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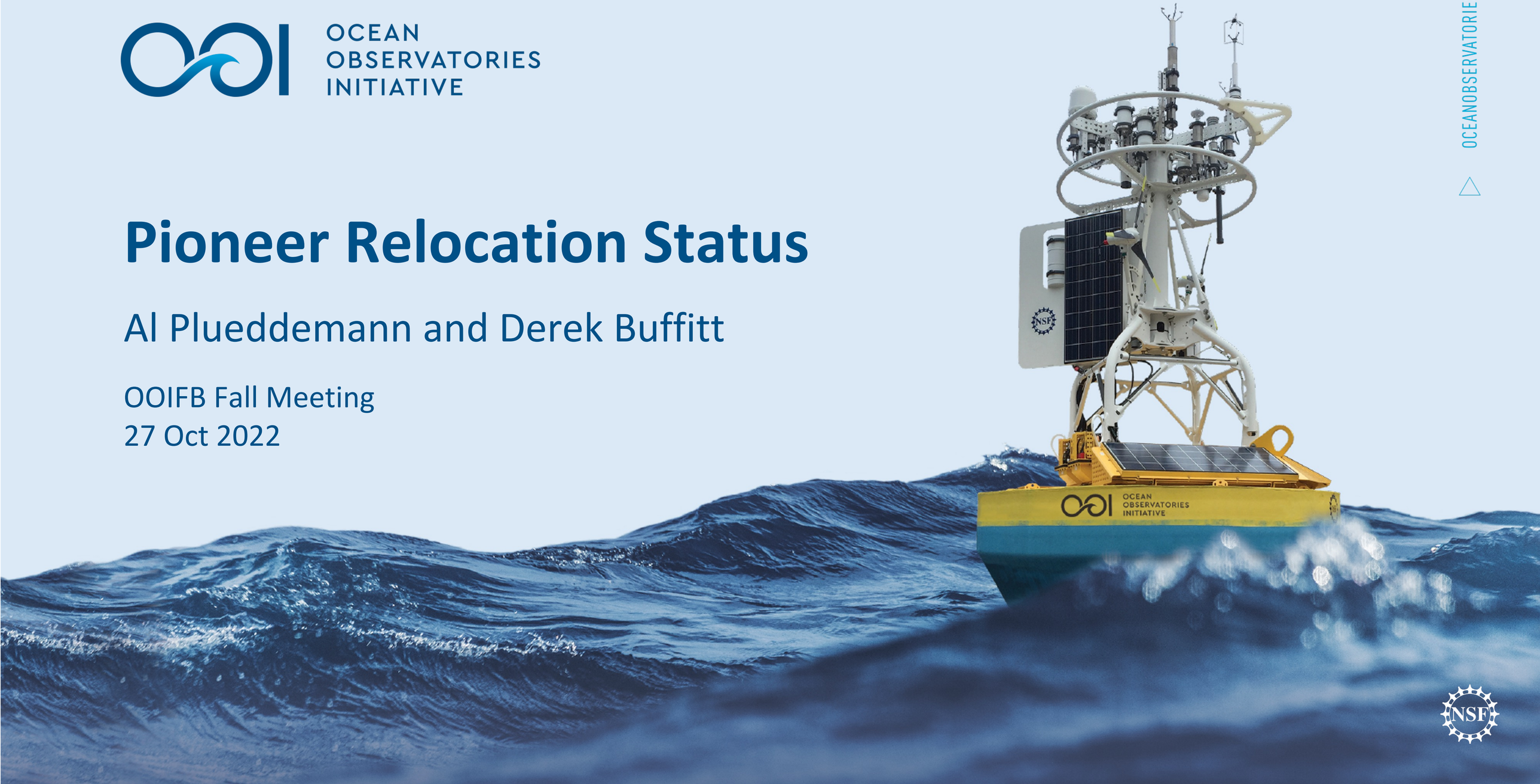
Pioneer Relocation Status

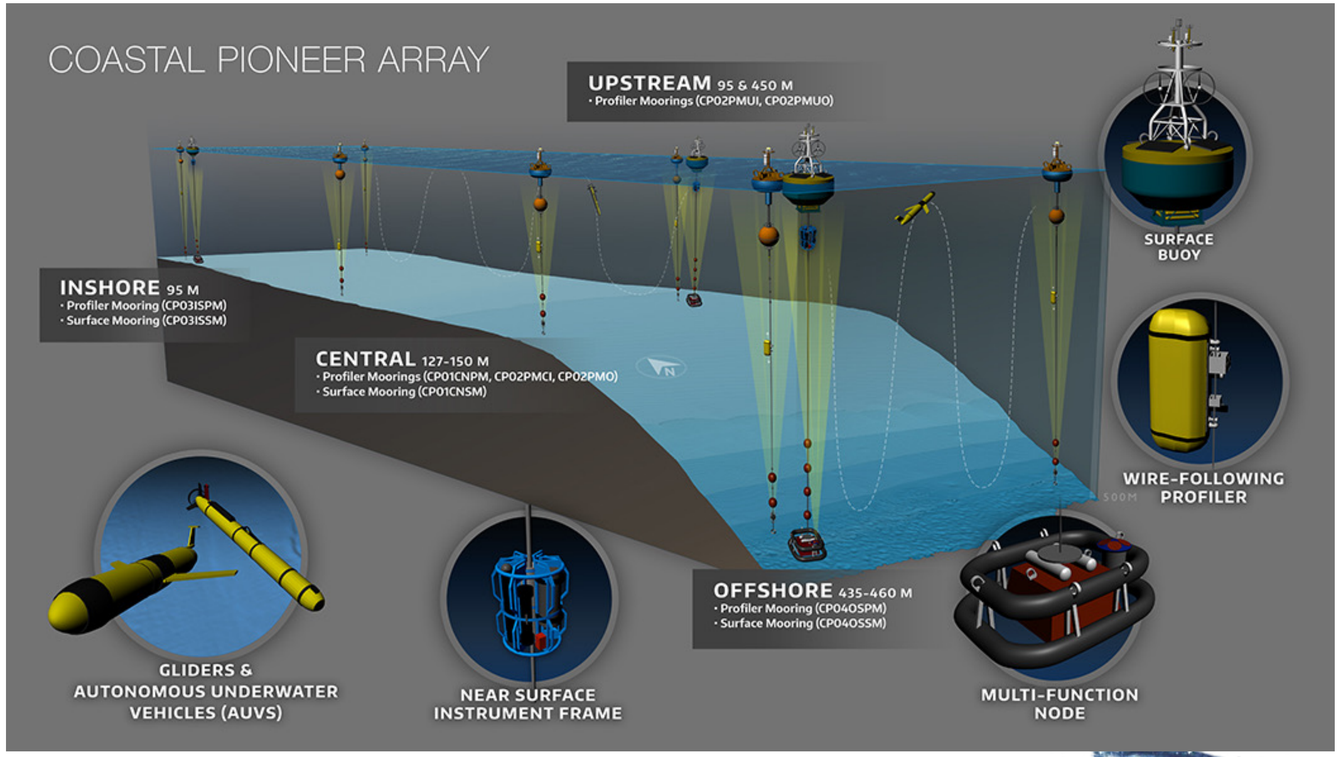
Al Plueddemann and Derek Buffitt

OOIFB Fall Meeting
27 Oct 2022



Overview

- The Pioneer Array was conceived within OOI as a re-locatable, coastal array suitable for moderate wave and current regimes on the continental shelf and upper slope.
- The array has been on New England Shelf since 2016, final recovery Nov 2022
- Existing infrastructure will be utilized to create a new Array
- The new location is the shelf and slope offshore of North Carolina, starting in 2024



Background

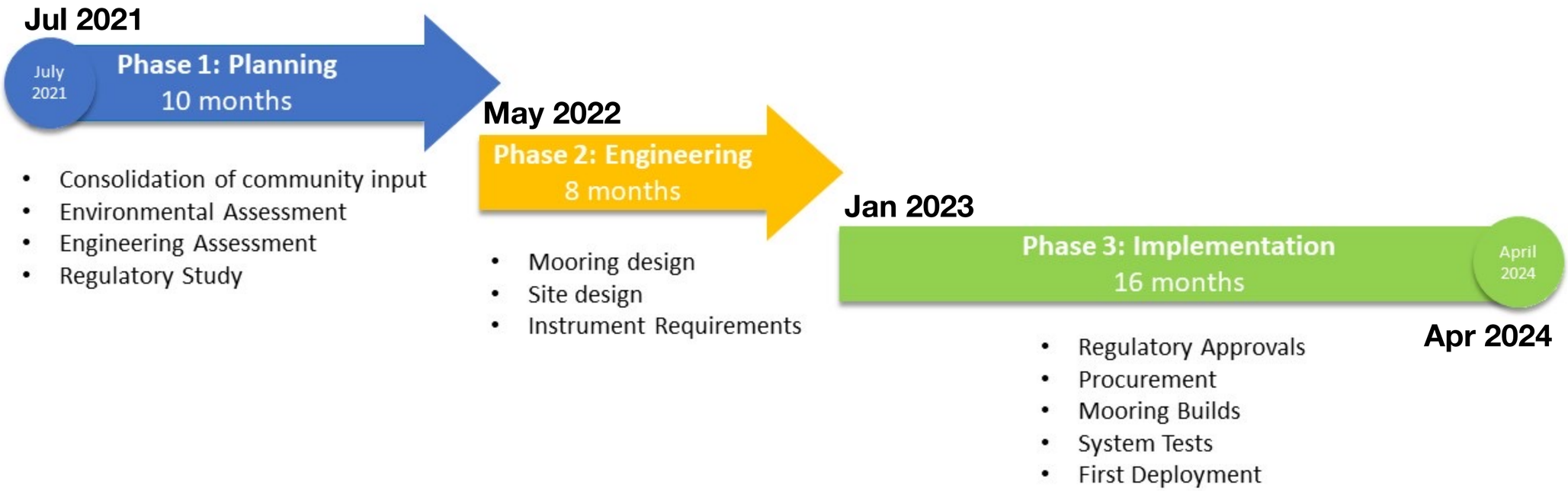
- NSF Announcement of intent to relocate (or retain)
  - Ocean Sciences Town Hall, Feb 2020
- Extensive community input from two Innovations Labs
  - 15-19 March and 21-15 June 2021
- Decision to relocate to southern MAB
  - Announced in Apr 2021
- Relocation process
  - Initiated Jul 2021

Relocation Process

- Approach
  - Guided by Innovations Lab science questions
  - Array design based on Innovations Lab consensus
  - Assessment and refinement by OOI Team
- Goals
  - Address science questions
  - Implement the consensus array design
  - Optimize use of existing inventory
  - Ensure feasible implementation
  - Operate within existing budget

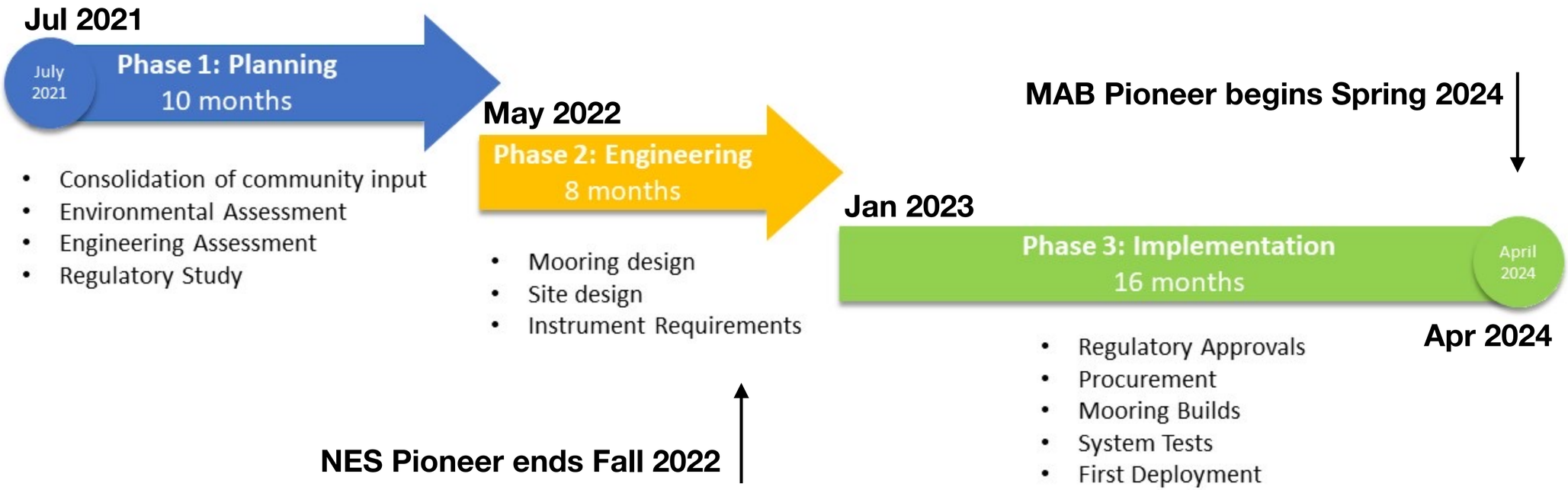
Relocation Timeline

- Three main phases: Planning, Engineering, Implementation

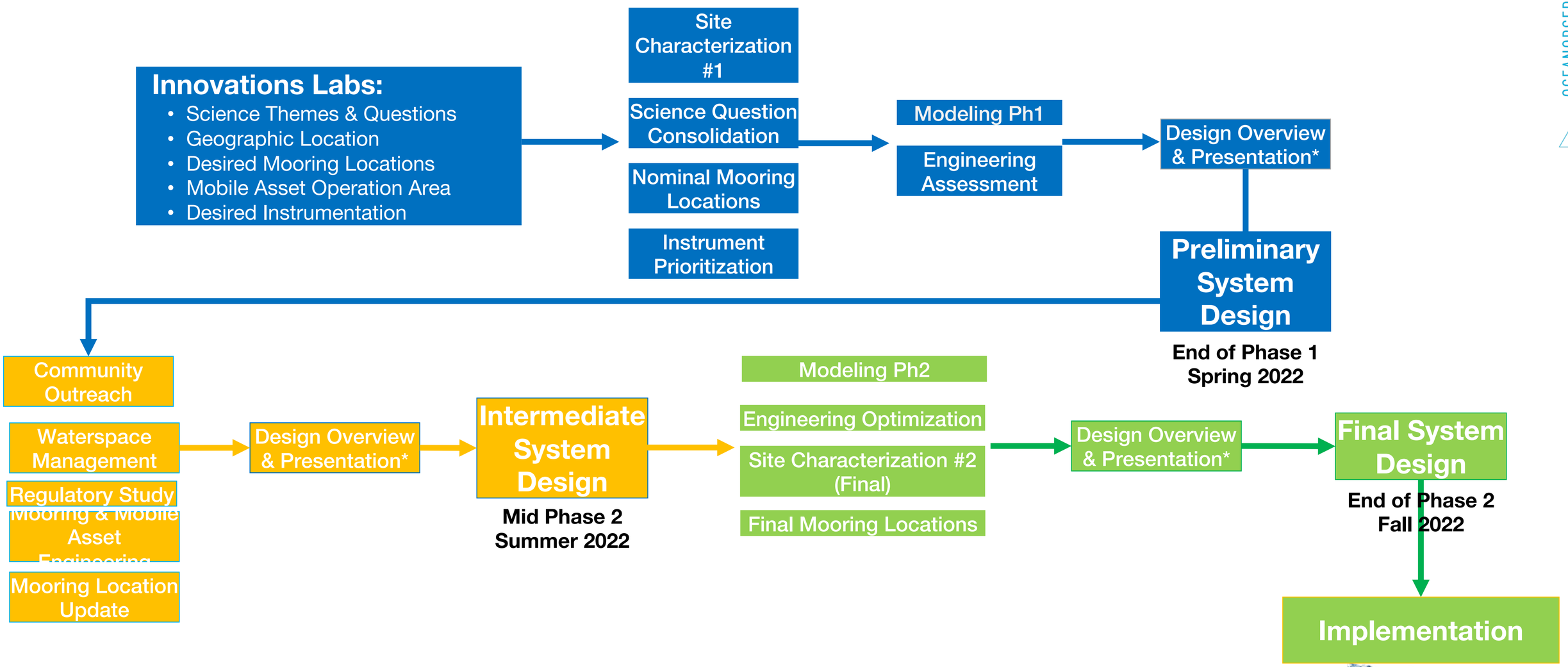


Relocation Timeline

- Three main phases: Planning, Engineering, Implementation
- NE Shelf Pioneer ends Fall 2022; MAB Pioneer starts Spring 2024



Workflow

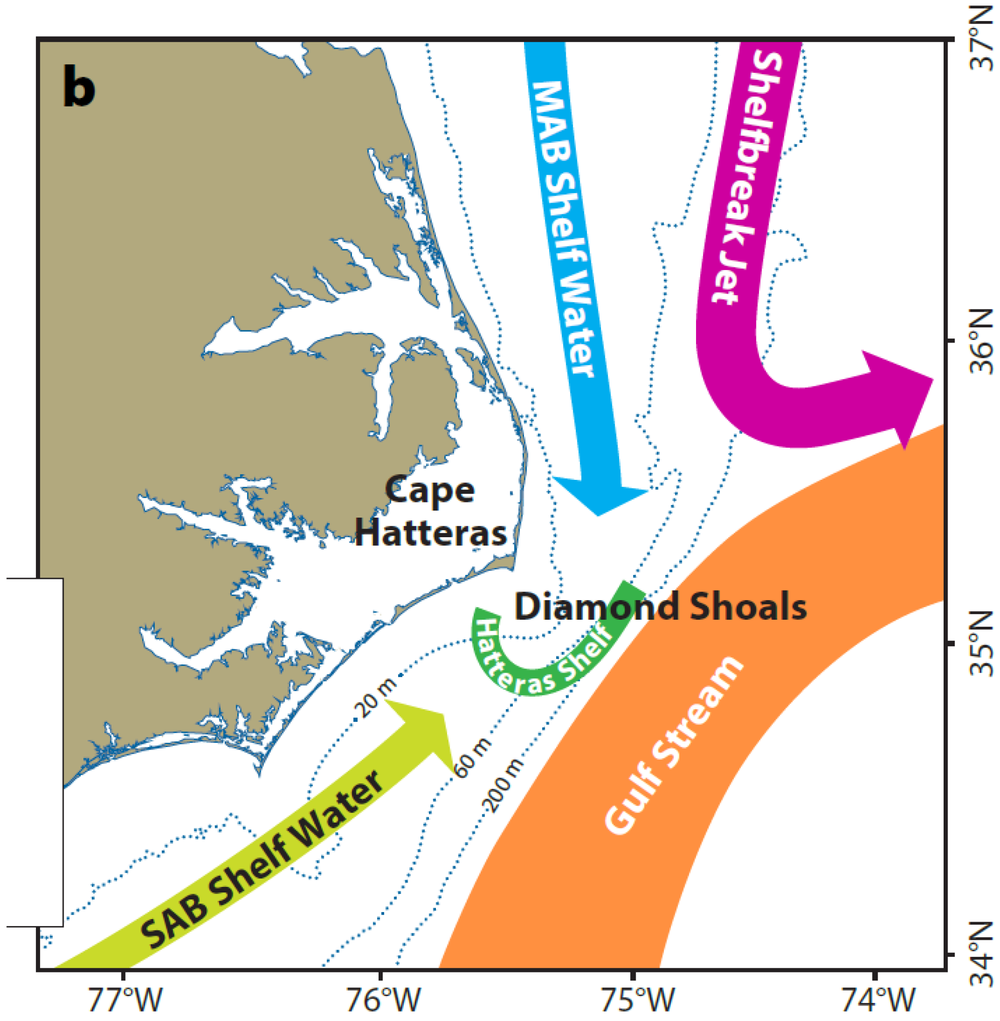


Planning Phase Tasks

- Establish Focus Group
- Consolidate Innovation Labs input
  - Science themes, array design, instrumentation
- Site Characterization
- Waterspace management
- Regulatory study
- Mooring modeling
- Regional ocean modeling
- Instrumentation assessment
- Array design

MAB Science Themes

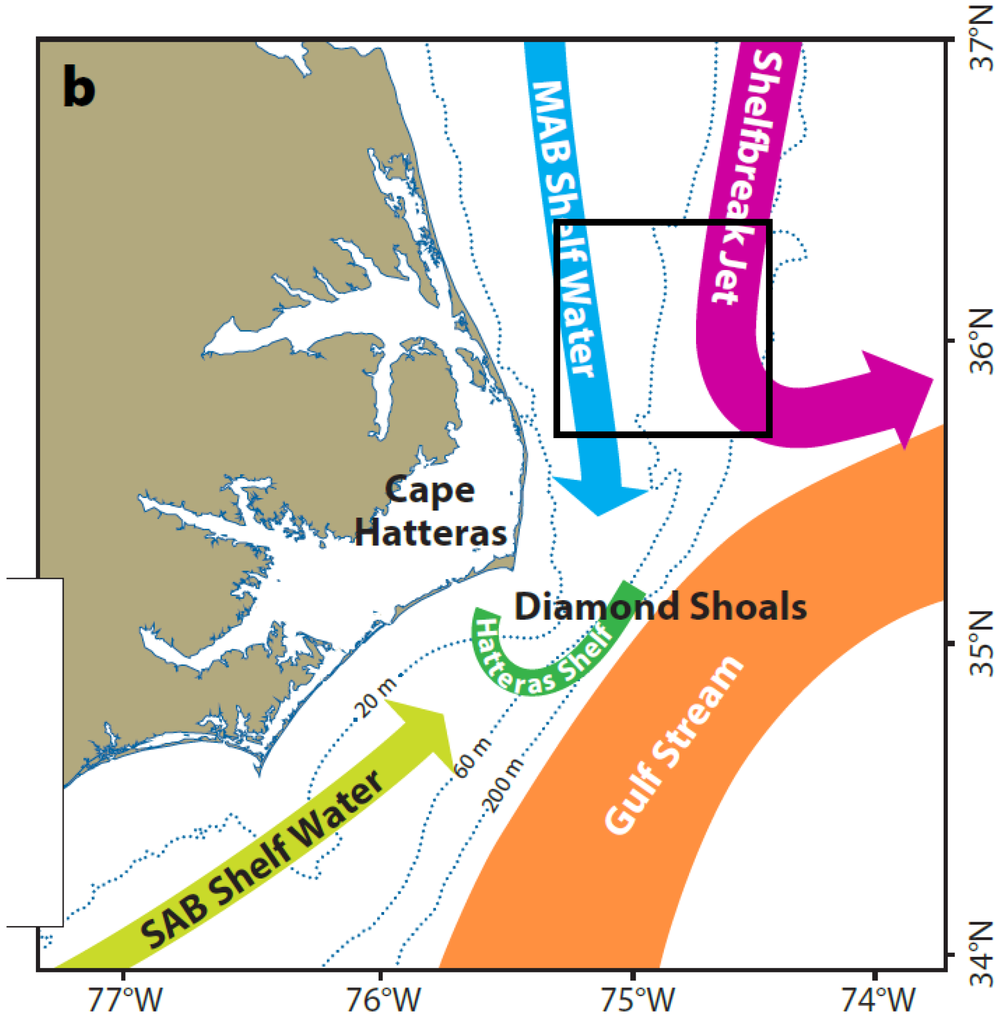
- Approach
  - Grouped into broad themes based on Innovations Lab input and ranking
- High level themes
  - Dynamics of shelf/slope exchange
    - Wind forcing, frontal instability, Gulf Stream influence
  - BGC cycling and transport
    - Carbon, nutrients, particulates
    - Ecosystem response
  - Extreme events
    - Hurricanes, freshwater outflows



Dana Savidge (Skidaway) and the PEACH Project

MAB Observing Region

- Environmental constraints
  - Away from: Gulf Stream, shallow water, strong fronts, strong currents
- Limits of spatially coherent array
  - Moored array ~ 60 km x 60 km
- Decision to focus on:
  - Shelf-slope region
  - S of Chesapeake, N of Hatteras
- Desire to extend offshore and north:
  - Glider domain



Dana Savidge (Skidaway) and the PEACH Project

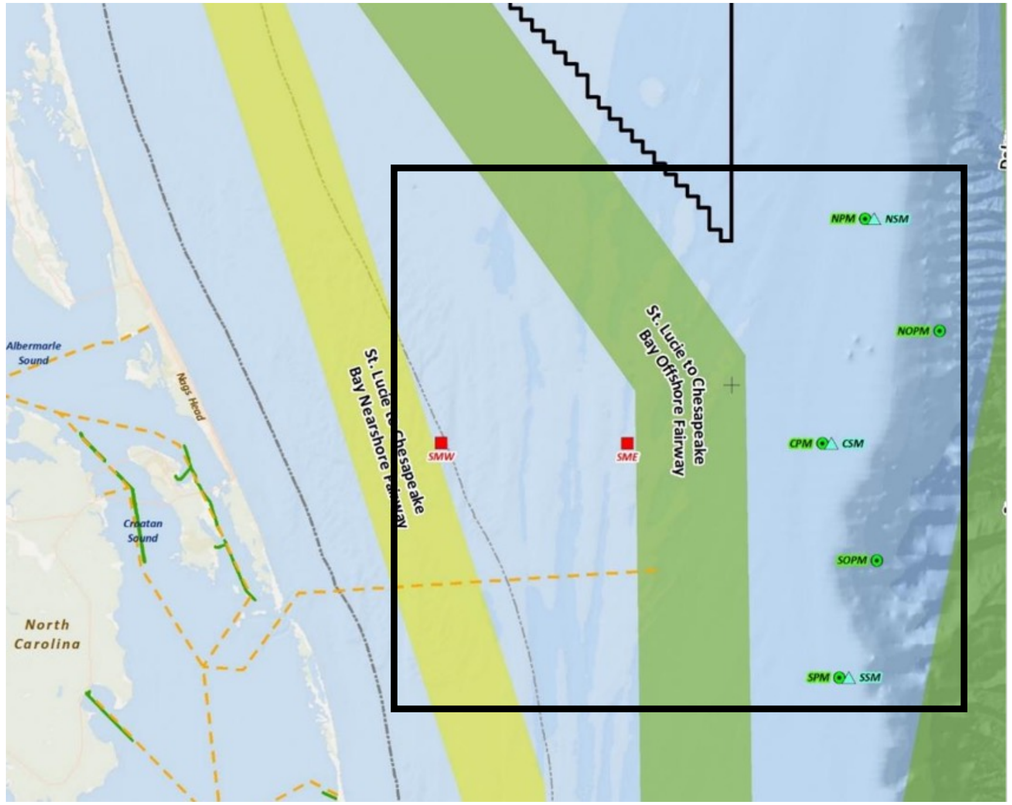
Site Characterization

- Forcing conditions similar to New England Shelf
  - Extremes more frequent, slightly stronger
- Conditions used as input to mooring design studies
  - Operation of NES CSM and CPM moorings is feasible for MAB

Factor	NES Design Criteria	MAB Site Characterization
Typical current speeds (m/s)	0.5 m/s	0.2 - 0.3 m/s
Intermittent current speeds (m/s)	0.6 - 0.8 m/s	0.8 - 1.0 m/s
Survive (m/s)	1.0	1.0 - 1.4
Typical significant wave height (m)	2 - 4	1 - 3
Intermittent wave height (m)	6 - 8	6 - 9
Survive (m)	10	10

Waterspace Management

- Territorial Sea (12 nm)
- Commercial ship traffic
  - Fairways proposed by USCG
- Offshore energy
  - BOEM wind farm lease areas
- Navy operation areas
- Shipwrecks
- Submarine cables
- Corals
- Etc …



Tetra Tech, 2022

Regulatory Study

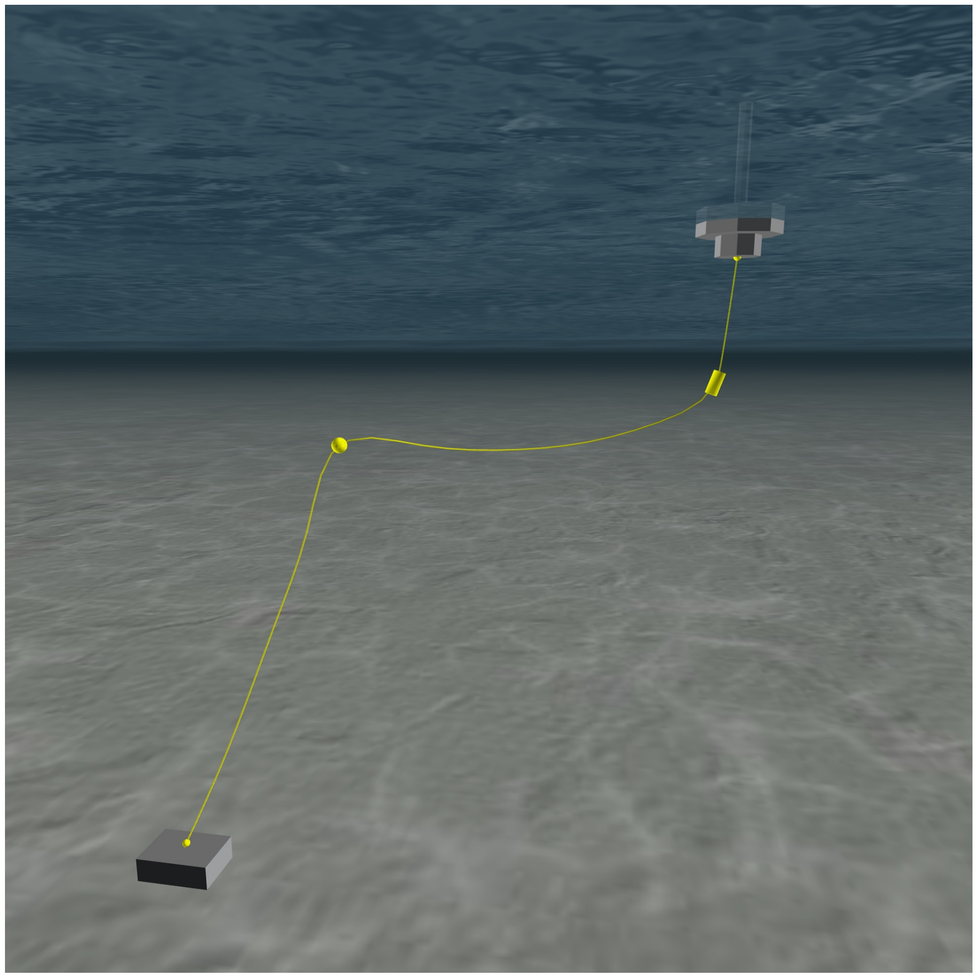
- Tetra Tech permit and regulatory assessment report completed
  - Will qualify for USACE Nationwide Permit (NWP) #5
  - Self-certification process: desktop analysis, plus field surveys
  - Notifications (USACE, USCG, Navy, PATON) prior to deployment
- Tetra Tech desktop analysis report draft completed
  - Bottom types, fish habitats, marine transportation, etc
  - Overall “low risk” of impacts, but mitigation recommended
- Marine archaeology/cultural resource study
  - Draft report completed, under review
- Will not be filing permits until Phase 3

Mooring modeling

- Designs for CSM, CPM complete
- Preliminary SWM design drafted

- Initial performance assessment (forcing by wind, waves, currents)
  - CSM, CPM designs meet requirements at 100 m and 600 m
  - CSM 30 m design appears feasible
  - SWM at 30 m being evaluated

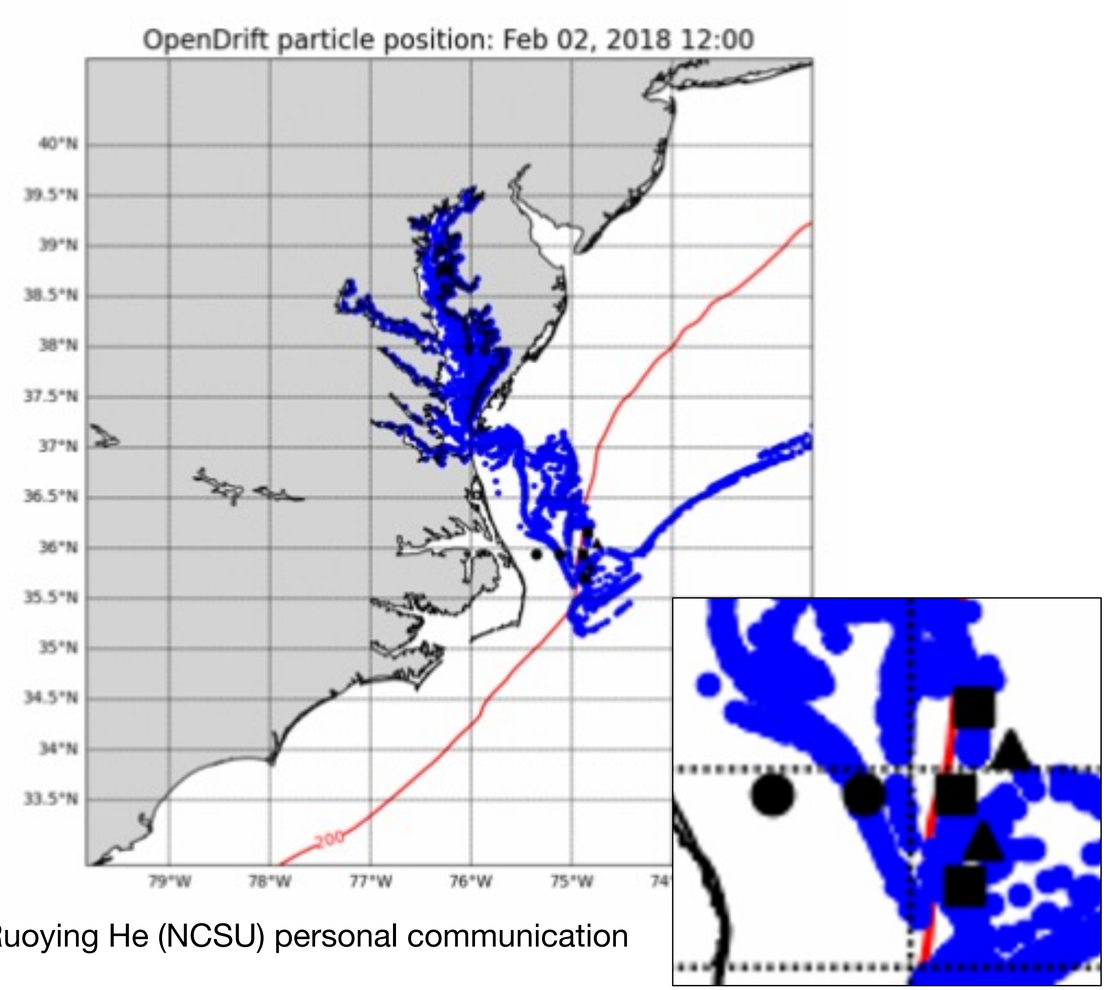
- Field tests planned for 2023



Don Peters (WHOI) personal communication

Regional Ocean Modeling

- Coordinated effort with Ruoying He and John Wilkin
- Model results in the context of science goals and array design
- Confirmed proposed array shape and spacing are appropriate
- Adjustments and refinements:
  - Retained offshore moorings
  - Shifted CSM to mid-shelf
  - Added ADCP to SWM
  - Adjusted glider lines



Ruoying He (NCSU) personal communication

Instrumentation Assessment

- Baseline: current OOI core sensors
- Innovations Lab input:
  - >40 instruments or measurement concepts suggested
  - “Short List” of 12 based on cross-group consensus
- Refined to “Tier 1” implementation list based on:
    - Science themes
    - Technical readiness
    - Operational feasibility/array design
    - Budget impacts
- Next Steps
    - Requirements, specs, RFIs, assessment, procurement

Instrument Additions

- Tier 1 Instruments (new procurements)
  - Near-surface temp/salinity
  - Near-surface velocity profile
  - Turbidity* (water column and near-bottom)
  - Suspended particulates
  - Phytoplankton imaging
  - Incident radiation** (CSM and CPM buoys)
  - Glider nitrate

* Preference for using existing FLORT instrument with manufacturer calibration for turbidity

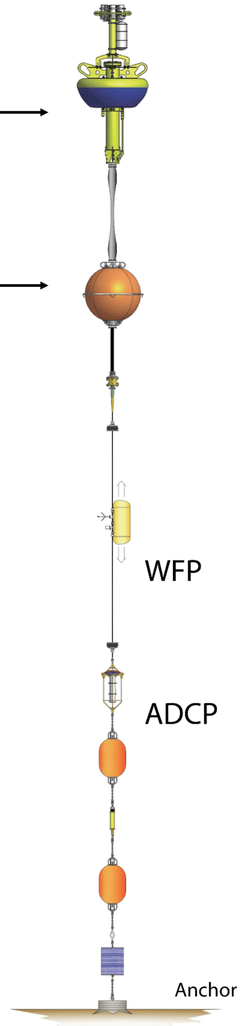
** Being evaluated, will seek Focus Group input

Instrument Additions

CPM

SURFACE
Buoy: PAR
Buoy: base CTD

SPHERE
Uplooking ADCP

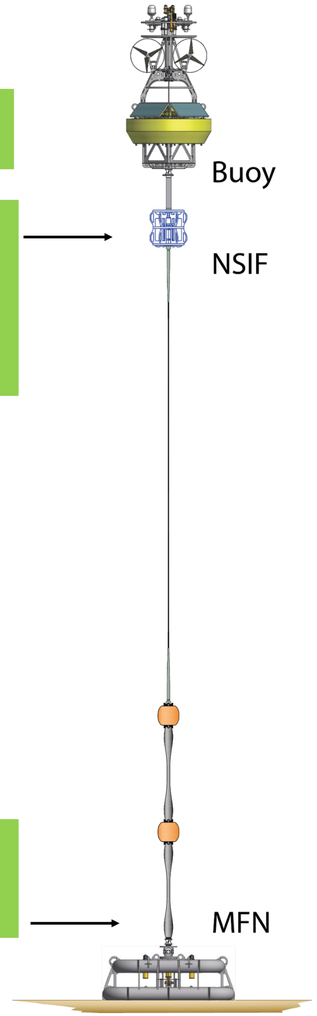


CSM

SURFACE
Buoy: SPKIR

NSIF
Uplooking ADCP
Phyto imagery
Particulates
Turbidity

MFN
Particulates
Turbidity

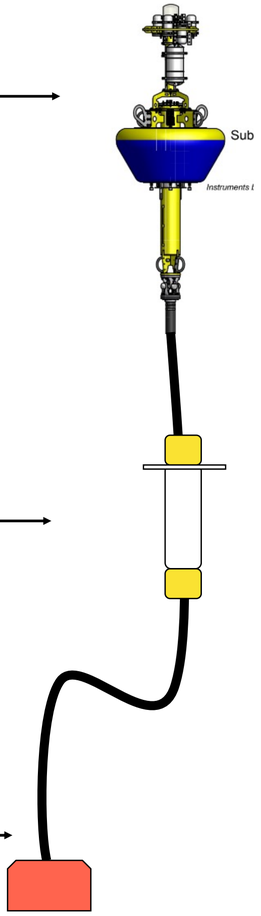


SWM

SURFACE
Telemetry only

PROFILER
CTD
Oxygen
Fluorometer

BOTTOM FRAME
Uplooking ADCP
(surface waves)



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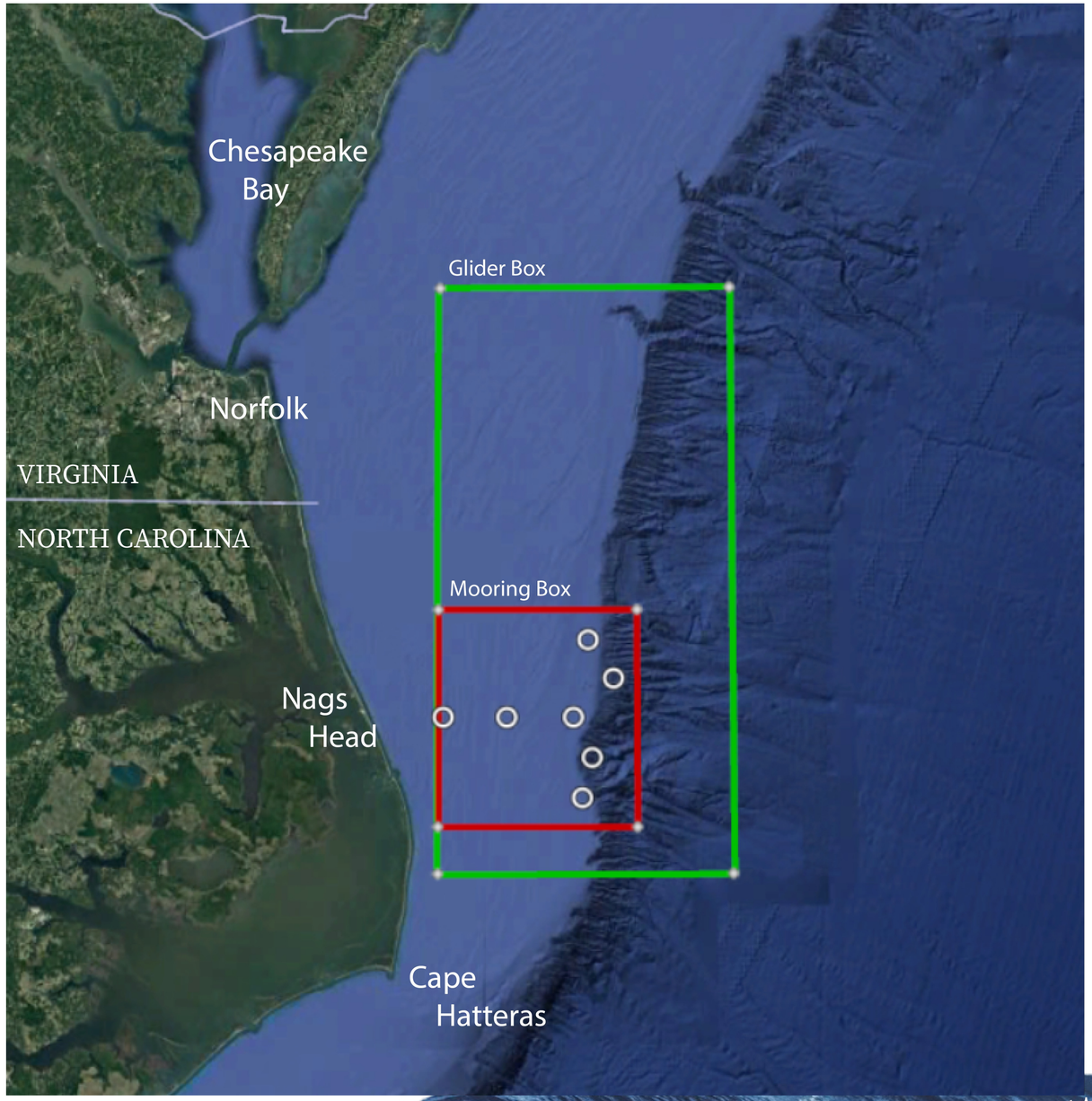
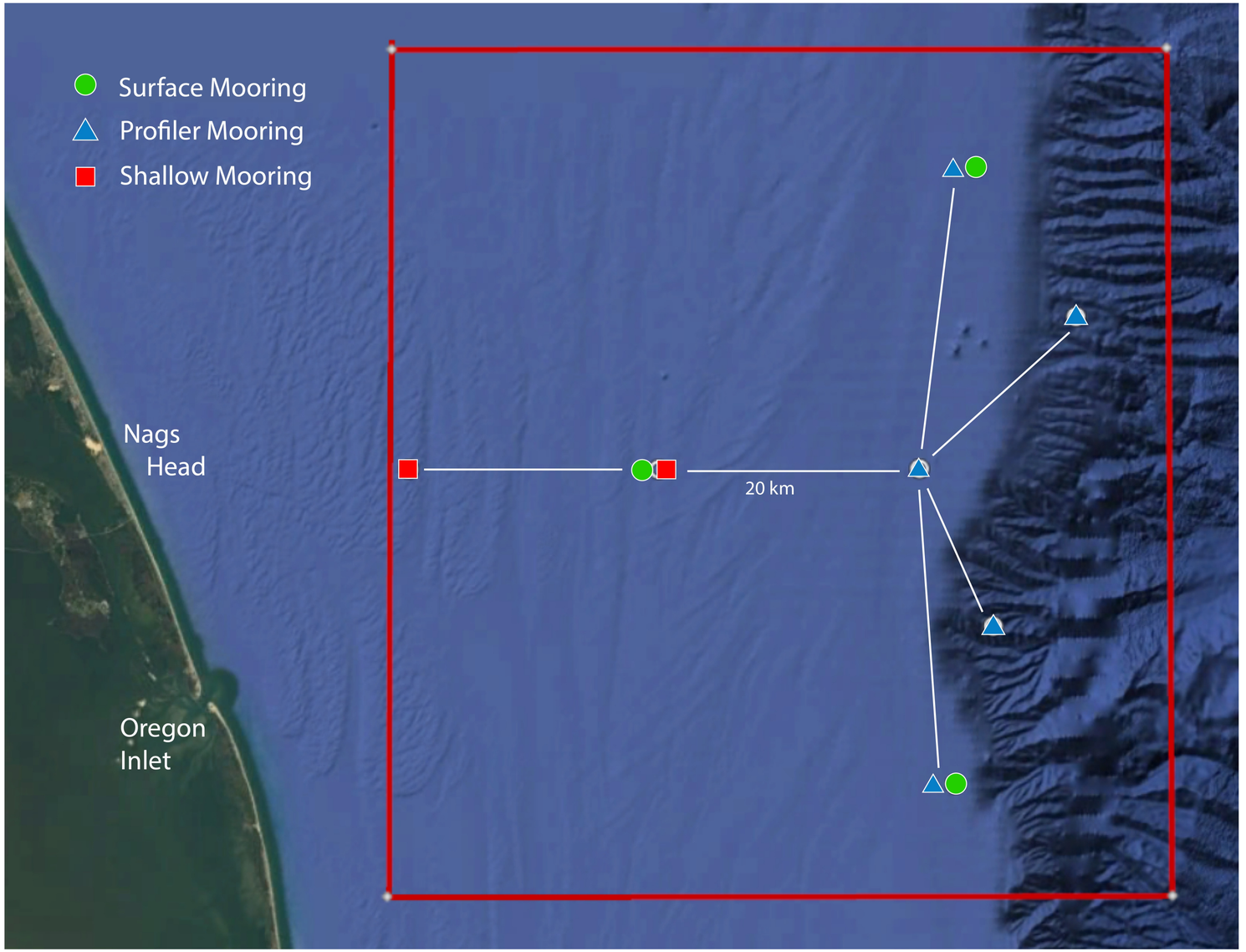
Array Design

- Region
  - Offshore of North Carolina, north of Cape Hatteras
- Moorings
  - Shelf and slope
  - East of Nags Head, NC
- Gliders/AUVs
  - Shelf and offshore
  - North to Norfolk Canyon



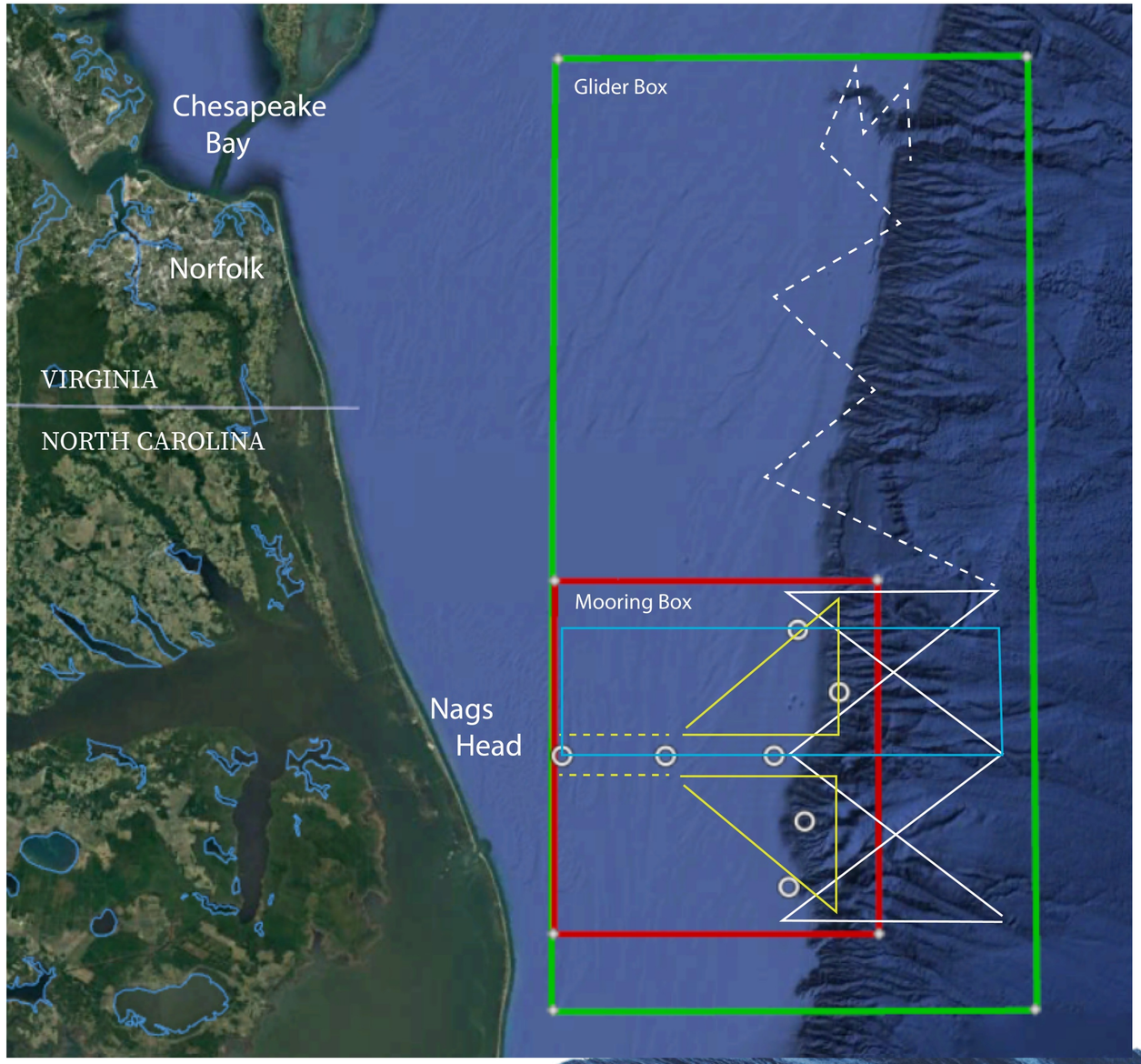
Moored Array

- Components
  - 3 CSM
  - 5 CPM
  - 2 SWM
- Challenges
  - Regulatory
  - Shallow water
  - Instruments
  - Logistics
  - Budget



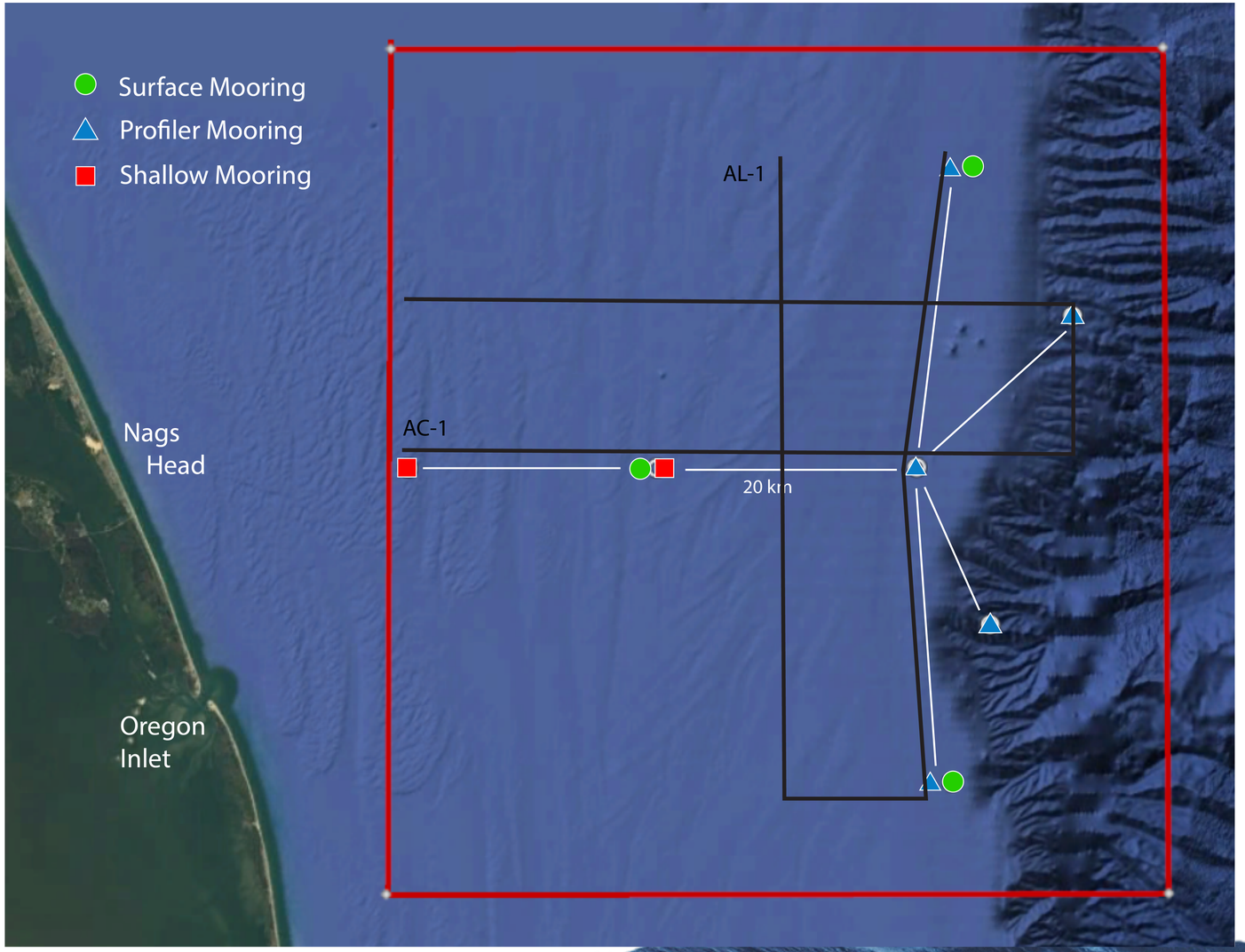
MAB glider plan

- Operations
  - Retain current fleet of 12
  - Deploy 4 (3:1 ratio)
  - ~90 dy endurance
- Four main tracklines
  - Moored array (yellow, 5 dy)
  - Cross-shelf (blue, 10 dy)
  - Slope Sea (white, 13 dy)
- Supplemental lines (dashed)
  - Norfolk Canyon (2x/yr)
  - Shallow shelf (summer)



MAB AUV plan

- Operations
  - Two REMUS-600 AUVs
  - “Campaign mode”
  - 4-6 missions/yr
- Two mission boxes
  - Cross-shelf box (20 hr)
  - Along-shelf box (20 hr)
- Objectives
  - Synoptic transects of moored array
  - Resolve shelfbreak front



Current Status and Look-Ahead

- Engineering Phase (Fall 2022)
  - Site Characterization: add solar radiation, compile document
  - Waterspace management: outreach to stakeholders
  - Regulatory: complete self certification, conduct site survey
  - Mooring design: Second round of design/modeling; test deployments
  - Instrument assessment: Requirements, specs, RFIs, in-situ tests
  - Array design: Ongoing refinement based on new input
- Implementation (2023):
  - Site survey: Mooring tests and environmental assessment, winter 2023
  - System engineering, electrical design, configuration management, permits
  - Integration with Cyberinfrastructure, data ingestion and delivery
  - Procure, build, and test; deploy April 2024

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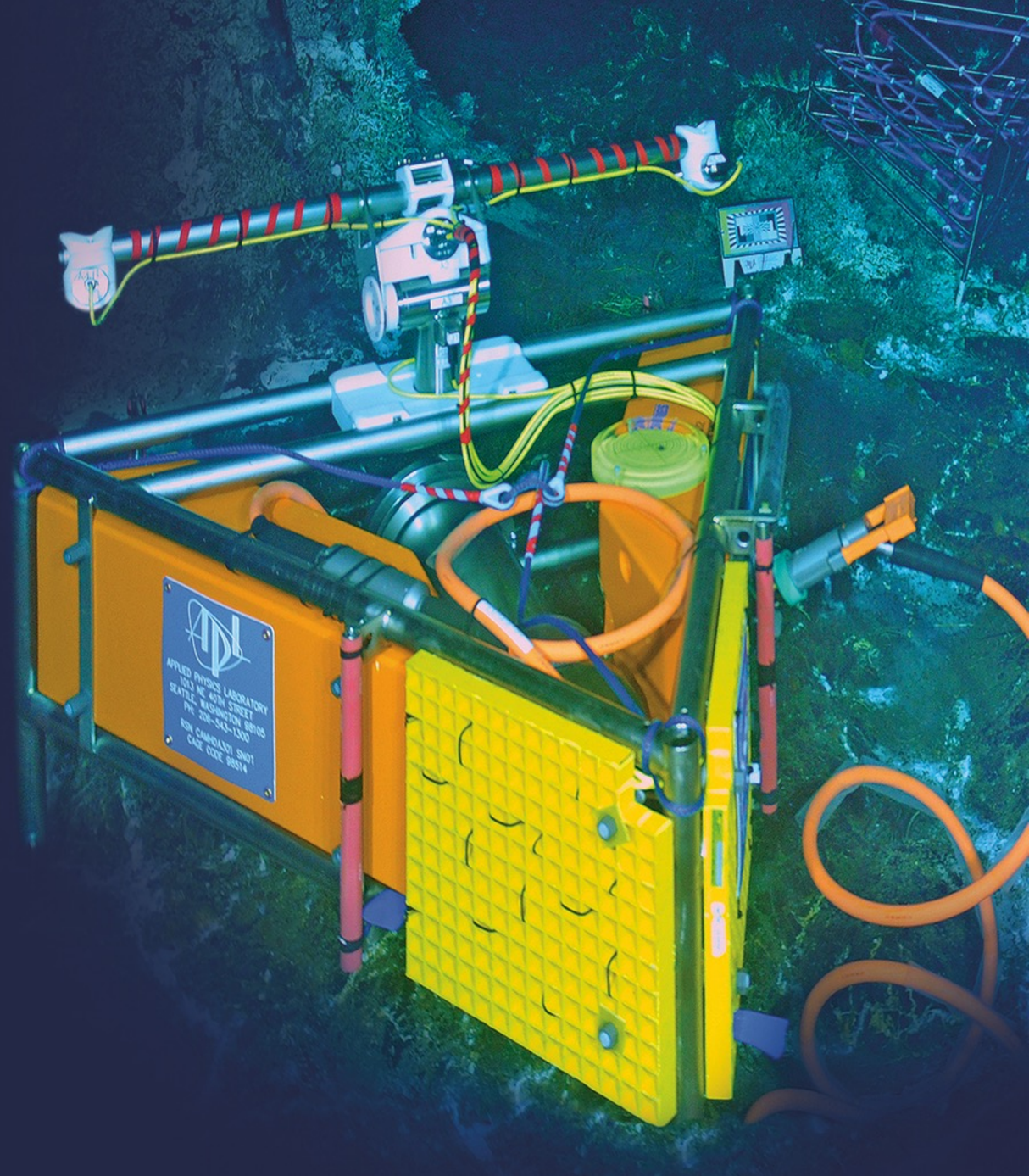
Questions?



Extras

Planning Phase Tasks

- Establish Focus Group
- Consolidate Innovation Labs input
  - Science themes, array design, instrumentation
- Site Characterization
- Waterspace management
- Regulatory study
- Mooring modeling
- Regional ocean modeling
- Instrumentation assessment
- Array design

Planning Phase Status

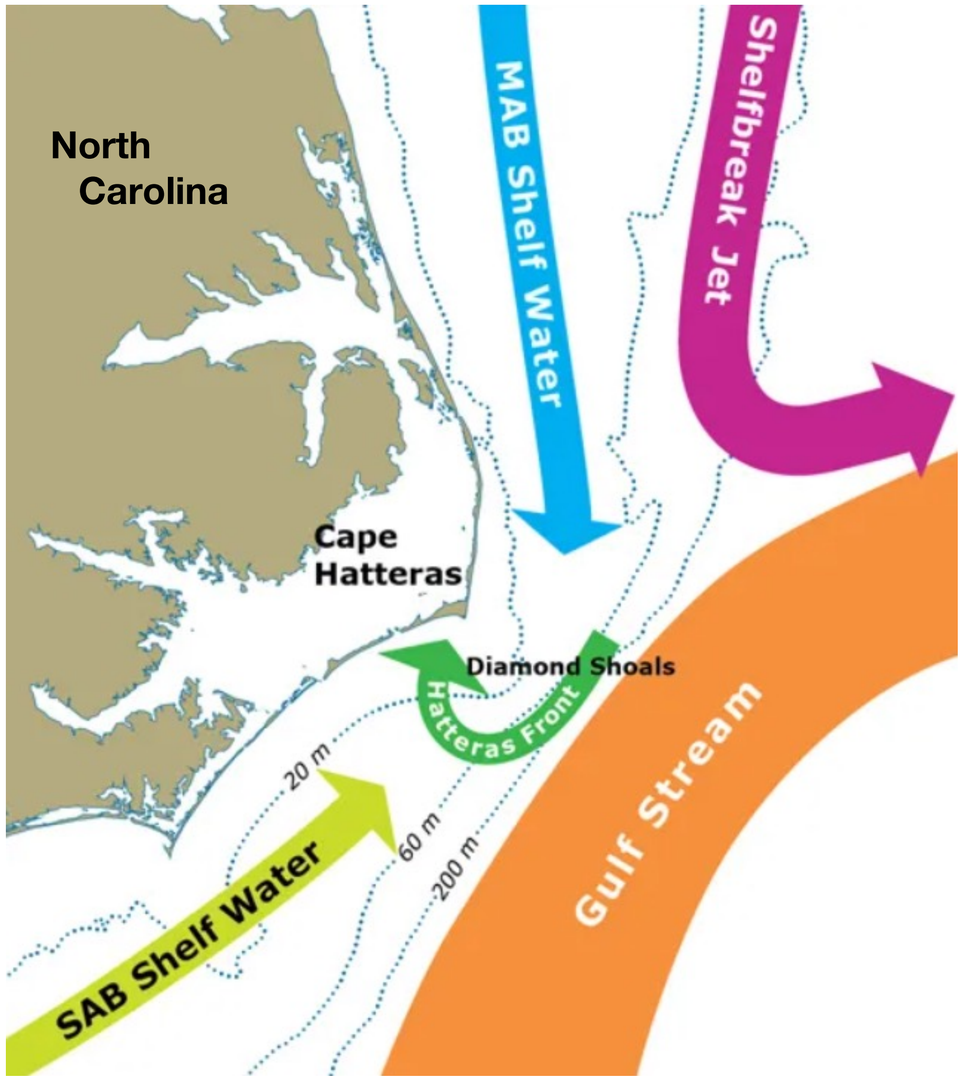
- Focus Group established
  - Feedback at each phase, response to targeted inquiries
- Consolidation of Innovation Labs input
  - Science themes, array design, instrumentation
- Site Characterization
  - Complete: Wind, waves, currents, bathy, stratification
  - TBD: solar radiation
- Waterspace management
  - Review by outside consultant (Tetra Tech)
  - Shipping lanes, seafloor cables, shipwrecks, wind farms, etc.
- Regulatory Study
  - Established process for NWP self certification

Planning Phase Status (cont'd)

- Mooring Modeling
  - Initial Proteus runs for all three moorings (CSM, CPM, SWM)
  - Further refinement needed (shallow CSM, SWM)
- Regional Ocean Modeling
  - Fundamental array design confirmed, various refinements
- Instrument Assessement
  - Seven measurements on Tier 1 list
  - Next steps are requirements & RFIs leading to procurement
- Array design
  - Implementable, permittable array design developed
  - Modest refinement expected from Focus Group, site survey

MAB Science Drivers

- Dynamics of shelf/slope exchange
  - Wind forcing, frontal instability, Gulf Stream influence
- BGC cycling and transport
  - Carbon, nutrients, particulates
  - Ecosystem response
- Extreme events
  - Hurricanes, fresh water outflows



Dana Savidge (Skidaway) and the PEACH Project

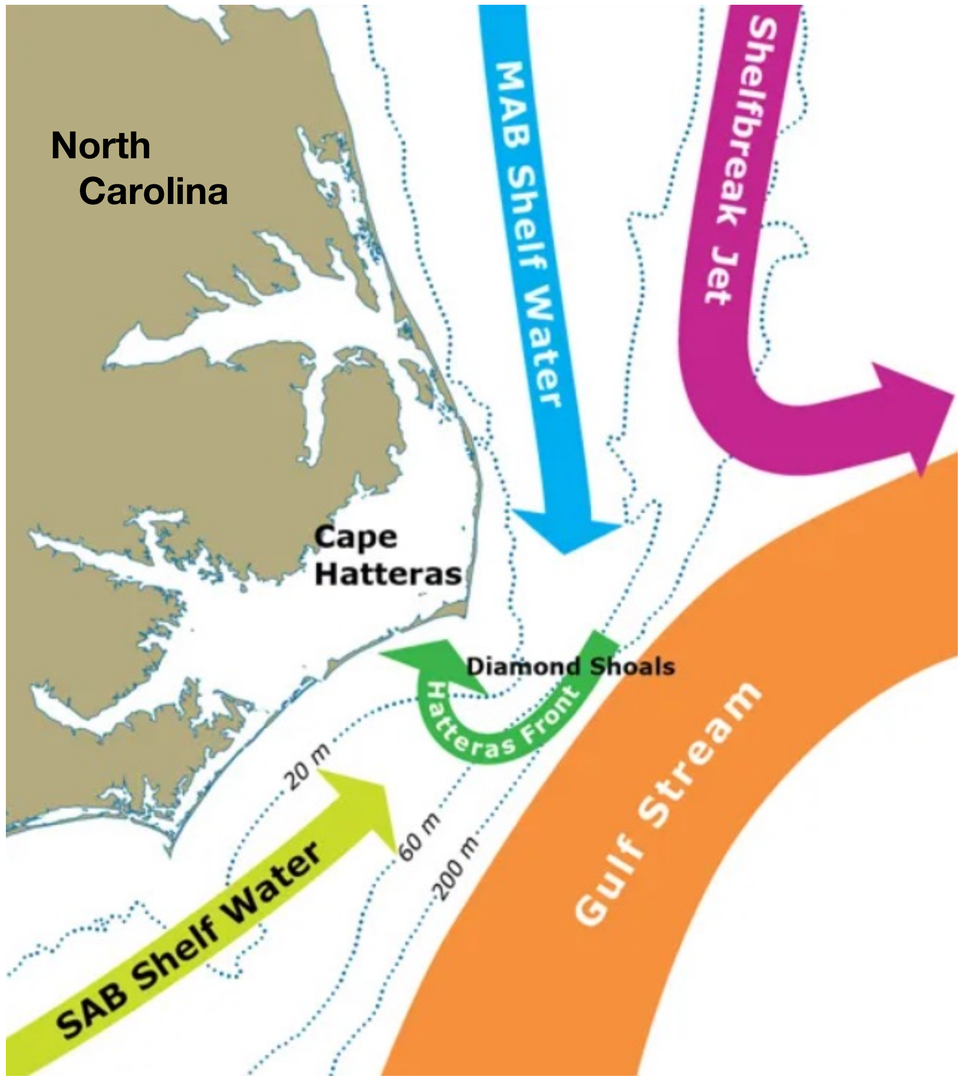
MAB Science Questions

- Highly-ranked examples from each of the three themes

- What are the dynamics of cross-shelf export of MAB waters from the shelf to the slope, including the role of ageostrophic currents and submesoscale variability?
- How do freshwater plumes impact the biogoechemistry on the MAB shelf, and how do these impacts vary from year to year?
- How can we better understand and predict the impact of nor'easters and hurricanes based on knowledge of surface fluxes and upper-ocean stratification in the MAB?

MAB Environment

- Proximity to Gulf Stream
  - Influence at shelfbreak, glider navigation
- Recirculation gyre
  - Delivers drifters to the Gulf Stream
- Storms/Hurricanes
  - Stronger and more frequent than NE Shelf
- Freshwater plumes
  - Thin surface layer difficult to measure
  - Complicates glider ballasting
- Shallow shelf
  - Depths <100 m require design changes



Dana Savidge (Skidaway) and the PEACH Project

Relocation Challenges

- Maintain the same operating budget
- Use existing platforms to create the new array
- Operate in a new environment
- Incorporate new instruments
- Operate in a busy waterspace with new stakeholders

Resources

No new funds are expected for the transition to a new configuration, or for the operation at a new location.

Transition

- A modified array for a new location will require:
  - Array design, platform engineering efforts
  - Procurement, fabrication, integration and testing
  - Outreach, logistics planning and permitting
- Supported by implementing a “phased transition”

Operation

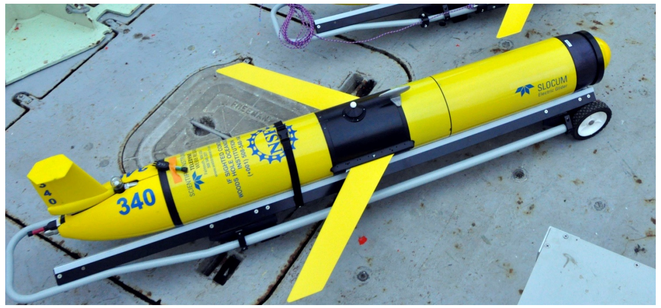
- Need for servicing multiple times per year (platform dependent)
- Annual operating costs include:
  - Prep/refurb, field logistics and ship time
- Constrained by existing Pioneer operating budget

Platforms

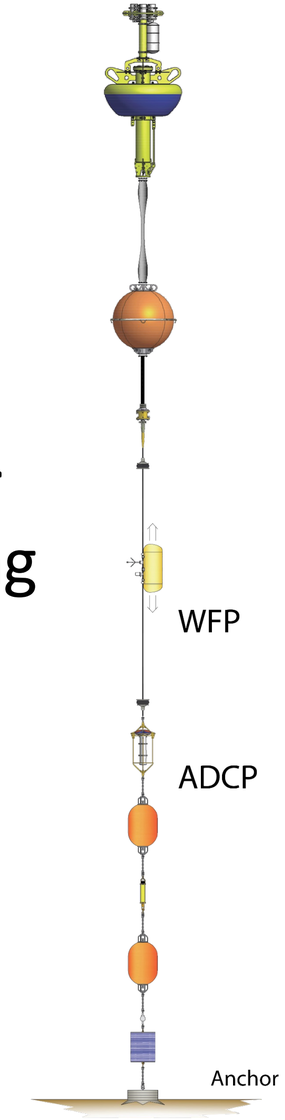
https://oceanobservatories.org/ooi-infrastructure/

AUV

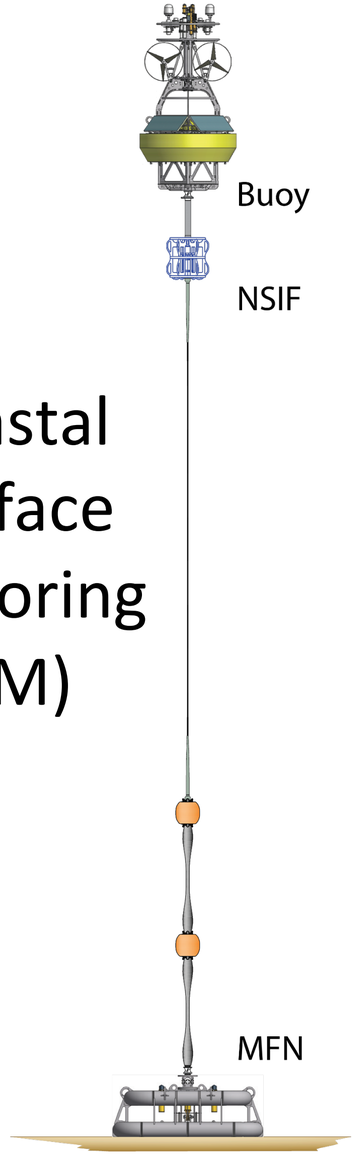
Glider



Coastal Profiler Mooring (CPM)



Coastal Surface Mooring (CSM)



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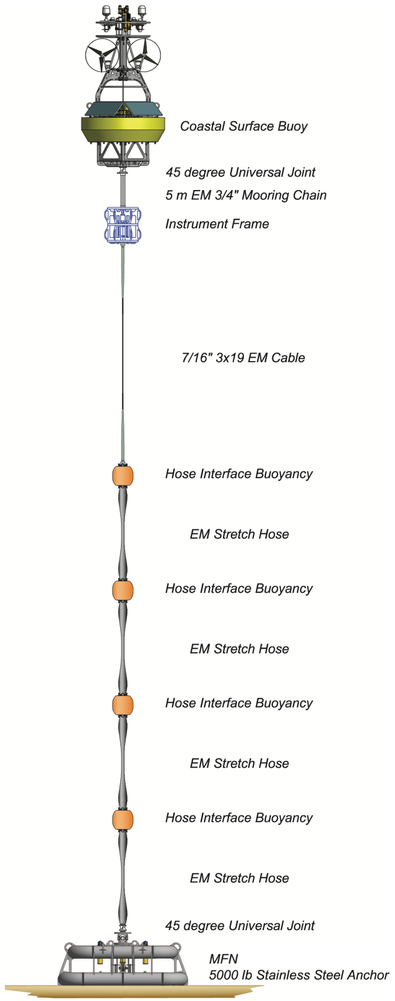
Instruments

https://oceanobservatories.org/instruments/

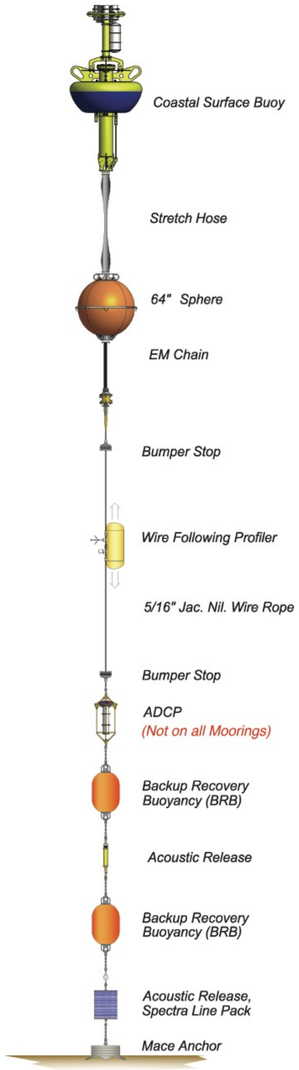
Pioneer Array Core Instrumentation		
Instrument Series	**Measurement(s)**	**Platform**
CTD	Temp, cond, press	all
Oxygen	Dissolved oxygen	all
Fluorometer	Chl-a, CDOM, optical backscatter	all
Radiometer	Spectral irradiance or PAR	all
Velocity profile	Profile and/or single point	all
Nutrients	Nitrate concentration	CSM, AUV
Surface Meteorology	AT, RH, BP, PRC, WSPD, WDIR, SWR, LWR, SST, SSS, covariance flux	CSM
Surface Waves	Surface wave properties	CSM
CO2	Partial press CO2 in air, water	CSM
pH	Seawater pH	CSM
Pressure	Seafloor pressure	CSM
Spectrophotometer	Optical absorp, attenuation	CSM
Bio-acoustics	Multi-frequency acoustic backscatter	CSM

MAB Pioneer Moorings

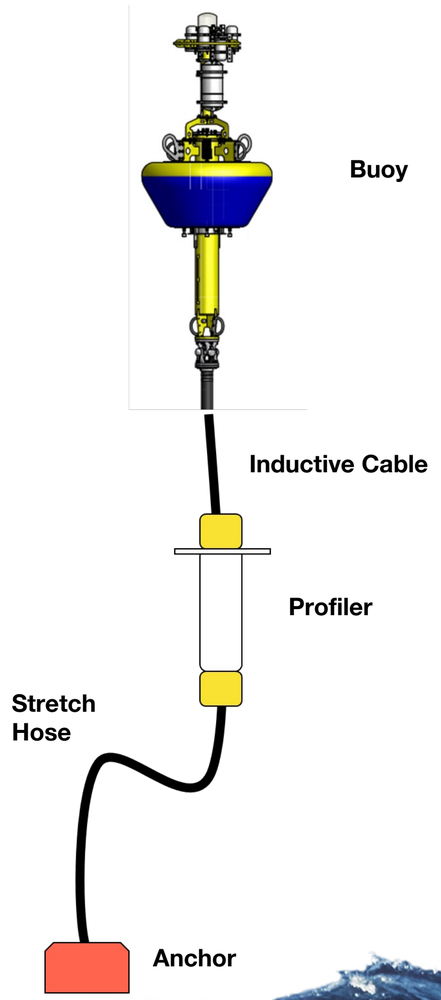
Coastal Surface Mooring



Coastal Profiler Mooring



Shallow Mooring (Schematic Design)



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Community Outreach

- Focus Group to provide feedback on evolving plans
- PI discussions and site visits to regional institutions
  - Science opportunities, partnerships, collaborations
- Waterspace management discussions
  - Specifics driven by regulatory and permitting requirements
  - (fishermen, wind farms, US Navy, USCG…)
- Southern MAB Pioneer science workshop
  - OOIFB lead, to be considered for Spring/Summer 2023

Communication Plan

- Website and social media postings
  - Timeline, science themes, array design, instruments, etc
- OOI newsletter articles
- Semi-annual updates to OOIFB and NSF at regular meetings
- Updates with Q&A at national meetings
  - Fall AGU, Ocean Sciences, MTS, MABPOM, etc
- SOC status reporting and ECR review as needed
- Program documents on OOI website and Alfresco
  - Site Characterization, Engineering Docs, Sampling Plan

Relocation presentations and discussion forums

- Fall AGU 2021: OOIFB Town Hall, OOI Booth
- Ocean Sciences Feb 2022: OOIFB Town Hall, OOI Booth
- MTS Buoy Workshop, Sep 2022
- MABPOM, Oct 2022
- Fall AGU 2022, OOIFB Town Hall; OOI Booth, Session talk

- Ongoing: OOI Website, content updates

Major Milestones

- Start configuration management: Sep 2022
- Start mobile asset planning: Oct 2022
- Start Electrical Design Work: Oct 2022
- Instrument RFIs (Tu, IFCB, LISST, ADCP): Oct/Nov 2022
- Shallow Mooring RFIs (Prawler/Wirewalker): Oct/Nov 2022
- Complete DTS & Self-Certification: Nov 2022
- Start Instrument Procurements: Nov 2022
- Complete Modeling Report: Nov 2022
- Test deployments (CSM, CPM): Feb 2023
- Test deployments (SWM, gliders): May 2023

Major Milestones

- Preliminary Design Review: Nov 2022
- CSM and CPM test and CDR
  - Start test mooring build: Oct 2022
  - Test Readiness Review for AST-3: Feb 2023
  - At-Sea Test 3: Deploy Feb 2023
  - “Delta” CDR: Jun 2023
- SWM test and CDR
  - Component CDR: Nov/Dec 2023
  - Test Readiness Review for AST-4: Apr 2023
  - At-Sea Test 4: Deploy May 2023
  - CDR: Aug 2023
- Pioneer MAB initial deployment: Apr 2024