Satellite Tag/Pop-Up Buoy Plan

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# Primary Goal:

Measure water conditions and productivity levels under sea ice in the Arctic. Primary interest in productivity at water/ice boundary where productivity is very high in the Spring before ice melts and ambient light levels are rapidly rising.

# Long Term Project Concept:

Develop new mooring system which is deployed during ice-free months, rests on the ocean floor until the surface above freezes, and releases “pods” which ascend through the water column to sample water at the water/ice boundary.

An ideal system would allow numerous pods to be connected to a central recording “hub” on the mooring. The hub would take periodic measurements from all of the pods while on the bottom and release individual pods at different intervals throughout the late winter and spring months. Each pod would be connected to the hub via a thin conductive wire, allowing them to transmit a vertical profile of the water column during their ascent to the surface. The pods would remain connected and transmit periodic measurements to the hub until ice movement causes the conductive wire to break and the pod to migrate away. Once free, the pods would migrate with ice floes at the water/ice boundary until ice fully melts and the pods reach the surface (if able to survive the forces of shifting ice floes).

Finally at the surface, individual pods would be able to transmit valuable data about the water/ice boundary via satellite for processing. Although unlikely, individual pods might be collected opportunistically.

During ice free months, the hub containing vertical profiles from the pods and local data about the water/ice boundary would be recovered, ensuring that significant data is recovered even if individual pods do not survive forces during ice break up.

# Satellite Tag Usage:

Investigate the feasibility of using satellite tags as the “pods.” Satellite tags have distinct advantages in that they are self-contained, pre-built units with the ability to collect oceanographic quality measurements and transmit them via satellite.

The University of St. Andrews has designed CTD/Fluorometer satellite tags which may be modified slightly to meet the specific needs of the project. We envision a Two Stage development process. Stage 1 would take place in 2015 and assess the basic software parameters, data quality, and survivability of the tags. Stage 2 would take place in 2016 and involve more substantial modification of the tags for installing customized instrumentation and allowing integration with the central mooring “hub”.

# Stage 1 – Feasibility Assessment

### **Main Goals**

* Assess survivability of pods (Do they arrive at surface after ice break-up?)
* Establish basic physical parameters (size/shape of pods, size/shape of floats, release mechanism)
* Establish software parameters (programming intervals, wet/dry sensing, transmission attempts)
* Assess data quality and identify areas of interest for future measurements
* Reduce costs by eliminating expensive instrumentation, minimizing custom modifications

### **Time Frame**

* Deploy in October 2015
* Units operational and ready by August 2015
* Pods release from mooring in January/February 2016
* Pods arrive at surface and transmit data sometime February-April 2016

### **Units**

* Approximately 4 Tags

### Sensors

* Temperature
* Depth
* PAR (non-directional)
* Multiple Wet/Dry Sensors

### Basic Program Flow

* Phase 1: On Bottom/At Depth
  + ~October 🡪 January
  + Record Periodic Measurements: ~2x per day=200 Records
* Phase 2: Ascent Through Water Column
  + ~January
  + Trigger when unit releases from Bottom
  + Rapid Sampling to Obtain Vertical Profile: 5min@~1Hz=300 Records
* Phase 3: Under Ice At Water/Ice Boundary
  + ~January 🡪 April
  + Record Periodic Measurements: ~Hourly=3000 Records
  + Record State of Wet/Dry Sensor
* Phase 4: At Surface
  + ~Anytime from February 🡪 May
  + Test wet/dry sensor? If dry, Attempt to transmit data
  + After Cut-off date (April?), attempt to transmit all data~1x per week?
  + After sending data, transmit daily position for possible recovery?

### Questions Still to Answer

* *What wet/dry sensors can we equip?*
* *How do we trigger Phase 2: Rapid Sampling for CTD Profile? (‘Burn-wire’ releases have some margin of error in time of release: +/- 2 minutes per month plus 10-20 minutes for erosion)*
* *Can we add a PAR easily/in time?*
* *What should the exact sampling rates for each phase be?*
* *What is the cost of 4 TD/PAR Satellite tags?*
* *Will a less expensive, conductive cell be available?*
* *Should we use a pressure sensor suited for more shallow depths?*
* *What additional costs do we incur from ARGOS, both in full transmit and ‘suspended’ status? How does that affect our programming for after units reach surface?*

# **Stage 2 – Full Development**

### **Main Goals**

* Develop complete hub and pod mooring system (PMEL responsible for “hub” portion)
* Assess conditions under Arctic sea ice at multiple times and locations
* Assess data quality and identify areas of interest for future measurements
* Assess survivability rates of pods

### **Time Frame**

* Deploy in October 2016
* Units operational and ready by August 2015
* Pods release from mooring in January/February 2017
* Pods arrive at surface and transmit data sometime February-April 2017

### **Units**

* Numerous pods/tags attached to several mooring hubs
* 2 types of pods
  + Most pods “simple” version (less instrumentation)
  + Fewer pods equipped with more complex instruments

### Sensors

* Temperature
* Depth
* PAR (non-directional)
* Wet/Dry Sensors
* Conductivity (Simpler Pods - New inexpensive conductive cell?)
* Conductivity (Complex pods - More precise/expensive inductive cell)
* Fluorescence (Complex pods only)

### Basic Program Flow

* Phase 1: On Bottom/At Depth
  + ~October 🡪 January
  + Record Periodic Measurements: ~2x per day=200 Records
  + Transmit Measurements to Hub via conductive wire
* Phase 2: Ascent Through Water Column
  + ~January 🡪 April
  + Trigger when unit releases from Bottom
  + Rapid Sampling to Obtain Vertical Profile: 5min@~1Hz=300 Records
  + Transmit Measurements to Hub via conductive wire
* Phase 3: Under Ice At Water/Ice Boundary
  + ~January 🡪 April
  + Record Periodic Measurements: ~Hourly=3000 Records
  + Record State of Wet/Dry Sensor
* Phase 4: At Surface
  + ~Anytime from February 🡪 June
  + Test wet/dry sensor? If dry, Attempt to transmit data
  + After Cut-off date (April?), attempt to transmit all data~1x per week?
  + After sending data, transmit daily position for possible recovery?

### Questions Still to Answer

* *What wet/dry sensors work? Do we even need them or should we just have unit ‘dump’ data periodically?*
* *What type of wire do we use for data transmission? Do pods have enough power to handle it?*
* *How will interface work between pod and hub? Can a single wire trigger the pod to release and transmit data to the hub? If not, what do we use to trigger the release?*
* *How do we isolate the circuitry on the pods to prevent short circuit/wicking/issues?*
* *What should the exact sampling rates for each phase be?*
* *Will a less expensive, conductive cell be available?*
* *What additional costs do we incur from ARGOS, both in full transmit and ‘suspended’ status? How does that affect our programming for after units reach surface?*

# Plan of Action

1. Get cost/lead time estimate for 4 tags for 2015 deployment (Temperature, Depth, and non-directional PAR)
2. Make sure long-term project is feasible (adding output data port to satellite tags). Consult with PMEL Engineering?
3. Get PO/Purchase Approval
4. Answer Design Questions listed under ‘Phase 1’ Above
5. Program/Build Units
6. Build Floats + Release System
7. (Test Deployment in Basin?)
8. Get units ready for the Bering Sea!