# OCEAN IRON FERTILIZATION

Assessing its potential as a climate solution

EXOIS

EXPLORING OCEAN IRON SOLUTIONS

# Ocean iron fertilization: assessing its potential as a climate solution

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Cover image courtacy of NASA Ocean Ecology

## EXECUTIVE SUMMARY

The continued warming of the Earth is pushing many ecosystems and components of the climate system beyond their tipping points, resulting in irreversible damages to our planet as we know it. To stem the tide, we need to aggressively shift away from our fossil fuel-based economies and actively pursue methods of removing existing carbon dioxide from the atmosphere. Only with this combined approach can we limit global warming to within 2°C and attempt to roll back the effects of our unintended geoengineering of the planet from centuries of fossil fuel dependence.

The ocean has an enormous capacity for storing carbon and already takes up about one-third of the carbon dioxide released by human activities. In parts of the ocean where biological activity is limited by a lack of iron in seawater, adding iron could help spur phytoplankton growth and increase both the ocean's uptake of atmospheric carbon dioxide and the amount of carbon that gets sequestered at depth.

Tens of gigatons per year of carbon dioxide need to be removed from the atmosphere in the coming decades and no single carbon dioxide removal (CDR) approach is likely to reach that capacity. But adding iron to the ocean may be a responsible and effective way to make a significant contribution. Analyses of natural and deliberate ocean iron fertilization (OIF) field experiments have suggested that large-scale OIF could potentially remove gigatons of atmospheric carbon dioxide per year. However, experiments to date were not designed to, nor can they, adequately quantify how effective, durable, or wise iron addition may be as a CDR approach.

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We need new, deliberate research led by international scientific collaborations to provide the greatest possible insight into both the intended and unintended consequences, as well as the long-term effectiveness, of adding iron to the ocean. Any ocean CDR must be done following an ethical path and with guidelines and a governance framework that protect the environment (including the ocean commons), advance equitable and just outcomes, and appropriately account for other social dimensions. The consequences of OIF must be weighed against other climate intervention approaches and the broad spectrum of harmful impacts brought on by human-induced climate change.

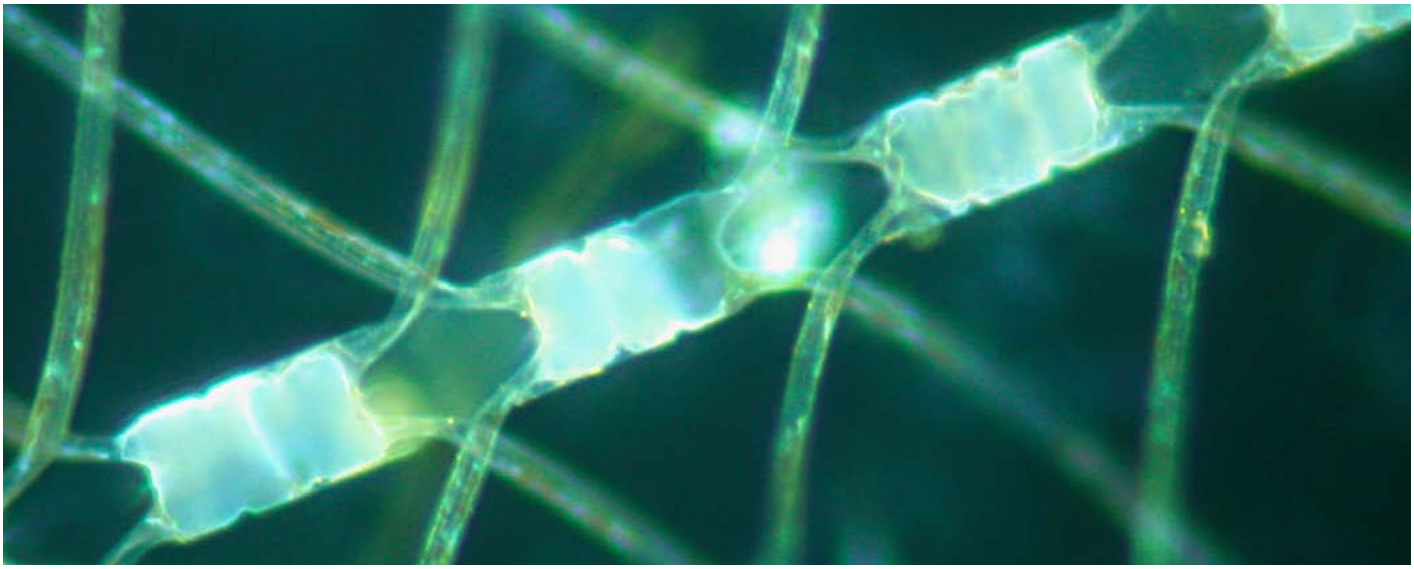
EXploring Ocean Iron Solutions (ExOIS; **oceaniron.org** ) is a consortium of scientists who came together in early 2022 to share ideas and move ahead on studies to consider OIF as one way to address our climate crisis. We follow five guiding principles that: 1) prioritize activities for the collective benefit of humans and the environment; 2) establish clear lines of responsibility; 3) commit to open and cooperative research; 4) assess results in an open, iterative and independent manner; and 5) engage the public in consideration of CDR options.

Together, we have laid out the needs and priorities required for a comprehensive assessment of OIF for ocean CDR. The research and development activities include planning and executing large lab, field, and modeling studies over a period of five to seven years, assessing public acceptance and improving public understanding of ocean CDR and OIF in particular, advancing development and adoption of international governance structures for open ocean field studies and large-scale CDR efforts, and providing training opportunities for future scientists, engineers, and policy experts.

This transformative R&D program would result in a detailed understanding of OIF as a CDR approach, including whether it is scalable and reproducible, has known deployment costs that can be transparent and accurate in terms of carbon accounting, and has known and acceptable ecological consequences. It would help to build a governance framework and clearly establish a set of responsibilities for large-scale deployment efforts.

No single institution or country can accomplish all of these scientific goals. Moving ahead with a coordinated OIF research program will require philanthropic, corporate, and private sources of funding support, along with national and international partnerships. But with the growing investment in commercial CDR markets, interest in ocean CDR is increasing rapidly. We have the opportunity to invest in the knowledge necessary to ensure that we can make scientifically and ethically sound decisions for the future of our planet.

Photo of a diatiom, ***Chaetoceros sp.***, that commonly respond to iron additions. Credit. M. W. Silver



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