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Max MACS: Constraining the potential scale of marine anoxic carbon storage for CO_2 removal

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The long-term preservation of organic carbon (OC) in marine sediments is a primary control on planetary temperatures and the marine biosphere, and negative feedbacks between OC burial and climate have contributed to the stabilization of global conditions throughout Earth history. OC sequestration may also be a feasible pathway for intentional atmospheric CO_2 removal in coming decades, which will be required alongside emissions reductions to avoid warming scenarios in excess of 2˚C. Estimates for the amount of CO_2 removal required by 2050 exceed 2.7 Gt C/yr [1], and goals for "highly scalable" individual pathways are ~0.3 Gt C/yr [2]. Ocean OC burial is one of the only Earth system feedbacks for which such ambitious removal goals are the same order of magnitude as apparent natural variability.

Here, we present a systematic evaluation of the potential global scale of marine anoxic carbon storage (MACS) for CO_2 removal, focusing specifically on uses of existing terrestrial biomass sources from agriculture and forestry management. We identify five factors that represent quantifiable limits to the global potential scale of MACS, and we evaluate the current state of knowledge and remaining knowledge gaps for each. Different types of anoxic sites each present their own opportunities and challenges, and further research is needed to understand the expected impacts of MACS at scale. Nevertheless, MACS has the potential to operate at a climatically-significant scale and thus deserves further consideration as a potential pathway for future climate mitigation.

[1] IPCC AR6, 2021.

[2] U.S. National Academies of Science, Engineering, and Medicine, 2022. A Research Strategy for Ocean-based Carbon Dioxide Removal and Sequestration. Washington, D.C.: The National Academies Press.