

Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

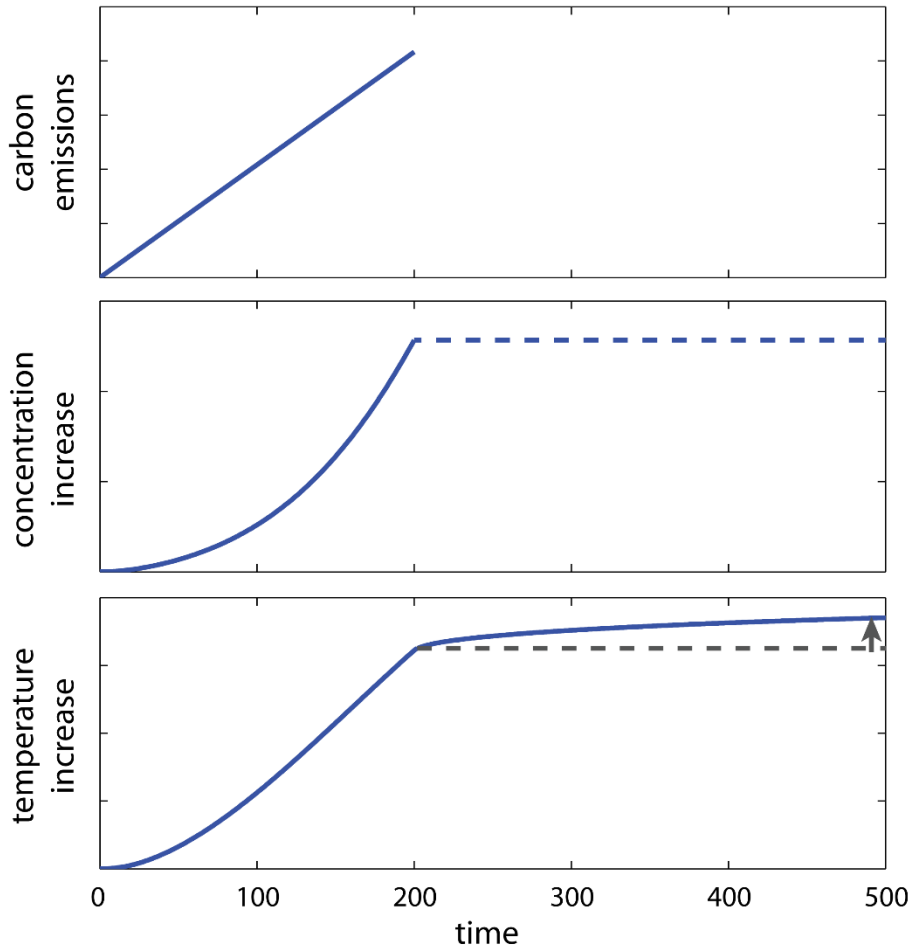
Commitment, irreversibility, targets, and cumulative CO₂ emissions

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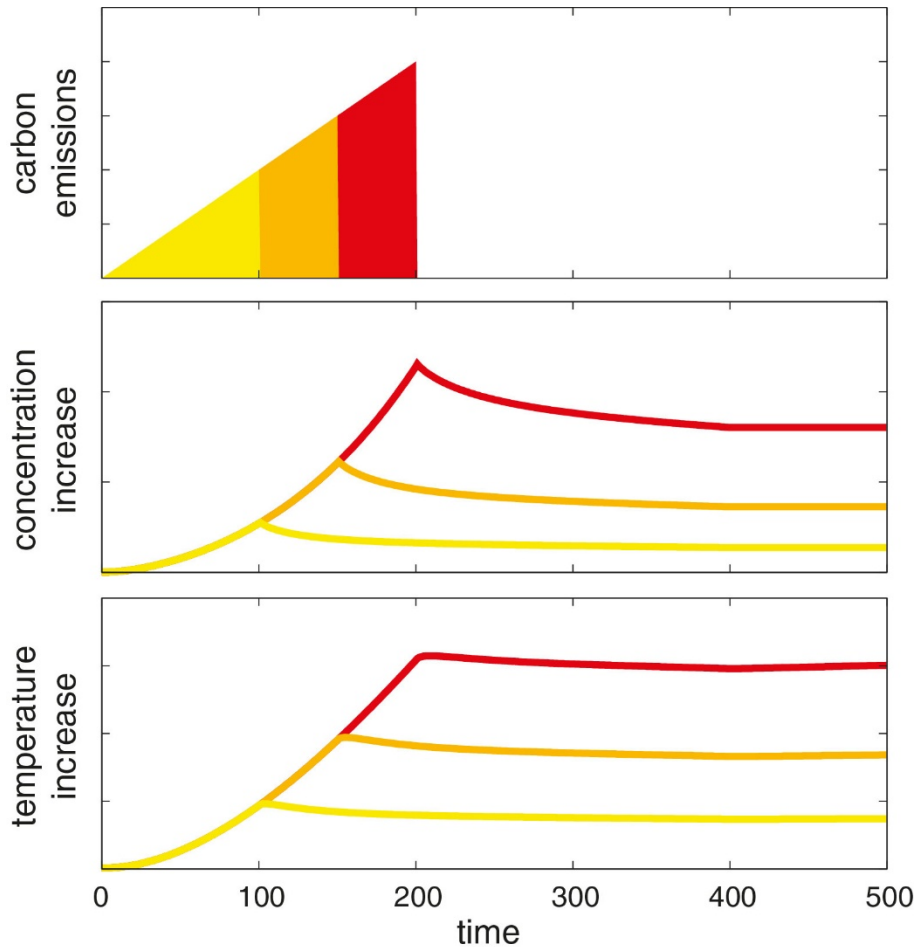
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Climate change commitment



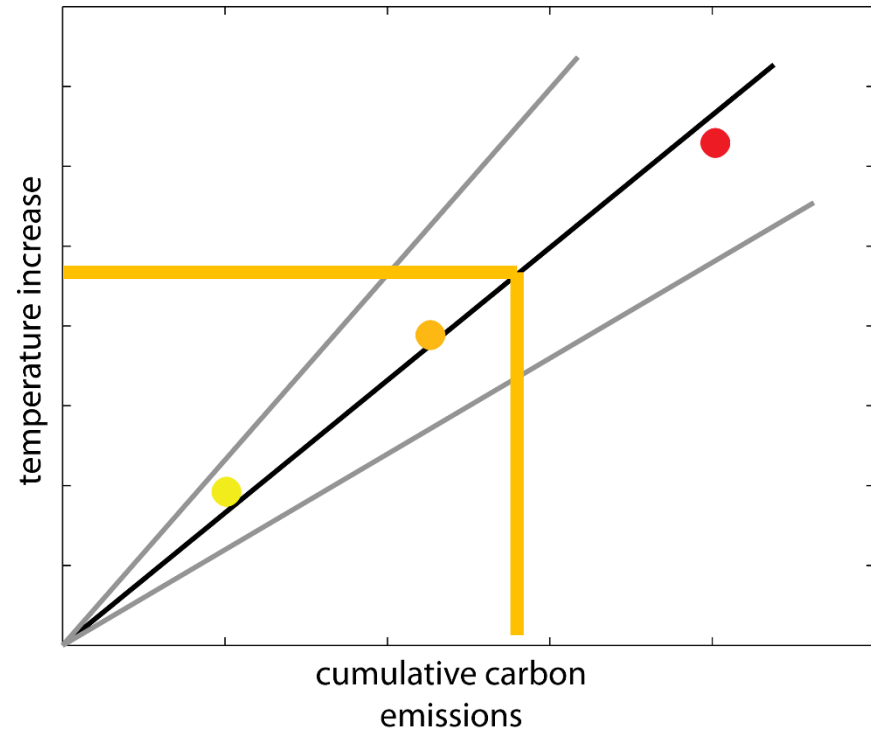
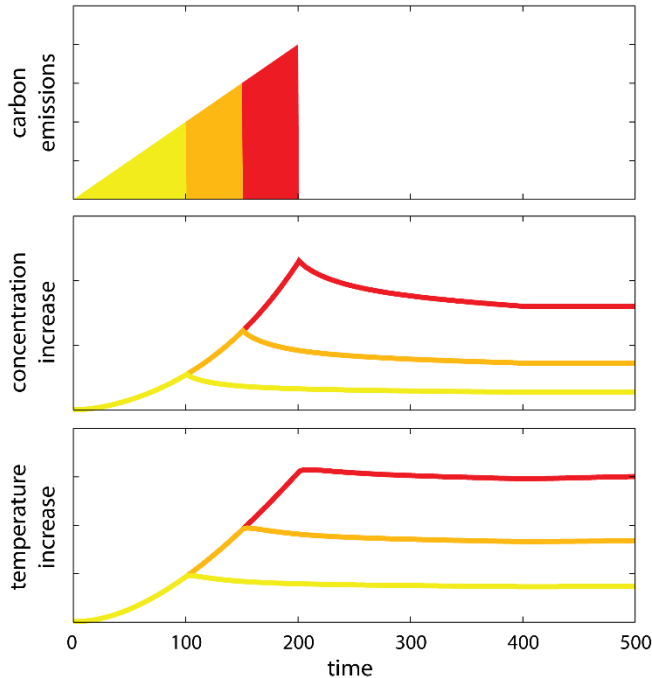
- Stable CO₂ concentration will result in further warming over centuries.

Warming will persist for centuries



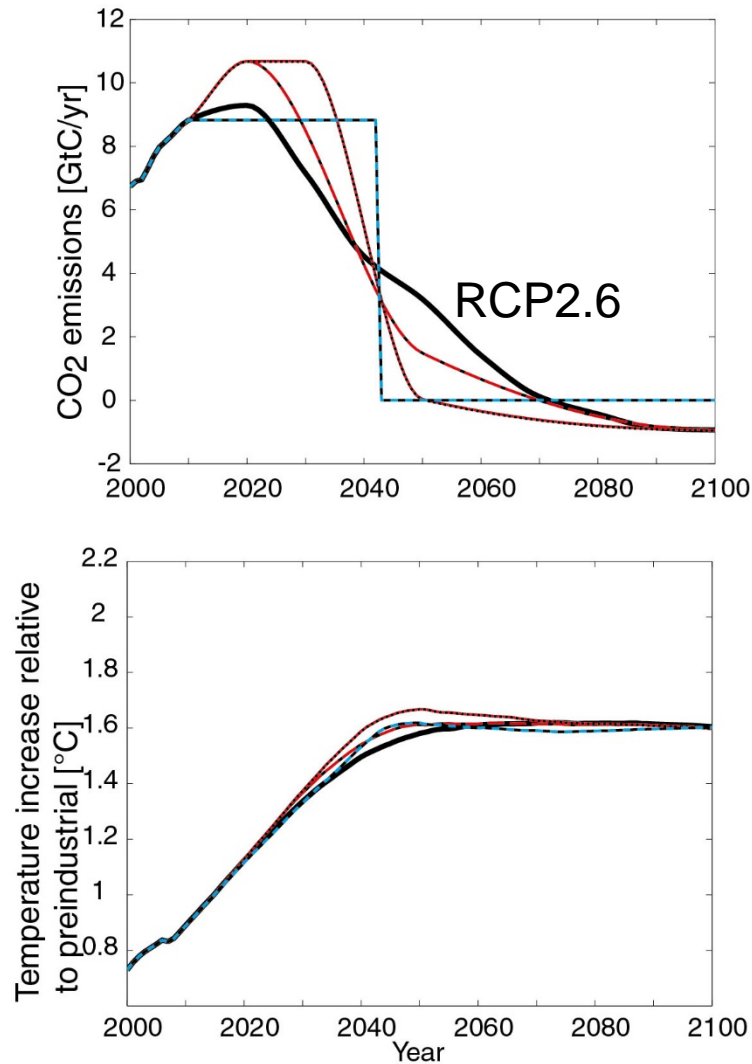
- Zero CO₂ emissions lead to near constant surface temperature.
- A large fraction of climate change persists for many centuries.
- Depending on the scenario, about 15-40% of the emitted carbon remains in the atmosphere for 1000 yrs.

Cumulative carbon determines warming



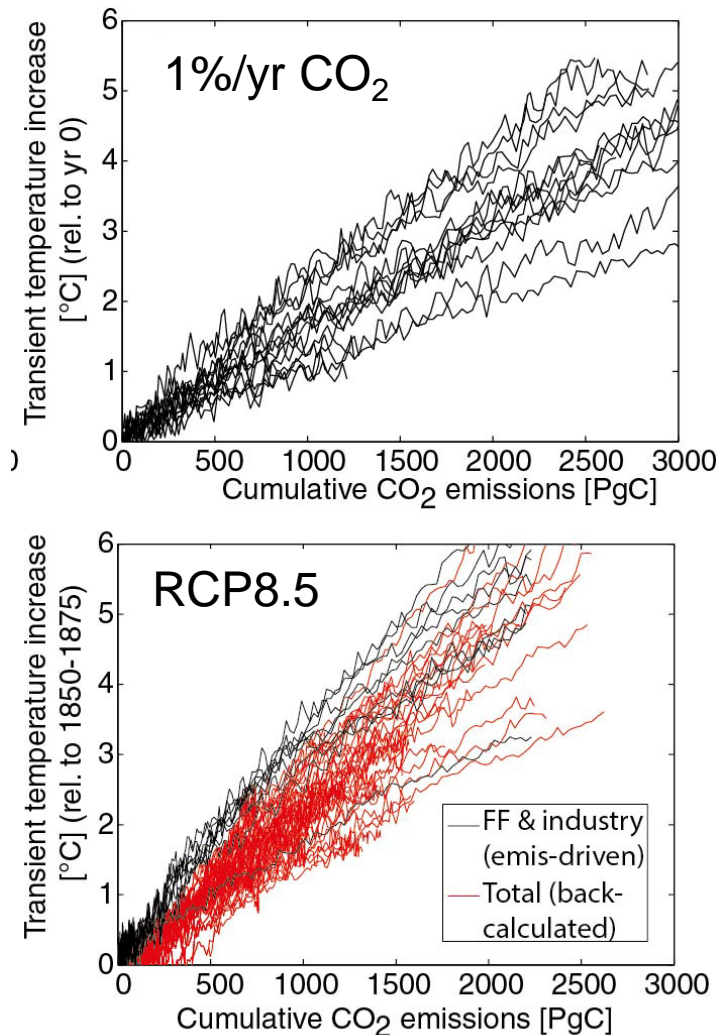
- Peak warming is approximately proportional to cumulative (total) emissions.
- Transient climate response to cumulative carbon emissions $TCRE = \text{Warming per } 1000 \text{ PgC}$

Cumulative carbon determines warming



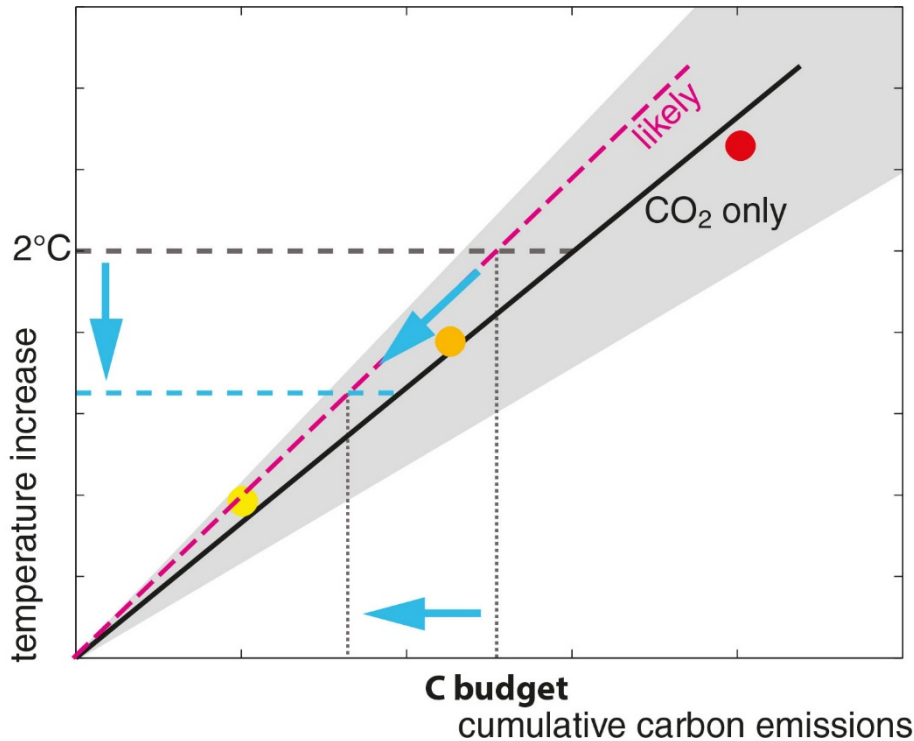
- Warming is largely independent of the emission profile. Only the total matters.
- More emissions early imply stronger reductions later.
- A temperature target implies a maximum in cumulative CO₂ emissions. This is purely a physical and carbon cycle problem.
- Allocation over time is a economic and policy question.

Cumulative carbon determines warming



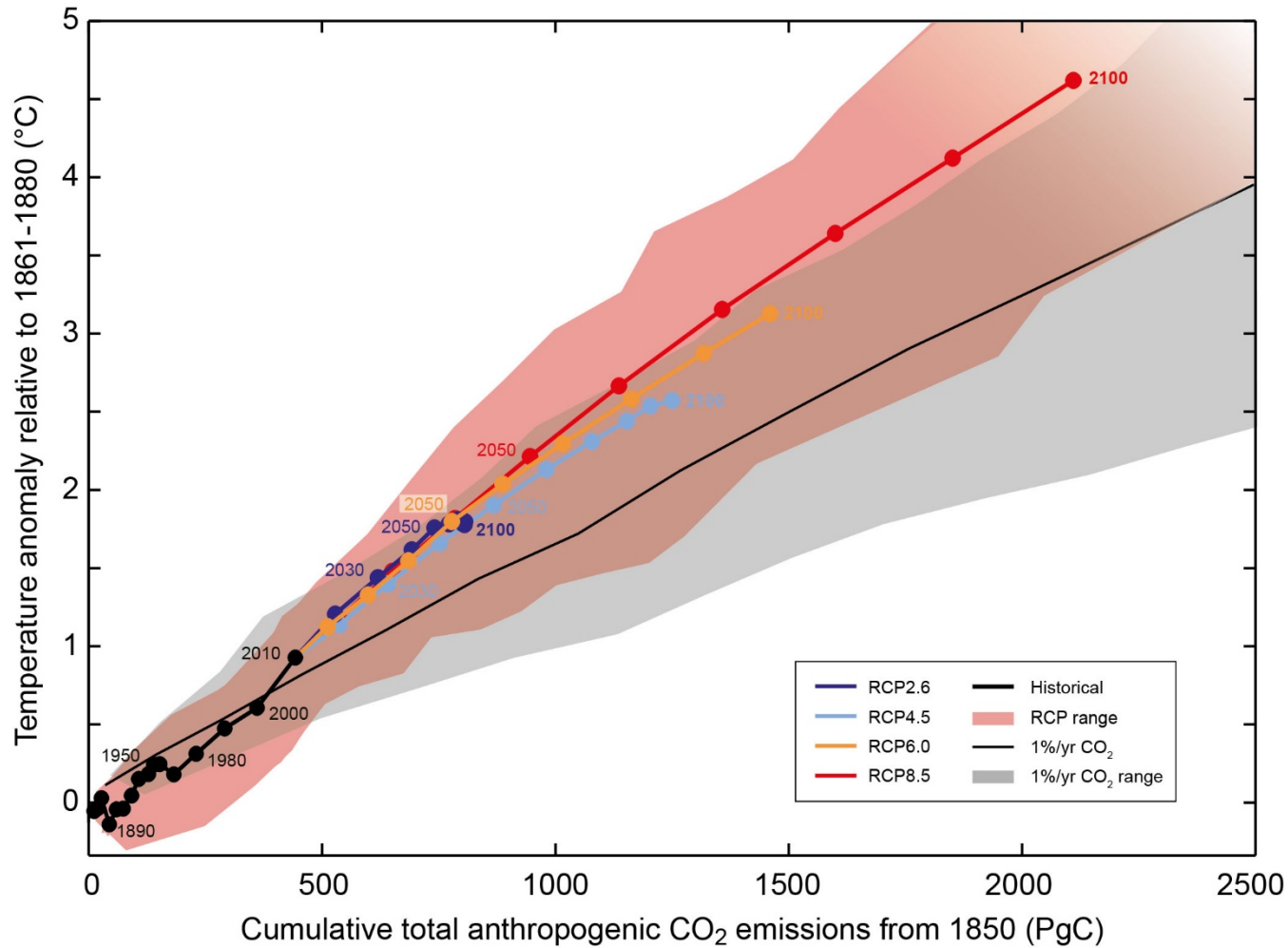
- Evidence from observations, and from simple to complex models for many scenarios.
- Near linear in all models, but the slope is uncertain.
- Any temperature target implies a maximum amount of carbon that can be emitted.
- Due to non CO₂, RCP warming is larger than from CO₂ only.

Controls on the carbon budget

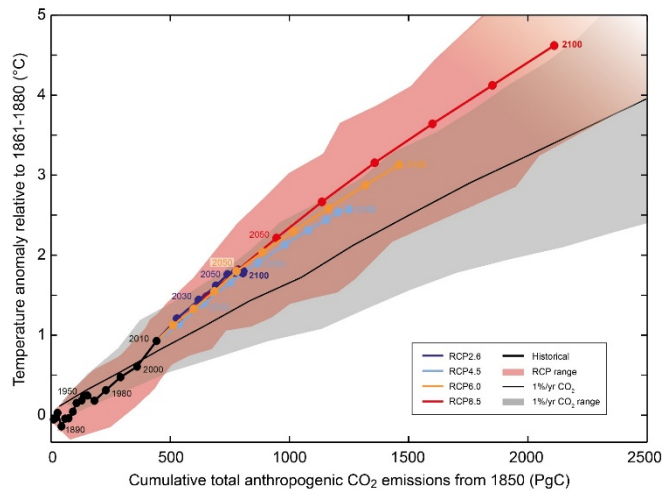


- Higher likelihood to achieve target implies lower budget
- Lower temperature target implies lower budget

Figure SPM.9



Summary



- Every ton of CO₂ causes about the same amount of warming, no matter when and where it is emitted.
- To limit warming to *likely* less than 2° C from CO₂ **alone**, total emissions since preindustrial need to be limited to less than 1000 PgC.
- Accounting for non-CO₂ forcing as in RCP2.6 reduces the allowed cumulative emissions to about 800 PgC.
- About 550 PgC were emitted by 2011.
- CO₂ emissions from permafrost or a higher likelihood require a lower budget.

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Further Information
www.climatechange2013.org

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