SEA MATE - Ocean Visions Joint Research Plan

Purpose

This document serves to define areas of focus where the Ocean Visions Advisors will engage with and advise the SEA MATE project at Stony Brook University and University of Washington

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Key questions and areas of engagement

Topic 1: Design of experiment

Key questions

- What is the ratio of the amount of CO_2 stored to the amount of HCl removed and NaOH returned to the ocean?
- After HCl is removed and NaOH is returned to the ocean, how long does it take for CO_2 to be absorbed by the ocean and stored as bicarbonate?

Areas of engagement

- Tank experiments
  - Experimental setup
    1. Strategies for minimizing biological growth
    2. Design of planned experiments and suggested additional experiments to support the SEA MATE workplan
  - Data collection and analysis
    1. How to quantify the carbon uptake? Need for bottom up (CO_2 partial pressure (pCO_2) difference) alongside direct (dissolved inorganic carbon accumulation) quantification of carbon uptake?
  - Sensors
    1. Potential for testing of new sensors
    2. Assessments of sensor reliability, durability, accuracy
    3. Sensor redundancy needs
- Field tests
  - Experimental setup
  - Data collection and analysis
  - Sensor requirements

Topic 2: Measurement and verification of CO_2 drawdown

Key questions

- What is the best sensor deployment and modeling strategy for quantifying CO_2 storage in deployed systems?
- What is the ecosystem response to SEA MATE and how does this affect verification?

Areas of engagement

- Assessment of advantages and disadvantages of measurement methodologies
    - Direct CO_2 flux measurements
    - Tracer injection
        i. Quantify the effect of potential for partial re-equilibration given the approximate two-week timescale for CO_2 absorption
    - “Signature” study that imposes, and then looks for, changes that vary at specific frequencies
    - Covariance between distance from dispersal of NaOH and CO_2 uptake
        i. Need predictable flow to position the second sensor
            1. Could a riverine environment be helpful despite the non-conservative alkalinity contribution?
            2. Identify locations with well studied and understood physical and biogeochemical properties.
- Suggested lab or field studies
    - Quantify the potential of partially confined environments to allow a gradual transition between small-scale tank experiments and large scale open ocean deployments while still creating measurable signals.
- Future needs in sensors or sensor networks
    - Quantify the need and state-of-the-art for the simultaneous measurement of two seawater carbonate chemistry parameters.
        i. Dissolved inorganic carbon and CO_2 partial pressure (pCO_2) in the surface ocean
        ii. Assess the state-of-the-art in alkalinity sensor development and relevance to SEA MATE
        iii. Confirm whether or not single carbonate chemistry parameter measurements can be effectively combined with approaches that estimate a second constraint from other more readily measured properties (e.g., temperature, salinity, and oxygen) for SEA MATE assessments
    - Identify the sensor platforms that will provide measurements on the needed scales, e.g.:
        i. Saildrones to rapidly measure widespread surface changes
        ii. Moorings or PRAWLERs to quantify changes at fixed locations
        iii. Gliders that make measurement profiles to moderate depths

Topic 3: Effect of SEA MATE on marine ecosystems

Key questions

- What are the limits on seawater chemistry we must stay within to avoid negative effects on marine organisms?
- What is the impact of SEA MATE on local vs. regional seawater chemistry?

Areas of engagement

- Estimation of reasonable bounds on seawater chemistry parameters such as pH and calcium saturation state that would avoid negative effects on marine life
- Quantify the potential for positive effects on marine life (i.e., co-benefits)
- Suggested lab or field studies
- Model parameterizations for biological and chemical responses and thresholds

Topic 4: Technology

Key questions

- What process steps, process flows, or equipment can be shared with related industries to lower overall costs?
- What are the ideal technologies (for example, membranes, treatment processes, etc.) for implementing SEA MATE in terms of the net cost of captured CO_2?

Areas of engagement

- Quantitatively assess potential for partnership and process intensification with water treatment industries like desalination and wastewater treatment
- Identify and potential users of the products made from the SEA MATE process

Topic 5: Permitting and regulation

Key questions

- What regulations apply to the SEA MATE process?
- What permits are required for field testing and deployment of SEA MATE?

Areas of engagement

- Assessment of permits required for operation
- Suggested lab or field studies
- Design of experiments and tests that gather the data required for environmental impact statements