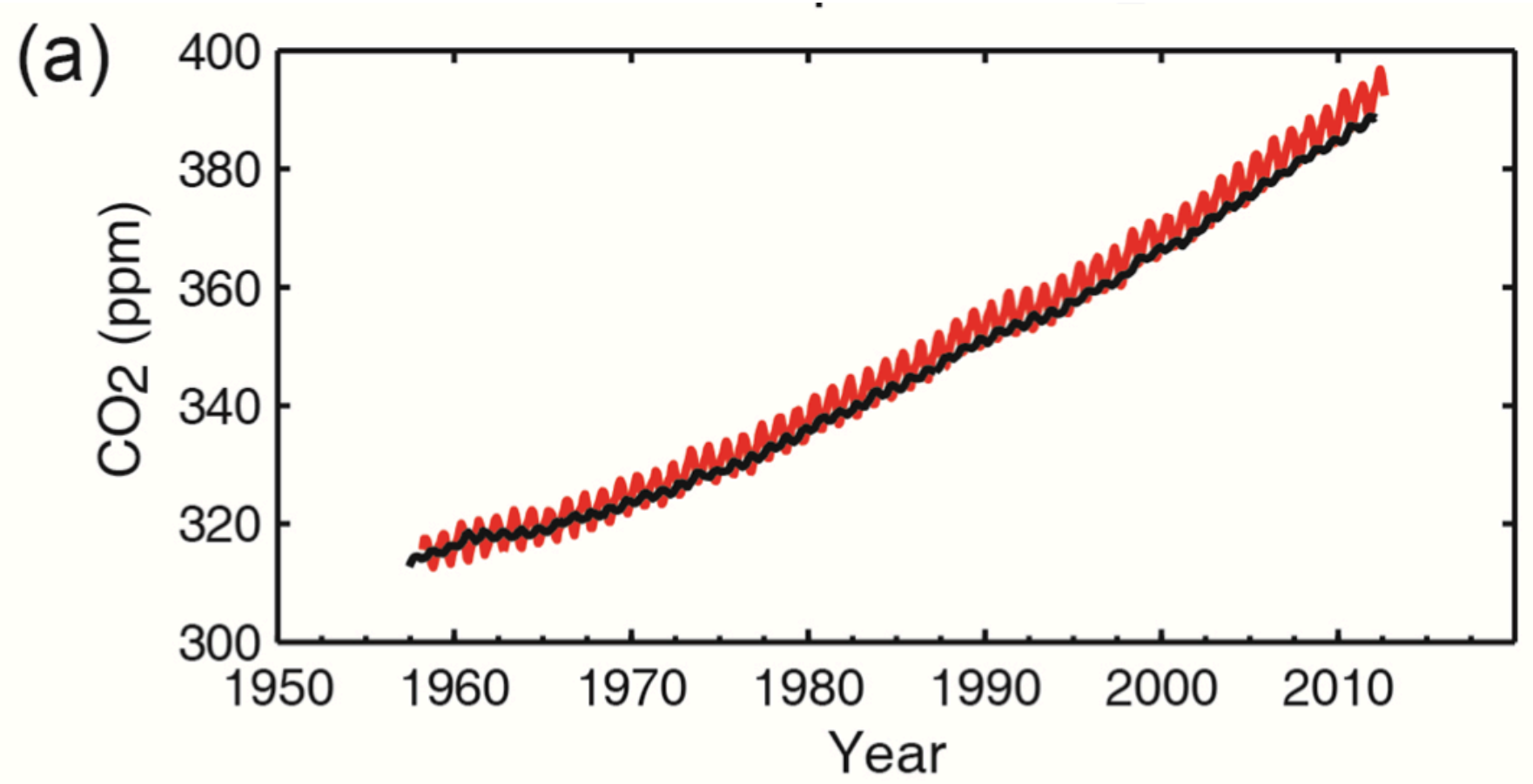
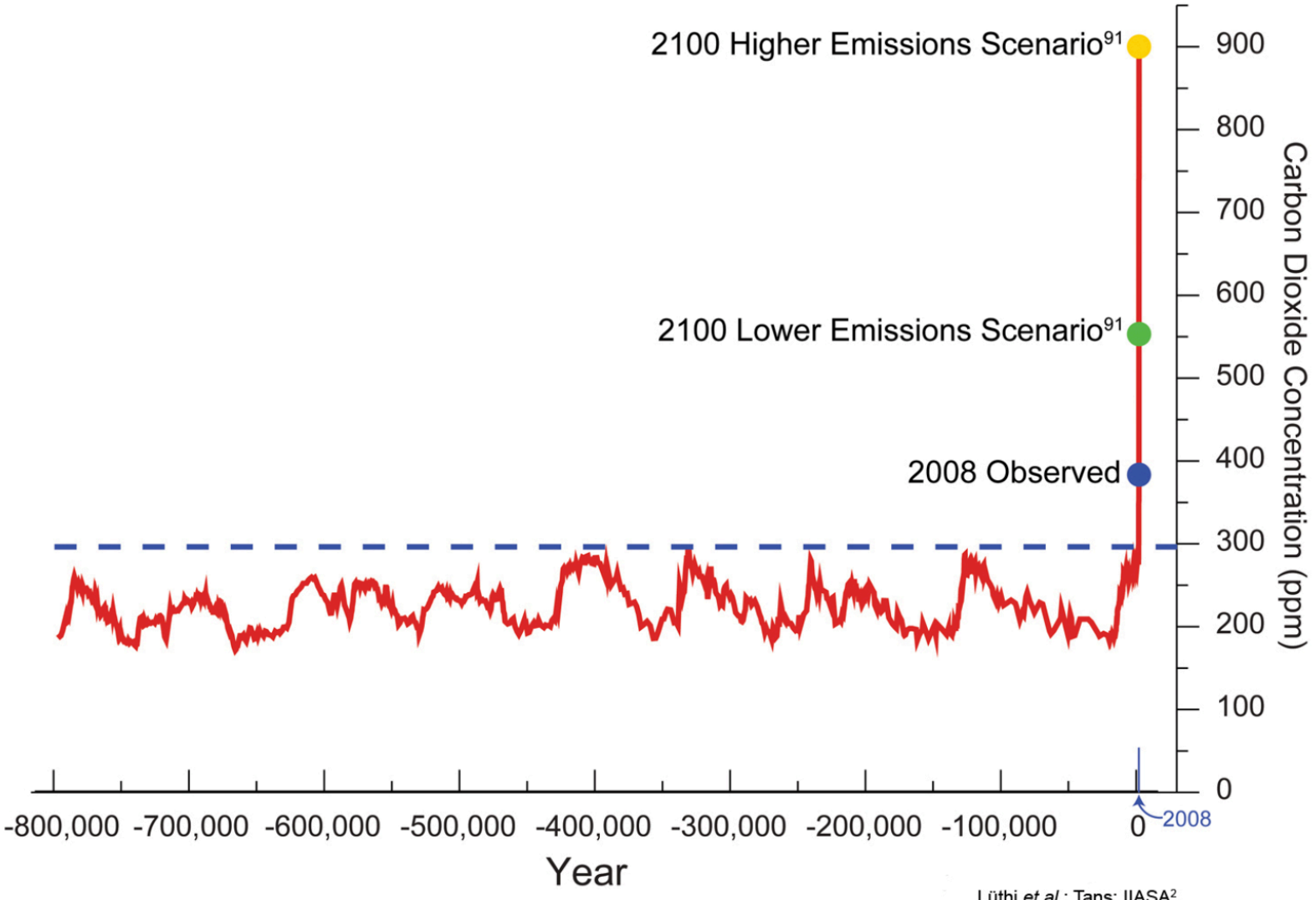
Atmospheric CO_2 concentration



AR5 WGI SPM - Approved version / subject to final copyedit

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

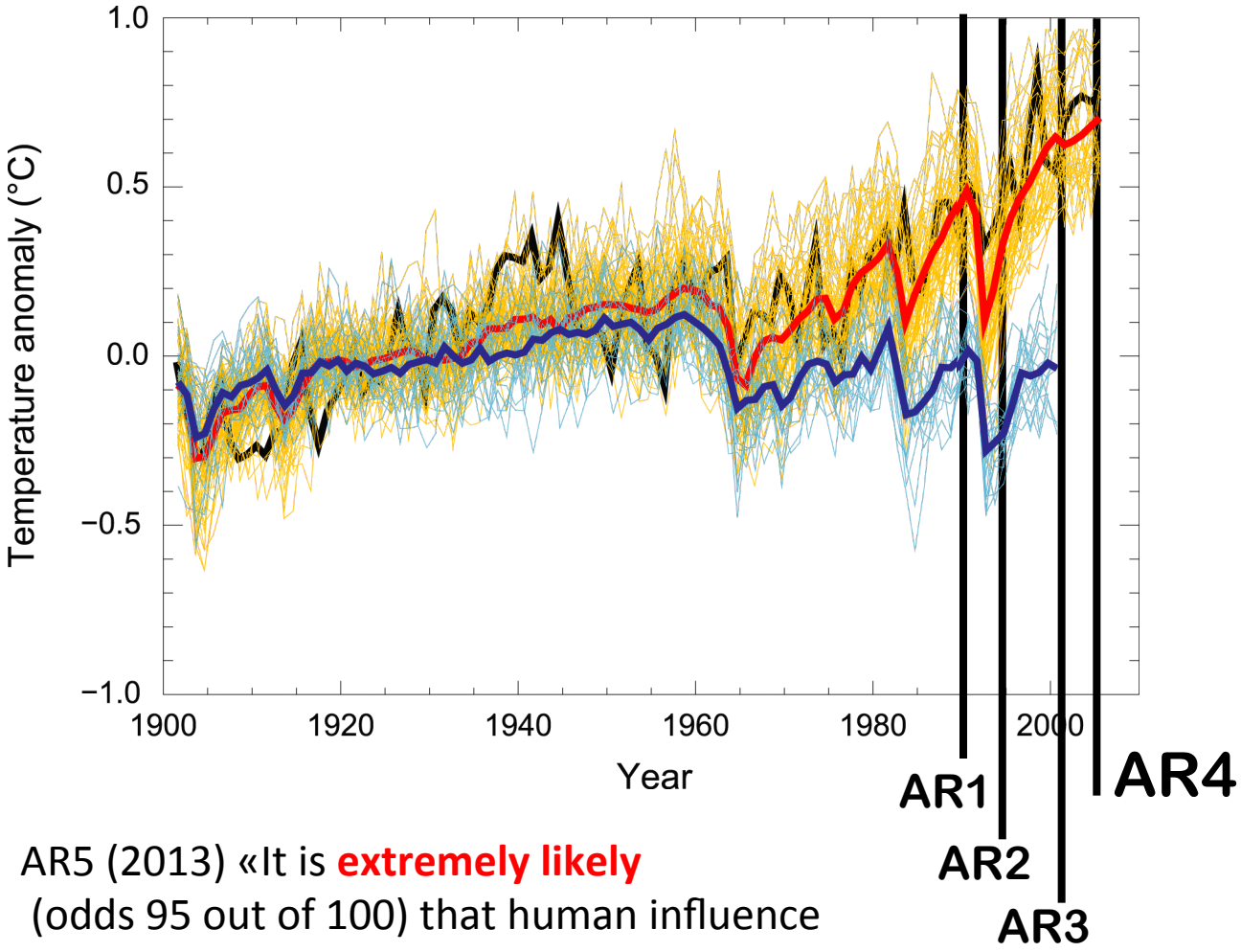
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

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

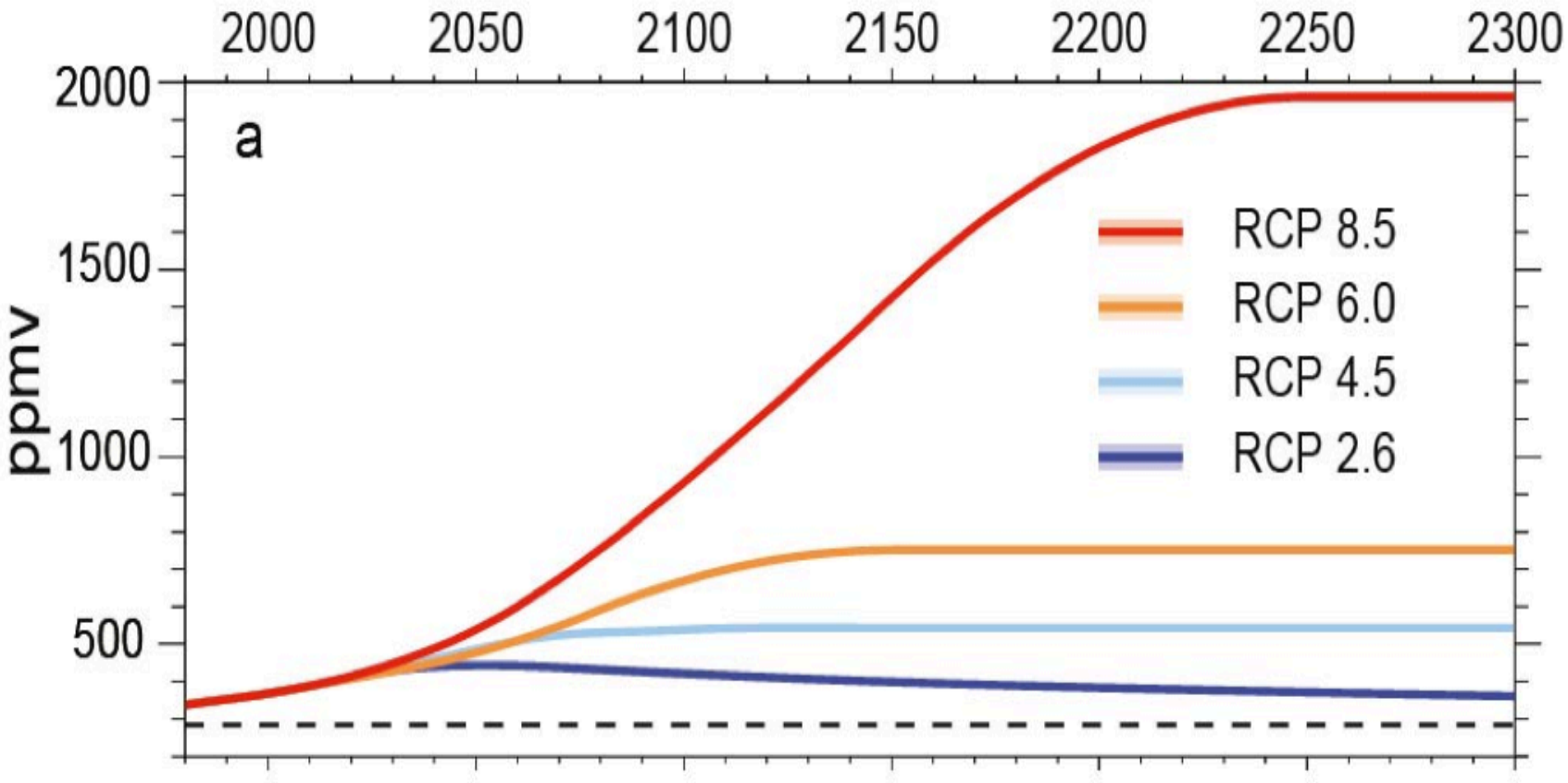
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

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



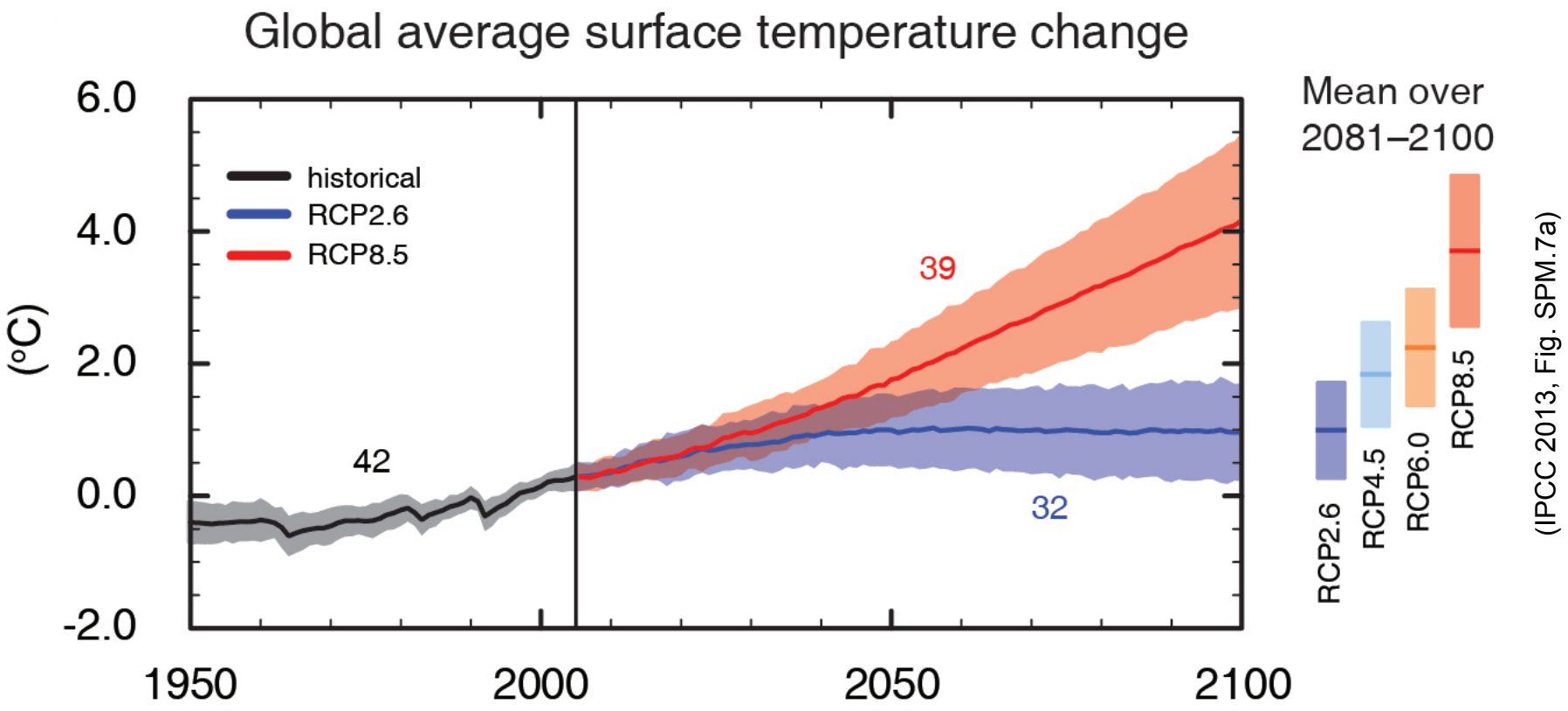
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

Atmospheric CO_2 concentration

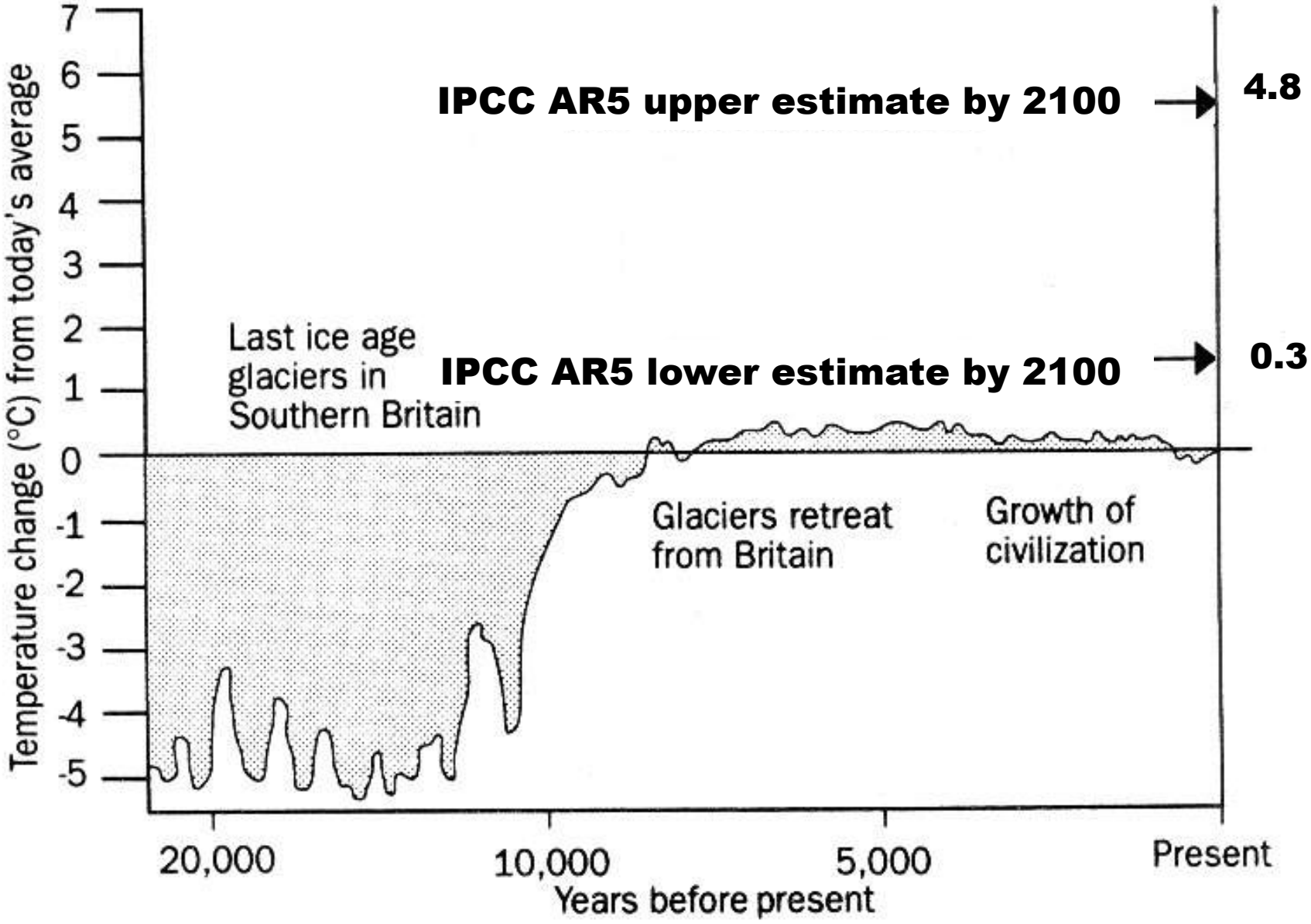


Most CMIP5 runs are based on the concentrations, but emissions-driven runs are available for RCP 8.5

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



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



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)

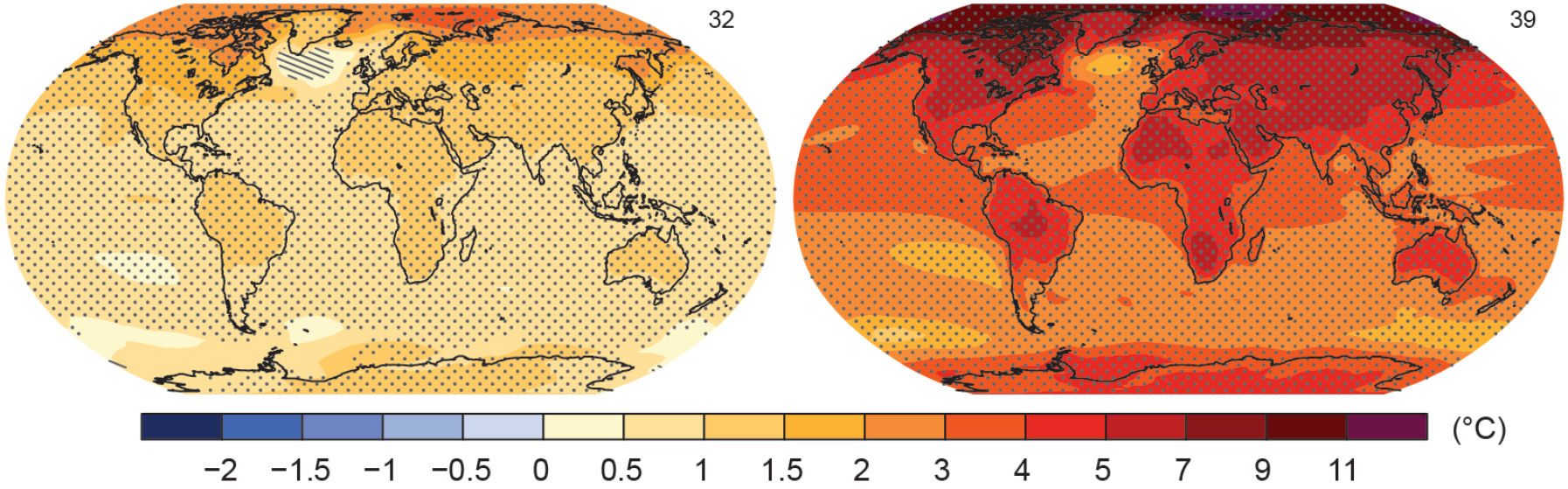
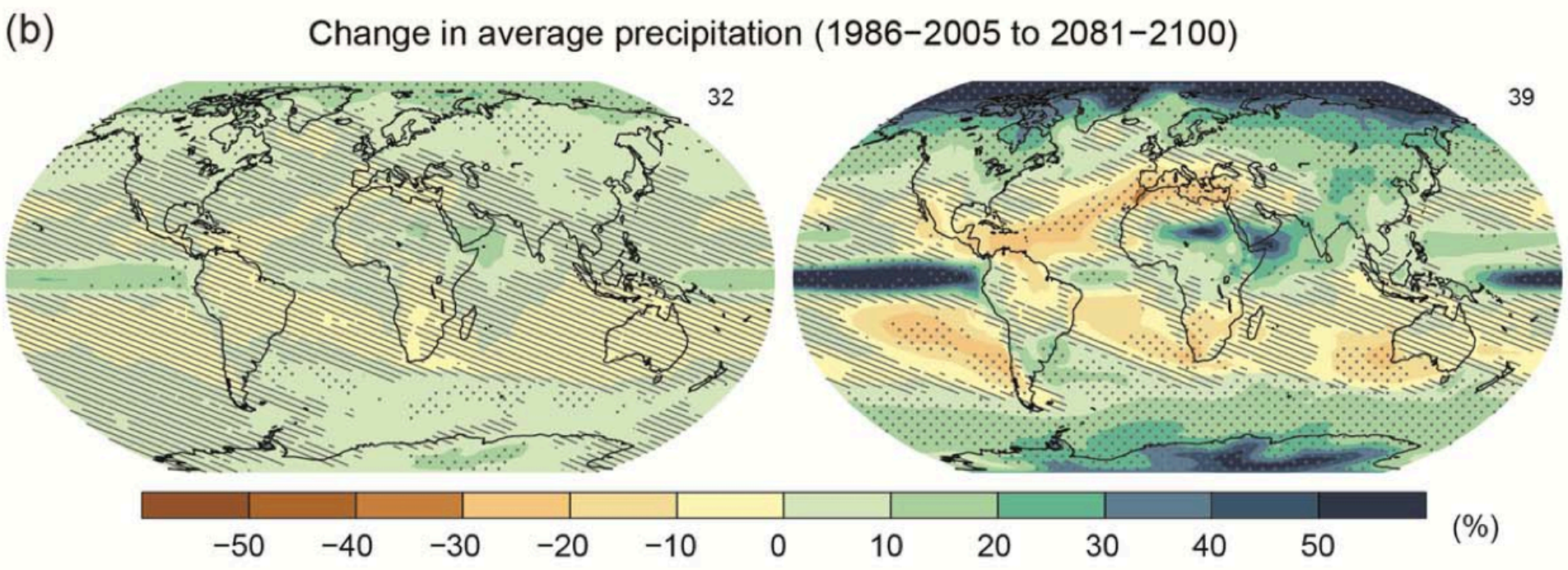


Fig. SPM.8

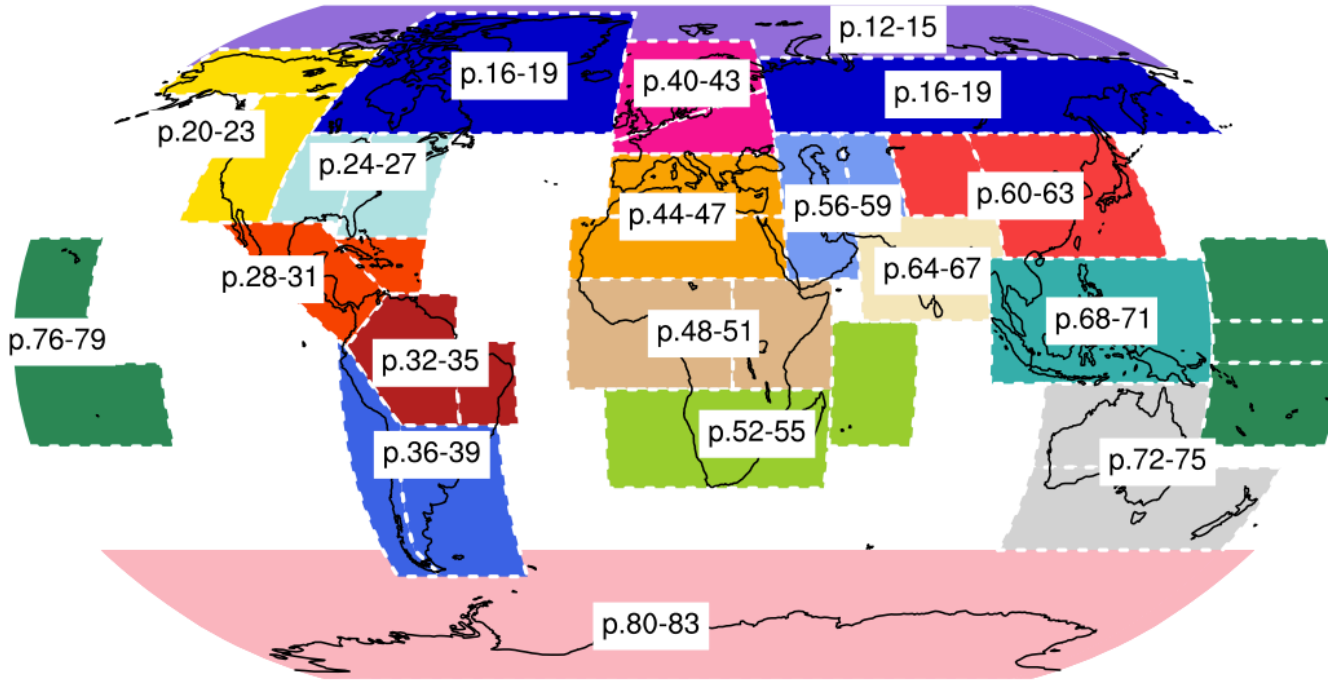
We have a choice.

Projected Change in Precipitation

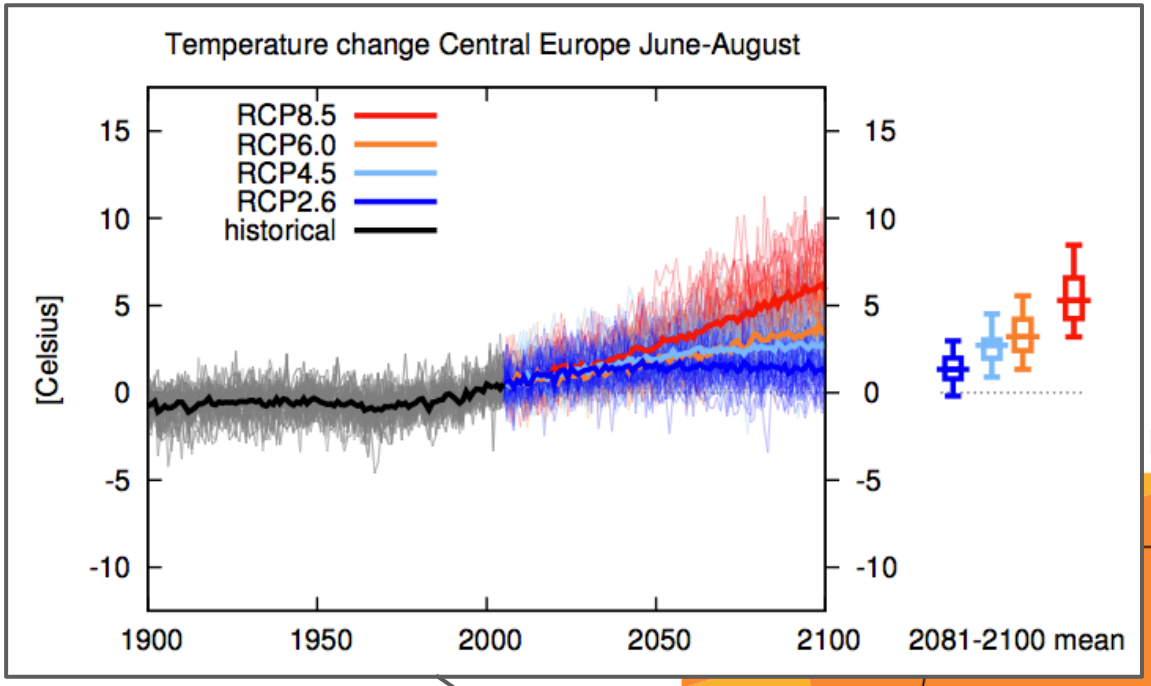


AR5 WGI Regional Atlas

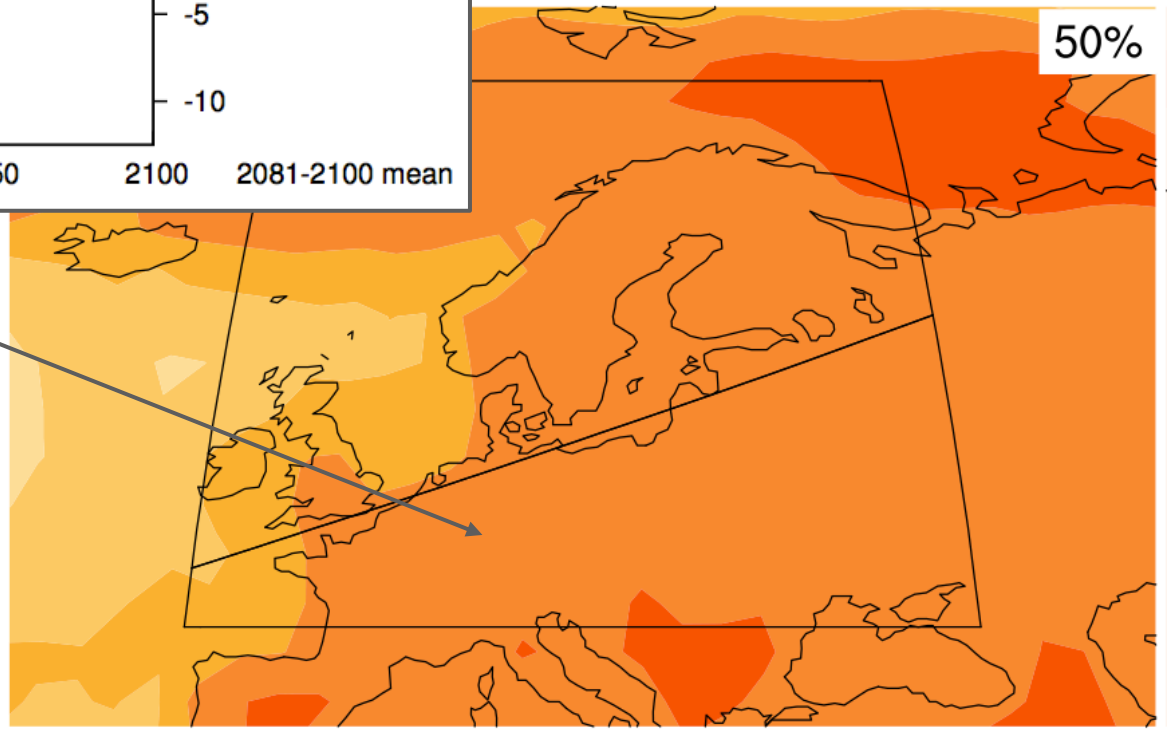
- Addition to previous reports
- > 70 pages of maps, for RCP4.5 only:
  temperature and precipitation changes
  (winter & summer average climate, including model uncertainties)
- Other RCPs & seasons will be available as suppl. material later



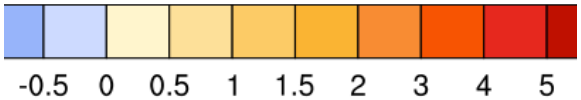
Regional Atlas - «Central Europe», summer temp.



RCP4.5 in 2081-2100: June-August

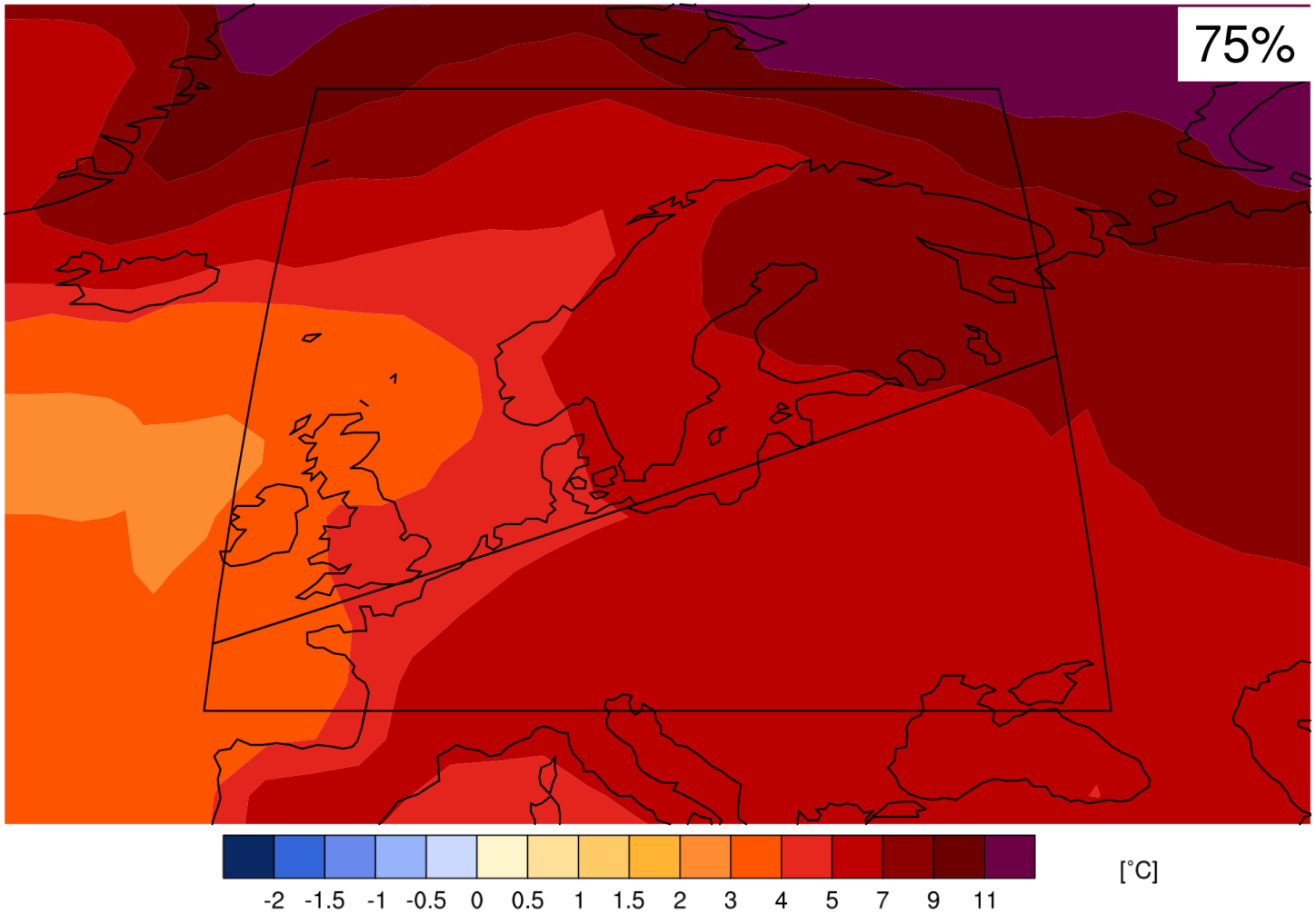


Median of multi-model distribution, average temp change JJA, 2081-2100



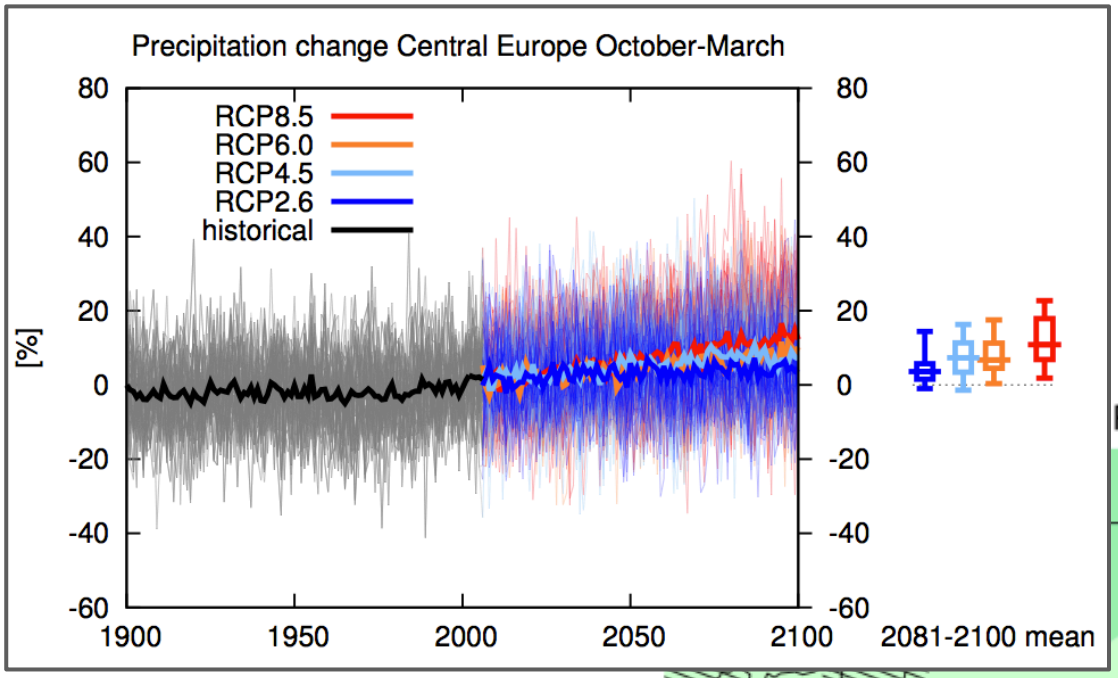
°C / 1985-2005

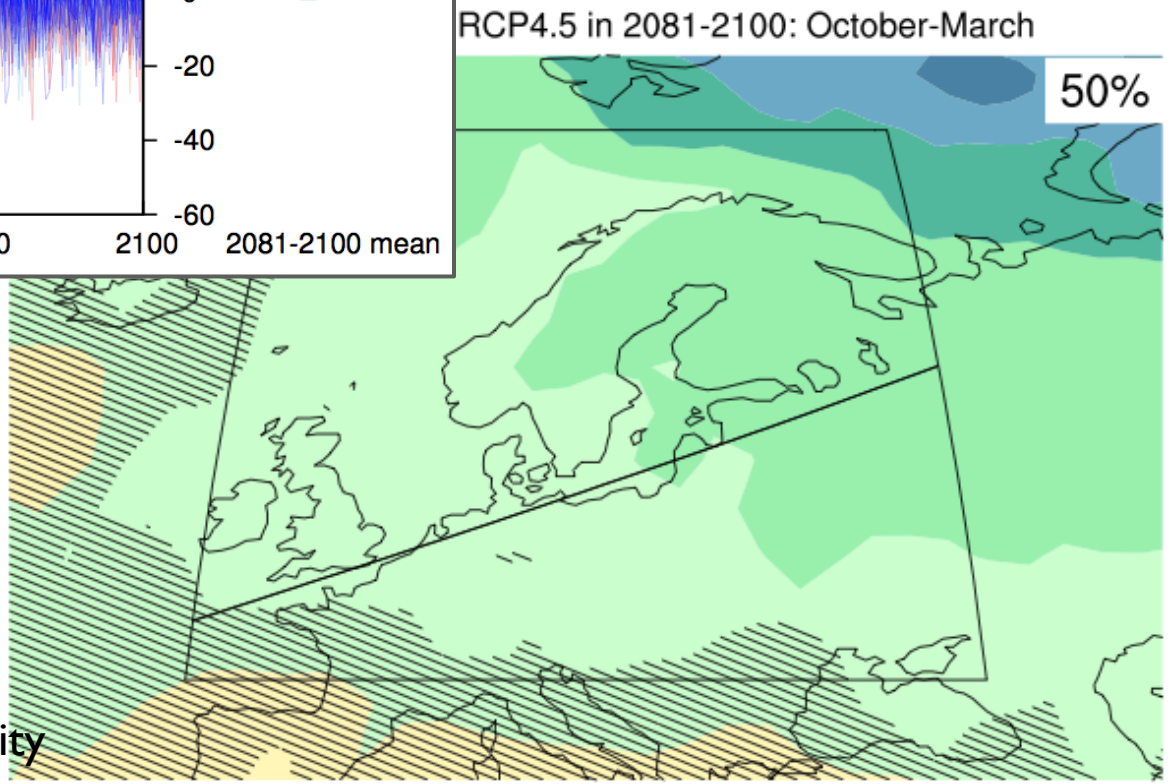
North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



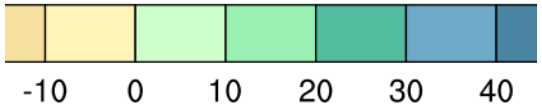
IPCC WG1 Fifth Assessment Report (Final Draft)

Regional Atlas - «Central Europe», precipitation



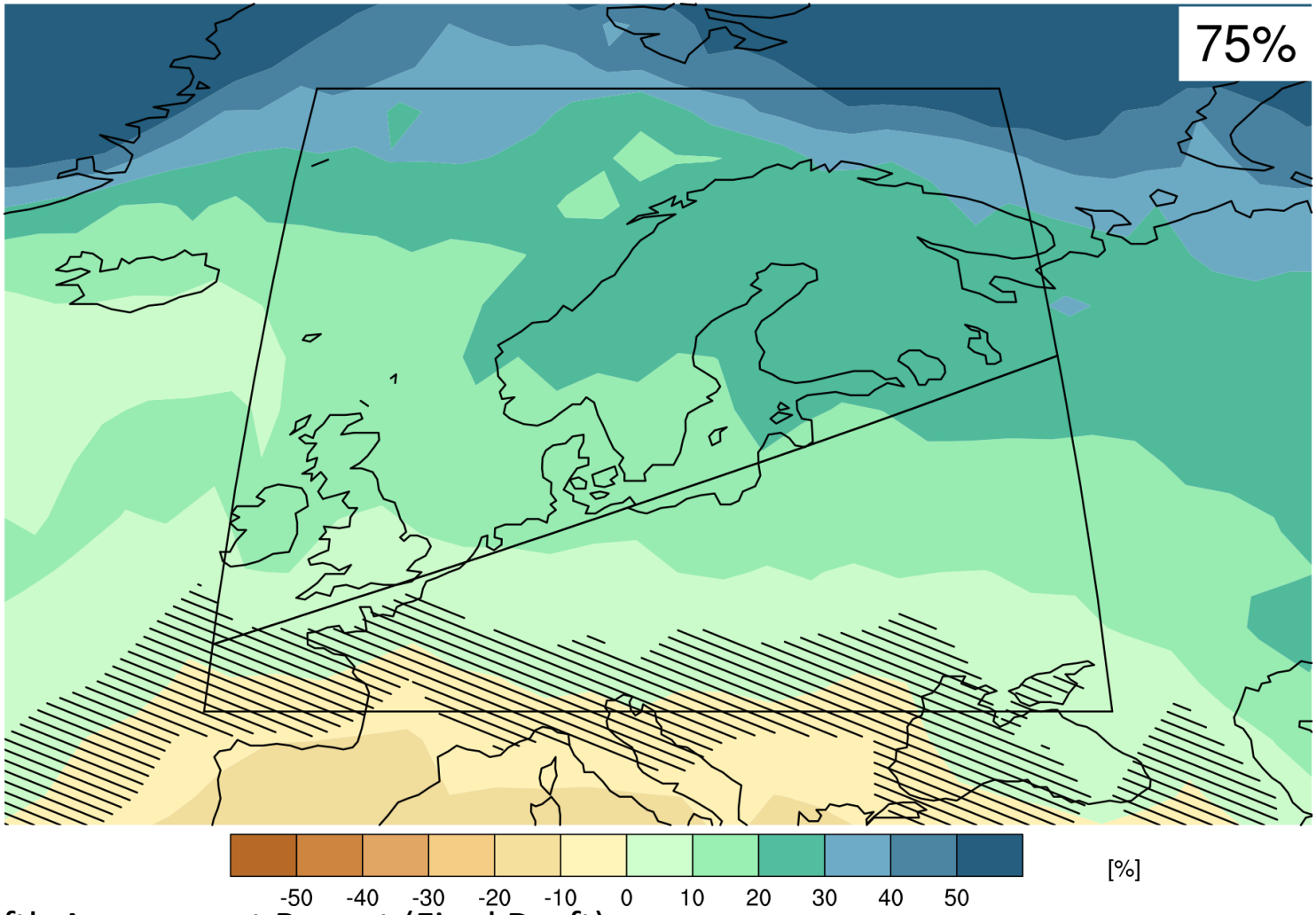


Median of multi-model distribution,
average over October-March,
2081-2100



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)



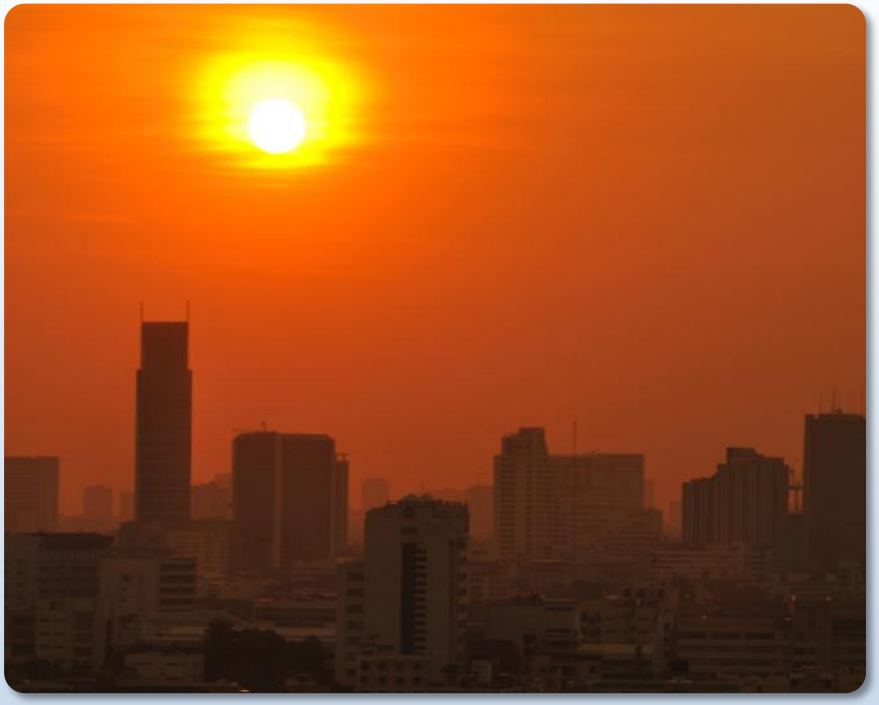
IPCC WG1 Fifth Assessment Report (Final Draft)

Extreme weather and climate events

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warmer and/or more frequent hot days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warm spells/heat waves. Frequency and/or duration increases over most land areas	***Medium confidence*** on a global scale Likely in large parts of Europe, Asia and Australia	***Likely***	Not formally assessed	***Very likely***
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	*Likely more land areas with increases than decreases*	***Medium confidence***	*Likely* over many land areas	***Very likely*** over most of the mid-latitude land masses and over wet tropical regions
Increases in intensity and/or duration of drought	***Low confidence*** on a global scale Likely changes in some regions	***Low confidence***	*Low confidence*	***Likely*** *(medium confidence)* on a regional to global scale
Increases in intense tropical cyclone activity	***Low confidence*** in long term (centennial) changes Virtually certain in North Atlantic since 1970	***Low confidence***	*Low confidence*	***More likely than not*** in the Western North Pacific and North Atlantic
Increased incidence and/or magnitude of extreme high sea level	*Likely* (since 1970)	***Likely***	*Likely*	***Very likely***

IPCC, AR5, Table SPM.1

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



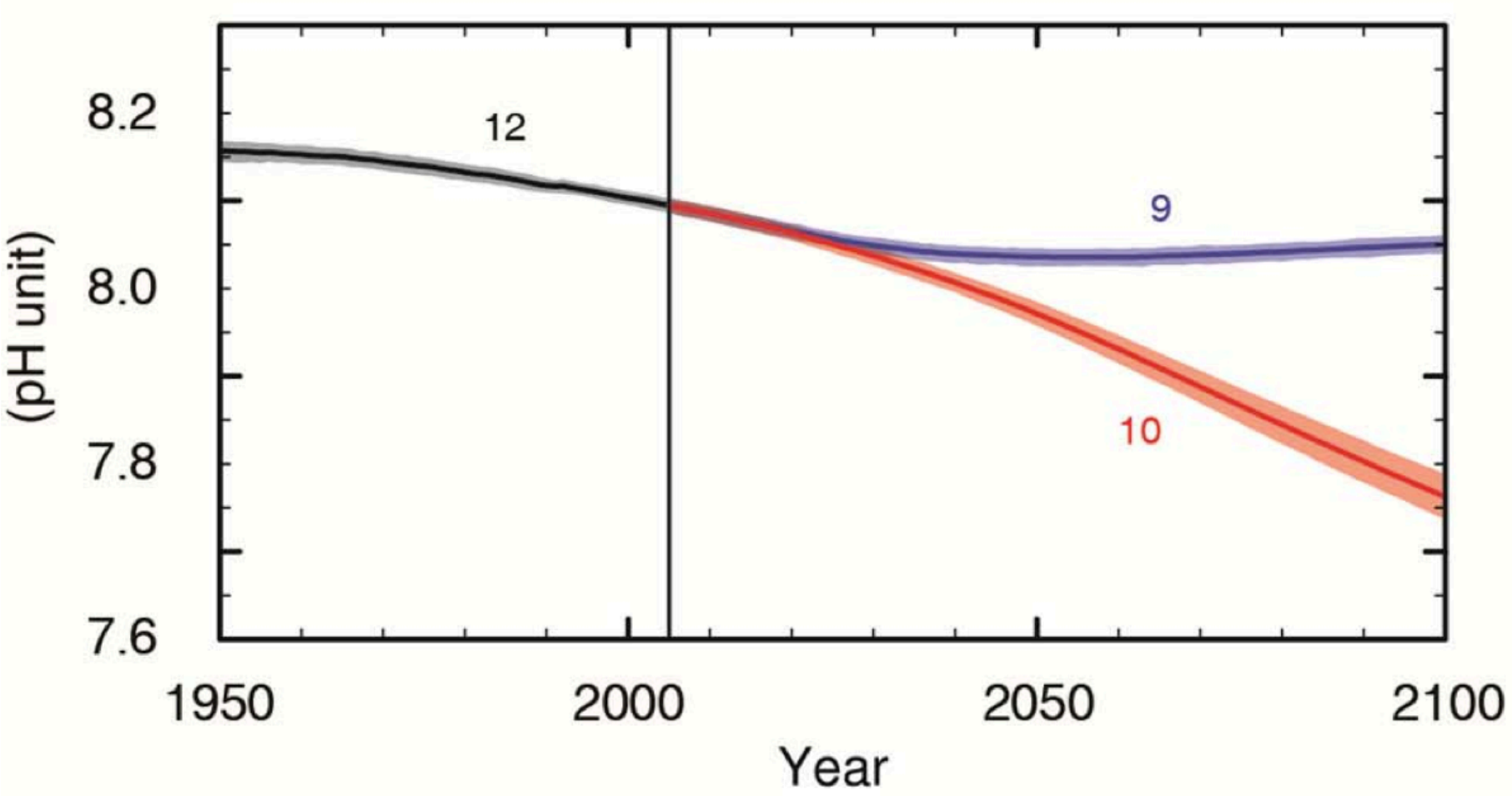
There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes

Changes in Extremes: Storms in North Atlantic

Since the 1970s, it is *virtually certain* that the frequency and intensity of storms in the North Atlantic has increased although the reasons for this increase are debated…

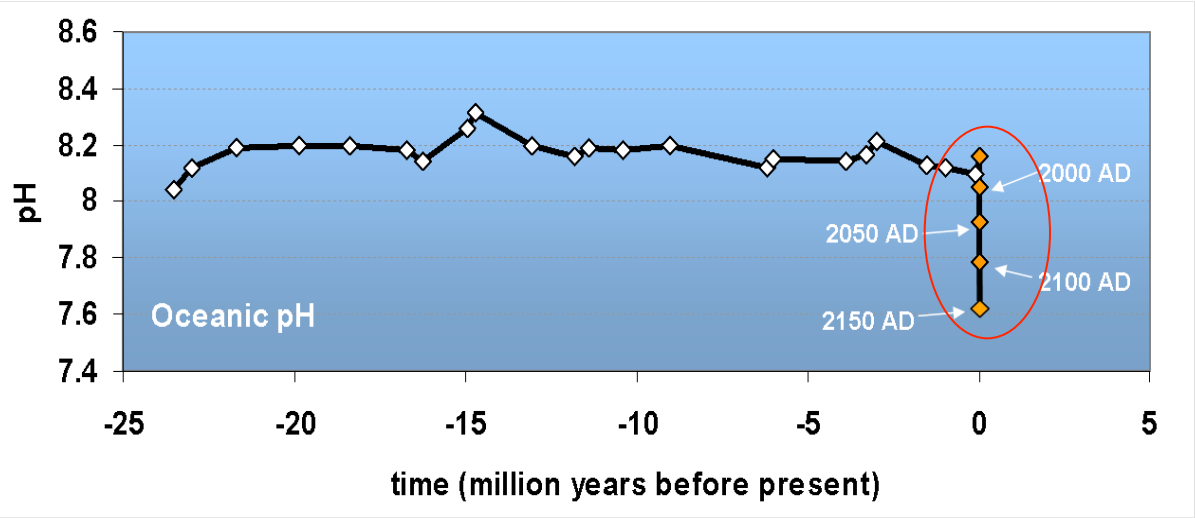
IPCC, AR5, WGI, TS-15

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

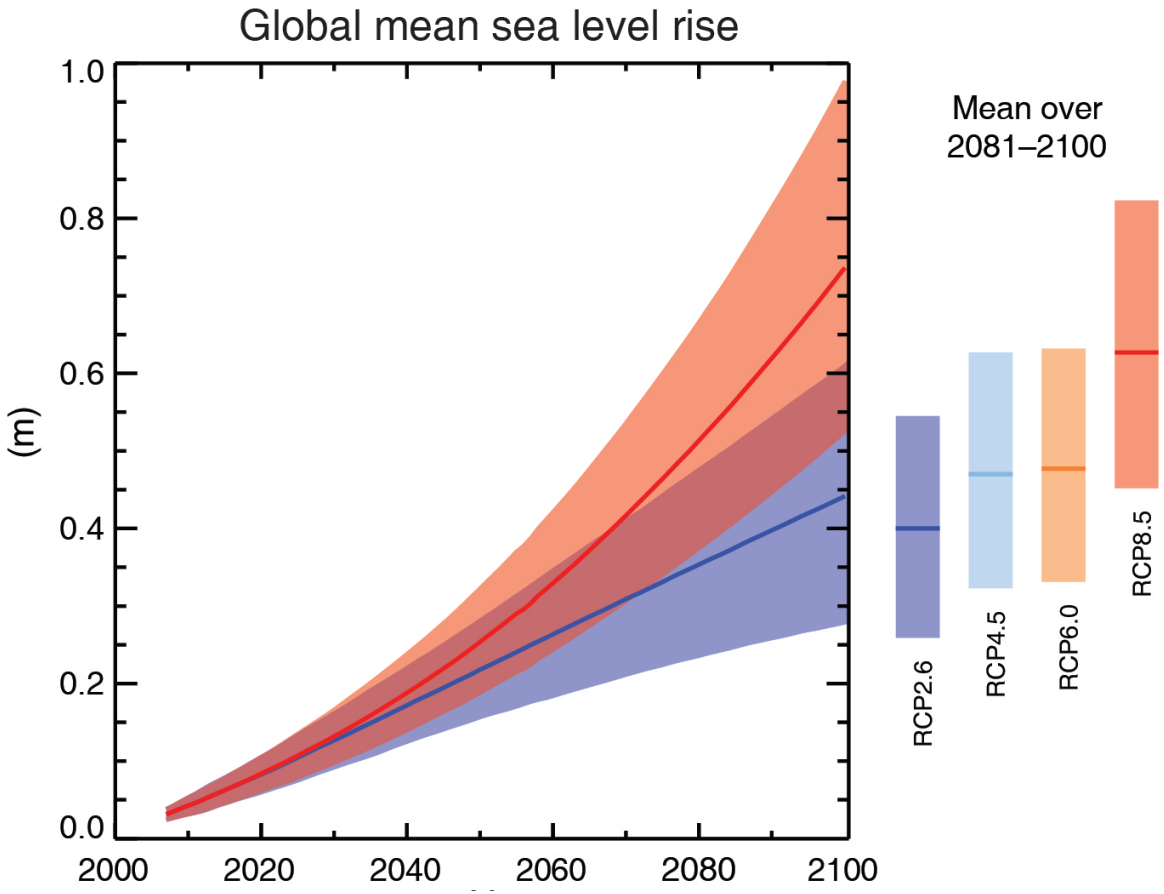


Fig. SPM.9

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

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

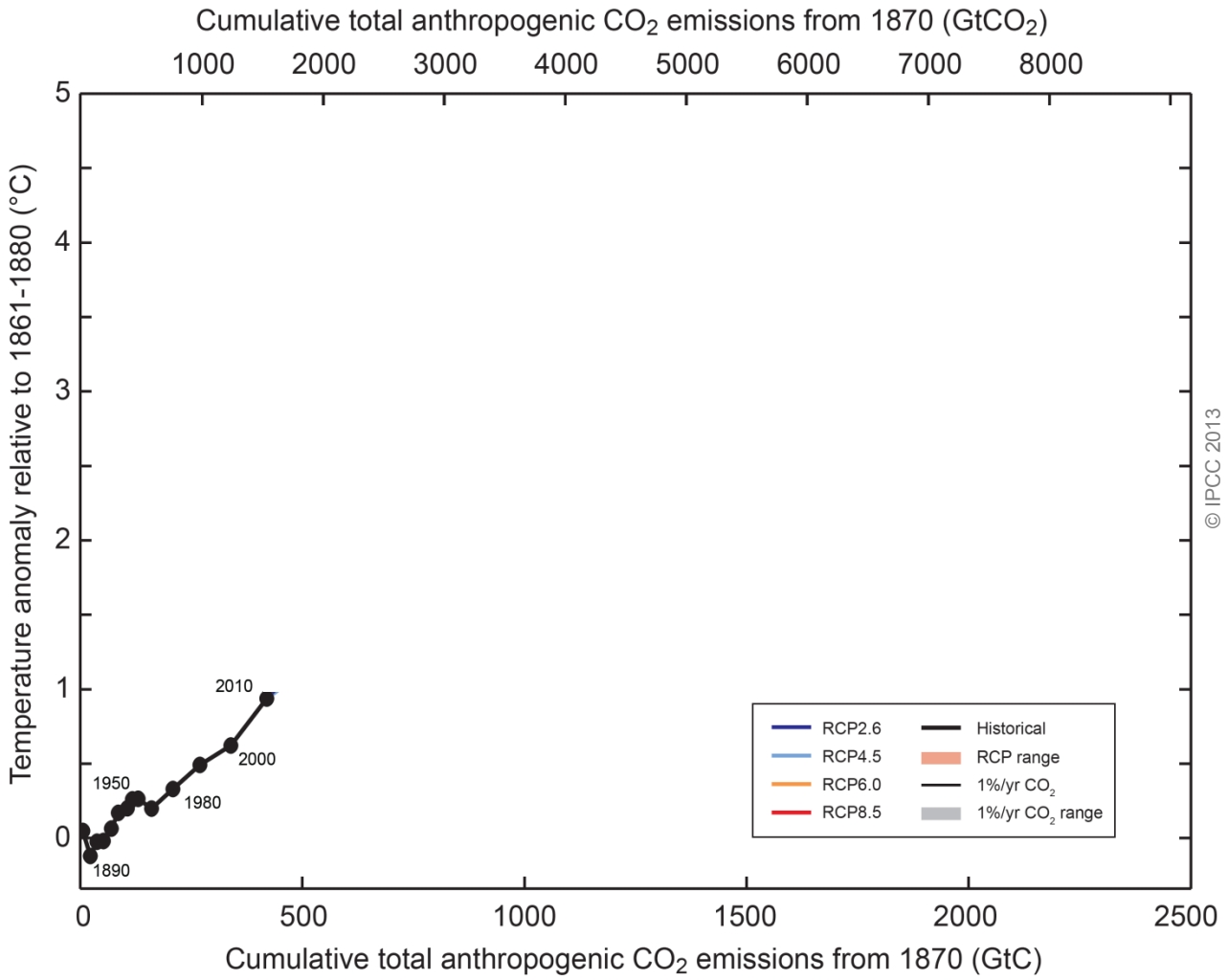


Fig. SPM.10

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

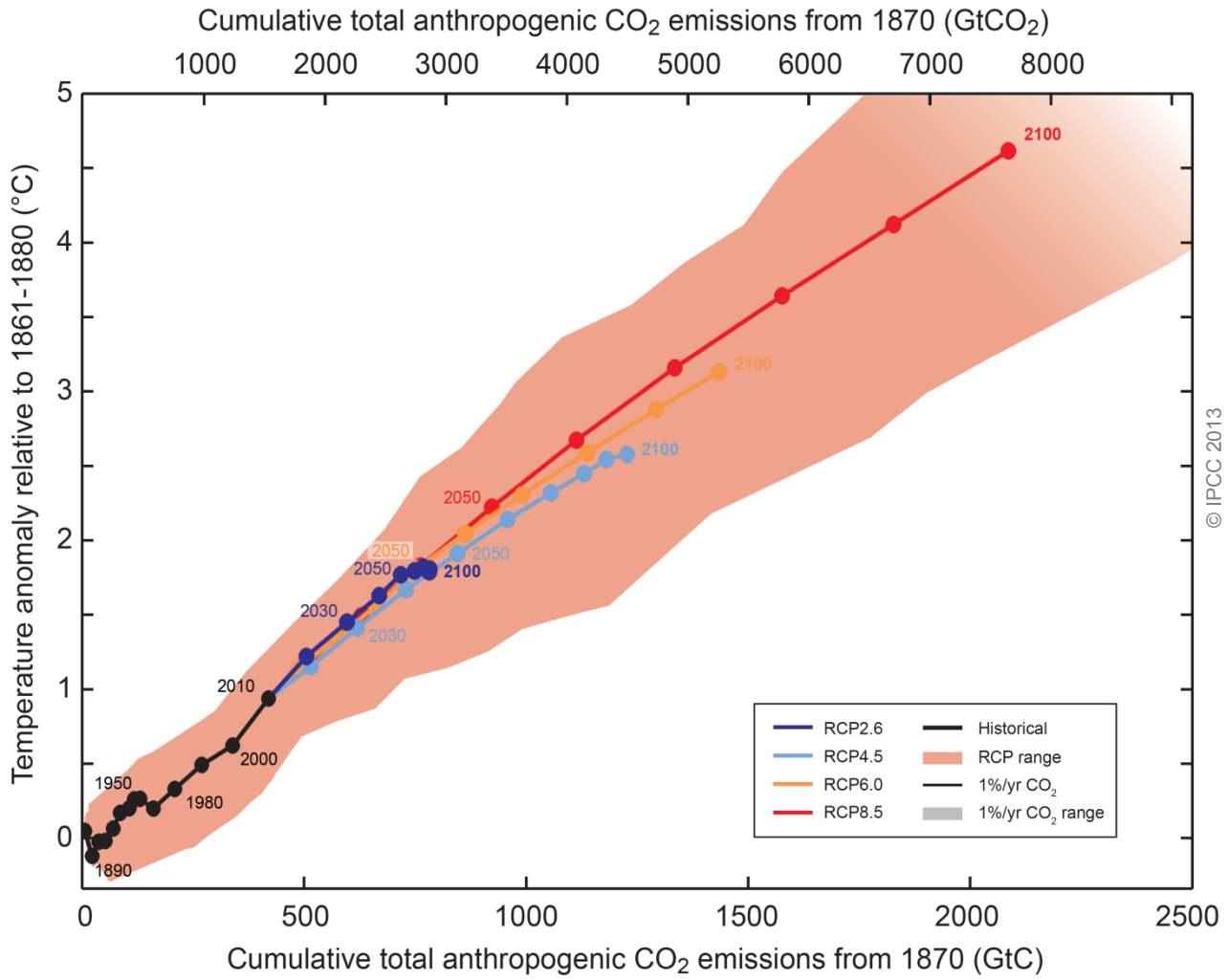
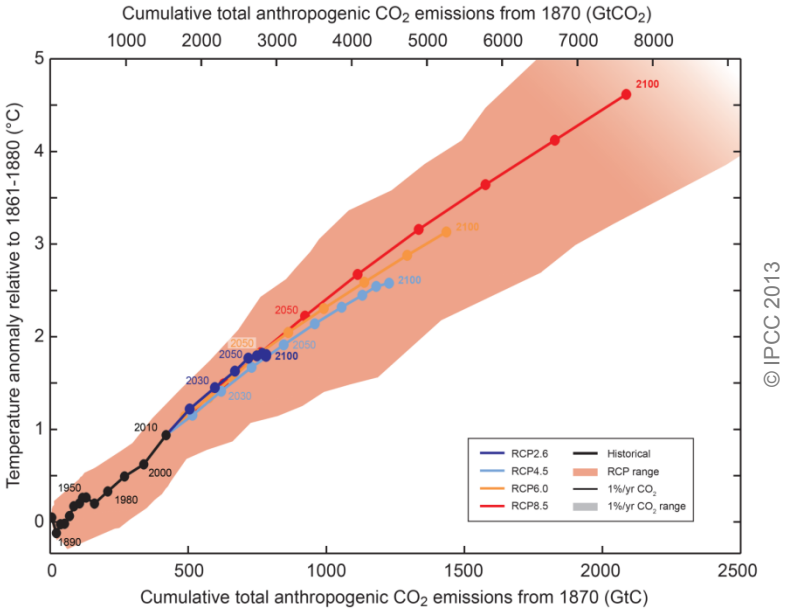


Fig. SPM.10

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



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)

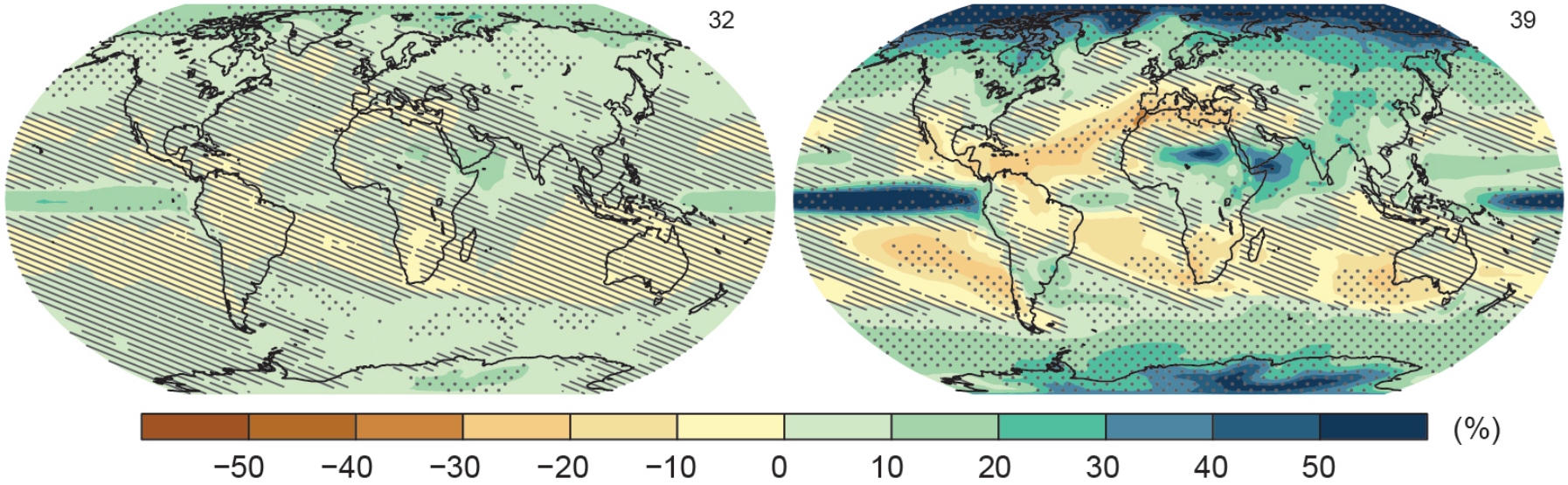
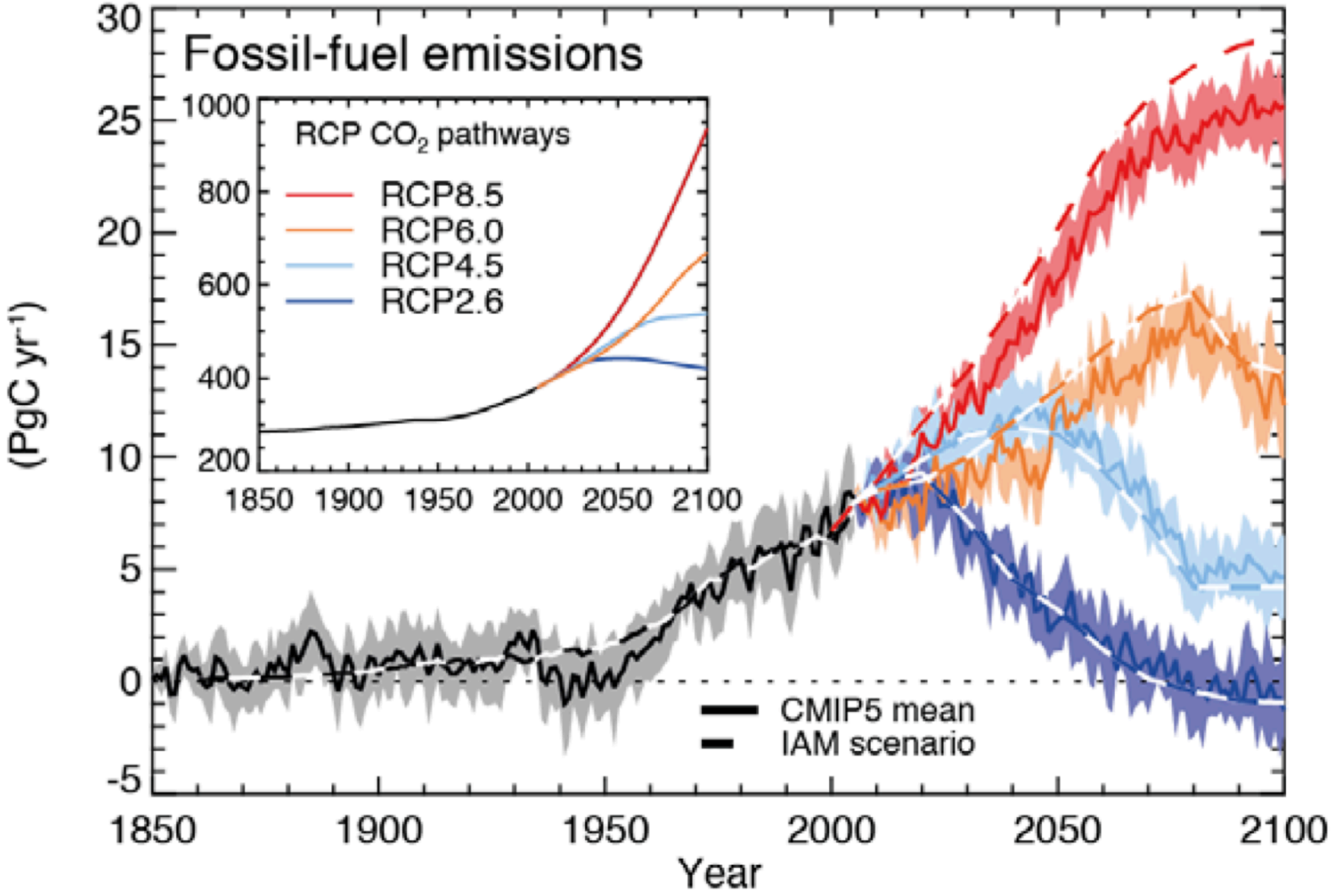


Fig. SPM.8

We have a choice.

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



AR5 WGI TS – Approved version/subject to final copy edit

Conclusion:

IPCC is eager to continue serving the climate and sustainable development process, with policy relevance, without being policy-prescriptive

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
- **On Twitter: @JPvanYpersele**