Marine CDR science meets social science

ORGANIZING THE NEXT GENERATION OF OCEAN IRON FERTILIZATION FIELD STUDIES

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EXPLORING OCEAN IRON SOLUTIONS

ONE OCEAN SCIENCE CONGRESS

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. Global problems require global solutions and wide collaboration.

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).

ExOIS is an independent program housed at the not-for-profit Woods Hole Oceanographic Institution, USA.

60 members (and growing)

37 Institutions

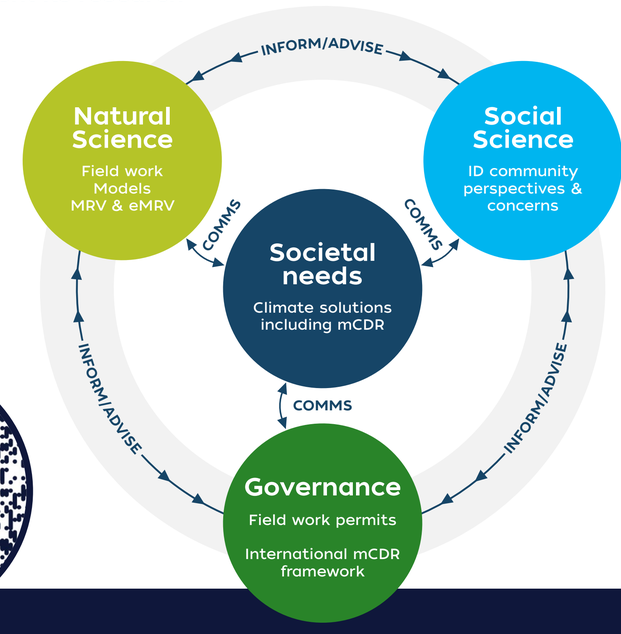
9 countries

OceanIron.org

THE ExOIS PROGRAM

ExOIS has published a plan to implement its research

Future OIF research programs must be developed and conducted in collaboration with social science experts to ensure they include community outreach and engagement, and are conducted in an open and transparent manner with appropriate social safeguards. International regulations allow for the permitting of legitimate scientific research and include environmental impact assessments as part of the process.

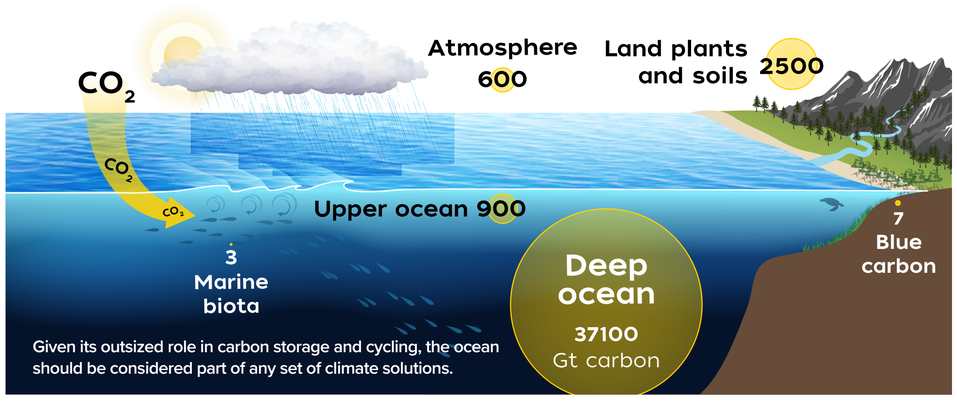


Access Frontiers in Climate article - Next steps for assessing OIF:

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



- 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

A promising climate solution

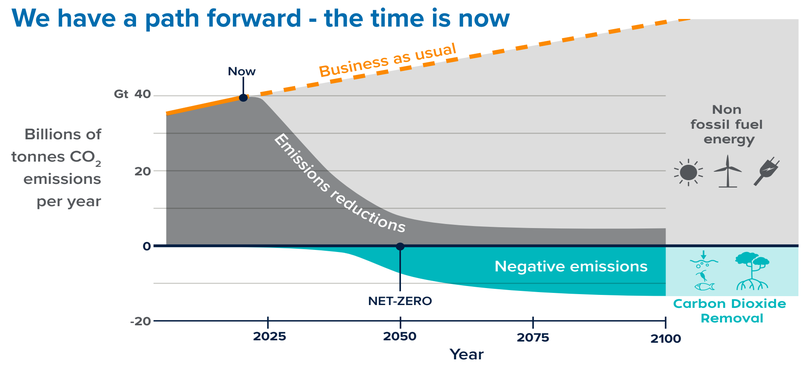
- Scalable - up to 1 Gt C per year in HNLC regions
- A little iron goes a long way
- Low cost – has the potential to be less than $50 per tonne CO_2
- Experience – 13 prior field experiments provide a wealth of existing data

Potential risks

Robust field studies will enable the evaluation of potential concerns and risks, and the uncertainty around them, such as:

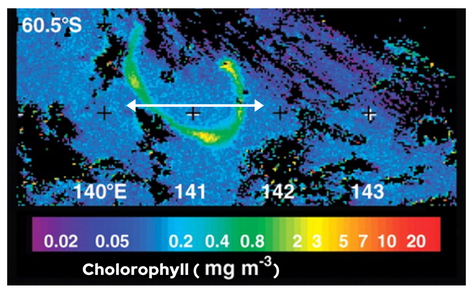
- Sinking organic matter can reduce subsurface oxygen levels and may produce other greenhouse gasses (N_2O, CH_4)
- How well can we anticipate unintended ecological shifts (ie. harmful algal blooms or shifts in productivity from one region to another)
- Impacts on fisheries and higher trophic levels (food web restructuring, benthic communities)

We have a path forward - the time is now



The international scientific community agree that the only way to solve the climate crisis is to both cut emissions and pursue the widest possible range of science-based carbon dioxide removal (CDR) strategies. No single CDR approach is likely to provide the scale needed, therefore we must responsibly investigate all options while working to cut emissions.

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 below: left not iron enriched, right iron enriched.



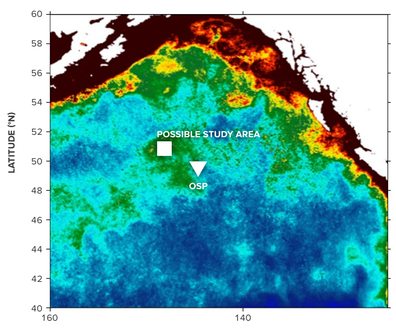
Satellite image from SOIREE, a purposeful in-situ ocean fertilization experiment in the Southern Ocean, 1999. (Boyd et al., 2007).

RESEARCH ACTIVITIES

ExOIS has 5 core research paths

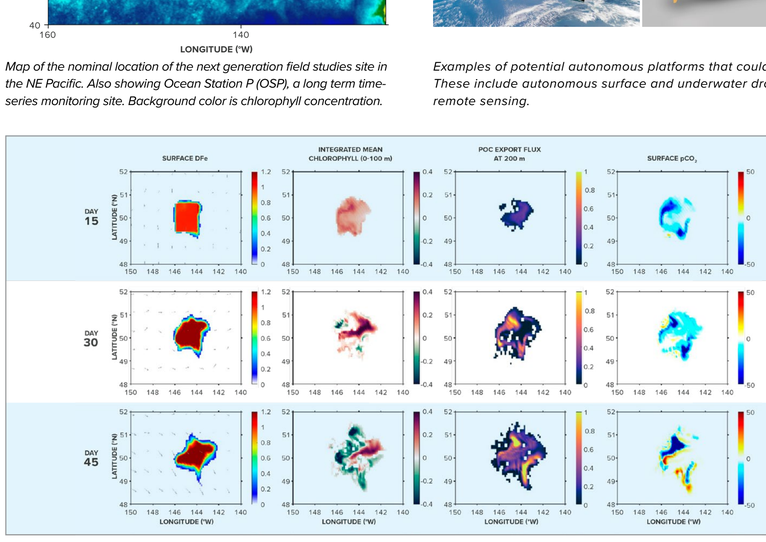
1. **Next generation field studies**
   Studies of long-term (durable) carbon storage will need to be longer (year or more) and larger (>10,000 km^2) than past experiments
2. **Regional, global and field study modeling**
   Incorporation of new observations and model intercomparisons are essential to 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

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.



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.).

Social science and governance: Research paths for field planning

Collaborative research governance

- Adopt collaborative research governance approaches that proactively respect and protect the rights of communities
- Align data collection and ownership with the Collective Benefit, Authority to Control, Responsibility and Ethics principles (CARE)
- Consider how risks posed by project activities might be assessed and managed

Community, rightsholder and stakeholder engagement

- Articulate the goals, intended extent of influence, and principles
- Commission a mapping study to characterize the landscape of communities, stakeholders, rightsholders, and other parties
- Develop an engagement plan that describes how priority groups can be involved in informing project operations

Social Science Research Priorities

- Community and public perceptions of research
- Trade-offs analysis associated with OIF research and deployment
- Appropriate staffing to address research priorities

VISIT: *oceaniron.org/our-plan*

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Thank you to the participants of the Moss Landing Marine Laboratories Meeting and the Woods Hole Oceanographic Institution Field Planning Meeting for contributions, and to WHOI Creative Studio for assistance with poster design.