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Vulnerability of the Natural Carbon Sinks, a System Under Increasing Human Pressure

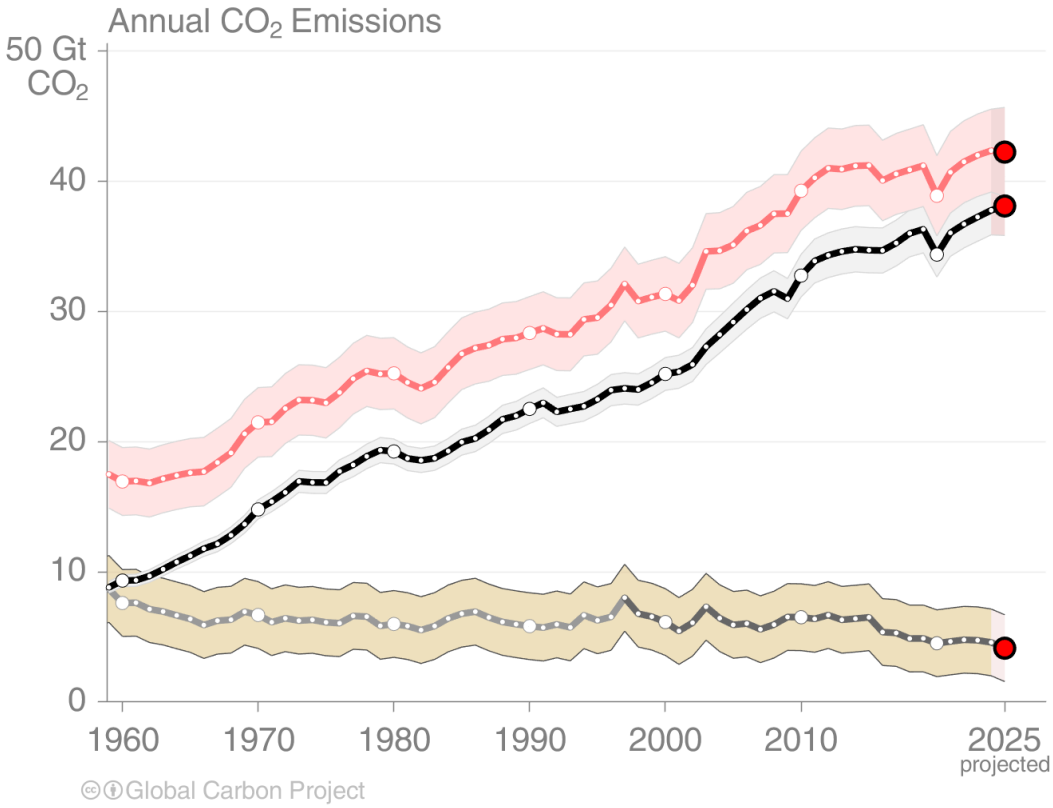
A Global Carbon Cycle view

Pierre Friedlingstein

p.friedlingstein@exeter.ac.uk

Global CO⊠ emissions from human activities

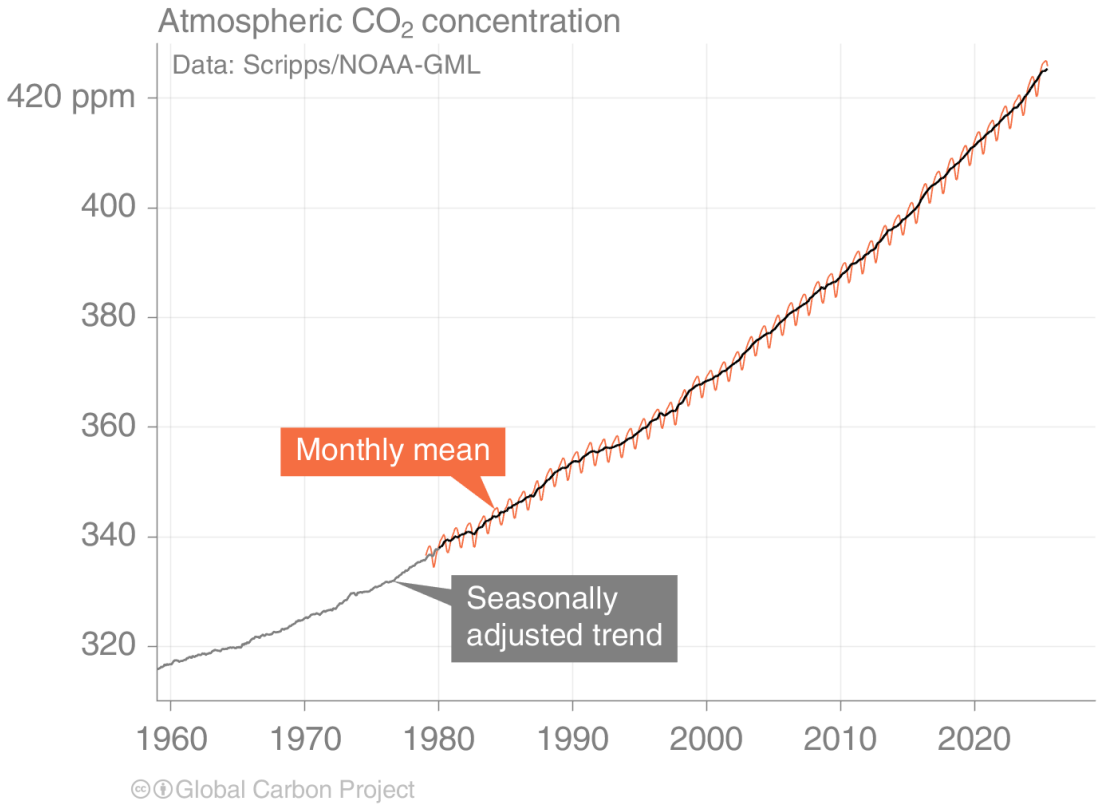
Every year, human activities release more than 40 billion tons CO_2 into the atmosphere. Fossil fuel burning 90%, deforestation10%



Friedlingstein et al., ESSD, 2026

Global CO⊠ concentration in the atmosphere

As a result, CO_2 has been increasing in the atmosphere, now 50% above pre-industrial level.

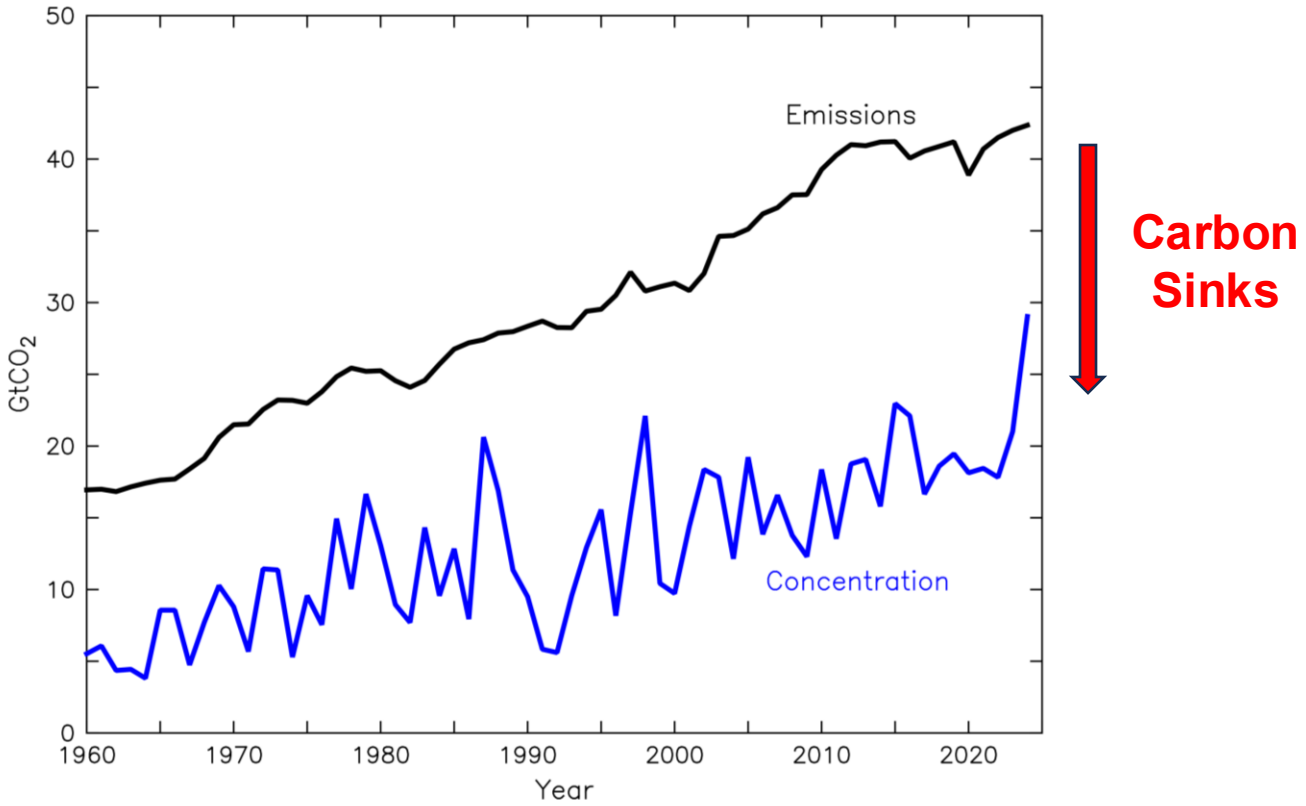


Friedlingstein et al., ESSD, 2026

Global CO⊠ concentration in the atmosphere

Only half of the emissions remains in the atmosphere, the rest is reabsorbed by the ocean and the land ecosystems (the carbon sinks).

Without these sinks, atmospheric CO_2 would be much higher and warming would already be above 2°C.



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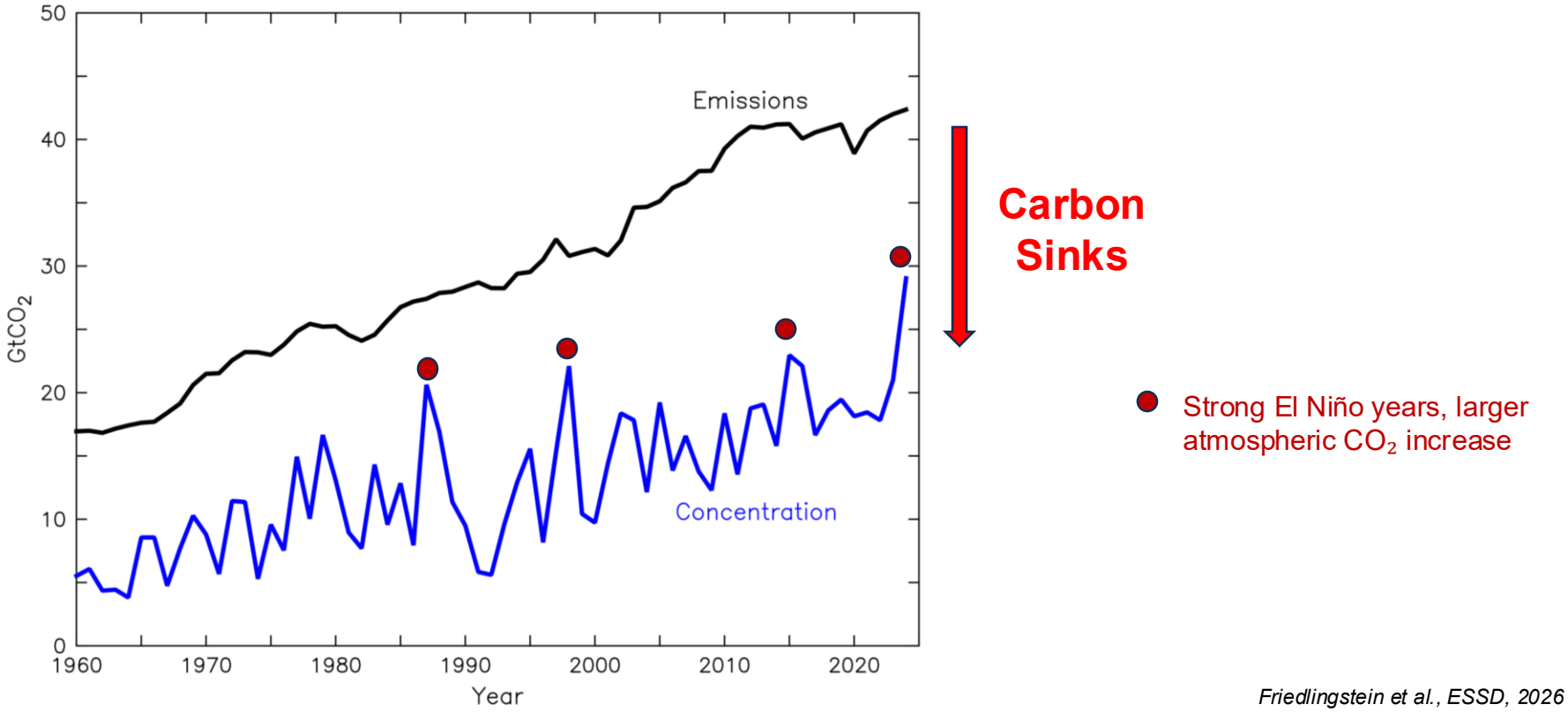

Friedlingstein et al., ESSD, 2026

Global Carbon Budget (2015–2024)

Sources = **Sinks**

35.9 $GtCO_2$/yr

88%

12%

5.0 $GtCO_2$/yr

20.4 $GtCO_2$/yr

50%

21%

8.7 $GtCO_2$/yr

29%

11.8 $GtCO_2$/yr

Friedlingstein et al., ESSD, 2026

Land and Ocean carbon sinks

What are the processes driving these sinks ?

The main driver of these sinks is the atmospheric CO_2 increase:

- Land : ➚ photosynthesis, ➚ biomass and soil carbon
- Ocean: ➚ CO_2 exchange, ➚ carbon export

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But the atmospheric CO_2 increase leads to climate change, which also affects the land and ocean sinks.

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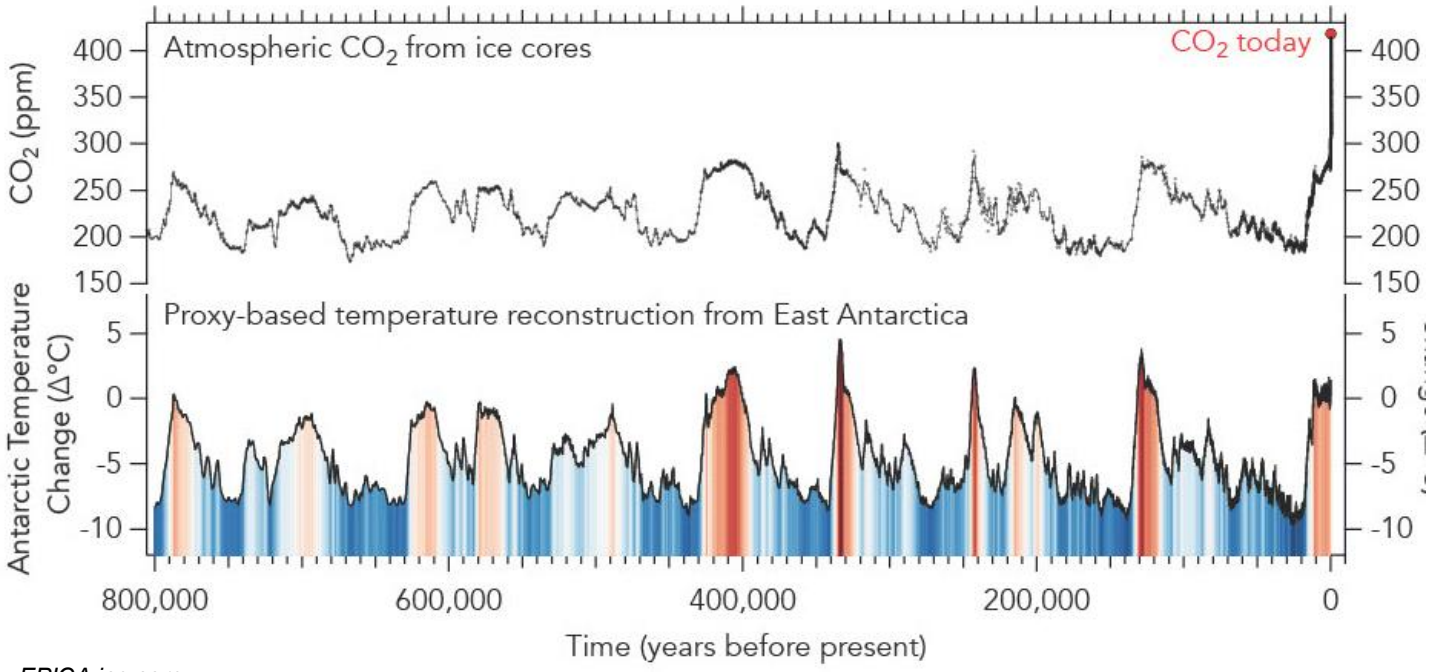
Carbon – climate interaction

On long, paleo- time scales: climate and carbon cycle are tightly coupled

Warm (interglacial) : more CO_2 in the atmosphere

Cold (glacial) : less CO_2 in the atmosphere



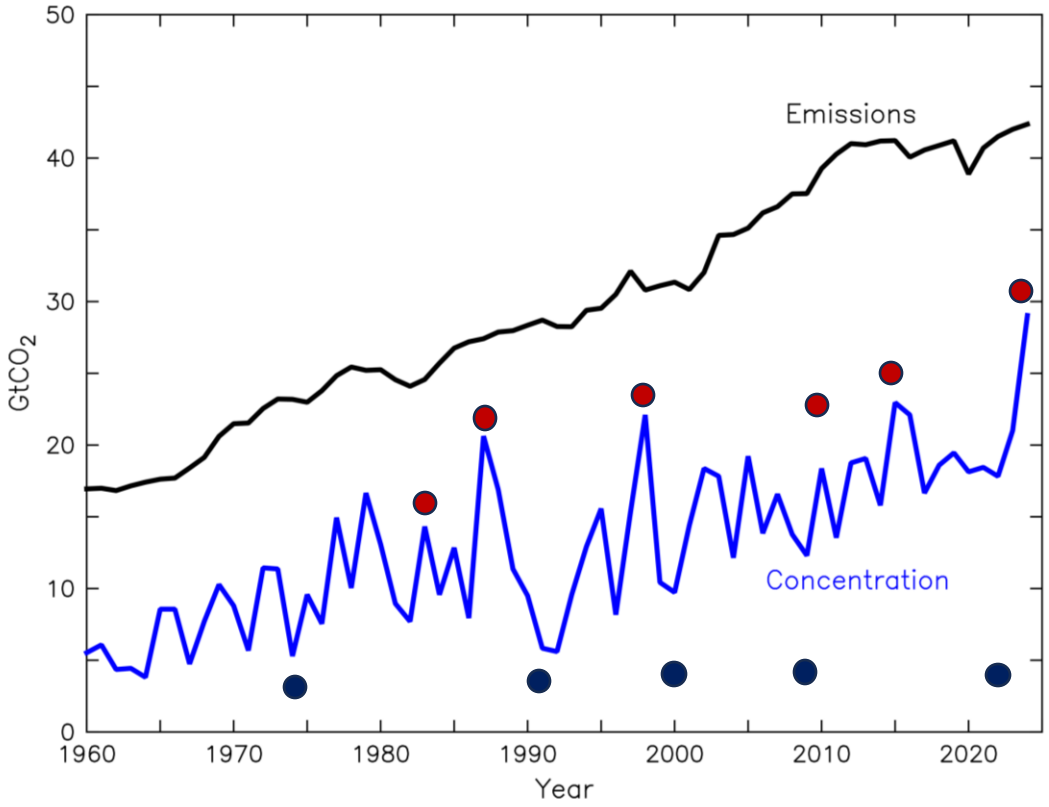
EPICA ice core

Carbon - climate interaction

On short, annual time scales: climate and carbon cycle are tightly coupled

Warm (El Niño) : more CO⊠ in the atmosphere

Cold (La Niña) : less CO⊠ in the atmosphere



Strong El Niño years, larger atmospheric CO_2 increase

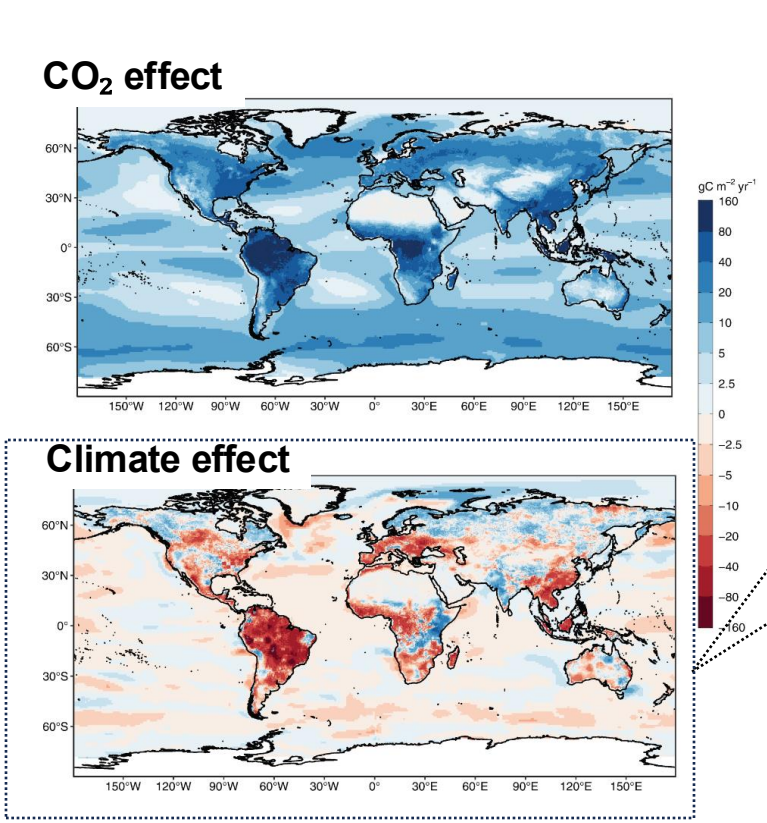
Strong La Niña years, smaller atmospheric CO_2 increase

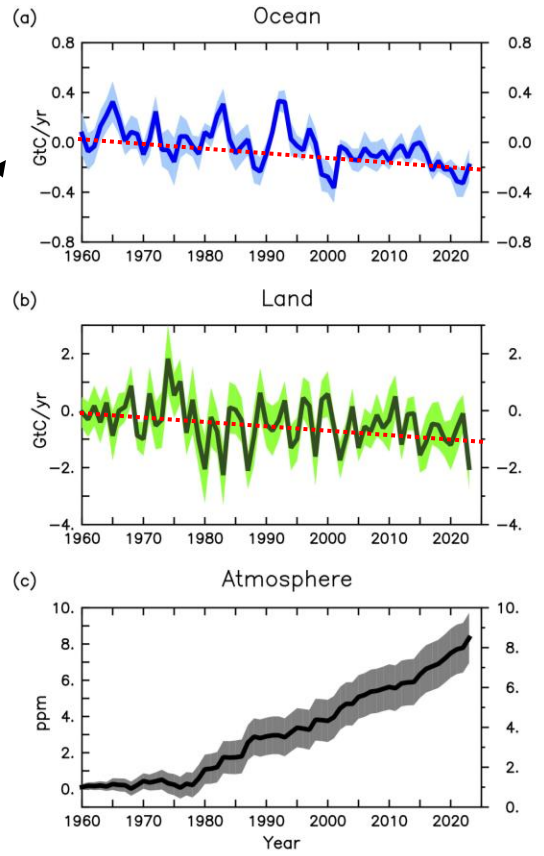
Friedlingstein et al., ESSD, 2026

Impact of current climate change

Ongoing climate change has already reduced the land and ocean sinks, by about 25% and 7% respectively, contributing to the atmospheric CO_2 increase

➔ positive feedback





Sink reduction

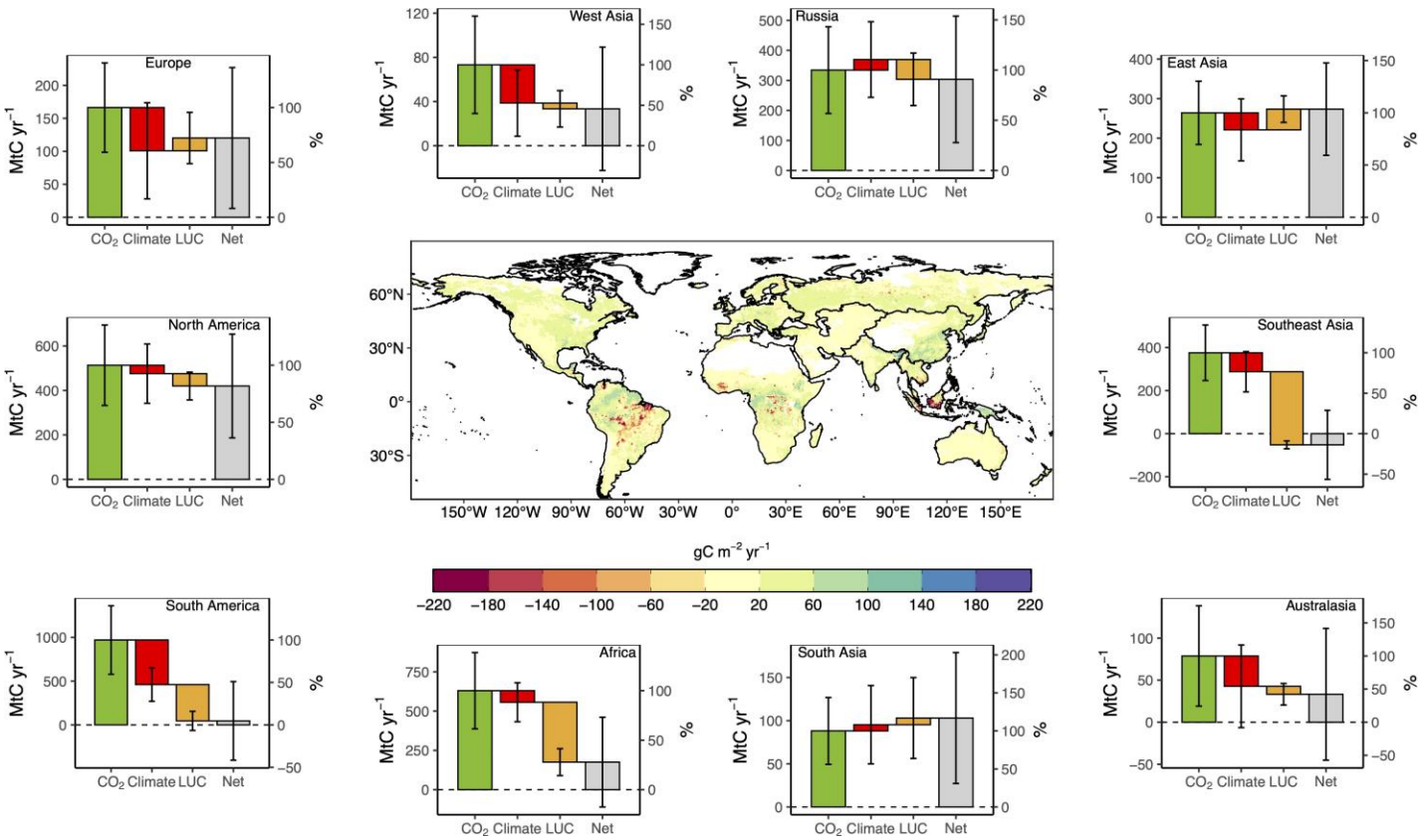
Sink reduction

Friedlingstein et al., 2026

Impact of current climate change

On land, in most part of the world, climate change reduces the land sink.

The combined effects of climate change and deforestation turns many parts of the tropics from sink to source of CO_2.



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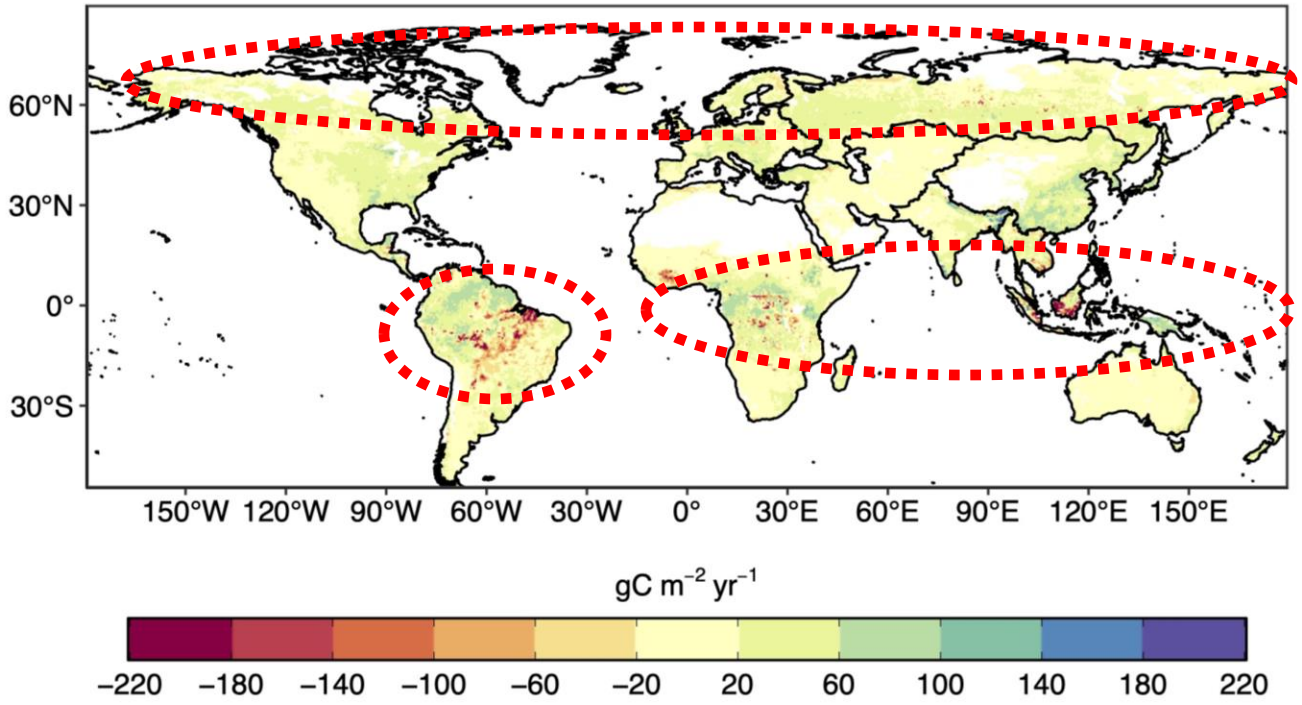

Conclusion

Global CO_2 emissions from human activities still increasing.

Land and ocean currently remove 50% of human emissions.

Current climate change negatively affects these sinks.

Future climate change will further reduce the efficiency of these sinks.

Bringing the risk of the land system to turn to a carbon source.

We need to reach Net Zero GHG emissions as quickly as possible.

Time is not our friend…

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