Studying Ice Shelves in the Western Ross Sea

Using Autonomous Vehicles Together to Answer New Questions

Teledyne Webb Research

Vehicles

Product:
Teledyne Webb Research Slocum Glider

Teledyne Gavia Autonomous Underwater Vehicle (AUV)

Application:
Understanding ice heat flux and its effect on the rate of ice shelf deterioration

Customer:
Alexander L. Forrest
Assistant Professor
Department of Civil and Environmental Engineering
University of California, Davis

Background:

Scientists from several major institutions around the globe led by the Korean Polar Research Institute (KOPRI) and including the University of California – Davis (UC Davis) conducted collaborative research in February 2017 in the Western Ross Sea. The goals of the expedition were broad and the expertise from the teams spanned a wide range of disciplines. Dr. Alexander Forrest headed up the group running autonomous systems both under and in front of the Nansen ice shelf in the Western Ross Sea to better understand under ice heat flux and its effect on the rate of ice shelf channeling and deterioration.

The channels are a result of melting of the underside of the ice mass caused by upwelling fresh water created from the melting ice at deeper depths. As this process continues, the channels work their way up through the ice shelf. This leads to a weakening of the ice shelf and eventual cracking and complete detachment. These large detachments, called large mass wasting events, are of significant size. A detachment occurred in April of 2016 that was roughly the size of Manhattan, about 20 kilometers long.

Prior to the use of autonomous vehicles, measurements were conducted both manually by walking out on the ice to measure ice thicknesses and also by making estimates using satellite measurements. There have also been some studies using data collected under the ice by passing submarines. All three methods are less desirable than using current AUV technologies because they are either less accurate or provide data from only relatively small sampling areas.

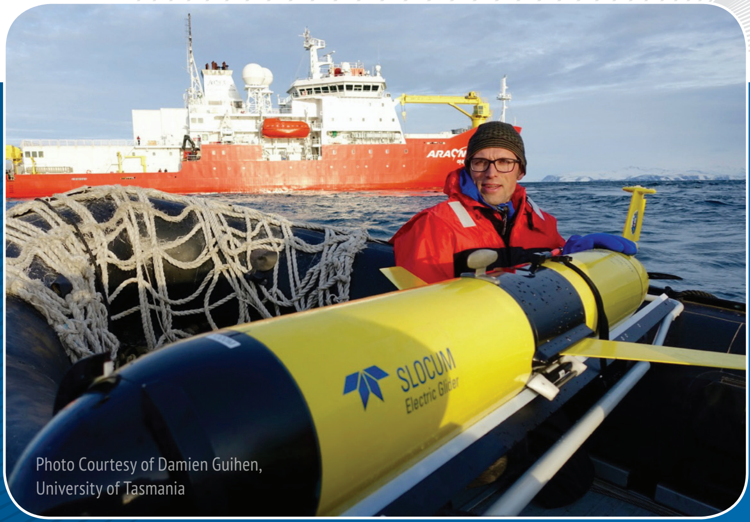

Photo Courtesy of Damien Guihen, University of Tasmania

Figure 1
Alex Forrest (UCDavis) on the final recovery of Storm Petrel at the end of a 10 day mission in Terra Nova Bay, Ross Sea Dependency, Antarctica (February, 2017).

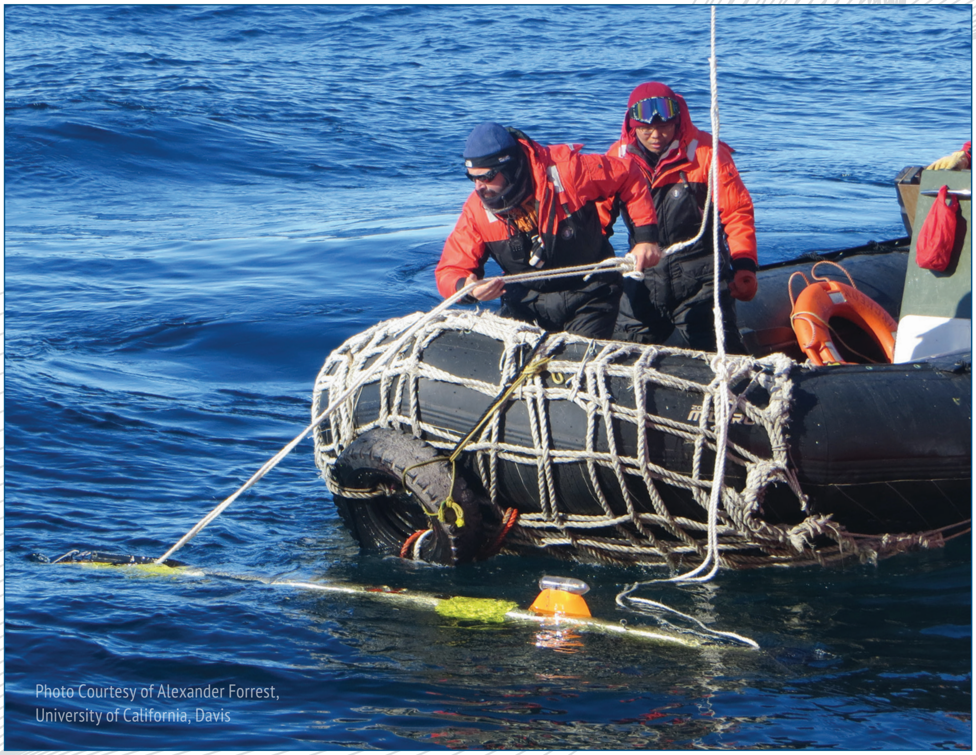

Figure 2
Damien Guihen (University of Tasmania) and Xianwei Wang (New York University Abu Dhabi) recovering UBC-Gavia after trials at the Nansen Ice Shelf, Ross Sea Dependency, Antarctica (February, 2017).

The Challenge

Forrest's team collaborated on a robotics investigation of the ice shelf using a Teledyne Gavia AUV from the University of British Columbia, some additional Gavia AUV parts from the Defense Science Technology Group (DSTG) and the University of Tasmania, and a new Teledyne Webb Research Slocum glider recently purchased by UC Davis to support this project.

> *Ten years ago you could have just written a paper on running an AUV, but we are beyond that era now.*

Working in these remote areas and with such a large group requires significant coordination both prior, during, and after the expedition. As time in the field was limited, the goal was to capture as much high quality data as possible when the team was on and around the ice. The concurrent use of two autonomous vehicles was able to provide information about both the structure of the ice as well as properties of the water beneath that would have been difficult to obtain using other methods.

Under ice operations are fraught with difficulty and greater risk than working on the open ocean. While open water AUV operations are typically quick, working from remote ice camps that need to be moved during the mission can be time consuming. The cost of AUV investigations under ice can be less costly than using other methods too but that equation is only true if the AUV is recovered at the end of the mission, which is always a risk with any autonomous system that is operating underneath a massive body of ice. The true advantages that an AUV offer in under ice research is the reduced risk to human life, the resolution (10-20cm) that can be obtained from an AUV mounted sonar, which is unattainable with nearly any other technique, and the ability to reach locations that wouldn't otherwise be impossible to go to.

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The Mission

The team deployed the Gavia AUV in straight line runs corresponding to helicopter overflights being run by the University of Texas – Austin. The Slocum glider was also "patrolling" in front of the ice shelf looking for evidence of fresh water and capturing evidence of the change over time. While AUVs provide a snapshot look at the bottom of the ice shelf during a specific moment in the tidal range, a glider running on two week missions will hopefully capture ebbs and means during the entire tidal cycle. This could allow researchers to understand if a pulsing effect occurs that would in turn effect the rate at which the ice shelf was melting.

> *So it becomes less about the AUVs and becomes more about what the questions are and how we get to answer them.*

The Conclusion

Unmanned vehicle technology is an ever expanding and evolving industry that enables scientists and engineers to reach never before explored locations and depths, and gather more accurate data, than was possible in the past. The evolution and reliability of the vehicles give researchers the ability to multi-task, running a wide range of systems simultaneously and therefore, increasing their ability to collect data.

"Even though they are not necessarily working together, the Gavia AUV and Slocum glider are working coincidentally and for me, these are tools," explained Forrest. "It becomes less about running an AUV. Ten years ago you could have just written a paper on running an AUV, but we are beyond that era now. I think the technology is robust enough that now I want to be able to say that we are going out and addressing a problem and we are using technologies that enable us to address that problem and we are running them together. So it becomes less about the AUVs and becomes more about what the questions are and how we get to answer them," concluded Forrest.

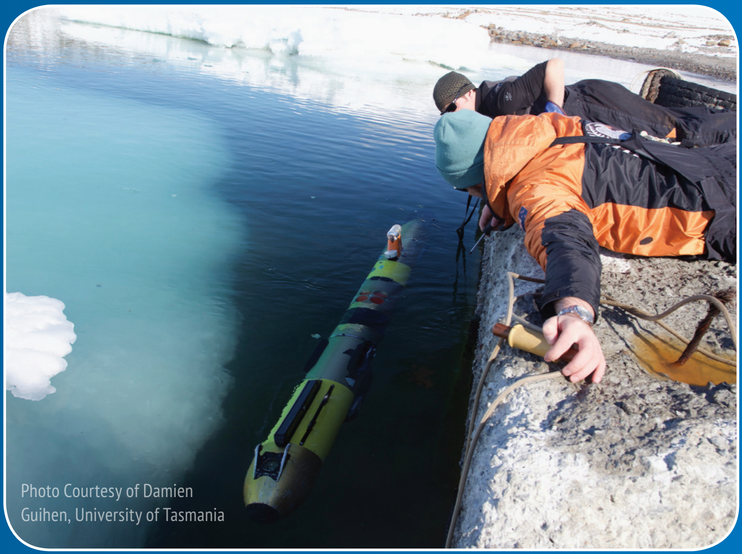
Photo Courtesy of Damien Guihen, University of Tasmania

Figure 3
Nathan Kemp (Blue Ocean Monitoring, Australia) and Alex Forrest (UCDavis) conducting ballasting trials of UBC-Gavia at the Korean Jang Bogo Station, Antarctica (January, 2017).

Figure 4
Aerial image of the Korean icebreaker, the R/V Araon, stationed near Jang Bogo Station, Antarctica (January, 2017).

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