Climate Change and Ecosystem Services in a Changing Climate

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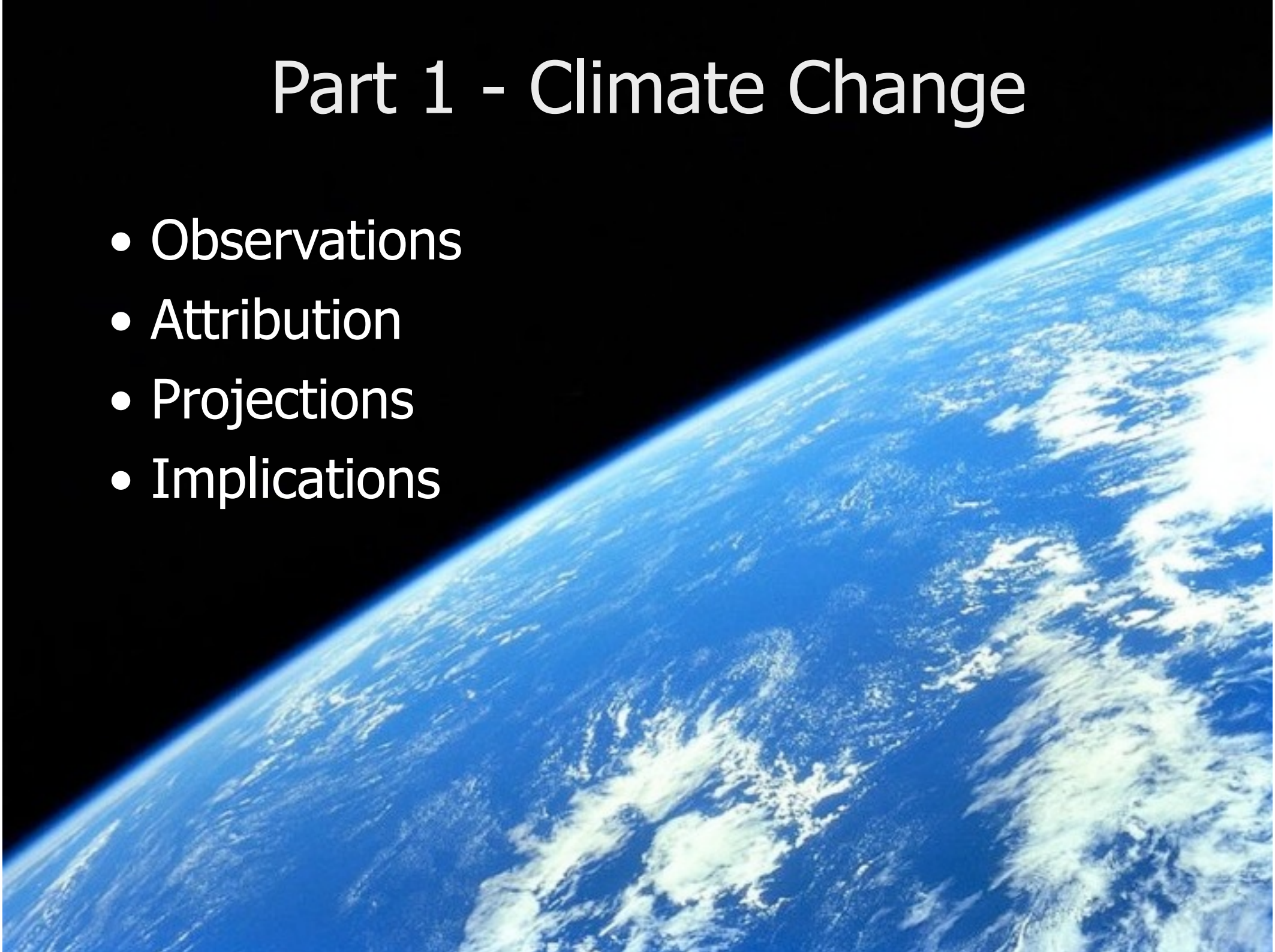
Please take home:

- The physical science basis is very robust
- Human caused warming is clear
- Risks can be managed via mitigation and up to some limits via adaptation
- Unless emissions are radically and soon reduced, warming will impact soon some ecosystems significantly, e.g. coral reefs or NH sea ice biome
- Unmitigated climate change as currently projected will exceed the adaptive capacities of most ecosystems and thus would come with most severe impacts on their structure, functioning, and services

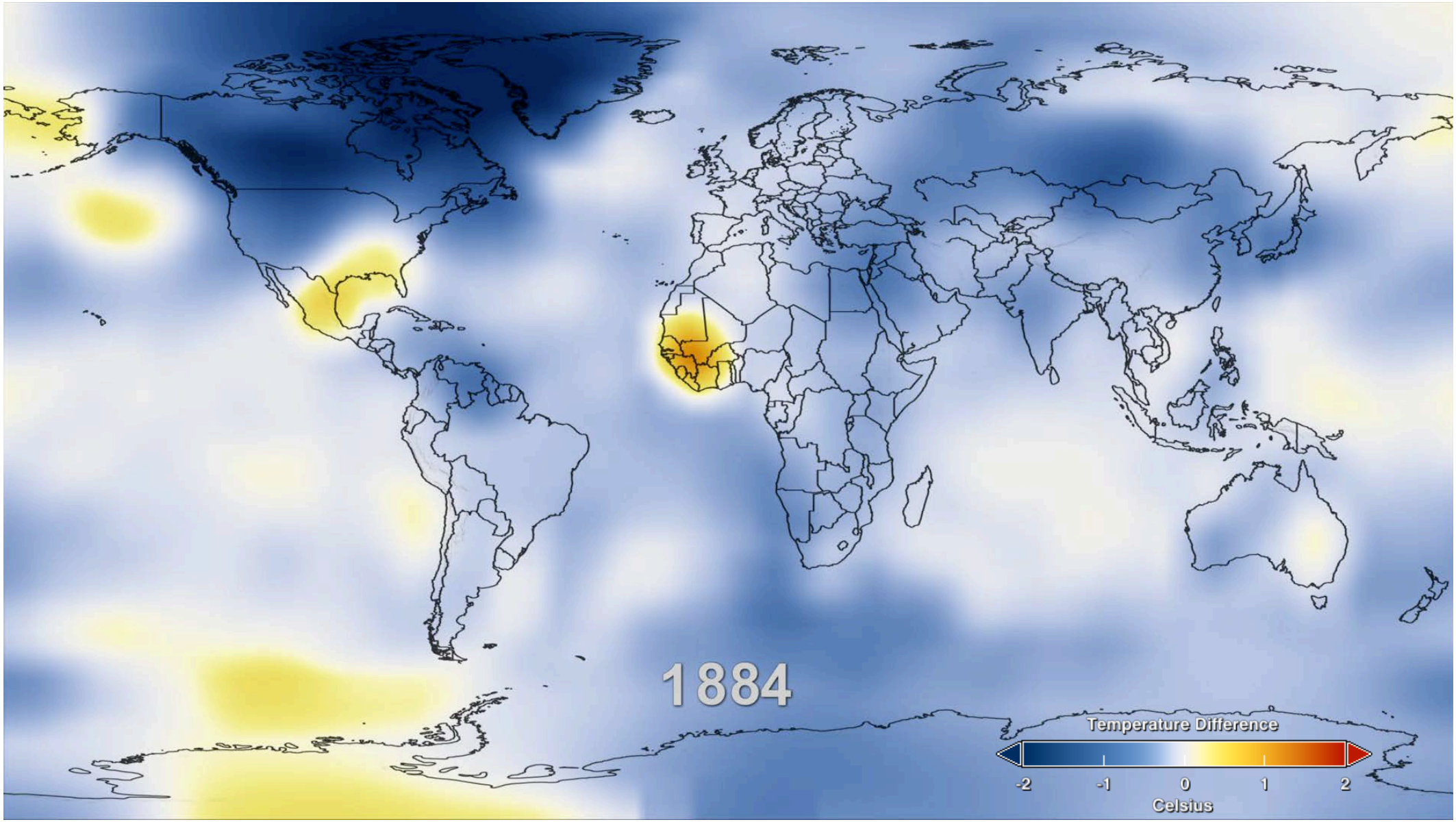
Part 1 - Climate Change

- Observations
- Attribution
- Projections
- Implications



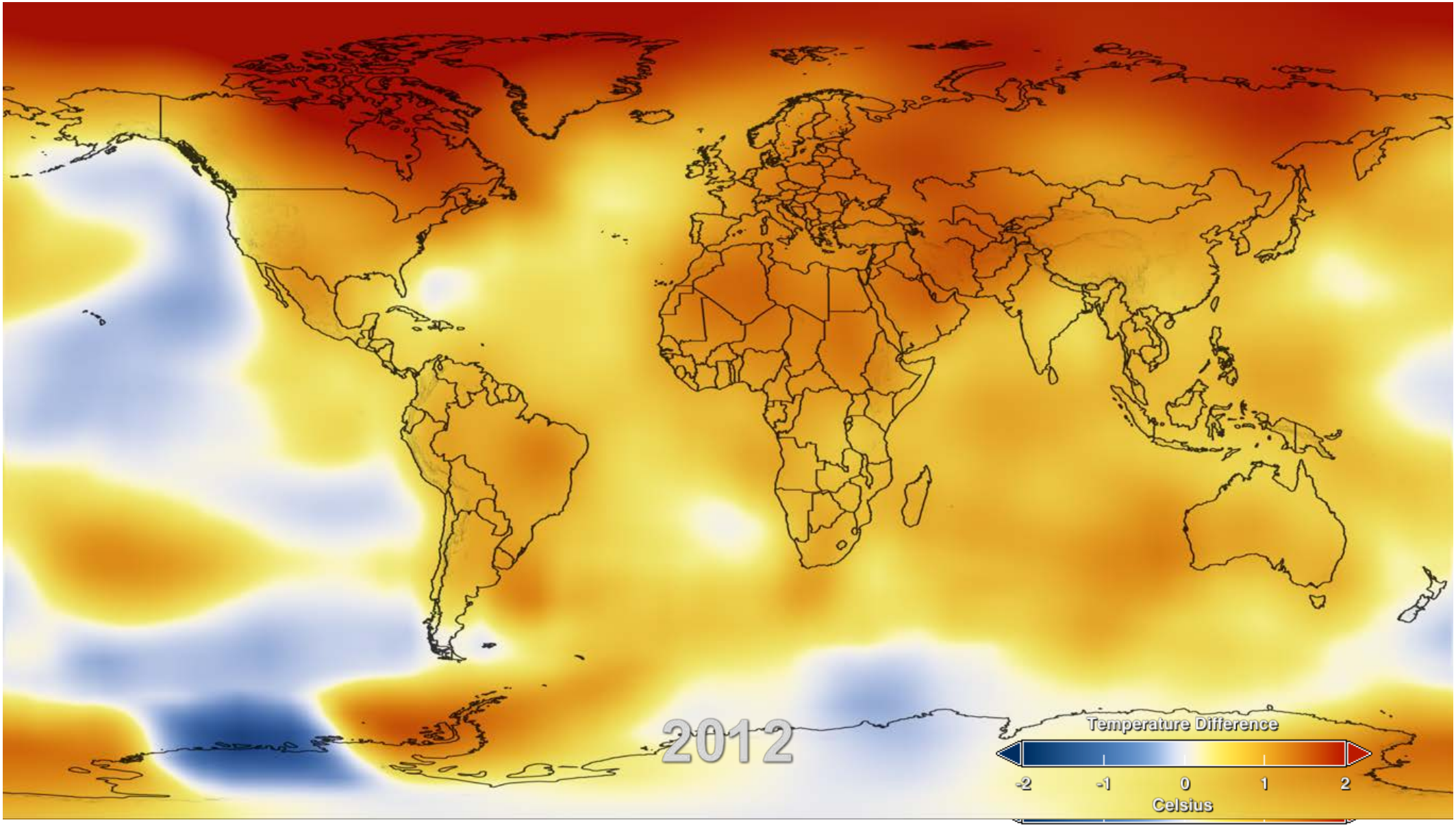
Observations

Warming in the instrumental period



NASA Goddard Space Flight Center Scientific Visualization Studio

Warming in the instrumental period



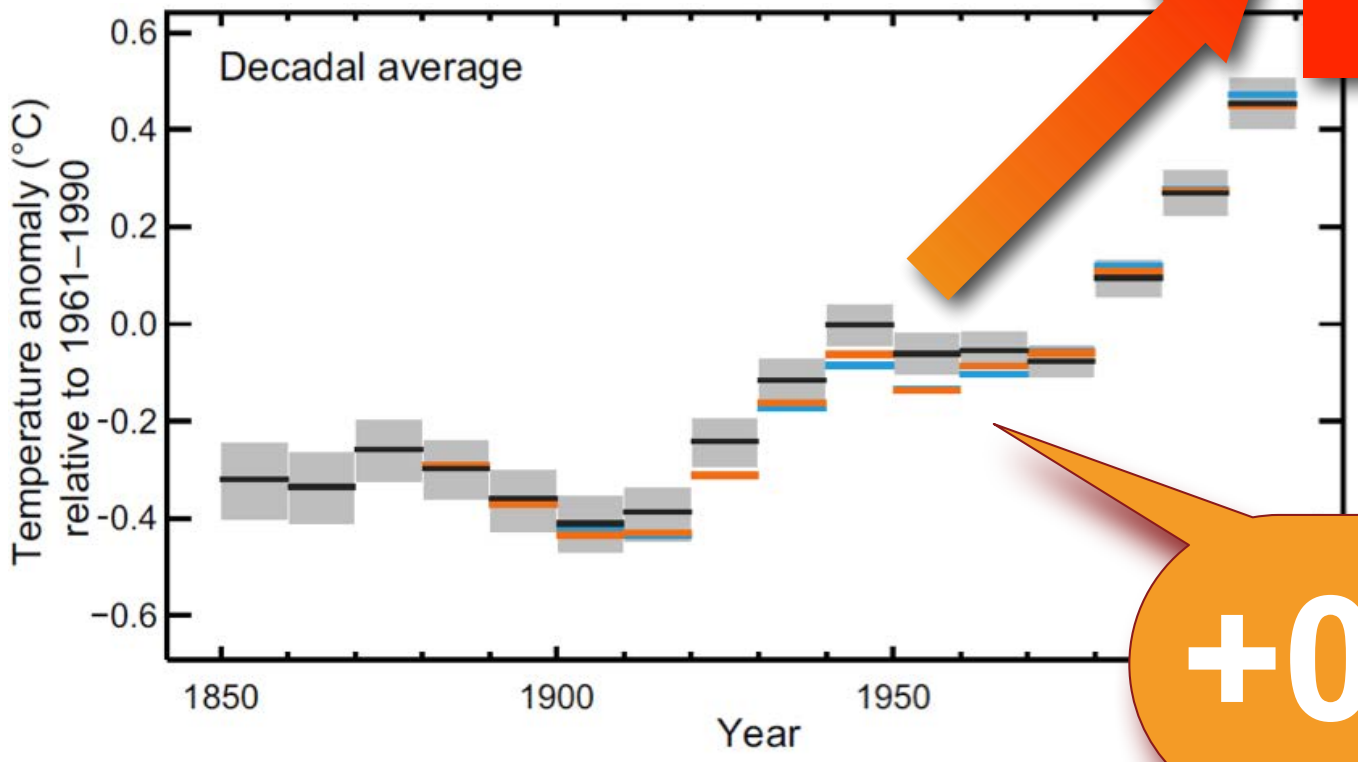
NASA Goddard Space Flight Center Scientific Visualization Studio

Warming of climate system is unequivocal

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).

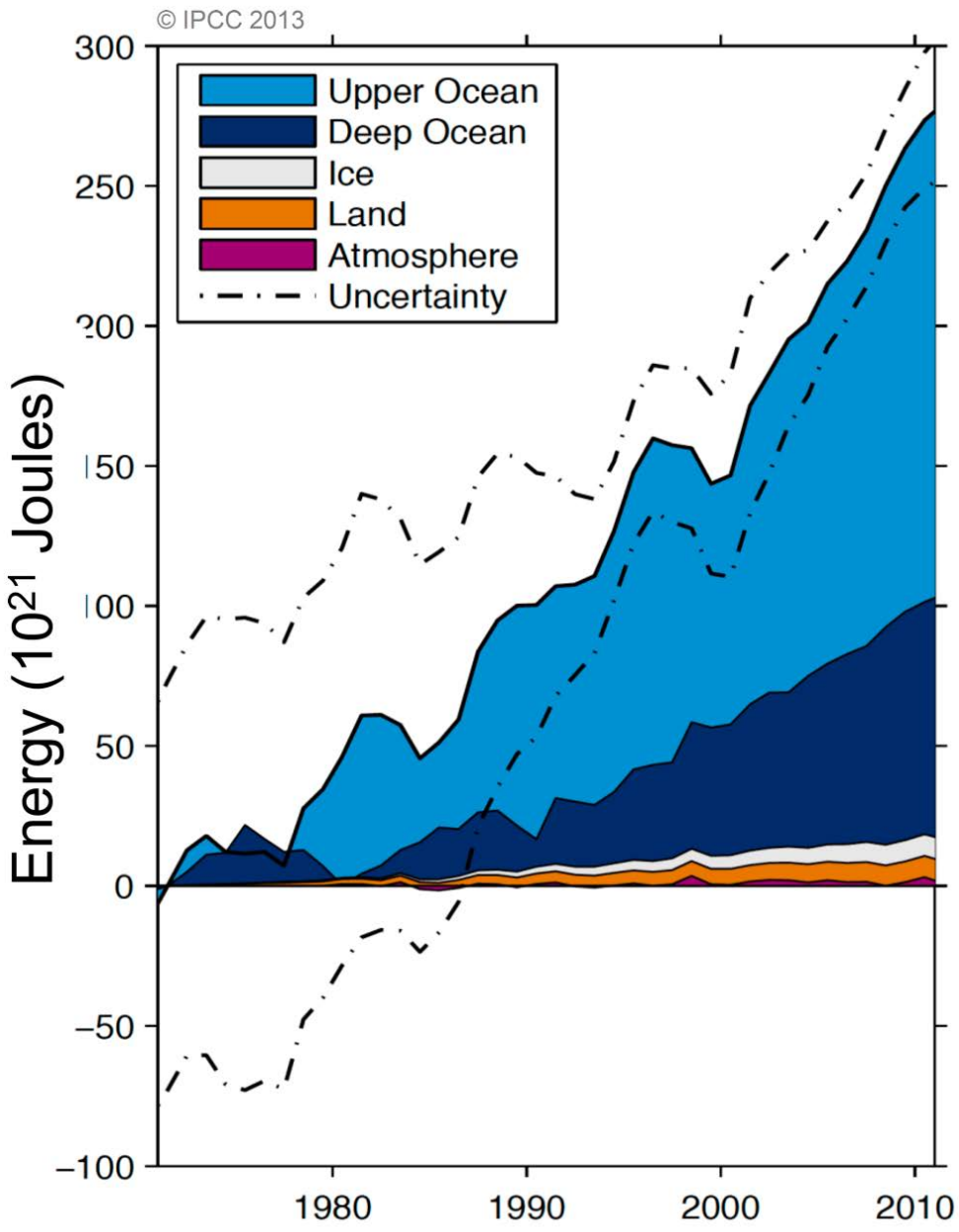
Clear warming trend



Summary for Policymakers in the contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.1(b)

+0.85°C

Where did the heat go?

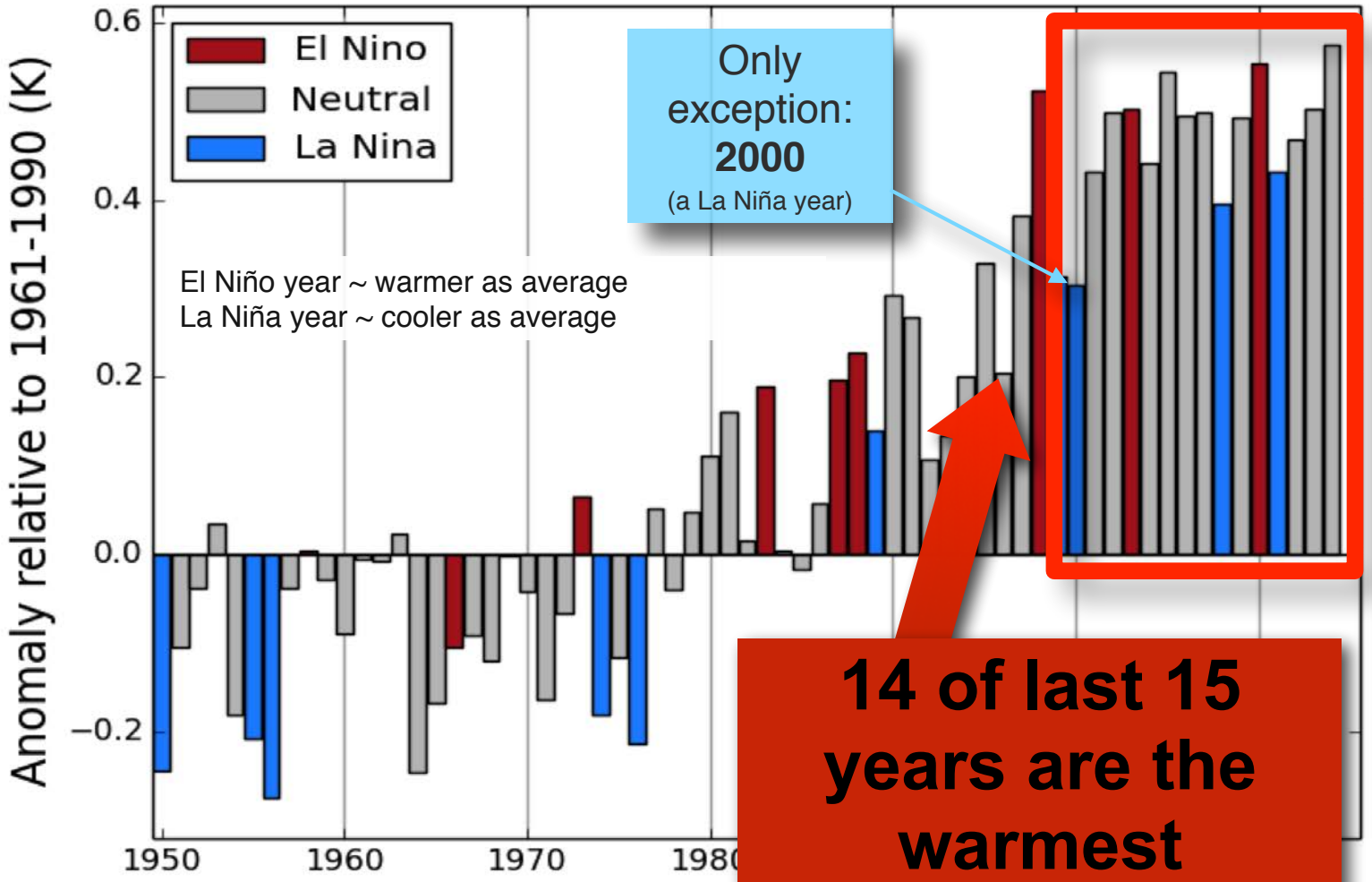


Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (high confidence).

It is virtually certain that the upper ocean (0–700 m) warmed from 1971 to 2010, and it likely warmed between the 1870s and 1971.

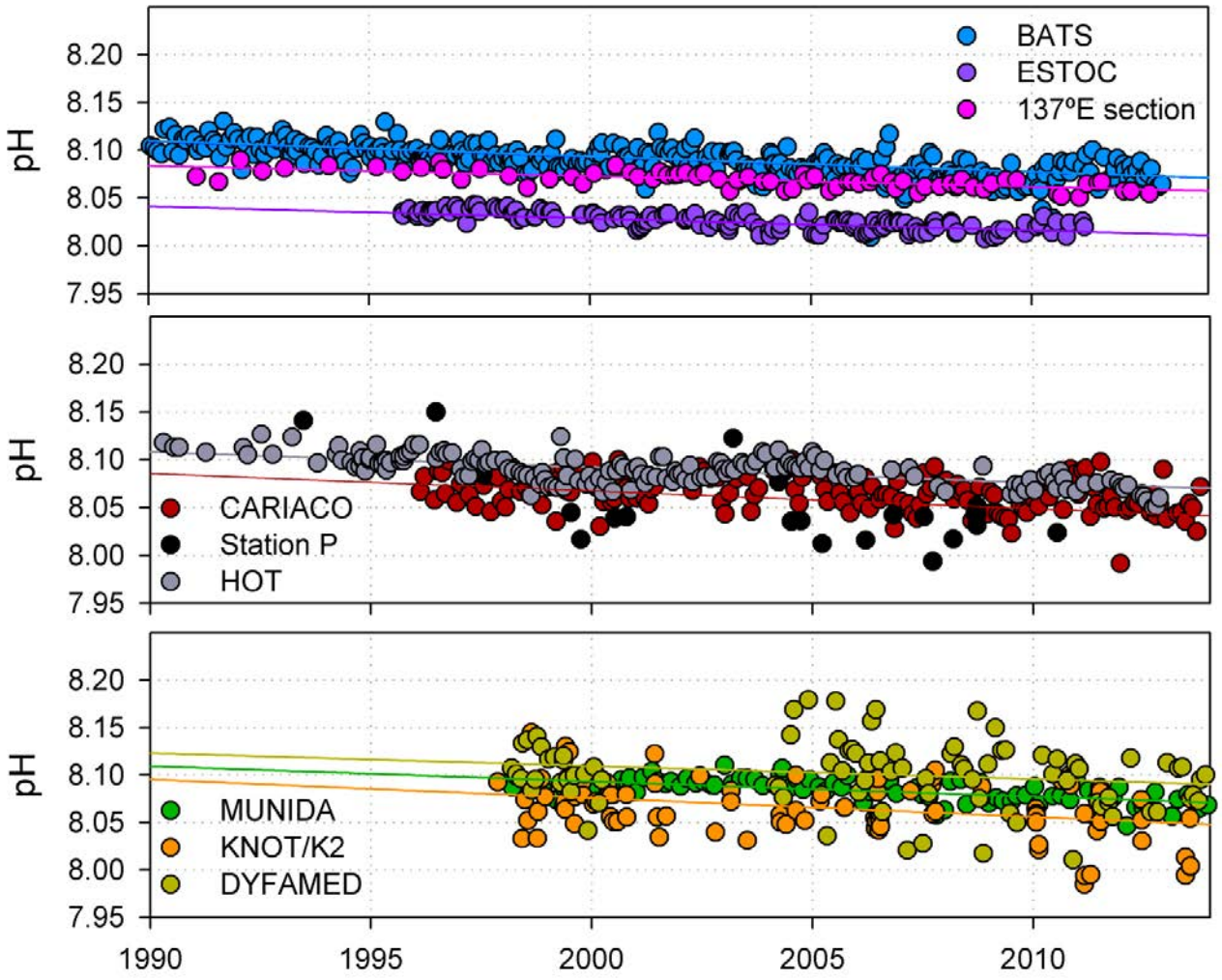
IPCC, 2014. Synthesis Report, Figure SPM.10

The last 15 years (alleged “hiatus”)



WMO 2015, kombinierte Daten aus NOAA-NASA -UK Datensätzen

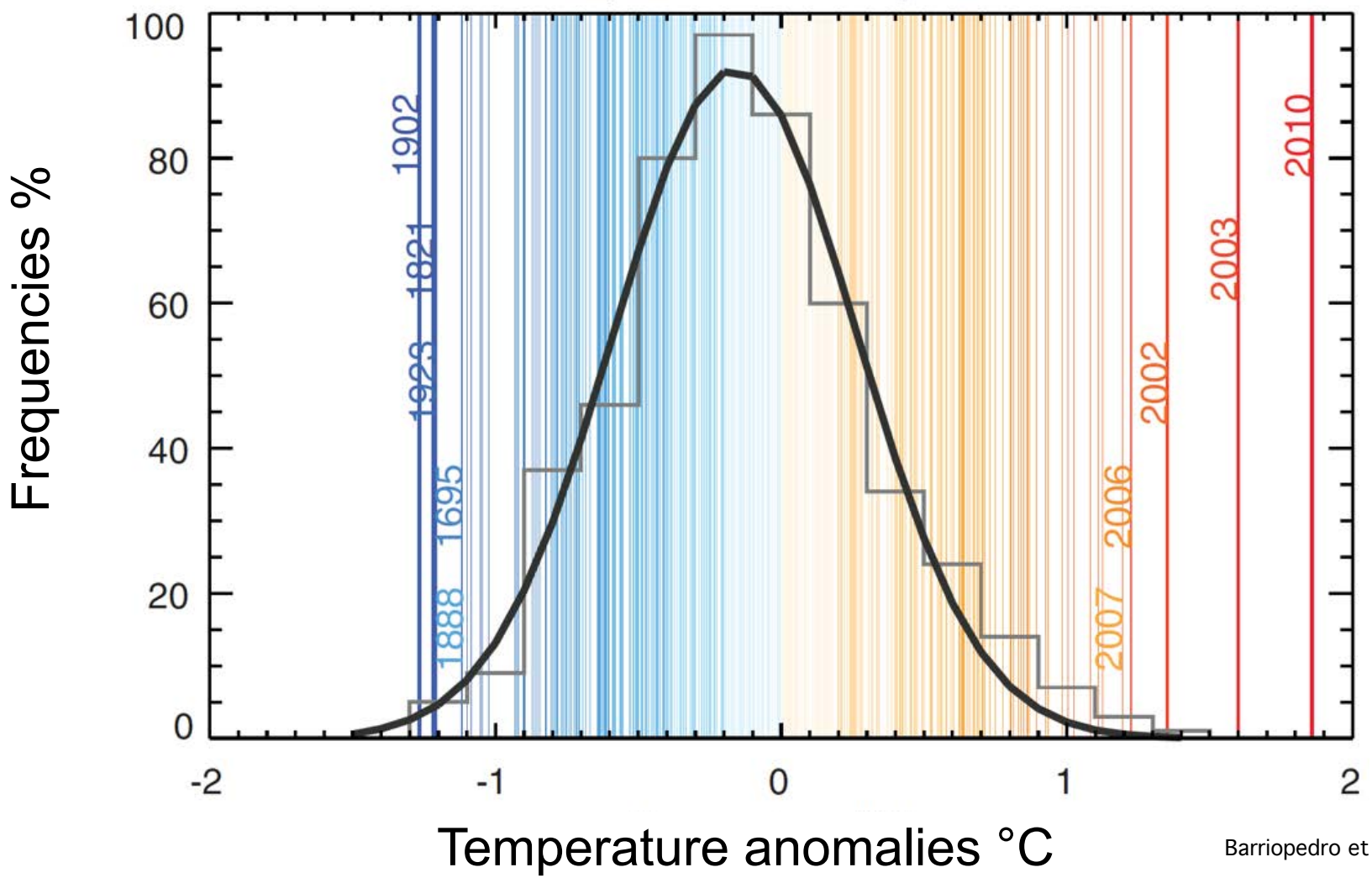
Ocean show clear trends of acidification



WMO, 2014. The state of greenhouse gases in the atmosphere based on global observations through 2013

The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification.

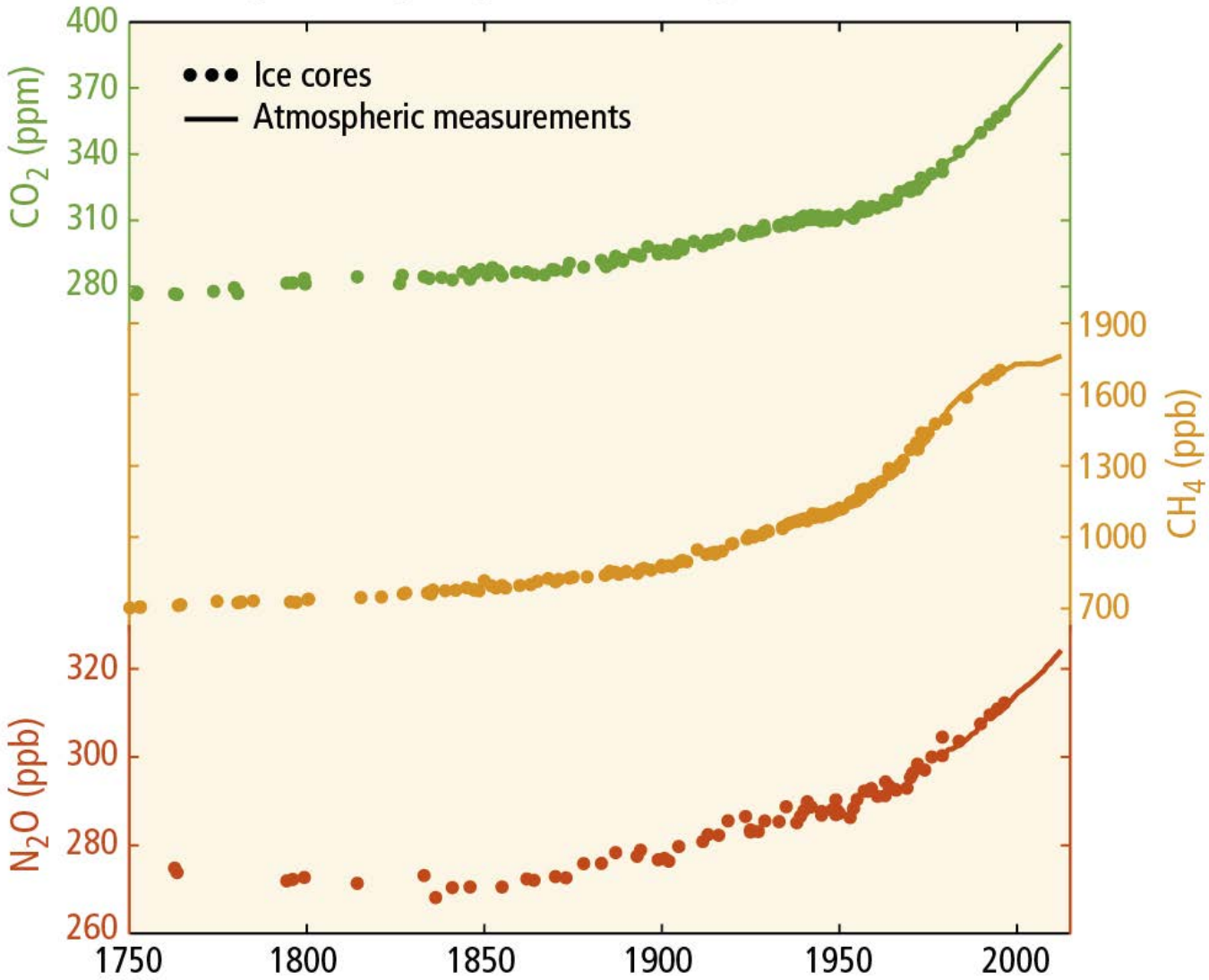
Some extreme events have become more frequent
Ex.: Summer Temperatures in Europe



Barriopedro et al., 2011. Science


Attribution

Globally averaged greenhouse gas concentrations

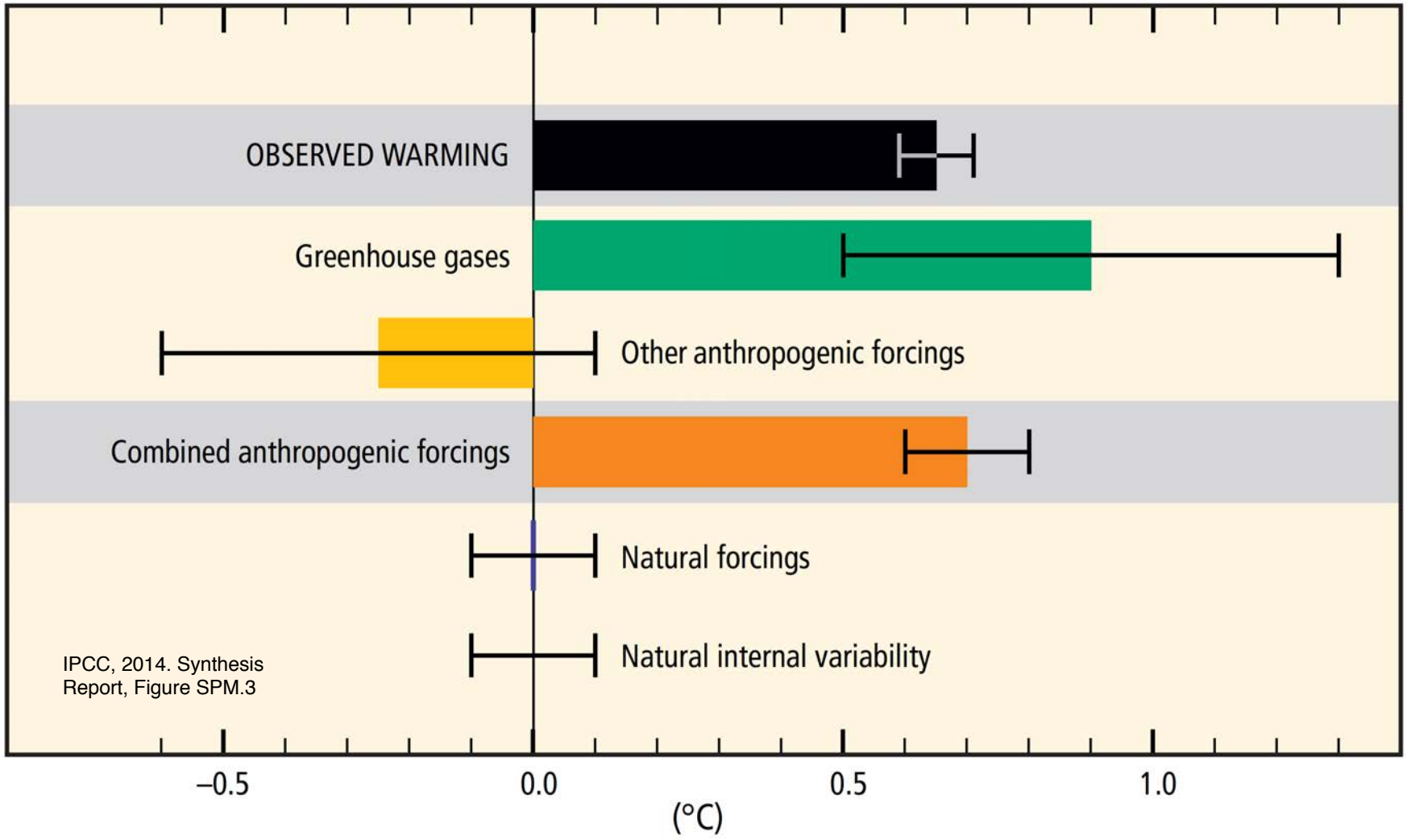


Atmospheric concentrations of CO2, CH4, and N2O have increased to levels unprecedented in at least the last 800,000 years.

Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions.

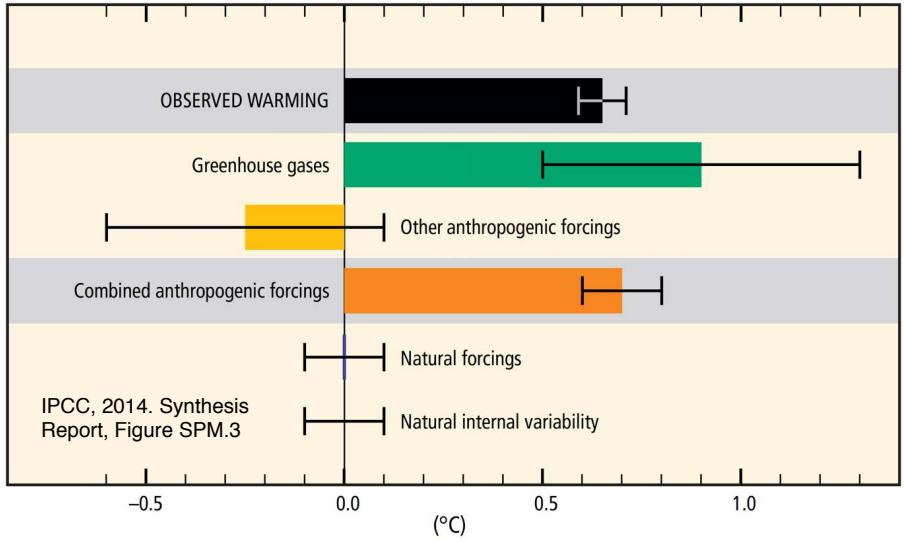
The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification.

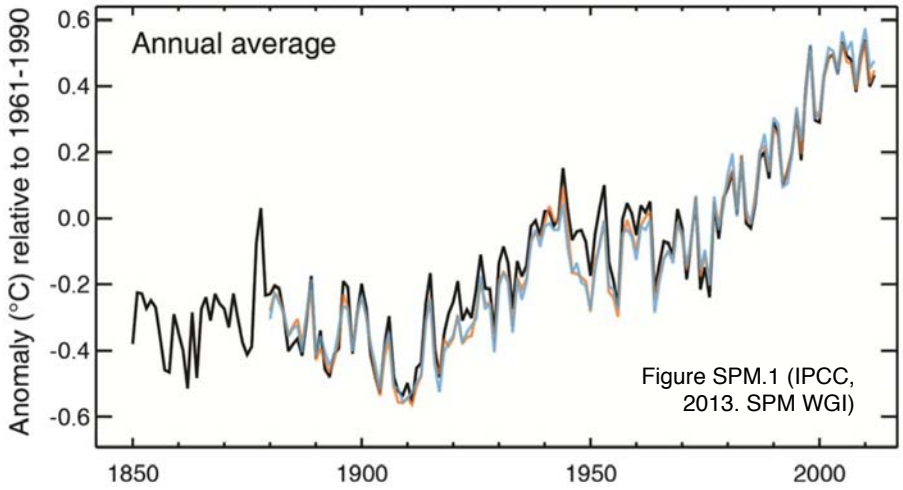
Contributions to observed surface temperature change over the period 1951–2010



IPCC, 2014. Synthesis Report, Figure SPM.3

Contributions to observed surface temperature change over the period 1951–2010





Human influence on the climate system is clear.

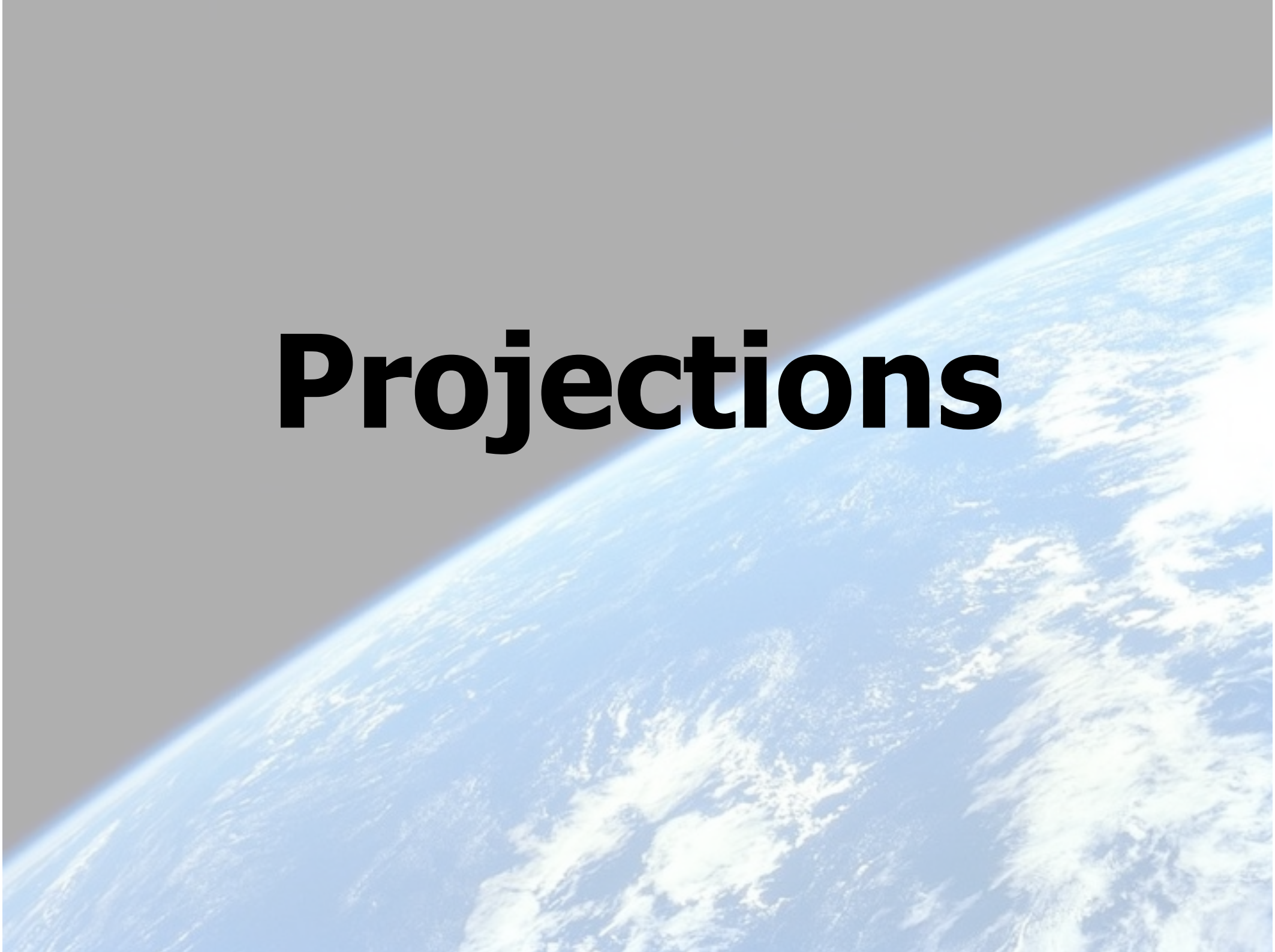
This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.

Human influence on the climate system is clear

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4.

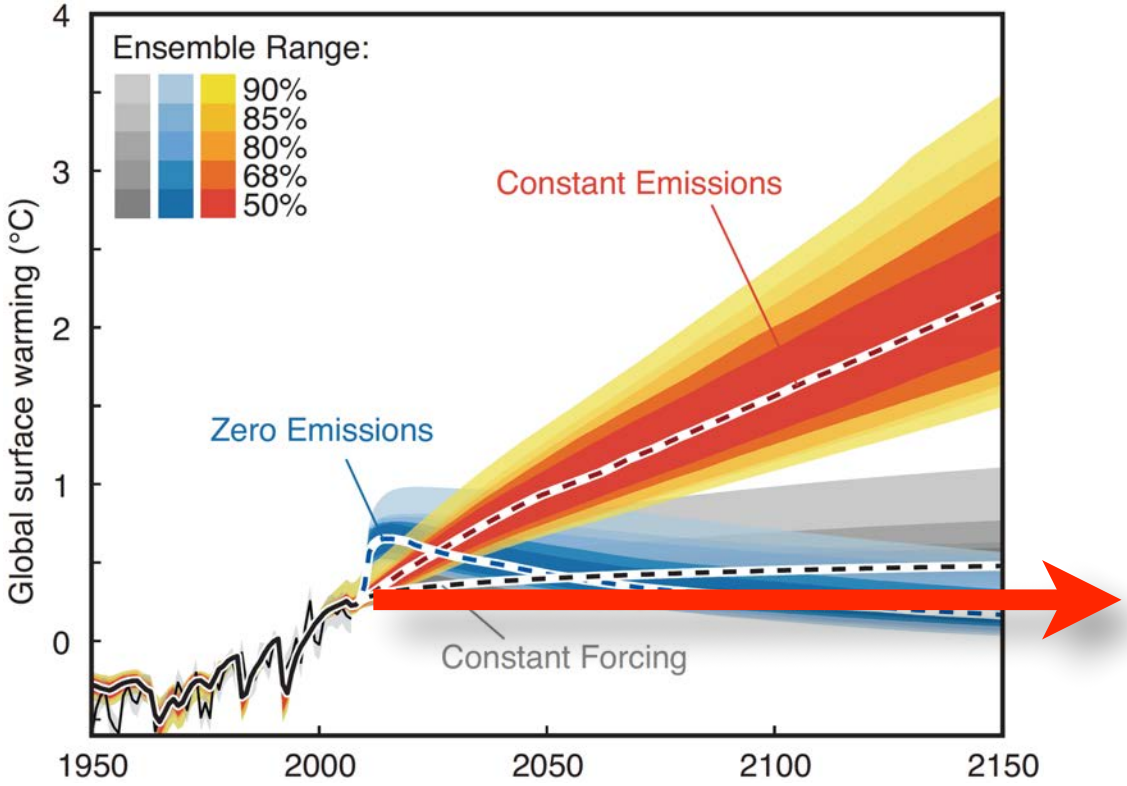
It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

IPCC, 2013. SPM WGI


Projections

What emissions do

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.



IPCC, 2013. FAQ 12.3

Future: Climate scenarios

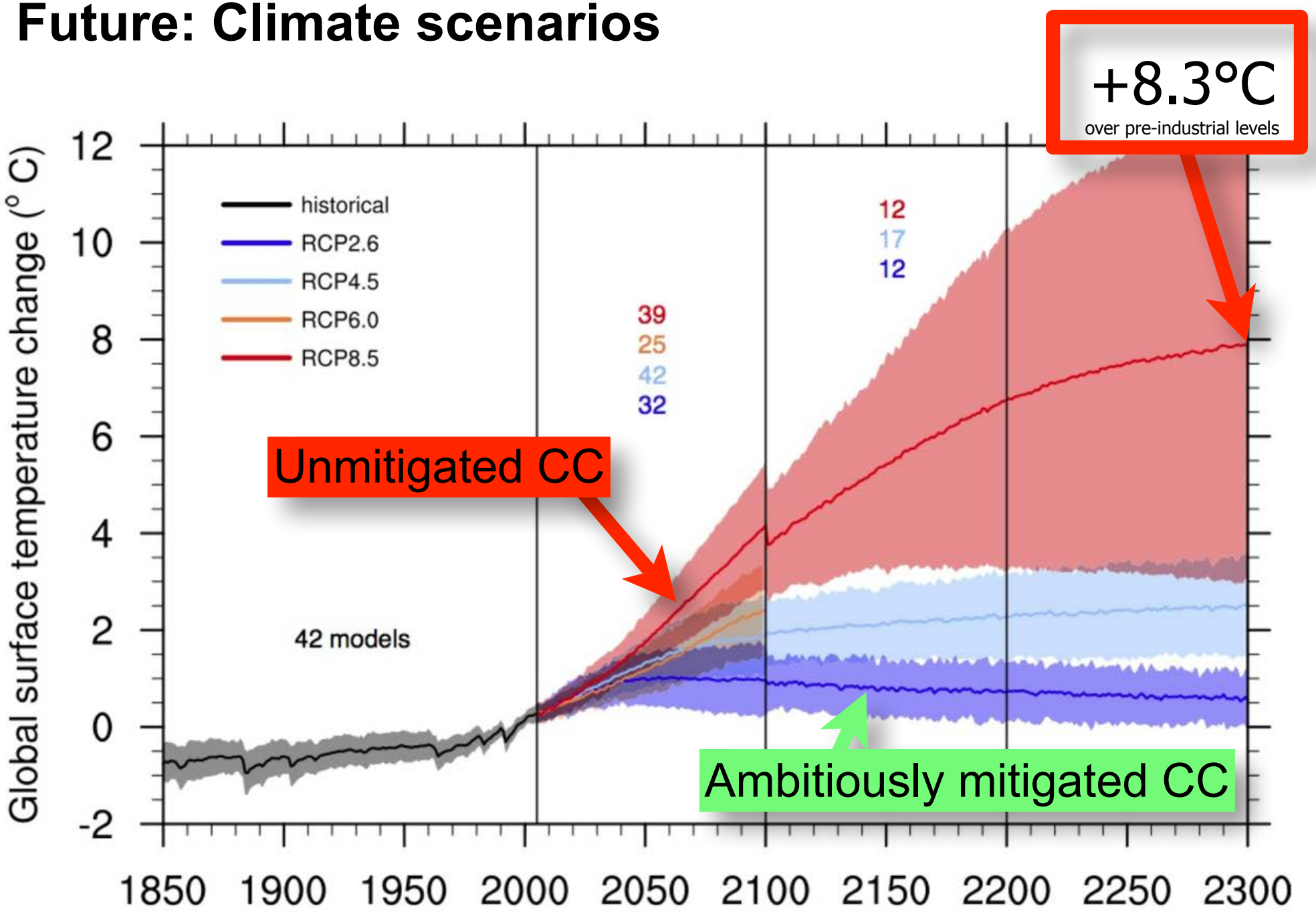
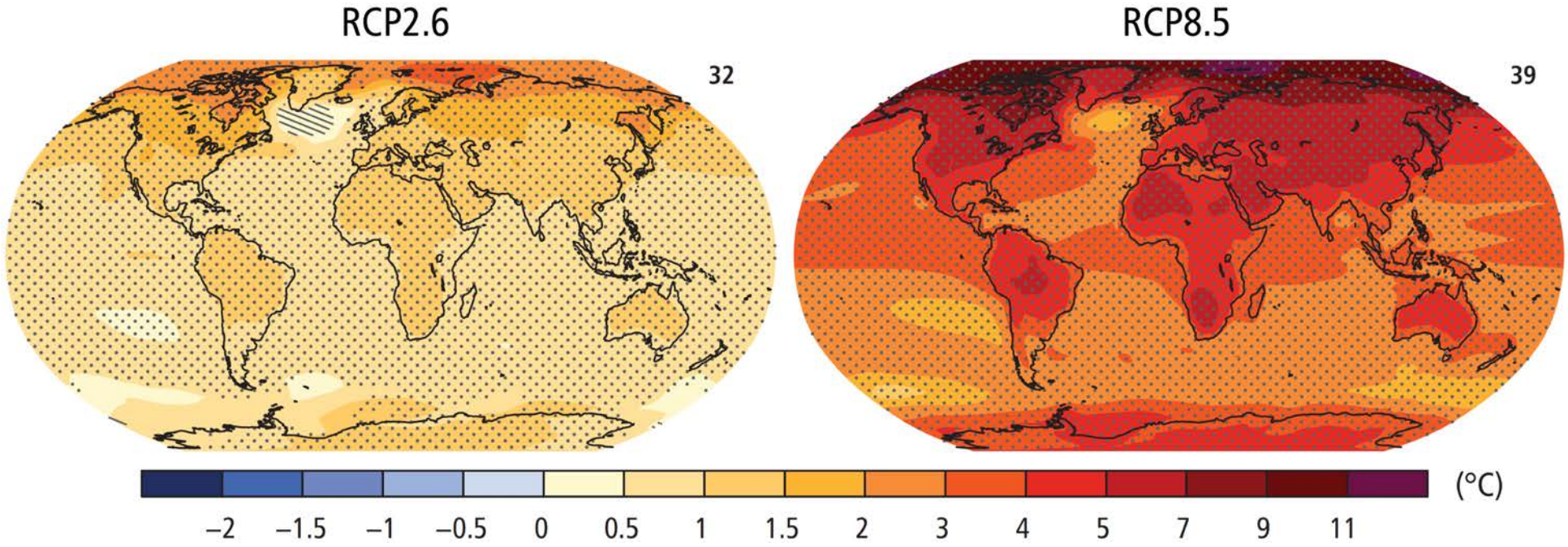


Figure 12.5: global annual mean surface air temperature anomalies (relative to 1986–2005) from CMIP5 concentration-driven (IPCC, 2013. AR5 WGI)

Projected temperature changes

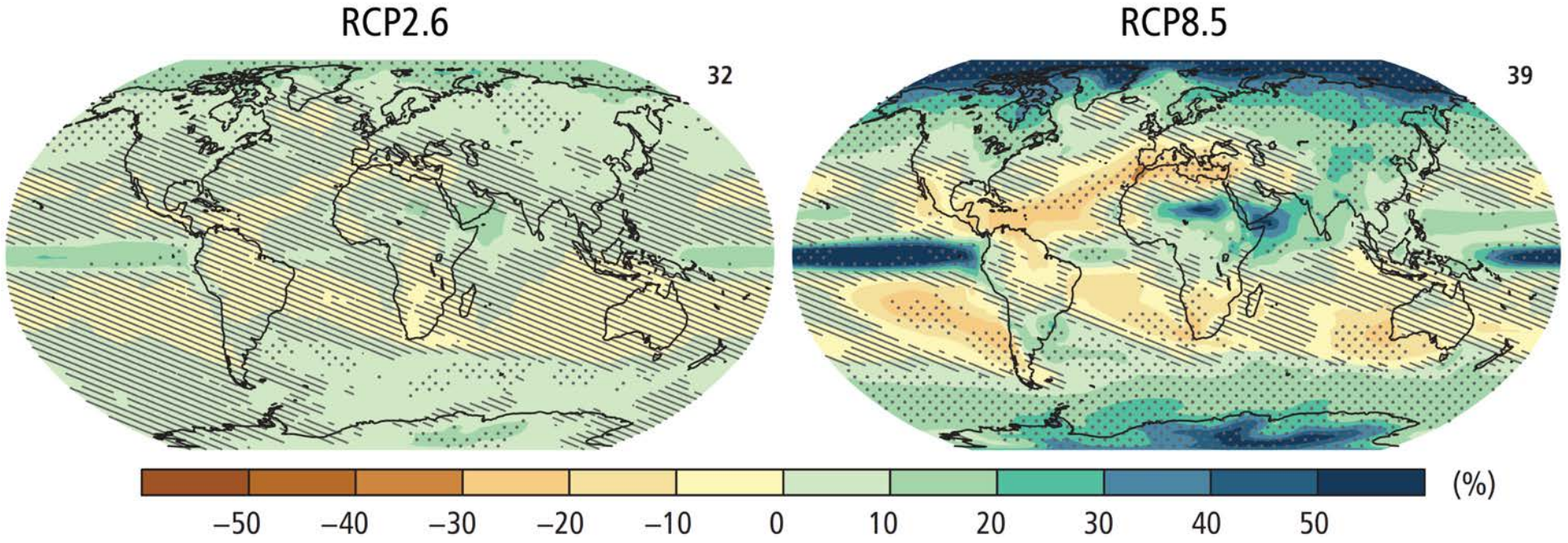
Change in average surface temperature (1986-2005 to 2081-2100)



IPCC, 2014. Synthesis Report, Figure SPM.7

Projected precipitation changes

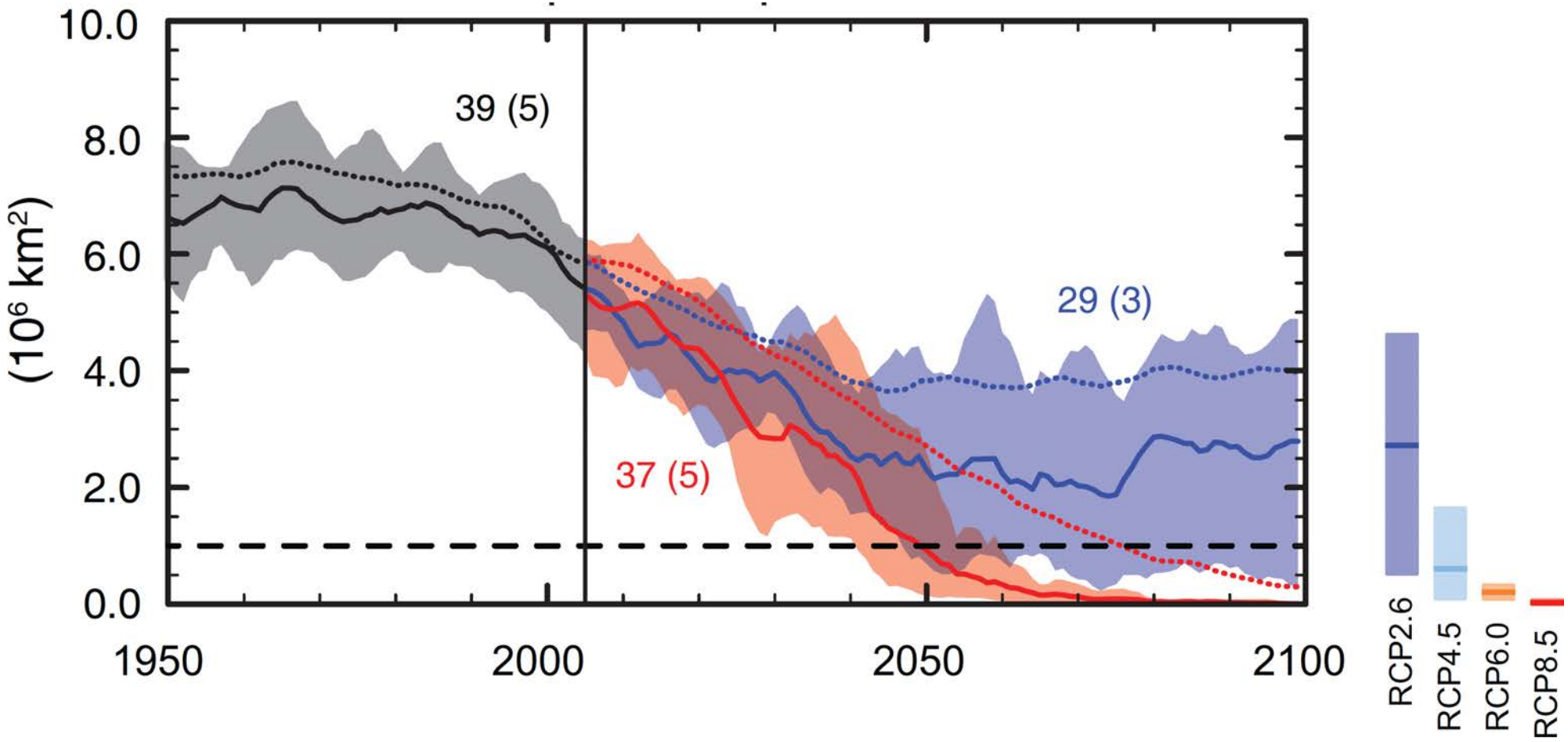
Change in average precipitation (1986-2005 to 2081-2100)



IPCC, 2014. Synthesis Report, Figure SPM.7

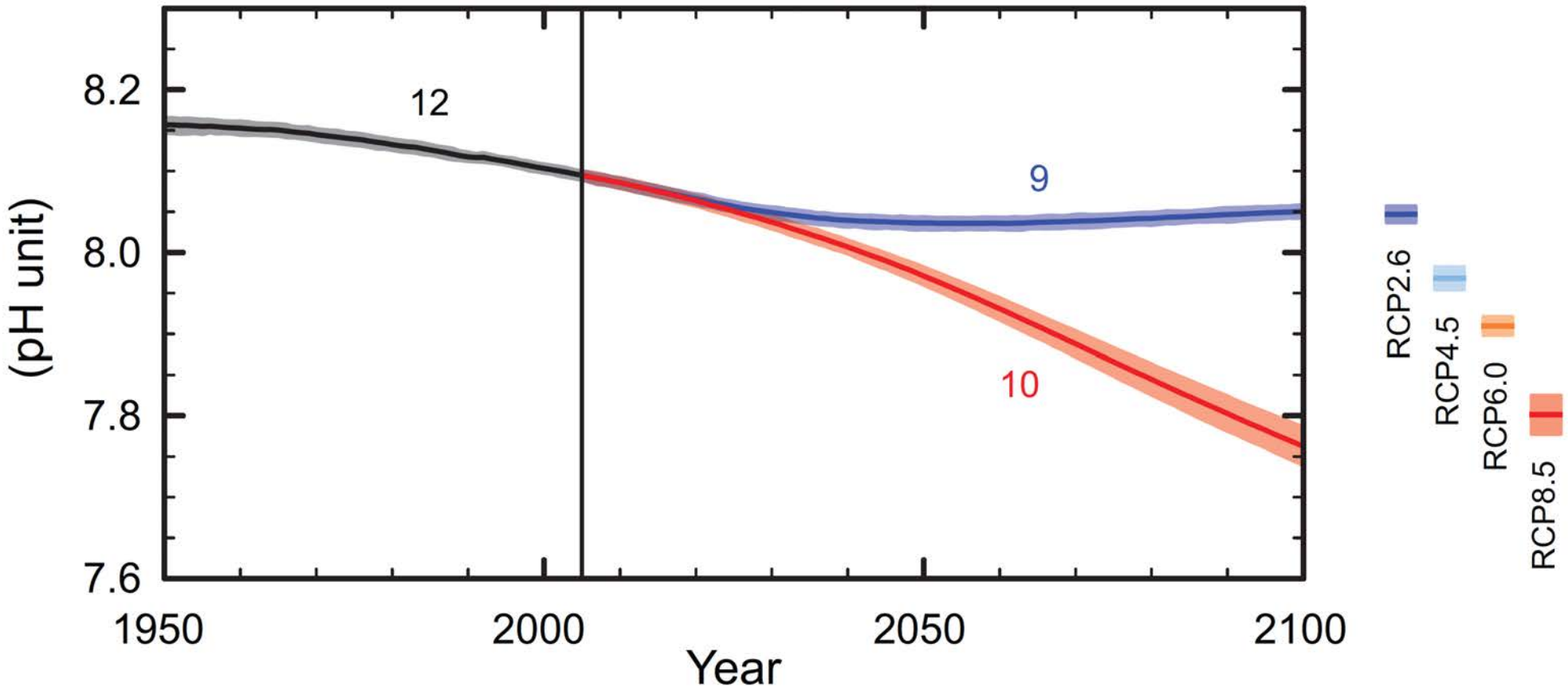
Implications

Arctic September sea ice extent



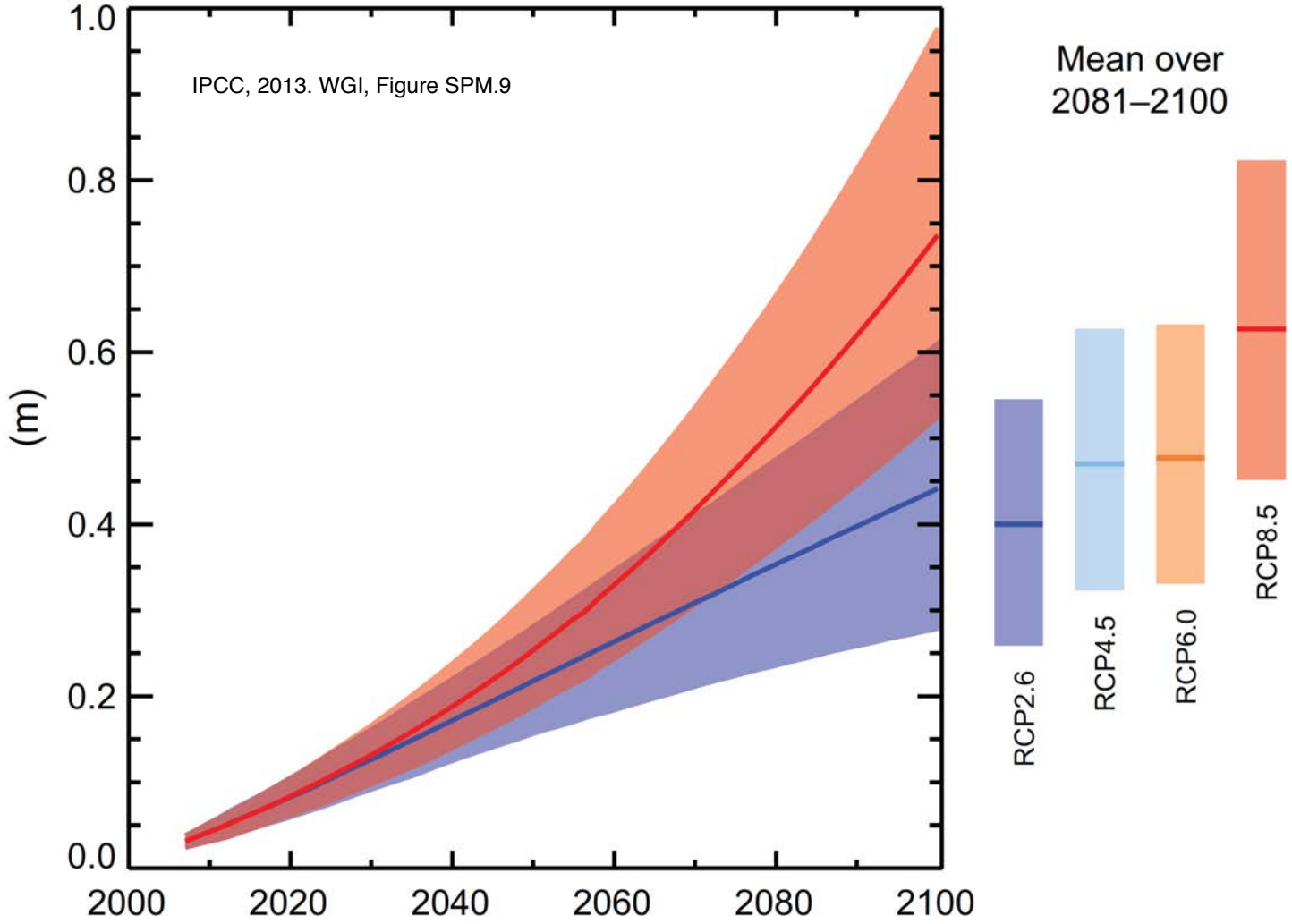
IPCC, 2013. WGI, Figure SPM.7

Global ocean surface pH



IPCC, 2013. WGI, Figure SPM.7

Global mean sea level rise



Part 2 - Ecosystem services in a changing climate

- On ecosystem services
- Impacts framework
- Managing the risks

On ecosystem services

Ecosystems Services

Provisioning Services

- Food
- Water
- Fuel
- Wood

...

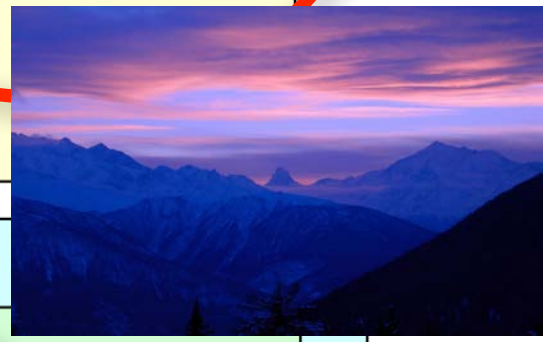
Regulating Services

- C-sequestration
- Climate
- Flood, erosion
- Air, water purification
- Pests, diseases

Cultural Services

- Recreational
- Educational
- Spiritual

...



Sup

- Primary & other productions
- Soil formation
- Nutrient cycling

Ecosystems Services

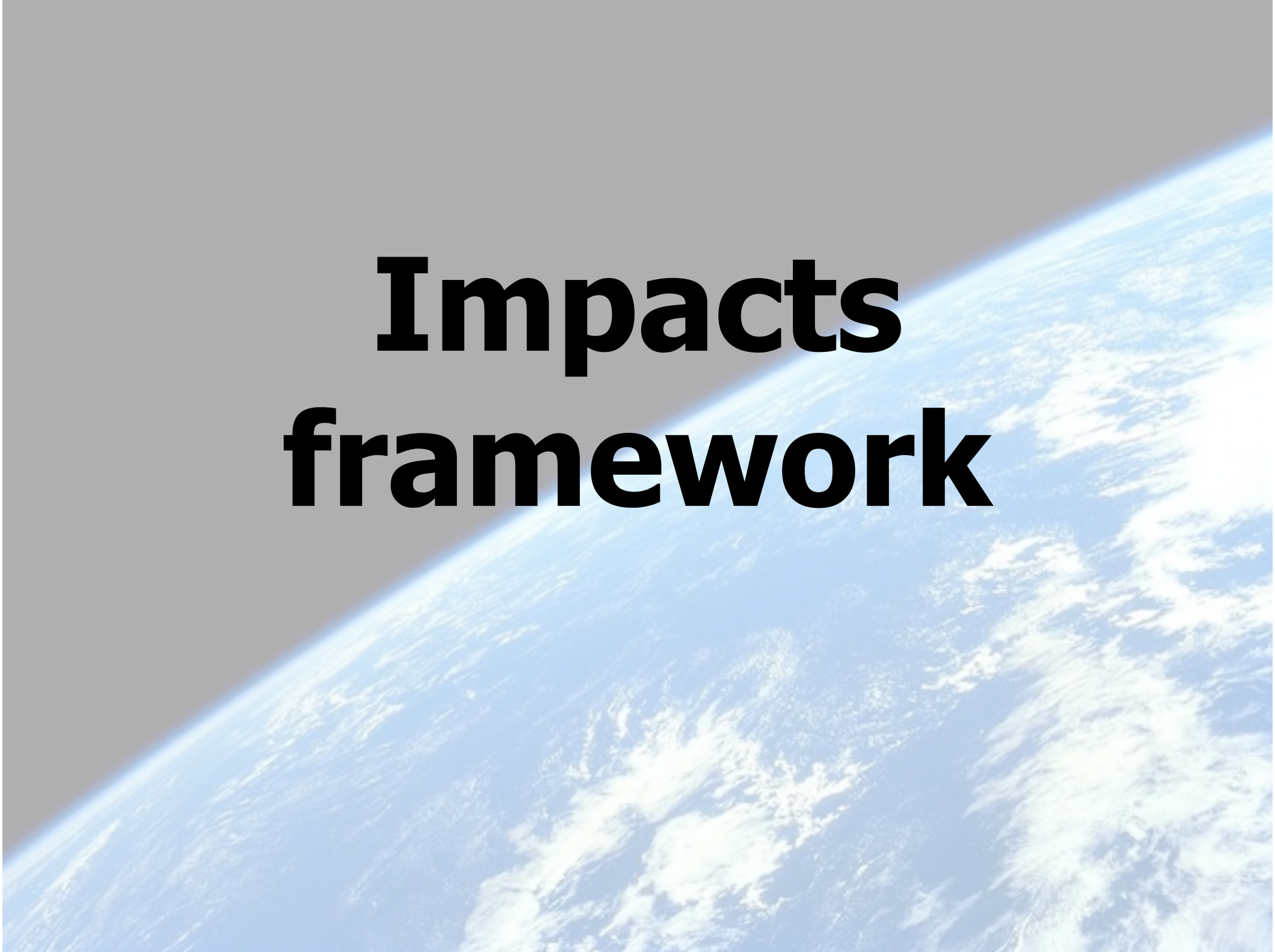
Global GDP 1997

18

Trillions (=10^{12} =Tera) US $

16 33 54

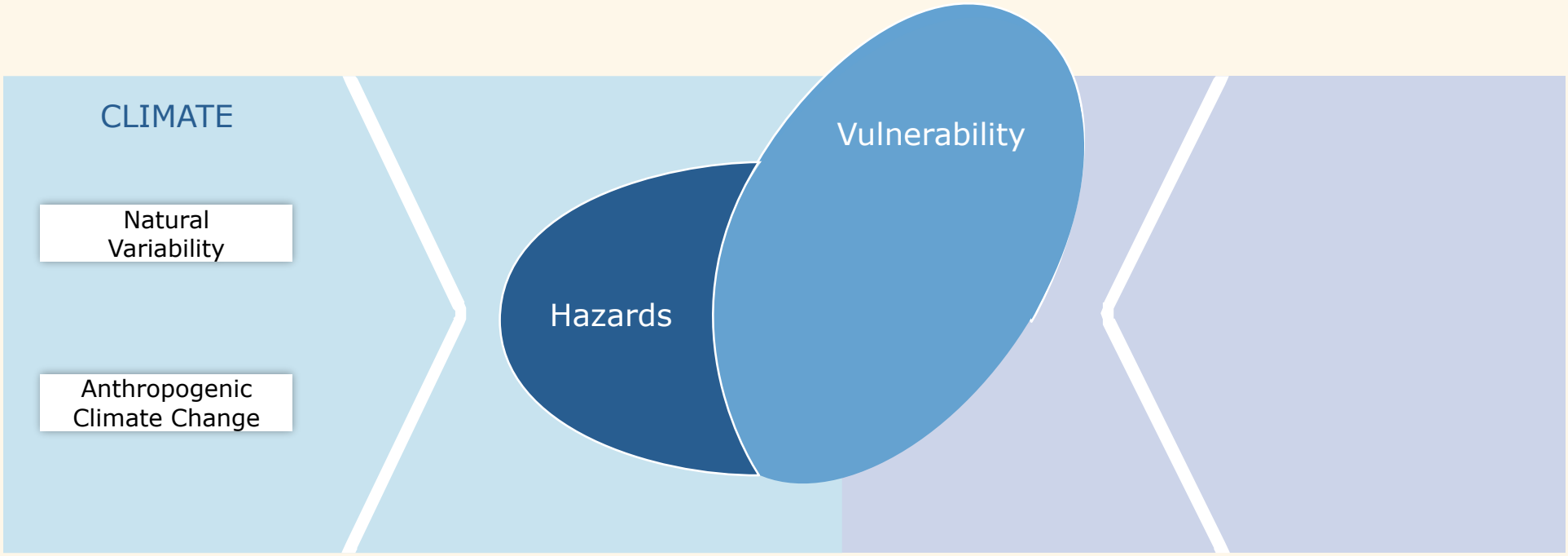
Costanza *et al.*, 1997. *Nature*, 387: 253-260


Impacts
framework

Risk Framework - IPCC AR5 WGII

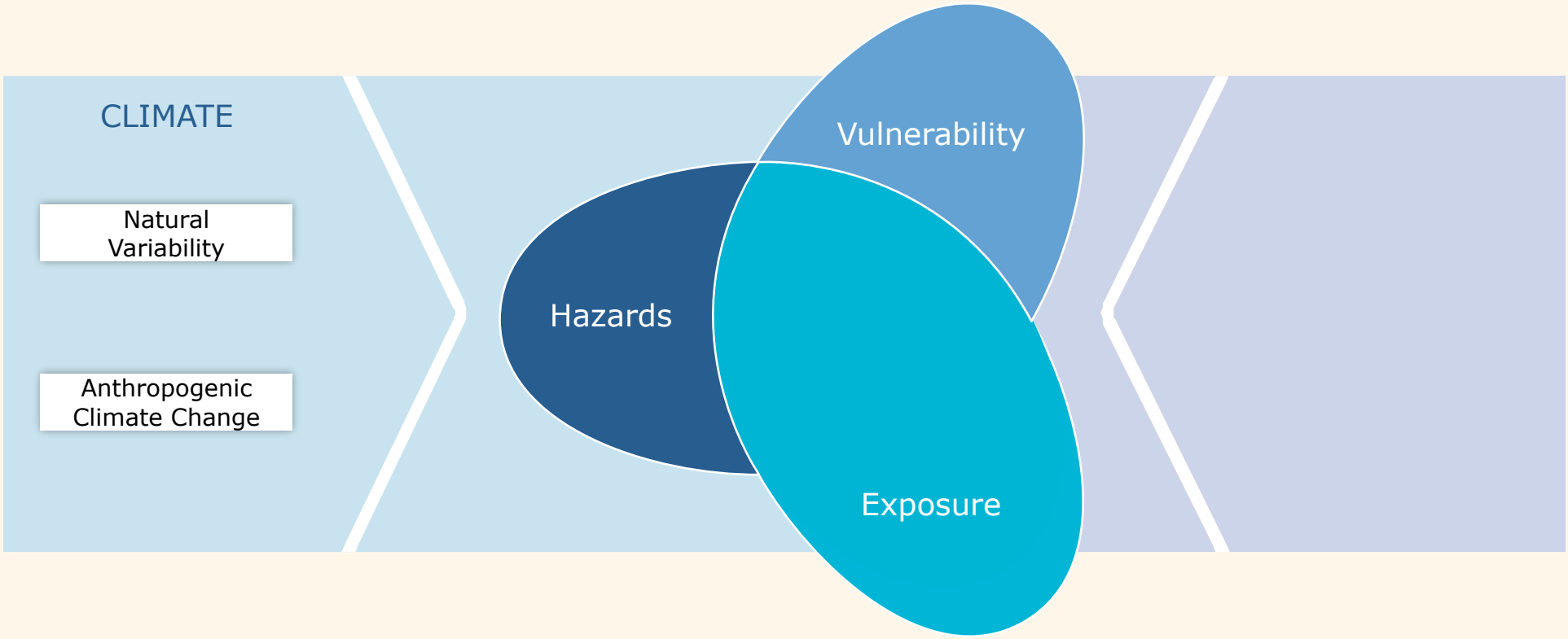
IPCC, 2014, AR5 WGII, Figure SPM.1

Risk Framework - IPCC AR5 WGII



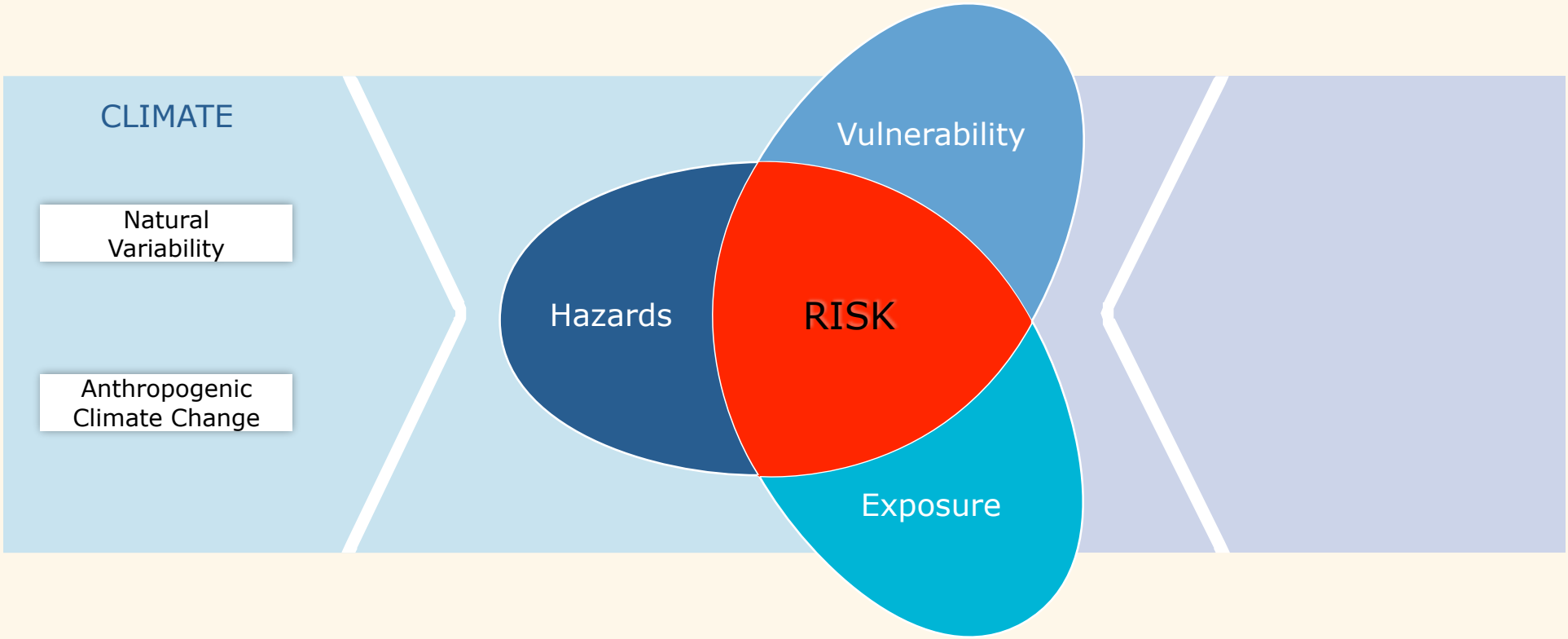
IPCC, 2014, AR5 WGII, Figure SPM.1

Risk Framework - IPCC AR5 WGII



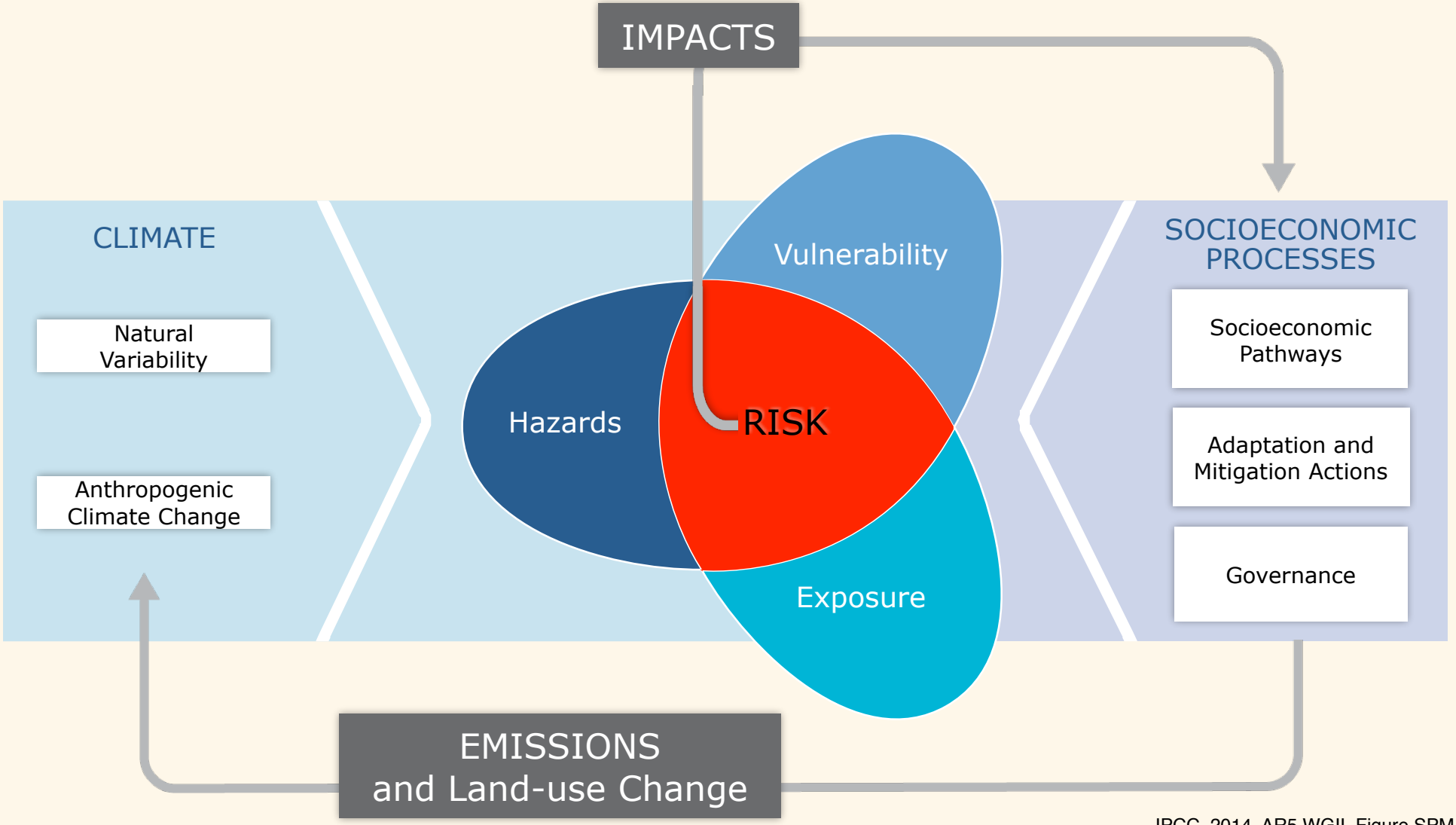
IPCC, 2014, AR5 WGII, Figure SPM.1

Risk Framework - IPCC AR5 WGII



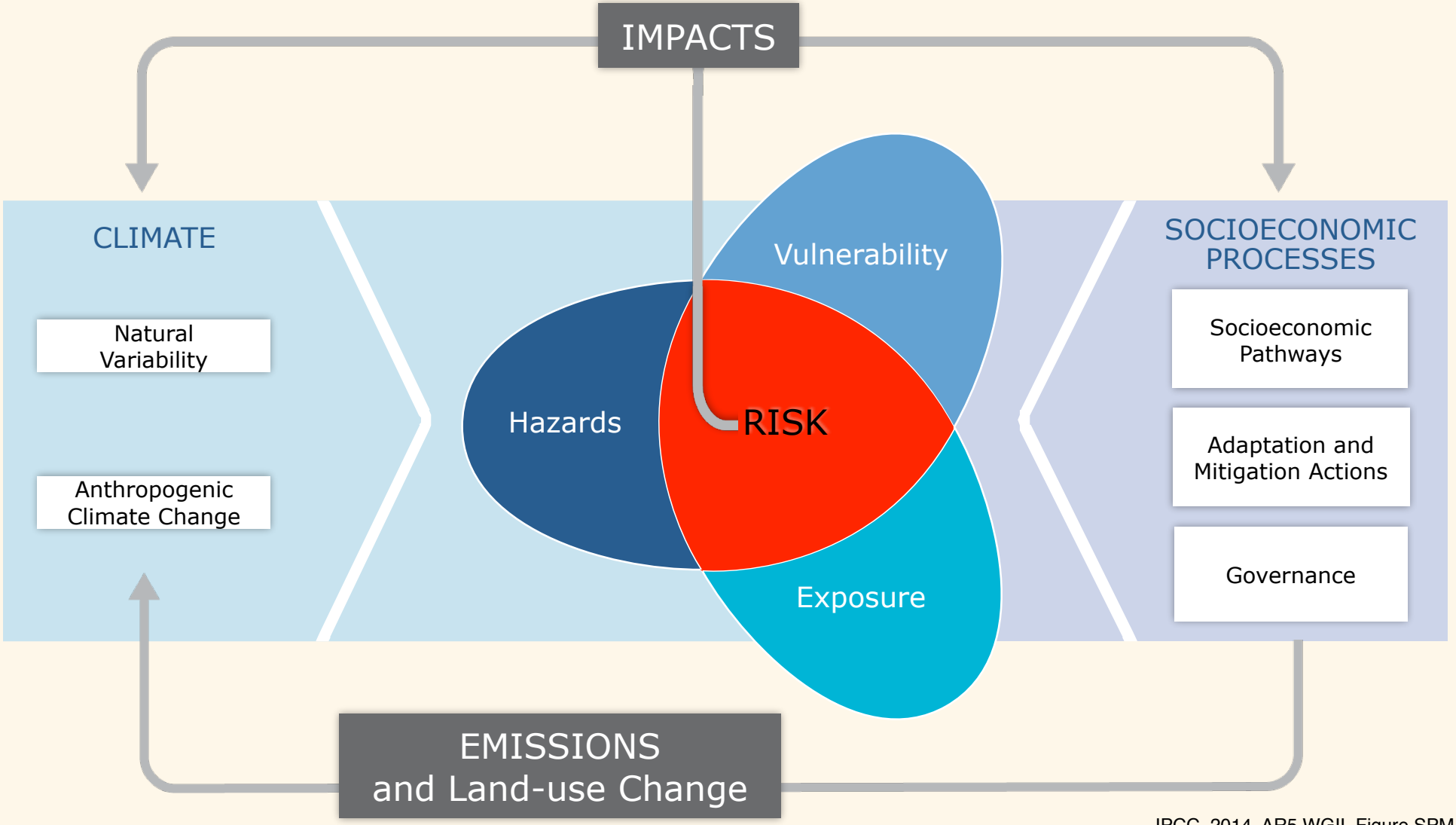
IPCC, 2014, AR5 WGII, Figure SPM.1

Risk Framework - IPCC AR5 WGII



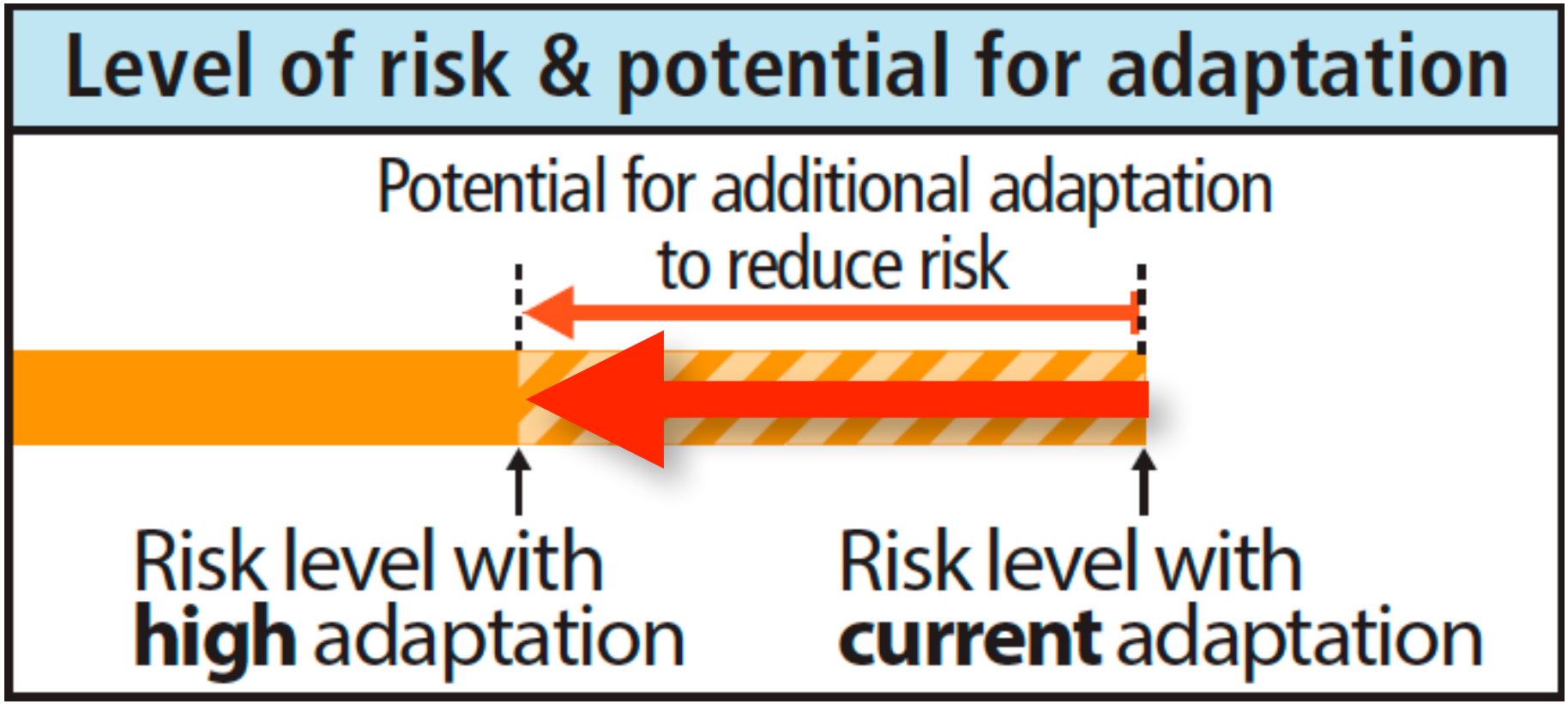
IPCC, 2014, AR5 WGII, Figure SPM.1

Risk Framework - IPCC AR5 WGII



IPCC, 2014, AR5 WGII, Figure SPM.1

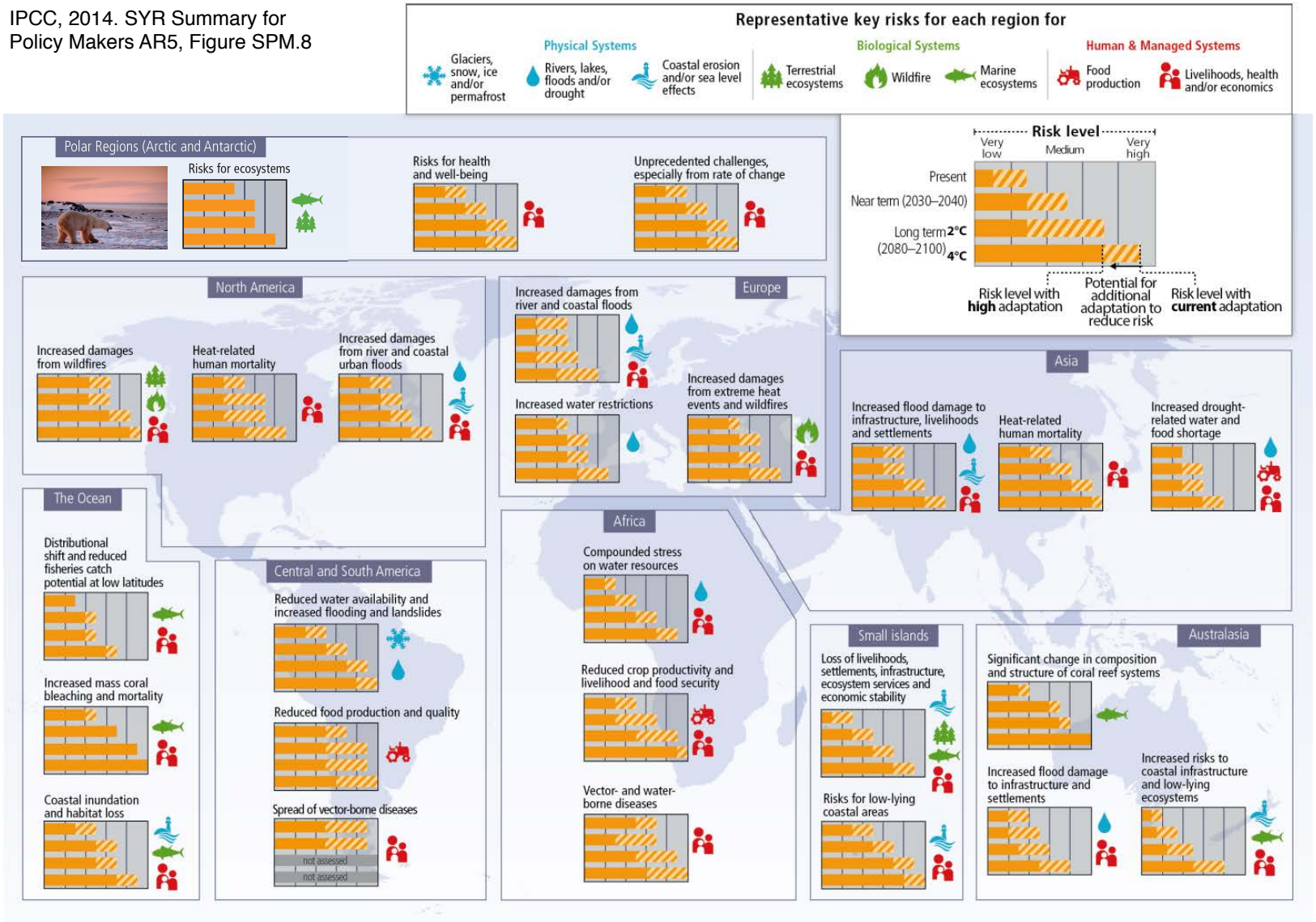
Impacts and Adaptation



IPCC, 2014. Summary for Policy Makers AR5 WGII. Assessment Box SPM.2 Table 1 Europe, p. 22

Risks assessed for all regions, sectors

IPCC, 2014. SYR Summary for Policy Makers AR5, Figure SPM.8



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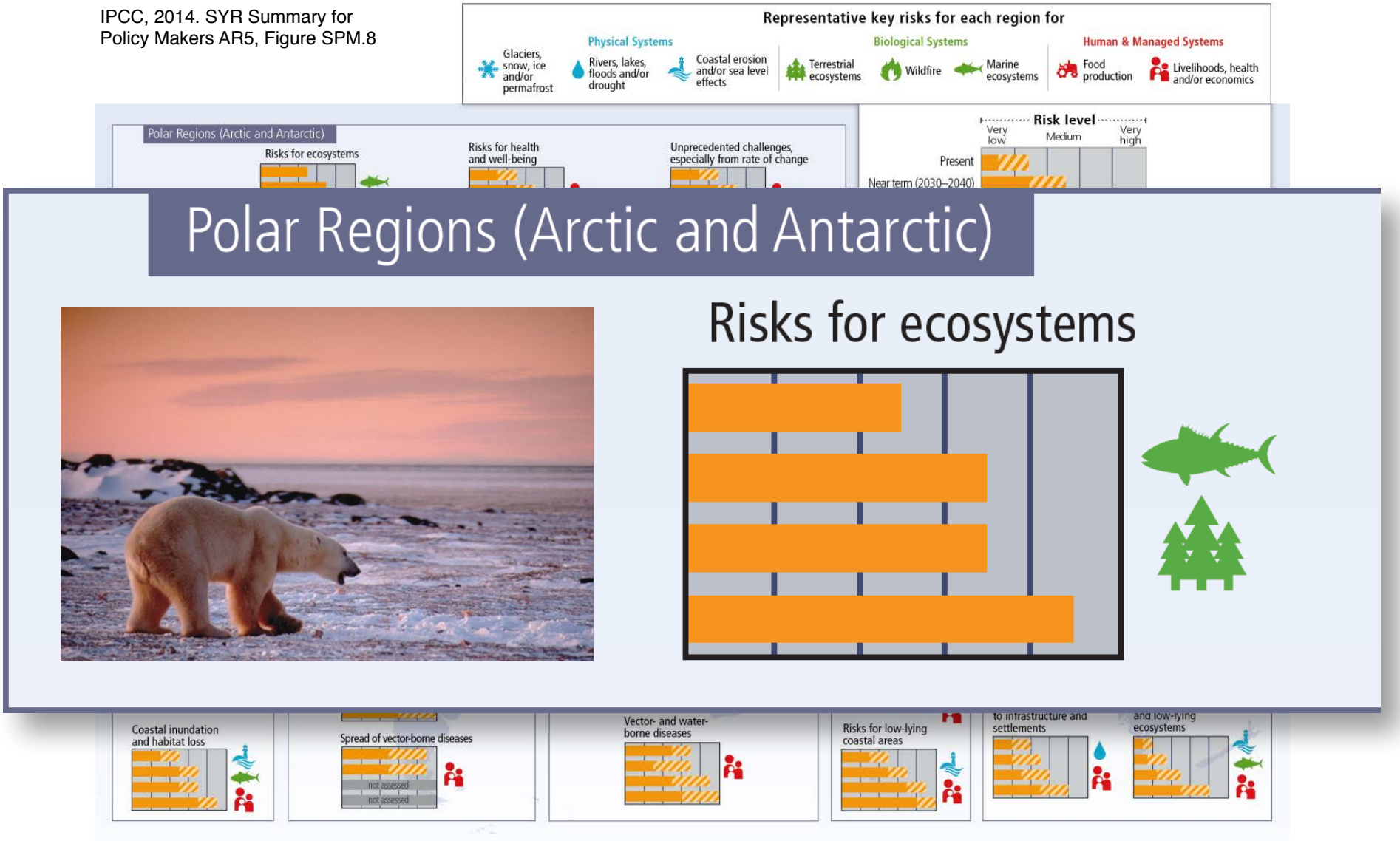

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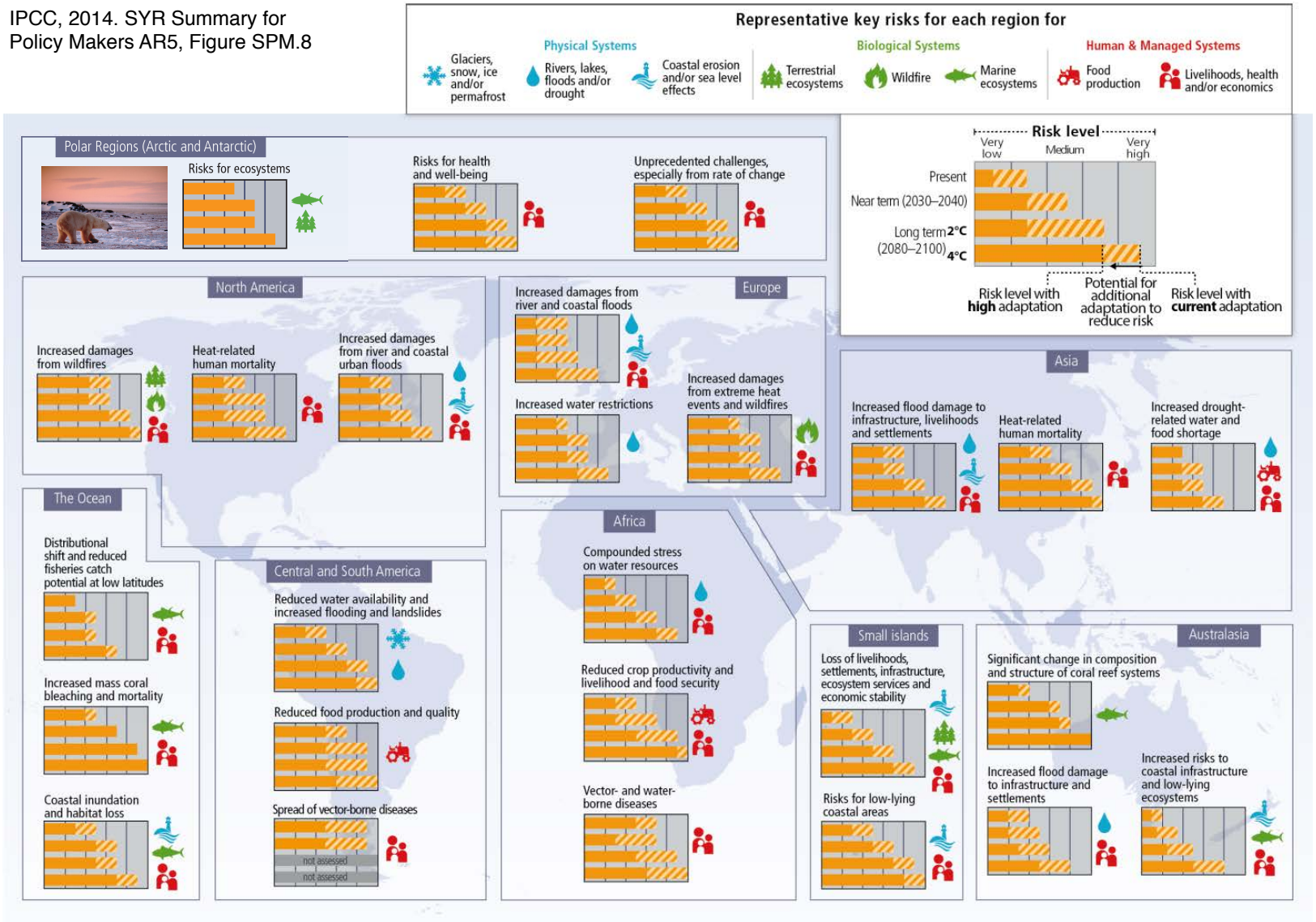

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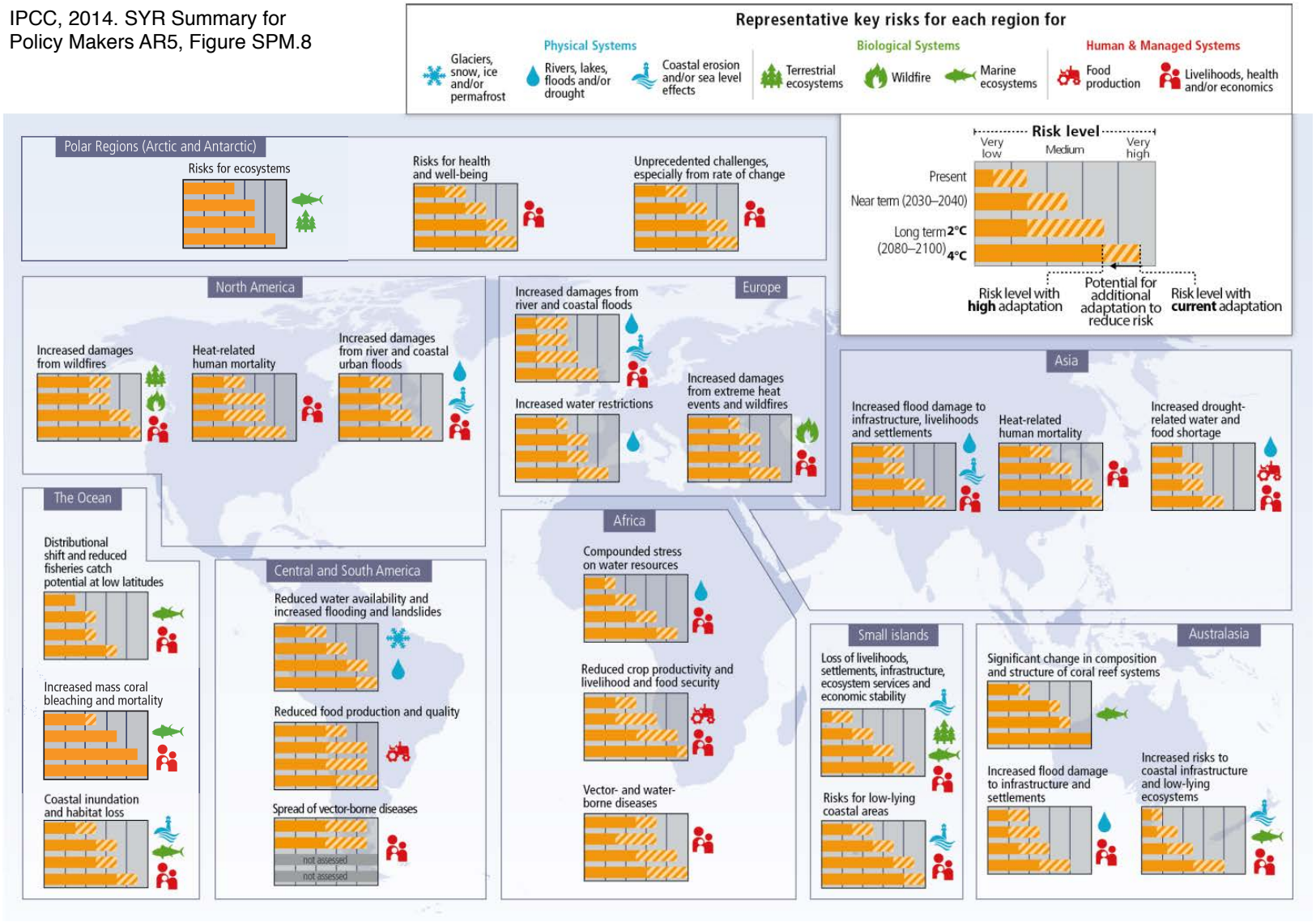

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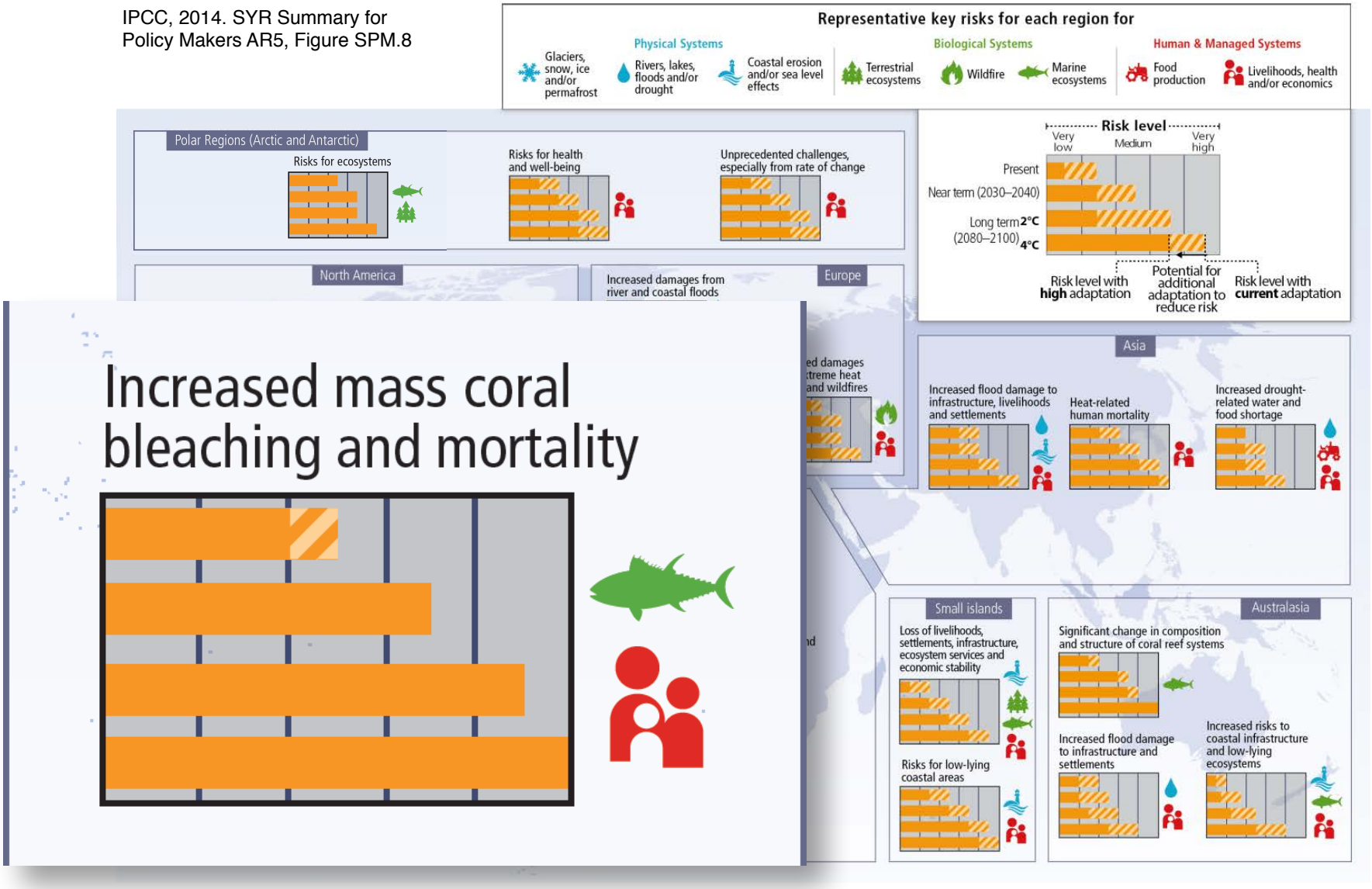
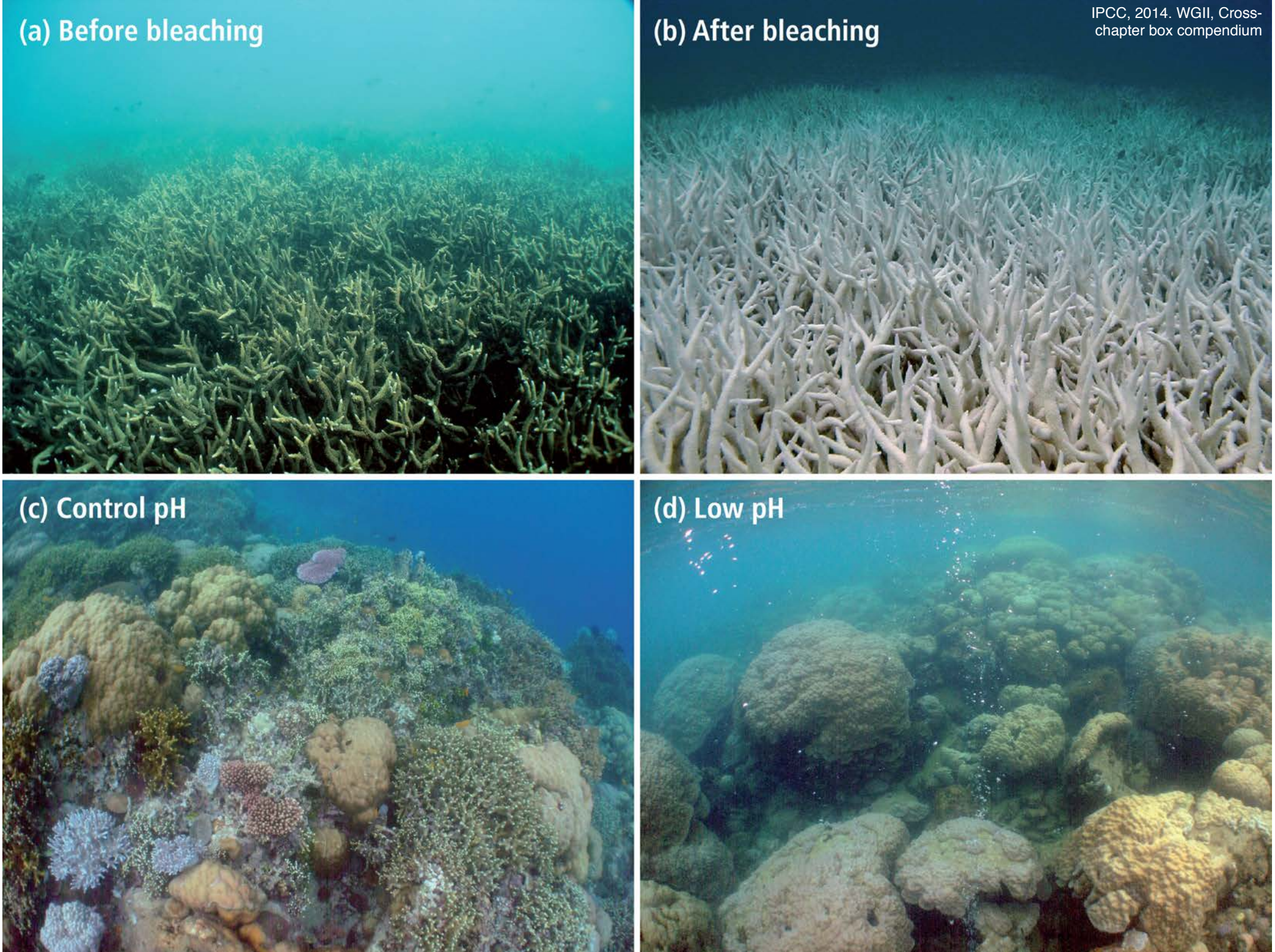


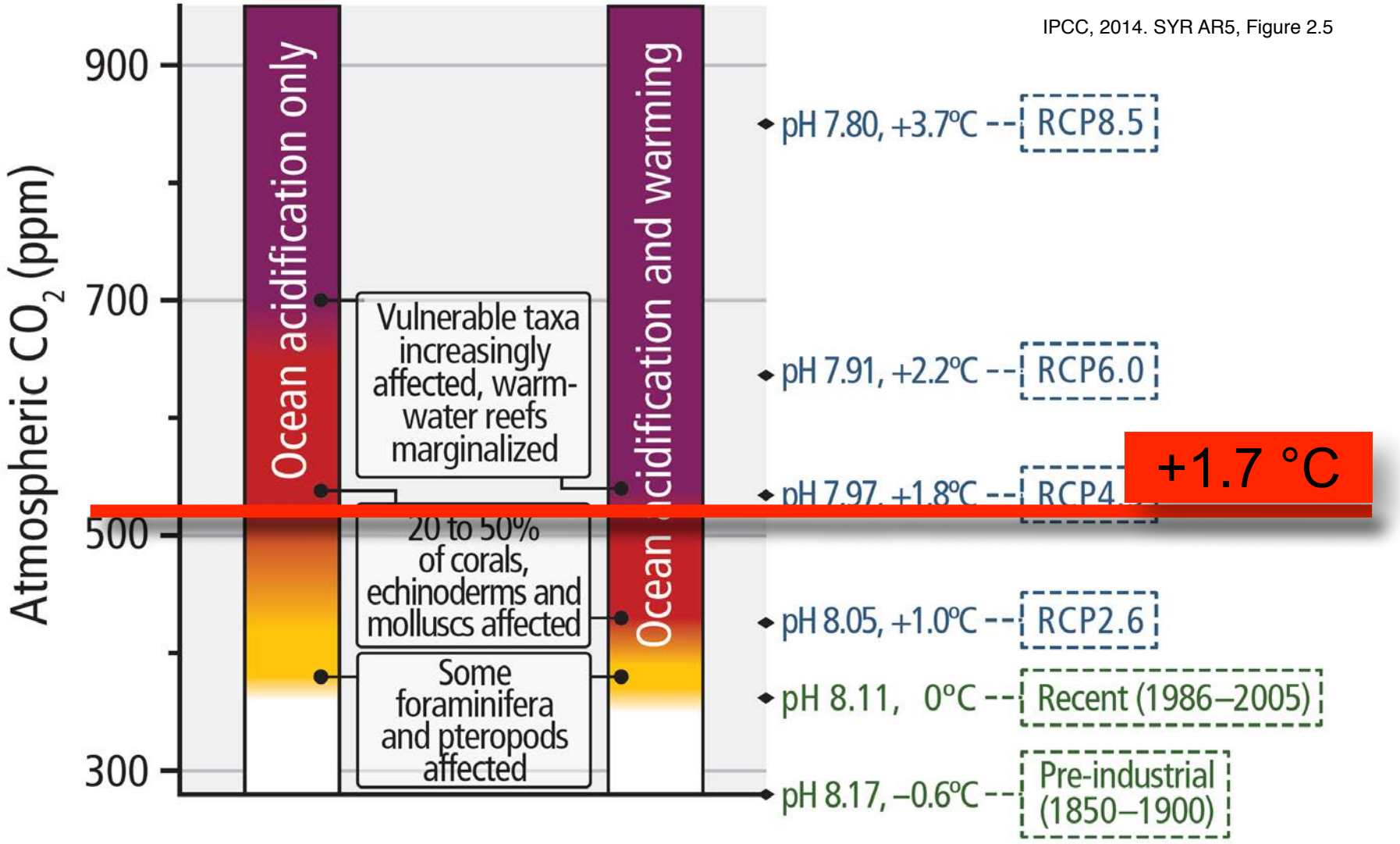
Fischlin et al., 2007. IPCC WGII, Figure TS.6

Pörtner et al., 2014. IPCC WGII,


(a) Before bleaching
(b) After bleaching
IPCC, 2014. WGII, Cross-chapter box compendium
(c) Control pH
(d) Low pH

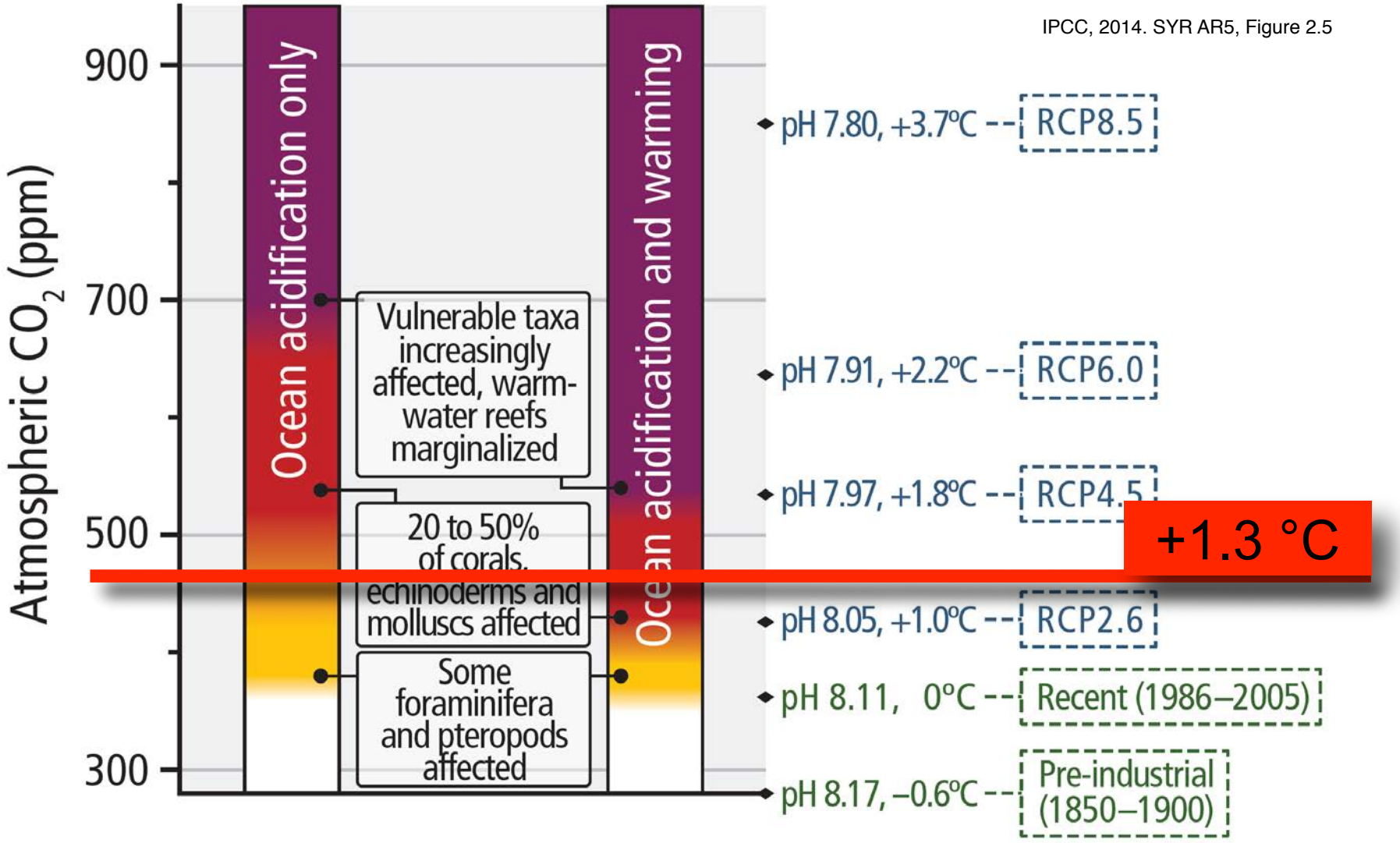
Marine ecosystems among most vulnerable

IPCC, 2014. SYR AR5, Figure 2.5

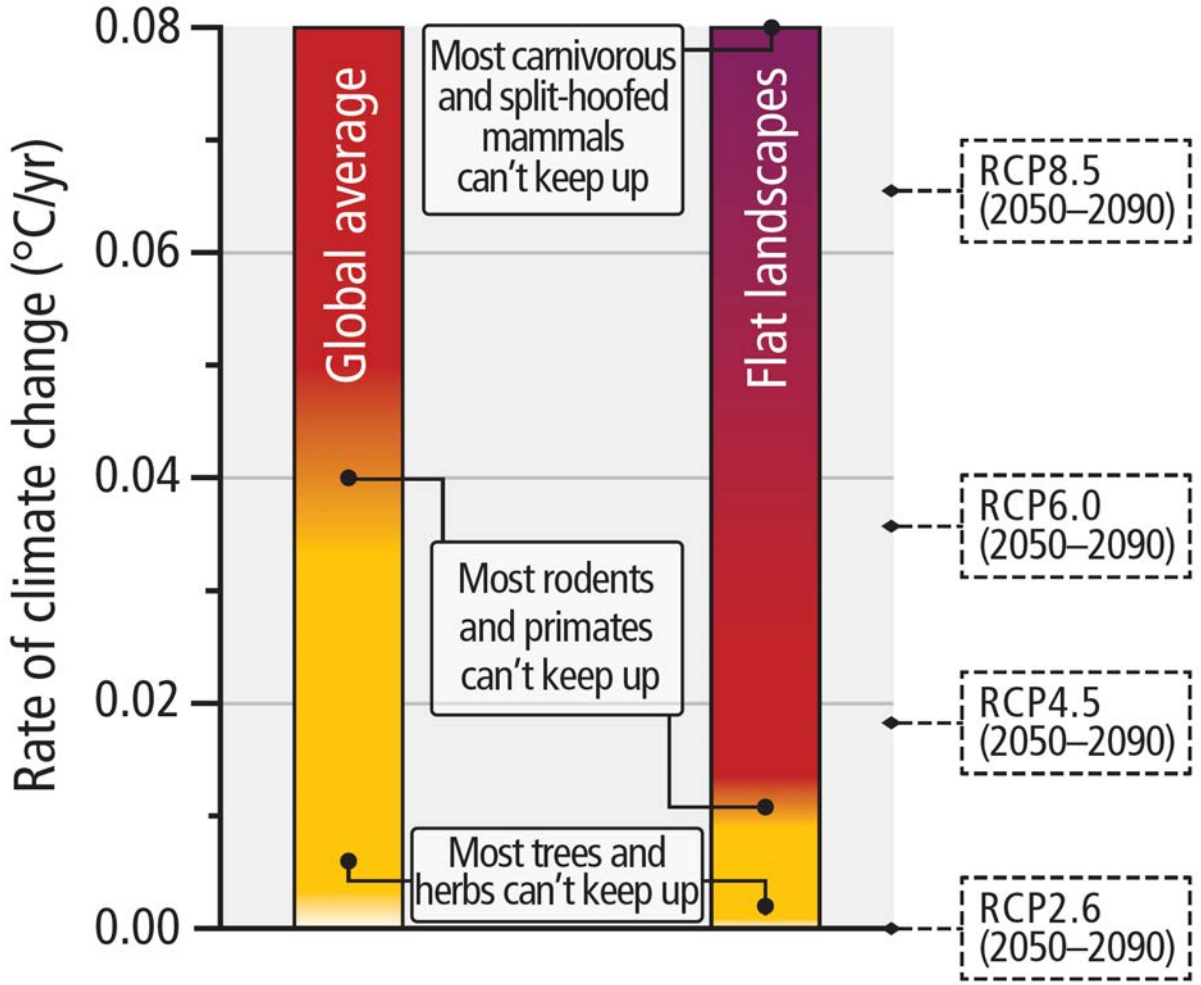


Marine ecosystems among most vulnerable

IPCC, 2014. SYR AR5, Figure 2.5



Risk for terrestrial and freshwater species impacted by the rate of warming



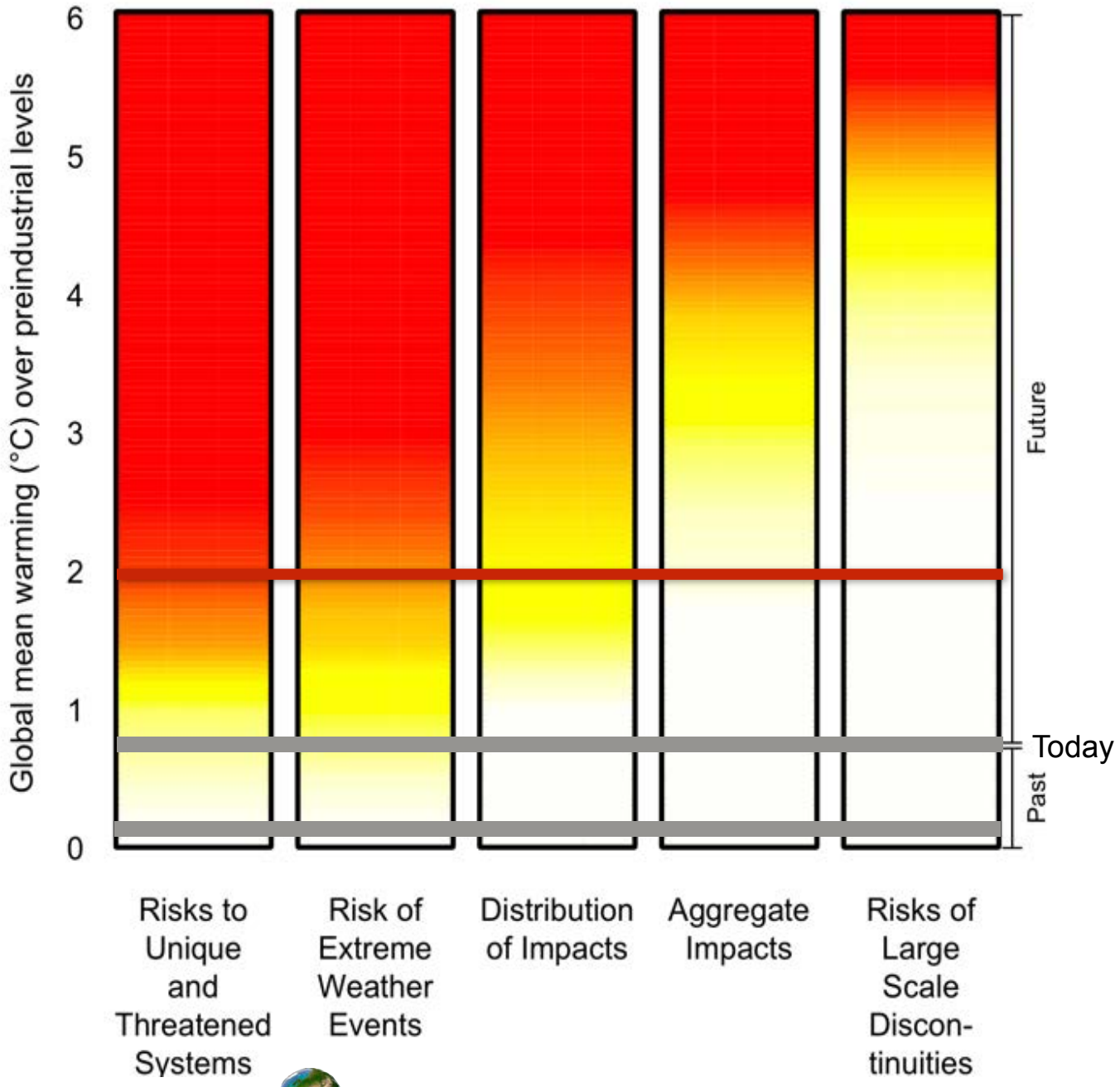
IPCC, 2014. SYR AR5, Figure 2.5


Managing the
risks

Reasons of Concern

Know-ledge **TAR 2001**

Dangerous Anthropogenic Interference (DAI)
vs. global mean warming (°C)

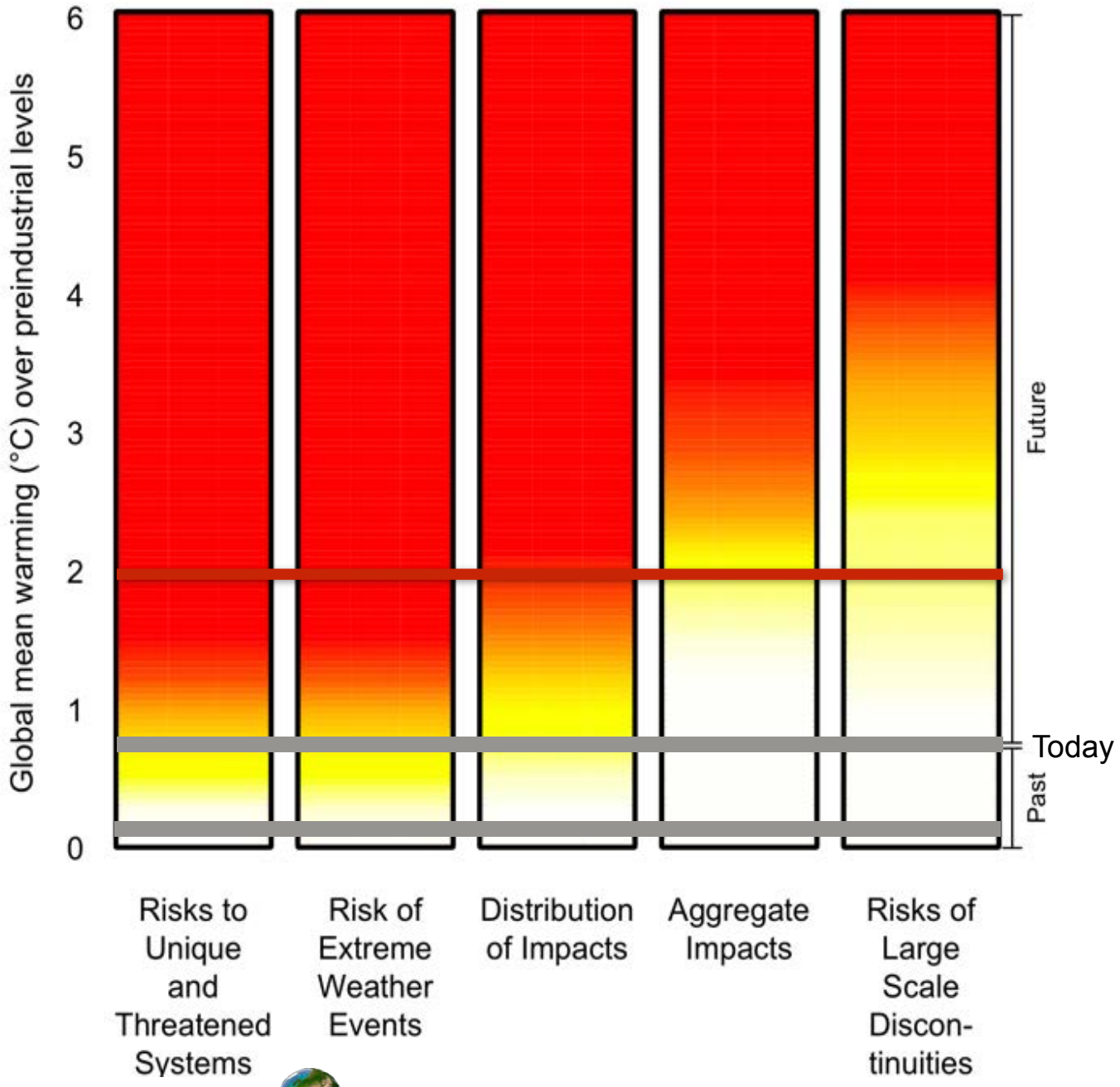


Smith et al., 2009. PNAS u. Fischlin, 2009

Reasons of Concern

Know-ledge **AR4 2007**

Dangerous Anthropogenic Interference (DAI)
vs. global mean warming (°C)

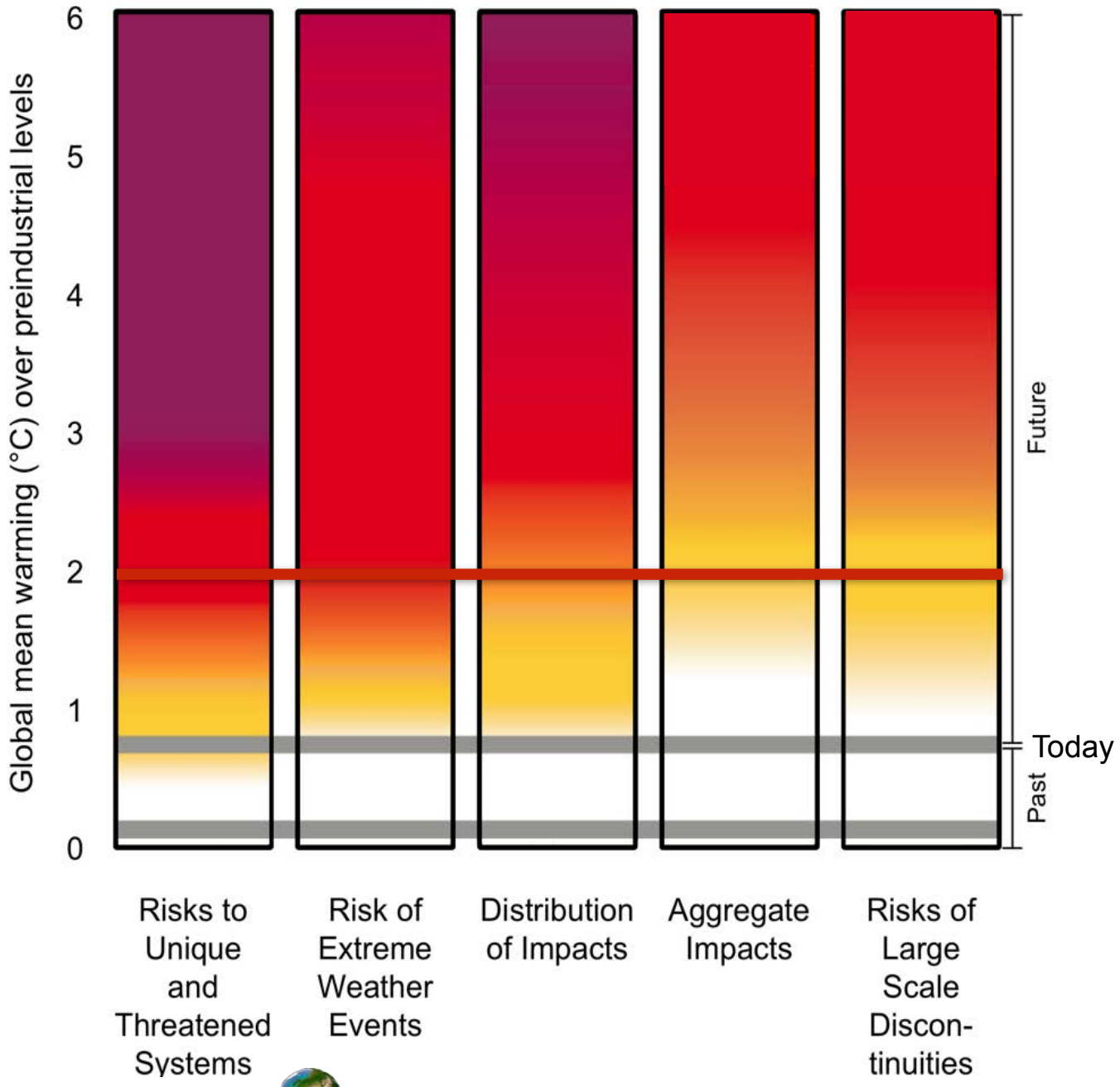


Smith et al., 2009. PNAS u. Fischlin, 2009

Reasons of Concern

Know-ledge **AR5 2014**

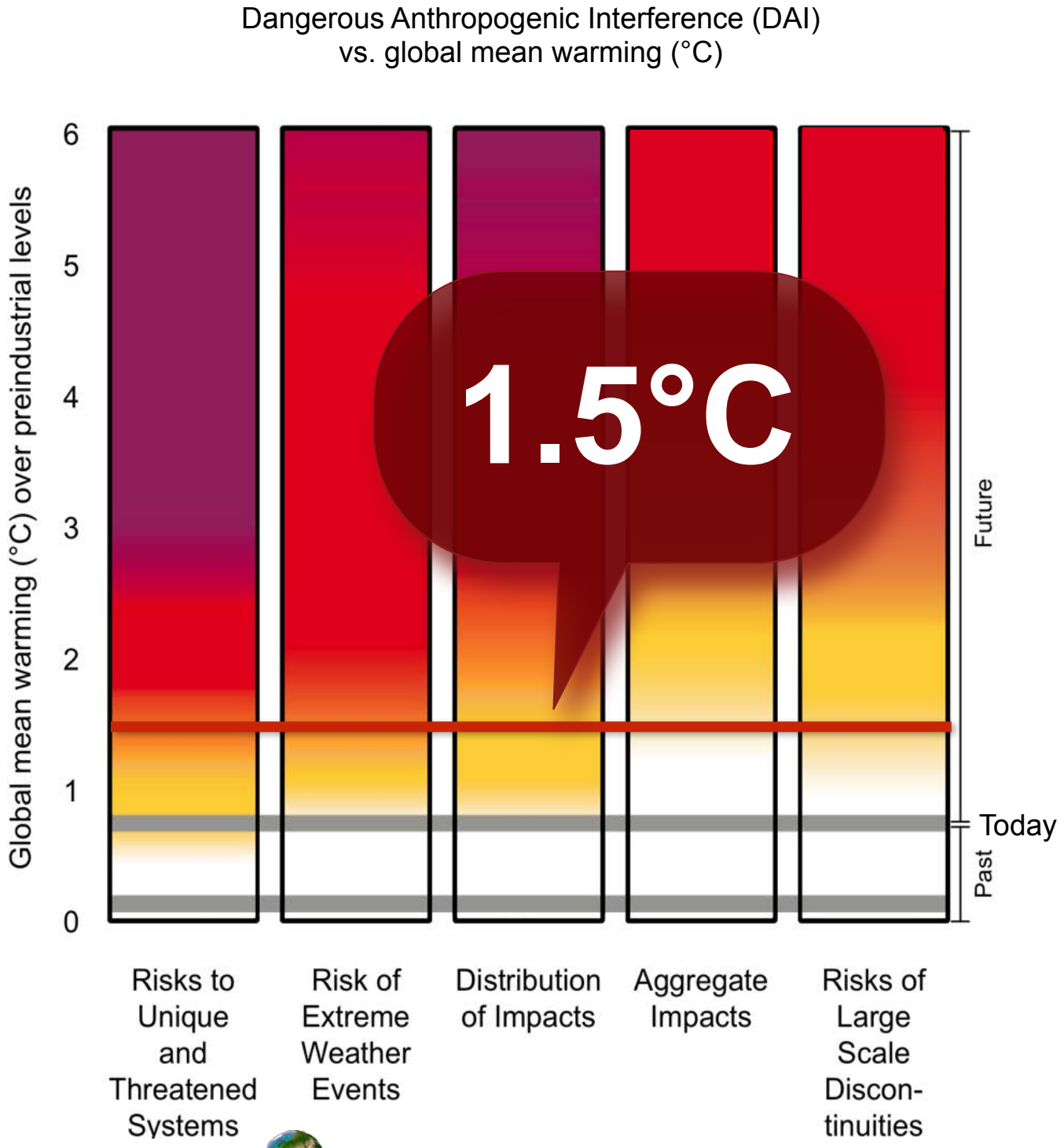
Dangerous Anthropogenic Interference (DAI)
vs. global mean warming (°C)



Smith et al., 2009. PNAS u. Fischlin, 2009

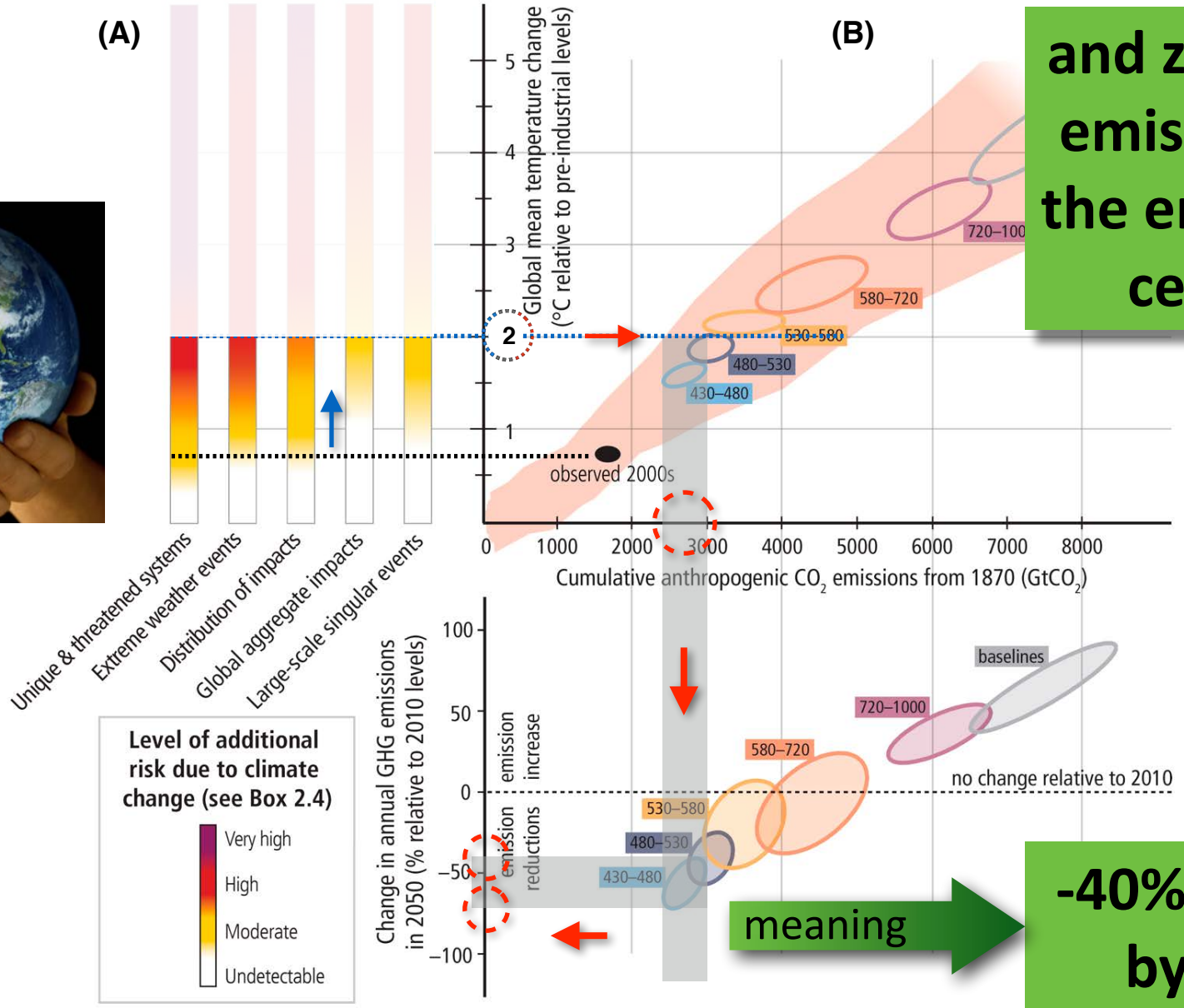
Reasons of Concern

Know-ledge **AR5 2014**



Smith et al., 2009. PNAS u. Fischlin, 2009

Mitigation



and zero GHG emissions by the end of the century

meaning

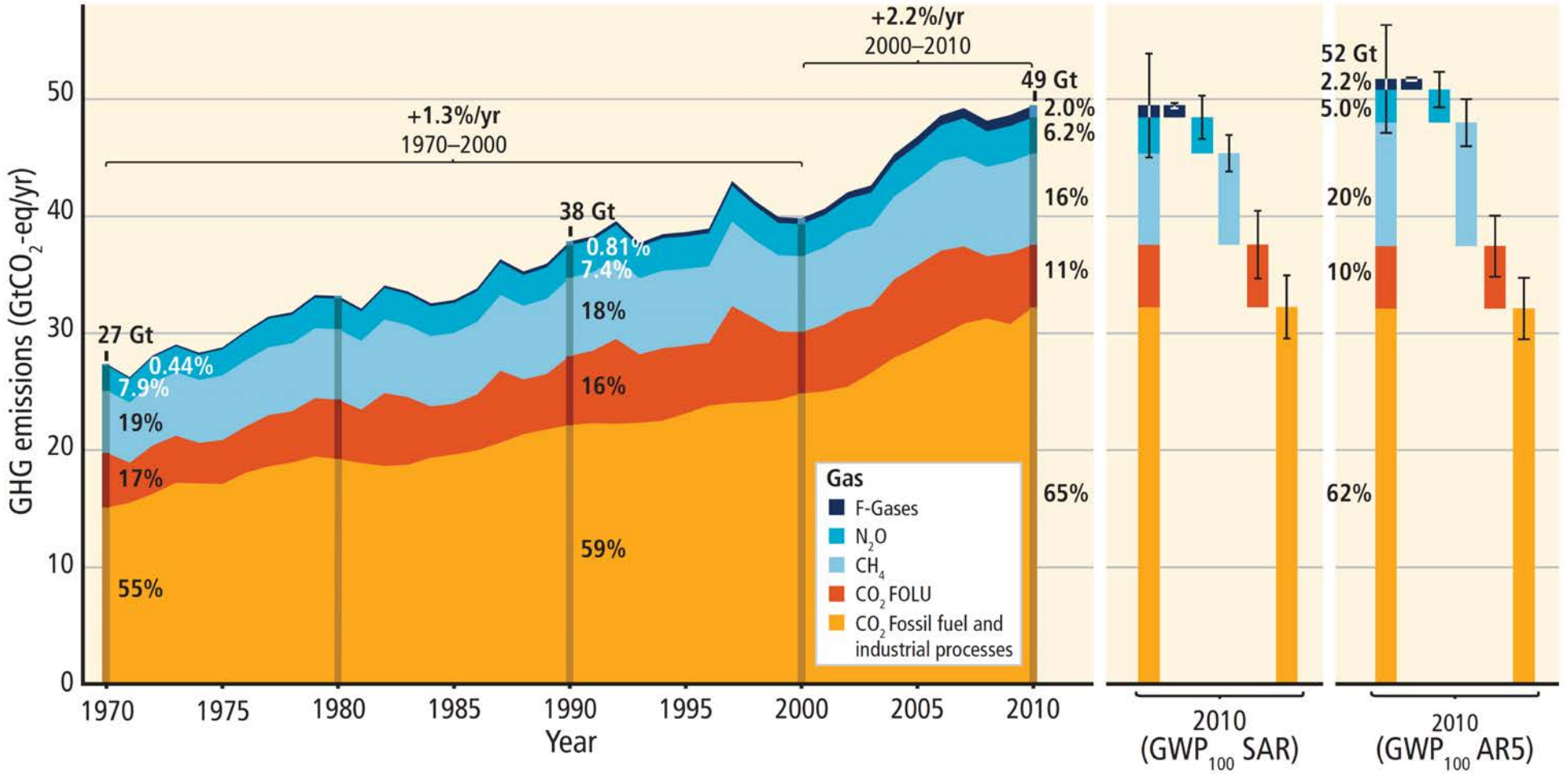
-40% to -70% by 2050

Fischlin et al., 2015. SED Report Figure 9

After IPCC, 2014. Synthesis Report, Figure SPM.10

However, current emission trends

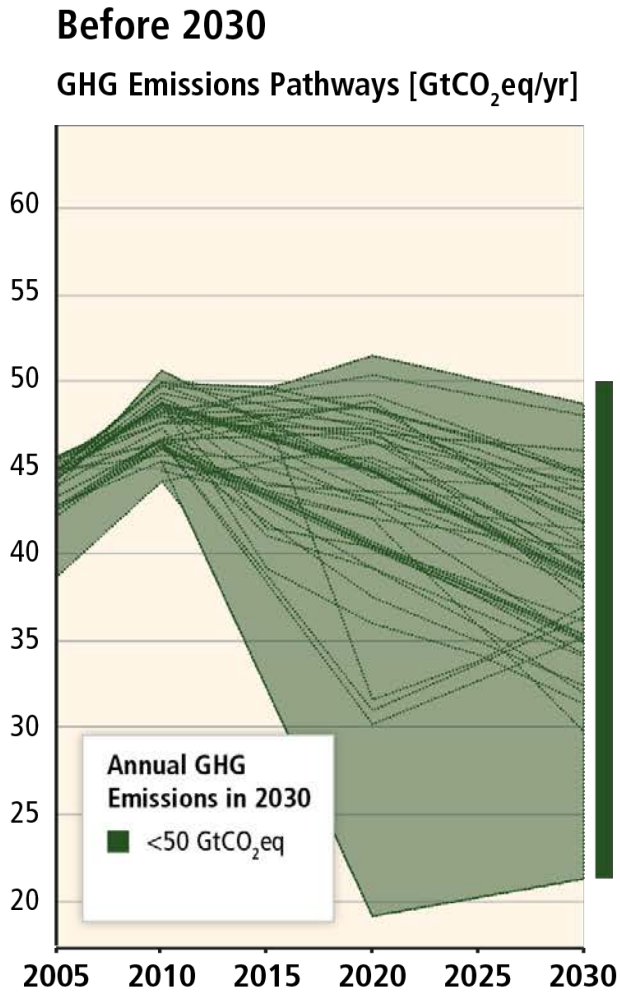
Total annual anthropogenic greenhouse gas emissions by groups of gases, 1970–2010



After IPCC, 2014. Synthesis Report, Figure SPM.2

Near term vs. deferred mitigation

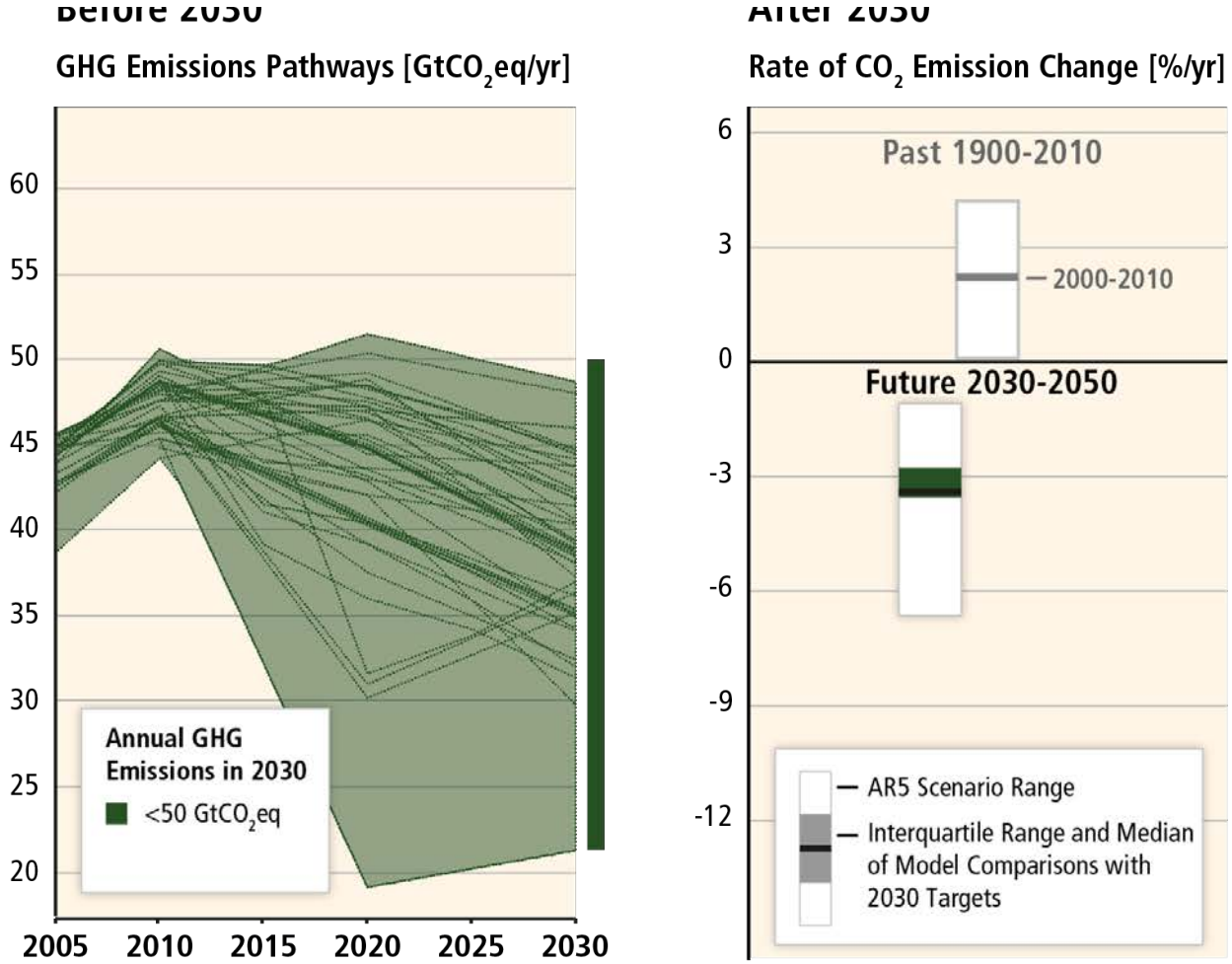
Fischlin et al., 2015. SED Report Figure 8



„immediate action“

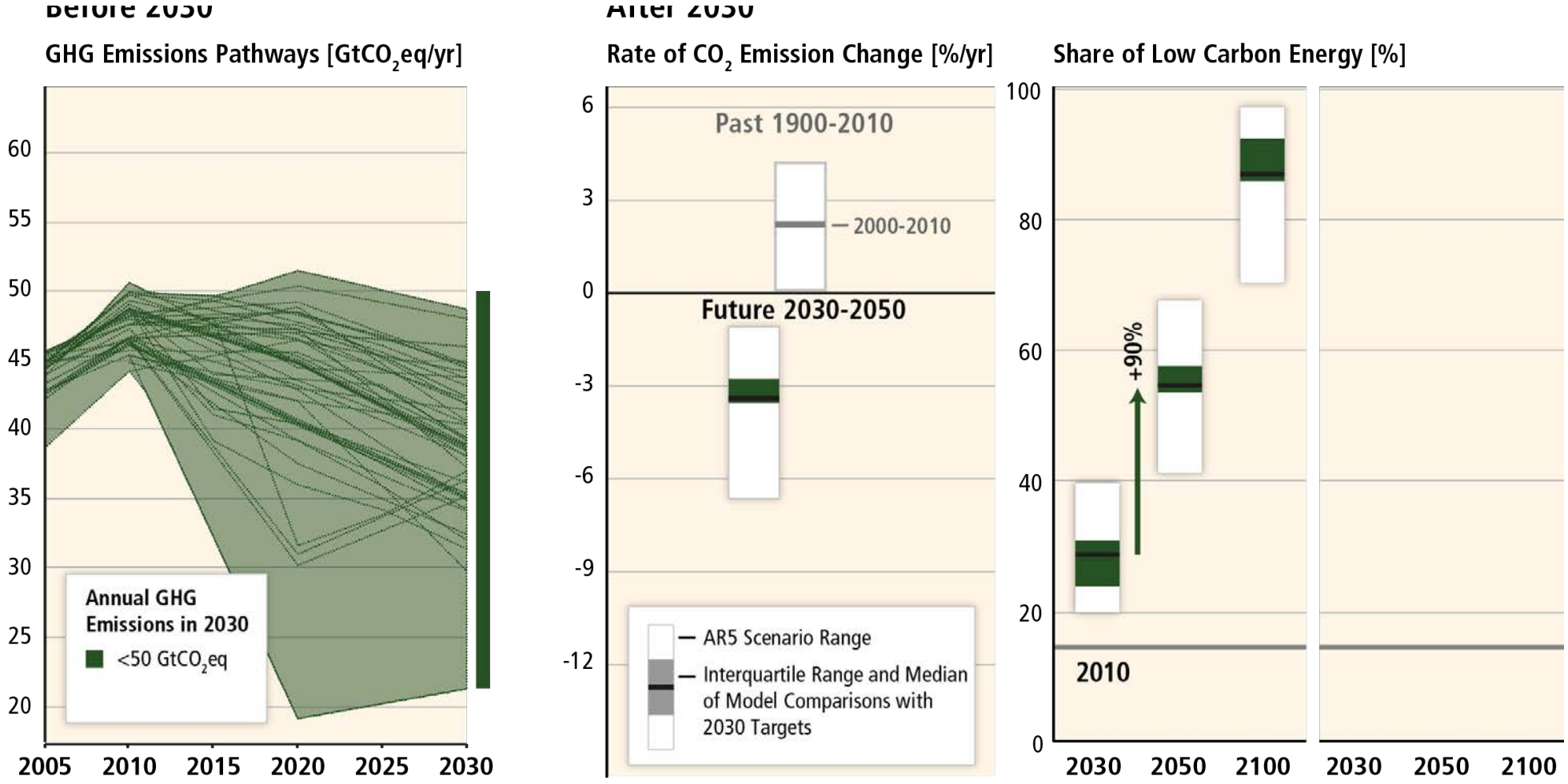
Near term vs. deferred mitigation

Fischlin et al., 2015. SED Report Figure 8



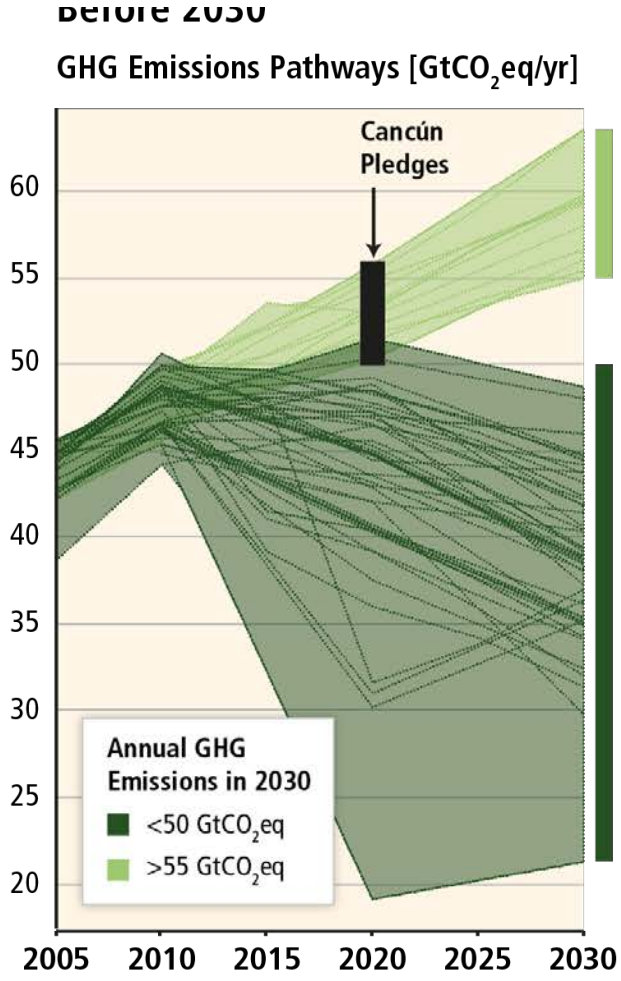
Near term vs. deferred mitigation

Fischlin et al., 2015. SED Report Figure 8



Near term vs. deferred mitigation

Fischlin et al., 2015. SED Report Figure 8

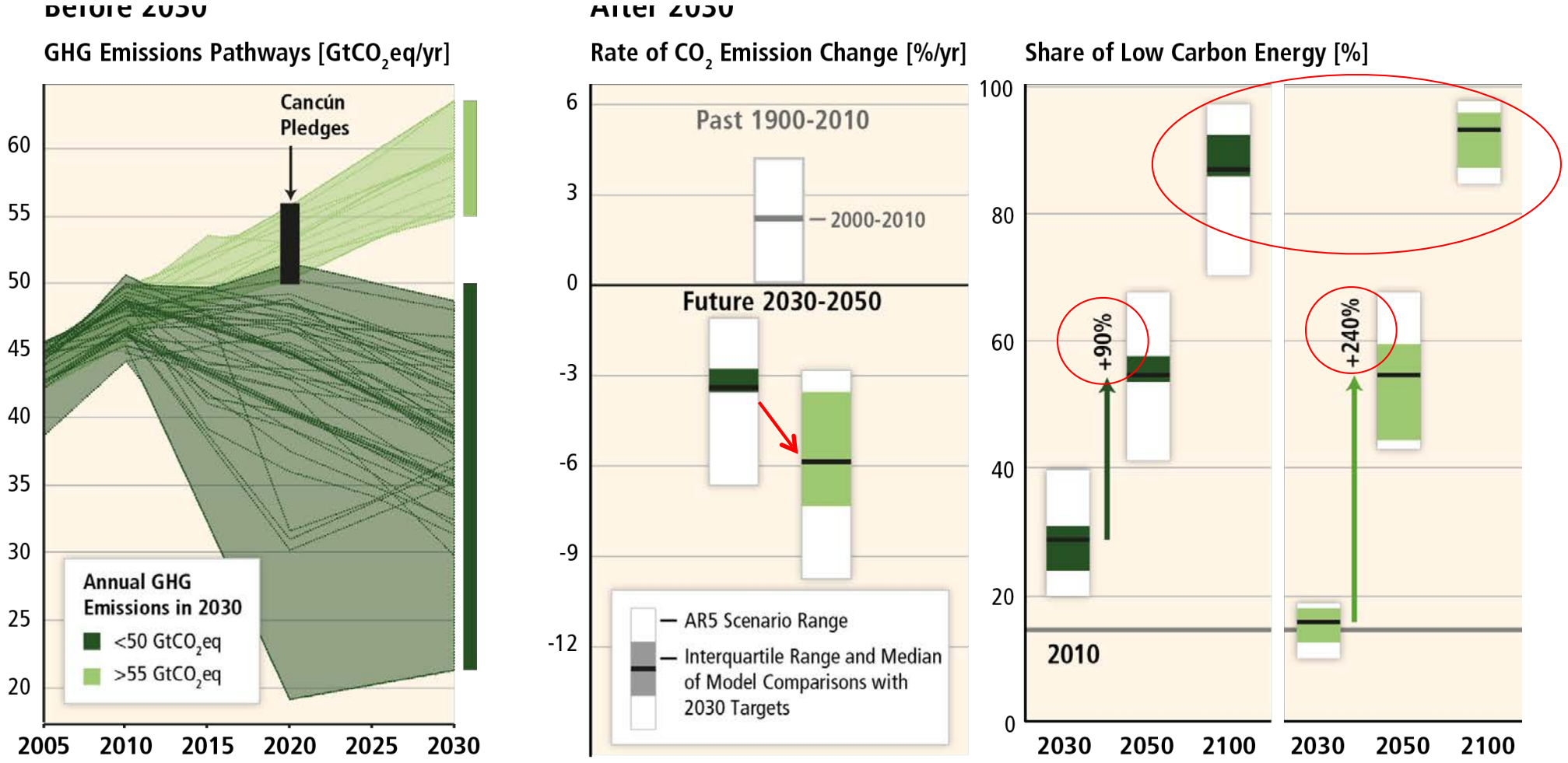


„delayed mitigation“

„immediate action“

Near term vs. deferred mitigation

Fischlin et al., 2015. SED Report Figure 8



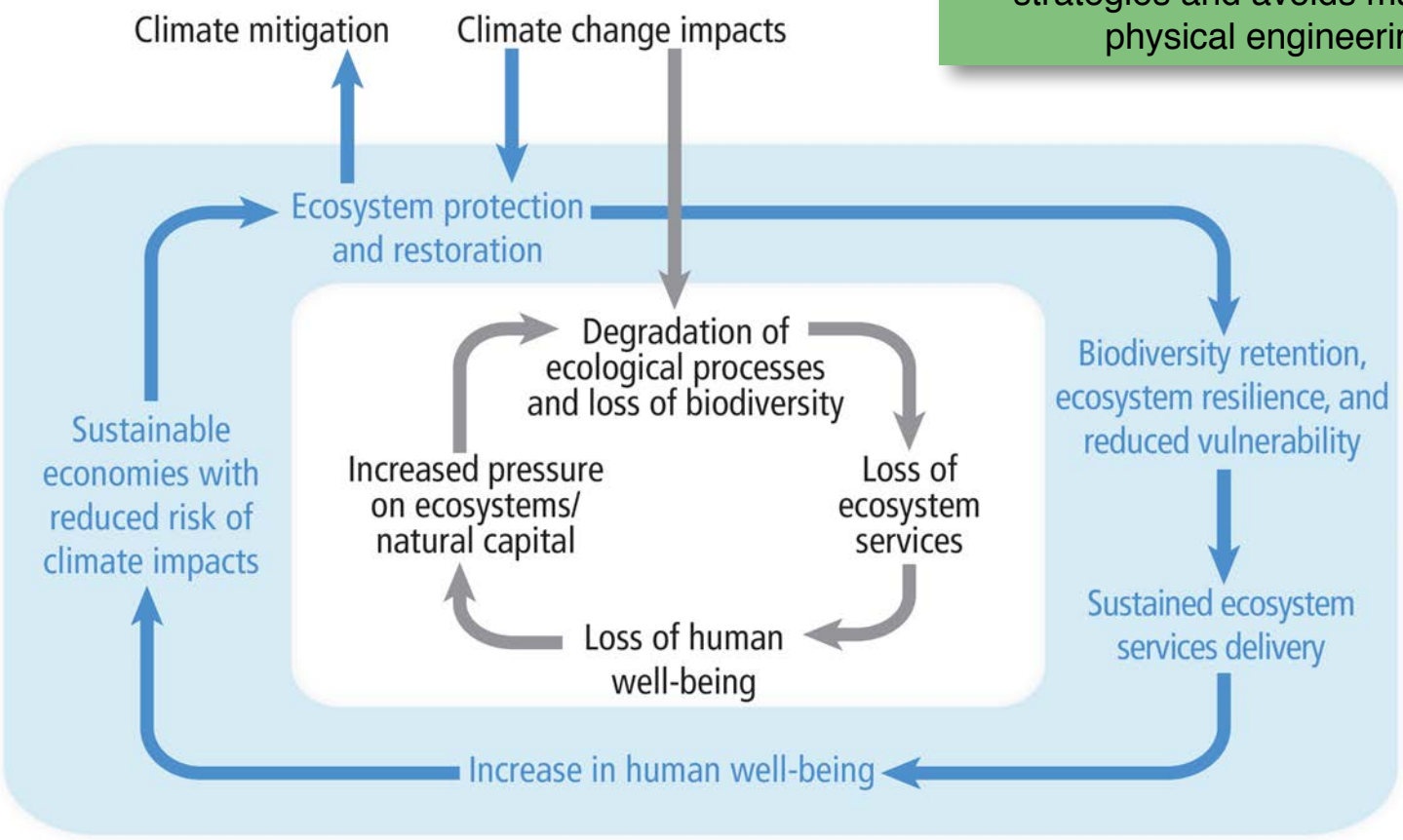
und ...

It isn't hell or high water, it is now both!

Fitz Simmons - www.cagle.com

Adaptation is necessary: E.g. Ecosystem Based Adaptation EBA

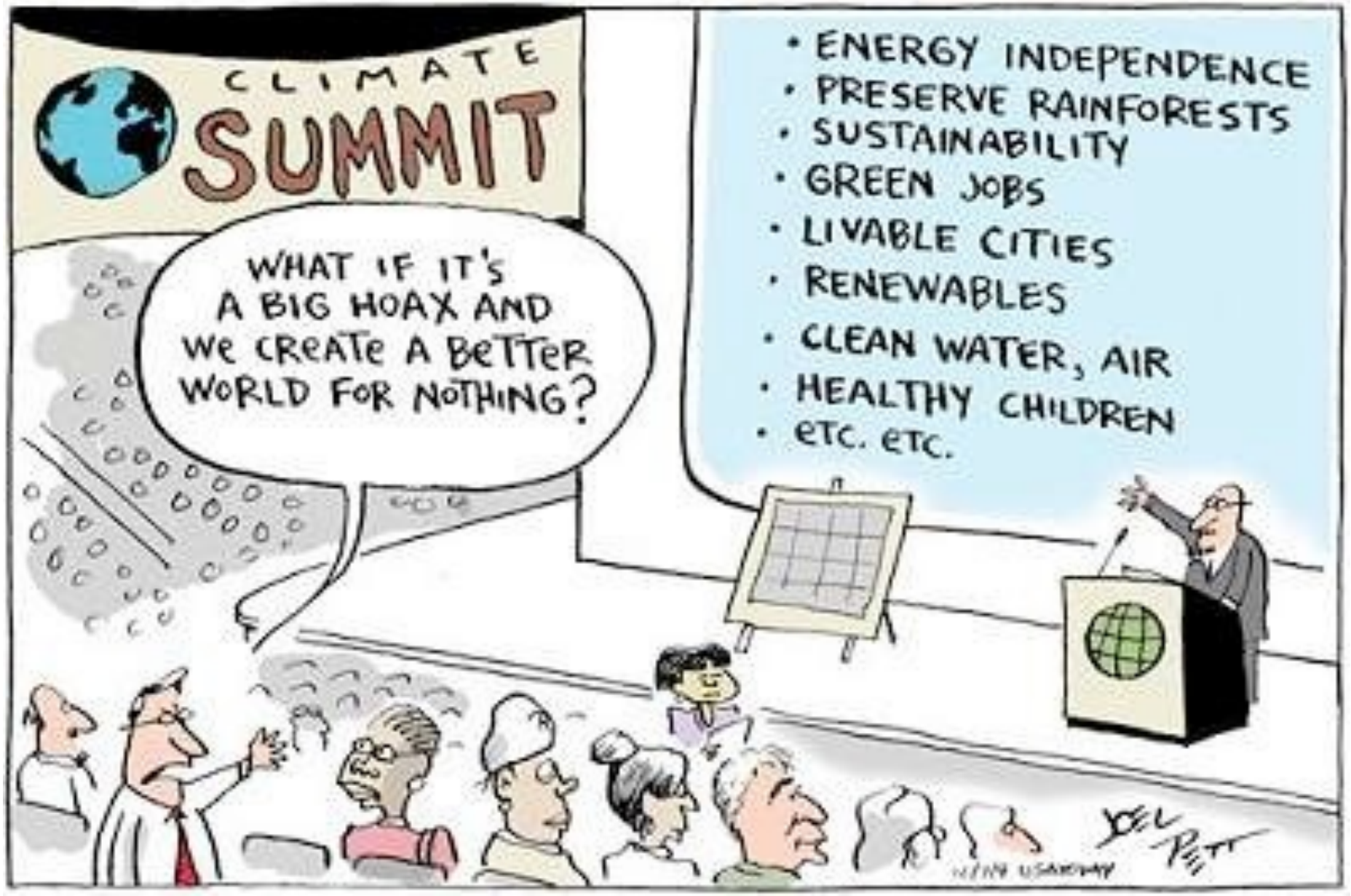
EBA integrates the use of biodiversity and ecosystem services into climate change adaptation strategies and avoids maladaptation through physical engineering approaches



IPCC, 2014. WGII, Cross-chapter box compendium


Climate change threatens our existence
Zzz...

and ...


CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT

Please take home:

- The physical science basis is very robust
- Human caused warming is clear
- Risks can be managed via mitigation and up to some limits via adaptation
- Unless emissions are radically and soon reduced, warming will impact soon some ecosystems significantly, e.g. coral reefs or NH sea ice biome
- Unmitigated climate change as currently projected will exceed the adaptive capacities of most ecosystems and thus would come with most severe impacts on their structure, functioning, and services

Thanks for your attention!

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Thanks for your attention!

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