Researchers reveal oceanic black carbon sink effect driven by seawater microdroplets

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Researchers reveal oceanic black carbon sink effect driven by seawater microdroplets. Credit: DICP

Pyrogenic carbon is widely produced during the incomplete combustion of biomass and fossil fuels on land. About one-third of pyrogenic carbon is exported to the ocean by rivers, and thereinto, the refractory fraction becomes the source of oceanic black carbon that can provide a long-term sink for atmospheric CO_2.

The chemical signature of black carbon in the oceans differs from pyrogenic carbon in rivers. Specifically, unknown degradations that

account for the losses of pyrogenic carbon or carbon-13 enrichment of pyrogenic carbon should exist as terrigenous refractory pyrogenic carbon transits coastal waters. Unveiling this enigma is helpful in verifying the role of oceanic pyrogenic carbon in buffering climate change, but it still needs to be clarified.

In a study published in *Journal of the American Chemical Society*, Prof. Wang Feng's group from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) and the collaborators have identified a degradation process that may be a significant contributor to the deposition of ^{13}C-enriched pyrogenic carbon in coastal sediments.

The coastal ocean surface harbors abundant wave energy. Wave energy dissipation through wave breaking is a prominent source of sprayed water microdroplets on Earth. Water microdroplets possess a high electric field at the interface of microdroplets, which is sufficient to pull electrons out of hydroxide ions.

Researchers found that seawater microdroplets can couple this interfacial electron transfer pathway with that caused by contact electrification at microdroplet water-carbon interfaces to accelerate refractory pyrogenic carbon degradation. This electrochemical degradation process can lead to a large fractionation of stable carbon isotopes and account for the deposition of refractory pyrogenic carbon.

Additionally, researchers proposed a hypothesis that the resuspension of such deposited refractory pyrogenic carbon could act as a source of ^{13}C-enriched black carbon in the open ocean. They indicated that with intensifying wave energy due to anthropogenic global warming, the chemical effect of seawater microdroplets in the marine carbon cycle requires more attention.

More information: Ruolan Zhang et al, Pyrogenic Carbon Degradation by Galvanic Coupling with Sprayed Seawater Microdroplets, *Journal of the American Chemical Society* (2024). DOI: 10.1021/jacs.4c00290

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