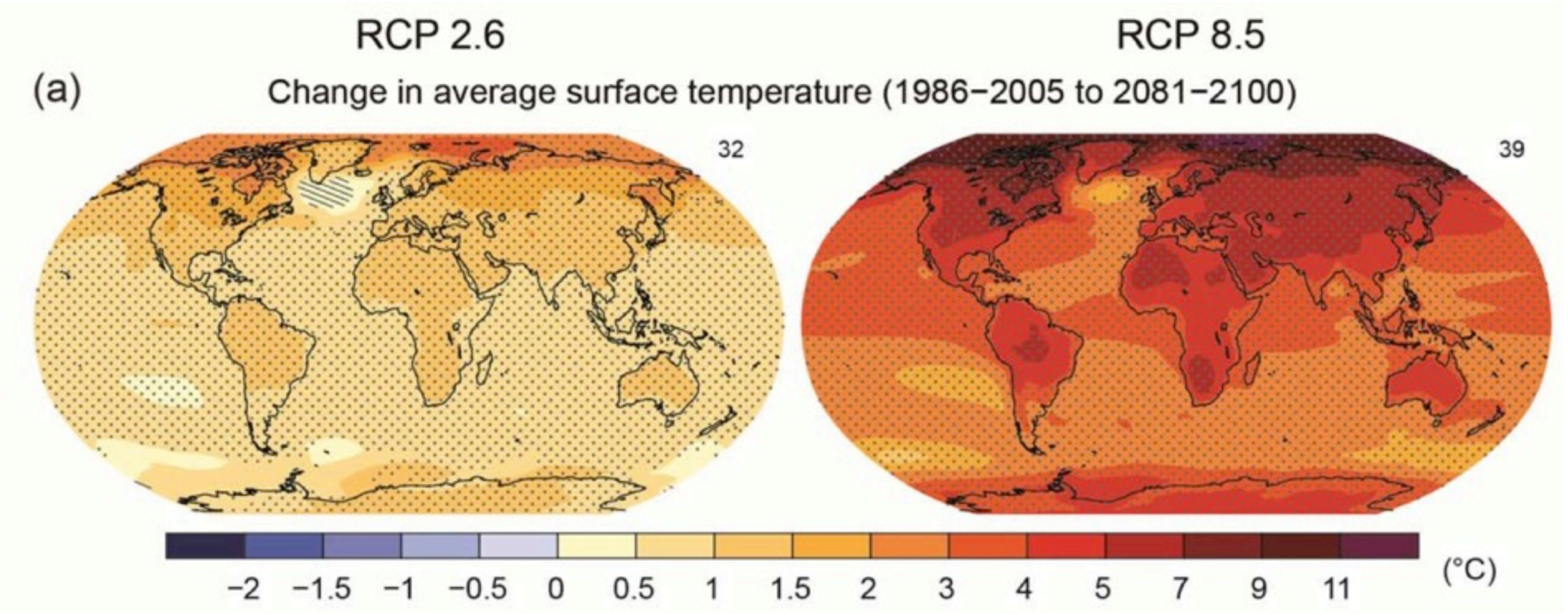
AR5, chapter 12. WGI- Adopted version / subject to final copyedit



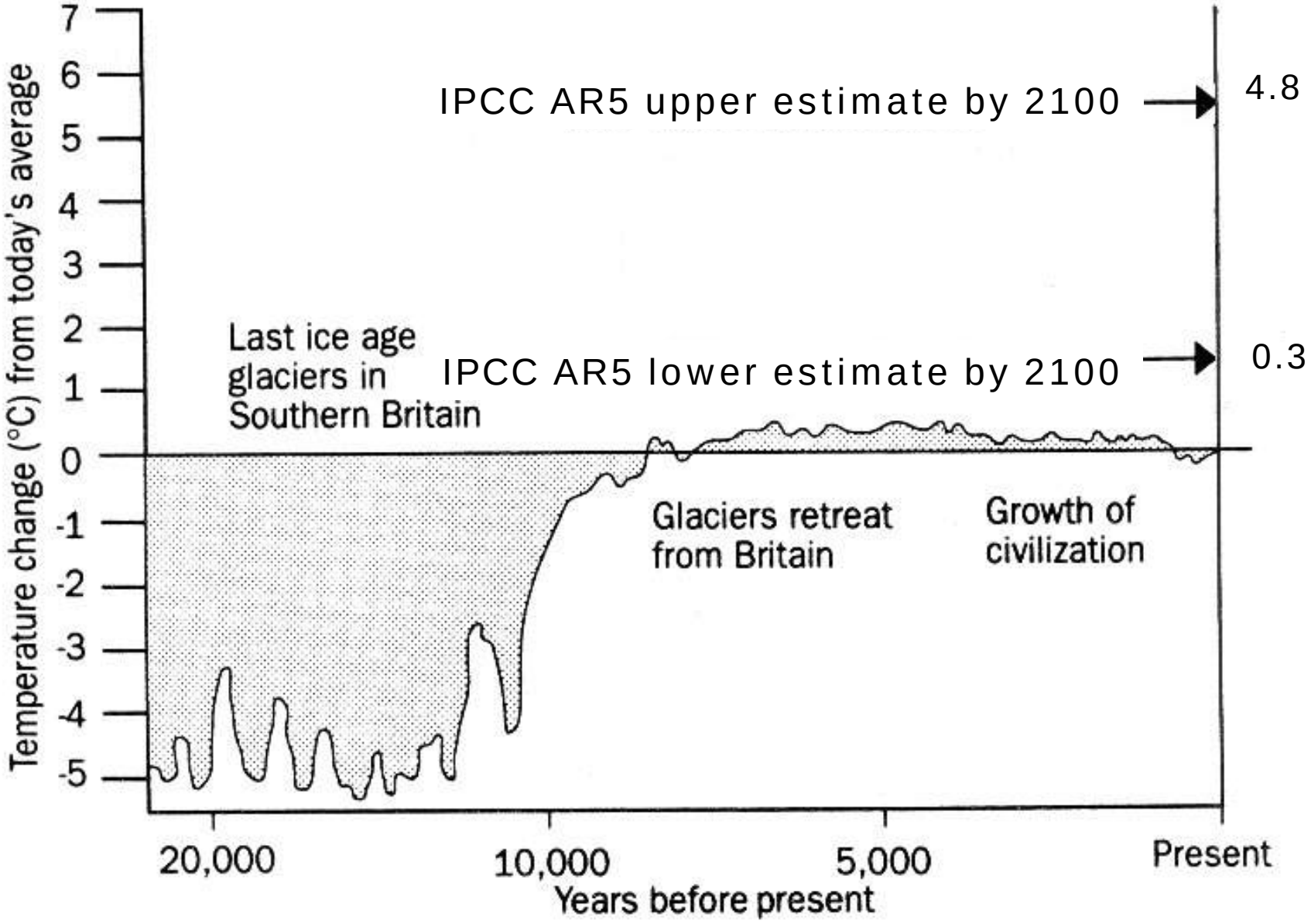

(IPCC 2013, Fig. SPM.7a)

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

# Surface temperature projections




AR5 WGI SPM - Approved version / subject to final copyedit



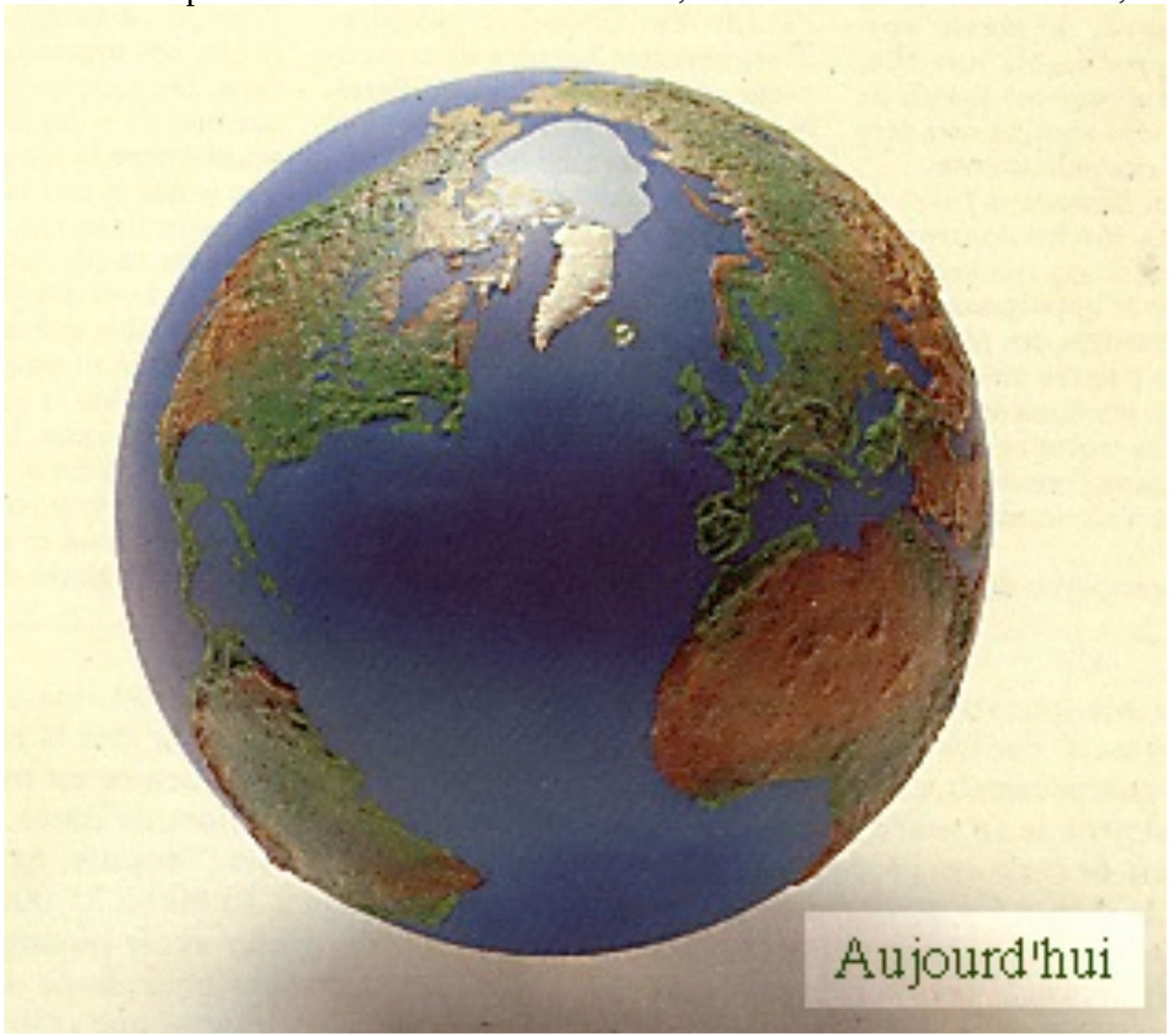

Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July1988

# 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.



# Projected climate changes

## Continued emissions of greenhouse gases will cause further warming and changes in the climate system

Oceans will continue to warm during the 21st century

Global mean sea level will continue to rise during the 21st century

It is very likely that the Arctic sea ice cover will continue to shrink and thin as global mean surface temperature rises

Global glacier volume will further decrease

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# Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

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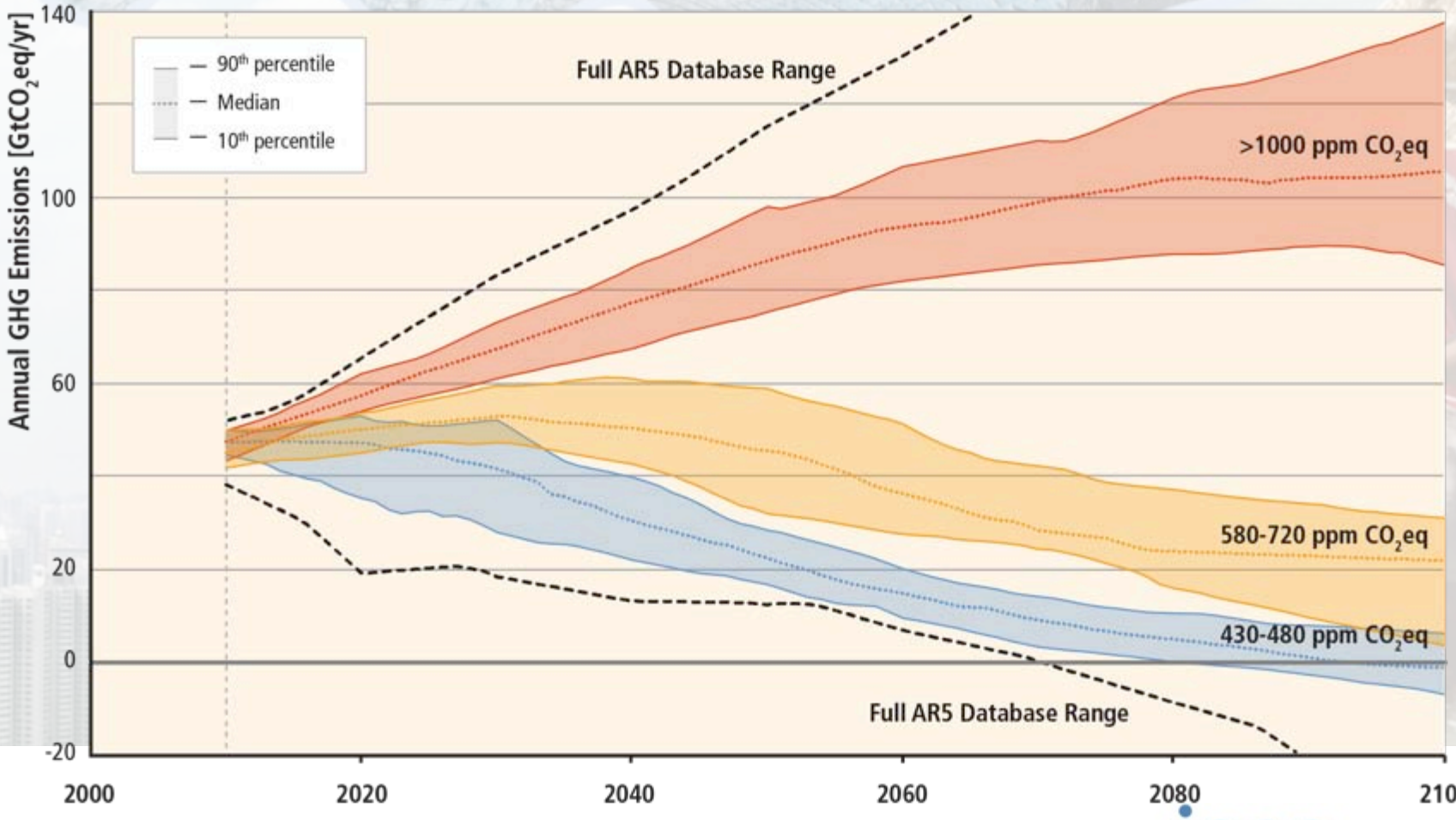
# Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.




Based on Figure 6.7

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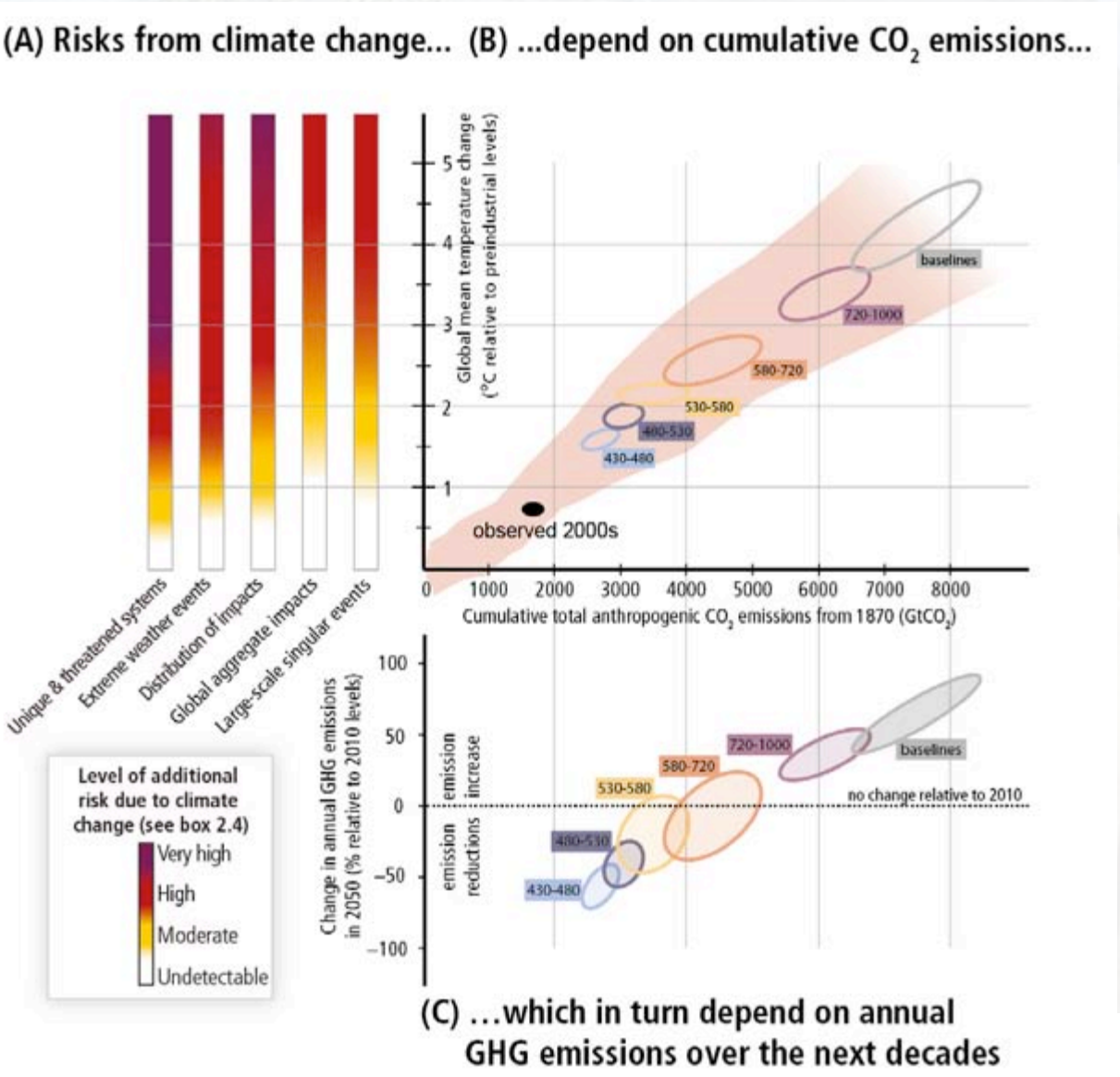
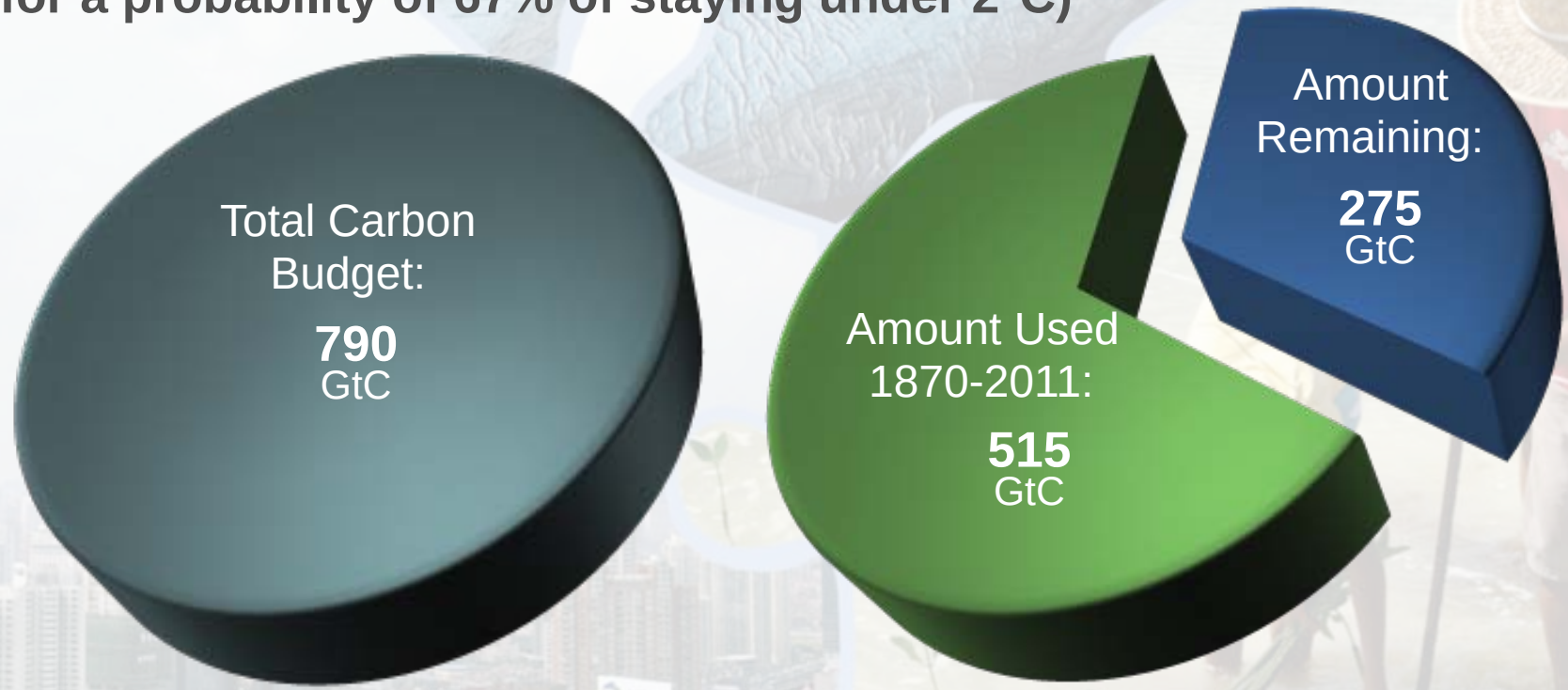
**Figure SPM.10, A reader's guide**

**From climate change risks to GHG emissionse**



# The window for action is rapidly closing

**65% of our carbon budget compatible with a 2°C goal already used (for a probability of 67% of staying under 2°C)**

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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

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# Mitigation Measures

## More efficient use of energy

## Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today

## 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

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# The importance of long-term data monitoring

- (Some remarks based on IPCC AR4)

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

# Observed changes in climate and their effects, and their causes: key uncertainties (IPCC AR4 SYR)

- Climate data coverage remains limited in some regions and there is a notable *lack of geographic balance in data and literature on observed changes* in natural and managed systems, with marked scarcity in developing countries.

- Effects of climate changes on human and some natural systems are difficult to detect due to *adaptation and non-climatic drivers*.

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

# Observed changes in climate and their effects, and their causes: key uncertainties (IPCC AR4 SYR)

- *Analysing and monitoring extremes* including drought, tropical cyclones, extreme temperatures, and the frequency and intensity of *precipitation* is more difficult than for climatic averages as it requires longer data time-series of higher spatial and temporal resolution.

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

# Observed changes in climate and their effects, and their causes: key uncertainties (IPCC AR4 SYR)

- Difficulties remain in reliably *simulating and attributing observed temperature changes* to natural or human causes *at smaller than continental scales*. At these smaller scales, factors such as land-use change and pollution also complicate the detection of anthropogenic warming influence on physical and biological systems.

- The magnitude of *CO2 emissions from land-use* change and from individual *methane* sources remain as key uncertainties.

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

# Drivers and projections of future climate changes and their impacts: key uncertainties (IPCC AR4 SYR)

- Models differ considerably in their estimates of the strength of different feedbacks in the climate system, particularly *cloud feedbacks, oceanic heat uptake, and carbon cycle feedbacks*, although progress has been made in these areas. Also, the confidence in projections is higher for some variables (e.g. temperature) than for others (e.g. precipitation), and is higher for larger spatial scales and longer time averaging periods.

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

# Drivers and projections of future climate changes and their impacts: key uncertainties (IPCC AR4 SYR)

- Future changes in the *Greenland and Antarctic ice sheet* mass, particularly due to changes in ice flow, are a major source of uncertainty that *could increase sea level rise* projections. The uncertainty in the penetration of the heat into the oceans also contributes to the future sea level rise uncertainty.

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

# Drivers and projections of future climate changes and their impacts: key uncertainties (IPCC AR4 SYR)

- *Large scale ocean circulation changes* beyond the 21st century cannot be reliably assessed because of uncertainties in the meltwater supply from Greenland ice sheet and model response to the warming.

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

# Drivers and projections of future climate changes and their impacts: key uncertainties (IPCC AR4 SYR)

- Projections of climate change and its impacts beyond about 2050 are strongly scenario- and model-dependent, and improved projections would require improved understanding of sources of uncertainty and enhancements in systematic observation networks.
- JPvY remark: pay attention to long term continuity, and need for in situ surface measurements as well

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

# 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