



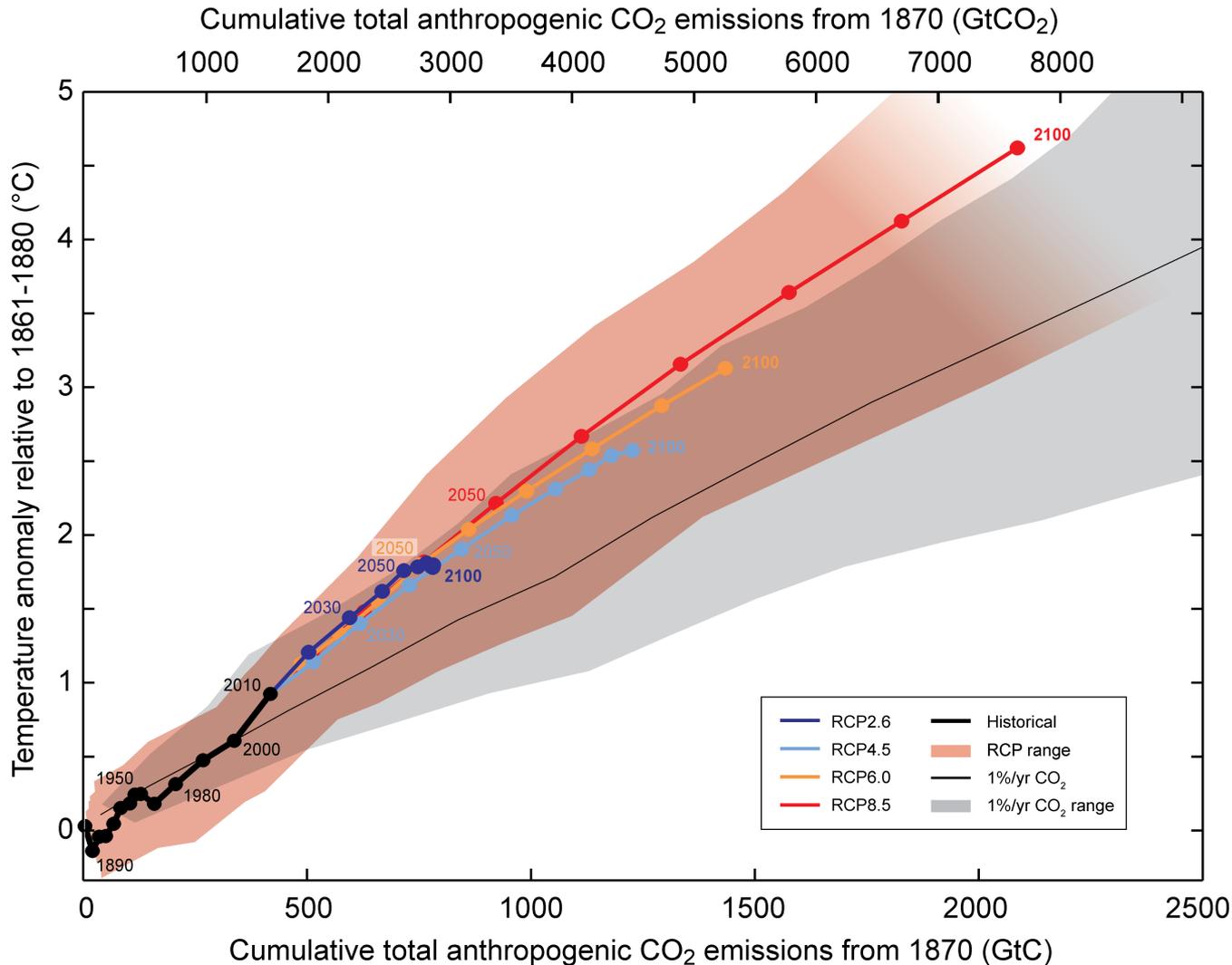
TCRE1.5: Quantifying the cumulative carbon emissions consistent with a 1.5C global warming

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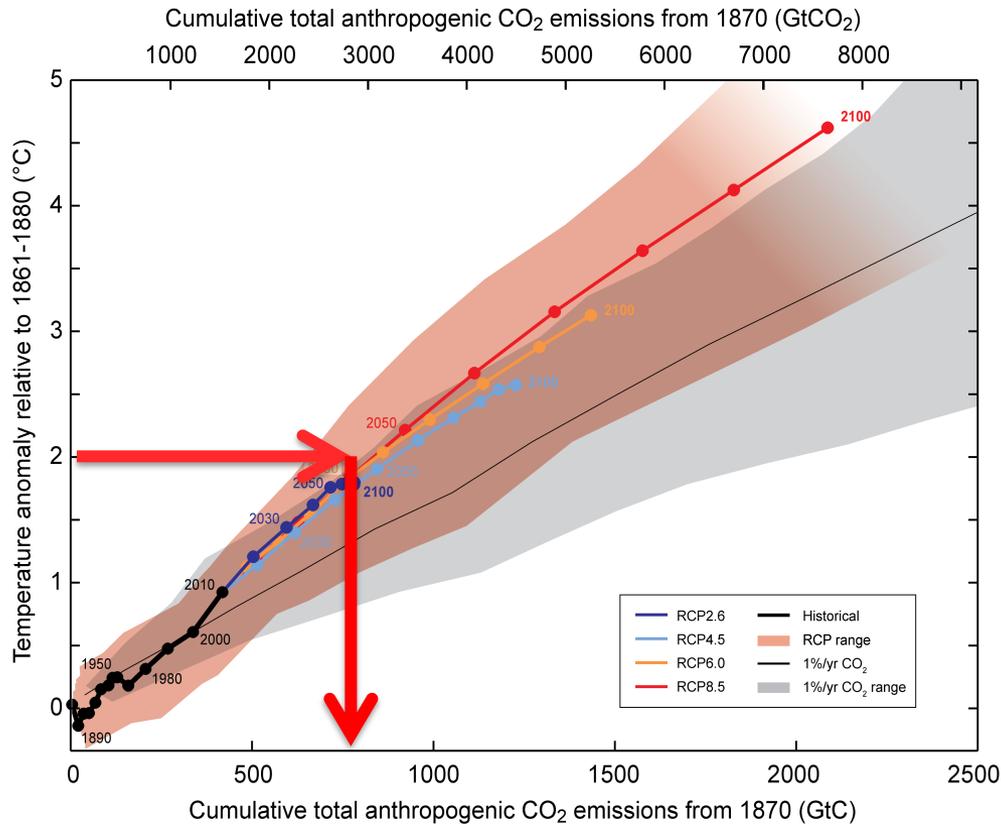
IPCC WG1 SPM :

Cumulative emissions of CO₂ largely determine global mean surface warming by the late 21st century and beyond



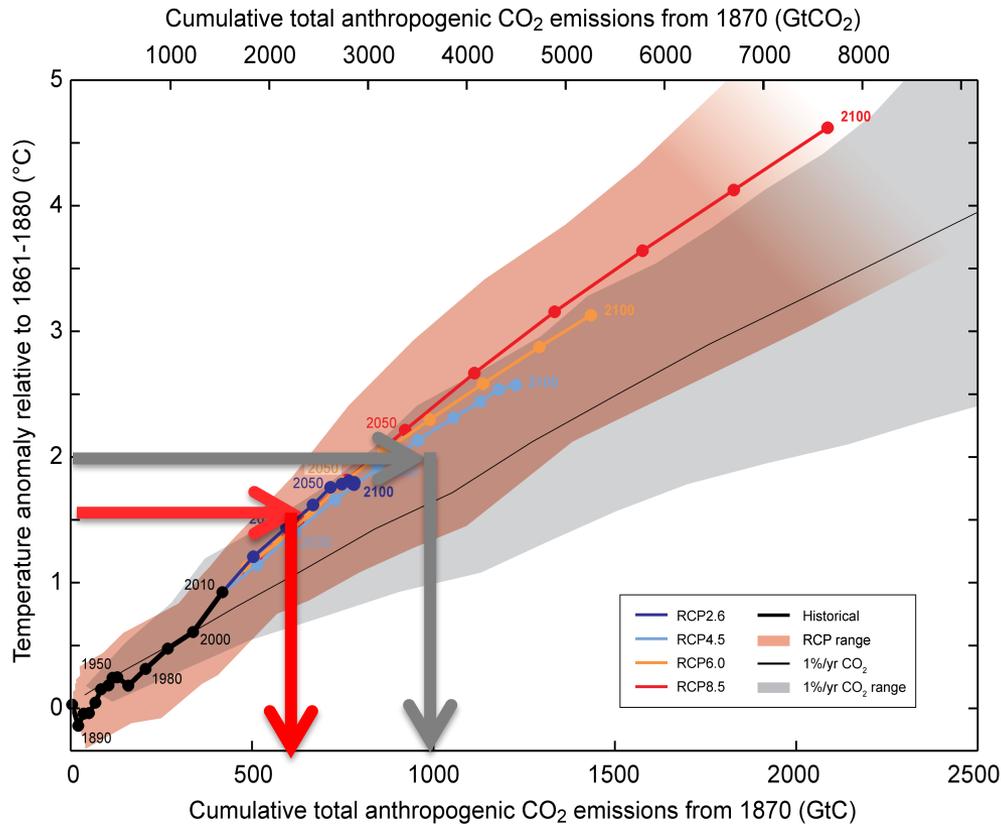
- *Probably one of the few novelty in AR5...*
- *Thanks to ESMs (climate and carbon cycle models)*

IPCC AR5 Cumulative Emissions Assessment



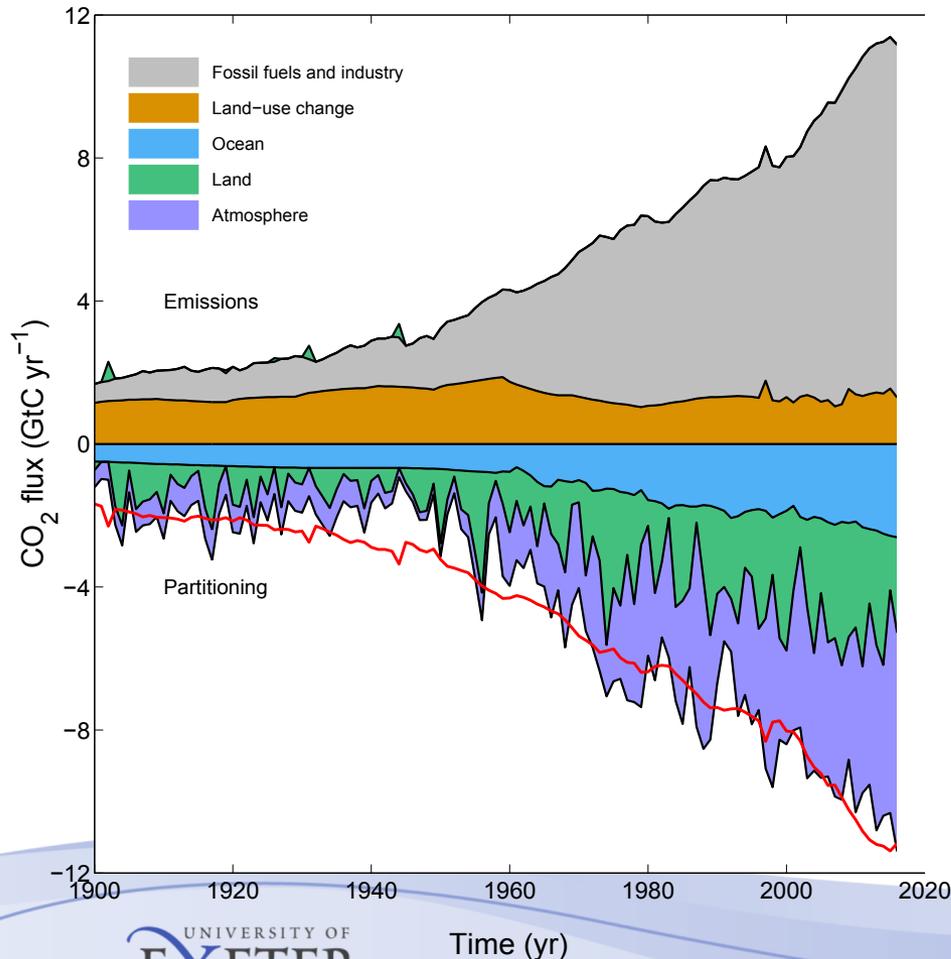
- To limit warming to *likely* less than **2° C** from CO₂ **alone**, total emissions need to be limited to less than **1000 GtC**.
- Accounting for non-CO₂ forcing as in RCP2.6 reduces the allowed cumulative emissions to about **790 GtC**.

IPCC AR5 Cumulative Emissions Assessment



➤ To limit warming to *likely* less than **1.5 ° C** (accounting for non-CO₂ forcing), CO₂ emissions need to be below **615 GtC**.

Historical emissions from the GCP Global Carbon Budget



- Cumulative budget for 1870-2016: **600 ± 65 GtC**
- About 190 GtC left for 2° C (less than 20 years at current rate)
- And about nothing left for 1.5° C

Confirmed on the web/twitter/blog-osphere

In the Paris Agreement, all countries worldwide decided to limit global warming to well below 2°C (ideally as much as 1.5°C) compared to pre-industrial levels. This is extremely ambitious and essentially means that we are tightening our carbon budget. In concrete terms, it means that reaching the 2°C target with a medium probability would allow us to emit at maximum only about 720 gigatonnes (Gt) of CO₂ between 2018 and 2100 into the atmosphere (stand 1.1.2018).¹ However, at present the world is still emitting 40 Gt of carbon dioxide.⁴ This equals 1,268 metric tonnes per second.

The Carbon Clock is ticking

time left until CO₂ budget depleted

year month day hour min sec
17 3 21 9 5 51 39

CO₂ budget left
692'284'268'766

[More →](#)

2°C scenario CO₂ emissions [tons/sec] **1'268** **1.5°C scenario**

time left until CO₂ budget depleted

year month day hour min sec
0 0 0 0 2 17 64

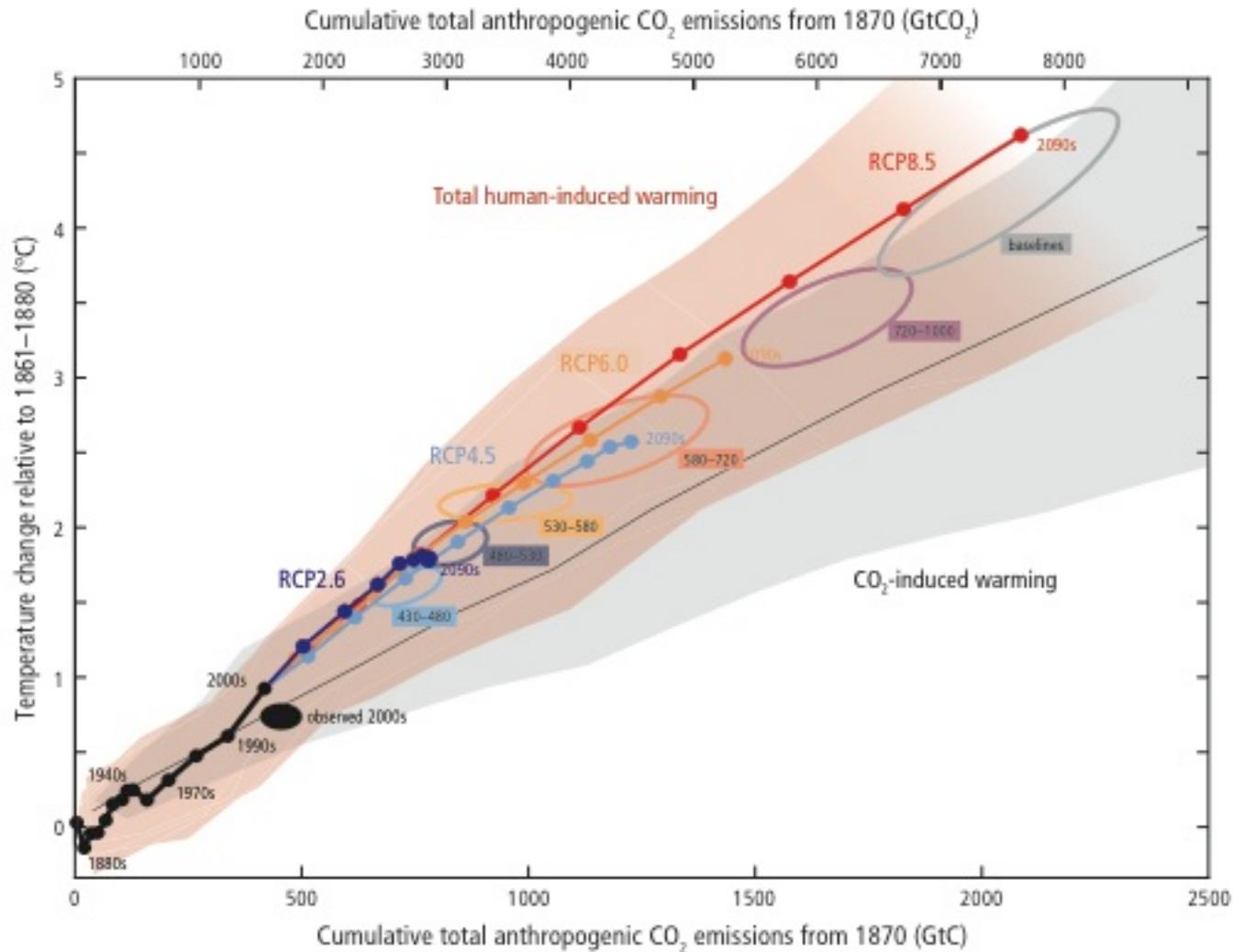
CO₂ budget left [tons]
exhausted by: 215'731'234

upper estimate
medium estimate
lower estimate

MCC

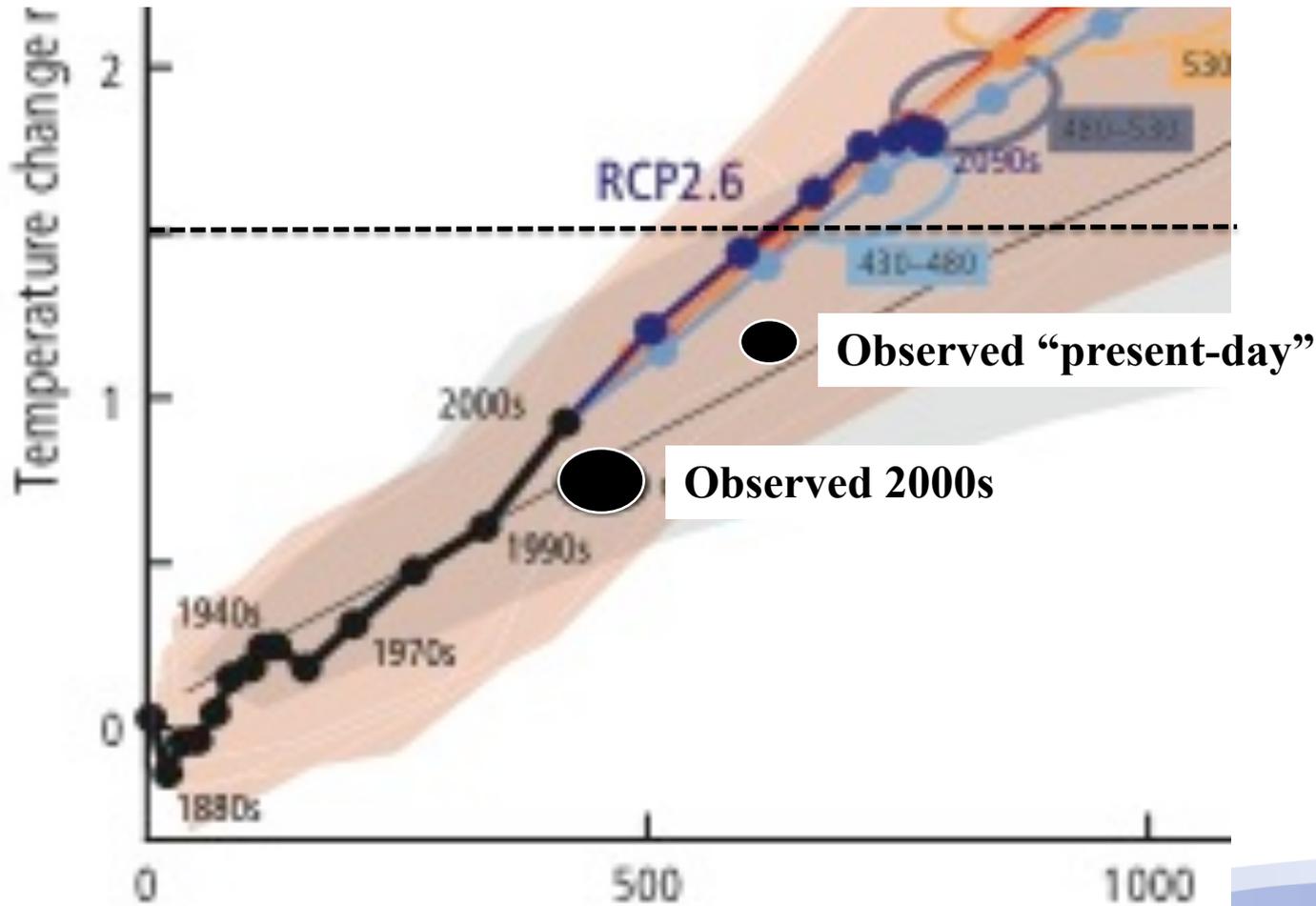
The clock is ticking. The carbon clock of the Mercator Research Institute on Global Commons and Climate Change (MCC) shows just how little time is left for political decision-makers. Visitors of

Where did we go wrong ?



Where did we go wrong ?

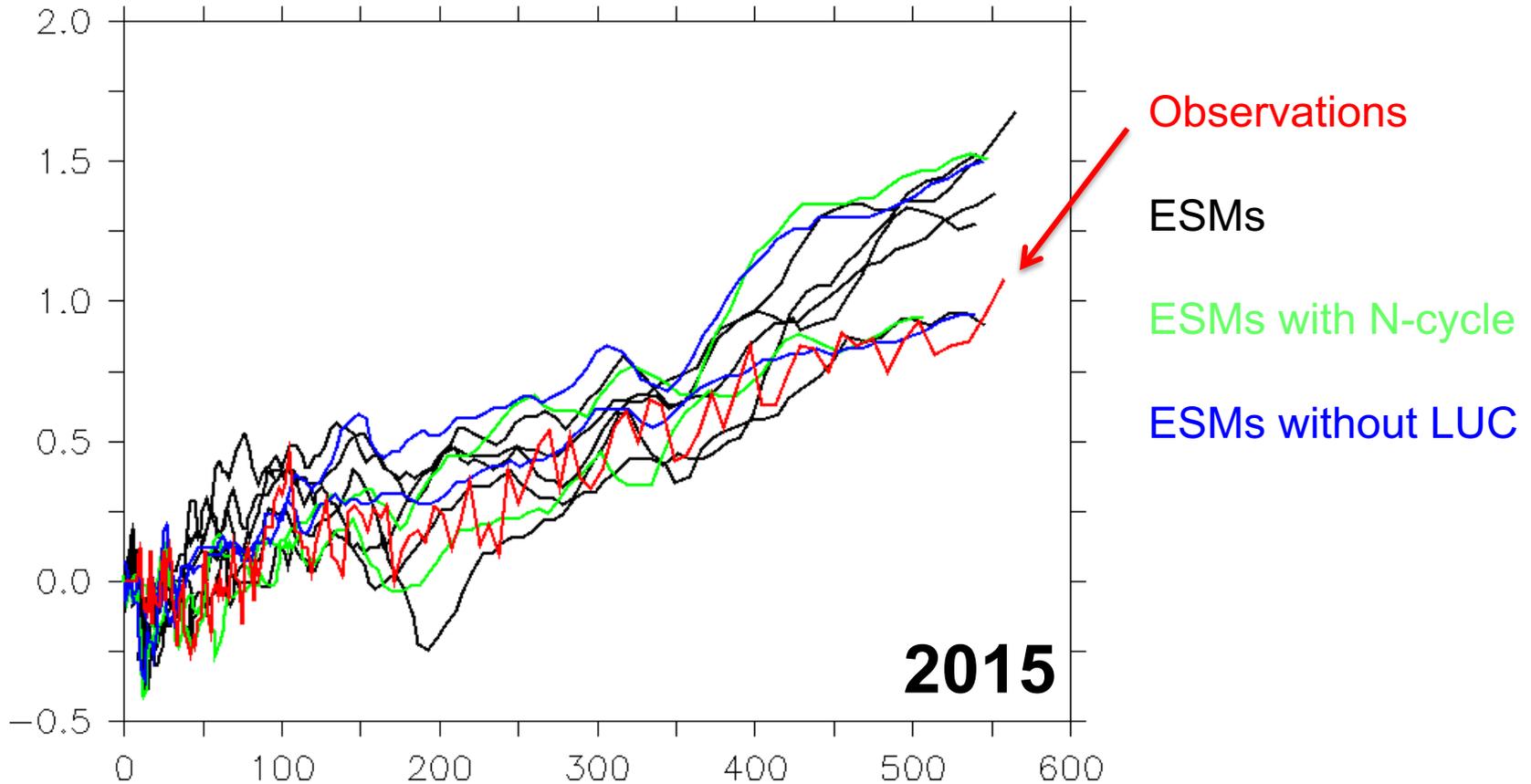
“Small” errors matter here



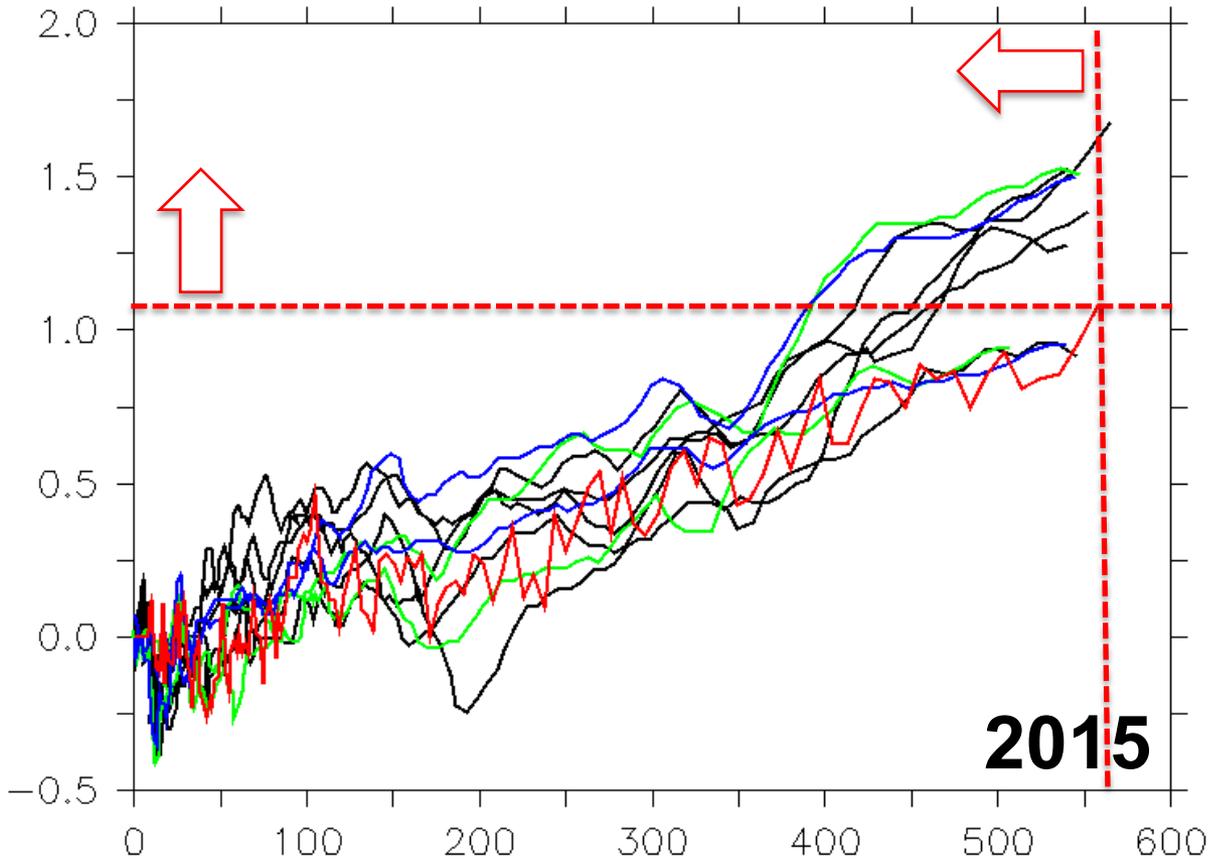
Models are
Well above
observations
(too warm
for too little
emissions)

Warming vs cumulative emissions

Mind the mess



Warming vs cumulative emissions

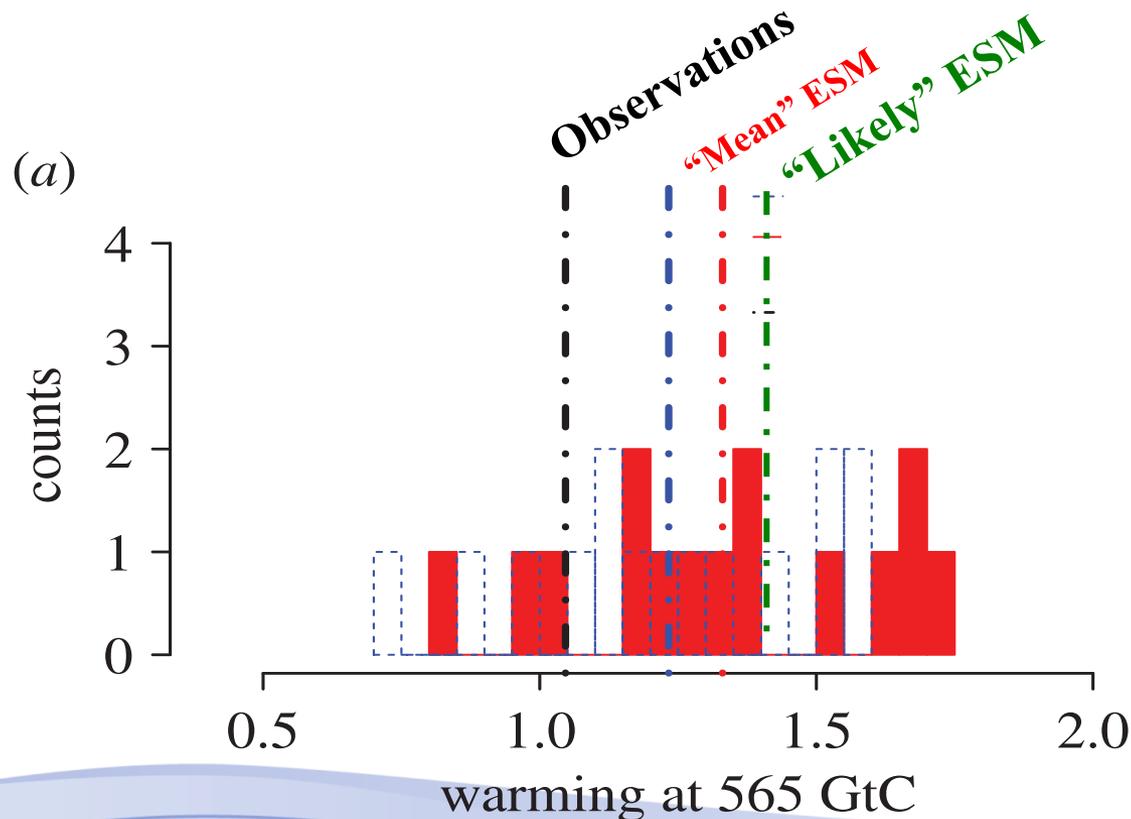


Most models are

- 1) too warm
- 2) for too little emissions

Let's check models "performances"

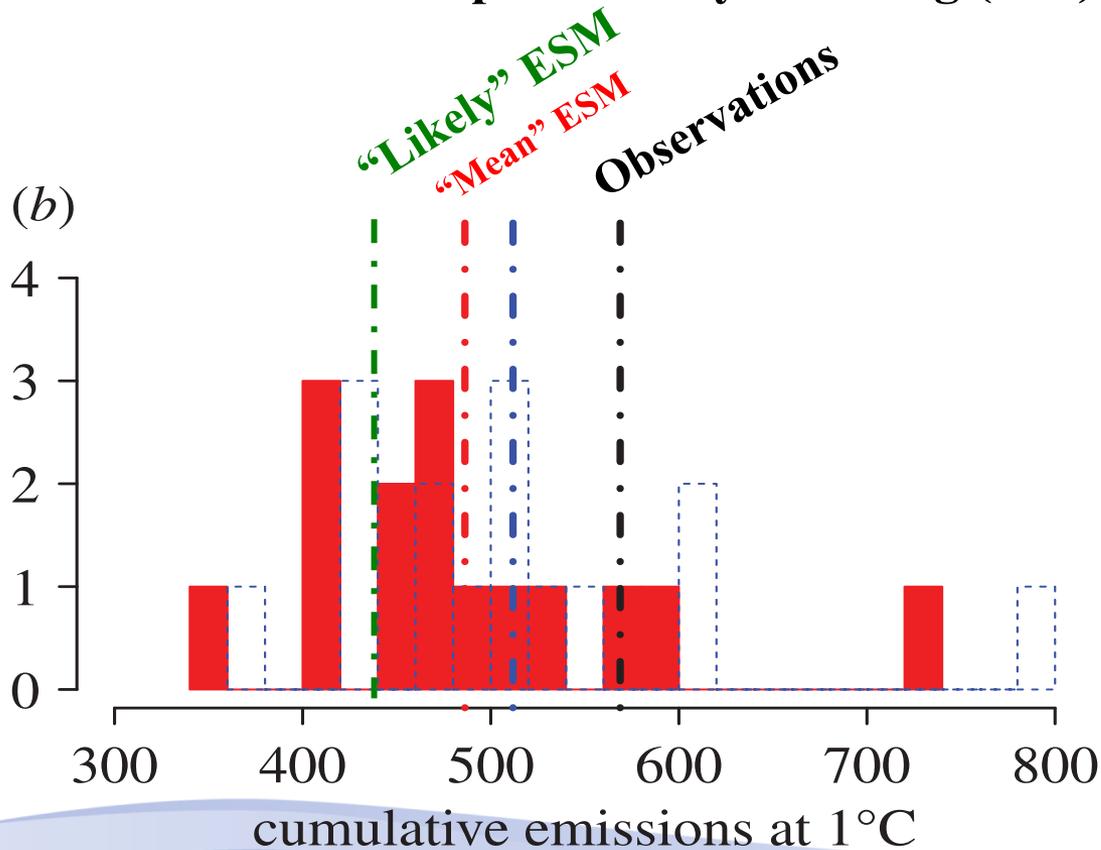
Q1: What is the simulated warming by the time the ESM compatible emissions reached present-day emissions (565 GtC)



➤ Answer from ESMs is:
about 1.4° C (66% of models)
Note that 4 models already reached 1.5° C by that time !

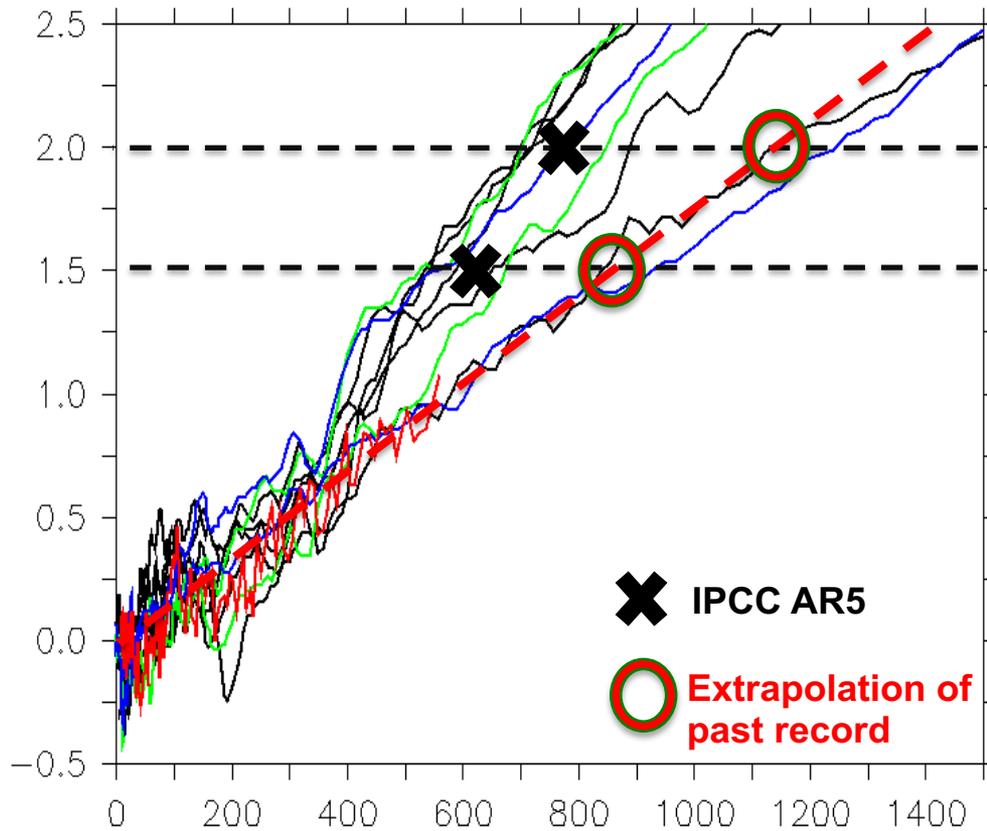
Let's check models "performances"

Q2: What are the simulated compatible emissions by the time the ESM reached present-day warming (1°C)



➤ Answer from ESMs is:
about 440GtC (66% of models)

Also inconsistent with the past

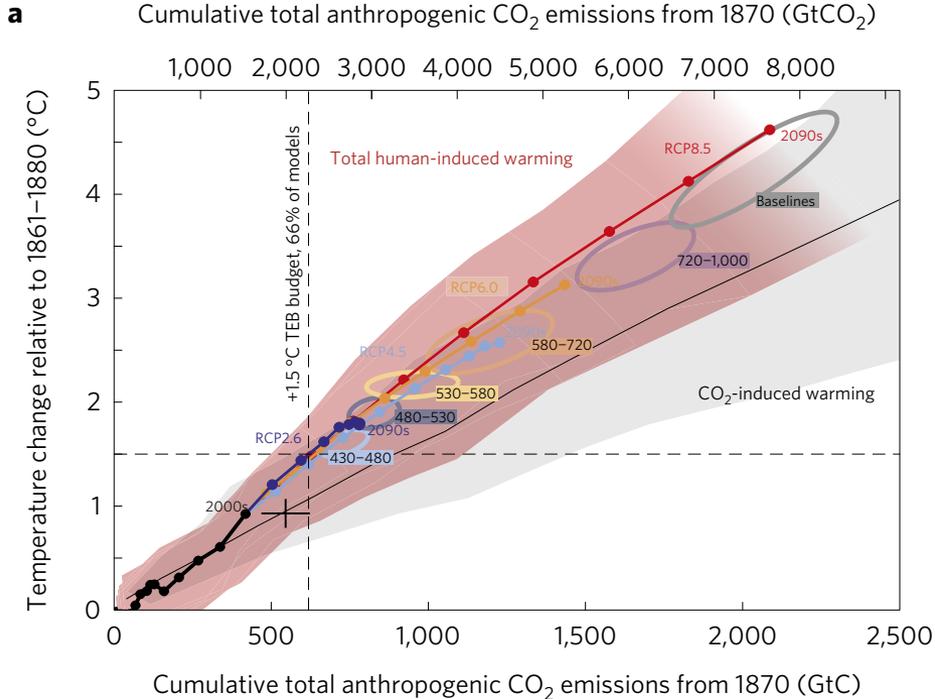


- No reason to believe that climate & carbon cycle feedbacks would be so different in the near future than in the past !
- Same for non-CO₂ forcing: it just can't explain it

Can we do better?



Take CMIP5 models



Millar et al, Nature Geo 2017

Normalize ESMs to present-day warming **and** emissions

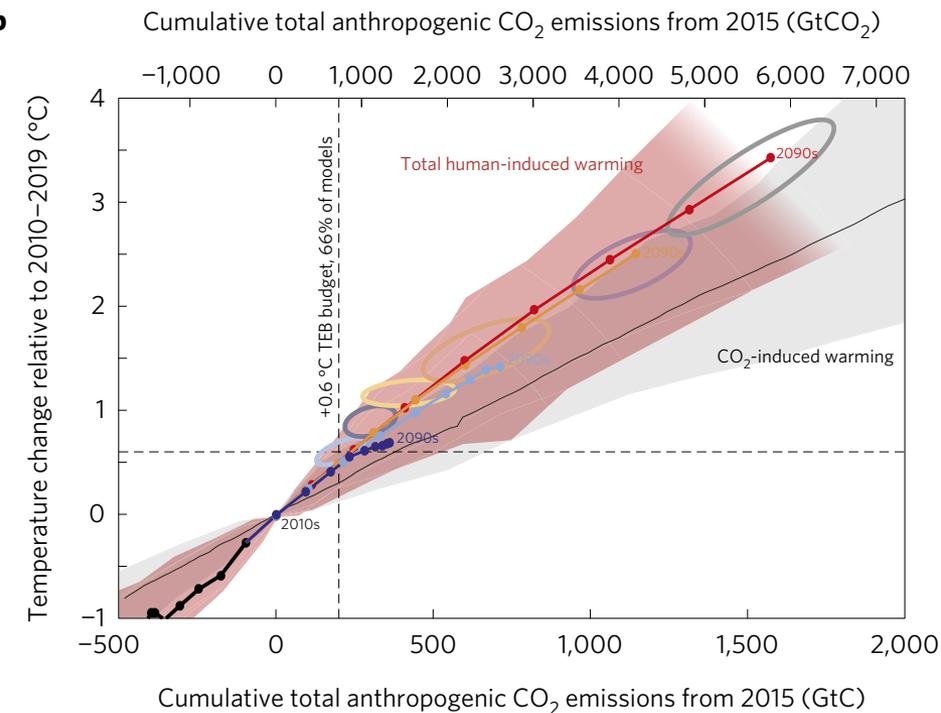


Table 2 | Future cumulative budgets (GtC) from January 2015 for percentiles of the distribution of RCP2.6 simulations of CMIP5 models and various levels of future warming above the modelled 2010–2019 average.

Warming above 2010–2019 average (°C)	Percentiles of CMIP5 models				
	90%	66%	50%	33%	10%
0.3	89	106	118	133	245
0.4	106	152	173	193	NA
0.5	126	191	214	258	NA
0.6	143	242	303	NA	NA
0.7	170	291	NA	NA	NA
0.8	177	372	NA	NA	NA
0.9	277	NA	NA	NA	NA
1.0	468	NA	NA	NA	NA
1.1	NA	NA	NA	NA	NA

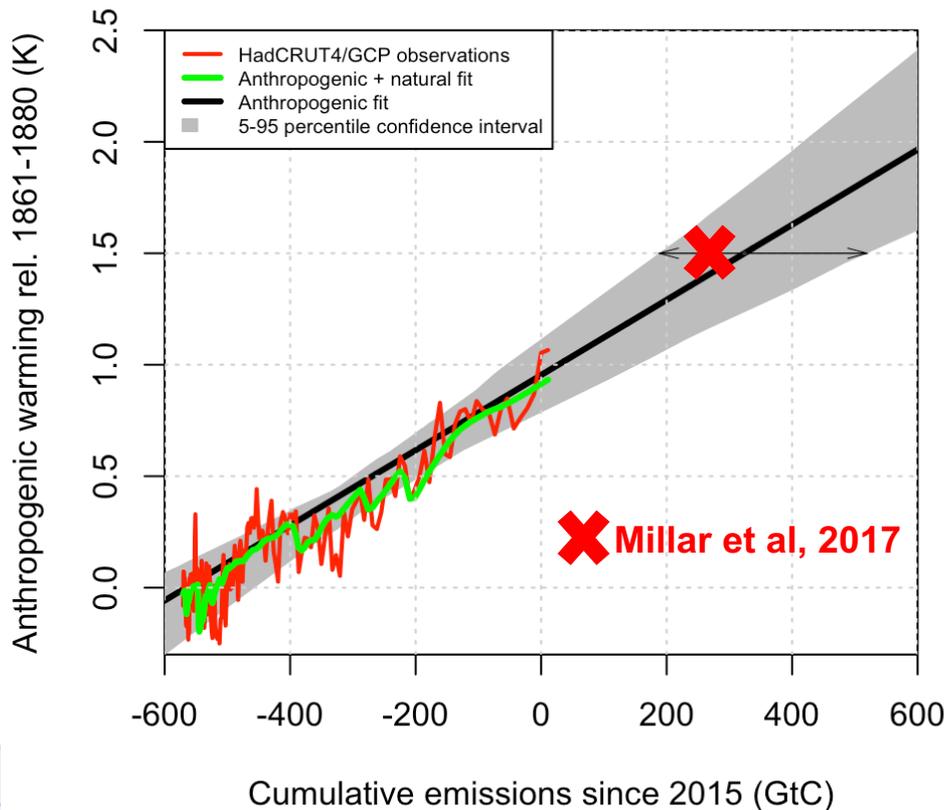
Percentiles correspond to the percentage of CMIP5 models that have greater cumulative emissions for the given level of warming. If an insufficient number of models warm above a particular threshold to calculate a given percentile of the total model distribution then a value of NA is given.

Millar et al, Nature Geo 2017

Assume an historical human-induced warming of about 1.0°C, remaining budget (from 2015) is about **190 GtC** (as opposed to **65 GtC** in AR5).

0.1°C uncertainty on historical warming translates into about **40GtC** uncertainty in remaining budget

More consistent with simple extrapolation of the past

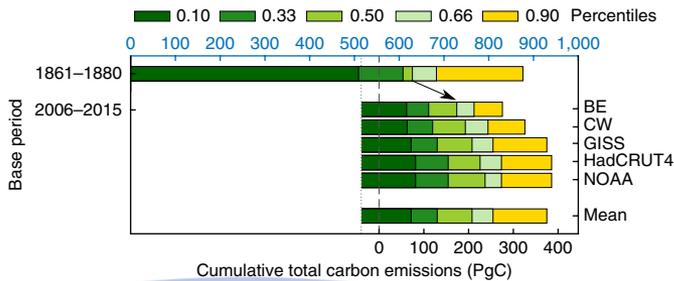
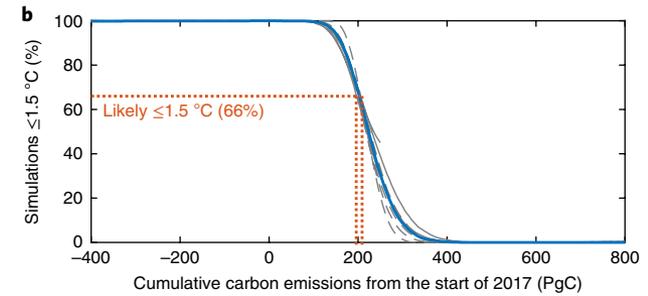
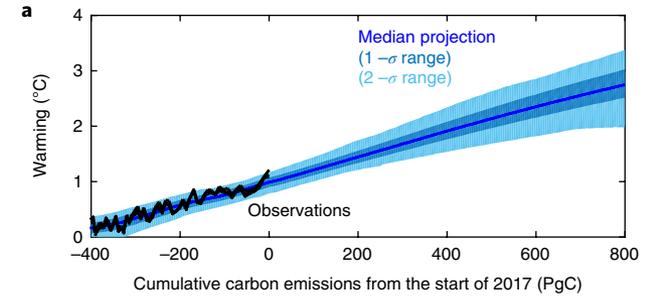
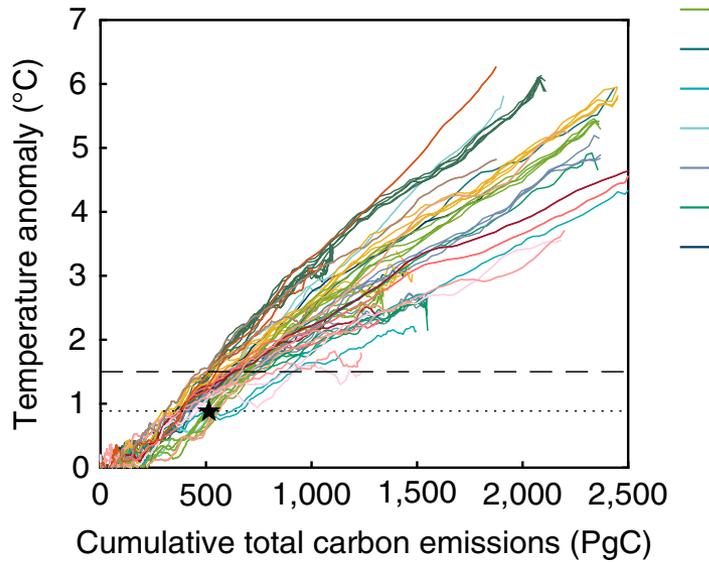


Observed “TCRE” range (GCP CO₂ emissions and HadCRU global temperature).

Calculate linear fit.

1.5°C gives a remaining C budget of about 300 GtC left.

Also confirmed by more recent studies



Goodwin et al., Nature Geo 2018

Tokarska and Gillett, Nature CC 2018

Conclusion

IPCC AR5 estimate of remaining carbon budget for **1.5°C** was **60GtC**

Our estimate is about **200 GtC**. This is consistent with observations and also confirmed by recent studies).

That's about **20 years** at current emission level (or **40 years** assuming emissions decrease linearly, **starting now**)

For **2°C**, remaining budget is about **400GtC**

Last: don't believe everything you find on the web about 1.5°C !



Thank you