The Challenges and Opportunities of Climate Change

An Overview Based on the IPCC Fifth Assessment Report (AR5)

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Why the IPCC ?

Established by WMO and UNEP in 1988

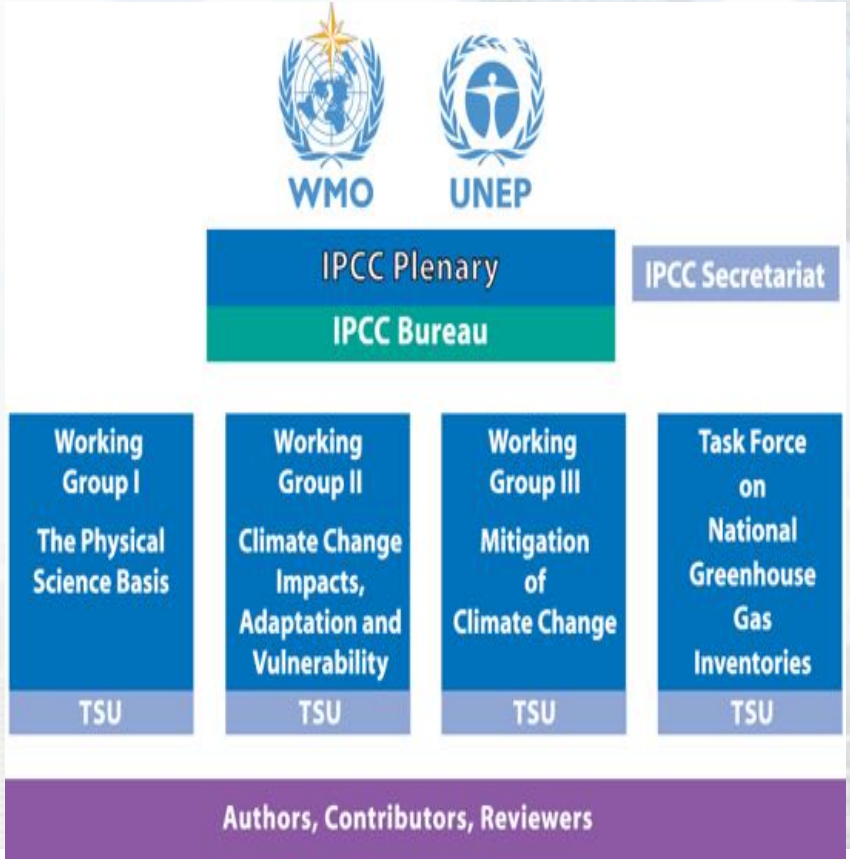
to provide policy-makers with an objective source of information about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options (adaptation & mitigation).

WMO=World Meteorological Organizatior

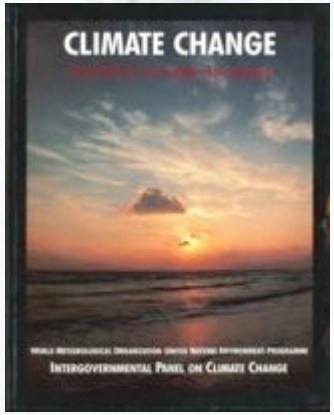
UNEP= United Nations Environment Programme

Inter-governmental Panel on Climate Change (IPCC): Organization Structure

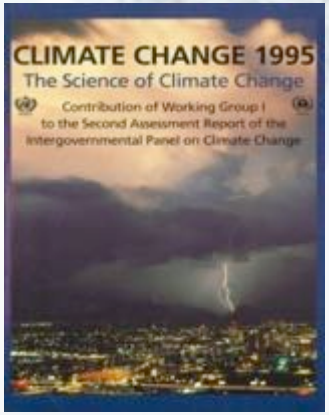


- IPCC plenary comprises of all countries in the world
- IPCC Bureau comprises of 34 elected members; IPCC elects its Bureau every 6-7 years
- 3 Working Groups & a Task Force on National Greenhouse Gas Inventories
- Authors, Contributors, Reviewers, Review Editors

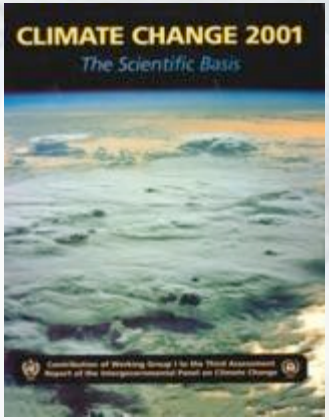
IPCC Assessment Reports



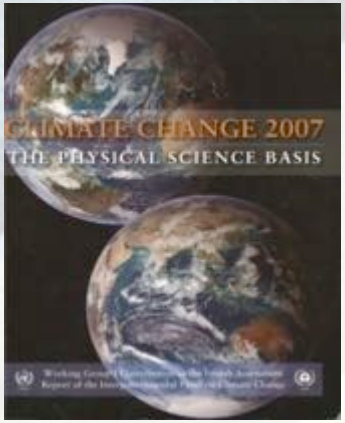
FAR 1990



SAR 1995



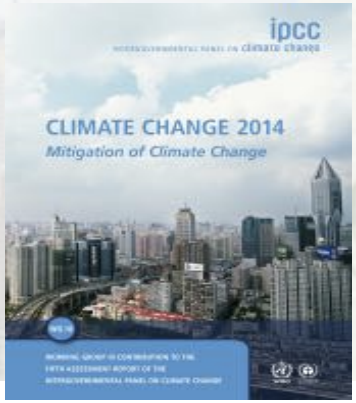
TAR 2001



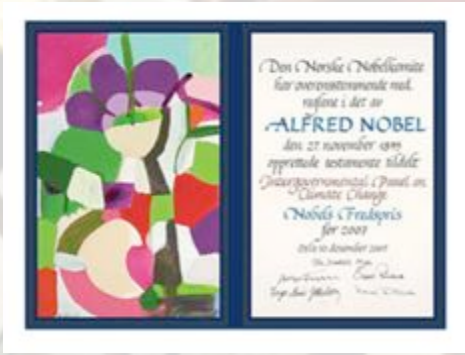
AR4 2007

AR5 WGI 2013

AR5 WGII 2014



AR5 WGIII 2014



IPCC AR5 Synthesis Report

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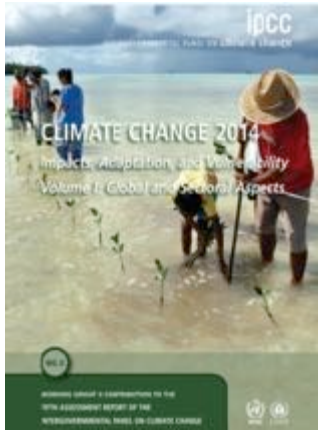
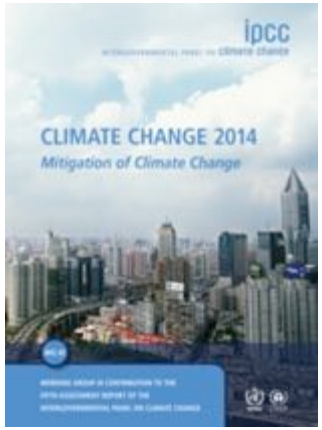
AR5 is the best ever

- Better integration of Mitigation and Adaptation
- Improved risk-management approach
- Evolving away from the non-mitigation SRES scenarios (SRES= Special Report on Emission Scenarios, 2000)
- Special effort to provide regional information when available
- Sustainable development & equity aspects
- More comprehensive treatment of economic aspects, and of cross-cutting issues
- Emerging issues handled (acidification, …)
- Better handling & communication of uncertainties





What is happening in the climate system?

What are the risks?

What can be done?

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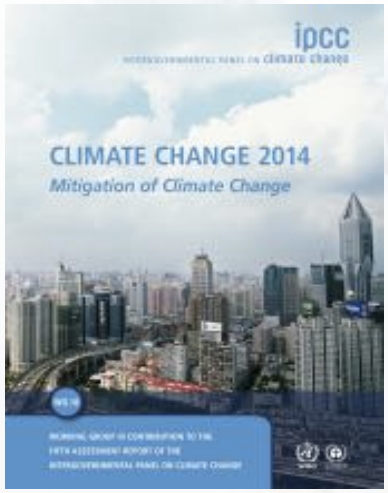
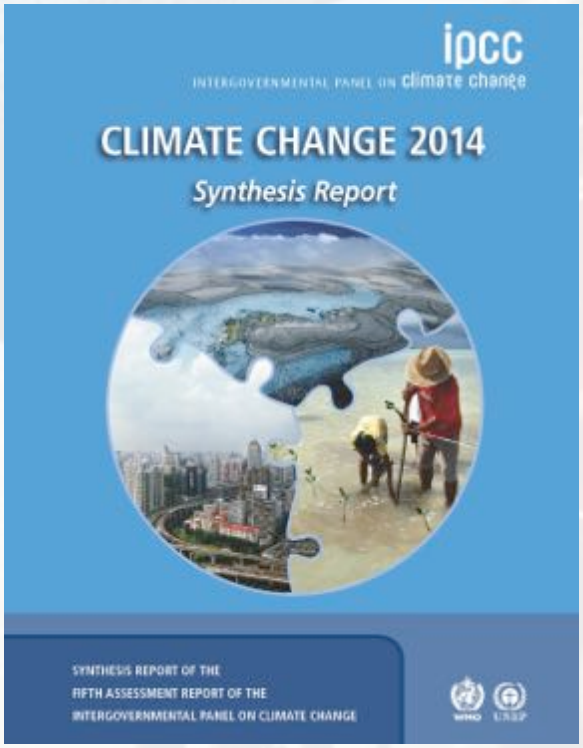
AR5 WGI 2013

AR5 WGII 2014



AR5 WGIII 2014



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Key messages from IPCC AR5

- **Human influence on the climate system is clear**
- **Continued emissions of greenhouse gases will increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems**
- **While climate change is a threat to sustainable development, there are many opportunities to integrate mitigation, adaptation, and the pursuit of other societal objectives**
- **Humanity has the means to limit climate change and build a more sustainable and resilient future**

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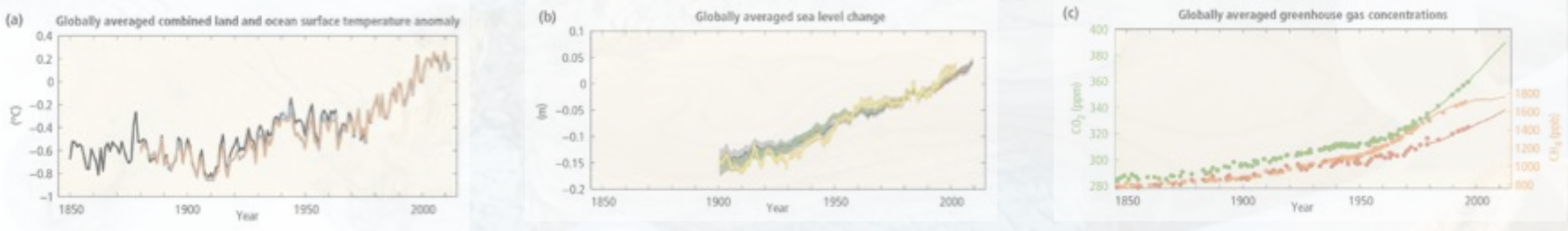
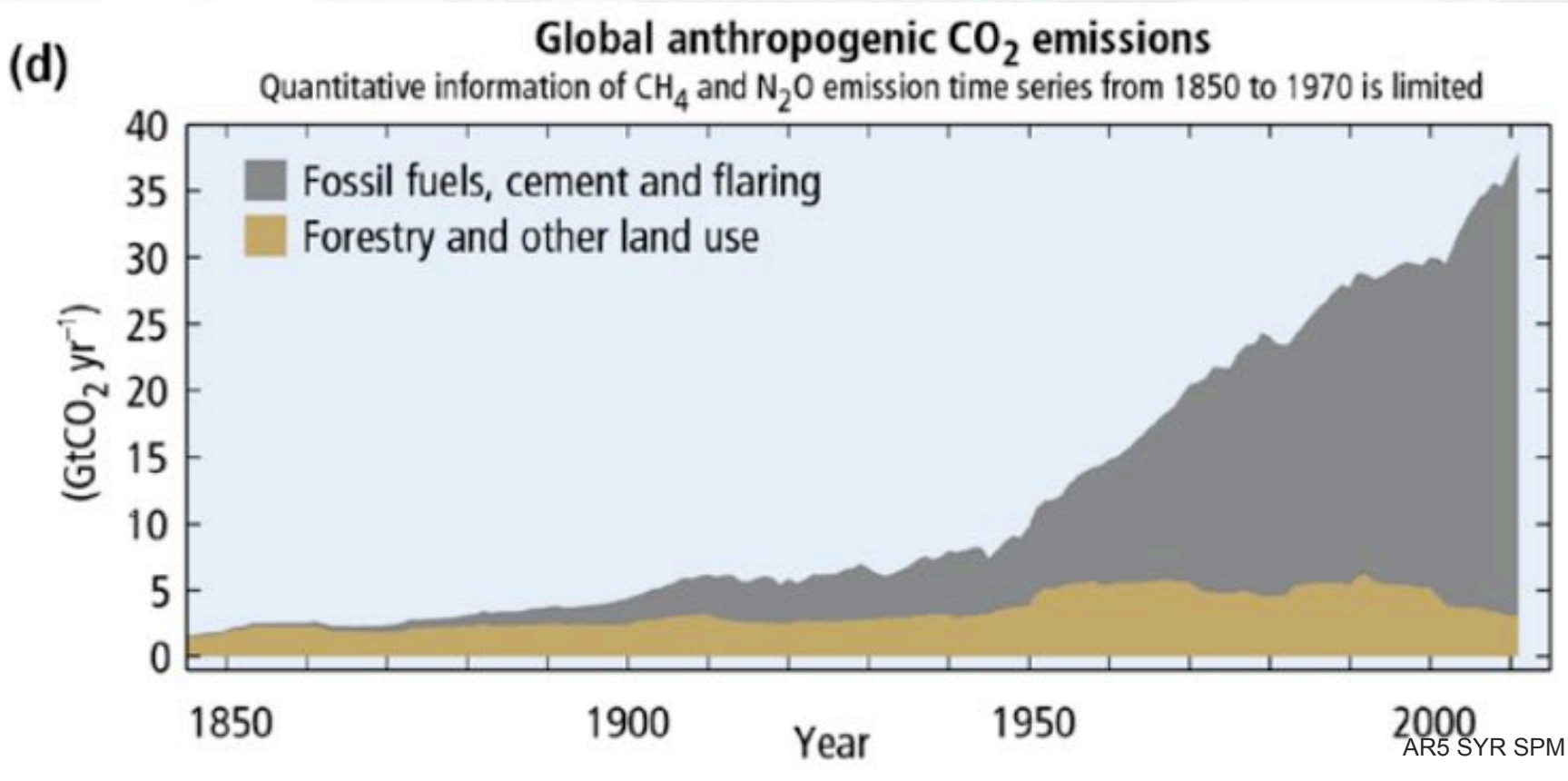
Atmospheric concentrations of CO_2

(Lüthi et al.,2008, NOAA)

The concentrations of CO_2 have increased to levels unprecedented in at least the last 800,000 years.





AR5 SYR SPM

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Sources of emissions

Energy production remains the primary driver of GHG emissions

2010 GHG emissions

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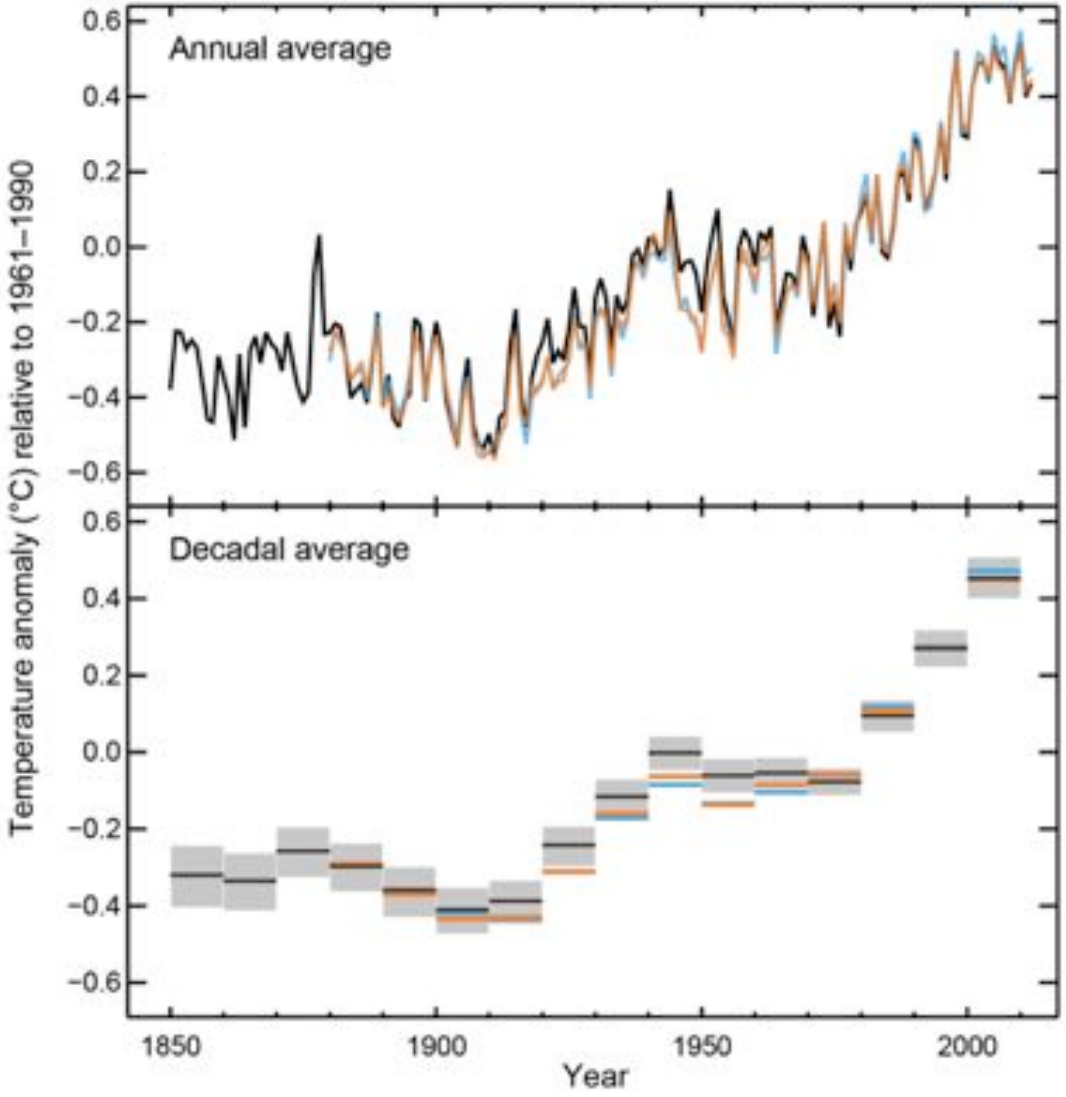
Figure SPM.1a Surface Temperature

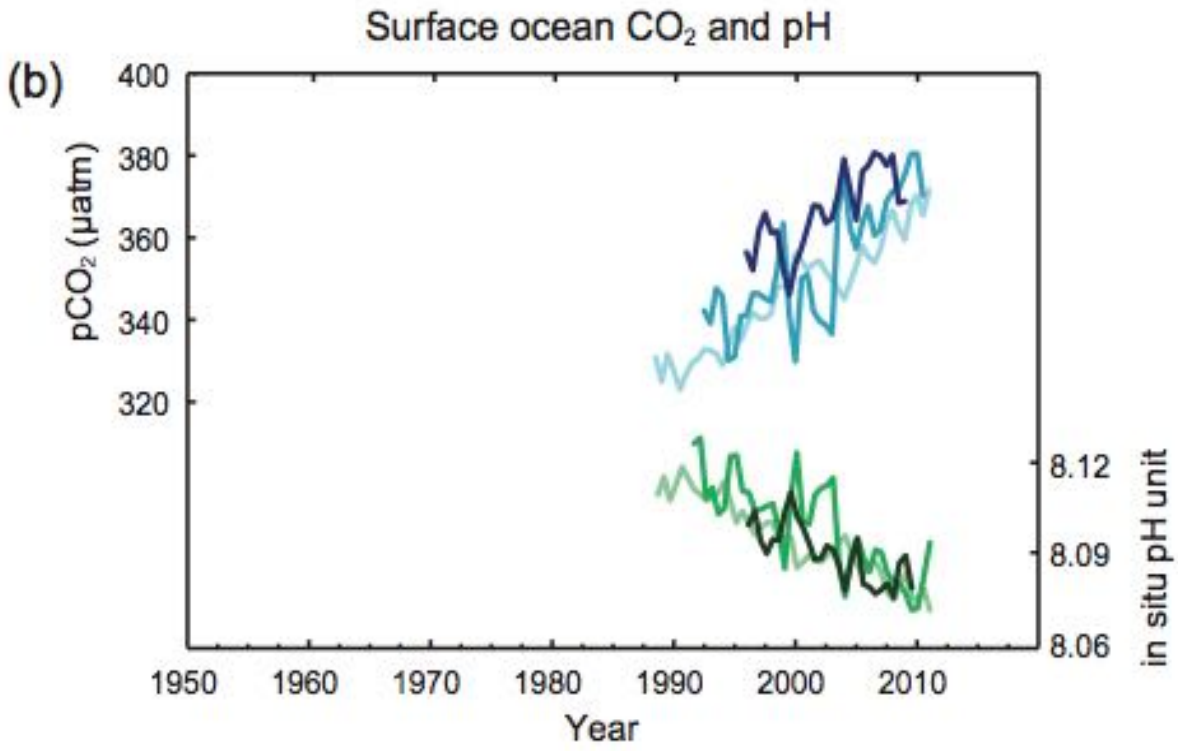
Observed globally averaged combined land and ocean surface temperature anomaly 1850-2012



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

Oceanic uptake of CO_2 has resulted in acidification of the ocean



The pH of ocean surface water has decreased by 0.1 (*high confidence*), corresponding to a 26% of increase in acidity, measured as hydrogen ion concentration

AR5 SYR; AR5 WG1 SPM.4b

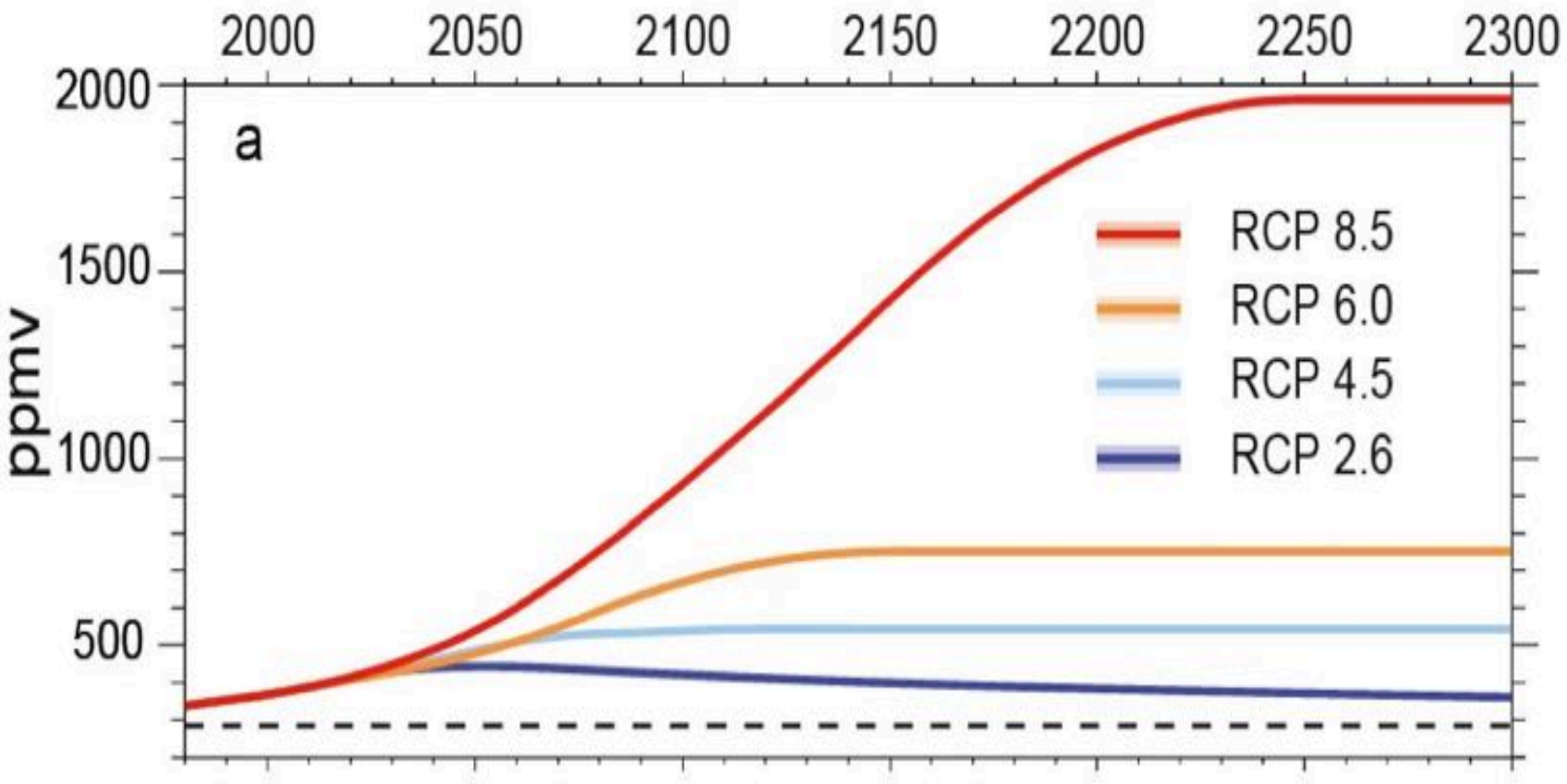
Impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries (but the poor are more vulnerable everywhere)



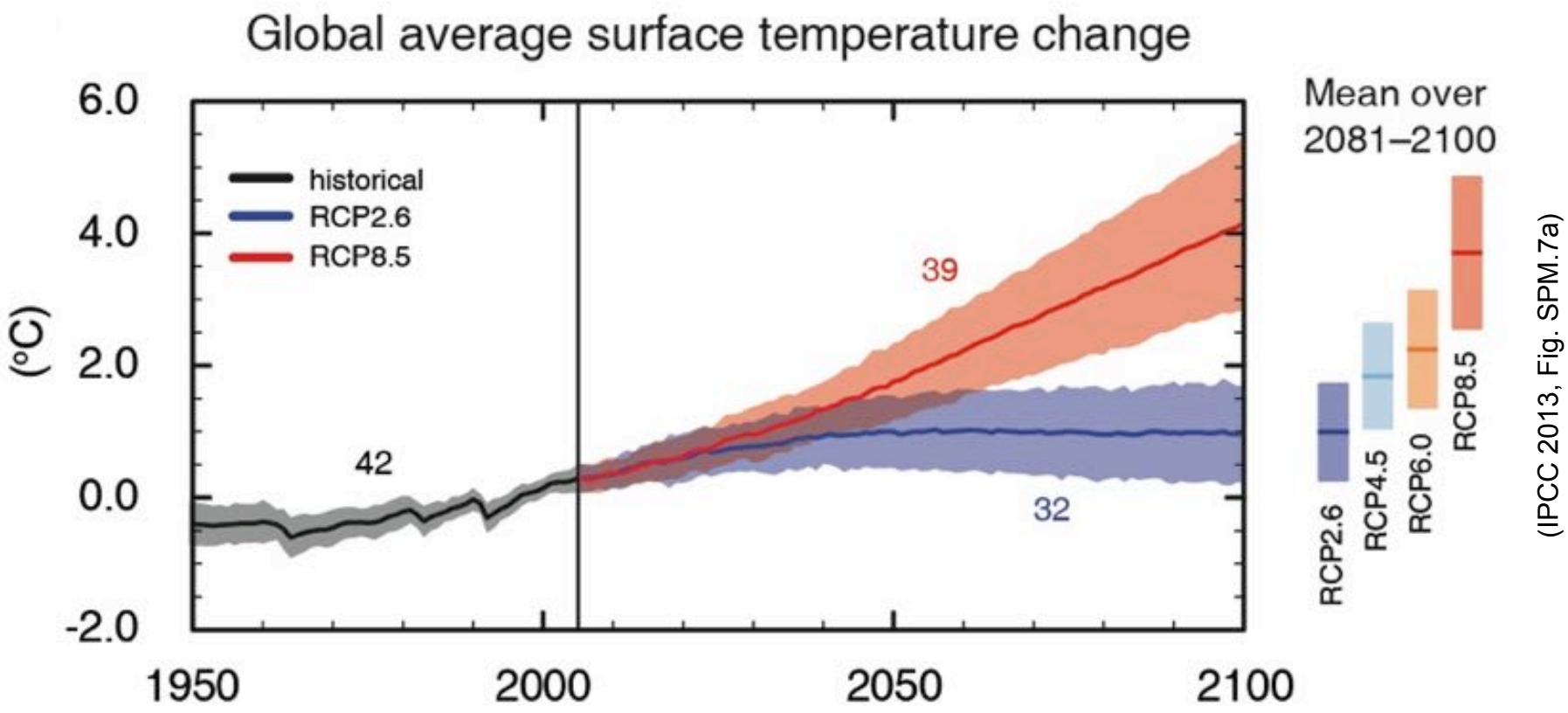

AR5 WGII SPM

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



(IPCC 2013, Fig. SPM.7a)

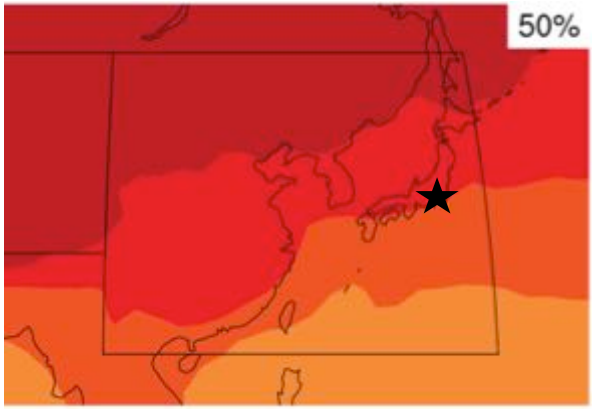
Only the lowest (RCP2.6) scenario maintains the global surface temperature increase above the pre-industrial level to less than 2°C with at least 66% probability

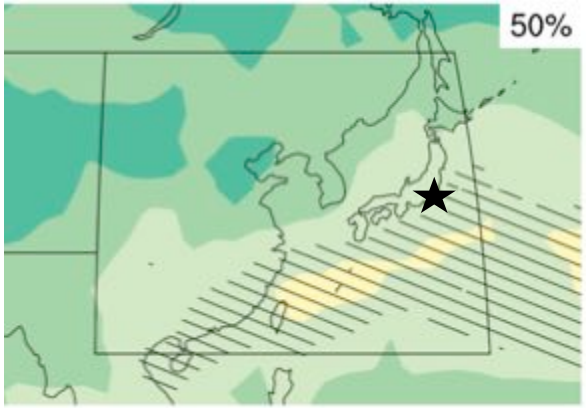
IPCC 2013: Atlas of Global and Regional Climate Projections

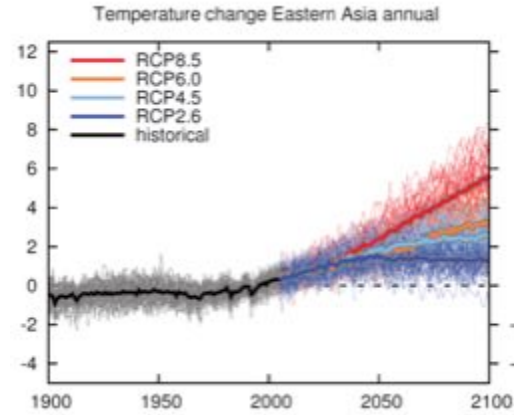
Changes in Eastern Asia (2081-2100)

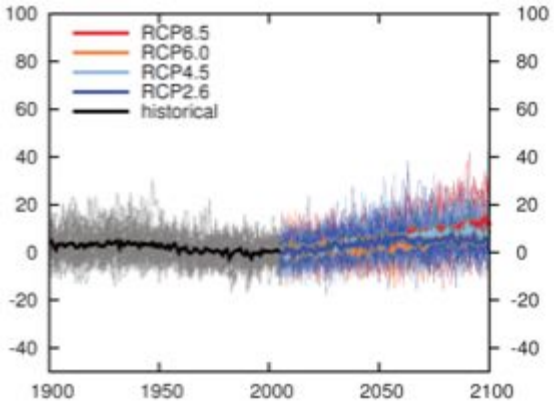
RCP 2.6 (annual)

RCP 8.5 (annual)

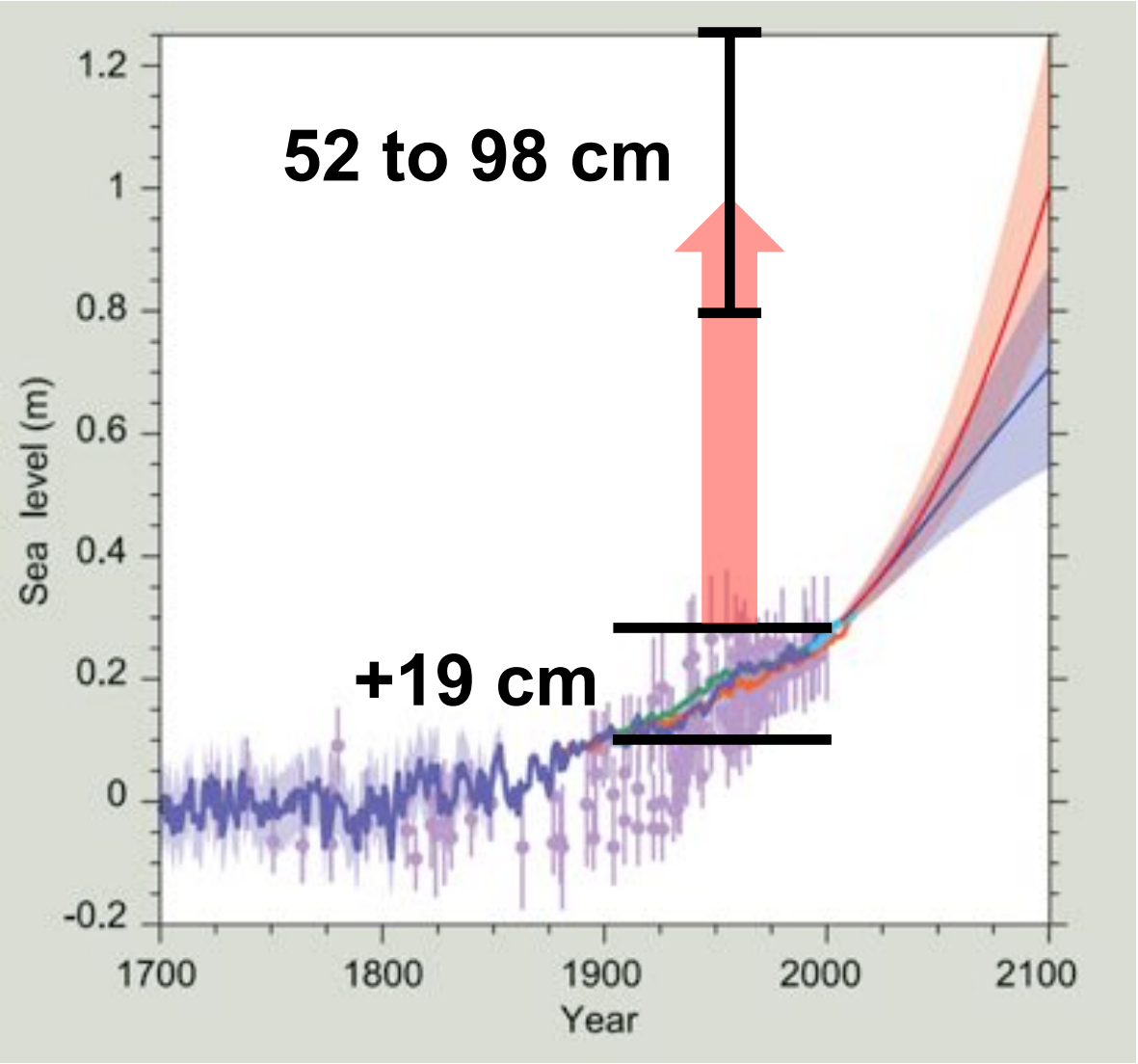








Sea Level



IPCC 2013, TFE.2, Fig. 2

Risk = Hazard x Vulnerability x Exposure (Katrina flood victim)

AP Photo - Lisa Krantz (http://lisakrantz.com/hurricane-katrina/zspbn1k4cn17phidupe4f9x5t1mzdr)

Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

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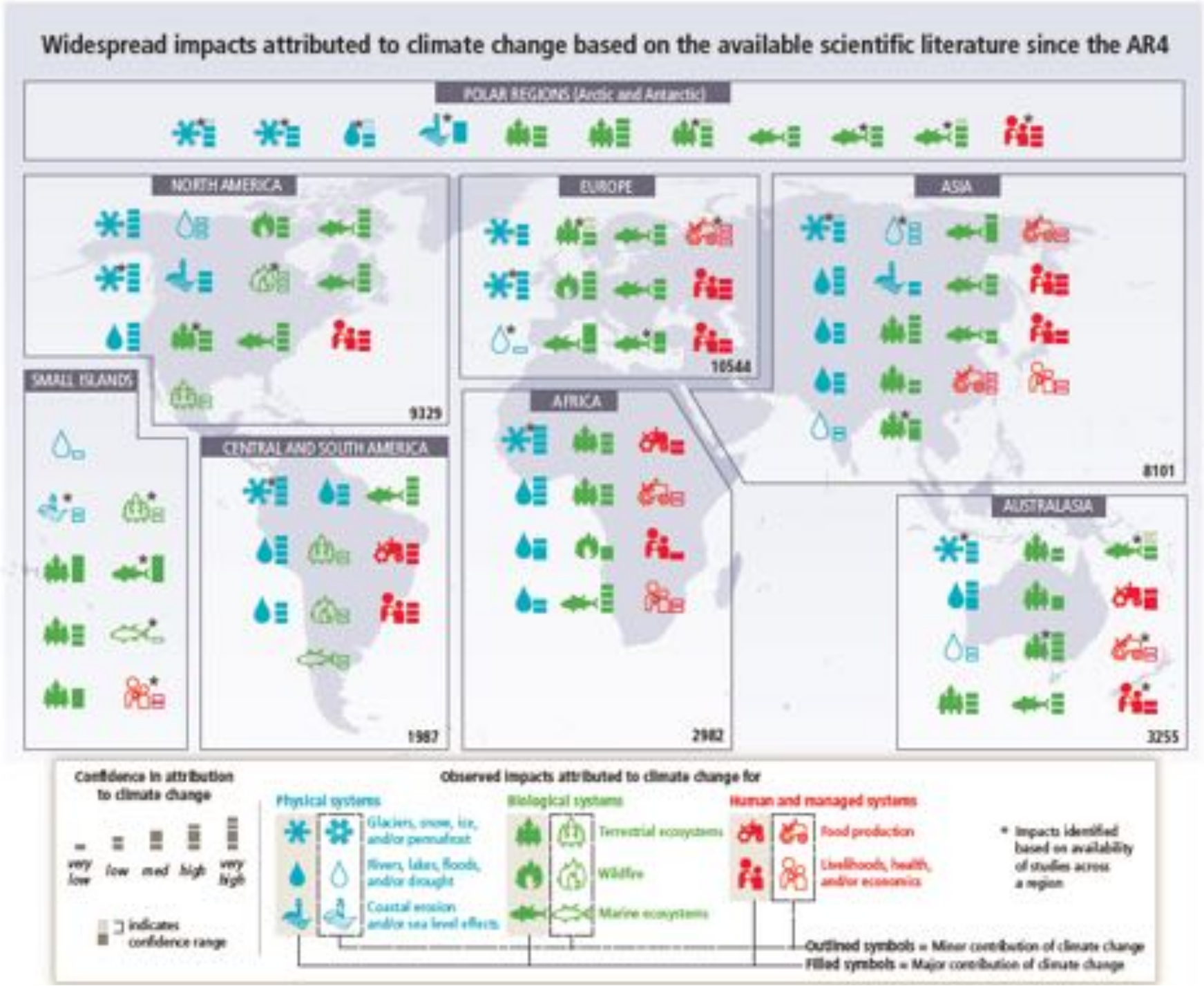
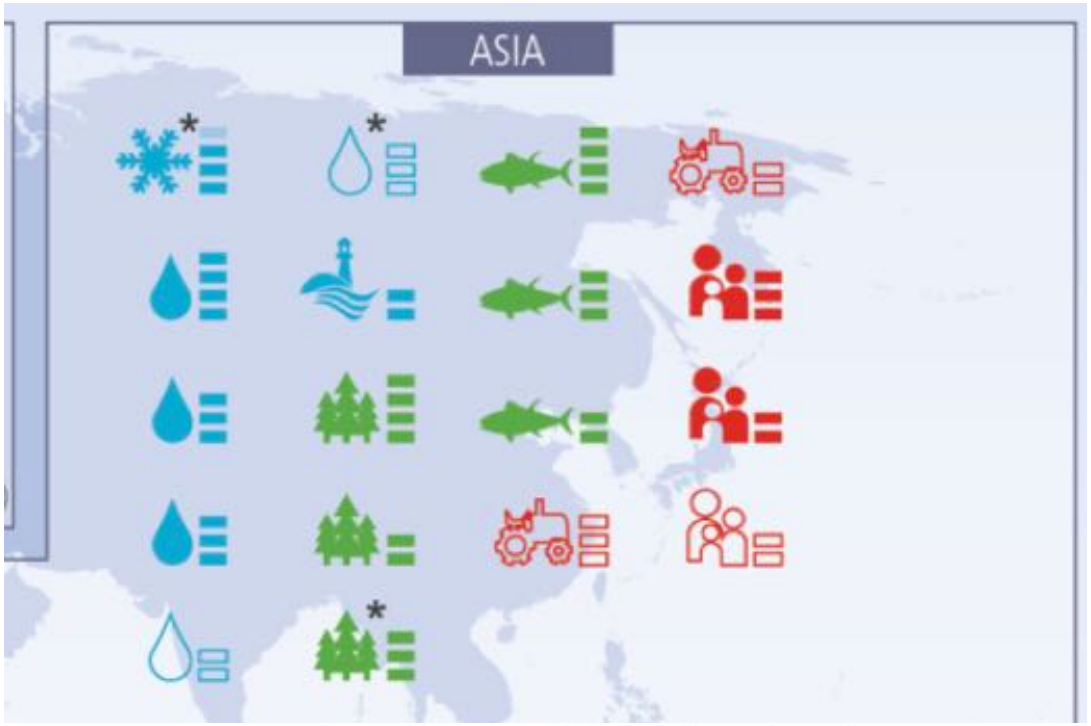

Widespread impacts attributed to climate change based on the available scientific literature since the AR4
POLAR REGIONS (Arctic and Antarctic)
NORTH AMERICA
9329
EUROPE
10544
ASIA
8101
SMALL ISLANDS
CENTRAL AND SOUTH AMERICA
1987
AFRICA
2982
AUSTRALASIA
3255
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change for
Physical systems
Glaciers, snow, ice, and/or permafrost
Rivers, lakes, floods, and/or drought
Coastal erosion and/or sea level effects
Biological systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human and managed systems
Food production
Livelihoods, health, and/or economics
* Impacts identified based on availability of studies across a region
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change

Widespread impacts attributed to climate change based on the available scientific literature since the AR4 (IPCC, AR5, SYR, Fig. SPM.4)



Food Production Systems and Food Security : Observed Impacts

In Japan, where mean air temperature rose by about 1°C over the 20th century, effects of recent warming include phenological changes in many crops, increases in fruit coloring disorders and incidences of chalky rice kernels, reductions in yields of wheat, barley, vegetables, flowers, milk, and eggs, and alterations in the type of disease and pest (*high confidence* in detection, *high confidence* in attribution; Sugiura et al., 2012).

IPCC, AR5, WG II, Chap. 24, p.1343

ADAPTATION IS

ALREADY OCCURRING

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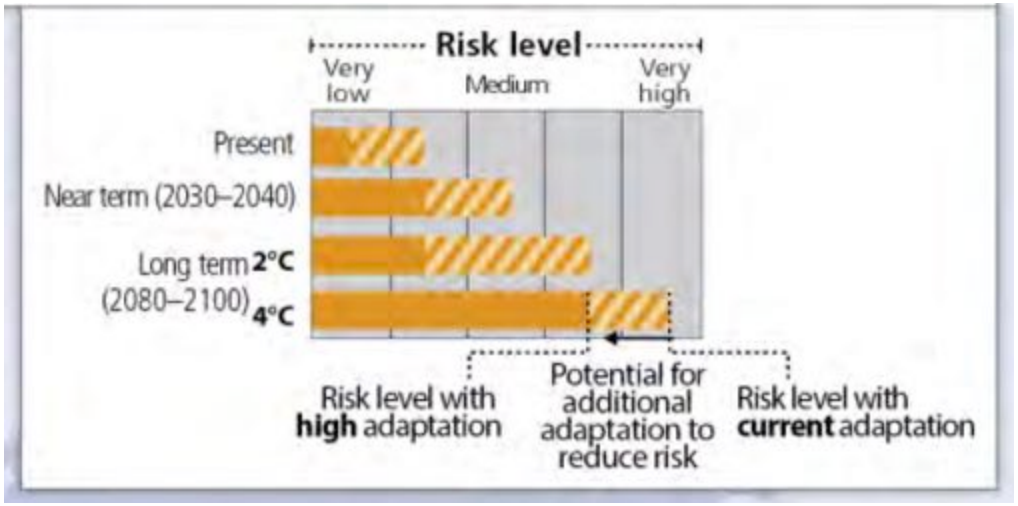
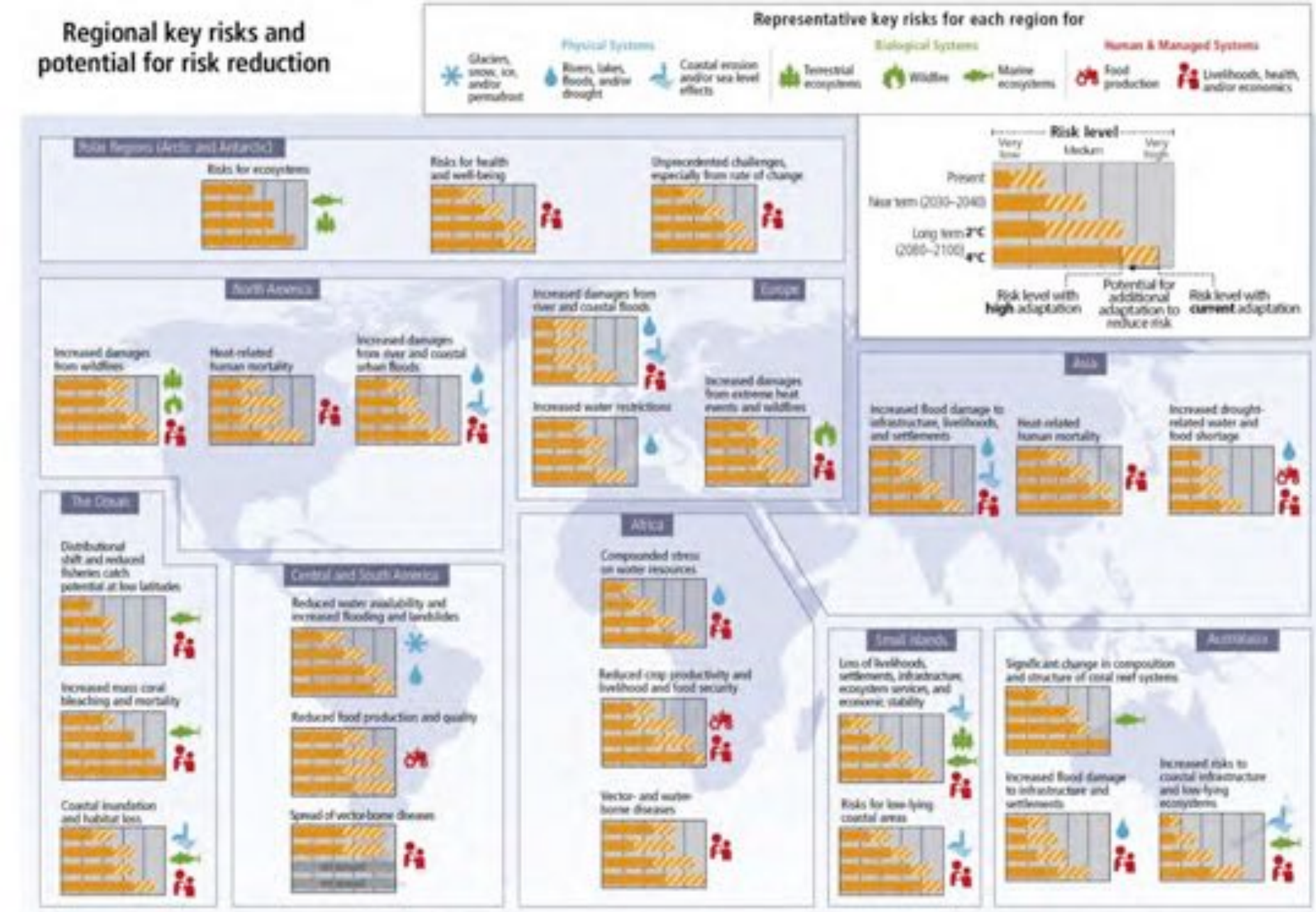
Regional key risks and potential for risk reduction through adaptation



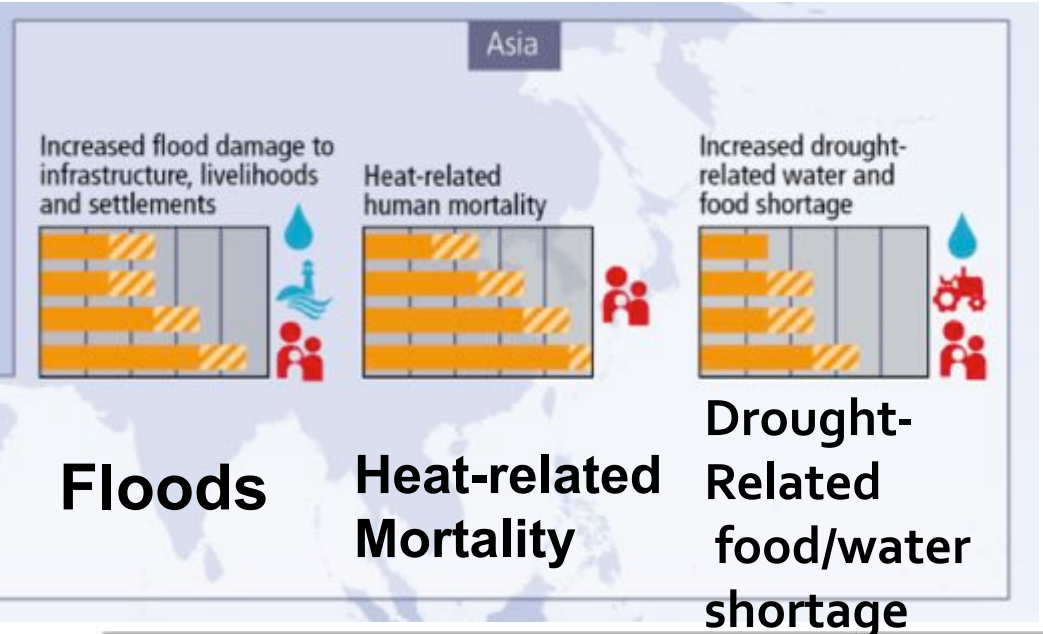
IPCC, AR5, SPM, Figure SPM.8

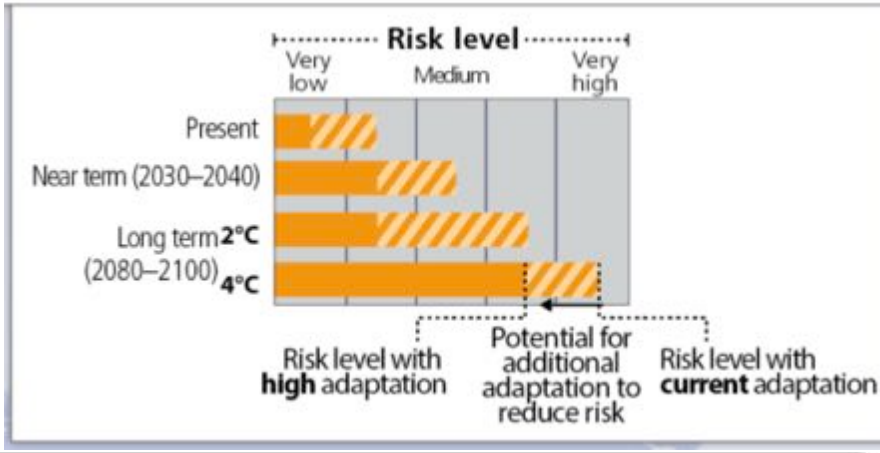
Regional key risks and potential for risk reduction



IPCC, AR5, SPM, Figure SPM.8

Regional key risks and potential for risk reduction: Asia





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IPCC, AR5, SYR, SPM.8

Future food supply and demand

Rice is a key staple crop in Asia and 90% or more of the world's rice production is from Asia. An Asia-wide study revealed that climate change scenarios (using 18 GCMs for A1B, 14 GCMs for A2, and 17 GCMs for B1) **would reduce rice yield over a large portion of the continent** (Masutomi et al., 2009). The most vulnerable regions were **western Japan**, eastern China, the southern part of the Indochina peninsula, and the northern part of South Asia.

IPCC, AR5, WG II, Chap. 24, p.1345

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RISKS OF
CLIMATE CHANGE
INCREASE
WITH CONTINUED
HIGH EMISSIONS
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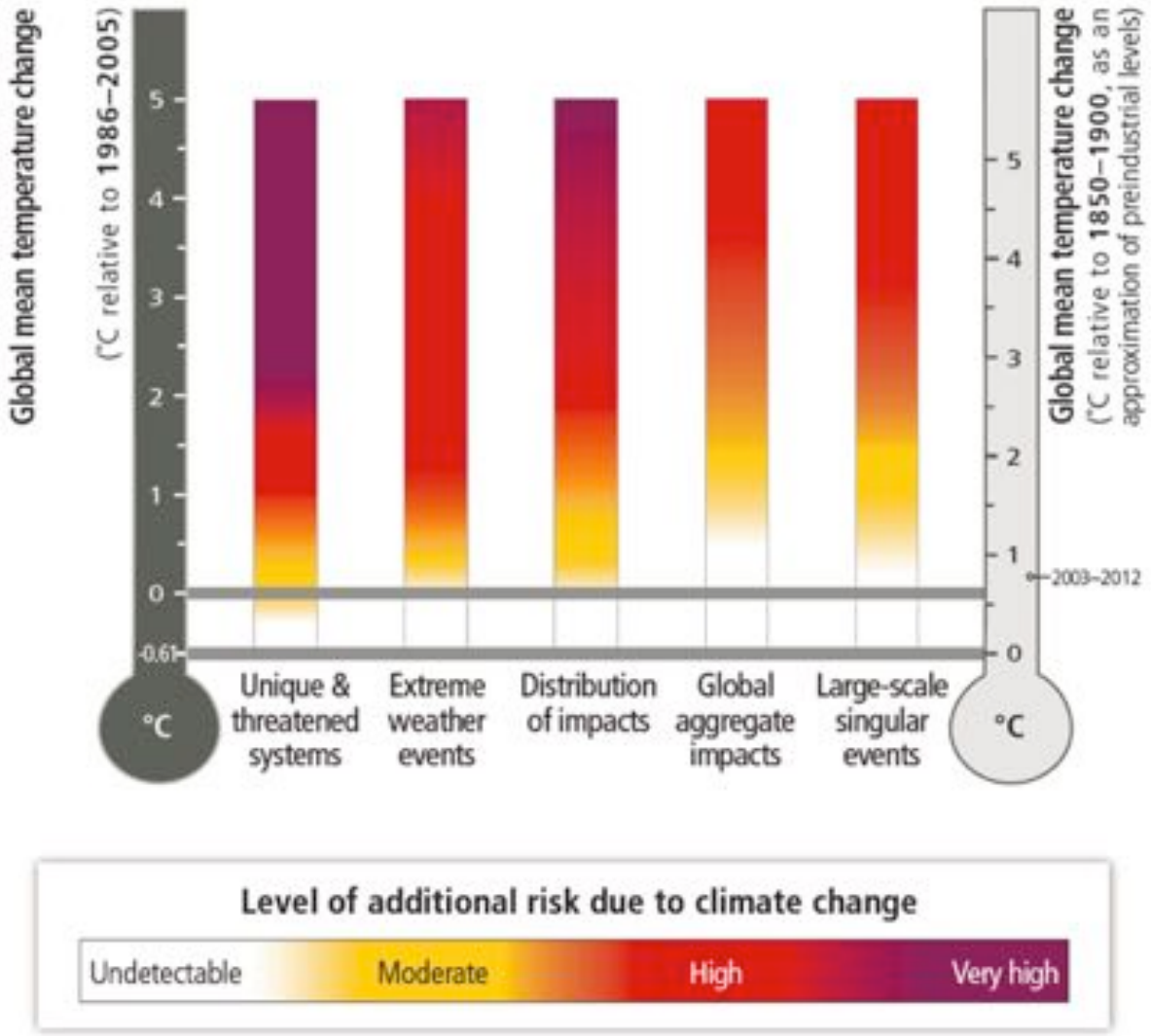
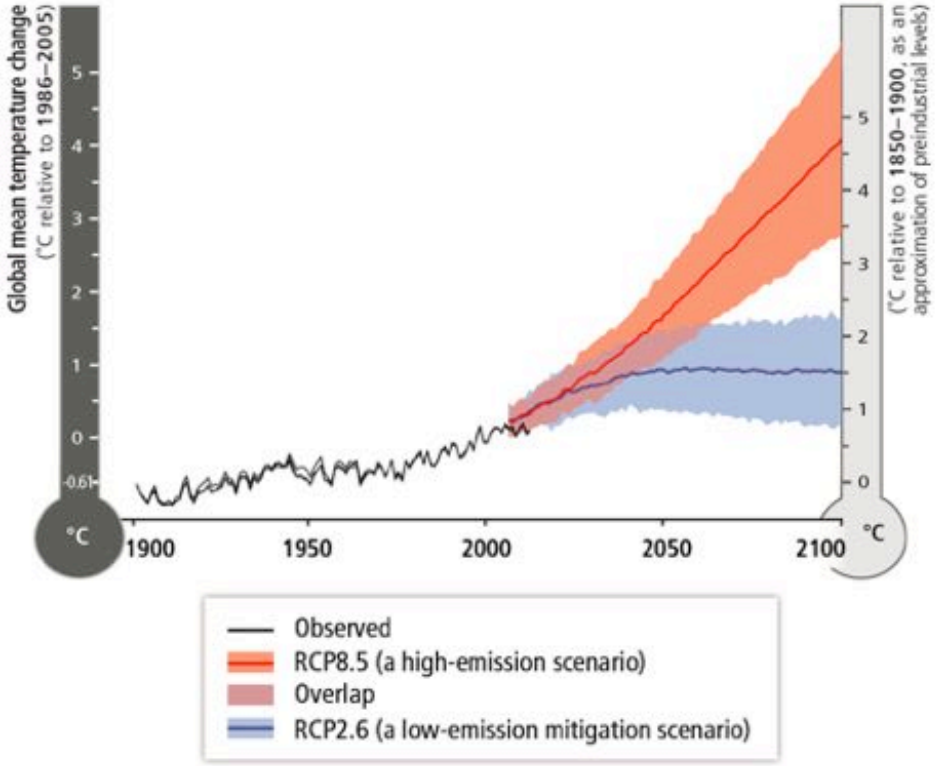
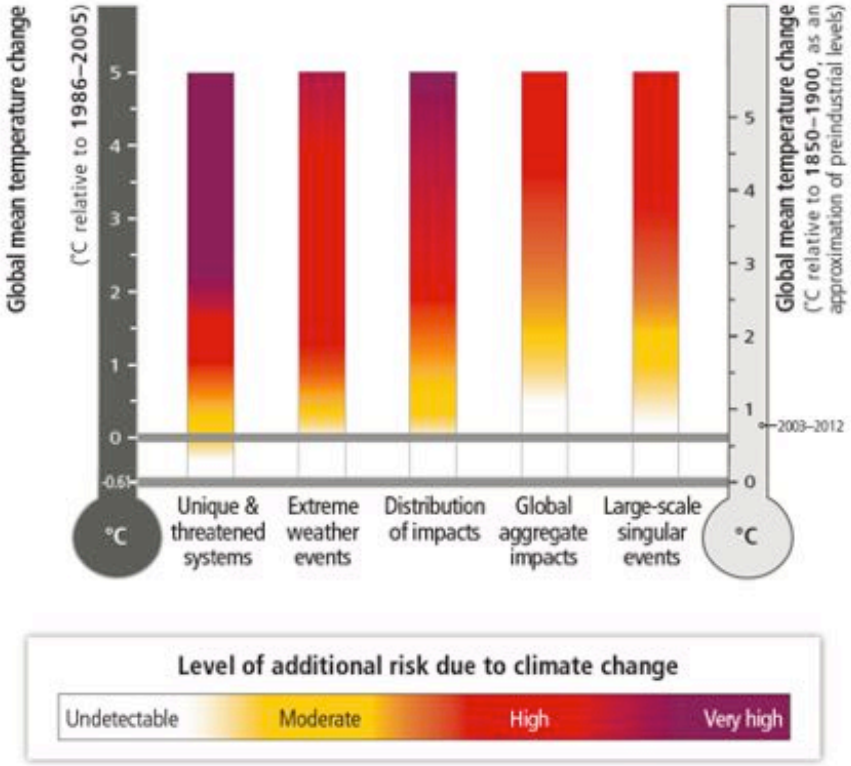
Reasons for concern



AR5, WGII, Box SPM.1 Figure 1





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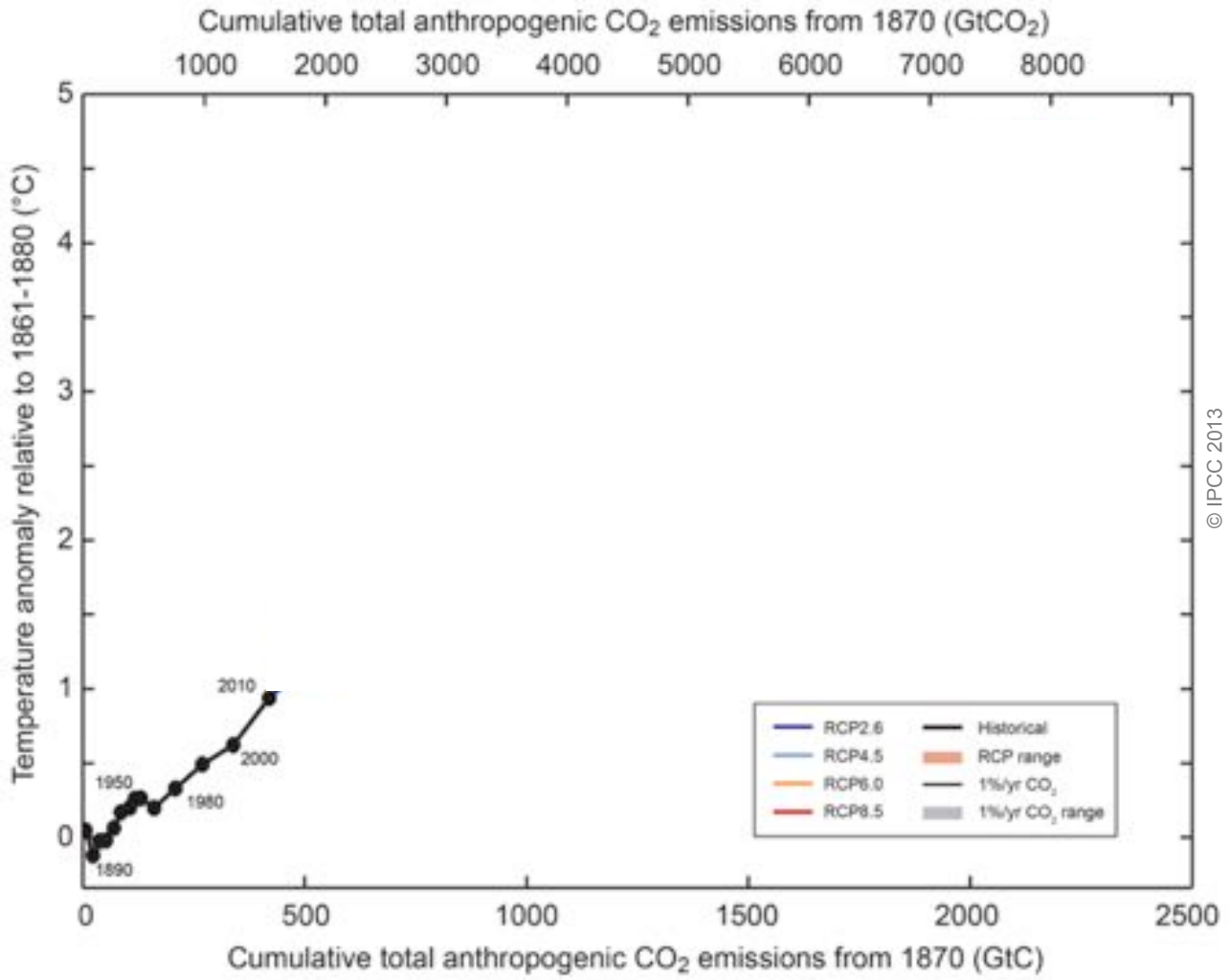


Fig. SPM.10

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

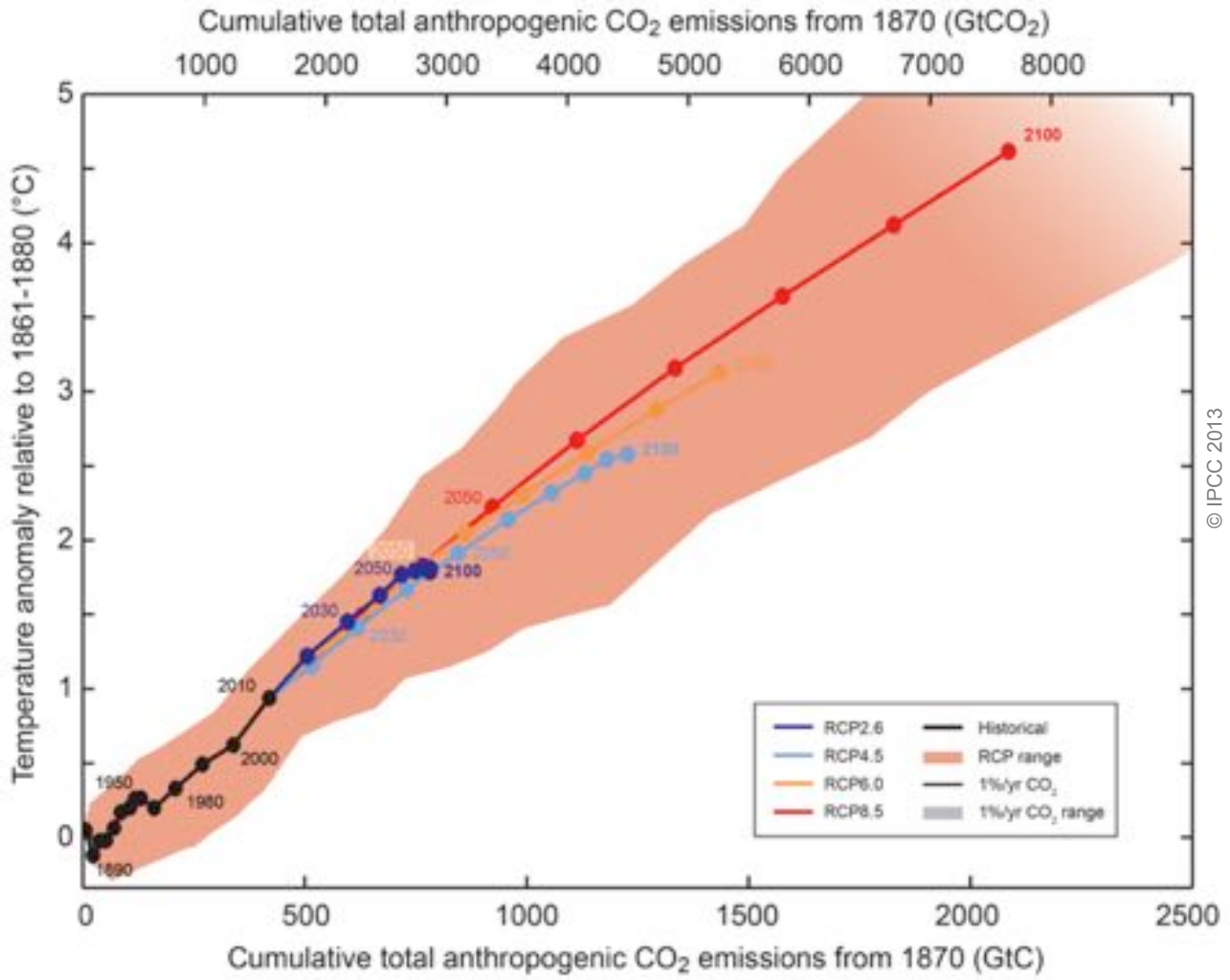
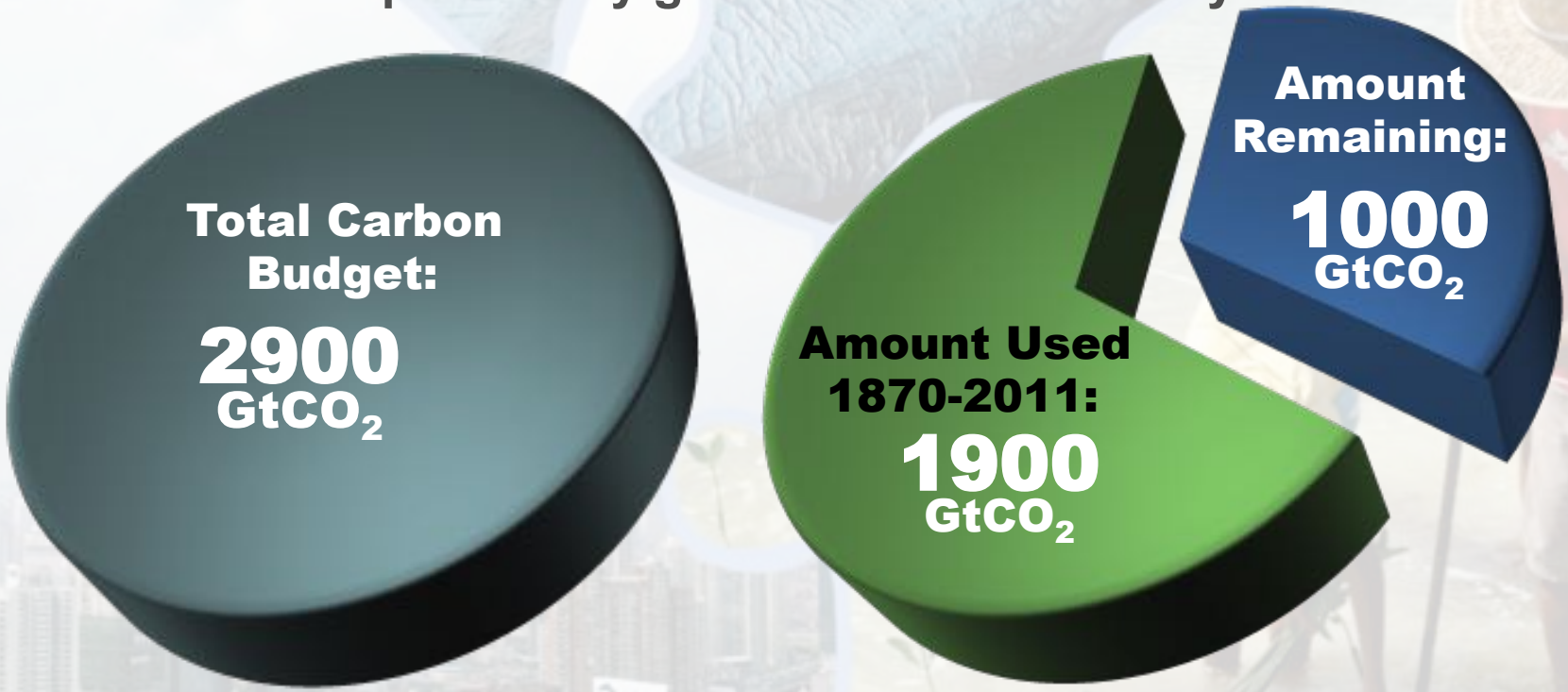


Fig. SPM.10

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

The window for action is rapidly closing

65% of the carbon budget compatible with a 2°C goal is already used
NB: this is with a probability greater than 66% to stay below 2°C



NB: Emissions in 2011: 38 GtCO2/yr

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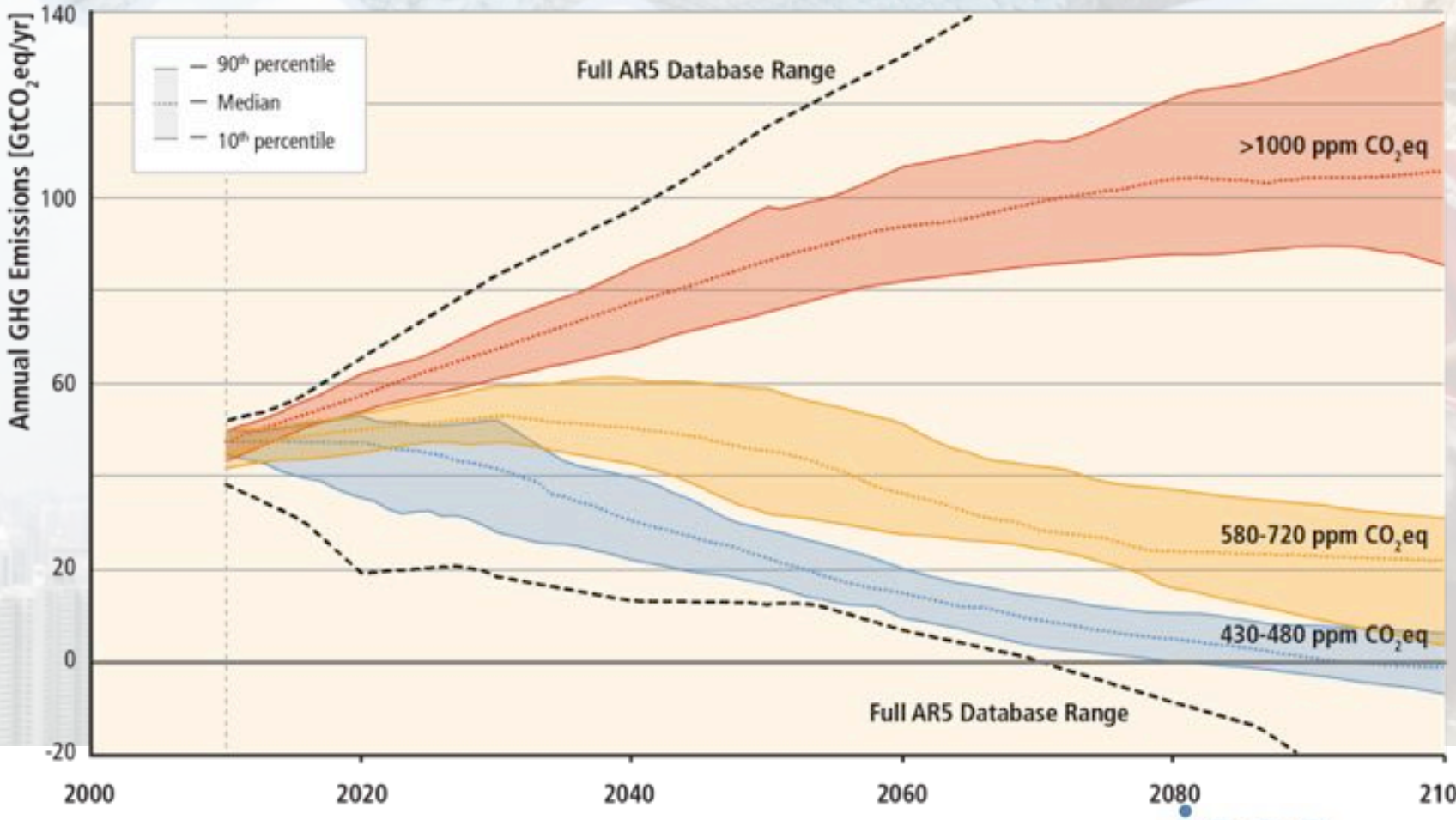
Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

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Emissions scenarios leading to GHG concentrations in 2100 of about 450 ppm CO2-eq or lower are *likely* to maintain warming below 2°C over the 21st century relative to pre-industrial levels

Temperature would be likely to stay below 2°C this century.

CO_2-eq Concentrations in 2100 (CO_2-eq) [f] Category label (conc. range)	Subcategories	Relative position of the RCPs [d]	Change in C emissions cor to 2010 (in		a specific 21st century 900) [d, e]			
			2050	2100	1.5°C	2°C	3°C	4°C
<430	Only a limited number of individual model studies have explored levels below 430 ppm CO_2-eq [j]							
450 (430 to 480)	Total range [a, g]	RCP2.6	–72 to –41	–118 to –78	*More unlikely than likely*	*Likely*		
500 (480 to 530)	No overshoot of 530 ppm CO_2-eq		–57 to –42	–107 to –73		*More likely than not*	*Likely*	*Likely*
	Overshoot of 530 ppm CO_2-eq		–55 to –25	–114 to –90		*About as likely as not*		
550 (530 to 580)	No overshoot of 580 ppm CO_2-eq		–47 to –19	–81 to –59	*Unlikely*	*More unlikely*		
	Overshoot of 580 ppm CO_2-eq		–16 to 7	–183 to –86				
(580 to 650)	Total range	RCP4.5	–38 to 24	–134 to –50				
(650 to 720)	Total range		–11 to 17	–54 to –21				
(720 to 1000) [b]	Total range	RCP6.0	18 to 54	–7 to 72				
>1000 [b]	Total range	RCP8.5	52 to 95	74 to 178		*Unlikely* [h]	*Unlikely*	*than likely*

The 450 ppmv CO2e scenarios are typically more unlikely than likely to remain below 1.5°C this century.

Emissions scenarios leading to GHG concentrations in 2100 of about 450 ppm CO2-eq or lower are *likely* to maintain warming below 2°C over the 21st century relative to pre-industrial levels

CO_2-eq Concentrations in 2100 (CO_2-eq) [f] Category label (conc. range)	Subcategories	Relative position of the RCPs [d]	Change in CO_2-eq emissions compared to 2010 (in %) [c]		Likelihood of staying below a specific temperature level over the 21st century (relative to 1850–1900) [d, e]			
			2050	2100	1.5°C	2°C	3°C	4°C
<430	Only a limited number of individual model studies have explored levels below 430 ppm CO_2-eq [j]							
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	Overshoot of 580 ppm CO_2-eq		–16 to 7	–183 to –86				
(580 to 650)	Total range	RCP4.5	–38 to 24	–134 to –50				
(650 to 720)	Total range		–11 to 17	–54 to –21		*Unlikely*	*More likely than not*	
(720 to 1000) [b]	Total range	RCP6.0	18 to 54	–7 to 72	*Unlikely* [h]		*More unlikely than likely*	
>1000 [b]	Total range	RCP8.5	52 to 95	74 to 178		*Unlikely* [h]	*Unlikely*	*More unlikely than likely*

Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **Many scenario studies confirm that it is technically and economically feasible to keep the warming below 2°C, with more than 66% probability ("likely chance").** This would imply limiting atmospheric concentrations to 450 ppm CO_2-eq by 2100.
- **Such scenarios** for an above 66% chance of staying below 2°C **imply reducing by 40 to 70% global GHG emissions compared to 2010 by mid-century, and reach zero or negative emissions by 2100.**

Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **These scenarios are characterized by rapid improvements of energy efficiency and a near quadrupling of the share of low-carbon energy supply (renewables, nuclear, fossil and bioenergy with CCS), so that it reaches 60% by 2050.**
- **Keeping global temperature increase below 1.5°C would require even lower atmospheric concentrations (<430 ppm CO_2eq) to have a little more than 50% chance.** There are not many scenario studies available that can deliver such results, **requiring even faster reductions** in the medium term, indicating how difficult this is.

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

AR5 WGI SPM, AR5 WGII SPM,AR5 WGIII SPM

ipcc INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

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

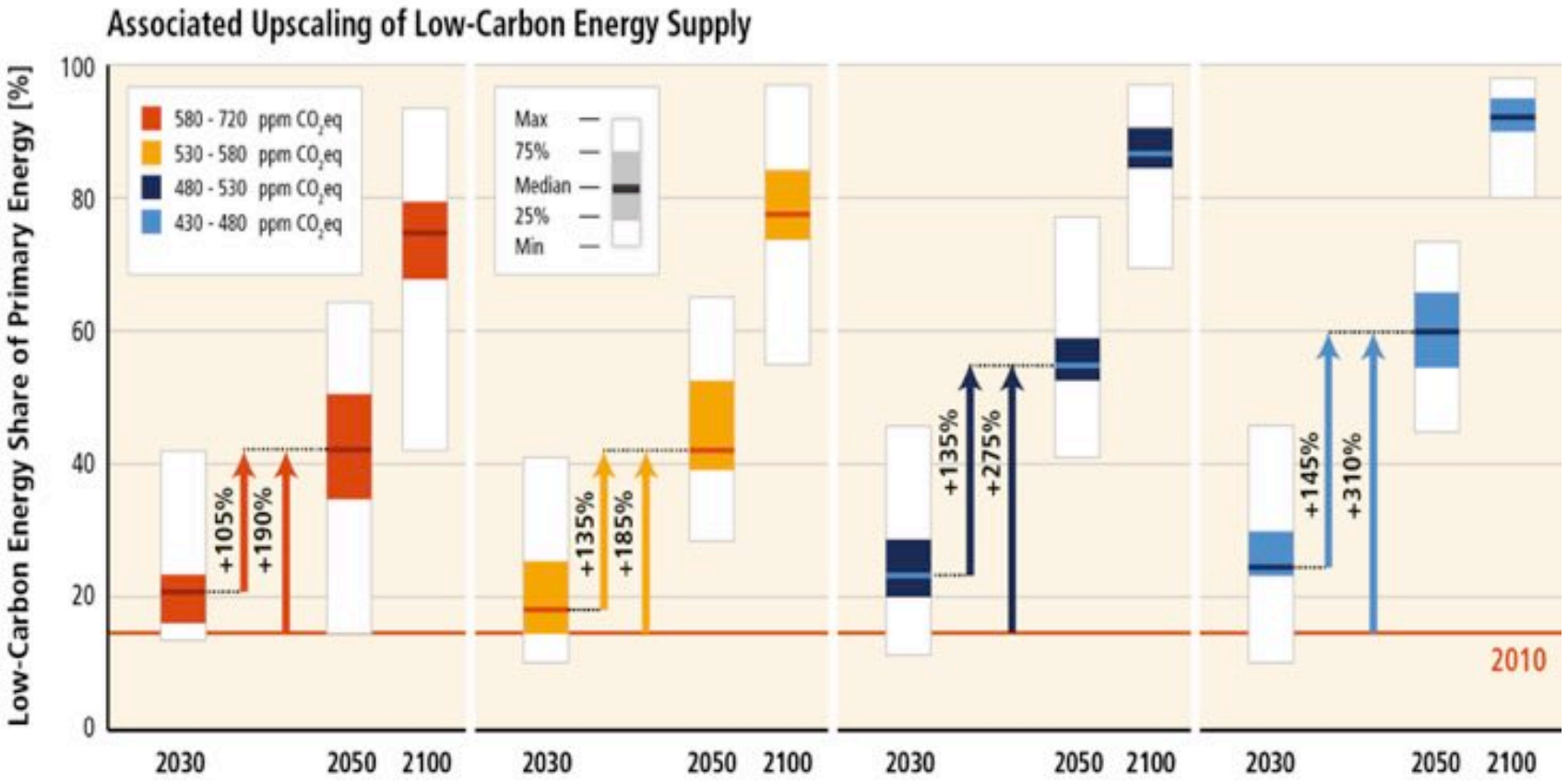
AR5 WGIII SPM

Ambitious Mitigation Is Affordable

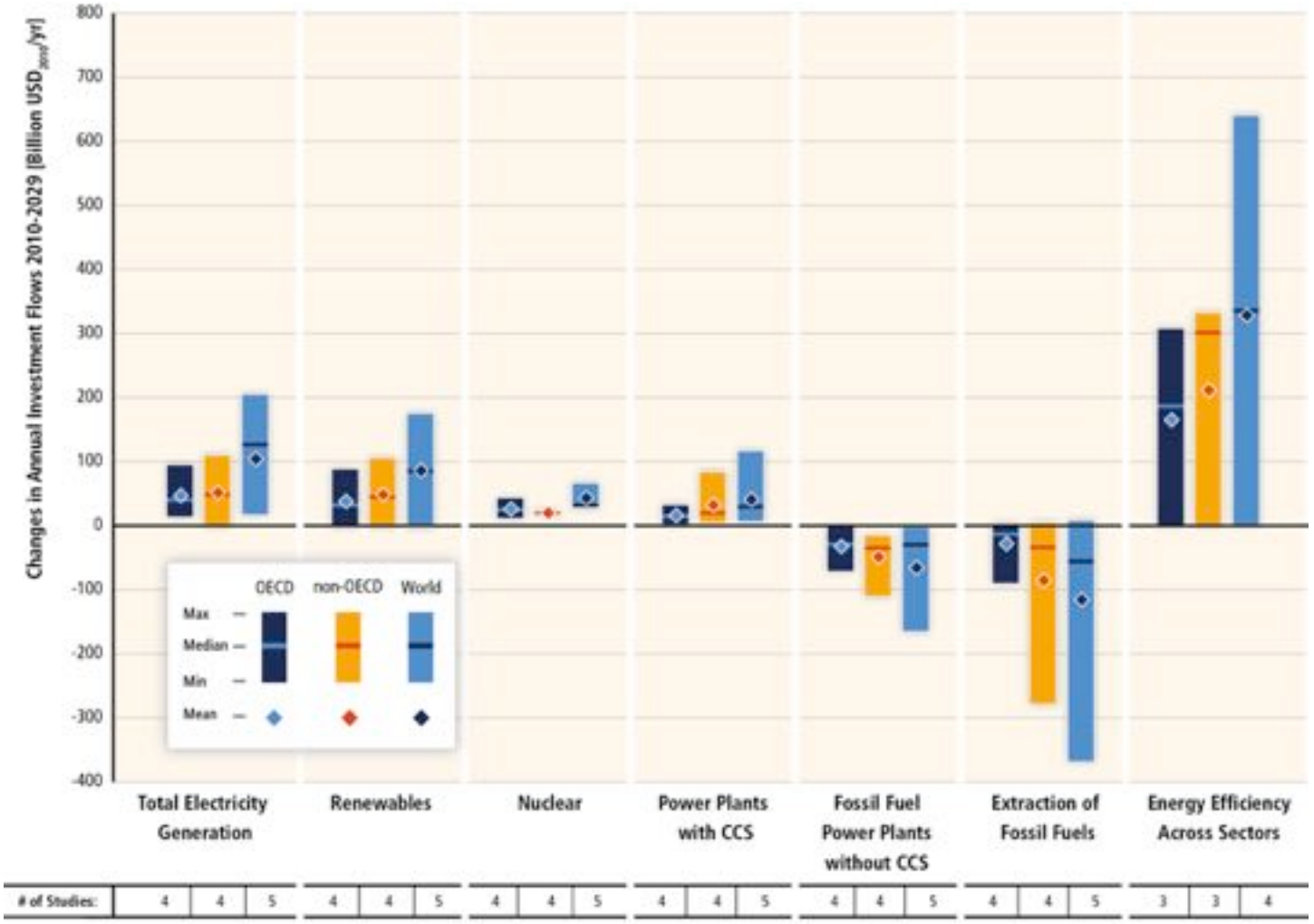
- ➜ Economic growth reduced by ~ 0.06%
  (BAU growth 1.6 - 3%/year)
- ➜ This translates into delayed and not forgone growth
- ➜ Estimated cost does not account for the benefits of reduced climate change
- ➜ Unmitigated climate change would create increasing risks to economic growth and efforts to eradicate poverty

AR5 WGI SPM, AR5 WGII SPM

Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy

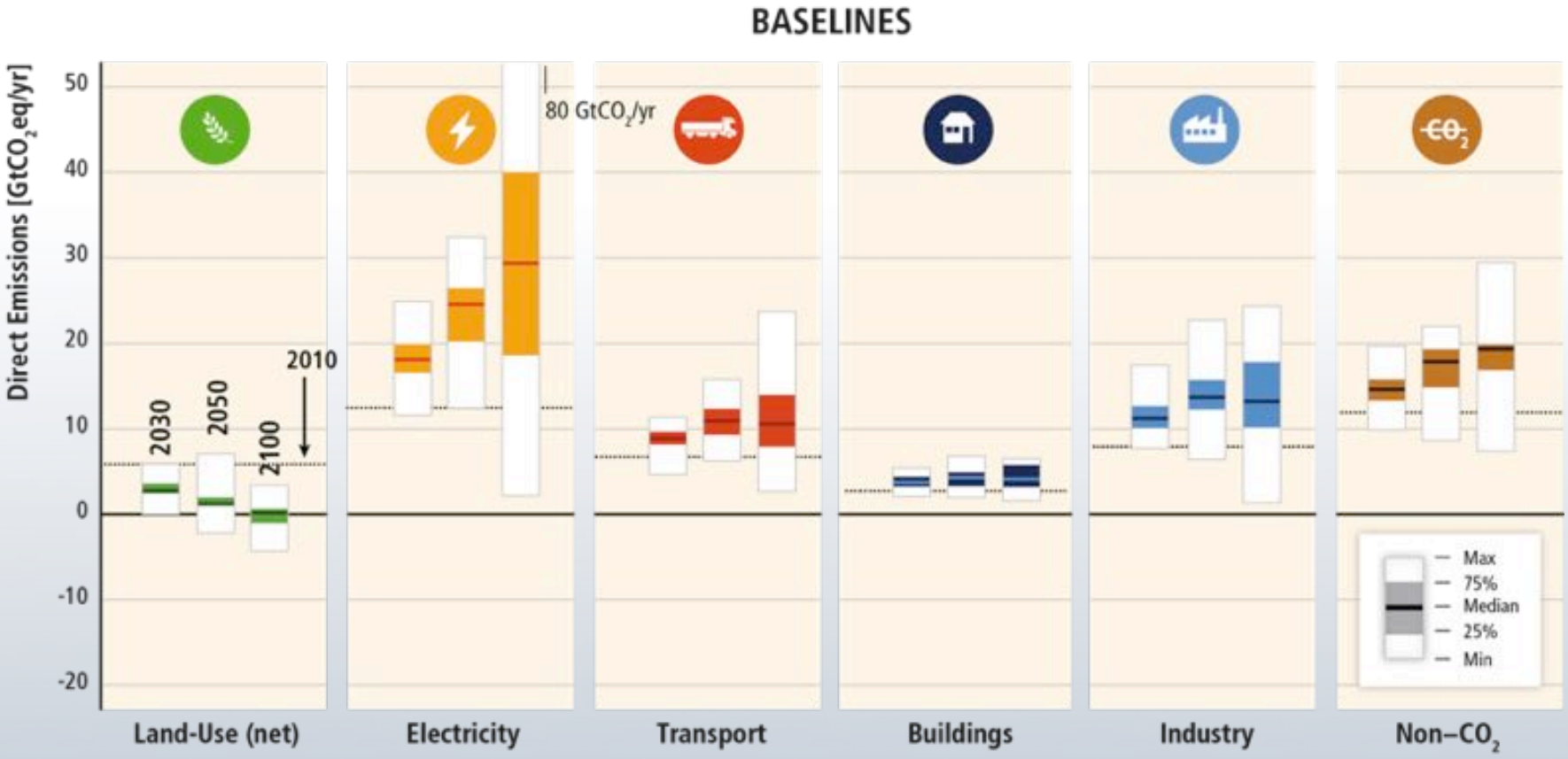


Substantial reductions in emissions would require large changes in investment patterns.



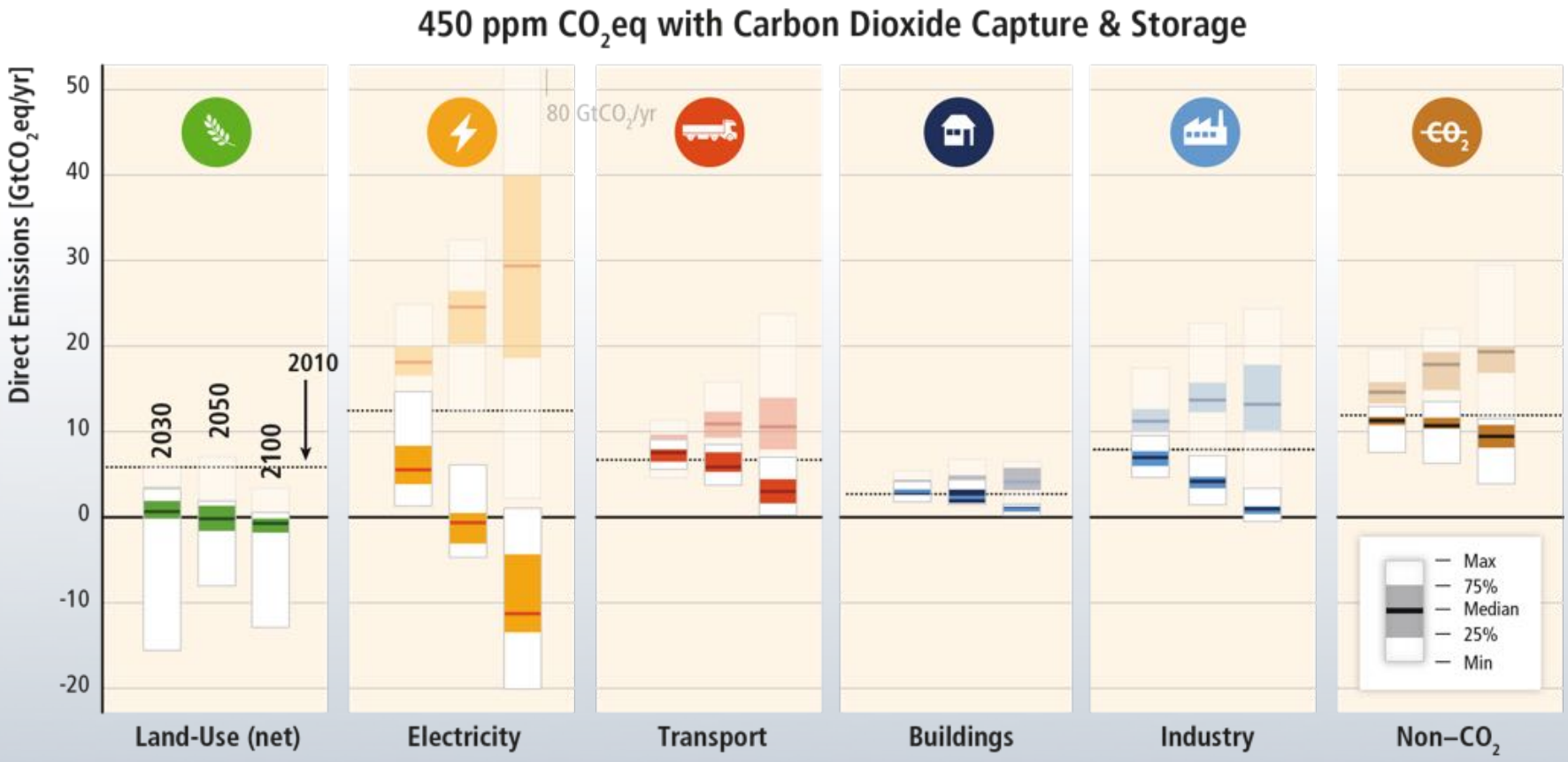

Mitigation options are available in every major sector.

Mitigation can be more cost-effective if using an integrated approach ….



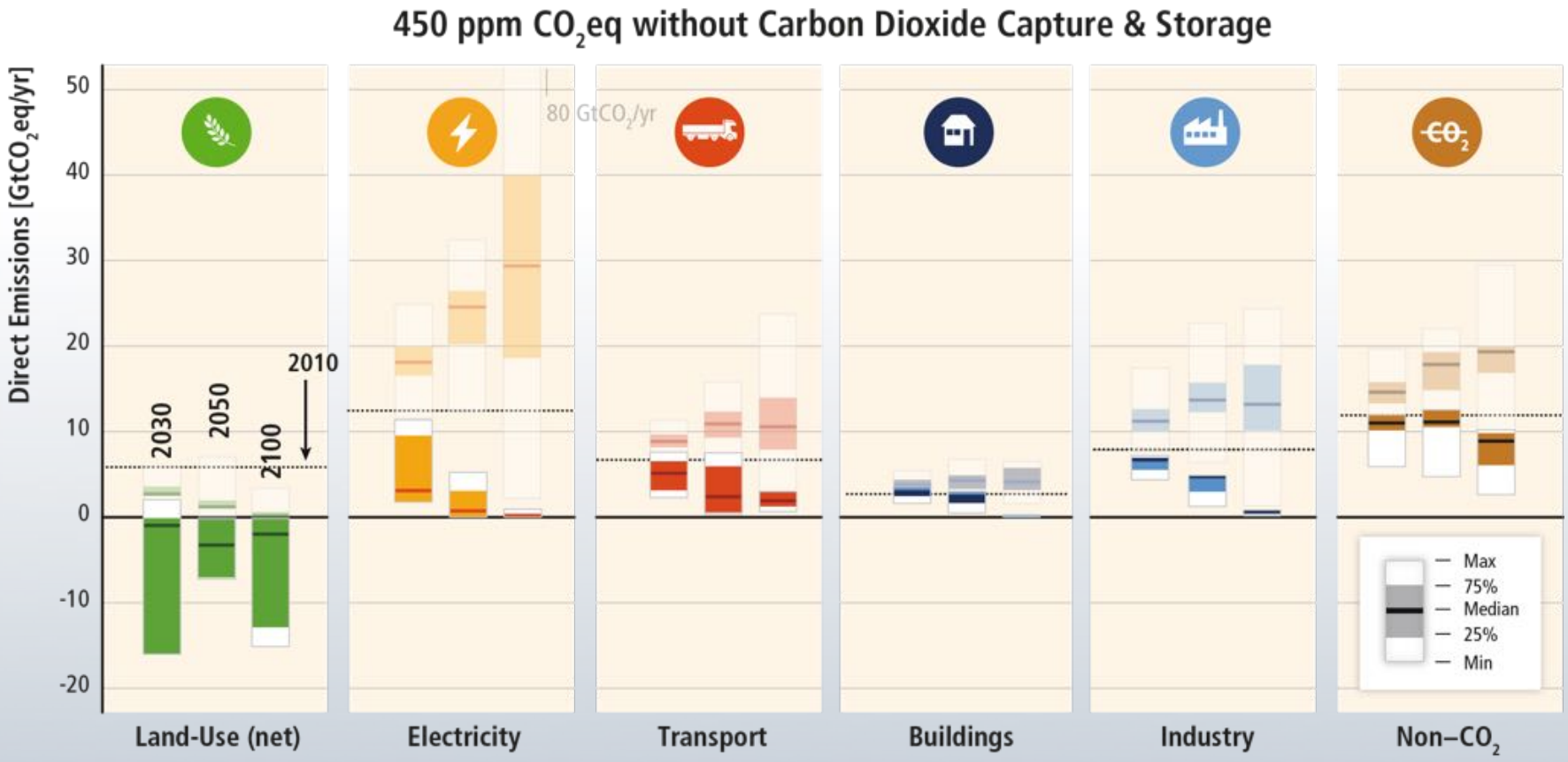
Based on Figure TS.17

Mitigation can be more cost-effective if using an integrated approach ….



Based on Figure TS.17

Mitigation can be more cost-effective if using an integrated approach ….

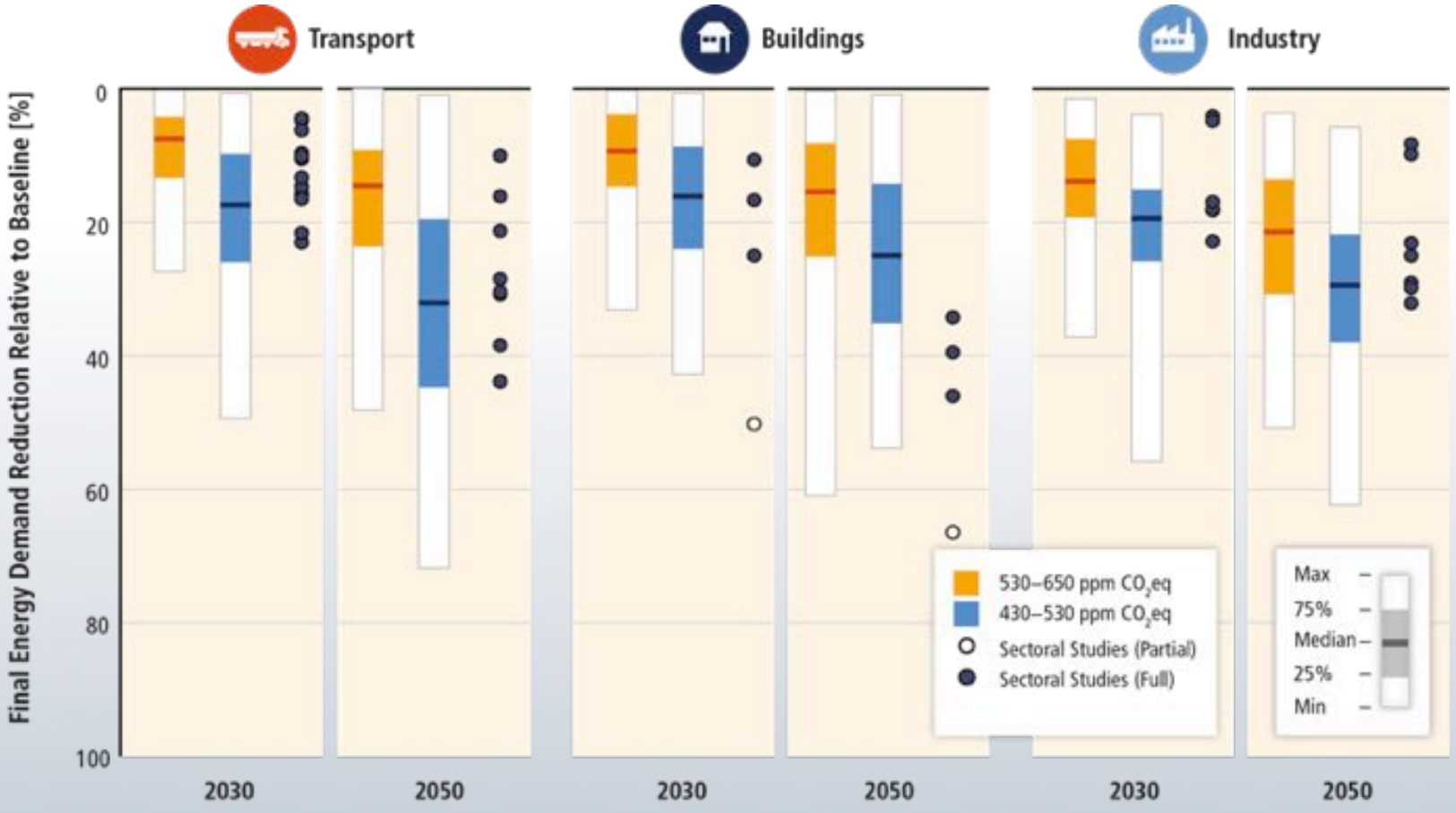


Based on Figure TS.17

Reducing energy demand through efficiency enhancements and behavioural changes are a key mitigation strategy.

Based on Figure 6.37

Reducing energy demand through efficiency enhancements and behavioural changes are a key mitigation strategy.



Based on Figure 6.37

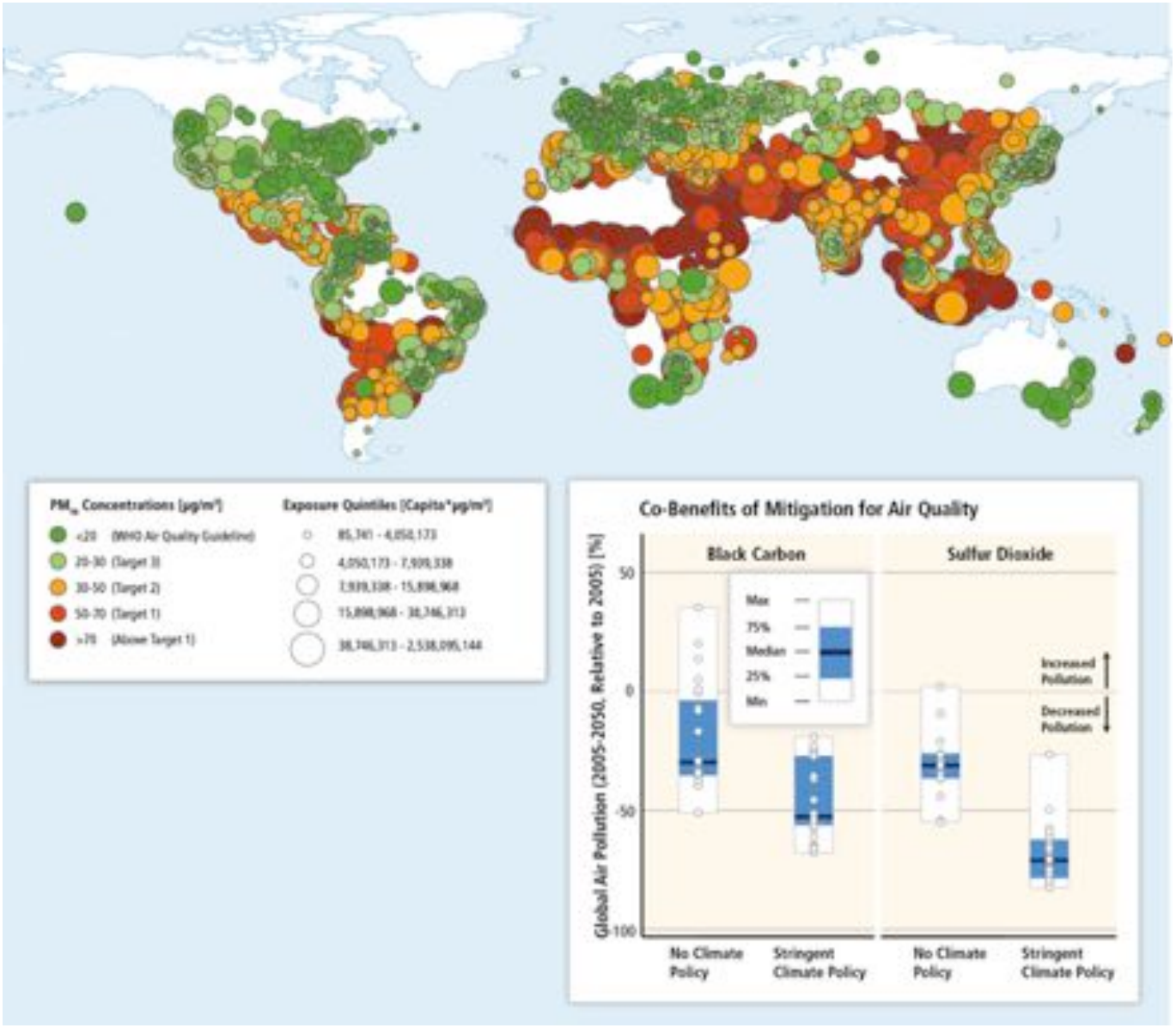

Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels.

Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

- **Sector-specific policies** have been more widely used than economy-wide policies.
- **Regulatory approaches and information** measures are widely used, and are often environmentally effective.
- Since AR4, **cap and trade** systems for GHGs have been established in a number of countries and regions.
- In some countries, **tax-based policies** specifically aimed at reducing GHG emissions–alongside technology and other policies–have helped to weaken the link between GHG emissions and GDP
- The **reduction of subsidies** for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context.

Effective mitigation will not be achieved if individual agents advance their own interests independently.

- Existing and proposed **international climate change cooperation** arrangements vary in their focus and degree of centralization and coordination.
- Issues of **equity, justice, and fairness** arise with respect to mitigation and adaptation.
- Climate policy may be informed by a consideration of a diverse array of risks and uncertainties, some of which are difficult to measure, notably events that are of low probability but which would have a significant impact if they occur.

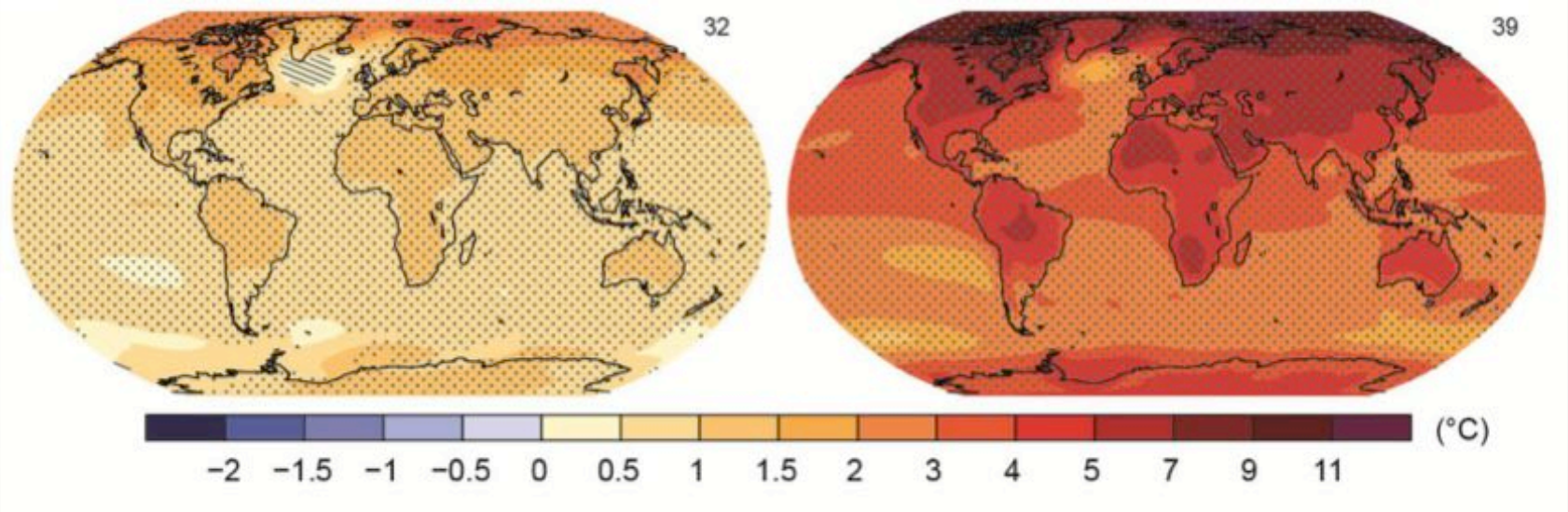


Mitigation can result in large co-benefits for human health and other societal goals.

The Choices Humanity Makes Will Create Different Outcomes (and affect prospects for effective adaptation)

With substantial mitigation

Without additional mitigation



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

AR5 WGI SPM

Useful links:

- www.ipcc.ch : IPCC (reports and videos)
- www.climate.be/vanyp : my slides and candidature to become IPCC Chair
- www.skepticalscience.com: excellent responses to contrarians arguments
- **On Twitter: @JPvanYpersele and @IPCC_CH**