Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24865

Carbon storage by the natural land and ocean reservoirs in a changing climate

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The concentration of CO_2 in the atmosphere has now doubled its pre-industrial level and continues to rise. In addition to warming the planet, the rise of CO_2 in the atmosphere has profound effects on the natural carbon reservoirs. This presentation will detail what we know of the response of the ocean and of the terrestrial biosphere to recent changes in atmospheric CO_2 and climate, and reflect on the likelihood of various CO_2 emissions pathways this century, their implications for the carbon cycle, and the questions they pose for the research community.

Global climate policy actions so far have succeeded in bending projected warming trajectories this century. Yet implemented policies alone would still drive global warming of around three degrees Celsius, with potentially extreme implications for the natural carbon cycle, including its capacity to store additional carbon and the stability of marine and terrestrial ecosystems. In contrast, the main objective of the Paris Agreement to limit warming well-below two degrees Celsius requires an appropriation of the land for climate mitigation which also has implications for the natural carbon cycle and for other uses of land. Most future emissions scenarios include large-scale capture and permanent geological storage of carbon, an industry in its infancy.

The land and ocean carbon reservoirs today absorb more than half of the CO_2 emitted to the atmosphere on average. These CO_2 ‘sinks’ are regulated by the level and rate of growth of CO_2 in the atmosphere. The sinks weaken in response to climate change, causing an amplifying climate feedback whose amplitude is poorly constrained. Process understanding is now sufficient to account for most of the observed mean, trend and interannual variability of the CO_2 sinks of the past six decades. However, there is a gap in our understanding of the response of the sinks to decadal climate variability, which translates into large uncertainties when projecting the carbon sinks in a changing climate. The contemporary data record provides limited information to constrain projections of the carbon-climate feedback this century and beyond. Several known-unknown remain that could potentially be answered with insights from the geological record.