Exploring ocean iron fertilization as a potential approach for marine carbon dioxide removal (mCDR)

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Introducing Exploring Ocean Iron Solutions

EXOIS

EXPLORING OCEAN IRON SOLUTIONS

We have a path forward

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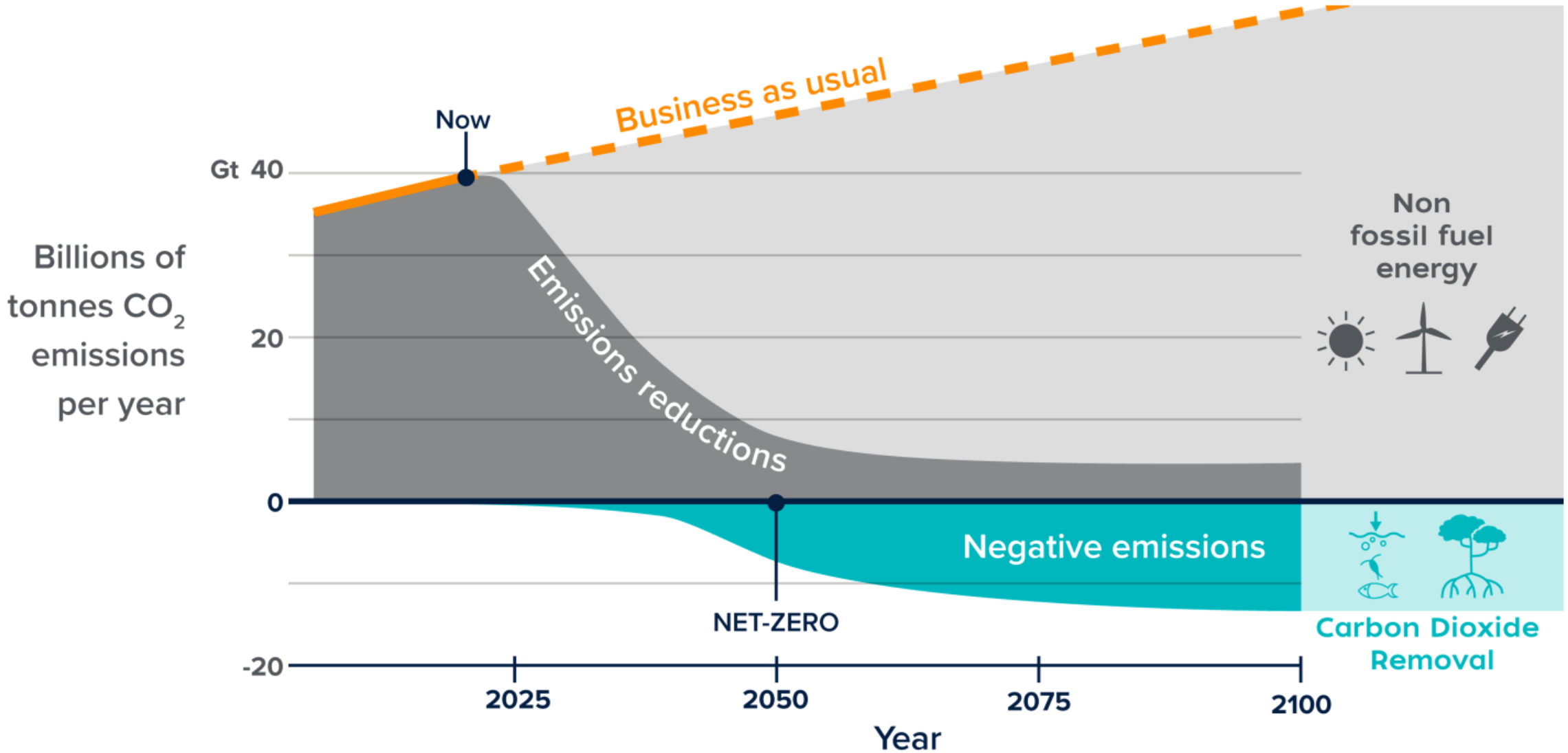
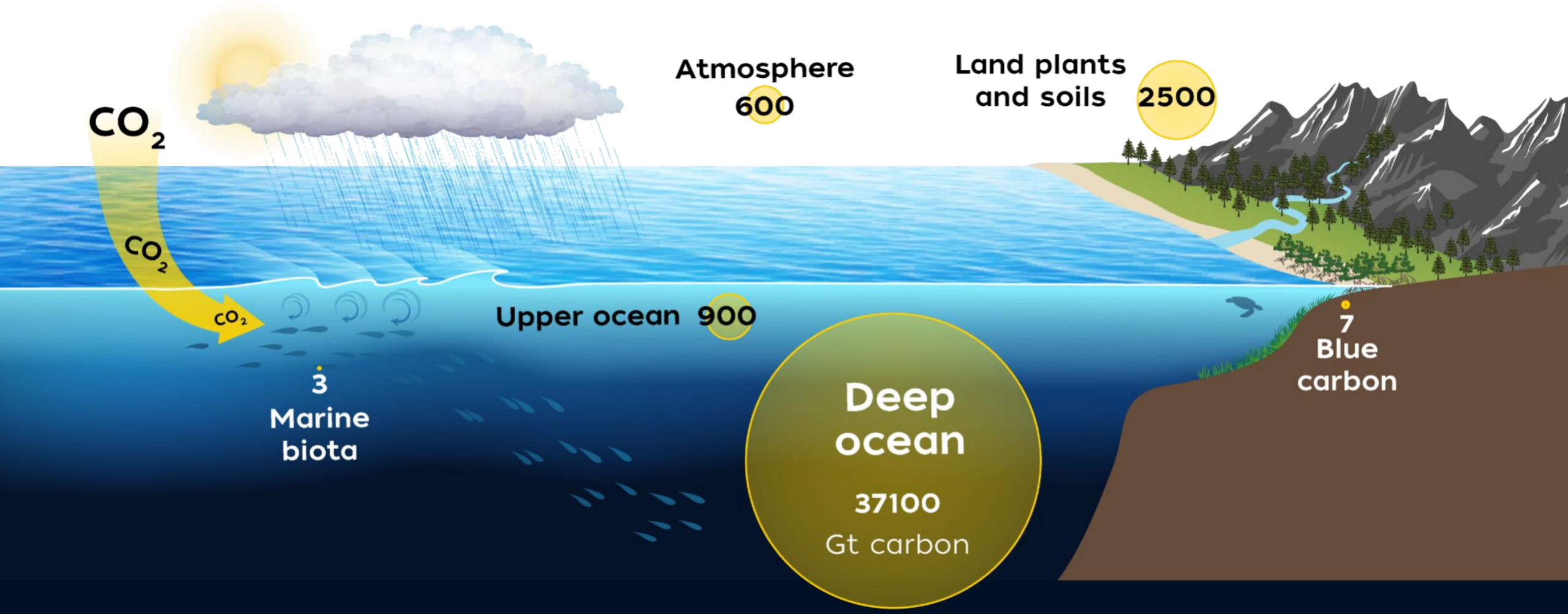


Where does nature store carbon?



There is no solution to our climate crisis without considering the ocean

Ocean CDR – example from iron fertilization

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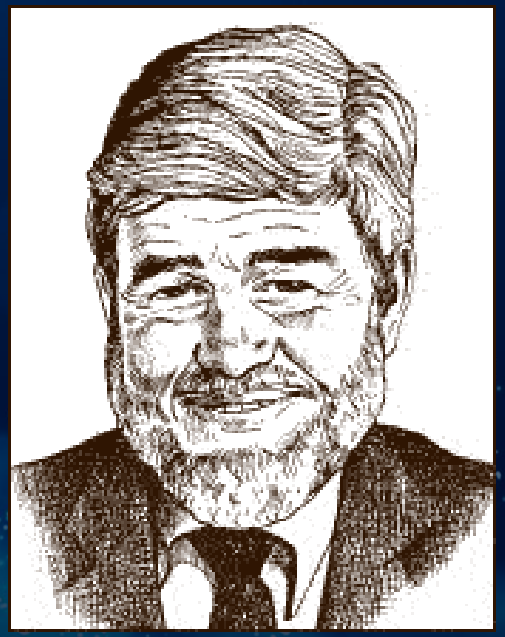
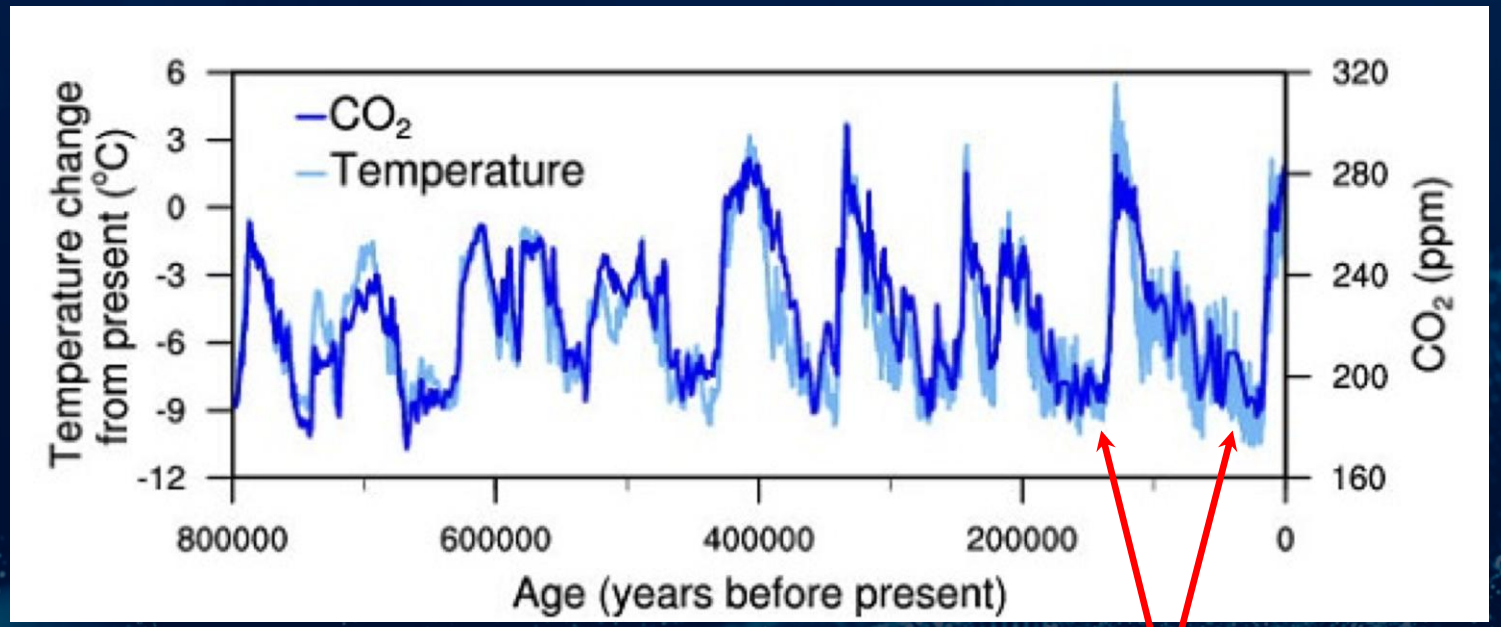
"Give me half a tanker of iron and I'll give you an ice age"



John Martin
WHOI seminar 1988



Colder ice-ages had lower CO_2 and higher dust (iron)

Small amounts of iron enhance phytoplankton growth in some locations

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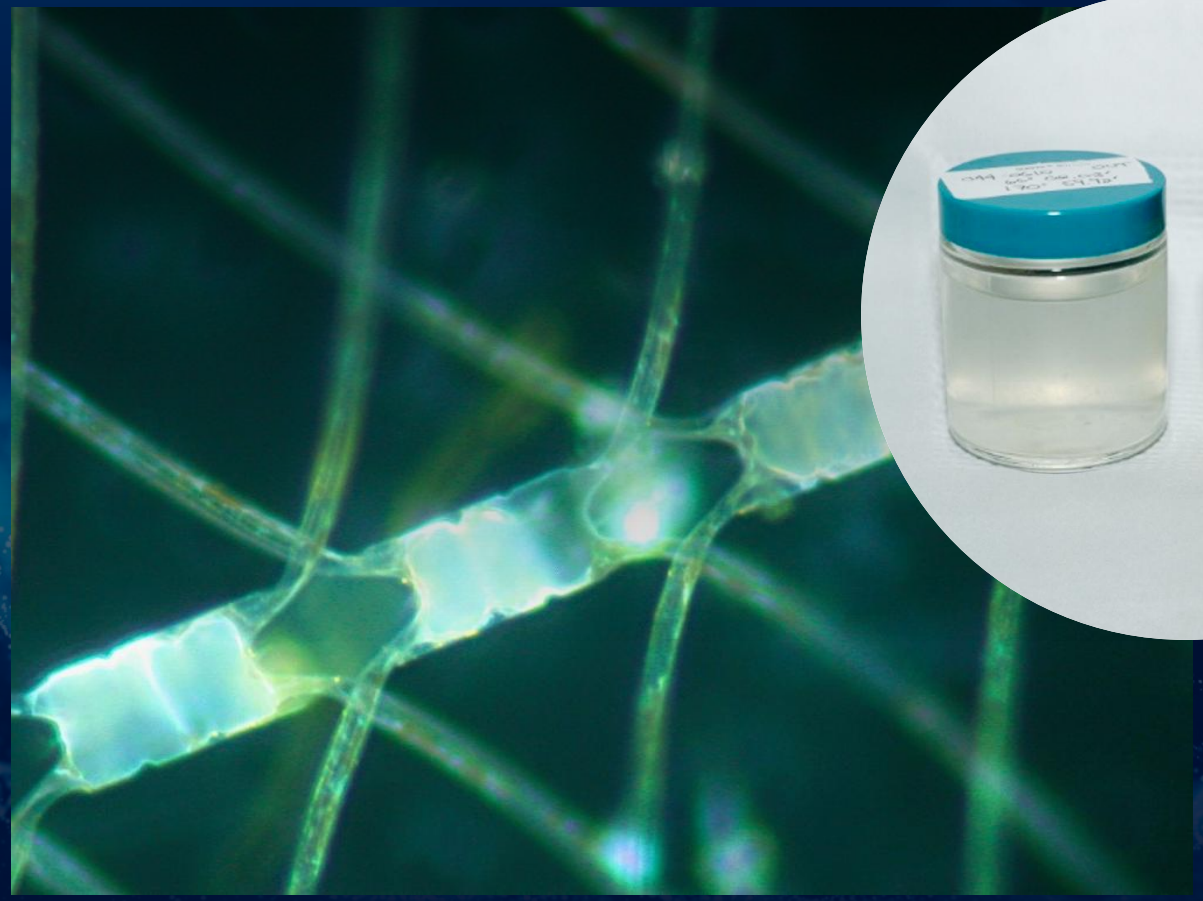
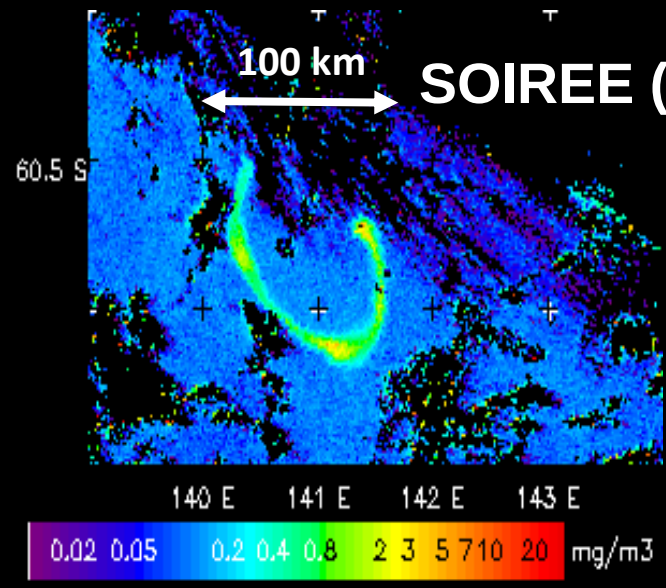
"Just add iron" 13 ocean experiments 1993-2009

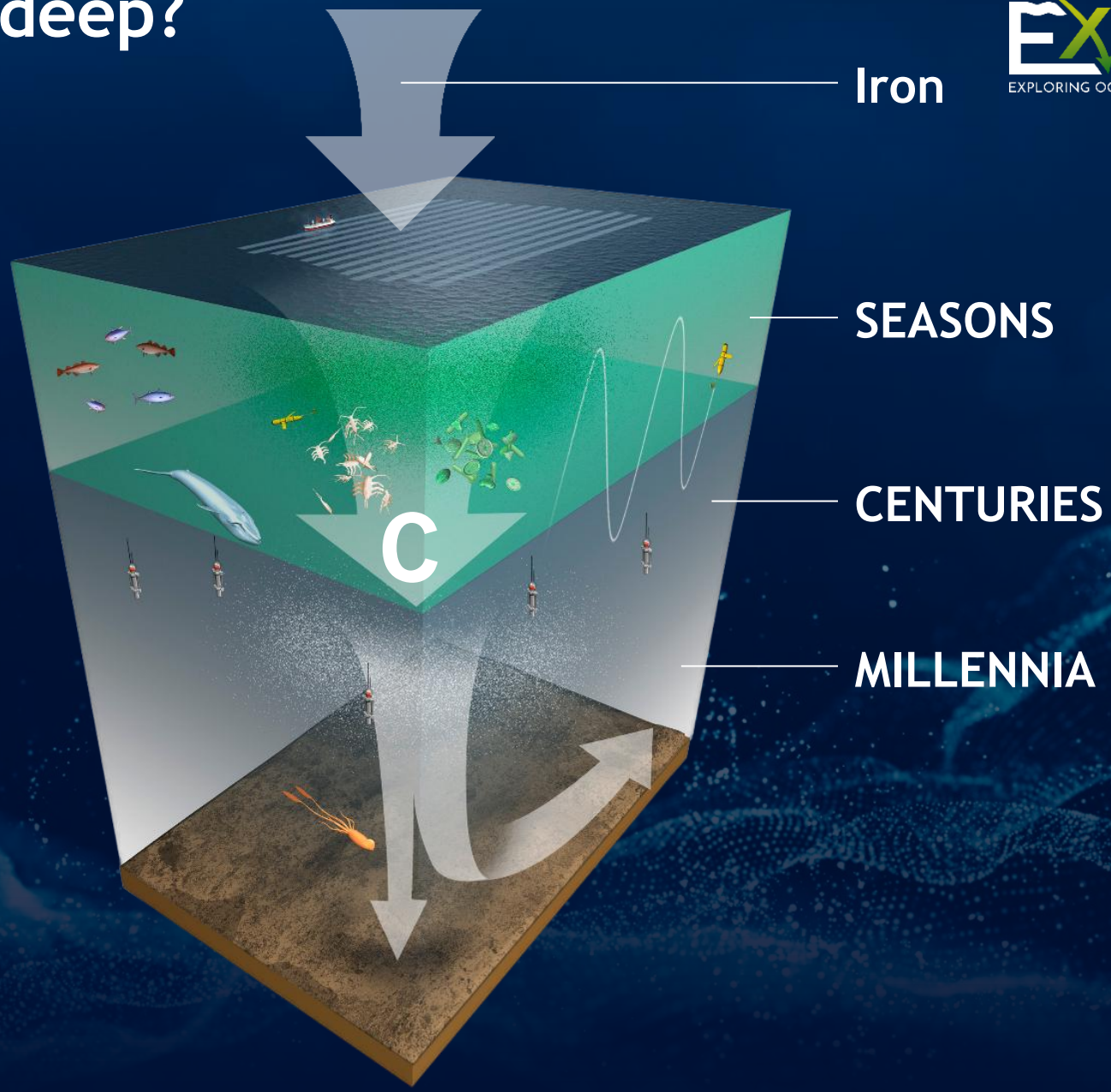




SOFeX (2002)
1.3 tonnes Fe added
2000 tonnes C removed at 100 m

How much carbon gets deep?

- ✓ Transport of carbon via *"Biological C Pump"* *aka "Marine Snow"*
- ✓ Key questions in next generation studies are additionality and durability



Why is ocean iron such a promising climate solution?

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- ✓ **Scaling**
  - *Up to 4 billion tonnes CO_2 per year, considering only HNLC areas*
- ✓ **A little iron goes a long way**
  - *1 : 1,000 iron:carbon ratio from (inefficient) field experiments*
  - *1 : 100,000 in nature*
- ✓ **Cost**
  - *<$50 tonne CO_2 -lower than any other marine CDR approach, iron is cheap*
  - *Leverages a natural process, energy from sunlight*
- ✓ **Experience**
  - *13 prior field experiments; no observed/direct harm*
  - *Already studied after volcanic eruptions, forest fires, island plumes*
  - *Removed ≈4,000 tonnes CO_2 in a 1-month ocean iron experiment*

Exploring Ocean Iron Solutions - ExOIS

- ✓ International consortium of experts 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

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 40 Gt C 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)

What other issues need further consideration?

- before ocean iron is deployed at scale

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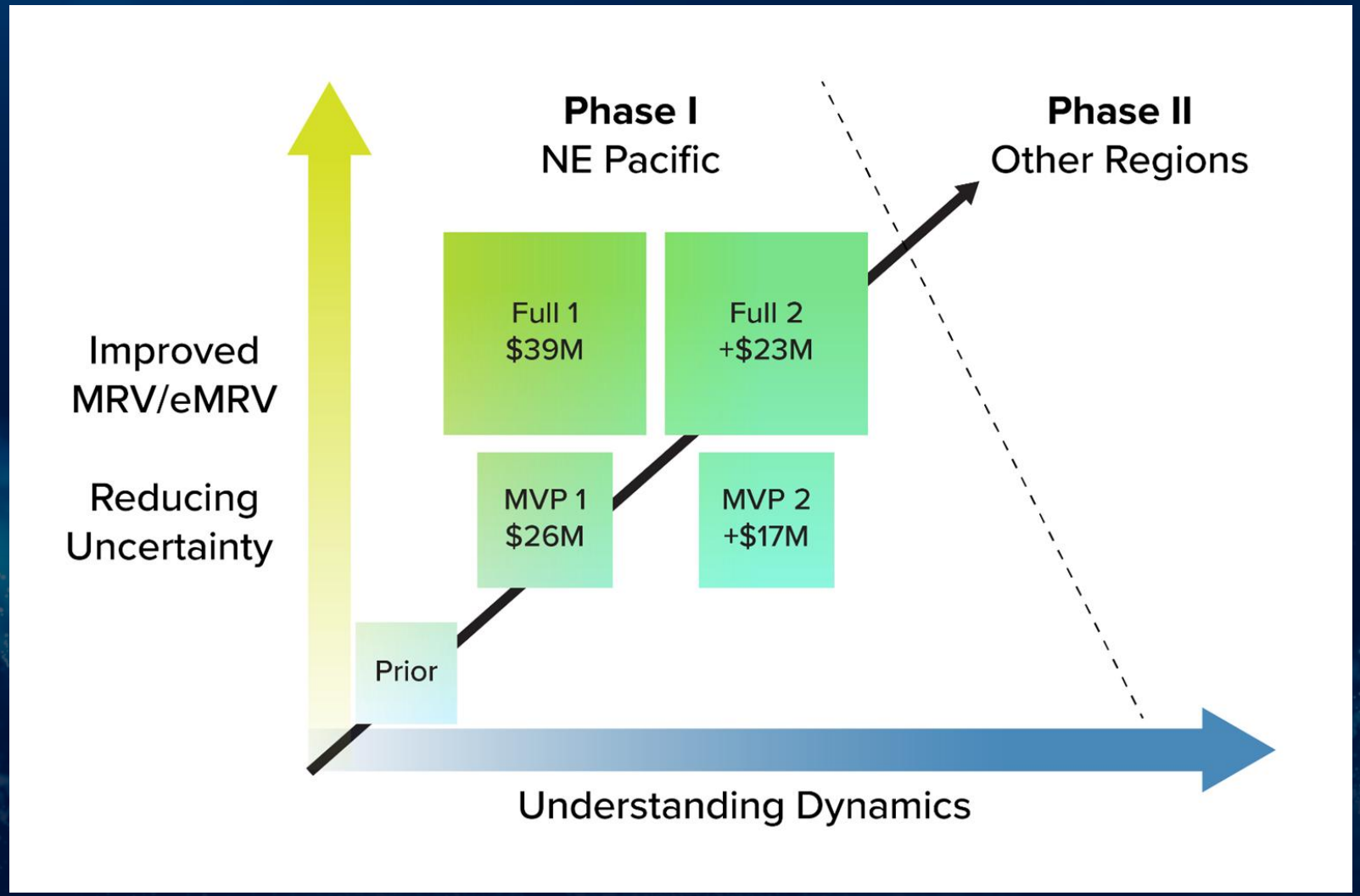
- ✓ **Fisheries**
  - *Enhanced productivity: diatoms » krill » whales/salmon- how to know?*
- ✓ **Benthos**
  - *Use at-scale examples in nature as field studies too small/short*
- ✓ **Multiple benefits with removal of atmospheric CO_2**
  - *Reduces surface ocean acidity*
  - *Limits worst of climate change impacts- temperature & sea level rise*

The cost of doing OIF research



- Platforms & equipment ≈40%
- Personnel ≈40%
- Sample and data handling ≈20%
- Costs assume all new equipment

How we conduct science matters

Guiding principles for responsible mCDR studies

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1. Prioritize benefit for humans and the environment
2. Establish clear lines of responsibility
3. Commit to open research and risk assessments
4. Perform iterative and independent assessments
5. Engage the public

K. Buesseler, K. Ramakrishna, M. Leinen
Nature Correspondence, 2022

Scientific integrity is the cornerstone of trust

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- The conclusions and outcomes of the research must be independent and driven by the data and results
- There cannot be any inference – real or perceived – that the research outcomes are biased by the source of the funding
- This is especially true during the initial research and if the research guides us to bigger scale pilot studies
- Scientific independence can be maintained by not selling carbon credits and IP

NOPP National Oceanographic Partnership Program

arpa·e

McConnell Family Foundation

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OCEAN VISIONS
Advancing Solutions for Ocean-Climate Restoration

OCEAN RESILIENCE & CLIMATE ALLIANCE

ASTERA INSTITUTE

Small financial donations

The Navigation Fund

In-kind and pro bono support

Visit the ExOIS website to learn more

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OceanIron.org