Accounting for the climate benefit of temporary carbon storage in nature

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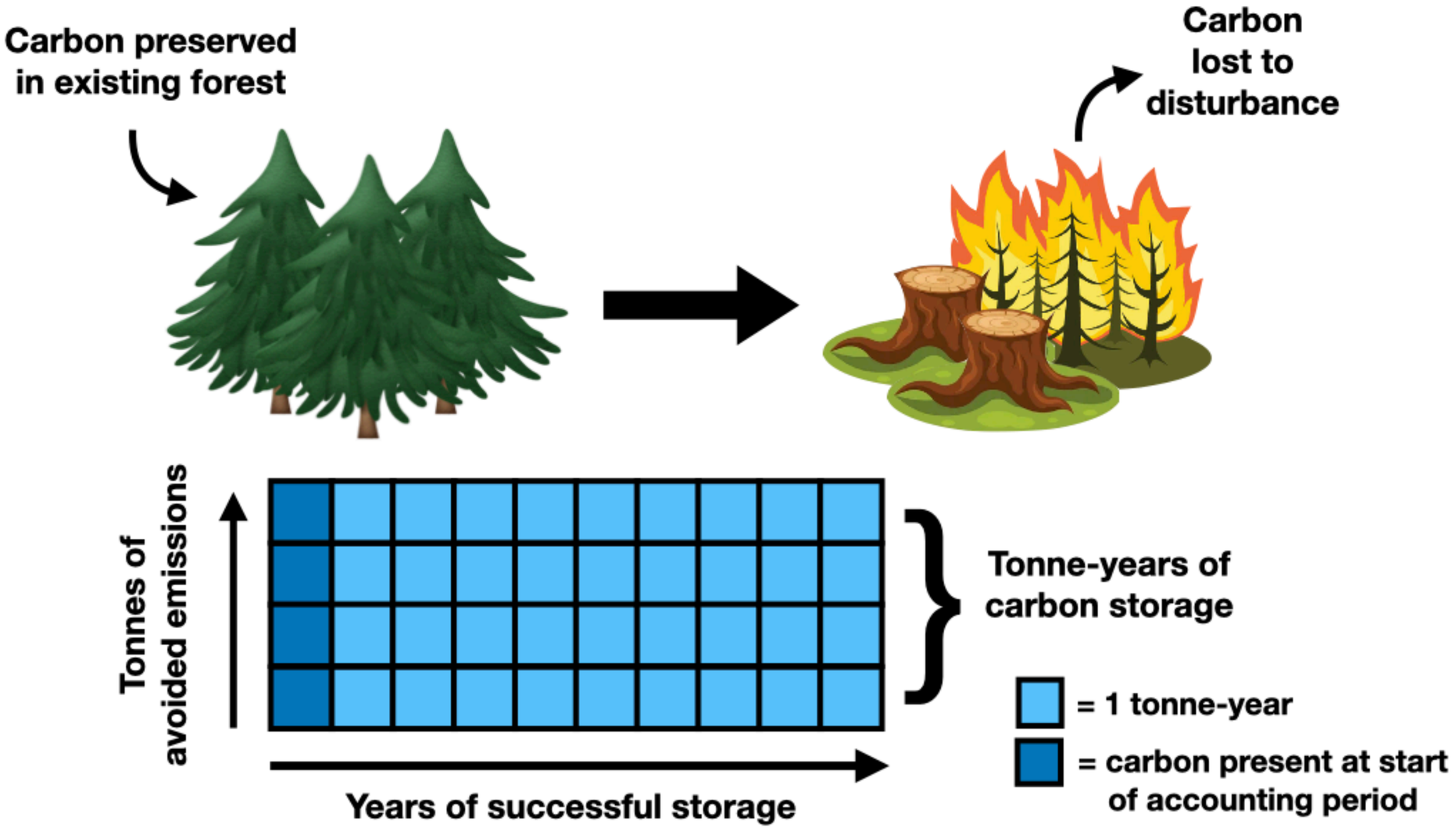
IEA Bioenergy Task 45 Workshop on temporary carbon storage
November 30, 2023

Problem

- Temporary carbon storage has climate value
- But … it is not equal to an avoided fossil fuel CO2 emission (which is permanent)
- How could we account differently for the value of temporary storage?
- Our suggestion: use tonne-years, but NOT as an equivalence metric

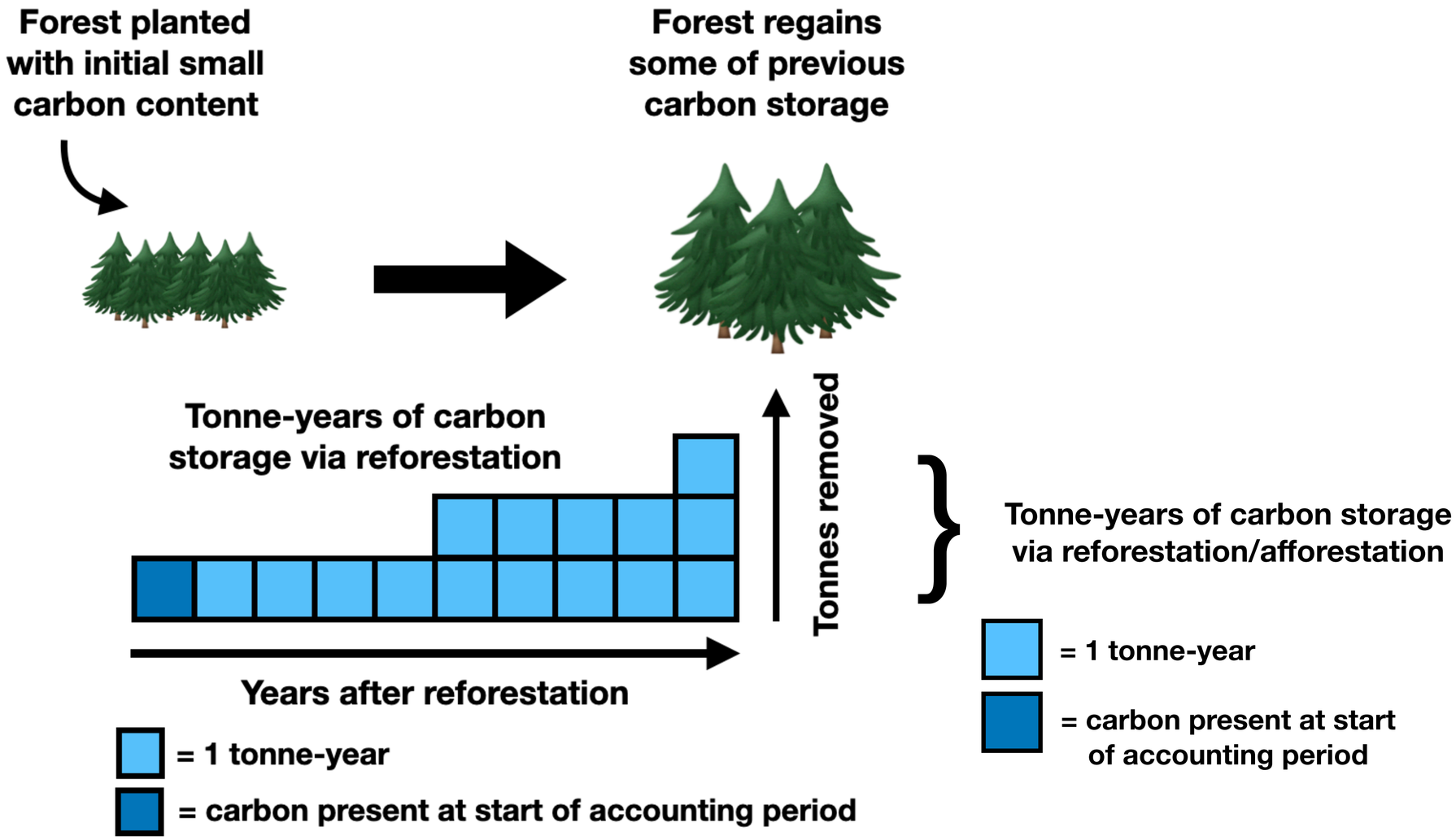
What is a tonne-year?

Case 1: Avoided emissions



What is a tonne-year?

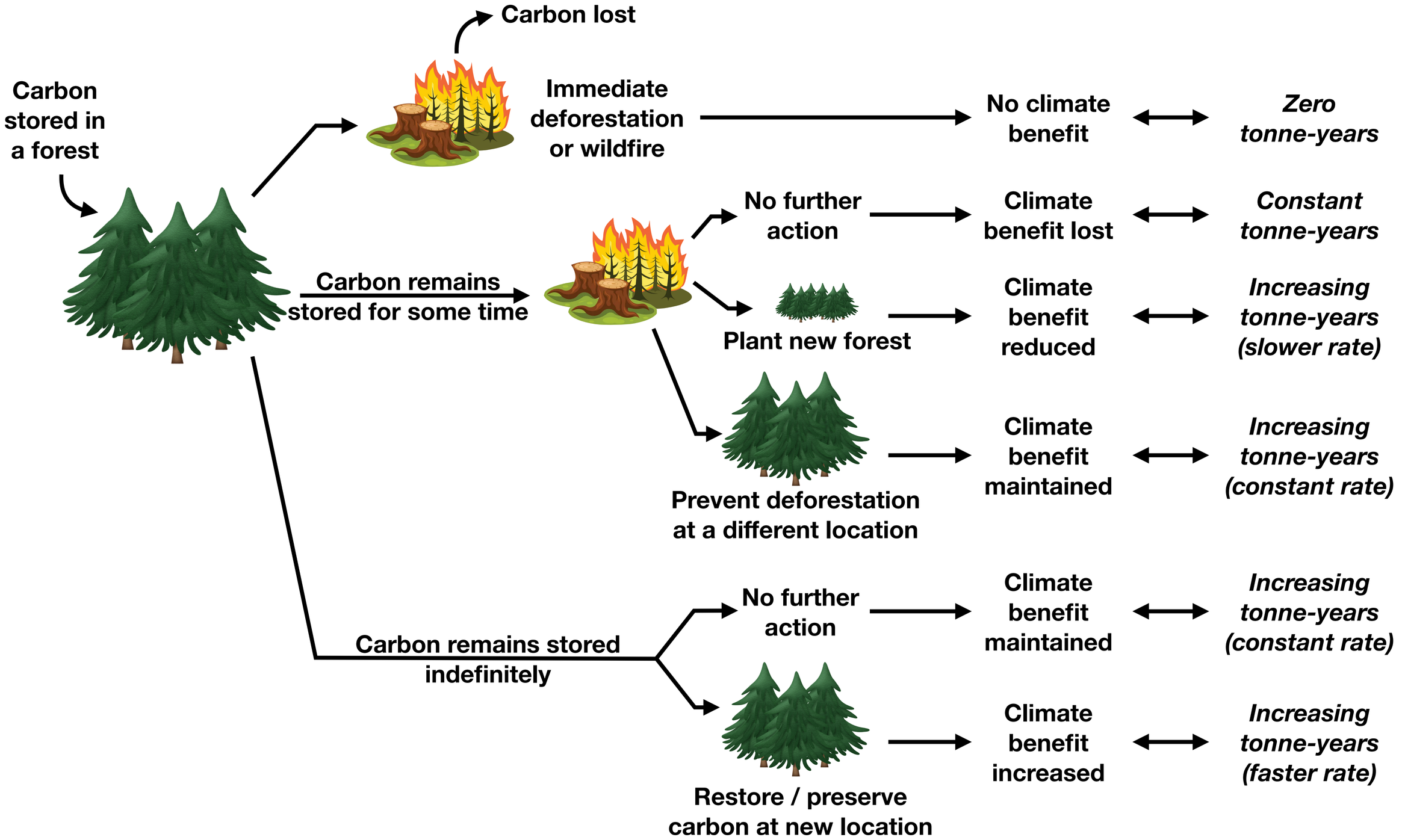
Case 2: Removal



Tonne-year accounting

- **Current approach:**
  (1) Calculate tonnes of storage in some temporary reservoir
  (2) Compare the cost of emitting that carbon to the benefit of delaying that emission for some period of time
  (3) Claim that X tonne-years of temporary storage is *equivalent to* 1 tonne of permanent storage

- **Reimagined approach:**
  (1) Calculate tonne years of land storage
  (2) Use the TCRE to infer degree-years of avoided warming
  (3) Track the changing climate benefit as a function of the rate of change of total tonne-years in the system


Carbon lost
Carbon stored in a forest
Immediate deforestation or wildfire
No climate benefit
Zero tonne-years
No further action
Climate benefit lost
Constant tonne-years
Carbon remains stored for some time
Plant new forest
Climate benefit reduced
Increasing tonne-years (slower rate)
Prevent deforestation at a different location
Climate benefit maintained
Increasing tonne-years (constant rate)
Carbon remains stored indefinitely
No further action
Climate benefit maintained
Increasing tonne-years (constant rate)
Restore / preserve carbon at new location
Climate benefit increased
Increasing tonne-years (faster rate)

nature communications

Article

https://doi.org/10.1038/s41467-023-41242-5

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Received: 12 January 2023

Accepted: 25 August 2023

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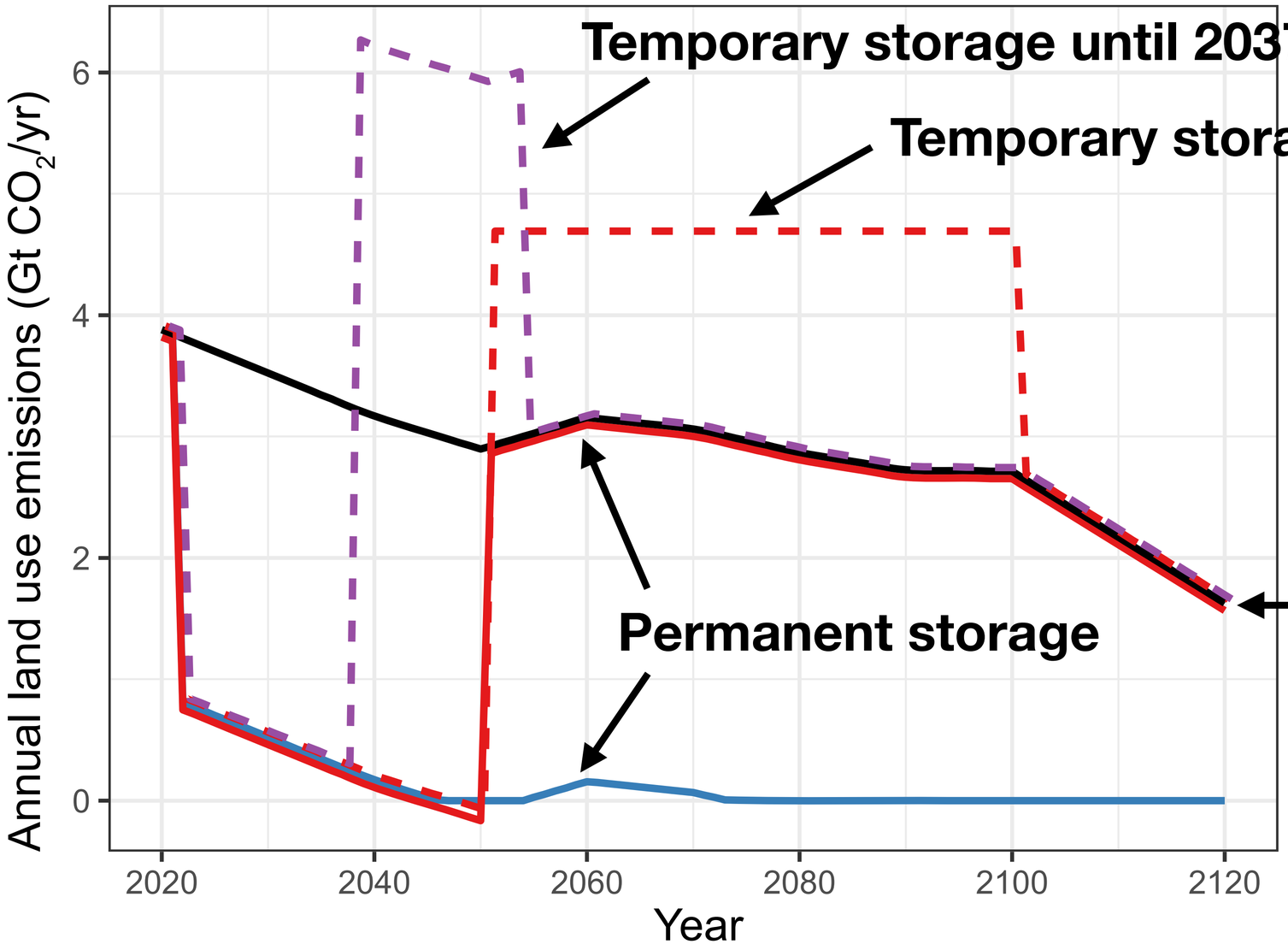
Annual emissions: temporary vs. permanent storage



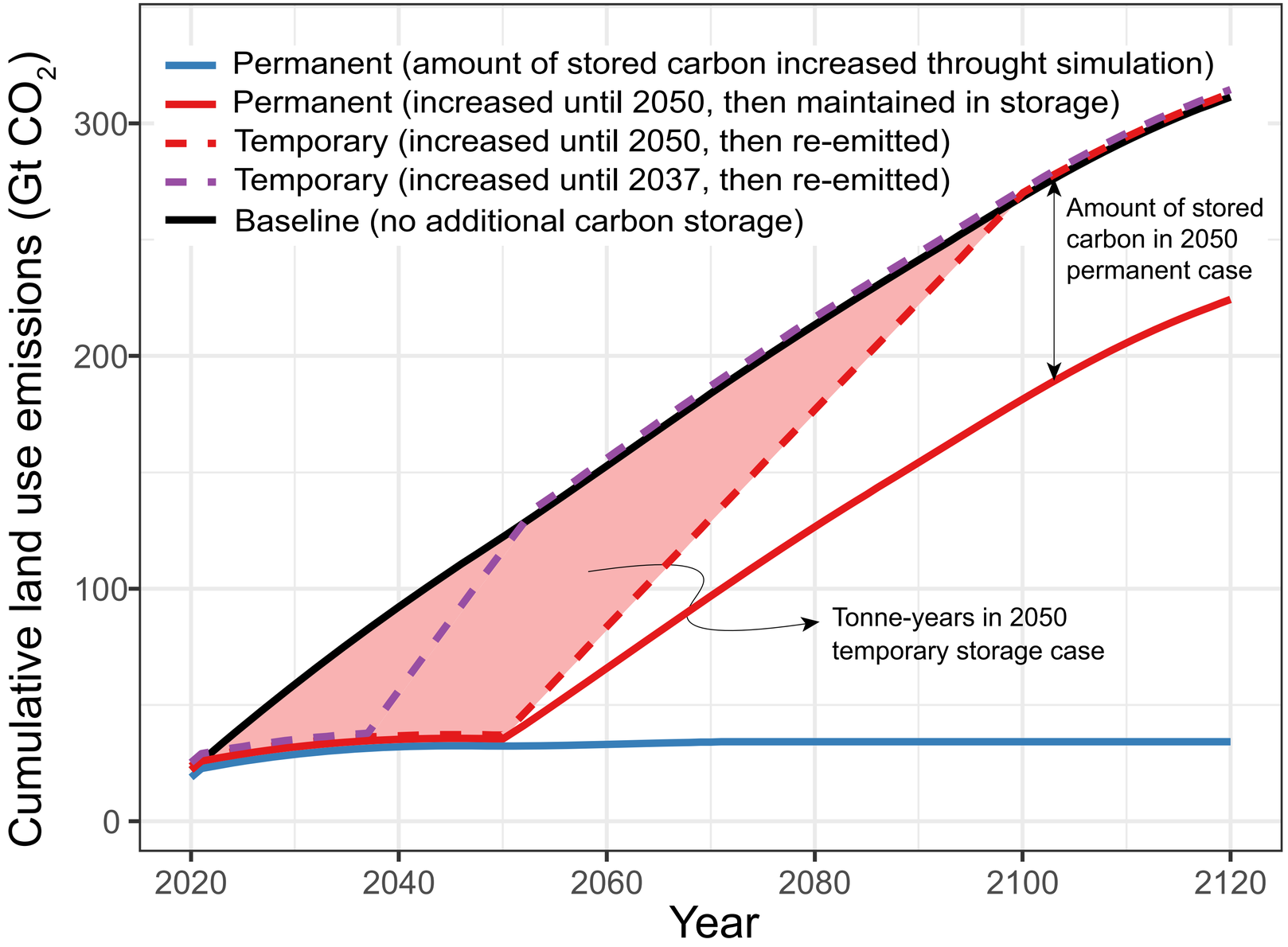
Temporary storage until 2037, then re-emitted

Temporary storage until 2050, then re-emitted

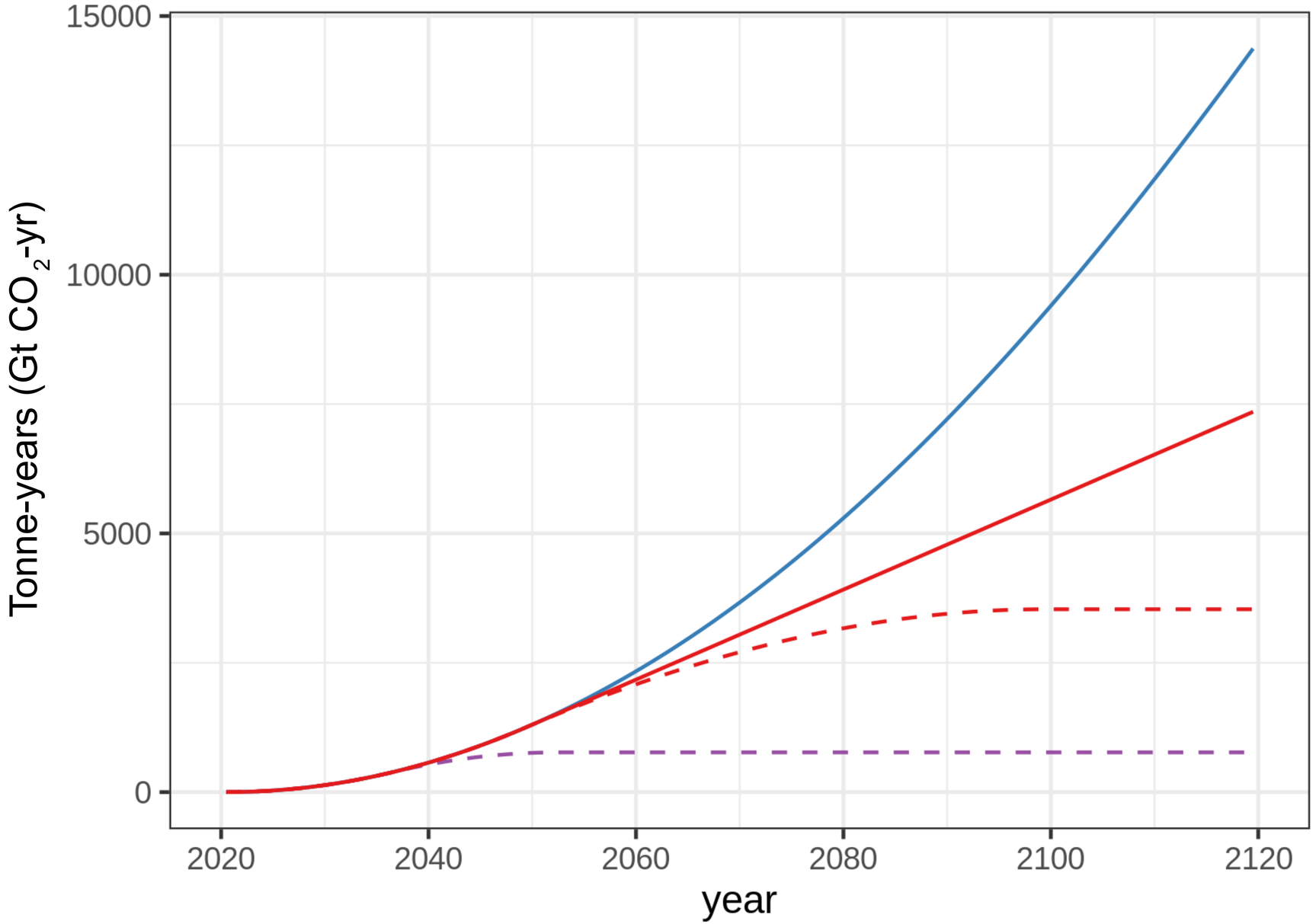
Permanent storage

Baseline land-use emissions (SSP3-70)

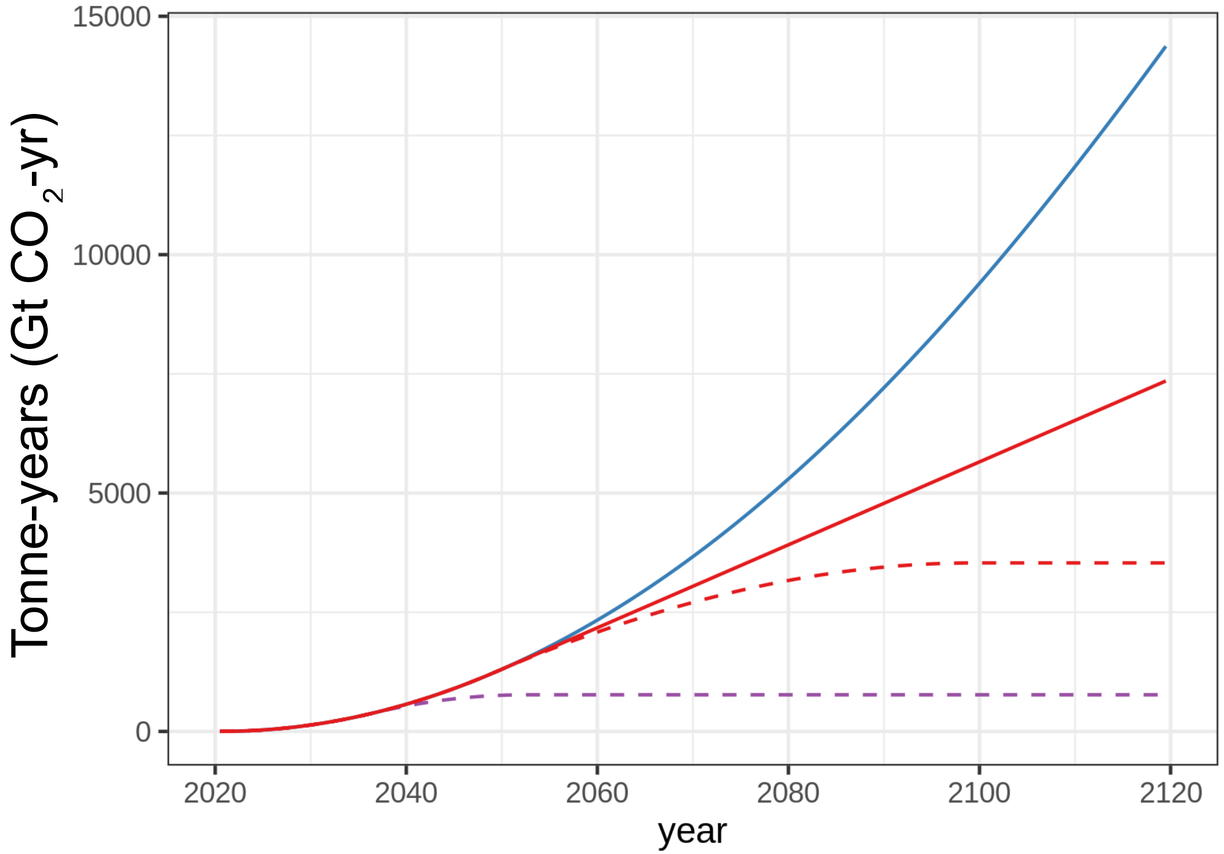
Cumulative emissions and tonne-years

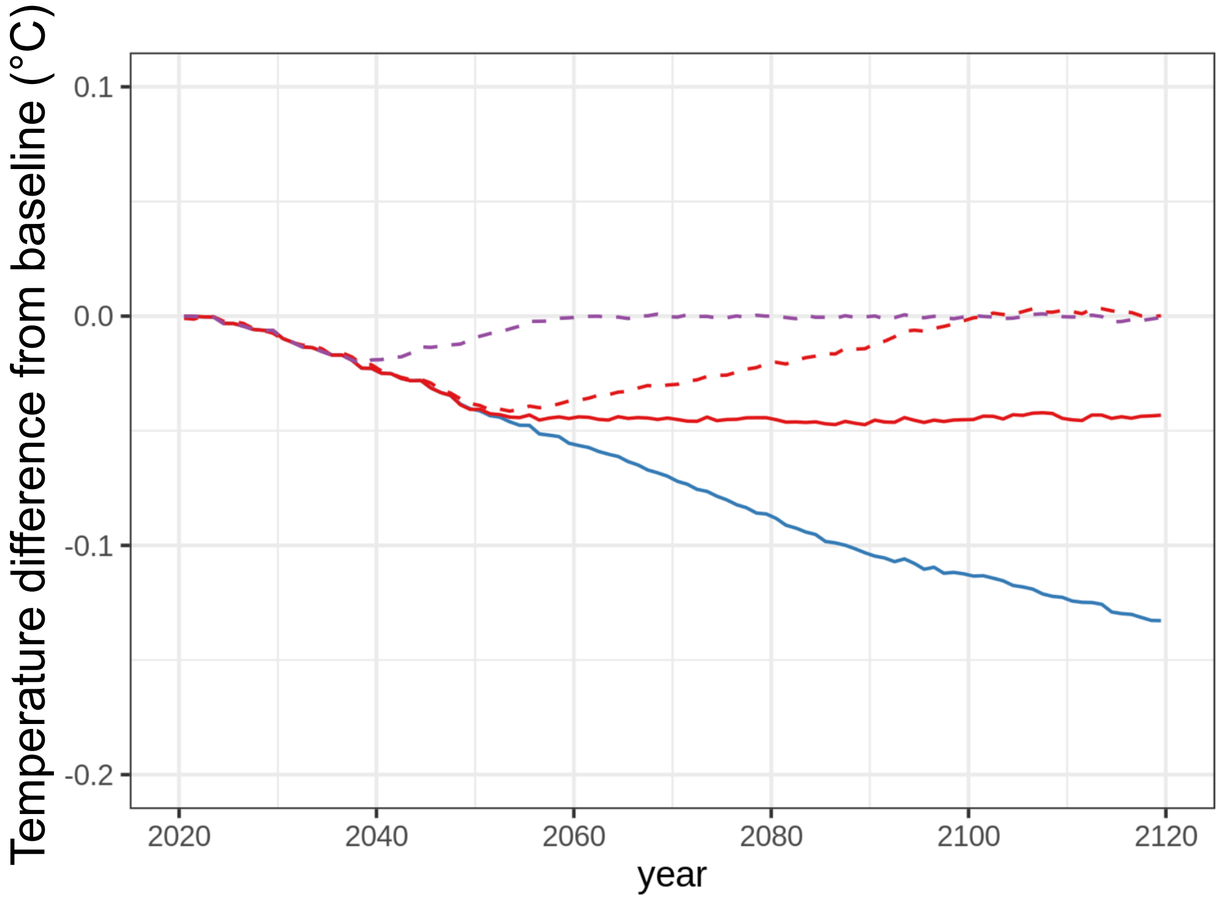


Tonne-years and avoided warming

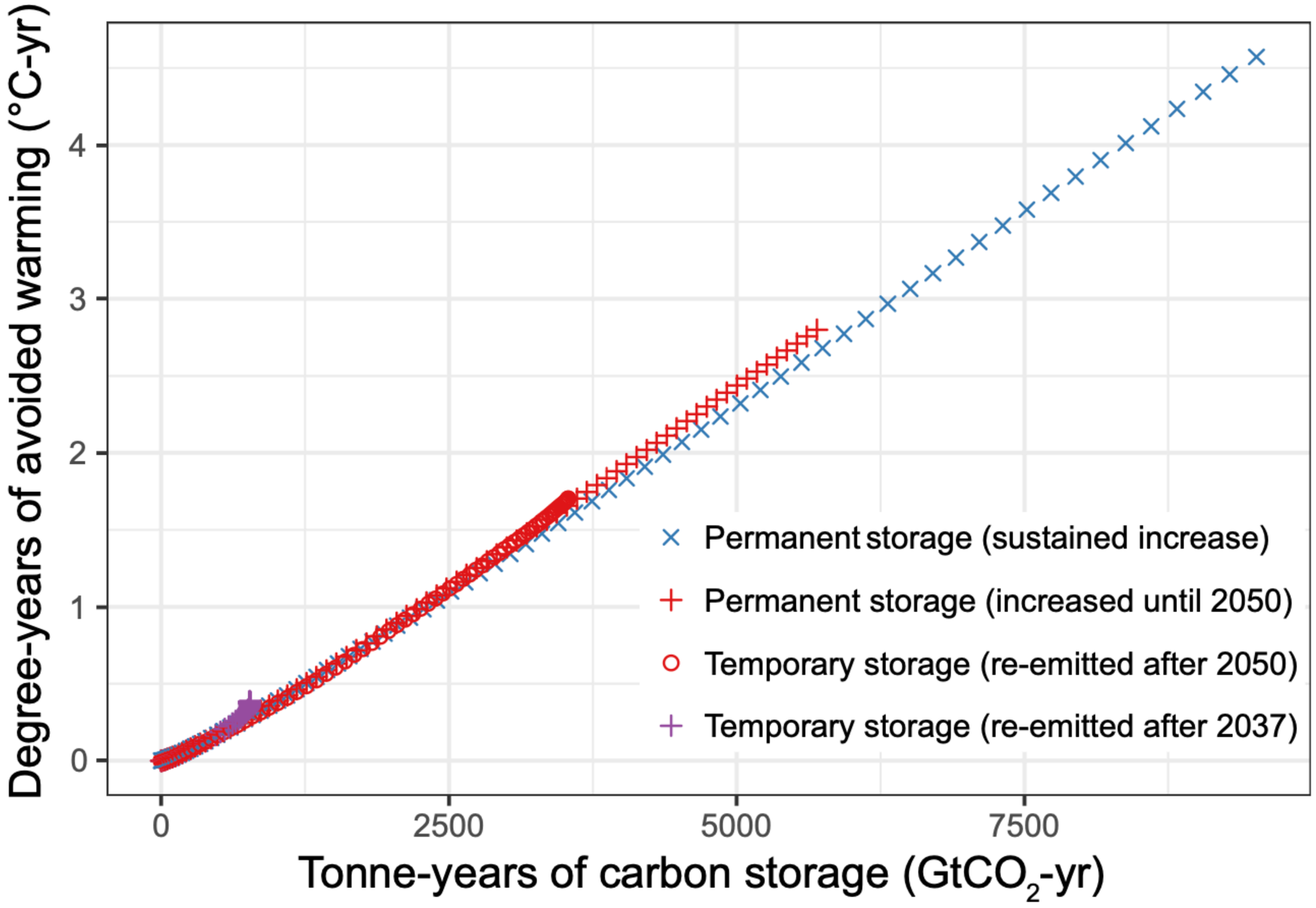


Tonne-years and avoided warming





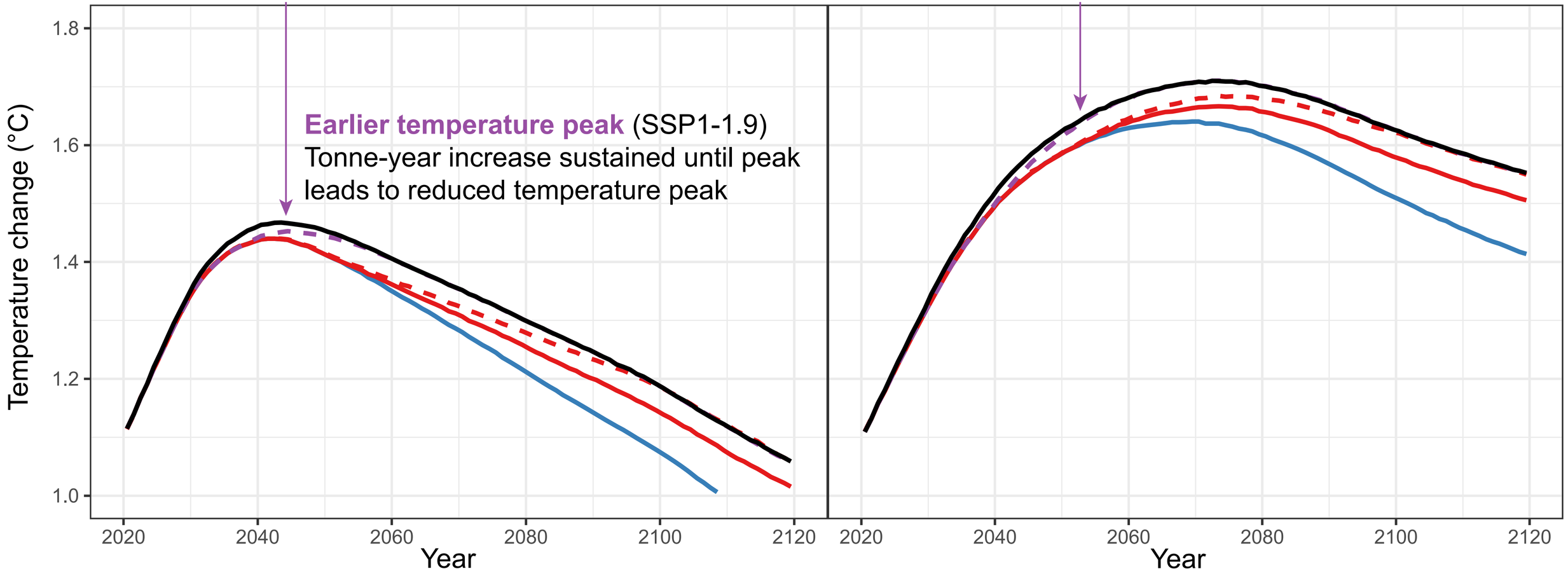
Degree-years of avoided warming



Effect on peak warming?

Earlier temperature peak (SSP1-1.9)
Tonne-year increase sustained until peak leads to reduced temperature peak

Later temperature peak (SSP1-2.6)
Tonne-year increase not sustained until peak has no effect on peak level



Conclusions

- Tonne-years could be reimagined to track the climate benefit of temporary AND permanent storage
- Tonne-years of carbon storage are proportional to degree-years of avoided warming
- Amount of avoided warming is proportional to the rate of increase of total tonne years
- If tonne years increase at a constant or increasing rate, the temperature benefit is sustained or increased
- If sustained until peak warming … then lower peak!