

Background/Objective

Atmospheric carbon (C) dioxide removal (CDR) is needed to stabilize global temperature. CDR can be achieved via ecosystem-based approaches that are cost-effective but reversible (e.g., soil and forest management) or by more durable but expensive approaches (e.g., direct air capture with geologic storage). This work examines trade-offs between these two approaches.

Approach

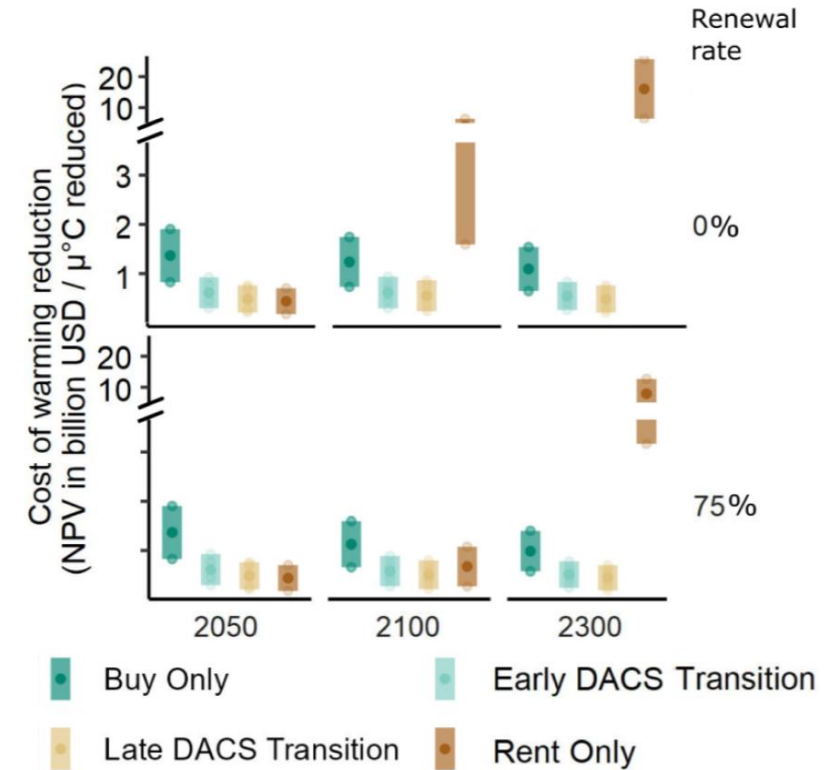
Researchers simulated reversible C accrual for a range of CDR contract structures using a model of ecosystem C cycling and parameterized it to simulate cover cropping as a case study. They quantified the resulting impact on atmospheric C and global temperature using a climate model emulator and then modeled the cost of replacing reversible agricultural soil CDR with geologic CDR.

Results

Maintaining a patchwork of reversible CDR projects can reduce warming by 22-195 $\mu^{\circ}\text{C}$ in 2100. The magnitude of this cooling effect depends on how effectively the patchwork is maintained. Long-term maintenance of reversible CDR requires institutional stability that cannot be guaranteed over multiple decades. Using reversible CDR as a bridge to durable CDR was potentially more cost-effective as a global strategy (0.20-0.81 billion USD per $\mu^{\circ}\text{C}$ avoided) than perpetual maintenance of reversible CDR (0.32-1.31 billion USD per $\mu^{\circ}\text{C}$ avoided) or an immediate transition to durable CDR (1.37-2.19 billion USD per $\mu^{\circ}\text{C}$ avoided).

Significance/Impacts

Stacking reversible soil CO_2 removal and storage over time can contribute to reducing peak temperatures and maintaining C storage for longer, leading to larger and more sustained temperature reductions. Uncertainty around the maintenance of reversible storage and future commitment to durable storage is a source of risk associated with this strategy. Accurately quantifying this risk is essential for ecosystem CDR use as an effective bridge to durable C storage.



Cumulative cost of cooling as net present value per degree of warming reduced. DACS = direct air capture with geologic storage. Rent only = reversible CDR. Buy only = durable CDR.