# HE17-01 After Action Report: NOAA

## Background for all projects:

 All NOAA projects aboard HE17-01 were funded by and a part of the ITAE program. ITAE is a joint program between NOAA’s Pacific Marine Environmental Laboratory (PMEL) and the University of Washington’s Joint Institute of Oceans and Atmosphere (JISAO). Its objective is to develop Innovative Technology for Arctic Exploration. The program is specifically targeted towards new autonomous platforms and high-resolution sensing technologies that can tackle the unique challenges of conducting research in the Arctic – notably the harsh, remote environment, the expansive area, and many extremely fine scale features.

These missions are conducted aboard the USCGC Healy because the Coast Guard’s and NOAA’s missions support each other – both are dedicated to protecting the present and future resources, environment, and economic interests of the United States. The Healy’s ice-breaking capabilities also provide unique research opportunities to conduct operations farther North and earlier in the summer than otherwise possible.

***The U.S. Coast Guard's mission*** *is to protect the public, the environment, and U.S. economic interests — in the nation's ports and waterways, along the coast, on international waters, or in any maritime region as required to support national security.*

***NOAA’s mission*** *is to understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources. Dedicated to the understanding and stewardship of the environment.*

## NOAA Glider deployments

### Section 1 – Background

One face of the ITAE program has been the development of a ‘coastal glider’, known as the Oculus Glider. It was designed and built in collaboration with the Office of Ocean and Atmospheric Research’s Autonomous Marine Sampling Technology Testbed program.

Legacy glider systems, such as the Seaglider, have been in use for nearly 30 years, but are used exclusively in the deep ocean as their buoyancy systems do not change buoyance rapidly enough to conduct shallow water dives.

The Oculus is designed for ecosystem research in shallow depths of less than 200m. This shallow water capability is critical for highly productive U.S. Arctic waters such as the Bering and Chukchi Shelves, which average 70m and 40m depth, respectively.

By using an enhanced buoyancy system, the Oculus glider can change buoyancy states 20 times faster than legacy gliders, allowing the gliders to conduct dives in shallow water. The Oculus is also 2‐3 times faster than legacy gliders, which allows for more efficient and adaptive arctic surveys.

The base sensor package on the Oculus includes CTD (conductivity, temperature, and depth), oxygen, chlorophyll fluorescence, turbidity, dissolved organic matter (CDOM) and photosynthetically Active Radiation (PAR). The sensor package provides data on the ocean physics and ecosystem of the Arctic. Placing these sensors on an autonomous glider improves spatial and vertical data resolution in the Arctic, which improves the ability to track dynamic and rapidly changing conditions in the region.

 Prior to HE17-01, the Oculus glider has undergone testing in water tanks, the Puget Sound, and one short term deployment in the Bering Sea (Spring 2017). The deployment during HE17-01 will be the first long term deployment of the Oculus glider (~ 2 months). It is scheduled to be recovered in late September or early October 2017 by the NOAA Ship Oscar Dyson.

### Section 2 – Goals

The goals for HE17-01 glider deployments were to:

1. Deploy 2 Oculus gliders in the Bering Sea at 59° 14.82’ N 170° 24.72’ W.
2. Conduct a CTD cast for data verification of the glider’s instruments
3. Stay in the vicinity for up to 12 hours until pilots on shore could confirm proper operation of the gliders

Both b) and c) were achieved successfully. One Oculus glider was deployed successfully; however, the second glider was held back from deployment. Due to a rigorous pre-launch testing procedure and communications with pilots at PMEL, a problem was identified with the unit’s pitch motor which could have caused malfunctions or failure during deployment. The unit will return to Seattle and be repaired for future missions.

### Section 3 – Overview of operations

 One day prior to arriving on station, meetings were held with the ship’s crew to determine deployment method and specific needs for personnel and ship maneuvering. Deployment via the ship’s aft A-frame was preferable because the ship was scheduled to be at the original launch point during night hours. A-frame deployment also simplified the operation and staffing, as a small boat was not needed.

 Two hours prior to deployment, thorough pre-launch checks were conducted for both gliders on board Healy. Pre-launch checks allowed pilots on shore to identify a problem with one unit’s pitch motor, so that glider was held back from deployment.

 Once on site, the glider was rigged to the aft A-frame using a slip line around the unit’s rudder and connected to a quick release. It was raised over the back deck, lowered into the water, and released from the line. The ship maintained ~0.5 knots of headway during this time, stopping propulsion just before the glider entered the water. Tag lines were used to help control the lowering. This method worked very well for getting the glider away from the ship’s hull and allowing it to drift safely away before the ship resumed using propulsion.

 After glider deployment, the ship transited 1nm away from the launch site and a CTD was conducted. 1nm was a safe distance to allow the gliders to conduct several dives without risk of surfacing under the ship. Nutrient and salinity samples were also taken at the site to be analyzed at PMEL. The CTD rosette experienced no problems with sensors or bottle closures, despite being the first cast of the field season (apart from gear trials).

### Section 4 – Conclusions

Overall, the Oculus glider deployment went very well. The Healy crew did an exceptional job of deploying the glider, a CTD was conducted smoothly, and pilots at PMEL in Seattle were able to confirm several successful dives before the Healy left the deployment site.

We had two setbacks during deployment of the Oculus gliders:

1. Upon arriving at the original deployment site and conducting pre-launch testing, pilots on shore noticed that the GPS position transmitted by the gliders was approximately 100nm from the desired deployment location. Between submission of the original mission planning document and the start of the cruise, the team at PMEL changed the desired deployment location, but communication of that update was not successfully made to the ship nor PMEL field personnel. As a result, the deployment had to be delayed until the next morning while the Healy moved to the updated location.
2. While conducting pre-launch checks of the gliders, pilots on shore also determined that one glider had an outdated version of software installed. This resulted in a delay of approximately 1 hour once on station, while communication was established with shore support and procedures for updating software could be completed.

### Section 5 – Recommendations

 Given the setbacks we had, our recommendations for future operations are:

1. Confirm any changes to mission planning are sent as soon as new information is available and confirmed by ship’s personnel.
2. Confirm locations for ALL operations with ship’s personnel prior to the start of every cruise.
3. Develop more thorough procedures for checking equipment before shipping to minimize modifications or changes to be made once on board.

Once the glider that was deployed is successfully recovered in Fall of 2017, scientists at PMEL will plan future missions for the Oculus gliders – likely in the Bering and Chukchi Seas. Improvements in sensor technology, such as a Video Plankton Recorder, are also being developed which will require testing and analysis for future missions.

For ease of operations we recommend that improved equipment is designed and provided for launching and recovering the gliders such as:

1. Sled, cradle, or frame to enable gliders to be launched from the ship’s rail without the use of an A-Frame, crane, or small boat.
2. Improved cradle, stretcher, lines, etc. for recovering gliders via small boat.

## NOAA Buoy deployments

### Section 1 – Background

2 moorings (1 surface and 1 subsurface) with scientific instruments will be deployed from the Healy in July for ~3 month deployments. Both moorings will then be recovered by another vessel in the fall before ice re-occupies the mooring site. The moorings serve as a test bed for evaluating innovative sensors and techniques for increasing the NOAA’s observational capabilities in the US Arctic. The primary areas of focus for the Prawler surface mooring (ITAE-A) are solar radiative flux, and physical and biological processes in the upper water column. The primary areas of focus for the subsurface alkalinity mooring (ITAE-C) are pCO2 and alkalinity measurements.

### Section 2 – Goals

The goals for HE17-01 buoy deployments were to:

1. Deploy a SAMI-Alk subsurface mooring in the Chukchi Sea (ITAE-C Mooring)
2. Deploy a Prawler surface mooring in the Chukchi Sea (ITAE-A Mooring)
3. Conduct a CTD cast for calibration of the Prawler and other CTD instruments
4. Collect samples during CTD cast for calibration of SAMI-Alk instrument
5. Deploy 2 ‘Pop-Up’ buoys in water <100m deep in a location covered by ice

Goals a) through d) were all completed with no setbacks. Goal e) was not possible because of ice conditions – no location with shallow water had sufficient ice coverage to deploy the ‘Pop-Up’ buoys. The Pop-Up buoys will be deployed during another cruise later in the year.

### Section 3 – Overview of operations

One day prior to arriving on station, meetings were held with the ship’s crew to determine deployment methods and specific needs for personnel, ship maneuvering, and deck equipment.

 Once on site, the SAMI-Alk subsurface mooring was deployed first. It was deployed via the ship’s A-frame using a single pick in between the SAMI and acoustic release. On the first attempt to deploy the mooring, the ship’s quick-release device did not release properly. As a result, the mooring had to be brought back on board and rigged with a Sea Catch TR-7 quick-release. The second deployment attempt went very smoothly.

 Next, the Prawler surface mooring was deployed. The deck crew connected all parts of the mooring and faked out the line and chain on the deck to avoid the need to stop off and connect separate pieces. This was possible because the depth of water in the Chukchi Sea (and subsequently the length of the mooring) is relatively shallow. This method worked very well. The surface buoy was deployed first, via the A-frame and the Prawler instrument was lowered by hand into the water while the buoy was being towed behind the ship. Once the remainder of the mooring line and chain was trailing behind the ship, the anchor was released by again using the ship’s A-frame.

 After both moorings were successfully deployed, the CTD was conducted close to the site. Nutrient, salinity, and DIC/Alkalinity samples were also taken at the site to be analyzed at a later date.

### Section 4 – Conclusions

 Both mooring deployments went very well. Fully connecting and faking out the surface mooring on the deck prior to starting deployment and hand lowering the Prawler into the water proved to be a very effective method for the length of that particular mooring. Scientists on shore were also able to verify that the equipment was operating properly after it was deployed. Both moorings are scheduled to be recovered in late September.

### Section 5 – Recommendations

Our only snag was that an improper quick-release device was used initially for the first mooring. Our only recommendation is that the ship should maintain an inventory of appropriate quick-release devices and verify the equipment is on board before any mooring cruise. The ship had already placed an order for several quick-release devices before the end of the cruise to prevent this from causing future problems.

The Prawler surface mooring continues to provide invaluable data and can hopefully deployed in future years during the ice-free season in the Chukchi.

The SAMI-Alk mooring will be analyzed and recommendations will be made after the mooring is recovered in late September.

## NOAA Buoy Recovery

### Section 1 – Background

This mooring is part of NOAA’s observational capabilities in the US Arctic to monitor the biophysical properties of the water column along the Chukchi shelf just North of Barrow. The float, scientific instruments and the associated mooring were recovered from the Healy after a ~10 month deployment. No mooring was deployed in its place.

### Section 2 – Goals

The goals for HE17-01 buoy recovery were to:

1. Conduct a CTD cast for calibration of the instruments on the mooring
2. Successfully recover the mooring and all attached instruments

### Section 3 – Overview of operations

One day prior to arriving on station, meetings were held with the ship’s crew to determine recovery methods and specific needs for personnel, ship maneuvering, and deck equipment.

Upon arriving on site, the mooring’s acoustic release was enabled and ranged to verify it was in the expected location. Next, a CTD cast was conducted close to the site. The CTD cast was done to verify the data on instruments that were recovered and account for any changes due to sensor drift or biofouling. Salinity samples were taken at the site to be analyzed at a later date. Salinity samples will also be used to calibrate the ship’s CTD to a very high degree of accuracy – necessary for detecting distinct water masses present at the site.

 After conducting the CTD, a small boat was launched in order to connect the mooring to a working line on the ship. The small boat was also launched with RDC personnel in order to conduct UUV operations concurrently with mooring recovery. When the small boat was in the water, the acoustic release on the mooring was triggered, bringing the mooring to the surface. The top float on the mooring was towed by the small boat and brought to a working line on the aft deck of the ship to begin mooring recovery. Using a combination of the A-Frame and a capstan, all line was reeled onto the ship and all instruments were recovered successfully.

### Section 4 – Conclusions

 Recovery of the 900m long mooring went well – taking just under 3 hours from when the small boat connected the mooring to the ship until all instruments and line were on deck. The main challenge in this situation is that the ship could not power both the A-Frame and capstan simultaneously, requiring the crew to switch power back and forth between the two during various stages of recovery and rigging gear. This added some time to the recovery, but the crew did an excellent job of communicating what needed to be done and conducting every part of the operation safely as several deck force members had been involved in Woods Hole mooring operations in the past.

### Section 5 – Recommendations

 After data from the various instruments on the mooring is analyzed, further decisions about research opportunities at the site will be made.

 For future operations, it may be useful to have pictures or video of previous recovery operations to facilitate communications and planning about the recovery with the ship’s crew.