OBSERVATION AND SAMPLING APPROACH

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Document Control Sheet

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1 Purpose

The purpose of this document is to define how the Ocean Observatories Initiative (OOI) operates the various *in situ* sensing elements of the system (sensors and mobile platforms) to ensure the collection of temporally and spatially optimal data and samples that address the overarching science goals of the program. It has two purposes:

- Guide project personnel involved with the day-to-day operation and maintenance of the observatory
- Inform potential users about how observations are routinely collected.

This document covers only the standard operation of core instruments (i.e., those that are procured and owned by the OOI Program). Standard operation refers to how sensors and platforms are routinely operated.

This document has a deliberate "temporal maturity" component. Early releases help the software developers understand the "higher level" aspects of sampling and operational planners implement the procedures required for the deployment, testing, validation, and acceptance of the instruments/platforms/arrays. Later releases focus on defining the optimal, sustainable sampling rates for scientific discovery. **The tables contained herein are evolutionary (exemplar) in nature and can be modified through the change control process prior to deployment and periodically during operations**. Recommended changes to this document from the external community should be sent the OOI Data Delivery Manager, Jeff Glatstein, jglatstein@whoi.edu.

This document does not address:

- The command and control of instruments, platforms or arrays.
- The collection and handling of physical samples
- Ship-based observations for the purpose of instrument calibration (e.g., those collected during OOI maintenance cruises.)
- Operation of instruments added to the system by independent organizations/researchers
- Operation of core instruments under non-routine situations such as specific research activities or during system anomalies.

It is critical to acknowledge that this document is only PART of the entire sampling approach description and documentation. While it expands on the descriptions provided in the Final Network Design (FND DCN 1101-00000), it does not provide the detailed information required to completely program and operate individual instruments at individual sites. Additional and essential information covering these subjects are contained in documents such as the individual instrument class Instrument Operations Specifications (IOSs) and array/platform/node operational specifications (NOSs).

2 Definitions

The following sampling definitions apply throughout this document:

1. **"Baseline"** – The minimum instrument sampling rate and/or mobile platform operation required to address daily to decadal scale variability and associated science objectives. For the potentially shorter term, relocatable Pioneer Array, "baseline" sampling must also support the OOI science themes of the Pioneer Array focus areas. "Baseline" is the mode of operation that should not be interrupted for the duration of the system life and must be preserved within all other sampling approaches. "Baseline" sampling will remain relatively unchanged, once established, over the life of the OOI array deployment.

2. **"As-deployed"** – The maximum instrument sampling rate and mobile platform performance that can realistically be maintained for the duration of a system component deployment. This is a function of instrument and platform requirements and the resources (e.g., power) available within the array component where the instruments/platforms reside. "As-deployed", as the term implies, is the defined sensor and platform operation in the absence of any superseding instrument/platform anomalies or specific science-based objectives (e.g., to accommodate a specific research project or a priori responses to short-term ocean events.) It does not necessarily refer to the maximum sampling capacity of a particular instrument or platform, but rather the optimum operation of instruments and/or platform(s) having known constraints (e.g. length of deployment) or synergies (e.g. instrument interferences). For example, several instruments may be defined to sample simultaneously, but the available power may prohibit operating the instrument suite at full capacity "as-deployed". Also, some sensors sample at a higher rate and automatically average to effectively provide lower rate data to the user; without retention of the original data. "As-deployed" also refers to how mobile platforms, such as gliders, autonomous underwater vehicles, and profilers are operated. Since instrument/platform operation is based on expected environmental variability over a broad range of temporal and spatial scales, "as-deployed" sampling is location and perhaps temporally (e.g., daily or seasonally) dependent. "As-deployed" sampling can change over the expected multi-decadal lifespan of the OOI as science requirements evolve, new sensing capabilities emerge, mobile platform performance changes, and power sources are developed. Particularly in the initial phase of OOI operation when there is likely to be a significant learning curve on optimal sampling rates, especially for mobile platforms, the as-Deployed rates are likely to change to address unexpected interferences from nearby instruments and or platforms, for example.

3. **Adaptive** – A temporary change in instrument or platform operations in order to address researcher-specific requirements or the occurrence of unique temporal or spatial events. Adaptive sampling is generally defined by individual research proposals. However, as knowledge is gained about the various operational environments, certain short-term events may trigger automatic adaptive responses. In certain scenarios, adaptive sampling may require instrument or platform operations that are more energetic or data prolific than specified by "as-deployed" sampling. In these cases, the local power budget may require that the "as-deployed" sampling for other instruments associated with the platform component be relaxed. However, adaptive sampling will rarely (and only under justified reasons) interrupt "baseline" sampling.

4. **Percentage Telemetered** – The "percentage telemetered" column in the sampling tables indicates the amount of data that can be sent back to shore while the instrument is

deployed, as opposed to the complete dataset available for download once the instruments have been recovered. Most cabled instruments stream 100% of total data back to shore, but depending on the platform, telemetry rates may be limited by the data transmission capability and cost of the Iridium satellite network, the power available to run the data concentrator/logger (DCL) computers onboard the moorings, or by the file sizes created by various instruments. Some instruments have onboard data storage that can only be fully downloaded via a direct connection following instrument recovery. When a DCL can only be powered once per hour (as on the Inshore moorings or the mooring MFNs), then instruments sampling once per hour will send 100% of their data. Instruments sampling every 15 minutes will send 25% of their data. Instruments such as the OPTAA (WET Labs AC-S) with large file sizes may only send one file per day, which is 4% of their total data. Instruments with onboard storage that either only send compressed files (CAMDS, ZPLSC-A), or can only be downloaded or processed after recovery (WAVSS, OSMOI, FLOBN, RASFL, PPSDN) will send <1% back to shore. Mobile assets like gliders need to minimize the amount of data sent via Iridium (for both power and surface time considerations), so they only send one data point per minute, even though the onboard computer is recording data at 1 Hz or 0.5 Hz, depending on the instrument. The glider ADCP files can only be downloaded after recovery, due to file size. **Note**: the percentage of a data set that is telemetered is only an indication of available data volume, not necessarily an indication of scientific utility. 1% of glider data is still one sample every minute from a full-depth profile, and one spectrophotometer file per day contains a large number of optical data samples.

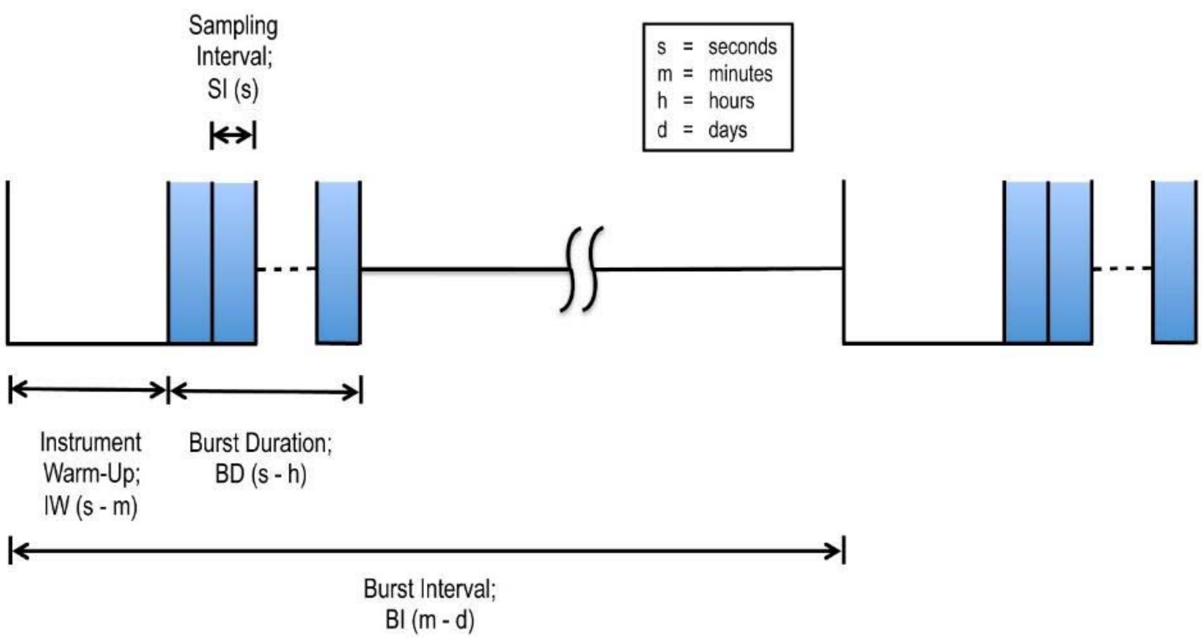

Figure 1. Operational sampling definitions.

In addition to the previous functional definitions of sampling, operational definitions describe the typical time sequence of how sensors are operated (Figure 1). Some sensors on fixed and mobile platforms will operate in continuous sampling mode, and some may conduct periodic sampling. Some acoustic instruments that sample periodically optimize measurements by collecting a high number of samples over a short period of time – commonly referred to as burst sampling.

After a sensor is turned on, a period of instrument warm-up follows (IW) and typically lasts from seconds to minutes. As soon as the instrument is warmed up and ready for sampling, observations are collected at a Sample Interval (SI) commonly on the order of seconds. The duration of this sampling is the Burst Duration (BD) - generally between seconds and hours. Finally, the interval between the start of each sampling sequence or Burst Interval (BI) can range anywhere from minutes to days. The case where BD=BI would imply continuous sampling at intervals SI. The parameters SI, BD and BI are typically selectable, although details of a given configuration depend upon the instrument capability, the platform, location of the platform, associated power draw and the science requirements.

3 Background

3.1 Supporting Documents

The Observation and Sampling Approach Document is a child document of the Data Management Plan (DMP), DCN 1102-0000 (Figure 2). The DMP prescribes how OOI system operations collect and deliver the required environmental observations specified within the Final Network Design (FND), DCN 1101-00000 and the Level 2 OOI Science Requirements.

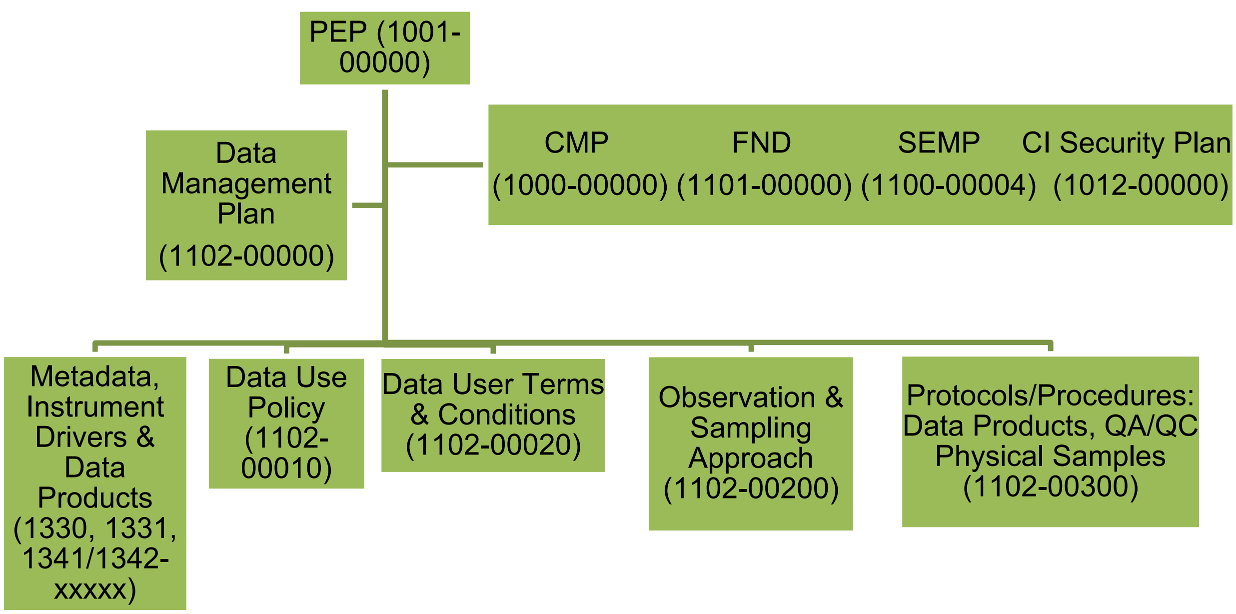

Figure 2. DMP documentation Tree

3.2 Science Drivers

The OOI Observation and Sampling Approach Document addresses the overarching science themes of the project and is derived from internal scientific expertise and input from the research community through workshops, conferences and publications. Guiding documents include proceedings from the many community meetings conducted over the past decade leading to the OOI Final Network Design (FND), the Level 2 OOI Science Requirements, and a few science workshops that have been conducted since the inception of the OOI Project. Examples are:

- Shelf/Slope Processes: *Science Opportunities and issues relating to the OOI Pioneer Array* (February, 2011),
- *Ocean Carbon and Biogeochemistry (OCB) Scoping Workshop on a Biogeochemical Flux Program Aligned with the Ocean Observatories Initiative* (May, 2011), and
- *Axial Seamount RSN Science Workshop* (September, 2011).

After science considerations, the sampling approaches and mobile platform operations developed for each system component were checked against available power, communications and data storage resources to verify that the prescribed operations could be accommodated for the duration of planned instrument/platform deployment. In some cases this verification exercise resulted in changes to sampling approaches.

Sampling strategy is a function of the collective knowledge about the environment in question and system capabilities. Because the purpose of the OOI is to facilitate basic oceanographic research, it is expected that as knowledge increases, ideas about sampling strategy will evolve. For example, sampling approaches could eventually be adopted that better observe anticipated short-term events, such as upwelling, the passage of eddies, phytoplankton bloom formation, methane gas release or submarine volcanic eruptions. Therefore, this sampling strategy is reviewed periodically by the OOI Program Office in consultation with the research community and the National Science Foundation.

3.3 Instruments and Platforms

The OOI core infrastructure includes 48 scientific instrument classes comprising approximately 761 individual instruments operating concurrently at sampling spatial scales ranging from centimeters to tens of kilometers at seven geographically distinct environments. The core infrastructure also includes a variety of engineering sensors, which are not included in this document. Sampling is organized by arrays of platforms containing instruments and infrastructure and junction boxes hosting cabled instruments. The arrays are:

- Pioneer Array, initially located along the northeast U.S. at the continental shelf-break, south and east of Cape Cod, Ma.
- Endurance Array, sampling a large section of the continental shelf, from coastal to offshore, along the coast of northern Oregon (Oregon Line) and southern Washington (Washington Line)
- Cabled Array, sampling both plate tectonic and associated biogeochemical processes at the ocean floor and water column phenomena in the North East Pacific within the central/southern half of the Juan de Fuca tectonic plate
- Global pelagic ocean arrays located in the North Atlantic south of Greenland in the Irminger Sea, the Southwest Atlantic in the Argentine Basin, the Northeast Pacific at Ocean Station PAPA, and the Southern Ocean off the southwest coast of Chile.

Many instruments are fixed in position- on the seafloor, at fixed depths within the water column or positioned above the ocean surface. Others are located on mobile platforms, such as winched and wire-following profilers (16 platforms), buoyancy-driven ocean gliders (32 platforms), and self-propelled autonomous underwater vehicles (2 platforms). The reader is referred to the Infrastructure Information page on the OOI website for detailed and current descriptions of instrument, platform, and array detail and associated components.

3.3.1 Cabled Instruments

All elements of the Cabled Array and portions of the Oregon Line within the Endurance Array are attached directly to high power (up to 8 kW) and optical communications cables (up to 10 Gb/s) installed on the seafloor and extending into the water column. They provide high power and data rate for the associated instruments and platforms (e.g. profilers and junction boxes). This enables nearly real-time data flow, two-way communication from shore, and offers maximum flexibility in how the instruments can be operated.

Platforms attached to the Cabled Array power/communications cables include both fixed-depth moored platforms and moored profilers. The system includes two different mooring types: 1) a 2-legged Shallow Profiler mooring with a fixed instrumented platform at 200 m and hosting an instrumented winched shallow profiler; and 2) a single cable Deep Profiler Mooring hosting an instrumented wire-following McLane profiler package. Both winched and wire-following profilers utilize the cabled infrastructure for power and communications, but the deep wire-following profilers are powered with onboard batteries that are recharged via the cable after docking. This capability potentially allows the wire-following profilers to perform more frequent vertical profiles over the lifetime of a deployment than their counterparts on uncabled moorings. Actual capabilities will be determined during the initial operation period.

3.3.2 Self-Powered, Moored Instruments

Instruments attached to self-powered moorings rely on a combination of battery power and local wind and solar power generation. These include all of the Pioneer and Global surface moorings, all of the surface moorings associated with the Washington Line of the Endurance Array, and surface moorings associated with the Oregon Endurance Line. Available power is, therefore, limited compared to cabled instruments and, in the case of wind and solar power generation, a function of local environmental conditions. Likewise, communication capability and data rate are more limited compared with the cabled instruments. In some cases, the majority of data are stored in situ and retrieved post mooring recovery while a subset of the collected data is transmitted to shore via satellite communications. Thus, some of these data are received with latencies of between several months and one year.

3.3.3 Moored Profilers

Moored, profiling platforms are designed to provide information about vertical structure throughout the water column. There are three types of moored profilers: 1) wire-following that operate within prescribed depth ranges from tens of meters above the sea floor to tens of meters below the sea surface, 2) winched, surface piercing profilers that operate within the upper 100 meters (m) of the ocean and are able to provide observations up to the ocean surface, and 3) winched profilers that rise from a platform at 200 m to within ~5 m beneath the surface (or three times the wave peak to peak height).

Profiler type, water column depth, and site-specific infrastructure design governs the sampling limitations and opportunities afforded in the deployment regions and across the observatory. Detailed infrastructure design drawings can be viewed in the Technical Data Packages and profiler–specific sampling information for all arrays are provided in these tables.

All uncabled moored, profiling platforms are self-powered using internal batteries. With the exception of the profilers attached to the power/communications cable, the battery charge at deployment is designed to power the platform and the associated instruments for the duration of the deployment. CGSN profiling instruments are only powered during profiling operations. Therefore, the primary power constraint impacts uncabled profiling frequency. Profilers attached to the power/communications cable are rechargeable and less limited by power or data transmission concerns, offering the potential for more complex mission plans than uncabled profilers. However, profiling frequency of cabled profilers will be managed to optimize mission execution while balancing lifecycle hardware wear and tear.

Winched profiling speeds are programmable and typically range between 0.1 and 1 m s-1. Wire-following profiler speeds are fixed at ~25 cm s-1. In general, shorter profiles enable higher profiling frequencies. Surface-piercing winched profilers traverse between the surface and 25 - 100 m depth. Cabled winched profilers do not pierce the surface. Given a profiler speed of 1 m s-1, maximum profiling frequencies are on the order of 10 per day. Uncabled, deep, wire-following profilers, on the other hand, must traverse from 100 m up to thousands of meters per profile, limiting the maximum profile frequency to < 10 per day. Cabled deep, wire-following profilers will initially be limited to profiling for a total of 9 days per month due to wear and tear; but increased operation periods may lengthen as operation experience is gained.

Cabled shallow profilers will profile at 10 or 5 cm s-1 speeds and with 1 Hz instrument sampling, resulting in less than one meter spatial resolutions. Both CGSN main profiling operations (i.e., “as-deployed” and “baseline”) are designed to provide a vertical spatial resolution of one meter, however instrument sampling rates can be adjusted to provide finer vertical resolution as an adaptive strategy. A cabled profiler can be instructed to loiter for a period of time at a user-prescribed depth, functioning as a temporary fixed mooring, but this is not possible on uncabled profilers at this time. During time between profiling operations, profilers may be situated at the deepest part of their capability in order to limit exposure to light and associated bio-fouling effects.

3.3.4 Autonomous Underwater Vehicles (AUV)

Propeller-driven, battery-powered AUVs are optimized for long life at slow speeds, generally between 1-2 m s^{-1}. OOI AUVs will carry a broad suite of sensors for interdisciplinary observations. They surface to obtain position information using GPS. AUVs can run continuous missions with durations up to two days between battery charges and can be programmed and re-tasked while in the field to perform a broad scope of adaptive sampling missions. AUVs operate at the Pioneer Array in “campaign mode” – deployed and recovered from a ship for each mission. Sampling rate for onboard sensors is configured to provide the capability for spatial resolution of one meter.

3.3.5 Underwater Gliders

Buoyancy-driven underwater gliders are battery powered and can be programmed and re-tasked in the field to perform a variety of sampling missions. Since they require vertical excursions to provide horizontal thrust (they glide down or up depending on buoyancy), they provide both horizontal and vertical descriptions of ocean properties between the surface and a maximum depth of 1000 m. Gliders achieve speeds of about one tenth of the AUVs (0.25 to 0.35 m s^{-1}) and, since they consume little power, can be deployed for several months. At the surface, gliders acquire position information using GPS, transmit data and receive commands via satellite. Gliders are deployed as part of the Pioneer, Endurance and Global arrays. As in the case of AUVs, sampling rates for onboard sensors are defined to provide the capability for one meter spatial resolution. The “as-deployed” sampling protocol is to operate all science instruments at their maximum possible sampling rates during profiling. The volume of transmitted data and the sampling rate is adjusted for optimum balance between data collection and battery life.

3.4 Platform Service Intervals

Platform service intervals are crucial in setting instrument sampling rates for nearly all OOI instruments. The exceptions are those instruments connected to cabled platforms that are not limited by battery life, or internal memory. For all other instruments, the sampling rates that can be achieved are directly tied to the service interval because the factor(s) limiting sampling are power, internal memory, and/or consumables.

3.4.1 Pioneer Array

Surface moorings will be entirely replaced at 6 month intervals, with refurbishment of all components during the 6 months between mooring deployments. Wire-following profiler moorings will be refurbished at 6 month intervals, with at-sea evaluation of anchors, chain, releases, wire, stretch hoses and EM chains for potential re-use. Refurbishment of returned components will take place during the 6 months between deployments. Gliders are scheduled for recovery after ~90 days at sea and new gliders deployed at the same time, with refurbishment during the 90 days between glider deployments. AUVs are scheduled to be deployed during ship operations every 1-2 months. Refurbishment will be performed on a 500 hour usage schedule (approximately once a year).

3.4.2 Endurance Array

Cabled infrastructure will be recovered and replaced at 12 month intervals, with refurbishment of all recoverable components during the year between cabled deployments. Surface moorings (inshore, shelf, and offshore) will be entirely replaced at 6 month intervals, with refurbishment of all components during the 6 months between mooring deployments. Wire-following profiler moorings will also be refurbished at 6 month intervals, with at-sea evaluation of anchors, chain, releases, wire, stretch hoses and EM chains for potential re-use. Refurbishment of returned components will take place during the 6 months between deployments. Coastal winched surface-piercing profiler moorings will be entirely replaced at 6 month intervals, plus undergo a partial service at 90 days. Partial service consists of at-sea replacement or re-charging of batteries and replacement of the winch line. Coastal winched surface-piercing profilers will be refurbished during the 6 months between deployments. Gliders are scheduled for recovery after ~90 days at sea and new gliders deployed at the same time, with refurbishment during the 90 days between glider deployments.

3.4.3 Cabled Array

Cabled instruments at Axial Seamount, Axial Base, Hydrate Ridge Summit, and Slope Base will be recovered and replaced at 12 month intervals, with refurbishment of all recoverable components during the year between cabled infrastructure O&M cruises.

3.4.4 Global Arrays

Surface moorings, subsurface moorings, and global gliders will be entirely replaced at 12 month intervals. Refurbishment of returned components will take place during the year between deployments. Gliders will be recovered after 12 months at sea and new gliders deployed at the same time, with refurbishment during the 12 months between glider deployments.

4 "Baseline" and "As-deployed" Sampling by Array

The observation strategy addresses the temporal and spatial scales of variability that characterize the local environment for each instrument. Whereas sampling rate determines temporal resolution for fixed instruments; sampling rate combined with platform speed and direction for instruments located on mobile platforms determines the temporal and spatial resolution of observations. Additionally, how mobile platforms are operated determines where (latitude, longitude, and depth) and when observations are made, thus, the sampling strategy attempts to optimize platform mobility as well as instrument operation.

4.1 Pioneer Array

The Pioneer Array is a multi-platform configuration deployed and operated at a targeted location for several years for studies of specific processes and then relocated to and reconfigured for another study site. The initial location is along the northeast U.S., at the outer continental shelf and shelf-break, south of Martha's Vineyard, Ma. (40° N, 70.75° W; water depth: 90 - 500 meters). The location was chosen to focus on shelf break exchange processes without further complicating factors such as Gulf Stream proximity, estuarine outflows, complex bathymetry, or strong tides. The sampling strategy is tailored specifically for this location and will be revisited with each change in array location.

4.1.1 Array Structure

The initial Pioneer Array configuration consists of three separate elements: an array of mooring locations that spans the outer shelf and upper slope, a fleet of up to six gliders and a pair of AUVs (Figure 3).

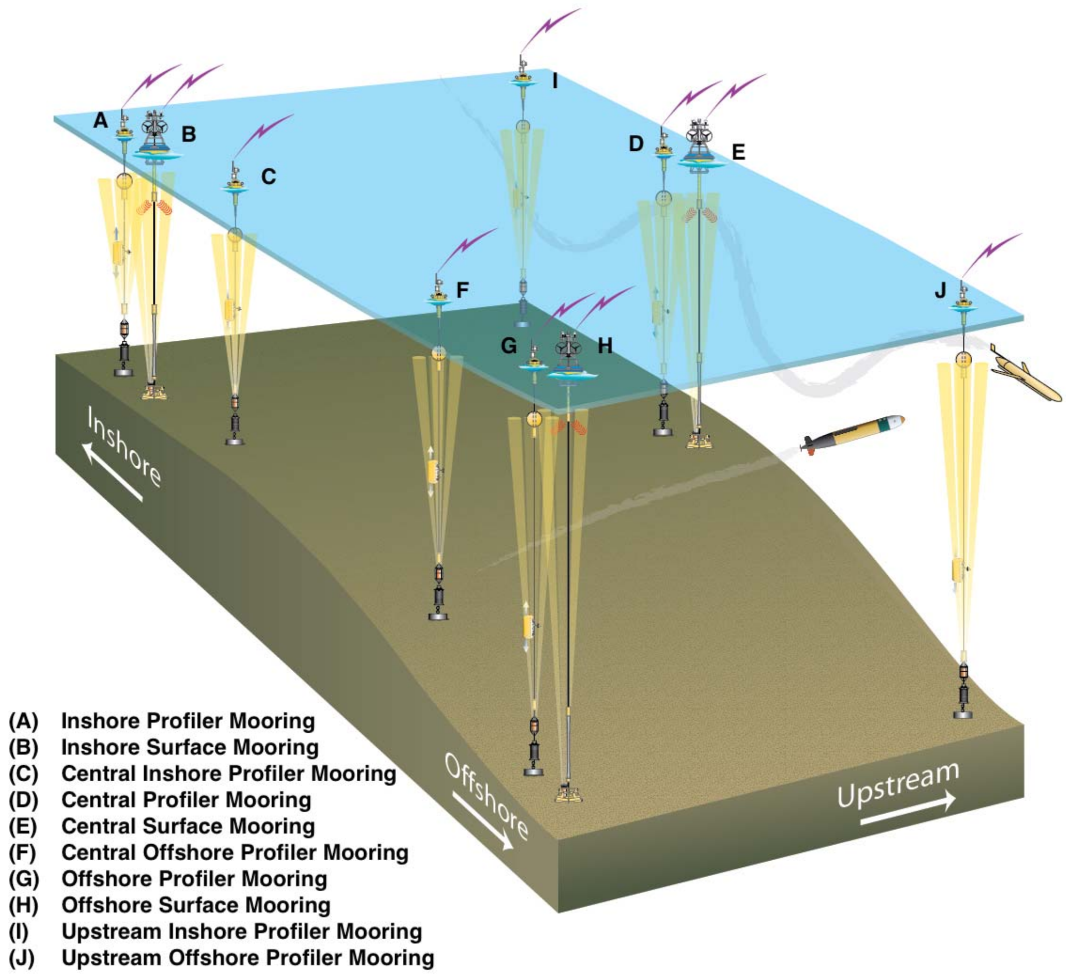

Figure 3. Schematic diagram of the Pioneer Array, showing three surface moorings with multi-function nodes at the mooring base; seven wire-following profilers; and gliders and AUVs.

Ten instrumented moorings are positioned at seven primary sites. The inshore, central and offshore sites contain both a surface mooring and a profiler mooring. The three middle sites (central-inshore, central, and central-offshore), form a triangle which includes the central mooring with extensive meteorological instruments on the surface buoy, and are located near the expected mean position of the shelf-break frontal jet.

A core component of the Pioneer Array consists of mobile assets that sample the three-dimensional, shelf break and slope environment over an extended period of time. Gliders may be deployed for long durations, sample to 1000 m and can be operated as a coordinated, multi-platform fleet. These mobile assets provide both regularly structured sampling, such as repeat lines or patterns, as well as adaptive sampling modes designed to resolve transient features (e.g., the evolving structure of a passing warm core eddy.) The gliders operate within a large area centered on moored components of the array (Figure 4).

AUVs add dynamic sampling capability to the Pioneer Array. These powered vehicles are able to follow mission tracks through strong currents while carrying larger instrument payloads. The current design employs two AUVs operating from ships 6-12 times a year.

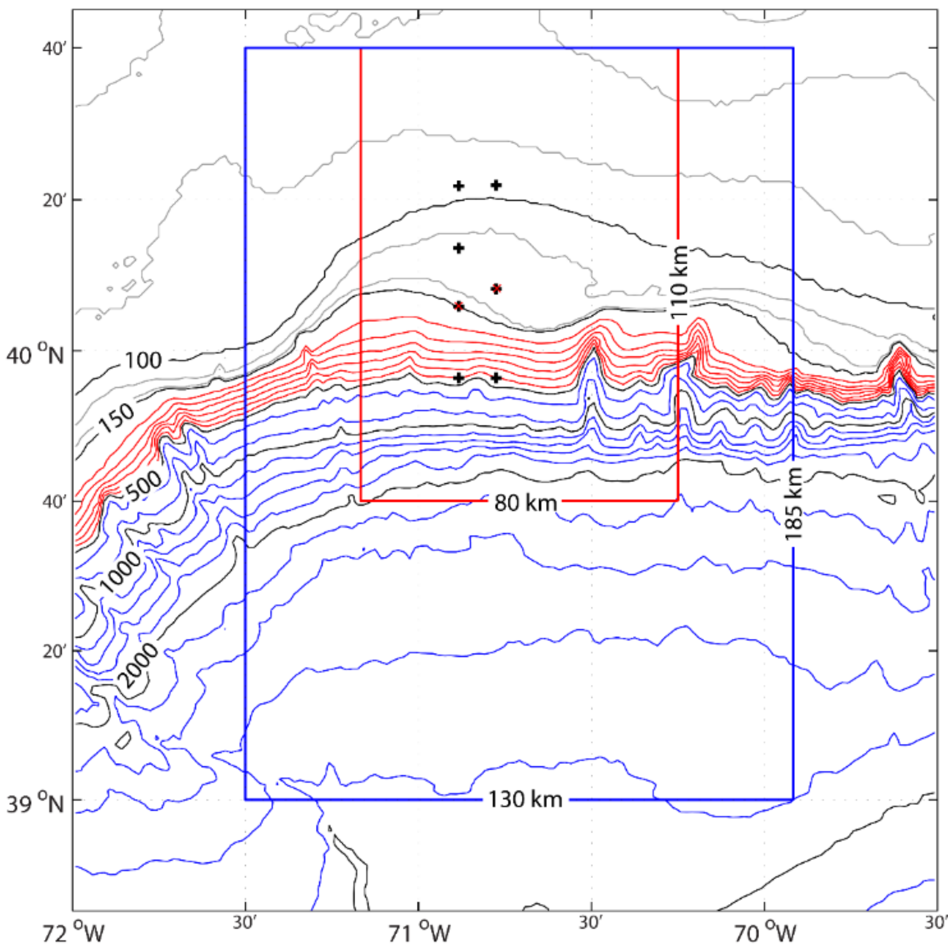

Figure 4. Pioneer Array configuration. Site centers are shown (plus signs). The AUV operations box is in red and the Glider operations box is in blue. Selected contours are labeled in meters.

4.1.2 Instrument Operation

A list of all Pioneer Array sensors, their location, and exemplar "baseline" and "as-deployed" sampling rates are shown in Table 1. The "as-deployed" sampling for all fixed instruments reflects the maximum sustainable rate possible for the duration of each instrument deployment and is a function of instrument capability and available power. "Baseline" observations must be capable of resolving synoptic forcing events and multiple tidal constituents as well as long-term variability and thus require sampling intervals of one to three hours. BI = Burst Interval; BD = Burst Duration; SI = Sampling Interval.

Table 5. Pioneer Array "as-deployed" & "baseline" Sampling (s = second; min = minute; h = hour; d = day)										
Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Inshore Surface Mooring – CP03ISSM										
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	Includes sea surface temperature and conductivity measurements
PCO2A	Surface Buoy	In Air	3 h	36 s	2 s	1 h	48 s	2 s	100	Alternating air and water measurements
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	2 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
SPKIR	NSIF	7	1 h	3 min	2 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
PHSEN	NSIF	7	3 h	3 min	1.5 s	1 h	3 min	1.5 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	1 h	17 s	1.5 s	100	6 light, 1 dark sample
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
CTDBP	MFN	91.5	1 h	3 min	10 s	15 min	2.7 s	2.7 s	25	
DOSTA	MFN	91.5	1 h	3 min	5 s	1 h	3 min	2 s	100	
VELPT	MFN	91.5	1 h	3 min	1 s	15 min	3 min	1 s	25	
PCO2W	MFN	91.5	3 h	5 min	6 s	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), equilibrate for 5 min process sample
PHSEN	MFN	91.5	3 h	3 min	1.5 s	1 h	3 min	3 min	100	Begins sample collection immediately; 3 minutes to equilibrate and process
OPTAA	MFN	91.5	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
ADCPT	MFN	91.5	1 h	3 min	1 s	30 min	3 min	2 s	50	
PRESF	MFN	91.5	1 h	1 h	1 s	1 h	1 h	1 s	100	
ZPLSC	MFN	91.5	1 h	6 m	2 s	15 m	3 m	3 s	20	Internal battery and data storage, downloaded post-recovery; 60 pings

Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Central Surface Mooring – CP01CNSM										
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	2 METBK systems Includes sea surface temperature and conductivity measurements
FDCHP	Surface Buoy	In Air	3 h	20 min	0.1 s	1 h	20 min	0.1 s	100	Processed science data sent via telemetry. Raw science/engineering data downloaded post-recovery.
WAVSS	Surface Buoy	In Air	3 h	20 min	0.25 s	1 h	20 min	0.25 s	100	Processed science data sent via telemetry. Raw science/engineering data downloaded post-recovery.
PCO2A	Surface Buoy	In Air	3 h	36 s	2 s	1 h	48 s	2 s	100	Alternating air and water measurements
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	2 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
SPKIR	NSIF	7	1 h	3 min	2 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
PHSEN	NSIF	7	3 h	3 min	1.5 s	1 h	3 min	1.5 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	1 h	17 s	1.5 s	100	6 light, 1 dark sample
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
CTDBP	MFN	133	1 h	3 min	10 s	15 min	2.7 s	2.7 s	25	
DOSTA	MFN	133	1 h	3 min	5 s	1 h	3 min	2 s	100	
VELPT	MFN	133	1 h	3 min	1 s	15 min	3 min	1 s	25	
PCO2W	MFN	133	3 h	5 min	6 s	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample
PHSEN	MFN	133	3 h	3 min	1.5 s	1 h	3 min	3 min	100	Begins sample collection immediately; 3 minutes to equilibrate and process
OPTAA	MFN	133	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
ADCPT	MFN	133	1 h	3 min	1 s	30 min	3 min	2 s	25	
PRESF	MFN	133	1 h	1 h	1 s	1 h	1 h	1 s	100	
ZPLSC	MFN	133	1 h	6 m	2 s	15 m	3 m	3 s	20	Sonar has internal battery and data storage, downloaded post-recovery

Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Offshore Surface Mooring – CP04OSSM										
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	Includes sea surface temperature and conductivity measurements
PCO2A	Surface Buoy	In Air	3 h	36 s	2 s	1 h	48 s	2 s	100	Alternating air and water measurements
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	2 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
SPKIR	NSIF	7	1 h	3 min	2 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
PHSEN	NSIF	7	3 h	3 min	1.5 s	1 h	3 min	1.5 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	1 h	17 s	1.5 s	100	6 light, 1 dark sample
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
CTDBP	MFN	450	1 h	3 min	10 s	15 min	2.7	2.7 s	25	
DOSTA	MFN	450	1 h	3 min	5 s	1 h	3 min	2 s	100	
VELPT	MFN	450	1 h	3 min	1 s	15 min	3 min	1 s	25	
PCO2W	MFN	450	3 h	5 min	6 s	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample
PHSEN	MFN	450	3 h	3 min	1.5 s	1 h	3 min	3 min	100	Begins sample collection immediately; 3 minutes to equilibrate and process
OPTAA	MFN	450	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	
ADCPS	MFN	450	1 h	3 min	1 s	30 min	3 min	2.5 s	25	
PRESF	MFN	450	1 h	1 h	1 s	1 h	1 h	1 s	100	
ZPLSC	MFN	450	1 h	6 m	2 s	15 m	5 m	5 s	20	Sonar has internal battery and data storage, downloaded post-recovery

Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Upstream Inshore Wire-Following Profiler Mooring, & Pioneer Inshore Wire-Following Profiler Mooring (Winter only) – CP02PMUI & CP03ISPM										
ADCPT	Frame	71	3 h	3 min	1.5 s	30 min	3 min	2 s	25	Set to PD12 mode for telemetry, PD0 recorded internally and downloaded post-recovery
CTDPF	Profiler	23-71	6 h	5 min	1 s	3 h	5 min	1 s	100	
DOFST	Profiler	23-71	6 h	5 min	1 s	3 h	5 min	1 s	100	
FLORT	Profiler	23-71	6 h	5 min	4 s	3 h	5 min	4 s	100	
PARAD	Profiler	23-71	6 h	5 min	4 s	3 h	5 min	4 s	100	
VEL3D	Profiler	23-71	6 h	5 min	0.5 s	3 h	5 min	0.5 s	65	Decimated by column, not temporally.
Pioneer Central Wire-Following Profiler Moorings (Winter only) – CP01CNPM										
ADCPT	Frame	115	3 h	3 min	1.5 s	30 min	3 min	2 s	25	See ADCPT note above.
CTDPF	Profiler	23-115	6 h	8 min	1 s	3 h	8 min	1 s	100	
DOFST	Profiler	23-115	6 h	8 min	1 s	3 h	8 min	1 s	100	
FLORT	Profiler	23-115	6 h	8 min	4 s	3 h	8 min	4 s	100	
PARAD	Profiler	23-115	6 h	8 min	4 s	3 h	8 min	4 s	100	
VEL3D	Profiler	23-115	6 h	8 min	0.5 s	3 h	8 min	0.5 s	65	Decimated by column, not temporally.
Pioneer Central Inshore Wire-Following Profiler Moorings – CP02PMCI										
ADCPT	Frame	105	3 h	3 min	1.5 s	30 min	3 min	2 s	25	See ADCPT note above.
CTDPF	Profiler	23-105	6 h	8 min	1 s	3 h	8 min	1 s	100	
DOFST	Profiler	23-105	6 h	8 min	1 s	3 h	8 min	1 s	100	
FLORT	Profiler	23-105	6 h	8 min	4 s	3 h	8 min	4 s	100	
PARAD	Profiler	23-105	6 h	8 min	4 s	3 h	8 min	4 s	100	
VEL3D	Profiler	23-105	6 h	8 min	0.5 s	3 h	8 min	0.5 s	65	Decimated by column, not temporally.

Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Central Offshore Wire-Following Profiler Moorings – CP02PMCO										
ADCPT	Frame	127	3 h	3 min	1.5 s	30 min	3 min	2 s	25	See ADCPT note above.
CTDPF	Profiler	23-127	6 h	10 min	1 s	3 h	10 min	1 s	100	
DOFST	Profiler	23-127	6 h	10 min	1 s	3 h	10 min	1 s	100	
FLORT	Profiler	23-127	6 h	10 min	4 s	3 h	10 min	4 s	100	
PARAD	Profiler	23-127	6 h	10 min	4 s	3 h	10 min	4 s	100	
VEL3D	Profiler	23-127	6 h	10 min	0.5 s	3 h	10 min	0.5 s	65	Decimated by column, not temporally.
Pioneer Offshore Wire-Following Profiler Mooring (Pattern Profiling: 415/200/200/415 m sequence) – CP04OSPM										
ADCPS	Frame	415	3 h	3 min	2.2 s	1 h	3 min	2.5 s	25	Set to PD12 mode for telemetry, PD0 recorded internally and downloaded post-recovery
CTDPF	Profiler	23-415	6 h	20/40 min	1 s	3 h	19/40 min	1 s	100	
DOFST	Profiler	23-415	6 h	20/40 min	1 s	3 h	19/40 min	1 s	100	
FLORT	Profiler	23-415	6 h	20/40 min	4 s	3 h	19/40 min	4 s	100	
PARAD	Profiler	23-415	6 h	20/40 min	4 s	3 h	19/40 min	4 s	100	
VEL3D	Profiler	23-415	6 h	20/40 min	0.5 s	3 h	19/40 min	0.5 s	65	Decimated by column, not temporally.
Pioneer Upstream Offshore Wire-Following Profiler Mooring (Pattern Profiling: 427/200/200/427 m sequence) – CP02PMUO										
ADCPS	Frame	427	3 h	3 min	2.2 s	1 h	3 min	2.5 s	25	See ADCPS note above.
CTDPF	Profiler	23-427	6 h	20/40 min	1 s	3 h	19/40 min	1 s	100	
DOFST	Profiler	23-427	6 h	20/40 min	1 s	3 h	19/40 min	1 s	100	
FLORT	Profiler	23-427	6 h	20/40 min	4 s	3 h	19/40 min	4 s	100	
PARAD	Profiler	23-427	6 h	20/40 min	4 s	3 h	19/40 min	4 s	100	
VEL3D	Profiler	23-427	6 h	20/40 min	0.5 s	3 h	19/40 min	0.5 s	65	Decimated by column, not temporally.

Instrument	Platform	Depth (m)	"baseline"			"as-deployed"			% Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Pioneer Coastal Gliders (6 Platforms) – CP05MOAS-GL										Gliders configured with either 200 m buoyancy engine, or 1000 m buoyancy engine
ADCPA	Hull	200 / 1000	1 of 4 profiles, dive only	N/A	2 s	1 of 4 profiles, dive only	N/A	2 s	0	Samples on dive only. Data stored internally, downloaded post-recovery.
CTDGV	Hull	200 / 1000	Dive only	N/A	2 s	Dive only	N/A	2 s	4	Samples on dive only. Data decimated temporally and by column
DOSTA	Hull	200 / 1000	Dive only	N/A	2 s	Dive only	N/A	2 s	4	
FLORT	Hull	200 / 1000	Dive only	N/A	1 s	Dive only	N/A	1 s	2	
PARAD	Hull	200 / 1000	Dive only, upper 200 m	N/A	1 s	Dive only, upper 200 m	N/A	1 s	2	
Pioneer AUVs (2 Platforms) – CP05MOAS-AV										
ADCPA	Hull	600	Continuous	N/A	1 s	Continuous	N/A	1 s	N/A	Operated from ship during deployment cruises
CTDAV	Hull	600	Continuous	N/A	1 s	Continuous	N/A	1 s	N/A	
DOSTA	Hull	600	Continuous	N/A	1 s	Continuous	N/A	1 s	N/A	
FLORT	Hull	600	Continuous	N/A	1 s	Continuous	N/A	1 s	N/A	
NUTNR	Hull	600	TBD	TBD	1.5 s	TBD	TBD	1.5 s	N/A	
PARAD	Hull	600	Upper 200 m	N/A	1 s	Upper 200 m	N/A	1 s	N/A	

4.1.3 Coastal Surface Moorings

Three coastal surface moorings are found in the Pioneer Array. They are located along near the inshore and offshore margins of the southwestern installation line; and at the mid-shelf region of the northeastern installation line. Surface moorings have instrumentation located in-air, on the submerged buoy base, on near-surface-instrument-frames (NSIF), and at multi-function nodes (MFN).

If power becomes limited due to environmental conditions or failure of power components, sampling is reduced using the following prioritization guidelines:

1) Reduce the duty cycle of the MFN and disable high-power instruments.
2) Power down the MFN – most instruments on the MFN (except for DOSTA and OPTAA) have internal batteries and self-log data.
3) Reduce duty cycle of the NSIF and disable high-power instruments.
4) Power down the NSIF.
5) Reduce the duty cycle of the buoy.
6) Power down all buoy instrumentation, except for METBK.
7) Power down the buoy except for minimal status via telemetry.

4.1.4 Profiling Moorings

Wire following profilers are capable of four profiles per day (6 h intervals between one-way profiles) at the deepest sites. This is the “baseline” rate which can be achieved throughout the array. For “as-deployed” sampling the profile interval can be reduced to 3 h. The 3 h “as-deployed” sampling interval for the Offshore and Upstream Offshore sites is achieved by a profiling sequence which does not include full depth excursions for each profile. The 3 h "as-deployed" sampling interval at the sites shallower than 200 m consist of full round-trip profiles every 3 hours.

If power becomes limited, telemetry may be reduced and engineering sensors, such as the motion pack may be powered down. The ADCP and WFP are self-powered and self-logging. If the WFP is stuck at a fixed depth (rather than profiling), the sampling schedule may be altered to better capture a time series of data at a fixed depth.

4.1.5 Mobile Platform Operation

4.1.5.1 Gliders

The “baseline” sampling for gliders comprises four lines, each occupied with one glider: Eastern Boundary (EB), Frontal Zone (FZ), Slope Sea 1 (SS-1) and Slope Sea 2 (SS-2). The tracks are lines are show in Figure 5. The EB line is ~200 km and can be completed in 8 days assuming 25 km/day. The line is largely in waters less than 250 m depth and would be tasked to a glider with 200-m engine. The FZ line is ~190 km long, allowing completion in 8 days. The line is largely in waters between 200 m and 1000 m depth and would be tasked to a glider with 1000-m engine. The SS-1 line is ~400 km long, allowing completion in 16 days. The line is entirely in waters greater than 1000 m deep and would be tasked to a glider with a 1000-m engine. The SS-2 line is ~300 km allowing completion in 12 days. The line is entirely in depths greater than 1000 m depth and would be tasked to a glider with 1000-m engine.

The "as-deployed" sampling for gliders dedicates a second glider to the FZ line (FZ-2) and adds the Gulf Stream line (GS). The FZ-2 line will be occupied by a second glider but using a 200-m engine. Operating in tandem with the "baseline" glider the repeat interval for the FZ line is reduced to four days. The GS line is ~200 km long allowing completion in eight days. The line is almost entirely in depths greater than 1000 m depth and would be tasked to a glider with 1000-m engine. The sampling strategy and science rationale for individual lines in each region are described in more detail below.

Table 3. Pioneer glider lines.

Name	Region	Priority	Buoyancy Engine	Track Length	Time to Complete
EB	Eastern Boundary	Baseline	200 m	200 km	8 days
FZ-1	Frontal Zone	Baseline	1000 m	190 km	8 days
SS-1	Slope Sea	Baseline	1000 m	400 km	16 days
SS-2	Slope Sea	Baseline	1000 m	300 km	12 days
FZ-2	Frontal Zone	As-deployed	200 m	190 km	8 days
GS	Slope Sea	As-deployed	1000 m	200 km	8 days

Eastern Boundary: The EB line is approximately 200 km long and can be completed in about 8 days assuming an average along-track speed of 25 km/day. The line is largely in waters less than 250 m depth and would be tasked to one glider with 200 m buoyancy engine. This is a baseline line. The western limit of the track avoids a canyon at the shelf edge that is an area of intense fishing activity. The line does cross a region of intense trawl activity around the 100-m isobath, but this is unavoidable. The 8-day repeat captures the ocean state upstream of the moored array, and will provide information on oceanic conditions that are swept into the array center by the prevailing westward flow on the MAB shelf. Velocity estimates in conjunction with tracers provides a direct estimate of the westward flux of tracers into the Pioneer control volume. Bottom-tracked velocity places a strong constraint on the barotropic component of along-shelf flow that is presently uncertain. The EB line includes parallel across-shelf segments between the 200 m and 1000 m isobaths, separated by approximately 20 km. These complement a third parallel segment on the FZ line 20 km to the west; these 3 transects are designed to sample variability in the location of the shelf-break front. Data from the EB line will assist data-assimilative modeling of conditions at the core of the array.

Frontal Zone: The FZ line is approximately 190 km long, allowing completion in about 8 days. The line is largely in waters between 200 m and 1000 m depth and would be tasked to one glider with a 1000-m engine and one with a 200 m engine. The first FZ glider is part of the Baseline sampling, while the second is As-deployed. This is a region of strong across-shelf gradients and the strongest along-shelf currents within the Pioneer Array. The current is surface intensified, so the line would be traversed counter-clockwise to enable the glider to make reasonable upstream (eastward) progress while largely below the current along the 1000-m deep offshore leg. The inshore leg roughly follows the 200-m isobath, and is thus expected to make excursions across the front. Velocity estimates in conjunction with tracers will provide a direct estimate of the across-shelf fluxes of tracers at the 200-m and 1000-m isobaths. Bottom-tracked velocity on the shallow legs assists with capturing processes in surface and bottom boundary layers.

The second FZ glider would be piloted along the FZ line with the goal of maintaining a distance of approximately half of the line between the two gliders. The purpose of operating two FZ gliders in tandem is to cut the cycle time around the line in half, which appropriately resolves frontal waves that we know have about a 4 day period. The use of a 200 m engine for the second FZ glider provides a backup for the EB line should that glider be unable to fulfill the baseline role – the second FZ glider could be re-tasked to EB.

Slope Sea: There are two Baseline SS lines. The SS-1 line is 400 km long, allowing completion in 16 days. The line is entirely in waters greater than 1000 m deep and would be tasked to a glider with 1000-m engine. This is a Baseline line. The eastern across-shelf leg of the SS-1 line extends the EB line into the Slope Sea, and could in principle be synchronized with every second EB mission to create an extended, synoptic cross-shelf section. The 16-day repeat is sufficient to capture mesoscale variability in the Slope Sea that impinges upon the shelf-break. The offshore extent of operations is chosen to make interactions with the Gulf Stream infrequent, but should a warm core ring enter this region this line will complement adaptive sampling directed toward observing eddy/shelf interaction processes. Direct velocity observations in conjunction with geostrophic currents based on hydrography will provide information on ageostrophic dynamics of the ocean mesoscale. The zigzag line achieves a balance between crossing gradients that are predominantly orthogonal to the shelf-break, while making reasonable progress eastward and westward to complete a circuit.

One glider cannot simultaneously resolve the necessary temporal and spatial scales in the Slope Sea. The SS-2 line interlaces with SS-1 to produce a grid of orthogonal transects approximately 20 km square, significantly increasing the spatial resolution of the Slope Sea mesoscale. The SS-2 line is 300 km allowing completion in 12 days. The line is entirely in depths greater than 1000 m depth and would be tasked to a glider with 1000-m engine. This is a Baseline line. We expect the time evolution to be coherent on the 12 to 16-day repeat interval of the gliders, but flow-topography interaction adjacent to the shelf-break renders the mesoscale anisotropic here so the interlaced pattern is designed to emphasize disparate length scales without sacrificing temporal resolution. The SS-2 glider may also serve as a backup if the SS-1 glider is unable to fulfill the higher-priority SS-1 mission. Since the SS-2 line is always within about 20 km of the SS-1 line, this transition is readily achieved.

The Slope Sea Gulf Stream (GS) line is 200 km long, allowing completion in 8 days. The line is almost entirely in depths greater than 1000 m depth and would be tasked to a glider with 1000-m engine. This is an As-deployed line. This line is an extension of the proposed AUV cross-shelf line (not described here). The GS line extends almost to the southern limit of the glider operations area, towards the north wall of the Gulf Stream, to sample the source of the water masses that ultimately circulate toward the shelf-break as a result of mesoscale processes within the Slope Sea. The east-west line separation echoes the approximate 15 to 20 km separation that resolves the submesoscale in the deep waters of the Slope Sea. The northern limit of the line is the 500-m isobath to capture the short across-shelf length scales where the Slope Sea impinges on the shelf-break, and where vertical transport can be significant in flow that converges toward and enters the shelf-break front itself. Because this line has some redundancy with SS-1 and SS-2, and recognizing that the benefits of operating this line must be weighed against the navigation risk introduced by approaching the Gulf Stream, this is considered the lowest priority of the six glider lines.

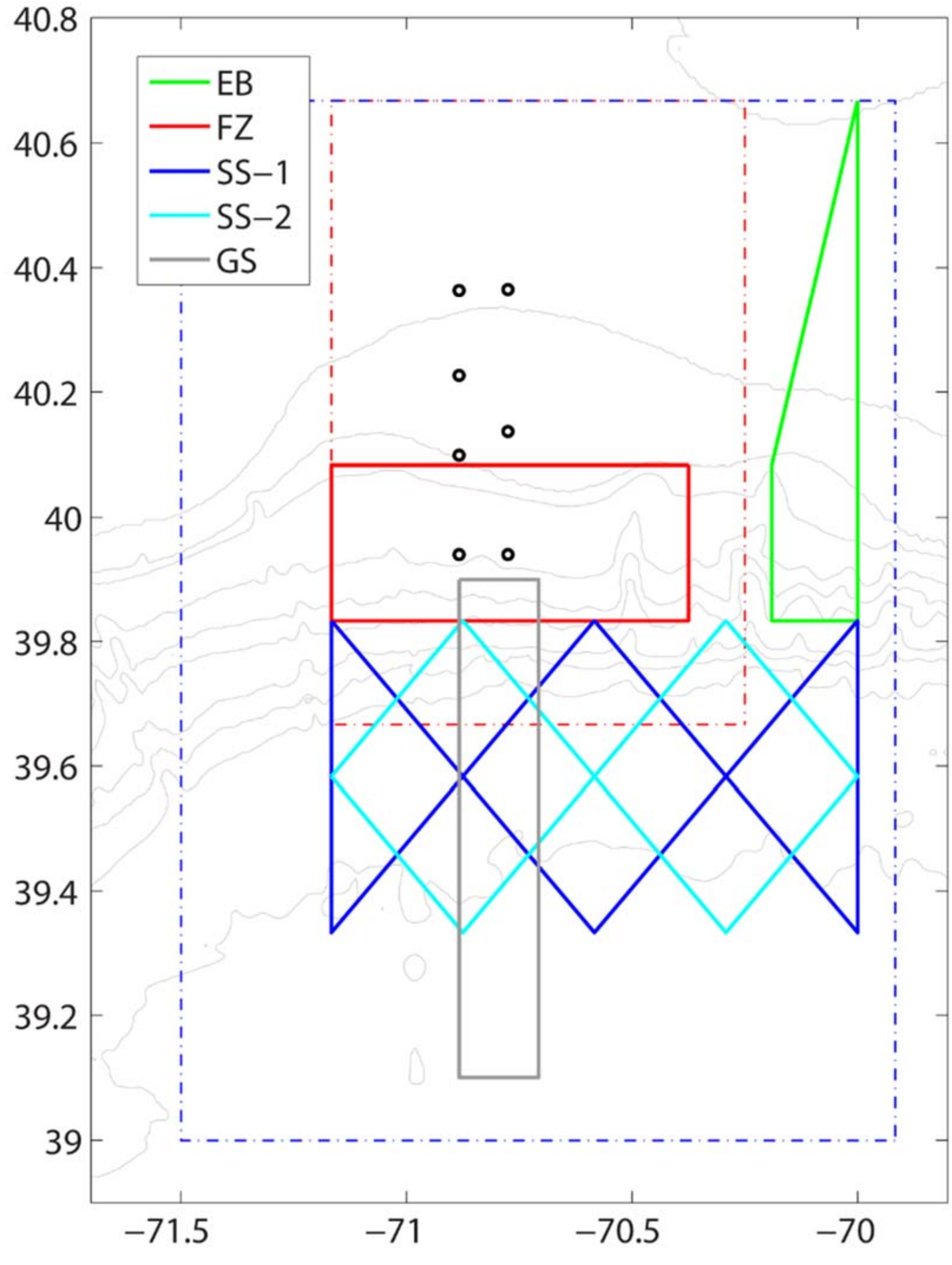

Figure 5. Pioneer glider line lines. The EB (green), FZ (red), SS-1 (blue), SS-2 (cyan) and SG (gray) lines are shown along with the Pioneer Array moorings (circles) and the glider and AUV operating areas (dashed lines).

For use in the Pioneer Array, the coastal gliders will carry a multi-disciplinary sensor payload (Table 4), including bio-optical sensors with copper faceplates to mitigate biofouling. The As-deployed sampling strategy will be to operate all science instruments at their maximum sustainable sampling frequency during profiling, but this strategy will be continually evaluated for the optimum balance between data collection and battery life. The gliders will routinely dive to within several meters of the sea floor or 1000 m depth, whichever is greater, and return to within several meters of the sea surface. Multiple profiles may be executed before surfacing for a location fix and data telemetry, and the discretion of the glider pilot. As described below, while sensor sampling frequency are expected to be fixed, not all sensors will operate for all portions of all profiles.

On a Coastal Slocum Glider (CSG), changing an instrument's sampling frequency does not result in a change in power consumption. However, reducing the profiling resolution (i.e. sampling only on dives) and reducing the sampling depth range (i.e. sampling only the first 200 m of a 1000 m profile) will reduce power consumption. The science instruments on a CSG (Table 3) are a Sea-Bird conductivity, temperature, and depth (CTD) instrument; a WET Labs Environmental Characterization Optics (ECO) triplet, which measures chlorophyll, colored dissolved organic matter (CDOM), and optical backscatter; a Biospherical photosynthetically active radiation (PAR) sensor; an Aanderaa 3835 dissolved oxygen (DO) sensor; and a Teledyne Doppler Velocity Logger (DVL). The CTD, ECO triplet, and DO will sample differently depending upon the glider depth type, shallow versus deep. The DVL, which is mounted in such a way as to only record useful data when aimed downwards, will sample only during dives. To maximize the battery life of the deep gliders, the DVL will sample at the maximum possible rate but at an intermittent profiling frequency (e.g. every 4th dive) and the ECO triplet will only record data during dives. The PAR sensor will sample at the maximum sampling frequency in the photic zone, but will be turned off at depths below which visible light is limited. The profiling strategy is listed in Table 5 for both types of gliders.

Table 4. Pioneer Glider Sensors and Sampling Frequency

Sensor	Sampling Frequency
Sea-Bird Slocum Payload CTD	0.5 Hz
Aanderaa Oxygen Optode 3835	0.5 Hz
WET Labs ECO FLBBCD	1 Hz
Biospherical PAR	1 Hz (125 Hz averaged over 125 samples)
Teledyne RDI DVL Explorer	0.5 Hz

Table 5. As-deployed Profiling Strategy

Sensor	1000 m Profiling Frequency	200 m Profiling Frequency
Sea-Bird Slocum Payload CTD	full depth, dive only, every profile	full depth, dive only, every profile
Aanderaa Oxygen Optode 3835	full depth, dive only, every profile	full depth, dive only, every profile
WET Labs ECO FLBBCD	full depth, dive only, every profile	full depth, only, every profile
Biospherical PAR	0-200 m, dive only, every profile	full depth, dive only, every profile
Teledyne RDI DVL Explorer (ADCP)	full depth, dive only, first profile and every 4th subsequent profile during a mission segment (surface to surface)	full depth, dive only, every profile

Graceful Degradation of sampling rates for gliders is shown in Figure 6. The as-deployed configuration is 100% sampling, over the full depth range, on dives only (except for the PAR sensor, which only samples to 200m due to the attenuation of sunlight at increasing water depths). If, within the first quarter or half of a deployment interval, it appears from the battery data as though the glider will not be able to meet the longevity goals, the sampling will be reduced to Baseline (ADCP off). In case of power loss or malfunction, sensors can be turned off in a further series of pre-selected settings that can be implemented by glider operators in coordination with system engineers (red and black). Red level reductions require contact with SE, and automatically trigger recovery plans. Setting 4 is an emergency recovery mode with only the ARGOS transmitter running.

Power consumption will only be reduced by turning off a sensor, not by reducing sampling frequency, and only towards the end of a glider transect. It is important to keep the full suite of water property data as long as possible, as it will be very difficult for users to constantly adjust their processing and visualization programs to multiple data sets that can change in mid-transect. The CTD is both a science and an engineering sensor, and provides backup estimates of pressure as well as density, which is important in terms of the glider buoyancy.

The reduction of successive sensors, according to remaining power, is described in the figure below. Percentages are compared to as-deployed strategy, and a refined power budget for coastal gliders will be available in the future.

Glider Sensor	Draw (amps)	As-Deployed	Baseline	Recover	Emergency
Teledyne RDI ADCP	2.00	100% (dive only)	0% (run w/o)	0% (run w/o)	0%
Biospherical PAR	0.05	100% (dive only, to 200m)	100% (dive only, to 200m)	0% (run w/o)	0%
ECO Triplet Fluorometer	0.49	100% (dive only)	100% (dive only)	0% (run w/o)	0%
Aanderaa Optode	0.10	100% (dive only)	100% (dive only)	0% (run w/o)	0%
SeaBird CTD	0.14	100% (dive only)	100% (dive only)	100% (dive only)	0%
ARGOS beacon	1.66	100% (dive only)	100% (dive only)	100%	100% (recover)

Figure 6. Glider Sampling Strategy and Power Conservation

Adaptive sampling (see Section 5) is any departure from the as-deployed missions in order to address science requests (e.g. a request to redirect a glider away from an as-deployed line to measure an ephemeral event).

Any adaptive request may reduce a glider's occupation of an as-deployed line. When requests are approved, gliders will be redirected according to the levels of the as-deployed sampling regime described in the as-deployed section above while still maintaining the baseline EB, FZ, SS, and GS lines. Planning for an adaptive mission follows the same process as outlined above with additional input from the scientists requesting the change. Adaptive sampling changes do not necessarily have to occur prior to deployment, but could take place as a change to an existing mission plan for a currently deployed glider.

4.1.5.2 AUVs

Two AUVs operate from surface ships, running synchronized, synoptic sampling missions. There are two "baseline" AUV missions, each with ~120 km total track length and a time to complete of approximately 24 hr. The cross-shelf mission is a rectangle (47 km across by 15 km along) oriented approximately perpendicular to isobaths, and circumscribing the moored array. The along-shelf mission is a rectangle (47 km along by 15 km across) approximately parallel to isobaths, with the along-shelf lines passing near the Inshore and Central Inshore mooring sites.

4.2 Endurance Array

The Endurance array is located in the coastal ocean along the northwest U.S. offshore from central Oregon and southern Washington. The environment is characterized by a relatively narrow shelf, an energetic eastern boundary current, persistent wind-driven upwelling, buoyant flows resulting from high volumes of fresh water outflow from the Columbia River, inter-annual variability forced by fluctuations in the tropical Pacific, e.g., El Niño Southern Oscillation, and decadal variations in the large-scale circulation of the North Pacific gyre. These processes result in a number of distinct biogeographical regimes punctuated by large gradients in water properties and biological community structure. In addition, upwelling regions offer natural laboratories in which to investigate impacts of ocean acidification on a broad scope of trophic levels. As deep, nutrient and CO_2 rich waters at depth well up into the sun lit surface regions in response to wind forcing, primary production is enhanced under conditions of depressed pH (elevated acidic) conditions.

4.2.1 Array Structure

The Endurance Array (Figure 7) is comprised of two lines of moorings trending perpendicular to the coast. The Oregon Line is located off Newport, Oregon (near the Newport Hydrographic line) extending from 44° 39' N, 125° W onshore to the coast; and the Washington Line, a contrasting site north of the mouth of the Columbia River in southern Washington (also known as the Grays Harbor line) stretching from 47° N, 125° W onshore to the coast. The array of surface and profiler moorings, primary nodes, and benthic experiment packages (BEP) deployed along the Oregon Line occupy locations with water depths of approximately 25, 80, and 580 m. Moorings along the Washington Line are situated at water depths of 29, 87, and 542 m.

Profiling moorings provide long-term observations of shelf processes, extending from the near-surface through the water column to the bottom. Surface piercing profilers are deployed at the inshore and mid-shelf locations, a wire-following profiler is deployed at the offshore Washington Line location. A cabled Shallow Profiler Mooring and Deep Profiler Mooring are installed at the offshore location on the Oregon Line. Cabled BEPs and instrumented junction boxes provide sampling on and near the seafloor. The Oregon Line profiling moorings, BEPs, and junction boxes are connected to the power and communications cable at the 80, and 580 m sites. Surface moorings located at 25, 80, and 580 m and all surface and profiler moorings along the Washington line are not connected to the cable and receive energy generated locally through solar panels, wind generators, and batteries.

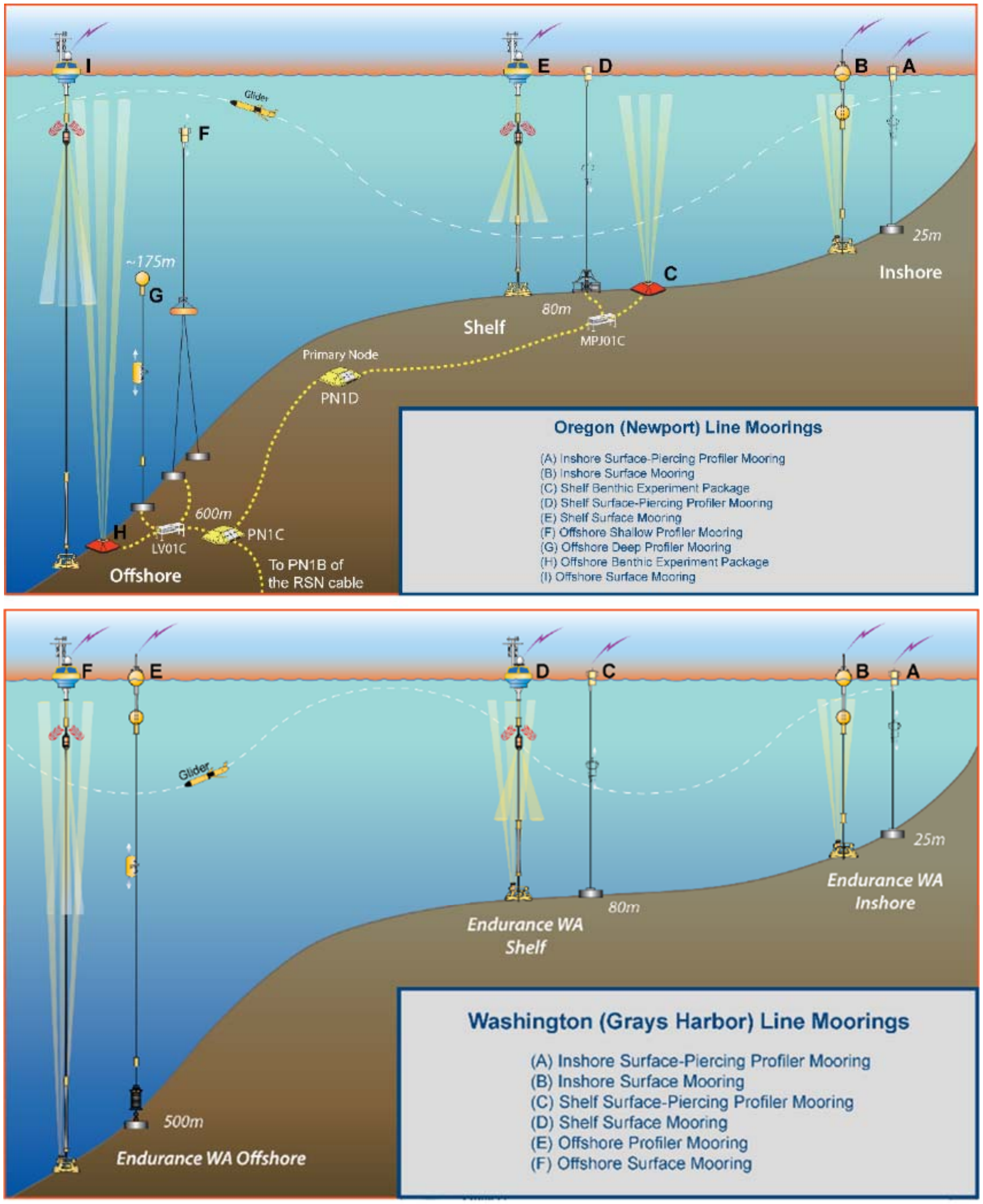

Figure 7. Endurance Array; Oregon Line (top panel) and Washington Line (bottom panel). Both lines are comprised of three primary mooring locations trending perpendicular to the isobaths; inshore (25-30 m depth), mid-shelf (80-90 m depth), and offshore (540-600 m depth). Profiling moorings are positioned at each mooring location and surface meteorological buoys are positioned at each mid-shelf and offshore location. The mid-shelf and offshore profiler moorings and BEPs on the Oregon Line are attached to the power and communications cable. All other assets are self-powered. The surface meteorological floats are equipped with solar and wind power generation.

4.2.2 Instrument Operation

Sampling frequencies may change to reflect operational capabilities or to conserve power. “As-deployed” sampling for all fixed instruments reflects the maximum sustainable rate possible for the duration of each instrument deployment and is a function of instrument capability and available power. Instruments along the Oregon Line and attached to the power and communications cable (benthic sensors at the 80 m and 580 m sites) are operated at or near the maximum sample frequency and defines “as-deployed” sampling for those instruments. “Baseline” sampling is less energy-intensive and designed to address long-term variability, thus providing the researcher with maximum adaptive sampling flexibility. In some cases where power is limited, the “as-deployed” and “baseline” sampling frequencies are the same, because the minimal sampling frequencies that support OOI science requirements use all available power. BI = Burst Interval; BD = Burst Duration; SI = Sampling Interval.

A list of all Endurance Array sensors, their location, and their provisional (exemplar) “as-deployed” and “baseline” sampling frequencies are shown in Table 7 (reference document 8205-61000_OOI_Endurance_Sampling).

4.2.3 Coastal Surface Moorings

Four coastal surface moorings are found in the Endurance Array. They are located at the inshore site on the Oregon line; and at the inshore, mid-shelf and offshore sites on the Washington line. Surface moorings have instrumentation located in-air, on near-surface-instrument-frames (NSIF), and at multi-function nodes (MFN).

If power becomes limited due to environmental conditions or failure of power components, sampling is reduced using the following prioritization guidelines:

1) Reduce the duty cycle of the MFN and disable high-power instruments.
2) Power down the MFN – most instruments on the MFN (except for DOSTA and OPTAA) have internal batteries and self-log data.
3) Reduce duty cycle of the NSIF and disable high-power instruments.
4) Power down the NSIF.
5) Reduce the duty cycle of the buoy.
6) Power down all buoy instrumentation, except for METBK.
7) Power down the buoy except for minimal status via telemetry.

4.2.4 Profiling Moorings

All profiling moorings conduct at least one vertical profile per day to satisfy “baseline” sampling. This profile is performed at mid-day to acquire vertical profiles of light intensity. Profilers that are attached to the cable (the surface-piercing profiler at the 80 m site, and the Shallow and Deep profiler moorings at the 500 m site) are operated at “as-deployed” frequencies that can be sustained for the duration of the deployments. Profilers not attached to the cable perform fewer “as-deployed” profiles per day in order conserve power. Uncabled profilers located on the continental shelf perform four “as-deployed” profiles per day (BD = 6 h) while profilers moored at continental shelf sites conduct two “as-deployed” profiles per day (BD = 12 h). Sampling frequency and profiler speed are adjusted to yield a minimum of one meter vertical resolution per “baseline” and “as-deployed” profile. With a nominal profiling speed of 0.25 m/sec, a sampling interval SI < 4s is required to achieve the required spatial resolution.

If power becomes limited for Wire Following Profilers, telemetry may be reduced and engineering sensors, such as the motion pack may be powered down. The ADCP and WFP are self-powered and self-logging. If the WFP is stuck at a fixed depth (rather than profiling), the sampling schedule may be altered to better capture a time series of data at a fixed depth.

If power becomes limited for Coastal Surface Piercing Profilers, the sampling can be reduced from 4 times a day to 2 times a day. The OPTAA, which is a high-power instrument can also be powered down.

Table 7. Endurance Array Baseline and As-Deployed Sampling (s = second; min = minute; h = hour)										
Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Oregon Inshore Surface Mooring (CE01ISSM)										Battery; DCL turns on every hour
VELPT	Surface Buoy	1	3 h	3 min	1 s	15 min	3 min	1 s	25	
CTDBP	Surface Buoy	1	3 h	2.5 s	0.25 s	30 min	2.5 s	0.25 s	50	
FLORT	Surface Buoy	1	3 h	1 s	1 s	30 min	1 s	1 s	50	Connected to CTDBP
CTDBP	NSIF	7	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	NSIF	7	3 h	1 s	1 s	15 min	1 s	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
FLORT	NSIF	7	3 h	3 min	1 s	1 h	3 min	1 s	100	1 minute minimum run time
NUTNR	NSIF	7	3 h	12 s	1.5 s	60 min	3 min	25 s	100	Requires 30 sec for lamp to warm up, then samples for 12 sec.
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires ~0.75 min to equilibrate.
PCO2W	NSIF	7	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration and then process the sample. Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
SPKIR	NSIF	7	3 h	3 min	1 s	1 h	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	25	
ADCPT	MFN	25	1 h	3 min	2 s	30 min	3 min	2 s	50	This is only for the horizontal currents, not wave sampling; 60 pings per ensemble, 1 ensemble every 15 minutes
ADCPT-WAVES	MFN	25	6 h	20 min	0.5 s	3 h	20 min	0.5 s	0	This is only for the wave sampling. Power limitations of CPM/DCL system prohibit collecting and transmitting wave burst data. Downloaded post-recovery
CAMDS	MFN	25	3 h	3 s	1 s	4 h	3 s	1 s	25	Has external battery and internal storage
CTDBP	MFN	25	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	MFN	25	3 h	1 s	1 s	15 min	1 s	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
OPTAA	MFN	25	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Req. 0.75 min to equilibrate.
PCO2W	MFN	25	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	MFN	25	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PRESF-TIDES	MFN	25	3 h	1 h	0.06 s	1 h	1 h	0.06 s	100	Integrates tide measurement (0.06 sec / sample) over 1 hour. Internal battery; runs continuously, transmits tide data every hour, waves recorded internally

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PRESF-WAVES	MFN	25	6 h	17 min	1 s	6 h	17 min	1 s	0	Collects one wave burst measurement every 6 hours. Bursts composed of 1024 samples collected at 1 Hz. Data stored internally, downloaded post-recovery.
VEL3D	MFN	25	3 h	5 min	0.125 s	1 h	3 min	0.125 s	100	This scheme will, if the system runs on battery only, only last for approx. 180 days.
ZPLSC	MFN	25	1 h	6 min	2 s	15 min	3 min	2 s	25	Sonar has internal battery and data storage, downloaded post-recovery
Oregon Inshore Surface Piercing Profiling Mooring (CE01ISSP)										Battery; Telemetry decimation is adjustable, currently set to every 8th record
CTDPF	Profiler	0 - 19	12 h	15 min	10 s	6 h	2 min	0.0625 s	12.5	
DOSTA	Profiler	0 - 19	12 h	15 min	10 s	6 h	2 min	1 s	12.5	
FLORT	Profiler	0 - 19	12 h	15 min	1 s	6 h	2 min	1 s	12.5	
NUTNR	Profiler	0 - 19	12 h	15 min	1 s	6 h	2 min	12 s	12.5	
OPTAA	Profiler	0 - 19	12 h	15 min	0.25 s	6 h	2 min	0.25 s	12.5	
PARAD	Profiler	0 - 19	12 h	15 min	1 s	6 h	2 min	1 s	12.5	
SPKIR	Profiler	0 - 19	12 h	15 min	0.143 s	6 h	2 min	1 s	12.5	
VEL3D	Profiler	0 - 19	12 h	15 min	0.0625 s	6 h	2 min	1 s	12.5	
Oregon Shelf Benthic Package (CE02SHBP)										Cabled; 100% telemetered
CAMDS	JBox	80	3 h	3 s	1 s	3 h	3 s	1 s	100	
HYDBB	BEP	80	4 h	5 min	0.0000625 s	5 min	5 min	0.0000625 s	100	On continuously
ZPLSC	JBox	80	1 h	60 min	1 s	1 h	60 min	1 s	100	On continuously
ADCPT	BEP	80	5 min	24 s	2.2 s	0.6 s	0.6 s	0.6 s	100	0.57 s per ping, 1 ping per ensemble
CTDBP	BEP	80	5 min	2 min	20 s	0.5 s	0.5 s	0.5 s	100	Uses profiling mode to collect data at 2 Hz continuously
DOSTA	BEP	80	5 min	2 min	20 s	0.5 s	0.5 s	0.5 s	100	Connected through CTDBP
OPTAA	BEP	80	1 h	3 min	0.25 s	0.25 s	0.25	0.25 s	100	

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PCO2W	BEP	80	2 h	7 min	7 min	2 h	7 min	7 min	100	Requires 5 minutes of equilibration time at sample depth before processing sample.
PHSEN	BEP	80	1 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record
VEL3D	BEP	80	1 h	1 min	0.125 s	0.125 s	0.125 s	0.125 s	100	
Oregon Shelf Coastal Surface Mooring (CE02SHSM)										Battery, wind, solar; 100% telemetered
FDCHP	Surface Buoy	In Air	3 h	20 min	0.1 s	1 h	20 min	0.1 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data are downloaded post-recovery.
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	As deployed system runs continuously, reporting values once a minute. Includes sea surface temperature and conductivity measurements.
PCO2A	Surface Buoy	Air and 1	3 h	36 s	2 s	1 h	36 s	2 s	100	
VELPT	Surface Buoy	1	1 h	3 min	1 s	15 min	3 min	1 s	100	
WAVSS	Surface Buoy	In Air	3 h	20 min	0.25 s	1 h	20 min	0.25 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data are downloaded post-recovery.
ADCPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	Creates one 3-minute ensemble of 180 pings every 15 minutes
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	5 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	30 min	12 s	1.5 s	100	Limited by linear calibration drift time (~70 hours)

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires 0.75 min for lamp to equilibrate
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
SPKIR	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
Oregon Shelf Surface Piercing Profiling Mooring (CE02SHSP)										Battery; Telemetry decimation is adjustable, currently set to every 8th record
CTDPF	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	0.0625 s	12.5	
DOSTA	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	1 s	12.5	
FLORT	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	1 s	12.5	
NUTNR	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	12 s	12.5	
OPTAA	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	0.25 s	12.5	
PARAD	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	1 s	12.5	
SPKIR	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	1 s	12.5	
VEL3D	Profiler	0 - 75	12 h	5 min	1 s	12 h	5 min	1 s	12.5	
Oregon Offshore Benthic Package (CE04OSBP)										Cabled; 100% telemetered
CAMDS	JBox	600	3 h	1 s	0.333 s	3 h	3 s	1 s	100	
HYDBB	BEP	600	4 h	5 min	0.0000625 s	5 min	5 min	0.0000625 s	100	On continuously
ADCPS	BEP	600	5 min	24 s	2.2 s	2.17 s	2.17 s	2.17 s	100	2.2 s per ping, 1 ping per ensemble

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
CTDBP	BEP	600	5 min	2 min	20 s	0.5 s	0.5 s	0.5 s	100	Uses profiling mode to collect data at 2 Hz continuously
DOSTA	BEP	600	5 min	2 min	20 s	0.5 s	0.5 s	0.5 s	100	Connected through CTDBP
OPTAA	BEP	600	1 h	3 min	0.25 s	0.25 s	0.25	0.25 s	100	
PCO2W	BEP	600	2 h	7 min	7 min	2 h	7 min	7 min	100	Requires 5 minutes of equilibration time at sample depth before processing sample.
PHSEN	BEP	600	1 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record
VEL3D	BEP	600	1 h	1 min	0.0625	0.125 s	0.125 s	0.125 s	100	
Oregon Offshore Hybrid Profiler Mooring (CE04OSHY)										Cabled; 100% telemetered
CTDPF	Shallow	0 - 200	1 d	20 min	10 s	6 h	40 min	10 s	100	
DOFST	Shallow	0 - 200	1 d	20 min	10 s	6 h	40 min	10 s	100	
FLORT	Shallow	0 - 200	1 d	20 min	1 s	6 h	40 min	1 s	100	
NUTNR	Shallow	0 - 200	1 d	20 min	1 s	6 h	40 min	1 s	100	
OPTAA	Shallow	0 - 200	1 d	20 min	0.25 s	6 h	40 min	0.25 s	100	
PARAD	Shallow	0 - 200	1 d	20 min	1 s	6 h	40 min	1 s	100	
PCO2W	Shallow	0 - 200	1 d	7 min	6 s	6 h	7 min	6 s	100	
SPKIR	Shallow	0 - 200	1 d	20 min	1 s	6 h	40 min	1 s	100	
VEL3D	Shallow	0 - 200	1 d	20 min	0.125 s	6 h	40 min	0.125 s	100	Can sample up to 64 Hz, but will suffer reduced data quality if no particles are present to scatter off of. Suggested sample rate is 8 Hz.
CTDBP	Mid-Water	200	1 d	20 min	20 s	1 h	5 min	20 s	100	
DOSTA	Mid-Water	200	1 d	20 min	20 s	1 h	5 min	20 s	100	
PCO2W	Mid-Water	200	1 d	7 min	7 min	1 h	7 min	7 min	100	Requires 5 minutes of equilibration time at sample depth before processing sample.

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PHSEN	Mid-Water	200	1 d	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record
ZPLSC	Mid-Water	200	1 d	60 min	1 s	1 h	60 min	1 s	100	
CTDPF	Deep	230 - 587	1 d	20 min	10 s	6 h	40 min	10 s	100	
DOFST	Deep	230 - 587	1 d	20 min	10 s	6 h	40 min	10 s	100	
FLORT	Deep	230 - 587	1 d	20 min	0.25 s	6 h	40 min	0.25 s	100	
FLORT	Deep	230 - 587	1 d	20 min	0.25 s	6 h	40 min	0.25 s	100	There are 2 FLORT
VEL3D	Deep	230 - 587	1 d	20 min	0.0625	6 h	40 min	0.0625	100	
Oregon Offshore Coastal Surface Mooring (CE04OSSM)										Battery, wind, solar; 100% telemetered
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	As deployed system runs continuously, reporting values once a minute. Includes sea surface temperature and conductivity measurements.
PCO2A	Surface Buoy	Air and 1	3 h	36 s	2 s	1 h	36 s	2 s	100	
VELPT	Surface Buoy	1	1 h	3 min	1 s	15 min	3 min	1 s	100	
WAVSS	Surface Buoy	In Air	3 h	20 min	0.25 s	1 h	20 min	0.25 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data are downloaded post-recovery.
ADCPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	Creates one 3-minute ensemble of 180 pings every 15 minutes
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	5 s	100	

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	30 min	12 s	1.5 s	100	Limited by linear calibration drift time (~70 hours)
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires 0.75 min for lamp to equilibrate
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
SPKIR	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
Shallow Gliders (CE05MOAS)										Battery
ADCPA	Hull	0 - 200	1 h	1 h	2 s	1 h	1 h	1 s	0	Samples on dive only. Data stored internally, downloaded post-recovery
CTDGV	Hull	0 - 200	1 h	1 h	2 s	1 h	1 h	2 s	4	Samples on dive only. Data decimated temporally and by column
DOSTA	Hull	0 - 200	1 h	1 h	2 s	1 h	1 h	2 s	4	
FLORT	Hull	0 - 200	1 h	1 h	1 s	1 h	1 h	1 s	2	
PARAD	Hull	0 - 200	1 h	1 h	1 s	1 h	1 h	1 s	2	
Deep Gliders (CE05MOAS)										Battery
ADCPA	Hull	0 - 1000	1 h	1 h	2 s	1 h	1 h	1 s	0	Samples on dive only. Data stored internally, downloaded post-recovery.
CTDGV	Hull	0 - 1000	1 h	1 h	2 s	1 h	1 h	2 s	4	Samples on dive only. Data decimated temporally and by column
DOSTA	Hull	0 - 1000	1 h	1 h	2 s	1 h	1 h	2 s	4	
FLORT	Hull	0 - 1000	1 h	1 h	1 s	1 h	1 h	1 s	2	
PARAD	Hull	0 - 200	1 h	1 h	1 s	1 h	1 h	1 s	2	

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Washington Inshore Surface Mooring (CE06ISSM)										Battery; DCL on every hour
VELPT	Surface Buoy	1	3 h	3 min	1 s	15 min	3 min	1 s	25	
CTDBP	Surface Buoy	1	3 h	2.5 s	0.25 s	30 min	2.5 s	0.25 s	50	
FLORT	Surface Buoy	1	3 h	1 s	1 s	30 min	1 s	1 s	50	Connected to CTDBP
CTDBP	NSIF	7	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	NSIF	7	3 h	1 s	1 s	15 min	1 s	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
FLORT	NSIF	7	3 h	3 min	1 s	1 h	3 min	1 s	100	1 minute minimum run time
NUTNR	NSIF	7	3 h	12 s	1.5 s	60 min	3 min	25 s	100	Requires 30 sec for lamp to warm up, then samples for 12 sec.
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires ~0.75 min to equilibrate.
PCO2W	NSIF	7	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration and then process the sample Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
SPKIR	NSIF	7	3 h	3 min	1 s	1 h	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	25	
ADCPT	MFN	25	1 h	3 min	2 s	30 min	3 min	2 s	50	Creates one 3-minute ensemble average of 90 pings every 30 minutes.

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
ADCPT-WAVES	MFN	25	6 h	20 min	0.5 s	3 h	20	0.5 s	0	This is only for the wave sampling. Power limitations of CPM/DCL system prohibit collecting and transmitting wave burst data. Downloaded post-recovery.
CAMDS	MFN	25	3 h	3 s	1 s	4 h	3 s	1 s	25	External battery and internal storage.
CTDBP	MFN	25	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	MFN	25	3 h	1 s	1 s	15 min	1 s	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
OPTAA	MFN	25	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Req. 0.75 min to equilibrate.
PCO2W	MFN	25	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	MFN	25	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PRESF-TIDES	MFN	25	3 h	1 h	0.06 s	1 h	1 h	0.06 s	100	Integrates tide measurement (0.06 sec / sample) over 1 hour. Internal battery; runs continuously, transmits tide data every hour, waves recorded internally
PRESF-WAVES	MFN	25	6 h	17 min	1 s	6 h	17 min	1 s	0	Collects one wave burst measurement every 3 hours. Bursts composed of 1024 samples collected at 1 Hz. Data stored internally, downloaded post-recovery.
VEL3D	MFN	25	3 h	5 min	0.125 s	1 h	3 min	0.125 s	100	This scheme will, if the system runs on battery only, only last for approx. 180 days.
ZPLSC	MFN	25	1 h	6 min	2 s	15 min	3 min	2 s	20	Sonar has internal battery and data storage, downloaded post-recovery

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Washington Inshore Surface Piercing Profiling Mooring (CE06ISSP)										Battery; Telemetry decimation is adjustable, currently set to every 8th record
CTDPF	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	0.0625 s	12.5	
DOSTA	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	1 s	12.5	
FLORT	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	1 s	12.5	
NUTNR	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	12 s	12.5	
OPTAA	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	0.25 s	12.5	
PARAD	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	1 s	12.5	
SPKIR	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	1 s	12.5	
VEL3D	Profiler	0 - 24	12 h	2 min	1 s	6 h	2 min	1 s	12.5	
Washington Shelf Surface Mooring (CE07SHSM)										Battery, wind, solar, fuel cell; MFN DCL only on every hour
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	As deployed system runs continuously, reporting values once a minute. Includes sea surface temperature and conductivity measurements.
PCO2A	Surface Buoy	Air and 1	3 h	36 s	2 s	1 h	36 s	2 s	100	
VELPT	Surface Buoy	1	1 h	3 min	1 s	15 min	3 min	1 s	100	
WAVSS	Surface Buoy	In Air	3 h	20 min	0.25 s	1 h	20 min	0.25 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data downloaded post-recovery.
ADCPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	Creates one 3-minute ensemble of 180 pings every 15 minutes
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	5 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	30 min	12 s	1.5 s	100	Limited by linear calibration drift time (~70 hours)
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires 0.75 min to equilibrate

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 min to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
SPKIR	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
ADCPT	MFN	80	1 h	3 min	2 s	15 min	3 min	2 s	25	Creates one 3-minute ensemble average of 90 pings every 30 minutes.
CAMDS	MFN	80	3 h	3 s	1 s	4 h	3 s	1 s	25	External battery and internal storage, downloaded post-recovery. Wi-Fi allows images to be sent, but limited by file size and driver capabilities.
CTDBP	MFN	80	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	MFN	80	3 h	1 s	1 s	15 min	1	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
OPTAA	MFN	80	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Req. 0.75 min to equilibrate. Files too large for telemetry, only one file sent per day, unless Wi-Fi is available.
PCO2W	MFN	80	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	MFN	80	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PRESF-TIDES	MFN	80	3 h	1 h	0.06 s	1 h	1 h	0.06 s	100	Integrates tide measurement (0.06 sec / sample) over 1 hour. Internal battery; runs continuously, transmits tide data every hour, waves recorded internally
PRESF-WAVES	MFN	80	3 h	17 min	1 s	6 h	17 min	1 s	0	Collects one wave burst measurement every 3 hours. Bursts composed of 1024 samples collected at 1 Hz. Data stored internally, downloaded post-recovery.
VEL3D	MFN	80	3 h	5 min	0.125 s	1 h	3 min	0.125 s	100	5 min at 8 Hz will provide more useful data than 10 min at 16 Hz (which it CAN do, to meet requirements)
ZPLSC	MFN	80	1 h	6 min	2 s	15 min	2 min	2 s	25	Sonar has internal battery and data storage, downloaded post-recovery
Washington Shelf Surface Piercing Profiling Mooring (CE07SHSP)										Battery; Telemetry decimation is adjustable, currently set to every 8th record
CTDPF	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	0625 s	12.5	
DOSTA	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	1 s	12.5	
FLORT	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	1 s	12.5	
NUTNR	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	12 s	12.5	
OPTAA	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	0.25 s	12.5	
PARAD	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	1 s	12.5	
SPKIR	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	1 s	12.5	
VEL3D	Profiler	0 - 82	12 hr	5 min	1 s	12 h	5 min	1 s	12.5	
Washington Offshore Wire-Following Profiler Mooring (CE09OSPM)										Battery
CTDPF	Profiler	30 - 510	6 h	40 min	1 s	6 h	40 min	1 s	100	
DOFST	Profiler	30 - 510	6 h	40 min	1 s	6 h	40 min	1 s	100	
FLORT	Profiler	30 - 510	6 h	40 min	5 s	6 h	40 min	5 s	100	
PARAD	Profiler	30 - 510	6 h	40 min	5 s	6 h	40 min	5 s	100	
VEL3D	Profiler	30 - 510	6 h	40 min	0. 5 s	6 h	40 min	0. 5 s	100	Decimated by column, not temporally.

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Washington Offshore Coastal Surface Mooring (CE09OSSM)										Battery, wind, solar, fuel cell; MFN DCL only on every hour
METBK	Surface Buoy	In Air	1 h	20 min	1 min	1 min	1 min	1 min	100	As deployed system runs continuously, reporting values once a minute. Includes sea surface temperature and conductivity measurements.
PCO2A	Surface Buoy	Air and 1	3 h	36 s	2 s	1 h	36 s	2 s	100	
VELPT	Surface Buoy	1	1 h	3 min	1 s	15 min	3 min	1 s	100	
WAVSS	Surface Buoy	In Air	3 h	20 min	0.25 s	1 h	20 min	0.25 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data are downloaded post-recovery.
ADCPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	Creates one 3-minute ensemble of 180 pings every 15 minutes
CTDBP	NSIF	7	1 h	3 min	10 s	15 min	3 min	10 s	100	
DOSTA	NSIF	7	1 h	3 min	5 s	15 min	3 min	5 s	100	
FLORT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
NUTNR	NSIF	7	3 h	12 s	1.5 s	30 min	12 s	1.5 s	100	Limited by linear calibration drift time (~70 hours)
OPTAA	NSIF	7	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Requires 0.75 min to equilibrate
PHSEN	NSIF	7	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
SPKIR	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	
VELPT	NSIF	7	1 h	3 min	1 s	15 min	3 min	1 s	100	

Instrument	Platform	Depth (m)	Baseline			As-Deployed			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
ADCPS	MFN	600	2 h	3 min	2.5 s	1 h	3 min	2.5 s	100	This is only for the horizontal currents, not wave sampling; 72 pings per ensemble, 1, 3 minute ensemble average every 120 min.
CAMDS	MFN	600	3 h	3 s	1 s	4 h	3 s	1 s	25	External battery and internal storage.
CTDBP	MFN	600	3 h	2.5 s	0.25 s	15 min	2.5 s	0.25 s	25	Every measurement is a 2.5 sec average
DOSTA	MFN	600	3 h	1 s	1 s	15 min	1 s	1 s	25	DOSTA is connected to the CTD, sampled once after CTD collects other sensor measurements.
OPTAA	MFN	600	3 h	4 min	0.25 s	1 h	4 min	0.25 s	100	Req. 0.75 min to equilibrate.
PCO2W	MFN	600	3 h	7 min	7 min	1 h	7 min	7 min	100	Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PHSEN	MFN	600	3 h	3 min	3 min	1 h	3 min	3 min	100	Begins sample collection immediately; 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record Instrument polled hourly at the bottom of the hour. Instrument samples every 3 hours at the top of the hour.
PRESF-TIDES	MFN	600	3 h	1 h	0.06 s	1 h	1 h	0.06 s	100	Integrates tide measurement (0.06 sec / sample) over 1 hour. Internal battery; runs continuously, transmits tide data every hour, waves recorded internally
PRESF-WAVES	MFN	600	6 h	17 min	1 s	6 h	17 min	1 s	0	Collects one wave burst measurement every 3 hours. Bursts composed of 1024 samples collected at 1 Hz. Data stored internally, downloaded post-recovery.
VEL3D	MFN	600	3 h	5 min	0.125 s	1 h	3 min	0.125 s	100	5 min at 8 Hz will provide more useful data than 10 min at 16 Hz (which it CAN do, to meet requirements)
ZPLSC	MFN	600	1 h	6 min	2 s	15 min	2 min	2 s	25	Sonar has internal battery and data storage, downloaded post-recovery

4.2.5 Mobile Platform Operation

4.2.5.1 Gliders

In order to provide observations between the fixed sites and allow a greater degree of adaptive sampling capability, six instrumented gliders are deployed simultaneously and operated cooperatively. Together, the gliders, surface buoys, profilers, and benthic experiment packages provide near real time data from the air-sea interface, through the water column and to the seafloor.

The gliders will operate along five east-west lines from approximately the 25 m isobath to 126° W (128° W along the Newport Hydrographic and Grays Harbor lines) and north-south along approximately 126° W and the 200 m isobath (see Figure 8). There will nominally be six gliders deployed year-round, although the exact number in the water at any one time may vary according to the maintenance and refurbishment schedule, weather conditions, and to optimize scientific data collection.

"As-deployed" missions are designated with priority levels beginning with "baseline" segments (which are occupied most frequently) and ending with the least occupied segments. The "baseline" missions, geographically, are the missions that are of vital importance and are occupied as continuously as possible, changing only for emergency, maintenance, or power saving needs. The remaining priority levels of "as-deployed" missions are structured by importance and the order by which they can be diverted to adaptive missions or scaled back.

The "baseline" sampling regime for the Endurance gliders will follow lines at Grays Harbor (GH) and Newport (NH), which will provide coverage between the moored and cabled Endurance Array deployment sites, as well as resolution of cross-shelf processes that will affect conditions at those sites. The "baseline" sampling regime consists of segments 2a, 2b, 2c, 4a, 4b, and 4c.

The "as-deployed" sampling regime has several levels beyond "baseline" that together form the ideal glider sampling strategy. However, they can be scaled back level-by-level if necessary due to power, maintenance, or adaptive sampling constraints. The "as-deployed" levels are separated out between the deep and shallow gliders as they generally cover separate areas. Table 8 shows the "baseline" lines for both types of gliders and the subsequent order of priority for the various lines of the Endurance Glider Array. Shallow segments will be occupied more frequently by gliders than deep segments, due to the more rapidly changing oceanographic conditions in inshore areas and the greater area of coverage of the offshore, deeper segments. A minimum occupancy rate of once per quarter has been built into the glider mission planning models.

4.2.5.1.1 Endurance Array Glider Paths

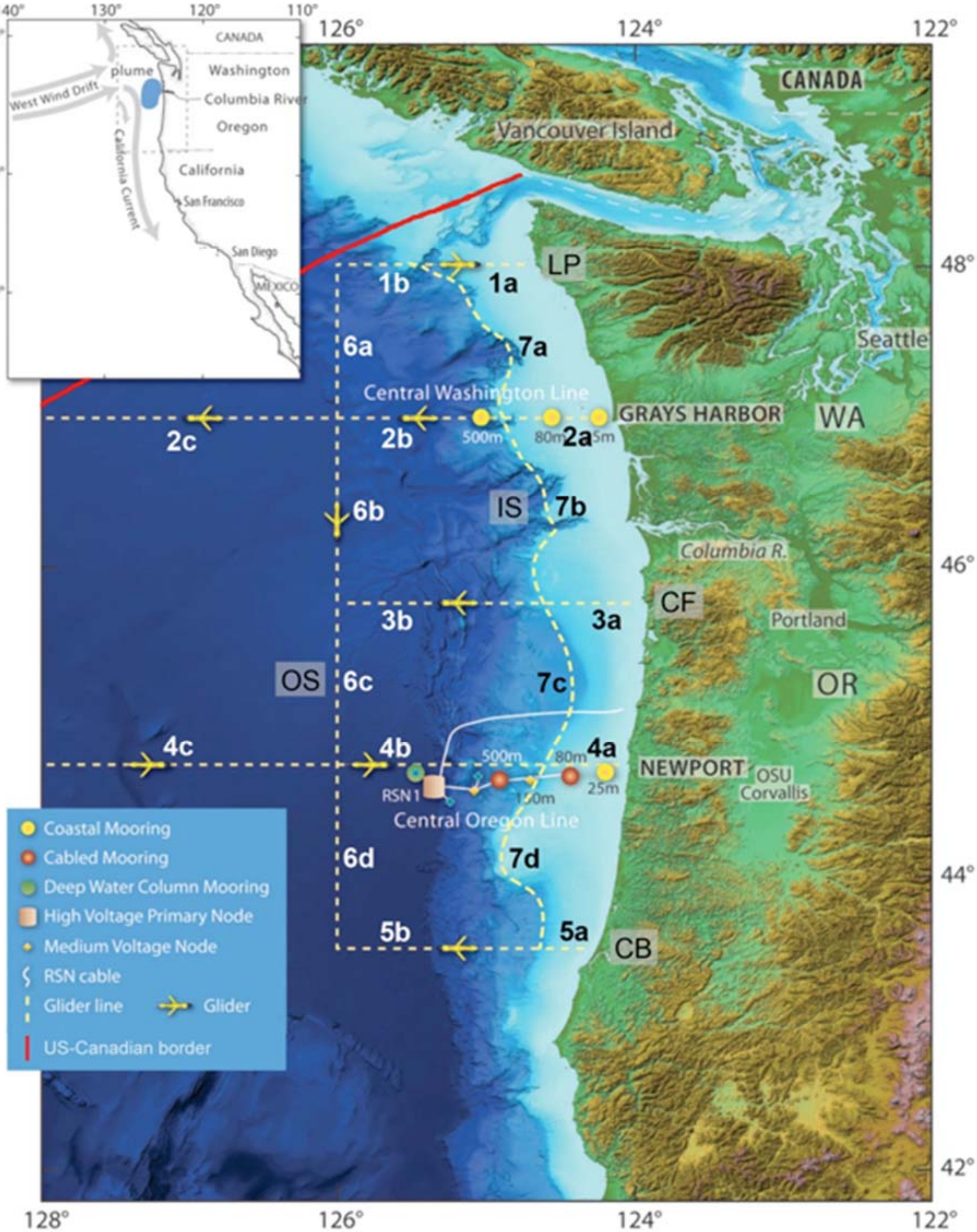

Figure 8. Endurance Sampling Lines with Section Labels

Table 8. "Baseline" and "As-deployed" Priority Levels

Priority	Geographic Description
"baseline" - Shallow	Newport Hydrographic Shallow (4a); Grays Harbor Deep and Shallow (2a).
1st - Shallow	La Push (1a) and Coos Bay (5a)
2nd - Shallow	Cape Falcon (3a)
"baseline" - Deep	Newport Hydrographic Deep (4b, 4c); Grays Harbor Deep (2b, 2c).
1st - Deep	La Push (1b) and Coos Bay (5b)
2nd - Deep	Offshore line (6a-d)
3rd- Deep	Cape Falcon (3b), may be run by a deep or shallow glider to increase frequency

The nominal sampling protocol will be to operate all science instruments at their maximum possible sampling frequencies during subsurface profiling, but will be continually evaluated for the optimum balance between data collection and battery life. On a Coastal Slocum Glider, changing an instrument's sampling resolution does not result in a change in power consumption. However, the profiling resolution and sampling depth range of the instrument can be changed on a glider to control power. However, reducing the profiling resolution (i.e. sampling only on dives) and reducing the sampling depth range (i.e. sampling only the first 200 m of a 1000 m profile) will reduce power consumption. The science instruments on the glider are a Sea-Bird conductivity, temperature, and depth (CTD) instrument; a WET Labs Environmental Characterization Optics (ECO) triplet, which measures chlorophyll, colored dissolved organic matter (CDOM), and optical backscatter; a Biospherical photosynthetically active radiation (PAR) sensor; an Aanderaa 3835 dissolved oxygen (DO) sensor; and a Teledyne Doppler Velocity Logger (DVL). The CTD, ECO triplet, and DO will sample differently depending upon the glider type. The DVL, which is mounted in such a way as to only record useful data when aimed downwards, will sample only during dives. The PAR sensor will sample at the maximum sampling frequency while in the photic zone, but will be turned off at depths below which visible light is limited. The exemplar sampling Frequencies are listed in Table 9 and the exemplar profiling strategy is listed in Table 10 for both types of gliders.

Table 9. Exemplar Endurance Glider Instrument Sampling Frequencies

Sensor	Sampling Frequency
Sea-Bird Slocum Payload CTD	0.5 Hz
Aanderaa Oxygen Optode 3835	0.5 Hz
WET Labs ECO FLBBCD	1 Hz
Biospherical PAR	1 Hz (125 Hz averaged over 125 samples)
Teledyne RDI DVL Explorer	0.5 Hz

Table 10. Exemplar Endurance Glider Profiling Strategy

Sensor	1000 m Profiling	200 m Profiling
Sea-Bird Slocum Payload CTD	full depth, dive and climb, every profile	full depth, dive and climb, every profile
Aanderaa Oxygen Optode 3835	full depth, dive and climb, every profile	full depth, dive and climb, every profile
WET Labs ECO FLBBCD	full depth, dive only, every profile	full depth, dive and climb, every profile
Biospherical PAR	0-200 m, dive and climb, every profile	full depth, dive and climb, every profile
Teledyne RDI DVL Explorer	full depth, dive only, first profile and every 4^{th} subsequent profile during a mission segment (surface to surface)	full depth, dive only, every profile

Graceful Degradation of sampling frequencies for gliders is shown in Figure 9. The as deployed configuration is 100% sampling over the full depth range, on both dives and climbs (except for the ADCP, which samples only on dives, and the PAR sensor, which only samples to 200m due to the attenuation of sunlight at increasing water depths). If, within the first quarter or half of a deployment interval, it appears from the battery data as though the glider will not be able to meet the longevity goals, the sampling will be reduced to Setting 1 (ADCP off) and then to Baseline (ADCP off, all other sensors reduced to dive-only sampling). In case of power loss or malfunction, individual sensors can be turned off in a series of pre-selected settings that can be implemented by glider operators in coordination with system engineers (red and black). Red level reductions require contact with SE, and automatically trigger recovery plans. Setting 4 is an emergency recovery mode with only the ARGOS transmitter running.

Power consumption will only be reduced by turning off a sensor, not by reducing sampling frequency, and only during the last half of a glider deployment. It is important to maintain the full suite of water property data as long as possible, as it will be very difficult for users to constantly adjust their processing and visualization programs to multiple data sets that can change in mid-transect. The CTD is both a science and an engineering sensor, and provides backup estimates of pressure as well as density, which is important in terms of the glider buoyancy. The reduction of successive sensors, according to remaining power, is described in the figure below. Percentages are compared to “as-deployed” strategy, and a refined power budget for coastal gliders will be available in the future.

Glider Sensor	Draw (amps)	As-Deployed	Setting 1	Setting 2 (Baseline)	Setting 3	Setting 4
Teledyne RDI ADCP	2.00	100% (dive only)	0% (run w/o)	0% (run w/o)	0% (run w/o)	0%
Biospherical PAR	0.05	100% (to 200m)	100% (to 200m)	50% (to 200m, dive only)	0% (run w/o)	0%
ECO Triplet Fluorometer	0.49	100%	100%	50% (dive only)	0% (run w/o)	0%
Aanderaa Optode	0.10	100%	100%	50% (dive only)	0% (run w/o)	0%
SeaBird CTD	0.14	100%	100%	50% (dive only)	100%	0%
ARGOS beacon	1.66	100%	100%	50% (dive only)	100%	100% (recover)

Figure 9. Glider Sampling Strategy and Power Conservation

Adaptive sampling (see Section 5) is any departure from the “as-deployed” missions in order to address science requests (e.g. a request to redirect a glider away from an “as-deployed” line to measure an ephemeral event).

Any adaptive request may reduce a glider’s occupation of an “as-deployed” line. When requests are approved, gliders will be redirected according to the levels of the “as-deployed” sampling regime described in the “as-deployed” section above while still maintaining the “baseline” Newport and Grays Harbor lines. Planning for an adaptive mission follows the same process as outlined above with additional input from the scientists requesting the change. Adaptive sampling changes do not necessarily have to occur prior to deployment, but could take place as a change to an existing mission plan for a currently deployed glider.

4.3 Cabled Array

The Cabled Array system is located in the Northeast Pacific within the footprint of the central/southern half of the Juan de Fuca tectonic plate (Figure 10). The infrastructure includes a high power and high bandwidth communications cables, providing two-way, real-time communication; data-video transfer from seafloor and water column sensors with less than one second latency; and significant expansion capability. The array's infrastructure is designed to support the investigation of plate-scale geological and water column processes (physical, chemical, and biological) associated with seven primary scientific locations. Sites 1 and 2 are the Base and Summit of Axial Seamount – the most magmatically robust volcano on the Juan de Fuca Ridge hosting numerous sites of hydrothermal flow. They are located ~ 470 km west of Astoria, Oregon and influenced by the outer edge of the California Current. Site 3 is Slope Base situated at the base of the Oregon shelf slope in the core jet of the California Current and located adjacent to the Cascadia Subduction Zone. Site 4 is Southern Hydrate Ridge located along the continental slope at a water depth of ~ 800 m, 90 km offshore from Newport, OR. This site is characterized by large, subsurface gas hydrate deposits with associated methane seeps supporting diverse biological communities on the seafloor. It is a site of very active venting of methane bubble plumes. Sites 5 and 6 are shared by the Cabled and Endurance Arrays and include the Endurance offshore site and the 80 m site off Newport Oregon. Site 7 is Mid Plate located near the middle of the Juan de Fuca Plate and includes a 5-km backbone extension cable for future expansion to the subduction zone off Washington.

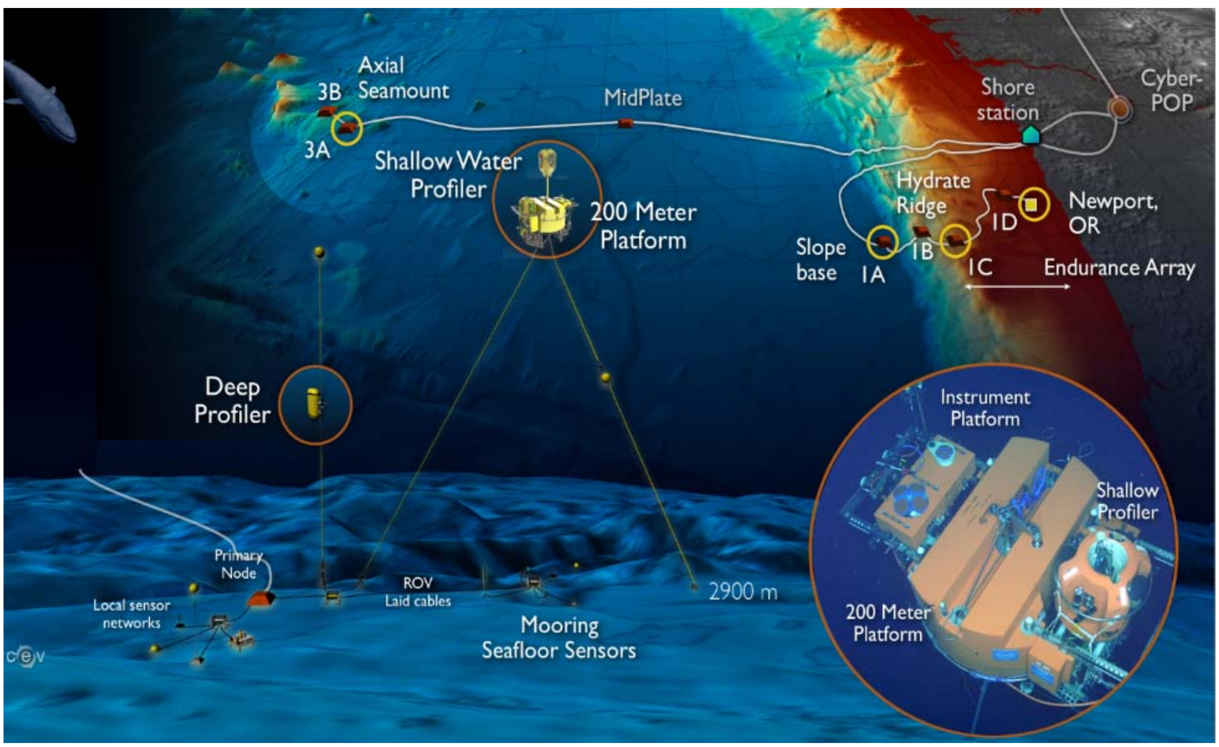

Figure 10. The configuration of the Cabled Array showing the location of the backbone cable and Primary Nodes (e.g. 1A, 1B etc) seafloor junction boxes, seafloor instruments and cabled moorings (at Nodes 1A, 3A, 1C and 1D). The backbone cables connect the primary and secondary infrastructure to the shore station at Pacific City, OR and the cable extension that connects to the Endurance

The Juan de Fuca Plate region presents a microcosm of the tectonic processes occurring at plate boundaries throughout the world. The high data rate and power provided by the cable provides near real-time, synchronous and sustained monitoring of seismic, magmatic and volcanic activity with concomitant measurements of water chemistry, sediment geochemistry, and biological activity at the seafloor and in the overlying water column. Research supported by the cabled infrastructure will lead to a better understanding of plate-scale ocean geodynamics, fluid-rock interactions, and the influence of the sub-seafloor biosphere and gas hydrate deposits on the overall carbon cycle and climate. Vertical profiles of water properties from the near-surface to the deep ocean floor permits monitoring and observations of event-driven responses associated with the westward bifurcation of basin-scale currents into the California Current, migration of low-oxygen waters up the slope that result in hypoxia events, and measurement of pH and CO_2 in an area where there are extremely high signal-to-noise ratios in ocean acidification.

4.3.1 Array Structure

The cabled component of the OOI is composed of primary and secondary infrastructure designed to provide both power and communication to instruments on the seafloor and throughout the water column at water depths of up to 2900 meters. The primary infrastructure consists of two high-power (10kV, 8kW) and high-data rate (10 GbE) backbone cables which connect the land-based shore station in Pacific City, Oregon to a series of seven seafloor and mooring sites across and at the boundary of the Juan de Fuca Plate. The northern cable connects to a single mid-plate expansion node (water depth ~ 2800 m) and two instrumented sites at the Base and Summit of Axial Seamount (water depth ~ 2700 m and 1500 m, respectively). The southern cable connects to instrumented sites at the base of the continental margin (Slope Base – 2900 m) and Southern Hydrate Ridge (~800 m) and then extends power and communication to two additional seafloor and mooring locations in support of the Coastal Endurance Array Oregon Line (see Section 4.2).

The Base of Axial Seamount (~ 46.1°N, 129.6°W; water depth: 2597 m) includes a cabled Deep Profiler mooring (wire-following profiler) and a cabled Shallow Profiler mooring (winched profiler based at a 200 m platform) which also supports a network of seafloor sensors for monitoring both water column and geological process. The Summit of Axial Seamount (water depth ~ 1500 m) includes an extensive array of extension cables, junction boxes, and myriad instruments to a) monitor hydrothermal activity at the ASHES and International District Hydrothermal Fields and b) provide geophysical monitoring at the Central Caldera and Eastern Caldera locations to investigate seismicity associated with melt migration, upwelling of hydrothermal fluids, volcanic eruptions, and seafloor spreading. At this summit, bottom pressure tilt instruments measure seafloor uplift and subsidence associated with inflation and deflation of the underlying magma chamber.

The Slope Base site (~ 44.5°N, 125.2°W; water depth: 2906 m) includes a cabled Deep Profiler mooring (wire-following profiler) and a cabled Shallow Profiler mooring (winched profiler based at a 200 m platform) which also supports a network of seafloor sensors for monitoring both water column and geological process associated with the Cascadia Subduction Zone.

The Southern Hydrate Ridge Site (~44.57°N, 125.15*W; water depth ~ 800) supports seafloor instruments focused at the active methane seep site called Einstein's Grotto, which hosts a robust methane bubble plume and bacterial mats. The site also supports an array of seis-mometers extending away from the seep to measure local and more regional seismic events.

4.3.2 Instrument Operation

The high-power and high-data rate capability of the cabled infrastructure provides enormous capacity and a high degree of flexibility for sampling ocean and geological phenomena both at and below the seafloor and within the water column.

"Baseline" sampling will be defined to establish a long-term sampling record to address multi-decadal (as well as short-term) environmental variability. "As-deployed" sampling will take advantage of the available power and communications capabilities offered by the cable. The instruments and communication systems will be operated at the maximum frequency sustainable over the period of deployment. It is currently difficult to clearly define the "baseline" frequencies for many of the Cabled Array instruments and platforms for three reasons. First, the oceanographic scientific community is inexperienced with the potential advantages and benefits of the high real-time data rate and continuous power available at these locations and depths. The opportunities for experimental design plus scientific exploration (and exploitation) need to be established with experience. Some of these instruments have not operated over these extended periods of time. Long-term instrument capabilities and operational engineering parameters must be discovered and implemented. Secondly, basic discoveries are anticipated during the first one or two years of operation. These discoveries will most likely direct and define the necessary minimum (i.e., "baseline") sampling frequencies. Thirdly, the maximum sampling frequencies targeted for as-deployed sampling must take into account instrument and platform interferences and other unforeseen operational limitations.

The full implementation of the following Cabled Array instrument and platform sampling plans is contingent upon the completion of the cyberinfrastructure as originally designed, including full integration of platform and instrument mission execution capabilities. The complexity of this type of integration may result in a phased implementation during the early stages of operations, similar to the "initial" sampling frequencies described herein.

4.3.2.1 Seafloor Instrument Operation

The initial, "baseline", and "as-deployed" sampling plans for the cabled seafloor instruments are provided in Table 8. The tabulated initial sampling frequencies will be used after deployment and during early operations and are designed to allow evaluation of the previous factors and better inform both the operators and the scientific community on the infrastructure capabilities. This approach allows a more informed determination of the appropriate sampling frequencies.

Most of the seafloor instruments will be operated continuously and transmit all data back to shore in real time, as required by the high-level science questions in the OOI Science Plan. For example, assessment of long-term trends and episodic events of seismic activity requires continuous measurements by Low Frequency Hydrophones (HYDLF) and Broadband Ocean Bottom Seismometers (OBSBB).

The temporal variability of measurements obtained from other instruments is less well known and development of long-term sampling strategies will require evaluation of the data from early deployments. These instruments include the Particulate DNA Sampler (PPSDN), Hydrothermal Vent Fluid Interactive Sampler (RASFL), Water Sampler for Trace Chemical Analyses (OSMOI), Benthic Fluid Flow (FLOBN), Mass Spectrometer for Dissolved Gases (MASSP), Digital Still Camera (CAMDS), and the High Definition Digital Video Camera (CAMHD).

Most of the cabled instruments stream 100% of the total recorded data back to shore in near real-time, but four instruments collect physical samples. The OSMOI instrument measures diffuse flow and seep fluids for major and trace element chemistry. The FLOBN instrument measures benthic fluid flow rates. The RASFL measures major and trace element chemistry, temperature, H_2S, and pH. The Particulate DNA Sampler (PPSDN) identifies and quantifies the seafloor microbial community. The samples collected by the these instruments are recovered annually and then processed post-recovery in onshore analytical laboratories, at which point the data is ingested into OOINet and delivered to OOI users.

The OSMOI instrument collects water samples for trace chemical analyses of diffuse fluids, while the FLOBN instrument measures diffuse fluid flow rates at the seabed by injecting a tracer at the sediment-water interface and collecting fluid samples. Both of these instruments are based on osmotic pumps and are capable of sampling continuously for at least 13 months with a 2-day, or better, sample resolution. The PPSDN and RASFL collect hydrothermal fluids and particulates (DNA) and are limited to a total of 24 and 48 samples, respectively. These instruments will sample every 20 and 10 days, respectively, which allows for adaptive sampling during event response. The MASSP instrument will initially sample a suite of dissolved gases in diffuse fluids at the seabed every 6 hours, and additional details of the process are detailed in Table 8. The operation of the Digital Still and HD Video Cameras (CAMDS and CAMHD) is designed to be highly adaptive to the needs of the community. As an example, the initial sampling strategy for the HD camera includes five, 20 minute periods during the day and night to establish if there are any tidal/daylight-night environmental-biological changes, a once a month 24-hour duration of operations, and a once a month 3-day continuous operations to examine animal behavior and longer-duration changes in hydrothermal flow. The initial sampling will be used to determine the optimal usage patterns to maximize scientific return.

The sampling schemes for some instruments (e.g. RASFL, PPSDN, MASSP, CAMDS, and CAMHD) require advanced scheduling and integration capabilities. The timely evaluation of the initial sampling strategies will depend on the overall timetable for provisioning of such mission execution capabilities within the OOI cyberinfrastructure. It is expected that these evaluations will continue post-commissioning and through at least the following full deployment period.

4.3.2.2 Cabled Deep and Shallow Profiler Mooring Operation

The Cabled Array profiling moorings include both a shallow winched profiler and a deep wire-following profiler at the Slope Base (PN1A) and Axial Base (PN3A) sites (see Fig 10). The high power, high data rate, and shore-side command and control capabilities that the cabled infrastructure provides these platforms allows the creation and execution of complex profiler missions which can be optimized for both spatial (vertical) and temporal resolutions and adjusted, as needed, to capture and explore various oceanographic phenomena. As previously noted, expectations are that initial operations will provide critical insight into the full spectrum of capabilities and limitations (e.g. instrument interferences and data biasing) of these profiler moorings and allow a fully-informed determination of the appropriate “baseline” and “as-deployed” instrument sampling plans.

Detailed descriptions of and rationale for the initial profiler missions and onboard instrument sampling frequencies for the shallow winched and deep wire-following profilers are provided in separate documents: RSN Deep (DP) Mission Execution and Sensor Sampling Plans (DCN 4310-69588) and RSN Shallow Profiler (SP) Mission Execution and Sensor Sampling Plans (DCN 4815-69574), respectively.

Table 8. Cabled Scale Seafloor Instrument Initial, Baseline and As-Deployed Sampling
(s = second; min = minute; h = hour; d = day; fps/fpm = frames per second/minute; tbd = to be determined; na = not applicable; Percentage Telemetered = 100% for all except OSMOI, FLOBN, RASFL, and PPSDN)

Instrument	Platform	Depth (m)	Initial			"Baseline"			"As-Deployed"			Comments
			BI	BD	SI	BI	BD	SI	BI	BD	SI	
Slope Base and Axial Base												
HYDLF	MJ01A/MJ03A	2921/2607	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	Long-term record of seismic activity or ambient noise level.
OBSBB	MJ01A/MJ03A	2921/2607	Continuous	Continuous	200,40,8,1 Hz	Continuous	Continuous	200,40 ,8,1 Hz	Continuous	Continuous	200,40,8,1 Hz	
PREST	MJ01A/MJ03A	2908/2606	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	* SI of 1 Hz is intended to measure microseisms and its utility will be evaluated. Instrument default SI of 15 sec provides 0.11 ppm resolution (in % of full scale pressure)
VEL3D	MJ01A/MJ03A	2908/2608	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	4 MHz Emission Frequency.
Southern Hydrate Ridge Summit												
HYDLF	LJ01B	779	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	
OBSBB	LJ01B	779	Continuous	Continuous	200,40,8,1 Hz	Continuous	Continuous	200,40 ,8,1 Hz	Continuous	Continuous	200,40,8,1 Hz	
OBSSP	LJ01B	778,789, 818	Continuous	Continuous	200,40,8,1 Hz*	Continuous	Continuous	200,40 ,8,1 Hz*	Continuous	Continuous	200,40,8,1 Hz*	*Actuals depend on output from ORB

PREST	LJ01B	775	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	* SI of 1 Hz is intended to measure microseisms and its utility will be evaluated. Instrument default SI of 15 sec provides 0.11 ppm resolution (in % of full scale pressure)
VEL3D	LJ01B	775	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	4 MHz Emission Frequency
ADCPS	MJ01B	773	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	75 kHz Emission Frequency * Ping Rate: 1 Hz (typical) Initial Settings: 32 m depth cells 30 bins ~ 44 actual samples per min
CAMDS	MJ01B	774	Adaptive*	Adaptive*	Adaptive*	12 d	15 min	30 s	6 h	30 min	30 s	* Current lack of automation and projected absence of actual marine operators will limit initial use. Max 3 fps at full resolution Adaptive – full utilization of pan/tilt system and multiple sampling modes
MASSP[1]	MJ01B	774	6 h*	2 min*	~20 s*	tbd	tbd	tbd	tbd	tbd	tbd	* Current lack of automation and projected absence of actual marine operators will limit initial use. Requires data from ancillary onboard pH and temperature sensors

OSMOI	MJ01B	774	Continuous	Continuous	2 d	tbd	tbd	tbd	tbd	tbd	tbd	Uncabled; enough tubing to sample for 13 months, fixed rate = 2 day resolution
FLOBN	MJ01B	773,774	Continuous	Continuous	2 d	tbd	tbd	tbd	tbd	tbd	tbd	Uncabled; enough tubing to sample for 13 months, fixed rate = 2 day resolution
AXIAL SUMMIT												
Ashes												
OSMOI	MJ03B	1541	Continuous	Continuous	2 d	tbd	tbd	tbd	tbd	tbd	tbd	Uncabled; enough tubing to sample for 13 months, fixed rate = 2 day resolution
TMPSF	MJ03B	1540	Continuous	Continuous	15 s	Continuous	Continuous	1 min	Continuous	Continuous	15 s	
OBSSP	MJ03B	1534	Continuous	Continuous	200,40,8,1 Hz*	Continuous	Continuous	200,40, 8,1 Hz*	Continuous	Continuous	200,40,8,1 Hz*	Actuals depend on output from ORB
CAMHD	PN03B	1542	Adaptive*	Adaptive*	Adaptive*	24 hr†	20 min†	60 fps†	6 hr†	20 min†	60 fps†	On 10 GB Cable. * Current lack of automation and projected absence of actual marine operators will limit initial use. †Description are averages - sampling will be adaptive.
International District												
PPSDN	MJ03C	1521	Continuous	Continuous	20 d	Continuous	Continuous	20 d	Continuous	Continuous	20 d	Maximum number of samples = 24
RASFL	MJ03C	1521	Continuous	Continuous	10 d	Continuous	Continuous	10 d	Continuous	Continuous	10 d	Maximum number of samples = 48

RASFL-D1000	MJ03C	1521	Continuous	Continuous	1 min	Continuous	Continuous	10 min	Continuous	Continuous	1 min	The D1000 is the temperature sensor onboard RASFL-PPSDN instrument
CAMDS	MJ03C	1521	Adaptive*	Adaptive*	Adaptive*	12 d	15 min	30 s	6 h	30 min	30 s	* Current lack of automation and projected absence of actual marine operators will limit initial use. Max 3 fps at full resolution Adaptive – full utilization of pan/tilt system and multiple sampling modes
MASSP[1]	MJ03C	1521	6 h*	2 min*	~20 s*	tbd	tbd	tbd	tbd	tbd	tbd	* Current lack of automation and projected absence of actual marine operators will limit initial use. Requires data from ancillary onboard pH and temperature sensors
THSPH	MJ03C	1520	Continuous	Continuous	5 s	Continuous	Continuous	60 s	Continuous	Continuous	5 s	
TRHPH	MJ03C	1514	Continuous	Continuous	20 s	Continuous	Continuous	60 s	Continuous	Continuous	20 s	
VEL3D	MJ03D	1527	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	Continuous	Continuous	1 Hz	4 MHz Emission Frequency
BOTPT	MJ03D	1529	Continuous	Continuous	Pressure:40 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Pressure: 40 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Pressure:40 Hz LILY Tilt: 1 Hz	Instrument Includes two additional lower resolution tilt sensors (IRIS,HEAT) that produce auxiliary data products (1 s, 2-3 s continuous)
OBSSP	MJ03D	1528	Continuous	Continuous	200,40,8,1 Hz*	Continuous	Continuous	200,40,8, 1 Hz*	Continuous	Continuous	200,40,8,1 Hz*	*Actuals depend on output from ORB

Central Caldera												
BOTPT	MJ03F	1526	Continuous	Continuous	Pressure: 20 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Pressure: 1 to 20 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Pressure: 1 to 20 Hz LILY Tilt: 1 Hz	Instrument Includes two additional lower resolution tilt sensors (IRIS,HEAT) that produce auxiliary data products (1 s, 2-3 s continuous)
HYDLF	MJ03F	1528	Continuous	Continuous	200 Hz	Continuous	Continuous	200 Hz	Continuous	Continuous	200 Hz	
OBSBB	MJ03F	1528	Continuous	Continuous	200 Hz	Continuous	Continuous	200 Hz	Continuous	Continuous	200 Hz	
Eastern Caldera												
BOTPT	MJ03E	1519	Continuous	Continuous	Pressure: 20 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Press:1 to 20 Hz LILY Tilt: 1 Hz	Continuous	Continuous	Pressure: 1 to 20 Hz LILY Tilt: 1 Hz	Instrument Includes two additional lower resolution tilt sensors (IRIS,HEAT) that produce auxiliary data products (1 s, 2-3 s continuous)
HYDLF	MJ03E	1519	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	Continuous	Continuous	200,1 Hz	
OBSBB	MJ03E	1519	Continuous	Continuous	200,40,8,1 Hz	Continuous	Continuous	200,40,8, 1 Hz	Continuous	Continuous	200,40,8,1 Hz	
OBSSP	MJ03E	1512,1516	Continuous	Continuous	200,40,8,1 Hz*	Continuous	Continuous	200,40,8, 1 Hz*	Continuous	Continuous	200,40,8,1 Hz*	*Actuals depend on output from ORB

[1] MASSP will initially sample every 6 hours. At that time data will be collected nominally for 10 mins in each of 4 different modes. The first 8 min are for gas equilibration and signal stabilization, the last 2 minutes of data will be processed. Those 2 minutes of data are composed of measurements of 100 different masses at 0.1 dalton resolution and at nominal intervals of ~20 secs (excluding overhead). Each 2 minute interval of mass intensities will be averaged/processed using averaging and deconvolution steps to produce a single measurement of each mass. Mass data in each of the 4 modes will be combined to calculate concentrations of different dissolved gases. Two other onboard sensors for pH and temperature are also sampled at appropriate intervals as input to the algorithms.

Table 9. Cabled Water Column Moored Instruments Initial Sampling
(s = second; min = minute; h = hour; d = day; fps/fpm = frames per second/minute; tbd = to be determined; na = not applicable)

Instrument	Platform	Depth (m)	Fixed Depth Platform			Profiler Mooring (Upcast[1])			Profiler Mooring (Downcast[2])			Comments
			BI	BD	SI	BI	BD	SI	BI	BD	SI	
Axial Base and Slope Base												
CTDPF	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	4 Hz*	Continuous	Continuous	4 Hz*	*Effective SI ~ 1 Hz due to averaging of 3-6 samples to attain OOI required accuracy
DOSTF	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	*Response time is ~ 18-25 s. Approximately 42 measurements to attain OOI required accuracy.
FLORT	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	*SI ~ 1 Hz at Instrument Averaging/Data Rate = 18
NUTNR	Shallow Profiler	5 – 190; 5 – 195[3]				~40 s	~ 2 s	1 Hz	na	na	na	Lamp life = 900 hours. Sensor drift dependent on lamp usage – requires limiting lamp time to meet requirements.
OPTAA	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	4 Hz*	na	na	na	Lamp life = 1000 hours. * Approximately 100 samples needed to attain

												OOI required accuracy.
PARAD	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	4 Hz	Continuous	Continuous	4 Hz	
PCO2W	Shallow Profiler	5 – 190; 5 – 195[3]				na	na	na	Depth-dependent[4]	5 min	5 min	Sampling is reagent limited. Response time is ~ 5 mins due to gas equilibration being required.
PHSEN	Shallow Profiler	5 – 190; 5 – 195[3]				na	na	na	Depth-dependent[4]	3 min	3 min	Sampling is reagent limited. Pumping/mixing of reagents and measurements require a total of 3 min between samples.
SPKIR	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	4 Hz	Continuous	Continuous	4 Hz	
VELPT	Shallow Profiler	5 – 190; 5 – 195[3]				Continuous	Continuous	4 Hz	Continuous	Continuous	4 Hz	
ADCPT	Fixed Depth Platform	190;195	Continuous	Continuous	1 Hz*							150 kHz Emission Frequency * Ping Rate: 1 Hz (typical) Initial Settings: 8 m depth cells 50 bins ≥ 0.5 secs
CAMDS	Fixed Depth Platform	190;195	Adaptive*	Adaptive*	Adaptive*							* Current lack of automation and projected absence of actual marine operators will limit initial use. Adaptive – full utilization of pan/tilt system

												and multiple sampling modes
CTDPF	Fixed Depth Platform	190;195	Continuous	Continuous	4 Hz*							*Effective SI ~ 1 Hz due to averaging of 3-6 samples to attain OOI required accuracy
DOSTA	Fixed Depth Platform	190;195	Continuous	Continuous	0.5 Hz*							*Maximum Sampling rate but response time ~ 25 sec
FLORD	Fixed Depth Platform	190;195	Continuous	Continuous	1 Hz*							*SI ~ 1 Hz at Instrument Averaging/Data Rate = 18
HYDBB	Fixed Depth Platform	190;195	Continuous	Continuous	256 kHz							
PHSEN	Fixed Depth Platform	190;195	1 h	3 min	3 min							Sampling is reagent limited. Pumping/mixing of reagents and measurements require a total of 3 min between samples.
VADCP	Fixed Depth Platform	190;195	Continuous	Continuous	tbd							600 kHz Beam Multiple setups of beam configurations (master/slave) will be evaluated. Initial Settings: 1 m depth cells 220 bins
CTDPF	Deep Profiler	167 – 2592; 175 – 2881				Continuous	Continuous	1 Hz*	Continuous	Continuous	1 Hz*	* OOI required accuracy attained with 1 Hz sampling rate
DOSTA	Deep Profiler	167 – 2592; 175 – 2881				Continuous	Continuous	0.5 Hz*	Continuous	Continuous	0.5 Hz*	*Maximum Sampling rate but response time ~ 25 sec
FLORT	Deep Profiler	167 – 2592; 175 – 2881				Continuous	Continuous	8 Hz	Continuous	Continuous	8 Hz	Combination of ECO FLNTURTD

												and ECO FLCDRTD sensors to satisfy requirements.
OPTAA	Deep Profiler	167 – 2592; 175 – 2881				Continuous	Continuous	4 Hz*	Continuous	Continuous	4 Hz*	Lamp life = 1000 hours. Sensor will only be operated ~ 10% of profiles. * Approximately 100 samples needed to attain OOI required accuracy
VEL3D	Deep Profiler	167 – 2592; 175 – 2881				Continuous	Continuous	4Hz	Continuous	Continuous	4 Hz	4 MHz Emission Frequency.
ADCPT	LJ03A;LJ01A	2610;2905	Continuous	Continuous	1 Hz							150 kHz Emission Frequency * Ping Rate: 1 Hz (typical) Initial Settings: 8 m depth cells 50 bins ≥ 0.5 secs
CTDPF	LJ03A;LJ01A	2607;2904	Continuous	Continuous	1 Hz							
DOSTA	LJ03A;LJ01A	2607;2904	Continuous	Continuous	0.5 Hz*							*Maximum sampling rate but response time ~25 sec
HPIES	LJ03A;LJ01A	2610;2896	HEF*: 2 min IES†: 10 min P,T#: 10 min	HEF*: 2 min IES†: ~68 s P,T#: 30 s	HEF*:10 Hz IES†: 16-18 s P,T#: 30 s							* Horizontal Electric Fields: Each of six (6) signal channels block- averaged to 1 Hz before transmission †Inverted Echo Sounder: Measurements of 4 travel times (each ~ 16-18 s) # Pressure and temperature in

												frequency output averaged for 30 secs every 10 mins.
HYDBB	LJ03A;LJ01A	2610;2905	Continuous	Continuous	256 kHz							
OPTAA	LJ03A;LJ01A	2607;2904	Continuous	Continuous	4 Hz*							Lamp life = 1000 hours. * Approximately 100 samples needed to attain OOI required accuracy

1) Profiler Upcast: Shallow Profiler (5 cm/s continuous); Deep Profiler (25 cm/s continuous)
2) Profiler Downcast: Shallow Profiler (10 cm/s with predefined stops); Deep Profiler (25 cm/s continuous)
3) Vertical Excursion of the Shallow Profiler will be from its cradle on the fixed platform (~ 200 m water depth) to either 5 m or three times (3x) maximum wave height below the sea surface, whichever is deeper.
4) During downcast, the Shallow Profiler will stop at specific depths (10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, and 200 m) to provide sufficient time for sampling by the reagent-based instruments PHSEN and PCO2W.

4.4 Global Arrays

The Global Arrays are located at four distinct high-latitude regions of the pelagic ocean: Southern Ocean, southwest of Chile (55°S, 90°W; water depth: 4,800 m), Irminger Sea, southeast of Greenland (60°N, 39°W; Water Depth: 2,800 m), Argentine Basin (42°S, 42°W; Water Depth: 5,200 m) and Station Papa, North Pacific (50°N, 145°W; Water Depth: 4,250 m). These arrays, with power sufficient to support measurements of basic meteorological parameters, dissolved gases, and the basic physical and ecological parameters governing carbon fixation and sequestration are used to address questions of spatial and temporal variability of the ocean as a source or sink for atmospheric carbon dioxide (Figure 11). These high-latitude areas, identified as large global CO_2 sinks or having high CO_2 inventories, are also areas that routinely experience extreme wind, sea states and deep mixing and are therefore well suited to addressing questions concerning the role of energetic storms in ocean processes.

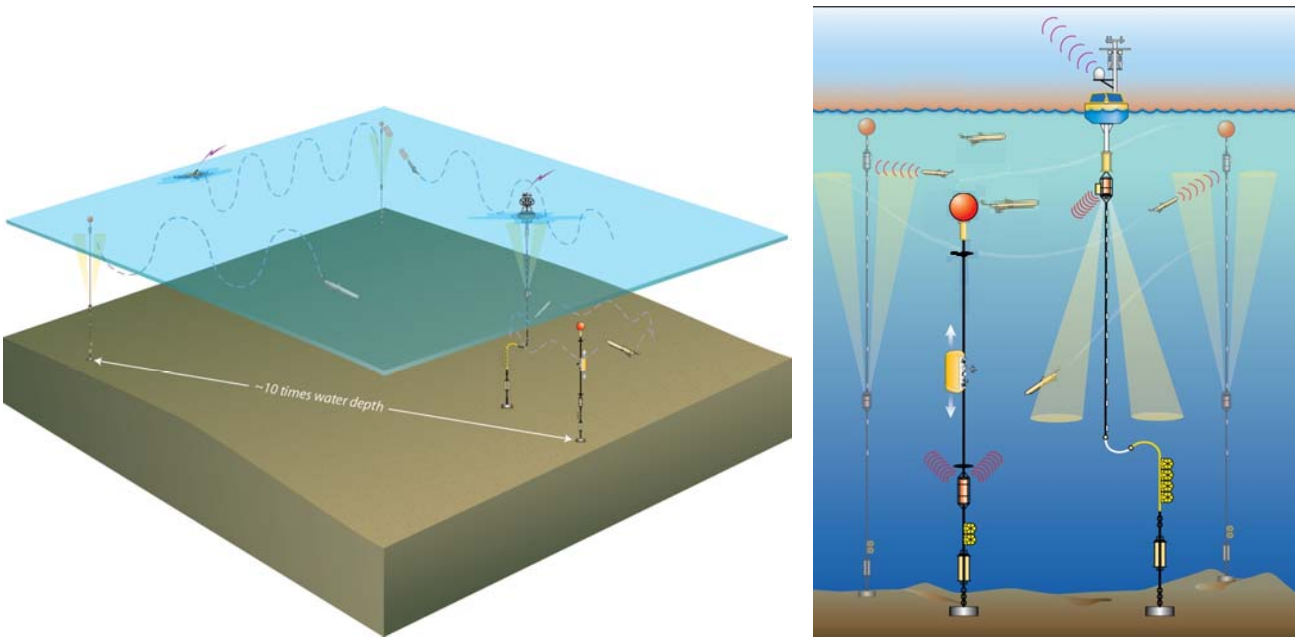

Figure 11. Global Array structure (left panel) and mooring components (right panel) of the Irminger Sea, Southern Ocean, and Argentine Basin Arrays. Station Papa will not include the Global Surface Mooring. Three instrumented ocean gliders survey the array boundaries at each location between the ocean surface and 1000 m.

4.4.1 Array Structure

The four Global Array locations are based on a common design that combines surface moorings, subsurface moorings, profiler moorings, and gliders to achieve a unique space-time sampling capability for air-sea interaction and bio-physical processes on the ocean mesoscale. With the exception of PAPA, each global array location is comprised of one surface mooring capable of wind and solar power generation, one hybrid profiler mooring (a deep wire-following profiler and one or two profiling gliders) co-located with the surface mooring, two subsurface flanking moorings with fixed sensors and three instrumented open ocean gliders with extended endurance. The three moorings roughly form an equilateral triangle with the length of each side approximately 10 times the water depth.

The hybrid profiler mooring, being comprised of one or two profiling gliders operating between the surface and a depth of 200 m, a fixed platform at ~150 m, and one or two deep, wire-following profiler operating between 230 m and the local sea floor (2,800 – 5,200 m). With a maximum profiling speed of 1 m s^{-1}, the deep profiler requires between 1.5 and 3 hours to complete a single profile, assuming a round trip per profile. Associated instruments are only operated during profiling operations and between profiles the platforms are stopped at their deepest excursion in order to minimize biofouling.

4.4.2 Instrument Sampling

A list of all Global Array sensors, their location, and the exemplar “as-deployed” and “baseline” sampling frequencies are shown in Table 10. “As-deployed” sampling for all fixed instruments is designed to minimally resolve wind forcing of vertical structure, advection of water masses through the array and diurnal biological responses. Exceptions to this are the bulk meteorological instruments on the surface buoys, all of which sample at 1 Hz but then average the data every minute, providing minute averages (BI = 1 min) to the end user without retention of the 1 Hz observations, and the pCO_2 sensor that requires a five minute stabilization period. Telemetry rates for the sensors transmitting via the glider data mules are variable. See section 4.4.5.1 for details.

4.4.3 Global Surface Moorings

One Global Surface Moorings are found in the Irminger Sea, Southern Ocean and Argentine Basin Arrays. They are located at the Apex site, paired with a profiler mooring. Surface moorings have instrumentation located in-air, on the submerged buoy base, on near-surface-instrument-frames (NSIF), and along the mooring riser down to 1500 m.

If power becomes limited due to environmental conditions or failure of power components, sampling is reduced using the following prioritization guidelines:

1) Reduce duty cycle of the NSIF and disable high-power instruments.
2) Power down the NSIF.
3) Power down all buoy instrumentation, except for METBK.
4) Power down the buoy except for minimal status via telemetry.

4.4.4 Global Subsurface Moorings

There is one Global Profiler mooring located at the Apex site of each Global Array. The “baseline” profiling frequency is one profile every 20 hours and all associated instruments are only operated during the profiling period. The sampling interval (SI) is of nominally one second and the profiler speed is fixed to yield a minimum vertical spatial resolution of one meter.

There are Global Flanking Moorings at each Global Array. They are battery-powered and consist of instrumentation in the subsurface sphere at 30 m and along the mooring riser down to 1500 m.

Table 10. Global Array "Baseline" & "As-deployed" Sampling (s = second; min = minute; h = hour; d = day)										
Instrument	Platform	Depth (meters)	"Baseline"			"As-deployed"			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Profiler Moorings: Irminger Sea (x = 2560), Southern Ocean (x = 4341), Argentine Basin (x = 5022), Station Papa (x = 4062)										Data telemetered every 400 s, ~100m vertical resolution; Fixed instruments send data every 4 h
CTDPF	Profiler	161 - x	72 h	3 h	10 s	20 h	3 h	10 s	2.5	
DOSTA	Profiler	161 - x	72 h	3 h	10 s	20 h	3 h	10 s	2.5	
FLORD	Profiler	161 - x	72 h	3 h	10 s	20 h	3 h	10 s	0.25	FLORD cannot be on continuously; Sampled approx. every 10s., avg. of 30 samples at 4 Hz
VEL3D	Profiler	161 - x	72 h	3 h	0.5 s	20 h	3 h	0.5 s	<1	
CTDMO	Fixed Depth	161	6 h	1 s	0.25 s	15 min	1 s	0.25 s	6.25	1 second average over 4 Hz
ZPLSG	MP	200	6 h	10 min	1 s	1 h	10 min	1 s	20	Sonar has internal battery and data storage, downloaded post-recovery
Profiling Gliders: Irminger Sea/Southern Ocean/Argentine Basin/Station Papa										
CTDGV	Profiler	0-200	3 d	30 min	1 s	12 h	30 min	1 s	4	Samples on dive only. Data decimated temporally and by column
DOSTA	Profiler	0-200	3 d	6 s	2 s	12 h	6 s	2 s	4	
FLORT-O	Profiler	0-200	3 d	30 min	1 s	12 h	30 min	1 s	2	
FLORT-M	Profiler	0-200	3 d	30 min	1 s	12 h	30 min	1 s	2	
PARAD	Profiler	0-200	3 d	30 min	1 s	12 h	30 min	1 s	2	
NUTNR	Profiler	0-200	3 d	30 min	1 s	12 h	30 min	1 s	2	
Flanking Moorings: Irminger Sea/Southern Ocean/Argentine Basin/Station Papa										Decimated data telemetered via glider mule once every 3 days
ADCPS	Fixed Depth	600	6 h	216 s	8 s	1 h	216s	8 s	Variable	Each profile consists of 27 pings 8 seconds apart.
CTDMO	Fixed Depth	30 - 1,500 (12 depths)	6 h	1 s	0.25 s	15 min	1 s	0.25 s	Variable	1 second average over 4 Hz.
DOSTA	Fixed Depth	30	6 h	6 s	2 s	15 min	6 s	2 s	Variable	
FLORT	Fixed Depth	30	6 h	5 s	5 s	15 min	5 s	5 s	Variable	Each sample is an average of 18 values at 4 Hz.
PHSEN	Fixed Depth	30	6 h	3 min	3 min	2 h	3 min	3 min	Variable	Begins sample collection immediately, requiring 3 minutes to equilibrate and process 23 1.5 s pump cycles into a single record.

Instrument	Platform	Depth (meters)	"Baseline"			"As-deployed"			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
Flanking Moorings: Irminger Sea Only										No telemetered data; Downloaded post-recovery
OSNAP CTDMO	Fixed Depth	1500-2800	NA	NA	NA	7.5 min	1 s	0.25 s	0	1 second average over 4 Hz
OSNAP VELPT	Fixed Depth	1500-2800	NA	NA	NA	1 h	30 s	1 s	0	Each sample is an average over 30 seconds, with individual pings one second apart.
Open Ocean Gliders: Irminger Sea/Southern Ocean/Argentine Basin										
CTDGV	Hull	0-1,000	Continuous	Continuous	2 s	Continuous	Continuous	2 s	4	Samples on dive only every second dive. Data decimated temporally and by column
DOSTA	Hull	0-1,000	Continuous	Continuous	2 s	Continuous	Continuous	2 s	4	
FLORD	Hull	0-1,000	Continuous	Continuous	1 s	Continuous	Continuous	1 s	2	
Surface Mooring: Irminger Sea/Southern Ocean/Argentine Basin										DCL's are on continuously, 100% of data is telemetered
METBK	Buoy tower	In Air	2 h	1 h	1 s	1 min	1 min	1 min	100	Continuous sampling, heater on port 07, not easily configurable to alternate rates. Includes sea surface temperature and conductivity measurements.
FDCHP	Buoy tower	In Air	2 h	20 min	0.1 s	1 h	20 min	0.1 s	100	100% of processed science data is sent via telemetry. Raw science data and engineering data are downloaded post-recovery.
SPKIR	Buoy tower	In Air	2 h	3 min	1 s	15 min	3 min	1 s	100	
WAVSS	Buoy	1	4 h	20 min	0.25 s	1 h	20 min	0.25 s	100	Minimum 20 min BD at 4 Hz to get meaningful wave spectra. 100% of processed science data sent via telemetry. Raw science & engineering data downloaded post-recovery.
DOSTA	Buoy	1	2 h	3 min	2 s	15 min	3 min	2 s	100	Turn on every 15 ms for 3 min duration
FLORT	Buoy	1	2 h	3 min	1 s	15 min	3 min	1 s	100	

Instrument	Platform	Depth (meters)	"Baseline"			"As-deployed"			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
OPTAA	Buoy	1	4 h	4 min	0.25 s	1 h	4 min	0.25 s	100	One sequence = signal & reference counts for absorption and attenuation. Sequence takes ~250 ms to complete. High sample rate, large data record per sample, high power draw = long BI (1 h) and short BD (2 min).
NUTNR	Buoy	1	2 h	12 s	1.5 s	1 h	12 s	1.5 s	100	Lamp limit at BD=12 sec is (50 h*60 min*60 sec)/12 sec = 15,000 samples
PCO2A	Buoy	In Air, 1	4 h	6 s	2 s	1 h	48 s	2 s	100	Requires 20 min startup at low power. Alternates between air and water samples. Limited sampling options: 6h, 3h, 1h, continuous. "baseline" BD=3 samples at 2 s = 6 s; "as-deployed" BD=5 samples at 2 s = 10 s. Alternating air and water samples
CTDBP	NSIF	12	2 h	3 min	0.25 s	15 min	3 min	10 s	100	
FLORT	NSIF	12	2 h	3 min	1 s	15 min	3 min	1 s	100	
VELPT	NSIF	12	2 h	5 min	1 s	15 min	5 min	1 s	100	"Measurement Load" parameter controls the number of samples within the SI. Maximum load (100%) represents 23 pings/sec/beam, minimum is 1 ping/sec/beam (4%). Higher load = better precision but high power drain. Suggest "baseline" =4%, "as-deployed" =100%.
DOSTA	NSIF	12	2 h	6 s	2 s	15 min	3 min	2 s	100	
OPTAA	NSIF	12	4 h	4 min	0.25 s	1 hr	4 min	0.25 s	100	See OPTAA note above
SPKIR	NSIF	12	2 h	3 min	2 s	15 min	3 min	1 s	100	
NUTNR	NSIF	12	2 h	12 s	1.5 s	1 h	12 s	1.5 s	100	See NUTNR note above
PCO2W	NSIF	12	2 h	3 min	1.5 s	2 h	7 min	7 min	100	Reagent-limited; Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample

Instrument	Platform	Depth (meters)	"Baseline"			"As-deployed"			Percentage Telemetered	Comments
			BI	BD	SI	BI	BD	SI		
PHSEN	Mooring riser	20, 100	3 h	3 min	1.5 s	1h	3 min	3 min	100	PHSEN flush/pump cycle=180 sec, measurement portion is 23 pump cycles at 1.5 s/cycle. Battery powered.
CTDMO	Mooring riser	20-1500 (10 depths)	1 h	1 min	10 s	7.5 min	1 min	10 s	100	Battery powered.
CTDBP	Mooring riser	40, 80, 130	2 h	3 s	0.25 s	1 hr	1 s	0.25 s	100	3 second average over 4 Hz Battery powered.
DOSTA	Mooring riser	40, 80, 130	2 h	6 s	2 s	1 hr	1 s	1 s	100	Connected to CTDBP
FLORD	Mooring riser	40, 80, 130	6 h	1 min	4 s	1 hr	1 s	1 s	100	Connected to CTDBP
PCO2W	Mooring riser	40, 80, 130	2 h	3 min	1.5 s	2 h	7 min	7 min	100	Reagent-limited; Run pump for 5 s (collects sample), wait 5 min for equilibration, process sample . Battery powered.
ADCPS	Mooring riser	500	3 h	5 min	1 s	3 h	2.87 min	2.15 s	100	Each measurement = 80 ping ensemble average. Battery powered.

4.4.5 Mobile Platform Operation

4.4.5.1 Gliders

At each global array, OOI will deploy three Open Ocean gliders and one or two Global Profiling gliders. The pivotal sampling regime for the Open Ocean Gliders will be to circulate around the array and collect inter-mooring science profile data across a range of time and space scales. The secondary sampling scheme is to acquire data from subsurface moorings by means of acoustic modems. Pivotal Open Ocean glider missions will collect at least 1 profile to 1000 meters every 3 days (sensor list Table 11). The default missions will collect 4 profiles to 1000 meters each day and sample inter-mooring meso- and large-scale variability around the perimeter of each array, sustain OOI approved data sampling and delivery rates, and retrieves and transmits data from moored instruments via acoustic telemetry. Default missions for Global Profiling gliders will sustain a minimum of 4 vertical profiles per day to 200 m near the hybrid profiler mooring. The sensor sampling frequencies will be consistent with 3304-00011 Glider Logistics Operations and Refurbishment Plan

For use in the Global Array, the Open Ocean gliders will carry a multi-disciplinary sensor payload (Table 11). The Default sampling strategy will be to operate all science instruments at their maximum sustainable sampling frequencies during profiling, but this strategy will be continually evaluated for the optimum balance between data collection and battery life. The gliders will routinely dive 1000 m depth and return to within several meters of the sea surface. Multiple profiles may be executed before surfacing for a location fix and data telemetry. While sensor sampling frequencies are expected to be fixed, not all sensors will operate for all portions of all profiles.

The science instruments on an Open Ocean glider are a Sea-Bird conductivity, temperature, and depth (CTD) instrument; a WET Labs Environmental Characterization Optics (ECO) triplet, which measures chlorophyll and optical backscatter; and an Aanderaa 3835 dissolved oxygen (DO) sensor. The CTD, ECO triplet, and DO will sample over the gliders full profile range.

In addition to the instruments noted above, Global Profiling gliders will carry Satlantic nutrient samplers (SUNA), and Biospherical photosynthetically active radiation (PAR) sensors. All sensors will be turned on over the first 200 m of each profile, but will be turned off at greater depths to minimize energy consumption. The profiling strategy is listed in Table 12 for both types of gliders.

Open Ocean gliders will approach each Flanking mooring and the Hybrid Profiler mooring in turn and download data using the acoustic modem. The modems communicate at 600 baud. After establishing the link, the glider modem makes requests for a sequence of discrete data blocks. Failed block transfers get requested again until they timeout and end the mission. There are energetic penalties to starting the glider mission, establishing the link, handling transfer of each block, and reporting the result. The data rate is variable and depends on the signal to noise ratio (SNR) present at each location. The total data volume throughput depends on a number of internal factors (e.g how the firmware handles errors) and external factors (weather, glider motor noise). The mooring modem microcontroller aggregates decimated data from the instruments and stores it for transmission. The modem system is designed to achieve at least 50 Kbytes/hour. Each mooring will accumulate approximately 5-10 Kbytes of instrument data each day. Three gliders permit a visitation schedule of approximately once every three days for each moorings.

Table 11. Open Ocean and Global Profiling Glider Sensors and Sampling Frequency

Sensor	Description	Frequency
CTD	Sea-Bird Slocum Payload CTD	0.5 Hz
DO	Aanderaa Oxygen Optode 3835	0.5 Hz
ECO	WET Labs ECO FLBBCD-SLK	1 Hz
ECO	WET Labs ECO BB3	1 Hz
PAR	Biospherical PAR	1 Hz
SUNA	Satlantic Nutrient sampler	1 Hz
ATM-900	Benthos Acoustic Modem (Open Ocean gliders)	NA

Table 12. Profiling Strategy

Sensor	1000 m Profiling	200 m Profiling
CTD	full depth, dive only, every 2nd profile	200 m dive only, every profile
DO	full depth, dive only, every 2nd profile	200 m dive only, every profile
ECO(s)	full depth, dive only, every 2nd profile	200 m dive only, every profile, both ECO sensors
PAR	2nd 0-200 m, dive only, every profile	200 m dive only, every profile
SUNA	NA	200 m dive only, every profile

Table 13. Sensor Degradation Strategy

Glider Sensor	Draw (amps)	As-Deployed	Setting 1	Setting 2 (baseline)	*Setting 3*	Setting 4
SUNA	1.0	100%	0%	0%	*0%*	0%
Biospherical PAR	0.05	100%	100%	50% (every 2nd dive)	*0%*	0%
Sea-Bird CTD	0.14	100%	100%	50% (every 2nd dive)	*100%*	0%
ECO Triplet FLORD-M	0.49	100%	100%	50% (every 2nd dive)	*0%*	0%
ECO Triplet FLORT-M	0.49	100%	100%	50% (every 2nd dive)	*0%*	0%
ECO BB3 FLORT-O	0.49	100%	100%	50% (every 2nd dive)	*0%*	0%
Aanderaa Optode	0.1	100%	100%	50% (every 2nd dive)	*0%*	0%
Benthos ATM Modem	Variable	100%	100%	50%	*0%*	0%
Argos Beacon	1.66	100%	100%	100%	*100%*	100

The as-deployed configuration is 100% sampling down to 200 m during the dive. If, within the first quarter or half of a deployment interval, it appears from the battery data as though the glider will not be able to meet the longevity goals, the sampling will be reduced by turning off sensors in the order specified in Table 13.

Power will be reduced to Setting 1 (SUNA off) and then to Baseline (SUNA off, all other sensors every on every 2nd dive). In case of power loss or malfunction, individual sensors can be turned off in a further series of pre-selected settings that can be implemented by glider operators in coordination with system engineers (red and black). Red level reductions require contact with SE, and automatically trigger recovery plans. Setting 4 is an emergency recovery mode with only the ARGOS transmitter running.

Power consumption will only be reduced by turning off a sensor, not by reducing sampling rates, and only towards the end of a glider transect. It is important to keep the full suite of water property data as long as possible, as it will be very difficult for users to constantly adjust their processing and visualization programs to multiple data sets that can change in mid-transect. The CTD is both a science and an engineering sensor, and provides backup estimates of pressure as well as density, which is important in terms of the glider buoyancy.

The Benthos modem is utilized during each visit to a mooring site. At least one acoustic communication attempt is made per visitation. Power available for communication efforts is regulated by the daily power availability and extra attempts can be made at the discretion of the pilot. Extra communications attempts will impact the ability to sustain science profiles for the full year.

5 Adaptive Sampling

Adaptive scenarios are possible that address both event-driven and researcher-defined science. Since the fixed instruments are operating close to or at the maximum instrument capacity, the most significant opportunities for additional sampling are likely associated with instruments on mobile platforms (profilers and gliders) and are defined more in terms of platform motion rather than instrument sampling frequency. Adaptive scenarios evolve with knowledge of the environment and are defined through periodic research community workshops and science requirements proposed by individual investigators.

Adaptive scenarios involving gliders center around the need to resolve evolving large- and meso-scale features passing through the global arrays as indicated by the array data and/or other observations such as satellite observations of sea surface temperature and color. For example, a portion of the 3 deployed Open Ocean gliders could be directed as needed to sampling outside of the array through nearby evolving meso-scale ocean features. The Profiling Gliders could be commanded to increase the frequency of vertical profiles by temporarily sampling all sensors on both the dive and climb phases, instead of the dive-only.

The sampling strategy of the sub-surface moorings can be changed remotely from shore using the glider as a satellite link to the sub-surface platform controller. The glider communicates with the sub-surface mooring controller over an acoustic connection. The sampling plan for each mooring can be adapted to change the sampling rates of the fixed instruments, or to change the profiling strategy or timing of the wire-following profilers. For example, the moored profilers could be instructed to sample more intensely vertical structure associated with water mass advection through the array or even loiter at key depths to capture important transitions in water properties. Finally, all mobile platforms could be instructed occasionally to perform coordinated sampling designed to validate or constrain ocean process models such as physical circulation, ecological processes, or aspects of air-sea interaction. While much of the adaptive sampling supports specific research projects, over the course of time as experience is gained regarding array capabilities and local processes, array responses could be developed that would allow it to respond automatically to evolving conditions in ways that optimize the value of the resulting data sets while preserving the long term project goals associated with “baseline” sampling.

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7 Instrument Glossary

OOI Class	OOI Series*	Instrument Name	Instrument Manufacturer	Instrument Make/Model	Array
ADCPA	M	Velocity Profiler (short range) for gliders	Teledyne RDI	Explorer DVL 600 kHz ADCP	Endurance/Pioneer Gliders
	N	Velocity Profiler (short range) for AUVs	Teledyne RDI	Workhorse Navigator 600 kHz dual	Pioneer AUVs
ADCPS	I, K	Velocity Profiler, long range	Teledyne RDI	WorkHorse LongRanger Monitor 75khz ADCP	Cabled/Endurance
	J, L, N	Velocity Profiler, long range	Teledyne RDI	WorkHorse LongRanger Sentinel 75khz ADCP	Global/Pioneer
ADCPT	A, M	Velocity Profiler, short range	Teledyne RDI	WorkHorse Sentinel 600khz ADCP	Endurance
	B	Velocity Profiler, short range	Teledyne RDI	WorkHorse Monitor 300khz ADCP	Endurance
	C	Velocity Profiler, short range	Teledyne RDI	WorkHorse Sentinel 300khz ADCP	Endurance
	D, E	Velocity Profiler, short range	Teledyne RDI	WorkHorse Quartermaster 150khz ADCP	Cabled
	F, G	Velocity Profiler, short range	Teledyne RDI	WorkHorse Sentinel 150khz ADCP	Pioneer
BOTPT	A	Bottom Pressure and Tilt	NOAA/PMEL & Oregon State University (PI: William Chadwick)	Custom	Cabled

CAMDS	A	Digital Still Camera, Uncabled	Kongsberg	0484-6002 Color Digital Stills Camera, OE10-102 P&T Unit, 2x OE11-150 Lamps	Endurance
	B	Digital Still Camera, Cabled			Cabled/Endurance
CAMHD	A	HD Digital Video Camera	SubC	Camera: 1-Cam, Pan/Tilt: PT-25 (titanium), Lamps: Aquorea LED	Cabled
CTDAV	N	AUV CTD	Sea-Bird	AUV Payload CTD	Pioneer AUVs
CTDBP	C, D, E, F, N, O	Pumped CTD	Sea-Bird	16plusV2 CTD (with various pressure housings)	Endurance/Global/Pioneer
	P	Pumped CTD with inductive modem		16plusV2 CTD with inductive modem	Global
CTDGV	M	Glider CTD	Sea-Bird	Glider Payload CTD	Endurance/Pioneer
CTDMO	G, H, Q, R	Mooring CTD	Sea-Bird	SBE 37IM CTD (with various pressure housings)	Global
CTDPF	A, B	Profiling CTD	Sea-Bird	16plus V2 CTD (with 19plus V2 profiling firmware)	Cabled/Endurance
	J			SBE 49 FastCAT profiling CTD	Endurance
	K, L			SBE 52MP CTD	Global/Pioneer
DOFST	A	Fast-Response Dissolved Oxygen (Voltage Output)	Sea-Bird	SBE 43 Oxygen Sensor	Cabled/Endurance
	F	Fast-Response Dissolved Oxygen (Frequency Output)		SBE 43F Oxygen Sensor	Endurance/Pioneer
DOSTA	D, J, L, M, N	Stable Dissolved Oxygen	Aanderaa	Oxygen Optode 4831	Endurance/Global/Pioneer
FDCHP	A	Direct Covariance Flux	WHOI and Univ. of Connecticut (PIs: Ware and Edson)	Custom	Endurance/Global/Pioneer

FLOBN	A	Benthic Fluid Flow	UCSD (PI: Michael Tryon)	Chemical and Aqueous Transport (CAT) Meter	Cabled
			UW (PI: Evan Solomon)	Mosquito	
FLORD	D	2-Wavelength Fluorometer	WET Labs	ECO Triplet-w	Cabled
	G			ECO FLBB-SB	Global
	L			FLBB(RT)D	Global
	M			ECO Puck FLBB-SLC	Global
FLORT	A	3-Wavelength Fluorometer	WET Labs	FLNTURTD (ChlA and backscatter) and FLCDRTD (CDOM)	Cabled/Endurance
	D			ECO Triplet-w	All
	J, K			ECO Triplet	Endurance/Pioneer
	M, N			ECO Puck FLBBCD-SLK for Gliders and AUVs	Endurance Pioneer Global
	O			ECO Puck BB3 for Gliders	Global
HPIES	A	Horizontal Electric Field, Pressure Inverted Echosounder	UW/APL (PI: Tom Sanford)	Custom	Cabled
HYDBB	A	Broadband Hydrophone	OceanSonics	icListen Smart Hydrophone	Cabled/Endurance

HYDLF	A	Low Frequency Broadband Hydrophone	HTI	90-U with pre-amp	Cabled
MASSP	A	*In situ* Dissolved Gas Mass Spectrometer	Harvard University (PI: Peter Girguis)	Custom	Cabled
METBK	A	Bulk Meteorology Instrument Package	Star Engineering	ASIMET	Endurance/Global/Pioneer
NUTNR	A	Nitrate Sensor	Sea-Bird (formerly Satlantic)	Deep SUNA	Cabled/Endurance
	B			SUNA V2 (formerly ISUS V3)	Endurance/Global/Pioneer
	J, M			SUNA V2	Endurance/Global
	N			Deep SUNA for AUV	Pioneer
OBSBB	A	Broadband Ocean Bottom Seismometer	Guralp	CMG-1T/5T	Cabled
OBSSP	A	Short-Period Ocean Bottom Seismometer	Guralp	CMG-1sec	Cabled
OPTAA	C	Absorption Spectrophotometer	WET Labs	AC-S deep with pump	Cabled/Endurance
	D, J			AC-S with pump	Endurance/Pioneer/Global
OSMOI	A	Osmosis-based Water Sampler	TLR, Inc.	OsmoSampler	Cabled
PARAD	A	Photosynthetically Active Radiation	Sea-Bird (formerly Satlantic)	Digital PAR-SER-1000m (formerly Digital PAR-SER-600m)	Cabled/Endurance
	J		WET Labs	ECO PAR	Endurance/Pioneer
	K		Biospherical Instruments	QSP-2200	Endurance/Pioneer
	M		Biospherical Instruments	QSP-2155	Endurance/Global/Pioneer
	N		Biospherical Instruments	QSP-2150	Pioneer

PCO2A	A	Air-Sea pCO_2	Pro-Oceanus	pCO_2-pro-ATM	Endurance/Global/Pioneer
PCO2W	A	Seawater pCO_2	Sunburst	SAMI2 CO2	Cabled/Endurance
	B, C			SAMI2 CO2, pumped	Endurance/Global/Pioneer
PHSEN	A, D, E, F	Seawater pH	Sunburst	SAMI2 pH	All
PPSDN	A	DNA Particulate Sampler	NOAA/PMEL (PI: David Butterfield) and McLane Research Labs	PPS (McLane Research Labs)	Cabled
PRESF	A, B, C	Wave & Tide Pressure	Sea-Bird	SBE 26plus Wave & Tide Recorder	Endurance/Pioneer
PREST	A, B	Tidal Seafloor Pressure	Sea-Bird	SBE 54 Tsunami Pressure Sensor (externally powered)	Cabled
RASFL	A	Hydrothermal Vent Fluid Rapid Access Sampler	NOAA/PMEL (PI: David Butterfield) and McLane Research Labs	RAS (McLane Research Labs)	Cabled
SPIKR	A, B, J	Spectral Irradiance	Satlantic	OCR507 ICSW w/ Midrange Bioshutter	All
THSPH	A	Hydrothermal Vent Fluid *in situ* Chemistry (H2, H2S, pH)	University of Minnesota (PI: Ding Kang)	Custom	Cabled
TMPSF	A	Diffuse Vent Fluid 3-D Temperature Array	RBR Global	Thermistor Array with XR-420 data logger	Cabled
TRHPH	A	Hydrothermal Vent Fluid Temperature and Resistivity	University of Washington (PI: Marv)	Temperature Resistivity Probe (ResProbe)	Cabled
VADCP	A	5-Beam, 600 kHz Acoustic Doppler Current Profiler	Teledyne RDI	600 kHz 5 Beam Workhorse ADCP (custom based on WH Monitor)	Cabled

VEL3D	A	3-D Acoustic Velocimeter	Falmouth Scientific	ACM-3D-MP	Endurance/Cabled
	B		Nobska	MAVS-4	Cabled
	C, D		Nortek	Vector 3D Acoustic Velocimeter	Endurance
	K		Nortek	Aquadopp II	Endurance/Pioneer
	L		Falmouth Scientific	ACM-Plus	Global
VELPT	A	Single Point Velocity Meter	Nortek	Aquadopp 300m Current Meter	Endurance/Global/Pioneer
	B			Aquadopp 3000m Current Meter	Global/Pioneer
	D			Aquadopp Current Meter	Cabled/Endurance
	J			Aquadopp HR with Symmetric Head	Endurance/Pioneer
WAVSS	A	Surface Wave Spectra	Axys Technologies	TRIAXYS	Pioneer/Endurance
ZPLSC	C	Bioacoustic Sonar, Coastal Uncabled	ASL	Acoustic Zooplankton Fish Profiler	Endurance/Pioneer
	B	Bioacoustic Sonar, Coastal Cabled	Kongsberg	Modified EK-60	Endurance
ZPLSG	A	Bioacoustic Sonar, Global	ASL	Modified Acoustic Zooplankton Fish Profiler	Global