<u>Using Seaglider data to observe submesoscale and mixed layer processes in the Southern Ocean – Drake Passage</u>

Louise Biddle, University of Gothenburg

A progress report

Acknowledgement

I would like to express my thanks to Antarctic Science Ltd. for their support for this research project through the International Bursary scheme. This support enabled me to join a multi-institutional campaign and contribute infrastructure, building new collaborations and learning new skills. It has directly contributed to my ability to offer Masters projects to students, thereby also enhancing my supervisory/educational development.

Introduction

The Southern Ocean plays a critical role in the global climate system by being a hotspot for the transport of heat and carbon from the atmosphere through the surface mixed layer and into deeper bottom layers, where it can remain for centuries. Deepening or shoaling of the mixed layer results in the transport of properties between surface and intermediate waters, and so the variability in the mixed layer depth must be understood on multiple time and spatial scales.

In recent years, the impact of submesoscale mixing on this vertical transport in the global ocean has been demonstrated through both modelling and some observational studies, and may be of equivalent, or greater, magnitude than mesoscale eddies. However, due to the time and space scales this type of mixing occurs at – hours or days and less than 5 km spatial scales in the polar oceans – it has been difficult to observe around the Southern Ocean without high resolution observations.

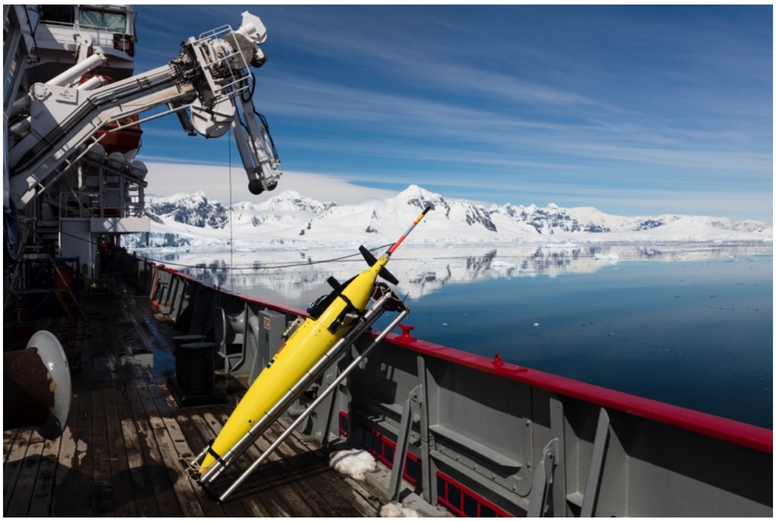

Figure 1: A Seaglider leaning against the RRS James Clark Ross before deployment

The ORCHESTRA project, led by the British Antarctic Survey (BAS) in collaboration with multiple UK and international partners, aimed to advance our understanding of this heat and carbon exchange, using a combination of cutting-edge observations and climate simulations.

The support from Antarctic Science Ltd allowed me to participate in the fieldwork of this project and enhance the existing observational plan by providing an ocean glider to collect high resolution observations over a 2 month period from November 2017 – February 2018. It further developed into a Masters project that I supervised, validating a novel sensor to detect wind speeds.

Fieldwork summary

The study region was focused on the southern boundary of the Drake Passage, off from the NW Antarctic Peninsula. This was chosen as a hotspot of possible vertical transport due to the dynamics associated with the flow of the ACC through Drake Passage. The project was designed to assess how the mixed layer varies in this region over the summer period, and what the main drivers are: in a region impacted by mesoscale eddies, alongside strong atmospheric forcing, what impact do submesoscale eddies have?

To answer this question, a total of 5 ocean gliders (4 Slocums and 1 Seaglider) were deployed to map on both submesoscale and mesoscale transects. In tandem to the underwater gliders, an uncrewed surface vehicle (Waveglider) was deployed to collect atmospheric measurements. The deployments went smoothly and collected 2-3 months of data before the gliders were collected by a later cruise.

The fieldwork also provided the opportunity to test a novel sensor to detect wind speeds underwater in collaboration with PhD student Pierre Cauchy (University of East Anglia). Passive acoustic sensors (PAM sensors) are traditionally used to detect and record marine mammals, understanding their foraging styles and the habitats they favour. However, the sound pressure at certain frequencies can also be equated to surface wind speeds. As this fieldwork component involved a Waveglider being deployed in the immediate vicinity, recording wind speeds from the surface, it provided a unique opportunity to validate the PAM sensor.

Project summary

Analysis work is ongoing in conjunction with Alex Brearley at BAS. The initial datasets proved complex to process and calibrate across the gliders and has required close collaboration and problem solving. However, initial results are indicating that there are interesting stories to be told with this data. Most notably, that we see a clear shift across all gliders in the mixed layer dynamics a few weeks into the deployment. By combining our unique set of atmospheric and oceanic observations we hope to elucidate the main driver for this regime shift.

The validation of the PAM sensor for wind speeds created a focused Masters project for student Hanna Rosenthal at the University of Gothenburg, who showed that it performed well when compared to the Waveglider and ERA5 reanalysis data in the region. Whilst this work has not been published, it has been referred to in both PhD theses and in future research proposals.

The opportunities that this project support gave me, to not only participate in a multi-institutional campaign but also create a new side project that led to a Masters dissertation, were (and are still) invaluable. I developed my leadership skills through planning fieldwork strategies, and the collaborative work involved has expanded my scientific network. I became a lead supervisor for a Masters project for the first time and enjoyed developing another student's toolbox for their future academic career. In addition to these personal and professional developments, there are two papers in progress that we expect to be published in the next year.

Dr Louise Biddle
louise.biddle@gu.se