EGU2020-2194 - Non-CO_2 forcing changes will likely decrease the remaining 1.5°C carbon budget

Nadine Mengis and H. Damon Matthews

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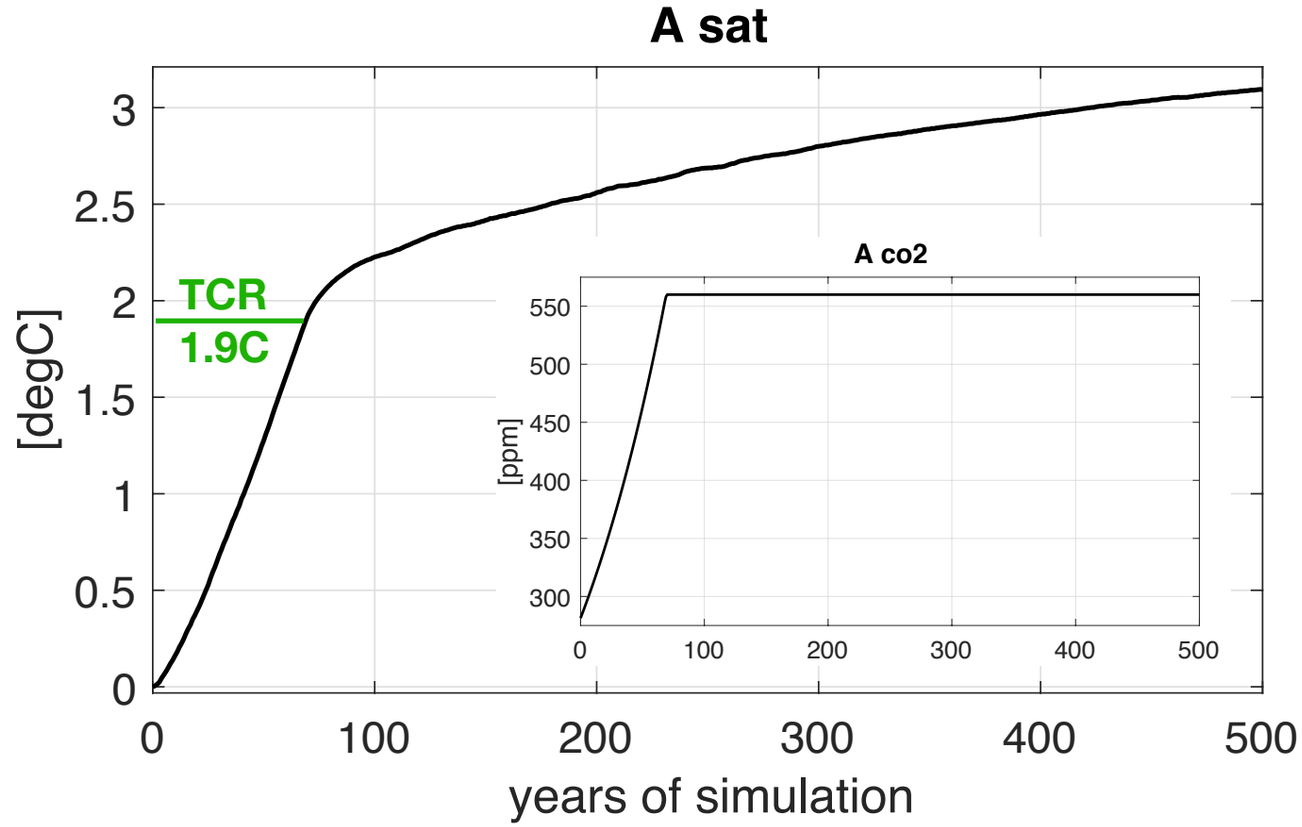
Université Concordia University
SFU Simon Fraser University Engaging the World
GEOMAR Helmholtz Centre for Ocean Research Kiel
Helmholtz Climate Initiative

Concept: Transient climate response to cumulative CO_2 emissions (TCRE)

- +1% / year increase in CO_2 concentration until $2xCO_2$ is reached



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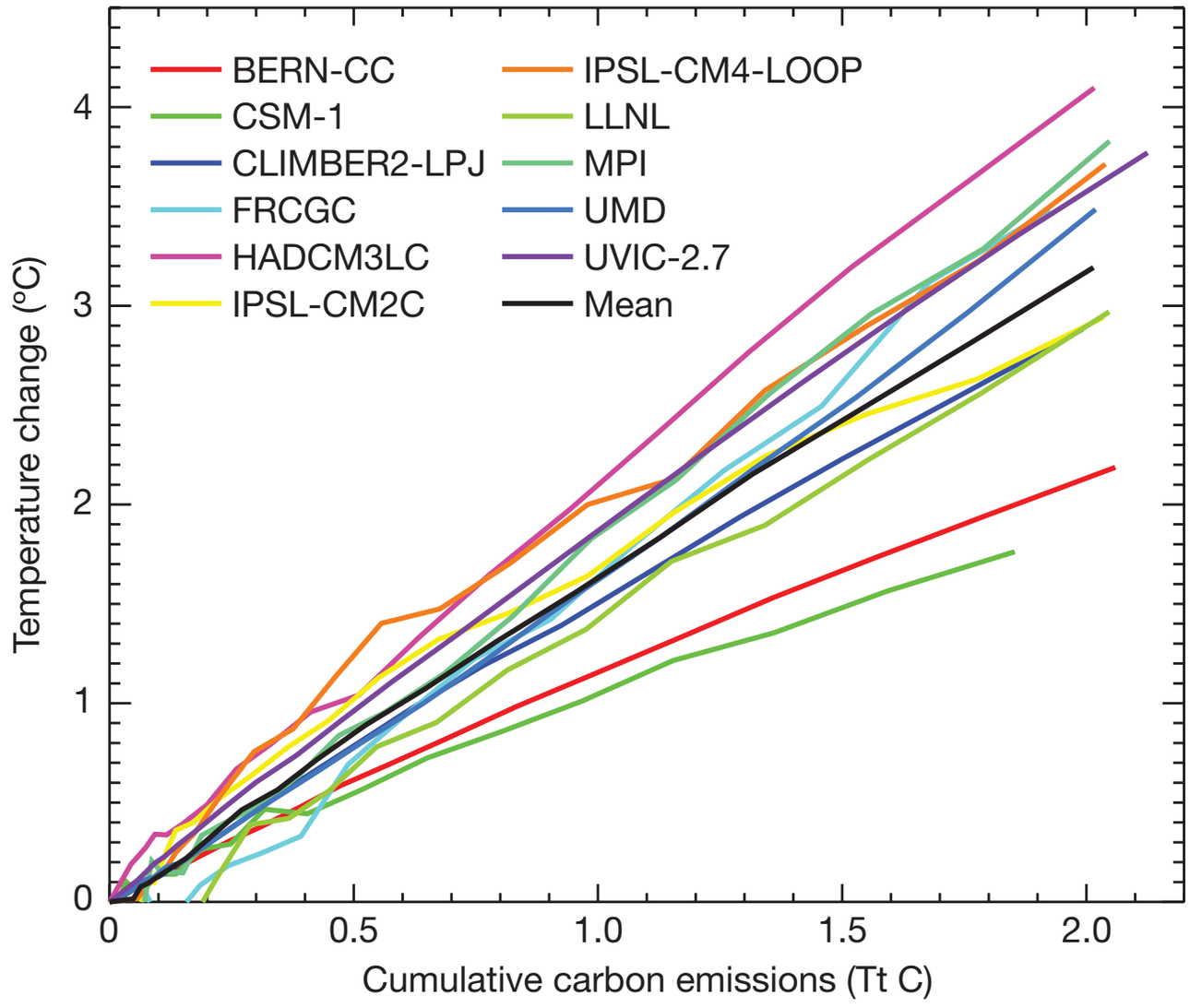

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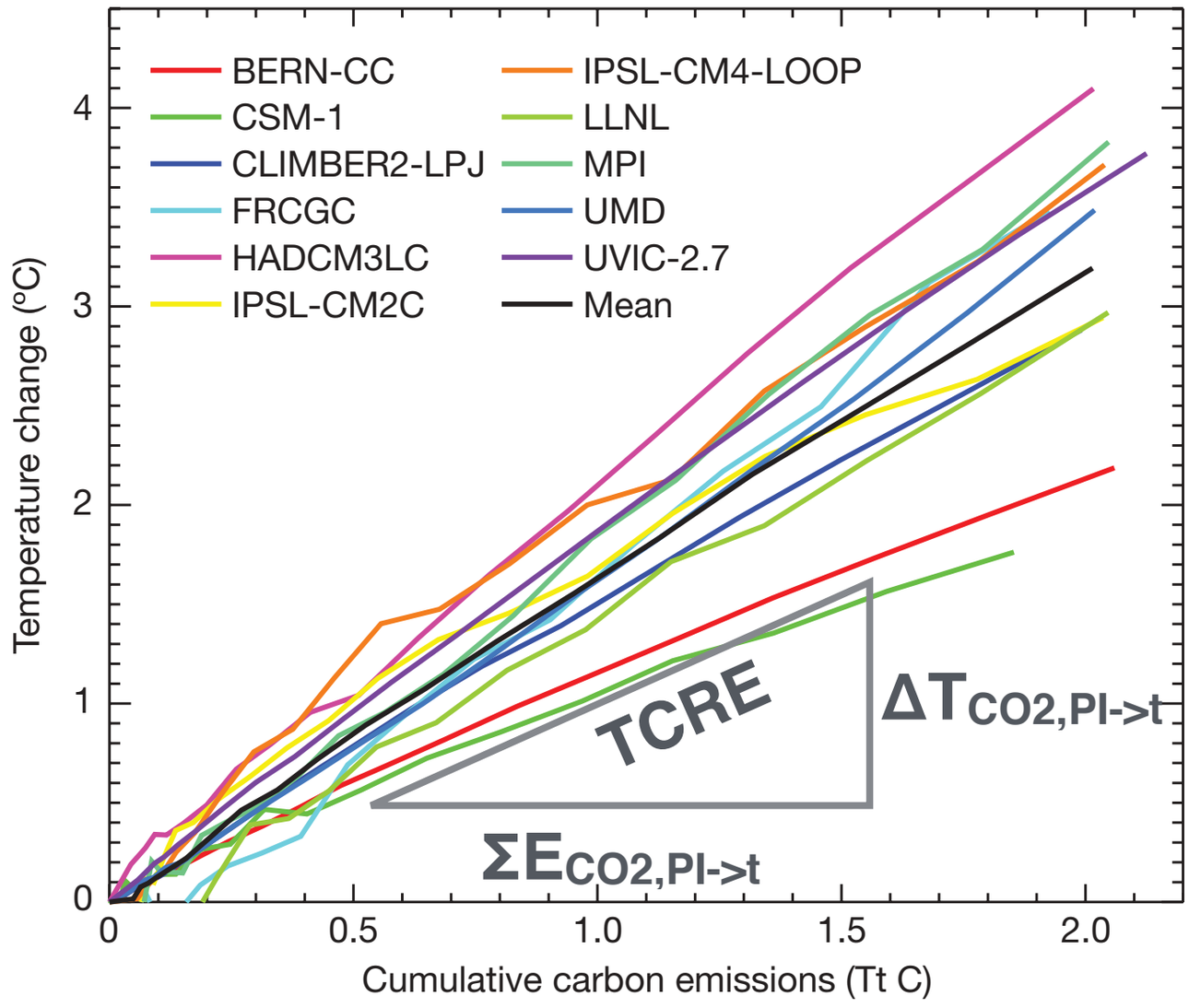

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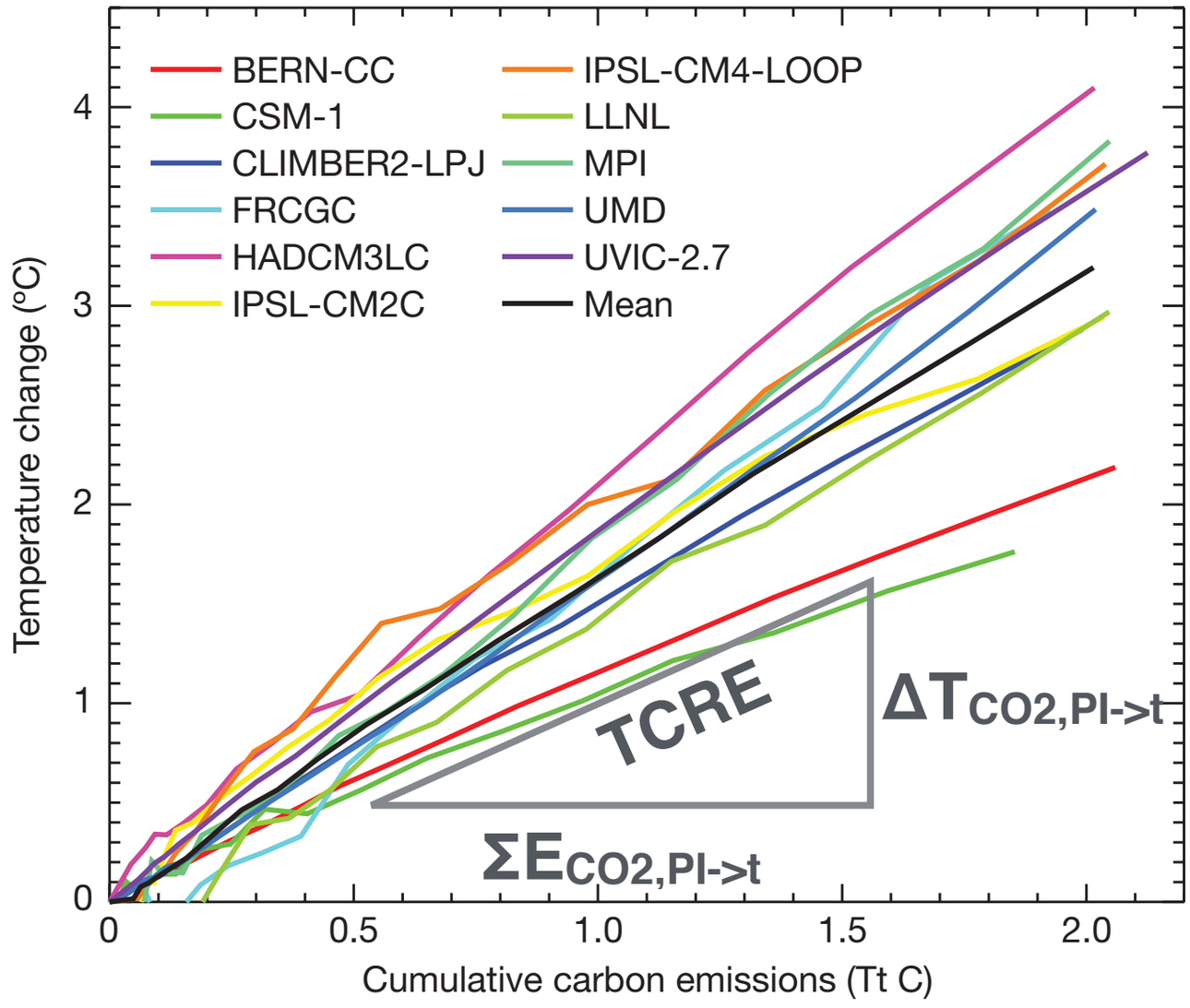

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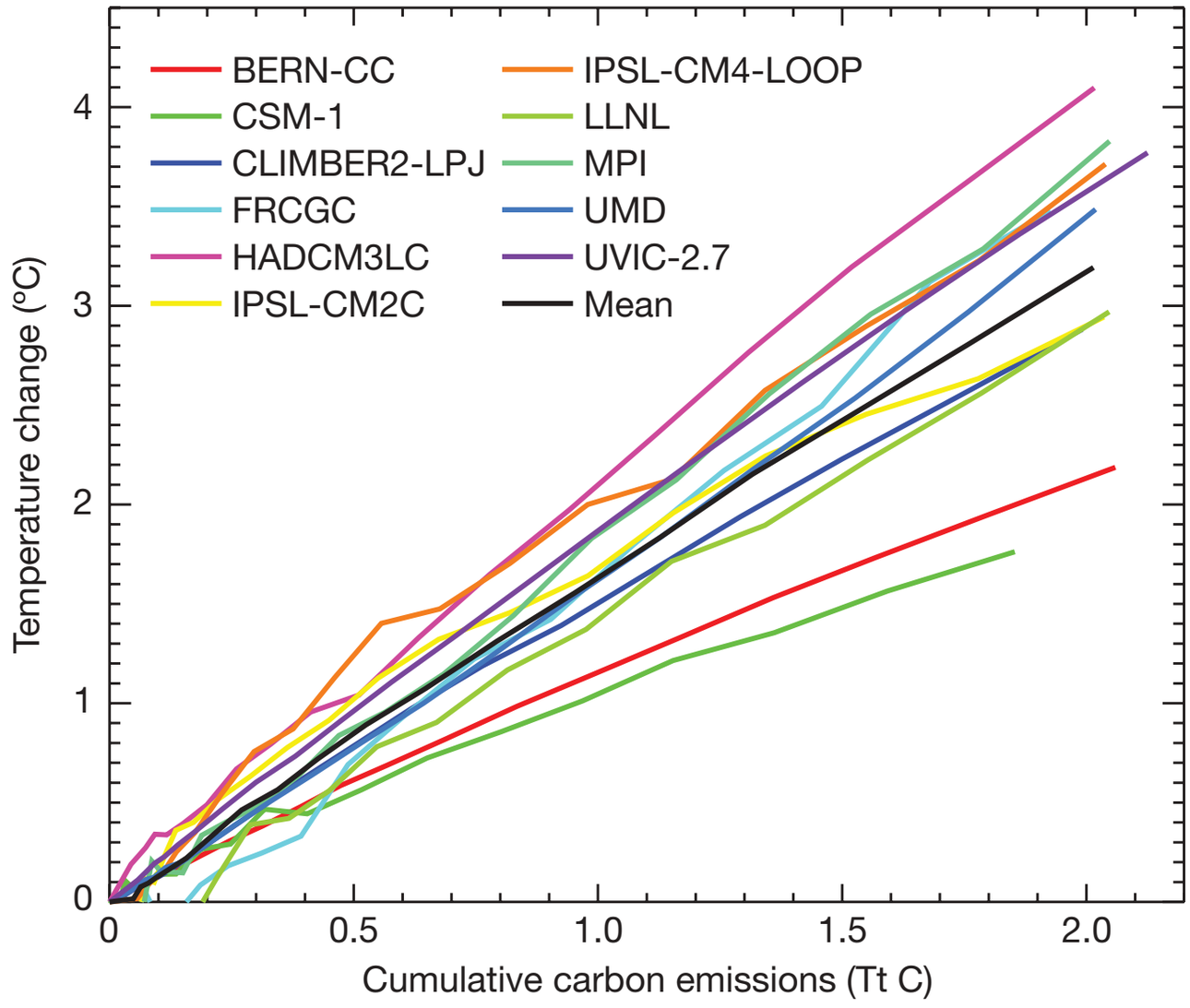

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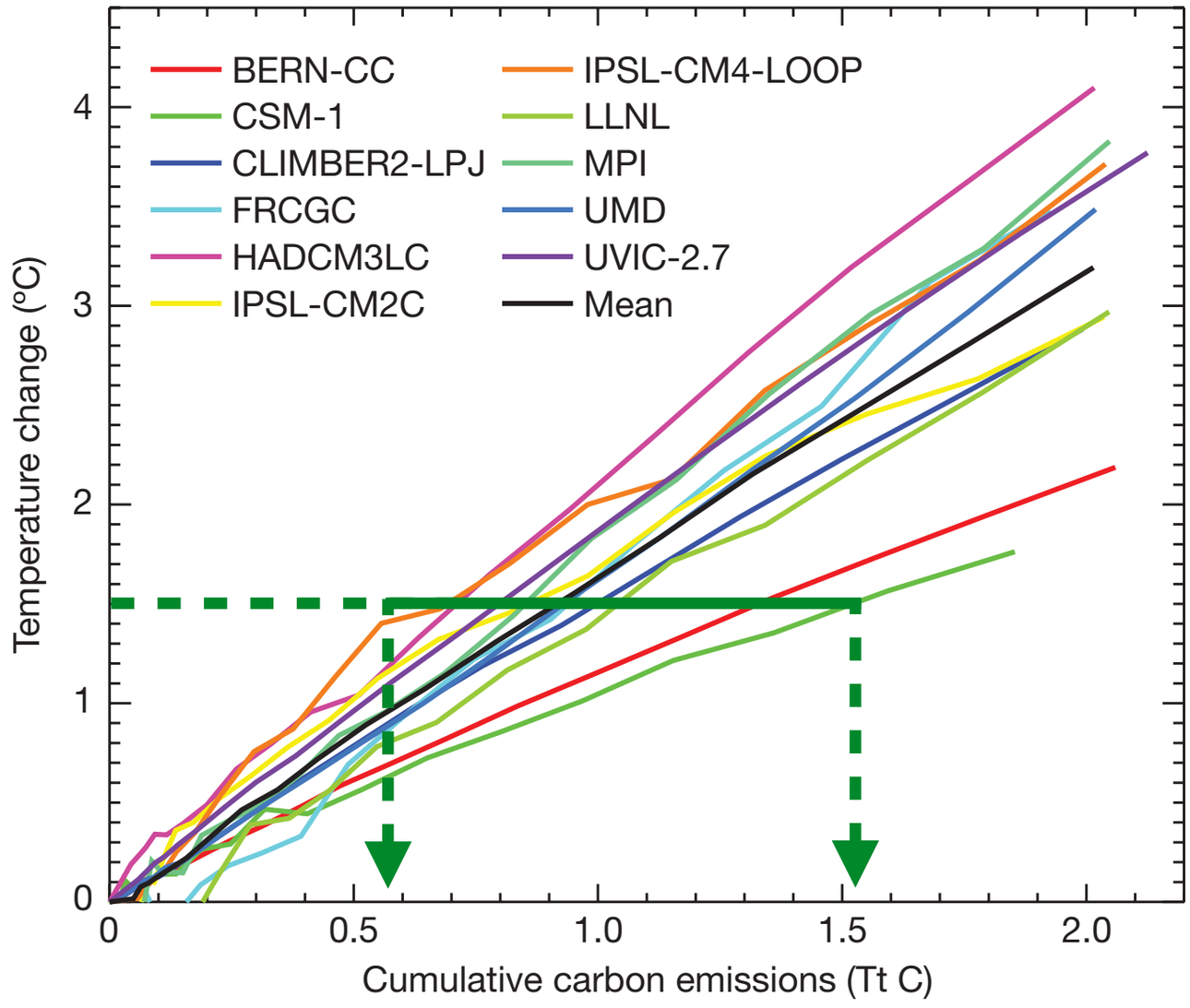

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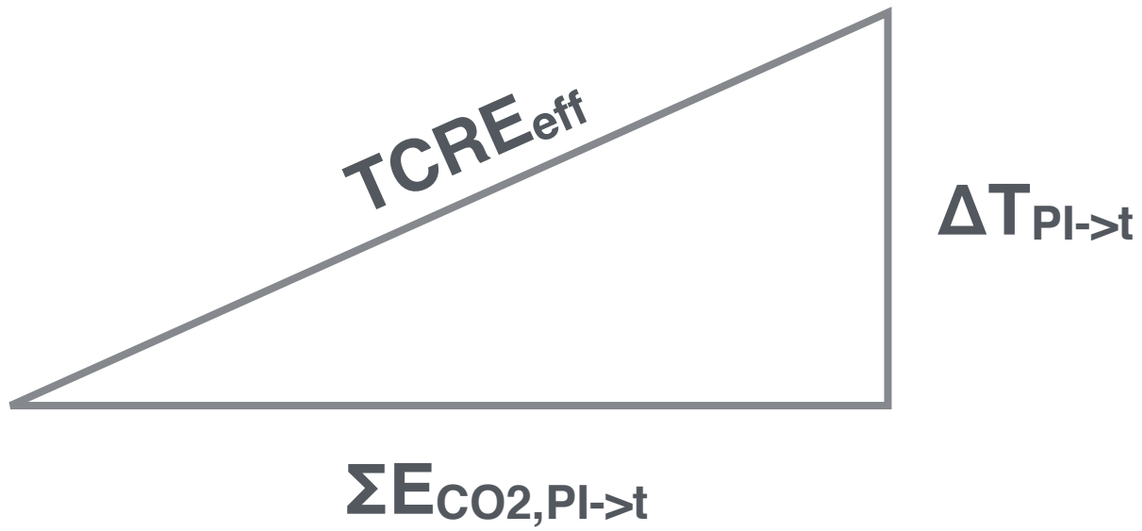

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x globalwarmingindex.org
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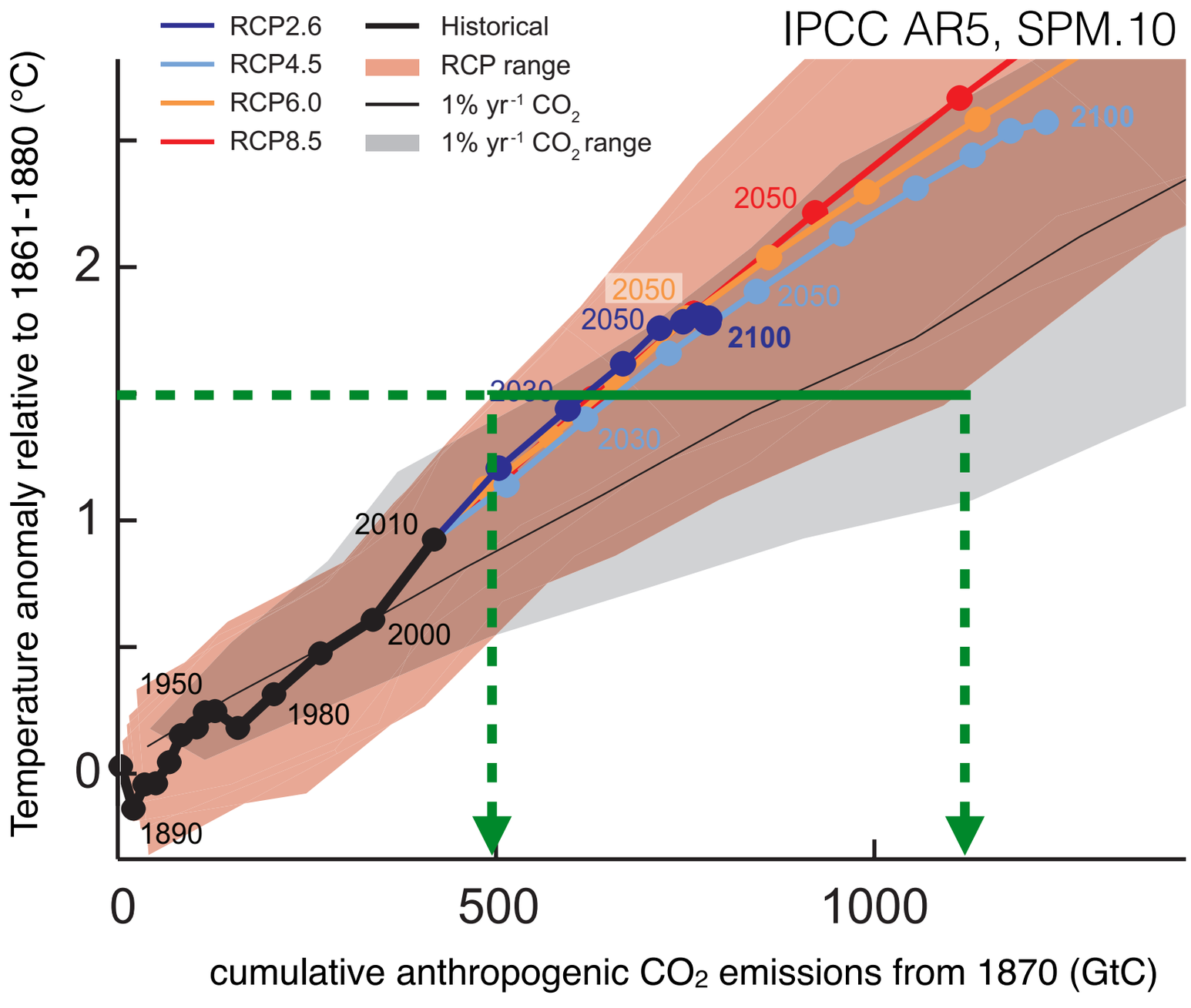
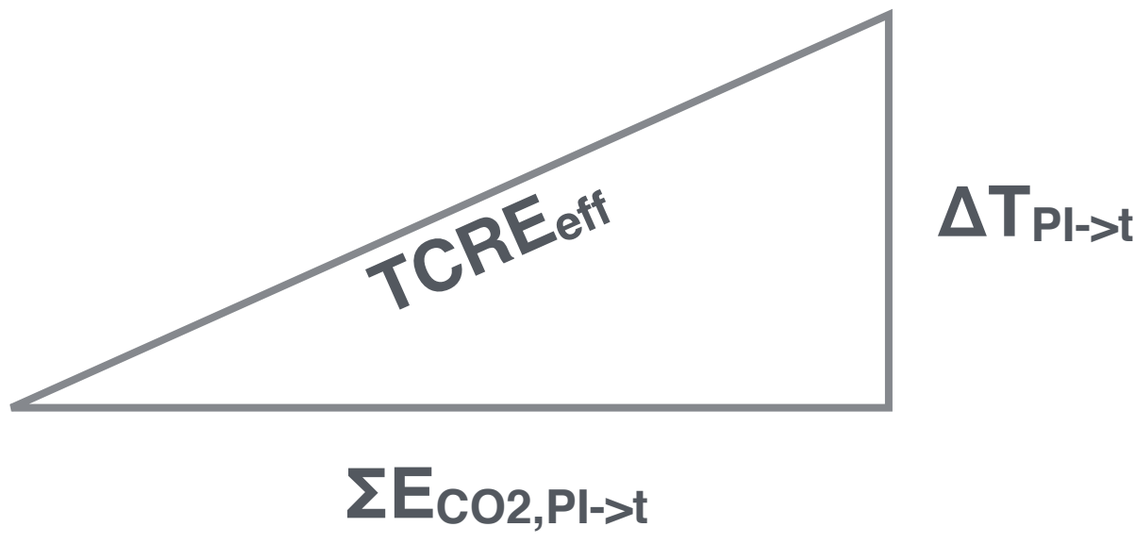


What is the effect of non-CO_2 forcers on the 1.5 °C carbon budget?

1. How important is the contribution of non-CO_2 climate forcers?
2. Can we use the effective TCRE to calculate future carbon budgets?



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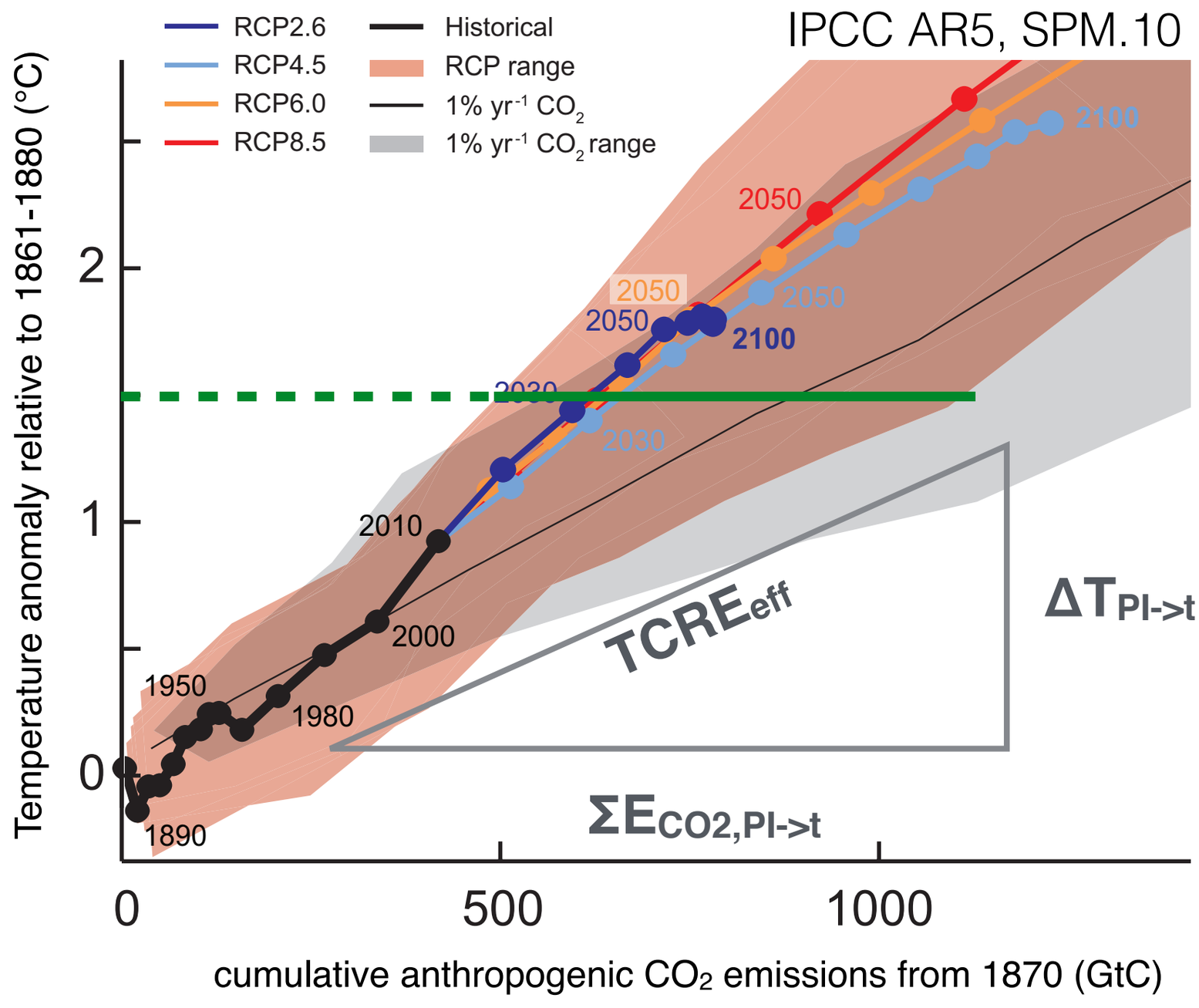
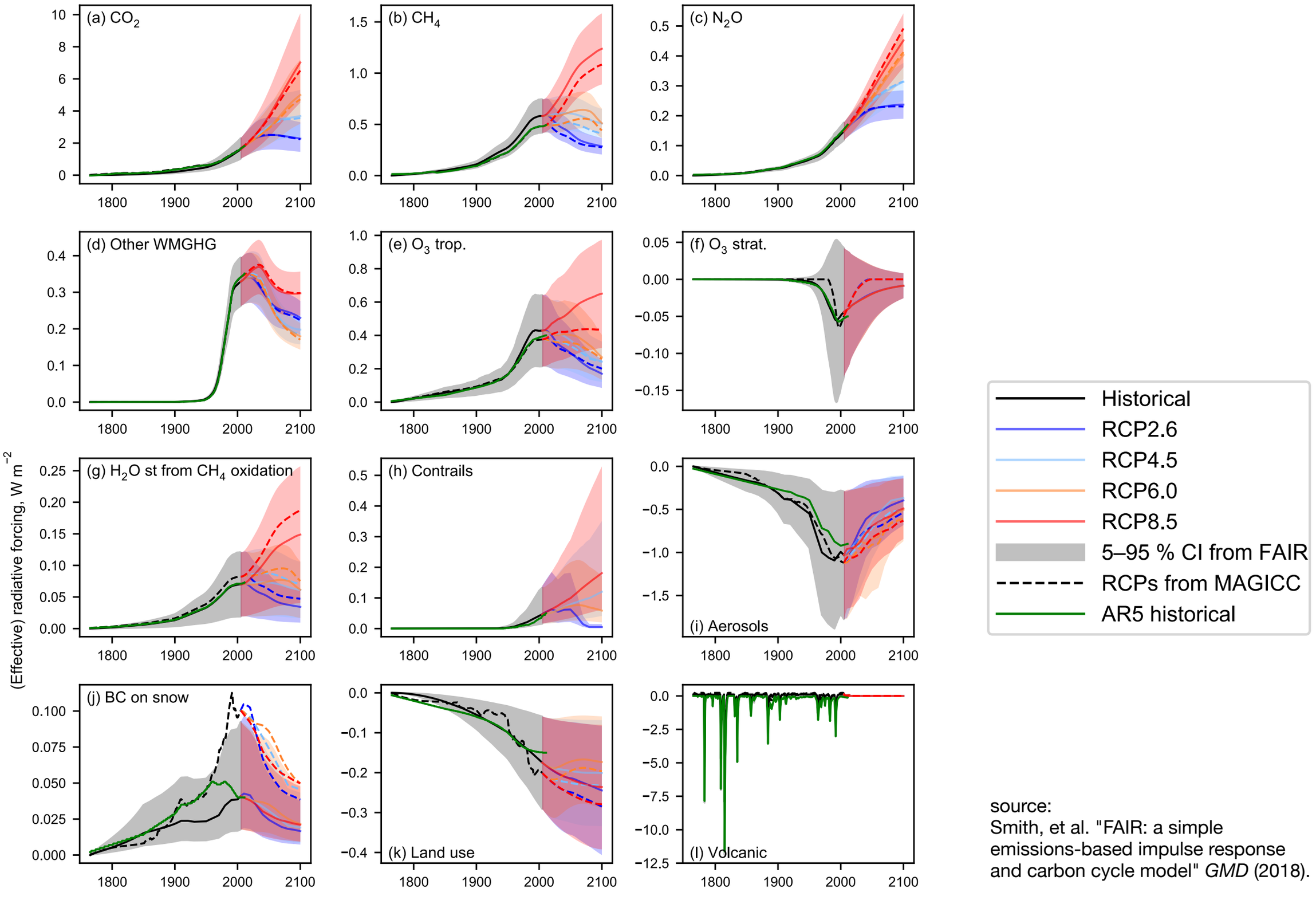


What are the non-CO_2 climate forcers?



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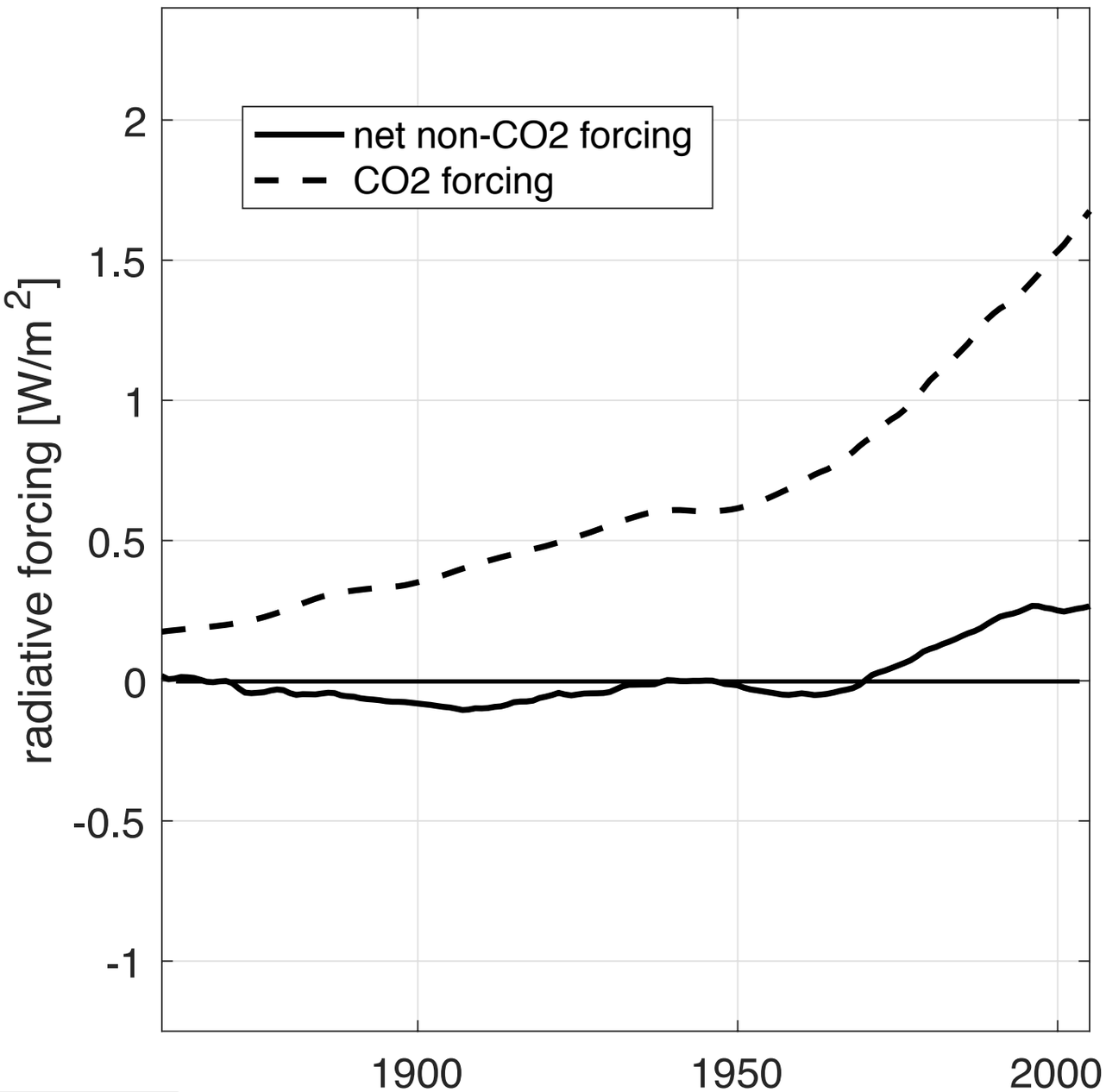

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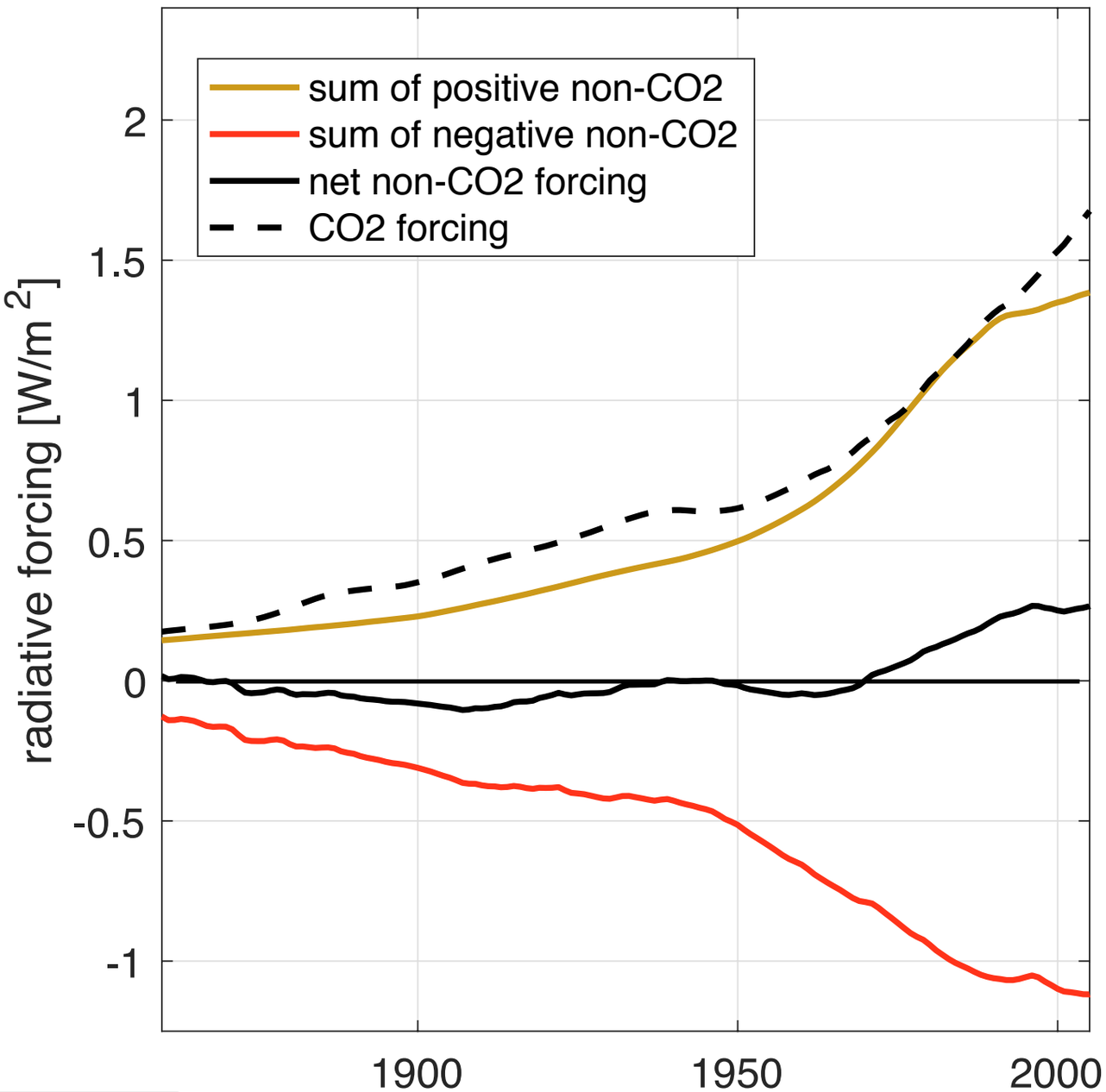

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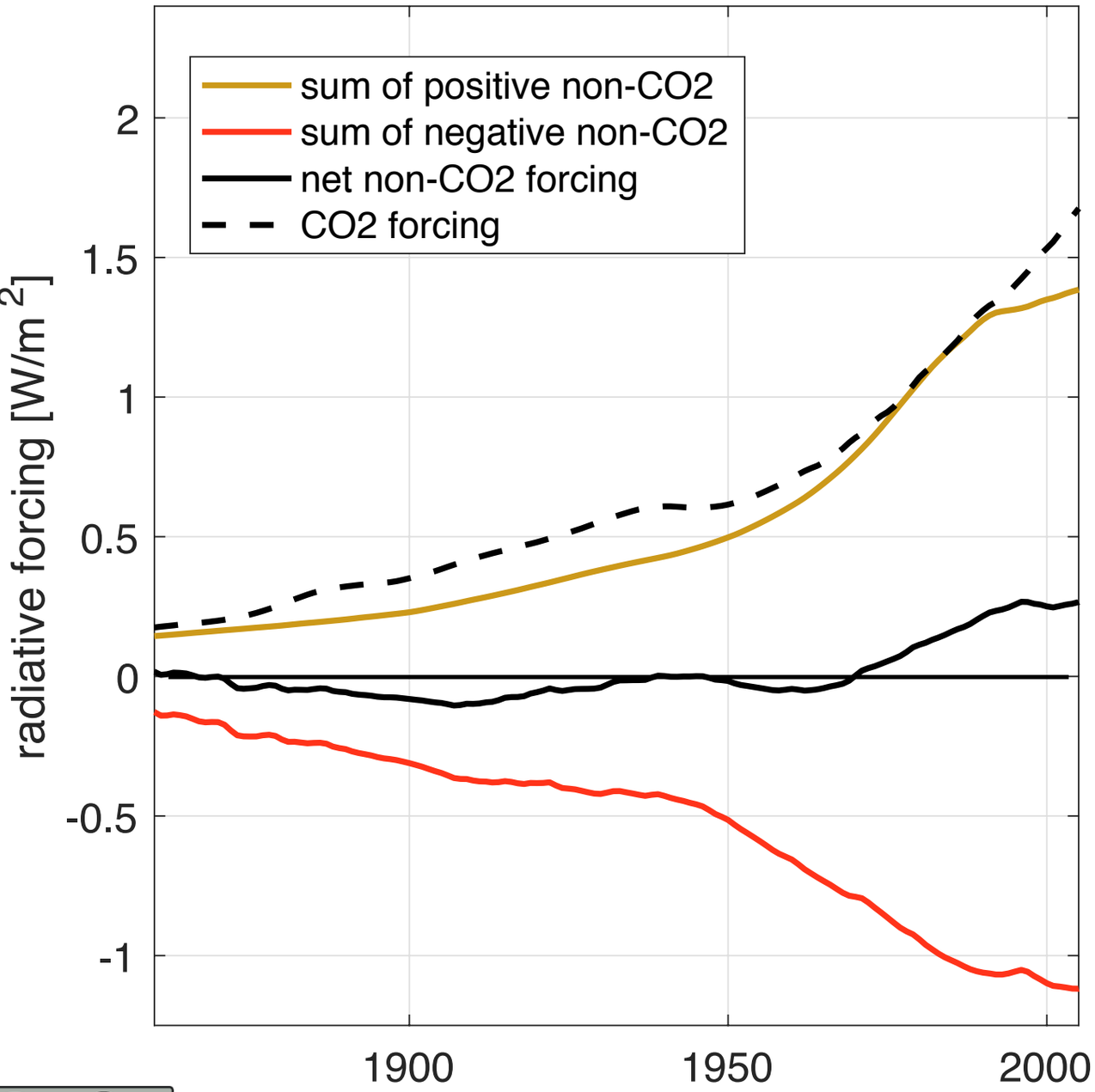

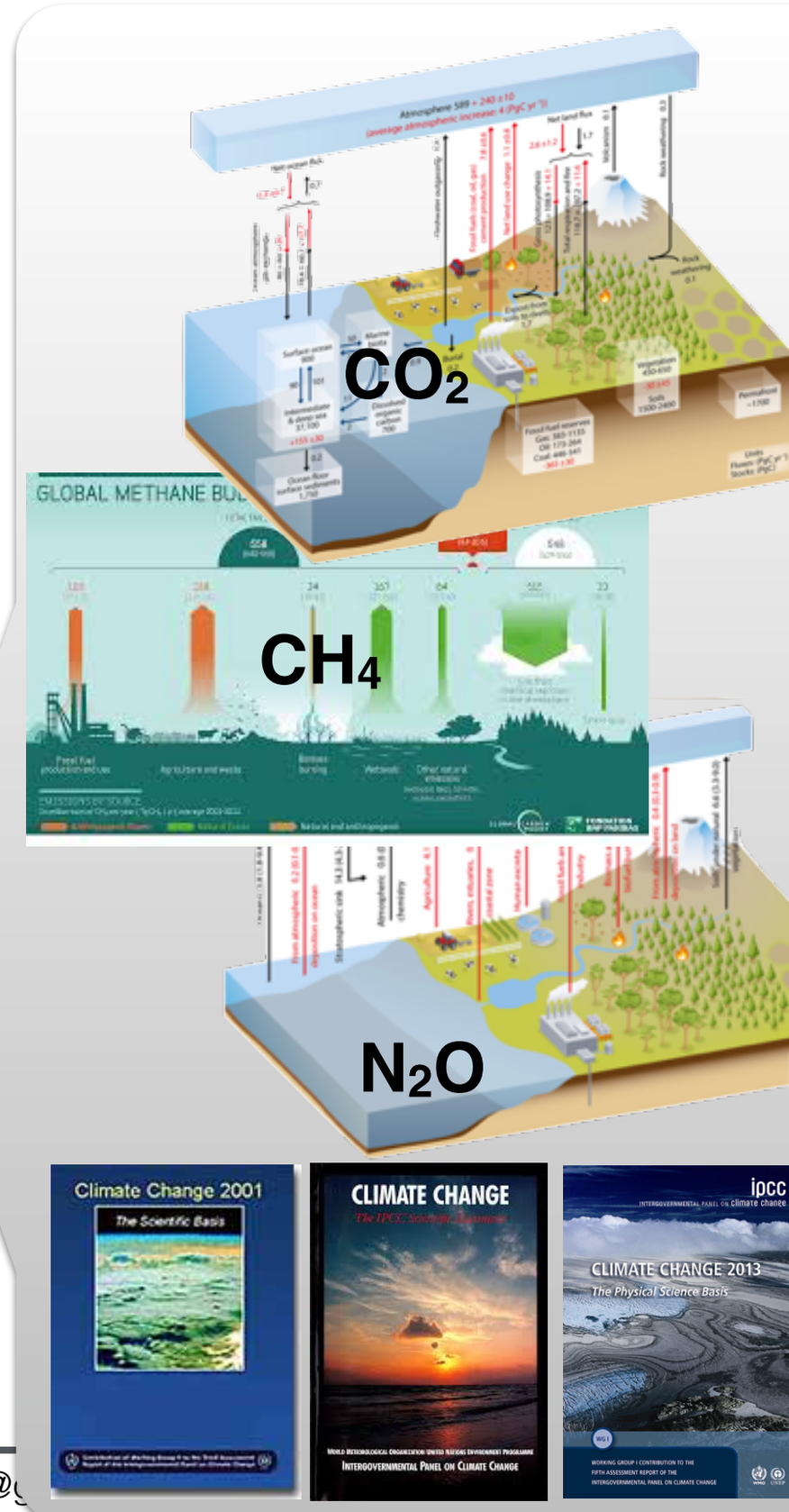

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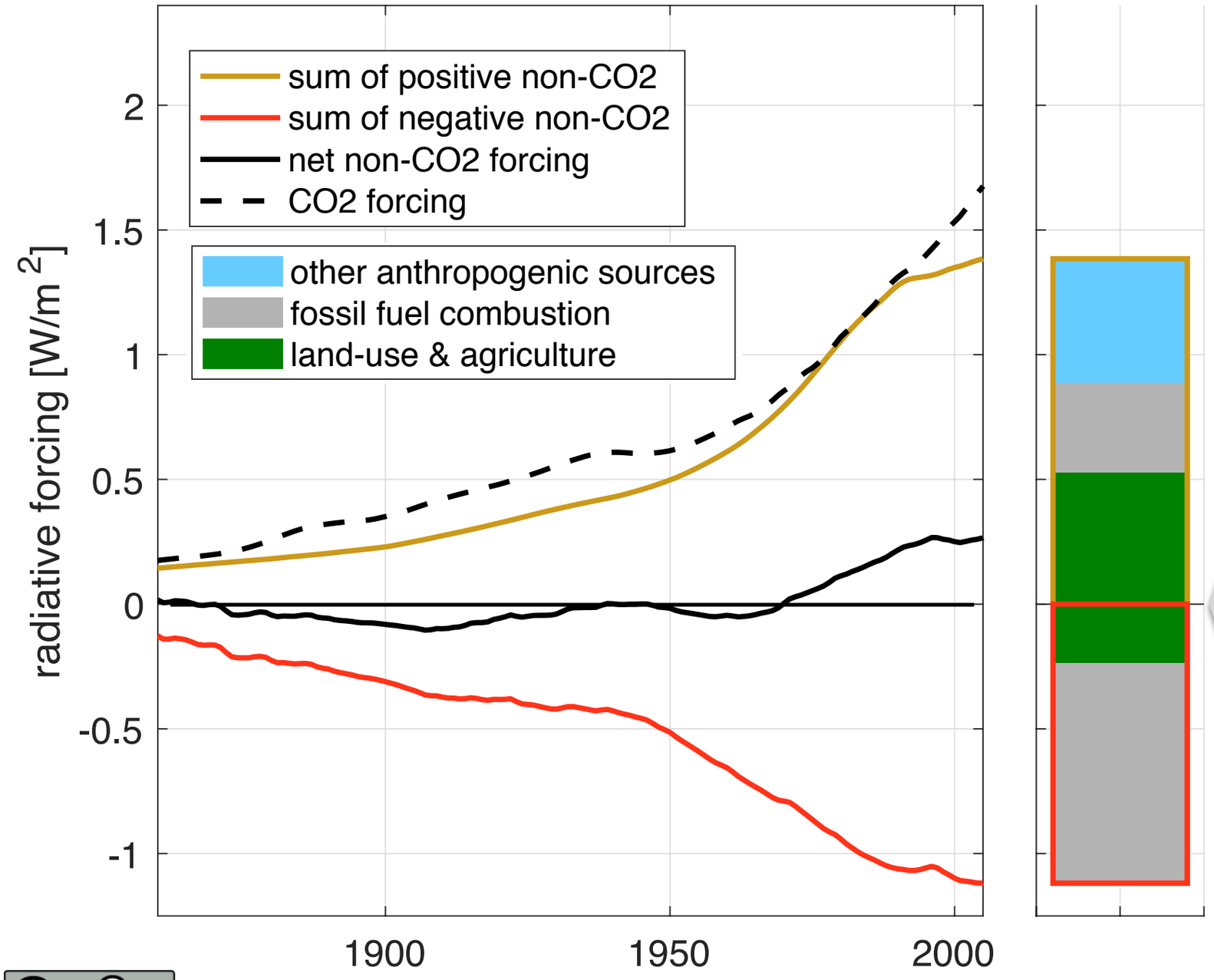

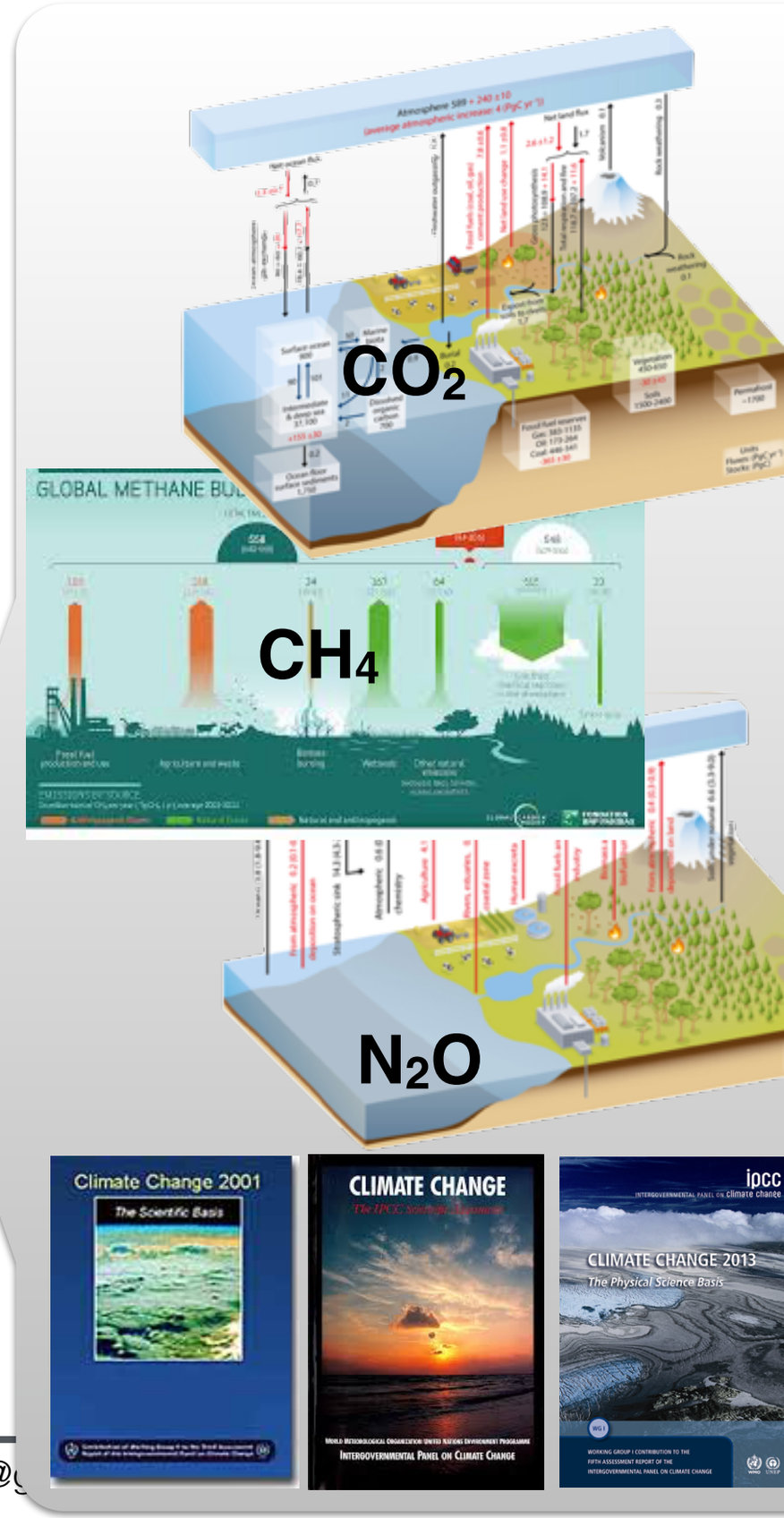

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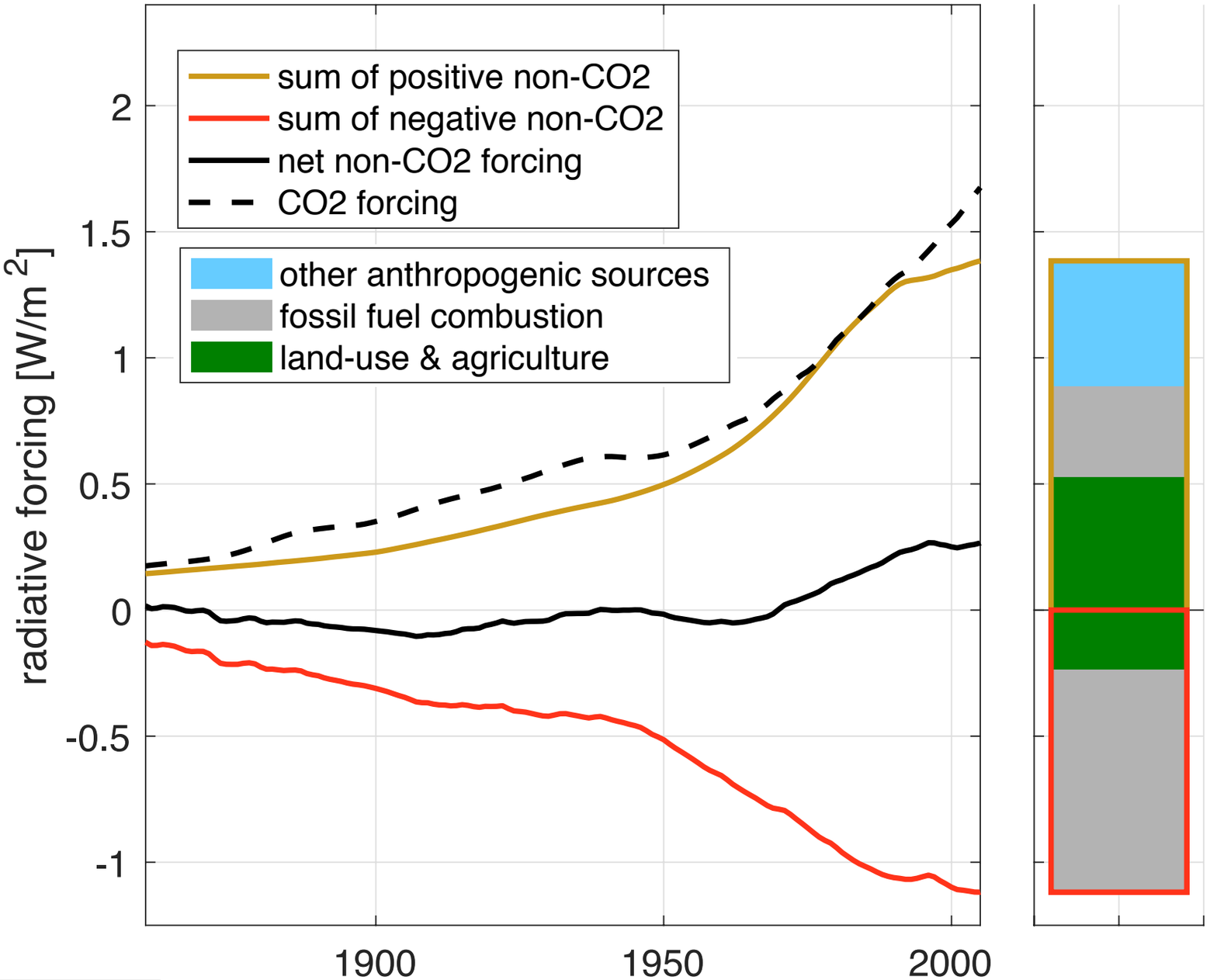

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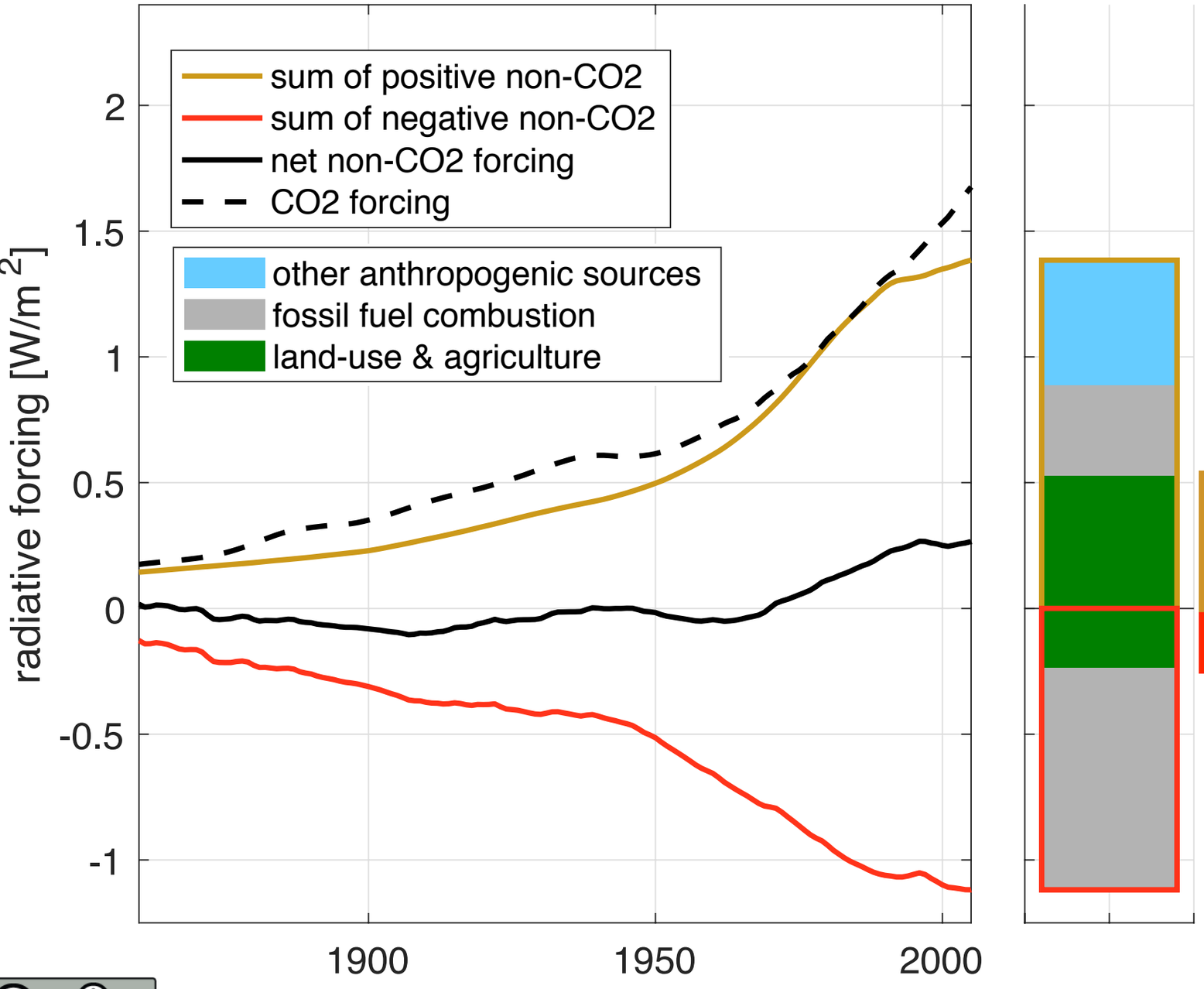

current non-CO_2 forcing from **agriculture** emissions increases warming

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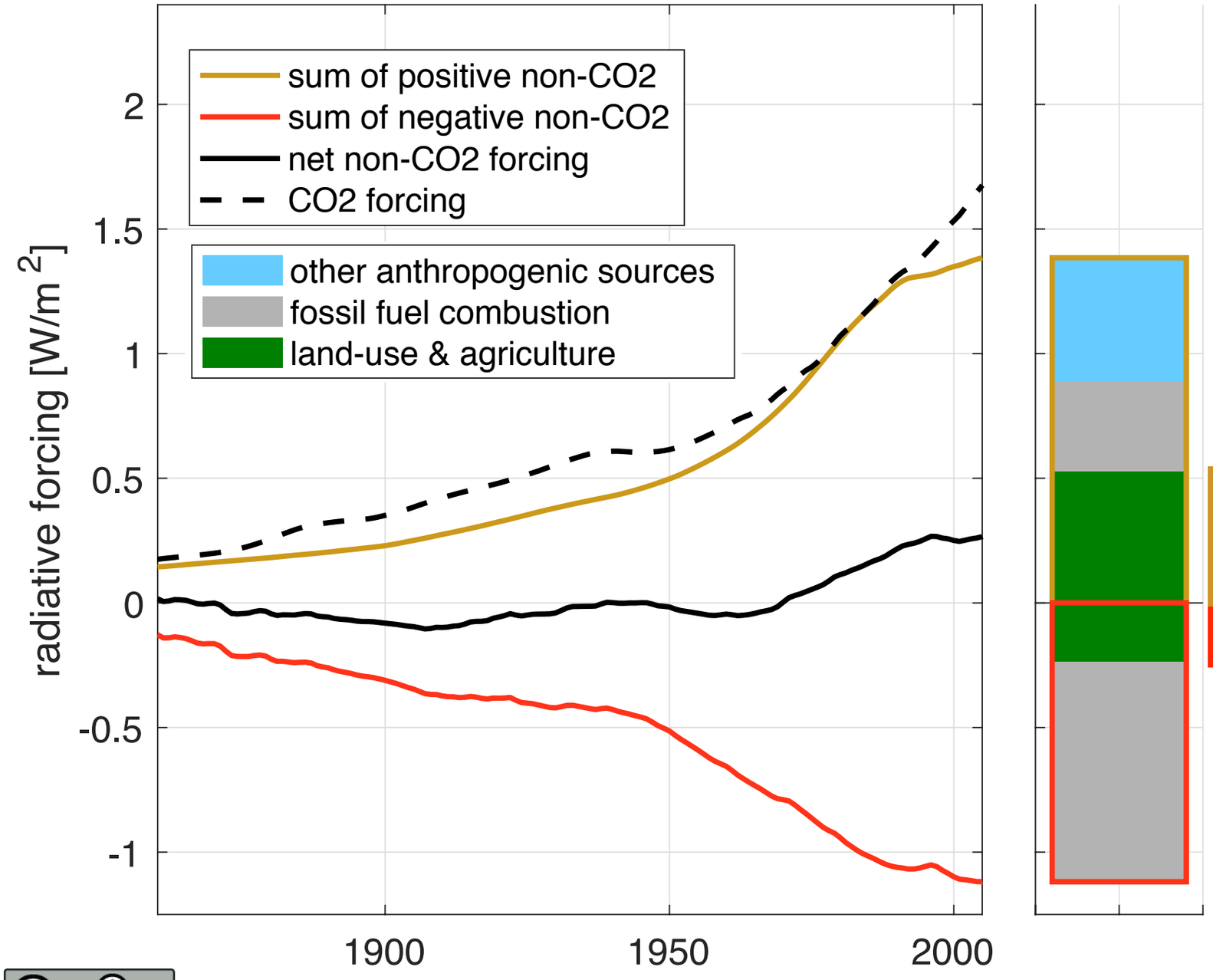

current non-CO_2 forcing from **agriculture** emissions increases warming

current non-CO_2 forcing from **fossil fuel** emissions decreases warming

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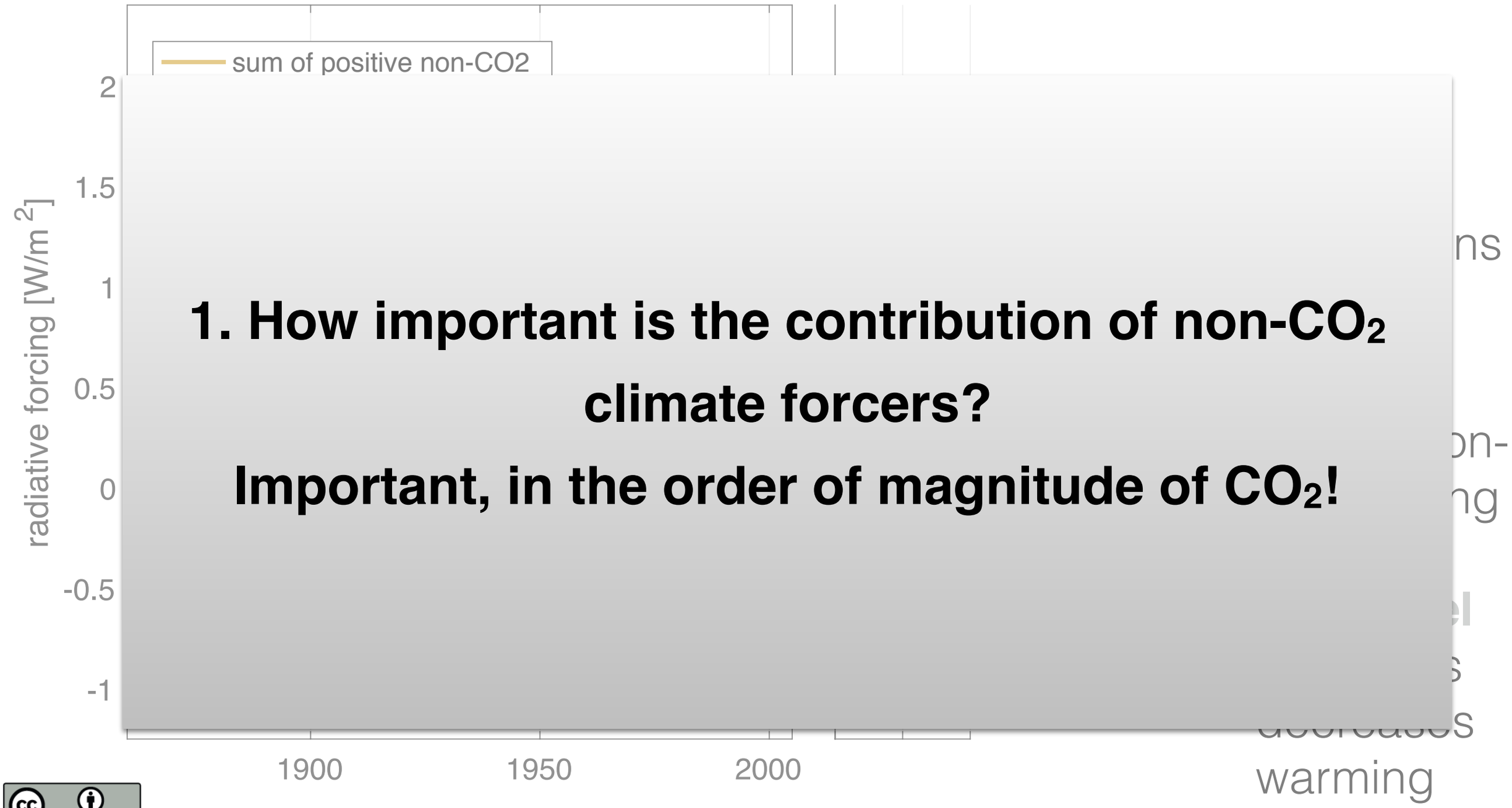

1. How important is the contribution of non-CO_2 climate forcers?

Important, in the order of magnitude of CO_2!

ns

on-

ng

el

s

decreases

warming

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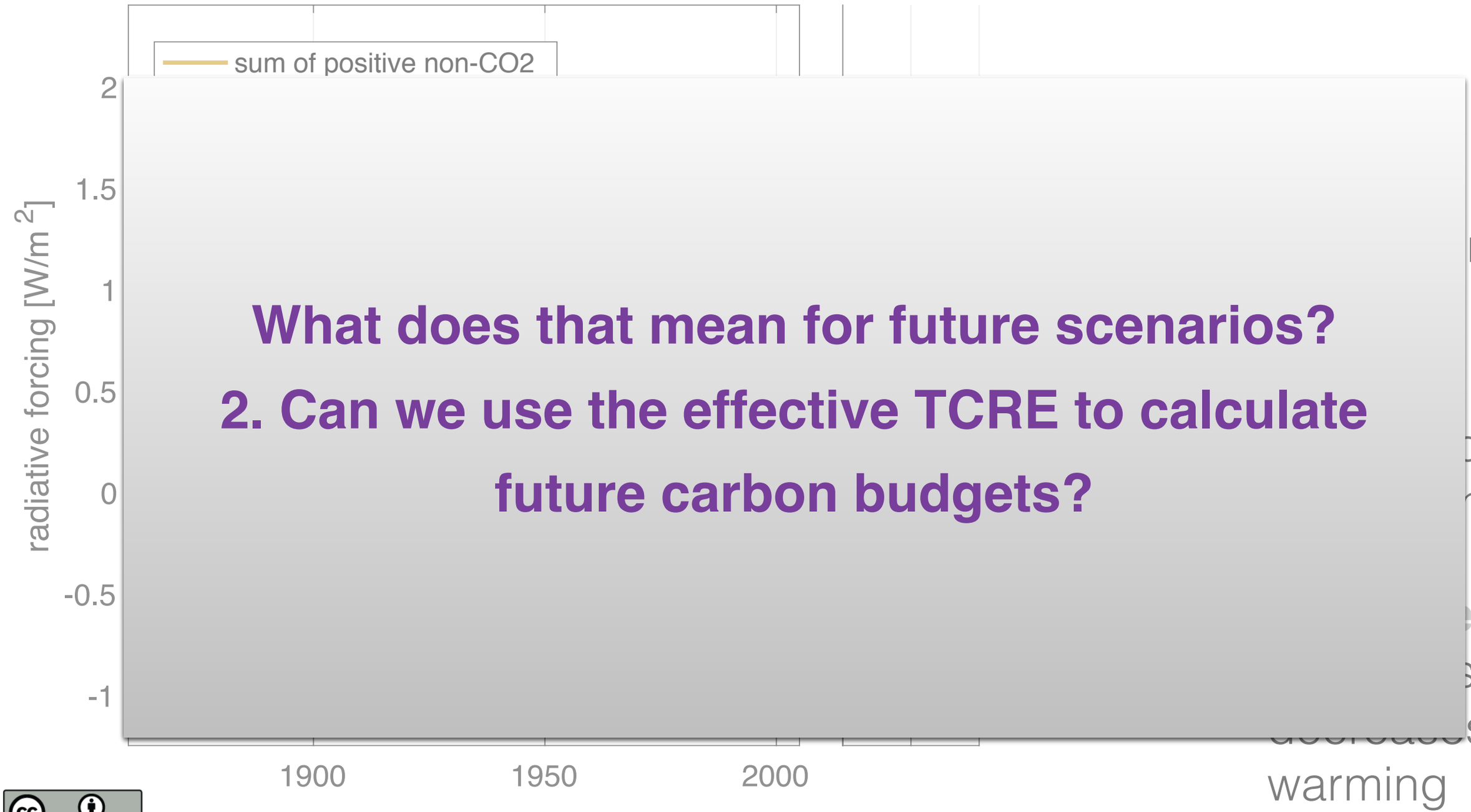

What does that mean for future scenarios?

2. Can we use the effective TCRE to calculate future carbon budgets?

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Non-CO_2 scenario uncertainty

Mengis et al. 2018 estimate for 1.5°C FF+LUC budget:
700 (640,760) **PgC**

= **75** (15,135) **PgC***

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non-CO2 scenario variability:
± 70 PgC
non-CO2 forcing and response uncertainty:
-110 to 55 PgC

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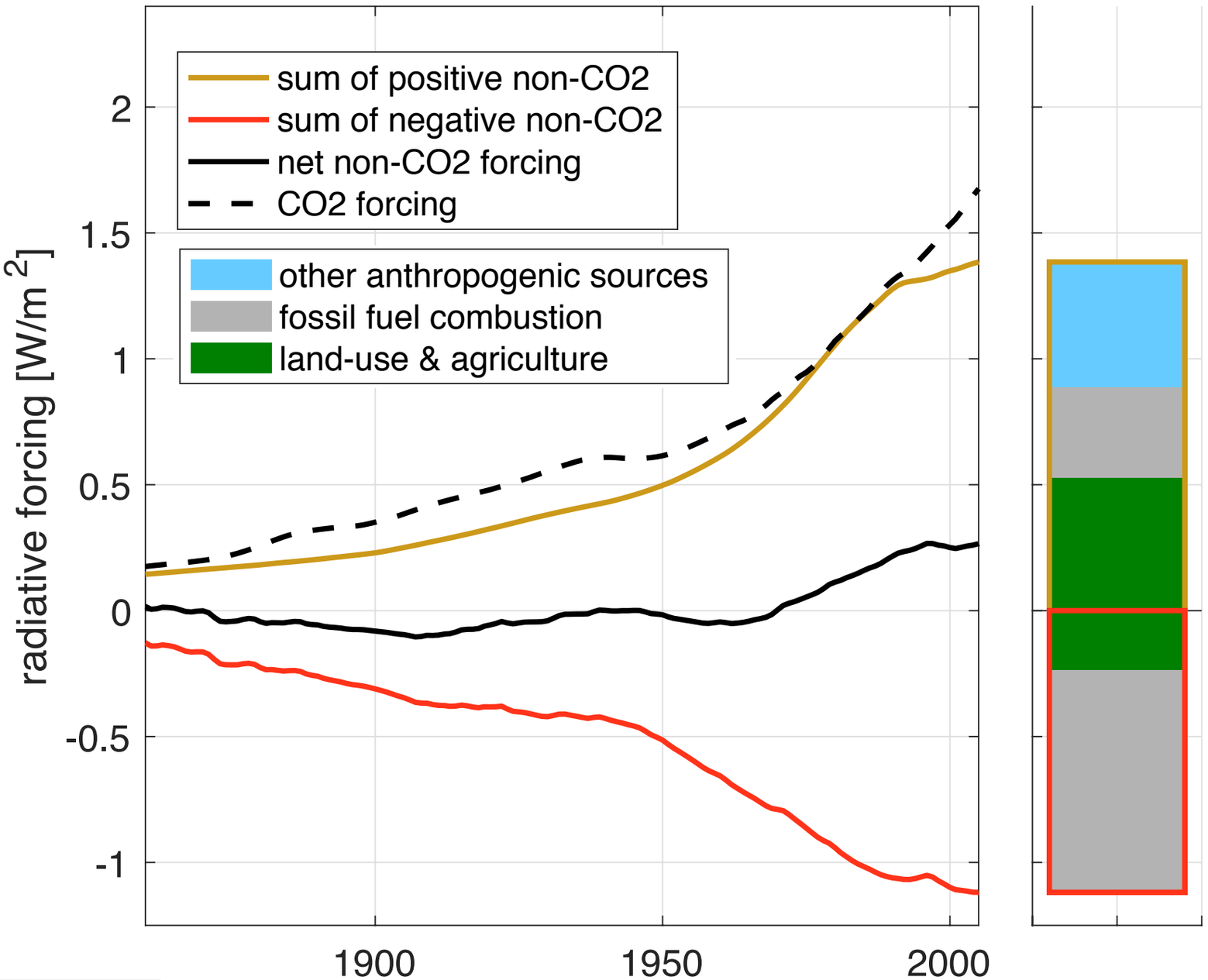

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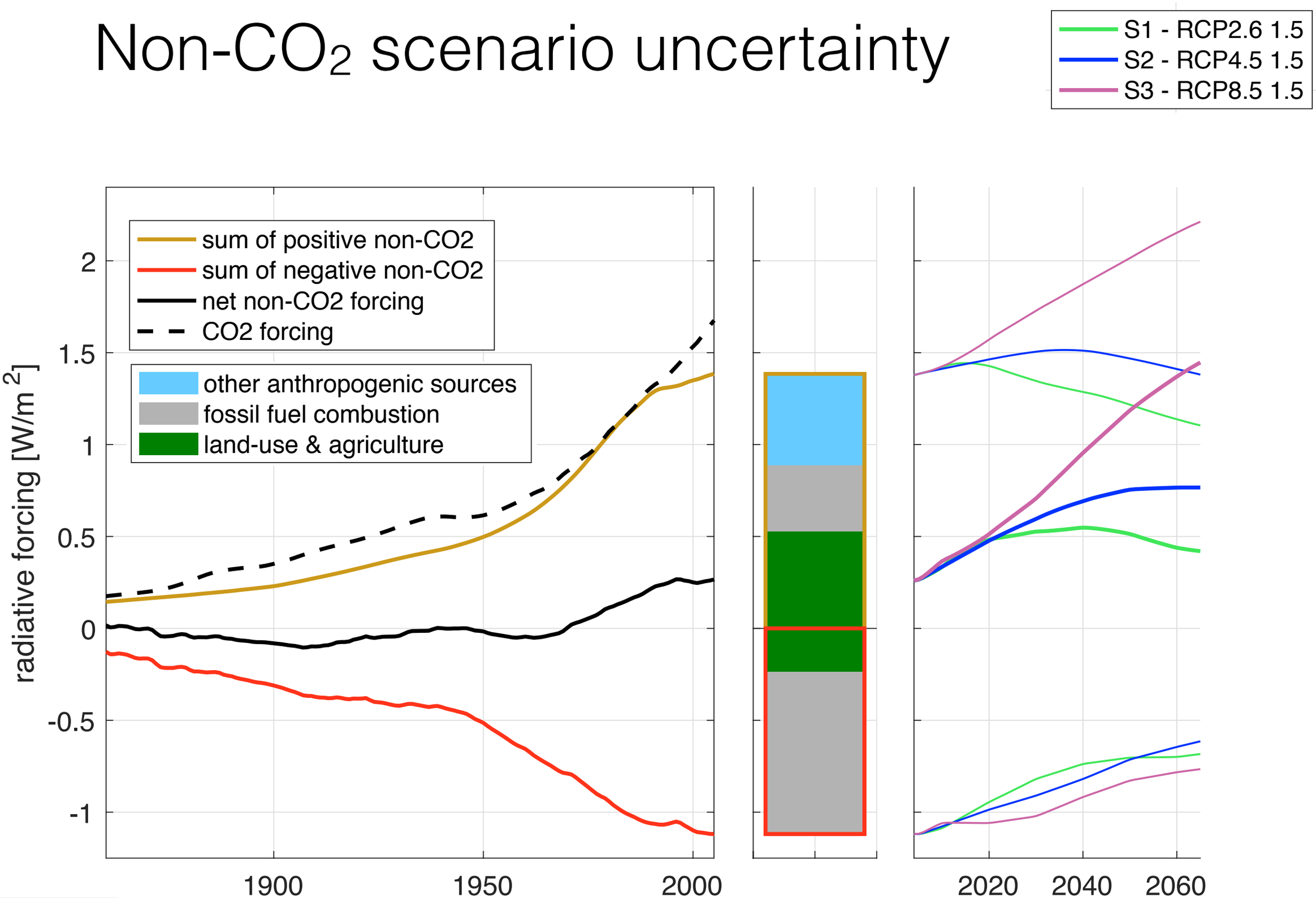

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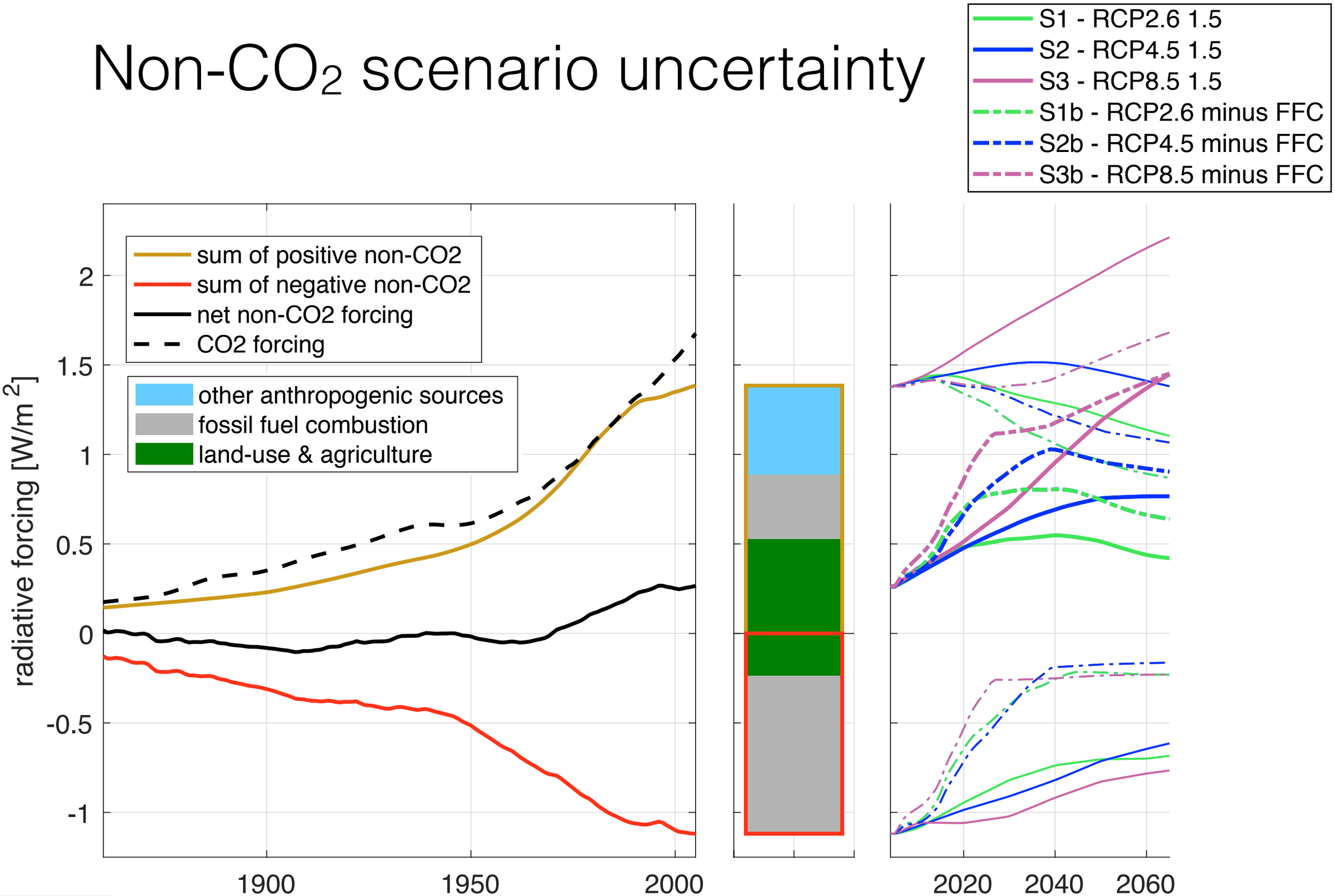
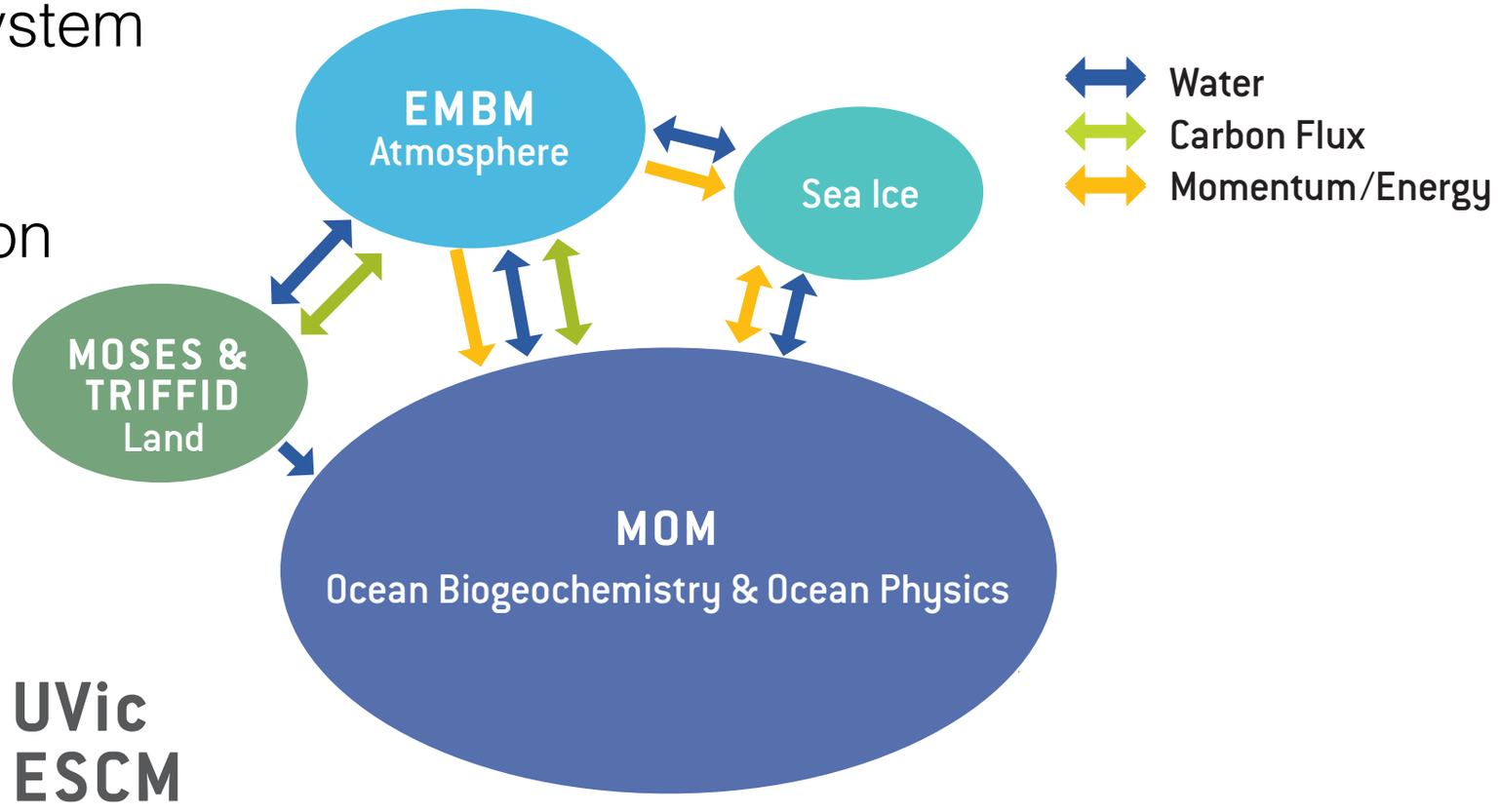


Experimental design - UVic ESCM 2.9

- University of Victoria Earth System Climate Model (UVic ESCM)
- 1.8° x 3.6° horizontal resolution
- 19 vertical ocean levels
- 5 plant functional types



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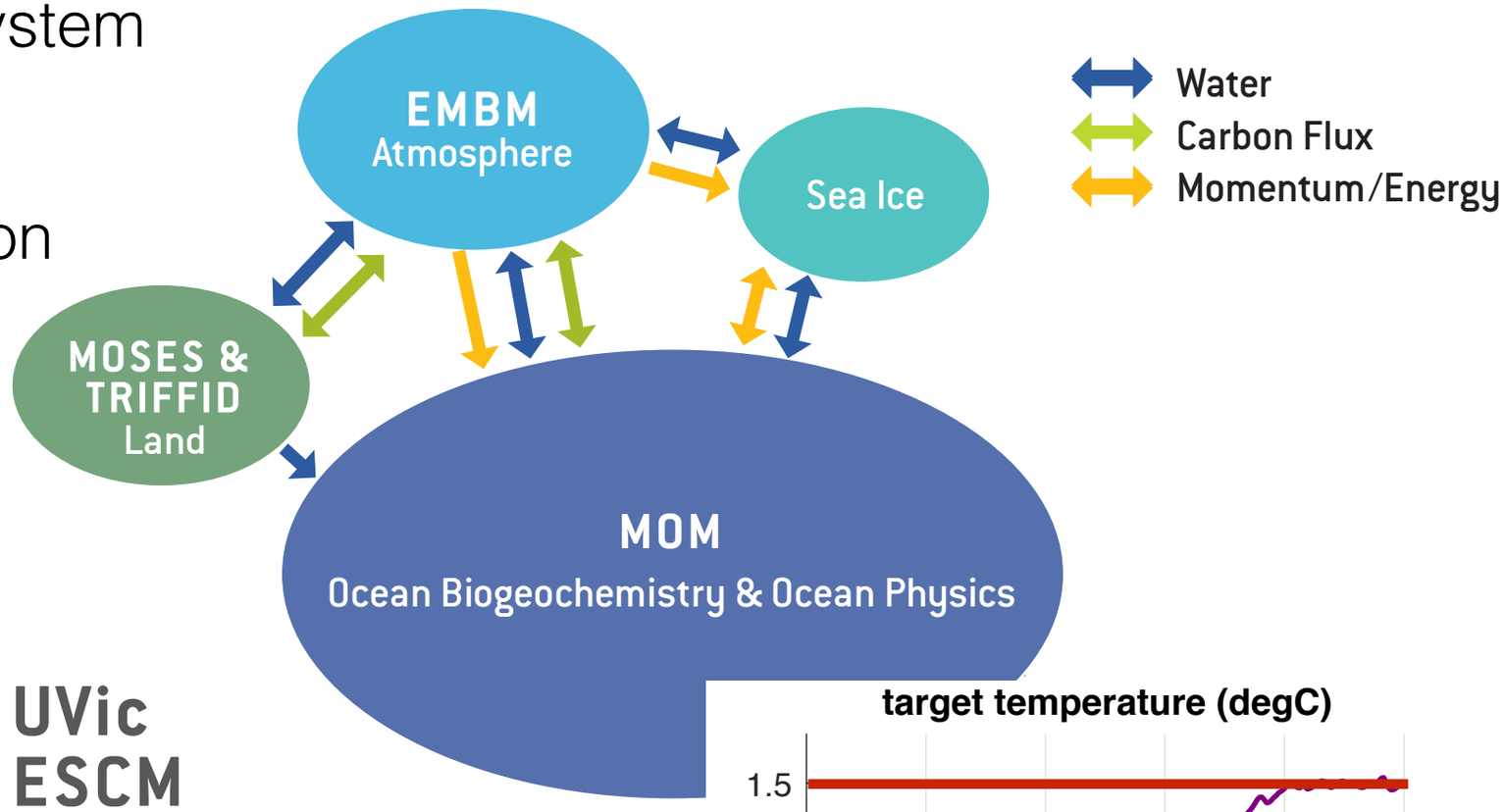
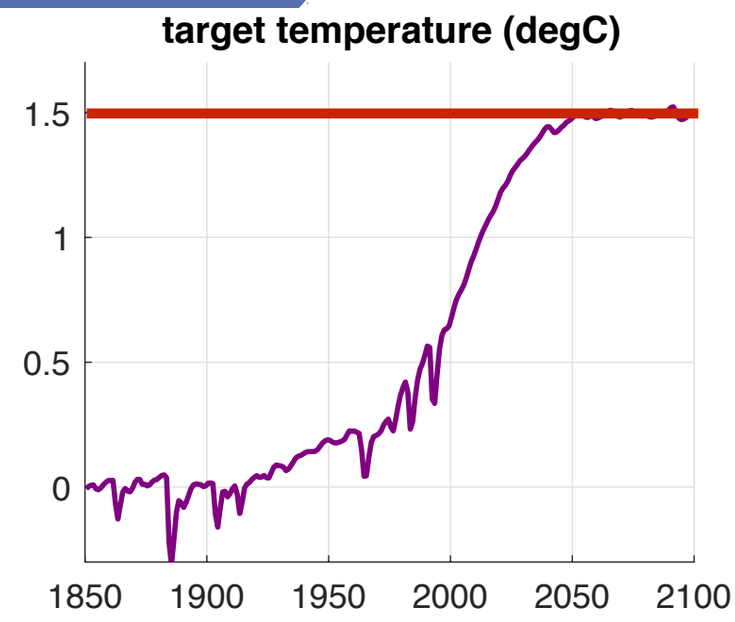


UVic ESCM

- temperature tracking
- strict guardrail of 1.5°C in 2100
- no temperature overshoot



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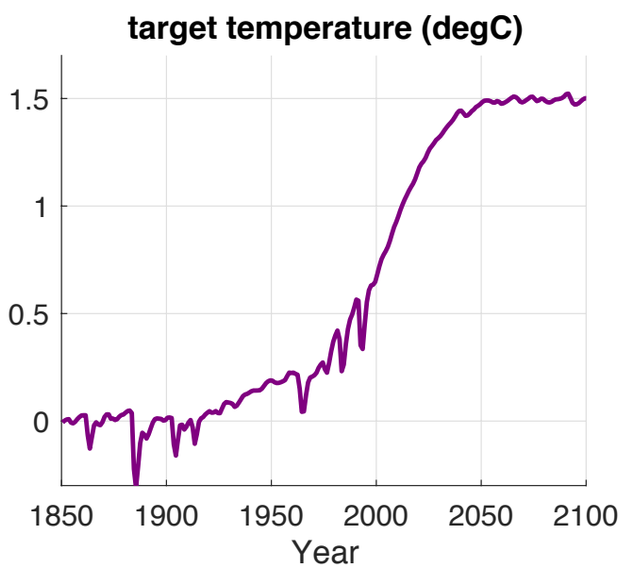

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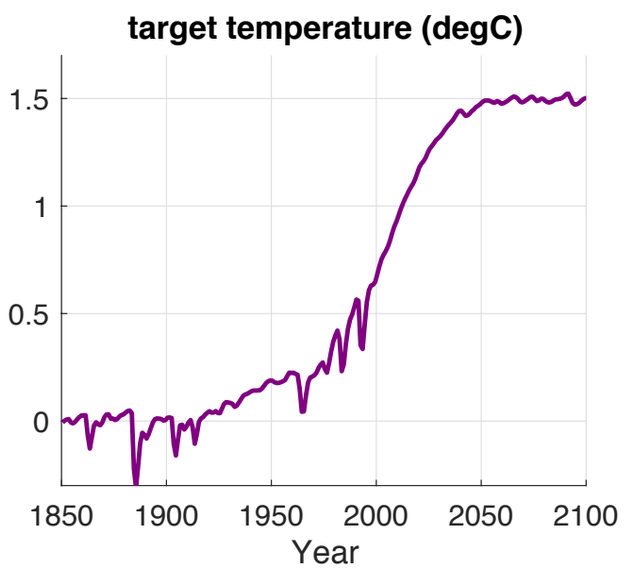

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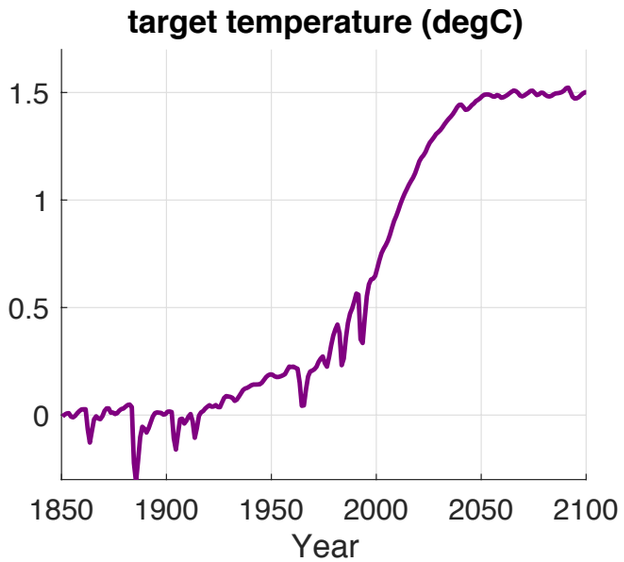

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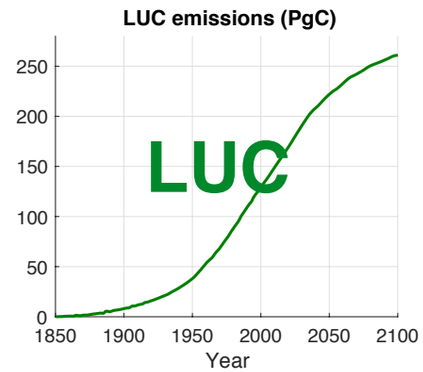

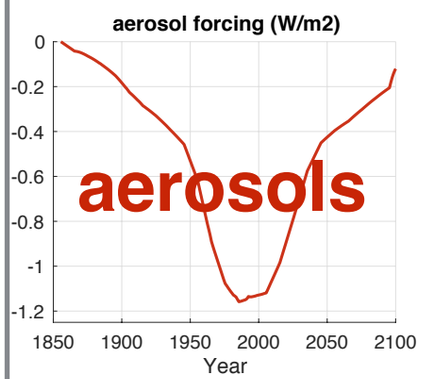

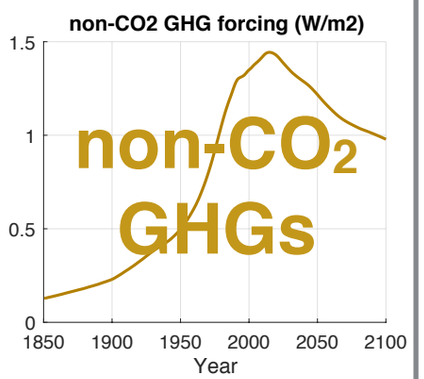

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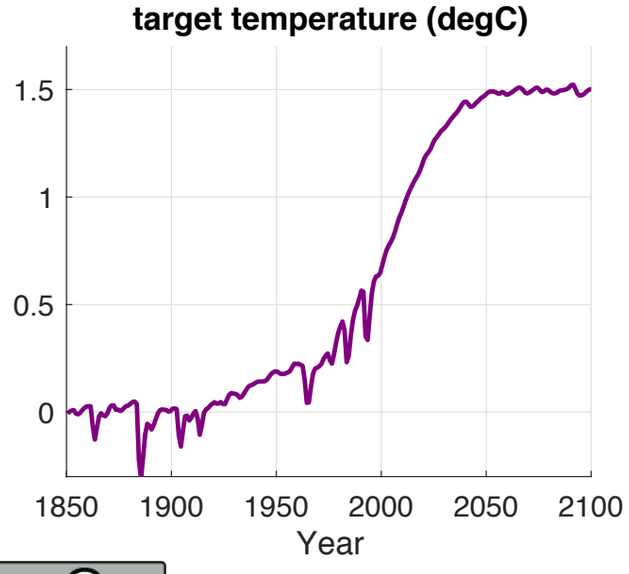

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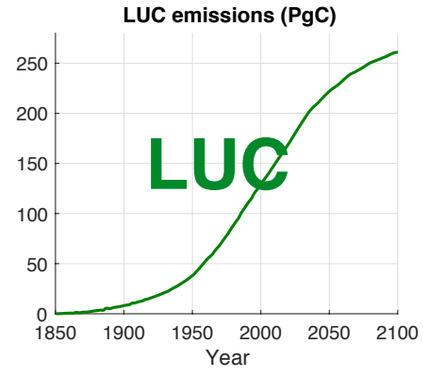

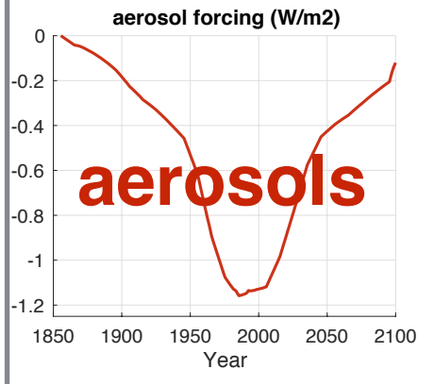

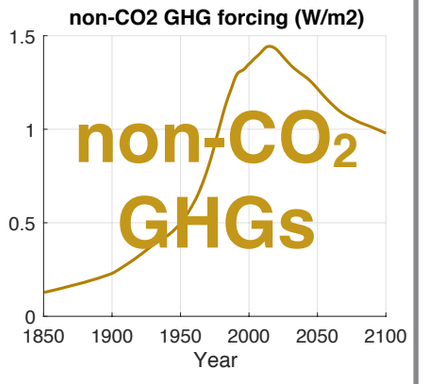

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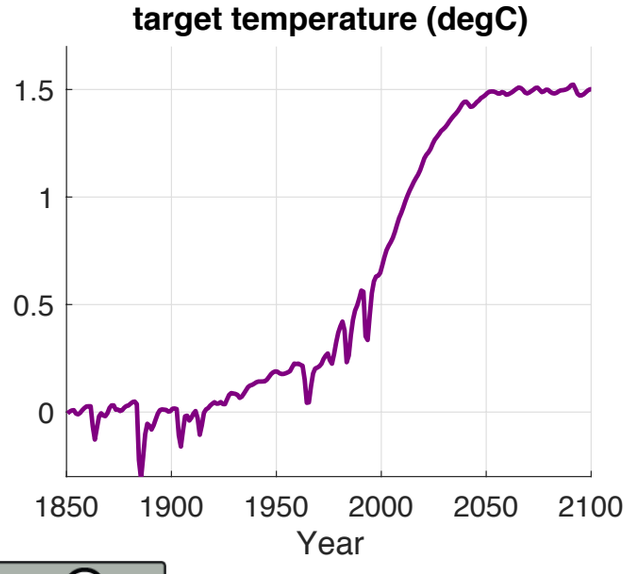

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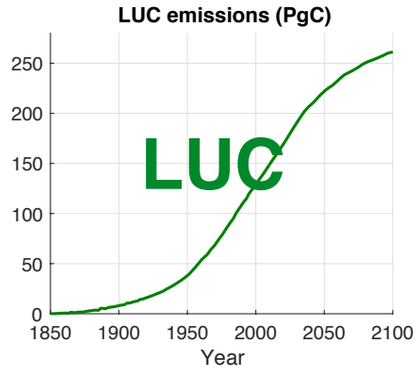

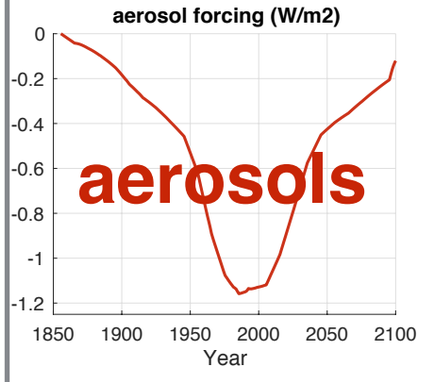

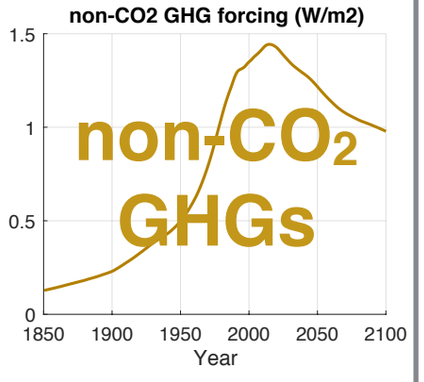

- diagnosed **fossil fuel** emissions

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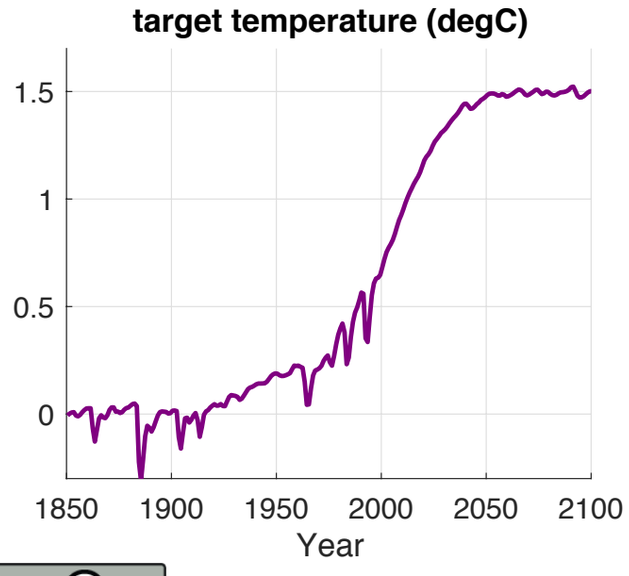

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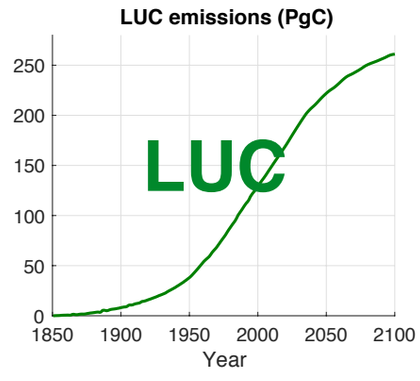
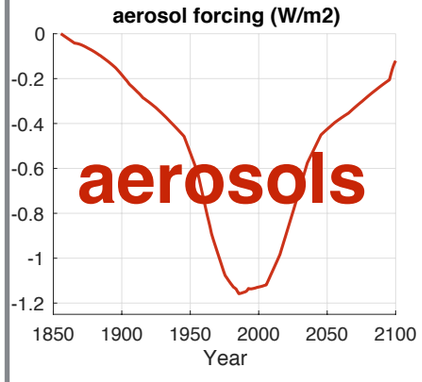
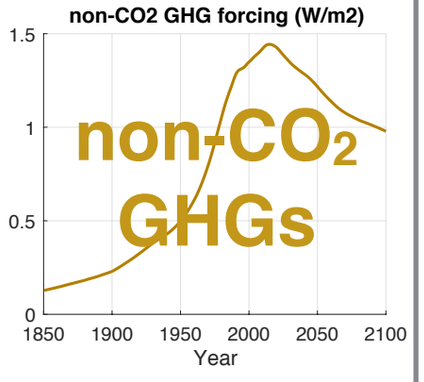
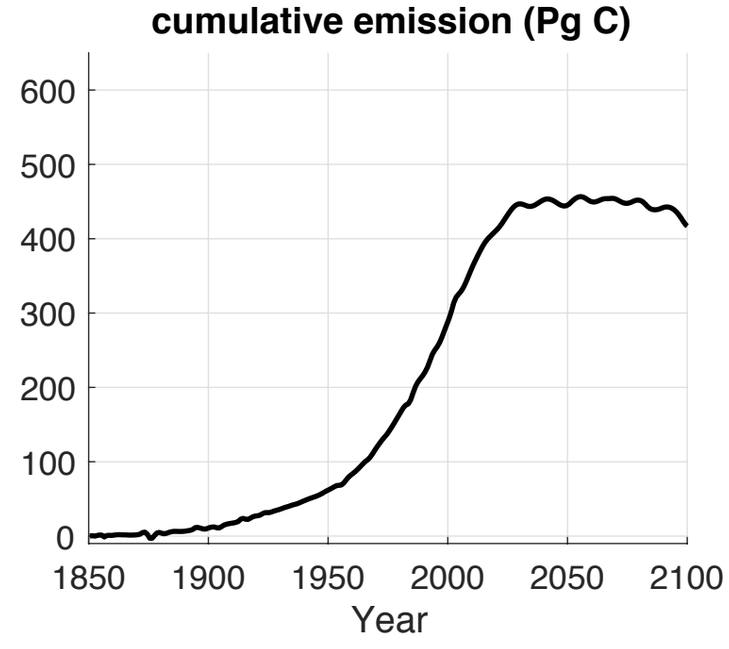






- diagnosed **fossil fuel** emissions



Diagnose CO_2 forcing equivalent emissions (CO_2-fe)

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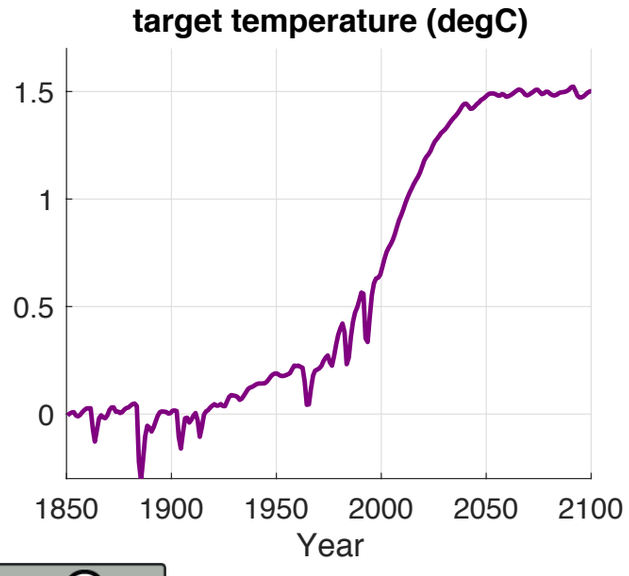
- strict guardrail of 1.5°C in 2100
- no temperature overshoot

&

- historical + RCP extended scenarios **minus non-CO2 forcing**

→

- diagnosed **difference** fossil fuel emissions



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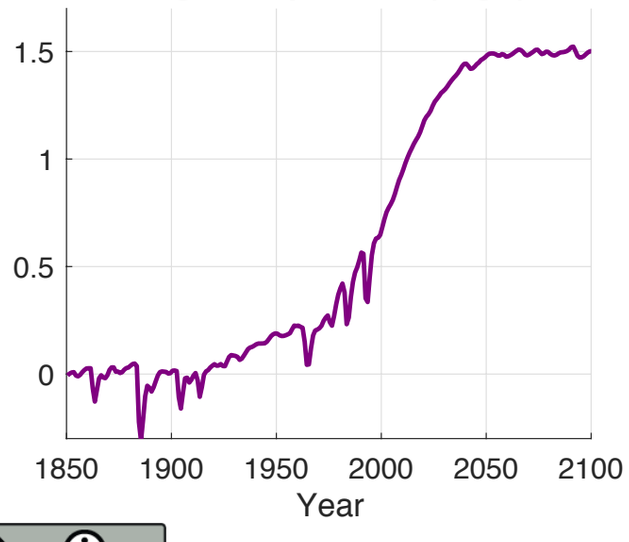
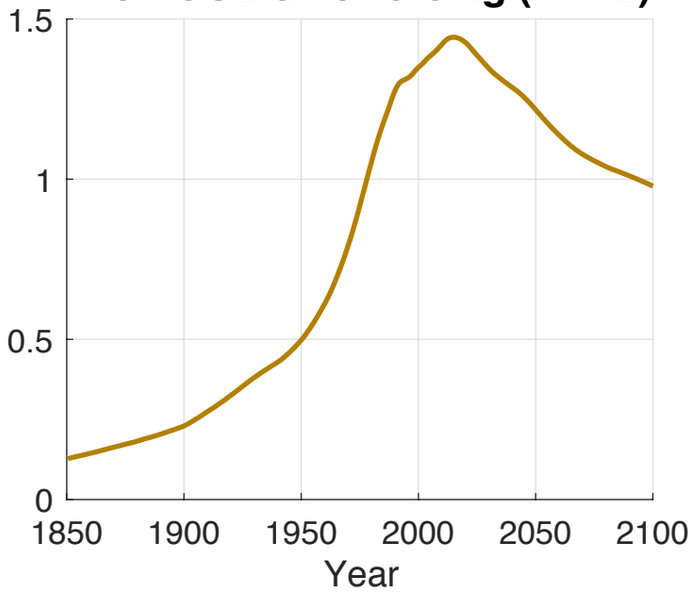
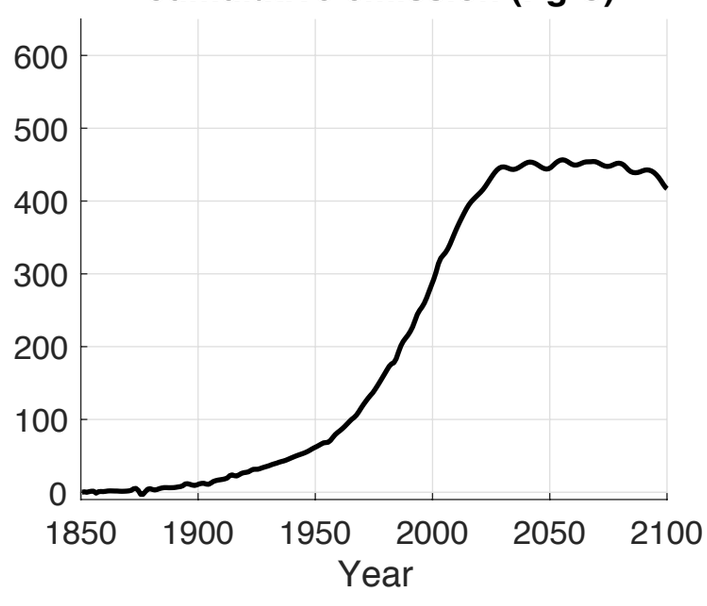
target temperature (degC)



non-CO2 GHG forcing (W/m2)



cumulative emission (Pg C)



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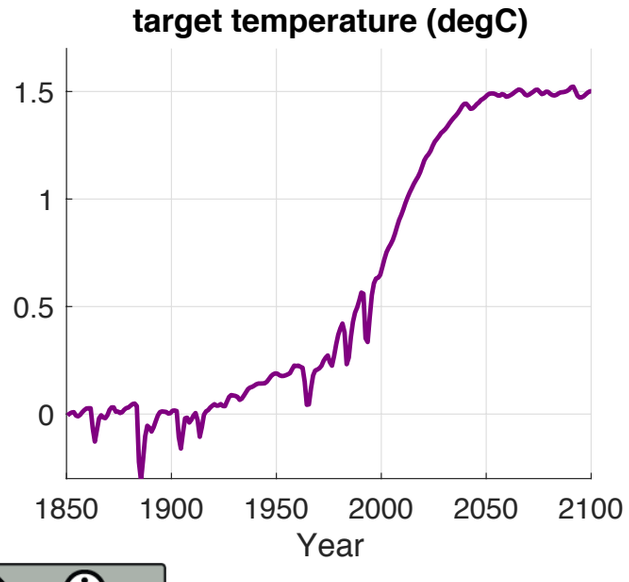

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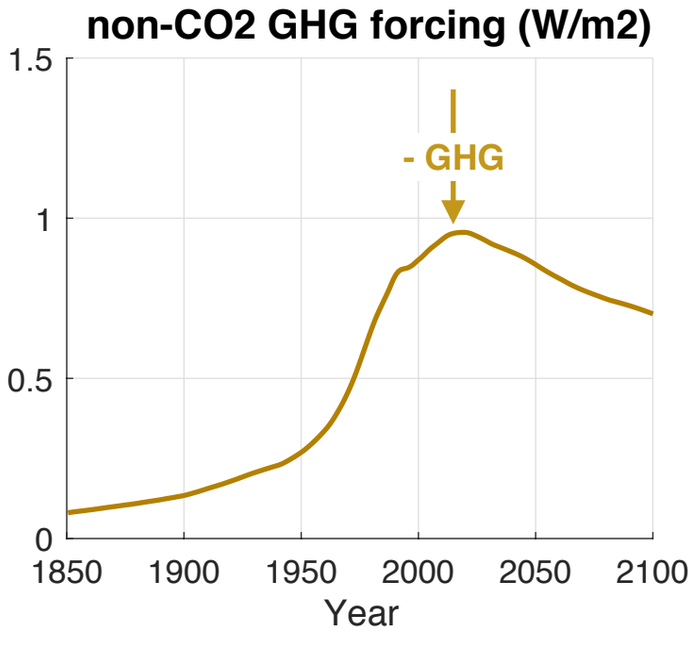

→

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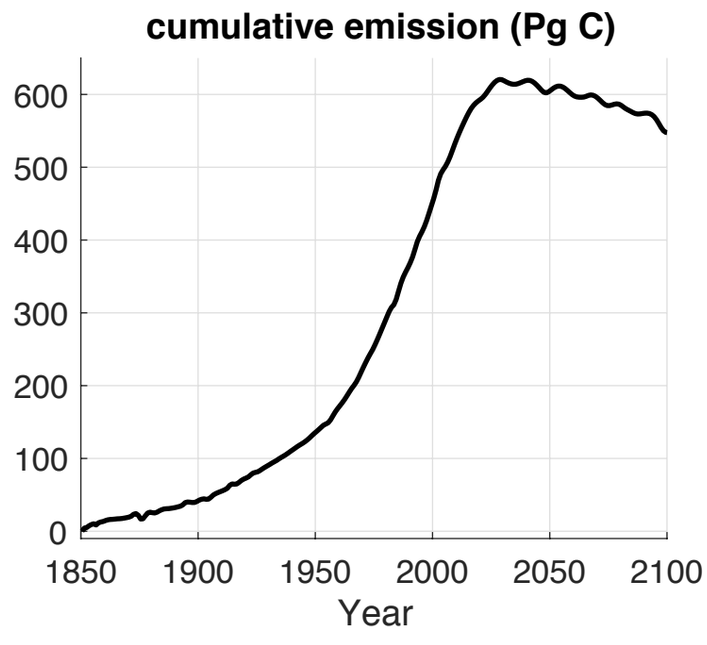

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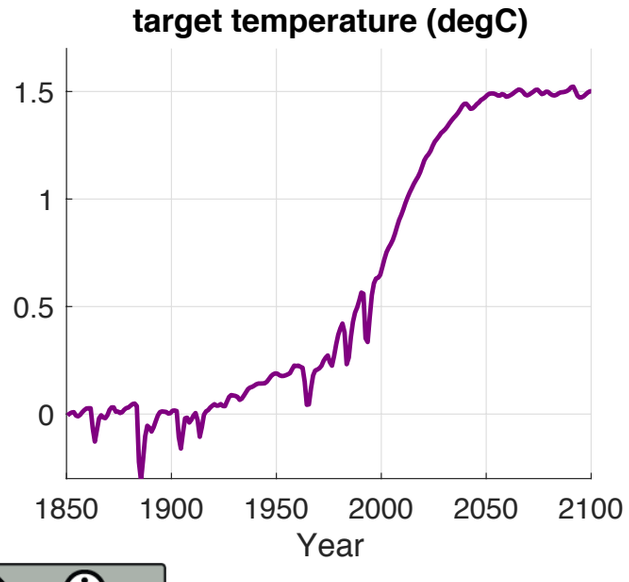

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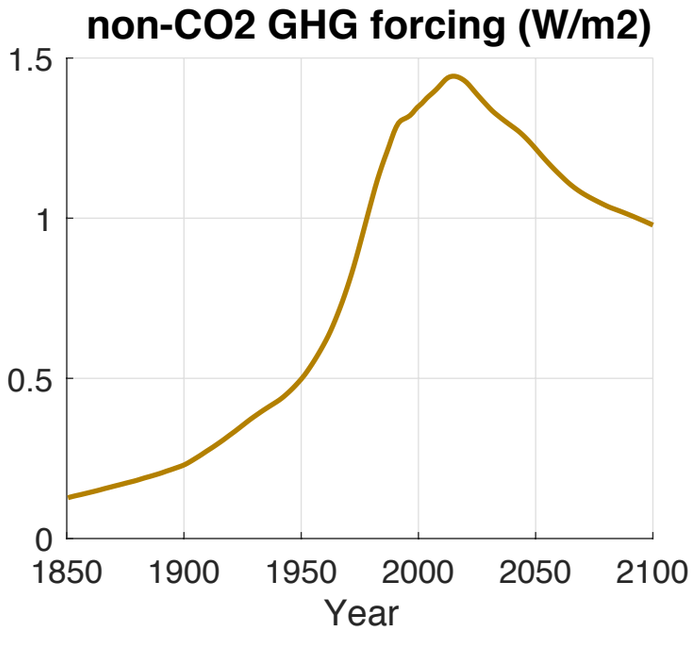

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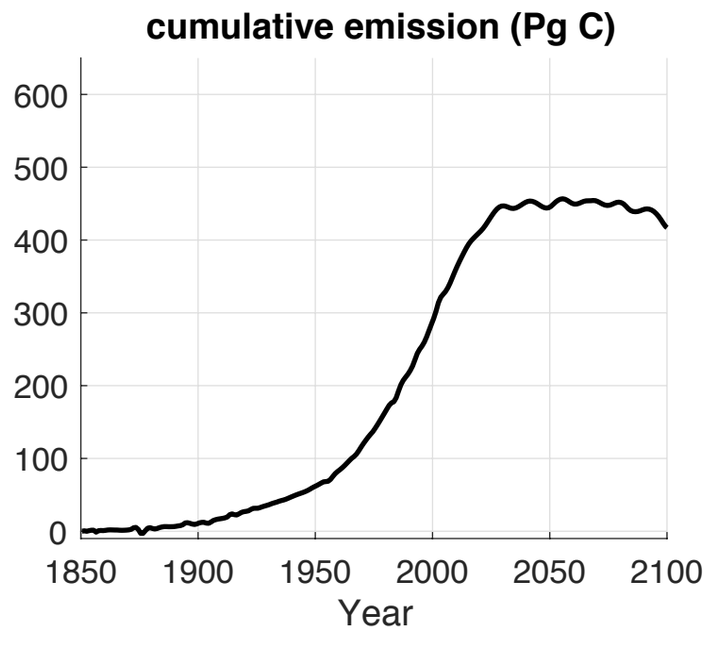

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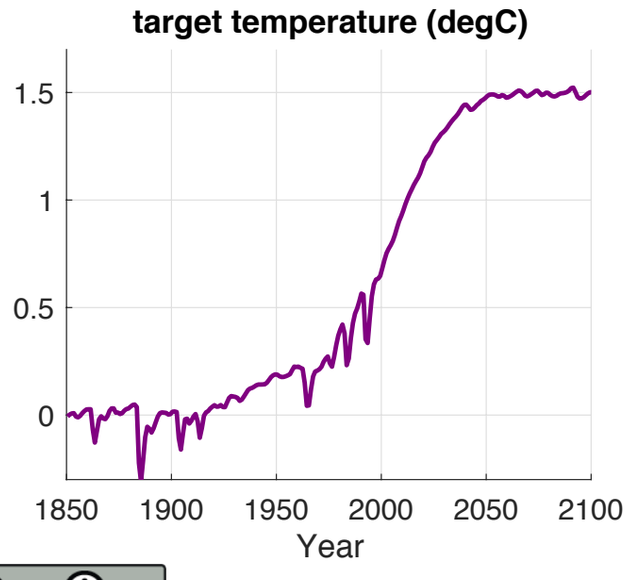

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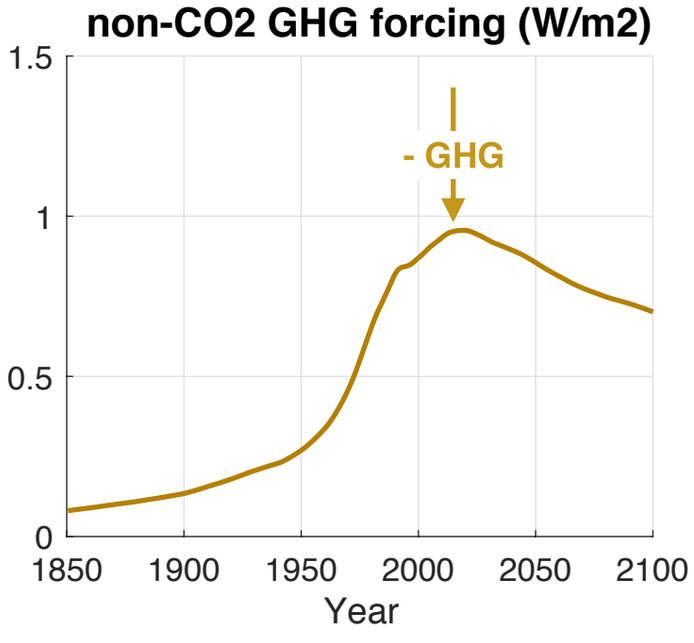

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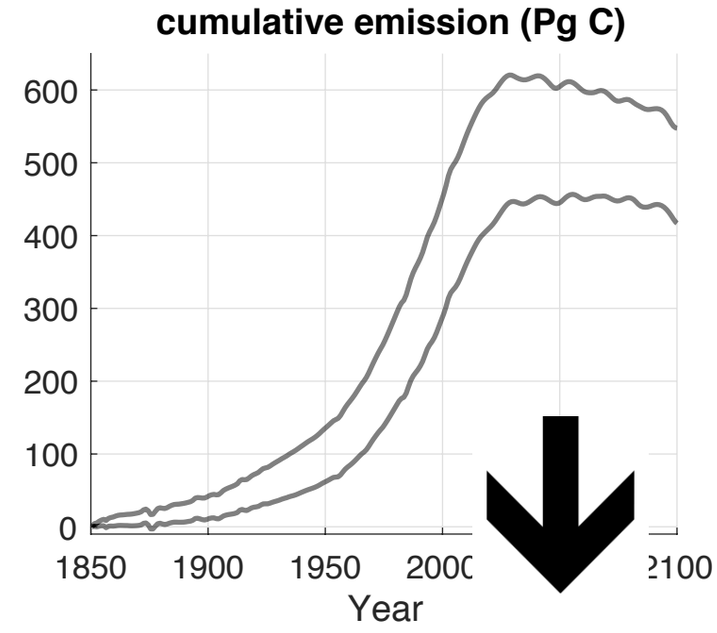

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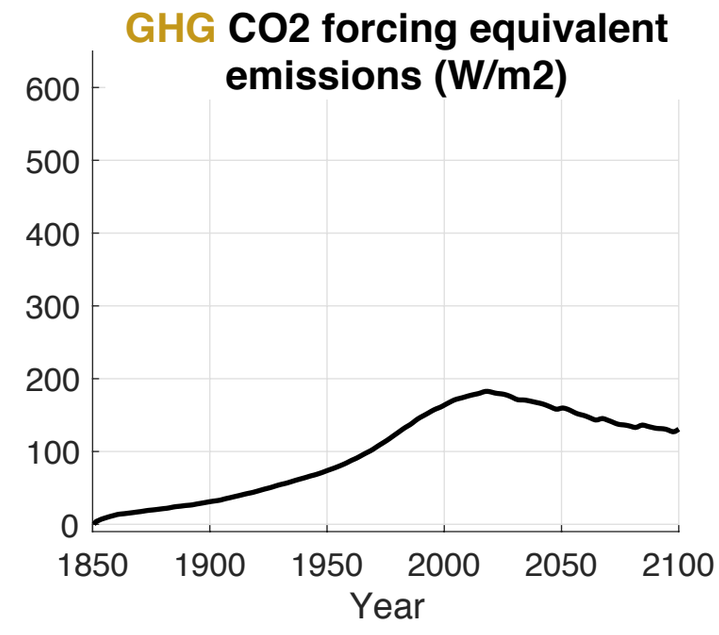
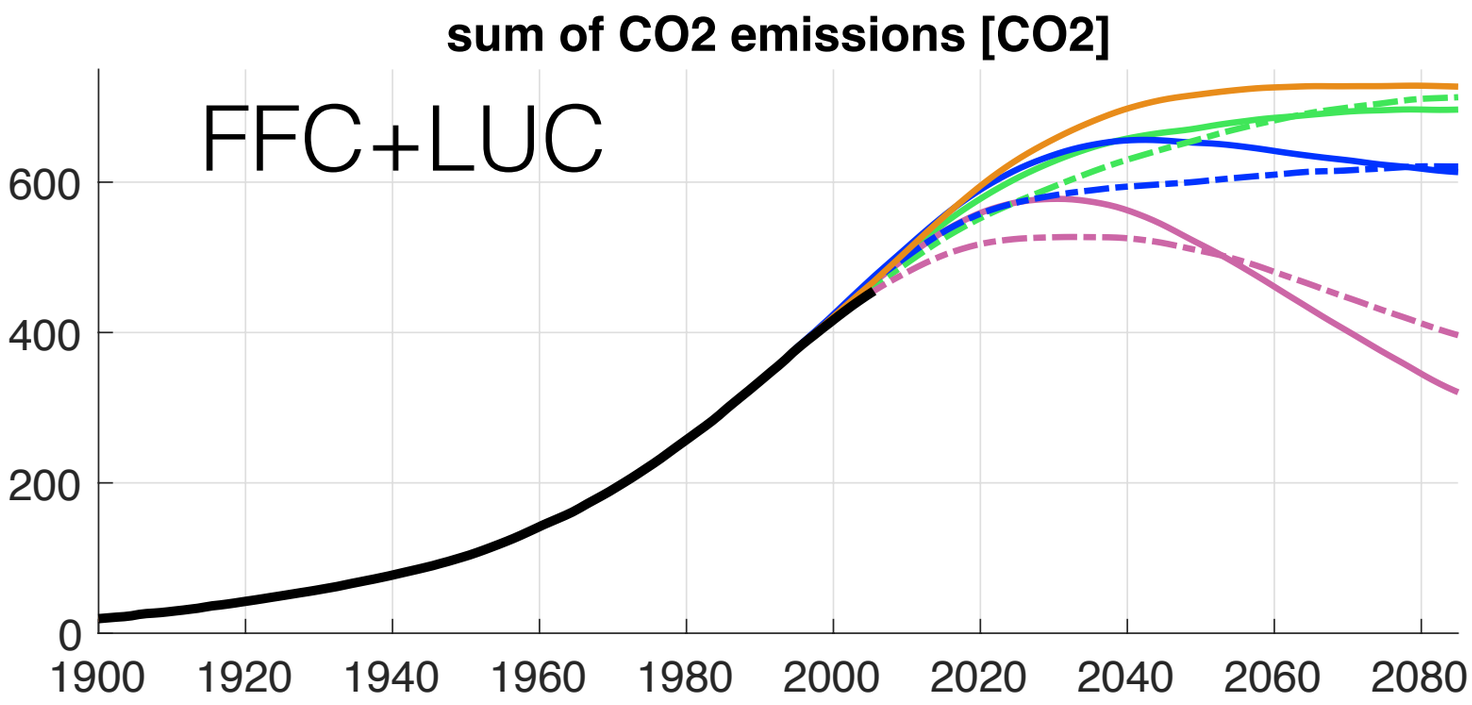


The effective TCRE in a 1.5 °C scenario



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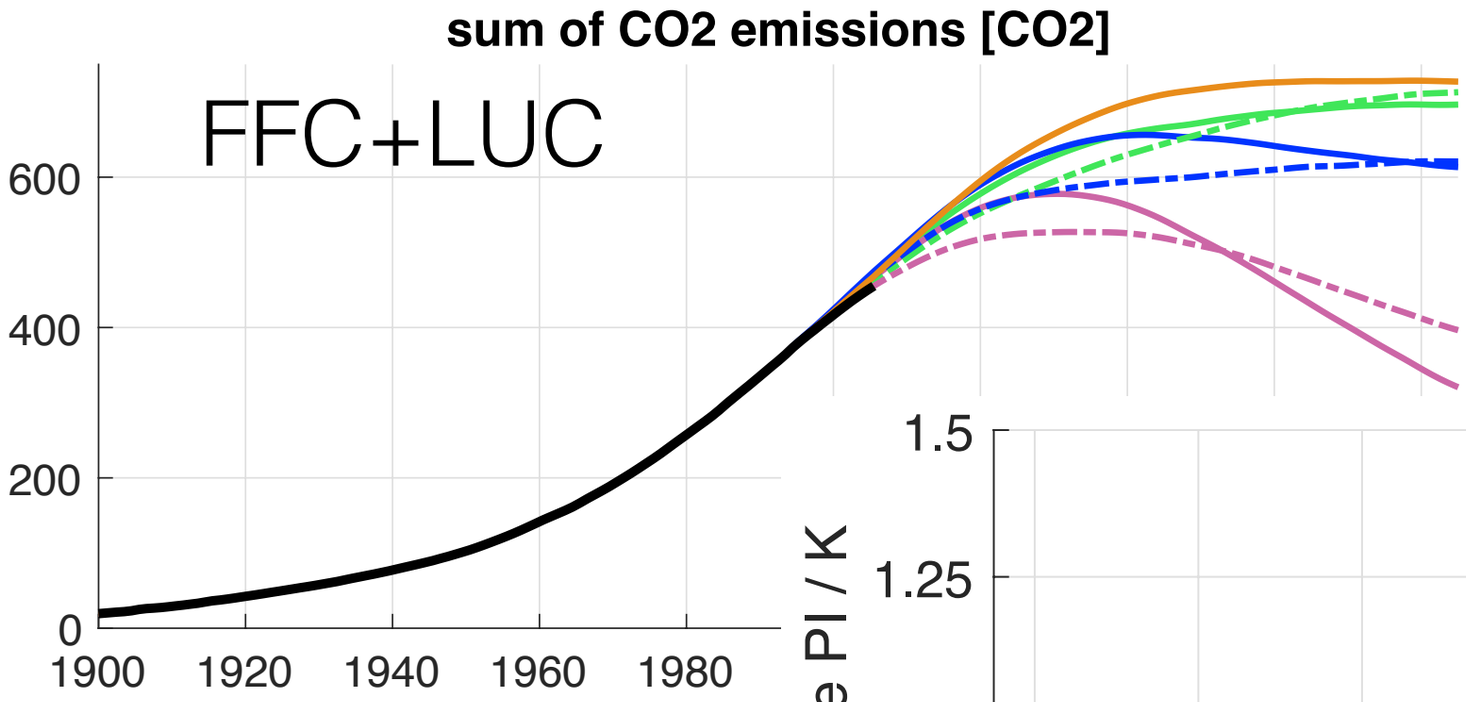

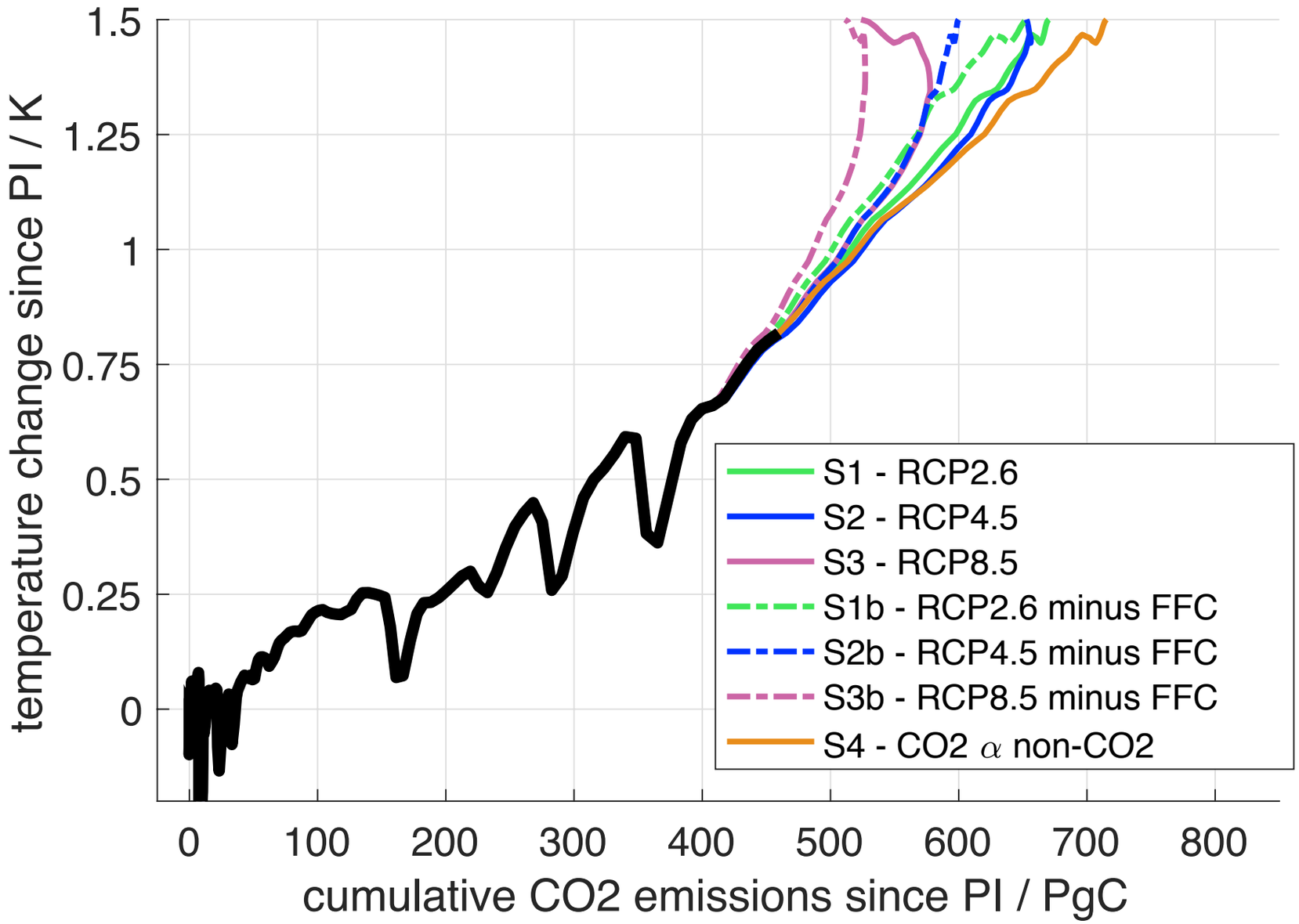

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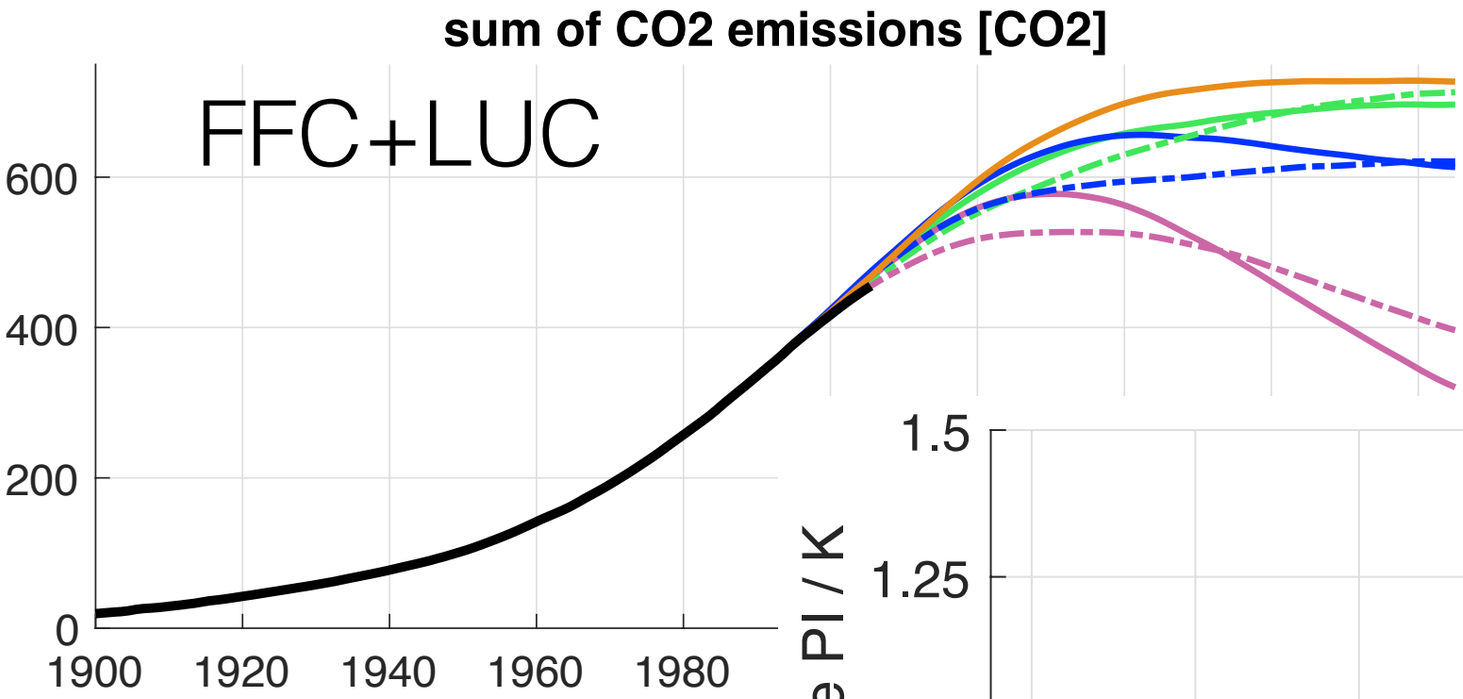

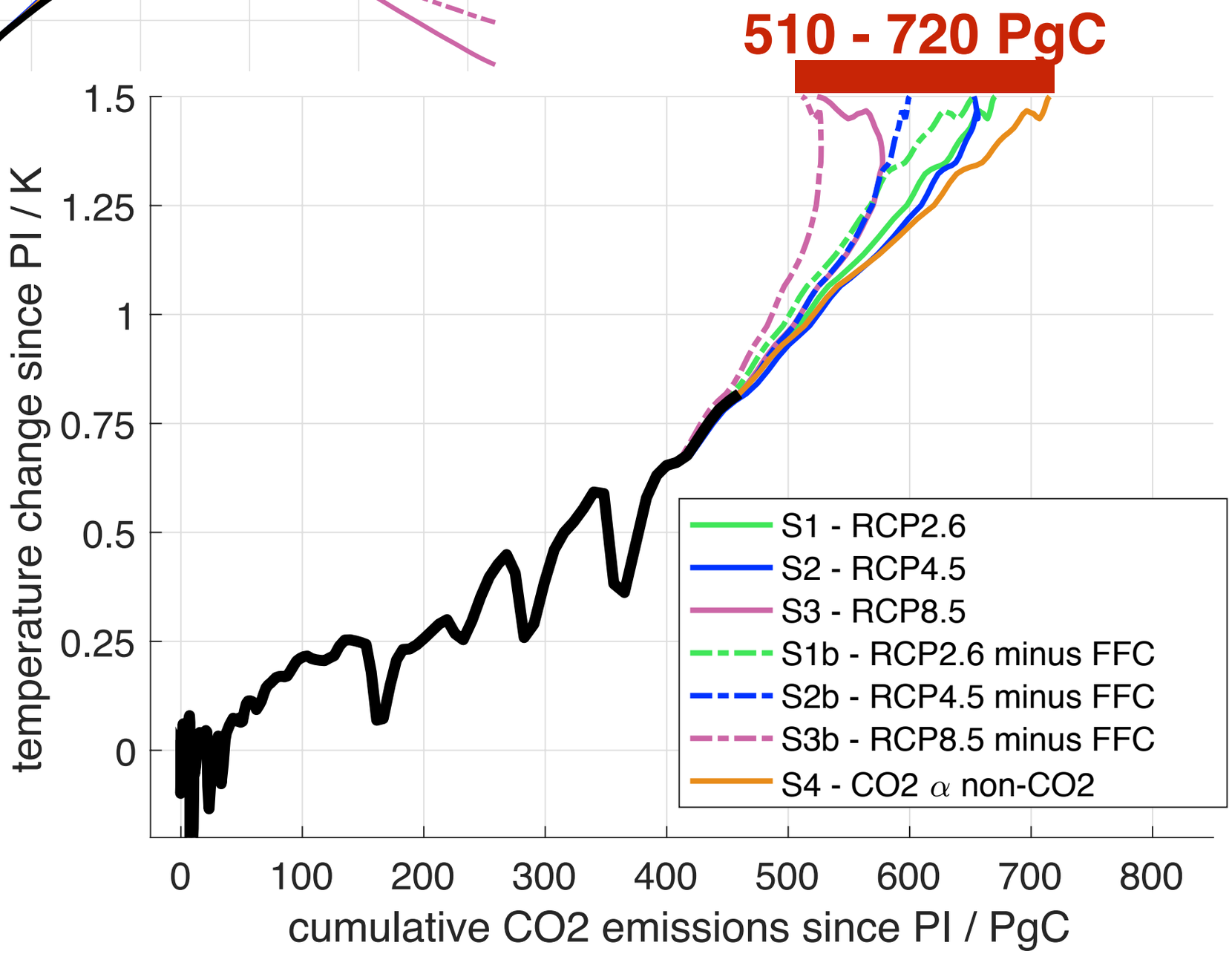

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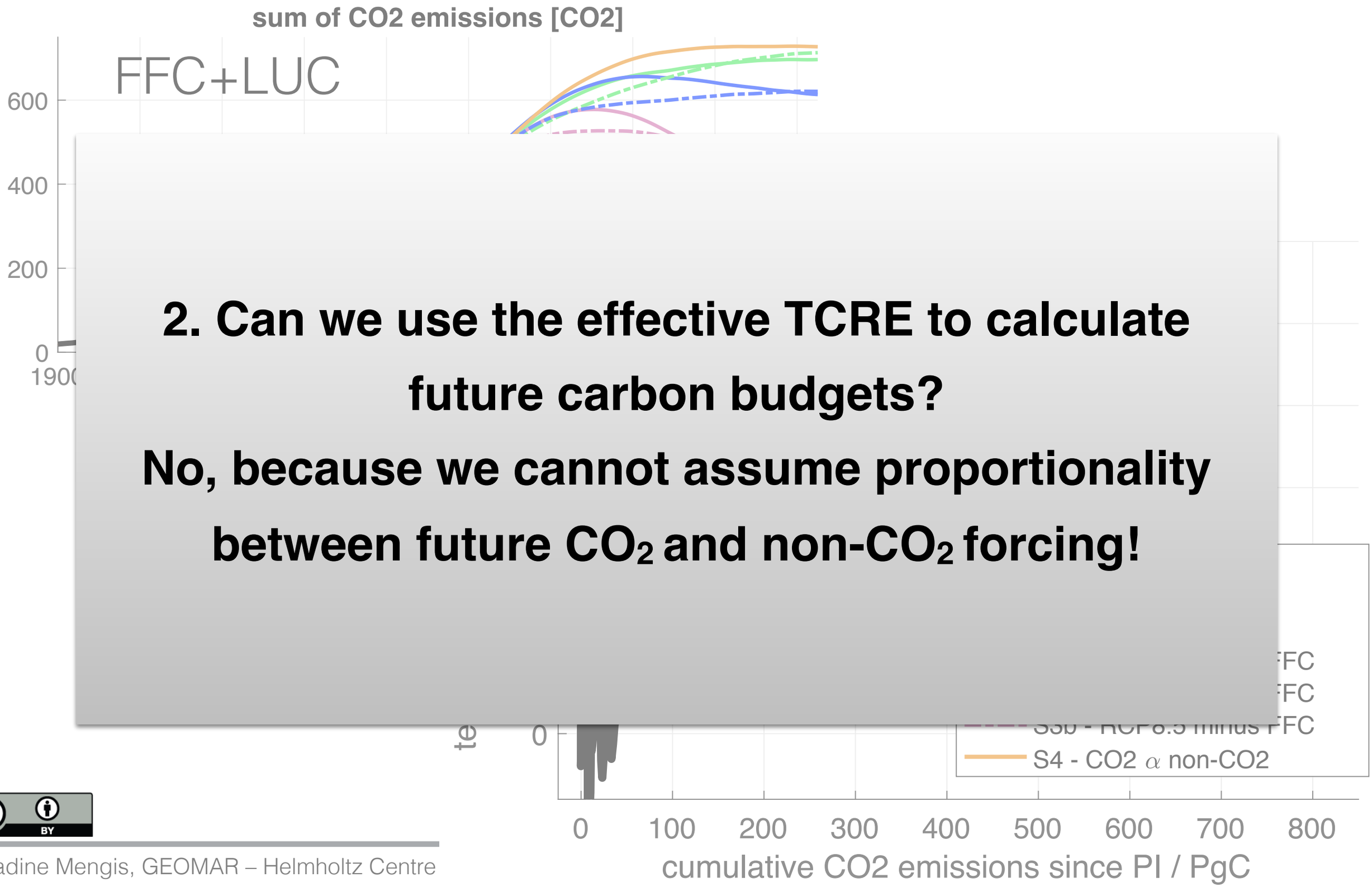
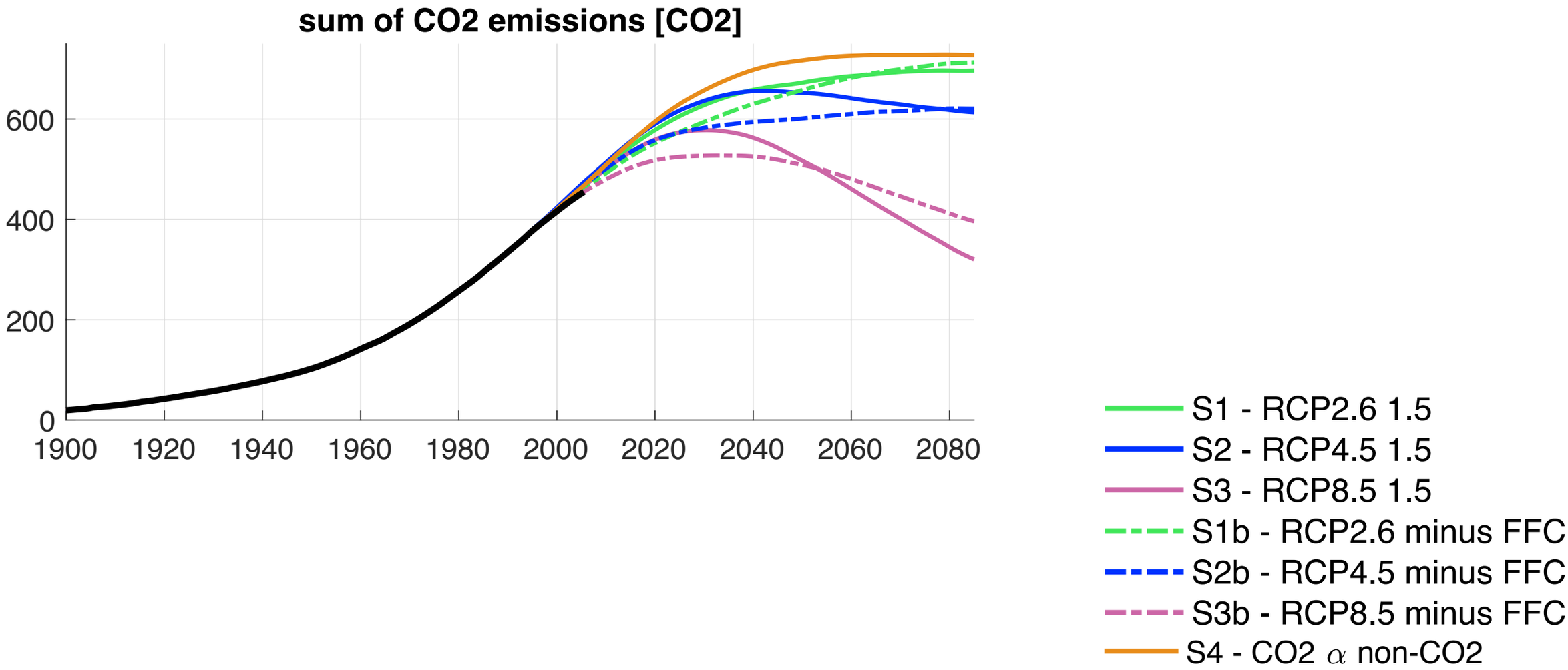


2. Can we use the effective TCRE to calculate future carbon budgets?

No, because we cannot assume proportionality between future CO_2 and non-CO_2 forcing!

1.5 °C carbon budgets in units of CO_2-fe



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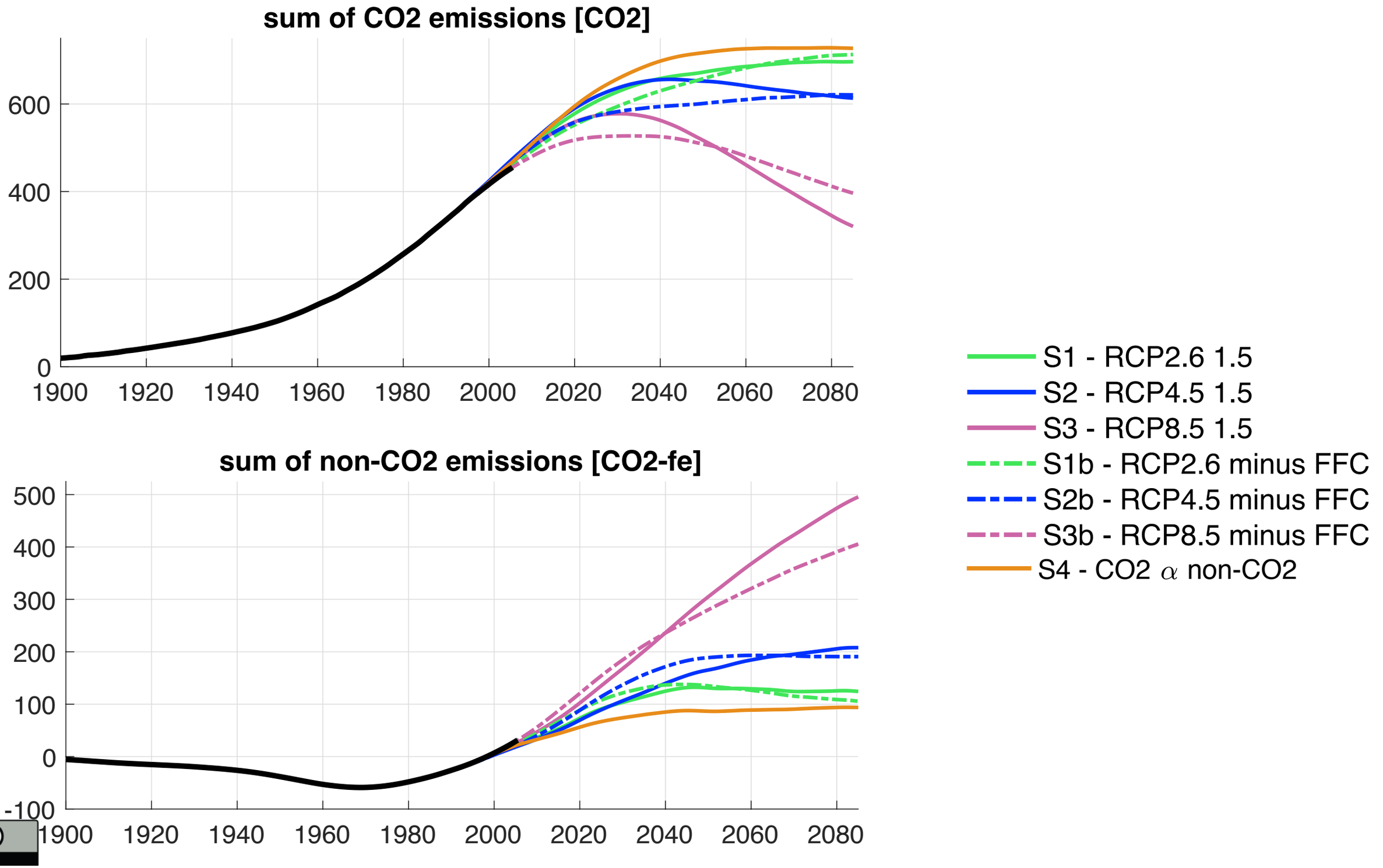

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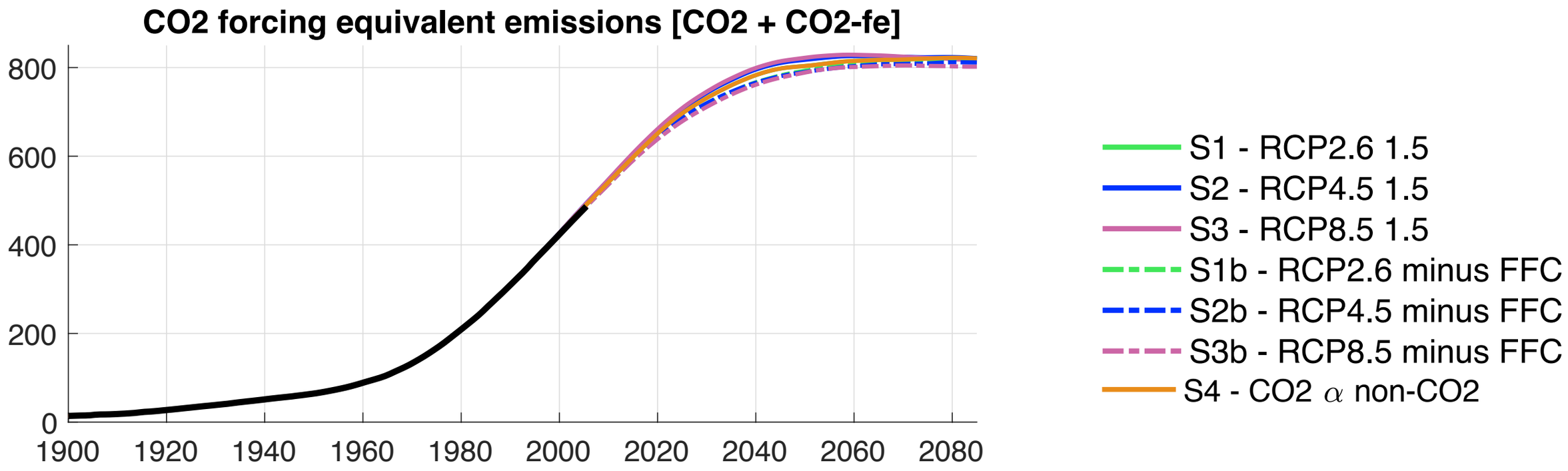

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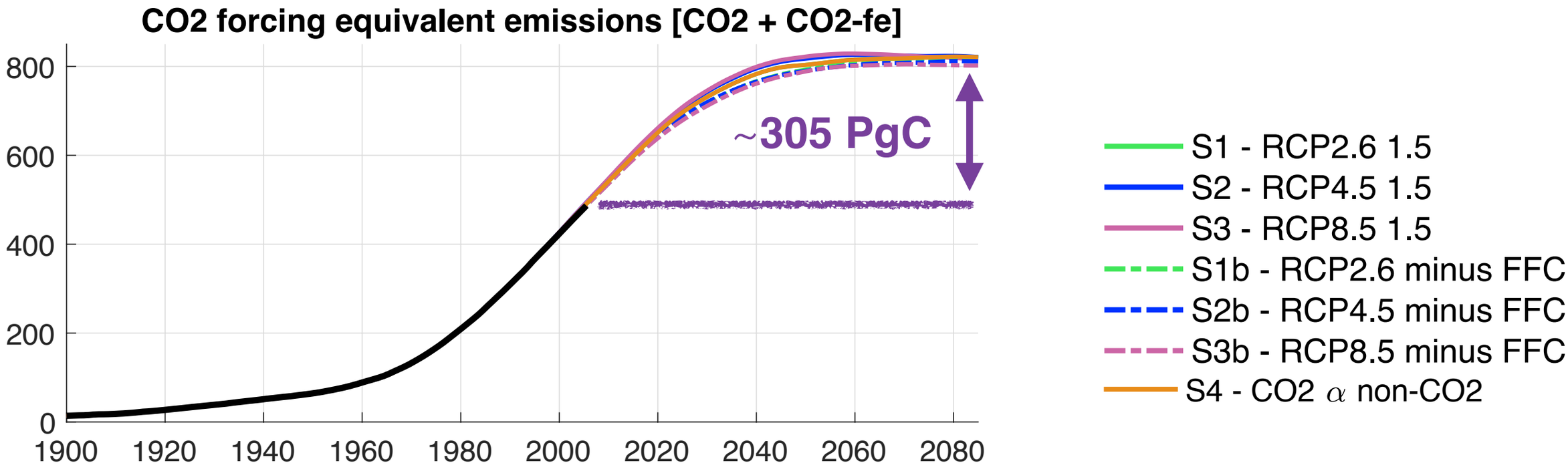

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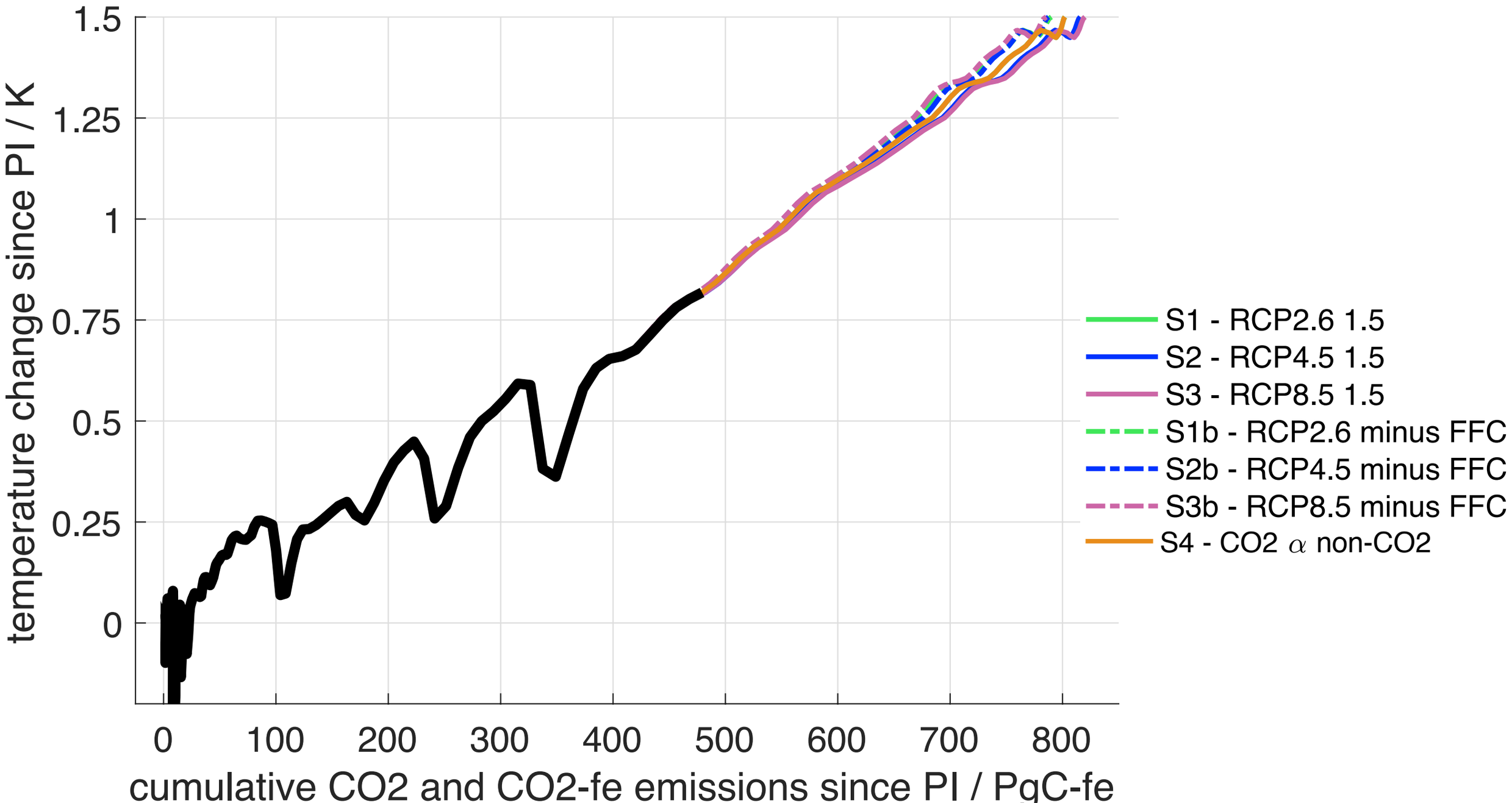

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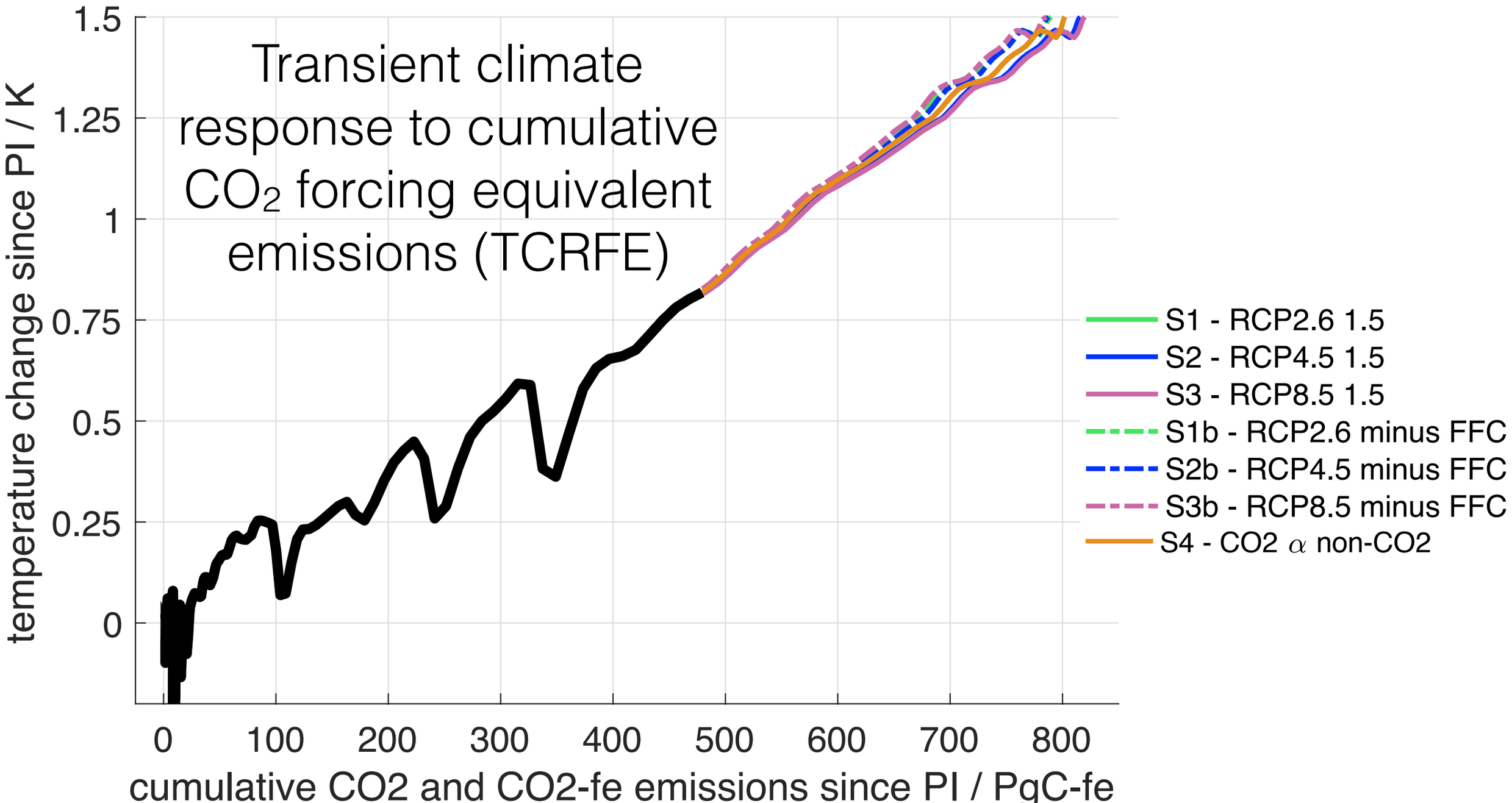

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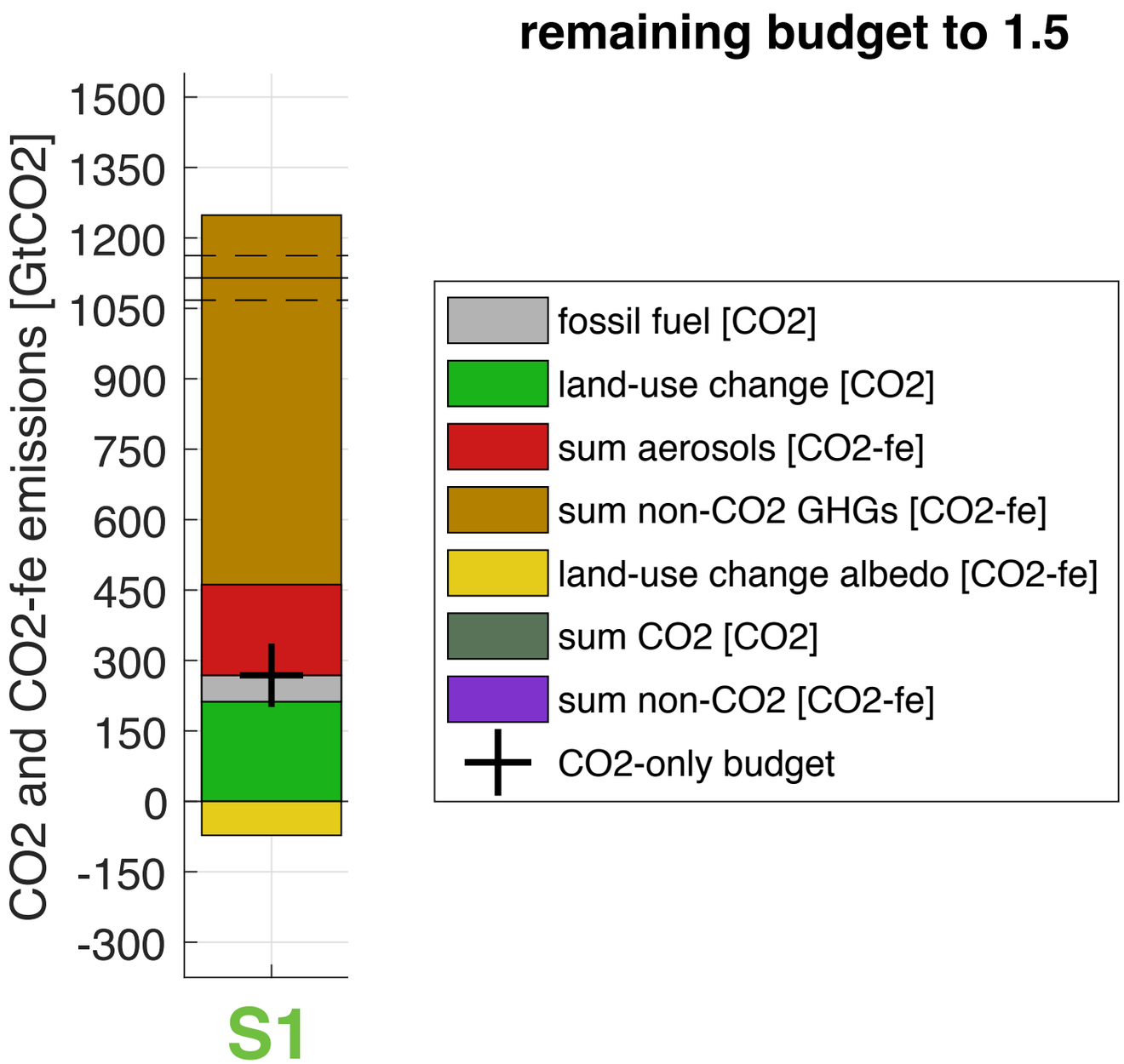

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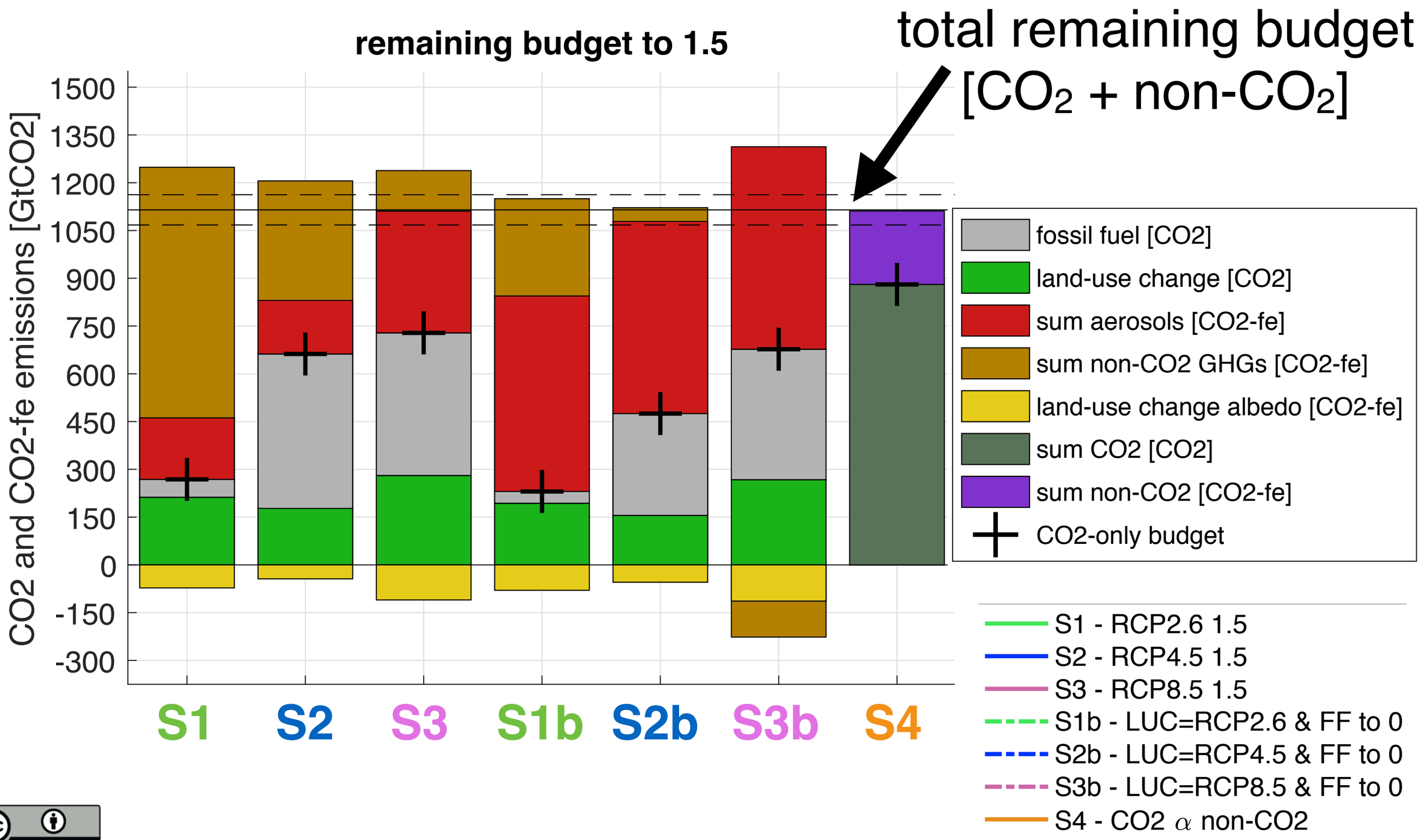

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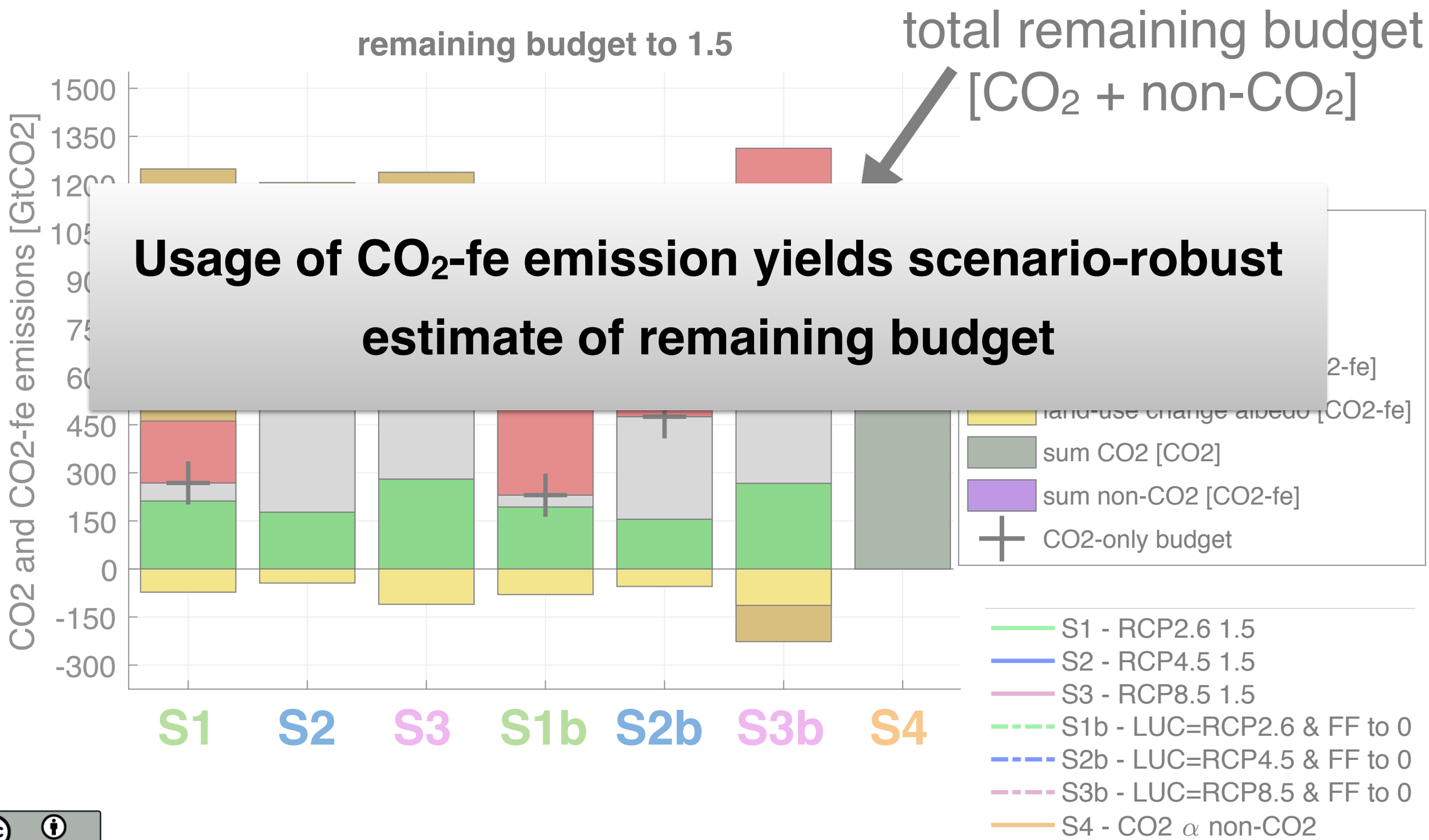

Usage of CO_2-fe emission yields scenario-robust estimate of remaining budget

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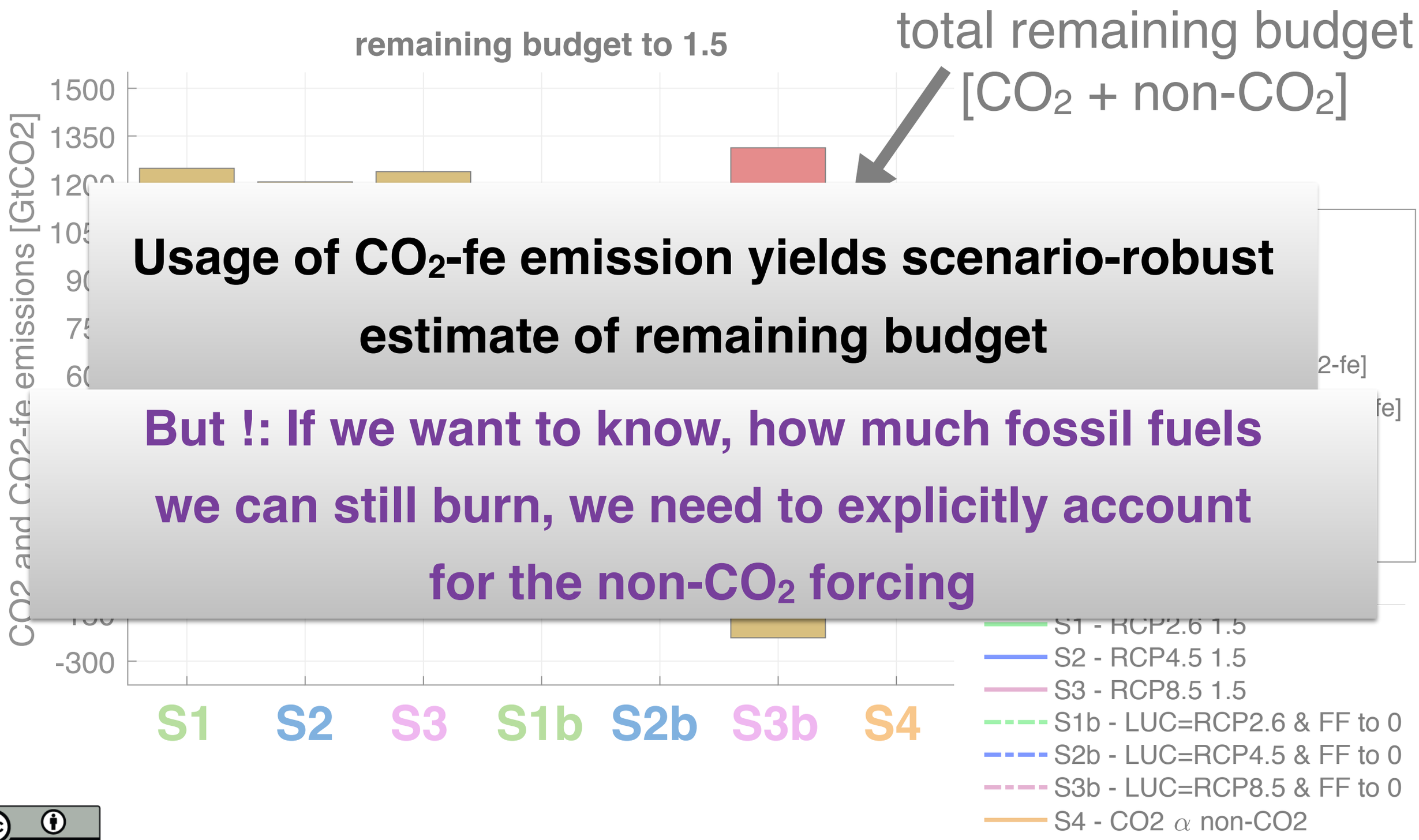

Usage of CO_2-fe emission yields scenario-robust estimate of remaining budget

But !: If we want to know, how much fossil fuels we can still burn, we need to explicitly account for the non-CO_2 forcing

1. How important is the contribution of non-CO_2 climate forcers?

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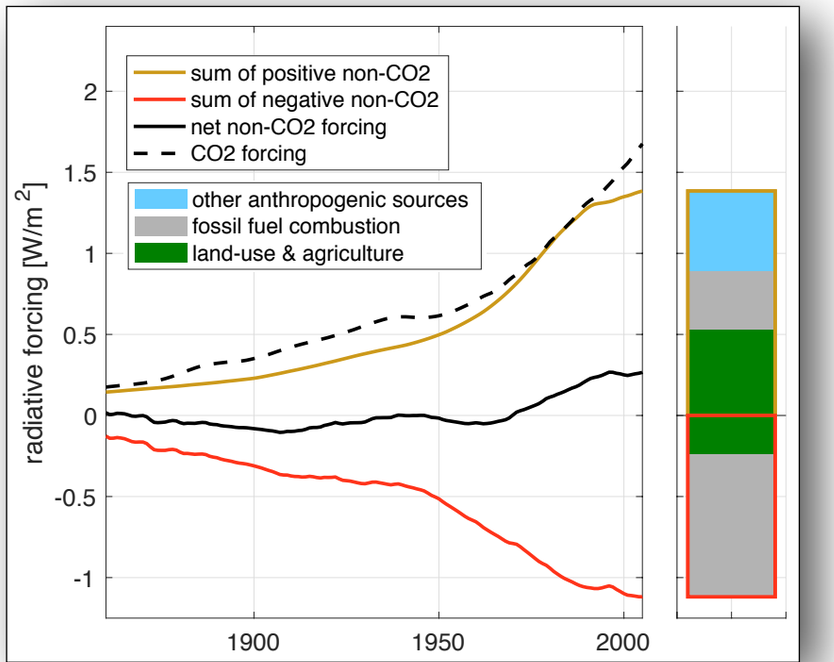
Important, it can be in the order of magnitude of CO_2! Different anthropogenic activities have different co-emissions: **LUC and agriculture** (**fossil fuels**) currently have a **warming** (**cooling**) non-CO_2 effect.



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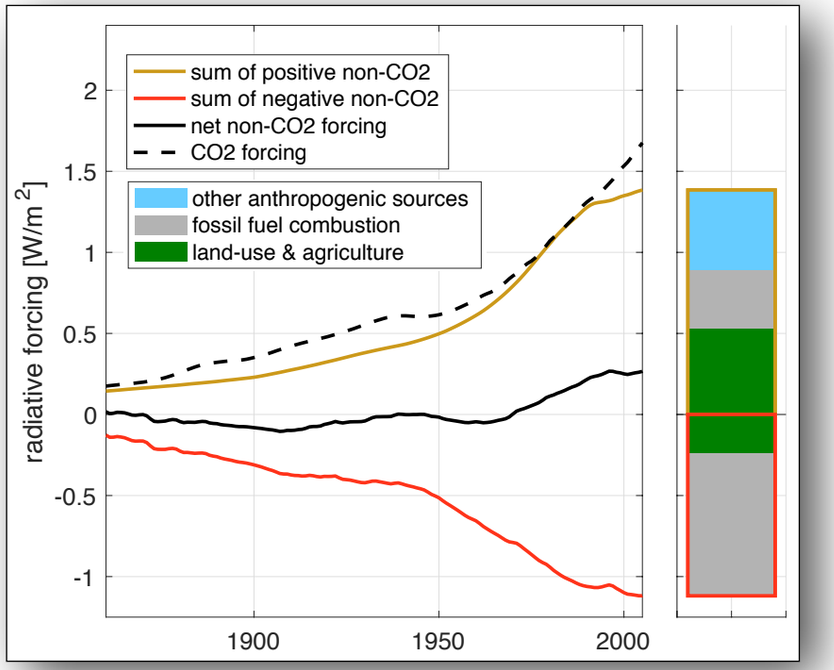

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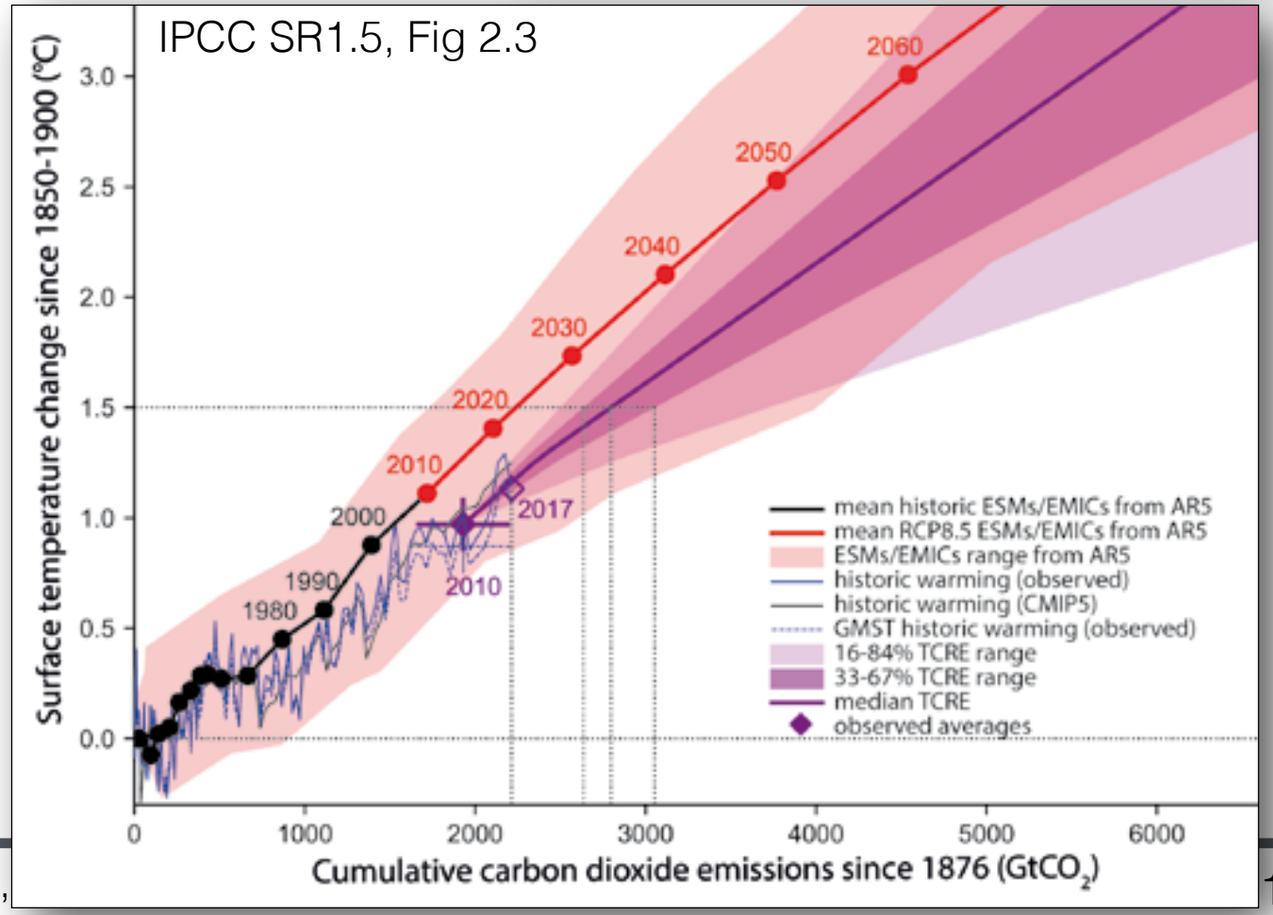

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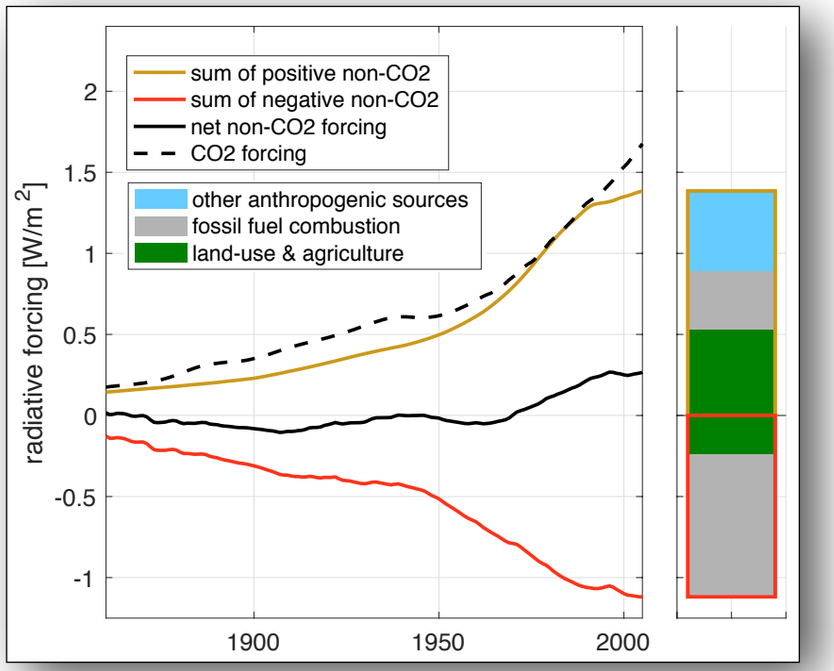

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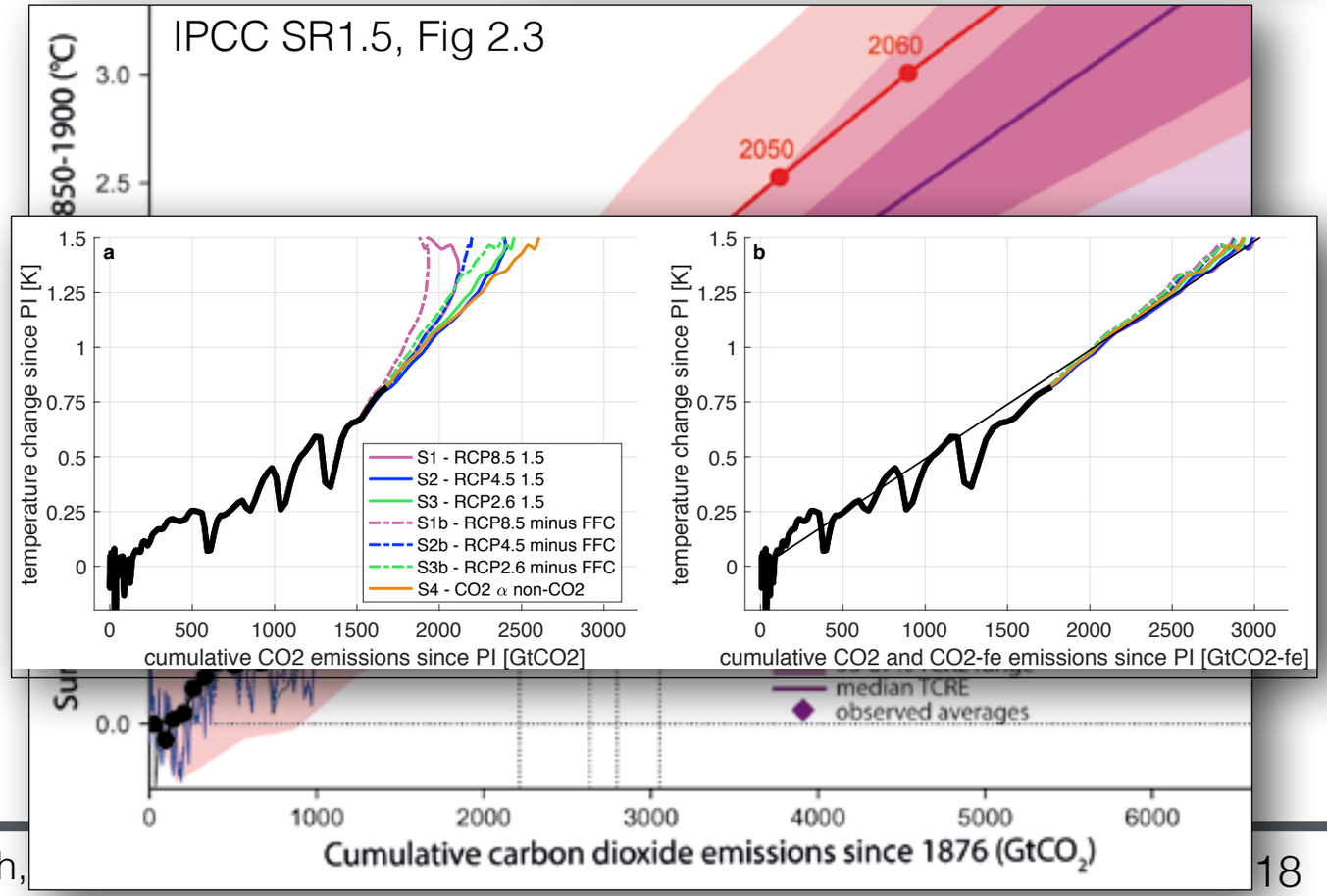
No, not without accounting for the effect of non-CO_2 climate forcers, by e.g. using forcing equivalent estimates of non-CO_2 forcers with the TCRFE.



Thank you

the presented results are based on:

Mengis, N., and H. D. Matthews. **Non-CO_2 forcing changes will likely decrease the remaining carbon budget for 1.5°C**, npj Climate and Atmospheric Science, accepted for publication

I am happy to answer questions !

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