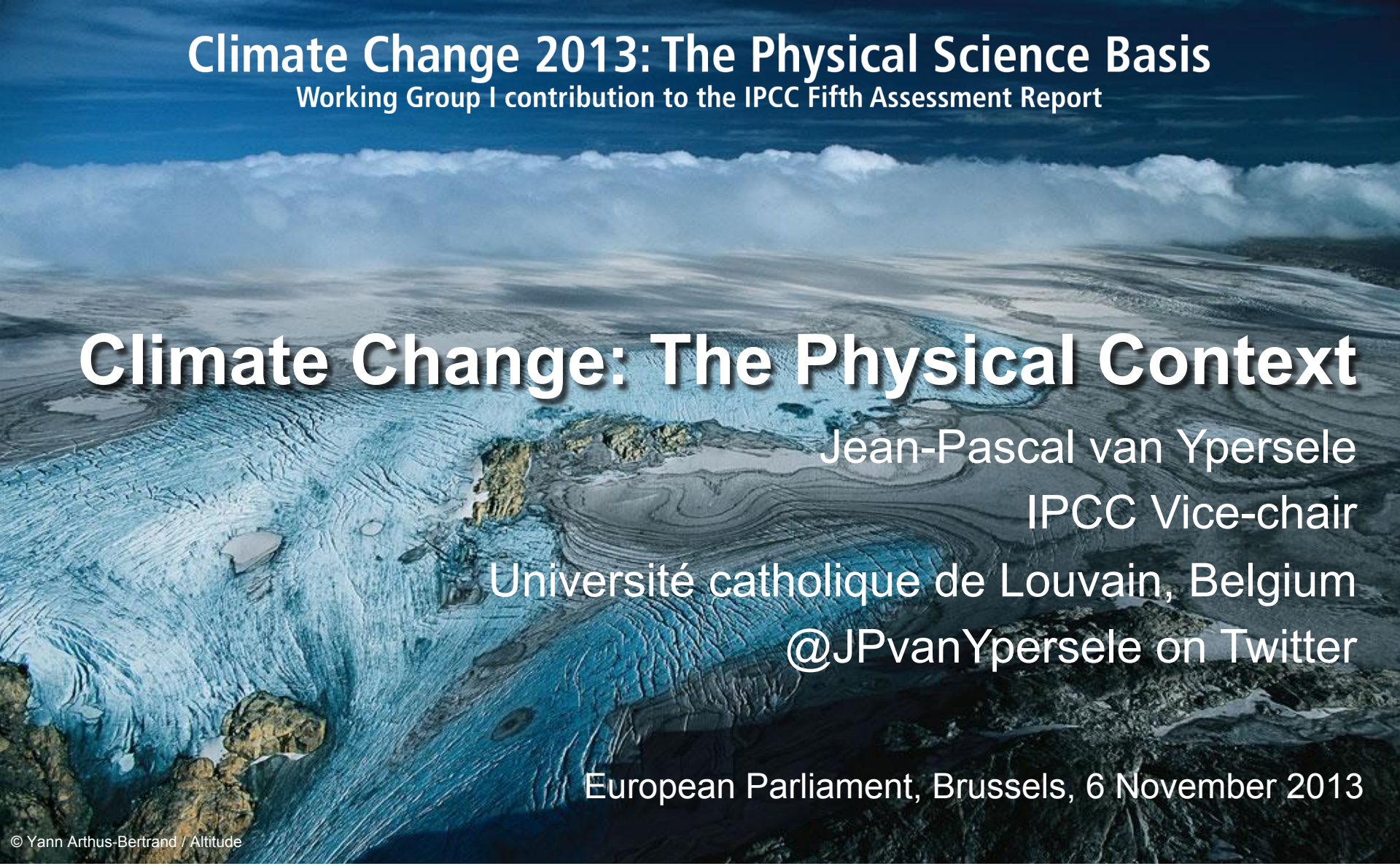


Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

Climate Change: The Physical Context

Jean-Pascal van Ypersele
IPCC Vice-chair
Université catholique de Louvain, Belgium
@JPvanYpersele on Twitter

European Parliament, Brussels, 6 November 2013

Thanks to the Belgian Federal Science Policy Office for their support,
to IPCC WGI for some of the slides, and to Dr Philippe Marbaix & Dr Bruna Gaino for their help

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.

WMO=World Meteorological Organization

UNEP= United Nations Environment Programme

Recent/Coming IPCC Products

- ***2011: Special report on Renewable Energy Sources and Climate Change Mitigation***
- ***2011: Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation***
- ***2013: AR5 WGI report (physical science)***
- ***2014: AR5 WGII (Impacts & Adaptation); WGIII (Mitigation), Synthesis Report***
- ***All available on www.ipcc.ch***

Key SPM Messages

19 Headlines

on less than 2 Pages

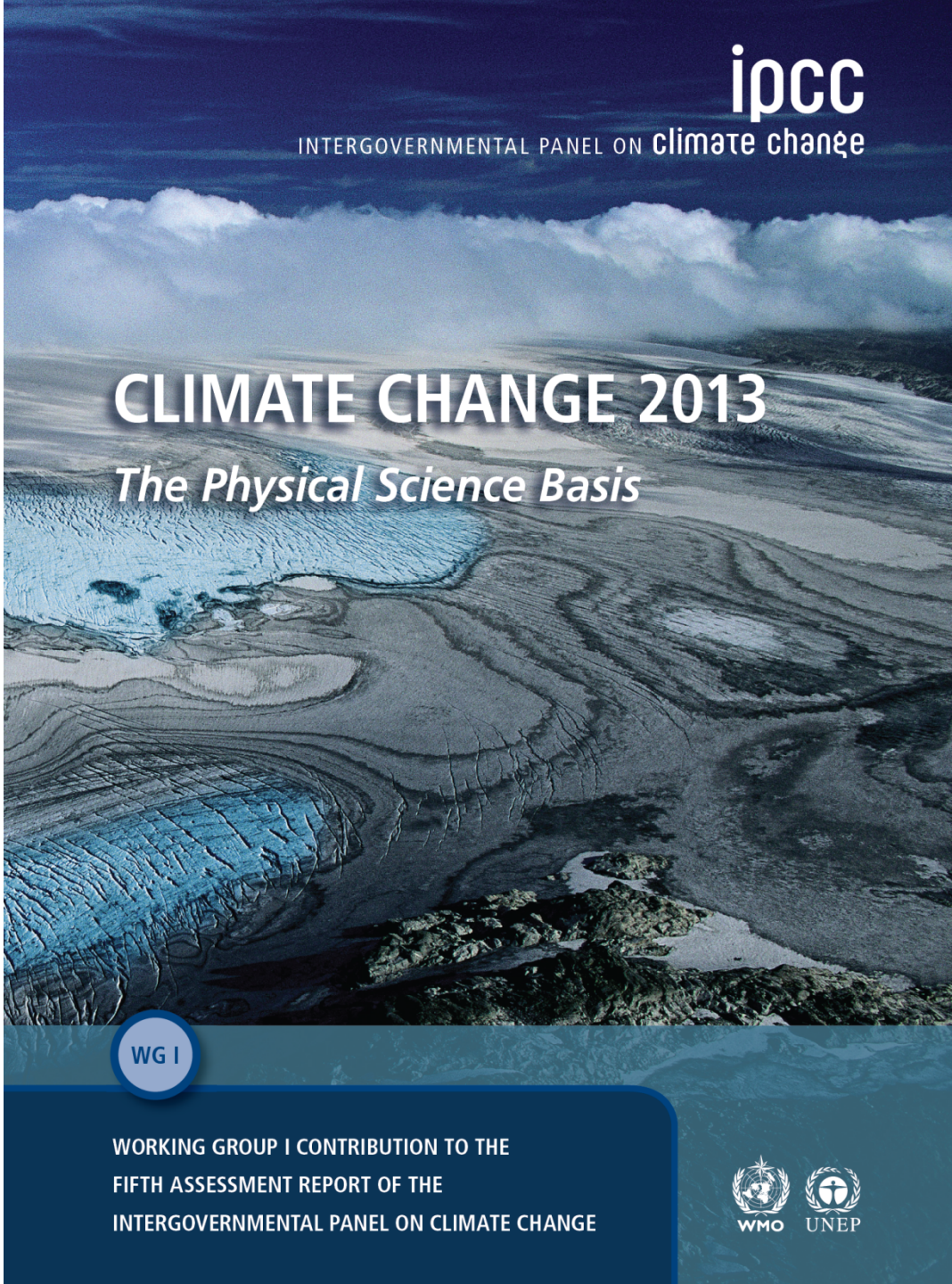
Summary for Policymakers
~14,000 Words

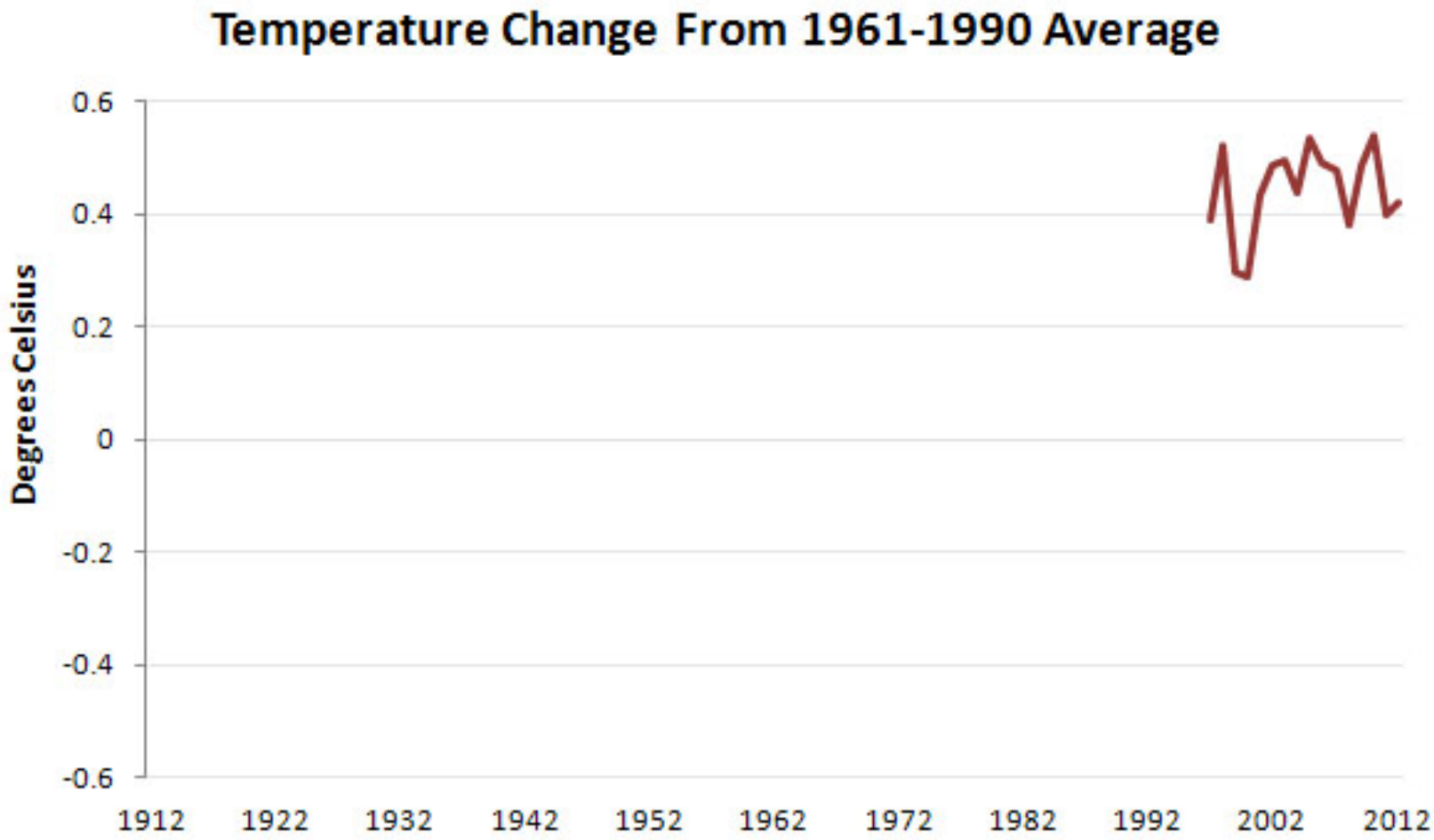
14 Chapters
Atlas of Regional Projections

54,677 Review Comments
by 1089 Experts

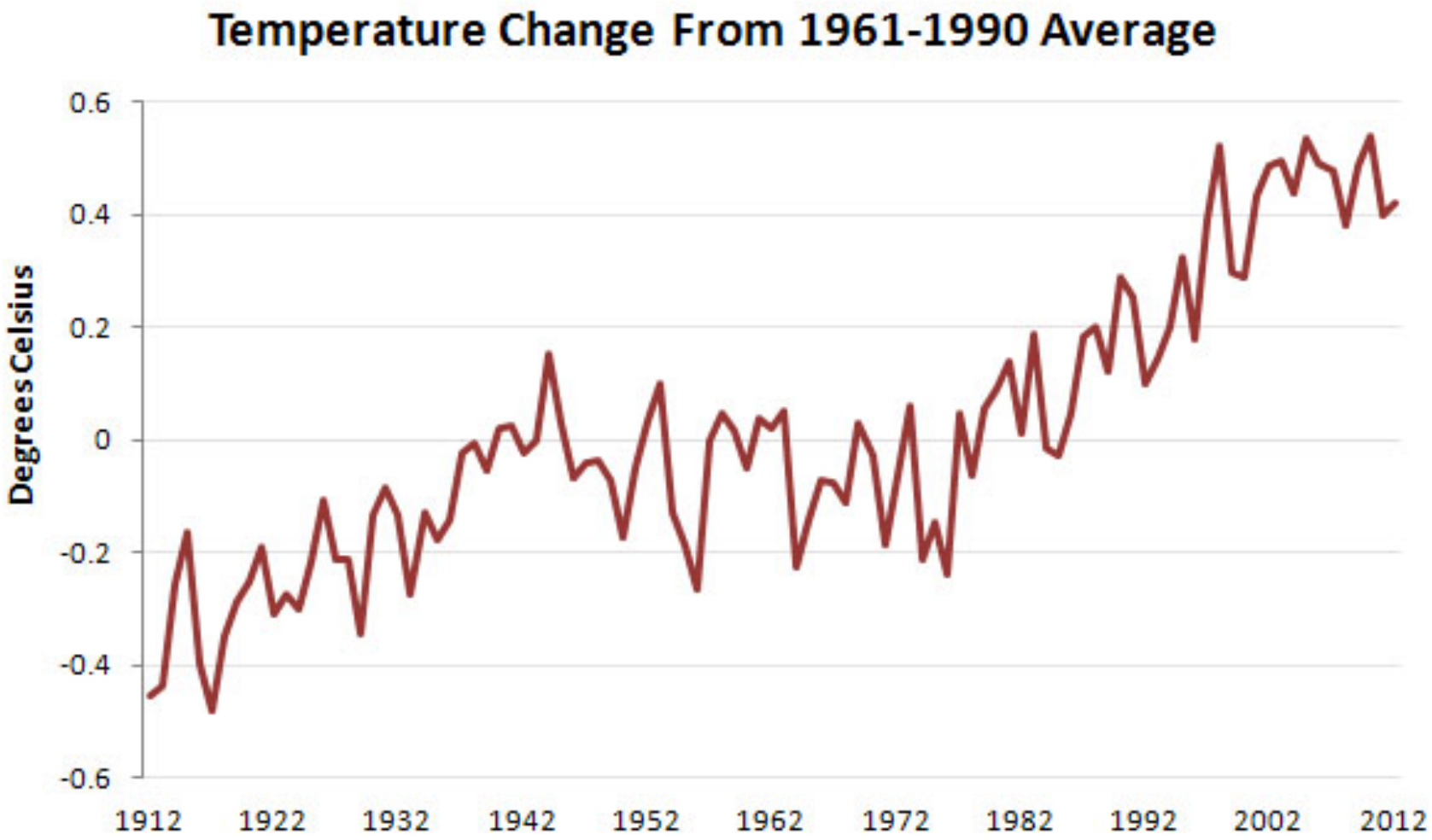
2010: 259 Authors Selected

2009: WGI Outline Approved



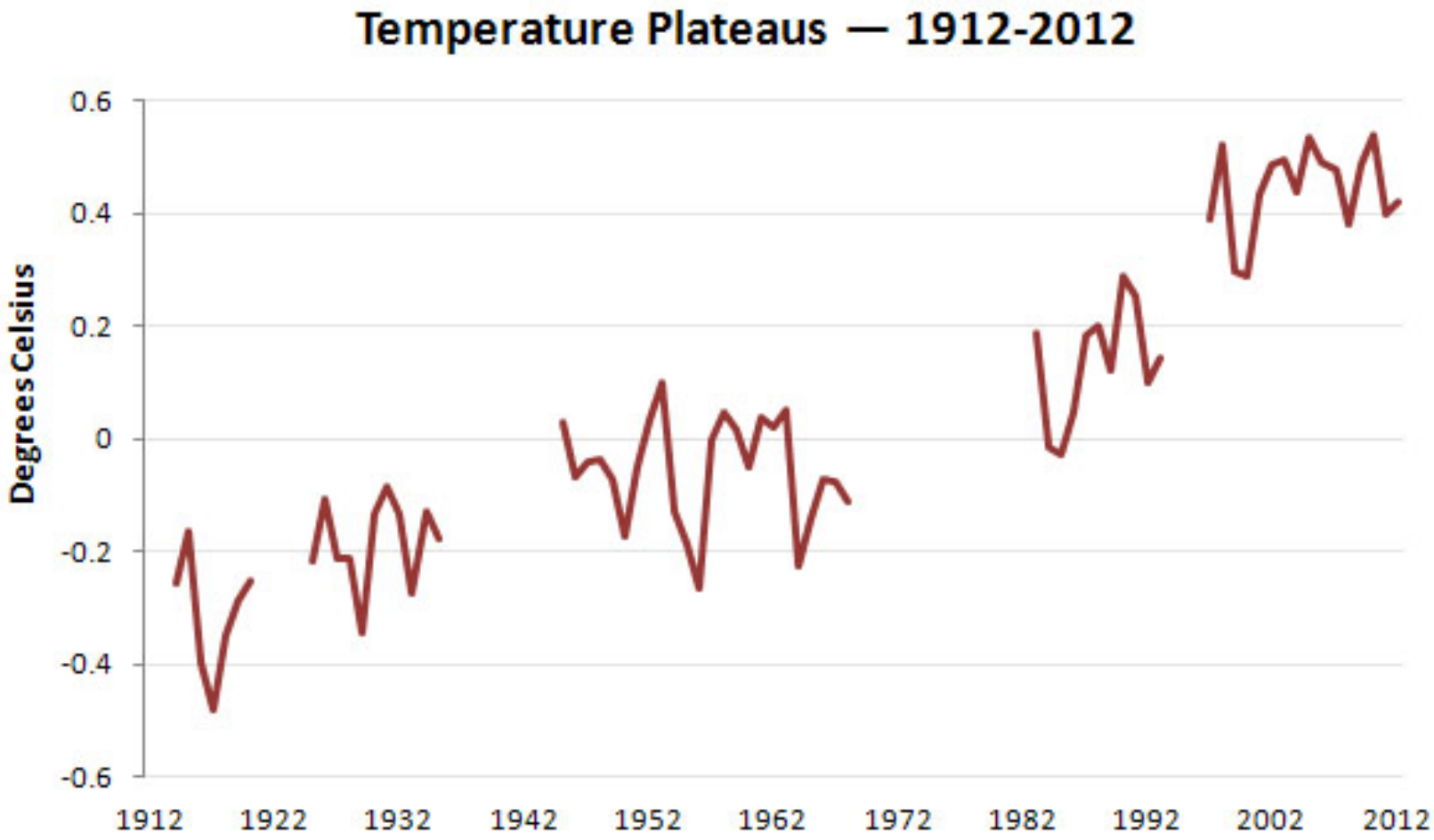


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition



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

Lying With Statistics, Global Warming Edition



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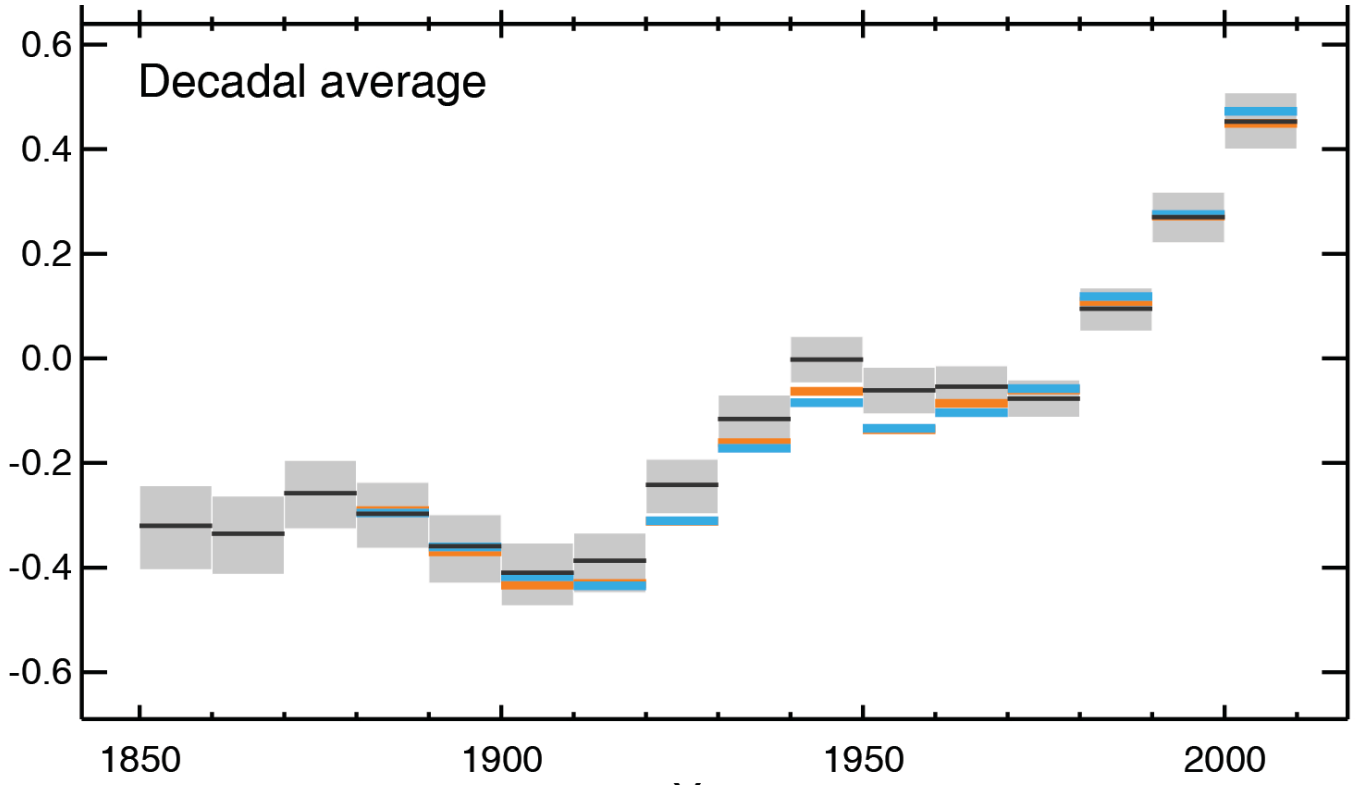


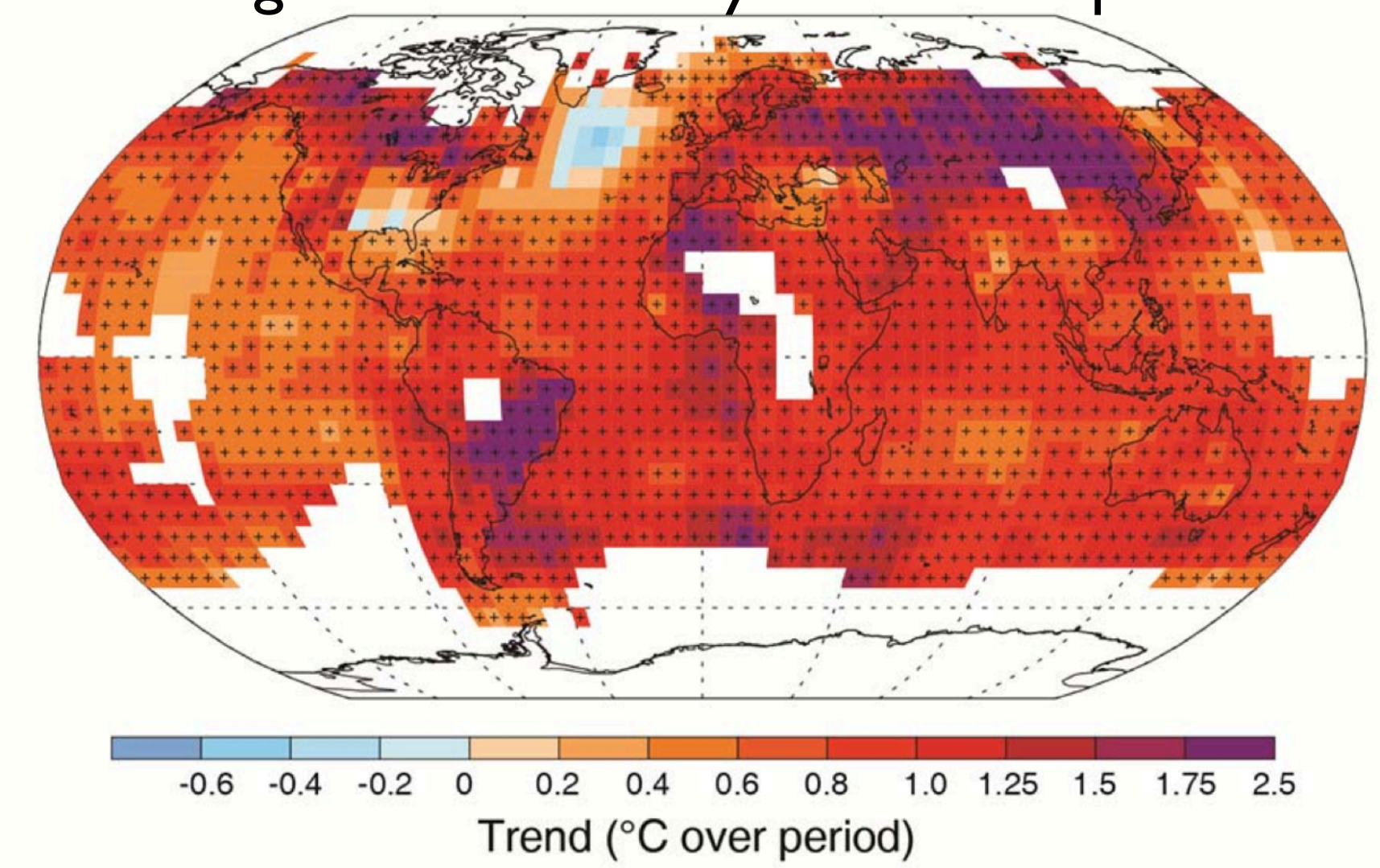
(IPCC 2013, Fig. SPM.1a)

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*).

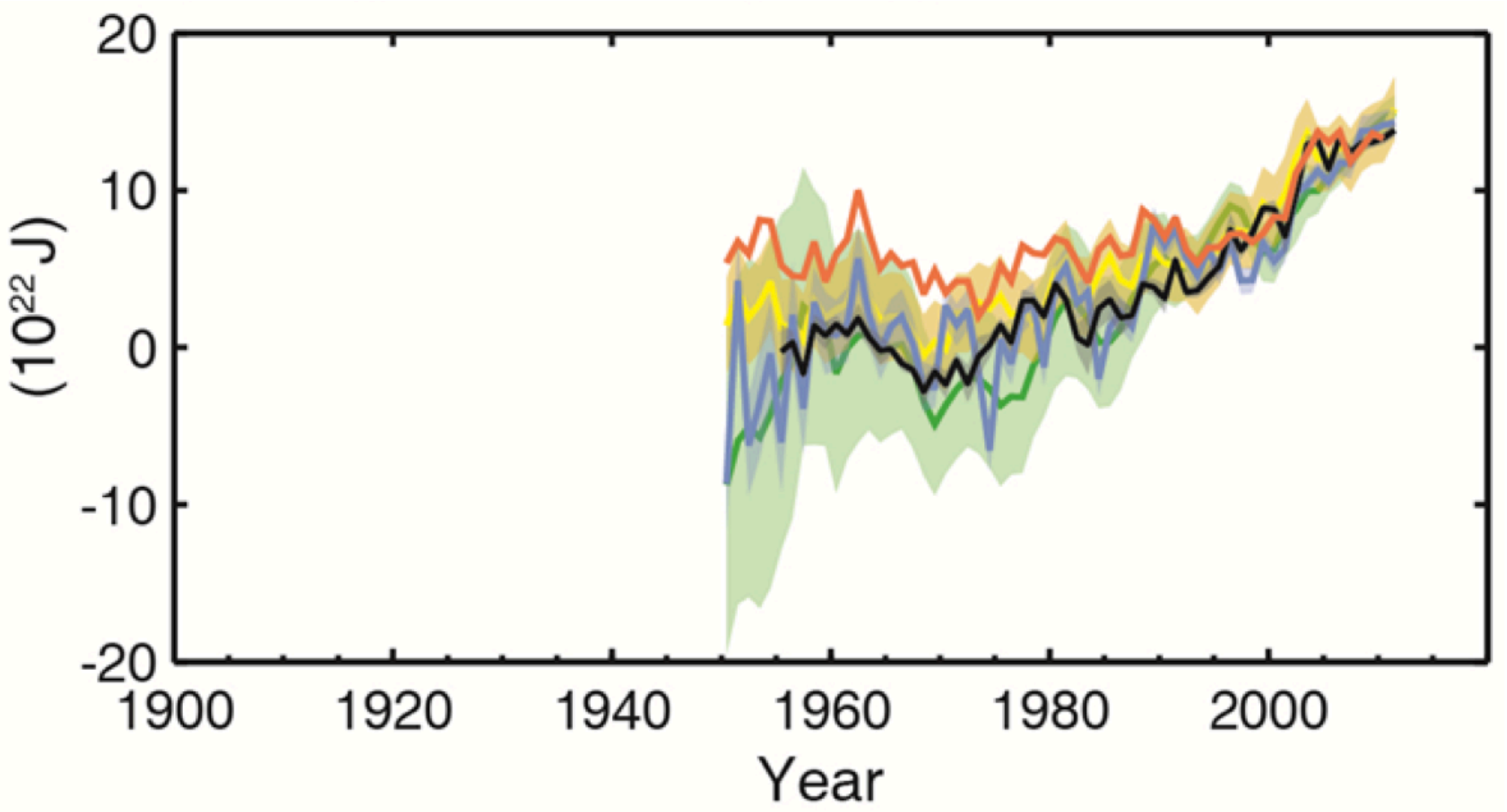
Change in average surface temperature 1901-2012

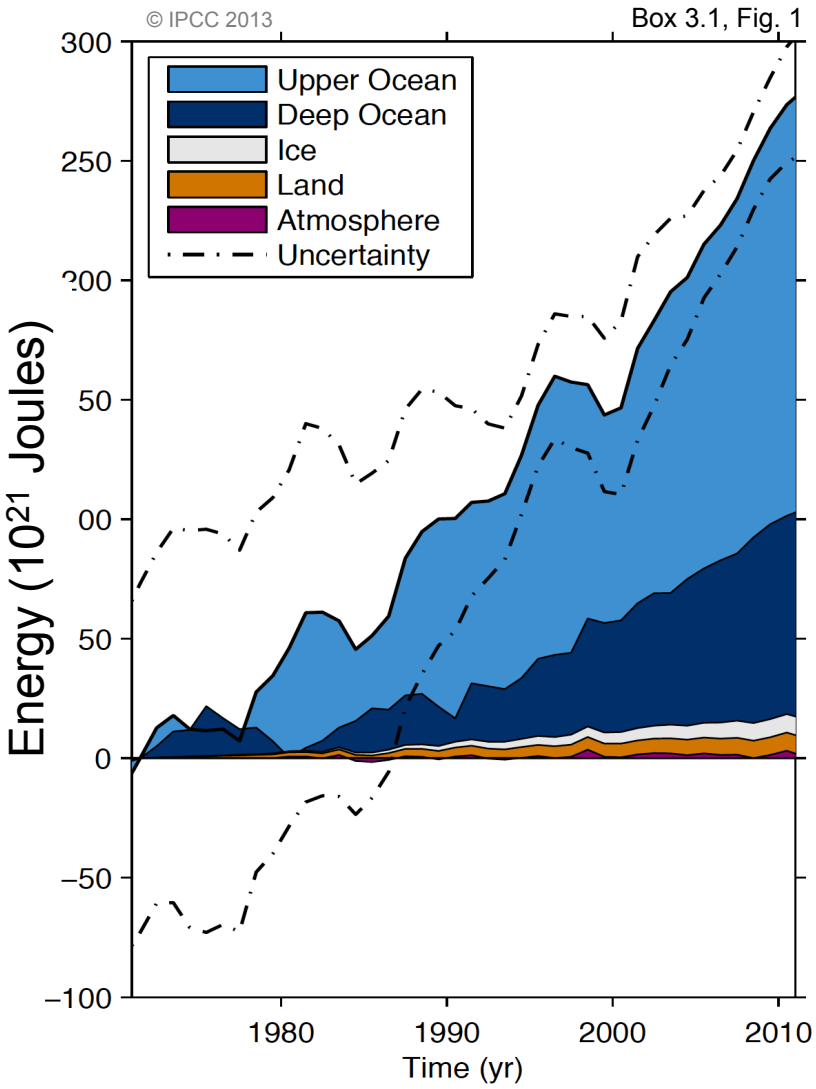
Warming in the climate system is unequivocal



AR5 WGI SPM - Approved version / subject to final copyedit

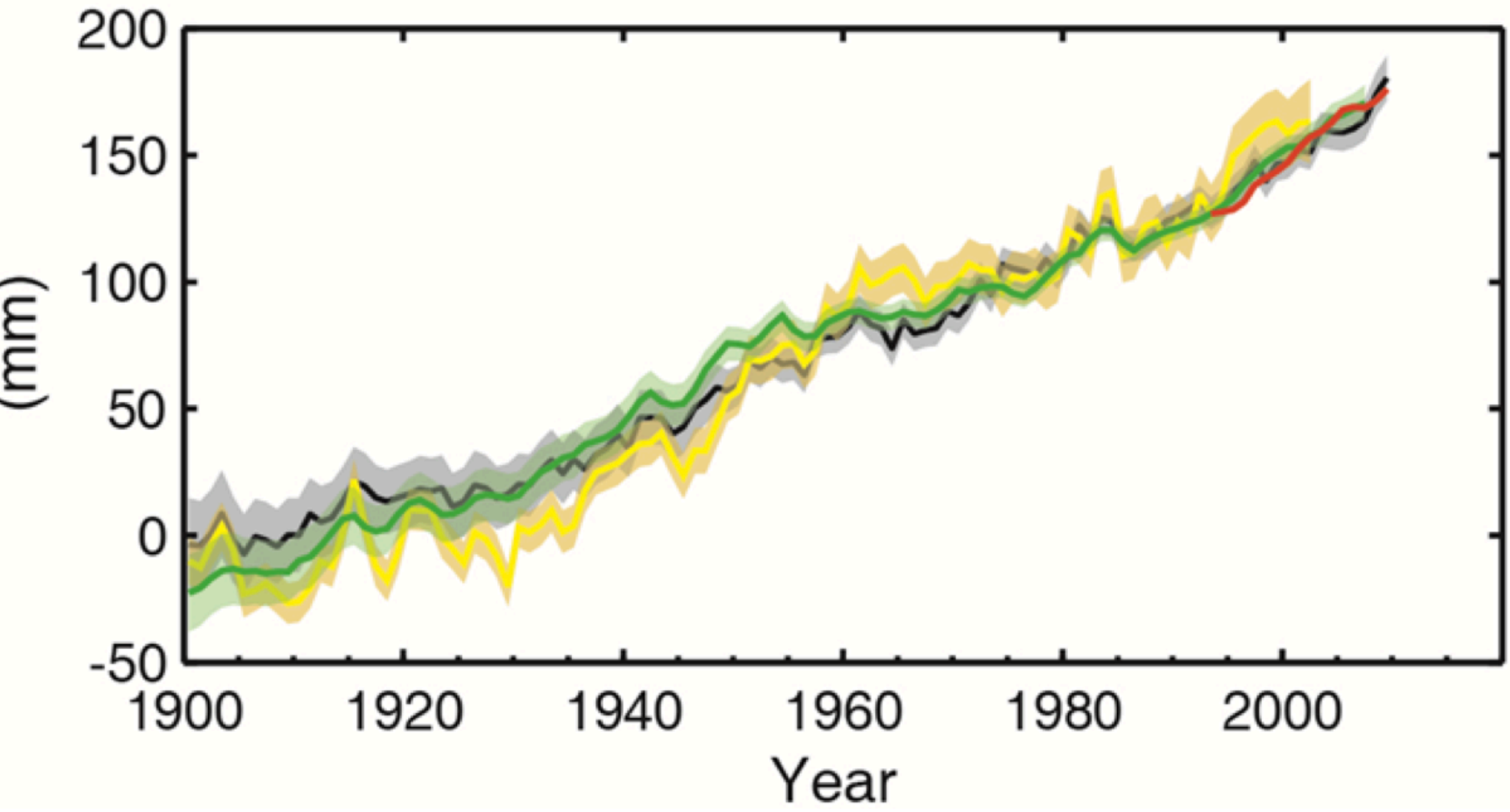
Change in global average upper ocean heat content





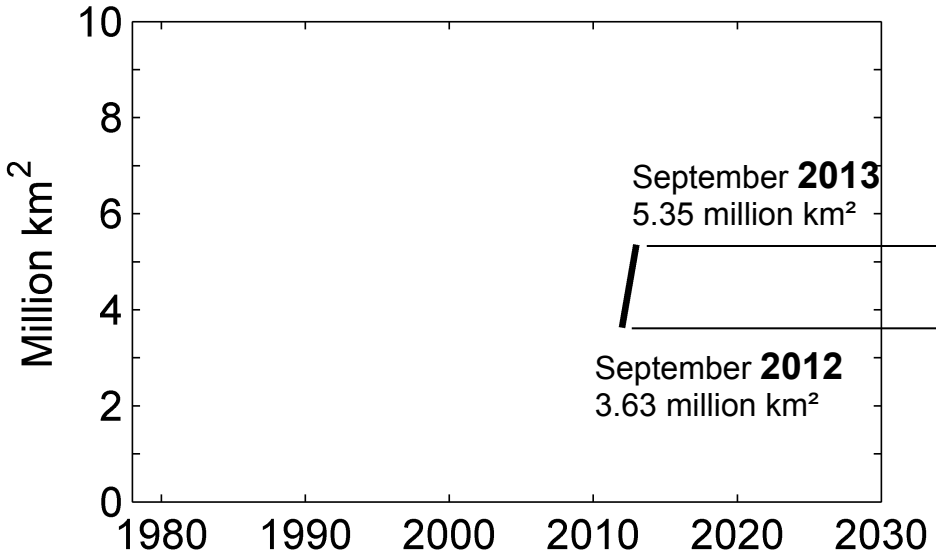
Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*).

Change in average sea-level change



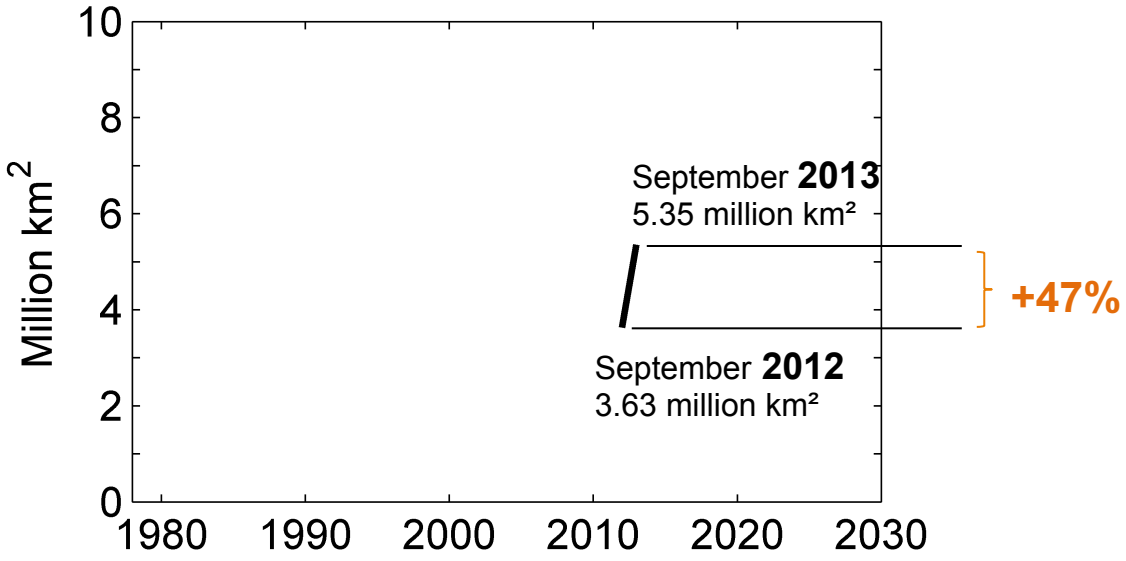
AR5 WGI SPM - Approved version / subject to final copyedit

Observed Arctic September sea ice extent



Credit: F. Massonnet, UCL, 2013
Sea ice extent data: www.nsidc.org

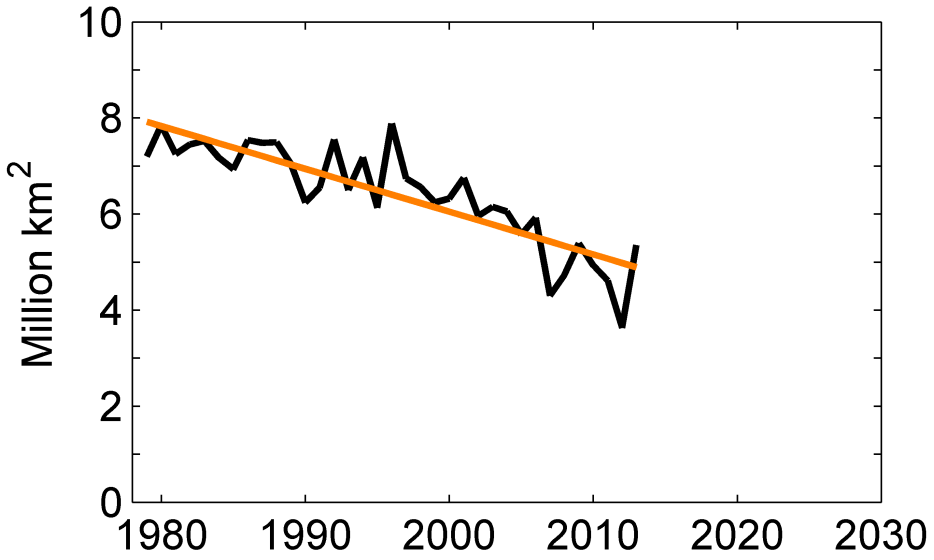
Observed Arctic September sea ice extent



Cherry-picking analysis

-« Arctic sea ice cover is rebounding »

-« Climate is cooling »



Scientific approach: the full view

-Variability of September sea ice extent at the interannual time scale is important

-Significant negative trend over record period (1979-2013): −0.89 million km²/ decade

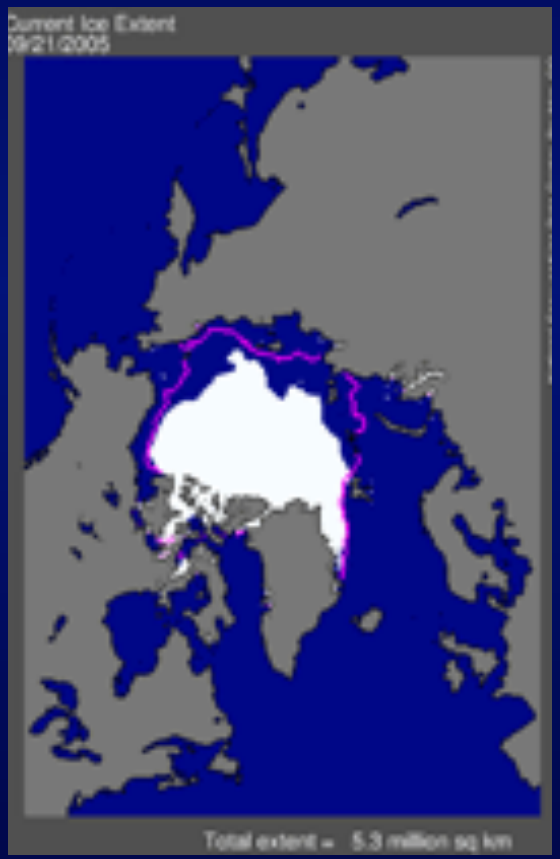
-September 2013 sea ice extent is 6th lowest on record and 16.5% below 1979-2013 average

Credit: F. Massonnet, UCL, 2013
Sea ice extent data: www.nsidc.org

Extension of the Arctic ice cap

September 1979

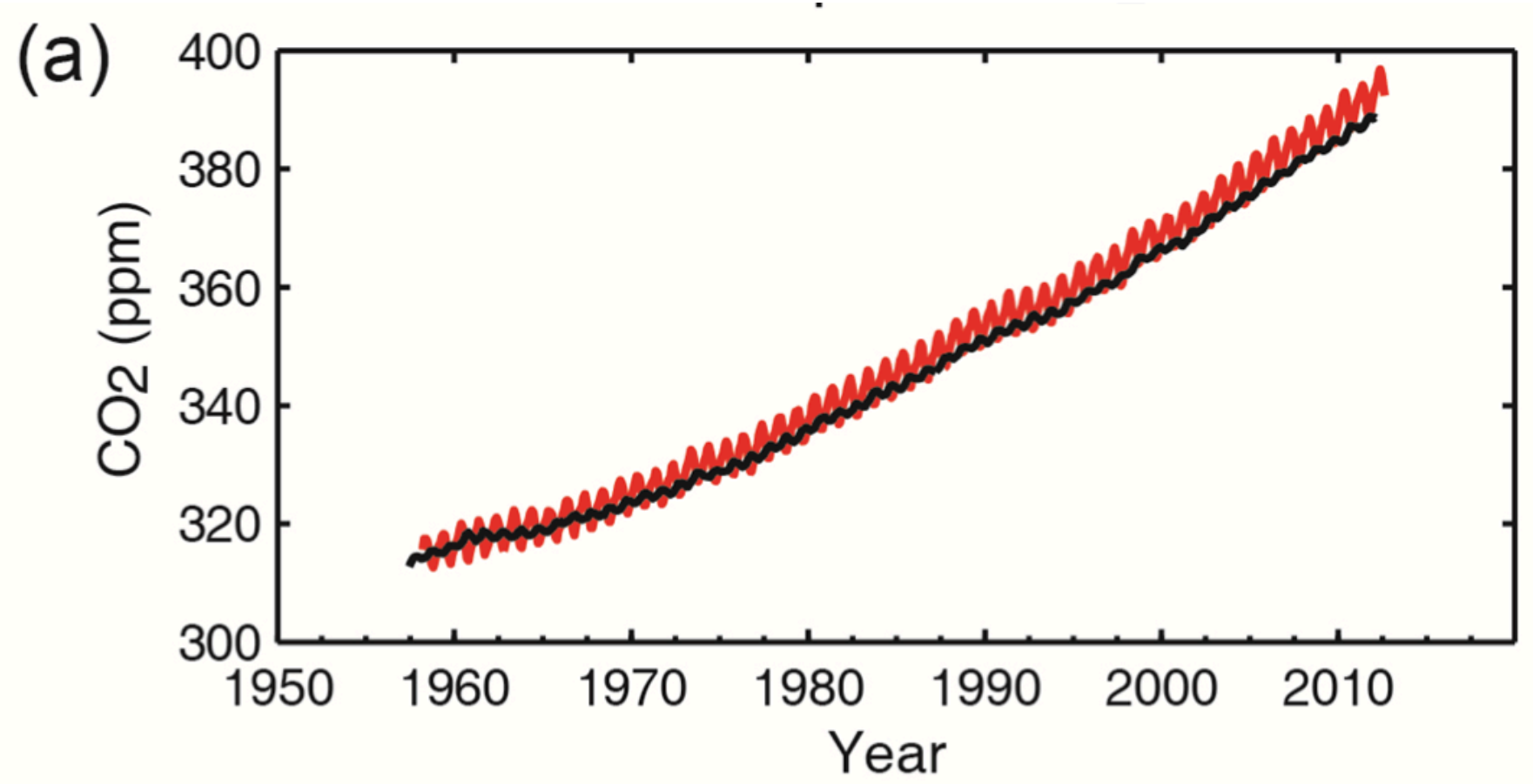
September 2005



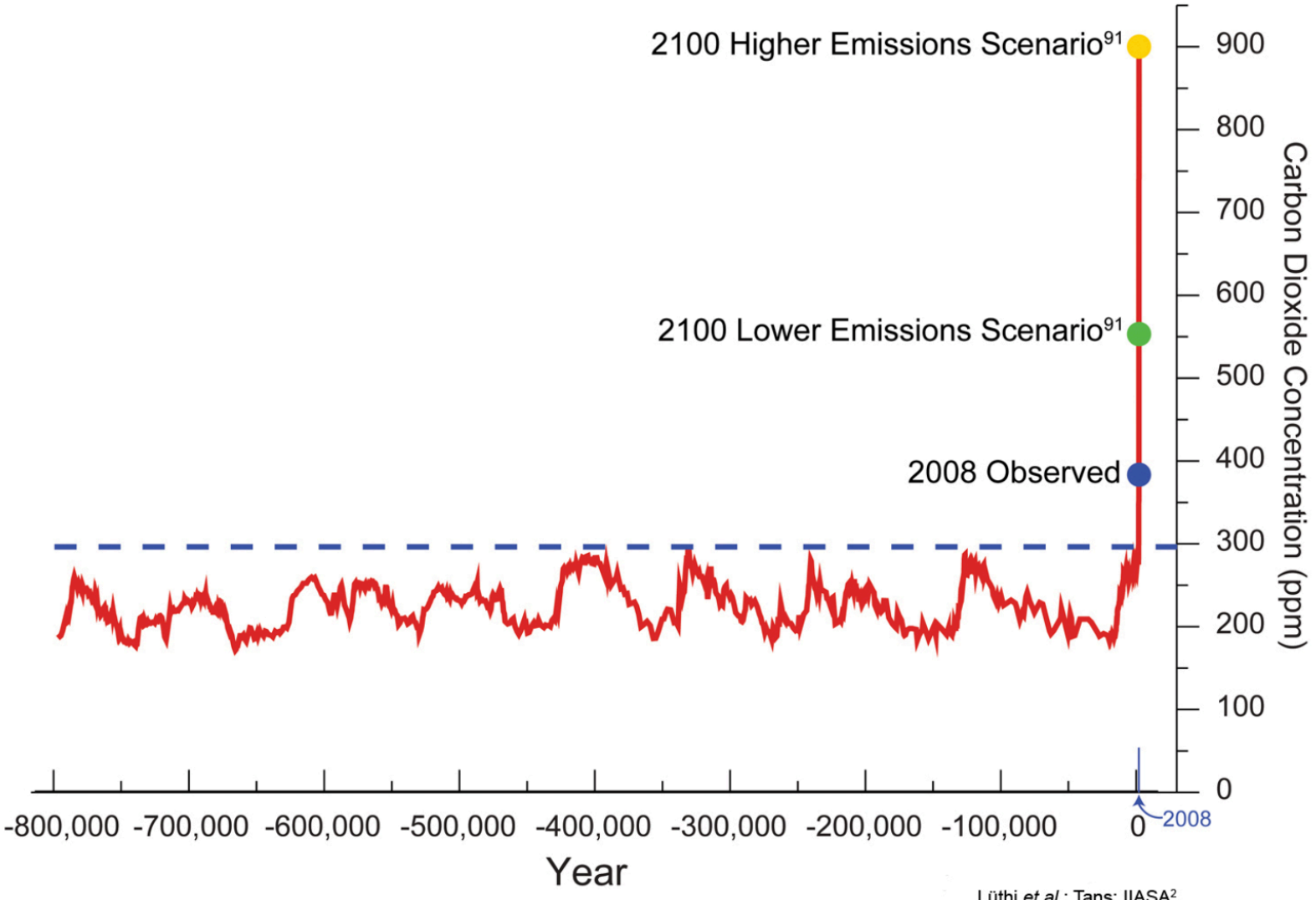
September 2007

The pink line indicates the average ice cap extension since 1979

Atmospheric CO_2 concentration



Atmospheric CO_2 over the last 800000 years



IPCC AR5 Wo
Climate Char

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

UNEP

CO_2 provides largest RF

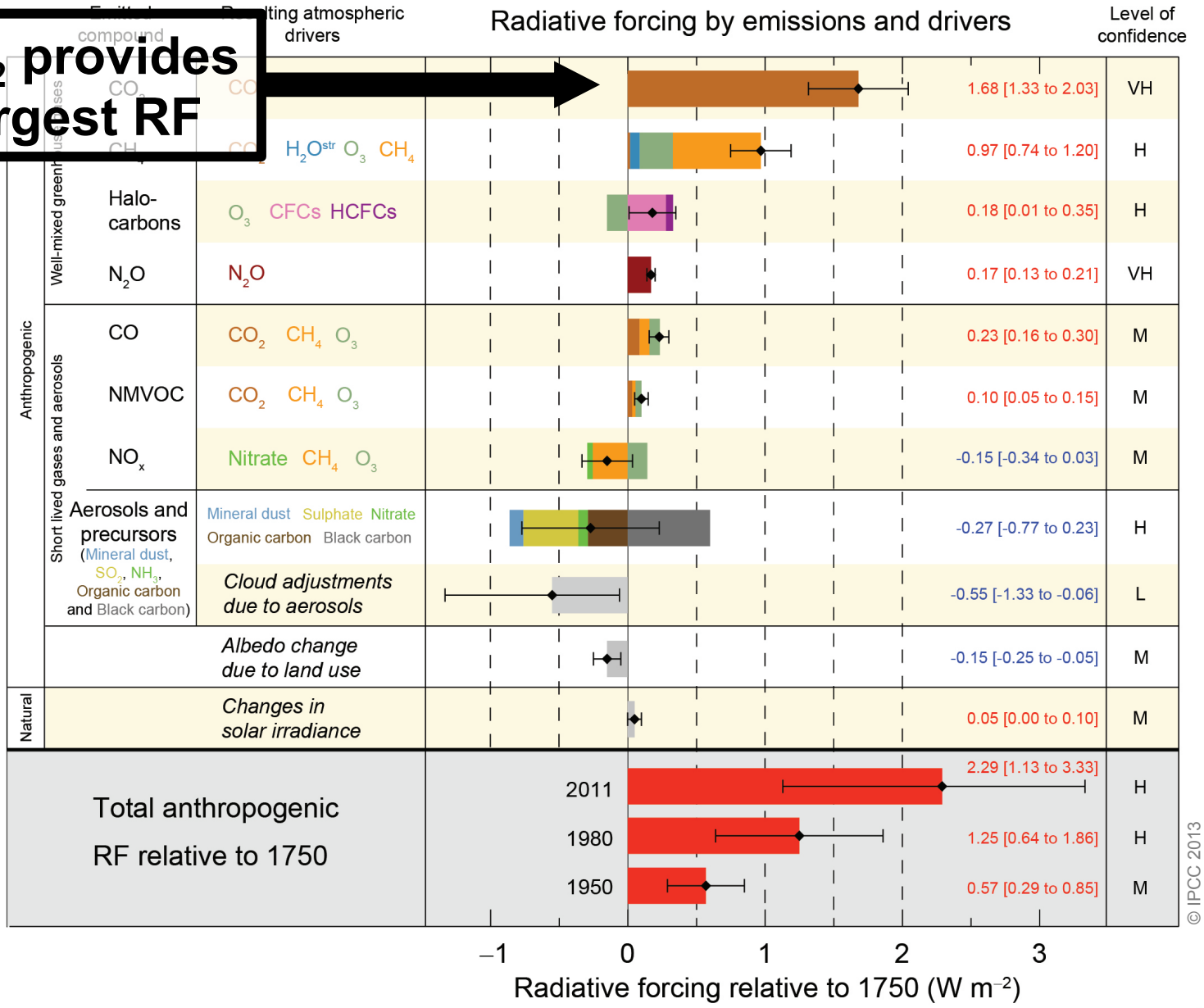


Fig. SPM.5

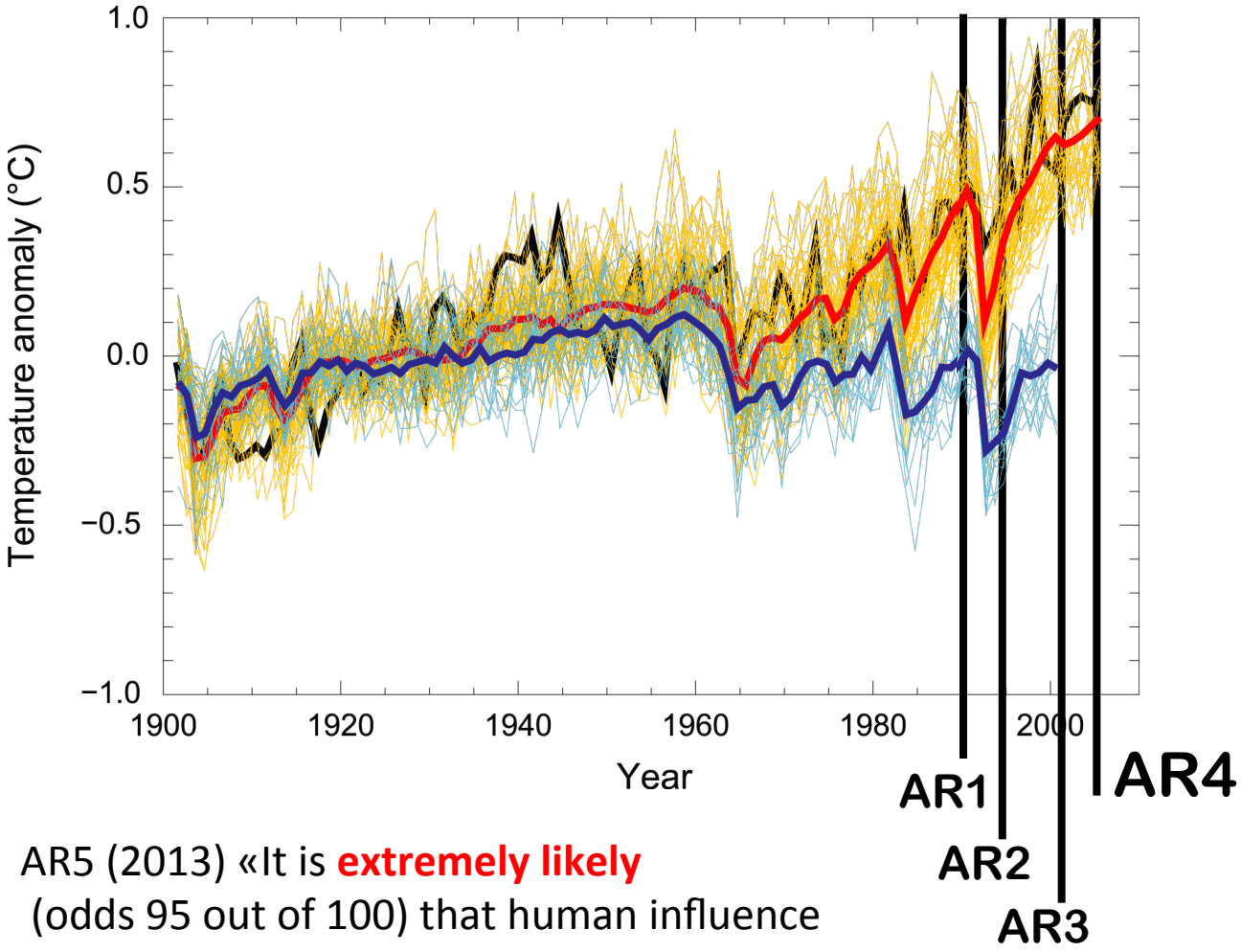
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

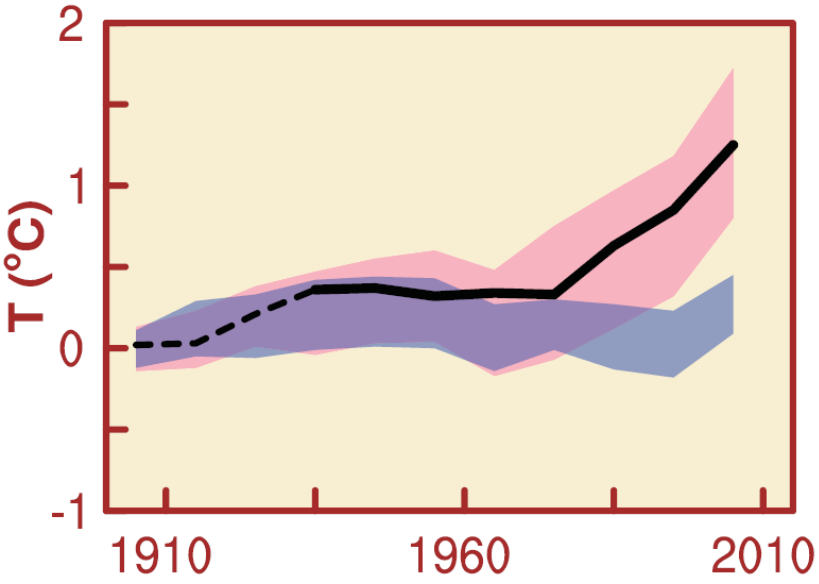
AR2 (1995): "balance of evidence suggests **discernible** human influence"

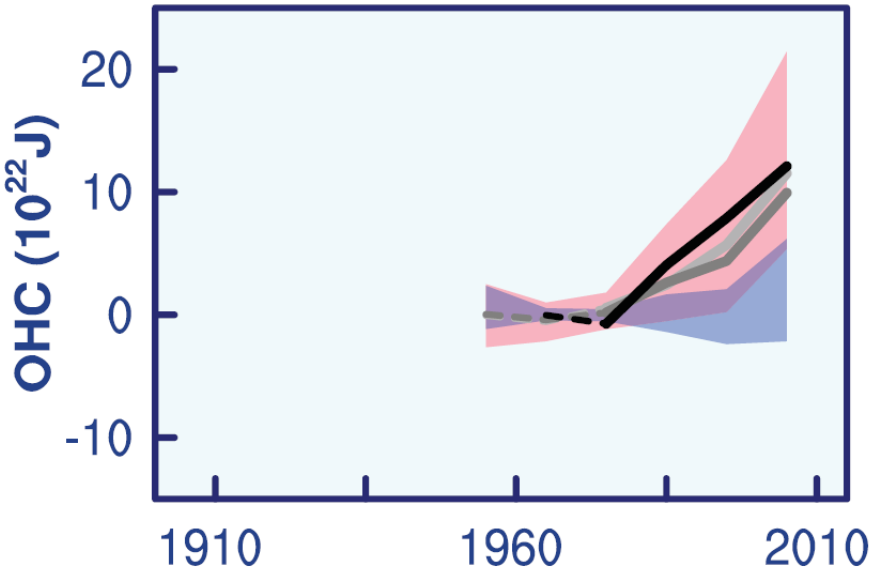
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

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… »

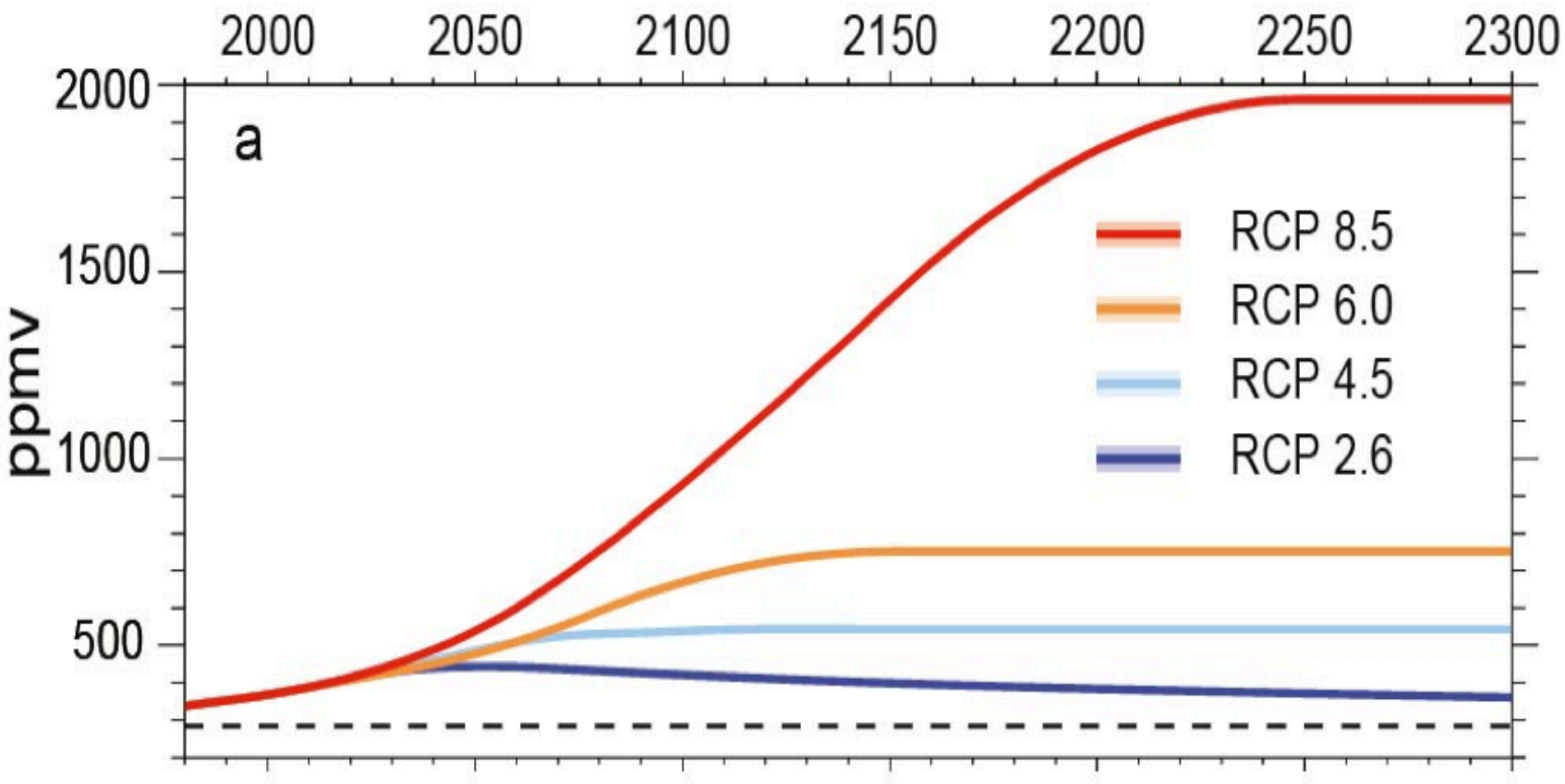




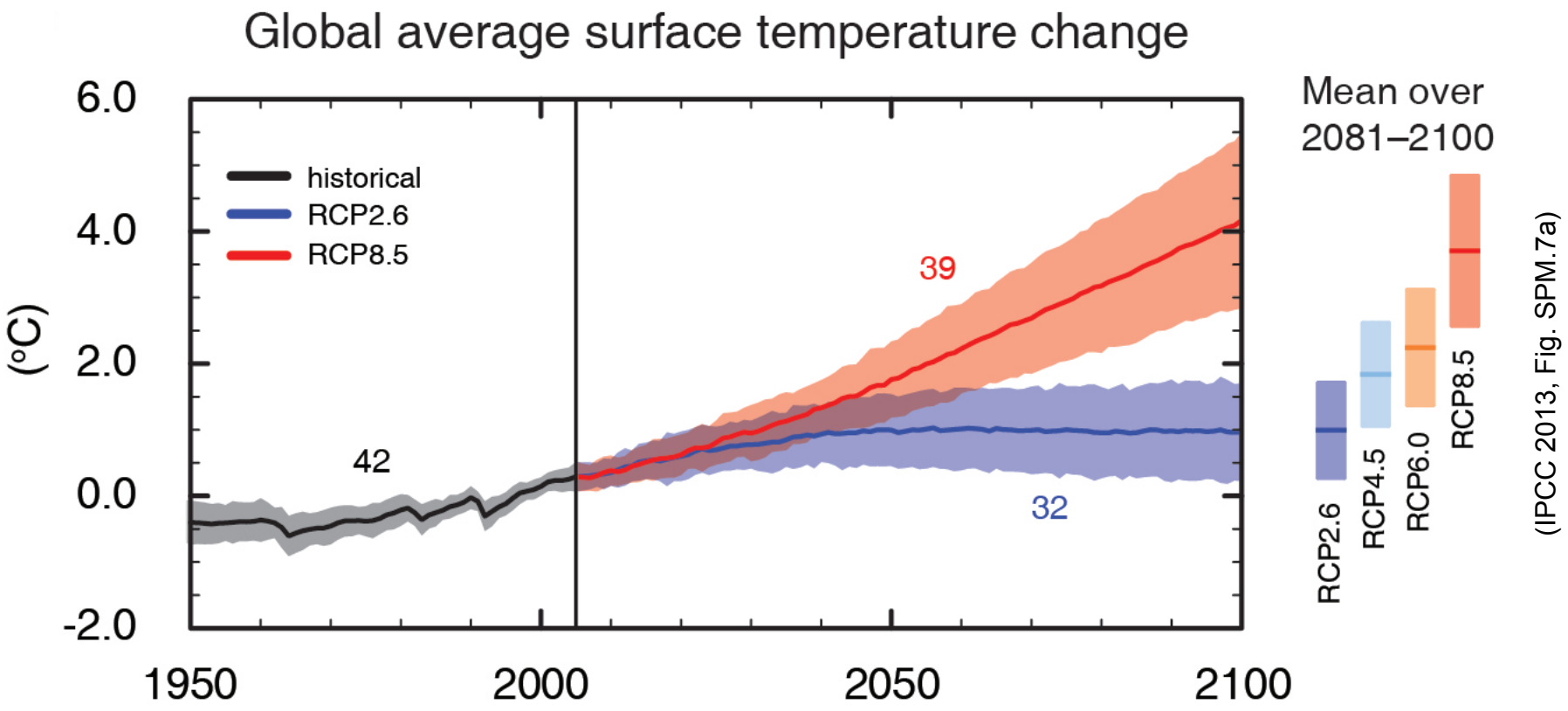
(IPCC 2013, Fig. SPM.6)

Human influence on the climate system is clear

Atmospheric CO_2 concentration



Most CMIP5 runs are based on the concentrations, but emissions-driven runs are available for RCP 8.5



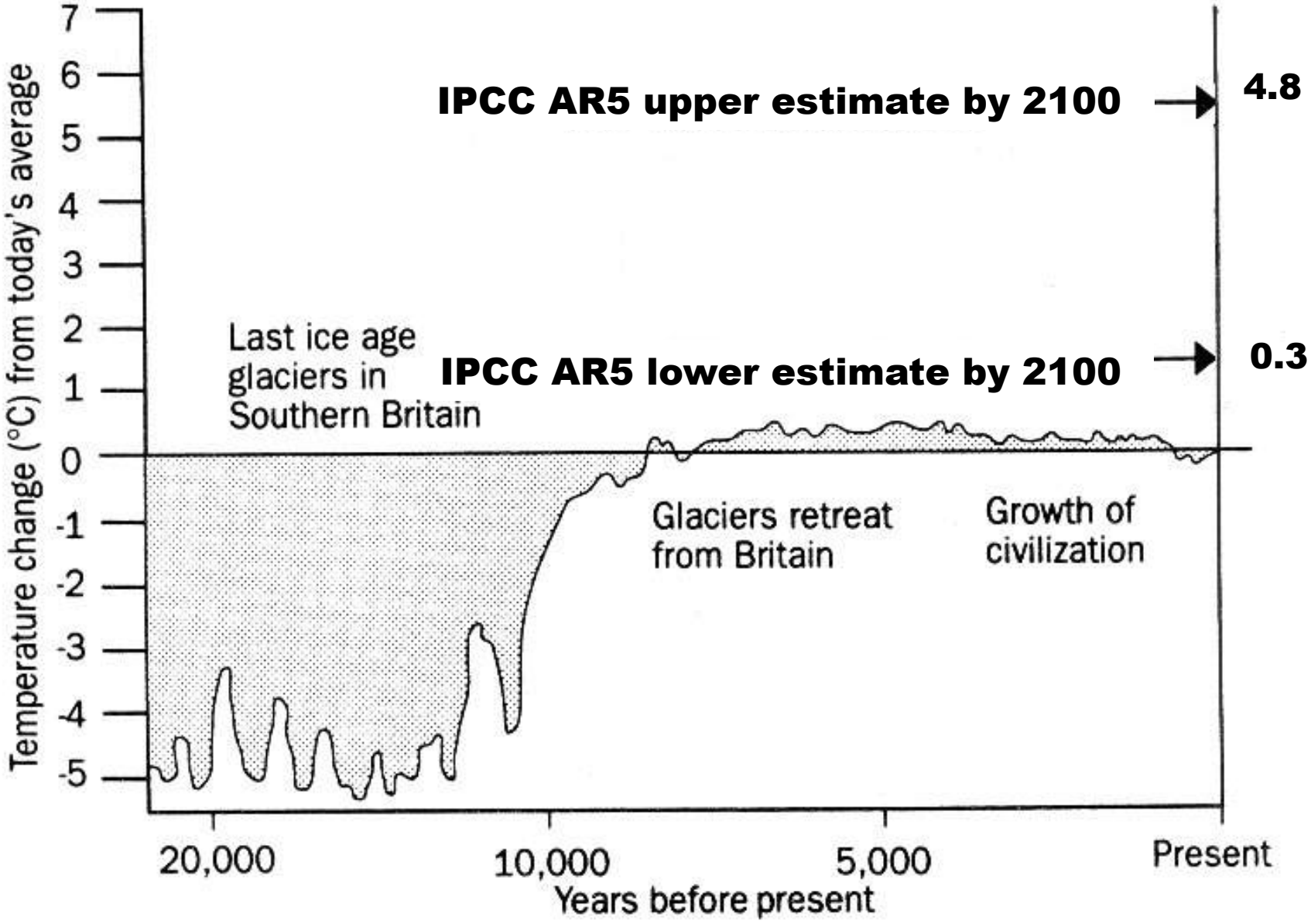
Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 for all scenarios

Global mean surface temperature change projections

(Increase over 21st century, from 1986-2005 to 2081-2100)

	mean	likely range
RCP2.6	1.0	0.3 to 1.7
RCP4.5	1.8	1.1 to 2.6
RCP6	2.2	1.4 to 3.1
RCP8.5	3.7	2.6 to 4.8

(°C)



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.

RCP2.6

RCP8.5

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

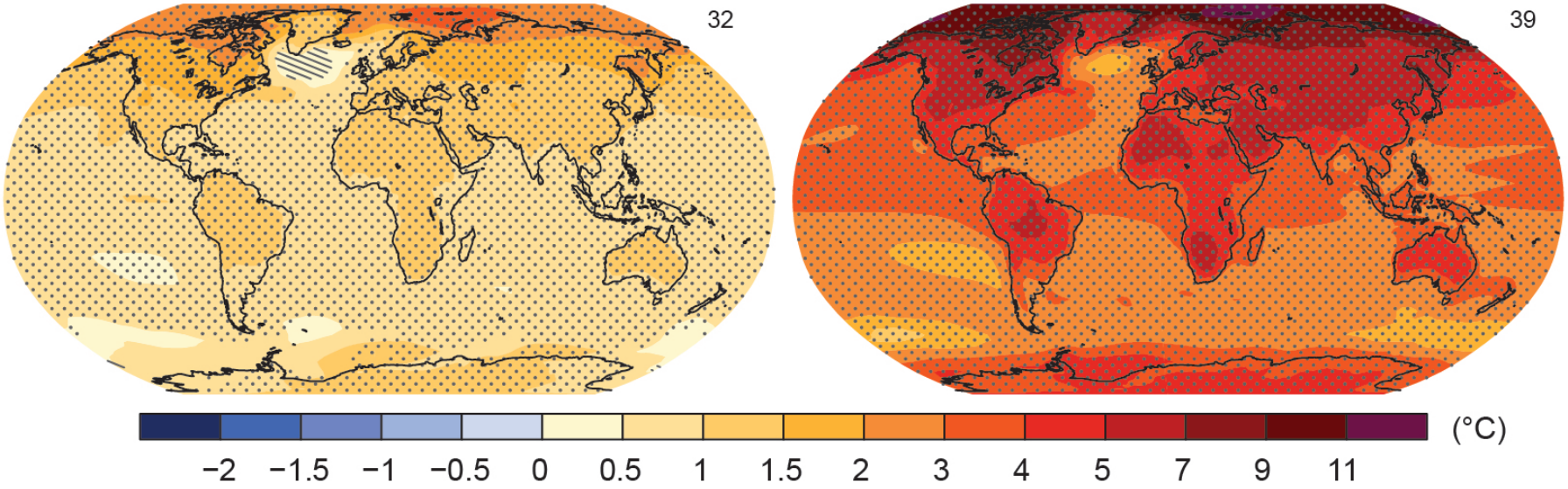
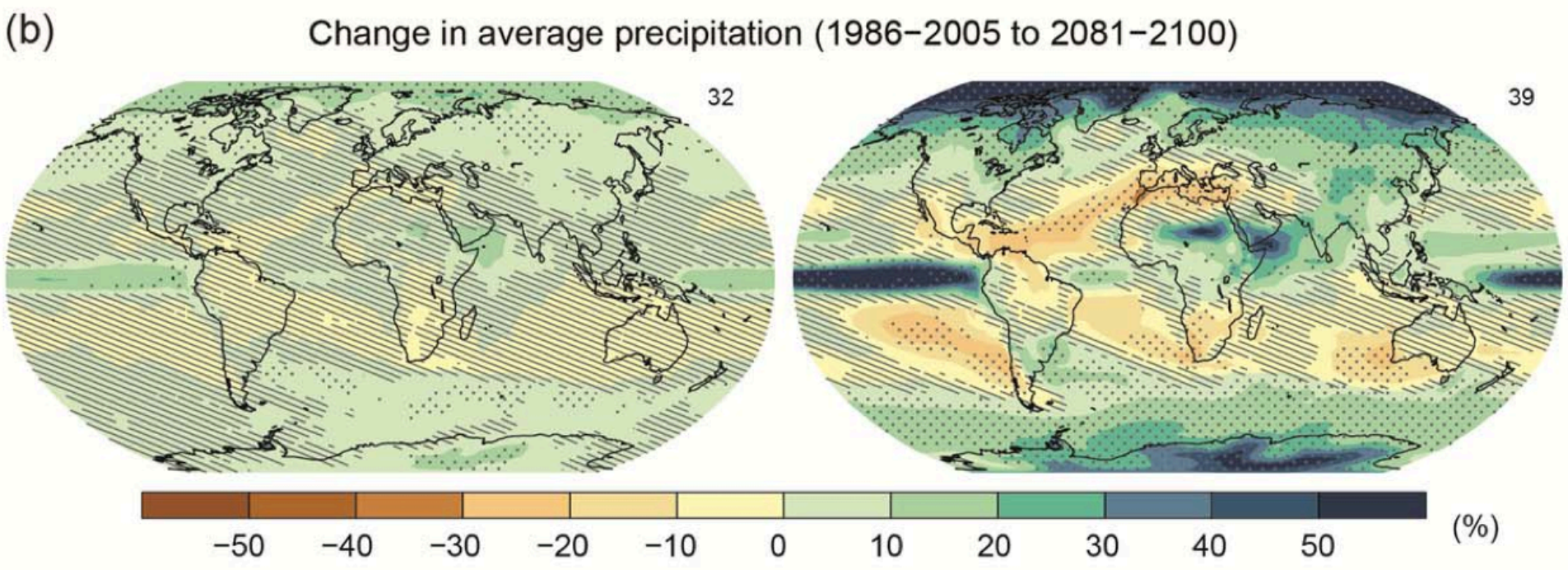


Fig. SPM.8

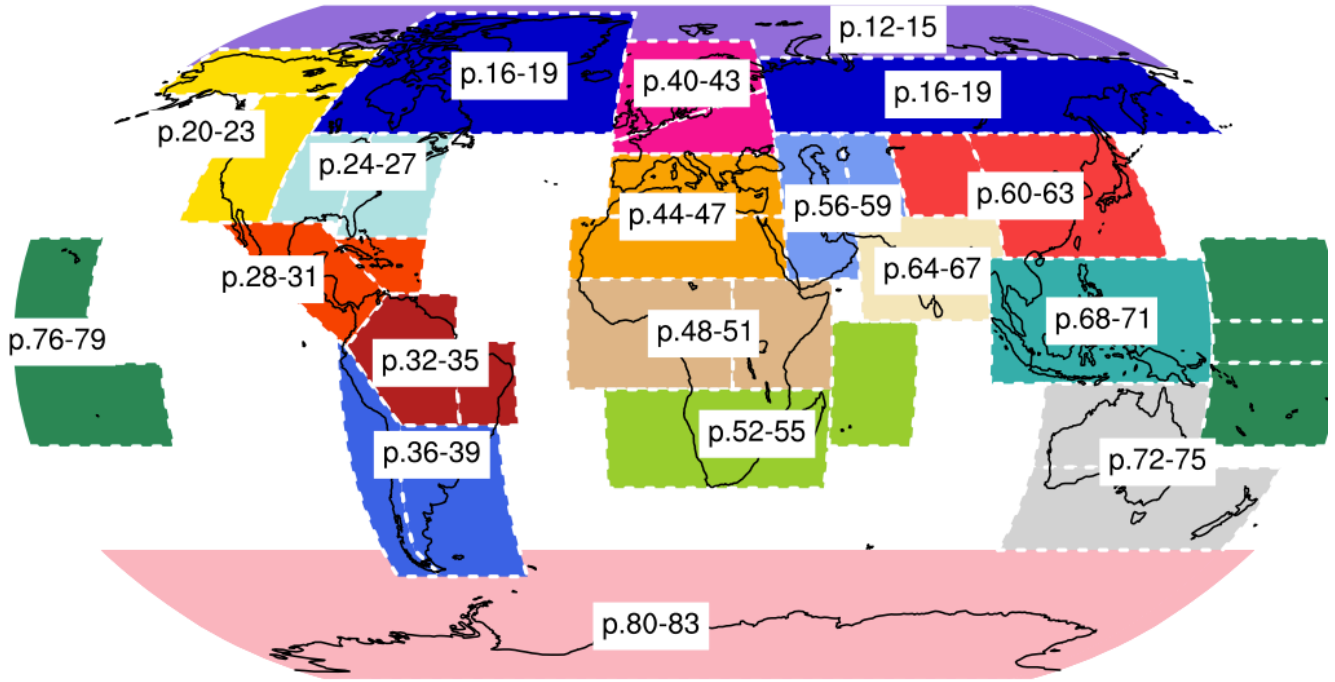
We have a choice.

Projected Change in Precipitation

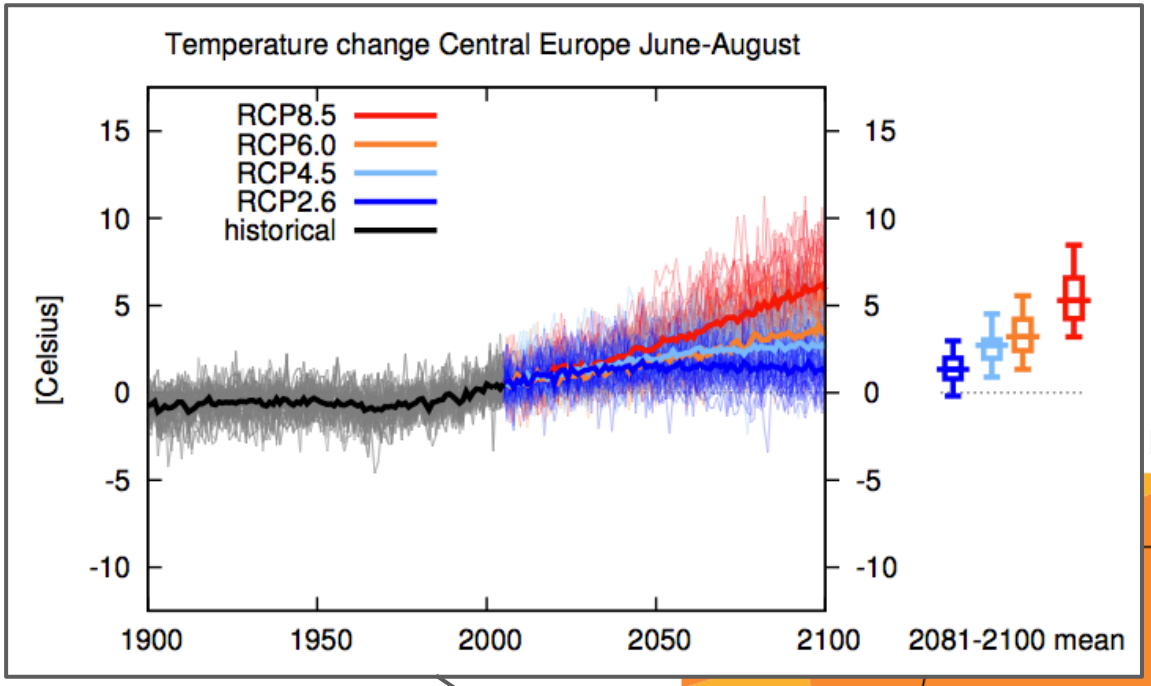


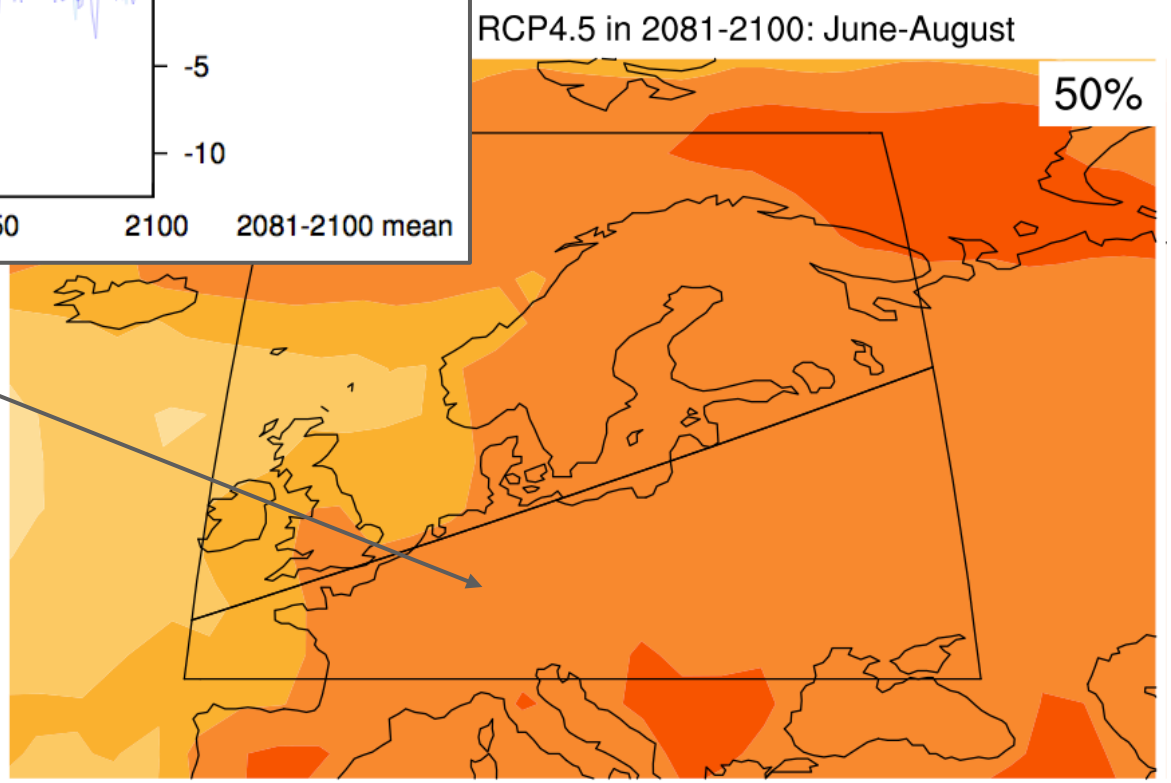
AR5 WGI Regional Atlas

- Addition to previous reports
- > 70 pages of maps, for RCP4.5 only:
  temperature and precipitation changes
  (winter & summer average climate, including model uncertainties)
- Other RCPs & seasons will be available as suppl. material later



Regional Atlas - «Central Europe», summer temp.

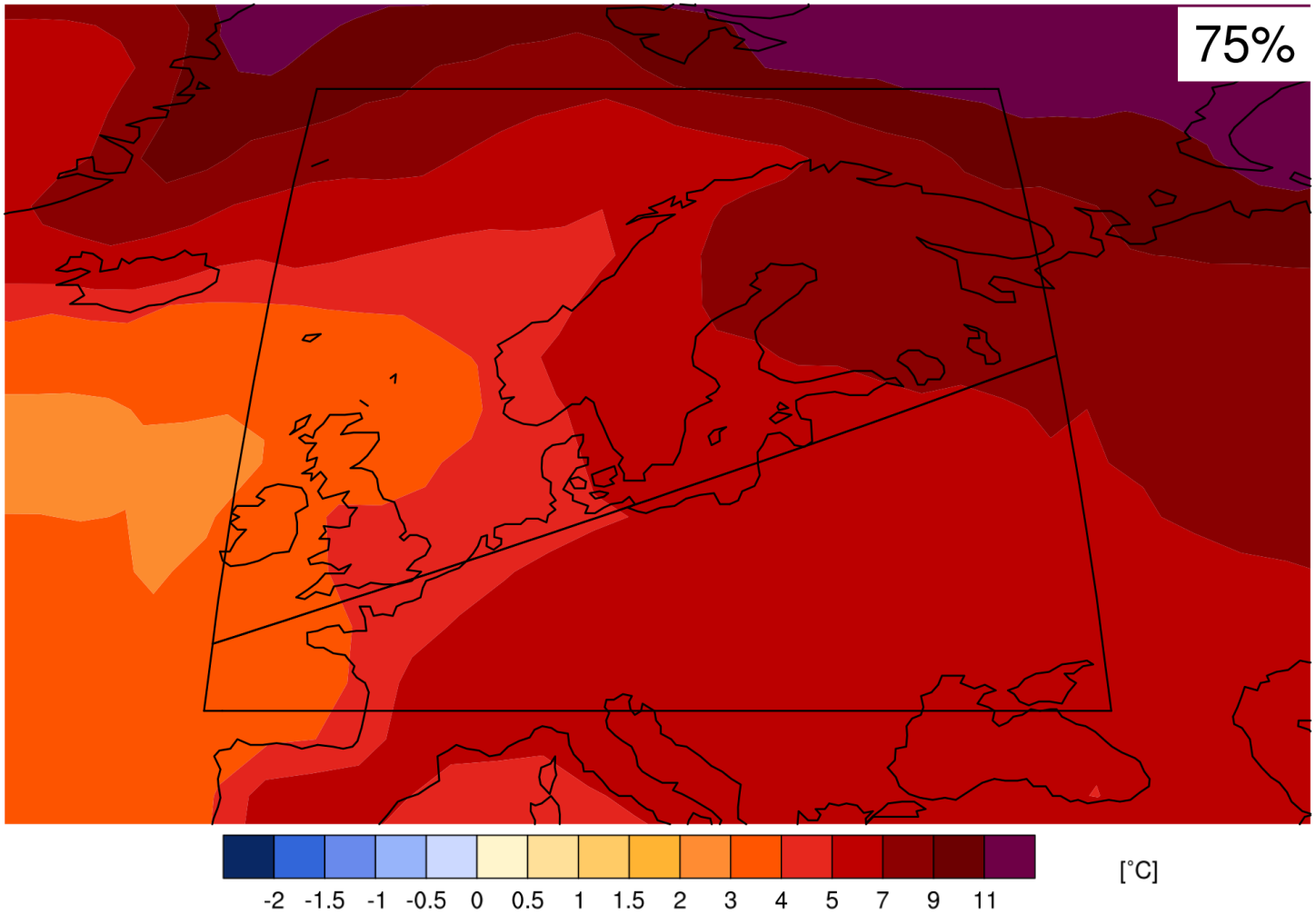




Median of multi-model distribution, average temp change JJA, 2081-2100

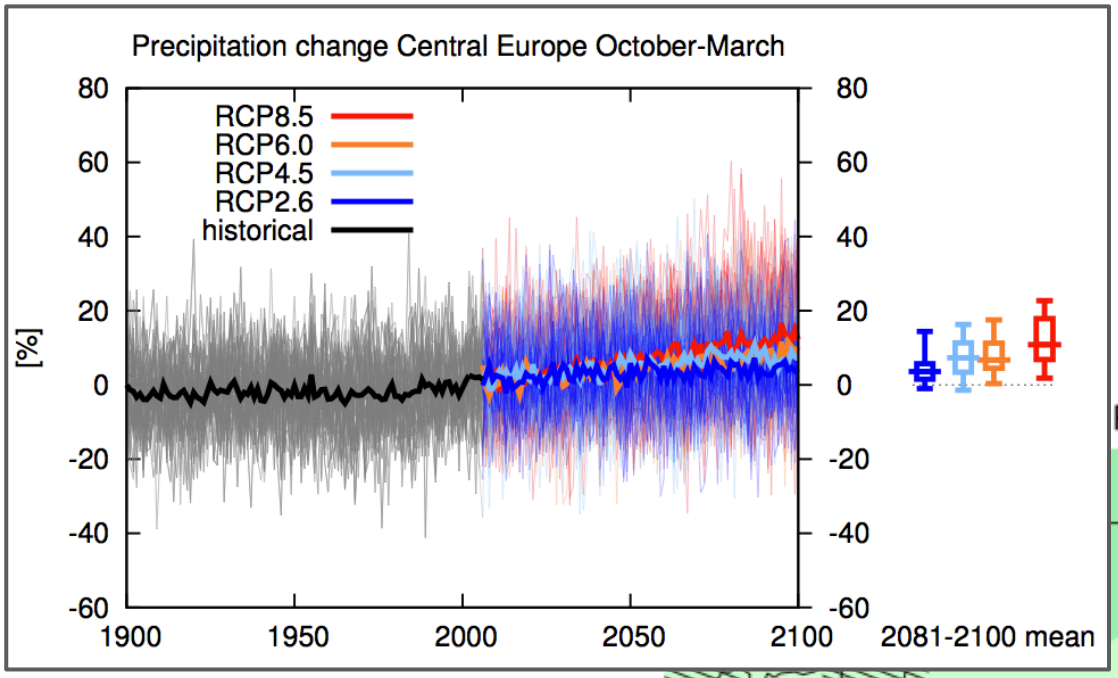
°C / 1985-2005

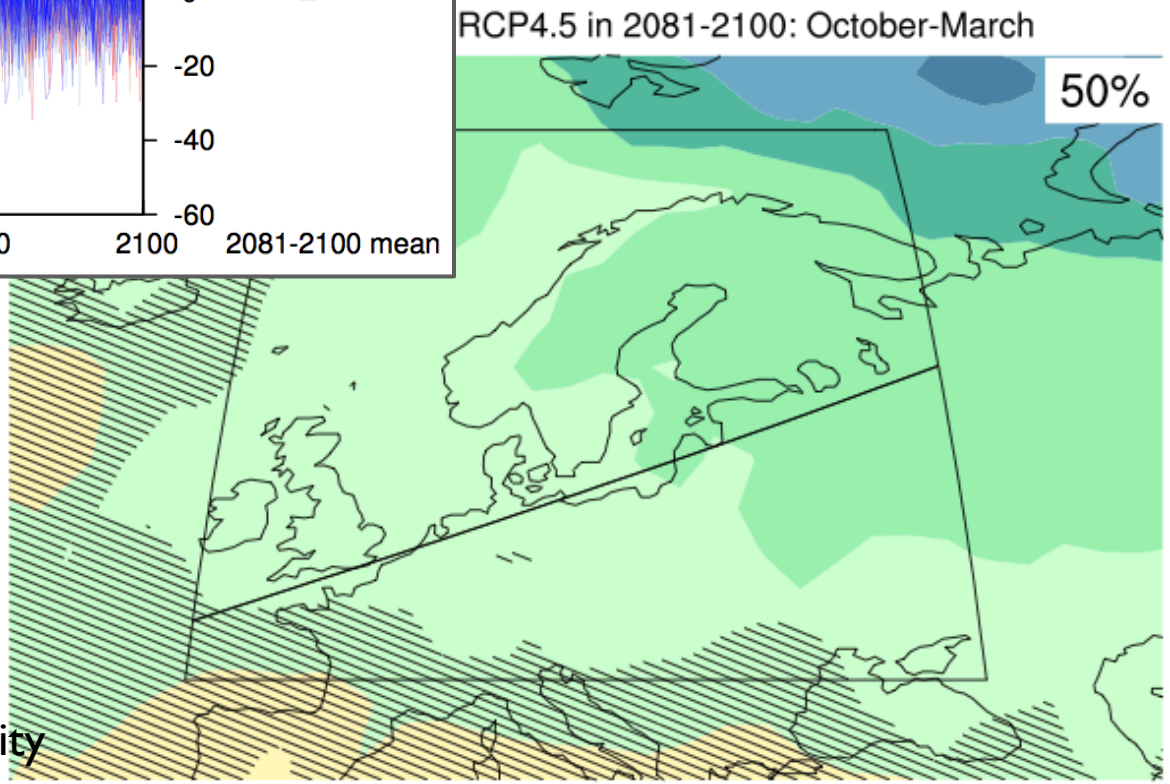
North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



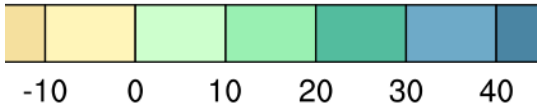
IPCC WG1 Fifth Assessment Report (Final Draft)

Regional Atlas - «Central Europe», precipitation



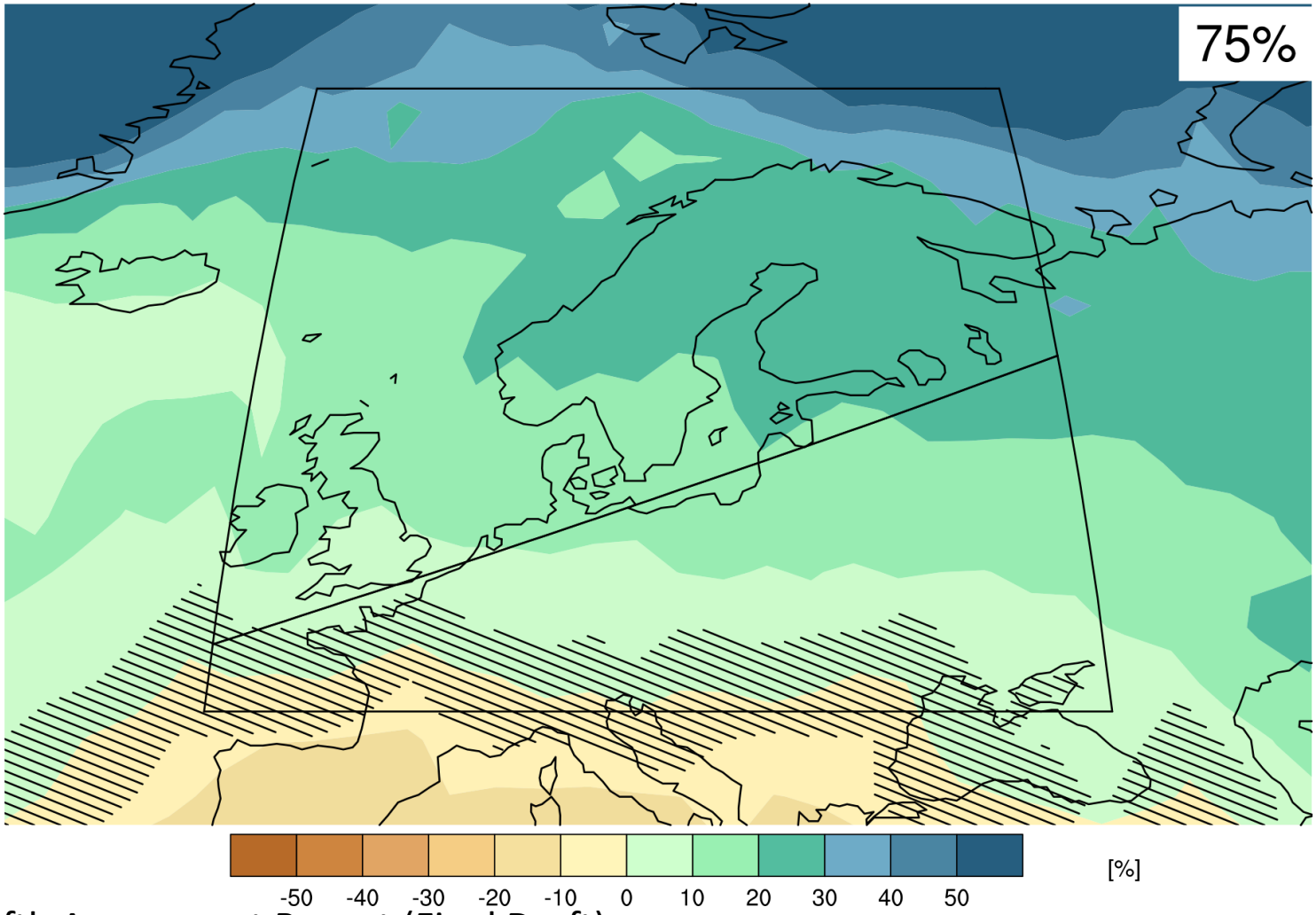


Median of multi-model distribution,
average over October-March,
2081-2100



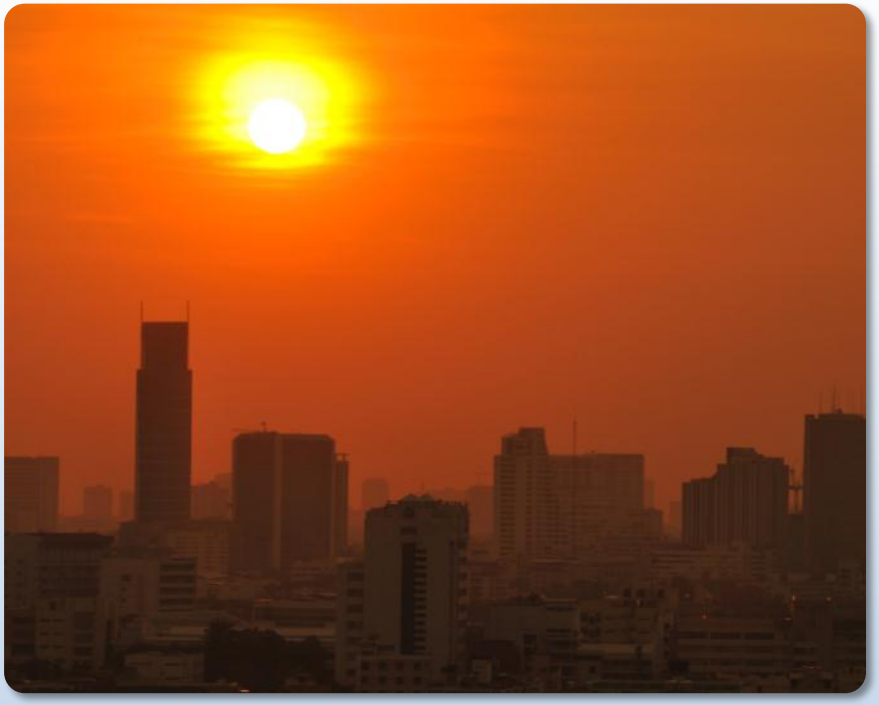
atching : change < present day variability
for 20 years periods)

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



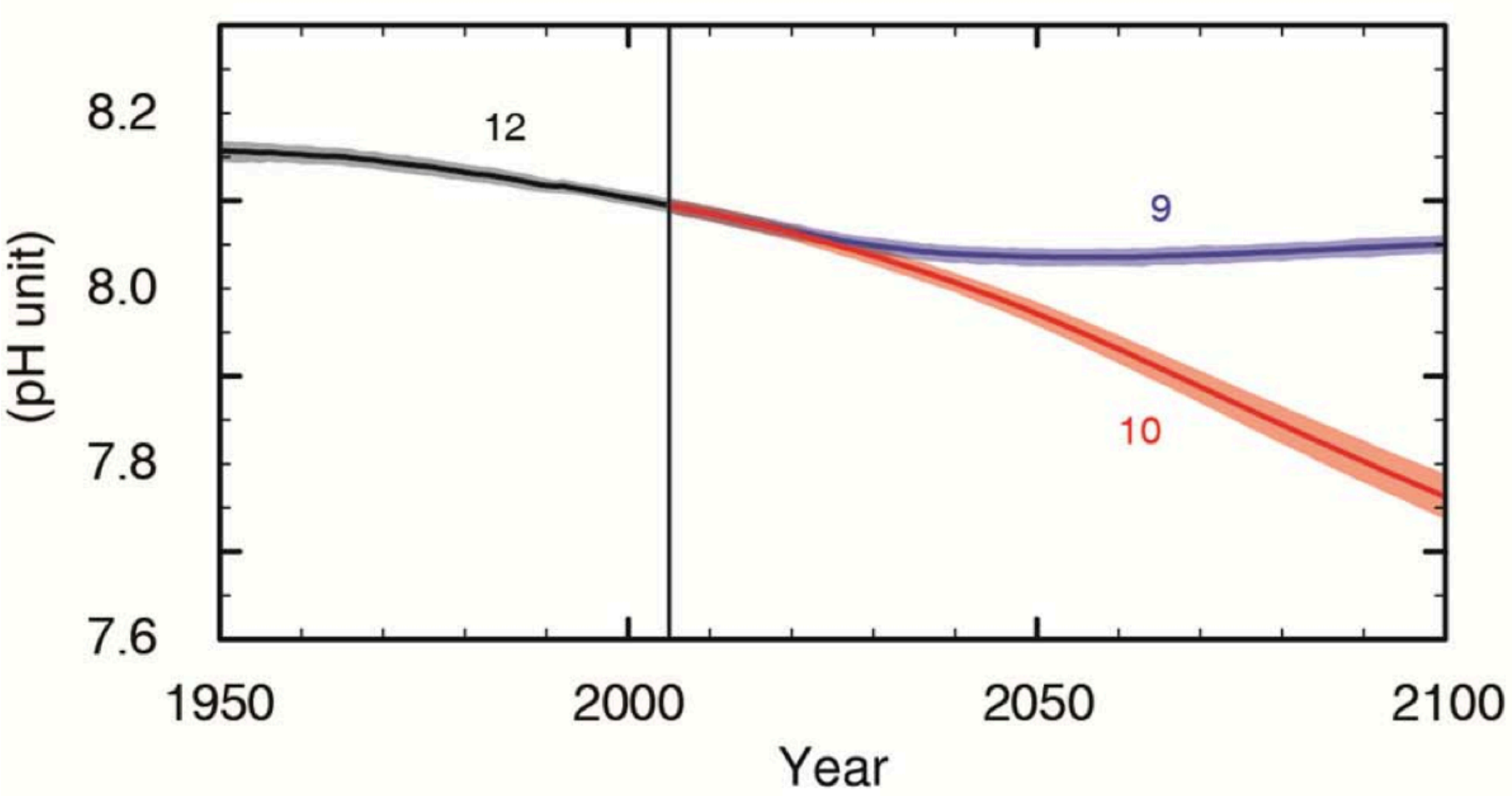
IPCC WG1 Fifth Assessment Report (Final Draft)

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



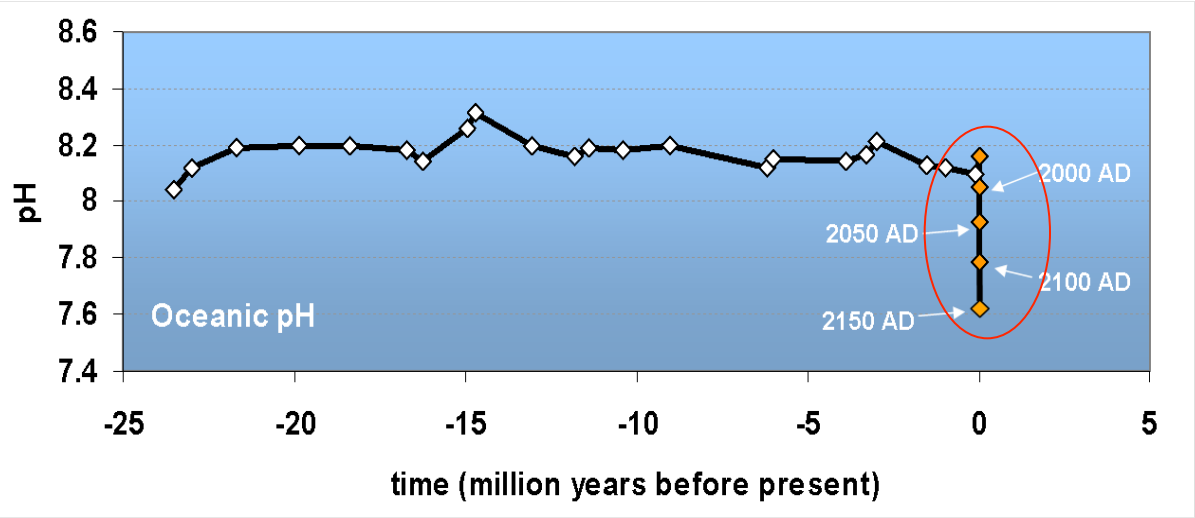
There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes

Ocean Acidification, for RCP 2.6 (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

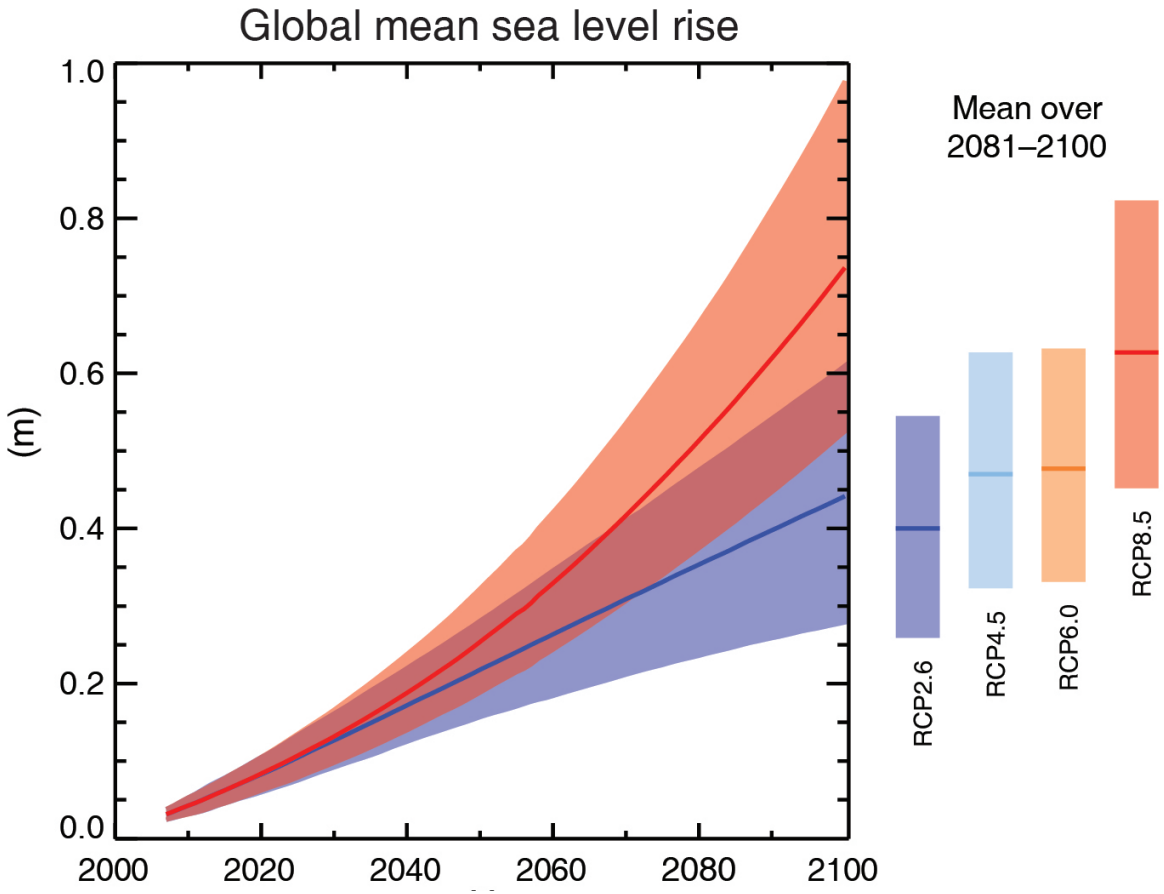


Fig. SPM.9

RCP2.6 (2081-2100), *likely* range: **26 to 55 cm**

RCP8.5 (in 2100), *likely* range: **52 to 98 cm**

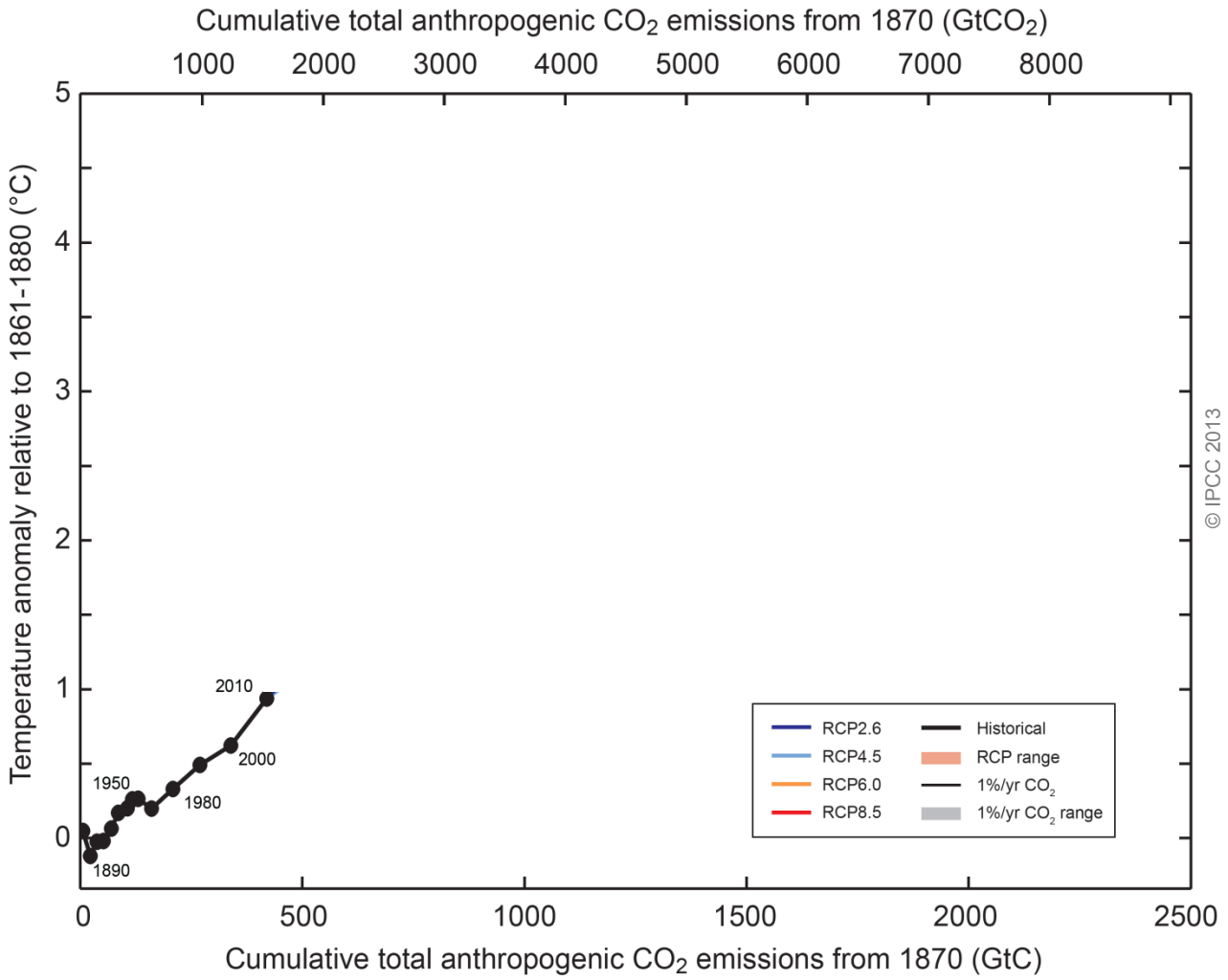


Fig. SPM.10

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

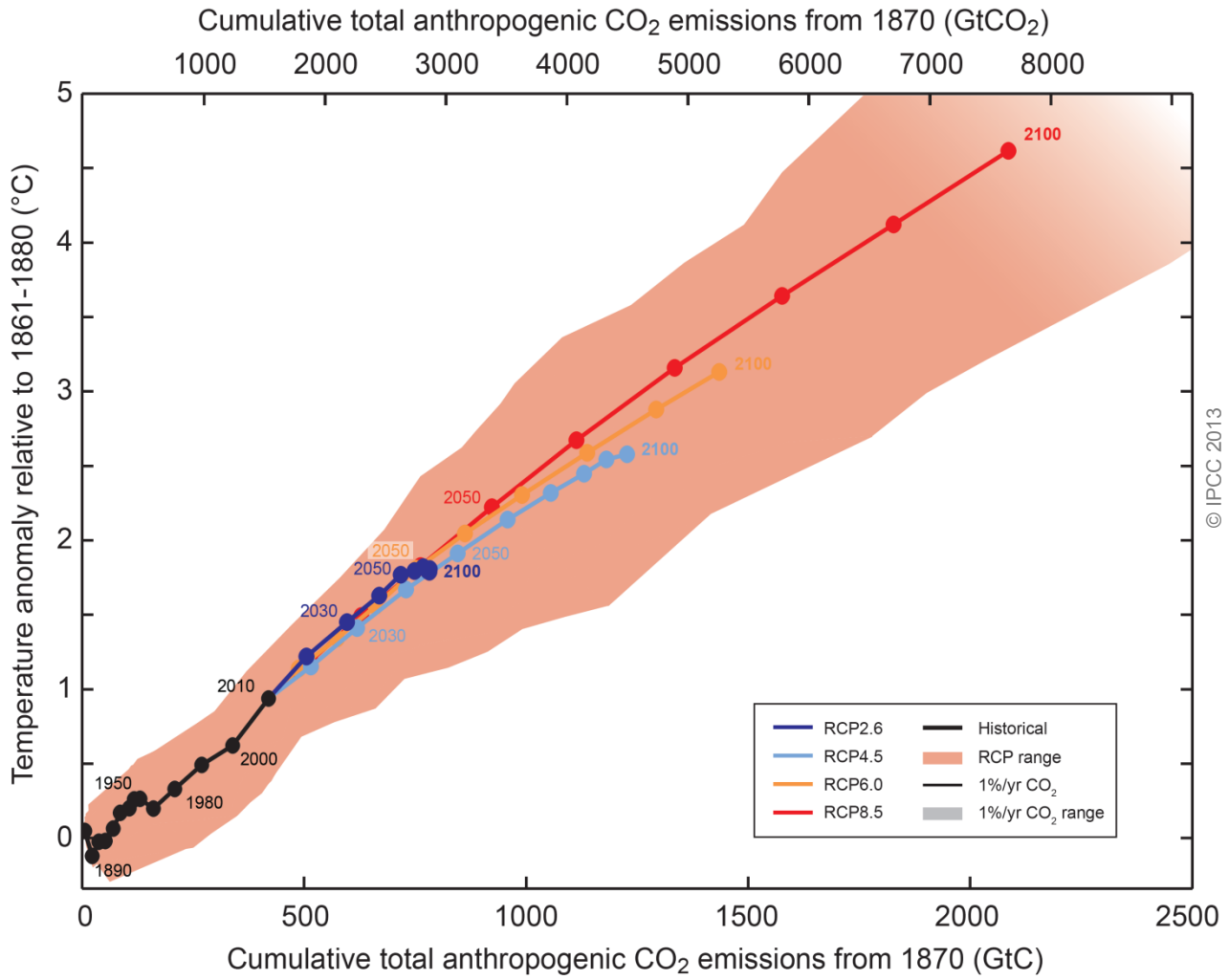


Fig. SPM.10

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

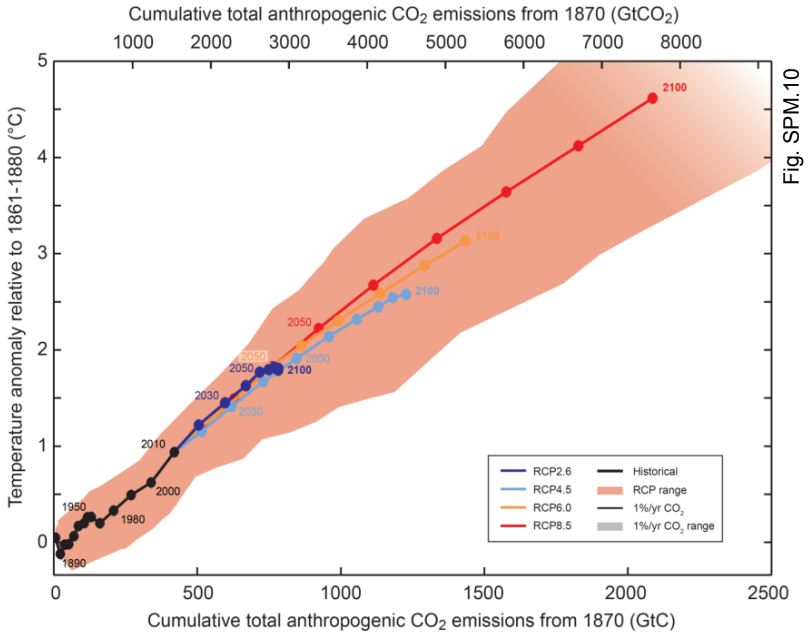
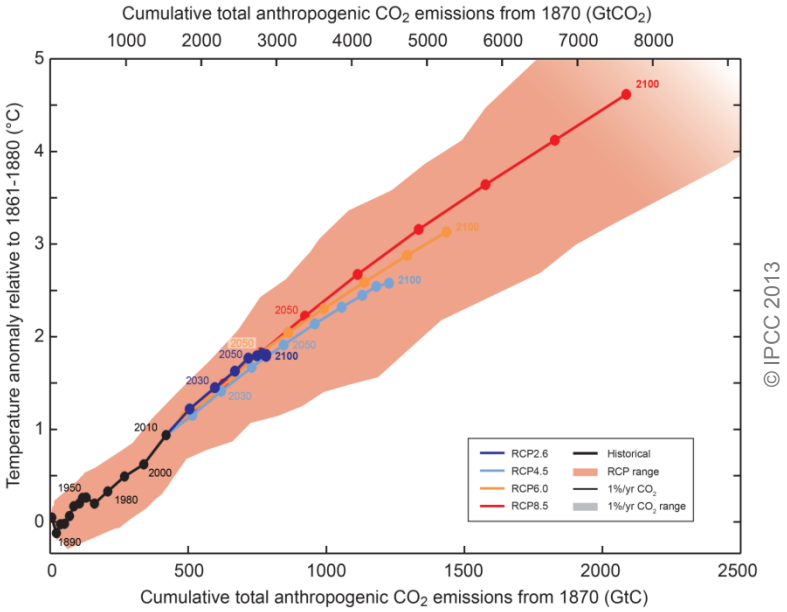


Fig. SPM.10

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

$\Delta T_{(1850\text{-}1900 \text{ to } 2100)}$	**Likelihood**	**Scenarios**
> 1.5°C	*likely*	RCP4.5, RCP6.0, RCP8.5
> 2°C	*likely*	RCP6.0, RCP8.5
> 2°C	*more likely than not*	RCP4.5



Limiting warming to *likely* less than 2°C since 1861-1880 requires cumulative CO_2 emissions to stay below 1000 GtC. Until 2011, over 50% of this amount has been emitted.

Accounting for other forcings, the upper amount of cumulative CO_2 emissions is 800 GtC; over 60% have been emitted by 2011.

RCP2.6 RCP8.5

Change in average precipitation (1986–2005 to 2081–2100)

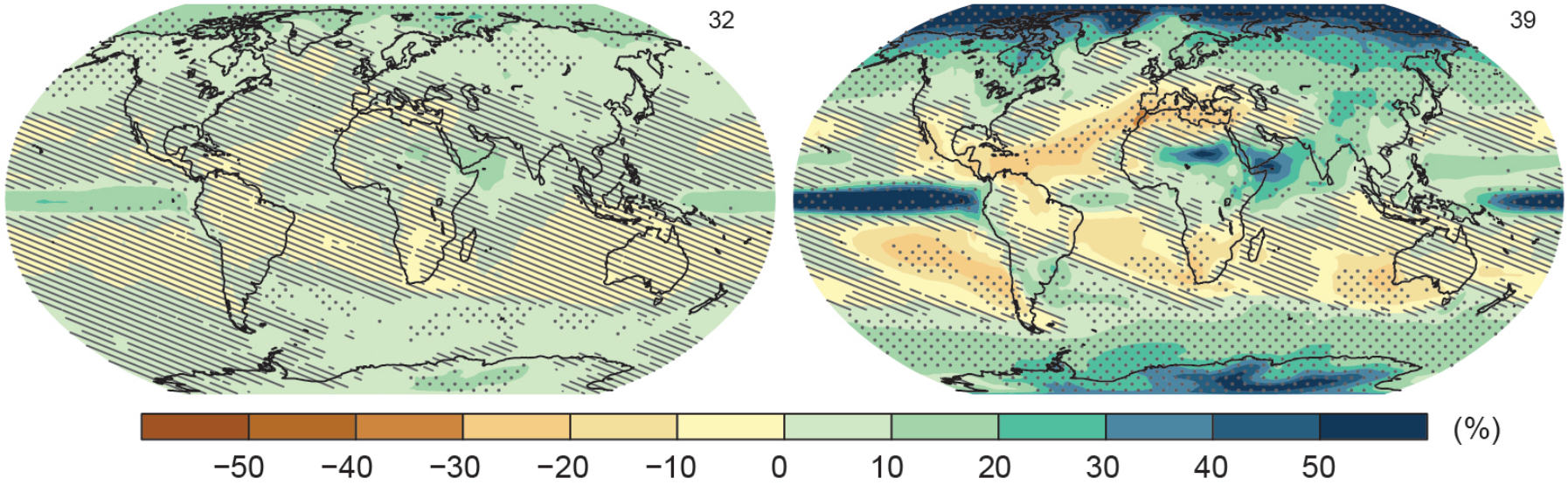
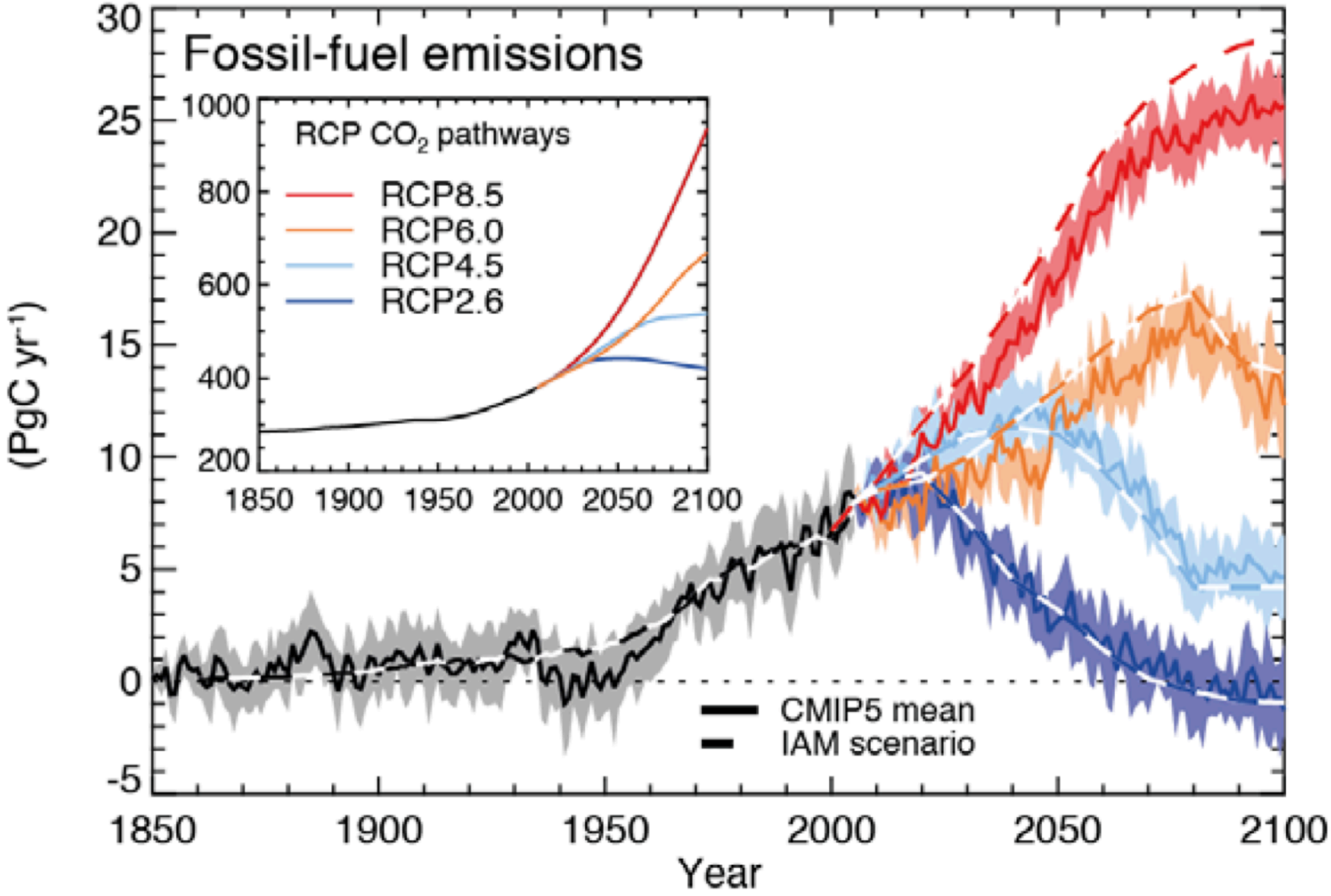


Fig. SPM.8

We have a choice.

Compatible fossil fuel emissions simulated by the CMIP5 models for the four RCP scenarios



Useful links:

- www.ipcc.ch : IPCC
- www.climatechange2013.org : IPCC WGI AR5
- www.climate.be/vanyp : my slides and other documents
- www.skepticalscience.com: excellent responses to contrarians arguments

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