Quantifying carbon leakage from enhanced rock weathering

April 5 2023

Spreading basalt rock dust with a conventional lime spreader on row crop acres in the U.S. corn belt. As the rock dust dissolves in the soil, it converts carbon dioxide to dissolved ions that are eventually transported to the ocean via runoff and stored for thousands of years. Credit: Gavi Welbel

A technique known as "enhanced rock weathering" may help remove carbon from the atmosphere, and a model shows the method will only leak minimal carbon if its products are stored in the ocean. Constraining

the planet below 1.5ºC or 2ºC of global warming from a preindustrial baseline by century's end will be more likely if carbon dioxide currently in the atmosphere is physically removed. Many climate models include the removal of between 5 and 10 gigatons of carbon dioxide per year through the end of the century.

Christopher Reinhard and colleagues used a large number of Earth system model simulations to create a complex representation of the physical and chemical response of the atmosphere and sea to enhanced rock weathering. The research is published in the journal *PNAS Nexus*.

Enhanced rock weathering is the practice of processing rock materials in such a way as to encourage chemical reactions between rock and atmospheric carbon, forming substances like bicarbonate, which then keep carbon out of the atmosphere. Bicarbonate can be added to the ocean and stored for up to 10,000 years before the hydrological cycle eventually transports it back into the atmosphere.

There has been concern, however, that some fraction of the bicarbonate added to seawater will break down almost immediately, rapidly leaking carbon back into the atmosphere. The models predict that the oceanic storage of carbon is 90% effective and "leakage" on decadal timescales is minimal. Carbon will leave the ocean as atmospheric levels come down, simply because carbon concentrations seek equilibrium across the surface of the sea, but this flux will not be significantly augmented by leakage from enhanced rock weathering, according to the authors.

More information: Yoshiki Kanzaki et al, New estimates of the storage permanence and ocean co-benefits of enhanced rock weathering, *PNAS Nexus* (2023). DOI: 10.1093/pnasnexus/pgad059

Provided by PNAS

Citation: Quantifying carbon leakage from enhanced rock weathering (2023, April 5) retrieved 9 April 2024 from https://phys.org/news/2023-04-quantifying-carbon-leakage-weathering.html

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