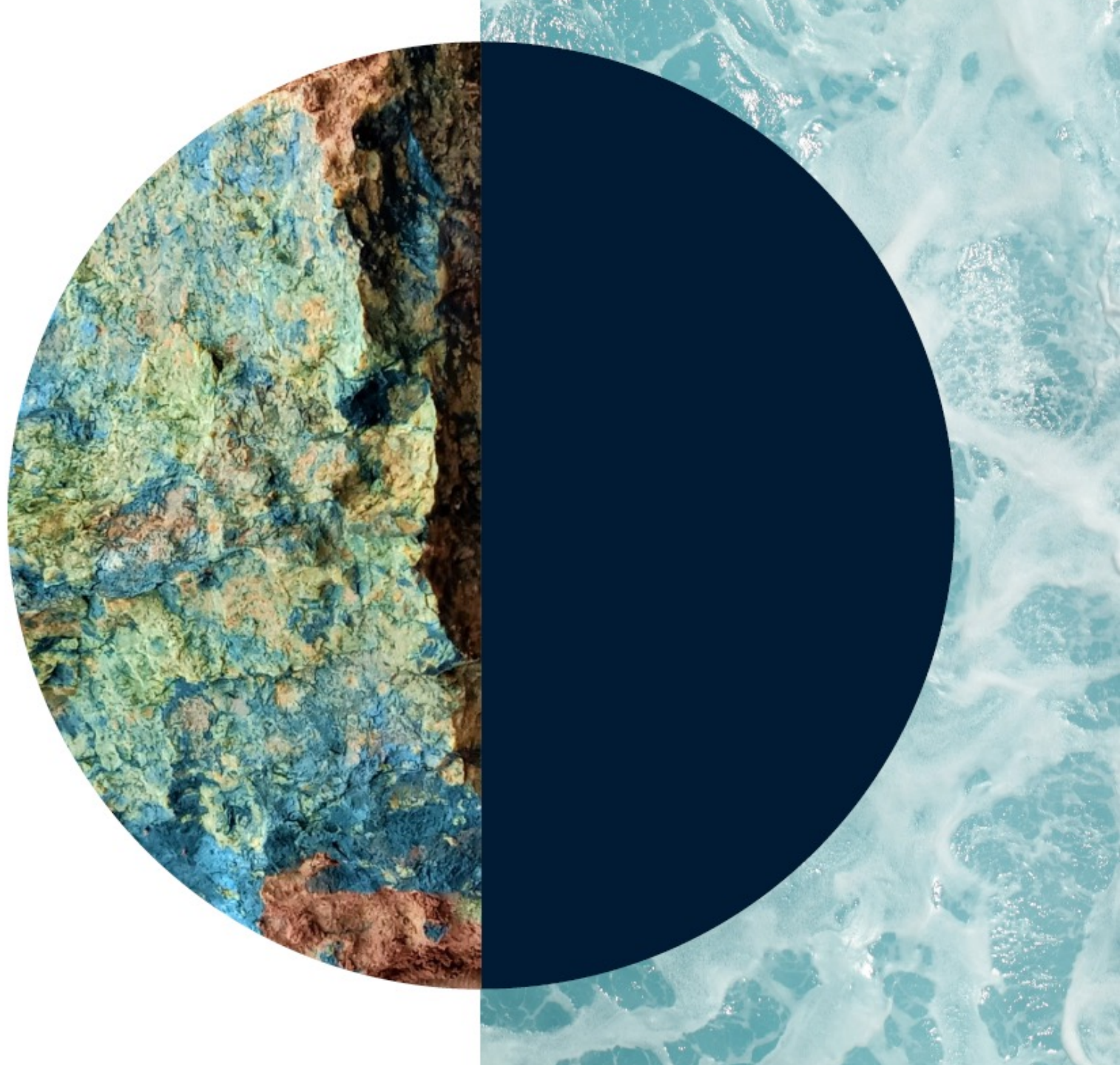




# *mCDR in territorial waters: the challenges and opportunities*

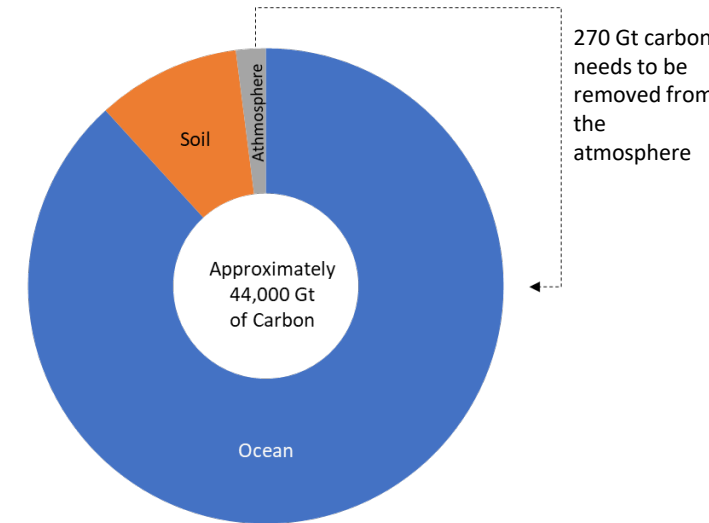
Andrew Lenton  
Director CarbonLock



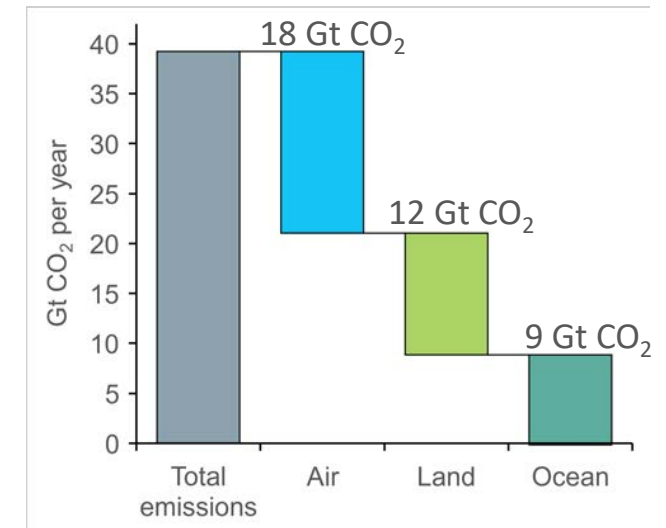
# Ocean Carbon

- Ocean will take up 95% of the atmospheric carbon, but slowly...
- The ocean is the largest reservoir of carbon on the planet, storing 38,000 Gt carbon (as dissolved inorganic carbon, DIC) with a residence time of ~100,000 yrs.
- Restoring atmospheric CO<sub>2</sub> levels to 280ppm requires removing 270 Gt carbon
- This represents only **0.7%** of the current global ocean inventory.

Global Carbon Inventory (not including rocks)



Current Destination of CO<sub>2</sub> Emissions



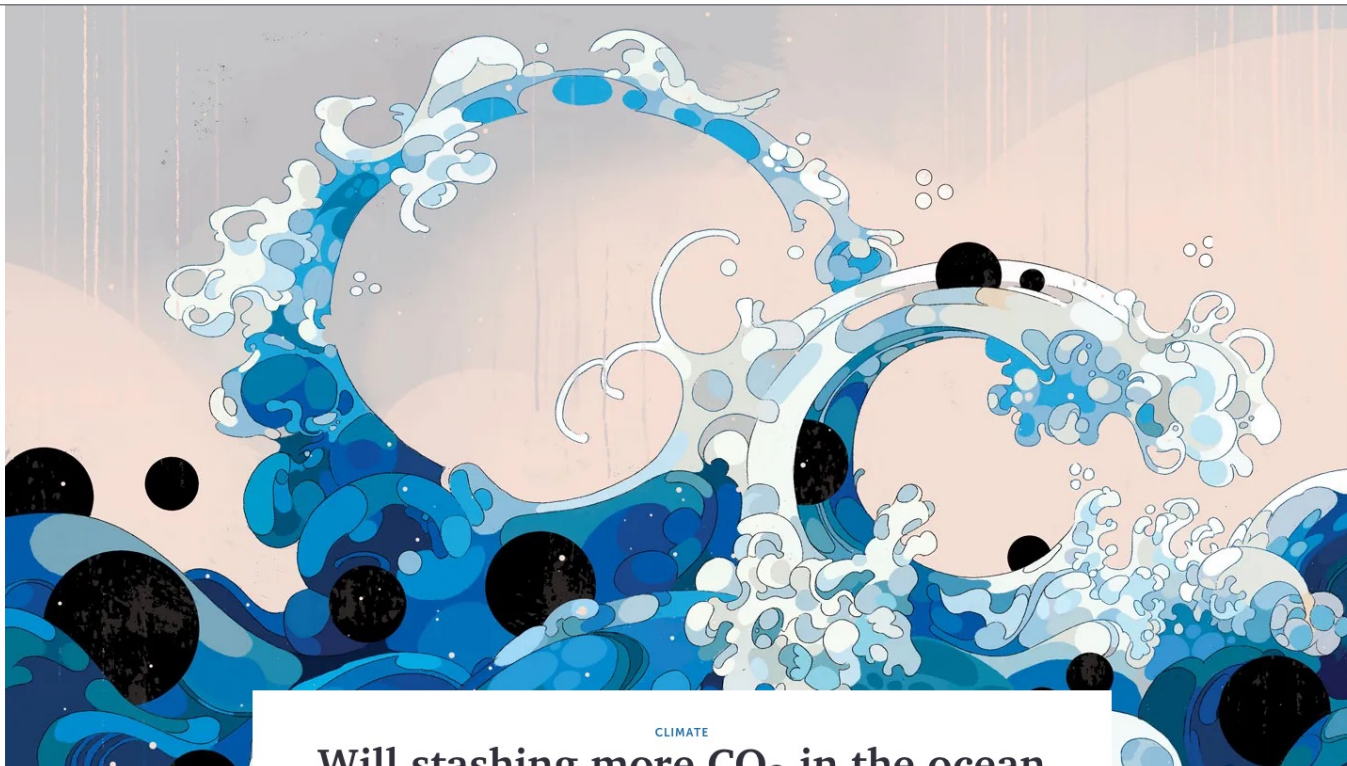
Source: Friedlingstein et al. 2020

# mCDR – an open system problem

Effective CDR requires **efficient capture** and **long-term storage** – the ocean has the potential to do both.

ScienceNews  
INDEPENDENT JOURNALISM SINCE 1921

ALL TOPICS HEALTH HUMANS LIFE EARTH PHYSICS SPACE

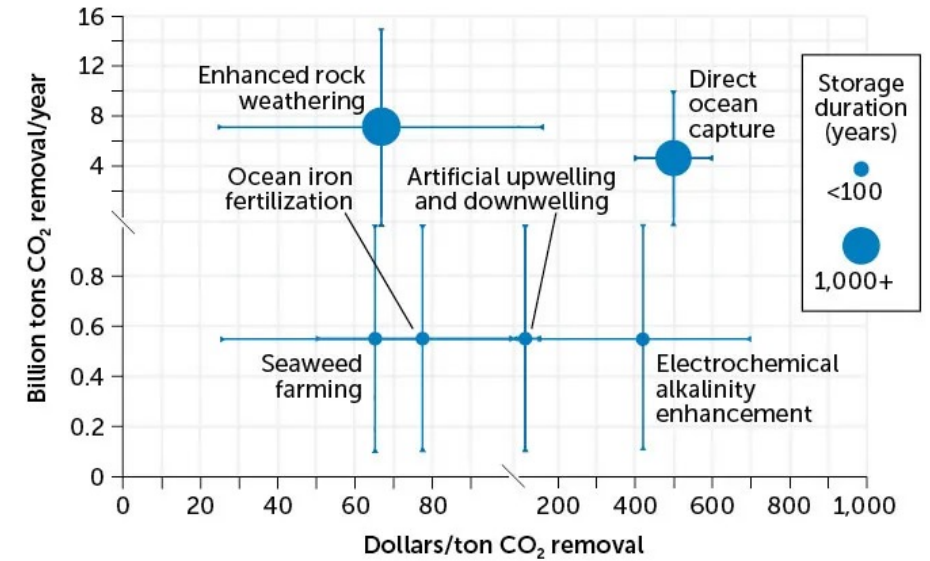


CLIMATE  
**Will stashing more CO<sub>2</sub> in the ocean help slow climate change?**

Seaweed farming, iron fertilization and direct capture are among the strategies being tested

Ocean carbon dioxide removal could draw the greenhouse gas out of the atmosphere to help slow climate change.

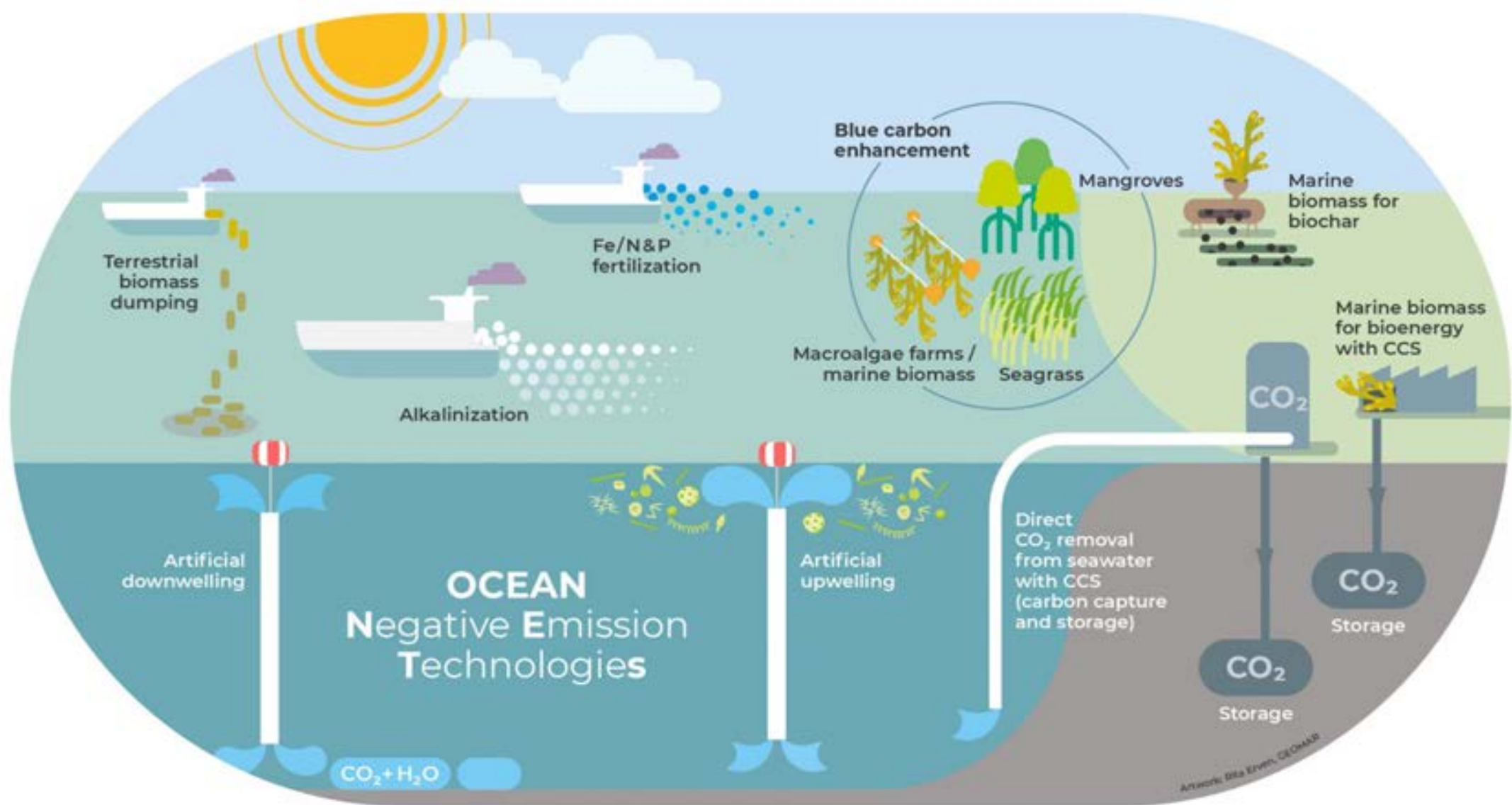
DEB JJ LEE



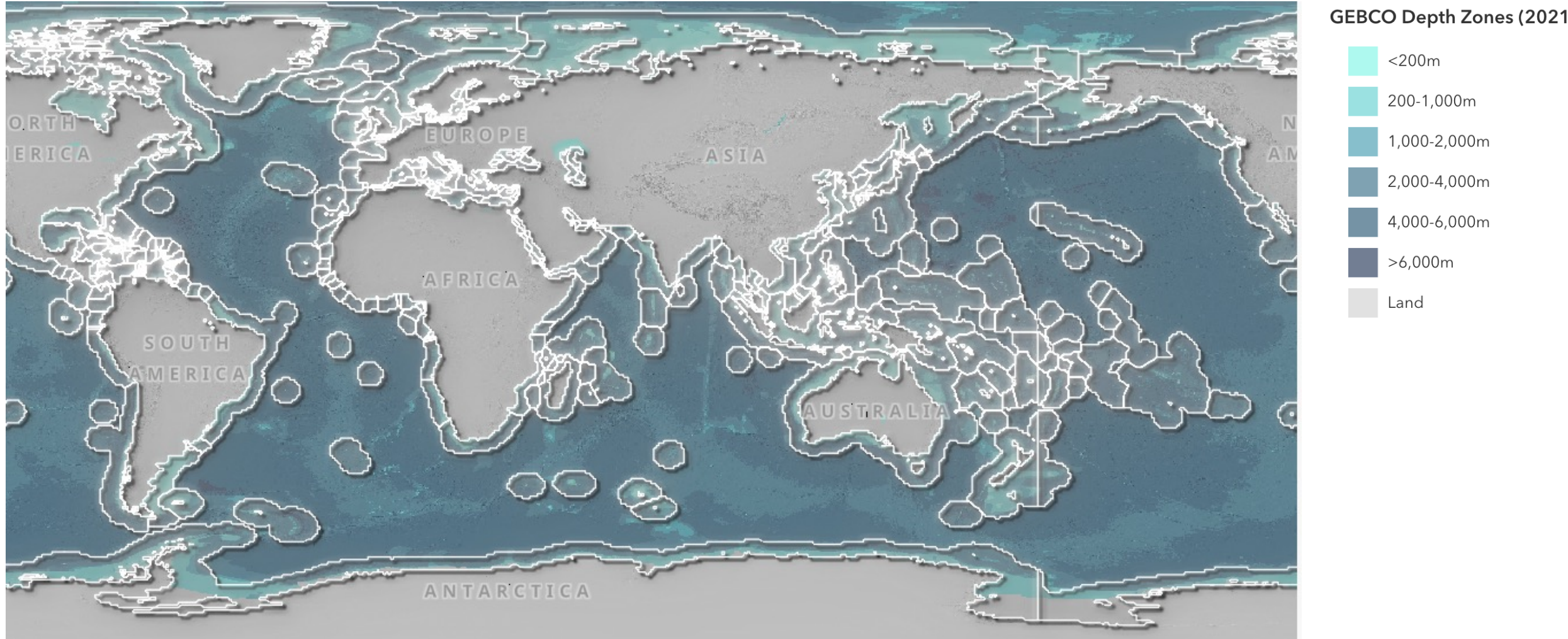
Global ocean CDR opportunity  
> 1 GT yr<sup>1</sup> CO<sub>2</sub>  
*100s to >1000s of years*



# mCDR: What is being considered?



# Its not all territorial waters, but.....

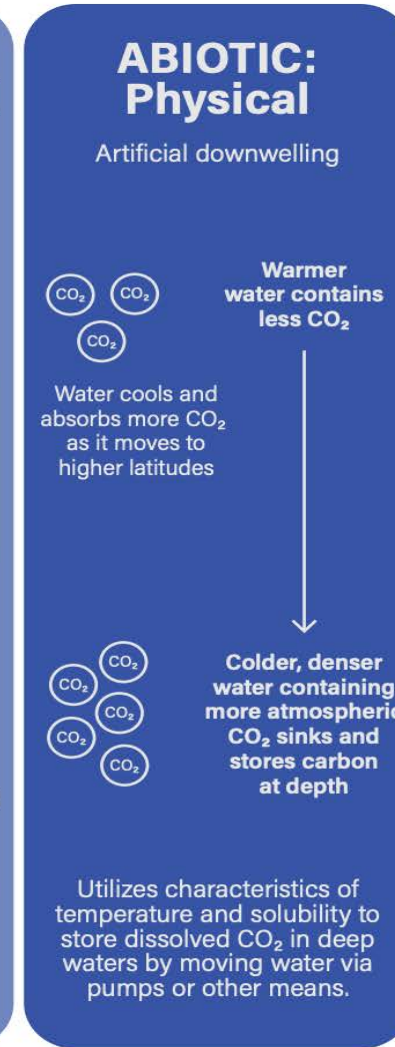
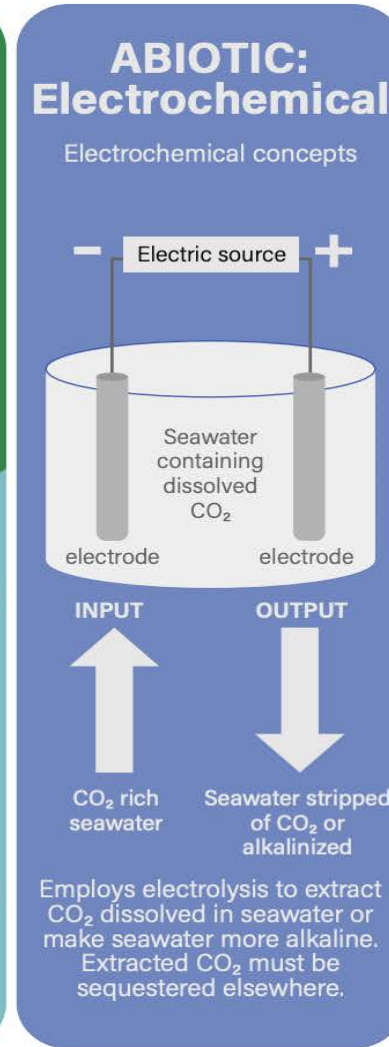
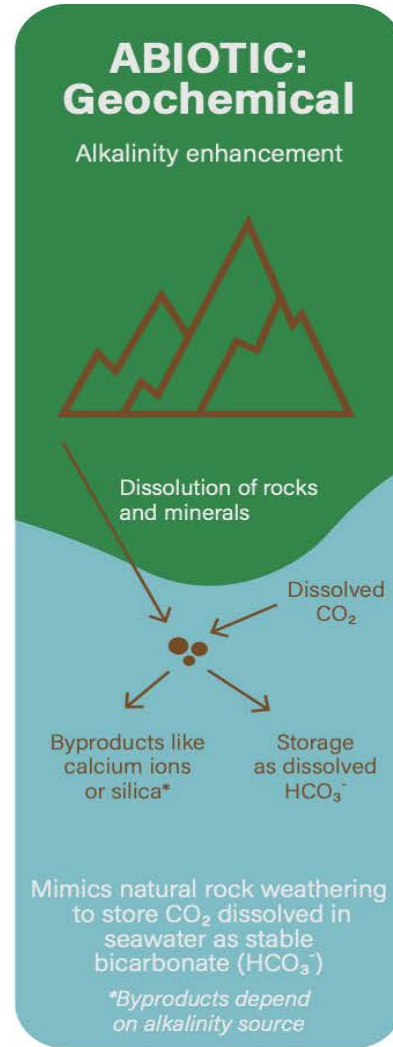
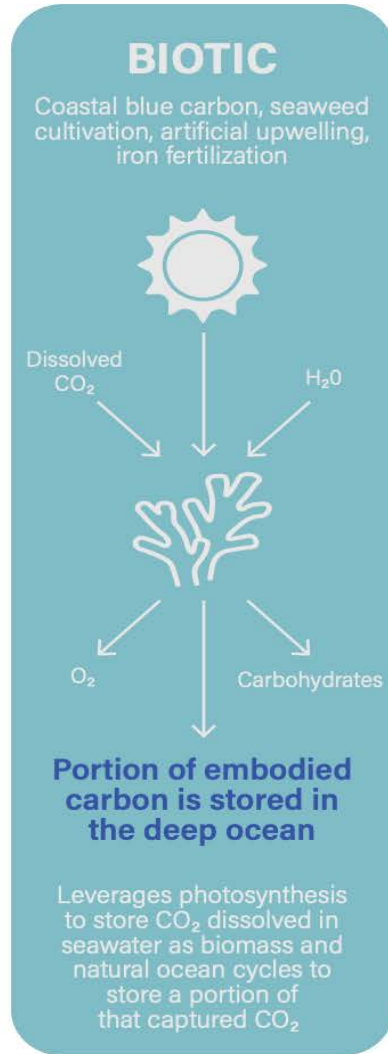


So, all comments are predicated on the scope of the Workshop



# Broadly Biotic (living) & Abiotic (non-living)

Foundation for Climate Restoration. 2023



# Biotic: Blue Carbon

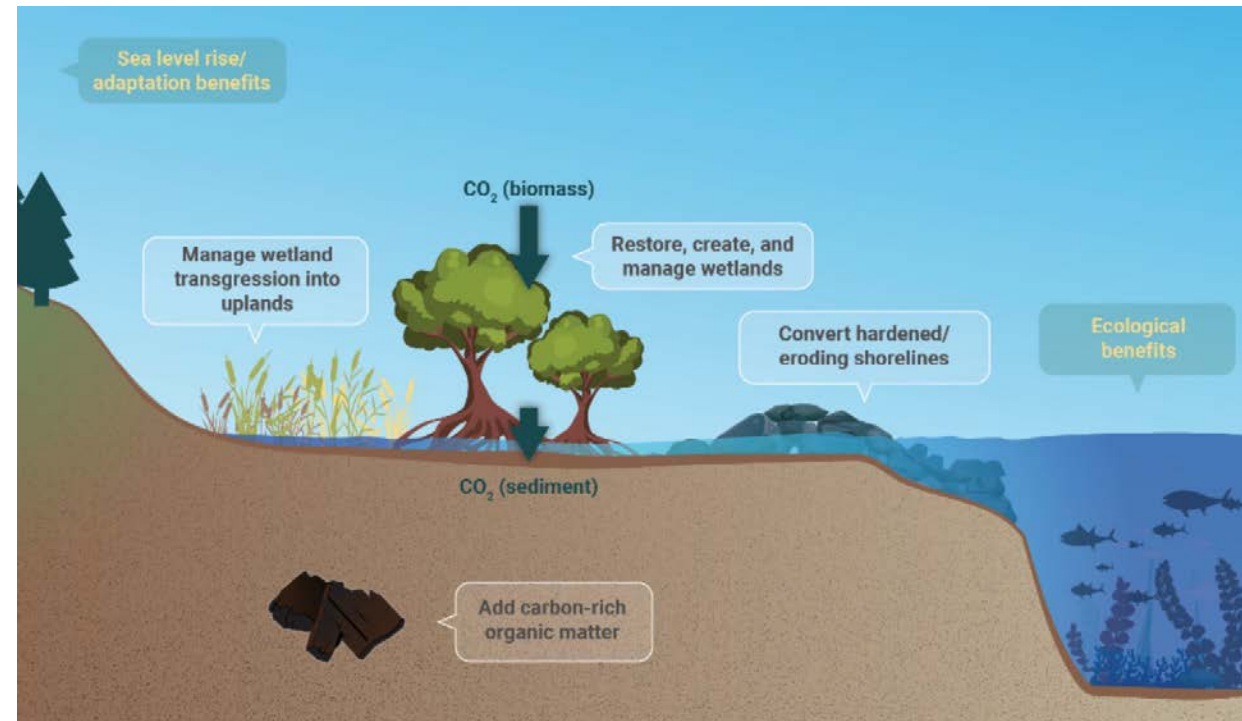
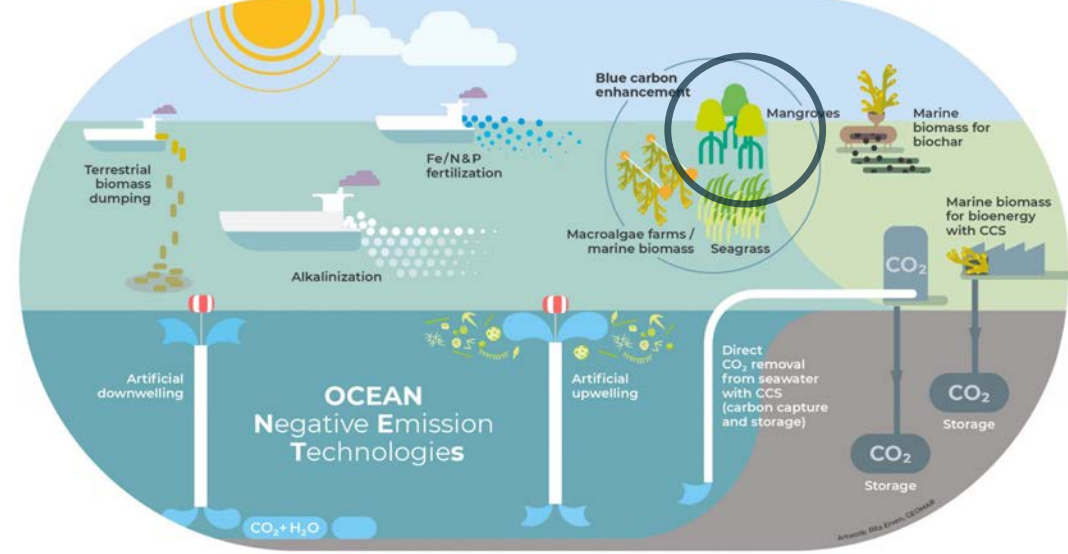
*What is it? Coastal Ecosystems: eg. Kelp. Mangrove, seagrass meadows, wetlands, ecosystem restoration*

*How does it work? Photosynthesis (years to decade & Burial (centuries to millennia)*

*Potential? Low*

*Could we detect the changes? Yes (some)*

*R&C? Non-CO<sub>2</sub> GHGs, Vulnerable carbon stores*





# Biotic: Macroalgae Cultivation

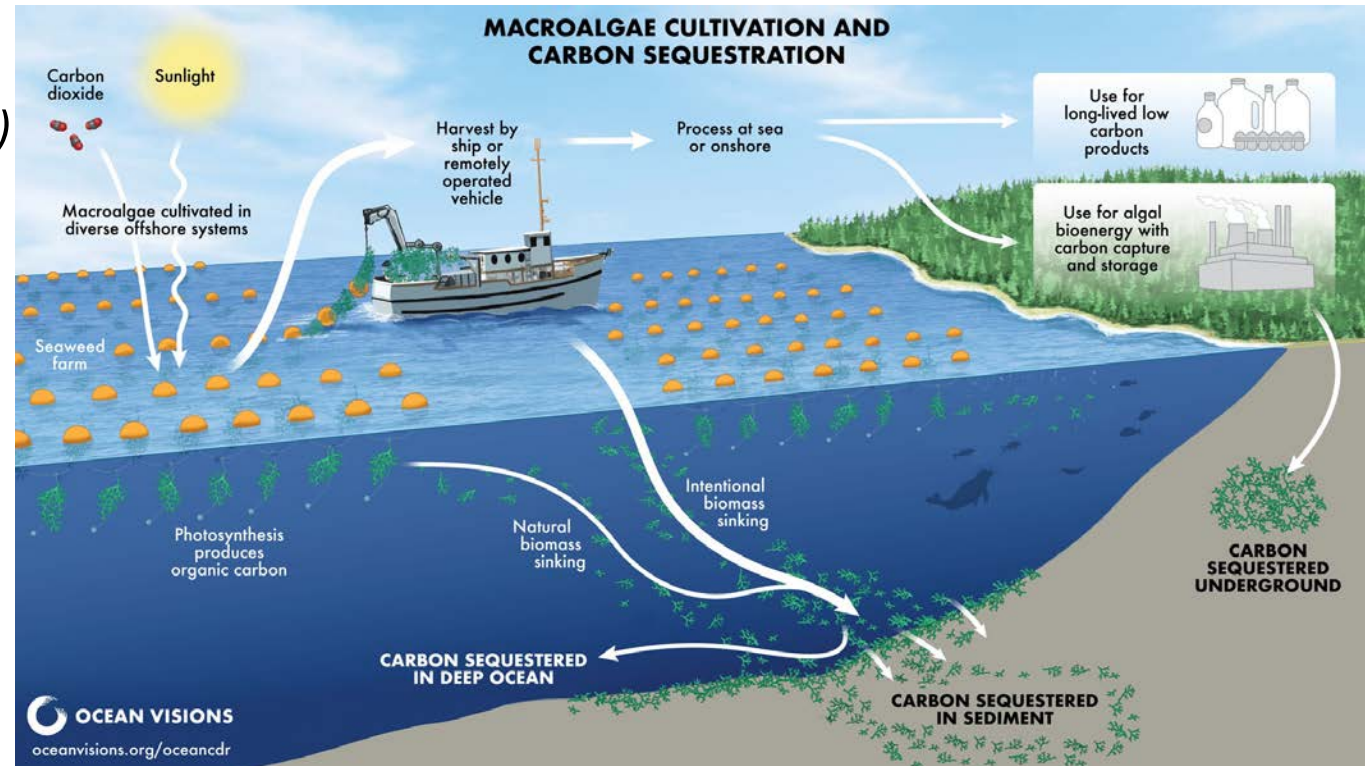
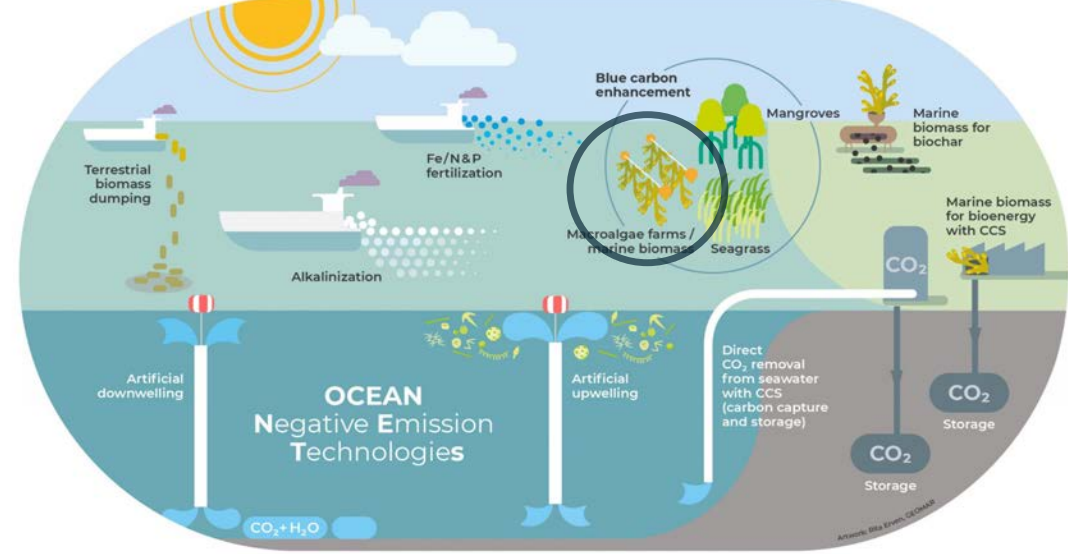
*What is it? Growing macroalgae deliberately for harvesting or sinking*

*How does it work? Photosynthesis Harvesting or Sinking*

*Potential? Low*

*Could we detect the changes? Maybe (depends)*

*R&C? Active management, Nutrients lost out of the system, downstream impacts, Additionality*





# Biotic: Fertilization

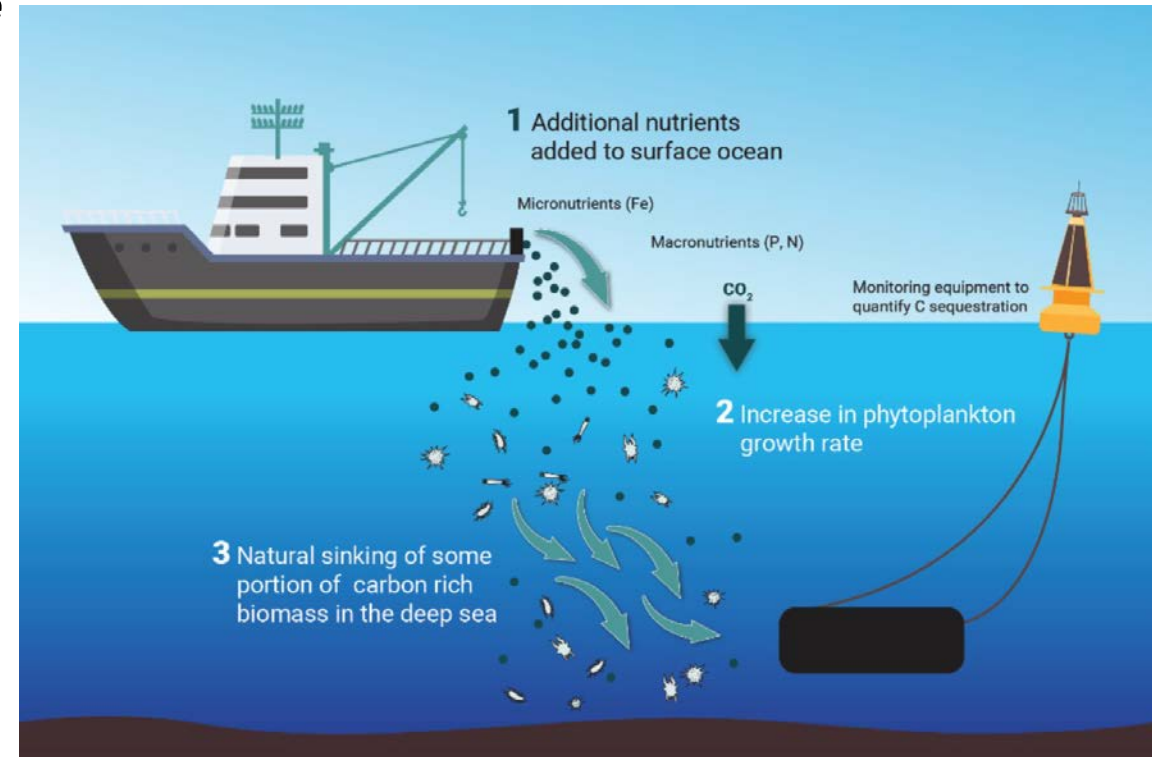
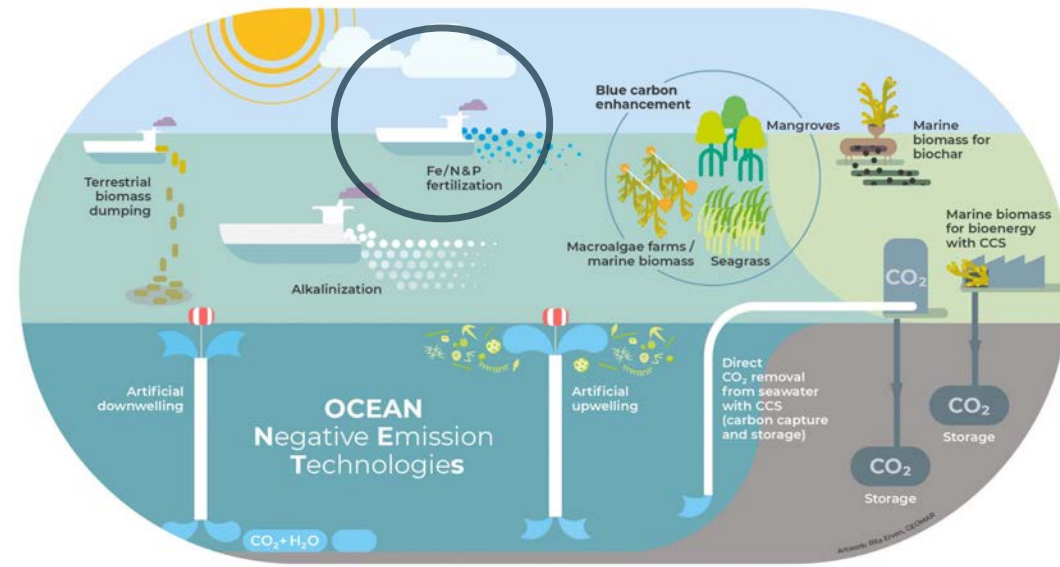
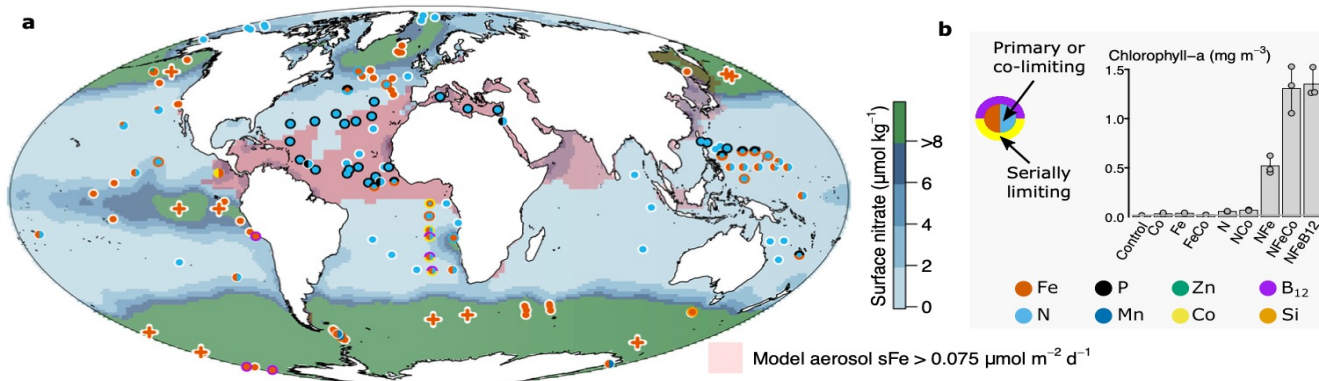
*What is it? Adding macro (N&P) and micronutrients (Fe)*

*How does it work? Stimulates organic carbon growth through photosynthesis*

*Potential? Low*

*Could we detect the changes? Medium export remains the challenge*

*R&C? Oxygen levels, additionality, nutricline deepening, lock-in, inefficient, often co-limiting*



# Biotic: Upwelling

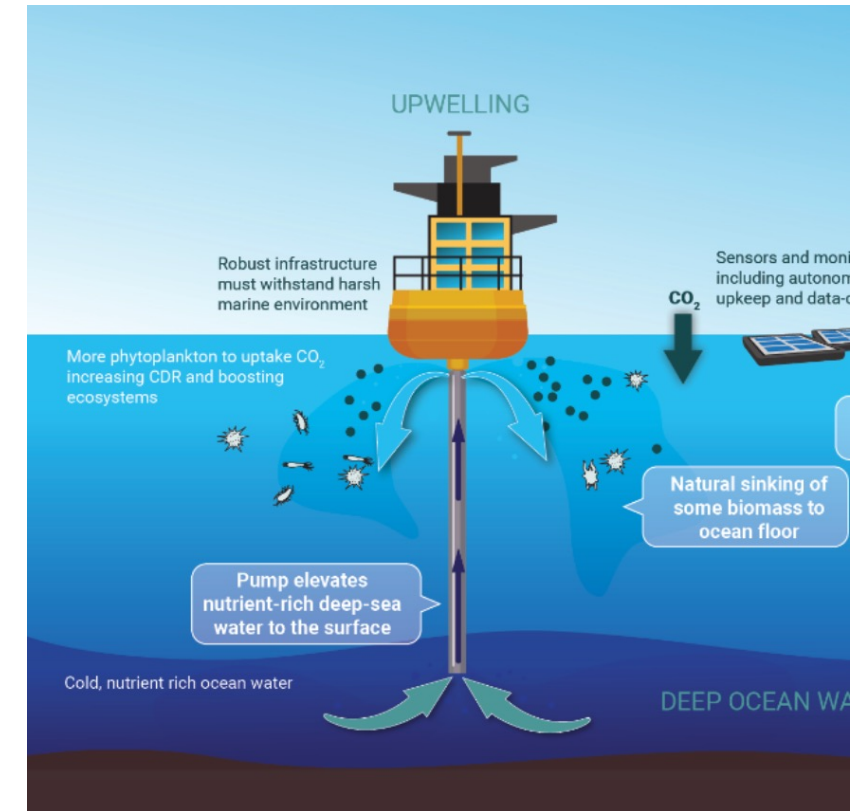
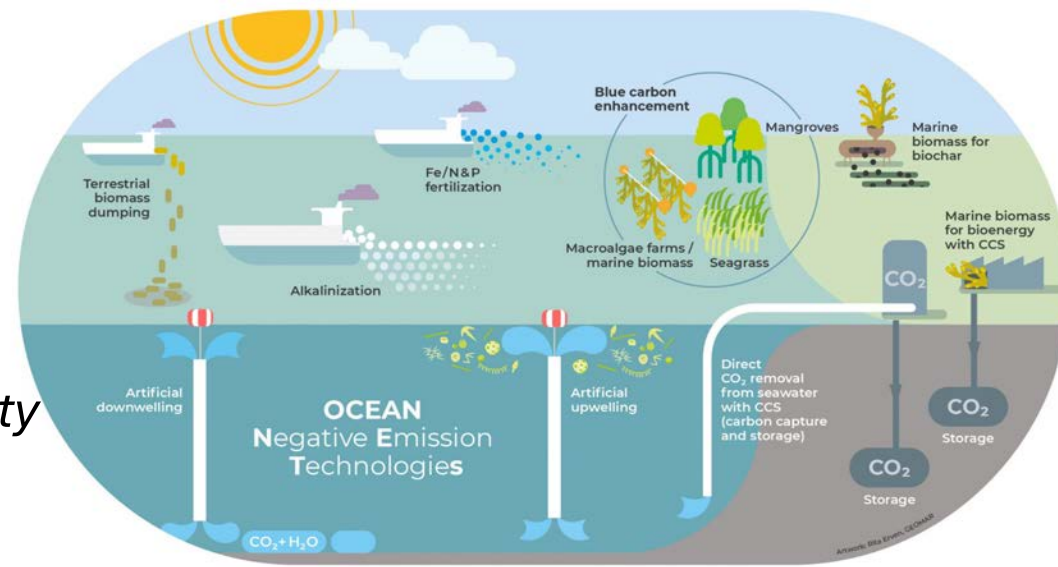
*What is? Upwelling nutrients & cold water to the surface ocean*

*How does it work? Increased photosynthesis & sinking, + solubility*

*Potential? Low*

*Could we detect the changes? Medium export remains the challenge*

*R&C? Oxygen levels, brings up carbon, and cold water breaks ocean stratification, serious impacts on heat etc, scenario dependent*





# Biotic : Biomass Burial & Downwelling

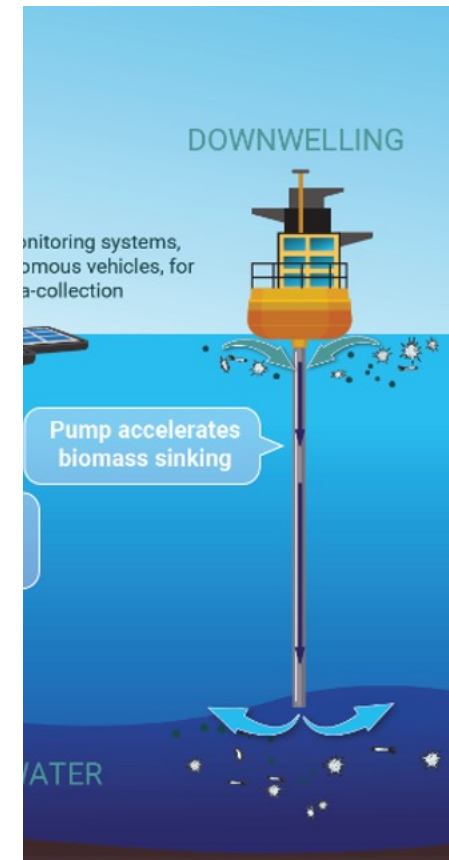
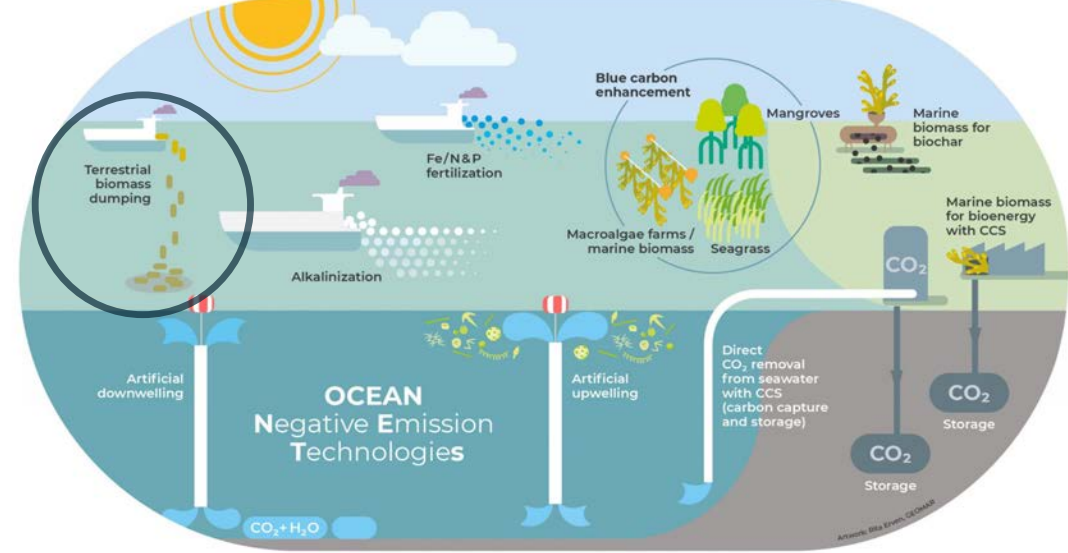
*How does it work? Sinking biomass into the deep ocean*

*How does it work: into low ocean areas or areas that ventilate on very long time scales*

*Potential: Low*

*Could we detect the changes? Yes*

*R&C? Loss of valuable biomass & oxygen loss  
Loss of Oxygen in the deep ocean, ocean biota*



# Abiotic: Direct Seawater Carbon Extraction

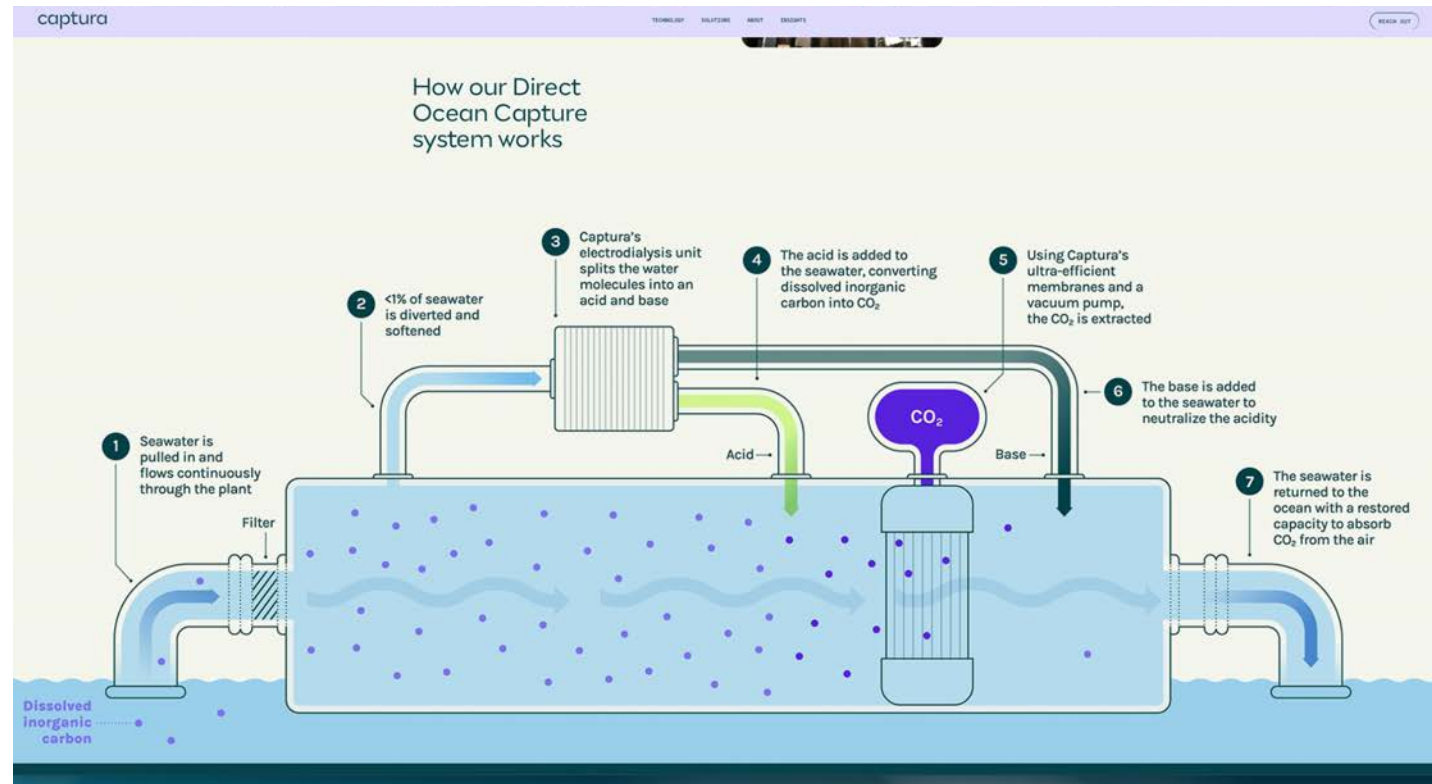
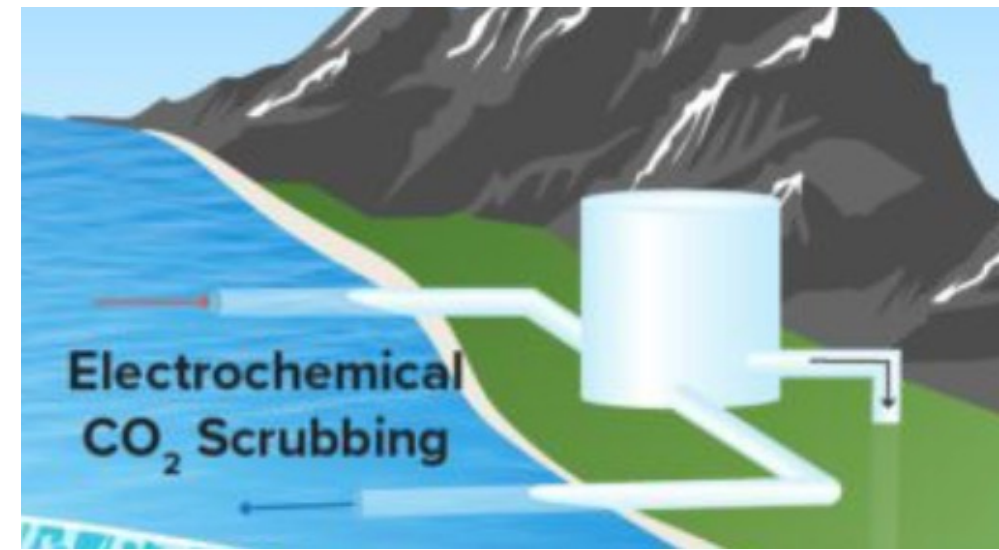
*What is it? Directly removing CO<sub>2</sub> from sea water*

*How does it work? Pump in water, scrub CO<sub>2</sub>, and release*

*Potential? Moderate*

*Could we detect the changes? Yes*

*R&C? Energy usage, can be combined with Desalination*





# Abiotic: Alkalinisation

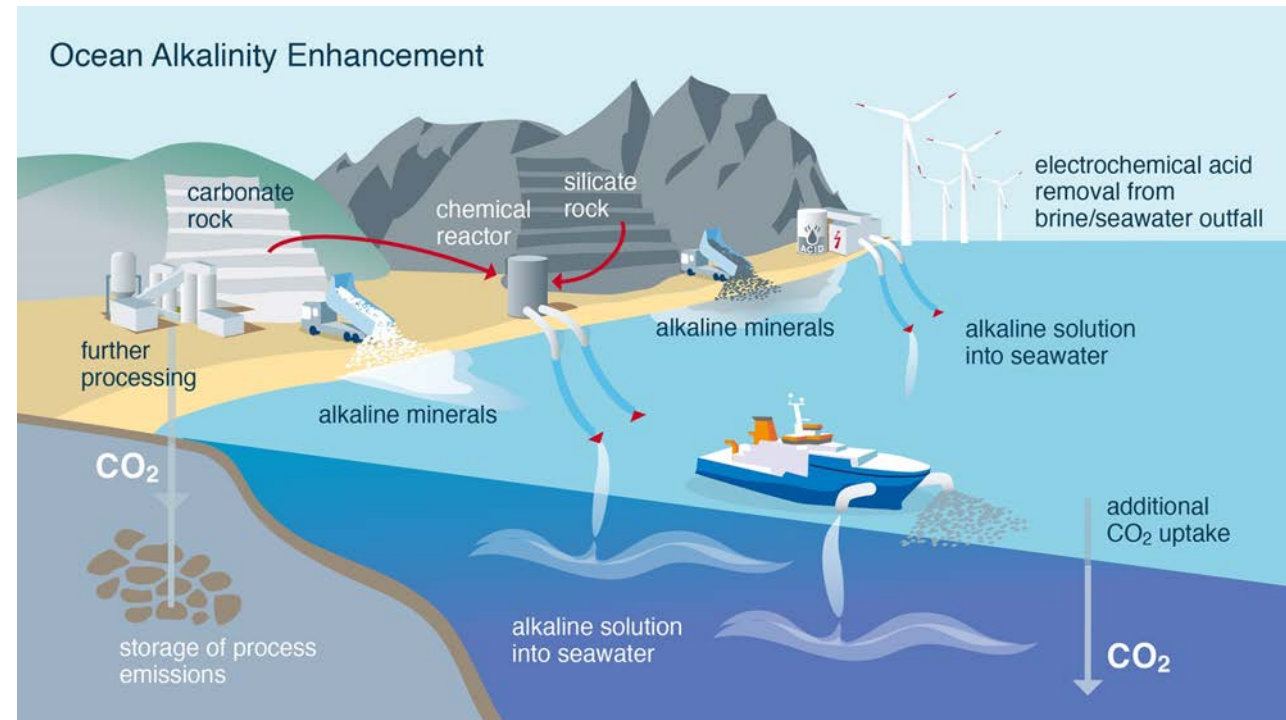
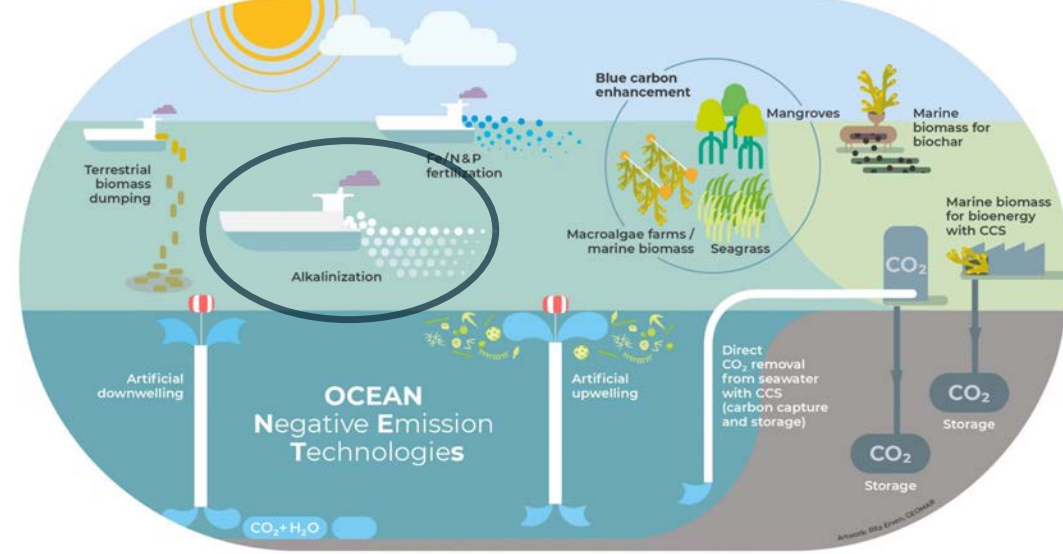
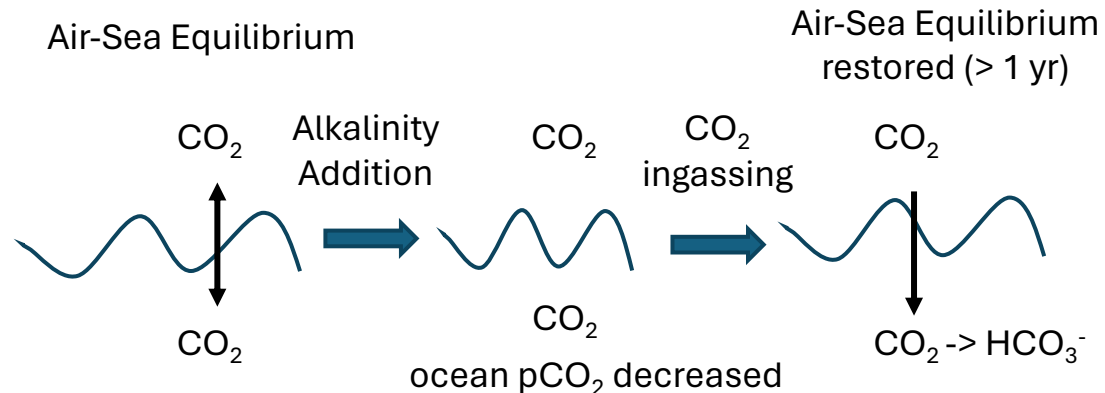
*What is it? Adding alkalinity to seawater*

*How does it work? Alkalinity addition changes chemistry, leading to more ocean carbon uptake*

*Potential? Moderate*

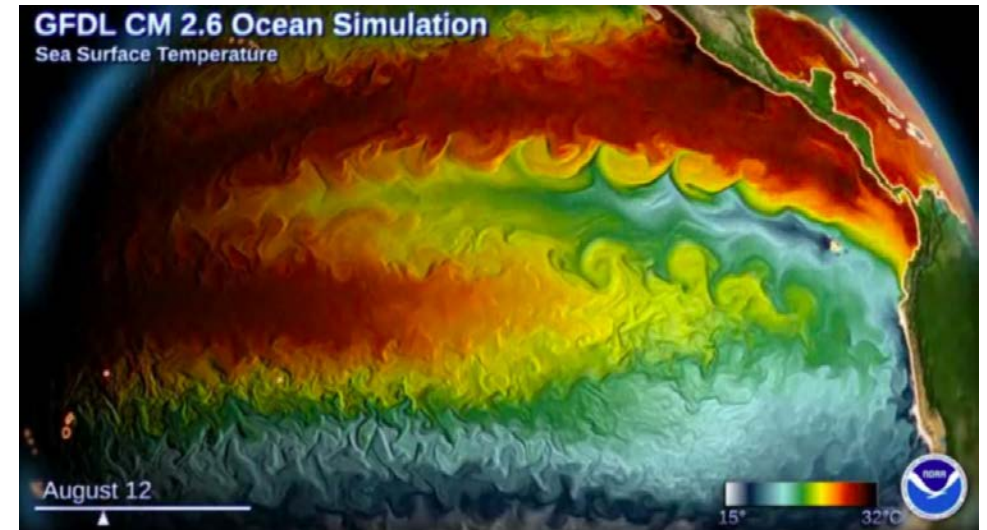
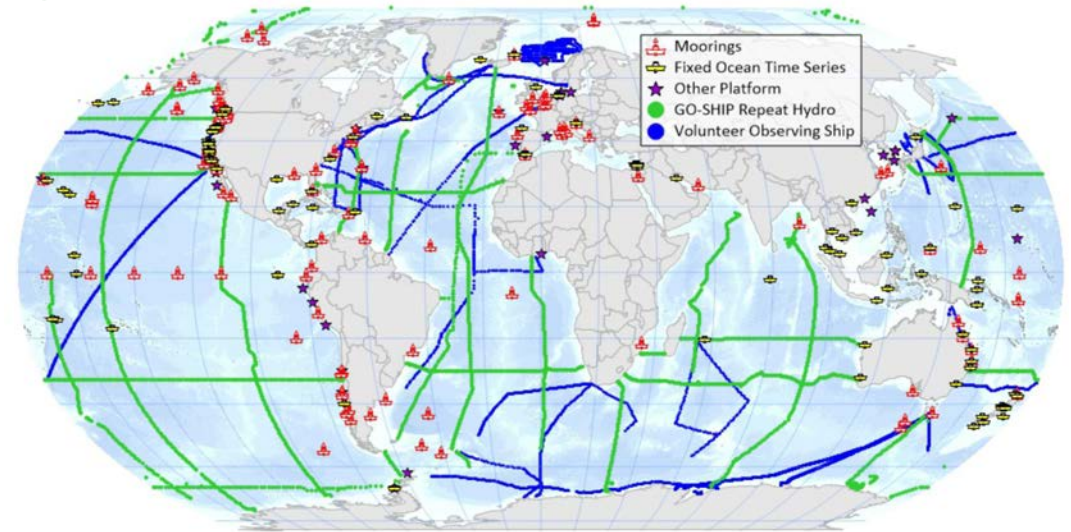
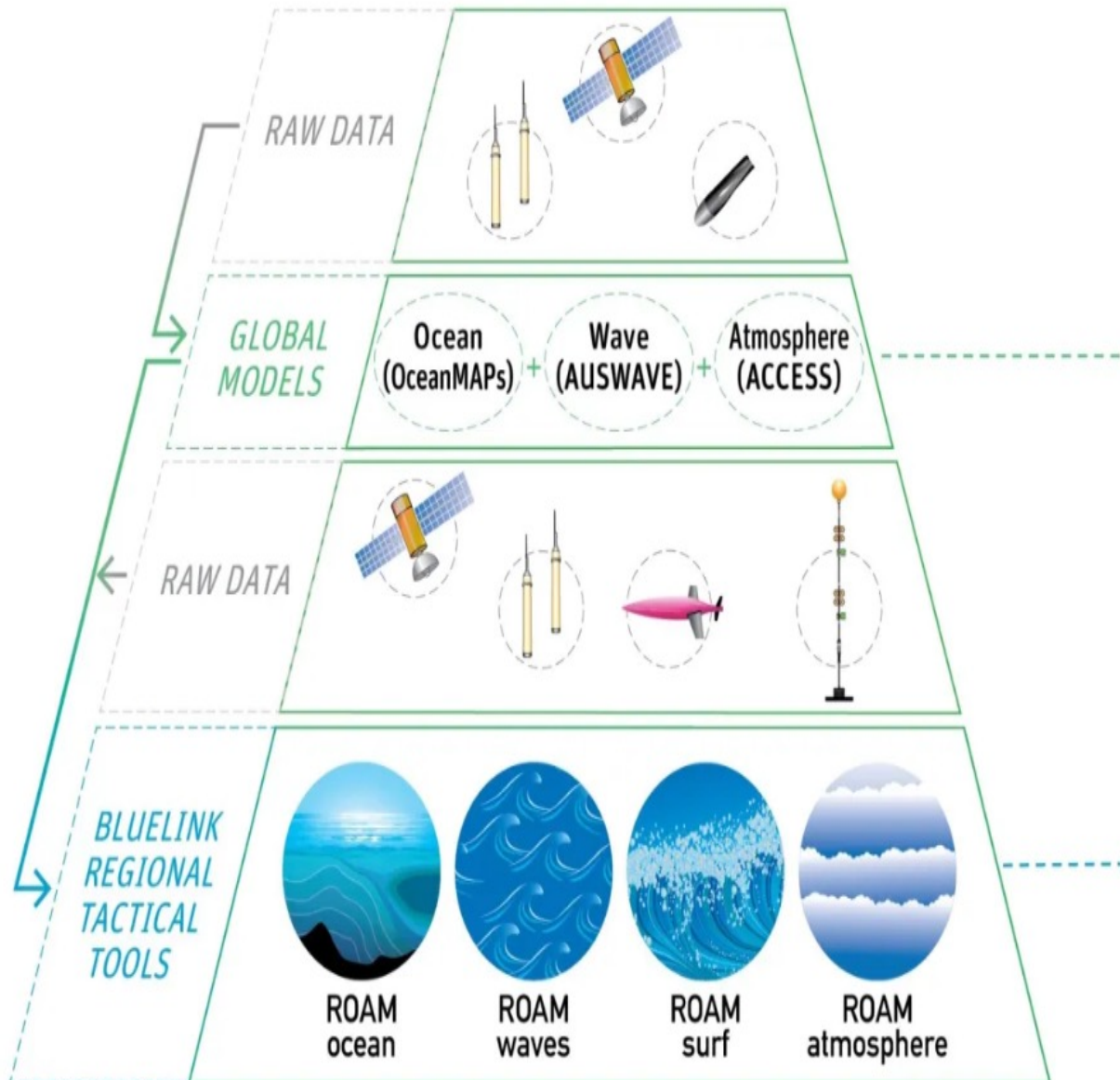
*Could we detect the changes? Maybe*

*R&C? pH changes, not pure sources of alkalinity (leaching), non-linear chemistry, energy use*



# MRV – combined approaches

From Tilbrook et al., 2019





# Efforts Underway

## mCDR Field Trials Map



<https://oceanvisions.org/mcdr-field-trials/mcdr-field-trial-map/>

# Thank you

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**CarbonLock Director**  
**CSIRO Environment**

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**W** <https://research.csiro.au/CarboLock>