Climate Change: Do we need CCS?
What does the IPCC say?

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Bellona Pavillion, COP21 side event, Paris, 7 December 2015

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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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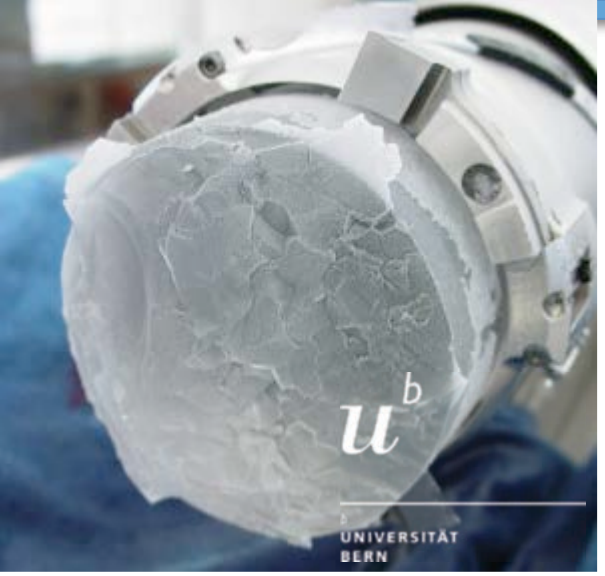
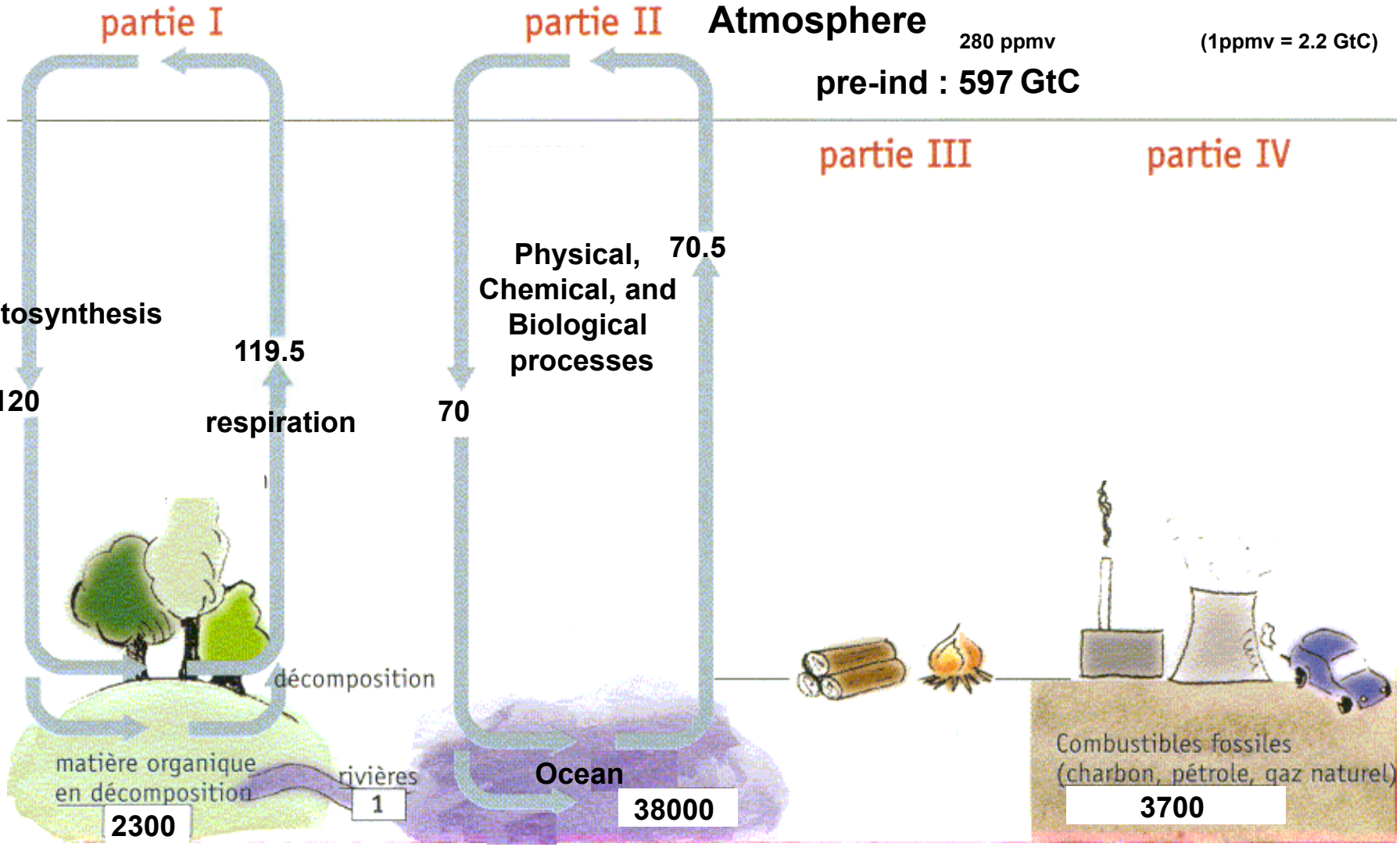


(Lüthi et al.,2008, NOAA)

Les concentrations atmosphériques en dioxyde de carbone (CO_2) ont augmenté jusqu'à des niveaux sans précédent au cours des 800 000 dernières années

Carbon cycle: unperturbed fluxes



Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

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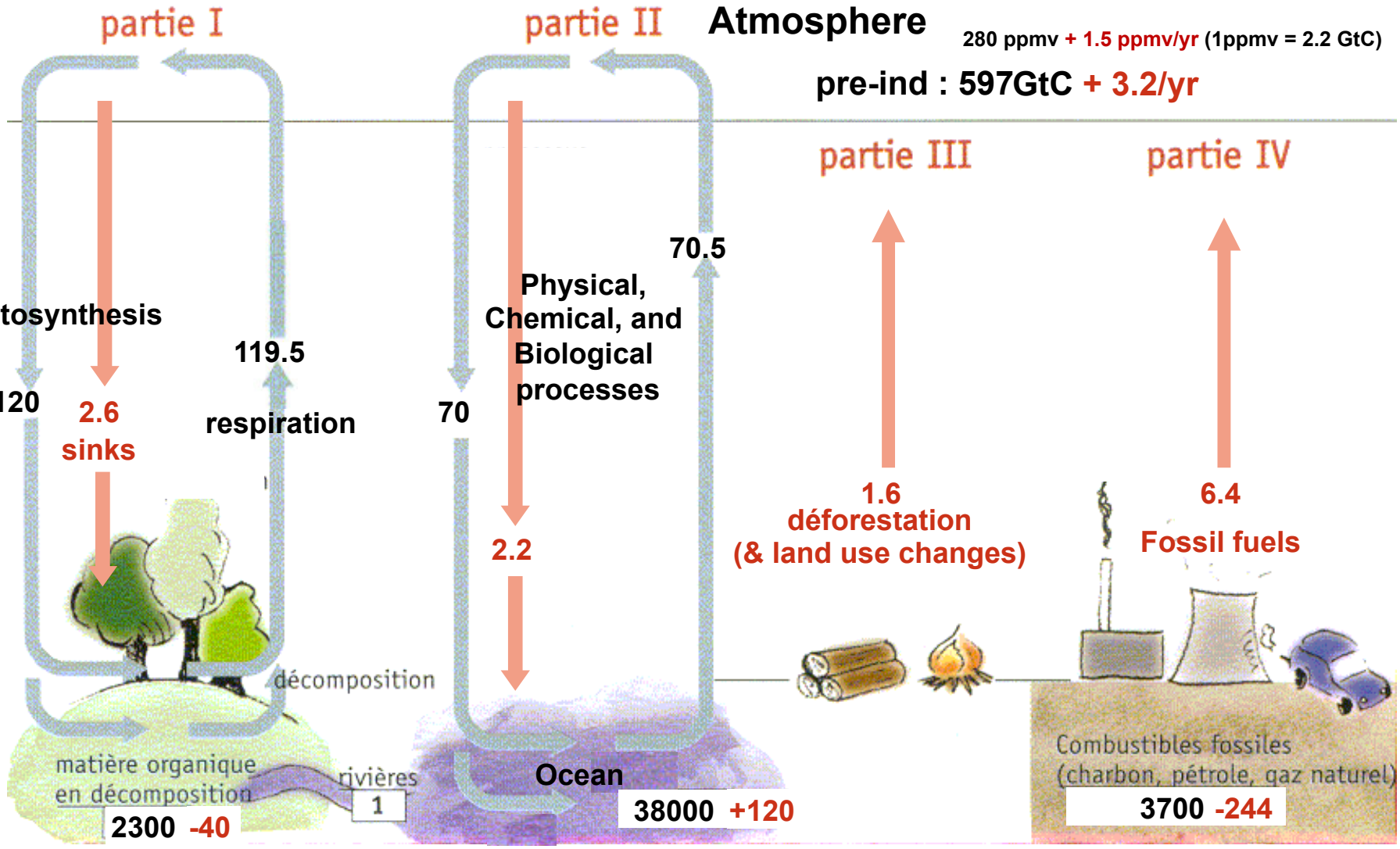
Carbon cycle: perturbed by human activities

(numbers for the decade 1990-1999s, based on IPCC AR4)



Units: GtC (billions tons of carbon) or GtC/year

Stocks!

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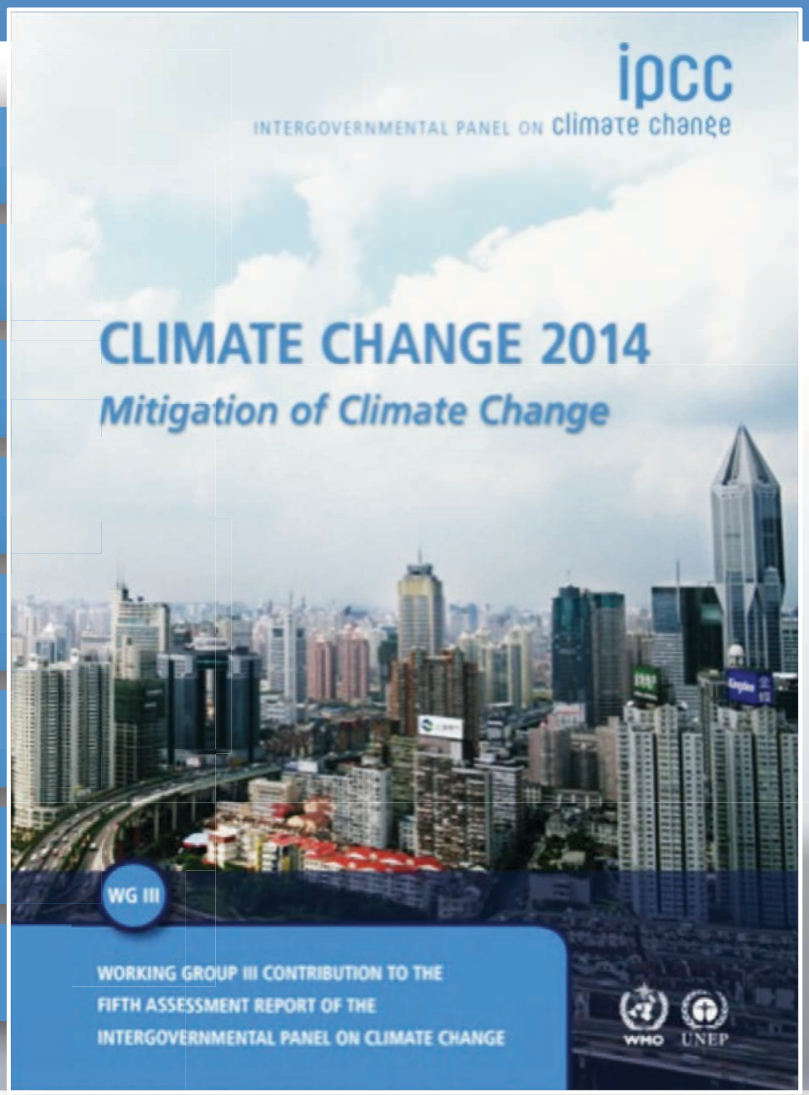
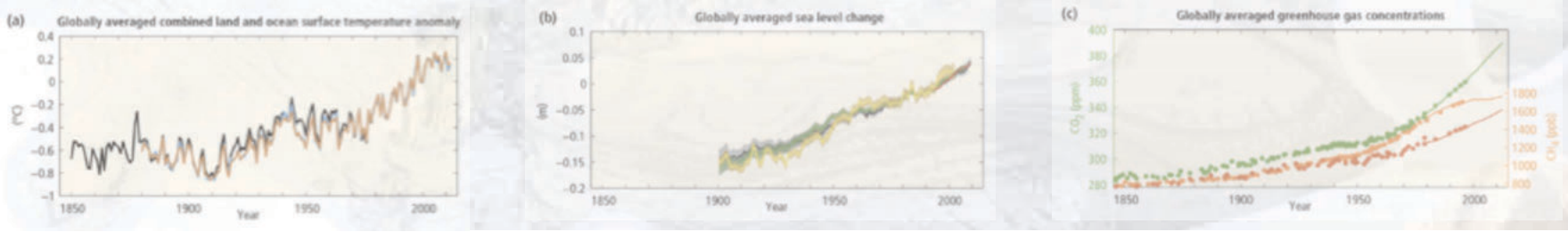
The carbon cycle is policy-relevant

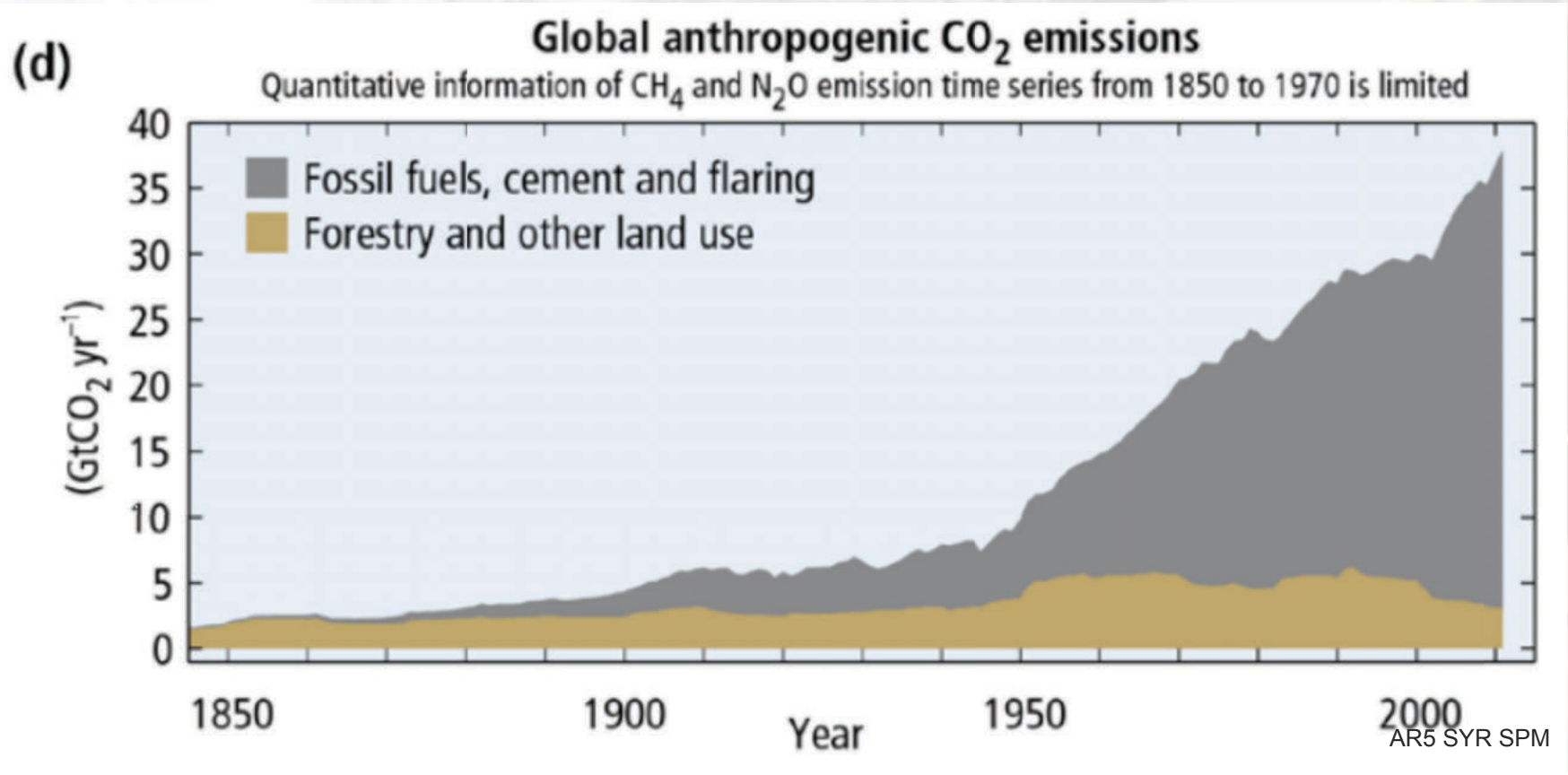
- **CO_2 accumulates in the atmosphere as long as human emissions are larger than the natural absorption capacity**
- **Historical emissions from developed countries therefore matter for a long time**
- **As warming is function of cumulated emissions, the carbon « space » is narrowing fast (to stay under 1.5 or 2°C warming)**

IPCC reports are the result of extensive work of many scientists from around the world.

- 1 Summary for Policymakers
- 1 Technical Summary
- 16 Chapters
- 235 Authors
- 900 Reviewers
- More than 2000 pages
- Close to 10,000 references
- More than 38,000 comments




(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
Year
(b)
Globally averaged sea level change
(m)
Year
(c)
Globally averaged greenhouse gas concentrations
Year


(d)
Global anthropogenic CO_2 emissions
Quantitative information of CH_4 and N_2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
$(GtCO_2\ yr^{-1})$
0
5
10
15
20
25
30
35
40
1850
1900
1950
2000
Year

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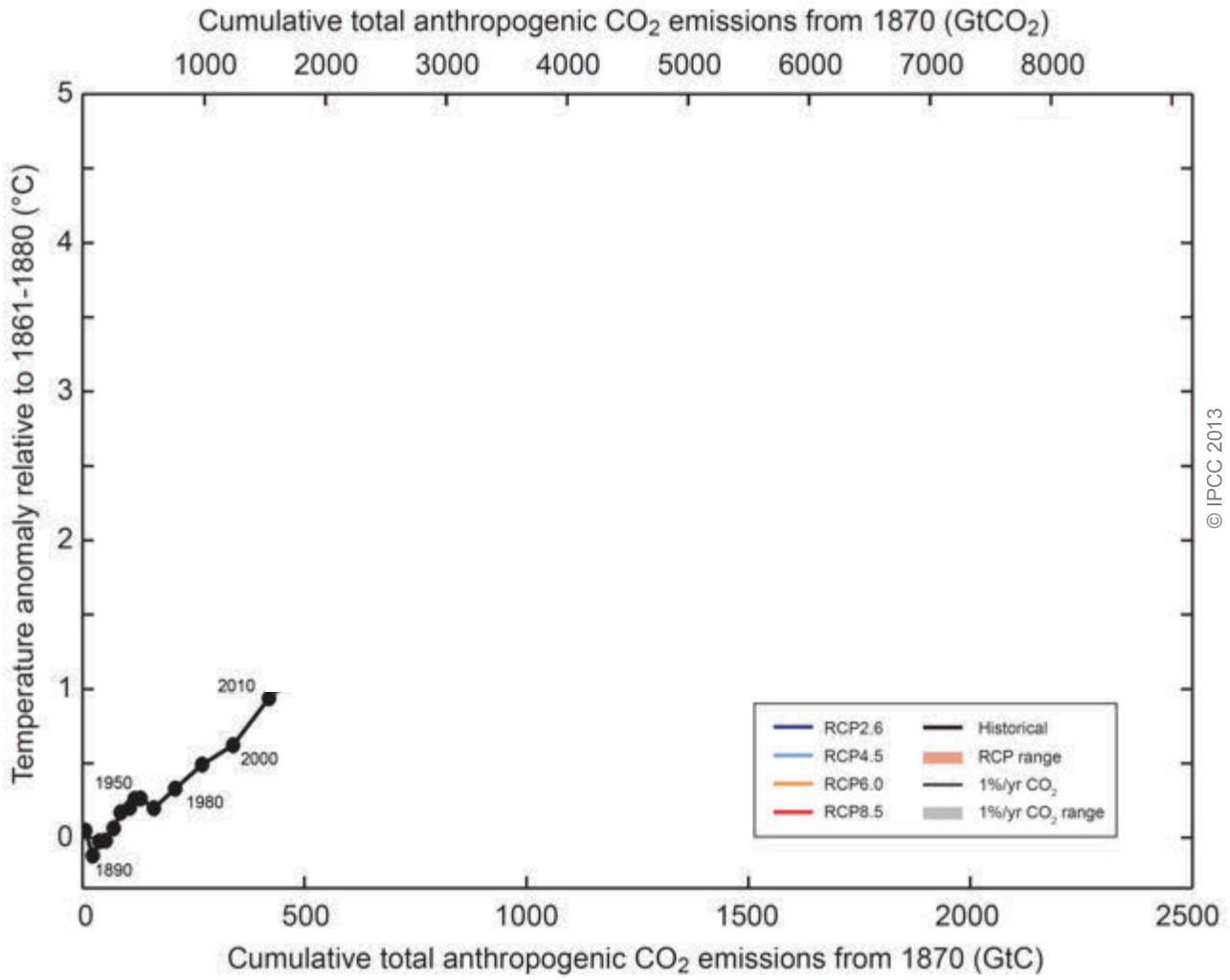


Fig. SPM.10

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

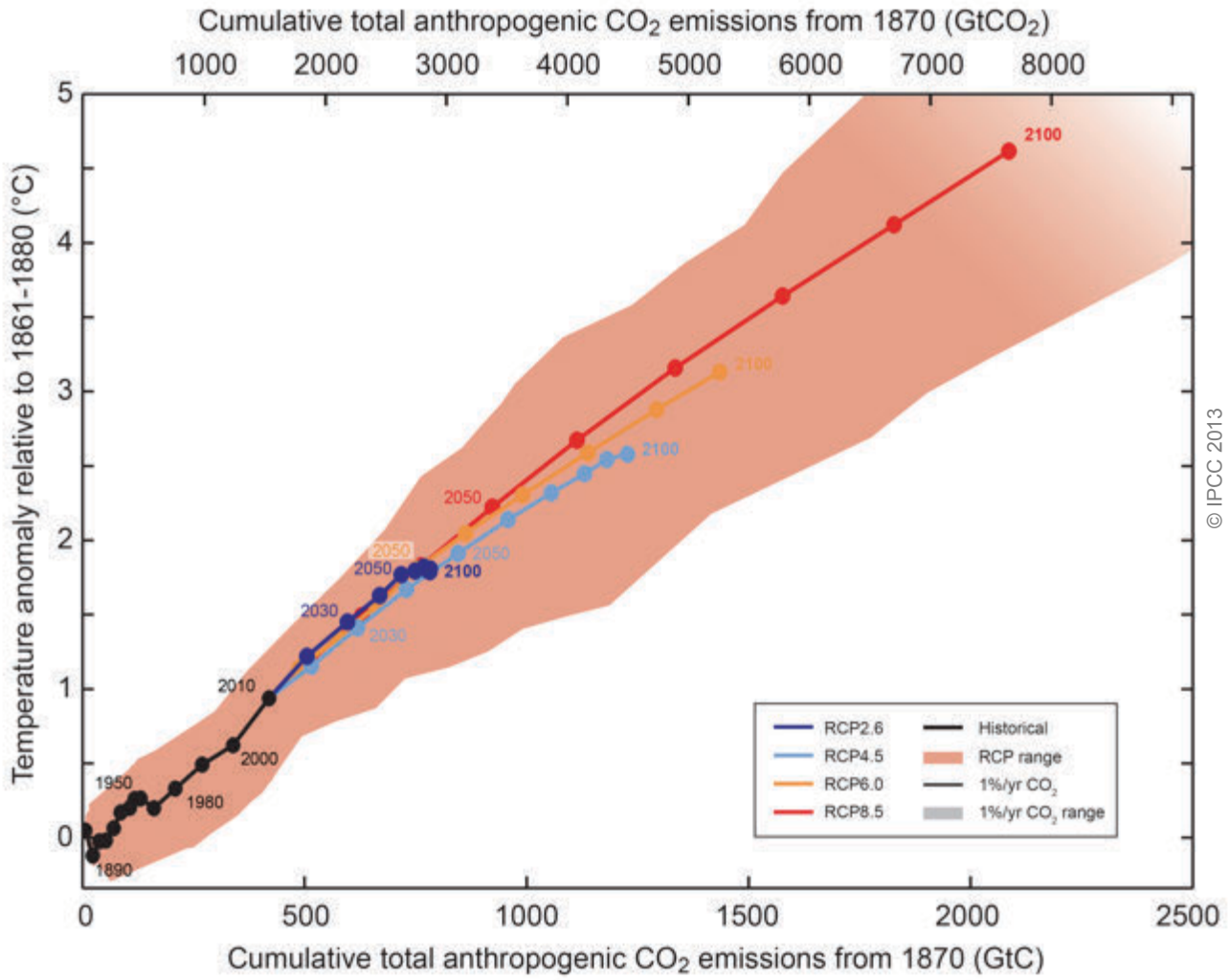
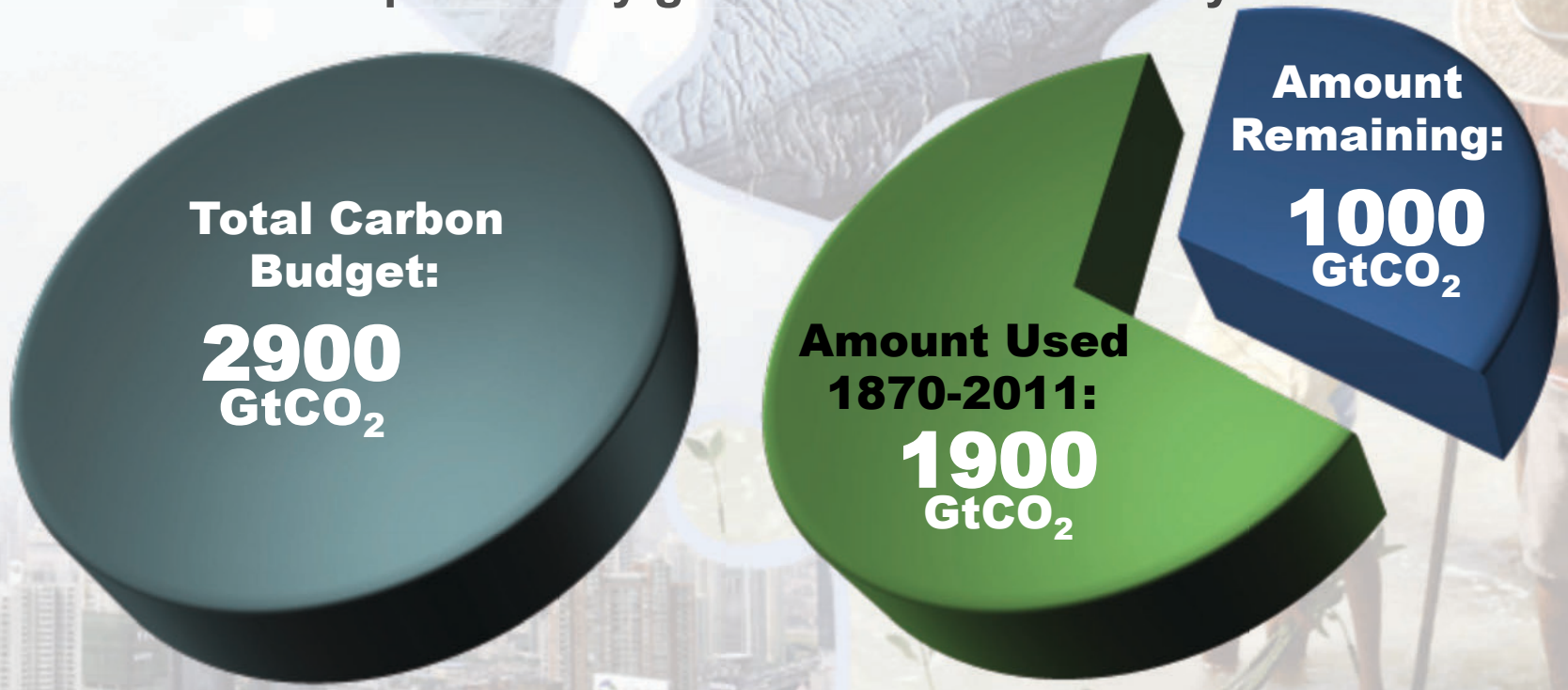


Fig. SPM.10

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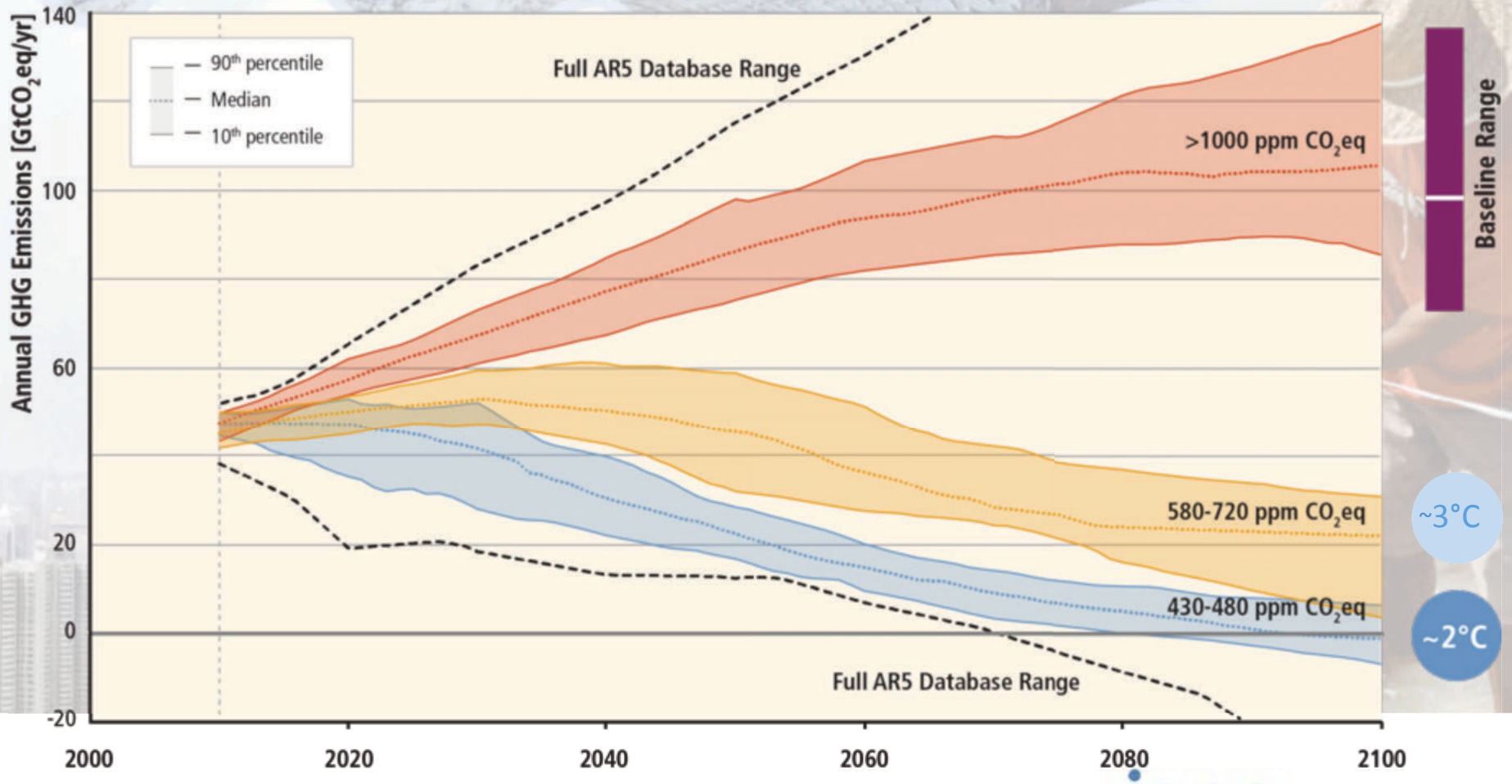
Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

AR5 WGIII SPM

IPCC AR5 Synthesis Report

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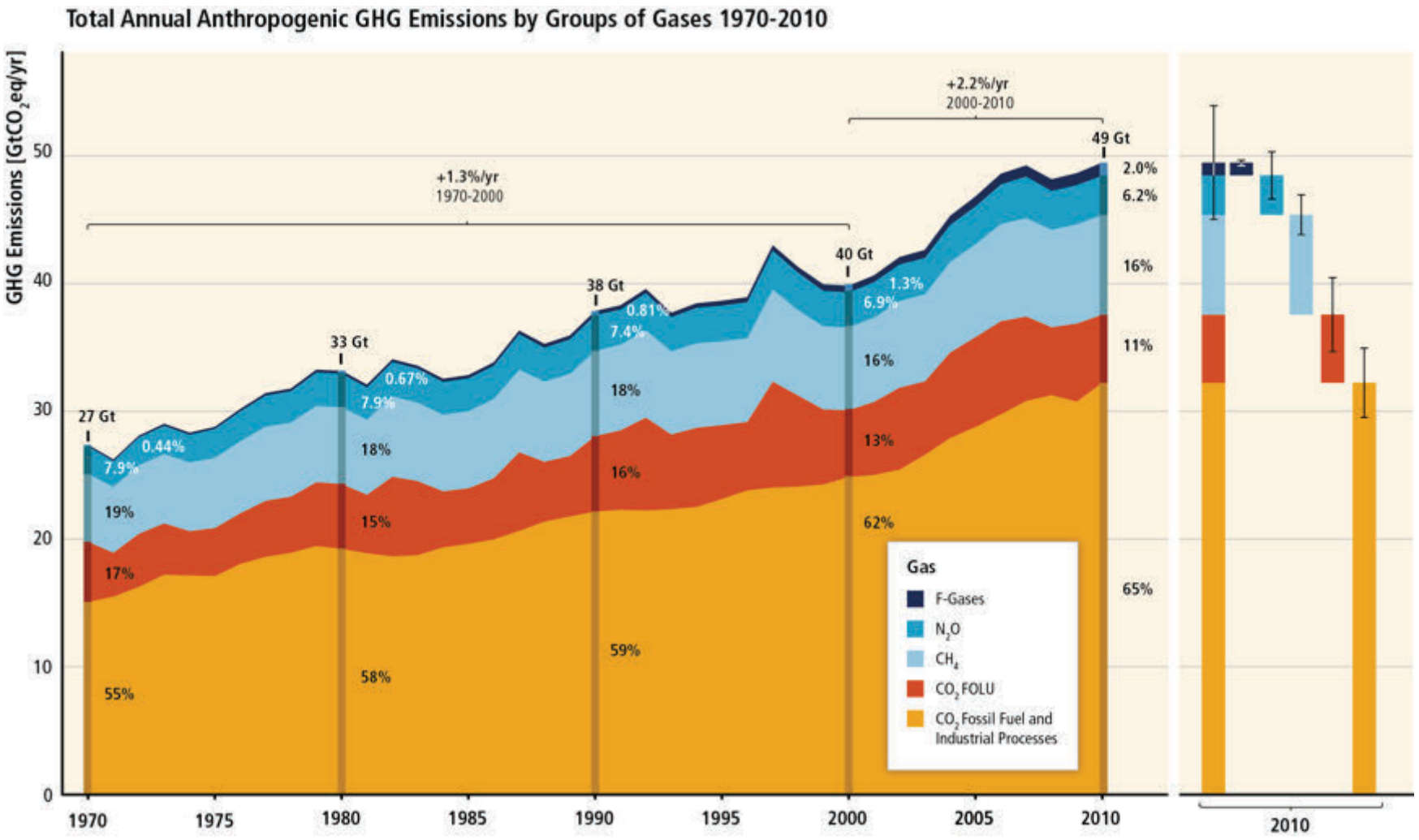
GHG emissions accelerate despite reduction efforts. Most emission growth is CO_2 from fossil fuel combustion and industrial processes.



Working Group III contribution to the
IPCC Fifth Assessment Report

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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.

Mitigation Measures

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today
- But worldwide investment in **research** in support of GHG mitigation is small…

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

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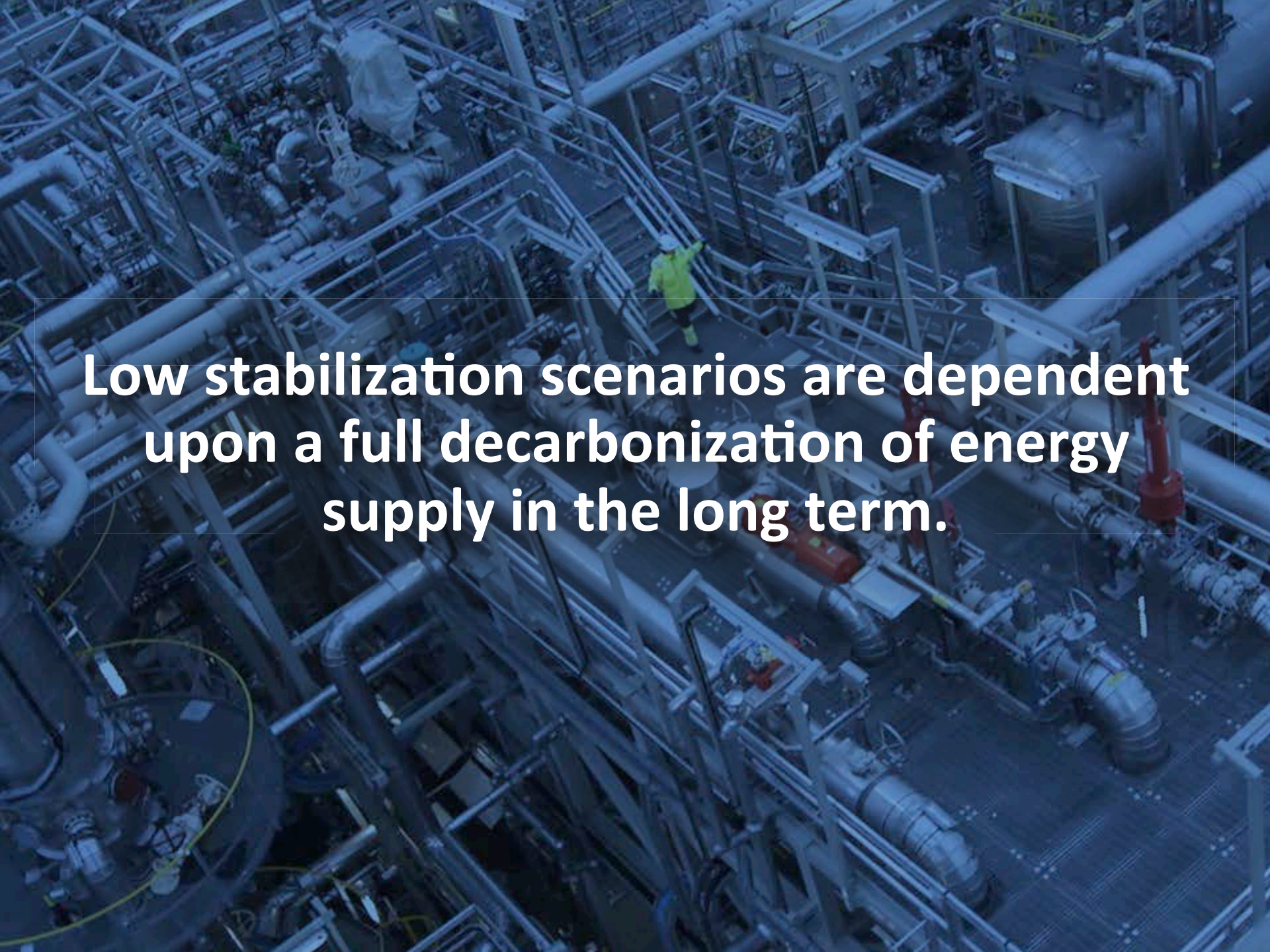
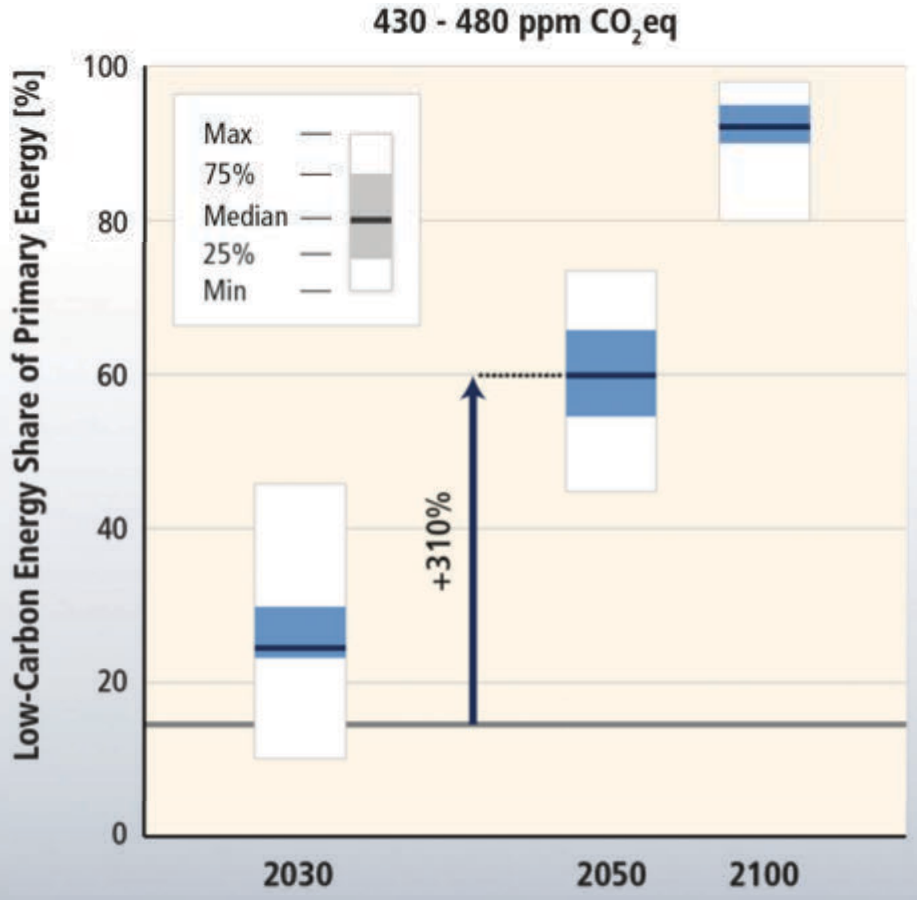
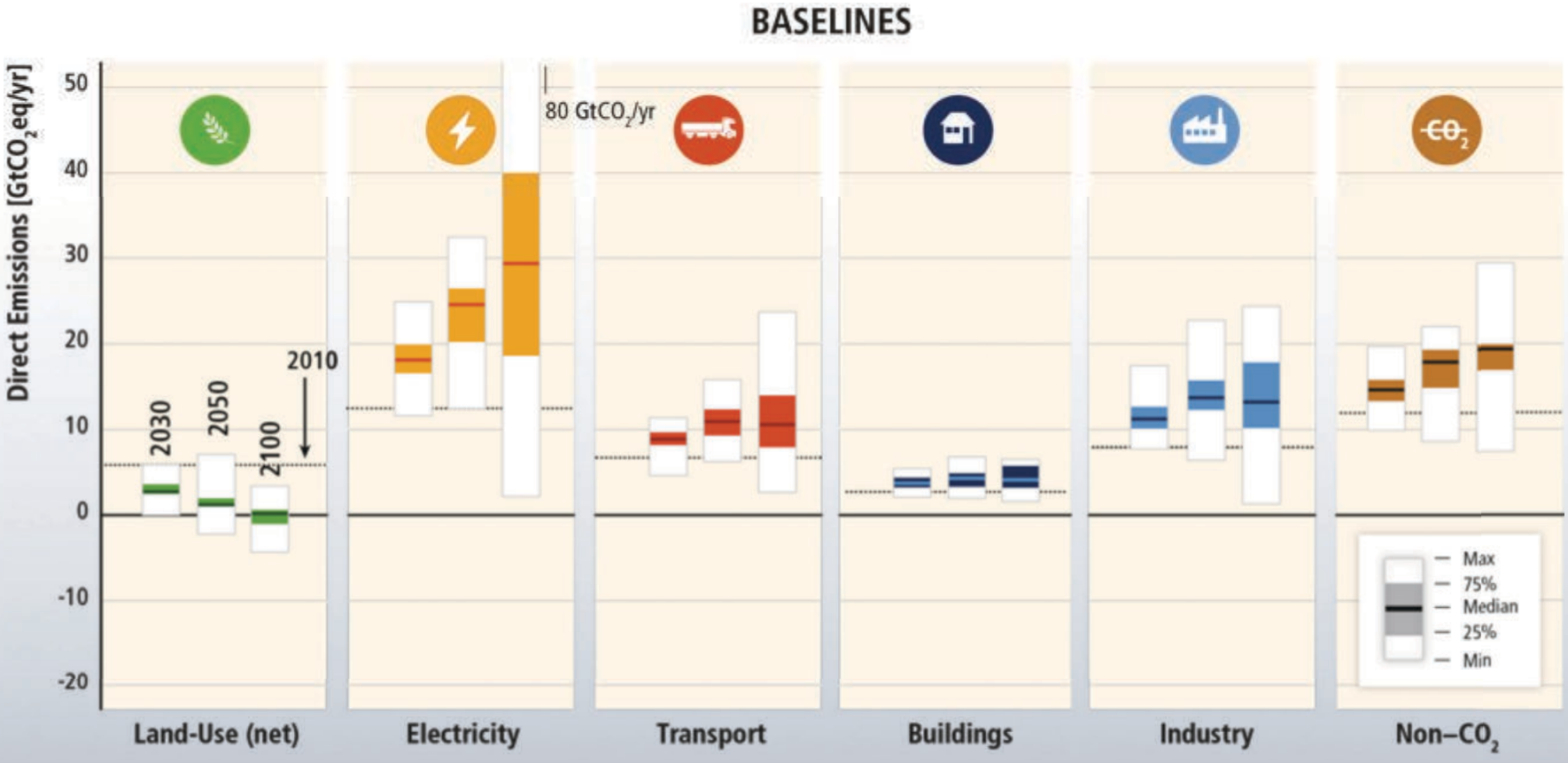

Low stabilization scenarios are dependent upon a full decarbonization of energy supply in the long term.

Mitigation involves substantial upscaling of low-carbon energy.



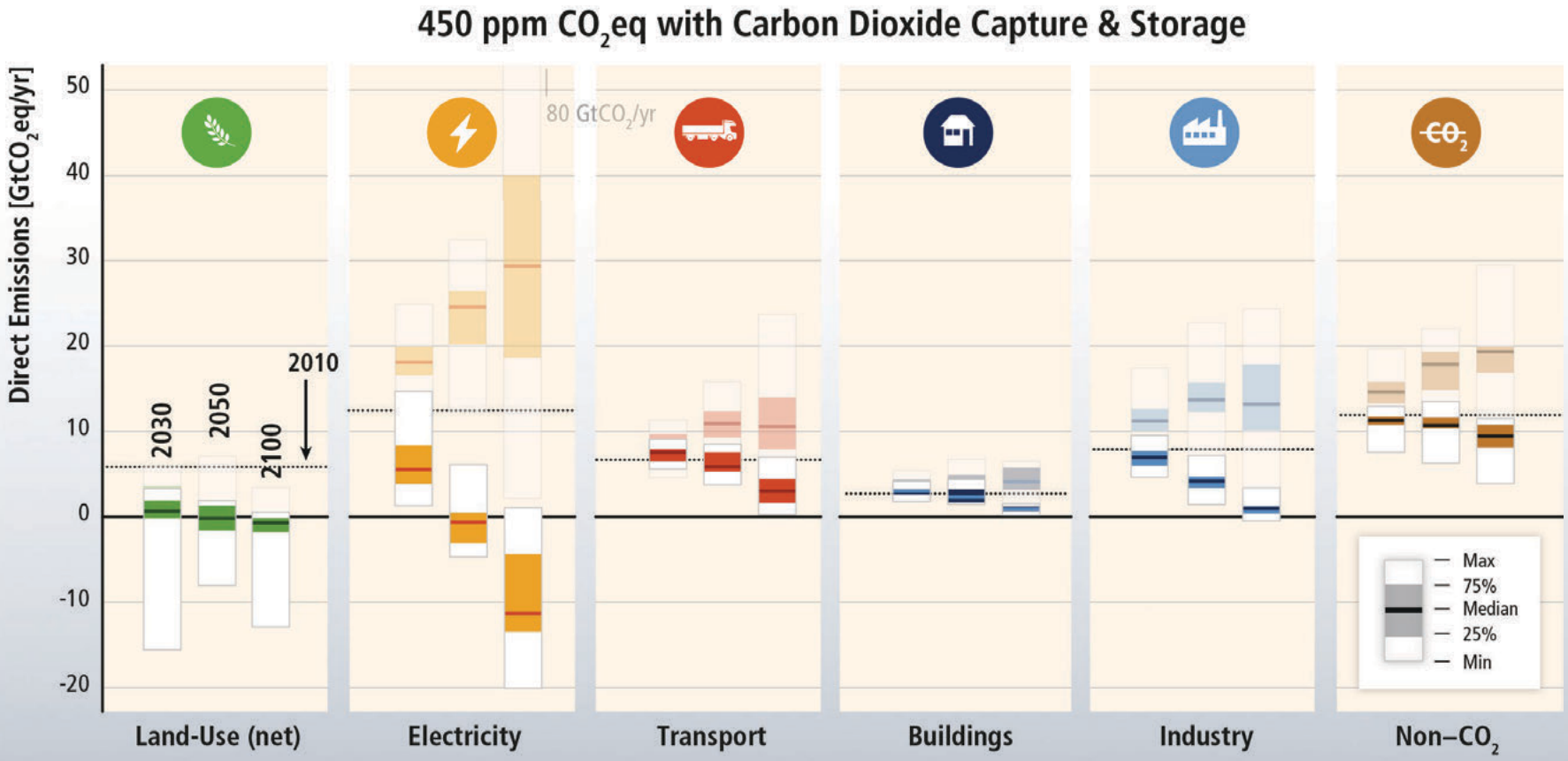
- **Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy (quadrupling from 2010 to 2050 for the scenario limiting warming below 2°C)**

Baseline scenarios suggest rising GHG emissions in all sectors, except for CO_2 emissions in the land-use sector.



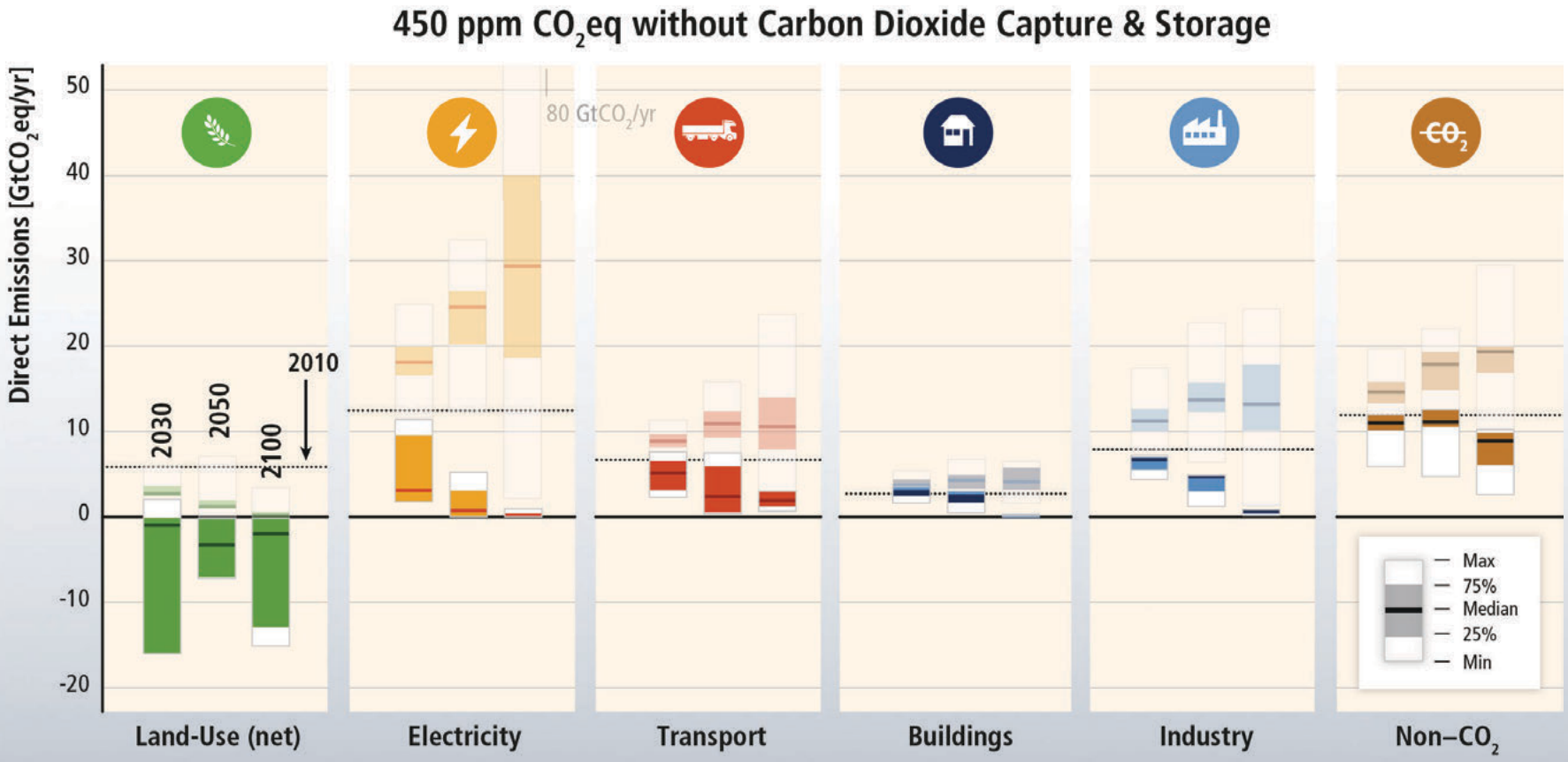
Based on Figure TS.17

Mitigation requires changes throughout the economy. Systemic approaches are expected to be most effective.



Based on Figure TS.17

Mitigation efforts in one sector determine efforts in others.



Based on Figure TS.17

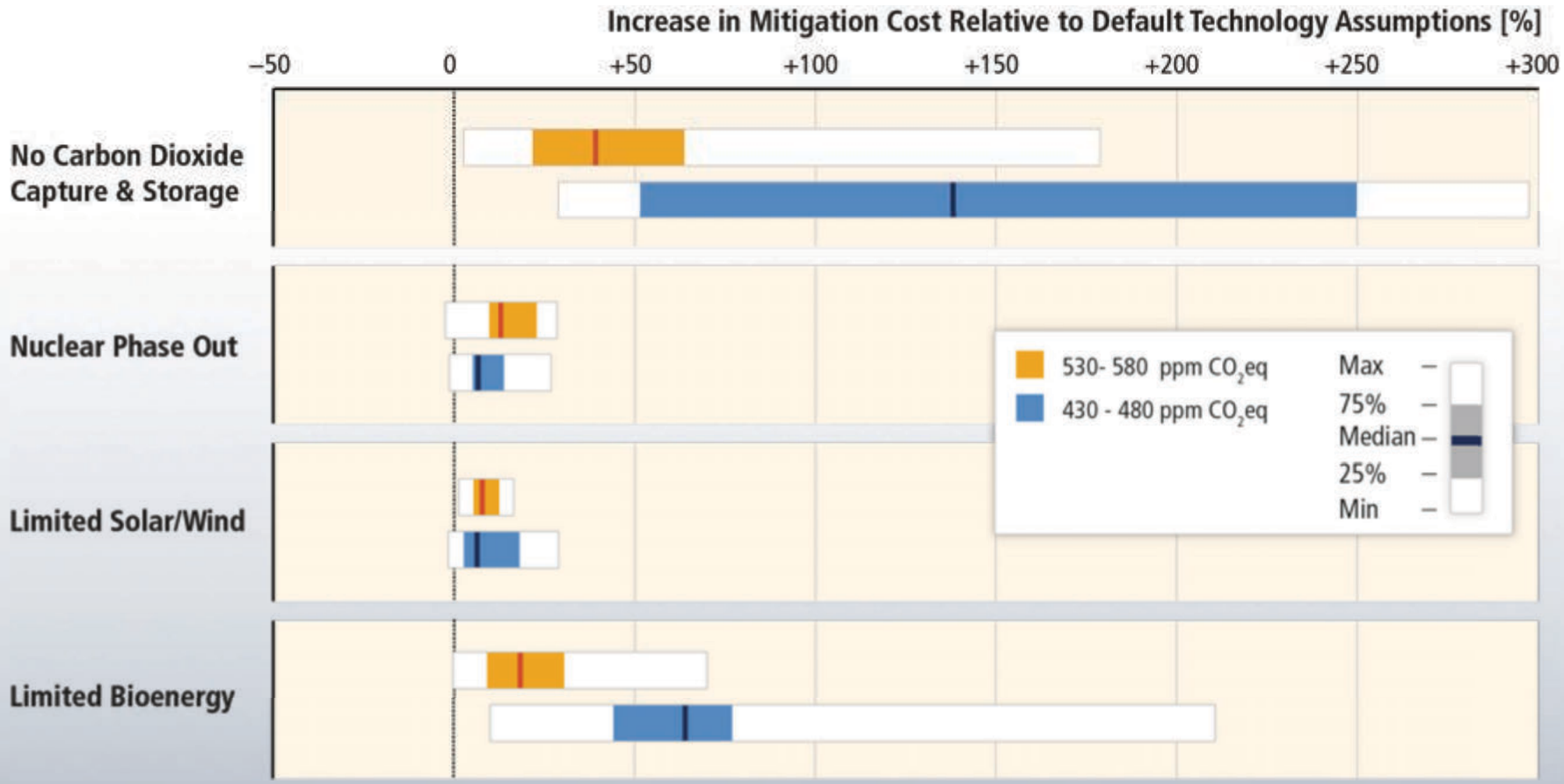
- **Substantial reductions in emissions would require large changes in investment patterns e.g., from 2010 to 2029, in billions US dollars/year:**
  (mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)
- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**

Cost of Mitigation over 2015-2100 for the 430-480 ppm CO_{2eq} range

	Consumption losses in cost-effective scenarios[1]						Increase in total discounted mitigation costs in scenarios with limited availability of technologies			
	[% reduction in consumption relative to baseline]			[percentage point reduction in annualized consumption growth rate]			[% increase in total discounted mitigation costs (2015–2100) relative to default technology assumptions]			
Concentration in 2100 [ppm CO_2eq]	2030	2050	2100	2010 –2030	2010 –2050	2010 –2100	No CCS	Nuclear phase out	Limited Solar/ Wind	Limited Bioenergy
450 (430–480)	1.7 (1.0–3.7) [N: 14]	3.4 (2.1–6.2)	4.8 (2.9–11.4)	0.09 (0.06–0.2)	0.09 (0.06–0.17)	0.06 (0.04–0.14)	138 (29–297) [N: 4]	7 (4–18) [N: 8]	6 (2–29) [N: 8]	64 (44–78) [N: 8]

IPCC AR5 WG3 TS Figure TS.2

Availability of technology can greatly influence mitigation costs.



Based on Figure 6.24

Concerns about CCS

- **Barriers to large-scale deployment of CCS technologies include concerns about the operational safety and long-term integrity of CO2 storage, as well as risks related to transport and the required up-scaling of infrastructure** (limited evidence, medium agreement). (IPCC AR5 WGIII TS p. 70)

Concerns about BECCS

- **Technological challenges and risks [of bioenergy with CCS (BECCS)]include those associated with the upstream provision of the biomass that is used in the CCS facility, as well as those associated with the CCS technology itself.** (IPCC AR5 WGIII TS p. 70)

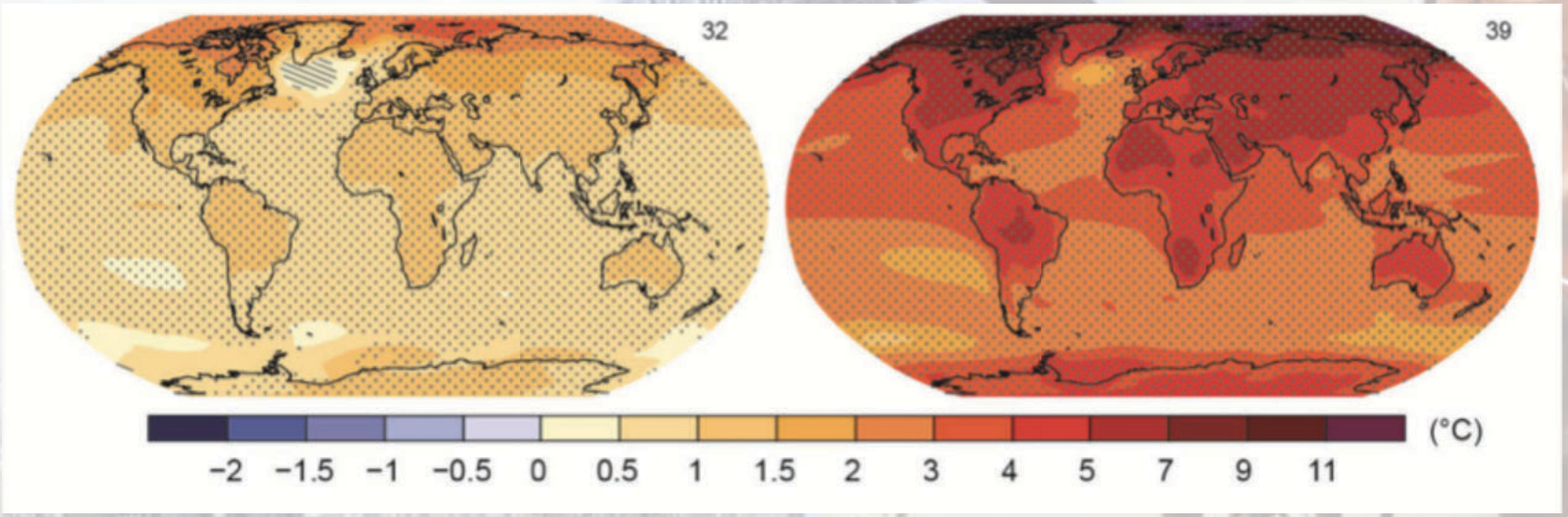

Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels.

NB: Ambition *before* 2020 is essential as well (lock-in & entrainment effects)

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

With substantial mitigation

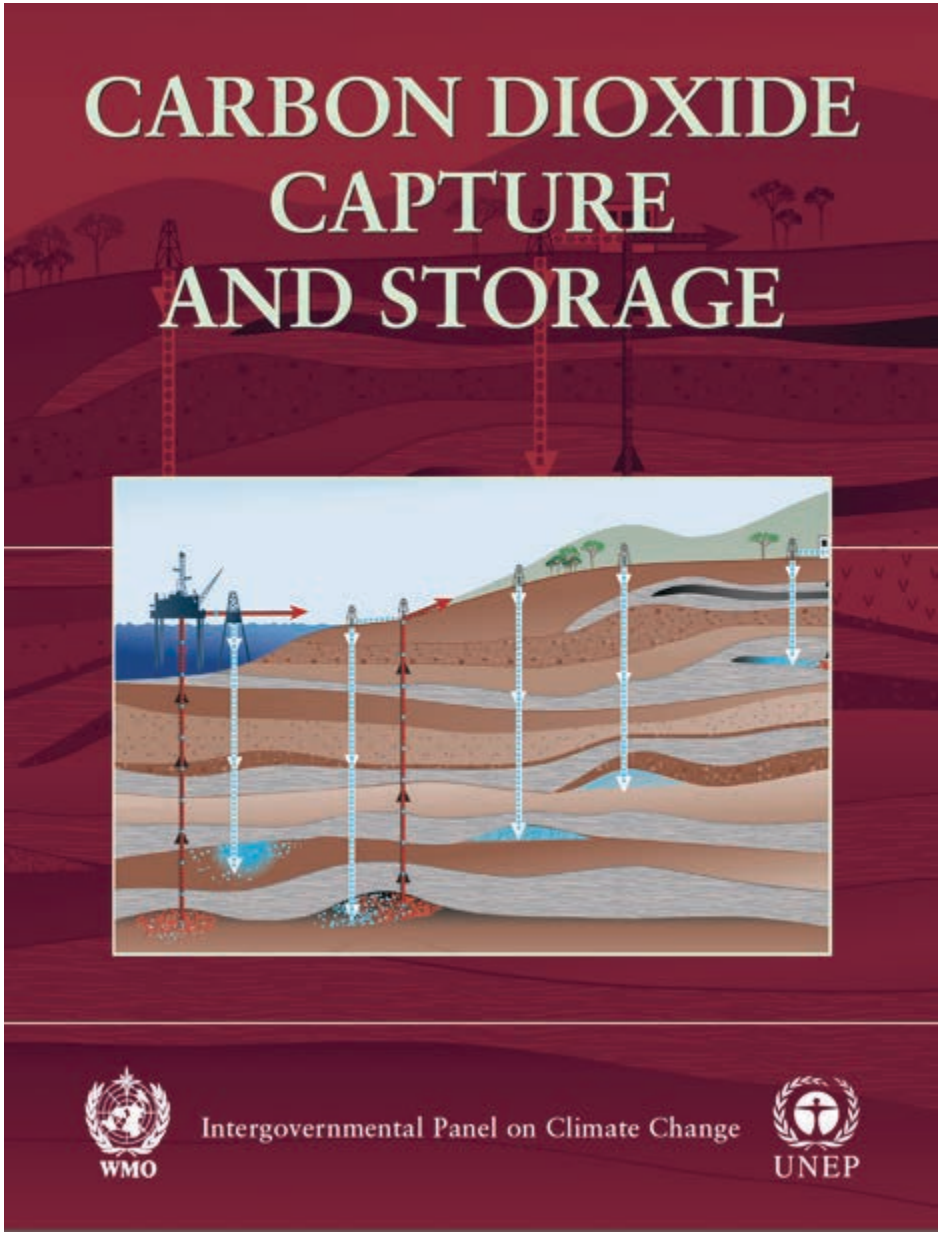
Without additional mitigation



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

AR5 WGI SPM

IPCC Special Report (2005)



Useful links:

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