2021 2030 United Nations Decade of Ocean Science for Sustainable Development

N-DA5

Challenge 4 Develop a sustainable and equitable ocean economy

Challenge 5 Unlock ocean-based solutions to climate change

Challenge 7 Expand the Global Ocean Observing System

INTRODUCING ExOIS EXPLORING OCEAN IRON SOLUTIONS

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WHO WE ARE

Exploring Ocean Iron Solutions (ExOIS) is a not-for-profit non-commercial consortium of experts that strives to foster partnerships for scientific research, as well as with public and private partners for funding. ExOIS strives to establish best practices and governance for the study of ocean iron fertilization (OIF) as one of many steps that will be needed to remove atmospheric carbon dioxide (CO_2) over the coming decades.

GUIDING PRINCIPLES

For ocean carbon dioxide removal studies

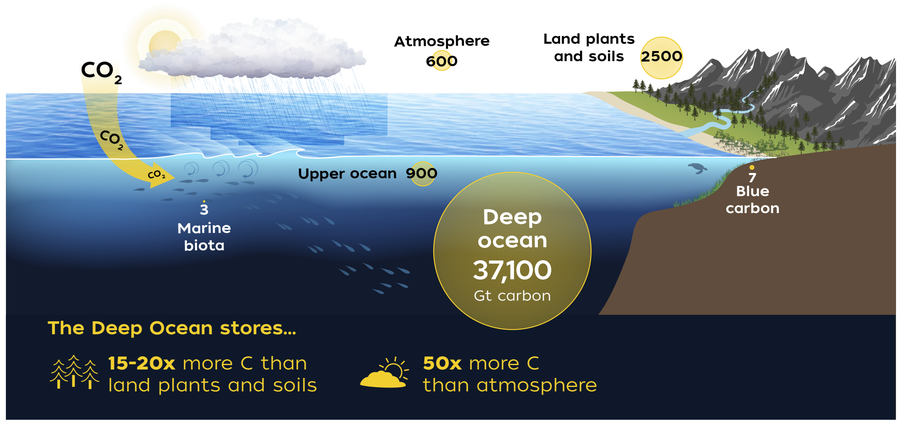
1. Prioritize collective benefit for humans and the environment
2. Establish clear lines of responsibility to oversee studies
3. Commit to open and cooperative research, including risk assessments
4. Perform evaluation and assessment in an iterative and independent manner
5. Engage the public in consideration of climate intervention options

ExOIS is organized around a responsible and ethical code of conduct that prioritizes activities for the collective benefit of our planet, while engaging in open and transparent studies that include public engagement (Buesseler et al., 2022).

THE NEED FOR OIF RESEARCH

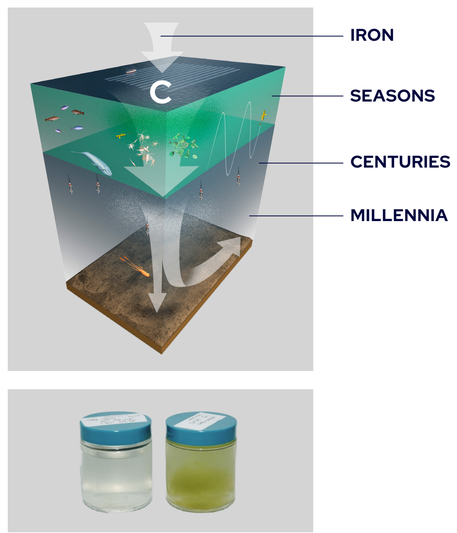
There is concern that commercialization of marine carbon dioxide removal (mCDR) is moving ahead faster than the science needed to assess carbon sequestration efficiencies and ecological impacts. ExOIS is seeking to establish open-source protocols for OIF for mCDR that can be assessed with appropriate monitoring, reporting and verification (MRV) for carbon accounting. ExOIS will also expand MRV to assess environmental, ecological, and other non-carbon related effects (eMRV).

The Ocean's Outsized Role



- The ocean plays an outsized role in the carbon cycle with a capacity for carbon storage more than 50 times larger than the atmosphere and 15-20 times larger than all land-based plants and soils
- Urgent and immediate action is needed to develop mitigation strategies to the climate crisis
- Enhancing the ocean's natural ability to store CO_2 needs to be considered
- Field studies are a necessity to advance our understanding of OIF and its potential for mCDR
- Ocean iron fertilization has been shown to stimulate biological productivity following natural and deliberate iron inputs to the ocean

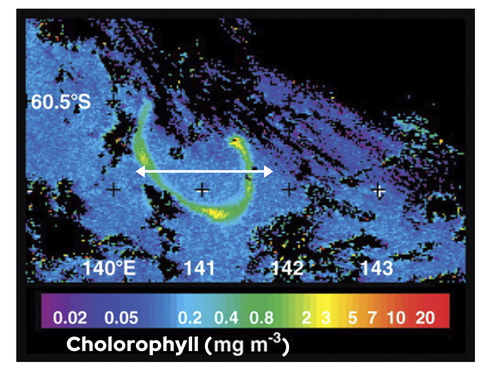
WHY OCEAN IRON FERTILIZATION



Numerous purposeful iron enrichment studies have been conducted, mostly in the iron-limited subpoloar and equatorial regions. Iron additions have been shown to stimulate phytoplankton growth, as shown in the seawater samples above: left not iron enriched, right iron enriched.

The magnitude and durability of carbon export following OIF needs further research following the conclusion of the 2002 SOFeX experiment that showed that an addition of 1.3 tonnes of iron removed about 2,000 tonnes of carbon (Buesseler et al., 2004).

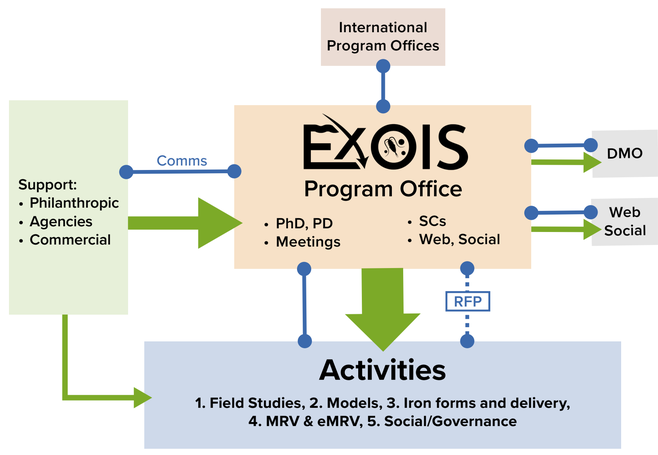
There are many different approaches to mCDR of which ocean iron fertilization has the longest history. This includes field experiments that have confirmed that a small addition of iron is effective at stimulating substantial phytoplankton growth in parts of the ocean where iron is limiting. As a consequence, CO_2 can be effectively drawn-down from the atmosphere, with some fraction of the carbon transferred to durable storage in the deep ocean.



Satellite image from SOIREE, a purposeful in-situ ocean fertilization experiment in the Southern Ocean, 1999. (Boyd et al., 2007).

THE ExOIS PROGRAM

ExOIS has published a plan to implement its research



Conceptual drawing of the ExOIS Program Office (PO) and management structure. The ExOIS PO would be central to fundraising and managing the resources needed for the 5 core activities (upper right). Green arrows indicate funding paths.

Access the Paths Forward report

RESEARCH ACTIVITIES

ExOIS has 5 core research paths

1. Next generation field studies

Studies of long-term (durable) carbon storage will need to be longer (year or more) and larger (>10,000 km²) than past experiments

2. Regional, global and field study modeling

Incorporation of new observations and model intercomparisons are essential to accurately represent how iron cycling processes regulate OIF effects on marine ecosystems and carbon sequestration

3. New forms of iron and delivery mechanisms

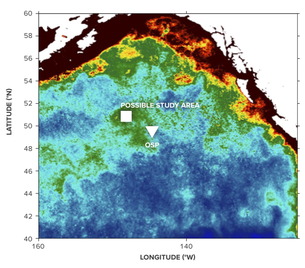
Rigorous testing and comparison of new forms of iron and their potential delivery mechanisms

4. Monitoring, reporting, and verification

Advances in observational technologies and platforms are needed to support the development, validation, and maintenance of models required for MRV

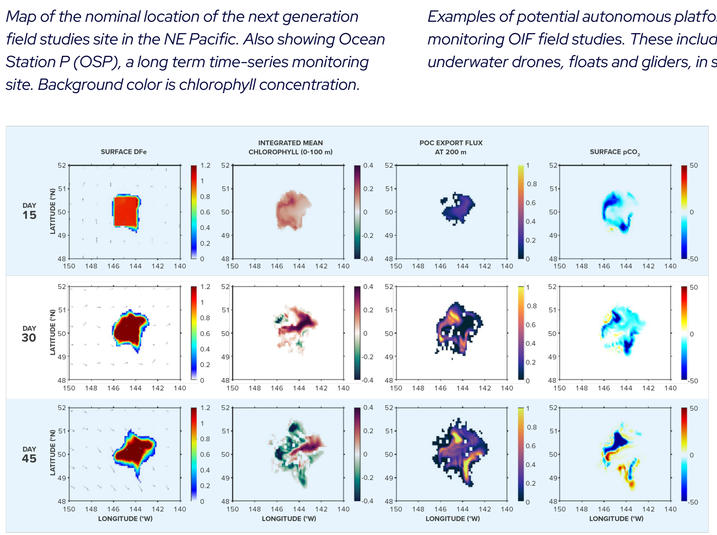
5. Governance, and stakeholder engagement

Attention to social dimensions, governance, and stakeholder perceptions will be essential from the start



Map of the nominal location of the next generation field studies site in the NE Pacific. Also showing Ocean Station P (OSP), a long term time-series monitoring site. Background color is chlorophyll concentration.

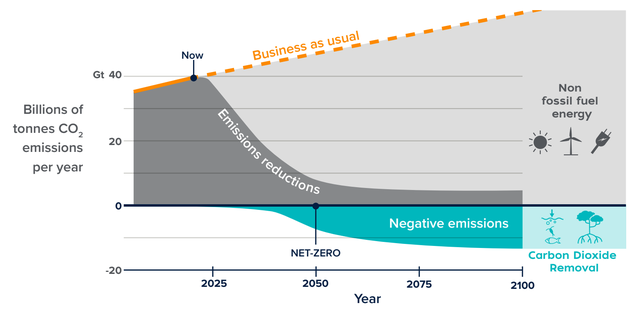
Examples of potential autonomous platforms that could be used for monitoring OIF field studies. These include autonomous surface and underwater drones, floats and gliders, in situ samplers, and remote sensing.



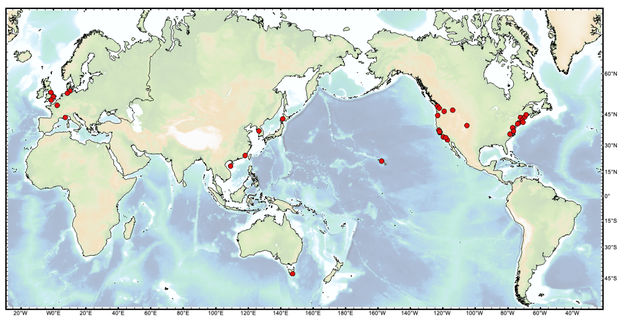
Model of biogeochemical response to OIF addition in NE Pacific for 15, 30, and 45 days after iron addition to a 200 x 200 km patch. Left to right: surface dissolved iron; integrated chlorophyll; particulate organic carbon flux at 200 m; and surface pCO2. (F. Chai et al. pers. comm.).

JOIN ExOIS

We have a path forward - the time is now



We are always growing and welcome new members to ExOIS. If you would like to learn more please see our website and sign up to join monthly forum meetings and receive updates. OceanIron.org.



ExOIS is in discussion with JETZON (Joint Exploration of the Twilight Zone Ocean Network - Decade Action 189) to become a recognized JETZON project.
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References: Boyd, P.W. et al. (2007) *Science*, 315, 612-617; Buesseler, K.O. et al. (2004) *Science*, 304, 414-417; Buesseler, K.O. et al. (2022) *Nature*, 606, 864.

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