

# Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

## IPCC 2013/2014: Assessing the Science of Climate Change

Gian-Kasper Plattner

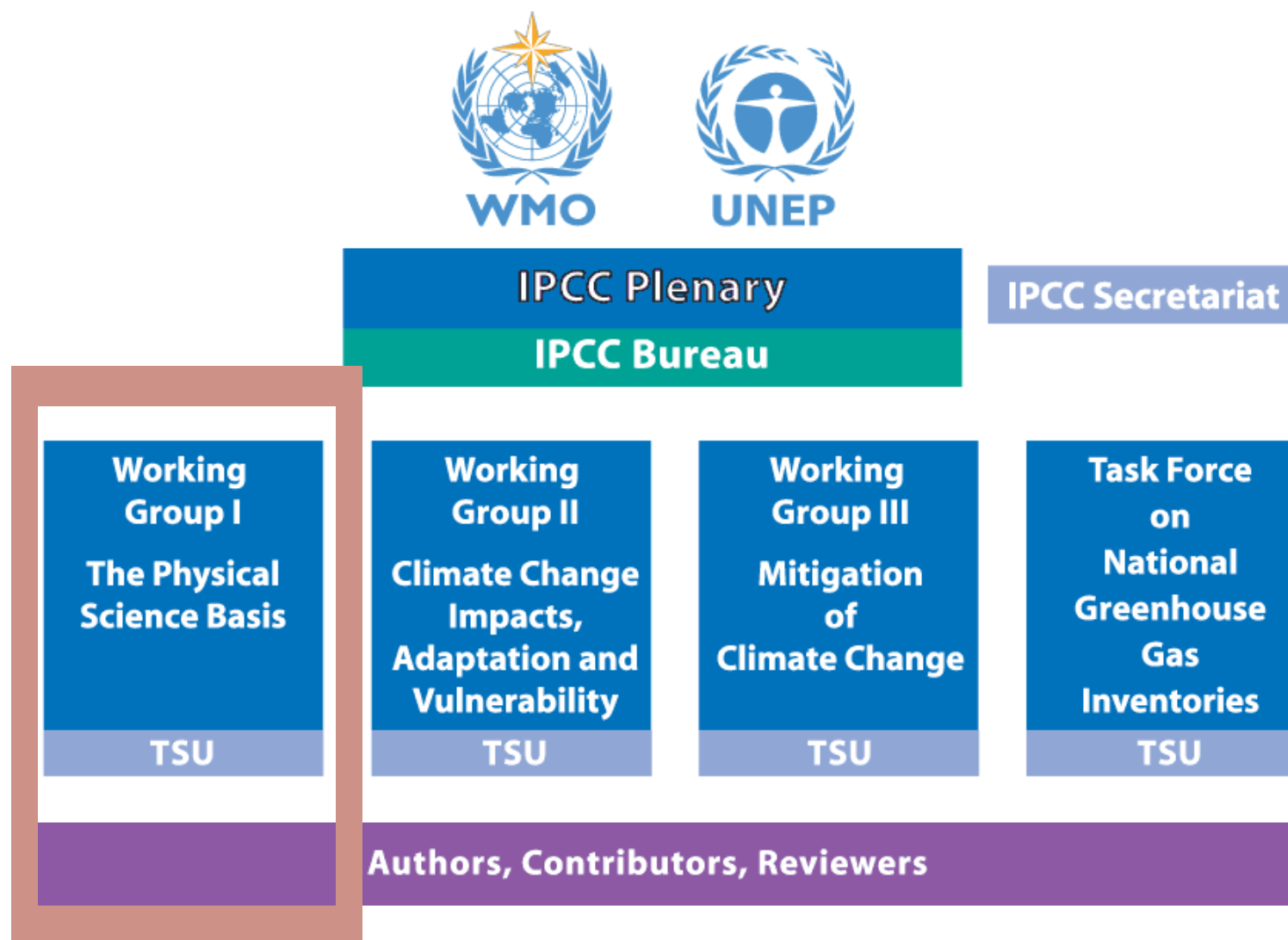
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# The Intergovernmental Panel on Climate Change: Structure



# Principles of the IPCC (1998, 2003, 2006, 2011)

[...]

2. The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies.
3. Review is an essential part of the IPCC process. Since the IPCC is an intergovernmental body, review of IPCC documents should involve both peer review by experts and review by governments.

[...]



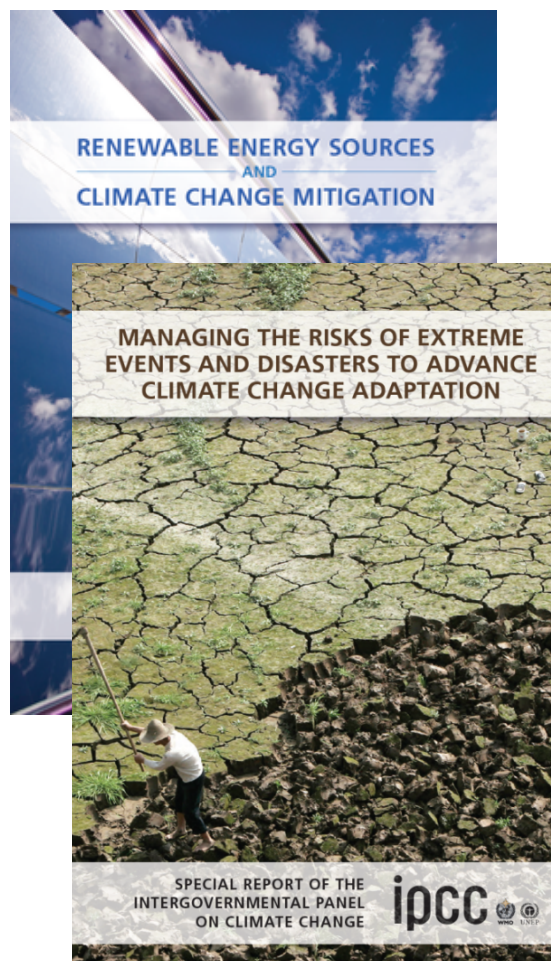
## Principles of the IPCC (1998, 2003, 2006, 2011)

Assessment of scientific-technical literature to provide reports on climate change issues that are

- ❖ policy relevant, but not policy prescriptive
- ❖ scientific-technically robust
- ❖ comprehensive
- ❖ balanced
- ❖ present uncertainties



# The 5<sup>th</sup> IPCC Assessment Report 2008 - 2014





Key SPM Messages

# 19 Headlines

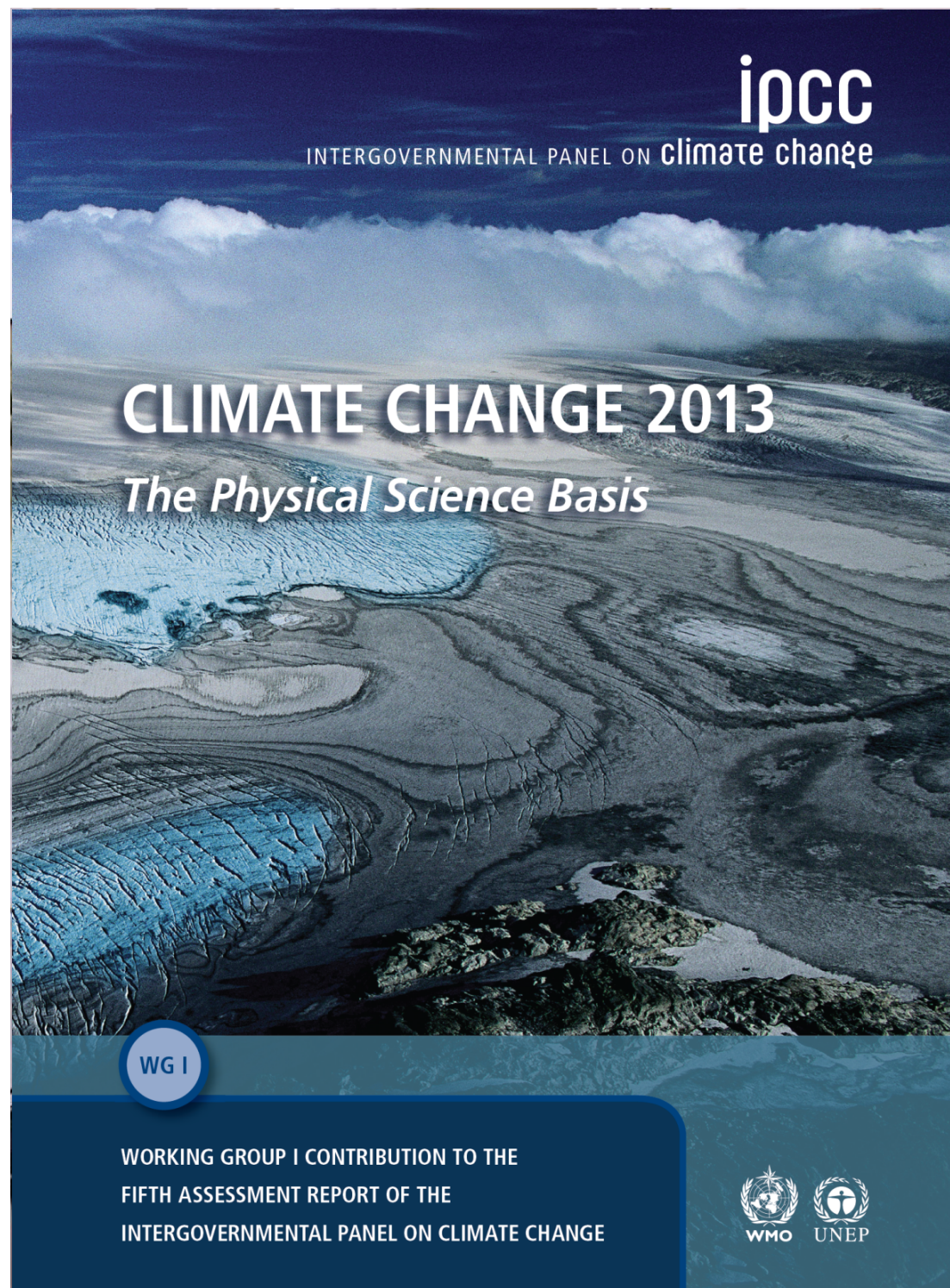
on less than 2 Pages

Summary for Policymakers

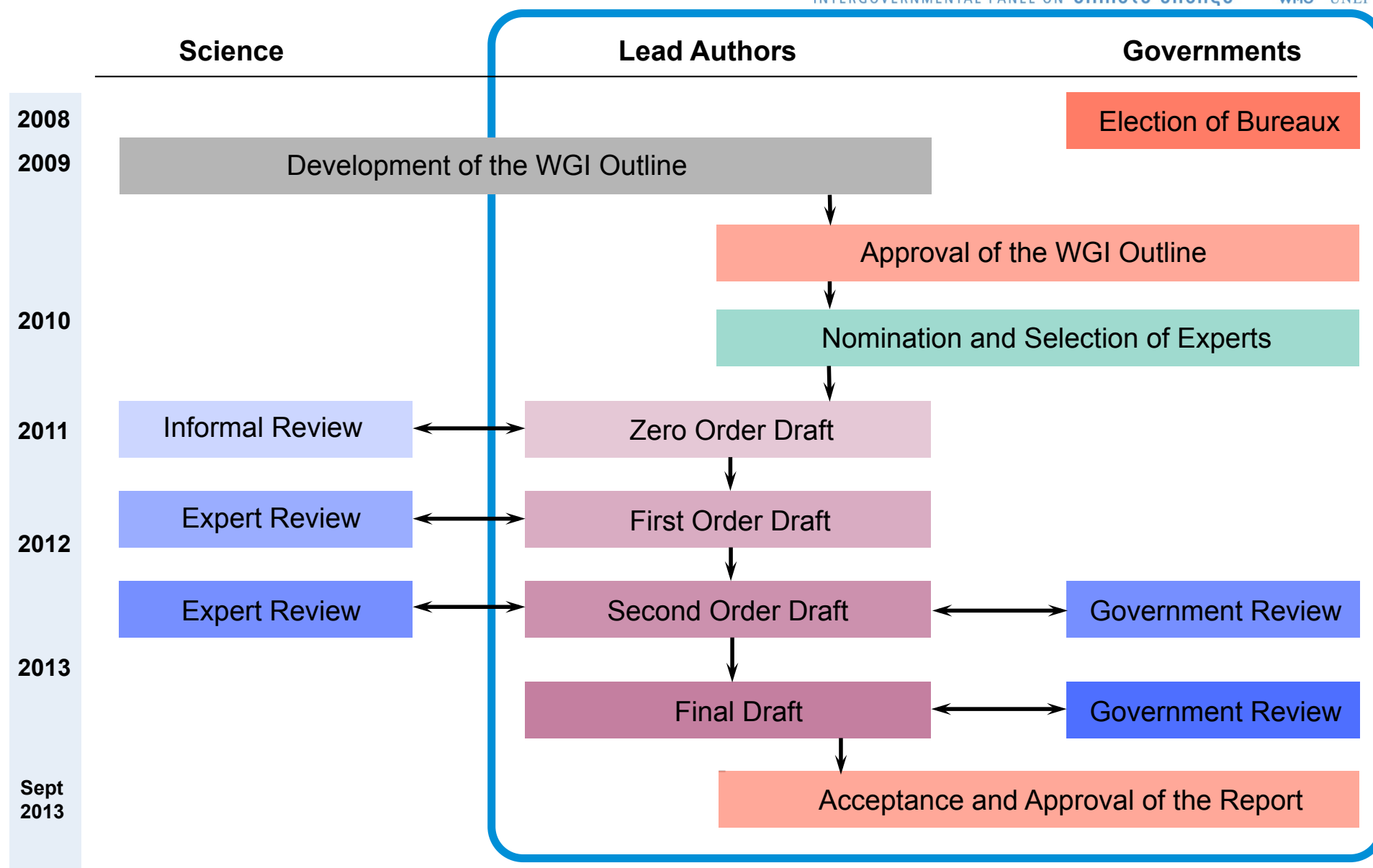
14,000 Words

14 Chapters & Atlas

1,100,000 Words



# The Process for IPCC Working Group I



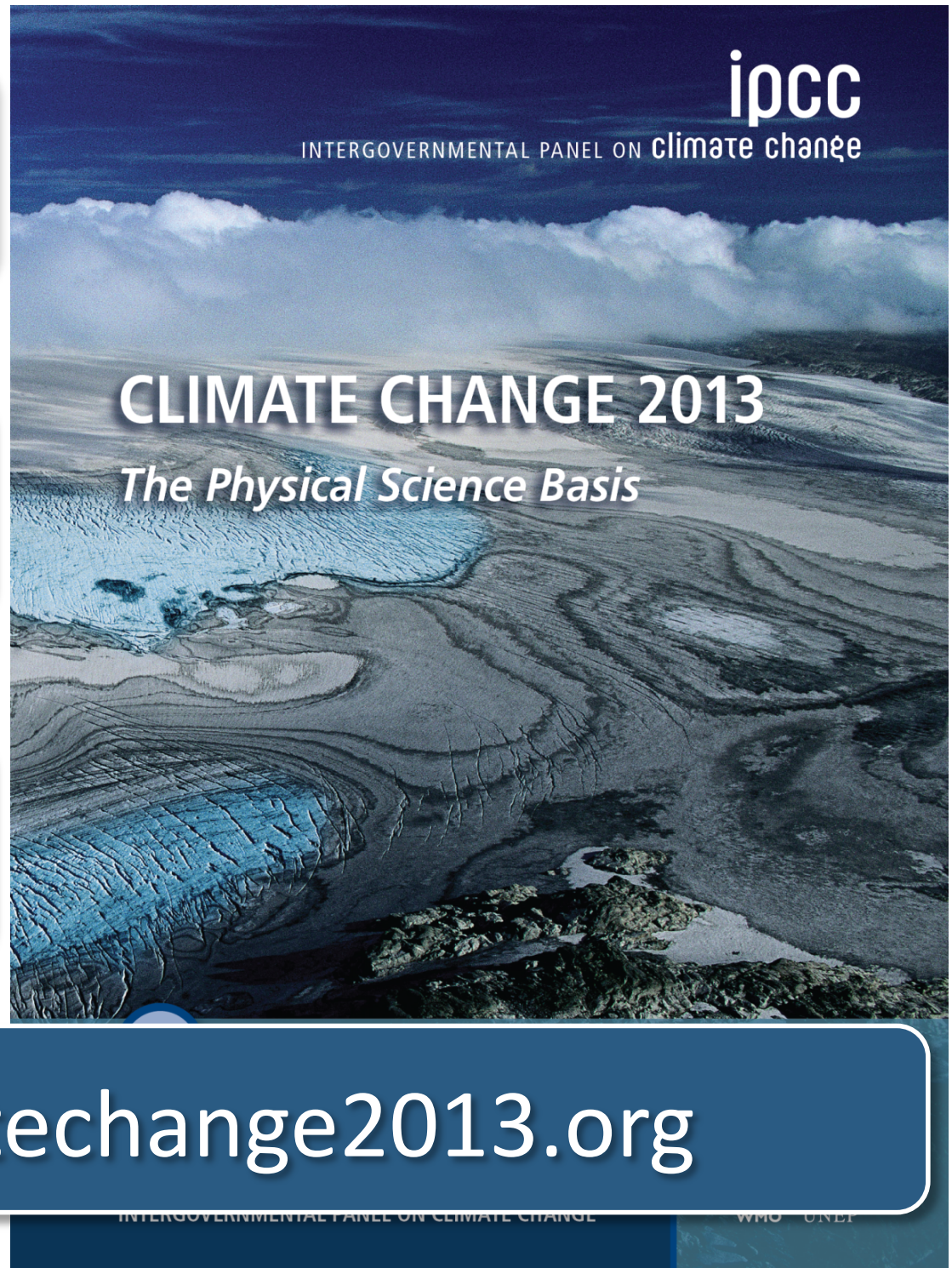


Observation

Understanding

Future

[www.climatechange2013.org](http://www.climatechange2013.org)



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Warming in the climate system  
is unequivocal, [...]

Human influence on the  
climate system is clear.

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

# Consistent Treatment of Uncertainties

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## The IPCC AR5 Approach

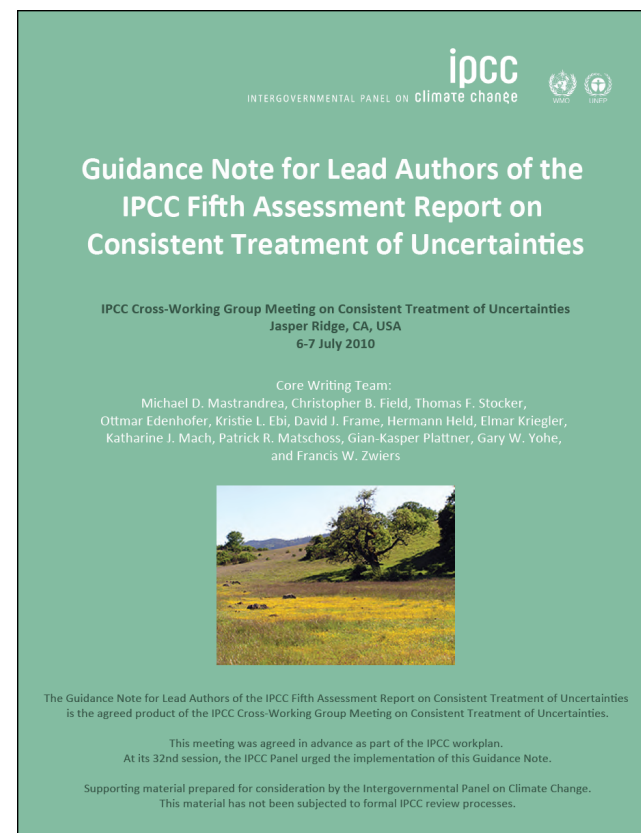


# Treatment of Uncertainty in AR5?

- ❖ How to determine uncertainty?
- ❖ How to display uncertainty?
- ❖ How to formulate uncertainty?
- ❖ How to communicate uncertainty?

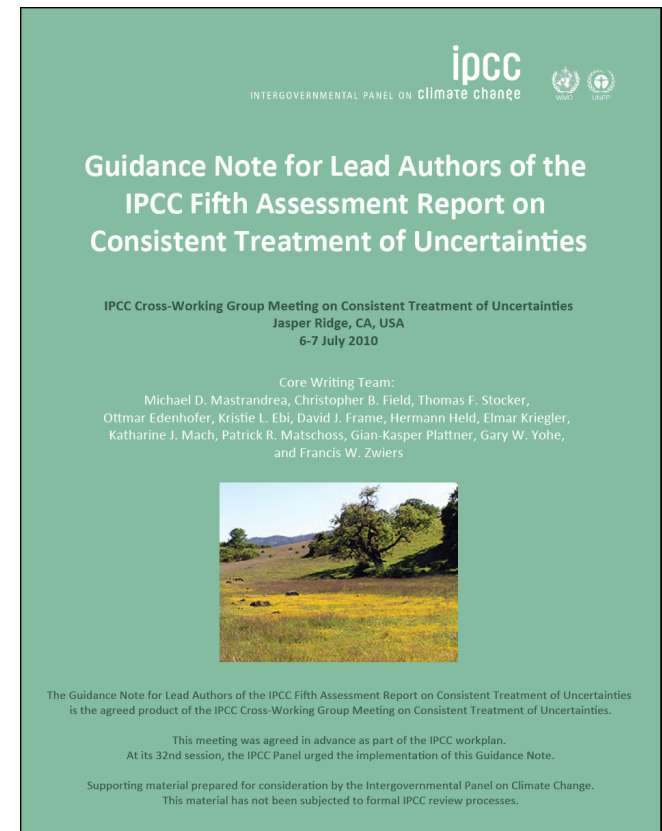
→ Revised IPCC Guidance Note on the Consistent Treatment of Uncertainties in AR5

(the result of an IPCC cross-WG meeting, July 2010)



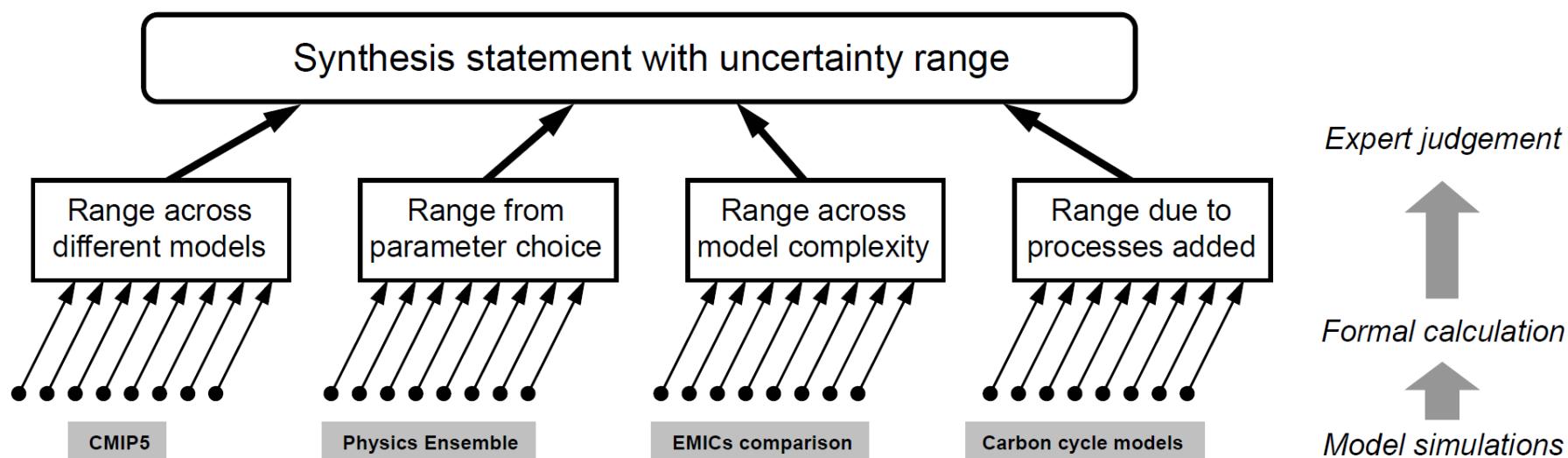
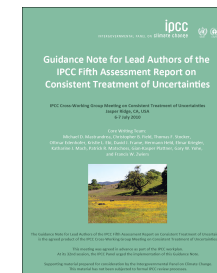
# Guidance Note *for Lead Authors* of the IPCC AR5 on *Consistent Treatment of Uncertainties*

- ❖ Integrated framework for evaluating and communicating the degree of certainty in key findings.
- ❖ Guidance on treating uncertainty in developing key findings of the assessment process.



# Treatment of Uncertainty in AR5?

How to determine uncertainty?

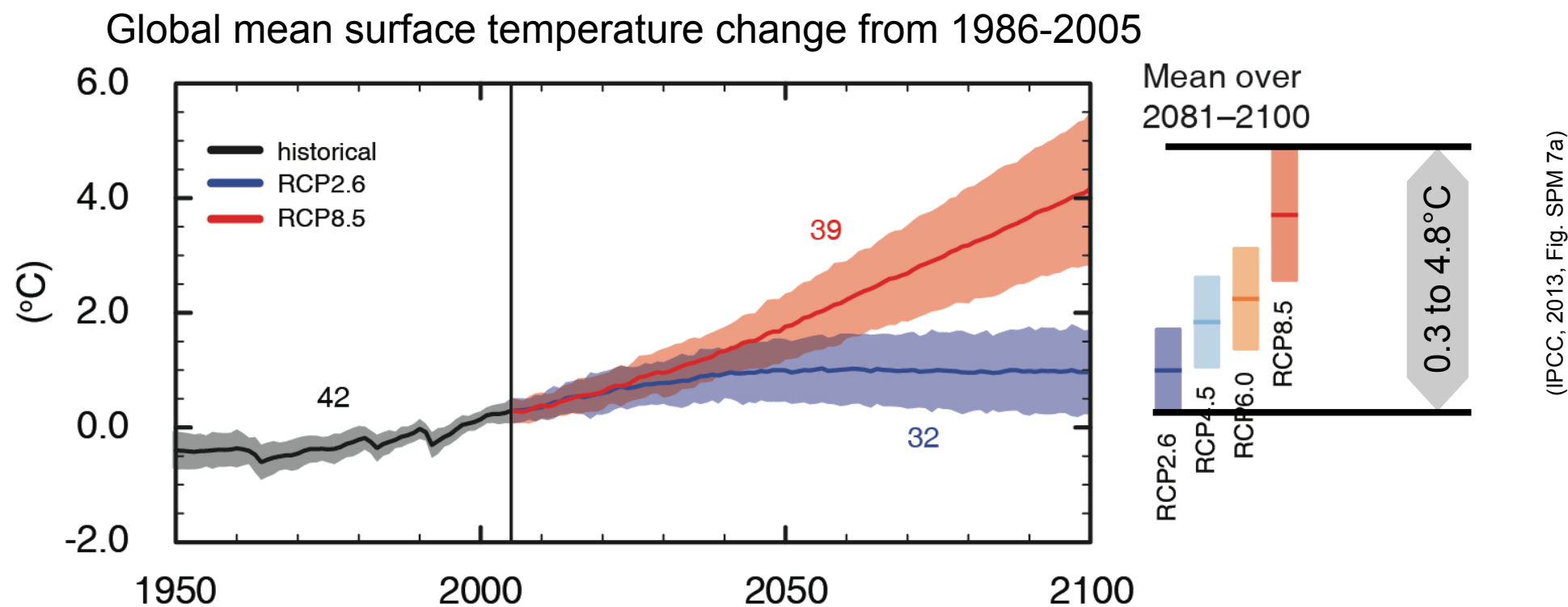
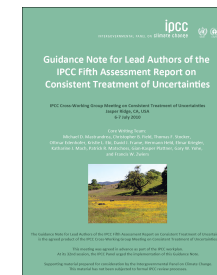


(Mastrandrea et al., 2011)



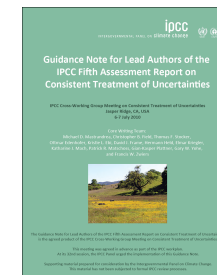
# Treatment of Uncertainty in AR5?

How to determine uncertainty?

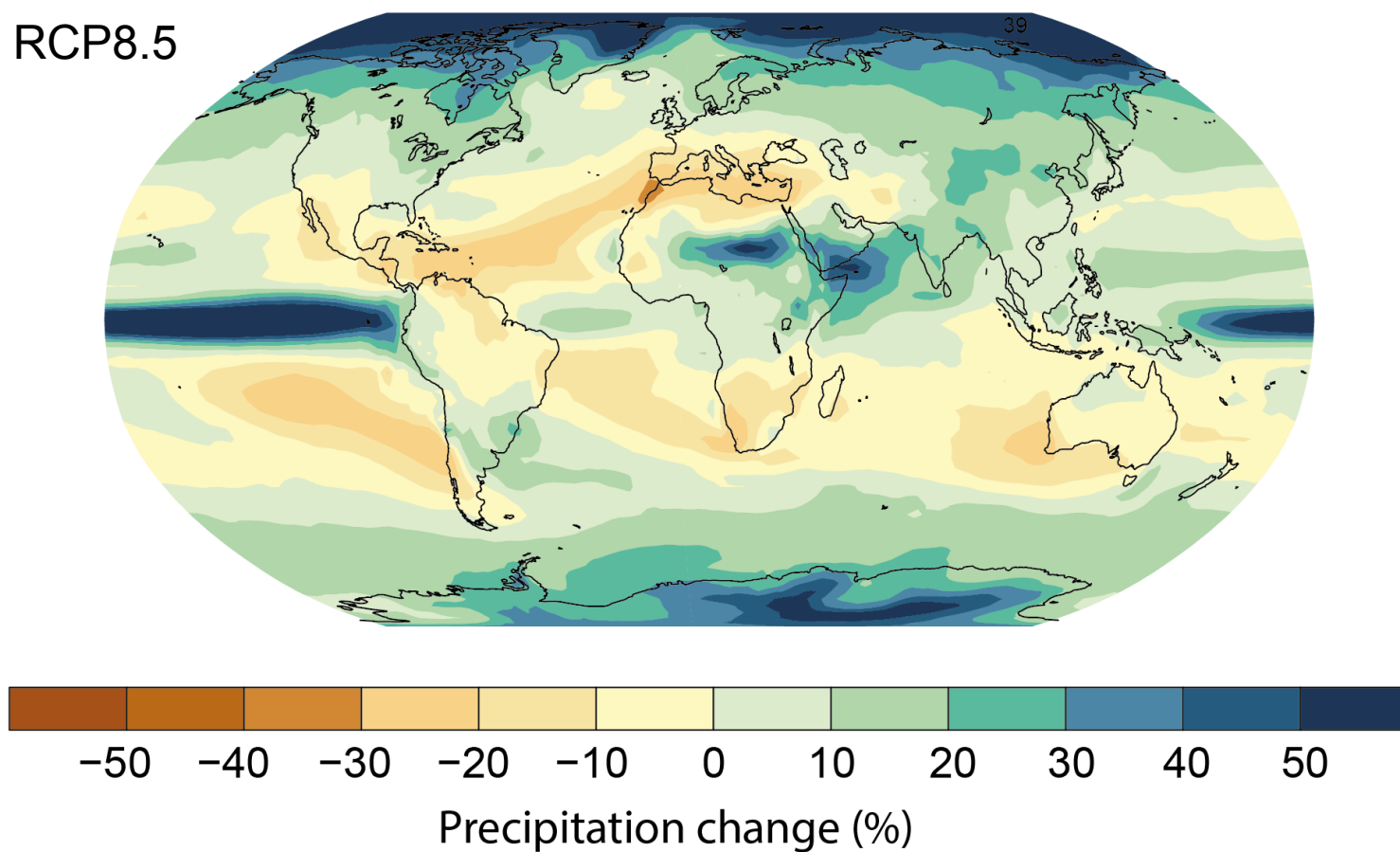


# Treatment of Uncertainty in AR5?

How to display uncertainty?



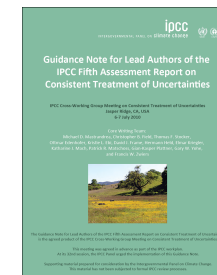
RCP8.5



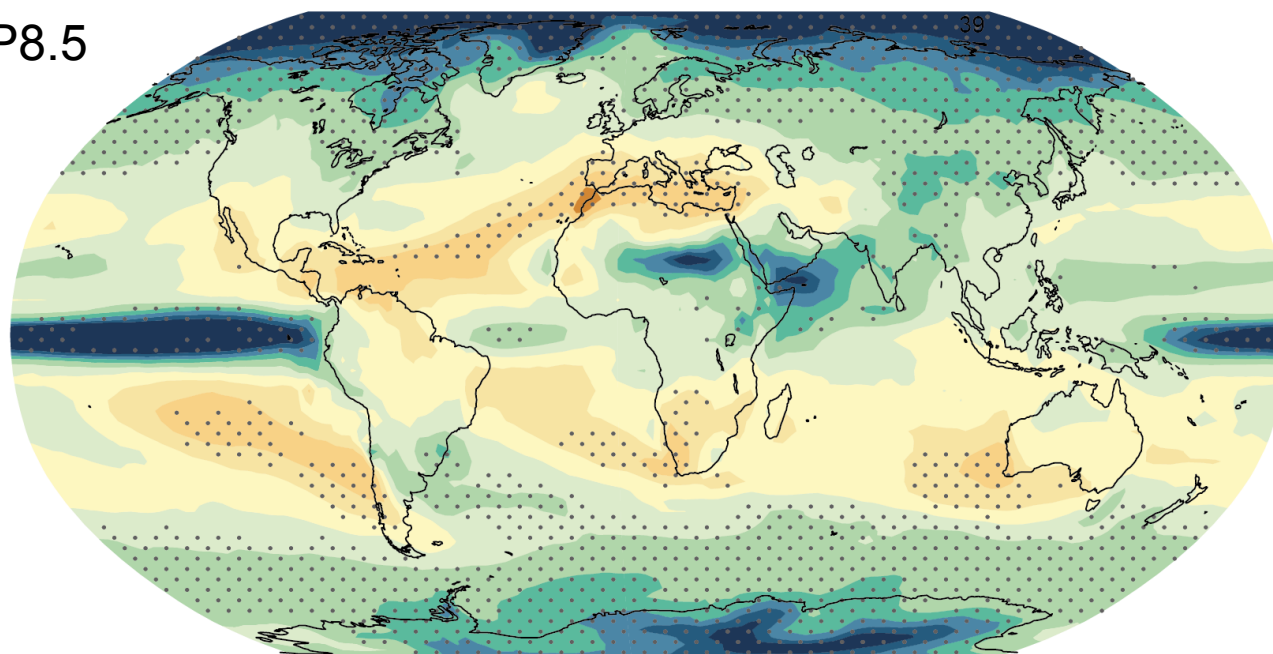
(IPCC, 2013, Fig. SPM 8b)

# Treatment of Uncertainty in AR5?

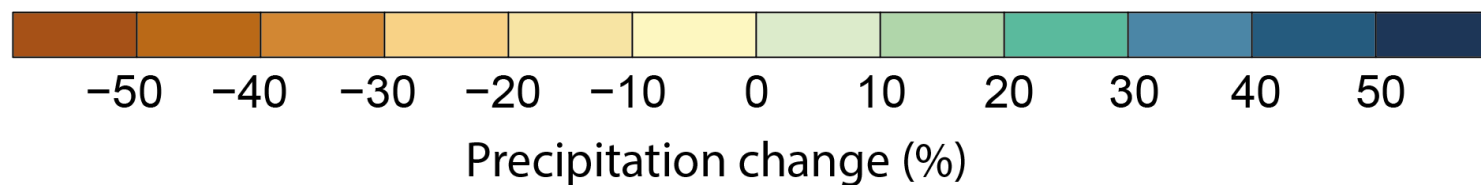
How to display uncertainty?



RCP8.5



**Stippling** to indicate regions with robust changes



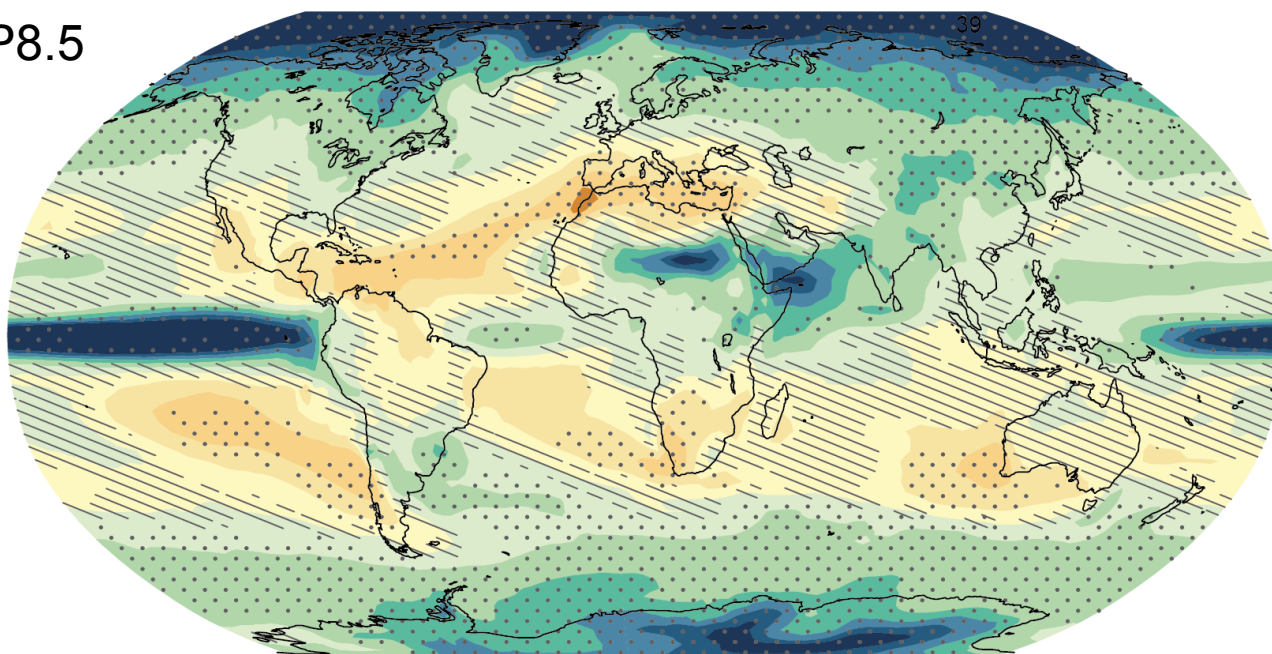
(IPCC, 2013, Fig. SPM 8b)



# Treatment of Uncertainty in AR5?

How to display uncertainty?

RCP8.5



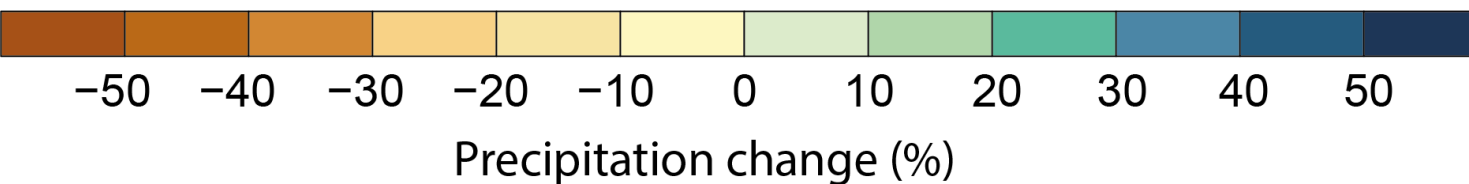
**Stippling** to indicate regions with robust changes



**Hatching** to indicate regions where changes are non-significant



(IPCC, 2013, Fig. SPM 8b)



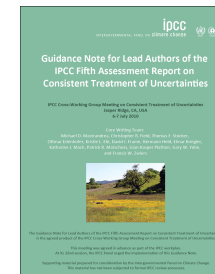
# Treatment of Uncertainty in AR5?

How to formulate uncertainty?

## Qualitative:

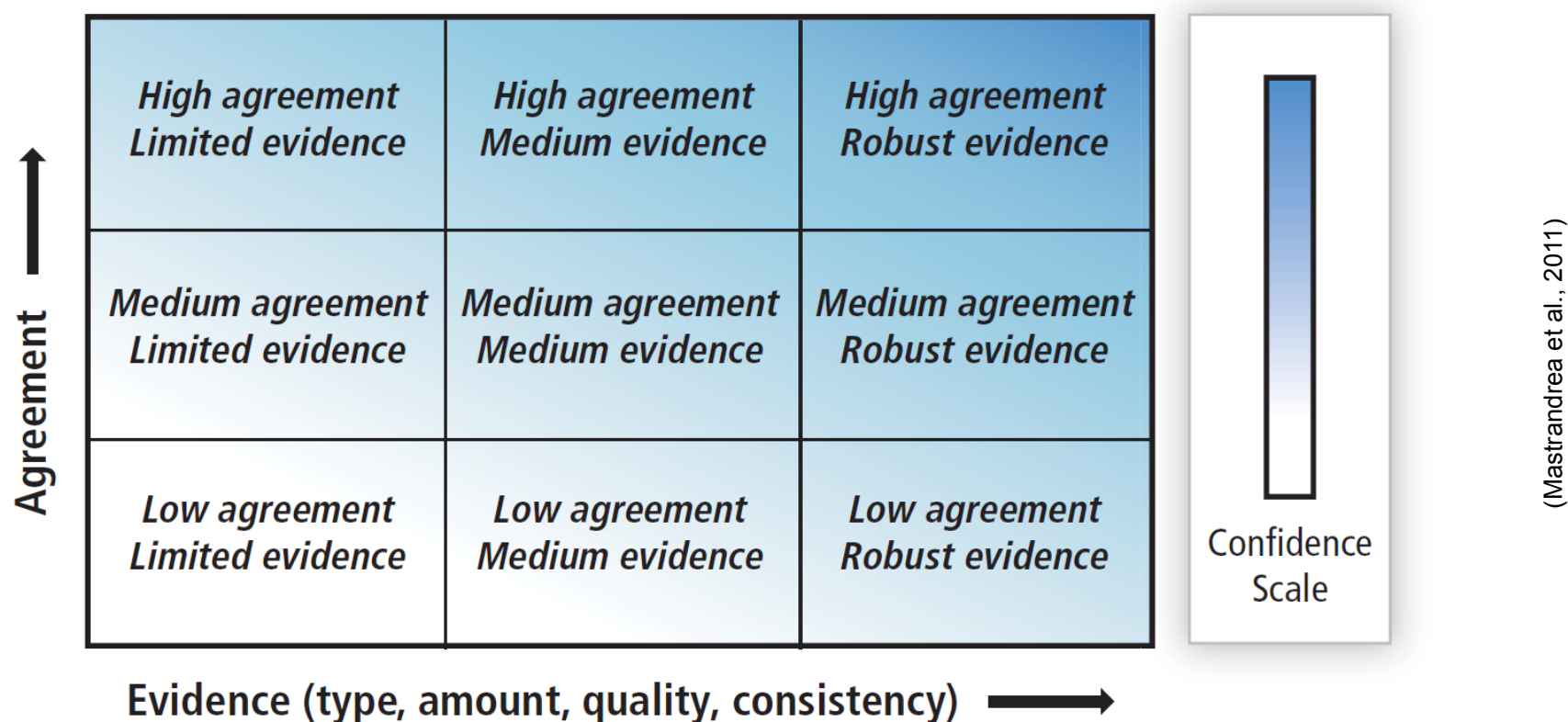
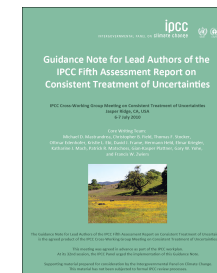
level of ***agreement***  
amount and quality of ***evidence***

} ***confidence***



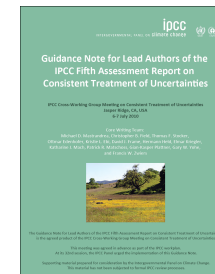
# Treatment of Uncertainty in AR5?

How to formulate uncertainty?



# Treatment of Uncertainty in AR5?

How to formulate uncertainty?

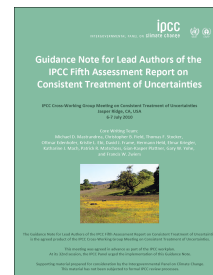


## Qualitative:

level of ***agreement***  
amount and quality of ***evidence***

} ***confidence***

- ❖ In WGI, assessments of *evidence and agreement* are usually reported *implicitly* in the form of a **traceable account** of the evidence.
- ❖ WGI makes many *explicit* confidence assessments.



# Treatment of Uncertainty in AR5?

How to formulate uncertainty?

## Qualitative:

level of **agreement**  
amount and quality of **evidence**



**confidence**

## Quantitative:

quantified likelihood

**virtually certain**

≥ 99%

**very likely**

≥ 90%

**likely**

≥ 66%

**unlikely**

< 33%

...

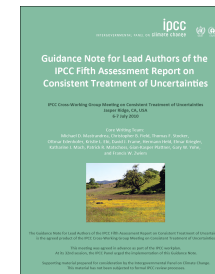
**Statements of fact:** «Warming of the climate system is unequivocal» (SPM, WGI AR4 & AR5)



# Treatment of Uncertainty in AR5?

## How to communicate uncertainty?

- ❖ Communicate uncertainty carefully
- ❖ Using calibrated language for key findings
- ❖ Provide traceable accounts describing evaluations of evidence and agreement in individual chapters



# Observation

## What has changed?

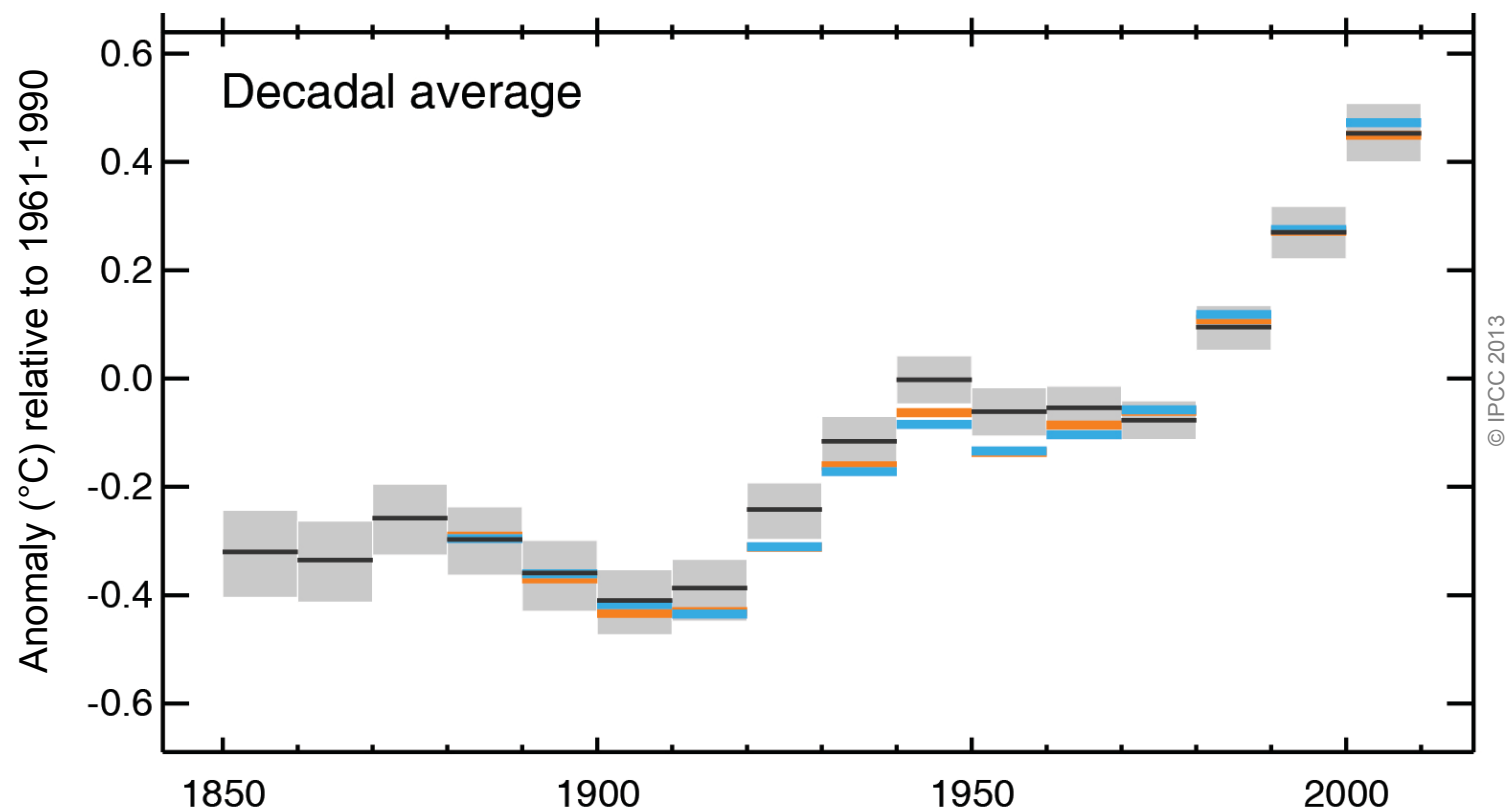


Fig. SPM.1a

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*).

Fig. SPM.1b

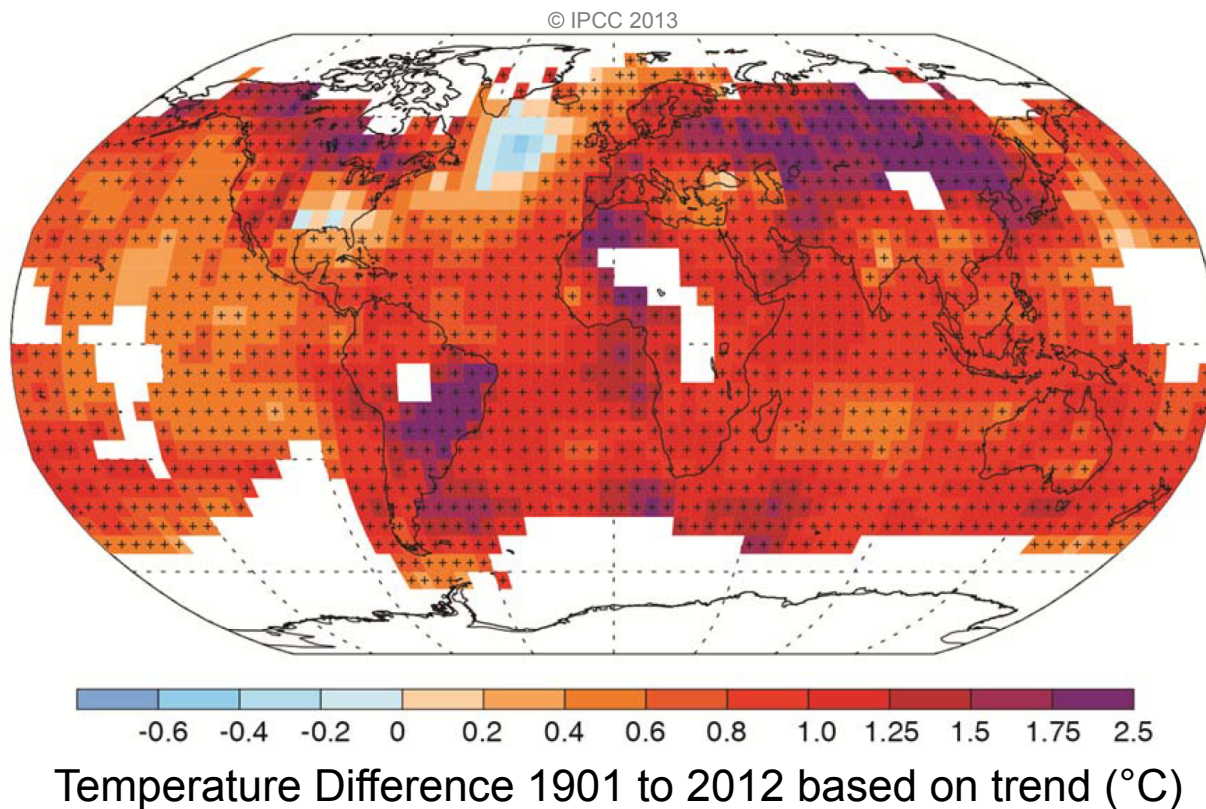
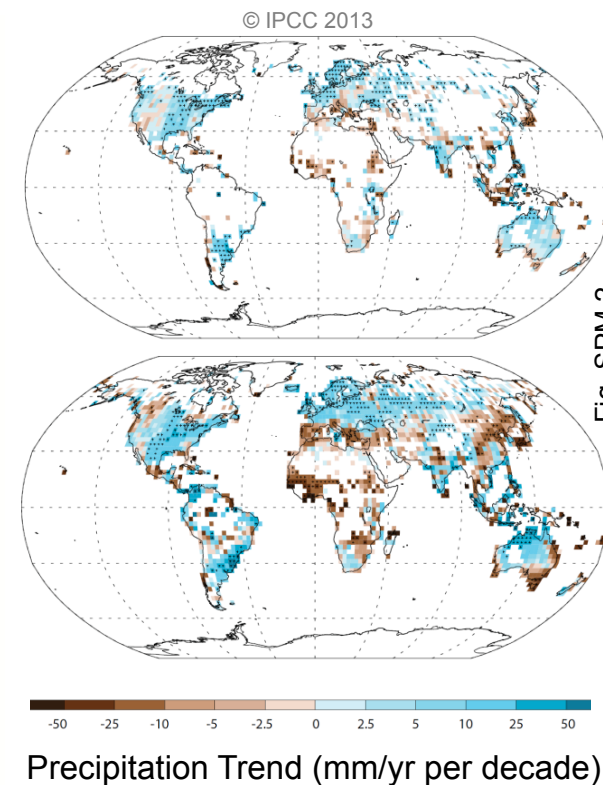
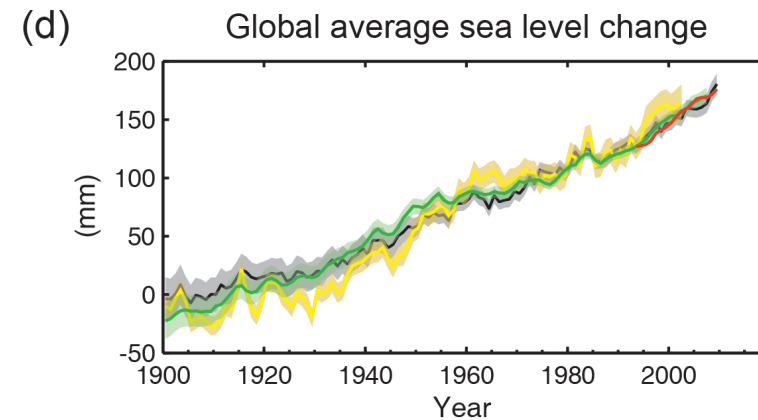
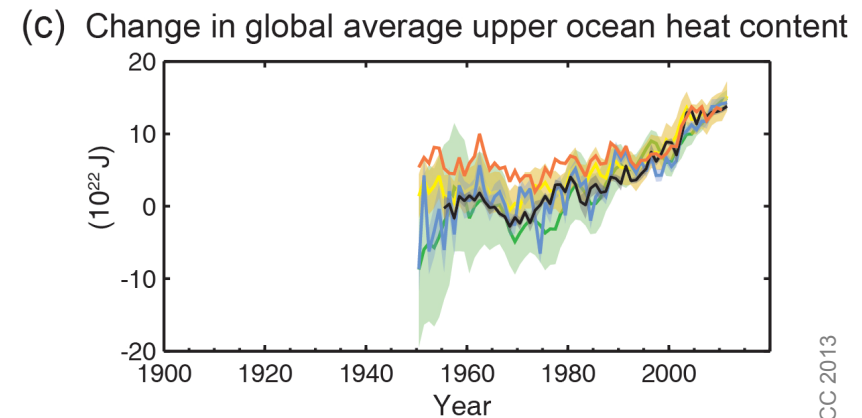
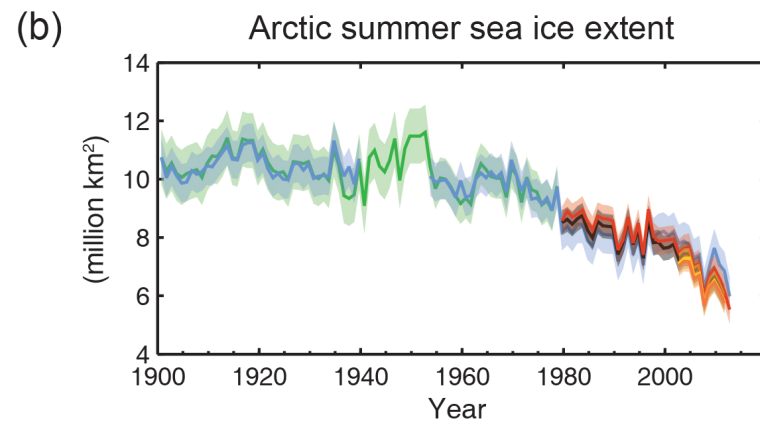
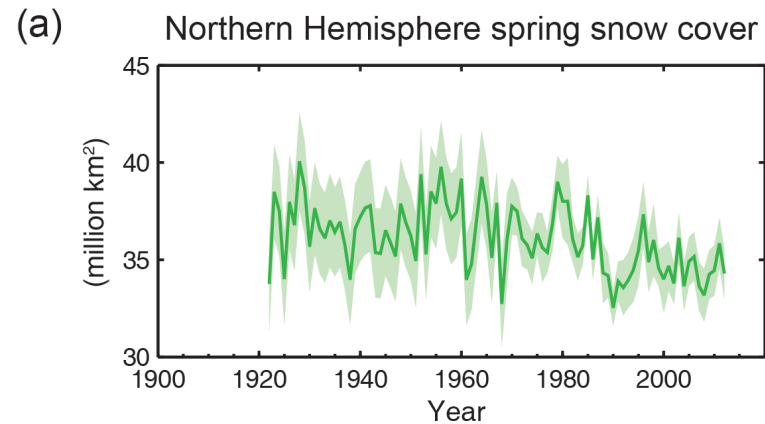


Fig. SPM.2



Warming of the climate system  
is unequivocal, [...]

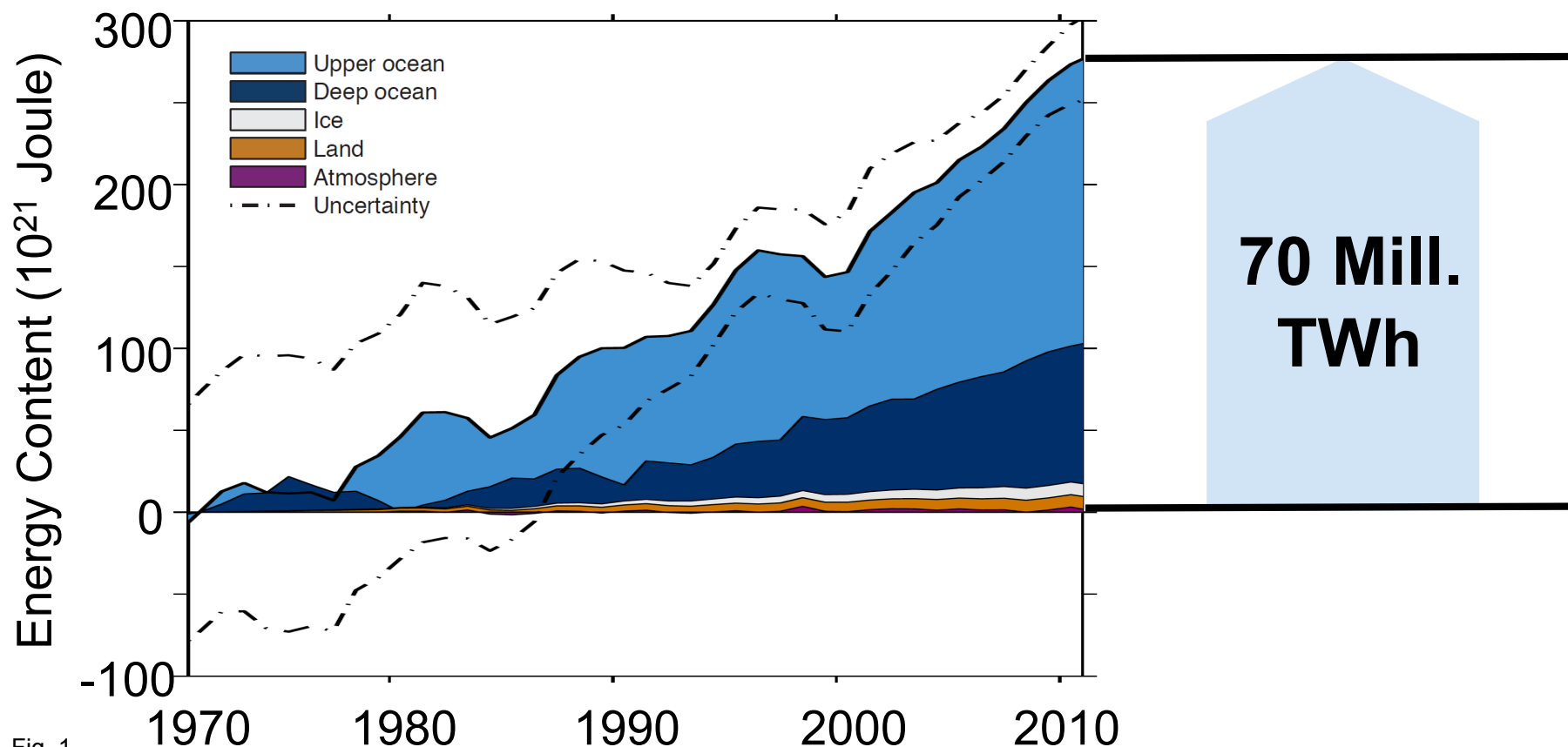




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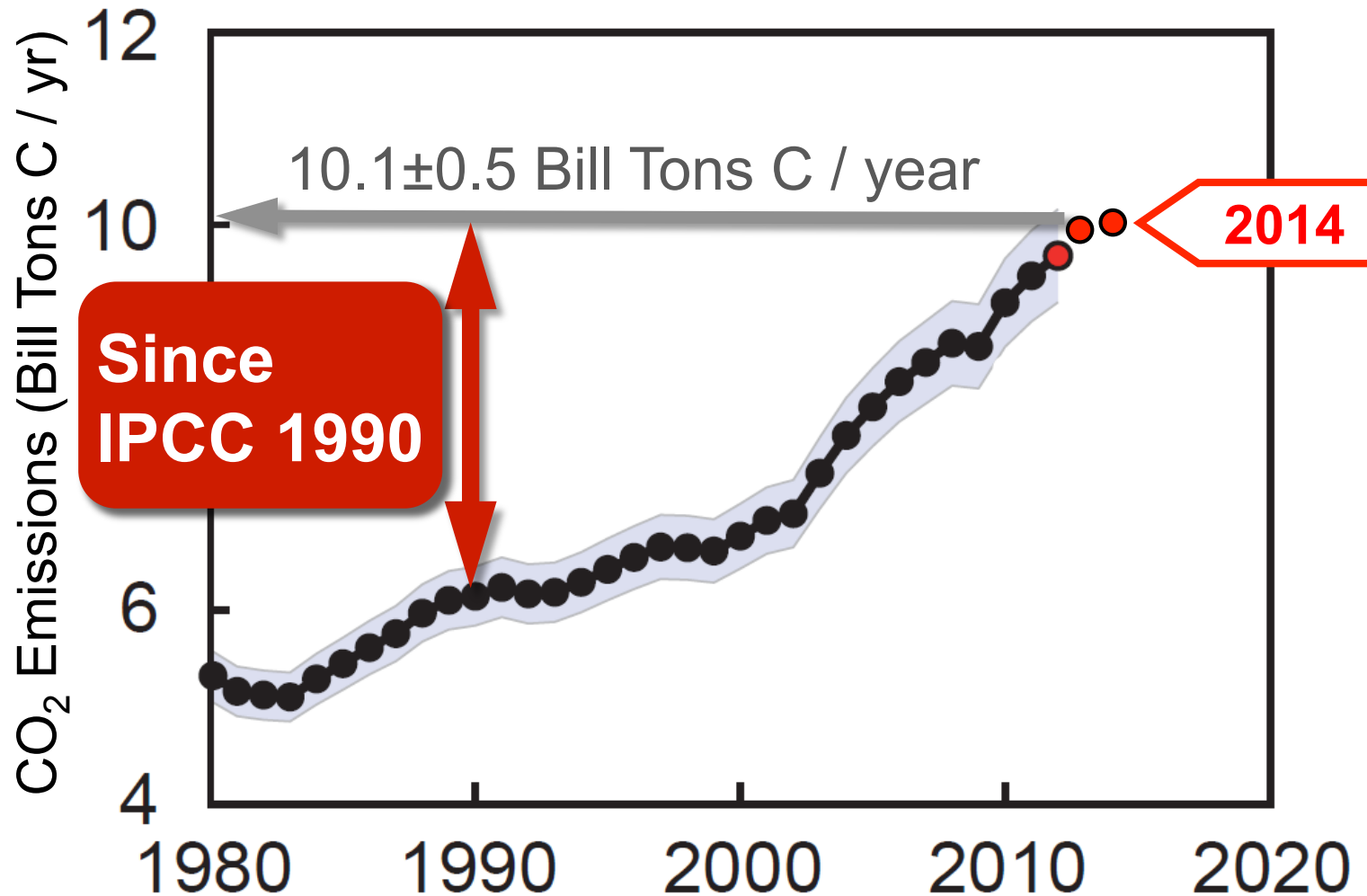
Fig. SPM.3

Warming of the climate system  
is unequivocal, [...]



Box 3.1, Fig. 1

Ocean warming dominates the increase in energy stored in the climate system.



(modified from Peters et al., 2013, Global Carbon Project)

Manmade CO<sub>2</sub> emissions are higher than ever before.

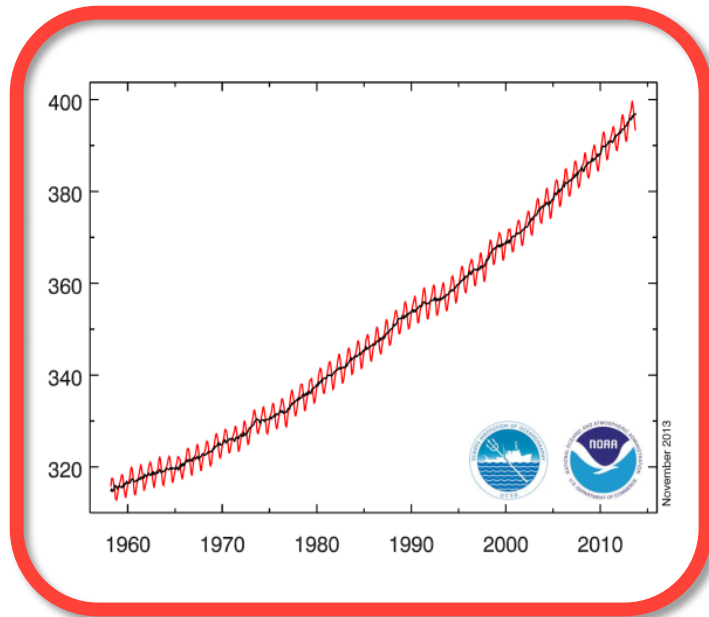
# Understanding

Why has it changed?



# Worldwide Effects

## Cause



**atmosphere, land, ocean**

**extreme events**

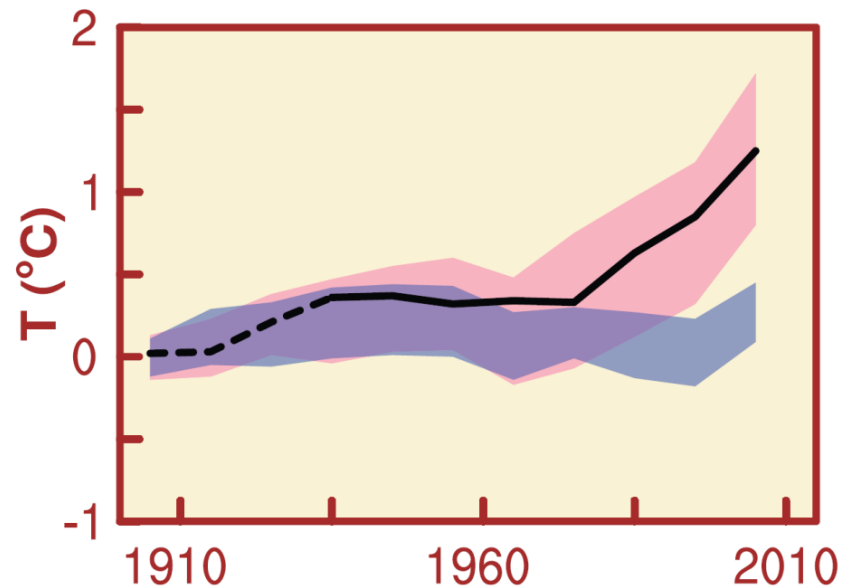
**water cycle**

**sea ice, glaciers, ice sheets**

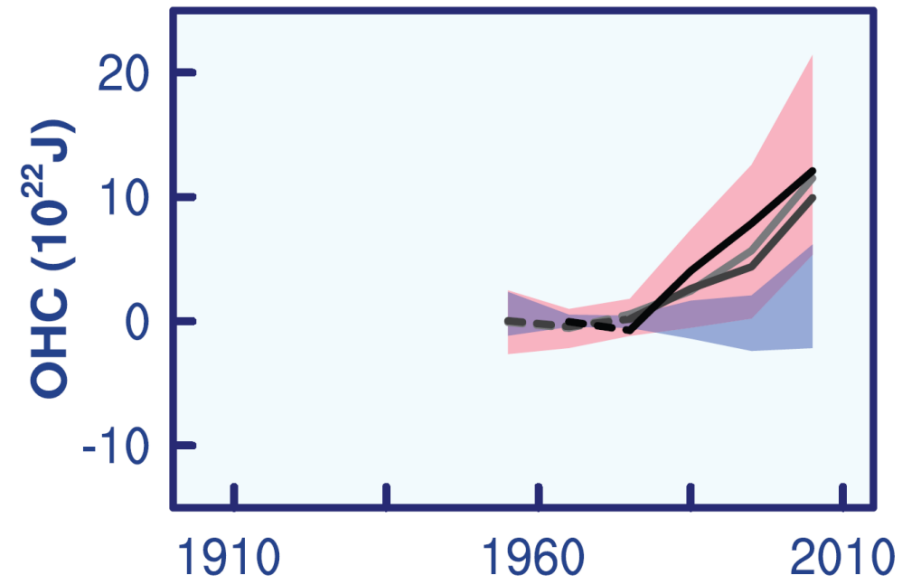
**global mean sea level**

**Human influence on the climate system is clear.**

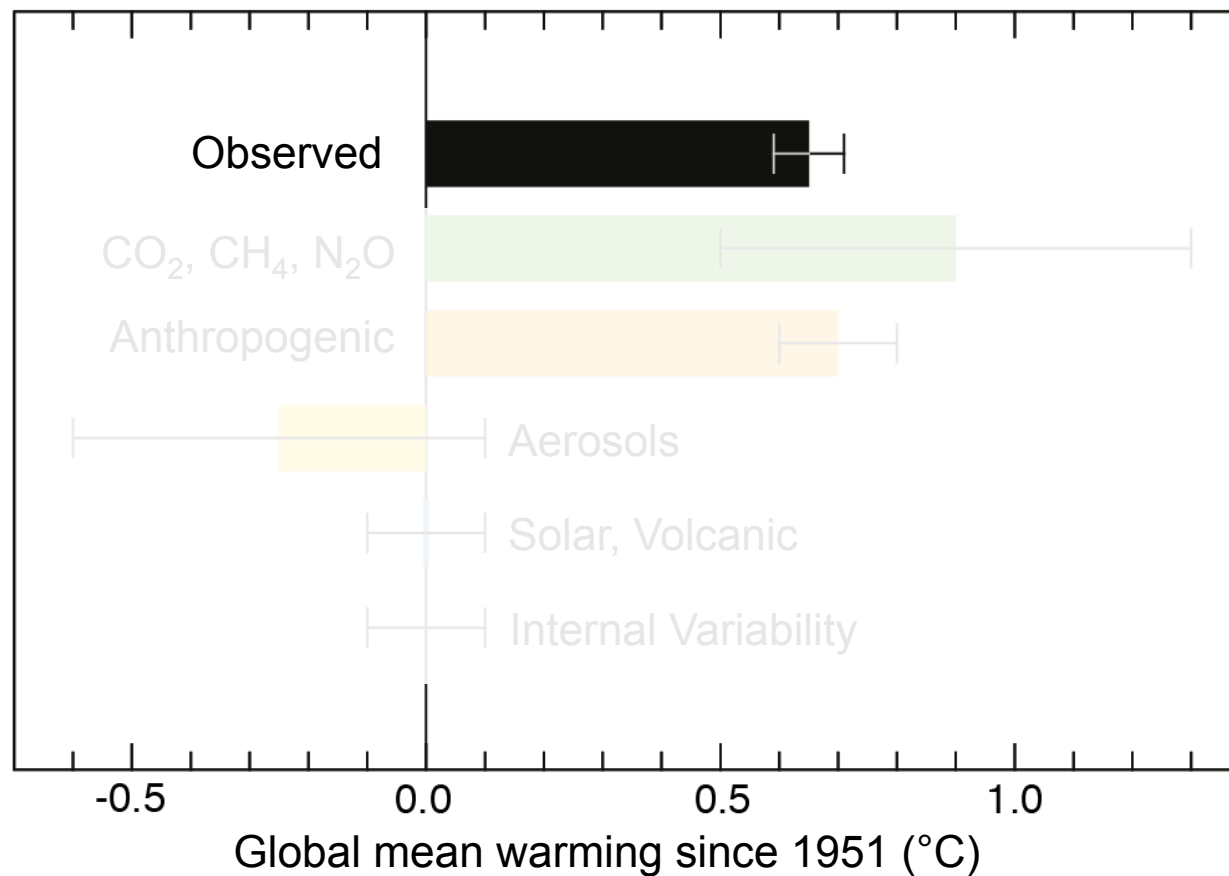
## Land surface



## Ocean heat content



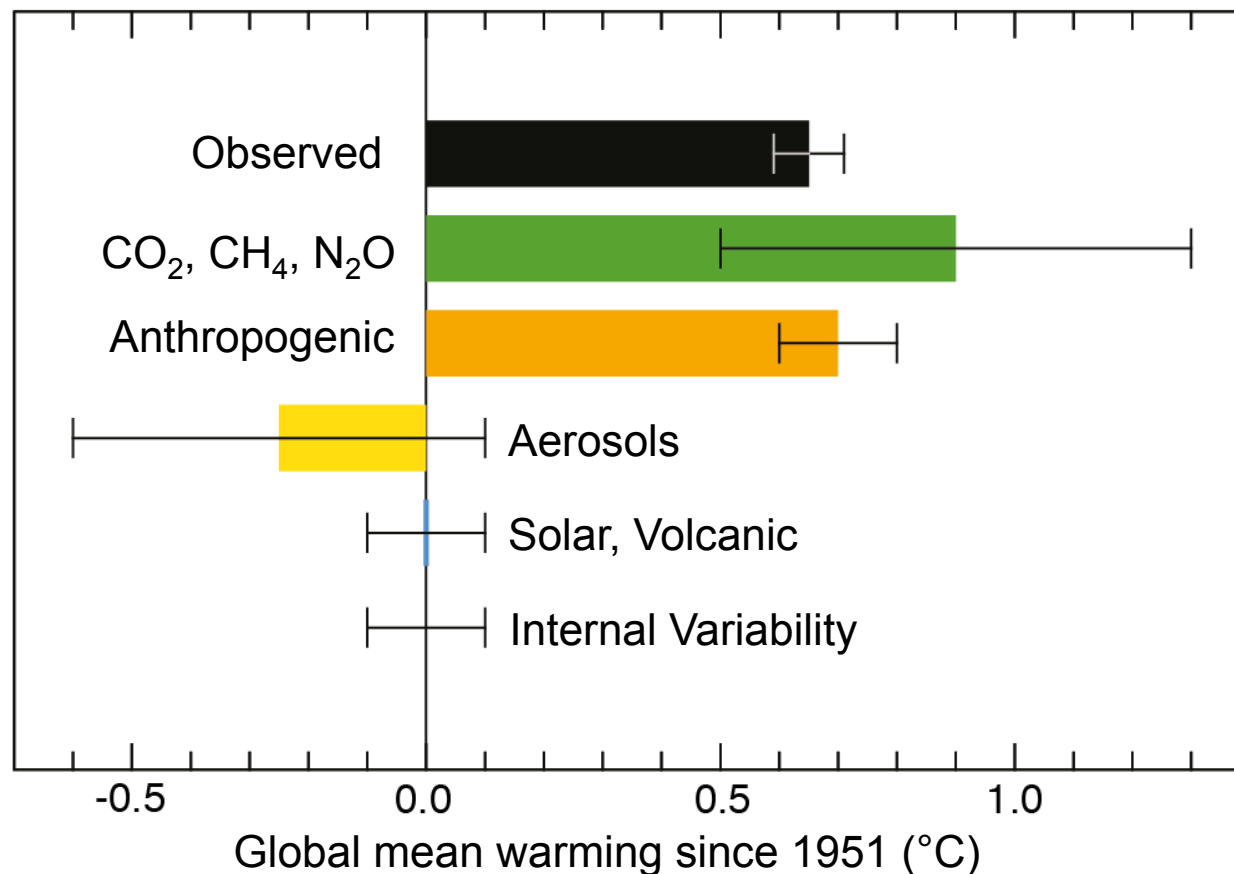
Human influence on the climate system is clear.



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Fig. TS.10

The observed warming 1951–2010 is approximately 0.6°C to 0.7°C.



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Fig. TS.10

It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century.



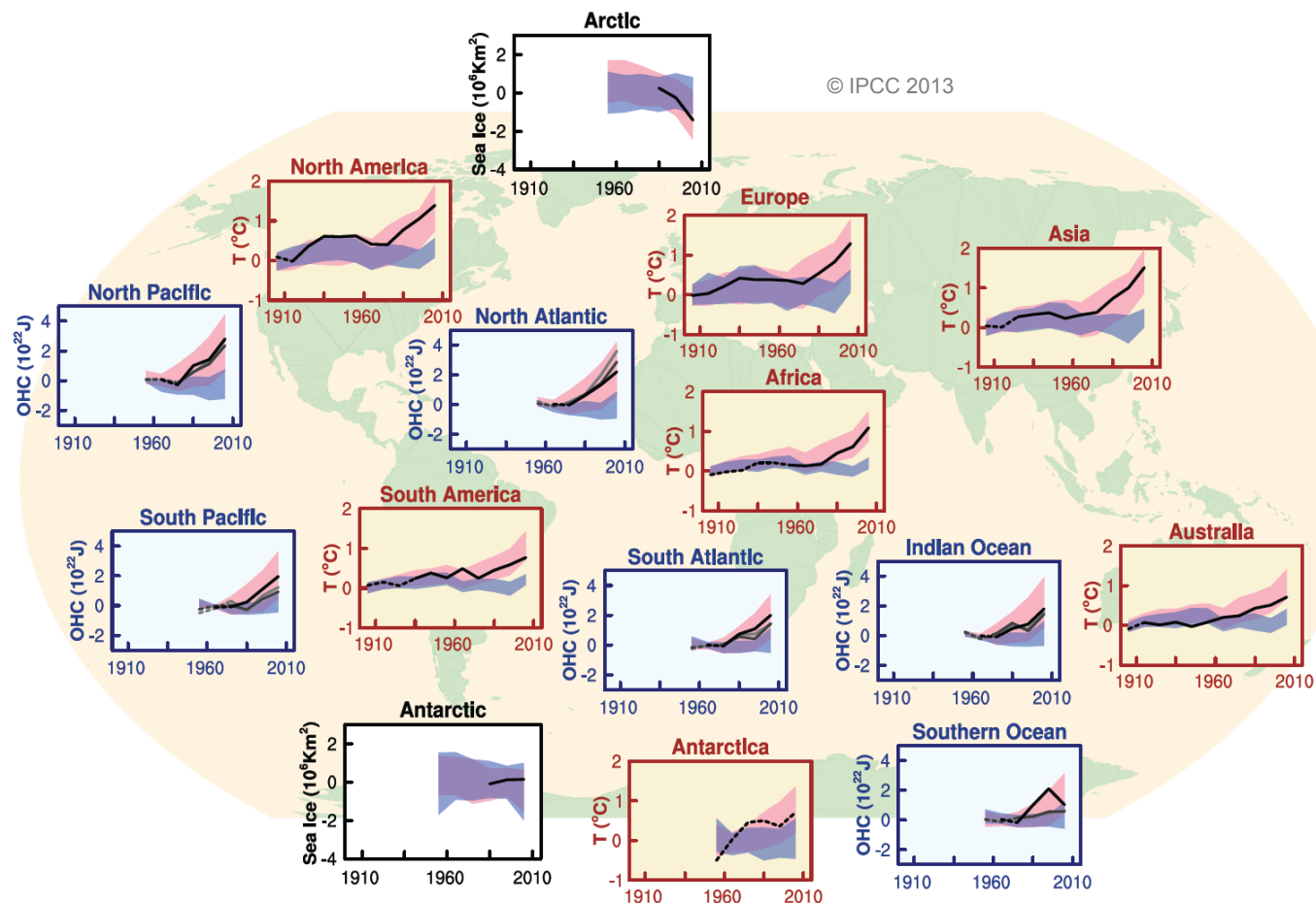


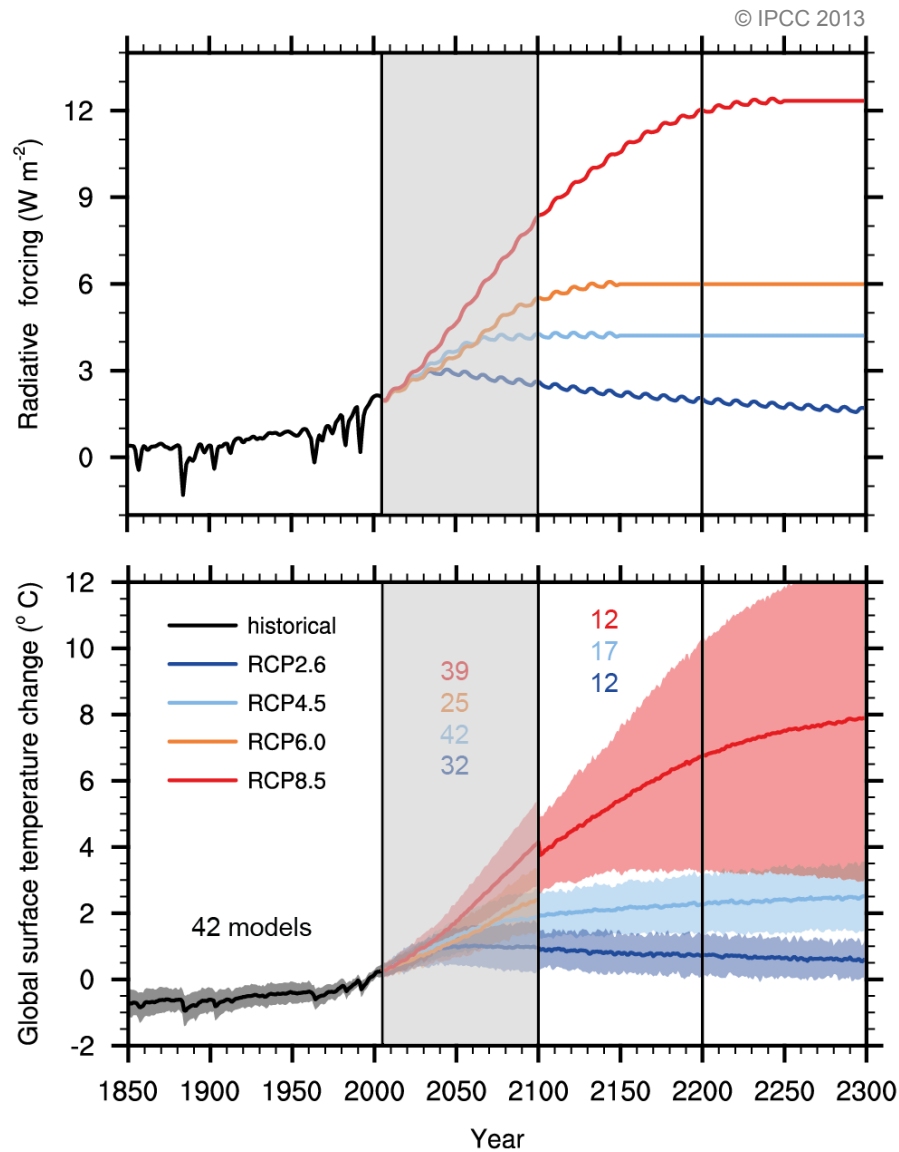
Fig. SPM.6

Human influence on the climate system is clear.

# Future

## How will it change?

# Scenarios of Future Climate



## Change in Surface Temperature 2016 - 2035      2081 - 2100

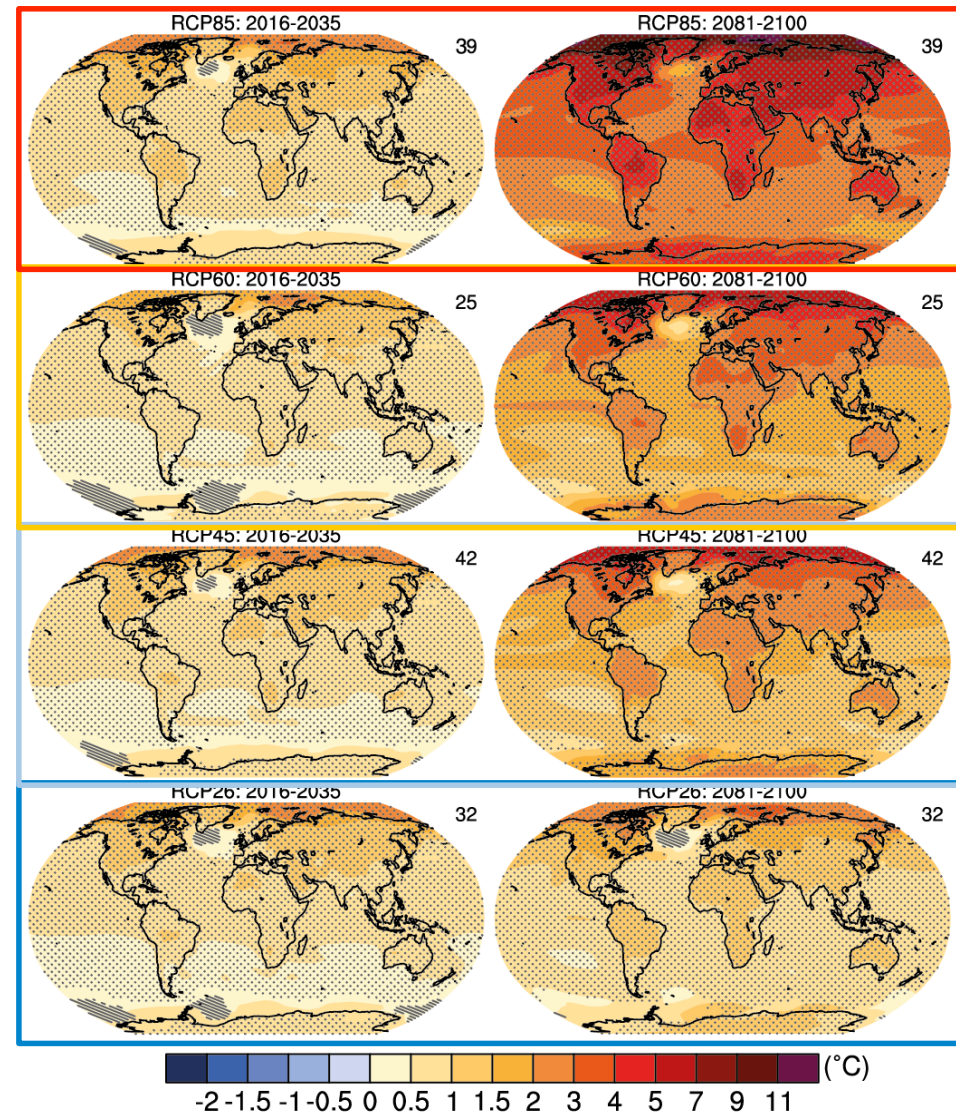


Fig. TS.15

## Global mean surface temperature change from 1986-2005

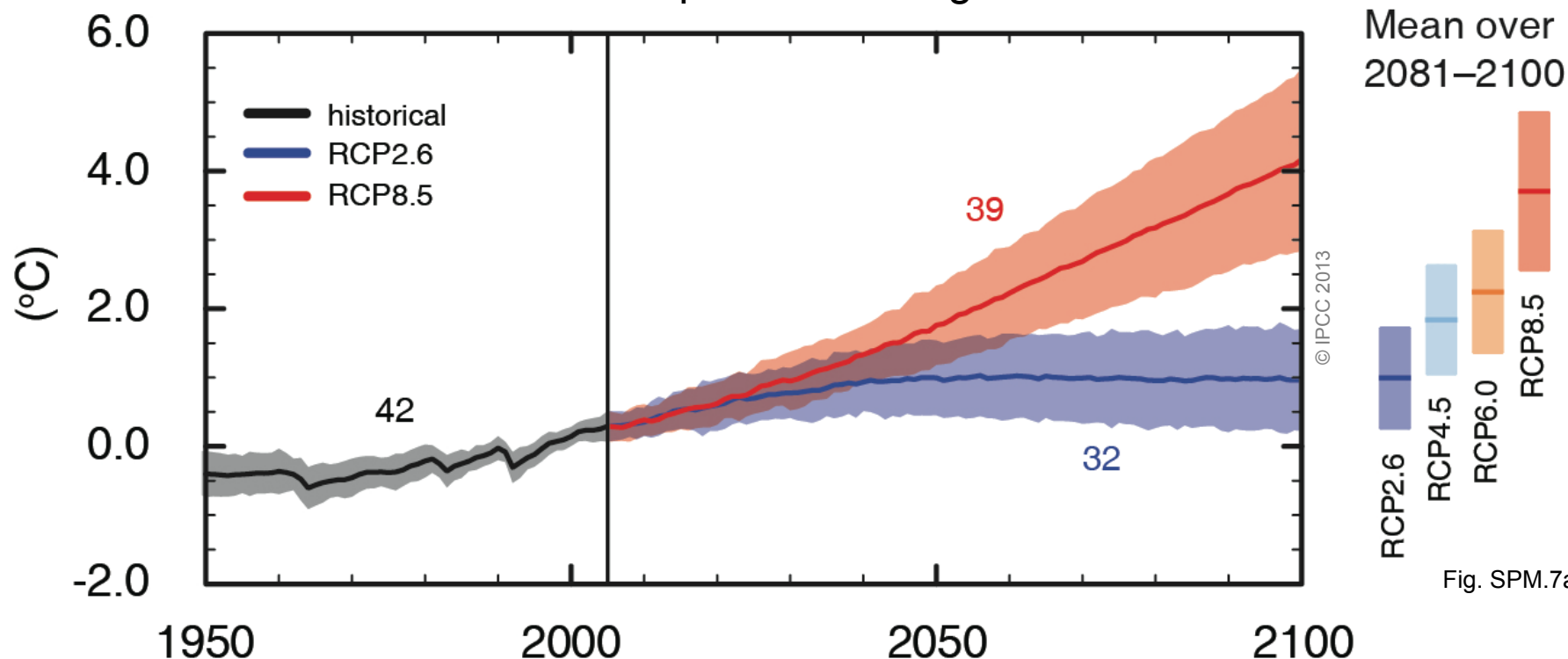


Fig. SPM.7a

Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850–1900 for all scenarios except RCP2.6.



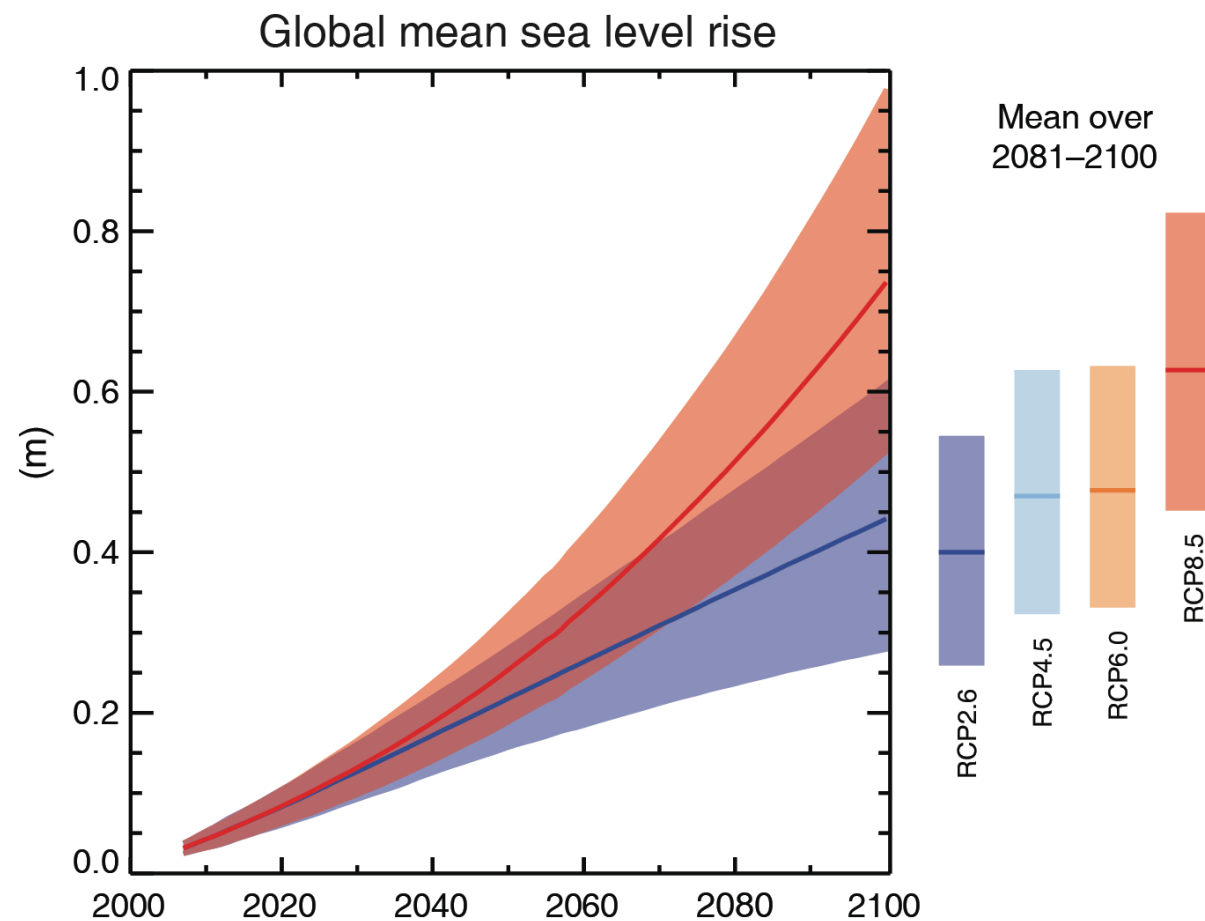


Fig. SPM.9

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

RCP8.5 (2081-2100), *likely* range: 45 to 82 cm

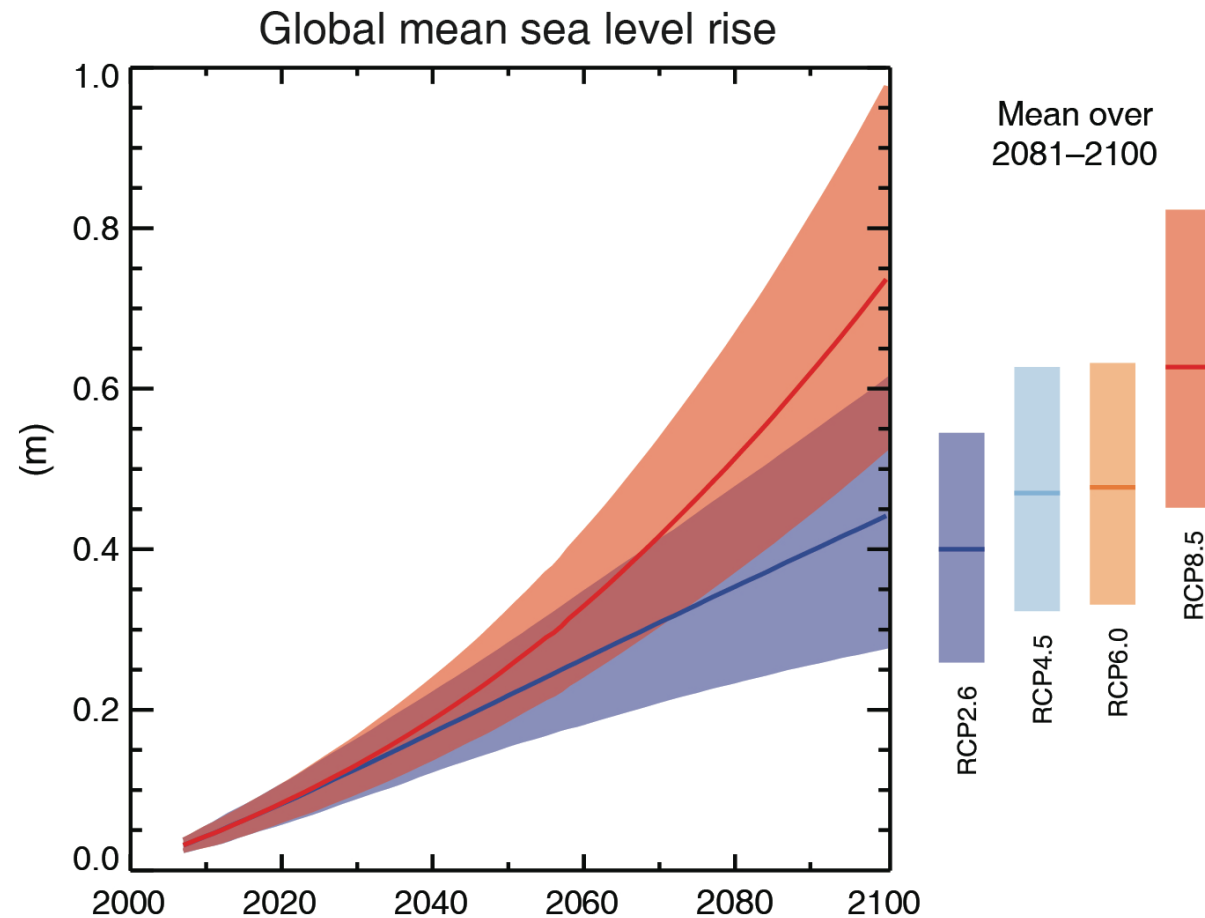
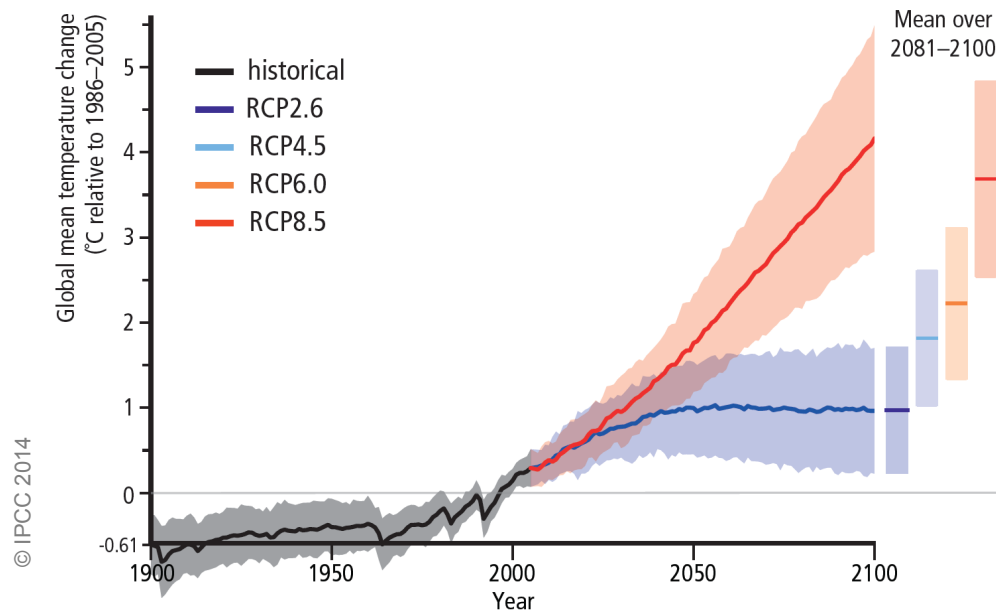


Fig. SPM.9

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

# Impacts of Climate Change

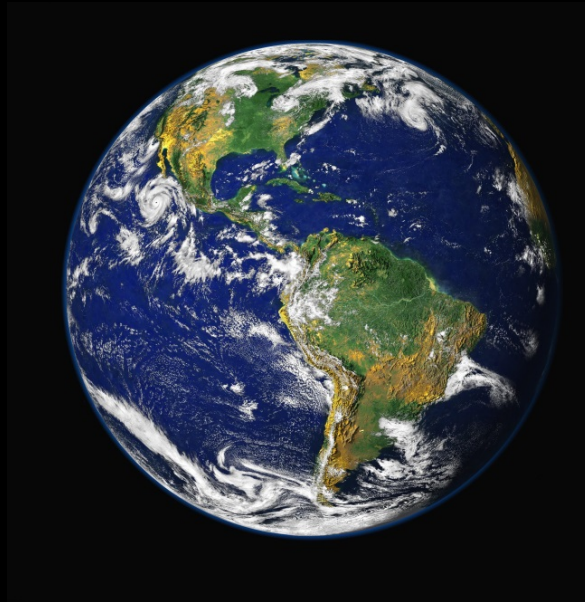
## Temperature Change



Adapted from Fig. SPM.7a

Adapted from WGII SPM Box Fig. 1

**Climate change will amplify existing risks and create new risks for natural and human systems.**



Cumulative emissions of CO<sub>2</sub> largely determine global mean surface warming by the late 21st century and beyond.

**Warming of 0.8 to 2.5°C**



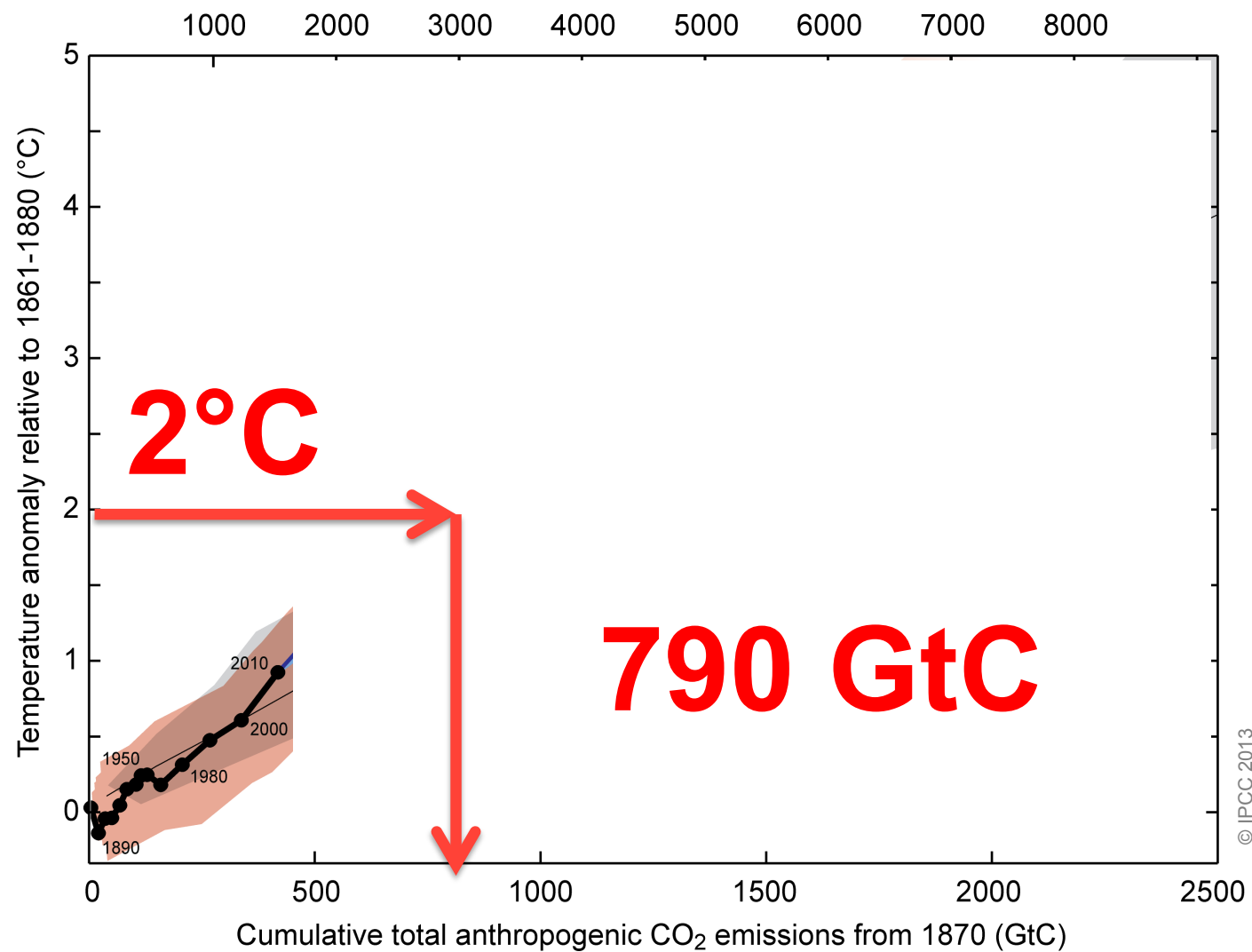
**Any climate target implies  
a limited carbon budget**



**1000 billion tons of carbon**



# Limiting human-induced warming



Budget for 2°C target:	790 bill t C
CO <sub>2</sub> emissions until 2015*:	–555 bill t C

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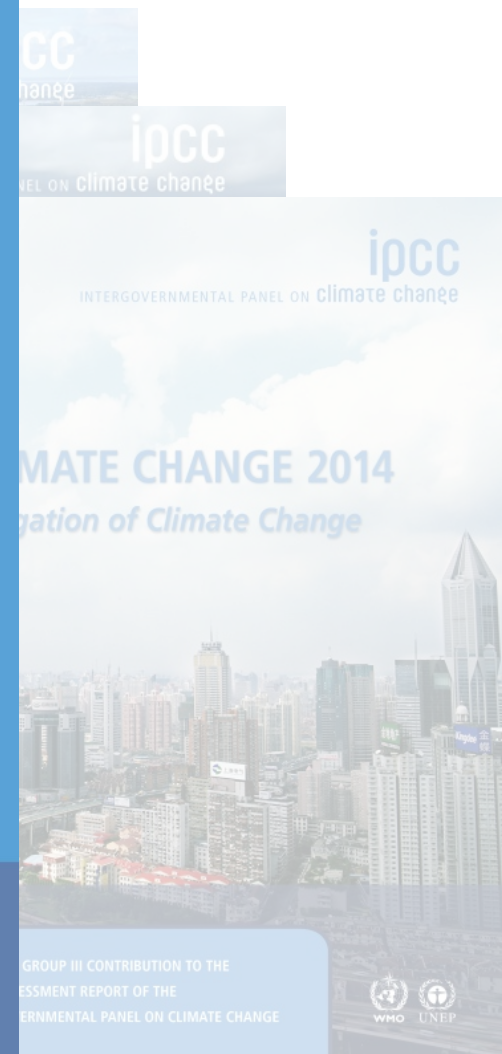
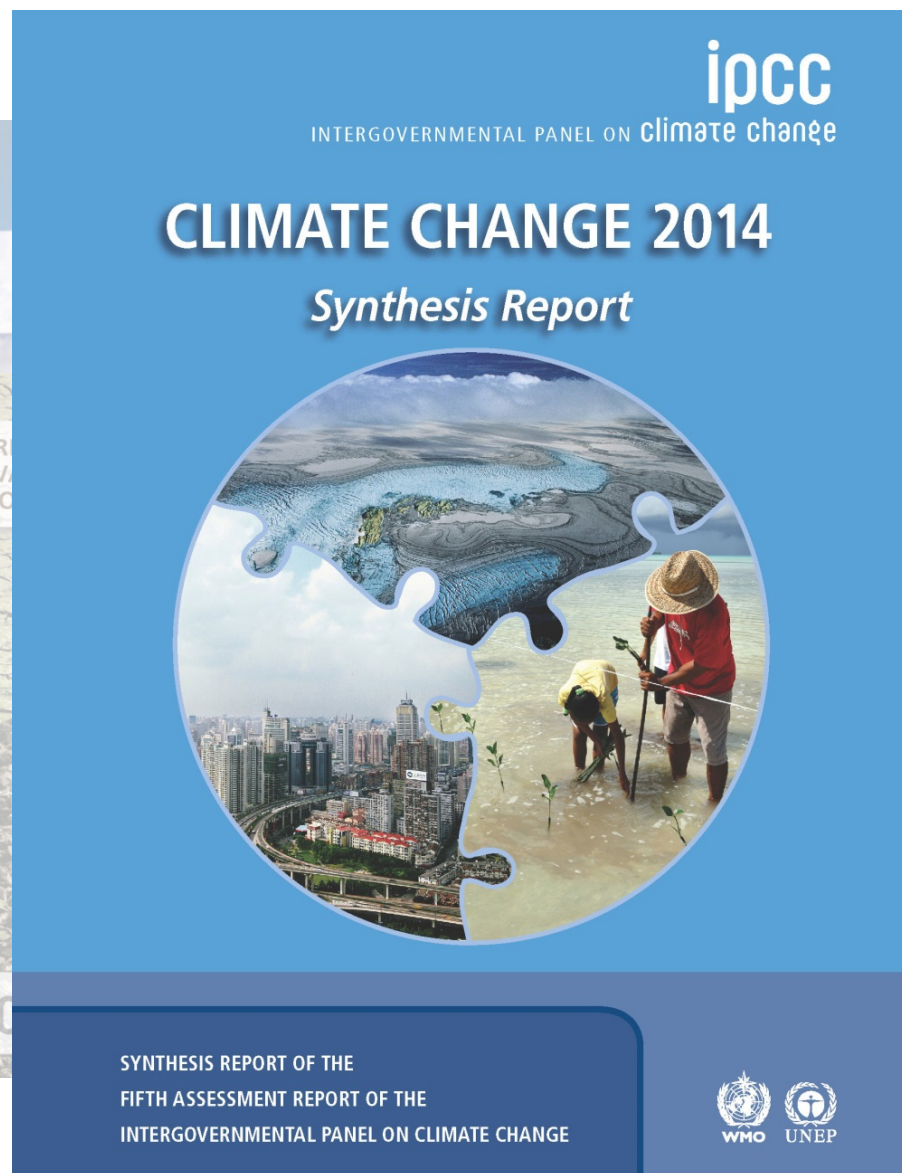
**Remaining CO<sub>2</sub> emissions: 235 bill t C**

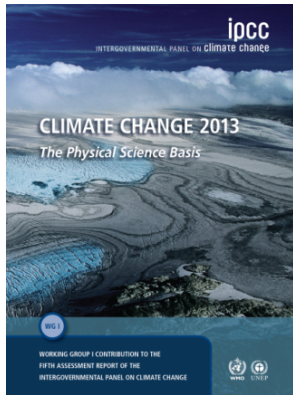
***CO<sub>2</sub> emissions in 2015\*:***                      ***9.7 bill t C***

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

\* updated from IPCC 2007, WGI SPM

# The 5<sup>th</sup> IPCC Assessment Report 2008 - 2014

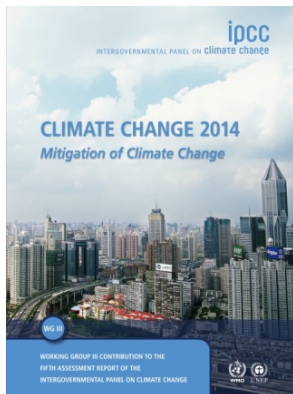




Human influence on the climate system is clear.

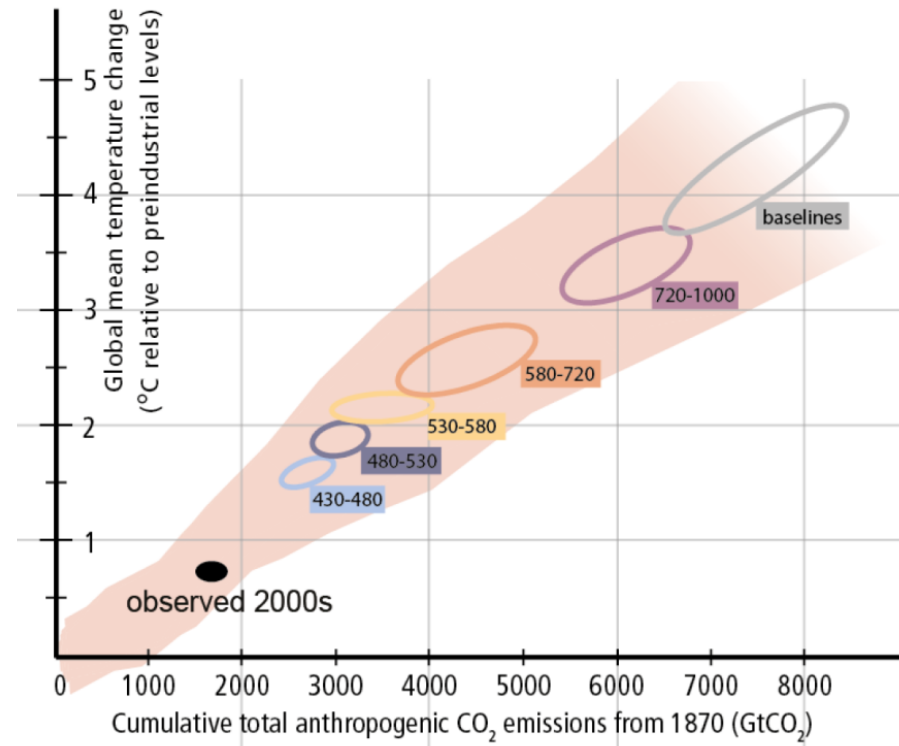


Changes in climate have caused impacts in natural and human systems.



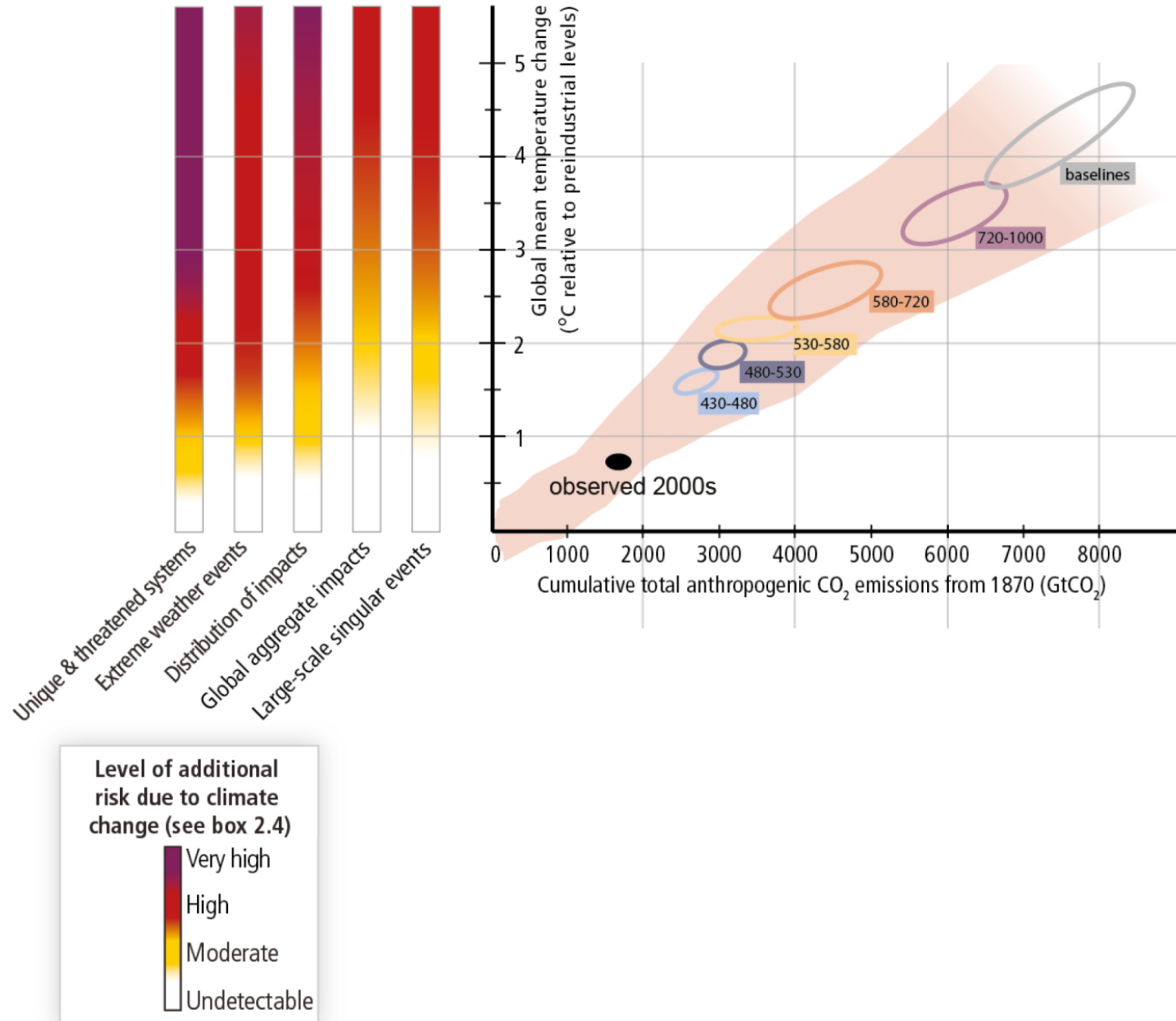
Continued GHG emissions will cause further warming and amplify existing risks.

Multiple pathways exist to *likely* limit warming to below 2°C.

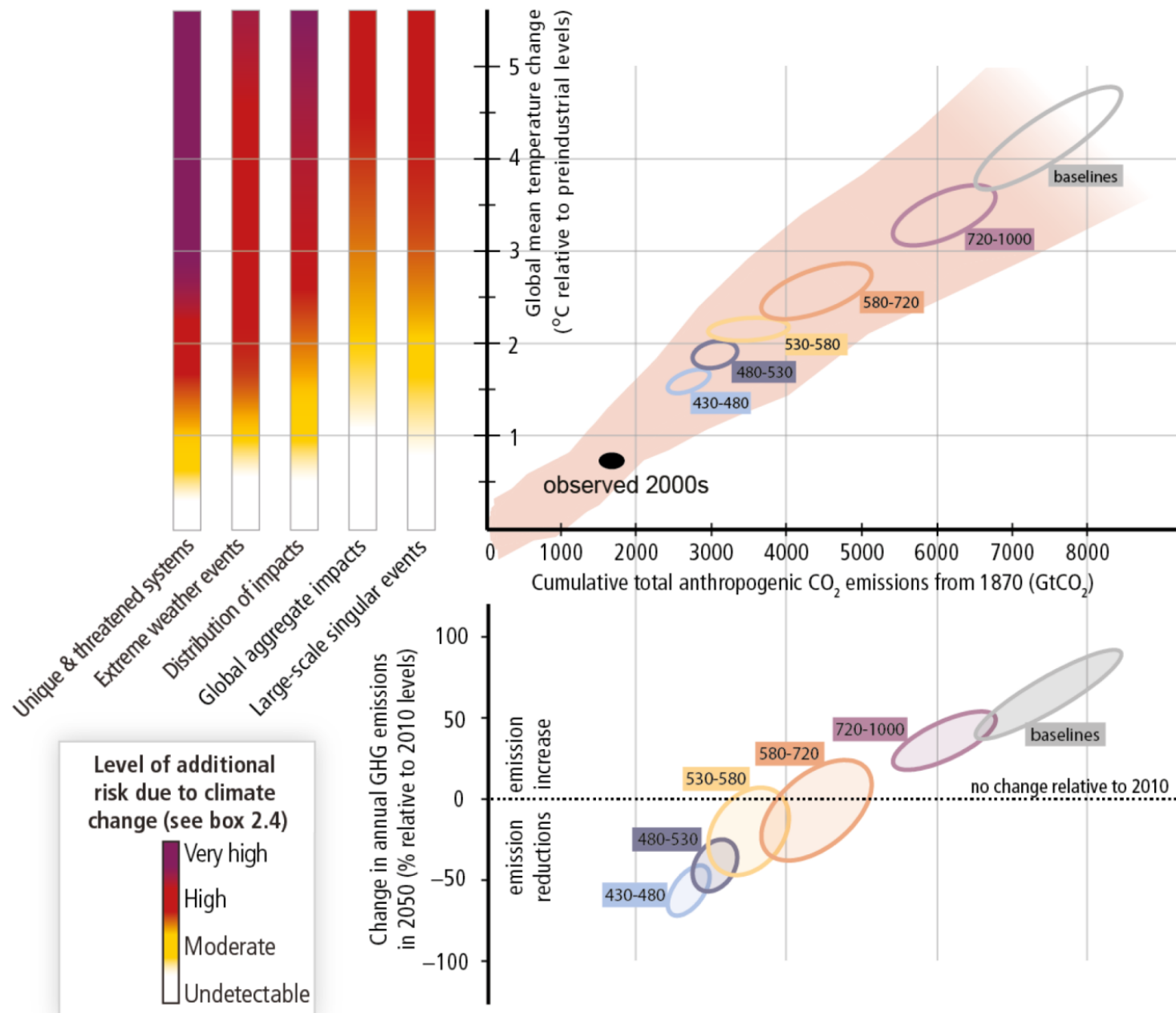


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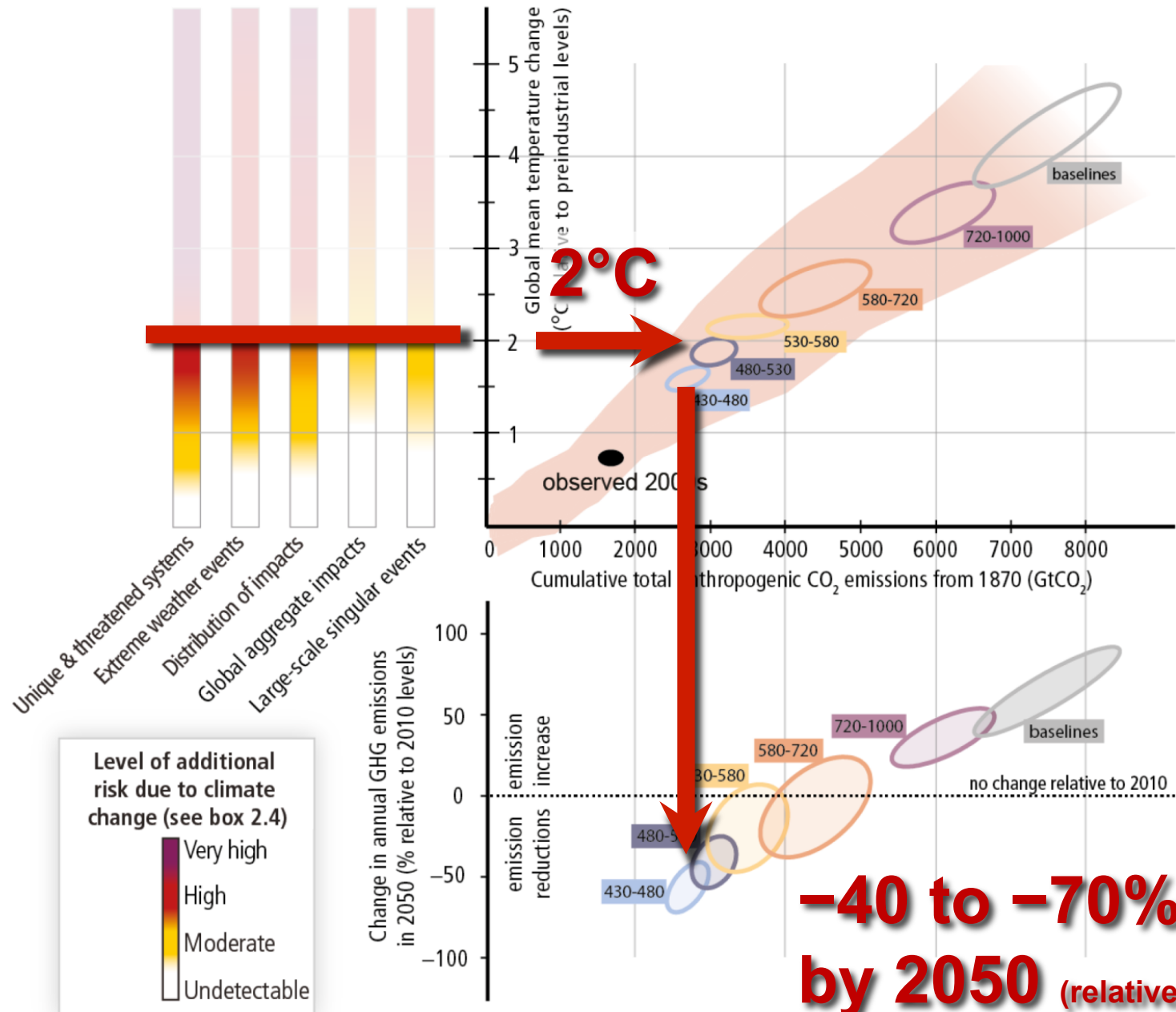




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**-40 to -70%  
by 2050 (relative to 2010)**

# 2°C world

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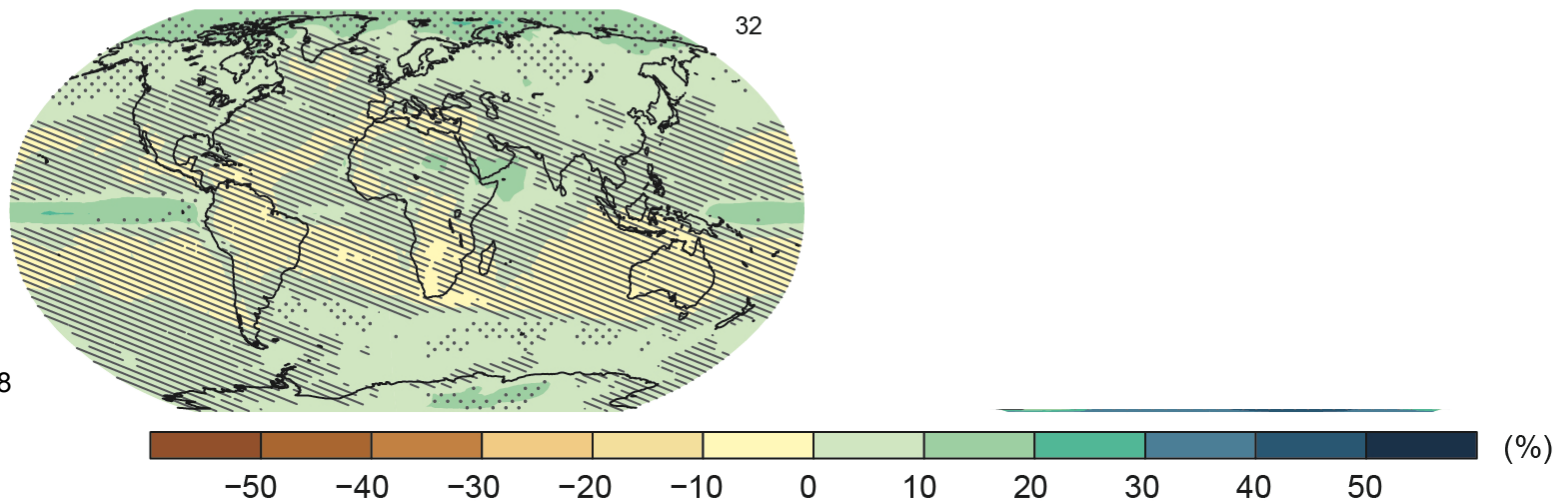
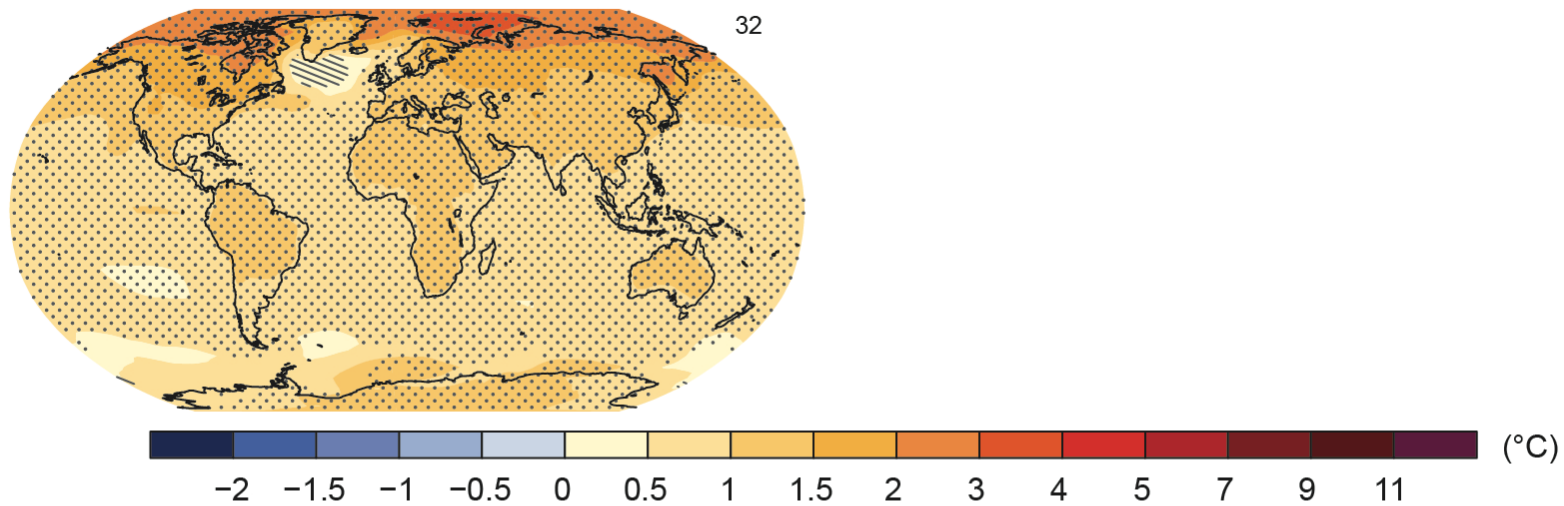


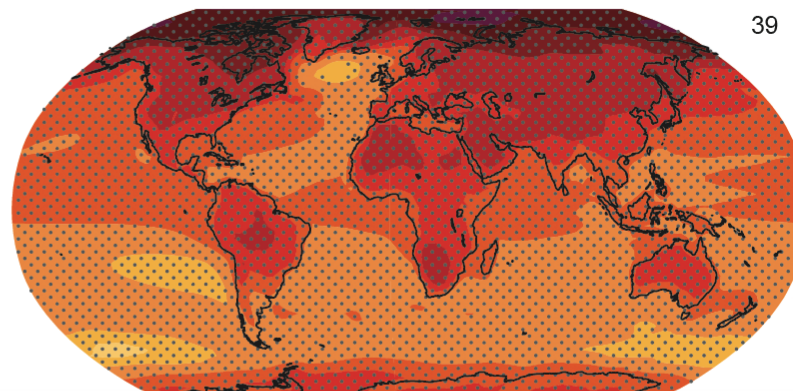
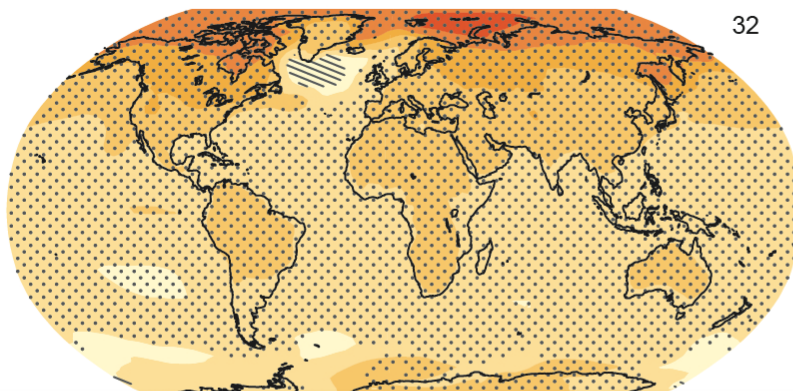
Fig. SPM.8

IPCC AR5  
Climate C



2°C world

4.5°C world



Today we have a choice.

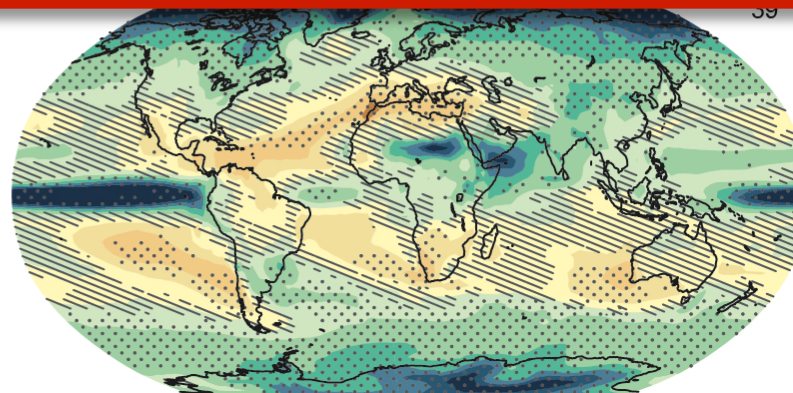
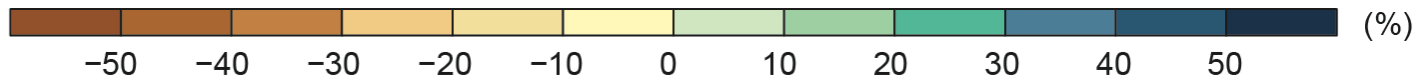


Fig. SPM.8





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Working Group I contribution to the IPCC Fifth Assessment Report

Further Information

[www.climatechange2013.org](http://www.climatechange2013.org)

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