A modern approach to Southern Ocean Phytoplankton CDR

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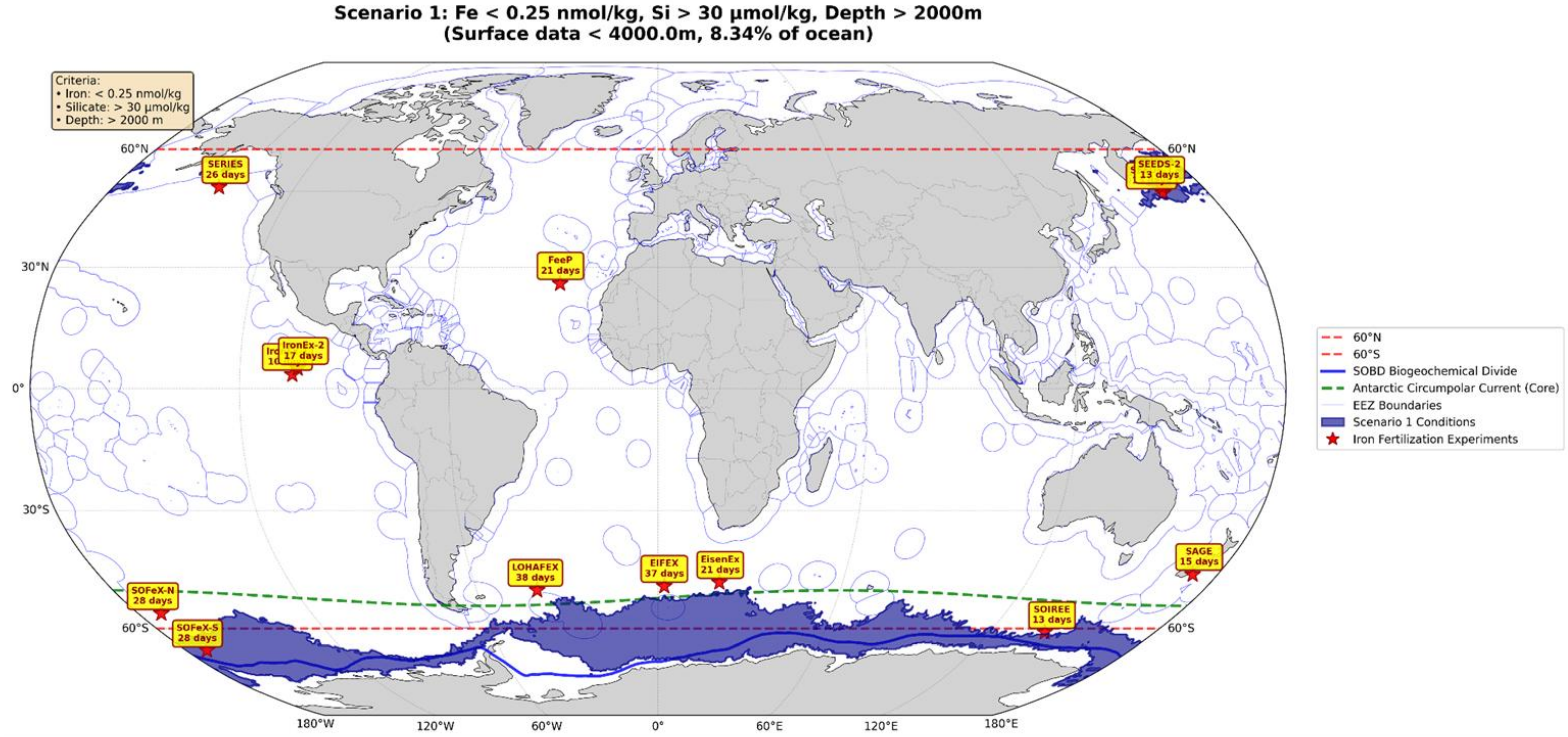
Why another ocean experiment?



	New suggested approach	IronEx-1 (1993)	IronEx-2 (1995)	SOIREE (1999)	EisenEx (2000)	SOFeX-N (2002)	SOFeX-S (2002	EIFEX (2004)	SAGE (2004)	LOHAFEX (2009)	SEEDS-1 (2001)	SERIES (2002)	SEEDS-2 (2004)	FeeP (2004)
Iron-only addition	✗	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✓
Repeated / sustained additions	✔	✗	✔	✓	✓	✓	✓	✔	✓	✔	✗	✔	✓	✓
Retentive eddy / coherent water mass	✔	✗	✗	✗	✔	✓	✓	✔	✗	✔	✗	✗	✗	✗
Extended monitoring >35 days	✔	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗	✗	✗
Direct export flux measurements	✔	✗	✗	✓	✓	✓	✓	✔	✓	✔	✓	✔	✔	✗
Deep export / seq. assessed	✔	✗	✗	✗	✗	✓	✓	✔	✗	✓	✗	✓	✓	✗
Grazing / remin. assessed	✔	✗	✓	✓	✓	✓	✓	✔	✓	✔	✓	✔	✔	✗
Nutrient redistribution / downstream assessed	✔	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
Governance / MRV framework from outset	✔	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Legend: Core consideration ✔ Partially addressed ✓ Not addressed ✗

Momentum has started…

SCIENCE

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The case for ocean iron fertilization field trials

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Abstract
Solving the climate-ocean crisis requires both cutting emissions and pursuing carbon dioxide removal (CDR). Past ocean iron fertilization (OIF) experiments in some parts of the ocean have shown that small additions of iron can enhance phytoplankton growth and CO_2 drawdown. However, prior experiments did not assess the efficacy, durability, or feasibility of OIF for CDR, and broader ecological and biogeochemical responses were not evaluated given the short duration and limited spatial scales. The next generation of OIF field trials must be larger (ca. 1000 km^2) and longer (>3–6 months) to observe the full

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GOVERNMENT

NEW ZEALAND / ENVIRONMENT

Start-up asked for regulation changes to allow controversial marine carbon storage

8:57 am on 1 April 2026

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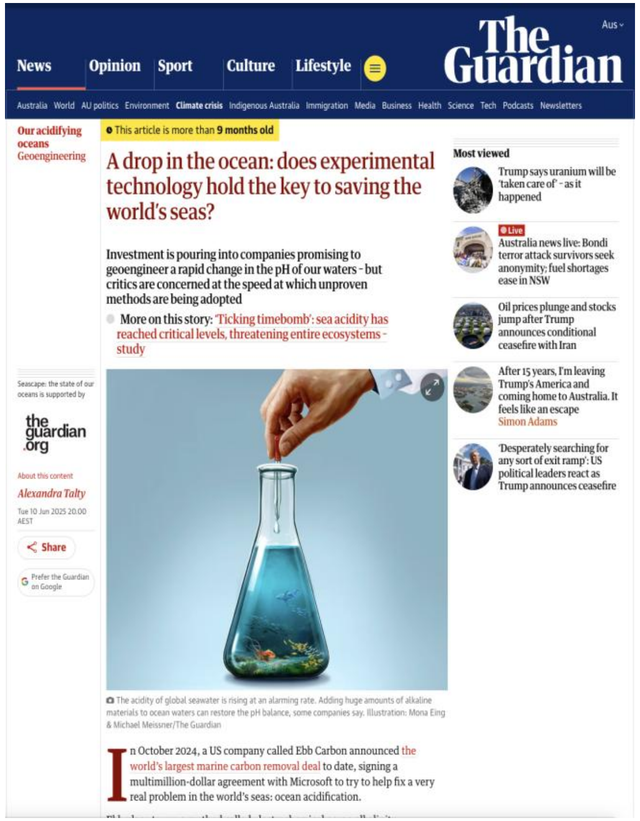

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Our acidifying oceans
Geoengineering

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A drop in the ocean: does experimental technology hold the key to saving the world's seas?

Investment is pouring into companies promising to geoengineer a rapid change in the pH of our waters - but critics are concerned at the speed at which unproven methods are being adopted

More on this story: 'Ticking timebomb': sea acidity has reached critical levels, threatening entire ecosystems - study

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About this content

Alexandra Talty

Tue 10 Jun 2025 20.00 AEST

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The acidity of global seawater is rising at an alarming rate. Adding huge amounts of alkaline materials to ocean waters can restore the pH balance, some companies say. Illustration: Mona Eing & Michael Meissner/The Guardian

In October 2024, a US company called Ebb Carbon announced the world's largest marine carbon removal deal to date, signing a multimillion-dollar agreement with Microsoft to try to help fix a very real problem in the world's seas: ocean acidification.

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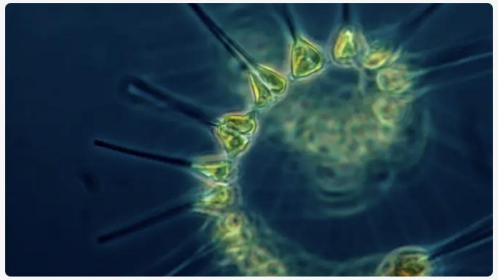


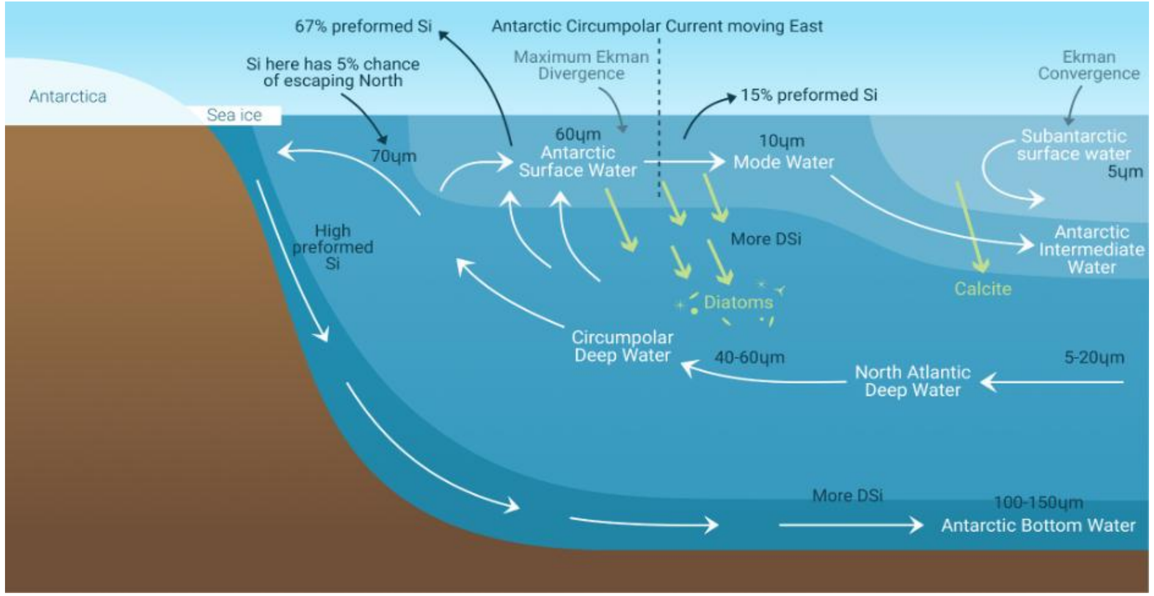
FEBRUARY 3, 2026

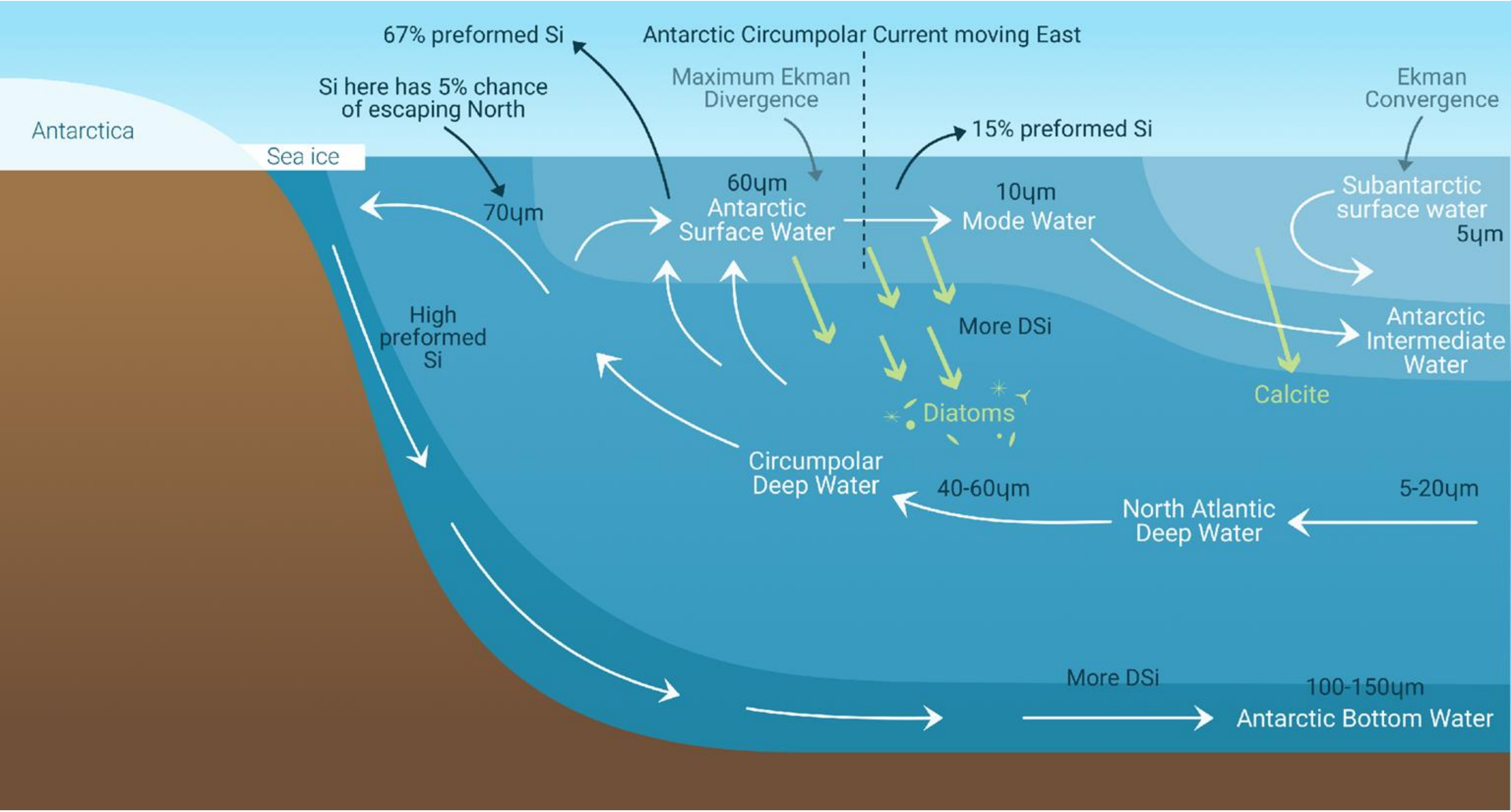
New Ocean Visions Report: Can Phytoplankton Help Close the Carbon Dioxide Removal Gap?

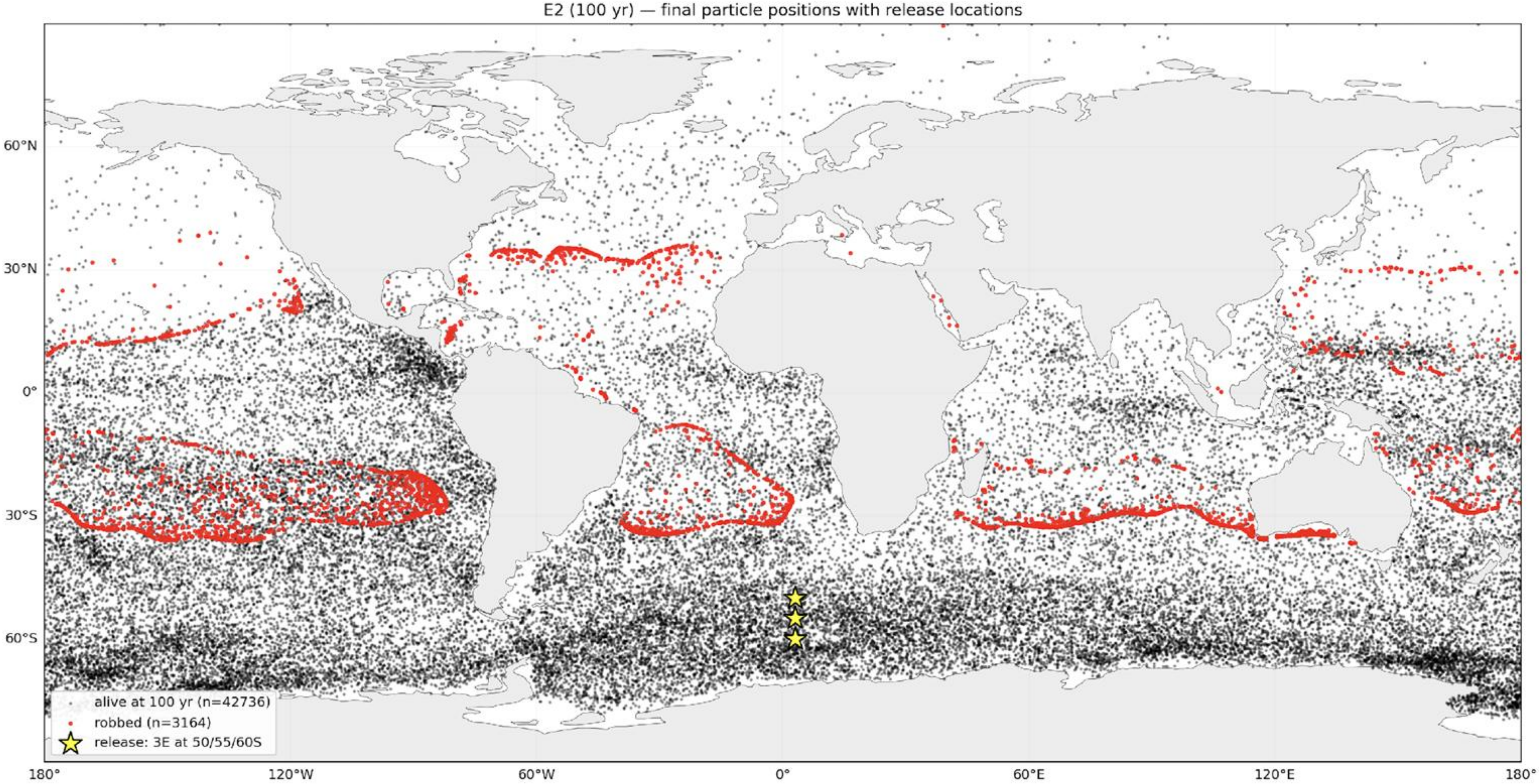
Ocean Visions' new report examines whether and how phytoplankton might contribute to the gigatons of carbon dioxide removal (CDR) needed to meet global climate goals. Produced through a year-long investigation, and informed by an international advisory board, the report outlines recommendations to address critical knowledge gaps and calls for new investment into priority RD&D and enhanced coordination of efforts.

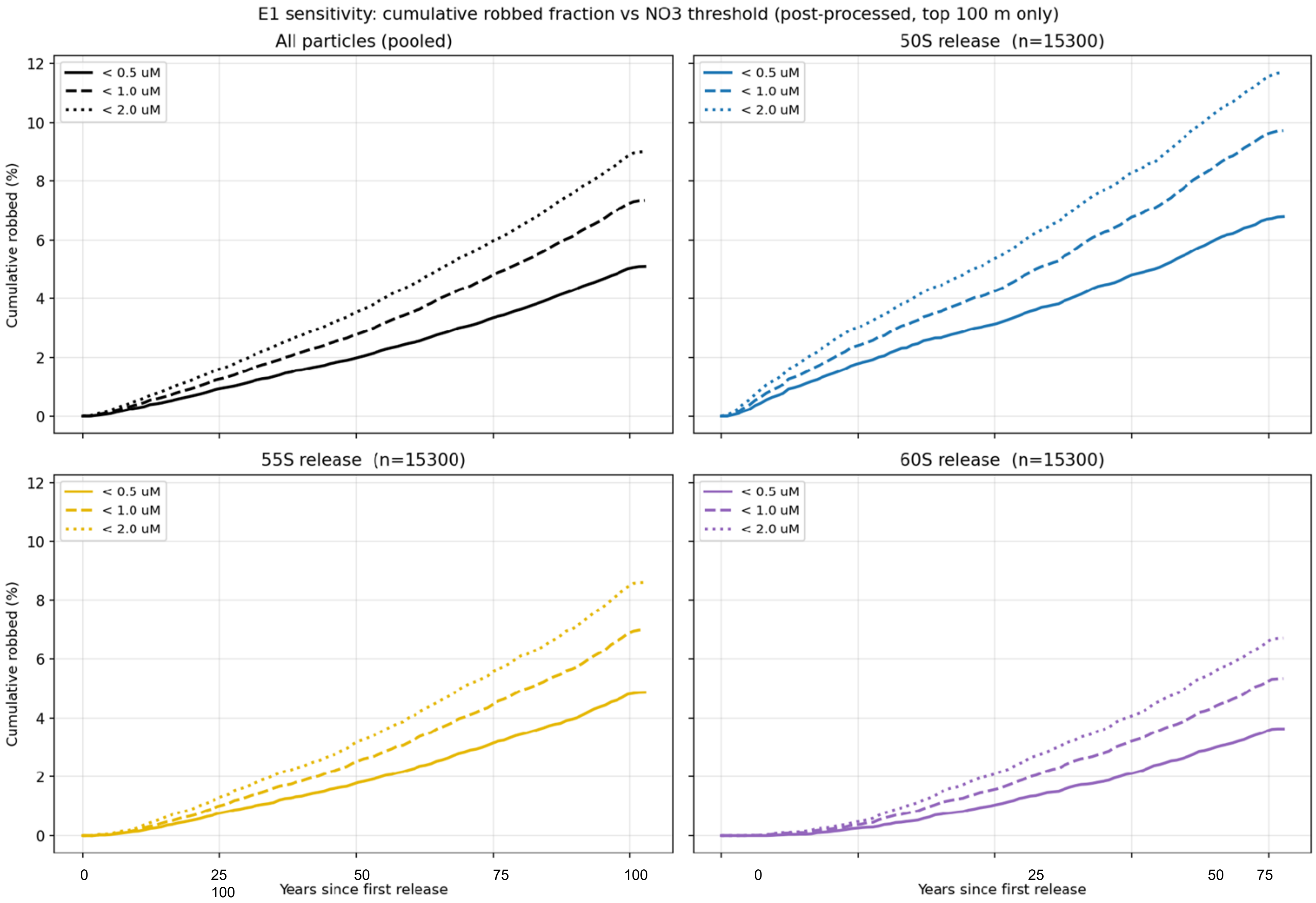
What we are currently working on

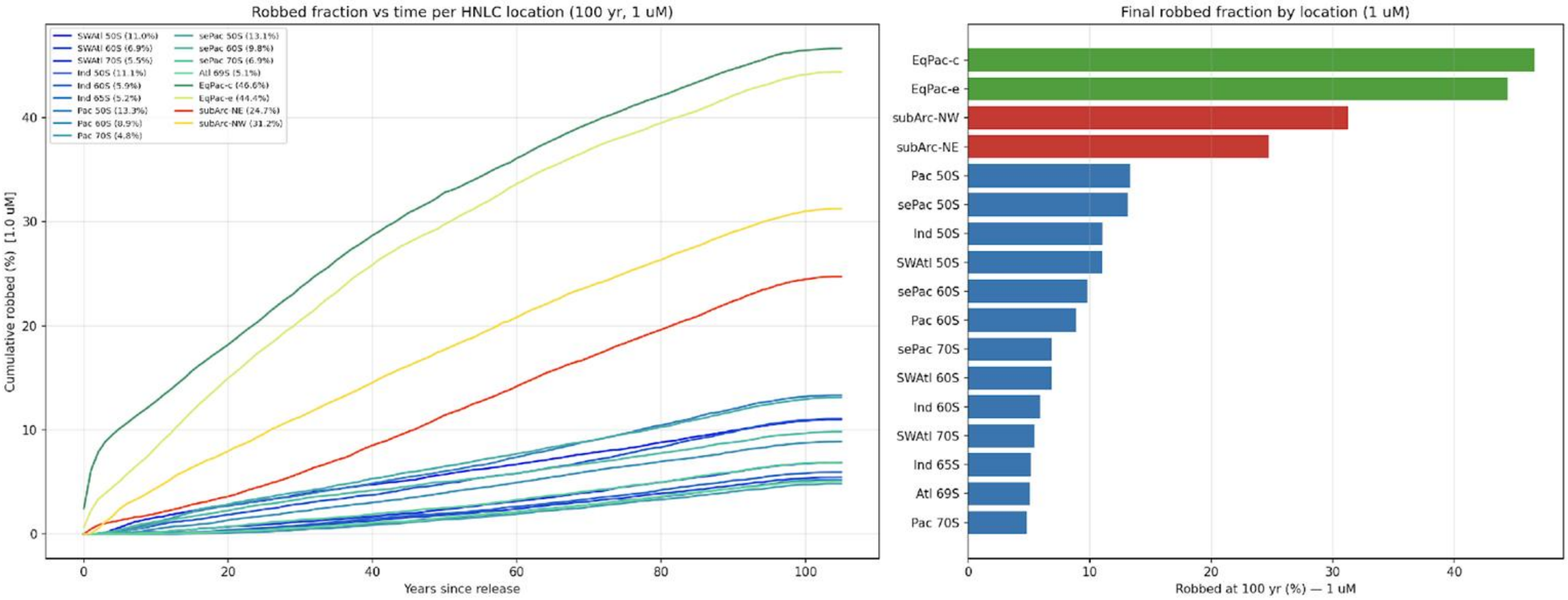
- Developing an additionality framework for phytoplankton CDR
- Lab incubation experiments examining TEP production, aggregation, growth rates, and inferred export
- Modelling preformed nutrient dynamics

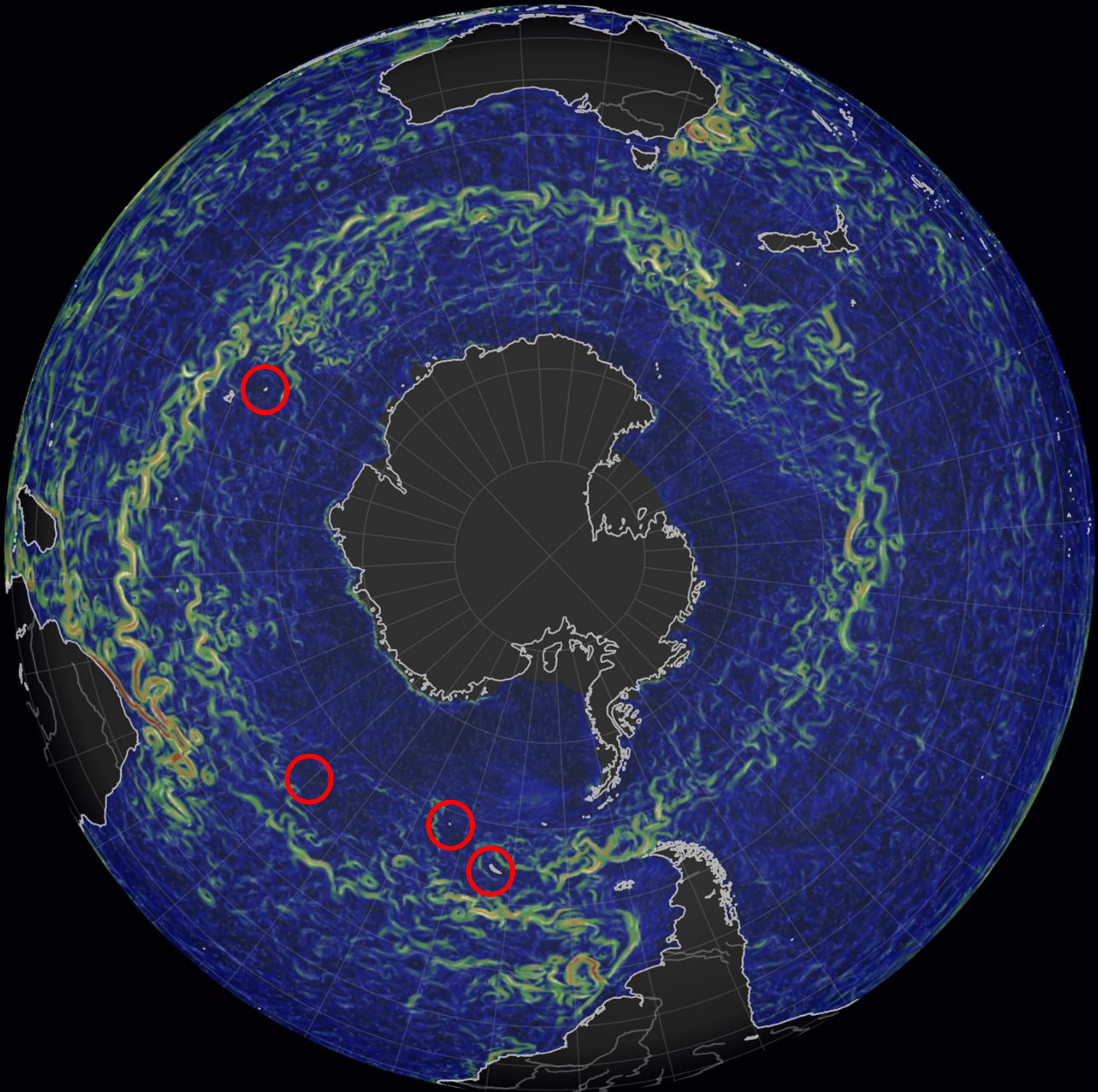


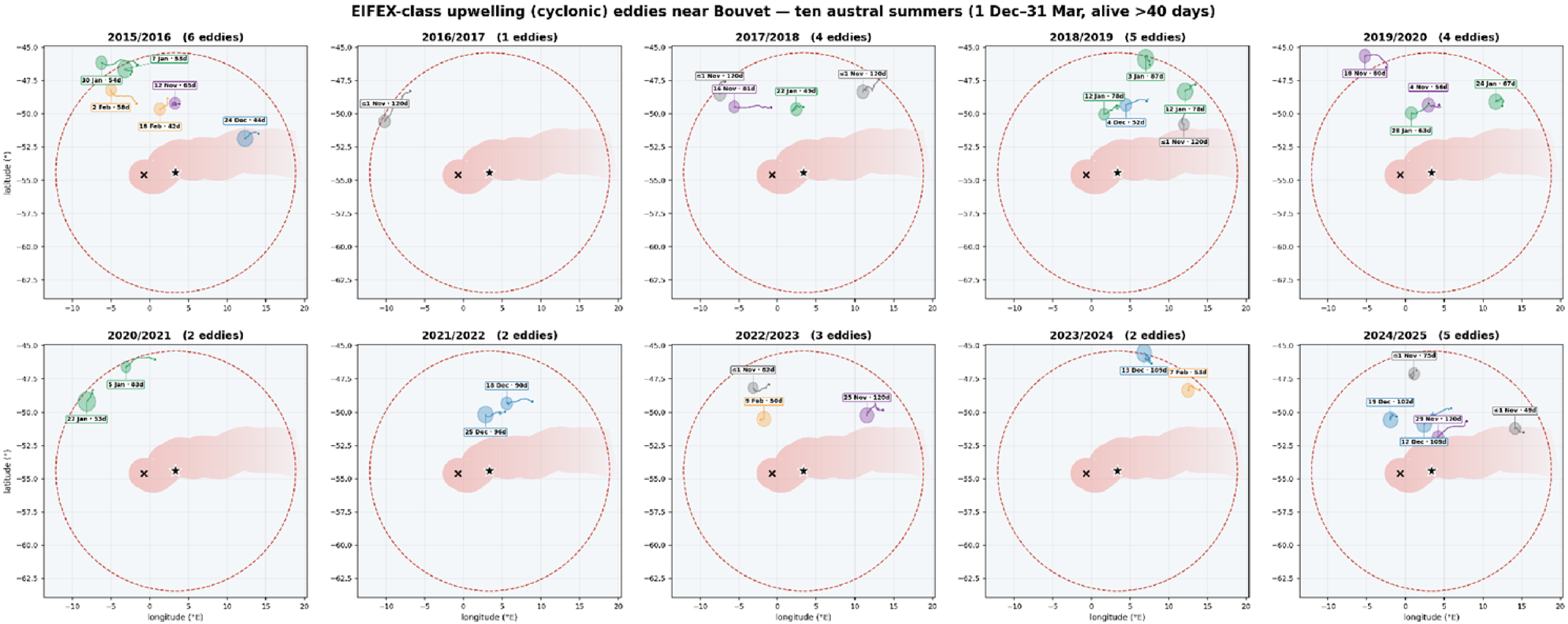

67% preformed Si
Antarctic Circumpolar Current moving East
Si here has 5% chance of escaping North
Maximum Ekman Divergence
Ekman Convergence
Antarctica
Sea ice
15% preformed Si
60μm
Antarctic Surface Water
70μm
10μm
Mode Water
Subantarctic surface water
5μm
High preformed Si
More DSi
Antarctic Intermediate Water
Calcite
Diatoms
Circumpolar Deep Water
40-60μm
North Atlantic Deep Water
5-20μm
More DSi
100-150μm
Antarctic Bottom Water


E2 (100 yr) — final particle positions with release locations
60°N
30°N
0°
30°S
60°S
180°
120°W
60°W
0°
60°E
120°E
180°
alive at 100 yr (n=42736)
robbed (n=3164)
release: 3E at 50/55/60S

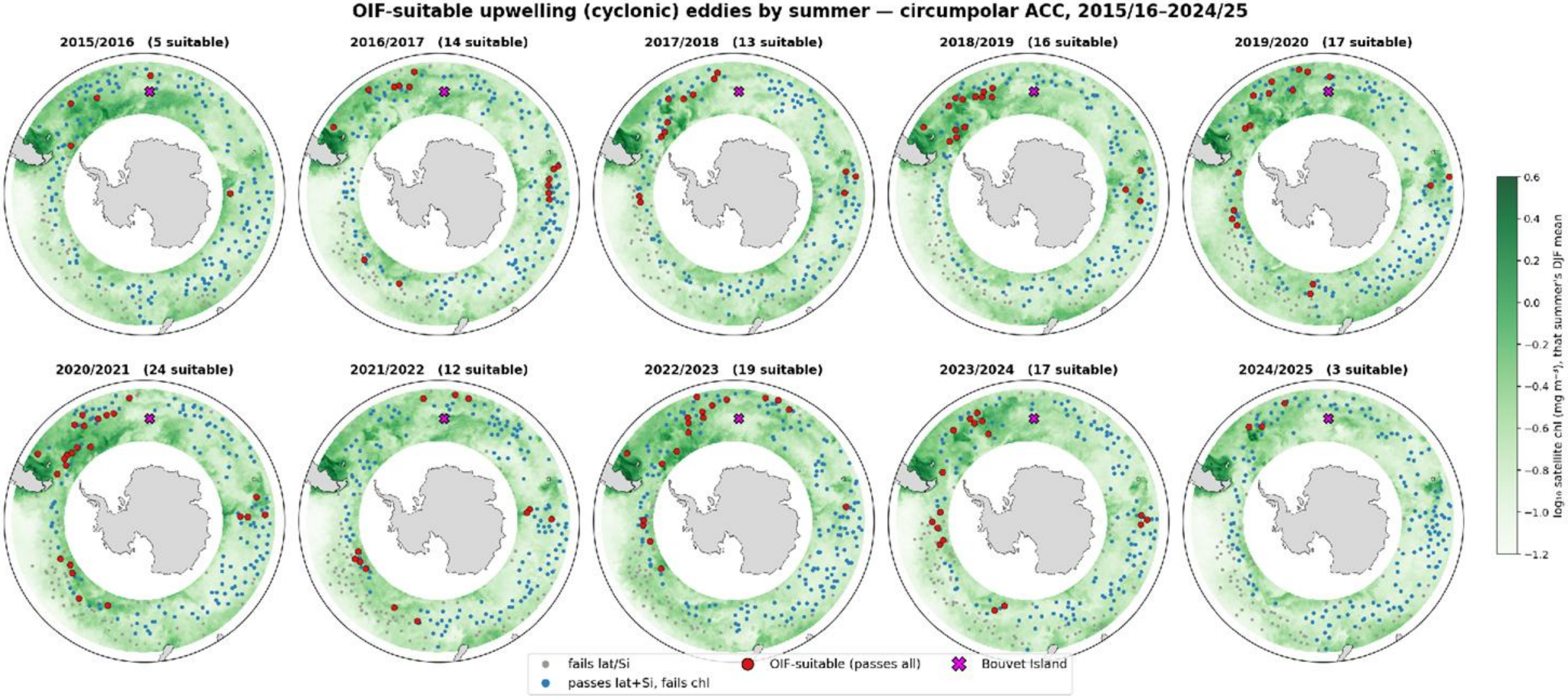

E1 sensitivity: cumulative robbed fraction vs NO3 threshold (post-processed, top 100 m only)
All particles (pooled)
50S release (n=15300)
55S release (n=15300)
60S release (n=15300)
< 0.5 uM
< 1.0 uM
< 2.0 uM
Cumulative robbed (%)
Years since first release
0
25
50
75
100
0
2
4
6
8
10
12


Robbed fraction vs time per HNLC location (100 yr, 1 uM)
SWAtl 50S (11.0%)
SWAtl 60S (6.9%)
SWAtl 70S (5.5%)
Ind 50S (11.1%)
Ind 60S (5.9%)
Ind 65S (5.2%)
Pac 50S (13.3%)
Pac 60S (8.9%)
Pac 70S (4.8%)
sePac 50S (13.1%)
sePac 60S (9.8%)
sePac 70S (6.9%)
Atl 69S (5.1%)
EqPac-c (46.6%)
EqPac-e (44.4%)
subArc-NE (24.7%)
subArc-NW (31.2%)
Cumulative robbed (%) [1.0 uM]
Years since release
0
10
20
30
40
0
20
40
60
80
100
Final robbed fraction by location (1 uM)
EqPac-c
EqPac-e
subArc-NW
subArc-NE
Pac 50S
sePac 50S
Ind 50S
SWAtl 50S
sePac 60S
Pac 60S
sePac 70S
SWAtl 60S
Ind 60S
SWAtl 70S
Ind 65S
Atl 69S
Pac 70S
0
10
20
30
40
Robbed at 100 yr (%) — 1 uM

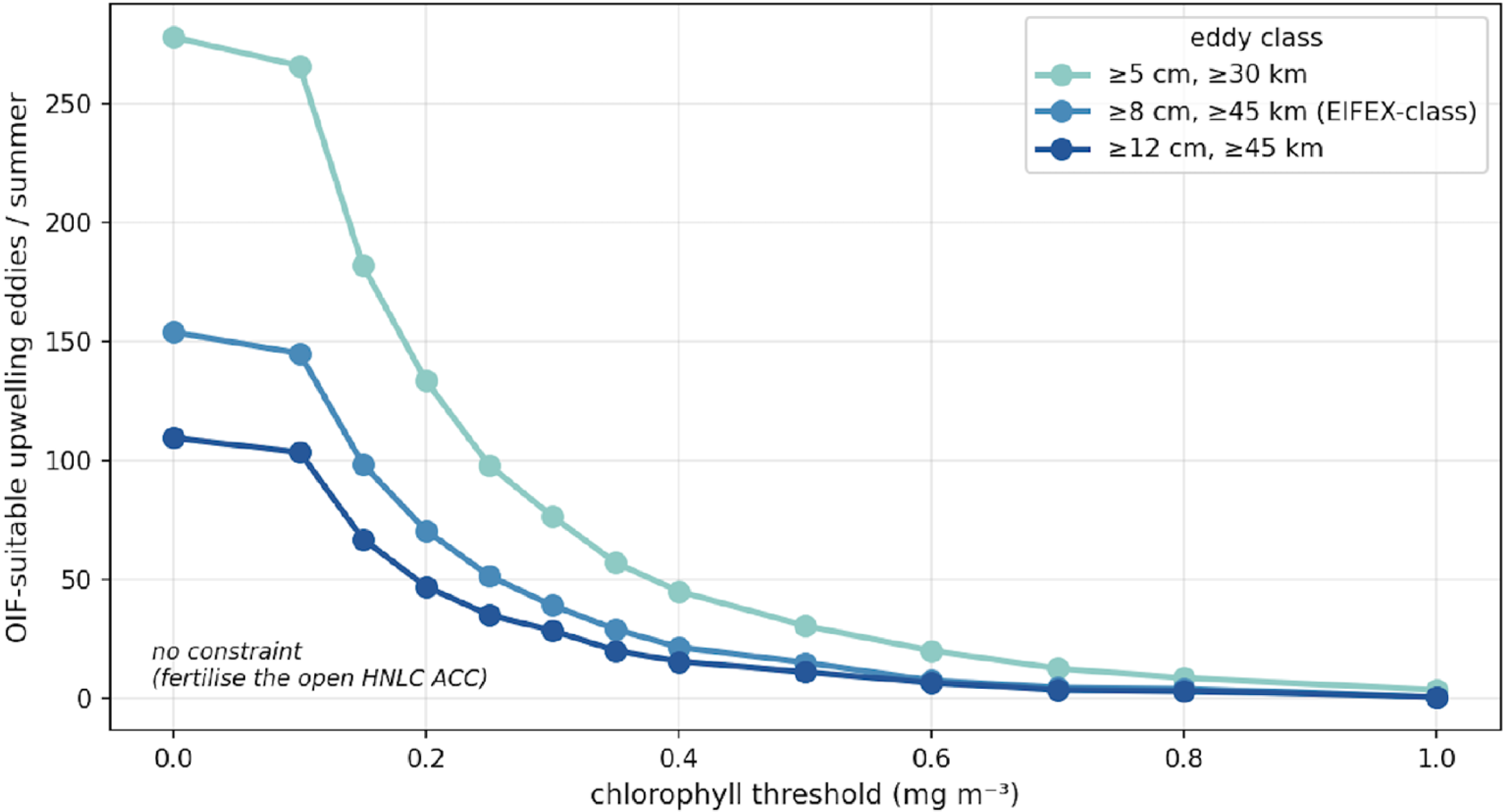




Counted: cyclonic (upwelling) eddies within 1000 km of Bouvet that persist >40 days during the 1 Dec–31 Mar window, with mean amplitude ≥ 8 cm and mean speed radius ≥ 45 km (EIFEX-class). Colour = when it formed; GREY = already present on 1 Nov (start of the altimetry record), formed on or before 1 Nov; PURPLE = formed in November — both predate the Dec–Mar window but persist into it. "days" = days present within the window; circle = true size at the eddy's position at the window start (1 Dec). Iron plume advected by the 10-yr mean ACC flow, fading downstream. CMEMS DUACS L4, 2015/16–2024/25.

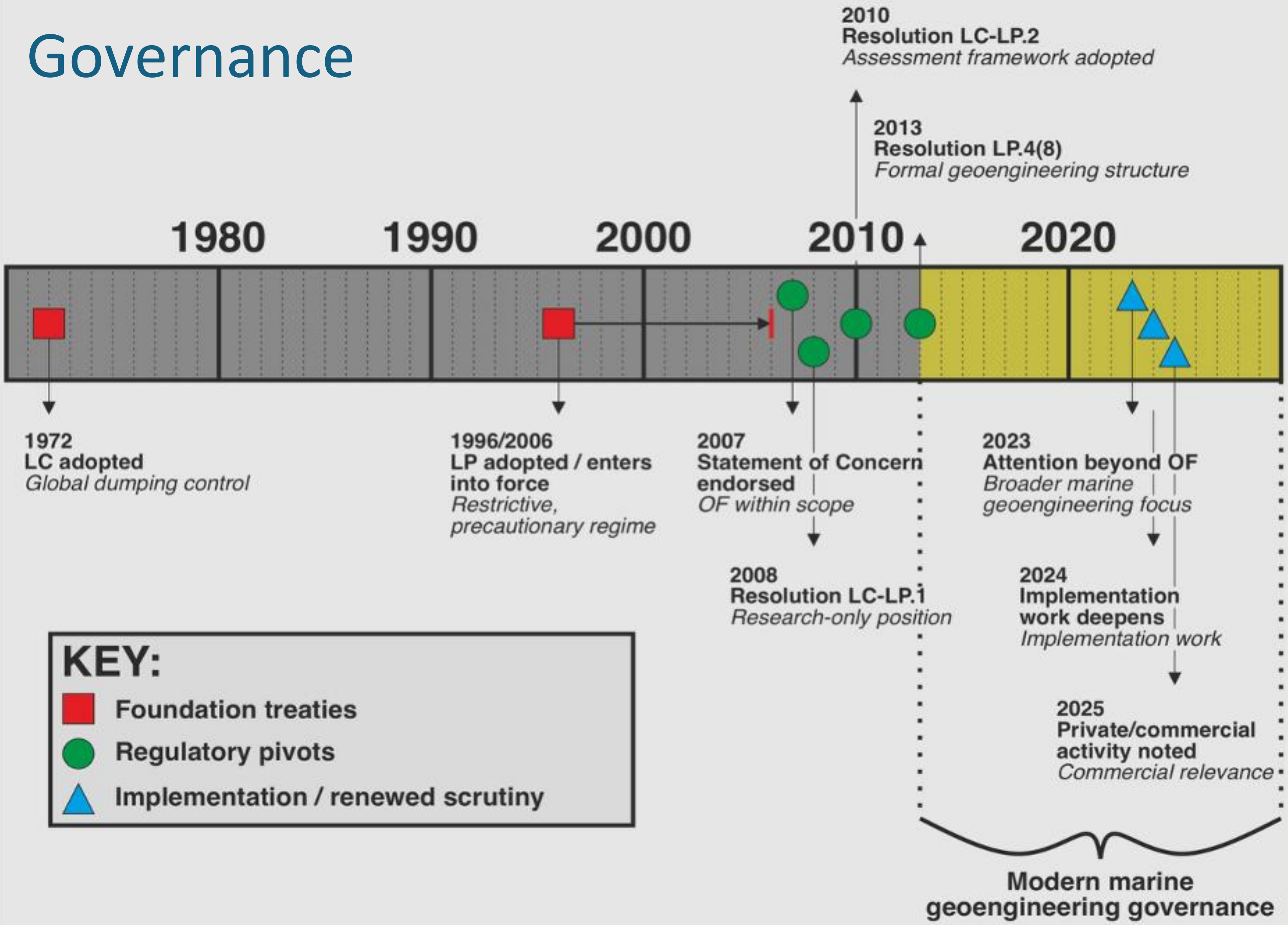


Suitability: EIFEX-class cyclonic eddy — amplitude ≥8 cm, speed radius ≥45 km, lifetime ≥42 d — in water at latitude 45–60°S with silicate ≥15 µM and concurrent satellite chlorophyll ≥0.5 mg m⁻³.



Cyclonic (upwelling) eddies, lifetime ≥42 d during DJF, latitude 45–60°S, silicate ≥15 μM.
Chlorophyll = core-mean concurrent satellite chl, scored at intervention.
Circumpolar ACC; per-summer medians over 10 summers (2015/16–2024/25).

Governance


2010
Resolution LC-LP.2
Assessment framework adopted
2013
Resolution LP.4(8)
Formal geoengineering structure
1980
1990
2000
2010
2020
1972
LC adopted
Global dumping control
1996/2006
LP adopted / enters into force
Restrictive, precautionary regime
2007
Statement of Concern endorsed
OF within scope
2008
Resolution LC-LP.1
Research-only position
2023
Attention beyond OF
Broader marine geoengineering focus
2024
Implementation work deepens
Implementation work
2025
Private/commercial activity noted
Commercial relevance
KEY:
Foundation treaties
Regulatory pivots
Implementation / renewed scrutiny
Modern marine geoengineering governance