SIXTH ASSESSMENT REPORT
Working Group 1 - The Physical Science Basis

ipcc
INTERGOVERNMENTAL PANEL ON climate change

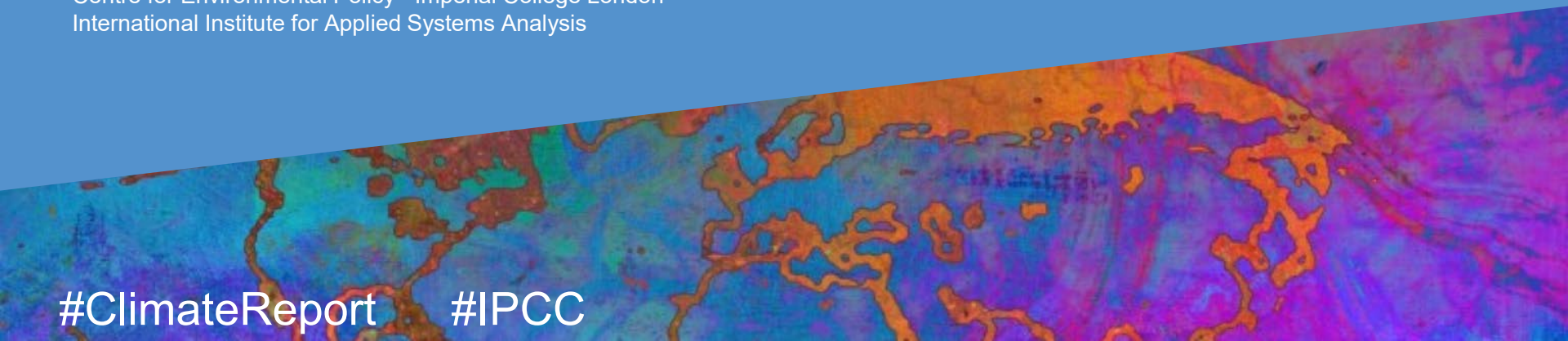
WMO UNEP

19 May 2022

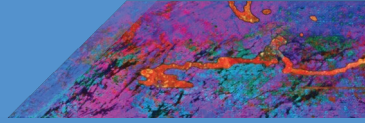
Scientific contributions to climate: Results of the IPCC Physical Science Report

Dr. Joeri Rogelj
Lead Author IPCC AR6 WG1

Grantham Institute Climate Change and Environment
Centre for Environmental Policy - Imperial College London
International Institute for Applied Systems Analysis



#ClimateReport #IPCC



IPCC AR6 Working Group I by the numbers

Author Team

234 authors from **65** countries

28% women, **72%** men

30% new to IPCC
63% new leading authors

Review Process

14,000 scientific publications assessed

78,000+ review comments

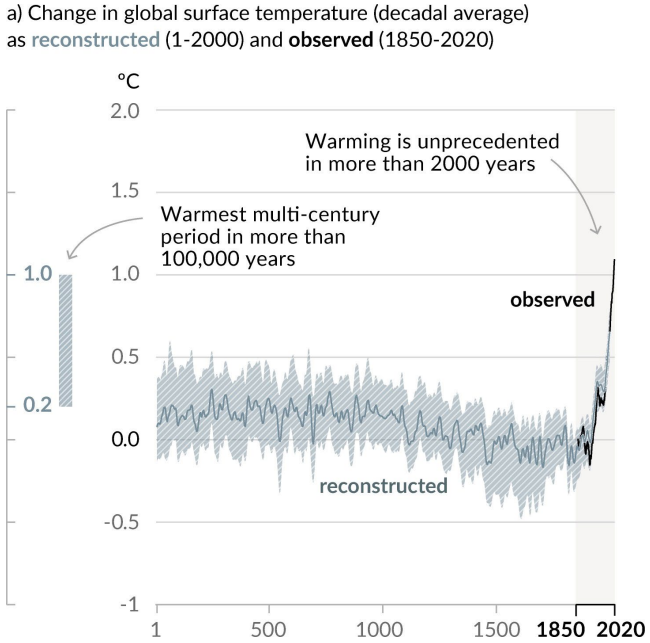
46 countries commented on Final Government Distribution

[Credit: NASA]

“Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

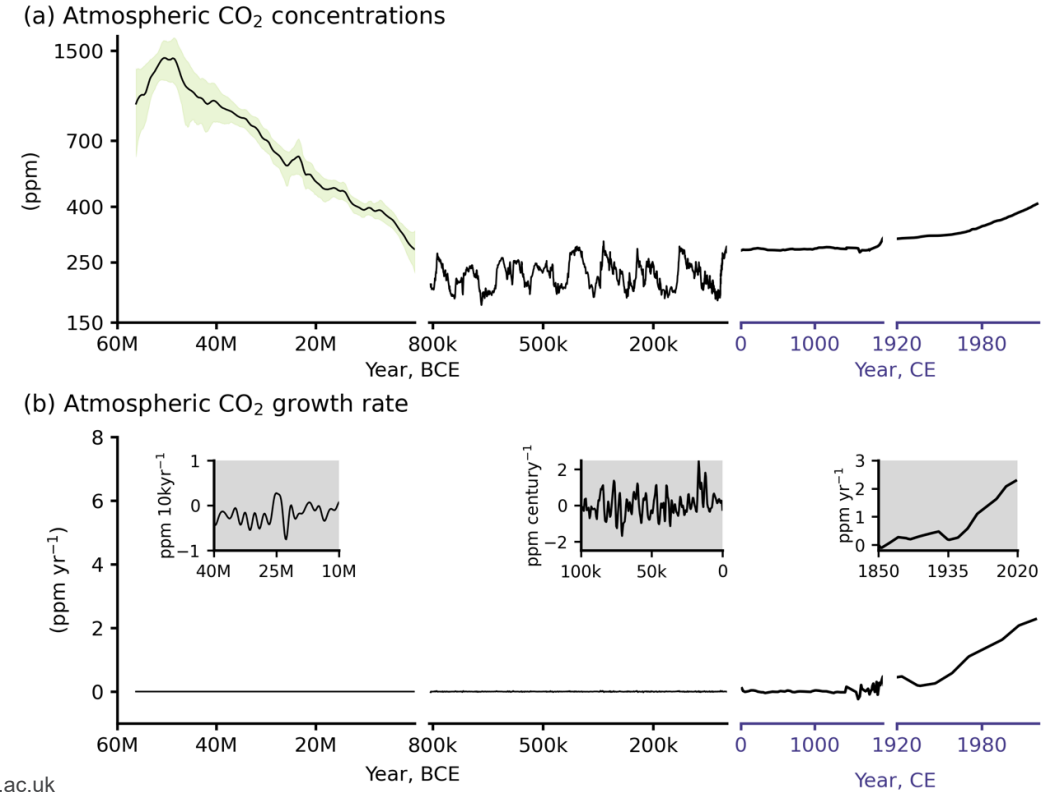
Figure SPM.1



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Figure 5.3

Unprecedented perturbation of the carbon cycle



Joeri ROGELJ – j.rogelj@imperial.ac.uk

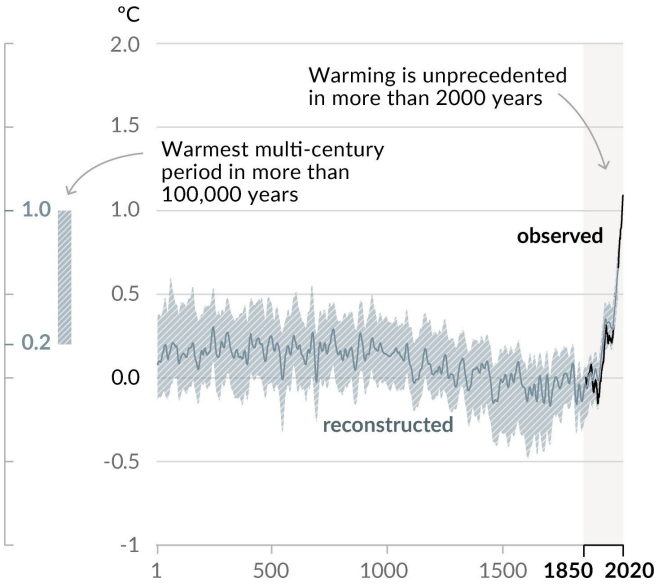
[Credit: Yoda Adaman | Unsplash]

> It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

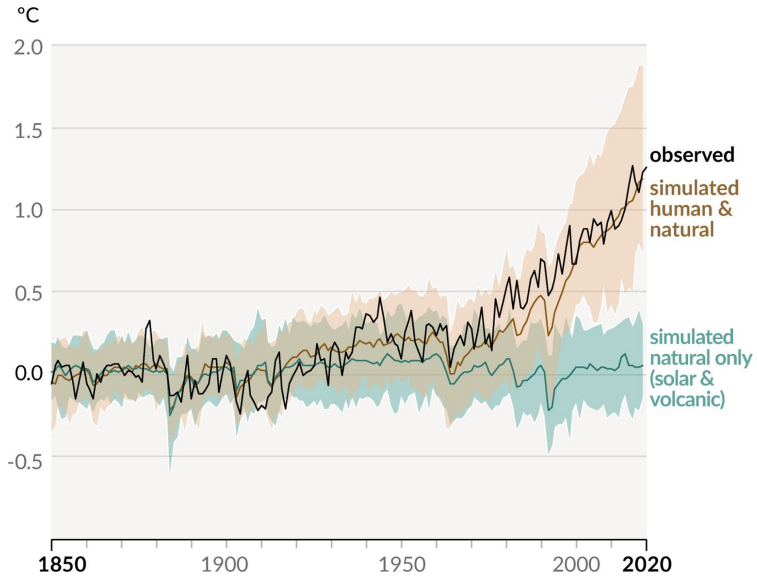
Human-caused pollution causes warming

Figure SPM.1

a) Change in global surface temperature (decadal average) as reconstructed (1-2000) and **observed** (1850-2020)



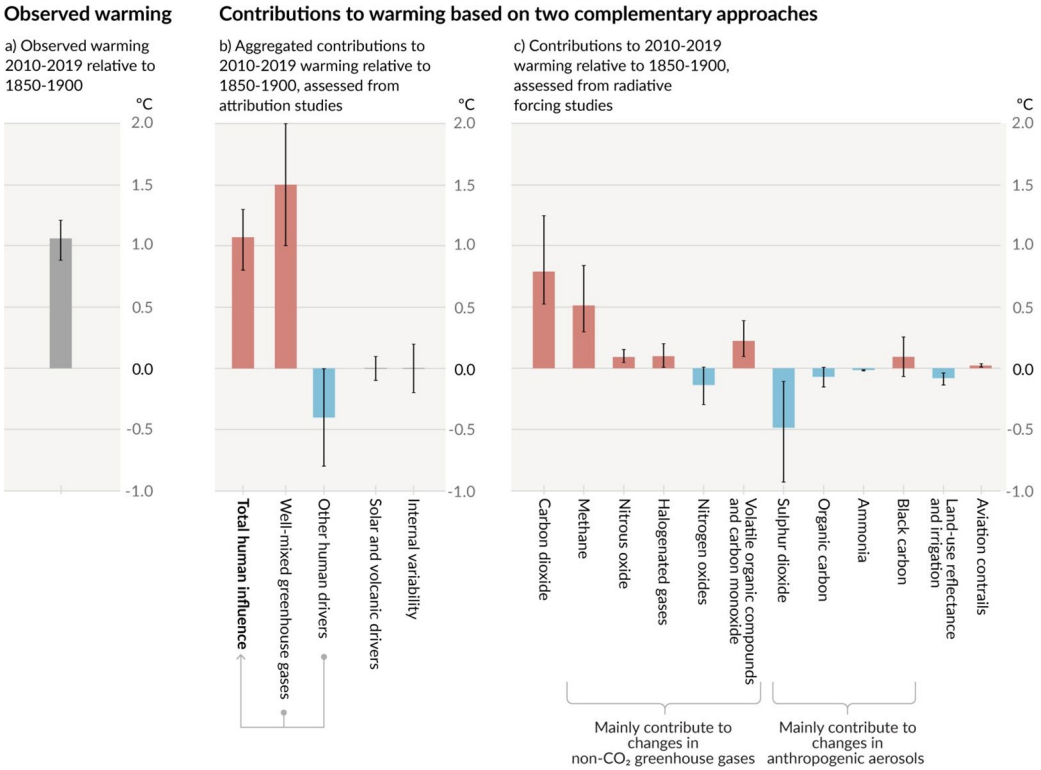
b) Change in global surface temperature (annual average) as **observed** and simulated using human & natural and only natural factors (both 1850-2020)



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Figure SPM.2

Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling



Joeri ROGELJ – j.rogelj@imperial.ac.uk

[Credit: Hong Nguyen | Unsplash]

“Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

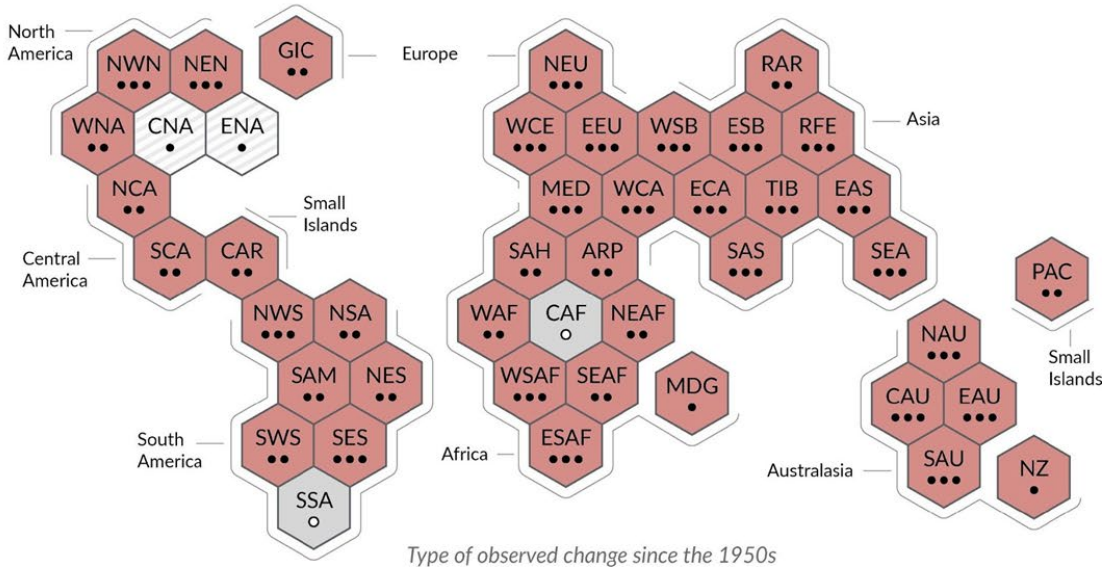
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

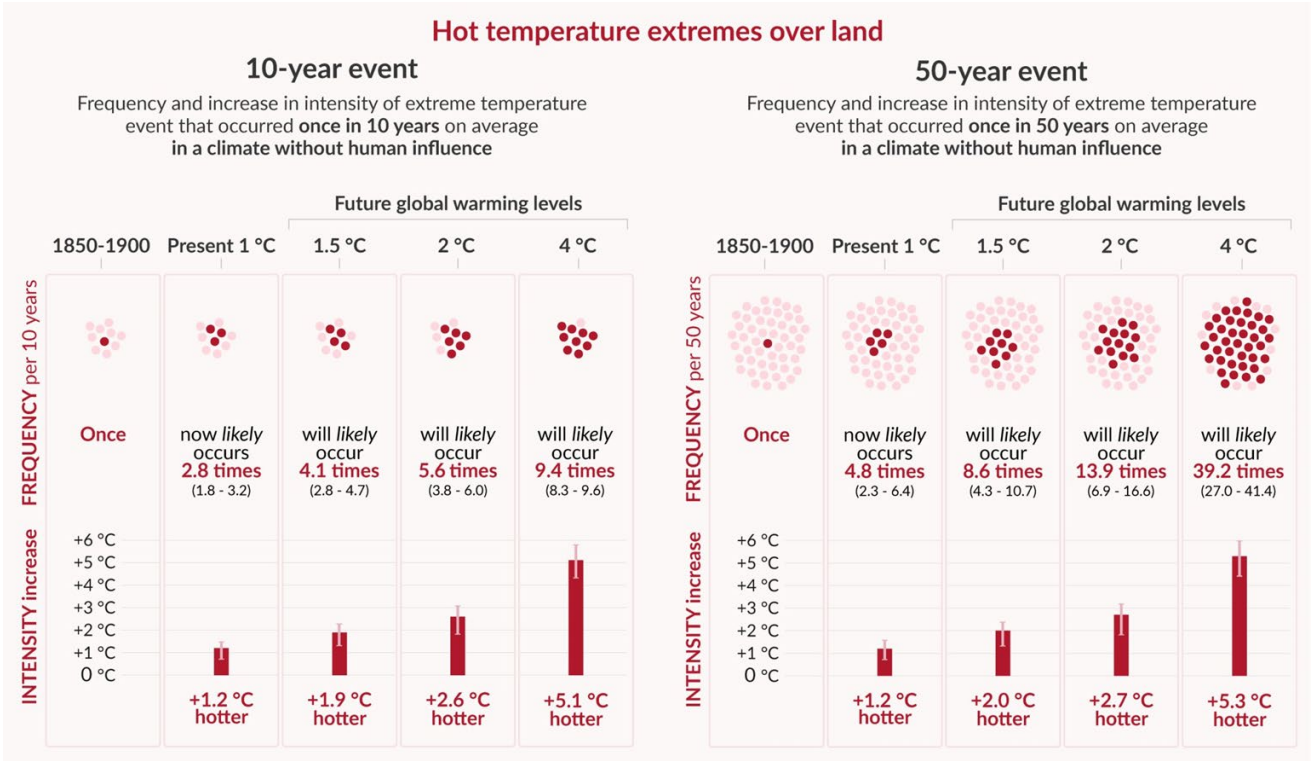
Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence

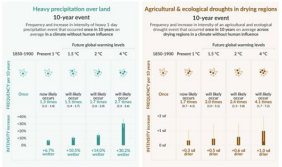


Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

Figure SPM.6



Also available for extreme precipitation and drought:



Joeri ROGELJ – j.rogelj@imperial.ac.uk

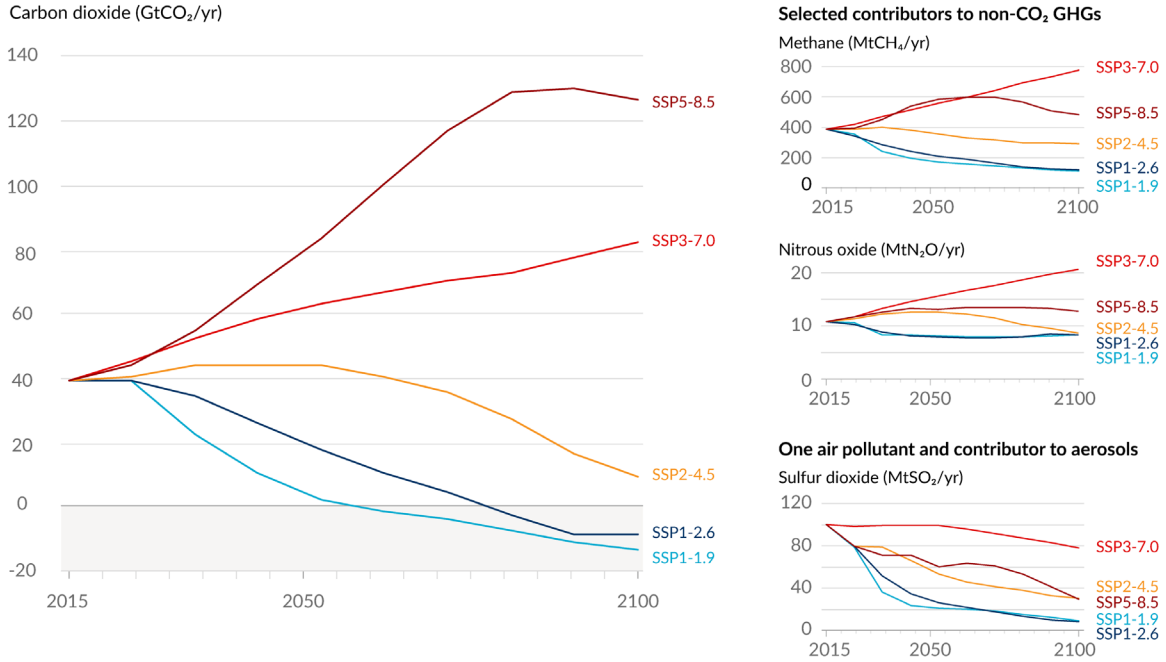
[Credit: Shari Gearheard | NSIDC]

> “There’s no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.

Emissions scenarios as tools to understand our global futures

Figure SPM.8

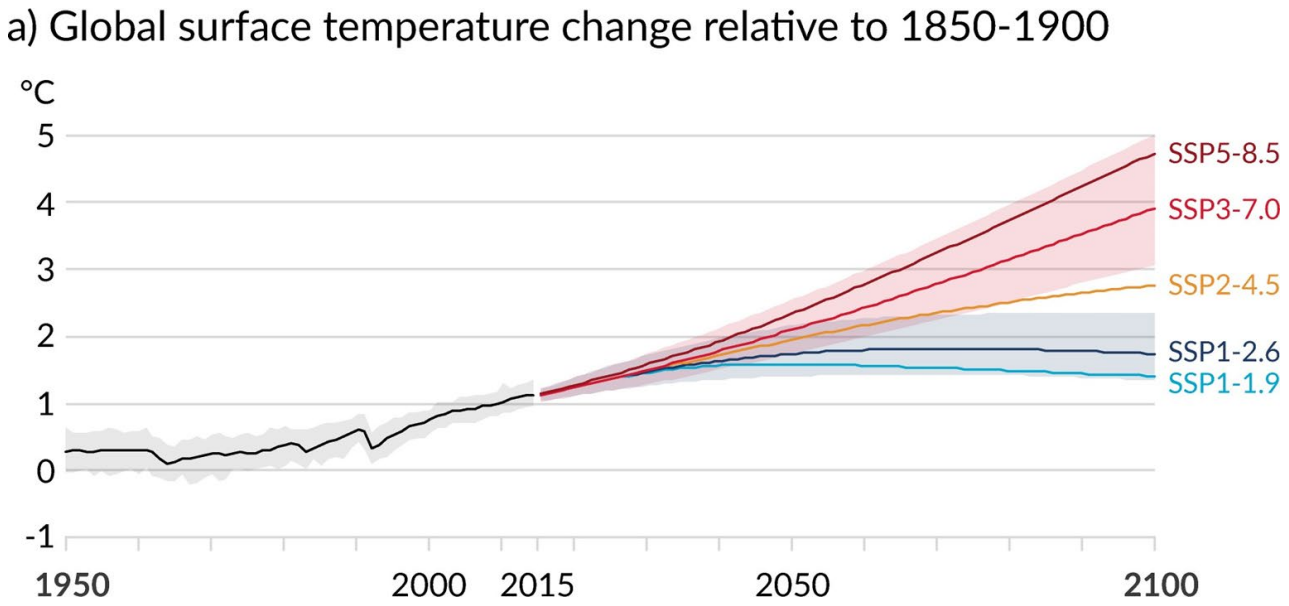
a) Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Figure SPM.8

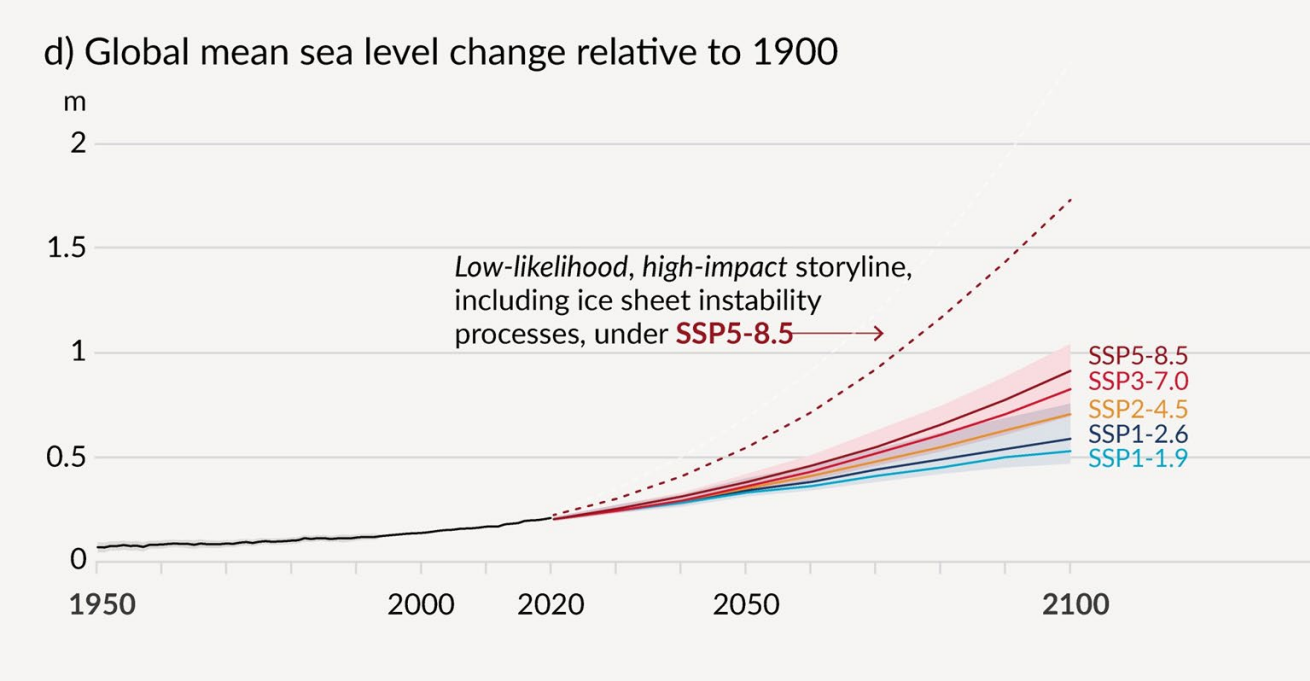
Human activities affect all the major climate system components, with some responding over decades and others over centuries



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Figure SPM.8

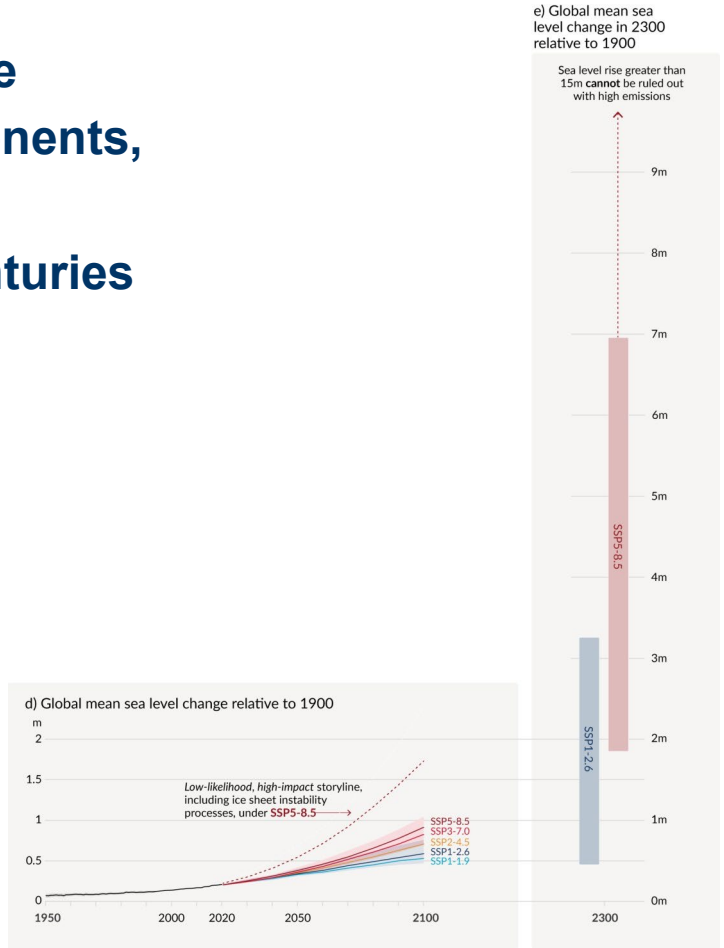
Human activities affect all the major climate system components, with some responding over decades and others over centuries



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



Joeri ROGELJ – j.rogelj@imperial.ac.uk

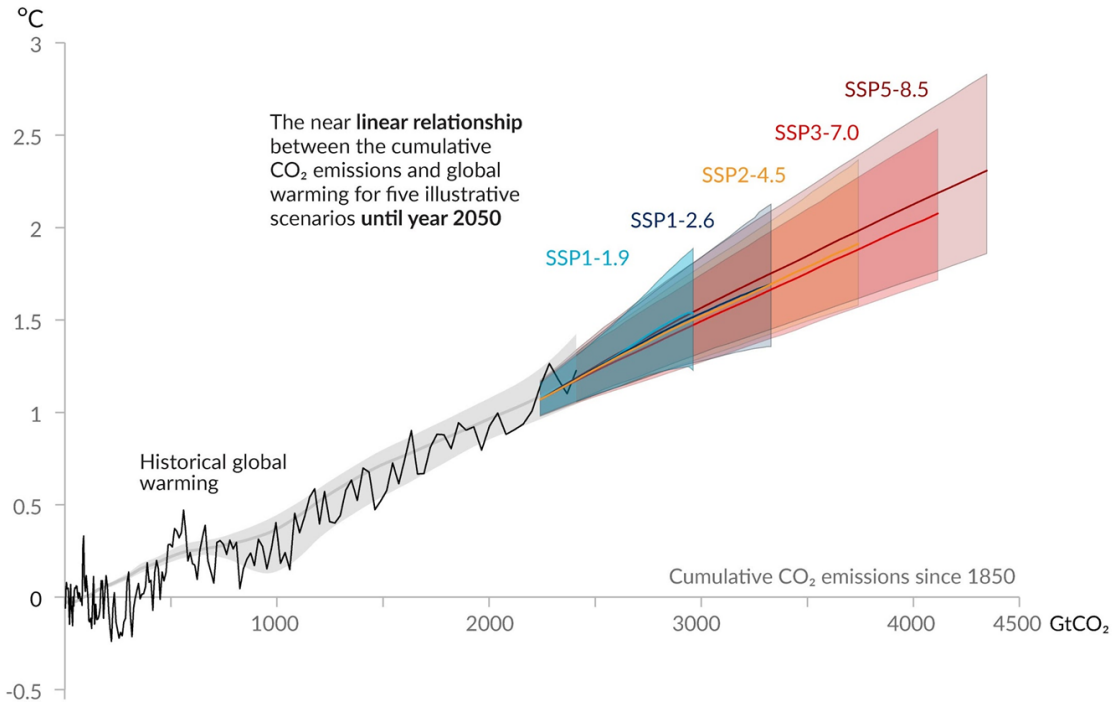
[Credit: Evgeny Nelmin | Unsplash]

> To limit global warming, strong, rapid, and sustained reductions in CO_2, methane, and other greenhouse gases are necessary.

Every tonne of CO_2 emissions adds to global warming

Figure SPM.10

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Joeri ROGELJ – j.rogelj@imperial.ac.uk

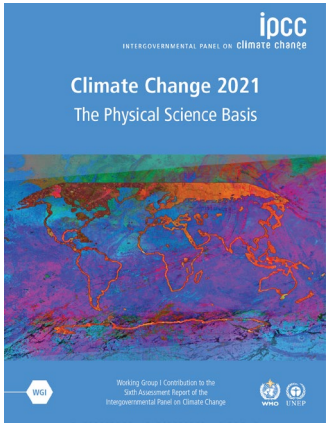
Table SPM.2

We understand better than ever what needs to be done to limit warming to the goals of the Paris Agreement

Global Warming Between 1850–1900 and 2010–2019 (°C)	Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)	2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

Joeri ROGELJ – j.rogelj@imperial.ac.uk

Using the carbon budget to understand mitigation needs



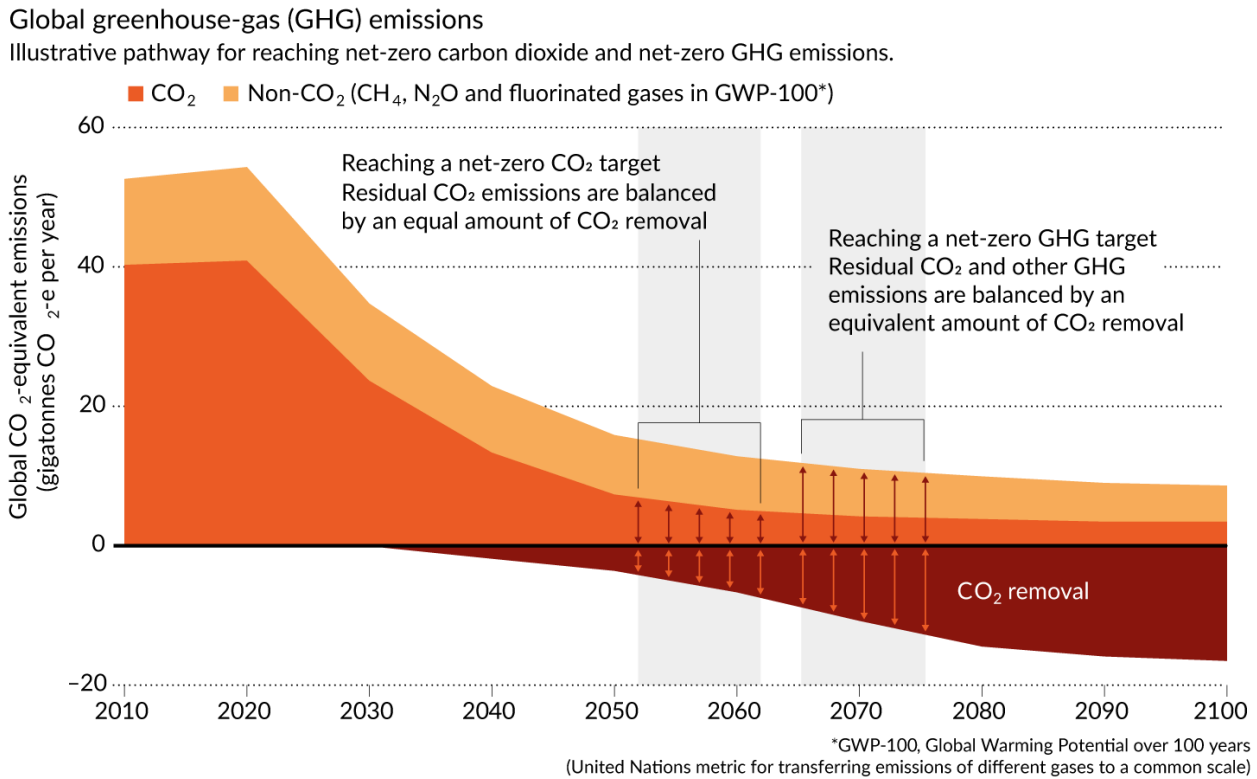
Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[a]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$, or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

Global warming in 2050 as function of continued annual reduction rates [°C]

Annual rate of change [%]	Base year				
	2016	2017	…	2023	2024
-20	1.2	1.3	…	1.5	1.5
-6.2	1.5	1.5	…	1.7	1.7
0	1.9	1.9	…	2.1	2.1
…	…	…	…	…	…
+5	3.1	3.1	…	2.8	2.7
…	…	…	…	…	…

Joeri ROGELJ – j.rogelj@imperial.ac.uk

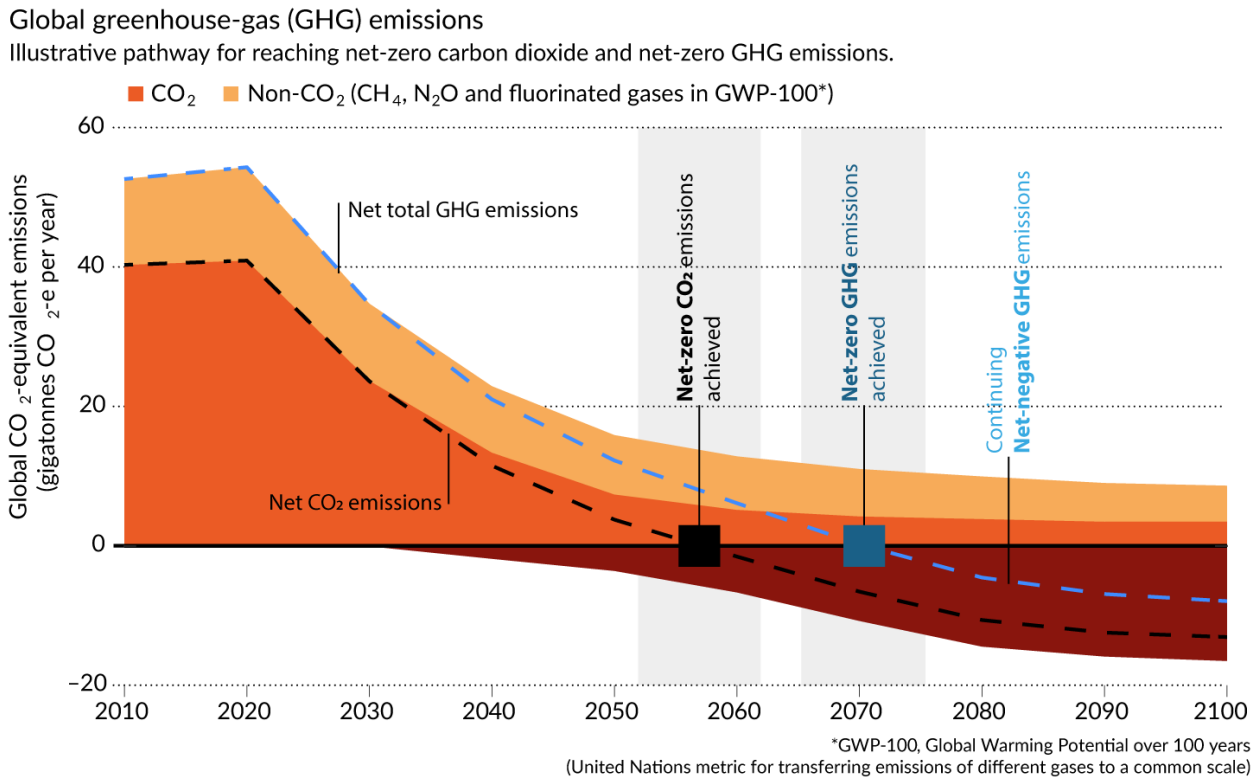
NET-ZERO BASICS:
A key part of any Paris-aligned pathway



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Source: Rogelj et al, 2021, Nature: https://www.nature.com/articles/d41586-021-00662-3

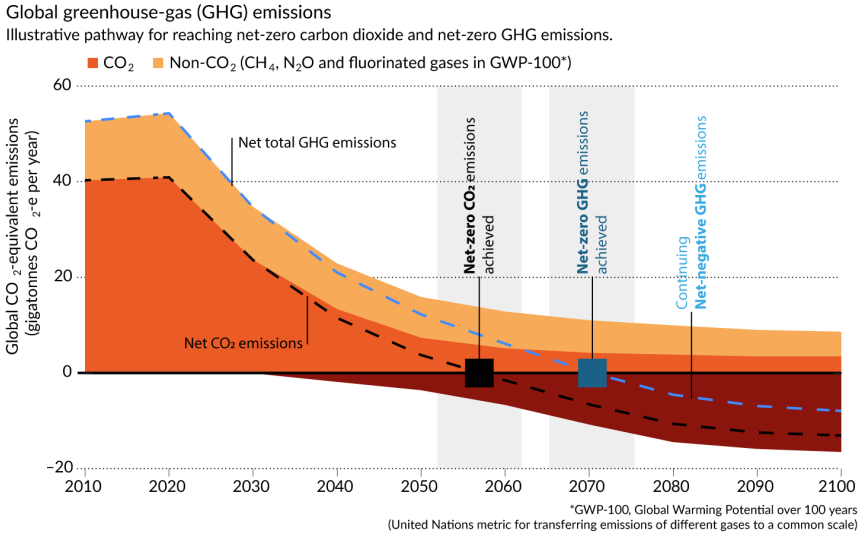
NET-ZERO BASICS:
A key part of any Paris-aligned pathway

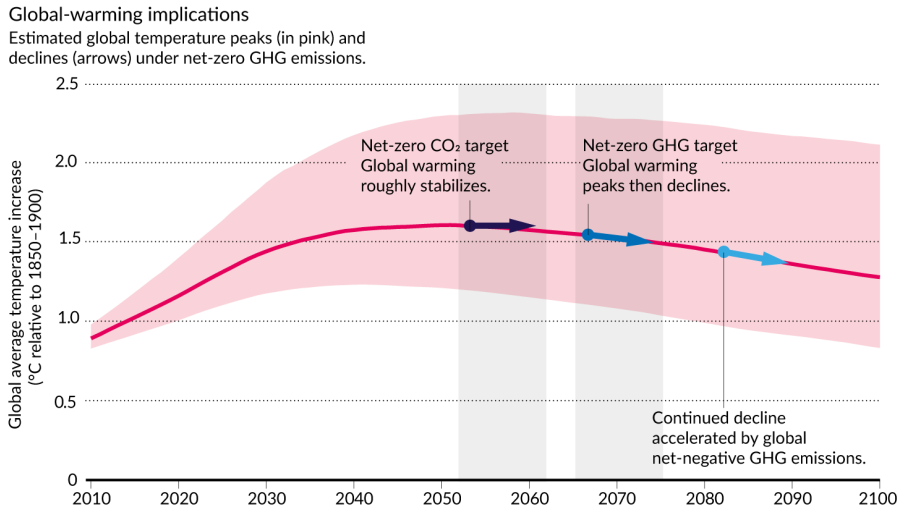


Joeri ROGELJ – j.rogelj@imperial.ac.uk

Source: Rogelj et al, 2021, Nature: https://www.nature.com/articles/d41586-021-00662-3

The Paris Agreement net-zero target achieves more than stabilisation: a peak and decline in global warming



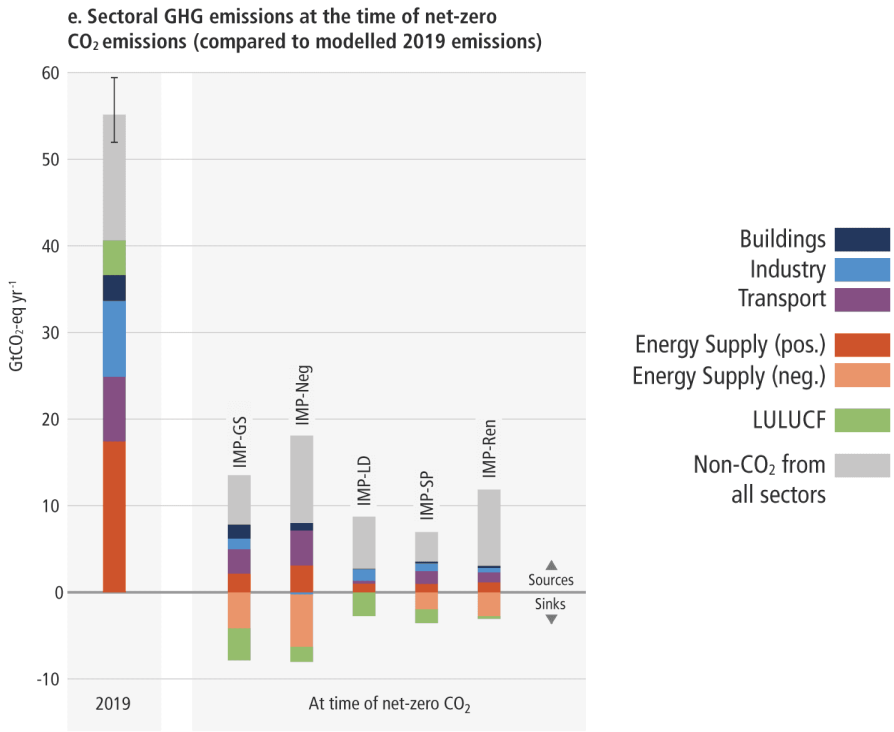


Joeri ROGELJ – j.rogelj@imperial.ac.uk

Source: Rogelj et al, 2021, Nature: https://www.nature.com/articles/d41586-021-00662-3

NOT ALL PATHWAYS ARE CREATED EQUAL

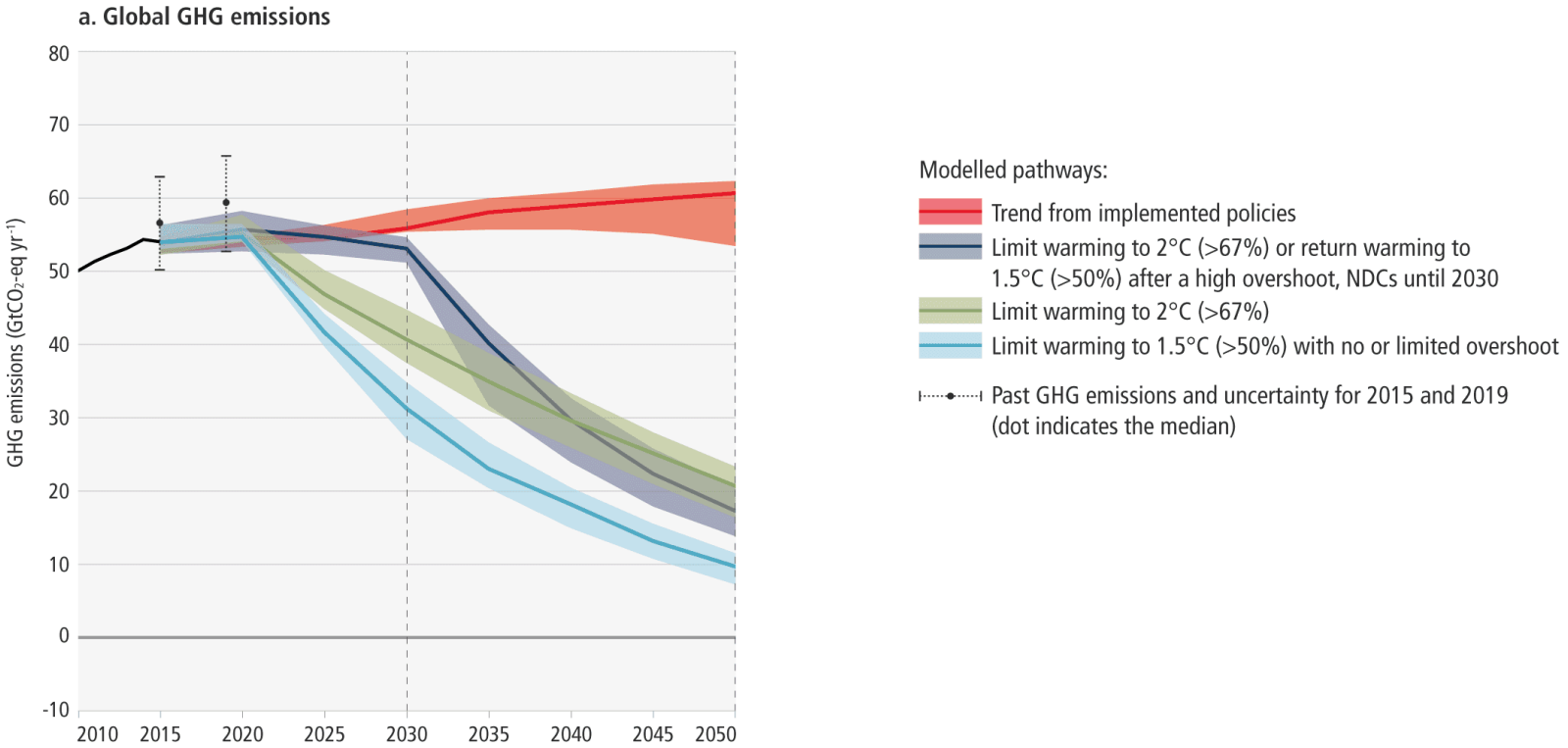
Societal choices about the strategies
to reach net zero determine benefits
or challenges for sustainable development



Joeri ROGELJ – j.rogelj@imperial.ac.uk

Source: IPCC AR6 WG3, Figure SPM.6

THE EMISSIONS GAP REMAINS LARGE

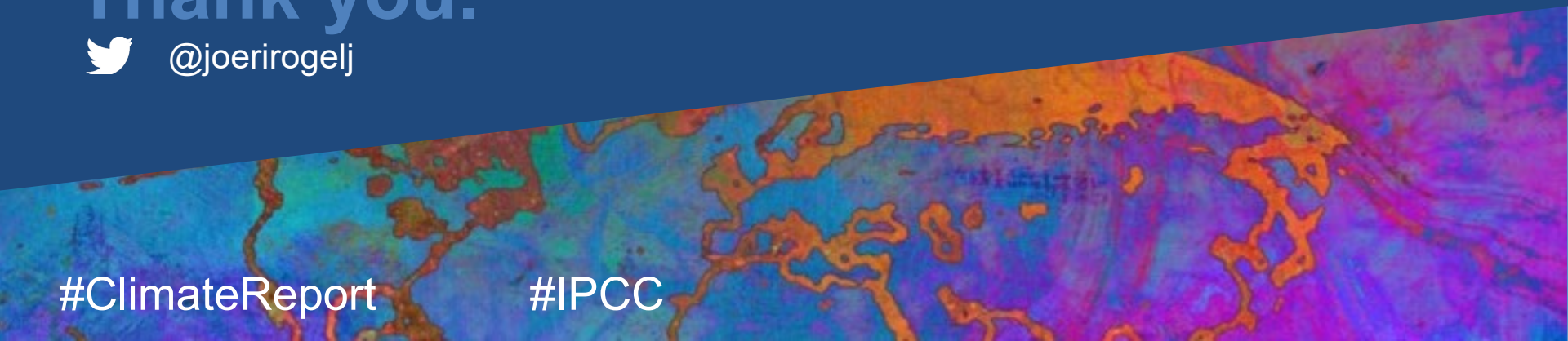


Joeri ROGELJ – j.rogelj@imperial.ac.uk

Source: IPCC AR6 WG3, Figure SPM.3

Thank you.

@joerirogelj



#ClimateReport #IPCC