“Give me half a tanker of iron and I’ll give you the next ice age”

J. Martin, 1988

Ken Buesseler

Senior Scientist, Woods Hole Oceanographic Institution

Executive Director, Exploring Ocean Iron Solutions

Why is ocean iron worth considering for mCDR?

EXOIS
EXPLORING OCEAN IRON SOLUTIONS

- ✓ **Scaling**
  >1-2 Gt CO_2/y considering only high nutrient areas
- ✓ **A little iron goes a long way**
  1 : 1000 iron:carbon ratio from (inefficient) field experiments
- ✓ **Cost**
  <$50 tonne CO_2 -lower than any other marine CDR approach
- ✓ **Experience**
  13 field experiments; no observed harm & 4,000 tonnes $CO_{2\text{-}eq}$ removed

What potential risks need further consideration?

- before OIF is deployed at scale

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- ✓ **Downstream impacts**
  Models suggest a 5% biomass impacts, but with 200 Gt CO2-eq removal by 2100
- ✓ **Deoxygenation**
  Mid-water decreases likely small, even at scale
- ✓ **Harmful algal blooms**
  Pseudonitszchia diatoms with domoic acid - not higher in OIF field studies
- ✓ **Other greenhouse gases**
  Prior OIF studies encouraging, but can't ignore (N_2O, CH_4, DMS)

Exploring Ocean Iron Solutions - ExOIS

- ✓ International consortium of experts launched 2022 dedicated to studying ocean iron fertilization for carbon dioxide removal (CDR)

  - 60+ members
  - 37 institutions
  - 9 countries

- ✓ Not-for-profit independent program housed at the Woods Hole Oceanographic Institution
- ✓ ExOIS fosters partnerships for scientific research and outreach, as well as with public and private partners for funding

How we conduct science matters

Guiding principles for responsible mCDR studies

EXOIS
EXPLORING OCEAN IRON SOLUTIONS

- Prioritize benefit for humans and the environment
- Perform iterative and independent assessments
- Establish clear lines of responsibility
- Engage the public
- Commit to open research and risk assessments

Ken Buesseler, Kilaparti Ramakrishna, Margaret Leinen, Nature Correspondence, 2022

✓ **ExOIS is not seeking C credits**

EXPLORING Ocean Iron Solutions

- Monthly virtual forums

1. Field studies
2. Modeling
3. Iron forms and delivery
4. New technologies for MRV/eMRV
5. Social & governance issues

Paths Forward workshop
May 2023

frontiers | Frontiers in Climate

Next steps for assessing ocean iron fertilization for marine carbon dioxide removal

Ken O. Buesseler[1]*, Daniele Bianchi[2], Fei Chai[3], Jay T. Cullen[4], Margaret Estapa[5], Nicholas Hawco[6], Seth John[7], Dennis J. McGillicuddy Jr[1], Paul J. Morris[1]*, Sara Nawaz[8], Jun Nishioka[9], Anh Pham[2], Kilaparti Ramakrishna[1], David A. Siegel[10], Sarah R. Smith[11], Deborah Steinberg[12], Kendra A. Turk-Kubo[13], Benjamin S. Twining[14], Romany M. Webb[15], Mark Wells[16], Angelicque White[6], Peng Xiu[3] and Joo-Eun Yoon[17]

September 2024

OCEAN IRON FERTILIZATION
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What's else is ongoing/next

- ✓ Modelling intercomparisons for OIF
  - Supported by NOAA/NOPP and ExOIS/OV
- ✓ MRV for C- Models and tech- supported by ARPA-E
- ✓ Field Studies
  - 2024 field planning workshop for NE Pacific 2027/28; case for larger/longer trials; off-ramps; permit under EPA and LC/LP; community engagement; MRV and eMRV
- ✓ Recommendations on collaborative research governance, community engagement and social science for ExOIS
- ✓ Outreach continues at several events
  - COP, UN Oceans, UN Busan, Liege Symp., SXSW, EarthX, Ocean Visions summits, Ocean Sciences, PICES, Alaska Marine Sci Symp., American Geophysical Union, NYC Climate Week, etc.

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