ETH zürich
CLIMATE ANALYTICS
UNIVERSITY OF LEEDS
MAX-PLANCK-GESELLSCHAFT
METEO FRANCE
International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at
Imperial College London

Climate science2policy 17-18th November 2020

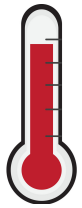
Remaining carbon budget estimates, uncertainties, and the importance of net zero dates

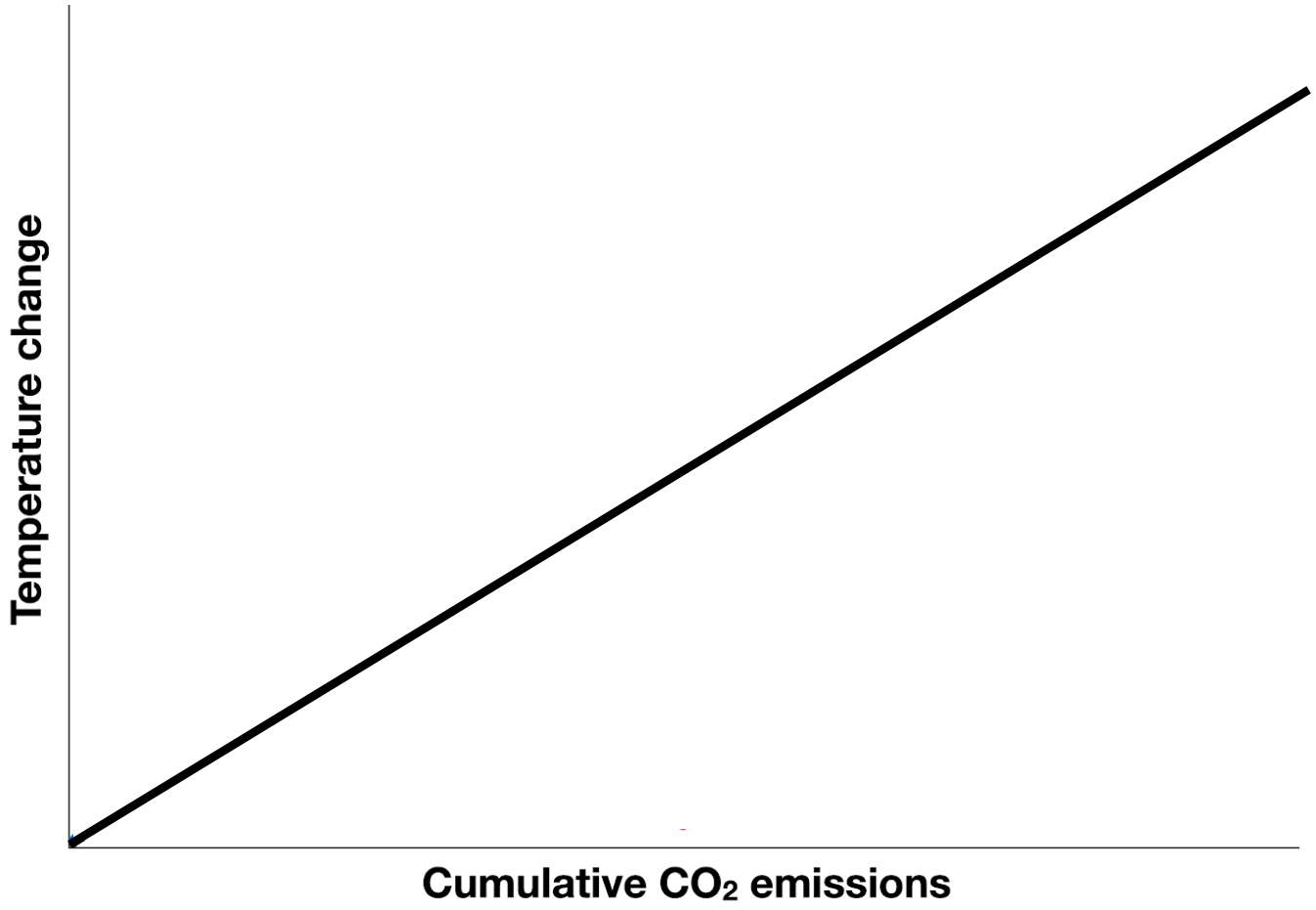
CONSTRAIN

@kasia_tokarska

REMAINING CARBON BUDGET

Warming

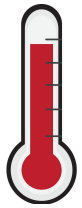




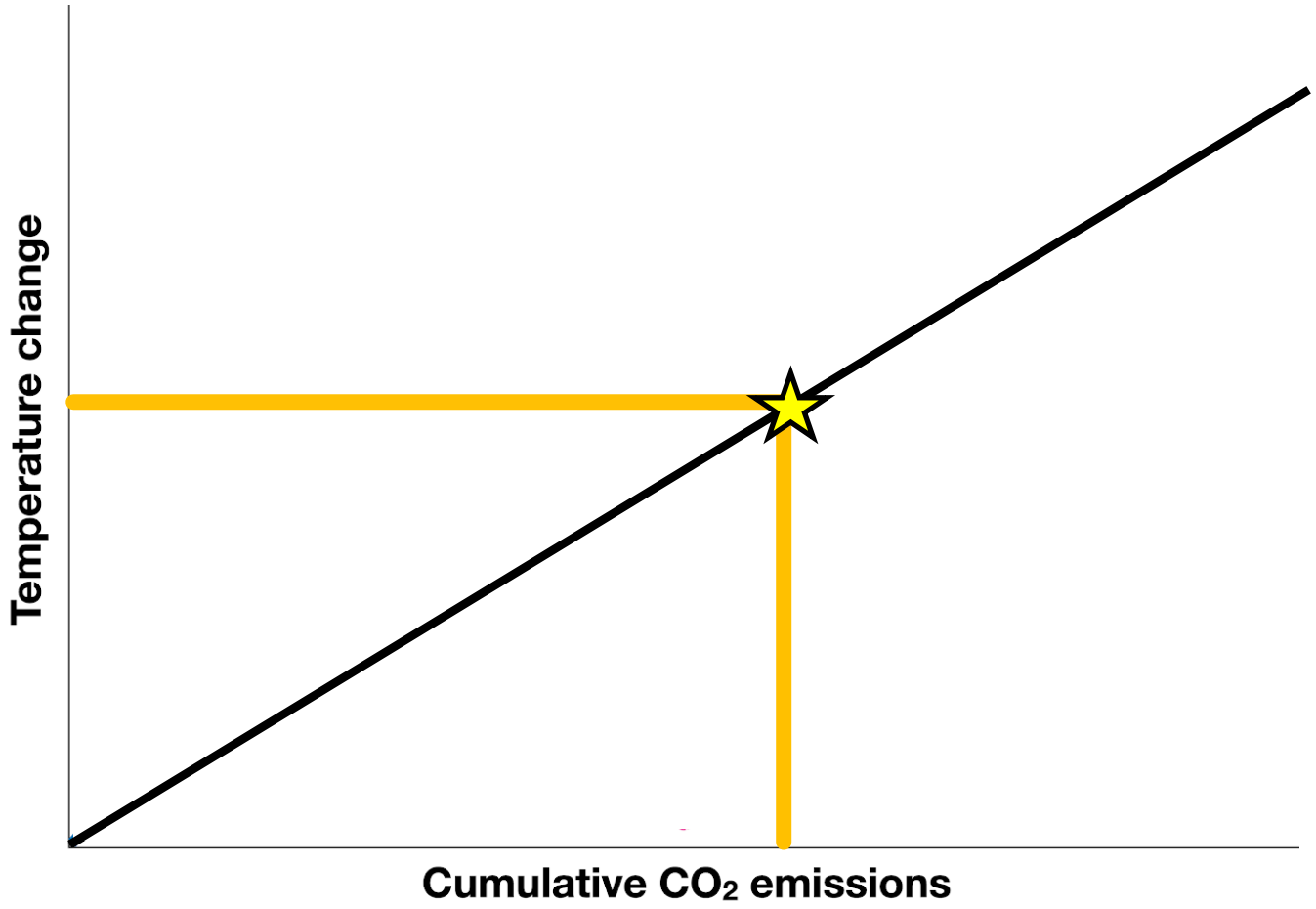
Total emissions

REMAINING CARBON BUDGET

Warming



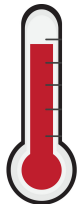
1.5 °C

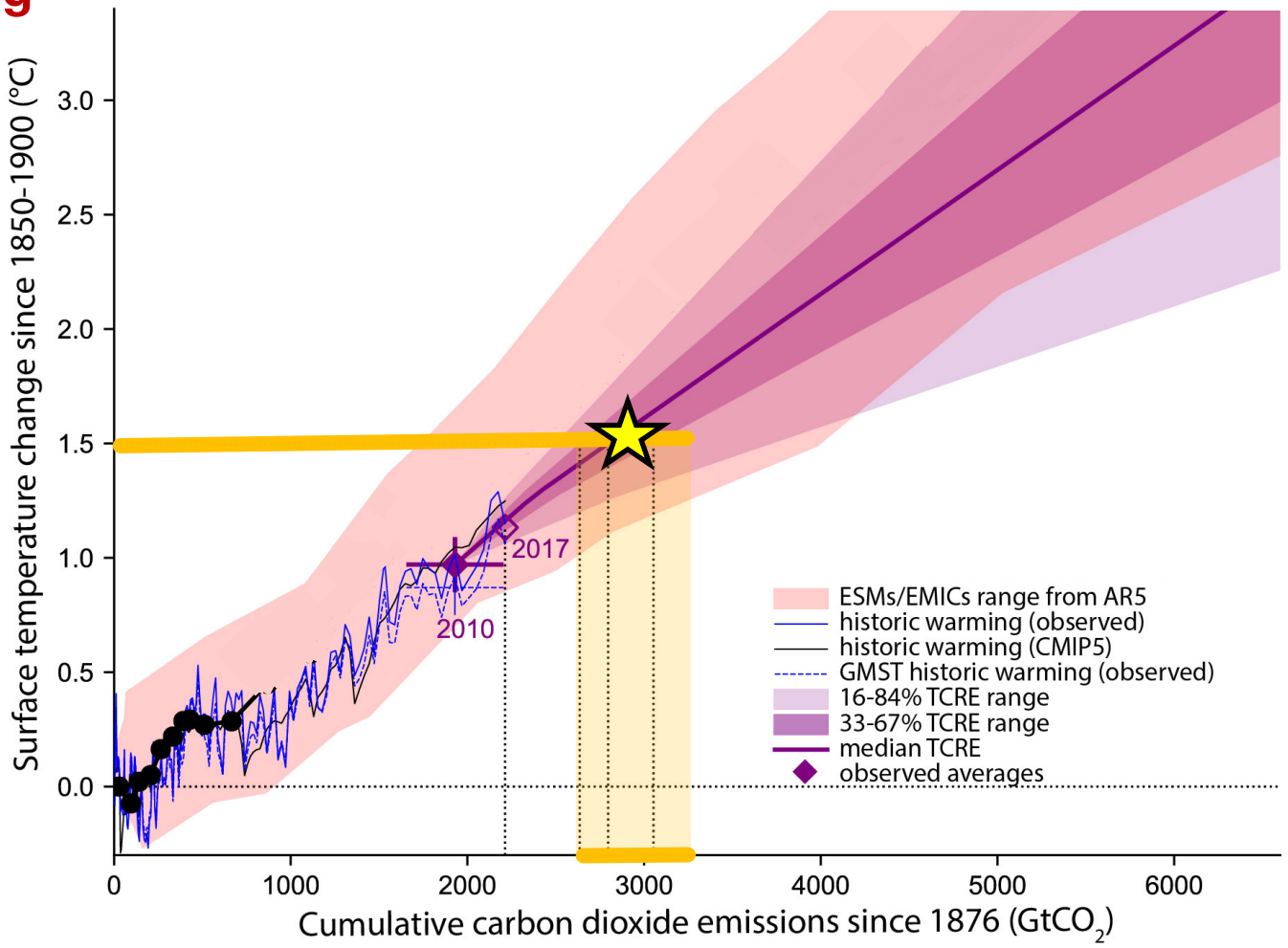


Total emissions

REMAINING CARBON BUDGET

Warming



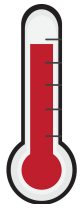


Total emissions

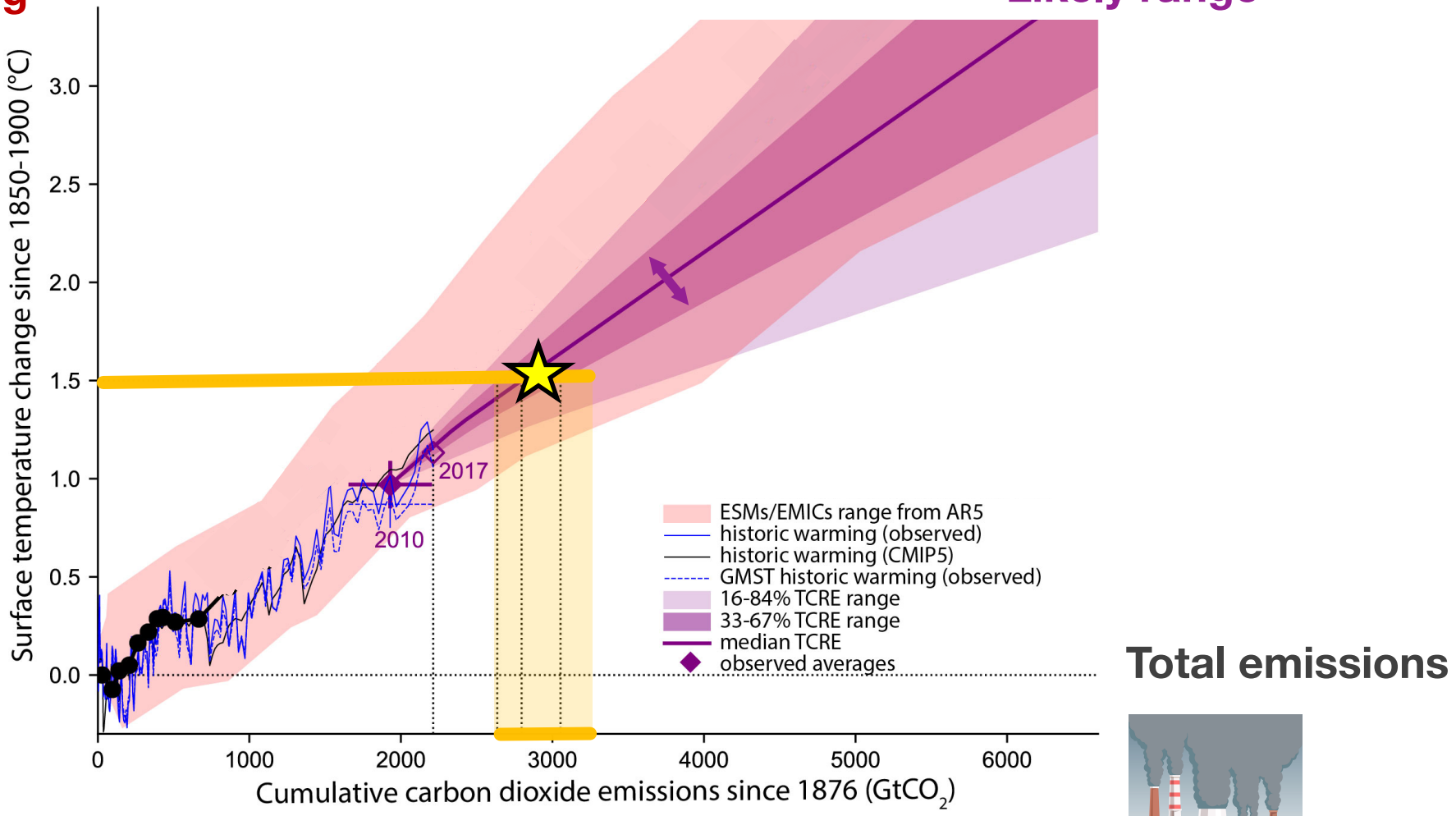
IPCC SR1.5, Ch 2 (Rogelj et al. 2018), Figure 2.3 (*simplified*)

REMAINING CARBON BUDGET

Warming



Likely range

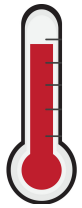


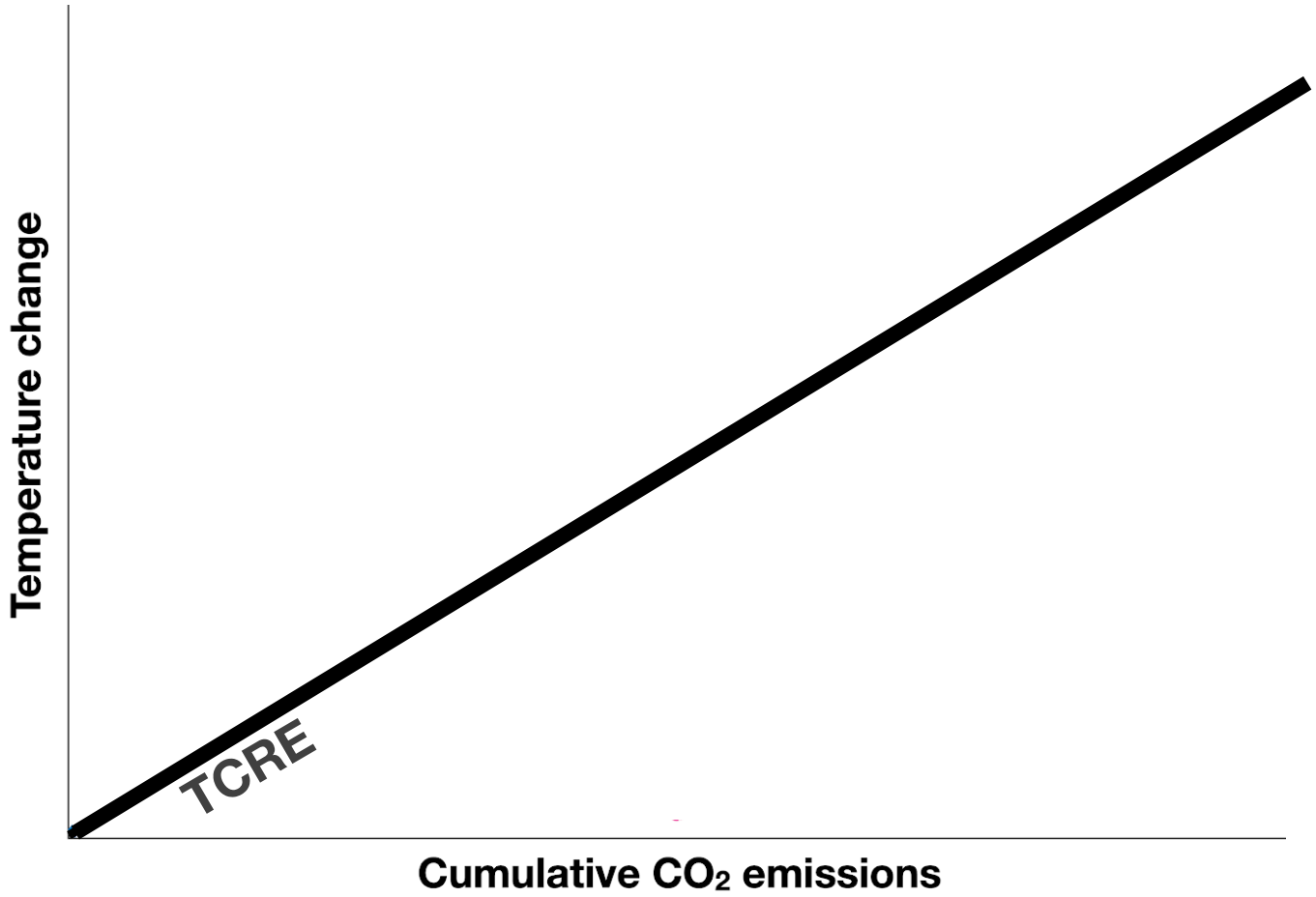
Total emissions

IPCC SR1.5, Ch 2 (Rogelj et al. 2018), Figure 2.3 (*simplified*)

UNCERTAINTIES

Warming

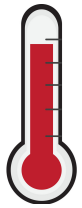


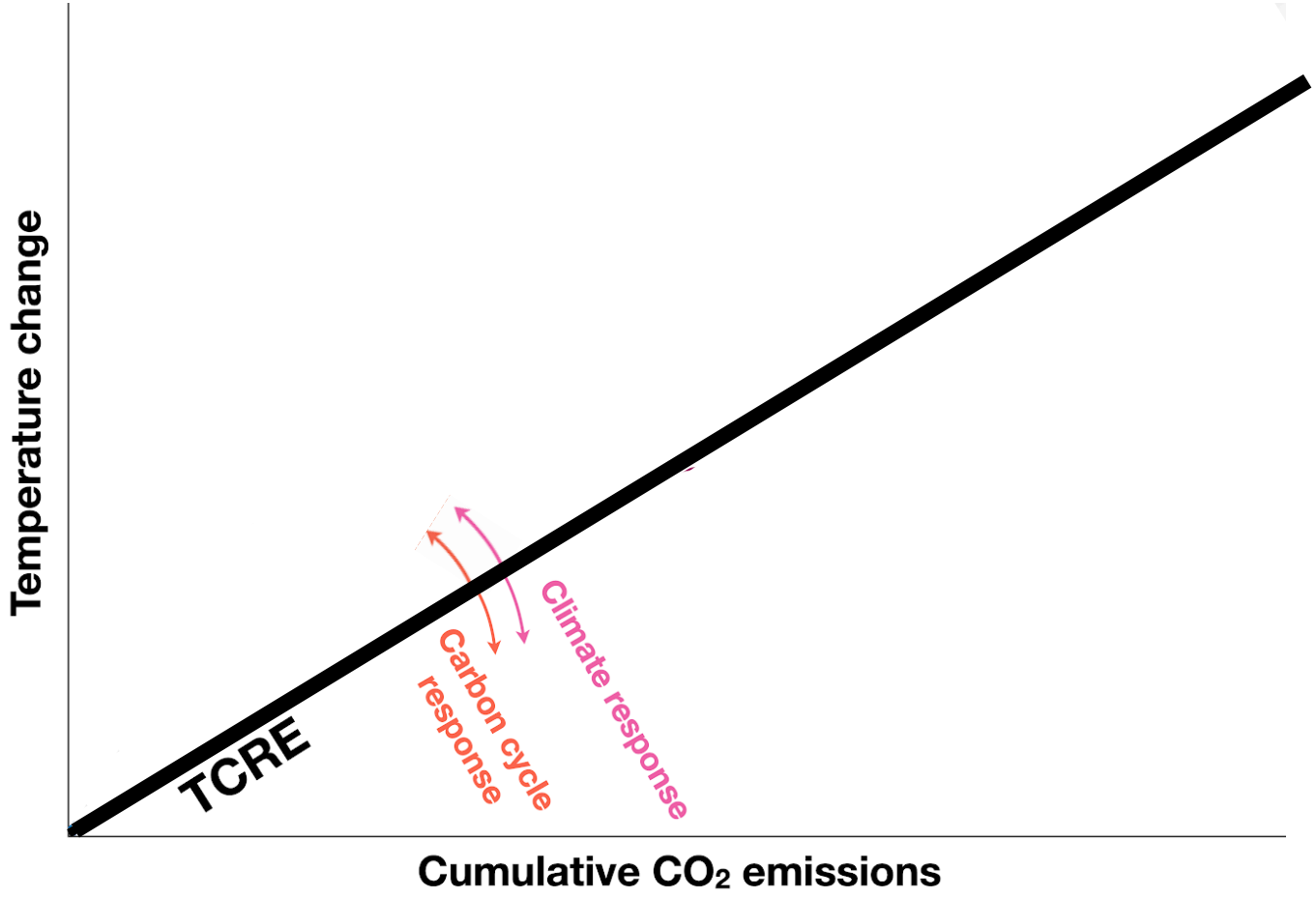


Total emissions

UNCERTAINTIES

Warming



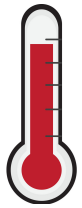


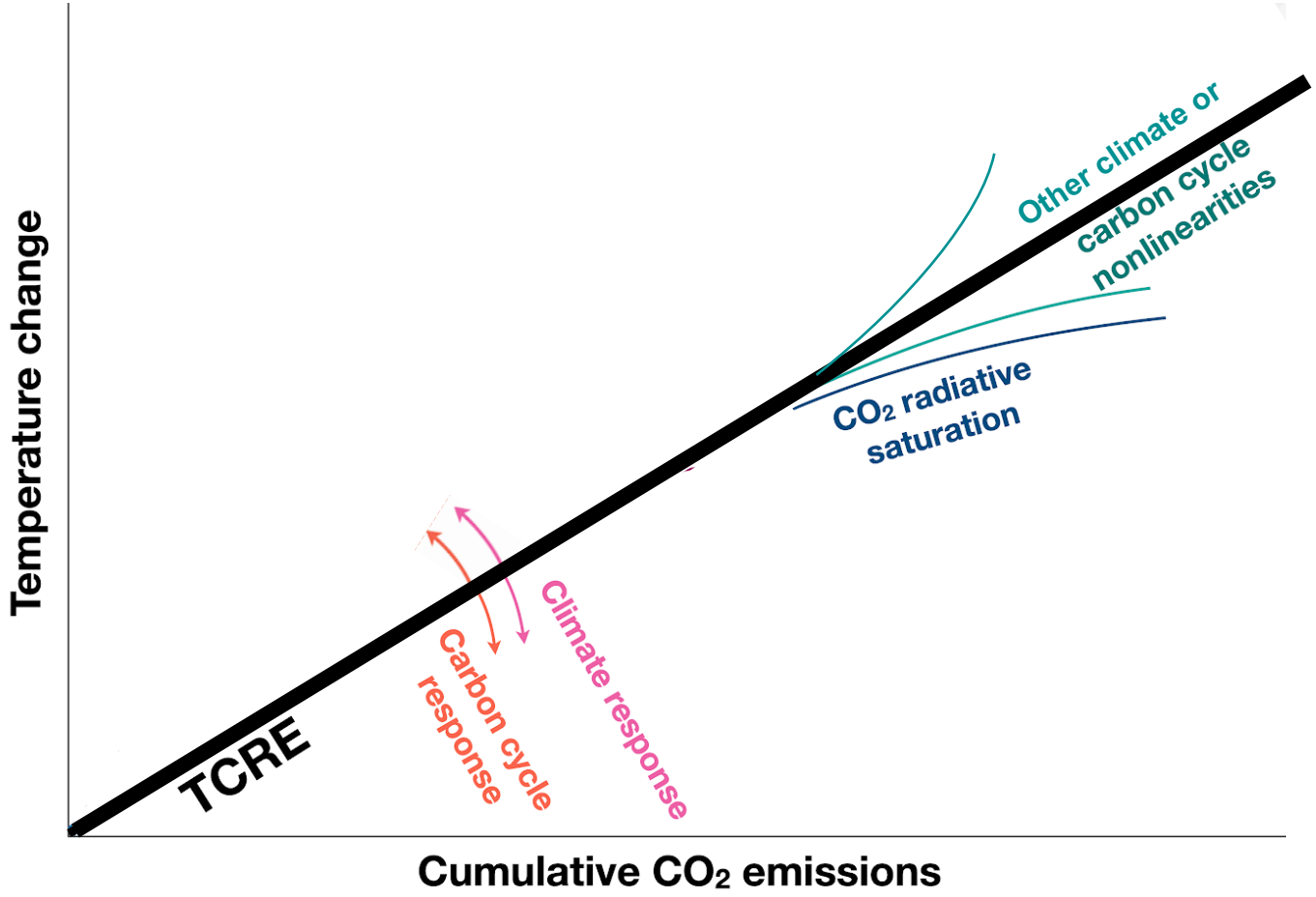
Total emissions

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

UNCERTAINTIES

Warming



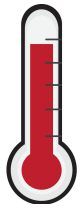


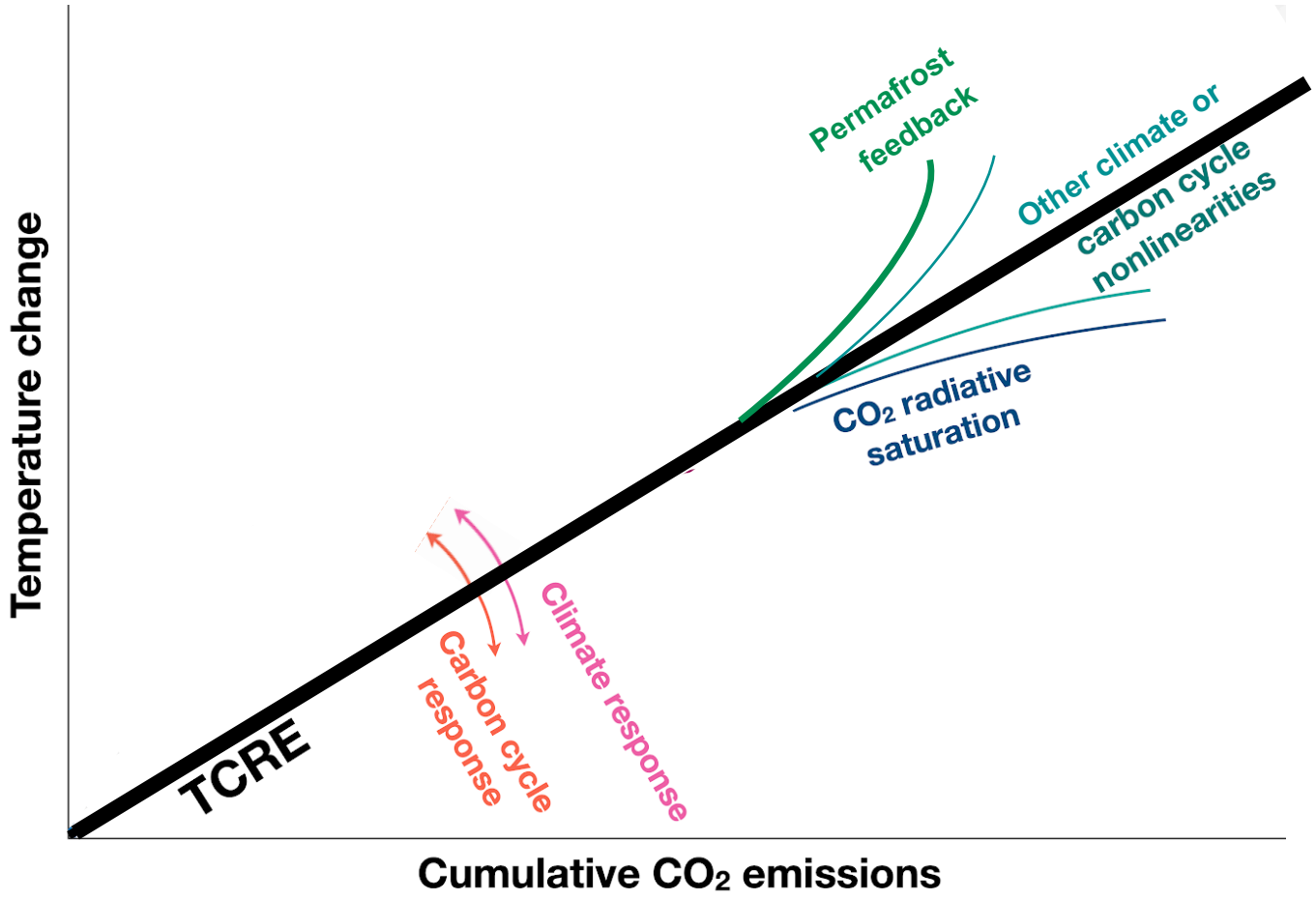
Total emissions

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

UNCERTAINTIES

Warming





Total emissions

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

UNCERTAINTIES

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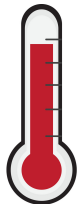
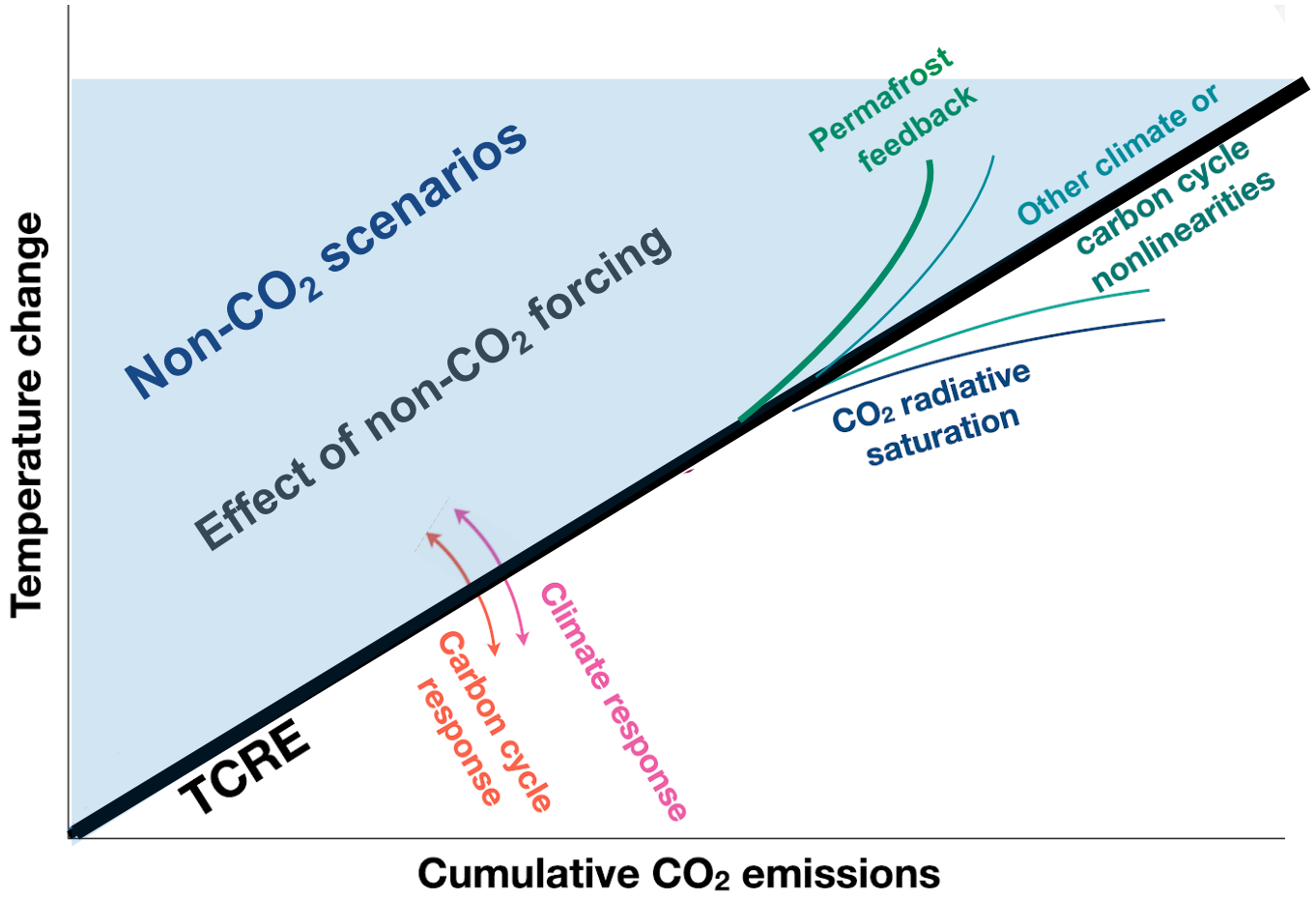
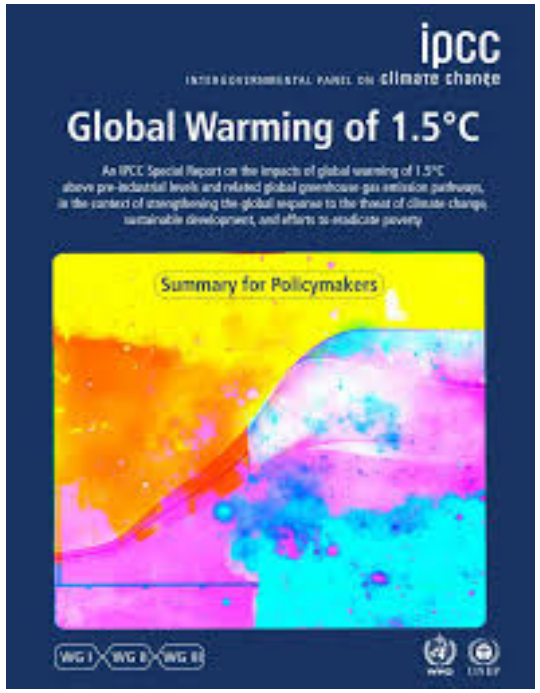




Total emissions

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

How can we **incorporate different sources of uncertainty** into remaining carbon budget estimates?



2

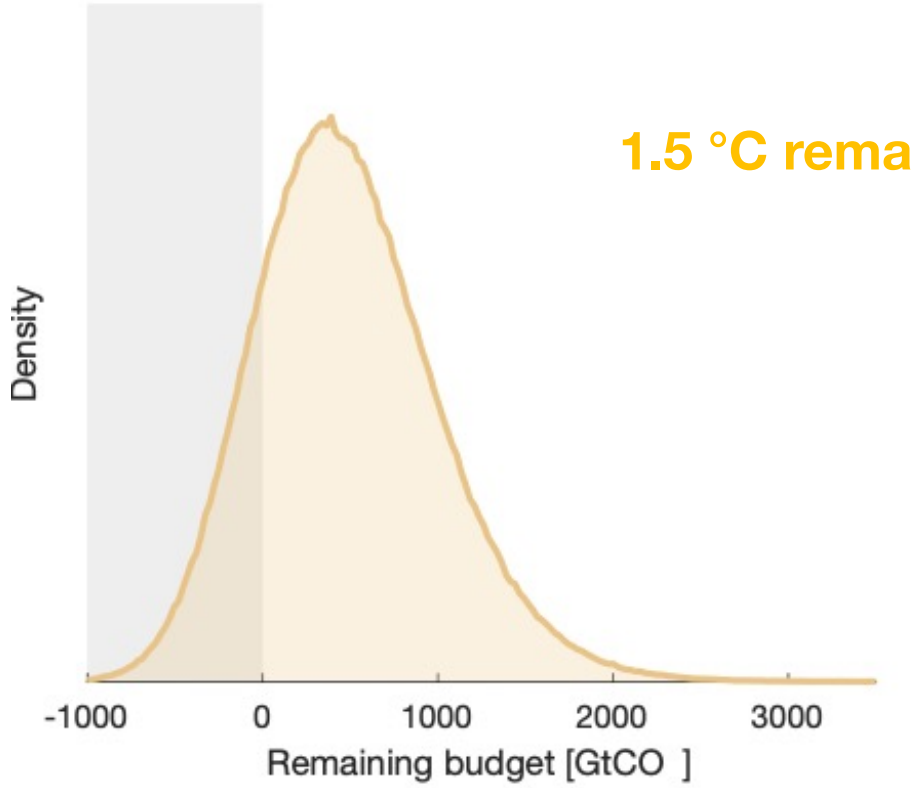
Table 2.2 | The assessed remaining carbon budget and its uncertainties. Shaded blue horizontal bands illustrate the uncertainty in historical temperature increase from the 1850–1900 base period until the 2006–2015 period as estimated from global near-surface air temperatures, which impacts the additional warming until a specific temperature limit like 1.5°C or 2°C relative to the 1850–1900 period. Shaded grey cells indicate values for when historical temperature increase is estimated from a blend of near-surface air temperatures over land and sea ice regions and sea-surface temperatures over oceans.

Additional Warming since 2006–2015 [°C]*(1)	Approximate Warming since 1850–1900 [°C]*(1)	Remaining Carbon Budget (Excluding Additional Earth System Feedbacks*(5)) [$GtCO_2$ from 1.1.2018]*(2)			Key Uncertainties and Variations*(4)					
		Percentiles of TCRE *(3)			Earth System Feedbacks *(5)	Non-CO_2 scenario variation *(6)	Non-CO_2 forcing and response uncertainty	TCRE distribution uncertainty *(7)	Historical temperature uncertainty *(1)	Recent emissions uncertainty *(8)
		33rd	*50th*	*67th*	*[$GtCO_2$]*	*[$GtCO_2$]*	*[$GtCO_2$]*	*[$GtCO_2$]*	*[$GtCO_2$]*	*[$GtCO_2$]*
0.3		290	160	80	Budgets on the left are reduced by about –100 on centennial time scales					
0.4		530	350	230						
0.5		770	530	380						
0.53	**~1.5°C**	**840**	**580**	**420**		±250	–400 to +200	+100 to +200	±250	±20
0.6		1010	710	530						
0.63		1080	770	570						
0.7		1240	900	680						

REMAINING CARBON BUDGET

Considering only geophysical uncertainties, a median estimate of the **1.5 °C remaining carbon budget** (globally) is around 440 $GtCO_2$ from 2020 onwards, equivalent to approximately

10 years at the current CO_2 emission rate



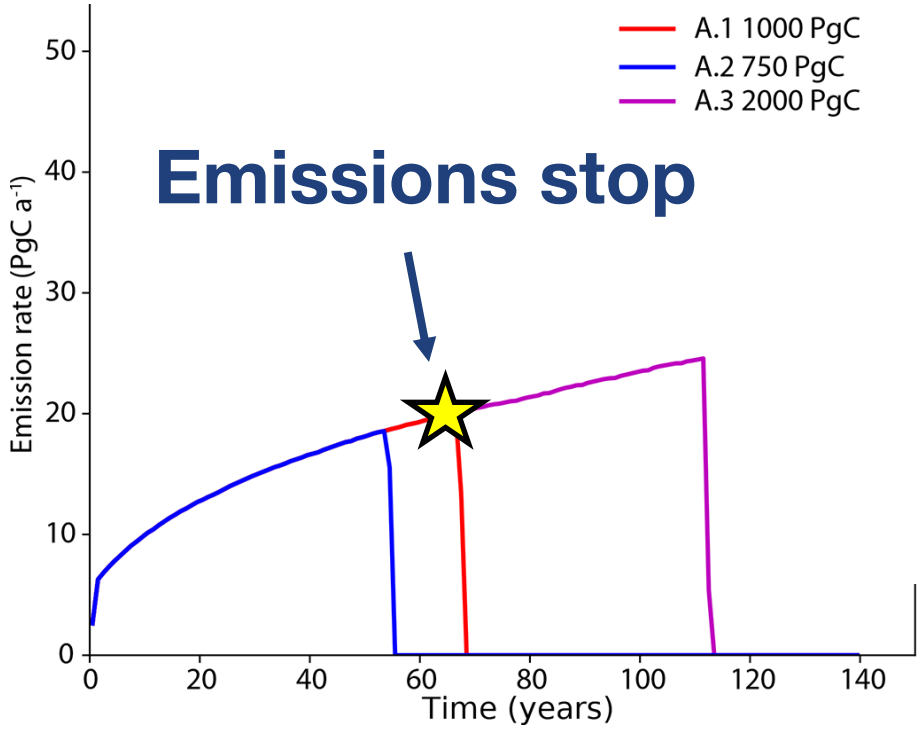
1.5 °C remaining carbon budget

Matthews, Tokarska, et al. 2020 Comm. Earth and Env. (in press)

ZERO EMISSION COMMITMENT

CRESCENDO CONSTRAIN and many others…

MacDougall et al. 2020 Biogeosciences



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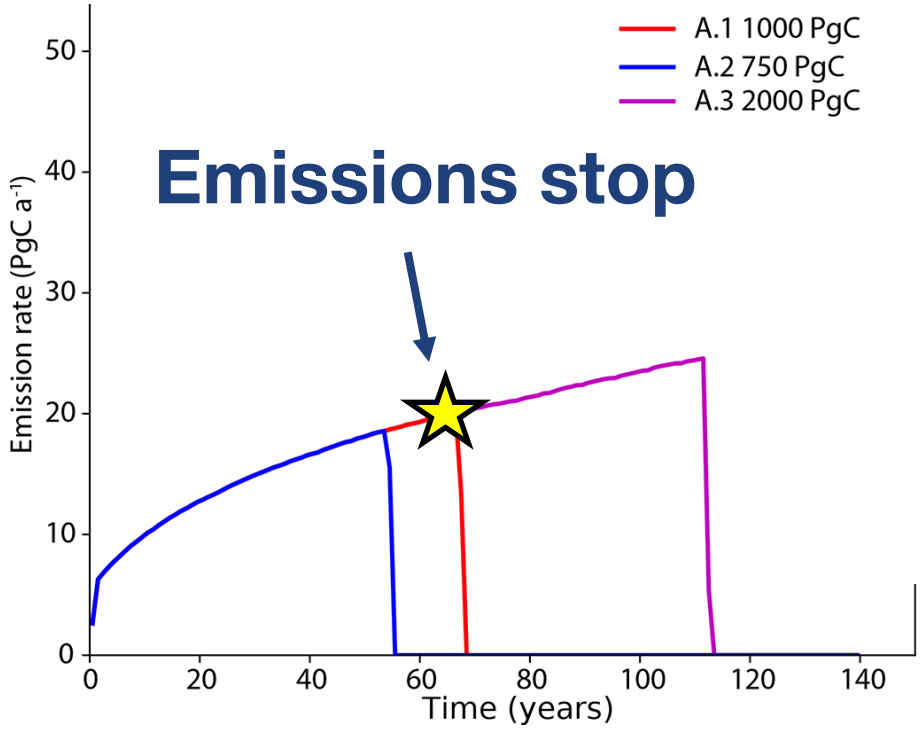

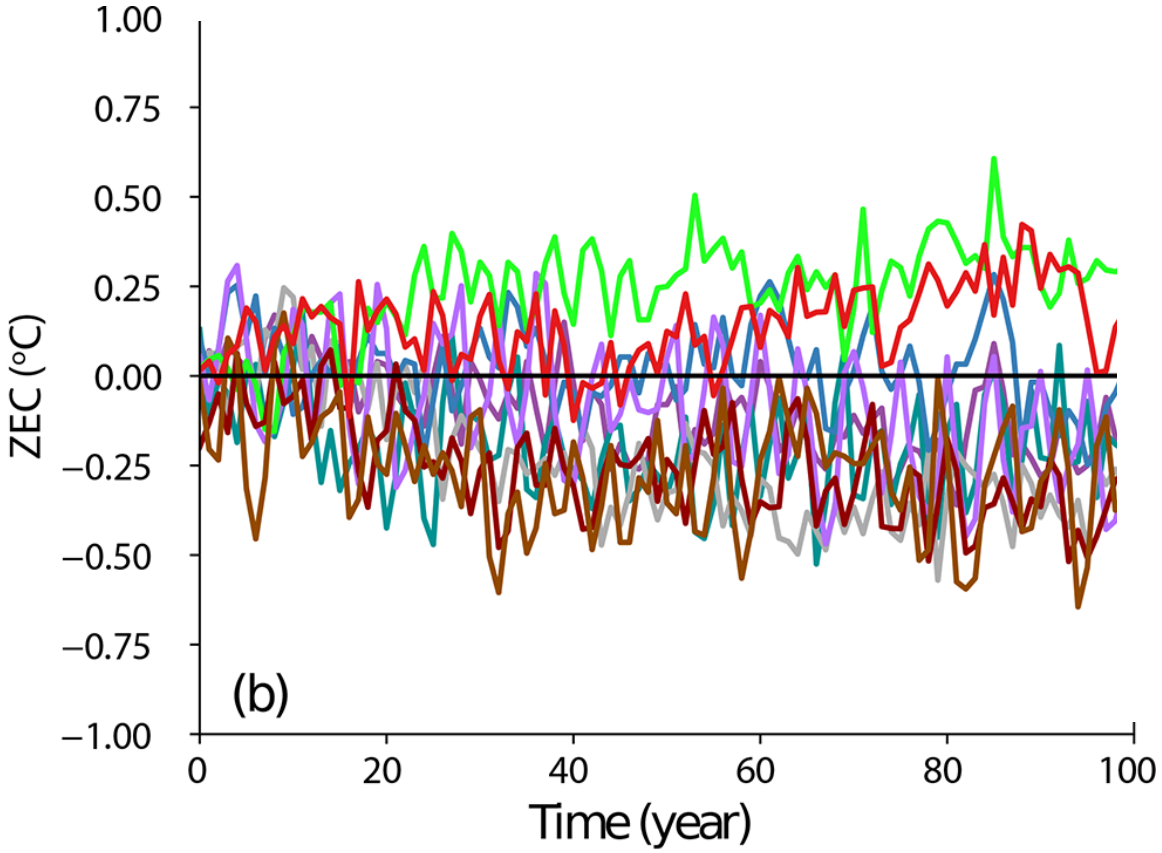

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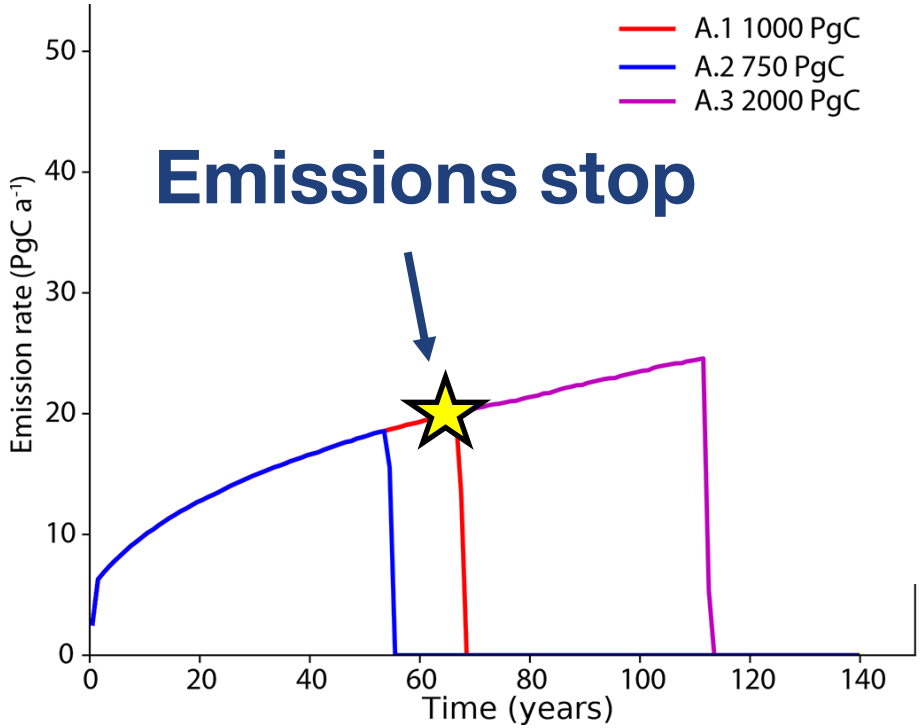
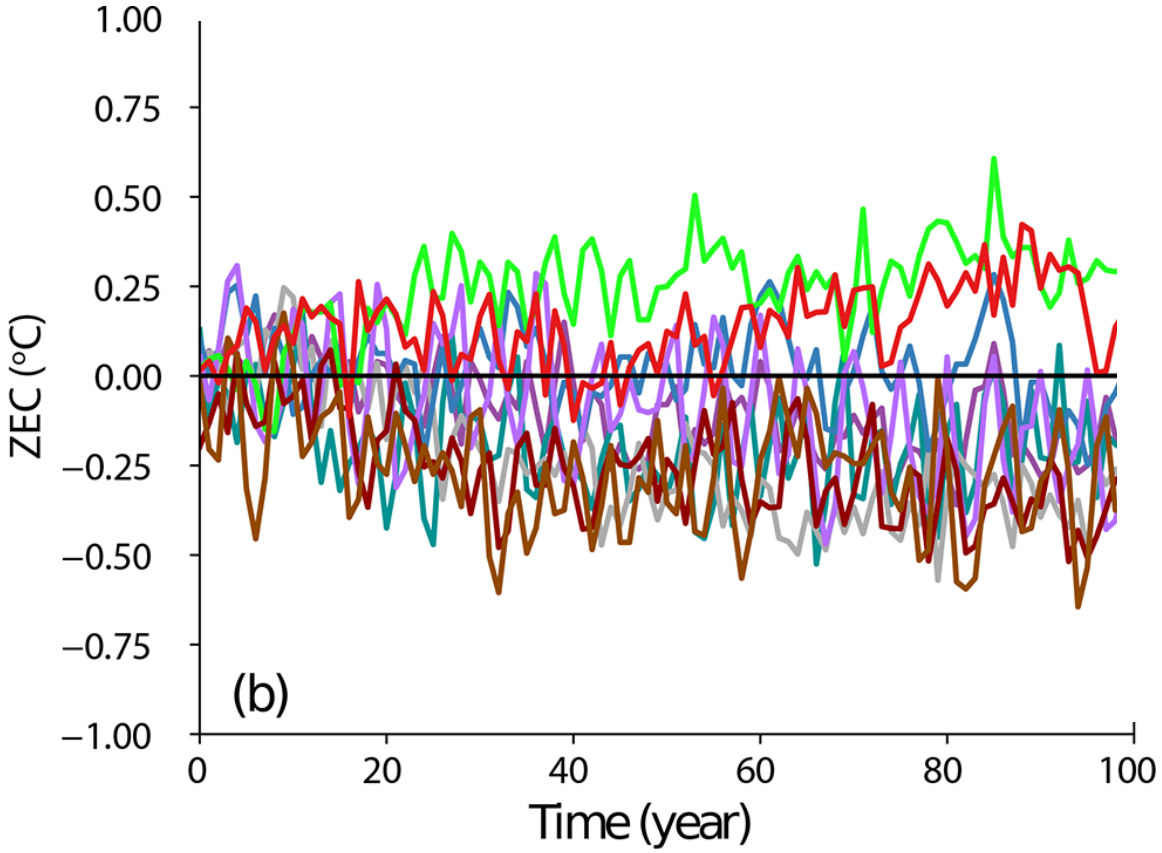


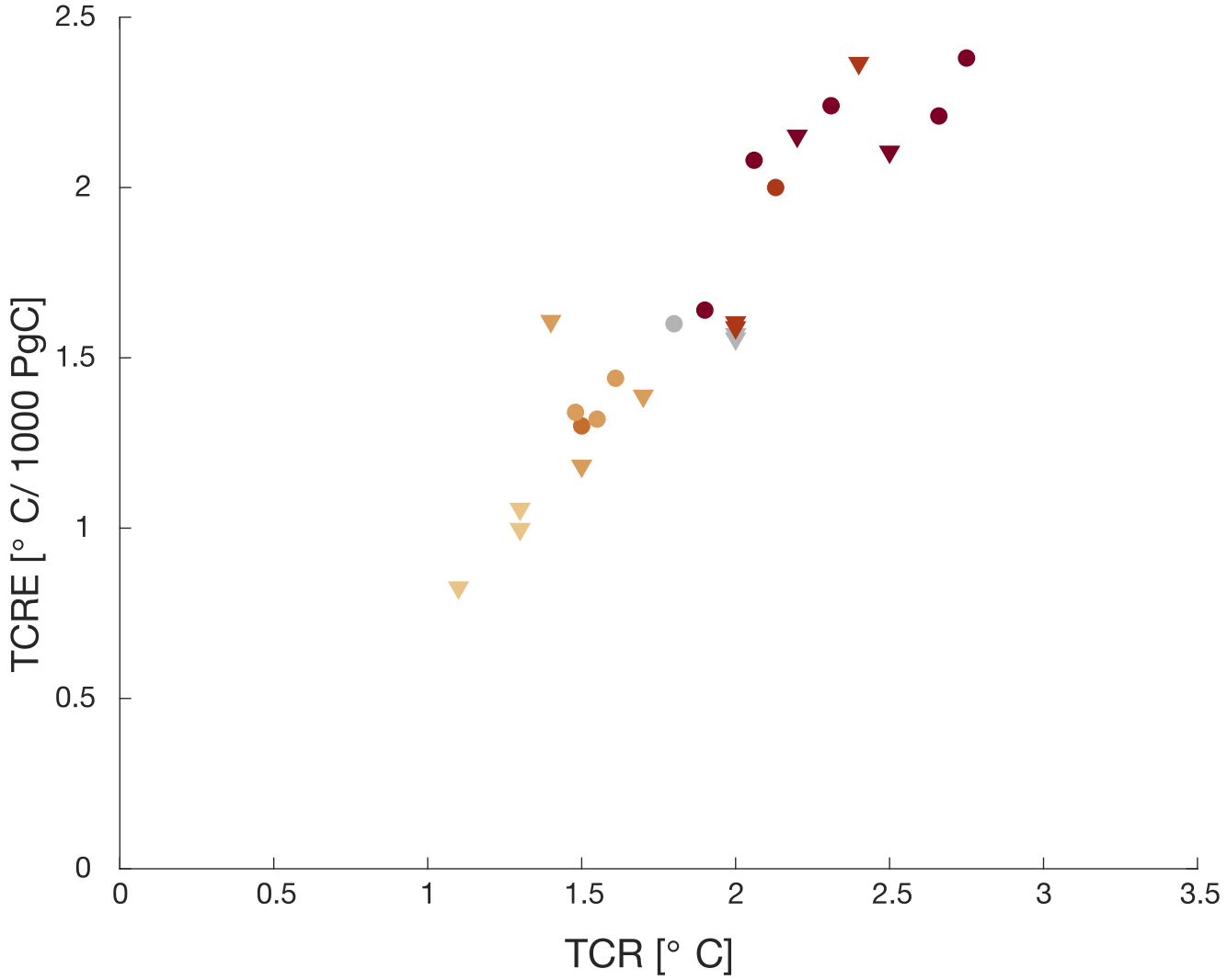
is approximately zero

(i.e., no additional warming)

Additional temperature change after emissions are stopped



REMAINING CARBON BUDGET



Individual models
coloured by ECS values

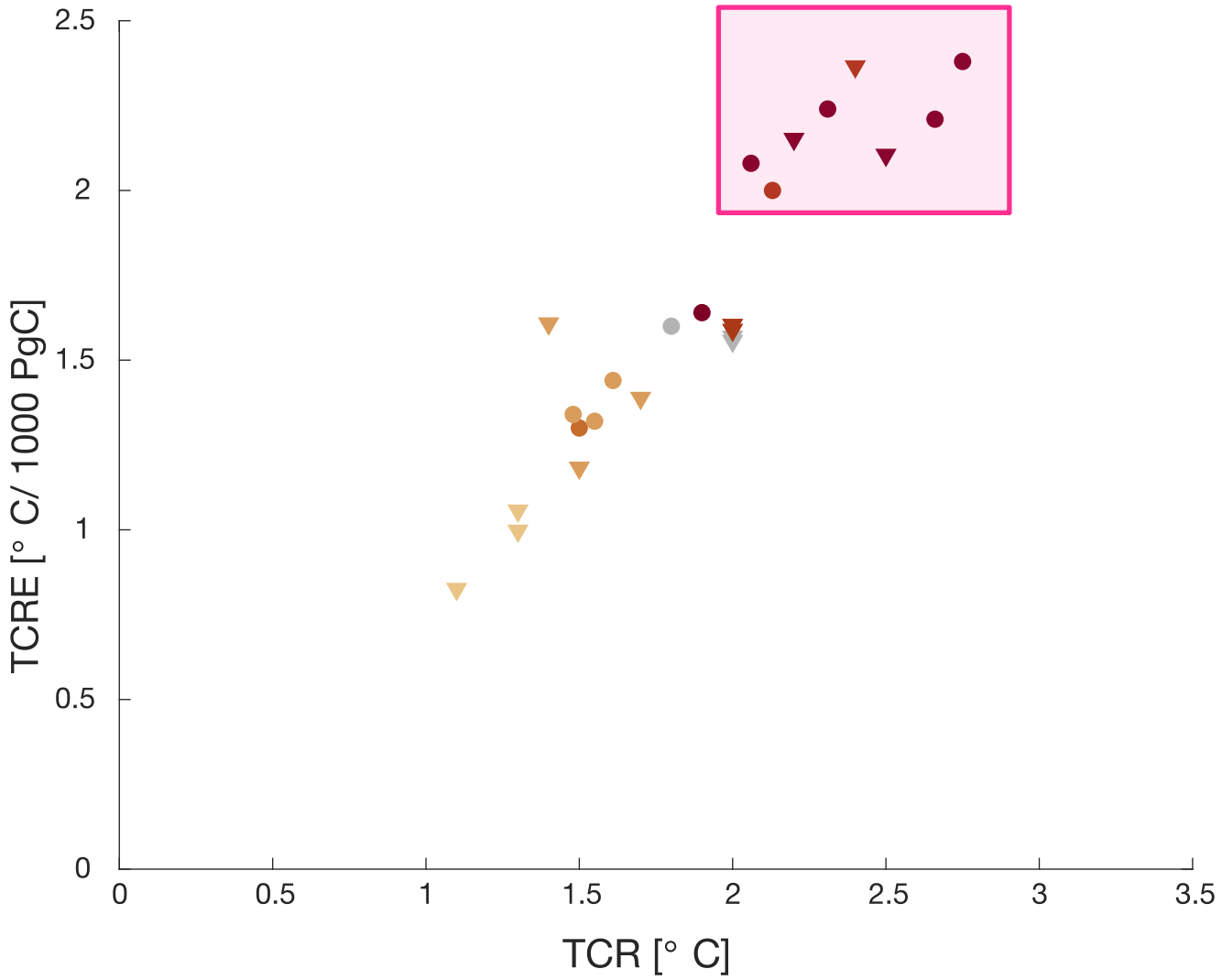
- >4.5
- 3.5-4.5
- 3.0-3.5
- 2.5 -3.0
- 2-2.5
- < 2
- unknown

● CMIP6 ▼ CMIP5

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

REMAINING CARBON BUDGET

High ECS CMIP6 models



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REMAINING CARBON BUDGET

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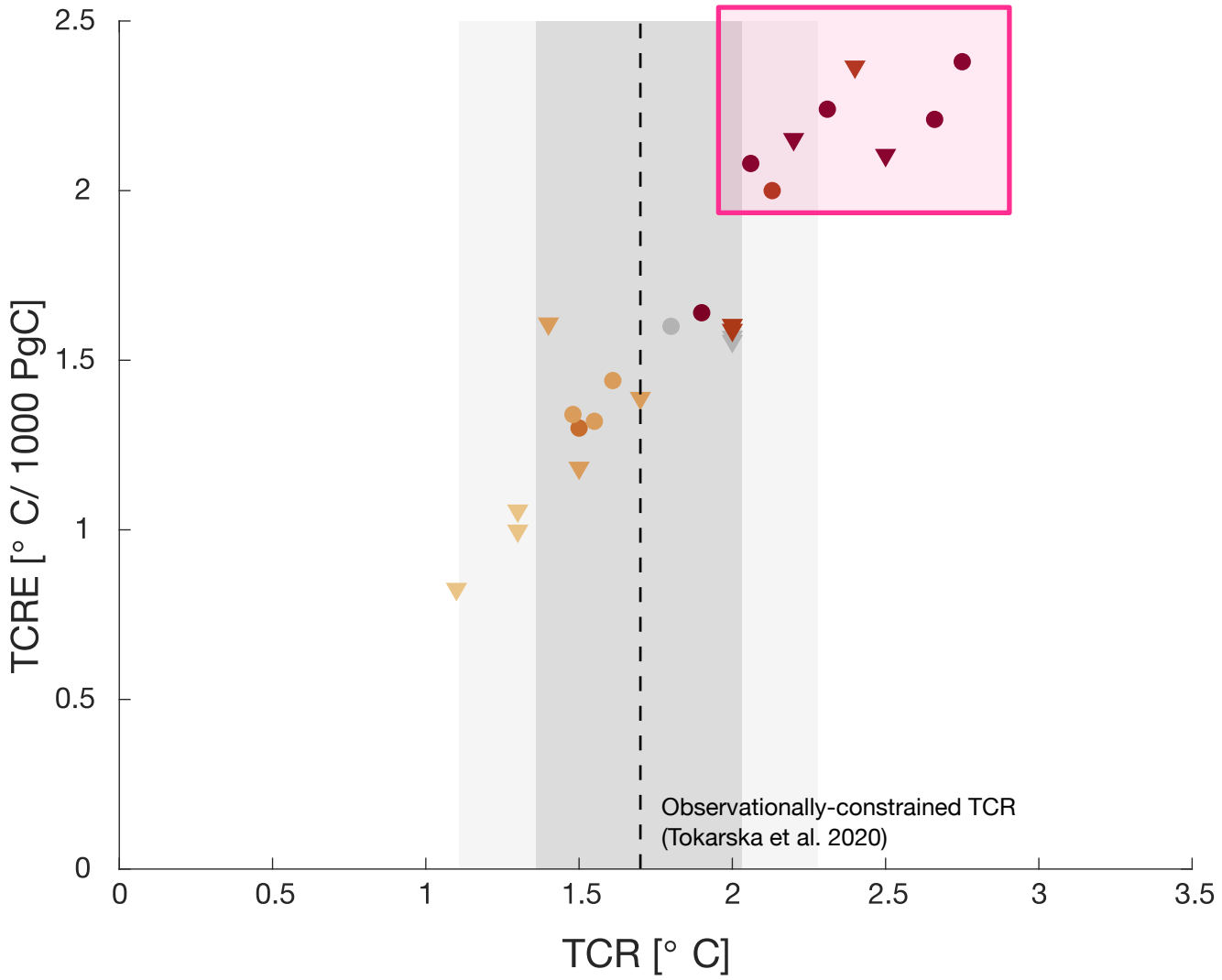

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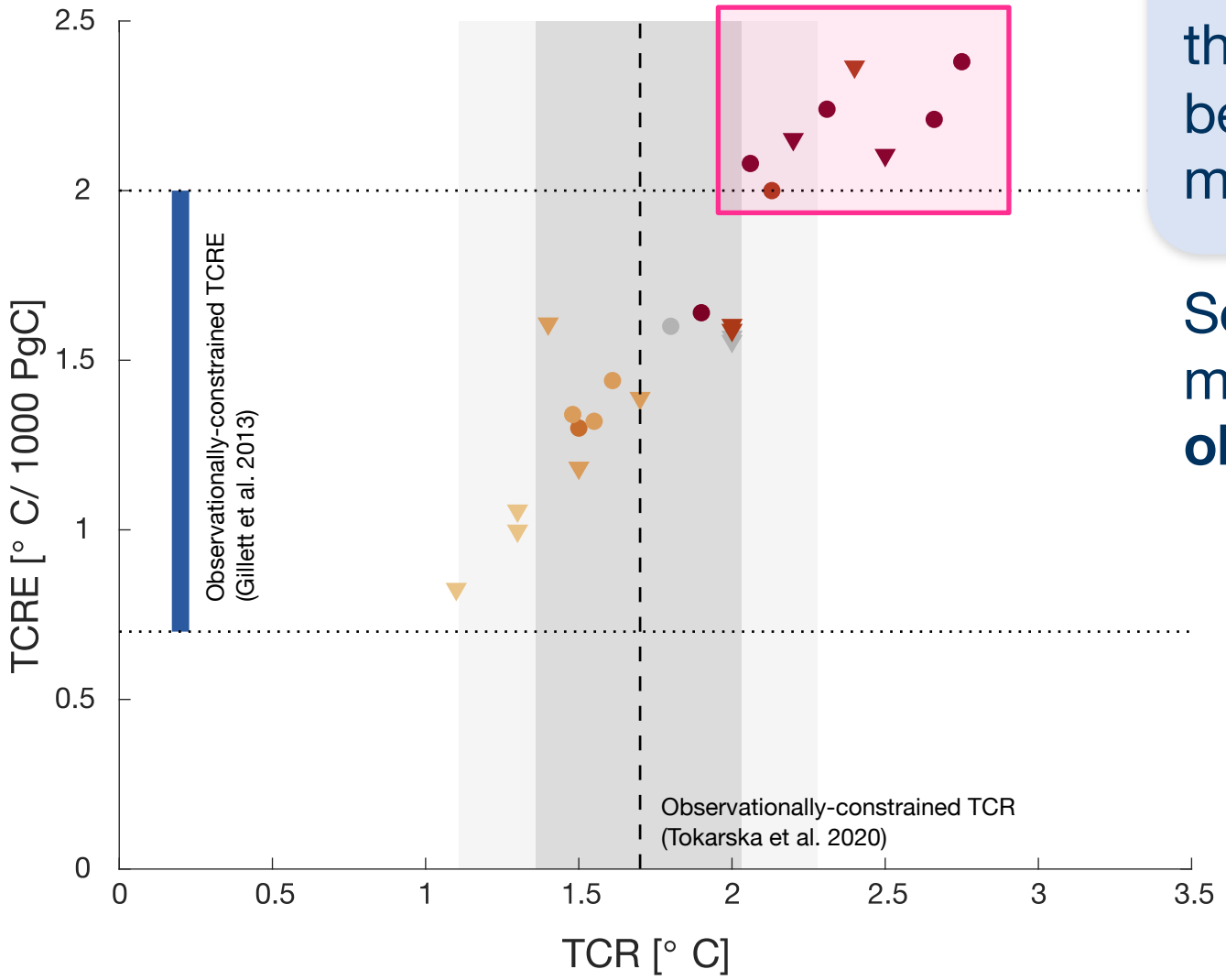
Matthews et al. 2020 Nat. Geosci. (2020/accepted)

REMAINING CARBON BUDGET



High ECS CMIP6 models **do not imply** that remaining carbon budgets are lower, because responses of some high ECS models are less likely

Some of the TCRE values in high ECS models are **outside of the observationally-constrained TCRE**

Individual models coloured by ECS values

- >4.5
- 3.5-4.5
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- < 2
- unknown

● CMIP6 ▼ CMIP5

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

TOWARDS A NET-ZERO WORLD

Photo: Gorner Glacier, Switzerland

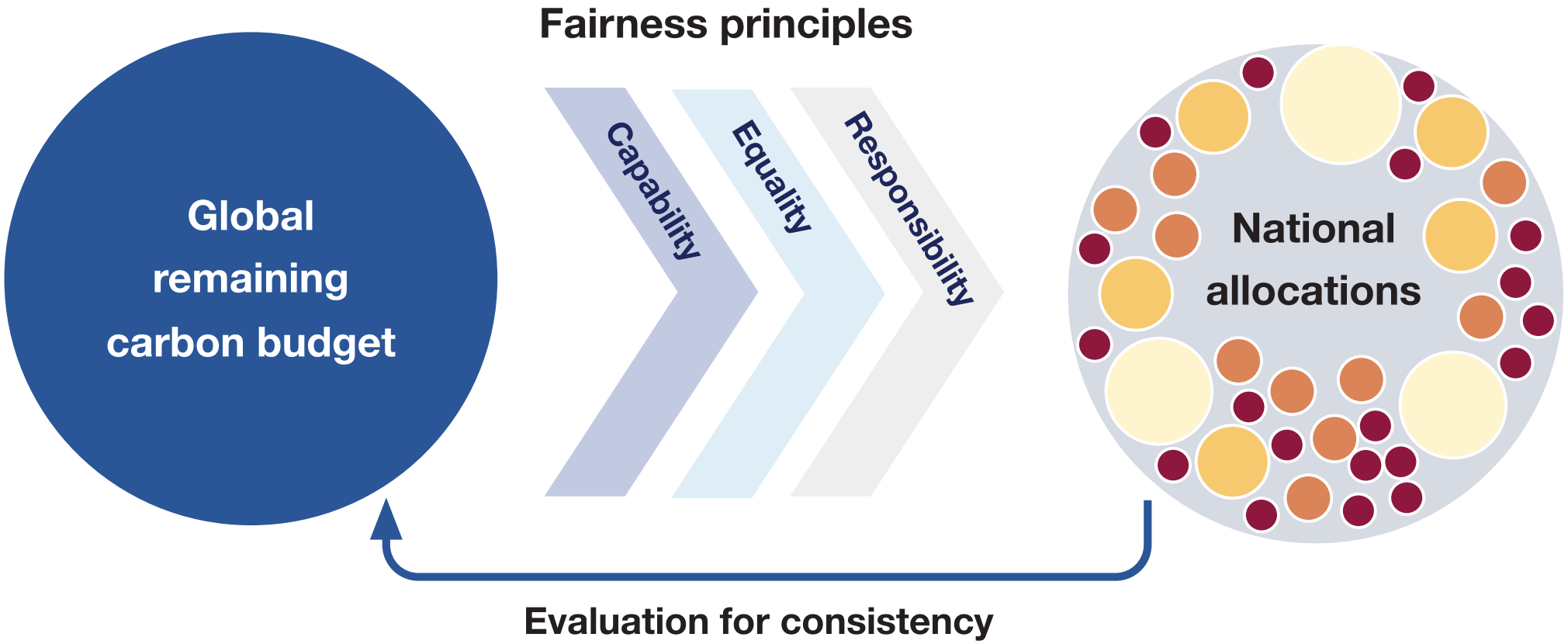
A FAIR DISTRIBUTION OF THE REMAINING CARBON BUDGET

Global remaining carbon budget

Matthews et al. 2020 Nat. Geosci. (2020/accepted)

A FAIR DISTRIBUTION OF THE REMAINING CARBON BUDGET

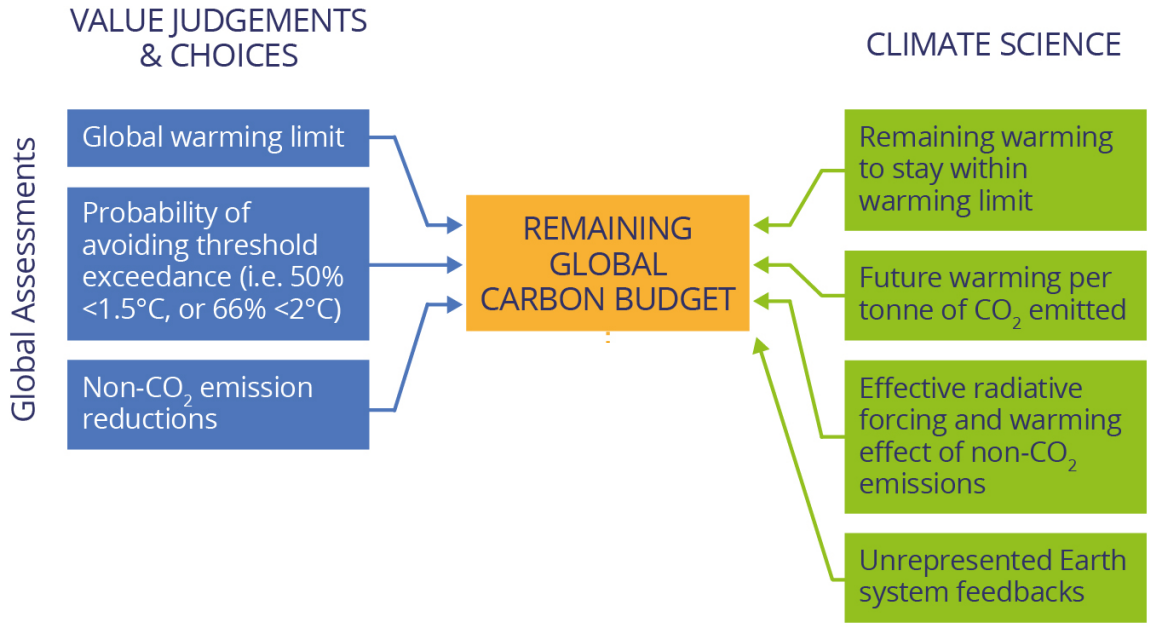
There is a need for scientists to work together with both social scientists and policy makers to **communicate the implications** of the remaining carbon budgets in a way that can help improve and **strengthen national climate policies.**



Matthews et al. 2020 Nat. Geosci. (2020/accepted)

A FAIR DISTRIBUTION OF THE REMAINING CARBON BUDGET

Overview of **value judgements** and **climate science** components determining the size of the remaining **national carbon budget**



CONSTRAIN ZERO IN report (2019)

A FAIR DISTRIBUTION OF THE REMAINING CARBON BUDGET

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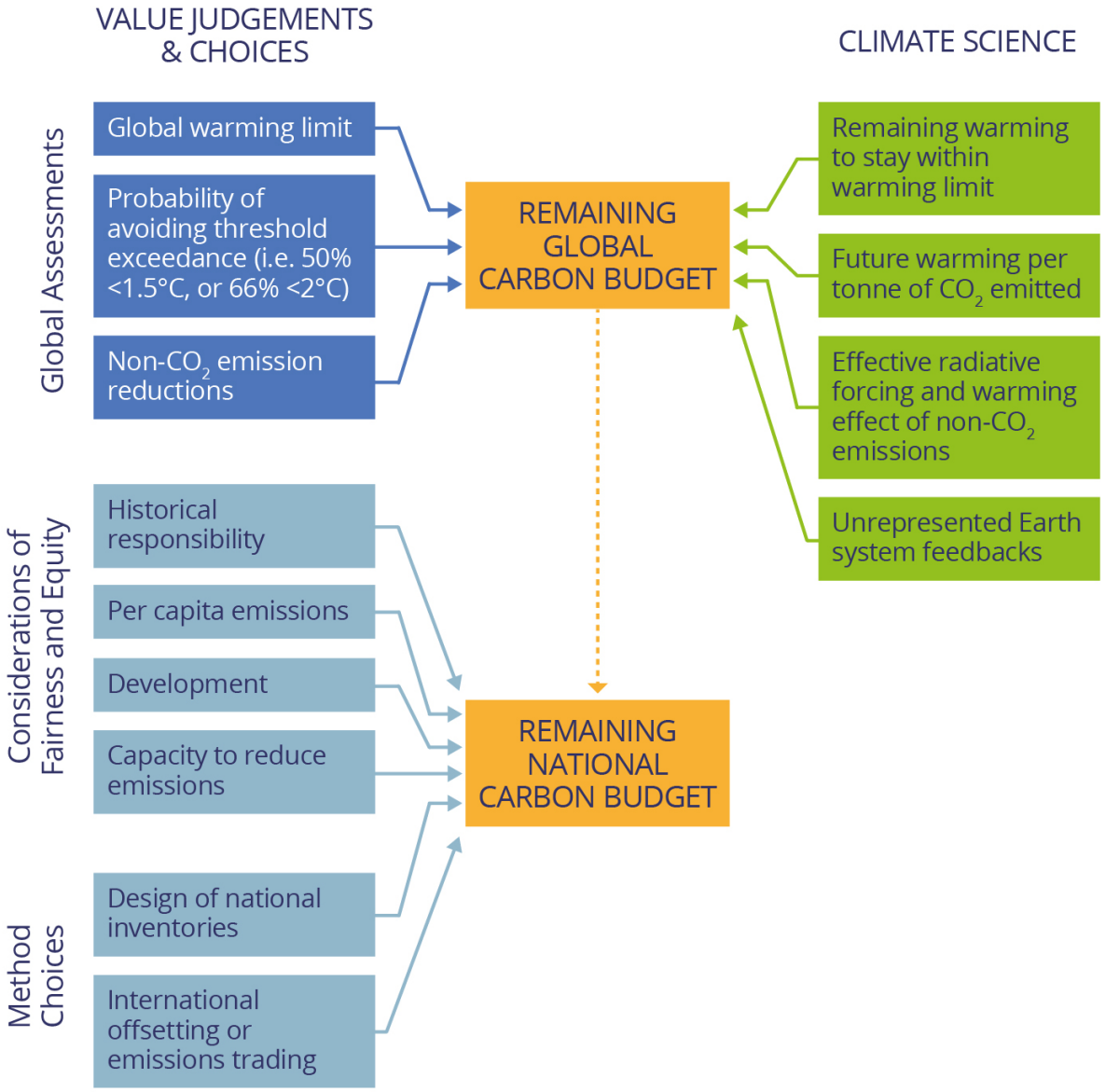


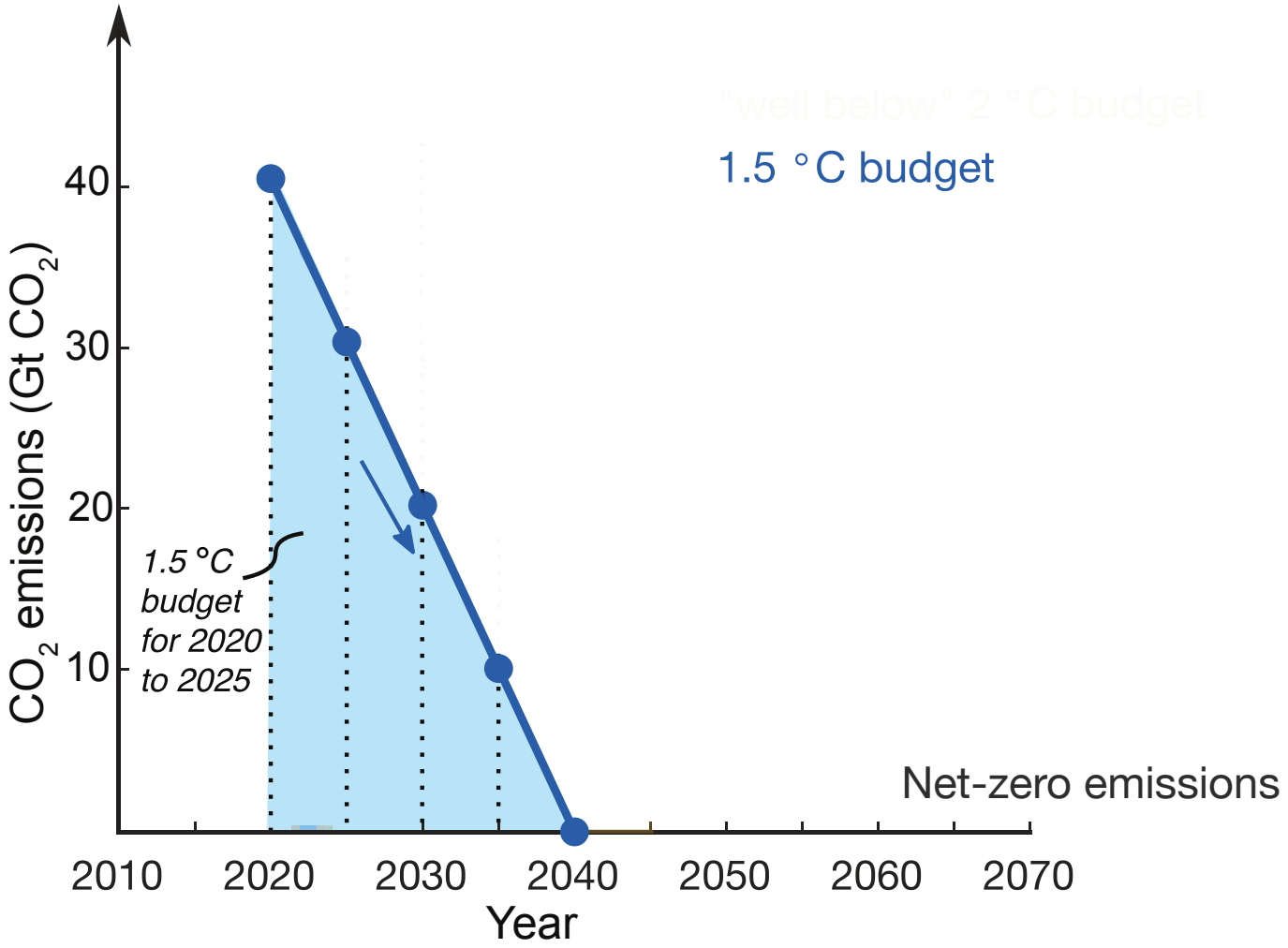
CONSTRAIN ZERO IN report (2019)

TOWARDS A NET-ZERO EMISSIONS

An illustrative example of setting

net-zero emission targets

within a given carbon budget



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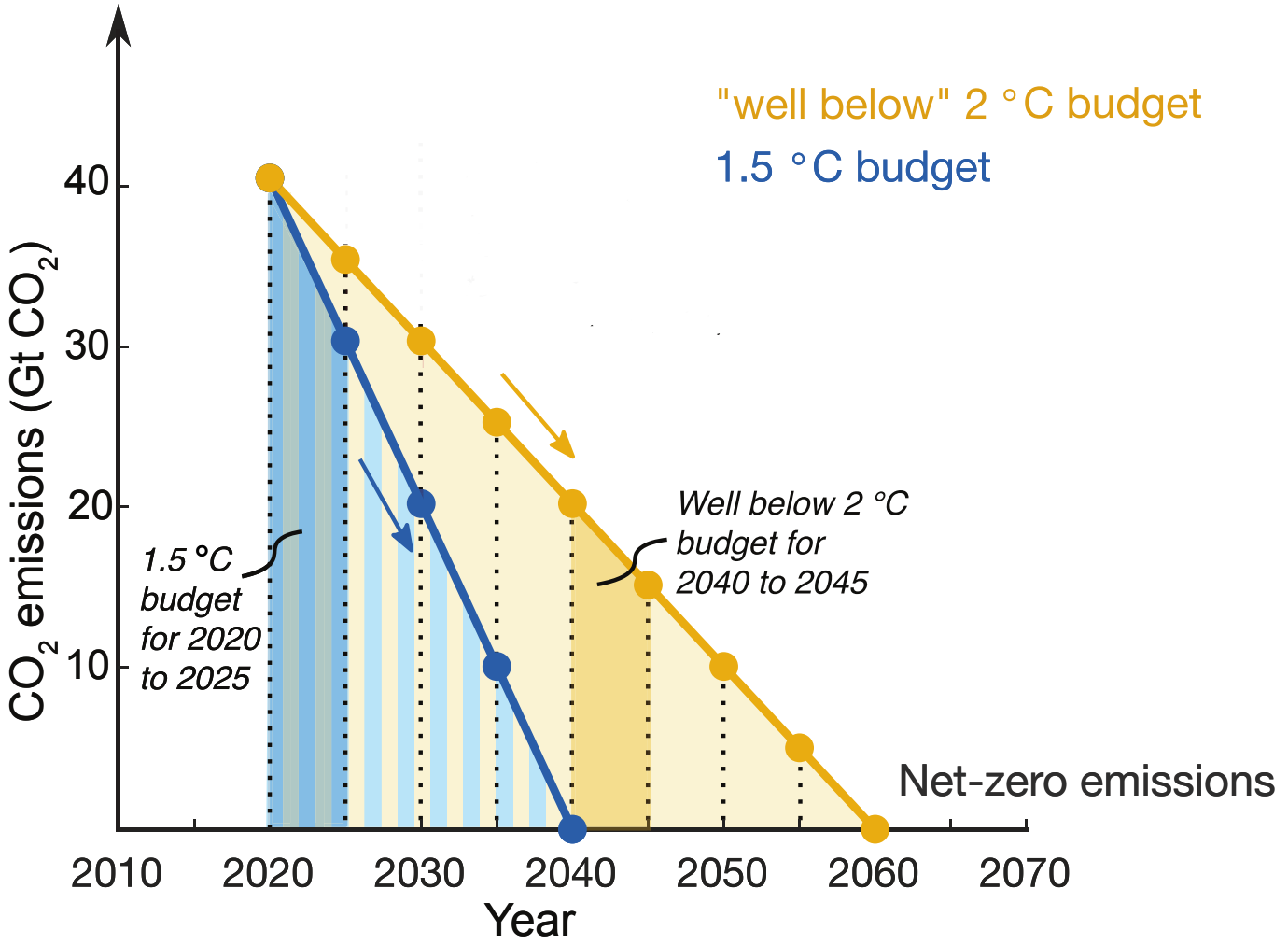
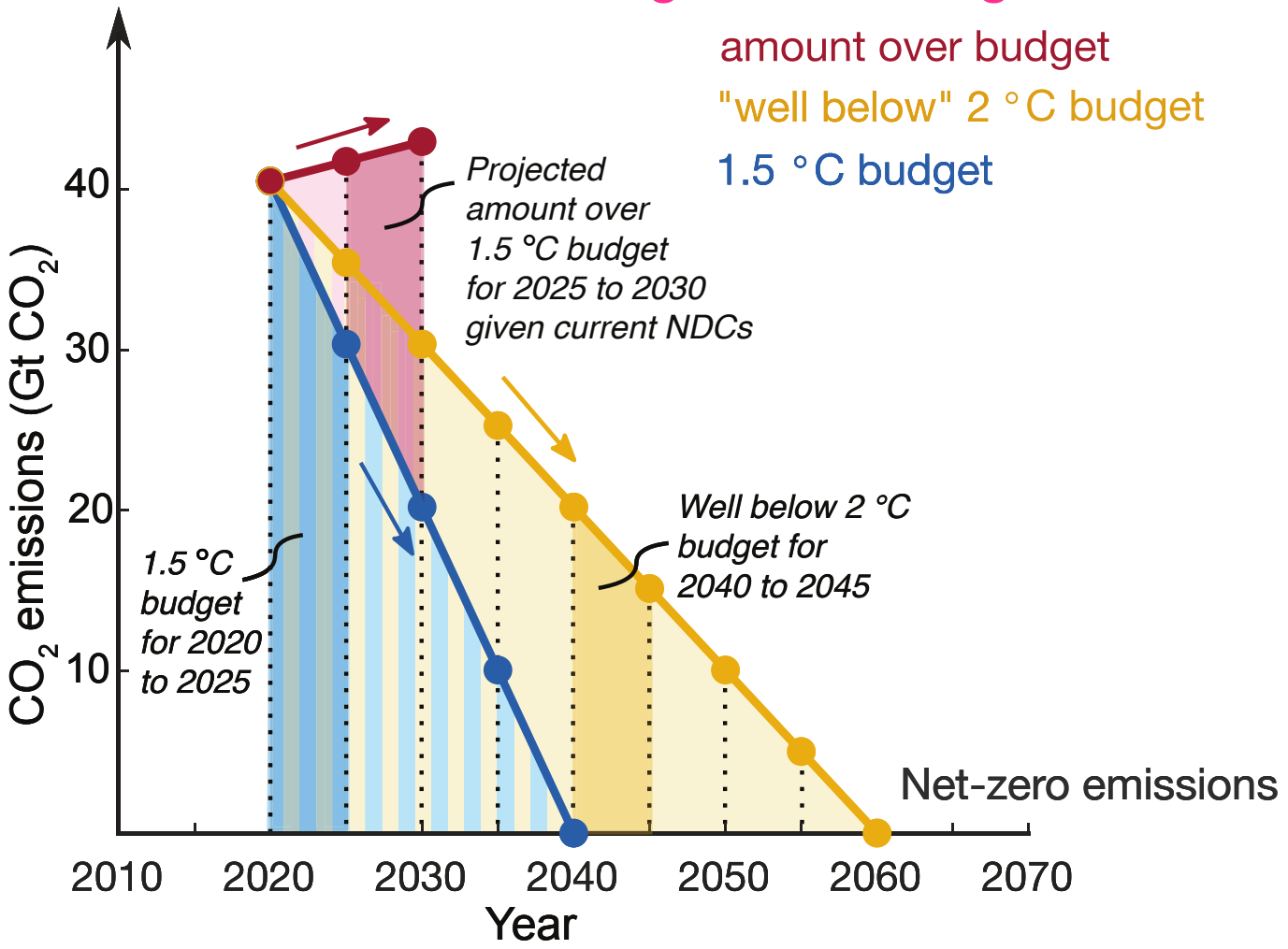


Matthews et al. 2020 Nat. Geosci. (2020/accepted)

TOWARDS A NET-ZERO EMISSIONS

- Current **NDC pledges are insufficient** to meet the Paris Agreement long-term temperature stabilization goal

An illustrative example of setting **net-zero emission targets** within a given carbon budget



Matthews et al. 2020 Nat. Geosci. (2020/accepted)

Photo: Mt. Edith Cavell Meadows, Canada

CONCLUSIONS

- We need to reach **a net-zero global emissions level** to stop global warming
- Current **NDC pledges are insufficient** to meet the Paris Agreement long-term temperature stabilization goal
- Limiting other environmental changes (e.g., ocean acidification) may require even **stronger emission reductions**
- **Fair allocation** of the remaining carbon budget to individual countries & sectors (industries, businesses, etc.) is a key priority to address
- A recommended approach is to **focus on reaching net-zero emission targets** while staying within a given carbon budget

THANK YOU!

Photo: Garibaldi Provincial Park, Canada