# Greenhouse gas emission targets for limiting global warming to 2°C


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# <2°C

More than 100 countries call for 2°C target or lower.

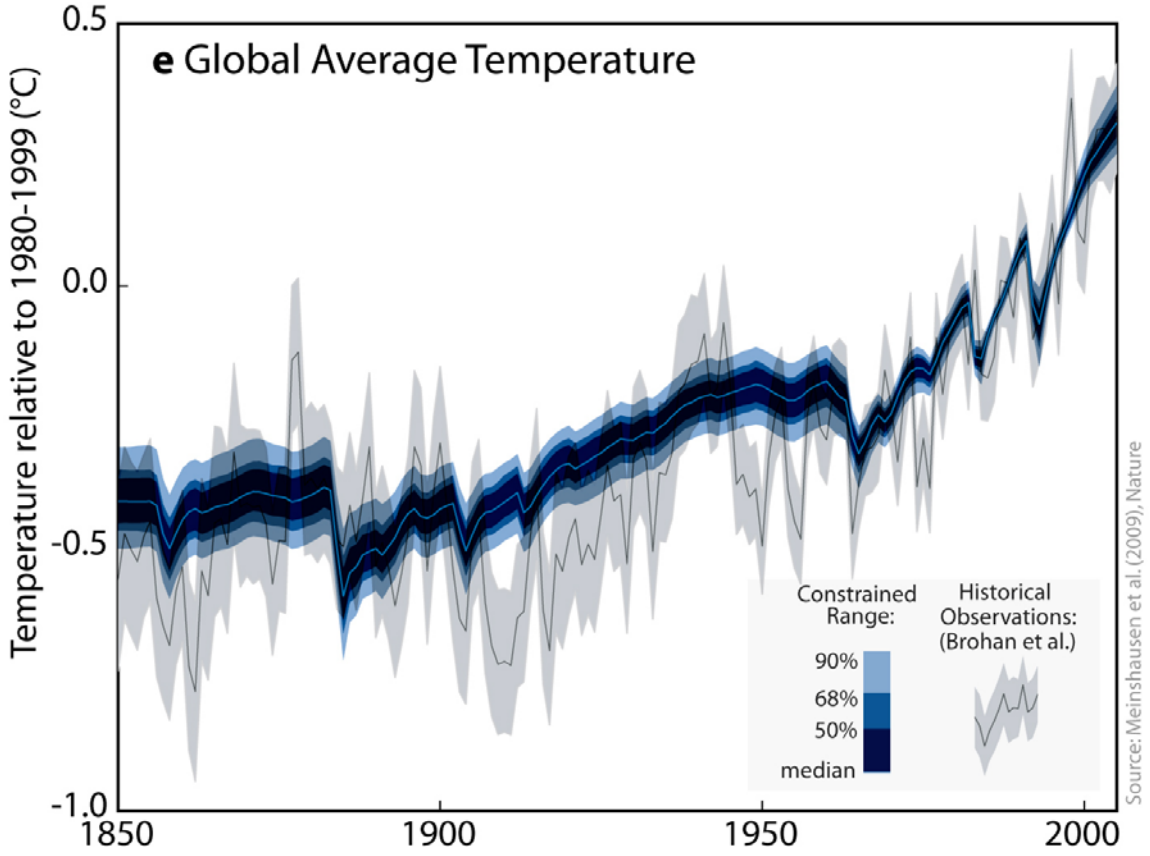
→ How much emission reductions necessary for reaching this target?

MAGICC

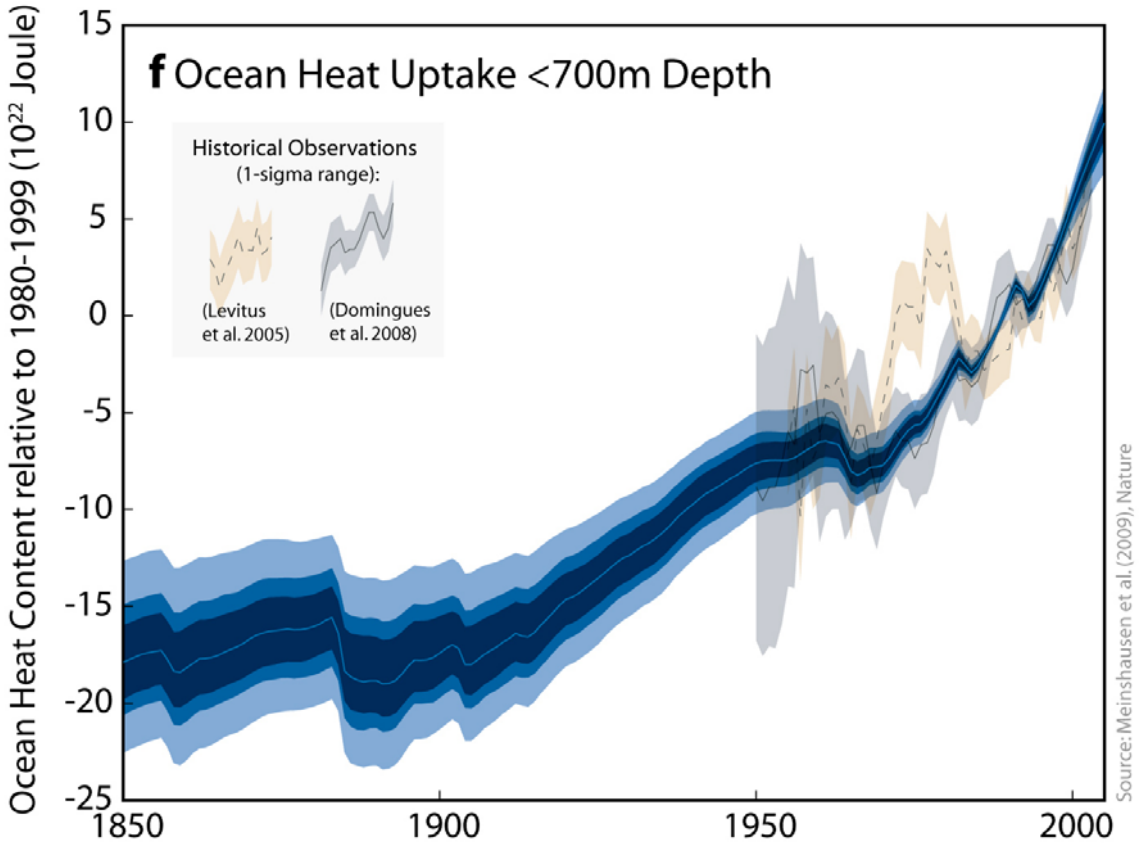
We used MAGICC 6.0, the latest version of a reduced complexity coupled carbon cycle-climate model, used in past IPCC Assessment reports.

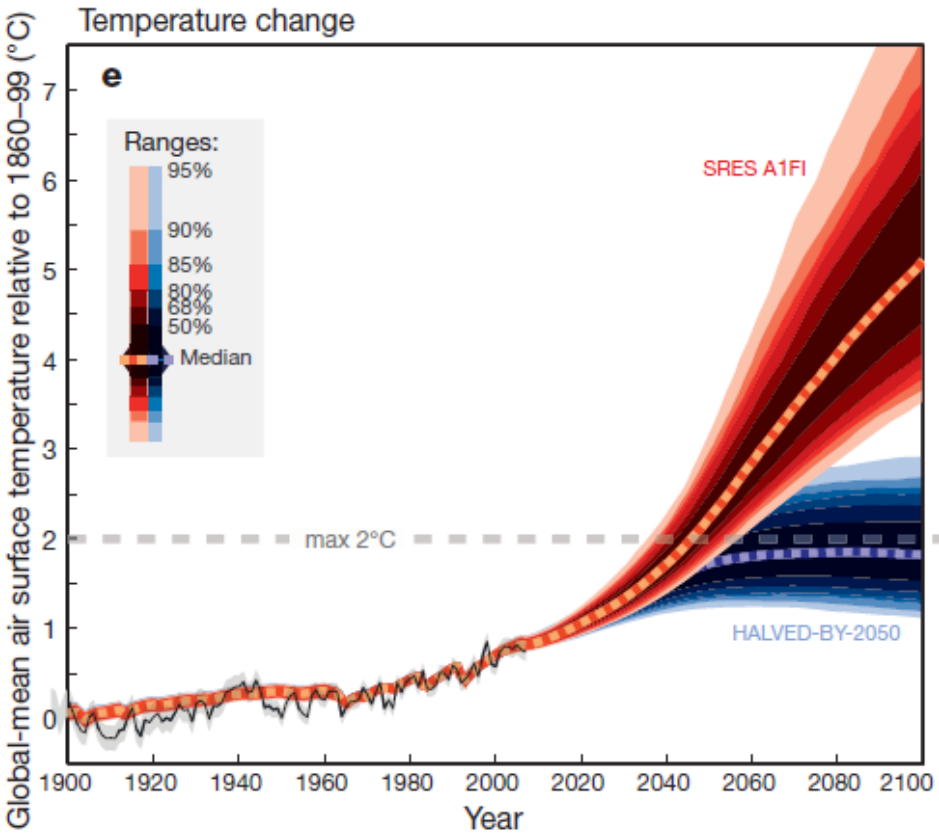
→ Reflecting current scientific uncertainties across carbon cycle and climate response, as well as radiative forcing.

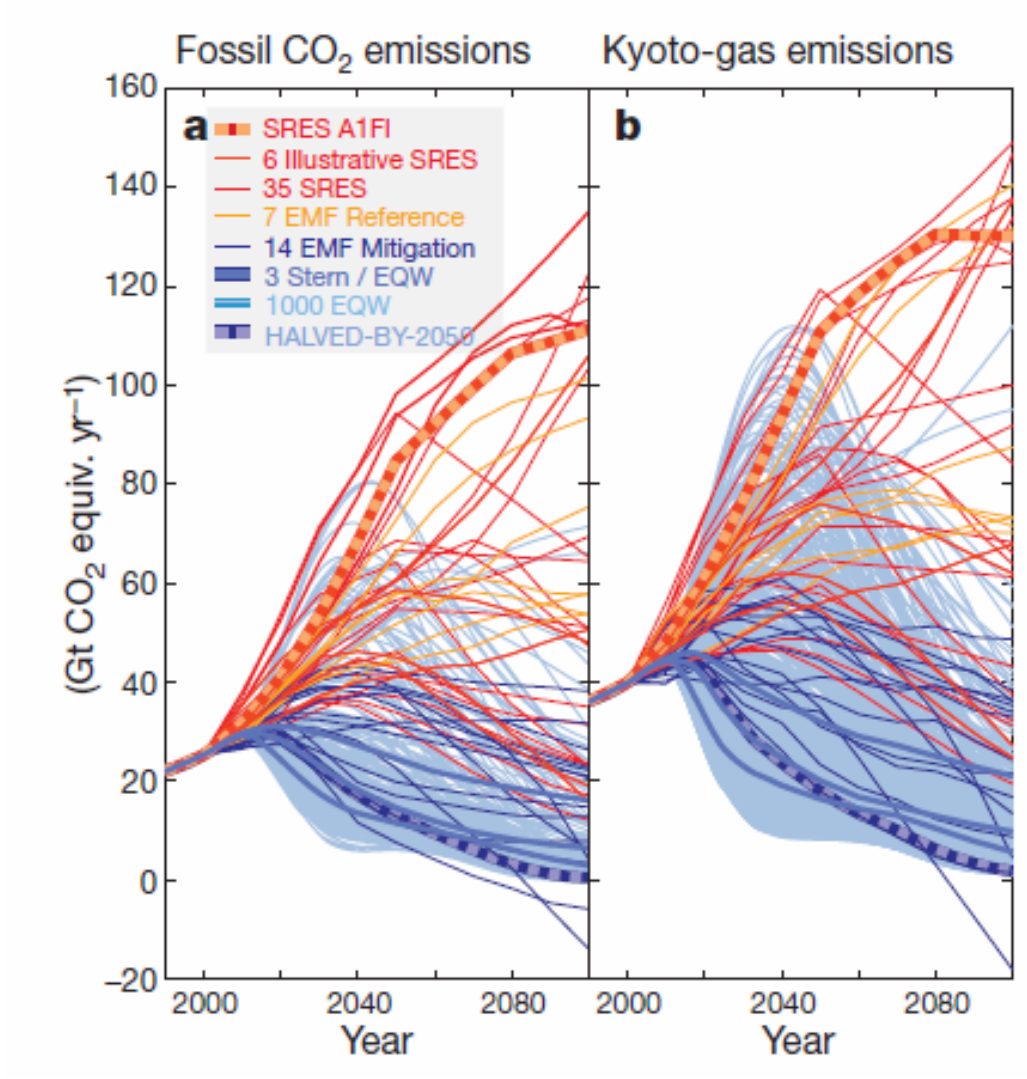
# Observational constraining

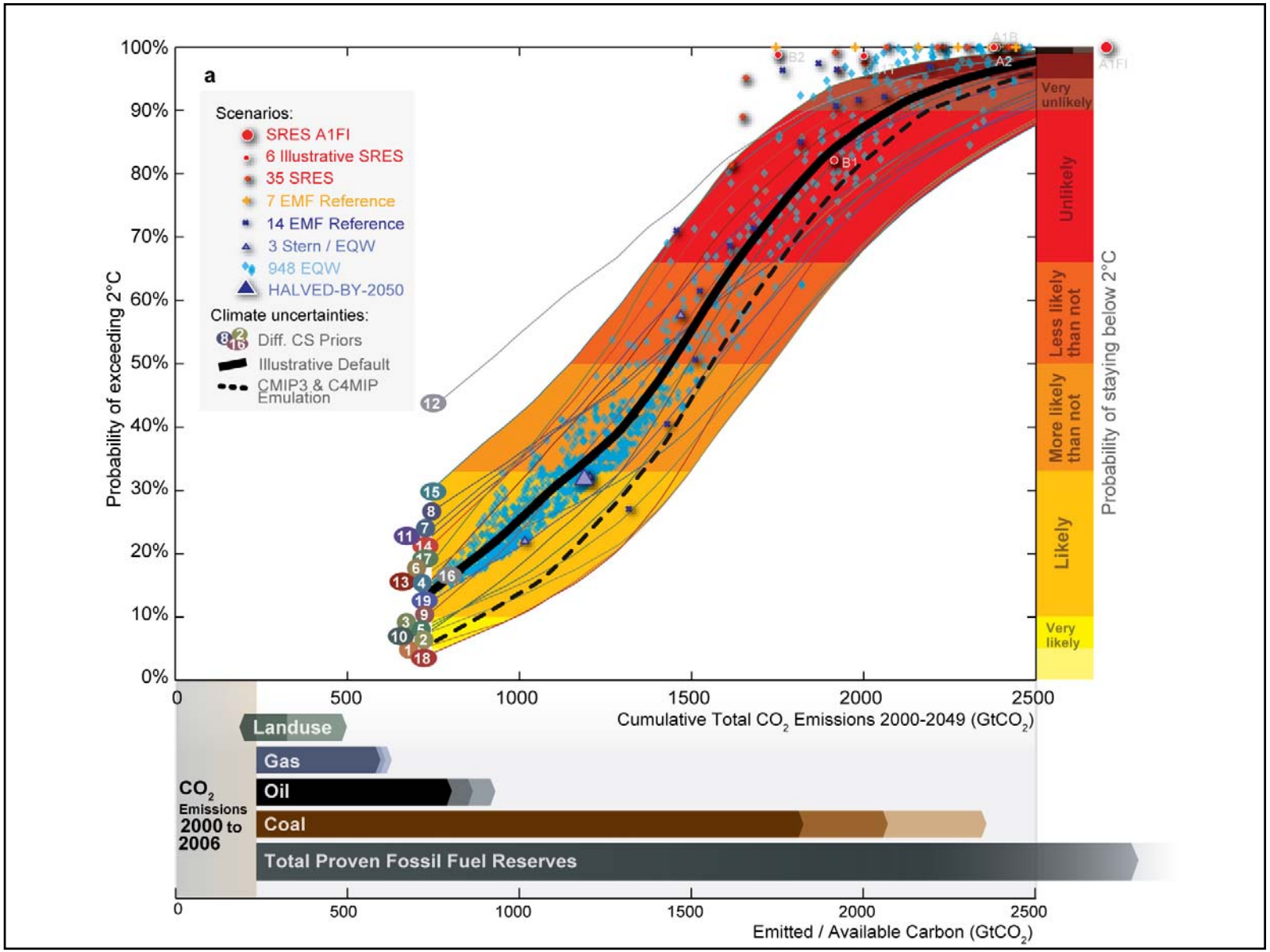


# Observational constraining




Temperature change
e
Ranges:
95%
90%
85%
80%
68%
50%
Median
SRES A1FI
max 2°C
HALVED-BY-2050
Global-mean air surface temperature relative to 1860–99 (°C)
0
1
2
3
4
5
6
7
1900
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
Year


Fossil $CO_2$ emissions
Kyoto-gas emissions
a
b
SRES A1FI
6 Illustrative SRES
35 SRES
7 EMF Reference
14 EMF Mitigation
3 Stern / EQW
1000 EQW
HALVED-BY-2050
(Gt $CO_2$ equiv. $yr^{-1}$)
160
140
120
100
80
60
40
20
0
–20
2000
2040
2080
Year


a
Scenarios:
SRES A1FI
6 Illustrative SRES
35 SRES
7 EMF Reference
14 EMF Reference
3 Stern / EQW
948 EQW
HALVED-BY-2050
Climate uncertainties:
Diff. CS Priors
Illustrative Default
CMIP3 & C4MIP Emulation
Probability of exceeding 2°C
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
500
1000
1500
2000
2500
Cumulative Total $CO_2$ Emissions 2000-2049 ($GtCO_2$)
A1B
B2
A2
A1FI
B1
Very unlikely
Unlikely
Less likely than not
More likely than not
Likely
Very likely
Probability of staying below 2°C
Landuse
Gas
Oil
Coal
Total Proven Fossil Fuel Reserves
$CO_2$ Emissions 2000 to 2006
0
500
1000
1500
2000
2500
Emitted / Available Carbon ($GtCO_2$)

# 1 Trillion tonnes $CO_2$ between 2000 and 2050

**Table 1 | Probabilities of exceeding 2 °C**

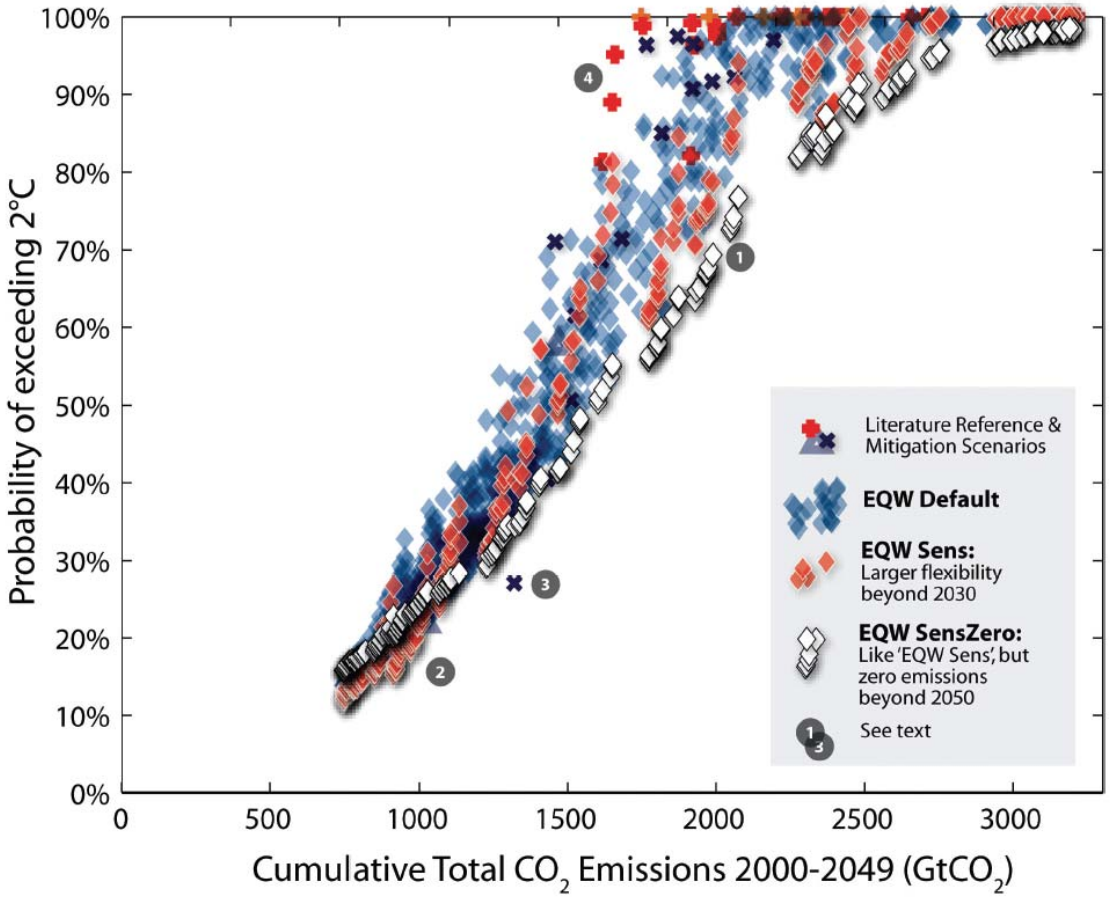
| Indicator | Emissions | Probability of exceeding 2 °C* | |
|---|---|---|---|
| | | Range | Illustrative default case‡ |
| Cumulative total $CO_2$ emission 2000–49 | 886 Gt $CO_2$ | 8–37% | 20% |
| | 1,000 Gt $CO_2$ | 10–42% | 25% |
| | 1,158 Gt $CO_2$ | 16–51% | 33% |
| | 1,437 Gt $CO_2$ | 29–70% | 50% |
| Cumulative Kyoto-gas emissions 2000–49 | 1,356 Gt $CO_2$ equiv. | 8–37% | 20% |
| | 1,500 Gt $CO_2$ equiv. | 10–43% | 26% |
| | 1,678 Gt $CO_2$ equiv. | 15–51% | 33% |
| | 2,000 Gt $CO_2$ equiv. | 29–70% | 50% |
| 2050 Kyoto-gas emissions | 10 Gt $CO_2$ equiv. $yr^{-1}$ | 6–32% | 16% |
| | (Halved 1990) 18 Gt $CO_2$ equiv. $yr^{-1}$ | 12–45% | 29% |
| | (Halved 2000) 20 Gt $CO_2$ equiv. $yr^{-1}$ | 15–49% | 32% |
| | 36 Gt $CO_2$ equiv. $yr^{-1}$ | 39–82% | 64% |
| 2020 Kyoto-gas emissions | 30 Gt $CO_2$ equiv. $yr^{-1}$ | (8–38%)† | (21%)† |
| | 35 Gt $CO_2$ equiv. $yr^{-1}$ | (13–46%)† | (29%)† |
| | 40 Gt $CO_2$ equiv. $yr^{-1}$ | (19–56%)† | (37%)† |
| | 50 Gt $CO_2$ equiv. $yr^{-1}$ | (53–87%)† | (74%)† |

* Range across all priors reflecting the various climate sensitivity distributions with the exception of line 12 in Fig. 3a.
† Note that 2020 Kyoto-gas emissions are, from a physical perspective, a less robust indicator for maximal twenty-first century warming with a wide scenario-to-scenario spread (Supplementary Fig. 1c).
‡ Prior chosen to match posterior of ref. 19 with uniform priors on the TCR.

# Key findings

- Temperature results: Cumulative Emissions (and emission levels in 2050) are the key.
- 1 Trillion Tonnes of CO2 between 2000 and 2050, if probability of exceeding 2 °C shall be limited to 25%.
- A third of that budget we used already in past nine years.
- Less than a quarter economically recoverable fossil fuel reserves can still be used

# Additional material



**Emissions, concentrations and 21st century global mean temperatures.**